COUNTY OF SANTA CRUZ

PLANNING DEPARTMENT
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KATHLEEN MOLLOY PREVISICH, PLANNING DIRECTOR

January 28, 2015

AGENDA: February 10, 2015

Board of Supervisors
County of Santa Cruz
701 Ocean Street
Santa Cruz, CA 95060

SUBJECT: Broadband Master Plan

Dear Members of the Board:

On January 27, 2015, your Board directed staff to return on today's agenda with the draft assessment of the County's broadband options as part of establishing a Broadband Master Plan. Staff have been working with Design Nine, a nationally recognized broadband planning firm, to perform a "Rapid Assessment" of the County's current state of broadband and provide recommendations for future goals. The attached draft details findings, goals and objectives based on the work of Design Nine, meetings with County staff and broadband stakeholders, and a tour of the County's focus areas for economic development.

One of the key goals identified in the report is to encourage and create public/private partnerships. It is our intention to coordinate strategic improvements with the Sunesys Project, a 91.18 mile fiber network from Santa Cruz to Soledad that is funded by a grant from the California Public Utilities Commission. Sunesys is in the process of submitting an environmental study that was required by the State. Once Sunesys receives approval to move forward, the middle mile fiber network will be built within 18 to 24 months. Sunesys will then work with service providers and other entities to gain access to the network. Surfnet and Cruzio are two service providers and last mile carriers that have planned to partner with Sunesys and serve the Sunesys Project area. Through a public/private partnership, an independent Fiber Initiative Team (hereinafter referred to as FI) could be formed to build off these plans in developing a last mile fiber network. Staff should continue to explore the options with this in mind.

As part of the Rapid Assessment, Design Nine also developed detailed cost estimates for potential projects within the County. They are organized into sections that would allow the FI to decide how and when to invest and what different options may cost. The approximate costs of materials and labor are included in the estimates. The potential projects are located in Davenport, Live Oak, the Medical Area, Upper 41st and the Aptos Area. There is also a larger

project that groups Live Oak, the Medical Area and Upper 41st as part of the Urban Core Backbone. These are all areas where the FI could partner with local service providers to invest in a last mile fiber network.

Design Nine is present at today's meeting to describe the current state of broadband in the County, discuss the economic impact of broadband, provide an overview of partnership and funding options, and explain the cost estimates. The draft report and cost estimates are meant to be informational documents, and any input received at today's meeting will be taken into consideration for the final report.

It is therefore RECOMMENDED that your Board accept and file this report and direct staff to return with the final assessment of broadband options and recommended next steps in March 2015.

Sincerely,

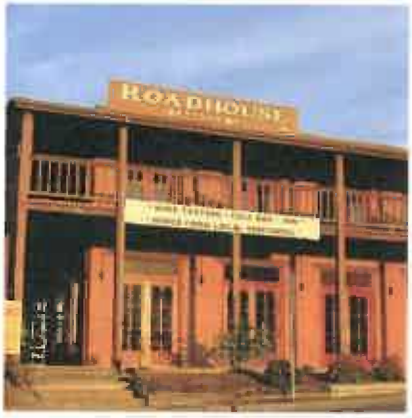
Kathy M. Previsich
Planning Director

RECOMMENDED:

SUSAN A. MAURIELLO
County Administrative Officer

Attachments:
1. Broadband Network Rapid Assessment Draft
2. Santa Cruz County Cost Estimates and Maps

cc: County Administrative Office
Information Services
Public Works



Broadband Network Rapid Assessment

JANUARY 30, 2015

Draft

DESIGN NINE
broadband planners

Disclaimer

The telecommunications business is continually evolving. We have made our best effort to apply our experience and knowledge to the business and technical information contained herein. We believe the data we have presented at this point in time to be accurate and to be representative of the current state of the telecommunications industry.

Design Nine, Inc. presents this information solely for planning purposes. This document is not intended to be a replacement for formal engineering studies that are normally required to implement a telecommunications infrastructure. No warranty as to the fitness of this information for any particular building, network, or system is expressed or implied. Design Nine, Inc. will not be responsible for the misuse or misapplication of this information.

For more information:

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Executive Summary

In 2013, the County of Santa Cruz Board of Supervisors requested that County staff establish a Broadband Master Plan. Since November 2014, members of the County Government have been working with Design Nine, a nationally recognized broadband planning firm to perform a "Rapid Assessment" of the County's current state of broadband and provide recommendations for future goals. This report details the findings and recommendations based upon the Design Nine work and meetings with County staff and broadband stakeholders.

High-performance broadband is essential infrastructure for support of 21st century economic development in Santa Cruz County. Technology firms, film makers, artists, entrepreneurs, medical providers, banks, businesses, and startups require fast, reliable, and affordable connections to their clients. Educational institutions increasingly depend on broadband to provide high quality instruction and meet standards for integrating technology into the classroom to prepare students for careers.

Through a public – private partnership, an independent Santa Cruz Broadband Initiative would seek to increase access to fiber and significantly lower the cost of broadband for business by stimulating competition for private sector service delivery through public and private infrastructure investment.

Design Nine was tasked to explore current conditions of broadband in the County and to provide recommendations on partnership options, funding options, and provide detailed cost estimates on potential projects within the County. The overall goals of this effort is to:

- Identify the kind and type of broadband network needed to retain existing Santa Cruz county businesses and to help attract new businesses and jobs.
- Provide better and more affordable connectivity options for the large number of home-based workers and those running a business from home.
- Identify the benefits of a high performance, affordable broadband network to community institutions like County government, healthcare, and higher education.
- Identify the costs to develop potential pilot project if a decision is made to move forward.

For the County government to make an informed decision about moving forward with a broadband initiative, several questions have to be answered:

- Does the demand exist for improved high performance, affordable broadband?
- What are the design goals for the effort?
- If a new high performance fiber network is built, who will own and manage it?
- What is the business model for the venture (e.g. retail services, wholesale only)?

- Can the venture generate the necessary revenue to be financially sustainable?
- How will it be funded?

FEASIBILITY OF A FIBER INITIATIVE

A fiber project in Santa Cruz County is feasible and practical. The county has significant assets and advantages. These include:

- **Local demand** - Santa Cruz County has a critical mass of government and municipal agencies, colleges, health care institutions, and large and small businesses that can provide the early customer base needed to generate the revenue that would provide the financial support for the network.
- **Excellent quality of life** – Abundant possibilities for rural mountain and coastal living and the County's high quality of life can be an economic development attractor, especially for self-employed businesspeople and entrepreneurs.
- **Excellent recreational activities** – The area has superb outdoor recreational activities, including water-based sports, surfing, kayaking, hiking, and other many other outdoor opportunities.
- **Rich history** – The region has a rich set of traditions and history dating back to the early 1800s that adds historical interest to the area and enhances the quality of life.
- The county has some **private fiber** passing through it--more than some other similar areas. This is currently an under-used economic development tool. Some investment is needed to make access to this fiber more widely available to the business community.
- The grant funded Sunesys middle mile fiber project provides even **more possibilities** for lowering the cost of telecommunications. Sunesys fiber will pass by key economic development areas, including the Medical District, Upper 41st, and Aptos. However, to truly bring the benefit of that regional network to the County, an expanded last mile fiber investment is needed. Additionally, there are other local and regional service providers that could also use the network to offer services to business, institutional, and residential customers.
- UCSC is a key asset and contributes significantly to the economic prosperity of the region. Faculty, staff, students, and off-campus facilities all represent a significant market opportunity for high performance **affordable fiber services**.
- **Santa Cruz** has tremendous potential to attract younger people, start up businesses, and entrepreneurs if affordable Gigabit fiber services are more widely available in the area, including some of the residential areas of unincorporated (and incorporated) regions of the County (for live/work opportunities).

- Over **8000 home based businesses** represent another key market segment that will be early prospects for improved fiber services.

Overview of Master Plan Recommendations

We recommend that the network effort have the following characteristics:

- **Passive Assets** - Fiber in Santa Cruz County could be based on a passive infrastructure model or an "active" lit fiber network. In the passive only model, the new network entity would build fiber and conduit and allow independent providers to "light" the fiber in an open-access model that would promote competition among providers for customers. A passive infrastructure model reduces the initial investment and would have low operational costs. Service providers would be responsible for installing and managing the network electronics for their own customers. In an active model, the community enterprise would install and operate network electronics to create a full provisioned network. Service providers would lease circuits on the network rather than dark fiber.

- **Scalable** - The initial development of the network should be in County economic development focus areas, and over time should support a graceful expansion to be extended to all areas of the County.

- **Business-class capable** - The passive infrastructure would give service providers the ability to deliver any amount of bandwidth needed by any business connected to the network, with any desired quality of service (QoS) required to make Santa Cruz businesses competitive in the world economy.

- **Offer equal access to all providers** – The network should be operated on an open access, wholesale business model with all business and residential services provided by qualified private sector providers. A single public wholesale price list will be used to determine the cost of provider use of the network.

- **Equal access to all residents and businesses over time** – The goal of the network investment would be to deliver high performance fiber services to all residents and businesses who request service as rapidly as possible consistent with fiscally conservative operations.

- **Support a wide range of competitive providers and services** – the multi-provider, multi-service network would give Santa Cruz businesses, institutions, and residents with a wide range of competitive price and service options.

- **Dig Once** - The County should continue to promote the existing "dig once" strategy when and where it makes sense, adding telecom conduit, handholes, and other basic infrastructure as part of other projects (e.g. private sector construction, street rehabilitation, sidewalk repairs and construction, etc.).

- **Limited County Role** - When feasible, Santa Cruz County can make targeted investments in passive infrastructure (e.g. conduit, handholes, dark fiber) that further specific County goals (e.g. smart traffic management, smart street lighting, reduced energy use, and reduced telecom costs for connections between County facilities). In deploying Dig Once, the County should also consider making spare conduit capacity available on an equal access basis for community-based and private sector networks.

- **Ownership and Governance** - The network should be operated as an independent entity firmly vested as a community enterprise. Network management and outside plant maintenance (e.g. routine repairs and emergency break-fix) operations could be outsourced to a qualified private sector firms to minimize permanent staff costs.

- **Business Model** - The network should be available to any and all service providers, including incumbent providers who want access to the significant market opportunity represented by Santa Cruz. This shared business model is fundamentally different from the twentieth century copper-based networks where each provider has to build and operated a completely duplicated network (i.e. two providers each build a separate and duplicated network to reach the same customers, which results in higher costs across the board for customers).

- **Funding Strategy** - The enterprise should develop a "basket" of funding options, including long term service commitments from anchor tenants (e.g. major businesses, County Government, incorporated city governments), state and Federal grant opportunities (e.g. public safety grants), revenue from the network itself, charitable contributions, tax credits, and one time fees for costs associated with connecting a new customer to the network.

ABOUT THE REPORT

This report presents information that Santa Cruz County and stakeholders needs to make an informed decision about strategic investments in modern broadband infrastructure. This includes investments for Santa Cruz County infrastructure needs, and for the wider business and institutional needs in the County . Business retention and new business attraction can only be accomplished if Santa Cruz County has the right telecommunications infrastructure that will enable area businesses to compete in the global economy.

A word about the report content and organization may be helpful at the outset. This subject area is a very challenging one for governments. The complex technical nature of the undertaking sometimes makes the policy issues hard to assess. This report attempts to assist in this regard by providing technical information which can be thought of as informational or educational, in the body of the report and in several appendices.

The goal is not to make this a technical document but to assist the reader in placing the policy decisions in context.

- The *Economic Impact* chapter describes the potential benefits of a community-owned fiber network.
- The *Master Plan Strategies and Goals* chapter outlines strategies and goals for the County of Santa Cruz Broadband Master Plan.
- The *Economic Impact of Broadband* provides an overview of existing conditions and the significance and impact of improved and affordable broadband.
- The *Business Models and Ownership* section describes a variety of business models and ownership models available and in common use and their advantages and disadvantages.
- *Financing Options* provides an overview of funding options and strategies.
- The *Planning for Success* section provides a summary of best practice from other community projects
- *Project Phases* provides a high level overview of the tasks and activities that are required to be successful in deploying community-owned broadband infrastructure.
- *Operating and Managing a Network* provides detail on roles, responsibilities, and tasks related to network operations.

Master Plan Strategies and Goals

This report provides a series of strategies and activities to help get more, and more advanced, broadband in Santa Cruz County. Increased affordability and availability of broadband delivered services has the potential to increase job creation in the County, help retain existing businesses, and improve the County's ability to attract new businesses and entrepreneurs.

While many residents and businesses have access to copper-based (or existing wireless) "little broadband" services with bandwidth in the range of 1-10 megabits/second, many other cities and towns in the country (more than 130, according to Broadband Communities magazine) have already made the leap to fiber-based "big broadband" with a minimum bandwidth of 100 megabits/second and many of those communities are now "Gigabit Cities" with a standard residential and business connection of 1,000 megabits (one Gigabit).

One might reasonably ask, "Why does anyone need a Gig of bandwidth?" The value of a Gig fiber connection is about the future, not the present. It is about preparing citizens, businesses, and the community to be able to compete for jobs and businesses over the next five to thirty years, with future-proof infrastructure that will support future needs.

The economy in Santa Cruz has a long and rich history of being driven by tourism, art, education, technology, and agriculture. More recently, the creative technology boom of mid-coastal California brought new opportunities to Santa Cruz. In the past fifteen years, the U.S. economy has been undergoing a dramatic transformation as digital road systems now transport the products and services of the new economy.

As just one example, music was formerly a "heavy" product that required both a local and national road system to carry first vinyl records and then CDs from manufacturing plant to customers. Today, virtually all music is transported directly to buyers over the new Internet-based digital road system. Software, formerly sold in stores, packaged in boxes, is now delivered via the digital road system. In the week after Christmas (2014) Apple Computer sold and delivered more than half a billion dollars in software--all delivered via the Internet-based transport system.

Today, Santa Cruz County needs a modern transportation system--a digital road system--both within the County and to other points in the state and the nation.

Without some action, the County will stand still economically with its current copper-based telecom infrastructure, effectively freezing economic development where it is today. But if the community wants to grow economically, retain businesses, create jobs, attract entrepreneurs, and bring new businesses, Gigabit connections in key locations like the population centers and business districts become a critical part of a forward-thinking economic development strategy.

In summary, if a fiber initiative in Santa Cruz County makes targeted investments in broadband infrastructure, with the goal of creating a successful public/private partnership,

expected outcomes can include increased economic growth through increased business attraction, increased local business expansion, and an increase in good-paying job opportunities.

LONG TERM GOALS

Long Term Goals	Description
Encourage Public/Private Partnerships	Partnerships among Santa Cruz County local government, local schools (including Cabrillo College and USCS), service providers, public safety agencies, and major businesses will assist with business attraction and lower telecom costs for all partners.
Create New Business Opportunities for Existing Service Providers	Local government should only provide basic infrastructure and transport, and should not compete with existing providers by selling services to businesses and residents.
Fiber Should Support Economic Development	Broadband investments should be targeted to promote business growth and jobs creation.
Reduce Cost, Improve Quality of Government Services	Local investments in basic broadband infrastructure will reduce the cost of telecom services and related expenses for businesses in the County while simultaneously improving service delivery.
Reduce Costs for Small and Large Businesses	Modest investments in fiber infrastructure will reduce the cost services for entrepreneurs, business start ups, and existing businesses.
Don't Wait	Many other communities have already made investments and are aggressively promoting their infrastructure as part of their economic development strategies.

ENCOURAGE PUBLIC/PRIVATE PARTNERSHIPS

The size of the region and the diversity of public and private interests in the County will require a commitment to collaboration between the private sector and local government. From a network perspective, the entire county is a single market. Important and critical partners include:

- Santa Cruz County and other local governments including the four incorporated areas as well as surrounding counties.
- Existing incumbent and competitive telecom service providers, in particular the local service providers who already have invested heavily in the market.
- Businesses, institutions, and other stakeholders that have high bandwidth needs.

By taking the time to develop partnerships:

- Costs are spread across a larger market area, making the long term financial sustainability much more likely.

- The larger market base will attract more providers and services, leading to even lower prices and a greater diversity of service offerings.
- The larger market base will also encourage more private investment, especially in creating new and diverse fiber routes in and out of the County.
- It will be possible to raise more funds more quickly and thereby build to more businesses, residents, and institutions more quickly.

Create New Business Opportunities for Existing Service Providers

Any local government investment in telecom and broadband infrastructure should be at the basic infrastructure layer of the network. Local government should avoid selling services to businesses and residents. Providing basic infrastructure will allow providers to reach new customers at much lower cost and allow them to offer improved services to their existing customers. An important goal of any local government investment should be to create new business opportunities for existing incumbent and competitive providers.

Build Fiber in Support of Economic Development Goals

The County needs more distribution and access fiber, which is essential for meeting future demand for broadband services as well as attracting and retaining businesses.

- Fiber to the home is needed to support work from home opportunities and keep commuters in Santa Cruz more often.
- Fiber to the home is needed to support business from home ventures, especially small business start-ups and entrepreneurial ventures.
- Fiber is needed to every economic development area and corridor in the County, and open fiber is needed in the the heavily populated areas and in other commercial and retail areas of the County to reduce the cost of broadband services for businesses located in those areas.
- Broadband is needed to both improve the delivery of government services and to reduce the cost of those services.

Reduce Cost, Improve Quality of Government Services

A shared network will help reduce the cost of telecommunications and broadband services for the County through increased competition and the cost advantage of shared infrastructure. Critical services like public safety will benefit from a long range plan to make fiber available to most local government locations (e.g. fire and rescue, police stations, pumping stations, and parks.

Reduce Costs for Small and Large Businesses

A shared, high performance network will reduce the cost of telephone, Internet, data back up, videoconferencing, and other business services through reduced cost of infrastructure and

increased competition. Santa Cruz County is competing for jobs and businesses with other communities in California and communities in other states that already have this kind of infrastructure in place--and most of those communities are aggressively promoting it as part of their economic development business attraction and retention strategies.

DON'T WAIT

Many other regions, some close by, are well ahead of Santa Cruz County in their plans to acquire 21st century broadband infrastructure.

- There are numerous other county and multi-county broadband networks that have been operating successfully for years. New Hampshire FastRoads is a community-owned Gigabit network providing open access services to 22 towns in rural New Hampshire.
- Kansas City, Kansas and Kansas City, Missouri have the Google partnership underway, which is connecting hundreds of government locations, thousands of businesses, and tens of thousands of homes.
- Danville, Virginia has been successfully operating a municipal open access network since 2007, and the project generates enough revenue to fund a steady expansion.
- The City of Eagan, Minnesota has built 17 miles of Gigabit fiber that passes most of the primary business and commercial areas of the city, and the network was a key factor in attracting a major data center to Eagan.
- More than 135 other communities in the United States have operating networks or have substantial network construction underway.

SHORT TERM GOALS

A variety of short term goals should be considered as next steps in this effort.

Short Term Goals	Description
Continue the Current Broadband Initiative	The current group of public and private stakeholders and interested parties should continue development of this initiative.
Select an Ownership and Business Model	Answering the questions, "What entity will own and manage the infrastructure?" and "What will the entity sell (i.e. dark fiber or lit circuits) is an essential first step.
Commitment from Key Stakeholders to Support the Effort	Support from elected officials and key stakeholders like the UCSC, local providers, County government, and local health care providers is essential to success.

Short Term Goals	Description
Consistent Message and Coordinated Public Awareness	If a decision to move forward is made by the County, stakeholders, and interested parties, a consistent message about the benefits and advantages will be critical to gain public support.
Create a Public/Private Partnership	Investments in basic infrastructure create an ideal opportunity to form a public/private partnership with existing local and regional providers.
Continue to Develop a Common Fiber Overlay Plan and Open Ditch Policy	Conduit and handholes should be included where appropriate in all new public and private construction. Shared trenching should be vigorously pursued.
Coordinate Broadband Infrastructure Improvements with Public Safety Spending	Coordinate upgrades to public safety communications systems with planned fiber improvements to reduce the cost and improve the quality of public safety voice/data traffic.

Continue the Current Broadband Initiative

The current group of County officials, private sector business people, and institutional stakeholders should continue to meet regularly, identify key decision points, recommend an overall strategy, and adopt an action plan for next steps.

Select a Ownership and Business Model

There are several ownership options (e.g. nonprofit, LLC, stock corporation), and what is chosen will depend in part on the early funding sources and key stakeholder participation.

Commitment from Key Stakeholders to Support the Effort

County support may consist of investments in conduit and other passive infrastructure that can be leased out on an open access basis, commitments to buy services once the network is constructed, and commitments to provide expedited rights-of-way and construction permit processing. The commitment to buy services for County facilities and agencies is particularly important for financial sustainability and stability over time. This is also true for the incorporated cities within the County. Currently, both the County and the incorporated cities utilize dark fiber provided by Comcast which will no longer be available starting in 2022 (at the current rate of $1 per year).

As more private sector businesses are connected, government purchases of services have less financial impact on the enterprise, but early commitments from anchor tenant customers can ease financing (both for public and private ownership) and can help attract service providers.

During the planning stages of first phase of development, it is also important that local businesses consider the impact of purchasing or renewing long term broadband and telecom service contracts with providers. Large "anchor tenant" customers for the new infrastructure

can use their purchasing power to encourage local incumbent and competitive service providers to amend their contracts to allow a graceful transition to the new open network.

Consistent Message and Coordinated Public Awareness

Public support for the project will be important to the long term success of the effort. All parties involved in the effort must be able to address key talking points clearly, succinctly, and consistently to avoid confusion and negative rumors. Incumbents may embark on extremely negative and mis-leading public relations campaigns that seem to suggest a wide range of poor outcomes to such an effort. Citizens may assume that taxes will be increased to support the effort. A well-managed public awareness campaign that includes helping elected and appointed officials both understand and discuss key parts of the project will be very important.

Create a Public/Private Partnership

Any new community-owned entity formed should partner with local and regional private sector providers to avoid competing with the private sector and to limit the size and scope of County government involvement.

Continue to Develop a Common Fiber Overlay Plan and Open Ditch Policy

A fiber overlay plan is an essential part of any next steps. The County should continue to develop its current work efforts to identify desired fiber routes and connected facilities, any road reconstruction or repairs, and other civic construction or utility work should be compared to the overlay plan to determine if the new work is on a desired fiber route. If it is, funds should be budgeted during the planning phase of the effort to include adding duct and fiber along that route.

The Public Works Department should update new project guidelines and checklists to aggressively encourage both public and private development projects to include conduit, duct, and handholes where appropriate, just as private developers routinely provide shared infrastructure like roads and sidewalks.

The Public Works Department should be trained to install duct so that incremental build opportunities can be pursued at the least cost and funding should be made available such that the Public Works Department can invest modest funds where appropriate.

Coordinate Broadband Infrastructure Improvements with Public Safety Spending

Public safety can benefit substantially from cost sharing with a community-owned network. Fiber can be reserved specifically for public safety use so that those agencies have secure data transmission with no information co-mingled with commercial and residential data. The public safety radio network can be enhanced by running fiber (over time) to all repeater towers, improving the quality of voice transmission and potentially reducing the overall number of towers and repeaters needed.

The Economic Impact of Broadband

Over the next thirty years, the businesses, residents, and institutions of Santa Cruz will spend seven billion dollars on telecommunications services--in today's dollars, unadjusted for inflation and unadjusted for price increases. Some analysts believe that the average household bill for services delivered via broadband may double in the next ten years, which would make the thirty year projection easily reach $8-10 billion. Currently, there exists a substantial opportunity to capture more of these funds and direct them towards greater job creation and business opportunities for the County.

Numerous studies indicate that demand for bandwidth is doubling every two years, and that the Federal Communications Commission (FCC) expects that the typical bandwidth needed by businesses and residents in 2016 (in just one year) will exceed 50 megabits. Indeed, the New Hampshire FastRoads community-owned fiber network is finding that their 50 meg residential Internet service is extremely popular...in rural and remote New Hampshire.

Community livelihood and the economic future in the Santa Cruz area is dependent upon the availability of affordable high speed broadband services--at the bandwidths that will be needed to conduct business in the future ("big" broadband), not at today's "little" broadband speeds. Businesses large and small are already heavy users of the Internet, and their bandwidth needs will increase dramatically as two business trends accelerate:

Firstly, business travel costs are increasing rapidly as the cost of fossil fuel increases. Both the cost of ordinary commuting to the workplace is increasing as well as the cost of out of town business travel by air. Not to mention in Santa Cruz the upwards of 35,000 daily commuters to leave the County for their jobs. Businesses are already investing heavily in High Definition (HD) quality business videoconferencing systems, and will make more use of them to reduce travel costs. These HD quality business videoconferencing systems require dramatic increases in bandwidth that are not affordable or in most cases not even available in Santa Cruz. There is no question that the market exists in Santa Cruz to implement the infrastructure to support resources like HD quality business videoconferencing systems considering the largest business sector in the area comes from professional business services.

In many states and the federal government, the employment commission encourages businesses to allow employees to work from home to help with work-life balance and reduce overhead costs in the office, but the broadband infrastructure must be in place. High performance broadband could have positive effects: it could enable more people to work from home, it could enable more home-based businesses, and it could attract more businesses to the County. In Santa Cruz, additional workers who stay in the County, even if a few days a week, will benefit the local economy in multiple tangible and intangible ways including increasing foot traffic at local businesses, decreasing traffic on highways during rush hours, increasing the quality of life of individuals who can limit the number of weekly commutes.

Additionally, more and more workers and business people are working from home, either on a part time or a full time basis. New work from home job opportunities are growing rapidly, but most of those jobs require a wired Internet and a wired phone connection to qualify. Many corporate and business employees will be seeking permission to work more from home (e.g. one or two days per week) to reduce travel costs.

Some major businesses in other parts of the U.S. are already actively planning to have 20% of their workforce work full time from home to reduce employee travel costs and office energy costs. Telework initiatives are becoming more widespread throughout each state, where states Corporate employees working from home require high bandwidth services to be connected to the office network and to use corporate videoconferencing systems. These corporate network services will require 35-50 megabit connections within five years. Santa Cruz is already missing opportunities to attract remote workers from Silicon Valley because of the lack of broadband service. If Santa Cruz does not execute on plans to get big broadband in every home, this trend is likely to continue.

This report presents the information that Santa Cruz needs to continue on the path to big broadband and start planning strategic investments in modern broadband infrastructure. For the County, business retention and new business attraction can only be accomplished if the area has the right telecommunications infrastructure that will enable area businesses to compete in the global economy.

County of Santa Cruz 30 Year Telecom Expenditure Analysis			
	Households still on dial-up	Households with "little" broadband cable modem/DSL/wireless	Households with no Internet
Total households	104,698		
Total businesses	6,785		
Household Percentage	3%	84%	13%
Number of households	3,141	87,957	13,611
Average monthly telecom expenditures	Local phone: $25 Long distance: $25 Cable/satellite TV: $65 Dial up Internet: $20	Local phone: $25 Long distance: $25 Cable/satellite TV: $75 Broadband Internet: $45	Local phone: $25 Long distance: $25 Cable/satellite TV: $65
Annual cost/household	$1,620	$2,040	$1,380
30 year expenditure	$152,649,684	$5,382,955,536	$563,484,636
Total residential expenditures	$6,099,089,856		
Total expenditures	$7,013,953,334		

Demographic data from Santa Cruz County, CA QuickFacts from the US Census Bureau

WHAT IS BROADBAND?

There is much confusion about the "true" definition of broadband. From the perspective of economic development, there can be no upper limit on the definition of broadband. Saying that broadband (as an example) is 5 megabits/second of bandwidth or 10 megabits/second is to immediately tell businesses in the County that there will be structural limits on their ability to do business in the future–it is dictating the size of truck that can be used to deliver goods and services. Here is the only appropriate definition of broadband:

Broadband is whatever amount of bandwidth is needed to support a business' ability to compete in the global economy.

Broadband is a community and economic development issue, not a technology issue. The essential question is not, "What system should we buy?" or "Is copper or fixed wireless better or cheaper than fiber?" Instead, the question is:

"What do Santa Cruz businesses and residents need to be able to compete globally over the next thirty years?"

In short, Santa Cruz today has "little broadband" in the form of Digital Subscriber Line (DSL) and cable modem service, along with a very limited amount of "big broadband" in the form of fiber to a few businesses and institutions.

If Santa Cruz is to make investments in broadband and telecommunications infrastructure, it is absolutely critical that those investments are able to scale gracefully to meet business and economic development needs for decades. This drives the solution towards fiber, more importantly - fiber to every home and business. Some off the shelf business videoconferencing systems in use today require a minimum of 50 megabits of bandwidth--speeds that can only be achieved reliably by fiber. Two key concepts that should drive community investments in telecom are:

"Broadband" is not the Internet

Bandwidth is not a fixed number

Broadband and "the Internet" are often used interchangeably, but this has led to much confusion. Broadband refers to a delivery system, while "the Internet" is just one of many services that can be carried on a broadband network. The challenge for communities is to ensure that businesses and homes have a broadband network with sufficient bandwidth to deliver all the services that will be needed and expected within the next three to four years, including but not limited to "the Internet."

Bandwidth needs for the past decade have been growing by 25% to 50% per year, and show no sign of slowing. As computers and associated hardware (e.g. video cameras, audio equipment, Voice Over Internet Protocol (VoIP) phones) become more powerful and less expensive, new applications and services are continually emerging that drive demand for more bandwidth. The table below indicates the likely growth in bandwidth, based on current uses, emerging high end

equipment, and research lab/university/government networks already deployed and in use. Lightpaths refer to placing multiple wavelengths (paths) of light on a single fiber. High end commercial equipment already in production is routinely placing 20+ lightpaths on a single fiber, with each lightpath capable of carrying data at gigabit (or higher) speeds. This technology will move down to ordinary business and residential network equipment over the next ten to fifteen years. Current fiber being installed will require only a relatively inexpensive equipment upgrade to increase carrying capacity over the same fibers. As the cost of construction inevitably grows and as the right-of-way continuously becomes more crowded, the cost of installing fiber will steadily increase as well.

From a report by the Information Technology and Innovation Foundation (March, 2009), listed below are the bandwidth requirements for services already commonly in use and for emerging services like telepresence business videoconferencing.

Application/Service	Upstream Bandwidth Requirement	Downstream Bandwidth Requirement	Total Combined Bandwidth Required
Medium resolution videoconferencing	1.2 megabits	1.2 megabits	2.4 megabits
Streaming video (720p)		1.2 megabits	1.7 megabits
Standard definition TV		4 megabits	4.25 megabits
Basic HD videoconferencing (720p)	1.2 to 4 megabits	1.2 to 4 megabits	2 to 8 megabits
Telepresence high resolution HD videoconferencing	5 megabits	5 megabits	10 megabits for 2 attendees, 15 meg for 3 attendees
Video home security service	10 megabits		2.5 to 5 megabits
HD digital television (1080p)		15 megabits	5 to 10 megabits
Telepresence very high resolution HD videoconferencing (1080p)	15 megabits	15 megabits	30 megabits for 2 attendees, 45 megabits for 3 attendees
4K digital television	1 megabit	19 megabits	20 megabits

Note that the business videoconferencing services all require symmetric bandwidth. This is a critically important issue, as current incumbent "little broadband" services like DSL and cable modem systems do not offer symmetric bandwidth (where the upstream and downstream bandwidth is equal). Using this information we can project what Santa Cruz homes and businesses will need in the coming years.

	Current	Next decade	Twenty years
Small business needs (1-9 employees)	10-25 megabits of symmetric bandwidth and 5-10 megabits of Internet access	100 megabits of symmetric bandwidth and 20-40 megabits of Internet access	Gigabit+ symmetric bandwidth and 50 to 100 megabits of Internet access
Medium-sized business needs (10-100 employees)	50-100 megabits of symmetric bandwidth and 10-20 megabits of Internet access	Gigabit symmetric bandwidth and 50 to 100 megabits of Internet access	Multiple gigabit symmetric circuits and lightpaths and 100+ megabits of Internet access
Large business needs (100-1000+ employees)	Gigabit+ symmetric bandwidth and 100+ megabits of Internet access	Multiple gigabit symmetric connections and 250 to 500 megabits of Internet access	Multiple gigabit symmetric circuits and lightpaths and 1 Gigabit+ of Internet access
Residential needs	25-50 megabits of symmetric bandwidth and 4-8 megabits of Internet access	100 megabits of symmetric bandwidth and 20-30 megabits of Internet access	A Gigabit symmetric circuit and/or lightpaths, with 50 to 100 megabits of Internet access

World class broadband infrastructure will be necessary to maintain the County's attractiveness as a great place to live.

When local governments undertake a study of broadband infrastructure, a key question should be:

"What is the benefit if government invests in broadband infrastructure?"

And the inverse question should also be asked:

"What happens if we don't make strategic broadband investments?"

OUTCOMES OF STRATEGIC LOCAL GOVERNMENT INVESTMENT	OUTCOMES OF LEAVING IT ENTIRELY TO THE PRIVATE SECTOR
Increased competitiveness with other cities and regions that have made broadband investments and have driven down the cost of Internet and voice services for businesses and residents.	Communities with shared broadband infrastructure are seeing increased economic development activity and increased business attraction success.
Better prepared to attract businesses and jobs to the area.	The County is at an economic disadvantage without a strategy to ensure than affordable high speed broadband is in place as a business attraction and business retention tool.

OUTCOMES OF STRATEGIC LOCAL GOVERNMENT INVESTMENT	OUTCOMES OF LEAVING IT ENTIRELY TO THE PRIVATE SECTOR
Cities and counties that have made investments have seen the cost of telecom services sharply reduced, keeping more money in the community and freeing up business funds for expansion and jobs creation.	Residents and businesses will continue to pay more for voice, TV, Internet, and other broadband services.
A long term strategy of "fiber everywhere" gives the County better educational opportunities and improved access to jobs. Fiber service in the County will also attract entrepreneurs and business people who want to work from home.	The County may see less population growth, loss of younger workers and families, and diminished educational opportunities.
Aggregation of the marketplace for telecom services via shared community infrastructure attracts more providers and helps keep prices for broadband services lower.	Private sector providers will continue to "Balkanize" the County, with higher prices and more limited bandwidth options because of limited competition.

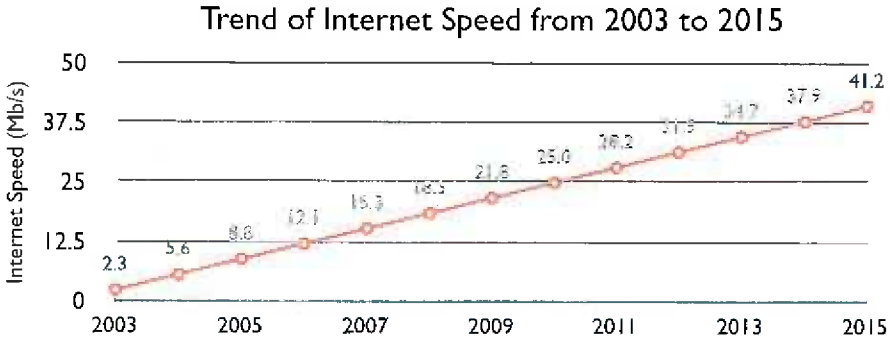
This report assesses and analyzes current conditions and future potential of broadband in the County so that the government of Santa Cruz County can take advantage of the emerging business and residential growth within the area. This can only be accomplished if the County has the right telecommunications infrastructure that will support the needs of existing businesses and also attract new businesses.

EXISTING CONDITIONS

Although the U.S. once led the way in the World Wide Web, the U.S. has now fallen to the 27th place among developed nations for broadband usage according to a report conducted by the OECD (Organization for Economic Co-operation and Development) in 2012.

In addition, limited choices often force U.S. consumers to purchase slower bandwidth speeds at a higher cost as compared to other nations. However, increasing bandwidth speed at an affordable price point will be necessary to compete in a global economy. The speed of the bandwidth can have a significant impact at the local, state, federal, and international level in regards to the standard of living and economic development.

The Internet-enabled local and regional networks service the purpose of maintaining and creating jobs, facilitating telemedicine, improving education, ensuring public safety, and providing public services. Just within the past decade, the key purposes of the Internet were intended for basic use to hop onto the web. However, the Internet is now used for both play and for work.



The steadily increasing use of the Web and other Internet-based services is creating the need for more bandwidth both at home and in business. Broadband bandwidth has increased from 300 Kb/s in 2003 to 25 Mb/s in 2010 according to a report conducted by Cisco. Despite the fact that global IP traffic has increased eightfold over the past 5 years, and will increase fourfold over the next five years, most U.S. Internet connections are not sufficient enough to support interactive home-based medical monitoring, multi-media distance learning, or to send and receive data to run a home-based business as denoted by the Cisco Visual Networking Index.

In other words, the U.S. is average on the playing field of first generation broadband measures. The U.S. is an even weaker performer on providing reasonable prices for high and next-generation speeds. This translates into a significant concern if business users of broadband want to compete globally for business concerns and enjoy the same connectivity capabilities as their competitors in a worldwide marketplace. Various predictions are forecasting steady future growth as the number of Internet-connected devices increases and users make more sophisticated use of those devices and the services available on those devices.

- By 2017, average global broadband speed will grow 3.5-fold, from 11.3 Mbps (2012) to 39 Mbps (2017) -- Santa Cruz can't rely on antiquated copper and cable networks to support future bandwidth needs.
- Annual global IP traffic will reach the zettabyte threshold (966 exabytes or nearly 1 zettabyte) by the end of 2015. (A zettabyte is a measure of storage capacity. 1 zettabyte is approximately equal to a thousand exabytes or a billion terabytes.)
- The OECD (Organization for Economic Co-operation and Development) predicts that 2022, the average household with two teenage children will own roughly 50 Internet-connected devices, up from approximately 10 in 2014. This trend has been dubbed the "Internet of Things."
- The "terabyte club" will reach 6 million by 2015. In 2015, there will be 6 million Internet households worldwide generating over a terabyte per month in Internet traffic, up from just a few hundred thousand in 2010. There will be over 20 million households generating half a terabyte per month in 2015.

- Global IP traffic has increased eightfold over the past 5 years, and will increase fourfold over the next 5 years. Overall, IP traffic will grow at a compound annual growth rate (CAGR) of 32 percent from 2010 to 2015.

- A growing amount of Internet traffic is originating with non-PC devices. In 2010, only 3 percent of Internet traffic originated with non-PC devices, but by 2015 the non-PC share of Internet traffic will grow to 15 percent. PC-originated traffic will grow at a CAGR of 33 percent, while TVs, tablets, smartphones, and machine-to-machine (M2M) modules will have growth rates of 101 percent, 216 percent, 144 percent, and 258 percent, respectively.

- Globally, video will be 73 percent of all Internet traffic (both business and consumer) by 2017, up from 60 percent in 2012. The sum of all forms of video (TV, video on demand [VoD], Internet, and P2P) will continue to be in the range of 80 and 90 percent of global consumer traffic by 2017. -- the County of Santa Cruz needs broadband infrastructure that will support current and future video uses, especially high-def business videoconferencing.

- Busy-hour traffic is growing more rapidly than average traffic. Busy-hour traffic will increase fivefold by 2015, while average traffic will increase fourfold. During an average hour in 2015, the traffic will be equivalent to 200 million people streaming high-definition video continuously. During the busy hour in 2015, the traffic will be equivalent to 500 million people streaming high-definition video continuously.

- Internet video is now 40 percent of consumer Internet traffic, and will reach 62 percent by 2016, not including the amount of video exchanged through P2P file sharing. The sum of all forms of video will continue to be approximately 90 percent of global consumer traffic by 2016. Internet video is not just entertainment, in encompasses educational content including college credits and on the job training, healthcare consultations, business video conferencing, security and many other uses.

- The highest quality IP-based video streams today require six to twelve megabits/second, but the emerging Ultra HD, designed to support the new 4K TVs, will require fifteen to twenty megabits/second--per channel. If there are two people in a home watching two different channels at the same time, the base bandwidth requirement just to watch TV will be on the order of 40 megabits/second.

- Globally, mobile data traffic will increase 13-fold between 2012 and 2017. Mobile data traffic will grow at a CAGR of 66 percent between 2012 and 2017, reaching 11.2 exabytes per month by 2017. -- Fiber-enabled data backhaul services are critical to ensuring that mobile phone and data networks have enough capacity to support demand.

- Business IP traffic will grow at a CAGR of 24 percent from 2010 to 2015. Increased adoption of advanced video communications in the enterprise segment will cause business IP traffic to grow by a factor of 2.7 between 2010 and 2015.

- Business video conferencing will grow sixfold over the forecast period. Business video-conferencing traffic is growing significantly faster than overall business IP traffic, at a CAGR of 41 percent from 2010-2015.

IN SANTA CRUZ:

- There are approximately 8000 home based businesses, and that number is increasing every year. These businesses are highly reliant on affordable broadband, many of them being Etsy, Ebay, or other online storefronts. Santa Cruz has one of the highest per capita concentration of artists in the country.
- Approximately 35,000 workers commute out of Santa Cruz to go to work in surrounding localities, namely to the North. This is a strong indication that improved broadband access will have a significant economic impact by increasing the number daytime workers in the County. Keeping these workers in the County, even a few days a week will benefit the local economy and reduce the traffic burden.
- There are no middle tier providers in the County. Until a reliable backbone exists in Santa Cruz it will be difficult to attract large businesses with high bandwidth needs (such as data centers).
- Currently, only Comcast and Charter offer cable services in town. The existing Charter cable plant is becoming Comcast as part of the TWC/Comcast merger. This leaves a single provider in the town with the capacity to provide residential "little" broadband. Comcast has indicated that they have no plans to upgrade to DOCSIS 3.0. DOCSIS or Data Over Cable Service Interface Specification, is how high speed Internet is delivered over the cable television plant. A DOCSIS 3.0 upgrade would allow for services up to 100Mbps (downstream) to be delivered. Santa Cruz has few options to negotiate or influence investment because of a CA statewide cable franchise agreement created in 2014, which prevents or overrides any local franchise agreements.
- Santa Cruz does have several local resources to leverage when it comes to broadband. There are two local providers, Cruzio, and Surfnet who are likely to be interested in local investments made in infrastructure. Santa Cruz also benefits from a connection to Sunesys, a $14M middle mile fiber network. The Sunesys network is an open network and the majority of the funding came from a state grant.
- The County of Santa Cruz already has an open ditch or "Dig Once" ordinance which can be leveraged to continue building infrastructure resources locally.

NEXT GENERATION CONNECTIVITY

"Next generation" is the term used to describe future planning for the next step in network connectivity and infrastructure. There seems to be an emphasis on deploying fiber-to-the-home (FTTH). But why? By pulling fiber deeper into the neighborhood and providing greater access

to connectivity, this allows the infrastructure to be in place to accommodate future communication needs, capacities, and innovations. Because of the U.S. demographic bulge that occurred during the baby boom after WW2 caused exurban migration, the U.S. is currently the only country where fiber is being deployed in largely suburban areas with single family homes. In countries like Japan and Korea, fiber to the apartment is widely available, in part because the cost of delivering fiber to a high rise apartment building that might have 500 subscribers is much lower than the build cost of fiber to 500 single family homes in a sub-division.

Next generation broadband reaps substantial benefits; there are several key benefits of "Next-Generation Broadband":

- Dramatically faster file transfer speeds for both uploads and downloads
- The ability to transmit streaming video, transforming the Internet into a far more visual medium
- Means to engage in true-real time collaboration
- The ability to use many applications simultaneously
- Ability to maintain more flexible work schedules by being able to work from home on a part time or full time basis
- The ability to obtain health-related services for an occasional illness and/or long term medical services for chronic illnesses.

Clearly, consumers have a strong interest in a visual medium from when and wherever they are. YouTube is the second most popular search engine after Google, which demonstrates the need to support the infrastructure to transmit streaming video.

In addition to video streaming, true-real time collaboration also provides an effective way for people to interact from wherever they are. People can engage in a two-way, real-time collaboration, so that fruitful, visual conversations can be held between friends, family, business associates from the state, country, or internationally.

Because of fiber networks, employees have the capabilities of working from their home. Findings suggest that if all Americans had fiber to the home, this would lead to a 5 percent reduction in gasoline use, a 4 percent reduction in carbon dioxide emissions, $5 billion in lower road expenditures, and 1.5 billion commute hours recaptured.

SIGNIFICANCE OF BIG BANDWIDTH FOR THE FUTURE

According to the 2009 report from the World Bank on information and communications technologies, for every ten additional broadband subscribers out of 100 inhabitants are correlated in high income countries with GDP growth increases of 1.21%.

PROSPERITY

As suggested from the statistic above, the Internet generates growth. In more than a handful of countries, GDP growth doubled to over 21% due to the Internet. Although some jobs have been eliminated due to the emergence of the Internet, nearly 1.2 million jobs have been created over the past 15 years from the Internet. The McKinsey's global SME survey suggests that 2.6 jobs were created for each lost.

HEALTH CARE DELIVERY

According to "The 2008 State New Economy Index" healthcare can be significantly improved in the future through greater use of information technology and connectivity to the web. Healthcare costs can potentially be cut by $80 billion annually. The cost of health care continues to rise annually. For instance, health care as a share of U.S. GDP has almost doubled from 8.8 percent to 15.3 percent in 2005. One aspect of health care that is gaining steam is electronic prescribing. Electronic prescribing cuts medical transaction costs by eliminating the need for confirmation phone calls and faxes and reduces the chance of health risks due to prescription delays. This is a particularly useful asset for communities in rural areas who do not have convenient access to medical assistance.

GOVERNMENT AND CIVIC LIFE

The term E-Government refers to networked information technologies online to serve constituents. The Internet cuts costs for many state governments from reducing the paper trail to expediting services through the Web like renewing drivers' licenses and paying taxes. Furthermore, E-government will become a setting for online based discussions between constituents and bureaucrats. This allows for greater transparency in hopes of garnering a better perception of how government functions. More local and state governments and the federal government are attempting to involve constituents through webinars, blogs, wikis, and videos.

EDUCATION

Students benefit greatly through the use of computers and Internet. Nearly every public school in America has access to the Internet. In 2007, there were 180,000 more instructional computers in the schools than in 2006. Students who attend schools without access to computers and the Internet may be ill prepared for the work place. The prevailing use of information technologies in not only the United States, but also globally, is a clear indicator that future prosperity is in the hands of students who are able to understand and use the pertinent tools.

USE TRENDS AND SERVICE NEEDS ANALYSIS

Mark Peterson, a Professor of Community and Economic Development at the University of Arkansas who studies the impact of broadband access and affordability on communities, wrote recently, "Broadband connectivity is not the infrastructure of the future, it is the infrastructure of the present." Santa Cruz faces a challenge in economic development infrastructure with primarily "little broadband" (i.e. DSL, wireless, and cable services) when many communities, regions, and countries have already made the decision to focus resources on the development of

"big broadband," which is typically fiber with a minimum capacity of 100 megabits or Gigabit to the premises.

- A third of IBM employees work from home at least part time, and the company has reported annual savings of $110 million.
- Australia's government is converting the entire telecommunications infrastructure for the country to an open access system by buying a major portion of Telstra assets. Telstra, which is currently the country's primary incumbent telecom provider, will become a service provider on the new open network.
- In a 2013 report to the Fiber To The Home Council, Render Research and Consulting reported that fiber to the premises adds $5000 to $6000 to the sales price of the house.
- Fiber to the home users say they are able to work from home more often, averaging 7.3 workdays per month, reducing their carbon footprint and decreasing wear and tear (and maintenance) on roads.
- About 13% of homes in the U.S. had been passed by fiber by 2012.
- Nationally, less than 10% of homes have no access to any kind of broadband service, but in the County, more than 13% of homes still have no broadband access, or nearly 50% higher than the national average.

In its March, 2009 report, the ITIF (Information Technology & Innovation Foundation) listed some of the next generation services and applications enabled by high performance, affordable broadband. The table on the next page lists these and other services that all represent broadband-enabled applications and services that must be available in Santa Cruz if it is to remain economically viable.

Health Care	Teleconsultations
	Telepathology
	Telesurgery
	Remote patient monitoring
	Remote diagnosis
	Remote medical imaging
	Grid computing for medical research
Education and Research	Distance education
	Virtual classrooms
	Remote instrumentation
	Multi-campus collaboration
	Digital content repositories and distribution (digital libraries)
	Data visualization
	Virtual laboratories
	Grid computing for academic research

Residential and Business	Videoconferencing
	IP TV (Internet Protocol TV)
	HD streaming video
	Ultra hi-def (BluRay) video streaming
	Video on demand (e.g. Netflix)
	Place-shifted video
	Cloud computing services
	Online and cloud-based gaming
	Smart homes, buildings, and appliances, including smart electric meters, AMR (automated meter reading), and AMI (advanced metering infrastructure)
	Remote computer aided design (CAD)
	Work from home jobs
	Business from home
	3D graphic rendering and CGI server farms
	Remote network management and managed services
	Virtual collaboration spaces (e.g. enhanced GoToMeeting, Webex style services)
Public Safety	Intelligent transportation applications (smart road systems)
	Public safety and first responder networks
	Emergency dispatch and coordination
	Webcast agency meetings (e.g. virtual meetings)
	Online training for first responders, fire, and rescue
Society	Broadcast of local sports events
	Videoconferencing of community and town hall meetings for wider participation
	Wider availability of nonprofit and community organization services

- When analyzing future service needs, it is important to take into account ALL services that may be delivered over a broadband connection. As we noted in the previous section, "broadband" is not a service--it is a delivery medium. If we think about broadband using a roads analogy, broadband is the road, not the trucks that use the road. Internet access is a service delivered by a broadband road system, and that Internet service is just one of many services that are in demand. Today, congestion on broadband networks is not due just to increased use of email and Web surfing, but many other services.

- As of 2012, Americans were watching more than 10 billion videos per month over the Internet. Cisco has said that by 2015 more than one million video minutes will travel across the Internet every second.

- This means that current DSL, wireless, and cable modem services are completely inadequate for future needs. Current DSL offerings are in the range of 384 kilobits to 20 megabits for most residential users, 768 kilobits to 20 megabits for business DSL users, and there are severe distance limitations on DSL. However, the upstream capability of DSL is extremely limited and based upon distance. Most DSL subscribers receive less than 1 Mbps upstream capacity (768 kbps being very common).

- Current wireless offerings are in the range of 1/2 megabit to 3 megabits, and WiMax services are only be able to deliver 4-8 megabits to individual customers. Some wireless providers are rolling out 10-15 megabit services, but wireless does not scale up well with respect to cost. As bandwidth increases, the cost of the equipment also increases, and even a 15 megabit service is well short of the FCC projections of the need for 50 megabits of bandwidth in the near term. Wireless performance and capacity is heavily dependent upon backhaul (the local connection to the provider's core network); if this connection is also wireless, the bandwidth available at the access point is shared among all users, even if the rated capacity of an individual connection is 15 megabits. In other words, if the backhaul capacity is 100 megabits, and twenty local users are sharing that capacity, actual bandwidth available to any single user may be much lower than 15 megabits. If all the users are trying to watch video at the same time (not uncommon in early evening), performance can suffer drastically.

- Current average bandwidth for cable modem services is typically 5 to 10 megabits, with cable companies promising "up to..." twenty or twenty-five megabits. It is important to note that cable providers make heavy use of the phrase "up to" in their advertising, and it is not unusual to see ads promoting cable modem speeds of "up to 25 megabits." However, that amount of bandwidth is shared among many users (often 200 or more) in a neighborhood, which results in much lower average speeds, and during peak use times in residential areas, the actual bandwidth available to a single household may be less than one megabit.

The challenge for Santa Cruz is to ensure that the businesses, residents, and institutions in the community have a telecommunications infrastructure in place that will be able to handle the 50x bandwidth increase projected by the FCC (which is based on many years of real world data).

At a recent broadband conference, a talk by a DirecTV official provided additional insight into residential bandwidth needs. The DirecTV speaker noted that one of their biggest complaints is that the company does not have enough HD format programming. He went on to note that a single channel of "standard" HD content uses 10 megabits of bandwidth when delivered via IP-TV, and a live event like a race or sporting event (e.g. football) requires 15 megabits of bandwidth. The emerging HD 4K video standard requires 19 megabits per channel--far beyond the ability of existing wireless and copper-based broadband services to deliver with any quality (or at all).

DirecTV is already delivering video programming to end users using Internet-based IP-TV formats, and noted that many buildings and homes do not have the internal cabling to support the IP-TV bandwidth needs. He also indicated that their early IP-TV users cannot tell the difference between IP-TV delivery of video and traditional cable/satellite delivery.

Distance learning, entertainment, and video conferencing are three major applications of internet video. Distance learning from home with live video feeds will require high performance 2+ megabit connections in the near term (next 2-4 years), and over the next 4 to 7 years, there will be many distance learning courses that will incorporate live HD two-way video feeds, enabling students to participate in classroom discussions at a much higher quality level. Distance learning could be an important home-based application for workforce training and retraining. Some California community colleges, including Cabrillo College, offer "hybrid courses" where a student attends several class sessions at the college and the remaining sessions online from their home, the library, or another location.

The University of California Santa Cruz (UCSC) offers many STEM courses and the nationally recognized Computer Game Design Major. The off-campus student population would benefit from affordable broadband connections during their participation in this type of course.

Entertainment will also drive bandwidth demand from the home, and the popularity of video sites like YouTube and Netflix provide a good indication of the long term demand for video in many forms, including:

- Live feeds (e.g. live TV shows, sports coverage, and live news reports).
- Video on demand (TV shows available for viewing at any time, rather than at scheduled times).
- Movies on demand (instead of going to the video store).
- Two way video conversations (family, friends).
- Video stored on home computers and distributed across the Internet (e.g. videos of grandchildren, family activities).
- Local video content streamed live or from a server (e.g. high school football games, other sporting events, council meetings, other civic activities).

Most homes in Santa Cruz have multiple TVs, meaning that a minimum of 25 megabits of bandwidth is required just to have both televisions on and tuned to two different channels. If a third person in the home is attending an evening distance learning course that uses HD video, the total bandwidth need would be more than 40 megabits.

Another source of increased demand, alluded to above, is multi-tasking. Surfing the Web while watching TV is becoming commonplace. With the proliferation of smart-phones, tablets, and laptop computers, the amount of potential users is also increasing. A recent study collected data showing that the average U.S. household has an average of 10 Internet-enabled devices:

"U.S. homes now have more than half a billion devices connected to the Internet, according to a study by the NPD Group. Furthermore, the overall number of connected devices per household, according to a 2014 OECD study, is 10. This is more than three times the average number of people per household. The proliferation of connected devices is primarily fueled by tablet sales...."

SERVICE AND GAP ANALYSIS

BUSINESS BANDWIDTH NEEDS

The next table shows bandwidth consumption for several types of businesses and a projection of the bandwidth needed 5 and 10 years out. The cost of fuel is already affecting business travel decisions, and more and more businesses will invest in HD quality business videoconference systems to reduce the need for travel. These HD systems require substantial bandwidth; a two way HD video conference requires 20-25 megabits during the conference, and a three way conference requires 30-35 megabits during the conference. As more workers try to reduce the cost of driving to and from work by working part or full time from home, the business location must provide network access (Virtual Private Network, or VPN) to the employees working from home. These home-based workers will make extensive use of videoconferencing to attend routine office meetings remotely and to enhance communications with co-workers, including videoconferences with other home-based workers in the company. A VPN network providing remote access to just two or three home-based employees could require 50 megabits of bandwidth during normal work hours.

	Large Business		Small Business		Home Based Worker		Business From Home	
Description	A larger business with about 50 workstations.		A small business with 10 to 15 employees, and 7-10 workstations.		A single employee working at home for his/her company.		A home business with one or two employees working at home.	
	Concurrent Use	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**
Telephone	20	1.28	5	0.32	1	0.064	1	0.064
TV		0		0		0		0
HDTV		0		0		0		0
Credit Card Validation	4	4	1	1		0		0
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	20	30	7	10.5	1	1.5	1	1.5
VPN Connection	5	25		0	1	5		0
Data Backup	5	7.5	1	1.5	1	1.5	1	1.5
Web Hosting	1	2		0		0		0
Workforce Training (online classes)	2	20	1	10	0	0	1	10

	Large Business		Small Business		Home Based Worker		Business From Home	
HD Videoconferencing	10	100	2	20	1	10	1	10
Telecommuting workers	5	15	2	6	0	0	0	0
Totals		**205.0**		**49.6**		**18.3**		**23.3**
5 years from now (megabits)	615		149		55		70	
10 years from now (megabits)	1845		446		165		210	

RESIDENTIAL BANDWIDTH NEEDS

The table below depicts the bandwidth needed for typical residential services which are available now or will be available in the near future. In a next generation network all services will be delivered over a single network infrastructure which will require an access network that can support providing most services to most consumers simultaneously. Today's shared networks (cable and wireless in particular) rely on the "bursty" nature of traffic to provide services to end users. If all end users were consuming their "advertised" bandwidth today's cable and DSL networks would grind to a halt.

In fact, they already are; some cable providers have begun to receive heavy criticism for undocumented manipulation of data traffic. Existing cable modem network users are overwhelming the digital cable networks that were upgraded as little as three or four years ago, and the firms have had to artificially reduce the bandwidth available for certain kinds of high bandwidth services (e.g. peer to peer file sharing). Some cable providers have even run into capacity issues with the TV portion of their networks, and some consumers have observed that some HD TV channels have been so highly compressed that picture quality has been noticeably degraded when compared to the same channel delivered by satellite.

The table below is designed to show bandwidth consumption in several scenarios. Network design requires a system than can meet peak demand across the entire network, meaning the network must be able to deliver peak bandwidth demand to a majority of households at the same time. Super Bowl Sunday is a typical example of a day when a majority of households may be watching a video at the same time. Political debates, season finales of popular shows, and even a typical Saturday afternoon during football season may see many households trying to access multiple channels of video simultaneously. This table shows the severe gap between current DSL, wireless, and cable modem options in Santa Cruz and projected future demand.

	Residenual Day-time		Early Evening		Evening and Late Night		Holiday or no-school week days	
Description	Intermittent Television and Internet use across a small percentage of households.		Increased television, telephone, and Internet use as children arrive home from school and employees from work. Use of other services increases.		Peak television and Internet use. Multiple TV's are on, phone and computer being used.		On top of typical daytime traffic children are home from school, and many employees are home working.	
	Concurrent Use	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**	**Concurrent Use**	**Mbps**
Telephone	1	0.064	1	0.06	1	0.06	1	0.064
Standard Definition TV	1	2.5	1	2.5	1	2.5	1	2.5
HD TV	1	4	2	8	2	8	3	12
Security System	1	0.25	1	0.25	1	0.25	1	0.25
Internet	1	1.5	1	1.5	2	3	3	4.5
Online Gaming		0.25		0.5		1		1
VPN Connection	0	0	1	2	1	2	2	4
Data Backup		0	1	5	1	5	1	0
Telehealth (subscriber)	1	4	1	4	1	4	0	0
Distance Learning / Workforce Training		0	1	10	1	10	2	20
HD Videoconferencing		0		0		0	1	14
Totals		**12.6**		**33.8**		**35.8**		**58.3**
5 years from now (megabits)	38		101		107		175	
10 years from now (megabits)	113		304		322		525	

ECONOMIC IMPACT POTENTIAL

Other communities across the United States are already actively pursuing new and innovative public/private partnerships to improve the access and affordability of telecom services delivered via broadband. The Fiber To The Home Council maintains statistics on the growth of residential fiber in the United States. About 13 million premises have been connected with fiber, but that represents only about 12% of American homes. The deployment of fiber is highly dependent upon location, so some densely populated urban areas, primarily on the East Coast, are getting fiber much more rapidly than other areas of the country.

Communities that have affordable broadband are enjoying a faster rate of economic growth than communities that lack broadband, based on a CMU/MIT study (Measuring the Economic Impact of Broadband Deployment, Sirbu and Gillett, 2006).

A more recent study (2014) by David Sosa of the Analysis Group found that the availability of next-generation broadband speeds provided by Gigabit fiber substantially improves a

community's gross domestic product. The study examined 55 cities in nine states and discovered an economic boost in all 14 communities where gigabit service was widely available. Those 14 cities displayed per capita GDP about 1.1 percent higher than the other 41 communities with limited or no access to gigabit broadband, equating to about $1.4 billion in additional GDP. The report stated, "Next-generation broadband is likely to have a substantial impact on economic output and, consequently, consumer welfare."

In Kansas City, the site of Google's first fiber initiative, KCnext President Ryan Weber said that Google and AT&T plans to offer Gigabit fiber in the city will result in several perks. Weber noted that competition is a very good thing when it comes to providing utilities like fiber:

"When businesses relocate to an area, that is now a big part of the conversation — access to fiber. They want to make sure there are a number of carriers because for some tech companies, they have two carriers coming into their office."

A Brookings Institution study (Crandall, Lehr, and Litan) in 2009 found that for every 1% increase in the availability of broadband in a community, the level of employment increases correspondingly by .3% annually. The study also found that as the level of Internet users increased in a community, there was a corresponding increase in economic growth, with a 10% increase in Internet use yielding a 1.3% increase in the economy.

A new digital divide is emerging, with fiber as a differentiator. Communities with affordable broadband infrastructure and the ability (i.e. fiber) to expand capacity as demand grows over the next seven to ten years should enjoy a measurable economic development advantage over communities that lack such infrastructure.

Job Creation and Retention

As businesses inevitably rely more on dependable access to telecommunications to sustain their trade, they are also seeking fast and affordable networks as well. In many cases, cable and DSL companies are monopolies within a community. Unsurprisingly, these companies are able to provide unreliable and slow networks, since customers have no other choice but to purchase their products. As a result, numerous communities have taken the issue into their own hands and built their own networks. Communities are able to control the connections and the reliability of the services. Ultimately, affordable access to reliable internet services is a catalyst for economic growth and job creation.

- Chanute, Kansas (Chanute Municipal Network): One of the reasons why Spirit AeroSystems chose Chanute for their new manufacturing facility is because of their leading broadband infrastructure. As a result, the plant created over 100 new jobs.
- Bristol, Virginia (Optinet): This community has a publicly owned network that attracted companies like CGI and Northrup Grumman. These companies not only created 700 jobs, but also paid twice the average wage in the community due to the convenience of the network.

- Springfield, Missouri (SpringNet): When a carrier failed to meet the demands of Springfield, SpringNet was created and ultimately served to provide the necessary connectivity to create over 400 jobs to the community.
- Chattanooga, Tennessee (EPB Fiber): According to an academic study, the first ten years of the EPB fiber network will produce over 3,600 new jobs correlated with the City's high speed Internet, phone, and television services.
- Palm Coast, Florida was able to retain the city's largest employer (over 500 jobs) because the city-owned open access fiber network sharply reduced the cost of Internet access within the City.

Public Savings

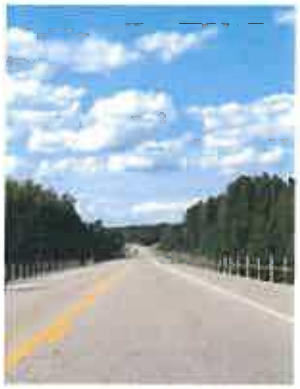
When local governments build their own networks, they experience striking savings and greater reliability. How? Since the local governments own the network, they have the leverage to determine the future costs and when these price hikes would occur. Community anchor institutions like schools, libraries, and government facilities may reap in the greatest savings because they are no longer contracted to sign a lease to join a network.

- Martin County, Florida: Once the initial capital investment in the fiber asset is paid off, Martin County School District will save nearly $340,000 per year. In other words, the school district will only pay an estimated $6,000 per year for a gigabit connection to 26 locations.
- Bristol, Virginia: One study concluded that Bristol schools have saved $1 million from 2003-2008 just by self-provisioning phone services. This results in nearly $10 million in savings for the community.
- Martinsville, Virginia: Similarly to Bristol, Virginia, Martinsville saves between $130,000 and $150,000 annually because they do not need to lease telephone lines.
- Medina County, Ohio: When data needs were fulfilled by Time Warner Cable, Highland Public Schools spent $100,000 per year for the company's services. However, the County saved $82,000 in 2012 when it switched over to the Medina County municipal network since the cost was only $18,000 per year.
- The City of Wilmington, North Carolina uses its fiber network to turn the lights off at sports parks at night. Cameras have been placed at every sports and recreation field, along with remote control light switches. A single city employee can quickly check the cameras to see if anyone is still at a field, and if not, a couple of mouse clicks turn off the lights. The city expects to save $800,000 per year on electricity costs.

Business Models and Ownership

Broadband Infrastructure as a Utility

Governments build and manage roads, but don't own or manage the businesses that use those roads to deliver goods and services. In this third way, there is true competitive pricing between competing service providers, and little or no government regulation is required.



The tremendous versatility of the Internet and the underlying technology bases now allows services that used to require their own, separate (analog) road system (voice telephony and TV services) to be delivered alongside other services like Internet access on a single, integrated digital road system.

If we managed overnight package delivery the way we manage telecom, UPS and Fedex would only deliver packages to residences and businesses where each delivery firm had built a private road for their exclusive use. We recognize immediately the limitations of such a business model–few of us would have overnight package delivery to our homes because the small number of packages delivered would not justify the expense of building a private paved road.

Before the rise of the automobile, most roads were built largely by the private sector. After cars became important to commerce and economic development, communities began building and maintaining roads because it became an economic development imperative to have a modern transportation system in communities.

Before the rise of the Internet, digital networks were built largely by the private sector. As broadband has become critical to commerce and economic development, communities with digital roads are more competitive globally.

A UTILITY COMPARISON		
SHARED ROADS	SHARED AIRPORTS	SHARED TELECOM
Historically, roads have been built and maintained by the community for the use of all, especially private firms that want to use them to deliver goods and services.	Airports are built and maintained by a community or region as an economic and community development asset. Both public and private users benefit from the shared use of a single, well-designed airport	Duct and fiber may be installed and maintained by the community and/or a neutral owner/operator for the use of all, including private firms that want to use them to deliver goods and services.
Access to the community road system is provided by parking lots and driveways, built by property owners, developers and builders.	Airport assets like departure gates, ticket areas, and runways provide access to the airline services.	In the digital road system, access across private property to the community–wide network in the public right of way is provided by duct and fiber built by property owners and/or developers and builders.
The local government uses roads only to deliver government services. Local government does not offer services like overnight package delivery.	While the local government or a consortium of local governments typically own the airport facility, the local governments do not offer flight services.	Local government uses the digital transport system only to deliver government services. Government does not offer services like Internet access or Voice over IP.
Private sector businesses use roads so that their own cars and trucks can deliver goods and services to customers. Because businesses do not have to build and maintain roads, all businesses benefit directly by being able to reach more customers at less expense.	Private sector airlines are able to offer competitively priced airfares because of the shared cost of the airport terminal facilities. Each airline does not build its own airport (which would sharply increase the cost of airfare).	Private sector businesses use the digital transport system to deliver goods and services to customers. Because businesses do not have to build and maintain a digital road system, all service providers benefit directly by being able to reach more customers at less expense.
There are no road connection fees, and anyone may connect to the road system for free. Governments pay for the cost of maintaining roads largely from those that use the roads . Fees are proportional to use, from taxes on tires and gasoline.	Businesses and citizens do not pay a fee to access the airport facility. The cost of maintaining the airport facility is paid by the airlines, which bundle that cost into the price of airfare. Fees are proportional to actual use by flying customers. Airlines benefit because they do not have to build, own, and operate the airport directly. Those costs are shared across all users.	Any qualified service provider may connect to the digital road system for a nominal fee and begin to offer services, without any significant capital expense. Network capital and operating costs are recovered by charging service providers a small fee that is based on a percentage of their income from services offered over the system.

THE PUBLIC/PRIVATE PARTNERSHIP

Because virtually any modern broadband network (and most older telecom networks) use public right of way for a large portion of network distribution, ALL business models are "public/private partnerships." The notion of the public/private partnership is not a distinct business model, but rather exists along a continuum, with minimal public involvement on one end (i.e. only use of public right of way) to full public ownership on the other end.

BUSINESS MODEL OPTIONS

There are three business/ownership models that are were considered as part of the study. These models are:

- **Private Sector Only**
- **Municipal Retail**
- **Wholesale Multi-Service**

The table below summarizes the three models.

Features	Private Sector Only	Municipal Retail	Wholesale Multi-Service Network
Basic Concept	Three separate services (voice, video, data) with little or no sharing of network.	Only three services (voice, video, data) with little or no sharing of network.	Very high efficiency achieved by end to end automated service provisioning. All providers share network capacity.
Government Involvement	No government involvement. Private sector decides where and when to offer services. Some areas get little or no service.	Government competes directory with the private sector. Government decides what services are offered.	Government does not compete with private sector. Government provides high performance digital road system that benefits all public and private users. Buyers have rich set of choices.
Governance	Owned by a private company. Community must accept whatever services are offered.	Owned and operated by local government. Limited triple play services sold directly by local government.	May be owned by local government or by a community enterprise like a broadband authority or coop. Wide variety of services sold by private sector companies.
Competition	Little or none in most areas. Cartel-like pricing keeps prices high.	Government bureaucrats pick providers of each service. No incentive to lower prices.	Level playing field creates robust competition. Service providers drive down costs and provide great service to get customers.

Features	Private Sector Only	Municipal Retail	Wholesale Multi-Service Network
Service Options	Limited. Providers can offer triple play at most.	Limited. Government resells triple play services.	Unlimited. Low cost of market entry and high level of service automation attracts service providers and encourages innovation.
Revenue	Limited by low returns on the individual services.	Limited by low returns on the triple play services.	Unlimited. Revenue directly linked to demand. Revenue increases with demand.
Service Area Expansion	Limited to high density population areas. Rural areas and smaller cities area at a structural disadvantage.	Limited by triple play approach, which keeps funds for expansion low.	Unlimited. Expansion completely supported by revenue sharing or use fees. Open services network can provide become financially sustainable relatively quickly.
Risks	Some areas do not get adequate service or affordable pricing.	Government officials must predict business technology needs years in advance.	More complex network management required, but reduces costs sharply for service providers, which encourages competition.

PRIVATE SECTOR ONLY

The "leave it to the private sector" model has obvious shortcomings, which is why so many communities are now beginning to consider telecom as essential public infrastructure. Private sector firms have a primary responsibility to preserve and enhance shareholder value. They do not make operational and service area deployment decisions based on community and economic development needs. For many communities, this has meant that broadband services have lagged well behind the rest of the world and places those communities at a competitive disadvantage when trying to attract or retain businesses.

The private sector model requires overbuilding, which means that each service provider must build its own network end to end to serve customers. This leads to completely duplicated networks, which increases costs and makes it more difficult for these firms to make a business case for enhanced services in many areas. This business model is a fundamental weakness, because these private networks are not only expensive, but typically underutilized. Residential networks are only used heavily in late afternoon and evenings, and are virtually unused overnight and during the work day. Business networks that are only used heavily during work hours typically have very low utilization for the other two-thirds of the day. School and education networks are used only 8 to 12 hours per day, and are empty the rest of the time.

Community broadband projects can overcome this fundamental weakness and substantially reduce the operating cost of networks by using a shared model, rather than a private model.

Municipal Retail

Also known as Muni (Municipal) Triple Play. Local government builds the network and sells services in direct competition with the private sector, offering only traditional "triple play" voice, video, and broadband. Muni triple play systems are usually closed systems that offer little choice to customers. Muni triple play systems compete directly with the private sector, and tend to have very low take rates. Opponents of community broadband often cite the low take rates of muni triple play projects to "prove" that community broadband is a poor investment. But the low take rates only show that muni triple play business models are not financially viable over the long term.

The two key issues with this model are:

- It requires local government officials and leaders to sign long term contracts (typically 5 to nine years) with the providers whose services will be resold over the network. This means that those local leaders must have a high degree of confidence that they can accurately predict, seven to nine years out, what level and quality of services the businesses and residents of the community will require. While contracts can be renegotiated as needs change, prices are likely to rise during that renegotiation.
- This model situates the local government in direct competition with incumbent providers. This not only tends to keep take rates low, which threatens financial viability, but adoption of this model also encourages lawsuits from the incumbents (Bristol, Virginia, Lafayette, Louisiana, Geneva, Illinois, and Monticello, Minnesota are examples of communities that were sued after selecting the muni retail model).

Wholesale Multi-Service Approach

Local government and/or an independent entity firmly vested in the long term interests of the community builds and manages the infrastructure and provides access to service providers on a wholesale basis. In turn, service providers offer business, residential, and government/ institutional customers retail services. In this model, the private sector offers all services to their own private sector customers directly. Government manages the infrastructure but does not compete with private sector providers.

Wholesale Option One

In this first option, local government investments are limited primarily to passive infrastructure (i.e. no network electronics). This is often called the "dark fiber" model, but passive infrastructure can and may include conduit, handholes, cabinets and shelters, and splice closures.

For smaller communities with limited resources and/or a very small market, passive infrastructure only is an excellent approach. The advantages include:

- Reduced capital costs by eliminating network electronics. Providers lease fiber strands and provide their own network electronics to "light" the fiber.

- Reduced operational costs. By limiting the infrastructure investment to passive components, there is little to no day to day operational responsibilities. Emergency break-fix repairs and routine repairs and maintenance work can be performed on an as-needed basis by qualified private sector companies.
- Reduced management and administrative oversight. While fiber strand and asset management tasks, billing, and financial management are still required, these are of limited scope.

Disadvantages of this model include:

- Revenue opportunities are limited to leasing fiber strands and small amounts of revenue derived from leasing cabinet or shelter space.
- The fiber strand leasing model does not always scale up well for large area deployment, as it requires predicting how much fiber is going to be needed well in advance of actually market demand. This is not always an easy task. Fiber cable is much less expensive than it was ten years ago, but the initial fiber strand mapping work prior to construction has to be done very carefully.
- It is possible to end up with limited competition because the cost of network equipment shifts the marketing advantage to the first provider who signs up a customer, often for very long periods of time.

Wholesale Option Two

The providers buy wholesale transport (i.e. raw bandwidth with no services--called a Layer 2 circuit) from the network, and then add their own services (e.g. Internet, voice, TV, etc.) on that circuit to their customers. Services are provisioned individually for each subscriber. This approach limits the initial investment required of a new service provider that wants to enter the market--thereby encouraging more competition and lower prices. Advantages of this model include:

- Higher revenue potential by leasing capacity on the network rather than fiber strands.
- Lower cost of entry to the market for smaller providers, which increases competition and helps reduce service costs for businesses and residents.
- Greater long term control over expansion since the network owner is providing a complete end to end network, including electronics.

Disadvantages include:

- Higher operational costs since the network owner must provide 24/7/365 network monitoring and support. While this can often be outsourced to a qualified private sector firm, this increases the expense of the network (note that the higher revenue potential can and usually does provide sufficient revenue to cover expenses).

- Increased administrative and management oversight due to the more complex end to end network.

Issues to consider with this approach include:

- The Layer 2 provisioning approach allocates one or more circuits to each customer of each provider. Troubleshooting technical problems requires excellent network operations with NOC (Network Operations Center) staff able to sort out whether the problem is caused by customer equipment, service provider equipment, or the network itself.
- Service providers require regular market and price incentives to ensure that take rate targets are met.
- The network has to maintain a regular public awareness marketing effort to ensure that businesses and residents are aware that the community-owned network offers new price and service options.

A lesson learned from communities that have implemented community broadband networks is that with both wholesale options (dark fiber, end to end network), it is essential to ensure that a sufficient number of service providers are prepared to sell services on the network--a minimum of two is desirable during the first year of operations.

WHY OPEN ACCESS: THE MULTI-SERVICE NETWORK CONCEPT

Customer aggregation is a key advantage to a shared, community-owned telecommunications infrastructure. By building fiber to homes and businesses, the community maximizes the market potential for private providers who want to sell services. For the County of Santa Cruz, the early focus should be tied to economic development goals. Infrastructure investments should be supporting areas where business and jobs growth is most likely to occur, as this will also help ensure financial sustainability for the network. As the revenue increases from leasing network services, the revenue that exceeds operating costs and debt can be used to expand into other areas of the County, including residential suburbs and smaller communities. Residential fiber build outs can occur over time as the network expands. The community investment allows these businesses to reach more customers than any single company could reach on its own. Some of the outcomes are:

- More customers -- When a community builds the transport layer of a digital road system (the roadway), each provider has a much lower cost of infrastructure needed to enter a market. In smaller towns and regions, this is a critical difference. Community investments allow more companies to profitably offer services in smaller markets than a firm could do on its own.
- Lower costs -- When a firm can reach more customers via a community broadband system, lower costs of service usually results. Typical reductions in cost in open access systems are usually on the order of 15%, and are frequently much more than that. It is not unusual to see the cost of telephone service decline by 40% or more.

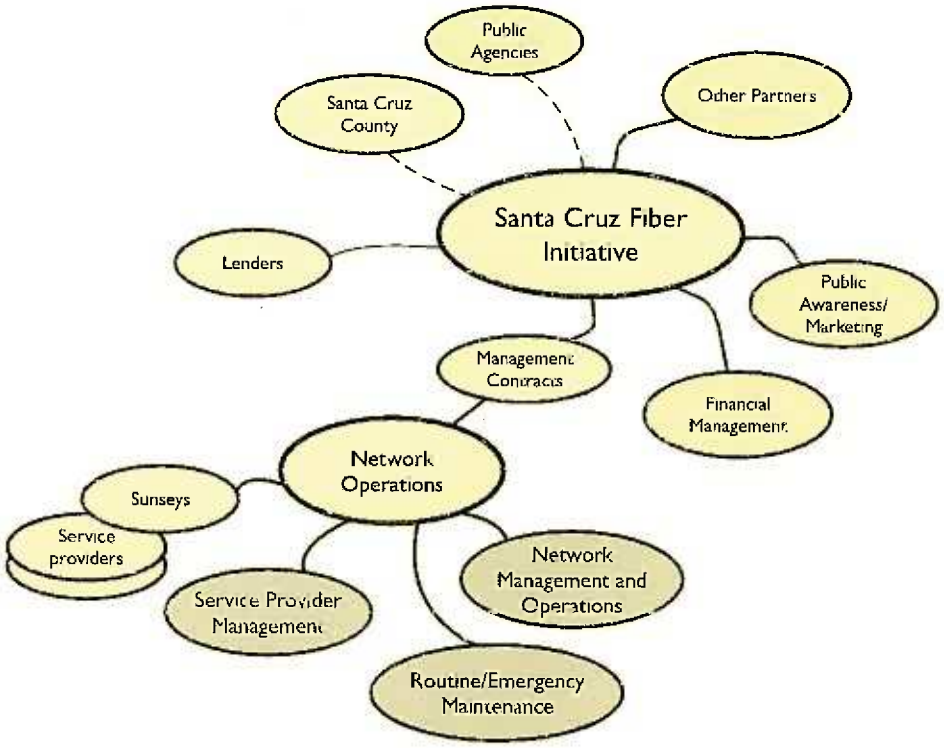
Services aggregation occurs when communities build open networks, meaning that any qualified service provider can offer services using the community digital roadway. In this business model, there are usually several service providers competing for customers in each category of services (e.g. voice telephone service, TV, Internet access).

- More choice-- A natural outcome of more services is more choice for purchasers of services. Instead of a single monopoly provider of telephone or television, customers can pick and choose among a variety of service plans at various price points.
- More competition -- When more services are available, there is more competition for customers. Subsequently, service providers must sell services for the lowest possible price, and also creates incentives to provide excellent service to customers. Compare this to a monopoly environment where there is no competition and hence little pressure for a company to provide good service--customers have no other service options.
- More services -- When there is a wider choice of services on the community system, there is more opportunity to use more services. This is, in part, what makes open service provider networks financially sound investments for communities: Open systems create a bigger market for telecom services, and thereby creates more revenue flowing through a community revenue sharing plan.

OWNERSHIP AND MANAGEMENT

There are a variety of ownership and governance options for a Santa Cruz Fiber Initiative (SCFI). This section outlines one approach that seems particularly appropriate for the Santa Cruz area. The intention would be to operate Santa Cruz Fiber Initiative as an open access network, meaning businesses and residents would purchase services from private sector providers.

SCFI would not offer retail Internet, phone, and related broadband services and would not compete directly with local providers. Incumbent providers and competitive providers in the County would all be invited to use the network to lower their cost of delivering high performance fiber services in the County.



In this model, the independent Fiber Initiative owns most of the passive and active network assets. The initiative operates the network as an open access, multi-provider, multi-service network and would welcome any and all service providers to use capacity on the network to deliver their services to their own customers. A separate entity that manages the network relieves the County of direct management responsibility and limits County involvement.

Some passive assets like conduit and handholes could be built and owned by incorporated cities and/or Santa Cruz County and leased to the SCFI and/or other providers in return for recurring lease payments.

It should be noted that SB 1191, passed by the legislature in 2008, puts some limits on what a Community Service District (CSD) can do with respect to telecom infrastructure. While a

CSD could "*construct, own, improve, maintain, and operate broadband facilities and to provide broadband services,*" if a private entity wanted to enter the CSD market area, the CSD would have to relinquish the telecom assets at fair market value. An independent entity, firmly vested with appropriate community oversight, would not be subject to the same restrictions.

A fiber initiative in Santa Cruz County would have several essential roles:

- ***Contract Management*** - The independent entity would hold contracts for outsourced network operations, outsourced network repairs and maintenance, outsourced construction of network extensions, and service provider contracts for the services offered on the network. Where it is efficient and effective, qualified private sector firms would be used to handle the technical operations of the network to minimize the number of staff required by the independent entity.

- ***Financial Management*** - The independent entity would provide the financial oversight of the network. Most routine bookkeeping and accounting would not require full time staff and could be outsourced to a local accounting firm.

- ***Public Awareness*** - The initiative would have to maintain an ongoing public awareness campaign to ensure that local businesses are aware of the opportunity to obtain higher performance, fiber-delivered services at attractive (lower) rates. While service providers would be responsible for their own sales, billing and customer management, the Fiber Initiative would focus on name and brand awareness in the community.

The network, as a private sector enterprise owned by the initiative, keeps the local government out of the business of telecommunications services. The County role would be limited to building passive infrastructure (conduit, handholes) for both municipal purposes (SCADA controls, smart street lighting, energy management, public safety) and making any excess capacity available to the private sector.

Financing Options

"THERE IS NO MONEY FOR BROADBAND...."

The bandwidth needs and analysis section of this report provides a conservative 30 year expenditure estimate for routine and normal telecom services for businesses, residents, schools, and institutions in the County of Santa Cruz. Over the next three decades, more than a seven billion dollars will be spent on telecom services. This is estimate that does not include any adjustments for inflation or price increases, nor does it take into account the ever expanding demand for new kinds of services. The model looks only at current demand and today's retail prices. A community investment in a community-owned and managed digital road system, where all services are provided by the private sector, would have substantial benefits.

What the table shows is that the County's businesses, residents, and institutions are already spending substantial sums of money on broadband–over $200 million a year. This amount represents an estimate of what is being spent by all public, residential, institutional, and business customers for landline services, including telephone, TV, and Internet access across the County.

In fact, ***just the money spent in less than two years in the County of Santa Cruz*** would more than pay for the complete cost of building the proposed new all-fiber network to most homes and businesses in the County.

FUNDING OPTIONS

A wide variety of funding strategies are available for building telecom infrastructure, but there are some emerging rules of thumb:

- The first money is the most difficult, and some local funds are almost always required.
- Most granting agencies want to see collaboration across political boundaries, as the market for network services usually spans those boundaries.
- Once even a modest network infrastructure has been built and has some customers and service providers, it becomes much easier to raise additional funds. So the most important funding strategy is to ***fund something and get it built.***
- It is quite feasible to finance a large part of expansion with funds directly from customers (i.e. property owners) that receive fiber connections. The Utopia project has been very successful with the approach in suburban communities in the Salt Lake City area. Those local funds can be leveraged to acquire the additional capital needed to support network expansion. The one time connection fee is identical in concept to the use of pass-by and tap fees used to help finance water and sewer construction.
- Partnerships with entities like community or state colleges, and the local government are critical funding sources, especially for a "Phase One" initiative. The opportunity is

to dramatically improve the quality of service (e.g. 10x to 50x bandwidth increases for local colleges for what they are paying now), and/or the opportunity to reduce the overall cost of telecommunications by improved efficiencies for combined voice and data uses. One funding approach used by other projects is to get an up front cash payment from local anchor tenants that is equivalent to several years of savings from their telecom budget or by brokering dark fiber IRUs up front to fund the capital expansion.

- Partnering with the incorporated Cities can provide additional market size, increase overall demand as well as increase opportunities for State or Federal Grant funding which tend to favor cross jurisdictional projects..

- Partnering with adjacent counties may also offer increased changes of obtaining grants as well as lowering County operational costs by sharing the larger costs across a larger network. The Central Coast Broadband Consortium has been studying the improvement of broadband availability in Santa Cruz, Monterrey, and San Benito Counties for a decade and has an extensive database of broadband resources available in and around the Central Coast area.

- Partnering with a "Middle Mile" fiber provider such as Sunesys (California Public Utilities Commission funded Connected Central Coast Unserved and Underserved Broadband Project) can lower the costs of services on the network by providing an alternative to current services available only from the AT&T Central Office. Local service providers have expressed interest in partnering with Sunesys and offering services in the Medical District, Upper 41st and Aptos areas.

- Many public safety agencies are embarking on extremely expensive upgrades from analog voice radio systems to digital voice radio systems. There may be additional redundancy and resiliency benefits by taking fiber to more of the public safety towers, thereby increasing capacity and reliability. If public safety agencies partner with the fiber initiative, it may be possible to reduce the cost of these fiber upgrades via grant funding from the U.S. Department of Justice.

- Property Owner Construction Fee (via Micro Lending up front payment) is another vehicle in which property owners connect to the network pay a one time fee to get connected to the network. This approach is very similar to the way that pass-by and tap fees are used to finance water and sewer construction. This method works well with "map-sourcing" where a neighborhood or geographic region has to get a high percentage (50-60%) of commitments or "take rate" not only to buy a service (like the Google "Fiberhood" model), but also to finance the construction at a reasonable rate ($3000-5000 per premise).

Funding Source	Description	Notes
Revenue Bonds	Long term debt instruments guaranteed with revenue from the network.	Requires some equity/funding from other sources.
General Obligation Bonds	Long term debt guaranteed by local taxes.	Generally more difficult to get approval from elected officials and voters.
Tax Increment Financing	Funds generated from a taxes levied within a specified area of the County	Funds can only be used for improvements within the specified district.
Special Property Assessment	Some communities are levying a special tax assessment for a period of several years to pay for a fiber to the home initiative.	California has multiple special assessments that can be passed by a majority or super majority of property owners or local businesses to fund projects.
Cash	Funding provided directly by the local government(s).	Many community broadband projects have been funded in part or in whole by the local government. These are often treated as a loan to be repaid with revenue.
Revenue Bond Guarantees	Third party guarantees on revenue bonds; if revenue fails to meet financial targets, bond guarantor makes debt payments.	Guarantors could be local or state governments. Does not require a direct cash outlay. Guarantor must have a good credit rating.
New Markets Tax Credits	Tax credits are sold to investors, and funds are used for the network.	Project must meet eligibility requirements and typically takes a year to plan and to receive approval.
State Funds	State agencies may be source of planning & capital funds.	Capital funds are usually small, but direct grants from the legislature are possible.
Federal Funds	Grants and loans of various kinds are often available from Federal agencies.	Federal grant programs and funding tend to change with changes in administration. Can take 1-2 years for approval.
Municipal Leasing	Local governments can borrow money and pledge the asset as collateral.	Can be used for funding specific (limited) projects, like fiber to a school system or government offices.
Commercial Loans	Local banks are often willing to assist with funding.	Usually requires pledging network assets as collateral. Must be able to show a revenue stream to pay back the loan. Good for small, high priority network extensions with guaranteed customers.

Funding Source	Description	Notes
Private Sector Financing	A public/private partnership approach offers the possibility of attracting a mix of private investors as well as some local government financial support.	It depends on the corporate structure, but local businesses and investors could become shareholders or partners in the new telecom firm, effectively vesting community control for the effort. Because most of the funds will be used to create hard assets, it will be possible to attract institutional investors for larger amounts if a good business case is constructed.
Grants and Donations	Citizens and local foundations will sometimes provide grants.	Local foundations may require tying funds to a specific purpose.
Property Owner Construction Fee	Property owners pay a one time "pass by/tap" fee to get connected to the network.	This works best on a neighborhood by neighborhood basis, with a specific target set for each neighborhood (e.g. 60% of property owners have to agree to pay the fee).
Sales Tax	Assess a small increase in the local sales tax to pay for construction, or use existing sales tax revenues as a bond guarantee.	May require a voter referendum.

Revenue Bonds

Many community projects are already being financed with revenue bonds, including Monticello, Minnesota, Powell, Wyoming, and the Utopia project (14 towns and cities in Utah). Revenue bonds are repaid based on the expectation of receiving revenue from the network, and do not obligate the local government or taxpayers if financial targets are not met. In that respect, they are very different from general obligation bonds. Many kinds of city or county projects (water, sewer, solid waste, etc.) are routinely financed with revenue bonds. We believe most community projects will finance a significant portion of the effort with revenue bonds. Obtaining funding using revenue bonds requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network.

Revenue bonds must be used carefully, and a well-designed financial model is required to show investors that sufficient cash flow exists to pay back the loans. Some issues to consider are:

- Revenue bonds are paid back solely from system revenue.
- A very solid business plan is needed.
- Management, marketing, and operations of the network must be professional and with careful attention to meeting operational and financial targets.

A Santa Cruz venture will need some local fund-raising and/or equity investments to support any required initial borrowing. This local funding initiative should be targeted to support some

initial construction and operations to show that the new entity can plan, construct, and manage a state of the art network, and that the project can attract both customers and service providers.

Market conditions at the time the initial bonding is attempted can affect the cost of the bonds and the success in selling those bonds.

General Obligation Bonds

General obligation bonds are routinely used by local governments to finance municipal projects of all kinds. G.O. bonds are guaranteed by the good faith and credit of the local government, and are not tied to revenue generated by the project being funded (i.e. revenue bonds). G.O. bonds obligate the issuing government and the taxpayers directly, and in some cases could lead to increased local taxes to cover the interest and principal payments.

Even though G.O. bonds are quite common for more traditional community infrastructure, local leaders and taxpayers have typically been resistant to using them to finance community telecom projects. G.O. bonds require a voter referendum, which raises the bar even higher, but some community telecom projects, notably the City of Lafayette, Louisiana, prevailed in a voter referendum to build a city fiber network despite heavy advertising against the referendum by incumbent providers. In California, G.O. Bonds require a super-majority (2/3) vote.

Tax Increment Financing

Tax Increment Financing (TIF) allows a local government or redevelopment authority to generate revenues for a defined area targeted for improvement, known as a TIF district. As improvements are made within the district, and as property values increase, the incremental increases in property tax revenue are earmarked for a fund that is used for improvements within the district. Expenditures of TIF-generated revenues are subject to certain restrictions and must be spent within the district.

California does allow for Infrastructure Financing Districts (IFDs) as of Q4 2014. It is unclear if Telecommunications projects are specifically prohibited under the new law, SB 628, signed by Governor Brown on September 29, 2014. SB 628 was passed to replicate some of the functions of the state's abolished local redevelopment agencies. However, the statute does allow localities to create Enhanced IFDs and issue bonds to finance capital improvement projects and, "other specified projects of community wide significance." As with any Tax increase there is often a political cost or political barrier to be overcome and IFDs are no exception as they require approval of the taxing entities.

Special Property Assessment

This is likely to become a more common financing strategy as the need for fiber to the home becomes viewed as more of a necessity than a luxury. The citizens of Leverett, Massachusetts passed a special five year tax assessment in 2013 to build fiber to every property.

California has multiple special property assessments available including Business Improvement Districts (BIDs) and their derivatives of the BID concept. A BID is a financing mechanism

that is used or provide revenue for local improvements and services that enhance (not replace) existing municipal services.

PBID - PROPERTY-BASED BUSINESS IMPROVEMENT DISTRICT
A PBID is a BID in which the assessment is assessed on real property

BBID - BUSINESS BASED BUSINESS IMPROVEMENT DISTRICT
A BBID is a BID in which the assessment is paid by local business owners

In either case the BID is formed with a defined boundary whereupon a super majority vote (2/3) is required by either property owners or business owners to pass the assessment.

CASH

Many community broadband projects have been funded in part or in whole by cash from the local government. This source of funding is often treated as a loan that is repaid over time from from revenue earned from the network. It is good practice to create an enterprise fund that manages the loan, network revenues and network expenses in a completely separate set of financial books to ensure that there is no cross-subsidy from general fund revenues and to provide full transparency for audits and management oversight.

REVENUE BOND GUARANTEES

Revenue bond guarantees are not a direct source of funds but can be extremely valuable as part of a revenue bond offering. A bond guarantee could come from local governments that are involved in the network development, a state financing authority that helps underwrite municipal bond offerings, or as a special authorization from the state legislature. Some community network project bond offerings have been guaranteed by tax revenues from the local communities (e.g. the Utopia project in Utah).

NEW MARKETS TAX CREDIT

New markets tax credits are a form of private sector financing supported by tax credits supplied by the Federal government. The New Markets Tax Credit (NMTC) Program permits taxpayers to receive a credit against Federal income taxes for making qualified equity investments in designated Community Development Entities (CDEs). The CDEs apply to the Federal government for an allotment of tax credits, which can then be used by private investors who supply funds for qualifying community projects. Substantially all of the qualified equity investment must, in turn, be used by the CDE to provide investments in low-income communities which will rule out much of Santa Cruz County. The credit provided to the investor totals 39 percent of the cost of the investment and is claimed over a seven-year credit allowance period. In each of the first three years, the investor receives a credit equal to five percent of the total amount paid for the stock or capital interest at the time of purchase. For the final four years, the value of the credit is six percent annually. Investors may not redeem their investments in CDEs prior to the conclusion of the seven-year period.

Throughout the life of the NMTC Program, the Fund is authorized to allocate to CDEs the authority to issue to their investors up to the aggregate amount of $19.5 billion in equity as to which NMTCs can be claimed.

STATE FUNDS

Many local broadband projects are receiving help from state sources of funding, particularly for early stage planning, but some funds are often available for pilot projects and specific expansion projects that meet certain kinds of public safety or economic development criteria. State granting agencies are more likely to fund projects with multi-jurisdictional benefits (such as a joint project between Santa Cruz County and one or more of the incorporated cities or Santa Cruz County and one or more of the surrounding counties).

As a couple of examples, the Virginia Department of Housing and Community Development (DHCD) has been providing early phase planning funds to communities that commit to following a specific planning process supplied by DHCD. The South Carolina Department of Commerce has also been providing some support for similar local efforts in South Carolina.

State agencies may also be able to assist with applying for Federal funds. Community Development Block Grants (CDBG) are now being provided for some kinds of local broadband efforts. CDBG grants have to meet eligibility requirements (e.g. Low and Moderate Income areas, distressed downtown areas, etc.). Some community broadband projects have also successfully received direct grants from the state legislature.

California Public Utilities Commission has funded broadband projects in mid-coast California, including the Sunesys Connected Central Coast Unserved and Underserved Broadband Project, which serves Santa Cruz County. The Sunesys project was funded out of the California Advances Services Fund and included local matching funds.

FEDERAL FUNDS

Several different Federal agencies provide some support for community or regional broadband efforts. Some other Federal agencies also provide funds for telecom, and the County may be able to qualify for some of them by collaborating with the right mix of partners. The FCC recently distributed $400 million for community and regional telehealth and telemedicine projects across the U.S.

In the past, earmarks have been a valuable source of funding, albeit a highly unpredictable one. In the current political climate, earmark funding has been very difficult.

The Eastern Shore of Virginia Broadband Authority was able to obtain several million dollars in earmarks funds to help build its 80 mile fiber backbone, but it took more than two years to get the funds approved and allocated. Earmark funds can be approved but not allocated, which has sometimes caused problems–approval by Congress for the earmark does not automatically ensure that the Federal agency serving as the administrator of the funds receives a budget allocation. In some cases, earmark funds that have been allocated can be re-allocated by the receiving agency for a related purpose. Strong Congressional support is needed for earmarks.

Federal funds usually require long lead times to obtain (12 to 18 months is typical) and are best used for specific opportunities where the funding guidelines match well with a specific local need or opportunity. It seems unlikely that there will be another round of ARRA-style broadband stimulus funds, given the budget difficulties of the Federal government.

Municipal Leasing

Communities routinely use municipal leasing to fund a wide variety of needs, including water and sewer projects, buildings, equipment, and vehicles like police cars, fire trucks, and public works equipment. Municipal leases can take the form of a straight loan, but for telecom projects, one option called a "moral obligation" lease may be more appropriate. In a moral obligation lease, the network itself is used as collateral to guarantee the loan, rather than requiring the use of general funds to pay back the loan if the network does not perform as expected. Obtaining approval for a moral obligation loan requires an excellent municipal credit rating and an investment quality financial plan for the operation and management of the network. This approach would be more appropriate for building extensions of the network related directly to local government needs. It is not likely to be viable as a primary means of financing.

Private Sector Financing

If a public/private partnership approach is chosen, a substantial portion of the early development funds would likely come from private sources, which could include local investors and partners, larger institutional investors (e.g. pension funds), or groups of private equity investors. For early fundraising, long term notes offered to local investors is an option. In this approach, the network offers long term notes (e.g. fifteen or twenty year terms) with interest-only payments for several years; repayment starts after the interest-only period. This enables the network to raise funds relatively quickly and the interest-only period allows the network to develop adequate cash flow before having to make loan payments.

Commercial loans from local banks are an option that could provide funds for small, urgent short term opportunities (e.g. building a short fiber run to reach a business that needs improved connectivity to add jobs). If a business case can be developed that shows how the improvements or extensions will increase revenue to repay the loan, this form of financing should be easy to obtain.

Business Contributions

Some businesses recognize the value of having community fiber at their premises because they may be able to obtain previously unaffordable services and/or lower the cost of existing services. If the savings are substantial, some businesses may be very willing to pay pass by and connection fees to obtain access to the community fiber, and we have spoken to businesses in other communities that have expressed willingness to make no strings attached contributions to the local effort. However, such contributions are usually linked to specific plans to pass the businesses with fiber within a reasonable time frame.

GRANTS AND DONATIONS

Grants and donations can provide funds for planning and for targeted construction projects (e.g. fiber to a local hospital, a community institution, etc.). Community foundations will often contribute funds to local technology projects. Sometimes the expenditures have to be tied to specific foundation goals (e.g. improved K12 education), but often local foundations will accept grant applications for a wide variety of local projects. Some community efforts have also received private donations, although these are usually modest, and have also usually been provided to support a specific need or project.

Given Santa Cruz's location and economics, there is a potential for a local individual or local foundation to fund a pilot project. Other projects have been aided by "angel" investors who have a vested interest in their locality.

PROPERTY OWNER CONSTRUCTION FEE

Much like water and sewer pass by and tap fees, in this approach, property owners are assessed a one time connection fee that can be paid as a one time payment, or as a series of payments over time. Some communities are using a special tax assessment to finance a 100% build out (e.g. Leverett, Massachusetts). Other projects will not build in a pre-defined neighborhood unless a certain percentage of homeowners agree to pay the fee. Property owners who refuse to pay are passed by fiber, but do not receive the connection from the curb to the side of the building.

SALES TAX

Increasing Sales Tax, with voter approval, is one option for raising capital to fund the network build. Generally, the increase is set for a specific project and is usually rolled back once a pre-determined amount of capital is raised.

The Arrowhead Electric Coop in rural Minnesota is paying for a full fiber build out to all homes and businesses by working with the local county government (Cook County) to collect a special 1% sales tax. The tax is actually used for a variety of infrastructure improvements, with the broadband build out using about 48% of the funds collected. The broadband portion of the sales tax is used to underwrite the cost of the CPE (Customer Premise Equipment), which is the device installed at the residence or business. This approach lowers the overall capital cost and reduces the financial risk for the electric coop. The Utopia project in Utah has been financed in large part by using loan guarantees backed by existing local sales tax revenue. This approach does not require changes in how existing sales tax revenue is used unless the fiber project runs into financial difficulties; in that case, the localities collecting sales taxes would be obligated to use some of the sales tax collected to make loan payments. In Minnesota, creating this kind of sales tax levy requires state-level legislative approval.

ATTRACTING EXTERNAL NETWORK CONSTRUCTION

The focus of this report and the recommendations contained herein encourage the County taking an active role in it's economic development future by investing in telecommunications

infrastructure rather than leaving it to the existing (or new) private sector provider to determine what is available to the businesses and residents in Santa Cruz. However, it is worth mentioning that there are existing opportunities for communities to attract a private sector network owner/operator to build within the community.

Google Fiber Initiative

Five years ago (2009) Google offered to build a state of the art fiber-optic network in one US city as an experiment. More than 1000 cities and regional areas responded to Google's RFI. After fierce competition and lots of national media coverage, Kansas City was selected. Since then Google has built (or acquired) networks in a few large metropolitan areas (Kansas City (see attached case study), Austin, and acquired and added to Provo, UT).

Google just announced it's latest potential markets for expansion of the Google Fiber Initiative in Atlanta, Charlotte, Nashville, and Raleigh-Durham. In that announcement, they also indicated there are additional potential cities (Portland, Salt Lake City, San Antonio, and San Jose) that were close runners-up to the four new announcements. It is still not clear whether the Google Fiber Initiative, billed as an experiment, will continue and is largely up to the market (Wall Street) as the results from the initial projects start to impact Google's financials.

Once a city is chosen, Google uses a "fiberhood" concept where they build to neighborhoods which have a high percentage of "take rate" where residents agree to purchase a service in advance. This crowd-sourcing or map-sourcing type of activity is being used in other areas and is not exclusive to Google's approach.

Attracting Google to Santa Cruz would be a significant accomplishment when competing against large municipalities. It's clear in Google's initial awards that the requirements are for a large and dense population. However, given Google's close proximity, the County should continue to watch the developments (notably in San Jose) too see if there is an opportunity.

Other Private Sector Network Owner/Operators

There are other alternatives to the Google Fiber Initiative. There are many companies watching the Google projects and may (or may not) follow Google's lead to build and operate networks to provide broadband.

There is one one such opportunity that is currently being negotiated in Monterey County by the City of Pacific Grove. Pacific Grove is working with a 3rd Party Network Owner/Operator to build, maintain, and operate a broadband network to serve its businesses and residents. At this time, it is too early to speculate if this project will get funded, get built, and provide improved services to the residents and businesses in the City of Pacific Grove.

Best Practice: Planning for Success

With more than a dozen years of operation for a variety of community-owned network infrastructure projects around the country, there is very little "experimentation" that is still necessary. With more than three hundred communities making investments in broadband infrastructure, there is now enough information about what works and what does not work to be able to identify best practice across nearly all areas of operations, planning, management, and finance.

HIRE STAFF AS A START UP BUSINESS

The one area that we see causing the most operational problems is poor staffing decisions. While there is a natural impulse to think that a network infrastructure project needs someone with a telco background, someone with thirty years experience with CenturyLink is not likely to be a good choice for a variety of reasons, chiefly because a new broadband infrastructure venture is more like an entrepreneurial start up than a multi-billion dollar company.

The project manager for the Santa Cruz Fiber initiative should be someone with a track record of successful business/administrative management and a demonstrable record of innovation. They should be flexible, knowledgeable about local government, and be comfortable with technology. They do not necessarily need to have a technical background. They should be comfortable supervising someone with a technical background.

FUND FOR EARLY OPERATIONS

Successful projects provide enough funding to support eighteen to twenty-four months of operations. There are a variety of fixed costs (staffing, outside plant maintenance, network operations, utility costs, office costs, etc.) that accrue beginning on day one, when revenue is low. While some community projects have been successful getting into the black operationally in year one, it sometimes takes longer.

USE GRANTS AS SUPPLEMENTAL FUNDING

Grants can be extremely important in the early stages of an effort to support planning activities and/or to fund a Phase One build out initiative. But grants rarely will allow spending on operational expenses. Grants should be used to supplement other sources of funding and as one time cash injections to support very specific goals. Communities that have relied too heavily on "the next grant" as a key source of expansion or operational funding usually experience severe financial problems.

MANAGE FINANCES

Broadband infrastructure projects require hard-nosed financial oversight. Projects that have developed financial problems have usually over-estimated early revenue, under-estimated expenses, and/or simply spent too much without aligning expenses with revenue. Volunteer board members who are contributing time while also maintaining a full time job (often in local

government) may not provide enough financial oversight to ensure that staff use the budget as a tool to measure financial performance.

USE TAKE RATE TARGETS AS A KEY PERFORMANCE MEASURE

The initial business plan should have a minimum three to ten year projection of connected premises (i.e. the take rate), including local government facilities, large and small businesses, health care facilities, and residential customers (if fiber to the home is part of the business plan). Take rates directly affect revenue: if take rate projections are not being met, revenue shortfalls are likely. Take rates (both raw numbers and month to month growth rates) should be analyzed at least quarterly (monthly would be preferable).

PLAN FOR MARKETING AND PUBLIC AWARENESS EFFORTS

If the Santa Cruz County Fiber initiative moves forward, it will be necessary to have a modest but regular marketing and awareness campaign to ensure that area businesses know that the new Santa Cruz County Fiber network is available, that they know what service providers are available on the network, and they know how to order service. While service providers will be responsible for sales (that is, selling their services and signing up their own customers), the network itself will have to market general awareness of the network.

PLAN FOR EXPANSION

Most community-funded efforts start small. This minimizes financial risk and gives the senior leadership the opportunity to learn on the job. But some projects tend to stall out after the first year or two. Part of the problem we have observed is that the volunteer boards realize that assisting with the management of this new start up business is not quite the same as serving on the board of the local food bank or some other charitable enterprise. The underlying problem is twofold: even small networks have a certain amount of fixed operational costs regardless of size, and the network needs enough revenue to pay those expenses, as well as make principal and interest payments on any loans. The second problem is that network infrastructure wears out and needs routine maintenance. Lack of funding to keep the network in good condition will degrade service over time. The solution is to have an expansion plan (which could be modest) that contributes to revenue growth over time.

BUDGET FOR CUSTOMER CONNECTIONS

If the network is going to achieve financial sustainability, new customers have to be added on a schedule that matches the financial projections. This means the project must have the funds to support adding customer "drops" from the distribution fiber on poles or underground in right of way at the edge of the street or road. This is where careful budgeting and adequate funding is a necessity. The worst possible outcome is to have business and residents requesting a connection to the network but having a lack of the funds to make that "last hundred feet" connection. There are a variety of charge back and fee-based strategies for raising the capital needed to complete drops, and a plan that supports funding of new customer connections is essential.

Broadband Policy Recommendations

Broadband Trends

Numerous studies indicate that demand for bandwidth is doubling every two years. Current projections indicate an increase in bandwidth requirements that is fifty times (50x) what it was in 2010 (current average bandwidth to homes and businesses then was 1-2 megabits.) A number of factors are driving these trends.

- As business travel is becoming more expensive, more companies are relying on video conferencing to conduct meetings and reduce travel costs. HD quality business video-conferencing systems require dramatic increases in bandwidth that are often not affordable or in most cases even available in certain areas of Santa Cruz County.
- There is an increase in the number of teleworkers. More and more workers and business people are working from home, either on a part time or full time basis. Home businesses and work from home job opportunities are growing rapidly, but most of those jobs require a wired Internet and a wired phone connection to qualify. Some major businesses in other parts of the U.S. are already actively planning to have 20% of their workforce work full time from home to reduce employee travel costs and office energy costs. Additionally, many states have are actively promoting telework initiatives to reduce traffic congestion and auto emissions. Data shows that Santa Cruz County already has a large number of home-based workers and businesses.
- Americans are watching more than 10 billion videos per month over the Internet. Globally, video will be 73 percent of all Internet traffic (both business and consumer) by 2017, up from 60 percent in 2012. The sum of all forms of video (TV, video on demand [VoD], Internet, and P2P) will continue to be in the range of 80 and 90 percent of global consumer traffic by 2017.
- In 2008, U.S. industries invested over $455 billion dollars in telecom and technology investment, including over $60 billion in broadband.
- A 2011 report from the McKinsey Global Institute studied the Internet's growing impact on the economy. The report found that the Internet accounted for 21% of GDP growth in the last five years for mature countries, and this number is only expected to climb higher. $8 trillion dollars is exchanged through e-commerce annually.

Next Generation Broadband Networks

The FCC's prediction for increased bandwidth indicates that current DSL and cable modem services will be inadequate, especially for businesses, but also for home uses of telecom services. Current DSL offerings are in the range of 384 kilobits to 1.5 megabits for most residential users, 768 kilobits to 3 megabits for business DSL users, and there are severe distance limitations on DSL. Higher bandwidth are now possible, but as the DSL bandwidth goes up,

the distance it can be delivered goes down and many neighborhoods are unable to subscribe to these higher speeds.

Current wireless offerings are in the range of 1/2 megabit to 3 megabits, and future WiMax services will only be able to deliver 4-8 megabits. Some wireless providers are rolling out 10-15 megabit services, but wireless does not scale up well with respect to cost. As bandwidth increases, the cost of the equipment also increases, and even a 15 megabit service is well short of the FCC projections of the need for 50 megabits of bandwidth in the near term.

Current average bandwidth for cable modem services is typically 5 to 10 megabits (actual throughput). Although some companies are now advertising packages of 20 to 30 mbps, it is important to note that cable providers make heavy use of the phrase "up to" in their advertising. In reality, that amount of bandwidth is shared among many users (often 200 or more) in a neighborhood, which results in much lower average speeds, and during peak use times in residential areas, the actual bandwidth available to a single household may be much less.

The challenge for Santa Cruz County is to ensure that the businesses, residents, and institutions in the community have a telecommunications infrastructure in place that will meet the goal of the FCC National Broadband Plan for 100 Mbps to the home and one Gigabit per second to anchor institutions. We would note that this FCC target is already low, as a Gigabit residential fiber connection costs no more than 100 Meg network equipment, and we encounter many anchor institutions that (e.g. K12 schools, hospitals, etc.) that are already requesting bandwidth in excess of one Gig.

"Next generation" is the term used to describe future planning for the next step in network connectivity and infrastructure. This suggests an emphasis on deploying fiber-to-the premise (FTTP). Fiber provides greater access to connectivity and allows the infrastructure to be in place to accommodate future communication needs, capacities, and innovations. An increasing number of cities are deploying fiber networks to improve broadband speed and obtain a competitive advantage in attracting businesses.

Next generation broadband reaps in a number of substantial benefits in functionalities including:

- Dramatically faster file transfer speeds for both uploads and downloads
- The ability to transmit streaming video
- Means to engage in true-real time collaboration
- The ability to use many applications simultaneously
- Improved cellular voice and data access when cellular towers have fiber backhaul

Santa Cruz County faces a challenge in economic development infrastructure with primarily "little broadband" (i.e. DSL, wireless, and cable services) while many communities, regions, and countries have already made the decision to focus resources on the development of "big

broadband," which is typically fiber with a minimum capacity of 100 megabits or Gigabit to the premises.

Any investments in broadband and telecommunications infrastructure should be able to scale gracefully to meet business and economic development needs for decades. This drives the solution towards a fiber system.

BROADBAND GOALS AND OBJECTIVES

Santa Cruz County may wish to consider adopting specific goals and objectives that would facilitate the deployment of broadband infrastructure and support efforts of private and public partners in meeting the needs for reliable, robust and affordable bandwidth.

Goal 1: Take measures to ensure that businesses, institutions and residents of the County have affordable access to "state of the art" broadband infrastructure to meet current and future needs.

Rationale: Broadband is essential infrastructure that businesses, institutions and residents rely on to work, learn, access health care and other county services. Businesses need next generation broadband to be competitive in today's economy and to develop innovative applications. Public agencies require broadband to cost effectively provide services and adopt sustainable practices.

Objective: Work with local public agencies, schools, health care providers, economic development officials , utilities and service providers to develop a broadband vision and plan to form a public/private Fiber Initiative that provides leadership and focus for establishing an open access network..

Objective Require new residential subdivisions and commercial development projects to include broadband infrastructure components necessary to support next generation broadband.

Objective Support efforts to provide community anchor institutions such as libraries, schools, hospital and government buildings with next generation broadband infrastructure,

Objective Promote competition for broadband services that will foster affordable Internet access and advocate for reliability through redundant infrastructure.

Objective Adopt policies, regulations and construction standards to coordinate deployment of broadband infrastructure with road construction projects in order to achieve cost efficiencies. Santa Cruz already has a "Dig Once" initiative. Based upon preliminary discussions with local service providers, they would like additional focus on this ordinance.

Objective Create and maintain an inventory of public and private broadband assets including fiber/conduit in the right-of-way, towers, and other assets.

Objective Promote the orderly and appropriate development of wireless facilities to achieve reliable access in a manner that will protect public health and safety and prevent visual blight.

Goal 2: Promote adoption of broadband technologies to support business innovation, enhance delivery of local services, realize cost efficiencies, engage citizens and support sustainable applications.

Rationale: The benefits of investments in next generation broadband infrastructure will come from the adoption of new technologies. Technology applications have the potential to reduce costs for public agencies and can expand the range of educational, health and e-government services that residents and businesses can access on-line. New broadband technologies can reduce energy usage, conserve water and promote sustainable practices.

Objective: Encourage telecommuting, telework and low-impact home businesses to create jobs and to reduce transportation impacts and improve air quality.

Objective: Support innovative applications such as smart grid, smart water, automation, remote monitoring with sensors and big data analysis that can conserve resources.

Objective: Support public hot-spots and computer centers so all citizens can access technology and fully participate in the community.

Objective: Continuously improve local government use of e-government applications to provide transparency, improve services and engage citizens.

Case Studies

City of Eagan, MN

The City of Eagan began planning for a city-owned fiber network in 2008 at the urging of key business leaders who represented both large and small businesses, including some Fortune 500 companies. One of the first efforts by the City included asking the private sector, including the incumbents, to help solve the bandwidth affordability problem. Both the primary cable and telephone company in Eagan declined to offer any substantive improvements. Several other private sector firms also submitted proposals, but none were deemed adequate to meet the needs of a diverse business community employing tens of thousands of employees.

During the planning process, the City also began to examine strategies to attract one or more commercial data centers to the community, and it was determined that the availability of City-owned competitive fiber would assist in that effort. In 2011, the City allocated funds to construct AccessEagan, which was planned to be 17 miles of high performance, business class Gigabit fiber capable of serving a large percentage of the business and commercial areas of the city. The network was constructed to meet the most demanding technical requirements of Eagan's larger businesses, with a Gigabit connection as standard for any connected business, and the active Ethernet network has ample capacity to provide 10Gig, 40Gig, 100Gig, and wavelengths as needed to meet business requirements.

Operating as an open access, lit circuit network, four private sector providers have signed master agreements to sell services, and the City began taking orders from those providers for the first connected businesses in 2013. The City also announced in 2013 that a data center was coming to the City, and was to be located in an existing building that was passed by the City-owned fiber.

Attribute	Description
Governance	AccessEagan is City-owned; operated as an enterprise fund.
Funding	Funds from cellular providers who rent space on City structures was used to construct the initial build out.
Business Model	Operating as an open access network, with all business services provided by private sector companies.
Management	The City IT department manages the network. New construction (e.g. drops to businesses) is contracted out.
Technology	AccessEagan is an active Ethernet network.

Google Fiber Initiatives

In 2013, fiber deployments began to accelerate in the wake of Google Fiber's announcement that they were expanding their fiber deployments to Austin, Texas and Provo, Utah. Google's first project was in Kansas City, Missouri.

In Austin, AT&T, the incumbent provider there, immediately announced they would begin deploying fiber in that city, despite the fact that the company had been previously stubborn about insisting that "nobody needs fiber." AT&T might have to update that mantra to "*Nobody needs fiber in our markets until someone tries to compete with us, and then we will suddenly discover fiber is very important.*"

Google is currently evaluating proposals from more than thirty other large metro areas, and is expected to start additional fiber deployments in a handful of them.

A Google-connected home or business gets low cost Internet, but the service agreement gives Google wide latitude to examine all of the traffic moving over the customer connection (e.g. Web pages, email addresses, documents, spreadsheets, etc) so that the firm can mine that data to target specialized advertising as well as sell the data to third parties.

Attribute	Description
Governance	In Google Fiber cities, Google is the retail provider. While Google touts its projects as public-private initiatives, Google networks are entirely in the private sector.
Funding	Google uses its own funds to build and operate the networks.
Business Model	The primary service is Internet access. Google does have a streaming TV offering (Chromecast) but it is not, strictly speaking, comparable to a traditional cable/satellite TV service. Customers get whatever Google gives them, and the company encourages the use of Google-branded services like Google Docs, Google+, and gmail.
Management	The network is managed entirely by Google staff.
Technology	Google networks include both GPON and active Ethernet technologies.

ROCKBRIDGE AREA NETWORK AUTHORITY

Rockbridge County, Virginia and the two independent cities of Lexington and Buena Vista (both within the borders of the County) formed a broadband authority in 2009 after completing an initial feasibility and market demand study. The authority consists of elected officials from each of the three localities, as well as representatives from the business community and Washington & Lee University. Rockbridge was able to build upon the study for the submission and successful award of a $7 million grant.

The grant, which included $7 million in ARRA Federal stimulus funding and $3 million in local match, constructed 60 miles of backbone fiber and provide another 35 miles of Gigabit last mile connections to 53 community anchor institutions and 175 homes and businesses. The project includes a state of the art data center and will also construct 29 DSL cabinets throughout the County, to help extend service into the underserved regions of Rockbridge County. Construction began in 2012 and the network's first customers were connected in the summer of 2013. The data center in Lexington is the most sophisticated facility of its kind in this part of Virginia. The 95 miles of fiber being built passes more than 11,000 homes and businesses and is "last mile ready," meaning businesses and residents can get the standard Gigabit fiber connections quickly and easily once initial construction is complete.

Attribute	Description
Governance	The network and data center is owned and operated by the Rockbridge Area Network Authority (RANA).
Funding	Approximately $500,000 in local match from the three local governments and $2.5 million in funding from Washington & Lee University helped get the project started. These local funds were used as match to obtain $7 million in Federal ARRA stimulus funds.
Business Model	Services are sold to business and residential customers by private sector service providers using the RANA network for transport
Management	The network began operating in the summer of 2013, and most operations and maintenance has been outsourced.
Technology	The network is an active Ethernet system with a standard Gigabit symmetric fiber connection. 10Gig connections are also available.

LAFAYETTE, LOUISIANA

Lafayette, Louisiana is perhaps one of the best known community broadband projects in the United States. The City announced its intentions to go into the broadband business in 2004, and was promptly sued by the incumbent cable provider. The court case ground on slowly, and it was not until the City had spent nearly $4 million on legal fees that the Louisiana Supreme Court decided that the City had the right to compete directly with private sector telecom companies.

Since then, thousands of customers have been connected and Lafayette is now famous for having some of the lowest rates for Internet access in the United States, with a 50 megabit symmetric package of Internet access for only $58/month. The network has now been operational since early 2009.

Cox Communications, famous in Louisiana for regular rate increases, froze its rates in Lafayette for several years following the city's initial announcement that it would offer telecommunications services. Meanwhile Cox continued to raise its rates in other parts of the state. The result was that even before Lafayette's system began operating it had saved its residents and businesses nearly $4 million.

Attribute	Description
Governance	The network is owned and operated by the City of Lafayette and is part of the Lafayette Utilities Department.
Funding	The City raised $110 million in funding to build the network. The long term plan is to pass all 57,000 homes in the city.
Business Model	Services are sold directly by the City in a traditional triple play retail model.
Management	The City Utilities Department operates the network and handles outside plant maintenance.
Technology	LUSFiber is an active Ethernet system with a standard 100 megabit symmetric fiber connection. Gigabit connections are also available.

CHATTANOOGA, TENNESSEE

The City of Chattanooga is an electric city with its own electric utility. As the electric utility began to examine the feasibility of using smart meters to better manage the electric grid and to reduce energy costs to its customers, it realized that just implementing smart meters to all its customers was a significant portion of the cost of building a general purpose all fiber network that would also support smart meters and the utility's grid management needs.

The utility was able to secure a $110 million grant from the U.S. Department of Energy, bonded an additional $220 million, and by 2013, more than 56,000 homes and businesses had been connected with Gigabit fiber, and more than 170,000 meters had been connected. A residential Gigabit fiber connection costs $70/month. The electric utility estimates that it is saving as much as half of its overtime costs per year because of improved energy management.

The utility owns and operates the fiber network, and customers are billed for services directly by the electric utility. The primary service offering is Internet access, but customers can also purchase TV and voice services. A triple play package of Internet, voice, and TV sells for $125/month. Most customers purchase a 100 meg Internet service. The network is operated as a retail triple play business model, and would not be considered open access, as all services are provided by the electric utility.

Attribute	Description
Governance	The network is owned by the City electric utility.
Funding	A U.S. Department of Energy grant provided $110 million, and the City issued bonds for an additional $220 million dollars to connect more than 170,000 customers with smart meters and to provide fiber connectivity.
Business Model	The network is operated as a retail triple-play business, with customers buying all services directly from the electric utility.
Management	All management, maintenance and repairs are handled in-house by the electric utility.
Technology	Most customers get a GPON (passive) Gigabit fiber connection. The utility can provide active Ethernet connections to businesses who need it.

Scott County, Minnesota

Scott County determined to build a robust fiber backbone and highly redundant network with direct connections to major telecommunications and State hubs. The county of 365 square miles was growing rapidly with a population of 130,000. In January, 2007 the County board approved a budget of $4 million to build a 90 mile fiber-optic backbone. The initial reason for the network construction was to improve public safety which had long relied on microwave connections to link communications facilities for fire and police needs.

The fiber backbone quickly became a base for improved communications among all county facilities and saved the County more than $500,000 per year by eliminating expensive leased lines. As with other Minnesota counties that constructed their own fiber backbone, Scott County was able establish a debt payment schedule that actually reduced communications costs to the County by $35,000 per year.

In addition to the improved efficiency, redundancy and lower costs, Scott County was able to leverage the new broadband network for economic development. In 2013, before network construction was completed, the County was able to attract an Emerson Process Management plant with 500 jobs in the rapidly expanding manufacturing process control industry. Shutterfly brought more than 300 jobs and a $60 million facility to Shakopee, the County seat.

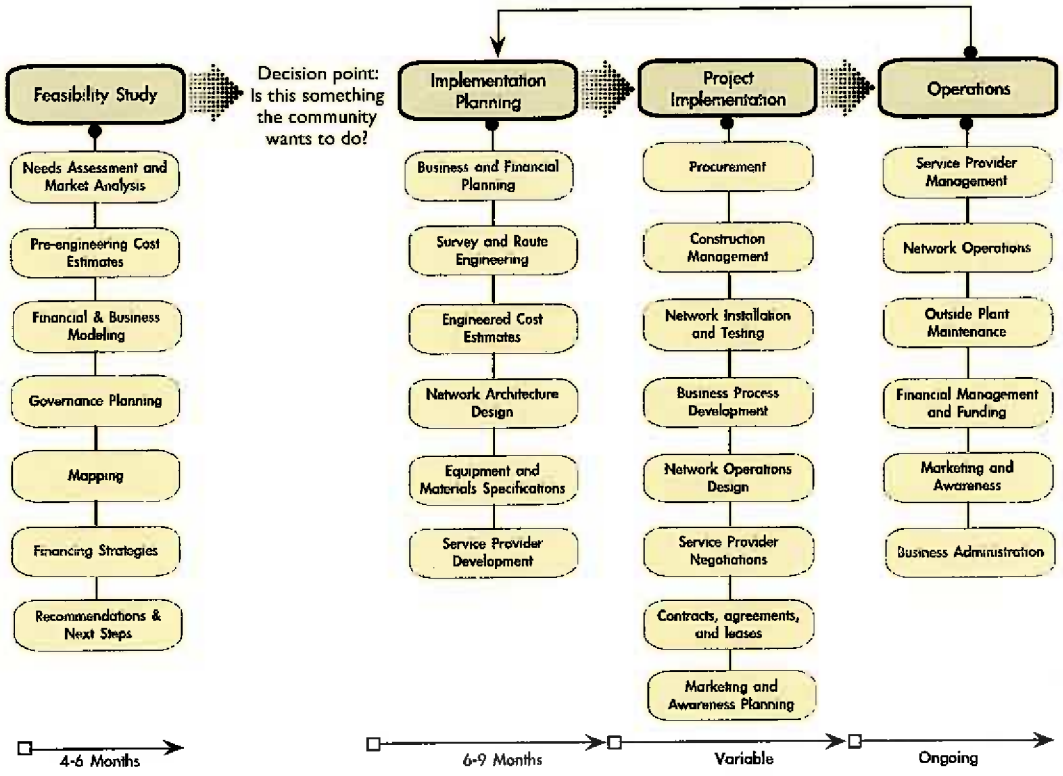
The county partnered with Access Communications (now owned by Zayo, LLC) to build and maintain the network. The state Office of Enterprise technology also provides network management services in exchange for access to fiber. The county is now seeking options to bring the benefits of fiber-optic broadband to residences and small businesses.

Attribute	Description
Governance	The network is owned by the County.
Funding	The County appropriated approximately $4 Million for the initial build.
Business Model	The network is operated by Zayo, LLC (who also built the network). Zayo, LLC is a nationwide Middle Mile fiber provider.
Management	Management, maintenance and repairs are handled by Zayo or Zayo subsidiaries or outsourced by Zayo to local contractors. The state Office of Enterprise Technology does manage portions of the network providing services to state and local government clients.
Technology	Gigabit Active Ethernet line rate for County Government and large institutional customers. If expanded to residences and businesses, the technology will be a mix of Gigabit Active Ethernet and/or GPON.

Project Phases

For Santa Cruz County, the development of a successful community-owned open access wholesale network will require attention in several areas including the technical (network equipment selection), engineering and construction, and business and financial planning. It is important to note that the business and financial planning are critical elements that will in large part determine the long term success of the effort. This section provides an overview of the key task areas and activities.

The illustration below shows the sequence of key phases and activities in the course of a network project. On the pages following this diagram is more detailed information about the individual tasks and activities that will lead to successful completion of a fully operational network, including the business processes required.



A successful project requires a plan that ensures the right resources are available at the appropriate times during the various phases of development. Some resources must be identified and procured during the planning phase, some during the implementation and construction phases, and some during the operations phase.

- **Financial Planning** – Financial planning includes the development of short term and long term budget estimates and pro formas. These materials form the basis of developing a funding plan, as well as providing a solid base for ongoing evaluation of the success of the enterprise.

- **Business Model** – The business model selected determines the kind and type of revenue that will be generated by the project, and also affects the kind and type of expenses that are incurred. For community-owned infrastructure, there are two basic model. A "retail" network has business and/or residential customers buying services directly from the local government, which creates direct competition with local private sector providers. The alternative is the "wholesale" model, in which the community-owned infrastructure is leased out to private sector providers on a wholesale basis--the local government sells no retail services and does not compete with the private sector.

- **Legal Counsel** – Whether the retail or wholesale business model is chosen, there is a short term and long term need for legal counsel familiar with telecom and broadband business agreements and contracts. Well written contracts with service providers protect the network and create a fair and equitable "level playing field" for competitive providers.

- **Engineering** – Whether fiber cable is hung on utility poles or placed underground in conduit, prior to construction, the routes must be surveyed and engineered drawings must be developed to meet DOT (Dept. of Transportation) requirements and to provide contractors with the information needed to construct the network to industry and state technical requirements.

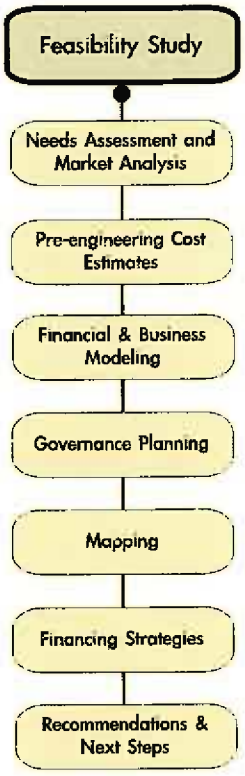
- **Network Design** – The logical design of the network must be matched to the business model, as the architecture of the network may vary according to a retail or wholesale model. The network design must also meet the requirements of large and small businesses, and for large businesses with extensive broadband and data needs, the network must be capable of meeting both current needs and future growth.

- **Equipment** – Once a network design is complete, an evaluation of equipment vendors must take place, ideally via a bidding process to ensure that the selected equipment will meet all of the business and technical requirements of the network, at the best possible price. A Total Cost of Ownership (TCO) evaluation should be completed to ensure that the right initial price is balanced with the longer term costs of extended warranties and technical support. The least expensive purchase price for equipment may be more expensive over time than equipment from a vendor with a higher initial equipment cost but lower support and warranty fees.

- **Build Out** – While fiber construction is generally much less expensive than other typical community projects like water and sewer development, care must be taken to select contractors with the appropriate experience installing fiber in both aerial and underground designs. The cost of construction can vary widely, so the development of very specific bid documents that include the right engineering information as well as a carefully structured proposal response on pricing is needed to ensure the community obtains the right contractor at the right price.

EARLY PHASE PLANNING

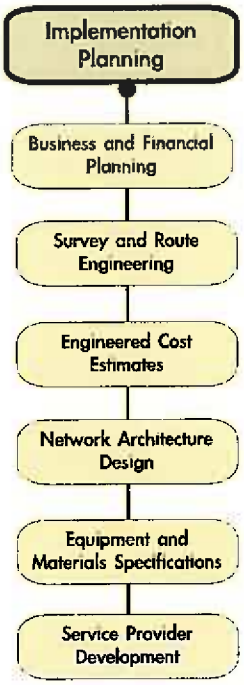
This report represents some of the primary activities of the early phase planning. The work includes:



- **Needs Assessment and Market Analysis** – An evaluation of current assets and projections of future needs, based on local business and economic conditions. Design Nine worked with the County to obtain an understanding of the current telecommunications landscape in the County.
- **Pre-engineering Cost Estimates** – Pre-engineering cost estimates of potential network projects provide a baseline for understanding the costs of getting started, provide necessary inputs to the financial pro forma development, and also inform funding strategies.
- **Financial and Business Modeling** – A ten year financial pro forma, using inputs from the business requirements analysis and the cost estimates, provides an early test of the financial sustainability of the project and provides a long term road map for financial management.
- **Governance Planning** – Before making a commitment to move to implementation planning, it is necessary to have a basic understanding of the key operations and management tasks related to operating the public/private enterprise.
- **Mapping** – Mapping of current assets, areas and business locations of needs, economic growth areas, and key customers and stakeholders informs the development of the network architecture and the financial pro forma.
- **Funding Strategies** – Before moving to the next steps, it is vital to understand where the planning, engineering, and initial construction funds will come from. There are many options available.
- **Next Steps** – A list of key activities and milestones needed to move the project ahead.

IMPLEMENTATION PLANNING PHASE

This phase produces the equipment and construction specifications needed to bid out the work of constructing the network.



- **Business and Financial Planning** – The Project Manager performs detailed business and financial planning. This includes planning how the business front office and back office will be run.

- **Survey and Route Engineering** – An on the ground survey is needed to complete a final route design. This work is performed by an engineering firm that also has the responsibility to produce the engineered design and obtain required permitting. The field survey confirms that the final route can be built to the necessary standards and regulations.

- **Engineered Cost Estimates** – The engineering or engineer/build firm completes a set of cost estimates based on the final surveyed routes. If the construction is bid out, the full drawing set is attached to the construction bid documents and becomes the basis for the awarded construction contract.

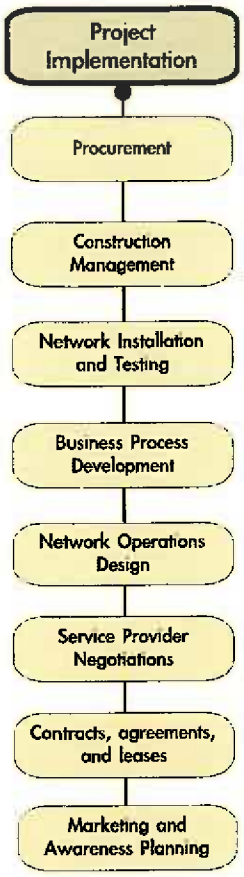
- **Network Architecture Design** (Detailed) – Final analysis of vendor equipment is performed and selection is made. The detailed network design starts with the completed network architecture and completely specifies all of the equipment, cabinets, patch cables, power supplies, optical lasers, batteries, and all other necessary parts and equipment needed to create a functional network. The output is a complete Bill Of Materials (BOM) used to create purchase orders for equipment, as well as specifications for the configuration of routers and switches.

- **Equipment and Materials Specifications** – The Engineering firm also completes a detailed list of all equipment required for the construction. The Bill Of Materials is produced for fiber, conduit, handholes, fiber splice enclosures, and related hardware needed to install the fiber cable underground and/or on utility poles.

- **Service Provider Development** – In an open access network, service providers have to be recruited and formally signed to a contract to become a provider on the network. Providers usually need "coaching" because they are typically unfamiliar with open access networks and need help understanding the unique business opportunities they represent for private sector companies.

CONSTRUCTION PHASE

The documents produced in the Implementation Phase are used to bid out the construction work and to procure the network equipment needed to produce an operational network.



- **Procurement** – At the beginning of the construction phase the project work is bid out (or an engineer/build firm has already been procured). Multiple contractors may be involved depending on how the engineering and construction documents were planned in earlier phases. All network equipment such as servers, switches, and routers must be purchased and tracked.

- **Construction Management** – The construction work is bid out and an award is made to a qualified contractor with the best price. It is common to negotiate the final cost of this work once a firm has been selected.

- **Network Equipment Installation** – Network equipment is ordered from a vendor that meets the technical specifications. Equipment must be tested, installed in cabinets or shelters, powered up, connected to the fiber cable, and then configured and tested.

- **Business Process Development** – During the construction phase, business and operational decisions must be made to produce a set of business processes that will guide the day to day operations of the network.

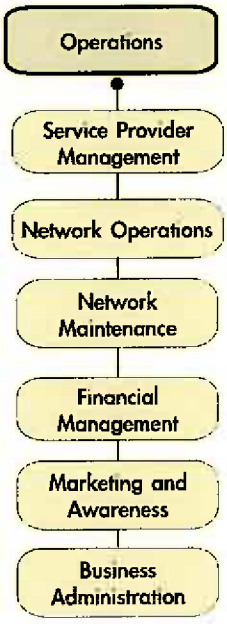
- **Service Provider Negotiations** – Negotiations with qualified service providers continues. Additional development and specification of the Master Agreements and Service Level Agreements (the contracts between the network and the Service Providers) are finalized.

- **Contracts, Agreements, and Leases** – The construction phase will generate the need for a variety of legal documents. Some will be related directly to the construction (e.g. an easement agreement to have conduit cross property). Typical documents include the development of the Master Network Agreement that is used to sign service providers to the network. Other contracts would include the development of a draft network operations agreement if network operations is outsourced, and a similar agreement for outside plant maintenance and repairs.

- **Marketing and Public Awareness** – As the network is constructed, a modest but ongoing public awareness and publicity effort is required to ensure that business customers, schools, local government agencies and other potential users of the network are aware of the project and the possibility of reducing costs and obtaining more and better services.

Operating and Managing a Network

Once the network is completed, service providers are connected first and then their customers receive fiber connections. At that point, the enterprise becomes operational and a variety of ongoing activities begin to take place.



SERVICE PROVIDER MANAGEMENT

Service Providers are a vital part of any Open Access Network. In essence the Service Providers are the customers of the network. The actual network end users (institutions, businesses, and residents) are the Service Provider's customers. Service providers sell directly to the end users--their customers.

PROVISIONING - MANAGING ORDERS FOR SERVICE

Once they have obtained a new customer that is passed by distribution or access fiber, the Service Provider contacts the network to get either a physical fiber connection completed (e.g. from the curb to the building) and/or a logical connection across the network to deliver the service requested by the customer (e.g. Internet, phone, data backup, etc.). This process is initiated via a self service portal, an order ticket, or some other automated mechanism (e.g. a link between the SP's Customer Relationship Management (CRM) system and the ordering system) and flows through a defined process which may include external work orders to contractors and ultimately ends in a billing event when the Service Provider's customer is active and will be billed for services.

BILLING

The Network Operator or Owner needs to bill for services provisioned on the network. Unlike the retail model, the bills created by the Network Operator are only created for the Service Providers. The Service Providers handle billing of their own customers. While the process of billing only the Service Providers is simpler when compared to retail billing, nevertheless this is a process that requires attention to detail on a daily and monthly basis as customers are added, dropped or changed. Bills need to include a level of detail such that an individual Service Providers can tie their own invoices to individual subscribers back to the Network invoice, potentially generate their own bills from the details in the Network invoice, audit their records against the Network bills, and work with the Network Operator in the event of inconsistencies. During the planning phase, the Network Operator needs to determine several items about billing of Service Providers such as partial month billing, credits for service outages, and credits for bad payers.

CUSTOMER CARE

As the Service Providers are the customers of the Network a well designed network operations center (NOC), staffed with experienced personnel, must be in place to support the providers.

The NOC operators will be available during normal business hours (Monday-Friday, 8 AM to 5 PM) to deal with routine provider needs, and the NOC will provide 24/7/365 monitoring the network and connected customers for outages and follow up repairs.

Marketing Incentives

The Network Operator has a role in marketing the network, even though the end users of the network are the customers of the Service Providers. Marketing incentives can be time based, geography based, or revenue based. Marketing incentives must be offered to all Service Providers. However, basing the incentives on number of customers, number of new customers, or revenue can be used to provide an incentive for the Service Providers to aggressively pursue additional customers or market share.

Attraction

Even though the Network is operational with one or more Service Providers offering services, it is vital to the growth of the Network that the Operator/Owner continues to work to attract new Service Providers to the network. These can either be new "traditional" providers (Internet, VoIP, IPTV) or can be niche providers offering services like security (e.g. closed circuit video), healthcare, gaming or any other service which can be delivered over the network.

Quality Assurance

While the Service Providers are the customers of the Network, they also can have an impact on the overall impression of the network. If a Service Provider is not paying its bills to the Network or if there are many end user customer complaints the Network Owner may, in extreme circumstances, need to intervene. Such intervention may include canceling a Service Provider's contract with the Network (potentially switching end-users from one Service Provider to another), penalizing a Service Provider via increased costs on the Network, or other intermediate strategies to encourage good quality service.

Network Operations

Operations can be managed in-house, but start-up networks generally find it less expensive to out-source operations to a qualified firm. Operations must include 24/7/365 activities, and it is generally better in the first several years, when the network is small, to use a service rather than bear the expensive of several dedicated technical staff that would be needed to cover nights, weekends, holidays, and vacations.

Network Operations Center (NOC)

Network Operations Center or NOC is a 24/7/365 staffed facility with many tools to manage, operate, debug and assist the NOC staff in identifying the root cause of issues reported, in monitoring network electronics, and to keep the network running smoothly. The NOC can be an outsourced remote center or can reside on the network.

Help Desk

Service providers are responsible for handling Tier 1 support to their customers--the network end users. However, when the Service Provider can not solve the problem or believes the

problem is in the Open Access Network they need to be able to contact a help desk for assistance. This Help Desk is part of the NOC, and should be staffed to handle problems during both normal business hours and on nights and weekends.

MONITORING

One of the tools available to the NOC is software which monitors the active elements of the network. Some monitoring systems are available from the manufacturers of the network hardware, known as Element Management Systems (EMS), as well as systems which use standards-based software tools to monitor the network for problems. Monitoring takes a variety of forms, including a standard uptime monitor that periodically checks the status of the Network Elements as well as more sophisticated tools that monitor bandwidth, CPU cycles, temperature, fan speeds, etc.

Monitoring systems are useful not only during troubleshooting with a service provider or end user but as well as providing proactive capabilities to prevent problems or outages. As an example, a sophisticated monitoring system could provide NOC technicians with alarms when bandwidth exceeds a set threshold, allowing the technician to take proactive actions to prevent an outage.

TICKETING

Trouble Ticketing or just Ticketing is a system or process that uses software to manage and track reported troubles, outages, orders, or questions submitted online via Web forms or via email and phone calls. NOC staff are responsible for tracking all tickets and timestamps as well as allowing the providers visibility into the system to see what action is being taken or what is planned for an outage or other problem that arises on the network.

Ticketing systems include Web based portals, text messaging tools, and e-mail based responders, and can receive and respond to tickets in a variety of ways including phone calls, emails, SMS, or other means.

OUTAGE REPORTING

When an outage is discovered via monitoring or a call to the Help Desk, outage reports can be broadcast to Service Providers or end users. This type of proactive reporting can reduce the burden of calls to the NOC by notifying the service providers of pre-existing outages.

PROVISIONING

Provisioning is the act of setting up services on the network. Provisioning can be for service providers, end users, or can be required for core network requirements. Small networks often rely on a manual process for provisioning but can utilize manufacturer provided Element Management Systems (EMS) or even more sophisticated systems, known as Manager of Managers (MoM). For service provider and end user provisioning, the end result is usually a billable event such as adding, changing, or terminating a end user service.

Order Management

While provisioning is the setting up of services on the actual network elements, Order Management is a higher level activity that can include dispatch of physical assets, estimating of network build costs, or processing a more complex order for Network changes. Order Management can be provided through a Ticketing system or can be a stand alone system in larger networks.

Performance Reporting and Metrics

To provide proactive feedback to network operators, owners, and service providers there can be systems dedicated specifically to reporting on the health and reliability of the network. Metrics can also be created out of the ticketing system, provisioning system, or order management. Overall the performance of not only the network, but also of contractors, outsourced providers, vendors, and even data on service providers can be reported on and used as a mechanism to view the health of the network and entities charged with providing services. As an example, a ticketing system report could indicate the average length of time before a ticket is addressed by NOC personnel, or the monitoring system can report on the total number and average length of time for outages in a given period.

Change Management

Any time there are changes made to the network via provisioning, repair, or otherwise, it is vital that those changes be managed and tracked. Simple methods of Change Management include keeping a record of every update in a spreadsheet, or keeping configuration files in a directory on a server. More complex methods involve using change tracking software to automatically capture network changes and provide capabilities for reversing changes in the event of an outage or interruption of services.

Network Maintenance

While routine maintenance (e.g. replacement of worn out equipment) may be limited in the first year or two of operations, non-routine/emergency maintenance support must be in place as soon as the network has customers.

Network Equipment Maintenance

Maintaining network equipment involves regular patching of firmware or software upgrades as well as performing physical maintenance if required. Network elements must be patched when critical security or performance updates are released from the manufacturer. Maintenance which can potentially cause an outage need to be scheduled with the NOC and these events often occur as scheduled maintenance windows during non critical times (typically on weekends at 2-5am). Examples of required physical maintenance can include keeping equipment in clean working conditions such as cleaning fans, testing UPS systems, or replacing batteries as needed.

SECURITY

Security is both a physical and logical problem in keeping networks operational. Physical security includes protecting expensive or sensitive equipment with access controls or locks. Logical security can include required password rotation, keeping equipment on the latest security release of software, and protecting confidential information of end users and service providers. Firewalls are needed to protect the network not only from outside threats, but the network needs to be protected against internal attacks as well.

OUTSIDE PLANT MAINTENANCE

Fiber is occasionally damaged (e.g. tree limb falling on aerial fiber, backhoe damaging buried fiber), and a qualified firm must be available to make repairs within two to four hours. This service is almost always outsourced to a qualified private sector company and is referred to as "break-fix"

In addition to break-fix underground utilities often need to be "located" when new construction, street repairs, or other activities disturbing the earth occur near buried cable. The network should belong to the local dial-before-you-dig service and should respond to tickets originating from those systems. Utilizing an accurate inventory of the network if digging will occur in close proximity to owned plant, NOC staff will dispatch a locator to locate the fiber cable. This is often part of the break-fix contract, but can be outsourced to another entity specializing in such work. In small municipal networks, the Public Works Department will often locate fiber optic cable as they are already locating water and sewer assets.

BACKUPS AND CONFIGURATION MANAGEMENT

NOC staff are responsible for keeping secure backups of all Network Element configurations, backups of critical systems mentioned in this chapter including ticketing, provisioning, and billing. Backups should be stored locally for a quick restoration in the event of a failure, but also should be kept offsite in a physically diverse location.

INVENTORY MANAGEMENT

Keeping track of all Network Elements and all network assets is key to keeping a Network reliable and operational. Inventory Systems should:

- Track equipment location, in-service dates, serials numbers, model numbers
- Link equipment with end-uerss or service providers
- Provide location reports for technicians and service providers
- Store logical information such as IP addresses, OS versions, etc.

Managing the physical assets is also required in a network. Tracking all Outside Plant (OSP) assets reduces the time needed to find and solve outages, and reduces the time required to provision new services, or create work orders for changes to the physical network. A network asset management system provides an overall view of the physical state of the network. Fiber Optic OSP management systems should:

- Track conduit, cables, buffer tubes, individual fiber, splices
- Generate reports and information for splice work

Business Administration

An open access network only has a small number of customers, which are usually just the connected service providers and perhaps a handful of local government agencies. Nonetheless, prudent and careful financial management is needed for accounts receivables and accounts payables, along with other normal bookkeeping activities--chart of accounts maintenance, bank deposits, check writing, and other related tasks. A part time bookkeeper may be an affordable solution in the early days of operations.

Accounting Budget Support

As the Open Network is a business enterprise, maintaining an operational budget is required. The network will have operational costs such as pole rentals, locate costs, annual equipment maintenance, electric bills, debt service, or other costs. Having an accounting office is often out of the reach of a small network so these functions can be completed by an outsourced company or even completed by NOC staff.

Service Provider Billing

Monthly bills need to be created and sent to the service providers. Tracking payment and handing billing disputes needs to be performed. Often the NOC staff are responsible for creating the bills and handing billing inquiries while an accounting office is responsible for sending invoices and tracking payments. In the event of billing disputes the NOC staff, the customer (in most cases a Service Provider), and the accountant are involved in developing a remedy for a billing dispute.

Marketing and Awareness

While service providers will be responsible for their own marketing and sales efforts, an ongoing modest awareness/marketing campaign is required to ensure that customer take rate targets are met.

Outreach

Outreach is often required to make sure that the local and regional community are aware of the network. Working with local economic developers, chambers of commerce, local technology companies is often required. Additionally municipal and Open Access Fiber projects receive regional and national awareness. Local, regional, state and even national elected officials need to be aware of the network, how it was funded, and how it is benefiting local constituents.

Incentives

As mentioned above in the Service Provider section, it may also become necessary for the network to offer incentives to acquire new connected businesses and residences or to attract businesses to the area. While the Network Operator/Owner will not offer services directly to

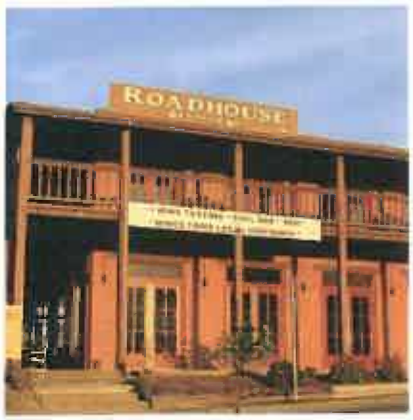
end-users there may be economic development reasons to offer to fund things like the initial cost of constructing a new drop, as one example.

GROWING THE NETWORK

Often the network is built in stages. There may be a pilot phase or a small deployment followed by larger deployments. These deployments need to be planned and managed, but the Network Operator/Owner and board of directors should constantly be looking for new funding opportunities like state or federal grants. While the network is being expanded, the NOC staff will be responsible for bringing newly constructed segments of the network into operations.

FINANCIAL MANAGEMENT AND OVERSIGHT

The enterprise needs a board of directors and a senior manager responsible for day to day oversight. The senior manager should have a strong business background with experience in successfully starting and managing new businesses.



Santa Cruz County - Cost Estimates and Maps

JANUARY 30, 2015

Draft

DESIGN NINE
broadband planners

Disclaimer

The telecommunications business is continually evolving. We have made our best effort to apply our experience and knowledge to the business and technical information contained herein. We believe the data we have presented at this point in time to be accurate and to be representative of the current state of the telecommunications industry.

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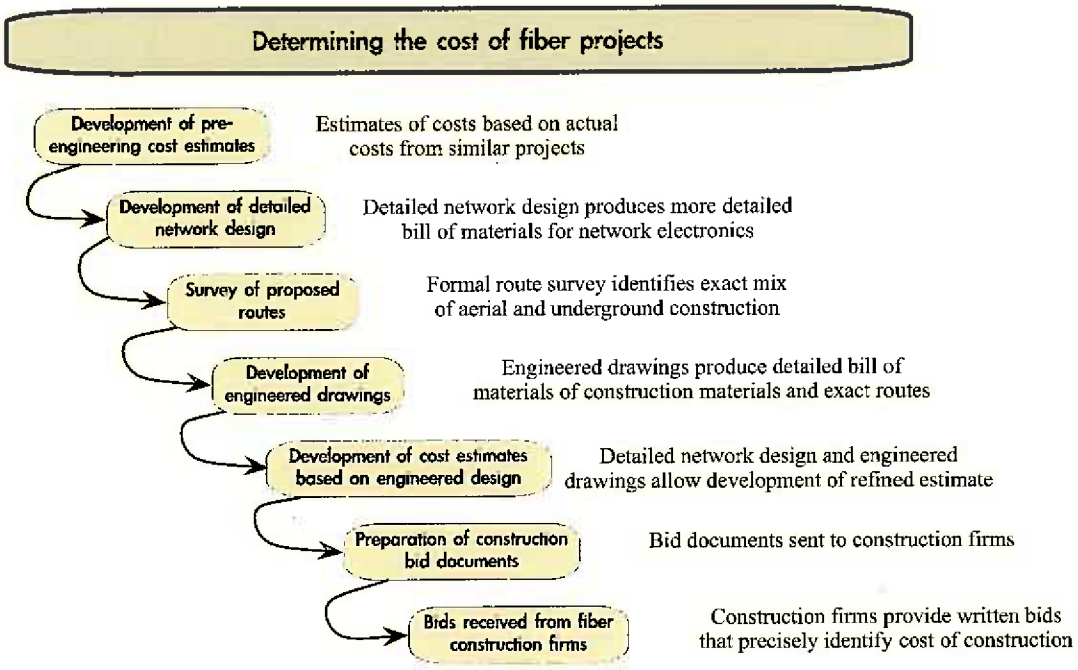
Cost Estimates

Pre-engineering cost estimates provide an early look at the cost of build out; these estimates do not include formal pole surveys or the significant expense of route engineering. Even after route surveys are performed, and engineered route blueprints are developed, the true cost of construction is not known until the construction bid documents are prepared and bids are received. The diagram below illustrates the process of establishing the exact cost of a fiber project.



It is important to note that the fiber construction costs in this report are estimates for a "phase one" build out in Santa Cruz County. Cost savings for a larger build out and for additional phases could be substantial, especially in the network equipment, outside plant materials (e.g. fiber cable), and construction labor.

When preparing cost estimates, it is good practice to use conservative cost estimates (i.e. higher cost estimates) to ensure that the funds are adequate to complete the project, as there is usually no additional funds if actual construction or materials costs turn out to be higher than the estimates. It is always more desirable to have the actual cost of the project be under the estimated cost rather than over the estimated cost.

The project summary breaks out costs by the five identified phases that would complete a high performance fiber network in Santa Cruz County. This estimate includes two tables for each phase; one table provides a detailed estimate of the fiber construction, including drop construction, throughout that area, and one table shows a detailed description of the shelter/

cabinet and network equipment needed in that area. There is a map which corresponds to each estimate showing the locations of each of the five areas with the proposed fiber routes shown.

The fiber construction cost estimate for installation throughout the Santa Cruz County is based on primarily underground construction. The initial construction cost of this might be higher than aerial installation but it provides a lower cost for operation because there are no pole use fees or cable moving costs when a pole is replaced in the future. The cost of underground construction can actually be lower than aerial installation depending on the amount of make ready needed in a certain area (make ready is the cost of paying other pole tenants to move or modify their attachments to make room for the new attachee).

The detailed cost estimates include a range of costs based on previous purchases and past experience with equipment vendors and contractors. This range depicts the average cost of the service or equipment and the optimism factor picks out the estimated cost from the range. The optimism factor is a number that shows the approximation of which end of the range the actual cost will be, lower or higher. These estimates are based on the routes shown in the maps for each area of Santa Cruz County.

The detailed cost estimates show the hardware and other equipment that usually is purchased by the construction contractor and is part of their overall bid price.

Some construction cost estimates include only the cost of construction labor and materials (e.g. fiber cable, attachment hardware, and splice enclosures). But a different cost estimate may include other necessary and essential costs, like project management, engineering, and network equipment. In other words, two cost estimates with the same aerial/underground and make-ready assumptions could still vary widely if one includes all necessary costs needed to produce a functional, working network and the other estimate includes only the construction costs.

The cost estimate show allowances for contingencies, engineering, project management, network integration, testing, and permitting fees. The cost estimate also include the cost of drops (the access fiber), based on a moderate percentage take rate, from the backbone fiber network to businesses along the backbone network.

> ***It is only correct to compare the costs of two estimates from two different sources if you can reliably determine that the underlying assumptions and costs are the same for both estimates.***

In other words, the percentage of aerial construction, the amount of make-ready, inclusion of engineering and equipment costs, and the inclusion of drops all must be the same. Two estimates of construction costs for the same area may appear to be widely divergent, but one estimate may include only direct labor and material costs, all aerial construction, no drops, no network equipment or design and engineering costs, and no make-ready fees.

Note that an estimate like this would be very low but would not be a functional network and no residences or businesses would actually be connected to the fiber. The other estimate may include all the necessary costs needed to actually connect customers, including reasonable

make-ready costs, some underground construction, network electronics, drop fiber cables to businesses or residents, and other costs like network design and engineering.

Estimates for construction materials and network equipment vary largely based on the amount of materials or equipment purchased. Small purchases of network electronics generally receive little or no price discount, but for larger purchases, discounts can be substantial (e.g. a range of 10% to 40% off list). Construction materials purchased in large lots also receive more discounts. Our pre-engineering estimates are conservative, with prices for materials and equipment generally using list prices or prices that we have previously seen from vendors on other similar sized projects. Labor costs are based on prices from other construction projects and knowledge of local conditions. Cost of labor can vary widely based on the time of year, the overall size of the job, the local economy, and the national economy.

Note that all costs are estimates based on current market prices for materials and construction costs are based on typical prices paid in past projects. Actual construction and materials costs may vary.

Both the estimates for fiber construction and wireless installation include a summary table with estimated costs for each area or wireless link, contingencies, engineering, project management, network integration, testing, and permitting fees. From all of these factors the estimated project total is calculated for each summary table.

Cost Estimate Categories

The Cost Estimate Spreadsheets are in the appendices of this document. They are organized into into sections that will allow Santa Cruz County to choose how and when it invests capital and what different options of investment may cost.

The approximate costs of materials and labor are included in the estimates. The values were sampled from actual Design Nine projects, but could vary depending on many factors including weather, labor costs, fair wage requirements, union contracts, or other factors.

The initial summary page is for a full investment and committing to build the entire network up front. There are some economies of scale to be gained when investing on a very large construction project. However, as the full capital amount may not be available, the estimates also include summary and detail pages for individual or targeted investment. If the Santa Cruz County Fiber Initiative chooses to only build or commit to build some of the individual segments the economies of a large scape project will not be realized and the sum of the smaller projects could well be higher than a full committed up front buildout. This is due to various efficiencies such as project management, permitting, and engineering.

The "Project Total" estimates in this report include estimates of the costs in the categories described below. All of these activities and efforts are generally required to produce a working network, including network hardware and (1 year) maintenance and support. As noted in the previously, some firms may provide cost estimates that only include two categories: Outside Plant Construction Materials and Outside Plant Construction Labor. Also noted previously

noted, even two estimates of just direct construction costs (materials and labor) may vary widely if one estimate includes drops and one estimate does not (these estimates include a reasonable number of drops to businesses along the segment routes.

Network Construction (Item/Project)

The Project Summary table shows the estimated costs for each phase or segment of the proposed network. It includes not only the direct construction costs for burying conduit and cable and/or hanging aerial fiber on utility poles, but also includes the estimated costs for shelter/cabinet and network equipment for each route or portion of the network.

A reasonable number of drops (connections) are included in these estimates and will be performed during the network construction. While the initial number of drops is relatively small, the network will have the capability of serving many additional drops. Future drops will involve construction costs to be born by the network, the Service Providers, or the individual customers.

Project Management, Network Integration and Testing

Project management for a telecom build requires thorough and detailed planning, experience in procuring construction materials for a telecom project, and the ability to oversee and convey project information to contractors through the duration of the project, including construction inspection work (ensuring construction contractors have done their job properly).

Some configuring and testing will take place after the network is built and before it is ready for use. In a dark network this involves labeling and documenting the routes of individual fiber strands, and testing of any other features of the network such as generators, air conditioners, and locks. In an active network the testing and integration includes integration requirements for a dark fiber network plus the configuring and installation of switches, routers, and other network equipment. Work in this category requires a skilled professionals who are familiar with the network architecture and the business model (e.g. open access).

Engineering, Construction Inspection, and Permitting

This work include a full design of the outside plant network, cabinet and shelter specifications, and extensive detail (blueprints) that specifies how all fiber cable, wireless towers, and network equipment is to be installed. These documents have to be completed prior to bidding out any construction work, and are usually included as part of a construction bid package. The detail includes fiber optic cable route determination and size determination, active and passive network equipment selection and placement planning, splicing layouts and documentation, network configuration planning, and all engineering necessary to complete construction.

Some costs will be incurred based on the permitting requirements of the project. If shelters/ cabinets are able to be placed on some properties at no charge, the cost of leases will be lower. If cabinets or shelters have to be placed on private property, the cost of the land or long term leases will increase. Some property owners prefer to receive ten or twenty years of lease payments up front, which can make this cost unpredictable. The cost of permits needed for

crossing wetlands, streams, other sensitive areas, and Department of Transportation (DOT) permits are also included in this category. Formal leases and negotiated lease payments are more desirable than providing some form of free access to services.

FTTH Mapping and Asset Management

The record keeping related to mapping and managing fiber cable can be substantial. Once the network is built, careful records have to be maintained of where the fiber is located (e.g. in public right of way, on what poles and who owns the poles), what fiber strands are in use and by whom, and in particular, fiber strand splicing records. The engineer typically delivers an electronic "As-Built" document which includes detailed records of the network as it was constructed. To this material is added the testing results provided by the network contractors or splice contractors. Going forward, accurate splice data can generate hundreds or thousands of individual splice records that have to be maintained, updated, and tracked. A fiber and network asset management system can help control costs and preserve assets both during construction and after network operations begin. There are many commercial options for Fiber to the Premise (FTTP) Mapping and Asset Management software which can maintain records for operating the network which include both an upfront capital cost as well as cloud based OPEX type systems.

Business, Service Provider and Operations Development

It is important to understand that the project management and building the network can not be completed without building the business that is the network. These tasks include Business and Financial Planning and Service Provider Development and are detailed in the Santa Cruz Rapid Assessment.

Miscellaneous Fees and Technical Services

Many projects routinely incur a variety of mostly small amounts for fees and services. Typical items might include railroad crossing fees, lease and title fees, notary fees, legal fees for lease agreements or other legal matters, fees for archeological studies, etc.

Bookkeeping and Administration

Network projects create substantial amounts of paperwork, invoices, and related bookkeeping requirements. Grant-funded projects typically incur additional state level and/or Federal reporting and bookkeeping.

Contingencies

The Contingency category is included and calculated as a percentage of the construction subtotal estimated cost (e.g. 10% of subtotal cost) to provide flexibility in managing the overall budget. Equipment costs can and do change between the time an estimate is made and construction commences. Labor costs can vary depending upon the time of year the work starts, the state of the local economy, and the state of the national economy.

NETWORK SEGMENTS (MAPS)

A series of 6 maps have been included in a separate document that includes the full detail of the cost estimates. The maps are as follows:

- Map 1- Basemap - shows the entire County and the five focus areas
- Map 2 - Davenport - detailed
- Map 3 - Live Oak - detailed
- Map 4 - Upper 41st Avenue Focus Area - detailed
- Map 5 - Medical Center Focus Area - detailed
- Map 6 - Aptos Focus Area - detailed

ESTIMATES (BASE NETWORK + LATERALS AND PER SEGMENT)

The estimates are attached as an appendix to this document. The estimates are broken up into sections. Each section has a short description in the notes adjacent to the summary tables. The network and segments are described below. The segments reflect the County's focus areas for economic development.

DAVENPORT

This segment (Map 2) will initiate in the center of the County, near the City of Santa Cruz and will include a small FTTP build in and around Davenport, including the old cement factory. This segment is includes 17 miles of new fiber and only connects 12 buildings (out of a total of 593 passed). This limited number is due tot he nature of this build as mostly a "middle mile" segment to connect the cement factory. Due to the designation of US 1 as a Scenic Highway, any new utility line construction (including fiber optics) may be required to be placed underground. This will add costs to this build. However, as the Regional Transportation Commission has ownership of the old rail line, most of the construction for this would take place using vibratory plowing alone the old rail line.

It was noted by Design Nine in early December that there are at least two fiber providers with fiber optic lines to Davenport (assuming AT&T and NextG). If the County requires high speed broadband to encourage development of the cement factory, it should examine the cost of leasing capacity from NextG and/or AT&T and compare it to the cost of this build

URBAN CORE BACKBONE

This segment wasn't a focus area requested by the County to be examined by Design Nine. However, based upon the three areas in the center of the County (Live Oak, the Medical Area, and Upper 41st Avenue) in close proximity, this small build would enable all three of those areas to be developed without their own link back to a central location (Cabrillo College). This segment only consists of 5 miles of fiber and and would pass 553 premises and connect 28 (a higher percentage than the Davenport backbone due to it's many potential businesses as network users. This can also be tied into the Sunesys middle mile fiber.

Live Oak

This segment covers the dense residential area of Live Oak. There are approximately 2500 premises passed by the 17 miles of fiber optic laterals in this neighborhood. This would be the best area for Santa Cruz to use as a FTTH pilot area due to the density.

Medical Focus Area

This segment only has 4 miles of new fiber and would connect approximately 23 buildings. Out of the five focus areas examined by Design Nine, this area would probably bring the most benefit to a needed market segment, namely medical offices. Due to this area's lack of symmetrical high speed broadband, it was reported during the early meetings with stakeholders, that only DSL is available to the medical offices in this area which was not adequate for transmitting the large files (images, radiographs, etc.) between offices or between the offices and the hospital. Like the Urban Core segment, his can also be connected to the Sunesys middle mile fiber.

Upper 41st Avenue

This is the smallest and lowest cost focus area to build a pilot network. The build would only be one mile of new fiber and would pass 218 premises and connect 11. If this area is being considered for a redevelopment effort, deploying a fiber optic network would be a cost effective method of lowering the cost of operating a business in the redeveloped area. Additionally, if high speed symmetric service were available, it may be attractive to knowledge economy businesses and professionals. The Sunesys middle mile fiber also enhances the value of this investment.

Aptos Focus Area

Towards the eastern (or southern) half of the County, the Aptos area would require a backbone link back to the center of the County. This segment includes 6.5 miles of fiber and would pass 632 premies and connect 16. The link back to the center of the County could use the Regional Transportation Commission owned rail for underground construction. It was also noted that there is limited areal opportunities in this area and that there are many underground utilities and obstacles. This area can also benefit from the Sunesys fiber, although the Sunesys route does not pass directly through the Village.

Project Summary - Santa Cruz County Fiber Network Full Buildout

This "whole network" estimate includes all segments for a total of 43 miles of new fiber construction and connects 193 buildings (out of a total of 4,176 passed). This initial fiber network would be considered the core for a larger buildout for the entire County.

APPENDIX - DETAILED COST ESTIMATES

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Stand Alone Project Summary: Davenport Project

	ITEM/PROJECT	ESTIMATED
2	Davenport Fiber and Outside Plant	$1,478,243.99
3	Davenport Shelter/Equipment	$45,422.77
4	Network Construction Subtotal	$1,523,666.76
5	Project Management, Network Engineering, Integration, and Testing	$228,550.01
6	Engineering, Construction Inspection, Permitting and Fees	$169,871.21
7	Railroad Permitting (0 crossing) - engineering and fees	$0.00
8	Misc. Fees, and Technical Services	$76,183.34
9	Bookkeeping and Administration	$3,000.00
10	Other Costs Subtotal	$477,604.56
11	Contingency (10%)	$200,127.13
12	**Project Total**	**$2,201,398.46**

Total Linear Construction	16.99 miles
Total Underground Construction	16.56 miles
Total Aerial Construction	2,242 feet
Buildings Passed	593
Buildings Connected	12

Notes/Assumptions:
This includes the backbone link from the center of the County up to Davenport as well as a modest FTTP network in Davenport.

It should be noted that due to Rt. 1 being designated a Scenic Highway any portion of the route must be underground where visible from the highway.

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Davenport - Backbone and limited drops

	VARIABLE	VALUE	NOTES
V1			
V2	Aerial Construction percentage	2.50%	
V3	Trenching percentage	10.00%	
V4	Boring percentage	20.00%	
V5	Vibratory Plow	67.50%	
V6	Linear construction length	89,692 feet	Length of segment in feet.
V7	Underground Construction	87,450 feet	
V8	Aerial Construction	2,242 feet	
V9	Conduit Exists	0 feet	
V10	Poles (for make ready)	8 poles	
V11	Handholes	60	Number of handholes for the segment.
V12	FOSCs	60	
V13	Optimism	5	0-10 scale used in Best Estimate column (10 is best)
V14	Buildings Passed	593	368 Residential, 225 Business
V15	Take Rate	2.00%	
V16	Drop Construction	12	

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Generic 1.25" Conduit	2 87,450	$0.40	$0.50	$69,960.00	$87,450.00	$78,705.00
3	Buried Fiber Marker Posts/Medallions	180	$6.00	$12.00	$1,080.00	$2,160.00	$1,620.00
4	144 Strand Fiber Optic Cable (avg strand count)	89,692	$0.80	$0.95	$71,753.60	$85,207.40	$78,480.50
5	Slack Fiber (50' per hand hole)	2,990	$0.80	$0.95	$2,392.00	$2,840.50	$2,616.25
6	Trace Wire - Insulated 12AWG or better	87,450	$0.10	$0.15	$8,745.00	$13,117.50	$10,931.25
7	Muletape 1250P (3000ft reel) or equivalent	30	$115.00	$230.00	$3,450.00	$6,900.00	$5,175.00
8	Handhole - 24x30x24 Concrete Polymer (incl. Lid)	60	$300.00	$350.00	$17,938.40	$20,928.13	$19,433.27
9	Handhole Installation Materials (Gravel, Straw, etc.)	60	$5.00	$10.00	$298.97	$597.95	$448.46
10	FOSC (144 count TYCO Type B or equivalent)	60	$125.00	$250.00	$7,474.33	$14,948.67	$11,211.50
11							
12	Aerial Cable Placement	2,242	$2.00	$5.00	$4,484.00	$11,210.00	$7,847.00
13	Make Ready Heavy	0	$450.00	$1,000.00	$0.00	$0.00	$0.00
14	Make Ready Light	8	$200.00	$450.00	$1,600.00	$3,600.00	$2,600.00
15	Pole Replacement	0	$1,200.00	$2,400.00	$0.00	$0.00	$0.00
16	Trenching	8,970	$8.00	$10.00	$71,760.00	$89,700.00	$80,730.00
17	Boring (Road Crossings)	17,939	$25.00	$40.00	$448,475.00	$717,560.00	$583,017.50
18	Direct Bury / Vibratory Plow	60,543	$3.00	$5.00	$181,629.00	$302,715.00	$242,172.00
19	Handhole Installation	60	$600.00	$800.00	$35,876.80	$47,835.73	$41,856.27
20	FOSC Assembly and Installation	12	$350.00	$600.00	$4,200.00	$7,200.00	$5,700.00
21	Drop Construction (average cost per drop)	12	$2,750.00	$5,000.00	$33,000.00	$60,000.00	$46,500.00
22	Splicing (per splice estimate)	8,640	$25.00	$35.00	$216,000.00	$302,400.00	$259,200.00
23	Total				$1,180,117.11	$1,776,370.88	$1,478,243.99
24							
25	Notes/Assumptions: -Estimate includes funding for drop construction for 2.00% of the buildings passed.						

	ITEM	VALUE
S1		
S2	Total Materials	$208,621.23
S3	Total Labor	$1,269,622.77
S4	OSP - Fiber Construction	$1,478,243.99

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Davenport - Shelter and Equipment

	VARIABLE	VALUE	NOTES
V1			
V2	Buildings Passed	593	
V3	Initial Sign Up	2.00%	
V4	Initial ONTs/Equip.	12	
V5	Optimism	5	0-10 scale used in Best Estimate column (10 is best)

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Small Shelter	1	$9,000.00	$14,000.00	$9,000.00	$14,000.00	$11,500.00
3	Shelter Installation	1	$4,000.00	$6,000.00	$4,000.00	$6,000.00	$5,000.00
4	Patch Panel (144 port)	5	$3,000.00	$4,500.00	$15,000.00	$22,500.00	$18,750.00
5	New Power Service / Installation	1	$500.00	$1,250.00	$500.00	$1,250.00	$875.00
6	Patch Cables (POP)	12	$14.00	$25.00	$166.94	$296.50	$231.27
7	Patch Cables (Customer Premises)	12	$20.00	$30.00	$237.20	$355.80	$296.50
8	Calix E7-2 Shelf	1	$600.00	$700.00	$600.00	$700.00	$650.00
9	Calix E7-2 GE24 (FTTx Line Card)	1	$3,800.00	$4,000.00	$3,800.00	$4,000.00	$3,900.00
10	Calix 10G Optics	2	$300.00	$350.00	$600.00	$700.00	$650.00
11	Calix CSFP (FTTx Optics)	11	$160.00	$180.00	$1,760.00	$1,980.00	$1,870.00
12	Calix 48V DC System Retrofit Kit	1	$1,500.00	$1,900.00	$1,500.00	$1,900.00	$1,700.00
13							
14							
15							
16							
17							
18							
19					$37,163.24	$53,682.30	$45,422.77
20							
21	Notes/Assumptions:						

	ITEM	VALUE
S1	OSP	$36,125.00
	Equipment	$9,297.77
S2	Core Equipment & Pre-fab shelters	$45,422.77

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Urban Core - Summary

	ITEM/PROJECT	ESTIMATED
2	Urban Core Fiber and Outside Plant	$941,596.38
3	Urban Core Equipment	$17,310.43
4	Network Construction Subtotal	$958,906.80
5	Project Management, Network Engineering, Integration, and Testing	$143,836.02
6	Engineering, Construction Inspection, Permitting and Fees	$49,748.11
7	Misc. Fees, and Technical Services	$47,945.34
8	Bookkeeping and Administration	$3,000.00
9	Other Costs Subtotal	$244,529.47
10	Contingency (10%)	$120,343.63
11	**Project Total**	**$1,323,779.90**

Total Linear Construction	4.97 miles
Total Underground Construction	4.48 miles
Total Aerial Construction	2,626 feet
Buildings Passed	553
Buildings Connected	28

Notes/Assumptions:
This urban core is required if any of the three urban segments (Live Oak, Medical Area, or the Upper 41st Avenue Area) are to be built. This assumes that we can locate equipment at the Cabrillo College campus which is a logical meet-me point for this portion of the network.

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Urban Core - Backbone and Limited Drops

	VARIABLE	VALUE	NOTES
V2	Aerial Construction percentage	10.00%	
V3	Trenching percentage	10.00%	
V4	Boring percentage	70.00%	
V5	Vibratory Plow	10.00%	
V6	Linear construction length	26,267 feet	Length of segment in feet.
V7	Underground Construction	23,641 feet	
V8	Aerial Construction	2,626 feet	
V9	Conduit Exists	0 feet	
V10	Poles (for make ready)	9 poles	
V11	Handholes	38	Number of handholes for the segment.
V12	FOSCs	19	
V13	Optimism	5	0-10 scale used in Best Estimate column (10 is best)
V14	Buildings Passed	553	377 Residents, 176 Businesses
V15	Take Rate	5.00%	
V16	Drop Construction	28	

1	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Generic 1.25" Conduit	23,641	$0.40	$0.50	$18,912.80	$23,641.00	$21,276.90
3	Buried Fiber Marker Posts/Medallions	53	$6.00	$12.00	$318.00	$636.00	$477.00
4	144 Strand Fiber Optic Cable (avg strand count)	26,267	$0.80	$0.95	$21,013.60	$24,953.65	$22,983.63
5	Slack Fiber (50' per hand hole)	1,880	$0.80	$0.95	$1,504.00	$1,786.00	$1,645.00
6	Trace Wire - Insulated 12AWG or better	23,641	$0.10	$0.15	$2,364.10	$3,546.15	$2,955.13
7	Muletape 1250P (3000ft reel) or equivalent	9	$115.00	$230.00	$1,035.00	$2,070.00	$1,552.50
8	Handhole - 24x30x24 Concrete Polymer (incl. Lid)	38	$300.00	$350.00	$11,257.29	$13,133.50	$12,195.39
9	Handhole Installation Materials (Gravel, Straw, etc.)	38	$5.00	$10.00	$187.62	$375.24	$281.43
10	FOSC (144 count TYCO Type B or equivalent)	19	$125.00	$250.00	$2,345.27	$4,690.54	$3,517.90
11							
12	Aerial Cable Placement	2,626	$2.00	$5.00	$5,252.00	$13,130.00	$9,191.00
13	Make Ready Heavy	0	$450.00	$1,000.00	$0.00	$0.00	$0.00
14	Make Ready Light	9	$200.00	$450.00	$1,800.00	$4,050.00	$2,925.00
15	Pole Replacement	0	$1,200.00	$2,400.00	$0.00	$0.00	$0.00
16	Trenching	2,627	$8.00	$10.00	$21,016.00	$26,270.00	$23,643.00
17	Boring (Road Crossings)	18,387	$25.00	$40.00	$459,675.00	$735,480.00	$597,577.50
18	Direct Bury / Vibratory Plow	2,627	$3.00	$5.00	$7,881.00	$13,135.00	$10,508.00
19	Handhole Installation	38	$600.00	$800.00	$22,514.57	$30,019.43	$26,267.00
20	FOSC Assembly and Installation	28	$350.00	$600.00	$9,800.00	$16,800.00	$13,300.00
21	Drop Construction (average cost per drop)	28	$2,750.00	$5,000.00	$77,000.00	$140,000.00	$108,500.00
22	Splicing (per splice estimate)	2,760	$25.00	$35.00	$69,000.00	$96,600.00	$82,800.00
23	Total:				$732,876.25	$1,150,316.51	$941,596.38
24							

25 Notes/Assumptions:
-Estimate includes funding for drop construction for 5.00% of the buildings passed.

S1	ITEM	VALUE
S2	Total Materials	$66,884.88
S3	Total Labor	$874,711.50
S4	OSP - Fiber Construction	$941,596.38

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Urban Core - Equipment

	VARIABLE	VALUE	NOTES
V1			
V2	Buildings Passed	553	
V3	Initial Sign Up	5.00%	
V4	Initial ONTs/Equip.	28	
V5	Optimism	5	0-10 scale used in Best Estimate column (10 is best)

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Medium Telecom Cabinet	0	$4,500.00	$8,500.00	$0.00	$0.00	$0.00
3	Cabinet Foundation and Installation	0	$300.00	$800.00	$0	$0.00	$0.00
4	Patch Panel (144 port)	1	$3,000.00	$4,500.00	$3,000	$4,500.00	$3,750.00
5	New Power Service / Installation	0	$500.00	$1,250.00	$0	$0.00	$0.00
6	Patch Cables (POP)	28	$14.00	$25.00	$387.10	$691.25	$539.18
7	Patch Cables (Customer Premises)	28	$20.00	$30.00	$553	$829.50	$691.25
8	Calix E7-2 Shelf	1	$600.00	$700.00	$600	$700.00	$650.00
9	Calix E7-2 GE24 (FTTx Line Card)	2	$3,800.00	$4,000.00	$7,600	$8,000.00	$7,800.00
10	Calix 10G Optics	2	$300.00	$350.00	$600	$700.00	$650.00
11	Calix CSFP (FTTx Optics)	19	$160.00	$180.00	$3,040	$3,420.00	$3,230.00
12	Calix 48V DC System Retrofit Kit	0	$1,500.00	$1,900.00	$0.00	$0.00	$0.00
13	Battery Backup System	0	$1,500.00	$1,900.00	$0.00	$0.00	$0.00
14	Small Network Core Router	0	$0.00	$0.00	$0.00	$0.00	$0.00
15					$15,780.10	$18,840.75	$17,310.43
16							
17	Notes/Assumptions:						

	ITEM	VALUE
S1	OSP	$3,750.00
	Equipment	$13,560.43
S2	Core Equipment & Pre-fab shelters	$17,310.43

Cabinet Foundation and Installation

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Stand Alone Project: Live Oak

	ITEM/PROJECT	ESTIMATED
2	Live Oak Fiber and Outside Plant	$2,442,946.59
3	Live Oak Cabinet/Equipment	$58,074.40
4	Network Construction Subtotal	$2,501,020.99
5	Project Management, Network Engineering, Integration, and Testing	$375,153.15
6	Engineering, Construction Inspection, Permitting and Fees	$173,804.92
7	Railroad Permitting (0 crossing) - engineering and fees	$0.00
8	Misc. Fees, and Technical Services	$125,051.05
9	Bookkeeping and Administration	$3,000.00
10	Other Costs Subtotal	$677,009.12
11	Contingency (10%)	$317,803.01
12	**Project Total**	**$3,495,833.12**

Total Linear Construction	17.38 miles
Total Underground Construction	15.64 miles
Total Aerial Construction	9,176 feet
Buildings Passed	2,584
Buildings Connected	130

Notes/Assumptions:
This covers a dense residential area with few businesses.

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Live Oak - FTTP

	VARIABLE	VALUE	NOTES
V2	Aerial Construction percentage	10.00%	
V3	Trenching percentage	25.00%	
V4	Boring percentage	35.00%	
V5	Vibratory Plow	30.00%	
V6	Linear construction length	91,769 feet	Length of segment in feet.
V7	Underground Construction	82,593 feet	
V8	Aerial Construction	9,176 feet	
V9	Conduit Exists	0 feet	
V10	Poles (for make ready)	31 poles	
V11	Handholes	131	Number of handholes for the segment.
V12	FOSCs	66	
V13	Optimism	5	0-10 scale used in Best Estimate column (10 is best)
V14	Buildings Passed	2,584	2,215 Residential, 269 Business
V15	Take Rate	5.00%	
V16	Drop Construction	130	

1	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Generic 1.25" Conduit	82,593	$0.40	$0.50	$66,074.40	$82,593.00	$74,333.70
3	Buried Fiber Marker Posts/Medallions	184	$6.00	$12.00	$1,104.00	$2,208.00	$1,656.00
4	144 Strand Fiber Optic Cable (avg strand count)	91,769	$0.80	$0.95	$73,415.20	$87,180.55	$80,297.88
5	Slack Fiber (50' per hand hole)	6,555	$0.80	$0.95	$5,244.00	$6,227.25	$5,735.63
6	Trace Wire - Insulated 12AWG or better	82,593	$0.10	$0.15	$8,259.30	$12,388.95	$10,324.13
7	Muletape 1250P (3000ft reel) or equivalent	31	$115.00	$230.00	$3,565.00	$7,130.00	$5,347.50
8	Handhole - 24x30x24 Concrete Polymer (incl. Lid)	131	$300.00	$350.00	$39,329.57	$45,884.50	$42,607.04
9	Handhole Installation Materials (Gravel, Straw, etc.)	131	$5.00	$10.00	$655.49	$1,310.99	$983.24
10	FOSC (144 count TYCO Type B or equivalent)	66	$125.00	$250.00	$8,193.66	$16,387.32	$12,290.49
11							
12	Aerial Cable Placement	9,176	$2.00	$5.00	$18,352.00	$45,880.00	$32,116.00
13	Make Ready Heavy	0	$450.00	$1,000.00	$0.00	$0.00	$0.00
14	Make Ready Light	31	$200.00	$450.00	$6,200.00	$13,950.00	$10,075.00
15	Pole Replacement	0	$1,200.00	$2,400.00	$0.00	$0.00	$0.00
16	Trenching	22,943	$8.00	$10.00	$183,544.00	$229,430.00	$206,487.00
17	Boring (Road Crossings)	32,120	$25.00	$40.00	$803,000.00	$1,284,800.00	$1,043,900.00
18	Direct Bury / Vibratory Plow	27,531	$3.00	$5.00	$82,593.00	$137,655.00	$110,124.00
19	Handhole Installation	131	$600.00	$800.00	$78,659.14	$104,878.86	$91,769.00
20	FOSC Assembly and Installation	130	$350.00	$600.00	$45,500.00	$78,000.00	$61,750.00
21	Drop Construction (average cost per drop)	130	$2,750.00	$5,000.00	$357,500.00	$650,000.00	$503,750.00
22	Splicing (per splice estimate)	4,980	$25.00	$35.00	$124,500.00	$174,300.00	$149,400.00
23	Total:				$1,905,688.77	$2,980,204.41	$2,442,946.59
24							
25	Notes/Assumptions: -Estimate includes funding for drop construction for 5.00% of the buildings passed.						

	ITEM	VALUE
S2	Total Materials	$233,575.59
S3	Total Labor	$2,209,371.00
S4	OSP - Fiber Construction	$2,442,946.59

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Live Oak - Cabinet and Equipment

	VARIABLE	VALUE	NOTES
V1			
V2	Buildings Passed	2,584	
V3	Initial Sign Up	5.00%	
V4	Initial ONTs/Equip.	129	
V5	Optimism	5	0-10 scale used in Best Estimate column (10 is best)

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Medium Telecom Cabinet	1	$4,500.00	$8,500.00	$4,500.00	$8,500.00	$6,500.00
3	Cabinet Foundation and Installation	1	$300.00	$800.00	$300	$800.00	$550.00
4	Patch Panel (144 port)	1	$3,000.00	$4,500.00	$3,000	$4,500.00	$3,750.00
5	New Power Service / Installation	1	$500.00	$1,250.00	$500	$1,250.00	$875.00
6	Patch Cables (POP)	129	$14.00	$25.00	$1,808.80	$3,230.00	$2,519.40
7	Patch Cables (Customer Premises)	129	$20.00	$30.00	$2,584	$3,876.00	$3,230.00
8	Calix E7-2 Shelf	3	$600.00	$700.00	$1,800	$2,100.00	$1,950.00
9	Calix E7-2 GE24 (FTTx Line Card)	6	$3,800.00	$4,000.00	$22,800	$24,000.00	$23,400.00
10	Calix Gigabit Optics	6	$0.00	$0.00	$0	$0.00	$0.00
11	Calix CSFP (FTTx Optics)	70	$160.00	$180.00	$11,200	$12,600.00	$11,900.00
12	Calix 48V DC System Retrofit Kit	1	$1,500.00	$1,900.00	$1500	$1,900.00	$1,700.00
13	Battery Backup System	1	$1,500.00	$1,900.00	$1500	$1,900.00	$1,700.00
14	Small Network Core Router	0	$0.00	$0.00	$0	$0.00	$0.00
15					$51,492.80	$64,656.00	$58,074.40
16							
17	Notes/Assumptions:						

	ITEM	VALUE
S1		
	OSP	$11,675.00
	Equipment	$46,399.40
S2	Core Equipment & Pre-fab shelters	$58,074.40

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Stand Alone Project: Medical Focus Area

	ITEM/PROJECT	ESTIMATED
2	Medical Focus Area Fiber and Outside Plant	$515,739.77
3	Medical Focus Area Equipment	$21,032.35
4	Network Construction Subtotal	$536,772.12
5	Project Management, Network Engineering, Integration, and Testing	$80,515.82
6	Engineering, Construction Inspection, Permitting and Fees	$38,482.95
7	Misc. Fees, and Technical Services	$26,838.61
8	Bookkeeping and Administration	$3,000.00
9	Other Costs Subtotal	$148,837.38
10	Contingency (10%)	$68,560.95
11	**Project Total**	**$754,170.45**

Total Linear Construction	3.85 miles
Total Underground Construction	3.46 miles
Total Aerial Construction	2,031 feet
Buildings Passed	446
Buildings Connected	23

Notes/Assumptions:
Covering the Medical Focus Area, this is the lowest cost focus area to build fiber. This also may provide the most benefit for the expense as this portion of the County has DSL and limited High Speed Cable Internet, but has a need for symmetric bandwidth.

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Medical Focus Area - FTTP

	VARIABLE	VALUE	NOTES
V1			
V2	Aerial Construction percentage	10.00%	
V3	Trenching percentage	25.00%	
V4	Boring percentage	35.00%	
V5	Vibratory Plow	30.00%	
V6	Linear construction length	20,319 feet	Length of segment in feet.
V7	Underground Construction	18,288 feet	
V8	Aerial Construction	2,031 feet	
V9	Conduit Exists	0 feet	
V10	Poles (for make ready)	7 poles	
V11	Handholes	29	Number of handholes for the segment.
V12	FOSCs	15	
V13	Optimism	5	0-10 scale used in Best Estimate column (10 is best)
V14	Buildings Passed	446	283 Residential, 163 Business
V15	Take Rate	5.00%	
V16	Drop Construction	23	

I	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Generic 1.25" Conduit	2 18,288	$0.40	$0.50	$14,630.40	$18,288.00	$16,459.20
3	Buried Fiber Marker Posts/Medallions	41	$6.00	$12.00	$246.00	$492.00	$369.00
4	144 Strand Fiber Optic Cable (avg strand count)	20,319	$0.80	$0.95	$16,255.20	$19,303.05	$17,779.13
5	Slack Fiber (50' per hand hole)	1,451	$0.80	$0.95	$1,160.80	$1,378.45	$1,269.63
6	Trace Wire - Insulated 12AWG or better	18,288	$0.10	$0.15	$1,828.80	$2,743.20	$2,286.00
7	Muletape 1250P (3000ft reel) or equivalent	7	$115.00	$230.00	$805.00	$1,610.00	$1,207.50
8	Handhole - 24x30x24 Concrete Polymer (incl. Lid)	29	$300.00	$350.00	$8,708.14	$10,159.50	$9,433.82
9	Handhole Installation Materials (Gravel, Straw, etc.)	29	$5.00	$10.00	$145.14	$290.27	$217.70
10	FOSC (144 count TYCO Type B or equivalent)	15	$125.00	$250.00	$1,814.20	$3,628.39	$2,721.29
11							
12	Aerial Cable Placement	2,031	$2.00	$5.00	$4,062.00	$10,155.00	$7,108.50
13	Make Ready Heavy	0	$450.00	$1,000.00	$0.00	$0.00	$0.00
14	Make Ready Light	7	$200.00	$450.00	$1,400.00	$3,150.00	$2,275.00
15	Pole Replacement	0	$1,200.00	$2,400.00	$0.00	$0.00	$0.00
16	Trenching	5,080	$8.00	$10.00	$40,640.00	$50,800.00	$45,720.00
17	Boring (Road Crossings)	7,112	$25.00	$40.00	$177,800.00	$284,480.00	$231,140.00
18	Direct Bury / Vibratory Plow	6,096	$3.00	$5.00	$18,288.00	$30,480.00	$24,384.00
19	Handhole Installation	29	$600.00	$800.00	$17,416.29	$23,221.71	$20,319.00
20	FOSC Assembly and Installation	23	$350.00	$600.00	$8,050.00	$13,800.00	$10,925.00
21	Drop Construction (average cost per drop)	23	$2,750.00	$5,000.00	$63,250.00	$115,000.00	$89,125.00
22	Splicing (per splice estimate)	1,100	$25.00	$35.00	$27,500.00	$38,500.00	$33,000.00
23	Total				$403,999.96	$627,479.58	$515,739.77
24							

25 Notes/Assumptions:
-Estimate includes funding for drop construction for 5.00% of the buildings passed.

S1	ITEM	VALUE
S2	Total Materials	$51,743.27
S3	Total Labor	$463,996.50
S4	OSP - Fiber Construction	$515,739.77

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Medical Focus Area - Equipment

	VARIABLE	VALUE	NOTES
V1			
V2	Buildings Passed	446	
V3	Initial Sign Up	5.00%	
V4	Initial ONTs/Equip.	22	
V5	Optimism	5	0-10 scale used in Best Estimate column (10 is best)

1	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Medium Telecom Cabinet	1	$4,500.00	$8,500.00	$4,500.00	$8,500.00	$6,500.00
3	Cabinet Foundation and Installation	0	$300.00	$800.00	$0	$0.00	$0.00
4	Patch Panel (144 port)	1	$3,000.00	$4,500.00	$3,000	$4,500.00	$3,750.00
5	New Power Service / Installation	0	$500.00	$1,250.00	$0	$0.00	$0.00
6	Patch Cables (POP)	22	$14.00	$25.00	$312.20	$557.50	$434.85
7	Patch Cables (Customer Premises)	22	$20.00	$30.00	$446	$669.00	$557.50
8	Calix E7-2 Shelf	1	$600.00	$700.00	$600	$700.00	$650.00
9	Calix E7-2 GE24 (FTTx Line Card)	1	$3,800.00	$4,000.00	$3,800	$4,000.00	$3,900.00
10	Calix 10G Optics	2	$300.00	$350.00	$600	$700.00	$650.00
11	Calix CSFP (FTTx Optics)	17	$160.00	$180.00	$2,720	$3,060.00	$2,890.00
12	Calix 48V DC System Retrofit Kit	1	$1,500.00	$1,900.00	$1500	$1,900.00	$1,700.00
13					$17,478.20	$24,586.50	$21,032.35
14							
15	Notes/Assumptions:						

S1	ITEM	VALUE
	OSP	$10,250.00
	Equipment	$10,782.35
S2	Core Equipment & Pre-fab shelters	$21,032.35

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Stand Alone Project: Upper 41st Avenue

	ITEM/PROJECT	ESTIMATED
2	Upper 41st Avenue Fiber and Outside Plant	$177,746.61
3	Upper 41st Avenue Equipment	$19,505.05
4	Network Construction Subtotal	$197,251.66
5	Project Management, Network Engineering, Integration, and Testing	$29,587.75
6	Engineering, Construction Inspection, Permitting and Fees	$10,178.03
7	Misc. Fees, and Technical Services	$9,862.58
8	Bookkeeping and Administration	$3,000.00
9	Other Costs Subtotal	$52,628.36
10	Contingency (10%)	$24,988.00
11	**Project Total**	**$274,868.02**

Total Linear Construction	1.02 miles
Total Underground Construction	0.92 miles
Total Aerial Construction	537 feet
Buildings Passed	218
Buildings Connected	11

Notes/Assumptions:

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Upper 41st Avenue - FTTP

	VARIABLE	VALUE	NOTES
V1	Aerial Construction percentage	10.00%	
V2	Trenching percentage	25.00%	
V3	Boring percentage	35.00%	
V4	Vibratory Plow	30.00%	
V5	Linear construction length	5,374 feet	Length of segment in feet.
V6	Underground Construction	4,837 feet	
V7	Aerial Construction	537 feet	
V8	Conduit Exists	0 feet	
V9	Poles (for make ready)	2 poles	
V10	Handholes	11	Number of handholes for the segment.
V11	FOSCs	11	
V12	Optimism	5	0-10 scale used in Best Estimate column (10 is best)
V13	Buildings Passed	218	136 Residential, 82 Business
V14	Take Rate	5.00%	
V15	Drop Construction	11	

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Generic 1.25" Conduit	4,837	$0.40	$0.50	$3,869.60	$4,837.00	$4,353.30
3	Buried Fiber Marker Posts/Medallions	11	$6.00	$12.00	$66.00	$132.00	$99.00
4	144 Strand Fiber Optic Cable (avg strand count)	5,374	$0.80	$0.95	$4,299.20	$5,105.30	$4,702.25
5	Slack Fiber (50' per hand hole)	537	$0.80	$0.95	$429.60	$510.15	$469.88
6	Trace Wire - Insulated 12AWG or better	4,837	$0.10	$0.15	$483.70	$725.55	$604.63
7	Muletape 1250P (3000ft reel) or equivalent	2	$115.00	$230.00	$230.00	$460.00	$345.00
8	Handhole - 24x30x24 Concrete Polymer (incl. Lid)	11	$300.00	$350.00	$3,224.40	$3,761.80	$3,493.10
9	Handhole Installation Materials (Gravel, Straw, etc.)	11	$5.00	$10.00	$53.74	$107.48	$80.61
10	FOSC (144 count TYCO Type B or equivalent)	11	$125.00	$250.00	$1,343.50	$2,687.00	$2,015.25
11							
12	Aerial Cable Placement	537	$2.00	$5.00	$1,074.00	$2,685.00	$1,879.50
13	Make Ready Heavy	0	$450.00	$1,000.00	$0.00	$0.00	$0.00
14	Make Ready Light	2	$200.00	$450.00	$400.00	$900.00	$650.00
15	Pole Replacement	0	$1,200.00	$2,400.00	$0.00	$0.00	$0.00
16	Trenching	1,344	$8.00	$10.00	$10,752.00	$13,440.00	$12,096.00
17	Boring (Road Crossings)	1,881	$25.00	$40.00	$47,025.00	$75,240.00	$61,132.50
18	Direct Bury / Vibratory Plow	1,613	$3.00	$5.00	$4,839.00	$8,065.00	$6,452.00
19	Handhole Installation	11	$600.00	$800.00	$6,448.80	$8,598.40	$7,523.60
20	FOSC Assembly and Installation	11	$350.00	$600.00	$3,850.00	$6,600.00	$5,225.00
21	Drop Construction (average cost per drop)	11	$2,750.00	$5,000.00	$30,250.00	$55,000.00	$42,625.00
22	Splicing (per splice estimate)	800	$25.00	$35.00	$20,000.00	$28,000.00	$24,000.00
23	Total				$138,638.54	$216,854.68	$177,746.61
24							
25	Notes/Assumptions: -Estimate includes funding for drop construction for 5.00% of the buildings passed.						

	ITEM	VALUE
S1	Total Materials	$16,163.01
S2	Total Labor	$161,583.60
S3	OSP - Fiber Construction	$177,746.61

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Upper 41st Avenue - Equipment

	VARIABLE	VALUE	NOTES
V2	Buildings Passed	218	
V3	Initial Sign Up	5.00%	
V4	Initial ONTs/Equip.	11	
V5	Optimism	5	0-10 scale used in Best Estimate column (10 is best)

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Medium Telecom Cabinet	1	$4,500.00	$8,500.00	$4,500.00	$8,500.00	$6,500.00
3	Cabinet Foundation and Installation	0	$300.00	$800.00	$0	$0.00	$0.00
4	Patch Panel (144 port)	1	$3,000.00	$4,500.00	$3,000	$4,500.00	$3,750.00
5	New Power Service / Installation	0	$500.00	$1,250.00	$0	$0.00	$0.00
6	Patch Cables (POP)	11	$14.00	$25.00	$152.60	$272.50	$212.55
7	Patch Cables (Customer Premises)	11	$20.00	$30.00	$218	$327.00	$272.50
8	Calix E7-2 Shelf	1	$600.00	$700.00	$600	$700.00	$650.00
9	Calix E7-2 GE24 (FTTx Line Card)	1	$3,800.00	$4,000.00	$3,800	$4,000.00	$3,900.00
10	Calix 10G Optics	2	$300.00	$350.00	$600	$700.00	$650.00
11	Calix CSFP (FTTx Optics)	11	$160.00	$180.00	$1,760	$1,980.00	$1,870.00
12	Calix 48V DC System Retrofit Kit	1	$1,500.00	$1,900.00	$1500	$1,900.00	$1,700.00
13					$16,130.60	$22,879.50	$19,505.05
14							
15	Notes/Assumptions:						

	ITEM	VALUE
	OSP	$10,250.00
	Equipment	$9,255.05
S2	Core Equipment & Pre-fab shelters	$19,505.05

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Stand Alone Project: Aptos Area

	ITEM/PROJECT	ESTIMATED
2	Aptos Area Fiber and Outside Plant	$928,613.96
3	Aptos Area Equipment	$20,063.10
4	Network Construction Subtotal	$948,677.06
5	Project Management, Network Engineering, Integration, and Testing	$142,301.56
6	Engineering, Construction Inspection, Permitting and Fees	$64,560.61
7	Misc. Fees, and Technical Services	$47,433.85
8	Bookkeeping and Administration	$3,000.00
9	Other Costs Subtotal	$257,296.02
10	Contingency (10%)	$120,597.31
11	**Project Total**	**$1,326,570.38**

Total Linear Construction	6.46 miles
Total Underground Construction	5.16 miles
Total Aerial Construction	6,817 feet
Buildings Passed	632
Buildings Connected	16

Notes/Assumptions:
This segment includes a backbone link back to the center of the County and local FTTP in the focus area.

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Aptos Area - FTTP

	VARIABLE	VALUE	NOTES
V2	Aerial Construction percentage	20.00%	
V3	Trenching percentage	20.00%	
V4	Boring percentage	50.00%	
V5	Vibratory Plow	10.00%	
V6	Linear construction length	34,088 feet	Length of segment in feet.
V7	Underground Construction	27,271 feet	
V8	Aerial Construction	6,817 feet	
V9	Conduit Exists	0 feet	
V10	Poles (for make ready)	23 poles	
V11	Handholes	40	Number of handholes for the segment.
V12	FOSCs	40	
V13	Optimism	5	0-10 scale used in Best Estimate column (10 is best)
V14	Buildings Passed	632	375 Residential, 257 Businesses
V15	Take Rate	2.50%	
V16	Drop Construction	16	

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Generic 1.25" Conduit	27,271	$0.40	$0.50	$21,816.80	$27,271.00	$24,543.90
3	Buried Fiber Marker Posts/Medallions	69	$6.00	$12.00	$414.00	$828.00	$621.00
4	144 Strand Fiber Optic Cable (avg strand count)	34,088	$0.80	$0.95	$27,270.40	$32,383.60	$29,827.00
5	Slack Fiber (50' per hand hole)	2,005	$0.80	$0.95	$1,604.00	$1,904.75	$1,754.38
6	Trace Wire - Insulated 12AWG or better	27,271	$0.10	$0.15	$2,727.10	$4,090.65	$3,408.88
7	Muletape 1250P (3000ft reel) or equivalent	12	$115.00	$230.00	$1,380.00	$2,760.00	$2,070.00
8	Handhole - 24x30x24 Concrete Polymer (incl. Lid)	40	$300.00	$350.00	$12,031.06	$14,036.24	$13,033.65
9	Handhole Installation Materials (Gravel, Straw, etc.)	40	$5.00	$10.00	$200.52	$401.04	$300.78
10	FOSC (144 count TYCO Type B or equivalent)	40	$125.00	$250.00	$5,012.94	$10,025.88	$7,519.41
11							
12	Aerial Cable Placement	6,817	$2.00	$5.00	$13,634.00	$34,085.00	$23,859.50
13	Make Ready Heavy	0	$450.00	$1,000.00	$0.00	$0.00	$0.00
14	Make Ready Light	23	$200.00	$450.00	$4,600.00	$10,350.00	$7,475.00
15	Pole Replacement	0	$1,200.00	$2,400.00	$0.00	$0.00	$0.00
16	Trenching	6,818	$8.00	$10.00	$54,544.00	$68,180.00	$61,362.00
17	Boring (Road Crossings)	17,044	$25.00	$40.00	$426,100.00	$681,760.00	$553,930.00
18	Direct Bury / Vibratory Plow	3,409	$3.00	$5.00	$10,227.00	$17,045.00	$13,636.00
19	Handhole Installation	40	$600.00	$800.00	$24,062.12	$32,082.82	$28,072.47
20	FOSC Assembly and Installation	16	$350.00	$600.00	$5,600.00	$9,600.00	$7,600.00
21	Drop Construction (average cost per drop)	16	$2,750.00	$5,000.00	$44,000.00	$80,000.00	$62,000.00
22	Splicing (per splice estimate)	2,920	$25.00	$35.00	$73,000.00	$102,200.00	$87,600.00
23	Total:				$728,223.94	$1,129,003.98	$928,613.96
24							
25	Notes/Assumptions: -Estimate includes funding for drop construction for 2.50% of the buildings passed.						

	ITEM	VALUE
S2	Total Materials	$83,078.99
S3	Total Labor	$845,534.97
S4	OSP - Fiber Construction	$928,613.96

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Aptos Area - Equipment

	VARIABLE	VALUE	NOTES
V1			
V2	Buildings Passed	632	
V3	Initial Sign Up	2.50%	
V4	Initial ONTs/Equip.	16	
V5	Optimism	5	0-10 scale used in Best Estimate column (10 is best)

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	Medium Telecom Cabinet	1	$4,500.00	$8,500.00	$4,500.00	$8,500.00	$6,500.00
3	Cabinet Foundation and Installation	0	$300.00	$800.00	$0	$0.00	$0.00
4	Patch Panel (144 port)	1	$3,000.00	$4,500.00	$3,000	$4,500.00	$3,750.00
5	New Power Service / Installation	0	$500.00	$1,250.00	$0	$0.00	$0.00
6	Patch Cables (POP)	16	$14.00	$25.00	$221.20	$395.00	$308.10
7	Patch Cables (Customer Premises)	16	$20.00	$30.00	$316	$474.00	$395.00
8	Calix E7-2 Shelf	1	$600.00	$700.00	$600	$700.00	$650.00
9	Calix E7-2 GE24 (FTTx Line Card)	1	$3,800.00	$4,000.00	$3,800	$4,000.00	$3,900.00
10	Calix 10G Optics	2	$300.00	$350.00	$600	$700.00	$650.00
11	Calix CSFP (FTTx Optics)	13	$160.00	$180.00	$2,080	$2,340.00	$2,210.00
12	Calix 48V DC System Retrofit Kit	1	$1,500.00	$1,900.00	$1500	$1,900.00	$1,700.00
13					$16,617.20	$23,509.00	$20,063.10
14							
15	Notes/Assumptions:						

	ITEM	VALUE
S1	OSP	$10,250.00
	Equipment	$9,813.10
S2	Core Equipment & Pre-fab shelters	$20,063.10

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Project Summary: Stand Alone Projects - minimum investment

	ITEM/PROJECT	ESTIMATED
2	Core, Spare, and Customer Premise Equipment	$54,600.00
3	Network Construction Subtotal	$54,600.00
4	Project Management, Network Engineering, Integration, and Testing	$5,460.00
5	Engineering, Construction Inspection, Permitting and Fees	$0.00
6	Business, Service Provider and Operations Development	$75,000.00
7	Misc. Fees, and Technical Services	$2,000.00
8	Bookkeeping and Administration	$850.00
9	Other Costs Subtotal	$83,310.00
10	Contingency (10%)	$13,791.00
11	**Project Total**	**$151,701.00**

Total Linear Construction	0 miles
Total Underground Construction	0 miles
Total Aerial Construction	0 feet
Buildings Passed	0
Buildings Connected	0

Notes/Assumptions:
If they County of Santa Cruz decides to invest in individual segments as opposed to all segments the total in this sheet is required for any investment if the County builds a "lit" network.

As an example, if only the Urban core and the Medical Office areas are to be constructed, this cost should be added to the cost of those two segments to understand the total cost for the lit network.

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Core, Spare, and Other Network Equipment

	VARIABLE	VALUE	NOTES
V1			
V2	Weight Variable	5	0-10 scale used in Best Estimate column (10 is best)
V3	Potential Connections		
V4	Take Rate		
V5	Drop Construction	0	

	ITEM/PROJECT	UNITS	COST(LOW)	COST(HIGH)	TOTAL (LOW)	TOTAL (HIGH)	BEST ESTIMATE (WEIGHTED AVERAGE)
2	CORE EQUIOPMENT - minimum requirement						
3	Calix Advantage System Support and Maintenance (1 year)	2	$3,500.00	$7,500.00	$7,000	$15,000.00	$11,000.00
4	CMS Server	1	$3,000.00	$4,500.00	$3,000.00	$4,500.00	$3,750.00
5	Dell Server	1	$2,500.00	$3,500.00	$2,500.00	$3,500.00	$3,000.00
6	Calix E7-2 GE24 (FTTx Line Card)	1	$3,800.00	$4,000.00	$3,800.00	$4,000.00	$3,900.00
7	Battery Backup System	1	$1,500.00	$1,900.00	$1,500.00	$1,900.00	$1,700.00
8	Medium Network Core Router	1	$12,500.00	$25,000.00	$12,500.00	$25,000.00	$18,750.00
9	SPARE EQUIPMENT						
10	Backup Generator	1	$1,200.00	$1,800.00	$1,200.00	$1,800.00	$1,500.00
11	Calix E7-2 Chassis	0	$0.00	$0.00	$0.00	$0.00	$0.00
12	Calix GE24 Active Ethernet Card	0	$0.00	$0.00	$0.00	$0.00	$0.00
13	CUSTOMER PREMISES EQUIPMENT						
14	Calix 716 GE - 1	50	$200.00	$240.00	$10,000.00	$12,000.00	$11,000.00
15			$0.00	$0.00	$0.00	$0.00	$0.00
16			$0.00	$0.00	$0.00	$0.00	$0.00
17			$0.00	$0.00	$0.00	$0.00	$0.00
18			$0.00	$0.00	$0.00	$0.00	$0.00
19	Total				$41,500.00	$67,700.00	$54,600.00
20							
21	Notes/Assumptions: Identify a storage area that can be available to contractors on a 24/7 basis.						

	ITEM	VALUE
S1	Equipment	$43,600.00
	Customer Premises Equipment	$11,000.00
S2	Other Equipment	$54,600.00

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Project Summary: Santa Cruz Fiber Buildout - all segments

	ITEM/PROJECT	ESTIMATED
2	Davenport Fiber and Outside Plant	$1,478,243.99
3	Davenport Shelter/Equipment	$45,422.77
4	Urban Core Fiber and Outside Plant	$941,596.38
5	Urban Core Equipment	$17,310.43
6	Live Oak Fiber and Outside Plant	$2,442,946.59
7	Live Oak Cabinet/Equipment	$58,074.40
8	Medical Focus Area Fiber and Outside Plant	$515,739.77
9	Medical Focus Area Equipment	$21,032.35
10	Upper 41st Area Fiber and Outside Plant	$177,746.61
11	Upper 41st Area Equipment	$19,505.05
12	Aptos Area Fiber and Outside Plant	$928,613.96
13	Aptos Area Equipment	$20,063.10
14	Core, Operations, and Spare Equipment (minimum requirement)	$54,600.00
15	Network Construction Subtotal	$6,720,895.39
16	Project Management, Network Engineering, Integration, and Testing	$672,089.54
17	Engineering, Construction Inspection, Permitting and Fees	$367,121.12
18	Railroad Permitting (0 crossings) - engineering and fees	$0.00
19	Business, Service Provider and Operations Development	$75,000.00
20	Misc. Fees, and Technical Services	$336,045
21	Bookkeeping and Administration	$18,000
22	Legal	$35,000
23	Other Costs Subtotal	$1,503,255.43
24	Contingency (10%)	$822,415.08
25	**Project Total**	**$9,046,565.90**

Total Linear Construction	43.19 miles
Total Underground Construction	40.15 miles
Total Aerial Construction	16,075 feet
Buildings Passed	4,176
Buildings Connected	193

Notes/Assumptions:
This estimate contains the segments needed to complete the core "lit" network.

There are economies of scale included in this summary table which if taken individually would not be present. Therefore if you take the sum of al the individual segment stand alone summaries in the subsequent pages and add them up, they would exceed the cost of the full buildout. This is due to reductions in PM and engineering cost when taken as a whole.

Network Segments (Maps)

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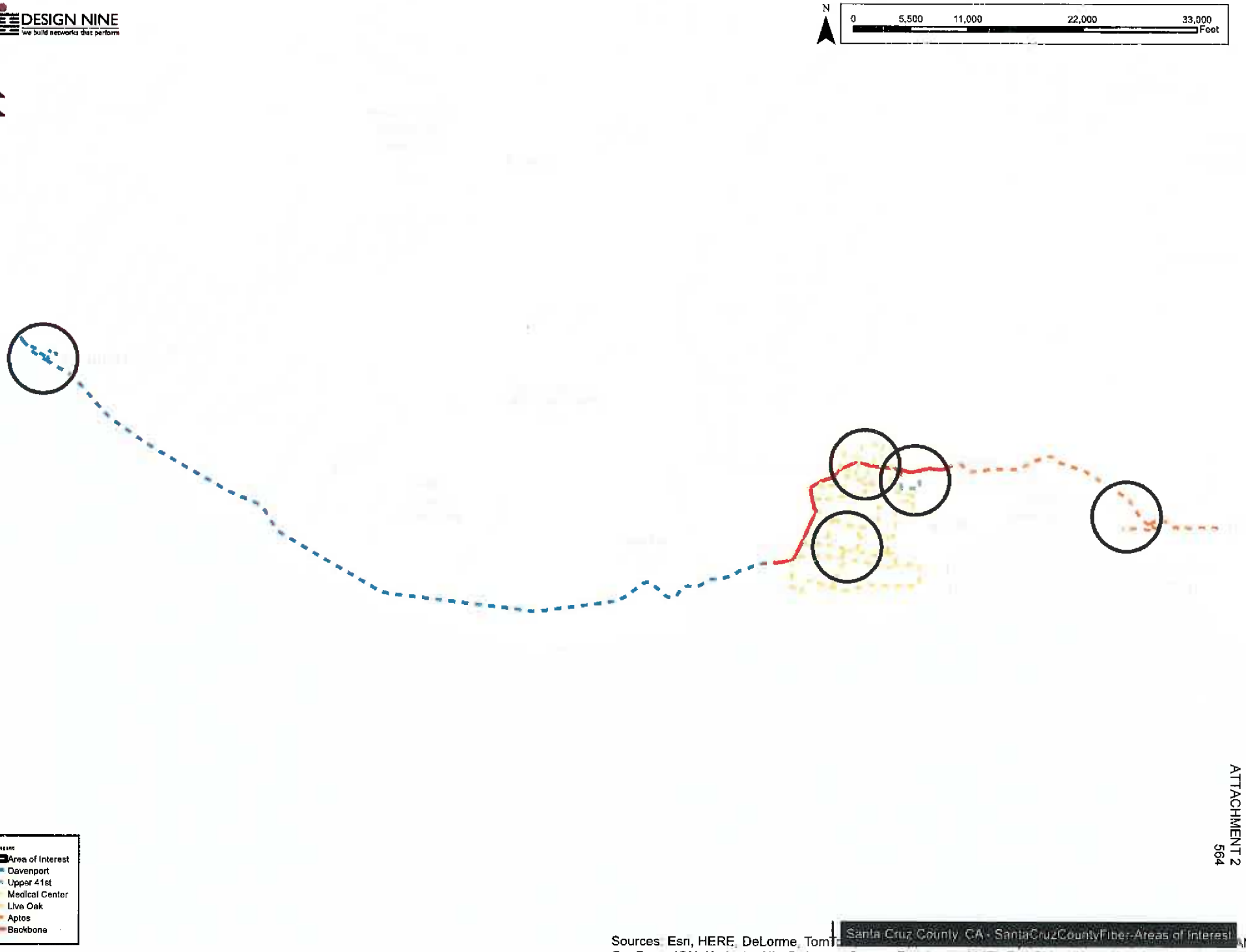

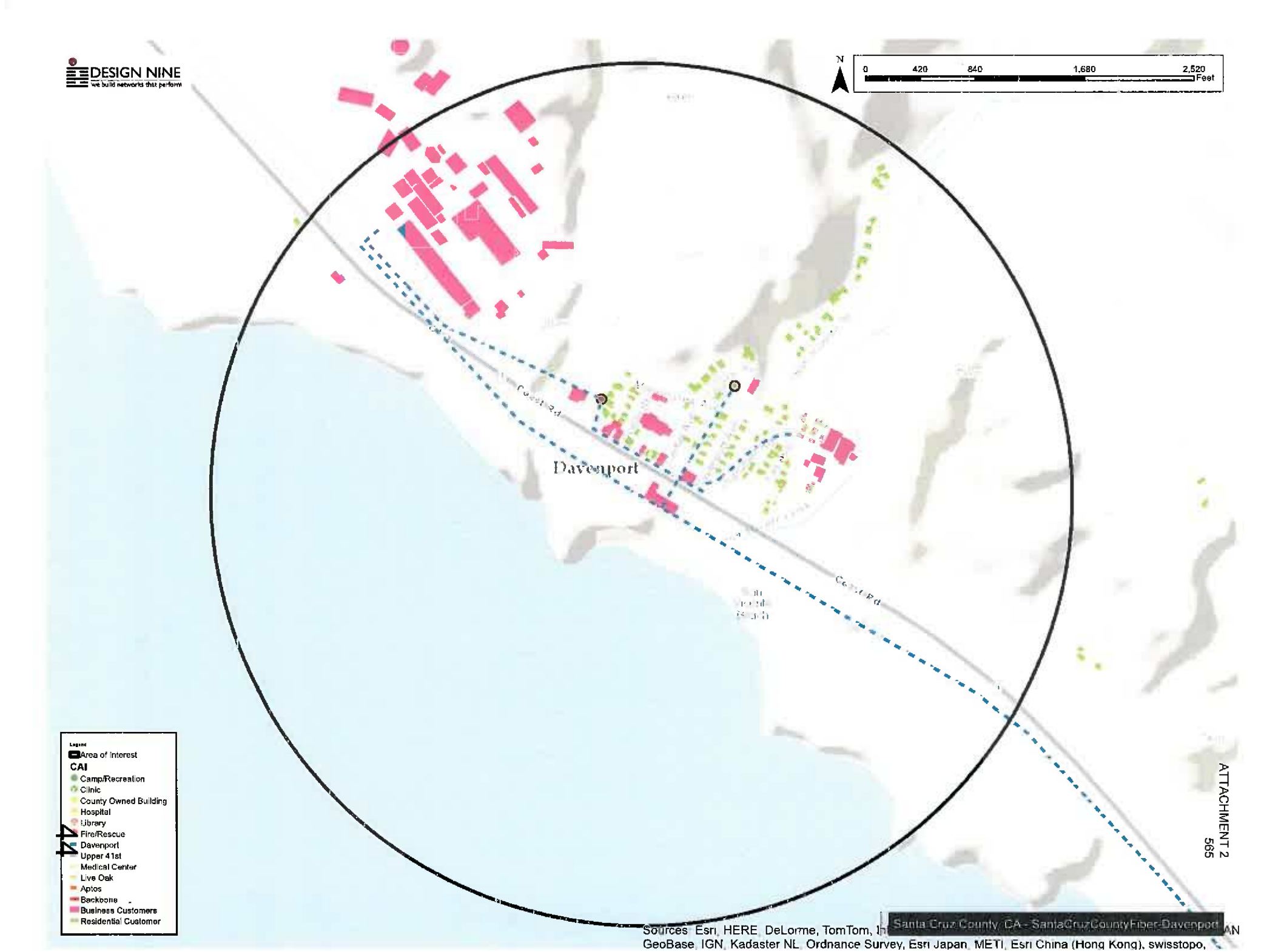
DESIGN NINE
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Davenport
Legend
Area of Interest
CAI
Camp/Recreation
Clinic
County Owned Building
Hospital
Library
Fire/Rescue
Davenport
Upper 41st
Medical Center
Live Oak
Aptos
Backbone
Business Customers
Residential Customer
Sources: Esri, HERE, DeLorme, TomTom,
GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo,
Santa Cruz County, CA - SantaCruzCountyFiber-Davenport

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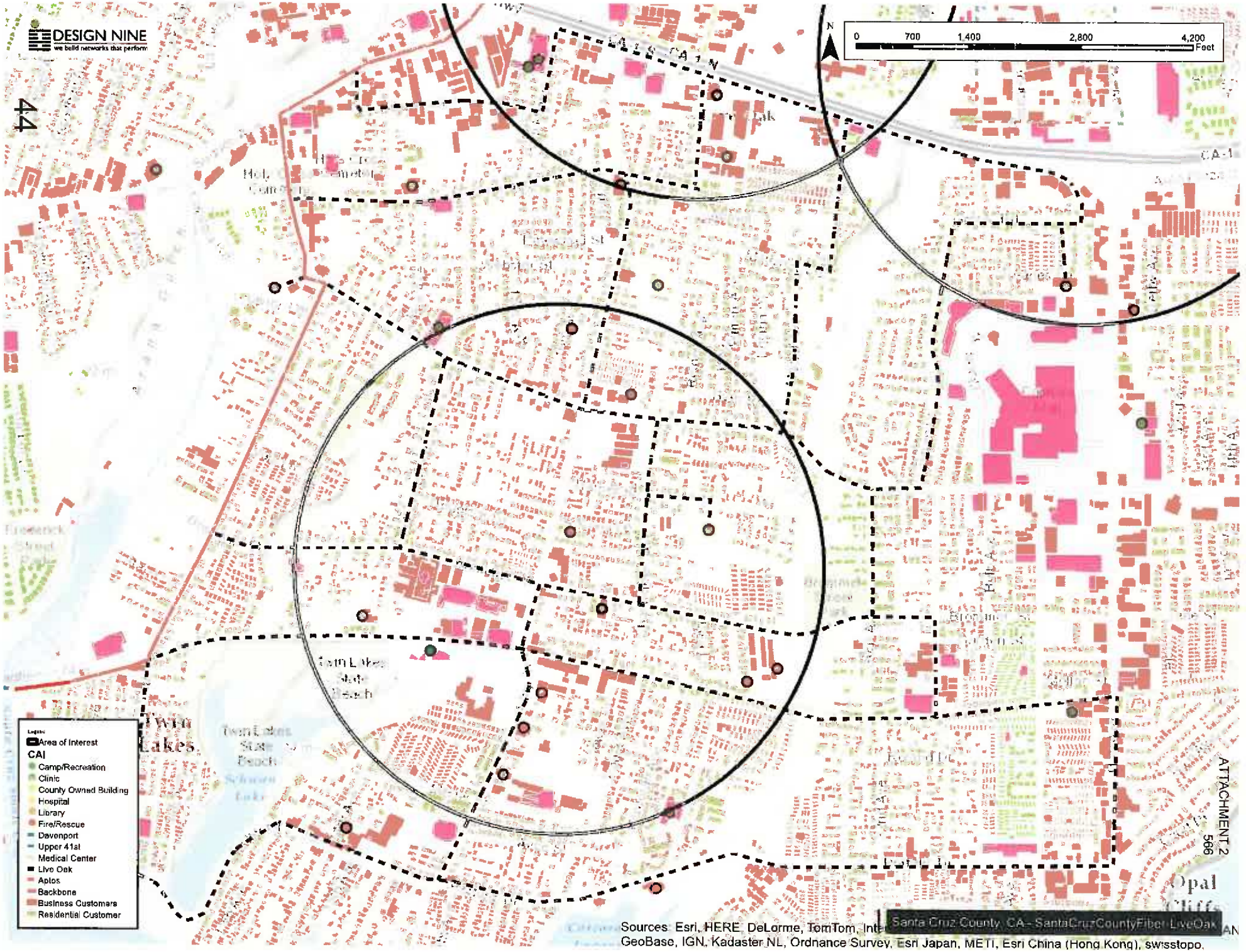

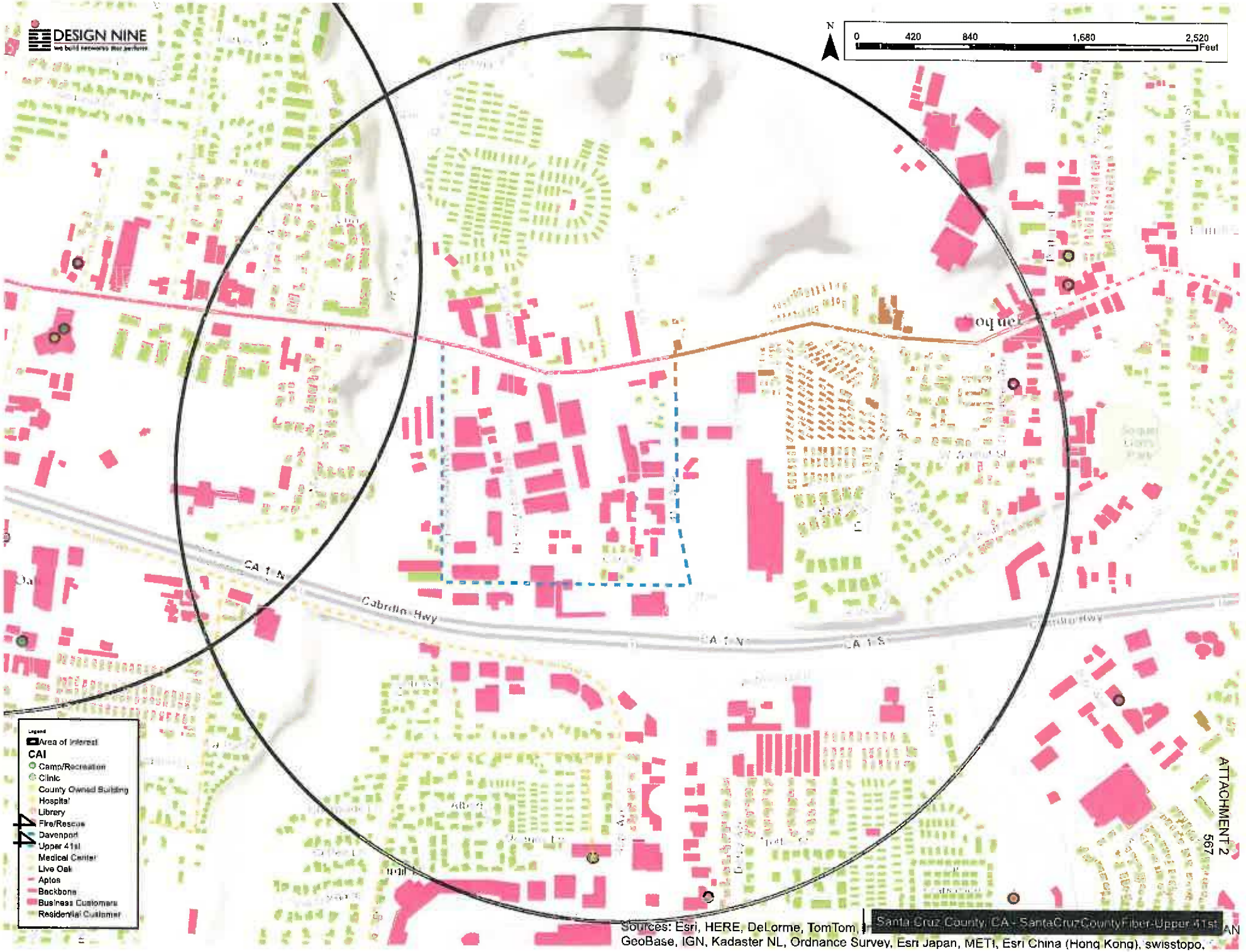
DESIGN NINE
we build networks that perform
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Area of Interest
CAI
Camp/Recreation
Clinic
County Owned Building
Hospital
Library
Fire/Rescue
Davenport
Upper 41st
Medical Center
Live Oak
Aptos
Backbone
Business Customers
Residential Customer
Sources: Esri, HERE, DeLorme, TomTom,
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Santa Cruz County, CA - SantaCruzCountyFiber-Upper 41st

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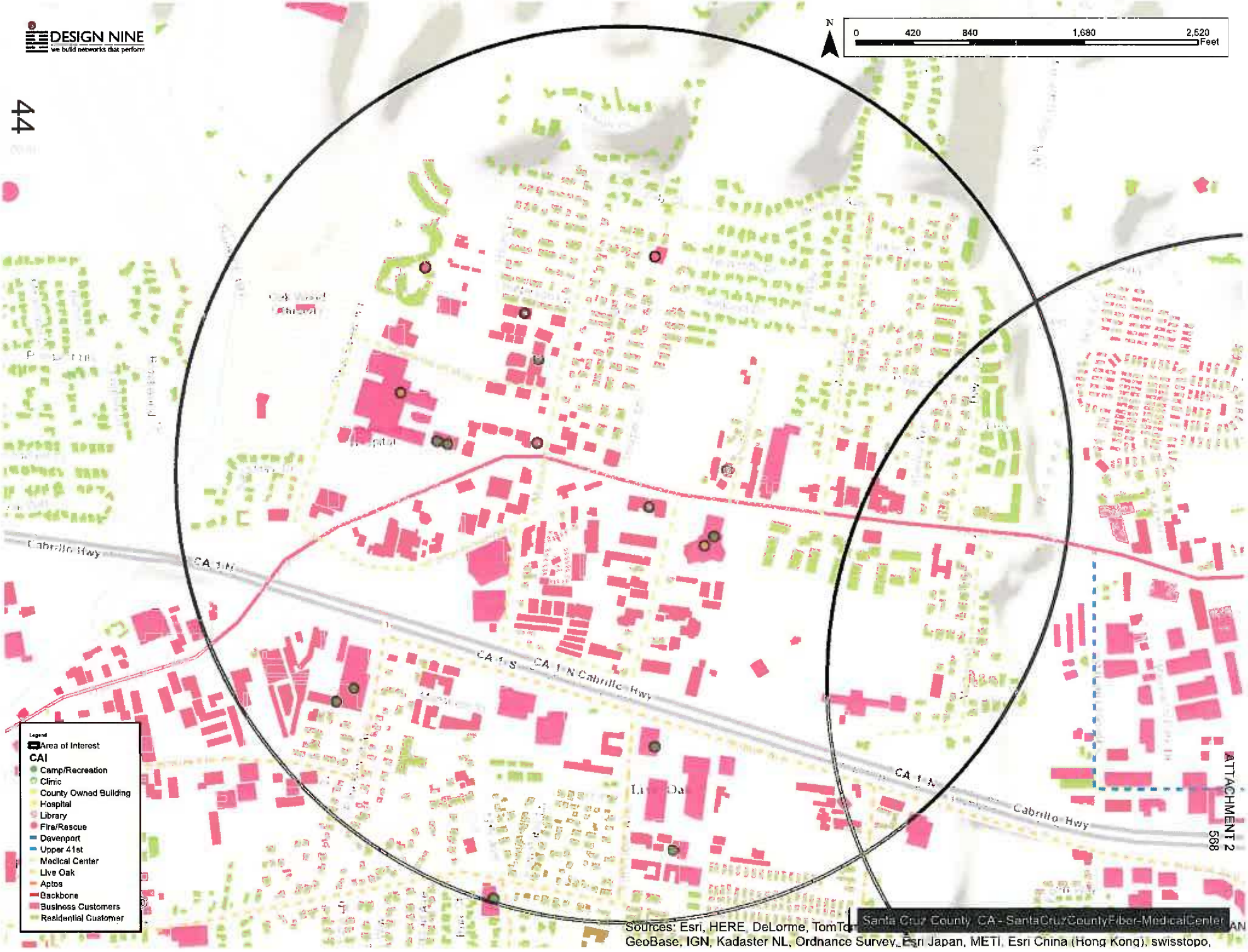

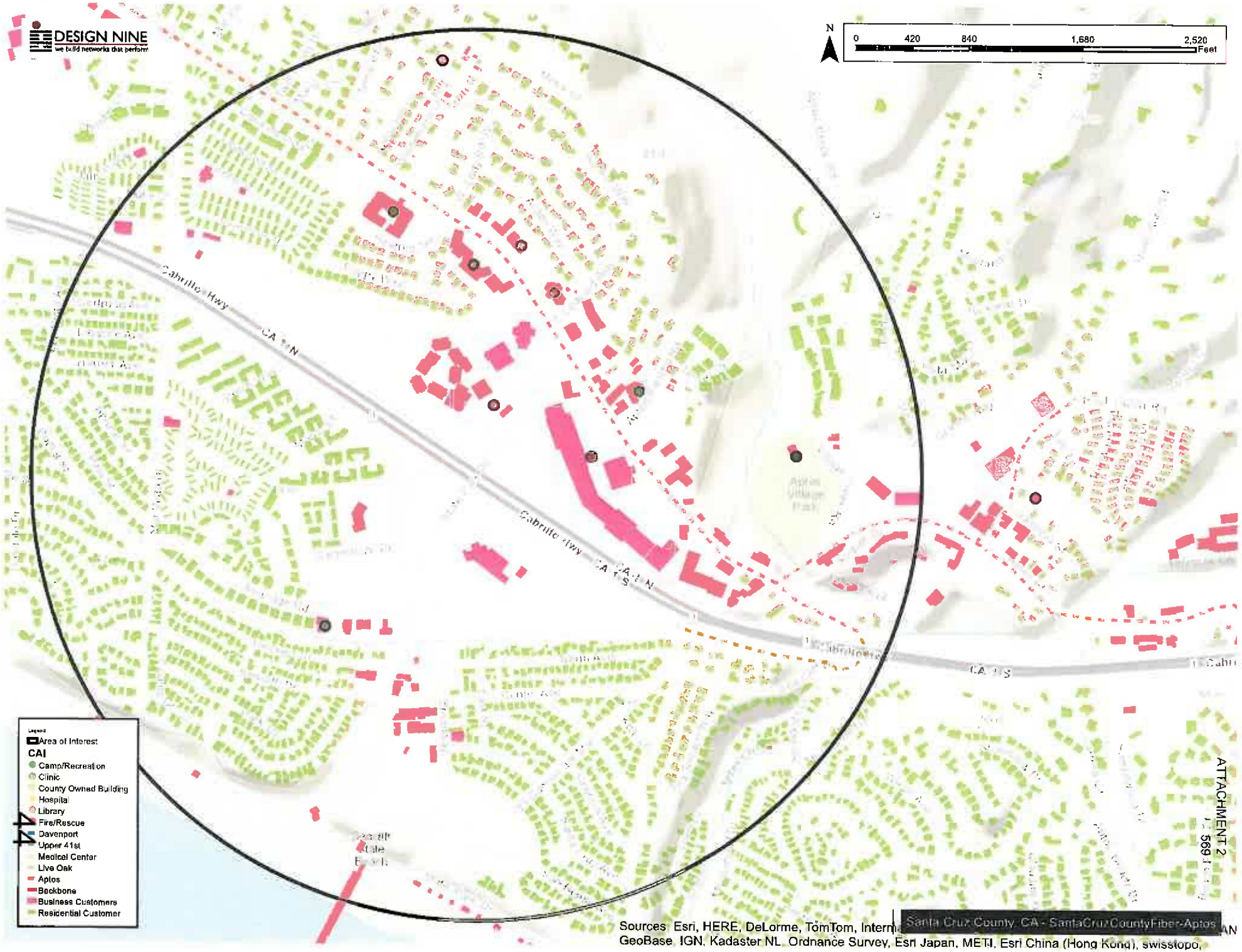
DESIGN NINE
we build networks that perform
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CA 1 N
CA 1 S
Legend
Area of Interest
CAI
Camp/Recreation
Clinic
County Owned Building
Hospital
Library
Fire/Rescue
Davenport
Upper 41st
Medical Center
Live Oak
Aptos
Backbone
Business Customers
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Sources: Esri, HERE, DeLorme, TomTom, Intermap, increment P Corp, GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey, Esri Japan, METI, Esri China (Hong Kong), swisstopo,
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