

CITY OF HAYWARD

Hayward City Hall
777 B Street
Hayward, CA 94541
www.Hayward-CA.gov



CITY OF
HAYWARD
HEART OF THE BAY

Agenda

Thursday, February 2, 2017

4:30 PM

City Hall, Conference Room 4A

Council Technology Application Committee

CALL TO ORDER

ROLL CALL

PUBLIC COMMENTS:

(The Public Comment section provides an opportunity to address the City Council Committee on items not listed on the agenda as well as items on the agenda. The Committee welcomes your comments and requests that speakers present their remarks in a respectful manner, within established time limits, and focus on issues which directly affect the City or are within the jurisdiction of the City. As the Committee is prohibited by State law from discussing items not listed on the agenda, any comments on items not on the agenda will be taken under consideration without Committee discussion and may be referred to staff.)

1 APPROVAL OF MINUTES

[MIN 17-015](#)

Attachments: [Attachment I CTAC Draft Minutes of 11-3-16](#)

REPORTS/ACTION ITEMS

2 VIDEO RETENTION POLICY - ORAL REPORT

WITH ORIGINAL STAFF REPORT OF NOVEMBER 3, 2016 FOR REFERENCE

[RPT 16-144](#) Recorded Video Data Retention and Release Policy

Attachments: [Attachment I Staff Report](#)
[Attachment II Administrative Rule - Guidelines for Release of Recorded Video](#)
[Attachment III - Changes to Administrative Rule 1.7 - Computer Network System Use Policy](#)

3 FIBER LOOP GRANT - ORAL REPORT

4 EBRCS INSTALLS - ORAL REPORT

5 NEW GENERAL PLAN SECTION OF WEBSITE - ORAL REPORT

6 MICROCELL TOWERS - ORAL REPORT

7 FIBER MASTER PLAN - ORAL PRESENTATION

WITH STAFF REPORT FROM CITY COUNCIL MEETING OF 1/24/17 FOR REFERENCE

[WS 17-003](#) Draft Fiber-Optic Master Plan (Report from City Manager
McAdoo)

Attachments: [Attachment I Staff Report](#)
[Attachment II Draft Fiber Optic Master Plan](#)
[Attachment III Fiber Optic Master Plan Appendix B](#)
[Attachment IV Fiber Optic Master Plan Appendix F](#)
[Attachment V Letter of Commitment](#)

8 I.T. STATUS UPDATE - ORAL REPORT

FUTURE AGENDA ITEMS

COMMITTEE MEMBER/STAFF ANNOUNCEMENTS AND REFERRALS

ADJOURNMENT



CITY OF HAYWARD

Hayward City Hall
777 B Street
Hayward, CA 94541
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File #: MIN 17-015

DATE: February 2, 2017

TO: Council Technology Application Committee

FROM: Director of Information Technology

SUBJECT: Approval of Meeting Minutes from November 3, 2016

RECOMMENDATION

That the Committee approves the meeting minutes from the November 3, 2016 meeting.

ATTACHMENTS:

Draft Minutes of November 3, 2016

File #: MIN 17-015



Council Technology Application Committee (CTAC)

Meeting Minutes of November 3, 2016

Members Present: Al Mendall, Elisa Marquez, Mark Salinas

Staff: Kelly McAdoo, Adam Kostrzak, Mark Dostal, Nathaniel Roush, Carolyn Saputo, Linda Mitchell, Brianne Elizarrey, Morad Fakhrai, Micah Hinkle, Paul Nguyen, Fred Kelley, Garrett Contreras

Guests: Clark Smith, CrossLink, Jason Osborne, Beacon Development, Bob Gundermann, Beacon Development

Public Comments: Chief Information Officer Adam Kostrzak informed the committee of an item that was not on the agenda. Nominated for the Acquia Engage Award for the public sector was the Hayward Website, it was down to Hayward and Boston in the finals and we ended up losing out to Boston but it was great being a finalist. Also, Access Hayward is getting a facelift with the formatting of the existing website. The Fire Department is currently working on new Fire safety videos which will be featured on the homepage.

1. Approval of Minutes:

Minutes of July 27, 2016 Approved

2. Fiber Master Plan – Oral Presentation

Chief Information Officer Adam Kostrzak gave the Committee an update on the selected survey, results can now be shared. A survey was done to get feedback and interests, there were 256 responses. We reviewed the draft master plan and provided comments to the consultant, the full presentation will be given on January 24, 2017 for the entire City Council that will detail the proposed routes on the business model options and implementation plan. Our final decided plan is anticipated to be in March 2017.

3. Update on High-Speed Hayward Fiber Optic Network Activities

Chief Information Officer Adam Kostrzak informed the Committee that the City was awarded a Grant of \$2.7 million for us to complete the city fiber loop and filling in the last piece we are missing in the Industrial Crescent. This is a significant win from the City's perspective, we now need to match funds with a general fund contribution of \$480,000.

4. Microcell on Light Poles – Oral Presentation

Transportation Manager Fred Kelly presented the Committee with a PowerPoint presentation on the Microcell on Light Poles. The City has received applications for PG&E joint pole installation. There are primarily two types of wireless antennas, Singular Antenna Sites (SAS) which are installed by the carrier themselves and the second one is Distributed Antenna System (DAS) which is provided by a third party. The public works team continues to work towards a policy for addressing these requests.

5. Recorded Video Data Retention and Release Policy

Chief Information Officer Adam Kostrzak gave the Committee an update on the Recorded Video Data Retention and Release Policy on behalf of Laurel James, Management Analyst who was out today. The advice from our legal team is to provide a retention length of one year where possible. Hayward is broader in our retention efforts than most other cities as they both have shorter retention schedules and less areas covered. The item will be discussed further when Laurel returns and the legal team can attend the meeting to answer questions.

6. EBRCS Financing – Oral Presentation

Fire Chief Garrett Contreras gave the Committee an update on EBRCS (East Bay Regional Communications Systems) Financing. We voted on the acquisition of the radios currently being installed approximately 3-4 weeks ago. We have all radios in house, Station #1 is being programmed and we're doing about 30 radios per day. The programming process will be done by November 15th and installation will start on November 14th for all the mobile units, the portables will be completed first and deployed throughout the Police Department and all non-Public Safety departments that have radios coming. This is a 3-year lease agreement.

7. Downtown WiFi – Oral Presentation

Chief Information Officer Adam Kostrzak gave the Committee an update on Downtown WiFi. The downtown WiFi network has been implemented from City Hall to Foothill Boulevard on B Street.

8. Future Topics Discussion – Oral Report

Chief Information Officer Adam Kostrzak informed the Committee that he pulled in other departments on Technology related updates and confirmed that the format for today's agenda was fine. The dates and times for the standing CTAC meetings will work for everyone. A request was made to include at least one item for a brief summary update of what's going on within the I.T. Department.

Future Agenda Items

Councilmember Marquez – Banner to announce Website Award, would like a brief summary on what's going on in the I.T. Dept.

Councilmember Mendall – Frequency of meetings is good (every other month), Citizen suggested Tree City Flag on flag pole.

Councilmember Salinas – Moving into next year – Discussion of the Promise Neighborhood Grant (5 years ago) to partner with school districts and school campuses to have WiFi around the schools.

Committee Member/Staff Announcements and Referrals

Next Meeting: February 2, 2017

Meeting adjourned at 6:05pm



CITY OF HAYWARD

Hayward City Hall
777 B Street
Hayward, CA 94541
www.Hayward-CA.gov

File #: RPT 16-144

DATE: November 3, 2016

TO: Council Technology Application Committee

FROM: Director of Information Technology

SUBJECT

Recorded Video Data Retention and Release Policy

RECOMMENDATION

That the Council Technology Application Committee reviews and comments on this informational report.

ATTACHMENTS

Attachment I	Staff Report
Attachment II	Administrative Rule - Guidelines for Release of Recorded Video
Attachment III	Changes to Administrative Rule 1.7 - Computer Network System Use Policy



DATE: November 3, 2016

TO: Council Technology Application Committee

FROM: Director of Information Technology

SUBJECT

Video Data Retention and Release Policy

RECOMMENDATION

That the Council Technology Application Committee reviews and comments on this informational report.

BACKGROUND

With advances in technology, the availability and use of video capture devices has become commonplace, including in the public sector. Security cameras, body worn public safety cameras, and other video capture devices are widely deployed by cities throughout the country. With the availability of federal grants for body worn public safety cameras, deployment of video capture devices continues to spread. A 2013 Police Executive Research Forum survey of 500 departments nationwide found that 25% were using body-worn cameras. A more recent survey released by the Major Cities Chiefs' Association and Major County Sheriffs' Association found that 95% of their membership was committed to the implementation of body worn cameras or had already completed their implementation.

This widespread increase in public sector video capture devices, particularly in public safety, has given rise to a national debate on the disposition of recorded video data driven by concerns about privacy, public safety, transparency, and cost. However, no consensus has emerged at the national or state levels. In California, the Public Records Act (PRA), which compels governments to disclose their records to the public absent a specific reason not to do so, provides a framework for this conversation.

For the purposes of ensuring public safety, the City of Hayward owns and operates a number of video capture devices, including traffic cameras, security cameras at City facilities, and body-worn public safety cameras.

Traffic cameras monitor traffic at some signaled intersections in the City to control congestion and do not record any footage, so images they capture may only be viewed in real time.

Security cameras, or V5 cameras, are located at City worksites and in the downtown area. These cameras record high-quality video that can be viewed live at the City Hall security desk, and can be accessed by City staff, including HPD, as needed.

Body Worn Cameras were first deployed on Hayward Police Department officers in 2014 as part of a pilot program designed to increase officer safety and accountability. The cameras, slightly larger than a marker, record officers' interactions with the public and have been shown to reduce negative outcomes and complaints. Since the initial pilot, all HPD officers have been equipped with body cameras. Officers are required to upload recordings to a third-party repository by the conclusion of every shift.

Policy at the federal, state, and local levels has not kept pace with technology and emerging issues surrounding recorded audio or video data. In the California State Legislature, every bill introduced to regulate recorded body camera footage – those intended to increase transparency as well as those restricting access to footage – has failed. Issues of privacy, accountability, and transparency have largely been addressed by local governments in the absence of comprehensive directives from higher levels of government.

Within the City of Hayward, the City Council has discussed recorded video data release and retention, and requested that staff work to create a citywide policy. A policy working group comprised of staff from the City Manager's Office, City Attorney's Office, IT, and HPD was convened to accomplish this task.

DISCUSSION

Absent comprehensive directives or guidelines from the state or federal government, local governments have developed their own policies regarding recorded video data, resulting in wide variation in formality and balance between transparency and restriction. In the interest of consistency, staff chose to develop a formal policy addressing the disposition of all the City's recorded video data via an addition to the City's Administrative Rules, which establish, explain, and define procedures for the implementation of City policy.

Staff considered two main questions guiding local government policies regarding recorded video:

1. When should recorded video data be released, and when should it not be?
2. How long does recorded video data need to be retained?

Staff addressed the issue of when to release video with an Administrative Rule (see Attachment II) that lays out guidelines for release of video based on the content of the video, in line with best practices/case law/statutory requirements. The Administrative Rule is intended to provide guidance and direction regarding: the appropriate storage and use of captured video data; ensuring citywide compliance with federal, state, and local laws; ensuring compliance with the Public Records Act; and balancing the public interests of government transparency and individual privacy.

The Administrative Rule states that recorded video may be released upon request, and identifies situations in which video may not be released to the public – specifically, in order to comply with statutory requirements, protect sensitive or vulnerable subjects, preserve the integrity of ongoing investigations and critical incidents, and in cases when releasing the requested video would endanger the safety of any person involved. Additionally, the Rule addresses circumstances in which video footage may need to be extracted prior to release. Some of these circumstances include the protection of personal or medical information, preservation of public safety operational integrity, and preventing endangerment. The policy also states that except in the circumstances where unedited release is not appropriate as defined by the policy, departmental policies, or in cases where release is prohibited by law, recorded video will be made available to the requestor in its original, unedited form.

The issue of data retention is being addressed with an update to the Records Retention Program (Administrative Rule 1.9) governing the retention and destruction of all records in the City. Discussions in the State legislature are occurring about a 60- to 90-day retention policy for BWCs, generally considered best practice by privacy advocates. However, the Public Records Act requires that at a minimum video recordings should be retained for one year unless a duplicate record (in the form of a written record summarizing the video's contents) exists, in which case records can be destroyed after 90 days. Staff is currently working to update the records retention schedule to specifically address recorded video.

Finally, in the course of the discussion regarding balancing transparency and privacy, staff concluded that addressing employee conduct with regard to social media sharing would also further the City's goal to protect resident privacy. As such, staff created an amendment to Administrative Rule 1.7 (Computer Network System Use Policy) to address the expectation that all Hayward employees conduct themselves in a manner that maintains the safety, privacy, and dignity of all community members and Hayward employees, including in materials posted on the internet and social media (Attachment III).

FISCAL IMPACT

In order to comply with the current provisions of the Public Records Act, recorded video will need to be retained for one year. This requirement will increase the amount of storage needed to retain recorded video footage. The body worn camera third party storage system currently has the storage capacity to meet this mandate. However, the City's security camera footage is stored on City servers, and more storage space will be required to meet the requirement. Additionally, the City's liability in response to PRA requests will grow because of the longer retention period.

NEXT STEPS

City staff will adopt and implement the amendments to the Administrative Rules according to Administrative Rule 1.1 – Guidelines for the Writing, Revising, Rescinding, Classifying, and Enforcement of Administrative Rules. As the nationwide and statewide policy conversations around the use, retention, and release of captured video evolve, the City Manager, City

Attorney, and Police Chief will continue to review Hayward's policies to ensure compliance with any new legal precedents and statutory requirements that emerge.

Prepared by: Laurel James, Management Analyst

Recommended by: Adam Kostrzak, Director of Information Technology

Approved by:

A handwritten signature in black ink, appearing to read 'K. McAdoo', written in a cursive style.

Kelly McAdoo, City Manager

CITY OF HAYWARD
ADMINISTRATIVE RULE

A.R. NUMBER 1.XX

SUBJECT: GUIDELINES FOR RELEASE OF RECORDED VIDEO

- I. Purpose: This Administrative Rule is intended to provide guidance and direction in the appropriate storage and use of captured video data; ensure citywide compliance with federal, state, and local laws; and balance the public interests of government transparency and individual privacy.
- II. Application: This policy shall apply to all recorded video data captured by devices owned and/or operated by any and all departments within the City of Hayward.
- III. Policy: For the purposes of ensuring public safety, the City of Hayward owns and operates a number of video capture devices, including security cameras at City facilities and body-worn public safety cameras. The City is committed to transparency and disclosure, as well as full compliance with all local, state, and federal laws and regulations governing the release of public records and recorded video, including the Public Records Act. Recorded video may be released upon request, subject to the guidelines outlined below. These guidelines are to be applied to the content of the recorded video, independent of its source.

In the case of a conflict between the policy detailed below and federal, state, or local law, the law shall supersede this administrative rule. Department-specific written policies regarding the release of recorded video may elaborate on or extend this policy as applicable to their operations.

- a. No Release – Some recorded video will not be released to the public. Reasons for declining a request to release recorded video may include, but are not limited to:
 - i. Statute or Law – Recorded video will not be released if doing so would constitute a violation of federal, state, or local law.
 - ii. Sensitive or Vulnerable Subjects – Except in cases where it is required by law, recorded video depicting juveniles, victims of domestic violence, victims of sexual assault, and/or minor victims of crimes will not be released.
 - iii. Endangerment – Except in cases where it is required by law, recorded video will not be released in circumstances where the release of the recorded video would endanger the safety of any person involved.

- iv. Ongoing Investigations and Critical Incidents – Video that involves criminal investigations and/or critical incidents such as officer involved shootings or custody deaths will not be released until the investigation and any prosecution is complete.
- b. Video footage that contains sensitive information and/or information related to personal privacy or public safety will be only be released in edited or extracted form. A complete list of material exempt from the Public Records Act is available in California Government Code 6275-6276.48. Please note that original video recordings shall not be extracted, edited, or otherwise altered; only video files provided to the requestor will be edited or extracted.

Reasons for releasing edited or extracted video footage may include, but are not limited to:

- i. Personal Information – Recordings containing personal information, including social security or driver's license numbers, or other sensitive personal information will be edited and/or extracted to protect individual privacy of those depicted in the video.
- ii. Operational Integrity – Video recordings that depict public safety operations in such detail as to jeopardize the efficacy of those procedures and/or the safety of personnel are to be edited and/or extracted. Operational information that may warrant the extraction and/or editing of released video recordings may include, but is not limited to:
 - Tactics & maneuvers
 - Confidential informants
 - Intelligence information
 - Information that would endanger the successful completion of an investigation
- iii. Medical Information – Released video that documents or depicts documentation of a person's medical conditions or medical history will be edited and/or extracted to protect the privacy of that person.
- iv. Endangerment – Except in cases where it is required by law, released video will be edited and/or extracted in circumstances where the release of the unextracted or unedited recorded video would endanger the safety of any person involved.

- c. Unedited Release – Except in the circumstances where unedited release is not appropriate as defined by the above policies, departmental policies, or in cases where release is prohibited by law, recorded video will be made available to the requestor in its original, unedited form.

Amend [A.R. 1.7 – Computer Network System Use Policy](#), Section C. Appropriate Use to read:

C. Appropriate Use

1. E-mail, on-line services, Internet/Intranet and related services made available to employees shall be used for City business. Incidental and minimal personal use is allowable to the extent that the use does not fall into one of the categories listed under IV. D and does not hinder an employee's ability to accomplish his or her work objectives.
2. When using the City's electronic systems, city employees shall use professional and courteous language since they represent the City.
3. **City employees hold a trusted position in the community and frequently interact with community members in sensitive situations. As such, Hayward employees are expected to conduct themselves in a manner that respects and maintains the safety, privacy, and dignity of all community members and City of Hayward employees. This expectation extends to posts, interactions, and other content posted on the internet, including social media.**

Nothing in this policy is intended to prohibit or infringe upon any communication, speech, or expression that is protected or privileged under law.



CITY OF HAYWARD

Hayward City Hall
777 B Street
Hayward, CA 94541
www.Hayward-CA.gov

File #: WS 17-003

DATE: January 24, 2017

TO: Mayor and City Council

FROM: City Manager

SUBJECT

Draft Fiber-Optic Master Plan

RECOMMENDATION

That Council reviews the Draft Fiber-Optic Master Plan and provides comments following the consultant presentation.

ATTACHMENTS

- Attachment I Staff Report
- Attachment II Draft Fiber Optic Master Plan
- Attachment III Fiber Optic Master Plan Appendix B
- Attachment IV Fiber Optic Master Plan Appendix F
- Attachment V Letter of Commitment



DATE: January 24, 2017

TO: Mayor and City Council

FROM: City Manager

SUBJECT Draft Fiber-Optic Master Plan

RECOMMENDATION

That Council reviews the Draft Fiber-Optic Master Plan and provides comments following the consultant presentation.

SUMMARY

The development of a fiber optic network is a complex process that requires strategic planning to ensure the system is well designed, subscribed to, and managed. The City initiated the formulation of a Fiber Optic Master Plan to collect the data needed to analyze and recommend the most feasible path and business model to deploy a fiber optic network that meets the community's needs with an initial emphasis on serving businesses in the Industrial Technology and Innovation Corridor. The Draft Fiber Optic Master Plan (Fiber Master Plan) is attached for Council's review (Attachment II).

BACKGROUND

In today's fast-moving, technology-driven world, broadband internet service is considered the foundation for economic growth, job creation, global competitiveness and a better quality of life. Like electricity did a century ago, broadband infrastructure is driving economic development. It attracts new advanced industries and is helping existing businesses expand and remain competitive. Broadband is also changing the way communities educate children, provide public services, and access and disseminate knowledge.

Work Task IS3.C of the [Economic Development Strategic Plan \(FY 2014-2018\)](#) tasks staff to "explore a public/private partnership to secure broadband/fiber optic network in the industrial area." To achieve this task, which is programmed over the duration of the five-year plan, Economic Development staff developed, and is actively executing, a comprehensive work plan designed to meet near- and long-term needs. Core elements of this program include:

1. Collecting data on existing broadband resources and business needs;
2. Engaging with technology and service providers to identify each organization's plan or willingness to expand service to the Industrial Crescent and explore potential public-private partnerships;
3. Pursuing funding opportunities including federal economic development and public works grants for network design and construction; and
4. Developing a Fiber Master Plan to guide the City in planning, budgeting and implementing a telecommunications infrastructure project.

Staff outlined this programmatic approach and presented regular activity updates at meetings of the City Economic Development Committee ([September 14, 2015](#); [February 1, 2016](#); and [October 3, 2016](#)) and the Council Technology Application Committee (October 15, 2015; [December 9, 2015](#); and [November 3, 2016](#)).

On [February 23, 2016](#), Council authorized the City Manager to negotiate and execute a professional services contract with consultant CTC Technology and Energy (CTC) to prepare a Fiber-Optic Network Master Plan. The contract was executed on April 6, 2016.

Over the past ten months, CTC and staff have worked closely to produce a Draft Master Plan that thoroughly analyzes and recommends the best potential approach and business model to deploy the High Speed Hayward system. This extensive work program incorporates the products of data collection and analysis, market research, interviews with staff, and an extensive public outreach initiative targeting the business community in the Industrial Crescent.

Staff completed multiple reviews of the Master Plan iterations and is prepared to share publically the results of the study effort and consultant final recommendations. Specifically, this Master Plan:

- Provides the City with information and data to set its goals and objectives to facilitate the design and deployment of a fiber optic network in Hayward;
- Presents and evaluates the current supply of broadband communications assets, products, and services in the City;
- Provides an inventory and assessment of existing City-owned assets and infrastructure required to support deployment of a fiber optic network;
- Defines and evaluates potential fiber optic network routes and requirements;
- Identifies potential impacts of a fiber optic network, including impacts on City right-of-way (ROW), City-owned conduit, streetlight poles, traffic lights, existing fiber systems, and other real property;
- Defines services and technologies to be offered on the fiber optic network;
- Presents an engineering study, network design, and deployment cost model;
- Outlines a potential phased approach to deliver the network; and
- Evaluates potential business models to build, operate, and make "last-mile" connections to a fiber optic network.

DISCUSSION

A. Evaluating Business Model Options

While the Master Plan provides detailed guidance for technical specifications and configurations of the network, its primary goal is to analyze and recommend the best potential path and business model to deploy a fiber optic network that meets the community's goals. The following provides a brief summary of the three business models analyzed in the Master Plan.

Staff seeks Council feedback on the approach to be adopted.

Retail Service Model (Highest Risk Option):

In a Retail Service model, the City deploys the fiber optic network, "lights" the network to provide internet service and directly offers services to end users. In this model, the City constructs and maintains the network and all related electronics and markets and sells services to retail customers. The City essentially becomes an internet service provider and enters the market as a direct competitor to existing providers.

While this model presents the benefits of complete control over the network, it also presents the greatest risk to the City. Not only does the approach not include any level of partnership from private providers, it also places the City with the responsibility for all aspects of network construction and administration; marketing and advertising; and billing and customer service. Because complete financial and operational responsibility for the network and service falls to the City, the City would need to compete with private providers that have an established presence and brand in the market and that can make use of economies of scale. As a result of these significant risks, the consultant and staff do not recommend the Retail Service model approach.

Dark Fiber Model (Recommended Option):

The Dark Fiber model involves the City directly deploying a fiber optic network and providing a private partner with a license or lease to use the City-owned fiber. This partner then "lights" the fiber and offers services to end users. In this model, the City would be responsible for all construction and maintenance of the fiber, but would not incur costs of managing network electronics, customer premise equipment, marketing or customer contracts. This model assumes the private partner will make a substantial investment in network electronics and lead the marketing, advertising and support responsibilities associated with providing service to end users.

The consultant team recommends and staff concurs that the Dark Fiber Model represents the best option. This approach will leverage City assets and create the public-private partnerships called for in the Council-adopted Economic Development Strategic Plan. The Dark Fiber model is essentially a public works model, in which fiber is infrastructure that the City manages and maintains.

Wholesale Service Model (Hybrid Option)

A Wholesale Service model represents a hybrid of the Dark Fiber and Retail Service models. In a Wholesale Service model, the City would deploy the network and would add network electronics to “light” the fiber. The City would then offer these “lit” services over the network to one or more private internet service providers, who then would offer services to end users. This would allow the City to retain control of the fiber and network electronics while shifting responsibilities for daily operation, marketing, sales and customer service to the private sector. It would also enable multiple service providers to utilize the City’s network to offer services, thereby lowering the barriers to entry.

While this model represents a lower-risk option than the Retail Service model, the approach does expose the City to significant financial and operational risk. In this model, the City would be tasked with operating and maintaining both the fiber and network electronics. The private partners with which the City partners with bear less of the responsibility to maintain the network infrastructure and related electronics. As a result of these significant risks, staff does not recommend the Wholesale Service model approach.

B. Evaluating Other Key Recommendations for Near-Term Action

The Master Plan also recommends multiple high-level policy and operational initiatives that can be undertaken by the City in the near term to advance the High Speed Hayward effort. These initiatives are designed to create an environment conducive to the phased construction approach outlined in the Plan. Staff seeks Council direction on whether staff should proceed to begin scoping and programing the following key Master Plan recommendations into work tasks:

1. Adopt a Dig-Once Policy: A “Dig-Once Policy” would require any excavation plans fitting specific criteria to install municipal fiber conduit or fiber, unless the City opts out. This would allow the City to leverage public and private projects to expand the City’s conduit and fiber network.
2. Conduct an Extensive Infrastructure Audit and Implement Records Management System: A thorough evaluation and compilation of all City fiber assets and their condition is key to accurate planning and management. While the Master Plan involved a major data collection effort, more detailed information and a formalized record keeping system will be necessary as a robust fiber optic network is constructed. For example, documenting the network’s fiber runs and individual strand usage is crucial to managing leases and expanding the system.
3. Engage the Private Sector through a Procurement Process: If Council adopts the recommendation to pursue the Dark Fiber model, staff recommends that a Request for Information or Request for Proposals be issued to signal to the private sector that the City is willing to invest in infrastructure and is seeking a partner. San Leandro Dark

Fiber, the service provider of the City of San Leandro's fiber system ("Lit San Leandro") has been working with the City to negotiate a lease. However, it may be necessary to solicit other marketplace actors to ensure the City achieves its goals and maximizes the return on investment.

ECONOMIC IMPACT

The job creation impacts attributable to this initiative cannot be estimated at this time. However, information collected through the Economic Development Business Visitation Program since September 2014, as well as the results of the business surveys and interviews conducted during the Master Plan formation process, indicates there is demand for broadband connectivity for small to medium-sized businesses within the advanced industries sector. Firms in the biotechnology, construction and engineering, information and business services, and manufacturing sectors have expressed a need for such service to help them grow and remain competitive.

The ability to add this infrastructure to Hayward's Industrial Crescent will also serve as a competitive advantage over other communities. Improved broadband connectivity in the City's industrial areas will support business attraction efforts. While the existence of fiber is only one of many site selection factors (such as lease rents, building configuration, traffic patterns, etc.), being able to market Hayward's broadband connectivity to the business community at-large not only helps satisfy a site selection criterion, it will strengthen the City's reputation as a center for innovation and growth.

FISCAL IMPACT

The formulation of the Master Plan comes on the heels of a \$2.74 million grant award from the U.S. Department of Commerce - Economic Development Administration. As part of the federal grant application, former City Manager Fran David committed the City to a 50 percent match (\$2,744,824). As outlined in Attachment V – Letter of Commitment, dated July 10, 2015, this amount is comprised as follows:

- An in-kind contribution of City owned right-of-way land at an estimated value of \$2,108,117;
- Funds already committed to construction and installation of fiber conduit in the Whitesell Street segment of the loop valued at \$156,000; and
- A City General Fund contribution of \$480,707 (cash).

The grant funding enables the City to install conduit and fiber optic cables in the Industrial Crescent to construct the backbone of the fiber optic network. This backbone will consist of existing infrastructure and newly constructed conduit and fiber. These grant funds served as the basis for the engineering design and were included in the cost estimate developed by the consultant and presented in the Master Plan.

Staff is currently developing a grant implementation plan, which will identify project staffing resource requirements, sources for the required matching funds and outline project milestones. A staff update on the grant project will follow this spring.

Note that the consultant estimates that an additional \$5.4 million will be required to deploy the complete fiber optic network described in Section 5 of the Master Plan. To be clear, the \$2.7 million grant will build the fiber optic backbone, but an additional \$5.4 million will be needed to complete the last mile components of the network.

In dark fiber business model recommended by the consultant, the City deploys, owns, and operates the network and seeks a private partner to lease city assets and invest in additional electronics to “light” the network and offer services to end users. The cost estimate does not include any potential City revenue from lease contracts with service providers.

Also note that the cost estimates do not include the resource requirements to initiate the near-term recommendations outlined above. Additional research and staffing resources may be required to develop a “Dig Once Policy,” conduct an infrastructure audit, and implement a Records Management System.

Following Council direction and adoption of the Plan, staff will begin scoping costs, funding sources and timelines of all future actions needed for implementation of the Fiber Master Plan.

PUBLIC CONTACT

Development of the Fiber Master Plan incorporated a thorough outreach effort to the City’s industrial business community. This work included an online survey and telephone interviews with business representatives and organizations, property owners and other public and private stakeholders. The survey was sent by the City and also by the Hayward Chamber of Commerce to over 2,600 businesses in July 2016. There were 259 respondents. Of these 259 respondents, 24 were further contacted for in-depth telephone interviews.

NEXT STEPS

Following the Work Session, staff and the consultant will integrate Council’s comments and produce a Final Fiber Optic Master Plan for Council adoption. Following adoption, staff will initiate scoping for the timelines, specific resource requirements and funding sources for implementing the near-term and long-term actions outlined in the final plan.

Prepared by: Paul Nguyen, Economic Development Specialist

Recommended by: Micah Hinkle, Economic Development Manager

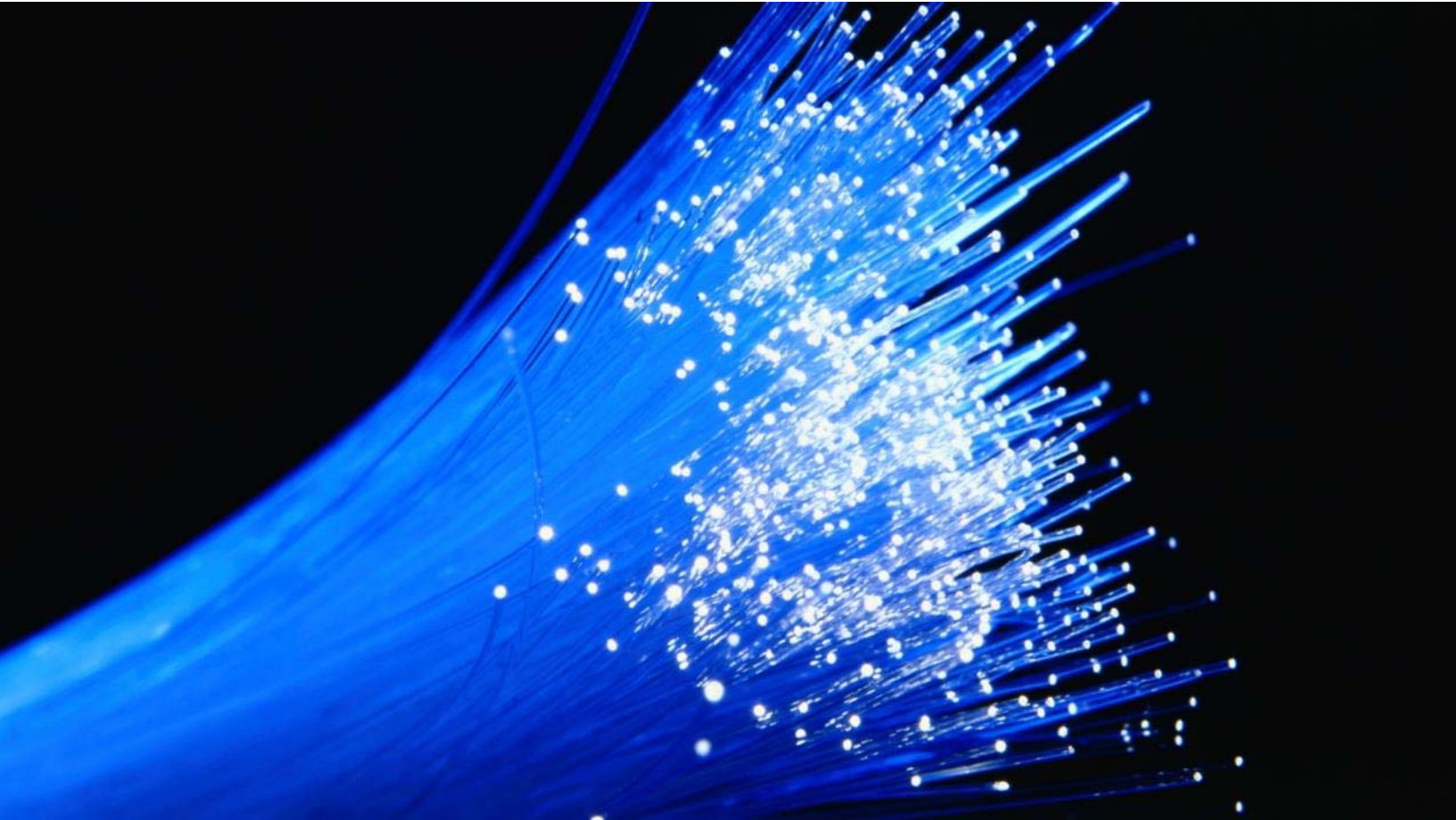
Approved by:

A handwritten signature in black ink, appearing to read 'K. McAdoo', written in a cursive style.

Kelly McAdoo, City Manager

ctc technology & energy

engineering & business consulting



Fiber Optic Master Plan

Prepared for the City of Hayward, California

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1 Executive Summary

There is a growing desire for robust, fiber-based broadband throughout the U.S., particularly among businesses of all sizes as their needs evolve, and connectivity becomes increasingly integral to business operations. Given this, localities are eager to find ways to fill gaps in available service to help their communities attract and retain businesses. Cities that want to advance economic development and attract a talented workforce are seeking ways to deploy fiber-to-the-premises (FTTP) in their communities, or to partner with private providers that are willing and able to help meet connectivity needs.

The City of Hayward is committed to enabling greater fiber-based connectivity for its numerous businesses, and to eventually expanding services to its residential neighborhoods. The City is focused on a phased municipal broadband deployment, and exploring a potential public–private partnership to achieve these goals.

1.1 Project Background and Objectives

The City intends to leverage any available conduit and fiber infrastructure to support a municipal FTTP deployment to advance the availability, affordability, and reliability of connectivity services for its business sector, which hosts thousands of businesses in a broad range of industries. To this end, the City has received funding from the U.S. Department of Commerce to install a preliminary fiber optic and conduit network. CTC’s engineers developed a proposed fiber design (see Section 5) based on the assumption that this infrastructure would be foundational to any future City efforts to deploy an FTTP network.

To supplement the City’s direct efforts to deploy FTTP and to potentially support its long-term vision, the City also seeks to understand emerging public–private partnerships in the broadband industry, how to balance risk and reward, and whether a partnership makes sense in Hayward. In short, the City aims to take any steps it can to enable greater connectivity in the community, while not taking on undue risk.

The Fiber Optic Master Plan’s primary objective is to analyze and outline the best potential path and business model to deploy a fiber optic network that can meet the community’s needs, with an initial emphasis on serving businesses located in Hayward’s Industrial Corridor.

1.1.1 Fiber Optic Master Plan Objectives

To achieve the City's vision as outlined in its General Plan 2020,¹ the Industrial Technology and Innovation Corridor (Industrial Corridor)—an approximately nine-square-mile section of industrial-zoned land with more than 5,100 businesses—needs infrastructure to attract investment and support business growth. Today, fiber infrastructure that supports access to broadband Internet service is as vital as streets, water, and sewer infrastructure. Broadband connectivity enhances a community's economic development potential by attracting new advanced businesses and providing existing businesses the tools they need to expand. Accordingly, the City engaged CTC Technology & Energy (CTC) to prepare a Fiber Optic Master Plan to assist in the planning, budgeting, and implementation of a landmark fiber optic network infrastructure project.

The Fiber Optic Master Plan's primary objective is to analyze and outline the best potential path and business model to deploy a fiber optic network that can meet the community's needs, with an initial emphasis on serving businesses located in Hayward's Industrial Corridor. Additional information on this targeted area and the types of business activities within it can be found in the Industrial Technology and Innovation Corridor Baseline Profile,² published by the City's Economic Development Division in March 2015.

Specifically, this plan outlines strategies for improved consumer choice for data connection services (including Internet), and economic development and job creation within the community. This plan:

- Provides the City with information and data to set its goals and objectives to facilitate the design and deployment of a fiber optic network in Hayward;
- Presents and evaluates the current supply of broadband communications assets, products, and services in the City;
- Provides an inventory and assessment of existing City-owned assets and infrastructure required to support deployment of a fiber optic network;
- Defines and evaluates potential fiber optic network routes and requirements;
- Identifies potential impacts of a fiber optic network, including impacts on City right-of-way (ROW), City-owned conduit, streetlight poles, traffic lights, existing fiber systems, and other real property;
- Defines services and technologies to be offered on the fiber optic network;
- Presents an engineering study, network design, and deployment cost model;

¹ The General Plan 2040 is available on the City's website at <http://cityofhayward-ca.gov/GENERALPLAN/>

² The Industrial Technology and Innovation Corridor Baseline Profile is available on the City's website at <http://cityofhayward-ca.gov/CITY-GOVERNMENT/BOARDS-COMMISSIONS-COMMITTEES/PLANNING-COMMISSION/pc/2015/pca040915-P01.pdf>

- Outlines a potential phased approach to deliver the network; and
- Evaluates potential business models to build, operate, and make “last-mile” connections to a fiber optic network.

1.2 Methodology

This report was researched and prepared in the summer and autumn of 2016 by CTC, with ongoing input from City staff. In addition to drawing on our extensive industry experience, our analysis is guided by our conversations and interviews with City staff about the City’s objectives and desired outcomes.

Over the course of the engagement, CTC performed the following general tasks:

1. Reviewed the City’s key physical infrastructure;
2. Developed and administered an online survey of Hayward businesses;
3. Conducted follow-up interviews with a select group of Hayward businesses to further gauge interest in City FTTP efforts;
4. Researched the region’s available broadband services and costs;
5. Conducted onsite and desk surveys of City infrastructure;
6. Evaluated potential public–private partnership business models based on current developments in the broadband industry; and
7. Developed pro forma financial statements for the City, including a governance model for a fiber enterprise.

In addition to those tasks, CTC prepared a proposed fiber design (Section 5), which provides data relevant to assessing the financial viability of network deployment, and offers guidance to develop business models for a potential City construction effort (including the full range of models for public–private partnerships). This estimate also provides key inputs to financial modeling (see Section 7) to determine the approximate revenue levels necessary for the City to service any debt incurred in building the network.

1.3 The City of Hayward’s Industrial Corridor Is Unique

Hayward is an economically and ethnically diverse city of approximately 150,000 residents within 45.32 square miles on the eastern edge of the San Francisco Bay. As a regional center of retail, industrial, and public activities, Hayward combines a hometown atmosphere, ideal climate, cultural attractions, parks, and recreational facilities with easy access to suppliers and customers throughout the Bay Area and beyond.

The City is known as the “Heart of the Bay” because of its central location in Alameda County—25 miles southeast of San Francisco, 14 miles south of Oakland, 26 miles north of San Jose, and 10 miles west of Pleasanton and surrounding valley communities. Hayward has two Bay Area Rapid Transit (BART) stations, an Amtrak station, its own executive airport, and an extensive network of freeways and bus lines that provide easy access to the San Francisco, Oakland, and San Jose international airports. The City also boasts easy access to the Port of Oakland, the fourth-busiest container port in the U.S.

The City leveraged its strategic location and natural assets to become a regional hub for commerce and trade. Today, Hayward is home to more than 7,000 businesses, ranging from family-owned retail shops and restaurants, to globally recognized manufacturers, distributors, and retailers. The City’s key industries include:

- Advanced and specialized manufacturing;
- Clean and green technology;
- Food and beverage manufacturing;
- Life science and biotechnology; and
- Transportation and logistics.

The City’s Industrial Corridor is a large crescent-shaped area of industrial-zoned land located along the City’s western and southwestern boundaries. This roughly nine square miles of land is home to more than 5,100 businesses that employ nearly 47,500 workers. According to the City’s General Plan, this corridor is expected to grow as an economic and employment center and evolve to achieve a healthy balance of traditional manufacturing and information- and technology-based uses.

Given the importance of the Industrial Corridor, we recommend focusing on providing service to businesses there as part of a phased implementation approach to deploying FTTP in Hayward. Rather than a pilot project, we believe that finding a way to serve the Industrial Corridor—or a subset of businesses there—and maintain service long term will serve the City’s interests. This may be possible through a public–private partnership under one of the business plans outlined in Section 1.5. Specifically, the City can target infrastructure deployment to lower barriers for one or more private providers that aim to serve these locations, and it can enable a mid-range FTTP-based retail product.

1.4 The City’s U.S. Economic Development Administration Grant Decreases FTTP Construction Costs

The U.S. Department of Commerce’s Economic Development Administration (EDA) announced in 2016 that it had awarded just over \$2.74 million in grant funds to the City to support fiber optic

infrastructure development.³ This grant funding will enable the City to install conduit and fiber optic cables, which will support an FTTP deployment in the Industrial Corridor.

The cost estimates in Section 6 anticipate an additional approximately \$5.4 million to deploy the the proposed fiber design in Section 5.⁴ The design and associated costs take the EDA grant into consideration and anticipate that any infrastructure the City develops with the \$2.74 million grant will become part of a broader FTTP deployment. The fiber optic infrastructure that the City deploys with grant funds will serve as a backbone for a middle-mile and FTTP deployment.

Our analysis assumes that the grant funds will be used to install both conduit and fiber, and that the conduit will be fully deployed with City fiber infrastructure. Given this, it is unlikely that the City will have excess conduit to make available for other entities to use. In our experience, unless an entity already has excessive unused conduit or has a need to install innerduct,⁵ leasing conduit can hamper expansion of fiber as the entity's needs evolve. Further, there is not significant

The City's approximately \$2.74 million in Economic Development Administration (EDA) grant funds serve as the basis for CTC's engineering design and cost estimates, and enable cost savings for the City's FTTP deployment. The projected cost to deploy the proposed fiber design in Section 5 is approximately \$5.4 million, in addition to the \$2.74 million grant.

revenue to be realized from leasing empty conduit. Instead, if the City seeks to monetize its infrastructure, it can offer excess fiber strands for dark fiber licensing.

One key network infrastructure component is known as a "hub site," which is a location in the community, typically in the City's ROW, where network backbone fiber terminates in a shelter or enclosure. From this point, middle-mile network fiber is distributed deeper into the community to support eventual FTTP connections to customers.⁶ Another important part of network deployment is to connect the network to an Internet point of presence (POP) where the City can access services offered at the POP. Services could include hosting servers and network electronics in a datacenter environment and "peering," which involves direct access to application providers⁷ that reside at the

³ "U.S. Department of Commerce Invests Nearly \$4 Million in Northern California to Help Build Infrastructure and Support Job Creation," *U.S. Economic Development Administration*, last modified September 9, 2016, <https://www.eda.gov/news/press-releases/2016/09/14/northern-ca.htm>.

⁴ Note that this cost is associated with a "dark fiber model," in which the City would directly deploy an FTTP network and provide a private partner with a license to use the City-owned fiber. This estimate is for outside plant (OSP) infrastructure only and does not include the cost for network electronics, fiber drop cables, or customer premises equipment. See Section 1.5.1.

⁵ Innerduct is smaller conduit (or tube) used to subdivide a larger conduit or duct for the placement of optical fiber cables.

⁶ This is also commonly referred to as "distribution fiber," given its purpose.

⁷ Examples include Netflix, Vonage, Yahoo, Dropbox, etc.

POP. In addition to serving as a backbone, the City's grant-funded infrastructure will help connect the network hub to the POP, which can help the City gain access to Internet service providers (ISPs) that may be interested in procuring dark fiber from the City to serve businesses in the Industrial Corridor or along the fiber routes.

Perhaps the simplest benefit the EDA grant offers is approximately \$2.74 million in avoided costs to the City. While this does not cover the entire cost to serve the City's target area, it gives the City a notable head start toward achieving its connectivity goals.

1.5 The City Can Consider Three Potential Business Models With Varying Degrees of Risk

We evaluated three core business models for the City to consider, two of which assume the City will seek a private partner. Each model assumes the City will invest in FTTP and take some financial and operating risk, even if the City pursues a public-private partnership based on one of these models. While a private company could come into the City and invest directly without requiring the City to take financial risk of its own, this private investment approach is not a true partnership, and the private sector has not signaled to the City a willingness to take this approach.

*We recommend considering a **dark fiber model** in which the City deploys, owns, and operates an FTTP network and seeks a private partner to invest in electronics to "light" the network, and offers services to end users.*

In a **dark fiber model**, the City directly deploys an FTTP network, and provides a private partner with a license to use the City-owned fiber; the partner "lights" the fiber, and offers services to end users. In this model, the partner would pay a per-passing cost to the City to help offset the public-sector costs for fiber deployment. In this model, the City is responsible for all construction and maintenance of the fiber, but does not manage network electronics, customer premises equipment (CPEs), or any customer contracts.

In a **wholesale service model**, the City deploys an FTTP network and "lights" the fiber, and then offers lit services to one or more private providers to offer service to end users. The City is responsible for fiber construction and maintenance as well as all network electronics, including replenishments and vendor contracts.

In a **retail service model**, the City deploys an FTTP network, "lights" the network, and directly offers services to end users. In this model, the City will construct and maintain an FTTP network, "light" the fiber and maintain all network electronics, and market and sell services to retail customers. The City is responsible for customer service at every level in this model, and enters the local market as a direct competitor to existing providers.

Table 12 describes the City’s and a partner’s responsibilities in each of the models. It is important to note that certain aspects of a partnership may be negotiable, but that we recommend a division of responsibilities as outlined below. A partnership should help manage the City’s risk, and substantially modifying this division of responsibilities could place undue risk on the City. For example, we would view with skepticism a dark fiber partnership that required the City to invest in both the fiber network and network electronics because it shifts much of the risk onto the City.

The three models we evaluated can be categorized from lowest to highest risk to the City: a dark fiber model entails the least risk, a wholesale service model is riskier than the dark fiber model, and a retail service model involves a great deal of risk to the City.

Table 1 shows a visual representation of the responsibilities that would fall to the City under each of the potential business models, and thus the potential degree of risk.

Table 1: Three Potential Business Models

City Responsibility	Model		
	Dark Fiber	Wholesale Service	Retail Service
Invest in and own outside plant (OSP)	X	X	X
Fund and perform fiber maintenance	X	X	X
Invest in own network electronics		X	X
Replenish network electronics		X	X
Manage electronics vendor contracts		X	X
Purchase and maintain CPEs			X
Marketing and customer acquisition			X
Conduct customer service			X

1.5.1 A Dark Fiber Model Will Enable the City to Partner with the Private Sector and Balance Risk

We believe the dark fiber model represents the best balance of shared risk and reward between the City and a potential partner. In this model, the City is responsible for a substantial capital investment to deploy fiber to the Industrial Corridor (and, perhaps, eventually the entire community), but its risk is offset in part by retaining ownership of an asset. Further, this model assumes the private partner will make a substantial investment of its own in network electronics, and the marketing, advertising, and support responsibilities associated with providing service to end users.

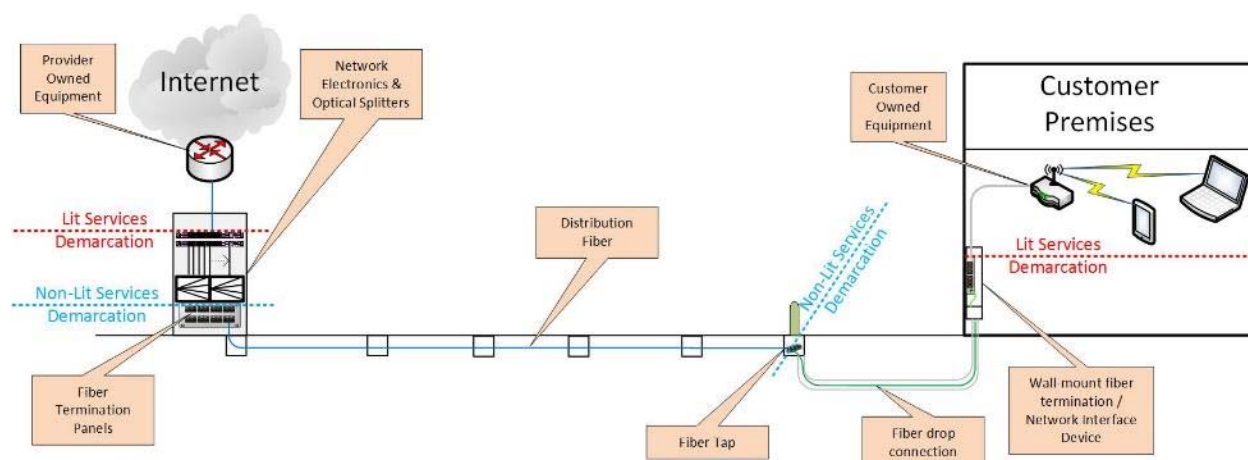
The City is already versed in making infrastructure investments on various public works projects, and will not have to employ a broad range of new staff to learn unfamiliar skill sets such as providing technical support over the phone to customers who call for help with issues related to the equipment in their businesses or homes. Some of the responsibilities for maintaining the dark

fiber network will require additional staff, but we anticipate less than four full-time positions will be necessary to support the City’s dark fiber deployment (see Section 7).

Further, as we noted, the City’s approximately \$2.74 in grant funding to support conduit and fiber installation is a meaningful step toward infrastructure investment, which will help lower the City’s risk even further. Unlike other communities that may not have access to grant funding, the City already has a head start on making an investment in fiber and conduit. If the City can supplement this investment to strategically deploy a dark fiber network to its preferred target area in the Industrial Corridor, it may become an attractive partner for the private sector.

An example of the demarcation points between the City dark fiber and the partners’ electronics is shown in Figure 1. The Figure also shows the potential demarcation points for lit services (wholesale model).

Figure 1: Demarcation Between City and Partner Network Elements



1.5.2 A Wholesale Service Model Can Enable Multiple ISPs to Serve Customers

A wholesale service model is a lower-risk option than the City choosing to directly provide retail service, but it still represents a significant financial and operational risk for the City. Because the financial and operational risk for the fiber *and* the network electronics falls to the City, any private partner(s) with which the City contracts will automatically shoulder less of the partnership’s risk. That is, there will be an imbalance in the shared risk and reward between the parties, which puts the City at a disadvantage from the outset.

This model may still be attractive, however, if the City wishes to retain control of the fiber and the network electronics while shifting responsibilities such as operations, customer support, and marketing to the private sector. If the City is willing and able to take on additional financial and operational risk associated with network electronics—for example, maintaining vendor licenses, upgrading firmware, and periodically replacing network electronics—a wholesale service

approach may be a viable option. This model can enable multiple ISPs to use the City's network to offer services by lowering costly barriers to entry.

1.5.3 A Retail Service Model Is High Risk

The only model that does not anticipate some level of partnership is the retail service model, where the City would construct, own, and operate a fiber network over which it would directly provide services to end users. While this model gives the City complete control, it also represents the greatest possible risk to the City. In this model, the City would be responsible for all aspects of network construction and administration, as well as marketing and advertising services to potential customers, providing services, and offering customer support. This is a high-risk model, because all financial and operational responsibility for every aspect of the network and service falls to the City; the City must compete with existing providers that have an established presence in the market and can make use of economies of scale; and the City would be entering the market as a new provider.

There are numerous steps the City must take to implement a retail service model that provides service to end users. Even then, there is no guarantee that the City can successfully manage an inherently unpredictable for-choice business that requires an ability to compete in the

*Our analysis indicates that it would cost approximately **\$5.4 million** for the City to deploy a dark fiber network to the Industrial Corridor. This cost is in addition to the \$2.74 million the U.S. Economic Development Administration awarded the City in 2016.*

marketplace against established providers. If the City opts to pursue this model, it will likely need to create new positions for additional staff; determine whether the fiber optic enterprise will be housed in an existing City department or will be a separate entity; develop a range of policies related to use, including compliance with digital millennium copyright act (DMCA) requirements and other state and federal regulations; and launch a marketing campaign. These are merely the steps necessary to get started. While these considerations are substantial, the complexities associated with ongoing operations are

especially significant.

1.6 Estimated Fiber Costs and Phased Deployment

To ensure our design cost estimates reflected City goals and the reality of the infrastructure and market in Hayward, our engineers conducted extensive desk surveys and an onsite field survey, and engaged City staff in discussions throughout the course of this project. Our analysis examined potential costs associated with bringing FTTP to the Industrial Corridor, and a possible phased deployment.

1.6.1 Industrial Technology and Innovation Corridor

Based on a conceptual, high-level design prepared by our engineers, we developed cost examples for the City to consider. While we believe that a dark fiber model will best meet the City’s needs, we conducted analysis for a retail service model as well (see Section 6). This helps illustrate the difference in costs that the City might incur if it opts to pursue a retail service model—if, for example, the City is unable to find a partner to lease dark fiber and still wishes to ensure service to select portions of the community.

Here, we look at the cost to deploy *only* the FTTP outside plant (OSP)⁸ infrastructure. This is the total capital cost for the City to build a dark fiber network for lease to a private partner, which will then provide retail service over the FTTP infrastructure. In other words, this portion of our analysis is consistent with the dark fiber business model we outlined in Section 1.5.1.

We estimate that a dark fiber model, in which the City deploys a dark fiber network to the Industrial Corridor, will cost approximately \$5.4 million. As we noted, such a model does not include costs for network electronics, subscriber equipment, or fiber drop cables.

In this model, the partner would take on the costs for the network electronics, which represents approximately a \$3 million upfront investment, based on our analysis. Further, the partner would also be responsible for network electronic replenishments and annual fees associated with network electronics, such as vendor licenses.

Table 2, below, outlines the projected costs for this model, and Section 6 provides additional details about this approach.

Table 2: Breakdown of Estimated Dark FTTP Cost

Cost Component	Total Estimated Cost
OSP Engineering	\$0.5 million
Quality Control/Quality Assurance	0.2 million
General OSP Construction Cost	3.2 million
Special Crossings	0.7 million
Backbone and Distribution Plant Splicing	0.1 million
Backbone Hub, Termination, and Testing	0.5 million
FTTP Lateral Installations	0.2 million
Total Estimated Cost:	\$5.4 million

⁸ OSP, known as “layer 1” or the “physical layer” of the network, is both the most expensive part of the network and the longest lasting.

1.7 Recommendations and Next Steps

Section 2.1 indicates that the City is served similarly to comparable markets. While there are some gaps in available service, many of the City’s businesses currently have access to fiber-based connectivity or alternative technologies that offer sufficient speeds for their business needs. We note that, based on our experience and analysis, Hayward is ahead of similar cities—even by simply commissioning this Master Plan, the City has set itself apart from many of its peers. Although there is not great urgency for the City to fill gaps, this section describes potential steps the City can take increase broadband availability—especially to businesses—and thereby potentially advance its standing in a global economy.

One of the most important decisions the City must make, which will inform next steps, is which business model to pursue. We believe the City will achieve the most favorable outcome by pursuing a dark fiber model, in which it expands its existing dark fiber and conduit, and grants access to its network to private entities that will offer services. We believe this approach represents shared investment and risk for the public and private sector, and may help offset the City’s financial obligations.

We recommend that the City:

- *Consider a dark fiber model*
- *Adopt a dig-once policy*
- *Audit its infrastructure and records*
- *Implement a records management system*
- *Construct a fiber segment to connect an Internet POP*
- *Expand FTTP to select Industrial Corridor areas*
- *Signal to the private sector through a procurement process*
- *Lease dark fiber strands to select Industrial Corridor customers*

In this approach, the City constructs and owns the fiber network and the private partner “lights” the fiber with electronics and directly serves end users. This model is currently underway on a large scale in the City of Westminster, Maryland, with its private partner Ting Internet,⁹ and in the City of Huntsville, Alabama, with its private partner, Google Fiber.¹⁰

Retaining ownership of the fiber OSP assets is important to mitigate risk; owning assets is a way for the City to retain some control of the network, and to have some say in when, where, and how it is built. This approach includes a scenario in which a community pursues a partnership with a private provider; a good way to balance risk and

reward is for the City to maintain ownership and control of the assets while it assigns operational responsibilities, including the capital investment for network and consumer electronics, to a

⁹ Wiley Hayes, “Westminster, Md. Partners with Private Sector to Broaden Fiber-Optic Network,” *GovTech*, last modified October 26, 2015, <http://www.govtech.com/dc/articles/Westminster-Md-Partners-with-Private-Sector-to-Broaden-Fiber-Optic-Network.html>.

¹⁰ Frederic Lardinois, “Google Fiber Is Coming To Huntsville, Alabama,” *Tech Crunch*, last modified February 22, 2016, <http://techcrunch.com/2016/02/22/google-fiber-is-coming-to-huntsville-alabama/>.

private partner. This enables both parties to perform functions that highlight their strengths while not having to expend resources and energy attempting to carry out tasks for which they are ill-equipped.

There is risk to the City in this model because it requires a substantial capital investment to build (or expand) and maintain the fiber network, but it also gives the City a degree of control because the City owns the network. In the event the partnership fails for any reason the City owns its assets and can take over control of the network directly or engage a different partner. This partnership model where the City retains ownership of the fiber assets will likely enable the City to make use of its existing fiber assets, and retain more control than simply relying on the private sector, while tempering risk in a way that a retail model cannot.

We note that recent developments with Google Fiber—particularly its apparent scaling back of infrastructure deployment—do not change any of CTC’s recommendations in this report.¹¹ The City is focused on finding ways to serve business customers, while Google Fiber has historically focused on providing residential service.

1.7.1 The City Can Take Small Steps with Potentially Big Rewards Toward Achieving Its Goals

There are opportunities for the City to improve telecommunications services in the community with minimal capital investment. A phased fiber construction approach would allow the City to invest in infrastructure over time that facilitates the goal of eventually providing FTTP to all residents and businesses in the City.

At a high level, we believe the City can take on the following projects to help advance toward its goals without requiring a multi-million-dollar investment in the near term:

- We recommend that, in the coming months, the City consider modifying its ROW ordinance to provide the City with the option of obtaining conduit on routes where utilities are performing excavation. This type of “Dig Once” policy would require any excavation plans fitting specified criteria to include municipal use conduit or fiber, unless the City opts out of the excavation project.
- Conduct an in-depth audit of existing fiber infrastructure and corresponding records, and implement a thorough records management program. This will support the City’s current efforts, and will enable a stronger enterprise going forward.
- Spend approximately \$60,000 to construct a roughly 0.3-mile segment of fiber to the Internet POP at 25070 O’Neil Avenue. If the City expands fiber and conduit through the

¹¹ Jon Brodtkin, “Google fiber division cuts staff by 9%, “pauses” fiber plans in 11 cities,” *Ars Technica*, last modified October 25, 2016, <http://arstechnica.com/information-technology/2016/10/google-fiber-laying-off-9-of-staff-will-pause-plans-for-10-cities/>.

Industrial Corridor as planned, and begins offering dark fiber services to high-end customers, this will add value to that offering.

- Begin expanding FTTP to select portions of the Industrial Corridor, and signal to the private sector through a procurement process that the City seeks one or more partners to offer services over a City-owned fiber network.
- Offer dark fiber services to some locations to support key customers in the Industrial Corridor.

1.7.1.1 Consider Modifying the City's ROW Ordinance to Include a Dig-Once Policy

Future public works projects should also be leveraged to expand the City's conduit and fiber network. Projects such as utility replacements, road widenings, and other major capital improvement efforts may provide the opportunity to install conduit and fiber optics without the need for surface restoration. A coordinated Dig Once ordinance, which typically requires the installation of City-owned communications infrastructure in excavation projects where the City has determined that it is both financially feasible and consistent with the City's long-term goals, is recommended to leverage these types of public and private excavation projects. Section 4.3 further discusses our Dig Once recommendations.

Similar to Dig Once is a concept called "One-Touch Make-Ready," which applies to infrastructure that will be placed on electric or communication poles. Enacting a One-Touch Make-Ready ordinance is similar to implementing a Dig Once policy in that both aim to simplify the process of deploying infrastructure through coordinated efforts among entities and agencies. The goal is to streamline the process of deploying future-generation communications infrastructure throughout as much of a locality as possible, while minimizing cost and disruption to the ROW.

This analysis does not include a recommendation that the City enact a One-Touch Make-Ready ordinance at this time because our design anticipates a fully underground network. If the City expects to deploy additional infrastructure on poles in the future, or partner with a private entity that may deploy an aerial network, it may be prudent to explore a One-Touch Make-Ready policy.

It is important to note that Dig Once policies typically govern ROW spaces that a locality owns and over which it has control, whereas a One-Touch Make-Ready ordinance generally applies to poles that the locality may not own, or to which it may not have rights. While these poles are often located in the locality's public ROW, it is unclear to what degree a locality can direct pole owners to provide access to their poles. While CTC cannot provide legal guidance, we note that

Louisville Metro Government in Kentucky¹² and Metro Government of Nashville and Davidson County in Tennessee¹³ are currently involved in litigation over One-Touch Make-Ready policies.

1.7.1.2 Conduct Asset Audit and Carefully Manage any Existing and Expanded Fiber and Conduit Assets

One of the most important steps the City can take is to ensure that it is carefully managing its assets, including conduit and fiber. Whether the City opts to expand its assets or maintain the status quo, fiber strand management on the front end can have enormous benefits over the life of the fiber network, and can save potential confusion and cost in the long run.

One initial step toward this end is to conduct a thorough evaluation of any and all fiber management documentation the City currently has in place. There may exist documentation in the form of spreadsheets, correspondence, or simple text documents. A full fiber management system may be a necessary long-term investment, but the City cannot evaluate its needs until it understands what it already has available. An audit of existing documentation will enable the City to identify gaps in its fiber strand management—and if any documentation already exists, this can be used to develop an initial fiber map, which can then be built onto as the City expands its network.

We encourage the City to maintain detailed records of all its fiber strands and their locations. The importance of keeping meticulous records does not cease once the network is fully constructed. On the contrary, it is critically important for all ongoing and additional connections made on the network to be documented. Updates should be made to “as-built” and strand management documentation in real time to avoid making mistakes later, misremembering strand allocations, or simply forgetting important items altogether.

Documenting the network’s fibers and strand usage is crucial, and making sure that City staff has unrestricted access to its strand management tools is equally important. Even if the City works with an outside firm to manage this process, we believe that it is a worthwhile investment to appoint a staff person who will become knowledgeable about and maintain documentation regarding the location of strands on the City’s network. Further, using an intuitive and straightforward system and/or software is also key; this will help guard against such critical knowledge being inaccessible to future iterations of City staff and leadership.

¹² Brodtkin, Jon, "Charter, like AT&T, sues Louisville to stall Google Fiber," *ArsTechnica*, last modified October 5, 2016, accessed January 5, 2017, <http://arstechnica.com/tech-policy/2016/10/charter-like-att-sues-louisville-to-stall-google-fiber/>.

¹³ Fingas, Jon, "Comcast sues Nashville over law that helps Google Fiber," *Engadget*, last modified October 26, 2016, accessed January 5, 2017, <https://www.engadget.com/2016/10/26/comcast-sues-nashville-over-google-fiber-law/>.

Another key aspect of taking care of its infrastructure is to ensure that the City has access to an on-call fiber maintenance contractor that can perform network repairs on an emergency basis. This contractor should be empowered and required to access the City's fiber management system—even if it is simply a shared spreadsheet—to record any network changes as close to real time as possible. The City will benefit tremendously from taking an inventory of its records and ensuring that anyone involved with the network going forward is accountable for this as well.

As we note in Section 7.4.3, the City can choose to hire new staff, engage existing staff, or contract out for various responsibilities related to managing the network. Generally, the degree to which a locality elects to maintain certain responsibilities internally or contract them out is specific to the unique needs of the locality. That is, each locality has its own structure, hierarchy, and collection of staff with various skill sets, and only the locality can determine which functions it may be capable of managing internally versus which responsibilities are best delegated to highly skilled contracted vendors. However, although the City may end up contracting out most responsibilities, we encourage keeping documentation creation and management as an internal function for either existing or new City staff. While there are many competent firms that can perform GIS and other network documentation functions for the City, we believe that because the City has a vested interest in the documentation's integrity, fiber documentation and records management is best performed internally.

1.7.1.3 Construct 0.3 Miles of Fiber To Connect To Internet Point of Presence

We recommend the City construct fiber to the Internet POP at 25070 O'Neil Avenue. This requires approximately 0.3 miles of fiber construction at a cost of approximately \$60,000. Establishing a presence at the Internet POP allows dark fiber customers to access the services offered at the POP. Services could include hosting servers and network electronics in a datacenter environment, accessing multiple ISPs at rates lower than can be achieved at the customer's premises, and direct access to applications providers that may reside at the POP (such as voice over Internet protocol, or VoIP, services providers).

With the connection to the Internet POP, ISPs may be interested in procuring dark fiber from the City to serve businesses in the Industrial Corridor or along the fiber routes. The dark fiber services may also be used by wireless ISPs to provide connectivity to telecommunications towers and distributed antenna systems to provide backhaul for wireless service. Expanded wireless service may be a way to meet some of the network services needs for businesses in the Industrial Corridor.

1.7.1.4 Deploy FTTP In a Concentrated Area in the Industrial Corridor

The City may want to deploy dark fiber to select areas of the Industrial Corridor. The City should select a targeted area for deployment where it can reach the maximum number of customers

with the least amount of fiber construction. The City should take into consideration the following factors when choosing such an area:

- Density of businesses along specific routes;
- Types of businesses within the area (i.e. technology firms typically require more network services than manufacturers);
- Feedback from businesses in the area on their existing needs;
- Presence of multi-tenant office buildings; and
- Feasibility of fiber construction (i.e. minimal railway and interstate crossings, minimal environmental impact, and presence of existing conduit and fiber).

Once the City has selected a target area, the FTTP network should be constructed to support a full FTTP deployment in the future, which may require additional conduit and larger handholes than currently necessary. To complete an FTTP network that will serve approximately 15 percent of businesses, we estimate a cost of approximately \$2.3 million.

Note that because our projection in Section 1.6.1 shows that it would cost approximately \$5.4 million to deploy FTTP to the entire Industrial Corridor, the projected cost to serve only 15 percent of businesses may seem high. However, whether the City deploys FTTP to 15 percent or 100 percent of businesses in the Industrial Corridor, the backbone must be built out and fiber routed to an aggregation point to support network core development.

It is also important to note that this targeted FTTP network will require the City to establish many of the policies and procedures required to support a larger scale FTTP deployment. This approach can help the City capture the cost to build and operate the network, and helps project the potential cost to expand the network to the full Industrial Corridor and other areas.

1.7.1.5 Initiate a Procurement Process to Communicate the City's Plans to the Private Sector

If the City pursues a dark fiber or a wholesale service model, it may be prudent to issue a request for information (RFI) or request for proposal (RFP) to signal to the private sector that the City is willing to invest in infrastructure and is seeking a partner. The process can also provide feedback on price point a potential partner might consider (see Section 7.4).

*Our analysis indicates that it would cost approximately **\$2.3 million** to serve approximately 15 percent of businesses in the Industrial Corridor.*

An RFI process allows the City to cast a wide net and ask the private sector for input on potential business models and partnership configurations. An RFP is not as broad as an RFI, but allows the City to set the parameters of the business model it hopes to pursue in a partnership, and define specific requirements it will have of its partner(s). If the

City can identify its preferred business model and can develop a framework of what it hopes to accomplish through a partnership, the terms defined in an RFP and a potential partner's response can serve as the foundation for an eventual partnership contract.

If the City opts to pursue a dark fiber model, the procurement process can describe the type of investment the City is seeking from a private provider, the exact service area the City's dark fiber deployment will target, and thoroughly describe the City's vision. This can lay out very clearly the City's expectations of a partner, and enable potential partners to evaluate the feasibility of partnering with the City.

For a wholesale service model approach, the City may want to start with a brief questionnaire aimed at known ISPs in the region before it moves forward with a full procurement process. This may identify providers that would be willing to purchase wholesale service from the City, and give the City a sense of what type of potential revenue it may be able to expect from a partnership.

1.7.1.6 Offer Dark Fiber Strands for Lease to Select High-End Customers

One of our key recommendations is that the City continue to expand its fiber and conduit network as planned, specifically through the Industrial Corridor. The expanded fiber and conduit system will allow the City to begin offering dark fiber services to high-end customers. As customers purchase dark fiber services, the City will construct additional fiber and conduit to the customers—thus expanding the footprint of the existing network.

Dark fiber services include the City offering fiber optic strands between locations without active electronics. The customer would be responsible for the electronics to activate, or "light," the fiber. In this scenario, the City would only be responsible for maintaining and repairing the fiber. This approach minimizes the City staffing required, as the City would be responsible *only* for the network electronics for the City network. Fiber maintenance and repair can be contracted to a third party, and most of the costs associated with maintaining and repairing the fiber would already be required to run the City's network.

1.8 Expanding FTTP to Residential Customers Adds Considerable Cost

The City aims to eventually consider deploying residential FTTP in addition to serving the Industrial Corridor, and potentially other business customer locations in Hayward. Considering this desire to serve residential users, it is important to understand the potential costs associated with FTTP deployment, and particularly with providing retail service to residential users.

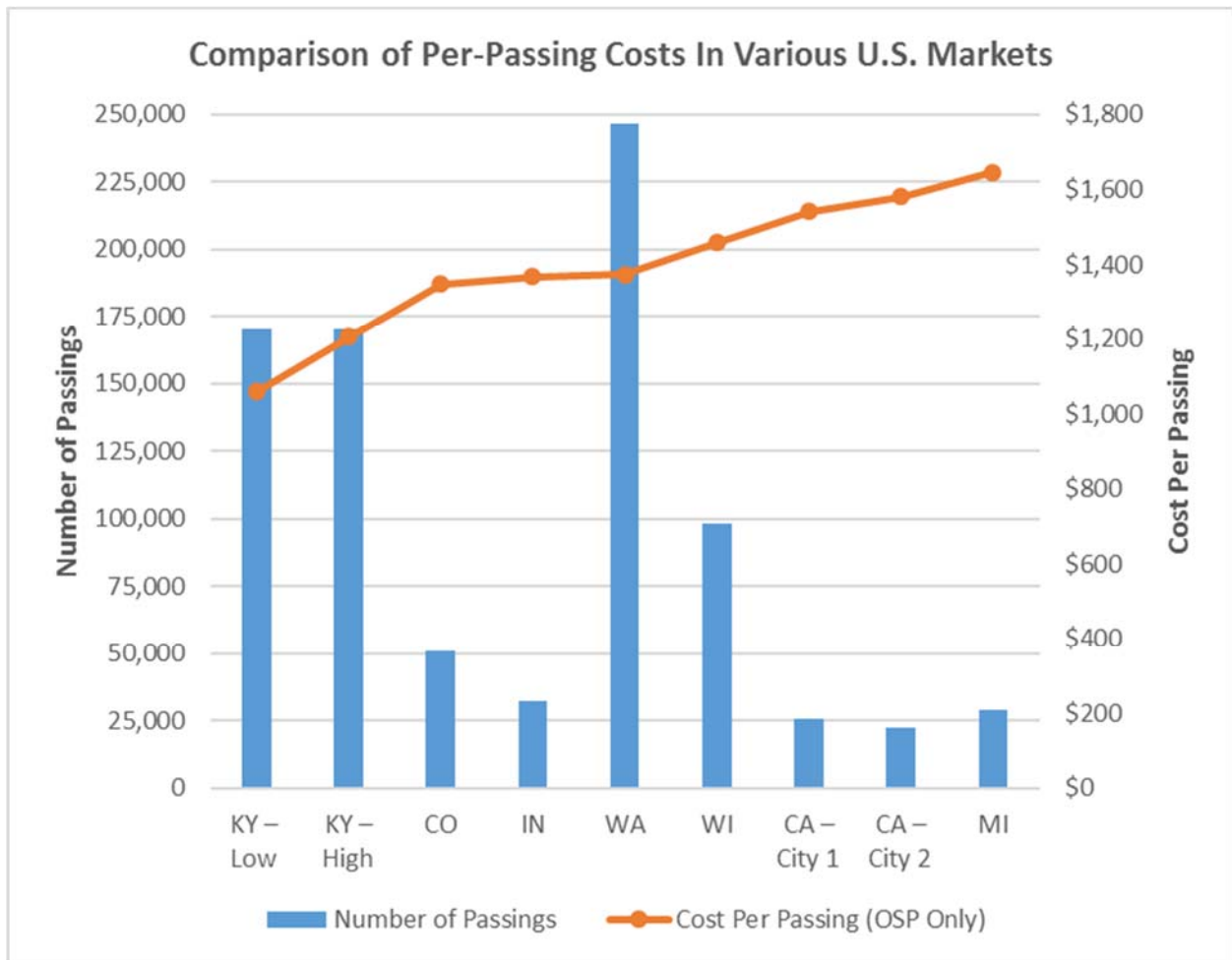
We conducted a high-level analysis of the cost per passing in various states in the U.S., including California, Colorado, Indiana, Kentucky, Michigan, Washington, and Wisconsin. The "per passing cost" is the approximate cost to pass a premises with fiber optics. This cost does not include the cost of the drop cable or the CPEs; it is simply the cost to run fiber in front of a location. Our

analysis showed an average per-passing cost of just under \$1,400, based on the per-passing costs in the several communities we evaluated.

It is important to note the per-passing costs ranged from \$1,100 to over \$1,600; as such, we encourage localities to use caution when examining costs estimates from other communities. It is important to note the per-passing costs ranged from \$1,100 to over \$1,600; as such, we encourage localities to use caution when examining cost estimates from other communities. Using this cost range and assuming there are 46,000 residential passings in Hayward results in a fiber per-passing cost estimate of \$50.6 million to \$73.6 million. Actual costs will depend on housing densities, construction types, traffic control requirements, make-ready, and other factors.

Still, even with this caveat, the City can begin to understand through other communities' experience the kinds of costs it may incur in an FTTP deployment that includes residential customers. Figure 2, below, shows the range of costs that we considered from various markets throughout the U.S. Note that these examples point to a scenario that considers *only* the FTTP outside plant (OSP), or the fiber and conduit associated with the network. These costs do not consider the cost of network electronics necessary to "light" the network. Additionally, these do not include the cost for installing the customer drop cable, which is the fiber extension that connects a customer's premises to the fiber network.

Figure 2: Comparison of Per-Passing Costs in Various U.S. Markets



2 Broadband Needs and Trends

The need for high-speed broadband is increasingly evident as consumers become more educated on the merits of ultra-fast connectivity. Businesses of all sizes in every industry are finding that their ability to compete successfully depends more than ever on their access to a broadband connection. From manufacturing organizations that rely on high-speed connectivity for automation,¹⁴ to small business owners that need broadband to complete customer transactions and provide WiFi to patrons, businesses' demand is steadily growing.

Further, the workforce is becoming increasingly mobile, and businesses that wish to effectively compete must be aware and accommodating of this reality. Cloud computing and reliable wireless broadband services are two potential areas of significant need for business customers, and examples of accommodating a mobile workforce. Having employees who are mobile and can work from anywhere potentially reduces overhead costs and enables companies to be nimble. As reliable wireless service becomes an integral component of effectively doing business, companies find this is an area where they need significant improvement in dependable connectivity.

Cloud computing—which refers to information technology services, such as software, virtualized computing environments, and storage, available “in the cloud” over a user’s Internet connection—is also changing the way businesses operate. The business drivers behind cloud computing are ease of use and, in theory, lower operating costs. For example, business owners understand that adding a new employee to their growing business requires ample resources. This includes purchasing a computer, installing necessary software, and ongoing software license management. Also, local server and application administration requires either dedicated staff or contracted support.

As an alternative, cloud services eliminate the need to maintain local server infrastructure and software, and instead allow the user to log into a subscription-based cloud service through a web-browser or software client. The cloud is essentially a shift of workload from local computers in the network to servers managed by a provider that make up the cloud. This, in turn, decreases the end user’s administrative burden for information technology (IT) services.

Even where businesses’ needs may be mostly met, many communities have areas that lack reasonably priced, high-speed options for residential customers. Because of this, a pervasive challenge that impacts local businesses is the area's ability to attract and recruit top professional talent. The availability of broadband service varies widely throughout the U.S., and the small- to

¹⁴ Chopra, Aneesh, “Insourcing American Jobs: The Importance of “Smart” Manufacturing, Broadband, and IT,” *The White House*, last modified January 14, 2012, accessed September 15, 2016, <https://www.whitehouse.gov/blog/2012/01/14/insourcing-american-jobs-importance-smart-manufacturing-broadband-and-it>.

medium-size business market tends to lack a range of options to meet these users' needs. Cable and digital subscriber line (DSL) service is typically available to businesses, and options for higher-end services like Metro Ethernet are often available in urban areas. But many communities lack a mid-level service that offers more capacity and reliability than residential-grade cable or DSL, but is less costly than Metro Ethernet and similar dedicated services targeted at large organizations.

This gap represents a market niche that we believe the City may be able to fill by deploying FTTP that can support fiber-based business connectivity. Even if the City does not directly offer services, it can fill broadband availability gaps by enabling one or more private providers to offer services over a robust fiber optic network.

2.1 The City Is Served Similarly to Other Markets, but There Are Still Gaps in Service

Many of the City's services—especially the lowest-priced offerings—provide download speeds far below the Federal Communications Commission (FCC)'s updated definition of broadband of at least 25 Mbps download speed.¹⁵ Further, these tiers may even be “up to,” services, which means that the actual speed a customer experiences is less than the advertised amount. For example, if a customer subscribes to an “up to” 5 Mbps service, they may experience speeds as low as 1 Mbps or even less. Given the FCC's updated definition, these services cannot technically be classified as broadband.

In some cases, the available service tiers that would meet the minimum definition of broadband are priced much higher than many of the City's consumers may be able to afford. Unfortunately, this is not unique to the City. On the contrary, our analysis shows that the available speed tiers and price points in the City are comparable to other markets throughout the U.S. In fact, some of the City's existing available service offerings are priced lower for higher service tiers than in other markets. Further, some businesses in the Industrial Corridor are limited to only DSL service.

As the City considers how to pursue a fiber deployment, it may want to focus on gaps in affordable mid-range service offerings. Some subscribers may opt to purchase low-tier service because it meets their needs, but the current market does not adequately meet the needs of subscribers that desire affordable mid-range service. This often applies to small- and medium-sized businesses that have limited funds to allocate to telecommunications spending, but that require fast, reliable service to conduct their day-to-day business.

¹⁵ “2015 Broadband Progress Report,” *Federal Communications Commission*, last modified February 4, 2015, accessed September 1, 2016, <https://www.fcc.gov/reports-research/reports/broadband-progress-reports/2015-broadband-progress-report>.

These users, and potentially others, likely desire more robust and affordable service, as well as better upload speeds. The upload speeds available in the City today are either minimal (as low as 1.5 Mbps in some cases), or are priced very high (\$249.95 per month for 20 Mbps upload for Comcast's small business service). Though upload speeds may not be as important in some markets, the need for improved upload speeds in a city like Hayward is especially prominent, given its location and large business sector.

If the City can directly or in a partnership focus on filling the gap for mid-range services, it may find that this eases the process of introducing a new broadband offering into the market. Competing directly with existing providers to offer roughly the same service that is available today will not set the City or its partner(s) apart in any way. Our analysis shows that the City and the other markets we evaluated seem "well-served," in that there are several providers offering service in the existing market. However, a new offering that is sensitive to availability and supply challenges can address service gaps.

3 Needs Assessment

The City has a range of broadband user groups and stakeholders, and is especially interested in understanding local businesses' connectivity needs. An important part of understanding the potential success of a municipal FTTP deployment is to determine the perceived need for better connectivity options within the community, and willingness to switch to a different service.

To assist in understanding the demand for fiber connectivity and related services, CTC conducted an online survey of Hayward businesses on behalf of the City. Additionally, we compared available services in Hayward to those in select communities, particularly those that identify as "Gigabit Cities." The analysis in this section helps illustrate with broad strokes the potential desire for fiber-based connectivity in the City.

3.1 Business Survey Results

The business survey was designed to collect a range of data to understand current use of Internet and data services, satisfaction with current service providers, and interest in higher-speed Internet and data service offerings. While the survey should not be considered a truly representative sample of all Hayward businesses, it offers some insight into a potential customer base and market in the City, and provides the City with a starting point to understand the service attributes where it may need to focus its efforts.

In general, the survey shows that:

- Most of the respondents represent small- to medium-size businesses;
- Most respondents are not significantly unhappy with most attributes of their current service;
- More than 40 percent of respondents believe the City should have some role in enhancing broadband connectivity options for businesses in Hayward; and
- Approximately 75 percent of respondents would be very or somewhat willing to switch to a 1 Gbps service for \$75 per month, and the willingness steadily drops as the service prices increases.

The full survey results are described in Appendix G: Online Business Survey Results, attached to this Report.

3.2 Comparison of Services in Hayward to Gigabit Communities

As is typical of most cities of similar size in the U.S., the City of Hayward has more than a dozen carriers offering residential, small business, enterprise-grade, and carrier services.

We identified 13 service providers in the Hayward area that offer fiber-based enterprise services, from dark fiber connectivity to data transport services, with speeds that range from 1 Megabits

per second (Mbps) to 100 Gigabits per second (Gbps). The carriers that provide enterprise-grade lit services in the Hayward area are:

- Access One
- AT&T
- Comcast
- EarthLink
- Integra
- Level 3
- Line Systems
- MegaPath
- Sonic
- TelePacific
- Windstream
- XO Communications
- Zayo

Four service providers in the City have dark fiber availability:

- Integra
- Level 3
- Line Systems
- Zayo

With respect to the availability and pricing of enterprise-grade services, we have seen that the offerings in Hayward are on par with services in regions of similar size and urbanity. The City has a good mix of facilities-based and non-facilities-based providers, with all the major carriers having an established presence in the City. Prices for services are dependent on bandwidth, location, and network configuration; whether the service is protected or unprotected; whether the service is managed; and whether the customer has a service-level agreement (SLA).¹⁶ The pricing for enterprise grade services have continued to drop over the last several years across the country and we expect that trend to continue in Hayward.

Residential and small business customers in the Hayward area have access to a range of services, though individual service options are dependent on location. The main ISPs in Hayward are AT&T, Comcast, and Sonic. Of these providers, Comcast offers fiber-based internet services up to 2 Gbps. There are also wireless ISPs (WISPs), such as Etheric Networks and Cruzio, and satellite-based services available in the City.

¹⁶ An agreement between a provider and a customer that outlines certain parameters about the service an end user can expect; for example, an SLA may indicate that, in the event of an outage, the provider has a limited amount of time to restore service.

The key difference that we see between the residential and small business services in the City in comparison to other communities that have municipal broadband or fiber-to-the-home (FTTH) by a provider like Google Fiber is the ubiquity of service. Though Comcast offers gigabit services in Hayward, the availability of the service would vary based on location and most likely only if there was a strong business case to warrant an expansion of service to a particular location.

With regard to pricing, we have seen communities with a municipality backed service offering price gigabit services from \$50 (in Longmont, Colorado), to \$100 (in Westminster, Maryland) per month, with low installation costs.¹⁷ Google Fiber offers its residential 1 Gbps services at \$70 per month with waived installation costs with a 1-year contract (typically \$100).¹⁸ In comparison, the service provided by Comcast in Hayward is for the 2 Gbps speed at \$299.95 per month and requires a two-year contract, plus \$1,000 in upfront installation and activation fees.

We have provided an assessment of the broadband service available in the City in Appendix B.

¹⁷ In such cases, the municipality has made a substantial capital and/or operating investment in the network, which potentially enables lower service prices than scenarios of purely private investment.

¹⁸ <https://fiber.google.com/cities/kansascity/plans/>, accessed June 2016

4 Operational and Business Model Options

There are several business models that the City can consider for its fiber deployment. Overall, we believe that the City's key focus should be to deploy fiber in at least select areas of the community, such as the Industrial Corridor. We believe that the City is most likely to be successful if it focuses on infrastructure, and works to lower barriers to market entry for the private sector. By doing this, the City can encourage competition and increase the range of service options available to consumers, but it does not have to take the enormous risk of becoming a service provider and competing with established providers.

The dark fiber model will have the least risk for the City because it does not entail operational unknowns like a retail service model. Managing agreements with and providing service to end users is generally expensive and unpredictable, and—unlike the dark fiber model—is not an approach for which the City is already at least partially equipped. Even a wholesale service model carries more risk than a dark fiber model because there are additional costs and uncertainties associated with maintaining network electronics.

A dark fiber model is essentially a public works model, in that fiber is simply infrastructure, which the City is already accustomed to managing. This approach allows the City to play to its strengths, and carefully navigate around its potential vulnerabilities (e.g., not having the expertise to successfully market retail service).

If the City determines that a dark fiber model does not appropriately achieve its goals in the short term, it can opt to pursue a retail service model, where the City becomes the provider and offers services directly to end users. This model carries greater risk for the City because of the marketing, advertising, competition, and customer service components. While it is challenging for a municipality to become a retail service provider, it is not impossible, and the City can choose this path. We recommend this model only if the City finds that it is for some reason unable to pursue a dark fiber model, or if it is unable to attract a partner to offer services over a City-owned network.

A wholesale service offering is a “middle ground” between a dark fiber approach and the City becoming a retail service provider. In a wholesale service offering, the City would deploy the FTTP network, and would add network electronics to “light” the fiber. It would then offer “lit services” over the network to one or more ISPs. This model is attractive in that it potentially enables numerous ISPs to offer services. In a dark fiber model, on the other hand, one provider may control the strands to a location and may or may not offer lit services to a competing provider. The wholesale service offering could potentially help the City achieve open access goals it may have.

4.1.1 Staffing Considerations for Various Business Models

Each of the potential business models we outlined in Section 1.5 requires some additional staffing. Consistent with our assertion that the dark fiber model entails the least risk for the City, this model requires the lowest investment in additional staff. Similarly, the retail service model requires the greatest investment in additional staff, while the wholesale service model is between these.

For a dark fiber model, we anticipate that the City will likely need to add 1.5 full time employees (FTEs) in year one, and 2.75 FTEs in year two and beyond. This model requires primarily fiber infrastructure and management staff, with some minimal sales requirements. The “marketing” necessary for this model is restricted to working directly with providers to encourage them to lease access to the City’s dark fiber network.

Table 3: Staffing for Dark Fiber Business Model

New Employees	Year 1	Year 2	Year 3	Year 4	Year 5+
Business Manager	0.50	0.50	0.50	0.50	0.50
GIS	0.50	1.00	1.00	1.00	1.00
Communications - Sales	0.25	0.25	0.25	0.25	0.25
Customer Service Representative	-	-	-	-	-
Service Technicians/Installers & IT Support	-	-	-	-	-
Fiber Plant O&M Technicians	0.25	1.00	1.00	1.00	1.00
Total New Staff	1.5	2.75	2.75	2.75	2.75

Projections for necessary staff increase slightly for a wholesale service model. We anticipate that the City will need to increase staffing by approximately 2.5 FTEs for this model in year one; 4.25 FTEs in years two and three; and 5.25 FTEs in year four and beyond. Because this model requires the City to “light” the fiber by adding network electronics, IT support staff and additional GIS support is added in this model. The sales requirements for this model will be similar to a dark fiber model: convince private providers to purchase services on the City’s network, though in this case providers will purchase “lit” services from the City.

Table 4: Staffing for Wholesale Service Model

New Employees	Year 1	Year 2	Year 3	Year 4	Year 5+
Business Manager	0.50	1.00	1.00	1.00	1.00
GIS	0.50	1.00	1.00	1.00	1.00
Communications - Sales	0.25	0.25	0.25	0.25	0.25
Customer Service Representative	-	-	-	-	-
Service Technicians/Installers & IT Support	1.00	1.00	1.00	2.00	2.00
Fiber Plant O&M Technicians	0.25	1.00	1.00	1.00	1.00
Total New Staff	2.5	4.25	4.25	5.25	5.25

For the retail service model, these numbers increase again because of the addition of a customer service representative. This function is necessary in a retail model, whereas in other models the City will not directly manage or interact with end users. The retail model anticipates a total of 4.75 FTEs in year one, 8 FTEs in years two and three, and 9 FTEs in year four and beyond.

Table 5: Staffing for Retail Service Model

New Employees	Year 1	Year 2	Year 3	Year 4	Year 5+
Business Manager	0.50	1.00	1.00	1.00	1.00
GIS	0.50	1.00	1.00	1.00	1.00
Communications - Sales	0.50	2.00	2.00	2.00	2.00
Customer Service Representative	2.00	2.00	2.00	2.00	2.00
Service Technicians/Installers & IT Support	1.00	1.00	1.00	2.00	2.00
Fiber Plant O&M Technicians	0.25	1.00	1.00	1.00	1.00
Total New Staff	4.75	8	8	9	9

4.2 Fiber Management Requirements

One of the most important steps the City can take is to ensure that it is carefully managing its assets, including conduit and fiber. Whether the City opts to become a retail service provider or simply provide access to its dark fiber network, fiber strand management on the front end can have enormous benefits over the life of the fiber network, and can save potential confusion and cost in the long run.

Even—or, perhaps, *especially*—if the City contracts out the construction of fiber network, we encourage the City to maintain detailed records of all its fiber strands and their locations. This process is extremely important during the construction phase of the network, and is easiest to carry out during this phase. As construction is underway to build or expand fiber, the City can allocate a staff member or work with a firm to keep track of its fiber usage, which will lay the foundation for ensuring the network’s long-term usability and growth.

However, the importance of keeping meticulous records does not cease once the network is fully constructed. On the contrary, it is critically important for all ongoing and additional connections

made on the network to be documented. Updates should be made to “as-built” and strand management documentation in real time to avoid making mistakes later, misremembering strand allocations, or simply forgetting important items altogether.

Documenting the network’s fibers and strand usage is crucial, and making sure that City staff has unrestricted access to its strand management tools is equally important. Even if the City works with an outside firm to manage this process, we believe that it is a worthwhile investment to appoint at least one staff person who will become knowledgeable about the location of strands on the City’s network. Further, using an intuitive and straightforward system and/or software is also key; this will help guard against such critical knowledge being inaccessible to future iterations of City staff and leadership.

4.3 Dig Once Considerations

We recommend that in the coming months, the City consider modifying its ROW ordinance to provide the City with the option of obtaining conduit on routes where utilities are performing excavation. This type of “Dig Once” policy would require any excavation plans fitting specified criteria to include municipal use conduit or fiber, unless the City opts out of the excavation project. This would require the installation of City communications infrastructure in excavation projects where the City determines that it is both financially feasible and consistent with the municipality’s long-term goals to develop the communications infrastructure.

Such a policy can reduce the cost of the conduit to the City by 25 percent to 75 percent relative to the cost of a standalone construction project if it installs or has conduit installed in coordination with other excavation. A Dig Once approach can also reduce the impact on ROW and inconvenience to the public.

4.3.1 The Case for Dig Once Policies

The construction of fiber optic communications cables is a costly, complex, and time-consuming process. The high cost of construction is a barrier to entry for potential broadband communications providers. In addition, available space is diminishing in the public ROW. Moreover, cutting roads and sidewalks substantially reduces the lifetime and performance of those surfaces.

Accordingly, encouraging or requiring simultaneous construction and co-location of facilities in the public ROW will reduce the long-term cost of building communications facilities. This is because there are significant economies of scale through:

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

The reason that these economies are available is primarily because fiber optic cables and installation materials alone are relatively inexpensive, often contributing to less than one-quarter of the total cost of new construction. While material costs typically fall well below \$40,000 per mile (even for large cables containing hundreds of fiber strands), labor, permitting, and engineering costs commonly drive the total price toward \$200,000 per mile if conducted as a stand-alone project.

Moreover, as the ROW becomes more crowded with communications infrastructure and other utilities, the cost of new construction can grow rapidly. In general, however, it is in the best interests of both public and private entities for the public sector to identify construction collaboration opportunities that share the burden of expensive and duplicative labor-related costs and efficiently use physical space in the ROW.

If fiber construction is coordinated with a major road or utility project that is already disrupting the ROW in a rural area, the cost of constructing the fiber, communications conduit, and other materials can range from \$10,000 per mile up. However, if fiber construction is completed as part of a separate stand-alone project, the cost of constructing fiber and communications conduit can range from \$95,000 to \$200,000 per mile and even higher in complex urban environments.

There are numerous methods for constructing fiber optic infrastructure. Underground construction using protective conduits generally provides the most scalable, flexible, and durable method for developing long-term communications infrastructure, but is also typically more expensive than aerial construction methods requiring attachments to utility poles. Underground construction can be preferable despite the cost because of the limit in the quantity of cables and attachments that can be placed on existing utility poles in more crowded areas, and because aerial construction is more exposed and vulnerable to outside conditions.

Banks of conduits constructed simultaneously or large conduits segmented with innerduct, provide multiple pathways for the installation of multiple fiber optic cables located in close proximity, with the ability to remove, add, or replace fiber optic cables without disturbing neighboring cables.

Conversely, multiple conduits installed at different times must be physically spaced, often by several feet, to prevent damage to one while installing the next. Once the ROW becomes crowded, often the choices of construction methods are reduced, leaving only less desirable methods and more costly locations for construction of additional infrastructure.

Some of the key savings achieved through coordinated construction efforts include:

- Incremental labor and material costs, through reduced crew mobilization expenses and larger bulk material purchases
- Trenching or boring costs, particularly when coordination enables lower-cost methods (e.g., trenching as opposed to boring) or allows multiple entities to share a common trench or bore for their independent purposes
- Traffic control and safety personnel costs, particularly when constructing along roadways requiring lane closures
- Engineering and survey costs associated with locating existing utilities and specifying the placement of new facilities
- Engineering and survey costs associated with environmental impact studies and approvals
- Lease fees for access to private easements, such as those owned by electric utilities
- Railroad crossing permit fees and engineering
- Restoration to the ROW or roadway, particularly in conjunction with roadway improvements
- Bridge crossing permit fees and engineering

4.3.2 Coordinating Conduit Construction with Other Utility Projects Reduces Costs

Where other types of construction are occurring within or along the ROW, such as road construction or resurfacing, roadway widening, sidewalk repairs, bridge construction, and water or gas main installation, there is an opportunity to place telecommunications infrastructure at an overall reduced cost and with reduced disruption to public ROW.

4.3.3 Standard Specification

The challenge in developing a standard specification for a Dig Once project is to incorporate the requirements of known and unknown users, and to provide sufficient capacity and capability without excessive costs.

We considered the following factors in developing a conduit specification:

1. Capacity—sufficient conduit needs to be installed, and that conduit needs to have sufficient internal diameter, to accommodate future users' cables and to be segmented to enable conduit to be shared or cables added at a future date

2. Segmentation—users need to have the appropriate level of separation from each other for commercial, security, or operational reasons
3. Access—vaults and handholes need to be placed to provide access to conduit and the ability to pull fiber. Vaults need to be spaced to minimize the cost of extending conduit to buildings and other facilities that may be served by fiber
4. Costs—materials beyond those that are likely to be needed will add cost, as will the incremental labor to construct them. Beyond a certain point, trenches need to be widened or deepened to accommodate conduit
5. Robustness—the materials, construction standards, and placement need to reasonably protect the users’ fiber, and not unduly complicate maintenance and repairs
6. Architecture—sweeps, bend radius, and vault sizes need to be appropriate for all potential sizes of fiber

We recommend further discussions with private carriers to better develop a specification. It may be appropriate to have a different specification for different projects. Based on our knowledge of similar efforts in other cities, and our analysis, we believe the following standardized approach is suitable for major corridors and can be modified as discussions continue with excavators in the rights-of-way:

- Four two-inch conduit, minimum SDR 11 High-density polyethylene (HDPE), each of a separate color or unique striping to simplify identification of conduits within vaults and between vaults, in the event conduit must be accessed or repaired at intermediate points. Conduit count can be reduced if the Industrial Corridor is assessed not to justify the capacity.
- Composite anti-theft vaults having dimensions of 30” x 48” x 36” (W x L x D), placed in the sidewalk or available green space within the city or municipality ROW, as close to the curb or gutter as possible.
- Vaults spaced at intervals of 600 feet or less, typically at the intersection of a city or municipality block.
- Sweeping conduit bends with a minimum radius of 36 inches to allow cable to be pulled without exceeding pull-tension thresholds when placing high-count fiber cables (e.g., 864-count).
- Conduit placed in the same trench directly above the excavator’s infrastructure or, where this is not possible, placed with minimum horizontal offset, to minimize cost.

It is important to note that the proposed approach is designed to create consistency and predictability in costs and deployment and is a necessary compromise among the potential users. If an excavation project has a long-time horizon and sufficient budget, it is possible to customize

the Dig Once build, potentially adding conduit or adding vaults at particular locations. This plan provides a baseline approach.

The approach is a compromise among different types of users of conduit constructed under *dig once*. Some users might prefer larger conduit for consistency with earlier builds. Others sought a larger count of smaller conduit, to provide more flexibility and the capability for more providers to participate with smaller cable counts.

Two-inch conduit has become a standard size for a wide range of construction projects, and can support the widest range of use cases. A single two-inch conduit can accommodate a range of multi-cable configurations, while retaining recommended fill ratios, allowing a single user to serve its backbone and “lateral”/access cable requirements with a single, dedicated conduit. A few example cable configurations supported by a single two-inch conduit, which are not supported by smaller conduit, include:

- Two medium backbone cables (e.g., 144-strand to 288-strand cables) and one smaller “feeder” cable (e.g., 24-strand cable);
- Large backbone cable (e.g., 864-strand) and two or more smaller feeder cables; or
- Three medium backbone cables.

Compared to placing fewer, larger conduits segmented with innerduct, this approach provides greater opportunity for individual conduit to be intercepted and routed for future vault installation by a particular user. Additionally, two-inch conduit is substantially cheaper to install and physically more flexible than larger varieties, offering more options to route around existing utilities and other obstructions. Placing four conduit will provide a standard allotment of one or two conduit for State or municipality use and provide capacity for other use and for spares.

We recommend SDR 11 HDPE in all cases except where conduit is exposed to the elements (for example, as a riser to building entry), or under extreme levels of pressure (such as under a train or trolley track). SDR 11 HDPE designs will generally support standard highway and railway loads with less than 1 percent deflection when buried with two feet of cover.

5 Proposed Fiber Design

5.1 Construction Methodology

Our analysis assumes underground construction will consist primarily of horizontal, directional drilling to minimize ROW impact and to provide greater flexibility to navigate around other utilities. There are a variety of methods for underground construction, including plowing, trenching, directional boring, and microtrenching.

Plowing is generally the cheapest construction method, and is performed in unpaved areas where little subsurface rock is present, and the fiber route maintains a straight path (e.g., along a highway). The plowing machine pushes away dirt, inserts conduit and covers the conduit with the backfill.

Trenching is similar to plowing in that a narrow hole is dug and conduit is laid and the bottom of the trench, and is then covered with backfill. Unlike plowing, trenching can be performed in most situations but may not be cost-effective when expensive restoration is required to return the streets or rights-of-way to their original (i.e., pre-installation) condition.

Directional Boring is a process in which conduit is placed by drilling horizontally underground without disturbing the surface. The boring machine pushes a long drill that displaces the dirt underground so that a conduit can be installed. The direction and depth of the directional bore can be altered to navigate around other existing utilities. Directional boring is ideal in situations where trenching is not feasible, such as stream and railroad crossings.

Microtrenching uses a specialized saw blade to cut a small trench about a foot deep into the road or sidewalk subsurface. Very tiny conduit is inserted and covered with backfill, and the cut or “microtrench” is then sealed. Specialized fiber is then blown through the conduit system. Microtrenching is best suited for areas where the cost to perform surface restoration is high and roadway construction is not anticipated.

Underground construction costs are subject to uncertainty related to utilities congestion in the public rights-of-way, and the prevalence of subsurface hard rock—neither of which can be fully mitigated without physical excavation and/or testing. Surface restoration requirements can also greatly impact the cost of underground construction. For, example unpaved land is far less expensive to restore than cobblestone streets.

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

5.2 Overview of Existing Assets

We compiled an inventory of Hayward's current and planned broadband assets, data, and related information. During the process, the City provided documentation of its fiber and conduit. At the City's request, we focused on how the City's assets could be leveraged for future plans, relying on existing documentation rather than performing new surveys and condition assessments. To complete our assessment, we requested several pieces of GIS data from the City, including:

1. Political boundaries
2. Hydro layers (rivers, wetlands, etc.)
3. Rights-of-way/property Lines
4. Street centerlines
5. Street polygons
6. Sidewalk/parking lot polygons
7. Address points
8. Building polygons
9. City facilities
10. Parks and green spaces
11. Existing conduit and fiber
12. Existing assets
13. Huts
14. Water towers
15. Special development areas
16. Any other utility information

We discussed with the City any known plans for constructing fiber and conduit in the future, including:

1. Planned public works projects
2. Current and planned construction by private contractors, utilities, and others

We note that this type of investigation aligns with our longstanding guidance to municipal clients to take advantage of public or private sector construction that creates an opportunity to install City-owned conduit or fiber.

5.2.1 City Conduit and Fiber

Based on the City's GIS data, the City constructed and operates 14.1 miles of fiber and 13.6 miles of conduit. Approximately nine miles of the infrastructure is a U-shaped core fiber path made up of 60-strand cables, which run along Hesperian Boulevard, Mission Boulevard, and Winton Avenue. In addition, a 48-count cable extends north of Winton Avenue on Hesperian Boulevard, and 24-strand cables extend along Harder Road from Mission Boulevard to Tarman. 24-strand

cables extend the Winton Avenue fiber west of Hesperian Boulevard and down Clawiter Road. There is fiber on Enterprise Avenue from Clawiter Road to a water treatment plant. The City also expects to install fiber as part of a project related to California State Route 238, south of Industrial and north of A Street, along Mission Boulevard.

The City's conduit follows much of the same path, including lateral extensions into City Hall, Fire Stations 1 and 4, Hayward Executive Airport, and the Water Pollution Control Facility. Based on conversations with City engineers, most of the existing conduit is 2 inches in diameter with notable exceptions of the conduit along Hesperian Boulevard between Panama Street and Industrial Boulevard, which is 1.5 inches in diameter, and the newer conduit along Mission Boulevard, which is 2.5 inches in diameter.

Vaults, or pull boxes, are generally located every 500 to 600 feet along the fiber path. City engineers indicated that, with some exceptions, pull boxes along Hesperian Boulevard, Harder Road, Clawiter Road, and Mission Boulevard are generally in good condition. Pull boxes along Winton Avenue require some repair work, and fiber along Hesperian Boulevard from Fire Station 4 to Winton Avenue should be further evaluated. Most of the conduit only contains one cable, which means there is room for future additions. City staff reports that the fiber is primarily used for traffic and fire station communications.

Based on our discussions with the City, there is not innerduct or pull cables in this conduit. Standards for fiber and conduit construction have largely been determined by individual contractors hired by the City. It is our understanding that the City is developing a construction standard for future projects.

An additional 27 miles of planned fiber and conduit construction will expand the City's fiber backbone and allow for future expansion in new areas, including multiple paths through the City's Industrial Corridor. In addition to expanding the reach of the City's core loop, the additional fiber will create several loop structures that will allow for redundant connections over diverse physical paths. The proposed fiber also includes connections to Fire Station 3, Weekes Branch Library, and the Hayward Area Recreation & Park District office as well as a loop through the California State University (CSU) East Bay campus. The new fiber would also pass several other community institutions, including schools, parks, and hospitals. The existing conduit and fiber routes are shown alongside proposed future routes in Figure 3 and Figure 4.

Figure 3: Existing and Proposed City-Constructed Infrastructure

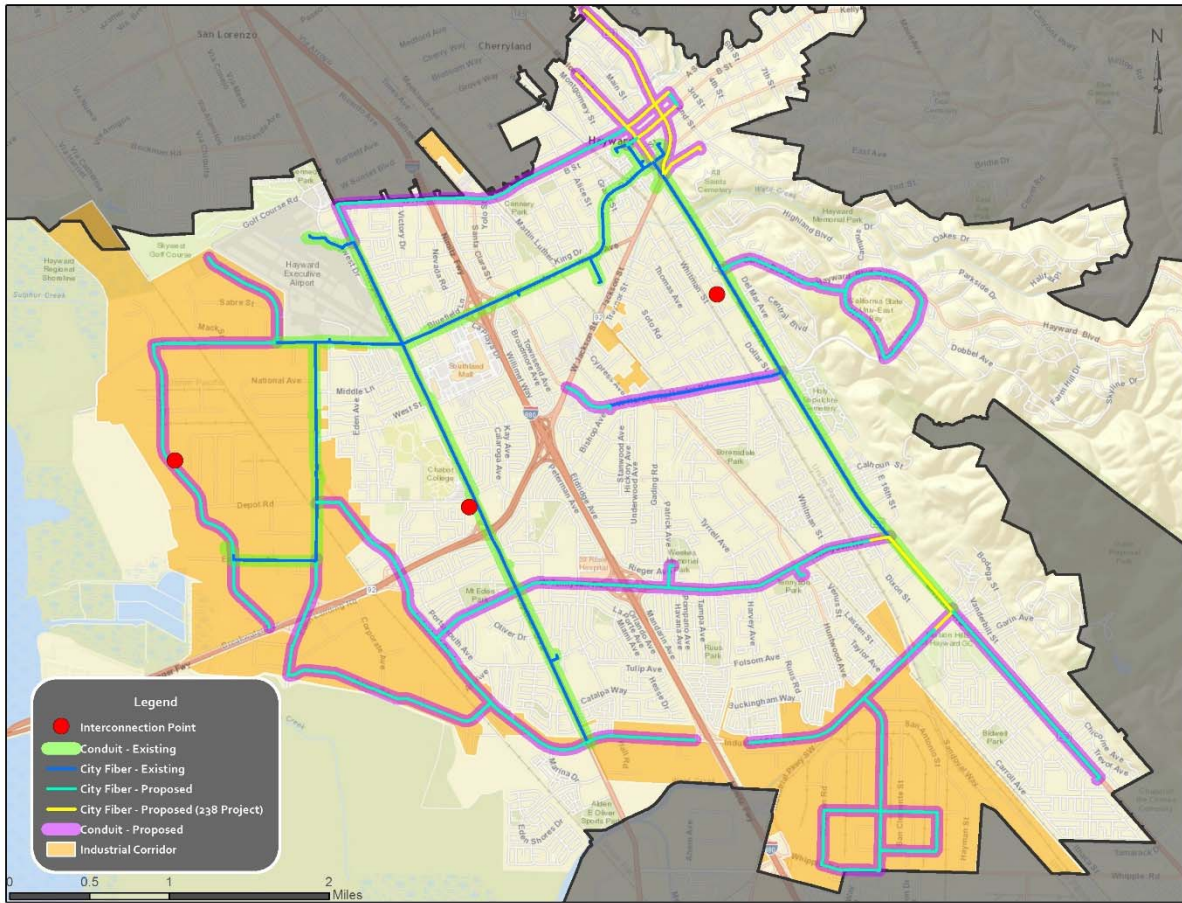
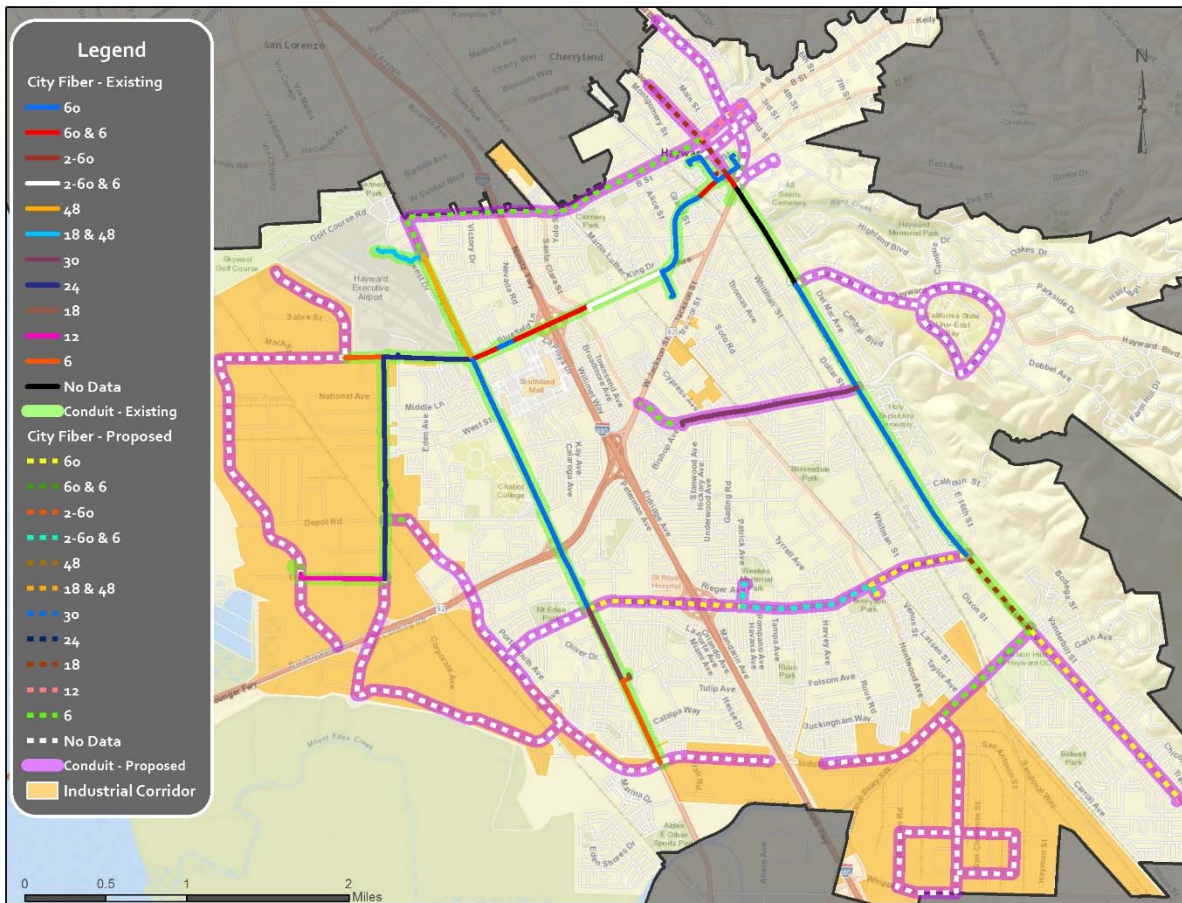


Figure 4: Existing and Proposed City-Constructed Fiber by Strand Count



During our review of the City’s records, City staff reported that the City does not currently maintain records of fiber assignment, fiber use, and splice matrices, and that available GIS data does not necessarily include all the City’s assets. We recommend that, going forward, the City include fiber assignment and splice matrices in its documentation efforts as this will aid in troubleshooting, future construction, and allocation of fiber strands.

5.3 Leverage Existing Assets

The existing conduit and fiber assets provide a starting point from which the City can expand. The proposed fiber builds will increase the resiliency of the network and allow the City to reach new key areas and institutions such as the Industrial Corridor. The existing strand counts, however, may not be sufficient for future needs.

If the City desires to significantly expand its fiber service, it should examine its current and future fiber needs and use strand counts that accommodate those needs plus those of potential external fiber users in new construction. Where higher strand counts are not available, new

cables can be pulled into the existing conduit if sufficient space is available. Where space is not available, new cables can replace the smaller cable to provide enhanced fiber counts along routes.

Future public works projects should also be leveraged to expand the City's conduit and fiber network. Projects such as utility replacements, road widenings, and other major capital improvements may provide the opportunity to install conduit and fiber optics without the need for surface restoration. A coordinated Dig Once ordinance, which typically requires the installation of City-owned communications infrastructure in excavation projects where the City has determined that it is both financially feasible and consistent with the City's long-term goals, is recommended to leverage these types of public and private excavation projects.

There may also be opportunities for the City to engage further with private partners to serve the Industrial Corridor. The City could, for example, provide transport for service providers that need to reach existing and potential customers as well as strategic peering points such as Internet POPs or data centers in another part of the City. The City may offer conduit to reduce construction costs to the Industrial Corridor—however, as we noted above, we do not recommend this approach.

We have identified three potential connection points within the City:

1. 25070 O'Neil Avenue
2. 21350 Cabot Boulevard¹⁹
3. 1880 Depot Road

The O'Neil Avenue location is an Internet POP where the City may be able to interconnect with other national and regional networks including Zayo. This POP is close to Route 238 where the City is planning to construct new fiber. The City may be able to arrange for connectivity at this site and include it in the Route 238 project construction so that it may offer transport or use the connectivity for its own purposes.

The Cabot Boulevard location is a Verizon data center approximately 1 mile west of the City's conduit along Clawiter Road.

The Depot Road location is an incumbent local exchange carrier (ILEC) central office, located next to the City's fiber and conduit along Hesperian Boulevard. If it is determined that interconnection services are available at this location, the City may want to take advantage of its proximity to existing fiber.

¹⁹ <https://fiberlocator.com>, accessed June 2016.

5.4 Conceptual Design and Specifications – Industrial Technology & Innovation Corridor

OSP (layer 1, also referred to as the physical layer) is both the most expensive part of the network and the longest lasting. The architecture of the physical plant determines the network's scalability for future uses and how the plant will need to be operated and maintained; the architecture is also the main determinant of the total cost of the deployment.

Figure 5 (below) shows a logical representation of the high-level FTTP network architecture we recommend for deployment to the Industrial Corridor. This design is open to a variety of architecture options. The figure illustrates the primary functional components in the FTTP network, their relative position to one another, and the flexibility of the architecture to support multiple subscriber models and classes of service.

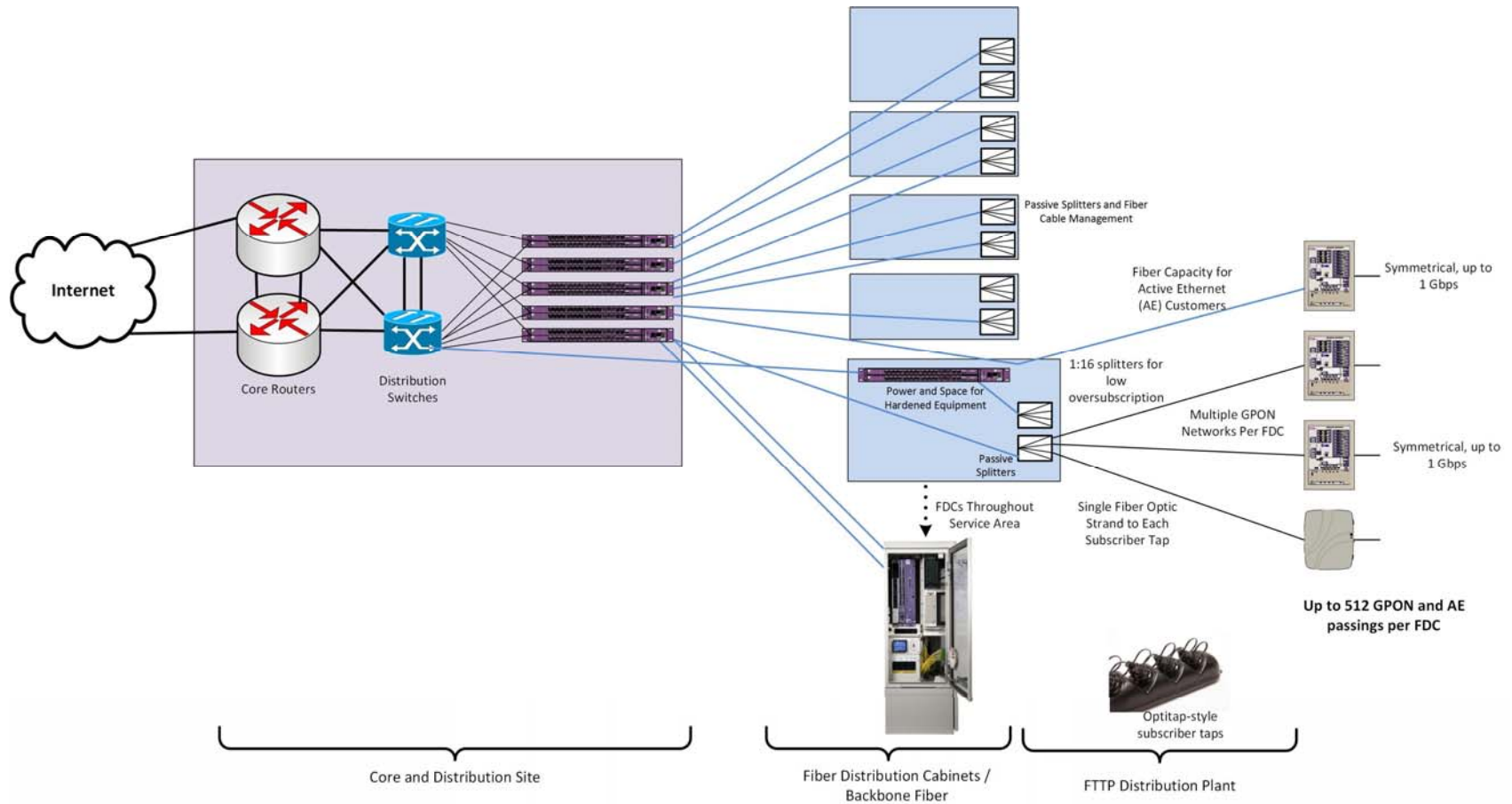
The recommended architecture is a hierarchical data network that provides critical scalability and flexibility, both in terms of initial network deployment and its ability to accommodate the increased demands of future applications and technologies. The characteristics of this hierarchical FTTP data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

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

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

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

Figure 5: High-Level FTTP Architecture



5.4.1 Network Design

The network design and cost estimates assume the City will:

- Use existing fiber and conduit to connect to an Internet POP in the City;
- Procure space at the POP to host network electronics and provide backhaul to the Internet;
- Use existing City land or ROW space in the Industrial Corridor to locate the core and distribution hub facility with adequate environmental and backup power systems to house network electronics;
- Construct fiber to connect the hub to the FDCs;
- Construct fiber optics from the FDCs to each business (i.e., from termination panels in the FDC to tap locations in the ROW or on City easements); and
- Construct fiber laterals into large, multi-tenant business facilities.

Leveraging the City's existing conduit and fiber resources could decrease the costs associated with both constructing a backbone and identifying locations to house electronics that are near the City's existing resources.

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

- Targeting 512 passings per FDC;
- FDCs suitable to support hardened network electronics, providing backup power and an active heat exchange;²⁰ and
- Avoiding the need for distribution plant to cross major roadways and railways.

Coupled with an appropriate network electronics configuration, this fiber design serves to greatly increase the reliability of services provided to customers as compared to that of more traditional cable and telephone networks.

The access layer of the network, which encompasses the fiber plant from the FDCs to the customers, dedicates a single fiber strand from the FDC to each passing (i.e., potential customer

²⁰ These hardened FDCs reflect an assumption that the City's operational and business model will require the installation of provider electronics in the FDCs that can support open access among multiple providers. We note that the overall FTTP cost estimate would decrease if the hardened FDCs were replaced with passive FDCs (which would house only optical splitters) and the providers' electronics were housed only at hub locations.

address). This traditional FTTP design allows either network electronics or optical splitters in the FDCs. See Figure 6 below for a sample design.

Figure 6: Detail Showing FTTP Access Layer Design



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

5.4.2 Network Core and Hub Site

The core site is the bridge that links the FTTP network to the public Internet and deliver all services to end users. The proposed network design includes a single core location given the size of the network. However, if consumer demand dictates it, a second Internet POP could be added to increase redundancy to the network.

For the cost estimate, we assumed that the core site electronics would be collocated with the distribution electronics in the Industrial Corridor hub with connectivity to the Internet POP at 25070 O'Neil Avenue.

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

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

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

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

For the cost estimate, we assumed that the core and distribution hub will be located on existing City land within the Industrial Corridor.

5.4.3 Distribution and Access Network Design

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

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

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

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

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

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

5.4.3.1 Access Network Technologies

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

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

In this model, we assume the use of GPON electronics for most subscribers and Active Ethernet for a small percentage of subscribers (typically large business customers) that request a premium

service or require greater bandwidth. GPON is the most commonly provisioned FTTP service—used, for example, by Verizon (in its FiOS systems), Google Fiber, and Chattanooga EPB.

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

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

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

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

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

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

5.4.3.2 Expanding the Access Network Bandwidth

GPON is currently the most commonly provisioned FTTP technology, due to inherent economies when compared with technologies delivered over home-run fiber²¹ such as Active Ethernet. The cost differential between constructing an entire network using GPON and Active Ethernet is 40

²¹ Home run fiber is a fiber optic architecture where individual fiber strands are extended from the distribution sites to the premises. Home run fiber does not use any intermediary aggregation points in the field.

percent to 50 percent.²² GPON is used to provide services up to 1 Gbps per subscriber and is part of an evolution path to higher-speed technologies that use higher-speed optics and wave-division multiplexing.

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

1. Reducing the number of premises in a PON segment by modifying the splitter assignment and adding optics. For example, by reducing the split from 16:1 to 4:1, the per-user capacity in the access portion of the network is quadrupled.
2. Adding higher speed PON protocols can be accomplished by adding electronics at the FDC or hub locations. Since these use different frequencies than the GPON electronics, none of the other CPE would need to be replaced.
3. Adding WDM-PON electronics as they become widely available. This will enable each user to have the same capacity as an entire PON. Again, these use different frequencies than GPON and are not expected to require replacement of legacy CPE equipment.
4. Option 1 could be taken to the maximum, and PON replaced by a 1:1 connection to electronics—an Active Ethernet configuration.

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

5.4.3.3 Customer Premises Equipment (CPE) and Subscriber Services

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

The drop cable extends from the subscriber tap (in a handhole underground) to the building, enters the building, and connects to CPEs.

²² "Enhanced Communications in San Francisco: Phase II Feasibility Study," CTC report, October 2009, at p. 205.

6 Cost Estimate – Industrial Technology & Innovation Corridor

The City recognizes the importance of deploying a robust, scalable FTTP network infrastructure that can support a wide range of applications and services. At the City’s request, CTC prepared a high-level network design and cost estimate for deploying a gigabit FTTP network in the City’s Industrial Corridor. The FTTP network will promote economic development in the Industrial Corridor where businesses traditionally have limited options for telecommunication services.

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

The CTC design and cost estimate are underpinned by data and insight gathered by CTC engineers through several related steps, including discussions with City stakeholders and an extensive field and desk survey of candidate fiber routes.

The descriptions in this document are highly technical and make use of acronyms. We have included a glossary as Appendix A.

6.1 FTTP Cost Estimate Summary

Based on these inputs and other guidance from the City, we developed a conceptual, high-level FTTP design that reflects the City’s goals and is open to a variety of architecture options. From this design, we present two cost examples.

The first is the cost to deploy FTTP infrastructure, all electronics, service drops to the consumer, and CPEs. This estimate shows the total capital costs—which would be incurred by the City, or the City and its partner(s)—to build an FTTP network to support a ubiquitous 1 Gbps data-only service. This is the capital cost the City would incur if it pursued a wholesale or retail model.

The second cost estimate example is the cost to deploy *only* the FTTP OSP infrastructure—consistent with the dark fiber model, as described in Section 1.5.1. This is the total capital cost for the City to build a dark fiber network for lease to a private partner.

6.1.1 FTTP Cost Estimate (Fiber and Electronics) – Wholesale and Retail Models

This Industrial Corridor FTTP network deployment will cost approximately \$8.5 million, inclusive of OSP construction labor, materials, engineering, permitting, network electronics, drop installation, CPEs, and testing.²³

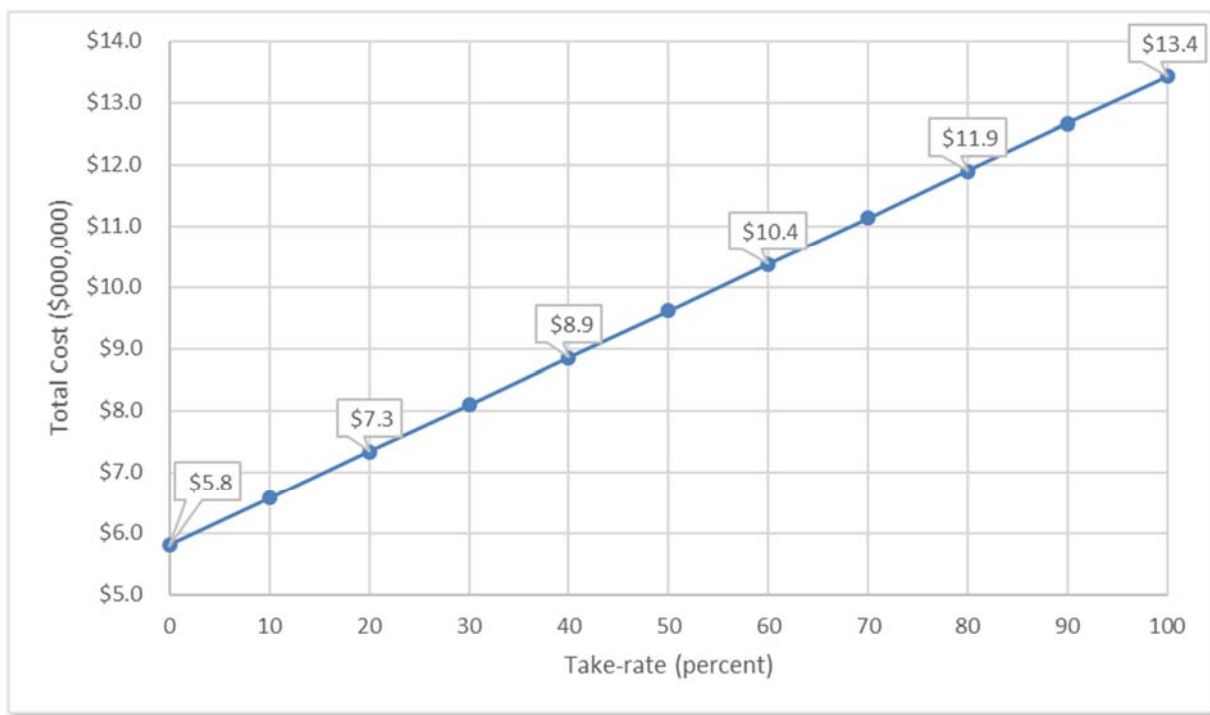
²³ The estimated total cost breakdown assumes a percentage of businesses that subscribe to the service, otherwise known as the penetration rate or the “take rate,” of 35 percent.

Table 6: Breakdown of Estimated Total Cost

Cost Component	Total Estimated Cost
OSP	\$5.2 million
Central Network Electronics	0.6 million
FTTP Service Drop and Lateral Installations	2.1 million
CPE	0.6 million
Total Estimated Cost:	\$8.5 million

Figure 7 shows the change in total estimated cost by varying the expected take rate.

Figure 7: Total Estimated Cost versus Take Rate



The cost is roughly linear by take rate as the per-subscriber cost of adding additional subscribers is constant.

Actual costs may vary due to unknown factors, including: 1) costs of private easements, 2) congestion in the public ROW, 3) variations in labor and material costs, 4) subsurface hard rock, and 5) the City’s operational and business model (including the percentage of businesses who subscribe to the service, otherwise known as the penetration rate or the “take rate”). We have incorporated suitable assumptions to address these items based on our experiences in similar markets.

The total estimated technical operating costs for this model are outlined in Section 6.5 (not including non-technical operating costs such as marketing, legal services, and financing costs). The total cost of operations will vary with the business model chosen and the level of existing resources that can be leveraged by the City and any potential business partners.

6.1.2 FTTP Only Cost Estimate (No Electronics, Drops, or CPEs) – Dark Fiber Model

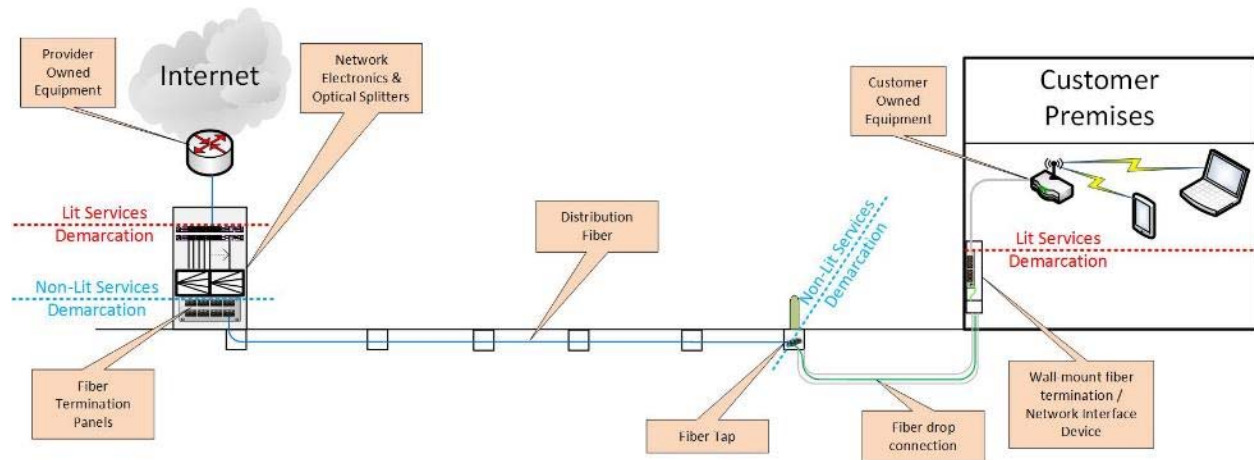
This Industrial Corridor dark FTTP network deployment will cost more than \$5.4 million, inclusive of OSP construction labor, materials, engineering, and permitting. This estimate does not include any electronics, subscriber equipment, or drops.

Table 7: Breakdown of Estimated Dark Fiber Model Cost

Cost Component	Total Estimated Cost
OSP Engineering	\$0.5 million
Quality Control/Quality Assurance	0.2 million
General OSP Construction Cost	3.2 million
Special Crossings	0.7 million
Backbone and Distribution Plant Splicing	0.1 million
Backbone Hub, Termination, and Testing	0.5 million
FTTP Lateral Installations	0.2 million
Total Estimated Cost:	\$5.4 million

This estimate assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point at the optical tap near each business, and leases the dark fiber backbone and distribution fiber to a private partner. The private partner would be responsible for all network electronics, fiber drops to subscribers, and CPEs—as well as network sales, marketing, and operations.

Figure 8: Demarcation Between City and Partner Network Elements



6.2 Cost Estimate Breakdown

The cost components for OSP construction include the following tasks:

- **Engineering** – includes system level architecture planning, preliminary designs and field walk-outs to determine candidate fiber routing; development of detailed engineering prints and preparation of permit applications; and post-construction “as-built” revisions to engineering design materials.
- **Quality Control / Quality Assurance** – includes expert quality assurance field review of final construction for acceptance.
- **General Outside Plant Construction** – consists of all labor and materials related to “typical” underground outside plant construction, including conduit placement, fiber installation, and surface restoration; includes all work area protection and traffic control measures inherent to all roadway construction activities.
- **Special Crossings** – consists of specialized engineering, permitting, and incremental construction (material and labor) costs associated with crossings of railroads, bridges, and interstate / controlled access highways.
- **Backbone and Distribution Plant Splicing** – includes all labor related to fiber splicing of outdoor fiber optic cables.
- **Backbone Hub, Termination, and Testing** – consists of the material and labor costs of placing hub shelters and enclosures, terminating backbone fiber cables within the hubs, and testing backbone cables.

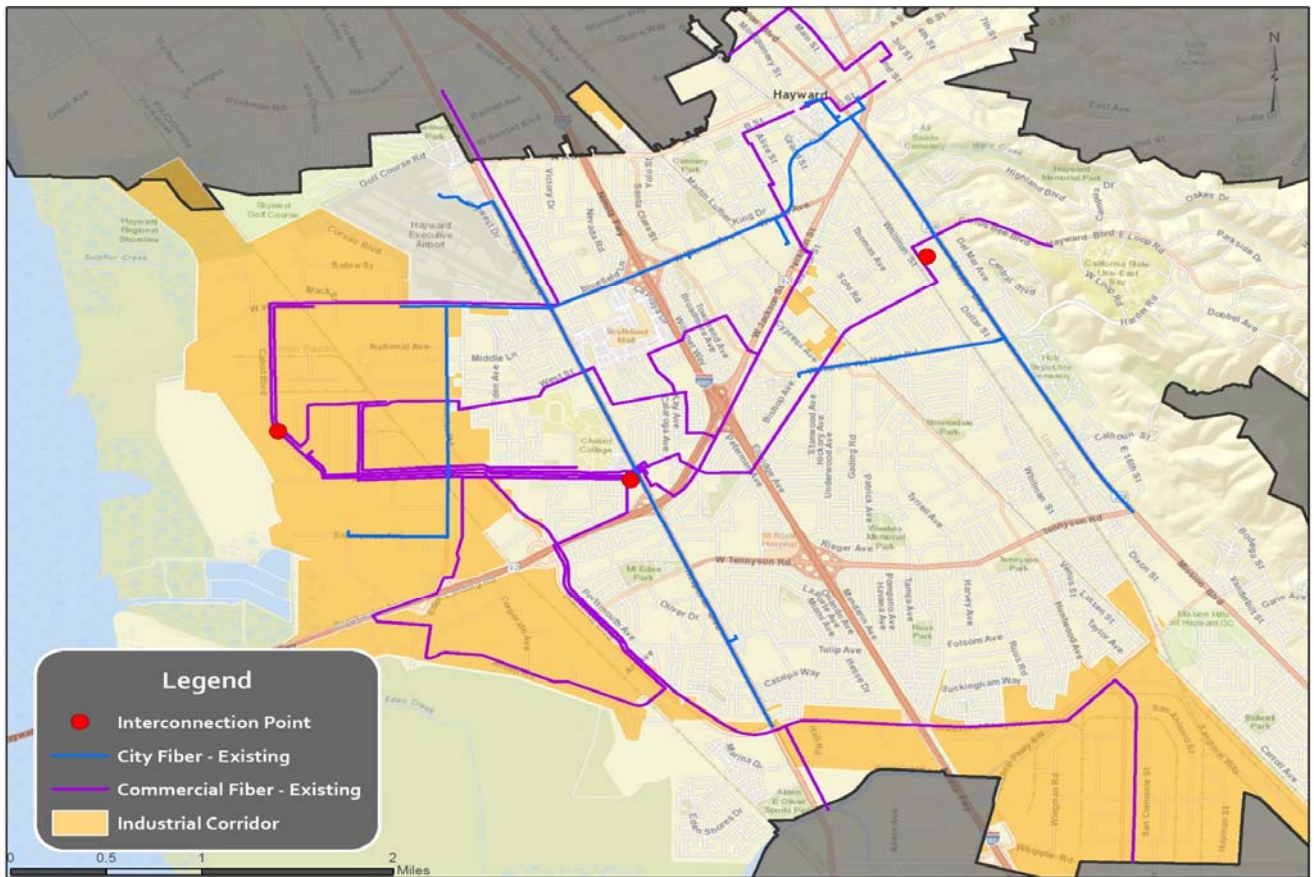
- **FTTP Service Drop and Lateral Installations** – consists of all costs related to fiber service drop installation, including outside plant construction on private property, building penetration, and inside plant construction to a typical backbone network service “demarcation” point; also includes all materials and labor related to the termination of fiber cables at the demarcation point. A take-rate of 35 percent was assumed for standard fiber service drops.

6.2.1 Existing City Network Infrastructure Decreases FTTP Construction Costs

The cost estimate assumes the use of the City’s conduit and fiber optic network to provide fiber optic connectivity along most the route between the Industrial Corridor and Internet POPs for network connectivity.

The use of the City’s conduit and fiber optic resources as a backbone could reduce the cost and complexity of deploying an FTTP network because the network can reduce the amount of construction needed to provide backbone connectivity in the City (Figure 9).

Figure 9: Map Showing Existing Conduit and Fiber Resources



A detailed engineering design will determine the exact level of savings that the conduit and fiber resources can provide to the Industrial Corridor FTTP network, but we estimate the savings to be between \$500,000 and \$1 million.

6.3 Field Survey Methodology for Network Design and Cost Estimate

A CTC OSP engineer performed a preliminary survey of the Industrial Corridor via Google Earth Street View to develop estimates of per-mile cost for underground construction in the existing ROW. A CTC engineer then conducted a brief onsite field study of the City’s existing conduit and the Industrial Corridor to determine the costs with underground construction in the area. The engineer reviewed available green space, ROW widths, building setbacks, and existing underground utility placements—all of which have been factored in to our design and cost estimate.

The ROW in the Industrial Corridor tends to be wide and many of the areas have additional ROW under sidewalks where existing utilities are not located. Some areas are served by aerial utilities while most the service drops and other areas of the Industrial Corridor have all underground

utilities. Given the width of the ROW we do not anticipate any issues with constructing City fiber optics in the ROW.

One obstacle for construction is the rail lines that crisscross the Industrial Corridor. Railroad crossings require permitting and special construction, which can increase the costs and time required to construct fiber optics. The owner of the rail bed must provide a permit or easement to cross the tracks, which is typically a straightforward process with the larger railroads such as Union Pacific. Crossings may be more difficult if someone else owns the rail bed, and/or it is abandoned.

The review of the existing conduit showed that the conduit and fiber optic system appeared to be in good shape. The older of the existing conduit system was designed to support traffic systems using either twisted copper pair or small count fiber optic cables. Traffic conduit tends to have closer handholes (every 250 feet) than fiber optic telecommunications conduit (every 500+ feet). We also noted that the handholes in the older conduit are smaller than what would be recommended today for a fiber optic network. Higher-count fiber optic cables require larger handholes to properly store slack cable and house the fiber optic splice enclosures. If higher fiber optic cable counts were needed in the future, approximately every other handhole would need to be replaced to accommodate the cable. It is important to note that even with potentially having to replace handholes, the fiber optic and conduit system provide tremendous value to the City.

6.4 FTTP Cost Estimate

This section provides a summary of cost estimates for construction of the FTTP network to all businesses in the Industrial Corridor. With the wholesale and retail models, assuming a 35 percent take rate, this deployment will cost approximately \$8.5 million—inclusive of OSP construction labor, materials, engineering, permitting, network electronics, drop installation, CPEs, and testing. Table 8 shows the breakdown of estimated total costs for each network component.

Table 8: Breakdown of Estimated Total Capital Cost – Retail and Wholesale Model

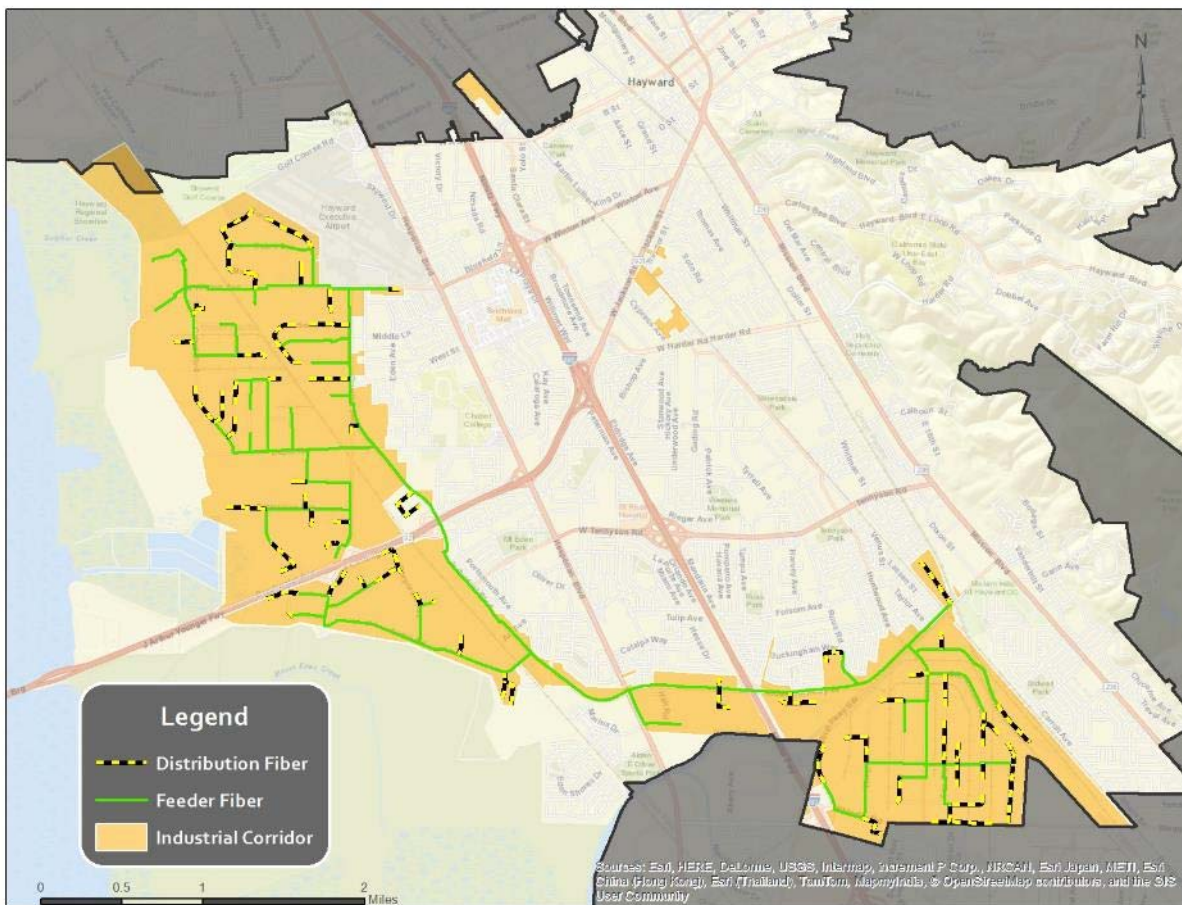
Cost Component	Total Estimated Cost
OSP	\$5.2 million
Central Network Electronics	0.6 million
FTTP Service Drop and Lateral Installations	2.1 million
CPE	0.6 million
Total Estimated Cost:	\$8.5 million

6.4.1 OSP Cost Estimation Methodology

As with any utility, the design and associated costs for construction vary with the unique physical layout of the service area—no two streets are likely to have the exact same configuration of fiber optic cables, communications conduit, and underground vaults. Costs are further varied by soil conditions, such as the prevalence of subsurface hard rock; location and number of existing utilities; and crossings of bridges, railways, and highways.

To estimate costs for the Industrial Corridor network, we developed a high level FTTP sample design on the basis of street mileage and passings. Since much of the Industrial Corridor has underground utilities, we assumed that the entire FTTP network would be constructed underground.

Figure 10: High-Level FTTP Sample Design Overview



The assumptions, sample design, and cost estimates were used to estimate a cost per passing for the OSP. This number was then multiplied by the number of businesses based on the City’s GIS data. The actual cost to construct FTTP to every premises in the Industrial Corridor could differ

from the estimate due to changes in the assumptions underlying the model. Further and more extensive analysis would be required to develop a more accurate cost estimate.

6.4.2 OSP

6.4.2.1 Cost to Construct the Network

In terms of OSP, the estimated cost to construct the proposed FTTP network is approximately \$5.2 million, or \$2,030 per passing.²⁴ As we discussed above, our model assumes all underground fiber construction. Table 9 provides a breakdown of the estimated OSP costs. (Note, the costs have been rounded.)

Table 9: Estimated OSP Costs for FTTP

Area	Distribution Plant Mileage	Total Cost	Passings	Cost per Passing	Cost Per Plant Mile
Corridor	33.9	\$5,200,000	2,560	\$2,030	\$150,000

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

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

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

We assume underground construction will consist primarily of horizontal, directional drilling to minimize ROW impact and to provide greater flexibility to navigate around other utilities. The design model assumes a single two-inch, High-Density Polyethylene (HDPE) flexible conduit over

²⁴ The passing count includes individual single-unit buildings and units in small multi-business buildings as single passings. It treats larger multi-tenant businesses as single passings.

underground distribution paths, and dual two-inch conduits over underground backbone paths to provide scalability for future network growth.

6.4.3 Central Network Electronics

Central network electronics will cost an estimated \$580,000, or \$225 per passing, based on an assumed take rate of 35 percent.²⁵ (These costs may increase or decrease depending on take rate, and the costs may be phased in as subscribers are added to the network.) The central network electronics consists of the electronics to connect subscribers to the FTTP network at the core, hub, and cabinets. Table 10 below lists the estimated costs for each segment.

Table 10: Estimated Central Network Electronics Costs

Network Segment	Subtotal	Passings	Cost per Passing
Core and Distribution Electronics	\$360,000	2,560	\$140
FTTP Access Electronics	220,000	2,560	85
Central Network Electronics Total	\$580,000	2,560	\$225

6.4.3.1 Core Electronics

The core electronics connect the FTTP network to the Internet. The core electronics consist of high performance routers, which handle all the routing on both the FTTP network and to the Internet. The core routers should have modular chassis to provide high availability in terms of redundant components and “hot swappable”²⁶ modular line cards in the event of an outage. Modular routers also provide the ability to expand the routers as demand for additional bandwidth increases.

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

The cost of the core routing equipment is \$260,000. These costs do not include the service provider’s OSS—such as provisioning platforms, fault and performance management systems,

²⁵ The take rate affects the electronics and drop costs, but also may affect other parts of the network, as the city may make different design choices based on the expected take rate. A 35 percent take rate is typical of environments where a new provider joins the telephone and cable provider in a city.

²⁶ Hot swappable means that the line cards or modular can be removed and reinserted without the entire device being powered down or rebooted. The control cards in the router should maintain all configurations and push them to a replaced line card without the need for reconfirmation.

remote access, and other OSS for FTTP operations. The service providers and/or their content providers may already have these systems in place.

6.4.3.2 Distribution Electronics

The distribution network electronics aggregate the traffic from the FDCs and send it to the core to access the Internet. The distribution electronics consist of high performance aggregation switches, which consolidate the traffic from the many access electronics and send it to the core for route processing. The distribution switches typically are modular switch chassis that can accommodate many line cards for aggregation. The switches should also be modular to provide redundancy in the same manner as the core switches.

The cost estimate assumes that the aggregation switches connect to the access network electronics with 10 Gbps links to each distribution switch. The aggregation switches would then connect to the core switches over single or multiple 10 Gbps links as needed to meet the demand of the FTTP users in each service area.

The cost of the distribution switching equipment is \$100,000. These costs do not include any of the service provider's OSS or other management equipment.

6.4.3.3 Access Electronics

The access network electronics at the FDCs connect the subscribers' CPEs to the FTTP network. We recommend deploying access network electronics that can support both GPON and Active Ethernet subscribers to provide flexibility within the FDC service area. We also recommend deploying modular access network electronics for reliability and the ability to add line cards as more subscribers join in the service area. Modularity also helps reduce initial capital costs while the network is under construction or during the roll out of the network.

The cost of the access network electronics for the network is \$220,000. These costs are based on a take rate of 35 percent and include optical splitters at the FDCs for that take rate.

6.4.4 Customer Premises Equipment (CPE) and Service Drop Installation (Per-subscriber Costs)

CPEs are the subscriber's interface to the FTTP network. For this cost estimate, we selected CPEs that provide only Ethernet data services (however, there are a wide variety of CPEs offering other data, voice, and video services). Using the estimated take rate of 35 percent, we estimated the CPE for business customers will be \$630,000.

Each activated subscriber would also require a fiber drop installation and related electronics, which would cost roughly \$2,860 per subscriber, or \$2.7 million total (assuming a 35 percent take rate).

The drop installation cost is the biggest variable in the total cost of adding a subscriber. A short aerial drop can cost as little as \$250 to install, whereas a long underground drop installation can cost upward of \$3,000. (We estimate an average of \$2,160 per drop installation within the Industrial Corridor.)

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

Table 11: Per-subscriber Cost Estimates

Construction and Electronics Required to Activate a Subscriber	Estimated Average Cost
Drop Installation and Materials	\$2,160
Subscriber Electronics (ONT and OLT)	400
Electronics Installation	200
Installation Materials	100
Total	\$2,860

6.5 Operating Cost Considerations

This section outlines some of the key technical operating expenditures the Industrial Corridor FTTP network would incur. Costs for FTTP network technical operations include staffing (technicians, program manager), OSP maintenance, electronics maintenance, and customer support.

The costs discussed in this section are not meant to be inclusive of all operating costs such as marketing, legal, and financial costs. Further, the magnitude of total cost of operations will vary with the business model chosen, balance of added new staff versus using contractors, the level of existing resources that can be leveraged by the City, and any potential business partners. Staffing requirements and operation costs will vary based on the selected business model. We provide additional staffing and operational cost details in Section 7.

6.5.1 Technical Operational Expenditures

If the City chooses to offer a retail data service, we estimate that the City would likely initially purchase 2 Gbps of Internet capacity. This is an estimated number for the beginning of the

network deployment and can be expected to grow as video streaming and other cloud applications grow in importance. Depending upon the contract terms Internet bandwidth we would estimate costs in the \$0.75 per Mbps per month to \$1.50 per Mbps per month range in Hayward. We recommend that the Internet access be purchased from multiple Internet providers and be load balanced to ensure continuity during an outage.

The operating costs also include maintenance contracts on the core network electronics. These contracts ensure that the City has access to software support and replacement of critical network electronics that would be cost-prohibitive to store as spares. Where cost effective such as the distribution aggregation switches and the FTTP electronics, we recommend storing spares to reduce the total costs of maintenance contracts. We estimate hardware maintenance contracts and sparing at 15 percent of the total electronics cost.

In addition, we recommend planning for an annual payment into a depreciation operating reserve account based on the equipment replacement cost to help limit risk. This reserve fund should never go negative; the balance that accrues in this account will fund the capital needs for ongoing capital replenishments.

6.5.1.1 Fiber Maintenance Costs

The City would need to augment its current fiber staff or contractors with the necessary expertise and equipment available to maintain the fiber optic cable in an Industrial Corridor FTTP network. Typical maintenance costs can exceed 1 percent of the total fiber OSP construction cost per year and includes a mix of contracted services.

Fiber optic cable is resilient compared to copper telephone lines and cable TV coaxial cable. The fiber itself does not corrode, and fiber cable installed over 20 years ago is still in good condition. However, fiber can be vulnerable to accidental cuts by other construction, traffic accidents, and severe weather. In other networks of this size, we have seen approximately 80 outages per 1,000 miles of plant per year.

The fiber optic redundancy from the hubs to the FDCs in the backbone network will facilitate restoring network outages while repair of the fiber optic plant is taking place.

Depending on the operational and business models established between the City and service providers, the City may be responsible for adds, moves, and changes associated with the network as well as standard plant maintenance. These items may include:

- Adding and/or changing patching and optical splitter configurations at FDCs and hubs;
- Extending optical taps and laterals to new buildings or developments;
- Extending access to the FTTP network to other service providers; and

- Relocating fiber paths due to changes such as the widening of roadways.

The City would need to obtain contracts with fiber optic contractors that have the necessary expertise and equipment available to maintain an Industrial Corridor FTTP network. These contracts should specify the service level agreements the City needs from the fiber optic contractors to ensure that the City can meet the service level agreements it has with the network service providers. The City should also ensure that it has access to multiple fiber optic contractors if one contractor is unable to meet the City's needs. The fiber optic contractors should be available 24x7 and have a process in place for activating emergency service requests.

6.5.1.2 Fiber Locating

The City will be responsible for locating and marking all underground conduit for excavation projects per California's DigAlert System statutes. Locating involves receiving and reviewing excavation tickets to determine whether the area of excavation may impact the City's underground FTTP infrastructure. If the system is impacted, the City must mark its utilities in the manner and within the allotted timeframe provided by the statute.

Locating is either done in-house or by contractors who specialize in utility locating. The City may be able to leverage its existing utility locating personnel, processes, or contractors to reduce the cost of utility locating for the FTTP network.

6.5.2 Technical Staffing Requirements

Additional staffing will be required to perform the maintenance and operation responsibilities of an Industrial Corridor FTTP network. The staffing levels and the responsibility for that staffing will vary greatly with the various potential business models. The following sections outline the technical groups that will be required to maintain and operate the network.

6.5.2.1 Outside Plant

The OSP group will be responsible for the maintenance, operations, and expansion of the City's telecommunications infrastructure including conduit, fiber, and splice enclosures. During construction, the OSP group will be responsible for tracking and overseeing the construction of new infrastructure. Once the network is constructed, the OSP group will oversee any future adds, moves, or changes to the network.

The OSP group may use contractors to perform activities such as construction, repair, and locating. Management of contractors will be a responsibility of an OSP manager with OSP technicians assisting with project oversight and quality assurance and quality control. The OSP manager will also assist with engineering and design of any adds, moves, and changes that occur on the network.

The OSP group will have responsibility for general field operations. This group will include OSP technicians to perform locates, and contracted support to provide repair services. Tasks will include management of the One Call process, fiber locates, response and troubleshooting of Layer 1 troubleshooting, and fleet management. Additionally, it is critical that while many of OSP jobs may be outsourced, that the OSP group be equipped with the proper locate and testing equipment.

6.5.2.2 Network Engineering

The network engineering group develops and maintains the network architecture, responds to high-level troubleshooting requests, manages network electronics and makes sure the network delivers to the end user a reliable service.

The network engineering group is responsible for making architecture decisions that will determine how the network can deliver services to users. The network engineering group will also be responsible for change management and architectural review to ensure that network continuity is ensured after changes.

The network engineering group will also be responsible for vendor selections when new hardware, technologies, or contractor support is needed to support the network. The network engineering team will perform regular maintenance of the network as well as provision, deploy, test, and accept any electronics to support new sites or services.

Network technicians will be responsible for troubleshooting issues with network electronics and responding to customer complaints.

To operate network electronics (if required by the business model) we estimate a staffing requirement of one network manager, up to one network engineer, and up to two network technicians that could be a combination of personnel as well as contracted support. Network staffing levels may vary depending on the take rate of the FTTP network.

6.5.2.3 Network Operations Center and Customer Service

The network will require individuals to perform monitoring and oversight of the network electronics. The group will be responsible for handling technical calls from users, actively monitoring the health of the network, and escalating issues to the proper operations groups. The group is also required to develop and monitor network performance parameters to ensure that the network is meeting its obligations to its users as defined in the network service level agreements (SLAs).

Often network operations require a 24x7 customer service helpdesk and tools for network monitoring, alerting, and provisioning.

7 Business and Financial Model

This section presents a financial analysis based on the candidate business models we outline in Section 1.5, above. Our modeling is based on an FTTP deployment to the Industrial Corridor, and assumes that the City will take some financial risk by investing at least in dark fiber infrastructure. The models are briefly summarized again in Table 12, with an emphasis on the division of responsibilities between the City and a partner.

Table 12: Responsibility Matrix for Potential Business Models

Activity	Model		
	Dark Fiber	Wholesale Service	Retail Service
Who invests in and owns the outside plant (OSP), like fiber?	City	City	City
Who invests in and owns the network electronics?	Partner(s)	City	City
Who is responsible for customer service to end users?	Partner(s)	Partner(s)	City

7.1 Overview

Potential business models for an FTTP deployment range from:

- A **retail service model** in which the City directly provides fiber service;
- To a **wholesale service model** in which the City builds an open access network and invites private partners to deliver services over the network;
- To a **dark fiber model** in which the City builds the fiber and enters a partnership with an anchor service provider, similar to the business model the City of Westminster, Maryland adopted when it partnered with Ting Fiber.²⁷

As we noted in Section 1.5, we believe a dark fiber model will best fit the City’s needs, because it leverages the City’s abilities and offsets some of the risk associated with implementing a new broadband enterprise, as the City would be required to do in a retail service model.

We conducted financial modeling based on the three potential business models to illustrate the kind of costs and revenues the City might see under each model. This section presents an overview of the FTTP financial model, based on the cost estimates in Section 6. We have provided the City with a complete financial model in Excel format; because the Excel spreadsheet can be

²⁷ “Westminster Fiber Network,” *City of Westminster*, accessed November 8, 2016, <http://www.westminstermd.gov/419/Westminster-Fiber-Network>.

modified to show the impact of changing assumptions, it will be an important tool for the City to use if it negotiates with a private partner.

These financial projections do not include any economic development or other indirect benefits, which are often not easily quantifiable. The projections also do not include potential revenues from small cell or distributed antenna system (DAS) providers, which may represent a modest revenue source the City can tap into if it can find interested providers.

7.2 Retail Model Financial Projections

The financial analysis in this section assumes the City of Hayward owns and operates the FTTP infrastructure and provides retail service to businesses in the identified service area. As we described above, the City will be the service provider in a retail service model and will be responsible for all aspects of network deployment and maintenance, network and customer electronics, service delivery, and customer service and support. This financial analysis is based on several assumptions, outlined below.

In the analysis, we assume the City offers four base services, at prices that compare favorably to similar services in other cities:

- A 250 Mbps commercial service at \$100 per month,
- A 1 Gbps small commercial service at \$200 per month,
- A 1 Gbps medium commercial service at \$400 per month (including service-level agreement), and
- A 1 Gbps Metro Ethernet transport service at \$1,000 per month (including service-level agreement).

We assumed that 68 percent of subscribers will purchase the 250 Mbps service; 15 percent will purchase the 1 Gbps small commercial service; 15 percent will purchase the 1 Gbps medium commercial service; and 2 percent will purchase the 1 Gbps Metro Ethernet service.

Given the assumptions outlined in this section, a 60 percent take rate (the percentage of customers that subscribe to the service) is required to maintain a positive cash flow. Note that this analysis does not indicate or review whether obtaining this required take rate is realistic; rather, it reflects the take rate necessary to maintain a positive cash flow, considering all other assumptions in the model. The complete model is provided in Appendix C.

Please note that, based on other competitive overbuilds, obtaining a 60 percent take rate is considered aggressive, and will likely be difficult to obtain and maintain. Realistically, we would expect a 35 percent to 45 percent take rate.

The financial analysis for this base case scenario is as follows:

Table 13: Base Case Retail Model Financial Analysis with 60 Percent Take Rate

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$341,000	\$3,280,000	\$3,280,000	\$3,280,000	\$3,280,000
Total Cash Expenses	(911,000)	(1,419,000)	(1,419,000)	(1,419,000)	(1,419,000)
Depreciation	(234,000)	(1,254,000)	(625,000)	(617,000)	(617,000)
Interest Expense	(185,000)	(617,000)	(485,000)	(321,000)	(111,000)
Taxes	=	=	=	=	=
Net Income	\$(989,000)	\$(10,000)	\$751,000	\$923,000	\$1,133,000

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$(50,000)	\$491,000	\$2,770,000	\$5,548,000	\$8,319,000
Depreciation Reserve	-	1,132,000	1,150,000	354,000	(138,000)
Interest Reserve	185,000	-	-	-	-
Debt Service Reserve	<u>185,000</u>	<u>660,000</u>	<u>660,000</u>	<u>660,000</u>	<u>660,000</u>
Total Cash Balance	\$320,000	\$2,283,000	\$4,580,000	\$6,562,000	\$8,841,000

The income statement demonstrates an overall health of the enterprise on a year-by-year basis. The above cash flow statement shows the cumulative cash balance of the enterprise. It shows unrestricted and restricted (depreciation, interest, and debt service reserves) cumulative cash balances. The cash flow statement is the most important measure for a public entity. It is important for the enterprise to maintain a positive unrestricted cash balance at the end of each year.

Please note that we used a “flat model” in the analysis. With a “flat model,” inflation and salary cost increases are not used in the analysis because it is assumed that operating cost increases will be offset and passed on to subscribers in the form of increased prices. Models that add an inflation factor to both revenues and expenses can greatly overstate net revenues in the out-years since net revenues would then also increase by the same inflation factor.

7.2.1 Financing Costs and Operating Expenses

This financial analysis assumes a combination of bonds and loans will be necessary to deploy the FTTP network. We expect that the City will seek 20-year bonds with principal repayments starting the year after the bond issuance.

We project that the bond issuance costs will be equal to 1.0 percent of the principal borrowed. For the bond, a debt service reserve account is maintained at 5.0 percent of the total issuance amount. An interest reserve account equal to years one and two interest expense is maintained for the first two years.

Our analysis estimates total bonding requirements to be \$13.2 million, and we assume that bonds are issued at a 5 percent interest rate.

The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span while network equipment will need to be replaced after 10 years. Last mile fiber and CPEs, as well as other miscellaneous implementation costs, will need to be accounted for after five years. Network equipment will be replaced or upgraded at 80 percent of its original cost, miscellaneous implementation costs will be at 100 percent, and last mile and CPEs will be at 100 percent. The model plans for a depreciation reserve account starting in year three—these monies are set aside to fund future electronics replacements and upgrades.

Table 14 shows operating expenses for years one, five, 10, 15, and 20. As the table indicates, some expenses will remain constant while others will increase as the network matures and the customer base increases.

Table 14: Operating Expenses in Years 1, 5, 10, 15, and 20 – Retail Model

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Support Services	\$52,000	\$28,000	\$28,000	\$28,000	\$28,000
Insurance	25,000	50,000	50,000	50,000	50,000
Utilities	-	-	-	-	-
Office Expenses	6,000	6,000	6,000	6,000	6,000
Facility Lease	-	-	-	-	-
Locates & Ticket Processing	8,000	31,000	31,000	31,000	31,000
Peering	-	-	-	-	-
Contingency	10,000	25,000	25,000	25,000	25,000
Billing Maintenance Contract	10,000	20,000	20,000	20,000	20,000
Fiber & Network Maintenance	16,000	55,000	55,000	55,000	55,000
Vendor Maintenance Contracts	-	83,000	83,000	83,000	83,000
Legal and Lobby Fees	50,000	10,000	10,000	10,000	10,000
Planning	-	-	-	-	-
Consulting	50,000	10,000	10,000	10,000	10,000
Marketing	100,000	50,000	50,000	50,000	50,000
Education and Training	11,000	19,000	19,000	19,000	19,000
Customer Handholding	-	-	-	-	-
Customer Billing (Unit)	-	5,000	5,000	5,000	5,000
Allowance for Bad Debts	3,000	33,000	33,000	33,000	33,000
Churn (acquisition costs)	1,000	15,000	15,000	15,000	15,000
Pole Attachment Expense	-	-	-	-	-
Internet	<u>30,000</u>	<u>41,000</u>	<u>41,000</u>	<u>41,000</u>	<u>41,000</u>
Sub-Total	\$372,000	\$481,000	\$481,000	\$481,000	\$481,000
Labor Expenses	<u>\$539,000</u>	<u>\$938,000</u>	<u>\$938,000</u>	<u>\$938,000</u>	<u>\$938,000</u>
Sub-Total	<u>\$539,000</u>	<u>\$938,000</u>	<u>\$938,000</u>	<u>\$938,000</u>	<u>\$938,000</u>
Total Expenses	<u>\$911,000</u>	<u>\$1,419,000</u>	<u>\$1,419,000</u>	<u>\$1,419,000</u>	<u>\$1,419,000</u>

Table 15 shows the income statement for years one, five, 10, 15, and 20.

Table 15: Income Statement – Retail Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Internet - Business	\$277,000	\$3,280,000	\$3,280,000	\$3,280,000	\$3,280,000
Connection Fee (net)	64,000	-	-	-	-
Per Passing	-	-	-	-	-
Per Customer	-	-	-	-	-
Provider Fee	-	-	-	-	-
Assessments	-	-	-	-	-
Ancillary Revenues	-	-	-	-	-
Total	\$341,000	\$3,280,000	\$3,280,000	\$3,280,000	\$3,280,000
b. Content Fees					
Internet	\$30,000	\$41,000	\$41,000	\$41,000	\$41,000
Total	\$30,000	\$41,000	\$41,000	\$41,000	\$41,000
c. Operating Costs					
Operation Costs	\$342,000	\$440,000	\$440,000	\$440,000	\$440,000
Labor Costs	539,000	938,000	938,000	938,000	938,000
Total	\$881,000	\$1,378,000	\$1,378,000	\$1,378,000	\$1,378,000
d. EBITDA	\$(570,000)	\$1,861,000	\$1,861,000	\$1,861,000	\$1,861,000
e. Depreciation	234,000	1,254,000	625,000	617,000	617,000
f. Operating Income (EBITDA less Depreciation)	\$(804,000)	\$607,000	\$1,236,000	\$1,244,000	\$1,244,000
g. Non-Operating Income					
Interest Income	\$ -	\$4,000	\$5,000	\$3,000	\$1,000
Interest Expense (10 Year Bond)	-	-	-	-	-
Interest Expense (20 Year Bond)	(185,000)	(621,000)	(490,000)	(324,000)	(112,000)
Interest Expense (Loan)	-	-	-	-	-
Total	\$(185,000)	\$(485,000)	\$(485,000)	\$(321,000)	\$(111,000)
h. Net Income (before taxes)	\$(989,000)	\$(10,000)	\$751,000	\$923,000	\$1,133,000
i. Facility Taxes	\$ -	\$ -	\$ -	\$ -	\$ -
j. Net Income	\$(989,000)	\$(10,000)	\$751,000	\$923,000	\$1,133,000

Table 16: Cash Flow Statement – Retail Model

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Net Income	\$ (989,000)	\$ (10,000)	\$ 751,000	\$ 923,000	\$ 1,133,000
b. Cash Outflows					
Debt Service Reserve	\$ (185,000)	\$ -	\$ -	\$ -	\$ -
Interest Reserve	(370,000)	-	-	-	-
Depreciation Reserve	-	(439,000)	(219,000)	(216,000)	(216,000)
Financing	(37,000)	-	-	-	-
Capital Expenditures	<u>(2,588,000)</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Total	\$ (3,180,000)	\$ (439,000)	\$ (219,000)	\$ (216,000)	\$ (216,000)
c. Cash Inflows					
Interest Reserve	\$ 185,000	\$ 95,000	\$ -	\$ -	\$ -
Depreciation Reserve	-	-	-	-	-
Investment Capital	-	-	-	-	-
Start Up Funds	-	-	-	-	-
Grants (infrastructure)	-	-	-	-	-
Grants (customer premises)	-	-	-	-	-
10-Year Bond/Loan Proceeds	-	-	-	-	-
20-Year Bond Proceeds	3,700,000	-	-	-	-
Loan Proceeds	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Total	\$ 3,885,000	\$ 95,000	\$ -	\$ -	\$ -
d. Total Cash Outflows and Inflows	\$ 705,000	\$ (344,000)	\$ (219,000)	\$ (216,000)	\$ (216,000)
e. Non-Cash Expenses - Depreciation	\$ 234,000	\$ 1,254,000	\$ 625,000	\$ 617,000	\$ 617,000
f. Adjustments					
Proceeds from Additional Cash Flows (10 Year Bond)	\$ -	\$ -	\$ -	\$ -	\$ -
Proceeds from Additional Cash Flows (20 Year Bond)	\$ (3,700,000)	\$ -	\$ -	\$ -	\$ -
Proceeds from Additional Cash Flows (Loan)	\$ -	\$ -	\$ -	\$ -	\$ -
g. Adjusted Available Net Revenue	\$ (3,750,000)	\$ 900,000	\$ 1,157,000	\$ 1,324,000	\$ 1,534,000
h. Principal Payments on Debt					
10 Year Bond Principal	\$ -	\$ -	\$ -	\$ -	\$ -
20 Year Bond Principal	-	472,000	602,000	768,000	981,000
Loan Principal	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>	<u>-</u>
Total	\$ -	\$ 472,000	\$ 602,000	\$ 768,000	\$ 981,000

Significant network expenses—known as “capital additions”—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building, implementing, and lighting a fiber network. Table 17 shows the capital additions costs in years one, two, and three, and the total for years one through three.

This analysis projects that the capital additions in year one will total approximately \$2.6 million. These costs will total approximately \$3.5 million in year two, \$1.8 million in year three, and \$2.6 million in year four. This totals just over \$10.5 million for total capital additions costs for years one through four.

Table 17: Capital Additions – Retail Model

Capital Additions	Year 1	Year 2	Year 3	Year 4
Network Equipment				
Core Network Equipment	\$380,000	\$ -	\$ -	\$ -
TBD	-	-	-	-
Additional Annual Capital	-	-	-	-
Total	\$ 380,000	\$ -	\$ -	\$ -
Outside Plant and Facilities				
Total Backbone and FTTP	\$1,635,000	\$2,726,000	\$1,090,000	\$ -
Additional Annual Capital	-	-	-	-
Total	\$1,635,000	\$2,726,000	\$1,090,000	\$ -
Last Mile and Customer Premises Equipment				
CPE (residential and small commercial)	\$91,000	\$182,000	\$182,000	\$638,000
CPE (medium commercial)	18,000	36,000	35,000	124,000
CPE (enterprise)	6,000	10,000	10,000	36,000
Average Drop Cost	263,000	525,000	523,000	1,836,000
Additional Annual Replacement Capital	-	-	-	-
Total	\$378,000	\$753,000	\$750,000	\$2,634,000
Miscellaneous Implementation Costs				
Splicing	\$ -	\$ -	\$ -	\$ -
Vehicles	50,000	-	-	-
Emergency Restoration Kit	50,000	-	-	-
Work Station, Computers, and Software	10,000	7,000	-	2,000
Fiber OTDR and Other Tools	85,000	-	-	-
Generators & UPS	-	-	-	-
OSS	-	-	-	-
Additional Annual Capital	-	-	-	-
Total	\$195,000	\$7,000	\$ -	\$2,000
Replacement Costs for Depreciation				
Network Equipment	\$ -	\$ -	\$ -	\$ -
Customer Premises Equipment	-	-	-	-
Miscellaneous Implementation Costs	-	-	-	-
Total	\$ -	\$ -	\$ -	\$ -
Total Capital Additions	\$2,588,000	\$3,486,000	\$1,840,000	\$2,636,000

7.2.2 Operating and Maintenance Expenses

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

- Expand office facilities for management, technical and clerical staff

- Expand retail “storefront” to facilitate customer contact and enhance their experience doing business with the FTTP enterprise
- Provide warehousing for receipt and storage of cable and hardware for the installation and on-going maintenance of the broadband infrastructure
- Establish location to house servers, switches, routers, and other core-network equipment

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

The expanded business and increased responsibilities will require the addition of new staff. Marketing and sales are critical. It is important to be proactive in setting customer expectations, addressing security concerns, and educating the customers on how to initiate services.

The initial additional positions, staffing levels, and base salaries are shown in Table 18. Please note that the table only lists estimated salaries and in the analysis, we added a 40 percent overhead to these salaries.

Table 18: Labor Expenses – Retail Model

	Year 1	Year 2	Year 3	Year 4	Year 5+	Labor Cost
New Employees						
Business Manager	0.50	1.00	1.00	1.00	1.00	\$130,000
GIS	0.50	1.00	1.00	1.00	1.00	\$80,000
Communications - Sales	0.50	2.00	2.00	2.00	2.00	\$75,000
Customer Service Representative	2.00	2.00	2.00	2.00	2.00	\$65,000
Service Technicians/Installers & IT Support	1.00	1.00	1.00	2.00	2.00	\$90,000
Fiber Plant O&M Technicians	<u>0.25</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	<u>1.00</u>	\$90,000
Total New Staff	4.75	8	8	9	9	

7.2.3 Summary of Operating and Maintenance Assumptions

Additional key operating and maintenance assumptions include:

- Salaries and benefits are based on estimated market wages. See Table 18 for a list of staffing requirements for the retail service model. Benefits are estimated at 40 percent of base salary.
- Use of a help desk service, which includes a \$50,000 startup cost and \$1.50 per month per customer service fee.
- Insurance is estimated to be \$25,000 in year one and \$50,000 from year two on.
- Office expense allocations are estimated to be \$6,000 per year.
- Locates and ticket processing are estimated to start in year one at \$8,000, increase to \$15,000 in year two, and increase to \$31,000 from year three on.

- Contingency is estimated to be \$10,000 in year one and \$25,000 from year two on.
- Billing and maintenance contract fees are estimated at \$10,000 in year one, and \$20,000 from year two on.
- Legal fees are estimated to be \$50,000 in year one, and \$10,000 from year two on.
- Consulting fees are estimated at \$50,000 in year one, and \$10,000 from year three on.
- Marketing and promotional expenses are estimated to be \$100,000 in year one, and \$50,000 from year two on.

Vendor maintenance contract fees are expected to start at \$43,000 in year two, increase to \$52,000 in year three, and increase again to \$83,000 in year four; these fees are expected to remain steady at \$83,000 per year beyond year four. Annual variable and operating expenses not including direct Internet access include:

- Education and training are calculated as 2 percent of direct payroll expense.
- Customer billing is estimated to be \$0.25 per bill per month.
- Allowance for bad debts is computed as 1 percent of revenues.
- Churn is anticipated to be 5 percent annually.

Fiber network maintenance costs are calculated at 1 percent of the total construction cost, per year. This is estimated based on a typical rate of occurrence in an urban environment, and the cost of individual repairs. This is in addition to staffing costs to maintain fiber.

Internet and peering is estimated at \$1.25 per Mbps per month for the first 2 Gbps, and \$1.00 per Mbps per month thereafter.

7.2.4 Take-Rate Sensitivity

This section shows the large impact that fluctuations in take rate can have on financial modeling. In the following tables, we show the financial projections for take rates of 50 percent, 40 percent, and 30 percent.

Please note that, based on other competitive overbuilds, obtaining a 60 percent take rate is considered aggressive, and will likely be difficult to obtain and maintain. Realistically, we would expect a 35 percent to 45 percent take rate.

Note that the total unrestricted cash balance in year one with a 50 percent take rate is projected as a loss of \$50,000, as shown in Table 19, below. This number is the same as the projections for a 60 percent take rate (see Table 13, above), but by the time we reach year five, the numbers diverge significantly.

The projected unrestricted cash balance with a 60 percent take rate is projected to be approximately \$491,000 in year five. With a 50 percent take rate, the unrestricted cash balance in year five is projected as a loss of approximately \$451,000.

This is nearly a \$1 million difference in unrestricted cash balances based on the difference between a 60 percent and a 50 percent take rate. As the take rate declines, this gap widens, as the tables below show.

Table 19: Take Rate Reduced to 50 Percent – Retail Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$341,000	\$2,738,000	\$2,738,000	\$2,738,000	\$2,738,000
Total Cash Expenses	(911,000)	(1,390,000)	(1,390,000)	(1,390,000)	(1,390,000)
Depreciation	(234,000)	(1,104,000)	(579,000)	(572,000)	(572,000)
Interest Expense	(185,000)	(577,000)	(453,000)	(297,000)	(98,000)
Taxes	-	-	-	-	-
Net Income	\$ (989,000)	\$ (333,000)	\$316,000	\$479,000	\$678,000

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (50,000)	\$ (451,000)	\$ (220,000)	\$404,000	\$1,023,000
Depreciation Reserve	-	1,026,000	1,082,000	434,000	90,000
Interest Reserve	185,000	-	-	-	-
Debt Service Reserve	<u>185,000</u>	<u>620,000</u>	<u>620,000</u>	<u>620,000</u>	<u>620,000</u>
Total Cash Balance	\$320,000	\$1,195,000	\$1,482,000	\$1,458,000	\$1,733,000

As Table 20 shows, the total projected revenues in year five with a 40 percent take rate are approximately \$2,176,000. The base case analysis with a 60 percent take rate projected year five revenues at approximately \$3,280,000. This is greater than a \$1.1 million difference in projected revenues based on take rate.

Similarly, the unrestricted cash balance in year five for the base case analysis—with a 60 percent take rate—is projected at approximately \$491,000 per year in year five. With a 40 percent take rate (see Table 20, below), the unrestricted cash balance is projected as a loss of approximately \$1.5 million per year in year five.

Table 20: Take Rate Reduced to 40 Percent – Retail Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$341,000	\$2,176,000	\$2,176,000	\$2,176,000	\$2,176,000
Total Cash Expenses	(911,000)	(1,362,000)	(1,362,000)	(1,362,000)	(1,362,000)
Depreciation	(234,000)	(953,000)	(533,000)	(526,000)	(526,000)
Interest Expense	(185,000)	(532,000)	(417,000)	(271,000)	(85,000)
Taxes	-	-	-	-	-
Net Income	\$ (989,000)	\$ (671,000)	\$ (136,000)	\$ 17,000	\$203,000

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (50,000)	\$(1,514,000)	\$ (3,394,000)	\$ (4,988,000)	\$ (6,586,000)
Depreciation Reserve	-	922,000	1,018,000	520,000	326,000
Interest Reserve	185,000	-	-	-	-
Debt Service Reserve	185,000	575,000	575,000	575,000	575,000
Total Cash Balance	\$320,000	\$ (17,000)	\$ (1,801,000)	\$ (3,893,000)	\$ (5,685,000)

Again, the unrestricted cash balance in the base case analysis (Table 13) for a retail model is projected as approximately \$491,000 in year five. As Table 21 shows below, the projected unrestricted cash balance with a 30 percent take rate is a loss of approximately \$2.5 million in year five.

Table 21: Take Rate Reduced to 30 Percent – Retail Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$341,000	\$1,634,000	\$1,634,000	\$1,634,000	\$ 1,634,000
Total Cash Expenses	(911,000)	(1,340,000)	(1,340,000)	(1,340,000)	(1,340,000)
Depreciation	(234,000)	(803,000)	(488,000)	(480,000)	(480,000)
Interest Expense	(185,000)	(493,000)	(384,000)	(247,000)	(72,000)
Taxes	-	-	-	-	-
Net Income	\$ (989,000)	\$ (1,002,000)	\$ (578,000)	\$ (433,000)	\$ (258,000)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (50,000)	\$ (2,469,000)	\$ (6,431,000)	\$ (10,216,000)	\$ (14,002,000)
Depreciation Reserve	-	816,000	950,000	600,000	554,000
Interest Reserve	185,000	-	-	-	-
Debt Service Reserve	185,000	535,000	535,000	535,000	535,000
Total Cash Balance	\$ 320,000	\$ (1,118,000)	\$ (4,946,000)	\$ (9,081,000)	\$ (12,913,000)

7.3 Wholesale Model Financial Projections

The financial analysis in this section assumes the City of Hayward owns and operates the FTTP infrastructure and provides wholesale service to ISPs. The ISPs in turn offer retail service businesses in the identified service area. This financial analysis is based on several assumptions, outlined below.

In the analysis, we assume the City offers four wholesale base services, based on a 25 percent discount from the retail model.

- A 250 Mbps commercial service at \$75 per month;
- A 1 Gbps small commercial service at \$150 per month;
- A 1 Gbps medium commercial service at \$300 per month (including service-level agreement); and
- A 1 Gbps Metro Ethernet transport service at \$750 per month (including service-level agreement).

We assumed that 68 percent of subscribers will purchase the 250 Mbps service; 15 percent will purchase the 1 Gbps small commercial service; 15 percent will purchase the 1 Gbps medium commercial service; and 2 percent will purchase the 1 Gbps Metro Ethernet service.

As in the case of the retail model, a 60 percent take rate is required to maintain a positive cash flow.

The financial analysis for this base case scenario is as follows:

Table 22: Wholesale Model Financial Analysis with 60 Percent Take Rate (Base Case)

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$271,000	\$2,460,000	\$2,460,000	\$2,460,000	\$2,460,000
Total Cash Expenses	(572,750)	(934,250)	(934,250)	(934,250)	(934,250)
Depreciation	(233,000)	(1,253,000)	(623,000)	(616,000)	(616,000)
Interest Expense	(175,000)	(589,000)	(465,000)	(308,000)	(107,000)
Taxes	-	-	-	-	-
Net Income	<u>\$ (709,750)</u>	<u>\$ (316,250)</u>	<u>\$437,750</u>	<u>\$601,750</u>	<u>\$802,750</u>

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$55,250	\$57,250	\$909,000	\$2,257,750	\$3,601,500
Depreciation Reserve	-	1,132,000	1,154,000	366,000	(118,000)
Interest Reserve	175,000	-	-	-	-
Debt Service Reserve	<u>175,000</u>	<u>630,000</u>	<u>630,000</u>	<u>630,000</u>	<u>630,000</u>
Total Cash Balance	<u>\$405,250</u>	<u>\$1,819,250</u>	<u>\$2,693,000</u>	<u>\$3,253,750</u>	<u>\$4,113,500</u>

This analysis does not indicate or review whether obtaining this required take rate is realistic; rather, it reflects the take rate necessary to maintain a positive cash flow, considering all other assumptions in the model. The complete model is provided in Appendix D.

Please note that we used a “flat model” in the analysis. With a “flat model,” inflation and salary cost increases are not used in the analysis because it is assumed that operating cost increases will be offset and passed on to subscribers in the form of increased prices. Models that add an inflation factor to both revenues and expenses can greatly overstate net revenues in the out-years since net revenues would then also increase by the same inflation factor.

7.3.1 Financing Costs and Operating Expenses

This financial analysis assumes a combination of bonds and loans will be necessary. We expect that the City will seek 20-year bonds with principal repayments starting the year after issuance.

We project that the bond issuance costs will be equal to 1.0 percent of the principal borrowed. For the bond, a debt service reserve account is maintained at 5.0 percent of the total issuance amount. An interest reserve account equal to years one and two interest expense is maintained for the first two years.

Our analysis estimates total bonding requirements to be \$12.6 million and are issued at a 5 percent interest rate.

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

Table 23 shows operating expenses for years one, five, 10, 15, and 20. As seen, some expenses will remain constant while others will increase as the network matures and the customer base increases.

Table 23: Operating Expenses in Years 1, 5, 10, 15, and 20 – Wholesale Model

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Support Services	\$ -	\$ -	\$ -	\$ -	\$ -
Insurance	25,000	50,000	50,000	50,000	50,000
Utilities	-	-	-	-	-
Office Expenses	6,000	6,000	6,000	6,000	6,000
Facility Lease	-	-	-	-	-
Locates & Ticket Processing	8,000	31,000	31,000	31,000	31,000
Peering	-	-	-	-	-
Contingency	10,000	25,000	25,000	25,000	25,000
Billing Maintenance Contract	10,000	20,000	20,000	20,000	20,000
Fiber & Network Maintenance	16,000	55,000	55,000	55,000	55,000
Vendor Maintenance Contracts	-	83,000	83,000	83,000	83,000
Legal and Lobby Fees	50,000	10,000	10,000	10,000	10,000
Planning	-	-	-	-	-
Consulting	50,000	10,000	10,000	10,000	10,000
Marketing	30,000	15,000	15,000	15,000	15,000
Education and Training	7,000	11,000	11,000	11,000	11,000
Customer Handholding	-	-	-	-	-
Customer Billing (Unit)	-	5,000	5,000	5,000	5,000
Allowance for Bad Debts	-	-	-	-	-
Churn (acquisition costs)	-	-	-	-	-
Pole Attachment Expense	-	-	-	-	-
Internet	<u>30,000</u>	<u>41,000</u>	<u>41,000</u>	<u>41,000</u>	<u>41,000</u>
Sub-Total	\$242,000	\$362,000	\$362,000	\$362,000	\$362,000
Labor Expenses	<u>\$330,750</u>	<u>\$572,250</u>	<u>\$572,250</u>	<u>\$572,250</u>	<u>\$572,250</u>
Sub-Total	\$330,750	\$572,250	\$572,250	\$572,250	\$572,250
Total Expenses	\$572,750	\$934,250	\$934,250	\$934,250	\$934,250

Table 24 shows the income statement for years one, five, 10, 15, and 20.

Table 24: Income Statement – Wholesale Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Internet - Business	\$207,000	\$2,460,000	\$2,460,000	\$2,460,000	\$2,460,000
Connection Fee (net)	64,000	-	-	-	-
Per Passing	-	-	-	-	-
Per Customer	-	-	-	-	-
Provider Fee	-	-	-	-	-
Assessments	-	-	-	-	-
Ancillary Revenues	-	-	-	-	-
Total	\$271,000	\$2,460,000	\$2,460,000	\$2,460,000	\$2,460,000
b. Content Fees					
Internet	\$30,000	\$41,000	\$41,000	\$41,000	\$41,000
Total	\$30,000	\$41,000	\$41,000	\$41,000	\$41,000
c. Operating Costs					
Operation Costs	\$212,000	\$321,000	\$321,000	\$321,000	\$321,000
Labor Costs	330,750	572,250	572,250	572,250	572,250
Total	\$542,750	\$893,250	\$893,250	\$893,250	\$893,250
d. EBITDA	\$(301,750)	\$1,525,750	\$1,525,750	\$1,525,750	\$1,525,750
e. Depreciation	233,000	1,253,000	623,000	616,000	616,000
f. Operating Income (EBITDA less Depreciation)	\$(534,750)	\$272,750	\$902,750	\$909,750	\$909,750
g. Non-Operating Income					
Interest Income	\$ -	\$4,000	\$4,000	\$2,000	\$1,000
Interest Expense (10 Year Bond)	-	-	-	-	-
Interest Expense (20 Year Bond)	(175,000)	(593,000)	(469,000)	(310,000)	(108,000)
Interest Expense (Loan)	-	-	-	-	-
Total	\$(175,000)	\$(465,000)	\$(465,000)	\$(308,000)	\$(107,000)
h. Net Income (before taxes)	\$(709,750)	\$(316,250)	\$437,750	\$601,750	\$802,750
i. Facility Taxes	\$ -	\$ -	\$ -	\$ -	\$ -
j. Net Income	\$(709,750)	\$(316,250)	\$437,750	\$601,750	\$802,750

Table 25 shows the cash flow statement for years one, five, 10, 15, and 20.

Table 25: Cash Flow Statement – Wholesale Model

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Net Income	\$ (709,750)	\$ (316,250)	\$437,750	\$601,750	\$802,750
b. Cash Outflows					
Debt Service Reserve	\$ (175,000)	\$ -	\$ -	\$ -	\$ -
Interest Reserve	(350,000)	-	-	-	-
Depreciation Reserve	-	(439,000)	(218,000)	(216,000)	(216,000)
Financing	(35,000)	-	-	-	-
Capital Expenditures	<u>(2,583,000)</u>	-	-	-	-
Total	\$ (3,143,000)	\$ (439,000)	\$ (218,000)	\$ (216,000)	\$ (216,000)
c. Cash Inflows					
Interest Reserve	\$175,000	\$105,000	\$ -	\$ -	\$ -
Depreciation Reserve	-	-	-	-	-
Investment Capital	-	-	-	-	-
Start Up Funds	-	-	-	-	-
Grants (infrastructure)	-	-	-	-	-
Grants (customer premises)	-	-	-	-	-
10-Year Bond/Loan Proceeds	-	-	-	-	-
20-Year Bond Proceeds	3,500,000	-	-	-	-
Loan Proceeds	-	-	-	-	-
Total	\$3,675,000	\$105,000	\$ -	\$ -	\$ -
d. Total Cash Outflows and Inflows	\$532,000	\$ (334,000)	\$ (218,000)	\$ (216,000)	\$ (216,000)
e. Non-Cash Expenses - Depreciation	\$233,000	\$1,253,000	\$623,000	\$616,000	\$616,000
f. Adjustments					
Proceeds from Additional Cash Flows (10 Year Bond)	\$ -	\$ -	\$ -	\$ -	\$ -
Proceeds from Additional Cash Flows (20 Year Bond)	\$ (3,500,000)	\$ -	\$ -	\$ -	\$ -
Proceeds from Additional Cash Flows (Loan)	\$ -	\$ -	\$ -	\$ -	\$ -
g. Adjusted Available Net Revenue	\$ (3,444,750)	\$602,750	\$842,750	\$1,001,750	\$1,202,750
h. Principal Payments on Debt					
10 Year Bond Principal	\$ -	\$ -	\$ -	\$ -	\$ -
20 Year Bond Principal	-	450,000	574,000	732,000	935,000
Loan Principal	-	-	-	-	-
Total	\$ -	\$450,000	\$574,000	\$732,000	\$935,000
j. Cash Balance					
Unrestricted Cash Balance	\$55,250	\$57,250	\$909,000	\$2,257,750	\$3,601,500
Depreciation Reserve	-	1,132,000	1,154,000	366,000	(118,000)
Interest Reserve	175,000	-	-	-	-
Debt Service Reserve	<u>175,000</u>	<u>630,000</u>	<u>630,000</u>	<u>630,000</u>	<u>630,000</u>
Total Cash Balance	\$405,250	\$1,819,250	\$2,693,000	\$3,253,750	\$4,113,500

Significant network expenses—known as “capital additions”—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building, implementing, and lighting a fiber network. Table 26 shows the capital additions costs in years one, two, and three, and the total for years one through three.

This analysis projects that the capital additions in year one will total approximately \$2.6 million. These costs will total approximately \$3.5 million in year two, \$1.8 million in year three, and \$2.6 million in year four. This totals just over \$10.5 million for total capital additions costs for years one through four.

Table 26: Capital Additions – Wholesale Model

Capital Additions	Year 1	Year 2	Year 3	Year 4
Network Equipment				
Core Network Equipment	\$380,000	\$ -	\$ -	\$ -
TBD	-	-	-	-
Additional Annual Capital	-	-	-	-
Total	\$380,000	\$ -	\$ -	\$ -
Outside Plant and Facilities				
Total Backbone and FTTP	\$1,635,000	\$2,726,000	\$1,090,000	\$ -
Additional Annual Capital	-	-	-	-
Total	\$1,635,000	\$2,726,000	\$1,090,000	\$ -
Last Mile and Customer Premises Equipment				
CPE (residential and small commercial)	\$91,000	\$182,000	\$182,000	\$638,000
CPE (medium commercial)	18,000	36,000	35,000	124,000
CPE (enterprise)	6,000	10,000	10,000	36,000
Average Drop Cost	263,000	525,000	523,000	1,836,000
Additional Annual Replacement Capital	-	-	-	-
Total	\$378,000	\$753,000	\$750,000	\$2,634,000
Miscellaneous Implementation Costs				
Splicing	\$ -	\$ -	\$ -	\$ -
Vehicles	50,000	-	-	-
Emergency Restoration Kit	50,000	-	-	-
Work Station, Computers, and Software	5,000	4,000	-	2,000
Fiber OTDR and Other Tools	85,000	-	-	-
Generators & UPS	-	-	-	-
OSS	-	-	-	-
Additional Annual Capital	-	-	-	-
Total	\$190,000	\$4,000	\$ -	\$2,000
Replacement Costs for Depreciation				
Network Equipment	\$ -	\$ -	\$ -	\$ -
Customer Premises Equipment	-	-	-	-
Miscellaneous Implementation Costs	-	-	-	-
Total	\$ -	\$ -	\$ -	\$ -
Total Capital Additions	\$2,583,000	\$3,483,000	\$1,840,000	\$2,636,000

7.3.2 Operating and Maintenance Expenses

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

- Expand office facilities for management, technical and clerical staff

- Provide warehousing for receipt and storage of cable and hardware for the installation and on-going maintenance of the broadband infrastructure
- Establish location to house servers, switches, routers, and other core-network equipment

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

The expanded business and increased responsibilities will require the addition of new staff. Even in the wholesale service model - marketing and sales are critical. It is important to be proactive in setting expectations, addressing security concerns, and educating the ISPs on how to initiate services.

The initial additional positions, staffing levels, and base salaries are shown in Table 27. Please note that, in the financial model, a 40 percent overhead is added to the salaries listed below.

Table 27: Labor Expenses – Wholesale Model

	Year 1	Year 2	Year 3	Year 4	Year 5+	Labor Cost
New Employees						
Business Manager	0.50	1.00	1.00	1.00	1.00	130,000
GIS	0.50	1.00	1.00	1.00	1.00	80,000
Communications - Sales	0.25	0.25	0.25	0.25	0.25	75,000
Customer Service Representative	-	-	-	-	-	65,000
Service Technicians/Installers & IT Support	1.00	1.00	1.00	2.00	2.00	90,000
Fiber Plant O&M Technicians	0.25	1.00	1.00	1.00	1.00	90,000
Total New Staff	2.5	4.25	4.25	5.25	5.25	

7.3.3 Summary of Operating and Maintenance Expenses

Additional key operating and maintenance assumptions include:

- Salaries and benefits are based on estimated market wages. See Table 27 for a list of staffing requirements. Benefits are estimated at 40 percent of base salary.
- Insurance is estimated to be \$25,000 in year one and \$50,000 from year two on.
- Office expense allocations are estimated to be \$6,000 per year
- Locates and ticket processing are estimated to start in year one at \$8,000, increase to \$15,000 in year two, and increase to \$31,000 from year three on.
- Contingency is estimated to be \$10,000 in year one and \$25,000 from year two on.
- Billing and maintenance contract fees are estimated at \$10,000 in year one, and \$20,000 from year two on.
- Legal fees are estimated to be \$50,000 in year one, and \$10,000 from year two on.

- Consulting fees are estimated at \$50,000 in year one, and \$10,000 from year three on.
- Marketing and promotional expenses are estimated to be \$30,000 in year one, and \$15,000 from year two on.

Vendor maintenance contract fees are expected to start at \$43,000 in year two, \$52,000 in year three, and \$83,000 year four on. Annual variable and operating expenses not including direct Internet access include:

- Education and training are calculated as 2 percent of direct payroll expense.
- Customer billing is estimated to be \$0.25 per bill per month.

Fiber network maintenance costs are calculated at 1 percent of the total construction cost, per year. This is estimated based on a typical rate of occurrence in an urban environment, and the cost of individual repairs. This is in addition to staffing costs to maintain fiber.

Internet and peering is estimated at \$1.25 per Mbps per month for the first 2 Gbps and \$1.00 per Mbps per month thereafter.

7.3.4 Take-Rate Sensitivity

This section shows the large impact that fluctuations in take rate can have on financial modeling. In the following tables, we show the financial projections for take rates of 50 percent, 40 percent, and 30 percent.

As discussed in the retail model, obtaining a 60 percent take rate is considered aggressive, and will likely be difficult to obtain and maintain. Realistically, we would expect a 35 percent to 45 percent take rate.

Table 28, below, shows financial projections for a 50 percent take rate. While projections for year one are identical to our base case scenario of 60 percent (seen in Table 22, above), the City's unrestricted cash balance shows a loss of approximately \$641,000 by year five, and this continues to increase. By year 20, the unrestricted cash balance shows a loss of approximately \$1.6 million. This is a \$5.2 million difference between the base case scenario with a 60 percent take rate and a scenario with a 50 percent take rate.

Table 28: Take Rate Reduced to 50 Percent – Wholesale Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$271,000	\$2,053,000	\$2,053,000	\$2,053,000	\$2,053,000
Total Cash Expenses	(572,750)	(918,250)	(918,250)	(918,250)	(918,250)
Depreciation	(233,000)	(1,102,000)	(578,000)	(570,000)	(570,000)
Interest Expense	(175,000)	(549,000)	(432,000)	(284,000)	(94,000)
Taxes	-	-	-	-	-
Net Income	\$ (709,750)	\$ (516,250)	\$124,750	\$280,750	\$470,750

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$55,250	\$ (640,750)	\$ (1,226,000)	\$ (1,422,250)	\$ (1,621,500)
Depreciation Reserve	-	1,026,000	1,087,000	447,000	111,000
Interest Reserve	175,000	-	-	-	-
Debt Service Reserve	175,000	590,000	590,000	590,000	590,000
Total Cash Balance	\$405,250	\$975,250	\$451,000	\$ (385,250)	\$ (920,500)

As take rate continues to decrease, financial projections follow suit. As shown in Table 29, below, unrestricted cash balance for a take rate of 40 percent falls to a deficit of nearly \$1.5 million by year five. This negative balance continues to grow to over \$7 million by year 20. Further, with a take rate of 40 percent, the City would not generate a positive net income until year 20.

Compared to the base model, a 40 percent take rate will dramatically affect unrestricted cash balance, result in a nearly \$1.5 million difference by year five, and an over \$10.5 million difference by year 20.

Table 29: Take Rate Reduced to 40 Percent – Wholesale Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$271,000	\$1,632,000	\$1,632,000	\$1,632,000	\$1,632,000
Total Cash Expenses	(572,750)	(903,250)	(903,250)	(903,250)	(903,250)
Depreciation	(233,000)	(952,000)	(532,000)	(524,000)	(524,000)
Interest Expense	(175,000)	(504,000)	(395,000)	(257,000)	(81,000)
Taxes	-	-	-	-	-
Net Income	\$ (709,750)	\$ (727,250)	\$ (198,250)	\$ (52,250)	\$ 123,750

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$55,250	\$ (1,447,750)	\$ (3,501,000)	\$ (5,268,250)	\$ (7,039,500)
Depreciation Reserve	-	920,000	1,020,000	525,000	334,000
Interest Reserve	175,000	-	-	-	-
Debt Service Reserve	175,000	545,000	545,000	545,000	545,000
Total Cash Balance	\$405,250	\$17,250	\$ (1,936,000)	\$ (4,198,250)	\$ (6,160,500)

Table 30 shows our lowest projected take rate of 30 percent. In this model, the unrestricted cash balance is a deficit of over \$2 million by year five, and the deficit continues to grow to over \$12

million by year twenty. In this model, the City is unable to generate a positive net income over the course of 20 years.

In comparison to our base model of a 60 percent take rate, the difference in unrestricted cash balance by year five is over \$2.2 million, and nearly \$16 million by year 20.

Table 30: Take Rate Reduced to 30 Percent – Wholesale Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$271,000	\$1,226,000	\$1,226,000	\$1,226,000	\$1,226,000
Total Cash Expenses	(572,750)	(893,250)	(893,250)	(893,250)	(893,250)
Depreciation	(233,000)	(801,000)	(486,000)	(479,000)	(479,000)
Interest Expense	(175,000)	(465,000)	(362,000)	(234,000)	(68,000)
Taxes	-	-	-	-	-
Net Income	\$ (709,750)	\$ (933,250)	\$ (515,250)	\$ (380,250)	\$ (214,250)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$55,250	\$ (2,155,750)	\$ (5,671,000)	\$ (9,014,250)	\$ (12,358,500)
Depreciation Reserve	-	814,000	952,000	610,000	572,000
Interest Reserve	175,000	-	-	-	-
Debt Service Reserve	175,000	505,000	505,000	505,000	505,000
Total Cash Balance	\$405,250	\$ (836,750)	\$ (4,214,000)	\$ (7,899,250)	\$ (11,281,500)

7.4 Dark Fiber Model Financial Analysis

The financial analysis for all scenarios presented here represents a minimum requirement for the City to break even each year, excluding any potential revenue from other dark fiber lease opportunities that may be available to the City.

The base case scenario assumes that the City’s private partner will pay a fee of \$40 per passing per month, with no upfront or balloon payments. Based on an assumption that the City will deploy an FTTP network in the identified business area, the financial model applies the fee to all business premises in the identified service area. The current model keeps constant the \$40 per passing fee, though the City and its partner could negotiate periodic increases.

Please note there is no market data or examples of the dark fiber model with a business focus. For example, in its agreement with Huntsville Utilities in Huntsville, Alabama, Google Fiber pays under \$10 per month per passing, but this is for residences only—no businesses are included. The per-passing fee is the largest “risk” in the model and could be tested with the recommended RFI.

Further, the \$40 fee is based on a full recovery of capital and expenses. The FTTP deployment is likely to have additional economic development and other benefits that are not easily measured.

In recognition of these benefits, the City could choose to provide funding to the proposed enterprise that would lower the required per passing fee.

The financial analysis for the base case scenario is as follows:

Table 31: Base Case Financial Analysis – Dark Fiber Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$6,140	\$1,226,880	\$1,226,880	\$1,226,880	\$1,226,880
Total Cash Expenses	(373,750)	(549,250)	(549,250)	(549,250)	(549,250)
Depreciation	(119,000)	(311,000)	(311,000)	(311,000)	(311,000)
Interest Expense	(130,000)	(351,000)	(275,000)	(176,000)	(51,000)
Taxes	-	-	-	-	-
Net Income	\$ (616,610)	\$15,630	\$91,630	\$190,630	\$315,630

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (6,610)	\$10,340	\$25,490	\$40,640	\$56,790
Depreciation Reserve	-	141,000	185,000	229,000	273,000
Interest Reserve	130,000	-	-	-	-
Debt Service Reserve	<u>130,000</u>	<u>380,000</u>	<u>380,000</u>	<u>380,000</u>	<u>380,000</u>
Total Cash Balance	\$253,390	\$531,340	\$590,490	\$649,640	\$709,790

Please note that we used a “flat model” in the analysis, which means that inflation and operating cost increases (including salaries) are not used because it is assumed that operating cost increases will be offset by increases in operator lease payments over time (and likely passed on to subscribers in the form of increased prices). We anticipate that the City will apply an inflation factor, typically based on a Consumer Price Index (CPI), to the portion of the per-subscriber fee that covers projected operating expenses during negotiations with a private partner. Please note that it is not appropriate to apply a CPI to the entire passing fee because most of the fee is to support the principal and interest on the debt service.

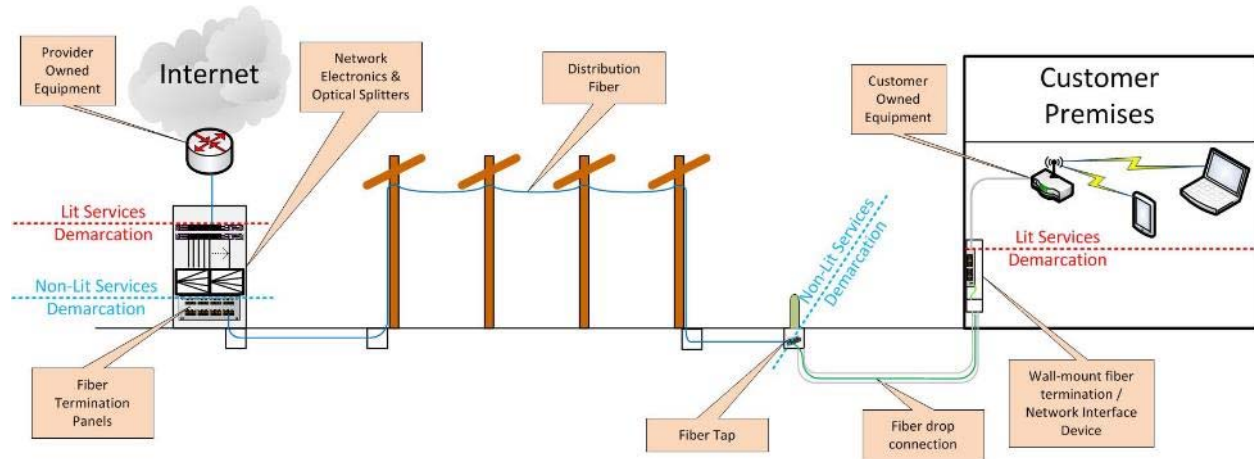
This document presents an overview of the financial model; we have provided the City with a complete financial model in Excel format. Because the Excel spreadsheets can be manipulated to show the impact of changing assumptions it will be an important tool for the City to use as it negotiates with a private partner.

This analysis does not contain any potential revenue from wireless ISPs that are looking for connectivity to wireless access points. A wireless ISP could leverage the FTTP infrastructure and avoid drop costs and investment in the electronics for the FTTP network. The use of the fiber is dependent upon the wireless technologies implemented by the wireless ISP.

7.4.1 Cost Implications of the Dark Fiber Model

The financial analysis in this section assumes that the City constructs and owns the FTTP infrastructure up to a demarcation point at the optical tap near each residence and business, and leases the dark fiber backbone and distribution fiber to a private partner. The private partner would be responsible for all network electronics, fiber drops to subscribers, and CPEs—as well as network sales, marketing, and operations.

Figure 11: Demarcation Between City and Partner Network Elements



Using 100 percent underground construction, the dark FTTP network deployment for the business park will cost approximately \$5.5 million, including OSP construction labor, materials, engineering, permitting, and pole attachment licensing. This estimate does not include and electronics, subscriber equipment, or drops.

Table 32: Breakdown of Estimated Dark Fiber Model Cost (aerial and underground construction)

Cost Component	Total Estimated Cost
OSP Engineering	\$519,000
Quality Control/Quality Assurance	192,000
General OSP Construction Cost	3,158,000
Special Crossings	703,000
Backbone and Distribution Plant Splicing	139,000
Backbone Hub, Termination, and Testing	475,000
FTTP Lateral Installations	265,000
Total Estimated Cost:	\$5,451,000

The above estimates assume that the City constructs and owns the FTTP infrastructure up to a demarcation point at the optical tap near each business, and leases the dark fiber backbone and distribution fiber to a private partner. The private partner would be responsible for all network electronics, fiber drops to subscribers, and CPEs—as well as network sales, marketing, and operations.

The ownership of the drops is an assumption that could be changed through negotiation with a private partner—as, indeed, could many of the assumptions underpinning this analysis. We have chosen this key parameter for the base case scenario because we believe this approach presents a reasonable balance of costs, control, and risk for the City. (City ownership of the drops, for example, would increase the City's control, but also significantly increase the City's costs.)

In a related vein, we note that some network operators suggest that the network's optical splitters should be a part of the Layer 1 or dark fiber assets. We caution against this approach. The network operator (i.e., the City's partner) should maintain the splitters because, as operator of the electronics, it must determine and control the GPON network split ratio to meet the network's performance standards. This may involve moving power users to GPON ports with lower split ratios, or moving users to different splitters to manage the capacity of the GPON ports. The City should not be involved in this level of network management. Also, the City should not have to inventory various sized splitters or swap them as the network operator makes changes. Even if the City were to decide to purchase some of the optical splitters for the network, we believe it should be the network operator's responsibility to manage and maintain the splitters.

7.4.2 Financing Costs and Operating Expenses

For the base financial analysis, we used the OSP costs for a combination aerial and underground construction. In the scenarios, we show the impact of the increased costs for an all-underground deployment.

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

We expect that the City will take three 20-year bonds—one each in years one, two, and three—for a total of \$7.6 million in financing. (The difference between the financed amount and the total capital costs represents the amount needed to maintain positive cash flow in the early years of network deployment.) The resulting principal and interest (P&I) payments will be the major factor in determining the City's long-term financial requirements; P&I accounts for about 53 percent of the City's annual costs in our base case model after the construction period.

We project that the bond issuance costs will be equal to 1.0 percent of the principal borrowed. For the bond, a debt service reserve account is maintained at 5.0 percent of the total issuance

amount. An interest reserve account will be maintained for the first two years. Principal repayment on the bonds will start in year two.

The model assumes a straight-line depreciation of assets, and that the OSP and materials will have a 20-year life span. Because we assume the City's partner will be responsible for network electronics and CPE, we have not included depreciation or replacement costs for that equipment (although we note that, typically, network equipment would be replaced after 10 years, while CPE and last-mile infrastructure would be depreciated over five years). The model plans for a depreciation reserve account starting in year three to fund future replacements and upgrades.

Table 33 shows the income statement for years one, five, 10, 15, and 20.

Table 33: Income Statement – Dark Fiber Model

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Revenues					
Internet - Business	\$ -	\$ -	\$ -	\$ -	\$ -
Connection Fee (net)	-	-	-	-	-
Per Passing	6,140	1,226,880	1,226,880	1,226,880	1,226,880
Per Customer	-	-	-	-	-
Provider Fee	-	-	-	-	-
Assessments	-	-	-	-	-
Ancillary Revenues	-	-	-	-	-
Total	\$ 6,140	\$ 1,226,880	\$ 1,226,880	\$ 1,226,880	\$ 1,226,880
b. Content Fees					
Internet	\$ -	\$ -	\$ -	\$ -	\$ -
Total	\$ -	\$ -	\$ -	\$ -	\$ -
c. Operating Costs					
Operation Costs	\$169,000	\$194,000	\$194,000	\$194,000	\$194,000
Labor Costs	204,750	355,250	355,250	355,250	355,250
Total	\$373,750	\$549,250	\$549,250	\$549,250	\$549,250
d. EBITDA	\$ (367,610)	\$ 677,630	\$ 677,630	\$ 677,630	\$ 677,630
e. Depreciation	119,000	311,000	311,000	311,000	311,000
f. Operating Income (EBITDA less Depreciation)	\$ (486,610)	\$366,630	\$366,630	\$366,630	\$366,630
g. Non-Operating Income					
Interest Income	\$ -	\$1,000	\$1,000	\$2,000	\$2,000
Interest Expense (10 Year Bond)	-	-	-	-	-
Interest Expense (20 Year Bond)	(130,000)	(352,000)	(276,000)	(178,000)	(53,000)
Interest Expense (Loan)	-	-	-	-	-
Total	\$ (130,000)	\$ (275,000)	\$ (275,000)	\$ (176,000)	\$ (51,000)
h. Net Income (before taxes)	\$ (616,610)	\$15,630	\$91,630	\$190,630	\$315,630
i. Facility Taxes	\$ -	\$ -	\$ -	\$ -	\$ -
j. Net Income	\$ (616,610)	\$15,630	\$91,630	\$190,630	\$315,630

Table 34 shows the cash flow statement for years one, five, 10, 15, and 20.

Table 34: Cash Flow Statement – Dark Fiber Model

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
a. Net Income	\$ (616,610)	\$15,630	\$91,630	\$190,630	\$315,630
b. Cash Outflows					
Debt Service Reserve	\$ (130,000)	\$ -	\$ -	\$ -	\$ -
Interest Reserve	(260,000)	-	-	-	-
Depreciation Reserve	-	(47,000)	(47,000)	(47,000)	(47,000)
Financing	(26,000)	-	-	-	-
Capital Expenditures	(1,823,000)	-	-	-	-
Total	\$ (2,239,000)	\$ (47,000)	\$ (47,000)	\$ (47,000)	\$ (47,000)
c. Cash Inflows					
Interest Reserve	\$130,000	\$ -	\$ -	\$ -	\$ -
Depreciation Reserve	-	-	-	-	-
Investment Capital	-	-	-	-	-
Start Up Funds	-	-	-	-	-
Grants (infrastructure)	-	-	-	-	-
Grants (customer premises)	-	-	-	-	-
10-Year Bond/Loan Proceeds	-	-	-	-	-
20-Year Bond Proceeds	2,600,000	-	-	-	-
Loan Proceeds	-	-	-	-	-
Total	\$ 2,730,000	\$ -	\$ -	\$ -	\$ -
d. Total Cash Outflows and Inflows	\$491,000	\$ (47,000)	\$ (47,000)	\$ (47,000)	\$ (47,000)
e. Non-Cash Expenses - Depreciation	\$119,000	\$311,000	\$311,000	\$311,000	\$311,000
f. Adjustments					
Proceeds from Additional Cash Flows (10 Year Bond)	\$ -	\$ -	\$ -	\$ -	\$ -
Proceeds from Additional Cash Flows (20 Year Bond)	\$ (2,600,000)	\$ -	\$ -	\$ -	\$ -
Proceeds from Additional Cash Flows (Loan)	\$ -	\$ -	\$ -	\$ -	\$ -
g. Adjusted Available Net Revenue	\$ (2,606,610)	\$279,630	\$355,630	\$454,630	\$579,630
h. Principal Payments on Debt					
10 Year Bond Principal	\$ -	\$ -	\$ -	\$ -	\$ -
20 Year Bond Principal	-	277,000	353,000	451,000	576,000
Loan Principal	-	-	-	-	-
Total	\$ -	\$277,000	\$353,000	\$451,000	\$576,000

j. Cash Balance

Unrestricted Cash Balance	\$ (6,610)	\$10,340	\$25,490	\$40,640	\$56,790
Depreciation Reserve	-	141,000	185,000	229,000	273,000
Interest Reserve	130,000	-	-	-	-
Debt Service Reserve	<u>130,000</u>	<u>380,000</u>	<u>380,000</u>	<u>380,000</u>	<u>380,000</u>
Total Cash Balance	\$253,390	\$531,340	\$590,490	\$649,640	\$709,790

Significant network expenses—known as “capital additions”—are incurred in the first few years during the construction phase of the network. These represent the equipment and labor expenses associated with building a fiber network. (Again, because the City’s responsibility will be limited to OSP, we have not included any costs for core network equipment, drops, or CPE.) This analysis projects that the capital additions (including vehicles and test equipment) in year one will total approximately \$1.8 million. These costs will total approximately \$2.7 million in year two, and \$1.1 million in year three. This totals just over \$5.6 million in capital additions for years one through three.

Table 35 – Capital Additions – Dark Fiber Model

Capital Additions	Year 1	Year 2	Year 3
Network Equipment			
Core Network Equipment	\$ -	\$ -	\$ -
TBD	-	-	-
Additional Annual Capital	-	-	-
Total	\$ -	\$ -	\$ -
Outside Plant and Facilities			
Total Backbone and FTTP	\$1,635,000	\$2,726,000	\$1,090,000
Additional Annual Capital	-	-	-
Total	\$1,635,000	\$2,726,000	\$1,090,000
Last Mile and Customer Premises Equipment			
CPE (residential and small commercial)	\$ -	\$ -	\$ -
CPE (medium commercial)	-	-	-
CPE (enterprise)	-	-	-
Average Drop Cost	-	-	-
Additional Annual Replacement Capital	-	-	-
Total	\$ -	\$ -	\$ -
Miscellaneous Implementation Costs			
Splicing	\$ -	\$ -	\$ -
Vehicles	50,000	-	-
Emergency Restoration Kit	50,000	-	-
Work Station, Computers, and Software	3,000	3,000	-
Fiber OTDR and Other Tools	85,000	-	-
Generators & UPS	-	-	-
OSS	-	-	-
Additional Annual Capital	-	-	-
Total	\$188,000	\$3,000	\$ -
Replacement Costs for Depreciation			
Network Equipment	\$ -	\$ -	\$ -
Customer Premises Equipment	-	-	-
Miscellaneous Implementation Costs	-	-	-
Total	\$ -	\$ -	\$ -
Total Capital Additions	\$1,823,000	\$2,729,000	\$1,090,000

7.4.3 Operating and Maintenance Expenses

The cost to deploy an FTTP network goes far beyond fiber implementation. Network deployment requires network maintenance and technical operations, and other functions. In this model, we assume that the City's partner will be responsible for lighting the fiber and selling services, so the City's financial requirements are limited to expenses related to OSP infrastructure and network administration.

These expanded responsibilities will require the addition of new staff. We assume the City will add a total of three and three-quarters full-time-equivalent (FTE) positions within the first three years, and will then maintain that level of staffing. Our assumptions include one-half FTE for management, one FTE for GIS, one-quarter FTE for communication support, and one FTE for fiber plant maintenance and operations. Salaries and benefits are based on estimated market wages, and benefits are estimated at 40 percent of base salary.

Some of these responsibilities can be contracted out, while some can be absorbed into existing positions within the City. Each City's circumstances is unique, and the skill sets that exist within an organization will inform to what degree responsibilities must be contracted out. We encourage the City to train internal staff for all record-keeping responsibilities—particularly network details such as fiber strand usage and locations. We cannot overstate the importance of keeping meticulous records on the fiber to maintain the long-term integrity of the network, and keeping this function in-house gives the City the greatest degree of control over these records' accuracy.

Locates and ticket processing will be significant ongoing operational expenses for the City. Based on our experience in other cities, we estimate that a contract for locates will cost \$8,000 in year one, increase to \$15,000 in year two, and increase to \$31,000 from year three on. (If the City decides to perform this work in-house, the contract expense would be eliminated—but staffing expenses would increase.)

Additional key operating and maintenance assumptions include the following:

- Insurance is estimated to be \$25,000 in year one and \$50,000 from year two on.
- Office expenses are estimated to be \$2,400 annually.
- Contingency expenses are estimated at \$10,000 in year one and \$25,000 in subsequent years.
- Legal fees are estimated to be \$50,000 in year one and \$10,000 from year two on.
- Consulting fees are estimated at \$50,000 in year one and \$10,000 from year two on.

Fiber network maintenance costs are calculated at one percent of the total construction cost, per year. This is estimated based on a typical rate of occurrence in an urban environment, and the cost of individual repairs. This is in addition to staffing costs to maintain the fiber.

Table 36 lists the City's projected operating expenses for years one, five, 10, 15, and 20.

Table 36: Operating Expenses Dark Fiber Model

Operating Expenses	Year 1	Year 5	Year 10	Year 15	Year 20
Support Services	\$ -	\$ -	\$ -	\$ -	\$ -
Insurance	25,000	50,000	50,000	50,000	50,000
Utilities	-	-	-	-	-
Office Expenses	6,000	6,000	6,000	6,000	6,000
Facility Lease	-	-	-	-	-
Locates & Ticket Processing	8,000	31,000	31,000	31,000	31,000
Peering	-	-	-	-	-
Contingency	10,000	25,000	25,000	25,000	25,000
Billing Maintenance Contract	-	-	-	-	-
Fiber & Network Maintenance	16,000	55,000	55,000	55,000	55,000
Vendor Maintenance Contracts	-	-	-	-	-
Legal and Lobby Fees	50,000	10,000	10,000	10,000	10,000
Planning	-	-	-	-	-
Consulting	50,000	10,000	10,000	10,000	10,000
Marketing	-	-	-	-	-
Education and Training	4,000	7,000	7,000	7,000	7,000
Customer Handholding	-	-	-	-	-
Customer Billing (Unit)	-	-	-	-	-
Allowance for Bad Debts	-	-	-	-	-
Churn (acquisition costs)	-	-	-	-	-
Pole Attachment Expense	-	-	-	-	-
Internet	-	-	-	-	-
Sub-Total	\$169,000	\$194,000	\$194,000	\$194,000	\$194,000
Labor Expenses	<u>\$204,750</u>	<u>\$355,250</u>	<u>\$355,250</u>	<u>\$355,250</u>	<u>\$355,250</u>
Sub-Total	<u>\$204,750</u>	<u>\$355,250</u>	<u>\$355,250</u>	<u>\$355,250</u>	<u>\$355,250</u>
Total Expenses	<u>\$373,750</u>	<u>\$549,250</u>	<u>\$549,250</u>	<u>\$549,250</u>	<u>\$549,250</u>

7.4.4 Revenue

The base case scenario assumes that the City's private partner will pay a fee of \$40 per passing per month, with no upfront or balloon payments. Based on an assumption that the City will deploy a ubiquitous FTTP network in the business park. The financial model applies the fee to all business premises in the business park. The current model keeps that \$40 per passing fee constant, although the City and its partner could negotiate periodic increases.

Operating and maintenance expenses account for approximately 47 percent of the City's total annual costs. (P&I payment on debt is the remaining amount.) At a minimum, 47-percent of the per-passing fee should be increased by a CPI each year.

In the scenarios below, we show the sensitivity of the monthly fee.

7.4.5 Dark Fiber Fee Sensitivity

This section demonstrates the sensitivity of the financial projections to changes in per passing fee. We show the financial projects for fees at \$35, \$30, and \$25 per passing per month.

Table 37, below, shows financial analysis for a \$35 per month passing fee. In this model, the unrestricted cash balance shows a loss of approximately \$435,000 by year five, and more than \$2.6 million by year 20.

Compared to our base model of a \$40 per-month passing fee, the decreased fee results in an unrestricted cash balance difference of \$760 at year one, growing to an approximately \$445,000 difference by year 5, and ultimately a difference of over \$2.7 million by year 20.

Table 37: Dark Fiber Model Financial Analysis - \$35 Per Month Passing Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$5,380	\$1,073,520	\$1,073,520	\$1,073,520	\$1,073,520
Total Cash Expenses	(373,750)	(549,250)	(549,250)	(549,250)	(549,250)
Depreciation	(119,000)	(311,000)	(311,000)	(311,000)	(311,000)
Interest Expense	(130,000)	(351,000)	(275,000)	(176,000)	(51,000)
Taxes	-	-	-	-	-
Net Income	\$ (617,370)	\$ (137,730)	\$ (61,730)	\$37,270	\$162,270

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (7,370)	\$ (435,160)	\$ (1,186,810)	\$ (1,938,460)	\$ (2,689,110)
Depreciation Reserve	-	141,000	185,000	229,000	273,000
Interest Reserve	130,000	-	-	-	-
Debt Service Reserve	<u>130,000</u>	<u>380,000</u>	<u>380,000</u>	<u>380,000</u>	<u>380,000</u>
Total Cash Balance	\$252,630	\$85,840	\$ (621,810)	\$ (1,329,460)	\$ (2,036,110)

As the per-passing fee decreases, unrestricted cash balance and net income also decrease.

Table 38, below, shows financial projections for a \$30 per month passing fee. Were the City to charge this fee, we project an unrestricted cash balance deficit of \$8,140 at year one, and that deficit increasing to over \$5 million by year 20.

In comparison to our base model of a \$40 per month passing fee, a \$30 fee results in an unrestricted cash balance difference of \$1,530 at year 1, growing to a difference of nearly \$5.5 million by year 20.

Table 38: Dark Fiber Model Financial Analysis - \$30 Per Month Passing Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$4,610	\$920,160	\$920,160	\$920,160	\$920,160
Total Cash Expenses	(373,750)	(549,250)	(549,250)	(549,250)	(549,250)
Depreciation	(119,000)	(311,000)	(311,000)	(311,000)	(311,000)
Interest Expense	(130,000)	(351,000)	(275,000)	(176,000)	(51,000)
Taxes	-	-	-	-	-
Net Income	\$ (618,140)	\$ (291,090)	\$ (215,090)	\$ (116,090)	\$ 8,910

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (8,140)	\$ (880,680)	\$ (2,399,130)	\$ (3,917,580)	\$ (5,435,030)
Depreciation Reserve	-	141,000	185,000	229,000	273,000
Interest Reserve	130,000	-	-	-	-
Debt Service Reserve	130,000	380,000	380,000	380,000	380,000
Total Cash Balance	\$251,860	\$ (359,680)	\$ (1,834,130)	\$ (3,308,580)	\$ (4,782,030)

Table 39, below, shows our projections for the lowest passing fee of \$25 per month. In this projection, the unrestricted cash balance begins as a deficit of \$8,910, with that deficit growing to \$8.1 million by year twenty. Further, this per-passing fee is unable to generate positive net income over the twenty-year projection.

In comparison to our base model, a \$25 per month passing fee results in a difference of \$2,300 at year one, \$1.3 million difference by year five, and ultimately an \$8.2 million difference by year 20.

Table 39: Dark Fiber Model Financial Analysis - \$25 Per Month Passing Fee

Income Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Total Revenues	\$3,840	\$766,800	\$766,800	\$766,800	\$766,800
Total Cash Expenses	(373,750)	(549,250)	(549,250)	(549,250)	(549,250)
Depreciation	(119,000)	(311,000)	(311,000)	(311,000)	(311,000)
Interest Expense	(130,000)	(351,000)	(275,000)	(176,000)	(51,000)
Taxes	-	-	-	-	-
Net Income	\$ (618,910)	\$ (444,450)	\$ (368,450)	\$ (269,450)	\$ (144,450)

Cash Flow Statement	Year 1	Year 5	Year 10	Year 15	Year 20
Unrestricted Cash Balance	\$ (8,910)	\$ (1,326,190)	\$ (3,611,440)	\$ (5,896,690)	\$ (8,180,940)
Depreciation Reserve	-	141,000	185,000	229,000	273,000
Interest Reserve	130,000	-	-	-	-
Debt Service Reserve	130,000	380,000	380,000	380,000	380,000
Total Cash Balance	\$251,090	\$ (805,190)	\$ (3,046,440)	\$ (5,287,690)	\$ (7,527,940)

Appendix A: Glossary of Terms

The descriptions in our FTTP design and cost estimate analysis are highly technical and make use of several acronyms that can be confusing, especially to a non-technical audience. While we try to define each acronym the first time it appears in the text, we also believe that a glossary can be a useful tool to navigate this document. This section outlines most of the acronyms that appear in this analysis.

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

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

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

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

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

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

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

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

Hub – At the hub, optical splitting is used to distribute network services deeper into the community, enabling eventual FTTP connections.

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

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

MDU – Multi-dwelling unit (i.e., an apartment or office building).

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

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

OSS – Operational Support Systems (OSS); includes a provider’s provisioning platforms, fault and performance management systems, remote access, and other operational support systems for FTTP operations. OSS is housed in a network’s core locations.

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

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

Peering – An interconnection between two service providers, or a service provider and an application provider (Netflix, Dropbox, etc.) to facilitate faster, less-expensive connections.

PON – Passive optical network; uses passive optical splitting, which is performed inside FDCs, to connect fiber from the OLTs to multiple customer premises over a single PON port.

POP – Point of presence; a physical location where network switches, routers, and servers are housed. POPs frequently offer appropriate power, cooling, and security resources for network equipment, peering (see above) and at times enable connections to multiple ISPs.

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

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

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

ROW – Right-of-way; land reserved for the public good such as utility construction. ROW typically abuts public roadways.

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

Appendix B: Assessment of Local Broadband Market

This Appendix is attached as a separate PDF file.

Appendix C: Retail Financial Model (spreadsheet)

This Appendix is attached as a separate Microsoft Excel file.

Appendix D: Wholesale Financial Model (spreadsheet)

This Appendix is attached as a separate Microsoft Excel file.

Appendix E: Dark Fiber Financial Model (spreadsheet)

This Appendix is attached as a separate Microsoft Excel file.

Appendix F: Online Business Survey Questions

This appendix is attached as a separate PDF file.

Appendix G: Online Business Survey Results

To understand the potential market demand for fiber connectivity and related services among Hayward businesses, CTC conducted an online survey in summer 2016. At a high level, the survey showed that the respondents that completed the questionnaire are not overwhelmingly unhappy with their current speeds, and that there is a modest willingness to switch to a higher-speed service—but only if the price point is \$75 per month or less.

Most of the businesses indicated that price, reliability, and speed are important factors for them to consider as their connectivity needs evolve and they become increasingly dependent on cloud-based business solutions to support their operations.

Survey Methodology

The survey was sent out via e-mail on behalf of the City to approximately 2,600 businesses in July 2016. An online survey mechanism enabled completion of the survey questionnaires over the Internet. The survey was designed to collect a range of data to understand businesses' current use of data and Internet services; satisfaction with current service providers; and interest in new, higher-speed data and Internet service offerings.

The survey's e-mail distribution list was culled from data purchased from InfoUSA on approximately 900 businesses located in Hayward, in conjunction with email lists provided by the City and Chamber of Commerce. CTC worked with City staff to develop a set of questions for Hayward businesses, which were then entered into a survey instrument on SurveyMonkey, an online tool that allows for customization, and provides granular output of responses in various formats for analysis. The survey questionnaire is attached to this report as Appendix C.

50 recipients opted out of the survey; 18 emails were returned as undeliverable; and 1,545 emails were unopened. Of the 1,006 potential respondents that opened the email, 183 clicked through. There were 156 total responses through the email collector, which included the original email we sent through SurveyMonkey.

In the weeks following the initial SurveyMonkey email notification, the City sent a follow-up email outside the SurveyMonkey system, which contained a web link for potential respondents to access the survey. There were 103 responses collected through the web link, for a total of 259 responses all together. Of the approximately 2,600 email recipients, there were 259 respondents that filled out at least some portion of the survey.

While there were 259 responses to the survey, not every respondent completed the full survey, as respondents were able to skip questions and answer questions only partially. We designed the survey in this way to encourage respondents to answer questions for which they had a response, while not forcing them to attempt to answer questions they do not believe are applicable to their

business. Although this does not produce statistically valid results, it can provide insight into the business community's connectivity needs, their willingness to switch to a new provider, and what role they believe the City should play in an FTTP deployment.

Further, a secondary purpose of the survey was to identify potential businesses that would be willing to further discuss their connectivity needs, and their potential willingness to purchase services from the City. The final questions in the survey prompted willing respondents to provide specific information about their contact information and their willingness to speak in greater detail with City representatives about their connectivity needs. While 77 respondents listed their business' specific address, only 41 respondents indicated a willingness to be contacted further. CTC was able to reach 24 businesses for follow-up discussions.

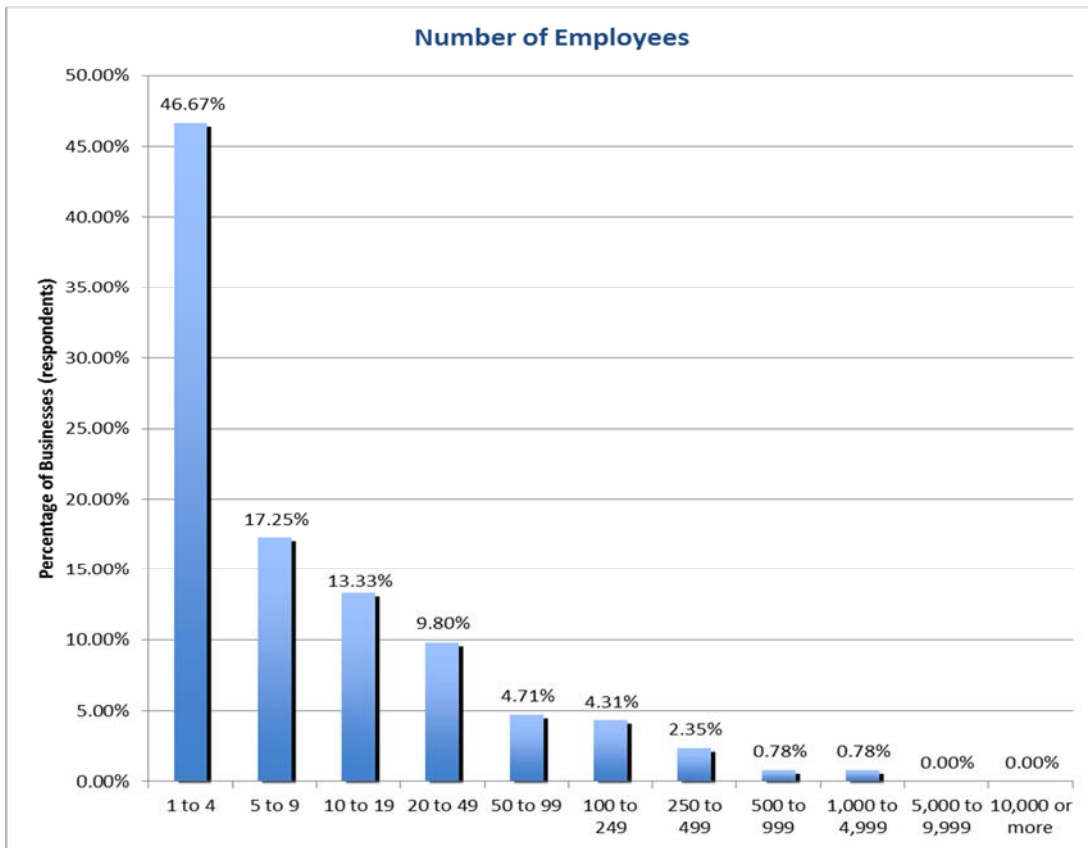
Online Survey Results

As we noted, the survey had some inherent limitations, and the respondents are not truly representative of a random selection of the population. Still, the City can potentially glean some valuable information from the businesses that chose to respond, caveats aside.

The Majority of Responses Were from Small-to-Medium Size Businesses

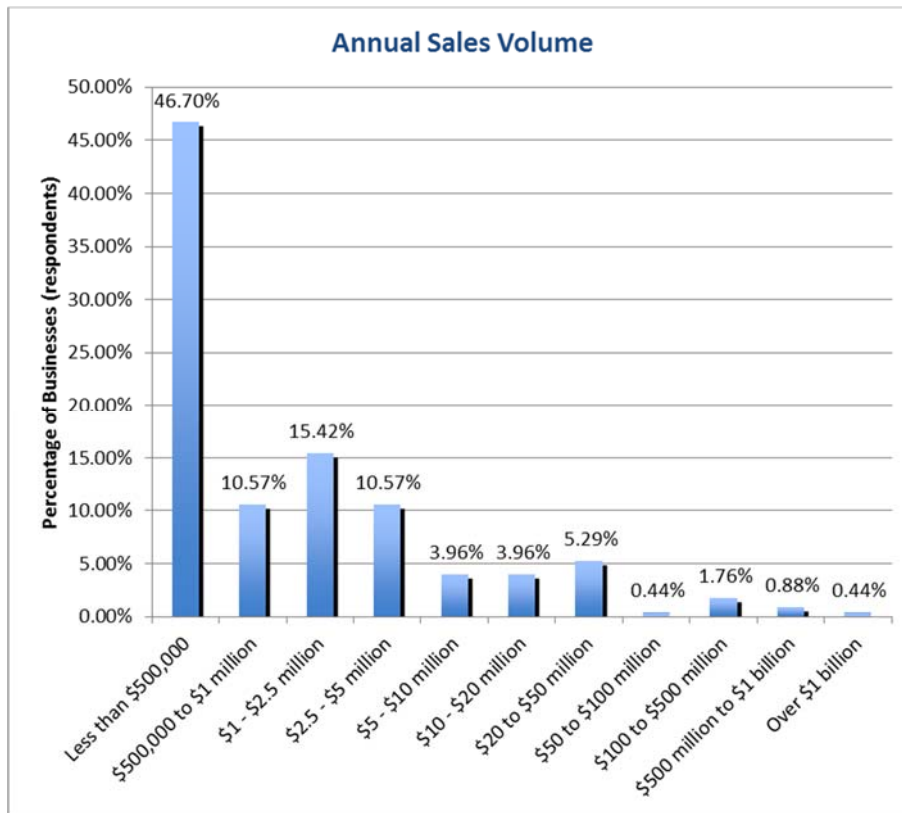
91 percent of the responses were from businesses with only one location. Nearly half the respondents to the business survey represented businesses with 1 to 4 employees, and more than three-quarters (approximately 77.25 percent) came from businesses with less than 20 employees. About 14.5 percent of responses were from businesses with 20 to 99 employees, and about 6.7 percent of responses were from businesses with 100 to 499 employees. Only about 1.5 percent of responses were from business with 500 or more employees. There were no responses from businesses with more than 5,000 employees. See Figure 12, below.

Figure 12: Respondents' Number of Employees (Based on 255 Responses)



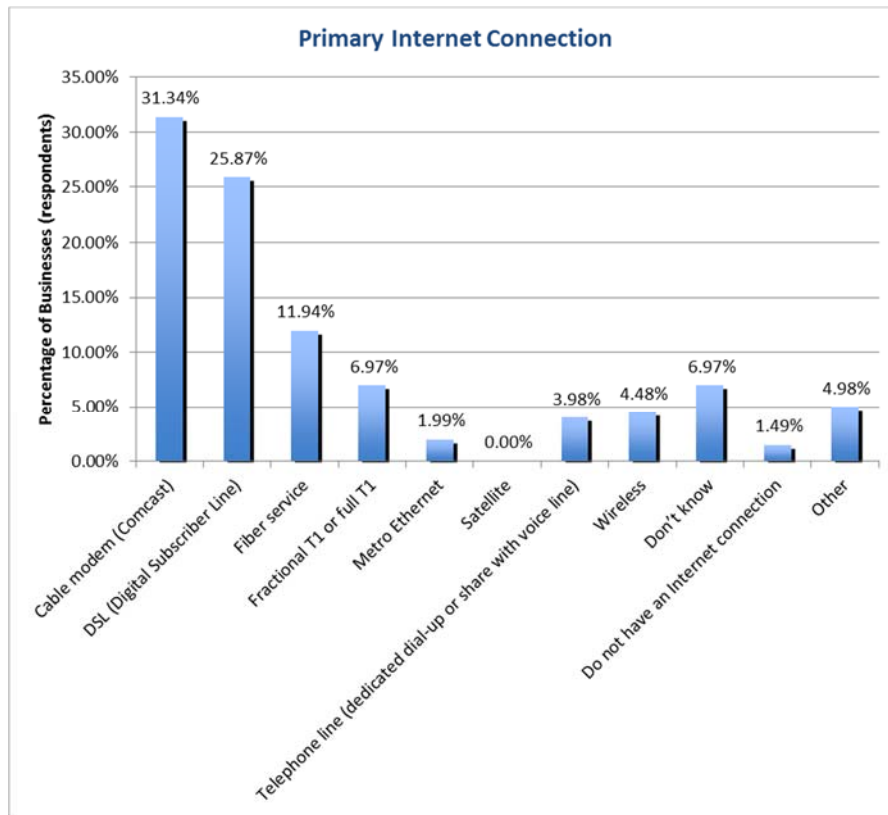
Nearly half of the responses were from businesses with a sales volume of less than \$500,000 per year. A majority of businesses (approximately 83.3 percent) represented had an annual sales volume of \$5 million or less. Only approximately 3.5 percent of respondents represented businesses with an annual sales volume of \$50 million or greater.

Figure 13: Respondents' Annual Sales Volume (Based on 227 Responses)



More than half of the respondents (approximately 57.2 percent) currently subscribe to either cable or DSL; nearly 12 percent of respondents are connected via fiber; and slightly less than 7 percent are connected to a fractional or full T1. See Figure 14, below.

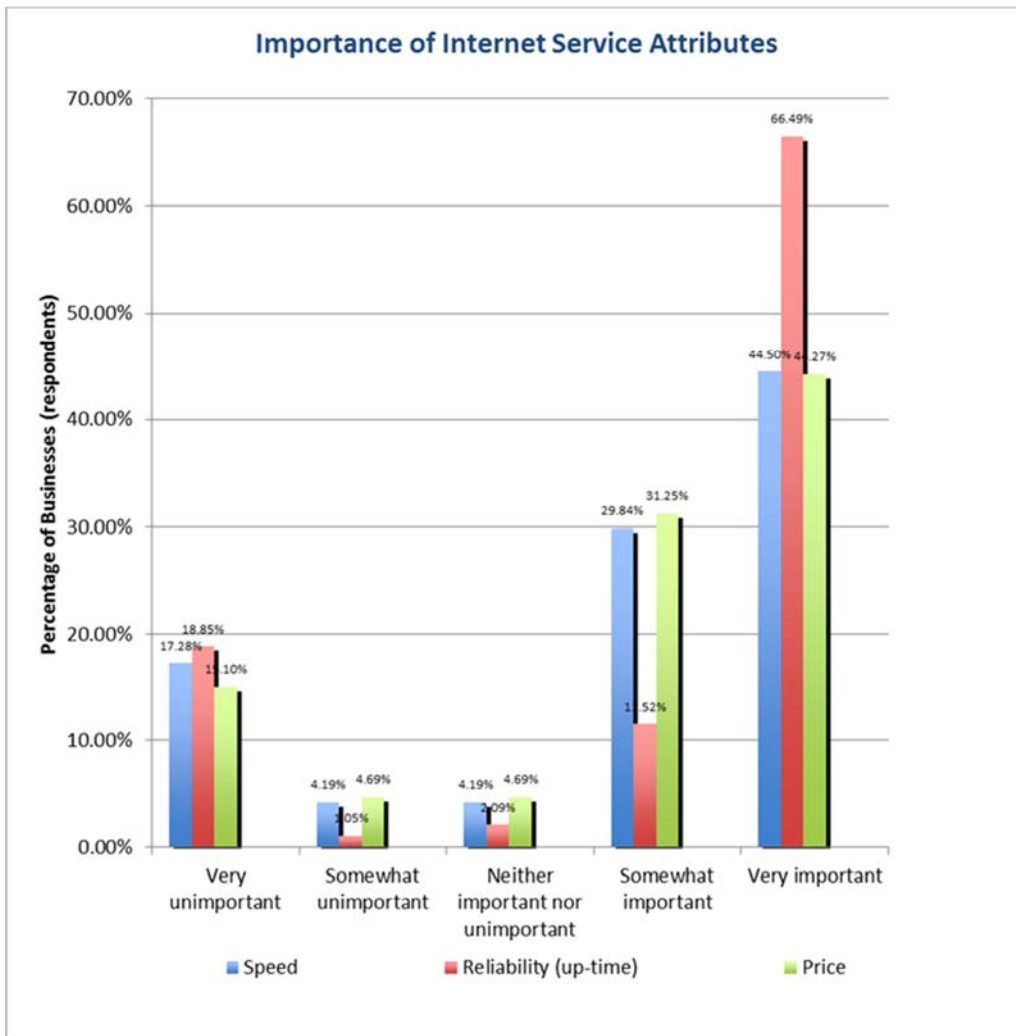
Figure 14: Business Respondents' Primary Internet Connection (Based on 201 Responses)



Nearly Half of Respondents Are Satisfied with Current Internet Speeds

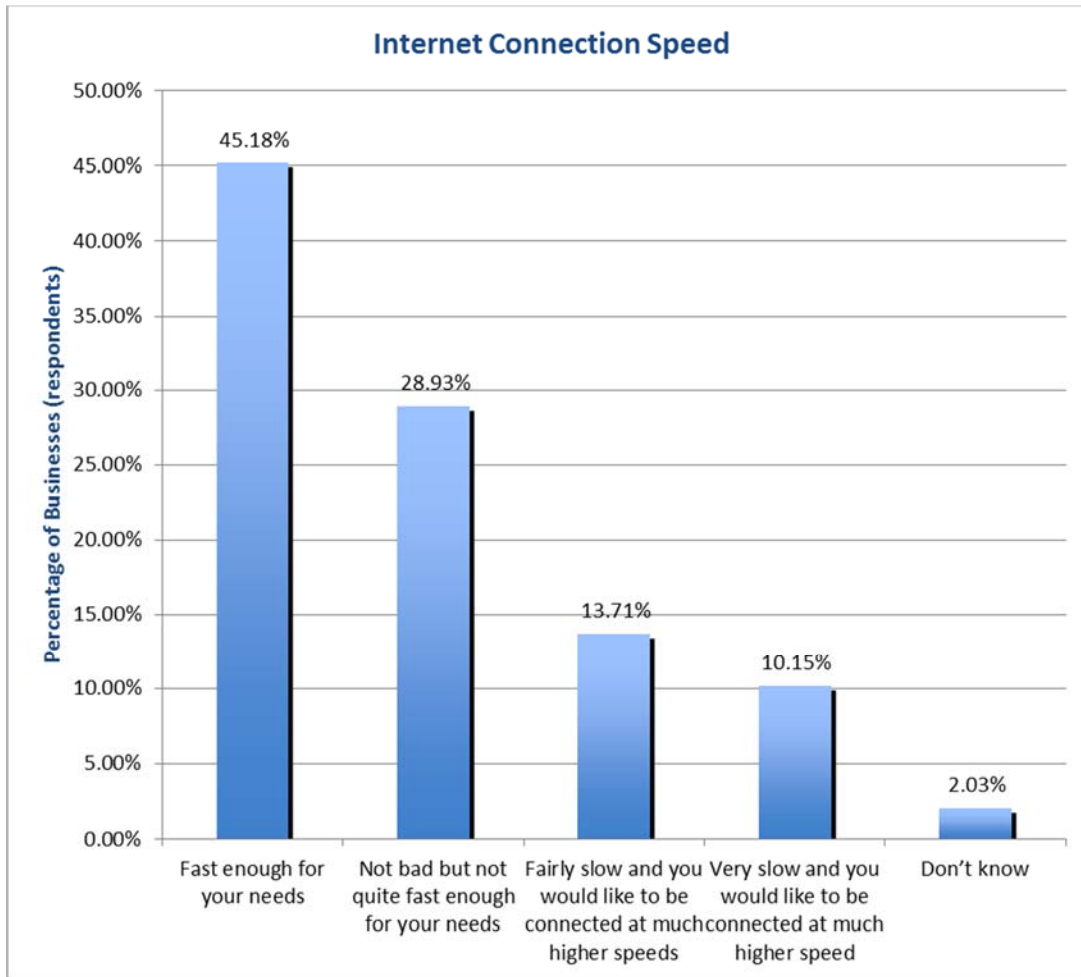
Price, Reliability, and Speed tend to be the most important factors that businesses consider when evaluating their connectivity options, and when considering the possibility of switching providers. Based on the 191 full responses to the question that prompted respondents to indicate the importance of various aspects of their business Internet service, it appears that reliability is most important, followed by price, and speed. Approximately 78 percent of respondents indicated that reliability was somewhat or very important; approximately 76 percent indicated price was somewhat or very important; and approximately 74 percent of respondents indicated that speed was somewhat or very important. See Figure 15, below.

Figure 15: Importance of Price, Reliability, and Speed (Based on 191 Responses)



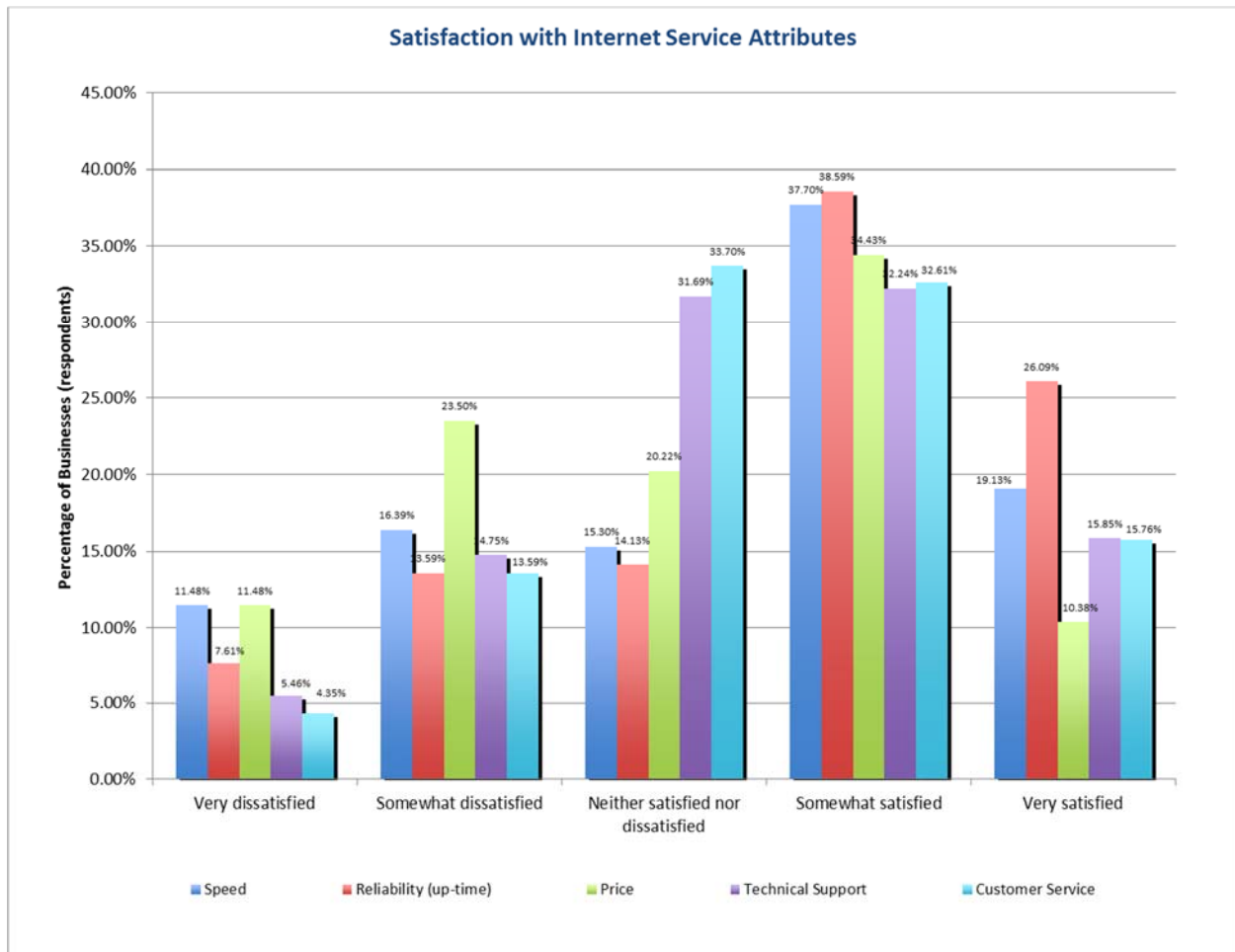
While speed appears to be an important attribute to the respondents, nearly half of the 197 respondents that fully answered the question indicated that their current Internet speed was fast enough for their needs. Approximately 29 percent of respondents indicated that their current speed was not bad, but not quite fast enough for their needs. Only a little over 10 percent of respondents indicated that their current Internet speed was very slow, and approximately 13.7 percent indicated it was fairly slow. That group—approximately 23.9 percent of respondents to the question—indicated that they would like to be connected at higher speeds.

Figure 16: Respondents' Satisfaction With Current Internet Speeds (Based on 197 Responses)



It appears that most respondents are not particularly unhappy with various attributes of their current service (see Figure 17, below). This does not mean that respondents would not consider alternative service from a different provider, but it does indicate that the City would have to find ways to differentiate itself to stand out among its competitors—particularly as a retail service provider.

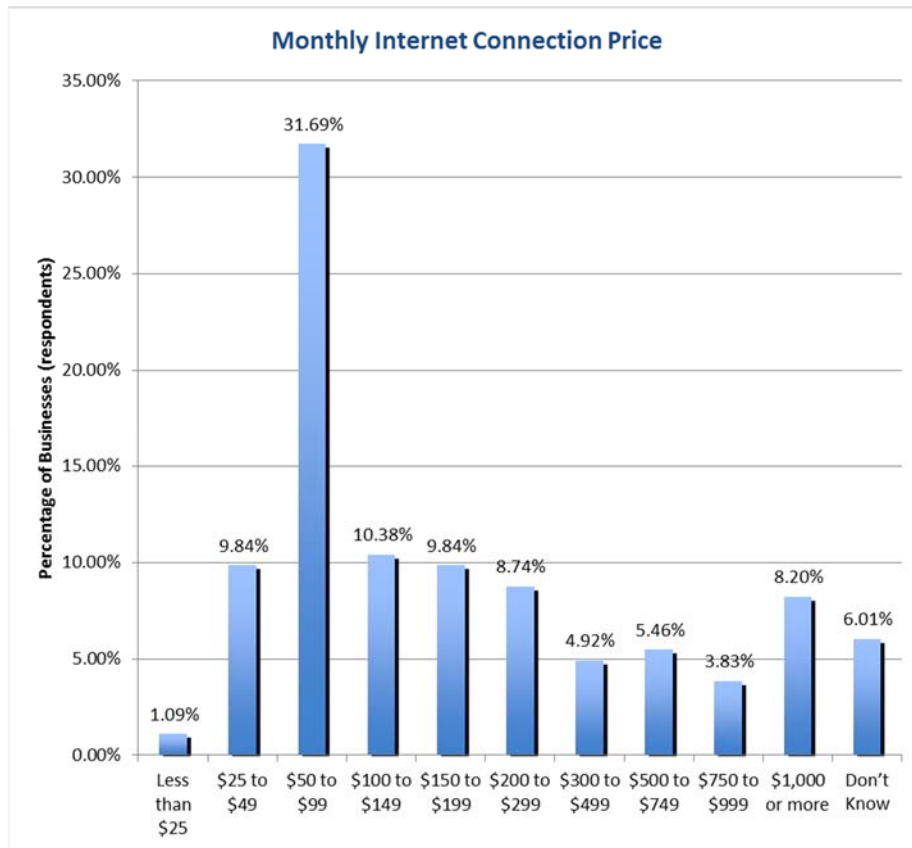
Figure 17: Satisfaction with Current Internet Service Attributes (Based on 192 Responses)



Pricing Sensitivity and Willingness to Switch Service Providers

Almost 60 percent of respondents indicated that they currently pay \$100 or more per month for their business Internet connection. Just over 10 percent of respondents indicated that they currently pay \$49 or less per month for their business Internet connection. Nearly 32 percent of respondents indicated that they currently pay \$50 to \$99 per month. See Figure 18, below.

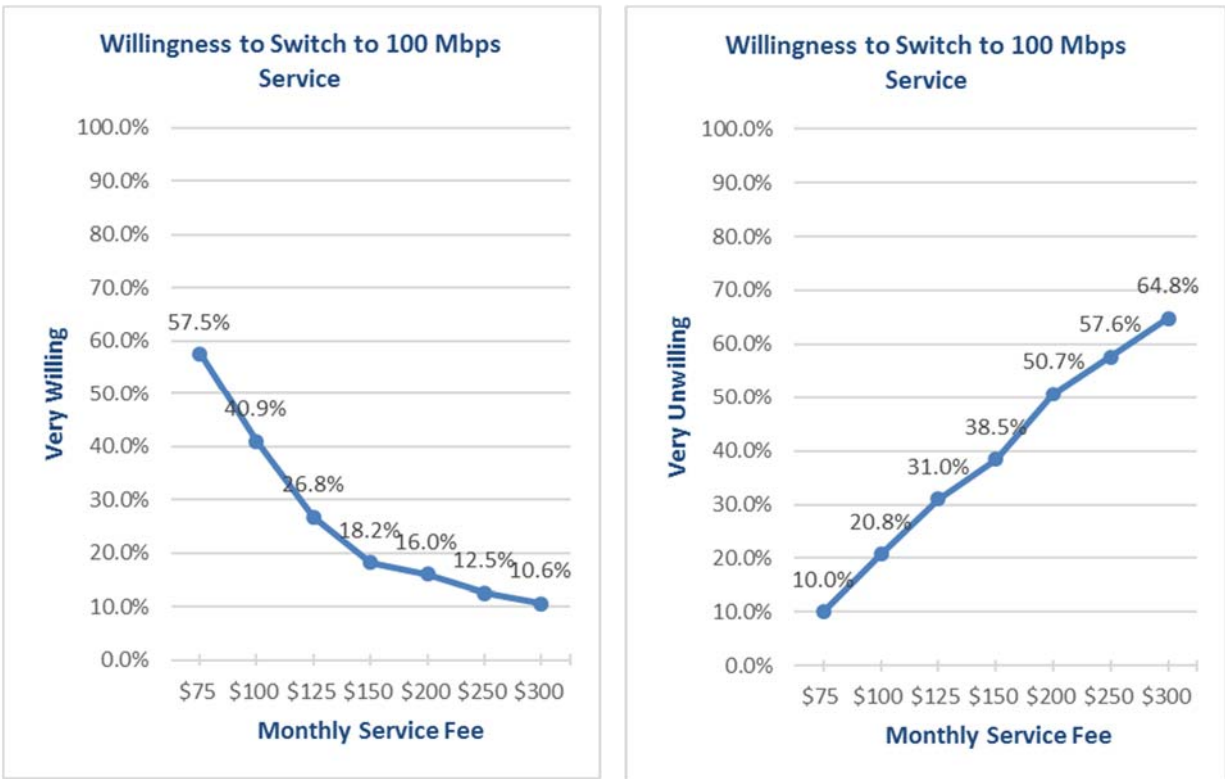
Figure 18: Monthly Cost for Internet Services (Based on 183 Responses)



Although most respondents appear to pay more than \$75 per month, or somewhere near that price point, there did not appear to be a significant willingness to switch to much higher speeds. Nearly half of respondents (approximately 45 percent) indicated that they were somewhat or very satisfied with the price of their current services—based on the 192 respondents that fully answered the question. Still, only approximately 35 percent indicated that they were very or somewhat *dissatisfied* with the price of their current services.

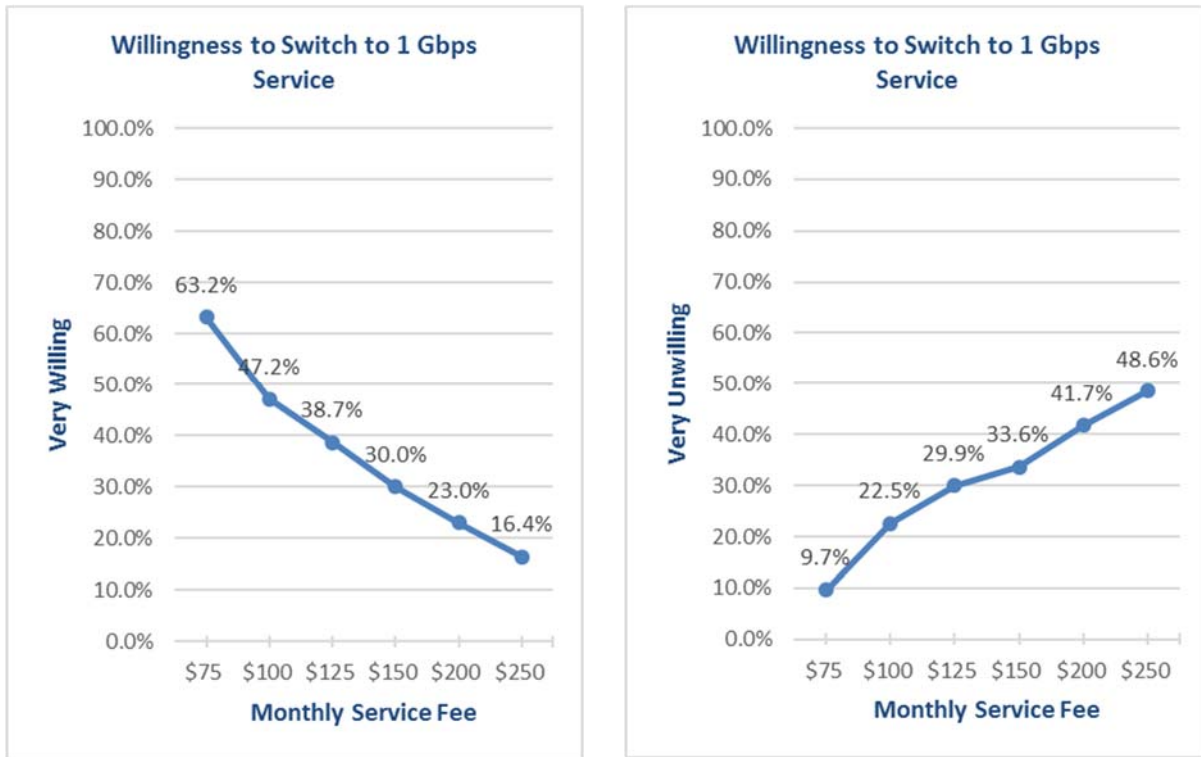
Just under 60 percent of respondents indicated that they would be “very willing” to switch to a 100 Mbps service for \$75 per month, and only 10 percent indicated they would be “very unwilling” to switch to 100 Mbps service for \$75 per month. The respondents appear to be particularly sensitive to price

Figure 19: Respondents' Willingness to Switch to 100 Mbps Service at Various Price Points (Based on 142 Responses)



Approximately 63 percent of respondents to the survey indicated they would be “very willing” to switch to 1 Gbps service for \$75 per month, which is a slightly higher willingness than those respondents that indicated they would switch to 100 Mbps service at the same price point. Respondents seem slightly more likely to switch service for higher speeds.

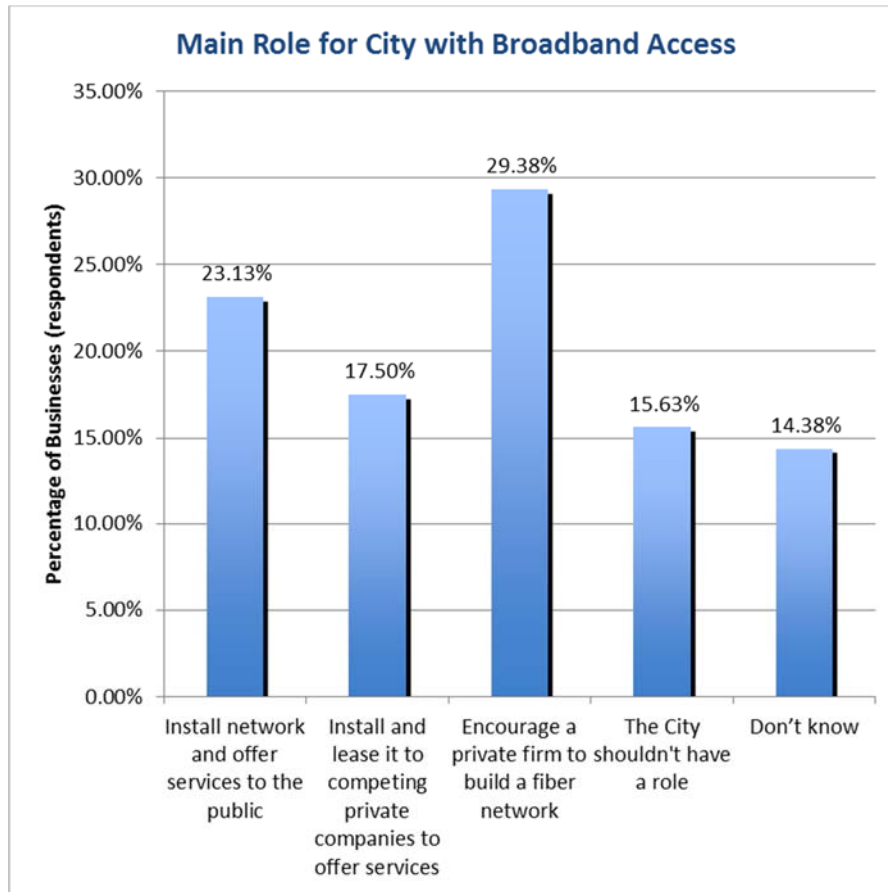
Figure 20: Respondents' Willingness to Switch to 1 Gbps Service at Various Price Points (Based on 137 Responses)



The City's Role

One of the questions the survey asked all respondents was what role they believe the City should play in facilitating broadband access in Hayward. Only approximately 15.6 percent of the 160 responses indicate a belief that the City should have no role. Just over 40 percent of respondents indicate that the City should either install a network and offer services to the public or install a network and lease it to competing private companies to offer services. Approximately 29.4 percent of respondents believe the City should encourage a private firm to build a fiber network in Hayward. Approximately 14.4 percent of respondents do not know what role the City should play. See Figure 21, Below.

Figure 21: Main Role for the City With Respect to Broadband Access (Based on 160 Responses)



Follow-Up Interviews with Select Businesses

As we noted, approximately 40 businesses indicated that they could be contacted further for additional discussions. We managed to reach 24 unique businesses for follow-up conversations to gather these businesses’ insights. Most of these respondents believe that the City has some role in at least providing infrastructure to help manage the connectivity challenges in the market today, and especially in the future. Only one respondent indicated the City should become a provider, while only three respondents were on the opposite end of the spectrum and claimed the City’s only role should be to expedite permits.

In general, the respondents that we reached indicated that they believe connectivity is critical for their business operations, and their dependency on it is growing. This is especially true as their business operations grow increasingly dependent on cloud computing. Most respondents indicated that the current market does not meet their needs, and that the speed and reliability of currently-available services is especially unlikely to meet their future needs as their businesses grow and evolve.

As is the case with many small- to medium-size businesses in other markets, connectivity options are limited to only DSL or cable for many of the respondents to the business survey. There is a shared perception that competition is lacking in the Hayward business market, and that it must be increased in order to drive better choice for businesses. Further, choices are limited for alternative services, or for back-up options to help offset the speed and reliability challenges these businesses face with their primary providers.

While some of the respondents could purchase cable modem service through Comcast, it tends to be much more expensive than AT&T's DSL service, and the speeds and reliability do not necessarily justify the increased cost. Still, satisfaction related to reliability and speed seems to be marginally higher with Comcast than with AT&T. Most of these respondents claimed that the customer service they receive from their current providers is not good, and they would prefer more positive experiences when seeking support.

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Appendix B: Assessment of Local Broadband Market

Prepared for the City of Hayward, California

October 2016

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1 Enterprise Market

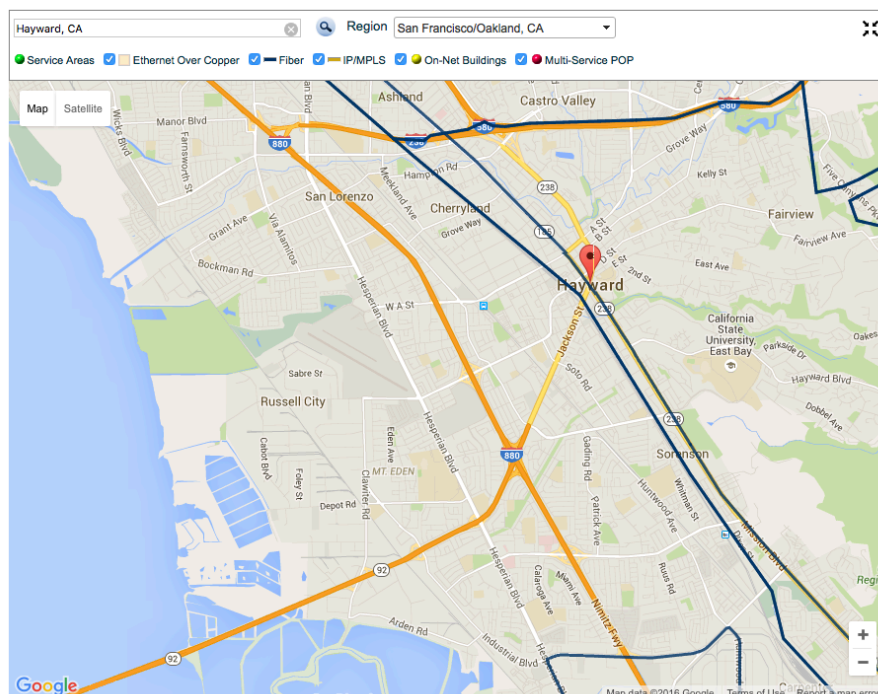
This section provides an overview of competitive providers for dark fiber and lit services with respect to the residential and small business customers within the City of Hayward. During our research, we identified 14 service providers in the Hayward area that offer a range of services, from dark fiber connectivity to data transport services, with speeds that range from 1 Mbps to 100 Gbps. Individual providers tailor these services to customers’ requirements (e.g., speed, class of service). Greater proximity to the provider’s existing network infrastructure results in lower service pricing. Providers typically prefer to offer transport services between locations on their networks (on-net) and provision Multiprotocol Label Switching (MPLS) based services for connecting locations that are off-net.

1.1 Dark Fiber Services

Four service providers in the City have dark fiber availability: Integra Telecom, Level 3, Line Systems, and Zayo.

Integra Telecom, which operates primarily in the western U.S., has long-haul and metro fiber in Hayward (Figure 1). Integra offers lease and Indefeasible Rights of Use (IRU) options.¹

Figure 1: Integra Fiber Paths²

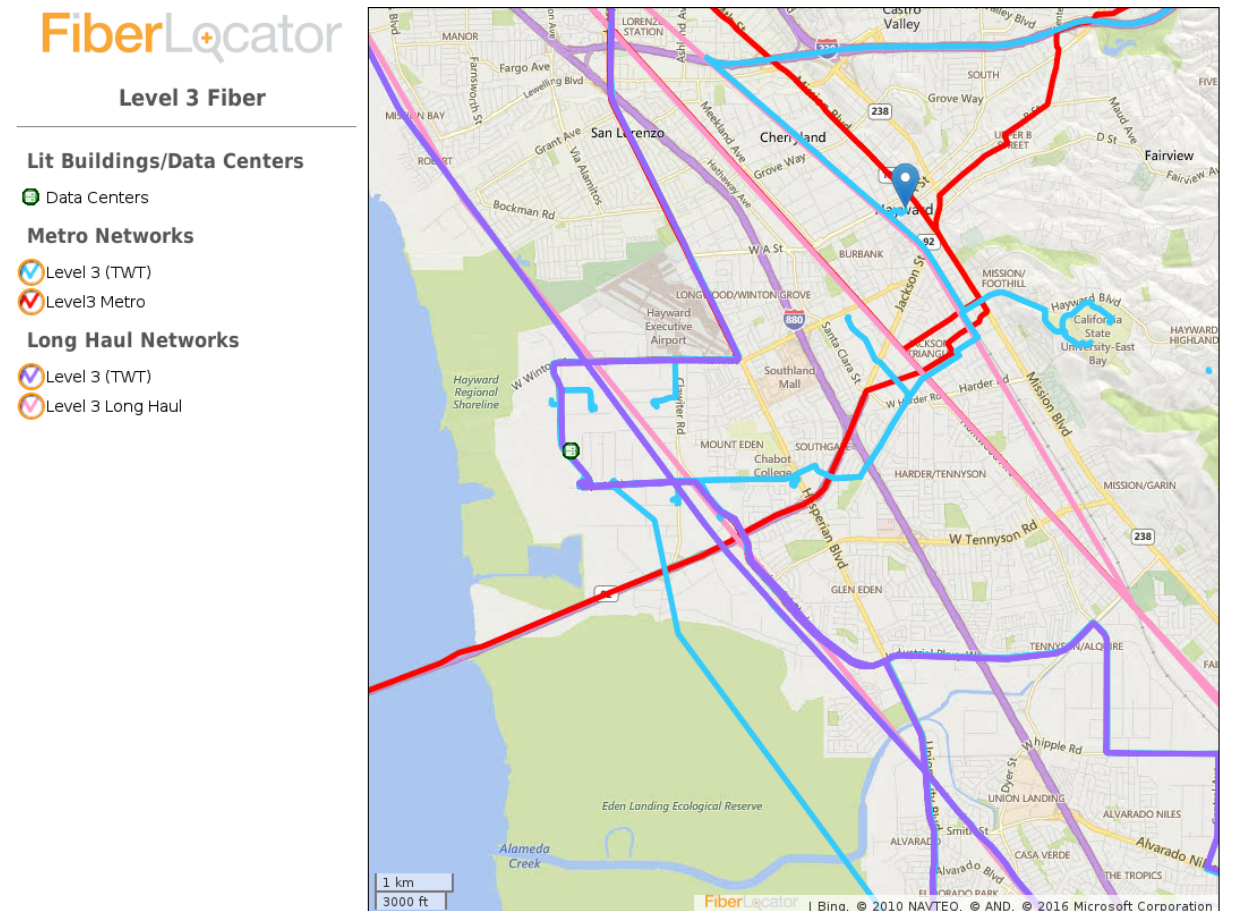


¹ <http://www.integratecom.com/enterprise/products/pages/dark-fiber-network-provider.aspx>, accessed June 2016.

² <http://www.integratecom.com/pages/network-map.aspx> accessed June 2016.

Level 3 has long-haul dark fiber routes and metro fiber in Hayward, as depicted in Figure 2. Pricing varies based on the customer’s distance from Level 3’s infrastructure. A difference of a few tenths of a mile can lead to significant differences in the price of dark fiber connectivity, due to additional construction costs.

Figure 2: Level 3 Fiber Routes³



Line Systems operates within the United States as well as in Canada, England, and Singapore. The company offers dark or lit private fiber services with a range of options for leasing or independent ownership. Pricing varies significantly by location, depending on construction costs.⁴

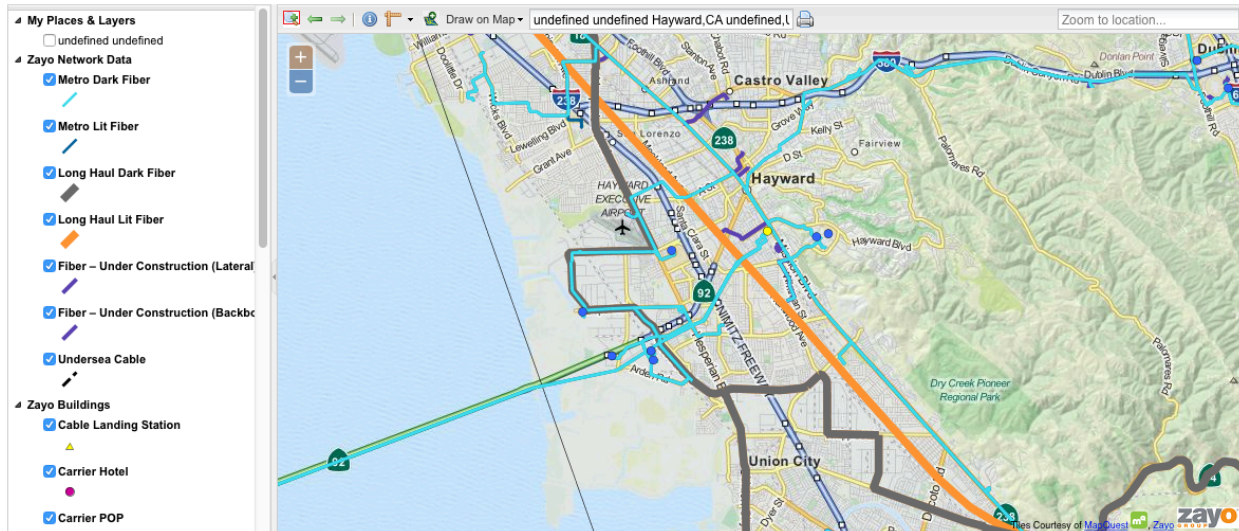
Zayo provides dark fiber connectivity over its network of metro and intercity fiber, as depicted in Figure 4. The company claims to have proven expertise in deploying major new dark fiber networks and offers multiple financing options, including leases and IRU agreements. Pricing

³ <http://fiberlocator.com>, accessed June 2016.

⁴ <http://linesystems.com/services/data/ethernet-services>, accessed June 2016.

varies significantly depending on whether the customer site is on-net or not; if the location is off-net, construction and splicing costs would apply. As an example, a dark fiber lease between two on-net locations, (one in San Francisco, one in Hayward) that are 25 miles apart has a monthly recurring charge of \$11,166 for a one-year term and \$5,592 for a five-year term. The customer will also pay additional non-recurring charges, which we have typically seen to be approximately \$5,000.⁵

Figure 3: Zayo Fiber Routes⁶



1.2 Lit Services

Ethernet service can be classified into three types—Ethernet Private Line (EPL or E-Line), Ethernet Virtual Private Line (EVPL), and ELAN:

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

⁵ <http://www.zayo.com/services/dark-fiber>, accessed June 2016.

⁶ <http://www.zayo.com/solutions/global-network/>, accessed June 2016.

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

The carriers that provide these services in the Hayward area are Access One, AT&T, Comcast, EarthLink, Integra, Level 3, Line Systems, MegaPath, Sonic, TelePacific, Windstream, XO Communications, and Zayo. Prices depend on the bandwidth, location, and network configuration; whether the service is protected or unprotected; and whether the service has a switched or mesh structure.

Access One provides a range of business-focused solutions over fiber with speeds ranging from 1.5 Mbps to 1 Gbps.⁷ Services include DIA, MPLS IP-VPN, and EPL. Access One operates in 30 states, but has the highest coverage in California, Illinois, and New Jersey.⁸

AT&T has three basic types of Ethernet products—Dedicated Ethernet, Switched Ethernet, and OPT-E-WAN—which are similar to EPL and ELAN.⁹ Dedicated Ethernet services provide point-to-point Ethernet connectivity between two customer locations, while Switched Ethernet and OPT-E-WAN can facilitate point-to-point, point-to-multipoint, or multipoint-to-multipoint service. All support bandwidths ranging from 1 Mbps to 1 Gbps. Connections and speed can be managed directly by the customer and new locations can be added quickly in multipoint scenarios.

Comcast provides EPL services, which enable customers to connect their customer premises equipment (CPE) using a lower-cost Ethernet interface, as well as using any Virtual Local Area Networks (VLAN) or Ethernet control protocol across the service without coordination with Comcast.

Comcast offers EPL service with 10 Mbps, 100 Mbps, 1 Gbps, or 10 Gbps Ethernet User-to-Network Interfaces (UNI) and is available in speed increments from 1 Mbps to 10 Gbps.¹⁰ Comcast's fiber optic network is depicted in Figure 3.

⁷ <http://www.accessoneinc.com/services/data-services.aspx>, accessed June 2016.

⁸ <http://broadbandnow.com/Access-One>, accessed June 2016.

⁹ <https://www.business.att.com/enterprise/Family/network-services/ethernet/>, accessed June 2016.

¹⁰ <http://business.comcast.com/ethernet/products/ethernet-private-line-technical-specifications>, accessed June 2016.

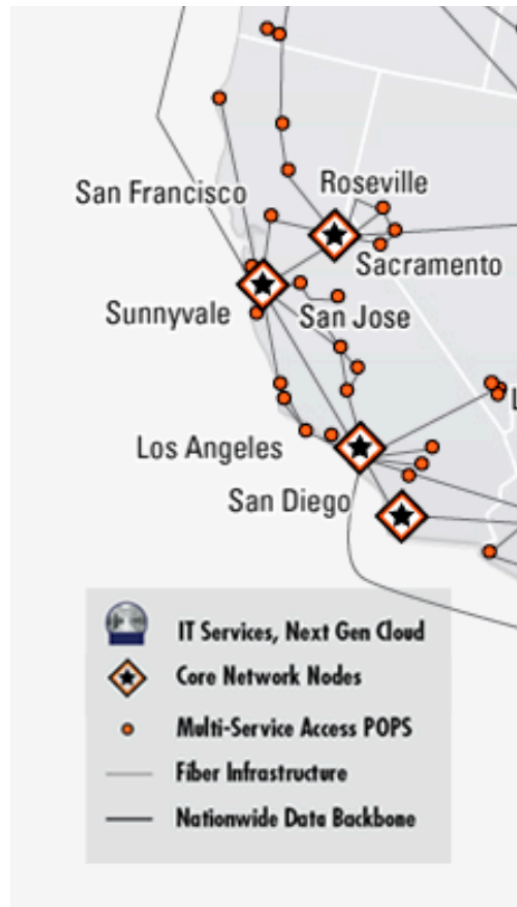
Figure 4: Comcast Fiber Routes¹¹



EarthLink offers a variety of Ethernet services in Hayward, including DIA, MPLS IP-VPN, and IPsec VPN, which uses the IPsec protocol instead of IP over MPLS. It also offers Hybrid WAN service, which allows connectivity between multiple locations with different types of service. Symmetrical Ethernet service is available over both copper and fiber connections. The cost of a typical 100 Mbps fiber service would be in the range of \$1,900 per month, but pricing varies significantly by location, proximity to existing infrastructure, and construction costs.

¹¹ <http://business.comcast.com/about-us/our-network>, accessed June 2016.

Figure 5: EarthLink Fiber Map¹²



Integra offers several Ethernet services, including DIA, E-Line, E-LAN, and MPLS IP-VPN. Available speeds range from 1.5 Mbps to 10 Gbps. It also offers wavelengths over fiber using Dense Wave Division Multiplexing (DWDM). DWDM allows several different point-to-point connections to be carried over the same strand of fiber using different wavelengths of light, greatly expanding the amount of bandwidth available over a single strand. This is often used in long-haul applications (where the expense of a DWDM system is justified by the avoided expense of constructing additional fiber over long distances), but it also has regional applications.

Level 3's Metro Ethernet dedicated service is available in bandwidth options of 3 Mbps to 1 Gbps and its EVPL offers speeds ranging from 3 Mbps to 10 Gbps.¹³ It is an end-to-end, Layer 2, switched Ethernet service delivered via an MPLS backbone. Internet services are available in a range of 14 speeds up to 10 Gbps.¹⁴

¹² <https://www.earthlink.com/why-earthlink/our-network>, accessed June 2016.

¹³ <http://www.level3.com/en/products/virtual-private-lan-service>, accessed June 2016.

¹⁴ http://www.level3.com/~media/files/factsheets/en_ethernet_fs_ethernetmatrix.pdf, accessed June 2016.

Line Systems offers a lit private fiber service with terms similar to its dark fiber offering, and a point-to-point Ethernet service with speeds of 10, 50, or 100 Mbps. It also offers a metro-area LAN service called Fastpath. Fastpath is available at several speeds ranging from 1 Mbps to 1 Gbps and offers Quality of Service (QoS) management via separate Ethernet Virtual Connections (EVCs) or VLANs.

Line Systems provided a rough cost estimate of \$1,200 to \$1,400 per month for 100 Mbps Fastpath service and approximate \$4000 per month for 1 Gbps service, but price and availability may vary significantly by location. Line Systems also offers an MPLS IP-VPN service.¹⁵

MegaPath offers a fiber DIA service called Fiber Access which provides symmetrical connectivity at speeds ranging from 5 Mbps to 1 Gbps.¹⁶ Our staff corresponded with MegaPath sales staff to obtain pricing information. A 1 Gbps fiber connection costs approximately \$8,000 per month. MegaPath also offer MPLS and IPsec VPN services for connecting multiple locations. MegaPath also offers symmetric and asymmetrical Ethernet service.¹⁷

MegaPath's asymmetrical service starts at \$90 per month for 8 Mbps download speeds and 1 Mbps upload, and ranges up to \$243 per month for 50 Mbps down and 10 Mbps up. Symmetrical Ethernet ranges from \$299 per month for 2 Mbps service to \$1,399 for 45 Mbps service. Signing a three-year contract will provide the best pricing and enable customers to waive the initial installation fee.

TelePacific offers a range of business connectivity options, including fiber connections up to 10 Gbps where fiber is available (Figure 6). It offers an EPL service called Metro Private Line for point-to-point connections between two locations, as well as IPsec and MPLS IP-VPN services.

TelePacific does not have its own fiber in the City, but offers its services over fiber leased from other providers.¹⁸

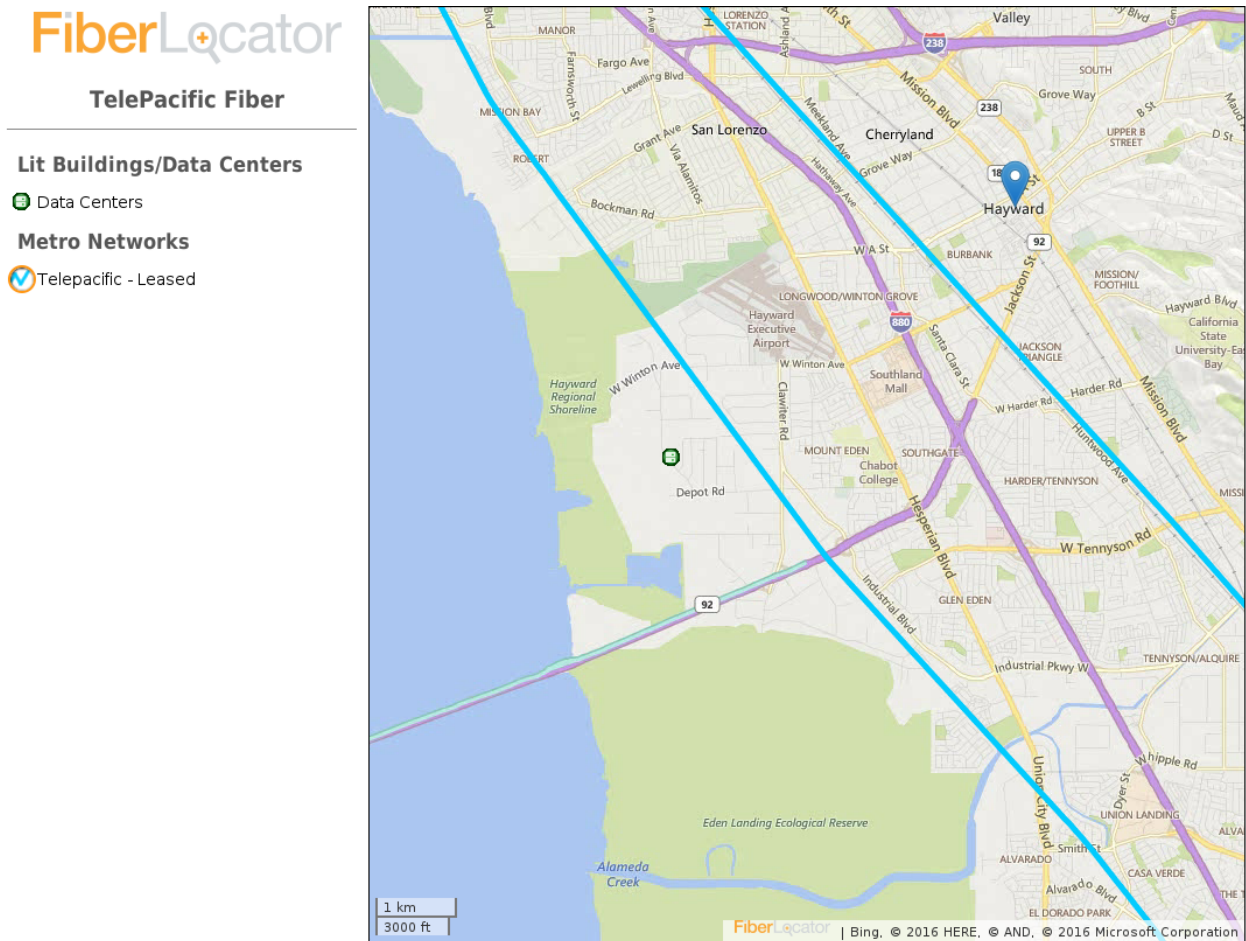
¹⁵ <http://linesystems.com/services/data/ethernet-services>, accessed June 2016.

¹⁶ <https://www.megapath.com/data/fiber-access>, accessed June 2016.

¹⁷ <https://www.megapath.com/data/ethernet>, accessed June 2016.

¹⁸ <http://www.telepacific.com/offer/data-networking/internet-access/ethernet-broadband.asp>, accessed June 2016.

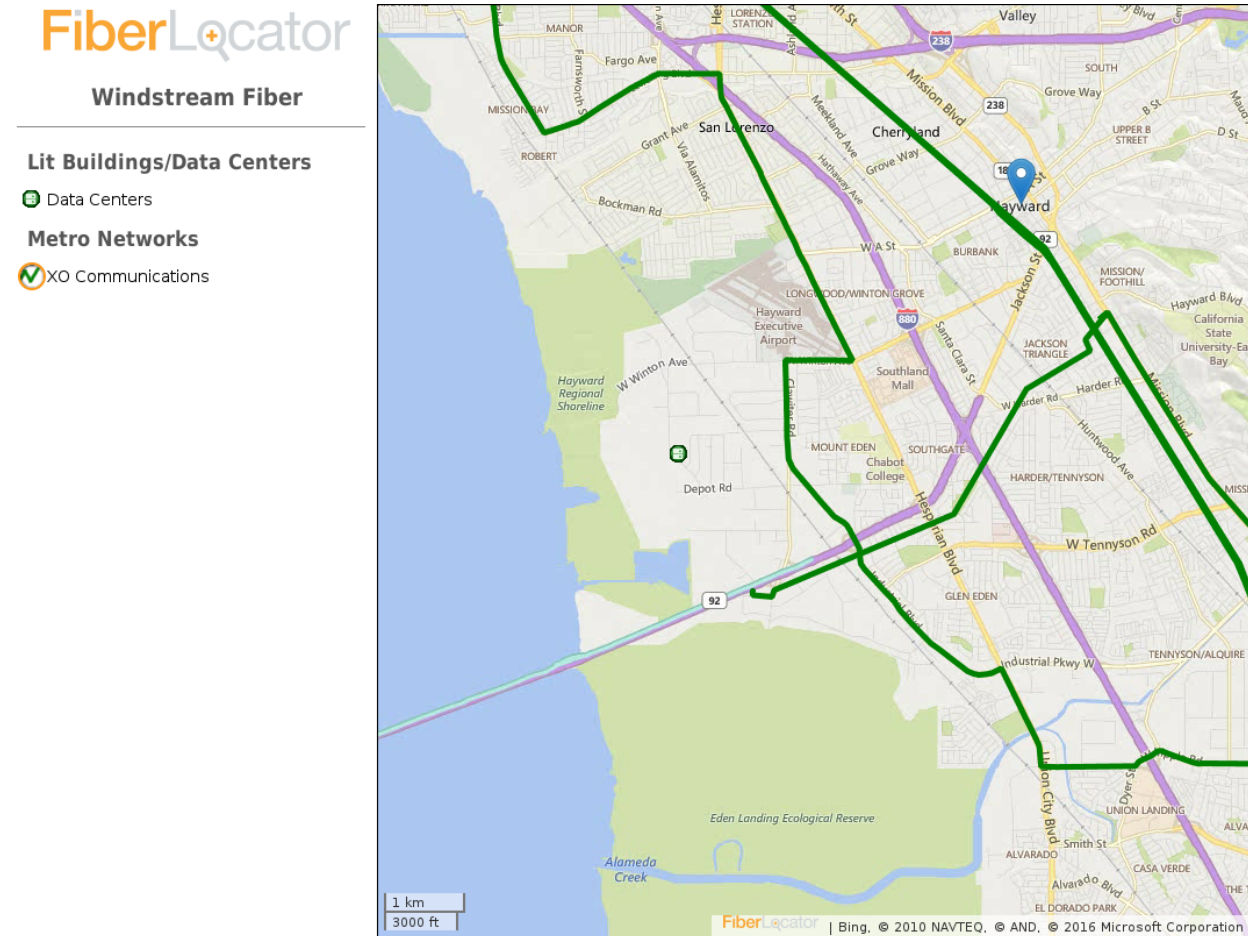
Figure 6: TelePacific Fiber Routes¹⁹



¹⁹ <https://fiberlocator.com>, accessed June 2016.

Windstream Communications has a nationwide presence serving major metropolitan areas. In Hayward, it offers DIA services with speeds up to 1 Gbps.²⁰ It also provides MPLS IP-VPN and an E-LAN product called VLS (Virtual LAN Service).²¹ Windstream also sells wavelengths over regional, metro, and long-haul fiber. Available speeds are 1 Gbps, 2.5 Gbps, 10 Gbps, 40 Gbps, and 100 Gbps.²²

Figure 7: Windstream Fiber Routes²³



²⁰ <http://www.windstreambusiness.com/products/enterprise-network-services/dedicated-internet-services/ethernet-internet>, accessed June 2016.

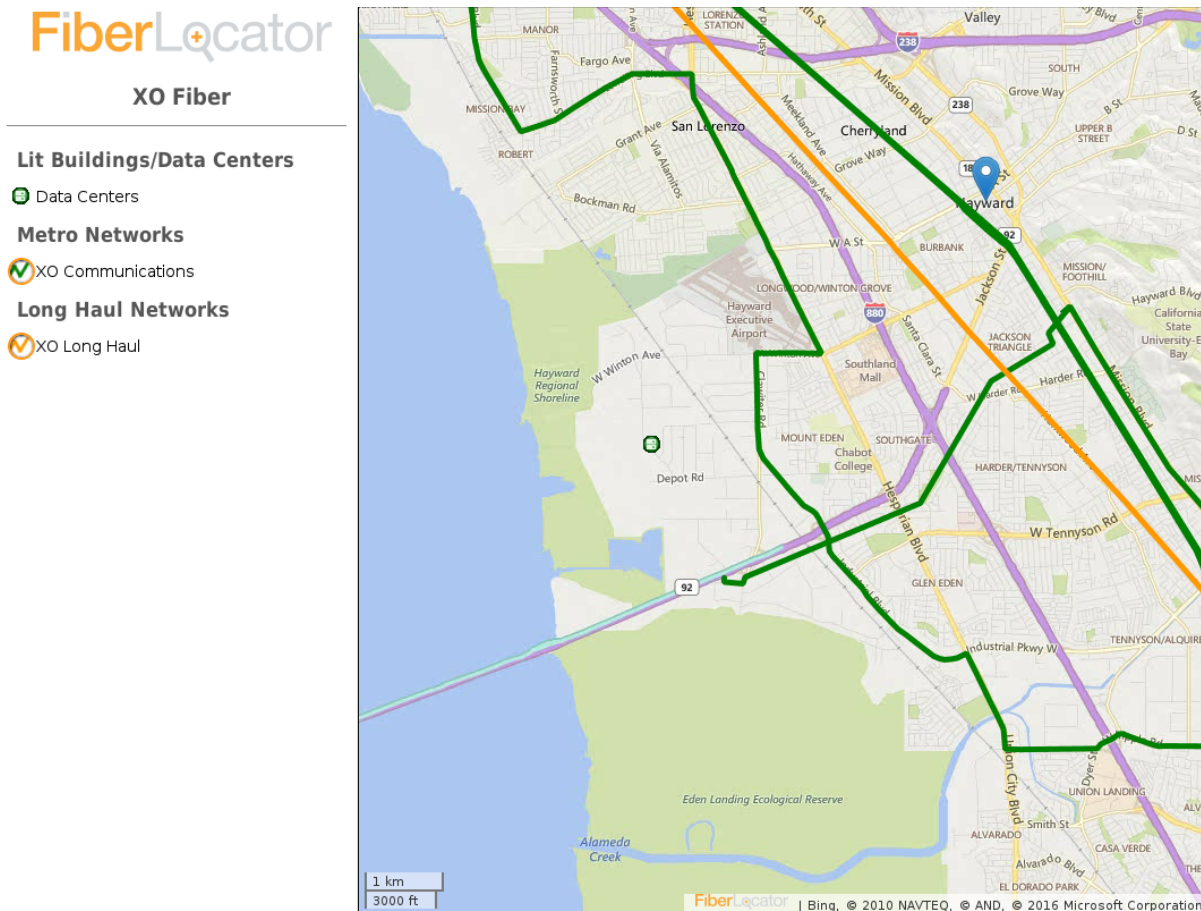
²¹ <http://www.windstreambusiness.com/shop/products/ca/Hayward>, accessed June 2016.

²² <http://www.windstreambusiness.com/products/enterprise-network-services/dedicated-internet-services/wave-service> accessed June 2016.

²³ <https://fiberlocator.com>, accessed June 2016.

XO Communications offers carrier Ethernet and DIA services at multiple bandwidth options, from 3 Mbps to 10 Gbps, over its Tier 1 IP network. XO does not have fiber in the City but resells services over routes provided by other providers.^{24, 25}

Figure 8: XO Fiber Routes²⁶



Zayo delivers Ethernet in three service types, with bandwidth ranging from 10 Mbps to 100 Gbps and options like quality of service (QoS) guarantees and route protection based on customer needs. The different types of services offered are: Ethernet-Line, which provides point-to-point and point-to-multipoint configurations with reserved bandwidth availability; Ethernet-LAN, with multipoint configurations having a guaranteed service level; and Ethernet

²⁴ <http://www.xo.com/carrier/transport/ethernet/>, accessed May 2016.

²⁵ <http://www.xo.com/network-services/internet-access/ip-transit/100G/>, accessed May 2016.

²⁶ <https://fiberlocator.com>, accessed June 2016.

Private Dedicated Network (E-PDN) with a completely private, managed network operated by Zayo, with dedicated fiber and equipment.²⁷

Zayo’s FlexConnect service allows customers to pay for bandwidth used at \$0.03 per gigabyte with no minimums, plus a monthly port charge ranging from \$50 for 500 Mbps to \$250 for 10 Gbps.²⁸

Pricing for a 10 Gbps and 1 Gbps point-to-point Ethernet line between two on-net locations in Hayward that are a mile apart is provided in the tables below. We would see non-recurring charges depending on the proximity of a site to the existing Zayo network.

Table 1: Zayo Ethernet Transport Pricing in Hayward (Monthly Recurring Cost)

Service	60 Month	12 Month
1 Gbps	\$1,841	\$2,522
10 Gbps	\$4,337	\$5,941

Pricing for a 10 Gbps and 1 Gbps DIA service at an on-net location in Hayward is provided in the table below.

Table 2: Zayo DIA pricing in Hayward (Monthly Recurring Cost)

Service	60 Month	12 Month
1 Gbps	\$4,016	\$6,693
10 Gbps	\$19,103	\$31,843

²⁷ <http://www.zayo.com/ethernet>, accessed May 2016.

²⁸ <http://www.zayo.com/services/ethernet/flexconnect>, accessed June 2016.

2 Residential and Small Business Services

Residential and small business customers in the Hayward area have access to a range of services, though individual service options are dependent on location. Table 3 lists the service providers and minimum price for each type of service that is available in at least some part of the City.

Table 3: Overview of Residential and Small Business Data Services in Hayward

Service Type	Provider	Minimum Monthly Price
Cable	Comcast	\$29.99
DSL	AT&T	\$25
	Sonic	\$40
	EarthLink	\$14.95
Fiber	Comcast	\$299.95
Fixed Wireless	Etheric	\$99
Satellite	HughesNet	\$59.99
	Exede	\$59.99

2.1 Cable

Comcast offers Internet service with download speeds from 25 Mbps to 250 Mbps starting at \$29.99 per month in some locations in the City. Promotional rates are available for the first year, after which the rates increase. Discounted prices are available if bundled with another service like voice or TV.²⁹ On the small business side, multiple options are available starting at 16 Mbps download speeds up to 150 Mbps download speeds, as illustrated in Table 3.³⁰ Bundling with voice introduces a monthly savings of \$30 to \$40. Comcast also offers residential fiber service, which is discussed below.

²⁹ <http://www.comcast.com/internet-service.html>, accessed June 2016.

³⁰ <http://business.comcast.com/internet/business-internet/plans-pricing>, accessed June 2016.

Table 4: Comcast Residential Internet—Internet Only

Package	Internet Speed	Monthly Regular Price	Monthly Promo Rate
Performance Starter	Up to 10 Mbps download	\$29.99	\$49.95
Performance 25	Up to 25 Mbps download	\$39.99	\$59.95
Performance Pro	Up to 100 Mbps download	\$49.99	\$74.95
Blast Pro	Up to 200 Mbps download	\$59.99	\$89.95
Extreme 250	Up to 250 Mbps download	\$79.99	\$149.95

Table 5: Comcast Small Business Internet—Internet Only

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

2.2 DSL

AT&T offers DSL service for residential customers in Hayward, starting at as \$30 per month for unbundled or standalone DSL service at 6 Mbps download with a 12-month commitment. Additional options up to 75 Mbps are available, as indicated in Table 6.

Table 6: AT&T Residential Internet—Internet Only

Internet Speed	Monthly Price	Monthly Promo Rate
----------------	---------------	--------------------

Internet Speed	Monthly Price	Monthly Promo Rate
Up to 6 Mbps download	\$40	\$30
Up to 24 Mbps download	\$60	\$50
Up to 45 Mbps download	\$70	\$60
Up to 75 Mbps download	\$80	\$70

AT&T offers DSL-based small business services starting at \$70 per month for 12 Mbps download and 1.5 Mbps upload speeds.³¹

EarthLink provides DSL-based business services in the region starting at \$80 per month and offering speeds up to 6 Mbps with 99.9 percent network availability.³²

Sonic provides DSL-based services called Fusion starting at \$40 for 10 Mbps or 20 Mbps download, depending on the location. Where available, Fusion X2 provides double the speed of Fusion for \$60. Business DSL and phone bundles also start at \$40 per month.³³ Sonic is in the process of deploying fiber in the Bay Area, but has not announced availability in Hayward.

2.3 Fiber

Comcast, in addition to Internet connectivity over coaxial cable, offers its Gigabit Pro fiber service in Hayward. The service provides 2 Gbps speeds for \$299.95 per month and requires a two-year contract plus \$1,000 in up-front installation and activation fees. Gigabit Pro is available for residential customers only.³⁴

2.4 Fixed Wireless

Fixed wireless services use long-range wireless signals between the provider's antenna and an antenna installed in a fixed location at the customer's home or business.

Etheric Networks provides wireless service to much of the Bay Area. Plan pricing varies by guaranteed and maximum speed and monthly data caps, and are broken out into three classes of service: residential, small office/home office (SOHO), and business. Because wireless service can be affected by topology and obstructions such as trees or buildings, Etheric offers a free

³¹ <https://www.att.com/internet>, accessed June 2016.

³² <http://www.earthlinkbusiness.com/DSL>, accessed June 2016.

³³ <https://www.sonic.com/availability>, accessed June 2016.

³⁴ <http://www.xfinity.com>, accessed June 2016.

site survey to determine availability of service. Plan pricing and details are broken out in the tables below.

Table 7: Etheric Residential Plans³⁵

Plan	Cost per Month	Guaranteed Speed	Maximum Speed	Monthly Data Allowance
Silver NG	\$99	3 Mbps	15 Mbps	300 GB
Gold NG	\$139	6 Mbps	30 Mbps	500 GB
Platinum NG	\$179	10 Mbps	38 Mbps	1,000 GB
Diamond NG	\$229	15 Mbps	45 Mbps	1,500 GB
Burst 100 NG*	\$349	25 Mbps	100 Mbps	2,400 GB

Table 8: Etheric SO/HO Plans³⁶

Plan	Cost per Month	Guaranteed Speed	Maximum Speed	Monthly Data Allowance
Silver NG	\$159	3 Mbps	9 Mbps	500 GB
Gold NG	\$229	6 Mbps	15 Mbps	900 GB
Platinum NG	\$339	10 Mbps	25 Mbps	1,950 GB
Diamond NG	\$449	15 Mbps	35 Mbps	3,000 GB
Adamantium NG	\$599	20 Mbps	50 Mbps	4,000 GB
Burst 100 NG*	\$699	25 Mbps	100 Mbps	5,000 GB

Table 9: Etheric Business Plans³⁷

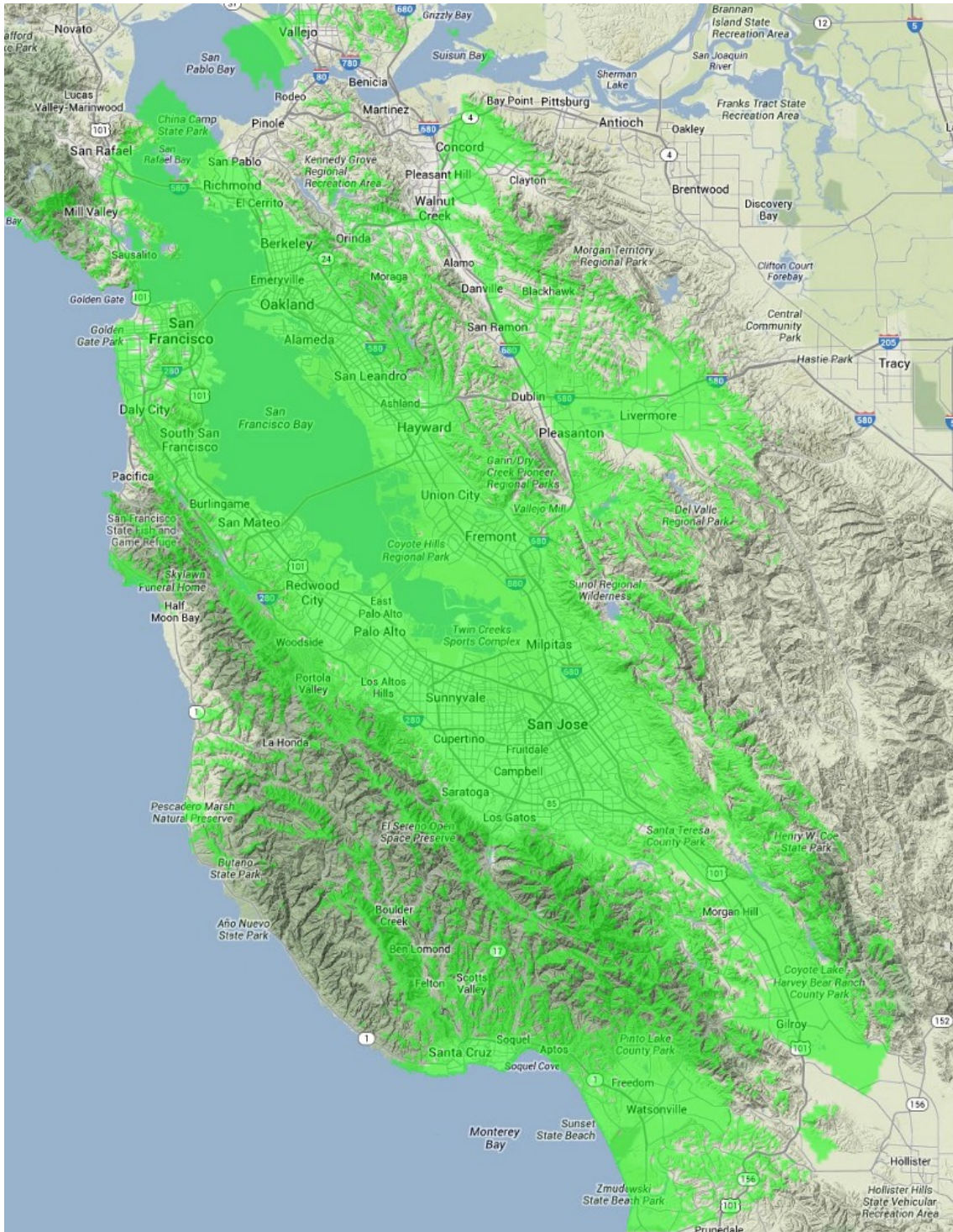
Next Gen (G6) Plan Details	Cost per Month	Guaranteed Speed	Maximum Speed	Monthly Data Allowance
Bronze NG	\$199	2 Mbps	5 Mbps	Unlimited
Silver NG	\$249	3 Mbps	9 Mbps	Unlimited
Gold NG	\$399	6 Mbps	15 Mbps	Unlimited
Platinum NG	\$499	10 Mbps	25 Mbps	Unlimited
Economy ENX	\$699	20 Mbps	50 Mbps	Unlimited
Standard ENX	\$999	30 Mbps	75 Mbps	Unlimited
Comprehensive ENX	\$1,299	50 Mbps	100 Mbps	Unlimited
Maximum ENX	\$1,499	100 Mbps	150 Mbps	Unlimited

³⁵ <http://ethericnetworks.com/residential>, accessed June 2016.

³⁶ <http://ethericnetworks.com/soho-small-office>, accessed June 2016

³⁷ <http://ethericnetworks.com/business-class>, accessed Just 2016

Figure 9: Ethernic Fixed Wireless Coverage Area³⁸



³⁸ <http://ethernicnetworks.com/coverage-map>, accessed June 2016.

2.5 Satellite

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

Table 10: HughesNet Satellite Residential Plans³⁹

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

Table 11: HughesNet Satellite Business Plans⁴⁰

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

³⁹ <http://www.hughesnet.com/plans-and-pricing/internet-service>, accessed June 2016.

⁴⁰ <http://business.hughesnet.com/plans-and-pricing/internet-service>, accessed June 2016.

Business Package	Internet Speed	Monthly Data Allowance (Business Period + Anytime)	Monthly Price
Select 400	15 Mbps down/ 2 Mbps up	50 GB + 10 GB	\$159.99

Exede Internet also offers residential and business satellite services in Hayward. Residential plans provide 12 Mbps download and 3 Mbps upload. They start at \$59.99 per month for 10 GB of data and go up to 18 GB for \$99.99 or 30 GB for \$149.99. After reaching the monthly data cap, download speeds are reduced to 1 Mbps to 5 Mbps. Exede’s Business Class product provides 15 Mbps download speeds and 4 Mbps upload. There are two separate 30 GB data caps that run from 8 a.m. to 3 a.m. and 3 a.m. to 8 a.m. providing 60 GB total per month.⁴¹

⁴¹ <https://www.inmyarea.com/internet/94557>, accessed June 2016.



City of Hayward Business Broadband Survey

Introduction to City of Hayward Business Broadband Survey

Dear Valued Hayward Business,

The City of Hayward is committed to providing our business community with the infrastructure needed to support your growth and continued success. The City, through our consultant CTC Technology & Energy, is sending you this survey as part of its research into how businesses access and use data connection services, including the Internet.

This survey is designed to help the City understand your current use of data connection services and your projected future needs. It will ask you questions such as what your current services are like and whether they meet your needs; your satisfaction with the services that are currently available to business owners in Hayward; and what you believe the City's role should be in bringing high-speed connectivity to businesses and residents in Hayward.

Your input will help the City develop strategies for improved consumer choice for data connection services (including Internet), and economic development and job creation within the community. The City wants to understand how these services benefit your business, and how we may be able to help fill gaps and reduce barriers to access. The information gathered will not be used to sell you anything. It will not be used for any purpose other than its stated intention—to inform the City's understanding of businesses' use of connectivity services and to explore strategies to improve accessibility and affordability in Hayward.

We understand that, as a business owner, your time is precious, and we have designed this survey to take approximately 10 minutes to complete. The person who selects Internet services for your business should complete the survey.

If you have any questions regarding this survey, please contact Economic Development Specialist Paul Nguyen at 510-583-5542 or paul.nguyen@hayward-ca.gov.

Thank you!



City of Hayward Business Broadband Survey

Information About Your Business

1. How many employees does your business employ in Hayward?

- 1 to 4
- 5 to 9
- 10 to 19
- 20 to 49
- 50 to 99
- 100 to 249
- 250 to 499
- 500 to 999
- 1,000 to 4,999
- 5,000 to 9,999
- 10,000 or more

2. How many total locations does your business have in Hayward?

- 1
- 2
- 3
- 4
- 5 or more

3. Does your business own or lease its Hayward location(s)?

- Lease
- Own
- Combination of lease and own

4. Do your Hayward location(s) share space with other, unrelated businesses (e.g., in an office building)?

Yes

No

Other (please specify)



City of Hayward Business Broadband Survey

Information About Your Business

5. How many personal computers or terminals do you have at your Hayward location(s)?

- None
- 1 to 4
- 5 to 9
- 10 to 19
- 20 to 49
- 50 or more
- Don't know

6. What is the annual sales volume for your business?

- Less than \$500,000
- \$500,000 to \$1 million
- \$1 - \$2.5 million
- \$2.5 - \$5 million
- \$5 - \$10 million
- \$10 - \$20 million
- \$20 to \$50 million
- \$50 to \$100 million
- \$100 to \$500 million
- \$500 million to \$1 billion
- Over \$1 billion

7. What is the annual telecommunications expense for your business?

- Less than \$499
- \$500 to \$999
- \$1,000 to \$2,499
- \$2,500 to \$4,999
- \$5,000 to \$9,999
- \$10,000 to \$49,999
- Over \$50,000



City of Hayward Business Broadband Survey

Business Use of Data Transport and Other Connectivity Services

8. What connectivity services do you use at your PRIMARY business location? (Check all that apply)

- Data
- Internet
- Telephone
- Video conferencing
- Other (please specify)

9. Does your business use data transport and other connectivity services on a day-to-day basis to transfer data to other locations or organizations?

- Yes – to locations in Hayward only
- Yes – to locations outside Hayward only
- Yes – to locations both inside and outside Hayward
- No

10. Is your business required to store any records at an off-site location?

- Yes
- No

11. Have you ever considered redundant or backup network access for your business?

- Yes
- No

12. Do you use any cloud-based services to support business activities?

Yes

No

13. If your business has multiple locations in the region, do you meet your connectivity needs by leasing fiber optic connections to these locations?

Yes

No

N/A – my business does not have multiple locations

14. Do you have a contract with an Internet service provider (ISP) or telecommunications provider for data connectivity services?

Yes

No



City of Hayward Business Broadband Survey

Business Use of Data Transport and Other Connectivity Services

15. Approximately how many months remain on your existing contract with your ISP?

- 1-3
- 4-6
- 7-9
- 10-12
- 13-18
- 19-24
- More than 24

16. Where are decisions about connectivity services made in your organization?

- Within Hayward (local)
- Outside of Hayward (non-local)
- A combination of local and non-local
- Don't know



City of Hayward Business Broadband Survey

Business Internet Connection and Use

17. What do you use for your PRIMARY Internet connection? (Please indicate the way the building/office is connected to the Internet, not the internal Wi-Fi wireless or internal building cabling.)

- Cable modem (Comcast)
- DSL (Digital Subscriber Line)
- Fiber service
- Fractional T1 or full T1
- Metro Ethernet
- Satellite
- Telephone line (dedicated dial-up or share with voice line)
- Wireless
- Don't know
- Do not have an Internet connection
- Other (please specify)



City of Hayward Business Broadband Survey

18. Do you use a backup or secondary connection? If so, what type?

- Cable modem (Comcast)
- DSL (Digital Subscriber Line)
- Fiber service
- Fractional T1 or Full T1
- Metro Ethernet
- Satellite
- Telephone Line (dedicated Dial-Up or share with voice line)
- Wireless
- Don't know
- Not applicable – no backup or secondary connection
- Other (please specify)

19. Would you say your Internet connection speed is:

- Fast enough for your needs
- Not bad but not quite fast enough for your needs
- Fairly slow and you would like to be connected at much higher speeds
- Very slow and you would like to be connected at much higher speed
- Don't know



City of Hayward Business Broadband Survey

Business Internet Connection and Use

20. How IMPORTANT or UNIMPORTANT are the following aspects of your business Internet service?

	Very unimportant	Somewhat unimportant	Neither important nor unimportant	Somewhat important	Very important
Speed of connection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reliability of connection (up time)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Price of services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technical support service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall customer service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Business Internet Connection and Use

21. How SATISFIED or DISSATISFIED are you with the following aspects of your current business Internet service?

	Very dissatisfied	Somewhat dissatisfied	Neither satisfied nor dissatisfied	Somewhat satisfied	Very satisfied
Speed of connection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Reliability of connection	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Price of services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Technical support service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Overall customer service	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Business Internet Connection and Use

22. How important to your business is Internet access in regards to the following?

	Very unimportant	Somewhat unimportant	Neither important nor unimportant	Somewhat important	Very important
Ability to achieve your strategic goals?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Decision of where to locate facilities?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Ability to remain competitive?	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Business Internet Connection and Use

23. Approximately how much do you pay PER MONTH for Internet service at this location? (Do not include charges for telephone lines, data circuit, etc.)

- Less than \$25
- \$25 to \$49
- \$50 to \$99
- \$100 to \$149
- \$150 to \$199
- \$200 to \$299
- \$300 to \$499
- \$500 to \$749
- \$750 to \$999
- \$1,000 or more
- Don't Know



City of Hayward Business Broadband Survey

Business Internet Connection and Use

24. Consider what price level would make you interested in switching to another Internet service provider. How willing or unwilling would you be to switch to a service of 100 Mbps downstream and upstream (5 to 10 times faster than a cable modem) for the following monthly price?

	Very unwilling	Somewhat unwilling	Neither willing nor unwilling	Somewhat Willing	Very willing
\$75 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$100 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$125 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$150 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$200 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$250 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$300 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Business Internet Connection and Use

25. How willing or unwilling would you be to switch to a service of 1 Gbps downstream and upstream (100 times faster than a cable modem) for the following monthly prices?

	Very unwilling	Somewhat unwilling	Neither willing nor unwilling	Somewhat willing	Very willing
\$75 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$100 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$125 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$150 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$200 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$250 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$300 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$500 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
\$1,000 per month	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

26. How IMPORTANT or UNIMPORTANT are these features when selecting *abusiness* (not cellular/mobile) Internet service provider?

	Very unimportant	Somewhat unimportant	Neither important nor unimportant	Somewhat important	Very important
I can choose from multiple Internet providers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can buy service with very high speeds (10–100 times DSL or cable speeds)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I can pay for Internet service based on usage (amount of data)	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
My service provider does not place “caps” on my total data use	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Role of the City

27. Using a scale of 1 to 5, where 1 is Strongly Disagree and 5 is Strongly Agree, please indicate to what degree you believe that the City of Hayward should do the following:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
Help provide communications for local nonprofit organizations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Help ensure that all residents have access to competitively priced broadband Internet services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Help ensure that all residents have access to competitively priced broadband Internet services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Help ensure that all school-aged students, parents, and teachers have access to competitively-priced broadband Internet services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Build a publicly-financed network on which competing private sector companies can offer competitive Internet, phone, and cable television services	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Role of the City

28. Using a scale of 1 to 5, where 1 is Strongly Disagree and 5 is Strongly Agree, please indicate to what degree you agree with the following statements:

	Strongly disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
The competitive market currently offers high-speed Internet access at prices that my business can afford	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
The availability of competitively priced high-speed and/or wireless Internet access is now a factor I would consider when choosing where to locate this business	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
High-speed Internet access is (or is quickly becoming) as essential a service as water and electricity	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
I find it more efficient if businesses and households have high-speed Internet access to purchase products and conduct other transactions	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>



City of Hayward Business Broadband Survey

Role of the City

29. What do you think the MAIN role for the Hayward City government should be with respect to broadband access? (Check MAIN role)

- Install state-of-the-art network and offer services to the public
- Install state-of-the-art network and lease it to competing private companies to offer services to the public
- Encourage a private firm to build a fiber network
- The City shouldn't have a role
- Don't know



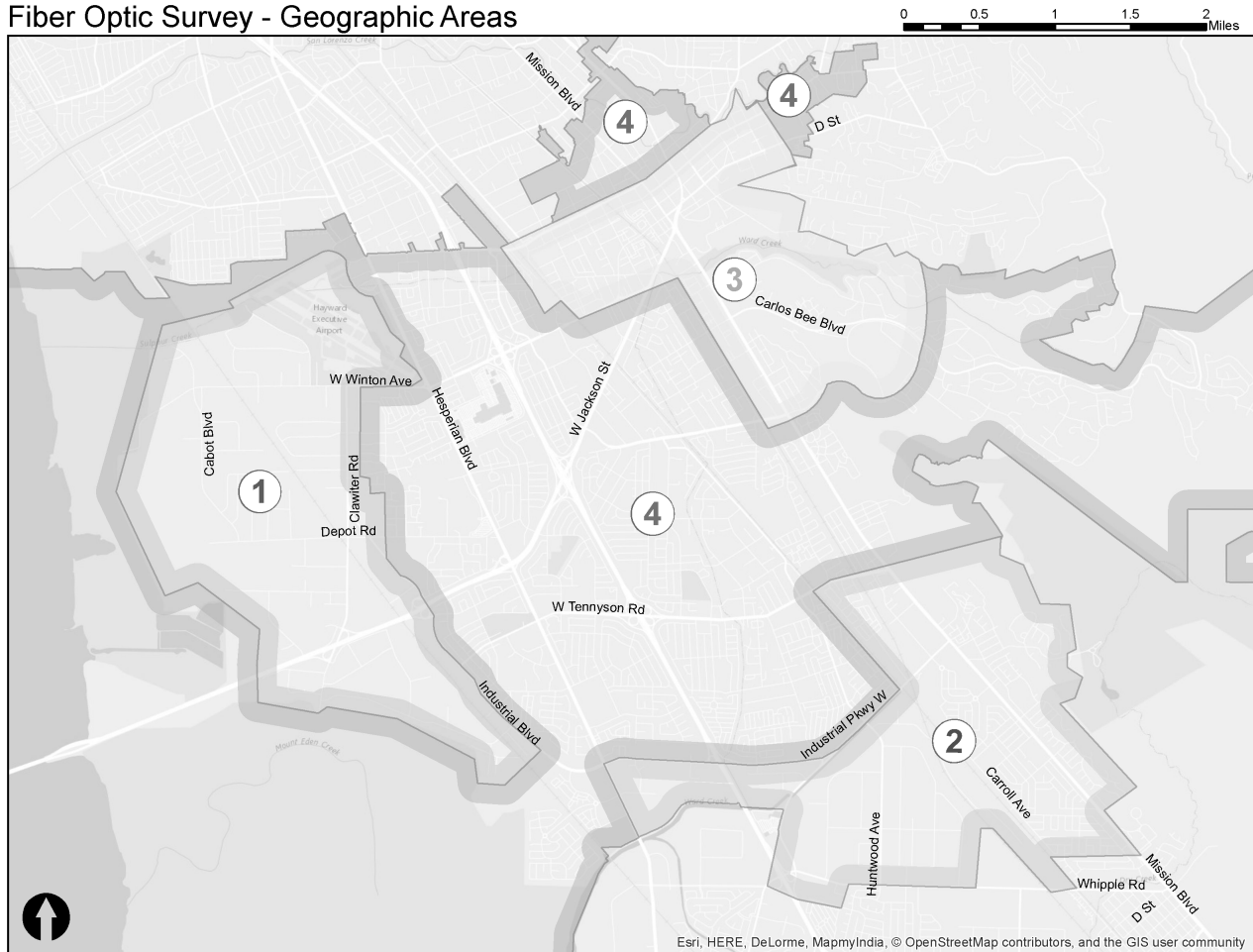
City of Hayward Business Broadband Survey

Business location

30. Please indicate from the map below the approximate location of your business:

- Zone 1
- Zone 2
- Zone 3
- Zone 4

Fiber Optic Survey - Geographic Areas





City of Hayward Business Broadband Survey

Business location

31. Are you willing to share the location(s) of your business in Hayward?

Yes

No



City of Hayward Business Broadband Survey

Business location

32. Please list the address(es) of your business location(s) in Hayward:



City of Hayward Business Broadband Survey

Contact

33. May we contact a designated representative from your business to further discuss the City's broadband initiative(s)?

- Yes
- No



City of Hayward Business Broadband Survey

Contact

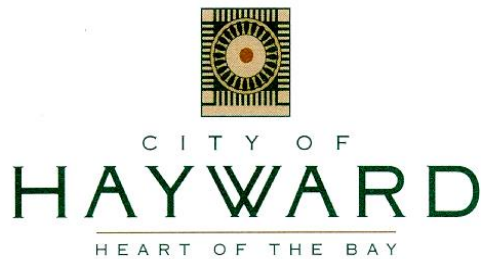
34. Please fill out the information below so that a City representative may contact you.

First and last name

Title

Email

Phone



July 10, 2015

U.S. Economic Development Administration
A. Leonard Smith, Regional Director
Seattle Regional Office
Jackson Federal Building
915 Second Avenue, Room 1890
Seattle, WA 98174

**RE: City of Hayward Economic Development Assistance Grant Application
EDA Control Number 109256**

Director Smith:

Thank you for your continued consideration of the City of Hayward's application for funding under the Public Works Economic Development Assistance program. The total project cost of the proposed High-Speed Hayward Fiber Optic Network is \$5,489,647. The City's share of this cost is equal to fifty percent or \$2,744,824.

The purpose of this letter is to confirm the City's commitment to providing the local match. This match will be compromised of the following:

- City owned right-of-way land at an estimated value of \$2,108,117;
- Funds committed for the construction and installation of the fiber conduit in the Whitesell Street segment of the proposed fiber loop valued at \$156,000; and
- A City General Fund contribution of \$480,707 (cash).

We value the opportunity to leverage a funding contribution from the Economic Development Administration (EDA) and are pleased to make these local funds available to support the project. By partnering to lay the foundation for Hayward's broadband infrastructure, the EDA will help transform our Industrial Technology and Innovation Corridor into a more attractive place for new and existing Advanced Industries to stay, establish roots, and create new quality employment opportunities for our residents.

If you would like to speak to me further about the availability of local funding or anything else associated with this application, please call me at 510-583-4300. Our staff point on this project is Mr. Micah Hinkle, Economic Development Manager, who can be reached at the same number.

Sincerely,

Fran David
ICMA-CM
City Manager

Office of the City Manager

777 B Street • Hayward • CA • 94541-5007
Tel: 510-583-4300 • Fax: 510-583-3601 • Website: www.hayward-ca.gov