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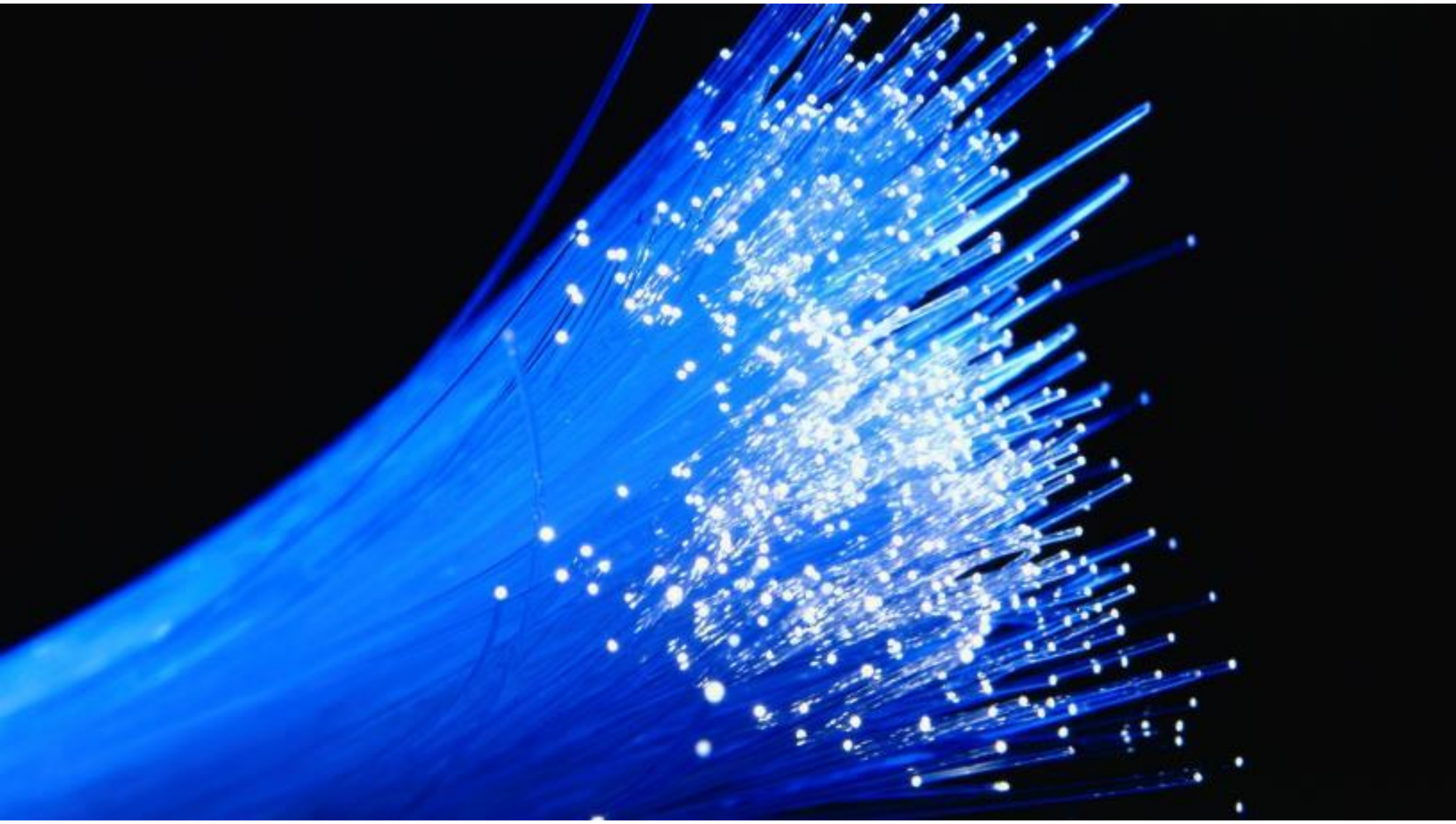

City of Seattle Fiber-to-the-Premises Feasibility Study

Prepared for City of Seattle

June 2015

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1 Executive Summary

The overarching broadband goal of the City of Seattle and its Mayor is to bring affordable, competitive, and equal high-speed service to all of Seattle's residents. Over the course of many years, the City has sought solutions to address the lack of such ubiquitous service.[1] Based on its previous analysis and its understanding of the current broadband market, the City is now investigating the feasibility of building and operating a fiber-to-the-premises (FTTP) enterprise (a "Broadband Utility") to address gaps in the market and to bring high-speed broadband access to all City residents and businesses.

Just a few years ago, we cautioned the City to be wary of building infrastructure to effect change in the market. Building an FTTP network and pursuing a traditional business model (with a triple-play bundle of voice, video, and data) to address market gaps and meet the City's immediate needs would have fallen short of achieving the City's vision and been difficult to sustain financially. Further, this approach would have treated the symptom (lack of fiber) without addressing the underlying problem (key market structure). Addressing the market structure would have required constructing a ubiquitous FTTP network and operating it as open-access infrastructure—meaning a network that connects every structure in the City, and that any qualified service provider can use to provide communications services to customers.

At the time we cautioned the City that building and operating a ubiquitous open-access network was not feasible. But in the intervening years, the communications market has changed. In today's broadband landscape, a data-only network—not the more expensive and complex triple-play approach of years past—may meet the City's goals.[2] Further, the concept of open access has evolved in recent years beyond the traditional model of multiple Internet service providers (ISPs) delivering service over one infrastructure. It has expanded to include applications providers that offer over-the-top (OTT)[3] services (see Section 1.5).

The demand for high-capacity broadband data connections is steadily rising in Seattle and across the U.S. while consumer demand is declining for services like traditional cable and fixed telephone lines. These and other services have become applications that are offered by hundreds of providers over the Internet and that no longer need to be tethered to a local provider or a

[1] CTC has provided guidance to the City in the past on bringing high-speed connectivity to the community. Though this report considers the analysis presented in prior studies and builds on previous research we conducted, it is an independent assessment of Seattle's market today and how the City might achieve its goals.

[2] This is consistent with the decision by the City's Director of the Office of Cable Communications to explore the data-only model in lieu of traditional triple-play service.

[3] "Over the top" content is delivered over the Internet by a third-party application or service. The Internet Service Provider does not provide the content (typically video and voice) but provides the Internet connection over which the content is served.

specific infrastructure.[4] In a sense, Seattle (like many other cities) is becoming a data-only communications market; that is, many consumers want data connections, but fewer and fewer want landline telephones and, to a lesser extent, cable television bundles.

If the City were to focus its efforts on delivering a data-only service over ubiquitous fiber infrastructure that supports at least 1 Gigabit per second (Gbps) speeds, it would now conceivably be able to address both the lack of fiber and, indirectly, the market structure. And the fiber infrastructure that the City might build would conceivably support 10 Gbps speeds and even up to 100 Gbps. Data access with speeds of 1 Gbps and higher would support future applications and enable private sector competition—thus potentially achieving the City's long-term strategic vision of ubiquitous access and competition for value-added services.

1.1 Background and Objectives

As part of the Mayor's broadband initiative, the City seeks to understand municipal broadband delivery's potential risks and opportunities, especially given recent industry developments that may reduce the cost to deploy and operate an FTTP network. The City requested updated business models and insights into technological developments, construction methods, and other industry practices that have reduced the cost of FTTP network deployment and operations in recent years.

In addition to conducting all-new market research and analysis, we provided independent cost estimates and financial projections (Section 6 and Section 8, respectively) for deployment and operation of a data-only FTTP network. Per the City's direction, we did not include costs and projections associated with installing and operating a cable head end or voice switching components. Our updated analysis includes explanations of assumptions for cost estimates and financial projections. We estimated marketing, operational, and staffing costs based on our experience of standards present in the industry today. Similarly, our take rate assumptions and cash flow requirements are based on a combination of what we believe will be necessary to make the Broadband Utility viable as well as what market survey projections indicate (see Section 2).

The City's Department of Information Technology (DoIT) aims to examine previous studies in the context of today's broadband landscape to discern to what degree industry evolution may aid the feasibility of delivering affordable 1 Gbps data-only municipal service. The City further seeks

[4] Historically, communications services were delivered over specific infrastructure—cable infrastructure provided cable service and telephone lines provided telephone service. This enabled a monopoly because the infrastructure and the customer's end service were inextricably bundled. Through the evolution of Internet technology, applications that were once tethered to infrastructure can now be provided over fiber. Telephone and television services can be delivered over data networks with no ties to legacy infrastructure. As data network speeds increase, more and more applications will be delivered this way.

to consider potential pilot projects that may illustrate the viability of a municipal delivery business model that provides a 1 Gbps data-only service and supports OTT applications.

This report is informed by the City's previous FTTP feasibility and broadband studies, but is independent of previously conducted analyses. It includes an updated market analysis based on current market information and recently conducted surveys. The City seeks to evaluate the potential market opportunity for a municipal retail service offering. To this end, we conducted targeted market research and analysis to determine the potential sustainability of a municipal retail offering providing 1 Gbps data-only service.

As we discuss in Section 1.4, we conducted residential and business surveys that sought to determine the necessary market share to make the Broadband Utility sustainable. The surveys also aimed to gauge residents' and businesses':

- Willingness and desire to change service providers
- Interest in and demand for symmetrical 1 Gbps service
- Desire for bundled services
- Perception of the importance of data caps
- Trust in the City to act as an Internet service provider (ISP)

The survey results strengthen the assertion that a Broadband Utility could be sustainable in Seattle (see Section 1.4) and could enable the City to provide 1 Gbps data-only service, thus eliminating the need for costly investment in voice and video network components.

1.2 Focus of This Analysis

Many of the City of Seattle's businesses and residents have access only to marginal communications infrastructure and have limited choice in service providers, which potentially results in stifled technological innovation and substandard service.[5] These are symptoms of the core problem—a market structure with well-entrenched incumbent providers that have few incentives to offer enhanced data services[6] or allow unfettered access to alternative over-the-top (OTT) application providers.

The cable providers (Comcast or Wave, depending on location)[7] and local telephone company (CenturyLink) that serve the broadband market in Seattle connect businesses and residences to Internet and data services over their infrastructure (i.e., cables and equipment). These incumbent entities are the sole providers of broadband service over their respective infrastructures. And

[5] When compared to leading cities and nations in Europe and Asia.

[6] Enhanced data services better enable new applications that replace add-on services promoted by the incumbent provider. This provides incentives to the incumbent provider to limit data performance and capabilities.

[7] Comcast and Wave each serve a portion of The City. Their service areas have a small overlap.

these entities enjoy legislative/regulatory protection that provides little to no incentive to open their infrastructures to other potential providers.[8]

Because of the high cost of building new infrastructure, potential new competitors are effectively barred from entering the market. These favorable conditions for the incumbents incent the market to advance the status quo, ensuring a continuation of limited investment and stifling competition. This condition is not unique to Seattle or limited to cable and broadband; it is prevalent in numerous industries throughout the United States.

Though true monopolies are rare due to anti-monopoly legislation, oligopolies (when only a small number of companies serve a particular market) are common where there are significant barriers to market entry. Imperfect competition allows incumbents to influence market prices because there is little price competition. Because they are aware that few other providers can truly compete with them, incumbents often exert market power by controlling supply and/or demand, limiting service performance, and raising prices substantially above marginal cost. This effectively stifles any meaningful competition among providers.

This study examines the feasibility of a municipal broadband delivery model, focusing on:

- Reviewing the financial feasibility of deploying and operating a municipal broadband network in Seattle[9]
- Evaluating the services and applications that are most likely to be developed on a high-capacity data network
- Analyzing current market conditions to gauge consumer interest in a municipal retail broadband offering
- Examining the possibility of a pilot project and advising on how to approach it
- Assessing the potential of pursuing a property tax funded utility model

1.3 Market Assessment

The Seattle provider market has changed considerably in recent years, consistent with a shifting national broadband landscape. Some providers have less of a foothold in Seattle than they did

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[8] A given apartment building or condominium might have niche a provider that serves that given facility. Often these providers have an exclusive contract for access to the in-premises wiring, a costly and challenging element of providing service to multi-unit buildings.

[9] The parameters of this project were to look solely at municipal ownership options. We did not evaluate the feasibility of public–private partnerships or other kinds of shared-risk models.

just a few years ago, while others have a stronger presence. The Broadband Utility will have to be cognizant of both the present market and how it will change and grow in coming years.

The Broadband Utility may not fare well by simply entering the market as a public provider offering service in a marketplace that is already served by private providers. The best approach is to strive to change the market structure by providing something that does not exist today—developing a specialized niche to fill a gap in currently available service.

The goal of providing a "niche service" is to identify gaps where the City is not already well served, and then focus the Broadband Utility's efforts there to foster the greatest possibility of success. Based on our market assessment, we believe that the City's primary gap is 1 Gbps data service, which we believe represents a market niche that the Broadband Utility might be able to successfully fill. We recommend that the Broadband Utility offer *only* a data service at a minimum of 1 Gbps.

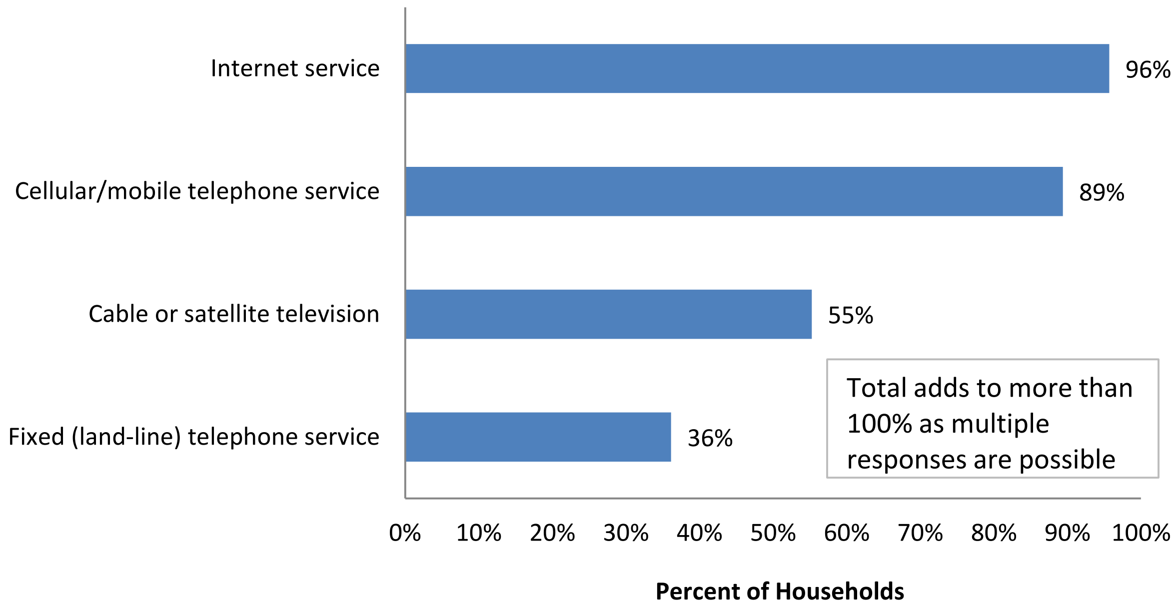
1.4 Survey Results

One of the steps we took to assess the market was to conduct surveys—an online business survey and a paper survey mailed to residents—to gather market information. The goal was to determine residents' and businesses' willingness and desire to change service providers, particularly in pursuit of a high-speed offering. We also sought to determine whether residents and businesses would trust the City itself to deliver service, and to determine what market penetration the Broadband Utility might achieve.

The residential response, especially, supports our recommendation of pursuing a 1 Gbps niche service. Figure 1 below shows that around 96 percent of residential respondents purchase Internet service today.[10] The 96 percent subscription rate suggests there is high demand in the City's Internet market, and that Internet use has overtaken cable and landline telephone use (shown in Figure 1).

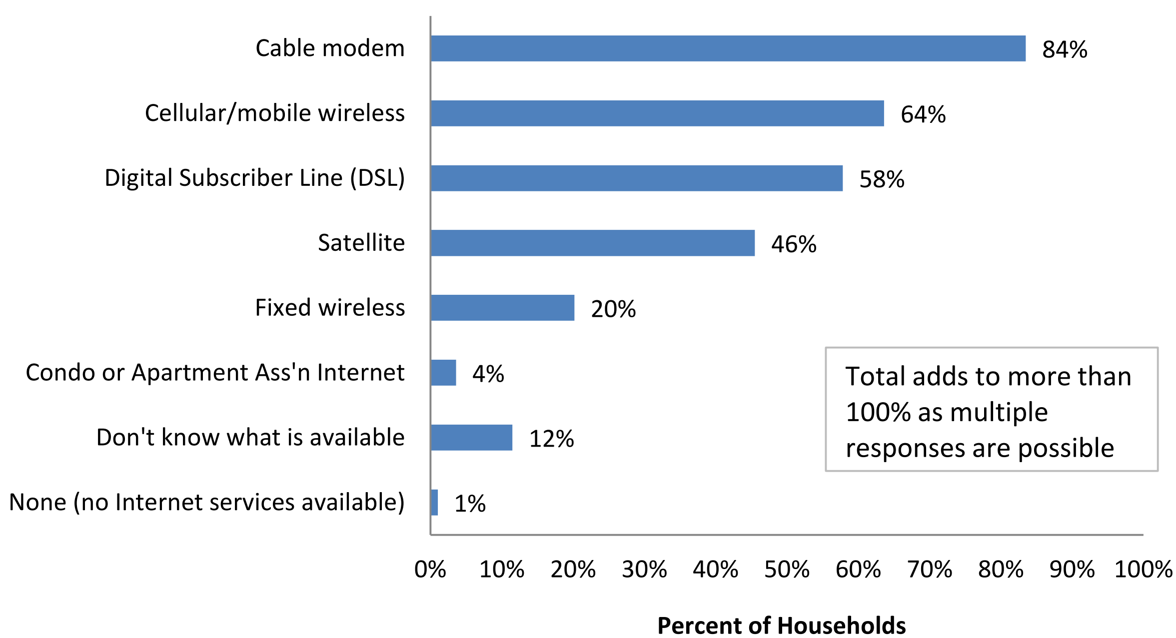
[10] This information is based on responses to residential surveys.

Figure 1: Residential Survey Response—Household Services Purchased



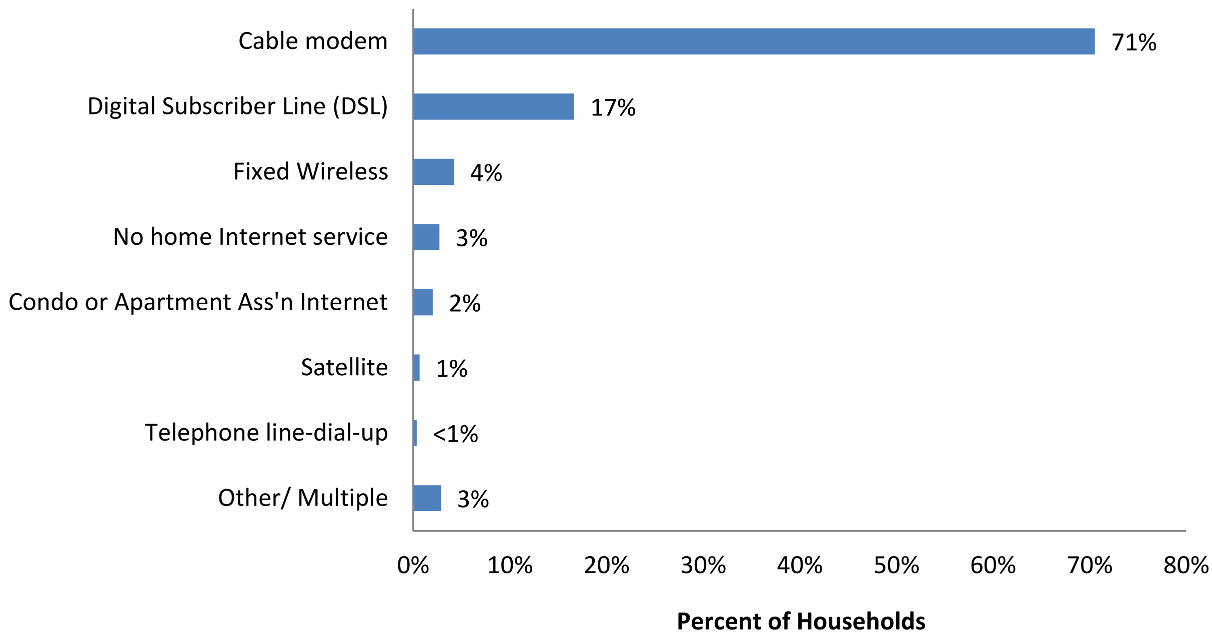
According to the residential survey response (see Figure 2), cable modem is the most readily available type of service, followed by cellular/mobile wireless and digital subscriber line (DSL).

Figure 2: Residential Survey Response—Internet Services Available at Residence



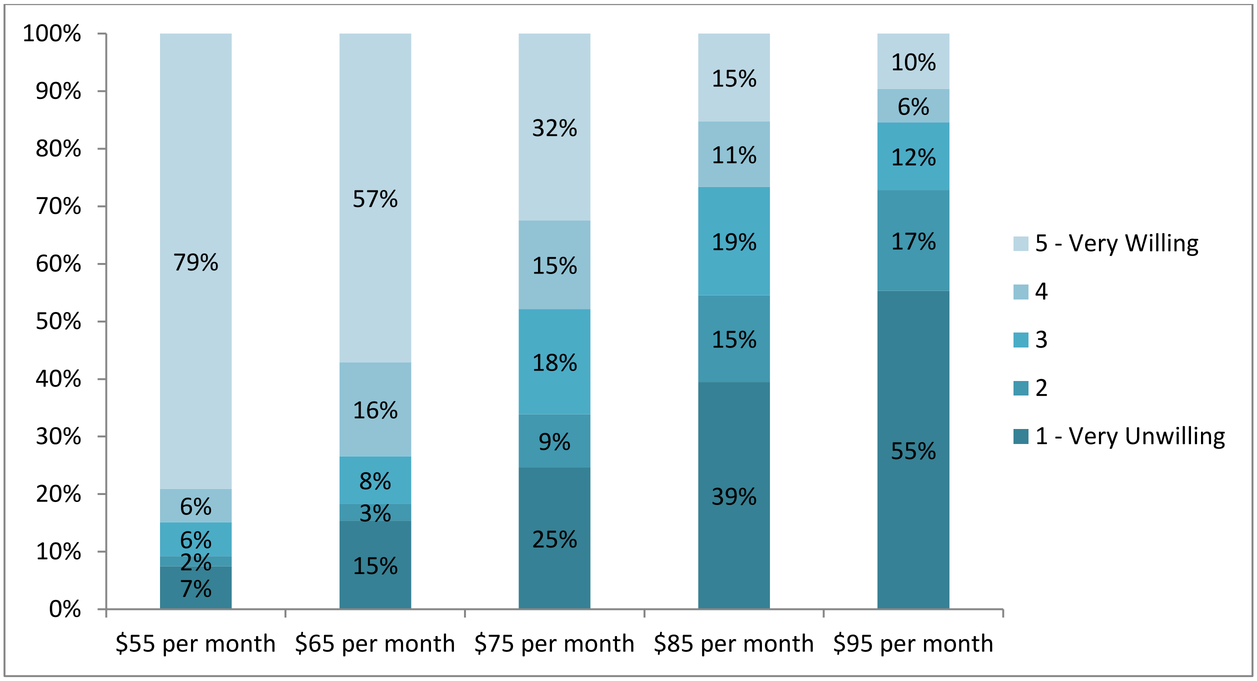
Of the available services, the majority of residential respondents purchase cable modem service (see Figure 3).

Figure 3: Residential Survey Response—Internet Services Purchased at Residence



The demand for a 1 Gbps service appears relatively high—47 percent of residential respondents with Internet show a willingness to pay $75 per month for a 1 Gbps service (See Figure 4).

Figure 4: Willingness to Switch to 1 Gbps Service for $55 – $95 per Month



The residential survey also indicated that Internet has become an essential service. Over 80 percent of respondents indicated that Internet is essential (though only 30 percent indicated that it is affordable) (see Section 7).

The business survey did not yield statistically valid results because the respondents were self-selected and thus not representative of the entire community. However, we were able to gather from the 112 responses that reliability is the most important factor for business survey respondents. Speed and price are also important, and many respondents indicated dissatisfaction with their currently available speeds.

We discuss the results of the residential and business surveys in Section 7 below with a summary of responses by question in Appendices D and E.

1.5 Redefining Open Access

Open access traditionally means that multiple providers offer service over one network infrastructure. In a municipal setting, usually the locality owns the fiber optic network and enters into wholesale transport, dark fiber lease, or indefeasible right of use (IRU) agreements with third-party providers to offer retail data, video, and voice services over the network. With FTTP, the municipality typically allows third-party providers to access lit services instead of dark fiber to achieve their service goals. Whatever the means (dark or lit services), open access has historically meant that multiple providers offer services over one central infrastructure, which is usually publicly owned.

As the broadband landscape has evolved in recent years, the definition of open access has also shifted. While it has traditionally required network owners to provide access to their infrastructure, communities are finding that they can achieve their goals even without a traditional open-access network. Instead of multiple ISPs and other private entities providing service over one network, open access can be achieved through multiple OTT providers offering various services.

This is particularly effective if the network is provisioned for an affordable 1 Gbps data service—ultra-high speed fiber networks offering top tier speeds can support a variety of OTT applications to meet consumers' needs. As awareness and access increase and prices decrease, consumers are likely to continue pursuing alternatives to conventional voice and video services. A new era of OTT content via 1 Gbps data services is emerging—and with it comes an updated definition of open access, and alternative paths for communities to attain their broadband goals.

1.5.1 Open Access Goals

Among the most important considerations of providing an open access network is the end goal—competition. The purpose of open access networks is to enable as many providers as possible to deliver service over the network, to give consumers greater choice and flexibility in picking a provider, and ultimately to broaden availability. Communities are beginning to understand that the objective of competition is key, and that providing a competitive marketplace for consumers may not look like what has traditionally constituted open access. In other words, data connections enable "cloud-based" applications and services.[11] A public offering that provides a robust retail data service brings the open-access objectives to the market.

If the Broadband Utility delivers an unfettered data offering that does not impose caps or usage limits (i.e., does not limit streaming), it will create an open access network on the applications side. All application providers (data, voice, video, cloud services) will be equally able to provide their services, and consumers' access to advanced data will open up the marketplace.

The Broadband Utility as a premium data-only provider would foster access in the near-term to create an open network. This is a building block toward potentially opening the network further in the future as the enterprise evolves, if this form of open access remains an ongoing goal for the City. Typically, however, getting to traditional open access—where multiple ISPs offer

[11] "Cloud services" refers to technology services such as software, software services, virtualized computing environments, and managed services available "in the cloud" through a user's Internet connection rather than on the user's computer hard drive or office server, as with traditional software.

service—has been slow going and problematic in the United States. Focusing on other forms of open access provides a viable and attractive stopgap in the meantime, and may eliminate the need for traditional open access altogether. One of the most important elements in successfully redefining open access is the emergence and evolution of OTT providers and next-generation applications to support consumers' needs.

1.5.2 Evolving Over-the-Top Providers

OTT or "value added" services is not a new concept, though it has been quicker to evolve in the voice market than in video. But recent announcements of expanded OTT video offerings suggest that consumers are seeking alternatives to traditional video services and the market is responding. Even the Federal Communications Commission (FCC) recognizes that "video services are being provided increasingly over the Internet," and it issued a Notice of Proposed Rulemaking (NPRM) in December 2014 to update its definition of "multichannel video programming distributor."[12]

To illustrate what we expect to happen with video content, we look at important changes in the landline telephone market over the past decade. Ten years ago, home telephones were still nearly ubiquitous, even in households where all members subscribed to wireless phone service. Data from a December 2013 National Institutes of Health (NIH) report, however, showed that only about 25 percent to 30 percent of homes in King County, Washington had landline telephone service.[13] National usage has continued to decline—January through June 2014 was the first ever six-month period during which a majority of U.S. children lived in households with wireless-only telephone service.[14]

This decline is possible due to increasingly accessible and affordable cellular and wireless service along with other alternatives to landline—OTT applications like Skype and Google Voice, services like Vonage and Lingo, and technology like magicJack and Ooma. In Seattle, only about 36 percent of respondents to the residential survey we conducted in February 2015 purchase landline services.[15]

The cable industry is poised to see a similar shift toward nontraditional technologies, applications, and services that allow consumers greater flexibility and choice. This will likely be more gradual than the changes to the voice industry because of cable content owners' great

[12] http://transition.fcc.gov/Daily_Releases/Daily_Business/2014/db1219/FCC-14-210A1.pdf, accessed April 2015.
[13] National Institutes of Health. (2014). Wireless Substitution: State-level Estimates from the National Health Interview Survey, 2012 (Report No. 1250). Retrieved from http://www.cdc.gov/nchs/data/nhsr/nhsr070.pdf
[14] National Institutes of Health. (2014). Wireless Substitution: Early Release of Estimates from the National Health Interview Survey, January-June 2014. Retrieved from http://www.cdc.gov/nchs/data/nhis/earlyrelease/wireless201412.pdf.
[15] See Section 6 for additional survey findings.

degree of control, but an increased consumer inclination toward OTT offerings could be an industry game changer.[16]

As an example of the firmly rooted power of cable, when Google Fiber entered the Kansas City market just a few years ago, it found that a data product alone was not strong enough to obtain the necessary market share to make the endeavor viable. If it wanted to get people to switch providers, Google *had* to offer cable, deviating from its original plan and introducing more cost and complexity than the simple data service it had anticipated. If an OTT cable offering were available when Google entered the Kansas City market, Google likely would have found that offering traditional cable television was unnecessary.

The industry has evolved even in the few years since Google Fiber began serving Kansas City residents. Earlier this year, Dish Network launched an OTT service that offers sports programming on channels such as ESPN as well as other programming and popular TV channels without a cable subscription. The service, called Sling TV, is streamed over the Internet.[17] It does not require any additional hardware and is enabled by installing an application on a device such as a smartphone, tablet, laptop, or Internet-connected television. Sling TV currently is priced at $20 per month with no time commitments.

Verizon FiOS recently announced its own "a la carte" offering called Custom TV, which allows consumers to choose from bundled packages that more appropriately reflect their programming desires and include fewer unwanted channels. While this is not a true OTT application, it demonstrates the recognition within the incumbent market that consumers are dissatisfied with traditional content delivery and are seeking alternative choices. (We note that not all players in the market are accepting of this shift, particularly in light of the Verizon FiOS announcement.)[18]

HBO announced plans last year to offer its own OTT service,[19] and as of early 2015 it began offering HBO NOW over Apple devices and to Optimum service subscribers.[20] Content can also be streamed through the HBO NOW website and there will soon be access via additional providers. Consumers can sign up for a 30-day free trial; service is $14.99 per month after the introductory period expires.

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[16] This change is not without other risks to the City. Unless legislation changes in accordance with changes in the industry, this market transition to OTT services could have serious adverse consequences to City cable franchise fee and utility tax revenue.

[17] https://www.sling.com/, accessed April 2015

[18] Stelter, B. (2015, April 22). *ESPN, Fox, NBC: We're Not Happy with New Verizon Pricing Plan.* Retrieved from http://money.cnn.com/2015/04/22/media/verizon-unbundling-fox-nbc/

[19] Littleton, C. (2014, October 15). *HBO to Launch Standalone Over-the-Top Service in U.S. Next Year*. Retrieved from http://variety.com/2014/tv/news/hbo-to-launch-over-the-top-service-in-u-s-next-year-1201330592/

[20] https://order.hbonow.com/, accessed April 2015.

Access to premium programming like sports and HBO has been a stubborn barrier to customers who want to eliminate their cable subscriptions (and to competitors that want to disrupt the market). Often, consumers would happily give up enormous cable bills in favor of more streamlined, inexpensive services—but they do not take the leap because they want specific programming that is only available over cable. It is significant when a content powerhouse like HBO acknowledges the importance of change in the industry, and it alters the face of the market the City can expect to enter.

Only 50 percent of respondents to the City of Seattle residential survey subscribe to cable television at their residence while 70 percent stream Netflix (see Section 7). We previously noted that Seattle has become a data-only market, and these findings further support that assertion. The increase in OTT television will only help strengthen the Broadband Utility's position in the market.

Other services and applications already exist that will continue to propel the cable industry in the direction of greater consumer control. Since 2008, standalone media-streaming boxes like Apple TV and Roku have allowed consumers to stream content with applications such as YouTube, Netflix, and Hulu without a cable subscription. These "cord-cutters" cancel their cable subscriptions in favor of accessing their favorite content via applications and services over the Internet. Apple has announced that, like Dish, it will begin providing OTT content later this year.[21]

Other similar devices like the Chromecast, Google Nexus, and Amazon Fire TV have hit the market in recent years, allowing consumers more choice. Further, consumers can now purchase smart TVs, which come with preinstalled platforms that support streaming applications. These devices require no additional hardware—with only an Internet connection, consumers can stream music, TV shows, and movies, and even play games.

1.6 Changes to the Competitive Landscape

The broadband industry has evolved rapidly due to advances in technology, ongoing network construction in cities and states nationwide, and changing telecommunications policy. We anticipate that the market will continue to change, especially in regards to consumer demand for increased performance and use of cloud-based applications and services. Funding and grant programs through federal and state government entities have spurred localized fiber investment, but not necessarily changes to the market structure or ubiquitous availability. The entrance of Google Fiber in a number of cities appears to have raised awareness and interest in symmetrical residential 1 Gbps services.

[21] Hagey, K. (2015, March 17). *Apple Plans Web TV Service in Fall.* Retrieved from http://www.wsj.com/articles/apple-in-talks-to-launch-online-tv-service-1426555611

We noted in our 2011 report that the market was subject to limited investment and minimal competition, and that the condition was not unique to Seattle but was prevalent throughout the United States. While that statement still largely rings true, there have been changes to the competitive environment in the City in recent years, as with the national landscape. We summarize the key changes as they relate to the development of a Broadband Utility below.

1.6.1 Comcast

Currently Comcast offers up to 150 Mbps (download) service in the City. It has not publicly stated any specific plans to build FTTP in Seattle, though it has indicated that it will increase its speeds via software and electronics upgrades (e.g., migration to DOCSIS 3.1).[22] With no plans for infrastructure upgrades, this is not a major change from recent years.

1.6.2 CenturyLink

Unlike just a couple of years ago, when there were no plans for FTTP development within the City, CenturyLink planned in 2014 to initially pass 35,000 homes with FTTP, and to offer 1 Gbps service in three neighborhoods.[23] As of December 2014, there were 22,000 customers connected in two neighborhoods, including 5,000 businesses.[24] By late February 2015, the company announced that it had exceeded its initial goal and had achieved more than 45,000 passings in the three neighborhoods it initially planned to serve.[25] While this does not address the underlying issues with market structure, it is a significant step toward a more connected City.

1.6.3 Wave

Wave has announced a small pilot of about 600 customers to build FTTP in the Eastlake neighborhood of Seattle. Wave also owns Condo Internet, which provides gigabit service over fiber and sometimes over microwave mostly to MDUs.

1.6.4 Multi-Dwelling Unit Providers

Multi-dwelling units (MDUs) are buildings that contain more than one business or residential "unit"—apartment buildings, condominiums, and office suites. An MDU may contain only two units (such as duplex housing) or it may be a large building that contains dozens or even hundreds

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[22] Information provided by DoIT.

[23] Information provided by DoIT. Also reported at http://www.geekwire.com/2014/centurylink-gigabit, accessed March 2015.

[24] Soper, T. (2014, December 11). *CenturyLink Expands High-Speed Gigabit Internet in Seattle to 20K Homes*. Retrieved from http://www.geekwire.com/2014/centurylink-expands-high-speed-gigabit-internet-seattle-20k-homes/

[25] Soper, T. (2015, February 26). *CenturyLink Exceeds Initial Estimates, Expands Seattle Gigabit Internet to Five More Neighborhoods*. Retrieved from http://www.geekwire.com/2015/centurylink-exceeds-initial-estimates-expands-seattle-gigabit-internet-to-five-more-neighborhoods/

of units (as in the case of large buildings in downtown metropolitan areas). Given the vast array of MDUs, the type and range of services available to these buildings can vary significantly.

A unique set of providers usually markets their services specifically to MDU tenants, often through agreements with homeowner's associations, building landlords, or building owners. Agreements are often negotiated on a building-by-building basis, making it challenging to quantify the services that each provider offers at each location. In light of these specialized providers offering targeted services, MDU locations typically tend to be well-served and are not an easy market for new providers to enter. Many of these buildings may even have access to the ultra-high speed service that the City intends to provide.

Section 5 outlines various competitors in the Seattle market, though it does not analyze in depth the complex nature of serving MDUs. A case-by-case analysis would be necessary to identify specific services provided and associated costs—and it still may not yield a clear picture of the various services available at different MDUs. The City may find that it is especially challenging to provide service at these locations.

1.7 Recommendations

This report makes several recommendations about how the City of Seattle might achieve its broadband goals, particularly through a municipal delivery model. As we noted, the national broadband landscape is changing fast. Unique partnerships are emerging from coast to coast, and we do not believe that these partnerships and a municipal retail model are mutually exclusive. Rather, the City may be able to achieve its goals by considering a municipal delivery model in conjunction with varying degrees of partnership with local public and private entities, including cooperation among City departments and utilities.

As we describe in detail below, one area of enormous opportunity for the City, if it chooses to proceed with FTTP deployment, is to work collaboratively with Seattle City Light (SCL). If the Broadband Utility were to construct its infrastructure in SCL's power space on utility poles, it would save an estimated $130 million in construction costs as compared to building the same network in the communications space on the poles. Note that this is contingent on SCL's ability and willingness to allow for construction in its power space (see Section 1.7.4).

1.7.1 Retain Ownership of Assets

Most communities that decide to pursue some form of network implementation prefer to retain ownership and control of the "assets." This usually includes at least the fiber in the ground or on poles and all accompanying ducts, splice cases, and other network components known as the "outside plant" (OSP). It often also entails ownership of network electronics such as routers and other equipment at the network core or central office (CO).

Retaining ownership of the assets is an important way for communities to retain some control of the network, and it mitigates the City's risk. This includes a scenario wherein a community pursues partnership with a private provider—a good way to balance risk and reward is for the City to maintain ownership and control of the assets while it assigns operational responsibilities to a private partner. This enables both parties to perform functions that highlight their strengths while not having to expend resources and energy attempting to carry out tasks for which they are ill-equipped.

1.7.2 Develop an Application Demonstration Center

One way the Broadband Utility can demonstrate the power of the network is to create a space where members of the public and media can go to test applications and see what 1 Gbps speed really feels like. This is a potentially powerful way to arouse interest in and understanding of 1 Gbps service. Consumers can test drive the network and truly experience its capabilities, enabling them to fully grasp in concrete terms the breadth of what next-generation connectivity can do.

This space can also be a designated location for vendors and OTT providers to showcase their applications, and for potential customers to get a sense of new applications and what the future of application development might entail. Vendors and OTT providers can demonstrate how their applications interact with unbridled connectivity and foster public education in the process (e.g., alternatives to popular household-name applications). Application development is a fast-paced, constantly changing arena and there are myriad applications for a wide range of services, interests, and fields. A demonstration center can be a powerful marketing tool for the Broadband Utility and its application partners, and can function as a dynamic test bed for vendors, developers, and OTT providers.

Such a space might be a public computing center or it might function like a storefront where representatives from the Broadband Utility and various application developers are available to explain services and answer questions. The City may be able to partner with interested entities in the community to determine an existing location that may make sense for such a space—a space within the library, a centrally located co-working space, or a community center. Or the Broadband Utility may find that it is feasible to generate buzz and interest by creating a new space that it can tailor to be an effective application demonstration center. If the City opts to create a new space, it may find that potential partners (including developers, vendors, and providers who might benefit from use of the space) are interested in sharing some of the cost in exchange for a presence there.

1.7.3 Develop a Focused Pilot Project

The City seeks to understand what costs, tasks, and risks might be associated with launching a Broadband Utility; one step toward this would be to develop a pilot project. We evaluated the

City's current market, particularly in the context of the overall national broadband landscape, to determine the characteristics of a pilot that would be most beneficial. We also received guidance from the City on the parameters of a pilot project.

Pilot projects often serve as information-gathering and marketing endeavors for the communities that undertake them. However, a retail-offering pilot project rarely provides meaningful insight into what a communitywide offering may entail unless the project can encompass a full range of neighborhoods.

Neighborhoods tend to comprise groups of people whose demographics (age, ethnicity, education level, and income) are similar. So providing service to a neighborhood that consists largely of young professionals, for example, is unlikely to illustrate what it may look like to provide service to neighborhoods that consist mostly of college students or elderly residents. Because factors like take rates and the level of required customer support will vary by neighborhood, pilot projects do not necessarily reflect the potential operational costs and revenues for a full-scale deployment.

Further, the cost of deployment will vary tremendously from one neighborhood to another. And because of the high cost of deploying FTTP, it is not feasible to implement multiple pilot projects (i.e., to provide pilot service to a small group of homes in several neighborhoods throughout the City).

Therefore, we recommend consideration of developing a single pilot that demonstrates the value of gigabit speeds and allows vendors to demonstrate new devices and applications. This would likely build excitement and public support while engaging the Seattle business community and developers. In other words, it might be used to help drive demand. The pilot should focus on proving the value of the network rather than the economics of the model.

There are numerous local businesses and industries that could be powerful allies in demonstrating the capacity of the network and what it truly means to have 1 Gbps service. These could include:

- Local healthcare providers that can show in practical terms how healthcare is positively impacted by 1 Gbps symmetrical service.
- Software and application developers who can demonstrate the power of applications they are designing and implementing—applications as simple as enhanced smartphone functionality, or as complex as major data management systems.

- Large tech-centric companies that could model the heightened productivity created when teams of top talent can collaborate remotely.
- Seattle-based companies that can effectively show the local impact of 1 Gbps service—everything from streamlining operations at a local food coop to setting up an intricate network of surveillance cameras to monitor inventory at a local car dealership.

Section 9 details advisable pilot projects and how City-allocated funds can be best put to use.

Finally, a pilot project may offer additional and unexpected benefit by inciting incumbent providers to increase their service speeds, lower pricing, and strive to be more competitive in the marketplace. Even if the City is not able to sustain a communitywide build out, it may be beneficial to disrupt the market just enough to keep pressure on incumbent providers to offer more competitive service to consumers.

1.7.4 Work with SCL as a Partner

It is unlikely that the Broadband Utility will be a branch of the City's existing municipal utilities, Seattle Public Utilities (SPU) and Seattle City Light (SCL), but its exact structure is yet to be determined.[26]

Seattle City Light (SCL) can potentially be a valuable ally and partner for the City and the Broadband Utility. It is critical to understand SCL's priorities and needs, and to foster the most mutually beneficial relationship.

Because SCL operates transmission and generation facilities, it is subject to strict requirements by the North American Electric Reliability Corporation (NERC) and the Federal Energy Regulatory Commission (FERC). One of the most important of these requirements is that SCL must maintain control of infrastructure located in its power space on utility poles, including maintenance activities. This means that even if the Broadband Utility were able to place fiber in SCL's power space, the enterprise will necessarily contract with SCL for the maintenance of the infrastructure there.

One potential approach to enable the Broadband Utility to place fiber infrastructure in the SCL-administered power space is having the Broadband Utility retain ownership of the fiber infrastructure and then reimburse SCL for its cost of performing maintenance tasks. Generally, this reimbursement would be the actual cost of the maintenance plus a small administration fee to offset overhead costs incurred by SCL. The goal is *not* for SCL to profit from this endeavor—

[26] There are potentially numerous options for how the entity should be structured (e.g., a unique department within the City organization, an "enterprise" department of the City, a standalone utility). The City should consult qualified legal counsel to determine what option legally fits most appropriately with its goals.

rather, it is to ensure that SCL is able to adhere to regulations and be at no financial risk while performing necessary maintenance work for the Broadband Utility. This and other possible structures would need to be vetted by SCL and City legal counsel and cleared through an SCL NERC and FERC compliance review.

It is our understanding that SCL is unable to take any financial risk, and that its collaboration with the Broadband Utility would require guaranteed payments that adequately cover all operational and maintenance expenses. We discuss in Section 4.4 different funding mechanisms for the Broadband Utility, such as the possibility of the City seeking municipal bonds. One such type of bonding uses electric revenues to guarantee payment of the loan; however, this is not possible in Seattle because the proposed FTTP network does not directly benefit SCL or its ratepayers.[27]

Most likely, if the City seeks municipal bonds, it will need to pursue general obligation (GO) bonds[28] or revenue bonds secured with sales tax or other revenues.[29] Use of GO bonds would help reduce the debt services borne by the Broadband Utility, but it would also put at risk the same revenue streams that support basic government functions such as police, fire, parks and human services. If the Broadband Utility did not succeed financially, the City would still be obligated to pay debt service on the broadband infrastructure. To make such payments, the City would have to reduce spending on some or all of these basic functions. Alternatively, the City may pursue funding through use of property taxes.

Regardless of the funding mechanism it pursues, we encourage the enterprise to work as closely as possible with SCL to foster a positive and mutually beneficial relationship. For example, SCL could potentially enable construction of the fiber network in the power space, which would reduce the overall cost of the project by approximately $130 million. We discuss this in greater detail in Section 6 and Section 8.

1.7.5 Continue to Support City Connectivity Needs

The City should not rule out any possible avenue for collaboration, especially among City departments and with other partners that also have a vested interest in the overall well-being of the community. There are numerous types and degrees of partnership that the City could consider to increase the Broadband Utility's likelihood of success.

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[27] SCL serves ratepayers in the City of Seattle, but also at locations outside of the City of Seattle—so SCL ratepayers are not always City of Seattle citizens.

[28] Based on discussions with City staff, for Council-approved (rather than voter-approved) the City currently has a legal debt capacity of approximately $1 billion. Depending on the cost scenario, a Broadband system could consume somewhere between 45 percent and 70 percent of that total.

[29] The financial community generally views municipal broadband as high risk, and therefore tends not to accept projected broadband revenues as security. In rare cases where these revenues might be accepted, the bond rates would be extremely high.

Additional internal "partnerships" include cooperation among City departments to help develop and deploy the fiber network to support the operations of such departments. If there are telecommunications savings that can be realized internally, this money can potentially be reallocated to help offset ongoing costs for construction and operations. Further, as the City pursues a municipal delivery retail model for its Broadband Utility, there are opportunities to partner with the private sector like OTT content providers (see Section 1.5.2).

1.7.6 Potential Public-Private Partnerships

Finally, we believe it is prudent for the City to consider the possibility of partnering with one or more providers that can potentially offer different services for network operations. This type of public–private partnership would enable the City to exert great control over how much risk it is willing to take on.

A public–private partnership does not have to preclude the municipal delivery model; the City has absolute authority at this point to determine what type of partnership it aims to participate in, and it can negotiate the terms. For example, the City may want to partner with a provider that is willing to absorb ongoing network maintenance and act as the liaison with the end user. Certain responsibilities may be best carried out directly by the Broadband Utility, while it may make better business sense to contract out or partner for others. The City may be able to negotiate a partnership with terms that retain the City of Seattle brand, even as the private partner carries out certain high-risk, specialized functions.

2 Understand the Financial Forecast Models, Assumptions and Sensitivities

We developed several financial models to demonstrate the Broadband Utility's potential expenses and revenues, and to outline the impact of different funding mechanisms. Each model is designed to be cash flow positive in year one—this is accomplished through borrowing funds or using property tax funds to finance the Broadband Utility.

There are several scenarios where assumed monthly service price and take rates have been adjusted to demonstrate the impact of these sensitivities on the income statement and cash flow statement. It is important to maintain positive unrestricted and total cash balances throughout the project—if the Broadband Utility has a year where the unrestricted cash balance is negative, other City funds may be required to cover the shortage.

The financial forecast's sensitivities and assumptions are important to bear in mind as the City considers this endeavor. The numbers are very sensitive and even slight fluctuations in take rates, the amount the Broadband Utility is able to charge its customers, and other assumptions can have a big impact on the enterprise's overall financial health.

Additionally, the financial projections use several assumptions that are a snapshot in time, especially the survey results. These numbers are likely to shift and change over time and may not always be as favorable as they are in our initial projections. For example, consumer follow-through is typically less than what a survey may project, and surveys do not measure the consumer's potential reaction to changes in competitors' offerings. There will likely be some response from incumbent providers—an attempt to undermine the Broadband Utility's efforts and to reduce its customer base. Given the anticipated reaction from the competition, Broadband Utility take rates are likely to fluctuate, particularly downward.

Again, the goal is to show how even slight changes in take rate and pricing can affect the Broadband Utility's financial wellbeing. This is especially important to consider in light of potential incumbent response. If incumbent providers significantly reduce their pricing, the Broadband Utility may not be as capable of successfully obtaining customers (take rate) or

This section explains how even slight changes to the assumptions of these models can dramatically impact associated financial outcomes. Note that no matter which funding mechanism it pursues, the best case scenario is that the Broadband Utility is able to work closely with SCL to build in its power space to realize cost savings there.

2.1 Financial Models

We initially sought to create four separate models to outline the Broadband Utility's financial forecast. Each of these assumes that the City will pursue municipal bonding to fund the Broadband Utility:

1) Construction in SCL power space, given market penetrations estimated by the surveys
2) Construction in SCL power space, given market penetrations necessary for cash flow
3) Construction in communications space, given market penetrations estimated by the surveys
4) Construction in communications space, given market penetrations necessary for cash flow

Although there were initially four models, it happened to work out that the market share projections for a network constructed in the power space (as estimated from the surveys) is equal to the market share needed for the enterprise to be sustainable. That is, the market share we project the Broadband Utility must obtain to maintain cash flow. Thus, we ended up with three models.

We subsequently conducted analysis based on the assumption that the City may fund the Broadband Utility through property tax revenues. This is a demand-driven model and does *not* assume a ubiquitous FTTP build.

We present all the models in detail in Section 8.

2.2 Base Take Rate and Pricing Assumptions

According to the residential surveys we conducted,[30] 48 percent of residential users might be willing to purchase 1 Gbps service for $75 per month. When we take into consideration market size and occupancy rate in the City, the Broadband Utility could potentially achieve a take rate of 43.2 percent of residential users, assuming that incumbent providers do not move to reduce the price of their services or other actions in order to retain customers.

We estimated that the take rate for business customers would be approximately half that of residential, or 21.6 percent.[31] Based on our calculations, there are 220,725 residential passings[32] and 25,910 business passings for an overall total of 246,635 passings.[33] Thus, the residential take

[30] See Section 7.1.

[31] Because responses to the business survey were limited, this is an estimation based on our experience and the insights we were able to gather from the significant residential survey response and the business responses that were submitted.

[32] Household or business that is a potential customer and has fiber infrastructure build close to the premises- i.e. "passes" the premises.

[33] Section 4.4.1 further explains passings and take rate.

rate would be 95,354 (220,725 multiplied by 43.2 percent) and the business take rate would be 5,597 (25,910 multiplied by 21.6 percent) for a total of 100,951. This means that the overall take rate the Broadband Utility might realize, based on survey projections, is approximately 41 percent. It is important to note that these numbers do not include MDU locations. As we noted in Section 1.6.4, MDUs likely must be calculated on a case-by-case basis due to the inherently complex nature of serving these locations. Obtaining a contract to serve MDU locations would likely bolster the business case.

These particular survey-based projections and assumptions apply to construction both in SCL power space and in the communications space. Further, the 41 percent overall take rate is the same number that is necessary to make the model cash flow if the network is constructed in SCL's power space. The tax funded model also assumes a 41 percent overall take rate. This number is optimistic; as a point of comparison, the Electric Power Board of Chattanooga (EPB), which has been in operation for more than a decade[34], has reported that its take rate for fiscal year 2014 was 33 percent.[35]

To make the Broadband Utility cash flow if constructing in the communications space, a 54 percent residential and a 27 percent business take rate are necessary. The total take rate necessary in this model is approximately 51 percent.

Our projection for the initial three models assumes that $75 per month is the base price for residential service. We encourage the Broadband Utility to start at this price point because it has a greater likelihood of attracting early adopters—consumers who want the service and are willing to pay for it. The price can always be adjusted downward if that makes sense later, but it is more challenging to raise prices from the initial starting point. Further, based on our analysis, the Broadband Utility will struggle to maintain a sustainable customer base if its starting price is any higher than $75 per month.

The property tax funded utility model assumes a $45 monthly service fee. This is lower than the other models because residents are essentially subsidizing their own service fee through the property tax revenues used to fund the Broadband Utility in this model. The likelihood of residents subscribing to the City's service increases if the monthly service fee is $45.

Based on our projections, the City of Seattle's Broadband Utility could potentially be a breakeven business, but not a revenue generator—and the breakeven point will come after several years of operation. To demonstrate the sensitivity of the model, we consider small fluctuations in pricing

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[34] Started in the early 2000s with a fiber-based business telephone service

[35] Electric Power Board of Chattanooga. (2014). *EPB Financial Report 2014*. Retrieved from https://www.epb.net/flash/annual-reports/2014/EPB-Financials-2014.pdf

and the percentage of Internet users. These sensitivity tests also highlight the potential financial risks to the City. While under some assumptions a Broadband Utility could break even or make money, under others the system could lose substantial sums of money and potentially force reductions in existing government functions.

2.3 Price and Take Rate Fluctuation Scenarios

We focused on residential service to develop several potential scenarios demonstrating the sensitivity of take rate and price. These assume construction in the SCL power space and demonstrate sensitivities for both the bond funded and property tax funded utility model.

See Section 8 for further explanations and key assumptions of the models.

We summarize in Table 8 the impact of each of the sensitivity models on IRR and unrestricted cash balance.

2.3.1 Fully Subscriber-Funded Model (GO Bond Financed) with Construction in SCL Power Space

Our base case scenario for the fully subscriber-funded model in the SCL power space shows residential service priced at $75 per month and 48 percent of occupied households with Internet (43.2 percent of homes passed, 21.6 percent of businesses passed).

The total cash balance in year one for the base case scenario is $25.9 million and by year 20 it is $58.3 million.[36] The internal rate of return (IRR)[37] in the base case scenario is -5.32 percent.

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[36] It is important to maintain positive unrestricted and total cash balances throughout the project. If the unrestricted cash balance is negative in a given year, other City funds may be required to cover the shortage.

[37] The Internal Rate of Return (IRR) is the discount rate that makes the net present value (NPV) equal to zero. The NPV is the difference between the present value of cash inflows and the present value of cash outflows. Typically, the higher the IRR, the more desirable the project. As an example, private sector firm would generally require an IRR of approximately 20 percent to consider investing in a project to ensure it was sustainable.

Table 1: Base Case – Residential Service Price at $75 per Month, 48 percent of Occupied Households with Internet (43.2 percent of homes passed, 21.6 percent of businesses passed)

Income Statement	1	5	10	15	20
Total Revenues	$11,715,600	$91,527,540	$91,527,540	$91,527,540	$91,527,540
Total Cash Expenses	11,201,280	32,861,720	35,271,390	37,931,860	40,869,240
Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
Interest Expense	(10,070,400)	(18,960,800)	(13,719,190)	(7,818,670)	(675,550)
Net Income	($23,469,700)	($4,639,400)	$8,232,620	$11,472,670	$15,678,410
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$3,923,040	$23,277,580	$23,277,580	$1,894,460	($118,240)
Depreciation Reserve	-	24,272,970	24,272,970	21,946,730	33,192,280
Interest Reserve	10,070,400	-	-	-	-
Debt Service Reserve	11,900,500	25,200,500	25,200,500	25,200,500	25,200,500
Total Cash Balance	**$25,893,940**	**$72,751,050**	**$72,751,050**	**$49,041,690**	**$58,274,540**
Investment Metric					
Internal Rate of Return (IRR)			-5.32%		

In Table 2 we show the impact of a price increase of $5 per month. The total cash balance in year 1 is $26.5 million, which is just over half a million dollars greater than the base case scenario. However, the difference increases to almost $20 million by year 5 and continues to increase. The total cash balance in year 20 is $159.8 million, which is more than a hundred million dollars greater than the base case scenario.

The IRR in this scenario is -3.83 percent.

Table 2: Residential Service Price Increases by $5 per Month

Income Statement	1	5	10	15	20
Total Revenues	$12,306,840	$97,248,780	$97,248,780	$97,248,780	$97,248,780
Total Cash Expenses	11,207,190	32,918,930	35,328,600	37,989,070	40,926,450
Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
Interest Expense	(10,070,400)	(18,960,800)	(13,719,190)	(7,818,670)	(675,550)
Net Income	($22,907,270)	$803,040	$13,675,060	$16,915,110	$21,120,850
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$4,485,470	$43,172,050	$43,172,050	$76,213,330	$101,412,830
Depreciation Reserve	-	24,272,970	24,272,970	21,946,730	33,192,280
Interest Reserve	10,070,400	-	-	-	-
Debt Service Reserve	11,900,500	25,200,500	25,200,500	25,200,500	25,200,500
Total Cash Balance	**$26,456,370**	**$92,645,520**	**$92,645,520**	**$123,360,560**	**$159,805,610**
Investment Metric					
Internal Rate of Return (IRR)			-3.83%		

Table 3 shows the impact of a $5 per month service price decrease. The total cash balance in year 1 is $25.3 million, which approximately a half million dollar decrease from the base case scenario. However, the total cash balance in this scenario by year 20 shows a loss of $43.3 million. This is $101.5 million less than the base case scenario.

The IRR in this scenario is negative 7.02 percent.

Table 3: Residential Service Price Decreases by $5 per Month

Income Statement	**1**	**5**	**10**	**15**	**20**
Total Revenues	$11,124,360	$85,806,300	$85,806,300	$85,806,300	$85,806,300
Total Cash Expenses	11,195,360	32,804,500	35,214,170	37,874,640	40,812,020
Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
Interest Expense	(10,070,400)	(18,960,800)	(13,719,190)	(7,818,670)	(675,550)
Net Income	($24,032,120)	($10,081,840)	$2,790,180	$6,030,230	$10,235,970
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$3,360,620	$3,383,120	$3,383,120	($72,424,400)	($101,649,300)
Depreciation Reserve	-	24,272,970	24,272,970	21,946,730	33,192,280
Interest Reserve	10,070,400	-	-	-	-
Debt Service Reserve	11,900,500	25,200,500	25,200,500	25,200,500	25,200,500
Total Cash Balance	**$25,331,520**	**$52,856,590**	**$52,856,590**	**($25,277,170)**	**($43,256,520)**
Investment Metric					
		Internal Rate of Return (IRR)	-7.02%		

Table 4 shows the impact of a 5 percent residential take rate increase. Note that the total cash balance in this scenario is $25.8 million, which is less than $100 thousand lower than the base case scenario. However, with this take rate increase, the total cash balance increases to $87.4 million in year 5 (approximately $14.7 greater than the base case scenario) and $152,440,470 by year 20 (an approximately $94.1 million difference).

The total cash balance is lower in the beginning in this scenario because of the cost of connecting more customers if the take rate is higher. The larger customer base increases revenues over time, however, and ultimately the total cash balance is greater than that of the base case scenario.

The IRR in this scenario is negative 3.79 percent.

Table 4: Residential Take Rate Increases by 5 Percent (percent of Internet users)

Income Statement	1	5	10	15	20
Total Revenues	$11,715,600	$101,061,900	$101,061,900	$101,061,900	$101,061,900
Total Cash Expenses	11,201,280	35,012,685	37,601,015	40,458,745	43,613,905
Depreciation	13,728,030	43,175,270	32,094,290	32,094,290	32,094,290
Interest Expense	(10,127,600)	(19,010,910)	(13,734,220)	(7,833,170)	(697,010)
Net Income	($23,731,010)	($51,095)	$13,718,245	$16,761,565	$20,742,565
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$3,724,100	$36,463,355	$36,463,355	$75,203,885	$102,631,860
Depreciation Reserve	-	25,676,870	25,676,870	16,053,350	24,512,610
Interest Reserve	10,127,600	-	-	-	-
Debt Service Reserve	11,972,000	25,296,000	25,296,000	25,296,000	25,296,000
Total Cash Balance	**$25,823,700**	**$87,436,225**	**$87,436,225**	**$116,553,235**	**$152,440,470**
Investment Metric					
Internal Rate of Return (IRR)			-3.79%		

Table 5 shows the impact of a 5 percent residential take rate decrease. In year 1, the total cash balance is $25.9 million, which is slightly greater than the base case scenario. This is due to cost savings realized by connecting fewer customers. By year 5, however, the total cash balance is approximately $58 million, which is roughly $15 million less than the base case scenario. By year 20, the total cash balance shows a loss of $36.5 million, which is approximately $94.8 million less than the base case scenario year 20 total cash balance of $58.3 million.

The IRR in this scenario is negative 7.11 percent.

Table 5: Residential Take Rate Decreases by 5 Percent (percent of Internet users)

Income Statement	1	5	10	15	20
Total Revenues	$11,715,600	$81,993,180	$81,993,180	$81,993,180	$81,993,180
Total Cash Expenses	11,201,280	30,634,675	32,857,755	35,312,235	38,022,165
Depreciation	13,393,420	38,521,550	29,522,470	29,522,470	29,522,470
Interest Expense	(10,034,000)	(18,930,190)	(13,708,730)	(7,805,840)	(655,630)
Net Income	($23,302,800)	($9,268,835)	$2,728,625	$6,177,035	$10,617,315
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$4,053,940	$9,903,340	$9,903,340	($71,668,860)	($102,858,785)
Depreciation Reserve	-	22,927,720	22,927,720	27,138,090	41,219,900
Interest Reserve	10,034,000	-	-	-	-
Debt Service Reserve	11,855,000	25,140,000	25,140,000	25,140,000	25,140,000
Total Cash Balance	$25,942,940	$57,971,060	$57,971,060	($19,390,770)	($36,498,885)
Investment Metric					
Internal Rate of Return (IRR)			-7.11%		

In Table 6 we show the impact of a 5 percent residential take rate increase along with a $5 per month rate increase. Recall that the first year total cash balance reflects costs associated with connecting additional customers. As such, the $26.4 million total cash balance in year 1 is only about $500 thousand greater than the base case scenario.

By year 5, the total cash balance in this scenario increases to $109.3 million, which is approximately $36.6 higher than the base case scenario. Significantly, the total cash balance by year 20 is $264.5 million—approximately $206 million greater than the base case scenario.

The IRR in this scenario is negative 2.32 percent.

Table 6: Residential Take Rate Increases by 5 Percent (percent of Internet users) and Price Increases by $5 per Month

Income Statement	1	5	10	15	20
Total Revenues	$12,306,840	$107,379,120	$107,379,120	$107,379,120	$107,379,120
Total Cash Expenses	11,207,190	35,075,855	37,664,185	40,521,915	43,677,075
Depreciation	13,728,030	43,175,270	32,094,290	32,094,290	32,094,290
Interest Expense	(10,127,600)	(19,010,910)	(13,734,220)	(7,833,170)	(697,010)
Net Income	($23,168,580)	$5,958,295	$19,727,635	$22,770,955	$26,751,955
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$4,286,530	$58,342,105	$58,342,105	$157,176,535	$214,651,460
Depreciation Reserve	-	25,676,870	25,676,870	16,053,350	24,512,610
Interest Reserve	10,127,600	-	-	-	-
Debt Service Reserve	11,972,000	25,296,000	25,296,000	25,296,000	25,296,000
Total Cash Balance	**$26,386,130**	**$109,314,975**	**$109,314,975**	**$198,525,885**	**$264,460,070**
Investment Metric					
Internal Rate of Return (IRR)			-2.32%		

Table 7 shows the impact of a 5 percent take rate decrease along with a $5 decrease in monthly price. The total cash balance in year 1 for this scenario is $25.38 million and by year 5 it is $40 million. By year 20, the total cash balance shows a loss of $127.5 million. The IRR in this scenario is negative 8.91 percent.

Table 7: Residential Take Rate Decreases by 5 Percent (percent of Internet users) and Price Decreases by $5 per Month

Income Statement	**1**	**5**	**10**	**15**	**20**
Total Revenues	$11,124,360	$76,867,920	$76,867,920	$76,867,920	$76,867,920
Total Cash Expenses	11,195,360	30,583,425	32,806,505	35,260,985	37,970,915
Depreciation	13,393,420	38,521,550	29,522,470	29,522,470	29,522,470
Interest Expense	(10,034,000)	(18,930,190)	(13,708,730)	(7,805,840)	(655,630)
Net Income	($23,865,220)	($14,144,335)	($2,146,875)	$1,301,535	$5,741,815
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$3,491,520	($8,006,790)	($8,006,790)	($138,333,990)	($193,901,415)
Depreciation Reserve	-	22,927,720	22,927,720	27,138,090	41,219,900
Interest Reserve	10,034,000	-	-	-	-
Debt Service Reserve	11,855,000	25,140,000	25,140,000	25,140,000	25,140,000
Total Cash Balance	**$25,380,520**	**$40,060,930**	**$40,060,930**	**($86,055,900)**	**($127,541,515)**
Investment Metric					
Internal Rate of Return (IRR)			-8.91%		

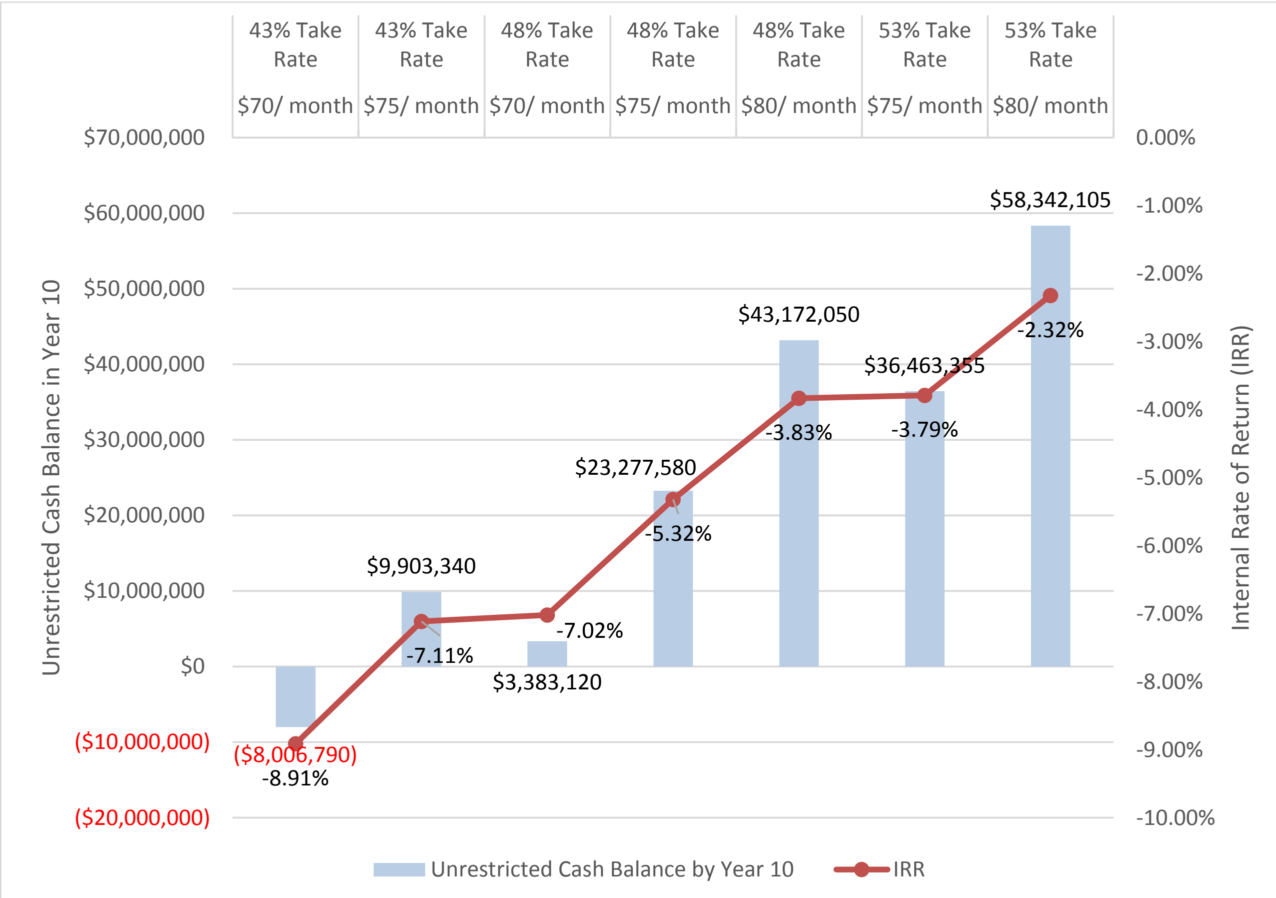
Table 8 summarizes sensitivities in the fully subscriber-funded (GO bond financed). It shows the unrestricted cash balance in year 10 and the IRR based on fluctuations in take rate and monthly service price.

Table 8: Summary of Sensitivity Scenarios for Fully Subscriber-Funded (GO Bond Financed) Model

Take Rate	**Monthly Service Price**	**Unrestricted Cash Balance in Year 10**	**Internal Rate of Return (IRR)**
43%	$70/ month	($8,006,790)	-8.91%
43%	$75/ month	$9,903,340	-7.11%
48%	$70/ month	$3,383,120	-7.02%
48%	$75/ month	$23,277,580	-5.32%
48%	$80/ month	$43,172,050	-3.83%
53%	$75/ month	$36,463,355	-3.79%
53%	$80/ month	$58,342,105	-2.32%

The year 10 unrestricted cash balance and IRR at various price points and take rates for the fully subscriber-funded (GO bond financed) model are also shown in Figure 5.

Figure 5: Unrestricted Cash Balance in Year 10 and Internal Rate of Return (IRR) at Various Price Points and Take Rates for Fully Subscriber-Funded (GO Bond Financed) Model



2.3.2 Property Tax Funded Utility Model with Construction in SCL Power Space

We also include several scenarios to demonstrate the sensitivities of assumptions for this model. The tables below show the impact on the income and cash flow statements if we change certain assumptions, like monthly service fee and projected take rate.

In this model, peering costs are anticipated at $33,100 in year 1, $168,100 in year 2, and $302,900 for year 3 forward.

The base scenario in Table 9 assumes $440 million tax revenue collected in year 1.[38]

The base case scenario shows a net loss of $17.2 million in year 1, a net loss of $12.6 million in year 10, and a net loss of $18.1 million in year 20. The total cash balaance in year 1 is $236.6 million. It is $53.8 million in year 10, and $97.8 million in year 20.

[38] For modeling purposes the property tax funded model we assumed a single issue of debt. In reality the debt would not be issued in a single tranche, but rather timed to match the expected rate of spending.

Table 9: Property Tax Funded Utility Model Base Case Scenario

Tax Funded Base Case - Residential Service Price at $45 per month (business $10 higher), 48 percent of Occupied Households with Internet (43.2 percent of homes passed, 21.6 percent of businesses passed).					
Income Statement	**1**	**5**	**10**	**15**	**20**
Total Revenues	$7,746,960	$55,185,180	$55,185,180	$55,185,180	$55,185,180
Total Cash Expenses	11,161,590	32,498,290	34,907,960	37,568,430	40,505,810
Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
Interest Expense	-	60,680	56,780	54,870	82,980
Net Income	($17,174,550)	($20,189,310)	($12,562,800)	($15,225,180)	($18,134,450)
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$236,559,190	$29,506,450	$29,506,450	$64,838,020	$64,570,150
Depreciation Reserve	-	24,272,970	24,272,970	21,946,730	33,192,280
Interest Reserve	-	-	-	-	-
Debt Service Reserve	-	-	-	-	-
Total Cash Balance	$236,559,190	$53,779,420	$53,779,420	$86,784,750	$97,762,430
Investment Metric					
Internal Rate of Return (IRR)			n/a		
Tax Revenue (all collected in year 1)			$440,000,000		

In the next scenario, we assume $440 million tax revenue collected in the first year. Residential service is priced at $75 per month for 48 percent of occupied households with Internet—this price is assumed for comparison to the subscriber-funded model.

Year 1 in this scenario shows a $13.4 million net loss. By year 10 the net income is $22 million and by year 20 it is $16.4 million.

The total cash balance in this scenario is $240.3 million in year 1, $180.5 in year 10, and $743 million in year 20.

Ignoring the $440 million in property tax funded capital investment, the IRR in this scenario is 5.88 percent.

Table 10: Property Tax Funded Utility Model – $75 Service Fee, 48 Percent Take Rate Scenario

Residential Service Price at $75 per month, 48 percent of Occupied Households with Internet (43.2 percent of homes passed, 21.6 percent of businesses passed).					
Income Statement	**1**	**5**	**10**	**15**	**20**
Total Revenues	$11,715,600	$91,527,540	$91,527,540	$91,527,540	$91,527,540
Total Cash Expenses	11,201,280	32,861,720	35,271,390	37,931,860	40,869,240
Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
Interest Expense	-	60,680	56,780	54,870	82,980
Net Income	($13,399,300)	$14,382,080	$22,008,590	$19,346,210	$16,436,940
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$240,334,440	$156,182,380	$156,182,380	$537,227,850	$709,816,930
Depreciation Reserve	-	24,272,970	24,272,970	21,946,730	33,192,280
Interest Reserve	-	-	-	-	-
Debt Service Reserve	-	-	-	-	-
Total Cash Balance	**$240,334,440**	**$180,455,350**	**$180,455,350**	**$559,174,580**	**$743,009,210**
Investment Metric					
Internal Rate of Return (IRR)	5.88%				
Tax Revenue (all collected in year 1)	$440,000,000				

The next scenario shows the sensitivity of changing the take rate to 20.47 percent.[39] There is a $16.3 million net loss in year 1, a $21.6 million net loss in year 10, and a $25 million net loss in year 20.

The total cash balance in year 1 is $242.4 million. It is $47.4 million in year 10 and $35.1 million in year 20.

[39] The changes made in each scenario are intended to illustrate sensitivity.

Table 11: Take Rate 22.17 Percent (26 percent of residential and 13 percent of business Internet users) and 44 Percent LIA Participation (approximately 25,000 by year 5)

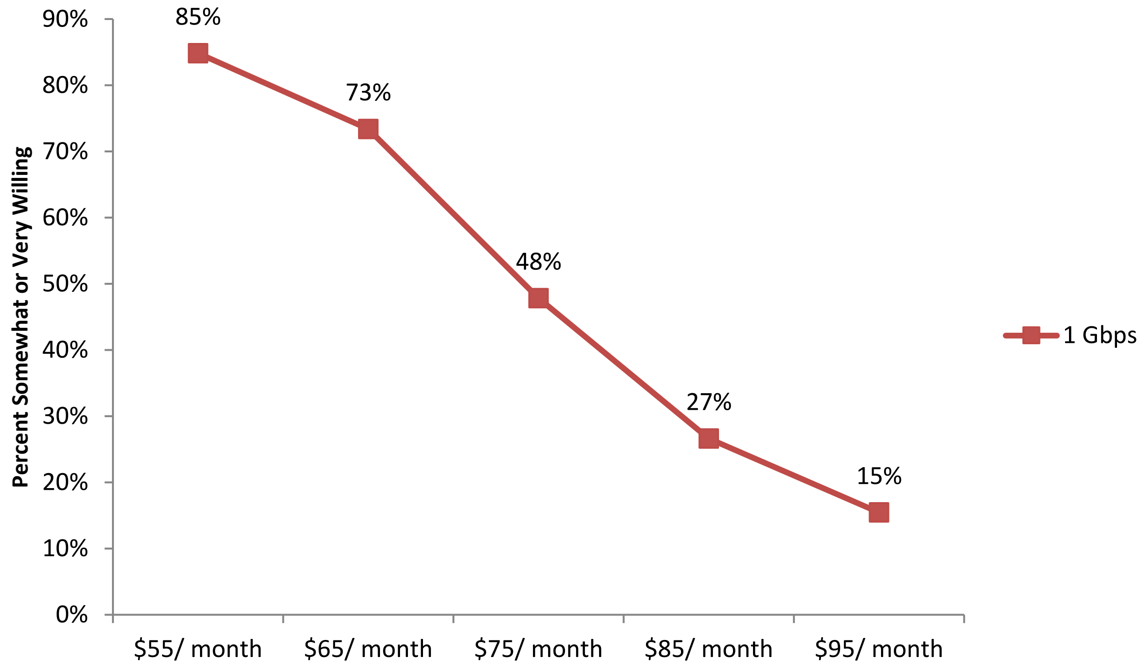
Take Rate 20.47 percent (24 percent of residential and 12 percent of business Internet users)					
Income Statement	**1**	**5**	**10**	**15**	**20**
Total Revenues	$7,746,960	$27,592,920	$27,592,920	$27,592,920	$27,592,920
Total Cash Expenses	11,161,590	22,087,735	23,611,975	25,294,835	27,152,865
Depreciation	12,694,110	29,594,990	24,551,350	24,551,350	24,551,350
Interest Expense	-	44,130	80,550	122,020	183,820
Net Income	($16,344,740)	($25,114,345)	($21,558,525)	($23,199,915)	($24,996,145)
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$242,367,920	$29,704,190	$29,704,190	($54,757,140)	($108,633,405)
Depreciation Reserve	-	17,653,630	17,653,630	48,806,470	73,528,460
Interest Reserve	-	-	-	-	-
Debt Service Reserve	-	-	-	-	-
Total Cash Balance	$242,367,920	$47,357,820	$47,357,820	($5,950,670)	($35,104,945)
Investment Metric					
Internal Rate of Return (IRR)	n/a				
Tax Revenue (all collected year 1)	$440,000,000				

2.4 Scenarios Based on Residential Willingness to Switch Providers

One of the questions we asked in the residential survey was what price point at which customers would consider changing Internet service.[40] Figure 6 shows the percent of survey respondents willing to purchase 1 Gbps services for various price points. In this section we show the impact of different price points for 1 Gbps service.

[40] Please note this is a best-case static analysis that does assume any pricing or other marketing response from incumbent providers.

Figure 6: Somewhat or Very Willing to Switch Internet Service for Various Monthly Prices



In the scenario in Table 12 we show the impact of charging $55 per month for service with a take rate of 85 percent (see price points from survey results in Figure 6). The total cash balance in year 1 in this scenario is $23.2 million, it is $43.2 by year 5, and $39.3 by year 20. This model shows an IRR of negative 4.45 percent.

Table 12: Residential Service Price at $55 per Month, Take Rate at 85 Percent (percent of Internet users)

Income Statement	**1**	**5**	**10**	**15**	**20**
Total Revenues	$9,350,640	$121,554,180	$121,554,180	$121,554,180	$121,554,180
Total Cash Expenses	11,177,630	48,765,820	52,538,440	56,703,720	61,302,510
Depreciation	14,731,850	57,978,090	40,235,120	40,235,120	40,235,120
Interest Expense	(10,408,800)	(19,252,130)	(13,811,790)	(7,919,080)	(828,010)
Net Income	($27,265,750)	($9,149,650)	$10,261,040	$11,988,470	$14,480,750
Cash Flow Statement	1	5	10	15	20
Unrestricted Cash Balance	$493,410	($16,987,140)	($16,987,140)	$20,382,550	$41,869,560
Depreciation Reserve	-	34,420,740	34,420,740	(18,779,310)	(28,357,470)
Interest Reserve	10,408,800	-	-	-	-
Debt Service Reserve	12,323,500	25,764,500	25,764,500	25,764,500	25,764,500
Total Cash Balance	**$23,225,710**	**$43,198,100**	**$43,198,100**	**$27,367,740**	**$39,276,590**
Investment Metric					
Internal Rate of Return (IRR)			-4.45%		

Table 13 shows a $65 per month service price and a take rate of 73 percent. The total cash balance in year 1 is $24.5 million and by year 5 it is $86.6 million. This model shows a total cash balance of $221.4 million by year 20. The IRR in this scenario is negative 2.41 percent.

Table 13: Residential Service Price at $65 per Month, Take Rate at 73 Percent (percent of Internet users)

Income Statement	1	5	10	15	20
Total Revenues	$10,533,120	$121,795,500	$121,795,500	$121,795,500	$121,795,500
Total Cash Expenses	11,189,450	43,700,955	47,030,835	50,707,315	54,766,425
Depreciation	14,353,750	52,424,800	37,180,090	37,180,090	37,180,090
Interest Expense	(10,302,800)	(19,161,220)	(13,782,600)	(7,886,820)	(778,850)
Net Income	($25,656,780)	$1,791,385	$19,084,835	$21,304,135	$24,352,995
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$1,986,030	$29,852,970	$29,852,970	$143,006,240	$204,338,795
Depreciation Reserve	-	31,140,440	31,140,440	(5,701,120)	(8,516,390)
Interest Reserve	10,302,800	-	-	-	-
Debt Service Reserve	12,191,000	25,588,000	25,588,000	25,588,000	25,588,000
Total Cash Balance	**$24,479,830**	**$86,581,410**	**$86,581,410**	**$162,893,120**	**$221,410,405**
Investment Metric					
Internal Rate of Return (IRR)			-2.41%		

Table 14 shows an $85 per month service price and a 27 percent take rate. The total cash balance in year 1 is $27.3 million and by year 5 it is $34.7 million. By year 20, the total cash balance in this model shows a loss of $219.6 million.

This results in a negative 12.46 percent IRR.

Table 14: Residential Service Price at $85 per Month, Take Rate at 27 Percent (percent of Internet users)

Income Statement	1	5	10	15	20
Total Revenues	$12,898,080	$57,921,720	$57,921,720	$57,921,720	$57,921,720
Total Cash Expenses	11,213,100	23,566,795	25,192,205	26,986,805	28,968,165
Depreciation	12,811,210	31,013,140	25,344,970	25,344,970	25,344,970
Interest Expense	(9,871,200)	(18,788,820)	(13,665,050)	(7,761,060)	(588,440)
Net Income	($21,432,930)	($17,690,345)	($8,523,815)	($4,414,425)	$776,835
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$5,754,090	($8,659,790)	($8,659,790)	($219,482,450)	($312,865,885)
Depreciation Reserve	-	18,491,580	18,491,580	45,322,310	68,369,360
Interest Reserve	9,871,200	-	-	-	-
Debt Service Reserve	11,651,500	24,868,500	24,868,500	24,868,500	24,868,500
Total Cash Balance	**$27,276,790**	**$34,700,290**	**$34,700,290**	**($149,291,640)**	**($219,628,025)**
Investment Metric					
Internal Rate of Return (IRR)			-12.46%		

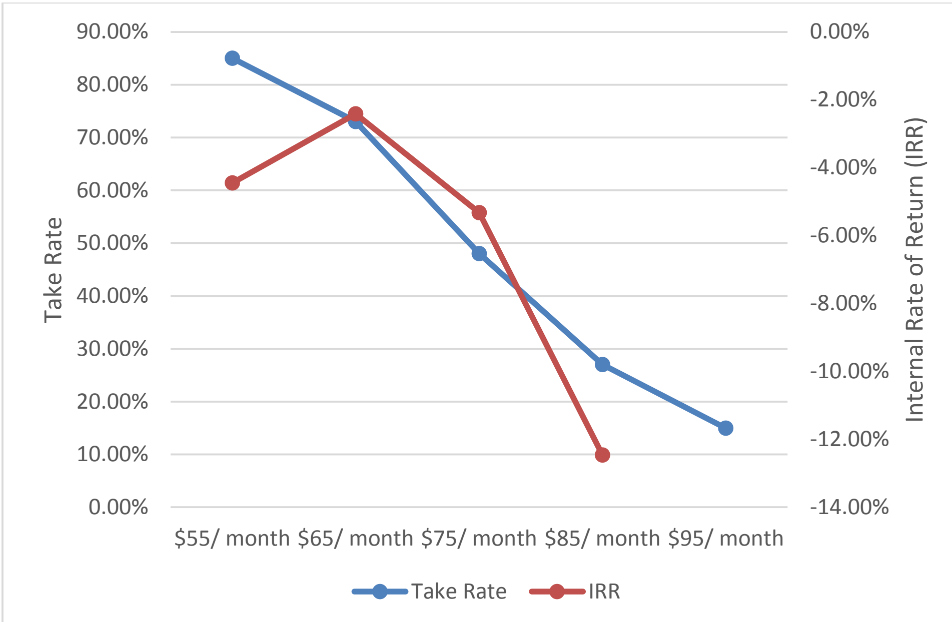
Table 15 is a model with a $95 per month service price and a 15 percent take rate. The total cash balance in year 1 is $28.6 million and $3.9 million in year 5. By year 20, the total cash balance shows a loss of $430 million.

Table 15: Residential Service Price at $95 per Month, Take Rate at 15 Percent (percent of Internet users)

Income Statement	1	5	10	15	20
Total Revenues	$14,080,560	$35,753,700	$35,753,700	$35,753,700	$35,753,700
Total Cash Expenses	11,224,930	18,277,670	19,460,360	20,766,160	22,207,860
Depreciation	12,359,520	25,361,460	22,191,660	22,191,660	22,191,660
Interest Expense	(9,744,400)	(18,678,690)	(13,631,350)	(7,727,130)	(537,720)
Net Income	($19,729,590)	($27,948,860)	($20,914,410)	($16,315,990)	($10,568,280)
Cash Flow Statement	**1**	**5**	**10**	**15**	**20**
Unrestricted Cash Balance	$7,314,630	($35,939,410)	($35,939,410)	($383,239,580)	($543,133,420)
Depreciation Reserve	-	15,152,280	15,152,280	59,104,630	88,865,830
Interest Reserve	9,744,400	-	-	-	-
Debt Service Reserve	11,493,000	24,657,500	24,657,500	24,657,500	24,657,500
Total Cash Balance	**$28,552,030**	**$3,870,370**	**$3,870,370**	**($299,477,450)**	**($429,610,090)**
Investment Metric					
Internal Rate of Return (IRR)			na		

As shown in the tables above, the sustainability of the models is highly dependent on service price and take rates, and the survey results show the dependency of take rate on pricing. As indicated in the above analysis, maintaining cash flow will be challenging. Further, as shown in Figure 7 below, obtaining the maximum IRR is a balance of take-rate and service pricing.

Figure 7: Internal Rate of Return at Various Price Points and Take Rates



3 Influences on the City's FTTP Model

Each municipal fiber enterprise is as unique as the city that plans, builds, and operates it. The success or failure of one jurisdiction's endeavor may not reflect the outcome of a different city's pursuit, even when the cities are very similar. One city may find that FTTP makes sense, while another may decide to build a network only to connect its own facilities.

The City of Seattle's pursuit of FTTP is rooted in its desire to enhance the quality of life for its residents; its metric for success is tied to intangible benefits. This ability to focus on more than a quantifiable balance sheet enables the City to concentrate on its goals. That said, the City's model is still influenced by a variety of factors, which we discuss here.

3.1 Strengths, Weaknesses, Opportunities, Threats (SWOT)

Strategic planning can benefit tremendously from identifying and evaluating potential strengths, weaknesses, opportunities, and threats (SWOT). Here we outline our conclusions based on a preliminary SWOT analysis that considers the City of Seattle's unique characteristics and market.

We also discuss how the City might navigate potential difficulties, how it can best use its assets, and what its position in the market might be. To be successful, the City should aim to leverage strengths and opportunities and mitigate weaknesses and threats.

3.1.1 Strengths

Entering the FTTP market can be challenging for any municipality, particularly those that provide services intended to compete with established providers. However, the City of Seattle is an established entity with a strong credit rating and the ability to provide long-term financing for projects.[41] In this vein, it is capable of seeing and understanding the value of long-term investments and recognizing that the overall wellbeing of the community is a forward-looking payoff in the short term while waiting for longer term benefits. Further, it is positioned to manage the infrastructure it creates.

The City also has a good track record providing services to its citizens through SCL and Seattle Public Utilities (SPU). The community will potentially respond favorably to a new City offering, and is likely to trust the City to provide broadband services.

3.1.2 Weaknesses

The City's greatest weakness will be operating a for-choice, competitive business because it is simply not structured to support such a service without significantly adding and reallocating resources. As an example, the addition of 100,000 subscribers for an established entity like

[41] https://www.moodys.com/credit-ratings/Seattle-City-of-WA-credit-rating-600026704, accessed March 2015.

Comcast has minimal impact on its daily operations. But adding the same number of subscribers to a City organization is profound and would have a major impact on City support infrastructure.

Although the City currently provides diverse services through dozens of its offices and departments, it is essentially a monopoly for many of these. It does not have to compete to provide most of the services it offers, and it is unaccustomed to a competitive environment. Market conditions can be unpredictable and adjusting to them is often challenging. Those in the market typically must exhibit great flexibility and ability to change course quickly. Remaining nimble and responsive is one of the greatest difficulties all providers face.

Further, although the City does offer a range of standard City services, it is unfamiliar with the nuances and difficulties of administering an always-on service like an FTTP network. Because of its inherently round-the-clock nature, network management can be exceptionally challenging. Often there is a steep learning curve for municipalities that enter the retail market because they must learn to navigate a unique business world that bears little resemblance to a typical government environment. Because this would be the City's first venture into this arena, we have identified this as its primary weakness. We anticipate the City will struggle most with adjusting to market conditions and remaining responsive. The details of providing service at any level are many, and are especially tedious during startup.

3.1.3 Opportunities

As we noted, we believe the City is well positioned to seek cooperation internally among City departments and with potential partners like SCL. The cost savings that could be realized through building a relationship with SCL and placing infrastructure in the power space is compelling.

Collaboration among City departments is an incredible asset in development and deployment of the network, and will likely have a ripple effect. For example, employees who are familiar with the capacity of the network and who experience its power every day at the workplace are more prone to purchase the service for their homes and to speak positively about the Broadband Utility. Although a robust marketing effort is absolutely necessary, word-of-mouth marketing can have a profound impact on the success of a startup business.

One of the greatest and simplest opportunities the City has is in what it can offer—1 Gbps data-only service. Although the Seattle market is served fairly well with broadband there is little access to high-end services. The City will likely find its greatest opportunity in providing high-end offerings at reasonable rates and not over-complicating what it provides. Simplicity is key in favorably penetrating the market—by offering just one package, the City has the chance to set itself apart as the go-to provider for that high-caliber of service.

The City can also benefit from considering varying degrees of partnership, and these opportunities should not be overlooked. The municipal delivery retail model is possible, but it is not without challenge and significant risk to the City. A public–private partnership where the private entity handles the components of service with which it is familiar and for which it is well equipped could save the City a great deal of risk[42] and cost.

3.1.4 Threats

While the degree of threat is unpredictable, it is prudent to exercise caution when entering what could be a contentious market. The service provider industry can be inhospitable, particularly to a public provider. A major challenge faced by networks built and operated by public institutions is opposition from existing, private-sector providers. There are a number of reasons for this, some of which are related to perception while others relate to the market itself. Criticisms will range from allegations of cross-subsidization of expenses, using general or other funds for debt service coverage, to questioning the need or demand for public based connectivity services.

Providers in the private sector often desire access to publicly owned fiber through an Indefeasible Right of Use (IRU) or wholesale leasing. Somewhat paradoxically, these providers also frequently have misgivings about the ability of public entities to competently provide lit, or retail, services to the end user. Often there is enormous political complexity involved when a public entity enters the market as a competitor. In order to best mitigate this threat, the City may want to aim for varying degrees of partnership or collaboration with local providers. Further analysis may identify local providers and assess what level of objection the City might receive from them, if any.

The City should be prepared for the possibility that some local incumbent providers may be displeased about the creation of the Broadband Utility. This is one of the reasons we suggest focusing only on a niche service and one single offering—by filling a gap and providing a service that only minimally exists, there is little overlap with incumbent providers.

3.1.5 SWOT Conclusion

We acknowledge that this SWOT analysis is a dynamic framework that will shift and evolve over time as the Broadband Utility matures. This analysis indicates that the City is in a favorable position because of its ability to focus on long-term goals in its pursuit of FTTP. Fiber tends to be a capital-intensive endeavor with a somewhat slow return on investment (ROI). The City is at an advantage because of its bonding power and ability to prioritize goals other than only a bottom line (unlike most private companies). If the City is able to partner with SCL and build fiber in the power space as well as seek cooperation internally, it has a better chance at succeeding. The City's weakness is that it has never taken on an endeavor like this. That fact highlights incumbent

[42] The private partner might invest in electronics or other parts of the network. A partner could also bring operations support and marketing expertise, which would reduce the City's operating risk.

providers as the greatest threat. There will be much to learn and prepare to successfully deploy and operate a new FTTP network; as the Broadband Utility finds its footing, it may struggle to navigate challenging relationships.

3.2 Market Forces

Examining the business model in the context of the Porter's Five Forces Model—the competitive framework developed by Michael Porter, a professor at Harvard Business School[43]—provides important insights into the opportunities and threats the Broadband Utility may face. (See Figure 8 for an illustration of the model).

Figure 8: Porter's Five Forces

According to Porter, competitive rivalry within an industry is determined by conditions related to five factors. These factors and their relationship to the City's infrastructure are as follows:

[43] Porter, Michael. *Competitive Advantage: Creating and Sustaining Superior Performance.* New York: Free Press, 1985.

Intensity of the rivalry. Seattle consumers have, at best, two broadband infrastructure operators: Comcast/Wave[44] and CenturyLink. Given the high fixed costs to build and maintain infrastructure, there are both extremely high market-entry barriers and high exit barriers. (Because Internet service providers and infrastructure owners are generally one and the same, an ISP that fails will lose the enormous value of its infrastructure investment.) Furthermore, incumbent providers do not have an "obligation to serve" customers with data services, and they face limited threat to market share because the barriers to entry are so high. Viewed in this light, the incumbents are likely to act forcibly against the potential deployment of the City's FTTP network—but application developers and others will see the network as a platform for selling services and creating new business opportunities.

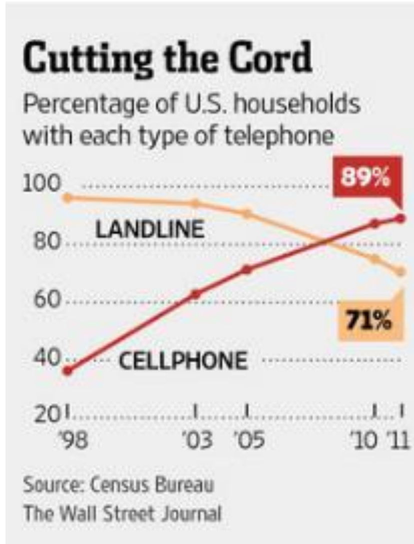
Threat of new competitors. Cost is the primary barrier to entry for potential infrastructure over-builders (i.e., a network operator that builds infrastructure "over" the existing wires and cables in an area that is already served by other providers). Duplicative infrastructure costs make the prospect nearly impossible due to a number of factors, including limited rights-of-way, pole congestion, access to existing internal building or home wiring, and material and labor costs. Working with SCL to access the power space would lower deployment costs.

Threat of substitute products. While it may seem that satellite is a substitute for wireline broadband infrastructure (FTTP, copper, or coaxial), the limited capability and high subscription cost of satellite-based Internet as compared with a wireline network dispels that notion. Likewise, wireless networks are not full competitors with wireline networks given the relatively limited speed of wireless networks, their stringent caps on bandwidth usage, the difficulty providers are having keeping up with growth in demand, and the fact that wireless traffic is ultimately handed off to wireline infrastructure. This is compounded in Seattle by topographical barriers to high-quality wireless service. In this regard, the City's proposed network would be well positioned—and, in fact, is in a position of strength relative to competitors that do not have FTTP networks.

The classic example of the impact of substitute product is the effect that cellular telephones have had on the landline telephone market. As seen in Figure 9, more than a quarter of U.S. households no longer have landline telephones, down from almost 99 percent just a decade ago. According to surveys we conducted in the City, only 36 percent of Seattle residents purchase landline telephone for their homes.[45]

[44] Comcast and Wave each serve a portion of the City and their service areas overlap in a few sections of the City.
[45] See Section 6 for additional survey findings.

Figure 9: Cutting the Telephone Cord[46]



OTT video programing, streaming video from Netflix, Amazon, and others, and consumer created video distributed on YouTube are positioned to change the video market. The cutting of the video cord has been predicted ever since cable modems started to emerge in the late 1990s. The transition, however, has not been dramatic. Figure 10 and Figure 11 show paid television subscribers in 2011 and 2012. The total number of paid subscriptions remained relatively flat with cable television losing some ground to IPTV packages (i.e., television programming similar to cable TV offerings, but delivered over IP data networks), showing minimal movement toward OTT programming at that time. In these figures IPTV is actually packaged television line-ups offered by Verizon and AT&T. The transition demonstrated is the impact that AT&T and Verizon have had in the markets they have entered. Since both slowed their respective video expansions in their markets served[47] we would have expected that the erosion away from the traditional cable television providers was not a trend.

Two obstacles must be addressed for true video competition. These are 1) access to ubiquitous FTTP by multiple data providers (market competition), and 2) reduction of the control and restriction of video content used in cable television offerings by a handful of organizations. The advent of services like Sling TV demonstrate that the market is undergoing change—albeit slowly—through minimizing control of content.

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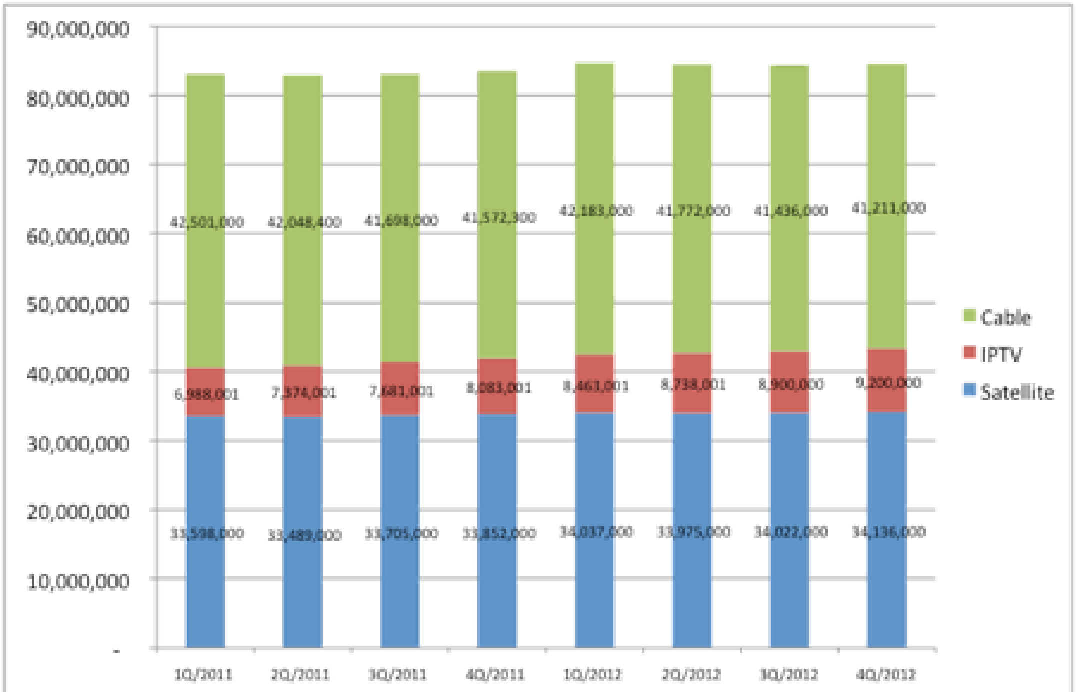
[46] Sparshott, J. (2013, September 5). *More People Say Goodbye to Their Landlines*. Retrieved from http://online.wsj.com/news/articles/SB10001424127887323893004579057402031104502

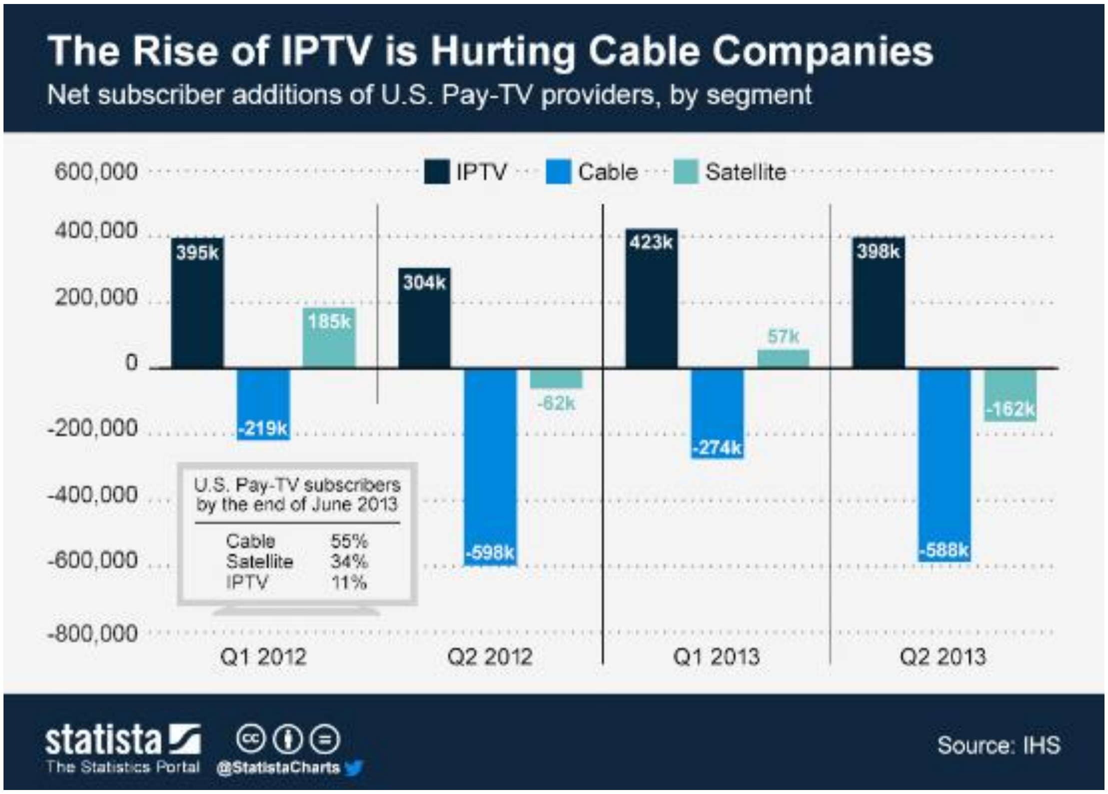
[47] Verizon is not planning to expand FIOS (their FTTP offering) in any additional markets. AT&T has slowed its expansion of DSL-based video programming. In both cases these companies are the incumbent telephone provider.

Figure 10: U.S. Paid Television Subscribers[48]



[48] Source: Company financials, compiled by MRG

Figure 11: Impact of Verizon and AT&T IPTV



Note: IPTV in this figure is not OTT video, but "packaged" video that has the same form, fit, and feel as offered by the cable television companies. The "anytime-anywhere" video access offered by DirecTV, Comcast, AT&T, Verizon, and others require consumers to subscribe to a cable television package at their households.

The rising popularity of streaming content devices like Roku and Apple TV, and the introduction of new devices in just the past year indicate that there will be continued transition away from traditional cable television. As consumers gain simpler access to content by having more control over the services they subscribe to and the content they desire, this shift will likely increase.

Bargaining power of buyers. Alternative Internet providers that want to enter the market tend to have limited buying power, in terms of access to the existing infrastructure and content. The alternative providers must usually acquire this access from the incumbent providers with which they compete in the retail marketplace—making it difficult or impossible for new entrants to offer a competing retail service. However, Seattle is unique because it is the region's center for direct Internet access (DIA) and peering. This reduced cost of key and often expensive elements of a network positions the City to face a reasonable cost structure. Such direct access might encourage Netflix and other streaming video providers to locate servers on the City's network (see additional detail under "Bargaining power of suppliers" below).

Bargaining power of suppliers. Suppliers (owners) of cable video content are few and they have substantial market power. Comcast is both a content owner and the incumbent retail cable provider, meaning that its cost of content is significantly lower than other cable operators. (Public sector network operators often believe that they can offer lower pricing to consumers because they do not have the same profit motive as incumbent providers; that may be true, but their higher cost of providing service generally more than counters the reduced profit.)

The pricing pressures here are extremely complex—pitting content owners, cable operators, and customers against each other (with customers inevitably paying higher rates). "While the FCC reports that customer rates have been increasing by about 6% annually—the current inflation rate, by comparison is 1.5%—cable companies counter that their programming costs have been rising by as much as 10% in recent contract renewals with media companies."[49]

Without affordable access to content, alternative service providers are not able to offer competitive and innovative retail video services. To a lesser extent, ISPs often face price pressure on DIA costs and small ISPs tend to be too small to encourage Netflix and Amazon to locate their servers "on net"—meaning that subscribers may not have the same high-quality streaming experience, even with a fiber connection. If the servers are not located on the Broadband Utility's network, subscribers will be accessing video files in another location in the country over an ISP's DIA connection. We believe the City's Broadband Utility will have the potential for some bargaining power, which will allow it to gain some market size.

The following tables illustrate, at a high level, some of the opportunities and threats facing the proposed FTTP network:

[49] Amadou Diallo, "Cable TV Model Not Just Unpopular But Unsustainable," *Forbes*, 2013 October 14. http://www.forbes.com/sites/amadoudiallo/2013/10/14/cable-tv-price-hikes-unsustainable/

Table 16: Opportunity Matrix

Success Probability

Attractiveness	**High**	**Low**
High	○ Increased awareness and demand for Gigabit data connections due to efforts of Google and others	○ Completely break the consumer cable television addiction (control of content limits creativity today; limits content access to online distributors, requires bundling of "channels," other).
Low	○ Compete with incumbents with a low-priced Gigabit data connection – obtain a high take rate but with low contribution margins.	○ City attempts to compete with tiered services similar to incumbents – a "me-too" offering.

Table 17: Threat Matrix

Seriousness	Probability of Occurrence: High	Probability of Occurrence: Low
High	○ Only a moderate percentage of businesses and residences choose City services (revenue covers operational costs but not debt service) ○ The City struggles with reacting to changes in the market conditions (demand, competition, pricing)	○ Only a small percentage of businesses and residences choose City services
Low	○ Incumbent providers launch a negative advertising campaign attempting to discredit the capabilities and intentions of the City	○ Comcast and other providers expand low-cost services

4 Evolution of the Market

Costs have decreased since we produced a report that considered a standalone enterprise for providing service in Seattle. These are offset somewhat by the increase in marketplace competition—Comcast is more advanced; Wave has replaced Millennium and is an organized and motivated provider; CenturyLink is reinvesting in its properties, it is more aggressive in expanding services, and has deployed FTTP passing more than 45,000 locations.

But some areas have become less expensive and have driven costs down. For example, just a few years ago, optical network terminals (ONTs) had to be placed outside the home, which was sometimes an onerous and expensive process. These devices must have access to a power supply and finding the right balance between the cost of running fiber to a specific location on the outside of a building based on its proximity to power access is often problematic. An advancement as simple as optical network terminals (ONTs) no longer necessarily being placed outdoors can have a significant impact on overall cost to deploy.

Further, the evolution of applications to replace services has continued to erode the voice and video market. That is, consumers' use of applications like Skype and Google Voice for calls, and YouTube and Netflix for video, has reduced the stronghold of the traditional incumbent telephone and cable industry.

In our analysis, we included applications and services that have the potential for the greatest community impact as well as those that might generate ongoing revenue for the Broadband Utility. Industries like healthcare, security, research and development, and even gaming have the potential to be a boon to the overall wellbeing of the community and to provide necessary income for the Broadband Utility.

4.1 Partnerships

We mentioned that the broadband industry has undergone significant changes in recent years, and one of the most notable of these is the emergence of true potential partners who are prepared to take on risk. These providers stand out against a backdrop of others in the past that made promises that went unfulfilled and had inaccurate expectations of what a municipality's role in a partnership should be.

The municipal broadband landscape went through a phase where it was riddled with so-called partners whose goal was to allow the public partner to take all the risk while the private entity reaped all the reward. Not surprisingly, some unfortunate relationships came from this era, and some of the consequences were painful for certain communities. However, we believe that the emergence of truly motivated private companies who are committed to growing the fiber industry is a promising step toward a bright future for municipal endeavors and partnerships.

4.1.1 Google Fiber

Google Fiber is one of the most momentous forces behind the significant changes in the fiber industry. By providing simplified offerings in the communities it serves, it cuts down on financial and service complexity and streamlines its business model. We do not anticipate that the Broadband Utility will partner with Google Fiber. However, we do believe that it can benefit from the effect Google has had on the market.

Typically, Google Fiber offers three simple services:[50]

- Basic Internet for $0 per month (for up to seven years from the date the address was initially connected) plus a $300 construction fee
- Gigabit Internet for $70 per month
- Gigabit Internet + TV for $130 per month

This approach has driven demand for 1 Gbps data connections and it has compelled consumers' willingness and ability to pay a little more for a higher-end service—and the buzz it has created in the communities where it has built should not be underestimated. Although its footprint is not large at this point, Google Fiber has had a profound influence on perceptions in the marketplace.

As noted earlier, Google may find that its cable offering is unnecessary as the market continues to evolve. But even its current package with only one plain offering is a trend away from the traditional cable market.

The Broadband Utility should be prepared to leverage Google's efforts to educate its own market about what types of things subscribers can do over fiber. This will help it successfully market and provide a simple 1 Gbps data offering.

4.1.2 Alternative ISPs

As we noted, the nature of partnerships has changed, and the partners themselves have also evolved. In just the past couple of years, we have witnessed the emergence of compelling private entities that bring true partnership to the table—providers like Ting Internet[51] and Macquarie Capital.[52] These are providers who are willing to put skin in the game in the form of their own capital or through taking other risks.

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[50] https://support.google.com/fiber/answer/2657118?hl=en, accessed March 2015.

[51] Goldstein, M. (2015, January 13). *Next Ting Town: Westminster, MD Chooses Ting to Provide Service on Its Fiber Network*. Retrieved from https://ting.com/blog/next-ting-town-westminster-md/

[52] Brammer, J. (2014, December 23). *State Awards Contract for Statewide High-Speed Internet by 2018.* Retrieved from http://www.kentucky.com/2014/12/23/3608689/state-awards-contract-to-bring.html.

One of the City's goals has consistently been to provide ubiquitous access to avoid creating or furthering digital inequity. We previously considered ensuring that FTTP service was available to support schools, the general community, and to provide a basic connection to all households in the form of community intranet. This model anticipated a portal where citizens could choose from local providers if they wanted to purchase Internet services and it anticipated a free or low cost 5-10 Mbps connection. This would require a property tax funding model to be successful because of the sheer magnitude and correlating costs.

This remains an option for the Broadband Utility, though it is not without significant risk. Engaging a partner like Macquarie[53] or Ting[54] may help reduce the City's risk and further its goals. A public–private partnership with a single entity to operate the network can represent shared investment, risk, and opportunity.

Partnerships such as Ting might be attractive for enabling a public–private partnership—an arrangement that could enable the City to build, maintain, and retain ownership of the while a private provider offers retail services on the City's behalf. A private partner is able to put in some of its own capital and reap some business benefits from providing service while the City is able to make some investment and shift a portion of its risk to the private provider.

4.1.3 Seattle City Light

Section 1.7.4 above addressed the possibility of working with SCL as a potential partner, and at this point the utility is open to discussions about how it may fit in to the City's plan for a Broadband Utility. As we noted, SCL is subject to a number of legal and regulatory constraints that inform to what degree it is able to partner with the Broadband Utility.

We believe the best opportunity for collaboration lies in the Broadband Utility gaining access to SCL's power poles to place fiber infrastructure in the power space. The cost estimate for the Broadband Utility's success rests in large part on its ability to gain this access; make-ready costs for construction in the communications space are much higher).

4.2 Municipal Retail Model Considerations

We have included here some definitions to help explain the market and shed light on some retail model considerations. Take rate is an essential component of any fiber enterprise's success and an important way to make a retail model work. To fully define take rate and market share, it is important to also define the percentage of "passings," or homes and businesses passed. The

[53] For FTTP, Macquarie typically proposes a "utility fee" model, in which an "assessment" is applied to all properties. This assessment is in essence a property tax, and is used to finance the FTTP build.

[54] Ting generally supplies electronics and offers retail service while it relies on the public entity with whom it is partnering to invest in fiber infrastructure. This enables the public entity to retain ownership and control of the fiber asset.

percentage of passings is the number of homes or businesses passed with the municipal fiber divided by the potential number of passings times 100. As a simple example, consider a deployment that passes 100,000 homes and businesses of 200,000 total potential. If you divide 100,000 actual passings served by 200,000 potential passings and multiply the result by 100, your percentage of passings is 50 percent..

To derive take rate, divide the number of municipal customers served by the number of passings excluding unoccupied premises. You then multiple the result by 100. Let's say in the above example you had 40,000 customers and there are 100,000 passings but 5,000 of the premises passed are unoccupied. You would divide the 40,000 municipal customers served by 95,000. Then multiply this number by 100 for a take rate of 42 percent.

Finally, market share is the number of municipal customers served divided by the total number of customers acquiring service from *any* provider in the territory. Again, returning to the previous example, if the municipal enterprise serves 40,000 customers and all the other ISPs in the area serve a combined total of 45,000 customers, you divide the 40,000 customers served by 85,000 (the total number of customers acquiring service from any service provider in the territory, including the municipal enterprise's customer base). Multiply the result by 100 for a market share of 47 percent.

4.2.1 Take Rate

Take rate—the percentage of subscribers who purchase services from the enterprise—is a crucial driver in the success of a retail model enterprise. For the Broadband Utility to be successful, we expect that a take rate of 41 percent take rate will be necessary.[55] This number is important in consideration of a self-sustaining Broadband Utility that will subsist on subscriber revenues and will not require funding outside its own revenue sources.

If the take rate is not met, the enterprise will not be able to sustain itself and its operational costs will have to be offset through some funding source (such as ongoing subsidization by the City) to avoid allowing the enterprise to fail. Section 2 outlines the sensitivities Section 8 discusses the financial projections for the enterprise,[56] including the expected take rate necessary for ongoing financial sustainability of the Broadband Utility.

To drive this number up, the Broadband Utility will have to aggressively market and advertise its services throughout the community. A pilot project may be helpful in successfully marketing the network and demonstrating its capabilities for potential customers. Marketing and advertising is

[55] Based on a $75 per month residential data service and an $85 per month small business data service. The cost estimate and market share estimate does not include MDUs of 20 households/businesses or larger.
[56] See section 2 for the sensitivities of the financial forecast.

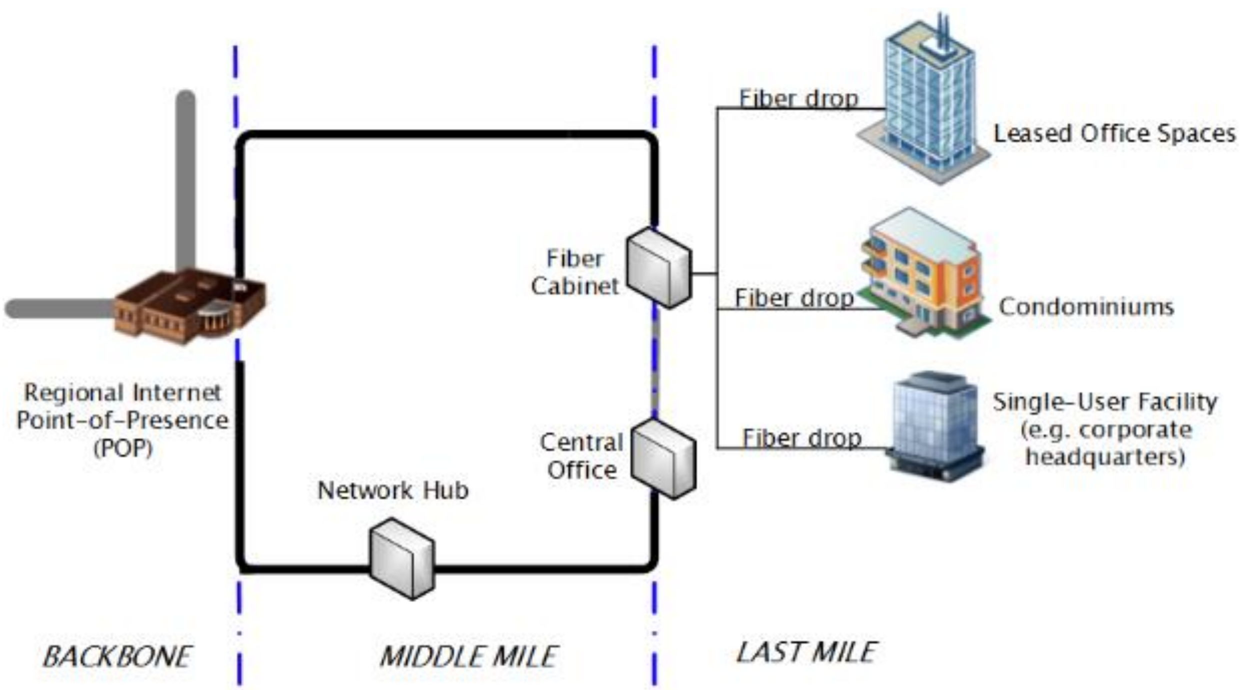
necessary for a strong marketing campaign try to obtain realistic take rates to make the enterprise succeed.

4.2.2 Multi-Dwelling Units (MDUs)

A community's concentration of large, multi-tenant MDUs is an important factor in delivering service in any market—generally, a higher concentration tends means more challenging (and often more expensive) service delivery. As we noted in the Executive Summary, the Broadband Utility will undoubtedly face numerous challenges if it attempts to enter the MDU market based on the saturation of specialized providers alone. Even if this were not the case, serving MDU locations is inherently expensive, complex, and fraught with unpredictable challenges that vary significantly by location.

We do not estimate in detail costs associated with serving MDUs because an accurate estimation would require a case-by-case analysis of all locations to be served. To shed some light on the complexity of serving MDUs and similar large buildings, it is first necessary to briefly highlight the components of a network. Figure 12 shows a simple rendering. Network construction includes the core fiber network's backbone and middle mile infrastructure as well as the drop cables that connect the "last mile" of the network—that is, fiber from the central network to the end-user.

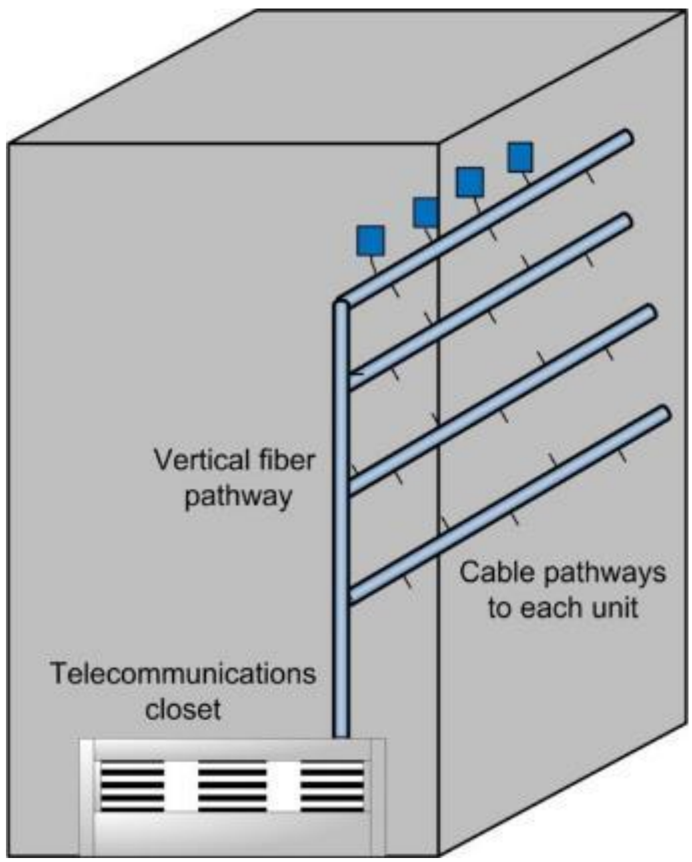
Figure 12: Example Fiber Architecture



As the Broadband Utility plans and deploys its network, true accessibility to the fiber lies in what is available to tenants within each building, including single-family or single-business locations and those where there are several units in a building. Put another way, having fiber run *to* a building in no way guarantees that all the tenants *in* the building will be served. Once a drop cable has been installed to connect the fiber cabinet to the building, the connection must be distributed within a building, known as internal building wiring.

Simply bringing fiber to the premises will not always be sufficient, particularly with MDUs. Some large buildings have hundreds, and even upwards of a thousand units. Once the fiber is brought to the building, all of those units must somehow be served, and bringing high-speed connectivity to each unit is an expensive and complex process that typically involves extensive wiring within the building (see Figure 13).

Figure 13: Internal Building Wiring



To further complicate matters, we noted that building owners often have exclusive contracts with specific providers. This puts potential new providers including the Broadband Utility at a disadvantage—they must negotiate a deal with the building owner, if the owner is willing to consider a contract with an additional provider. And new providers may lose revenue through forced profit sharing in addition to the expense of running in-building wiring. The Broadband Utility may be limited in its ability to enter into such contracts with building owners, and even if there are no legal or political restrictions some building owners may not be amenable to contracting with a municipal service.

This is not to completely dissuade the Broadband Utility from considering service to MDU locations, but we urge extra caution when considering these locations. It may be prudent to pursue that portion of the market only after the Broadband Utility has established itself, developed a positive reputation in the community, and become financially stable.

4.2.3 Ubiquitous Access

One of the City's objectives is to provide ubiquitous Internet access to its citizens, and we recognize this as an important goal. Universal, communitywide access will not happen overnight—the City can expect that it will be phased in over time. It is unlikely that a network that encompasses the entire community will be deployed right away. Rather, construction will be completed in phases, thus citizen access will increase as the network is deployed.

In keeping with the City's goal of ubiquitous access, it is prudent to strategically plan in which key areas the network should be deployed in earlier phases, and in what order. For example, while it is not realistic to reach every single neighborhood in the City right away, perhaps there are major community centers, religious institutions, computer labs, or other community spaces that can potentially provide access to a large range of people (including citizens who may not have Internet service at home).

4.3 Services

The Broadband Utility's core service will connect its municipal locations and provide 1 Gbps Internet service to residents and businesses. It can also focus its efforts toward promoting the applications most likely to be successful on a Gigabit-capable network, including ultra-fast access to services the City may provide, or other community-oriented applications and services.

These additional, alternative services may not affect market share or increase revenues. Instead, it is likely that applications will drive demand within the market, which could positively impact the market share over time, though there may not be a direct, immediate correlation. Further, the impact on revenues in the near-term will likely be minimal, and the Broadband Utility should not rely on such a pursuit for a significant revenue stream.

That said, the Broadband Utility and even the City may find that collaboration within the community like with the local healthcare industry, research and development foundations, educational institutions, and others may provide beyond-the-balance-sheet benefits. Enabling providers and applications to exist and thrive on the Broadband Utility's network is good for the health of the overall community, even if there is no direct tie to a revenue stream provided by such collaboration. However, it is important to determine early on what the Broadband Utility's role will be in championing and administering collaboration. If it is to be the facilitator of such relationships and to provide education, it will need to factor into its budget and staffing the overhead and administrative costs and time associated with these efforts.

4.4 Funding Mechanisms

A key consideration for a retail model is how to fund both capital construction costs and ongoing operational expenses. The importance of factoring in the ongoing cost of operations cannot be overstated—these expenses fluctuate based on the success of the enterprise, and can vary considerably each year, and even month to month.

The City is able to go out for bond (i.e., borrow funds) to enable construction of an FTTP network. We discuss here the two types of bonds that municipalities typically rely on for capital projects, and our recommendations for each.

4.4.1 General Obligation Bonds

General obligation or GO bonds are directly tied to the City's credit rating and ability to tax its citizens. This type of bond is *not* tied to any specific revenues from specific projects, but is connected instead to citywide taxes and revenues can be used to repay this debt. This is what also creates the risk to other public services should be the Broadband Utility fail to break even.

In Seattle, GO bonds are not authorized through a public approval process, unlike many other communities. Rather, GO bonds are approved by the City Council, which may make them easier to pass. However, this does not reduce risk. As we noted, if the City seeks municipal bonds, it will likely be prudent to pursue general obligation GO bonds or revenue bonds secured with sales tax or other revenues.[57] Use of GO bonds would help reduce the debt services borne by the Broadband Utility, but it would also potentially create risk for important City revenue streams that support core public services. If the Broadband Utility did not succeed financially, the City would still be obligated to pay debt service on the broadband infrastructure. To make such payments, the City would have to reduce spending on some or all of these basic functions.

Based on discussions with City staff, for Council-approved (rather than voter-approved) the City currently has a legal debt capacity of approximately $1 billion. Depending on the cost scenario, a Broadband system could consume somewhere between 45 percent and 70 percent of that total.

[57] The financial community generally views municipal broadband as high risk, and therefore tends not to accept projected broadband revenues as security. In rare cases where these revenues might be accepted, the bond rates would be extremely high.

4.4.2 Revenue Bonds

Like the name implies, revenue bonds are directly tied to a specific revenue source to secure the bond and guarantee repayment of the debt. The revenue stream from a municipality's electric, natural gas, or water utility may be used to secure a revenue bond. In fact, in theory, any municipal service that generates some sort of revenue that could be used to pay back the debt might potentially be used to secure a revenue bond—municipally owned public transportation or hospitals, for example. Given this, it stands to reason that the new Broadband Utility's revenues could be used to guarantee a revenue bond, but this is typically not an accepted practice within the bonding community, particularly with FTTP endeavors.

The bonding community views FTTP overbuilds as a relatively high-risk business venture, and is unlikely to approve revenue bonds tied to an FTTP venture. The risky nature of the endeavor makes these revenues unusable in this context.

4.4.3 Property Tax Funded Utility Model

Instead of borrowing funds, the City could opt to use property tax revenues to support the deployment of an FTTP network. Though this can be politically challenging, one avenue to pursue this funding is to put the request to public vote on a referendum. Passage would require a 60 percent "yes" vote. This enables the City to seek public approval and—if the referendum passes—to minimize the risk to other City services. Note, however, that the financial risk to City residents remains. If the Broadband Utility were to fail, property owners would still be obligated to the tax payments needed to cover the debt on the initial capital investments made to start the system.

5 Competitive Assessment

In this section we look at the competitive market in Seattle—which providers are offering what services at what price level. This assessment helps frame what may be necessary for the City's Broadband Utility to successfully compete in the market.

5.1 Residential and Small Business Services

Residential and small business customers in the Seattle region have access to a range of services, though individual service options are largely dependent on location. Table 18 lists the service providers and minimum price for each type of service that is available in at least some part of the City.

Table 18: Overview of Residential and Small Business Data Services in Seattle

Service Type	Provider	Minimum Price (per month)
Cable	Comcast	$39.99
	Wave	$39.95
DSL	CenturyLink	$29.95
FTTH	Wave	$60
	CenturyLink (bundled)	$49.95
Satellite	DishNET	$49.99
	HughesNet	$49.99
3G/4G/ Wireless ISP	Cricket	$35
	Sprint	$35
	AT&T	$50
	Verizon	$60
	T-Mobile	$20

5.1.1 Cable

Comcast offers internet service from 3 Mbps to 150 Mbps download speeds starting at $39.95 in the City as illustrated in Table 2. Discounted prices are available if bundled with another service like voice or TV.[58] On the small business side, multiple options are available with the 75 Mbps download and 15 Mbps upload service starting at $149.50 per month.

Table 19: Comcast Residential Internet – Internet Only

PACKAGE	INTERNET SPEED	PRICE
Performance Starter	Up to 6 Mbps download	$29.99/mo
Performance 25	Up to 25 Mbps download	$61.95/mo
Performance	Up to 50 Mbps download	$39.99/mo
Blast!	Blast! Internet - up to 105 Mbps download	$78.95/mo
Economy Plus	Up to 3 Mbps download	$39.95/mo
Extreme 150	up to 150 Mbps download	$114.95/mo

Wave offers Internet services at 5 Mbps download/1 Mbps upload ($49.95 per month),55 Mbps download/5 Mbps upload ($ 59.95 per month), 100 Mbps download/5 Mbps upload($69.95 per month) and 110 Mbps download/10 Mbps upload ($89.95 per month). Promotional discounts for 3 to 6 month periods are available. Bundled packages also offer lower prices.[59] Please note that—as with Comcast—these services are best effort, "up-to" speeds.

5.1.2 DSL

CenturyLink offers DSL service for residential customers in Seattle starting at as $29.95 per month for unbundled or standalone DSL service at 1.5 Mbps with a 12-months commitment. Additional options up to 40 Mbps at $60 per month are available in some areas.

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[58] http://www.comcast.com/internet-service.html, accessed April 2015
[59] http://www.wavebroadband.com/for-home/internet/packages/, accessed December 2014

5.1.3 FTTH

Wave offers Internet services via fiber-to-the-home in select locations in Seattle including the Eastlake neighborhood and some condos and apartment complexes; 1 Gbps speeds are available for a flat rate of $80 per month, while 100 Mbps service is available for $60 per month, with no contract, equipment or service bundle requirements.

CenturyLink has recently begun offering fiber-based service up to 1 Gbps to locations in the City such as parts of Ballard, Beacon Hill, West Seattle and the Central District at $152 per month for standalone service, after promotions. Low-income residents would be offered services at lower speeds and prices.[60]

5.1.4 Satellite

Satellite Internet access is available in the area as well. HughesNet has four packages available for residential users: 1) Connect Satellite with speeds up to 5 Mbps download/1 Mbps upload, a monthly data cap of 5 GB, and 5 GB of "bonus" data (10 GB total) for $49.99 per month2) HughesNet Power with speeds up to 10 Mbps download/1 Mbps upload, a 10 GB monthly data cap, and 10 GB of bonus data (20 GB total) for $59.99 per month; and 3) HughesNet Power Pro with speeds up to 10 Mbps/2 Mbps, a monthly data cap of 15 GB, and 15 GB bonus bytes (30 GB total) for $79.99 per month; and 4) HughesNet Power Max with speeds up to 15 Mbps/2 Mbps, a monthly data cap of 20 GB, and 20 GB of bonus data (40 GB total) for $129.99 per month.

HughesNet offers two packages for Internet services to small businesses. The Business 50 package provides speeds of up to 5 Mbps download and 1 Mbps upload for $69.99 per month with a 5 GB per month anytime allowance and 10 GB bonus bytes from 2am to 10 am for a total monthly data allowance of 15 GB. This package requires a two-year agreement and only supports up to five users. The Business 100 package provides the same download and upload speeds of the Business 50 package, but offers a higher data allowance threshold of 10 GB per month anytime and 15 GB bonus bytes from 2 am to 10 am for a monthly data allowance of 25 GB. This package also requires a two year agreement and is best for 5 to just over 10 users.

DishNET offers three residential Internet packages in the region. These packages are: 1) Up to 5 Mbps download speed with a monthly 5 GB data cap and 5 GB of bonus data for $49.99 per month with a 24-month commitment; 2) download speeds up to 10 Mbps with a 10 GB monthly data cap and 10 GB of bonus data for $59.99 per month with a 24-month commitment; and 3) up to 10 Mbps download speed with a 15 GB monthly data cap and 15 GB of bonus data for $79.99 per month with a 24-month commitment.

[60] http://blogs.seattletimes.com/brierdudley/2014/08/05/centurylink-giving-parts-of-seattle-ultrafast-broadband-finally/, accessed December 2014

5.1.5 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 is a data-only 4G LTE service with WiFi connectivity and wired Ethernet for up to four devices. There are download speeds of 5 Mbps to 12 Mbps and upload speeds of 2 Mbps to 5 Mbps. Monthly prices range from $60 for a 10 GB data allowance to $120 for a 30 GB data 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.

Sprint offers 4G LTE wireless data in Seattle. 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 12 GB per month data allowance for $80 per month. Each MB over the limits 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 also an early termination fee of $200.

AT&T also provides 4G LTE wireless data service in the area, but only offers one package type with 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.

Cricket Wireless offers 4G LTE wireless service in Seattle with a download speed of up to 8 Mbps with three options for data allowance packages. Starting at $35 per month for 1 GB of data allowed there are also options for data allowances of 3 GB ($45) and 10 GB ($55). 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.

Of the cellular wireless providers in the area, the least expensive wireless data option offered is from T-Mobile for $20 per month with a limit of 1 GB per month. T-Mobile offers additional capabilities and increasing data limits at incremental costs in a total of six packages up to $70 per month for up to 11 GB of data. Depending upon current promotions, the $35 activation fee may be waived.

5.2 Enterprise Market

This section provides an overview of competitors for dark fiber and Ethernet services with respect to the enterprise customers within the City of Seattle.

During the course of our research, we identified 12 service providers in the Seattle area that offer a range of services from dark fiber connectivity to data transport services with speeds that range from 1 Mbps to 100 Gbps. Individual providers tailor these services to a customer's requirements (for example, speed and/or class of service). Greater proximity to the provider's existing network infrastructure results in lower service pricing. Providers prefer to offer transport services between locations on their network (On-Net) and provision Multiprotocol Label Switching (MPLS) based services for connecting locations that are Off-Net.

A trend that we expect to continue is the consolidation of competitors through mergers and acquisitions.

For this analysis, we will refer to dark fiber and Ethernet as the two services or product lines. Competitors are discussed in detail in the following sections.

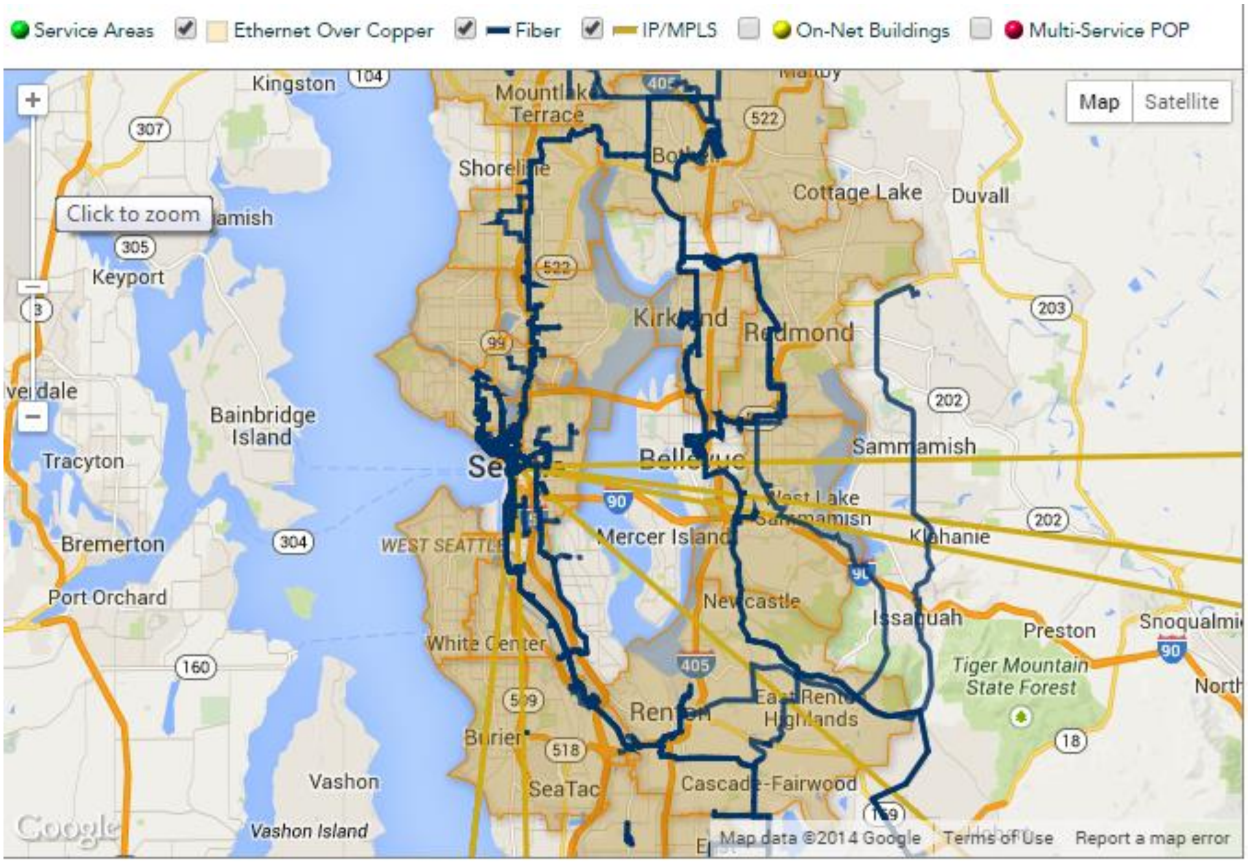
5.2.1 Dark Fiber Services

Four service providers in the City offer dark fiber services: Integra Telecom, Level (3), Wave and Zayo.

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 Figure 1.[61] 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.

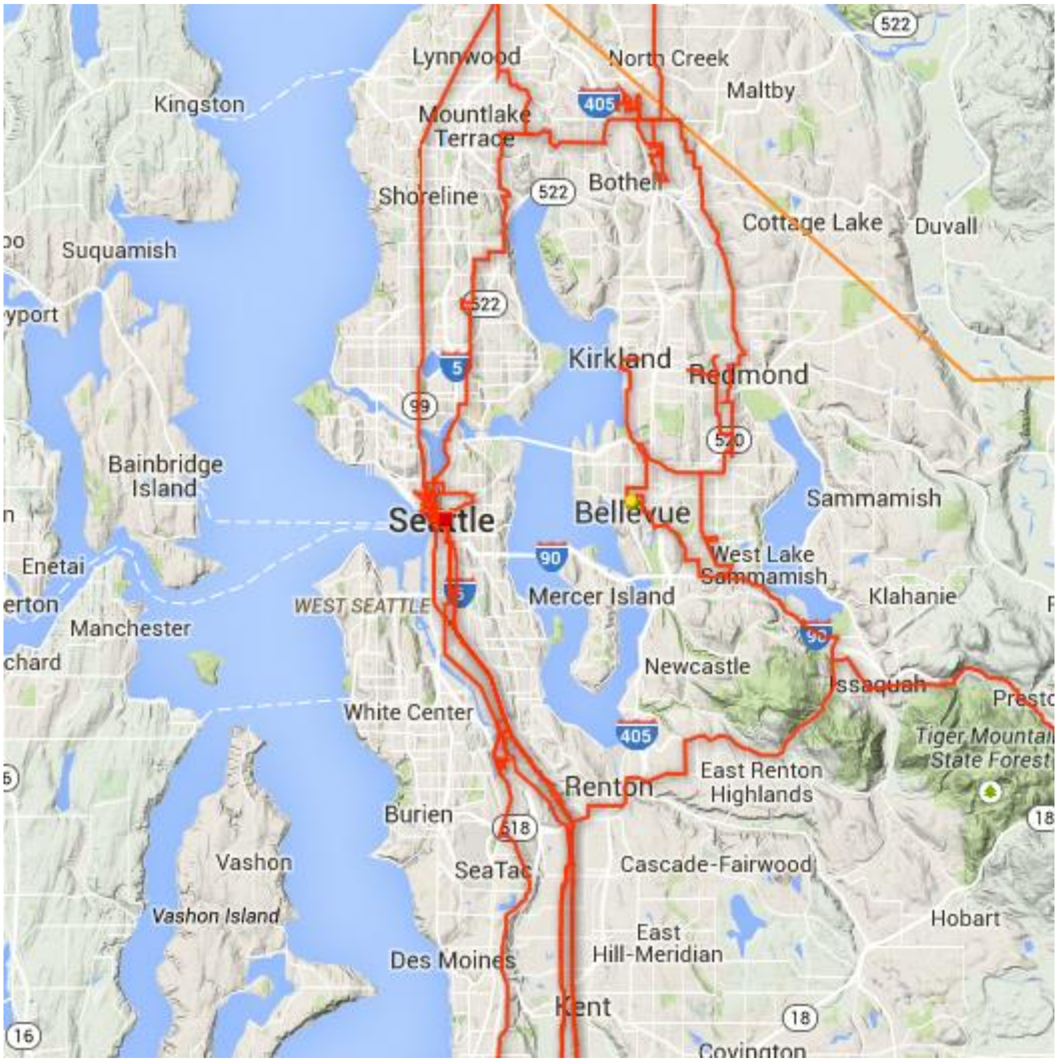
[61] http://www.integratelecom.com/pages/network-map.aspx, accessed December 2014

Figure 14: Integra Telecom Network Map



Level(3) has multiple dark fiber routes in Seattle as depicted in Figure 15. Services are offered only to select customers based on their application requirements.

Figure 15: Level(3) Dark Fiber Routes[62]

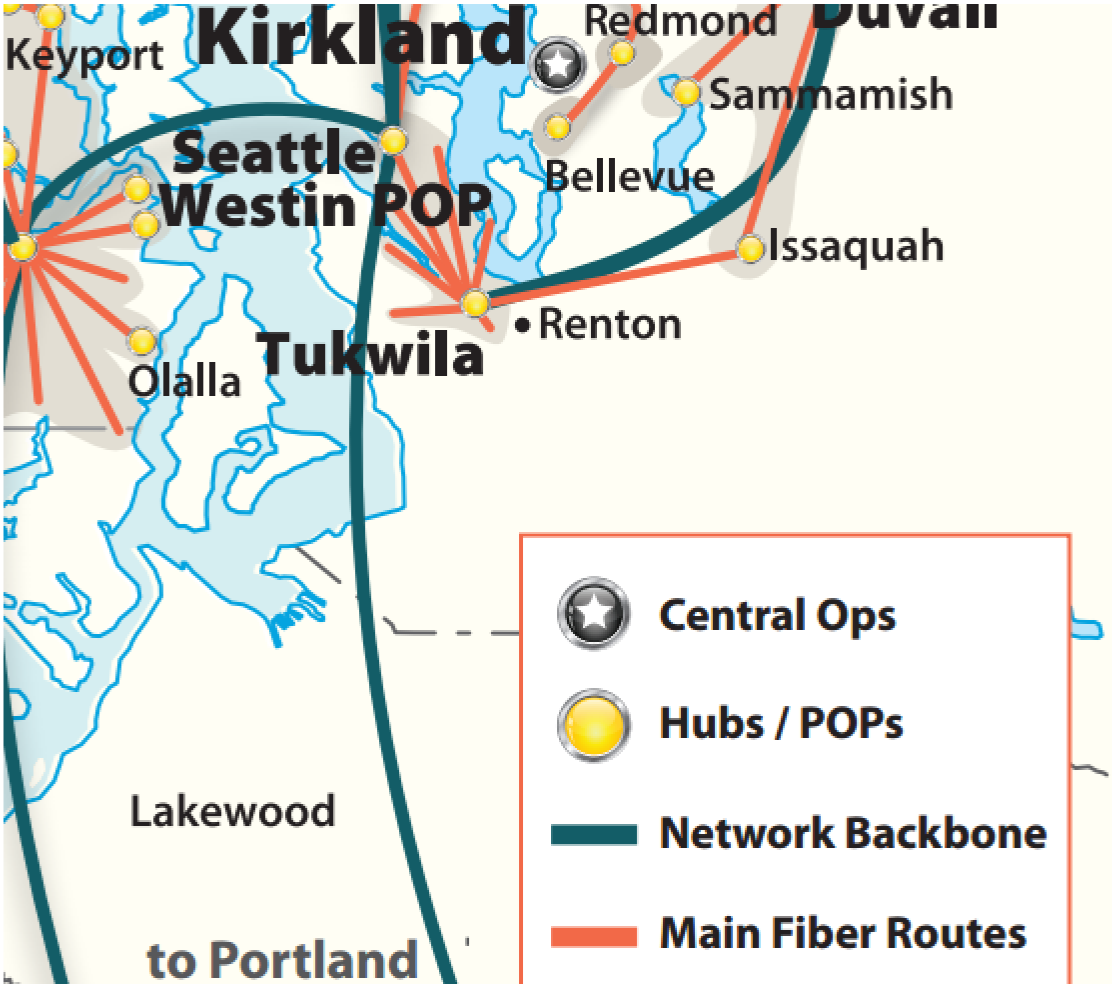


Wave offers dark fiber access within the City with connectivity to rural and metro routes on the West Coast. The fiber routes in the Seattle region are depicted in Figure 3.[63]

[62] http://maps.level3.com/default/, accessed December 2014

[63] http://www.wavebroadband.com/business/, accessed December 2014

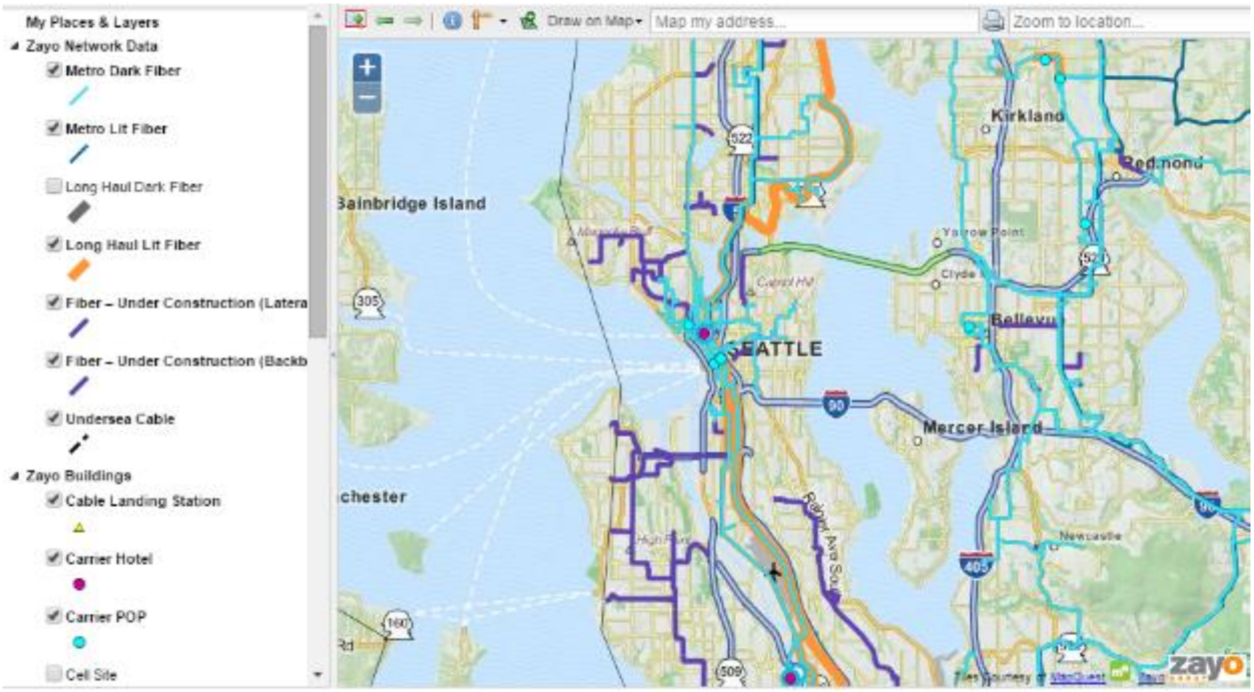
Figure 16: Wave Fiber Routes



Zayo provides dark fiber connectivity over its national network of metro and intercity fiber. The company claims to have proven expertise in deploying major new dark fiber networks and offers multiple financing options including lease or Indefeasible Rights of Use (IRU). Pricing varies significantly depending on whether the building is On-Net or not; if the location is Off-Net, construction and splicing costs would apply.[64]

[64] http://zayofibersolutions.com/why-dark-fiber, accessed December 2014

Figure 17: Zayo Fiber Map[65]



5.2.2 Ethernet Services

Almost all existing service providers offer Ethernet based services. The services are typically classified under two categories: Point-to-point connectivity and access services, such as Dedicated Internet Access (DIA) and IP Virtual Private Networks (IP-VPN). Bandwidths range from 1 Mbps to 100 Gbps. 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 carriers who provide these services in the Seattle region are AT&T, Level (3), CenturyLink, Cogent Communications, Comcast, Frontier Communications, Integra Telecom, Verizon, Windstream Communications, XO Communications, Wave Broadband and Zayo. 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

[65] http://www.zayo.com/network/interactive-map, accessed December 2014

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.[66]

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.[67]

Cogent Communication's Ethernet services are available at speeds of 1.5 Mbps to 10 Gbps. [68] The company provides middle mile services with the last mile service provisioned through local exchange carriers (LEC). Often, more competitive pricing and better customer support is available through Cogent even though the company utilizes the LECs' last-mile services.

Comcast provides Ethernet Private Line (EPL) services. EPL service enables customers to connect their Customer premises equipment (CPE) using a lower cost 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 10Mbps, 100Mbps, 1 Gbps or 10 Gbps Ethernet User-to-Network Interfaces (UNI) and is available in speed increments from 1 Mbps to 10 Gbps.[69]

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 Seattle.[70]

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.[71]

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[66] 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 2014

[67] http://www.centurylink.com/business/products/products-and-services/data-networking/private.html, accessed December 2014

[68] http://www.cogentco.com/en/products-and-services, accessed December 2014

[69] http://business.comcast.com/ethernet/products/ethernet-private-line-technical-specifications, accessed December 2014

[70] http://www.fiberlight.com/files/fiberlight/22/227273f5-6997-4ae2-a5b3-91b6bc65108e.pdf, accessed December2014

[71] http://www.level3.com/en/products-and-services/data-and-internet/vpn-virtual-private-network/evpl/, accessed December 2014

Windstream Communications has a nationwide presence serving major metropolitan areas, including the City, with speeds up to 1 Gbps.[72]

Integra Telecom 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.[73]

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 1000 Mbps.[74]

Wave provides point-to-point metro Ethernet service as well as fully managed WAN solutions that are scalable from 10 Mbps to 10 Gbps.[75]

XO Communications offers carrier Ethernet services at multiple bandwidth options from 3 Mbps to 100 Gbps over their Tier 1 IP network.[76]

Zayo delivers Ethernet in three service types with bandwidth ranging from 100 Mbps to 10 Gbps and options like quality of service (QoS) guarantees and route protection based on customer needs. The different types of services offered are: Ethernet-Line, which provides point-to-point and point-to-multipoint configurations with reserved bandwidth availability; Ethernet-LAN, with multipoint configurations having a guaranteed service level; and Ethernet Private Dedicated Network (E-PDN) with a completely private, managed network operated by Zayo with dedicated fiber and equipment.[77] As an example of pricing, Zayo charges a monthly recurring cost of $1,613

[72] http://www.windstreambusiness.com/, accessed December 2014
[73] http://www.integratelecom.com/enterprise/products/pages/carrier-ethernet-services.aspx, accessed December 2014
[74] http://www.verizonbusiness.com/products/data/ethernet/, accessed December 2014
[75] http://www.wavebroadband.com/business/enterprise/data-solutions-fiber/metro-ethernet/, accessed December 2014
[76] http://www.xo.com/carrier/transport/ethernet/, accessed December 2014
[77] http://www.zayo.com/ethernet, accessed December 2014

to $2,090 (depending on contract term) for 1 Gbps point-to-point Ethernet service between On-Net sites in the Los Angeles region that are three miles apart.

5.3 MDU Providers

As we noted, MDU building owners often have exclusive agreements with one provider to serve an entire building, and each MDU is unique. One landlord, building owner, or homeowners'/condo association may have multiple agreements with multiple providers for different buildings.

Wave provides service to several buildings ranging in speed from 100 Mbps for $60 per month to 1 Gbps for $80 per month.[78] They offer service to numerous buildings in several neighborhoods, including downtown.

Wolf, a provider with a national footprint, offers business and residential service to some buildings in Seattle, though they do not advertise pricing.

[78] http://www.condointernet.net/our-buildings/, accessed March 2015

6 FTTP Design and Cost Estimates

In the sections that follow, we describe a recommended fiber-to-the-premises (FTTP) network design, organized by network layers. We evaluated current construction practices, including the cost of materials and anticipated labor expenses.

We begin our discussion with the physical layer (layer 1, also referred to as outside plant or OSP). The physical layer is both the most expensive part of the network and the longest lasting. 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 initiative.

To develop the inputs and insights necessary to create this network design, we drew on our experience with a wide range of fiber initiatives; held discussions with representatives of Seattle City Light (SCL); completed an extensive desk survey of the City using the comprehensive street-level views available in Google Earth; and drew on the analysis we developed during our previous engagements with the City and Seattle City Light.[79]

The majority of the City has aerial utilities and therefore aerial plant is an option for a citywide fiber network. Aerial plant is typically less expensive to build than underground plant—and that will be the case in Seattle. But because the communications space on the poles in many parts of the City is so highly congested, there will often be substantial cost involved in going aerial. And, indeed, building fiber underground will actually be less expensive in some portions of the City than going aerial, given the cost and complexity of moving existing communications utilities to make space on the poles (i.e., "make-ready") and how frequently shorter poles would need to be replaced with taller poles to create space for attachment.

To support the City's analysis and decision-making process, we have examined two potential aerial construction approaches: 1) Installing fiber in the power space of utility poles, above the communications utilities, and thereby avoiding the congestion in the communications space, and 2) installing fiber in the communications space. From a purely technical standpoint, there are advantages and disadvantages to each approach. And, as we describe below, there is a significant cost difference between the two scenarios.

As background, Figure 18 illustrates SCL's construction standard for utility pole attachments; the series of figures that follows the SCL standard illustrate the communications and power space on

[79] CTC's previous engagements with the City of Seattle and Seattle City Light have included the preparation of three major reports: "Seattle Community Broadband Initiative: Defining the Strategic Vision, Goals, and Objectives, and Building the Business Case" (2011) and "Benefits Beyond the Balance Sheet: Quantifying the Business Case for Fiber-to-the-Premises in Seattle" (2009), prepared for the City of Seattle; and "Evaluation of Potential Risks and Benefits of Municipal Broadband" (2008), prepared for Seattle City Light.

utility poles, as well as some of the issues related to congestion in the communications space and the transition from aerial to underground construction.

Figure 18: Seattle City Light Construction Standard for Utility Pole Attachments

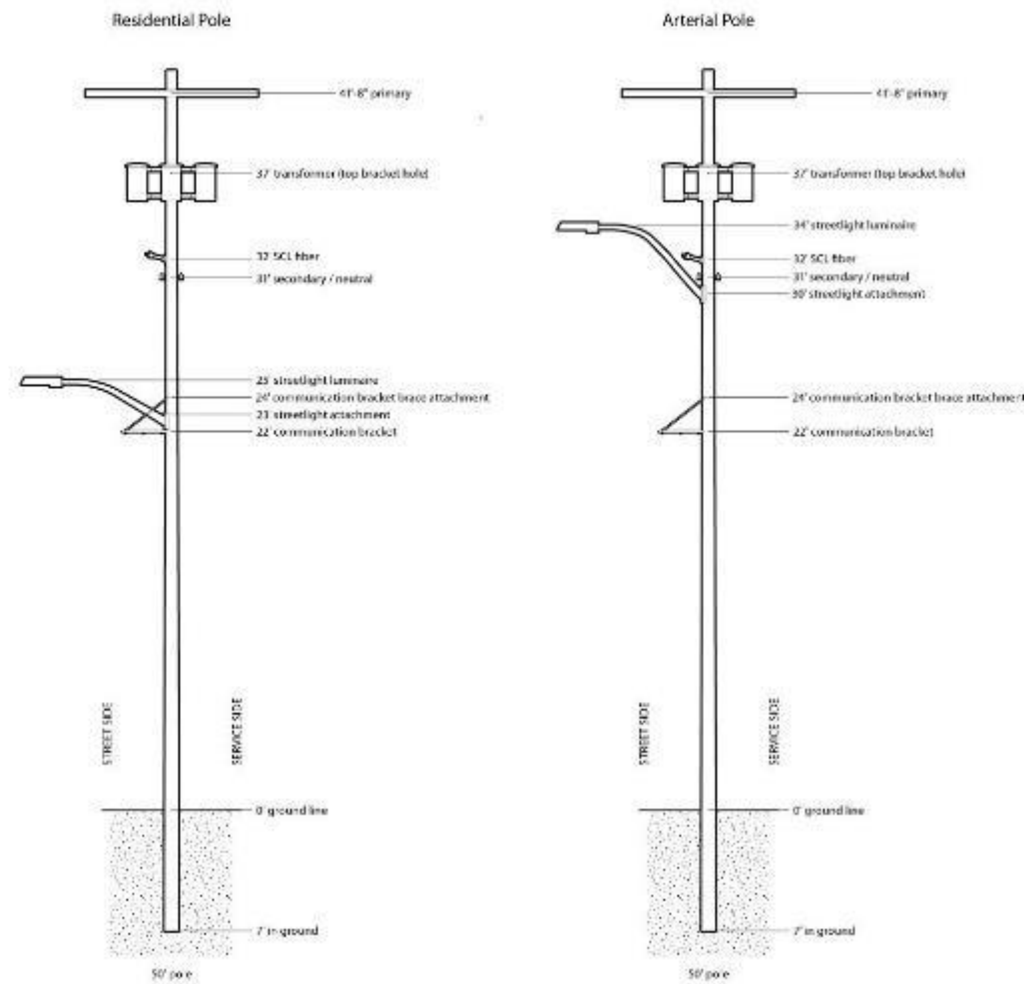


Figure 19: Illustration of Attachments in the Power Space and Communications Space

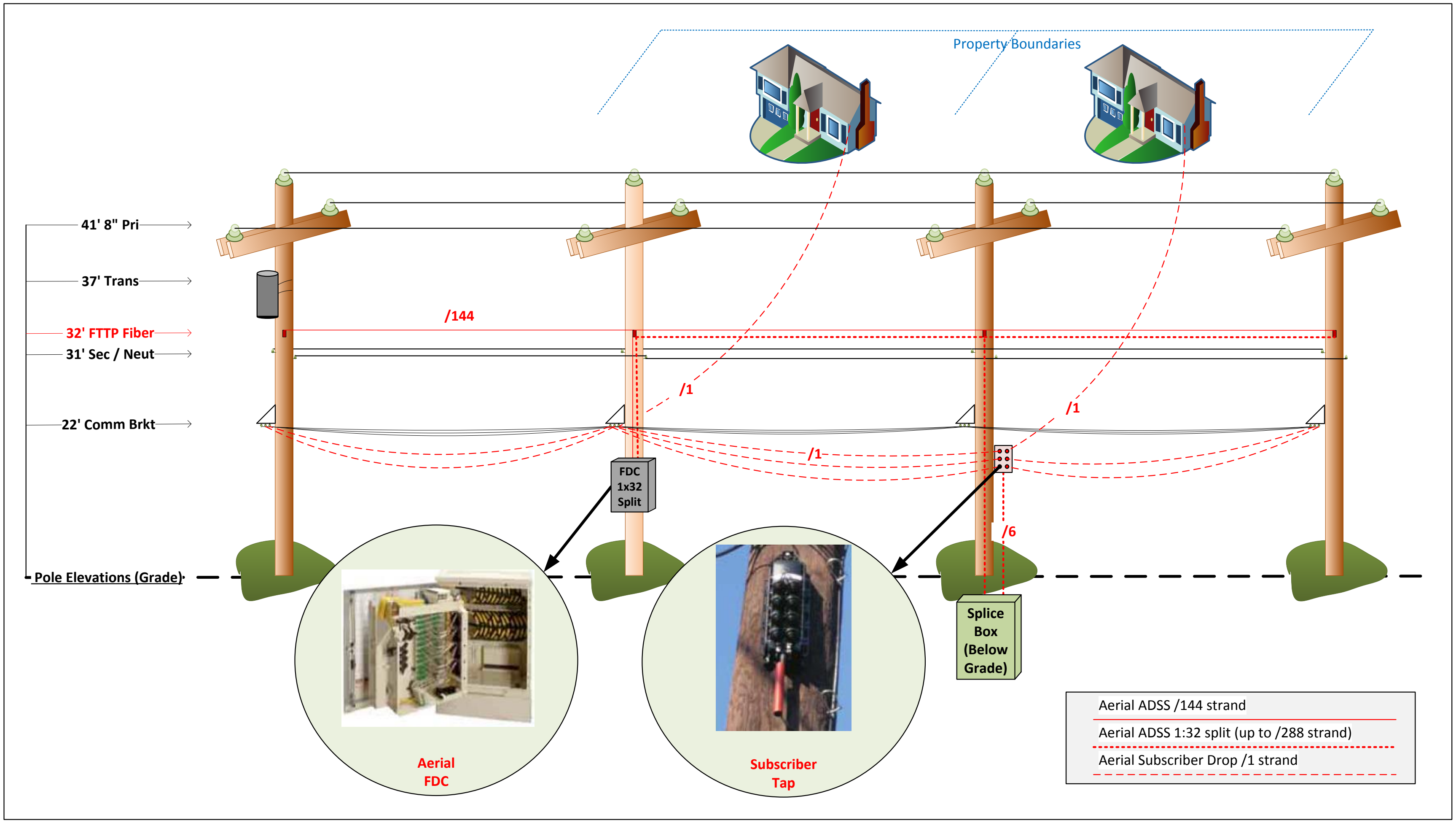
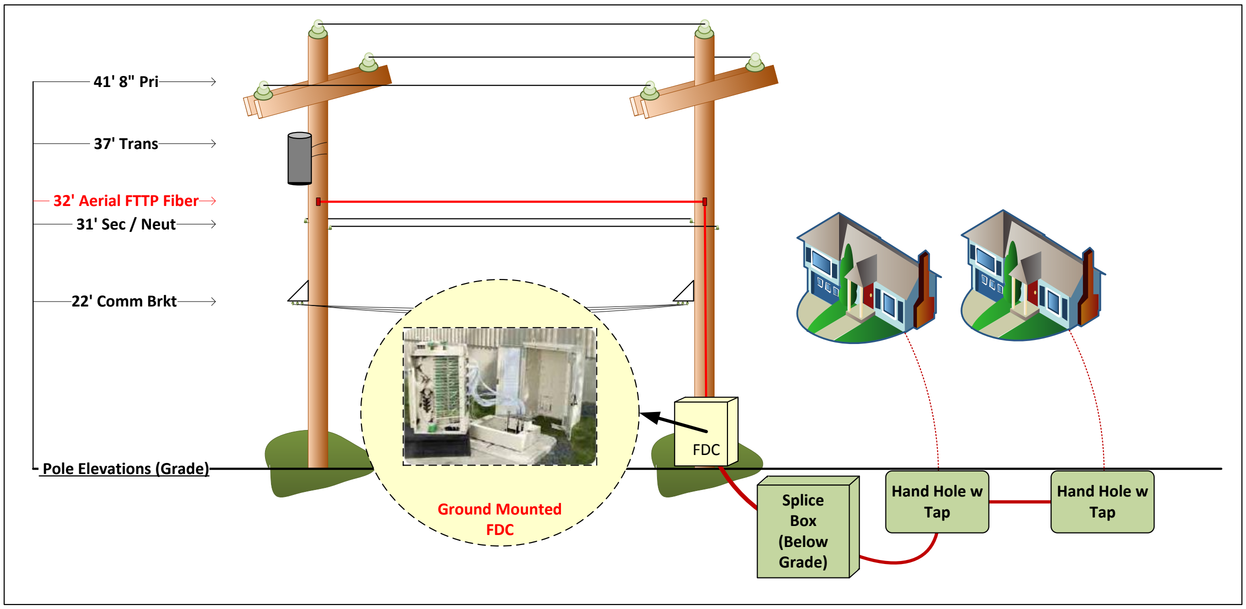


Figure 20: Example of a Pole in Seattle with Congested Communications Space (Google Earth)

Figure 21: Aerial and Underground Construction



Whether the fiber is deployed in the power space or the communications space, the high-level FTTP network design (outside plant and network electronics) presented below will support the

City's goals of delivering broadband service to every resident, business, and public building in Seattle, and delivering a unified network for internal City use.

The candidate network design would also support the City's other stated goals, including public or retail Wi-Fi, excess dark fiber leasing, and triple-play services. (Each of these would be separate initiatives, with separate business models and approaches; we note only that the network design is sufficiently robust to enable these revenue and service opportunities, either by the City or with private sector partners.)

6.1 Aerial Construction Approaches — Communications Space vs. Power Space

The City's proposed coverage area represents a relatively high-density subscriber footprint. The density in some ways simplifies the FTTP design effort because passings are tightly grouped, and more homes and businesses can be connected using less fiber. In Seattle, however, our survey found many areas where poles are short and congested with existing utilities in the communications space. This lack of readily available space offsets the benefits of density.

The primary cost differential and inhibiting factor between construction in the communications space and the power space comes in the way of make-ready. And the make-ready work would not only add considerable expense, but would also require a much longer timeline for construction.

When other cables occupy the communications space, they must be moved to allow space for the placement of the new attachment in compliance with National Electric Safety Codes for clearance between power and communication cables, and between communication cables and ground levels. Make-ready tasks include moving existing utilities and installing extension arms.

When poles cannot be made ready for an additional attachment simply by moving cables on the existing pole and keeping all clearances from ground and power space, it may become necessary to place a taller pole that would allow the new attachment with adequate clearances. (The same issue arises for poles that are too old and worn-out to support a new attachment.) All utilities currently on the pole would need to be transferred from the old pole to the new pole.

In some cases, right-of-way (ROW) access limitations become a dominant factor in determining overall project feasibility, because OSP make-ready costs are central to overall construction costs. This is particularly significant in markets like Seattle with higher labor costs, which represent the main component of make-ready cost.

6.1.1 Power Space

During our meetings, representatives of SCL suggested the possibility of placing fiber in the power space on the poles. In particular, SCL suggested that the FTTP fiber could be lashed to existing SCL fiber (which is installed in the power space in a small percentage of SCL's overall plant mileage in the City).

Speaking more broadly, if it would be permissible to put fiber in the power space throughout the City (including placing new fiber on poles where fiber does not yet exist), the cost of the FTTP deployment would be reduced. Because more room is available in the power space than in the communications space, the City would not need to perform much make-ready and, in the most congested areas, would not need to replace short poles with taller ones. We estimate that construction in the power space would require make-ready on 8 percent of poles.

Some of the make-ready cost savings realized by constructing fiber in the power space would be offset by higher labor costs. Constructing FTTP in the power space would require SCL or SCL-certified crews to construct, maintain, and operate the fiber; in comparison, infrastructure constructed in the communications space could be built, operated, and maintained by any entity permitted to be on the utility poles.

Because SCL handles generation and transmission, as well as distribution, it is governed by NERC/FERC regulations. According to SCL, this means, for example, that if a fiber splice case were to contain strands used by SCL, then SCL must control all access to that case. However, in a power-space installation, it might be possible to have pad-mounted, pole-mounted, or underground access points (FDCs and taps) that non-SCL directed or controlled staff can access (as long as no SCL used strands are accessible). It might also be possible to use separate fiber cables for non-utility use (potentially as a separate power space attachment).

If the fiber were to be installed in the power space, the cabinets and taps could be placed in the communications space, so they would be accessible to general contractors and would not be restricted to power space certified crews. This is a practice used in many FTTP networks that are associated with power utilities, including those in Jackson and Pulaski, Tennessee, and in Bristol, Virginia.

Figure 22: OSP Crew Replacing a Pole

Based on our estimates, for a citywide fiber network, constructing fiber in the power space reduces build costs by about 28 percent—lowering the total cost from $472.5 million to $338.7 million.

6.1.2 Communications Space

The second scenario is a model in which the FTTP network is deployed in the communications space citywide. In this scenario, the City would work with pole owners to identify space on the poles. Based on our discussions with SCL, this could be in any space above the minimum surface clearance and the minimum clearance from the power neutral. It is also possible to install communications brackets or extension arms to place the fiber.

The functional advantage of construction in the communications space is that construction and maintenance crews do not need to be certified in power space construction, which will reduce costs. Cables can be any type, whereas power space construction needs to be non-metallic dielectric cable, which is more expensive both to acquire and to install. We estimate the communications space labor and materials costs, in the absence of make-ready and pole replacement, to be two-thirds of the costs in the power space.

However, based on our analysis, it will still be necessary to perform make-ready on 38 percent of poles, including in many cases the movement of street lights as well as existing utilities, and potentially the movement of the other utilities to new positions on brackets. So even with lower materials and labor costs, constructing in the communications space will be more expensive than constructing in the power space.

During our surveying, we found that, on average, each pole would require four attachments to be moved at a cost of $450 per attachment ($1,800 total per pole). Pole density averages one pole every 140 feet. On average, then, the additional per foot implications of this cost equates to $5.11 in all densities.

With total cost per foot in the power space ranging from $7.53 to $10.87 (depending on density), the make-ready alone in the communications space equals 47 percent to 68 percent of the entire cost to construct in the power space. (This is just comparing the make-ready costs; it does not factor in the other costs associated with the aerial build in the communications space.)

While SCL offers considerable flexibility in finding space on utility poles, there is still considerable cost in using the communications space. Based on our estimates, this approach would require make-ready on 38 percent of the poles, replacement of 10 percent of the poles, and underground construction in areas where the poles are so congested that going underground represents the lowest cost option.

6.2 Cost Estimates

FTTP construction in Seattle will entail costs in three basic categories:

- Outside plant (OSP) materials
- OSP labor
- Network electronics

Our model assumes a mix of aerial and underground fiber construction, based on the prevailing mix of utilities in the City. Based on our field survey, we found that the percentage of aerial and underground utilities varied by the density of the neighborhood (see Table 20). The density zones are described in Section 6.3.

Table 20: Percentage of Aerial and Underground Utilities in Seattle

Density Zone	Aerial Percentage	Underground Percentage
Low	40%	60%
Mid	80%	20%
High	85%	15%

As discussed above, while aerial construction is typically less expensive than underground construction, the cost of placing aerial fiber in the communications space vs. the power space will have a significant impact on the overall project cost. In terms of OSP, the estimated cost to construct the proposed FTTP network is $338.7 million (assuming aerial installation in the power space) or $472.5 million (assuming aerial installation in the communications space). Table 21 and Table 22 summarize the cost differences.

Table 21: Estimated OSP Costs for FTTP with Aerial Construction in the Power Space

A. FTTP OSP Summary	
Item	Total Cost
Backbone	$ 5,925,500
Low Density Single Units	35,461,200
Mid Density Single Units	88,478,000
High Density Single Units	91,954,000
MDU's	34,794,600
Project Management - 10%	25,661,400
Contingency - 20%	56,455,000
Total	$ 338,729,700

Table 22: Estimated OSP Costs for FTTP with Aerial Construction in the Communications Space

A. FTTP OSP Summay	
Item	Total Cost
Backbone	$ 8,494,200
Low Density Single Units	45,847,300
Mid Density Single Units	134,864,100
High Density Single Units	125,150,900
MDU's	43,586,700
Project Management - 10%	35,794,400
Contingency - 20%	78,747,600
Total	$ 472,485,200

Assuming a 41 percent take rate, the required electronics will cost approximately $70 million (regardless of whether aerial installation is in the communications space or power space). The total price will vary with different take rates, as described in the financial analysis.

Table 23: Summary of Electronics Costs for FTTP

Segment	**Qty**	**Price**	**Ext**
CPE			$55,024,000
ODCs	29	$406,000	$11,774,000
BNGs	6	$687,000	$4,122,000
COREs	2	$1,363,000	$2,726,000
PROF SERVICES			$5,397,000
			$79,043,000

In the sections below, we describe our methodology and provide more detail on the estimated costs. Costs for aerial and underground placement were estimated using available cost data for materials and estimates on the labor costs for placing, pulling, and boring fiber. 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.

OSP estimates include costs for make-ready, with substantial make-ready required in the communications space and limited make ready required in the power space. The labor costs associated with the placement of fiber were estimated based on similar construction projects. Pole replacement costs are unique to aerial placement in the communications space.

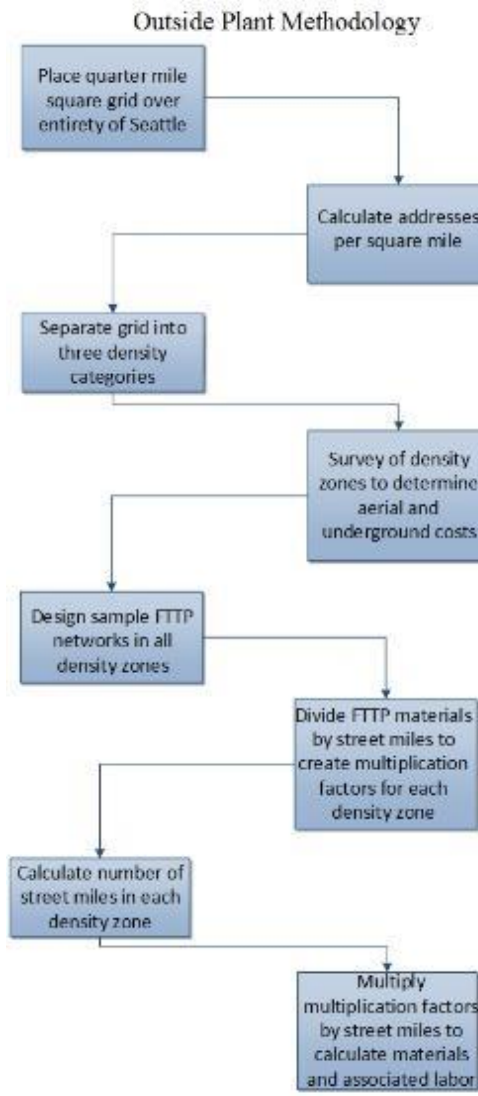
For purposes of design and cost estimates, we identified the small and mid-sized multi-dwelling unit (MDU) buildings across the City. Based on Census data, there are 4,072 MDU buildings in Seattle that comprise five to 19 units. We estimate that the average drop from the closest existing fiber to these buildings is about 370 feet. (Buildings that have 20 or more units will generally need to be dealt with on a case-by-case basis because those larger buildings may already have provider agreements in place between broadband providers and building owners.)

Based on our desk survey, we also made assumptions about the average amount of required pole replacements, make-ready, and guy and anchor replacements in each density zone, in both the power space and the communications space. In each of these scenarios the percentage of poles meeting each criterion were averaged out to a per-mile cost.

6.3 Methodology for Developing OSP Route Assumptions

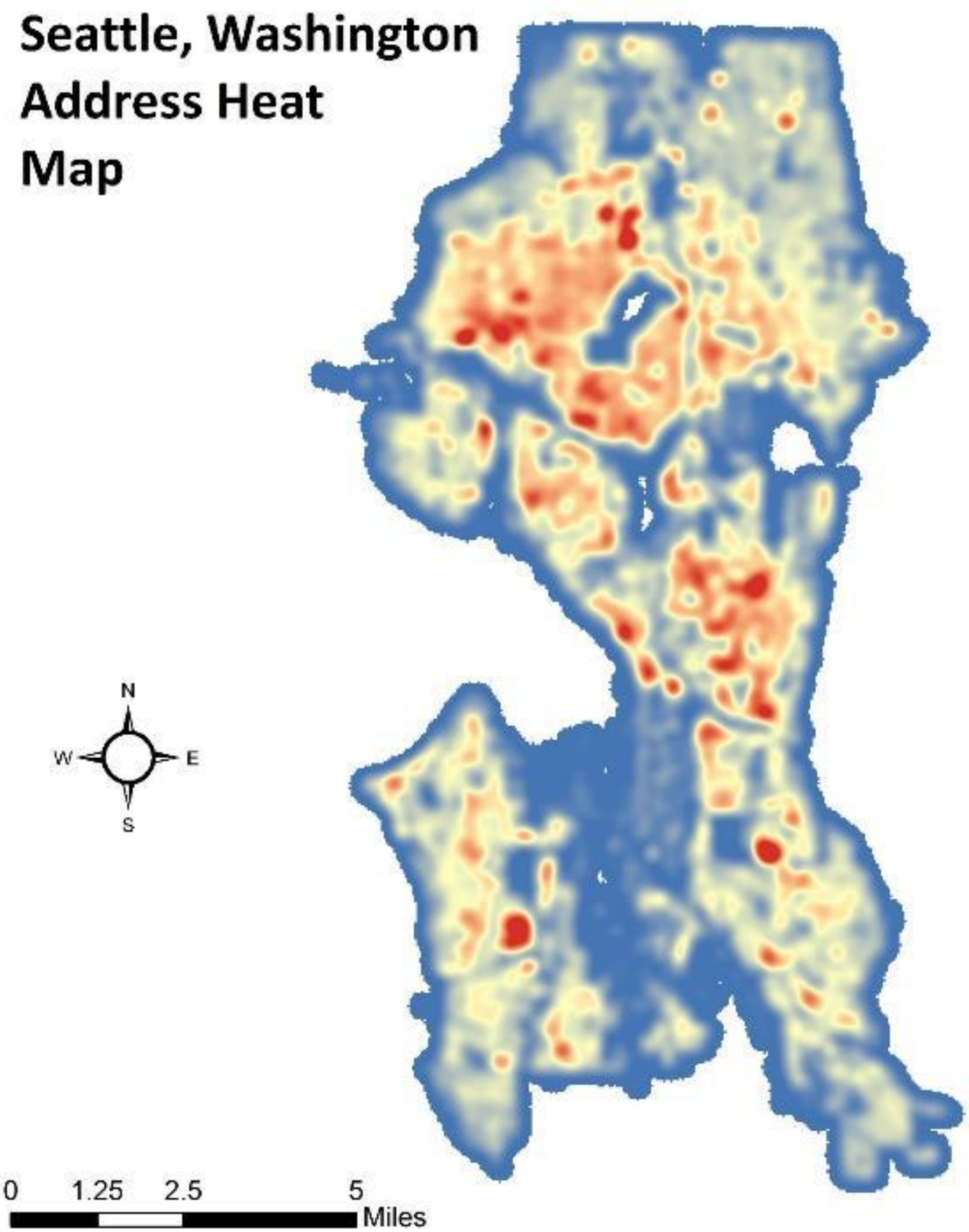
Our high-level methodology is described in Figure 23, below.

Figure 23: Methodology for Estimating Outside Plant Costs



Using ArcGIS software, CTC engineers created a quarter-mile-square grid to overlay on a map of the City. The purpose was to generalize the number of addresses per square mile at a granular level that still allowed for summarization. Figure 24 below is a heat map of the addresses in Seattle, displaying density at a very granular level.

Figure 24: Address Heat Map of Seattle

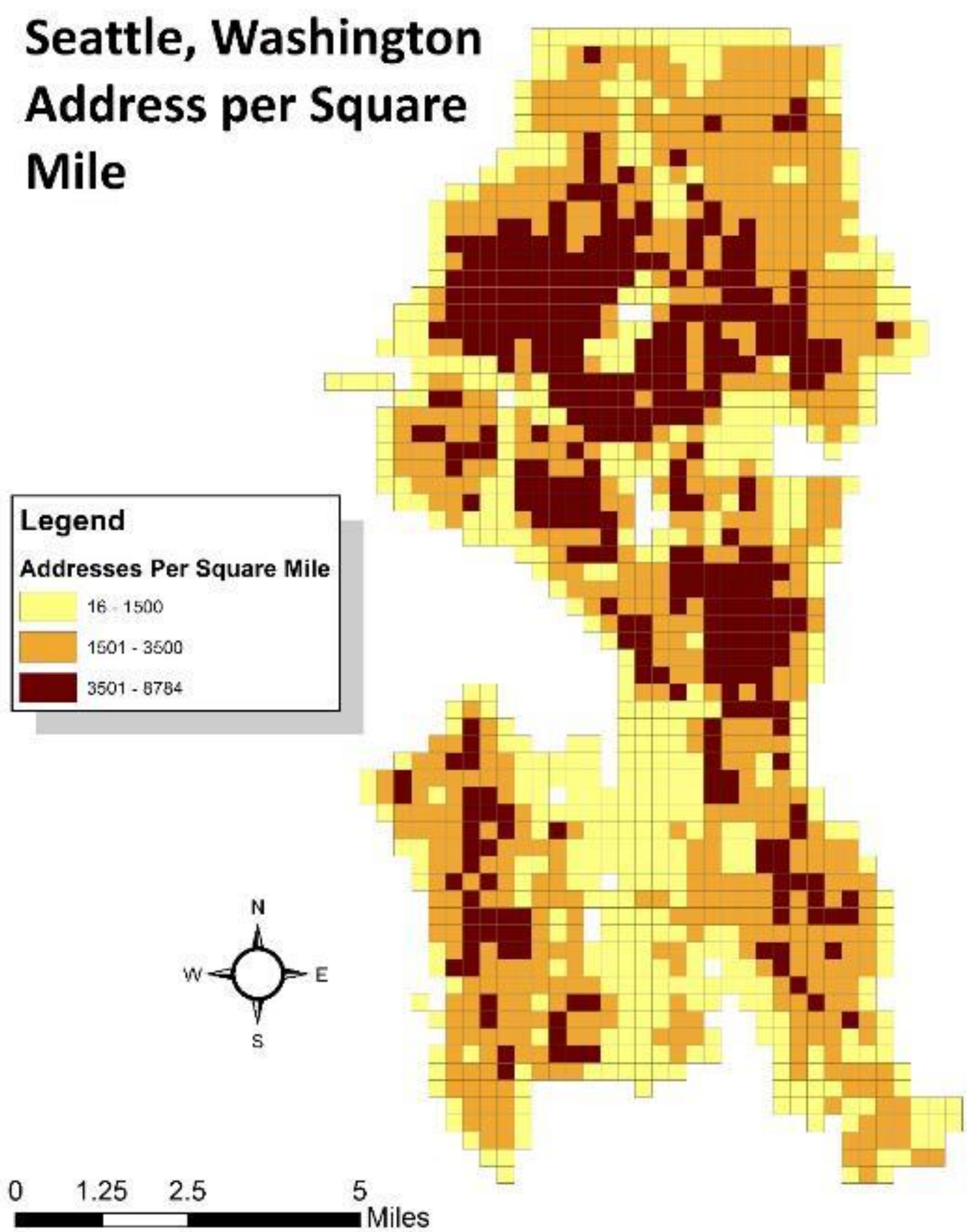


We then calculated the number of addresses per square mile using ESRI ArcGIS. After analyzing the data, we established three density zones to represent the data:

- Low density: 16 – 1,500 addresses per square mile
- Mid density: 1,501 – 3,500 addresses per square mile
- High density: 3,501 – 8,784 addresses per square mile

Figure 25 illustrates the grid and associated densities.

Figure 25: Quarter Mile by Quarter Mile Grid with Associated Densities

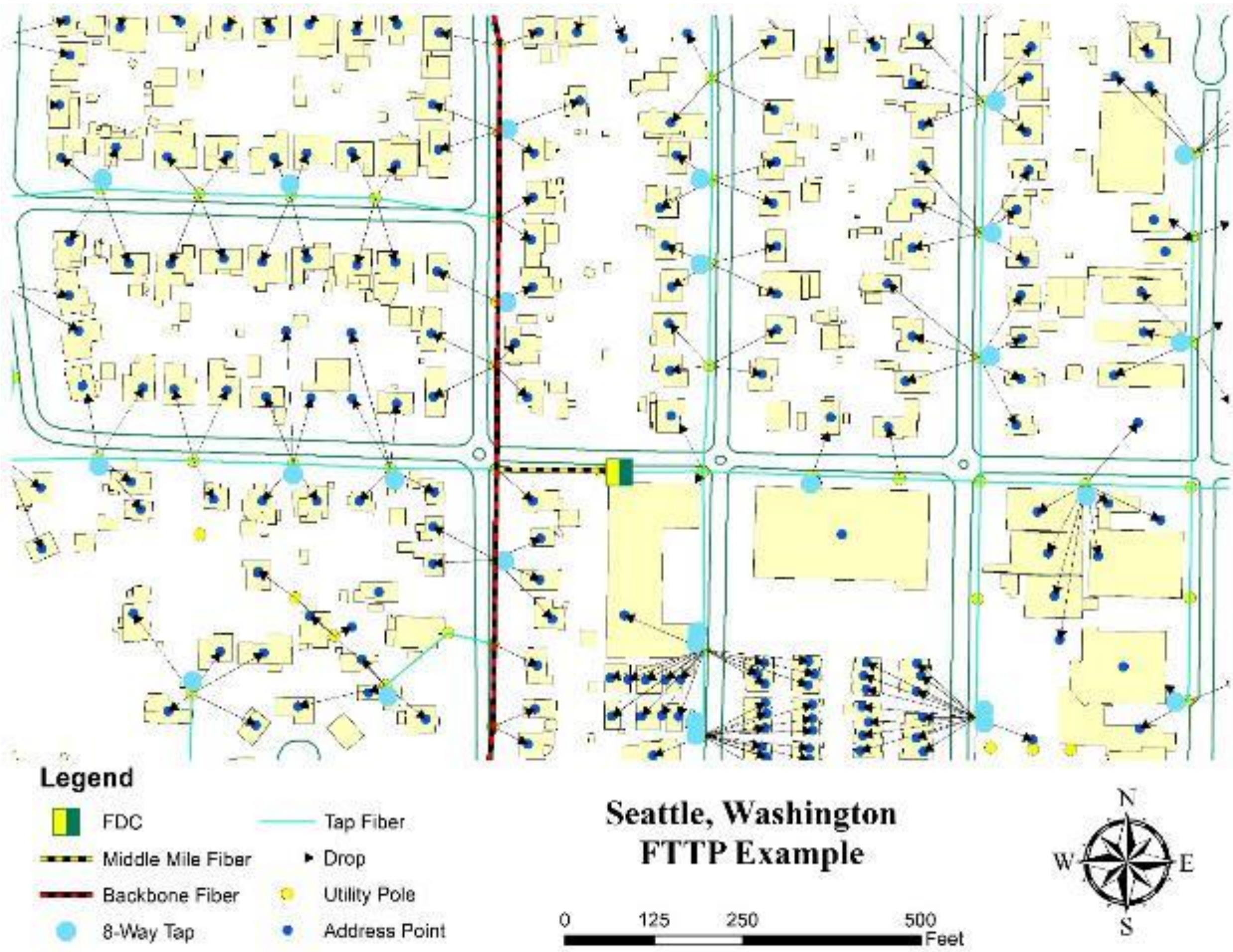


The densities were separated out to capture the cost difference related to different variables specific to different densities, including available green space, necessary make-ready on poles, pole replacement, and guy replacement. A CTC OSP Engineer then surveyed the three density zones via Google Earth Street View to develop estimates of underground versus aerial percentages, per mile cost for aerial in the power space and communications space, per mile costs for underground (where poles are not available), and cost estimates for fiber drops to customer premises. The aerial placement of fiber for each density zone in both the power space and communications space was also determined through surveying in Google Earth Street View.

CTC engineers then developed FTTP designs in sample areas of the three different density zones. The engineering was completed down to the drop level. (See Figure 26 below for the sample design of an FTTP route.) The sampling was strategically completed in locations that are representative of the entirety of Seattle at each density level.

For the low and mid densities, squares in the upper end of the ranges were used to budget on the conservative side. For the high-density areas, the FTTP sampling was done in a square representative of the median of the high density range. This was done to minimize the influence of the high number of outliers that were very dense, which would otherwise skew the budget much higher.

Figure 26: Sample FTTP Network Design to Determine Quantities Per Street Mile



Based on the engineered FTTP samples, we created a ratio between the street miles and the labor plus materials needed for each of the three density zones. These "multiplication factors" were created for the following elements of the FTTP deployment:

- Taps
- Splices
- Handholes
- Flower pots (i.e., small handholes for street crossings to reach customer premises)
- Conduit

The next process was completed using ESRI's ArcGIS suite to calculate the number of street miles within each respective density zone. We then multiplied the street miles by the multiplication factors to aggregate out the required materials and the labor associated with the construction. Cost estimates were made for each of the three categories and then summed together.

We developed unit labor and materials pricing based on a composite of projects of similar scale in urban environments.

6.4 Backbone Routes

CTC engineers designed backbone routes to be as equidistant as possible to the entire City while also accounting for higher density areas (which will demand more fibers to serve the high number of possible subscribers). The backbone contains four rings for redundant and diverse routing. The routing was limited by environmental factors, such as bridges and railroad crossings.

The total distance of the route is slightly less than 58 miles. The backbone build and the FTTP build would utilize the same underground infrastructure so no overbuild would take place in the underground portion. Figure 27 shows the backbone design. Figure 28 shows the backbone design as it correlates to address density.

Figure 27: Backbone Design

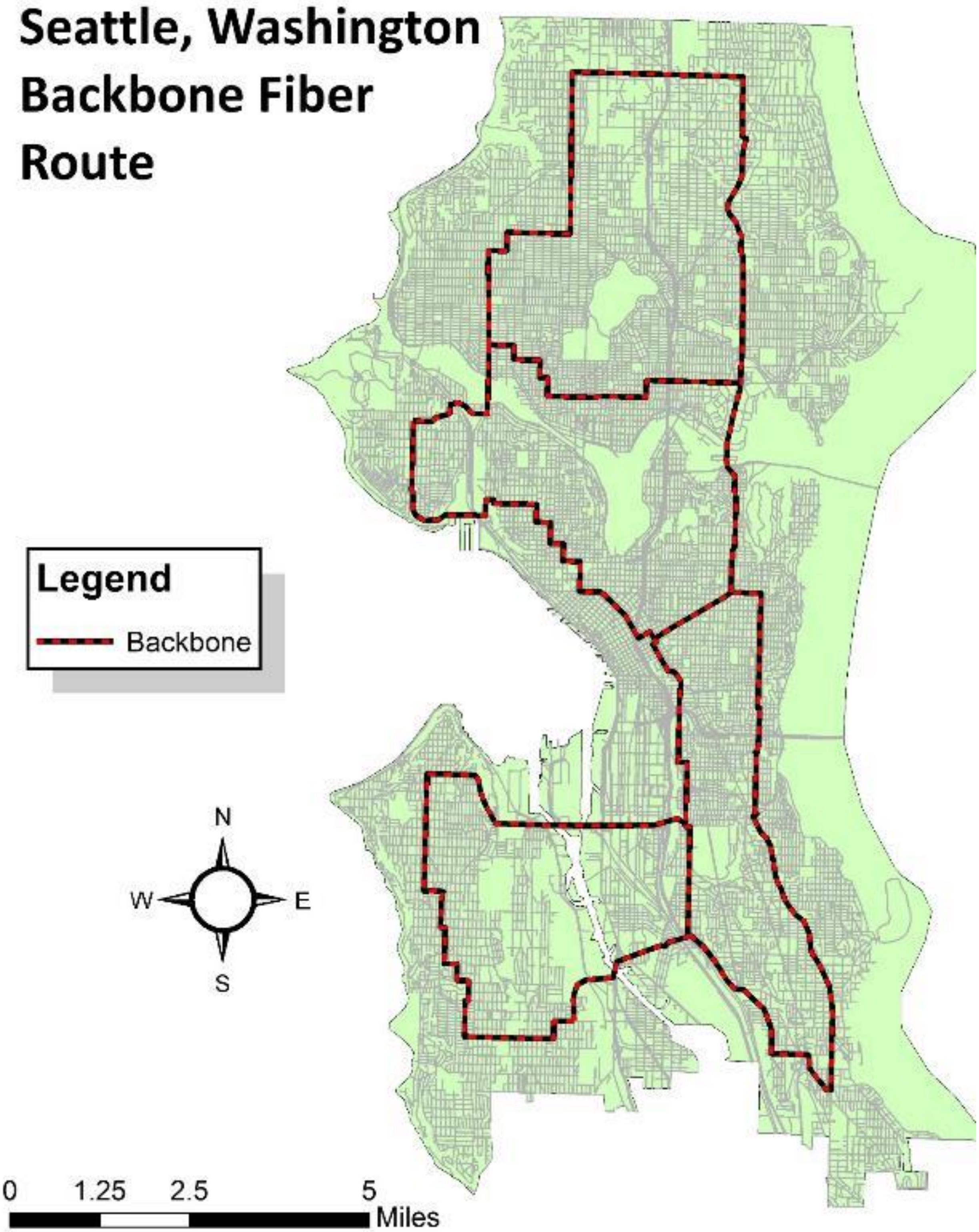
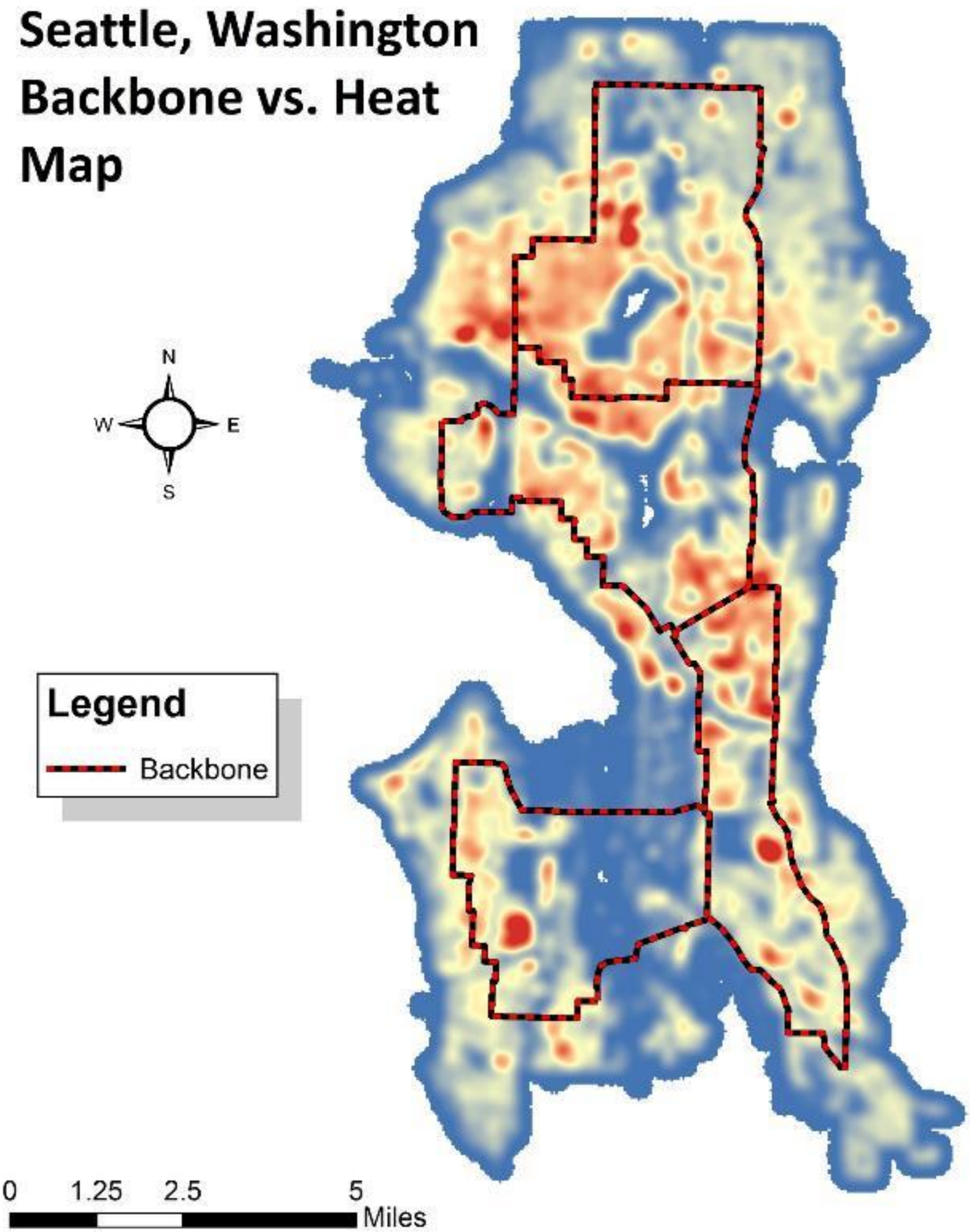


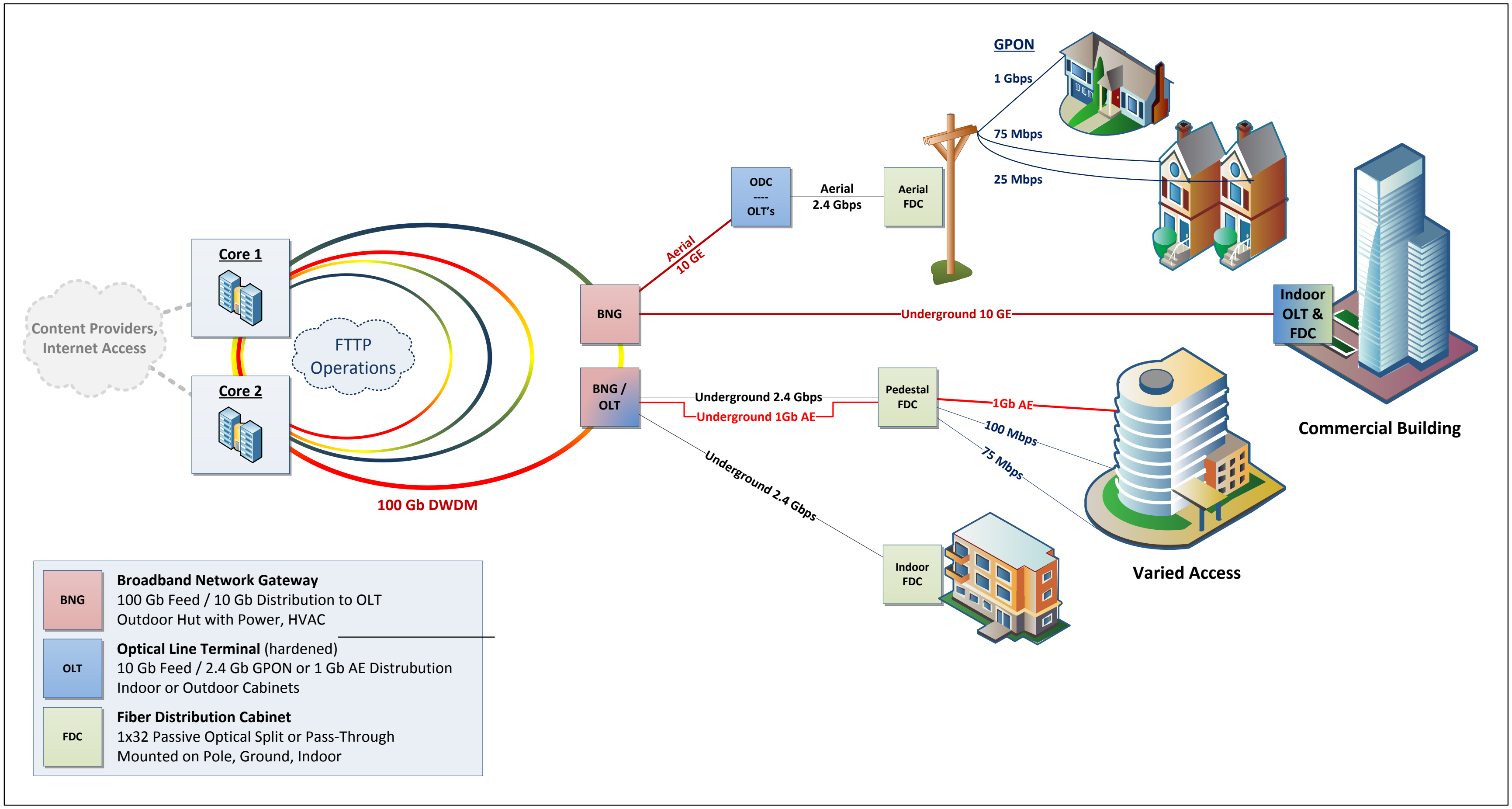
Figure 28: Backbone Route as It Correlates to Address Density



6.5 Network Architecture and Electronics

Figure 29 shows a logical representation of the recommended FTTP network. It is intended to illustrate the primary functional components in the FTTP network, their relative position to one another, and the flexible nature of the architecture to support multiple subscriber models and classes of service.

Figure 29: High-Level FTTP Architecture



The underlying foundation for the recommended design is a hierarchical data network that provides critical scalability and flexibility, both in terms of initial network deployment and capability to accommodate the increased demands of future applications and technologies. The critical design 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 to quickly detect faults and re-route traffic
- Diversity – physical path diversity to minimize operational impact resulting from fiber or equipment failure
- Efficiency – no traffic bottlenecks or poor 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 into different customer environments. Can support an open access network or a single-provider network. Separation between service providers can be provided on the physical (separate fibers) or logical (separate VLAN or VPN) layers.
- Security – controlled physical access to all equipment and facilities, plus network access control to devices

The following sections provide an overview of requirements and recommendations for the core and distribution network layers of the network.

6.5.1 Core Network Sites

The core sites are the bridges that link the FTTP network to the public Internet (via a network access point, or NAP), 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. For our design and cost estimates, we assume that the Seattle core sites will be housed in relative proximity to NAPs such as those operated by Internap.[80]

The core locations typically house 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.

For Seattle's FTTP, there is a wide range of options for core locations. One possibility is the use of outdoor enclosures. In an urban environment like Seattle, however, it may be more cost-effective and secure to use an existing building. We recommend using part of the City's Emergency Communications Center or other similar City-owned facilities with robust physical security, diverse fiber entry, and reliable backup power. We estimate the floor space requirements for each core facility to be approximately 76 square feet. See Figure 30 for a sample design, and Figure 31 for a sample list of materials.

The operational environment of the core network locations is quite similar to that of a large data center environment. 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 all 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 generation.

[80] See: "Seattle, WA Data Centers," Internap. http://www.internap.com/data-centers/data-center-locations/seattle/ (accessed March 5, 2015).

Figure 30: Sample Floorplan for Core Location

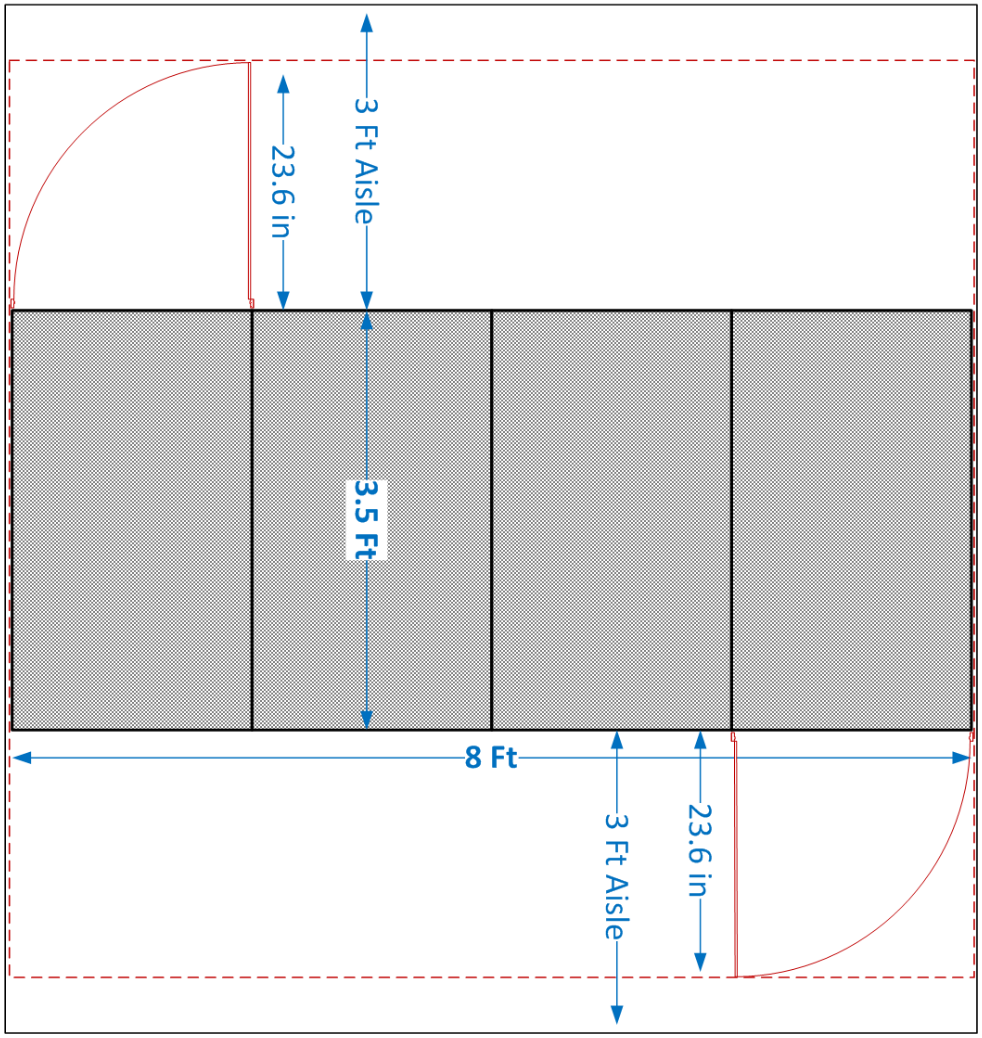


Figure 31: Core Site List of Materials

QTY	Name	Description
1	Remote Device Access Server; Async, Ethernet	Remote Device Access Server; Async, Ethernet (1 RU)
1	Core KVM Console	KVM Console (4 RU)
4	19" Cabinet	19" Data Equipment Cabinet / enclosure (42 RU)
2	Core L2 Switch	Core L2 Switch (1 RU)
1	Core AAA Server	AAA Appliance (2 RU)
1	Core Firewall	Firewall Appliance (2 RU)
1	Core Router	10x100GE DWDM, 10 SFP, 8x Subscriber ports, 2x ISP ports (21 RU)
2	Fiber panels / cross connects	Fiber panels / cross connects (4 RU)
4	Cable ladders / mgmt	Cable ladders / mgmt
2	X68 Server HW	HW for X86 Applications (1 RU)
1	Win Server	X86 Applications - Tools, Management, Documentation
1	DNS Server	Appliance (1 RU)
1	NTP Server & GPS	Appliance (1 RU)
1	DHCP Server	Appliance (1 RU)
1	Node Manager	X86 Software Application - fault & performance management
1	Content Caching Server	Appliance (1 RU)

The list of materials above includes the equipment the City would need to provide all required core services. For example, the AAA servers work together to provide an extremely high level of security for access to critical devices in the data network, and for the FTTP electronics equipment. The AAA Service supports multiple secure access protocols (TACACS, RADIUS, Diameter) to authenticate any individual requesting access, to control what the authenticated individual has permission to access, and finally to keep a thorough accounting of the individuals' activities during the period of access.

The FTTP layer of the architecture is tightly integrated to an Element Management System (EMS). The EMS provides Fault, Performance, and Configuration Management for the FTTP electronics, and provides a unified platform for subscriber provisioning activities. This provides a wealth of invaluable data for engineering and operational purposes, including equipment inventory, resource utilization and performance data, Quality-of-Service data for Service Level Agreements (SLA), and numerous performance threshold alarms.

The EMS platform for FTTP electronics is integrated with a higher level fault and performance management platform which supports the entire network from edge to edge. This provides a single top-level platform for all devices in the architecture to be monitored and managed on a 24x7x365 basis.

The top-level fault and performance management platform polls all devices at regular intervals and records measurement of resource attributes that are critical to the operational health and availability of each device. This typically includes monitoring key resources such as processor utilization, interface errors, etc. In addition, all network devices are configured to send asynchronous (immediate) notifications to the management platform in the event of hardware failure or unexpected conditions such as a connection to a neighboring device has been lost. Such fault and threshold alarms are sent to operational personnel for immediate evaluation and response.

Other important core network services include essential applications such as Domain Name Services (DNS), Network Time Protocol (NTP), and Dynamic Host Configuration Protocol (DHCP).

6.5.2 Distribution and Access Network Design

The nature of a high-speed network requires that it supports high levels of throughput and availability at all layers of the architecture. The network layer between the core network locations and the last-mile subscriber connections is considered the distribution network. The key characteristics and capabilities in the distribution network are capacity, availability, resiliency, and reliability.

The distribution network carries heavily aggregated traffic closer to the core, and extends over long distances to end users. Fiber cuts and equipment failures have progressively greater operational impact as they happen in closer proximity to the network core. For this reason, it is critical to build in redundancies and physical path diversities, to seamlessly re-route traffic when necessary.

6.5.2.1 Rings

The simplest way to achieve the design objectives of the City's distribution network is with multiple DWDM rings, which provide an extremely high level of service availability. The rings in our proposed design cross-connect at multiple points to protect against physical cuts in underground applications, and pole / line damage in aerial applications. Each DWDM ring connects directly to both core network locations, and the rings are designed from the start to provide service to all parts of the City's expected coverage area.

6.5.2.2 Broadband Network Gateway Routers

As illustrated in Figure 29 above, each DWDM ring supports multiple ring access nodes, which are Broadband Network Gateway (BNG) routers. The primary function of the BNG nodes is to distribute/aggregate traffic to/from multiple 10 Gbps subscriber-side links. These links connect to smaller outdoor cabinets which are home to the FTTP-specific electronics, and the edge of the subscriber access network.

In our model, the four BNG nodes each serve approximately 60,000 passings.

BNG nodes require a controlled operational environment similar to core network locations, but they are generally much smaller in terms of physical size, equipment capacity, and power consumption. In some cases, a BNG node may be collocated with a core network location. When this is the case, they remain functionally separate, only sharing real estate footprint and right-of-way (ROW) access.

For the four BNG nodes in our model, we recommend outdoor shelters. BNG sites must provide clean power, HVAC, UPS batteries, and diesel generation for sustained outages.

Figure 32 illustrates a sample BNG shelter. Figure 33 represents a sample floorplan, while Figure 34 is a sample list of required materials.

Figure 32: Exterior View – Sample Precast Concrete Shelter with Generator Pad / HVAC

Figure 33: Sample Floor Plan for BNG Shelter

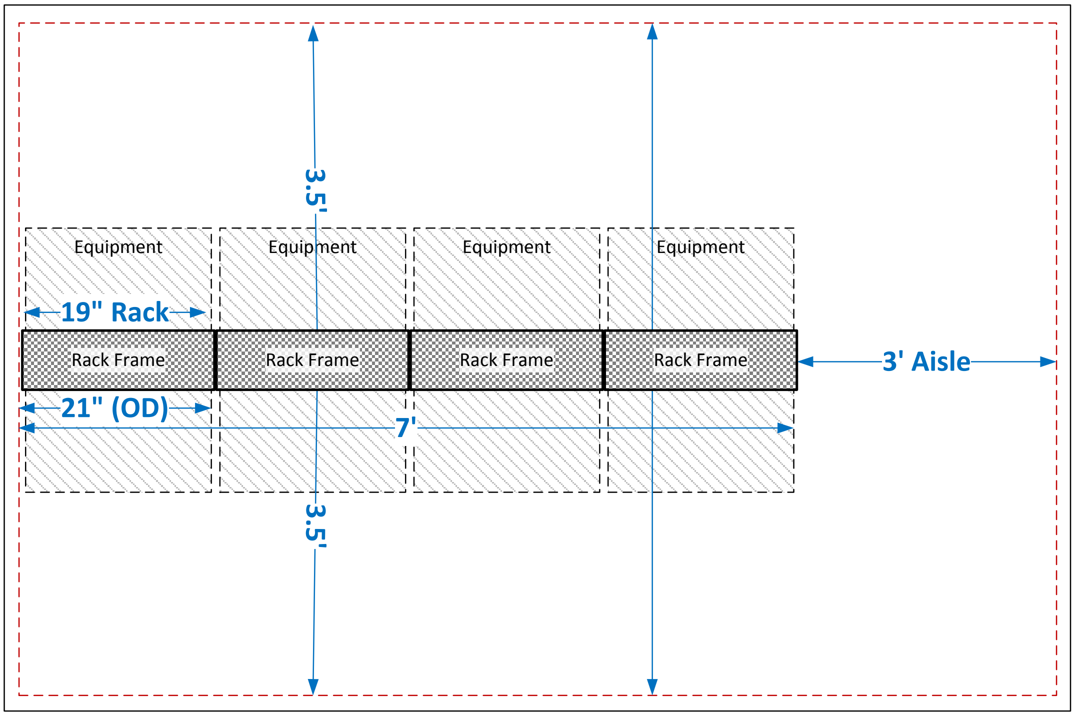


Figure 34: BNG Sites – List of Materials

QTY	Item	Description
1	Remote Device Access Server; Async, Ethernet	Remote Device Access Server; Async, Ethernet (1 RU)
1	BNG Router	6x100GE DWDM, 6 SFP (10 RU)
1	Outdoor Pre-Fab Hut 12x10	Gen, HVAC, Batts, ~4 racks - INSTALLED
4	19" Rack	19" Rack / Frame (42 RU)
1	Core L2 Switch	Core L2 Switch (1 RU)
4	Fiber panels / cross connects	Fiber panels / cross connects (4 RU)
1	Cable ladders / mgmt	Cable ladders / mgmt

6.5.2.3 Optical Line Terminals

The Optical Line Terminal (OLT) is the upstream connection point (to the provider core network) for subscribers. In some contexts, the name OLT may be used to refer to an individual optical interface (SFP), but OLT generally refers to the device which provides multiple subscriber interfaces.

OLTs provide tremendous flexibility in terms of supporting varying subscriber densities and subscriber services. The choice of an optical interface (SFP) installed in the OLT is the only difference between provisioning shared access (one fiber split among 32 subscribers in a GPON architecture) versus dedicated Active Ethernet access (for one subscriber). Furthermore, OLT chassis' are typically stackable, which enables multiple OLT chassis to share a backplane (stack ring) with a common uplink to BNG nodes. In the recommended design, the uplinks to BNG nodes are 10 Gbps.

GPON is generally the most commonly provisioned FTTP technology, due to inherent economies when compared with technologies delivered over home-run fiber, such as Active Ethernet. The cost differential between constructing an entire network using GPON and Active Ethernet is 40 percent to 50 percent.[81] GPON is used to provide services up to 1 Gbps per subscriber and is part an evolution path to higher-speed technologies that use higher-speed optics and wave-division multiplexing.

As illustrated in Figure 29, the BNG connects to optical line terminals (OLT), which are housed in optical distribution cabinets (ODC). ODCs are relatively inexpensive and have minimal power requirements. The electronics housed in an ODC are hardened and designed to operate across a wide range of environmental conditions.

Our recommended design limits each ODC to a service area of fewer than 10,000 passings. The ODCs can be placed in the public right-of-way, on City property, or on private property where appropriate to serve multiple-dwelling units (MDU). Due to their larger physical size as compared to traditional telephone cabinets and cable TV pedestals (see Figure 35), locations would likely need to be selected to minimize visual impact in residential areas.

A key advantage of using multiple distributed ODCs rather than a more centralized design is the flexibility to place aggregation points at ideal geographic locations to minimize the quantity and length of fiber laterals, and thereby potentially increase network availability with greater overall redundancy of the network paths serving individual customers. Compared to other models, this approach potentially allows the full citywide FTTP deployment to occur at lower cost (supporting short- to mid-term requirements), with a plan to segment the network into a greater number of hub areas as capacity demands grow in the future.

[81] "Enhanced Communications in San Francisco: Phase II Feasibility Study," CTC report, October 2009, at 205.

Figure 35: Example Large ODC Housing an OLT

Figure 36: Example Indoor Cabinet Option for OLTs

Figure 37: List of Materials for High-Density OLT Site (Up to 4,000 Subscribers)

QTY	Item	Description
1	OLT, Outdoor Cabinet (lg) - INSTALLED	Lg ODC w slab, power, batts, inverter, heat exchanger, all labor included
8	OLT; Hardened 2-Blade AC Chassis	Hardened OLT chassis, 2 slots, 2x10Gb Uplink SFPs, stackable
16	OLT; GPON line card, 8-port	8 GPON ports and 4 GE ports, needs SFPs
4	OLT; Uplink 10GE SFP+ 10km 1310nm	For 10 GE DWDM uplink
128	OLT; GPON OIM, single port	Supports 32x and 64x
8	OLT; Stack ring Cable, 10GE, 1m	Stack Ring Cables - modular - fixed RJ45 ends

6.5.2.4 Passive Optical Splitters

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 32 customers (in the case of GPON service); for subscribers receiving Active Ethernet service, a single dedicated fiber goes directly to the subscriber premises with no splitting.

FDCs can sit on a curb, be mounted on a pole, or reside in a building. Because the cost of labor for FDC installation is significant, our 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.

Our FTTP design also includes the placement of indoor FDCs and splitters to support multi-dwelling units. This would require obtaining the right to access the equipment for repairs and installation on 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.

6.5.2.5 Customer Premises Equipment (CPE) and Services

In the final segment of the FTTP network, fiber runs from the FDC to customers' homes, apartments, and office buildings; a drop cable extends from the subscriber tap (either on the pole or underground) to the building, enters the building, and connects to customer premises equipment (CPE).

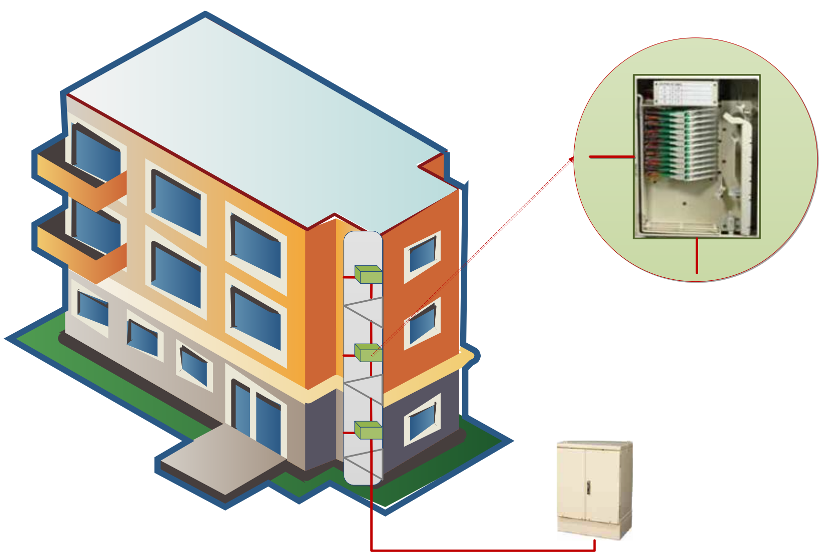
We have specified five CPE kits to offer various features and capabilities and to meet subscriber budgets. Figure 38 lists the basic and premium kits for single family unit (SFU) and multiple dwelling unit (MDU) subscribers, as well as the quantity of each estimated in our model. The primary distinction between the two subscriber classes is the cost of inside plant cabling (for MDUs). The basic CPE kit provides simple Ethernet on the subscriber LAN, whereas the premium CPE includes the fastest Wi-Fi available today (802.11ac).

Figure 38: CPE Kits

Qty	Name	Description
15,125	ONT Kit - Basic	ONT, Enclosure, NID, 8hr UPS, Ethernet
60,500	ONT Kit - Premium	ONT, Enclosure, NID, 8hr UPS, Ethernet, Advanced Wi-Fi
3,946	ONT Kit - Basic (MDU)	ONT, Enclosure, 8hr UPS, Ethernet (MDU)
15,783	ONT Kit - Premium (MDU)	ONT, Enclosure, NID, 8hr UPS, Ethernet, Advanced Wi-Fi (MDU)
5,597	ONT Kit - Premium (Bus.)	ONT, Enclosure, NID, 8hr UPS, AE Interface, Ethernet, Advanced Wi-Fi (Bus.)

We recommend indoor CPE devices. CPE devices generally do not need to be configured or maintained by the operator after they are installed, therefore placing them outdoors unnecessarily increases cost by requiring hardened equipment.

Figure 39: Example MDU Inside Wiring / FDC



In this model we assume 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. GPON is the most commonly provisioned FTTP service, used 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 enable all subscribers to 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 32) subscribers.

Active Ethernet 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 easily supports legacy voice (GR-303 and TR-008) and Next Gen Voice over IP (SIP and MGCP). AE also supports Video. Service distance (from the OLT) can extend as far as 75 Km (about 46 miles).

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. This hardware cost differential is partially reflected in the CPE kit pricing for an AE subscriber, which includes the dedicated SFP module on the OLT. The GPON CPE ($455) costs less than half the CPE for Active Ethernet service ($976).

Our fiber plant is designed with adequate capacity from the OLT to subscriber taps to enable at least 10 percent of subscribers to select Active Ethernet service in any given OLT service area.

6.6 Operations and Maintenance Cost Estimates

6.6.1 Subscriber Provisioning

The recommended subscriber provisioning platform will generally be purchased from the selected vendor for FTTP electronics. The platform facilitates additions, moves, changes, and deletions of subscribers on the system, and tracks all activities. The provisioning platform is accessed by system administrators and customer service representatives in direct support of end subscribers.

6.6.2 Maintenance

6.6.2.1 Sparing

The City will need to manage spare equipment inventory for lower-cost quick-fix items such as line cards, interface modules, and power supplies.

6.6.2.2 Electronic Equipment Support and Maintenance

Network equipment is covered by each vendor's maintenance program, which typically includes extended warranty support, repair and replacement services, remote technical support, on-site technical support, and SLAs for response times to various types of reported issues. Support services often vary significantly between vendors; a common level of support often falls into the range of 10 percent of initial equipment cost.

6.6.2.3 Fiber Maintenance

Fiber optic cable is resilient compared to copper telephone lines and cable TV coaxial cable. The fiber itself does not corrode, and fiber cable installed over 20 years ago is still in good condition. However, fiber can be vulnerable to accidental cuts by other construction, traffic accidents, and severe weather. The City would need to have staff or contractors with the necessary expertise and equipment available to repair cable. In addition to fiber technician staffing, fiber maintenance costs are 0.5 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.

7 Survey Results

CTC conducted two surveys to help create a clear picture of the Seattle market today—one survey was conducted via mail to gather information from residents and an online survey was distributed to City of Seattle businesses. Here we analyze the results of the survey and outline what these findings mean for the City's proposed Broadband Utility.

7.1 Residential Survey

Seattle has a diverse and resilient economy, driven by an entrepreneurial spirit, technological innovation, and an educated population. A foundation for Seattle's successful business climate and quality of life is its utilization of technology, including reliable and robust access to the Internet.

As part of its ongoing efforts to evaluate and improve Internet access and quality for its residents, the City of Seattle conducted a survey of residents in early 2015. Key findings of the survey include:

- Seattle residents are highly connected, with 96 percent of residents having home Internet service and 89 percent owning a cell/mobile telephone.
- The majority of Seattle homes use a cable modem Internet connection. DSL, satellite, fixed wireless, and other connections have much smaller market shares.
- Reliability of the Internet connection ranks as the most important aspect, followed by connection speed and price paid. Residents are generally satisfied with most aspects of their Internet service, with the exception of price paid.
- Respondents indicated willingness to switch to a very high-speed Internet connection, although the share willing to switch drops substantially at prices higher than $75 per month.
- Respondents indicated a willingness to pay approximately $10 per month additional for 1 Gbps service compared to 100 Mbps Internet connection speed. This indicates a limited willingness to pay for very high speeds.
- Respondents indicated a willingness to pay a one-time hookup fee for very fast Internet service, although the willingness drops sharply at hookup fees above $250.
- The most frequent uses of home Internet connections are streaming movies or videos, buying products online, streaming music, and connecting to a work computer. More than one-half of respondent's employers allowed telework.
- More than two-thirds of respondents indicated that the City should install a state-of-the-art communications network and either offer services or allow private companies to offer services to the public.

This report documents the survey process, discusses methodologies, presents results, and provides key findings that will help the City assess the current state and ongoing needs of its residents regarding high-speed communications services.

7.1.1 Survey Process

7.1.1.1 Overview

The City of Seattle has a diverse and robust urban climate, and is known for its embrace of new trends and technologies to improve its economy and quality of life. Supporting its innovative culture is the use of the Internet and the myriad of applications and services that are enabled by robust Internet access and services.

As part of a broader effort to evaluate and improve high-speed communications services, the City of Seattle conducted a mail survey of 3,750 randomly-selected residences in January of 2015, and received 833 completed responses. The survey captured information about residents' current communications services, satisfaction with those services, desire for improved services, willingness to pay for faster Internet speeds, and opinions regarding the role of the City regarding Internet access and service. A copy of the survey instrument is included in Appendix B – Residential Survey Instrument.

The City acquired the services of Columbia Telecommunications Corporation (CTC) to help assess communications services within the City. CTC and its partner market research firm, Clearspring Research (together, the "Consultant"), coordinated and managed the survey project, including development of the draft questionnaire, sample selection, mailing and data entry coordination, survey data analysis, and reporting of results. CTC and Clearspring have substantial experience conducting similar surveys for municipalities nationwide.

7.1.1.2 Coordination and Responsibilities

A project of this magnitude requires close coordination between the City and the Consultant managing the project. This section briefly describes the project coordination and responsibilities.

In the project planning phase, the City and the Consultant discussed the primary survey objectives, the timing of the survey and data needs, and options for survey process. The project scope, timeline, and responsibilities were developed based on those discussions.

The Consultant developed the draft survey instrument based on the project objectives and provided it to City staff for review and comment. The City provided revisions and approved the final questionnaire. The Consultant purchased a mailing list of randomly selected City households to receive the survey packet. The Consultant also coordinated all printing, mailing, and data entry efforts and provided regular updates to City staff. The Consultant performed all data coding and cleaning, statistical analyses, response summaries, and reporting of results.

The primary responsible party at the City was the Director of the Office of Cable Communications, who is also President of the National Association of Telecommunications Officers and Advisors. The primary responsible party at Consultant was the Principal Engineer, the Principal Research Consultant, and the Research Director.

7.1.1.3 Survey Mailing and Response

A total of 3,750 survey packets were mailed first-class in January 2015 with a goal of receiving 600 valid responses. Recipients were provided with a postage-paid business reply mail envelope in which to return the completed questionnaire. The sample size was designed to capture enough surveys to provide statistically valid results at the 95 percent probability level with a confidence interval within ±4.0 percent. That is, for questions with valid responses from all survey respondents, one would be 95 percent confident (19 times in 20) that the survey responses lie within ±4.0 percent of the population as a whole (the approximately 300,000 households in the City).

A total of 833 useable surveys were received by the date of analysis,[82] providing a gross response rate of 22.2 percent.[83] The margin of error for aggregate results at the 95 percent confidence level for 833 responses is ±3.4 percent, within the initial sample design criteria.

7.1.1.4 Data Analysis

The survey responses were entered into SPSS[84] software and the entries were coded and labeled. SPSS databases were formatted, cleaned, and verified prior to the data analysis. Address information was merged with the survey results using the unique survey identifiers printed on each survey. The survey data was evaluated using techniques in SPSS including frequency tables, cross-tabulations, and means functions. Statistically significant differences between subgroups of response categories are highlighted and discussed where relevant.

The survey responses were weighted based on the age of the respondent. Since older persons are more likely to respond to surveys than younger persons, the age-weighting corrects for the potential bias based on the age of the respondent. In this manner, the results more closely reflect the opinions of the Seattle adult population as a whole.

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[82] At least 19 responses were received after analysis had begun, and are not included in these results.

[83] 106 surveys were undeliverable, mostly due to vacant residences. The "net" response rate is 833/(3,750-106) = 22.9 percent.

[84] Statistical Package for the Social Sciences (http://www-01.ibm.com/software/analytics/spss/)

Table 24 and Figure 40 summarize the weighting used for survey analysis.

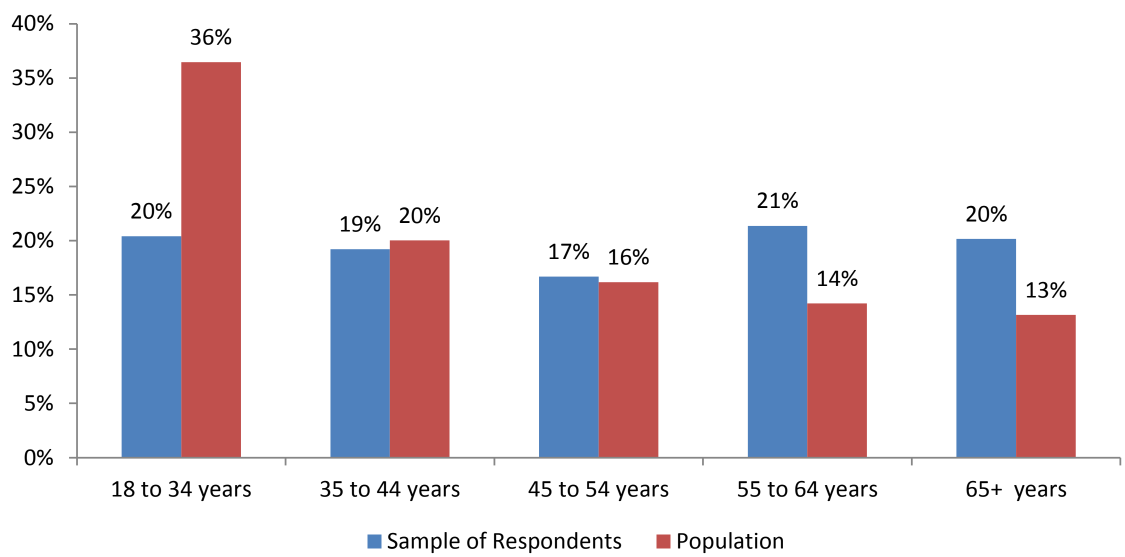
Table 24: Age Weighting

Age Cohort	Census Population	** Survey Responses	Weight
18-34*	181,501	170	1.747
35-44	99,704	160	1.020
45-54	80,543	139	0.948
55-64	70,762	178	0.651
65+	65,495	168	0.638
Total	498,005	815	

* For Census data, the 20-34 age cohort was used since many younger adults will not live in separate households.

* Not all respondents provided their age

Figure 40: Age of Respondents and Seattle Adult Population



The following sections summarize the survey findings.

7.1.2 Survey Results

The results presented in this report are based on analysis of the information provided by 833 respondents. As noted previously, results at the aggregate level are representative of the entire set of Seattle households with a confidence interval of ±3.4 percent.

Unless otherwise indicated, the results presented in the following sections represent age-weighted results, adjusting for the differences in ages between the survey respondents and the Seattle adult population as a whole. In this manner, the survey results more accurately represent the broader population of Seattle households.

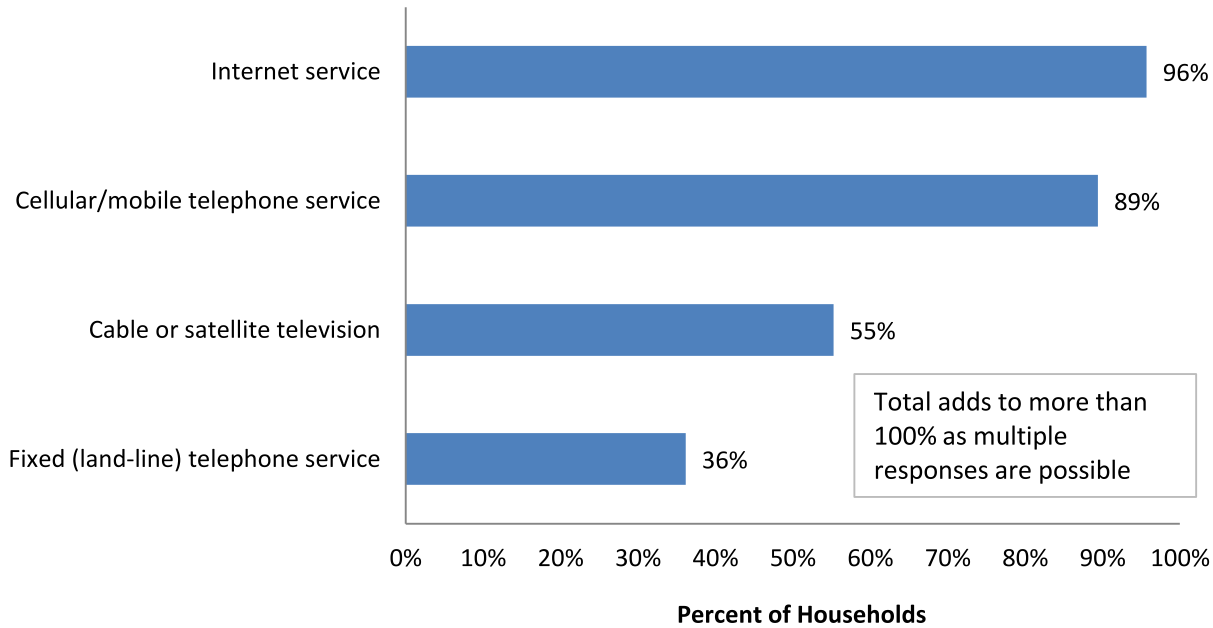
Unless otherwise indicated, the percentages reported are based on the "valid" responses from those who provided a definite answer and do not reflect individuals who said "don't know" or otherwise did not supply an answer because the question did not apply to them. Key statistically-significant results ($p \leq 0.05$) are noted where appropriate.

7.1.2.1 Home Communications Services

Respondents were asked about the Internet services available to them, the services currently purchased, and their satisfaction with their current Internet services.

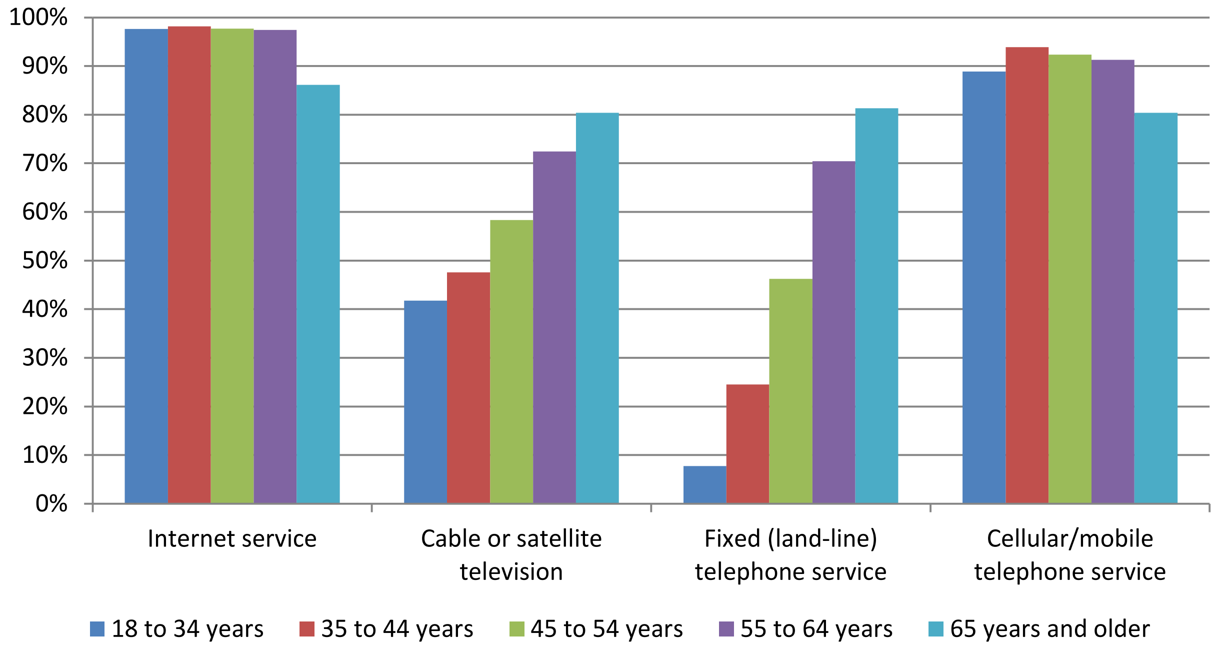
Seattle residents are highly connected, with 96 percent of respondents having Internet service at their home. In addition, 89 percent have cell/mobile phone service and 55 percent have cable or satellite television service. Only 36 percent of respondents reported having land-line telephone service.

Figure 41: Communications Services Purchased for Household



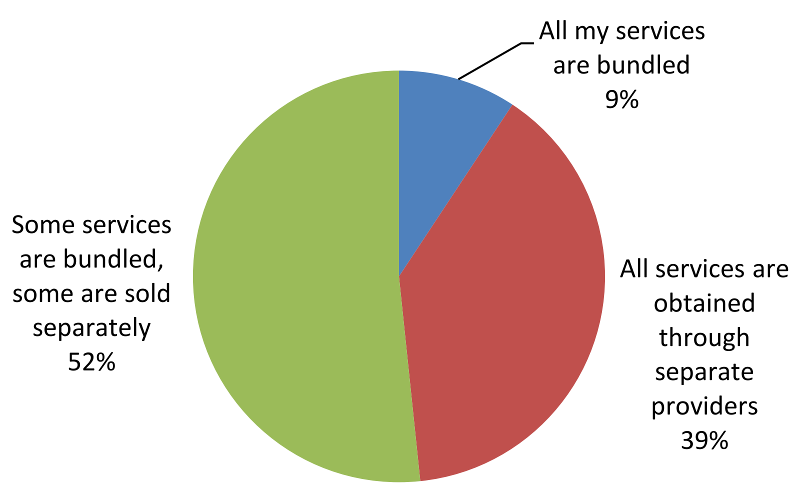
There is a strong correlation between the respondents' age and likelihood to purchase cable or satellite television services or a land-line telephone. Respondents in the highest age bracket (65 and older) were somewhat less likely to purchase Internet service or have a cell phone. Figure 42 illustrates the communications services purchased by the age of the respondent.

Figure 42: Communications Services Purchased by Age of Respondent



Approximately 60 percent of households bundle at least some of their communications services, but less than 10 percent bundle all with one company as illustrated in Figure 43.

Figure 43: Bundling of Services



Respondents were asked about the importance of various communications services to their household. Internet and cell/mobile phone service were by far the most important, with more than 80 percent of respondents indicating they were “very important”. Two-thirds of respondents indicated that “high-speed” Internet was “very important”.

While 21 percent of respondents indicated that basic cable television service was “very important”, 34 percent said it was “not at all important”. Furthermore, only nine percent of respondents indicated that premium cable television was “very important” while nearly one-half said it was “not at all important”. This indicates relatively modest importance of cable/satellite television services, with even less value placed on premium service.

Approximately 12 percent of respondents said a land line telephone was “very important”, 60 percent said it was “not important at all”. As noted previously, only 36 percent of homes have land line telephone service.

Figure 44: Importance of Communications Service Aspects

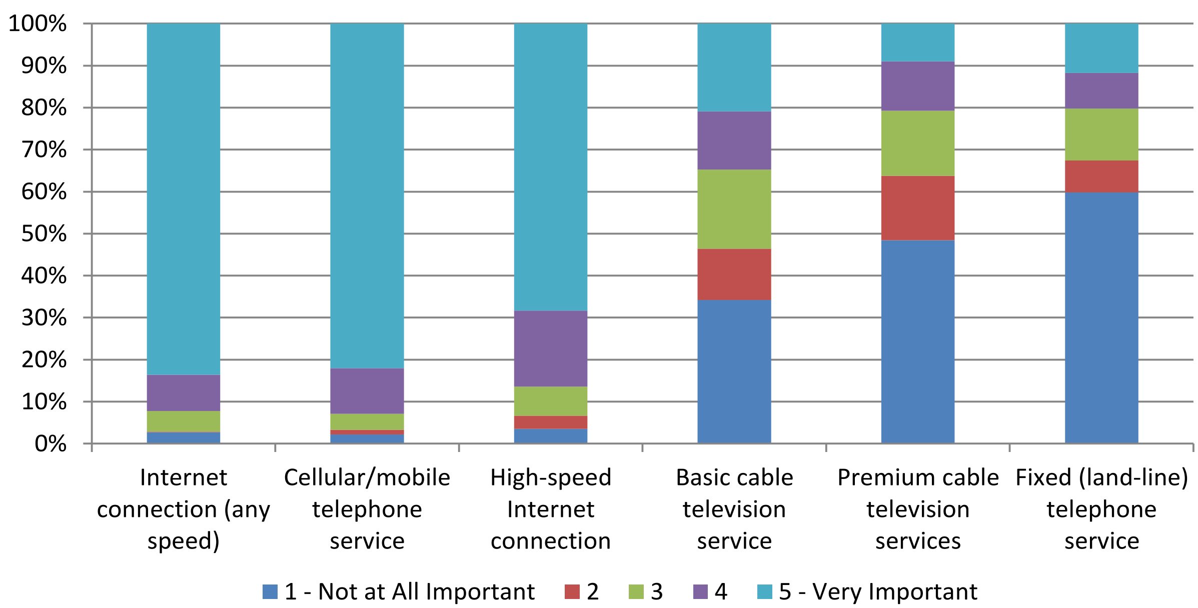
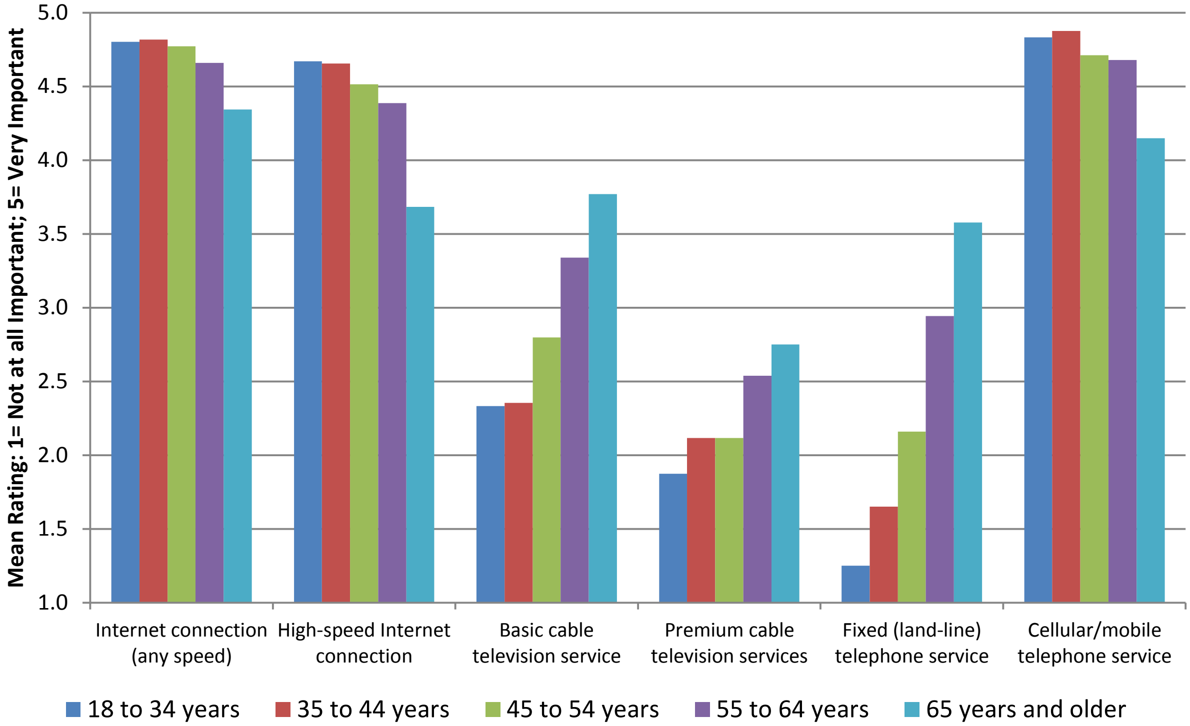


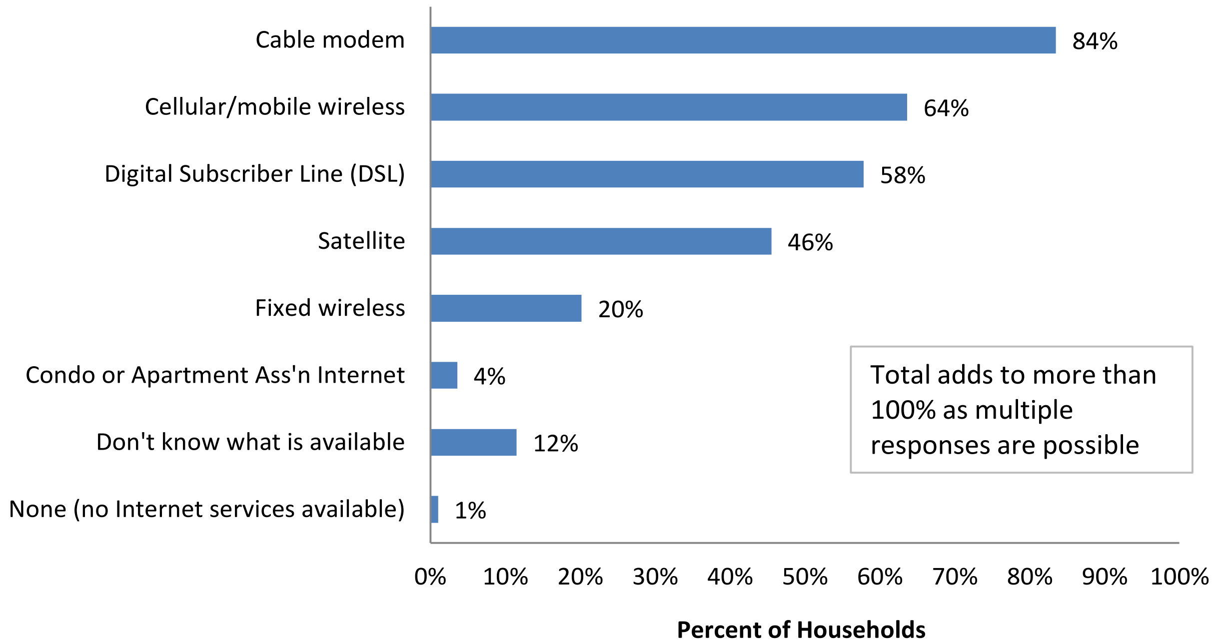
Figure 45 illustrates the importance of communications services by the age of the respondent. The importance of an Internet connection and cellular telephone service declines for the older age cohorts. Conversely, the importance of cable television and landline telephone services increases with the age of the respondent.

Figure 45: Importance of Communications Services by Age Cohort



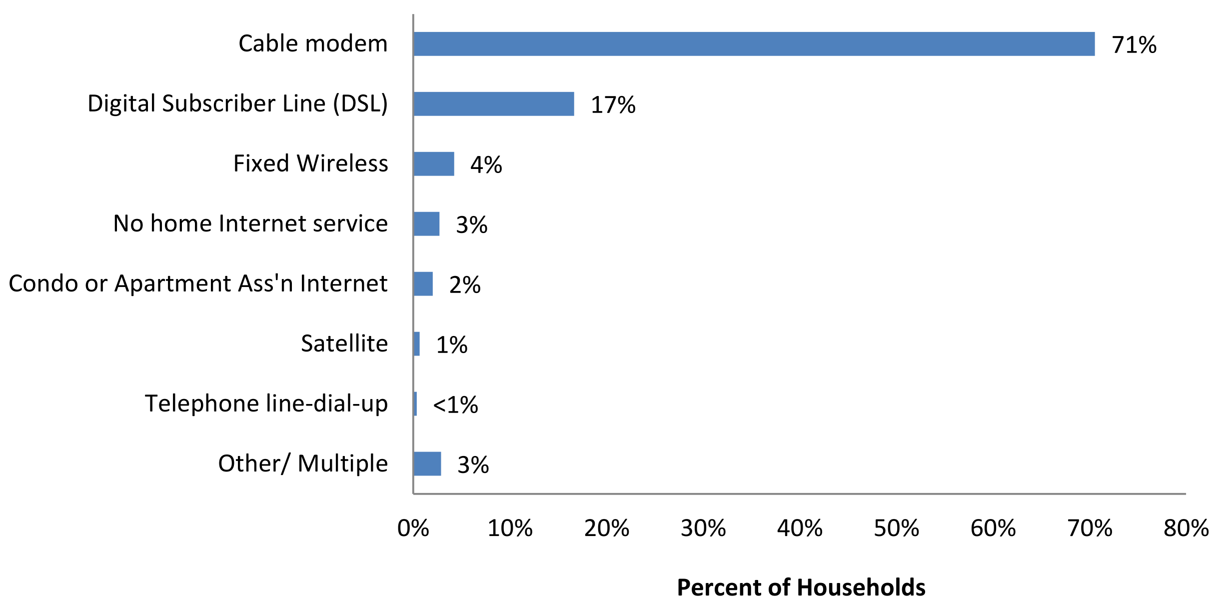
Respondents were asked to indicate what Internet interconnection types were available at their residence. More than 80 percent of respondents said that cable Internet service was available at their residence, and over one-half said that DSL Internet service was available. Less than one-half said that satellite Internet service was available and only 20 percent said that fixed wireless service was available, as illustrated in Figure 46.

Figure 46: Internet Connections Available at Residence



Over 96 percent of Seattle homes have Internet service at their home. The most popular home Internet connection is a cable modem, serving 71 percent of all Seattle homes. Approximately 17 percent have DSL and smaller shares have other connections, as shown in Figure 47.

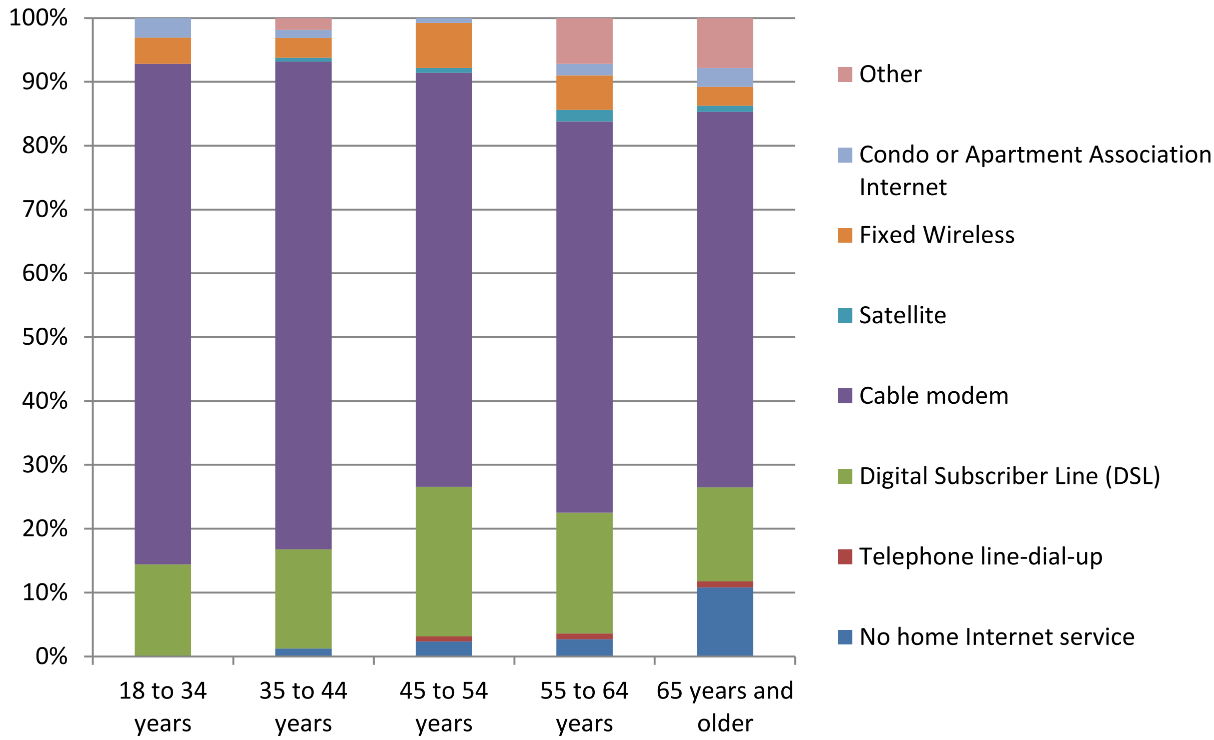
Figure 47: Primary Home Internet Service



Of the few respondents with no Internet service, most stated the reason was either that the price was too high or that they had no need for the Internet.

As illustrated in Figure 48, most of the respondents with no home Internet service were age 65 or older. Younger respondents were somewhat more likely to have a cable modem connection.

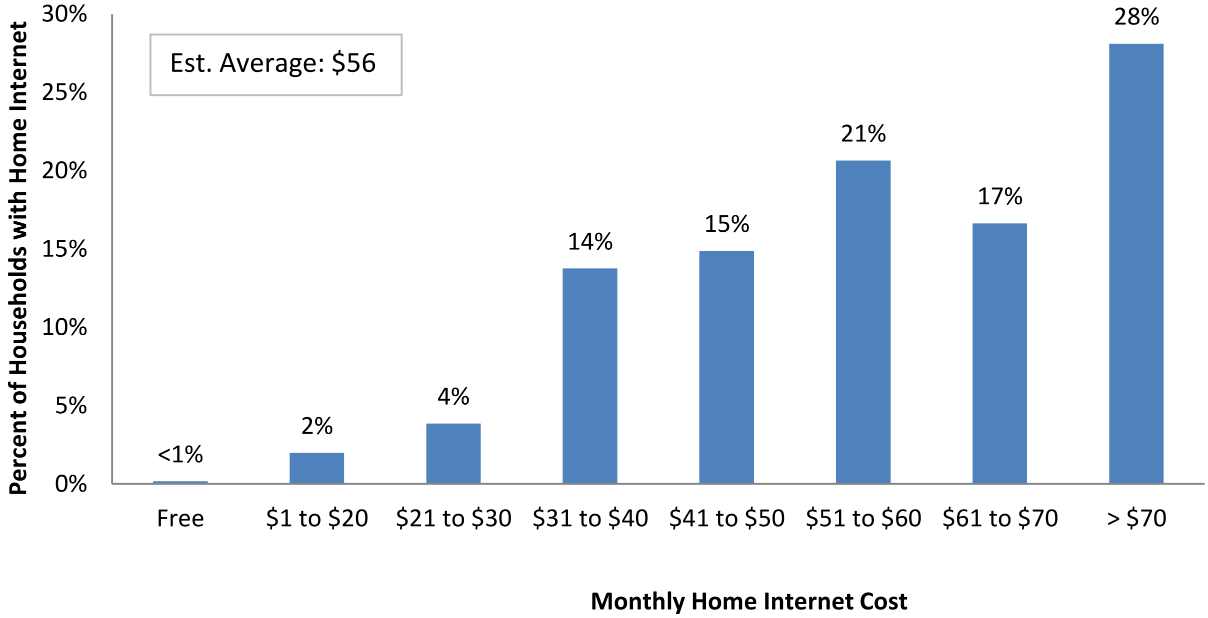
Figure 48: Primary Home Internet Connection by Age of Respondent



About 35 percent of homes pay $50 per month of less for home Internet service while 28 percent pay more than $70 per month as shown in Figure 49. The average monthly Internet bill is approximately $56.[85] Survey analysis indicates that cable modem service is more expensive than DSL, on average.

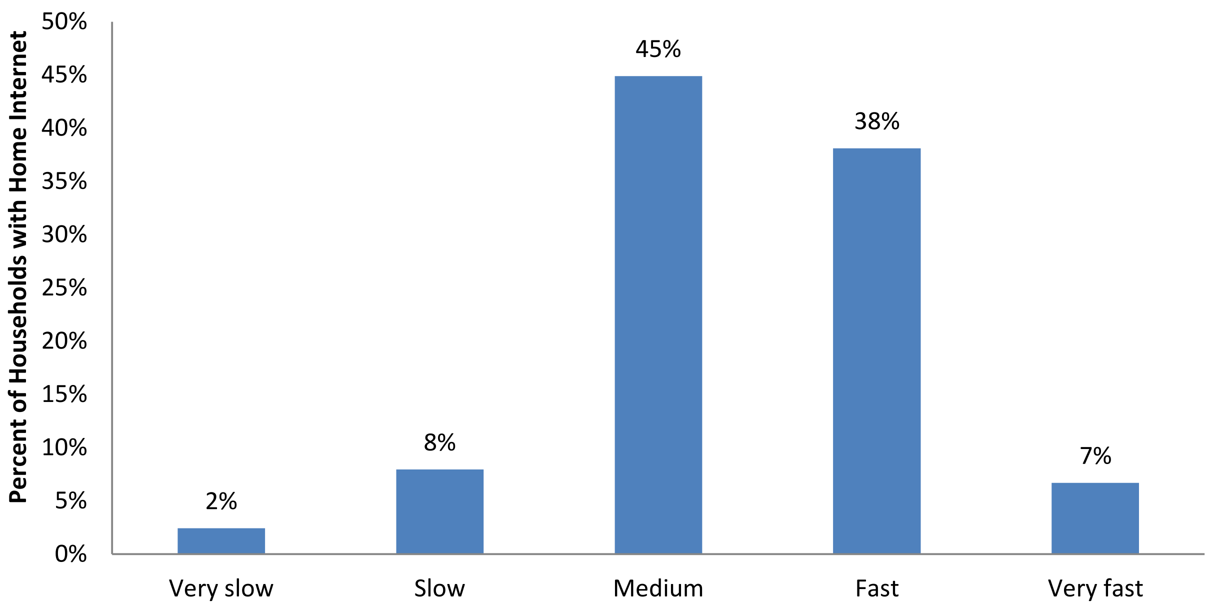
[85] The question asked respondents to reflect only the price of Internet service, not the entire bundle of services. As noted earlier, more than half of subscribers bundle services, so individual prices may be difficult to estimate.

Figure 49: Monthly Price for Home Internet Service



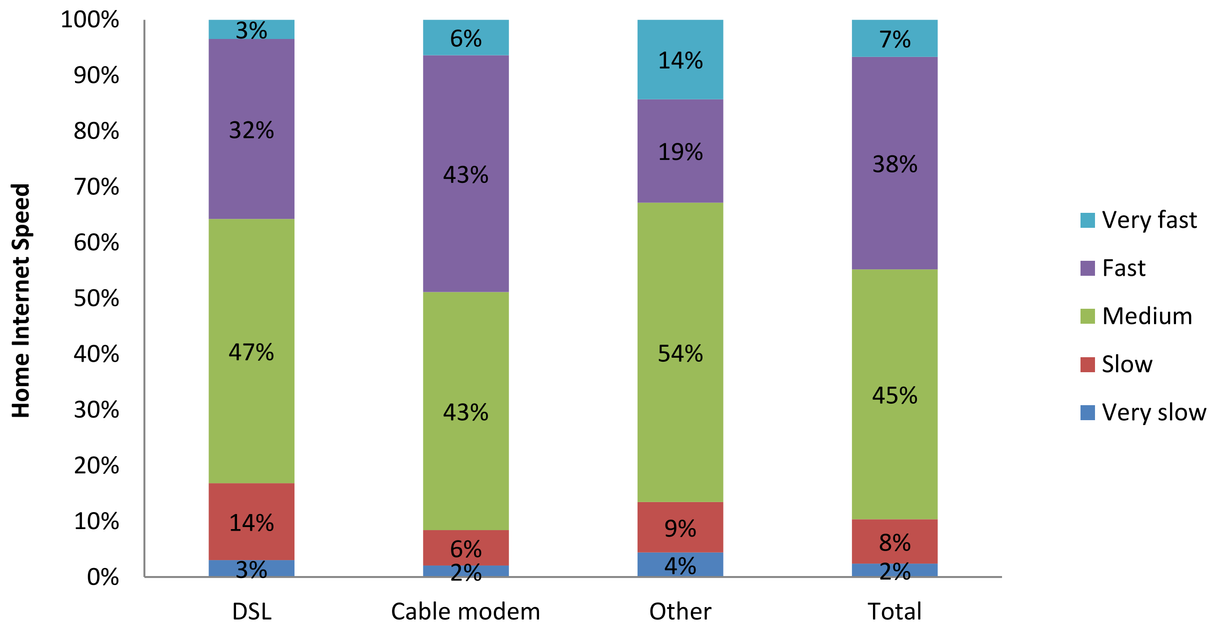
Respondents were asked about the speed of their Internet connection. Nearly one-half described it as "fast" or "very fast", while only ten percent described it as "slow" or "very slow".

Figure 50: Speed of Internet Connection



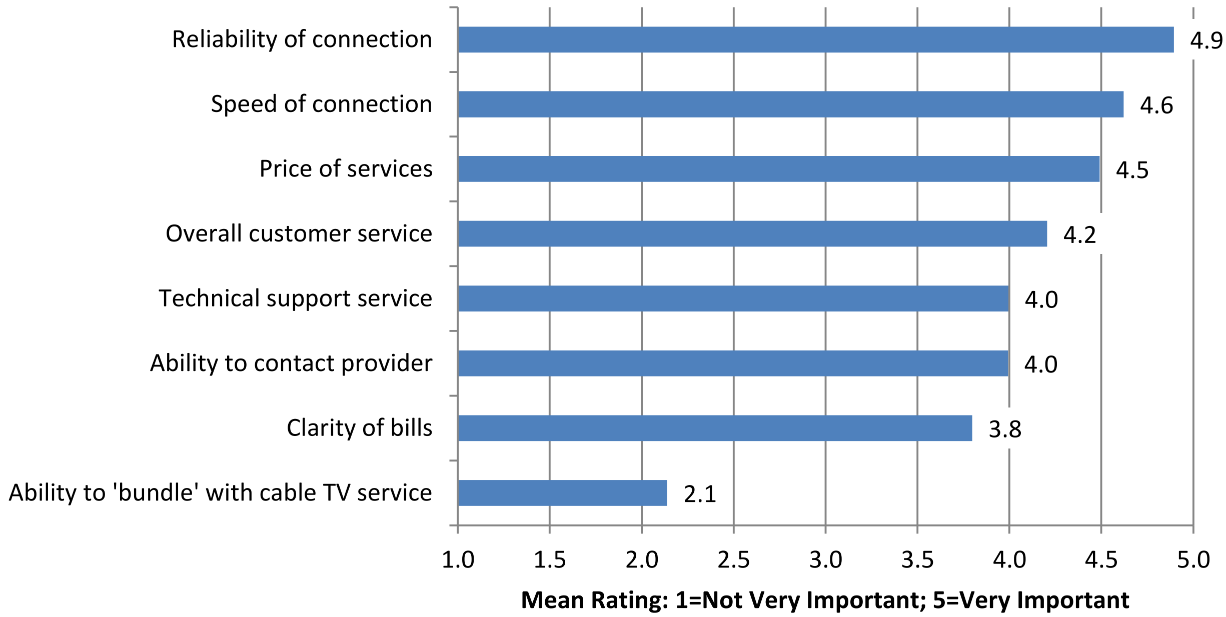
In general, respondents with cable modem connections described their speed as somewhat faster than DSL. Nearly one-half of cable Internet customers described their speed as "fast" or "very fast", compared to only 35 percent of DSL customers, as shown in Figure 51.

Figure 51: Internet Speed by Connection Type



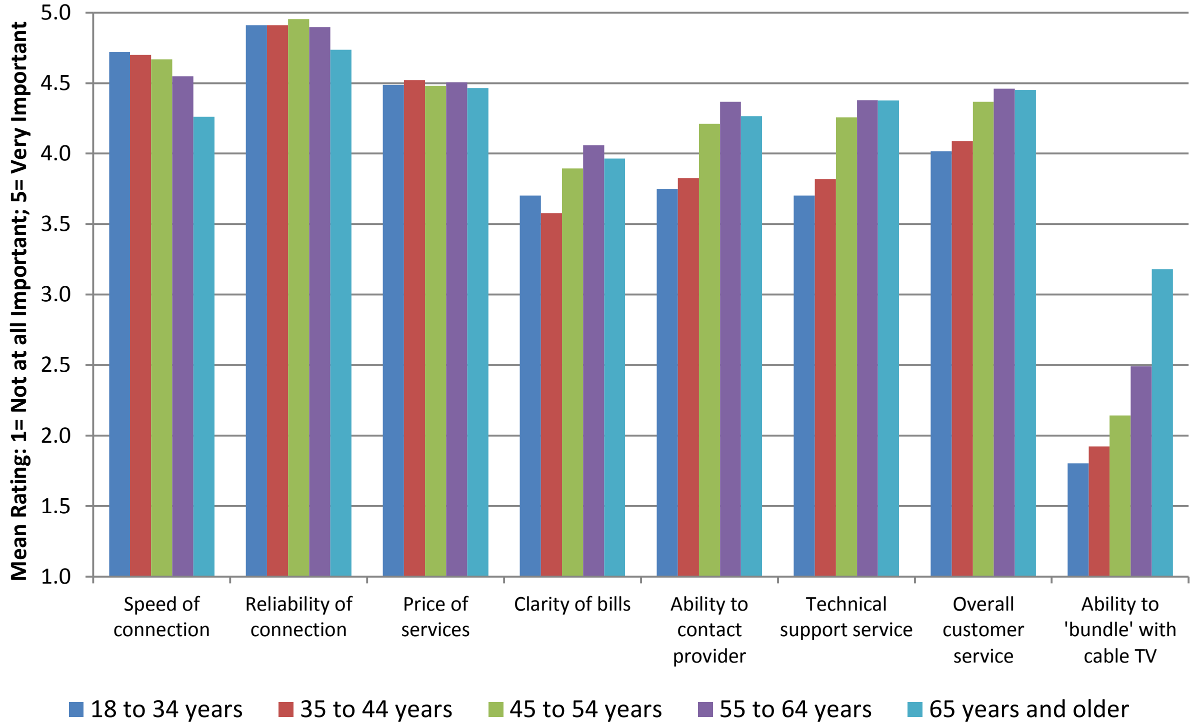
Respondents were asked to rate the importance of various Internet service aspects. The reliability of the connection was the most important, followed by connection speed and price paid. The ability to bundle with cable television service was the least important aspect by a significant margin, as shown in Figure 52.

Figure 52: Importance of Internet Service Aspects



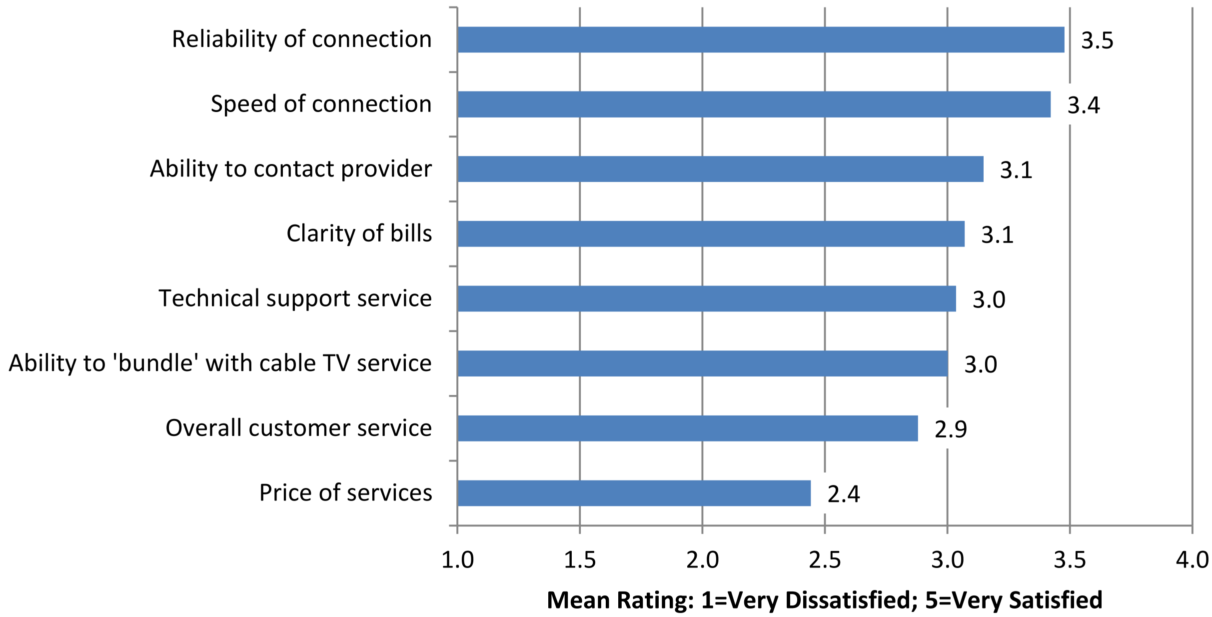
The importance of some Internet aspects is correlated with the age of the respondent. As illustrated in Figure 53, the ability to bundle services is much more valued by older respondents. Older respondents also place higher importance on several customer service aspects, while younger respondents place somewhat greater value on connection speed.

Figure 53: Importance of Internet Aspects by Age of Respondent



Respondents were asked about their satisfaction with various aspects of their current Internet service. The reliability and speed of the connection ranked as the two highest service aspects, as illustrated in Figure 54. The price paid ranked as having the lowest satisfaction level, which is typical in surveys such as this.

Figure 54: Satisfaction with Internet Service Aspects



Comparing respondents' stated importance and satisfaction with Internet service aspects allows an evaluation of how service providers are meeting the needs of consumers. Aspects that have higher stated importance than satisfaction can be considered areas in need of improvement. Aspects that have higher satisfaction than importance are areas where the market is meeting or exceeding customers' needs.

As illustrated in Figure 55 and detailed in Table 25, the satisfaction with all aspects of Internet service fell short of the importance level except for the ability to bundle services. The price of service was the strongest "underperformer" followed by reliability and speed of connection. It should be noted that consumers were quite satisfied with the reliability of service (the second highest aspect in terms of satisfaction), but the importance of reliability is extremely high.

Figure 55: Internet Aspects Importance and Satisfaction

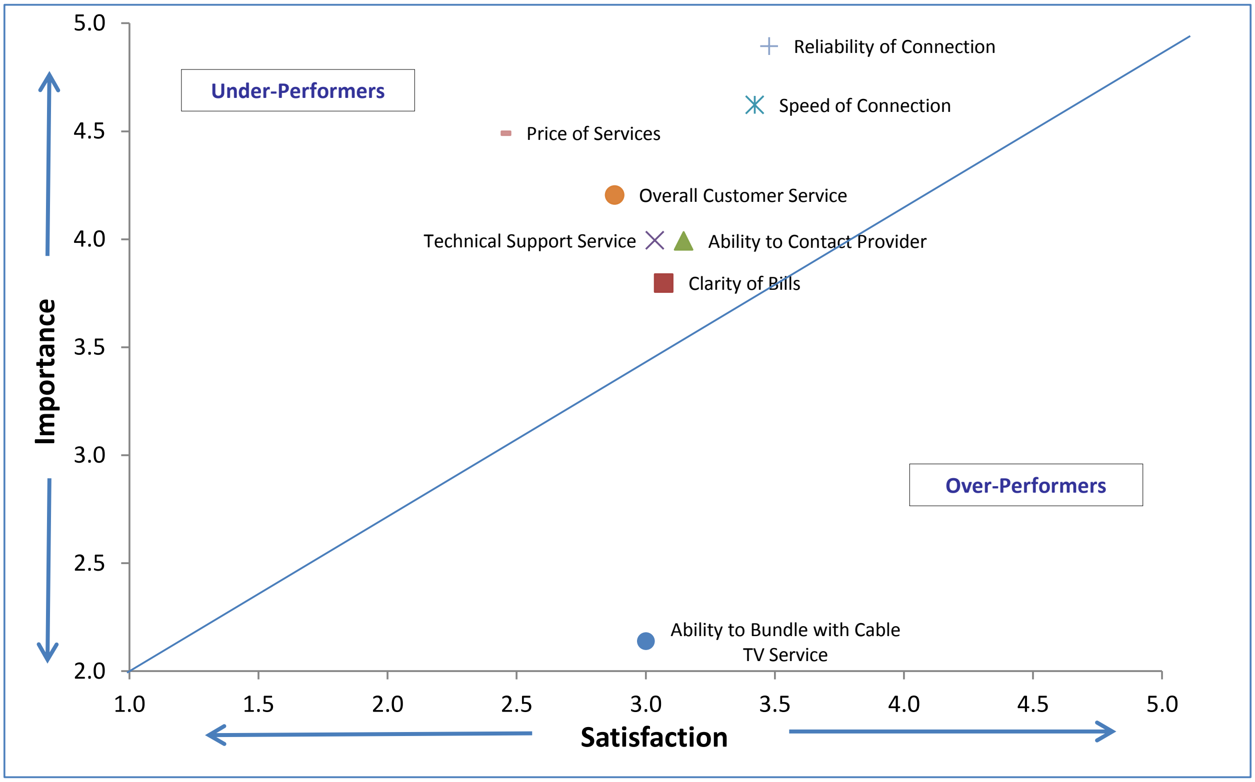
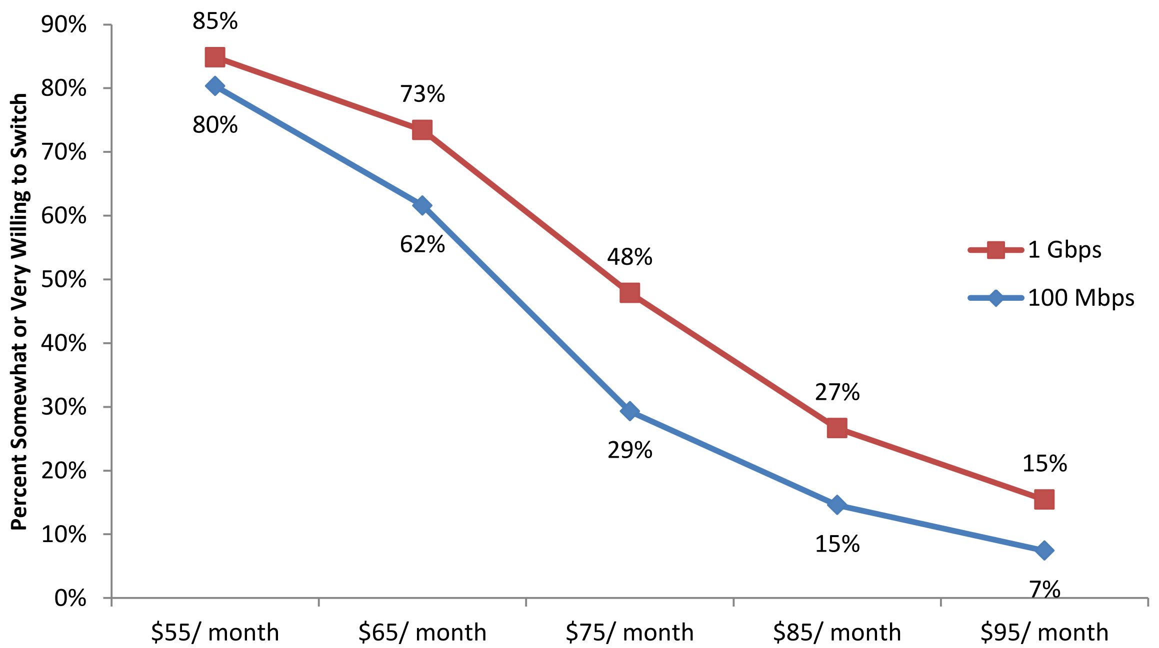


Table 25: Gap Between Importance and Satisfaction with Internet Aspects

	Mean Satisfaction	Mean Importance	GAP < = >	Customer Expectations
Ability to Bundle with Cable TV Service	3.0	2.1	0.9	Exceeded
Clarity of Bills	3.1	3.8	-0.7	Not Met
Ability to Contact Provider	3.1	4.0	-0.8	Not Met
Technical Support Service	3.0	4.0	-1.0	Not Met
Speed of Connection	3.4	4.6	-1.2	Not Met
Overall Customer Service	2.9	4.2	-1.3	Not Met
Reliability of Connection	3.5	4.9	-1.4	Not Met
Price of Services	2.4	4.5	-2.0	Not Met

Respondents were asked if they would be interested in switching to a very high speed Internet connection of 100 Mbps (5 to 10 times faster than a cable modem) or 1 Gbps (100 times faster than a cable modem) at different monthly price ranges. This allows an evaluation of the propensity to switch to a faster Internet service and the price points at which consumers are likely to switch. The results are illustrated in Figure 56.

Figure 56: Willingness to Switch Internet Service at Varying Prices and Speeds



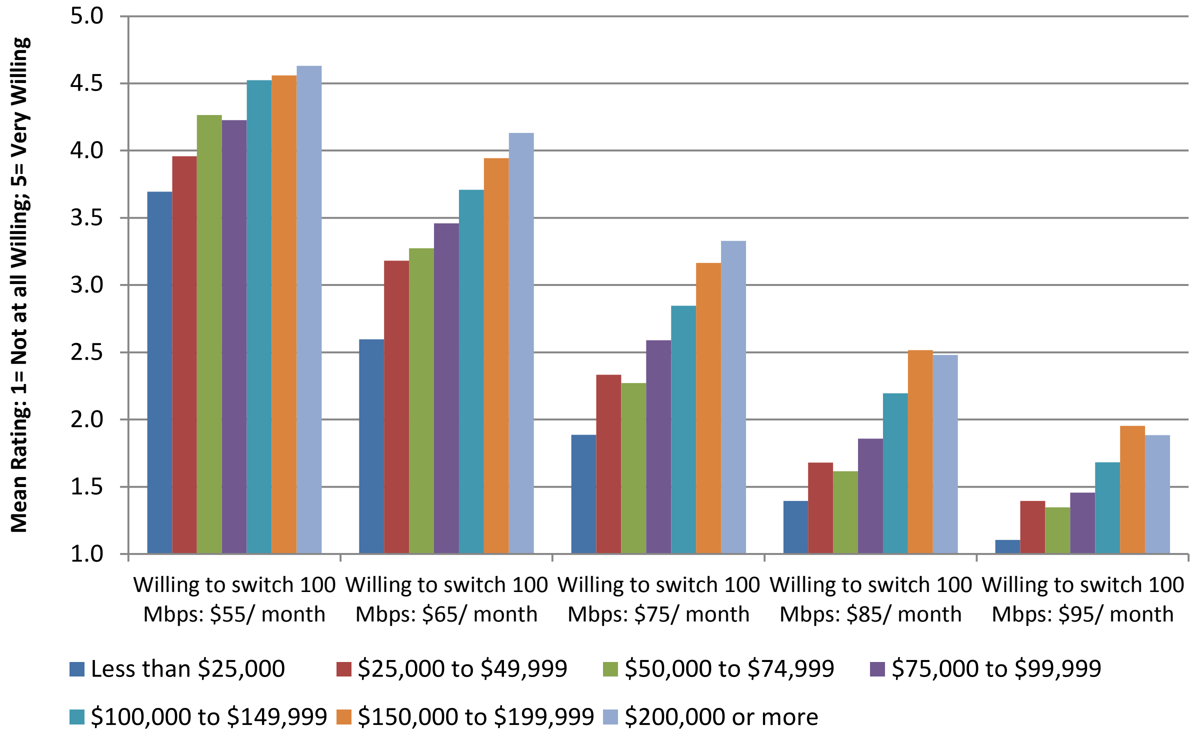
As shown in Figure 56, most consumers indicated that they would be somewhat or very likely to switch to a faster service for a monthly price of $55 (about the average Internet service cost paid currently). At a monthly price of $75, nearly half would switch to 1 Gbps service, but only 29 percent would switch to 100 Mbps service. At a monthly price of $95, only 15 percent would be somewhat or very likely to switch to 1 Gbps service and seven percent to 100 Mbps service.

A further review of Figure 56 indicates that the incremental value placed on 1 Gbps over 100 Mbps service (the horizontal "gap" between the lines) is approximately $10 per month. This is an important finding, as some cable modem speeds are approaching 100 Mbps and even higher speeds would likely require fiber-optic infrastructure and the associated development costs.

It should also be noted that this data indicates respondents' stated willingness to switch services, but does not guarantee that all will carry out those actions when given the choice. Thus, any projections of "take rates" for these services should account for likely consumer behaviors rather than expressed willingness, especially in the "somewhat willing" category.

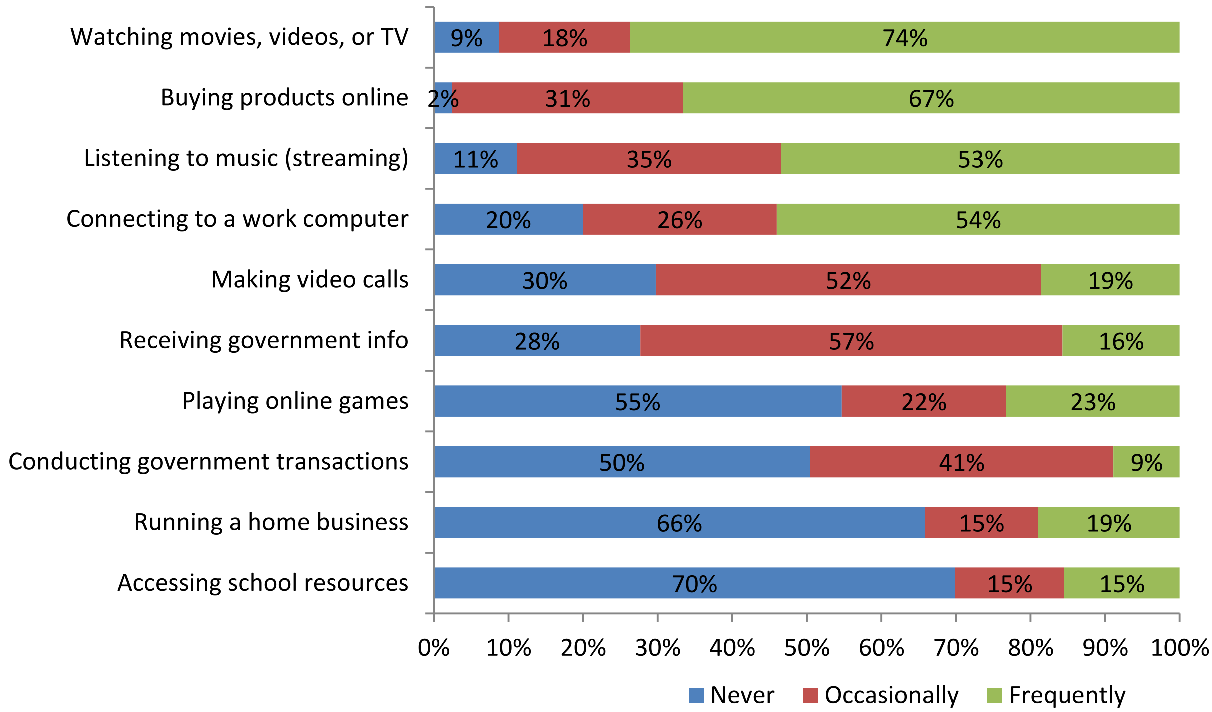
As one would expect, the willingness to switch at various price points is strongly correlated with household income. Those with higher incomes are more willing to pay for very high speed Internet service at any price level as illustrated in Figure 57.

Figure 57: Willingness to Switch to High-Speed Internet by 2014 Household Income



The most common use of home Internet connections are watching movies and buying products online. More than one-half of respondents also stated that they frequently streamed music online or connected to a work computer. The uses of home Internet are illustrated in Figure 58.

Figure 58: Uses of Home Internet Connection



The frequency of several Internet activities is correlated with the age of the respondent. The two strongest correlations are streaming music and watching movies or videos, as illustrated in Figure 59 and Figure 60.

Figure 59: Frequency of Streaming Music via Internet by Age of Respondent

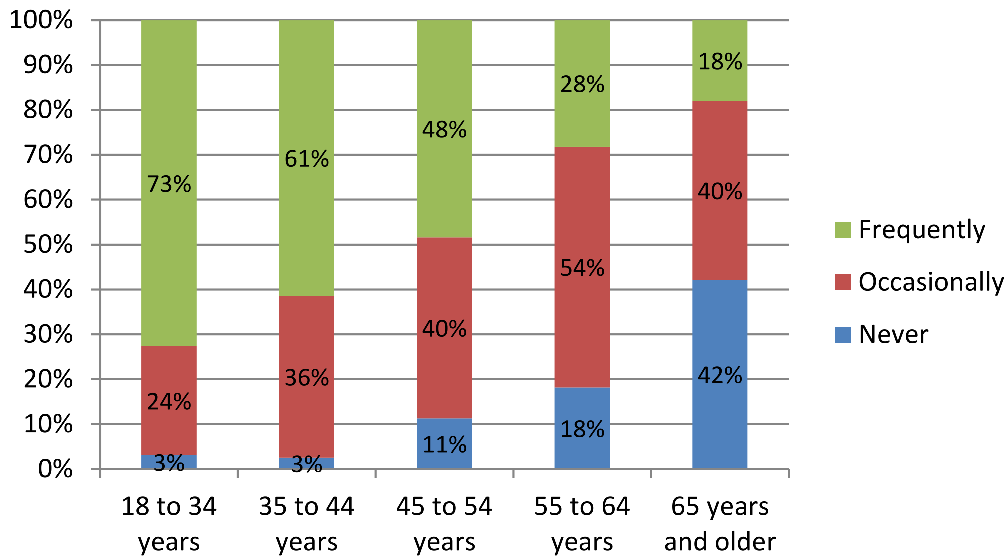
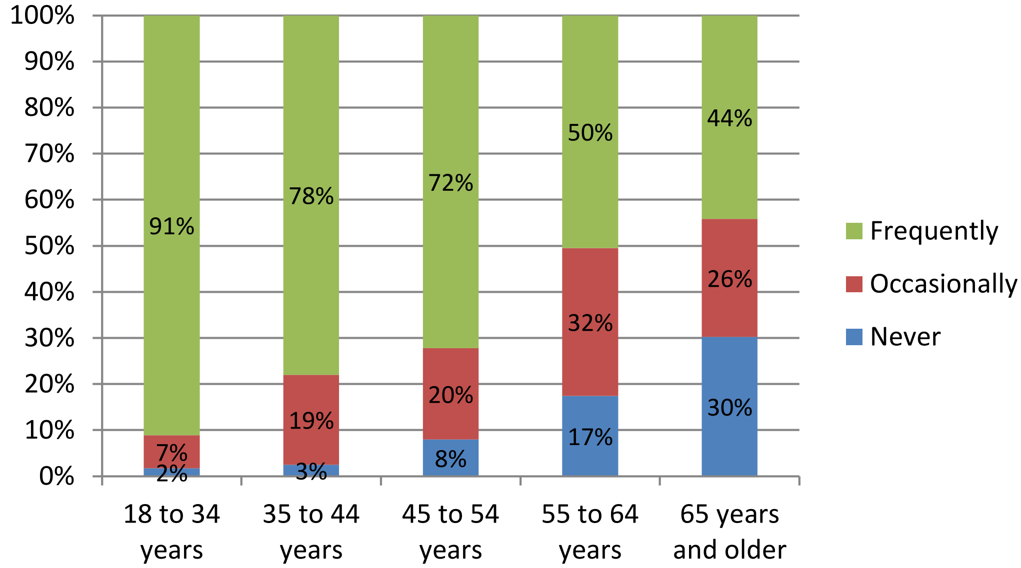
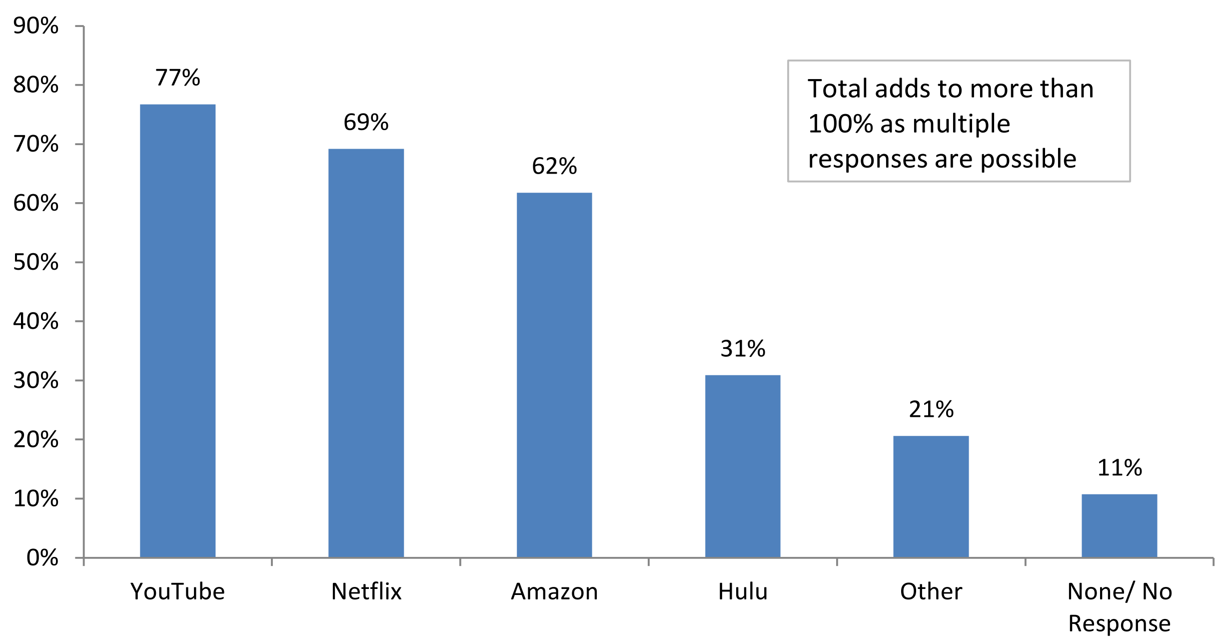


Figure 60: Frequency of Watching Movies/Videos via Internet by Age of Respondent



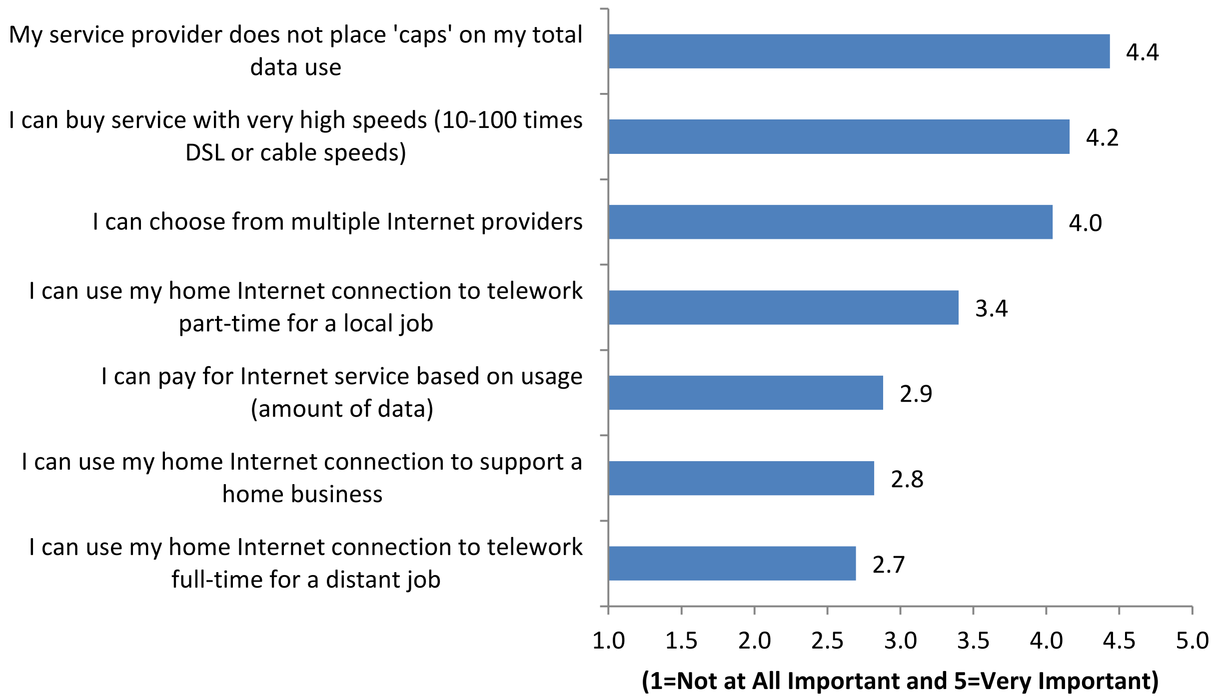
As indicated previously in Figure 58, over 90 percent of respondents watch movies, videos, or television on-line and nearly three-fourths do so frequently. The most common video streaming is YouTube, followed by Netflix and Amazon, as illustrated in Figure 61.

Figure 61: Streaming Services via Home Internet Connection



Respondents were asked about the importance of several features they consider when selecting a home Internet service provider. As illustrated in Figure 62, the absence of "caps" on data use ranked as the most important, followed by the option to purchase very high speed service and the ability to choose from multiple Internet providers. Using home Internet to telework to a distant job, supporting a home business, and paying for Internet service based on usage all ranked slightly less than the mid-point on the importance scale.

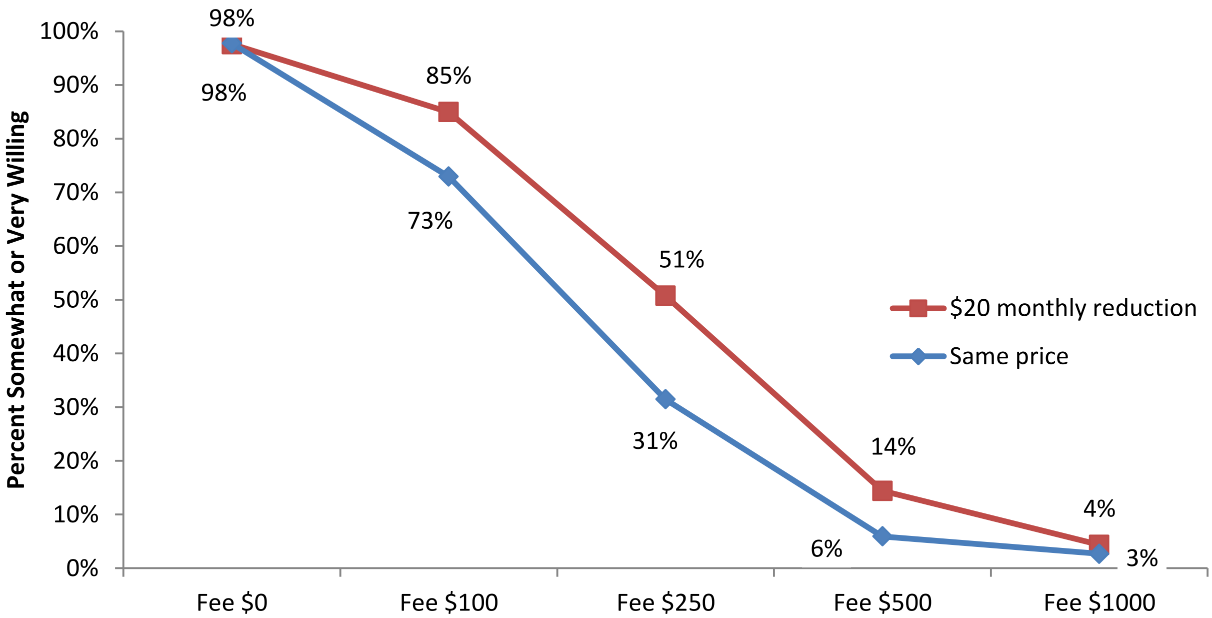
Figure 62: Importance of Internet Service Features



One potential financing model for a fiber optic network is to have consumers pay a one-time connection fee to hook-up to the network. Respondents were asked if they were willing to pay hookup fees of various levels for a very high-speed connection. They were also asked about their willingness to pay a one-time hookup fee if it also resulted in a reduction of $20 per month on their communications bill.

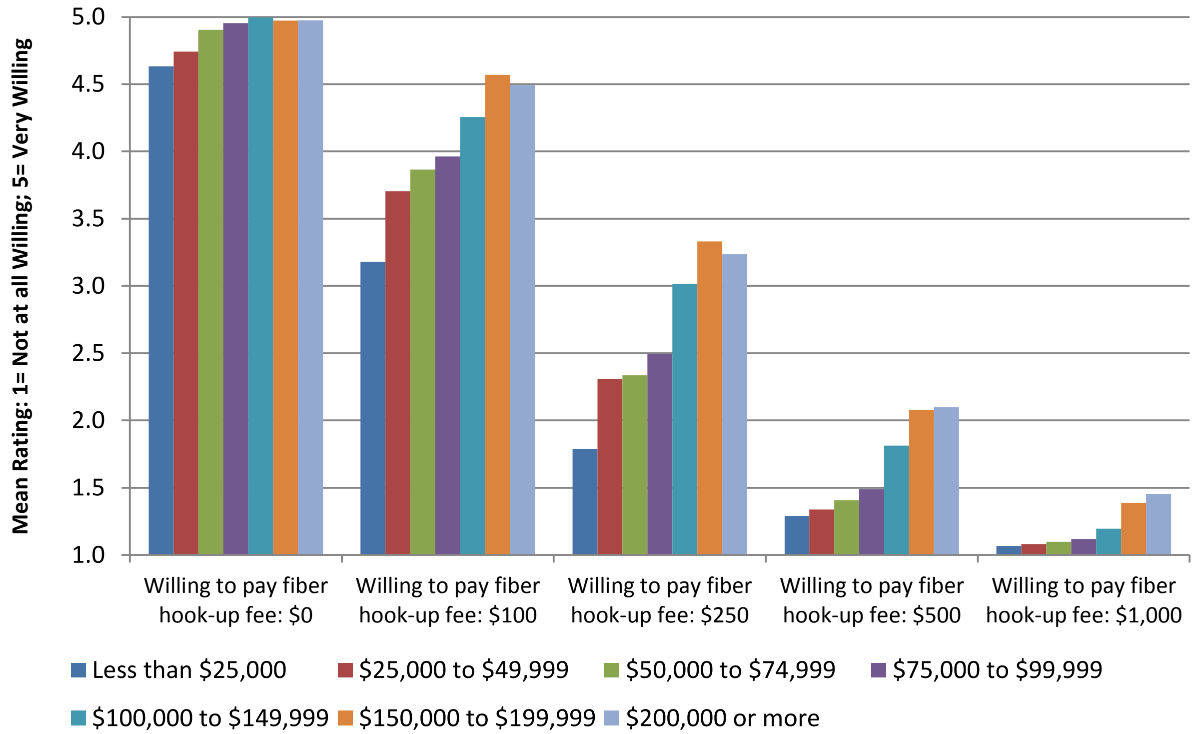
As illustrated in Figure 63, 73 percent of consumers are somewhat or very willing to pay a $100 fee for a very high-speed (fiber) connection and 31 percent are willing to pay a $250 fee. If the hook-up also included a $20 per monthly price reduction, those shares increase to 85 percent and 51 percent, respectively. Very few consumers are willing to pay a one-time hookup fee of $500, even with a monthly price reduction.

Figure 63: Willingness to Pay Hook-Up Fee for Very High Speed Internet



Respondents' willingness to pay a one-time hook-up fee for a very high speed Internet connection is correlated to household income, as illustrated in Figure 64.

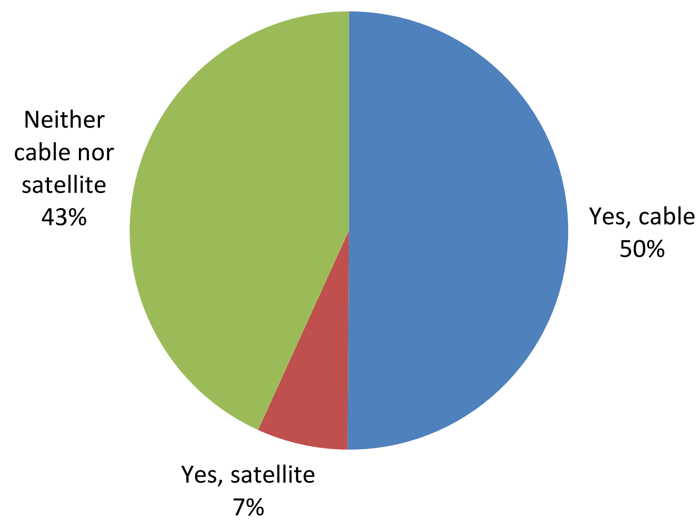
Figure 64: Willingness to Pay for Hook-Up by 2014 Household Income



7.1.2.2 Television and Telephone Services

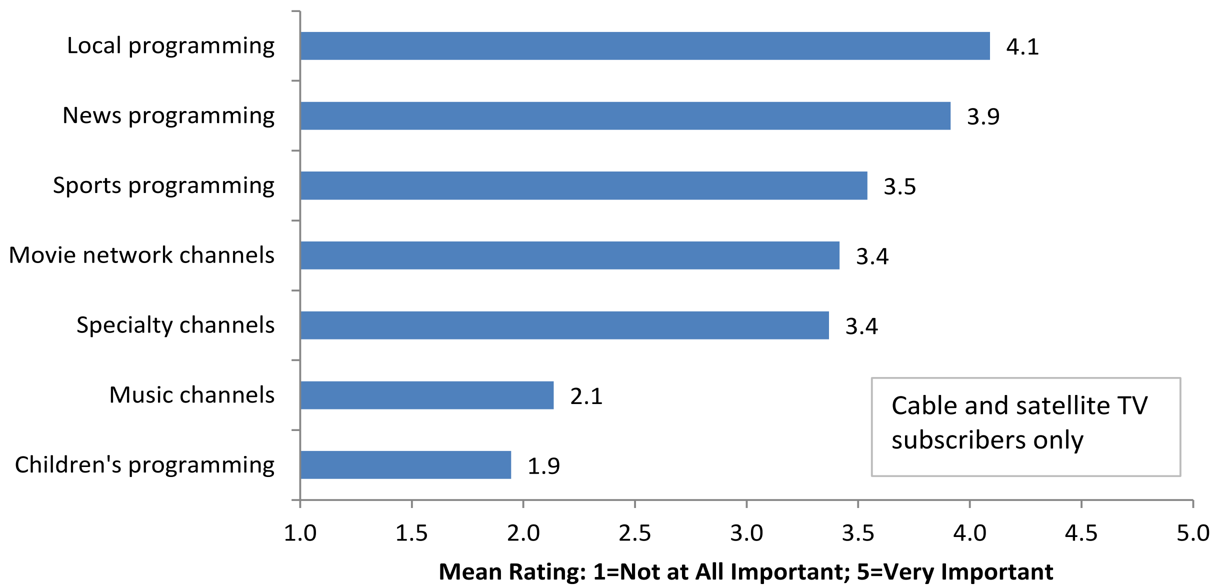
Respondents were asked about the television and telephone services currently purchased. As illustrated in Figure 65, one-half of homes subscribe to cable television service and seven percent have satellite television service. In perspective, 69 percent of respondents subscribed to Netflix, 62 percent to Amazon, and 31 percent to Hulu.

Figure 65: Home Television Service



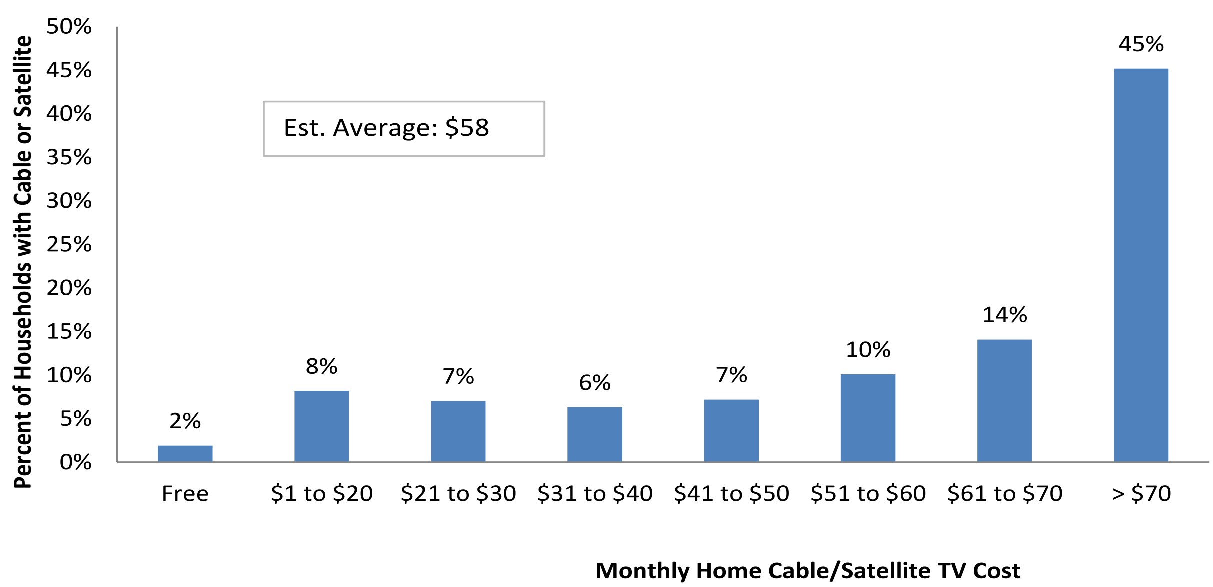
For those consumers with cable or satellite television, the most important aspect of television programming features is local programming, followed by news and sports programming.

Figure 66: Importance of Television Programming



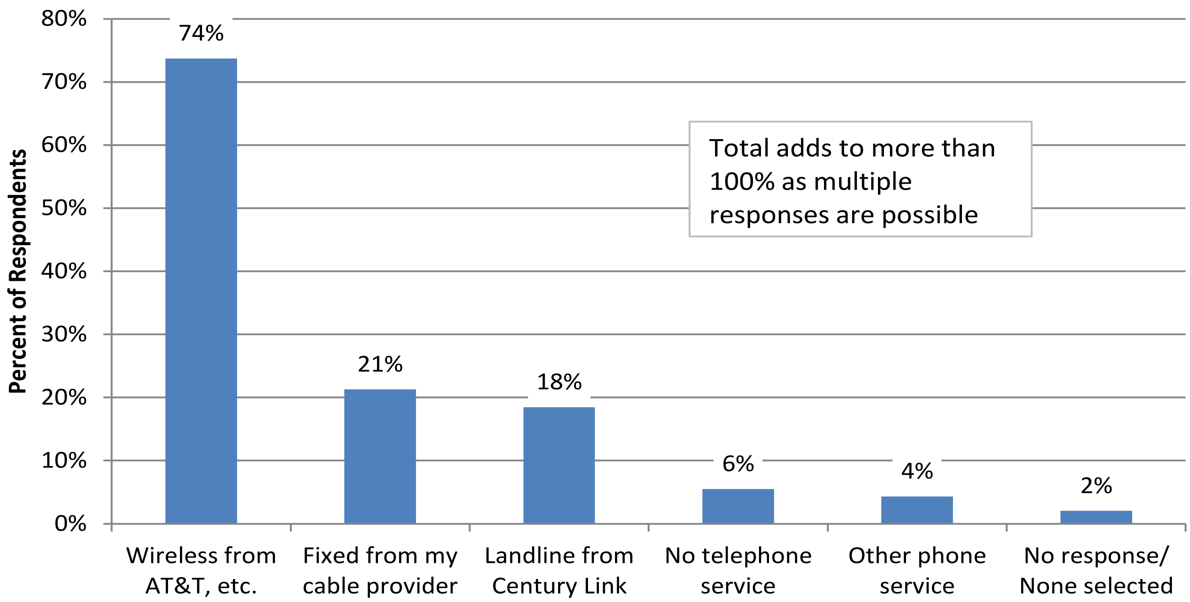
On average, cable and satellite television subscribers pay approximately $58 per month for service (the estimated averages of the two are statistically equivalent), with nearly half of subscribers paying more than $70 per month, as illustrated in Figure 67.

Figure 67: Cable or Satellite TV Monthly Price



Respondents were also asked about the telephone services purchased. Nearly three-fourths of respondents have a cell phone, while less than 40 percent had a form of landline telephone service (21 percent from telephone provider and 18 percent from cable provider). Six percent indicated that they do not have any telephone service (see Figure 68).

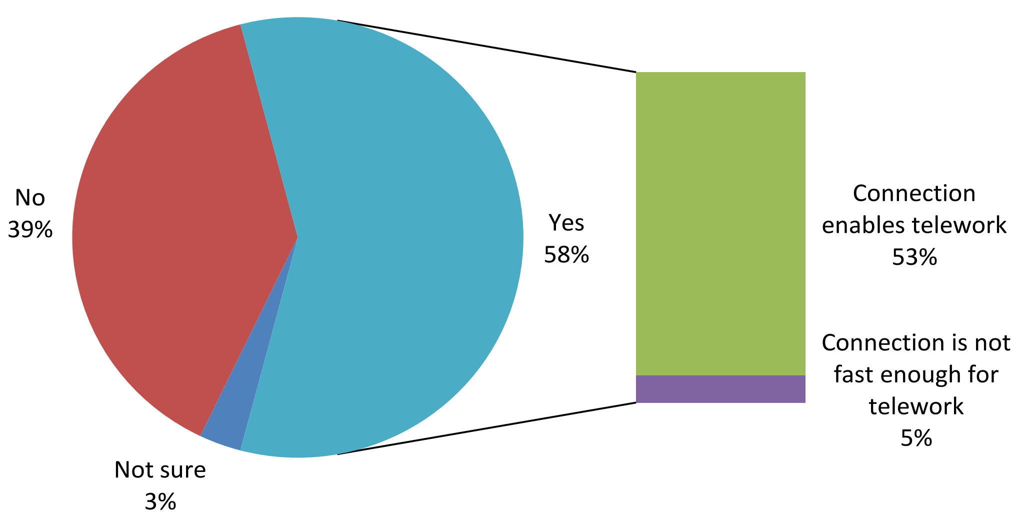
Figure 68: Telephone Services Purchased



7.1.2.3 Internet Use for Jobs/Careers

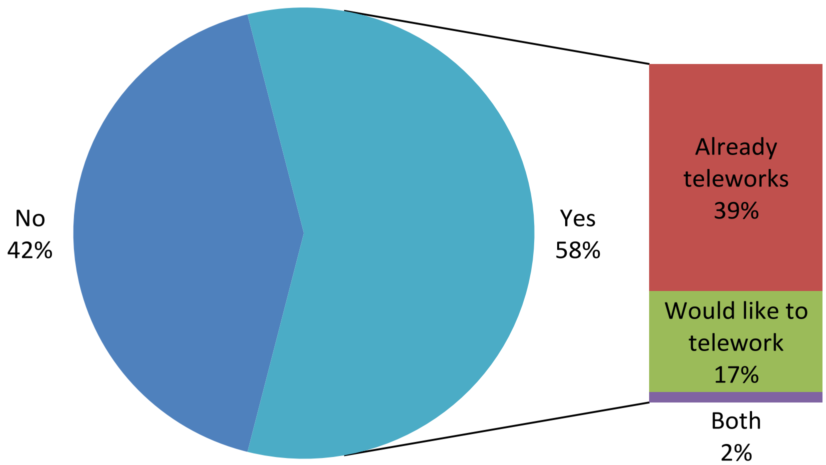
Over one-half of respondents indicated that a member of their family is allowed to telework by their employer. While 58 percent are allowed to telework, five percent indicated that their Internet connection was not fast enough to allow telework (see Figure 69).

Figure 69: Employer Allows Telework



Forty-one percent of respondents indicated that someone in their family already teleworks from home and another 19 percent would like to telework (two percent stated both). This indicates that a substantial additional share that would telecommute if their employer allowed it and if their connection were fast enough to enable telework (see Figure 70).

Figure 70: Current Telecommuting and Interest



One-third of respondents either have a home-based business or are planning to start one within the next three years, as illustrated in Figure 71. Of those who operated or were planning to start a home-based business, 78 percent indicated that a high-speed Internet connection is (or would be) very important to this business, as indicated in Figure 72.

Figure 71: Own or Plan to Start a Home-Based Business

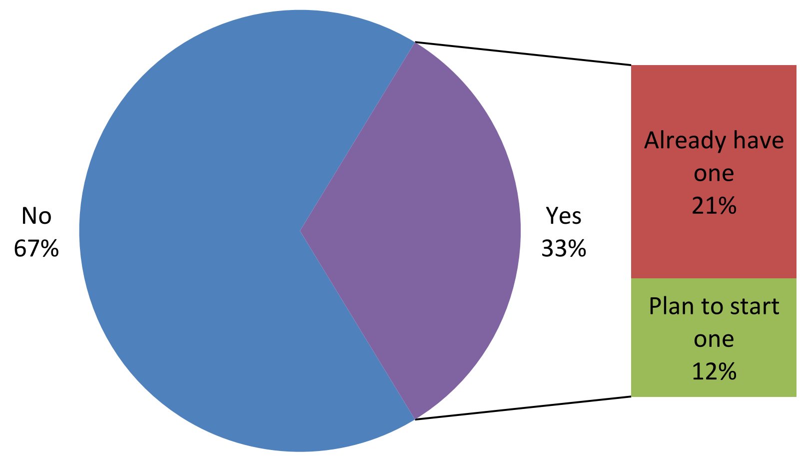
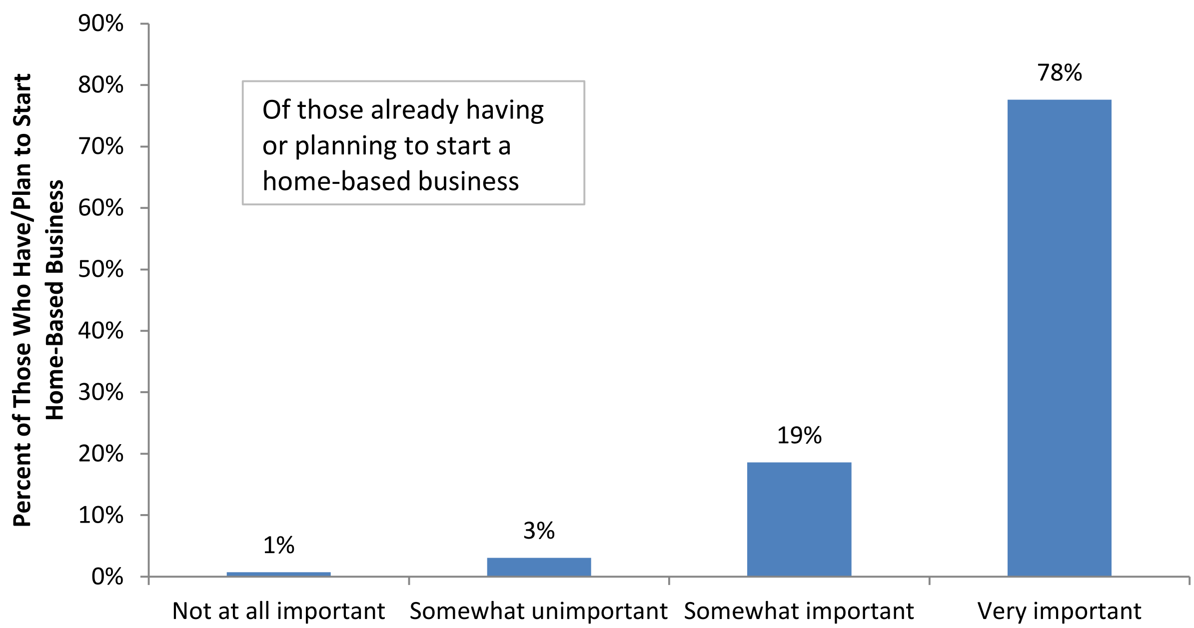


Figure 72: Importance of High-Speed Internet to Home Business



7.1.2.4 Role of the City

Respondents were asked their opinions about the City's role in providing or promoting broadband communications services within the City. The most favorable opinion was that the City should help ensure that all residents have access to competitively-priced broadband services. Respondents were also favorable toward ensuring that students and teachers had broadband access, the City should build a publicly-financed communications network, and the City should help provide broadband services to local non-profit organizations. Figure 73 illustrates the mean ratings while Figure 74 provides detailed responses to each portion of the question.

Figure 73: Opinions about the Role(s) for the City

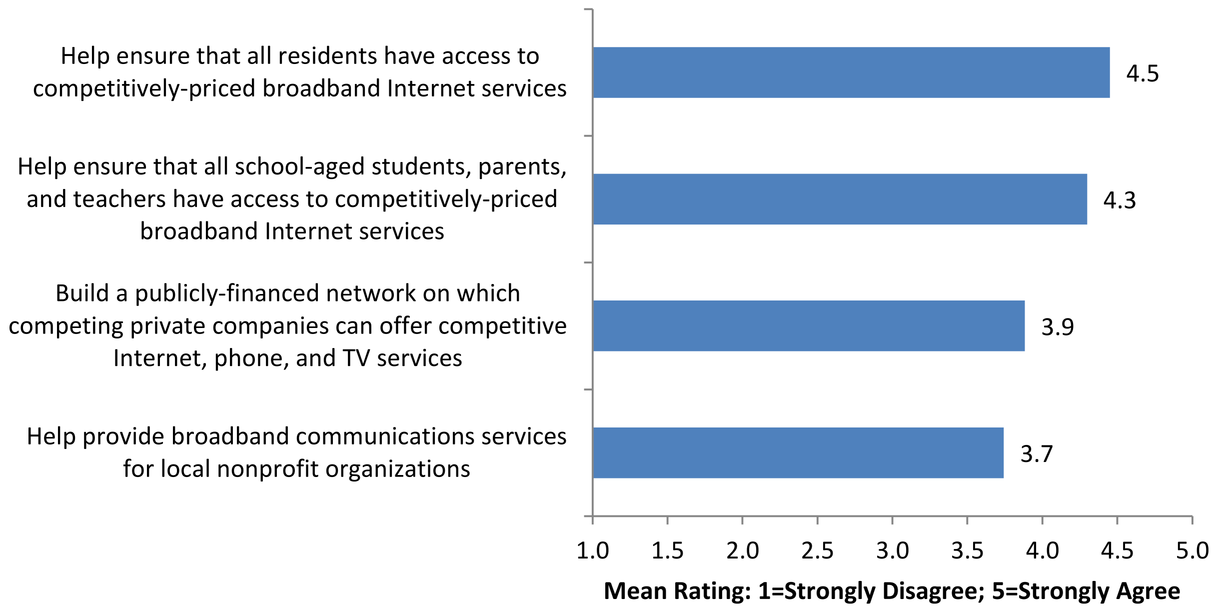
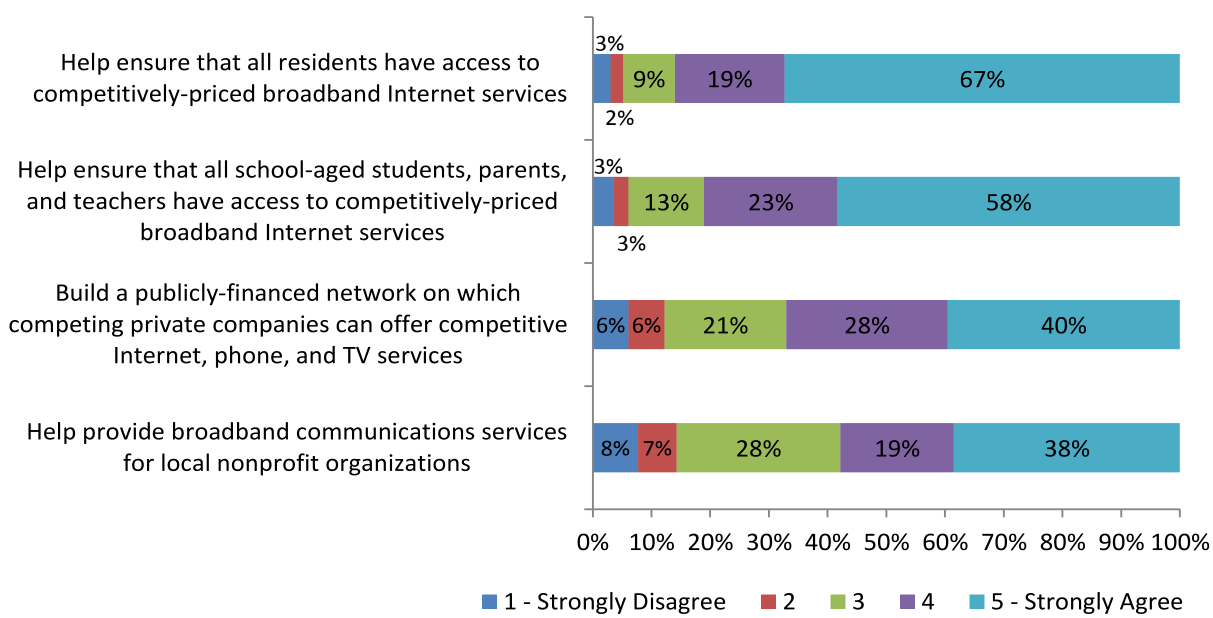


Figure 74: Detailed Opinions about the Role(s) for the City

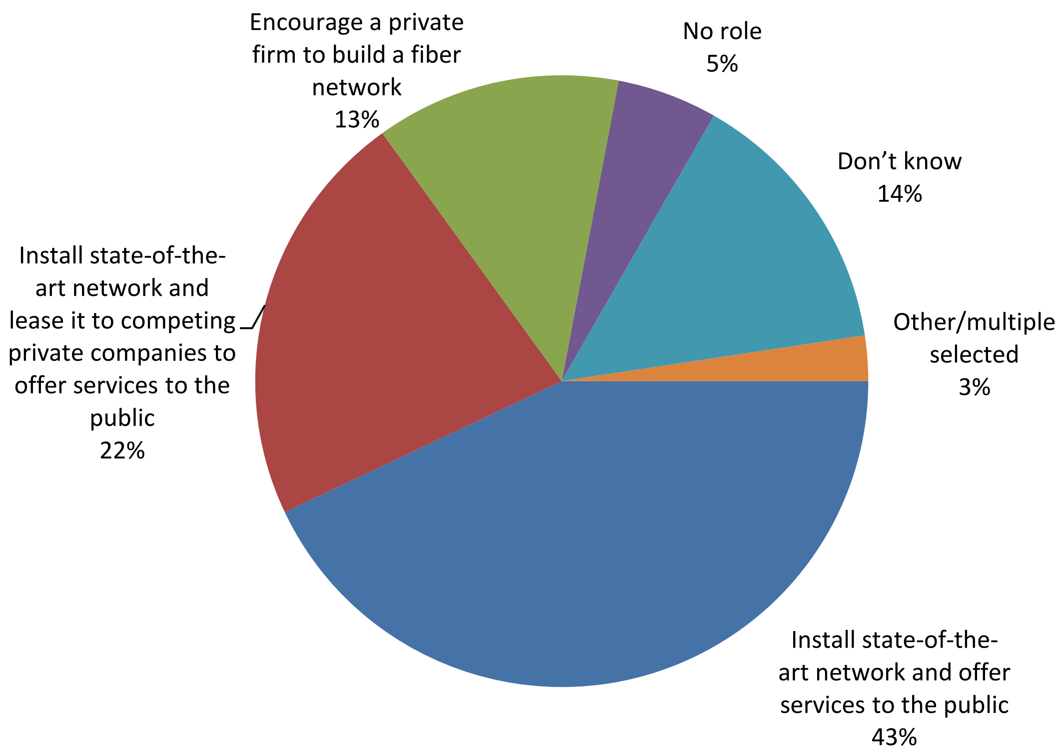


Respondents were also asked what the main role of the City should be with respect to broadband:

- 43 percent of respondents indicated that the City should install state-of-the-art network and offer services directly to the public.
- 22 percent of respondents indicated that the City should install state-of-the-art network and lease it to competing private companies to offer services to the public
- 13 percent of respondents indicated that the City should encourage a private firm to build a fiber network

Respondents were asked what the ***main*** role of the City should be with regards to Internet infrastructure and services. As illustrated in Figure 75, nearly two-thirds of respondents indicated that the City should install a state-of-the-art communications network. Nearly one-half of respondents thought the City should install a network and offer services to the public.[86] An additional 22 percent said that the City should build the communications network and lease it to competing companies to offer services to the public. Thirteen percent thought the City should encourage a private firm to build a communications network and only five percent thought the City should play no role.

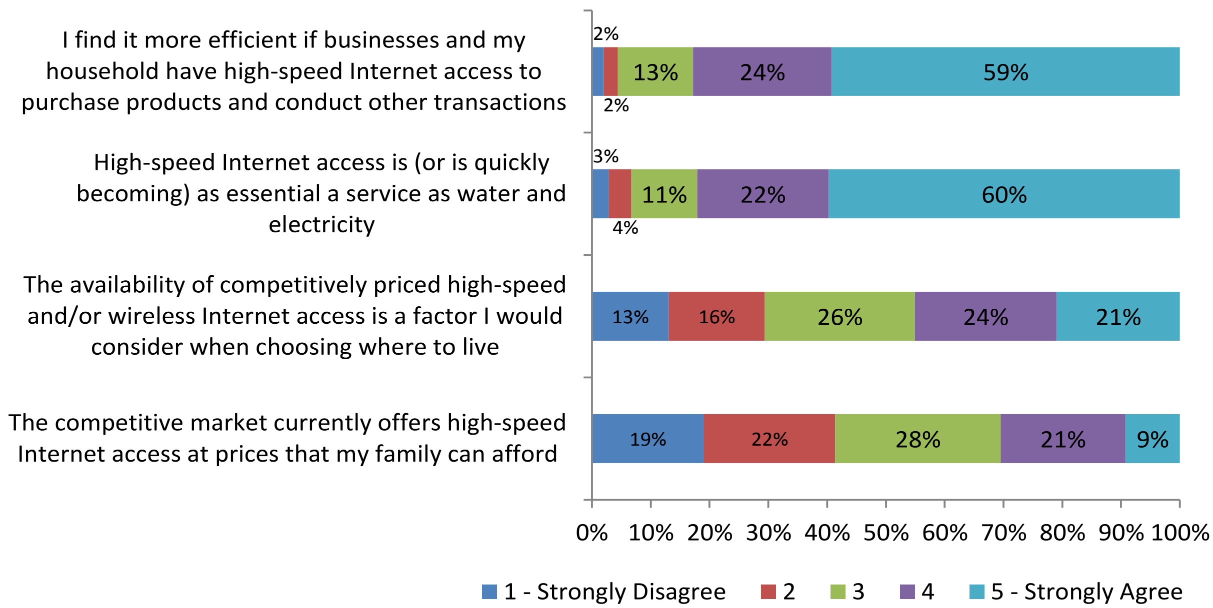
Figure 75: Main Role of the City



[86] These numbers indicate that residents support public ownership of infrastructure with no distinction between support for wholesale versus retail services.

Respondents were asked general questions about their use and value of high-speed Internet services. More than one-half strongly agreed that high-speed Internet is an essential service and that high-speed Internet enables business efficiency. Much smaller shares thought that the market currently provides high-speed Internet at prices they can afford or that the availability of high-speed Internet is a factor they consider when choosing where to live, as illustrated in Figure 76.

Figure 76: Opinions about Broadband Internet



These responses indicate a relatively clear signal about residents' desire to have a state-of-the-art communications network and for the City to play some role in its installation. It should be noted that this question did not specifically ask about how that network should be financed or funded. Questions regarding consumers' willingness to pay monthly fees or hook-up costs for access to that network were presented previously.

7.1.2.5 Household Information

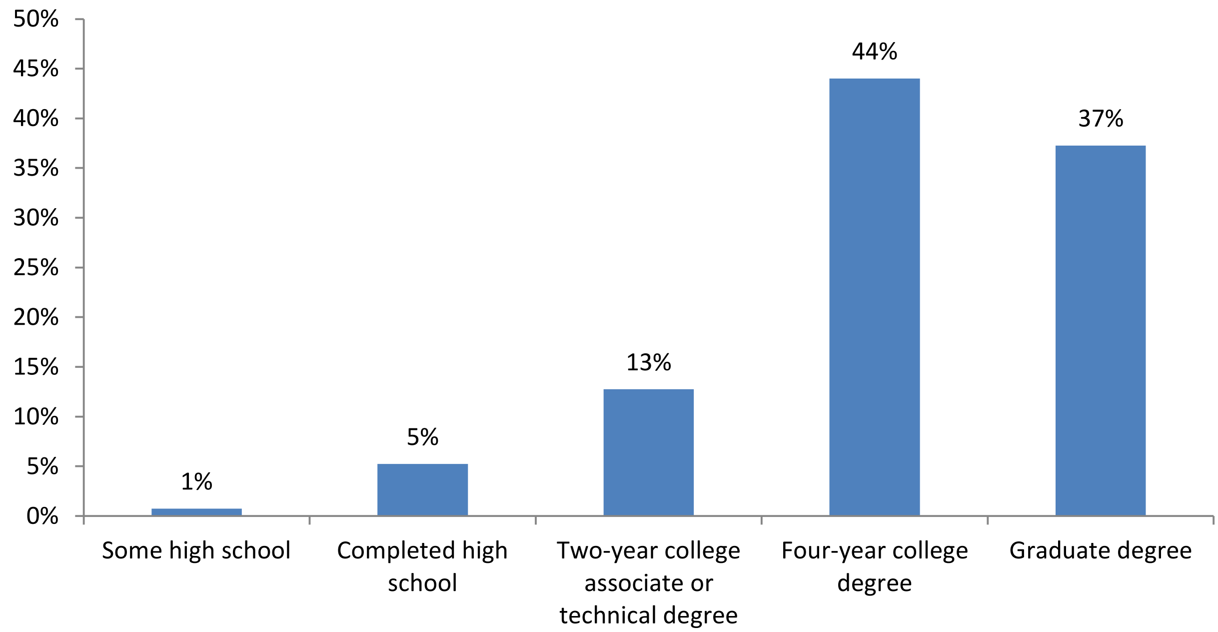
Basic demographic information was gathered from survey respondents and is summarized in this section. Selected correlations between this information and key survey questions were presented previously in this report.

Slightly more than one-half (55 percent) of respondents were male.

As indicated previously regarding age-weighting and in Figure 40, disproportionate shares of survey respondents were in the older age cohorts relative to the City's adult population as a whole. Approximately 41 percent of survey respondents were age 55 or older compared to only 27 percent of the population. Conversely, only 20 percent of survey respondents were under age 35 compared to 36 percent of Seattle's population. The survey results have been adjusted to account for these differences, as discussed earlier in this report.

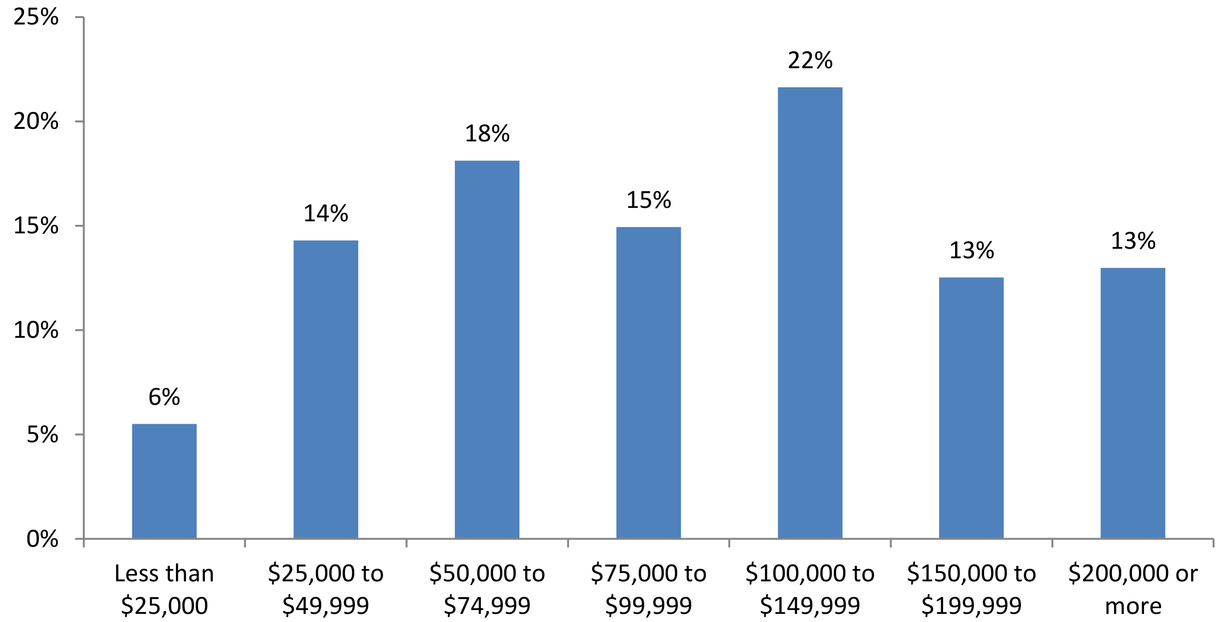
The group of respondents was highly educated, with 37 percent having a graduate degree and another 44 percent of respondents having a Bachelor's degree (without a graduate degree) as illustrated in Figure 77.

Figure 77: Respondents' Highest Level of Education



Household income was widely distributed across the available brackets, with approximately one-fourth earning $150,000 or more and 20 percent earning less than $50,000 as shown in Figure 78.

Figure 78: 2014 Household Income



Nearly two-thirds (64 percent) of survey respondents owned their home while 36 percent rented.

7.2 Business Survey

The City of Seattle business survey was conducted through SurveyMonkey and was distributed by the City's Office of Economic Development (OED). The survey was circulated through distribution lists and publications including the OED Digest, Startup Seattle, the Bottom Line Blog, the Only in Seattle newsletter, and Tech Talk Seattle. The OED also employed assistance from its business partners—the Seattle Chamber, the Downtown Seattle Association, Visit Seattle, and Economic Development Council of Seattle-King County.[87]

Despite numerous efforts to elicit significant response, including extending the survey deadline, we received only 112 total responses. The margin of error is high with so few responses, making accurate analysis difficult. However, though there are limitations, we were able to gather insight from the business survey and compare trends to those in the residential survey.[88]

Consistent with the residential survey response, the majority of respondents to the business survey claim to purchase Internet service for their business location.

[87] Based on conversations with City staff.

[88] The information presented here is not based on statistically valid data because of the low response rate to the business survey; these are insights into seeming trends based on the survey responses we did receive.

Three key responses from the business surveys seem to support our recommendations for providing niche service to residential and small business customers:

- It seems reliability of connection is the most important factor for business survey respondents, with speed and price of service close behind.
- Most business respondents answered that they pay somewhere between $50 and $199 for their current connection.
- Less than a quarter of respondents to the business survey claim that their Internet connection speed is fast enough for their business needs.

The majority of respondents represented single location businesses with 1-49 employees in facilities of 0-2,499 square feet—small businesses. We recommend that the City focus its efforts on residential and small business customers, and based on the information above, there may be a reasonable demand for services within the small business sector.

Some respondents seem dissatisfied with the reliability of their connection, and a larger sample size might help to understand the true satisfaction with services. But the above seems to uphold the City's potential success in serving these customers—they are already paying close to the target suggested small business price for services with many unhappy with current speeds. The City may find that small businesses are very willing to pay $85 per month for a reliable 1 Gbps connection.

Appendix E – Residential Survey Tables shows tables for the business survey.

8 Financial Projections

We intended to produce four separate models to outline financial projections:

1) Construction in SCL power space, given market penetrations estimated by the surveys
2) Construction in SCL power space, given market penetrations necessary for cash flow
3) Construction in communications space, given market penetrations estimated by the surveys
4) Construction in communications space, given market penetrations necessary for cash flow

Coincidentally, it happened to work out that construction in the power space market share projections estimated from the surveys is equal to the market share needed for cash flow. So we ended up with three models, which we summarize here.

We separately considered a property tax funded utility model, which assumes construction in the SCL power space. In this model, construction costs would be covered by a voter-approved (60 percent) property tax levy.

Our projections do not extend beyond 20 years, which is typically the expected life of fiber. Table 26 shows the total anticipated cost for each model.

Table 26: Total FTTP Cost Estimate for Each Construction and Financial Model

Financial Model	Total Cost
Construction in SCL power space	$463,114,020
Construction in communications space based on market penetrations projected by survey results	$600,201,920
Construction communications space based on market penetrations necessary for cash flow	$630,101,380
Property tax funded utility model (assumes construction in SCL power space)	$463,114,020

The monthly service fee is a primary driver of our financial projections. We suggest charging $75 per month for residential customers and $85 per month for small business customers for a 1 Gbps data-only offering. We do not recommend offering any other services at this time.

8.1 Financing Costs

Our models assume that bonding will be necessary but do not rely on internal loans. We expect that the City will seek a 10-year bond as well as a 20-year bond. Principal repayment on a 10-year bond will start in year two while for a 20-year bond it will start in year 3. We assume that the bond issuance costs are equal to 1.0 percent of the principal borrowed. For each bond, a debt service reserve account is maintained at 5.0 percent of the total issuance amount. An interest reserve account equal to years 1 and 2 interest expense is maintained for the first two years. We assume a 4 percent finance rate on a 10-year bond and a 4.25 percent finance rate for a 20-year bond.

The models assume a straight line depreciation of assets and that the outside plant and materials will have a 20 year life span while network equipment will need to be replaced after seven years. Last mile and customer premises equipment as well as other miscellaneous implementation costs will need to be accounted for after five years. Network equipment will be replaced or upgraded at 100 percent of its original cost, miscellaneous implementation costs will be at 80 percent, and last mile and customer premises equipment will be at 50 percent. Our models all plan for a depreciation reserve account starting in year four—this funds future electronics replacements and upgrades.

8.2 Summary of Assumptions Consistent Across All Models

Key annual operating and maintenance assumptions that will remain consistent in all the models we present are:

- Salaries and benefits are based on estimated market wages. See Table 31 for a list of staffing requirements. Benefits are estimated at 35 percent of base salary.
- Insurance is estimated to be $200,000 in year 1 and $400,000 in year 2 through 20.
- Utilities are estimated to be $36,000 in year 1 and $72,000 in year 2 through 20.
- Office expenses are estimated to be $36,000 in year 1 and $60,000 in year 2 through 20.
- Facility lease fees are estimated to be $120,000 in year 1 and $240,000 in year 2 through 20.
- Locates and ticket processing are estimated to start in year 2 at $280,000 and increase to $561,000 in year 3 through 20.
- Contingency is estimated to be $200,000 in year 1, $400,000 in year 2, and $600,000 in year 3 through 20.
- Legal fees are estimated to be $750,000 in year 1, $500,000 in year 2, and then are reduced to $250,000 in years 3 through 20.
- Consulting fees are estimated at $500,000 in years 1 and 2, and $200,000 in years 3 through 20.
- Marketing and promotional expenses are estimated to be $2,400,000 in years 1 and 2, and $1,200,000 in years 3 through 20.

Annual variable and operating expenses not including DIA also remain consistent across all models:

- Education and training are calculated as four percent of direct payroll expense.
- Customer handholding is estimated to be 10¢ per subscriber per month.
- Customer billing (incremental) is estimated to be 5¢ per bill per month.
- Allowance for bad debts is computed as 1.0 percent of revenues.
- Churn is anticipated to be 2.5 percent annually.
- In addition to fiber technician staffing, fiber maintenance costs are 0.5 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.

8.3 Operating and Maintenance Expenses

Facilities: The addition of new staff and inventory requirements will require allocation of office and warehousing space:

- Expand office facilities for management, technical and clerical staff
- Expand retail "storefront" to facilitate customer contact and enhance their experience with doing business with the Broadband Utility.
- Provide warehousing for receipt and storage of cable and hardware for the installation and on-going maintenance of the broadband infrastructure
- Establish location to house servers, switches, routers, and other core-network equipment

Training: Training of existing staff is important to fully realize the economies of starting the Broadband Utility. If the City opts to keep the Broadband Utility within its organization, this training is especially important for electric customer service representatives, account managers, and other staff that deal directly with the taxpayers or electric ratepayers—even if they will not be directly assigned to the Broadband Utility. If the City opts to create a standalone enterprise, the training will be particularly important in the short-term as the Broadband Utility establishes itself as a unique entity.

Billing and Collections: The City already has billing software and capabilities, and the Broadband Utility can save money by using these if it becomes an internal City department. However, if the Broadband Utility becomes a standalone entity, these costs will increase unless the City opts to allocate existing resources for these purposes. The estimated incremental cost of billing for the new broadband utility is five cents per bill. In addition, we have included $250,000 for upgrade or purchase of a billing module and a $50,000 set-up fee.

Marketing and Sales: It is important to be proactive in setting customer expectations, addressing security concerns, and educating the customers on how to initiate services.

Staffing Levels: Skills in the following disciplines are 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 regardless of whether the Broadband Utility stays "in house" at the City or becomes a standalone entity. The initial additional positions, staffing levels and base salaries are shown in Table 31, Table 36, and Table 41. These numbers assume that 24x7 customer service representative support is provided (three shifts) and two shifts of customer technicians are available. Changing the support to 7am to 8pm (or other reduced hours) will decrease the required number of staff.

8.4 Partnership with Seattle City Light to Construct in Power Space

In this section, we show various expenses based on the assumption that construction will occur in SCL's power space. The benefits of fostering a positive relationship with SCL will be significant in cost savings alone, and there will likely be other benefits that go beyond the quantifiable.

Peering costs are estimated to be $33,100 in year 1, $168,100 in year 2, and $302,900 in years 3 through 20.

Our analysis estimates total financing requirements to be $504,010,000 for the retail model if the network is constructed in the SCL power space. For financing, we assume two bonds.[89]

- A 10-year $24,010,000 bond[90] to be issued in two disbursements:
    - $18,010,000 in year 1
    - $6,000,000 in year 2

  This bond is issued at an interest rate of 4 percent and is paid off over the 10-year bond repayment period. Further we assume that principal payments do not start until year 2.

- We assume a 20-year bond in a total amount of $480,000,000 to be issued over the course of three years:

[89] 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 in the business planning phase.

[90] Experience suggests that the financial community is unlikely to offer the required bonding based on the projected voice, video and data revenues. Securing the bonds through existing revenue streams (water utility, sales tax, other) or through the general obligation of the City may be required (see Section 4.4).

- $220,000,000 in year 1
- $230,000,000 in year 2
- $30,000,000 in year 3

As we noted, this bond is issued a 4.25 percent finance rate and principal payments start in year 3.

Table 27 shows operating expenses for years 1, 5, 10, 15, and 20 for construction in the SCL power space. Some of these expenses will remain constant while others will increase as the network matures and the customer base increases.

Table 27: Operating Expenses – Network Constructed in SCL Power Space

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$200,000	$400,000	$400,000	$400,000	$400,000
Utilities	36,000	72,000	72,000	72,000	72,000
Office Expenses	36,000	60,000	60,000	60,000	60,000
Facility Lease	120,000	240,000	240,000	240,000	240,000
Locates & Ticket Processing	-	561,000	561,000	561,000	561,000
Peering	33,100	302,900	302,900	302,900	302,900
Contingency	200,000	600,000	600,000	600,000	600,000
Billing Maintenance Contract	-	-	-	-	-
Fiber & Network Maintenance	846,820	1,693,650	1,693,650	1,693,650	1,693,650
Vendor Maintenance Contracts	-	630,000	630,000	630,000	630,000
Legal and Lobby Fees	750,000	250,000	250,000	250,000	250,000
Planning	-	-	-	-	-
Consulting	500,000	200,000	200,000	200,000	200,000
Marketing	2,400,000	1,200,000	1,200,000	1,200,000	1,200,000
Education and Training	204,120	890,460	983,140	1,085,460	1,198,440
Customer Handholding	13,230	121,140	121,140	121,140	121,140
Customer Billing (Unit)	6,610	60,570	60,570	60,570	60,570
Allowance for Bad Debts	117,160	915,280	915,280	915,280	915,280
Churn (acquisition costs)	82,680	757,130	757,130	757,130	757,130
PSTN Connection Fee					
Internet	206,310	1,710,160	1,710,160	1,710,160	1,710,160
Sub-Total	$5,752,030	$10,664,290	$10,756,970	$10,859,290	$10,972,270
Labor Expenses	$5,186,070	$22,564,250	$24,881,240	$27,439,390	$30,263,790
Attachment Fees	$263,180	$263,180	$263,180	$263,180	$263,180
Sub-Total	$5,449,250	$22,827,430	$25,144,420	$27,702,570	$30,526,970
Total Expenses	$11,201,280	$33,491,720	$35,901,390	$38,561,860	$41,499,240
Principal and Interest	$10,070,400	$41,920,450	$41,920,450	$38,691,270	$20,151,700
Facility Taxes	$389,700	$3,544,860	$3,544,860	$3,544,860	$3,544,860
Sub-Total	$10,460,100	$45,465,310	$45,465,310	$42,236,130	$23,696,560
Total Expenses, P&I, and Taxes	$21,661,380	$78,957,030	$81,366,700	$80,797,990	$65,195,800

The income statement for construction in SCL's power space is shown in Table 28.

Table 28: Income Statement – Network Constructed in SCL Power Space

	Year 1	Year 5	Year 10	Year 15	Year 20
Revenues					
Internet - Residential	$8,868,600	$85,818,600	$85,818,600	$85,818,600	$85,818,600
Internet - Business	1,193,400	5,708,940	5,708,940	5,708,940	5,708,940
Connection Fee (net)	1,653,600	-	-	-	-
Assessments	-	-	-	-	-
Ancillary Revenues	-	-	-	-	-
Total	$11,715,600	$91,527,540	$91,527,540	$91,527,540	$91,527,540
Content Fees					
Internet	$206,310	$1,710,160	$1,710,160	$1,710,160	$1,710,160
Total	$206,310	$1,710,160	$1,710,160	$1,710,160	$1,710,160
Operating Costs					
Operation Costs	$5,545,720	$8,954,130	$9,046,810	$9,149,130	$9,262,110
Labor Costs	5,186,070	22,564,250	24,881,240	27,439,390	30,263,790
Pole Attachment Expense	263,180	263,180	263,180	263,180	263,180
Total	$10,994,970	$31,781,560	$34,191,230	$36,851,700	$39,789,080
EBITDA	$514,320	$58,035,820	$55,626,150	$52,965,680	$50,028,300
Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
Operating Income (EBITDA less Depreciation)	($13,009,600)	$17,236,260	$24,866,670	$22,206,200	$19,268,820
Non-Operating Income					
Interest Income	$0	$119,780	$119,780	$117,870	$145,980
Interest Expense (10 Year Bond)	(720,400)	(124,200)	(124,200)	-	-
Interest Expense (20 Year Bond)	(9,350,000)	(13,714,770)	(13,714,770)	(7,936,540)	(821,530)
Interest Expense (Loan)	-	-	-	-	-
Total	($10,070,400)	($13,719,190)	($13,719,190)	($7,818,670)	($675,550)
Net Income (before taxes)	($23,080,000)	($1,094,540)	$11,777,480	$15,017,530	$19,223,270
Facility Taxes	$389,700	$3,544,860	$3,544,860	$3,544,860	$3,544,860
Net Income	(23,469,700)	($4,639,400)	$8,232,620	$11,472,670	$15,678,410

Table 29 shows the cash flow statement for network construction in the SCL power space.

Table 29: Cash Flow Statement – Network Constructed in SCL Power Space

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	($23,469,700)	($4,639,400)	$8,232,620	$11,472,670	$15,678,410
Cash Flow	$3,923,040	$1,084,320	($2,931,150)	($2,364,350)	$13,265,950
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Principal Payments	$0	$22,835,970	$28,081,480	$30,754,730	$19,330,170
Interest Payments	10,070,400	19,084,480	13,838,970	7,936,540	821,530
Total Debt Service	$10,070,400	$41,920,450	$41,920,450	$38,691,270	$20,151,700
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Unrestricted Cash Balance	$3,923,040	$23,277,580	$8,285,030	$1,894,460	($118,240)
Funded Depreciation	-	24,272,970	22,710,680	21,946,730	33,192,280
Restricted Cash Balance (Interest Reserve)	10,070,400	-	-	-	-
Restricted Cash Balance (Debt Service Reserve)	11,900,500	25,200,500	25,200,500	25,200,500	25,200,500
Total Cash Balance	$25,893,940	$72,751,050	$56,196,210	$49,041,690	$58,274,540

Significant network expenses are incurred in the first few years during the construction phase of the network. These costs—known as “capital additions”—represent the equipment and labor expenses associated with building, implementing, and lighting a fiber network. Table 30 shows these costs for construction in SCL’s power space.

Table 30: Capital Additions – Network Constructed in SCL Power Space

Capital Additions	Year 1	Year 2	Year 3	Total Years 1 to 3
Network Equipment				
Headend- Data	$18,014,250	$6,004,750	$0	$24,019,000
Total	$18,014,250	$6,004,750	$0	$24,019,000
Outside Plant and Facilities				
Total Backbone and FTTP	$169,364,850	$169,364,850	$0	$338,729,700
Additional Annual Capital	-	-	-	-
Total	$169,364,850	$169,364,850	$0	$338,729,700
Last Mile and Customer Premises Equipment				
CPE Gbps Commercial	$1,141,920	$2,158,910	$2,161,840	
CPE Residential & Small Commercial	$5,121,720	$22,240,570	$22,198,990	$49,561,280
Enterprise CPE and Drop	-	-	-	-
IP Telephone Adapter (2 telephones)	-	-	-	-
Average Drop Cost	4,951,440	20,212,690	20,178,110	45,342,240
Total	$11,215,080	$44,612,170	$44,538,940	$100,366,190
Miscellaneous Implementation Costs				
Splicing	$250,000	$0	$0	
Vehicles	300,000	-	-	
Emergency Restoration Kit	50,000	-	-	
Work Station, Computers, and Software	$96,000	$210,000	$186,000	$492,000
Fiber OTDR and Other Tools	150,000	-	-	150,000
Generators & UPS	100,000	-	-	100,000
Billing Software	250,000	-	-	250,000
Additional Annual Capital	-	-	-	-
Total	$1,196,000	$210,000	$186,000	$1,592,000
Total Capital Additions	$199,790,180	$220,191,770	$44,724,940	$464,706,890

Table 31 shows labor expenses assuming the network is constructed in the SCL power space. Benefits are calculated at 35 percent of base salary. We project that 48 total employees will be necessary in year 1, this will increase to 153 in year 2, and will be 246 from year 3 through 20. This assumes 11,024 customers in year 1; 56,026 in year 2; and 100,951 in year 3 and on. It is also assumed the required human resource support will be conducted by existing City staff.

The total direct labor cost in year 1 is projected to be $5,103,000; $13,810,500 in year 2, and $20,574,000 from year 3 on. It is also assumed the required human resource support will be conducted by existing City staff.

Table 31: Labor Expenses – Network Constructed in SCL Power Space

Position	Year 1	Year 2	Year 3	Year 4	Year 5+	Year 1 Salary
Business/Finance Manager	1.00	1.00	1.00	1.00	1.00	$170,000
Market & Sales Manager	1.00	1.00	1.00	1.00	1.00	$120,000
Broadband Service Engineer	1.00	2.00	2.00	2.00	2.00	$120,000
Customer Service Representative	5.00	23.00	41.00	41.00	41.00	$50,000
Service Technicians/Installers & IT Support	5.00	23.00	41.00	41.00	41.00	$70,000
Sales and Marketing Representative	10.00	10.00	10.00	10.00	10.00	$75,000
Call Center Support (multiple shifts to provide 24x7 support)	14.00	71.00	128.00	128.00	128.00	$50,000
Fiber Plant O&M Technicians	11.00	22.00	22.00	22.00	22.00	$120,000
Total	48.00	153.00	246.00	246.00	246.00	
Total Customers	11,024	56,026	100,951	100,951	100,951	
Customers per Employee	230	366	410	410	410	
Total Salaries	$3,780,000	$10,230,000	$15,240,000			
Total Direct Labor Cost (Salary Plus Benefits)	**$5,103,000**	**$13,810,500**	**$20,574,000**			

8.5 Construction in Communications Space Given Market Survey Projections

Some of the financial projections are based on results of the business and residential surveys we conducted as part of our market research (see Section 7).

Peering costs are estimated to be $33,100 in year 1, $168,100 in year 2, and $302,900 in years 3 through 20. Our analysis estimates total financing requirements to be $662,350,000 for the retail model if the network is constructed in the SCL power space. For financing, we assume two bonds.[91]

- A 10-year $27,350,000 bond[92] to be issued in two disbursements:
  - $20,510,000 in year 1
  - $6,840,000 in year 2

[91] 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 in the business planning phase.

[92] Experience suggests that the financial community is unlikely to offer the required bonding based on the projected voice, video and data revenues. Securing the bonds through existing revenue streams (water utility, sales tax, other) or through the general obligation of the City may be required (see Section 4.4).

This bond is issued at an interest rate of 4 percent and is paid off over the 10-year bond repayment period. Further we assume that principal payments do not start until year 2.

- We assume a 20-year bond in a total amount of $635,000,000 to be issued over the course of three years:
    - $295,000,000 in year 1
    - $315,000,000 in year 2
    - $25,000,000 in year 3

  As we noted, this bond is issued a 4.25 percent finance rate and principal payments start in year 3.

Table 32 shows operating expenses for years 1, 5, 10, 15, and 20 for construction in the communications space based on market survey projections. Some of these expenses will remain constant while others will increase as the network matures and the customer base increases.

Table 32: Operating Expenses – Construction in Communications Space Based on Market Survey Projections

Operating Expenses					
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Insurance	$200,000	$400,000	$400,000	$400,000	$400,000
Utilities	36,000	72,000	72,000	72,000	72,000
Office Expenses	36,000	60,000	60,000	60,000	60,000
Facility Lease	120,000	240,000	240,000	240,000	240,000
Locates & Ticket Processing	-	561,000	561,000	561,000	561,000
Peering	33,100	302,900	302,900	302,900	302,900
Contingency	200,000	600,000	600,000	600,000	600,000
Billing Maintenance Contract	-	-	-	-	-
Fiber & Network Maintenance	1,181,210	2,362,430	2,362,430	2,362,430	2,362,430
Vendor Maintenance Contracts	-	732,000	732,000	732,000	732,000
Legal and Lobby Fees	750,000	250,000	250,000	250,000	250,000
Planning	-	-	-	-	-
Consulting	500,000	200,000	200,000	200,000	200,000
Marketing	2,400,000	1,200,000	1,200,000	1,200,000	1,200,000
Education and Training	186,300	851,890	940,560	1,038,450	1,146,540
Customer Handholding	13,230	121,140	121,140	121,140	121,140
Customer Billing (Unit)	6,610	60,570	60,570	60,570	60,570
Allowance for Bad Debts	117,160	915,280	915,280	915,280	915,280
Churn (acquisition costs)	82,680	757,130	757,130	757,130	757,130
PSTN Connection Fee	-	-	-	-	-
Internet	206,310	1,710,160	1,710,160	1,710,160	1,710,160
Sub-Total	$6,068,600	$11,396,500	$11,485,170	$11,583,060	$11,691,150
Labor Expenses	$4,740,570	$21,600,170	$23,816,820	$26,264,180	$28,966,260
Attachment Fees	263,180	263,180	263,180	263,180	263,180
Sub-Total	$5,003,750	$21,863,350	$24,080,000	$26,527,360	$29,229,440
Total Expenses	$11,072,350	$33,259,850	$35,565,170	$38,110,420	$40,920,590
Principal and Interest	$13,357,900	$54,863,700	$54,863,700	$51,185,320	$25,794,180
Facility Taxes	389,700	3,544,860	3,544,860	3,544,860	3,544,860
Sub-Total	$13,747,600	$58,408,560	$58,408,560	$54,730,180	$29,339,040
Total Expenses, P&I, and Taxes	$24,819,950	$91,668,410	$93,973,730	$92,840,600	$70,259,630

The income statement for construction in the communications space given market projections is shown in Table 33.

Table 33: Income Statement – Construction in Communications Space Given Market Survey Projections

	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Internet - Residential	$8,868,600	$85,818,600	$85,818,600	$85,818,600	$85,818,600
Internet - Business	1,193,400	5,708,940	5,708,940	5,708,940	5,708,940
Connection Fee (net)	1,653,600	-	-	-	-
Assessments	-	-	-	-	-
Ancillary Revenues	-	-	-	-	-
Total	$11,715,600	$91,527,540	$91,527,540	$91,527,540	$91,527,540
b. Content Fees					
Internet	$206,310	$1,710,160	$1,710,160	$1,710,160	$1,710,160
Total	$206,310	$1,710,160	$1,710,160	$1,710,160	$1,710,160
c. Operating Costs					
Operation Costs	$5,862,290	$9,686,340	$9,775,010	$9,872,900	$9,980,990
Labor Costs	4,740,570	21,600,170	23,816,820	26,264,180	28,966,260
Pole Attachment Expense	263,180	263,180	263,180	263,180	263,180
Total	$10,866,040	$31,549,690	$33,855,010	$36,400,260	$39,210,430
d. EBITDA	$643,250	$58,267,690	$55,962,370	$53,417,120	$50,606,950
e. Depreciation	17,224,850	47,963,390	37,923,310	37,923,310	37,923,310
f. Operating Income (EBITDA less Depreciation)	($16,581,600)	$10,304,300	$18,039,060	$15,493,810	$12,683,640
g. Non-Operating Income					
Interest Income	$0	$142,110	$142,110	$150,550	$193,170
Interest Expense (10 Year Bond)	(820,400)	(141,470)	(141,470)	-	-
Interest Expense (20 Year Bond)	(12,537,500)	(18,120,240)	(18,120,240)	(10,470,740)	(1,051,560)
Interest Expense (Loan)	-	-	-	-	-
Total	($13,357,900)	($18,119,600)	($18,119,600)	($10,320,190)	($858,390)
h. Net Income (before taxes)	($29,939,500)	($13,930,110)	$651,460	$5,905,620	$12,557,250
i. Facility Taxes	$389,700	$3,544,860	$3,544,860	$3,544,860	$3,544,860
j. Net Income	($30,329,200)	($17,474,970)	($2,893,400)	$2,360,760	$9,012,390

Table 34 shows the cash flow statement for construction in the communications space given market survey projections.

Table 34: Cash Flow Statement – Construction in Communications Space Given Market Survey Projections

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	($30,329,200)	($17,474,970)	($2,893,400)	$2,360,760	$9,012,390
Cash Flow	$949,920	($10,303,010)	($16,741,400)	($15,599,830)	$7,023,760
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Principal Payments	$0	$29,759,850	$36,601,990	$40,714,580	$24,742,620
Interest Payments	13,357,900	25,103,850	18,261,710	10,470,740	1,051,560
Total Debt Service	$13,357,900	$54,863,700	$54,863,700	$51,185,320	$25,794,180
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Unrestricted Cash Balance	$949,920	($13,733,400)	($98,130,350)	($170,941,540)	($231,864,110)
Funded Depreciation	-	21,857,800	23,727,280	27,101,780	44,151,980
Restricted Cash Balance (Interest Reserve)	13,357,900	-	-	-	-
Restricted Cash Balance (Debt Service Reserve)	15,775,500	33,117,500	33,117,500	33,117,500	33,117,500
Total Cash Balance	**$30,083,320**	**$41,241,900**	**($41,285,570)**	**($110,722,260)**	**($154,594,630)**

Table 35 shows capital additions costs for construction in the communications space given market survey projections.

Table 35: Capital Additions – Construction in Communications Space Given Market Survey Projections

Capital Additions	Year 1	Year 2	Year 3	Total Years 1 to 3
Network Equipment				
Headend- Data	$20,513,550.00	$6,837,850.00	$0.00	$27,351,400.00
Total	$20,513,550.00	$6,837,850.00	$0.00	$27,351,400.00
Outside Plant and Facilities				
Total Backbone and FTTP	$236,242,600.00	$236,242,600.00	$0.00	$472,485,200.00
Additional Annual Capital	-	-	-	-
Total	$236,242,600.00	$236,242,600.00	$0.00	$472,485,200.00
Last Mile and Customer Premises Equipment				
CPE Gbps Commercial	$1,141,920.00	$2,158,910.00	$2,161,840.00	
CPE Residential & Small Commercial	$5,121,720.00	$22,240,570.00	$22,198,990.00	$49,561,280.00
Enterprise CPE and Drop	$0.00	-	-	-
IP Telephone Adapter (2 telephones)	-	-	-	-
Average Drop Cost	4,951,440	20,212,690	20,178,110	45,342,240
Total	$11,215,080.00	$44,612,170.00	$44,538,940.00	$100,366,190.00
Miscellaneous Implementation Costs				
Splicing	$250,000.00	$0.00	$0.00	
Vehicles	300,000	-	-	
Emergency Restoration Kit	50,000	-	-	
Work Station, Computers, and Software	$96,000	$210,000	$186,000	$492,000
Fiber OTDR and Other Tools	150,000	-	-	150,000
Generators & UPS	100,000	-	-	100,000
Billing Software	250,000	-	-	250,000
Additional Annual Capital	-	-	-	-
Total	$1,196,000	$210,000	$186,000	$1,592,000
Total Capital Additions	$269,167,230	$287,902,620	$44,724,940	$601,794,790

Table 36 shows labor expenses for construction in the communications space given market survey projections. We project that 48 total employees will be necessary in year 1, this will increase to 153 in year 2, and will be 246 from year 3 through 20. This assumes 11,024 customers in year 1; 56,026 in year 2; and 100,951 in year 3 and on.

The total direct labor costs are projected to be $4,657,500 in year 1; $12,919,500 in year 2, and $19,683,000 from year 3 on. It is also assumed the required human resource support will be conducted by existing City staff.

Table 36: Labor Expenses – Construction in Communications Space Given Market Survey Projections

Position	Year 1	Year 2	Year 3	Year 4	Year 5+	Year 1 Salary
Business/Finance Manager	1.00	1.00	1.00	1.00	1.00	$170,000
Market & Sales Manager	1.00	1.00	1.00	1.00	1.00	$120,000
Broadband Service Engineer	1.00	2.00	2.00	2.00	2.00	$120,000
Customer Service Representative	5.00	23.00	41.00	41.00	41.00	$50,000
Service Technicians/Installers & IT Support	5.00	23.00	41.00	41.00	41.00	$70,000
Sales and Marketing Representative	10.00	10.00	10.00	10.00	10.00	$75,000
Call Center Support (multiple shifts to provide 24x7 support)	14.00	71.00	128.00	128.00	128.00	$50,000
Fiber Plant O&M Technicians	11.00	22.00	22.00	22.00	22.00	$90,000
Total	48.00	153.00	246.00	246.00	246.00	
Total Customers	11,024	56,026	100,951	100,951	100,951	
Customers per Employee	230	366	410	410	410	
Total Salaries	$3,450,000	$9,570,000	$14,580,000			
Total Direct Labor Cost (Salary Plus Benefits)	**$4,657,500**	**$12,919,500**	**$19,683,000**			

8.6 Construction in Communications Space Given Required Take Rate

In this section, we look at the financial projections associated with construction in the communications space in the context of the required take rate and market share to make the Broadband Utility sustainable.

Peering costs are estimated to be $33,100 in year 1, $205,900 in year 2, and $378,600 in years 3 through 20.

Our analysis estimates total financing requirements to be $667,160,000 for the retail model if the network is constructed in the SCL power space. For financing, we assume two bonds.[93]

- A 10-year $32,160,000 bond[94] to be issued in two disbursements:
    - $24,120,000 in year 1

[93] 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 in the business planning phase.

[94] Experience suggests that the financial community is unlikely to offer the required bonding based on the projected voice, video and data revenues. Securing the bonds through existing revenue streams (water utility, sales tax, other) or through the general obligation of the City may be required (see Section 4.4).

- $8,040,000 in year 2

  This bond is issued at an interest rate of 4 percent and is paid off over the 10-year bond repayment period. Further we assume that principal payments do not start until year 2.

- We assume a 20-year bond in a total amount of $635,000,000 to be issued over the course of three years:

  - $295,000,000 in year 1
  - $315,000,000 in year 2
  - $25,000,000 in year 3

  As we noted, this bond is issued a 4.25 percent finance rate and principal payments start in year 3.

Table 37 shows operating expenses for years 1, 5, 10, 15, and 20 for construction in the communications space given the necessary take rate to sustain the Broadband Utility. Some of these expenses will remain constant while others will increase as the network matures and the customer base increases.

Table 37: Operating Expenses – Construction in Communications Space Given Required Take Rate

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$200,000	$400,000	$400,000	$400,000	$400,000
Utilities	36,000	72,000	72,000	72,000	72,000
Office Expenses	36,000	60,000	60,000	60,000	60,000
Facility Lease	120,000	240,000	240,000	240,000	240,000
Locates & Ticket Processing	-	561,000	561,000	561,000	561,000
Peering	33,100	378,600	378,600	378,600	378,600
Contingency	200,000	600,000	600,000	600,000	600,000
Billing Maintenance Contract	-	-	-	-	-
Fiber & Network Maintenance	1,181,210	2,362,430	2,362,430	2,362,430	2,362,430
Vendor Maintenance Contracts	-	834,000	834,000	834,000	834,000
Legal and Lobby Fees	750,000	250,000	250,000	250,000	250,000
Planning	-	-	-	-	-
Consulting	500,000	200,000	200,000	200,000	200,000
Marketing	2,400,000	1,200,000	1,200,000	1,200,000	1,200,000
Education and Training	186,300	1,012,570	1,117,960	1,234,320	1,362,790
Customer Handholding	13,230	151,430	151,430	151,430	151,430
Customer Billing (Unit)	6,610	75,710	75,710	75,710	75,710
Allowance for Bad Debts	117,160	1,144,090	1,144,090	1,144,090	1,144,090
Churn (acquisition costs)	82,680	946,410	946,410	946,410	946,410
PSTN Connection Fee	-	-	-	-	-
Internet	206,310	2,137,680	2,137,680	2,137,680	2,137,680
Sub-Total	$6,068,600	$12,625,920	$12,731,310	$12,847,670	$12,976,140
Labor Expenses	$4,740,570	$25,692,870	$28,327,610	$31,236,570	$34,448,290
Attachment Fees	263,180	263,180	263,180	263,180	263,180
Sub-Total	$5,003,750	$25,956,050	$28,590,790	$31,499,750	$34,711,470
Total Expenses	$11,072,350	$38,581,970	$41,322,100	$44,347,420	$47,687,610
Principal and Interest	$13,502,300	$55,510,610	$55,510,610	$51,185,320	$25,794,180
Facility Taxes	389,700	4,431,050	4,431,050	4,431,050	4,431,050
Sub-Total	$13,892,000	$59,941,660	$59,941,660	$55,616,370	$30,225,230
Total Expenses, P&I, and Taxes	$24,964,350	$98,523,630	$101,263,760	$99,963,790	$77,912,840

Table 38 shows the income statement for construction in the communications space given the take rate necessary to make the Broadband Utility sustainable.

Table 38: Income Statement – Construction in Communications Space Given Required Take Rate

	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Internet - Residential	$8,868,600	$107,272,800	$107,272,800	$107,272,800	$107,272,800
Internet - Business	1,193,400	7,135,920	7,135,920	7,135,920	7,135,920
Connection Fee (net)	1,653,600				
Assessments					
Ancillary Revenues	-	-	-	-	-
Total	$11,715,600	$114,408,720	$114,408,720	$114,408,720	$114,408,720
b. Content Fees					
Internet	$206,310	$2,137,680	$2,137,680	$2,137,680	$2,137,680
Total	$206,310	$2,137,680	$2,137,680	$2,137,680	$2,137,680
c. Operating Costs					
Operation Costs	$5,862,290	$10,488,240	$10,593,630	$10,709,990	$10,838,460
Labor Costs	4,740,570	25,692,870	28,327,610	31,236,570	34,448,290
Pole Attachment Expense	263,180	263,180	263,180	263,180	263,180
Total	$10,866,040	$36,444,290	$39,184,420	$42,209,740	$45,549,930
d. EBITDA	$643,250	$75,826,750	$73,086,620	$70,061,300	$66,721,110
e. Depreciation	17,739,900	53,698,720	41,160,530	41,160,530	41,160,530
f. Operating Income (EBITDA less Depreciation)	($17,096,650)	$22,128,030	$31,926,090	$28,900,770	$25,560,580
g. Non-Operating Income					
Interest Income	$0	$125,220	$125,220	$108,950	$132,880
Interest Expense (10 Year Bond)	(964,800)	(166,360)	(166,360)	-	-
Interest Expense (20 Year Bond)	(12,537,500)	(18,120,240)	(18,120,240)	(10,470,740)	(1,051,560)
Interest Expense (Loan)	-	-	-	-	-
Total	($13,502,300)	($18,161,380)	($18,161,380)	($10,361,790)	($918,680)
h. Net Income (before taxes)	($30,598,950)	($2,132,950)	$14,598,710	$19,372,980	$25,475,900
i. Facility Taxes	$389,700	$4,431,050	$4,431,050	$4,431,050	$4,431,050
j. Net Income	($30,988,650)	($6,564,000)	$10,167,660	$14,941,930	$21,044,850

Table 39 shows the cash flow statement for construction in the communications space given the required take rate to make the Broadband Utility sustainable (cash flow positive).

Table 39: Cash Flow Statement – Construction in Communications Space Given Required Take Rate

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	($30,988,650)	($6,564,000)	$10,167,660	$14,941,930	$21,044,850
Cash Flow	$449,180	$4,512,890	($2,360,030)	($1,076,330)	$20,998,550
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Principal Payments	$0	$30,271,120	$37,224,010	$40,714,580	$24,742,620
Interest Payments	13,502,300	25,239,490	18,286,600	10,470,740	1,051,560
Total Debt Service	$13,502,300	$55,510,610	$55,510,610	$51,185,320	$25,794,180
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Unrestricted Cash Balance	$449,180	$18,218,585	$5,154,855	$5,991,995	$16,039,965
Funded Depreciation	-	24,444,720	16,730,970	10,222,130	19,792,540
Restricted Cash Balance (Interest Reserve)	13,502,300	-	-	-	-
Restricted Cash Balance (Debt Service Reserve)	15,956,000	33,358,000	33,358,000	33,358,000	33,358,000
Total Cash Balance	$29,907,480	$76,021,305	$55,243,825	$49,572,125	$69,190,505

Significant network expenses are incurred in the first few years during the construction phase of the network. These costs—known as "capital additions"—represent the equipment and labor expenses associated with building, implementing, and lighting a fiber network. Table 40 shows these expenses for construction in the communications space given the required take rate.

Table 40: Capital Additions – Construction in Communications Space Given Required Take Rate

Capital Additions	Year 1	Year 2	Year 3	Total Years 1 to 3
Network Equipment				
Headend- Data	$24,118,880	$8,039,630	$0	$32,158,510
TBD	-	-	-	-
Total	$24,118,880	$8,039,630	$0	$32,158,510
Outside Plant and Facilities				
Total Backbone and FTTP	$236,242,600	$236,242,600	$0	$472,485,200
Additional Annual Capital	-	-	-	-
Total	$236,242,600	$236,242,600	$0	$472,485,200
Last Mile and Customer Premises Equipment				
CPE Gbps Commercial	$1,141,920	$2,841,140	$2,845,040	
CPE Residential & Small Commercial	$5,121,730	$28,435,640	$28,394,060	$61,951,430
Enterprise CPE and Drop	-	-	-	-
IP Telephone Adapter (2 telephones)	-	-	-	-
Average Drop Cost	4,951,440	25,880,080	25,845,950	56,677,470
Total	$11,215,090	$57,156,860	$57,085,050	$125,457,000
Miscellaneous Implementation Costs				
Splicing	$250,000	$0	$0	
Vehicles	300,000	-	-	
Emergency Restoration Kit	50,000	-	-	
Work Station, Computers, and Software	$96,000	$262,000	$236,000	$594,000
Fiber OTDR and Other Tools	150,000	-	-	150,000
Generators & UPS	100,000	-	-	100,000
Billing Software	250,000	-	-	250,000
Additional Annual Capital	-	-	-	-
Total	$1,196,000	$262,000	$236,000	$1,694,000
Total Capital Additions	$272,772,570	$301,701,090	$57,321,050	$631,794,710

Table 41 shows labor expenses. Benefits are calculated at 35 percent of base salary. We project that 48 total employees will be necessary in year 1, this will increase to 179 in year 2, and will be 297 from year 3 through 20. This assumes 11,024 customers in year 1; 68,644; and 126,188 in year 3 and on.

The total direct labor costs are projected to be $4,657,500 in year 1; $14,809,500 in year 2, and $23,395,500 from year 3 on for construction in the communications space given the take rate necessary to make the Broadband Utility sustainable.

Table 41: Labor Expenses – Construction in Communications Space Given Required Take Rate

Service Position Total	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5+**	**Year 1 Salary**
Business/Finance Manager	1.00	1.00	1.00	1.00	1.00	$170,000
Market & Sales Manager	1.00	1.00	1.00	1.00	1.00	$120,000
Broadband Service Engineer	1.00	2.00	2.00	2.00	2.00	$120,000
Customer Service Representative	5.00	28.00	51.00	51.00	51.00	$50,000
Service Technicians/Installers & IT Support	5.00	28.00	51.00	51.00	51.00	$70,000
Sales and Marketing Representative	10.00	10.00	10.00	10.00	10.00	$75,000
Call Center Support (multiple shifts to provide 24x7 support)	14.00	87.00	159.00	159.00	159.00	$50,000
Fiber Plant O&M Technicians	11.00	22.00	22.00	22.00	22.00	$90,000
Total	48.00	179.00	297.00	297.00	297.00	
Total Customers	11,024	68,644	126,188	126,188	126,188	
Customers per Employee	229.67	383.49	424.88	424.88	424.88	
Total Salaries	$3,450,000	$10,970,000	$17,330,000			
Total Direct Labor Cost (Salary Plus Benefits)	**$4,657,500**	**$14,809,500**	**$23,395,500**			

8.7 Property Tax Funded Utility Model

We also considered a property tax funded utility model that assumes property taxes will fund the Broadband Utility and it will have no debt through bonding or loans. In this model, the total cost to build is $463.1 million.

Peering costs are anticipated at $33,100 in year 1, $168,100 in year 2, and $302,900 for year 3 forward.

Here we summarize the anticipated operating and capital additions expenses, along with projected income and cash flow statements for the property tax funded utility model.

Table 42 shows the operating expenses in the property tax funded utility model for years 1, 5, 10, 15, and 20.

Table 42: Operating Expenses – Property Tax Funded Utility Model

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Insurance	$200,000	$400,000	$400,000	$400,000	$400,000
Utilities	36,000	72,000	72,000	72,000	72,000
Office Expenses	36,000	60,000	60,000	60,000	60,000
Facility Lease	120,000	240,000	240,000	240,000	240,000
Locates & Ticket Processing	-	561,000	561,000	561,000	561,000
Peering	33,100	302,900	302,900	302,900	302,900
Contingency	200,000	600,000	600,000	600,000	600,000
Billing Maintenance Contract	-	-	-	-	-
Fiber & Network Maintenance	846,820	1,693,650	1,693,650	1,693,650	1,693,650
Vendor Maintenance Contracts	-	630,000	630,000	630,000	630,000
Legal and Lobby Fees	750,000	250,000	250,000	250,000	250,000
Planning	-	-	-	-	-
Consulting	500,000	200,000	200,000	200,000	200,000
Marketing	2,400,000	1,200,000	1,200,000	1,200,000	1,200,000
Education and Training	204,120	890,460	983,140	1,085,460	1,198,440
Customer Handholding	13,230	121,140	121,140	121,140	121,140
Customer Billing (Unit)	6,610	60,570	60,570	60,570	60,570
Allowance for Bad Debts	84,080	612,420	612,420	612,420	612,420
Churn (acquisition costs)	82,680	757,130	757,130	757,130	757,130
PSTN Connection Fee	-	-	-	-	-
Internet	206,310	1,710,160	1,710,160	1,710,160	1,710,160
Sub-Total	$5,718,950	$10,361,430	$10,454,110	$10,556,430	$10,669,410
Labor Expenses	$5,186,070	$22,564,250	$24,881,240	$27,439,390	$30,263,790
Attachment Fees	263,180	263,180	263,180	263,180	263,180
Sub-Total	$5,449,250	$22,827,430	$25,144,420	$27,702,570	$30,526,970
Total Expenses	$11,168,200	$33,188,860	$35,598,530	$38,259,000	$41,196,380
Principal and Interest	$ -	$ -	$ -	$ -	$ -
Facility Taxes	261,610	2,371,910	2,371,910	2,371,910	2,371,910
Sub-Total	$261,610	$2,371,910	$2,371,910	$2,371,910	$2,371,910
Total Expenses, P&I, and Taxes	$11,429,810	$35,560,770	$37,970,440	$40,630,910	$43,568,290

Table 43 shows the income statement for the property tax funded utility model for years 1, 5, 10, 15, and 20.

Table 43: Income Statement – Property Tax Funded Utility Model

	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Internet - Residential	$5,912,400	$57,212,400	$57,212,400	$57,212,400	$57,212,400
Internet - Business	772,200	3,694,020	3,694,020	3,694,020	3,694,020
Connection Fee (net)	1,653,600	-	-	-	-
Assessments	-	-	-	-	-
Ancillary Revenues	-	-	-	-	-
Total	$8,408,400	$61,242,240	$61,242,240	$61,242,240	$61,242,240
b. Content Fees					
Internet	$206,310	$1,710,160	$1,710,160	$1,710,160	$1,710,160
Total	$206,310	$1,710,160	$1,710,160	$1,710,160	$1,710,160
c. Operating Costs					
Operation Costs	$5,512,640	$8,651,270	$8,743,950	$8,846,270	$8,959,250
Labor Costs	5,186,070	22,564,250	24,881,240	27,439,390	30,263,790
Pole Attachment Expense	263,180	263,180	263,180	263,180	263,180
Total	$10,961,890	$31,478,700	$33,888,370	$36,548,840	$39,486,220
d. EBITDA	($2,759,800)	$28,053,380	$25,643,710	$22,983,240	$20,045,860
e. Depreciation	13,523,920	40,799,560	30,759,480	30,759,480	30,759,480
f. Operating Income (EBITDA less Depreciation)	($16,283,720)	($12,746,180)	($5,115,770)	($7,776,240)	($10,713,620)
g. Non-Operating Income					
Interest Income	$0	$56,780	$56,780	$54,870	$82,980
Interest Expense (10 Year Bond)	-	-	-	-	-
Interest Expense (20 Year Bond)	-	-	-	-	-
Interest Expense (Loan)	-	-	-	-	-
Total	$ -	$56,780	$56,780	$54,870	$82,980
h. Net Income (before taxes)	($17,128,070)	($19,710,780)	($12,084,270)	($14,746,650)	($17,655,920)
i. Taxes	$261,610	$2,371,910	$2,371,910	$2,371,910	$2,371,910
j. Net Income	($17,389,680)	($22,082,690)	($14,456,180)	($17,118,560)	($20,027,830)

Table 44 shows the cash flow statement for the property tax funded utility model for years 1, 5, 10, 15, and 20.

Table 44: Cash Flow Statement – Property Tax Funded Utility Model

	Year 1	Year 5	Year 10	Year 15	Year 20
Net Income	($17,389,680)	($22,082,690)	($14,456,180)	($17,118,560)	($20,027,830)
Cash Flow	$236,344,060	$6,477,000	$2,461,530	($200,850)	($3,110,120)
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Principal Payments	$ -	$ -	$ -	$ -	$ -
Interest Payments	-	-	-	-	-
Total Debt Service	$ -	$ -	$ -	$ -	$ -
	Year 1	**Year 5**	**Year 10**	**Year 15**	**Year 20**
Unrestricted Cash Balance	$236,344,060	$22,556,250	$34,527,090	$38,954,020	$29,219,250
Funded Depreciation	$ -	24,272,970	22,710,680	21,946,730	33,192,280
Restricted Cash Balance (Interest Reserve)	-	-	-	-	-
Restricted Cash Balance (Debt Service Reserve)	-	-	-	-	-
Total Cash Balance	$236,344,060	$46,829,220	$57,237,770	$60,900,750	$62,411,530

Table 45 shows capital additions costs for the property tax funded utility model for years 1, 2, and 3. We expect that these costs will drop off after year 3.

Table 45: Capital Additions – Property Tax Funded Utility Model

Capital Additions	Year 1	Year 2	Year 3	Total Years 1 to 3
Network Equipment				
Headend- Data	$18,014,250	$6,004,750	$ -	$24,019,000
TBD	-	-	-	-
Total	$18,014,250	$6,004,750	$ -	$24,019,000
Outside Plant and Facilities				
Total Backbone and FTTP	$169,364,850	$169,364,850	$ -	$338,729,700
Additional Annual Capital	-	-	-	-
Total	$169,364,850	$169,364,850	$ -	$338,729,700
Last Mile and Customer Premises Equipment				
CPE Gbps Commercial	$1,141,920	$2,158,910	$2,161,840	
CPE Residential & Small Commercial	$5,121,720	$22,240,570	$22,198,990	$49,561,280
Enterprise CPE and Drop	-	-	-	-
IP Telephone Adapter (2 telephones)	-	-	-	-
Average Drop Cost	4,951,440	20,212,690	20,178,110	45,342,240
Total	$11,215,080	$44,612,170	$44,538,940	$100,366,190
Miscellaneous Implementation Costs				
Splicing	$250,000	$ -	$ -	
Vehicles	300,000	-	-	
Emergency Restoration Kit	50,000	-	-	
Work Station, Computers, and Software	$96,000	$210,000	$186,000	$492,000
Fiber OTDR and Other Tools	$150,000	-	-	150,000
Generators & UPS	100,000	-	-	100,000
Billing Software	250,000	-	-	250,000
Additional Annual Capital	-	-	-	-
Total	$1,196,000	$210,000	$186,000	$1,592,000
Total Capital Additions	$199,790,180	$220,191,770	$44,724,940	$464,706,890

Table 46 shows labor expenses for the property tax funded utility model for years 1 through 4, and year 5 forward, assuming the network is constructed in the SCL power space. Benefits are calculated at 35 percent of base salary. We project that 48 total employees will be necessary in year 1, this will increase to 153 in year 2, and will be 246 from year 3 through 20. This assumes 11,024 customers in year 1; 56,026 in year 2; and 100,951 in year 3 and on.

The total direct labor cost in year 1 is projected to be $5,103,000; $13,810,500 in year 2, and $20,574,000 from year 3 on. It is also assumed the required human resource support will be conducted by existing City staff.

Table 46: Labor Expenses – Property Tax Funded Utility Model

Service Position Total	Year 1	Year 2	Year 3	Year 4	Year 5+	Year 1 Salary
Business/Finance Manager	1.00	1.00	1.00	1.00	1.00	$170,000
Market & Sales Manager	1.00	1.00	1.00	1.00	1.00	$120,000
Broadband Service Engineer	1.00	2.00	2.00	2.00	2.00	$120,000
Headend Technician	-	-	-	-	-	$ -
Telephone Technician	-	-	-	-	-	$ -
Internet Technician (staff in field tech support)	-	-	-	-	-	$ -
Customer Service Representative	5.00	23.00	41.00	41.00	41.00	$50,000
Service Technicians/Installers & IT Support	5.00	23.00	41.00	41.00	41.00	$70,000
Sales and Marketing Representative	10.00	10.00	10.00	10.00	10.00	$75,000
Call Center Support (multiple shifts to provide 24x7 support)	14.00	71.00	128.00	128.00	128.00	$50,000
Fiber Plant O&M Technicians	11.00	22.00	22.00	22.00	22.00	$120,000
Total	48.00	153.00	246.00	246.00	246.00	
Total Customers	11,024	56,026	100,951	100,951	100,951	
Customers per Employee	230	366	410	410	410	
Total Salaries	$3,780,000	$10,230,000	$15,240,000			
Total Direct Labor Cost (Salary Plus Benefits)	**$5,103,000**	**$13,810,500**	**$20,574,000**			

9 Pilot Project

The City has indicated that it would like to consider an FTTP pilot area with a total cost of $5 million, including capital and operating costs.

If the City pursues a pilot, it should consider the project not only to demonstrate the technology and gather insight for a citywide deployment, but also to build excitement and send the message that the City is prepared and ready to bring next-generation connectivity to its residents and businesses. In other words, it might be used to help drive demand.

However, a pilot will not create a mechanism to test the economics of a citywide deployment. Pilot projects can be most successfully used for marketing, generating community interest, and demonstrating the power of a network. Pilot projects that offer retail services are rarely scalable over an entire community, so the City must be prepared to support such a pilot project as a long-term business model. In addition, it is challenging to use such projects to prove the business model or market demand unless the pilot extends to many neighborhoods.

Cost and time are also important factors in considering pilot projects. Even if a pilot area were large enough to cover a range of representative City demographics, it would take years and significant capital to yield significant market data.

In this section, we outline suggested approaches to making the most of a pilot project, identify three specific City neighborhoods in which we believe a pilot may fare well, and provide examples of similar successful pilot approaches.

9.1 Marketing the Network

The marketing power of a pilot project is significant—and may in itself justify the funds allocated for a pilot. Branding and marketing are costly elements of starting a Broadband Utility, but it is imperative to successfully market the network, advertise services, and obtain customers even while network construction is underway.

Given that these functions usually must happen simultaneously, the process of successfully marketing and advertising can be onerous. Using a pilot project to market the network and its services can help the Broadband Utility focus its resources. For example, well-marked vehicles and construction and installation crews who broadcast the Broadband Utility’s chosen branding can be a powerful advertisement throughout the community. (Google Fiber vehicles are rolling billboards in the communities where the company is deploying new networks.) Friendly, helpful staff coupled with a reliable, ultra-fast connection can prompt an organic word-of-mouth campaign that might seriously bolster the Broadband Utility’s reputation.

Caution is important in choosing what services to offer through the pilot, because it will likely be necessary to continue these services in full network deployment and operations. For example, if the Broadband Utility offers a discounted $20 per month service for pilot customers, it should be prepared to continue offering that service to all eventual customers of the network. We believe that the pilot should provide a 1 Gbps offering to residential customers for $75 per month and to business customers for $85 per month, consistent with the offerings we suggest for the Broadband Utility.

The operators of the pilot project examples we discuss below each successfully marketed the network through a variety of innovative approaches.

9.2 Demonstrating the Power of the Network

As we noted in Section 1.7.2, an application demonstration center can demonstrate the power of the network by enabling consumers and the media to try out 1 Gbps speeds for themselves and experience firsthand the range of applications such speeds can support. We encourage the City to consider such a space because even if a full-scale pilot is not feasible, such a space may further public understanding and acceptance of a FTTP network build.

Another way to demonstrate the power of the network is to ensure that a range of customers are served through the project through a pilot. This could include single-family homes, businesses, MDUs, and public institutions like schools and libraries. A broad pilot like this would enable a spectrum of users to experience the network and learn, in practical terms, what 1 Gbps speeds can do in their lives. Illustrating how high-speed broadband can enhance everyday life is a powerful way to sell citizens on the Broadband Utility; abstract discussions of 1 Gbps service are exciting, but the true potential of the network lies in concrete demonstration of its capabilities.

The operators of the pilot project examples we discuss below each demonstrated the power of their networks, and each was successful in establishing a more advanced public understanding of the technology and service.

9.3 Pilot Project Examples

In our estimation, a successful pilot will create a mechanism that does not necessarily test the economics of a citywide deployment, but builds excitement and support around applications and 1 Gbps speeds. It will also provide private sector companies (including gear and application developers) with a platform for showcasing their products and services.

9.3.1 Urbana-Champaign Big Broadband (UC2B)

In Champaign-Urbana, Illinois, the two cities joined with the University of Illinois in 2009 to form the Urbana-Champaign Big Broadband (UC2B) consortium[95] to construct a communitywide backbone network and to deploy FTTP in select neighborhoods.[96] The project was funded by the federal Broadband Technology Opportunities Program (BTOP) along with matching funds at the state and local levels.[97]

The UC2B approach sought to provide high-speed connectivity to traditionally underserved neighborhoods; using U.S. Census data, it served only neighborhoods where broadband adoption was traditionally 40 percent or less.[98] There was no connection fee for grant-funded customers, but service was not free—packages ranged from $19.99 per month for 20 Mbps residential service to upwards of $400 per month for commercial-level service.

The ringed UC2B backbone infrastructure was designed with future growth in mind. The backbone extends throughout the community, with excess dark fiber capacity throughout most of the seven rings. This architecture enabled UC2B to offer private sector providers access to dark fiber through lease or Indefeasible Right of Use (IRU) agreements while maintaining plenty of capacity for future growth. UC2B also connected City and University locations and provides wholesale services.

Additionally, the project served many community anchor institutions (CAIs) across the cities. CAIs often consist of schools, government buildings, libraries, and other public facilities; UC2B broadened the definition of a CAI to encompass any institution that could potentially serve a vulnerable population, while adhering to certain restrictions under the terms of the BTOP grant. The development of the communitywide backbone enabled UC2B to serve CAIs even in areas outside of the target pilot neighborhoods.

Despite many challenges, the UC2B network successfully demonstrated the power of a communitywide fiber optic network. The communities have seen an increase in tech-based employers such as Yahoo! adding facilities and local jobs, providing a boost to the local economy.[99]

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[95] http://uc2b.net/wp-content/uploads/2011/05/UC2B-I-G-Agreement-7-29-09-Attach-D.pdf, accessed February 2015

[96] http://uc2b.net/wp-content/uploads/2011/09/UC2B-map_web1.pdf, accessed March 2015

[97] http://www2.ntia.doc.gov/all-recipients, accessed March 2015

[98] http://uc2b.net/about/general/, accessed February 2015

[99] http://www.news-gazette.com/news/local/2014-02-06/yahoo-add-80-jobs-research-park-site.html, accessed February 2015

A not-for-profit entity was ultimately created to continue operation of the UC2B network; its board is made up of members appointed by each of the founding entities.[100] Recognizing that the resources necessary for the enterprise to be sustainable and especially to allow it to grow were best sought through a public–private partnership, UC2B went on to develop an innovative public–private partnership with an Illinois-based private company for ongoing operation and maintenance of the network.[101] UC2B and its consultants negotiated the partnership with an Illinois-based, family-owned company called iTV-3,[102] and announced the partnership in May 2014.[103] (Prior to the partnership, UC2B was subsidized with funding from the cities and University.)

One of UC2B's successes was through partnering with local institutions in its service area to provide demonstration sites and computer labs for citizens to see the power of the network firsthand. We recommend that the Broadband Utility consider strategically placing its pilot project in a location where such demonstrations and citizen access can be easily replicated (we outline one such area in Section 9.4 below). The City could work with local tech innovators and companies to provide demonstrations of applications and services that thrive with high-speed connectivity.

As with any large-scale endeavor, UC2B faced a learning curve and overcame obstacles that could be understood only through the process of planning and deploying the network; certain elements of deployment and operation simply were not evident in the planning phase.

For example, one key challenge that UC2B faced was the underestimation of costs and the breadth of deployment for multi-dwelling units (MDUs). (We discuss in Section 4.2.2 the potential impact of MDUs in the Seattle market.) Further, the effect of MDUs on the market as a whole was not clear in planning for areas of deployment. Some neighborhoods contained large apartment complexes built to cater to University students, and each of these units contained multiple broadband connections (one in each bedroom and one in the common living space). These multiple connections counted toward the neighborhood's overall broadband adoption levels, which forced the project to exclude neighborhoods with high need because the Census data metric did not account for this nuance.

The sheer extent of operations and the staff and resources necessary to support them were also underestimated on the UC2B project. Unlike many communities that pursue FTTP networks, the

[100] http://uc2b.net/about/board-of-directors/, accessed March 2015
[101] http://uc2b.net/about/expansion/, accessed February 2015
[102] http://www.itv-3.com/, accessed March 2015
[103] http://uc2b.net/2014/05/uc2b-announces-partnership-with-itv-3/, accessed March 2015

cities of Champaign and Urbana had no prior experience operating utility services, so there were minimal existing resources to be used for the fiber enterprise.

9.3.2 Case Connection Zone

Case Western Reserve University in Cleveland, Ohio implemented a research project in 2009 to serve the University Circle neighborhood.[104] The "Case Connection Zone" project sought to understand potential community benefits from ultra-high-speed Internet connectivity by bringing 1 Gbps FTTP connections to select neighborhoods around the University.[105]

The University partnered with public and private entities to research four key areas:

- Education
- Health and wellness
- Household energy management
- Neighborhood and public safety[106]

To reduce construction and electronics costs and make the project a reality, the University partnered with numerous industry partners like Corning and Cisco.[107]

Like the larger UC2B project, the Case Connection Zone sought to bring connectivity to traditionally underserved and unserved areas and customers. The Case Connection Zone offered free connectivity to its pilot customers.

Similar to the City of Seattle, the Case Western Reserve University project focused on "benefits beyond the balance sheet"—the overall impact of 1 Gbps speeds on the community. The goal was to understand on both a micro and a national level what kinds of innovations might be possible by bringing fiber connectivity to a community. Several startups moved into the test bed area.

One of Case Connection Zone's many important initiatives was development of an "Alpha House"—a location specifically designed for citizens to visit and experience what a 1 Gbps

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[104] "Case Western Reserve University kicks off project to bring ultra high-speed Internet access to thousands of nearby homes," *The Plain Dealer*, March 26, 2010. http://www.cleveland.com/business/index.ssf/2010/03/case_western_reserve_universit.html, accessed March 2015.

[105] http://caseconnectionzone.org/about.html, accessed March 2015

[106] http://case.edu/pubaff/govrel/programinventory/economic.html, accessed March 2015

[107] "Cleveland Neighborhoods Testing Ultra High-Speed Broadband in University Study," *Government Technology*, August 23, 2010. http://www.govtech.com/e-government/Cleveland-Neighborhoods-Testing-Ultra-High-Speed-Broadband.html, accessed March 2015.

connection actually felt like. This was critical in demonstrating the project’s worth and helping educate the community on what it means to have this caliber of connectivity.

Because the Case Connection Zone project did not have to be financially sustainable—it was a research project meant to help stakeholders understand the impact of broadband—it had flexibility that the City of Seattle may not be able to share with its Broadband Utility. Funds allocated were not expected to be recovered in a traditional fashion; instead, the endeavor was meant to show profits of a different, unquantifiable nature.

9.4 Suggested Seattle Pilot Areas

Using the City’s guidelines and a $5 million total budget (including capital costs and operational expenses for a 12-24 month period), we identified three areas in the City where a pilot can be implemented. We used the following assumptions for capital costs:

- $3 million total outside plant
- $200,000 total electronics
- $18,480 per mile for engineering
- $125,000 per mile for construction in the communications space
- $100,000 per mile for construction in the power space
- $400 per drop cable
- $500 for customer premises equipment

We initially identified the Queen Anne neighborhood on direction from the City to outline a pilot area with approximately 500 customers. Direction was later given to identify additional areas using a $5 million total budget, at which point we identified pilot areas in the Central District and North Beacon Hill.

9.4.1 Central District

One of the potential pilot areas we identified is in the Central District, which is east of downtown. This area consists of primarily single family units with less than 10 percent commercial locations.

The area we outlined has 1388 address points and will require approximately 10 miles of fiber construction. Mann School and Madrona Elementary School are in the targeted pilot area in the Central District. There is also a U.S. Post Office and a Young Women’s Christian Association (YWCA).

We suggest this area because the Broadband Utility can reach a large number of residential customers and potentially connect at least one location that may serve as a community center where consumers can experience high-speed fiber connectivity.

This location is near SCL backbone, but the existing poles are crowded. Figure 79 shows the recommended pilot area in the Central District. We project the total capital cost for this pilot deployment will be $2.9 million.

Figure 79: Central District Potential Pilot Area

9.4.2 North Beacon Hill

We outline here a suggested pilot area in the North Beacon Hill neighborhood of Seattle, southeast of downtown. This area is a mix of potential customer types and MDUs are common in parts of the neighborhood.[108]

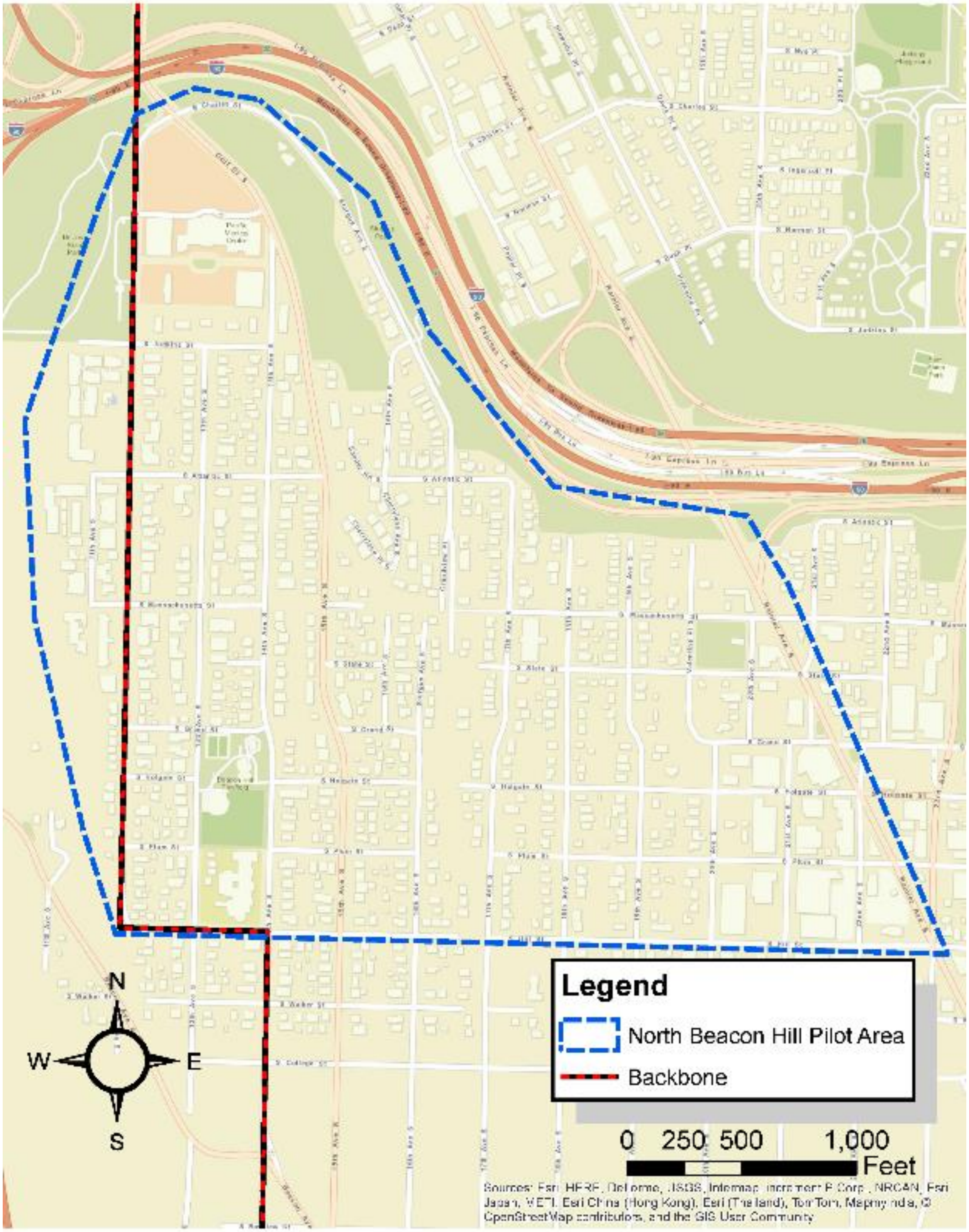
The North Beacon Hill area we outlined has 1260 address points and will require approximately 10.5 miles of fiber construction. There is one large medical facility (Pacific Hill Medical Center) and one smaller medical location. The Beacon Hill International School is also located here.

[108] These cost estimates do detail the potential expense of serving MDU locations. As we previously noted, analysis on a case-by-case basis is necessary to derive associated costs with each unique MDU location.

We suggest this area because the Broadband Utility can reach a large number of residential customers, it has an opportunity to connect MDU locations, and partnering with the medical center(s) may provide an opportunity to demonstrate the network's power. This area is mixed use with many more commercial locations than the Central District, though there is less density in this area.

Existence or density of SCL backbone in this location is unknown and pole space here appears less crowded than in the Central District. Figure 80 shows the recommended pilot area in the North Beacon Hill neighborhood. We project the total capital cost for this pilot deployment will be $2.9 million.

Figure 80: North Beacon Hill Potential Pilot Area



9.4.3 Queen Anne

We outline here a suggested pilot area in the Queen Anne neighborhood of Seattle, northwest of downtown. This area is a mix of potential customer types (residential, business, public institutions, and a combination of MDU and single-building locations).

The area we outlined has 493 address points, consistent with what the City originally suggested its pilot parameters should be.[109] The area contains two schools—Queen Anne High School and John Hay Elementary School. There are 374 residential units (primarily single family) and 93 mixed-use locations (MDUs and commercial). There are 19 commercial addresses.

We suggest this area because the Broadband Utility can connect a variety of customers within a relatively small geographic footprint, which will minimize construction and deployment costs while still reaching an assortment of customer types (see Figure 81).

The projected total capital cost for implementation of this pilot area is $1.4 million. Given the updated parameters and budget for a pilot, this suggested pilot area could potentially be expanded within the Queen Anne neighborhood, or a combination of locations may be considered.[110]

[109] Prior to determining a $5 million budget, we received direction from the DoIT to identify a pilot area to serve approximately 500 locations.

Figure 81: Queen Anne Potential Pilot Area

This recommended area would require some backbone fiber; the map above shows that we have developed the recommendation with the expectation that the fiber backbone will be constructed citywide. This would enable the City to simply roll the pilot area into the overall service area as the network is constructed and the Broadband Utility expands. Further, even if the City opted not to provide municipal retail fiber, a public–private partnership could encompass the pilot area or a private entity could serve the customers directly if it were granted access to the fiber.

One very important consideration for the City is to reserve the right to terminate the pilot project if it opts not to pursue an FTTP municipal retail offering. In the case of UC2B, the pilot areas were absorbed into the service area of the public–private partnership's long-term plan. (With the Case Connection Zone, the financial cost of serving the pilot area was not an important variable.) If the City of Seattle decides to implement a pilot, it should be prepared for what the potential end of the pilot looks like so that it can prepare its messaging and marketing before the pilot even begins.

Appendix A – Financial Projections for Tax Funded Utility Model with Construction in Power Space

This appendix is attached as a separate spreadsheet.

Appendix B – Residential Survey Instrument

This appendix is attached as a separate PDF file.

Appendix C – Business Survey Instrument

This appendix is attached as a separate PDF file.

Appendix D – Business Survey Tables

This appendix is attached as a separate spreadsheet.

Appendix E – Residential Survey Tables

This appendix is attached as a separate PDF document.

Appendix F – Financial Projections for Construction in Power Space

This appendix is attached as a separate spreadsheet.

Appendix G – Financial Projections for Construction in Communications Space Given Market Penetrations Necessary for Cash Flow

This appendix is attached as a separate spreadsheet.

Appendix H – Financial Projections for Construction in Communications Space Given Market Penetrations Estimated by Surveys

This appendix is attached as a separate spreadsheet.