COUNTY OF EL DORADO, BROADBAND ROADMAP

June 2018

Abstract

Local governments are taking a more active role in ensuring their communities have reliable, abundant and affordable broadband services for their citizens. Additionally, smart city applications are requiring local governments to plan for robust infrastructure to support these emerging technologies. This white paper discusses models and approaches for El Dorado County to consider and provides a platform to evaluate financial implications, levels of investment, models and strategies, and options for implementation.

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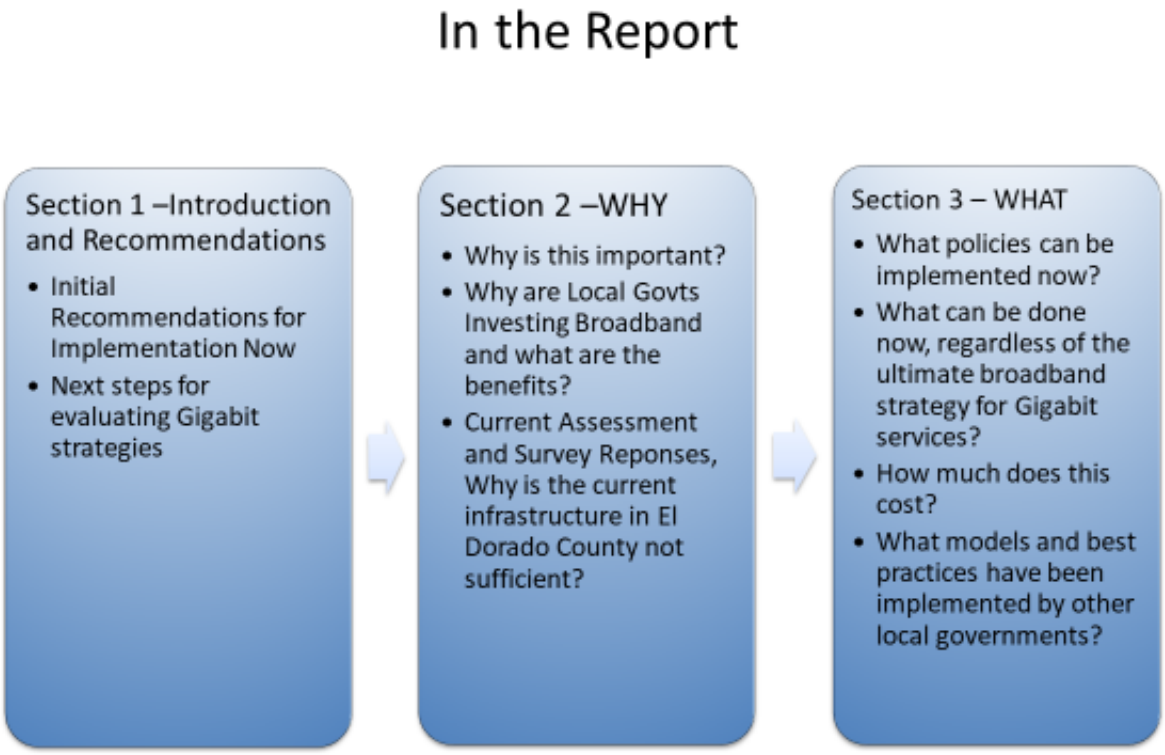
Contents

About this Report

The following report is a roadmap for improving broadband services within El Dorado County. This report is divided into three sections.



Section 1 of this report provides an introduction and background on El Dorado County's (the "County") broadband study. This section provides a call to action for consideration; essentially the recommendations that can be implemented now to facilitate and lower the costs for broadband implementation and a summary of the costs of implementing each level of investment in infrastructure to connect key facilities, smart city applications and government locations. These initial recommendations lay the foundation for improving broadband infrastructure within the County, regardless of whether the County decides to move forward with a Gigabit broadband strategy or not.

Section 2 provides answers to many of the "why" questions. It addresses why having abundant and affordable broadband services is important, why local governments are investigating building broadband infrastructure for their communities, and what El Dorado citizens are saying regarding their current services. This section also details the current assessment and findings regarding what existing services and infrastructure are available today. The current

assessment provides information regarding identified gaps in availability of broadband service and what the incumbent providers, Comcast and AT&T are offering within the study area.

Section 3 of this report describes "what" to consider. This section discusses what strategies and capital cost investment may be required to upgrade the existing infrastructure to support a variety of broadband, cellular backhaul, smart city and e-government applications. This section also discusses the considerations to implement a Gigabit broadband strategy or connecting homes and businesses with fiber, the estimated capital costs for doing so and what other local governments have done or are considering doing for implementation of a Gigabit broadband strategy. This section discusses several types of public private partnership models and examples of other local governments that have implemented them.

Following this report, a companion report will be provided that will discuss the financial considerations and implications of various Gigabit strategies. Financial projections, staffing considerations and financing strategies will be discussed for each model. Additionally, the companion report will address funding and financing options for consideration, as well as potential partnerships that may be developed to reduce or share in the capital costs.

Section 1 – Introduction and Initial Recommendations

Background Information

El Dorado has hired NEO Connect to provide strategic planning for facilitation of better broadband services for the communities within the County and for the remote parts of the County. In parallel with NEO's engagement, El Dorado County staff have conducted high-level surveys from citizens regarding their thoughts on current broadband services, what is important and their opinion regarding the role of government in solving broadband gaps.

Additionally, NEO and County staff have conducted community engagement meetings with the public for feedback. NEO's team provided a current assessment of the broadband landscape in El Dorado County. NEO researched the existing services, pricing and availability of broadband service within the County and identified gaps in service availability provided by the incumbent providers.

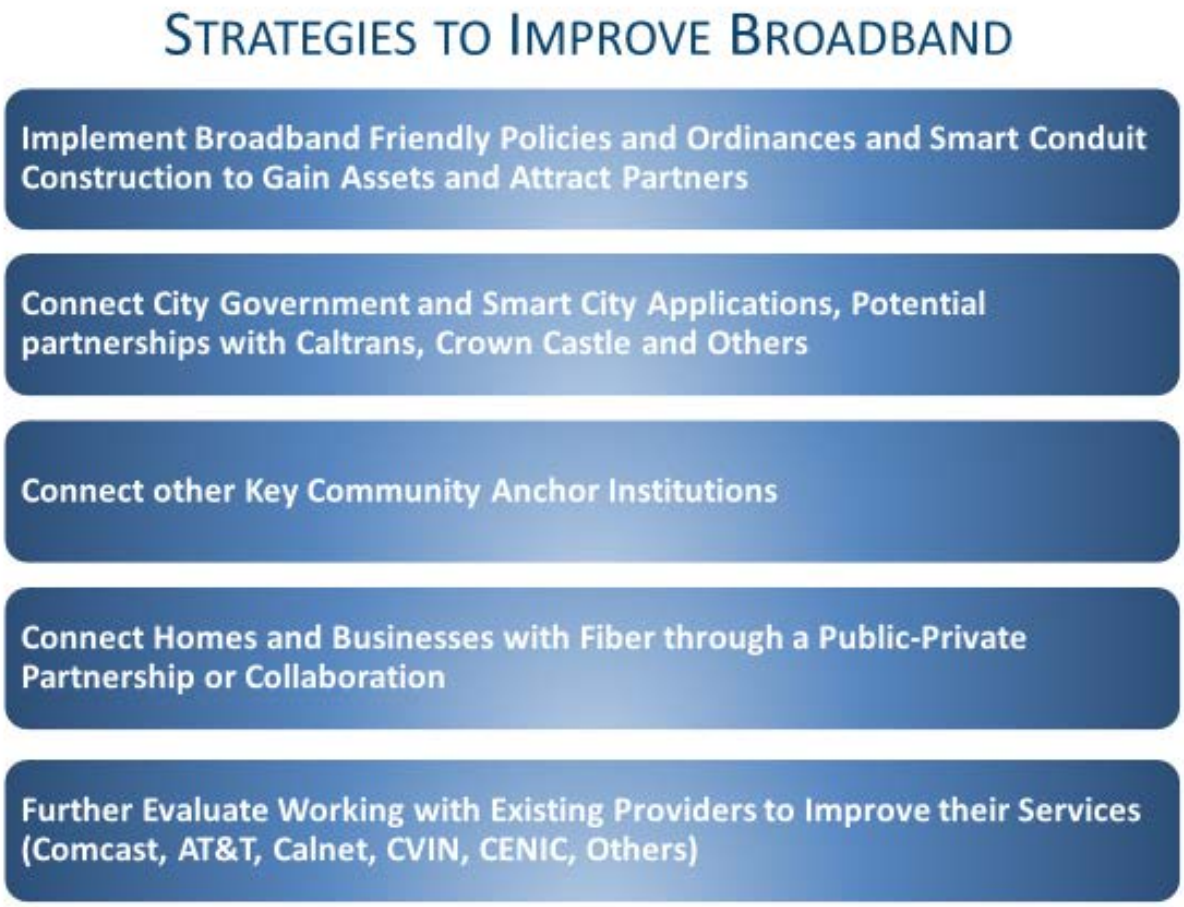
There are many strategies that may be considered by a local government to improve broadband services. The first may be to implement policies and ordinances that reduce the cost of broadband deployment. Another approach may be to connect various government and anchor institutions within each community to serve as a backbone network and to reduce operating expenses. These strategies lay the foundation for connecting important facilities and help create a broadband distribution system that can further be expanded. Another strategy may be to extend the broadband distribution system into neighborhoods to connect homes and businesses with fiber.

To identify the costs of various levels of investment, NEO's team gathered information regarding El Dorado County's traffic management and capital improvement projects, and other government communication needs. NEO identified and mapped existing assets that could potentially be leveraged to improve broadband services and identified key community anchor institutions that could benefit from having fiber built directly to their locations. We then provided a high-level design and capital cost projection for several levels of broadband infrastructure development and investment.

In addition to the above set of tasks, NEO's scope of work included providing models for public-private partnerships and best practices regarding what other local governments are doing or have done to improve broadband services.

Initial Recommendations and Strategies to Consider

As discussed, there are several levels of investment that may facilitate better broadband services within a County. Here are the various strategies that were evaluated as part of this study.



Based upon the initial findings of the broadband plan, NEO and staff recommend the first three strategies can be implemented in the near future. The first three recommendations will facilitate and lower the costs for broadband implementation and lay the foundation for improving broadband infrastructure within the County, regardless of whether the County decides to move forward with a Gigabit broadband strategy to connecting homes and businesses, or not.

Connecting city government locations (water monitoring systems, public safety, airport facilities and other government buildings), smart city applications (traffic lights and parking meters and other systems as they become important) and key community anchor institutions (i.e. hospitals, schools, and universities) with fiber will greatly enhance communications and broadband speeds for these locations, while dramatically reducing communications costs. Most of the schools within the County has already been connected with CENIC's California Research and Education Network (CalREN) fiber network. While these and other key facilities and anchor institutions are being connected with fiber, the County will gain more fiber assets that can be leveraged for building out to neighborhoods to connect homes and businesses with fiber. Implementing a shadow conduit/dig once policy will allow the County to facilitate further

broadband development by reducing the costs of broadband expansion, by levering existing public works or construction by other entities.

All of these first three strategies will improve communications for applications that will be needed regardless of whether or how the County moves forward with a more ambitious, ubiquitous Gigabit broadband strategy. Additionally, these strategies will lower the overall cost of further expansion and will provide assets (conduit and fiber) for the County to use as leverage to potentially negotiate a public-private partnership for further expansion.

NEO and staff recommend that investigation into how to implement a ubiquitous Gigabit broadband strategy for homes and businesses be further evaluated. This would include weighing the pros and cons of various public-private partnership models, working with companies that have implemented services in California and the region or working with the incumbent providers Comcast and AT&T to improve their availability of Gigabit broadband services.

The companion report will provide the financial implications and considerations for implementation of connecting homes and businesses with fiber. Financial models for public-private partnerships for the County to offer broadband services directly to citizens and businesses will be provided.

Summary of Capital Costs for the Various Strategies

Below is a summary of the capital costs for implementation of the various levels of investment.

Implementing Policies and Ordinances that are Friendly, Deploying Shadow Conduit

Local governments have the power to significantly reduce the capital costs of broadband infrastructure deployment by implementing policies and ordinances that are broadband-friendly. NEO has provided a white paper describing in detail these recommended policies to El Dorado County staff. These recommendations include implementation of a Dig Once Policy, Shadow Conduit Requirements, Joint Trench and Joint Build Agreements, Abandoned Fiber and Conduit Policy, Land Use Policies for New Developments, Streamlined Permitting Processes, and One-Touch Make Ready Requirements.

These policies can be implemented to facilitate investment from the private sector and can also be used to gain substantial assets owned by El Dorado County that can be leveraged for future broadband deployment.

NEO worked with the County's transportation department to identify possible capital improvement projects that could benefit or be leveraged to put in shadow conduit. NEO

mapped the projects being considered and this is addressed in detail in Section 3 of this report. Below are the potential capital costs of implementing a shadow conduit policy versus the costs to build fiber as a new project or a new build.

El Dorado County
Cost Proposal, Shadow Conduit vs. New Build

Description	Unit Rate	Capital Improvement Project New Build Quantity		Capital Improvement Project New Build Subtotal	Capital Improvement Project Joint New Build Quantity		Capital Improvement Project Joint New Build Subtotal	Capital Improvements New Build Cost Difference
Engineering Capital Improvement Project New Build	$ 0.31	281,789.66	FT	$ 87,221.94	281,789.66	FT	$ 87,221.94	$ -
Construction Management and As-Builts Capital Improvement Project New Build	$ 0.72	281,789.66	FT	$ 201,623.10	281,789.66	FT	$ 201,623.10	$ -
Materials								
1.25" SDR 11 HDPE Duct	$ 0.46	619,937.25	FT	$ 284,469.65	619,937.25	FT	$ 284,469.65	$ -
24"x36"x24" Polycrete Handhole with 1 Piece 20K Lid	$ 382.39	107.00	EA	$ 40,915.77	107.00	EA	$ 40,915.77	$ -
Labor								
Joint build construction	$ 5.00	-	FT	$ -	281,789.66	FT	$ 1,408,948.30	$ 1,408,948.30
Bore and Place 2 - 1.25" SDR 11 HDPE Duct	$ 47.06	281,789.66	FT	$13,261,988.38	-	FT	$ -	$ (13,261,988.38)
Place 24"x36"x24" handhole with gravel and soil removal	$ 955.98	107.00	EA	$ 102,289.43	107.00	EA	$ 102,289.43	$ -
Total				**$13,978,508.27**			**$ 2,125,468.19**	**$ (11,853,040.08)**

These costs were based upon the project lists that were shown on the County's website. NEO's team has asked the County to verify the timing of these projects and the validity of placing conduit when these projects are underway. If the County placed shadow conduit during these capital improvement projects, the estimated capital costs are $2.125 Million. Alternatively, if the fiber is built as a new project, the capital costs would be $13.978 Million, resulting in an $11.853 Million savings.

Additionally, there is a multi-use project slated for the County. Below are the potential capital costs of implementing a shadow conduit when the multi-use/trail project is underway.

El Dorado County
Cost Proposal, Shadow Conduit vs. New Build

Description	Unit Rate	Trail System New Build Quantity		Trail System New Build Subtotal	Trail System Joint New Build Quantity		Trail System Joint New Build Subtotal	Trail Systems New Build Cost Difference
Engineering Capital Improvement Project New Build	$ 0.31	201,412.01	FT	$ 62,342.77	201,412.01	FT	$ 62,342.77	$ -
Construction Management and As-Builts Capital Improvement Project New Build	$ 0.72	201,412.01	FT	$ 144,112.15	201,412.01	FT	$ 144,112.15	$ -
Materials								
1.25" SDR 11 HDPE Duct	$ 0.46	443,106.42		$ 203,327.56	443,106.42		$ 203,327.56	$ -
24"x36"x24" Polycrete Handhole with 1 Piece 20K Lid	$ 382.39	77.00		$ 29,444.06	77.00		$ 29,444.06	$ -
Labor								
Joint build construction	$ 5.00	-		$ -	201,412.01		$ 1,007,060.05	$ 1,007,060.05
Bore and Place 2 - 1.25" SDR 11 HDPE Duct	$ 47.06	201,412.01		$ 9,479,140.35	-		$ -	$ (9,479,140.35)
Place 24"x36"x24" handhole with gravel and soil removal	$ 955.98	77.00		$ 73,610.15	77.00		$ 73,610.15	$ -
Total				**$9,991,977.04**			**$ 1,519,896.74**	**$ (8,472,080.30)**

If the County placed shadow conduit while this project is underway, the estimated capital costs are $1.519 Million. As a new build, the estimated capital costs are $9.991 Million, resulting in a savings of $8.472 Million.

Some of the capital improvement routes parallel the multi-use project. Depending upon timing of these projects, portions of the routes could be eliminated for areas where the paths parallel each other.

Having County-owned conduit throughout much of the County can be leveraged to connect County facilities and key anchor institutions, as well as for use by the service providers to expand their services throughout the County. The County could recover its capital costs for shadow conduit by selling dark fiber leases to private providers. This is discussed below.

Build the Backbone Fiber, and Connect County Facilities and Anchor Institutions

The projected capital costs for El Dorado County to build for building the backbone fiber and connecting county facilities are shown below.

Middle Mile Capital Costs		
Description	**Estimated Capital Costs**	
Backbone Build	$	35,734,166
County Laterals	$	19,196,598
County Connections	$	1,973,356
Water Tank Laterals	$	7,067,788
Water Tank Connections	$	279,395
Airport Lateral	$	2,276,990
Airport Connection	$	53,730
Subtotal	**$**	**66,582,023**
Add Ons		
Hospitals	$	119,566
Subtotal	**$**	**119,566**

The costs for these potential builds may be shared amongst key stakeholders. For example, for much of the backbone build, Caltrans is planning to connect traffic lights with fiber. Much of these costs may be drastically reduced or shared. Also, much of the backbone route and laterals to the County facilities follow the CVIN fiber routes.

NEO and County staff are meeting with Caltrans, CVIN and other potential partners to discuss collaboration efforts the week of June 25, 2018.

CVIN, for example has 38.4 miles of existing fiber that could potentially be leased, resulting in approximately $11.1 Million in cost savings.

The County could potentially provide dark fiber leases or an Indefeasible Right of Use (IRU) to recover some of the capital costs to build these routes. Dark fiber is optical fiber infrastructure that is currently in place or has been constructed; but is not being used. Optical fiber conveys information in the form of light pulses so the "dark" means no light pulses are being sent. To the extent that these installations are unused, they are described as dark. Another way of describing dark fiber is the fiber is not “lit” with equipment on each end point. Equipment or data switches “light” or activate the fiber connection. Dark fiber leases usually do not include having the service provider include the cost for the equipment; the customer typically provides this equipment

An Indefeasible Right of Use (IRU) is the effective long-term lease (or often thought of as temporary ownership) of a portion of the capacity of fiber optic cable.

In structuring the IRU agreement, the owner of the network is the Grantor. The Grantor pays for the construction of the network. The Grantor then assigns parts of the constructed network to the Grantee for use of the dark fiber, and a select amount of bandwidth or capacity on the network between termination points or routes along the constructed network.

An IRU combines features of a sale, a lease, and a service contract. Every IRU is unique, but typically the agreement confers exclusive usage rights to Grantee, but title and control remain with the Grantor. In drafting an agreement, consideration should be given to the risk of bankruptcy of either party. Secured transactions or security leases, if correctly structured, may be exempt from Section 365 Bankruptcy Code. It is recommended to consult with an attorney regarding treatment of the IRU, the term of the agreement, and what happens at the end of the agreement in terms of a purchase option or conveyance of property rights. Consideration should also be given to the ability to assign and the right of access; in most IRU agreements, the ability to assign use to another is prohibited.

Based upon the range of dark fiber leases between $50 - $100 per month per fiber, here is the potential revenue that could be generated on the backbone and county lateral routes.

El Dorado County Dark Fiber Lease Considerations							
Route	**Miles**	**Fiber Count**	**Dark Fiber Lease**	**Monthly Revenue**	**Capital Costs**	**Time to Breakeven (Months)**	**Time to Breakeven (Years)**
Backbone Build	129.29	48	$50	$310,288	$ 35,734,166	115	9.60
County Laterals	69.44	48	$50	$166,666	$ 19,196,598	115	9.60
Route	**Miles**	**Fiber Count**	**Dark Fiber Lease**	**Monthly Revenue**	**Capital Costs**	**Time to Breakeven (Months)**	**Time to Breakeven (Years)**
Backbone Build	129.29	48	$75	$465,444	$ 35,734,166	77	6.40
County Laterals	69.44	48	$75	$249,984	$ 19,196,598	77	6.40
Route	**Miles**	**Fiber Count**	**Dark Fiber Lease**	**Monthly Revenue**	**Capital Costs**	**Time to Breakeven (Months)**	**Time to Breakeven (Years)**
Backbone Build	129.29	48	$100	$620,592	$ 35,734,166	58	4.80
County Laterals	69.44	48	$100	$333,312	$ 19,196,598	58	4.80

An Indefeasible Right of Use (IRU) would yield the following revenue potential:

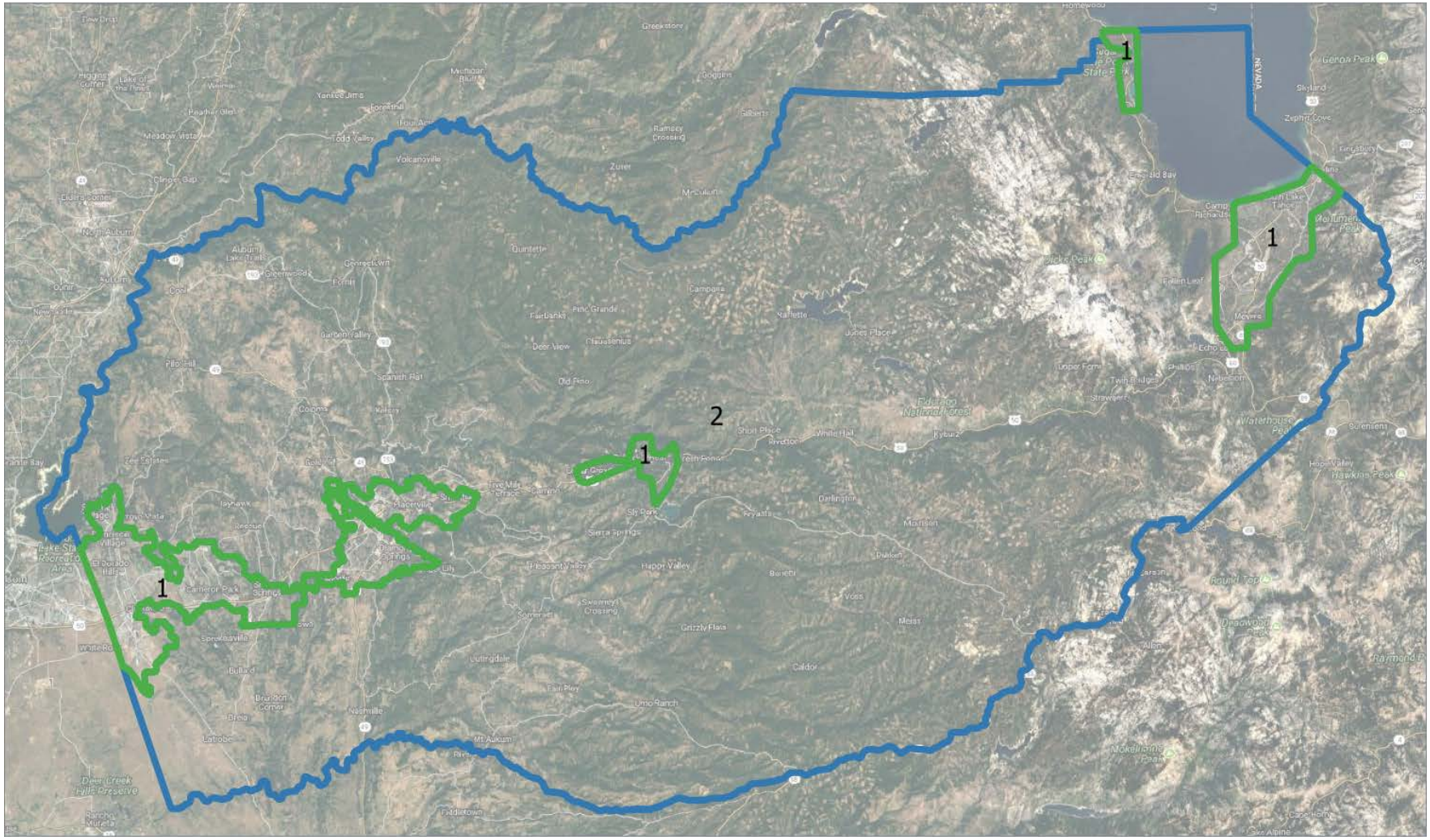
El Dorado County Indefeasible Right of Use (IRU) Considerations						
Route	**Miles**	**Fiber Count**	**Cost per Fiber Mile**	**One time Payment**	**Capital Costs**	**# of IRUs**
Backbone Build	129.29	6	$3,000	$2,327,220	$ 35,734,166	15
County Laterals	69.44	6	$3,000	$1,249,920	$ 19,196,598	15
Route	**Miles**	**Fiber Count**	**Cost per Fiber Mile**	**One time Payment**	**Capital Costs**	**# of IRUs**
Backbone Build	129.29	6	$3,800	$2,947,812	$ 35,734,166	12
County Laterals	69.44	6	$3,800	$1,583,232	$ 19,196,598	12
Route	**Miles**	**Fiber Count**	**Cost per Fiber Mile**	**One time Payment**	**Capital Costs**	**# of IRUs**
Backbone Build	129.29	6	$4,200	$3,258,108	$ 35,734,166	11
County Laterals	69.44	6	$4,200	$1,749,888	$ 19,196,598	11

IRU s are typically in multiples of (6) counts of fiber. For example, a cellular company might purchase an IRU of 48 counts of fiber on the backbone build. In this case, the one time payment would be 129.29 miles * 48 fiber counts * $3800/fiber mile = $23,693,760. It is possible, therefore, to receive a return on investment for building the middle mile routes within the County.

Pursuing a Gigabit Strategy, Building Fiber to the Homes/Businesses and Premises

Most Fiber-to-the-Premise network use a Gigabit Passive Optical Network (GPON) architecture with active connections to large businesses, mission critical or government locations. Active or passive simply refers to powered electronics in the field. In other words, with a passive architecture, there are no electronics located between the network operations center and the home.

Capital costs will increase when the market share or take rate percentage increases. Below are the projected capital costs with various take rate percentages. Phase 1 includes building Fiber to the Premise (FTTP) to the main cities and towns within the County.


1
1
1
2
1

Phase 1, FTTP	Take Rate	10%	20%	30%	40%	50%	60%
Overall	Project Cost	$ 66,223,982	$ 73,847,565	$ 81,471,147	$ 89,093,158	$ 96,716,741	$ 104,340,323
	Cost per HHP	$ 1,256	$ 1,401	$ 1,546	$ 1,690	$ 1,835	$ 1,980
	Cost per HHS	$ 12,564	$ 7,005	$ 5,152	$ 4,226	$ 3,670	$ 3,299
	Cost per MI	$ 92,029	$ 102,623	$ 113,217	$ 123,809	$ 134,403	$ 144,998
Phase 1, FTTP	**Take Rate**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**
Engr. Labor	Project Cost	$ 5,640,854	$ 5,640,854	$ 5,640,854	$ 5,640,854	$ 5,640,854	$ 5,640,854
Aerial Labor	Project Cost	$ 7,169,519	$ 7,169,519	$ 7,169,519	$ 7,169,519	$ 7,169,519	$ 7,169,519
UG Labor	Project Cost	$ 24,370,894	$ 24,370,894	$ 24,370,894	$ 24,370,894	$ 24,370,894	$ 24,370,894
OSP Materials	Project Cost	15317500	15532919	15748338	15963757	16179176	16394595
Tech Services Labor	Project Cost	$ 6,288,449	$ 6,288,449	$ 6,288,449	$ 6,288,449	$ 6,288,449	$ 6,288,449
Totals		$ 58,787,214	$ 59,002,634	$ 59,218,053	$ 59,433,472	$ 59,648,891	$ 59,864,310
Customer Premise Labor and Install Materials including Splitters	Project Cost	$ 6,981,143	$ 13,961,146	$ 20,941,149	$ 27,920,911	$ 34,900,915	$ 41,880,918
Electronics	Project Cost	$ 455,626	$ 883,785	$ 1,311,945	$ 1,738,775	$ 2,166,935	$ 2,595,094
Overall	Project Cost	$ 66,223,982	$ 73,847,565	$ 81,471,147	$ 89,093,158	$ 96,716,741	$ 104,340,323

A substantial part of this build is the backbone routes through the County. The capital costs shown above for FTTP include a portion of the backbone route.

The capital costs of building FTTP for Phase 2, which includes the homes and businesses in less dense areas of the county, is shown below.

Phase 2, FTTP	Take Rate	10%	20%	30%	40%	50%	60%
Overall	Project Cost	$ 109,359,571	$ 114,621,272	$ 119,881,644	$ 125,148,788	$ 130,392,828	$ 135,654,543
	Cost per HHP	$ 2,976	$ 3,119	$ 3,262	$ 3,405	$ 3,548	$ 3,691
	Cost per HHS	$ 29,756	$ 15,594	$ 10,873	$ 8,513	$ 7,096	$ 6,152
	Cost per MI	$ 56,881	$ 59,618	$ 62,354	$ 65,094	$ 67,821	$ 70,558
Phase 2, FTTP	**Take Rate**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**
Engr. Labor	Project Cost	$ 8,355,963	$ 8,355,963	$ 8,355,963	$ 8,355,963	$ 8,355,963	$ 8,355,963
Aerial Labor	Project Cost	$ 21,819,327	$ 21,819,327	$ 21,819,327	$ 21,819,327	$ 21,819,327	$ 21,819,327
UG Labor	Project Cost	$ 41,820,861	$ 41,820,861	$ 41,820,861	$ 41,820,861	$ 41,820,861	$ 41,820,861
OSP Materials	Project Cost	$ 27,846,550	$ 27,996,750	$ 28,146,951	$ 28,297,152	$ 28,447,353	$ 28,597,554
Tech Services Labor	Project Cost	$ 4,386,259	$ 4,386,259	$ 4,386,259	$ 4,386,259	$ 4,386,259	$ 4,386,259
Total		$ 104,228,959	$ 104,379,160	$ 104,529,361	$ 104,679,562	$ 104,829,763	$ 104,979,964
Customer Premise Labor and Install Materials including Splitters	Project Cost	$ 4,812,094	$ 9,621,690	$ 14,431,286	$ 19,242,227	$ 24,050,442	$ 28,860,051
Electronics	Project Cost	$ 318,517	$ 620,422	$ 920,997	$ 1,226,999	$ 1,512,624	$ 1,814,528
Overall	Project Cost	$ 109,359,571	$ 114,621,272	$ 119,881,644	$ 125,148,788	$ 130,392,828	$ 135,654,543

Direction from the County has been to investigate potential public-private partnership models with service providers such that the County does not need to become an Internet Service Provider. These discussions are underway as of the date of this report. As the capital costs and financial risk is high for building fiber to homes and businesses, NEO and County staff recommending further investigation into various strategies and models for implementing this approach.

If a public-private partnership can be reached, the County may share in the capital costs of the FTTP build. For example, the County might build and own the fiber network, for Phase 1, paying for the Engineering Labor, Aerial Labor, Underground Labor (UG), the Outside Plant Materials (OSP), and the Technical Services Labor. The range of capital costs are $58 - $59 Million. The private provider might pay for the Customer Premise Labor and Installation and the Electronics. A revenue share would be paid to the County to cover debt for the fiber. Financial models will be discussed in the companion report.

A Quick Lesson in Broadband, Speeds and Technologies Available

Before we go much farther, it may be helpful to include a quick lesson on broadband, speeds and broadband technologies. The following section is a reference for understanding the "basics" about broadband.

Speeds

There is much debate occurring in the U.S. on how to properly define "broadband". Prior to February 2015, the Federal Communications Commission (FCC) defined broadband as having the ability to download 4 Mbps of data and upload 1 Mbps of data. In February of 2015, the FCC increased the definition of broadband by raising the minimum download speeds needed from 4 Mbps to 25 Mbps and the minimum upload speed from 1 Mbps to 3 Mbps[1]. The current definition of broadband can be supported by a number of technologies – including wireless, cable modem, DSL, and fiber optic technologies.

Although the current FCC definition for broadband is 25 Mbps download and 3 Mbps in upload speeds, it should be noted that broadband demand and consumption of broadband is growing very rapidly every year. The gold standard for bandwidth capability is quickly becoming offering Gigabit services or speeds that support 1,000 Mbps in both download and upload speeds. Fiber optic networks or more specifically, building fiber directly to homes and businesses is the predominant way to achieve Gigabit download and upload speeds. This is referred to in the industry as "Fiber to the Premise," or "Fiber to the Home," or "Fiber to the Business."

Many of the cable networks are being upgraded to a technology called DOCSIS 3.1, which will support Gigabit levels in download speeds by not in upload speeds.

There have been dramatic improvements in wireless technologies and although we are now seeing the ability for wireless to support Gigabit speeds, the wireless access points need to be fed with fiber and have a Gigabit reach of less than 500 feet. Gigabit players, Google Fiber and AT&T have announced plans to trial Gigabit wireless services in select markets in the U.S. for serving homes and businesses but are not yet commercially available. Siklu is a company that is currently providing wireless equipment that supports Gigabit capacity; again, wireless access points need to be fed with fiber.

Why do we Care about Upload Speeds?

Incumbent providers typically advertise one number – their download speeds. But upload speeds are very important too. Put simply, upload speeds represent the amount of data that can

[1] *2016 Broadband Progress Report*, Federal Communications Commission, https://apps.fcc.gov/edocs_public/attachmatch/FCC-16-6A1.pdf.

be shared or sent in a given second. Upload speeds are important for content creators – people who create and send pictures, files, engineering drawings, videos, and the like.

Many applications require fast download and upload speeds. Online, real-time games, Voice over IP (phone calls using the internet), interactive web videos and/or web conferences require constant and fast two-way communications. Without fast upload speeds, video and voice services are stuttered or every third or fourth word is heard. If a business is running any of its own servers -- such as a Web, game, or email server -- available upload bandwidth will limit performance for people trying to access the information on the server.

Therefore, having fast upload speeds reflects a business' ability to create and share their content. Upload speeds have a great impact on economic development and business creation.

Description of Broadband Technologies

Below is a brief description of the various technologies used in broadband deployment:

DSL (Digital Subscriber Line) uses existing copper phone lines to deliver download and upload broadband speeds typically of 1.5 Mbps to 7 Mbps. DSL speeds diminishes as distance increases from the telephone company's central office. Homes or businesses located more than three miles from the central office will not receive as fast of speeds. There have been many improvements to DSL technologies to improve the speed available. In general, most forms of DSL service improvements support up to 10 Mbps. VDSL (Very High Bit Rate Digital Subscriber Line) can support up to 30 Mbps, but most Internet service providers do not support this type of service, including providers in the region.

Cable modem service uses coaxial cables already installed by the cable TV operators to provide broadband service. Most cable networks support speeds comparable to DSL. Cable operators are upgrading their cable networks by installing fiber optic cable closer to neighborhoods. These network improvements allow cable modem service to be able to support up to 30 Mbps. This connection type is a shared service, meaning, as more people are on the network within a neighborhood, the speed available to each customer diminishes. As discussed above, many cable companies are upgrading their cable networks to DOCSIS 3.1 which supports Gigabit speeds in download capabilities, but not upload capabilities.

Fiber optic technology converts electrical signals carrying data to light and sends the light through glass fibers about the diameter of a human hair. Fiber transmits data at speeds far exceeding current DSL or cable modem speeds, typically by tens or even hundreds of Mbps. Fiber is the best way to provide abundant broadband, but it often is the most capital-intensive to build. As fiber optic technology transmit pulses of light, more bandwidth can be delivered on a fiber optic network by adding various colors of light or additional spectrum. Fiber is unique because it can carry high bandwidth signals over long distances without signal or

bandwidth degradation and it can provide that capacity in both directions – for both upload and downloading information.

Wireless broadband connects a home or business to the Internet using a radio link between the customer's location and the service provider's facility. Wireless technologies using longer-range directional equipment provide broadband service in remote or sparsely populated areas where DSL or cable modem service would be costly to provide or fiber network installations may be too capital intensive.

Wireless broadband can be mobile or fixed. Wireless speeds are generally comparable to DSL and cable modem. Wireless services can be offered using both licensed spectrum and unlicensed devices. Wi-Fi networks typically use unlicensed spectrum. Wi-Fi networks use wireless technology from a fixed point and often require direct line-of-sight between the wireless transmitter and receiver. Wi-Fi networks can be designed for private access within a home or business or be used for public Internet access at "hot spots" such as restaurants, coffee shops, hotels, airports, convention centers, and city parks. Using licensed spectrum, greater amounts of bandwidth can be delivered and often do not require direct line-of-sight.

In some communities, especially sparse, geographically diverse rural communities, small providers build out a wireless solution since wireless infrastructure is not as capital-intensive as building out a fiber optic infrastructure. While wireless technology does have its limitations, needing to be designed to get around "line of sight' requirements as well as to support "shared" bandwidth on the network, smart engineering can deliver good connectivity.

Cellular 4G and LTE. Cellular service is often referred to as wireless service and it can be confused with Wi-Fi. Cellular and Wi-Fi are both wireless systems, meaning both use radio frequencies to transmit and receive data. But Wi-Fi has a radio transmitter and receiver that operates only at a range of 200 feet or so. The range of cellular is measured in miles. Wi-Fi's transmitter and receiver is called an access point. It is mounted in the corner of a room, or on a lamp post, or in a hotel lobby. A cellular transmitter and receiver is called a cell site, or a base station and can transmit for miles.

"4G" refers to the fourth-generation technology for data transmission over a cellular network. It can support greater data speeds than most public Wi-Fi networks and is used primarily when a customer is out of the range of a Wi-Fi network. LTE, which stands for "Long Term Evolution," is the fastest, most consistent variety of 4G.

"5G" cellular service is the fifth and latest generation for data transmission over a cellular network. 5G supports higher amounts of bandwidth, but in order to support 5G capabilities, more small cell sites need to be deployed because the bandwidth can only be sustained for short distances.

To date, the cellular companies have charged for data usage either by the amount of data used or with a flat fee for unlimited data use.

Cell sites need to be connected with fiber in order to support high bandwidth speeds.

Wireless Local Area Networks (WLANs) provide wireless broadband access over shorter distances and are often used to extend the reach of a "last-mile" wireline or fixed wireless broadband connection within a home, building, or campus environment. An in-home Wi-Fi network is a WLAN – it does not use spectrum, rather it sends radio waves at a limited range. Mobile wireless broadband services are also becoming available from mobile telephone service providers. These services are generally appropriate for highly-mobile customers and require a special wireless card with a built-in antenna that plugs into a user's laptop computer. Generally, they provide lower speeds, in the range of several hundred Kbps.

Satellite broadband is another form of wireless broadband and is useful for serving remote or sparsely populated areas. Typically, a consumer can expect to receive (download) at a speed of about 500 Kbps and send (upload) at a speed of about 80 Kbps. These speeds are slower than DSL and cable modem, but they are about 10 times faster than the download speed with dial-up Internet access. Service can be disrupted in extreme weather conditions and are typically oversubscribed.

With the tremendous growth in broadband demand, plans for long-term implementation of infrastructure must take into consideration the need for more fiber networks to be deployed and expanded.

Section 2 – "Why"

This section provides answers to many of the "why" questions. It addresses why having abundant and affordable broadband services is important, why local governments are investigating building broadband infrastructure for their communities, and what El Dorado citizens are saying regarding their current services. This section also details the current assessment and findings regarding what existing services and infrastructure are available today. The current assessment provides information regarding identified gaps in availability of broadband service and what the incumbent providers, Comcast and AT&T are offering within the study area.

Why is this Important and Why are Local governments Looking into Improving Broadband?

Having access to very high-speed broadband and Internet services has become one of the most critical components for education, government services, economic development, healthcare, utility operations, first responders and business operations. The demand for more bandwidth continues to grow. By 2021, there will be over 30 billion devices connected by the Internet of Things (IoT). Each person will have over 13 connected devices on average, including their cell phones, tablets, clothing, and their cars. The global Internet traffic continues to explode. In 1992, global Internet traffic per ***day*** was 100 Gigabits. In 2016, the global Internet traffic per ***second*** was 26,600 Gigabits. It is projected that global Internet use will continue to expand dramatically.

Global Internet Traffic	
1992	100 GB per DAY
1997	100 GB per HOUR
2002	100 GB per SECOND
2007	2,000 GB per SECOND
2016	26,600 GB per SECOND
2021	105,800 GB per SECOND

Internet, data and cellular growth will continue to double in bandwidth every one to two years. Although some of the existing Internet Service Providers (ISP) have invested in their networks to keep up with demand, the majority of networks built by cable and phone companies are maxed out. As the Internet drives all things regarding economic development and vitality, simply put, connectivity is essential.

Coupled with the ever-growing importance of the Internet, the convergence of new smart city applications, traffic management needs, the growth of and application for small cellular site installation and the soon-coming

implementation of self-driving vehicles, local governments are seeking strategies to facilitate and coordinate investment.

Recently, the FCC overturned Net Neutrality rules that govern the availability and access to content and bandwidth. These rules prevented ISP's from blocking certain types of content or placing specific websites or applications in preferential "fast lanes." The FCC's overturning these rules could help the large or incumbent providers stifle the ability of smaller internet companies to compete. Some critics of FCC's decision worry that the large ISPs will begin prioritizing certain websites, applications, content and services over others, either by charging customers to access that content or charging Internet companies to access customers. Internet websites could be "packaged" or "channelized" similar to the way cable companies provide a roster of channels and programming.

Many local governments are implementing locally-run Internet services as a way of ensuring their citizens and businesses are not impacted by the overturning of Net Neutrality rules. These local governments are stating that the Internet would remain open and equitable, serving as a countermeasure to corporations potentially taking over the Internet.

Another reason why local governments invest in broadband infrastructure is to address the availability of advanced broadband services throughout the entire city or town boundary. In many instances, the incumbent cable and phone companies have invested in some part of the municipality, but much of the community does not have adequate services. Local governments invest to ensure that all citizens and businesses have access to advanced broadband services at affordable prices and that no one is left out of participating in the digital economy.

Municipal and County facilitation can take the form of implementing broadband friendly policies and ordinances to reduce the cost of implementation by the private sector, to investing and implementing fiber for government applications and to key anchor institutions, to entering into a public-private partnership to promote a ubiquitous Gigabit strategy, to a full-blown implementation and operations of a municipally-owned Internet Service Provider.

Considerations that impact a local government's broadband strategy and involvement include the level or amount of municipal investment, examination of models and approaches implemented by other communities, exploration of how networks are typically implemented, constructed and operated, as well as exploration of public-private partnership models that are emerging in the industry and possible financing strategies for implementation.

What do Local Survey Data Show about El Dorado County?

The Tahoe Prosperity Center has conducted a survey of broadband users as part of its Connected Tahoe Project. Survey participants were asked questions concerning service levels, technology, and user experience. Roughly 63% of respondents identified Spectrum/Charter as their ISP (Internet Service Provider), while 23% subscribed to AT&T. In terms of service speeds,

participants were asked to identify whether or not they have access to the CPUC-defined, broadband minimum speed of 6 Mbps download, and 1.5 Mbps upload, and over 70% confirmed that they do. It should be noted however, that the FCC defines broadband as 25 Mbps download/3 Mbps upload, roughly 2-4 times the minimum speed used as a benchmark in this survey.

The survey results also provide insight into available technologies and user-experience. 80% of respondents subscribe to either DSL or Cable-based services, while only 9% rely on a wireless service or their cell phone for connection. This aligns closely with the 86% of users subscribing to the Spectrum/Charter and AT&T wireline services (DSL or cable). Nearly 72% of respondents work from home or run their business from home, and 64% use the internet to complete school or job training course work. Predictably, when asked what they would like to do online, that they can't do now, two of the top three responses included, "work from home" and "transmit large data files." The remaining response was "stream movies/television."

Nearly 72% of survey respondents work from home or run their business from home. More than 64% use the internet to complete school or job training course work.

Concerning user satisfaction, the results were clear. Participants were asked questions relating directly to satisfaction including, "Are you satisfied with your current internet service?" Thirty-nine percent (39%) of respondents were either very dissatisfied (lowest satisfaction), or quite dissatisfied. On the other end of the range, only 14% described their feelings as quite satisfied or very satisfied (highest satisfaction). And the largest group of respondents 46% responded simply 'It's okay.' when describing their broadband service. A second question asked respondents to address their satisfaction level with particular aspects of their broadband including, the quality of speed, quality of technical support, quality of service, provider choice, and monthly costs. Across all responses for quality of speed, 38% were either very, or quite dissatisfied. 45% described their service as "Okay", and only 17% reported a positive level of satisfaction.

The greatest levels of dissatisfaction surrounded the lack of choice when choosing an ISP. Less than 8% of all respondents reported that they are satisfied with available choices, and fully 80% indicated that they are dissatisfied with current service offerings in El Dorado County. This question is closely connected with the inquiry as to whether respondents would be willing to pay more for higher quality services. Sixteen percent (16%) agreed that they would pay more.

Current Assessment, Existing Services and Gaps

Although the survey results provide a good summary of the current providers in the market, a number of entities collect and map broadband availability by state in the U.S.

The **FCC** collects information from facilities-based Internet providers – providers that own their own network facilities. Facilities-based providers include telephone companies, cable system operators, wireless, satellite service providers and other facilities-based providers of advanced telecommunications capability. All facilities-based providers are required to file data with the FCC twice a year (Form 477) regarding where they offer Internet access service at speeds exceeding 200 kbps in at least one direction.[2]

Additionally, the National Telecommunications and Information Administration (NTIA), through the **Broadband USA Mapping Tool,** collects broadband datasets to be included in NTIA's National Broadband Map. This effort was started in 2009 and was kept updated through June 30, 2014 and is no longer being updated. The Federal Communications Commission (FCC) sought funding for Fiscal Year 2016 to continue to maintain and update the National Broadband Map, but this request was not granted.

BroadbandNow is a website that summarizes datasets provided by NTIA, the FCC and other sources regarding broadband availability, speeds, government spending and pricing information.

The **California Public Utilities Commission (CPUC)** also maps broadband services available within the State.

Local Research - Providers, Services, & Pricing

Although wireline services are available along the densely populated sections of the Highway 50 Corridor, many of the rural areas in the County rely heavily on fixed wireless and satellite broadband services. Many wireless providers in rural California however, do not deliver even the FCC defined, minimum broadband speeds, according to the National Broadband Map. Moreover, reliability is the larger issue for most wireless and satellite subscribers, as these technologies are heavily impacted by geography and/or weather issues throughout the County.

Although wireline services are available along the densely populated sections of Highway 50, many of the rural areas in the County rely heavily on fixed wireless and satellite broadband services.

[2] *FCC mapping data on Form 477 is reported on a census-block basis rather than based upon whether or not service is available at a particular home, business or other location within the census-block.*

Wireline broadband services available in the County consist of DSL and Cable-based services. Existing Fiber Optic services are provisioned by AT&T and Consolidated Communications and connect less than 5% of the households in the City of El Dorado Hills only. DSL services are delivered by AT&T County-wide, while Cable services are provided by Spectrum/Charter in the Tahoe Basin, and by Xfinity in Placerville and points West. Residential speed tests aggregated by the Tahoe Prosperity Center in 2017 show available wireline services in the County delivering an average of 38.77 Mbps download and 10.09 Mbps upload. Approximately 60% of the speed tests met the FCC definition for broadband – 25 Mbps download/3 Mbps upload. Pricing for internet services starts around $40-50.00/month, with data-caps, and with possible additional installation fees.

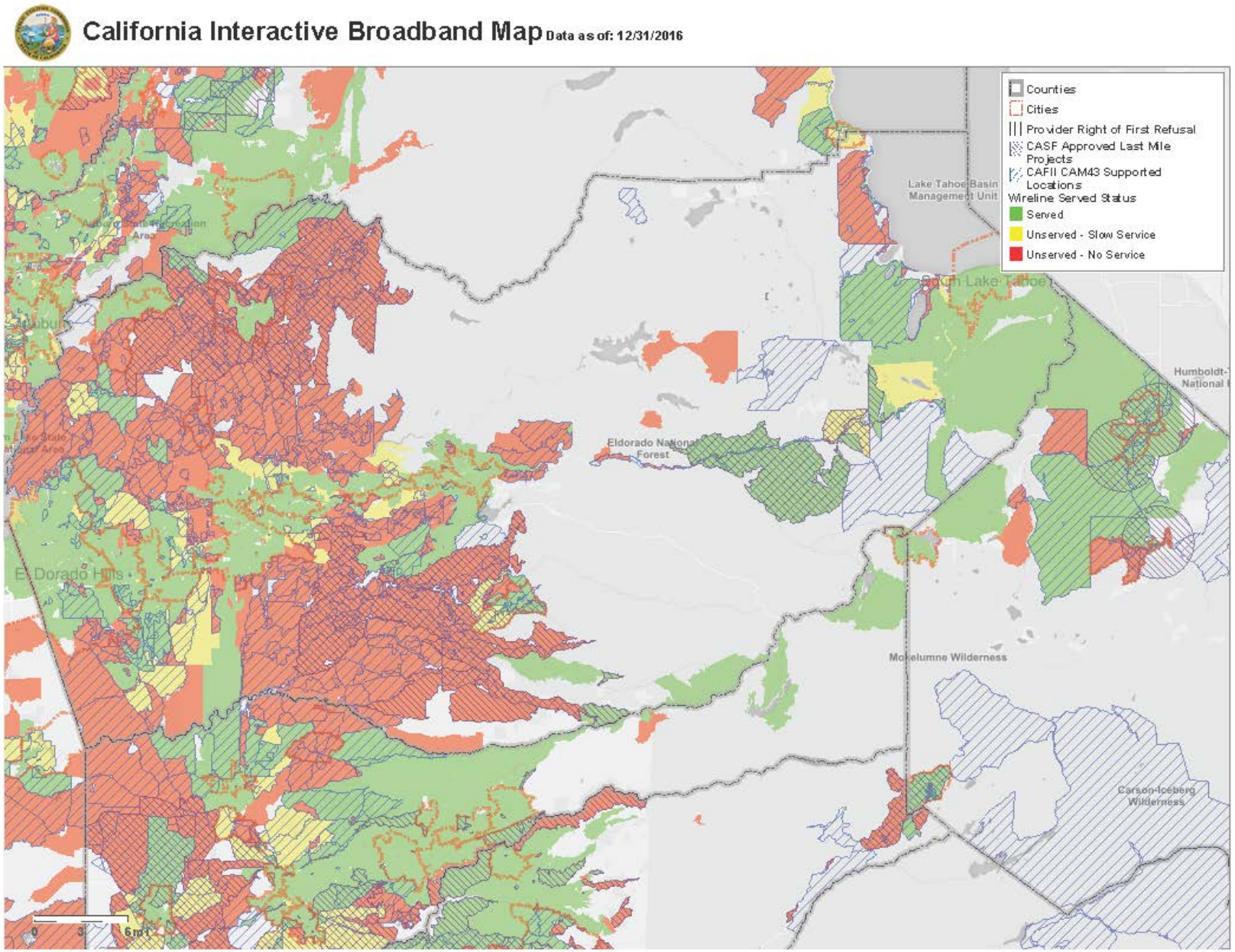
Wireless broadband services are available throughout the County in the form of fixed-wireless and satellite services. Compared to wireline broadband services, fixed wireless networks typically provide lower capacity connections, that are much more sensitive to network capacity and geographical constraints such as terrain, buildings, and foliage. Fixed wireless providers include Cal.net, RemotelyLocated.com, and RockyRidge.net. Only two of these providers advertise services that meet the FCC broadband, minimum guidelines. These service packages are priced between $150-200.00/month, with installation charges starting around $200.00 for a basic install, and additional work billed hourly.

Satellite broadband services are offered by Hughes.net and ViaSat, but can be significantly limited by geographical constraints, bad weather, and data caps. Pricing for 25 Mbps/3 Mbps packages start around $65.00/month with modem and include a 10Gb data allowance. Additional data allowance plans, and overage charges can quickly add costs that become prohibitive for the average household with children, or homeworker.

Broadband Mapping, Served and Unserved Areas.

The California Public Utilities Commission defines “served” as having access to 6 Mbps in download speeds and 1 Mbps in upload speeds. The FCC defines broadband as having a minimum of 25 Mbps in download and 3 Mbps in upload speeds. This is a very low bar. The Fiber to the Premise network design is capable of delivering 1000 Mbps in download and 1000 Mbps in upload speeds.

Below is the map of unserved areas of the County according to the CPUC. A substantial portion of the County is unserved; meaning no service is available. If the Fiber to the Premise map of Phase 1 and Phase 2 was overlapped with the following map; areas that are unserved would be shown as Phase 2.


California Interactive Broadband Map
Data as of: 12/31/2016
Counties
Cities
Provider Right of First Refusal
CASF Approved Last Mile Projects
CAFII CAM43 Supported Locations
Wireline Served Status
Served
Unserved - Slow Service
Unserved - No Service
Lake Tahoe Basin Management Unit
Eldorado National Forest
El Dorado Hills
Mokelumne Wilderness
Carson-Iceberg Wilderness
Humboldt-
0
3
6mi

The maps are notorious for being inaccurate because they are self-reported by the various services providers and because the maps depict ***advertised speeds*** by census block. Service providers may offer advertised speeds to one address within the census block; however, not all addresses may be able to receive that level of service. This causes the reported services to be inflated compared to what services are actually available at an address. Additionally, as more households use the network at the same time, during peak times of internet use, the network slows down because of network congestion. This network congestion occurs with most non-fiber broadband technologies.

According to the CPUC, of the 70,769 households in El Dorado County, 92.9% or 65,725 households have access to 6/1 Mbps. 1.7% or 1,180 households are unserved with slow service (speeds less than 6/1 Mbps) and 3,864 households or 5.5% have no service at all.

Broadband Now shows that 76.9% of the County has access to a minimum of 25 Mbps, 75% have access to 100 Mbps and .2% have Gigabit or 1,000 Mbps of service.

The CPUC has designated the following priority areas for potential funding through the California Advanced Service Fund in El Dorado County:

	Description
49	Coloma
46	Garden Valley (and Pilot Hill, Cool, Greenwood, Georgetown)
45	Greenwood (and Pilot Hill, Cool, Georgetown, Garden Valley)
50	Latrobe (and Shingle Springs)
47	Pilot Hill (and Cool, Georgetown, Garden Valley, Greenwood)
48	Pleasant Valley (and Chrome Ridge)
51	Rescue
183	West Shore

NEO's team is putting together Fiber to the Premise estimates for these priority areas and will provide the capital costs in the companion report.

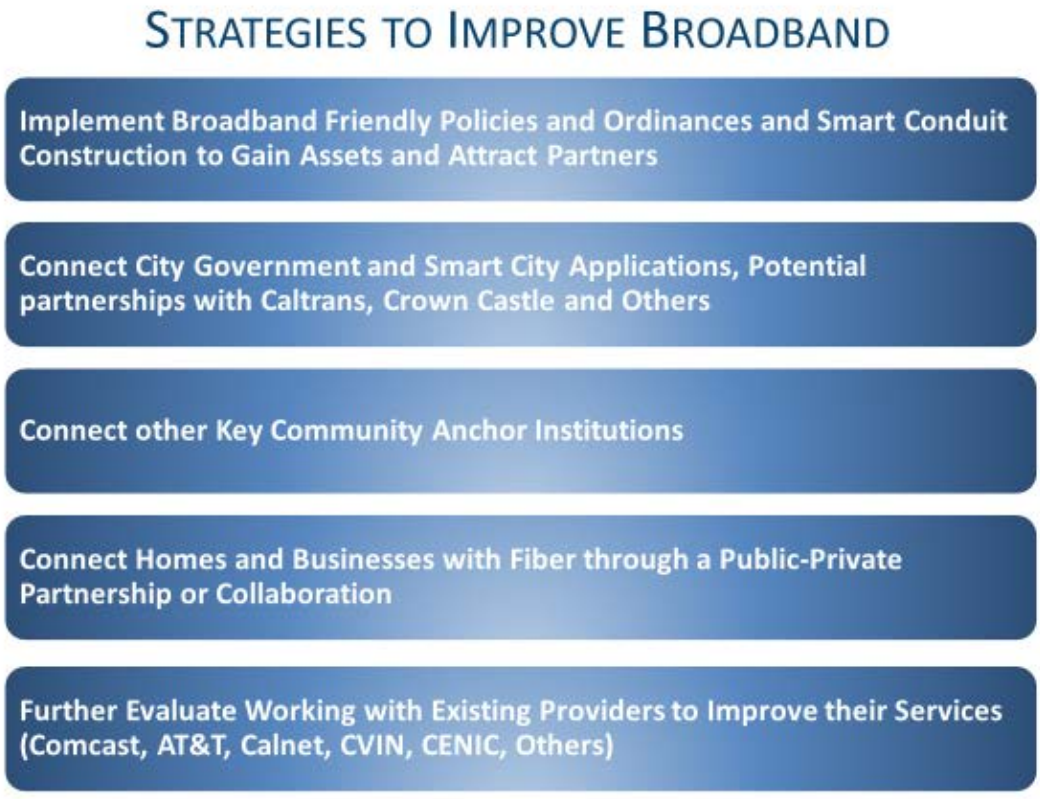
Section 3 – "What"

The following section describes "what" to consider. This section discusses what levels of investment may be required to upgrade the existing infrastructure to support a variety of broadband, cellular backhaul, smart city and e-government applications. It provides a detailed analysis of several levels of broadband infrastructure investment and what each level of investment may cost. This section also discusses the considerations to implement a Gigabit broadband strategy or connecting homes and businesses with fiber, the estimated capital costs for doing so and what other local governments have done or are considering doing for implementation of a Gigabit broadband strategy. This section discusses several types of public private partnership models and examples of other local governments that have implemented them.

Best Practices and Levels of Investment

Local governments are considering various approaches to prepare for future capacity and to facilitate better broadband services for their communities. These approaches and various levels of investment are discussed in detail below and examples of what other cities and local governments are doing are provided within each consideration for investment.

In summary, here are the various strategies that are considered within this plan.



The first three recommendations will facilitate and lower the costs for broadband implementation and lay the foundation for improving broadband infrastructure within the County, regardless of whether the County decides to move forward with a Gigabit broadband strategy to connecting homes and businesses, or not.

Connecting county government locations (water monitoring systems, public safety and other government buildings), smart city applications (traffic lights and parking meters) and key community anchor institutions (i.e. hospitals, libraries, and universities) with fiber will greatly enhance communications and broadband speeds for these locations, while dramatically reducing communications costs. While these key facilities are being connected with fiber, the County will gain more fiber assets that can be leveraged for building out to neighborhoods to connect homes and businesses with fiber. Implementing a shadow conduit/dig once policy will allow the County to facilitate further broadband development by reducing the costs of broadband expansion, by levering existing public works or construction by other entities.

All of these first three approaches will improve communications for applications that will be needed regardless of whether or how the County moves forward with a more ubiquitous Gigabit broadband strategy. Additionally, these strategies will lower the overall cost of further expansion and will provide assets (conduit and fiber) for the County to use as leverage to potentially negotiate a public-private partnership for further expansion.

NEO and staff recommend that investigation into how to implement a ubiquitous Gigabit broadband strategy for homes and businesses be further evaluated. This would include weighing the pros and cons of various public-private partnership models or providing broadband services directly to citizens and businesses or working with the incumbent providers Comcast and AT&T to improve their availability of Gigabit broadband services.

The companion report will provide the financial implications and considerations for implementation of connecting homes and businesses with fiber. Financial models for public-private partnerships or for the County to offer broadband services directly to citizens and businesses will be provided.

Implement Broadband Friendly Policies and Ordinances and Smart Conduit Construction to Gain Assets and Attract Partners

Often a local government does not have the capital to invest in a comprehensive broadband network, but it will have the ability to provide in-kind contributions, tax and other economic incentives, use of existing assets, and to enact policies and ordinances that are broadband-friendly. All of these strategies have the effect of lowering the cost for a private carrier to deploy a fiber or wireless network within a community, with little to no investment directly from the municipality.

Policies and Ordinances

Local governments have the power to significantly reduce the capital costs of broadband infrastructure deployment by implementing policies and ordinances that are broadband-friendly. NEO has provided a white paper describing in detail these recommended policies to El Dorado County staff. These recommendations include implementation of a Dig Once Policy, Shadow Conduit Requirements, Joint Trench and Joint Build Agreements, Abandoned Fiber and Conduit Policy, Land Use Policies for New Developments, Streamlined Permitting Processes, and One-Touch Make Ready Requirements.

These policies can be implemented to facilitate investment from the private sector and can also be used to gain substantial assets owned by El Dorado County that can be leveraged for future broadband deployment.

Other municipal facilitation to encourage and support investment could include removing roadblocks and creating efficiencies that a private company cannot achieve on its own.

Use of Existing Assets. Existing assets can include tower facilities, water towers, land, rights of way, existing conduit and existing fiber. Sixty to eighty percent of a fiber optic network's capital costs are in opening a trench or in burying conduit that will house fiber optic cable. Using existing conduit therefore, substantially reduces the capital costs of network deployment. If a municipality has existing conduit or fiber, these assets can be leveraged to entice further deployment of investment by the private sector. New networks can and are built on the foundation a community's already existing fiber and/or conduit as well as available land.

Economic Incentives. Economic incentives as well as logistic assistance from a city can help pave the way for more powerful broadband service. Most tax incentives are implemented at the State-level, but the City could influence the State's consideration of providing tax incentives in the form of accelerated depreciation, reduced property taxes and reduced sales taxes.

Establishing broadband friendly policies and ordinances will cost El Dorado County very little to implement, except potentially administrative and legal costs. Sample policies and ordinances that have been adopted by other local governments have been provided to County staff by NEO Connect.

These policies can be implemented to facilitate investment from the private sector and can also be used to gain substantial assets owned by El Dorado County that can be leveraged for future broadband deployment.

Smart Conduit Construction to Gain Assets and Attract Partners

Giving access to existing conduit owned by El Dorado County can be leveraged to attract potential partners that may be willing to deploy an all-fiber network. El Dorado has a relatively small amount of conduit already installed within the community; however, given the interest in

new construction within each of the communities, the County should implement a shadow conduit policy that requires installation of additional conduit whenever work is being done within the right of way. By creating and implementing a shadow conduit policy, the County will gain additional conduit that can be used to leverage further investment.

This strategy could also be used as leverage if the municipality chooses to pursue a strategy to work with the incumbent providers to offer ubiquitous Gigabit broadband services. The municipality can gain conduit assets that may be used at a later time if the County decides to become an infrastructure provider for broadband services or if the County decides to enter into a public private partnership with one or many other internet service providers. Either way, the costs for building new conduit and fiber would be greatly reduced and this could be used as leverage with the incumbent providers. If the incumbent providers do not build out, or if net neutrality rules are not followed, or for whatever reason the County needs to pivot on working with the incumbent providers, the County could more easily do so with existing assets that could be used for fiber construction.

There are hundreds of examples of local governments that are using smart conduit construction to gain assets and attract potential partners. In Centennial, CO, the City began a fiber optic and conduit initiative in 2008 as a public works effort connecting city buildings, traffic signals and other public facilities. The City implemented a dig once policy that required additional conduit be installed when work was being done in the right of way. To date, the City has installed more than 60 miles of conduit and fiber optic infrastructure suitable for broadband deployment while spending less than $600,000. This network is currently valued well over $6 Million. The City recently engaged in a formal process to incent providers to deploy a Gigabit-enabled fiber network to every home and business within the city limits. The City announced an agreement with Ting, where Ting would be able to use existing conduit and fiber to roll out its Gigabit services to the community.

As the community of Mesa, Arizona, began to grow, community leaders recognized that telecommunications would be a key element to its success. Mesa was an early adopter of "dig once" policy, placing conduit whenever streets were excavated for any other infrastructure purpose. Mesa has also taken advantage of non-traditional existing infrastructure, planting fiber in abandoned conduit that had been used for other utility purposes. This resulted in a network of 150 - 200 miles of fiber throughout the community. The investment has paid off in a number of ways over time and helped the city establish a broadband-friendly environment for economic development, allowing private sector companies to use the existing conduit and fiber to reduce their overall costs of infrastructure deployment.

Bozeman, MT invested in multi-duct conduits, making it possible for nonprofit Bozeman Fiber, who leases the conduit, to reach more residences and businesses with service. Lincoln, Nebraska invested $700,000 to install a conduit system in 2012. Since then, their conduit network has grown to more than 300 miles and has served as a key component to attracting

multiple (six) private carrier providers who lease the conduit, helping to pay off the initial investment.

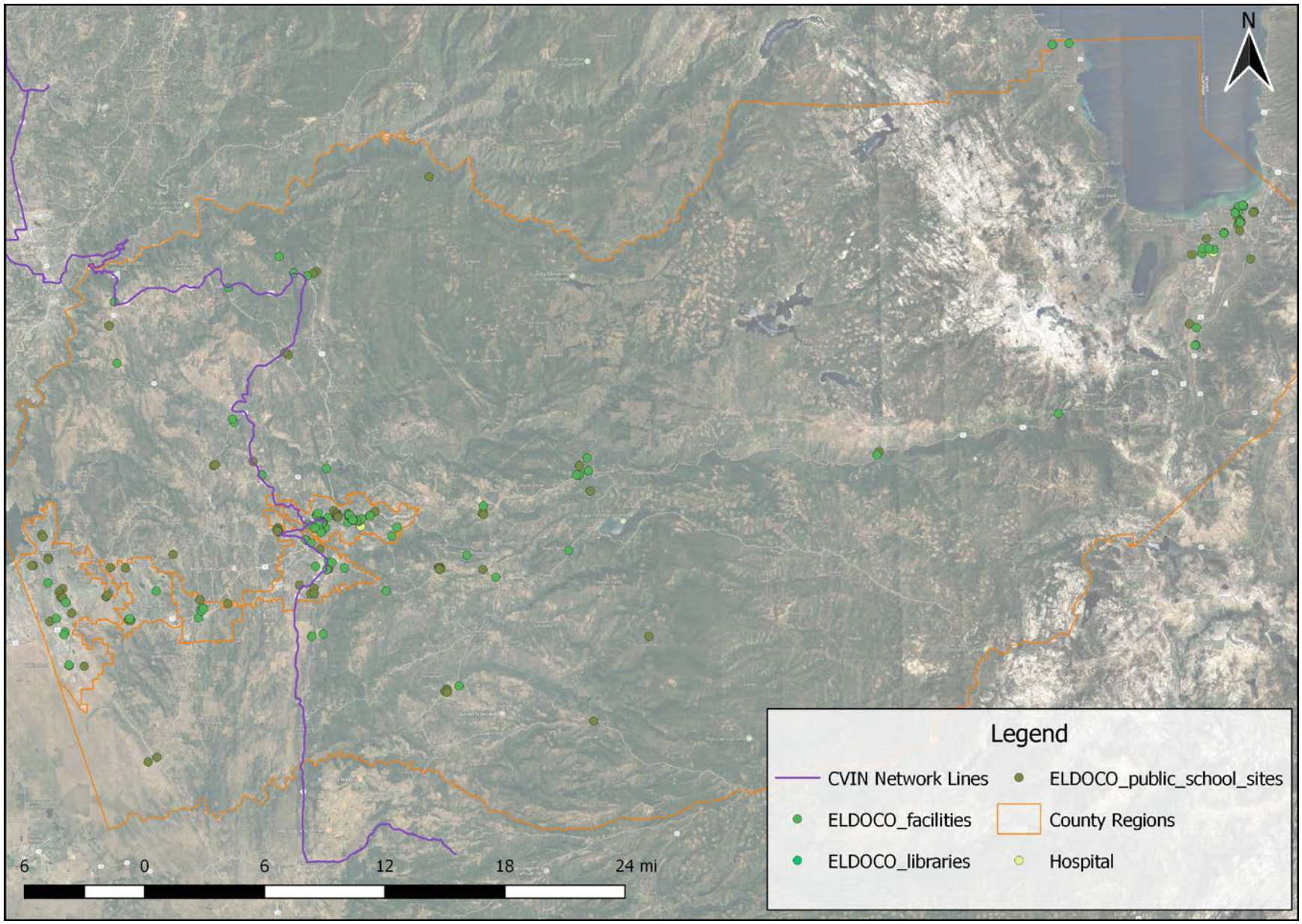
Financial Implication to El Dorado County: $3.00 - $6.50 per foot vs. $30 - $35 per foot in cost. Resulting in $28.50 per foot in cost savings

Putting in shadow conduit when work is being done in the right of ways would cost the City the incremental costs of the conduit (estimated at $1.50 - $3.50 per foot) plus the incremental cost for construction (estimated at $1.50 – 3.00 per foot). Consequently, if El Dorado County were to build conduit when trenches are not open, or when work is not being done in the right of way, costs for conduit material and labor would be approximately $30 - $35.00 per foot.

Typically, shadow conduit represents 1-2% of a road improvement's total project budget.

El Dorado County's website lists several Capital Improvement Projects (CIP). Traffic lights were identified as needing fiber connectivity for better traffic management and Caltrans is investigating installing fiber along the Highway 50 corridor. NEO's team is meeting with Caltrans and County staff the week of June 25th, 2018 to better understand the possibility of collaboration to build fiber along this route.

Central Valley Independent Network (CVIN) was awarded grant money during the American Recovery and Reinvestment Act, i.e. the Stimulus Program, to build a fiber backbone connecting schools, libraries and community colleges throughout the central valley of California. Below is a map of CVIN's network, along with County facilities, hospital, anchor institutions and traffic lights in El Dorado County.


N
Legend
CVIN Network Lines
ELDOCO_public_school_sites
ELDOCO_facilities
County Regions
ELDOCO_libraries
Hospital
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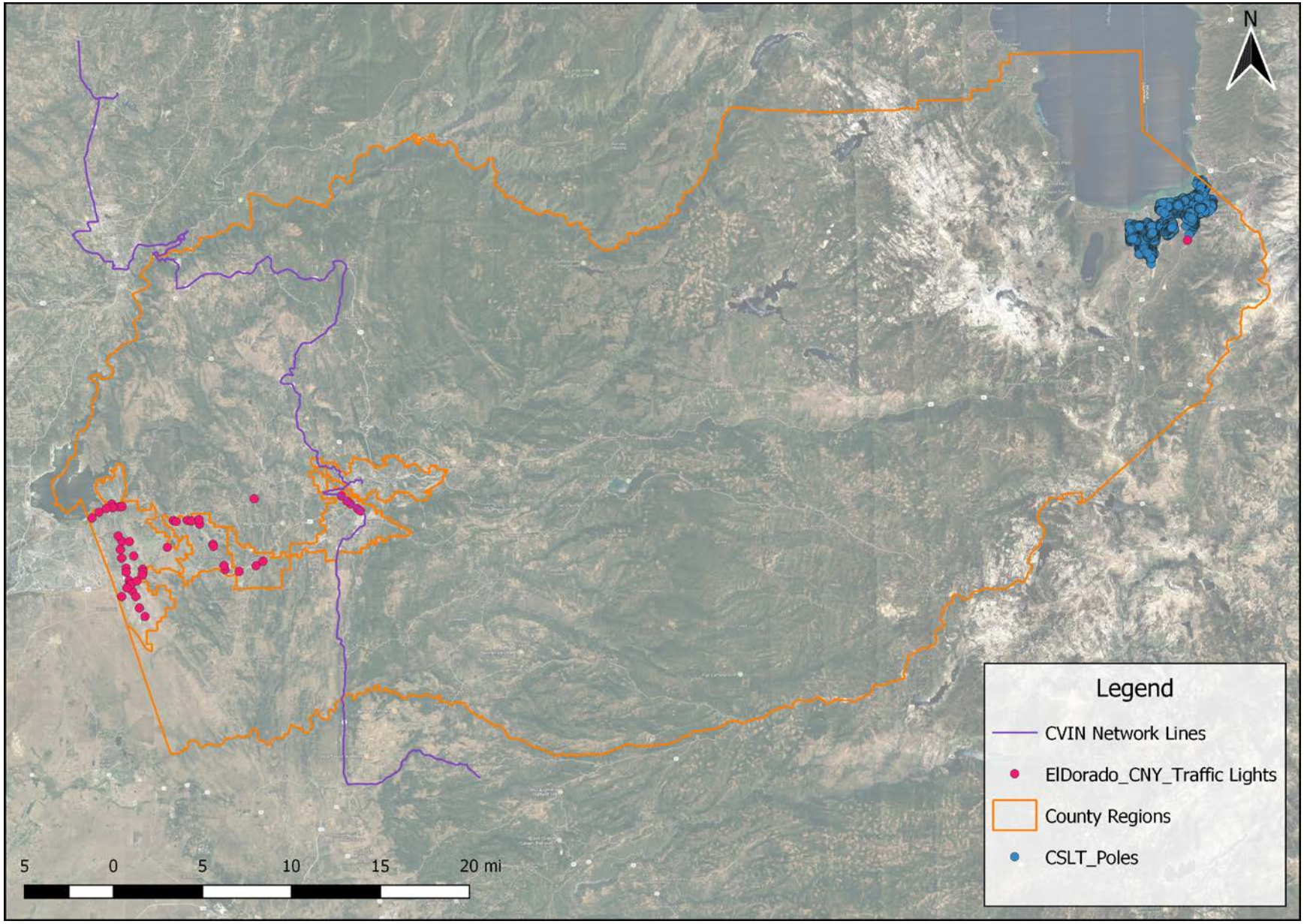
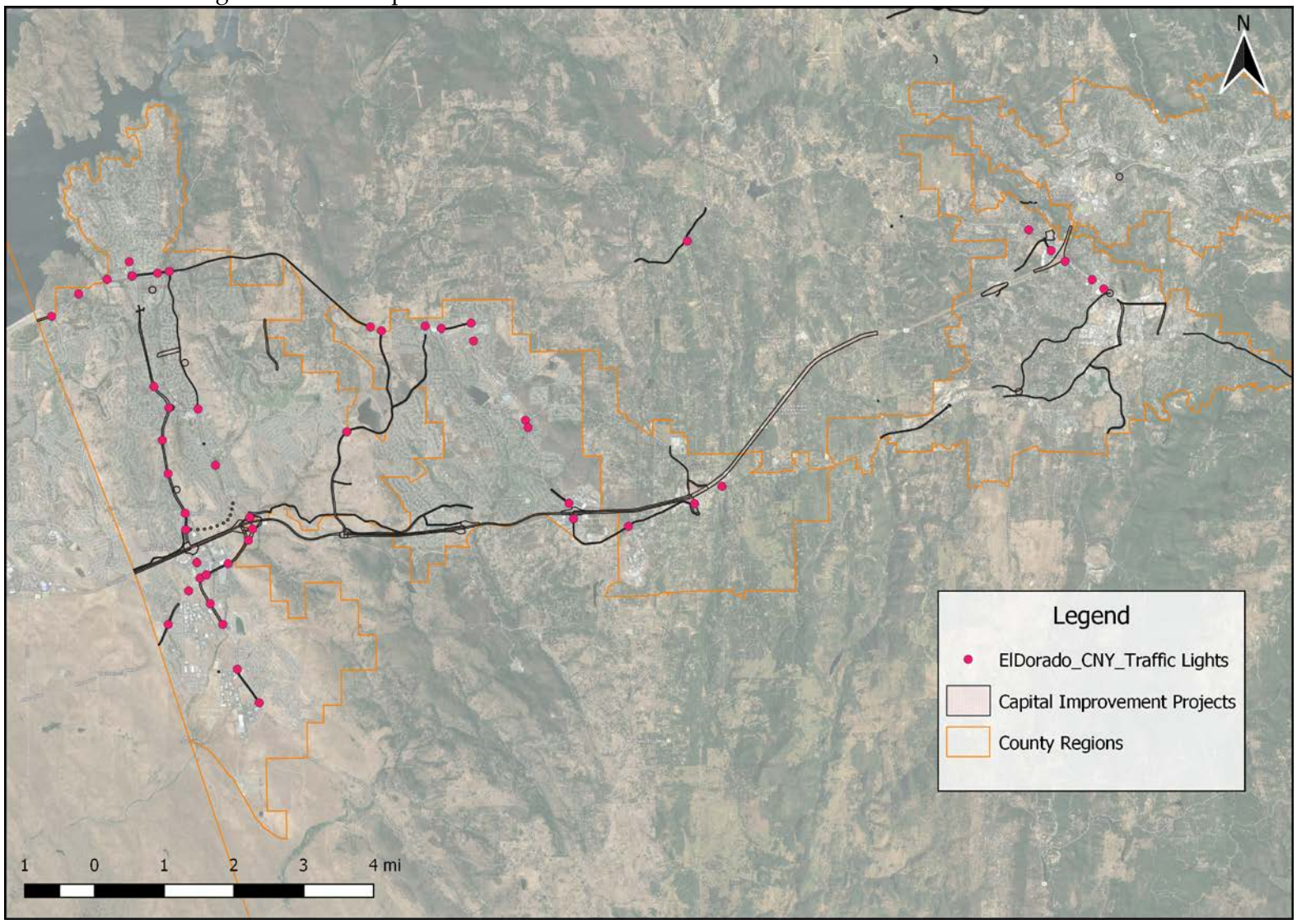
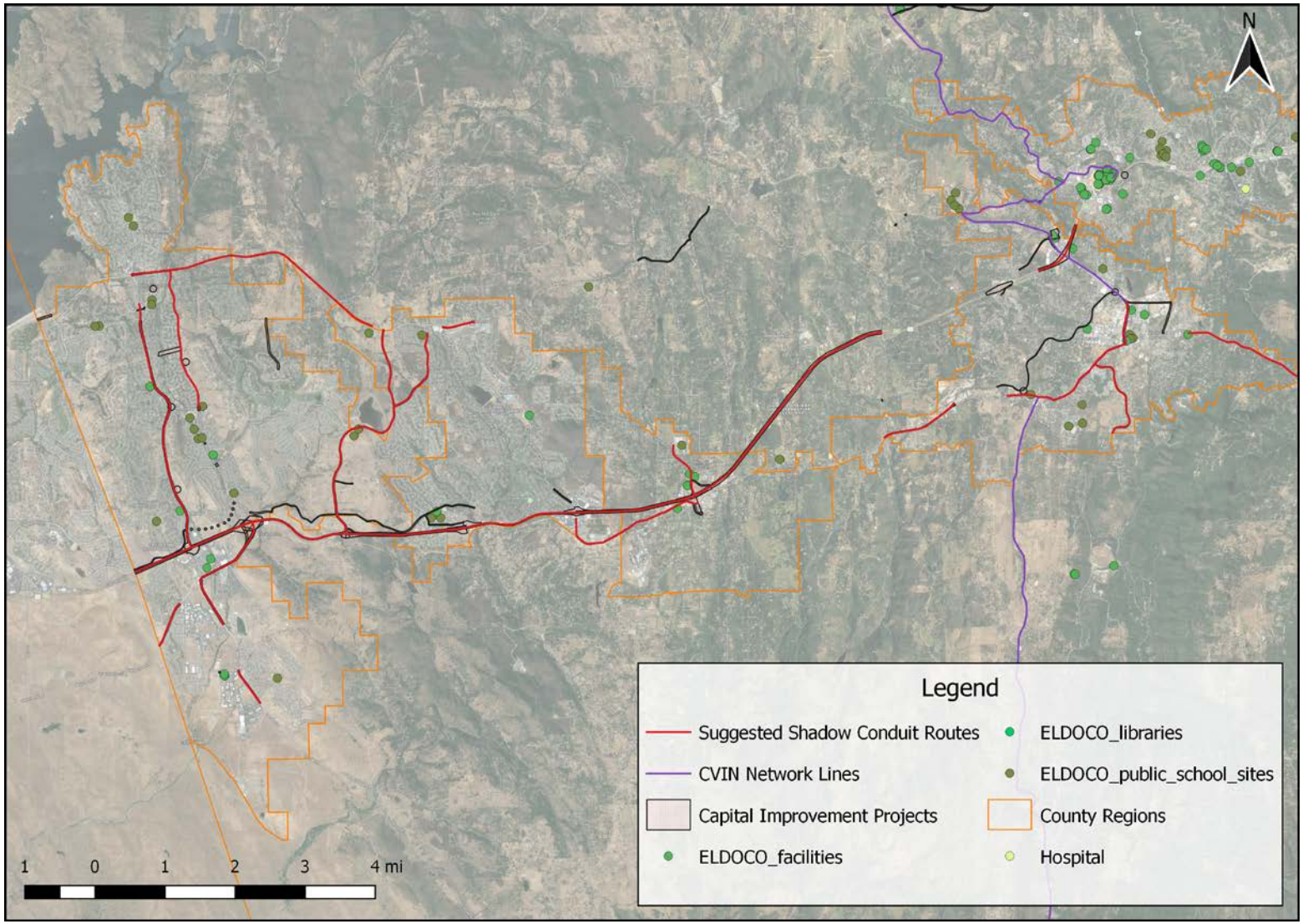

N
Legend
CVIN Network Lines
ElDorado_CNY_Traffic Lights
County Regions
CSLT_Poles
5 0 5 10 15 20 mi

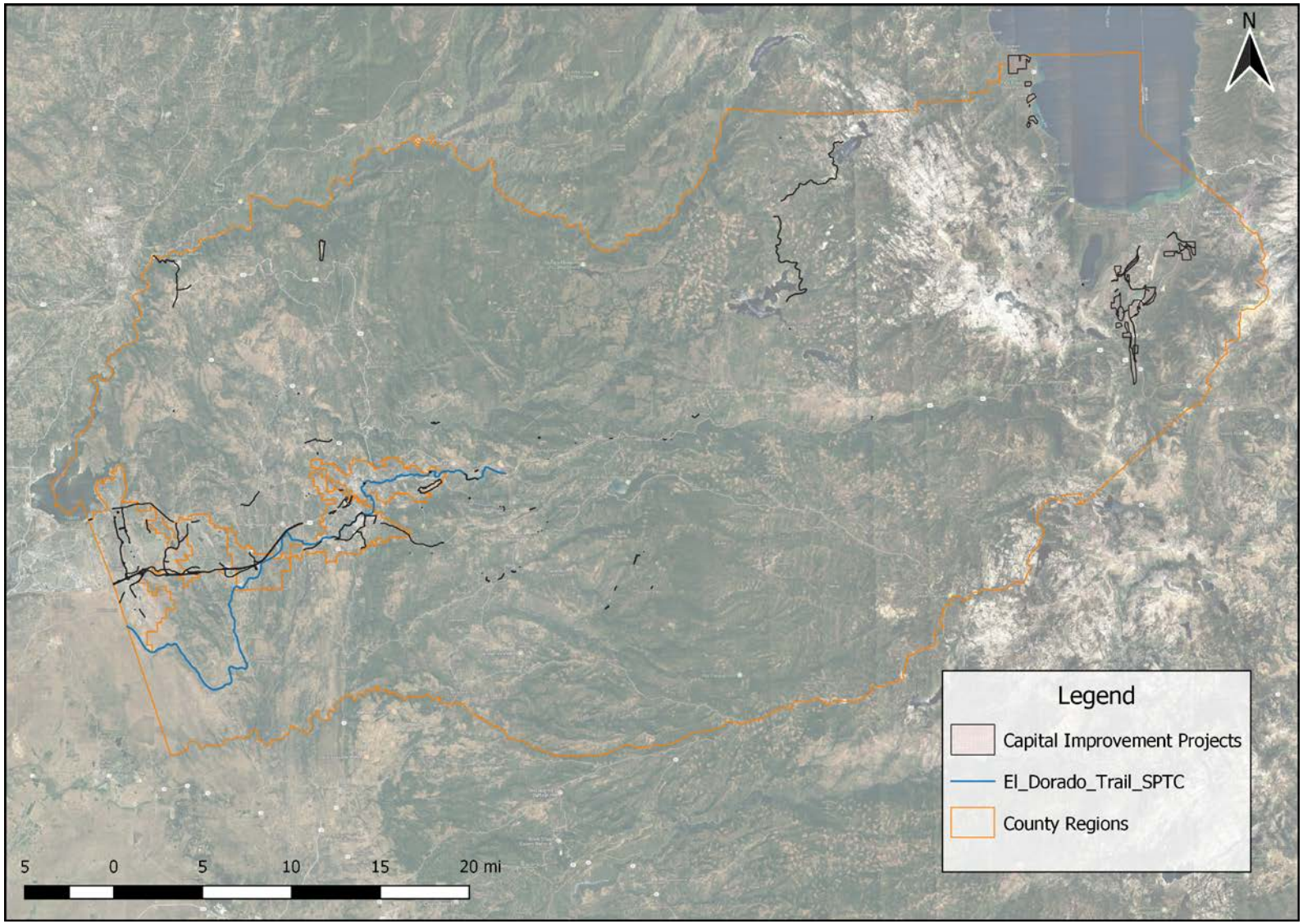
Below is a map of the traffic lights on the western part of El Dorado County and the potential capital improvement projects to connect the traffic lights with fiber optic cable.



Shadow conduit could be placed while these capital improvement projects are underway. Below is a map of the suggested shadow conduit routes.



Along with the above capital improvement projects, there is a multi-use corridor project planned (shown in blue). Below is a map of the capital improvement projects and the multi-use corridor project.



Below are the potential capital costs of implementing a shadow conduit policy versus the costs to build fiber as a new project or a new build.

El Dorado County
Cost Proposal, Shadow Conduit vs. New Build

Description	Unit Rate	Capital Improvement Project New Build			Capital Improvement Project Joint New Build			Capital Improvements New Build Cost Difference
		Quantity		Subtotal	Quantity		Subtotal	
Engineering Capital Improvement Project New Build	$ 0.31	281,789.66	FT	$ 87,221.94	281,789.66	FT	$ 87,221.94	$ -
Construction Management and As-Builts Capital Improvement Project New Build	$ 0.72	281,789.66	FT	$ 201,623.10	281,789.66	FT	$ 201,623.10	$ -
Materials								
1.25" SDR 11 HDPE Duct	$ 0.46	619,937.25	FT	$ 284,469.65	619,937.25	FT	$ 284,469.65	$ -
24"x36"x24" Polycrete Handhole with 1 Piece 20K Lid	$ 382.39	107.00	EA	$ 40,915.77	107.00	EA	$ 40,915.77	$ -
Labor								
Joint build construction	$ 5.00	-	FT	$ -	281,789.66	FT	$ 1,408,948.30	$ 1,408,948.30
Bore and Place 2 - 1.25" SDR 11 HDPE Duct	$ 47.06	281,789.66	FT	$13,261,988.38	-	FT	$ -	$ (13,261,988.38)
Place 24"x36"x24" handhole with gravel and soil removal	$ 955.98	107.00	EA	$ 102,289.43	107.00	EA	$ 102,289.43	$ -
Total				**$13,978,508.27**			**$ 2,125,468.19**	**$ (11,853,040.08)**

These costs were based upon the project lists that were shown on the County's website. NEO's team has asked the County to verify the timing of these projects and the validity of placing conduit when these projects are underway. If the County placed shadow conduit during these capital improvement projects, the estimated capital costs are $2.125 Million. Alternatively, if the fiber is built as a new project, the capital costs would be $13.978 Million, resulting in an $11.853 Million savings.

Additionally, there is a multi-use project slated for the County. Below are the potential capital costs of implementing a shadow conduit when the multi-use/trail project is underway.

El Dorado County
Cost Proposal, Shadow Conduit vs. New Build

Description	Unit Rate	Trail System New Build Quantity		Trail System New Build Subtotal	Trail System Joint New Build Quantity		Trail System Joint New Build Subtotal	Trail Systems New Build Cost Difference
Engineering Capital Improvement Project New Build	$ 0.31	201,412.01	FT	$ 62,342.77	201,412.01	FT	$ 62,342.77	$ -
Construction Management and As-Builts Capital Improvement Project New Build	$ 0.72	201,412.01	FT	$ 144,112.15	201,412.01	FT	$ 144,112.15	$ -
Materials								
1.25" SDR 11 HDPE Duct	$ 0.46	443,106.42		$ 203,327.56	443,106.42		$ 203,327.56	$ -
24"x36"x24" Polycrete Handhole with 1 Piece 20K Lid	$ 382.39	77.00		$ 29,444.06	77.00		$ 29,444.06	$ -
Labor								
Joint build construction	$ 5.00	-		$ -	201,412.01		$ 1,007,060.05	$ 1,007,060.05
Bore and Place 2 - 1.25" SDR 11 HDPE Duct	$ 47.06	201,412.01		$ 9,479,140.35	-		$ -	$ (9,479,140.35)
Place 24"x36"x24" handhole with gravel and soil removal	$ 955.98	77.00		$ 73,610.15	77.00		$ 73,610.15	$ -
Total				**$9,991,977.04**			**$ 1,519,896.74**	**$ (8,472,080.30)**

If the County placed shadow conduit while this project is underway, the estimated capital costs are $1.519 Million. As a new build, the estimated capital costs are $9.991 Million, resulting in a savings of $8.472 Million.

Some of the capital improvement routes parallel the multi-use project. Depending upon timing of these projects, portions of the routes could be eliminated for areas where the paths parallel each other.

Having County-owned conduit throughout much of the County can be leveraged to connect County facilities and key anchor institutions, as well as for use by the service providers to expand their services throughout the County. The County could recover its capital costs for shadow conduit by selling dark fiber leases to private providers.

Connect County Government Facilities, Smart City (i.e. County) Applications

Another level of investment may be for the County to connect their government facilities, and their smart city applications. Smart city applications may include connecting traffic lights, traffic management, and smart journey planning. Smart journey planning systems use open city data in order to recommend how individuals can best navigate from one place to the next. The systems are becoming sophisticated enough to take into consideration personal preferences such as cost, safety concerns and CO2 footprint, as well as real-time traffic congestion and traffic patterns.

Other smart city applications may include connecting smart parking meters, automated meter reading and utilities management. Street lights are often connected with fiber and applications are emerging that allow active safety; increasing light levels in city centers when the light system detects individuals or motion, at bus stops or along walkways.

Another top smart city application is environmental monitoring, where a local government that uses monitoring stations for pollution or weather conditions can now connect and use these systems for real time data collection and can pinpoint potential sources of pollution or weather issues and quickly react and efficiently deal with potential problems.

Other smart city applications are emerging around transport sharing, whether it is sharing bikes or cars or rideshare. Smart cars and electric cars will be a key enabler for wider adoption of city center car sharing, providing information to individuals about location and availability of shared cars and up-to-date information of pick up times for rideshare applications.

Connecting County Facilities with Fiber

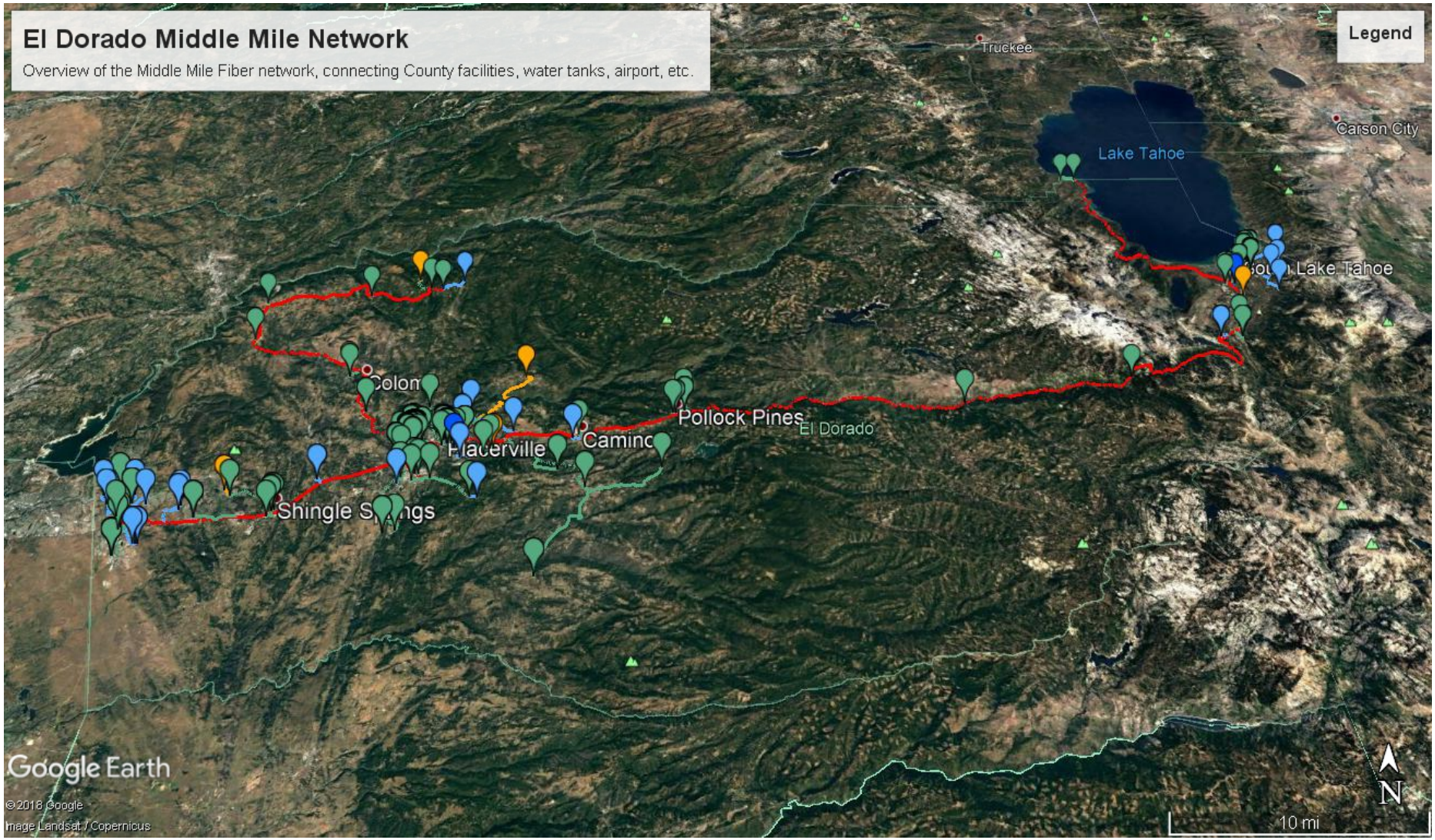
A design to connect the County government locations with fiber was conducted. Here is a list of the key anchor institutions that were included within the design:

Middle Mile Capital Costs	
Description	**Estimated Capital**
Backbone Build	$ 35,734,166
County Laterals	$ 19,196,598
County Connections	$ 1,973,356
Water Tank Laterals	$ 7,067,788
Water Tank Connections	$ 279,395
Airport Lateral	$ 2,276,990
Airport Connection	$ 53,730
Subtotal	**$ 66,582,023**
Add Ons	
Hospitals	$ 119,566
Subtotal	**$ 119,566**

Below is an overview map of the fiber network connecting County facilities, water tanks, airports, libraries and healthcare organizations.

The red route is the backbone network. The laterals connecting the various key anchor institutions are show in green and blue.

On the following pages are the lists of key anchor institutions that were included within the design.


El Dorado Middle Mile Network
Overview of the Middle Mile Fiber network, connecting County facilities, water tanks, airport, etc.
Legend
Truckee
Carson City
Lake Tahoe
Lake Tahoe
Pollock Pines
El Dorado
Placerville
Shingle Springs
Google Earth
© 2018 Google
Image Landsat / Copernicus
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10 mi

FIRE	EL DORADO COUNTY	OAK HILL	1834 Pleasant Valley Rd	County of El Dorado
FIRE	EL DORADO COUNTY	GOLD HILL	6051 Gold Hill Rd.	County of El Dorado
FIRE	EL DORADO COUNTY	MAIN STREET	730 Main St.	City of Placerville
FIRE	EL DORADO COUNTY	TEXAS HILL	3370 Texas Hill Rd.	County of El Dorado
FIRE	EL DORADO COUNTY	PLEASANT VALLEY	4429 Pleasant Valley Rd	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Agricultural Department	311 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Air Quality Management District - EM	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Animal Control - Placerville	511 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORADO	Animal Control - Business Office - Placerville	415 Placerville Drive, Suite N	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Airport - Placerville	3501 Airport Road	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Assessor's Office - Placerville	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Auditor - Controller's Office	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Board of Supervisors	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Chief Administrator's Office (CAO)	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Child Support Services - Placerville	3057 Briw Road, Suite B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Community Nursing - Public Health - Placervill	929 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	County Counsel	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Development Services Department - Placervill	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Building Services - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Planning Services - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	District Attorney - Placerville	515 Main Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	DOT - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Economic Development	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Elections	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORADO	Emergency Medical Services	415 Placerville Drive, Suite J	City of Placerville

COUNTY	COUNTY OF EL DORAD0	Environmental Health - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Environmental Management - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORADO	Fairgrounds	100 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORAD0	General Services - Placerville	345 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Grand Jury	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Human Resources	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Human Services - Community Services - Placer	937 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Human Services - Community Services - SLT	3368 Lake Tahoe Blvd, Suite 202	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Human Services - Placerville	3057 Briw Road, Suite A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Information Technologies	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	LAFCO	550 Main Street, Suite E	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Law Library - Placerville	550 Main Street, Suite A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Library - Placerville	345 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Mental Health - Senior Peer Conseling	935A Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORADO	Mental Health - Placerville	670 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORADO	Museum	104 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Parks & Recreation	3000 Fairlane Court	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Procurement and Contracts	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Public Defender - Placerville	630 Main Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Public Health - Placerville	931 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Public Health Prepardness	941 Spring Street, Suite 7	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Recorder - Clerk - Placerville	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Risk Management	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Sheriff's Department - Placerville	300 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Solid Waste & Hazardous Materials - EM	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Superior Court - Placerville	495 Main Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Surveyor's Office	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Treasurer / Tax Collector	360 Fair Lane, Building B	City of Placerville
COUNTY	COUNTY OF EL DORAD0	UCCE (UC Cooperative Extension)	311 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Veteran Affairs - Placerville	130 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Youth Commission	311 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Jail - Placerville - Sheriff's Department	300 Forni Road	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Chamber of Commerce - Placerville	542 Main Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Courts - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Airports, Parks & Grounds	3000 Fairlane Court, Suite 1	City of Placerville

COUNTY	COUNTY OF EL DORAD0	Facility Design & Development	3000 Fairlane Court, Suite 2	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Fleet Services	2441 Headington	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	H.E.A.R.T.	3057 Briw Road	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Housing Authority	550 Main Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Senior Day Care Center	935A Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORADO	Job One / One Stop - Placerville	4535 Missouri Flat Road, Suite A	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Juvenile Hall - Placerville	299 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Trec II School - Placerville	295 Fair Lane	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Communicable Disease - Public Health - Placer	941 Spring Street, Suite 7	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Contracts - Public Health	941 Spring Street, Suite 4	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Finance - Public Health	941 Spring Street, Suite 3	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Health Promotions - Public Health - Placerville	929 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Clinic - Public Health - Placerville	931 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Laboratory - Public Health	931 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Vital Statistics - Public Health	931 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Central Dispatch - Sheriff's Department - Pville	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Office of Emergency Servic	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	DOT - Maintenance & Operations - Placerville	2441 Headington Road	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	DOT - West Slope Construction	2441 Headington Road	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Revenue Recovery Division	330 Fair Lane, Building A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Verterans Memorial Building	130 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Human Services - IHSS Public Authority	3057 Briw Road, Suite A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	General Services - Building Mantenance	3000 Fairlane Court, Suite 3	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Superior Court - Placerville	2850 Fairlane Court, Building C	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Psychiatric Health Facility	935 Spring Street	City of Placerville
COUNTY	COUNTY OF EL DORADO	Sheriff Training Classrooms	100 Placerville Drive	City of Placerville
COUNTY	COUNTY OF EL DORADO	Mental Health - Day Treatment	2808 Mallard Ln, Ste A	City of Placerville
COUNTY	COUNTY OF EL DORAD0	DA Victim Witness/MDIC	550 Main Street, Suite E	City of Placerville
COUNTY	COUNTY OF EL DORADO	SHERIFF STAR PROGRAM	6051 Gold Hill Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORADO	Public Health Bio-Terrorism	415 Placerville Drive, Suite R	City of Placerville
COUNTY	COUNTY OF EL DORADO	Public Health Drug and Alcohol	415 Placerville Drive, Suite S	City of Placerville
COUNTY	COUNTY OF EL DORADO	Public Health Drug and Alcohol	415 Placerville Drive, Suite T	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Public Health Vital Stats	941 Spring Street, Suite 7	City of Placerville
COUNTY	COUNTY OF EL DORAD0	District Attorney - Placerville		City of Placerville
COUNTY	COUNTY OF EL DORAD0			City of Placerville

FIRE	EL DORADO COUNTY	POLLOCK PINES	6426 Pony Express Trl.	County of El Dorado
FIRE	EL DORADO COUNTY	SIERRA SPRINGS	5785 Sly Park Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	SHERIFF - OUTREACH	6430 Pony Express Trail	County of El Dorado
COUNTY	COUNTY OF EL DORADO	COMMUNITY SERVICES SENIOR MEAL SITE	5581 Gail Rd	County of El Dorado
FIRE	EL DORADO COUNTY	SHINGLE SPRINGS	3860 Ponderosa Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Animal Control - SLT	1128 Shakori Drive	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Environmental Management - SLT	3368 Lake Tahoe Blvd, Suite 303	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Vector Control - EM	1170 Rufus Allen Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Library - SLT	1000 Rufus Allen Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	Human Services - Social Services - SLT	971 Silver Dollar	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	Human Services - Protective Services - SLT	981 Silver Dollar	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Assessor's Office - SLT	3368 Lake Tahoe Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Child Support Services - SLT	3368 Lake Tahoe Blvd, Suite 100	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Community Nursing - Public Health - SLT	1360 Johnson Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Building Services - SLT	3368 Lake Tahoe Blvd, Suite 302	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Planning Services - SLT	3368 Lake Tahoe Blvd, Suite 302	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	District Attorney - SLT	1360 Johnson Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Law Library - SLT	1000 Rufus Allen Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Probation - SLT	1360 Johnson Blvd, Suite 102	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Public Defender - SLT	1360 Johnson Blvd, Suite 106	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Public Health - SLT	1360 Johnson Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Recorder - Clerk - SLT	3368 Lake Tahoe Blvd, Suite 108	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Sheriff's Department - SLT	1360 Johsnon Blvd, Suite 100	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	Superior Court - SLT	1354 Johnson Blvd, #2	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Veteran Affairs - SLT	1360 Johnson Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Jail - SLT - Sheriff's Department	1041 Al Tahoe Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	Courts - SLT	1354 Johnson Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	General Services - SLT	1051 Al Tahoe Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	Job One / One Stop - SLT	981 Silver Dollar	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Mental Health - SLT	1900 Lake Tahoe Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Juvenile Treatment Center - SLT	1041 Al Tahoe Blvd	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Communicable Disease - Public Health - SLT	1360 Johnson Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Health Promotions - Public Health - SLT	1360 Johnson Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0	Clinic - Public Health - SLT	1360 Johnson Blvd, Suite 103	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	DOT - Tahoe Engineering	924 Emerald Bay Road, Ste B	City of So. Lake Tahoe

COUNTY	COUNTY OF EL DORAD0	DOT - Maintanence & Operations - SLT	1121 Shakori Drive	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Development Services Department - SLT	3368 Lake Tahoe Blvd, Suite 302	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0			City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0			City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0			City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORAD0			City of So. Lake Tahoe
FIRE	EL DORADO COUNTY	STRAWBERRY	16201 Strawberry Ln.	County of El Dorado
COUNTY	COUNTY OF EL DORADO	DOT Snow Removal Crew	551 Mc Kinney Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	DOT Tahoma Shop	7101 Wilson Ave	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Airport - Georgetown	6245 Aerodrome Way	County of El Dorado
COUNTY	COUNTY OF EL DORADO	Planning Services - El Dorado Hills	4950 Hillsdale Circle, Suite 100	County of El Dorado
COUNTY	COUNTY OF EL DORADO	DOT - El Dorado Hills	4950 Hillsdale Circle, Suite 200	County of El Dorado
COUNTY	COUNTY OF EL DORADO	DOT - Foothill Engineering Division	4505 Golden Foothill Parkway	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Library - Cameron Park	2500 Country Club Drive	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Library - El Dorado Hills	7455 Silva Valley Parkway	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Library - Georgetown	6680 Orleans Street, Ste 3	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Library - Pollock Pines	6210 Pony Express Trail	City of Placerville
COUNTY	COUNTY OF EL DORAD0	Probation - Shingle Spring	3974 Durock Road, Suite 205	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Superior Court - Cameron Park	3321 Cameron Park Drive	County of El Dorado
COUNTY	COUNTY OF EL DORADO	Water Agency	3932 Ponderosa Road, Suite 200	County of El Dorado
COUNTY	COUNTY OF EL DORADO	Water & Power Authority	3932 Ponderosa Road, Suite 200	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	Treatment Plant - EM	5700 Union Mine Road	County of El Dorado
COUNTY	COUNTY OF EL DORADO	Alcohol & Drug Program - Public Health - SLT	1120 3rd Street	City of So. Lake Tahoe
COUNTY	COUNTY OF EL DORADO	Sheriff - Firing Range	5941 Union Mine Road	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	SHERIFF Detectives	768 Pleasant Valley Rd,	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	SHERIFF OUTREACH	3700 Fort Jim Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	SHERIFF STORAGE	3615 China Garden Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORADO	HUMAN SERVICES	5941 Union Mine Road	County of El Dorado
COUNTY	COUNTY OF EL DORADO	SHERIFF ADMIN AND FINANCE	1319 Broadway	City of Placerville
COUNTY	COUNTY OF EL DORAD0	SHERIFF ADMIN AND FINANCE	1323 Broadway	City of Placerville
COUNTY	COUNTY OF EL DORADO	SHERIFF ADMIN AND FINANCE	1337 Broadway	City of Placerville
COUNTY	COUNTY OF EL DORAD0	COMMUNITY SERVICES SENIOR MEAL SITE	4701 Missouri Flat Rd.	County of El Dorado
COUNTY	COUNTY OF EL DORAD0	PIONEER PARK	6740 FAIRPLAY RD	County of El Dorado

Libraries are highlighted above, as CVIN/CENIC may have already connected these locations with fiber.

Below are the Healthcare Locations included within the design:

OWNER_NAME	OWNER_ADDR	OWNER_CITY
BARTON MEMORIAL HOSPITAL	PO BOX 9578	SOUTH LAKE TAHOE
MARSHALL MEDICAL CENTER	PO BOX 872	PLACERVILLE
El Dorado Community Health Centers		
El Dorado County Health and Human Services	3057 Briw Ridge Ct #A	Placerville
El Dorado County Mental Health	670 Placerville Dr # 1B	Placerville
El Dorado County Behavioral Health - Outpatient Center	768 Pleasant Valley Road	Diamond Springs
El Dorado County Behavioral Health - Outpatient Center	1900 Lake Tahoe Blvd	South Lake Tahoe
El Dorado County Public Health	931 Spring Street	Placerville
	1360 Johnson Blvd., #103	South Lake Tahoe

Below is a further breakdown of these costs for each of the options listed above.

Middle Mile Capital Costs		
Description	**Estimated Capital Costs**	
Backbone Build	$	35,734,166
County Laterals	$	19,196,598
County Connections	$	1,973,356
Water Tank Laterals	$	7,067,788
Water Tank Connections	$	279,395
Airport Lateral	$	2,276,990
Airport Connection	$	53,730
Subtotal	**$**	**66,582,023**
Add Ons		
Hospitals	$	119,566
Subtotal	**$**	**119,566**

As discussed earlier in this report, a Caltrans partnership may dramatically reduce the costs for the Backbone build.

Also, CVIN has 38.4 miles of existing fiber that could potentially be leased, resulting in approximately $11.1 Million in cost savings toward the County Laterals. Detailed maps of the design have been provided to County staff to supplement this report.

Connecting other Key Community Anchor Institutions

Local governments and state agencies have been connecting their community anchor institutions with fiber optic networks for over twenty years. Community anchor institutions are state, county and local government offices and buildings, schools and libraries, hospitals, medical facilities and first responders. In fact, in the U.S., thousands of schools, libraries, community centers, and public health and safety providers obtain their broadband connectivity from local government and state non-profit networks, including state research and education networks.

Connecting these anchor institutions with fiber allows each location to receive very high-speed Internet and data connectivity while eliminating or drastically reducing the monthly lease or access costs paid to the private sector service providers. Anchor institutions often cannot afford to purchase high-capacity circuits from the private sector service providers and therefore, simply cap their bandwidth purchased. Capping their bandwidth requires the anchor institutions to choose which applications to deploy and limits their ability to use applications that require high bandwidth. Building a municipally-owned fiber network to anchor institutions allows these critical key facilities to have the bandwidth they need to support all of their applications and once these networks are in place, additional bandwidth needs can easily be met without additional capital cost for construction.

The local governments could consider connecting their community anchor institutions with fiber to ensure that they have the highest-quality broadband connectivity. This could be done in collaboration with the other agencies to share in the cost of construction. Then, once these networks are built, the County could also consider leasing excess capacity of conduit or of fiber to the private sector for last mile build out and use. Once a network is built that serves schools, government offices, fire districts and the like, generally, this network reaches deep into neighborhoods and past business parks. These networks can then serve as an opportunity to allow the private sector to lease excess capacity and in turn serve homes and businesses with high-speed fiber. This trend is fast accelerating as hundreds of local governments make available spare fiber optic capacity to private sector companies at rates designed to incentivize new private sector investment and opportunity.

Region 10 is a non-profit organization based in Montrose. Region 10 consists of six counties in western Colorado (Delta, Montrose, Hinsdale, San Miquel, Ouray and Gunnison) and the local governments located within these counties. Region 10 received grant funding for broadband implementation from the Department of Local Affairs (DOLA) to build a network connecting the communities within their region with fiber as well as their key community anchor institutions. The project has pulled in several partnerships with electric cooperatives and companies that have existing fiber in place, as well as partnerships with many of the local Internet Service Providers for collaboration. Once completed, the network will support 1 Gbps

and 10 Gbps connectivity between all points on the network, providing abundant, reliable and affordable Internet and data services throughout the region.

Connect Homes and Businesses with Fiber through a Public-Private Partnership or through offering Broadband as a Service

A community anchor institution network could be expanded to also connect key business locations, industrial parks, incubators or co-working spaces. This enables a community to target key industries and geographies for economic advancement. Having access to very high-speed Internet is the number one criteria for a business looking to relocate. The County could place various business locations on a priority list for fiber connectivity and connect these locations while building to key anchor institutions.

The most ambitious strategy for a local government to consider is the opportunity to connect all homes and businesses with fiber. More challenging geographies are sometimes forced to utilize wireless technologies to deliver service with a hybrid fiber/wireless network. Cities and Counties are building or facilitating Fiber to the Premise networks or "Gigabit-enabled" networks, allowing for Internet speeds of 1,000 Mbps or 1 Gbps in both upload and download speeds for all homes and businesses within a city's boundary.

There are a number of models to finance, design, construct and operate a Fiber to the Premise network. One of the models in the industry is when the municipality designs, builds, owns and operates a network and becomes the Internet Service Provider to homes and businesses. This model is often referred to as a Retail Model and is discussed in detail below. It is understood that El Dorado County does not desire to pursue this model, but it is discussed to show what is possible.

Another model is one in which the municipality builds and owns the fiber network and Internet services are provided directly by the private sector. This has often been referred to as a Wholesale Model, and again, is discussed in detail below.

Fiber to the Premise, Retail Model

In this model, the municipality or the County designs, builds, owns and operates the network, and essentially becomes the Internet Service Provider. An increasingly prevalent case for investing in building municipal broadband is being made by advocates defining the Internet as a "utility" and thus a necessity for the public sector to provide when otherwise unavailable.

Most local governments that have deployed a retail, Fiber to the Premise strategy have been providing electric services to their constituents. Municipal electric utilities have an easier implementation path because they already have the access to utility poles and other infrastructure, billing processes in place, customer service centers operational, and business relationships with each and every homeowner and business.

The City of Longmont's model has been discussed earlier in this report. Longmont has deployed a Gigabit fiber network and is offering Internet and voice services directly to homes and businesses. The City of Longmont's project is nationally known as a model of success. Dubbed "NextLight," this Gigabit fiber network is owned and operated by the City and its power utility, Longmont Power & Communications (LPC). Longmont opted out of Colorado's SB 152 law in November of 2011 with 60% of the vote. Two years later, Longmont voters approved a $40.3 million bond issuance to cover the startup costs and network build.

Longmont followed Google Fiber's marketing strategy by launching a pre-build sign-up campaign. The neighborhood with the most market share or "take rate" would be the first area where Longmont would build. The first neighborhood received a 72% take rate prior to construction. Longmont's 38,000 homes and businesses now have symmetrical Gigabit service for $50 per month for those who signed up early. The $50 per month is guaranteed for the lifetime of the home as well as the owner/tenant of the home if he/she moves within the City limits. Longmont's business service includes symmetrical 100 Mbps for $230 per month and symmetrical 250 Mbps service for $500 per month.

Longmont is experiencing an average take rate percentage of 56%. The initial feasibility study conducted in 2013 predicted a 27% take rate. Late in 2016, the City voted to increase LPC's budget by $7 million, sourced from the Electric and Broadband Utility Fund balance, to hire staff needed to support take rates twice as high as initially predicted.

Meanwhile NextLight is helping businesses and fostering growth by providing connectivity that's enabling the community to successfully compete with its neighbor to the south, Boulder. Local businesses that were looking to expand outside the city elected to stay and grow in Longmont thanks to the Gigabit network. The network is also attracting regional work-from-home Coloradans looking for an ideal place to work and raise their family.

Fiber to the Premise – Wholesale Model or Public Private Partnership, Shared Capital Costs and Shared Revenue

Local governments can take several approaches with the wholesale model, owning the fiber only or owning the fiber and the equipment it takes for it to run or be "lit." Fiber optic cable that does not have equipment on the ends of it is referred to as "dark" fiber. Fiber optic cable that has equipment in place is referred to as "lit" fiber.

Whether the municipality provides dark or lit fiber, the wholesale model assumes at least one and possibly multiple service providers are available to provide Internet services. The municipality owns the network, and in some cases, the equipment to light the network, and the service provider(s) pay a lease fee to the municipality in the form of a monthly payment or in the form of a revenue share, a percentage of the gross revenues generated by service fees on the network.

This ownership by a municipality, run by a private entity approach is nothing new; it has been prevalent for decades with toll roads that are managed privately. What is a new and emerging trend, is communities funding a network and turning it over to a traditional carrier to manage and operate the network.

As part of the Northwest Colorado Regional Broadband Strategic Plan effort, Rio Blanco County identified that broadband service in the County was inadequate to sustain 21st century economic development. Rio Blanco County is deploying a wholesale Fiber to the Premise model. In 2014, Rio Blanco County voted to opt out of SB 152 and reclaimed their local telecommunications authority. Shortly after opting out, Rio Blanco received grant funding with the Colorado Department of Local Affairs (DOLA) to build out the network. The County and some of the local community anchor institutions are providing the match funding required by the grant. The County is building fiber infrastructure to the block in Rangely and Meeker and service providers will finish the build-out to each home or business. In the more rural parts of the county, subscribers will be served by wireless infrastructure and technologies.

Subscribers have the option to choose between two providers which are offering services on Rio Blanco's network. Local Access Internet (LAI) and Cimarron Telecommunications are offering symmetrical Gigabit Internet access (1,000 Mbps or 1 Gbps) for $70 per month.

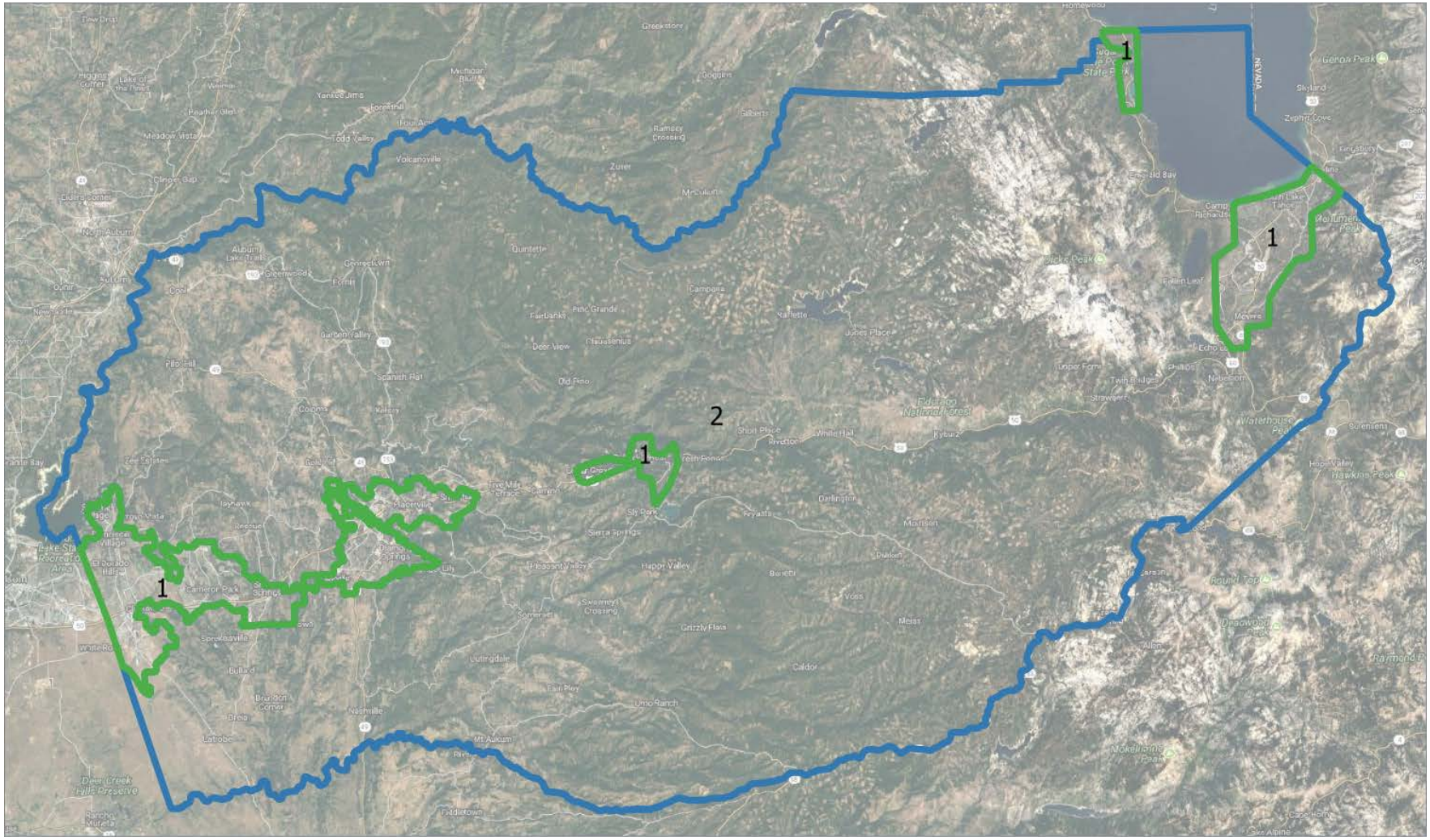
In addition to the retail and wholesale Fiber to the Premise models, there are a number of emerging public-private partnership models that are just being introduced in the industry. A description of typical funding mechanisms for local governments will be discussed below as well as a description of the emerging public-private partnership models.

Fiber-to-the-Premise Capital Cost Estimates

NEO's team put together preliminary design and projected capital cost estimates for building a fiber-to-the-premise network that is capable of handling symmetrical Gigabit broadband speeds. Our team separated the County into sections of approximately 1,000 units each. We assumed there would be a primary network operation center that would house the equipment to "light up" the fiber in each community. Secondary network operation centers would potentially be added for redundancy after each community reached a critical mass of customers.

Most Fiber-to-the-Premise network use a Gigabit Passive Optical Network (GPON) architecture with active connections to large businesses, mission critical or government locations. Active or passive simply refers to powered electronics in the field. In other words, with a passive architecture, there are no electronics located between the network operations center and the home.

Capital costs will increase when the market share or take rate percentage increases. Below are the projected capital costs with various take rate percentages.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Phase 1, FTTP	Take Rate	10%	20%	30%	40%	50%	60%
Overall	Project Cost	$ 66,223,982	$ 73,847,565	$ 81,471,147	$ 89,093,158	$ 96,716,741	$ 104,340,323
	Cost per HHP	$ 1,256	$ 1,401	$ 1,546	$ 1,690	$ 1,835	$ 1,980
	Cost per HHS	$ 12,564	$ 7,005	$ 5,152	$ 4,226	$ 3,670	$ 3,299
	Cost per MI	$ 92,029	$ 102,623	$ 113,217	$ 123,809	$ 134,403	$ 144,998
Phase 1, FTTP	**Take Rate**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**
Engr. Labor	Project Cost	$ 5,640,854	$ 5,640,854	$ 5,640,854	$ 5,640,854	$ 5,640,854	$ 5,640,854
Aerial Labor	Project Cost	$ 7,169,519	$ 7,169,519	$ 7,169,519	$ 7,169,519	$ 7,169,519	$ 7,169,519
UG Labor	Project Cost	$ 24,370,894	$ 24,370,894	$ 24,370,894	$ 24,370,894	$ 24,370,894	$ 24,370,894
OSP Materials	Project Cost	15317500	15532919	15748338	15963757	16179176	16394595
Tech Services Labor	Project Cost	$ 6,288,449	$ 6,288,449	$ 6,288,449	$ 6,288,449	$ 6,288,449	$ 6,288,449
Totals		$ 58,787,214	$ 59,002,634	$ 59,218,053	$ 59,433,472	$ 59,648,891	$ 59,864,310
Customer Premise Labor and Install Materials including Splitters	Project Cost	$ 6,981,143	$ 13,961,146	$ 20,941,149	$ 27,920,911	$ 34,900,915	$ 41,880,918
Electronics	Project Cost	$ 455,626	$ 883,785	$ 1,311,945	$ 1,738,775	$ 2,166,935	$ 2,595,094
Overall	Project Cost	$ 66,223,982	$ 73,847,565	$ 81,471,147	$ 89,093,158	$ 96,716,741	$ 104,340,323

A substantial part of this build is the backbone routes through the County. The capital costs shown above for FTTP include a portion of the backbone route.

The capital costs of building FTTP for Phase 2, which includes the homes and businesses in less dense areas of the county, is shown below.

Phase 2, FTTP	Take Rate	10%	20%	30%	40%	50%	60%
Overall	Project Cost	$ 109,359,571	$ 114,621,272	$ 119,881,644	$ 125,148,788	$ 130,392,828	$ 135,654,543
	Cost per HHP	$ 2,976	$ 3,119	$ 3,262	$ 3,405	$ 3,548	$ 3,691
	Cost per HHS	$ 29,756	$ 15,594	$ 10,873	$ 8,513	$ 7,096	$ 6,152
	Cost per MI	$ 56,881	$ 59,618	$ 62,354	$ 65,094	$ 67,821	$ 70,558
Phase 2, FTTP	**Take Rate**	**10%**	**20%**	**30%**	**40%**	**50%**	**60%**
Engr. Labor	Project Cost	$ 8,355,963	$ 8,355,963	$ 8,355,963	$ 8,355,963	$ 8,355,963	$ 8,355,963
Aerial Labor	Project Cost	$ 21,819,327	$ 21,819,327	$ 21,819,327	$ 21,819,327	$ 21,819,327	$ 21,819,327
UG Labor	Project Cost	$ 41,820,861	$ 41,820,861	$ 41,820,861	$ 41,820,861	$ 41,820,861	$ 41,820,861
OSP Materials	Project Cost	$ 27,846,550	$ 27,996,750	$ 28,146,951	$ 28,297,152	$ 28,447,353	$ 28,597,554
Tech Services Labor	Project Cost	$ 4,386,259	$ 4,386,259	$ 4,386,259	$ 4,386,259	$ 4,386,259	$ 4,386,259
Total		$ 104,228,959	$ 104,379,160	$ 104,529,361	$ 104,679,562	$ 104,829,763	$ 104,979,964
Customer Premise Labor and Install Materials including Splitters	Project Cost	$ 4,812,094	$ 9,621,690	$ 14,431,286	$ 19,242,227	$ 24,050,442	$ 28,860,051
Electronics	Project Cost	$ 318,517	$ 620,422	$ 920,997	$ 1,226,999	$ 1,512,624	$ 1,814,528
Overall	Project Cost	$ 109,359,571	$ 114,621,272	$ 119,881,644	$ 125,148,788	$ 130,392,828	$ 135,654,543

Direction from the County has been to investigate potential public-private partnership models with service providers such that the County does not need to become an Internet Service Provider. These discussions are underway as of the date of this report. As the capital costs and financial risk is high for building fiber to homes and businesses, NEO and County staff recommending further investigation into various strategies and models for implementing this approach.

If a public-private partnership can be reached, the County may share in the capital costs of the FTTP build. For example, the County might build and own the fiber network, for Phase 1, paying for the Engineering Labor, Aerial Labor, Underground Labor (UG), the Outside Plant Materials (OSP), and the Technical Services Labor. The range of capital costs are $58 - $59 Million. The private provider might pay for the Customer Premise Labor and Installation and the Electronics. A revenue share would be paid to the County to cover debt for the fiber. Financial models will be discussed in the companion report.

Best Practices for Gigabit Strategies

Most Fiber to the Premise model have the following attributes and benefits to the community.

- Symmetrical gigabit services
- $60 to $100 pricing for residential customers and
- $500 to $750 pricing for business customers are being offered in cities and towns across the country and not just by Google.
- Options to enter into Public-Private Partnerships, variety of models
- Models are driven mostly to mitigate debt coverage risk – driven by take rate – driven by pricing
- County involvement, capital and ownership is negotiable

Detailed financial models will be discussed in the companion report. Initial findings provide results that are feasible and can be financed.

Work with Existing Providers to Improve Broadband Services – Comcast and AT&T

One strategy that could be pursued is to work with the existing incumbent providers to expand their services ubiquitously throughout the County.

As of the date of this report, neither Comcast or AT&T have provided enough detail regarding where their existing networks are located and where within each County they provide various service levels. The County will continue to work with both incumbent providers to better understand how the County could facilitate further expansion of their Gigabit service offerings.

Financing Municipal Broadband Networks

There are several strategies local governments have used to finance municipal broadband networks. Local governments can sometimes appropriate funds available through the general fund, to cover the capital costs of network builds. Funds can be appropriated either on a one-time or multi-year basis.

If there is not sufficient funding available in the general fund, a number of local governments have used general obligation bonds, revenue bonds, or certificates of participation to finance the network build-out. Other financing options include New Market tax credits, for which allocations would have to be secured; economic development retail sales tax funds, internal loans, TIF, economic development financing programs, and crowd sourcing.

There is also a growing interest among private financial institutions willing to invest in municipal networks. Local governments may be able to find alternative means of financing government anchor networks using private capital.

Grant Funding

Grant funding is available from a number of state and national sources. At the federal level, E-rate and the Rural Healthcare Grants are provided through the Universal Service Administrative Company (USAC). USAC is an independent, not-for-profit organization, designated by the FCC to administer the Universal Service Fund. This fund receives approximately $10 billion annually and is used to deliver funding through four programs (E-rate, the Rural Healthcare Program, Lifeline Program and the High Cost Program). The E-rate program will pay for 40-60% of the capital costs to build fiber to schools and libraries. The Rural Healthcare Program will pay for 60-65% of the capital costs to build fiber to qualifying medical facilities.

Another federal program for financing broadband is the Economic Development Administration (EDA). EDA will fund development for partnership planning, local technical assistance and economic adjustment assistance. EDA will fund implementation and construction of broadband networks for public works projects and economic adjustment assistance projects. Other federal programs are offered through the US Housing and Urban Development. A variety of funding sources and funding mechanisms are available through HUD for planning and implementation of broadband networks.

The State of California has an advanced service fund that will provide grant funding to areas that have no service or service less than 6 Mbps in download and 1 Mbps in upload speeds.

Other Potential Sources of Funding, Supplemental Tax Revenues, Streaming and Over-the-Top Services

Across the U.S., cable companies are seeing their customers cancel their traditional broadband TV services and choose to receive their entertainment through over-the-top services or streaming services such as Hulu, Amazon Video, Netflix and HBO Go. As cord-cutting increases, some local governments have been trying to recoup lost franchise fees received from cable companies by charging taxes on over-the-top services.

Within the past year, approximately 45 cities in California are implementing or planning to implement a tax on streaming services and video games, using their city's existing tax rate for cable providers. Their tax rates on video services range from 4.5 to 11 percent. Already taxing these services at rates from 6% - 9.4% include communities in Pennsylvania, Minnesota and Chicago.

There has been push-back from content and streaming providers on this tax and it is likely that these taxes will be challenged in court. An argument can be made that taxes on Internet sales are not allowed without a physical address within states, and therefore, this streaming and gaming tax could be struck down as well.

Charging Fees for Use of Right of Ways
Cities in Oregon have started charging private and public entities for use of their right of ways as a means to fund infrastructure improvements. The fee amount varies based on the kind of utility and how many facilities are used in the right-of-way. Charging right of way fees may be another funding mechanism for cities to build broadband infrastructure.

Public Private Partnerships

In addition to the above funding sources, there are a number of public-private partnership models that have recently emerged that allow the municipality to pursue a Gigabit-enabled network, while sharing in the risk, rewards and capital cost outlay of the network.

When evaluating public-private partnerships, local governments need to balance the tension between control, risk and reward against the County's goals for the project. Control, in this context, refers to ownership of the network or how much capital the municipality is willing to invest. A local government must consider how much control or capital is needed to be invested to minimize risks and maximize rewards. Risks are associated primarily with financial risks such as debt and debt coverage, as well as implementation, execution and operational risks. Reward is often associated with where and how fast a network is constructed, coupled with what type of services will be offered and at what price. There may be other benefits that are classified under "reward" such as fiber built for the county's benefit at no cost or construction and operational efficiencies gained from the potential partnership.

Partners can include private for-profit companies, local non-profits, other anchor institutions (such as school district) and even local residents. In some instances, the municipality may have a very limited role in a partnership and may only provide access to rights of way or other city infrastructure such as conduit, excess fiber, water or public safety towers, licensed spectrum, light poles or local government buildings. In other cases, a municipality may agree to become

an anchor tenant and pay for service on the network for a contracted term, providing a guaranteed revenue source for the network project partner to justify the business plan to build out further in the community. In more extensive partnerships, the municipality can play a larger role, such as providing capital for part or all of the network construction. In some public partnership models, the private sector provides financing, while the municipality shares in some of the risk. In other models, the municipality pays for a substantial portion or all of the network build and contracts the operation of the network to the project partner. Sharing in the financial and operational risks and in the associated benefits of a project can allow communities to pursue broadband endeavors that may otherwise be unattainable.

Below are examples of three public partnership models that have been implemented by communities in the recent years.

Google Fiber, No Capital Outlay from the Municipality (and no Control)
Perhaps the most coveted example of a public-private partnership is the Google Fiber project in the Kansas City area. Google chose Kansas City, KS and Kansas City, MO as the community to embark upon its first foray into building fiber infrastructure. Kansas City, KS committed to facilitate access to local infrastructure and conduit that it owned and provided access to its rights of way. Kansas City, MO committed to waive local permitting fees and provided Google with unfettered access to dedicated County staff to support the project.

In return, Google has agreed to build and operate a fiber-to-the-premise network and provide Internet access service with 1 Gbps speeds to homes at $70 per month and to businesses at $300 per month. Google Fiber did not commit to ubiquitous coverage in Kansas City, but agreed to

build out fiber in neighborhoods (called "fiberhoods") that met a predetermined take rate percentage prior to construction.

Google Fiber used this same approach in Austin, TX and in Provo, Utah. Although in the past three years Google has announced plans to replicate this model in 35 other cities, Google has recently announced that it is pulling back its fiber-to-the-premise strategy and is experimenting with Gigabit wireless technologies. Currently Gigabit wireless technology is limited to 500 feet; meaning, fiber optic cable still needs to be installed very close to homes and businesses for the wireless technology to deliver Gigabit bandwidth. Nevertheless, Google's pull back has caused some trepidation in the industry. Google is evaluating other models for partnership with cities and their pause in fiber-to-the-premise implementation should not be taken as an indication of their appetite for collaboration with cities.

In the Google Fiber KS model, the local governments do not commit capital to build the network. This limits the cities' financial risk substantially, but it also curbs the control they have over how and where the network is built. The local governments in the Google Fiber projects have no say over prices charged to the customers, how the network is built or how fast. Google makes all of the decisions regarding current and future operations, and whether or not they pull out of a market. Given their most recent announcements of pulling back their plans, this has proven to be a substantial risk to the communities. Critics of Google's fiberhood approach claim that Google has "cherry-picked" more affluent neighborhoods to build its fiber and has left economically challenged neighborhoods off its build list.

As the Fiber-to-the-Premise market is fairly saturated; meaning, most local governments are trying to implement some type of approach, companies like Google are targeting cities where very little capital outlay is required from them. Therefore, the Google model of having another company come in a build the network is unlikely. Leaning on the incumbent providers, such as Comcast, may be a more viable approach for this model.

Ting, Municipality Builds the Fiber Network, Ting pays for Equipment and Operates the Network

Canada's Ting has recently made a name for itself as a private carrier that will deliver fiber-to-the-premises services over a city-owned network. Already underway in Westminster, MD, Santa Cruz, CA, and Huntsville, AL, Ting is now partnering with Centennial, CO to bring Gigabit fiber Internet access to Centennial's 107,000 residents and its local businesses.

In this model the municipality provides the capital to build, own and maintain the "dark" fiber throughout the community and to every home and business. Ting "lights" the fiber by providing capital for the equipment. Ting provides Gigabit services to homes for $89 per month and to businesses for $139 per month. In order for the city to pay down its debt associated with building the fiber network, Ting pays the city a fee for homes and businesses that are fiber-ready or have been passed with fiber and another fee when homes and businesses start subscribing to Internet services.

While the fiber network is the property of the city and eventually an "open network," meaning several service providers can use it to offer services to homes and businesses, Ting partnerships typically feature an "exclusive right to operate network" for a minimum amount of time. While the build is the responsibility of the respective cities, Ting will lease and light the fiber and provide all equipment and Internet access. Cities partnering with Ting are mitigating risk and staying out of the challenging ISP business, but have more control over where, how and how fast the network is built. The cities also have control over pricing and services offered and can require that the network is available for others to use after an initial period of time.

Long-term Lease, Shared Take Rate Risks or Utility Fee
Private firms including SiFi and Symmetrical Networks will fund a network build, and will oversee design, engineering, construction and operation of the network with a 20-year exclusive lease agreement. These firms are forecasting that the subscription rates they receive will provide healthy returns on their investment. And for extra measure, they ensure a sufficient return by requiring cities to guarantee take rates or pay the difference. The good news is that these potential city paybacks have a long ramp-up time before ever going into effect. Additionally, the guaranteed take rate is typically more than achievable at somewhere between 30-38%, depending on the negotiated terms. At the end of the negotiated years, the city owns the network free and clear but can continue to lease the fiber to their established partner(s).

Macquarie Capital will also work with communities to establish a fiber network using a similar model to that described above or with a utility fee structure model. This utility fee structure model was recently used to rescue Utah's Utopia network from its financial woes. In the Utopia project, Macquarie charges a flat utility fee for every home and business that the network passes, whether the home or business signs up for services or not. Terms of the deal were reported to be $22.60 per month for five cities. In terms of revenue sharing, each city is able to keep 75% of wholesale revenue after the first $2M per year. This arrangement is expected to wipe out Utopia's debt by 2021 if the network sees a 24% take rate for premium services

Macquarie Capital is also providing financing, design, engineering, construction and operations for an anchor institutions network for the State of Kentucky. This "concessionaire model" provides a long-term agreement of 30 years where Macquarie is the lead vendor coordinating all financing and implementation for the project and the State of Kentucky, in turn, shares in the risks and rewards of the project.

How is the Network Implemented and Operated?

As discussed, there are a myriad of ways that a public-private partnership can be funded. In the same vein, implementation and operation models vary. In many instances, the municipality has staff and resources that are already providing utilities to their constituents or are already maintaining roads and right of ways. With this being said, designing, building and operating a fiber network is not always in a municipality's wheelhouse. Often a municipality will

outsource the design, engineering, permitting, construction of the network and physical turn-up of services. In some cases, the municipality may also contract for operations of the network and in other instances, the municipality may source these functions in-house.

Private entities Macquarie, SiFi, Symmetrical Networks and Fujitsu, that are providing financing for these networks to be built under a public-private partnership model, are also looking for opportunities to work with local governments who wish to outsource either part or the entire above list. Other local governments are choosing to partner with these firms for the financing and operations, by keep the design, engineering and construction services under their control, using standard procurement processes for these functions.

As discussed in the funding section of this paper, each entity has a different model to recoup its investment and meet their business case for success. Usually these arrangements, fees, and exclusive rights contracts are complex and should be reviewed by a firm with extensive experience in multiple cities with a wide variety of business models and contingencies.

Software Defined Network, with an "Opt-In" Twist

Named the community broadband project of the year by the National Association of Telecommunications Officers and Advisors (NATOA), the City of Ammon, Idaho's open access network is obviously making many communities take notice. Ammon's fiber network is a "software defined network," allowing "fiber apps" to be setup and hosted on the network. One such application, is an innovative public safety application that uses the fiber network to coordinate immediate, real-time responses to school shootings. This has led to the City partnering with the University of Utah in a $600,000 initiative to research and develop a series of next-generation networking technologies supporting public safety, including broadband public emergency alerts.

Ammon has created Local Improvement Districts (LIDs) where residents can "opt in" or "opt out" of receiving service from the fiber-to-the-premise network. For those who opt-in, they are charged a monthly fee, where those who are not interested are not charged. The city council's logic is that those who opt-in are investing in an opportunity to increase their property value.

Within a specific LID, improvement bonds are used to cover the expense. Bonds are paid off by an assessment of each participating property. It's estimated that this will result in a $15 to $20 monthly charge for opting-in households.

The open-access network has an accessible online dashboard where Ammon's residents can change providers if they're not happy with their current provider. They can also set up private, high speed "rooms" online, with a few clicks. Virtual connections can be set up between all of the schools, or with the school and the hospital – on the fly, again, with a few clicks. Ammon's open access model offers very high-speed Internet with a number options for providers, but more importantly, it also supports a number of growing data applications, allowing collaboration with anyone on the network at any time.