ctc technology & energy

engineering & business consulting

Fiber Business Plan and Feasibility Study

Prepared for the City of Wilsonville, Oregon
August 2017

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Contents

Figures

Tables

1 Executive Summary

In 2016, the City of Wilsonville, Oregon (City) engaged CTC Technology & Energy (CTC) to develop a strategic and business plan for its dark fiber network—fiber-optic cabling that has been put in place by the City for its own use, or to be potentially leased to others.[1] Additionally, CTC was asked to conduct a high-level assessment of the costs for the City to expand its dark fiber footprint and explore deployment of fiber-to-the-premises (FTTP) infrastructure in Wilsonville.

The City has been methodically constructing and administering dark fiber for several years, slowly developing a dark fiber network to provide institutional connections to key City sites. The City plans to continue this slow organic growth, and aims to understand the costs associated with expanding its existing dark fiber footprint to support connections to additional institutional locations. As national and local interest in FTTP connectivity has grown, the City also seeks to understand the potential costs and risks associated with expanding its dark fiber network to support FTTP throughout Wilsonville.

This report presents candidate network designs for expanding dark fiber and deploying FTTP. This analysis is based on discussions between CTC and the City, a high-level assessment of existing City infrastructure and assets, an evaluation of recommended technologies, financial modeling and cost projections, and an assessment of additional considerations for the City.[2]

1.1 Project Background

In 2013, the City built a fiber backbone from City Hall to the South Metro Area Transit (SMART) Central Facility, providing a route for communications between City offices. Since the completion of that initial construction, the City has constructed new connections along this backbone, including to the Clackamas County broadband network, known as the Clackamas Broadband Express (CBE). The fiber enables faster, more reliable communication between points on the network; the City now seeks to develop a strategic and business plan for its network, including an analysis of the feasibility of expanding the network infrastructure.

In investigating potential plans for the network, CTC and the City considered several potential types of network expansion, including the feasibility of expanding the current network footprint, the feasibility of leveraging the fiber for economic development purposes, and the feasibility of a potential FTTP deployment.

[1] The fiber is "dark" because it is not yet in use and has not yet been "lit" by placing network electronics on the infrastructure.

[2] The descriptions in this document are highly technical and make use of several acronyms. A glossary is included in Appendix A.

1.2 Methodology

In early 2017, CTC and the City held a series of kick-off meetings to discuss the City's goals, and engage City stakeholders in discussions to evaluate their current and future broadband needs. Through these discussions, the City and CTC developed a list of City sites to connect, separating the sites into four priority groups. This report evaluates the City's options in connecting those priorities, as well as:

- Assesses the current broadband market in the City (Section 2);
- Discusses the strengths and weaknesses of various business plans for the City's consideration (Section 3);
- Presents a high-level design and cost estimate for a City network expansion to connect all sites identified by the City (Section 4);
- Presents and discusses a financial analysis for operating the City network (Section 5);
- Presents a high-level design and cost estimate for a ubiquitous FTTP network deployment (Section 6); and
- Presents and discusses financial analyses for three potential FTTP deployment business models (Section 7).

1.3 Key Conclusions from This Analysis

CTC's in-depth analysis made clear two pertinent conclusions:

1. Though the City's current "opportunistic" strategy to connect City sites will eventually accomplish the City's goals, the total benefits of having a City network will not be realized until all sites are connected. As such, it will be in the City's best interest to consider accelerating its budget and commit to connecting all sites.
2. A ubiquitous FTTP buildout will be an expensive and risky undertaking for the City. Given the cost to deploy a ubiquitous network, and the City's current broadband market, it does not make sense for the City to pursue an FTTP buildout at this time.

1.4 Connecting Key City Locations Would Cost Approximately $2.5 Million

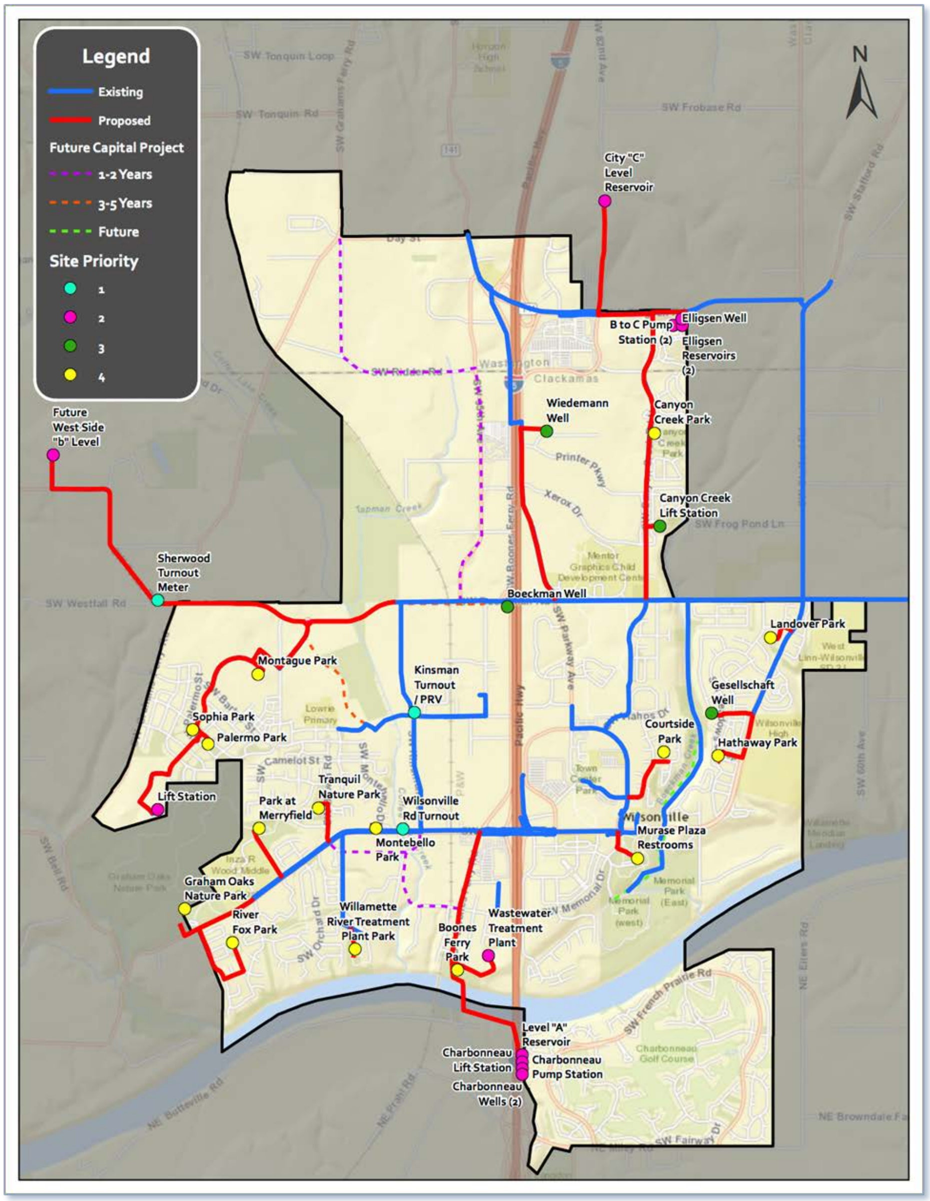
City staff identified 34 key sites that the City would like to imminently connect via dark fiber to the City's existing network. Connecting these sites, which include 18 additional water facilities and 16 City parks, would likely have two important outcomes:

1) Provide desired services at these locations; and
2) Expand the City's fiber footprint for other uses, such as strategic future growth.

This analysis projects that **approximately 11.5 total route miles of fiber would be required to connect the City's identified sites**, and CTC developed a system-level design for a fiber network expansion to reflect this. To develop a plan for connecting these key sites, and based on input from City staff, CTC engineers separated the construction into four priority sections:

- **Priority 1** includes 1.12 miles of outside plant (OSP) fiber construction to connect the Sherwood, Kinsman Road, and Wilsonville Road turnout meters.
- **Priority 2** includes 4.58 miles of fiber to connect the four Charbonneau water utility locations, the three Elligsen water utility locations, the West B Level reservoir, the North C Level reservoir, and the lift station off Grahams Ferry Road.
- **Priority 3** includes 1.38 miles of fiber to connect the wastewater treatment plant and the Gesellschaft, Boeckman, Canyon Creek, and Wiedermann wells.
- **Priority 4** includes 4.44 miles of fiber to connect 16 parks: Canyon Creek Park, Landover Park, Hathaway Park, Courtside Park, Town Center Park, Boones Ferry Park, Montebello Park, Murase Park, Tranquil Nature Park, Willamette Park, Graham Oaks Nature Park, Rover Fox Park, Merryfield Park, Montague Park, Sophia Park, and Palermo Park.

Figure 1: Map of City Network Expansion to Key Sites



This model assumed each location would receive 1 Gigabit per second (Gbps) service with network electronics capable of supporting high-bandwidth applications, such as live video, and that can be upgraded to 10 Gbps service.

The network expansion would cost approximately $2.5 million to construct and activate.[3] The estimated cost for Priority 1 and Priority 2 sites is approximately $1.3 million. The estimated cost

[3] While not fully vetted in the manner necessary for permitting and construction, this fiber optic design is likely to closely approximate a final design that meets the stated design objectives.

for Priority 3 sites is approximately $309,000. The cost to connect the City parks (Priority 4) is approximately $950,000. See Table 1, below.

Table 1: Summary of Estimated Network Construction and Electronics Costs

Cost Component	Priority 1 Sites	Priority 2 Sites	Priority 3 Sites	Priority 4 Sites (City Parks)	Estimated Cost
OSP Fiber Construction	$252,000	$953,000	$271,000	$832,000	$2,308,000
Network Electronics	22,000	75,000	38,000	120,000	255,000
Total Network Costs:	**$274,000**	**$1,028,000**	**$309,000**	**$952,000**	**$2,563,000**

The City could save as much as 75 percent on network electronics by installing equipment that offers lower bandwidth and fewer ports. However, network electronics make up only about 10 percent of the total project cost, so the impact on the overall project cost would be relatively small—and the loss of functionality and scalability would not be worth the cost savings.

CTC's financial analysis found that, to maintain positive cash flow over the course of 10 years, the City would need to receive $1,090 per month per site—or roughly $445,000 annually.[4] It is important to remember that the network proposed in this report offers the City many benefits, including a higher level of control over the network and the ability to scale the network as data demands increase. Further, the costs in this model are comprehensive, including labor, replacement electronics, and fiber maintenance costs for the lifetime of the model.

1.4.1 Any Phased Buildout Strategy Must Consider Site Dependencies

As the City plans expansion, it must evaluate which sites are dependent upon others being connected, and which can connect to existing infrastructure without further buildout. Not only will this facilitate connectivity to all sites, it will also reduce construction costs to connect the sites in question. If the City's opportunistic strategy connects two sites that are not yet connected to the overall network, neither site will receive service until one is connected back to the overall network. By strategically planning which sites to prioritize, the City can maximize the number of connected sites during the buildout process.

There are five laterals[5] in the CTC design that include site dependencies. The sites along these laterals are designed to be built together to reduce construction costs. On the lateral that extends south from the main ring, the Charbonneau area and the Wastewater Treatment plant sites are

[4] This total assumes that all 34 sites are served.

[5] A fiber cable that diverges from the main "backbone" fiber path to serve one or more sites.

dependent on the lateral to Boones Ferry Park. On the lateral that extends north to the Elligsen water sites, the C Level reservoir, Canyon Creek Park, and Canyon Creek Lift Station sites are dependent on the lateral to the Elligsen sites. On the laterals that extend west, the B Level reservoir site and the lateral that extends to the lift station off Grahams Ferry Road are dependent on the lateral to the Sherwood turnout meter. The Palermo, Sophia, and Montague Park connections depend on the lift station lateral. The lateral to River Fox Park is also dependent on the lateral to Graham Oaks Nature Park.

1.4.2 Connecting City Sites Using the City's Current Construction Strategy Would Take Decades to Achieve City Goals

To date, the City's strategy to connect City sites has been to build opportunistically, taking advantage of other infrastructure projects that require opening the ground. Capitalizing on projects already underway, the City has lowered its construction costs for building fiber infrastructure in response to its current business needs. The City has also overbuilt fiber infrastructure—placing more fiber than immediately necessary—to allow for future growth as well as opportunities to lease or swap unused fiber strands with private entities. Using strategies like these, the City continues to look for ways to leverage the fiber asset to improve the lives of the citizens of Wilsonville.

As noted, this analysis projects that it will cost approximately $2.5 million to connect all City sites. At present, the City budgets roughly $50,000 to $55,000 annually for construction to connect City sites. For the coming fiscal year, the budget has been increased to $100,000 to take advantage of additional opportunities. **If the City were to continue with the budget for this coming year, it would take roughly 25 years to realize the network in its entirety—longer than the projected lifespan of the fiber constructed in year one.** Further, it is anticipated that the City's budget will continue to fluctuate, depending on construction opportunities. This continued variance introduces a level of uncertainty that the City must consider if it elects to continue to employ this strategy.

The City's opportunistic approach also extends the time until construction to all sites is completed, which in turn extends the time the City is without the benefits of these connections or may need to pay for commercial services. Further, this strategy prevents the City from anticipating a final completion date. That is, the City will be unable to capitalize on the benefits of this network until construction is completed. If the City is dependent upon other construction projects, the benefits available to the City cannot be estimated, because the design of the network will be dependent on both the location and timeframe of other projects. The City must consider these factors against its priorities and current costs.

The network design presented in this report will enable the City to continue its building strategy. It should be noted, however, that while this strategy can reduce some construction costs, a phased build may mean that the City does not realize all the benefits of a network that may come to fruition with a more immediate build.

If the City wishes to commit to an accelerated buildout, **it could elect to budget roughly $400,000 to $500,000 annually, and complete deployment in five to six years. In that vein, the City could elect to pursue a more aggressive model, budgeting roughly $1.25 million annually to accomplish the project in two years.** Though these numbers are significantly higher than the City's current spending, they enable the City to fully realize the benefits of the network.

Given these considerations, **there will be a point, perhaps sooner rather than later, that the City's interests will best be served by accelerating the connectivity project and committing to completing this process.**

1.5 Fiber-to-the-Premises is An Admirable Goal but Such a Network Deployment Would Be an Expensive and Risky Venture for the City

For the foreseeable future, residential and business broadband needs will only continue to increase. As such, it makes little sense for the City to invest in a technology that cannot scale to meet the increased demand. In terms of capacity, scalability, and reliability, fiber-based networks are superior to all other fixed broadband technologies. Not only does fiber enable next-generation speeds coupled with the ability to scale to future data needs, but fiber also presents a solution to the network capacity limitations of copper-based and wireless technologies.

Further, FTTP network buildouts offer potential economic development benefits to the localities that deploy them—including by fostering startup companies; facilitating advanced telehealth, telework, and e-commerce solutions; and attracting and retaining businesses.[6] On the other side of that equation, a 2014 study noted a correlation between economic decline (as indicated by population growth) and those counties nationwide that are in the lowest 10th percentile of broadband access.[7]

That said, FTTP deployment can be a large financial, political, and logistical challenge. Further, models that are entirely financially dependent on competitive market forces present an increased risk to the deployer(s). As the City considers FTTP construction, it must also realistically assess the level of risk it is willing and able to tolerate. **Based on the CTC cost estimates below,**

[6] See, for example: http://internetinnovation.org/images/misc_content/Report_on_the_Economic_Impact_of_Broadband_-_Hassett-Shapiro_-_Rev_-_March_23_2016.pdf, accessed June, 2017

[7] http://www.bbpmag.com/Features/1114feature-BadBroadband.php, accessed June, 2017

this analysis projects that it would cost approximately $20.5 million to $23.7 million for the City to deploy a ubiquitous FTTP network.

These risks are illuminated as a pragmatic view of the economics and feasibility of the City deploying and operating a fiber network. No significant municipal undertaking is inherently risk-free; as such, it is advantageous for the City to understand the complete picture. Considering the financial implications, **it would be expensive and risky for the City to move forward with an FTTP buildout at this time**. These risks and other core considerations are discussed further throughout this analysis.

1.5.1 Municipal Retail Model

If the City elects to pursue a municipal retail model, in which it builds ubiquitous fiber throughout the City and provides internet, voice, and video services, it would be an "over-builder"—that is, it will build new communications infrastructure "over" existing broadband, cable, and telephone systems.

Among public sector over-builders that have pursued a retail model, most have entered the business with the expectation that theirs would be a stand-alone enterprise—one that would be able to cover its debt service, operating expenses, and expansion costs based solely on customer revenue. But municipal retail efforts have often not generated sufficient revenues to remain stand-alone enterprises.

In order to sustain itself solely on revenues, however, a stand-alone City enterprise would need to capture the majority of the voice, video, and data market in its service area. According to this analysis, the City would need to obtain $34.1 million in bonds, convince 63 percent of residents and businesses to sign up for the City's new service and retain customers (an extremely difficult level of market share to attain), and charge those customers higher monthly fees than most gigabit-speed FTTP providers charge today. Sustainability of the City's enterprise would also depend on the City maintaining its initial service prices (that is, not needing to reduce prices due to competitive market pressures); if the City were to lower its prices, the required percentage of subscribers (the "take rate") would be even higher. That is, the City could lower prices to increase the take rate, but doing so would result in an incremental decline in margins, which could mean the City was unable to cover its operating costs, and thus the fiber enterprise would no longer be sustainable.

1.5.2 Dark FTTP Lease Models

As an alternative to the municipal retail model presented above, the City could choose to pursue a dark FTTP model in which the City builds a fiber network and a private partner pays the City lease fees to use the network to provide service to residences and businesses. In this scenario, the City would need to develop a partnership with a private sector entity—ideally one that leverages each partner's strengths while sharing the overall risks of deployment.

For the City to deploy a dark FTTP network that a provider would lease, the City would need to bond either $19.1 or $22.6 million, depending on the business model chosen. As discussed in Section 7.2, the lease fees a partner would need to pay for the enterprise to operate cash-positive are multiple times higher than the fees that private-sector partners have agreed to pay in other localities. Further, the risks of the retail model would rest on the private partner. If the risk proves too burdensome, or the partner is unable to withstand competitive market pressures, the City may find itself without a willing partner.

The following report outlines the above concepts in detail. The report analyzes the strengths, weaknesses, opportunities, and threats of various models for fiber deployment that the City could choose to pursue.

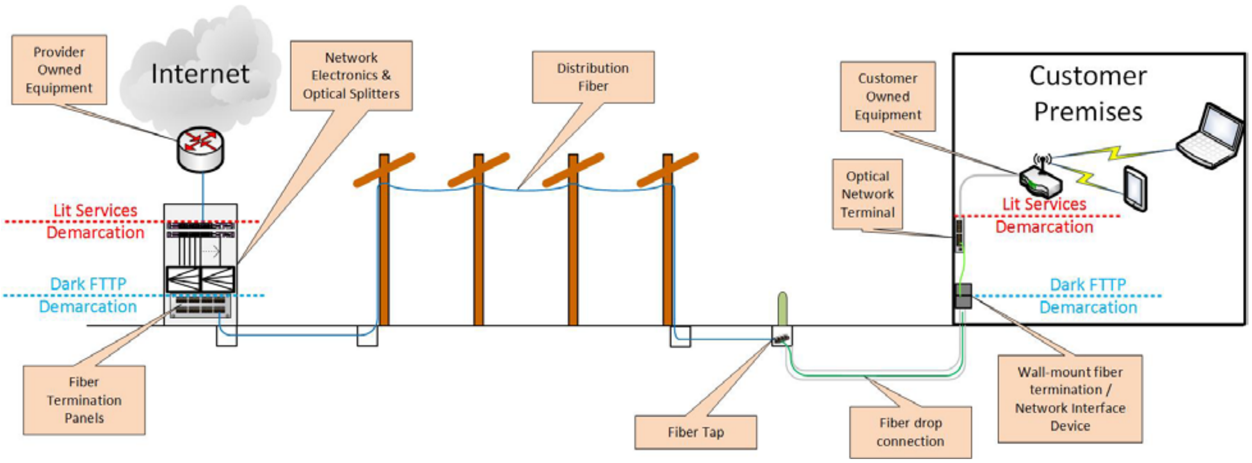
1.6 Building a Ubiquitous FTTP Network Would Cost $20.5 Million to $23.7 Million

CTC's engineers developed a sample network design for a ubiquitous FTTP network throughout the City. This analysis considered two approaches to deploying an FTTP network:

- A "lit" model, in which the City deploys all FTTP infrastructure—including all customer drop cables, network electronics, and customer premises equipment (CPE)—and serves end users
- A "dark FTTP" model, in which the City deploys a dark FTTP network and customer drop cables, and leases the infrastructure to a private partner that purchases network electronics and CPE and serves end users

This conceptual, high-level FTTP design reflects the City's goals and is open to a variety of architecture options. Figure 2 illustrates the demarcation between the City's network and a potential partner's network in the lit and dark models. In this diagram, the red demarcation line shows that in a "lit" model, the City would be responsible for all network elements between the customer-owned equipment and the internet. The blue demarcation line shows that in a dark model, the City is only responsible for the network elements.

Figure 2: Demarcation Between City and Partner Networks in the Lit and Dark FTTP Models



As outlined in greater detail in Section 6 and Section 7, this projection indicates that it will cost more than $23.7 million to deploy a ubiquitous FTTP network under a lit model in which the City directly serves end users with a 1 Gbps data service.[8]

If the City pursues a dark model in which it deploys FTTP OSP (including drop cables) but a private partner is responsible for network electronics, CPE, and for serving end users, the total deployment cost for the City would be approximately $20.5 million.

Table 2: Cost for Constructing Lit and Dark FTTP Networks[9]

	Lit Model	Dark Model
Total Estimated Cost	$23.7 million	$20.5 million

Also presented is a dark FTTP model in which a private partner would be responsible for constructing the drop cables (see Section 7.2.2).

Each of these approaches has merit, and the City will incur capital risk regardless of which model it selects. Delivering broadband service will be expensive, even if the City is deploying only the fiber infrastructure and partnering with one or more private partners to offer service over the network (i.e., the dark FTTP model).

[8] That cost estimate reflects only the cost of construction; it does not include the ongoing costs of operations.

[9] These estimated total costs assume a percentage of residents and businesses that subscribe to the service, otherwise known as the penetration rate or the "take rate," of 35 percent. Based on data CTC has observed in other markets, 35 percent is within the range of penetration rate that may exist in a market where both the cable and telephone companies also provide broadband service.

Based on CTC's analysis, if the City were to enter a public–private partnership in which it deployed a dark network and relied on a partner to deploy network electronics and CPE, the private partner would have an upfront cost of approximately $6 million (based on a 35 percent "take rate"). While $6 million is significantly less than the City's projected capital cost of approximately $20.5 million for the dark FTTP model, the partner would also be responsible for the cost associated with replenishing network electronics and CPE, which may occur every five, seven, or 10 years.

Additionally, in the dark FTTP partnership model, the City would avoid operational risk. The partner would be responsible for the costs associated with operating the network and the retail business—costs that are inherently variable, difficult to predict, and likely to be significant.

1.6.1 Assumptions That Inform This Analysis

This estimate assumes that there are 8,249 "passings" (i.e., the number of households and businesses—potential customers—that the fiber will pass) in the City of Wilsonville. The number of passings is important because it forms the basis for the entire analysis; based on the total OSP cost, this estimate projects that the network construction will cost $1,949 per passing.

CTC's engineers arrived at this number by evaluating the total number of passings in the City and subtracting the apartments and offices in large multi-dwelling unit (MDU) buildings, which are treated as one passing for this analysis. (The passing count treats single-unit buildings, individual units in small multi-business buildings, and large multi-tenant buildings as single passings.)

Among the total number of passings, only a certain percentage of residents and businesses will subscribe to services; this is known as the "take rate." Each of these subscribers will require a "drop cable" from the network to the customer premises to receive service. Both the take rate and the cost of the drop cable represent major variables in the cost of the network. This estimate anticipates that the average drop cost will be approximately $1,397. At a 35 percent take rate, this represents a cost of over $4 million for the 2,888 subscribers.

Figure 3 is a comparison of the City's OSP construction costs (per passing) to a representative sample of fiber build costs in localities nationwide. As the graph illustrates, Wilsonville's estimated $1,949 per-passing cost is higher than the majority of the examples shown here. However, the cost is in no way an outlier; average per-passing costs in six other cities are at least $849 more.

Figure 3: Cost per Passing for FTTP OSP in Localities Nationwide

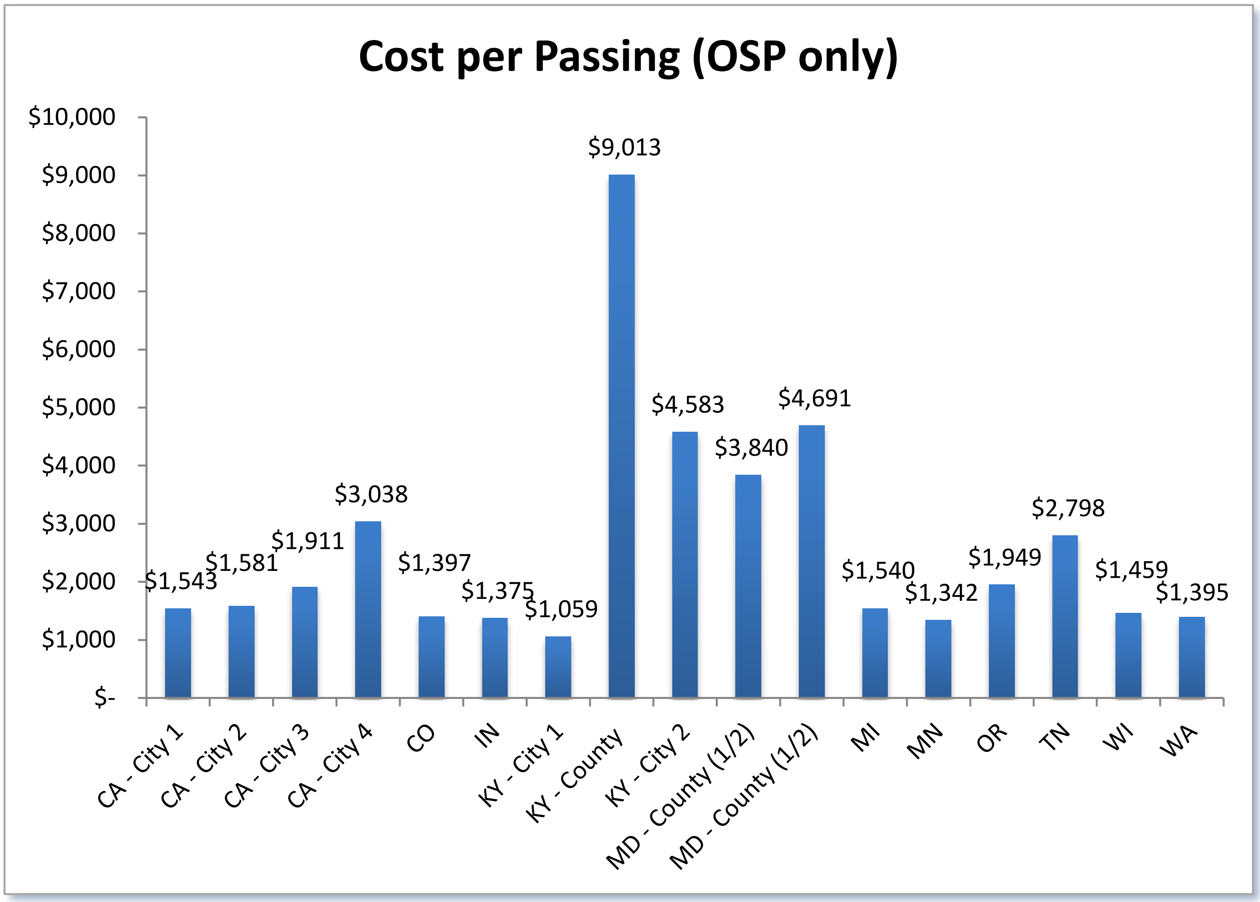
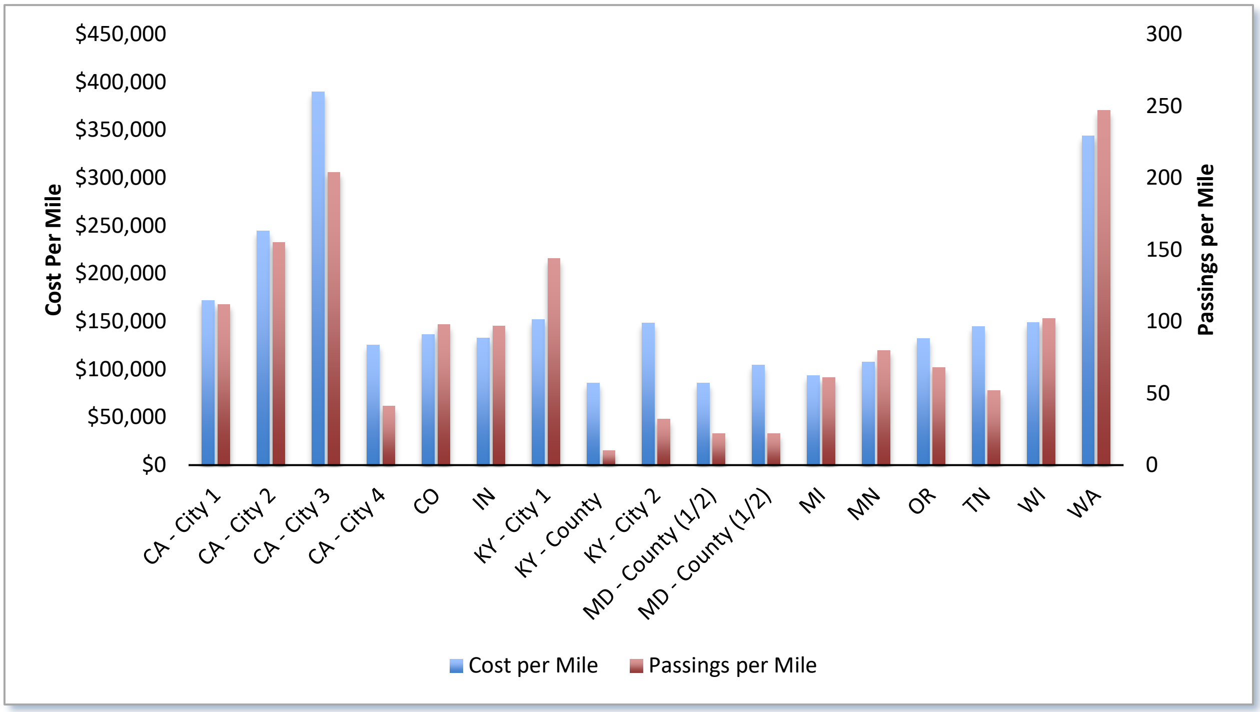


Figure 4 compares both OSP cost per mile and passings per mile in localities nationwide. Like the trend shown in Figure 3, Wilsonville's cost per mile and passing density are higher and lower, respectively, than in the majority of other localities shown. However, neither attribute is an extreme outlier.

Figure 4: Comparison of OSP Cost per Mile and Passings per Mile Nationwide



1.6.2 Lit FTTP Cost Estimate

A lit FTTP network deployment with a 35 percent take rate will cost more than $23.7 million, including OSP construction labor, materials, engineering, permitting, pole attachment licensing, network electronics, drop installation, CPE, and testing. The estimated average cost per passing is $1,966.

Table 3: Estimated Lit FTTP Cost

Cost Component	Total Estimated Cost
OSP	$16.2 million
Central Network Electronics	1.4 million
FTTP Service Drop and Lateral Installations[10]	4.3 million
CPE	1.8 million
Total Estimated Cost:	$23.7 million

[10] “Drops” connect individual customer premises to the network (i.e., the fiber cable extending from a home to the utility pole in the right-of-way). “Laterals” are cables that are considered part of the distribution fiber network, and include relatively short extensions from the backbone fiber routes and the connections to residential and commercial multi-dwelling units.

Actual costs may vary, and cannot be definitively determined until a detailed design is completed, or until construction commences. The factors that will have an impact on the total deployment cost include: 1) costs of private easements, 2) utility pole replacement and make ready costs, 3) variations in labor and material costs, 4) the amount of subsurface hard rock along the fiber routes, and 5) the City's operational and business model.

This estimate has incorporated suitable assumptions to address these items based on CTC's experience in similar markets.

The total cost of operations will also vary with the business model chosen and the level of existing resources that can be leveraged by the City and any potential business partners.

1.6.3 Dark FTTP Cost Estimate

This dark FTTP network deployment with a 35 percent take rate will cost about $20.5 million, including OSP construction labor, materials, engineering, permitting, pole attachment licensing, and drop installation. As previously noted, this estimate does not include any electronics or subscriber equipment—these costs would be incurred by the City's private partner.

Table 4: Estimated Dark FTTP Cost

Cost Component	Total Estimated Cost
OSP	$16.2 million
FTTP Service Drop and Lateral Installations	4.3 million
Total Estimated Cost:	$20.5 million

This estimate assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point (a network interface device) at each residence and business, and leases the dark fiber backbone, distribution fiber, and drop fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

1.7 A Lit FTTP Deployment Would Lead the City to a Municipal Retail Business Model

In a lit FTTP approach, the City would deploy all FTTP infrastructure—including all customer drop cables, network electronics, and CPE—and serve end users as a retail service provider. This is a high-risk and high-reward proposition, with a respectable track record in about 100 communities across the country. In CTC's observation, however, this is a difficult model to replicate, particularly for communities that do not own their own municipal electric utilities.

Some of these networks date back almost two decades; the great majority were deployed in the first decade of the 21st century. In almost every case, these networks have been deployed in towns located in largely rural areas. Some, but not all, of these towns already had cable modem service, but many of them were unserved or close to unserved by broadband service. Most of these networks were deployed by municipal electric utilities (for reasons described below).

The economics of FTTP are extremely challenging given the high capital costs and the modest revenues possible, particularly in light of competition from lesser broadband technologies. This is particularly true for local governments. Unlike other public utilities such as water and sewer, city communications networks do not operate in a monopoly environment, and several competitor technologies, however inferior, do exist. These include far-lower-bandwidth options such as DSL, cable modem service, and wireless service. These alternative technologies do not offer the same future-proof scalability and speeds as fiber, but can certainly offer robust competition with respect to price and other factors.

The most dramatic successes of municipal retail networks are in benefits that do not necessarily show up on financial statements such as enhanced productivity, innovation, education, healthcare, company recruitment, and related benefits that are among the reasons for the communications investment in the first place. Given this, even those public entities that have found it challenging to make FTTP networks self-sustaining on a balance sheet basis can still claim significant success based on these other benefits. Some call these positive externalities or ancillary benefits, but they are more central to the purpose of the network than any other factor.

1.8 A Dark FTTP Lease Model Could Enable the City to Share Deployment Costs and Risks

To frame the analysis around potential infrastructure development and collaboration between the City and the private sector, CTC considered two similar but unique partnership models. The City of Westminster, Maryland, has taken one approach in its partnership with Ting Internet. Google Fiber has taken a similar approach with Huntsville Utilities, in Huntsville, Alabama.

1.8.1 The Huntsville Utilities and Westminster, Maryland, Models

Each of these models is a “dark FTTP partnership” model, in which the City constructs and owns the fiber network, the private partner “lights” the fiber with electronics, and the private partner directly serves the end user. Each of these models entails a full FTTP network buildout, in which the City would construct and maintain ubiquitous infrastructure to every residence and business, and lease the fiber backbone and distribution fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

Where these models differ is in their treatment of drop cables, or the fiber cable that runs from the distribution fiber in the public right-of-way (PROW) into the customer’s home or business.

Because drop cables complete the connection between the customer and the "middle-mile" distribution fiber, they are frequently referred to as "last-mile" infrastructure.

In the Huntsville Utilities model, the City would be responsible for constructing backbone and distribution fiber up to the PROW, while the private partner would construct the drop cable into the home or business. Because the last-mile connection would be funded by the private partner, the number of subscribers (and thus the number of drop cables) would not affect the City's financial commitment. The partner's fiber lease payments to the City for this model would be based solely on the number of passings in the network.

In the Westminster model, the City would be responsible for constructing and maintaining both middle- and last-mile infrastructure (i.e., drop cables). Because this model presents additional cost to the City, the partner's fiber lease fees would have a two-tiered structure—one fee for the number of passings in the network and an additional fee for each subscriber. The subscriber fee would help offset the cost of the fiber drops, and would only apply to premises where drops have been constructed. Each resident or business that wishes to subscribe to the partner's services would need a City-funded drop cable installed; as such, the financial viability of the model is dependent upon the total customer take rate.

The City of Westminster negotiated a per-passing fee of $6 per customer and a per-subscriber fee of $17 per customer.

Huntsville Utilities negotiated a per-passing fee of $7.50. There is no per-subscriber fee in Huntsville because the public entity is not paying for the drop cables.

1.8.2 Per-Passing Costs and Per-Subscriber Costs

This analysis anticipates that in either a Huntsville or Westminster model, the City of Wilsonville would be able to charge its partner a per-passing fee, which is a fixed fee paid per passing per month from the private partner to the public entity. Because this fee is based on a known, fixed quantity, the incoming revenue from a per-passing fee would be predictable.

A per-subscriber fee, on the other hand, which the City would likely assess in a partnership model like the one in Westminster, would be paid to the City by its partner based on the number of subscribers that purchase service from the partner. This number would be variable and unpredictable, and would rely largely on the partner's ability to obtain and retain subscribers. The advantage of this model is that the City owns and controls the fiber to each premises.

In the City of Westminster's contract with Ting Internet, the locality negotiated a monthly per-passing fee ($6) and per-subscriber fee ($17) for dark fiber usage. That is, Ting pays the city a fee for every premises the network passes, plus an additional fee for every subscriber receiving service over the network; the fees total $6 per non-subscribed passing and $23 per subscribed passing. Because of the per-subscriber fee, the take rate is vitally important to the feasibility of the project.

In the Huntsville model, there is no per-subscriber fee, because the private partner is responsible for paying for the drop cable to connect the last mile. In its contract with Google Fiber, Huntsville negotiated a monthly per-passing fee of $7.50.

1.9 FTTP Financial Analysis

Significant financial considerations beyond construction costs will dictate the City's ability to deploy an FTTP network. This analysis examined the financial implications of deploying an FTTP network throughout the City under the lit FTTP (municipal retail) and dark FTTP models.

1.9.1 Municipal Retail Model

The financial model developed for this analysis is designed to be cash flow positive in year one; this is accomplished through bond financing. Over time, given the cost to construct, maintain, and operate the FTTP network, the model indicates that a 63 percent take rate of households and businesses passed will be required to maintain positive cash flow.[11]

This analysis assumes the City offers four data services:

- A 1 Gbps residential service at $100 per month
- A 1 Gbps small commercial service at $120 per month
- A 1 Gbps medium commercial service (with service-level agreements) at $350 per month[12]
- A 10 Gbps transport-only commercial service at $2,500 per month[13]

These prices reflect what is necessary to generate enough revenue to operate cash positive. It should be noted, however, that these prices are higher than Google's and Ting Internet's 1 Gbps services, which are $70 and $89 per month, respectively. The model assumes that subscribership for data services will ramp up over years one through four, and then remain steady.

[11] Based on the cost estimate in Section 7. Please note that these are solely financial calculations; this analysis has not evaluated whether that required take-rate is realistic.

[12] Medium commercial service receives a lower oversubscription rate, that is, less customers sharing the connection, decreasing the instances of network congestion reducing overall speeds.

[13] Transport-only service does not include DIA.

This analysis also assumes the City will offer video and data services through a service partner. The model assumes that subscribership for voice and video services will ramp up years one through four, but then decline as adoption of over-the-top (OTT) alternatives increases.

1.9.2 Dark FTTP Lease Model

This section analyzes the financial feasibility of two potential dark FTTP lease models. As with the municipal retail model analysis, the financial analysis presented here represents a minimum requirement for the City to obtain a break-even cash flow each year, given the estimated OSP construction and operating costs.

1.9.2.1 Huntsville Model (FTTP Dark Fiber Lease Not Including Drop Cable Costs)

In this modeling, CTC compared a similar FTTP deployment in the city of Huntsville, Alabama, where Huntsville Utilities negotiated a monthly per-passing fee of $7.50 in its contract with Google Fiber. The model includes this reference to demonstrate what pricing is attractive enough to incent partnership, the financial implications of that pricing, and what Huntsville pricing would look like in relation to network deployment costs for the City.

In all the scenarios evaluated in this analysis, the per-passing fees required for the City to maintain positive cash flow over 20 years are higher than the fees in Huntsville's partnership. If the City were to charge its partner lease fees similar to those paid by Google Fiber in Huntsville, the City would have an estimated cumulative cash deficit greater than $37.1 million over 20 years.

To cover construction costs and maintain a positive cash flow, the City would need to charge a private partner $30.75 per month per passing. This lease fee is 4.1 times the fee Huntsville Utilities and Google agreed upon.

1.9.2.2 Westminster Model (FTTP Dark Fiber Lease Including Drop Cable Costs)

For the base case scenario, this analysis presents what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs.

This model estimates each drop to cost an average of $1,397. If 35 percent of the City's 8,249 passings were to subscribe (2,888 subscribers), drop cost construction would total over $4 million. Though the City would be responsible for funding and constructing the drops, these costs are offset by the per-subscriber lease fees that would be the responsibility of the private partner.

To maintain positive cash flow with this model, assuming the private partner can obtain and maintain a 35 percent take rate, the City would need to charge the partner $18 per passing and an additional $51 per subscriber. These fees are three times the fees that Ting Internet agreed to pay the city of Westminster. This financial analysis also assumes that the City will cover its capital requirements through bonds. This analysis expects that the City will take will take three 20-year bonds—one each in years one, two, and three—for a total of $22.6 million in financing.

The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment. The resulting principal and interest (P&I) payments will be the major factor in determining the City's long-term financial requirements; P&I accounts for roughly 66 percent of the City's annual costs in the base case model after the construction period.

1.9.3 Additional FTTP Considerations and Recommended Next Steps

Building an FTTP network will be expensive and complex, whether the City chooses to pursue a partnership or become a service provider itself. If the City is determined to deploy FTTP, it may be prudent to do so as part of a partnership in which a private entity can share some of the risk.

That said, the lease fee that would be necessary to maintain positive cash flow in either the Huntsville or Westminster models are significant. The City would need to find a partner that would be willing to pay these fees—or the City would need to decide that a fiber deployment is important enough to warrant foregoing the recovery of its entire investment. That is, the City may determine that the "benefits beyond the balance sheet" of a fiber optic network in Wilsonville are enough to justify the difference between any per-passing costs the City can obtain from its partner and the City's total investment.

It is important for the City to consider its goals, and whether its community's needs may be met in other ways. As noted in the sections below, four internet service providers in Wilsonville offer high speeds at competitive prices to residential and business customers over cable, fiber, or both. If the needs of residents and businesses can generally be met through means other than a significant investment in municipal fiber, the City may find that it is prudent to hold off, at least temporarily, on making a significant investment in fiber infrastructure to support FTTP.

As next steps, the City should solidify its own goals, determine what it is willing and able to do, and create a clear outline of this involvement for any potential partners, if applicable. If the City determines that it will invest in an FTTP network as part of a partnership, it would be beneficial to first line up at least one private partner that will be willing to lease access to the City's infrastructure. To that end, as the City evaluates its options, it may be prudent to go through a procurement process in which the City delineates its plans and goals, and asks the private sector to respond to a set of guidelines and expectations. Such a process can establish which, if any, private providers are willing and able to partner with the City for deployment. This process might even form the basis for a long-term contract between the City and a partner.

2 Current State of the Market: Competitive Analysis

This section provides an overview of competitive providers of dark fiber and lit services for enterprise (large business) customers, and a range of broadband services for residents and small businesses in the City of Wilsonville.

2.1 Enterprise Services

CTC's research identified 11 providers in the Wilsonville region that offer a range of enterprise services, from dark fiber connectivity to data transport services, with speeds that range from 1 Megabits per second (Mbps) to 100 Gbps. (There will likely be continued consolidation of competitors through mergers and acquisitions.) These services would typically serve medium to large business customers.

While many providers do not own infrastructure in the City, they can offer lit services through agreements with other local providers. Individual providers tailor these services to customers' requirements (speed, class of service, etc.). Greater proximity of the service location to the provider's existing network infrastructure results in lower service pricing. They prefer to offer transport services between locations on their networks (on-net) and provision Multiprotocol Label Switching (MPLS) based services for connecting locations that are off-net, such as by obtaining last-mile connectivity from Comcast.

Comprehensive pricing comparisons are difficult, if not impossible, to compile for two reasons. First, service providers rarely make pricing publicly available, and will typically provide quotes only for a bona fide potential customer. Second, enterprise service providers do not have standard rates. Unlike the residential services that Frontier and Comcast deliver for a set monthly fee, enterprise services such as these are customized to individual customers' specific needs, and priced accordingly.

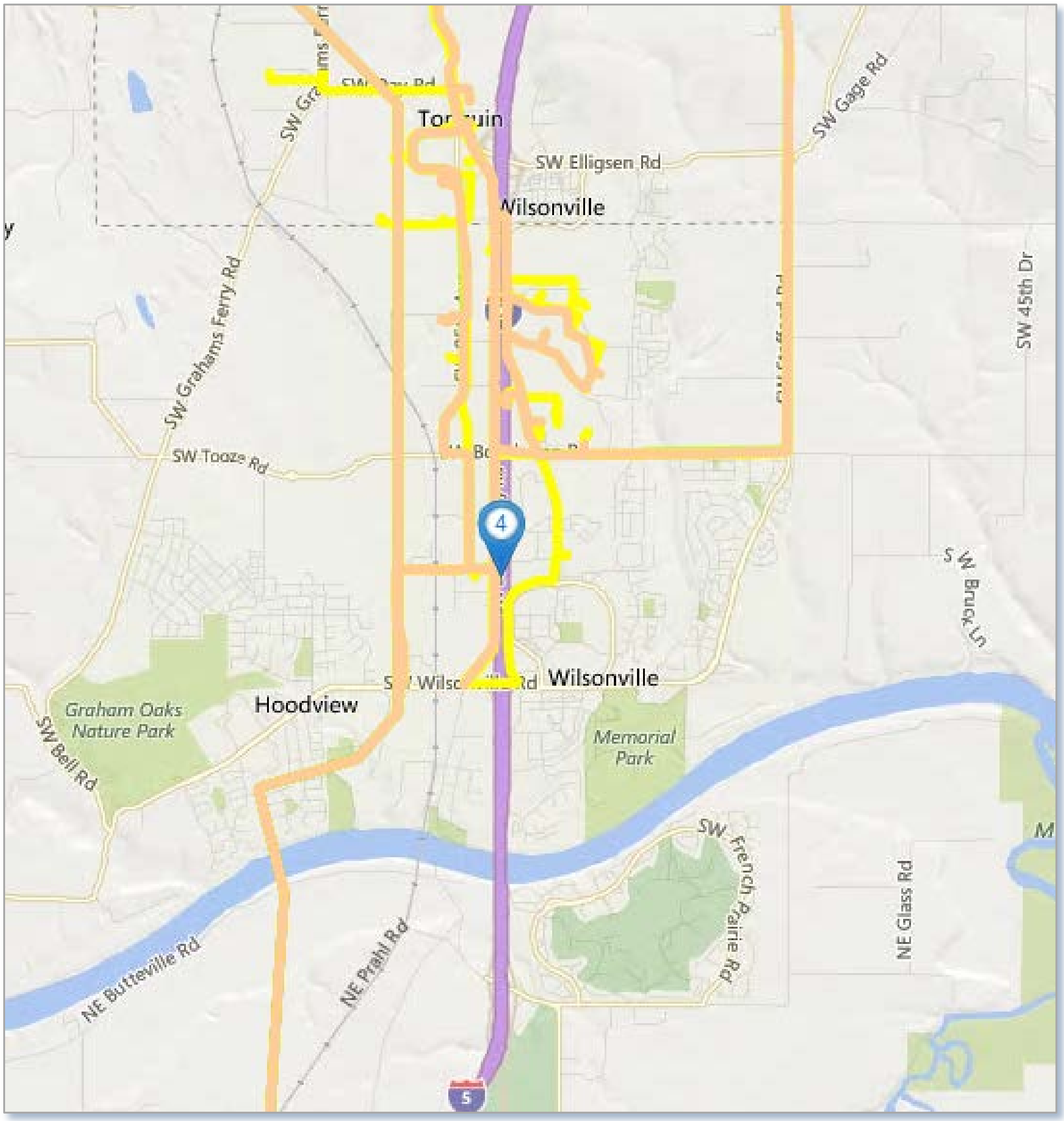
2.1.1 Dark Fiber Services

Dark fiber refers to fiber strands that are installed (e.g., in conduit or on aerial poles) but are not "lit" by network electronics. Local governments and network operators often install excess fiber to meet future needs, or install dark fiber specifically to lease to enterprise customers that have the technical capabilities to operate the fiber on their own.

Three service providers in the Wilsonville region offer dark fiber services: Electric Lightwave, Level (3), and Wave.

Electric Lightwave (formerly known as Integra Telecom) offers metro and long-haul dark fiber services within the City. They provide flexible options in securing dark fiber through bundles, lease and Indefeasible Rights of Use (IRU). The dark fiber routes are depicted in both orange and yellow in Figure 5.[14,15] Dark fiber pricing varies individually, based on distance from the provider's fiber ring. A difference in a few tenths of a mile can lead to significant differences in the price of dark fiber connectivity due to additional construction costs. As of December 2016, Electric Lightwave is being acquired by the Zayo Group.[16]

Figure 5: Electric Lightwave and Integra Network Map



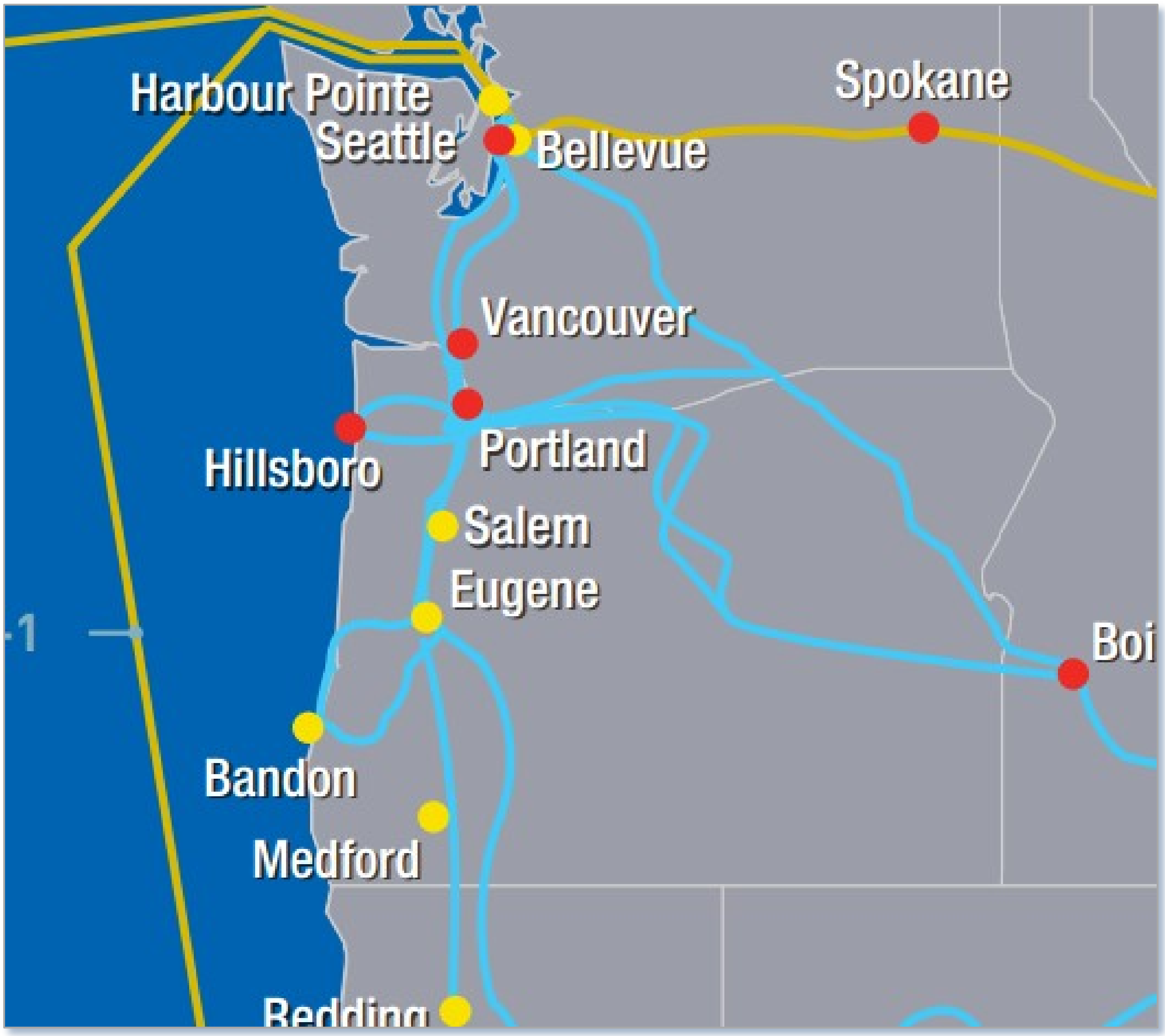
[14] Obtained from FiberLocator

[15] http://www.integratelecom.com/pages/network-map.aspx, accessed December 2016

[16] http://www.electriclightwave.com/news/press-releases/zayo-acquire-electric-lightwave/, accessed December 2016

Level(3) has dark fiber services, with regional routes depicted as blue lines in Figure 6. Services are offered only to select customers based on the provider's application requirements.

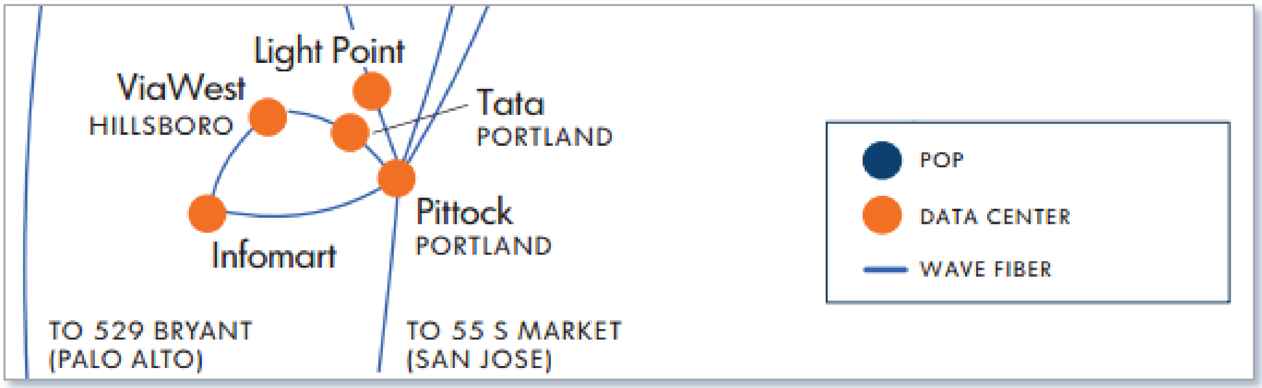
Figure 6: Level(3) Dark Fiber Routes[17]



Wave offers dark fiber access within the City with connectivity to rural and metro routes on the West Coast. A schematic of Wave's fiber routes in the Wilsonville region are depicted in Figure 7, with blue lines indicating fiber routes.[18,19]

[17] http://maps.level3.com/default/, accessed December 2016
[18] http://www.wavebroadband.com/business/, accessed December 2016
[19] http://business.wavebroadband.com/enterprise/data-solutions-fiber/dark-fiber/, accessed December 2016

Figure 7: Wave Broadband Network



2.1.2 Lit Fiber Services

Almost all existing service providers offer lit Ethernet and Dedicated Internet Access (DIA) services. Bandwidths typically range from 1 Mbps to 100 Gbps. Lit Ethernet service can be classified into three types: Ethernet Private Line, Ethernet (EPL or E-Line), Ethernet Virtual Private Line (EVPL) and ELAN. These may be known by different names among providers.

EPL is a dedicated, point-to-point, high-bandwidth Layer 2 private line between two customer locations. EVPL service is similar to EPL but is not dedicated between two locations. Instead, it provides the ability to multiplex multiple services from different customer locations onto one point on the provider's network (multiple virtual connections) to another point on the network. The ELAN is a multipoint-to-multipoint connectivity service that enables customers to connect physically distributed locations across a Metropolitan Area Network (MAN) as if they are on the same Local Area Network (LAN).

The internet services over Ethernet are typically classified under two categories: Dedicated Internet Access (DIA) and MPLS IP Virtual Private Networks (IP-VPN). Providers prefer to offer MPLS-based IP-VPN services when the service locations are off-net thus avoiding construction and installation costs. MPLS-based networks provide high performance for real-time applications such as voice and video and are typically priced higher.

The customer can choose a type of Ethernet service based on their bandwidth demands and the number of locations they would need to connect. Typically, Ethernet services are used by large business that have IT staff to manage their network.

The carriers that provide these services in the Wilsonville region are AT&T, Level (3), CenturyLink, Cogent Communications, Comcast, Frontier Communications, Electric Lightwave, Verizon, Wave Broadband, Windstream Communications, and XO Communications. Prices depend on the bandwidth, location, and network configuration; whether the service is protected or unprotected; and whether the service has a switched or mesh structure.

AT&T has four different types of Ethernet products—GigaMAN, DecaMAN, Opt-E-MAN, and Metro Ethernet. GigaMAN provides a native-rate interconnection of 1 Gbps between customer end points. It is a dedicated point-to-point fiber optic based service between customer locations which includes the supply of the GigE Network Terminating Equipment (NTE) at the customer premises. DecaMAN connects the end points at 10 Gbps and is transmitted in native Ethernet format similar to GigaMAN, only 10 times faster. Opt-E-MAN service provides a switched Ethernet service within a metropolitan area. It supports bandwidths ranging from 1 Mbps to 1,000 Mbps, and configurations such as point-to-point, point-to-multipoint, and multipoint-to-multipoint. Metro Ethernet service provides various transport capabilities ranging from 2 Mbps through 1 Gbps while meeting IEEE 802.3 standards.[20]

CenturyLink provides point-to-point inter-city and intra-city configurations for full-duplex data transmission. The company offers speeds of 100 Mbps to 10 Gbps.[21]

Cogent Communications' Ethernet services are available at speeds of 1.5 Mbps to 10 Gbps.[22] The company provides middle mile services with the last mile service provisioned through local exchange carriers (LEC) such as Comcast.

Comcast provides DIA and Ethernet services such as Ethernet Private Line. Their EPL service enables customers to connect their CPE using an Ethernet interface, as well as using any Virtual Local Area Networks (VLAN) or Ethernet control protocol across the service without coordination with Comcast. EPL service is offered with 10 Mbps, 100 Mbps, 1 Gbps or 10 Gbps Ethernet User-to-Network Interfaces (UNI) and is available in speed increments from 1Mbps to 10 Gbps.[23]

Electric Lightwave offers Ethernet services from 1.5 Mbps to 10 Gbps. The point-to-point E-Line and multipoint -to -multipoint E-LAN configurations are available.[24] Pricing for a 100 Mbps DIA service in City was quoted at $700 per month for a 60-month term.

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[20] http://www.business.att.com/service_overview.jsp?repoid=Product&repoitem=w_ethernet&serv=w_ethernet&serv_port=w_data&serv_fam=w_local_data&state=California&segment=whole, accessed December 2016

[21] http://www.centurylink.com/business/products/products-and-services/data-networking/private.html, accessed December 2016

[22] http://www.cogentco.com/en/products-and-services, accessed December 2016

[23] http://business.comcast.com/ethernet/products/ethernet-private-line-technical-specifications, accessed December 2016

[24] http://www.integratelecom.com/enterprise/products/pages/carrier-ethernet-services.aspx, accessed December 2016

Frontier Communications offers Ethernet Service, Data Private Line and Managed IP-VPN services to locations over local and long-haul routes up to 1 Gbps within the City.[25]

Level (3)'s Metro Ethernet dedicated service is available in bandwidth options of 3 Mbps to 1 Gbps and its Ethernet Virtual Private Line (VPL) offers in speeds ranging from 3 Mbps to 1 Gbps. It is an end-to-end Layer 2 switched Ethernet service delivered via a Multi-protocol Label Switched (MPLS) backbone.[26]

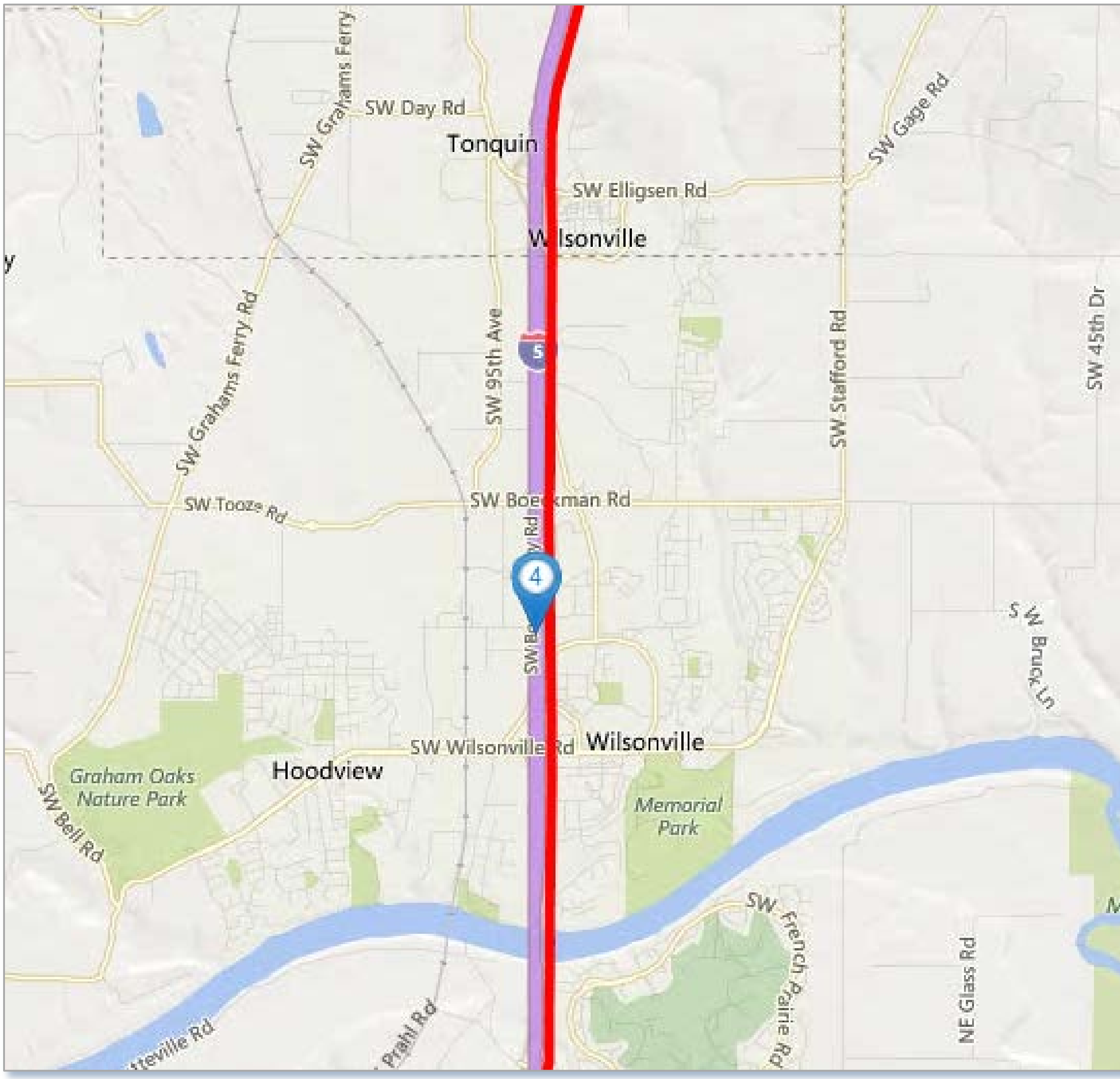
Verizon offers Ethernet services under three different product categories—Ethernet Local Area Network (LAN), EPL, and EVPL. The Ethernet LAN is a multipoint-to-multipoint bridging service at native LAN speeds. It is configured by connecting customer User-to- Network Interfaces (UNIs) to one multipoint-to-multipoint Ethernet Virtual Connection or Virtual LAN (VLAN), and provides two Class of Service options—standard and real time. The Ethernet Private Line is a managed, point-to-point transport service for Ethernet frames. It is provisioned as Ethernet over SONET (EoS) and speeds of 10 Mbps to 1 Gbps are available. The EVPL is an all-fiber optic network service that connects subscriber locations at native LAN speeds; EVPL uses point-to-point Ethernet virtual connections (EVCs) to define site-to-site connections. It can be configured to support multiple EVCs to enable a hub and spoke configuration and supports bandwidths from 1 Mbps to 1,000 Mbps.[27] Figure 8 depicts the Verizon long-haul network passing through the City, indicated by the red line along Interstate 5.[28]

[26] http://www.level3.com/en/products-and-services/data-and-internet/vpn-virtual-private-network/evpl/, accessed December 2016

[27] http://www.verizonbusiness.com/products/data/ethernet/, accessed December 2016

[28] Obtained from FiberLocator

Figure 8: Verizon Long-Haul Network through the City



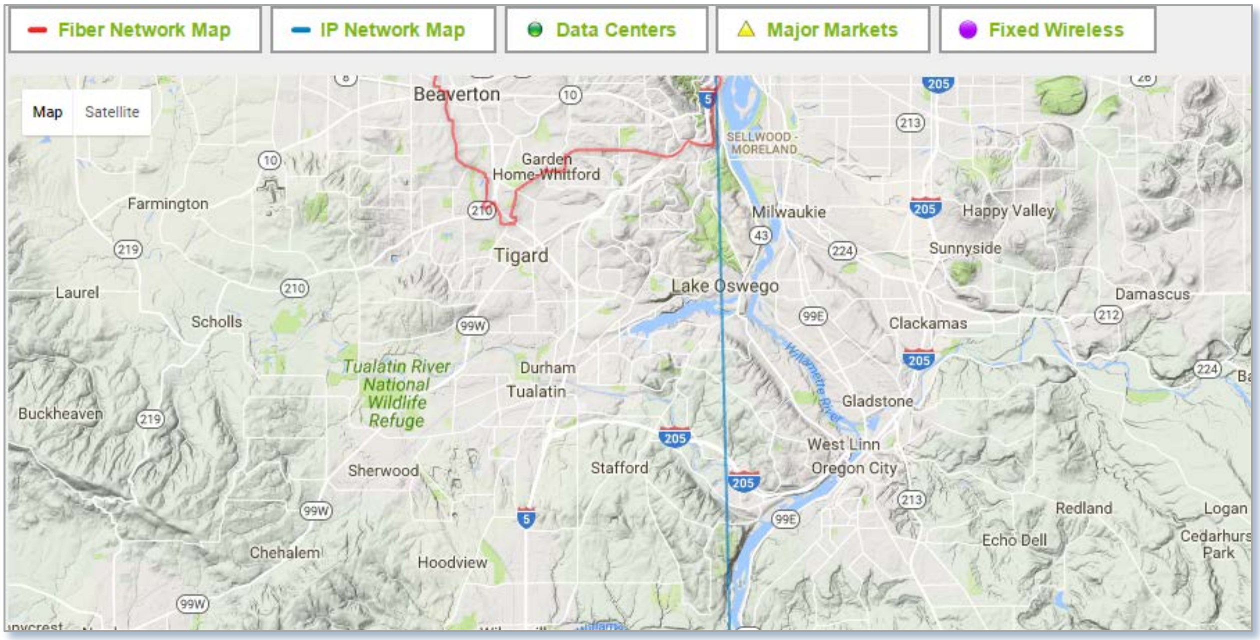
Wave provides point-to-point metro Ethernet service as well as fully managed WAN solutions that are scalable from 10 Mbps to 10 Gbps.[29]

Windstream Communications has a nationwide presence serving major metropolitan areas, including Wilsonville, with speeds up to 1 Gbps.[30] Pricing for a 1 Gbps Ethernet service in the City

[29] http://www.wavebroadband.com/business/enterprise/data-solutions-fiber/metro-ethernet/, accessed December 2016
[30] http://www.windstreambusiness.com/, accessed December 2016

was approximately $1,900 per month for a 60-month term. Figure 9 shows the Windstream network in the region, with the red line indicating a section of Windstream's fiber network.[31]

Figure 9: Windstream Network



XO Communications can offer Ethernet services at multiple bandwidth options from 3 Mbps to 100 Gbps over their Tier 1 and partnership networks.[32]

2.2 Residential and Small Business Services

Residential and small business customers in the Wilsonville region have access to a range of services, though individual service options are largely dependent on location. Table 5 lists the service providers and minimum price for each type of service that is available in at least some part of the City.

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[31] http://www.windstreambusiness.com/network-data-centers-map, accessed December 2016

[32] http://www.xo.com/carrier/transport/ethernet/, accessed December 2016

Table 5: Overview of Residential and Small Business Data Services in Wilsonville

Service Type	Provider	Minimum Price (per month)
Cable	Comcast Wave	$29.99 $39.95
DSL	Frontier	$29.99
FTTH	Comcast	$299.95
	Frontier	$24.99
	Fibersphere	Not available
Satellite	HughesNet	$49.99
3G/4G/ Wireless ISP	Cricket	$30
	Sprint	$15
	AT&T	$14.99
	Verizon	$60
	T-Mobile Online Northwest	$20 $49.95
	Freewire Broadband	Not available

2.2.1 Cable

Comcast offers internet service with download speeds from 10 Mbps to 250 Mbps starting at $29.99 per month in some locations in the City (Table 6). Promotional rates are available for the first year, after which the rates increase. Discounted prices are available if bundled with another service like voice or TV.[33] On the small business side, multiple options are available starting at 16 Mbps download speeds up to 150 Mbps download speeds, as illustrated in Table 7.[34] Bundling with voice introduces a monthly savings of $30 to $40. Comcast also offers residential fiber service, which is discussed below.

[33] http://www.comcast.com/internet-service.html, accessed November 2016

[34] http://business.comcast.com/internet/business-internet/plans-pricing, accessed November 2016

Table 6: Comcast Residential Internet—Internet Only

Package	Internet Speed	Monthly Regular Price	Monthly Promo Rate
Performance Starter	Up to 10 Mbps download	$29.99	$49.95
Performance 25	Up to 25 Mbps download	$29.99	$59.95
Performance Pro	Up to 100 Mbps download	$39.99	$74.95
Blast Pro	Up to 200 Mbps download	$49.99	$74.95
Extreme 250	Up to 250 Mbps download	$69.99	$151.95

Table 7: Comcast Small Business Internet—Internet Only

Package	Internet Speed	Monthly Price
Starter	16 Mbps download/3 Mbps upload	$69.95
Deluxe 25	25 Mbps download/10 Mbps upload	$99.95
Deluxe 50	50 Mbps download/ 10 Mbps upload	$109.95
Deluxe 75	75 Mbps download/15 Mbps upload	$149.95
Deluxe 100	100 Mbps download/20 Mbps upload	$199.95
Deluxe 150	150 Mbps download/20 Mbps upload	$249.95

Wave offers residential internet services at speeds of 5 Mbps download/1 Mbps upload (at $39.95 per month), 55 Mbps download/5 Mbps upload (at $59.95 per month), 100 Mbps download/5 Mbps upload at $69.95 per month) and 250 Mbps download/10 Mbps upload ($79.95 per month). These speeds have a 500 GB data cap. They also offer 110 Mbps download/10 Mbps upload ($89.95 per month) speed service option with a 1 TB data cap for power users. Promotional discounts for 12 month periods are available. Bundled packages also offer lower prices.[35]

Wave offers business internet services at 15 Mbps download/5 Mbps upload (at $59.95 per month), 55 Mbps download/10 Mbps upload (at $ 89.95 per month), 100 Mbps download/20 Mbps upload (at $179.95 per month) and 250 Mbps download/20 Mbps upload (at $199.95 per month). These speeds have a data cap from 300 GB to 1 TB. Promotional discounts for 2 year agreements are available. Bundled packages also offer lower prices.[36]

2.2.2 DSL

Frontier offers DSL service for residential customers in Wilsonville starting at $44.99 ($29.99 for the first year) per month for 12 Mbps download speed. The 24 Mbps speed is priced at $54.99 ($39.99 for the first year) per month.[37]

2.2.3 Fiber-to-the-Premises

Comcast, in addition to internet connectivity over coaxial cable, offers its X1 Gigabit Pro fiber service in Wilsonville to customers that are less than one-third of a mile from Comcast's fiber network. The service provides 2 Gbps speeds for $299.95 per month and requires a two-year contract plus $1,000 in up-front installation and activation fees. X1 Gigabit Pro is available for residential customers only.[38]

Frontier offers fiber-based internet at symmetrical speeds from 30 Mbps up to 150 Mbps for residential and business customers. The pricing is lower for the first year of service and is higher from the second year as shown in Table 8.[39]

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[35] http://www.wavebroadband.com/for-home/internet/packages/, accessed December 2016
[36] http://business.wavebroadband.com/business/, accessed December 2016
[37] https://frontier.com/shop/internet/dsl, accessed December 2016
[38] http://www.xfinity.com, accessed November 2016
[39] https://frontier.com/shop/internet/fios, accessed November 2016

Table 8: Frontier Residential Fiber Service

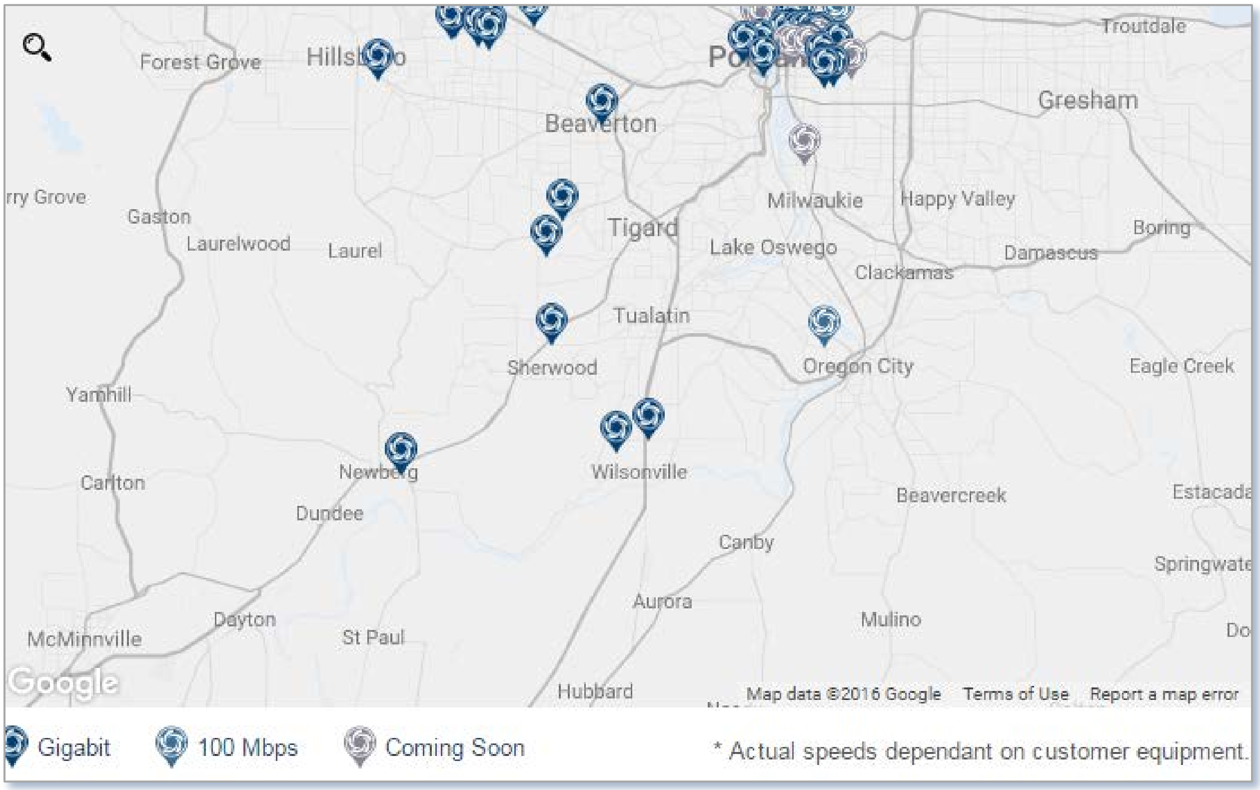
Internet Speed (symmetrical)	Monthly Price (year 1)	Monthly Price (year 2)
30 Mbps	$24.99	$39.99
50 Mbps	$49.99	$64.99
75 Mbps	$59.99	$74.99
100 Mbps	$69.99	$84.99
150 Mbps	$109.99	$124.99

For business customers, Frontier's pricing for 30 Mbps service is $109.99 per month for a one year agreement. For 50 Mbps, 75 Mbps and 150 Mbps, the pricing is $119.99, $144.99 and $204.99 per month for a two-year agreement. Promotional pricing of $109.99 for the first year (of a two -year agreement) is available for the higher speeds.

Fibersphere offers gigabit internet service to neighborhoods in the Portland region including in two communities in Wilsonville as shown in Figure 10.[40]

[40] http://fibersphere.net/coverage_map.php, accessed November 2016

Figure 10: Fibersphere Service Locations



2.2.4 Satellite

Satellite internet access is available in the area as well. HughesNet has four residential packages available and four geared toward businesses. In addition to slight increases in download and upload speeds, plans are differentiated by their monthly data allowances. Residential offerings include an anytime allowance, plus a larger 50 GB "bonus bytes" allowance which can be used from 1 a.m. to 10 a.m. Business offerings include a "business period" allowance to be used between 8 a.m. and 6 p.m. plus a smaller 10 GB anytime allowance. All packages require a two-year agreement. Details and pricing are listed in the tables below. Some promotional discounts are available for the first three months.

Table 9: HughesNet Satellite Residential Plans[41]

Package	Internet Speed	Monthly Data Allowance (Anytime + Bonus Bytes)	Monthly Price
Choice	5 Mbps down/1 Mbps up	5 GB + 50 GB	$49.99
Prime Plus	10 Mbps down/1 Mbps up	10 GB + 50 GB	$59.99
Pro Plus	10 Mbps down/ 2 Mbps up	15 GB + 50 GB	$79.99
Max	15 Mbps down/2 Mbps up	20 GB + 50 GB	$129.99

Table 10: HughesNet Satellite Business Plans[42]

Business Package	Internet Speed	Monthly Data Allowance (Business Period + Anytime)	Monthly Price
Select 100	10 Mbps down/1 Mbps up	20 GB + 10 GB	$79.99
Select 200	10 Mbps down/ 2 Mbps up	30 GB + 10 GB	$99.99
Select 300	10 Mbps down/ 2 Mbps up	40 GB + 10 GB	$129.99
Select 400	15 Mbps down/ 2 Mbps up	50 GB + 10 GB	$159.99

2.2.5 Wireless

Verizon offers two 4G LTE data packages with multiple choices for data allowances and pricing, depending on the desired mobility and equipment chosen. The HomeFusion Broadband Package (LTE-Installed) is a data-only 4G LTE service with Wi-Fi connectivity and wired Ethernet for up to four devices. Available download speeds are 5 Mbps to 12 Mbps and upload speeds are 2 Mbps to 5 Mbps. Monthly prices range from $60 for a 10 GB data allowance to $120 for a 30 GB data

[41] http://www.hughesnet.com/plans-and-pricing/internet-service, accessed November 2016
[42] http://business.hughesnet.com/plans-and-pricing/internet-service, accessed November 2016

cap. Overages are charged at $10 per additional GB. A two-year contract is required, with a $350 early termination fee. Verizon offers a $10 monthly deduction for every month completed in the contract.

The Ellipsis JetPack provides a mobile solution, with download speeds of 5 Mbps to 12 Mbps and upload speeds of 2 Mbps to 5 Mbps. Prices for the 12 options of data allowances range from $30 per month for a 4 GB data allowance to $335 per month for 50 GB of data, in addition to a monthly line access charge of $20.The device is $0.99 with a two-year contract. There is a $35 activation fee.[43]

Sprint also offers 4G LTE wireless data in Wilsonville. The three data packages offered range from 100 MB per month data allowance for $15 per month, to 6 GB per month data allowance for $50 per month, to 30 GB per month data allowance for $110 per month. Each MB over the limit is billed at a cost of $.05. A two-year contract is required, as well as an activation fee of $36 and equipment charges for three different types of devices. There is an early termination fee of $200.

AT&T also provides 4G LTE wireless data service in the area, and offers three packages, the 250 MB per month download allowance for $14.99 per month, 3 GB per month download allowance for $30 per month and a 5 GB per month download allowance for $50 per month. There is an overage fee of $10 per 1 GB over the limit. There are also equipment charges, with or without a contract, and an activation fee up to $45.[44]

T-Mobile offers a wireless data option for $20 per month with a limit of 2 GB per month. T-Mobile offers additional capabilities and increasing data limits at incremental costs in a total of five packages, up to $80 per month for up to 18 GB of data. Depending upon current promotions, the $35 activation fee is sometimes waived. [45]

Cricket Wireless offers 4G LTE wireless service in Wilsonville with a download speed of up to 8 Mbps with three options for data allowance packages. Starting at $30 per month for 1 GB of data allowed there are also options for data allowances of 2.5 GB (at $40 per month),8 GB ($50 per month) and 10 GB ($60 per month). Data used beyond allowances are at reduced speeds. There is a $79.99 modem fee for an additional device. There is a $15 activation fee, but no contract or early termination fees.[46]

[43] http://www.verizonwireless.com/support/wireless-internet-data-only/, accessed, November 2016
[44] https://www.att.com/shop/wireless/plans/planconfigurator.html, accessed November 2016
[45] http://www.t-mobile.com/cell-phone-plans/mobile-internet.html, accessed November 2016
[46] https://www.cricketwireless.com/cell-phone-plans, accessed November 2016

Online Northwest is a wireless ISP that offers residential internet services in Wilsonville. The available speeds and pricing is shown in Table 11. [47]

Table 11: Online Northwest Services

Plan	Cost per Month	Download Speed	Monthly Data Cap
Value	$49.95	3 Mbps	100 GB
Power	$64.95	5 Mbps	150 GB
Turbo	$79.95	8 Mbps	200 GB
Extreme	$99.95	11 Mbps	300 GB

Freewire Broadband offers dedicated internet service with scalable speeds up to 2.5 Gbps through microwave links in the City.[48] Their network coverage area is depicted in Figure 11.

Figure 11: Freewire Broadband Coverage Map

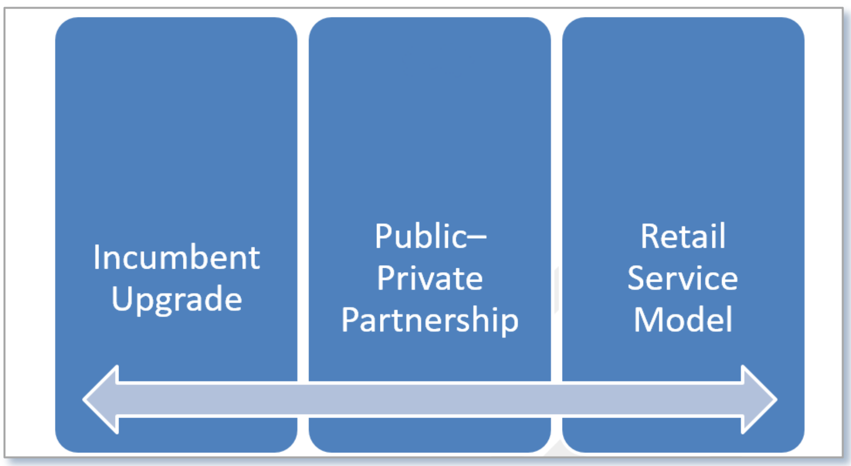
[47] http://www.onlinenw.com/internet-services-residential/, accessed November 2016
[48] http://freewirebroadband.com/fixed-wireless/, accessed November 2016

3 Evolving Network Service and Business Models Offer a Range of Opportunities for Expanding Broadband in Wilsonville

There are several potential service models a public entity can consider as it evaluates how best to address its broadband availability gaps. The options range from simply relying on local incumbent service providers to upgrade their infrastructure,[49] to a full public FTTP deployment in which the locality provisions service over a network that it constructs and owns.

Somewhere between a fully private and an entirely public approach is the possibility of a public–private partnership, which plays to the strengths of each entity, and helps manage risk. There is also significant variation within the framework of public–private partnerships, and the public and private entities can tailor their unique goals and needs to develop a mutually beneficial arrangement.

Figure 12: Service Models Continuum



On one end of the spectrum lies a full public retail service model in which the locality deploys and maintains network infrastructure and then provides service to end users over the public network. This approach involves tremendous financial and operational risk for the public entity because the locality must secure financing to build the network, as well as establish a significant enough revenue stream to maintain the network infrastructure and cover all costs associated with network and retail service operations. If incoming revenue does not cover these costs, the

[49] Note that there is a distinction between incumbent providers and competitive providers; competitive providers can install new infrastructure to offer service to an expanded area, but this analysis focuses on incumbent providers because of their existing large footprint in most communities. The incumbent provider's costs to upgrade infrastructure within an existing network footprint is likely to be lower than a competitive provider's cost to deploy an entirely new, or "greenfield," network.

locality must find alternatives—such as using funds from the public entity's general operating budget—to cover any shortfall.

In a retail service model, the public entity is responsible for all network infrastructure, including the electronics required to "light" the fiber and, in the case of a wireless deployment, all the equipment necessary to establish a robust wireless network. Retail operations costs encompass everything from customer outreach and marketing, to call center staff, to CPE, to retail store space where customers can go to establish service, pay their bill, or receive technical and other support. The cost to the public entity for operating a retail ISP is significant, varied, and unpredictable.

On the other end of the spectrum, localities can take small steps in the course of normal business—such enacting a dig-once policy—to encourage incumbent providers to upgrade and expand their existing infrastructure. In this approach, the locality does not take significant steps toward providing service, but instead relies on the private sector to do so. However, in this case, the locality has little to no control over whether any of the measures it takes will incite local providers to action. That is, if the locality takes steps to encourage private investment, there is no guarantee that its efforts will pay off in the form of upgraded or expanded infrastructure. While this approach entails only nominal risk to the public entity, there is also minimal control and the locality is relying entirely on the private sector to address concerns with the local broadband market.

In recent years, a potential mutually beneficial middle ground has emerged in the form of public–private partnerships that have the potential of meaningful competition in some cities, counties, and states throughout the U.S. For many localities, the prospect of a retail service model is daunting and unappealing, but waiting for incumbent providers to upgrade their networks to provide higher speeds and greater access is not sufficient. Often, a public–private partnership that balances the needs, risks, and rewards of the public and private sectors is a viable approach that helps achieve the locality's goals while not putting undue burden on the private sector or positioning the locality to directly compete with local providers.

3.1 The Middle-Mile Network

In this model, localities address "middle mile" needs by building less-extensive networks that ensure the availability of fiber optics to government users and key local institutions, but do not reach all the way to the home or business. This is a proven best practice with two decades of solid empirical data that demonstrates its viability.

Hundreds of localities have used this strategy, with a range of variations. Austin, Boston, Chicago, Los Angeles, New York City, San Antonio, San Francisco, Seattle, Washington, and hundreds of suburban and rural towns and counties have employed this strategy.

Two decades of public sector experience demonstrate that municipal ownership of a fiber network enables localities to better meet growing demands for communications capacity and functionality, while reducing the risk of private sector price increases for managed communications services. By owning its fiber infrastructure, a locality can determine how much it will pay for the initial infrastructure and also manage ongoing operating expenses, keeping them relatively constant—even as the network's capabilities increase over time.

Without control over its own network, a locality's costs for carrier-provided communications services may increase significantly with time. Aggregate pricing will increase as the community's communications needs grow to support cloud-based services and Smart Cities initiatives. Additionally, the locality may find itself constrained by limited bandwidth at its sites. The community may be limited to the offerings that service providers make available in a particular neighborhood or limited to the offerings that can be purchased under a given year's appropriation.

Communities may wish to enable a wide range of emerging, high-bandwidth applications including remote traffic signalization, traffic camera and surveillance camera backhaul, remote sensors and other devices, as well as a full range of Smart City and Internet of Things deployments. A robust, publicly-owned fiber network makes applications that require backhaul of wireline connectivity far more cost-effective

3.2 Middle Mile Plus: Incremental and Targeted Fiber Construction

In this model, a community that already meets its own internal needs for connectivity offers dark fiber connections, through a lease, to reach key economic or community development targets.

Experience suggests that this is the business and technical model with the lowest risk for many localities. This strategy can facilitate a modest portion of the public goals related to new broadband deployment while still minimizing risk. It requires a smaller capital investment than does more extensive fiber deployment and could allow the community to realize a modest revenue stream while meeting its own communications needs and reducing the cost of leasing circuits.

This model for fiber construction and leasing has been successfully implemented by a range of localities across the United States for nearly two decades.

Significantly, though this model can fill a market vacuum for select business customers and incrementally improve the availability of broadband services, it is less likely to improve services to residential and small business locations dramatically. The availability of cost-effective dark fiber does offer some incentives for a private provider to extend that fiber to the home and business, but is unlikely to be enough to attract all necessary private sector investment in FTTP because it only incrementally lowers the cost of market entry.

3.3 Private Provider Expansion and Upgrades

One key element that may help localities that aim to see greater competition and consumer choice is for incumbent cable and telephone companies to upgrade their outdated legacy infrastructure. While there may be little a locality can do to directly force such an upgrade, there are ways to potentially encourage companies to upgrade or build new infrastructure. For example, a locality may offer ease of access to the PROW or other incentives that encourage private investment. Although this is not necessarily always a strategy that the public entity can take, upgrades to legacy infrastructure on the part of incumbent providers is an important way the broadband industry continues to evolve.

3.4 Municipal Networks

In this model, localities build, own, and operate broadband networks themselves. This is a high-risk and high-reward proposition, with a respectable track record in communities across the country. In CTC's observation, however, this is a difficult model to replicate, particularly for communities that do not own their own municipal electric utilities (as described below). The risks and challenges involved in this model suggest that it will be adopted infrequently. Aggressive anti-municipal efforts by incumbent phone and cable companies make this model even more risky.

Despite the risks, about 100 local communities have built hybrid fiber-coaxial (HFC) networks (the architecture used by cable companies) or FTTP networks to comprehensively serve residential and business markets.

Some of these networks date back almost two decades; the great majority were deployed in the first decade of the 21st century. In almost every case, these networks have been deployed in towns located in largely rural areas. Some, but not all, of these towns already had cable modem service, but many of them were unserved or close to unserved by broadband service. Most of these networks were deployed by municipal electric utilities.

This correlation is not surprising for several reasons. First, communities in which the private sector did not have a business case for electrification are where local governments chose to build public power. Not surprisingly, those same communities did not see adequate private sector investment in broadband, and thus chose, in both cases, to invest in the infrastructure themselves for the benefit of the broader community.

Second, the challenge of undertaking a public-facing communications project is reduced for a municipal electric utility relative to a local government that is not already an electricity provider. A range of elements in a communications network overlap those of a power network, including the poles on which the infrastructure is built, the facilities in which network hubs are located, the skills and equipment of field staff, and even, in some cases, the billing, operating, and customer service systems that support the service offerings. A minority of the municipal, public-facing networks were built by localities that were not also power utilities.

The economics of FTTP are extremely challenging given the very high capital costs and the modest revenues possible, particularly in light of competition from lesser broadband technologies. Unlike other public utilities such as water and sewer, city communications networks do not operate in a monopoly environment, and several competitor technologies, however inferior, do exist. These include far-lower-bandwidth options such as DSL, cable modem service, and wireless service. (In contrast, some municipal FTTP networks were built at a time when there was not much or any competition in those rural towns.) These alternative technologies do not offer the same future-proof scalability and speeds as fiber, but can certainly offer robust competition with respect to price and other factors.

Public FTTP networks in Lafayette, Louisiana; Chattanooga, Tennessee; and Wilson, North Carolina—all of which are municipal electric utilities that attained substantial efficiencies—have achieved noted successes.

The most dramatic successes of these networks are in benefits that do not necessarily show up on financial statements such as enhanced productivity, innovation, education, healthcare, company recruitment, and related benefits that are among the reasons for the communications investment in the first place. Thus, even those public entities that have found it challenging to make FTTP networks self-sustaining on a balance sheet basis can still claim significant success based on these other benefits. Some call these positive externalities or ancillary benefits, but they are more central to the purpose of the network than any other factor.

3.5 Public–Private Partnerships

In recent years, three types of partnerships have emerged within the broadband industry, though not every model has been tested:

- **Model 1: Private Investment, Public Facilitation**, in which the public entity takes modest measures to encourage private investment in the area; the most prominent example of this model is Google Fiber's deployment in cities like Kansas City and Austin

- **Model 2: Private Execution, Public Funding,** which entails significant risk for the public entity and relies on the private sector for execution; this model is new in the broadband industry in the U.S., though it has been used in road construction and public transit projects in Europe and, more recently, in the U.S.
- **Model 3: Shared Investment and Risk,** which takes advantage of the strengths of both the public and private sector partners; this model aims to offset risk by assigning to each entity tasks with which it is familiar and that it is likely to be able to carry out successfully

There are variations within each partnership model, and even models that have been underway for a number of years are still fairly new with relatively few data points to provide meaningful insight into what does and does not work with respect to public–private partnerships. What is clear is that most localities are looking for a way to deploy state-of-the-art broadband infrastructure while managing risk, reward, and control, and most private entities are seeking ways to broaden their customer base while being mindful of their own need for significant-enough return on investment to make the deployment worthwhile.

In some cases, control is the driving factor for a locality and maintaining control means directly deploying infrastructure that the public sector will own. There is significant capital risk involved in developing fiber infrastructure and then seeking a partner. Localities that go this route must realize that, even if they directly deploy fiber infrastructure, they are not guaranteed a partner. Moreover, even if they find a private partner, these localities are not guaranteed a partner who is able and willing to assume enough risk to offset the locality's risk entirely. While this approach gives the locality the greatest degree of control, there is also substantial risk in the form of upfront capital costs and ongoing debt service. Localities that opt to go this route are likely to be well-served by strong procurement processes that inform the private sector of the locality's plans.

The balance of risk and rewards depends greatly on the locality itself, and what constitutes "risk." For example, a locality whose economic vitality relies on access to broadband infrastructure—such as through the ability to attract large businesses—may have reason to invest in a publicly-owned network, knowing that it will likely not recover its capital and operating costs. In this case, the locality may believe that the benefits conferred on the community through increased economic development will be significant enough to offset its financial risk. The key is for localities to understand their vulnerabilities, to take calculated risks, and to ensure that any partnership balances the risk and reward acceptably between the public and private entity.

3.5.1 Private Investment, Public Facilitation

The first partnership model represents the lowest level of risk to a locality. While not a fully mutually-beneficial partnership, it focuses on modest steps a locality can take to facilitate implementation and delivery of broadband services.

For example, the City can benefit by encouraging coordination and incentivizing efforts between the city and the private sector when excavating the PROW and placing conduit. Coordination can enable the City to better protect its PROW, minimize disruptions, and reduce costs of installation of utilities and conduit.

Such joint trenching efforts around the country—usually referred to as "Dig-Once"—have taken many different forms. Dig once policies reduce the long-term cost of building communications facilities by capitalizing on significant economies of scale through:

1. Coordination of fiber and conduit construction with utility construction and other disruptive activities in the PROW
2. Construction of spare conduit capacity where multiple service providers or entities may require infrastructure

The incentivizing measures range from implementing business processes for improved sharing of information, to facilitating coordination, to adopting legislative measures that enforce standards and specifications for additional conduits that can be used by the city or leased to other companies.

It is also important to note that City transportation and utility projects can provide many opportunities for Dig Once coordination and that taking advantage of those opportunities can start immediately, while the City potentially works in parallel to implement coordination with non-city utilities.

This model relies on the private sector being willing to invest capital and design and deploy infrastructure. In addition, the private partner would assume responsibility for asset management, network services, and customer relations. In turn, the locality facilitates construction through economic and procedural incentives, including tax benefits, streamlined permitting, public rights-of-way access, and allowing contracted inspectors to accelerate construction project timelines. In a best-case scenario, these processes can reduce the cost of OSP construction by up to an estimated 8 percent.

This partnership model is ideal for communities wishing to keep public cost as low as possible, and frequently results in increased broadband marketplace competition and incumbent equipment upgrades. However, in an un-served or underserved locality, these benefits most likely would not be immediately realized. Further, this model prevents the locality from obtaining any control over the installed network assets or construction timeline, and can prove to be a public relations risk if something goes wrong on the partner's end.

Case Study: Holly Springs, North Carolina

The town of Holly Springs, North Carolina is a fantastic example of this partnership model in practice. Based on Town-made design and engineering plans, the Town built a robust fiber backbone capable of a dramatically higher capacity than broadband need deemed necessary at the time of construction. By creating a future-proof, widely distributed infrastructure, the Town possessed a powerful tool to attract potential private partners. Leveraging this fiber asset, the Town sought partners capable of bringing last-mile fiber to each household and business in the area.

In addition to the infrastructure itself, the Town created policies and procedures which clearly demonstrated its interest in facilitating partnership. By streamlining government processes, allowing access to information and facilities, and providing project facilitation and support, the Town demonstrated its desire to be an active partner with the private sector.

In mid-2015, Ting Internet announced it would partner with Holly Springs to expand network connections throughout the area. Not only did the Town attract Ting with the ability to lease middle-mile fiber, but it also secured its confidence by enacting advantageous policy.

3.5.2 Private Execution, Public Funding

The second model is a higher public risk, higher public benefit variation on the traditional municipal ownership model for broadband infrastructure. Like current models used in the U.S. for highways, toll roads, and bridges, this model has proven successful for network deployments in Europe.

In this model, the public entity makes a significant investment, while the private partner assumes a combination of engineering, construction, financing, operations, and/or maintenance responsibilities. Depending on the partnership, sources of public capital may come from the local government, or in some models, a fee assessed on local property owners.

This model benefits the public partner as it capitalizes on the private partner's strengths to provide turnkey network services over an extended period (20-40 years). By removing the logistical barriers to a locality accomplishing such a large project, the partnership provides an effective solution for both parties by enabling private execution and capital.

The solution comes with the highest public risk of CTC's three proposed models. If the private partner is unable to generate enough revenue to recover cost, or even sustainable profit margins, the public partner is still responsible, assuming the role of guarantor for the project. Further, the competitive nature of the broadband marketplace introduces inherent political problems. Should a locality be unable to garner enough support for the project, or should a significant number of residents choose not to use the infrastructure, progress may be stalled or thwarted entirely.

Case Study: Macquarie Capital

Macquarie Capital pioneered this model in broadband infrastructure, proposing a scenario for network expansion. By using public funding, it sought to execute a complete FTTP network with potential long-term revenue benefits for the public.

In its proposed model, Macquarie offers to provide network financing, construction, operations, and service delivery. In return, the locality pays it on an ongoing basis using funds collected from placing a monthly fee on property owners' utility bills. The model suggests that as time passes, multiple internet service providers (ISPs) will be able to compete to use the network to provide services to local homes and businesses, effectively lowering prices for customers.

Macquarie theorizes that after the construction period, service revenue will grow over time. As this occurs, a portion of the profits will be shared with the locality. It is important to note that there is no guarantee that the partnership will ever reach a point where there are significant enough profits to share among the entities. This model entails a large risk, as the locality stands to shoulder all the capital risk if revenues are not sufficient to cover the debt service for the network. Further, the suggested utility fee may prove too heavy a political lift in some communities.

Case Study: SiFi Networks

SiFi Networks proposes another yet-untested model to use public funds and private partner contracts to build an FTTP infrastructure. In this option, the ISP providing service offsets the public partner's costs with monthly payments to the partner to use the city's infrastructure.

Compensated by lease payments from the public sector, SiFi Networks provides financing and turnkey network construction and operations. After the initial build-out, SiFi Networks brings the public partner one or more ISPs to provide services. The ISP(s) then contract(s) with the locality to pay for the opportunity to use the network at a negotiated rate based on the locality's actual cost.

The main benefit of this model is with an actual cost-negotiated payment from the ISP to offset lease payments to SiFi Networks. The inherent risk hinges on SiFi Networks' chosen ISP(s)' ability to realize significant revenue and profit margins. If the service provider were unwilling or unable to continue under the model, the city is left to bear the burden of payments to SiFi Networks. It should be noted that, especially in smaller markets, attracting enough ISPs to make this model viable and to reduce the locality's risk may be very challenging.

Case Study: Symmetrical Networks

Symmetrical Networks suggests a partnership like the above models, but with a few important changes, namely giving the public partner choice in the ISP to use, and the potential to negate the public partner's monthly payments.

In Symmetrical Networks' plan, the company and its partners build, finance, and provide turnkey construction of a network operated by a public partner-chosen ISP. The public partner pays Symmetrical Networks a lease payment which will cover the company's debt service, operating costs, and margins. In turn, the ISP pays the public partner an amount equal to the public partner's payment to Symmetrical Networks.

It is important to note that this model is estimated to be viable with a community take rate of 35 percent. Like SiFi Networks' model, the viability of the partnership hinges on the ISP's ability to generate sufficient revenue to cover its payment to the locality, its costs, and an acceptable operating margin. Thus, there is significant inherent risk to the public partner. If revenue falls beneath obligatory levels, the locality is still responsible for payments to Symmetrical Networks.

3.5.3 Shared Investment and Risk

The third model represents a partnership in the truest sense of the word. In this model, the unique strengths of both partners are capitalized, and the primary benefit arises from each partner sharing the heavy lifting of the project.

In this model, both partners develop a cooperative strategy to realize their common goal in a framework unique to the project and locality itself. The public and private partners both leverage assets as appropriate and negotiate logistics such as service provisioning, customer service operations, and maintenance. For greatest success, both must demonstrate willingness and an ability to compromise for the greater success of the project.

This concept manifests in a variety of ways. Frequently, the public partner provides fiber already in use for civil services, and the private partner invests to expand said fiber to develop a robust FTTP infrastructure. The public partner receives multiple "off the balance sheet" benefits, including substantial educational, health, and environmental benefits. Additionally, the private partner secures considerable upfront and long-term savings and enormous operational capabilities.

Case Study: Westminster, Maryland

The city of Westminster, Maryland, demonstrates one of the most successful instances of this type of partnership. Greatly underserved by incumbent providers, and located in an area with no major highways, the City found itself with little potential for economic development. In 2010, Maryland won a federal award to bring fiber infrastructure to the state, and fiber was constructed within the City.

The City wanted to expand the fiber within City limits, but did not have a municipal utility to help encounter the problem. Further, the City had neither the resources, expertise, nor the political will to build a competitive ISP. The City made a visionary shift in perspective: viewing the fiber assets brought by the state as an asset like water and sewage lines, noting the possibility of using the infrastructure for public good.

The City decided to build, own, and maintain dark fiber. They then sought a partner to light the fiber, provide service, and handle customer relations. This allowed the City to remain independent of network and customer operations, mitigating management risks.

After releasing a request for proposals, the City partnered with Ting Internet, who shared the City's vision of an open-access network facilitated by a strong partnership. While there are elements of risk to both partners, the partnership ensures both sides will be active partners in the deal. The City assumes the risk of funding the dark fiber, while Ting will pay the City a two-tiered lease payment, one portion based on the number of passings in the network, and the second portion based on the number of subscribers on the network. This structure incents Ting to both accrue customers, and continue to provide quality service to those already subscribed.

Further, the partnership secures mutual financial benefit for both partners after the network is deployed and functioning. Any quarter where Ting's lease obligations are less than what the City needs to cover debt service, the provider will pay the City half of the deficit. In any quarter where Ting's obligations are greater, the provider will be reimbursed the equivalent amount. Lastly, once Ting hits certain revenue thresholds, it will share the revenue, awarding the City's risk.

This partnership is a solid example of ideal mutuality in a partnership: capitalizing on strengths, mitigating risk, and reaping shared rewards.

Case Study: Garrett County, Maryland

Garrett County is a relatively remote community, which struggled to obtain dependable internet service due to its mountainous terrain and remote households. Before construction, the only service available was either the inadequate speed of DSL or mobile wireless broadband, hindered greatly by data caps. For this reason, the county struggled to attract and retain businesses and teleworkers, and enable home-based businesses and schooling.

The County decided to gradually build fiber out to certain institutions, hoping they could eventually leverage the asset to attract a partner help to expand the network to households in the area. In September 2015, Declarations Networks Group (DNG) partnered with the County to deploy a fixed-wireless network to the underserved areas in the County. After an initial County investment of $750,000, matched by the Appalachian Regional Commission (ARC), DNG committed to more than match the County to provide both capital and operational expertise to the project, enabling the County to reduce the number of homes without broadband access options to nearly zero percent.

While this partnership does entail a sizeable County investment, the money comes with enormous economic value for the dollar, enabling home schooling, teleworking, and bringing Internet service to roughly 3,000 under- or unserved homes. The County's ability to provide dark fiber, coupled with its willingness to take on some of the risk attracted DNG, and enabled the partnership to bring broadband to nearly every home in the County.

4 Design and Cost Estimate for City Network Expansion

Expansion of the City's fiber optic network to connect additional City facilities and parks is an alternative to commercial services that may offer long-term cost savings and provide technical advantages. CTC's engineers developed a candidate network design that builds on the City's existing and planned fiber and network resources and extends the network further out into the City. This section provides an overview of a technical approach and cost estimate developed to examine the feasibility of constructing the network.

4.1 Technical Approach

CTC developed a system-level design for a fiber optic network to serve as the basis for estimating costs. Design priorities targeted by this conceptual design include:

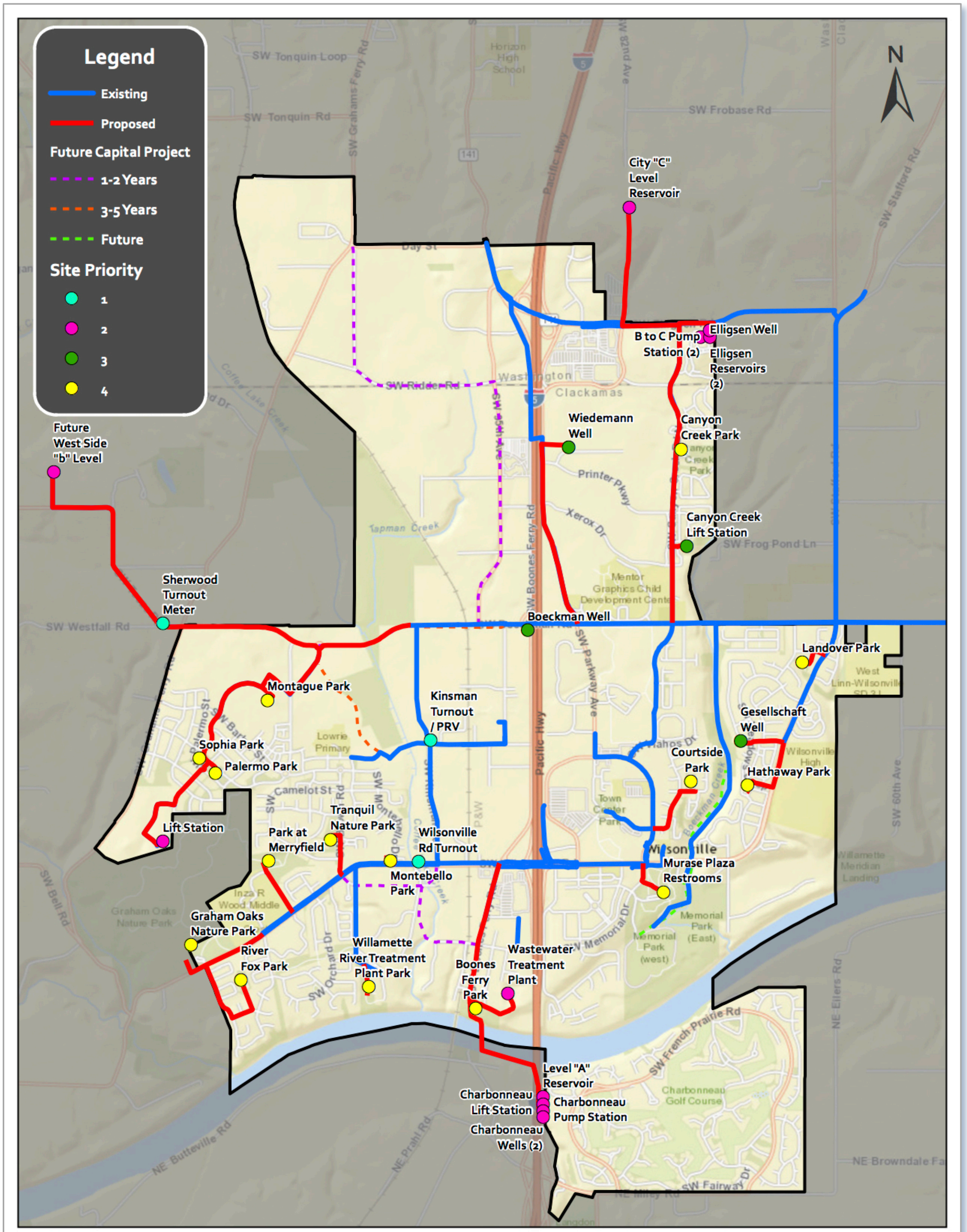
- Providing fiber connectivity to three City turnout meters
- Providing fiber connectivity to 15 wells, reservoirs, and pump stations and the wastewater treatment plant
- Providing fiber connectivity to 16 City parks
- Expanding the City's fiber footprint to allow for future expansion
- Minimizing costly railroad, highway, and river crossings

The resulting network architecture, illustrated in Figure 13, comprises approximately 11.5 route miles of fiber connecting all 34 locations (see Appendix B for a list of sites). Fiber routes in blue indicate infrastructure which is already in place, and red indicates the proposed routes used to estimate costs.

This fiber routing is separated into four groups, based on the City's prioritization:

1) **Priority 1** includes 1.12 miles of fiber construction that connects the Sherwood, Kinsman Road, and Wilsonville Road turnout meters.
2) **Priority 2** includes 4.58 miles of fiber that connects the four Charbonneau water utility locations, the three Elligsen water utility locations, the West B Level reservoir, the North C Level reservoir, and the Lift Station off Grahams Ferry Road.
3) **Priority 3** includes 1.38 miles of fiber that connects the wastewater treatment plant and the Gesellschaft, Boeckman, Canyon Creek, and Wiedermann wells.
4) **Priority 4** includes 4.44 miles of fiber that connects 16 parks: Canyon Creek Park, Landover Park, Hathaway Park, Courtside Park, Town Center Park, Boones Ferry Park, Montebello Park, Murase Park, Tranquil Nature Park, Willamette Park, Graham Oaks Nature Park, Rover Fox Park, Merryfield Park, Montague Park, Sophia Park, and Palermo Park.

Figure 13: System-Level Fiber Network Architecture



While not fully vetted in the manner necessary for permitting and construction, this fiber optic design is likely to closely approximate a final design meeting the stated design objectives.

A wide range of options is feasible given the physical architecture of the proposed network. Depending on how the fiber strands are spliced, single or ringed connections can be established over the backbone routes, and it is possible to provide "express" connections from one end of the network to another without the need for "patching" between intermediate sites.

The cost estimates are based on a backbone consisting of a 288-strand cable occupying one 4-inch conduit and laterals consisting of a 288-strand cable occupying one 2-inch conduit.

Beyond the physical fiber optic cable routing, there are several technical design and construction attributes impacting costs, including the following:

- **Fiber strand count:** The number of individual fiber strands provided in a single cable correlates to the capacity of the cable. Due to the vast effective bandwidth of fiber, it is feasible to scale the rate of data transmission carried by even a single fiber strand to meet all the City's needs indefinitely; however, the cost of network electronics increases exponentially with this capacity.

  On the other hand, the material cost of fiber strands represents a very minor component of the overall cost of fiber construction (about $0.01 per strand per foot, compared to $15 to $25 per foot for the total cost of typical construction). It is thus prudent to install a cable of sufficient size to meet any conceivable requirements so that these needs can be met with a configuration of electronics that are as low-cost as possible. In fact, with sufficient fiber strands, the City can increase network capacity many orders of magnitude above current levels with little or no change to its network electronics.

  Although no portion of the network will likely require more than a few dozen strands, cost estimates are based on the installation of a 288-count cable along most segments of the network. This should provide sufficient capacity for nearly any conceivable expansion of internal needs, fiber leasing, or even future support of business or residential services.

- **Underground versus aerial construction:** The cost estimates anticipate exclusively underground construction of the fiber with fiber cables placed in a 4-inch conduit. This is consistent with the City's policy to underground utilities wherever possible (because new aerial fiber construction risks having to be moved later).

  Additionally, since the City does not own its own utility poles, any aerial construction would require negotiating pole attachment agreements. These agreements generally require recurring fees per pole, and generally require the attacher to pay the cost of any upgrades or modifications to the utility poles necessary to support the new attachment.

The CTC site survey indicates that the poles along major roadways where middle mile fiber would go are in good shape and have room for additional attachments should aerial construction be required.

- **Conduit size and quantity:** Using industry best practices, cost estimates are based on the installation of fiber in a flexible plastic conduit that provides a path into which fiber cable can be installed, allowing for cable slack to be pulled to accommodate repairs, or for new cable to be installed to expand capacity.

  This analysis assumes underground construction will consist primarily of horizontal, directional drilling to minimize PROW impact and to provide greater flexibility to navigate around other utilities. While cost estimates are based on the placement of a single 4-inch, High-Density Polyethylene (HDPE) flexible conduit, it should be noted that placing additional conduits simultaneously results in relatively minor increases in cost, within limits.

  Depending on material prices, at least 2-inch conduit is preferable along backbone routes as it can accommodate one or more additional large-strand-count fiber cables in each with sufficient space for placing additional smaller cables to for purposes of placing "lateral" connections to future locations.

- **Handhole placement and size:** Handholes are enclosures installed underground in which conduit terminates to provide access to conduit for installing cable, as well as to house cable splice enclosures and cable slack loops required for future repairs. Handholes generally must be placed at intersections of multiple conduit paths, or where the conduit path makes a sharp change in direction.

  Handholes provide important access points to underground conduit, enabling expansion of the conduit infrastructure (i.e., installation of a lateral connection to a new network location) without disrupting conduit or installed cables. While cable can be pulled upwards of several thousand feet at a time, cost estimates for the City network assume installation of handholes every 500 feet on average, ensuring that the infrastructure supports cost-effective expansion to new sites, including access to businesses that might be targets of commercial network operators seeking to lease City fiber (or conduit space).

- **PROW restoration and fees**: The network cost estimates assume that the City may have to pay encroachment fees for construction along or under State roads and for railroad crossing application and licensing fees, which can total upwards of $15,000 per crossing, not including special construction costs, which generally entail steel encasement of conduit.

The cost estimates assume that the City will incur typical costs for permanent asphalt and concrete restoration required for utility "test pitting" necessary to verify the location of other utilities in the path of the fiber to prevent damage; generally, this consists of excavation within small areas of less than 2 feet in diameter.

4.2 Cost Estimates

CTC estimates the cost to construct and activate the fiber network described in the previous sections to be approximately $2.5 million. The estimated cost for only Priority 1 and 2 sites is approximately $1.3 million. The cost estimate is itemized between construction scenarios and includes network site electronics and lateral and fiber termination costs at City facilities.

Priority 1 sites include three turnout meter facilities, Priority 2 sites include 10 additional water utility sites, Priority 3 sites include the wastewater treatment plant and four additional wells, and Priority 4 sites include 16 City parks. Table 12 provides the cost estimate for fiber construction and network electronics.

Table 12: Summary of Construction Costs for Dark Fiber Network Expansion

Cost Component	Priority 1 Sites	Priority 2 Sites	Priority 3 Sites	Priority 4 Sites (City Parks)	Estimated Cost
Engineering	$20,200	$82,900	$25,000	$80,200	$208,300
Project Management / Quality Assurance	7,700	31,700	30,700	30,700	79,700
General OSP Construction	189,500	751,200	216,400	646,100	1,803,200
Railroad, Bridge, and Interstate Crossings	18,600	26,500	-	-	45,100
OSP Fiber Splicing	7,500	32,100	6,400	30,100	76,100
Fiber Termination / Building "Entrance"	8,400	28,100	14,000	44,900	95,400
Network Electronics	22,500	75,000	37,700	120,000	255,000
Total Network Costs:	**$274,400**	**$1,027,500**	**$308,900**	**$952,000**	**$2,562,800**

4.2.1 Outside Plant

OSP (layer 1, also referred to as the physical layer) is both the most expensive part of the network and the longest lasting. Cost estimates are inclusive of all engineering, project management, quality assurance, and construction labor anticipated to be necessary to implement the network on a turnkey basis, and are based on relatively conservative pricing assumptions. The following summarizes the scope anticipated by each of the cost components itemized in the table above:

- **Engineering:** Includes system level architecture planning, preliminary designs and engineering field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials

- **Project Management / Quality Assurance**: Includes expert quality assurance field review of final construction for acceptance, review of invoices, tracking progress, and coordination of field changes

- **OSP Construction**: Consists of all labor and materials related to "typical" underground OSP construction, including conduit placement, utility pole make-ready construction, fiber installation, and surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities

- **Railroad, Bridge, and Interstate Crossings**: Consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate/controlled access highways

- **OSP Fiber Splicing**: Includes all labor related to fiber splicing of outdoor fiber optic cables

- **Fiber Termination/Building Entrance**: Consists of all costs related to fiber lateral installation into network sites, including OSP construction on private property, building penetration, inside plant construction to a typical backbone network service "demarcation" point, fiber termination, and fiber testing

Actual costs may vary due to unknown factors, including: 1) costs of private easements, 2) congestion in the PROW, 3) variations in labor and material costs, and 4) subsurface hard rock. Costs for underground placement were estimated using available unit cost data for materials and estimates on the labor costs for placing, pulling, and boring fiber based on construction in comparable markets. The material costs were generally known apart from unknown economies of scale and inflation rates, and barring any sort of phenomenon restricting material availability and costs.

4.2.2 Network Access Electronics

The City operates a fiber network that interconnects the City's existing fiber-fed sites. The existing core network electronics can be leveraged to connect the City sites to the fiber optic network. Based on discussion with the City, this analysis assumed that the core electronics would have sufficient capacity to connect these additional sites. To accommodate a large number of new connections, redundant connections to some sites, or a substantial increase in required bandwidth, the current core electronics may need to be upgraded in the future.

For every site, a pair of 1 Gbps fiber optic transceivers would be purchased to connect the sites back to the core network site and sites may be upgraded to 10 Gbps links as needed. As capacity needs increase, the core network can be expanded by addition additional line cards, distribution switches, or by upgrading to electronics with more ports.

This estimated a total electronics cost of $255,000, including installation and integration, for all 34 sites. Though the fiber is the primary cost-drive in this model, with network electronics making up roughly 10 percent of the total cost, the City may significantly reduce the cost of site electronics if a site requires only a small number of connected devices or does not need bandwidth-intensive applications such as live video. If this capacity will not be needed for the foreseeable lifetime of the electronics, the City may reduce site costs by as much as 75 percent by purchasing less-capable electronics for sites that do not require the capacity assumed in the CTC estimate.

5 Financial Analysis of City Network Expansion

This section presents a high-level analysis of the financial implications of the City expanding the network at the costs presented in the above section. This model assumes the City connects all Priority 1 and 2 sites in year one, all Priority 3 sites in year two, and all Priority 4 sites in year three. The entirety of the tables presented in this analysis are available in Excel format in Appendix B.

5.1 City Network Expansion Base Case Scenario

This base case proposes the fees and financing which would be necessary for the City to maintain positive cash flow, and look at the implications of changing critical assumptions, such as the per month fee and operating and maintenance expenses. A complete financial model in Excel format that can be used to show the impact of changing assumptions is available in Appendix B.

To provide services to all sites in Priorities 1 through 4, the City would need to construct $1.84 million of OSP, as well as install network electronics totaling $255,000. These costs total roughly $2.1 million.

In this base case, to maintain positive cash flow over the course of 10 years, the City would need to receive $1,090 per month per site. For a total 34 sites, these fees would total roughly $444,000 per month.

It is important to remember that the network proposed in this report offers the City many benefits, including a higher level of control over the network and the ability to scale the network as data demands increase. Further, the costs in this model are comprehensive, including labor, replacement electronics, and fiber maintenance costs for the lifetime of the model.

This model assumes fees from 50 percent of sites will be collected in the first year of implementation of each Priority group, and all sites will be connected for the entirety of the second year of implementation of the Priority group onward. That is, 50 percent of fees from Priorities 1 and 2 in year one; 100 percent of fees from Priorities 1 and 2 plus an additional 50 percent of fees from Priority 3 in year two; 100 percent of fees from Priorities 1, 2, and 3 plus an additional 50 percent of fees from Priority 4 in year three; and finally, 100 percent of fees from all 34 sites in year four on.

Please note that this analysis uses a “flat model” in the analysis, which means that inflation and operating cost increases (including salaries) are not used. It also anticipates that the City will apply an inflation factor, typically based on a Consumer Price Index (CPI), to the portion of the per-site fee that covers projected operating expenses.

A financial summary for this model is included in Table 13.

Table 13: City Network Expansion Base Case Financial Summary

Income Statement	Year 1	Year 3	Year 5	Year 10
Total Revenues	$85,000	$340,440	$444,440	$444,440
Total Cash Expenses	(61,600)	(154,600)	(154,600)	(154,600)
Depreciation	(79,700)	(166,400)	(166,400)	(166,400)
Interest Expense	(70,000)	(135,210)	(129,650)	(103,040)
Net Income	$(126,300)	$(115,770)	$(6,210)	$20,400

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Unrestricted Cash Balance	$37,500	$860	$108,980	$185,780
Depreciation Operating Reserve	-	64,000	144,000	89,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$37,500	$64,860	$252,980	$274,780

This model would result in the City operating with a negative net income through year six, generating $2,500 in year seven, which would grow to $20,400 in year 10. The City would operate with a positive cash balance throughout the model, finishing year one with $37,500, and ending year 10 with almost $186,000.

5.2 City Network Expansion Base Case Financing

This financial analysis assumes that the City will cover all its capital requirements with general obligation (GO) bonds. It is assumed that the City's bond rate would be 5 percent.

This model expects that the City will take a series of 20-year bonds for a total of $2.4 million in financing. (The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment.) The resulting P&I payments will be the major factor in determining the City's long-term financial requirements.

This analysis projects that the bond issuance costs will be equal to 1 percent of the principal borrowed. For the bond, it assumes neither a debt service or interest reserve account are required. Principal repayment on the bonds will start in year two.

A detailed income statement is included in Table 14.

Table 14: City Network Expansion Base Case Income Statement

Income Statement	Year 1	Year 3	Year 5	Year 10
Revenues				
Anchor Connectivity Services	$85,000	$340,440	$444,440	$444,440
CAI Capital Contributions	-	-	-	-
Total	$85,000	$340,440	$444,440	$444,440
Operating Expenses - Cash (not including taxes)				
Operating & Maintenance Expenses	$19,000	$77,900	$77,900	$77,900
Operating Expenses - Training, Attachments, Utilities	600	2,700	2,700	2,700
Salaries	42,000	74,000	74,000	74,000
Total	$61,600	$154,600	$154,600	$154,600
Revenues less Cash Operating Expenses	$23,400	$185,840	$289,840	$289,840
Operating Expenses - Non-Cash				
Depreciation	$79,700	$166,400	$166,400	$166,400
Operating Income	$(56,300)	$19,440	$123,440	$123,440
Non-Operating Income				
Interest Expense (Long-Term)	$(70,000)	$(135,210)	$(129,650)	$(103,040)
Total	$(70,000)	$(135,210)	$(129,650)	$(103,040)
Net Income	$(126,300)	$(115,770)	$(6,210)	$20,400
Taxes	$-	$-	$-	$-
Net Income After Fees & In Lieu Taxes	$(126,300)	$(115,770)	$(6,210)	$20,400

This model will generate a negative net income in years one through five, growing to $20,400 in year 10.

A cash flow statement is included in Table 15.

Table 15: City Network Expansion Base Case Cash Flow Statement

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Net Income (From Income Statement)	$(126,300)	$(115,770)	$(6,210)	$20,400
Cash Outflows				
Depreciation Operating Reserve	-	(40,000)	(40,000)	(40,000)
Financing	(14,000)	(10,000)	-	-
Capital Expenditures	$(1,301,900)	$(952,000)	$-	$-
Total	$(1,315,900)	$(1,002,000)	$(40,000)	$(40,000)
Cash Inflows				
Long Term Financing (Bond)	$1,400,000	$1,000,000	$-	$-
Total	$1,400,000	$1,000,000	$-	$-
Total Cash Outflows and Inflows	$84,100	$(2,000)	$(40,000)	$(40,000)
Non-Cash Expenses - Depreciation	$79,700	$166,400	$166,400	$166,400
Adjustments (Proceeds from)				
Long Term Financing (Bond)	$1,400,000	$1,000,000	$-	$-
Total	$1,400,000	$1,000,000	$-	$-
Adjusted Available Net Revenue	$(1,362,500)	$(951,370)	$120,190	$146,800
Principal Payments on Debt				
Long Term Bond Principal	$ -	$48,130	$66,130	$131,440
Total	$ -	$48,130	$66,130	$131,440
Net Cash	$37,500	$500	$54,060	$15,360
Adjusted Net Cash	$37,500	$500	$54,060	$15,360
Cash Balance (Enterprise)				
Unrestricted Cash Balance	$37,500	$860	$108,980	$185,780
Depreciation Operating Reserve	-	64,000	144,000	89,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$37,500	$64,860	$252,980	$274,780

The City's cumulative unrestricted cash balance will total $37,500 at the end of year one, growing to almost $109,000 by year five, and finishing year 10 at almost $186,000.

Please see Appendix B for a complete income statement, cash flow statement, and capital addition statement.

5.3 City Network Expansion Base Case Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building a fiber network. As assets age, capital additions are necessary to replace equipment and software.

This analysis projects that the capital additions (including fiber and electronics for Metropolitan Area Network Services, or MAN services) will total $1.3 million in year one, $300,000 in year two, and $952,000 in year three.

A summary table of these capital additions is included in Table 16.

Table 16: City Network Expansion Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3
a. Fiber Implementation Costs			
Fiber (20-year depreciation)	$1,204,400	$271,400	$832,000
Total	$1,204,400	$271,400	$832,000
b. Electronics Costs (5-year depreciation)			
MAN Services	$97,500	$37,500	$120,000
Total	$97,500	$37,500	$120,000
Total Capital	$1,301,900	$308,900	$952,000
Total Accrued Capital	$1,301,900	$1,610,800	$2,562,800

The City's total accrued capital will total almost $2.6 million by the end of year three.

5.4 City Network Expansion Base Case Operating and Maintenance Expenses

The cost to deploy a fiber network goes far beyond fiber implementation. Network deployment requires maintenance and technical operations, support personnel, and other functions. In this model, the City's financial requirements are limited to expenses related to OSP infrastructure and network administration.

The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span.

While networks require additional personnel for maintenance, this model assumes the City will allocate partial (FTE) positions by year two for fiber plant operating and maintenance technicians, a network engineer, and a GIS specialist. Salaries and benefits are based on estimated market wages, and benefits are estimated at 40 percent of base salary, resulting in $74,000 annually from year two on.

These expenses are illustrated in Table 17.

Table 17: City Network Expansion Base Case Labor Expenses

Labor Expenses	Year 1	Year 2	Year 3+	Labor Cost
Fiber Plant O&M Technicians	0.00	.25	.25	90,000
Network Engineer	0.20	0.10	0.10	90,000
GIS	0.15	0.15	0.15	80,000
Total Staff	0.30	0.60	0.60	

Additional key operating and maintenance assumptions include the following:

- Locates and ticket processing are estimated to be $12,800 in year one, $15,900 in year two, and $125,900 from year three on
- Insurance is estimated to be zero in year one, and $5,000 annually in year two on
- Office expenses are estimated to be $1,200 in year one, and $2,400 annually in year two on
- Fiber maintenance and repairs are estimated to be zero in year one, $11,100 in year two and $34,500 from year three on
- Contingency is estimated at $5,000 in year one and $10,000 from year two on
- Training is estimated at $1,500 beginning in year three on
- Utilities fees are estimated at $600 in year one, and $1,200 in year two on
- Labor expenses are estimated at $42,000 in year one, and $74,000 in year two on

These expenses are summarized in Table 18.

Table 18: City Network Expansion Base Case Operating and Maintenance Expenses

Operating and Maintenance Expenses	Year 1	Year 3	Year 5	Year 10
Operating and Maintenance Expenses				
Locates & Ticket Processing	$12,800	$25,900	$25,900	$25,900
Insurance	-	$5,000	$5,000	$5,000
Office Expense	1,200	2,400	2,400	2,400
Fiber Maintenance	-	34,600	34,600	34,600
Contingency	5,000	10,000	10,000	10,000
Total	$19,000	$77,900	$77,900	$77,900
Operating Expenses - Training, Attachments, Utilities				
Education and Training	$-	$1,500	$1,500	$1,500
Utilities	600	1,200	1,200	1,200
Total	$600	$2,700	$2,700	$2,700
Salaries				
Fiber Plant O&M Technicians	$-	$32,000	$32,000	$32,000
Network Engineer	25,000	25,000	25,000	25,000
GIS	17,000	17,000	17,000	17,000
Total Staff	$42,000	$74,000	$74,000	$74,000
Total Operating and Maintenance Expenses	$61,600	$154,600	$154,600	$154,600

The City's total operating and maintenance expenses will be $61,600 in year one, growing to $154,600 in year three, and remaining constant through year 10.

5.5 City Network Expansion Sensitivity Scenarios

This section demonstrates how even small fluctuations in operating and staffing expense items can affect the financial modeling (i.e., the monthly per-site fee required for positive cash flow). These effects are important to understand and consider when considering expansion of the City Network.

5.5.1 City Network Expansion Scenario 2: Increase Operating and Staffing Expenses by 25 Percent

As described above, the City's operating and staffing expenses are in important aspect of the modeling. Assuming all other factors adhere to the base case, increasing the operating and staffing expenses by 25 percent would impact cash flow. As Table 19 below shows, the City would be unable to generate a positive net income in years one through five, and the unrestricted cash balance would total just $7,780 by year 10 in this scenario.

Table 19: City Network Expansion Scenario 2 Financial Summary: Increase Operating and Staffing Costs by 25 Percent

Income Statement	Year 1	Year 3	Year 5	Year 10
Total Revenues	$85,000	$340,440	$444,440	$444,440
Total Cash Expenses	(61,600)	(154,600)	(154,600)	(154,600)
Depreciation	(79,700)	(166,400)	(166,400)	(166,400)
Interest Expense	(70,000)	(135,210)	(129,650)	(103,040)
Net Income	$(126,300)	$(115,770)	$(6,210)	$20,400

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Unrestricted Cash Balance	$32,500	$(35,740)	$31,980	$7,780
Depreciation Operating Reserve	-	64,000	144,000	89,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$32,500	$28,260	$175,980	$96,780

5.5.2 City Network Expansion Scenario 3: Increase Operating and Staffing Expenses by 25 Percent and Increase Connection Fee to $1,140

If the City's operating and staffing expenses increase by 25 percent, the expense could be passed to network sites, by increasing the monthly connection fee to $1,140. As Table 20 shows, this adjustment makes this projection more closely resemble the base case, generating a net income of almost $14,600 in year five and $41,200 in year 10. The City would operate with a deficit in the beginning years, generating an unrestricted cash balance of almost $102,000 by the end of year five, and almost $182,000 by the end of year 10.

Table 20: City Network Expansion Scenario 3 Financial Summary: Increase Operating and Staffing Expenses by 25 Percent and Increase Connection Fee to $1,140

Income Statement	Year 1	Year 3	Year 5	Year 10
Total Revenues	$89,000	$355,240	$465,240	$465,240
Total Cash Expenses	(61,600)	(154,600)	(154,600)	(154,600)
Depreciation	(79,700)	(166,400)	(166,400)	(166,400)
Interest Expense	(70,000)	(135,210)	(129,650)	(103,040)
Net Income	$(122,300)	$(100,970)	$14,590	$41,200

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Unrestricted Cash Balance	$36,500	$(7,440)	$101,880	$181,680
Depreciation Operating Reserve	-	64,000	144,000	89,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$36,500	$56,560	$245,880	$270,680

5.5.3 City Network Expansion Scenario 4: Decrease Operating and Staffing Expenses by 25 Percent

Assuming all other factors adhere to the base case, reducing the operating and staffing expenses by 25 percent would have a substantial positive impact on cash flow. As Table 21 below shows, the enterprise would generate a net income of $20,400 in year 10, and the unrestricted cash balance would total almost $364,000 by the end of year 10 in this scenario.

Table 21: City Network Expansion Scenario 4 Financial Summary: Decrease Operating and Staffing Expenses by 25 Percent

Income Statement	Year 1	Year 3	Year 5	Year 10
Total Revenues	$85,000	$340,440	$444,440	$444,440
Total Cash Expenses	(61,600)	(154,600)	(154,600)	(154,600)
Depreciation	(79,700)	(166,400)	(166,400)	(166,400)
Interest Expense	(70,000)	(135,210)	(129,650)	(103,040)
Net Income	$(126,300)	$(115,770)	$(6,210)	$20,400

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Unrestricted Cash Balance	$42,300	$37,260	$185,780	$363,580
Depreciation Operating Reserve	-	64,000	144,000	89,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$42,300	$101,260	$329,780	$452,580

5.5.4 City Network Expansion Scenario 5: Decrease Operating and Staffing Expenses by 25 Percent and Decrease Connection Fee to $1,040

If the operating expenses were to decrease, and the City decided to pass those savings on to users of the network, by decreasing connection fees, the model would still operate cash-positive. As shown in Table 22, the City would generate a net income of $600 by year 10, and the City's cumulative unrestricted cash balance would remain positive throughout the projection, totaling $38,300 at the end of year one, and growing to almost $196,000 by the end of year 10.

Table 22: City Network Expansion Scenario 5 Financial Summary: Decrease Operating and Staffing Expenses by 25 Percent and Decrease Connection Fee to $1,040

Income Statement	Year 1	Year 3	Year 5	Year 10
Total Revenues	$81,000	$324,640	$424,640	$424,640
Total Cash Expenses	(61,600)	(154,600)	(154,600)	(154,600)
Depreciation	(79,700)	(166,400)	(166,400)	(166,400)
Interest Expense	(70,000)	(135,210)	(129,650)	(103,040)
Net Income	$(130,300)	$(131,570)	$(26,010)	$600

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Unrestricted Cash Balance	$38,300	$7,960	$116,880	$195,680
Depreciation Operating Reserve	-	64,000	144,000	89,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$38,300	$71,960	$260,880	$284,680

5.5.5 City Network Expansion Scenario 6: Network Construction Costs Equal "Best Case Scenario"

If the City could maximize the use of its existing conduit, and network implementation costs matched the "best case" estimate from 4.2, the necessary connection fee would reduce to $965 per site, and the amount financed would reduce to $2.27 million.

As Table 23 shows, the enterprise would generate a net income of $17,000 by year 10. The City's cumulative unrestricted cash balance will total $39,300 by the end of year one, growing to almost $97,000 by the end of year five, and over $162,000 by the end of year 10.

Table 23: City Network Expansion Scenario 6 Financial Summary: Network Construction Costs Equal "Best Case Scenario"

Income Statement	Year 1	Year 3	Year 5	Year 10
Total Revenues	$75,000	$301,440	$393,440	$393,440
Total Cash Expenses	(61,600)	(147,600)	(147,600)	(147,600)
Depreciation	(67,400)	(143,200)	(143,200)	(143,200)
Interest Expense	(57,500)	(111,620)	(107,130)	(85,280)
Net Income	$(111,500)	$(100,980)	$(4,490)	$17,360

Cash Flow Statement	Year 1	Year 3	Year 5	Year 10
Unrestricted Cash Balance	$39,300	$2,670	$96,970	$162,420
Depreciation Operating Reserve	-	61,000	139,000	79,000
Debt Service Reserve	-	-	-	-
Total Cash Balance	$39,300	$63,670	$235,970	$241,420

CTC conducted a full analysis of this model. For additional assumptions and scenarios, please see Appendix C.

6 Design and Cost Estimate for FTTP Construction

At the City's request, CTC prepared a high-level network design and cost estimate for deploying a gigabit-capable FTTP network to all homes and businesses in the City. The design and cost estimate are underpinned by data and insight gathered by CTC engineers through discussions with the City and an extensive field and desk survey of the candidate fiber routes.

The cost estimate provides data relevant to assessing the financial viability of network deployment and to developing a business model (including the full range of models for public–private partnerships) for a potential City construction effort. This estimate also enables financial modeling to determine the approximate revenue levels necessary for the City to service any debt incurred in building the network. (See Section 7 for the full financial analysis.)

6.1 Results of Field Survey

A CTC OSP engineer performed a preliminary survey of Wilsonville onsite and via Google Earth Street View to develop estimates of per mile cost for underground (and for aerial where underground is not possible or preferable). The engineer reviewed available green space, necessary make-ready on poles, and pole replacement—all of which have been factored in to the design and cost estimate.

Table 24 summarizes the conditions determined through field and desk survey. The table refers to the two types of population densities used in the FTTP cost estimation model—high and low. (See below for more details.)

Table 24: Field Survey Findings

	High Density	Low Density
Aerial Construction	20%	20%
Poles per Mile	40	40
Moves per Pole	3	2
Poles Requiring Make Ready	8%	8%
Poles Requiring Replacement	2%	2%
Intermediate Rock	2%	2%
Hard Rock	1%	1%

CTC's OSP engineer noted that the quality of the poles and pole attachments in Wilsonville varied, as they do in many cities—but that overall, most poles could support an additional communications attachment with moderate make ready and few would require replacement.

There are three special crossings that impact fiber construction in Wilsonville: Interstate 5 which runs through the City North-South, the railroad which also runs North-South to the West of the Interstate, and the Willamette River.

The City has conduit running underneath I-5 on Wilsonville Road and is planning a second crossing at Boeckman Road.

The City currently has a buried railroad crossing on Wilsonville Rd which contains a 288-strand fiber cable that run from City Hall to the City Fleet Facility on Boberg Road. The City is leasing duct from Integra from Wilsonville Rd to the Facility, which includes a second railroad crossing on Lisbon St. A third track crossing is indicated on city records on Boeckman Road.

The proposed fiber routes for the expansion of the City network and the FTTP network utilize these existing and planned crossings without the need for additional crossings.

6.1.1 Willamette River Crossing

The City's fiber network will need to cross the Willamette River in order to provide service to four water utility locations and to serve the Charbonneau area with an FTTP network. This analysis identified five options for crossing the river:

1. Attaching to the railroad bridge West of Boones Ferry Park;
2. Attaching to the existing aerial crossing at Boones Ferry Road;
3. Attaching to a planned footbridge at Boones Ferry Park;
4. Attaching to the I-5 bridge; or
5. Directional boring underneath the river.

A representative from the City indicated that it would not be feasible or desirable to achieve the crossing by attaching to the I-5 bridge. Of the remaining options, attaching to the planned footbridge may be the most desirable long-term solution because attaching to City-owned infrastructure will provide the City with full control over the fiber and avoid the need for obtaining permits from a third party. However, this option may require accelerating construction of the footbridge or delaying construction of fiber to the desired locations South of the river.

There is an aerial crossing at Boones Ferry Park used by PGE, Frontier, and Comcast. The crossing consists of two 60-foot poles, both of which have room for additional attachments. To cross the river here, the City would need to obtain a pole attachment agreement with PGE to cross the river at this location. There is also an existing pole line which extends from the crossing to Miley Road which other utilities currently use to feed the Charbonneau community.

The City may also be able to bore underneath the riverbed. This option would require locating a suitable space in the PROW for the required drill and conduit.

A final option is for the City to obtain an attachment agreement with the railroad to extend fiber across the river via the rail bridge just West of the aerial crossing.

Figure 14: Location of Existing Aerial Crossing

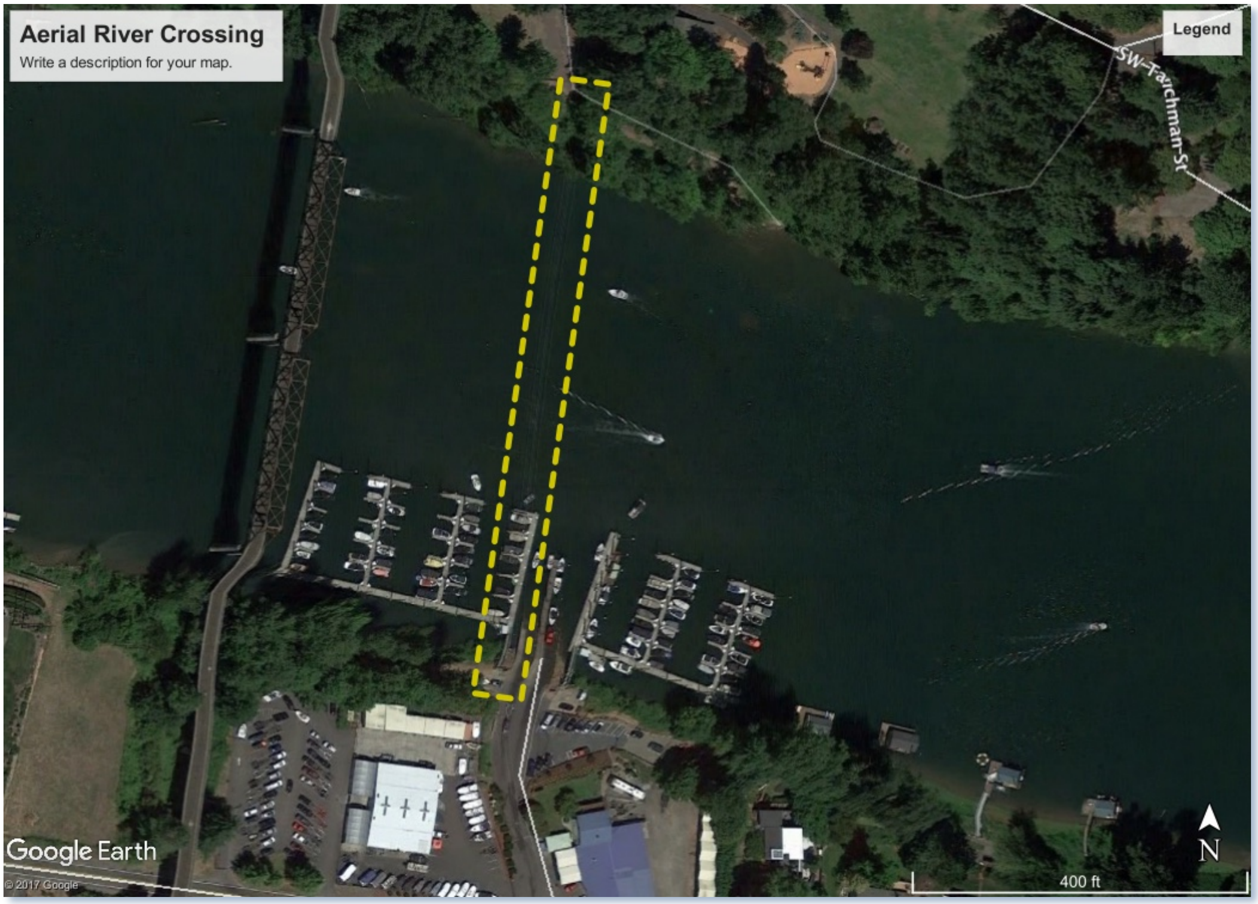


Figure 15: Existing Aerial Crossing

Figure 16: Pole Line to Charbonneau Area

Figure 17: I-5 Bridge River Crossing

6.1.2 New Developments: Coffee Creek, Frog Pond, and Basalt Creek

Three areas were identified by the City as areas of future development: Coffee Creek, Frog Pond, and Basalt Creek. These areas are sparsely developed now. The City should prepare to expand its existing fiber footprint into these areas as they are developed. To accommodate this expansion and allow room for growth, the City should construct two or three 4-inch conduits into these areas, coordinating with other construction efforts to reduce the cost of trenching.

6.2 FTTP Network Design

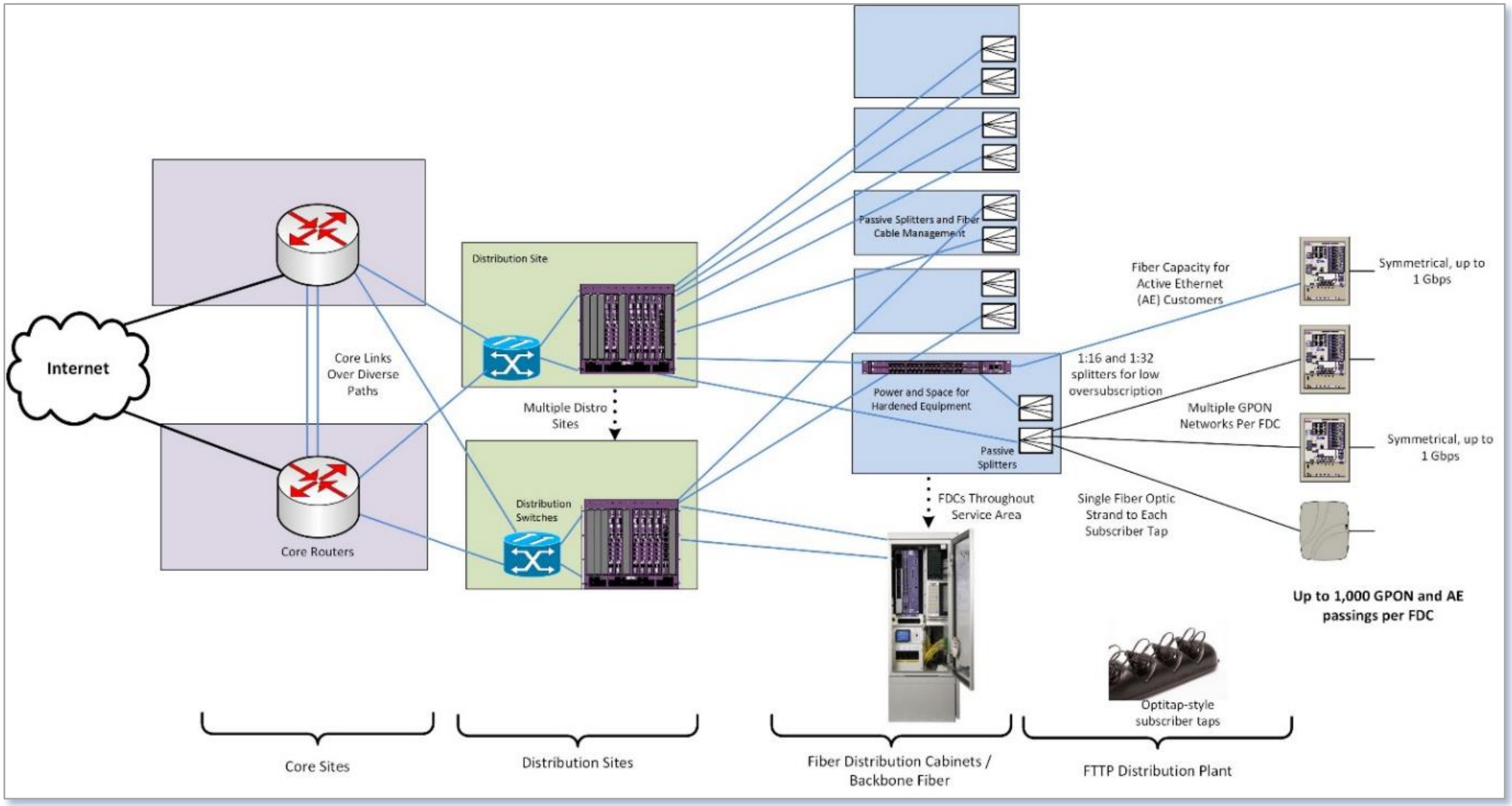
The network's OSP is both the most expensive and the longest lasting portion. The architecture of the physical plant determines the network's scalability for future uses and how the plant will need to be operated and maintained; the architecture is also the main determinant of the total cost of the deployment.

Figure 18 (below) shows a logical representation of the high-level FTTP network architecture recommended in Wilsonville. This design is open to a variety of architecture options. The drawing illustrates the primary functional components in the FTTP network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

The recommended architecture is a hierarchical data network that provides critical scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies. The characteristics of this hierarchical FTTP data network are:

- Capacity – ability to provide efficient transport for subscriber data, even at peak levels
- Availability – high levels of redundancy, reliability, and resiliency; ability to quickly detect faults and re-route traffic
- Failsafe operation – physical path diversity to minimize operational impact resulting from fiber or equipment failure
- Efficiency – no traffic bottlenecks; efficient use of resources
- Scalability – ability to grow in terms of physical service area and increased data capacity, and to integrate newer technologies
- Manageability – simplified provisioning and management of subscribers and services
- Flexibility – ability to provide different levels and classes of service to different customer environments; can support an open access network or a single-provider network; can provide separation between service providers on the physical layer (separate fibers) or logical layer (separate VLAN or VPN providing networks within the network)
- Security – controlled physical access to all equipment and facilities, plus network access control to devices

Figure 18: High-Level FTTP Architecture



This architecture offers scalability to meet long-term needs. It is consistent with best practices for an open access network model that might potentially be required to support multiple network operators, or at least multiple retail service providers requiring dedicated connections to certain customers. This design would support a combination of Gigabit Passive Optical Network (GPON) and direct Active Ethernet services (with the addition of electronics at the fiber distribution cabinets), which would enable the network to scale by migrating to direct connections to each customer, or reducing splitter ratios, on an as-needed basis.

The design assumes placement of manufacturer-terminated fiber tap enclosures within the PROW or easements, providing watertight fiber connectors for customer service drop cables and eliminating the need for service installers to perform splices in the field. This is an industry-standard approach to reducing both customer activation times and the potential for damage to distribution cables and splices. The model also assumes the termination of standard lateral fiber connections within larger multi-tenant business locations and multi-dwelling units (MDU).

6.2.1 Network Design

The network design and cost estimates assume the City will:

- Identify and procure space at two core facilities to house network electronics and provide backhaul to the internet
- Use existing City land to locate 17 distribution hub facilities with adequate environmental and backup power systems to house network electronics
- Use the existing City fiber optics to connect core sites to distribution hubs
- Construct additional fiber or use existing City fiber where available to connect the distribution hubs to fiber distribution cabinets (FDCs)
- Construct fiber optics from the FDCs to each residence and business (i.e., from termination panels in the FDC to tap locations in the PROW or on City easements)
- Construct fiber laterals into large, multi-tenant business facilities and MDUs

Leveraging the City's traffic conduit and fiber resources could decrease the costs associated with both constructing a backbone and identifying locations to house electronics that are near the City's existing resources. However, it is not expected that this will make a large impact on the costs.

The FTTP network and service areas were defined based on the following criteria:

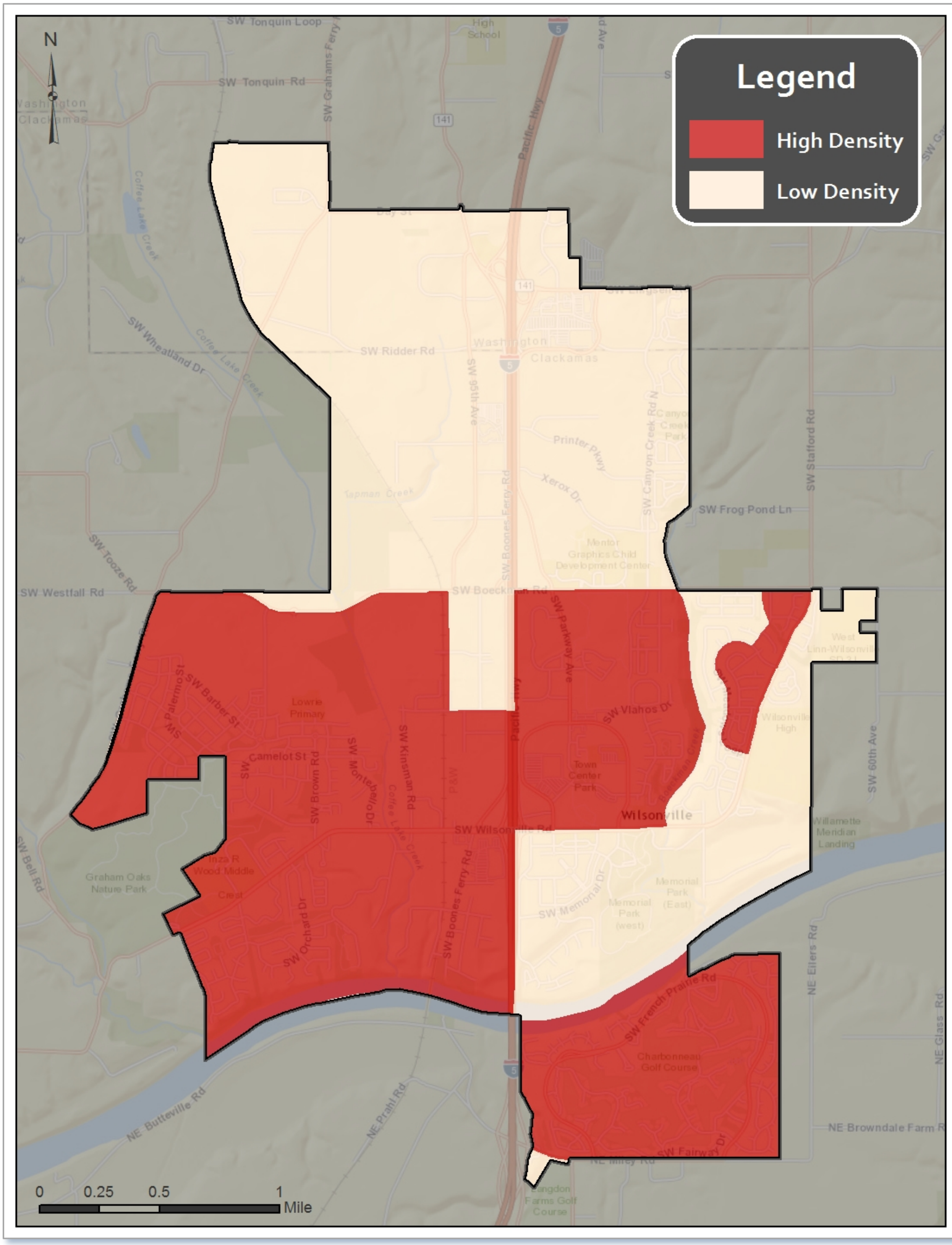
- Targeting 512 passings per FDC

- Service areas defined by passing density and existing utilities and are broken into the categories of high, medium, and low densities
- Multiple FDCs serve each service area
- FDCs suitable to support hardened network electronics, providing backup power and an active heat exchange[50]
- Avoiding the need for distribution plant to cross major roadways, levees, and railways

Coupled with an appropriate network electronics configuration, this design serves to greatly increase the reliability of fiber services compared to those of more traditional cable and telephone networks. The backbone design minimizes the average length of non-diverse distribution plant between the network electronics and each customer, thereby reducing the probability of service outages caused by a fiber break.

[50] These hardened FDCs reflect an assumption that the City's operational and business model will require the installation of provider electronics in the FDCs that can support open access among multiple providers. It should be noted that the overall FTTP cost estimate would decrease if the hardened FDCs were replaced with passive fiber distribution cabinets (which would house only optical splitters) and the providers' electronics were housed only at hub locations.

Figure 19: FTTP Service Areas



The access layer of the network, encompassing the fiber plant from the FDCs to the customers, dedicates a single fiber strand from the FDC to each passing (potential customer address). This traditional FTTP design allows either network electronics or optical splitters in the FDCs. See Figure 20 below for a sample design.

Figure 20: Sample FTTP Access Layer Design

This architecture offers scalability to meet long-term needs, and is consistent with best practices for an open access network model that might potentially be required to support multiple network operators, or at least multiple retail service providers requiring dedicated connections to certain customers.

6.2.2 Network Core and Hub Sites

The core sites are the bridges that link the FTTP network to the public internet and deliver all services to end users. The proposed network design includes two core locations, based on the network's projected capacity requirements and the need for geographical redundancy (i.e., if one core site were to fail, the second core site would continue to operate the network).

The location of core network facilities also provides physical path diversity for subscribers and all upstream service and content providers. The design and cost estimates assume the core sites will be housed in secure locations with diverse connectivity to the internet and the City's existing fiber optic network.

The core locations in this plan will house providers' Operational Support Systems (OSS) such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for FTTP operations. The core locations are also where any business partner or content / service providers will gain access to the subscriber network with their own point-of-presence. This may be via remote connection, but collocation is recommended.

The core locations are typically run in a High Availability (HA) configuration, with fully meshed and redundant uplinks to the public internet and/or all other content and service providers. It is imperative that core network locations are physically secure and allow unencumbered access 24x7x365 to authorized engineering and operational staff.

The operational environment of the network core and hub locations is similar to that of a data center. This includes clean power sources, UPS batteries, and diesel power generation for survival through sustained commercial outages. The facility must provide strong physical security, limited/controlled access, and environmental controls for humidity and temperature. Fire suppression is highly recommended.

Equipment is to be mounted securely in racks and cabinets, in compliance with national, state, and local codes. Equipment power requirements and specification may include -48-volt DC and/or 120/240 volts AC. All equipment is to be connected to conditioned / protected clean power with uninterrupted cutover to battery and generator.

The cost estimate assumes that the core facilities would be in leased data centers and distribution hubs will be located at existing City facilities with land for a telecommunications shelter.

6.2.3 Distribution and Access Network Design

The distribution network is the layer between the hubs and the fiber distribution cabinets (FDCs, which provide the access links to the taps). The distribution network aggregates traffic from the FDCs to the core. Fiber cuts and equipment failures have progressively greater operational impact as they happen closer to the network core, so it is critical to build in redundancies and physical path diversities in the distribution network, and to seamlessly re-route traffic when necessary.

The distribution and access network design proposed in this report is flexible and scalable enough to support two different architectures:

1. Housing both the distribution and access network electronics at the hubs, and using only passive devices (optical splitters and patches) at the FDCs
2. Housing the distribution network electronics at the hubs and pushing the access network electronics further into the network by housing them at the FDCs

By housing all electronics at the hubs, the network will not require power at the FDCs. Choosing a network design that only supports this architecture may reduce costs by allowing smaller, passive FDCs in the field. However, this architecture will limit the redundancy capability from the FDCs to the hubs.

By pushing the network electronics further into the field, the network gains added redundancy by allowing the access electronics to connect to both hub sites. In the event one hub has an outage the subscribers connected to the FDC would still have network access. Choosing a network design that only supports this architecture may reduce costs by reducing the size of the hubs.

Selecting a design that supports both models would allow the City to accommodate many different service operators and their network designs. This design would also allow service providers to start with a small deployment (i.e., placing electronics only at the hub sites) and grow by pushing electronics closer to their subscribers.

6.2.3.1 Access Network Technologies

FDCs can sit on a curb, be mounted on a pole, or reside in a building. The model recommends installing sufficient FDCs to support higher than anticipated levels of subscriber penetration. This approach will accommodate future subscriber growth with minimal re-engineering. Passive optical splitters are modular and can be added to an existing FDC as required to support subscriber growth, or to accommodate unanticipated changes to the fiber distribution network with potential future technologies.

Figure 21: Fiber Distribution Cabinet

The FTTP design also includes the placement of indoor FDCs and splitters to support MDUs. This would require obtaining the right to access the equipment for repairs and installation in whatever timeframe is required by the service agreements with the customers. Lack of access would potentially limit the ability to perform repairs after normal business hours, which could be problematic for both commercial and residential services.

This model assumes the use of GPON electronics for the majority of subscribers and Active Ethernet for a small percentage of subscribers (typically business customers) that request a premium service or require greater bandwidth. GPON is the most commonly provisioned FTTP service—used, for example, by Verizon (in its FiOS systems), Google Fiber, and Chattanooga EPB.

Furthermore, providers of gigabit services typically provide these services on GPON platforms. Even though the GPON platform is limited to 1.2 Gbps upstream and 2.4 Gbps downstream for the subscribers connected to a single PON, operators have found that the variations in actual subscriber usage generally means that all subscribers can obtain 1 Gbps on demand (without provisioned rate-limiting), even if the capacity is aggregated at the PON. Furthermore, many GPON manufacturers have a development roadmap to 10 Gbps and faster speeds as user demand increases.

GPON supports high-speed broadband data, and is easily leveraged by triple-play carriers for voice, video, and data services. The GPON OLT uses single-fiber (bi-directional) SFP modules to support multiple (most commonly less than 32) subscribers.

GPON uses passive optical splitting, which is performed inside fiber distribution cabinets (FDC), to connect fiber from the OLTs to the customer premises. The FDCs house multiple optical splitters, each of which splits the fiber link to the OLT between 16 to 32 customers (in the case of GPON service).

Active Ethernet (AE) provides a symmetrical (up/down) service that is commonly referred to as Symmetrical Gigabit Ethernet. AE can be provisioned to run at sub-gigabit speeds, and like GPON easily supports legacy voice, voice over IP, and video. AE is typically deployed for customers who require specific service level agreements that are easier to manage and maintain on a dedicated service.

For subscribers receiving Active Ethernet service, a single dedicated fiber goes directly to the subscriber premises with no splitting. Because AE requires dedicated fiber (home run) from the OLT to the CPE, and because each subscriber uses a dedicated SFP on the OLT, there is significant cost differential in provisioning an AE subscriber versus a GPON subscriber.

The fiber plant is designed to provide Active Ethernet service or PON service to all passings. The network operator selects electronics based on the mix of services it plans to offer and can modify or upgrade electronics to change the mix of services.

6.2.3.2 Expanding the Access Network Bandwidth

GPON is currently the most commonly provisioned FTTP technology, due to inherent economies when compared with technologies delivered over home-run fiber[51] such as Active Ethernet. The cost differential between constructing an entire network using GPON and Active Ethernet is 40 percent to 50 percent.[52] GPON is used to provide services up to 1 Gbps per subscriber and is part of an evolution path to higher-speed technologies that use higher-speed optics and wave-division multiplexing.

This model provides many options for scaling capacity, which can be done separately or in parallel:

1. Reducing the number of premises in a PON segment by modifying the splitter assignment and adding optics—for example, by reducing the split from 16:1 to 4:1, the per-user capacity in the access portion of the network is quadrupled

[51] Home run fiber is a fiber optic architecture where individual fiber strands are extended from the distribution sites to the premises. Home run fiber does not use any intermediary aggregation points in the field.
[52] "Enhanced Communications in San Francisco: Phase II Feasibility Study," CTC report, October 2009, at p. 205.

2. Adding higher-speed PON protocols can be accomplished by adding electronics at the FDC or hub locations; since these use different frequencies than the GPON electronics, none of the other CPE would need to be replaced.

3. Adding WDM-PON electronics as they become widely available, which will enable each user to have the same capacity as an entire PON; again, these use different frequencies than GPON and are not expected to require replacement of legacy CPE equipment

4. Option 1 could be taken to the maximum, and PON replaced by a 1:1 connection to electronics—an Active Ethernet configuration

These upgrades would all require complementary upgrades in the backbone and distribution Ethernet electronics, as well as in the upstream internet connections and peering—but they would not require increased fiber construction.

6.2.3.3 Customer Premises Equipment and Subscriber Services

In the final segment of the FTTP network, fiber runs from the FDC to customers' homes, apartments, and office buildings, where it terminates at the subscriber tap—a fiber optic housing located in the PROW closest to the premises. The service installer uses a pre-connectorized drop cable to connect the tap to the subscriber premises without the need for fiber optic splicing.

The drop cable extends from the subscriber tap (either on the pole or underground) to the building, enters the building, and connects to CPE.

6.3 Cost Estimate Breakdown

The cost components for OSP construction include the following tasks:

- ***Engineering*** – includes system level architecture planning, preliminary designs and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction "as-built" revisions to engineering design materials. The OSP engineering is estimated at $1.8 million.

- ***Quality Control / Quality Assurance*** – includes expert quality assurance field review of final construction for acceptance. The quality control/quality assurance is estimated at $940,000.

- ***General OSP Construction*** – consists of all labor and materials related to "typical" underground or aerial OSP construction, including conduit placement, utility pole make-ready construction, aerial strand installation, fiber installation, and surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities. General OSP construction is estimated at $11.9 million.

- ***Special Crossings*** – consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate / controlled access highways. This also includes the necessary costs for levee crossing and encroachments. Special crossings are estimated at $167,000.

- ***Backbone and Distribution Plant Splicing*** – includes all labor related to fiber splicing of outdoor fiber optic cables. Backbone and distribution plant splicing is estimated at $397,000.

- ***Backbone Hub, Termination, and Testing*** – consists of the material and labor costs of placing hub shelters and enclosures, terminating backbone fiber cables within the hubs, and testing backbone cables. The backbone hub, termination, and testing is estimated at $977,000.

- ***FTTP Service Drop and Lateral Installations –*** consists of all costs related to fiber service drop installation, including OSP construction on private property, building penetration, and inside plant construction to a typical backbone network service "demarcation" point; also includes all materials and labor related to the termination of fiber cables at the demarcation point. A take-rate of 35 percent was assumed for standard fiber service drops. The lateral costs are estimated at $16.2 million. At a 35 percent take rate, drop costs add $4.3 million.

6.4 Summary of FTTP Cost Estimates

CTC's projections estimate that it will cost more than $23.7 million to deploy a ubiquitous FTTP network under a lit model in which the City directly serves end users with a 1 Gbps, or Gigabit, data service.[53]

If the City pursues a dark model in which it deploys FTTP OSP (including drop cables) but a private partner is responsible for network electronics and CPE, and for serving end users, the total deployment cost for the City would be approximately $20.5 million.

6.4.1 Lit FTTP Cost Estimate

The full, lit FTTP network deployment will cost more than $23.5 million, assuming a 35 percent take rate. That cost is inclusive of OSP construction labor, materials, engineering, permitting, pole attachment licensing, network electronics, drop installation, CPE, and testing.[54] The cost per passing is $1,966 on average.

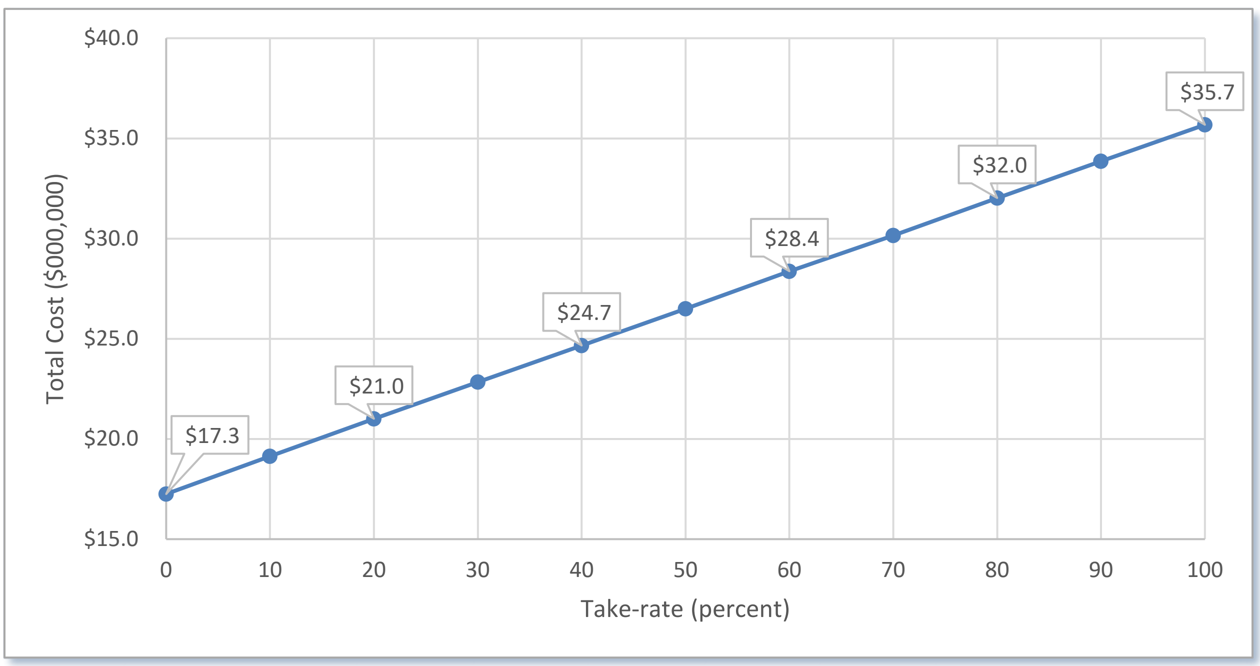
[53] That cost estimate reflects only the cost of construction; it does not include the ongoing costs of operations.
[54] The estimated total cost breakdown assumes a percentage of residents and businesses that subscribe to the service, otherwise known as the penetration rate or the "take rate," of 35 percent. This is within the range of

Table 25: Estimated Lit FTTP Cost

Cost Component	Total Estimated Cost
OSP	$16,218,000
Central Network Electronics	1,437,000
FTTP Service Drop and Lateral Installations	4,243,000
CPE	1,829,000
Total Estimated Cost:	$23,727,000

Figure 22 shows the total estimated cost by varying the expected take rate. The cost is roughly linear by take rate as the cost of adding additional subscribers is a fixed cost.

Figure 22: Total Estimated Cost versus Take Rate



Actual costs may vary due to factors that cannot be precisely known until the detailed design is completed, or until construction commences. These factors include: 1) costs of private easements, 2) utility pole replacement and make ready costs, 3) variations in labor and material costs, 4) subsurface hard rock, and 5) the City's operational and business model. This analysis has

penetration rate that may exist in a market where both the cable and telephone companies also provide broadband service.

incorporated suitable assumptions to address these items based on CTC's experience in similar markets.

The total cost of operations will also vary with the business model chosen and the level of existing resources that can be leveraged by the City and any potential business partners.

6.4.2 Dark FTTP Cost Estimate

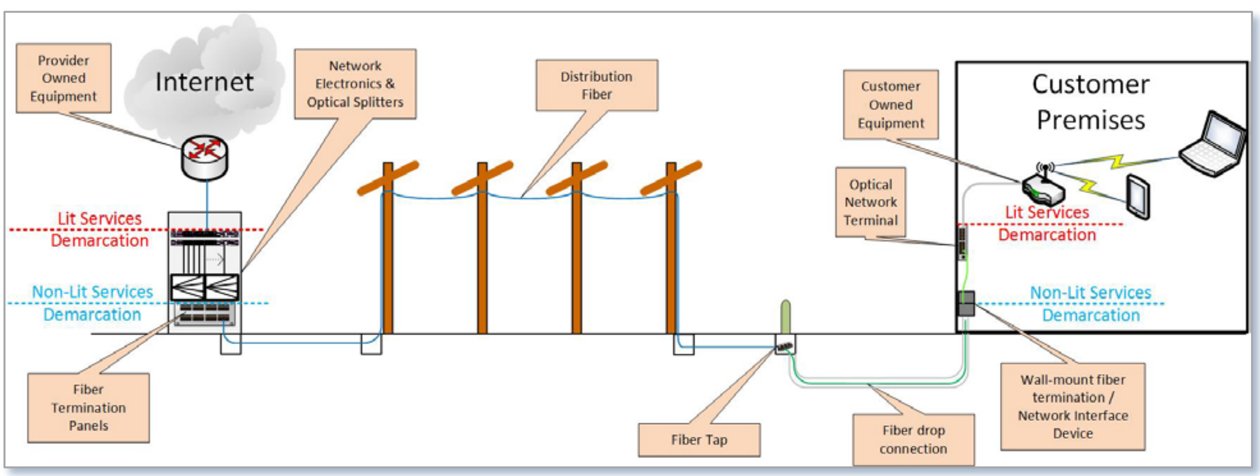
A dark version of the FTTP network deployment will cost about $20.5 million, inclusive of OSP construction labor, materials, engineering, permitting, pole attachment licensing, and lateral drop and materials. This estimate does not include any electronics or subscriber equipment.

Table 26: Estimated Dark FTTP Cost

Cost Component	Total Estimated Cost
OSP	$16,218,000
FTTP Service Drop and Lateral Installations	4,243,000
Total Estimated Cost:	$20,461,000

This estimate assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point (a network interface device) at each residence and business, and leases the dark fiber backbone, distribution, and drop fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

Figure 23: Demarcation Between City and Partner Network Elements in the Lit and Dark Models



6.5 Detailed Cost Estimates for Lit FTTP Construction

This section provides a summary of cost estimates for construction of an FTTP network to all City residents and businesses. This deployment will cost more than $23.7 million, inclusive of OSP construction labor, materials, engineering, permitting, pole attachment licensing, network electronics, drop installation, CPE, and testing.

The costs are described in detail below.

Table 27: Breakdown of Estimated Cost (Lit Model With 35 Percent Take Rate)

Cost Component	Total Estimated Cost
OSP	$16.2 million
Central Network Electronics	1.4 million
FTTP Service Drop and Lateral Installations	4.3 million
CPE	1.8 million
Total Estimated Cost:	$23.7 million

6.5.1 OSP Cost Estimation Methodology

As with any utility, the design and associated costs for construction vary with the unique physical layout of the service area—no two streets are likely to have the exact same configuration of fiber optic cables, communications conduit, underground vaults, and utility pole attachments. Costs are further varied by soil conditions, such as the prevalence of subsurface hard rock; the condition of utility poles and feasibility of "aerial" construction involving the attachment of fiber infrastructure to utility poles; and crossings of bridges, railways, and highways.

To estimate costs, this analysis extrapolated the costs for strategically selected sample designs on the basis of street mileage and passings. Specifically, CTC's engineers developed sample FTTP designs to generate costs per passing for two types of population densities: high and low.

CTC's observations determined that, for the medium underground and low-density areas, utilities are primarily underground, but the low-density areas require more construction of fiber to reach a smaller number of homes in an area.

Downtown business districts in high-density urban areas tend to have underground utilities; utilities are predominantly aerial in urban residential areas (although the poles there tend to require more make ready). Low-density areas tend to have the greatest variation in the percentages of aerial versus underground construction. Generally, the newest subdivisions and developments tend to be entirely underground, whereas older neighborhoods have a mixture of aerial and underground construction. Many areas also tend to have rear easements for utilities, which can increase the cost of construction due to restricted access to the utility poles.

The assumptions, sample designs, and cost estimates were used to extrapolate a cost per passing for the OSP. This number was then multiplied by the number of passings in each area based on the City's GIS data. The actual cost to construct FTTP to every premises in the City could differ from the estimate due to changes in the assumptions underlying the model. For example, if access to the utility poles is not granted or make-ready and pole replacement costs are too high, the network would have to be constructed underground—which could significantly increase the cost of construction. Alternatively, if the City were able to partner with a local telecommunications provider and overlash to existing pole attachments, the cost of the build could be significantly lower. Further and more extensive analysis would be required to develop a more accurate cost estimate across the entire City.

6.5.2 OSP

In terms of OSP, the estimated cost to construct the proposed FTTP network is $16.2 million, or $1,970 per passing.[55] As discussed above, the model assumes primarily underground fiber construction in keeping with City policy. Table 28 provides a breakdown of the estimated OSP costs by type of area. (Note that the costs have been rounded.)

Table 28: Estimated OSP Costs

Area	Distribution Plant Mileage	Total Cost	Passings	Cost per Passing	Cost Per Plant Mile
Entire City	124	$16.2 million	8,249	$1,970	$130,000
High Density	72	$9.9 million	6,499	$1,530	$138,000
Low Density	52	$6.3 million	1,750	$3,600	$121,000

Costs for underground placement were estimated using available unit cost data for materials and estimates on the labor costs for placing, pulling, and boring fiber based on construction in comparable markets.

[55] The passing count includes individual single-unit buildings and units in small multi-dwelling and multi-business buildings as single passings. It treats larger buildings as single passings.

The material costs were generally known with the exception of unknown economies of scale and inflation rates, and barring any sort of phenomenon restricting material availability and costs. The labor costs associated with the placement of fiber were estimated based on similar construction projects.

Aerial construction entails the attachment of fiber infrastructure to existing utility poles, which could offer significant savings compared to all-underground construction, but increases uncertainty around cost and timeline. The utility pole owners can impose costs related to pole remediation and "make-ready" construction that can make aerial construction cost-prohibitive in comparison to underground construction.

While generally allowing for greater control over timelines and more predictable costs, underground construction is subject to uncertainty related to congestion of utilities in the public rights-of-way and the prevalence of subsurface hard rock—neither of which can be fully mitigated without physical excavation and/or testing. While anomalies and unique challenges will arise regardless of the design or construction methodology, the relatively large scale of this project is likely to provide ample opportunity for variations in construction difficulty to yield relatively predictable results on average.

This analysis assumes underground construction will consist primarily of horizontal, directional drilling to minimize PROW impact and to provide greater flexibility to navigate around other utilities. The design model assumes a single two-inch, High-Density Polyethylene (HDPE) flexible conduit over underground distribution paths, and dual two-inch conduits over underground backbone paths to provide scalability for future network growth.

6.5.3 Central Network Electronics Costs

Central network electronics will cost an estimated $1.4 million, or $175 per passing, based on an assumed take-rate of 35 percent.[56] (These costs may increase or decrease depending on take rate and the costs may be phased in as subscribers are added to the network.) The central network electronics consists of the electronics to connect subscribers to the FTTP network at the core, hubs, and cabinets. Table 29 below lists the estimated costs for each segment.

[56] The take rate affects the electronics and drop costs, but also may affect other parts of the network, as the City may make different design choices based on the expected take rate. A 35 percent take rate is typical of environments where a new provider joins the telephone and cable provider in a City. CTC's financial analysis examines how the feasibility of the project depends on a range of take rates.

Table 29: Estimated Central Network Electronics Costs

Network Segment	Subtotal	Passings	Cost per Passing
Core and Distribution Electronics (Sections 6.5.3.1)	$825,000	8,249	$100
FTTP Access Electronics (Section 6.5.3.2)	$612,000	8,249	$75
Central Network Electronics Total	$1,437,000	8,249	$175

6.5.3.1 Core Electronics

The core electronics connect the hub sites and connect the network to the internet. The core electronics consist of high performance routers, which handle all of the routing on both the FTTP network and to the internet. The core routers should have modular chassis to provide high availability in terms of redundant components and the ability to "hot swap"[57] line cards and modular in the event of an outage. Modular routers also provide the ability to expand the routers as demand for additional bandwidth increases.

The cost estimate design envisions redundant rings between the core sites running networking protocols such as hot standby routing protocol (HSRP) to ensure redundancy in the event of a core failure. Additional rings can be added as network bandwidth on the network increases. The core sites would also tie to both hubs using 10 Gbps links. The links to the hubs can also be increased with additional 10 Gbps and 40 Gbps line cards and optics as demand grows on the network. The core networks will also have 40 Gbps to internet service providers that connect the FTTP network to the internet.

The cost of the core routing equipment for the two core sites is $825,000. These costs do not include the service provider's Operational Support Systems (OSS) such as provisioning platforms, fault and performance management systems, remote access, and other operational support systems for FTTP operations. The services providers and/or their content providers may already have these systems in place.

6.5.3.2 Distribution and Access Electronics

The access network electronics at the FDCs connect the subscribers' CPE to the FTTP network. The CTC analysis recommends deploying access network electronics that can support both GPON and Active Ethernet subscribers to provide flexibility within the FDC service area. It is also recommended to deploy modular access network electronics for reliability and the ability to add

[57] A "hot swappable" line card can be removed and reinserted without the entire device being powered down or rebooted. The control cards in the router should maintain all configurations and push them to a replaced line card without the need for reconfirmation.

line cards as more subscribers join in the service area. Modularity also helps reduce initial capital costs while the network is under construction or during the roll out of the network.

The cost of the access network electronics for the network is $612,000. These costs are based on a take rate of 35 percent and include optical splitters at the FDCs for that take-rate.

6.5.4 Customer Premises Equipment and Service Drop Installation (Per Subscriber Costs)

CPE are the subscriber's interface to the FTTP network. This cost estimate selected CPE that provide only Ethernet data services (however, there are a wide variety of CPE offering other data, voice, and video services). Using the estimated take rate of 35 percent, this analysis estimated the CPE for customers will be $1.8 million.

Each activated subscriber would also require a fiber drop cable installation and related electronics, which would cost roughly $2,030 per subscriber, or $5.9 million total (assuming a 35 percent take rate).

The drop installation cost is the biggest variable in the total cost of adding a subscriber. A short aerial drop can cost as little as $250 to install, whereas a long underground drop installation can cost upward of $3,000. (This includes an estimated average of $1,397 per drop installation.)

The other per-subscriber expenses include the cost of the optical network terminal (ONT) at the premises, a portion of the optical line termination (OLT) costs at the hub, the labor to install and configure the electronics, and the incidental materials needed to perform the installation. The numbers provided in the table below are averages and will vary depending on the type of premises and the internal wiring available at each premises.

Table 30: Per Subscriber Cost Estimates

Construction and Electronics Required to Activate a Subscriber	Estimated Average Cost
Drop Installation and Materials	$1,397
Subscriber Electronics (ONT and OLT)	330
Electronics Installation	200
Installation Materials	100
Total	**$2,027**

7 Financial Analysis for FTTP Deployment

Significant financial considerations beyond implementation costs will dictate the City's ability to deploy an FTTP network. This section examines the financial implications of deploying an FTTP network throughout the City under two distinct models:

- A "Municipal Retail" model, in which the City deploys, lights, manages, and maintains a fiber network in the City; and acts as an ISP to serve subscribers.
- A "Dark Fiber Lease" model, in which the City deploys dark fiber throughout the City, and partners with a private entity that "lights" the fiber and acts as an ISP. Two potential variations of this model are presented, distinguishing between ownership of the fiber drops that run from the right-of-way into customers' premises:
  - The "Huntsville Model", in which the private partner funds, constructs, and owns the fiber drops, and
  - The "Westminster Model," in which the City funds, constructs, and owns the fiber drops.

7.1 Municipal Retail Model

The financial analysis in this section assumes the City owns, operates, and provides retail voice, video, and data services to residents and businesses in the community. This financial analysis is based on a number of assumptions (outlined below and further detailed in Appendix D).

Please note that a "flat-model" is used in the analysis (i.e., it did not include inflation and salary cost increases because it is assumed that these operating cost increases will be offset and passed on to subscribers in the form of increased prices). Models that add an inflation factor to both revenues and expenses typically greatly overstate future cash flow because net revenues are unlikely to increase as quickly as inflation. At best, the provider will be able to match expenses increases with a dollar-for-dollar rate increase, which is what the flat model represents.

The model assumes that subscribership for data services will ramp up over years one through four, and then remain steady. The model assumes that subscribership for voice and video services will ramp up over the same period, but then decline as adoption of over-the-top (OTT) alternatives increases.

7.1.1 Municipal Retail Model Base Case Financial Projections

The financial model is designed to be cash flow positive in year one; which is accomplished through bond financing. Over time, given the cost to construct, maintain, and operate the FTTP network, the model indicates that a 63 percent take rate of households and businesses passed will be required to maintain positive cash flow.[58] Please note that these are solely financial calculations; the degree to which this required take-rate is realistic has not been evaluated as part of this analysis.

The analysis assumes the City offers four data services:

- A 1 Gbps residential service at $100 per month
- A 1 Gbps small commercial service at $120 per month
- A 1 Gbps medium commercial service (with service-level agreements) at $350 per month[59]
- A 10 Gbps transport-only commercial service at $2,500 per month[60]

These prices reflect what is necessary to generate enough revenue to operate cash positive. It should be noted, however, that these prices are higher than Google's and Ting Internet's 1 Gbps services, which are $70 and $89 per month, respectively.

It is assumed 25 percent of business customers will purchase the medium service, while 5 percent of business customers will purchase the 10 Gbps transport-only service.

It also assumed that the City will offer video and data services through a service partner. For video, this analysis assumes that customers will pay an average package price of $80 per month, and that the City will receive $12.00 per subscriber. For telephone, it is assumed that two services are offered—a residential service at $20 per month and a business line at $40 per month—and that the City will receive $5 per month and $10 per month, respectively.

A financial summary for this model is included in Table 31.

[58] Based on the cost estimate in Section 6.6.
[59] Medium commercial service receives a lower oversubscription rate, that is, less customers sharing the connection, decreasing the instances of network congestion reducing overall speeds.
[60] Transport-only service does not include DIA.

Table 31: Municipal Retail Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$561,540	$8,359,800	$8,242,200	$8,242,200	$8,242,200
Total Cash Expenses	(1,583,140)	(4,156,030)	(4,067,240)	(4,067,240)	(4,067,240)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,306,600)	$60,350	$596,260	$1,215,990	$1,992,140

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$27,700	$506,810	$1,603,740	$2,826,490	$4,051,610
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	560,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,259,700	$3,693,750	$5,140,070	$4,790,960	$6,205,820

7.1.2 Municipal Retail Model Base Case Financing

This financial analysis assumes that the City will finance the network by seeking a series of bonds. This analysis estimates total financing requirements to be $34.1 million via a series of 20-year bonds issued in the first three years.[61] These bonds are issued at a 6 percent finance rate and principal payments start in the third year after issuance. This analysis also assumes that a debt service reserve of five percent and an interest reserve account is required.

The model assumes a straight-line depreciation of assets, and that the OSP will have a 20-year life span while the network equipment will need to be replaced after 10 years. CPE as well as other miscellaneous implementation costs will need to be replaced every five years. Network equipment, including last mile and CPE will be replaced or upgraded at 80 percent of its original cost, miscellaneous implementation costs (test equipment, vehicles, computers) will be at 100 percent. The model plans for a depreciation reserve account, starting in year three, to fund future electronics replacements and upgrades.

Table 32 shows the income statement for years one, five, 10, 15, and 20. The City's net income is about negative $2.3 million in year one, and just over $60,000 in year five. By year 10, the operation will generate a net income just over $596,000, growing to just over $1.2 million in year 15, and almost $2 million in year 20.

[61] The scope of work for this report does not include a review of the City's bonding capability or review of local or state bonding restrictions. A more detailed review and opinion from the City's accountants of bonding capability and restrictions is recommended if bonding is pursued.

Table 32: Municipal Retail Model Base Case Income Statement

Income Statement		Year 1	Year 5	Year 10	Year 15	Year 20
Revenues						
Video		$156,480	$1,105,920	$1,105,920	$1,105,920	$1,105,920
Internet - Residential		296,400	5,925,600	5,925,600	5,925,600	5,925,600
Internet - Business		55,560	925,080	925,080	925,080	925,080
Voice		33,600	403,200	285,600	285,600	285,600
Connection Fee (net)		19,500	-	-	-	-
Ancillary Revenues		-	-	-	-	-
	Total	$561,540	$8,359,800	$8,242,200	$8,242,200	$8,242,200
Content Fees						
Video		$130,560	$938,400	$938,400	$938,400	$938,400
Internet		72,000	285,990	285,990	285,990	285,990
Voice		25,200	302,400	214,200	214,200	214,200
	Total	$227,760	$1,526,790	$1,438,590	$1,438,590	$1,438,590
Operating Costs						
Operation Costs		$462,880	$1,194,240	$1,193,650	$1,193,650	$1,193,650
Labor Costs		892,500	1,435,000	1,435,000	1,435,000	1,435,000
	Total	$1,355,380	$2,629,240	$2,628,650	$2,628,650	$2,628,650
EBITDA		$(1,021,600)	$4,203,770	$4,174,960	$4,174,960	$4,174,960
Depreciation		613,000	2,179,320	2,048,110	2,004,070	2,004,070
Operating Income (EBITDA less Depreciation)		$(1,634,600)	$2,024,450	$2,126,850	$2,170,890	$2,170,890
Non-Operating Income						
Interest Income		$-	$7,970	$8,840	$4,910	$5,390
Interest Expense (20 Year Bond)		(672,000)	(1,972,070)	(1,539,430)	(959,810)	(184,140)
	Total	$(672,000)	$(1,964,100)	$(1,530,590)	$(954,900)	$(178,750)
Net Income (before taxes)		$(2,306,600)	$60,350	$596,260	$1,215,990	$1,992,140
Facility Taxes		$ -	$ -	$ -	$ -	$ -
Net Income		$(2,306,600)	$60,350	$596,260	$1,215,990	$1,992,140

Table 33 shows the cash flow statement for years one, five, 10, 15, and 20. The cumulative unrestricted cash balance is approximately $28,000 at the end of year one and just over $1.6 million by the end of year 10. By the end of year 15, the unrestricted cash balance is $2.8 million; it is just over $4 million by the end of year 20.

Table 33: Municipal Retail Model Base Case Cash Flow Statement

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Net Income	$(2,306,600)	$60,350	$596,260	$1,215,990	$1,992,140
b. Cash Outflows					
Debt Service Reserve	$(560,000)	$-	$-	$-	$-
Interest Reserve	(1,344,000)	-	-	-	-
Depreciation Reserve	-	(740,970)	(696,360)	(681,380)	(681,380)
Financing	(112,000)	-	-	-	-
Capital Expenditures	(8,134,700)	-	-	-	-
Total	$(10,150,700)	$(740,970)	$(696,360)	$(681,380)	$(681,380)
c. Cash Inflows					
Interest Reserve	$672,000	$12,000	$ -	$ -	$ -
20-Year Bond Proceeds	11,200,000	-	-	-	-
Total	$11,872,000	$12,000	$ -	$ -	$ -
d. Total Cash Outflows and Inflows	$1,721,300	$(728,970)	$(696,360)	$(681,380)	$(681,380)
e. Non-Cash Expenses - Depreciation	$613,000	$2,179,320	$2,048,110	$2,004,070	$2,004,070
f. Adjustments					
Proceeds from Additional Cash Flows (20 Year Bond)	$(11,200,000)	$-	$-	$-	$-
g. Adjusted Available Net Revenue	$(11,172,300)	$1,510,700	$1,948,010	$2,538,680	$3,314,830
h. Principal Payments on Debt					
20 Year Bond Principal	$-	$1,272,480	$1,713,710	$2,293,330	$3,069,000
Total	$-	1,272,480	1,713,710	2,293,330	3,069,000
i. Net Cash	$27,700	$238,220	$234,300	$245,350	$245,830
j. Cash Balance					
Unrestricted Cash Balance	$27,700	$506,810	$1,603,740	$2,826,490	$4,051,610
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	560,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,259,700	$3,693,750	$5,140,070	$4,790,960	$6,205,820

Please see Appendix D for a complete income statement, cash flow statement, and capital addition statement.

7.1.3 Municipal Retail Model Base Case Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment, material and construction labor associated with building, implementing, and lighting a fiber network. Table 34 shows the capital additions costs in years one through four, assuming a 63 percent take rate, or about 4,950 customers.

This analysis projects that capital additions in year one will total approximately $8.1 million. These costs will total just under $10.9 million in year two, over $8 million in year three, and almost $2.7 million in year four.

Table 34: Municipal Retail Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3	Year 4
Network Equipment				
Core & GPON Equipment	$2,202,000	$ -	$ -	$ -
Additional Annual Capital	-	-	-	-
Total	$2,202,000	$ -	$ -	$ -
Outside Plant and Facilities				
Total Backbone and FTTP	$4,928,400	$8,214,000	$3,285,600	$ -
Additional Annual Capital	-	-	-	-
Total	$4,928,400	$8,214,000	$3,285,600	$ -
Last Mile and Customer Premises Equipment				
CPE (residential and small commercial)	$161,300	$806,400	$1,450,900	$807,000
CPE (medium commercial)	2,100	11,900	20,300	11,200
CPE (enterprise)	700	2,100	4,200	2,100
Average Drop Cost	363,200	1,816,100	3,266,200	1,816,100
Additional Annual Replacement Capital	-	-	-	-
Total	$527,300	$2,636,500	$4,741,600	$2,636,400
Miscellaneous Implementation Costs				
OSS	$200,000	$ -	$ -	$ -
Vehicles	35,000	35,000	35,000	35,000
Service Equipment	50,000	-	-	-
Work Station, Computers, and Software	17,000	9,000	-	2,000
Fiber OTDR and Other Tools	50,000	-	-	-
Billing Software	75,000	-	-	-
Fiber Management Software	50,000	-	-	-
Additional Annual Capital	-	-	-	-
Total	$477,000	$44,000	$35,000	$37,000
Total Capital Additions	$8,134,700	$10,894,500	$8,062,200	$2,673,400

7.1.4 Municipal Retail Model Base Case Operating and Maintenance Expenses

The cost to deploy an FTTP network goes far beyond fiber implementation. Network deployment requires additional staffing for sales and marketing, network operations, and other functions new to the City. The addition of new staff will require new office space. Similarly, network inventory requirements will require warehousing space. The City will need to:

- Expand existing office facilities for management, technical, and clerical staff,

- Open a retail "storefront" to facilitate customer contact and enhance their experience doing business with the FTTP enterprise,[62]
- Provide warehousing for receipt and storage of cable and hardware for the installation and ongoing maintenance of the broadband infrastructure, and
- Establish a location to house servers, switches, routers, and other core network equipment

Training new and existing staff is important to fully realize the economies of starting the FTTP network. The training will be particularly important in the short-term as the new enterprise establishes itself as a unique entity providing services distinct from City services provided today.

Marketing and sales are critical, and will represent a new activity for the City. It is important to be proactive in setting customer expectations, addressing security concerns, and educating customers on how to initiate services.

Staffing with skills in the following disciplines will be required:

- Sales/Promotion
- Internet and related technologies
- Staff Management
- Strategic Planning
- Finance
- Vendor Negotiations
- Networking (addressing, segmentation)
- Marketing

The expanded business and increased responsibilities will require the addition of new staff. The initial additional positions, staffing levels, and base salaries are shown in Table 35. These numbers assume two shifts of customer service representative support and 1.5 shifts of customer technicians. Changing to full 24x7 staffing will increase costs. Similarly, reducing the support hours (e.g., to 7 a.m. to 8 p.m.) will decrease the required staffing.

Note that Table 35 lists only new employees—the model assumes no existing staff will be allocated to the enterprise. Please note that the listed salaries do not include overhead. The model added 40 percent overhead to the base salaries.

[62] Due to the size of the enterprise, CTC assumes the City will use existing City facilities for office space and a "storefront," which will not require lease fees.

Table 35: Municipal Retail Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3	Year 4+	Year 1 Salary
Business Manager	0.50	1.00	1.00	1.00	$130,000
Marketing & Sales Manager	0.50	1.00	1.00	1.00	$100,000
GIS & Recordkeeping	0.50	1.00	1.00	1.00	$85,000
Network Engineer	0.50	1.00	1.00	1.00	$110,000
Network Technicians	0.50	1.00	1.00	1.00	$80,000
Sales & Marketing Representatives	2.00	2.00	2.00	2.00	$60,000
Customer Service Representatives	1.00	2.00	2.00	2.00	$65,000
Service Technicians/Installers & IT Support	1.00	1.00	1.00	1.00	$75,000
HR, Administration & Support	-	-	-	-	$75,000
Call Center Support	1.00	1.00	1.00	1.00	$55,000
Fiber Plant O&M Technicians	1.00	2.00	2.00	2.00	$80,000
Total	8.50	13.00	13.00	14.00	

Additional key operating and maintenance assumptions include:

- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated to be $2,400 in year one and $4,800 from year two on
- Office expenses are estimated to be $6,000 in year one and $12,000 from year two on
- Locates and ticket processing are estimated to start in year one at $71,300, increase to $356,400 in year two, and increase to $712,900 from year three on
- Peering expenses are estimated at $8,900 in year one, $44,700 in year two, and $89,400 in year three on
- Contingency is estimated to be $10,000 in year one and $15,000 from year two on
- Legal fees are estimated to be $100,000 in year one, and $15,000 from year two on
- Consulting fees are estimated at $75,000 in year one and $10,000 from year two on
- Marketing and promotional expenses are estimated to be $150,000 annually

Vendor maintenance contract fees are expected to start at $330,800 in year two and remain steady from year two on (based upon 10 percent of accrued investment). Annual variable operating expenses not including direct internet access include:

- Education and training are calculated as 2 percent of direct payroll expense ($17,850 in year one, and $28,700 in year two on)
- Allowance for bad debts is computed as 0.5 percent of revenues

- Churn is anticipated to be 6 percent annually, which initiates a $175 per subscriber acquisition cost.

The estimated cost of electronic billing for the new FTTP enterprise is $0.75 per bill. This is in addition to the $75,000 cost for the billing software, which will need to be updated every five years.[63]

Fiber network maintenance costs are calculated at 1 percent of the total construction cost, per year. This is estimated based on a typical rate of occurrence in an urban environment, and the cost of individual repairs. These costs will total $52,950 in year one, $153,220 in year two, $218,740 in year three, and roughly $236,900 in year four on. This is in addition to staffing costs to maintain the fiber.

Table 36 shows operating expenses for years one, five, 10, 15, and 20. As seen, some expenses will remain constant while others will increase as the network expands and the customer base increases.

[63] Replacement value estimated at 80 percent of the original cost.

Table 36: Municipal Retail Model Base Case Operating Expenses and P&I Payments

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Support Services	$-	$-	$-	$-	$-
Insurance	25,000	50,000	50,000	50,000	50,000
Utilities	2,400	4,800	4,800	4,800	4,800
Office Expenses	6,000	12,000	12,000	12,000	12,000
Facility Lease	-	-	-	-	-
Locates & Ticket Processing	8,900	89,400	89,400	89,400	89,400
Peering	4,500	89,100	89,100	89,100	89,100
Contingency	10,000	15,000	15,000	15,000	15,000
Billing Maintenance Contract	-	-	-	-	-
Fiber & Network Maintenance	52,920	236,900	236,900	236,900	236,900
Vendor Maintenance Contracts	-	330,800	330,800	330,800	330,800
Legal	100,000	15,000	15,000	15,000	15,000
Planning	-	-	-	-	-
Consulting	75,000	10,000	10,000	10,000	10,000
Marketing	150,000	150,000	150,000	150,000	150,000
Education and Training	16,310	25,620	25,620	25,620	25,620
Customer Handholding	-	-	-	-	-
Customer Billing (Unit)	2,240	44,560	44,560	44,560	44,560
Allowance for Bad Debts	2,700	39,770	39,210	39,210	39,210
Churn (acquisition costs)	2,610	51,990	51,990	51,990	51,990
Pole Attachment Expense	2,230	14,880	14,880	14,880	14,880
Video	122,400	897,600	897,600	897,600	897,600
Internet	72,000	273,260	273,260	273,260	273,260
Enterprise	2,230	14,880	14,880	14,880	14,880
Voice	25,200	289,800	205,200	205,200	205,200
Sub-Total	$690,640	$2,721,030	$2,632,240	$2,632,240	$2,632,240
Labor Expenses	$892,500	$1,435,000	$1,435,000	$1,435,000	$1,435,000
Sub-Total	$892,500	$1,435,000	$1,435,000	$1,435,000	$1,435,000
Total Expenses	$1,583,140	$4,156,030	$4,067,240	$4,067,240	$4,067,240
Principal and Interest	$672,000	$3,236,580	$3,244,300	$3,248,230	$3,247,750
Facility Taxes	-	-	-	-	-
Sub-Total	$672,000	$3,236,580	$3,244,300	$3,248,230	$3,247,750
Total Expenses, P&I, and Taxes	$2,255,140	$7,392,610	$7,311,540	$7,315,470	$7,314,990

The City’s operating and maintenance expenses, including P&I payments will total roughly $2.3 million in year one, grow to almost $7.4 million in year five, and decrease to roughly $7.3 million in years 10 through 20.

7.1.5 Municipal Retail Model Sensitivity Scenarios

This section demonstrates how even small fluctuations in the three largest operating expense items (staffing costs, vendor maintenance costs, and DIA) can affect the financial modeling (i.e., the take rate required for positive cash flow).

Note that some of these scenarios may not be realistically attainable. They are meant to demonstrate the sensitivity of the financial projections to these assumptions.

These effects are important to understand and consider when reviewing partnership opportunities. It is important that a partner be able to offer savings in these categories as compared to the base case assumptions used in the analysis.

7.1.5.1 Base Case

As previously noted, the base case shows that a 63 percent take rate is required to maintain cash flow. [64] Table 37 below shows a financial summary for this scenario.

Table 37: Municipal Retail Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$561,540	$8,359,800	$8,242,200	$8,242,200	$8,242,200
Total Cash Expenses	(1,583,140)	(4,156,030)	(4,067,240)	(4,067,240)	(4,067,240)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,306,600)	$60,350	$596,260	$1,215,990	$1,992,140

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$27,700	$506,810	$1,603,740	$2,826,490	$4,051,610
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	560,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,259,700	$3,693,750	$5,140,070	$4,790,960	$6,205,820

7.1.5.2 Scenario 2: Take Rate Drops to 50 Percent

If the take rate were to drop to 50 percent of the total passings in the City, the enterprise would quickly turn from an unrestricted cash balance of about $41,000 at the end of year one to a negative cash balance. By the end of year five, the unrestricted cash balance deficit would be almost $2.8 million, growing to a deficit of almost $13.9 million by the end of year 20.

[64] Indicates take rate in year 4. The take rate declines slightly over time due to the reduction of video and voice subscribers.

Table 38: Municipal Retail Model Scenario 2 Financial Summary: Take Rate Drops to 50 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$458,445	$6,626,640	$6,530,640	$6,530,640	$6,530,640
Total Cash Expenses	(1,551,760)	(3,733,790)	(3,661,310)	(3,661,310)	(3,661,310)
Depreciation	(572,020)	(1,930,950)	(1,826,830)	(1,788,910)	(1,788,910)
Interest Expense	(648,000)	(1,811,520)	(1,410,070)	(878,720)	(162,910)
Taxes	-	-	-	-	-
Net Income	$(2,313,335)	$(849,620)	$(367,570)	$201,700	$917,510

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$41,385	$(2,799,255)	$(6,565,625)	$(10,225,555)	$(13,880,435)
Depreciation Reserve	-	1,313,040	1,847,410	733,280	1,135,950
Interest Reserve	648,000	-	-	-	-
Debt Service Reserve	540,000	1,575,000	1,575,000	1,575,000	1,575,000
Total Cash Balance	$1,229,385	$88,785	$(3,143,215)	$(7,917,275)	$(11,169,485)

7.1.5.3 Scenario 3: Take Rate Increases to 70 Percent

If the take rate were to increase to 70 percent of the total passings, the City would need to increase the amount financed to $35.3 million. If all other assumptions were to remain the same, the enterprise would be able to operate cash positive, generating an unrestricted cumulative cash balance of $93,000 by the end of year one, and $14.3 million by the end of year 20.

Table 39: Municipal Retail Model Scenario 3 Financial Summary: Take Rate Increases to 70 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$627,510	$9,277,920	$9,145,920	$9,145,920	$9,145,920
Total Cash Expenses	(1,604,900)	(4,363,970)	(4,264,310)	(4,264,310)	(4,264,310)
Depreciation	(618,900)	(2,292,470)	(2,146,690)	(2,102,650)	(2,102,650)
Interest Expense	(678,000)	(2,034,730)	(1,586,480)	(990,030)	(186,010)
Taxes	-	-	-	-	-
Net Income	$(2,274,290)	$586,750	$1,148,440	$1,788,930	$2,592,950

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$93,010	$2,395,955	$6,259,915	$10,256,345	$14,253,595
Depreciation Reserve	-	1,558,880	1,793,870	98,250	164,230
Interest Reserve	678,000	-	-	-	-
Debt Service Reserve	565,000	1,765,000	1,765,000	1,765,000	1,765,000
Total Cash Balance	$1,336,010	$5,719,835	$9,818,785	$12,119,595	$16,182,825

7.1.5.4 Scenario 4: Staffing and Operating Expenses Decrease by 10 Percent

As described above, the City's operating and staffing expenses are considerable. Assuming all other factors adhere to the base case, reducing the operating and staffing expenses by 10 percent would have a substantial positive impact on cash flow. As the table below shows, unrestricted cash balance would total almost $11.7 million by year 20 in this scenario.

Table 40: Municipal Retail Model Scenario 4 Financial Summary: Staffing and Operating Expenses Decrease by 10 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$561,540	$8,359,800	$8,242,200	$8,242,200	$8,242,200
Total Cash Expenses	(1,367,280)	(3,763,960)	(3,675,230)	(3,675,230)	(3,675,230)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,090,740)	$452,420	$988,270	$1,608,000	$2,384,150

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$243,560	$2,254,230	$5,311,240	$8,494,040	$11,679,210
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	565,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,475,560	$5,441,170	$8,847,570	$10,458,510	$13,833,420

7.1.5.5 Scenario 5: Staffing and Operating Expenses Increase by 10 Percent

On the other side of that equation, if the City's operating and staffing expenses were to rise by 10 percent over the base, the enterprise would face large deficits over time. As the table below shows, the unrestricted cash balance deficit in this scenario would be roughly $2.4 million by year 10 and over $4.1 million by year 20.

Table 41: Municipal Retail Model Scenario 5 Financial Summary: Staffing and Operating Expenses Increase by 10 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$561,540	$8,359,800	$8,242,200	$8,242,200	$8,242,200
Total Cash Expenses	(1,816,850)	(4,576,800)	(4,487,960)	(4,487,960)	(4,487,960)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,540,310)	$(360,420)	$175,540	$795,270	$1,571,420

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(206,010)	$(1,373,270)	$(2,379,970)	$(3,260,820)	$(4,139,300)
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	565,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,025,990	$1,813,670	$1,156,360	$(1,296,350)	$(1,985,090)

7.1.5.6 Scenario 6: Residential Internet Fee Increases by $5 per Month

If the City increases the residential internet fee by $5 (to $105 per month), the increased revenue would enable the enterprise to operate with increased cash flow, finishing year one with an unrestricted cash balance of $42,000, year 10 with an unrestricted cash balance of almost $4 million, and year 20 with almost $9.4 million.

Table 42: Municipal Retail Model Scenario 6 Financial Summary: Residential Internet Fee Increases by $5 per Month

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$576,360	$8,656,080	$8,538,480	$8,538,480	$8,538,480
Total Cash Expenses	(1,583,210)	(4,157,510)	(4,068,720)	(4,068,720)	(4,068,720)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,291,850)	$355,150	$891,060	$1,510,790	$2,286,940

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$42,450	$1,420,710	$3,991,640	$6,688,390	$9,387,510
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	565,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,274,450	$4,607,650	$7,527,970	$8,652,860	$11,541,720

7.1.5.7 Scenario 7: Residential Internet Fee Decreases by $5 per Month

If competitive pressure were to force the City to decrease the residential internet fee by $5 (to $95 per month), the decreased revenue would result in an unsustainable operation. As shown in the table below, the City would finish year one with an unrestricted cash balance just under $13,000. By year five, the model generates a deficit of over $407,000, which will grow to a deficit of almost $1.3 million by the end of year 20.

Table 43: Municipal Retail Model Scenario 7 Financial Summary: Residential Internet Fee Decreases by $5 per Month

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$546,720	$8,063,520	$7,945,920	$7,945,920	$7,945,920
Total Cash Expenses	(1,583,060)	(4,154,550)	(4,065,760)	(4,065,760)	(4,065,760)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,321,340)	$(234,450)	$301,460	$921,190	$1,697,340

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$12,960	$(407,080)	$(784,150)	$(1,035,400)	$(1,284,280)
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	565,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,244,960	$2,779,860	$2,752,180	$929,070	$869,930

7.1.5.8 Scenario 8: Reduce Telephone and Cable Television Contribution Margins by 50 Percent

If telephone and cable television contribution margins were to decrease by 50 percent, the City's expenses would be slightly higher than the base case, but the model will still operate cash positive with no increase in the necessary take rate. As shown below, the City's cumulative unrestricted cash balance is just over $16,100 by the end of year one, which would grow to $785,800 by the end of year 10, and $2.4 million by the end of year 20.

Table 44: Municipal Retail Model Scenario 8 Financial Summary: Reduce Telephone and Cable Television Contribution Margins by 50 Percent

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$561,540	$8,359,800	$8,242,200	$8,242,200	$8,242,200
Total Cash Expenses	(1,594,660)	(4,238,830)	(4,150,040)	(4,150,040)	(4,150,040)
Depreciation	(613,000)	(2,179,320)	(2,048,110)	(2,004,070)	(2,004,070)
Interest Expense	(672,000)	(1,964,100)	(1,530,590)	(954,900)	(178,750)
Taxes	-	-	-	-	-
Net Income	$(2,318,120)	$(22,450)	$513,460	$1,133,190	$1,909,340

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$16,180	$102,890	$785,820	$1,594,570	$2,405,690
Depreciation Reserve	-	1,481,940	1,831,330	259,470	449,210
Interest Reserve	672,000	-	-	-	-
Debt Service Reserve	565,000	1,705,000	1,705,000	1,705,000	1,705,000
Total Cash Balance	$1,248,180	$3,289,830	$4,322,150	$3,559,040	$4,559,900

7.2 FTTP Dark Fiber Lease Models

This section investigates the feasibility of two potential network models. Both are fully FTTP network buildouts where the City would construct and maintain ubiquitous infrastructure to every residence and business and lease the fiber backbone and distribution fiber to a private partner. The private partner would be responsible for all network electronics and CPE—as well as network sales, marketing, and operations.

The fundamental difference between the two models concerns drop cables, or the fiber cable which runs from the distribution fiber in the PROW into the customer's home or business.

In the first model, presented in Section 7.2.1, the City would be responsible for constructing backbone and distribution fiber up to the PROW, while the private partner would construct the drop cable into the home or business. Since the last-mile connection would be funded by the private partner, the number of subscribers (and thus the number of drop cables) will not affect the City's financial commitment. As such, fiber lease payments to the City for this model will be based solely on the number of passings in the network.

This model is similar to the agreement between the city of Huntsville, AL and Google. This analysis has included reference and comparison to Huntsville's agreement with Google to demonstrate the terms and fees with which another jurisdiction could acquire a private partner.

The second model, presented in Section 7.2.2, proposes a scenario where the City would be responsible for constructing and maintaining both distributional fiber and drop cable infrastructure. Since this model presents significant additional costs to the City, the fiber lease fees would have a two-tiered structure—one fee for the number of passings in the network as well as an additional fee for each subscriber. This subscriber fee helps offset the cost of fiber drops, and only applies to premises where drops have been constructed. Each home and business who wishes to subscribe to the services provided by the partner would need a City-funded drop cable installed, and as such, the financial viability of the model is heavily dependent upon the total customer take rate.

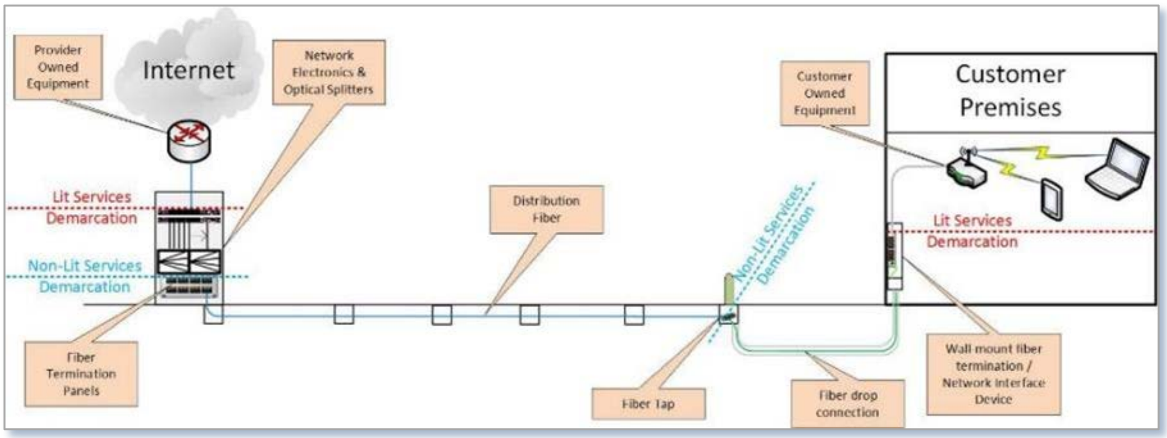
The city of Westminster, Maryland, and Ting Internet agreed to a similar structure; discussion of their terms and pricing is included as an example of the implications of this model.

Multiple scenarios are included for each model to demonstrate potential options the City can consider, as well as to illustrate funding and financing concerns. All the models in this analysis represent the minimum requirements for the City to maintain positive cash flow over the course of 20 years; in each one, higher partner lease fees than in both Huntsville and Westminster are necessary.

7.2.1 Huntsville Model (FTTP Dark Fiber Lease Not Including Drop Cable Costs)

The first model assumes that the City constructs and owns network infrastructure throughout the City area up to a demarcation point in the PROW, and leases the dark fiber backbone and distribution fiber to a private partner. This demarcation is illustrated in Figure 24, with City network elements located between the two blue lines.

Figure 24: Demarcation Between City and Partner Network Elements (Huntsville Model)



In this model, the private partner would be responsible for constructing drop cables into each subscriber's home or business; network electronics and CPE; and network sales, marketing, and operations. It should be noted that network electronics and CPE are significant additional expenses for the private partner to consider, and as such, the City should bear them in mind when negotiating pricing with potential partners.

The financial analysis presented here represents a minimum requirement for the City to obtain a break-even cash flow each year. A complete financial model is provided in Excel format that can be leveraged to show the impact of changing assumptions. The spreadsheet can be an important tool for the City to use if it negotiates with a private partner.

Please note that "flat model" is used in the analysis, which means that inflation and operating cost increases (including salaries) are not used because it is assumed that operating cost increases will be offset by increases in operator lease payments over time (and likely passed on to subscribers in the form of increased prices). This analysis anticipates that the City will apply an inflation factor, typically based on a CPI, to the portion of the per-subscriber fee that covers projected operating expenses during negotiations with a private partner.

These financial projections do not include any economic development or other indirect benefits, which are often not easily quantifiable.

In this modeling, CTC compared a similar FTTP deployment in the city of Huntsville, Alabama, where Huntsville Utilities negotiated a monthly per-passing fee of $7.50 in its contract with Google Fiber.

This reference is included to demonstrate what pricing is attractive enough to incent partnership, the financial implications of that pricing, and what Huntsville pricing would look like in relation to network deployment costs for the City. In all models, the required per-passing fees are higher than Huntsville's partnership, while charging similar lease fees paid by Google in Huntsville will result in cumulative cash deficits greater than $37.1 million over 20 years.

A base case scenario for this model is included, along with three alternate scenarios, demonstrating the effects of increased startup funding on necessary partner lease fees, as well as the implication of the City using the fees Google pays Huntsville.

7.2.1.1 Huntsville Model Base Case

The base case scenario presents what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs.

To cover construction costs and maintain a positive cash flow, the City would need to charge a private partner $30.75 per month per passing, for a total of 8,249 commercial and residential passings. This lease fee is 4.1 times the fee Huntsville and Google agreed upon.

As Table 45 shows, this model will operate cash-positive, generating a net income of $177,900 in year five, and growing to almost $1.2 million in year 20. The City will finish year one with an unrestricted cash balance of over $38,700, which will grow to $2.2 million by the end of year 10, and $4.9 million by the end of year 20.

Table 45: Huntsville Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$243,540	$3,043,880	$3,043,880	$3,043,880	$3,043,880
Total Cash Expenses	(417,360)	(902,460)	(902,460)	(902,460)	(902,460)
Depreciation	(284,220)	(867,000)	(867,000)	(867,000)	(867,000)
Interest Expense	(390,000)	(1,096,450)	(854,850)	(531,640)	(99,160)
Taxes	-	-	-	-	-
Net Income	$(848,040)	$177,970	$419,570	$742,780	$1,175,260

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$38,780	$878,570	$2,210,020	$3,542,690	$4,876,570
Depreciation Reserve	-	130,060	227,210	324,360	421,510
Interest Reserve	390,000	-	-	-	-
Debt Service Reserve	325,000	955,000	955,000	955,000	955,000
Total Cash Balance	$753,780	$1,963,630	$3,392,230	$4,822,050	$6,253,080

7.2.1.2 Huntsville Model Financing

This financial analysis assumes that the City will cover its capital requirements through seeking a series of 20-year bonds. This analysis expects that the City will take will take three 20-year bonds—one each in years one, two, and three—for a total of $19.1 million in financing. It assumes the City's bond rate would be 6 percent.

The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment. The resulting P&I payments will be the major factor in determining the City's long-term financial requirements; P&I accounts for roughly 66 percent of the City's annual costs in the base case model after the construction period.

It is projected that the bond issuance costs will be equal to 1 percent of the principal borrowed. It is assumed that neither debt service nor interest reserves need to be maintained for the lifetime of the bond. Principal repayment on the bonds will start in year three.

A detailed income statement is included in Table 46.

Table 46: Huntsville Model Base Case Income Statement

Income Statement		Year 1	Year 5	Year 10	Year 15	Year 20
Revenues						
Per Passing		$243,540	$3,043,880	$3,043,880	$3,043,880	$3,043,880
	Total	$243,540	$3,043,880	$3,043,880	$3,043,880	$3,043,880
Operating Costs						
Operation Costs		$154,860	$377,460	$377,460	$377,460	$377,460
Labor Costs		262,500	525,000	525,000	525,000	525,000
	Total	$417,360	$902,460	$902,460	$902,460	$902,460
EBITDA		$(173,820)	$2,141,420	$2,141,420	$2,141,420	$2,141,420
Depreciation		284,220	867,000	867,000	867,000	867,000
Operating Income (EBITDA less Depreciation)		$(458,040)	$1,274,420	$1,274,420	$1,274,420	$1,274,420
Non-Operating Income						
Interest Income		$-	$2,710	$2,960	$3,200	$3,440
Interest Expense (20 Year Bond)		(390,000)	(1,099,160)	(857,810)	(534,840)	(102,600)
	Total	$(390,000)	$(1,096,450)	$(854,850)	$(531,640)	$(99,160)
Net Income (before taxes)		$(848,040)	$177,970	$419,570	$742,780	$1,175,260
Facility Taxes		$ -	$ -	$ -	$ -	$ -
Net Income		$(848,040)	$177,970	$419,570	$742,780	$1,175,260

This base case results in a net income of negative $848,000 in year one. By year five, it will generate a positive net income of almost $178,000, which will grow to just under $1.2 million by year 20.

A cash flow statement is included in Table 47.

Table 47: Huntsville Model Base Case Cash Flow Statement

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Net Income	$(848,040)	$177,970	$419,570	$742,780	$1,175,260
b. Cash Outflows					
Debt Service Reserve	$(325,000)	$-	$-	$-	$-
Interest Reserve	(780,000)	-	-	-	-
Depreciation Reserve	-	(65,030)	(65,030)	(65,030)	(65,030)
Financing	(65,000)	-	-	-	-
Capital Expenditures	(5,117,400)	-	-	-	-
Total	$(6,287,400)	$(65,030)	$(65,030)	$(65,030)	$(65,030)
c. Cash Inflows					
Interest Reserve	$390,00	$ -	$ -	$ -	$ -
20-Year Bond Proceeds	114,800,000	-	-	-	-
Total	$114,800,000	$ -	$ -	$ -	$ -
d. Total Cash Outflows and Inflows	$602,600	$(65,030)	$(65,030)	$(65,030)	$(65,030)
e. Non-Cash Expenses - Depreciation	$284,220	$867,000	$867,000	$867,000	$867,000
f. Adjustments					
Proceeds from Additional Cash Flows (20 Year Bond)	$(6,500,000)	$ -	$ -	$ -	$ -
g. Adjusted Available Net Revenue	$(6,461,220)	$979,940	$1,221,540	$1,544,750	$1,977,230
h. Principal Payments on Debt					
20 Year Bond Principal	$ -	$713,590	$954,940	$1,277,910	$1,710,150
Total	$ -	$713,590	$954,940	$1,277,910	$1,710,150
i. Net Cash	$38,780	$266,350	$266,600	$266,840	$267,080
j. Cash Balance					
Unrestricted Cash Balance	$38,780	$878,570	$2,210,020	$3,542,690	$4,876,570
Depreciation Reserve	-	130,060	227,210	324,360	421,510
Interest Reserve	390,000	-	-	-	-
Debt Service Reserve	325,000	955,000	955,000	955,000	955,000
Total Cash Balance	$753,780	$1,963,630	$3,392,230	$4,822,050	$6,253,080

This base case keeps the City operating with a positive cumulative unrestricted cash balance totaling just under $39,000 at the end of year one, and growing to $2.2 million by the end of year 10, and $4.9 million by the end of year 20.

Please see Appendix E for a complete income statement, cash flow statement, and capital addition statement.

7.2.1.3 Huntsville Model Base Case Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building a fiber network. (Again, because the City's responsibility will be limited to OSP, no costs for fiber drops or core network equipment are included.)

This analysis projects that the capital additions (including vehicles and test equipment) in year one will total approximately $5.1 million. These costs will total approximately $8.3 million in year two, $3.3 million in year three. This totals roughly $16.7 million in capital additions for years one through three.

These costs are illustrated in Table 48.

Table 48: Huntsville Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3
Outside Plant and Facilities			
Total Backbone and FTTP	$4,928,400	$8,214,000	$3,285,600
Additional Annual Capital	-	-	-
Total	$4,928,400	$8,214,000	$3,285,600
Miscellaneous Implementation Costs			
Splicing	$ -	$ -	$ -
Vehicles	35,000	35,000	-
Service Equipment	50,000	-	-
Work Station, Computers, and Software	4,000	4,000	-
Fiber OTDR and Other Tools	50,000	-	-
Fiber Management Software	50,000	-	-
Additional Annual Capital	-	-	-
Total	$189,000	$39,000	$-
Total Annual Capital Additions	$5,117,400	$8,253,000	$3,285,600

7.2.1.4 Huntsville Model Base Case Operating and Maintenance Expenses

The cost to deploy a dark FTTP network goes far beyond fiber implementation. Network deployment requires sales and marketing, network maintenance and technical operations, and other functions. This model assumes the City's partner will be responsible for lighting the fiber and selling service. As such, the City's financial requirements are limited to expenses related to OSP infrastructure and network administration.

The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span while network test equipment will need to be replaced after five years.

These expanded responsibilities will require the addition of new staff. It is assumed the City will add a total of four full-time-equivalent (FTE) positions within the first three years, and will then maintain that level of staffing. Assumptions that underpin this analysis include:

- 1 FTE business manager & HR position
- 1 FTE GIS & record keeping position
- 2 FTE fiber plant operating & maintenance technicians

Salaries and benefits are based on estimated market wages, and benefits are estimated at 40 percent of base salary. Salaries (including benefits) are summarized in Table 49.

Table 49: Huntsville Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3+	Labor Cost
Business Manager & HR	0.50	1.00	1.00	130,000
GIS & Record Keeping	0.50	1.00	1.00	85,000
Fiber Plant O&M Technicians	1.00	2.00	2.00	80,000
Total New Staff	2	4	4	

Additional key operating and maintenance assumptions include the following:

- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated at $1,200 in year one and $2,400 in year two on
- Office expenses are estimated to be $3,000 in year one and $6,000 annually in year two on
- Locates and ticket processing are estimated at $8,900 in year one, $44,700 in year two, and $89,400 in year three on
- Contingency is estimated at $10,000 in year one and $15,000 in year two on
- Fiber and network maintenance are calculated at one percent of the total construction cost, per year (roughly $49,200 in year one, $131,400 in year two, and $164,300 in year three on) in addition to staffing costs to maintain the fiber
- Legal fees are estimated to be $30,000 in year one, reducing to $15,000 in year two on
- Consulting fees are estimated at $20,000 in year one, reducing to $10,000 in year two on
- Education and training are estimated at just over $5,300 in year one, and $10,500 in year two on

- Pole attachments are estimated at just over $2,200 in year one, $8,200 in year two, $13,400 in year three and $14,900 in year four on.

These expenses, as well as P&I payments, are shown in Table 50.

Table 50: Huntsville Model Base Case Operating and Maintenance Expenses

Operating Expenses & P&I	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$25,000	$50,000	$50,000	$50,000	$50,000
Utilities	1,200	2,400	2,400	2,400	2,400
Office Expenses	3,000	6,000	6,000	6,000	6,000
Locates & Ticket Processing	8,900	89,400	89,400	89,400	89,400
Contingency	10,000	15,000	15,000	15,000	15,000
Fiber & Network Maintenance	49,280	164,280	164,280	164,280	164,280
Legal	30,000	15,000	15,000	15,000	15,000
Consulting	20,000	10,000	10,000	10,000	10,000
Education and Training	5,250	10,500	10,500	10,500	10,500
Pole Attachment Expense	2,230	14,880	14,880	14,880	14,880
Sub-Total	$154,860	$377,460	$377,460	$377,460	$377,460
Labor Expenses	$262,500	$525,000	$525,000	$525,000	$525,000
Sub-Total	$262,500	$525,000	$525,000	$525,000	$525,000
Total Expenses	$417,360	$902,460	$902,460	$902,460	$902,460
Principal and Interest	$390,000	$1,810,040	$1,809,790	$1,809,550	$1,809,310
Facility Taxes	-	-	-	-	-
Sub-Total	$390,000	$1,810,040	$1,809,790	$1,809,550	$1,809,310
Total Expenses, P&I, and Taxes	$807,360	$2,712,500	$2,712,250	$2,712,010	$2,711,770

The City's total operating and maintenance expenses (including P&I payments) will total just over $800,000 in year one, and roughly $2.7 million annually in years five on.

7.2.1.5 Huntsville Model Sensitivity Scenarios

This section demonstrates demonstrate how even small fluctuations in assumptions can affect the financial modeling (i.e., increased startup funding, and using the fees Huntsville charged Google).

Note that some of these scenarios may not be realistically attainable. They are meant to demonstrate the sensitivity of the financial projections to these assumptions.

These effects are important to understand and consider when reviewing partnership opportunities. It is important that a partner be able to offer savings in these categories as compared to the base case assumptions used in the analysis.

7.2.1.5.1 Huntsville Model Base Case

As previously noted, the base case shows that a partner lease fee of $30.75 per passing is required to maintain cash flow. This fee is 4.1 times the fee agreed upon in Huntsville. A financial summary for this model is included in Table 51.

Table 51: Huntsville Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$243,540	$3,043,880	$3,043,880	$3,043,880	$3,043,880
Total Cash Expenses	(417,360)	(902,460)	(902,460)	(902,460)	(902,460)
Depreciation	(284,220)	(867,000)	(867,000)	(867,000)	(867,000)
Interest Expense	(390,000)	(1,096,450)	(854,850)	(531,640)	(99,160)
Taxes	-	-	-	-	-
Net Income	$(848,040)	$177,970	$419,570	$742,780	$1,175,260

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$38,780	$878,570	$2,210,020	$3,542,690	$4,876,570
Depreciation Reserve	-	130,060	227,210	324,360	421,510
Interest Reserve	390,000	-	-	-	-
Debt Service Reserve	325,000	955,000	955,000	955,000	955,000
Total Cash Balance	$753,780	$1,963,630	$3,392,230	$4,822,050	$6,253,080

7.2.1.5.2 Huntsville Model Scenario 2: Obtain $5 Million in Startup Funding

The second scenario proposes use of $5 million in startup funding to lower the required partner lease fees. These funds would be from cash reserves, grants, or other sources that would not need to be repaid.[65] The total amount financed would reduce accordingly, totaling $12.4 million. All other assumptions remained the same as the base case.

In this scenario, the City would be able to charge the partner $24.00 per passing per month, or 3.2 times that of the fees paid by Google in Huntsville.

Table 52 presents a summarized income and cash flow statement for this scenario. As shown, the City would eventually operate cash-positive, generating a net income around $45,000 in year 10, which would grow to roughly $542,000 by year 20. The City's cumulative unrestricted cash balance would be a deficit in years one and five, but would finish year 10 at over $1 million, growing to $3.3 million by the end of year 20.

[65] This scenario is for illustration only; there is no guarantee that such funding would be available to the City.

Table 52: Huntsville Model Scenario 2 Financial Summary: Obtain $5 Million in Startup Funding

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$190,080	$2,375,710	$2,375,710	$2,375,710	$2,375,710
Total Cash Expenses	(417,360)	(902,460)	(902,460)	(902,460)	(902,460)
Depreciation	(284,220)	(867,000)	(867,000)	(867,000)	(867,000)
Interest Expense	(24,000)	(719,680)	(561,000)	(348,740)	(64,750)
Taxes	-	-	-	-	-
Net Income	$(535,500)	$(113,430)	$45,250	$257,510	$541,500

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(16,680)	$(38,330)	$1,061,890	$2,163,320	$3,265,960
Depreciation Reserve	-	130,060	227,210	324,360	421,510
Interest Reserve	24,000	-	-	-	-
Debt Service Reserve	20,000	620,000	620,000	620,000	620,000
Total Cash Balance	$27,320	$711,730	$1,909,100	$3,107,680	$4,307,470

7.2.1.5.3 Huntsville Model Scenario 3: Use Huntsville Fees

As an example of the implications of Google's lease payments to Huntsville Utilities, this analysis includes a projection of the City charging the same fee ($7.50 per passing per month) to its private partner. Construction and operating costs remain the same as the base model, and no startup funding is obtained.

Table 53 shows the implications of this pricing, which would be unable to generate a positive net income in years one through 20, and the City would find itself with a deficit of over $37.1 million by the end of year 20.

Table 53: Huntsville Model Scenario 3 Financial Summary: Use Huntsville Fees

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$59,400	$742,410	$742,410	$742,410	$742,410
Total Cash Expenses	(417,360)	(902,460)	(902,460)	(902,460)	(902,460)
Depreciation	(284,220)	(867,000)	(867,000)	(867,000)	(867,000)
Interest Expense	(390,000)	(1,096,450)	(854,850)	(531,640)	(99,160)
Taxes	-	-	-	-	-
Net Income	$(1,032,180)	$(2,123,500)	$(1,881,900)	$(1,558,690)	$(1,126,210)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(145,360)	$(6,592,620)	$(16,768,520)	$(26,943,200)	$(37,116,670)
Depreciation Reserve	-	130,060	227,210	324,360	421,510
Interest Reserve	390,000	-	-	-	-
Debt Service Reserve	325,000	955,000	955,000	955,000	955,000
Total Cash Balance	$569,640	$(5,507,560)	$(15,586,310)	$(25,663,840)	$(35,740,160)

7.2.1.5.4 Huntsville Model Scenario 4: Use Huntsville Fees Plus a Monthly Passing Fee

In this scenario, the City charges the partner a $7.50 operator per-passing fee, as well as assessing a community per-passing fee of $22.50 on every residence and an average of $35.67 on every business in the City.[66] The revenue from this community per-passing fee enables the City to operate cash-positive. All other assumptions in this scenario remain the same.

A financial summary for this model is included in Table 54. As shown, the community per-passing fee supports the enterprise, generating a net income of $1.2 million by year 20. The City would finish year one with a deficit over $145,000, which would recover to an unrestricted balance of almost $1.1 million at the end of year five, and grow to just under $5 million by the end of year 20.

Table 54: Huntsville Model Scenario 4 Financial Summary: Use Huntsville Fees Plus a Monthly Passing Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$59,400	$3,034,740	$3,034,740	$3,034,740	$3,034,740
Total Cash Expenses	(417,360)	(902,460)	(902,460)	(902,460)	(902,460)
Depreciation	(284,220)	(867,000)	(867,000)	(867,000)	(867,000)
Interest Expense	(390,000)	(1,096,450)	(854,850)	(531,640)	(99,160)
Taxes	-	-	-	-	-
Net Income	$(1,032,180)	$168,830	$410,430	$733,640	$1,166,120

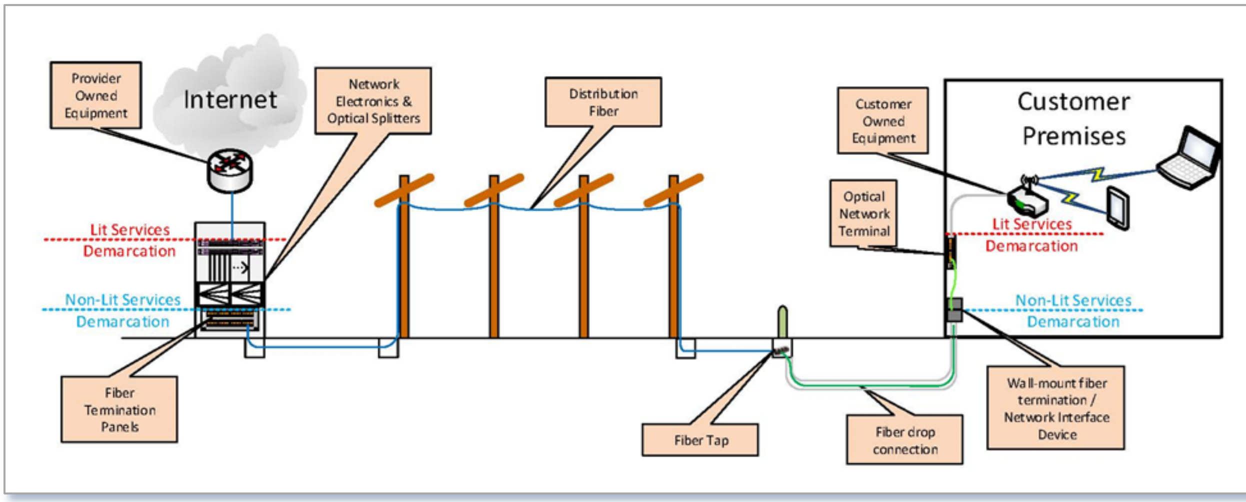
Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$(145,360)	$1,086,680	$2,372,430	$3,659,400	$4,947,580
Depreciation Reserve	-	130,060	227,210	324,360	421,510
Interest Reserve	390,000	-	-	-	-
Debt Service Reserve	325,000	955,000	955,000	955,000	955,000
Total Cash Balance	$569,640	$2,171,740	$3,554,640	$4,938,760	$6,324,090

7.2.2 Westminster Model (FTTP Dark Fiber Lease Including Drop Cable Costs)

The second FTTP dark fiber lease model assumes that the City constructs and owns network infrastructure throughout the entirety of the City up to a demarcation point in the customer's home or business, and leases the dark fiber backbone, distribution fiber, and fiber drops to a private partner. This demarcation is illustrated in Figure 25, with City network elements located between the two blue lines.

[66] The business per-passing fee is calculated as a factor of the residential fee, based on the total number of employees. This average community per-passing is based on a weighted average of the total businesses in Wilsonville with respect to their size. For a table of business community per-passing rates, please see Appendix E.

Figure 25: Demarcation Between City and Partner Network Elements (Westminster Model)



The financial analysis in this section assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point at the customer's home or business, and leases the dark fiber backbone, distribution fiber, and fiber drop cables to a private partner. The private partner would be responsible for all network electronics and CPE, as well as network sales, marketing, and operations.

Network electronics and CPE are significant additional expenses for the private partner to consider, and as such, the City should bear them in mind when negotiating pricing with potential partners.

The financial analysis presented here represents a minimum requirement for the City to obtain a break-even cash flow each year, excluding any potential revenue from other dark fiber lease opportunities that may be available to the City. A complete financial model is provided in Excel format that can be leveraged to show the impact of changing assumptions. The spreadsheet can be an important tool for the City to use if it negotiates with a private partner.

Please note that a "flat model" is used in the analysis, which means that inflation and operating cost increases (including salaries) are not used because it is assumed that operating cost increases will be offset by increases in operator lease payments over time (and likely passed on to subscribers in the form of increased prices). This analysis anticipates that the City will apply an inflation factor, typically based on a CPI, to the portion of the per-subscriber fee that covers projected operating expenses during negotiations with a private partner.

These financial projections do not include any economic development or other indirect benefits, which are often not easily quantifiable.

The modeling in this analysis compares a similar dark FTTP deployment in the city of Westminster, Maryland. In its contract with Ting Internet, the city negotiated a per-passing fee ($6) plus per-subscriber fee ($17) per month for dark fiber usage. That is, Ting pays the city for every premises the network passes, plus an additional fee for every subscriber receiving service over the network, totaling $6 per non-subscribed passing and $23 per subscribed passing. As such, the take rate is vitally important to the feasibility of the project.

This reference is included to demonstrate what pricing is attractive enough to incent partnership, the financial implications of that pricing, as well as what Westminster pricing would look like in relation to network deployment costs for the City. In all models, the required per-passing and per-subscriber fees are higher than Westminster's partnership, while charging lease fees similar to those paid by Ting in Westminster, Maryland, will result in a cumulative cash deficit of almost $36.7 million after 20 years.

Included are seven potential scenario projections for this model. These include a base case which projects what fees are necessary to maintain a positive cash flow each year, followed by four scenarios which demonstrate the implications of changing said fees and other variables, and two which show the implications of only building to high- or low-density areas.

7.2.2.1 Westminster Model Base Case

The base case scenario presents what would be necessary to maintain positive cash flow given the estimated OSP construction and operating costs. This base case model assumes a private partner can obtain and maintain a 35 percent take rate.[67]

Please note the construction cost estimate in Section 6.4 does not include the total of drop costs to individual residences and small businesses. This model estimates that each drop costs an average of $1,397. If 35 percent of the City's 8,249 passings subscribed (2,888 subscribers), drop cost construction would total over $4 million.

Though the City will be responsible for funding and constructing the drops, these costs are offset by the per-subscriber lease fees that are the responsibility of the private partner.

To maintain positive cash flow with this model, assuming the private partner can obtain and maintain a 35 percent take rate, the City would need to charge the partner $18 per passing and an additional $51 per subscriber. This fee is three times the fee that the city of Westminster and Ting Internet agreed to in their contract.

A summarized income and cash flow statement for this model is included in Table 55.

[67] Most overbuilders typically obtain at least a 35 percent take rate when entering a new market.

Table 55: Westminster Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$231,910	$3,549,240	$3,549,240	$3,549,240	$3,549,240
Total Cash Expenses	(419,400)	(942,810)	(942,810)	(942,810)	(942,810)
Depreciation	(294,420)	(1,068,730)	(1,068,730)	(1,068,730)	(1,068,730)
Interest Expense	(426,000)	(1,301,700)	(1,014,950)	(631,300)	(117,980)
Taxes	-	-	-	-	-
Net Income	$(907,910)	$236,000	$522,750	$906,400	$1,419,720

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$313,110	$440,730	$2,407,870	$4,376,160	$6,345,610
Depreciation Reserve	-	128,240	220,840	313,440	406,040
Interest Reserve	426,000	-	-	-	-
Debt Service Reserve	355,000	1,130,000	1,130,000	1,130,000	1,130,000
Total Cash Balance	$1,094,110	$1,698,970	$3,758,710	$5,819,600	$7,881,650

This base case projects the network generating a net income of $236,000 in year five, which would grow to over $1.4 million by year 20. The City's cumulative unrestricted cash balance would total over $313,000 by the end of year one, growing to $2.4 million by the end of year 19, and over $6.3 million by the end of year 20.

7.2.2.2 Westminster Model Base Case Financing

This financial analysis assumes that the City will cover its capital requirements through seeking a series of 20-year bonds. This analysis expects that the City will take will take three 20-year bonds—one each in years one, two, and three— for a total of $22.6 million in financing. It also assumes the City's bond rate would be 6 percent.

The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment. The resulting P&I payments will be the major factor in determining the City's long-term financial requirements; P&I accounts for roughly 66 percent of the City's annual costs in the base case model after the construction period.

This analysis projects that the bond issuance costs will be equal to 1 percent of the principal borrowed. It assumes neither debt service nor interest reserves need to be maintained for the lifetime of the bond. Principal repayment on the bonds will start in year three.

A detailed income statement is included in Table 56.

Table 56: Westminster Model Base Case Income Statement

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Per Passing	$142,560	$1,781,780	$1,781,780	$1,781,780	$1,781,780
Per Subscriber	89,350	1,767,460	1,767,460	1,767,460	1,767,460
Total	$231,910	$3,549,240	$3,549,240	$3,549,240	$3,549,240
c. Operating Costs					
Operation Costs	$156,900	$417,810	$417,810	$417,810	$417,810
Labor Costs	262,500	525,000	525,000	525,000	525,000
Total	$419,400	$942,810	$942,810	$942,810	$942,810
d. EBITDA	$(187,490)	$2,606,430	$2,606,430	$2,606,430	$2,606,430
e. Depreciation	294,420	1,068,730	1,068,730	1,068,730	1,068,730
f. Operating Income (EBITDA less Depreciation)	$(481,910)	$1,537,700	$1,537,700	$1,537,700	$1,537,700
g. Non-Operating Income					
Interest Income	$-	$3,150	$3,380	$3,610	$3,840
Interest Expense (20 Year Bond)	(426,000)	(1,304,850)	(1,018,330)	(634,910)	(121,820)
Total	$(426,000)	$(1,301,700)	$(1,014,950)	$(631,300)	$(117,980)
h. Net Income (before taxes)	$(907,910)	$236,000	$522,750	$906,400	$1,419,720
i. Facility Taxes	$-	$-	$-	$-	$-
j. Net Income	$(907,910)	$236,000	$522,750	$906,400	$1,419,720

This model will generate a negative net income of $907,900 in year one, growing to a positive net income of $236,000 in year 5, and totaling over $1.4 million in year 20.

A cash flow statement is included in Table 57.

Table 57: Westminster Model Base Case Cash Flow Statement

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Net Income	$(907,910)	$236,000	$522,750	$906,400	$1,419,720
b. Cash Outflows					
Debt Service Reserve	$(355,000)	$-	$-	$-	$-
Interest Reserve	(852,000)	-	-	-	-
Depreciation Reserve	-	(64,120)	(64,120)	(64,120)	(64,120)
Financing	(71,000)	-	-	-	-
Capital Expenditures	(5,321,400)	-	-	-	-
Total	$(6,599,400)	$(64,120)	$(64,120)	$(64,120)	$(64,120)
c. Cash Inflows					
Interest Rese	$426,000	$-	$-	$-	$-
20-Year Bond Proceeds	7,100,000	-	-	-	-
Total	$7,526,000	$ -	$ -	$ -	$ -
d. Total Cash Outflows and Inflows	$926,600	$(64,120)	$(64,120)	$(64,120)	$(64,120)
e. Non-Cash Expenses - Depreciation	$294,420	$1,068,730	$1,068,730	$1,068,730	$1,068,730
f. Adjustments					
Proceeds from Additional Cash Flows (20 Year Bond)	$(7,100,000)	$ -	$ -	$ -	$ -
g. Adjusted Available Net Revenue	$(6,786,890)	$1,240,610	$1,527,360	$1,911,010	$2,424,330
h. Principal Payments on Debt					
20 Year Bond Principal	$-	$847,110	$1,133,630	$1,517,050	$2,030,140
Total	$-	$847,110	$1,133,630	$1,517,050	$2,030,140
i. Net Cash	$313,110	$393,500	$393,730	$393,960	$394,190
j. Cash Balance					
Unrestricted Cash Balance	$313,110	$440,730	$2,407,870	$4,376,160	$6,345,610
Depreciation Reserve	-	128,240	220,840	313,440	406,040
Interest Reserve	426,000	-	-	-	-
Debt Service Reserve	355,000	1,130,000	1,130,000	1,130,000	1,130,000
Total Cash Balance	$1,094,110	$1,698,970	$3,758,710	$5,819,600	$7,881,650

The City's cumulative unrestricted cash balance at the end of year one will total just over $313,000, growing to $2.4 million at the end of year 10, and over $6.3 million at the end of year 20.

Please see Appendix F for a complete income statement, cash flow statement, and capital addition statement.

7.2.2.3 Westminster Model Base Case Capital Additions

Significant network expenses—known as "capital additions"—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building a fiber network. (Again, because the City's responsibility will be limited to OSP and fiber drops, no core network electronic or CPE is included here.)

This analysis projects that the capital additions in year one will total just over $5.3 million. These costs will total roughly $9.3 million in year two, just over $5.1 million in year three, and $1 million in year four, totaling just under $20.7 million in capital additions for years one through four.

These additions are shown in greater detail in Table 58.

Table 58: Westminster Model Base Case Capital Additions

Capital Additions	Year 1	Year 2	Year 3	Year 4
Outside Plant and Facilities				
Total Backbone and FTTP	$4,928,400	$8,214,000	$3,285,600	$-
Additional Annual Capital	-	-	-	-
Total	$4,928,400	$8,214,000	$3,285,600	$-
Last Mile and Customer Premises Equipment				
Average Drop Cost	$204,000	$1,007,200	$1,816,100	$1,007,200
Total	$204,000	$1,007,200	$1,816,100	$1,007,200
Miscellaneous Implementation Costs				
Splicing	$ -	$ -	$ -	$ -
Vehicles	35,000	35,000	-	-
Service Equipment	50,000	-	-	-
Work Station, Computers, and Software	4,000	4,000	-	-
Fiber OTDR and Other Tools	50,000	-	-	-
Fiber Management Software	50,000	-	-	-
Additional Annual Capital	-	-	-	-
Total	$189,000	$39,000	$-	$-
Total Annual Capital Additions	$5,321,400	$9,260,200	$5,101,700	$1,007,200

7.2.2.4 Westminster Model Operating and Maintenance Expenses

The cost to deploy a dark FTTP network goes far beyond fiber implementation. Network deployment requires sales and marketing, network maintenance and technical operations, and other functions. This model assumes that the City's partner will be responsible for lighting the fiber and selling service. As such, the City's financial requirements are limited to expenses related to OSP infrastructure (including drops) and network administration.

The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span while network test equipment will need to be replaced after five years.

These expanded responsibilities will require the addition of new staff. This assumes the City will add a total of 4 full-time-equivalent (FTE) positions within the first three years, and will then maintain that level of staffing. The assumptions that underpin this analysis include:

- 1 FTE business manager & HR position
- 1 FTE GIS & record keeping position
- 2 FTE fiber plant operating & maintenance technicians

Salaries and benefits are based on estimated market wages, and benefits are estimated at 40 percent of base salary. Salaries (including benefits) are summarized in Table 59.

Table 59: Westminster Model Base Case Labor Expenses

New Employees	Year 1	Year 2	Year 3+	Labor Cost
Business Manager & HR	0.50	1.00	1.00	130,000
GIS & Record Keeping	0.50	1.00	1.00	85,000
Fiber Plant O&M Technicians	1.00	2.00	2.00	80,000
Total New Staff	2	4	4	

Additional key operating and maintenance assumptions include the following:

- Insurance is estimated to be $25,000 in year one and $50,000 from year two on
- Utilities are estimated at $1,200 in year one and $2,400 in year two on
- Office expenses are estimated to be $3,000 in year one and $6,000 annually in year two on
- Locates and ticket processing are estimated at $8,900 in year one, $44,700 in year two, and $89,400 in year three on
- Contingency is estimated at $10,000 in year one and $15,000 in year two on
- Fiber and network maintenance are calculated at one percent of the total construction cost, per year (roughly $49,200 in year one, $131,400 in year two, and $164,300 in year three on) in addition to staffing costs to maintain the fiber
- Legal fees are estimated to be $30,000 in year one, reducing to $15,000 in year two on
- Consulting fees are estimated at $20,000 in year one, reducing to $10,000 in year two on
- Education and training are estimated at just over $5,300 in year one, and $10,500 in year two on
- Pole attachments are estimated at just over $2,200 in year one, $8,200 in year two, $13,400 in year three and $14,900 in year four on.

These expenses, as well as P&I payments, are shown in Table 60.

Table 60: Westminster Model Base Case Operating and Maintenance Expenses

Operating Expenses & P&I	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$25,000	$50,000	$50,000	$50,000	$50,000
Utilities	1,200	2,400	2,400	2,400	2,400
Office Expenses	3,000	6,000	6,000	6,000	6,000
Locates & Ticket Processing	8,900	89,400	89,400	89,400	89,400
Contingency	10,000	15,000	15,000	15,000	15,000
Fiber & Network Maintenance	51,320	204,630	204,630	204,630	204,630
Legal	30,000	15,000	15,000	15,000	15,000
Consulting	20,000	10,000	10,000	10,000	10,000
Education and Training	5,250	10,500	10,500	10,500	10,500
Pole Attachment Expense	2,230	14,880	14,880	14,880	14,880
Sub-Total	$156,900	$417,810	$417,810	$417,810	$417,810
Labor Expenses	$262,500	$525,000	$525,000	$525,000	$525,000
Sub-Total	$262,500	$525,000	$525,000	$525,000	$525,000
Total Expenses	$419,400	$942,810	$942,810	$942,810	$942,810
Principal and Interest	$426,000	$2,148,810	$2,148,580	$2,148,350	$2,148,120
Facility Taxes	-	-	-	-	-
Sub-Total	$426,000	$2,148,810	$2,148,580	$2,148,350	$2,148,120
Total Expenses, P&I, and Taxes	$845,400	$3,091,620	$3,091,390	$3,091,160	$3,090,930

The City's total operating and maintenance expenses (including P&I payments) will total just over $845,000 in year one, and roughly $3.1 million annually in years five on.

7.2.2.5 Westminster Model Sensitivity Scenarios

This section demonstrates how even small fluctuations in assumptions can affect the financial modeling (i.e., increased startup funding, and using the fees Westminster charged Ting Internet).

Note that some of these scenarios may not be realistically attainable. They are meant to demonstrate the sensitivity of the financial projections to these assumptions.

These effects are important to understand and consider when reviewing partnership opportunities. It is important that a partner be able to offer savings in these categories as compared to the base case assumptions used in the analysis.

7.2.2.5.1 Westminster Model Base Case

As previously noted, the base case shows that partner lease fees of $18 per passing and $51 per subscriber are required to maintain cash flow. This fee is three times the fees agreed upon in Huntsville. A financial summary for this model is included in Table 61.

Table 61: Westminster Model Base Case Financial Summary

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$231,910	$3,549,240	$3,549,240	$3,549,240	$3,549,240
Total Cash Expenses	(419,400)	(942,810)	(942,810)	(942,810)	(942,810)
Depreciation	(294,420)	(1,068,730)	(1,068,730)	(1,068,730)	(1,068,730)
Interest Expense	(426,000)	(1,301,700)	(1,014,950)	(631,300)	(117,980)
Taxes	-	-	-	-	-
Net Income	$(907,910)	$236,000	$522,750	$906,400	$1,419,720

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$313,110	$440,730	$2,407,870	$4,376,160	$6,345,610
Depreciation Reserve	-	128,240	220,840	313,440	406,040
Interest Reserve	426,000	-	-	-	-
Debt Service Reserve	355,000	1,130,000	1,130,000	1,130,000	1,130,000
Total Cash Balance	$1,094,110	$1,698,970	$3,758,710	$5,819,600	$7,881,650

7.2.2.5.2 Westminster Model Scenario 2: 50 Percent Take Rate

The second scenario looks at the impact of a higher take rate on necessary partner lease fees. This scenario increases the take rate from the base case of 35 percent to 50 percent. With this increase in subscribers, the City is responsible for the funding and construction of additional fiber drops. To offset these costs, the City would need to increase its bond amount to $24.4 million.

As a result, the fees necessary from the partner would decrease slightly: $15.60 per passing per month and $44.20 per subscriber per month. These fees are 2.6 times the fees agreed upon in Westminster.

A financial summary for this model is included in Table 62.

Table 62: Westminster Model Scenario 2 Financial Summary: 50 Percent Take Rate

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$233,340	$3,732,110	$3,732,110	$3,732,110	$3,732,110
Total Cash Expenses	(420,260)	(960,090)	(960,090)	(960,090)	(960,090)
Depreciation	(298,680)	(1,155,130)	(1,155,130)	(1,155,130)	(1,155,130)
Interest Expense	(432,000)	(1,407,990)	(1,098,550)	(683,230)	(127,560)
Taxes	-	-	-	-	-
Net Income	$(917,600)	$208,900	$518,340	$933,660	$1,489,330

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$310,480	$454,370	$2,338,400	$4,223,910	$6,110,910
Depreciation Reserve	-	138,620	257,170	375,720	494,270
Interest Reserve	432,000	-	-	-	-
Debt Service Reserve	360,000	1,220,000	1,220,000	1,220,000	1,220,000
Total Cash Balance	$1,102,480	$1,812,990	$3,815,570	$5,819,630	$7,825,180

This increased take rate will operate cash-positive, generating a net income of $208,900 in year five, which will grow to $1.5 million by year 20. The City's cumulative unrestricted cash balance will finish year one with just over $310,000, growing to $2.3 million at the end of year 10, and $6.1 million at the end of year 20.

7.2.2.5.3 Westminster Model Scenario 3: Obtain $5 Million in Startup Funding

The third scenario proposes use of $5 million in startup funding to lower the required partner lease fees. These funds would be from cash reserves, grants, or other sources that would not need to be repaid.[68] The total amount financed would reduce accordingly, totaling $17.1 million. All other assumptions remained the same as the base case.

In this scenario, the City would be able to charge the partner $15.00 per passing per month and $42.50 per subscriber per month, or 2.5 times that of the fees paid by Ting Internet in Westminster.

Table 63 presents a summarized income and cash flow statement for this scenario. As shown, the City would operate cash-positive, generating a net income around $171,000 in year 10, which would grow to roughly $856,000 by year 20. The City's cumulative unrestricted cash balance would be $764,00 at the end of year one and would finish year 10 at over $2.1 million, growing to $5.2 million by the end of year 20.

Table 63: Westminster Model Scenario 3 Financial Summary: Obtain $5 Million in Startup Funding

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$193,260	$2,957,700	$2,957,700	$2,957,700	$2,957,700
Total Cash Expenses	(419,400)	(942,810)	(942,810)	(942,810)	(942,810)
Depreciation	(294,420)	(1,068,730)	(1,068,730)	(1,068,730)	(1,068,730)
Interest Expense	(96,000)	(994,380)	(775,270)	(482,120)	(89,910)
Taxes	-	-	-	-	-
Net Income	$(616,560)	$(48,220)	$170,890	$464,040	$856,250

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$764,460	$574,330	$2,120,130	$3,667,080	$5,215,180
Depreciation Reserve	-	128,240	220,840	313,440	406,040
Interest Reserve	96,000	-	-	-	-
Debt Service Reserve	80,000	855,000	855,000	855,000	855,000
Total Cash Balance	$940,460	$1,557,570	$3,195,970	$4,835,520	$6,476,220

[68] This scenario is for illustration only; there is no guarantee that such funding would be available to the City.

7.2.2.5.4 Westminster Model Scenario 4: Use Westminster Fees

The implications of using the lease fees agreed upon in Westminster to illustrate the viability of such low fees in the City are included in this analysis. This model assumes a 35 percent take rate, with a $6 per passing per month and $17 per subscriber per month fee.

A summarized income and cash flow statement is included in Table 64.

Table 64: Westminster Model Scenario 4 Financial Summary: Use Westminster Fees

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$77,300	$1,183,080	$1,183,080	$1,183,080	$1,183,080
Total Cash Expenses	(419,400)	(942,810)	(942,810)	(942,810)	(942,810)
Depreciation	(294,420)	(1,068,730)	(1,068,730)	(1,068,730)	(1,068,730)
Interest Expense	(426,000)	(1,301,700)	(1,014,950)	(631,300)	(117,980)
Taxes	-	-	-	-	-
Net Income	$(1,062,520)	$(2,130,160)	$(1,843,410)	$(1,459,760)	$(946,440)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$158,500	$(7,069,410)	$(16,933,070)	$(26,795,580)	$(36,656,930)
Depreciation Reserve	-	128,240	220,840	313,440	406,040
Interest Reserve	426,000	-	-	-	-
Debt Service Reserve	355,000	1,130,000	1,130,000	1,130,000	1,130,000
Total Cash Balance	$939,500	$(5,811,170)	$(15,582,230)	$(25,352,140)	$(35,120,890)

This pricing structure would be unable to generate a positive net income over the life of the model, while the City would finish year one with a cumulative unrestricted cash balance of $158,500. By year 20, the balance would become a deficit of almost $36.7 million.

7.2.2.5.5 Westminster Model Scenario 5: Use Westminster Fees Plus a Monthly Passing Fee

In this scenario, the City charges the partner a $6 operator per-passing fee, as well as a $17 operator per-subscriber fee. Further, the City also assesses a community per-passing fee of $22.92 on every residence and an average of $36.33 on every business in the City.[69] The revenue from this community per-passing fee enables the City to operate cash-positive. All other assumptions in this scenario remain the same.

A financial summary for this model is included in Table 65. As shown, the community per-passing fee supports the enterprise, generating a net income of almost $1.4 million by year 20. The City would finish year one with an unrestricted cumulative cash balance of $158,500, which would

[69] The business per-passing fee is calculated as a factor of the residential fee, based on the total number of employees. This average community per-passing is based on a weighted average of the total businesses in Wilsonville with respect to their size. For a table of business community per-passing rates, please see Appendix F.

become almost $2.6 million at the end of year five, and grow to just under $6.2 million by the end of year 20.

Table 65: Westminster Model Scenario 5 Financial Summary: Use Westminster Fees Plus a Monthly Passing Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	$77,300	$3,517,890	$3,517,890	$3,517,890	$3,517,890
Total Cash Expenses	(419,400)	(942,810)	(942,810)	(942,810)	(942,810)
Depreciation	(294,420)	(1,068,730)	(1,068,730)	(1,068,730)	(1,068,730)
Interest Expense	(426,000)	(1,301,700)	(1,014,950)	(631,300)	(117,980)
Taxes	-	-	-	-	-
Net Income	$(1,062,520)	$204,650	$491,400	$875,050	$1,388,370

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	$158,500	$752,270	$2,562,660	$4,374,200	$6,186,900
Depreciation Reserve	-	128,240	220,840	313,440	406,040
Interest Reserve	426,000	-	-	-	-
Debt Service Reserve	355,000	1,130,000	1,130,000	1,130,000	1,130,000
Total Cash Balance	$939,500	$2,010,510	$3,913,500	$5,817,640	$7,722,940

Appendix A: Glossary of Terms

Access Fiber – The fiber in an FTTP network that goes from the FDCs to the optical taps that are located outside of homes and businesses in the PROW.

AE – Active Ethernet; a technology that provides a symmetrical (upload/download) Ethernet service and does not share optical wavelengths with other users. For subscribers that receive AE service—typically business customers that request a premium service or require greater bandwidth—a single dedicated fiber goes directly to the subscriber premises with no optical splitting.

CPE – Customer premises equipment; the electronic equipment installed at a subscriber's home or business.

Dark Fiber – Fiber optic strands that are installed in underground conduit or attached to utility poles, but are not "lit" by network electronics.

Distribution Fiber – The fiber in an FTTP network that connects the hub sites to the fiber distribution cabinets.

Drop – The fiber connection from an optical tap in the PROW to the customer premises.

FDC – Fiber distribution cabinet; houses the fiber connections between the distribution fiber and the access fiber. FDCs, which can also house network electronics and optical splitters, can sit on a curb, be mounted on a pole, or reside in a building.

FTTP – Fiber-to-the-premises; a network architecture in which fiber optics are used to provide broadband services all the way to each subscriber's premises.

GPON – Gigabit passive optical network; the most commonly provisioned FTTP service—used, for example, by Verizon (in its FiOS systems), Google Fiber, and Chattanooga Electric Power Board (EPB). GPON uses passive optical splitting, which is performed inside FDCs, to connect fiber from the Optical Line Terminals (OLTs) to multiple customer premises over a single GPON port.

IP – Internet Protocol; the method by which computers share data on the internet.

LEC – Local Exchange Carrier; a public telephone company that provides service to a local or regional area.

MDU – Multi-dwelling unit; a large building with multiple units, such as an apartment or office building.

OLT – Optical line terminal; the upstream connection point (to the provider core network) for subscribers. The choice of an optical interface installed in the OLT determines whether the network provisions shared access (one fiber split among multiple subscribers in a GPON architecture) or dedicated AE access (one port for one subscriber).

OSP – Outside plant; the physical portion of a network (also called "layer 1") that is constructed on utility poles (aerial) or in conduit (underground).

OSS – Operational Support Systems (OSS); includes a provider's provisioning platforms, fault and performance management systems, remote access, and other OSS for FTTP operations. The network's core locations house the OSS.

OTT – Over-the-top; content, such as voice or video service, that is delivered over a data connection.

Passing – A potential customer address (e.g., an individual home or business).

POTS – "Plain old telephone service;" delivered over the PSTN.

PROW – Public right-of-way; land reserved for the public good such as utility construction. PROW typically abuts public roadways.

PSTN – Public switched telephone network; the copper-wire telephone networks that connect landline phones.

QoS – Quality of service; a network's performance as measured on a number of attributes.

VoIP – Voice over Internet Protocol; telephone service that is delivered over a data connection.

Appendix B: City Network Expansion Financial Model Workbook

This Appendix is attached as a separate Microsoft Excel file.

Appendix C: City Network Expansion "Best Case" Financial Model Workbook

This Appendix is attached as a separate Microsoft Excel file.

Appendix D: Fiber-to-the-Premises Municipal Retail Model Financial Workbook

This Appendix is attached as a separate Microsoft Excel file.

Appendix E: Fiber-to-the-Premises Huntsville Model Financial Workbook

This Appendix is attached as a separate Microsoft Excel file.

Appendix F: Fiber-to-the-Premises Westminster Model Financial Workbook

This Appendix is attached as a separate Microsoft Excel file.