City of Hudson, Ohio

Broadband Needs Assessment & Business Plan

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Table of Contents

1. Executive Summary

Broadband is a vital element of the City of Hudson's economic vitality and welfare that affects nearly every function within the community. Where the roads provide the infrastructure necessary to connect communities physically, broadband provides the digital infrastructure necessary to connect communities virtually to the rest of the electronic world. As more of Hudson's citizens, businesses, and community organizations are connected to the Internet, the more reliant they become on high quality, affordable broadband services; more and more devices are requiring higher bandwidths.

Broadband is high-speed connectivity to the Internet that takes a variety of forms, including DSL, cable, and fixed and mobile wireless. In Hudson, most residents and businesses subscribe to either DSL or cable services. These services have some potential to provide greater speeds to Hudson's consumers who utilize more and more bandwidth. However, the demand for bandwidth is outpacing the supply because of inherent limitations in traditional broadband technologies.

Hudson's small and medium business community reported many issues with their current broadband services, citing poor reliability and performance as negatively affecting their ability to do business in the City. Many businesses wanted to upgrade to a better service but found that they could not afford to do so. This is a critical issue for Hudson's economic development. It limits Hudson's ability to attract and retain business in the City. Without affordable, next-generation broadband readily available, Hudson is not able to effectively compete with other cities that have access to these services. In addition, this issue also affects the retention of existing businesses, as the high price of broadband is a negative aspect of operating a business in the City.

Although broadband providers have made fiber-optic broadband services available to Hudson's business community, only larger businesses can afford and actively utilize them. This leaves Hudson's small and medium businesses, which represent over 58% of total GDP with limited options for their Internet connectivity.

It is unlikely that DSL and cable technologies will meet the long-term broadband needs of Hudson's community.

95% of Hudson residents surveyed said that they could not live without their Internet connections.

58% of Hudson businesses surveyed said that their current Internet services do not meet their needs.

To resolve this issue, next-generation fiber-optic broadband technologies are being deployed in cities across the country to provide much greater speeds, reliability, and performance. These fiber-optic technologies provide a solution to the problems faced by communities like Hudson that are equipped with traditional broadband technologies. Cities that are fortunate enough to have next-generation broadband are well positioned to thrive and take full advantage of every opportunity the Internet has to offer. Unfortunately, Hudson is not positioned as one of those cities in its current state.

Realizing the importance to their communities, many cities are taking an active role in how broadband develops in their communities. The City of Hudson Broadband Needs Assessment and Business Plan provides an analysis of Hudson's current and future broadband needs and proposes initiatives that the City can undertake to ensure these needs are met. It provides a range of options for the City to consider based on leveraging the City's existing fiber-optic network, strategic investments in broadband infrastructure, and broadband-friendly public policy tools. The following recommendations present the most plausible broadband initiatives for the City to consider that (1) fall within the City's core capabilities as a public organization, (2) utilize the City's strengths in infrastructure and policy to positively impact broadband development, (3) are economically and financially sustainable and (4) cultivate key public and private partnerships to increase the effectiveness how the community is served with broadband services.

Goals of the Broadband Needs Assessment & Business Plan

1. ***Document Hudson's current broadband environment and identify current gaps and potential future shortcomings.***
2. ***Identify feasible ways for the City to enhance broadband services to residents, businesses and community anchors.***
3. ***Expand and formalize public policies to accelerate the deployment of broadband infrastructure.***
4. ***Determine feasible business models and key partnerships that the City can utilize to expand broadband services to the community.***
5. ***Select the most plausible opportunities and develop an action plan to implement strategic broadband plans.***

A. Summary of Potential Benefits to Hudson

- **Reduce the costs of doing business in the City.**
- **Enable small and medium business to be more competitive.**
- **Attract economic development by branding Hudson as a Gigabit City.**
- **Drive new private sector investment in local broadband.**
- **Build a platform to serve long-term residential needs.**
- **Enable new Smart City innovation for municipal efficiencies.**

B. Summary of Recommendations

The City should plan strategic investments in broadband infrastructure to first serve Hudson's business community and subsequently serve its residents. Doing so requires the City to select the right business model, which will depend on how broadband providers choose to collaborate with the City. Therefore, the first recommendation is for the City to engage broadband providers to determine their role in the initiative. If broadband providers agree to utilize an open-access network owned and operated by the City, the City should proceed in building broadband infrastructure into the business corridors and enabling broadband providers to utilize the network to serve Hudson's businesses. This model could then be expanded to Hudson's residential communities.

If providers are unwilling to partner with the City, the City should consider becoming a retail provider of broadband services to its business community (and possibly, a residential provider in the future), as laid out in Section 7 of this Study. The retail option should only be considered if the City is not successful in implementing the open-access option because it requires the City to (1) make additional investments in capital (2) increase its operations and maintenance expenses (3) take on responsibility for providing business Internet and telephone services. If broadband providers are willing to utilize the City's open-access network, the City should not need to enter the retail market. However, if they are not, the City should be prepared to take the lead and provide these services directly to ensure that its community has the broadband services they will need to succeed in the future.

Figure 1-1 illustrates summary financial information on the project, based on an evaluation of the open-access and retail provider options for the City. These two options show the expected funding required for the City's initial buildout to the business community under an average case.

Figure 1-1. 10 Year Analysis

10 Year Analysis	Open Access Provider	Business Service Provider
Total Funding Required	$4,900,000	$6,500,000
Businesses Connected	339	377
Percent of Market Served	25% - 45%	35% - 55%
Positive EBITDA	Year 3	Year 4
Positive Net Income	Year 3	Year 4
Estimated Payback (After Debt Service)	9 Years	11 Years

Recommendation 1: Work with broadband providers to determine what role they will play in the City's broadband initiative.

1. Formally engage broadband providers to determine their interest in:
    a. Partnering with the City on its broadband initiative;
    b. Operating on a City-owned open-access network; and
    c. Signing a letter of intent to provide services on Hudson's open-access network.

Recommendation 2: Build out broadband infrastructure in key areas of the City to expand access to businesses and residents

1. Use a phased approach to build out to the business community first;
2. Build on success and identify opportunities for residential buildout; and
3. Partner with broadband providers to deploy services to residents.

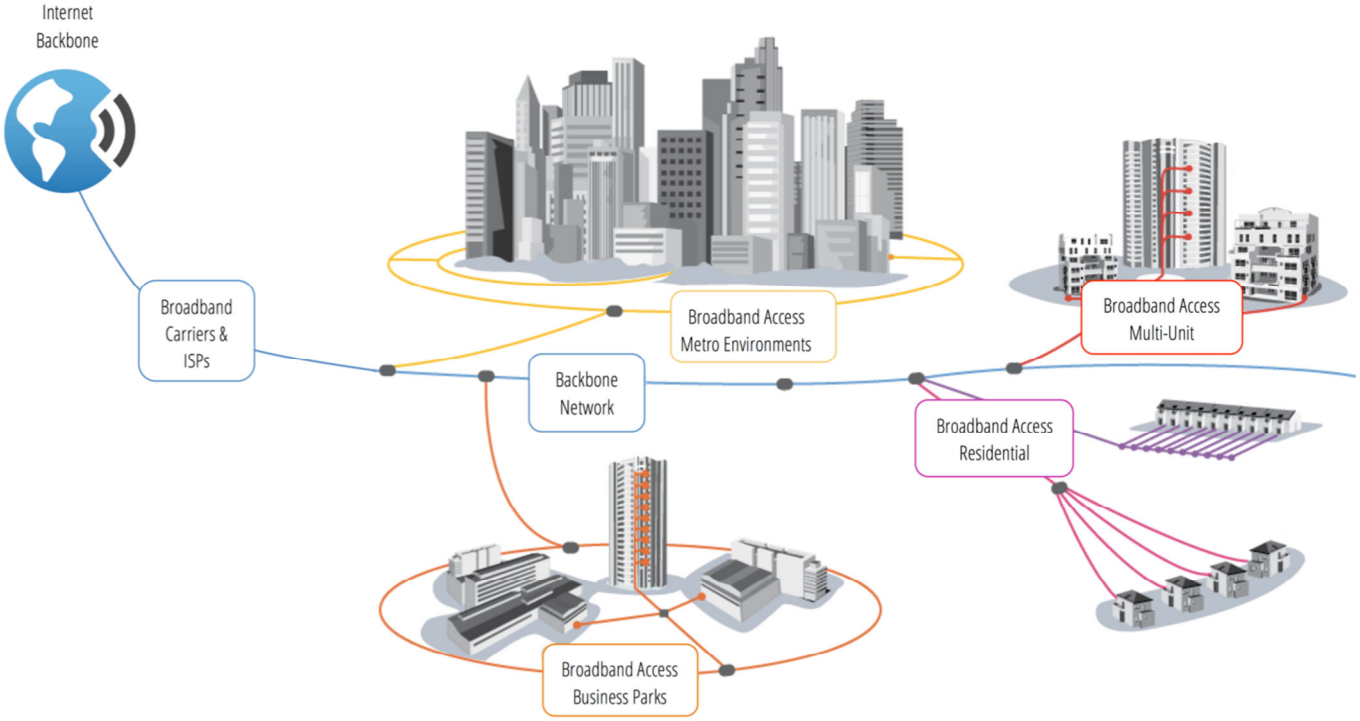
Recommendation 3: Adopt policies that incorporate broadband as a utility and create a policy framework to promote deployment in public and private projects.

1. Tailor draft policies and standards to the City's specific needs and adopt them into local policy, codes, and standards (including policies, dig-once, joint trenching, engineering standards, etc.).
2. Incorporate broadband in the City's Development Impact Fee program and the City's Capital Improvement Plan (CIP) as appropriate, and make a commitment to fund broadband infrastructure.
3. Identify opportunities to install broadband infrastructure in conjunction with public and private construction projects as appropriate.
4. Develop a process so that Planning and Public Works and Electric Departments coordinate with IT to identify projects that could install this infrastructure at reduced costs.
5. As the City makes key infrastructure investments, maintain broadband infrastructure in the City's GIS system, requiring GIS-based as-builts and implementation of other means for accurate documentation.
6. Create policies to streamline the broadband permitting processes within public rights-of-way to ensure broadband providers do not face unnecessary obstacles to building infrastructure.
7. Normalize fees levied on broadband providers for constructing broadband infrastructure to ensure they do not discourage broadband investment.

2. Overview of Broadband Technologies

Broadband is deployed throughout communities as wired and wireless infrastructure that carries digital signal between end users and the content they want to access. The content comes in many forms and from many locations across the world in the networks that connect the local community to the Internet backbone. Websites, television, streaming video, videoconferencing, cloud services, and even telephone service are just a few types of content that are delivered across local broadband networks. Access to this content is made available through the type of infrastructure and kinds of connections available in the local network. Robust local infrastructure results in faster, more reliable access to content. Conversely, local infrastructure that is aging and built on older technologies results in slower, less reliable access to content.

Figure 2-1: How Broadband Connects Our Communities



A. Types of Broadband Services

DSL

DSL is a wireline transmission technology that transmits data faster over traditional copper telephone lines already installed to homes and businesses. DSL-based broadband provides transmission speeds ranging from several hundred Kbps to millions of bits per second (Mbps). The availability and speed of your DSL service may depend on the distance from your home or business to the closest telephone company facility.

Cable

Cable modem service enables cable operators to provide broadband using the same coaxial cables that deliver pictures and sound to your TV set. Most cable modems are external devices that have two connections: one to the cable wall outlet, the other to a computer. They provide transmission speeds of 1.5 Mbps or more. Subscribers can access their cable modem service by simply turning on their computers, without dialing-up an ISP. You can still watch cable TV while using it. Transmission speeds vary depending on the type of cable modem, cable network, and traffic load. Speeds are comparable to DSL.

Wireless

Wireless broadband connects a home or business to the Internet using a radio link between the customer's location and the service provider's facility. Wireless broadband can be mobile or fixed. Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly to provide. Speeds are generally comparable to DSL and cable modem. An external antenna is usually required. Wireless broadband Internet access services offered over fixed networks allow consumers to access the Internet from a fixed point while stationary, and often require a direct line-of-sight between the wireless transmitter and receiver. These services have been offered using both licensed spectrum and unlicensed devices. For example, thousands of small Wireless Internet Services Providers (WISPs) provide such wireless broadband at speeds of around one Mbps using unlicensed devices, often in rural areas not served by cable or wireline broadband networks. Mobile wireless broadband services are also becoming available from mobile telephone service providers and others. These services are generally appropriate for highly mobile customers and require a special PC card with a built in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

Fiber to the Node (FTTN)

Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. Fiber to the Node technologies bring high-capacity fiber-optic cables to local services areas to connect to existing DSL equipment. Rather than bringing fiber-optic cables to every home or business, the fiber is connected to the existing DSL network to increase its capacity. It allows these networks to carry more traffic; however, often times the copper-based "last mile" DSL network, connecting homes and businesses to the local nodes is still a bottleneck and results in subscribers not able to access the true speeds of fiber-optic connections.

Fiber to the Premise (FTTP) – Next-Generation Broadband

Fiber optic technology converts electrical signals carrying data to light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far

exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. The actual speed you experience will vary depending on a variety of factors, such as how close to your computer the service provider brings the fiber, and how the service provider configures the service, including the amount of bandwidth used. The same fiber providing your broadband can also simultaneously deliver voice (VoIP) and video services, including video-on-demand. Telecommunications providers sometimes offer fiber broadband in limited areas and have announced plans to expand their fiber networks and offer bundled voice, Internet access, and video services. Variations of the technology run the fiber all the way to the customer's home or business, to the curb outside, or to a location somewhere between the provider's facilities and the customer.

Figure 2-2 compares traditional broadband technologies such as DSL, cable, and wireless to fiber-based next-generation broadband. Whereas traditional broadband technologies have an upper limit of 150 Mbps, next-generation broadband that utilizes fiber-optic connections surpasses these limitations and can provide 1 Gbps and greater.[1]

Figure 2-2: Comparing the Capacity of Regular Broadband to Next-Generation Broadband

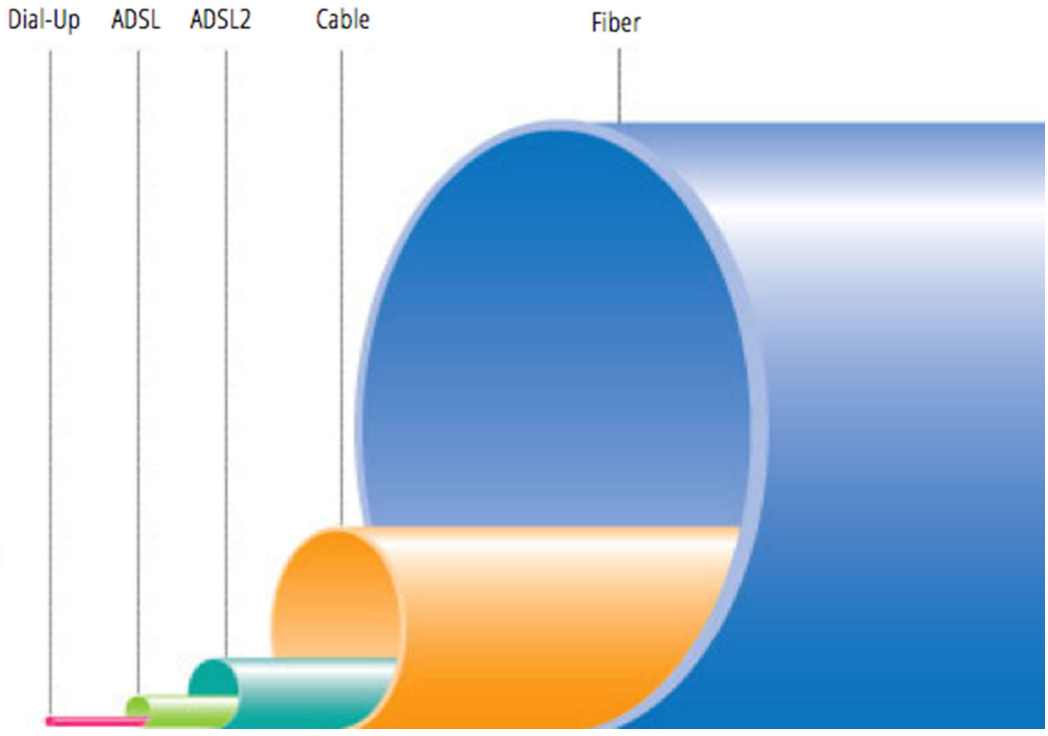
Dial-Up – 56 Kbps
- Legacy Technology
- Shared Technology

ADSL – 10 Mbps
- First Generation of DSL
- Shared Technology

ADSL2 – 24 Mbps
- Second Generation DSL
- Shared Technology

Cable – 150 Mbps
- DOCSIS 3.0
- Shared Technology

Next-Generation Fiber-Optic
- PON, Active Ethernet
- Shared and
- Dedicated Technology



[1] Actual speed and quality of service will depend on the specific service contracted by the end user, whether using a traditional broadband service or a next-generation broadband service.

3. The Current State of Broadband in Hudson

The majority of Hudson's residents and businesses still utilize copper-based broadband infrastructure to transmit information from a user to the Internet; this includes twisted-pair copper telephone and coaxial cable lines. DSL and cable networks have provided sufficient bandwidth to a majority of residential and small business users. However, as bandwidth needs have grown, subscribers demand more and more bandwidth out of these systems to support more applications and more devices. In reaction to the growing bandwidth needs, DSL and cable networks have evolved to provide more bandwidth to homes and businesses. Broadband providers have continued to upgrade equipment and networks to make these lines faster and more reliable, however; several fundamental issues exist with copper infrastructure that pose long-term challenges to the growing bandwidth demand:

- Broadband signals degrade significantly as distances increase in copper-based networks.
- Broadband signals are susceptible to electrical interference and signal degradation in copper-based networks, particularly as they age.
- Copper-based networks delivering broadband services generally utilize shared bandwidth among pools of users that results in an uneven distribution of speed to these users.

The limitations of Hudson's copper-based networks are overcome by deployment of new technologies such as fiber-optic infrastructure. The old standard of copper in local broadband networks is transitioning to fiber-optic, however; the pace of this transition is slow. Costs for deployment of fiber-optic infrastructure are extremely high, particularly in areas where no fiber-optic infrastructure exists. Providers understand that fiber-optic broadband delivers the only long-term solution to the ever-growing bandwidth needs of homes, businesses, and community anchors. Fiber-optic broadband connectivity is considerably different from its copper-based predecessor, in the following ways:

- Fiber-optic technology converts broadband data signals to light and sends the light through transparent glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps.
- Actual speeds are always dependent on the services provisioned by the service provider who operates the system, however; speeds generally range from 10 Mbps[2] to 100 Gbps[3].
- Variations of the technology run the fiber all the way to the customer's home or business, to the curb outside, or to a location somewhere between the provider's facilities and the customer.

[2] Mbps stands for millions of bits per second or Megabits per second and is a measure of bandwidth (the total information flow over a given time) on a telecommunications medium.

[3] GBPS stands for billions of bits per second or Gigabits per second and is a measure of bandwidth (the total information flow over a given time) on a telecommunications medium.

Magellan met with businesses in Hudson to gain an understanding of their Internet needs. Over a 3-day period in early December 2014, Magellan and City staff met with the following businesses:

1. Chamber of Commerce
2. Catastrophe Management Solutions
3. Developer Meeting
4. Laurel Lake Meeting
5. Western Reserve & Montessori Meeting
6. Corporate Technologies Group Meeting
7. Joanne Fabrics Meeting
8. Day Ketterer Law Firm
9. Norandex
10. Hudson City Schools
11. Kobelco
12. Ramco
13. Landlords
14. Western Reserve Systems Group

In general, businesses in Hudson reported consistent issues with their broadband Internet services, specifically around the reliability, performance, and affordability. Lack of availability seemed to be a recurring theme among businesses interviewed. Many of these businesses cited issues getting service from more than one provider and that only one provider was available in most cases. Several businesses reported an issue getting anything but Windstream DSL or Ethernet over Copper service to their facilities. Other businesses reported that Time Warner was not available and significant infrastructure construction was needed to establish service, at a high upfront cost. There appears to be a lack of Time Warner's service for "business class" services in some parts of Hudson. A few businesses reported that they have "learned to live with" the broadband services at their location because no other options were available.

There also appears to be a lack of any *affordable* fiber-optic infrastructure in the area, either through Time Warner or through Windstream. Fiber is clearly available through both providers as evidenced by Hudson's large businesses that subscribe to these services. In most cases, they were satisfied with the services but realized that they were paying a high price for these services.

Providers do not appear responsive to businesses needs in Hudson. In multiple instances, businesses reported that providers were not responsive to their needs and could not establish service in a timely manner. One business in particular reported that Windstream gave them a 9-month lead-time to install fiber. Another business reported that their move into the Omni Business Park was dependent on Windstream's timeframe to establish service at this facility.

A. Hudson's Current Providers and Broadband Networks

It is important to assess the degree to which high-speed broadband infrastructure has been deployed in Hudson to understand where this Needs Assessment can have the most impact for the community and minimize duplication of potential broadband overbuild. This Plan has identified the existence of the necessary facilities, networks, and backhaul capacity to enable expansion of high-speed broadband in Hudson. Providers have the necessary capabilities, infrastructure, and service platforms to deploy and manage services within the region and have done so in certain areas.

Fiber-optic broadband services are available in some of the City's corridors and through multiple providers. Outside of the City proper, this infrastructure is sparse and generally follows the highways that interconnect Hudson to neighboring communities. In many cases, this fiber-optic infrastructure may not be available to provide services directly because of its use as backhaul to interconnect communities in the Hudson area and to connect the region to long haul networks that connect to Internet points of presence in the region.

Magellan has evaluated the current state of the broadband networks in Hudson. Where information is available, we have documented and inventoried network assets to define a baseline from which to evaluate the network's capabilities, network gaps, and potentials for future applications and expansions. We include documentation where possible of physical fiber routes, conduit, poles and pole lines, rights of way, splice points, and other information related to physical plant. The analysis primarily focuses on fiber-optic facilities rather than wireless since wireless spectrum is a shared capacity (including that used for 4GLTE) such that if some users are consuming the full capacity, additional users have no access to capacity.

The broadband networks in Hudson are composed of networks built by private companies such as the telephone and cable TV providers as well as the network built by the City's municipal electric department. A variety of companies provide broadband infrastructure in the retail markets in the greater Hudson area, they include:

- Windstream is the incumbent local exchange provider in Hudson. As the incumbent LEC, Windstream provides both retail services to consumers and wholesale services to other telecommunications providers. Windstream is upgrading its current service offering to VDSL2, which will provide additional bandwidth to its subscribers in the market. During our stakeholder meetings, Windstream stated, "Fiber service is readily available – anyone can access it." In addition, the Windstream team informed us that all new residential communities would receive Fiber to the Home technologies; however, there is no plan to overbuild existing residential markets. Windstream provided a fiber map showing existing fiber routes in Hudson requesting that it not be published.
- Time Warner Cable (TWC) is a national cable telecommunications provider servicing the City of Hudson. TWC provides triple-play (voice, video and Internet) services to the community. While TWC was contacted to participate in this Assessment as a community stakeholder, they opted out.

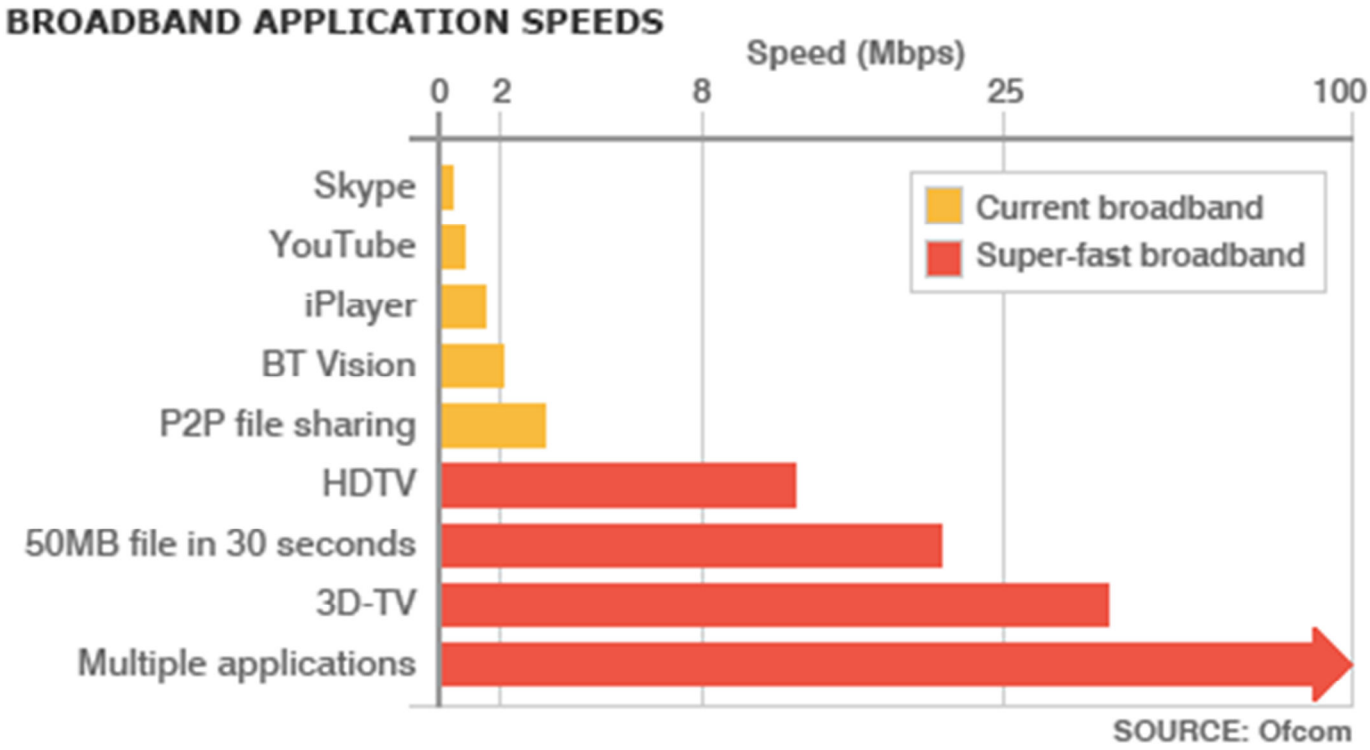
- Fibertech operates one of the fastest growing metro fiber optic infrastructures in the Northeast. The company has built more than 10,000 route miles of network in 30 markets across the Northeast. Fibertech has several customers in Hudson. These customers receive transport and Dedicated Internet Access (DIA) services provided over fiber optics. The Fibertech fiber offering in Hudson is delivered over a traditional point-to-point fiber architecture providing dedicated service offerings with associated service level agreements. Fibertech does not offer GPON services, which is a shared capacity fiber distribution technology. During our meeting with Fibertech, they stated that they would welcome the opportunity to construct fiber routes with the City jointly, but that they were not interested in leasing dark fiber or other lit Type II services from the City.
- OneCommunity was founded in 2003 as a nonprofit organization. OneCommunity has been charting a digital infrastructure path for Northeast Ohio for the 21st Century and is dedicated to realizing the transformational potential of broadband technology. OneCommunity maintains a nearly $200 million open network that covers more than 2,400 route-miles of fiber, connecting 1,800 facilities and organizations in 23 counties which includes Summit County.

4. What is Driving Broadband Demand in Hudson?

A. Residential

Broadband technologies have evolved to carry more and more data because of the advancements in online applications. Every application requires a certain amount of bandwidth on a broadband connection to function properly; as time has progressed, we have witnessed significantly more applications, and significantly, more bandwidth used by those applications. Figure 4-1 illustrates the bandwidth requirements of common applications and the impact of multiple applications running across a broadband connection.

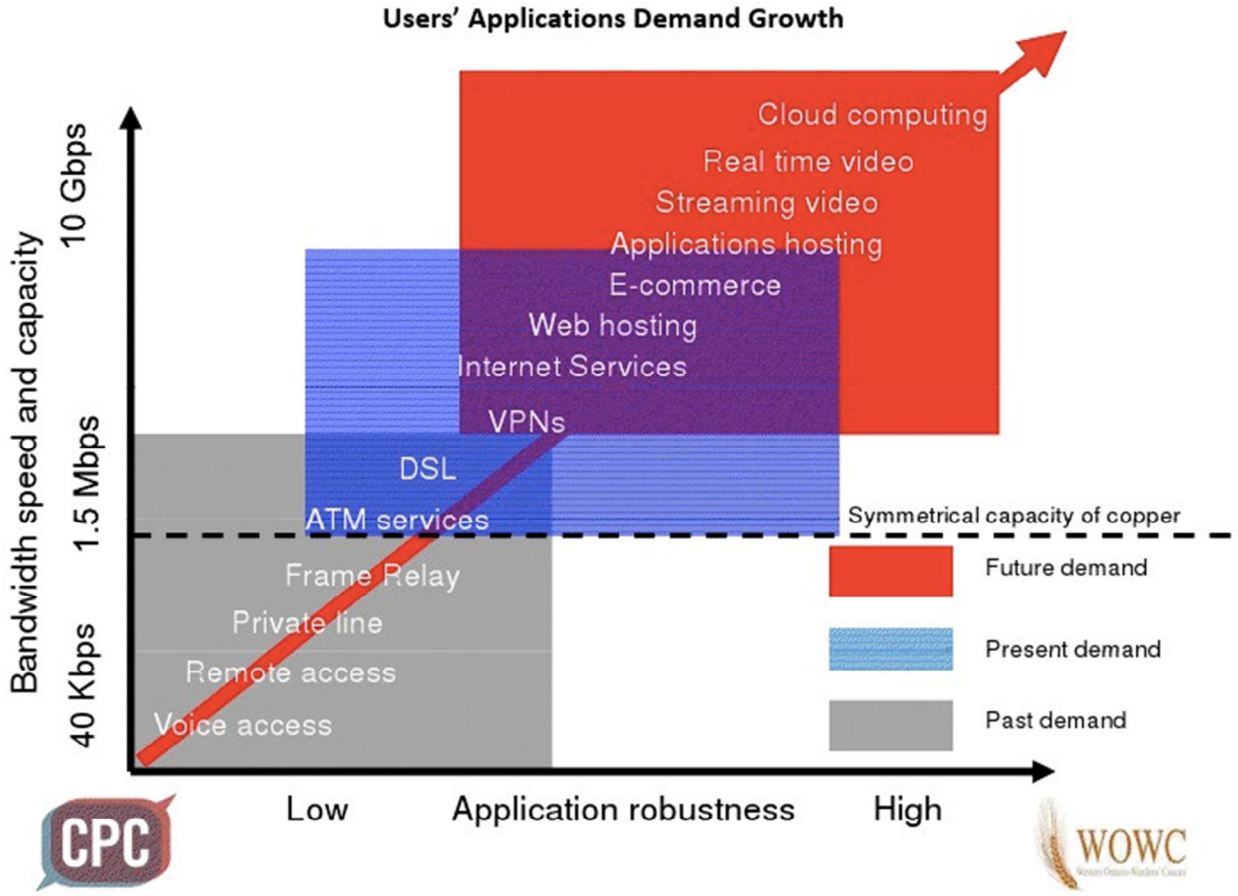
Figure 4-1: Broadband Application Speeds and the Impact of Multiple Applications



Today, broadband subscribers across every user class are utilizing more and more online applications and particularly those that consume larger amounts of high-quality bandwidth. Figures 4-1 and 4-2 illustrate user demands for applications today and the increases in broadband that are necessary to accommodate this demand. Currently, broadband subscribers make heavy use of the core Internet functions consisting of Internet browsing, web hosting, e-commerce, virtual private network connectivity, and voice services. However, subscribers are beginning to consume more real time video and streaming applications, which require significant bandwidth, reliability, and performance out of their broadband connections. We are still early in the lifecycle of Internet video applications and these are expected to grow significantly over the next 10 years, replacing much of the text-based Internet.

In addition, the myriad of cloud services is driving the need for more symmetrical[4] broadband as real time and cloud applications require additional bandwidth, both in download speed and upload speed. As more of these applications are deployed and replace traditional PC-based software, broadband connections will need to accommodate the increased bandwidth load. Many times these applications synchronize in real time, meaning that they are always consuming bandwidth at a constant rate rather than only when the user is actively engaging the application.

Figure 4-2: User Demands for Applications over Broadband Connections



The proliferation of devices is also driving the need for more bandwidth as more devices in the home, businesses and public places all access existing broadband connections. A report published by Google in 2012 demonstrates the amount of time the average user spends with their devices across each type of device, and how users interact with multiple devices simultaneously. Although the study's primary goals were to "gain a deep understanding of consumer media behavior over a 24-hour period…,"[5] an important implied finding is that users are spending significantly more time with their devices, devices that all

[4] Symmetrical broadband connections provide equal download and upload speeds, such as 10 Mbps down, 10 Mbps up, instead of traditional asymmetrical broadband services that provide unequal speeds, such as 10 Mbps down and 2 Mbps up.
[5] The New Multi-Screen World. Understanding Cross-Platform Consumer Behavior" Google 2012. http://think.withgoogle.com/databoard/media/pdfs/the-new-multi-screen-world-study_research-studies.pdf. Accessed, January 2015.

require broadband connections. As these devices all vie for bandwidth on a users' broadband connections, the demand for more bandwidth to support more applications grow.

Figure 4-3: The Proliferation of Broadband-Connected Devices

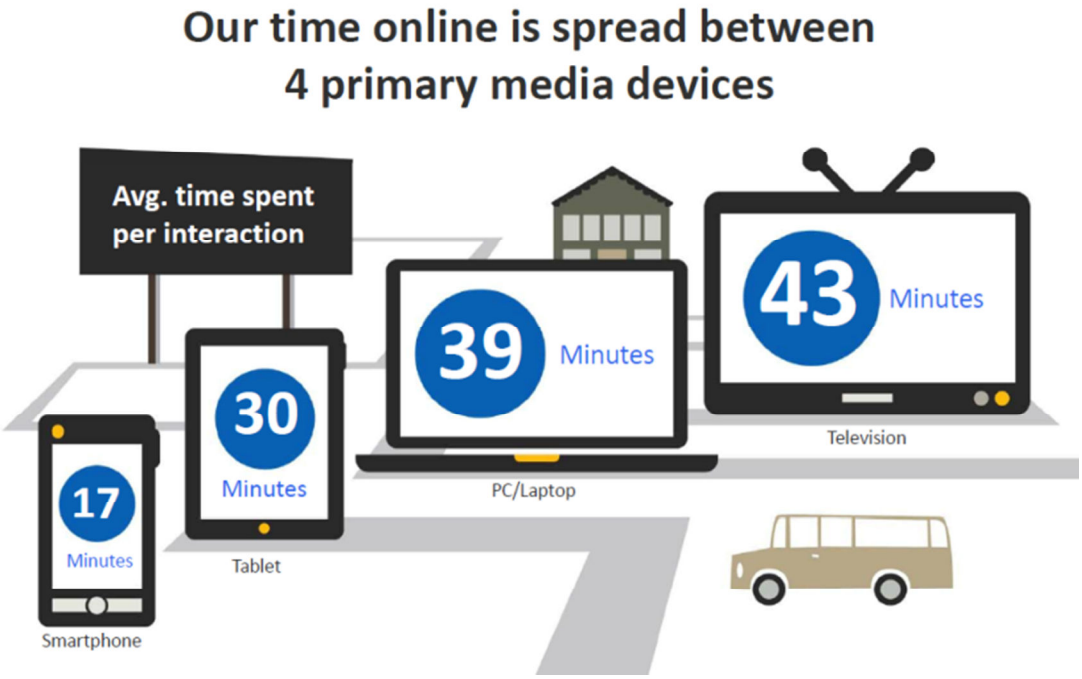
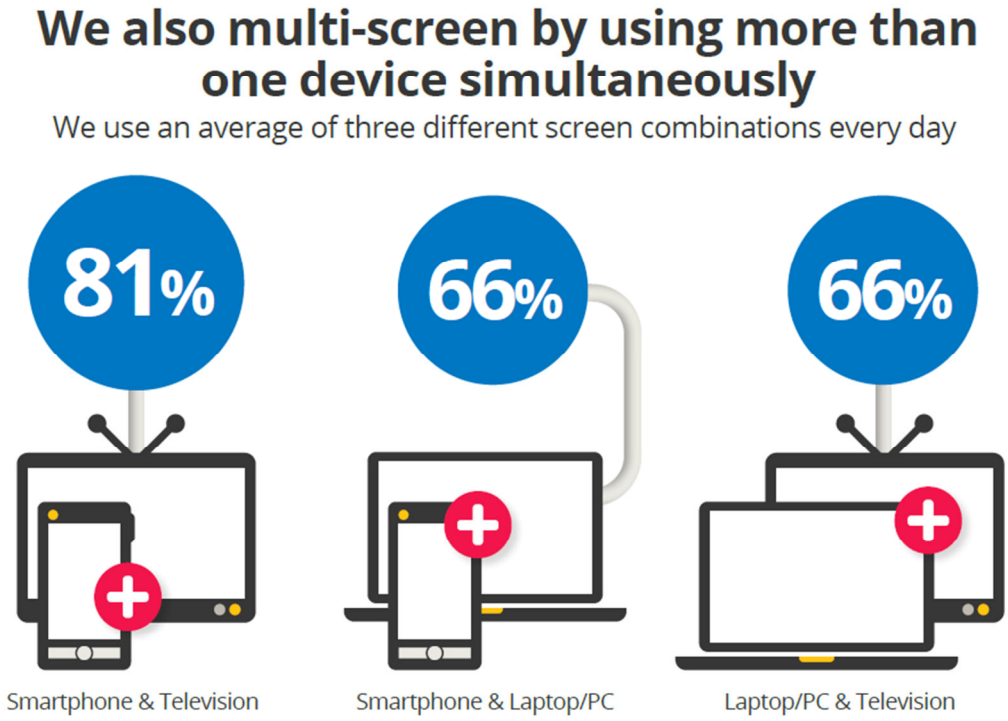


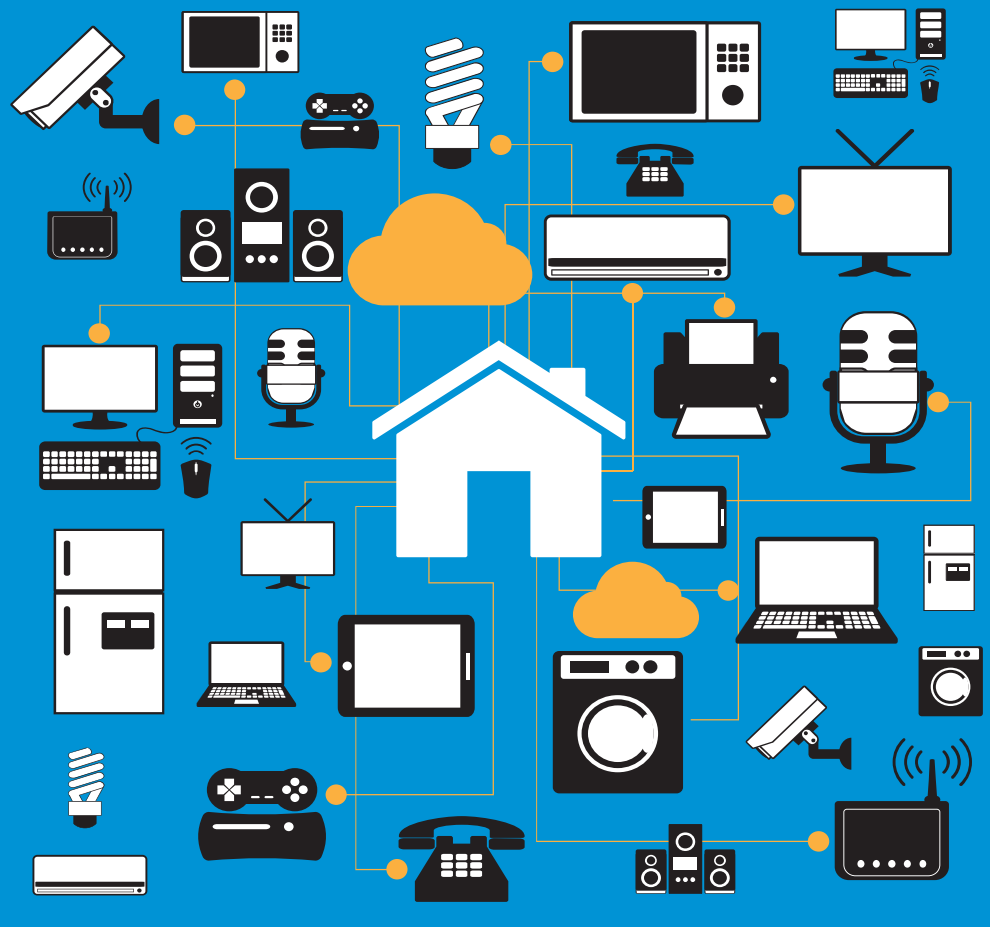
Figure 4-4: The Use of Multiple Broadband-Connected Devices



These devices also extend to many devices inside the home that are now being connected to the Internet and using our broadband connections. Many video/audio systems, thermostats, irrigation and security systems are now connected to the Internet, consuming more home broadband bandwidth.

78% of Hudson residential survey respondents have 5 or more devices connected to the Internet at home while 30% have more than 10 devices

The explosion of Internet-connected home devices will lead to increased use of residential broadband connections, as "always-on" technologies are constantly



An online survey of Hudson's residents was conducted to understand the community's broadband uses and needs better. Out of 986 residents surveyed, 99.8% have Internet at their home. An overwhelming majority of respondents are serviced by one of two incumbent carriers, Time Warner Cable and Windstream. 98% of residents have high-speed Internet services (e.g. DSL or cable). Residents across Hudson are connecting multiple devices to the Internet, with 78% reporting that they connect five or more devices, while 30% connect 10 or more devices to the Internet. Residents reported Internet services were important to the members of their households and 30% of households reported having a home-based business, with another 52% of households having someone who telecommutes.

Further details from the survey of residents include:

- One third (33%) of Hudson residents are paying between $50 and $74 a month for home Internet services, 11% are paying $75 to $99 a month, and an additional 28% of residents are paying above $100 a month.

- The vast majority of residents (75%) have experienced moderate, severe, or total disruption of their service from Internet problems with reliability and speed.
  - "It's terrible at times."
  - "Loss of Internet intermittently for no apparent reason at times. Miss Verizon FIOS in VA. Hate TWC."
  - "Time Warner Cable is horrible."
  - "I'm a telecommuter. If Internet is down, I CANNOT WORK. Reliability is more important than speed."
  - "Constantly going down."
  - "Always having trouble with Internet going out!!!"
- 67% of Hudson's residents stated that high-speed Internet is so important to the members of their households that "they can't live without it."
- Residents that reported not having home Internet services noted that the number one reason is that it is too expensive (29%). All additional explanatory responses are:
  - "It's a monopoly, not enough choices. High cost."
  - "I have Internet, it's too slow and too expensive."
  - "Thinking of cancelling my service as it's too expensive and there are not many options. I truly believe it's a monopoly."
- 56% of residents do not have access to a triple-play service that includes voice and video services, and another 25% are unsure if they do.
- Over 442 survey respondents provided additional comments regarding their Internet service. A full list of responses has been provided in the Business & Residential Survey Data Report.
  - "I would love to not have to deal with TWC."
  - "Hudson needs to get fiber optic throughout the city…"
  - "Local broadband as an alternative to TWC would be a great asset to the City."
  - "Corporate broadband services will try to ruin this, don't let them. Windstream is molasses and TWC is an evil monopoly that threatens the nation. PLEASE give us residential broadband, even if we have to pay for it, anything is better than current service."
  - "I wish we had more choice of Internet providers."
  - "Strongly urge the City to consider implementing fiber optics. Have had this service in Cincinnati and found it by far superior to any other Internet methodology."
  - "Like the idea of bringing broadband to Hudson."
  - "I emphatically support communities developing their own high speed fiber networks. Currently we're at the mercy of high cost and low quality telecom services, and we shouldn't have to be. This is a great step to promote Hudson's future."
  - "I don't understand half of how it works or why but we are becoming more dependent upon reliable service; hope this new initiative will provide the "broadband" experience with the same great service level as Hudson Power…"
  - "We are in favor of the broadband initiative."

75%

Of Hudson residents reported moderate, severe or total disruption of their business from Internet problems related to reliability or speed.

67%

Of Hudson residents reported that Internet is so important to the members of their households that "they can't live without it."

An overwhelming majority of respondents are serviced by one of two incumbent carriers, Time Warner Cable and Windstream.

30%

Of Hudson residents reported having a home-based business.

52%

Of Hudson residents reporting having someone in the household that telecommutes.

30%

Of Hudson residents reported having 10 or more devices connected to the Internet.

B. Business and Economic Development

Accessible, affordable, and reliable broadband services is a key economic development tool to attract and retain businesses in Hudson. In many cases, bandwidth consumption outpaces the broadband speeds local businesses are able to purchase and upgrading is often times not an option due to the prices businesses are able to afford as well as other IT related factors. When these broadband services cannot "keep up" with business needs, businesses lose productivity and efficiency, affecting their bottom line and making them less competitive with regions that have more widely deployed high-speed broadband services at more affordable prices. This will eventually result in a less competitive business market from an economic perspective. It also leads to retention issues as businesses that are not able to gain efficiencies with their existing broadband services will, in many cases, move operations to communities that have more availability of these services.

Over 58% of Hudson's GDP is produced by businesses with less than 50 employees. Small and medium businesses need high-quality broadband to grow and compete.

Magellan Advisors and the City of Hudson conducted an online survey of businesses regarding broadband uses and needs. Please see the Business & Residential Survey Data Report for charts, which depict survey results for each question. 133 businesses took the time to respond to the survey.

Out of 133 businesses surveyed, 90% were small businesses with 50 or fewer employees. The top five sectors by NAICS code were Professional Scientific & Technical Services, Retail Trade, Healthcare and Social Assistance, Finance and Insurance, and Manufacturing. Nearly all businesses surveyed were within Hudson's city limits. 58% of businesses reported that their Internet services were not currently meeting their needs due to inadequate speed or insufficient reliability. Of that percentage, 42% had not upgraded because services were not available and 42% had not upgraded because the price was too high.

Further details from the survey of businesses include:

- The vast majority (86%) were small businesses with 25 or fewer employees. Approximately 10% were large businesses with over 50 employees.
- Professional Scientific & Technical Services, Retail Trade, Healthcare and Social Assistance, Finance and Insurance, and Manufacturing were the top five industries represented in the survey.
- Four out of every five (80%) businesses have experienced moderate, severe, or total disruption of their business from Internet problems with reliability and speed being the main issues.

- 58% of businesses state current Internet services are insufficient for their business needs, and a further 8% are not sure that current Internet services are sufficient. Reasons current Internet services are not sufficient include:
    - 58%: Not fast enough
    - 61%: Unreliable
    - 39%: Lack of options
    - All additional explanatory responses are:
        - "Too expensive."
        - "Need more bandwidth and better speeds."
        - "Customer service is bad."
        - "I have the max speed available in my area, and it's pathetic to say the least."
        - "Bandwidth is inconsistent and not reliable."

- Businesses have not upgraded service to remedy these insufficiencies since services are not available (42%), the price is too high (42%), lack of knowledge of options (7%), and lack of technical skills (10%).
    - All additional explanatory responses are:
        - "ISPs cannot guarantee faster download and upload speeds than we currently have."
        - "It' not clear that faster service is available."
        - "Too costly to increase speed with Time Warner and the only other options are Dish or DSL, which are less reliable and slower."
        - "I already have the fastest service available."
        - "Looking for alternative facilities based service provider."
        - "Our service goes down frequently."
        - "We have two high-speed feeds only because we don't have confidence in either supplier."

- 65% of businesses state it is "Very Important" or "Extremely Important" to the long-term success and growth of the business to have multiple choices of broadband providers, offering a wide range of pricing options and features.

80%

Of Hudson businesses reported moderate, severe or total disruption of their business from Internet problems related to reliability or speed.

65%

Of Hudson businesses state it is Very Important or Extremely Important to the long-term success and growth of their business to have multiple choices in broadband providers.

58% of businesses state current Internet services are insufficient for their business needs. Reasons include:

58%

Of businesses say their current Internet service is not fast enough.

61%

Of businesses say their current Internet service is unreliable.

39%

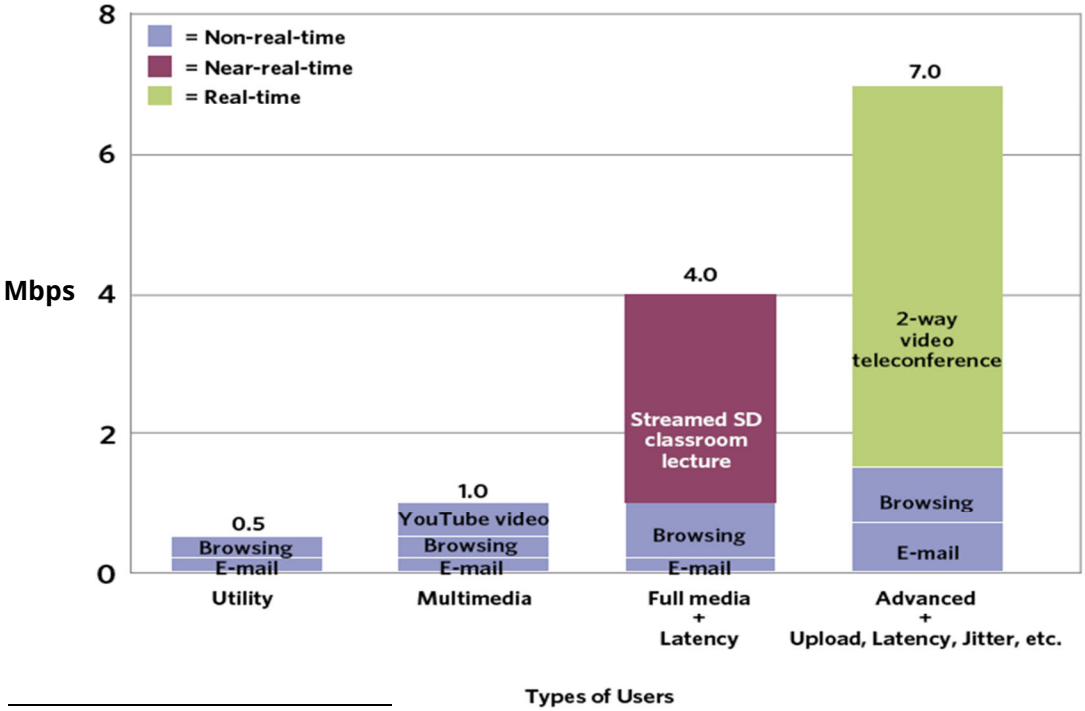
Of businesses say there are a lack of options when choosing a provider.

C. Education

Educational organizations are a major user of broadband in Hudson and their needs continue to grow. These include K-12 schools, community colleges, and higher education. Online applications used by these organizations require not only high-bandwidth broadband, but also services that meet strict quality and performance requirements to support real-time video and voice applications such as distance learning and teleconferencing. In addition, educational institutions are utilizing more online content to support their curricula, from sources such as YouTube, Vimeo, and Facebook.

Figure 4-5 illustrates the bandwidth requirements per student for common educational applications and the quality and performance requirements of these applications. Basic educational tools, such as web browsing and YouTube consume up to about 1 Mbps per student. However, moving up to more advanced educational technologies such as streamed classroom lectures and 2-way video teleconferences use significantly more bandwidth per student, 4 Mbps and 7 Mbps, when combined with the basic educational tools. In addition, these advanced tools require not only more bandwidth but also strict broadband quality metrics that allow them to function properly, such as low latency and higher upload speeds.

Figure 4-5: Bandwidth Requirements of Educational Technologies per Student[6]



[6] National Broadband Plan. "Current State of the Ecosystem" http://www.broadband.gov/plan/3-current-state-of-the-ecosystem/. Accessed June 2014.

While Hudson City Schools would be a prime candidate for the City of Hudson to target as a community anchor customer, we understand they already own their own dark fiber network that is utilized to interconnect the Schools and administrative facilities. It is more likely for the City of Hudson to provide a connection directly to the schools for primary Internet or redundant Internet services. In addition, the City could establish an interconnect with the Schools for public safety and security initiatives or as a provider of other "value-add" services.

D. Healthcare

Broadband is crucial for Hudson's healthcare providers that are interested in meaningfully leveraging electronic health records, as many of the capabilities of health IT such as telehealth and electronic exchange of health care information, require high performance broadband capability. Hudson's major hospitals currently maintain access to high-speed broadband services but beyond these organizations, few healthcare providers maintain this type of access. Doctor's offices, clinics, and imaging centers all have growing broadband needs to ensure they stay connected as their organizations transition to the digital healthcare environment. For these smaller organizations, high-speed broadband becomes a critical need to fulfill their mission and long-term success.

Many trends and applications in the healthcare field drive the need for more broadband infrastructure. There will be medical instrumentation and measurement at home, faster than many people realize – which will require substantial bandwidth and "always on" connectivity. Medical record billing and coding often is done from home that requires substantial bandwidth.

The City of Hudson could potentially act as the provider of transport services to the local hospital systems and doctor's offices, clinics and imaging centers, enabling the sharing of electronic medical records and other collaboration where possible. In addition, it is likely these organizations would also benefit in receiving the ability to bid and contract for services with multiple fiber-based providers.

Single Physician Practice – 4 Megabits per second (Mbps)

- Supports practice management functions, email, and web browsing
- Allows simultaneous use of electronic health record (EHR) and high-quality video consultations
- Enables non real-time image downloads
- Enables remote monitoring

Small Physician Practice (2-4 physicians) – 10 Mbps

- Supports practice management functions, email, and web browsing
- Allows simultaneous use of EHR and high-quality video consultations
- Enables non real-time image downloads
- Enables remote monitoring
- Makes possible use of HD video consultations

Nursing home – 10 Mbps

- Supports facility management functions, email, and web browsing
- Allows simultaneous use of EHR and high-quality video consultations
- Enables non real-time image downloads
- Enables remote monitoring
- Makes possible use of HD video consultations

Rural Health Clinic (approximately 5 physicians) – 10 Mbps

- Supports clinic management functions, email, and web browsing
- Allows simultaneous use of EHR and high-quality video consultations
- Enables non real-time image downloads
- Enables remote monitoring
- Makes possible use of HD video consultations

Clinic/Large Physician Practice (5-25 physicians) – 25 Mbps

- Supports clinic management functions, email, and web browsing
- Allows simultaneous use of EHR and high-quality video consultations
- Enables real-time image transfer
- Enables remote monitoring
- Makes possible use of HD video consultations

Hospital – 100 Mbps

- Supports hospital management functions, email, and web browsing
- Allows simultaneous use of EHR and high-quality video consultations
- Enables real-time image transfer
- Enables continuous remote monitoring
- Makes possible use of HD video consultations

Academic/Large Medical Center – 1,000 Mbps

- Supports hospital management functions, email, and web browsing
- Allows simultaneous use of EHR and high-quality video consultations
- Enables real-time image transfer
- Enables continuous remote monitoring
- Makes possible use of HD video consultations

E. Public Safety

We live in a changing world where public safety agencies must address new threats and challenges both natural and man-made. It is no longer enough for first responders to rely on a push-to-talk (PTT) network for situational awareness. Police, fire, and emergency medical services (EMS) play the central roles in emergency response. Mobile technology capable of sending and receiving bandwidth-intensive information can help first responders do their jobs much more effectively and safely. These emergency response organizations need broadband networks that let them share streaming real-time video, detailed maps and blueprints, high resolution photographs, and other files that today's public safety and commercial wireless networks cannot handle, especially during major events or catastrophes.

Broadband technology and infrastructure is critical to the success of our first responders because it provides them with enhanced situational awareness in emergencies. By leveraging broadband networks, public safety organizations can gain access to site information, video surveillance data, medical information or patient records, and other information that would be useful in an emergency. These networks also support and improve 9-1-1 Public Safety Answering Points (PSAPs) response time and efficiency by establishing a foundation for transmission of voice, data, or video to the responding entity.

New broadband technologies give first responders new tools to save lives. These tools include:

- Next-Generation Radio Systems;
- Advanced Security Camera Systems;
- Gunshot Detection Systems;
- Chemical, Biological, Radiological, Nuclear, and Explosives Sensor Systems;
- Body-Worn Cameras; and
- Next-Generation Wireless Data Systems.

F. Community Support

In order for a community to thrive and grow, community support organizations must be in place. Organizations such as local chambers of commerce, human services organizations, churches, and other organizations that help connect people to the services they need in the community. These organizations traditionally access the needs and resources available in the community and collect the data necessary to help fill the gaps in services and investigate opportunities to solve community problems and issues.

Broadband plays a vital role in helping these types of organizations fulfill their missions. Whether it is as simple as a community church streaming their weekly service or the local chamber of commerce advertising their latest event through their web presence and email, broadband equips these organizations with one of the most critical communication tools necessary to ensure they are successful in their support roles.

Broadband availability inspires these organizations to be innovative in their use of technology and brings a higher level of welfare to the communities they serve. Take for example All Saints Church in rural Norfolk County, UK. The church is utilizing its spire (the tallest structure in the area) to deliver wireless Internet service to the surrounding community. Now, in a community that was lucky to see speeds up to

1 Mbps, speeds of over 8 Mbps are common. This community support organization has brought broadband service into an area that was previously underserved and is helping to bridge the digital divide that plagues many communities around the globe.

G. Smart City Innovation

Broadband networks become key drivers of efficiency and innovation as more and more municipal applications are enabled online. As they expand online services, broadband will become an even more critical component of the daily operations to serve communities. Applications migrated to a community network enjoy greater availability and increased bandwidths over what has traditionally been available, creating a more effective and efficient municipal organization. High-speed, reliable broadband enables these organizations to:

- Improve operational efficiencies;
- Reduce direct and indirect costs;
- Enable new interactions with citizens and businesses;
- Respond more quickly to the local community;
- Ensure better preparedness in times of emergency;
- Provide enhancements to public safety;
- Provide more information to citizens and businesses; and
- Provide higher quality service to the local community.

Municipal fiber is capable of much more than just providing broadband services. It can provide a publicly owned communications infrastructure that can be used for additional public benefits, including enhanced municipal utilities, new e-government applications, technology collaboration, and infrastructure sharing programs. In addition, a municipally owned network can provide a platform for long-term innovation of Smart City technologies and applications, ranging from smart homes to energy conservation and management to green building programs. While the initial goal of this infrastructure is to enhance local broadband services, it will become a long-term asset to support Smart City programs increasing efficiency, lowering cost, reducing environmental impact, and enhancing the quality of life.

Smart City Innovations through Municipal Fiber Networks

Broadband Services

- Common backbone for all anchors
  - County & City
  - Schools
  - Libraries
  - Hospitals
  - Clinics
  - Public Safety
  - Community Support
- Interconnection with service providers
- WiFi in public centers

IT Collaboration

- E-Government applications
- Bulk Internet purchasing
- Application sharing
- Disaster recovery
- EOC communications

Public Safety Applications

- Video monitoring
- First responder support
- Collaboration with State & Federal agencies
- FirstNET preparedness

Future Energy & Utility Management

- Smart Grid & Demand Response
- Automated Meter Reading
- Advanced Metering Infrastructure
- SCADA communications and control

5. Opportunity Assessment

A. What Impact Can the City Have on Local Broadband?

The primary objectives of employing the City's fiber optic network, broadband-friendly public policies, and strategic investments are to improve access and availability of broadband services in Hudson. These tools are utilized to increase the supply of broadband infrastructure that is available to serve Hudson's businesses, residents, and community anchors. A number of benefits can be realized by expanding access and availability of broadband in Hudson, including:

Improving Affordability

By leveraging broadband assets that are already available within the City, the amount of new broadband construction is limited, reducing the investments necessary to provide services to subscribers. The cost of new broadband construction within the City may range from $50,000 - $100,000 per mile of fiber-optic infrastructure, depending on the location. In places where the City already has available conduit and fiber-optic infrastructure, "overbuilding" may not be necessary by broadband service providers, which will help them reduce their total costs to provide services to end users. In some cases, costs for broadband construction are directly passed on to end users in the fees collected by broadband service providers. In other cases, these costs become part of a broadband service provider's total cost of services from which standard rates for residential and business broadband services are derived. In both cases, the costs for broadband construction increase broadband service providers' "bottom line." Reducing these costs where feasible can positively impact costs for these providers and in turn, can lower the rates paid by subscribers

Enhancing Economic Development

Increasing the availability of fiber based services into the main business corridors and parks will allow the City and its local partners to enhance the economic development message regarding Hudson's broadband capabilities. Through the deployment of fiber distribution technology, the City can designate these areas as being "On-Net", allowing any business moving to Hudson to recognize that fiber services are available from a number of national carriers. This concept, partnered with a Data Center facility would provide the message that a business can locate in any business center such as Downtown, or one of the many business/tech parks in Hudson and they will have next-generation broadband availability.

Increasing Adoption

Broadband adoption is influenced by two key factors, relevancy, and affordability. The City has the opportunity to improve affordability by leveraging its fiber-optic network and making measured investments in additional infrastructure. Affordability and adoption of broadband services are positively correlated. As affordability increases, so does adoption. The City can positively influence adoption by negotiating agreements with broadband service providers to provide "lifeline" Internet services at low costs for disadvantaged residents, small businesses and other targeted populations in exchange for

discounted use of its broadband assets. These incentive programs can help broadband service providers deploy more quickly and at lower costs in exchange for their participation in such lifeline programs.

Improving Public Efficiency and Effectiveness

Leveraging the City's broadband assets to connect public institutions throughout the community creates the opportunity to establish collaborative technology programs across multiple organizations. Establishing institutional access to the City's conduit and dark fiber networks would create a high-speed, inter-governmental backbone through which these organizations could collaborate with one another on Information Technology and communications projects. Connecting schools, libraries, local government, public safety, and community organizations to one another could facilitate the sharing of technology resources among the organizations connected. Some of the potential benefits may include cost reductions through joint volume purchasing agreements, application sharing, and improvements to emergency operations and communications.

Reducing Taxpayer Spend

Improving public efficiency and effectiveness should reduce the costs of government to the local taxpayer. If employed effectively, the City's broadband initiatives can become a tool that facilitates cost reductions, not only for the City itself but also for other public organizations across the City, including schools, libraries and other community organizations. An inter-governmental network connecting these public organizations should consolidate the purchasing power of all agencies for common information technology and communications services, resulting in lower overall costs. The network can also "futureproof" the connectivity needs of these public agencies and protect them from cost increases, as they require additional bandwidth.

Reducing Lead Times for Installation

The time to install and activate end users' broadband services is significantly determined by the availability of infrastructure in the area. Businesses are negatively impacted by fiber construction lead-times that may result in delays to activate their services. 30 days is the typical industry standard lead-time for activation of fiber-optic broadband services, without a provision for special construction. In many cases, the lead-time may double or triple depending on how much additional fiber construction is necessary to reach the end user's location. The City's conduit and dark fiber infrastructure can be used to supplement existing broadband service provider infrastructure to reduce these lead times.

Supporting Reliability and Performance

The City's broadband assets can be used to support the reliability and performance of broadband services across Hudson. These assets can be employed to provide new physical route diversity to the networks of existing broadband service providers and increase capacity in existing routes. They can be used to increase backhaul capacity in areas of the City that are near or at their limit and equip more commercial towers with dark fiber connectivity, increasing the bandwidth available to mobile carriers serving Hudson's wireless needs. Community anchors can utilize these assets to achieve significant

upgrades in speed and connectivity between their facilities as well as diversity for their primary connectivity.

B. What Options Should the City Consider?

The City has several strategies that it can use to expand next-generation broadband to residents and businesses. These include the following:

- Implementation of broadband-friendly public policy tools;
- Development of broadband public-private partnerships;
- Implementation of a City-owned open-access network; or
- Implementation of the City as a broadband service provider.

1. Implement Broadband-Friendly Public Policy Tools

What are Broadband-Friendly Public Policy Tools?

Broadband-friendly public policies are tools that cities can utilize to accelerate deployment and reduce the cost of constructing broadband infrastructure within their jurisdictions. These policies also enable cities to create more opportunities for the installation of broadband infrastructure in conjunction with other public and private projects occurring within the city. Public policy tools are implemented according to each city's existing ordinances and processes; there is no "cookie cutter" approach to implementing them.

Comprehensive Broadband Standards & Joint Trenching Policies

Integrating broadband "utility" standards into the City's land development code will enable the City to incorporate basic broadband infrastructure requirements into the land development process and encourage broadband construction to occur in conjunction with other capital projects. Road widening, sidewalk, trail, and lighting projects all may be opportunities for the installation of basic conduit infrastructure at favorable costs. By installing conduit in concert with these related capital projects, the City can avoid incurring the significant costs of constructing this infrastructure by doing so when the ground is already open. Since the majority of costs to build broadband infrastructure in Hudson are incurred through trenching and boring, this strategy can alleviate some costs of constructing underground infrastructure. The City, in alignment with its CIP, can determine which projects will help build usable infrastructure.

This process should also be coordinated with local service providers to minimize overbuilding and to ensure that service providers have an opportunity to place their infrastructure in capital projects as well. Joint trenching policies between the City, utility companies, and broadband providers can facilitate more opportunities to install conduit, fiber, and other infrastructure at much lower costs. Joint trenching agreements are developed between public and private organizations to minimize the cost of

constructing conduit in the local area, by allowing each entity to take advantage of trenches that have been opened through each other's projects. The City likely has some joint trenching agreements established with utility companies and broadband providers. Standardization of these agreements across all potential owners of underground infrastructure can be established to ensure all parties are aware of the joint trenching opportunities as they become available.

Infrastructure Fund

The City would establish an infrastructure fund set-aside, allocating monies to build broadband infrastructure when opportunities arose, aligned with the City's capital project schedule. The City would determine how much funding to allocate based on the capital project schedule and locations where the City could favorably build infrastructure at low costs. This fund would typically roll from year to year and maintain a reserve or set-aside for unanticipated projects.

Record Keeping

The City maintains Geospatial Information Systems (GIS) that contain detailed maps of the community, right of way, easements, and other information. As the City considers implementing broadband-friendly public policy measures, it should ensure that GIS documentation of any broadband infrastructure is made a requirement. This will allow the City to maintain a clear understanding and records of locations of broadband infrastructure; which may include conduit, vaults, pull boxes, transitions, fiber-optic cable, and other outside plant resources.

How Would the City Implement Broadband-Friendly Public Policy Tools?

Developing broadband friendly-pubic policies requires the City to evaluate its current land use, permitting, construction, and right-of-way policies to determine how these can be tailored to incentivize development of more broadband infrastructure in Hudson. Below is a basic guide explaining how many cities have implemented these policies:

The City should adopt General Plan policies that incorporate broadband as a public utility and create a policy framework to promote its deployment in public and private projects as appropriate, including:

a) Tailor draft policies and standards to the City's specific needs and adopt them into local policy, codes, and standards (including policies, dig-once, joint trenching, engineering standards, etc.).
b) Incorporate broadband in the City's Development Impact Fee program and the City's Capital Improvement Plan (CIP) as appropriate and make a commitment to fund broadband infrastructure.
c) Identify opportunities to install broadband infrastructure in conjunction with public and private construction projects as appropriate.
d) Develop a process so that Planning and Public Works coordinate with IT to identify projects that could install this infrastructure at reduced costs.
e) As the City makes key infrastructure investments, maintain broadband infrastructure in the City's GIS system, requiring GIS-based as-builts and implementation of other means for accurate documentation.

f) Evaluate ways to streamline the broadband permitting processes within public rights-of-way to ensure broadband providers do not face unnecessary obstacles to building infrastructure.
g) Evaluate fees levied on broadband providers for constructing broadband infrastructure to ensure they do not discourage broadband investment.

What Cities Have Implemented Broadband-Friendly Public Policies?

Example: City of Palm Coast, FL

In 2005, the City Council adopted specifications for broadband standards that subsequently became part of the City's engineering standards for all projects. Since 2005, the City has built 30+ miles of underground conduit infrastructure at a fraction of the cost by incorporating it into the design of water and sewer, road widening, and street lighting projects. The City has also worked with local developers to incorporate these standards into their commercial and residential projects to ensure that any new or retrofit development is outfitted with basic broadband infrastructure.

Example: Santa Cruz County, CA (County Organization)

Santa Cruz County has implemented a number of broadband-friendly public policies that act to streamline, expedite, and reduce the cost of building broadband infrastructure. The County has implemented the following:

1. *A master lease agreement allowing the placement of broadband infrastructure on County assets.*
2. *A new ordinance that more easily allows the installation or upgrades of broadband infrastructure in the County rights-of-way.*
3. *Conduit specifications for placement of conduit during construction projects (dig once).*
4. *A broadband master plan to target sections of the county (such as economic vitality areas) for additional broadband infrastructure.*

What are the Risks?

Implementing broadband-friendly public policies pose little financial risk to cities because they require little upfront funding if managed correctly. In some cases, cities have struggled with incorporating broadband into their existing land use policies because they are unfamiliar with how to manage a new "utility" type of asset. This requires the collaboration of multiple departments and the ability of these departments to work together to a common goal. The City should expect that some new business and operational processes would be required as well as changes to existing processes in order for the policies to be effective.

2. Broadband Public-Private Partnerships

One option to consider is the evaluation on public-private partnership opportunities with existing broadband providers before the City embarks on any other strategies. This can be a first step for the City to take that will help it understand what benefits can be achieved working in partnership with broadband providers. As every public-private partnership is different, the City would consider some key questions

around these complex relationships. The following section provides some guidance on broadband public-private partnerships (PPPs).

What are Broadband Public-Private Partnerships?

A broadband public-private partnership ("PPP") is a negotiated contract between a public and private entity to fulfill certain obligations to expand broadband services in a given area. PPPs have gained popularity over recent years as more municipalities employ public broadband and utility infrastructure in conjunction with private broadband providers. PPPs leverage public broadband assets, such as fiber, conduit, poles, and facilities with private broadband provider assets and expertise to increase the availability and access to broadband services. Municipalities forgo "getting into the business" of providing retail services and instead, make their broadband infrastructure available to private broadband providers to enhance their communities.

How Would Hudson Implement a Broadband PPP?

One option to develop a broadband PPP is to hold a competitive negotiation with one or more broadband providers. This option is utilized when the City has determined that it will pursue public-private partnership(s) with broadband providers. The public-private partnership may take different forms, depending on the needs of the City. In Hudson's case, the City would bring public broadband assets to the negotiating table with private broadband providers to achieve mutually desirable benefits to both the City and the partner(s). The ITN is a public procurement vehicle that can be used to negotiate and execute public-private partnerships.

In this case, the City could issue a public ITN through a public procurement that would invite broadband providers to submit information concerning how they would make use of the City's broadband infrastructure to achieve a pre-defined set of goals laid out by the City. Most ITNs resemble Requests for Qualifications ("RFQ") or Requests for Information ("RFI"). In general, ITNs are evaluated similarly to these types of procurements and are scored on the merits of each respondent's ability to meet or exceed the City's goals. Similar to RFQs and RFIs, ITNs are generally not evaluated on price as the revenues and costs within the project negotiated between the parties are a "moving target" and many times are not determined until well into the negotiation. Rather, they are executed on the total value derived from the project, in terms of economic development, new jobs, increases in the tax base, pricing for services, quality of services, and other "non-financial" benefits.

Why Would Hudson Utilize an ITN?

Cities utilize the ITN approach for several reasons. First, in cases where cities do not want to engage in managing broadband resources, cities have used ITNs to negotiate the wholesale use of their assets while retaining the underlying public ownership. Second, cities often want to utilize established procurement vehicles through which they can negotiate "partnerships" with broadband providers. ITNs are generally an acceptable form of procurement in most states; enabling cities to follow procurement and negotiation guidelines that are familiar to them. Third, cities often want to ensure their procurements are open and non-discriminatory to qualified broadband providers. ITNs utilize public

procurement channels to ensure that all qualified broadband providers are given a chance to respond to an ITN. This enables cities to include local incumbents, competitive providers, CELCs, and non-facilities based providers in the procurement.

What Questions are Important to Answer in Broadband PPPs?

As the City begins its discussions with the current broadband provider, it is important that the City consider the following questions to ensure it is making informed decisions about moving forward:

1. ***Should the City negotiate with one or multiple broadband providers?***

   The decision to form a Broadband PPP with a single or multiple providers will determine how much power the City maintains at the negotiating table with potential partners and how much of the City's "ask" is agreed to by the partner. In a single provider PPP, the provider will generally be incentivized by the opportunity to capture a large market through use of the City's broadband assets and do so with no competition from other providers for those assets. In a multi-provider PPP, multiple providers will have access to those assets, reducing the incentives a single provider would enjoy. However, a multi-provider PPP would protect the City from a lack of performance or a default of a single provider, which may render the PPP ineffective.

2. ***What is the range of potential partners available to the City?***

   The City should consider making an Invitation to Negotiate ("ITN") open and non-discriminatory, allowing all qualified providers the opportunity to submit their proposal to the City. This will be somewhat determined by the City's legal ability to negotiate with one provider without a public procurement. In many public-private partnerships, a public procurement has been used to ensure the City enforces non-discrimination requirements as a public organization. The ITN may be inclusive of Hudson's current broadband providers, including incumbents, cable companies, and other competitive providers. The City may also consider the geographic scope of potential partners. Limiting the scope of qualified applicants to only those serving Hudson today could limit the City's range of proposals. The City should consider expanding this scope to cover the greater US telecom/broadband market to include potential partners that may deliver other new and innovative broadband solutions to the City.

3. ***What incentives can the City offer potential partners?***

   The City can make its broadband assets available to one or more partners at reduced or no cost to incentivize providers to accelerate broadband deployments in Hudson. These incentives may also help providers reduce costs to citizens, businesses, and community anchors. The City should clearly identify the assets that it will employ in the partnership, the value of these assets and the consideration given to partners for incentivized use of the assets. Doing so will ensure the City and partner(s) clearly document the exchange of value between the partners. Many cities have used economic development agreements to memorialize these exchanges.

4. What Conditions should the City ask of broadband providers?

The City should clearly define its expectations in the partnership(s). These expectations may include offering specific types of services in target areas, guaranteeing performance and quality of services and offering low-cost "lifeline" packages for economically disadvantaged residents and businesses. The City should identify which components are required and non-negotiable in the partnership versus those components that may be negotiated. For Hudson, some of the critical "ask" terms for the City should include:

- Providing free Internet service to public organizations
- Establishing a non-compete agreement for connectivity services to public organizations, the City desires to expand its services to schools, healthcare and other public organizations directly;
- Meeting price targets for specific tiers of service to residential and commercial customers;
- Providing Gigabit services to residents and businesses;
- Co-Marketing programs that the City's economic development department can utilize to recruit new business and promote Hudson as a connected City;
- Enabling low-cost "lifeline" broadband services for economically disadvantaged residents;
- Equipping business parks, community redevelopment areas, and other designated places with broadband services; and
- Guaranteeing performance, availability, and reliability of services provided under the PPP.

5. How will the partnership be managed?

The City should anticipate the need for ongoing management of a Broadband PPP. This will require the City to establish resources to manage the Broadband PPP. The primary management functions include measuring the progress and performance of the partner(s), overseeing the broadband assets employed in the partnership and managing ongoing operational functions such as new broadband buildouts.

What are the Outcomes?

Outcomes are highly dependent on the City's goals in the project, value of the broadband assets, and desire to maintain control over how the broadband provider utilizes the assets. The City should strive to accomplish several key items in negotiating a PPP with the potential partner (or others):

1. Treat broadband providers as stakeholders in the community
   a. Consider their capital requirements
   b. Remember that their decision-making will be based on achieving the required return
   c. Understand that their payback requirements are shorter than in the municipal world
   d. Understand their definition of ROI is primarily financial based rather than that of a municipality whose mission is based on the health, education, and welfare of its constituents.

2. Identify the target areas for broadband expansion in the PPP
   a. Identify the boundaries
   b. Pinpoint the City's broadband assets for use in these target areas
   c. Define the services that are expected to be provided by the broadband provider

3. Enable the provider to deploy services as quickly as possible by minimizing the following obstacles:
   a. Permitting timeframes
   b. Requiring single versus bulk/blanket permits for their projects
   c. Strict construction requirements for placement of conduit, fiber and facilities

4. Minimize one-time ongoing fees to keep prices for broadband services low in the local market
   a. Normalize, reduce or waive permitting fees for construction projects
   b. Minimize leasing fees for the City's broadband assets such as fiber and conduit
   c. Allow for lower cost construction methods where possible (in conjunction with item 1c)

5. Clearly define the consideration given and received in the project with the broadband provider
   a. Determine the value given by the City to the provider in the PPP
   b. Determine the value generated by the provider to the community as a result of the PPP
   c. Define the timeframe for the community to receive the benefits of the PPP

6. Define how the PPP will be managed and governed
   a. How will the parties conduct business with one another and maintain alignment?
   b. How do the parties deal with shortfalls if either party isn't able to meet the requirements in the timeframe desired?
   c. How is performance of the PPP and the partners measured?

Example: Google Fiber in Kansas City, Provo, and Austin

These projects utilize a form of public-private partnership whereby each municipality developed agreements for the use of municipal broadband infrastructure and/or policy incentives to attract the provider to the City.

Example: Axcess Ontario, NY

Axcess Ontario builds the fiber infrastructure to supply/lease telecom technology, which enables carriers to provide service to their customers. Axcess Ontario collaborates with broadband providers such as Verizon Wireless and Time Warner Telecom to leverage its fiber-optic network to bring more broadband services to the community.

What are the Risks?

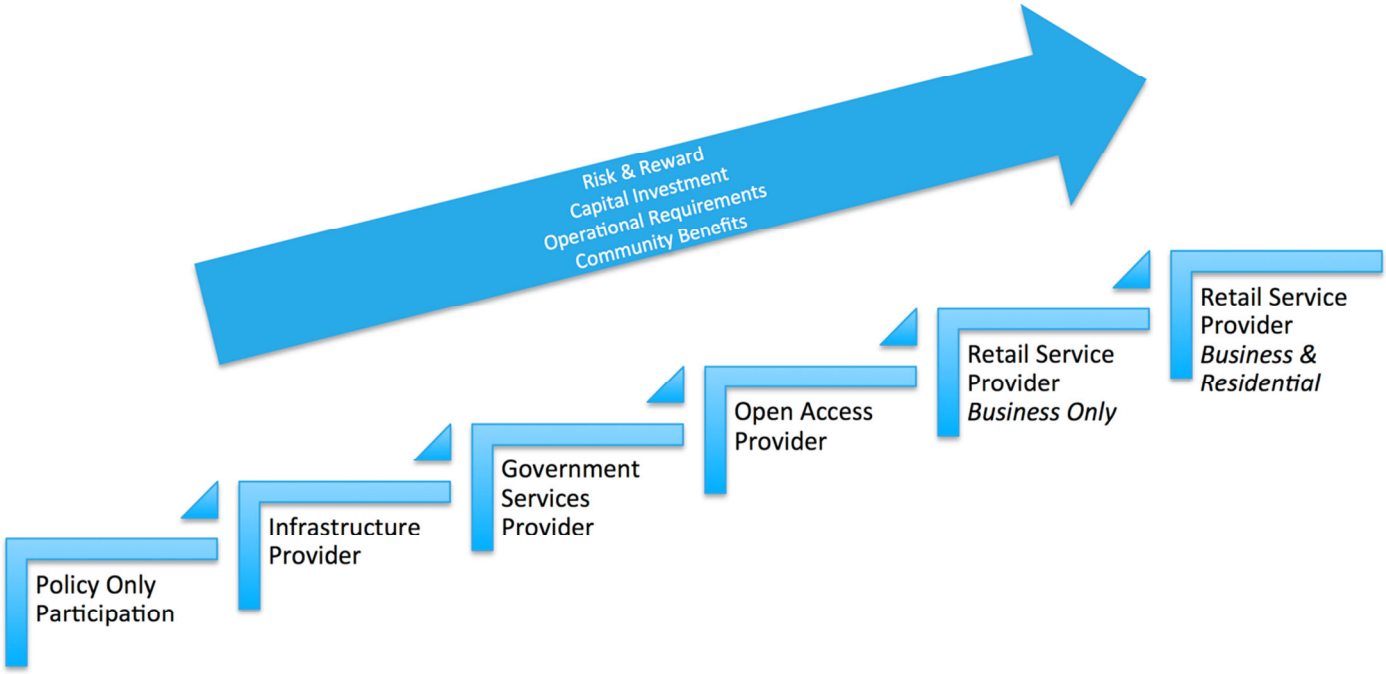
Broadband PPPs are relatively new to local governments but their popularity is growing because they align public organizations and private providers, leveraging each other's core strengths. In most cases, PPPs alleviate municipalities from the requirements to provide retail or wholesale broadband services and allow them to employ their broadband infrastructure and policies with providers who take on these responsibilities.

Fundamental alignment between the public and private partner(s) is important for successful PPPs. Municipal goals must be balanced with private sector goals and strategies. These goals and strategies must be forged early in the process and fulfill each party's critical needs. The identification and selection of the right partner(s) is paramount to success in the project. Execution risks can be high for municipalities that do not have a clear understanding of the true needs of their communities or those of broadband providers.

3. Implementing a Community Broadband Network

A community broadband network would entail Hudson building a City owned and operated network that would provide broadband services to the community. Community broadband networks utilize both retail and wholesale options, depending on the needs of the community and most appropriate business model. Selecting the right business model for Hudson's broadband strategy depends highly on the specific environment, market, needs, appetite for risk, funding availability, payback, and return requirements. The commonly implemented business models fall on a continuum that begins with low risk, low impact options and ends with high risk, high impact options. Figure 5-1 illustrates this continuum. As Hudson evaluates the various business model options from left to right, it will encounter greater degrees of risk and reward; risk, in terms of financial, operational, and regulatory risk; reward, in terms of community benefits, revenue generation, and overall profitability. Hudson must determine the most appropriate risk/reward balance to achieve its goals. To do so, Magellan has evaluated each business model to hone in on those that are most feasible for Hudson to consider. This evaluation accounted for local market, competition, funding requirements, organizational capabilities, and the regulatory environment.

Figure 5-1: Broadband Business Models Available to Hudson



Policy Participation Only

The City utilizes its public policy tools to influence how broadband services are likely to develop in its community. This includes permitting, right of way access, construction, fees, and franchises that regulate the cost of constructing and maintaining broadband infrastructure within its jurisdiction. This option is not considered a true business model, but does significantly affect the local broadband environment and is therefore included as one option. Municipalities that do not wish to take a more active role in broadband development often utilize policy participation to affect the local broadband environment positively.

Example: Santa Cruz County, CA

The Santa Cruz County board of supervisors in November 2013 approved an eight-month timeline to overhaul its broadband infrastructure plans and regulations. Specific areas of focus include permitting fee reductions and a proposed "dig once" ordinance that would make it easier to install new fiber-optic cables during other work on area roads or utilities lanes. "The County will continue a focus on broadband infrastructure throughout the county to enable businesses to function in the digital era, and students and households to have high quality access to information and communication. The County will work with industry providers to develop a Broadband Master Plan in order to identify focus areas within the county that will be most suitable for gigabyte services, particularly as the Sunesys backbone line is constructed during 2014 and 2015. The County will work with service (last mile) providers to ensure that these focus areas are deemed a priority, in order to support streaming requirements, product development, job creation and online selling capability."

Infrastructure Provider

The City leases and/or sells physical infrastructure, such as conduit, dark fiber, poles, tower space, and property to broadband service providers that need access within the community. These providers are often challenged with the capital costs required to construct this infrastructure, particularly in high cost urbanized environments. The municipal infrastructure provides a cost effective alternative to providers constructing the infrastructure themselves. In these cases, municipalities generally use a utility model or enterprise fund model to develop programs to manage these infrastructure systems, and offer them to broadband service providers using standardized rate structures.

Example: City of Palo Alto, CA

In 1996, Palo Alto built a 33-mile optical fiber ring routed within the City to enable better Internet connections. "Since then, we have been licensing use of this fiber to businesses. For the past decade, this activity has shown substantial positive cash flow and is currently making in excess of $2 million a year for the city. We now have that money in the bank earmarked for more fiber investments."

Government Services Provider

If Hudson becomes a government service provider, it will utilize its fiber-optic network to interconnect multiple public organizations with fiber-optic or wireless connectivity. These organizations are generally limited to the community anchors that fall within their jurisdiction, including local governments, school districts, higher educational organizations, public safety organizations, utilities, and occasionally healthcare providers. The majority of these anchors require connectivity and often, the municipal network provides higher capacity at lower costs than these organizations are able to obtain commercially. Municipal networks across the country have been built to interconnect cities, counties, school districts, and utilities to one another at lower costs and with long-term growth capabilities that support these organizations' future needs and protect them from rising costs. In these cases, government service providers may be cities, counties, or consortia that build and maintain the network. The providers utilize inter-local agreements between public agencies to establish connectivity, rates and the terms and conditions of service.

Example: Seminole County, FL

Seminole County owns and operates a 450-mile fiber-optic network that was installed over the past 20 years by the County's Public Works departments primarily to serve the needs of transportation. Since that time, the network has grown to connect the majority of the County's facilities, 5 cities within Seminole County, Seminole Community College, Seminole County Schools, and other public network to a common fiber-optic backbone. The network has saved millions of dollars in taxpayer dollars across the County and has become a long-term asset that enables the County and the other connected organizations to meet their growing connectivity needs.

Open-Access Provider

Municipalities that adopt open-access generally own a substantial fiber-optic network in their communities. Open-access allows these municipalities to "light" the fiber and equip the network with the electronics necessary to establish a "transport service" or "circuit" to service providers interconnecting with the local network. Service providers are connected from a common interconnection point with the open-access network and have access to all customers connected to that network. Open-access refers to a network that is available for any qualified service providers to utilize in order to connect their customers. It allows municipalities to provide an aggregation of local customers on a single network that they are able to compete for and provide services. The concept of open-access is designed to enable competition among service providers across an open network that is owned by the municipality. The municipality remains neutrality and non-discriminatory practices with the providers who operate on the network. The municipality establishes a standard rate structure and terms of service for use by all participating service providers.

Example: City of Palm Coast, FL

In 2006, the Palm Coast City Council approved a 5-Year fiber-optic deployment project funded at $500,000 annually for a total investment of $2.5 million. The network was developed to support growing municipal technology needs across all public organizations in the area, including city, county, public safety, and education. It was also planned to support key initiatives such as emergency operations, traffic signalization, collaboration, and video monitoring. The City utilized a phased approach to build its network using cost-reducing opportunities to invest in new fiber-optic infrastructure. As each phase was constructed, the City connected its own facilities and coordinated with other public organizations to connect them; incrementally reducing costs for all organizations connected to the broadband network. Showing a reasonable payback from each stage of investment allowed the City to continue to fund future expansion of the network. Through deployment of this network, the City has realized a savings of nearly $1 million since 2007 and projects further annual operating savings of $350,000 annually. In addition to these savings, the City's network provides valuable new capabilities that enhance its mission of serving the residents and businesses of the community.

Retail Service Provider – Business Only

Municipalities that provide end users services to businesses customers are considered retail service providers. Most commonly, municipalities provide voice and Internet services to local businesses. In many cases, a municipality may have built a fiber network for the purposes of connecting the city's primary sites that has been expanded to connect local businesses, in effort to support local economic development needs for recruitment and retention of businesses in the City. Municipalities that provide these services are responsible for managing customers at a retail level. They manage all operational functions necessary to connect customers to the network and providing Internet and voice services. Municipalities compete directly with service providers in the local business market, which requires the municipality to manage an effective sales and marketing function in order to gain sufficient market share to operate at a break-even or better.

Example: Fort Pierce Utilities Authority

Primary FPUAnet services are Dedicated Internet Access, fiber Bandwidth Connections, E-Rate IP Links, and Dark Fiber Links. FPUAnet services also include Wireless Broadband Internet and Wireless Bandwidth Connections, which extend FPUA's fiber through wireless communications. The FPUAnet Communications mission statement is "To help promote economic development and meet the needs of our community with enhanced, reasonably priced communications alternatives. It all began around 1994, when FPUA began to build a fiber-optic network to replace leased data links between its buildings in Fort Pierce. The new optical fiber system proved to be more reliable and cost effective while providing sufficient capacity for external customers. In 2000, FPUA allocated separate fibers through which it began to offer Dark Fiber Links to other institutions. This soon expanded to include businesses and more service types.

Retail Service Provider – Business & Residential

Municipalities that provide end users services to businesses and residential customers are considered retail service providers. Most commonly, municipalities provide voice, television and Internet services to their businesses and residents through a municipally owned public utility or enterprise fund of the city. As a retail service provider that serves businesses and residents, the municipality is responsible for a significant number of operational functions, including management of its retail voice, television and Internet offerings, network operations, billing, provisioning, network construction, installation and general operations and maintenance. The municipality competes with service providers in the business and residential markets and must be effective in its sales and marketing program to gain sufficient market share to support the operation. Many municipalities that have implemented these services are electric utilities that serve small to midsize markets. Many of these markets are rural or underserved in areas that have not received significant investments by broadband service providers. Retail service providers must comply with state and federal statutes for any regulated telecommunications services. These organizations must also comply with state statutes concerning municipal and public utility broadband providers; a set of rules has been developed in most states that govern the financing, provision, and deployment of these enterprises.

Example: Bristol Virginia Utilities (BVU OptiNet)

BVU OptiNet is a nonprofit division of BVU, launched in 2001, that provides telecommunication services to approximately 11,500 customers in areas around Southwest Virginia. OptiNet is known for its pioneering work in the area of municipal broadband throughout the area. BVU is acknowledged as the first municipal utility in the United States to deploy an all-fiber network offering the triple play of video, voice and data services. Offering digital cable, telephone service, and high-speed Internet from a remote-area utility provider makes BVU exceptional, even on a global level.

Comparison of Broadband Business Models

	Infrastructure Provider	Government Services Provider	Open Access Provider	Retail Service Provider Business Only	Retail Service Provider Business & Residential
Services Offered	• Conduit • Right of way • Dark fiber • Tower space • Property	• Connectivity services to public organizations, plus • Conduit • Right of way • Dark fiber • Tower space • Property	• Wholesale transport service to service providers, plus • Connectivity services to public organizations • Conduit • Right of way • Dark fiber • Tower space • Property	• Internet, voice and other business-focused retail services, plus • Connectivity services to public organizations • Conduit • Right of way • Dark fiber • Tower space • Property	• Internet, voice, video and other business and residential retail services, plus • Connectivity services to public organizations • Conduit • Right of way • Dark fiber • Tower space • Property
Customers	• Service providers • Community anchors	• Service providers • Community anchors	• Service providers • Community anchors	• Businesses • Community anchors • Service providers	• Residents • Businesses • Community anchors
Opportunity	• Improvements to general broadband access and availability • Accelerate broadband deployments • Reduce costs to provide new services	• Enhanced capacity and capabilities to community anchors • Increased efficiencies and collaboration among public organizations • Reduced cost for public organizations	• Specialized fiber services to serve business and economic development • Establishing a more competitive market with more providers • Accelerated delivery to the market	• Improved services to the business community • Establishing a more competitive market with more providers	• Triple-play fiber services to homes and businesses • Control over how and where services are available to maximize community impact
Risks	• Slow uptake • Inefficient utilization of assets	• Execution and collaboration with other public organizations	• Operating expertise • Meeting service provider performance requirements • Service provider adoption of a municipal broadband network	• Operating expertise • Significant funding required • Competition with service providers	• Operating expertise • Politically challenging • Market response • Significant funding required • Questionable financial sustainability • Competition with service providers

6. Broadband Strategies for Hudson

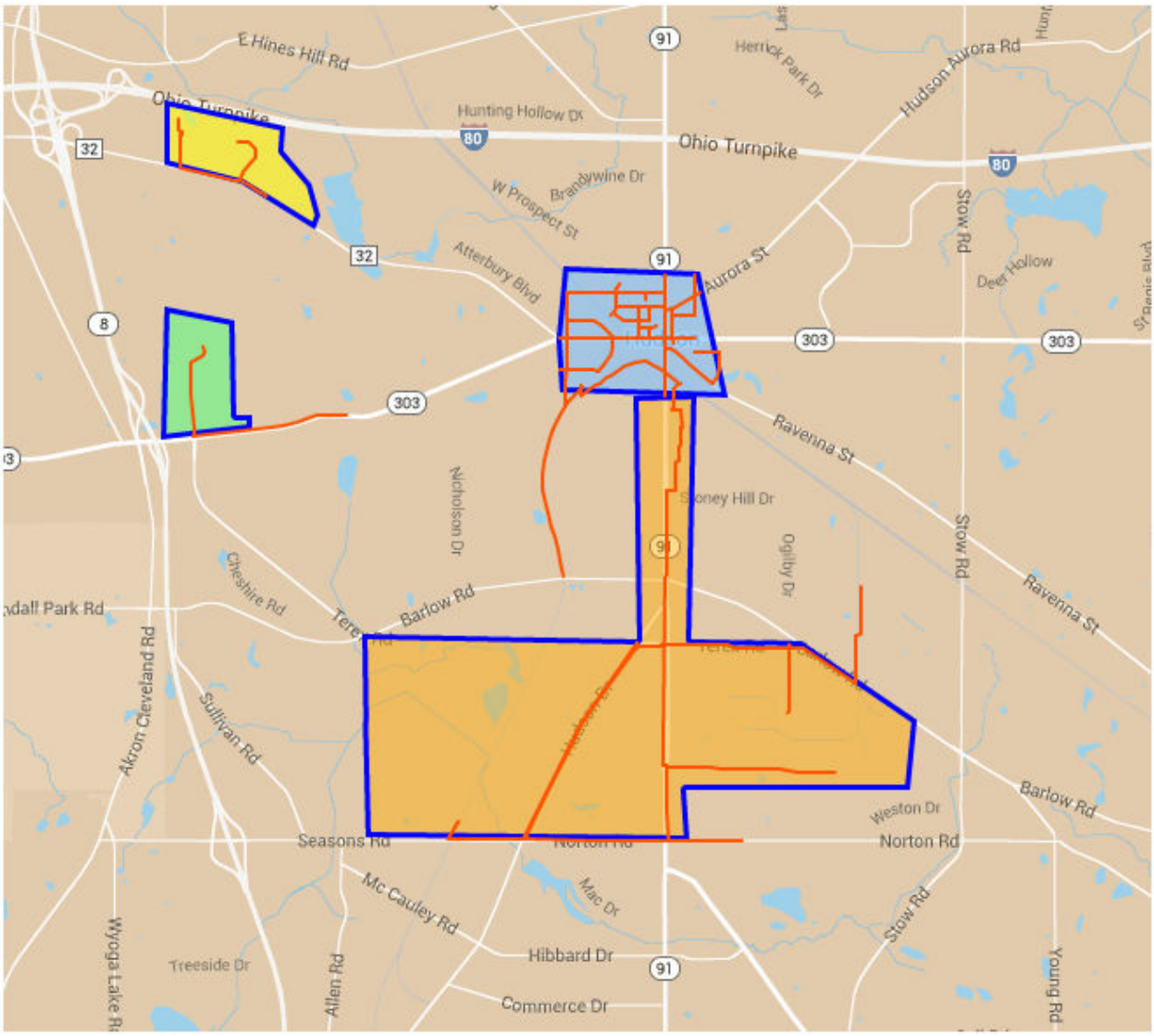
A. Where Would the City Deploy Infrastructure?

The City should continue the buildout of its fiber-optic network regardless of the business model utilized in the broadband initiative. Four zones in Hudson have been identified that would benefit from next-generation broadband services, based on the type, amount and density of businesses that are contained within these zones. Additionally, these zones have been identified as the focus for the City's economic development efforts. Buildout of broadband infrastructure in these zones would equip them with the physical fiber-optic network capable of providing nearly unlimited bandwidth to businesses, including 1 Gbps and 10 Gbps connectivity. These services will depend on the business model selected, providers involved, and needs of the actual businesses. The buildout of the network under any of the business models will be similar and will target key business corridors and industrial and technology parks to maximize the penetration of next-generation broadband services and to improve the economic development value of Hudson to site selectors and new businesses.

In addition, the service areas that have been chosen for initial buildout do not preclude any additional business or residential areas from being included in the overall plan. These additional areas should be vetted against their potential return on investment or benefit to the City. The proposed network and its supporting network components will scale to support a citywide expansion initiative when the timing is right.

Future build outs to residential neighborhoods within or outside of the proposed areas can easily be serviced by the City. The network connection to a residential unit is similar to that of the proposed business connections. Hudson could utilize the Google "Fiberhood" concept, which allows Google to build their fiber network in areas where there is enough demand. This concept would allow the City to gauge interest of a particular section of the community or neighborhood and extend the City's network and services once enough potential residential subscribers have "signed up". In addition, the City should continue its program of installing extra conduit when the under grounding of other utilities takes place. This would allow the City to provide service in new communities undergoing development and would allow them to do so at a substantial savings. This would also provide the City with a captive market who would likely choose advanced FTTH infrastructure over legacy copper offerings.

Broadband Deployment Zones



B. What Would it Cost?

To determine the geographic scope of the network, the City has identified key corridors and neighborhoods that were "prime" for network buildout based on business density. Most municipal networks are built into commercial areas first because costs are generally lower and revenues per subscriber are generally higher; resulting in a more feasible business case. These networks also generate positive economic development benefits in a short amount of time by enabling local businesses to access next-generation broadband at affordable rates. Magellan would suggest using a phased approach that first brings fiber-optic broadband to Hudson's business corridors and, if successful, expands into Hudson's residential neighborhoods.

Figure 6-1: Pilot Area Business Corridor Buildout Costs

Zone	1	2	3	4
Area	Downtown	Southern 91 Corridor	Hudson Crossing Business Park	Boston Mills Business Park
Number of Businesses	420	276	1	31
Fiber-Optic Network Costs	$853,000	$808,000	$95,000	$80,000

C. How Would it be Built?

The phasing plan presented is only one scenario that the City could utilize. There are other options that the City could consider based on the amount of funding available and how quickly it wants to accelerate broadband deployment. This phasing plan anticipates a Phase 1 project that is a "proof of concept" to validate the business case for fiber deployment and to minimize the City's financial exposure to a larger project.

Figure 6-2: Hudson Broadband Network Phasing Plan

Developing a business case in the pilot area allows the City to determine the feasibility of investing in infrastructure under any business model. To do so on a citywide level can be a significant undertaking and at this stage, there are far too many variables to forecast an accurate citywide network. For the purposes of this Study, a targeted business case was developed that could be used to "acid test" the feasibility of a pilot area and use these assumptions to build a more comprehensive business case.

D. Business Deployment Zones

Figure 6-3: Business Deployment Zone 1 - Downtown

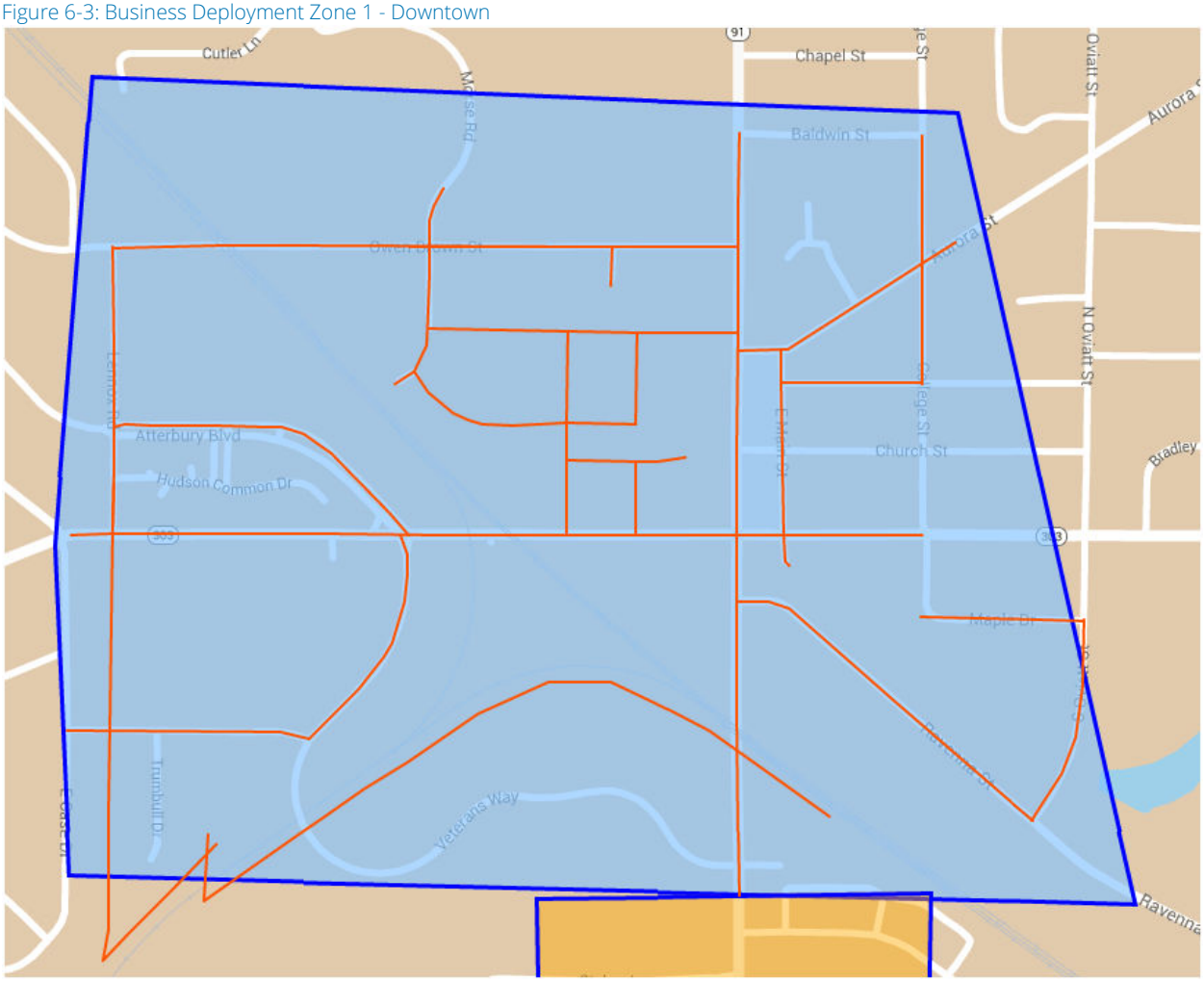


Figure 6-4: Business Deployment Zone 2 – Southern 91 Corridor

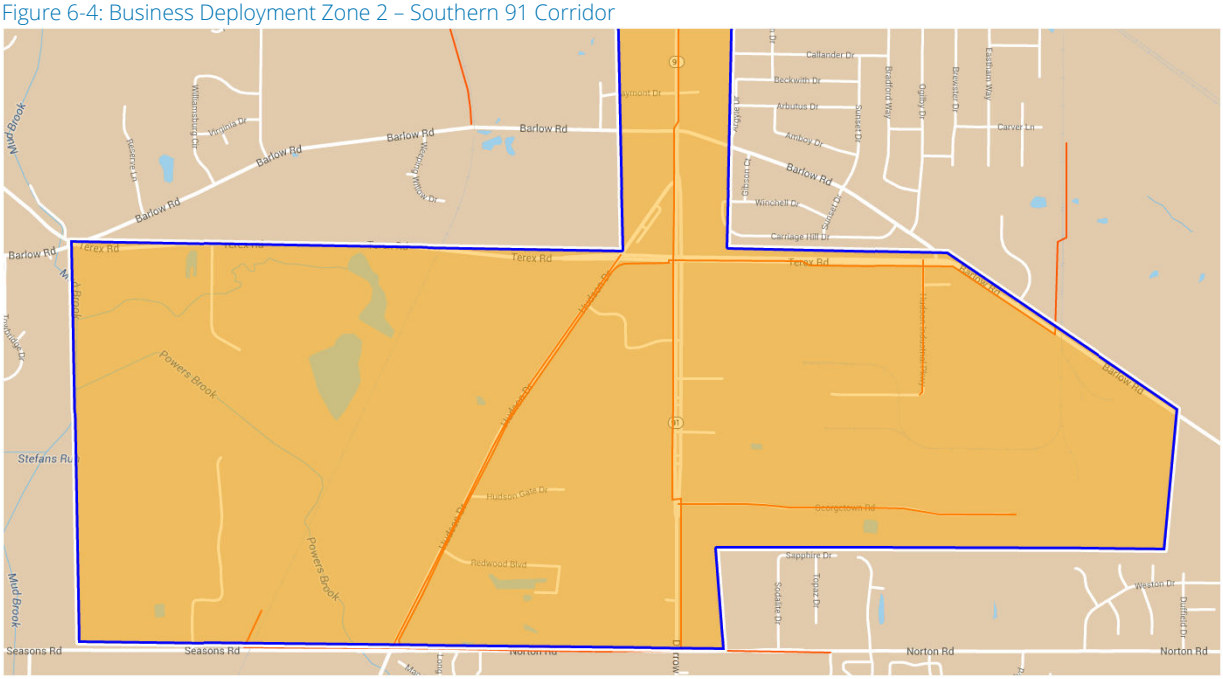


Figure 6-5: Business Deployment Zone 3 – Hudson Crossing Business Park

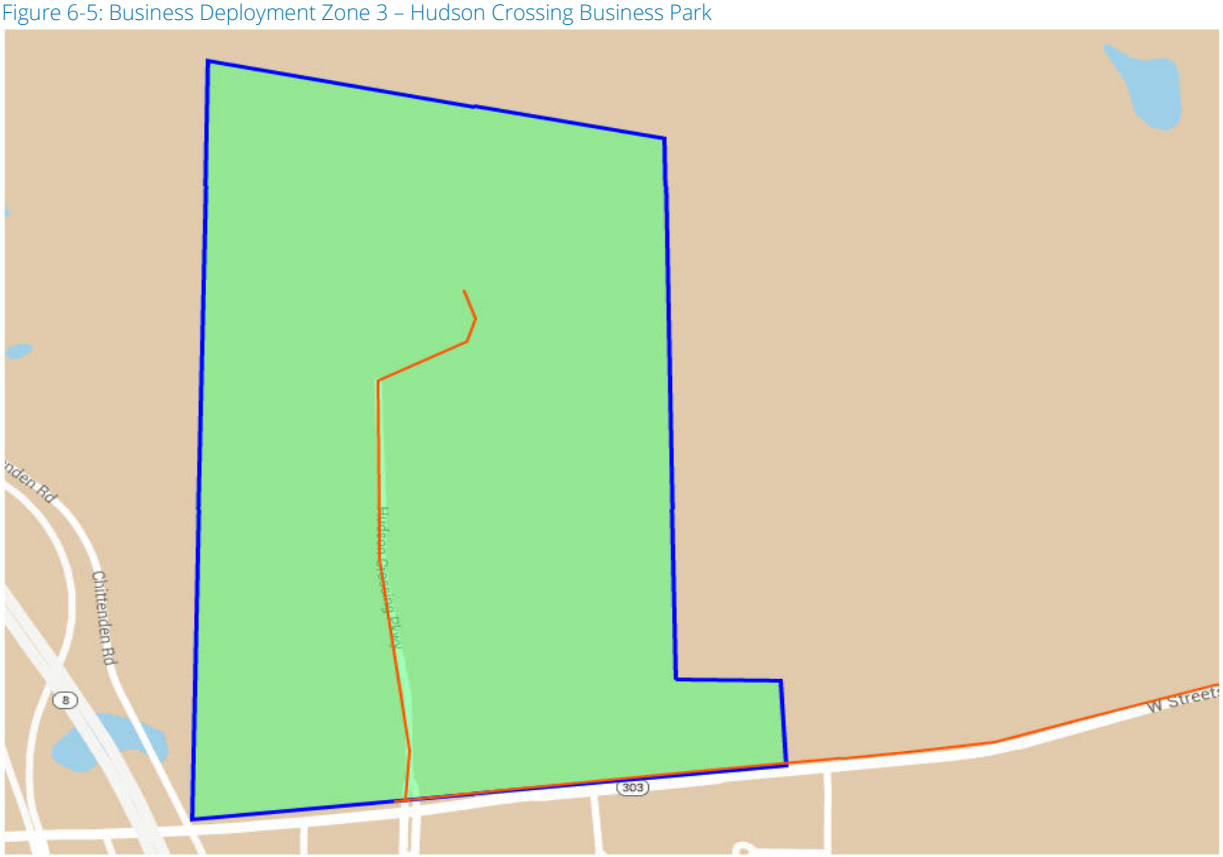
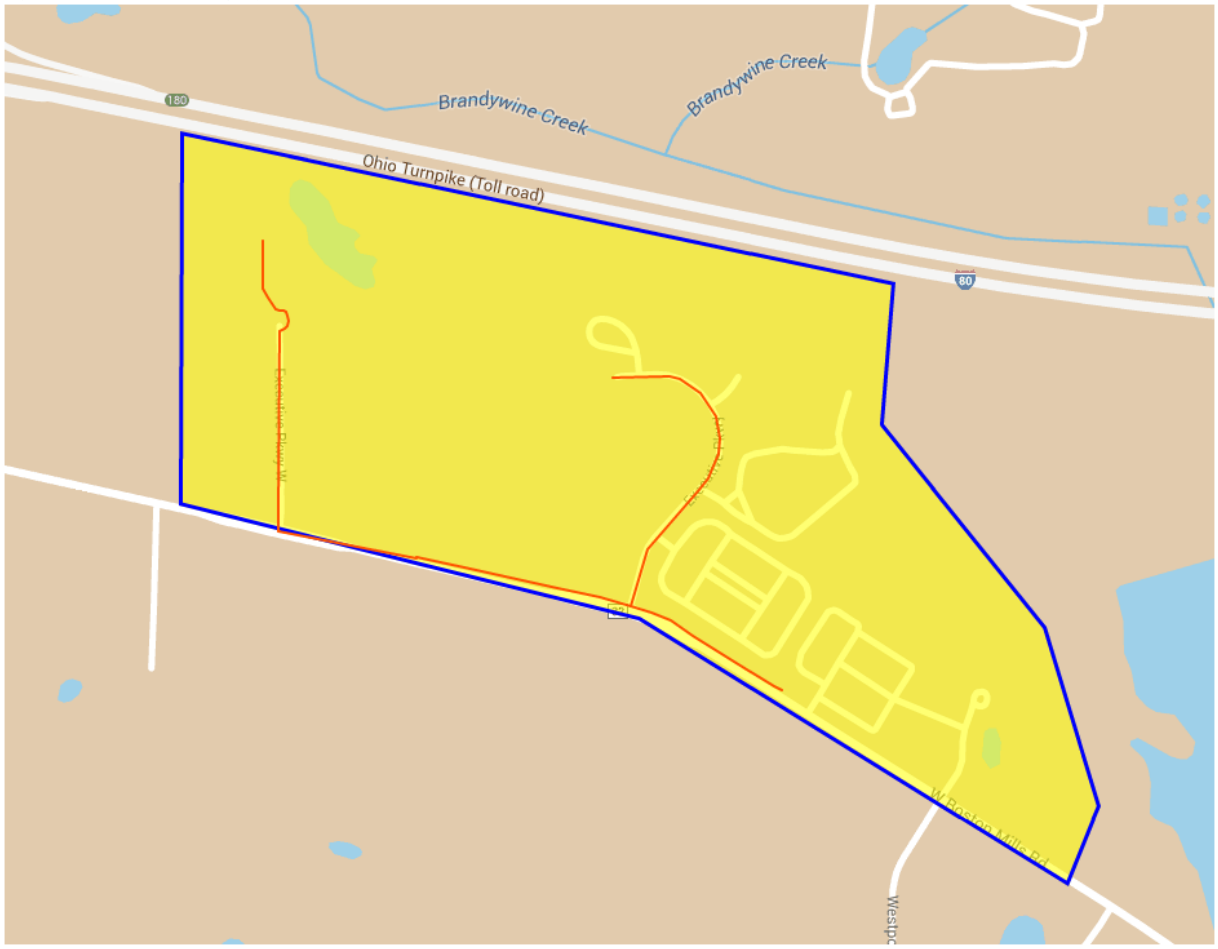


Figure 6-6: Business Deployment Zone 4 – Boston Mills Business Park



7. What are the Feasible Business Models?

All financial information provided herein is intended for planning purposes and a number of assumptions have been made to determine the overall financial results presented. Magellan's financial planning methodology is to practice financial conservatism through the analysis of best and worst case scenarios. The financial information presented is an average case of the possible scenarios. The results presented in this financial plan are not predictions of actual results. Actual results may vary to a material degree due to external factors beyond the scope and control of this financial plan. Historical data is used to produce future assumptions used in the financial plan, such as rates of return. Past performance is not a guarantee or predictor of future performance. Magellan suggests a comprehensive financial review with the City's financial manager to explore these scenarios, run sensitivity analyses, and vet assumptions made in this Plan.

All financial information provided is contained in the accompanying Broadband Financial Sustainability Plan, a Microsoft Excel-based broadband financial modeling tool developed by Magellan to assess the financial performance of municipal broadband and telecommunications utilities.

A. Open-Access

What is an Open-access Network?

An open-access network provides dark fiber and/or lit transport services to broadband providers as a wholesale service to reach more homes and businesses in Hudson. Retail service providers would purchase services from the City to reach end users using the City's fiber-optic network. This model alleviates the City from managing any retail services, reducing the City's financial and operational risk. It allows retail providers to use the open-access network to reach more customers without the need to build costly fiber infrastructure to subscribers; the City maintains responsibility for this function. This incentivizes broadband providers to use the City's network by buying access from the City, in a manner similar to one provider buying access from another provider.

Why Would the City Build an Open-Access Network?

Many cities find open-access a compelling business model because it allows them to attract multiple service providers to their networks, which helps stimulate competition and keep prices low for subscribers. It also allows them to incentivize providers to their local market without a provider needing to invest significant capital to build its own broadband network. This alleviates a key barrier to entry that many providers struggle with when entering a new market. It also allows the City to regulate the fees charged to broadband providers for use of the network, depending on the City's required return. Cities that opt for a lower return from

their network investments can charge significantly lower rates to broadband providers than cities that have a higher required return.

Building an open-access network also allows cities to maintain control over the fundamental broadband infrastructure in their communities. Because the fiber-optic network is the foundation of providing high-speed, quality broadband services, owning this asset places the City firmly in control of the type, quality, and number of broadband providers that serve the market. Owning this asset also allows them to continue the buildout of their fiber-optic networks for municipal and community purposes. In addition, open-access allows a City to maintain neutrality and non-discrimination, "staying out of the business" of providing retail broadband services. The City's only customers become service providers that utilize the City-owned network to reach residents and businesses in Hudson.

How Would the City Build an Open-Access Network?

Building an open-access network would require the City to create an appropriate organizational and operational structure to manage wholesale telecommunications services. Some considerations for the City to evaluate in implementing an open-access network include the additional operations and management responsibilities required to maintain the network, recruitment, negotiation, and provision of broadband providers and funding to build the network. The City may be also responsible for implementing and maintaining some network electronics to manage services on the network if a "lit fiber model" is utilized. While this equipment is simple to manage it does require the City to have technical resources and the right operational structure to manage wholesale services.

In order for service providers to consider providing services over Hudson's network, the City must establish Service Level Agreements (SLA) that are similar to what service providers receive in the current telecommunications industry. The City will also need to define business and operational processes to manage the network and ensure that service providers' needs are met. Further, deployment of an open-access network requires new funding for construction of last-mile fiber, network electronics, operational support systems, and potentially new staffing or an outsourced network operator who will manage the network on the City's behalf.

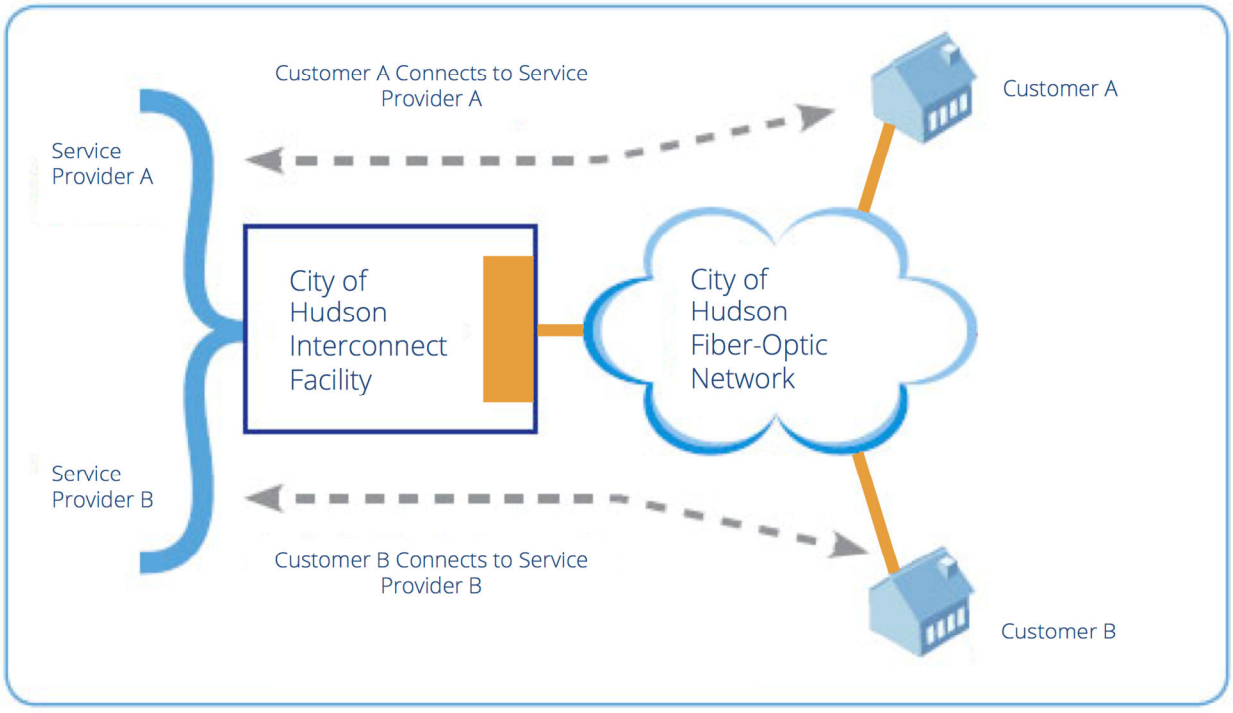
What Services Would the City Provide?

Service providers would interconnect with the City's open-access network through a Network-to-Network Interface (NNI) with the City's network electronics or through dark fiber interconnection. The City would strategically deploy field equipment, known as Optical Line Terminals ("OLTs"), in service areas throughout the City to serve local business districts and neighborhoods. This equipment would connect back to a centralized colocation facility or data center where service providers would interconnect with the City's network. Several data centers are currently available in the City that could accommodate these needs.

Service providers would request new connections to their customers from the City. Once a customer signed with a service provider, the service provider would order transport service to the new customer. Once the service provider signed a service order with the City and paid any upfront charges, the City would build the last-mile fiber connection to the end customer and provision a transport service through its network back to the interconnection point with that service provider. The City would charge a monthly recurring fee to the service provider for use of the transport service for a certain contract term and at a certain bandwidth. The City would maintain a rate structure based on bandwidth, with increasing charges for more bandwidth. This would allow the City to upcharge the service providers as customers utilize more bandwidth and implement a tiered pricing structure from lower-speed services to 1 Gbps and 10 Gbps services.

Another open-access option is for the City to provide the transport directly to the businesses or anchors potentially as a line item on the City's electric utility bill. The City would transport the contracted business or anchor into the colocation facility or data center, allowing the user to contract directly with a number of different providers that have established a presence in the facility. In this option, the City provides the fiber connection directly to the user and the user contracts for its retail services directly from a provider.

Hudson Open-Access Network



Example: Danville, VA

The City's high-performance, open-access fiber network, nDanville, has provided broadband connectivity to Danville businesses since 2007. Danville was the first municipality to deploy a fully automated, Layer 3 open-access network, nDanville, with more than 135 miles of fiber, passes more than 1,000 business locations, including every parcel in five business parks. Current customers have access to 100 Mbps fiber connections capable of delivering a wide variety of services, and 1 Gbps and 10 Gbps connections are available upon request. A major network expansion focused on the medical community led the City to receive one of the two 2011 Founders Awards from the Intelligent Community Forum, and the City was designated by the Forum as a Smart21 city in 2010, 2011 and 2012. In 2012, nDanville will complete its first FTTH residential service deployment to approximately 500 homes. Engineering and permitting on the FTTH expansion is complete and construction is expected to start before the end of 2011. The first customers should be able to receive services in early spring 2012.

Example: City of Palm Coast, FL

In 2009, the City employed its 60-mile municipal fiber-optic network to become the first open-access system in Florida. The City actively builds new fiber-optic capacity to businesses and community anchors in the community of 75,000 citizens. Businesses on the network have their choice of multiple providers through the City's active Ethernet transport system. The City enables service providers to deliver their services to customers in Palm Coast over an all fiber 10 Gbps network that enables businesses to receive significantly more bandwidth at low costs. Prices for symmetrical fiber connections start at $100 per month for businesses. The network has supported Palm Coast's economic development programs to lower the cost of doing business in the City and help recruit new businesses to the area. The network currently connects nearly all public organizations, 100+ businesses, and multiple service providers to a community network, owned and operated by the City's IT department.

Open-Access Rates, Service Revenues & Installation Revenues

Broadband providers utilize what is known commonly in the telecommunications industry as a Type-II service when they need to buy capacity on another provider's network. Type-II services are transport connections that maintain a certain bandwidth and connect between a broadband provider's existing network and a terminating location on another provider's network. In an open-access network, the City will become the "terminating carrier" that provides the Type-II service, connecting broadband providers from a common interconnection point (colocation facility or data center) to commercial parcels within Hudson.

Service providers will pay monthly recurring fees to the City for these connections based on the amount of bandwidth and type of service required by the service providers' end their customers. The City will offer two types of service, a shared service, and a dedicated service. The shared service is appropriate for any size of business that does not require guaranteed

bandwidth at all times. Bandwidth will fluctuate with the total number of subscribers on the system at one time. This service is sufficient for many small and medium businesses and a few large businesses that are not sensitive to fluctuations in bandwidth. Dedicated services provide guaranteed bandwidth to the subscriber based on the bandwidth tier purchased. A 100 Mbps service will deliver 100 Mbps to the subscriber at all times; the full bandwidth must always be available to the subscriber. Businesses that require dedicated services generally rely on their Internet services constantly for their normal operations and include big data companies, manufacturers, and high-tech industries.

The rate table below shows projected monthly recurring charges ("MRC") that the City would charge to broadband providers. These fees increase based on the bandwidth of each service. These are "wholesale rates" to broadband providers and not retail rates that businesses would pay. Broadband providers would add on their overhead costs and profit margin to these wholesale rates to arrive at the prices businesses would pay for services. Businesses could be expected to pay approximately 50% - 80% more than these wholesale rates. These are only sample rates and should be vetted with broadband providers to assess viable market rates for the broadband services.

Figure 7-1: Potential Monthly Fee Structure

Shared Service	City's Rate to Providers	Provider Markup	Retail Rate to Businesses
100 Mbps	$114	50% - 80%	$171 - $205
200 Mbps	$209	50% - 80%	$314 - $376
300 Mbps	$304	50% - 80%	$456 - $547
500 Mbps	$380	50% - 80%	$570 - $684
1 Gbps	$760	50% - 80%	$1,140 - $1,368
10 Gbps	$1,140	50% - 80%	$1,710 - $2,052
Dedicated Service	**City's Rate to Providers**	**Provider Markup**	**Retail Rate to Businesses**
50 Mbps	$570	50% - 80%	$855 - $1,026
100 Mbps	$1045	50% - 80%	$1,567 - $1,881
200 Mbps	$1,330	50% - 80%	$1,996 - $2,394
1 Gbps	$1,900	50% - 80%	$2,850 - $3,420
10 Gbps	$9,500	50% - 80%	$14,250 - $17,100

Subscriber Take Rates

Magellan estimates that the City can attain a take rate of 30% - 50% uptake of businesses covered in the four zones over a 10-year period. This equates to between 227 – 376 businesses connecting to the City's network. These figures will highly depend on the City's execution of the network, sales and marketing plan and participation of broadband providers.

Based on existing services in these areas, a competitively priced next-generation broadband service at similar (or slightly higher) costs is likely to generate strong business customer demand. Services in these areas currently are limited to cable, DSL, and wireless in the low to mid-price point range, $100 - $400 per month. Fiber-optic services are also available in these areas at significantly higher prices, ranging from $500 - $2,500 per month, based on a variety of factors including distance from existing networks, bandwidth purchased, and term of contract.

The charts in Figures 7-2 and 7-3 show estimated uptake of the City's fiber transport over the first 10 years of the project. The major growth in the customer base is expected in the first 5 years of operation.

Figure 7-2: Open Access Provider Annual Uptake

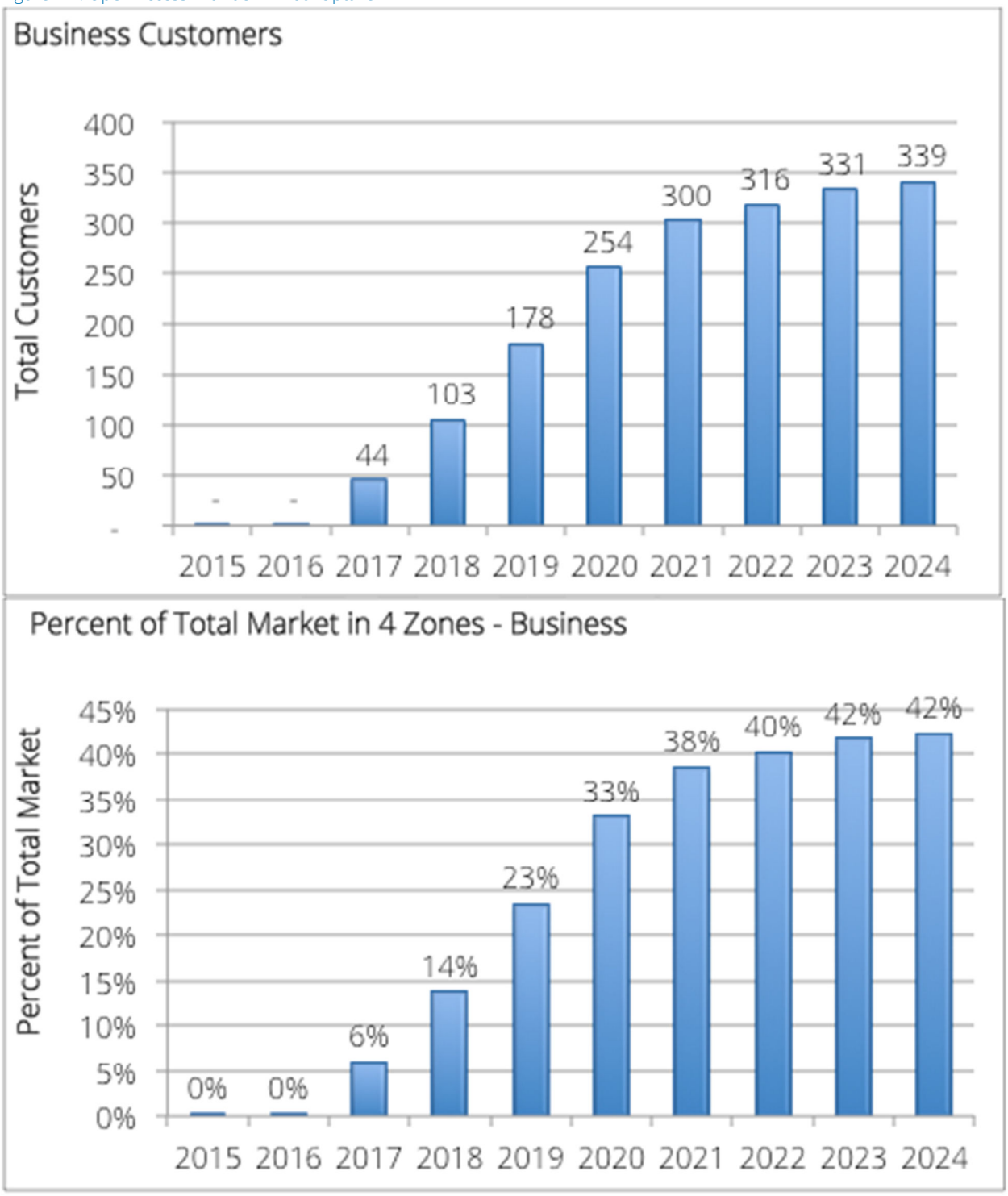
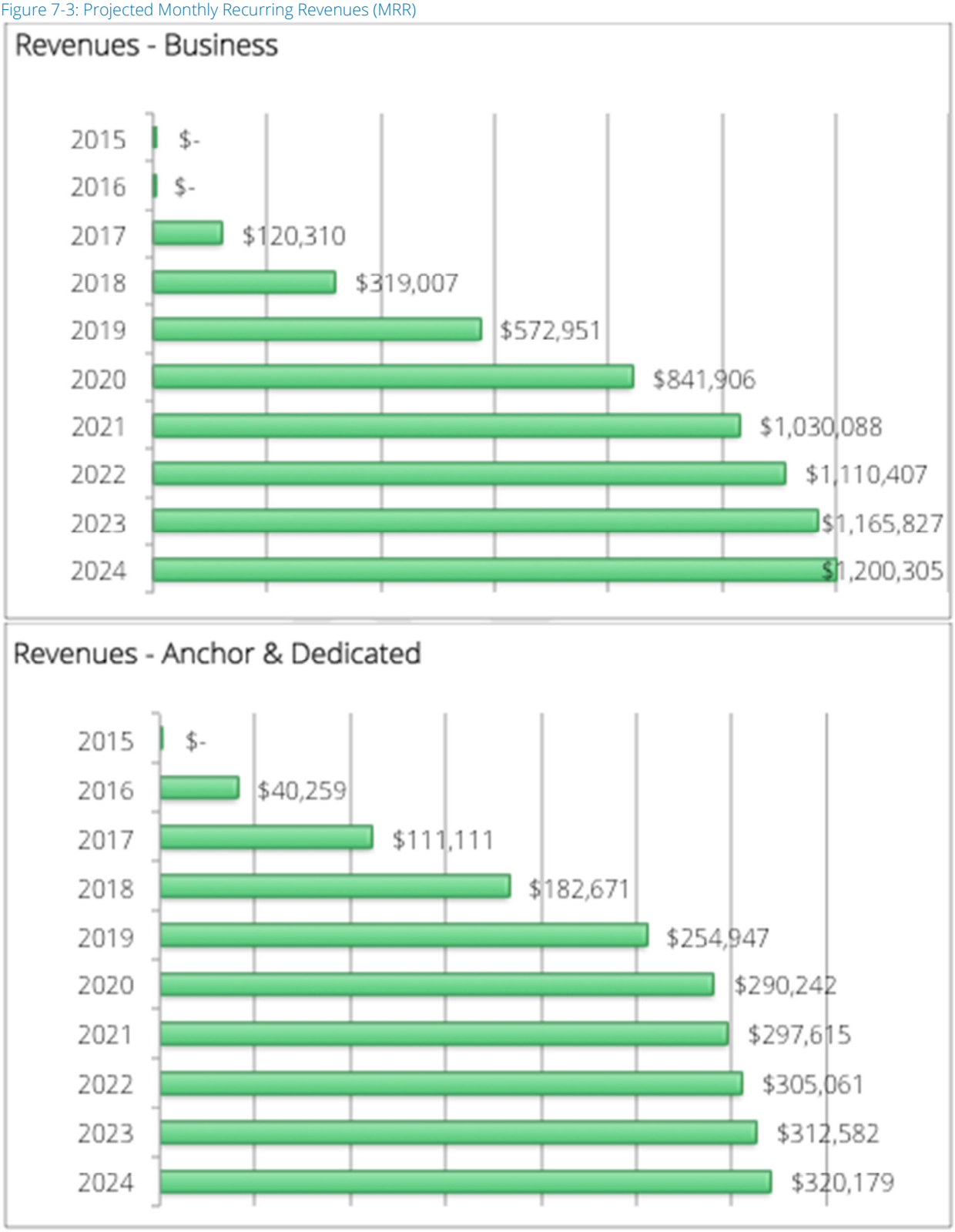


Figure 7-3: Projected Monthly Recurring Revenues (MRR)



Open-Access Operating Costs

The City will need to decide how the open-access broadband network will be managed. Personnel, systems, and new business processes will be required to provide operations and management of the network once constructed. The network would be supported either using in-house resources or outsourcing the management to a network operator. While Hudson has experience in outside plant operations and maintenance, the equipment, associated provisioning, and monitoring processes may be a component that the City would rather outsource to a qualified network operator. These decisions should be weighed carefully to determine the right mix of insourcing and outsourcing balanced with the financial performance of the network.

Annualized capital, operational costs, debt service, depreciation, and related costs that Hudson will incur in its open-access network are included in figures 7-4 and 7-5.

Operations & Maintenance

The City's O&M costs will include ongoing management of the City's equipment, software, and facilities.

- Network Equipment Maintenance - $25,000
- Software Maintenance - $20,000
- Facilities Power & Environmental – $5,000
- Miscellaneous O&M Costs – 1% of gross revenue

Direct and Indirect Staffing

Direct staffing includes all City personnel that are attributable to the provision of the City's services in the operation. Salaries and benefits were calculated using current staffing costs from similar broadband utilities and are as follows, adjusted annually for CPI using a 3% escalator. Figure 7-4 illustrates these costs.

Figure 7-4: FTE Costs

FTE Position	Fully Loaded Salary	Annual Escalator (CPI)
FTE - Network Management	$75,000	3%
FTE - Field Services	$75,000	3%
FTE - Sales & Marketing	$65,000	3%
FTE - Administration	$90,000	3%

Figure 7-5: Open Access Provider Staffing Plan

Broadband Operational Functions	Project Phase		
	Startup Phase (Year 1-2)	Growth Phase (Year 3-5)	Steady State (Beyond Year 5)
Customer Service • Customer activations/terminations • Basic billing support • Adds/moves/changes • Customer tier 1 support • Billing system integration • Advanced billing support • Reporting • Utility tax application	0 FTE	0 FTE	0 FTE
Network Management • Routine network management and maintenance • Service quality management • Provisioning • Contractor management • Troubleshooting • Outside plant repairs and maintenance	1 FTE	1 FTE	1 FTE
Field Services • Field installations • ONT, Gateway, Set top Box Installs • Service testing • Adds/moves/changes	.5 FTE	1 FTE	1 FTE
Administration • Contract Management • Financial Management • Marketing • Service Provider Management • RFP Management • Outside plant management • New construction planning and implementation • Record keeping	.5 FTE	1 FTE	1 FTE
Sales • Public Awareness and Outreach • Marketing of network availability • Economic development planning • Promotional opportunities • Co-marketing with service providers	.5 FTE	1 FTE	1 FTE

Operating, Debt Service and Depreciation Costs

Sales, General & Administrative Expenses	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Salaries and Benefits		$77,250	$79,568	$122,932	$126,620	$112,500	$134,331	$138,361	$142,512	$146,787
Professional & Legal Fees		$30,000	$30,900	$31,827	$32,782	$33,765	$34,778	$35,822	$36,896	$38,003
Sales Expense		$829	$4,767	$10,335	$17,055	$23,322	$27,351	$29,159	$30,455	$31,322
Marketing Expense		$1,244	$7,151	$15,502	$25,582	$34,983	$41,026	$43,738	$45,683	$46,983
Office Expense		$5,000	$5,150	$5,305	$5,464	$5,628	$5,796	$5,970	$6,149	$6,334
Utilities		$12,000	$12,360	$12,731	$13,113	$13,506	$13,911	$14,329	$14,758	$15,201
Bad Debt Expense		$403	$2,314	$5,017	$8,279	$11,321	$13,277	$14,155	$14,784	$15,205
Subtotal: Sales, General & Administrative Expenses		**$126,726**	**$142,210**	**$203,647**	**$228,894**	**$235,026**	**$270,470**	**$281,533**	**$291,238**	**$299,835**
Depreciation & Amortization										
Depreciation		**$161,083**	**$167,429**	**$175,368**	**$184,933**	**$194,458**	**$200,876**	**$211,624**	**$214,888**	**$145,096**
Amortization										
Subtotal: Depreciation & Amortization		**$161,083**	**$167,429**	**$175,368**	**$184,933**	**$194,458**	**$200,876**	**$211,624**	**$214,888**	**$145,096**
Interest										
Borrowings		$93,102	$98,751	$98,601	$93,354	$78,922	$64,056	$48,745	$32,975	$16,731
Subtotal: Interest Expenses		**$93,102**	**$98,751**	**$98,601**	**$93,354**	**$78,922**	**$64,056**	**$48,745**	**$32,975**	**$16,731**
Debt Principal Payments										
Borrowings		$305,481	$370,171	$428,936	$481,076	$495,508	$510,373	$525,684	$541,455	$557,699
Subtotal: Principal Payments		**$305,481**	**$370,171**	**$428,936**	**$481,076**	**$495,508**	**$510,373**	**$525,684**	**$541,455**	**$557,699**
Reserve Fund Requirements										
Operating Reserve Fund				$20,082	$21,868	$21,710	$24,620	$25,366	$26,198	$26,934
Renewal & Replacement Fund				$1,830	$2,127	$2,094	$1,527	$3,949	$952	$805
Capital Expansion Fund				$5,194	$6,374	$6,384	$4,127	$4,824	$1,836	$1,252
Subtotal: Reserve Fund Requirements				**$27,107**	**$30,369**	**$30,189**	**$30,274**	**$34,139**	**$28,986**	**$28,991**

Open-Access Funding Requirement

Phase 1 would require approximately $4.9M of funding, as follows:

Capital Item	Total Cost	Year
Fiber-Optic Feeder & Distribution Network	$1,850,000	2016
Network Electronics & Equipment	$560,000	2016
Colocation Facility	$250,000	2016
Drop Fiber Network and Customer Equipment	$600,000	Ongoing
Ongoing Operations	$1,640,000	Ongoing
Total	**$4,900,000**	

Magellan assumed a 10-year revenue bond would be utilized at an interest rate of 3% with annual principal and interest payments starting in 2016. Financial results will depend on the final debt instrument utilized to fund the project.

Distribution of funds would occur from 2016 to 2019, as follows:

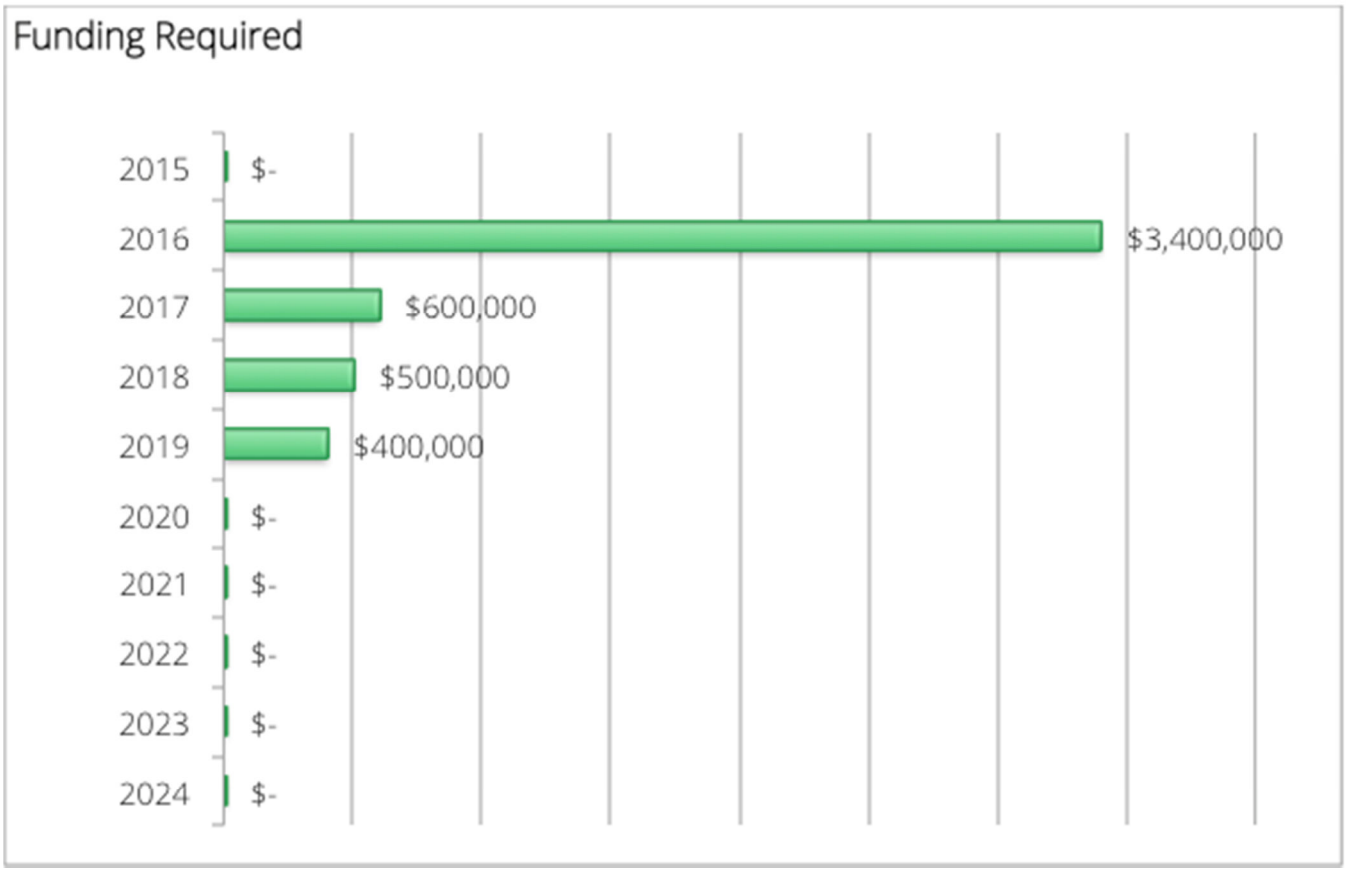
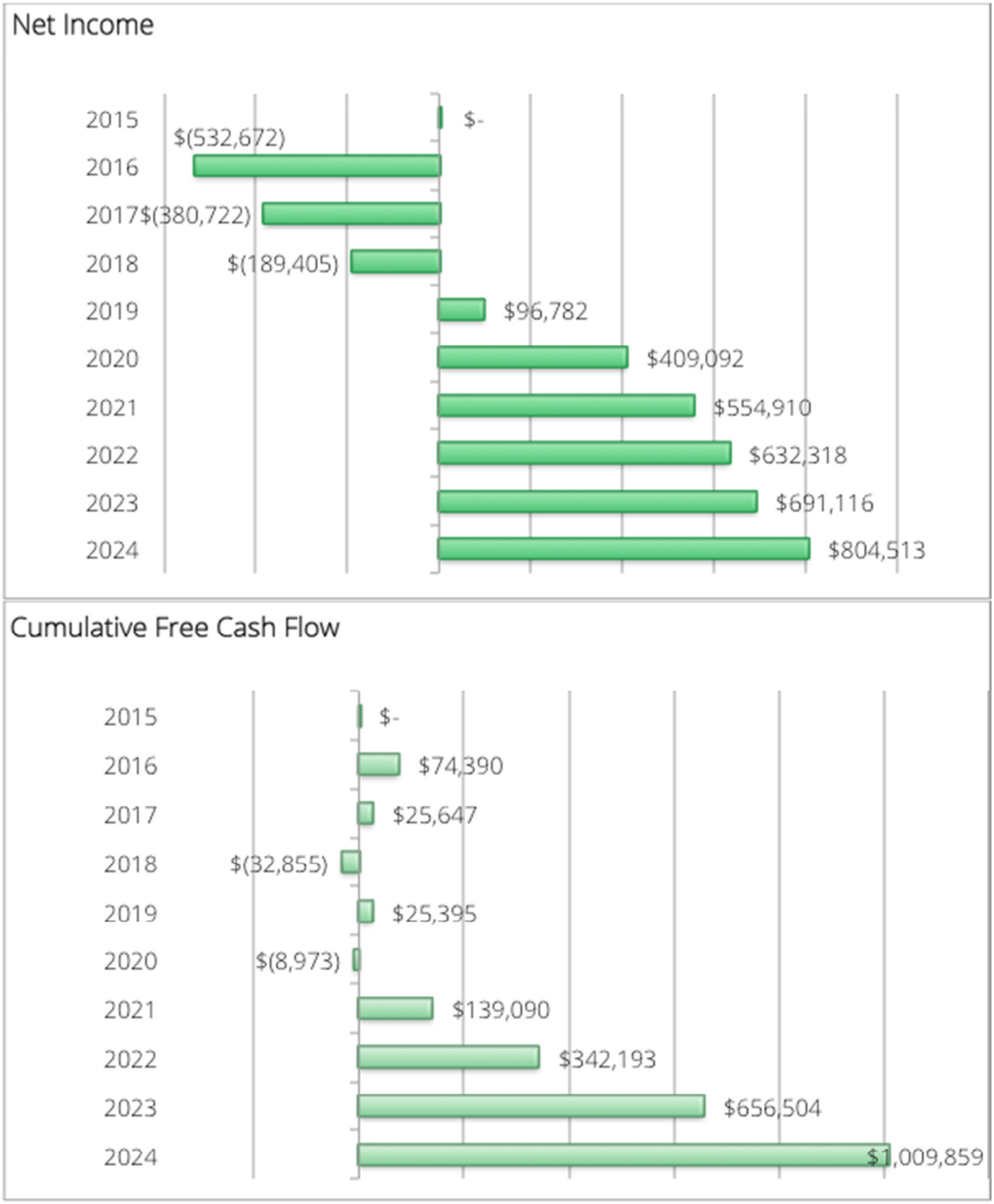


Figure 7-6: Net Income & Free Cash Flow



Profit & Loss Statement (attached in Microsoft Excel spreadsheets)

What are the Risks?

The City's two key risks in managing an open-access network include the burden of operating an active broadband services network and securing participation from local service providers. To operate an open-access network, the City would need to maintain management and operations personnel with relevant expertise and skills to ensure service level guarantees to both customers and their service providers. In an open-access network, the City's customers are service providers who require strict service level agreements to certify an open-access network for use. Providers will often run extensive quality testing to certify these networks before they agree to use them. The City would need to achieve and enforce these service quality guarantees to attract and secure service providers on its network. Providers are often skeptical of municipal capabilities to perform these functions and a lengthy process of recruitment may ensue to convince providers to use an open-access network.

One alternative would be to enlist the services of a network operator to manage the City's open-access network. Cities have done so when the requirements to manage these networks stray too far from their core competencies. There are many network operators capable of performing these functions but the services would come at a cost. These costs would need to be analyzed in a financial plan for the network to determine if outsourcing the management of the open-access network could be sustained financially.

The greatest risk to the open-access network is achieving uptake of the City's services by broadband providers. If the City's network does not achieve the projected take rates on an annualized basis, total expenses will exceed total revenues and the City will need to utilize reserves to compensate for the difference. Achieving strong market share in the first five years of the network's operation is critical to long-term revenue generation on the network. This will be achieved by the City's execution of the project, which includes the following key components:

1. **Engaging the business community, economic development, City Council, and other stakeholders to garner upfront and ongoing support for the network.**

2. **Recruiting and gaining commitments from broadband providers to utilize the network.**

3. **Executing the implementation plan effectively and building the network to carrier class standards.**

4. **Providing effective operations of the network by establishing an internal organizational structure dedicated to managing it.**

B. Business Services Provider

What is a Business Services Provider?

As a business broadband provider, the City would expand its current network to provide two core services to businesses in the Hudson service area: Internet and telephone. In addition to these two core services, the City has the opportunity to provide "value added" services to local businesses. These services include but are not limited to hosting, data backup, and cloud services. Many value added services can be delivered "on top" of Hudson's network through the cloud. Delivering Internet services to businesses allows the City to use this delivery platform to provide new services with relative ease, particularly when they are Internet or cloud based.

The City will also be able to offer transport services that provide connectivity between two points in the network, allowing businesses with multiple locations in Hudson to connect to one another. Transport can also provide a branch office with connectivity to its headquarter site if located outside of Hudson. In these cases, the City will be able to offer "Type-II Services" to other service providers, allowing them to interconnect with the Hudson network to provide last-mile connectivity to a local branch office from a connection to a headquarter site located in another geographic region (This Type-II service is identical to that described in the open-access option).

The City will also have the opportunity to provide some hosting and colocation services at its data center should Hudson choose to construct a facility. This data center facility would enable service providers, businesses, and organizations to utilize Hudson's local hardened facility to collocate technology and infrastructure. This offering may also be attractive to other community anchors in the area as a disaster recovery facility that provides redundancy and/or a hot standby site for these organizations.

Example: Fort Pierce Utilities Authority

Primary FPUAnet services are Dedicated Internet Access, fiber Bandwidth Connections, E-Rate IP Links, and Dark Fiber Links. FPUAnet services also include Wireless Broadband Internet and Wireless Bandwidth Connections, which extend FPUA's fiber through wireless communications. The FPUAnet Communications mission statement is "To help promote economic development and meet the needs of our community with enhanced, reasonably priced communications alternatives. It all began around 1994, when FPUA began to build a fiber-optic network to replace leased data links between its buildings in Fort Pierce. The new optical fiber system proved to be more reliable and cost effective while providing sufficient capacity for external customers. In 2000, FPUA allocated separate fibers through which it began to offer Dark Fiber Links to other institutions. This soon expanded to include businesses and more service types.

What services would Hudson offer?

The City would initially offer Internet and Voice services to businesses and anchors located in the Hudson service area, based on Zones 1-4. The network would allow the City to provide shared broadband services using Gigabit Passive Optical Network ("GPON") technology and dedicated broadband services using Active Ethernet ("AE") technology. GPON is a shared technology which provides an "up to" bandwidth but at much greater speeds than cable or DSL. GPON has the ability to

offer a 1 Gbps connection to every subscriber but does not provide guaranteed bandwidth at all times. Actual bandwidth is subject to other users in the system who are vying for bandwidth at the same time. GPON services are an excellent option for businesses small to large that do not require a guaranteed line rate connection (i.e. 1 Gbps available all of the time). Large businesses and others with high-bandwidth, consistent data needs would subscribe to the dedicated service based on Hudson's AE platform. This platform would guarantee full bandwidth on the service purchased 100% of the time. The AE product is priced significantly higher because of this guarantee.

Business Internet

Business Internet services will provide high-performance, scalable Internet services to businesses in the service area. The City's Business Internet Services will provide tiered services that allow businesses to purchase exactly the right amount of bandwidth for their Internet needs. The City also has the opportunity to provide symmetric service; a significant benefit to businesses that the competition cannot support today. Instead of rebranded residential services, which the local DSL and cable providers offer in the market, the City will be able to offer direct, symmetric, fiber-optic Internet to businesses at affordable prices. The City's Business Internet Services will provide the highest performing, most reliable services in the market. The City will compete on this differentiating advantage to drive significant market share in the small, medium, and large business market. The City's Business Internet Services will also be targeted at Hudson's community anchors including schools, hospitals, and other critical organizations.

Hudson will maintain redundancy with its upstream Internet providers and provision sufficient supply of Internet to ensure customers receive the services for which they subscribe. The City's Internet service will connect to the major Internet backbone to ensure high performance and low latency to the major Internet sites across the world. Hudson will be able to offer its customers IP addresses directly from its own allocation from the American Registry of Internet Numbers ("ARIN").

Business Lines, Hosted PBX & SIP Trunking

By leveraging VoIP technology, the City will offer its business customers flexibility and affordably while providing reliable and feature-rich business phone services. The City would provide a private label voice offering, which will minimize incremental operating costs as it grows. The private label option allows the City to offer voice services with very little upfront capital investment and use a license fee model to grow.

Business Lines

For small business customers, the City will offer competitive business line packages consisting of 1, 2, or more lines. Many different combinations are possible based on the needs of businesses in Hudson. Business lines will be delivered across the customer's Internet connection and converted to an analog signal via an ATA built into an optical network terminal or Internet gateway. The City will offer the flexibility to connect both digital handsets and analog handsets depending on the customer's needs. The City's business lines will be focused on providing flat rate packages to business customers with unlimited local and long distance calling. The City will utilize SIP-based trunking with its long-distance carrier(s) to ensure low cost usage based metering that reduces the City's incremental costs with increased volume.

The City's business lines will offer a range of voice services including the following:

- Voicemail
- Voice Message Notification
- Voice Message to Email
- Call Waiting
- Calling Line ID Delivery
- Calling Line Name Delivery
- Three-Way Call
- Anonymous Call Rejection
- Automatic Callback
- Call Forwarding
- Call Forwarding Selective
- Call Return
- Call Transfer
- Selective Call Acceptance
- Selective Call Rejection
- Speed Dial
- Hunt Group
- Support for Alternate Numbers
- Call Notify
- Shared Call Appearance
- Music On Hold
- Sequential Ring
- Simultaneous Ring Personal
- Do Not Disturb
- Last Number Redial
- Priority Alert

Hosted PBX

For those businesses that require more robust capabilities than basic business lines, the City would offer Hosted PBX services to business customers. Much like a traditional PBX, Hosted PBX platforms offer the same robust features as a traditional PBX without the task of having to manage the hardware and software. Hosted PBX services provide a great advantage for the City's business customers by reducing the customer's capital cost for centrally located call processing equipment, allowing customers to pay for only what they use and to keep up with future features and technology without incurring additional capital cost. Hosted PBX service will offer the customer a wide variety of benefits beyond the basic business line service. Aside from adding the capability to transfer calls and allowing multiple business extensions to be reached via a single business number, a Hosted PBX platform can also manage incoming calls that are not immediately answered by an individual, answer and route calls via an automated attendant, queue and distribute calls with Automatic Call Distribution (ACD) features, and even direct calls based on an individual's availability or how recently they have received a call.

Customers will have access to the City's Hosted PBX platform via their Internet connection and in some cases, will be required to purchase or supply SIP capable phones. Examples of compatible SIP phones are the Polycom IP450, Polycom IP 550, Cisco SPA504G, and Cisco 7960. Pricing for SIP phones ranges from $100 - $300 depending on the features required. The City could maintain reseller channels to procure hardware at wholesale pricing. The City may charge markups on this hardware where required.

The City's Hosted PBX services will include the following features, some of which will be included directly in the cost of each extension and some that will be priced a la carte:

- Voicemail
- Voice Message Notification
- Voice Message to Email
- Call Waiting
- Calling Line ID Delivery
- Calling Line Name Delivery
- Three-Way Call
- Anonymous Call Rejection
- Automatic Callback
- Call Forwarding
- Call Forwarding Selective
- Call Return
- Call Transfer
- Selective Call Acceptance
- Selective Call Rejection
- Speed Dial
- Hunt Group
- Support for Alternate Numbers
- Multiple Call Arrangement
- Instant Group Call
- Music On Hold
- Busy Lamp Indicator
- Simultaneous Ring Personal
- Do Not Disturb
- Directed Call Pickup
- Priority Alert

There are two types of business customers targeted for Hosted PBX services:

1. Business customers who have previously invested in traditional PBX systems.
   Traditional PBXs are quickly being phased out as businesses move to more streamlined, lower cost VOIP platforms. These customers currently pay ongoing maintenance fees for their traditional PBX hardware and periodically require technicians to reconfigure these systems, often times at an additional cost to the business. In many cases, a business case can be made to retire the traditional PBX and move to a more efficient Hosted PBX solution that carries no ongoing costs. In some cases, businesses will keep their existing phones, in others they will be replaced by new VOIP phones sourced by the City. The City can offer promotional deals on this hardware and/or lease the equipment to customers to reduce the upfront costs for potential customers, reducing or eliminating any startup costs. The City should show the benefits and cost reductions to businesses, helping them understand why they should switch to the City's Hosted PBX product.

2. New business customers who do not currently have a phone system.
   In these cases, a City Hosted PBX solution will cost less and provide significantly more features than a traditional phone system. Businesses can have their choice of desk phones, softphones, or both. The City will supply all hardware needed and can offer promotional deals on this hardware and/or lease the equipment to customers to reduce or eliminate any startup costs.

SIP Trunking

For businesses and enterprises that already own a PBX and want to take advantage of VoIP technology, the City will provide SIP Trunking as a lower cost option to traditional PRI and analog phone line services. In cases where a business maintains a SIP capable PBX, there is no additional equipment required. If the existing PBX is not SIP capable, an Integrated Access Device (IAD) will be required to convert the VOIP transmission into a handoff supported by the legacy PBX. Unlike traditional Basic Rate Interface (BRI) and Primary Rate Interface (PRI) services delivered by incumbent telecom

providers, a SIP trunk allows a company to replace these traditional fixed PSTN services with a SIP trunk operating on their current Internet connection.

SIP Trunking will allow the City to gain a higher market share of businesses. In cases where businesses have invested in a traditional PBX and cannot or do not want to change this hardware, the City will offer lower cost trunking than the businesses are currently paying telecom providers. This gives the City a "foot in the door" to these businesses with an easy-to-install service that creates immediate savings for the business with low or no upfront costs. Once businesses are ready to retire their traditional PBXs, the City can offer these customers the Hosted PBX solution and the City captures all of the customer's voice services.

Business Services Provider Rates, Service Revenues, & Installation Revenues

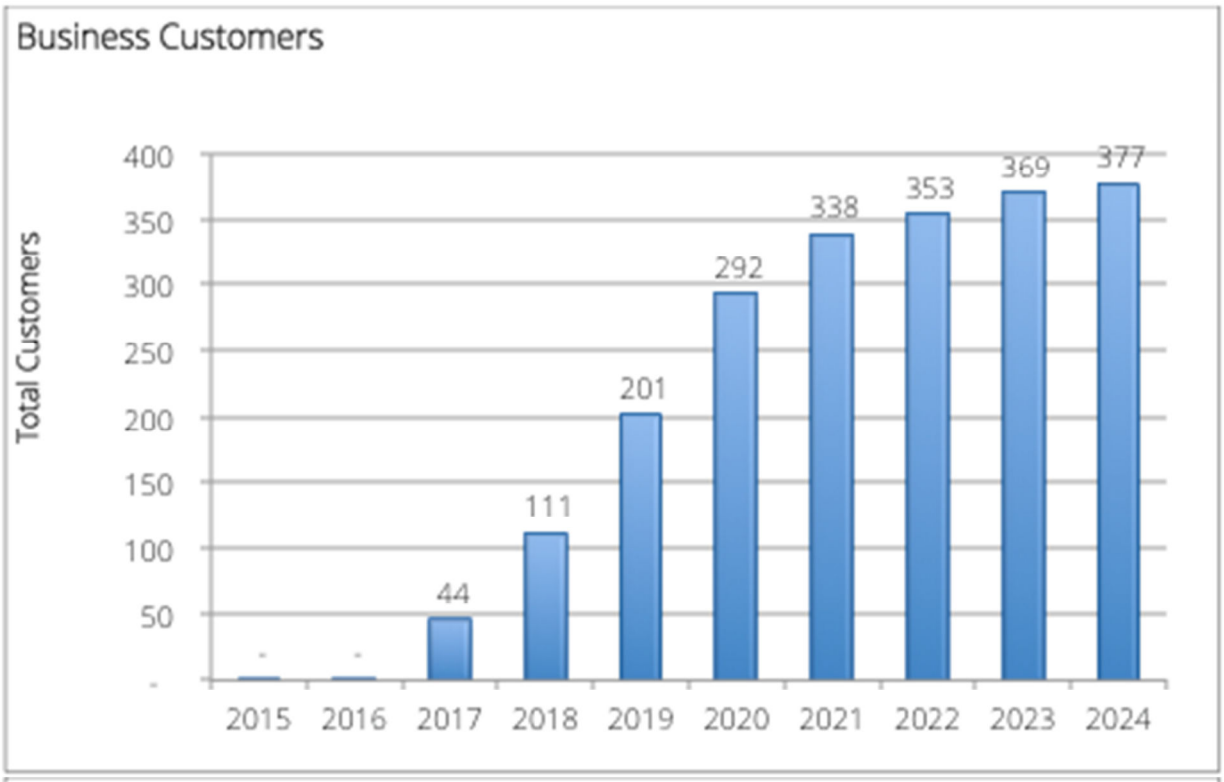
The City should strive to offer rates for Internet and Voice services that are below the current market to drive higher uptake of the City's services. The City's cost structure affords it the opportunity to sell services at rates lower than are being offered and with much greater Internet speeds. The City would offer two types of Internet services, shared and dedicated. Shared Internet services would provide an "up to" speed, suitable for most small and medium businesses. The City would start its offering at 100 Mbps and establish higher tiers up to 1 Gbps. At the 100 Mbps tier, the City's Internet service would trump the competitors DSL and cable offerings in the market today by tenfold and provide a higher performing, fiber-optic connection to small and medium businesses. For large businesses that required fixed bandwidth (100% of the bandwidth is always available), the City would offer a dedicated Internet product priced higher that provides service level guarantees to businesses that need these performance levels. The dedicated product would have similar speed tiers but generally be provisioned over an Active Ethernet connection rather than a GPON connection. The projected packages, speed tiers, and monthly pricing are provided in Figure 7-7. Standard business voice service packages would include a single line, two lines, five lines, and customer packages. Many other voice packages would be available through the City's Voice offering based on business needs. Larger businesses often will require a custom package with special pricing; these packages are lumped together and an average cost has been established for them as shown in Figure 7-7.

Figure 7-7: Potential Monthly Fee Structure

Business Voice	
Voice - 1 Line	$38.00
Voice - 2 Lines	$57-00
Voice - 5 Lines	$190.00
Voice - Custom	$380.00
Business Internet	
100 Mbps	$171.00
200 Mbps	$314.00
300 Mbps	$456.00
500 Mbps	$570.00
1 Gbps	$1,140.00
Anchor & Dedicated Internet	
50 Mbps	$855.00
100 Mbps	$1,568.00
200 Mbps	$1,995.00
1 Gbps	$2,850.00
Installation & Activation	
Business	$499.00
Anchor	$999.00

Revenues generated by the City consist of monthly recurring fees generated by services and equipment rental as well as non-recurring fees such as installation and activation. Revenues grow linearly with the amount of customer uptake on the network; therefore, uptake is a very important determinant of overall revenues as well as gross profit and net profit margin. Based on analysis of the Hudson market opportunity and potential competitive advantage, the City should be equipped to capture a significant market share of the business markets in Hudson if it is able to execute a strong sales and marketing plan. As an advanced business broadband provider with the only Fiber-to-the-Premise based network in the area, Hudson's network will have the greatest capabilities to deliver services to the businesses of the community. It is important that the City meet the projections in customer growth depicted in stated in this Plan as these forecasts are tied directly to overall revenues and cash flow generated by the utility. Therefore, the City will need to execute a strategic marketing plan, technical plan, and operations plan to achieve this uptake over the 10-year period.

Figure 7-8: Business Services Provider Annual Uptake



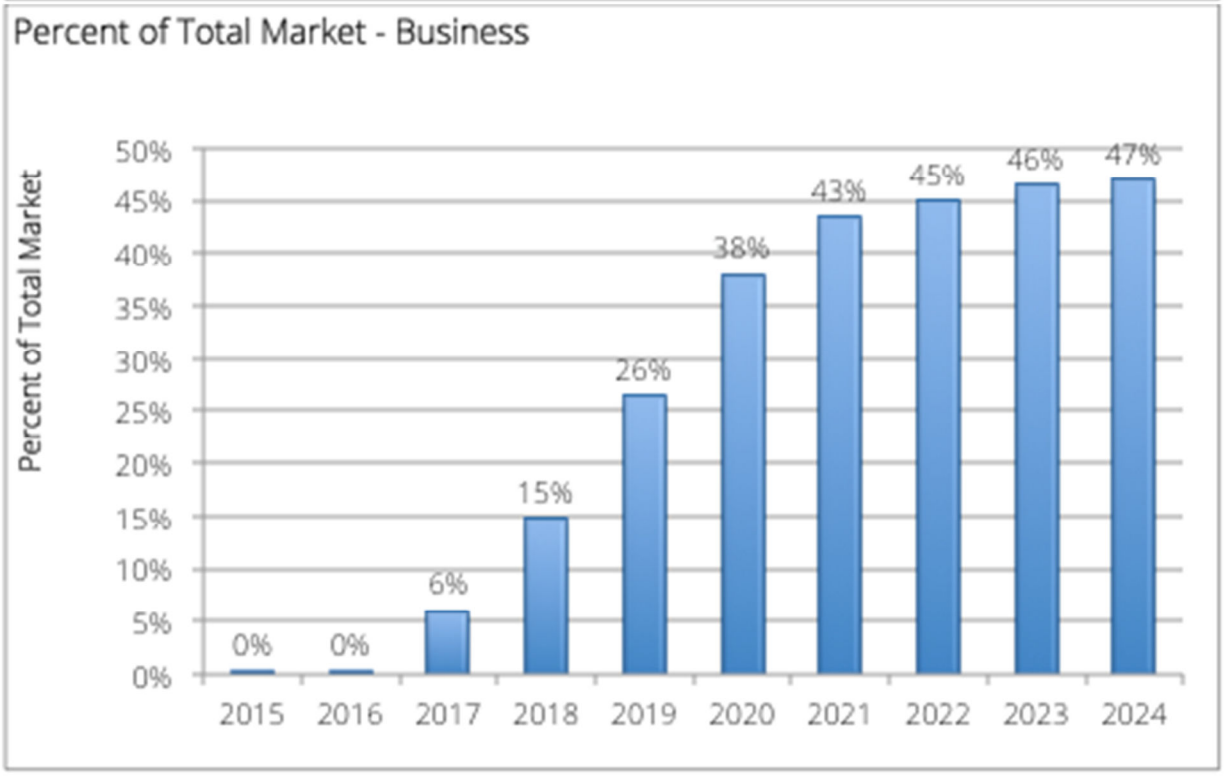
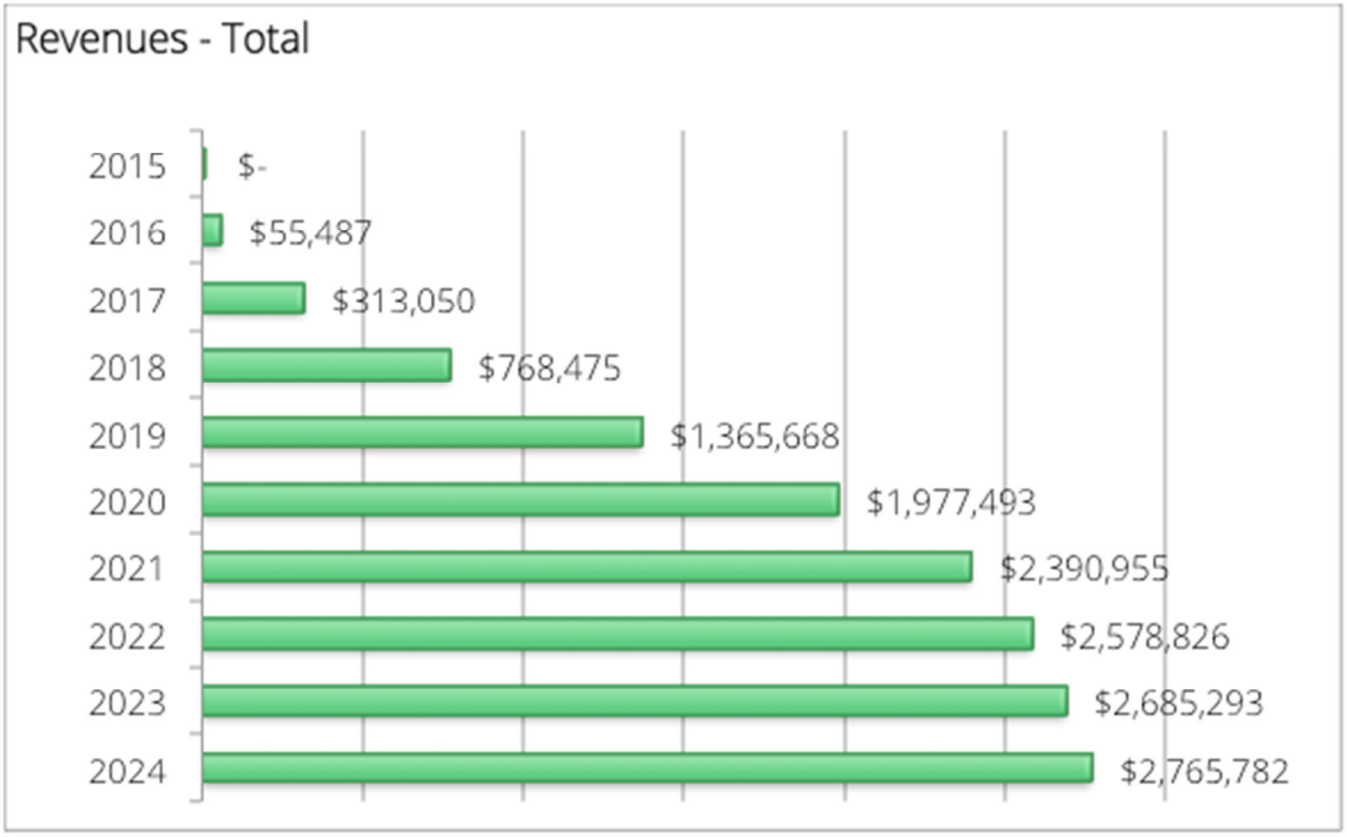


Figure 7-9: Projected Annual Monthly Recurring Revenues (MRR)



Business Services Provider Operating Costs

Wholesale Internet

Wholesale Internet Services will be contracted and delivered by one or multiple upstream providers. The cost structure for wholesale Internet is typically structured using a Port Charge (1 Gbps, 10 Gbps), a Commit Rate, and Burst Rate. The Commit Rate is a set fee per Mbps and the City would bear the full cost of the Commit Rate, while Burst Rate is charged on a per Mbps basis over and above the Commit Rate. Bursting (Burst Rate) will allow the City to manage capacity and costs more effectively. Estimated pricing for Bulk Internet services is:

- 100 Mbps/$7-00 per Mb
- 200 Mbps/$6.50 per Mb
- 300 Mbps/$6.00 per Mb
- 400 Mbps/$5.50 per Mb
- 500 Mbps/$5.00 per Mb

Wholesale Voice

The City will incur ongoing license fee costs from its private label voice provider. These costs average $7 - $15 per month for each business line, depending on the features enabled for businesses. These costs will grow linearly with the uptake of more business voice customers; however, as the City increases its total volume of voice lines, it should expect to negotiate better bulk pricing for these services with the private label voice provider.

Operations & Maintenance

Hudson's O&M costs will include ongoing management of the City's equipment, software, and facilities.

Network Equipment Maintenance - $45,000
Software Maintenance - $35,000
Facilities Power & Environmental – $23,000
Miscellaneous O&M Costs – 1% of gross revenue

Direct and Indirect Staffing

Direct staffing includes all City personnel that are attributable to the provision of the City's services in the operation. Salaries and benefits were calculated using current staffing costs from similar broadband utilities and are as follows (annually adjusted for CPI using a 3% escalator). Figure 7-10 illustrates these costs.

Figure 7-10: FTE Costs

FTE Position	Fully Loaded Salary	Annual Escalator (CPI)
FTE - Customer Service	$55,000	3%
FTE - Network Management	$95,000	3%
FTE - Field Services	$75,000	3%
FTE - Sales & Marketing	$65,000	3%
FTE - Administration	$90,000	3%

Figure 7-11: Business Services Provider Staffing Plan

Broadband Operational Functions	Project Phase		
	Startup Phase (Year 1-2)	Growth Phase (Year 3-5)	Steady State (Beyond Year 5)
Customer Service • Customer activations/terminations • Basic billing support • Adds/moves/changes • Customer tier 1 support • Billing system integration • Advanced billing support • Reporting • Utility tax application	1 FTE	2 FTE	2 FTE
Network Management • Routine network management and maintenance • Service quality management • Provisioning • Contractor management • Troubleshooting • Outside plant repairs and maintenance	1 FTE	1.5 FTE	2 FTE
Field Services • Field installations • ONT, Gateway, Set top Box Installs • Service testing • Adds/moves/changes	.5 FTE	1 FTE	1 FTE
Administration • Contract Management • Financial Management • Marketing • Service Provider Management • RFP Management • Outside plant management • New construction planning and implementation • Record keeping	1 FTE	1 FTE	1 FTE
Sales • Public Awareness and Outreach • Marketing of network availability • Economic development planning • Promotional opportunities • Co-marketing with service providers	1 FTE	1 FTE	1 FTE

Cost of Services	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**
Salaries and Benefits		$203,425	$209,528	$267,718	$275,750	$347,500	$414,933	$427,381	$440,203	$453,409
Bulk Internet		$36,000	$46,800	$60,840	$79,092	$102,820	$133,665	$173,765	$225,895	$293,663
Bulk Voice Services		$0	$3,970	$13,952	$28,064	$44,342	$56,651	$62,172	$64,967	$67,081
Equipment Maintenance		$45,000	$46,350	$47,741	$49,173	$50,648	$52,167	$53,732	$55,344	$57,005
Software Maintenance		$35,000	$36,050	$37,132	$38,245	$39,393	$40,575	$41,792	$43,046	$44,337
Facilities Maintenance, Power & Environmental		$23,000	$23,690	$24,401	$25,133	$25,887	$26,663	$27,463	$28,287	$29,136
ARIN, DNS & Subscriptions		$15,000	$15,450	$15,914	$16,391	$16,883	$17,389	$17,911	$18,448	$19,002
Miscellaneous		$556	$3,132	$7,686	$13,658	$19,776	$23,911	$25,789	$26,854	$27,659
Subtotal: Cost of Services		**$357,981**	**$384,969**	**$475,383**	**$525,505**	**$647,247**	**$765,955**	**$830,006**	**$903,044**	**$991,291**
Sales, General & Administrative Expenses										
Salaries and Benefits		$195,700	$201,571	$207,618	$213,847	$190,000	$226,870	$233,676	$240,686	$247,907
Professional & Legal Fees		$55,000	$56,650	$58,350	$60,100	$61,903	$63,760	$65,673	$67,643	$69,672
Sales Expense		$1,143	$6,449	$15,831	$28,133	$40,736	$49,254	$53,124	$55,317	$56,975
Marketing Expense		$1,715	$9,673	$23,746	$42,199	$61,105	$73,880	$79,686	$82,976	$85,463
Reporting		$4,000	$4,120	$4,244	$4,371	$4,502	$4,637	$4,776	$4,919	$5,067
Office Expense		$5,000	$5,150	$5,305	$5,464	$5,628	$5,796	$5,970	$6,149	$6,334
Utilities		$17,000	$17,510	$18,035	$18,576	$19,134	$19,708	$20,299	$20,908	$21,535
Bad Debt Expense		$555	$3,130	$7,685	$13,657	$19,775	$23,910	$25,788	$26,853	$27,658
Subtotal: Sales, General & Administrative Expenses		**$280,112**	**$304,254**	**$340,812**	**$386,346**	**$402,782**	**$467,815**	**$488,992**	**$505,452**	**$520,611**
Depreciation & Amortization										
Depreciation		**$179,208**	**$187,391**	**$198,887**	**$213,762**	**$228,651**	**$236,981**	**$248,372**	**$252,286**	**$164,698**
Subtotal: Depreciation & Amortization		**$179,208**	**$187,391**	**$198,887**	**$213,762**	**$228,651**	**$236,981**	**$248,372**	**$252,286**	**$164,698**
Interest										
Borrowings		$106,794	$123,438	$129,277	$123,837	$104,692	$84,973	$64,662	$43,742	$22,194
Subtotal: Interest Expenses		**$106,794**	**$123,438**	**$129,277**	**$123,837**	**$104,692**	**$84,973**	**$64,662**	**$43,742**	**$22,194**
Debt Principal Payments										
Borrowings		$350,405	$462,714	$562,383	$638,162	$657,306	$677,026	$697,336	$718,256	$739,804
Subtotal: Principal Payments		**$350,405**	**$462,714**	**$562,383**	**$638,162**	**$657,306**	**$677,026**	**$697,336**	**$718,256**	**$739,804**

Business Services Provider Funding Requirements

$6.5 million of funding would be required over the 10-year period to fund capital and operational expenses in the project, using the following funding schedule.

Capital Item	Total Cost	Year
Fiber-Optic Feeder & Distribution Network	$1,850,000	2016
Network Electronics & Equipment	$845,000	2016
Colocation Facility	$300,000	2016
Drop Fiber Network and Customer Equipment	$900,000	Ongoing
Ongoing Operations	$2,605,000	Ongoing
Total	**$6,500,000**	

Magellan assumed a 10-year revenue bond would be utilized at an interest rate of 3% with annual principal and interest payments starting in 2016. Financial results will depend on the final debt instrument utilized to fund the project.

Distribution of funds would occur from 2015 – 2019, as follows:

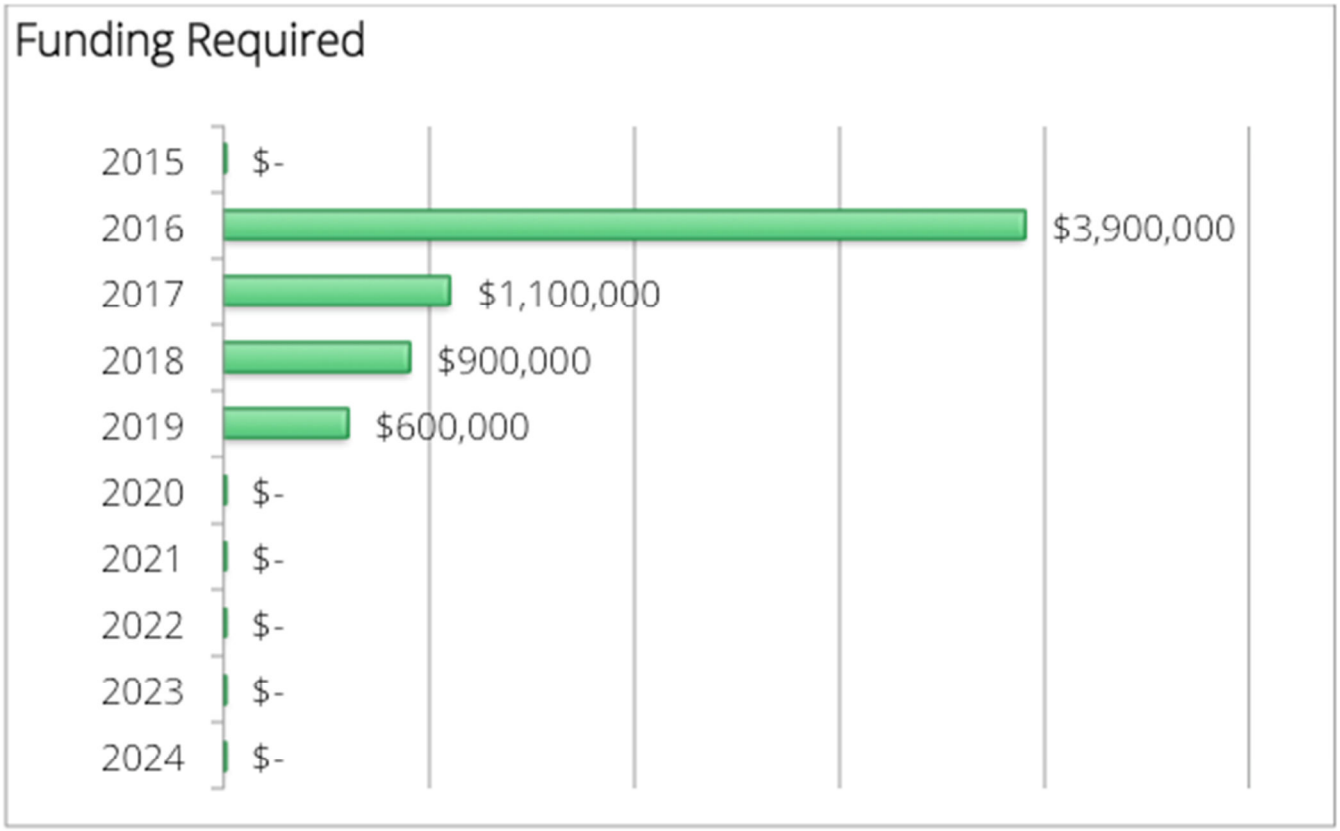
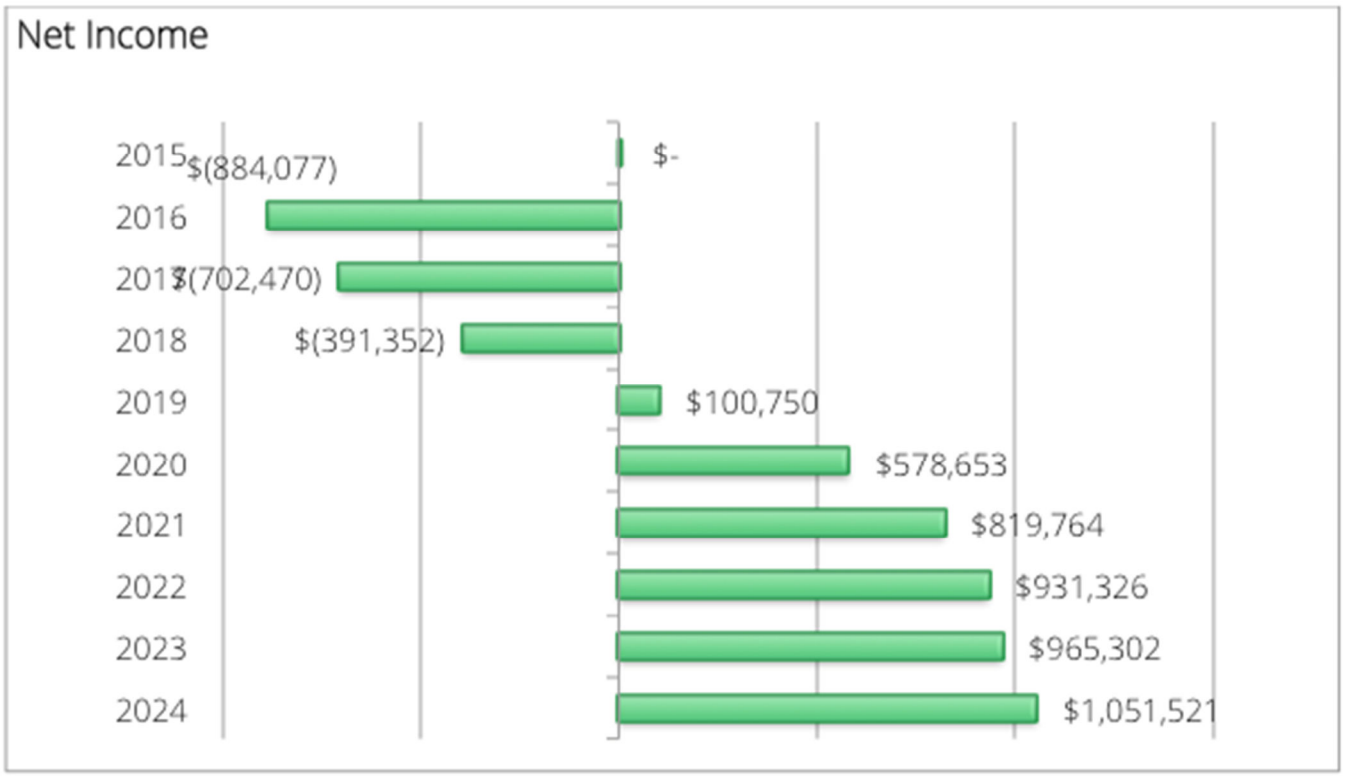
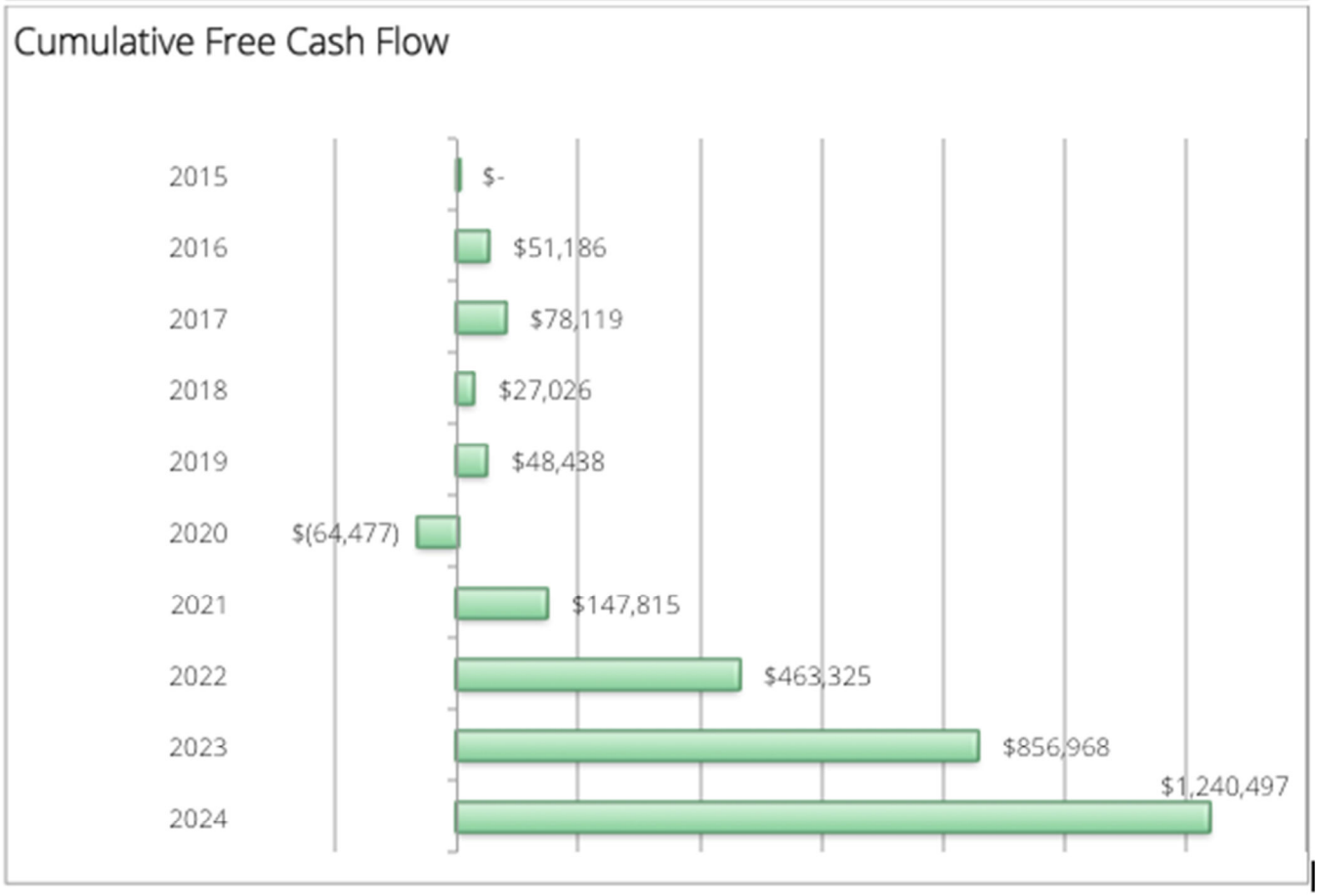


Figure 7-12: Net Income & Free Cash Flow





Profit & Loss Statement (attached in Microsoft Excel spreadsheets)

What are the Risks?

Managing retail broadband services requires more human and system resources than open-access. Key financial risks to the City are based primarily on the uptake of its services in the market and long-term operating costs. The City must gain significant markets share in the first 5 years of operations to ensure that it is able to pay all operating costs, service its debt, and maintain suitable reserves. Penetration rates in the first 3 years of the project are particularly sensitive and have significant impact to long-term cash flows across the 10-year period of operations.

The risk of "slow growth" poses significant risk to the City and results in an operating position where the City may not able be able to cover all operating costs and/or debt service, which may require additional capital infusions to maintain the operations. Successful execution of the City's sales and marketing plan and efficiency of the installation and activation of customers will help the City achieve its market penetration targets. Market penetration rates are also susceptible to factors outside of the City's control including economic changes and predatory pricing from incumbent providers who are trying to maintain their share of the Hudson market.

Competitive risks from other technologies and/or incumbent providers do not appear significant at this time. Competition from incumbent providers can be expected; however, their services to date are marginally sufficient services to businesses and no plans have been announced that significantly upgrade these services. It is important that the City maintain good intelligence on its competition though. If the City decides to pursue becoming a business services provider, they may realize that it is a great threat to their current high-margin market share and begin to make investments in fiber-optic to compete with the City's new offering. The City should focus on several key strategies that municipal broadband utilities have used successfully to deploy business broadband services:

1. **Develop a strategic sales and marketing plan that will be carried out by dedicated personnel and ensure they have the resources necessary to achieve the goals.**

2. **Use the City's data and tools to strategically target businesses that need next-generation Internet and voice services.**

3. **Use the good reputation of the City's electric utility to market the network to local businesses, focusing on service quality, customer responsiveness, and a hometown, locally-owned network.**

4. **Use the City's economic development department and chamber of commerce as conduits to attract the local business community.**

8. Regulatory Analysis

Magellan Advisors has reviewed the regulatory and policy environment in Ohio pertaining to municipal broadband. Information was gained from communication with the Ohio Municipal League staff and the Ohio Municipal Electric Association staff, review of Public Utilities Commission of Ohio (PUCO) requirements, as well as through Magellan's own research and knowledge. Broadband facilities and services are generally very lightly regulated at the federal (Federal Communications Commission) or state (PUCO) levels. Under federal law, broadband Internet access services are generally treated as unregulated services and are subject to fewer regulations than cable TV or telecommunications services.[1] However, the inclusion of retail telecommunications services and/or Cable TV services provided over the broadband Internet access facility, in some jurisdictions, can cause complications depending on the policy environment in the particular state.

No direct regulatory impediments to the provision of an open-access wholesale municipal broadband platform have been identified in Ohio. Furthermore, no laws or policies have been identified which would impede or impair additional development of fiber-optic facilities by the City to expand availability of high-speed broadband services via an open-access wholesale municipal platform.

If the City of Hudson determines that it will provide retail broadband and telecommunications and/or Cable TV services over the municipal broadband platform, there are additional steps and requirements that should be noted. Provision of such services will require consideration of registration, filing, and reporting requirements imposed by the FCC on telecommunications providers and Cable TV operators. While these requirements are not necessarily onerous, they do require time and care to ensure proper compliance. There would also be additional certification requirements at the PUCO that are not onerous but administrative in nature.

In summation, these requirements are not unusual or onerous, and reasonably represent common public utility practices and requirements for a "level playing field." Under this policy environment, a number of examples of innovative undertakings by municipal utilities exist, often using inter-local agreements. There have been no significant public policy controversies or legislative activity pertaining to municipal broadband in recent years; although, it should also be recognized that there have not been significant launches of new municipal networks or overbuilds in that same period. The policy environment enables municipal utilities to meet the expressed needs of the community.

[1] This discussion and analysis does not constitute a legal opinion and should not be construed as such.

9. Recommended Business Model and Operations Requirements

A. Recommended Business Model

The recommended option for the City of Hudson is to implement an open-access network. Development of the open-access network would result in the greatest benefits to Hudson's broadband environment and meet the objectives that Hudson is looking to achieve in this Assessment. First, a single fiber-optic network with multiple service providers introduces a more competitive environment for businesses and community anchors as they now have access to a greater number of service providers than were previously available. Second, businesses and residents would have the opportunity to shop for services amongst a pool of providers and could potentially contract for services from multiple providers; Internet from one, voice from another, and transport or backup services from yet another. Third, businesses and community anchors have more control over their services and can switch providers more easily if they are not satisfied with their current provider. Since all providers will utilize a single City-owned fiber network, customers will not be charged a second round of installation fees if they switch from one provider to another; all participating providers will utilize Hudson's open-access network. Finally, open-access lit networks have traditionally introduced new providers into markets offering competitive rates, as significant capital investment to enter these new markets is not required since the City is responsible for the costs of fiber construction and management.

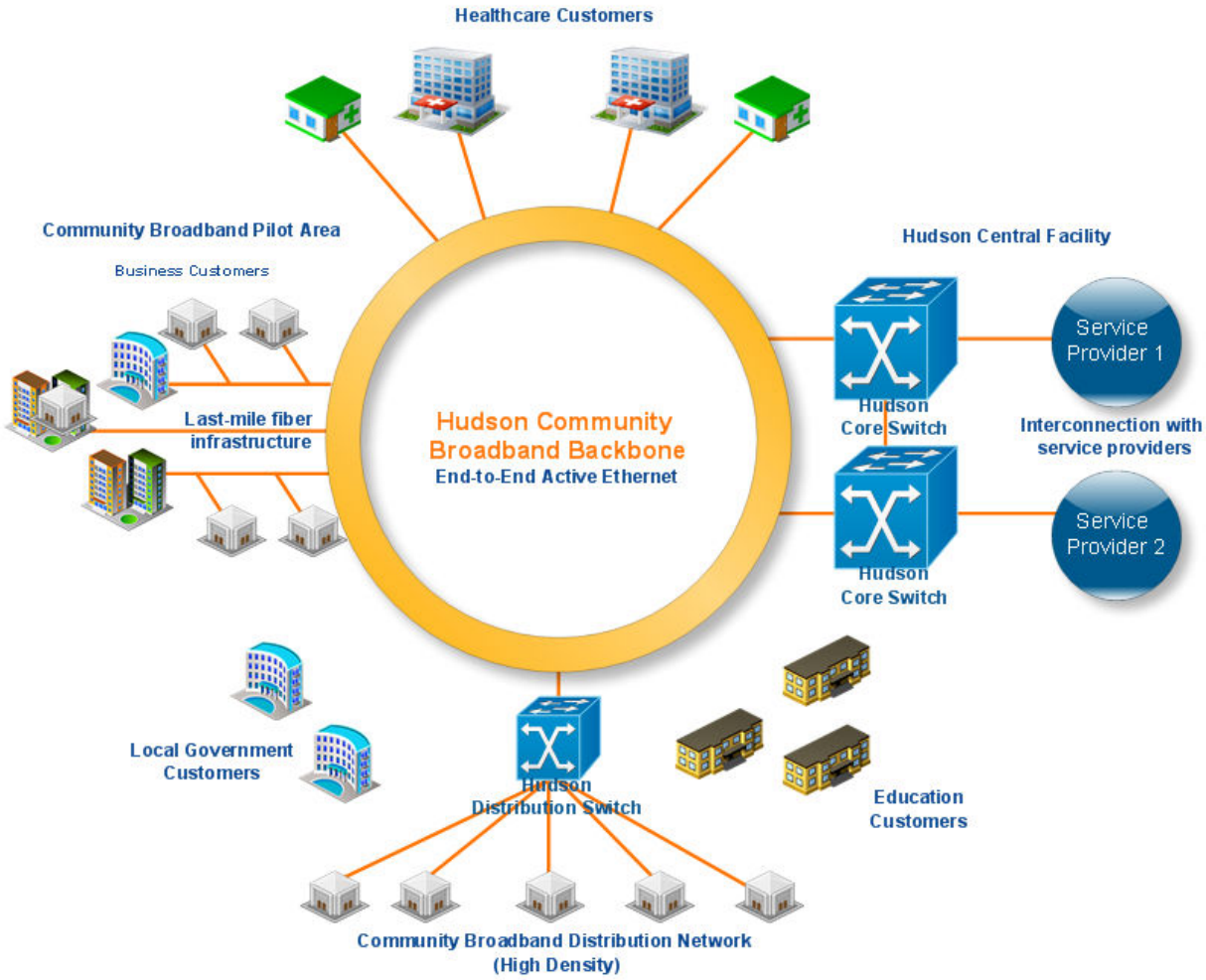
Building an open-access network would require Hudson to provide lit transport circuits to businesses throughout the City. Hudson would implement a Layer-2 transport network with active network electronics that would enable delivery of Ethernet and GPON services over the network. All end-user traffic would be aggregated onto the lit backbone allowing the City to conserve dark fiber capacity. The lit fiber network would aggregate traffic across a high-speed 10 Gbps backbone that interconnects service providers to their customers, coordinated through Hudson's equipment.

Service providers would interconnect with the Hudson's open-access network through a Network-to-Network Interface (NNI) with the City's network electronics. The City would strategically deploy field equipment known as Optical Line Terminals ("OLTs") in local business districts (and potentially neighborhoods in the future). This equipment would connect back to a centralized colocation facility or data center where service providers would interconnect with the City's network. Selection of the data center should be based on the location where the majority of service providers currently connect. This will enable the greatest number of service providers to interconnect with Hudson's network at the lowest cost to both the service providers and Hudson. The network would provide a significantly higher amount of redundancy, enabling redundant 1 Gbps and 10 Gbps paths to service providers rather than linear dark fiber strands. This would introduce a level of fault tolerance or diversity into the core backbone providing higher reliability and availability to businesses and community anchors using the network.

Service providers would request new connections to their customers from the City. Once a customer signed an agreement with a service provider, the service provider would order transport service to the new customer. Once the service provider signed a service order with the City and paid any upfront charges, the City would build the last-mile fiber connection to the end customer and provision a transport service through its network back to the interconnection point with that service provider. The City would charge a monthly recurring fee to the service provider for use of the transport service for a certain contract term and at a certain bandwidth. The City would maintain a rate structure based on bandwidth, with increasing charges for more bandwidth. This would allow the City to upcharge the service providers as customers utilized more bandwidth and implement a tiered pricing structure from lower-speed services to 1 Gbps and 10 Gbps services.

Some considerations for the City to evaluate in implementing an open-access network include the additional operations and management responsibilities required to maintain the network, recruitment, negotiation, and provision of new services, and financing requirements to build the network. The City will be responsible for implementing and maintaining network electronics to manage services on the network. While this equipment is simple to manage it does require the City to have technical resources to provision and monitor services as they are deployed. In order for service providers to consider providing services over Hudson's network, the City must establish Service Level Agreements (SLA) that are similar to what service providers receive in the current telecommunications industry. The City will also need to define business and operational processes to manage the network and ensure that service provider's needs are met. Further, deployment of an open-access network requires new funding for construction of last-mile fiber, network electronics, operational support systems, and potentially new staffing or an outsourced network management company who will operate the network on the City's behalf. These items are more fully described in the following sections.

Figure 9-1: Hudson's Open-Access Network



The open-access business model fits the City of Hudson's goals and objectives of building new fiber infrastructure, recruiting new service providers to town and enabling competition. It also allows the City to focus on its core competency of managing infrastructure while collaborating with private businesses to provide the end-user services that would be delivered across the network. It keeps the City "out of the business" of providing retail services while still enabling competition, reducing costs for local businesses and providing a platform for future innovation.

B. Open-Access Operations Requirements

Services

In an open-access network, the City would not provide any retail services directly but would provide a new wholesale fiber solution to service providers that would utilize the network to serve residents and businesses. In doing so, the City could potentially provide a new source of next-generation broadband access to service providers while maintaining neutrality and non-discrimination and staying out of competition with service providers. The Hudson network would provide transport services originating from service providers to their customers. With open-access, the City's customers are service providers rather than retail customers, allowing the City to maintain transparency and

avoid any direct "customer service" issues with customers using the network. Service Providers would deliver Internet, voice, video, and other broadband services using Hudson's open-access network.

Operations

The operations of a Hudson Community Broadband Network would include backbone and last mile construction, provisioning, management and support, and operations and maintenance of the outside plant infrastructure. It is important to ensure these operational processes are within an organizations knowledge and experience. For the City of Hudson, many of these processes are engrained into their current business processes as a provider of electric and dark fiber services. Hudson also owns many of the systems, vehicles, trailers, and splicing equipment that would be used in a new communications utility.

The provisioning, management, and support of the active electronics used to power the network would be a new undertaking for Hudson. These processes could be developed in-house with the right staffing and training programs or they could be outsourced to a network operator. It will be necessary to develop a financial plan that develops an internal support structure using Hudson staff and systems benchmarking costs against a potential outsourced contract. Opportunities to collaborate with existing organizations that may be able to fulfill the network operator role should be explored as a locally sourced organization with a "local presence" could be very well received in the community.

Drop Fiber Construction

New business service orders will generally require construction of last-mile fiber from a pedestal to a customer's premise. These will generally be direct buried drop fiber lines spliced into an ONT that is either mounted on the outside of the building or fed inside the building. In the case of large business customers and community anchors, special construction may be required to connect from the local distribution fiber network to the premise.

Hudson could maintain outside plant contractors that will be responsible for constructing new fiber drops or insource this function to the electric department. Hudson's construction crew will receive work orders once a new order has been registered by the City. They will also coordinate with installation technicians to ensure drop fiber lines are fully tested and ready for activation in customer's businesses. Hudson will develop business processes to ensure tight coordination between new order taking, order verification, drop fiber construction, and service installation. Hudson's goal should be to minimize any delays between the time a service order is accepted and the service is activated.

Installation

Installation is a critical function that requires coordination between multiple parties. Installation includes the activation of customer premise equipment, coordination with City personnel, troubleshooting with network technicians, and verification of service establishment with end customers. The City's install team should be well versed in connectivity and integration of fiber, Internet, voice and networking within the business environment. The City can insource or outsource installation technicians as they provide a valuable touch point that can strengthen Hudson's brand

with the customer. Knowledgeable, helpful install technicians promote a strong customer experience that will help Hudson reinforce its brand in the marketplace.

Order Management & Provisioning

City staff will be required to manage the order and provisioning process for customers. An order management resource will accept new orders from service providers for transport service. The City will first require that a check be performed to ensure the particular address is serviceable within the City's network. The City should utilize GIS-based verification systems to ensure that the customer address is within the service area and reachable by the network. For orders outside the service area, the City may decide to provide service based on the economic development value of connecting the particular business to the network. This may include connections to business and anchors that are not directly in the footprint of the City's feeder and distribution network. These will be analyzed on an individual case basis, or "ICB."

Network Operations

Network management through the City's network management systems will provide ongoing network support and monitoring of the service delivery network including core, distribution, and access networks. The City will need to implement a comprehensive network management system to manage the network, which has been budgeted in the financial plan. A single system that manages the core, distribution, and access network will be critical for the City's staff to maintain effective monitoring and troubleshooting of issues on the network. Network management systems should contain all configuration, addressing, customer, and management information to allow City staff to easily monitor and make changes to the network on a day-to-day basis. Network management systems should address the 5 key pillars of supporting a multi-service network including:

- Configuration management
- Capacity management
- Monitoring and reporting
- Troubleshooting
- Alarm management

During times when outages occur, it is important that the City have effective processes in place to manage restoration of services on the network. For major outages such as fiber cuts or core equipment failures, distribution of information to the affected customers and/or service providers needs to be managed effectively. Service providers will require immediate notification of network issues and outages with periodic updates toward service restoration; the interval dictated by the severity of the outage and the service level agreement with the Utility. Direct customers of the City such as other government organizations and community anchors also need immediate notification of outages as these disruptions will impact their operations. A multi-channel approach is generally the best method to disseminate information about outages; broadcast to the affected customers on a periodic interval, via active channels such as emails and text messages, and passive channels such as web posts.

Field Services

The City will require field services personnel to maintain responsibility for the outside plant fiber-optic network and related components. The City will need to manage existing fiber plant and new design/construction, interfacing with outside plant personnel on a routine basis. Primary responsibilities of field services include:

- Managing Existing fiber-optic network operations and maintenance
- Managing the design and construction of new fiber-optic network components
- Documentation and records management of fiber-optic network assets
- Work order management for new construction activities
- Testing and inspection of outside plant fiber-optic components
- Capacity management on the feeder, distribution and drop fiber-optic networks

Billing, Accounting & Finance

The City should maintain an accounting and finance function at the onset of the project implementation to track the implementation of the network and, once complete, move into an operational role. Accounting and finance functions will include:

- General project accounting and finance
- Purchase order management, vendor management and accounts payable
- Inventory management and tracking
- Data entry for capital assets into the financial system for balance sheet management, depreciation tracking and renewal and replacement planning
- Project budgeting and change order management
- Project accounting reporting

As the City moves out of its primary construction stage and into operations, accounting & finance will be responsible for the following:

- Customer billing management
- Accounts receivable management
- Accounts payable management
- Accounts reporting
- Support on billing issues and tier 2 billing support

10. Next Steps

Hudson has a significant opportunity to expand its current fiber-optic network to broaden the service offerings provided throughout the community. The current network is a strategic community asset that can be enhanced with additional funding commitments and further build out. Doing so will allow the network to accommodate a new portfolio of communications, information, and entertainments services that may be provided to businesses, community anchors and possibly the residents of the City. Hudson's proposed broadband network would be capable of providing Internet and other telecommunications services with better reliability and performance than is currently available in the market today.

Implementations of municipal broadband utilities are complex and challenging projects technically, operationally, and financially. Magellan Advisors recommends that the City of Hudson take a conservative and measured approach to implementing its utility; particularly focusing on building a sustainable operation through careful planning and phasing of the system.

There is much work still required to ensure that Hudson does so utilizing a conservative and measured approach. Based on the findings of this Study, Magellan has identified the following next steps for Hudson to consider in implementing its broadband utility. These items comprise pre-implementation tasks that Magellan believes are critical prior to Hudson implementing its broadband utility.

- Complete a full internal review of the Broadband Needs Assessment and Business Plan to ensure Hudson's management has a comprehensive understanding of the project, its financial and funding needs, technical and operational requirements, and timelines.

- Seek agreement and approvals from the Hudson City Council on the findings of the Broadband Needs Assessment and Business Plan.

- Identify the Hudson team that will manage the new utility and its operation.

- Begin discussions with potential service providers who may participate in the Hudson open-access network and seek letters of intent from them.

- Begin conceptual design work and prepare to release bids for construction services.

- Develop specifications for network equipment, management applications, and other necessary components in preparation for procurement.

11. Appendix A – Glossary

3G – Third Generation	The third generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
4G – Fourth Generation	The fourth generation of mobile broadband technology, used by smart phones, tablets, and other mobile devices to access the web.
ADSL – Asymmetric Digital Subscriber Line	DSL service with a larger portion of the capacity devoted to downstream communications, less to upstream. Typically thought of as a residential service.
ADSS – All-Dieletric Self-Supporting	A type of optical fiber cable that contains no conductive metal elements.
AMR/AMI – Automatic Meter Reading/Advanced Metering Infrastructure	Electrical meters that measure more than simple consumption and an associated communication network to report the measurements.
ATM – Asynchronous Transfer Mode	A data service offering that can be used for interconnection of customer's LAN. ATM provides service from 1 Mbps to 145 Mbps utilizing Cell Relay Packets.
Bandwidth	The amount of data transmitted in a given amount of time; usually measured in bits per second, kilobits per second (kbps), and Megabits per second (Mbps).
Bit	A single unit of data, either a one or a zero. In the world of broadband, bits are used to refer to the amount of transmitted data. A kilobit (Kb) is approximately 1,000 bits. A Megabit (Mb) is approximately 1,000,000 bits. There are 8 bits in a byte (which is the unit used to measure storage space), therefore a 1 Mbps connection takes about 8 seconds to transfer 1 megabyte of data (about the size of a typical digital camera photo).
BPL – Broadband over Powerline	A technology that provides broadband service over existing electrical power lines.
BPON – Broadband Passive Optical Network	BPON is a point-to-multipoint fiber-lean architecture network system which uses passive splitters to deliver signals to multiple users. Instead of running a separate strand of fiber from the CO to every customer, BPON uses a single strand of fiber to serve up to 32 subscribers.
Broadband	A descriptive term for evolving digital technologies that provide consumers with integrated access to voice, high-speed data service, video-demand services, and interactive delivery services (e.g. DSL, Cable Internet).
CAD – Computer Aided Design	The use of computer systems to assist in the creation, modification, analysis, or optimization of a design.
CAI – Community Anchor Institutions	The National Telecommunications and Information Administration defined CAIs in its SBDD program as "Schools, libraries, medical and healthcare providers, public safety entities, community colleges and

	other institutions of higher education, and other community support organizations and entities". Universities, colleges, community colleges, K-12 schools, libraries, health care facilities, social service providers, public safety entities, government and municipal offices are all community anchor institutions.
CAP – Competitive Access Provider	(or "Bypass Carrier") A Company that provides network links between the customer and the Inter-Exchange Carrier or even directly to the Internet Service Provider. CAPs operate private networks independent of Local Exchange Carriers.
Cellular	A mobile communications system that uses a combination of radio transmission and conventional telephone switching to permit telephone communications to and from mobile users within a specified area.
CLEC – Competitive Local Exchange Carrier	Wireline service provider that is authorized under state and Federal rules to compete with ILECs to provide local telephone service. CLECs provide telephone services in one of three ways or a combination thereof: 1) by building or rebuilding telecommunications facilities of their own, 2) by leasing capacity from another local telephone company (typically an ILEC) and reselling it, and 3) by leasing discrete parts of the ILEC network referred to as UNEs.
CO – Central Office	A circuit switch where the phone lines in a geographical area come together, usually housed in a small building.
Coaxial Cable	A type of cable that can carry large amounts of bandwidth over long distances. Cable TV and cable modem service both utilize this technology.
CPE – Customer Premise Equipment	Any terminal and associated equipment located at a subscriber's premises and connected with a carrier's telecommunication channel at the demarcation point ("demarc").
CWDM – Coarse Wavelength Division Multiplexing	A technology similar to DWDM only utilizing less wavelengths in a more customer-facing application whereby less bandwidth is required per fiber.
Demarcation Point ("demarc")	The point at which the public switched telephone network ends and connects with the customer's on-premises wiring.
Dial-Up	A technology that provides customers with access to the Internet over an existing telephone line.
DLEC – Data Local Exchange Carrier	DLECs deliver high-speed access to the Internet, not voice. Examples of DLECs include Covad, Northpoint and Rhythms.
Downstream	Data flowing from the Internet to a computer (Surfing the net, getting E-mail, downloading a file).
DSL – Digital Subscriber Line	The use of a copper telephone line to deliver "always on" broadband Internet service.
DSLAM – Digital Subscriber	A piece of technology installed at a telephone company's Central

Line Access Multiplier	Office (CO) and connects the carrier to the subscriber loop (and ultimately the customer's PC).
DWDM – Dense Wavelength Division Multiplexing	An optical technology used to increase bandwidth over existing fiber-optic networks. DWDM works by combining and transmitting multiple signals simultaneously at different wavelengths on the same fiber. In effect, one fiber is transformed into multiple virtual fibers.
E-Rate	A Federal program that provides subsidy for voice and data circuits as well as internal network connections to qualified schools and libraries. The subsidy is based on a percentage designated by the FCC.
EON – Ethernet Optical Network	The use of Ethernet LAN packets running over a fiber network.
EvDO – Evolution Data Only	EvDO is a wireless technology that provides data connections that are 10 times as fast as a traditional modem. This has been overtaken by 4G LTE.
FCC – Federal Communications Commission	A Federal regulatory agency that is responsible for regulating interstate and international communications by radio, television, wire, satellite and cable in all 50 states, the District of Rock Falls, and U.S. territories.
FDH – Fiber Distribution Hub	A connection and distribution point for optical fiber cables.
FTTN – Fiber to the Neighborhood	A hybrid network architecture involving optical fiber from the carrier network, terminating in a neighborhood cabinet with converts the signal from optical to electrical.
FTTP – Fiber to the premise (or FTTB – Fiber to the building)	A fiber-optic system that connects directly from the carrier network to the user premises.
Gbps – Gigabits per second	GBPS stands for billions of bits per second or Gigabits per second and is a measure of bandwidth (the total information flow over a given time) on a telecommunications medium
GIS – Geographic Information Systems	A system designed to capture, store, manipulate, analyze, manage, and present all types of geographical data.
GPON- Gigabit-Capable Passive Optical Network	Similar to BPON, GPON allows for greater bandwidth through the use of a faster approach (up to 2.5 Gbps in current products) than BPON.
GPS – Global Positioning System	a space-based satellite navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.
GSM – Global System for Mobile Communications	This is the current radio/telephone standard developed in Europe and implemented globally except in Japan and South Korea.
HD – High Definition (Video)	Video of substantially higher resolution than standard definition.
HFC – Hybrid Fiber Coaxial	An outside plant distribution cabling concept employing both fiber-optic and coaxial cable.

ICT – Information and Communications Technology	Often used as an extended synonym for information technology (IT), but it is more specific term that stresses the role of unified communications and the integration of telecommunications, computers as well as necessary enterprise software, middleware, storage, and audio-visual systems, which enable users to access, store, transmit, and manipulate information.
IEEE – Institute of Electrical Engineers	A professional association headquartered in New York City that is dedicated to advancing technological innovation and excellence.
ILEC – Incumbent Local Exchange Carrier	The traditional wireline telephone service providers within defined geographic areas. Prior to 1996, ILECs operated as monopolies having exclusive right and responsibility for providing local and local toll telephone service within LATAs.
IP-VPN – Internet Protocol-Virtual Private Network	A software-defined network offering the appearance, functionality, and usefulness of a dedicated private network.
ISDN – Integrated Services Digital Network	An alternative method to simultaneously carry voice, data, and other traffic, using the switched telephone network.
ISP – Internet Service Provider	A company providing Internet access to consumers and businesses, acting as a bridge between customer (end-user) and infrastructure owners for dial-up, cable modem and DSL services.
ITS – Intelligent Traffic System	Advanced applications which, without embodying intelligence as such, aim to provide innovative services relating to different modes of transport and traffic management and enable various users to be better informed and make safer, more coordinated, and 'smarter' use of transport networks.
Kbps – Kilobits per second	1,000 bits per second. A measure of how fast data can be transmitted.
LAN – Local Area Network	A geographically localized network consisting of both hardware and software. The network can link workstations within a building or multiple computers with a single wireless Internet connection.
LATA – Local Access and Transport Areas	A geographic area within a divested Regional Bell Operating Company is permitted to offer exchange telecommunications and exchange access service. Calls between LATAs are often thought of as long distance service. Calls within a LATA (IntraLATA) typically include local and local toll services.
Local Loop	A generic term for the connection between the customer's premises (home, office, etc.) and the provider's serving central office. Historically, this has been a copper wire connection; but in many areas it has transitioned to fiber optic. Also, wireless options are increasingly available for local loop capacity.
MAN – Metropolitan Area Network	A high-speed intra-city network that links multiple locations with a campus, city or LATA. A MAN typically extends as far as 30 miles.
Mbps – Megabits per second	1,000,000 bits per second. A measure of how fast data can be transmitted.
MPLS – Multiprotocol Label	A mechanism in high-performance telecommunications networks

Switching	that directs data from one network node to the next based on short path labels rather than long network addresses, avoiding complex lookups in a routing table.
ONT – Optical Network Terminal	Used to terminate the fiber-optic line, demultiplex the signal into its component parts (voice telephone, television, and Internet), and provide power to customer telephones.
Overbuilding	The practice of building excess capacity. In this context, it involves investment in additional infrastructure projects to provide competition.
OVS – Open Video Systems	OVS is a new option for those looking to offer cable television service outside the current framework of traditional regulation. It would allow more flexibility in providing service by reducing the build out requirements of new carriers.
PON – Passive Optical Network	A Passive Optical Network consists of an optical line terminator located at the Central Office and a set of associated optical network terminals located at the customer's premise. Between them lies the optical distribution network comprised of fibers and passive splitters or couplers. In a PON network, a single piece of fiber can be run from the serving exchange out to a subdivision or office park, and then individual fiber strands to each building or serving equipment can be split from the main fiber using passive splitters / couplers. This allows for an expensive piece of fiber cable from the exchange to the customer to be shared amongst many customers, thereby dramatically lowering the overall costs of deployment for fiber to the business (FTTB) or fiber to the home (FTTH) applications.
PPP – Public-Private Partnership	A Public–Private Partnership (PPP) is a government service or private business venture that is funded and operated through a collaborative partnership between a government and one or more private sector organizations. In addition to being referred to as a PPP, they are sometimes called a P3, or P^3.
QOS – Quality of Service	QoS (Quality of Service) refers to a broad collection of networking technologies and techniques. The goal of QoS is to provide guarantees on the ability of a network to deliver predictable results, which are reflected in Service Level Agreements or SLAs. Elements of network performance within the scope of QoS often include availability (uptime), bandwidth (throughput), latency (delay), and error rate. QoS involves prioritization of network traffic.
RF – Radio Frequency	a rate of oscillation in the range of about 3 kHz to 300 GHz, which corresponds to the frequency of radio waves, and the alternating currents which carry radio signals.
Right-of-Way	A legal right of passage over land owned by another. Carriers and service providers must obtain right-of-way to dig trenches or plant poles for cable systems, and to place wireless antennae.
RMS – Resource	A system used to track telecommunications assets.

Management System	
RPR – Resilient Packet Ring	Also known as IEEE 802.17, is a protocol standard designed for the optimized transport of data traffic over optical fiber ring networks.
RUS – Rural Utility Service	A division of the United States Department of Agriculture, it promotes universal service in unserved and underserved areas of the country with grants, loans, and financing. Formerly known as "REA" or the Rural Electrification Administration.
SCADA – Supervisory Control and Data Acquisition	A type of industrial control system (ICS). Industrial control systems are computer controlled systems that monitor and control industrial processes that exist in the physical world.
SNMP – Simple Network Management Protocol	An Internet-standard protocol for managing devices on IP networks.
SONET – Synchronous Optical Network	A family of fiber-optic transmission rates.
Steaming	Streamed data is any information/data that is delivered from a server to a host where the data represents information that must be delivered in real time. This could be video, audio, graphics, slide shows, web tours, combinations of these, or any other real time application.
Subscribership	Subscribership is how many customers have subscribed for a particular telecommunications service.
Switched Network	A domestic telecommunications network usually accessed by telephone, key telephone systems, private branch exchange trunks, and data arrangements.
T-1 – Trunk Level 1	A digital transmission link with a total signaling speed of 1.544 Mbps. It is a standard for digital transmission in North America.
T-3 – Trunk Level 3	28 T1 lines or 44.736 Mbps.
UNE – Unbundled Network Element	Leased portions of a carrier's (typically an ILEC's) network used by another carrier to provide service to customers. Over time, the obligation to provide UNEs has been greatly narrowed, such that the most common UNE now is the UNE-Loop.
Universal Service	The idea of providing every home in the United States with basic telephone service.
Upstream	Data flowing from your computer to the Internet (sending E-mail, uploading a file).
UPS – Uninterruptable Power Supply	An electrical apparatus that provides emergency power to a load when the input power source, typically main power, fails.
USAC – Universal Service Administrative Company	An independent American nonprofit corporation designated as the administrator of the Federal Universal Service Fund (USF) by the Federal Communications Commission.
VDSL – Very High Data Rate Digital Subscriber Line	A developing digital subscriber line (DSL) technology providing data transmission faster than ADSL over a single flat untwisted or twisted pair of copper wires (up to 52 Mbit/s downstream and 16 Mbit/s upstream), and on coaxial cable (up to 85 Mbit/s down and

	upstream); using the frequency band from 25 kHz to 12 MHz.
Video on Demand	A service that allows users to remotely choose a movie from a digital library whenever they like and be able to pause, fast-forward, and rewind their selection.
VLAN – Virtual Local Area Network	In computer networking, a single layer-2 network may be partitioned to create multiple distinct broadcast domains, which are mutually isolated so that packets can only pass between them via one or more routers; such a domain is referred to as a Virtual Local Area Network, Virtual LAN or VLAN.
VoIP – Voice over Internet Protocol	An application that employs a data network (using a broadband connection) to transmit voice conversations using Internet Protocol.
VPN – Virtual Private Network	A virtual private network (VPN) extends a private network across a public network, such as the Internet. It enables a computer to send and receive data across shared or public networks as if it were directly connected to the private network, while benefitting from the functionality, security and management policies of the private network. This is done by establishing a virtual point-to-point connection through the use of dedicated connections, encryption, or a combination of the two.
WAN – Wide Area Network	A network that covers a broad area (i.e., any telecommunications network that links across metropolitan, regional, or national boundaries) using private or public network transports.
WiFi	WiFi is a popular technology that allows an electronic device to exchange data or connect to the Internet wirelessly using radio waves. The Wi-Fi Alliance defines Wi-Fi as any "wireless local area network (WLAN) products that are based on the Institute of Electrical and Electronics Engineers' (IEEE) 802.11 standards".
WiMax	WiMax is a wireless technology that provides high-throughput broadband connections over long distances. WiMax can be used for a number of applications, including “last mile” broadband connections, hotspot and cellular backhaul, and high speed enterprise connectivity for businesses.
Wireless	Telephone service transmitted via cellular, PCS, satellite, or other technologies that do not require the telephone to be connected to a land-based line.
Wireless Internet	1) Internet applications and access using mobile devices such as cell phones and palm devices. 2) Broadband Internet service provided via wireless connection, such as satellite or tower transmitters.
Wireline	Service based on infrastructure on or near the ground, such as copper telephone wires or coaxial cable underground or on telephone poles.