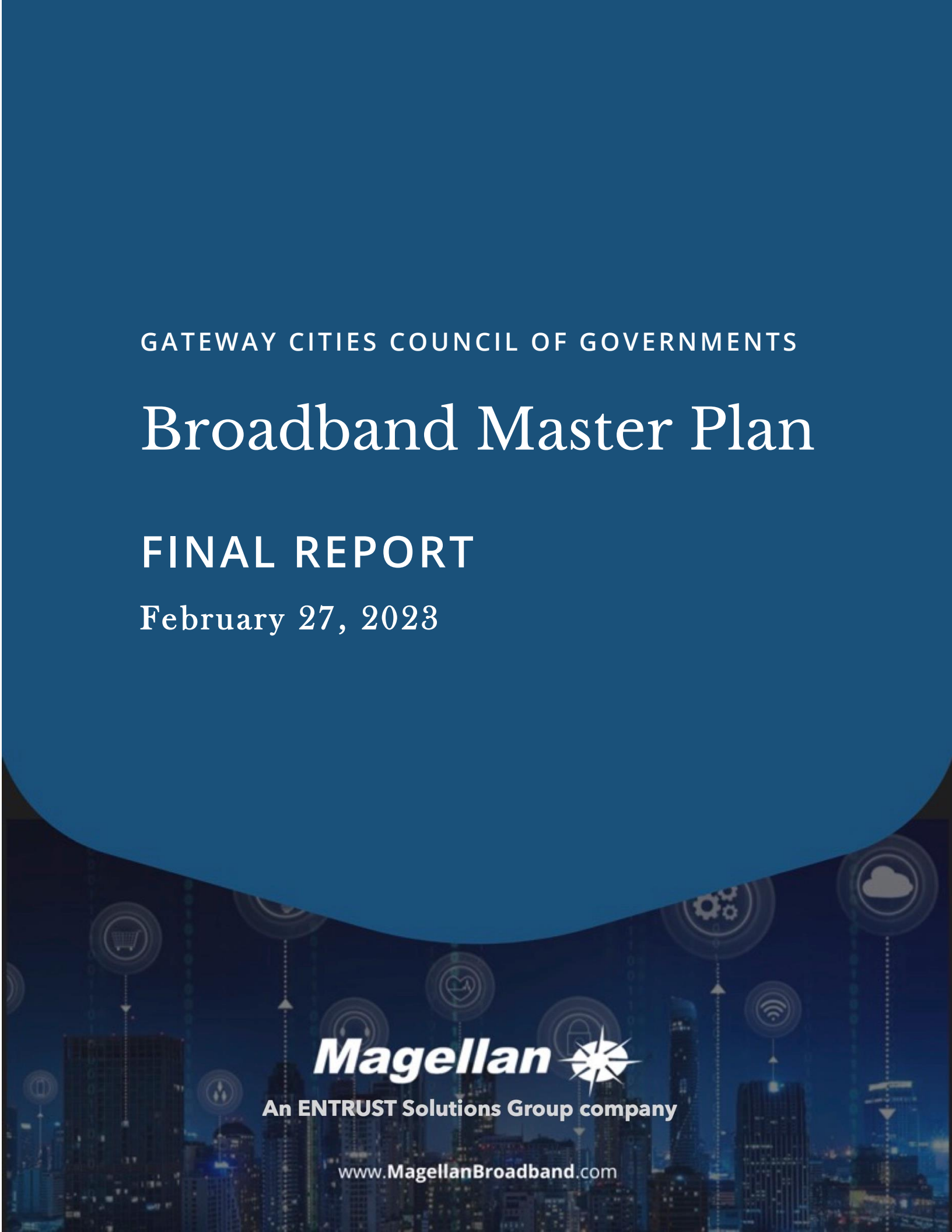
GATEWAY CITIES COUNCIL OF GOVERNMENTS

Broadband Master Plan

FINAL REPORT

February 27, 2023



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Executive Summary

The Gateway Cities Broadband Master Plan is for next generation infrastructure in some of the United States' most diverse and dynamic communities. ***The Gateway Cities are a demographic and economic powerhouse that require advanced, world-leading technology.*** The plan is to make digital technology highly accessible and impactful for everyone in the area. The strategic foundation for achieving this is the partnership between the 27 Gateway Cities, the Council of Governments (COG), Los Angeles County, and numerous other public, private, and non-governmental organizations.

A practical goal of the plan is to connect major facilities of all the Gateway Cities, reducing recurring costs for the cities and enabling municipal performance improvement. The network can enable cities to automate operations and collaborate in ways that make more of tax dollars and directly improve quality of place. The Gateway Cities need more connectivity for their municipal operations, quality of life, and economy. The fundamental goal is an inclusive, resilient, and sustainable local economy. Related, supporting goals are to attract investment in infrastructure to ensure affordable, flexible, high-performance connectivity for residents and to ensure public network investments meet public priorities.

The Gateway Cities Broadband Master Plan is a roadmap to achieve these goals together, and it lays the foundation for more detailed, in-depth planning and effective implementation. The basic recipe involves several key practices and critical success factors that can be adapted to each city's assets and requirements:

1. *Executive sponsorship/leadership engagement* and strategic focus (i.e., "how does network infrastructure help us achieve key public objectives?")
2. *Inclusive participation* in understanding why networks are important, defining what the infrastructure should be, and determining how it enables resilience and sustainability, answering fundamental questions:
    a. Why are we doing this? How does it benefit the community?
    b. What resources are involved as both inputs and outputs?
    c. How will it be executed? How do we maximize the value?
3. *Complementary investments* in hardware, software, skills, and transformation (organizational change), along with network assets
4. *Formal public-public partnerships* with capabilities to catalyze private investment and meet public priorities
5. *Smart practices*, including shared, publicly owned infrastructure to support the range of applications used by the cities, their residents, and stakeholders.

Connected city facilities provides a springboard to connect the rest of the community for better access to education, healthcare, job opportunities, and local government. Increasing incomes will come from better-paying jobs and more productive employers. Better access drives economic development in many forms: major employers in traded sectors, stronger small business and support industries, new tech-based startups, and from remote professionals working from home.

A combination of consistency and flexibility is key to a huge leap in broadband for the Gateway Cities. Many resources are in place. More are coming. Each city is distinctive. There are various needs and opportunities based on local conditions but also clear commonalities. Some cities have extensive assets. Some cities have very limited staff capacity. The cities of Industry and Vernon have relatively few residents while cities of Bell, Cudahy, and Maywood are densely populated. The cites range in size from Long Beach (over 80 square miles and over 450K population) to Cudahy (one and a quarter square mile with a population of over 22,000).

This report identifies connectivity needs and opportunities across the Gateway Cities. The focus is on the cities themselves and their internal, operational requirements but the assessment covers the range of network infrastructure and services. Educational information about various technology options is included in the report as is a full consideration of various business models the Gateway Cities might use to address these needs and opportunities. The plan focuses on a "shared public services" model because it capitalizes on the COG's inherent partnerships to lower costs and improve options for members.

The Gateway Cities should focus on a high-capacity fiber backbone infrastructure because it (a) meets critical requirements for the cities, (b) has long-term value anchored in the built environment, and (c) acts as a catalyst for private investment, providing a platform for network service providers and online businesses. The nature and costs of access infrastructure is included although the recommended model leaves those portions of the network to private partners.

This plan will bring major, sorely needed public and private investment into the Gateway Cities. It lays out several broadband-friendly policies and describes how to practically implement them. The Gateway Cities can improve processes, reduce staff workload, and promote private broadband development. The recommended governance structure builds on the COG via a Broadband Working Group that can evolve into a formal partnership or special district(s) as and when appropriate. If successful, this plan will require a formal, purpose-driven, public partnership. The

plan lays out the alternatives and what is involved in developing them in the most effective manner.

PHASED IMPLEMENTATION ROADMAP

The recommendations in this report are distilled down to four phases with milestones, estimated costs, potential funding sources, and roles of partners:

Phase 0 – Gateway Cities Broadband Master Plan (this report)

Phase 1 – Detailed Planning, Development Prioritization, and Partnership Development

Timeframe: Approximately 18 months, beginning as soon as possible

Routes will be specified during Phase 1 based on each city's requirements and level of participation in the partnership. Formal agreements to develop and own network assets will need to be addressed in this phase. It may be appropriate to form an organization to operate the network, lease assets, and collect revenue from private companies. Work during this phase will be paid for by the California Public Utilities Commission (CPUC) Local Agency Technical Assistance grant that was recently awarded to GCCOG.

Phase 2 – Initial Construction and Interconnection

Timeframe: Approximately 18 months, overlapping phase 1, beginning in early 2024

The second phase will involve acquiring financial and other resources to construct top priority routes, as well as the actual construction of those routes and interconnection with existing network assets. Specific arrangements will be made to connect with and utilize statewide middle-mile network during this phase. Additional grants, private investment, and other funding will be necessary for this phase. The statewide middle-mile network is slated to be complete by the end of 2026, but routes in the Gateway Cities are to be developed early in that project.

Phase 3 – Extension and Statewide Middle-Mile Interconnection

Timeframe: Approximately 12 months, overlapping phase 2, beginning in mid 2025; opportunistic joint-builds as early as late 2023

The GCCOG, or the new dedicated broadband entity will coordinate with various stakeholders, particularly the cities, County of Los Angeles, LA Metro, private providers, and school and utility districts—to opportunistically extend the area network via joint builds. Phase three will also include initial programs to provide access to area residents and actual interconnection with the statewide middle-mile network to create an inter-city backbone. Additional grants, private and public investment, and other funding will be necessary for this phase.

Phase 4 – Operations and Programs

Timeframe: On-going, overlapping phase 3, beginning in late 2025 or early 2026

The final phase of development will focus on establishing network operations and programs to ensure access for all. Operations will include collaboration with community-based non-profit organizations, coordination with and marketing to private partners, on-going network maintenance, and continuous improvement of network performance.

1. Introduction

The 27 Gateway Cities and adjacent unincorporated areas of Los Angeles County are some of the United States' most densely developed and populated areas. The diverse communities within them span cultures and enterprises from around the globe yet are deeply embedded in and contribute to the region's vibrancy. With over two million residents and over 70,000 business establishments in the heart of Southern California, as well as the cities themselves and other public agencies, Gateway Cities are a prime market for broadband and related technology.

This plan provides an assessment of needs and opportunities, options—business, organizational, and technical—for addressing those needs and opportunities, and recommendations for a prioritized action plan or roadmap to achieve shared goals and objectives. The Gateway Cities Council of Governments has multiple initiatives, generally around transportation, air quality, housing, and economic development. All of these are directly impacted by and can directly impact broadband. Access to education and work opportunities, commuting and freight transport, and housing opportunities all depend on broadband.

The overall purpose of the plan is creation of a new and inclusive economy. The objective is to efficiently meet the high-speed internet needs of the Gateway Cities, their residents, and businesses in the area. The planned network will enable government agencies, emergency services, schools, libraries, public works, and transportation to be faster and more effective. It will help residents be safer, healthier, and more prosperous, to increase their educational and employment skills, enter the work-from-home job market, and maintain connectivity even under adverse conditions such as the COVID-19 pandemic. Innovative businesses can grow sustainably in the Gateway Cities via this new infrastructure.

FOCUS AND SCOPE OF THE PLAN

The Gateway Cities' connectivity needs and opportunities—along with those of the County of Los Angeles, LA Metro, school districts, and many other public institutions in the area—are the focus of this plan. Every city connects its agencies and citizens with an enterprise network with internet access, various operational systems, and a web presence. Some cities are full-service municipalities, but many are contract cities with limited staff capacity. The extent of community services, economic development, fire, police, and public works vary greatly, with many relying on county services. Likewise, the local economy differs across the cities but there are technology-intensive enterprises spread throughout the area, clustered in nodes

around physical infrastructure. The industrial areas, mass transit, ports, rail lines, and even roadways require connectivity as they enable economic activity.

Opportunities come from network assets. Some Gateway Cities, Downey and Long Beach for example, have extensive fiber infrastructure for internal connectivity. Vernon operates its utilities via a fiber network that can enable retail broadband, too. LA County Department of Public Works (DPW) has interconnected traffic signals throughout the area, as do several cities. All the cities have public properties that could—if they don't already—host radio infrastructure for wireless connectivity. Capital improvement projects and permitting processes can also be opportunities for broadband development, especially when coordinated across jurisdictions.

The means for addressing connectivity needs by capitalizing on opportunities will vary among the Gateway Cities, but there are clearly some commonalities and major potential synergies. Optical fiber is the bedrock of broadband networks, which provide foundation for wireless networks. Common design and construction standards, permitting processes, and provider recruitment efforts are all opportunities

Connectivity needs are defined by municipal operations, residents' expectations, community values, and, ultimately, business investment. All this is based on technology making organizations more effective, efficient, flexible, and resilient. Tech-intensive organizations have more high-paying jobs, requiring more advanced skills, and push partners to adopt technology solutions. Organizations' investment in technology—including workers' skills—generates returns in the form of lower relative costs, greater productivity, and stronger customer value, all of which depend on connectivity. Thus, networks are essential to local governments, local economies, and communities.

This broadband master plan identifies pockets within the Gateway Council of Governments region (GCCOG) that lack sufficient broadband infrastructure and upgrades needed to ensure residents, educational institutions and businesses can remain competitive. It addresses present and future connectivity needs of key institutions and industry, focusing on the cities, identifying potential cost savings and revenue opportunities. It centers on backbone network infrastructure to interconnect the Gateway Cities:

- Artesia
- Avalon
- Bell
- Bell Gardens
- Bellflower

- Cerritos
- Commerce
- Compton
- Cudahy
- Downey
- Hawaiian Gardens
- Huntington Park
- Industry
- La Mirada
- Lakewood
- Long Beach
- Lynwood
- Maywood
- Montebello
- Norwalk
- Paramount
- Pico Rivera
- Santa Fe Springs
- Signal Hill
- South Gate
- Vernon
- Whittier
- County of Los Angeles unincorporated areas
    - East La Mirada
    - East Los Angeles
    - East Rancho Dominguez
    - East Whittier
    - Florence/Graham
    - Los Nietos
    - Rancho Dominguez
    - Rosewood
    - South Whittier
    - Walnut Park
    - West Whittier
    - Willowbrook

Items included in the Plan

1. Educational information and data for the cities and unincorporated communities to set their goals and objectives to facilitate the design and deployment of a Fiber Optic Network either individually or collectively;
2. Research and evaluation of the current supply of broadband communication assets, products and services in the cities and unincorporated communities of the Gateway Cities;
3. An inventory and assessment of existing city and County of Los Angeles assets and infrastructure required to support deployment of a fiber network;
4. Definition and evaluation of potential fiber optic network routes and requirements;
5. Impacts of a fiber network on right-of-way, conduit, streetlight poles, traffic lights, existing fiber system and other real property;
6. A review of services and technologies that could be offered on the fiber optic network;
7. A review and analysis of governance models to build and operate as a regional system; these will include models for cities to "phase in" the implementation of a broadband network.
8. A review, analysis and recommendations regarding the feasibility, costs and financing for the building of a fiber optic network and the best business model to achieve the goals; and
9. A phased implementation plan.

NETWORK BASICS

Broadband is essentially of type of network access. It is only one piece of the network infrastructure, illustrated in Figure 1, required to fully connect communities. Networks consists of fiber-optic cable, laid out in rings, interconnected by network service providers' central offices (CO), exchange points, and similar facilities, connecting cell sites, Wi-Fi access points, and other access infrastructure, and ultimately terminating in commercial, industrial, institutional, and residential premises. Traditionally, this infrastructure deployed based on profits. Investment focused on relatively affluent, moderately densely populated areas because those areas provided most revenue at the lowest costs. Consequently, disadvantaged people have less access than those with disposable income, stable families and jobs, and other valuable assets.

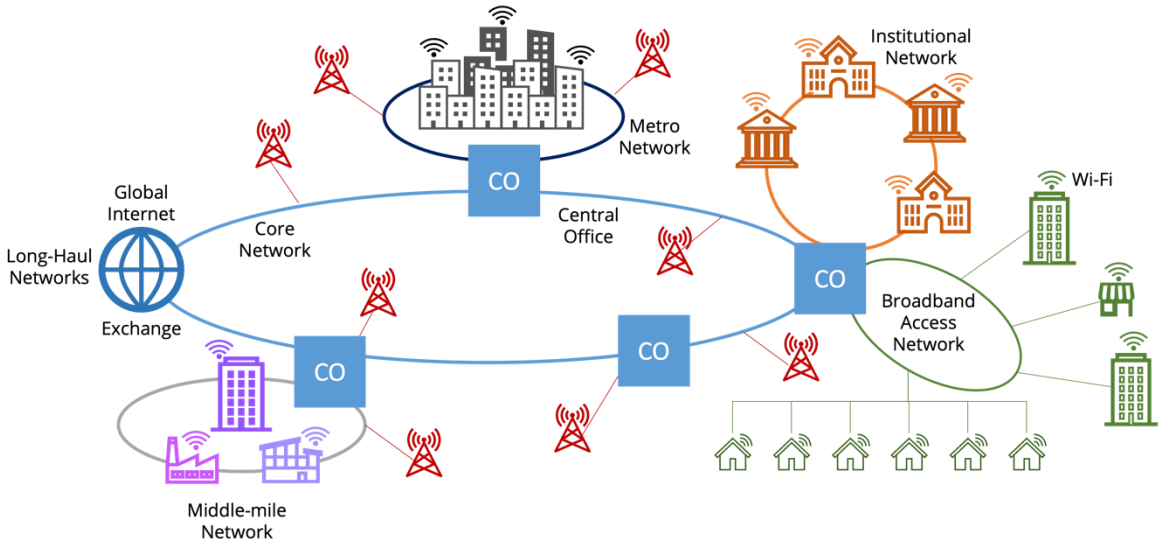


Figure 1. Infrastructure for various fiber network and radio access networks is necessary to connect communities; cities can provide key pieces.

The challenge is to drive network capacity and access infrastructure deeper and more broadly into Gateway Cities. Everyone in the area should have basic access but the overall goal should be to attract investment in next generation infrastructure. The technology is constantly evolving. Current fiber-based "gig-speed" access is the current gold standard but that will soon be surpassed by faster, more flexible network services. How can Gateway Cities get advanced network infrastructure but also continuously refresh it to provide its businesses, institutions, and residents world-class network services? How can it capitalize on those services to develop and maintain an open, inclusive local economy? It starts with basic understanding of network infrastructure.

Networks as Links and Nodes

Network systems generally consist of links and nodes. Some nodes are internal to the network, owned, operated, and maintained by network service providers to aggregate and route data traffic, manage links and other nodes, and provide services. Data centers, for example, are nodes, as are providers' central offices and head-end facilities. Most nodes, however, are customer devices and premises—which can have numerous nodes within them—at the network's edge. Typically, all the nodes within a network are represented by a cloud, as in Figure 2. While this diagram is intended to represent physical network assets, it also represents the ties between people and places that networks enable.

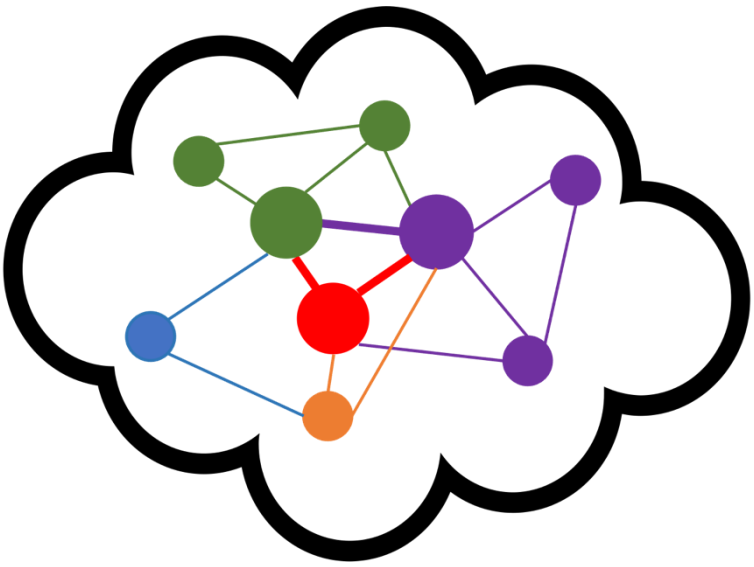


Figure 2. A network "cloud" consists of many nodes and links.

Think of the "cloud" in this diagram as your community. The circles as community members, local businesses, or municipal assets. Today, those social and economic connections are supported by physical network connections between various facilities with specific functions as nodes:

- ***Cells*** are wireless nodes on a radio access network (RAN) that are interconnected to other cells, typically via fiber, to connect end-user devices within a specific geographic area.
- ***Central offices*** (telco) ***and head-ends*** (cable company) are where traffic to and from customers on local network infrastructure is aggregated and routed, as appropriate, to the core network/inter-office backbone.
- ***Collocation facilities*** are interconnection points, housing equipment for multiple network service providers and other information services companies.
- ***Data centers*** house large numbers of computers and other devices for processing and storing data, typically referred to as "hosting" applications and services.
- ***Exchanges or internet exchanges*** are collocation facilities specifically for routing Internet Protocol traffic between major—Tier 1—networks on an equal basis, which is called "peering."
- ***Points-of-presence*** (PoP) are simply where a network can be accessed and/or connects to another network. A PoP can either be in a major node, interconnecting two large providers, or in a small, neighborhood node, connecting multiple subscribers to a providers' fiber-based feeder network.

The important aspects of the network "cloud" for practical purposes are (a) nodes are interconnected (b) in a hierarchy, with some having greater capacity than others, and (c) all of this is invisible to customers. Indeed, many different companies may own nodes and links within a network, as represented by different colors in Figure 2. End users don't see this complexity, they simply get data, images, sound, and text on their devices.

The links that connect nodes—also called "circuits" or just "connections"—can be various media, including copper cable or wire, optical fiber, or radio spectrum. Signals travel across these media at various frequencies or in channels. Generally, the broader the range of frequencies used for a connection, the more information a channel or link can carry. Thus, a link with many channels, each using a broad set of frequencies, has much more capacity than a link with a few or one channel using a narrow set of frequencies. The former is literally "broadband," and the latter defines narrowband, which is widely used for telemetry, monitoring and control.

As shown in Figure 3, this allows for many different types of connections that flexibly interconnect end nodes. All of this is enabled by *protocols* and services. Protocols define how nodes are identified (i.e., addresses and numbering), links established, and data routed across links to nodes. The Internet Protocol, or IP, is possibly the most recognized protocol, but there are many others including 5G and LTE, Ethernet, and passive optical network (PON).

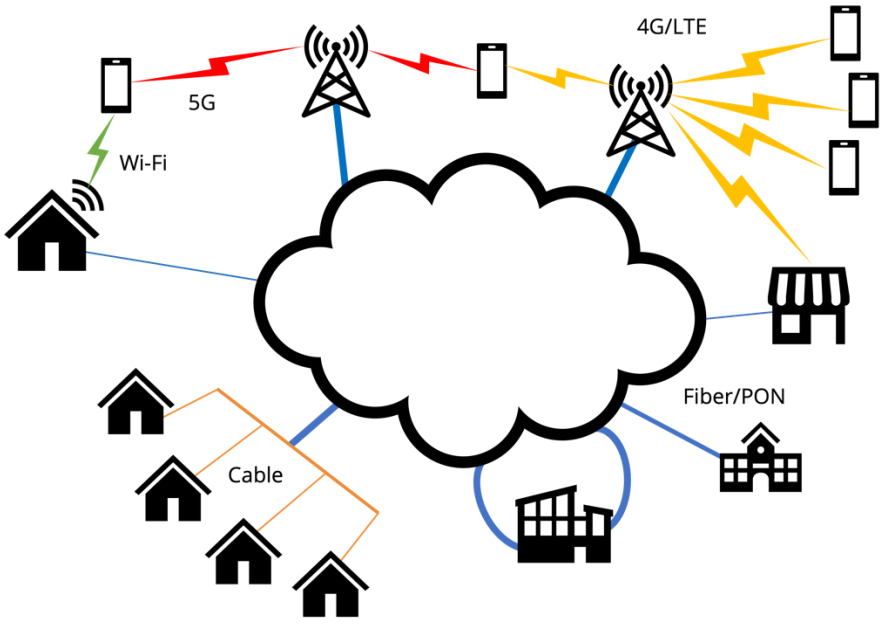


Figure 3. Networks use various access media for services that connect customers.

All of this makes up the infrastructure for network services, which applications for specific purposes—consumer apps like Facebook, TikTok, and Twitter, enterprise information systems, as well as "old-fashioned" telephone calling and cable TV. The key thing to understand is that providers can and do use many different infrastructure components to provide services. Some providers focus on infrastructure, and want to own as much as possible, others prefer to lease infrastructure from others.

REALIZING THE VISION

This report is structured as a recipe, starting with available ingredients and issues to address, which can be seen as the gap to close. Solutions can be very low-cost. Changes in policies and procedures can effectively catalyze broadband development. Closing the gap can reduce costs. Core functions of the Gateway Cities depend on connectivity, which creates substantial costs for them. Direct public investment can enable service improvements and transform operations. State and federal funds are available for this purpose, but private investment is also essential to achieving the vision. Just as the infrastructure is critical to the Gateway Cities, it is also valuable to businesses and institutions, which may pay to use it.

Broadband can be an economic development initiative targeting network service providers. Network infrastructure can be developed in the same manner as an industrial park. Some minor changes in city programs could have significant results. Major results will require additional capacity focused on developing and leveraging network assets for the community. All the ingredients—tactics—specifically prospective fiber routes, are included along with phasing and preparation recommendations and implementation guidelines.

Factors to Consider in Broadband Strategy

The factors to consider in broadband development, shown in Figure 4, can be simplified to needs and opportunities. Needs drive development while constraints determine opportunities. Needs are determined by goals, purpose, and values. Available assets and support are constraints. Broadband development involves working within constraints to address needs and achieve goals. Strategy is how and when resources are deployed to realize the vision.

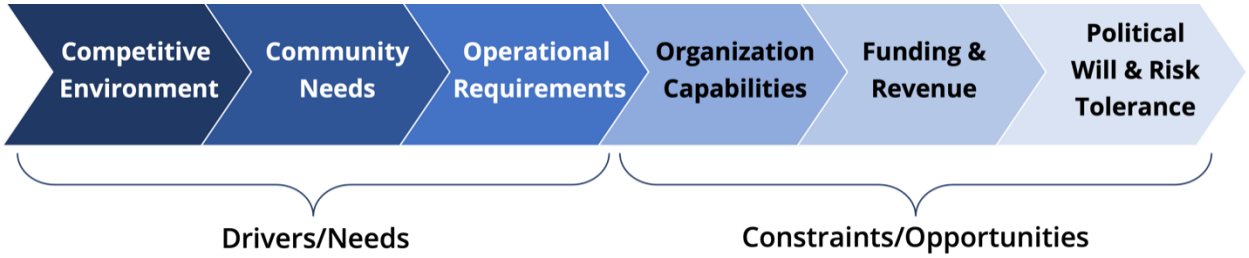


Figure 4. Key considerations for successful broadband development

The competitive environment is an important consideration if a goal is to increase competition and consumer options. The same is true for community needs, which range from basic access to ironclad uptime commitments. The cities themselves have operational requirements, including ability to innovate. That said, cities also have limited capacity and priorities other than broadband. Funding is needed for more capabilities, as well as infrastructure, and any revenue may be used for other priorities. In the end, leadership is the critical consideration. All the above requires leadership commitment to allocate resources and sustain practices.

Gateway Cities need organizational and social infrastructure as well as network infrastructure. By engaging community members in implementing this plan, the Gateway Cities Council of Governments can ensure broadband develops in alignment with community priorities. Data and devices are infrastructure, too. They depend on people's and organization's capabilities and thereby determine the value of networks. The cities' quality of life, local economy, and public safety require infrastructure to be developed in a holistic manner. All these factors should be included along with deployment metrics as key performance indicators for broadband. Measure infrastructure components in terms of the number and types of applications and the diversity of users and uses as well as miles of fiber and number of access points.

2. Broadband Needs and Opportunities

Gateway Cities' investment to make faster broadband more widely available, with more flexibility and lower costs will be most effective if they capitalize on existing network infrastructure and services. As discussed above, available services and unmet needs are the starting point for broadband planning, along with local government requirements. The general question for local policy makers is, "*where should we invest public funds for the greatest impact?*"

The general answer is core network assets for public facilities and in low-income areas. Core network assets are the physical components from which networks are assembled: conduit, fiber cables, poles, towers, etc. Further, it is essential to gather and maintain information about the location and disposition of these assets—where are they, what is their condition, and how are they being used? Public facilities, including recreation, transportation, and utilities, are a focus because connectivity is critical to operations and network assets can often be economically deployed in conjunction with other infrastructure. Telecom companies have traditionally under-served low-income areas due to profitability considerations – relatively high expenses and/or low revenue in those areas. By developing network assets in these areas, the public sector can reduce private sector costs to serve them. A key consideration is how the private sector provides return on the public investment.

This section provides a detailed analysis of local government connectivity needs and opportunities to get very specific about where to invest. Information for this analysis was gathered directly from Gateway Cities' representatives via interviews, surveys, and workshops. In some cases, these sessions were focused on a single city, while in others, several cities joined the conversation at the same time. One-on-one meetings were held with the cities of Vernon, Paramount, Cerritos, Norwalk, Long Beach, and Downey. Participants in group meetings included the cities of Cudahy, Signal Hill, La Mirada, Bell Gardens, Huntington Park, and Industry.

In addition, Magellan gathered data from Gateway Cities COG's member cities about their existing assets through a survey instrument. Additional data was acquired or directly generated. Information was captured in geographic information system (GIS), spreadsheets, and other forms. We also researched private infrastructure via providers' websites and third-party sources. Information was sourced from various public and third-party websites, cited in the text, internet service providers' corporate websites, and public geographic information sources.

We analyzed data provided to Magellan Broadband during that information gathering process and gleaned from the cities' websites. Tools such as Google Maps

were used to clarify and confirm data from other sources. We identified as many of the network links and nodes as practical and necessary for planning purposes. This information is intended as a basis for more detailed analysis and planning as well as strategic goal setting and prioritization.

CITIES' SERVICES AND SYSTEMS

Most Gateway Cities currently receive broadband service via contracts with major internet service providers. This section summarizes what we learned via interviews and workshops. Not all cities participated.

Like many others in the area, the City of Bell Gardens is connected via Spectrum. A couple of their facilities frequently have issues with service outages. The City of Cerritos also uses Spectrum and has a 1GB connection to all facilities, with a 2GB aggregate connection at the City Hall. They also use some cellular connections for SCADA. There are eleven connection points throughout the City, including three that are City-owned short haul campus connections. Cerritos also uses point-to-point wireless as a backup connection.

The City of Cudahy has some fiber connections for some City facilities through Frontier; others are connected through Spectrum coax due to high costs quoted for fiber connections.

The City of Downey has dark fiber to most of its City facilities that it uses to provide a 10 Gbps connections to those sites. In the past, the City used E-rate funding to provide free public Wi-Fi at some parks and the City is considering an allocation of $1M to fund this project moving forward. Downey recently established a development agreement with SiFi to deploy fiber throughout the city and provide low-cost service to residents and businesses.

The City of Long Beach owns approximately 50 miles of fiber and is in the process of developing a plan to connect all City facilities. This is discussed in more detail below.

The City of Norwalk has service primarily through Spectrum, including between their five main City facilities. There is also some fiber that runs down Imperial Highway in Norwalk. It was unclear who owns these assets, but we believe it is Spectrum. Norwalk is also in the process of selecting a provider for a project to provide free Wi-Fi in parks for which the City received federal funding; as of now, Spectrum is the leading choice, as they will extend data lines to parks for free with a service agreement.

Most facilities in the City of Paramount are served by Spectrum/Charter, although some of its smaller facilities have a different ISP because Spectrum said they cannot

access them. Paramount recently upgraded its service plan as a reaction to the Covid-19 pandemic to get more bandwidth.

The City of Signal Hill has connections through Verizon and Frontier, both of which have fiber throughout the City. Sensors on their SCADA system are also connected via fiber.

The City of La Mirada has some buildings that are connected, but not all. While service is good near the Civic Center, some satellite locations have issues with connectivity, including locations in the southern areas where the City has a Public Works facility and a theater. The City has previously tried several options including T1 lines to serve these locations, none of which has met their needs.

The City of Vernon has its fiber network operated by the City, which provides service to its facilities and also leases dark fiber, as discussed in more detail below. This network is used by the City's utility as well as for SCADA and other monitoring applications. Vernon also has a connection through CenturyLink.

Network Infrastructure

Three of the 27 cities—Downey, Norwalk, and Whittier—provided data on public network infrastructure. As shown in Figure 5, Downey has substantial fiber routes and some conduit, Norwalk has some fiber, and both cities have plans for more network infrastructure. Whitter has a "campus" fiber interconnecting key buildings and microwave to connect others. According to data gathered via survey of cities (total of 14 usable responses) at least four other cities also use microwave. Long Beach, Signal Hill, South Gate, and Vernon have fiber, and Bellflower, Cerritos, Long Beach, Signal Hill, South Gate, and Vernon have conduit.

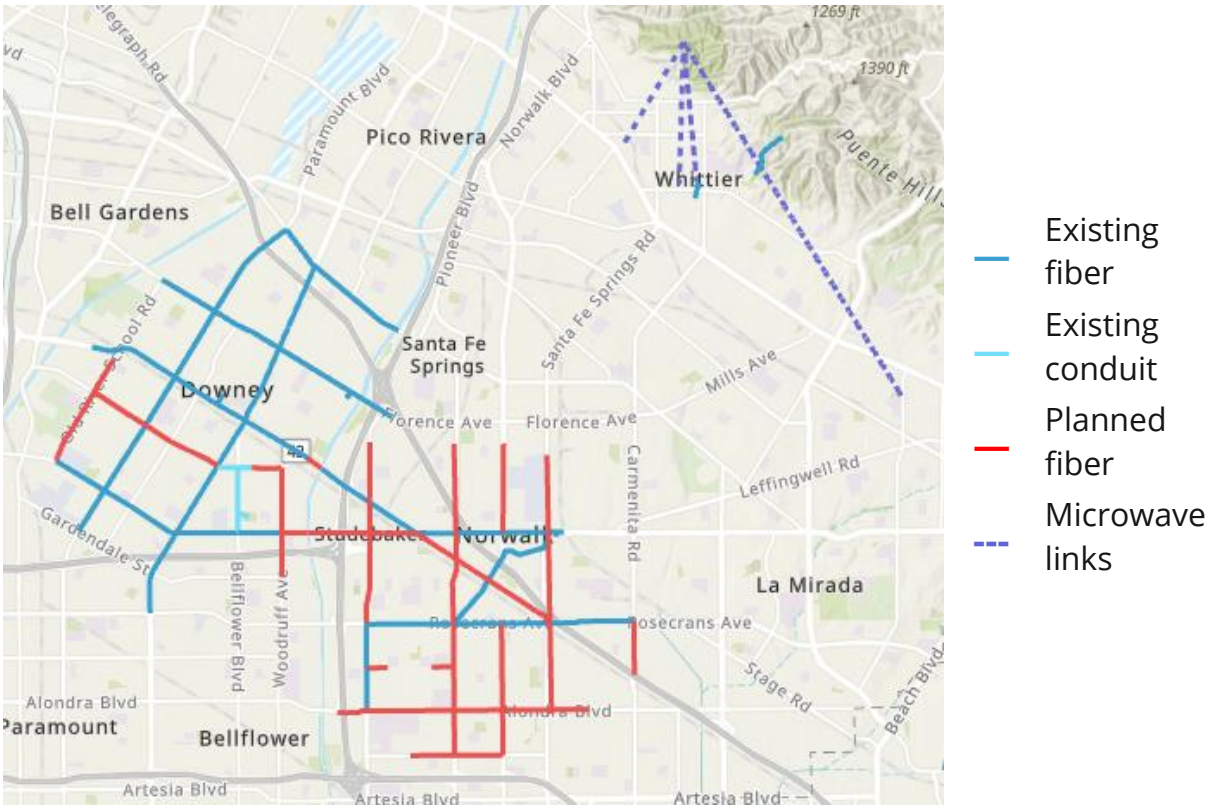


Figure 5. Publicly owned network infrastructure in Gateway Cities

At least three cities offer public Wi-Fi in parks, six have a total of 28 towers, 10 cities own over 42K streetlights in total, and 11 have at least 1,100 traffic signal control cabinets in total. All of these are important as potential nodes that could be used to provide connectivity to surrounding areas. At least seven cities are deploying or planning "smart city" technologies, which capitalize on such assets.

Among the cities we interviewed, Vernon and Long Beach owned the most robust broadband infrastructure. Vernon, which has its own electric utility, built out a fiber network years ago to serve the utility's SCADA and water needs and has since started providing services directly to residents and businesses. Most of the backbone is 288-strand aerial fiber, and the City owns the poles, making new installation relatively simple. Vernon's network is all fiber-based and does not currently include any wireless components.

Long Beach owns about 50 miles of fiber, which includes a variety of strand counts. The fiber was originally developed by the City's Traffic department, so it wasn't built to be a network solution. The City has also used "Dig Once" opportunities to install 2" or 3" conduit with innerduct throughout the City, as well as 288-strand fiber in some locations. Long Beach is in the process of using this methodology and additional

planning to complete a looped backbone, as well as upgrading existing strand counts, to support a citywide fiber network connecting city facilities, some parks, and bring in Wi-Fi to parks and the beach. The Plan may also include business corridors and residences. Long Beach currently has two data centers at City Hall and the 911 Center. The new fiber design includes adding hubs throughout the City using hardened City facilities. Current fiber projects in the works in Long Beach include:

- Studebaker Road – entire length, main corridor for the backbone, runs perpendicular to Mid Cities route; preliminary planning
- Mid Cities Fiber – entire length of 7th St; preliminary planning
- Santa Fe-Alameda – pick up existing fiber through agreement with Frontier to run across Los Angeles River bridge to Santa Fe and up Santa Fe to Willow; includes parks, fire station, and police station; in construction
- 2nd Street – existing fiber at Livingston would connect to Studebaker; seeking funding

Opportunities to expand network links

Network infrastructure can be economically deployed in conjunction with other infrastructure projects. We were able to find information about capital improvement plans (CIP) for 23 of the 27 Gateway Cities. Of those, eight CIPs either lacked any detail or simply did not have any applicable projects. In the final analysis, 11 cities had CIPs that may accommodate network infrastructure—listed in Table 1 and illustrated in Figure 6—some of which did not have any location information.

Table 1. Gateway Cities CIPs that might accommodate network infrastructure

City	Project
Bell Gardens	Florence Ave "Complete Streets" improvements
Bellflower	Street Improvements Traffic Signal Improvements
Cerritos	Coyote Creek Bridge widening/crossing Various other street improvements
Cudahy	Atlantic Corridor "Complete Streets" improvements Santa Ana and Wilcox Ave street improvements
Hawaiian Gardens	Carson St beautification

City	Project
Industry	Street widening and reconstruction
Long Beach	Anaheim corridor safety improvements Artesia Great Blvd Main gas pipeline replacement Major/arterial street rehabilitation Pike Ave Bike Blvd South St improvements Studebaker safety improvements
Lynwood	Bullis Rd improvements in front of City Hall Other excavation projects
Maywood	Atlantic Ave “Complete Streets” improvements
South Gate	Citywide residential resurfacing project and sidewalk improvements Garfield Ave “Complete Streets” improvements Hollydale area access improvements I-710 Firestone bridge southbound on-ramp Long Beach Blvd street improvements Alameda St road diet The Boulevard Project Phase II Tweedy Boulevard synchronization Tweedy Mile “Complete Streets” improvements
Vernon	Atlantic Blvd bridge widening over Los Angeles River

Figure 6. Locations of Gateway Cities CIPs that might accommodate network infrastructure

Current Needs

Many of Gateway Cities COG's member cities have plans or ongoing programs that require broadband. In addition to connections to City facilities, many cities, including Vernon, Cerritos, and Signal Hill, mentioned the need for connections to sensors for SCADA applications. Many of the cities, including the cities of Huntington Park, Industry, Cudahy, Downey, Long Beach, Norwalk, and Paramount, were also actively

providing, or planning to provide, Wi-Fi service at public locations such as parks and libraries. Other municipal uses included traffic signal system interconnections and automated license plate reader (ALPR) technologies that are used by cities' Traffic and Public Safety resources.

In addition to municipal needs, some cities pointed out the need for better high-speed internet options for their residents and/or businesses. In Cerritos, City Council has expressed interest in bringing options for wholesale broadband into the city to promote economic development, particularly because there are some businesses within the city that have expressed interest in interconnections between their locations. Cerritos is currently served by a mix of legacy Charter/Spectrum and legacy Time Warner infrastructure, and Census data shows about 7% of the community is unserved.

In Paramount, the city was hearing complaints from residents about the cost of service and limited number of providers available. Many residents are heavily reliant on cellular satellite, and the school system for their connectivity. Huntington Park has also fielded complaints from residents about their broadband, particularly during the Covid-19 pandemic, when many children did not have the ability to connect for online learning. Huntington Park is currently in the process of setting up a Citizen Portal to learn more about these issues. Long Beach pointed out that Digital Inclusion was a primary concern, including issues of access and equity. The city was exploring ways to address this, including considering deploying a citywide fiber solution.

Industry has a relatively small residential population but noted that there is a residential area on the hill that only has access to relatively low speeds through Frontier. Industry was considering how to address the needs of those residents. In Vernon, the city already provides service to around 50-60 residential customers and around 40 commercial customers. The only other provider in most locations within Vernon is AT&T, which does not have a strong service level or offer fiber.

La Mirada residents seem to be generally well served, although there may be some pockets on the west side that have issues. However, La Mirada often hears from businesses, especially in the industrial areas around Interstate 5, that lack connectivity. Both Bell Gardens and Cudahy have a significant disadvantaged population and also struggle with inclusion issues. In Bell Gardens, the city noted that at least 1000 of their residents only had one provider, and the majority of the rest only had two. Signal Hill and Norwalk both state that they have not heard of any need for additional or improved connectivity from businesses or residents.

The City of Avalon is in a unique position on the southeastern end of Catalina Island, over 20 miles from the mainland. It has robust tourism as well as a full-time

residential population but only one facilities-based internet service provider. City leaders want better, modern infrastructure and more service options. Backhaul to the mainland has been a major constraint so the city has focused on a submarine fiber route to the mainland. There is a space for a cable landing in Avalon harbor and a facility to inter-connect it to the City's network. The Port of Long Beach is a prime location for landing the cable on the mainland. At least one major telecommunications company has committed $3M to help cover the costs and others have expressed interest. The city has also approached state agencies about including this route in the statewide middle-mile network.

Trends and Future Needs

Housing

One of the most prevalent trends among the cities we spoke to was implementing new housing initiatives. Due to the density of the region, new housing is challenging, but additional developments are planned in Bell Gardens. Other cities are looking at rezoning or repurposing commercial areas for residential use, including Paramount, where areas previously heavily focused on M1 manufacturing are being rezoned for housing and mixed-use development. Norwalk has similar plans, with a focus on building new multiple dwelling units (MDUs) that can accommodate growing populations.

In Cudahy, the city is focused on new low to moderate income housing. Downey is the in process of rezoning areas for residential development and has preliminary plans for new mixed-use development near the planned West Santa Ana Branch Transit Corridor (see Figure 7), which includes 700 units, some of which may be considered for transitional housing. Other cities, including La Mirada and Long Beach, stated that new housing would consist mostly of infill and redevelopment since they are already mostly built out.

Economic Development

Several cities were also focused on economic development. The City of Paramount has a new strategic plan for its downtown area that focuses on new development, including economic development that will occur in tandem with the new West Santa Ana Branch Rail. The city also has plans for new development west of Paramount Boulevard, including new outdoor spaces and breweries, with a focus on mobility and sustainability. The rail will also pass through Cerritos, which will continue to develop its warehouse and retail spaces, including managing container traffic from the port and several shopping destinations.

The West Santa Ana Branch is a new 19-mile light rail transit line Los Angeles Count Metropolitan Transportation Authority (LA Metro) is considering to connect Downtown Los Angeles to southeast LA County. The Locally Preferred Alternative route, shown in Figure 7, would connect Slauson Station (A Line) to Pioneer Station in Artesia, was approved by the LA Metro Board of Directors on January 27, 2022, and is continuing through the Environmental Review process. It could be a prime opportunity to extend the backbone fiber along a major transit corridor.

Figure 7. The West Santa Ana Branch Transit Corridor that Metro is evaluating for a new light rail transit line would run for 19 miles through the Gateway Cities (source Metro, https://www.metro.net/projects/west-santa-ana/)

GCCOG should take advantage of the future construction of the rail line, which is expected to be completed in 2041, by budgeting and/or securing grant funding for jointly installing conduit for fiber optic connectivity along the route. Assuming a baseline fiber construction cost of $95 per foot, the 19-mile route should be roughly budgeted at $10 million. However, a joint trench/dig once opportunity should be able to reduce the cost per foot from the baseline since excavation/construction will already be taking place. Completing a full design engineering for the fiber expansion as the transit project moves closer to construction will validate and confirm actual costs.

Downey, which the rail will also affect, has plans for new development near the rail. In Cudahy, the city is focused on economic development along Atlantic, which is a key corridor. Norwalk has many industrial areas that it is looking to fill and has received interest from big box retailers as well as Amazon. Vernon has a lot of manufacturing, food processing, meat packers, as well as a small portion of warehouses. The city is looking to expand its data centers and has also been in talks with Aligned Energy, Prime, and Edge corps.

The City of Long Beach is focused on workforce development, particularly for the aerospace industry near the airport and a 3D printing and manufacturing sector called “Space Beach.” In La Mirada, an ongoing freeway improvement conducted by Caltrans has created new opportunities for commercial uses near Interstate 5, including new hotels, restaurants, and other retail spaces.

Smart City and Related Projects

Many cities are also conducting ongoing planning for Smart City initiatives. In the City of Vernon, this includes a more technology-focused approach to public safety, including the use of ALPRs and cameras. Cerritos has interest in deploying Internet of Things (IoT) technologies including traffic control and mobile workforce applications as well as sensors for AMR/AMI and detection of leaks in warehouses. In Downey, the city is in the process of developing an agreement with SiFi for Smart City applications. The City of Industry is also interested in implementing Smart City, including applications that tie into intelligent transportation to support their trucking industry.

Additionally, several cities have planned projects, including new aquatic facilities in Industry and Huntington Park. Huntington Park also has plans for updating five traffic signals along Swanson Boulevard in coordination with LA County. The City of Downey has plans to develop a STEM bio medical incubator over the next few years and is also working with Metro to explore installing access points on buses for Wi-Fi and signal prioritization. The City of Long Beach has an intelligent transportation project

underway which includes introducing connected vehicles along Atlantic Avenue in partnership with the Mercedes Benz Research & Development facility.

Norwalk has some plans for water and sewer infrastructure upgrades, although the details were unclear. The City of Cerritos is currently evaluating its water infrastructure for needed upgrades and has plans for a new well in the southern part of the city. Also in Cerritos, Metro and Caltrans are conducting a widening project where State Road 91 interchanges with 605. They will be constructing a bridge over Bloomfield Ave, for which the city put in a request to include a waterline on Bloomfield; it might make sense to include broadband as well.

Other Stakeholders

The County of Los Angeles and Southern California Edison (SCE), which provides power to the Gateway Cities, are key stakeholders that have extensive fiber infrastructure. We have not been able to obtain data for their assets as of the writing of this memo, but both have expressed willingness to partner with the Gateway Cities. The Los Angeles County Public Works Department (https://dpw.lacounty.gov/) has extensive fiber assets and interest in serving the twelve unincorporated areas covered by Gateway Cities COG. SCE (https://www.sce.com/) recently made a strategic decision to not develop or own network assets as a line of business but they are supportive of others doing so.

Other stakeholders for Gateway Cities are the various special districts in the area. The school districts are under the umbrella of the Los Angeles Office of Education (https://www.lacoe.edu/). The Los Angeles Economic Development Corporation (LA-EDC, https://laedc.org/) plays a similar role for its area of influence, including improving digital inclusion and ensuring broadband is available throughout the area. While these stakeholders don't specifically focus on, let alone develop, network infrastructure, they are important advocates for its development.

There are also numerous community-based organizations and umbrella groups for them. Specifically, UNITE-LA (https://www.unitela.com/) leads collaborative education reform efforts, promotes business-education partnerships, expands college access, and provides workforce development to ensure underserved youth can participate in the 21st century economy. LA-EDC and UNITE-LA undergird LA-DEAL (https://ladeal.org/), which is working to eliminate the digital divide in L.A. County as the California Public Utilities Commission (CPUC) Regional Broadband Consortium for Los Angeles County.

The Southeast Los Angeles (SELA) Collaborative is a network of organizations working together to strengthen the capacity of the nonprofit sector and increase civic

engagement in Bell, Bell Gardens, Cudahy, Florence-Firestone, Huntington Park, Lynwood, Maywood, South Gate, Vernon and Walnut Park. It operates under the auspices of the Southeast Development Corporation (https://www.scdcorp.org/), which includes bridging the digital divide for students as one of its strategic priorities.

PRIVATE NETWORK SYSTEMS AND SERVICES

Nearly all network services are provided by private companies. Generally, these services are retail broadband for commercial and residential customers, enterprise network services and managed services, and radio-based wireless services (including cellular, which is technically mobile), point-to-multi-point, narrowband, and point-to-point.

Retail services require extensive network infrastructure due to the large number of customers involved, as well as operational systems to manage customer accounts and network performance. Enterprise and managed services are more focused, typically on large organizations, which generally means limited infrastructure. Cellular generally involves very large investments to license radio spectrum and establish interconnected cell sites throughout a service area. Other wireless network technologies accommodate more focused investment, even to the level that relatively small businesses can afford to own the infrastructure.

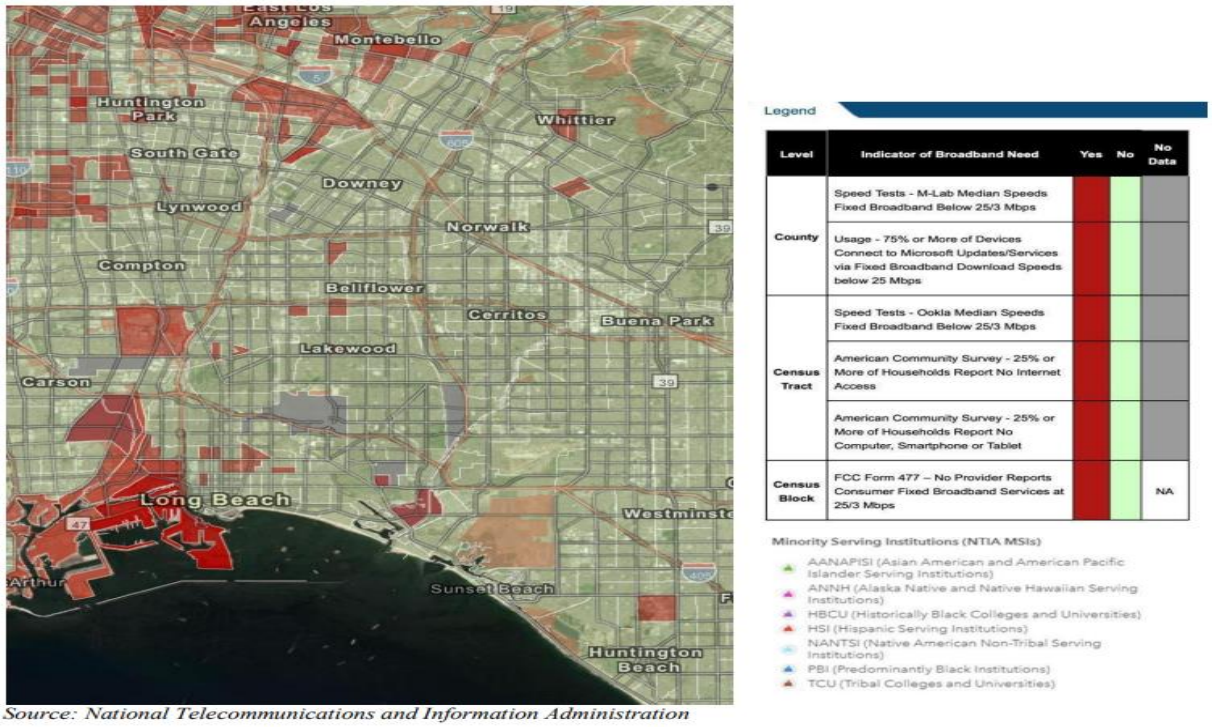
Retail Broadband services

Traditional, incumbent cable TV and telephone companies are “facilities-based” service providers—they own wired infrastructure they use to provide services. While originally focused on very different services, companies in both industries evolved into internet service providers (ISPs). Each had different legacy infrastructure. Cable companies used coaxial cable and telcos using twisted pairs wire. Each had historically different regulation, too. Telcos were required to provide telephone service available to everyone because it was deemed essential. Cable companies developed under local franchise agreements with limited-service areas.

While telephone and cable service territories overlapped in urban areas, there was no overlap (or overbuilding) within the industries. Cable companies would not compete head-to-head with each other, and telcos would not overbuild and compete with other telcos. Consequently, today most communities have a cable-telco duopoly. This also means most communities have two different sets of nodes and links comprising two separate network infrastructures.

Because DSL was provided over the same twisted pair wires used for telephone service, it is nominally available almost everywhere. Unfortunately, due to technical

and distance limitations, at best DSL can nominally provide only basic 25/3 broadband—25 Mbps downstream and 3 Mbps upstream in areas relatively close to the telco central office. Much of the wire used as links for this service is rather old and degraded, which means it has less capacity to carry data. Consequently, most DSL customers get 10/1 or slower, see NTIA map below.



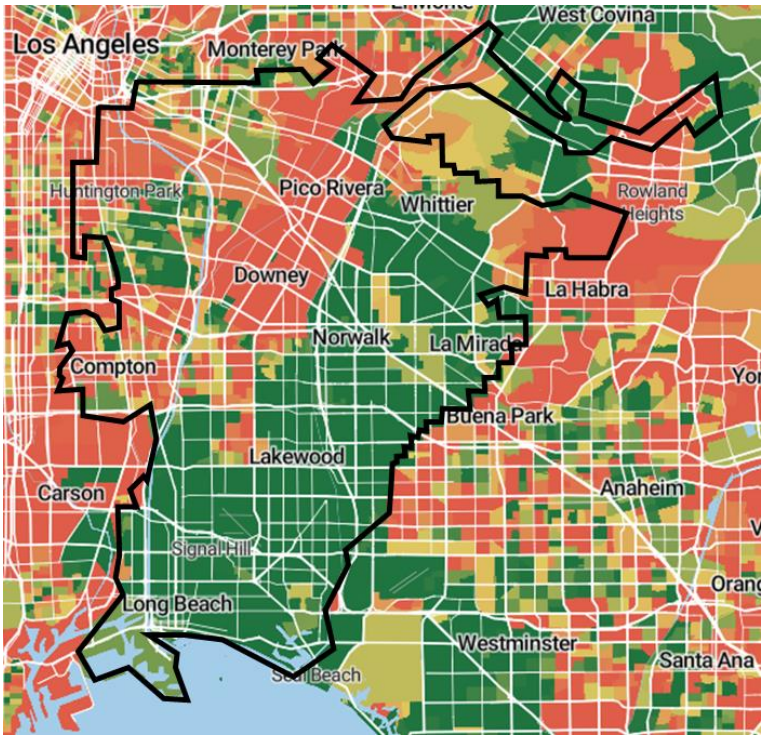
Source: National Telecommunications and Information Administration

Various ways of envisioning broadband availability are included here because (a) it is a difficult topic to assess and (b) various stakeholders have different takes on the topics. Major internet service providers in the market say all of Los Angeles County is fully served. Local community-based organizations and other community stakeholders deny that. Anecdotal evidence suggests the data presented here represent "best case scenario" for broadband availability, particularly for multi-dwelling units due to non-existent or outdated inside wiring.

Data suggests all premises in the Gateway Cities have DSL available to them. This is unlikely because DSL uses legacy twisted pair lines, many of which have degraded to the point that cannot support DSL. Also, the local DSL access multiplexer (DSLAM) nodes, which lines into customer premises to the telco's core network, have limited capacity. The companies would not expand or upgrade these devices. Instead, where

market forces dictate, the telcos overbuild old copper infrastructure with new fiber to the premises (FTTP). Rural and some urban core areas without burgeoning demand are stuck with DSL, if anything. This seems to be the case in portions of Gateway Cities area.

Coaxial cable has relatively high capacity compared to DSL, so cable companies have been able to deliver faster service by deploying fiber to the node (FTTN) at the neighborhood level, creating a hybrid fiber-coax (HFC) network infrastructure. With their deployment of the latest version of DOCSIS protocol, cable company ISPs can offer "up to" a gigabit speed throughout the Gateway Cities. Cable broadband has limited capacity to each local node that is shared among all subscribers in that area. Consequently, actual speeds may be much lower than what was offered, especially when a lot of people are online. This can especially be an issue in dense urban areas where it can be costly and difficult to deploy additional nodes.



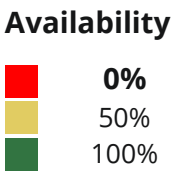


Figure 8. Fiber internet availability in the Gateway Cities area[1]

Fiber deployment for retail broadband in the Gateway Cities was led by Verizon with its Fios service, which it began deploying in 2007. Verizon sold its California properties to Frontier in 2016.[2]

Figure 8 shows fiber-based broadband in the Gateway Cities, most of which is Frontier's fiber. AT&T also has small amounts of residential fiber in some areas. In these green areas, consumers have a competitive choice of gigabit internet providers. In the red and yellow areas, Spectrum has an effective monopoly for high-speed services. They do have the same pricing in these areas as in areas where they have fiber competition from either AT&T or Frontier.

In Avalon the only broadband provider is Catalina Broadband Solutions, an independent local cable system that evolved into a broadband internet service provider. Given the companies' technology base, we presume it has not deployed fiber-to-the-premises and is probably using older equipment based on prior versions of DOCSIS. Its prices are quite a bit higher than other cable broadband companies. A new company, AVX Networks, is applying for USDA Reconnect Round 4 grant under the thesis that all of Catalina, including Avalon is unserved.

Table 2. Gateway Cities with retail gigabit broadband nominally available[3]

City	"Gigabit" Coverage	Other Coverage
Cerritos	▪ Spectrum 100% ▪ Frontier Fiber 99.6%	
Compton	▪ Spectrum 99.97% ▪ ATT Fiber 22.5%	▪ ATT DSL 97%

[1] Source: https://bestneighborhood.org/

[2] Frontier subsequently filed and emerged from bankruptcy in 2020.

[3] Available data indicates other Gateway Cities— Artesia, Avalon, Bell, Bell Gardens, Bellflower, Commerce, Cudahy, Hawaiian Gardens, Huntington Park, Industry, Maywood, Pico Rivera, Santa Fe Springs, Signal Hill, South Gate, and Vernon—and unincorporated areas have limited if any options for gigabit broadband.

Downey	▪ Spectrum 100% ▪ Frontier Fiber 4.8%	▪ Frontier DSL 97% ▪ AT&T DSL 3.25%
La Mirada	▪ Spectrum 100% ▪ Frontier Fiber 52%	▪ Frontier DSL 65%
Lakewood	▪ Spectrum 100% ▪ Frontier Fiber 84% ▪ AT&T Fiber 3.9%	▪ AT&T DSL 14.25% ▪ Frontier DSL 84%
Long Beach	▪ Spectrum 99.98% ▪ Frontier Fiber 94.25%	
Lynnwood	▪ Spectrum 100% ▪ AT&T Fiber 19.5%	▪ AT&T DSL 91.5%
Montebello	▪ Spectrum 99.5% ▪ AT&T Fiber 2%	▪ AT&T DSL 97%
Norwalk	▪ 98% Fiber Frontier ▪ 99.95% Spectrum	
Paramount	▪ Spectrum 99.7% ▪ AT&T Fiber 27.7%	▪ AT&T DSL 94.7 %
Whittier	▪ Spectrum 99.7% ▪ Frontier Fiber 70%	▪ Frontier DSL 100%

Current offerings for fast broadband, where available in Gateway Cities at the time of this research, were:

AT&T

- 300/300Mbps for $55/mo.
- 500/500 Mbps for $65/mo. For 12 mo.
- 1/1Gbps for $80/mo. for $36/mo. with a 1 yr. agreement
- DSL Services at any data rate: $50/mo.

Catalina Broadband Solutions

- 10 Mbps[4] for $49.95/mo.
- 15 Mbps for $62.95/mo.
- 25 Mbps for $79.95/mo.
- 50 Mbps for $89.95/mo.
- 100 Mbps for $99.95/mo.

Frontier

- 500/500 Mbps for $50/mo. For 12 mo.
- 1G (940M/880M)[5] for $75/mo. for $36/mo. with a 1 yr. agreement.
- DSL Services at any data rate: $50/mo.

Spectrum

- 400 Mbps[6] for $40/mo. for 24 mo.
- 1Gbps for $60/mo. For 24 mo.

Major Broadband Service Providers

Broadband service in the Gateway Cities area is dominated by Spectrum and Frontier. AT&T has a small footprint in some areas. This section will provide a brief overview of these companies and their likely near-term strategies in the Gateway Cities area.

Spectrum

Spectrum (Charter/Time Warner Cable) is the second largest cable company in the USA with revenues near $50 Billion per year. They have close to 30 million residential subscribers and over 2 million small and medium business customers. Only Comcast is larger.

Their residential offerings are a consumer-grade service using their existing cable-TV hybrid-fiber-coax (HFC) network. The downstream rates offered are 100's of Mbps to 1.2 Gbps. The upstream rates are below 50 Mbps for even the highest downstream offering. All rates are "up-to", as the HFC network's total available bandwidth is

[4] Catalina Broadband Solutions does not state offered upload speeds. Generally, these are 1/10 of download.

[5] The 940/880 Mbps in Frontier's "1G" offering is due to protocol overhead in a 1 Gbps physical connection.

[6] Spectrum does not publish their upstream data rates. Given their legacy architecture we do not expect them to exceed 50 Mbps.

shared amongst 250 to 500 homes per node. The actual performance will vary depending on the time of day and number of active users on the network.

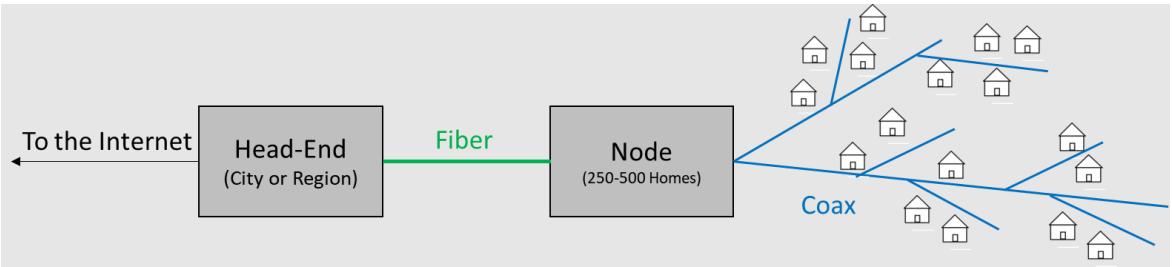


Figure 9. Cable Hybrid Fiber-Coax Architecture (HFC)

Spectrum, and the cable industry in general, has an upgrade path to multi-gigabit services with DOCSIS 4.0. New equipment at the headend (main local network node for cable companies) and customer premises equipment are required for advanced features and speeds. Thus, the upgrades will likely be concentrated initially in the more competitive markets. Many of the required upgrades are part of a general plan to push fiber closer to the homes and eliminate as many costly analog amplifiers as possible.

This issue for the Gateway Cities area, given Spectrum's large national footprint, is when will they upgrade this area. DOCSIS 4.0 won't be widely available until 2025-2026 and will be rolled out based on many factors including the competitive fiber from the incumbent telco. Spectrum takes a regional approach and will likely upgrade the entire southern California region at once. The Gateway Cities area is densely populated, which makes it a critical region for Spectrum, so we expect this area to be on the forefront of upgrades.

Frontier Communications

Frontier Communications is a large US-based telecommunications company that has undergone numerous acquisitions, mergers, and divestitures. It was originally founded in 1935 as an independent (non-Bell System) local telephone company. In the early 1990's it began acquiring rural telephone lines from other independent telcos, such as GTE, around the county.

Frontier Communications acquired Verizon's Incumbent Local Exchange Carrier (ILEC) business in California in April 2016, but subsequently filed and emerged from bankruptcy in 2020. The acquisition included Verizon's Fios Fiber-to-the-Premises (FTTP) network. Frontier now calls this Fiber Broadband and has a more aggressive FTTP buildout plan upon emergence from bankruptcy. Most of the fiber availability shown in Figure 8 is legacy Verizon Fios, now owned by Frontier.

Frontier's current fiber infrastructure is based on G-PON, or Gigabit Passive Optical Network. This is a 2.5 Gbps downstream/1.25 Gbps upstream architecture and that bandwidth is shared between 16-32 households. 2.5 Gbps share over 32 homes is about 78 Mbps per home. This limit would only apply if every home was a heavy user at the same time so actual data rates are effectively much higher.

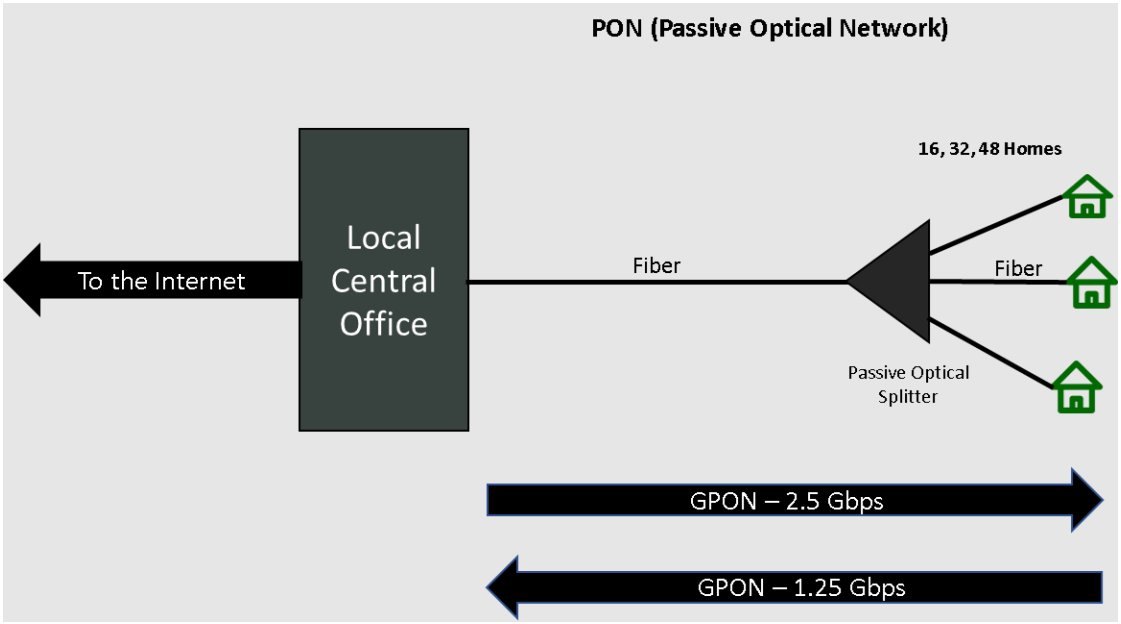


Figure 10. GPON architecture

10 Gbps XGS PON is the most common architecture deployed today and 25 Gbps and 50 Gbps PON architectures are on the way. For Frontier, an upgrade to XGS-PON would require new electronics in the central office and new customer premises equipment (e.g., Wi-Fi Routers) but not expensive new fiber construction. The issue for the Gateway Cities area is when will Frontier upgrade beyond GPON. Frontier operates in 22 states, and it is not clear when or where in the Gateway Cities region will be upgraded under Frontier's modified fiber deployment plan. Their stated strategic focus is to deploy new fiber in the legacy copper areas and not upgrade existing networks.

AT&T

AT&T is the incumbent telephone company in several of the Gateway Cities, including Compton, Lynnwood, Montebello and Paramount. They also serve parts of Lakewood and unincorporated areas. AT&T is essentially SBC (Southwestern Bell Corporation) which bought AT&T Long Distance years ago and kept well known AT&T brand name. SBC also bought fellow ILECs Pacific Bell, Ameritech and Bell South. As a result, AT&T provides local wired broadband and telephone service to much of the USA, depicted

in Figure 11. They also have a nation-wide mobile network and are deploying a lot of fiber to support towers and small cells as they expand their 5G coverage.

Figure 11. AT&T's local telephone and wired broadband service areas

For broadband internet, they have invested primarily in DSL (Digital Subscriber Lines) technologies which enable data services over their installed base of copper phone wires. The data rates supported by DSL depends on the length of the copper wire and the type of DSL deployed. To increase data rates AT&T has deployed limited fiber to select street cabinets and neighborhood pedestals.

Their yearly capital budgets may be measured in the $10s of billions but this must be spent throughout their footprint including for national 5G rollouts. The issue for Gateway Cities is when and where AT&T will deploy fiber in the region.

Private Fiber Networks

Long-haul Fiber

Fiber optic networks are classified by the types of access they accommodate. Long-haul networks connect major cities and distant facilities to each other. Generally, it is only possible to connect with long-haul fiber at specific points-of-presence in major internet exchange points. Most of the long-haul fiber in the area, shown in Figure 12, is owned by AT&T and Lumen Technologies (formerly CenturyLink, which acquired Level 3 Communications). AT&T's fiber is in the I-10 corridor. Lumen's routes are in Union Pacific railroad right-of-way along the western edge of the area and running east-west through South Gate, Downey, Norwalk, and La Mirada. T-Mobile (formerly Sprint) and redIT also have fiber in this route.

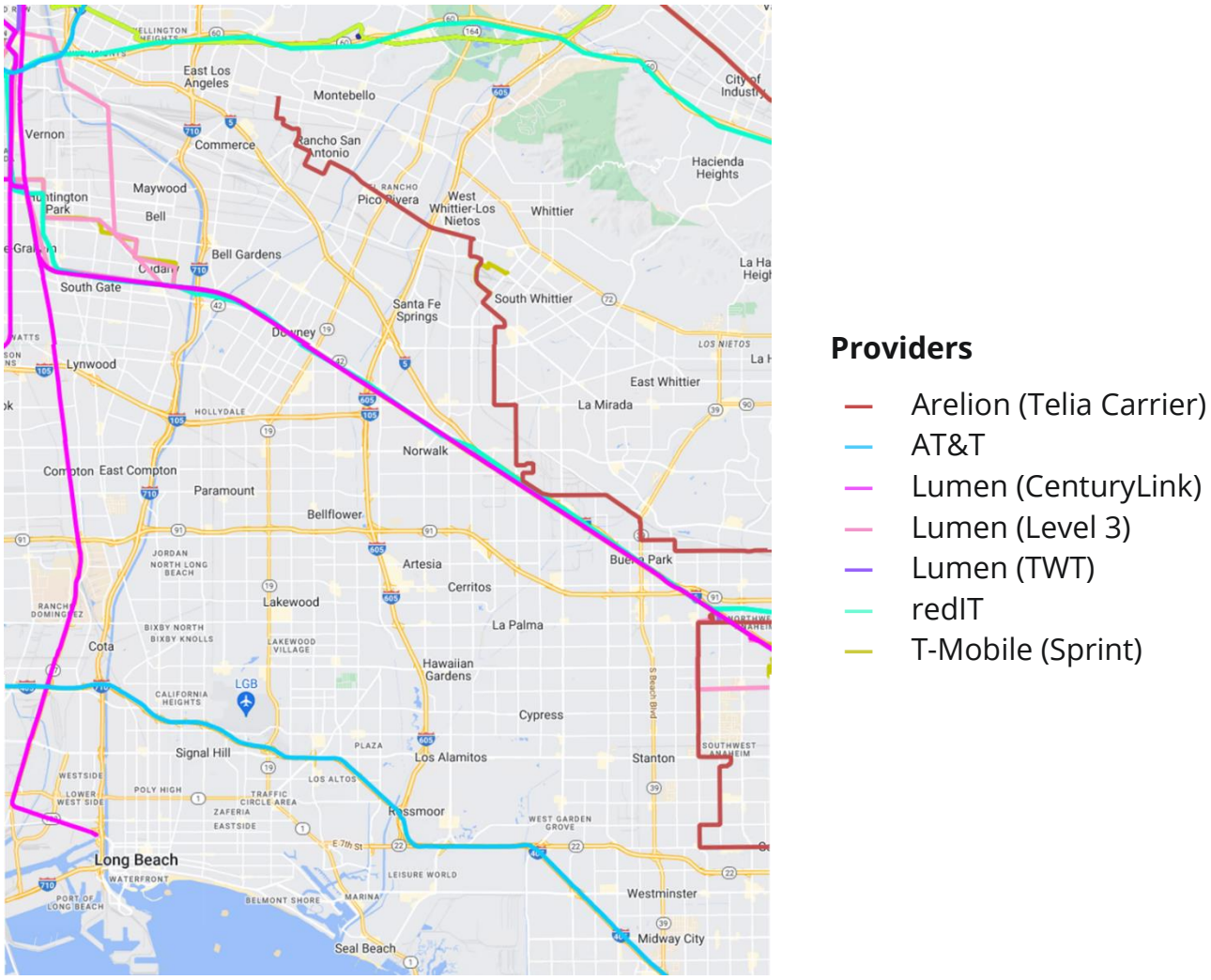


Figure 12. Long-haul fiber routes through the Gateway Cities area

Arelion, a global network company based in Sweden, with nearly 45K miles of network in 125 countries, has several routes through Gateway Cities, one of which appears to terminate at an AT&T central office at 6135 Whittier Blvd in East Los Angeles. This route wanders through Pico Rivera, South Whittier, La Mirada, and Norwalk, then extends south, paralleling I-5 and I-8 before terminating in a rural area. Arelion also has a route in the Union Pacific railroad right of way through the City of Industry that extends west to the internet exchange at One Wilshire in Los Angeles, then north, and east to Phoenix. These two routes do not appear to interconnect.

Metro Fiber

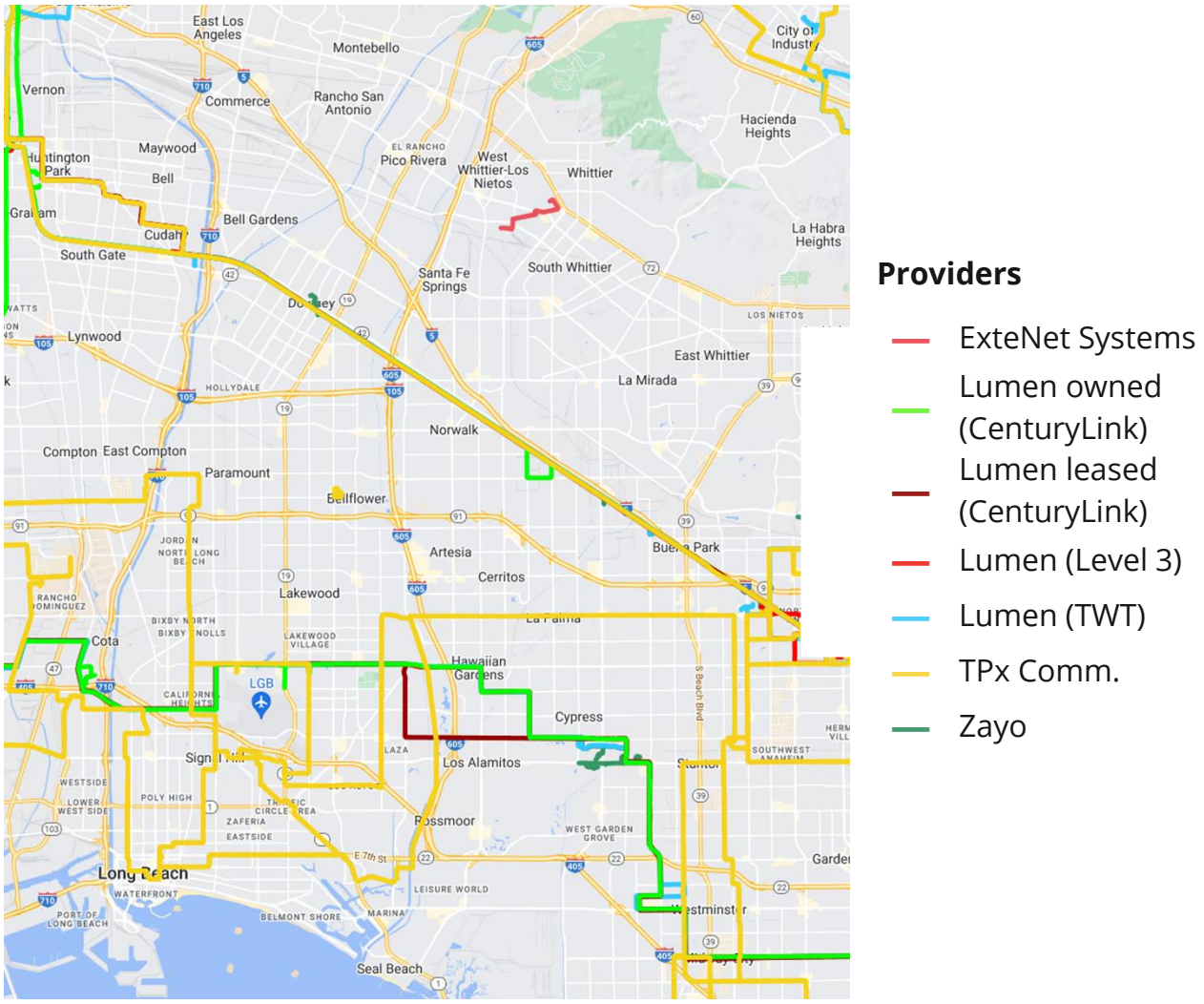


Figure 13. Metro fiber routes in the Gateway Cities area

Metro networks, as the name implies, are designed to connect major sites to each other, data centers, and other service providers across a metropolitan area, typically via co-location at or exchange facilities. Middle-mile networks are like metro networks but typically extend access to interconnection points in major cities.

As illustrated in Figure 13 there multiple metro networks in Gateway Cities. Besides Crown Castle, discussed below, TPx Communications has the most extensive fiber routes. What is not apparent from this map is that several providers share routes. TPx appears to have fiber in the same railroad right of way as the Lumen long-haul. They also have multiple routes through Long Beach, Signal Hill, Paramount, and Cerritos. Zayo appears to share routes with various Lumen metro fiber inherited

from CenturyLink and Level 3, which run along Wardlow Rd and Carson St, around Long Beach Airport and through Hawaiian Gardens.

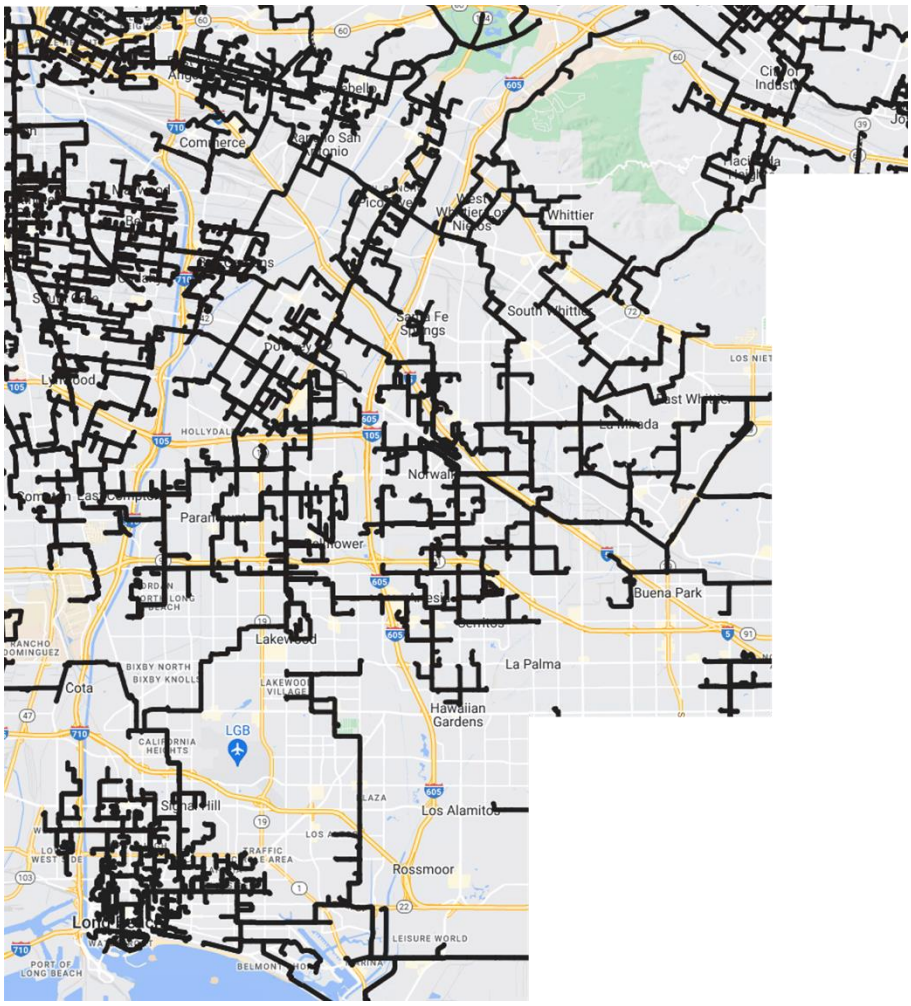


Figure 14. Crown Castle fiber routes in the Gateway Cities area

Crown Castle has a very extensive metro fiber in the Los Angeles region, including the Gateway Cities area. See Figure 14. These routes were developed to serve businesses, cell sites, and other locations. Crown Castle positions itself as infrastructure provider to other providers, particularly focused on connecting small cells and towers (macrocells). SiFi has development agreements with Downey, Lynwood, and Pico Rivera for similar infrastructure built via micro-trenching.[7]

[7] See https://sifinetworks.com/ for more information about SiFi and https://potsandpansbyccg.com/2017/03/31/the-pros-and-cons-of-microtrenching/ for analysis of micro-trenching as a fiber deployment method.

California Statewide Middle-Mile Network

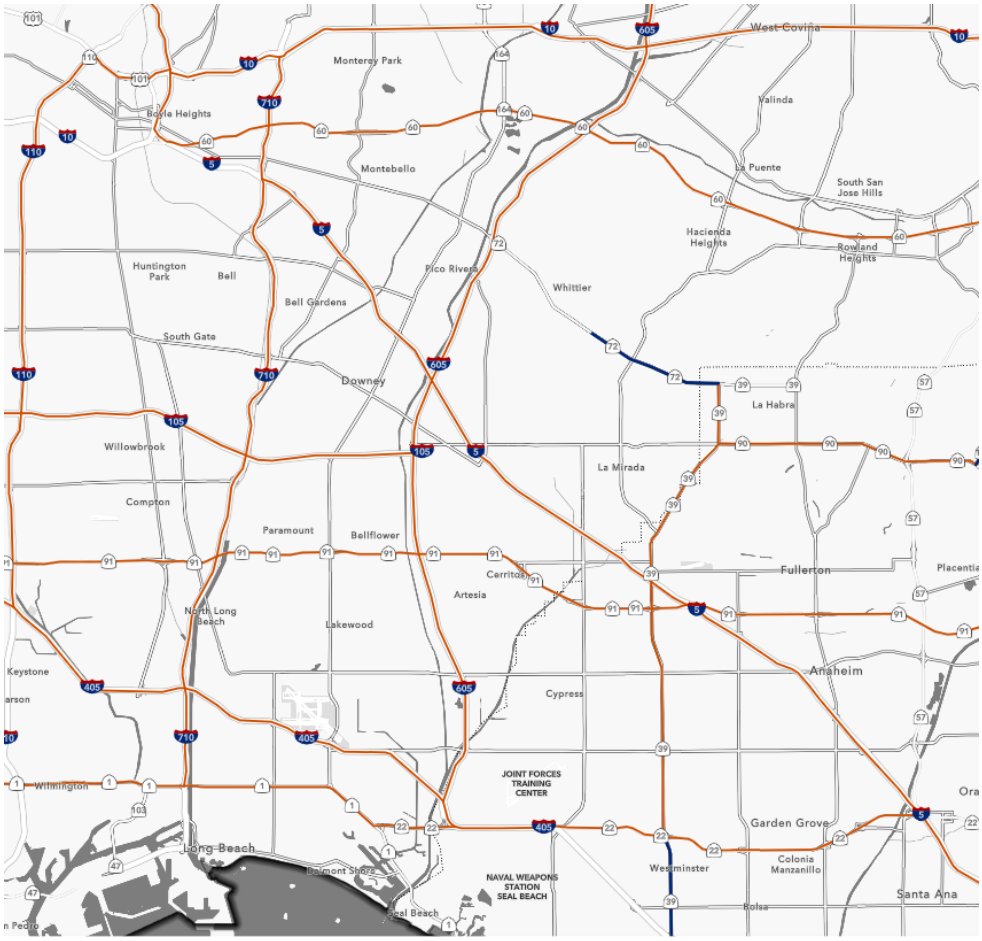


Figure 15. California statewide middle-mile routes and spurs in the Gateway Cities area

The State of California plans to spend $3.25B from the s an funds to build a statewide open access middle-mile ne be built by a new organization, GoldenStateNet (GSN), spun out from CENIC, which operates the state's education and research network, CalREN, in Caltrans rights-of-way, under direction of the California Department of Technology (CDT).

The specific design for GSN was still in flux at the time of this research. Figure 15 shows the most current location of its routes in the Gateway Cities area. The stated intention of GSN is to allow very flexible access, placing hand holes and splice cases wherever needed for making full use of the GSN fiber.

Radio Communication Assets

Radio communications includes any means for establishing links without wires via electromagnetic spectrum between 1 Hz and 3,000 GHz. This requires an antenna, which send signals out as radio waves, and base station, which generates the radio signals from data or other signals. Coverage of radio communications—or propagation—depends on the height of the antenna, the power of the signal, and the radio spectrum: low frequency signals travel farther and are less susceptible to interference but have greater information carrying capacity.

For broadband and other network services, this means an antenna must go somewhere. For "traditional" cellular, this means on a tower or large pole (i.e., monopole). In the Gateway Cities area there are over 200 cell sites, illustrated in Figure 16, at least 152 of which are in city limits while the others are in unincorporated areas, including Black Jack Peak on Santa Catalina Island. About 90% of these are on monopoles, which average less than 58' tall. Less than 10% are on taller—86' on average—self-supporting towers. There are other tower sites not included in this data, such as towers on Ridge Fire Rd in Whittier, which that city uses for microwave links to some of its facilities.

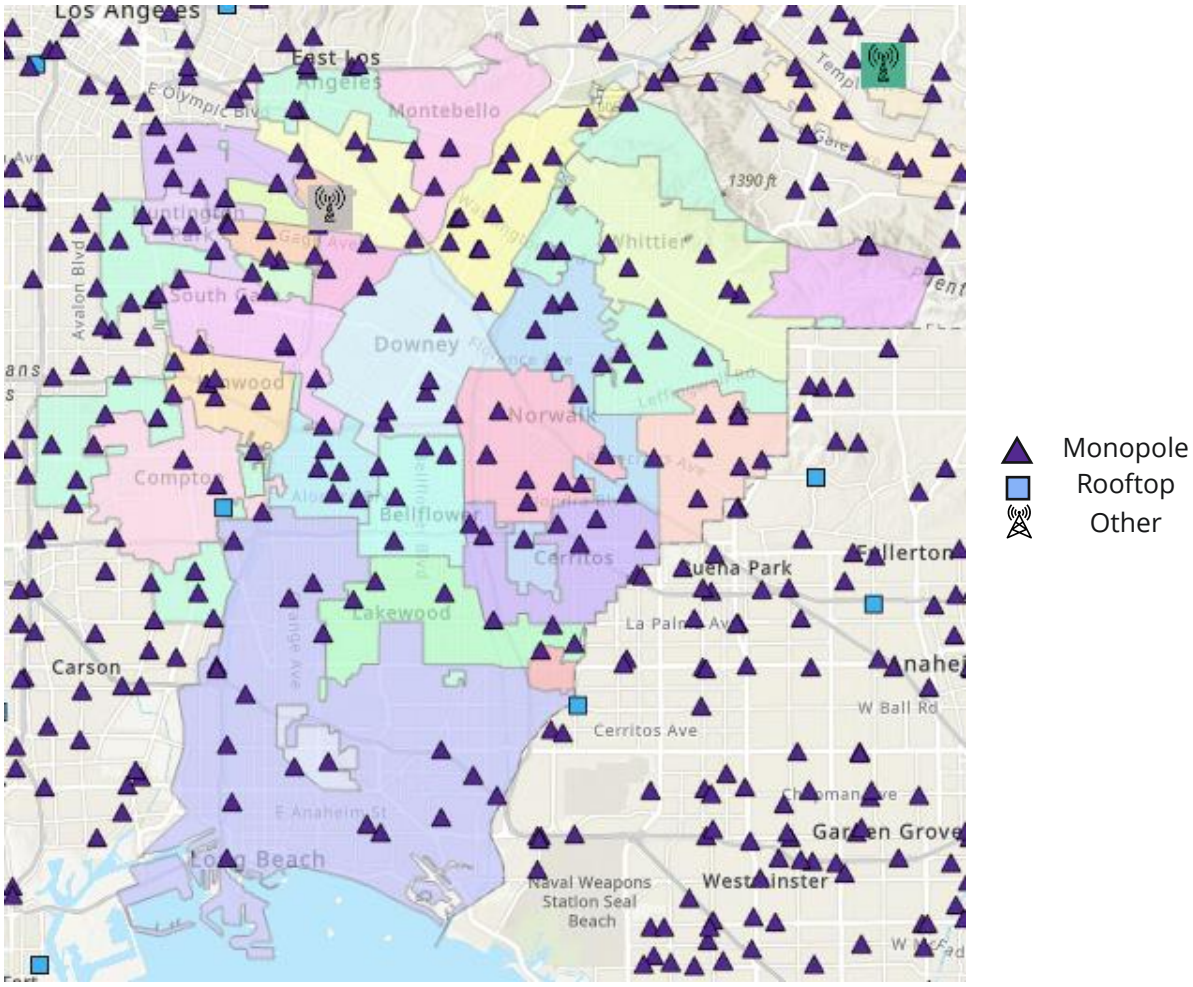


Figure 16. Locations of cell sites in Gateway Cities Area[8]

According to data provided by cellular companies to the FCC, the area has effectively total coverage with 4G LTE cellular data services from all three major providers, as shown in Figure 17, except for a few areas in and around the City of Industry, at the Port of Long Beach, and much of Santa Catalina Island.

[8] Sources: Homeland Infrastructure Foundation-Level Data (HIFLD), accessible at https://hifld-geoplatform.opendata.arcgis.com/, and ArcGIS REST Services Directory, hosted at https://services7.arcgis.com/HJ6NuXYZF6fDjms9/ArcGIS/rest/services/Sites_(Tower_and_Rooftop_Sites_View)/FeatureServer/0.

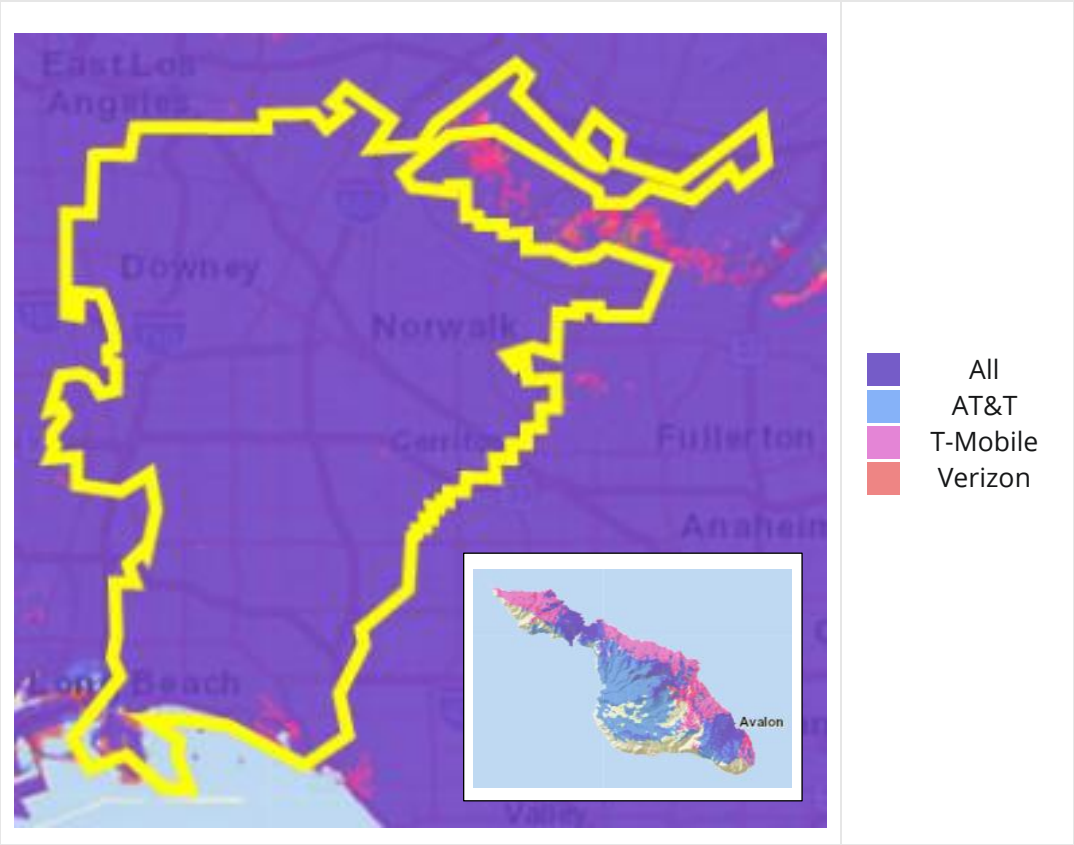


Figure 17. 4G LTE coverage in the Gateway Cities area (source: FCC[9])

As demand for higher speeds, more flexible, and reliable connections have increased, there has been a proliferation of smaller wireless infrastructure, generally referred to as radio access networks (RAN). This is particularly evident in the growth of Wi-Fi access points and networks. Most broadband routers today include a wireless local-area network (LAN) protocol. Each Wi-Fi access point can support multiple networks, and Wi-Fi networks can be virtually deployed to numerous access points via a centralized service. Many businesses offer Wi-Fi as an amenity to customers and other guests, and many local governments and other institutions provide open Wi-Fi in public spaces. The result is that Wi-Fi connections are widely available but rather inconsistent.

Newer wireless technologies—particularly 5G and Citizens Broadband Radio Service (CBRS) but also next generation Wi-Fi, Terragraph, and Low-Power Wide Area Network (LP-WAN)—and the trend to have more, smaller devices and intelligent appliance, vehicles, etc., has dramatically increased deployment of more, smaller

[9] https://fcc.maps.arcgis.com/apps/webappviewer/index.html?id=6c1b2e73d9d749cdb7bc88a0d1bdd25b

wireless network nodes. Specifically, many cellular companies have deployed small cells on streetlights and utility poles to increase capacity and coverage. More of these will be needed as 5G is rolled out in earnest. Also, some services have moved to non-traditional connections, such telephone calls over Wi-Fi. It is now possible to most anyone to deploy tiny, connected devices via the Things Network[10], which doesn't require centralized wireless nodes.

RANs have distributed infrastructure with centralized management. This means various wireless access infrastructure assets can be integrated into highly flexible networks. For example, several ISPs allow any customer to connect to secured Wi-Fi via business customers. Another example is private LTE networks, which can operate seamlessly over private infrastructure as well as public cellular networks, have proliferated in recent years. More small virtual networks will grow as RANs improve, become more inclusive of various technologies, and incorporate more, smaller wireless nodes.

Data Centers

Co-location facilities, data centers, and other nodes where multiple networks interconnect—also called meet-me rooms—are where service providers to interchange network traffic. Each provider requires two or more high speed paths into such facilities. One Wilshire Boulevard in Los Angeles, one of the largest interconnects in the world, is a prime example. There are over 250 service providers and cloud companies that interconnect there. A cluster of data centers has developed in the buildings around it (Figure 18). There are three data centers located in the Gateway Cities:

- Cogent La Mirada, 16680 Valley View Ave, La Mirada
- Long Beach Data Center, 3910 E 7th St, Long Beach
- Vernon Data Center, 5001 S. Soto St, Vernon

[10] https://www.thethingsnetwork.org/

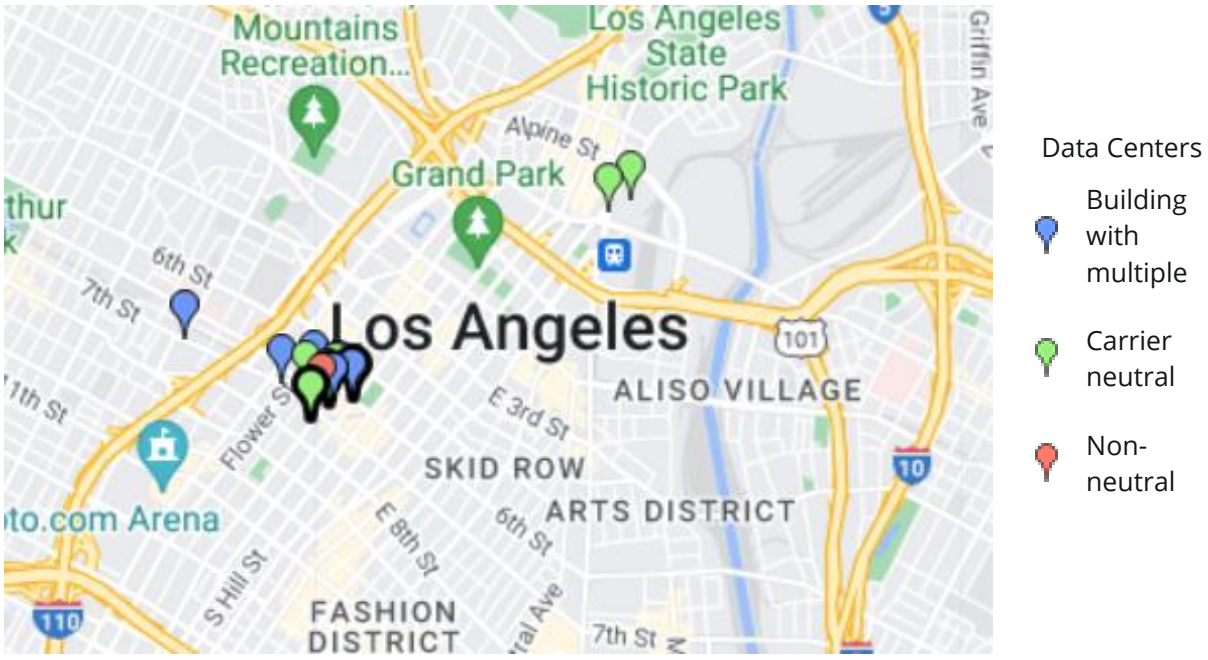


Figure 18. Data center ecosystem around One Wilshire Boulevard in Los Angeles (Source: Datacentermap.com)

Data centers are important because that is where most data for businesses and consumers are processed and stored, rather than on-site, on local computers. There are two conflicting realities at play. On one hand, distributing processing and storage, putting them as close to consumers as possible, improves performance of applications and reduces traffic on long-haul and middle-mile network links. It also increases resilience by replicating data in various locations.

On the other hand, centralizing data processing and storage reduces operating costs. With decreasing costs for data storage and increasing demands from data-intensive applications and high-bandwidth access, highly distributed approaches, generally referred to as “edge processing” are becoming more economical and practical. Edge processing requirements are driven by the wireless trends discussed above and by increasing availability of fiber. More nodes, generating more data, using more bandwidth, including on the go, require more distributed data processing and storage.

CONCLUSIONS AND IMPLICATIONS

While the Gateway Cites have substantial network systems and services, they do not seem adequate for some of the most densely populated areas of the country. With over 2M inhabitants and 850K workers, more than 600K households, and nearly 70K

business establishments in 27 cities and a dozen unincorporated areas, one would expect a larger base of network assets and services. The issues emerge with a deeper look at the numbers: Nearly 70% of the households earn less than $100k per year in the heart of the Los Angeles metro area. More than half the employment is in retail and services. While manufacturing features prominently in the economic base, it is concentrated in a few locales and is shrinking.

Beyond issues with the market for network services, the density and diversity of the area creates challenges for deployment. There is a great deal of existing infrastructure to work around. Buildings have to be retrofitted to accommodate next generation network technologies. Providers must work with multiple cities, some with limited staff capacity, and Los Angeles County to deploy infrastructure and offer services. The cultural diversity creates challenges, too, as any provider will need capabilities to interact with persons of various backgrounds. Any effective efforts to increase connectivity would almost have to involve the wide range of community-based organizations in the area.

The implication is that only large, well-capitalized providers are likely to make serious efforts to deploy or expand services in the Gateway Cities under current conditions. These companies are likely to take a general “steamroller” approach to broadband development as part of larger regional or national plans. Smaller providers would have to take a focused approach, serving only a limited area or set of customers. Unfortunately, Gateway Cities’ density, diversity, and economic position mean it is unlikely to be a leading area for further broadband development. That development is likely to occur in a manner that avoids involving community stakeholders or tailoring overall approach and specific services to community members. It will focus on the more affluent, competitive area to the south and on the major economic drivers for the region. Underserved areas will likely remain underserved absent action and investment by Gateway Cities COG.

3. Network Infrastructure

This section provides cost estimates and technical specifications for the various types of network infrastructure. Generally, networks are structured hierarchically. Each connected location has customer premise equipment (CPE) and a "drop" or other physical connection to CPE. The drop terminal is the interface between access infrastructure and CPE at the edge of the network. Beyond that, devices, equipment, and infrastructure are the responsibility of the network user. Drops are aggregated via access infrastructure connected to distribution equipment in hubs, which are connected to backbone or feeder networks. Backbones are built as rings to minimize risks from an equipment failure or fiber cut. The rings are interconnected to increase flexibility and resilience.

The local networks interconnect with long-haul and middle-mile networks but are typically totally separate infrastructures. Special purpose networks, particularly for utility SCADA systems and traffic signal interconnects, are typically totally separate infrastructures. Education, healthcare, and public safety may have separate, parallel networks. The standard medium for all these networks is optical fiber, although radio-based wireless connections are common in access infrastructure and other settings. Fiber has more capacity, but radio is more flexible. There is also a good bit of legacy copper coaxial and twisted pair cables but that is generally being phased out. All these forms of network infrastructure can and do coexist and interconnect.

More generally, local network infrastructure can be thought of as "backbone," "last mile," and middle-mile. Backbone routes follow major thoroughfares, as well as some secondary streets where appropriate to complete a ring. Spurs extend into remote areas where it is not practical to complete a ring. Last-mile infrastructure, also referred to as "edge networks," reaches into homes, offices, vehicles, and literally the palm of your hand. Middle-mile infrastructure interconnects backbones and major sites.

The Gateway Cities COG is not going to become a retail broadband service provider, so is unlikely to deploy last mile distribution and access infrastructure. The California statewide middle-mile and private providers have extensive middle-mile infrastructure in the area. Therefore, we focus on backbone infrastructure, which could be leased to network service providers to use as feeder network. We also review options for access infrastructure because (a) it defines prospective providers' capital investment and connectivity requirements, (b) it is required for achieving some of the City's goals, mission, and vision, and (c) the city may decide to deploy it for specific projects or purposes.

FIBER BACKBONE

A fiber backbone connects major sites together via high-strand-count (at least 288 fibers) physical cables, which are deployed overhead, attached to utility poles, or underground, in conduits. Distribution and access infrastructure, discussed below, represent much larger investments. The backbone, or feeder infrastructure, is the foundation for any network. For this reason, a sub-regional backbone has been the focus of this plan from the beginning.

The Gateway Cities saw a "digital divide" between internet services for their communities and other, more affluent areas created by the lack of backbone infrastructure. It created a huge barrier to providing access for everyone in the Gateway Cities area. Therefore, a fundamental purpose of the planning effort was to "develop a master plan for a high bandwidth backbone network… [to]… tie together the various area networks found in the 27 incorporated cities and 12 unincorporated communities of the Gateway Cities."[11]

Conceptual Network Design

A conceptual network design is a planning tool. It is a starting point that allows for initial analysis of costs and coverage to inform decision-making, and it is expected to be modified substantially as it evolves into more detailed designs. The basic concept for a Gateway Cities backbone was to interconnect the 27 city halls via routes adjacent to if not through unincorporated areas. A fundamental goal of network design is to minimize costs by connecting locations as directly, with as few route-miles, as possible, while also avoiding costly feature such as railroad and water crossing. This "shortest path" imperative must be balanced with the need for redundant routes for reliability. It was also limited by the fact that one city hall—Avalon—is on Catalina Island, 30 miles from its closest neighboring Gateway City.

Another key design concept emerged with the announcement of the state middle-mile network and consequential decision to deploy backbone fiber through CalTrans rights-of-way, which are extensive throughout the Gateway Cities. GSN infrastructure will be in or near all Gateway Cities' communities. It simply does not make sense to overbuild Golden State Net (GSN), especially as leaders of the new organization committed to make their infrastructure very accessible and usable.

[11] Request for Proposal: Gateway Cities Regional Broadband Master Plan, Gateway Cities Council of Governments, August 26, 2021, pg. 5, ¶6.

Therefore, the design concept for a Gateway Cities backbone network was to interconnect the 26 cities as economically as possible via the GSN. Figure 19 illustrates the resulting design. Basically, the design is for local sub-rings to one or more city halls extending from the sub-regional rings provided by GSN. Appendix A contains more detailed maps of each sub-ring.

Only the Avalon city hall is outside this design due to its location. Generally, it would require a submarine cable connection from the Port of Long Beach, or other site on the mainland, to some point in or near Avalon Bay. The Gateway Cities COG position is that this cable should be part of the statewide middle-mile network.

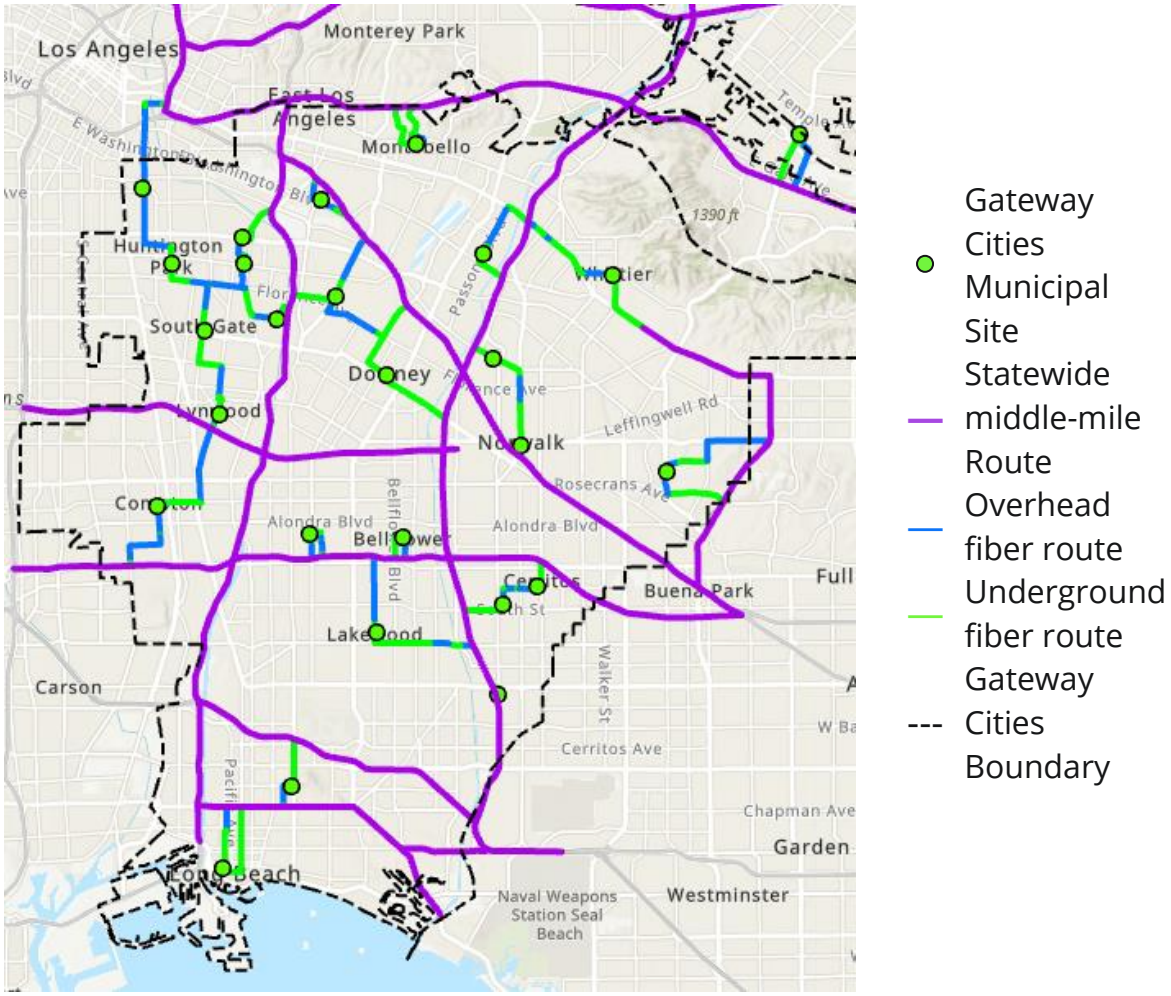


Figure 19. Conceptual design for a sub-regional backbone interconnecting Gateway Cities' city halls via the GSN.

Assumptions

The assumptions behind this design were (a) it would be a complete new-build that was (b) a combination of overhead and underground deployment, (c) connecting to the GSN at freeway/highway access/egress points (where fiber can run along off- and on-ramps, which is typical with such deployments). Connections to GSN may not be limited to these locations but we could not assume that because specific design and deployment decisions are still pending. While we know some Gateway Cities have extensive fiber, we could not assume that fiber would be available for use in this design because we do not have detailed information about availability or quality of that infrastructure. The design includes two separate conduits with shared access points (hand holes) at regular intervals and hubs at key locations.

Costs

The conservative estimate of the cost to implement this design, including 20% construction contingency costs but not including any costs associated with the GSN, is $36M. The actual backbone fiber is 94% of this cost. Laterals from the backbone into specific locations— "distribution" infrastructure—are less than 6% of the total cost but have substantially higher per unit costs: $125 per foot verses $85 per foot on average for backbone fiber. Part of the cost difference is attributable to laterals being completely underground while over 40% of the backbone design is overhead. With this design, it would cost an average of $1.4M to connect each of the 26 mainland Gateway Cities. Assuming a cable landing near the pier at 500 Crescent Ave, it would cost approximately $150K to extend backbone to Avalon City Hall. A single subsea fiber route would cost approximately $17M to construct. Redundant fiber routes would cost approximately $25.5M if deployed in a single project.

There are multiple factors that can profoundly impact costs. Possibly the largest cost savings may come from using existing public-owned fiber. The conceptual design, for example, parallels existing and planned city-owned fiber routes in Downey. Practically the entire cost of that sub-ring could be eliminated by using existing fiber. But it is unclear to what extent that fiber could be used for access services, particularly by private sector partners. We know several cities have fiber, as does LA County Department of Public Works for traffic signal interconnection. Other infrastructure, such as the LA Metro light rail may have fiber assets along its routes. There are also extensive—albeit not as extensive as the market seems to warrant—private sector network assets throughout the area.

Detailed information about the location and disposition of the public-owned fiber will be necessary to effectively cost-engineer the conceptual design. Similar information about private network assets and owners' willingness to swap infrastructure for

services (or other infrastructure) could also enable deep cost reductions. Demand data, even just about addresses of commercial, institutional, and residential premises would also be very helpful for optimizing the conceptual design and evolving it into a low-level engineering design.

Including network assets in other capital improvement projects can be a powerful means to reduce deployment costs. Specifically, the Gateway Cities COG's "Complete Streets" plans call for improvements along the Artesia Ave, Atlantic Ave, Florence Ave, and Lakewood Blvd, and Long Beach boulevards. At least Avalon, Cerritos, Downey, Lynwood, Santa Fe Springs, and Southgate have capital improvement plans that could accommodate network infrastructure. Including fiber along these routes would effectively cover much of the entire area from north to south and east to west. These routes run through under-served areas so this approach would effectively drive bandwidth into areas where it's needed most. Joint network builds could bring new, high-capacity fiber within a mile of most locations in the area, and they would add new meaning to "complete streets." Additional, detailed data will be needed for a high-level design that capitalizes on these opportunities.

Coverage

Beyond the city halls, 25 of the 221 municipal sites identified by the Gateway Cities were within "drop distance" (500 feet) of the backbone sub-rings. Many other municipal assets could also be connected via the sub-rings. The City of Downey, for example, could connect 345 of its traffic signals via this fiber. Approximately 7% of streetlights, which can be useful for wireless access points, are on the fiber routes. Numerous anchor institutions are also along these routes. See Appendix A for more detailed analysis of the sub-rings' coverage, showing adjacent and nearby sites.

Our analysis of Census data sourced via the CPUC indicates over 75K residential units and over 10K commercial units are within drop distance of the backbone routes. This equates to an astounding average of 1,200 prospective subscribers per mile along the backbone routes. The lowest average is in the City of Industry, which has a very small residential base, at 241 units per mile, which is easily enough to justify private interest. The Long Beach sub-ring, which is only 4.25 miles, passes within drop distance of over 13K commercial and residential units.

While these coverage statistics are impressive, modifications to the routes could greatly increase coverage. This would mean an expansion of the design concept to focus on supporting broadband services, which would come with substantially higher costs. For example, extending the Long Beach sub-ring along Pacific and Long Beach boulevards would pass numerous anchor institution sites, streetlights, and traffic signals, as well as commercial and residential units. Whether this would incorporate

City of Long Beach fiber and/or complement "complete streets" fiber along Atlantic Ave depends on availability of assets and flexibility of plans. Additional information and data about anchors, assets, and premises will be needed for detailed design to maximize coverage while minimizing costs.

Managing the Backbone

Backbone fiber can be managed as a physical asset by assigning specific strands to specific users, commonly on a lease basis, and uses. Strands in various cables must be physically spliced together or optically interconnected, including via splitters, to form complete paths so that any light shone (transmitted) down the fiber is seen (received) at the other ends. This approach has relatively low cost because it doesn't require purchasing or operating equipment, but it can also be very inefficient.

For example, if two strands in a 10-mile-long backbone (20 strand-miles total) are used to connect two sites that are a mile apart (2 strand-miles), the other 18 strand-miles become stranded and can only be used on each side of the interconnected sites. This approach also misses the benefit of redundant paths: If the fiber is cut between the two sites, the connection is lost because the information cannot flow in other directions. The key to effectively managing capacity is detailed information about sites to be connected along with additional infrastructure to aggregate traffic onto the network without having to dedicate strands to particular sites or types of sites

Fiber Construction Methods

There are many different construction methods to deploy a fiber optic network, some use existing infrastructure and other methods are new and require substantially more labor, materials, and expertise. There are types of construction that are better to use when a speedy deployment is desired. The baseline cost for fiber construction is approximately $95 per foot.[12] Plan for 20% contingency, which makes total baseline planning costs for fiber about $114 per foot or about $600K per mile. The specific type of construction depends on the built and natural environment and the location of sites to be connected. About 40% of the Gateway Cities conceptual design is overhead, which substantially reduces the average per unit cost to less than $90 per foot.

[12] Based on Magellan Advisors' information about current market conditions in the region and state, including local prevailing wages.

Aerial or Overhead

Overhead deployment can cost 60% less than the baseline cost, assuming the cable can be attached to existing poles.[13] Poles must be inspected and engineered to make sure that a new cable does not "blow" the pole. A blown pole means that the pole is unsafe and has more weight on it than it can safely handle. If the engineering proves the pole can support new cable placement on an existing strand, then placing a new cable on an existing strand can be a desired method. Cost for aerial fiber is between $40 and $60 a foot in favorable circumstances.

Boring/Directional Drilling

Direction drilling aka boring, requires a large, 4'x4'x4', hole to be dug for each 300'-500' segment. Locating the existing utilities is required and anytime the bore path crosses a utility, that utility must be "potholed" and physically located to verify the boring will not contact and damage existing utility facilities. Potholes slow the process of boring down, especially when numerous potholes are necessary. Next to open trench, boring is the most expensive construction method. Costs can range from the baseline amount to as high as $250 per foot in dense, highly developed urban areas.

Microtrenching

Microtrenching is a method of creating a small trench approximately 2" wide and up to 24" deep. It is approximately a quarter of the baseline cost. A machine with a carbide tipped blade cuts through rock, asphalt, concrete, dirt, etc. to make the trench. Then a conduit is placed in the bottom and the trench is then backfilled and compressed. The top 2"-4" is capped with different sealants and substances to protect the trench from accidental damage and prevent moisture from seeping into the ground and causing other serious issues. While cities may be hesitant to use or allow microtrenching due to the shallow depth of the conduit and risk of damage from other excavation efforts including water emergencies as well as the poor restoration that can occur, recent State of California legislation[14] requires it to be accommodated.

[13] General Order 95 contains the California Public Utilities Commission regulations for attaching to utility poles, which specifies standards that must be adhered to for the safe co-existence of electric and telecom assets.

[14] See discussion below in the Utility Coordination and "Dig Once" section.

Open Trench/ Joint Trench

Open trench is when a trench is dug into the ground with shovels, backhoes, skid steers, or mini excavators. The width may vary, but the trench is usually 12" wide by 4' deep. Once the trench is "cut" conduit is placed in the bottom of the trench and backfilled to cover the conduit. In most cases it is the most expensive method for new construction. The high cost is due to cutting through asphalt, concrete, other hardscape, labor cost, and restoration cost. This is a labor-intensive method. Joint trench is the same as open trench except there are many participants from different telecom, power, and cable companies that all share the expense of construction making it more cost-effective. Trenching can easily cost $120 per foot to as much as $150 per foot.

Plowing

Plowing or vibratory plow is a method where a large machine drags a blade ranging between 2'-4' deep in the ground and vibrates up and down to "cut" through the ground. The blade is rounded but sharp on the leading edge and has a slot on the back edge that conduit is fed through as the blade is moved forward. The conduit is routed over the top of the machine into the slot on the backside of the blade and is placed as the machine moves along only leaving a line where the blade had been. The restoration is minimal, and this is a very effective method in open areas with wide easements and minimal utilities in the ground. For these reasons, plowing costs about half to three-quarters of the baseline, depending on existing infrastructure, soil conditions, and other factors.

Rock Drill and Rock Wheel

Rock drills are like giant jack hammers, which make holes as small as 4" in solid stone. Rock wheels use a carbide tipped saw blade that cuts through asphalt, concrete, dirt, rock, etc. just like microtrenching, and cuts a trench that is 6" wide and up to 36" deep. Both rock drill and rock wheel are very expensive—two to three times baseline cost—and slow methods of construction but when needed they are effective methods for placing conduit.

Traffic Signal Interconnect

Traffic signal interconnect conduit systems are built to utilize copper cables and are usually not able to accommodate fiber optic cables with the needed specifications. Copper cable can be bent in hard 90-degree angles and wrapped very tightly inside of handholes resulting in small handholes and 90-degree elbows. Fiber cables consist of strands of flexible glass that carry light from one end of the cable to the other. If the strands are bent too tight the light cannot reach the other end. To use traffic

signals, conduits may need to be upgraded to accommodate fiber. The hard elbows need to be changed to sweeps and handholes must be large enough to allow for the static minimum bend radius of the new fiber. This construction method is more expensive than overhead but cheaper than other underground construction methods.

EQUIPMENT AND SERVICES

Beyond leasing dark fiber, use of network infrastructure involves offering services. There are two general classes or types of services that can be provided over modern network infrastructure. ***Access services*** are relatively inexpensive, "best effort" services that do not include any solid performance guarantees. Generally, access services are considered "retail broadband." ***Transport services*** are "dedicated" services that typically come with guaranteed bandwidth and uptime commitments, which are contained in *service level agreements* (SLAs). Transport services are variously referred to as "backhaul," "bulk IP," "carrier-class," "enterprise," "long-haul," "managed," "metro," or "middle-mile" services depending on the context. Generally, they are used by large organizations, including providers.

Access and transport services are complementary but involve different components and costs as well as customers. As Gateway Cities is most likely to offer transport as part of public sector connectivity business, we describe transport services infrastructure first, followed by information about co-location, a related service. We include a reasonably comprehensive consideration of access service infrastructure as Gateway Cities may seek partners to offer those services using a portion of the City's network. Improved access services for the community would directly achieve key results for this plan and address one or more of the City's strategic goals.

Transport Services

Transport services involve relatively few, stable but high-performance connections. Users are major businesses and institutions, including network service providers. The service is moving information from one point to another, rather than leasing an asset, so the value comes from ensuring the information keeps moving. This requires equipment that lights the fiber, maintains connections, and transmits data as diagrammed in Figure 20. Some form of hand-off to other networks or services, which requires additional equipment, is commonly a part of transport service.

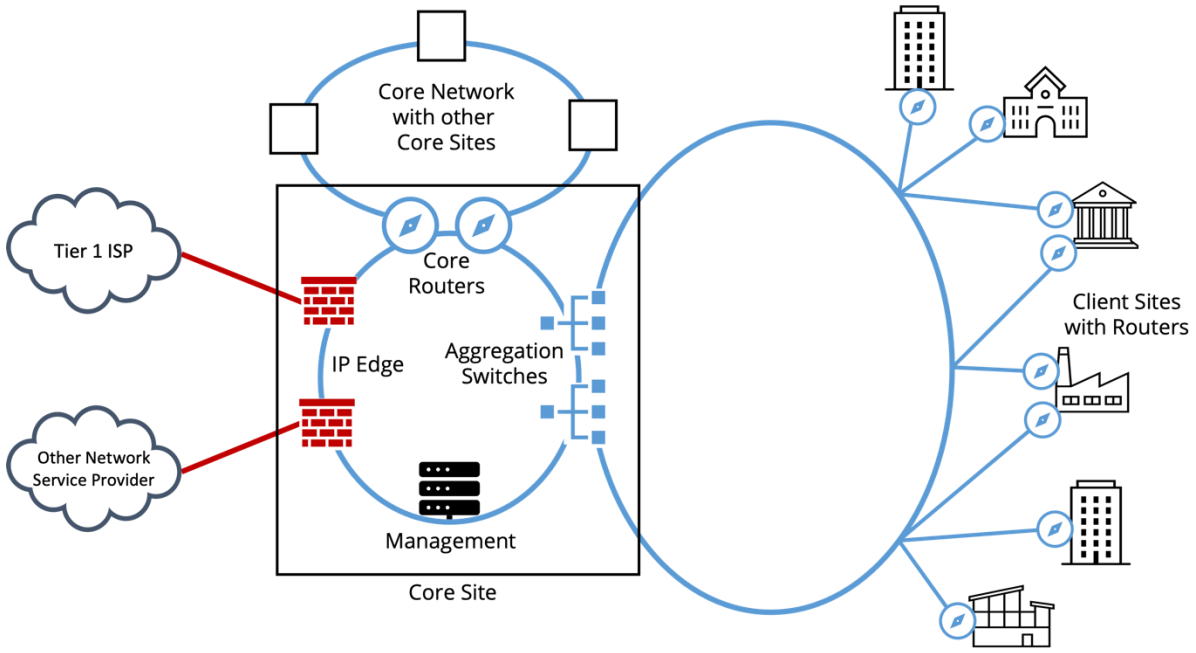


Figure 20. Transport networks interconnect sites and provide access to other networks, which could include access networks

Networks typically have a core network composed of a few centralized core sites—called central offices, data centers, or headends depending on type of ISP—interconnected by fiber in a ring architecture. Core sites contain the most powerful equipment to connect the local network to the global network. They must be secure, with high reliability power, and preferably centrally located. At least one, ideally two, sites must connect to high-capacity dedicated internet services, ideally via different providers with fiber following separate routes, for bulk IP.

Transport customers typically have substantial network operations of their own that incorporate transport services where needed, which requires next generation technologies—specifically software-defined wide-area networks (SD-WAN) and sophisticated management systems. Customers may require dual-homed connections, which connect to the core site via two diverse routes, and redundant connections to cloud services, tier 1 ISPs, and other service providers.

Transport service providers often co-locate in other companies' data centers to reduce costs. Access service providers generally prefer to own their core network sites, known as "central offices" or "headend" facilities, and access infrastructure called "pedestals" or "points of presence" (POP). This is changing somewhat with the emergence of wholesale open access infrastructure. Interconnection sites between different providers ranges from massive data centers to relatively small huts.

The network equipment required to deliver broadband services to customers is comprised of several functional groups and multiple components. All business models beyond infrastructure-only require core equipment, which is similar to what most cities currently use for their enterprise WANs. This must be supplemented with additional core capacity and various types of access equipment and infrastructure.

Core Equipment

The core equipment aggregates traffic from all access equipment, connecting customers and routing their data to and from the IP edge equipment or other end-point destinations. Standard network protocols provide link redundancy and dynamic traffic re-routing in the event of an equipment failure or fiber cut. Core equipment can easily support thousands of customers and hundreds of gigabits of traffic throughput at deployment and will accommodate future system growth through the addition of service modules, optical interfaces, and/or software licenses.

Internet Protocol Edge (IP Edge) Equipment

Separate from the core switches, the network must maintain an "internet perimeter." The internet perimeter will include internet routers and internet firewalls to be used to manage routing throughout the network. Firewalls will be utilized to protect critical back-office systems, including provisioning, network management, data storage, and other information. The two core switches will be interconnected to two internet routers providing redundancy for internet services in the event of a single interface or equipment failure. As mentioned above, bulk IP should be acquired from at least two providers using diverse paths, one of which should be a Tier 1 provider.

Estimated Costs

The estimated one-time capital costs for equipment and services to establish a transport network for the Gateway Cities COG's 51 sites,[15] based on vendor-provided pricing, would be about $530K as summarized in Table 3. The core network in this scenario would consist of the City's data center as the "central office" and a secondary, backup site, which we assume would be an existing site. We assume that each site would have a single router combining edge/core functionality, an aggregation switch, cloud service/firewall appliance for security, Internet Protocol services, and management software for server, network elements, and back-office functions.

[15] Based on information provided by the Gateway Cities Council of Governments as of June 10, 2022.

Table 3. One-time capital costs for equipment to establish a transport network to meet the Gateway Cities COG's internal connectivity requirements

Item	Unit Cost	Quantity	Total
Core/Edge Routing	$80,000	2	$160,000
Switching	$7,500	2	$15,000
Software	$15,000	2	$30,000
Security	$50,000	2	$100,000
Management	$30,000	2	$60,000
IP Services	$5,000	2	$10,000
Spares	$15,000	1	$15,000
			$390,000
CPE	$1,200	51	$61,200
			$451,200
Pro Services	$78,000	1	$78,000
Total Capital Cost			**$529,200**

Estimated costs for the two core network sites' equipment alone are $390K. Expect professional services at approximately 20% of the total equipment costs to be required. All the City's sites would get 1 Gbps connections, scalable to 10 Gbps. Each site requires customer premise equipment (CPE) that terminates the transport network and provides an interface to the sites local area network (LAN). We assume there are existing LAN equipment capable of 1 Gbps connections. Sites without connections or legacy equipment would involve additional site-specific costs. Budget around $47K annually for maintenance and other recurring equipment costs.

The central office would house core and edge equipment for ISPs serving customers within the area. Other carriers could be co-located in these sites so circuits and traffic could be connected and routed to the rest of the world. Equipment and facilities requirements are reasonably modest—primarily separate, secure cages for providers and major network users to place equipment, along with environmental controls and clean, reliable power. We assume the central office would be the City's data center. Otherwise, plan to spend approximately $500K to build out a data center, not including property acquisition or construction costs.

Access Services

The major difference between a local transport network and a fiber access network is the addition of access and distribution infrastructure, including hubs and multi-site terminals, illustrated in Figure 21. The core network delivers much the same functionality to broadband distribution hubs—also called points-of-presence (POP)—

as to transport service customer sites. The dedicated connections function as feeder lines, which are also typically deployed in rings, between the core sites and distribution hubs. The core and feeder networks and hubs comprise the "transport" network. Access requires additional equipment that supports connections to many customers.

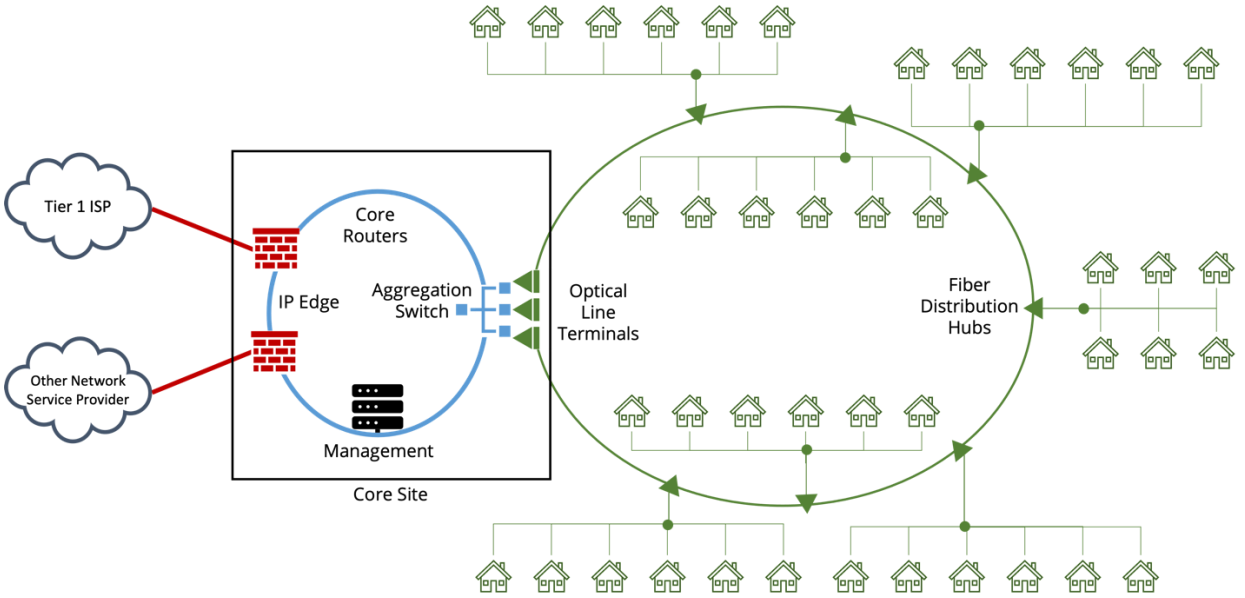


Figure 21. Passive Optical Network (PON) access infrastructure, including hubs and terminals, provides gigabit speed access services

Feeder fiber connects optical line terminators (OLT) in the core sites to passive splitters called fiber distribution hubs (FDHs), typically in outdoor cabinet enclosures placed strategically throughout the service area. Splitters may also be located within the access POP itself. In areas where aerial fiber deployment may be used, FDHs may be placed aerially or transitioned from the aerial pole to a ground mounted FDH. As this plan is limited to assessing major corridors as fiber routes, we assume coverage is limited to customer premises within 500 feet of the backbone. This requires only a single FDH.

The distribution network branches out from the FDHs. Multiple access lines drop off the distribution lines—hence the term "fiber drops"—via drop terminals into customer premises. Major sites can be directly and diversely connected to the core sites via "laterals," basically putting them on the feeder network. The backbone fiber may be used for a distribution, feeder network, and/or laterals, as well as core network. The particular use of specific fiber strands is a matter of how they are spliced together and where they terminate. Indeed, a single fiber cable can

accommodate multiple physically separate networks for purposes such as SCADA or traffic signal interconnection.

Hubs may be powered cabinets, prefabricated shelters, or existing structures with sufficient space for equipment racks and other components. Fiber in the routes analyzed above could connect retail ISPs' POPs anywhere in the Gateway Cities COG with backhaul via diverse routes to multiple upstream service providers for maximum fault protection. In practice, a distribution infrastructure can and should be built in a phased manner in response to consumer demand and/or in conjunction with other capital projects. For cost estimation, we assume:

- 3500 Customer Premises Served per Hub
- 50%[16] Prospective Customer Take Rate
- 1,750 Total Subscribers (Drops) per Hub
- 0 Video Subscribers
- 1 Data Center
- 1:32 Split ratio

The size of the subscriber base impacts the types, quantity, and costs of central office equipment. Core routing and edge routing are assumed to be separated due to increased capacity required. An optical line terminal (OLT), which establishes connections over access infrastructure to subscriber premises, is also required along with equipment for each subscriber site. For estimating costs, we assume that each customer requires a separate broadband/Wi-Fi router, enclosure, and interface (optical network unit or ONU). Required professional services will be approximately 20% of total equipment costs. If additional FDHs were required beyond the central office, plan to spend about $460K per remote hub to serve up to 2,250 subscribers.

Table 4. Capital costs for access services, including central office/core network equipment and customer premises equipment

Role	Unit Cost	Quantity	Total
Edge Routing	$80,000	2	$160,000
Core Routing	$125,000	2	$250,000
Switching	$7,500	2	$15,000
Access Network	$50,000	2	$100,000
Software	$10,000	1	$10,000
Security	$30,000	2	$60,000

[16] Take rate in the context is used to estimate costs only, not revenues, and is set to a level intended to result in conservative cost estimates.

Role	Unit Cost	Quantity	Total
Management	$75,000	2	$150,000
IP Services	$15,000	2	$30,000
Spares	$25,000	1	$25,000
			$800,000
ONU	$275	1,750	$481,250
NID enclosure	$50	1,750	$87,500
Residential Gateway	$159	1,750	$278,250
RG Management	$6,000	1	$6,000
			$853,000
Pro Services	$160,000	1	$160,000
			$1,813,000
Software/Systems			
Billing	$50,000	1	$50,000
Subscriber/Provisioning	$25,000	1	$25,000
			$75,000
Total Capital Expenses			$1,888,000

Feeder and Distribution Fiber

Feeder infrastructure that extends from the POPs to neighborhoods and business districts typically requires only a few fibers, at most a single 24-strand buffer tube. The backbone typically consists of 288-strand fiber therefore at least a hundred strands would be available for use as distribution. The estimated costs are based on feeder fibers are sized based on the demand forecast and sizing of each enclosure to ensure that each service area is well equipped for broadband services. These details are addressed in engineering design to get optimal coverage for the least practical costs.

Each OLT serves 512 subscribers at a 1:32 split. The number of POPs and OLTs per POP depends on the number subscribers. The cost includes OLT and backhaul hardware necessary to connect each POP to the core routers. In an actual design/implementation, each OLT would not need backhaul hardware, two-line cards, 16 optical interfaces, etc.

Distribution fiber extends from the splitters in the FDHs to network access points (NAPs), or drop terminals, which connect individual fibers entering customers' premises. NAPs may be attached to aerial strand, located in ground level pedestals or placed in underground vaults or hand holes located near the sidewalk or curb in residential neighborhoods or business districts. NAPs are costed as an integral component of the distribution infrastructure estimates. Fiber distribution to NAPs

will be sized based on the service area density to provide service to between 8-12 premises per NAP.

Fiber Service Drops

Fiber drops connect from each NAP to the customer premise equipment that delivers broadband service. At the customer premise, the drop cable terminates in a protective "clamshell" enclosure attached to a home or building for storage of slack and connection to the home equipment. Drop fiber may be installed aerially or underground, typically for a flat fee. Providers may charge additional drop costs for special circumstances such as burying fiber through difficult landscapes or under driveways. The average cost of a fiber drop in Magellan's experience, including all these components and labor, and recognizing that drops can vary greatly in complexity and distance, is approximately $2,500.

Optical Network Terminal

An Optical Network Unit (ONU), sometimes called an Optical Network Terminal (ONT), serves as the demarcation point between the retail ISP's fiber network and the router or firewall connecting to the customer's local area network (LAN). There are two general methods for installing ONTs. The first method involves mounting an outdoor rated ONT on an exterior wall of the structure and extending service wiring inside the premise. The second method involves extending the fiber into the premise and installing an indoor-rated ONU inside. In either case, the ONT is typically installed somewhere near the fiber entrance and an AC power source. The ONT terminates the fiber-based PON signals and provides customer access to their services through traditional copper interfaces. XGS-PON ONT's supporting greater than 1 Gbps data service may also support optical small form-factor pluggable (SFP) interfaces for connection to enterprise-class LAN equipment.

Wireless Access Infrastructure

While the Gateway Cities COG would not deploy or operate radio access network or other wireless infrastructure under the model in this study, it is important to consider this infrastructure in the design to accommodate cellular and fixed wireless ISPs and capitalize on the assets. Wireless broadband can operate as mobile or fixed service. Although cellular connections can approach broadband speeds, mobile wireless broadband is still in its infancy, as discussed below. Fixed wireless can be used to connect remote locations or sparsely populated areas, where DSL or cable service would not be economically feasible, via long-range directional microwave antennas. As discussed below, most of these connections are built on proprietary technologies, although they generally extend Wi-Fi and similar standards.

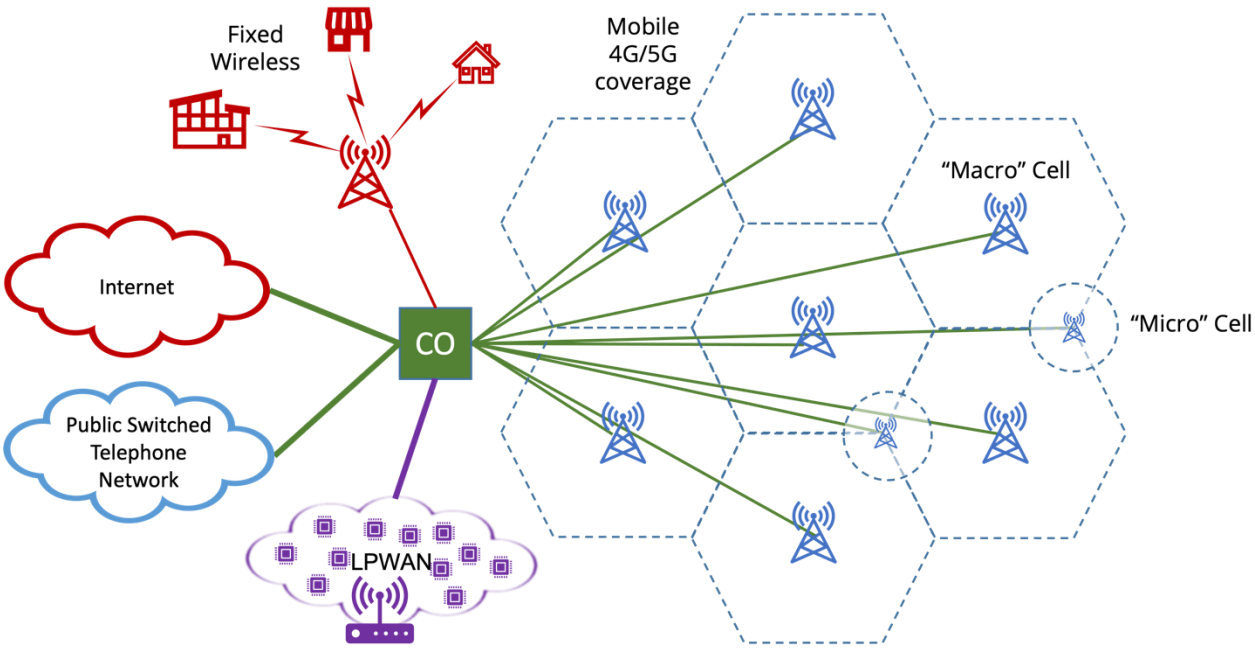


Figure 22. Radio-based wireless services provide flexible connections but have limited capacity and coverage

Coverage and speed are an intrinsic trade-off for wireless technologies. The farther a signal travels, the less information it can carry. High frequency signals, which have inherently high capacity, travel shorter distances than lower frequency signals (at the same power level). Lower frequency signals cover terrain and penetrate physical objects more effectively than high frequency signals. Spectrum in the lower frequency ranges offer better non-line-of-sight solutions, whereas the higher spectrum ranges need a more line-of-sight solution. Line-of-sight requires the transmitting antenna to be able to "see" the receiving antenna with limited trees and buildings in the way to be effective.

Terrain, then, plays an important role in the network design. Radio signals do not get over mountains or hills very well, nor does certain spectrum do very well in penetrating through buildings, foliage, or water, including rain and snow. The farther away the transmitter and the receiver are from each other, the less bandwidth is available. Transmitter sites need a means of connecting to the network, whether via fiber or microwave, to another site where it then transitions to a wireline fiber network. Fiber can be costly to install in remote locations. Electrical power, security and access are also considerations when locating appropriate tower sites. A propagation analysis to determine appropriate tower locations for Gateway Cities COG's specific terrain would be part of a wireless high-level design to be conducted in the future.

Cellular Mobile Wireless

Mobile wireless connections operate from antennas on towers that create wireless cells across a geographic area. Connectivity is maintained as devices move from wireless cell to wireless cell. The base of each tower site is connected to other tower sites and the internet, optimally via fiber-optic cables. Today, 4G transmits data at around 12/5 Mbps.[17] With each new generation, more wireless applications become possible as more data can be carried across the airwaves.

5G networks operate multiple frequencies using millimeter wavelengths to offer anticipated download/upload speeds of 1 Gbps. The networks are designed to provide increased efficiencies while decreasing latency and to improve the performance of connected devices that define the Internet of Things (IoT), including autonomous vehicles, healthcare monitoring technologies, ultra-high-definition video, virtual reality, and many more applications ripe for development.

With limits in return on investment and physics, it is unlikely that 5G will be an all-encompassing broadband solution. While the big three cellular providers have nominally launched 5G nationwide, a mature 5G network will take time and continued investment by carriers. The extent of full 5G rollout is to be determined, but if the investments in current infrastructure are any indicator, mid-sized cities like Gateway Cities are not the priority. Two keys to full 5G deployment are spectrum—all of which is effectively owned by AT&T, T-Mobile, and Verizon—and vertical assets with fiber connections.

Fixed Wireless

Fixed wireless services allow consumers to access the internet from a fixed point while stationary, and typically requires an external antenna with direct line-of-sight between the distant wireless transmitter and the customer building-mounted receiver. Speeds are generally comparable to DSL and cable modem. These services have been offered using both licensed spectrum and unlicensed devices. There are numerous small ISPs using fixed wireless to serve remote, sparsely populated areas, and several focused on more dense, urban areas.

Fixed wireless can be deployed as point-to-point (PtP) or point-to-multipoint (PtMP). PtP involves a one-to-one relationship between antennas at different locations. It is typically used for interconnecting sites, such as a headquarters or main buildings, to a remote facility. Fiber has much greater capacity and is more reliable, so internet service providers typically use this approach for connecting to customer locations

[17] Several providers have announced they will discontinue 3G services in 2022.

where they do not have wired infrastructure. End-users typically use it as a backup or secondary connection or for non-critical or remote sites. PtMP involves multiple—even hundreds of—users' antennas connecting to a single, central base station.

As illustrated in Figure 22, PtP and PtMP are complementary technologies. PtP can be used to interconnect PtMP base stations as well as for remote sites (although fiber is preferable due to its capacity and reliability). The networks require Line of Sight (LOS) or near Line of Sight (nLOS) to operate. As implied by the term, fixed wireless does not allow for mobile use. The systems utilize proprietary protocols and specialized devices to achieve the long ranges and high throughputs. Different vendors' products may not interoperate with each other.

Citizens' Broadband Radio Service (CBRS) and Private LTE

The FCC set aside the 3550-3700 MHz (3.5 GHz) spectrum in 2015 under a new, shared spectrum approach. There are three tiers of CBRS users, diagrammed in Figure 23. Current, incumbent, tier 1 spectrum users, which include US military, fixed satellite stations, and, for a limited time, wireless internet services providers (WISPs) are protected from interference by other users. Ten Priority Access Licenses (PAL) for 10 MHz channels between 3550 and 3650 MHz in each county was auctioned off by the FCC in July 2020. These licensees are protected from interference by other users but may not interfere with incumbent users. A licensee may aggregate up to 4 PALs. Any portion of the spectrum may be used without a license for General Authorized Access (GAA), but this may not interfere with incumbent or PAL users.

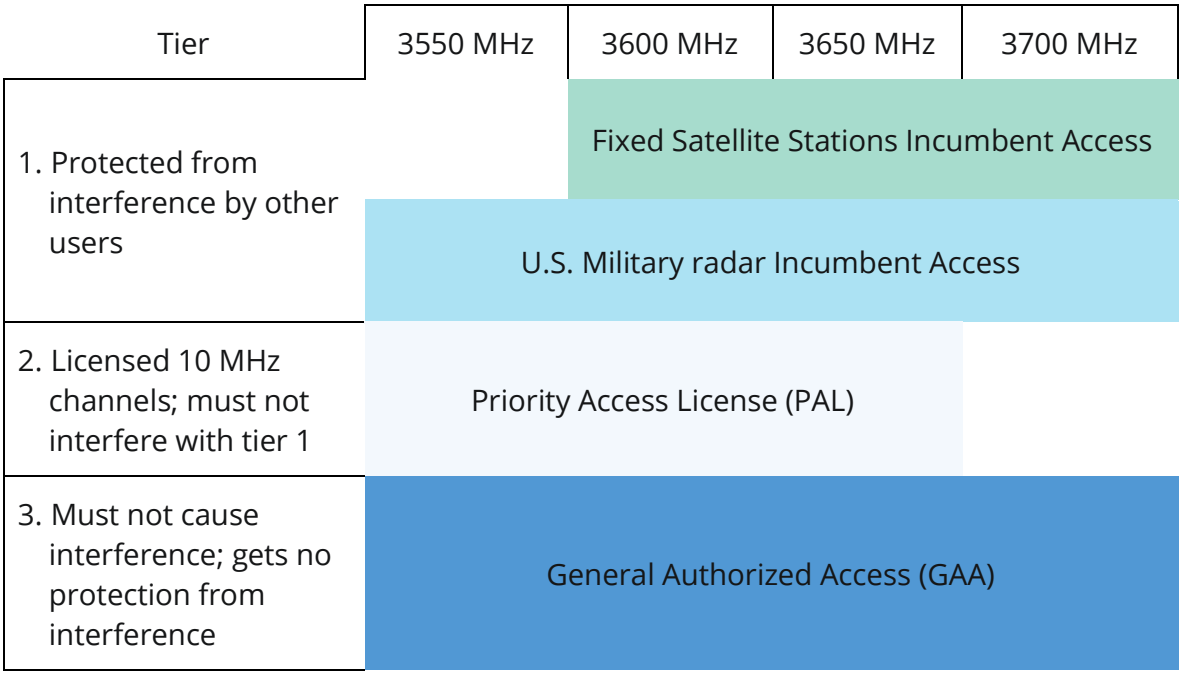


Figure 23 CBRS User Tiers

CBRS use is managed by a Spectrum Access System (SAS) with which all Citizen Broadband Service Device (CBSD) base stations must be registered. There are two classes of CBSD. Class A base stations, which can transmit at 1 watt of power, are meant for smaller-scale indoor, enterprise, or campus use. Class B base stations can transmit at 50 watts, giving them much greater range. Strategically placed radio signal sensors will ensure that uses do not interfere with each other, particularly military radar.

Another important characteristic of CBRS is the Long-Term Evolution (LTE) protocol is commonly used with the spectrum. LTE is also used for 4G cellular data service, so it is widely implemented in user equipment. CBRS involves different spectrum, but some smartphones have antennas that operate in the CBRS bands. It is reasonably easy and economical to add CBRS/LTE to devices without changing their operating characteristics or systems. Therefore, there are few barriers to end user adoption. This also allows for private networks to be easily established with only a few antennas (which need fiber connections).

The combination of CBRS/LTE in base stations and user equipment is a radio access network (RAN). A RAN has a network core (an Evolved Packet Core or EPC) that authenticates and authorizes user equipment and manages connections to multiple base stations. This allows for mobile roaming from base station to base station without loss of connectivity and makes RANs very secure. The downside of a CBRS/LTE RAN is that some entity must operate EPC and the SAS. These are relatively inexpensive services that can be purchased from vendors or operated on private servers.

Low-Power Wide Area Networks (LPWAN)

Although not broadband, LPWAN technology should be considered in any network infrastructure plans. It is generally used to connect many small devices over a large geographic area. Water meter reading is a prime example of a LPWAN application. These are message-based networks, meaning end devices send small packets of information to an LPWAN gateway that then sends the data via a wired network to monitoring or tracking software. Real-time control of the devices is very limited but other, similar technologies exist that allow for remote control.

There are numerous standards for LPWAN with varying degrees of openness and propriety. The proprietary technologies were first to develop and currently have the largest installed bases. The open standards for LPWAN are still evolving. The major open standards are extensions of other standards, specifically 5G and Wi-Fi. The costs and flexibility of open standard based systems tend to be much better than

proprietary technologies, although proprietary technologies may perform better in the short-term.

Wi-Fi

Wi-Fi, which was originally termed "Wireless Fidelity," is an open standard that was developed to connect computers to a local area network (LAN) via unlicensed radio spectrum (the same frequencies used for cordless phones, garage door openers, and other non-network wireless devices). Generally, Wi-Fi is a PtMP technology: Wi-Fi access points connect multiple devices within limited range, typically no more than 150 feet indoors and up to 1,500 feet outdoors. There are multiple standards or versions of Wi-Fi. Some can provide up to 1 Gbps of throughput. Other new Wi-Fi standards are intended to cover large areas with minimal power requirements.

Wi-Fi coverage and speed depends on multiple factors such as buildings, foliage, and other physical barriers, interference from other spectrum users, radio spectrum used, transmission power, type of antenna(s), and weather. New versions of the Wi-Fi protocol operate at greater distances and/or speeds. It can be deployed PtP to interconnect sites and is being adapted for LPWAN applications.

Wi-Fi access points are often integrated into routers that interconnect the Wi-Fi network (also called a service set identifier or "SSID") to other networks, including a broadband connection to the internet. This is typically referred to as a "hotspot" or Wi-Fi zone. Multiple access points can be interconnected to each other as well as a router to cover a larger area. A WiFi network can even be extended over multiple otherwise independent routers via a centralized server to create "community" Wi-Fi. The latest version, Wi-Fi 6, improves these functions as well as expands the spectrum and increases speeds for Wi-Fi connections.

Today, many organizations use Wi-Fi to provide wireless connectivity throughout a building or campus. Many cities and counties have deployed public Wi-Fi in zones that extend into parks, other public spaces, and even throughout the community. Wi-Fi hotspots are common at hotels, restaurants, and public buildings for public access, and are widely used in homes and businesses for private access. The conceptual network is designed to accommodate Wi-Fi as well as other wireless technologies but does not include them. While the Gateway Cities COG could potentially offer public Wi-Fi, we assume any such equipment would be provided separately by the Gateway Cities COG or other entity.

Radio Access Network model

The Radio Access Network (RAN) model, diagrammed in Figure 24, accommodates all the above forms of wireless connectivity, and thereby maximize the number, types,

and value of wireless providers as customers. Under this model, the Gateway Cities COG could lease co-location facilities, fiber backbone, poles, towers, and other assets to private companies to deploy and operate RANs. The particular type of RAN would depend on the equipment providers deploy.

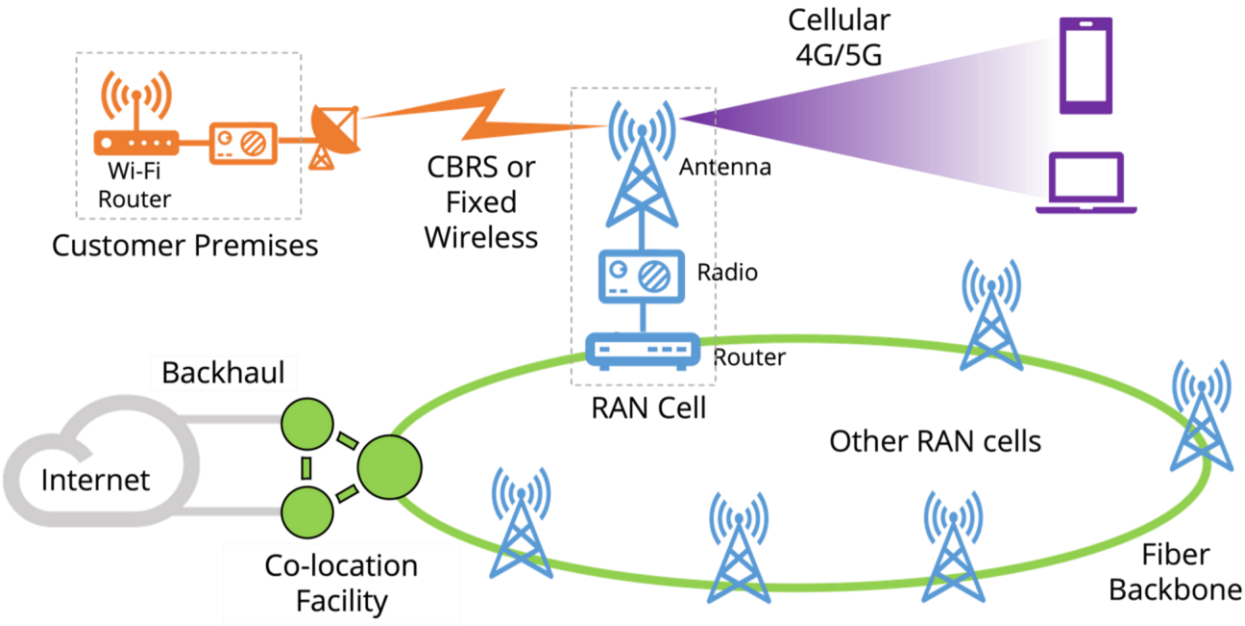


Figure 24 The Radio Access Network (RAN) Model

The key issue for the Gateway Cities COG is how and whether to develop assets and facilities to accommodate RANs. The conceptual network design incorporates poles, but that doesn't mean they can be used for RAN infrastructure. Fiber must be physically accessible at poles and towers to connect cells. Poles would need to be assessed and possibly upgraded to support small cell infrastructure. Tower sites would need secure, multi-tenant huts for providers to deploy their gear (these huts may also serve as fiber hubs, depending on location). Providers may need the backbone to route to their points-of-presence and will definitely need interconnection to their regional/national networks.

RANs are much less costly than fiber networks.[18] They are more flexible, too, but have much less capacity and lower reliability. Mounting facilities can be the largest cost for RAN because antennas need to be above the surrounding terrain. Aesthetics is also an important issue because, as boxes on poles and towers, cell sites are not

[18] The active components of a RAN will need refreshed in 5 years at most. Historical trends suggest the costs of those components can be expected to drop substantially in that time.

particularly attractive. People want connectivity but may object to cell sites in their neighborhood.

Wireless Broadband Cost Estimates

For cost purposes, we assume that any wireless solution must qualify as broadband, ideally meeting the State of California's new standard of 100 Mbps download and 20 Mbps upload. CBRS is the best technology for economically meeting these criteria. A CBRS cell with full coverage would have four sectors, each with an antenna and base stations which may come as an integrated unit. Each cell requires a router with fiber interface, power, and an equipment hut, which may be shared with other network infrastructure such as a GPON POP. Cells require up to 24 strands of fiber to connect with centralized switching facility, but GPON can reduce this to as few as four strands. Cells also require a tower, which would typically be a 50 to 150 feet tall monopole, or some other elevated structure suitable for antenna mounting.

Table 5. CBRS Radio Access Network Costs

Component	Unit Cost	Quantity	Cost
Antenna, base station, installation, wiring, and network management software license, per sector[19]	$12,500	4	$50,000
150-foot direct embed monopole, shipping and installation	$110,000	1	$110,000
Equipment hut, generator/battery backup and AC	$65,000	1	$65,000
Router with fiber interface	$1,000	1	$1,000
Construction, engineering, and project management services		15%	$33,900
Total per CBRS cell[20]			**$259,900**

Each 4-sector cell requires four, 65-degree, 4-port antennas and base stations, which may come as an integrated unit, one per sector. Antennas are mounted on towers and a hut is generally required for other network equipment. A router is required to

[19] Based on Telrad equipment (see https://telrad.com/products/breezecompact-1000/). There are multiple vendors of CBRS RAN equipment. Magellan Advisors does not endorse or recommend a particular solution or vendor.

[20] Costs do not include land acquisition or site development beyond tower construction.

connect the cell to the fiber network for backhaul. Each customer premise will need equipment that consists of an CBRS LTE antenna and base station with integrated router and Wi-Fi access point. Installation cost is approximately $200 based on Magellan's experience, and each customer initialization involves a $35 fee for EPC. Each customer involves about $750 in capital expenses. There is also a monthly recurring cost of $2.25 per customer.

Such a cell would accommodate 2,000 subscribers—500 subscribers per base station—with 200 Mbps throughput per base station, divided among all users in that sector. Users should generally get 50 Mbps to 100 Mbps throughput, depending on the number of other simultaneous users. A CBRS cell would nominally provide 60 Mbps download at a 10-mile radius in "ideal" circumstances, including no foliage or terrain. The practical range is around 3 miles.

ASSETS AND SITES

As discussed in detail above, optical fiber is the standard for high-capacity, high-reliability network infrastructure. As assets, fiber cables must be placed either overhead, attached to utility poles, or underground. While there are methods for directly burying fiber cables, they are typically placed inside conduits. Splice points are in "handhole" boxes or vaults at regular intervals. Underground fiber can be economically deployed via joint-build with other infrastructure—water, sewer, transportation, etc. Cabinets or huts may be needed for access and distribution equipment. Fiber must physically route into buildings to be served; major buildings may need dual, redundant connections.

Antenna and base stations for radio access networks (RAN) must be sited within range of customers—from a few hundred feet to a couple miles depending on the services, speeds, and technologies involved. The antenna must be installed somewhat above ground, ideally with line of sight to most of the covered area. Base stations must be adjacent to the antenna, ideally with fiber connection for backhaul. This means buildings, poles, and towers can be valuable "vertical assets," particularly in more densely populated areas. Towers in more remote areas can be essential to inexpensive broadband options.

Gateway Cities has numerous options for broadband assets and sites. One option is to utilize existing public-owned conduit and fiber. The conceptual design (Figure 19) overlaps existing assets owned by several cities. Other public entities, including Los Angeles County Department of Public Works, the Los Angeles Bureau of Street Lights, Los Angeles Department of Water and Power, and various school districts, also have assets. This would substantially reduce the cost to build an area-wide backbone, and

could greatly increase its coverage and, therefore, potential impacts and revenue. City-owned public properties may be ideal sites for RAN infrastructure or Wi-Fi.

Another opportunity is to build network infrastructure along with other projects, particularly transportation and utility capital improvements. Metro's West Santa Ana Branch is a prime example of this, as are Complete Streets projects. Several cities have redevelopment and sewer projects that could accommodate network assets. Sites in other parts of the city may be of interest to cellular companies, especially if Community anchor industry and institution sites, along with city sites can be seen as targets for the network infrastructure. Any commercial, industrial, and residential redevelopment should include network assets.

In some ways, the asset and sites options are the most straightforward: capitalize on every asset and to connect as many sites as possible. But assets and sites can be very complicated, especially due to the range of stakeholders involved. Coordination and planning are essential. The assets will need to be actively promoted to ensure they are fully used, so marketing and sales capabilities are also needed. Assets will not just develop on their own.

4. Business Models and Governance Options

The Gateway Cities COG has numerous options for developing and utilizing broadband in support of the Gateway Cities' mission and vision.

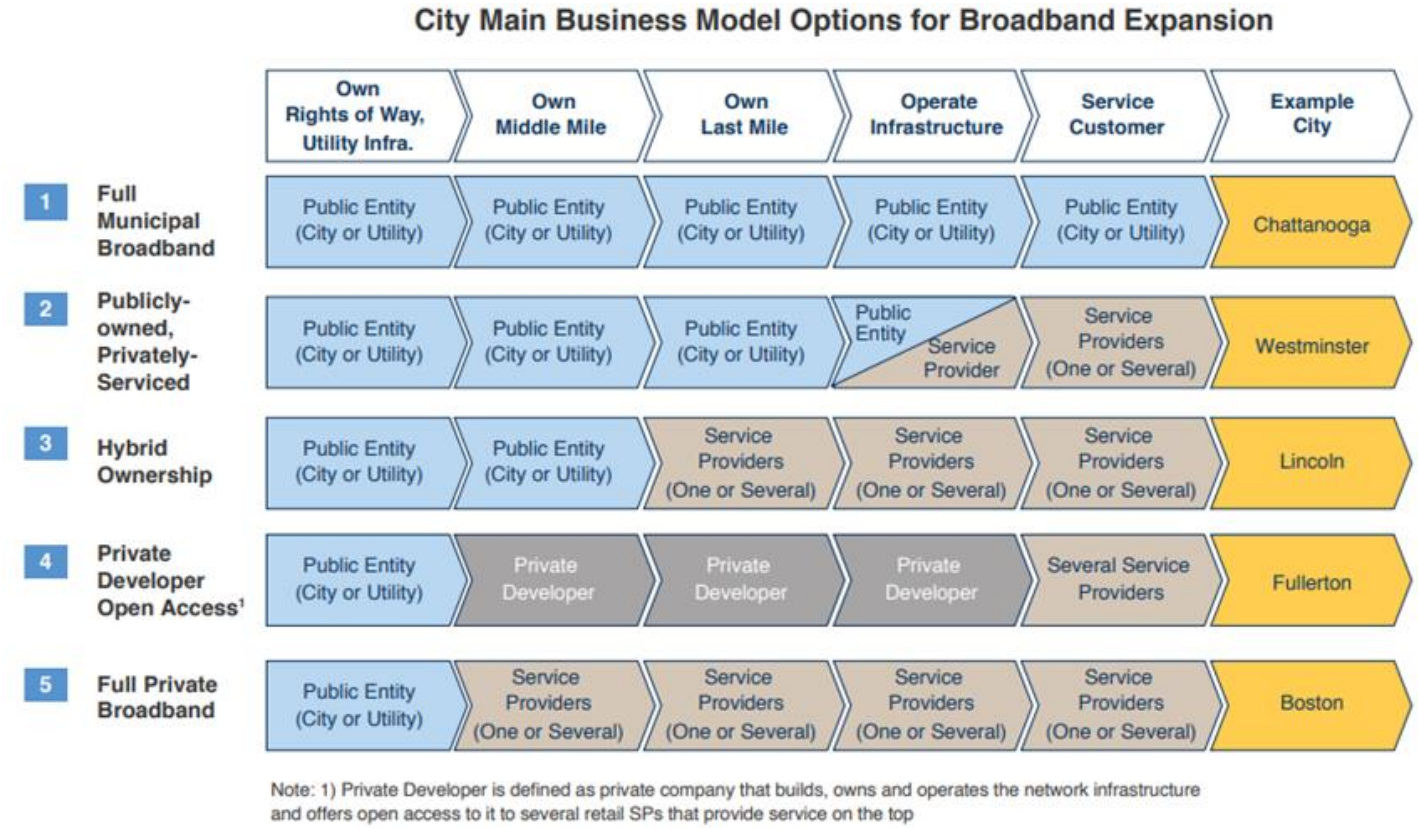


Figure 25. The Gateway Cities COG has Options for Broadband Expansion

BUSINESS MODEL OPTIONS

A business model describes how assets can be combined to achieve purpose as defined by vision: connectivity for all, investment by private providers, and a platform for municipal improvement and innovation. Broadband business models for local government to achieve such outcomes range from passive, policy-only approaches, through public-private partnerships, to directly providing retail broadband services.

As illustrated in Figure 26, the amount of investment required increases with service offerings. Revenue potential also increases, but so does risk. Organizational capacity is part of the investment needed for optimal outcomes. The risk depends on where the infrastructure is deployed but also

the level of effort put into selling physical connections and services. Focus on revenue, return on investment, and profits runs the risk of missing other benefits and impacts. Good governance reduces these risks.

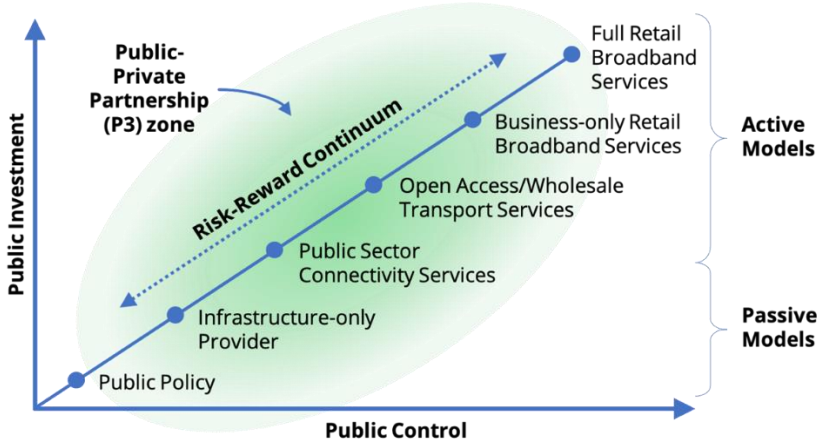


Figure 26. The broadband business models represent a continuum of options with various levels of public control and investment

The business models in the middle of the continuum accommodate, but don't necessitate, public-private partnership (P3). The essence of such a partnership is that for-profit and for-people entities collaborate to achieve complementary, if not common, objectives. The bottom line for private entities is profit, while it is quality of place for public agencies. In concept, private entities can flexibly mobilize resources where there is money to be made and public agencies can redistribute resources to ensure no one is left out. A P3 can help realize both these outcomes: public involvement reduces risk to private investment, and private involvement enables faster and more extensive execution. Generally, partnerships decrease risks while enabling larger or new forms of rewards.

The most apparent gaps in Gateway Cities are for municipal sites and operations. The Gateway Cities need more, better network infrastructure, particularly for distributed assets—cameras, pumps, streetlights, traffic signals, etc. The cities have clear interests and plans for development in commercial areas, particularly downtown and the Northeast Growth Area, that will require diverse, high-performance network services. City-owned parcels and streetlights can be used for radio access networks (RANs), particularly 5G, if they have fiber to them. While there is no clear gap in broadband availability, consumers clearly want more options and lower costs. Thus, it makes sense for Gateway Cities to focus on building network infrastructure for internal purpose but plan to capitalize on it as a catalyst for private investment.

Cost Savings, Revenue Potential, and Other Benefits[21]

Data from four Gateway Cities indicates they are paying an average of $4.7K per month per site for network connections. If we assume that applies to all 224 municipal sites for which we have data, the total telecom spend is over $1M annually. While the average monthly cost seems rather high—few cities Magellan works pay anything approaching that amount, even for 1Gpbs and faster connection—the estimated total spend is likely low estimate because we have facilities information for only 16 of the 27 cities. If we assume, based on cities for which we have data, all cities have an average of eight sites to connect, the total spend for all Gateway Cities' facilities would be over $12M per year. The actual cost is likely much lower because data from the cities indicates many sites are connected via cellular Wi-Fi hotspot or retail broadband or have no connection.

The bottom line is that connectivity is currently a substantial operational cost for the Gateway Cities. The cost can be a barrier to innovations that require network connections, such a building automation, citizen kiosks, public Wi-Fi, security monitoring, and utility demand management, as well as operational improvements from faster but more expensive connections. Other fundamental municipal functions, specifically public safety, traffic management, and water utilities, make use of public-owned network assets. Integrating these into a comprehensive network infrastructure would improve their efficacy, allow for broader deployment, and greatly reduce current telecom spending.

Computer hardware, and even software, including data, can—and really should—be thought of as infrastructure. The cloud provides these as network services but (a) many IT functions and systems essentially require local servers, (b) the cloud still consists of hardware that must be physically located somewhere, and (c) the emerging practice is to geographically distribute compute infrastructure and data storage into small sites along with next generation radio access network assets. Hardware and software per unit costs typically decrease substantially with scale, much as the value of a network connection increases with the number of connections.

Practically, Gateway Cities could collectively realize much greater value from investments in IT and related technologies by standardizing and interconnecting. Direct recurring connectivity costs are likely just the tip of the proverbial iceberg of costs and barriers to benefits the cities could be avoided with shared network

[21] All prices in this section are approximate and highly dependent on specific customer requirements and market conditions.

infrastructure. Substantial chunks of network infrastructure are in place, and more is being built. The challenge is to fully capitalize on it for digital inclusion and economic development as well as municipal operational improvements. For this, the network infrastructure will need to be more complete, comprehensive, and integrated.

One general benefit from such infrastructure is direct revenue. Currently, for example, La Mirada leases public property for 11 cell sites. Many other Gateway Cities are likely doing the same. Even private cell sites generate additional revenue for cities in the form of property and value-add taxes. Some cities have conduit and fiber that they may be leasing. These activities require relatively little administrative overhead and are very similar to any other public asset lease so typically don't require local governments to increase their capabilities.

The companies that lease such assets want to reach as many customers as economically as possible. They generally want to fill in coverage gaps and increase speeds, which require more assets. Thus, providers want complete infrastructure that comprehensively covers an area—without gaps and with minimal overlaps. This would require a huge investment, especially in densely developed areas like the Gateway Cities, but would have dubious revenue potential with two or even one current provider. Asset leasing can generate revenue for cities. An integrated, comprehensive approach will likely generate much more revenue while also more effectively achieving other goals of this plan.

Dark Fiber Leasing

The infrastructure leasing business model involves providing fiber (or conduit) for monthly or long-term capital leases. Demand for dark fiber depends on local market conditions. Conduit (2-inch) in core urban areas outside major metros leases for $3.00 to $5.00 per foot. Generally, Magellan Broadband does not recommend leasing entire conduits because it reduces ability to capitalize on the asset and flexibility to use it. It is possible to install inner-duct in 3-inch or larger conduits and lease one or more of those. We would only recommend leasing larger conduit to a private partner committed to building out fiber-to-the-premises for the entire area and providing deeply discounted services to anchor institutions.

Fiber leases can be boiled down to a cost per strand-mile. So, for example, a 10-mile long 244-strand backbone would have 2,440 strand miles, each of which could be

leased separately.[22] Typically, fiber leases have a minimum distance amount and an annual maintenance fee. A wide range of discounts may be offered, including leasing an entire buffer tube within the cable, entire end-to-end strands (rather than a portion), entire rings, and/or for longer terms. If structured as a long-term (20 years or more) capital lease—also known as indefeasible right to use or IRU—lessees pay the entire lease amount upfront.

Table 6. Target dark fiber lease rates (±20%) for Gateway Cities based on comparable markets

Service Component	Cost	Per
Monthly Dark Fiber Lease	$150	Strand Mile
20-year Dark Fiber IRU	$3,500	Strand Mile
Minimum Lease	3	Strand Miles
Annual Fee	$250	Route Mile

The lease rates shown in Table 6 are reasonable targets for Gateway Cities based on our analysis of the local market and comparable cities, particularly on the West Coast. Actual rates and total revenue depend on the amount, coverage, or length of the fiber infrastructure and the presence of major customers—including network service providers—in the area. Cellular providers pay $400 to $600 per strand per site per month for at least four and as many as two dozen strands with a median length around 5 miles. While these leases are generally limited to a few very large radio tower lessors, they provide some idea of the revenue potential and price point for leasing fiber in the Gateway Cities.

Data Transport Services and Revenue Sharing

Wholesale transport services revenue may come from leasing capacity—Ethernet connections or lambdas[23]—or from local government a share of revenue from service providers using the network. Generally, enterprise customers pay per circuit—a lit fiber or a portion thereof (a lambda)—for connecting one or more sites. They often purchase other services, such as dedicated internet and firewall, along

[22] Leasing a portion of a fiber strand can physically strand the rest of that strand. For example, if a 1-mile section of a strand is leased in the middle of a cable, the remainder on each end may be practically unusable. This is another reason for deploying fiber in rings: It reduces risk of stranded strands.

[23] A fiber path is a set of contiguous strands between two or more points. A *lambda wave* is a portion or "color" of laser light within a strand.

with transport. Retail providers purchase similar services at much larger scale than most enterprises but require integration with their core networks and direct routes to their switching centers ("central offices"). Actual fees can vary greatly depending on market conditions, service levels, and other factors. Competitive prices for local transport are approximately $2,500 for a 10 Gbps circuit or $900 for 1Gbps. Backhaul interconnection to internet exchanges or other services can effectively triple those costs.

Revenue share can make sense where a city owns all infrastructure including access and distribution lines. This approach ensures the cities have a stake in providers' success and providers only pay for actual revenue. Typical revenue shares are between 20% and 40% or around $30 average per residential subscriber or about $300 on average for a dedicated transport circuit. It isn't practical to provide meaningful estimates for revenue sharing due to complex dependencies, including build-out strategy. Under this business model, providers use the infrastructure "for free" but pay per subscriber. Therefore, the local government has financial interest in increasing subscribership and optimizing retail service costs for maximum adoption.

Macro And Micro Cell Lease Revenue

Many cities currently lease public property for cell sites. The lease fee varies greatly based on location and site type, but Magellan feels $3200 per month a reasonable baseline or target rate for undeveloped sites with 10-year lease. Given the density of the Gateway Cities and real estate costs, the local cell site lease rates are likely much higher.

Developed sites have towers or other supporting facilities that have one or more attachment positions. A baseline rate for a single position with three feet of clearance is $700 per month with 5% annual escalation plus $50/month for power and $2,000 one-time set-up for a 5-year lease. Micro-cell pole attachment lease costs are approximately $350 per month with 5% annual escalation plus $30/month for power, $2,000 one-time set-up for a 5-year lease.

These fees are in addition to any dark fiber lease or transport service fees, discussed above. Construction costs are typically borne by the lessee, but lessors typically must vet and approve all construction contractors.

Any business model beyond leasing a limited amount of dark fiber will require dedicated staff. The Gateway Cities COG would need a Broadband Director with strong understanding of facilities leasing and maintenance to be responsible for overall organizational performance, focused on finances and governance. If the

Gateway Cities' broadband entity is actively promoting use of the network, it will also need a Marketing Manager for identifying and managing lessees. The Marketing Manager may also work with wholesale customers to promote their internet services to the community.

GOVERNANCE OPTIONS

Special Districts

"Special districts are local government agencies that provide public infrastructure and essential services, including, but not limited to, water, fire protection, recreation and parks, and garbage collection."[24] Broadband infrastructure and services may be funded by a special district, specifically via fees or taxes levied on those within the district: The two key attributes of special districts are (a) a majority of citizens support formation, which effectively requires a vote on formation, and (b) citizens may receive dividends from the district(s) if revenues exceed costs and liabilities.

In Los Angeles County, most special districts are the purview of the Los Angeles Local Agency Formation Commission (LAFCO).[25] There is a rigorous process[26] and substantial costs involved in establishing special districts. As a municipal support organization, the Gateway Cities COG is well-positioned for the process if it chooses to pursue formation of a special district for broadband. Also, Magellan has done most of the planning and research necessary for the LAFCO analysis. The LAFCO does not regulate bridge/highway, improvement, school, or transit districts or redevelopment agencies and JPAs. Nor does it govern Mello-Roos community facilities districts.

Community Facilities District[27]

Under California law, Community Facilities Districts (CFD) enable financing of public improvements and services including streets, sewer systems and other basic infrastructure, police protection, fire protection, ambulance services, schools, parks, libraries, museums and other cultural facilities. A CFD can levy a special tax on

[24] Special District Formation Guide (2016). California Special Districts Association. https://higherlogicdownload.s3.amazonaws.com/CSDA/b24702e8-8a42-4614-8c45-bc3cba37ea2c/UploadedImages/About_Districts/2016-Formation-Guide-WEB.pdf. Page 4.

[25] For additional information on Los Angeles LAFCO, see https://lalafco.org/en/about-us/.

[26] A checklist and forms for application are online at https://lalafco.org/en/application/.

[27] http://cscda.org/getattachment/Infrastructure-Finance-Programs/Community-Facility-District-(CFD)-Financing/Further-Amended-and-Restated-CSCDA-Local-Goals-and-Policies-for-use-of-Mello-Roos-CFDs-2019-(1).pdf.aspx?lang=en-US

residential, commercial, and industrial property projects to raise funds to pay for infrastructure. The tax applies to residents of the area that benefit from the funding and requires approval (by vote) of at least two-thirds of residents.

Once established, special districts could also take on bonds and loans to finance construction. The cities' and county's financial officers should be consulted regarding bonds or loans. The California Statewide Communities Development Authority (CSCDA), California Infrastructure and Economic Development Bank (IBank), and California Enterprise Development Authority (CEDA) may also be resources for debt funding, although they do not appear to have formal programs for broadband or network infrastructure.[28] Local governments may opt for more traditional financing methods for network infrastructure, such as bonds and loans, including:

- 63-20 bonds: Tax-exempt bonds in which a non-profit organization issues tax-exempt bonds on behalf of the County
- Revenue bonds
- Revenue notes with subordinated debt to act as equity. Subordinated debt may give investors a tax-exempt high return with ownership retained by the Gateway Cities COG.

Joint Powers Authorities

Joint Powers Authorities (JPA) are authorized under Section 6500 of the California Government Code and allow public agencies to join to exercise their powers or to form a new separate legal entity by agreement among the public agencies.[29] Either form of JPA requires an agreement addressing specific topics. Formation of a JPA as a separate entity sets it up with a legal identity separate from each of the public agencies that formed it, and therefore the public agencies are insulated from debts, liabilities and obligations of the JPA while the JPA is authorized to enter into contracts and hold and operate assets including infrastructure. Use of a JPA is a creative approach to providing public services on a scale beyond which any of the individual public agencies can afford or justify.

[28] See http://cscda.org/, https://ibank.ca.gov/, and https://ceda.caled.org/ for information about these organizations.

[29] The Governance and Policy discussions do not constitute a legal opinion and should not be construed as such. Questions about interpretation or applicability of these or other provisions of federal or California law should be referred to legal counsel.

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SB 156 has expanded the value of using a JPA to provide broadband services by allowing use of revenue bonds for broadband infrastructure deployment, supported by the new Broadband Loan Loss Reserve Fund. The Fund covers costs of debt issuance, obtaining credit enhancement, and establishment and funding of reserves for payment of principal and interest on the debt.

RCRC Formation of Golden State Connect Authority

The Rural County Representatives of California (RCRC) provides a great example of the use of Joint Powers Authority to provide broadband services. RCRC is a non-profit entity established as a service organization for 38 rural counties in California. RCRC is organized to advocate on policy issues for rural counties including land use, water and natural resources, housing, transportation, wildfire protection policies, and health and human services.

Among the initiatives it supports, RCRC has undertaken to push for broadband access for rural California. The objective is to increase access to reliable, affordable high-speed broadband for all rural Californians. As an initial step RCRC has served as the applicant for US Economic Development Administration grants for broadband strategic plans to aid the member counties which do not have one.

Then RCRC formed a joint powers authority – Golden State Connect Authority – to deploy infrastructure to achieve this objective. 37 of 38 member counties voted to join GSCA (Santa Barbara County is a very new member of RCRC and as of January 5, 2022 was not currently a member of GSCA).

> Golden State Connect Authority (GSCA) is a joint powers authority of thirty-nine member counties designed for the purpose of increasing access to reliable, affordable high-speed internet for all rural Californians. Governance of GSCA is conducted by elected Supervisors from rural counties that elect to join GSCA. Through the collective efforts of its members, GSCA is focused on building and supporting the development of innovative future proof networks that provide the highest level of quality, service and transparency to rural California.[30]

GSCA capitalizes on the opportunities provided by enactment of SB 156 which include explicit authority for counties to operate broadband internet networks, creation of the state-owned, open-access middle mile network, and significant funding for deployment of broadband internet infrastructure. GSCA "will assist rural counties in identifying pathways for development of internet infrastructure within

[30] https://www.rcrcnet.org/affiliated-entities

their communities, including the construction of municipal-owned and/or operated internet systems, among other options."[31] Golden State Connect's initial areas of focus[32] will be:

- Foundational Readiness: ensure all member counties have broadband strategic plans
- Capacity Building: equip rural counties with information and resources about innovative models and approaches to broadband deployment
- Demonstration Projects: implement open-access municipal broadband projects

The Golden State Connect Joint Powers Agreement

Senate Bill 1266 became effective on January 1, 2017 and among other things obliges the filing of new JPA agreements with Local Agency Formation Commissions.[33] The Golden State Connect JPA agreement as provided for LAFCO filing is attached to this report. The GSCA JPA agreement is a recent and concrete example of a JPA agreement for providing broadband infrastructure. It can be used to inform Gateway Cities Council of Governments review of implications of a broadband JPA for the Gateway Cities. Key points of the JPA Agreement include the purposes of the Authority. In this case they "are to make reliable and adequate communications services and connectivity available for the benefit of rural communities, businesses, and residents, including without limitation establishing and operating programs and projects to facilitate provision and expansion of broadband internet access service and related telecommunications services in rural communities, and directly providing such services in substantially the same manner as a municipal utility."

Public agencies seeking to become a member can do so by presenting resolution or evidence of formal action adopting this JPA agreement. "Participating entities" include public agencies or other JPAs that are authorized to provide broadband internet access service upon adoption of a participation agreement as prescribed by the Authority. Each member appoints a delegate to the Governing Board. An Executive Committee is drawn from the Governing Board and composed of the Chair and Vice Chair (elected from the delegates) and additional members serving on the Executive Committee of RCRC with additional members appointed by the Board if

[31] https://goldenstateconnect.org/about-us/

[32] Rural County Representatives of California Letter to LAFCO Executive Officers, January 5, 2022.

[33] The obligation is only for filing JPA agreements and amendments. The LAFCO does not have any authority to review proposed JPAs.

necessary to reach the minimum number of Executive Committee members. The Executive Committee has the power to approve projects and programs, upon two-thirds vote of the full membership.

The JPA agreement is not exclusive, and members retain the right to carry out improvements on their own. The debts and liabilities of the JPA are not obligations for any of the members. Specific powers for the Authority include establishing and operating programs and projects to facilitate provision and expansion of broadband internet access service and related telecommunications services. This includes acquisition, construction, operation and maintenance of broadband infrastructure for broadband internet access service. Obtaining federal or state support and participation in any federal program whereby federal funds are granted for financing the construction, acquisition, improvement, preservation, and rehabilitation of real property and infrastructure are allowed.

Amounts received under bond purchase agreement, bonds issued by any of its members, issuing bonds or other indebtedness and pledge any of its property or revenues as security are under resolution of the Board or Executive Committee. Issuing other forms of indebtedness including industrial development bonds, imposition, levy, collection, receipt and use of sales taxes, parcel taxes, Mello-Roos taxes, property taxes, special taxes, or any other type of tax or assessment, application for, and receipt of all permits, grants, loans, or other aids from any federal, state, tribal or other local public agency, promulgation, adoption and enforcement of any ordinances, policies, rules and regulations may be necessary to implement and effectuate the JPA agreement, and exercise the common powers of the members and any additional powers available under the laws of the State of California.

Specific actions permitted for the Authority include those necessary to operate a business such as executing contracts, employing staff, acquiring, constructing and operating plant, incurring debts and obligations, receiving grants and contributions, investing funds, suing and being sued, setting and collecting fees, assessing members as needed, cooperating and contracting with other public agencies, and doing any and all things necessary to accomplish the purpose of the JPA.

POLICY OPTIONS

The state and federal broadband policy environment strongly supports expansion of the local public broadband infrastructure to achieve Broadband Master Plan goals and vision while ensuring the cities can maintain their unique aesthetic qualities. State and national policy is squarely focused on eliminating the “digital divide” and

making broadband access available to all citizens and communities. Federal and State of California broadband developments are explained in further detail in Appendices B and C.

The Gateway Cities COG can most effectively capitalize on the current broadband policy environment through a comprehensive, proactive approach to developing its digital infrastructure, including but not limited to broadband. Traffic and utility infrastructure require and are co-located with network assets in the public right of way. Access infrastructure directly supports economic development, education, essential services, health care, and housing. While abundant resources are coming available for broadband development, it is unlikely they will be adequate, but they may be used as leverage for other funding. A wide range of complementary investments and impact multipliers are made possible by a comprehensive strategic approach.

Aligning Gateway Cities' Broadband Policies and Resources

To the extent not already accomplished, the Gateway Cities' policies regarding wireless broadband infrastructure must be aligned with the FCC "Small Cell Order" in 2020. Further documentation on small cell should provide common terms and conditions for all wireless providers regarding deployment of small cell facilities on city structures and details for installation of small wireless facilities on City streetlights. Each city's Public Works and Community Development should be aware of requirements of subsequent FCC decisions on wireless siting. The "5G Upgrade" decision[34] allows applicants for siting of 5G antennas to start the shot clock with the first procedural step required by a city, including a pre-submittal meeting.

For larger wireless infrastructure, cities should have a telecommunications facilities ordinance to regulate permits for wireless towers and antennas, ideally in line with other California cities. After the Small Cell Order the FCC issued its "Site Modification Order"[35]. This Order expands the definition of an "eligible facilities request" to include ground excavation or deployment of transmission equipment up to 30 feet in any direction outside the boundaries of an existing tower site. The Gateway Cities may see applications for modification of existing tower sites which cite this provision.

Finally, public works departments will need to plan for compliance with SB 378, which mandates approval of "micro-trenching" applications, which is defined as a narrow

[34] See Appendix B at page 14.

[35] See Appendix B at page 16.

open excavation trench that is: (1) no wider than 4 inches; (2) at a depth of 12 to 26 inches; and (3) created for the purpose of installing a subsurface pipe or conduit. The shallower depth is undesirable for long term health of the City's streets as it inevitably requires additional maintenance and reduces lifespan. Requirements for maintenance and restoration should be clearly spelled out in response to this mandate.

Improving Policies to Support the Broadband Master Plan's Goals and Vision

Affordable Connectivity Program

The Gateway Cities could assist in expanding the penetration of broadband services by making it a practice to regularly publicize and promote the availability of new FCC Affordable Connectivity Program benefits[36] to qualifying City residents. At least some of the Gateway Cities members are likely doing this already. The ACP provides a $30 per month subsidy through participating broadband providers to reduce the price for a minimum 100 Mbps download speed broadband connection for eligible households. The Gateway Cities region can benefit from the ACP by gaining awareness of program details and communicating them to their low-income residents and program managers for services provided to the low-income communities.

Fiber is the Foundation for Fast Broadband Access

Both wireline and wireless broadband services require fiber optic cable. The Infrastructure Investment and Jobs Act (IIJA) and SB 156 in California have made large amounts of funding available to invest in fiber optic technology, particularly in open-access middle mile networks and last-mile fiber networks for unserved areas lacking access to 100 Mbps upload/100 Mbps download speeds. Additional policy actions by the City can also contribute to expanding the reach of fiber optic connections in Gateway Cities. Generally, it is advisable to incorporate fiber—or at least conduit—into all capital projects and plans. For example, including broadband in HUD plans could allow multi-dwelling units to be retrofitted with fiber.

Radio is Essential for Flexible Access

Whether via cellular or Wi-Fi, most people connect to the net via radio access network. Citizens Band Radio Service, low-power wide-area network, and millimeter

[36] The FCC's Affordable Connectivity Program is funded by the Infrastructure Investment and Jobs Act.

wave, not to mention 5G, are growing more common. Typically, these technologies co-exist, and all rely on fiber for backhaul to core networks. They also require mounting on physical facilities—buildings, poles, tanks, or towers. Gateway Cities has a strong precedent for placing cell sites on public property. City assets, particularly streetlights, can be used as micro-cell sites, if connected via fiber. Permitting and zoning, including reasonable design and construction standards, can facilitate this. A thorough review of assets and sites will identify what is practical for development. Wi-Fi infrastructure can be inexpensively deployed in most public spaces—community centers, major parks, public buildings, transit centers, etc.—particularly if implemented in a standardized manner.

Transportation and Utility Projects and Broadband

Transportation and utility infrastructure are getting smart so require connectivity to operate, improving traffic and reducing impact on natural resources. Network assets can be economically incorporated into other infrastructure. Fiber for traffic signal interconnects can include additional fiber and conduit for other applications, including broadband services and cell site backhaul. IIJA provides more funding for traditional infrastructure programs than specifically for broadband. The Gateway Cities can capitalize on that and complement investment specifically for network assets. The key to this is to fully incorporate and include network infrastructure into other capital projects and permits.

Utility Coordination and "Dig Once"

State and federal policies are being established for coordination of utility work in the public rights of way to foster efficient and cost-effective placement of fiber whenever the public rights-of-way are opened for any project. Substantial federal funding is provided for transportation projects including roads, bridges, highways and Intelligent Transportation Systems (ITS). Federal policy previously strictly prohibited non-highway use of ITS traffic fiber and related work in the highway rights of way, which impeded efficient deployment of broadband infrastructure.

The Federal Highway Administration implemented a new rule[37] this year to facilitate installation of broadband infrastructure. To accommodate broadband in the right of way federal highway projects by rule the state department of transportation is to identify a "broadband utility coordinator" to be responsible for facilitating infrastructure efforts in the rights of way. This is a substantial change of policy direction at the federal level, toward allowing the use of federal highway funding to

[37] See, 23 CFR Part 645.307(a).

expand broadband infrastructure and encouraging broadband utility coordination while working on projects involving work in the right-of-way.

Similarly, Caltrans has implemented new policies under state legislation pertaining to wired broadband facilities on state highway right of way on its website. This includes a new resource for "Accommodation of Wired Broadband Facilities within Access-Controlled State Highway Right of Way" [38] dated March 14, 2022, that addresses state legislation and considers the new rule from FWHA. The Caltrans website provides contact information for its Broadband Coordinators, including for the Gateway Cities region (District 7).[39] Inventory and mapping of Caltrans-owned wired data communications assets including broadband conduits is available from the Caltrans district contact.

AB 41 passed in 2021 requires that Caltrans projects funded by the Budget Act of 2021, and that are located in priority areas as identified by the CPUC under SB 156, include the installation of conduits capable of supporting fiber optic cables. Prioritized locations include those for the state's middle-mile network that will serve locations unserved with last-mile broadband facilities capable of 25/3 Mbps service as well as unserved community anchor institutions (schools, colleges, libraries, healthcare institutions, government entities, etc.) and tribal areas.

As described above, the Golden State Network is a new public corporation that will build and operate statewide middle-mile network in Caltrans rights-of-way. The Gateway Cities should explore these opportunities with the representative on broadband utility coordination and GSN. Deployment of additional broadband infrastructure for other purposes can be planned in conjunction with traffic fiber for Intelligent Transportation Systems (ITS) and the Gateway Cities' fiber master plan.

Implementation of the utility coordination concept often begins by coordination among city departments first, such as Public Works, Utilities, Community Development and the various transportation improvements at regional and local levels. The concept can then be extended to include projects of private utilities and other occupants of the public right of way using the same cost saving/pavement protecting objectives.

Utility coordination can begin with city departments ensuring they are coordinating on major projects to include broadband infrastructure where needed by considering

[38] https://dot.ca.gov/-/media/dot-media/programs/traffic-operations/documents/encroachmentpermits/attachment-a-wired-bb-accommodation-a11y.pdf

[39] Caltrans Broadband Coordinators, Caltrans. https://dot.ca.gov/programs/design/wired-broadband/poc

at early stages of the projects how can it be used to expand broadband capacity and availability. Going forward, all significant City projects and initiatives should include explicit consideration of broadband implications. Broadband is critical infrastructure and general plan elements should incorporate actions which support expansion of broadband infrastructure.

Utility maintenance and installation work coordination can avoid damage to the public investment in landscaping and roads, and to avoid disruption to residential neighborhoods. It supports deployment of fiber to streetlights and traffic signals in alignment with this Regional Broadband Master Plan (RBMP), as well as include placement of conduit in economic development corridors, transportation planning and capital improvement projects. In sum design and development processes and documents need to include broadband as a fundamental consideration.

Development Standards and Conditions on Development Agreements

The Gateway Cities COG members could consider inclusion of requirements to place fiber/conduit, concurrent with development, in developer agreements to ensure efficient provision of fiber-optic based next generation broadband services. Examples of approaches to conditioning development include:

- The City of Brentwood California requires developers to place conduits and fiber optic systems for use by the city and its licensed franchisees. [See, Title 16, Subdivisions and Land Development, Chapter 16.120.120, Undergrounding – Electric, communications, street lighting and advanced technology systems.]
- The City of Shafter California conditions approval of developer agreements in part on installation of fiber optic systems to serve each buildable lot and dwelling in the development in concert with its municipal fiber optic network. The city provides detailed fiber optic requirements. See, Developer Agreement Conditions for the City of Shafter CA in Appendix E.
- Sandy, Oregon requires all development sites shall be provided with public water, sanitary sewer, broadband (fiber) and storm drainage, constructed concurrent with development. Work to install public improvement facilities must proceed according to procedures adopted by the City Engineer, to among other things “provide for orderly and efficient land division patterns supported by a connected system of streets, fiber (broadband), water supply, sanitary sewer and stormwater drainage facilities.” [Development Code, Chapter 17.84.60]
- Ocala Florida through its Utility Services department establishes fiber conduit rules which contain detailed specifications and procedures for conduit to be installed by the developer, including developer/contractor responsibilities, trench specifications and procedures, requirements for use of joint trench, conduit specifications and procedures, and drawings and exhibits. Ocala Utility

Services will install the fiber optic systems using these conduits constructed under its "Fiber Conduit Rules and Regulations". These specifications are similar in nature to the City of Shafter's developer conditions.

Broadband access and internal building wiring can be required for affordable and public housing and CDBG and other HUD funds can be applied to this purpose.

RECOMMENDED MODEL

The business model and governance structure that is best-suited to Gateway Cities' goals and available resources is a public-public partnership or local government cooperative to develop, maintain, and capitalize on network infrastructure. This includes providing a limited range of services (e.g., transport) to members. The primary purpose would be to reduce costs and support operational improvements for members. The secondary purpose would be to attract private capital investment to extend the network and offer services to under-served areas. This approach will have the greatest chance of success and will be the most financially sustainable.

Specifically, we recommend the Gateway Cities establish a formal partnership – in the form of a JPA – among themselves and with other public entities, including the County of Los Angeles, LA Metro, school districts, and other special districts. The purpose of the partnership would be to integrate city-owned and other public-owned network assets into a coherent regional infrastructure, along with GSN, to meet the cities operational requirements, increase digital inclusion, and support economic development. Conceptually, benefits in terms of increased inclusion, reduced costs, and support for development would be based on both resources contributed to the partnership and gaps in infrastructure and services.

A primary objective of the partnership would be to attract or grow private companies to lease or otherwise use the public network infrastructure to provide services to the community. This may include community-based and micro-enterprises as well as emerging regional companies and established national and international corporations. Revenue and services from these companies should be intended to support digital inclusion, providing devices and skills training along with connectivity. A collaborative approach by the cities will allow them to drive private investment into under-served areas as a condition of tapping more lucrative market opportunities.

Other Partnerships

Partnerships basically involve complementary contributions toward some shared purpose in which all partners benefit. This is distinct from a client-provider or customer-vendor relationship in which a consumer pays a producer for a good, typically in an open market in which the consumer selects one of multiple offerings.

Partnerships tend to be highly differentiated, customized to circumstances, and involve close coordination. The value of partnerships come from cost savings to each partner and synergies that no one partner could achieve on its own.

The most fundamental partnership in the Gateway Cities is the COG itself. A new broadband authority would build on this partnership. It is important to add value to and build on this partnership, recognizing that the cities have varying levels of assets, capabilities, and requirements. Beyond local municipalities, potential public partners include:

- Central Basin Municipal Water District
- Golden State Net
- Los Angeles County
    - Department of Public Works
    - Internal Services Department
- Los Angeles County Office of Education, college districts, and school districts
- LA DEAL
- LA EDC
- LA Metro
- Port of Long Beach
- SoLa Impact

There are also numerous prospective private partners, generally the providers listed above in the "Private Network Systems and Services" section, above, and tower companies (American Tower, Crown Castle, SBA Communications, et al.), but also Southern California Edison.

Several factors unique to any private partner impact the Authority's need for financing. For example, a private ISP that is already operating in the region would likely have the advantage of economy of scale and spreading costs over its existing administrative overhead, reducing staffing requirements; existing private assets could be brought to bear on the Gateway COG network, reducing equipment and/or fiber plant needs; operational efficiencies from billing, customer service, and troubleshooting processes could reduce recurring software and accounting expenses; marketing strategies could simply be augmented at marginal cost rather than developed from the ground up. Of course, private partnerships must be carefully structured to avoid any discrimination and maximize overall investment and market options.

5. Recommendations

There is a clear case for the Gateway Cities to develop a flexible, high-capacity, highly resilient network infrastructure. Simply reducing municipal expenses is the foundation but just the start. Digital inclusion and operational improvements, which support quality of life for residents, are also strong reasons to invest. If these goals could be achieved, it makes sense to invest in broadband infrastructure. Being able to leverage existing public assets and the planned Statewide middle-mile for these purposes makes the case even stronger. Attracting private investment by service providers to use the infrastructure would be the proverbial icing on the cake.

Magellan recommends the Gateway Cities ***develop and use the infrastructure in a comprehensive, methodical, objective-oriented manner*** via the COG or comparable organization. This involves building network assets—cell sites, fiber, Wi-Fi, etc.—into housing and running fiber through economic development areas, along LA Metro lines, and into data center sites. The Gateway Cities should focus on areas with key economic clusters/drivers, specifically food processing and logistics because of their high revenue and biotech/biosciences and healthcare because their number of jobs. Advanced manufacturing and arts/entertainment are also important clusters to be connected.

Adopt smart practices across cities including broadband friendly policies, IoT (Internet of Things) integrated with other infrastructure, and network assets included in comprehensive planning. Broadband-friendly policies, summarized above, include development conditioning, "Dig Once," expedited permitting, and wireless master services agreements. Municipal IoT includes building and irrigation controls, environmental monitoring, parking automation, traffic management, and utility metering. Power microgrids and autonomous vehicles are prime examples of emerging applications that are critical to long-term viability. Capital improvement projects, comprehensive plans, developments, and permitting should all include network assets as a matter of course.

Collaboration and partnerships are essential to successful broadband development, particularly with objectives such as increasing digital inclusion and reducing connectivity costs for cities. ***Engage local non-profits, other public agencies, and private utilities as partners***. The county departments of Internal Services and Public Works along with LA Metro may be the most important simply due to their size. Capitalize on existing infrastructure, GSN, and other public plans. Seek private investment to serve all areas but link access to the most desirable areas with investment in the most challenging areas. Consider the range of network infrastructure required to achieve goals—plan for access—but ***focus investment on***

fundamental assets with long-term value to cities, connecting facilities and supporting municipal operations.

The next step is to ***identify local priorities in each city and integrate them into an area-wide effort***. Consistent policies and practices will also be critical. The conceptual design will need to be built in phases, which will require some consensus among the cities. ***Extend backbone infrastructure along major corridors as appropriate***, in conjunction with "Complete Streets" project, for example. Build economically but for resilience, including traffic signal interconnects, water/sewer, and developments. Deploy transport equipment to provide services for cities across the backbone to data centers, etc., as/when appropriate. All of this should be done consistently across cities and may be most economical if done by a central, shared support organization.

We recommend the Gateway Cities ***develop a collaborative public sector connectivity services entity, either within the COG or as a new, separate joint powers authority***. It may also make sense to establish special districts—community services or facilities districts—for broadband. Generally, we recommend these efforts focus on establishing a core "backbone" infrastructure that is designed to accommodate access infrastructure. But ***seek private companies to deploy distribution and access assets***. The Authority can deploy these directly where appropriate for members (Wi-Fi in parks, for example).

The objective is to lease assets, including cell sites, and provide wholesale transport only if/where appropriate or necessary. This provides maximum room for private investment without depending on it. It also focuses private investment on those assets that change and depreciate the fastest, where there are the best opportunities for profit but also the greatest risks. The Gateway Cities should ***establish clear, consistent, transparent governance focused on policy and procedures to facilitate development and reduce costs***. We believe it will ultimately make sense to establish a new JPA for the purpose of building and maximizing use of network assets.

PHASED IMPLEMENTATION PLAN

Policies, procedures, regulations, and standards are needed to implement the regional or individual city master plans and facilitate the building of broadband infrastructure. Near term, high-impact projects should be selected to build capabilities and competence toward larger goals while minimizing capital investment. This section provides an initial version of a year-by-year roadmap for fiber infrastructure deployment along with recommended milestones that should be achieved along the way. It will need to be detailed and revised based on the priorities of the Gateway Cities with activities, funding, partnerships, and other resources

needed to be successful developing the network, as well as high-level costs of each phase of the implementation.

Phase 0 – Initial Planning and Stakeholder Engagement

This report represents the outcomes of phase 0. The Gateway Cities Broadband Master Plan (GCBMP) is the foundation and starting point for increasing connectivity, digital inclusion, and tech-enable economic development for the Gateway Cities. A roadmap for additional phases is included in Figure 27 on page 102.

Phase 1 – Detailed planning, development prioritization, and partnership development

The first phase of the GCBMP is detailed planning for infrastructure asset deployment, including prioritization of projects. The general priority is to connect city halls, to establish a platform for cost reduction and operational improvement. There are other assets and facilities that could be connected along the process. Routes may be extended, particularly in conjunction with other capital projects, to greatly increase coverage, especially through under-served areas and near industry clusters. Existing assets may be incorporated to economically achieve these goals.

Activities

The primary activity in this phase is high-level network design and, where appropriate, low-level engineering. Dual supporting activities for this phase are (1) identifying and prioritizing assets and sites to connect or integrate and (2) developing working relations between partners, specifically for planning and policies. Business development for wholesale services, particularly focused on private providers, should be initiated during this phase.

Supporting activity #1 is a critical input to design work. It defines the scope of the high-level design and determines where low-level engineering is required in the short-term. Supporting activity #2 involves the cities adopting Dig Once ordinances, development conditions for network infrastructure, expedited permitting processes, wireless master license agreements, and similar. An associated activity is establishing a broadband working group for the Gateway Cities to coordinate the other activities.

Funding

Most funding for phase 1 is expected to come from the State of California via the CPUC's Local Agency Technical Assistance (LATA) grant program. These funds will pay for network design and planning support services. Some funding for these activities

in this phase is essentially overhead for participating entities. Staff members or other representatives will need to provide additional, detailed information about assets and facilities. They will also need to work with their associates to change policies and procedures to facilitate broadband development, including options for special districts to support broadband development.

Milestones

1. Gateway Cities Broadband Working Group
2. Consensus on initial project scope and additional phase
    - Master site list, assets to be included, and routes finalized
    - Specific development priorities set
3. Broadband-friendly policies template for cities and county
4. Funding sources identified and proposals produced
5. Initial decision on whether to develop a JPA and/or special districts
6. High-level design for sub-regional backbone utilizing GSN and other public assets
7. Low-level engineering of top priority projects
8. Broadband-friendly policy adoption by cities
    - Ordinances adopted by councils
    - Procedures defined and implemented by staff
    - Consideration of special district options
9. Area network development partnership among public entities
    - Range of applications, assets, and services defined
    - Framework for partnering with or providing services to private companies established
10. Funding secured for initial construction and interconnection

Partnerships

The critical partnerships for this phase are among the Gateway Cities and with County of Los Angeles departments, LA Metro, school districts, and other special districts. It will be necessary to work with SCE and other private utilities, particularly for joint build opportunities. The public partners should actively include non-profits, particularly community-based organizations, in development and planning.

Resources

Key resources for this phase are data. Data about assets and facilities are particularly important as those will be resources for next phases. Staff resources will be required for data gathering and planning activities. Initial projects are intended for operational

capacity-building so it is possible additional personnel may be required during this phase, particularly for business development and organizational development.

Costs

Direct costs for phase 1 are approximately $500K for professional services to do high-level design, low-level engineering, and planning/policy development. The cities and COG should plan to allocate staff time to Broadband Work Group meetings and data gathering. Additional professional services costs may come with establishing the Authority and any related special districts.

Phase 2 – Initial construction and interconnection

The second phase of the GCBMP is focused on construction of initial routes, integration of existing assets where available, and interconnection of key facilities. This phase also involves capacity building and partnership development.

Activities

The key activities in this phase are infrastructure construction and operational startup. Construction services and materials will need to be procured, and the overall process will need to be managed. The Broadband Working Group will oversee these processes and plan for next steps, including formalizing a broadband authority for the area and prioritizing infrastructure expansion and planning services.

Additional data gathering will be required, which will need to be integrated with data created by construction and design. Business development will also be essential in this phase, laying the groundwork for success in the next phase. Planning for operations, including on-boarding key personnel, during this phase will be necessary for the same reasons.

Funding

Construction funding is likely to come from various sources. State Last Mile grant funds, Measure M funds for transit/transportation-related projects, and other regional and state programs will likely fund the bulk of construction, as well as federal grants where applicable. Specifically, IIJA funds for resilient infrastructure, transportation, and utilities could be important for construction.

Local capital improvement funds and enterprise funds may be used in this phase as it involves connecting municipal facilities. To the extent that schools are included in phase 1, it may be possible to tap E-Rate funds for construction. Private sector investment in the form of joint builds and indefeasible rights of use (IRUs) should be promoted early in this phase, ideally starting in phase 1, resulting in customer

milestones included below. Attracting initial wholesale customers and investors will be an essential activity during this phase.

Special districts may provide substantial funding or resources for broadband development. One or more community facilities districts, community services districts, or other special districts could be established to fund network infrastructure. Decisions about this should made during phase 1.

Milestones

1. Funding secured and allocated to priority/proposed initial projects
2. Establishment of JPA and special districts initiated as appropriate
    - Governance structure formalized
3. Construction RFPs released
4. Broadband-friendly polices fully adopted at least by initial project cities
5. First private investor or lessor signed contract
6. Construction contractor selected and materials purchased
7. Construction begins
8. Additional investors or lessors acquired
9. Key personnel (e.g., Broadband Director or General Manager) in place
10. Equipment acquired and installed, including facilities improvements
11. Construction completed
12. Initial sites connected
13. As-built documentation completed and management system in place

Partnerships

Partnerships in this phase are an extension of those in phase 1. Key partnerships, particularly among cities leading broadband development and with the COG, will be deepened if not formalized. Private partners will be more important for practical reasons related to construction and funding. It will be important to clarify and differentiate “partners” from customers and vendors during this phase as these will require different organizational capabilities.

Resources

Existing network assets, public properties, and rights of way will be critical assets in this phase along with construction equipment, materials, and network equipment. The human resources to manage physical resources will largely come from construction contractors and other vendors but some will need to be provided by the cities, COG, and county. Depending on decisions about tactics made during phase 1—whether to establish a JPA or special district(s), for example, and how aggressively to pursue private customers or investors—additional personnel may be added in this

phase. Consultants may be required in the interim to assist with planning and development.

Costs

The total estimated cost of construction, based on the conceptual design, is $36M. The estimated baseline cost per mile is $455K, assuming 40% of the infrastructure in overhead. This does not include any costs associated with a submarine route to Avalon but does apply to local construction throughout the area. Laterals into buildings and other facilities will conservatively cost $125 per foot. Costs will vary greatly across the area due to highly localized conditions. These baseline estimates include 20% construction contingency.

These costs may be greatly reduced by incorporating network into other capital projects and using existing assets. Costs will increase if initial routes are extended to other areas or sites, even if those do use existing assets. For example, integrating traffic signal interconnect infrastructure into the sub-regional backbone may cut relative cost while expanding coverage, but it would still involve substantial costs. Very detailed costs will come from phase 1.

Phase 3 – Extension and GSN interconnection

Phase 3 continues construction and organizational development with the focus shifting to the latter. Specifically, GSN should be developing in parallel with phase 2, so this phase will involve physically integrating the sub-rings into GSN. Network extension may be an on-going activity depending on available resources, capital projects, and partner investments but major routes will be complete or planned in this phase.

Activities

An initial activity if phase 3 will be validating and verifying outcomes from phase 2, likely in the form of a strategy conference or workshop among the partners and attended by top officials of all formal partners. This activity should cement partnerships, specifically with GSN and other public agencies, and should confirm priorities and resources for expanding the network.

Activities beyond this event will be business development and construction. The business development should focus on under-served areas to fully achieve the goals of this plan. Similarly, construction will shift to very focused areas and laterals into specific facilities, although some major routes may still be in development in conjunction with other projects.

Activities during phase 3 will generally shift to "community customers," partner organizations that will use the network for specific activities or programs. These should include social services, school districts, public health, libraries, and community-based organizations along with city departments. It may occur in conjunction with construction to ensure maximum uptake and use. Promotional activities with wholesale customers may be appropriate.

There will be major technical activities during this phase accompanied by management development or support activities. The technical activities involve installing and configuring hardware to fully interconnect facilities across the Gateway Cities with partners, specifically GSN, and resources such as data centers. Operational systems for security/surveillance, traffic, utilities, etc., will likely be handled by city and county personnel.

Funding

Some funding for phase 3 will come from additional grants, particularly for programs. Most of the funding will have to come from partners, particularly cities, as customers or from actual wholesale customers. It is expected that the cities will pay some amount for connectivity, offset by the value of any assets they contributed to the network. Other anchor institutions and community customers may be paying customers. Private companies should be leasing facilities and/or paying a share of revenue by phase 3.

Milestones

1. Construction to-date verified and priorities for extension set
2. GSN strands spliced into all interconnection points
3. Core network equipment deployed and operating
    - All targeted sites fully operational
    - Network management systems fully operational
4. Outside plant maintenance, including on-going construction and regular expansion, in place
5. Private wholesale customer base established and generating revenue
    - Access infrastructure fully operational
    - Significant uptake by community members
6. Programs established for anchor institutions and community customers

Partnerships

Phase 3 is all about operationalizing partnerships. Strong technical partnerships among members will be especially important in this phase.

Partners should see costs, including overhead and soft costs, decrease. In contrast, anchor, community, and private wholesale customers should find new opportunities and revenue—which are greater for strengthening partnership.

Resources

The primary resources in this phase will be talents of employees and partners. Technical resources, including expertise as well as equipment, software, and systems, will be especially important. It is expected that private wholesale customers will provide access and distribution equipment.

Programmatic resources, including content, equipment, and staff to conduct programs, will be critical for digital inclusion and economic development outcomes, and may be very helpful for improvements in municipal operations. Community customers will need resources to engage community members for adoption and support activities.

Costs

The major cost components for this phase are equipment and systems and staff. Costs for access and core equipment are summarized in the "Equipment and Services" sub-section, above, and the "**Error! Reference source not found.**" sub-section lays out other costs.

Costs for programs include staff time, materials, and support systems. These will vary greatly. Some grassroots programs should be possible with very small budgets. Advanced or large-scale programs for access, skills, or technical solutions require equipment, software, and talent.

Phase 4 – Operations and programs

Phase 4 represents full implementation of the plan and on-going operations of the Authority, including programs for digital inclusion, economic development, and municipal operations. Many aspects of the Gateway Cities will be impacted but those impacts may be relatively small and unremarkable in context. In aggregate, the impacts will likely be huge. Therefore, it is important to measure performance and results. The indicators and metrics for the plan overall include:

- Business utilization of digital technology
- Cost per month per megabit per second for wired and wireless connections
- Investment in network assets by private companies
- Miles of fiber deployed
- The number of:

    - Community members connected via high-speed wired and wireless services
    - Fiber-connected buildings
    - Persons working remotely or in technical jobs
    - Radio access points
- Public revenue from network assets and related services
- Service level agreements, down time, and failures

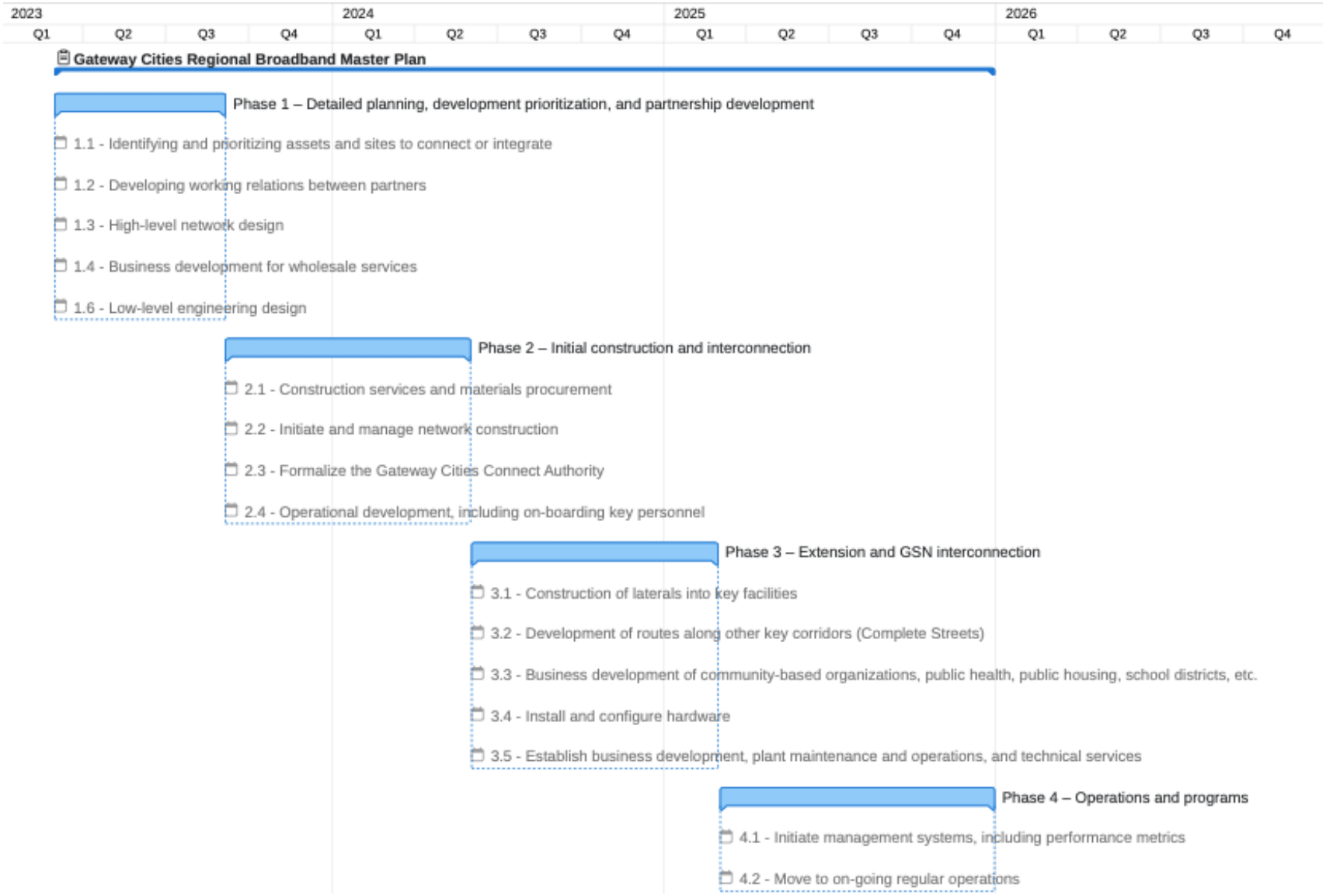


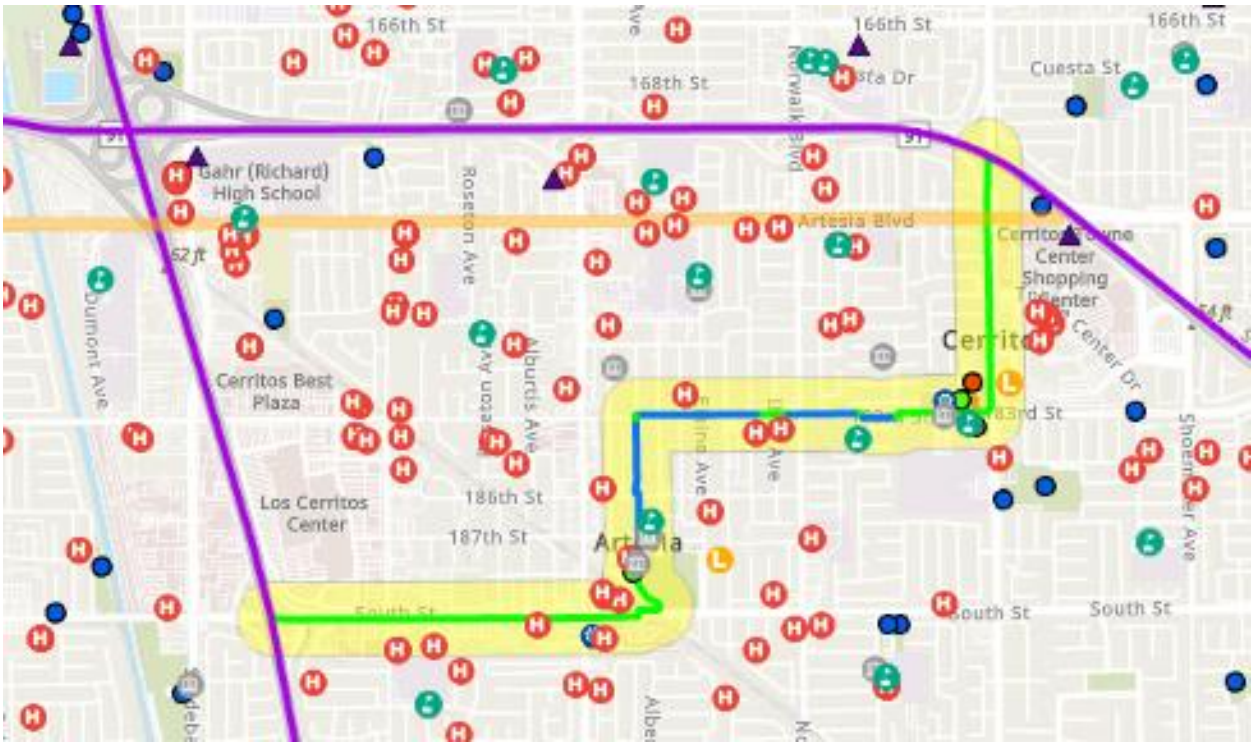
Figure 27. Gateway Cities Broadband Master Plan roadmap

Appendix A: Gateway Cities Conceptual Sub-rings

Legend

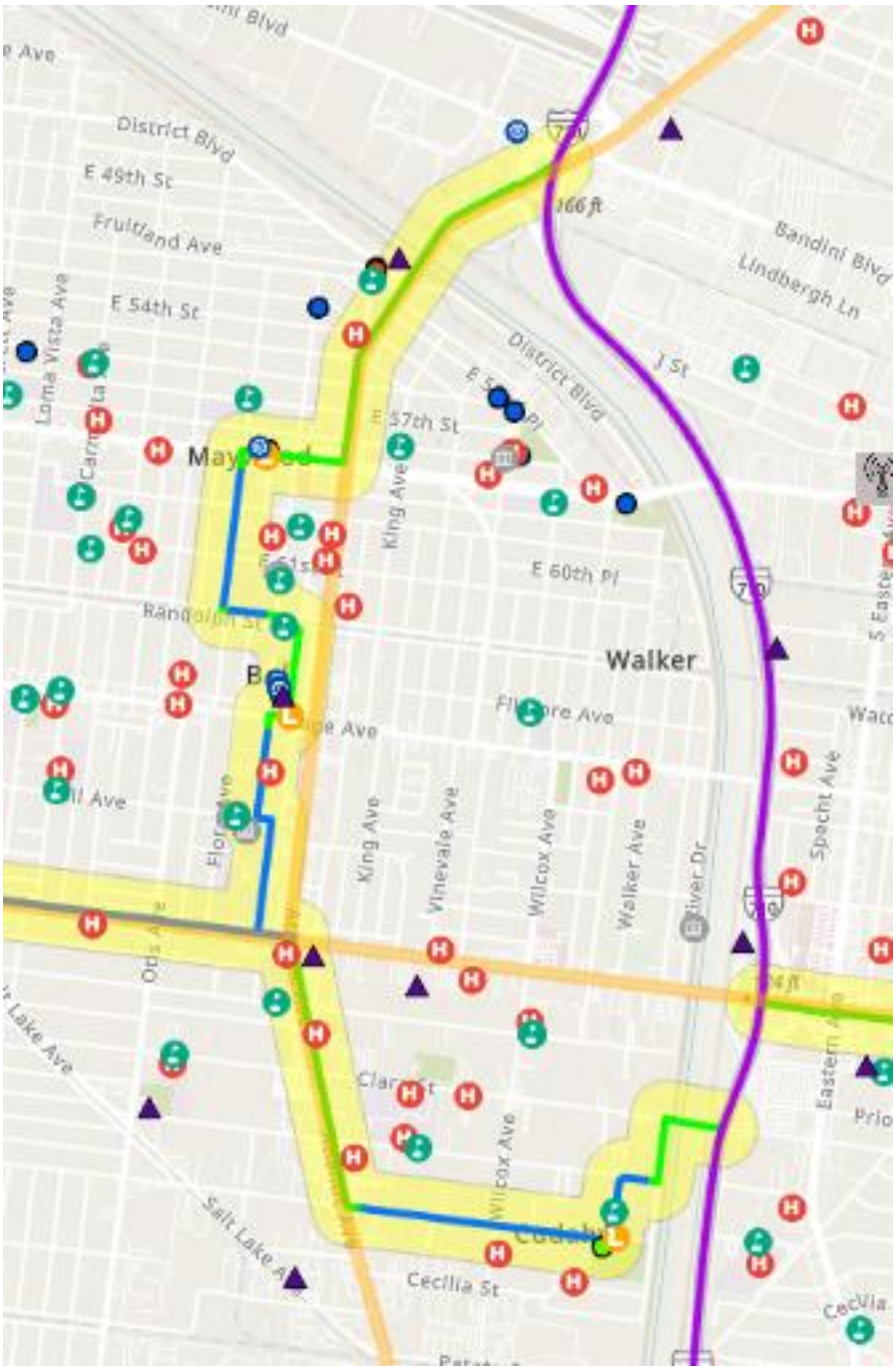
- - -	Area Boundary
	Backbone Fiber 500ft Buffer
	Backbone Fiber: Overhead
	Backbone Fiber: State Middle-Mile/GSN
	Backbone Fiber: Underground
	Capital Improvement Corridor
	Other Sites: Cell Sites
	Other Sites: CPUC Anchors
	Targeted Sites (218 total)
	Targeted Sites in Backbone Fiber 500ft Buffer (52)
	Targeted Sites: City Halls (28)

ARTESIA-CERRITOS



Feet	18,686.07
Estimated Cost	$1,588,316
Total Locations	1,774
Total Units	2,169
Units/Mile	613
Cost/Unit	$732
Total Residential Units	1,993
Total Non-Residential Units	176
Unserved Locations	14
Unserved Units	16
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	14
Unserved Non-Residential Units	16

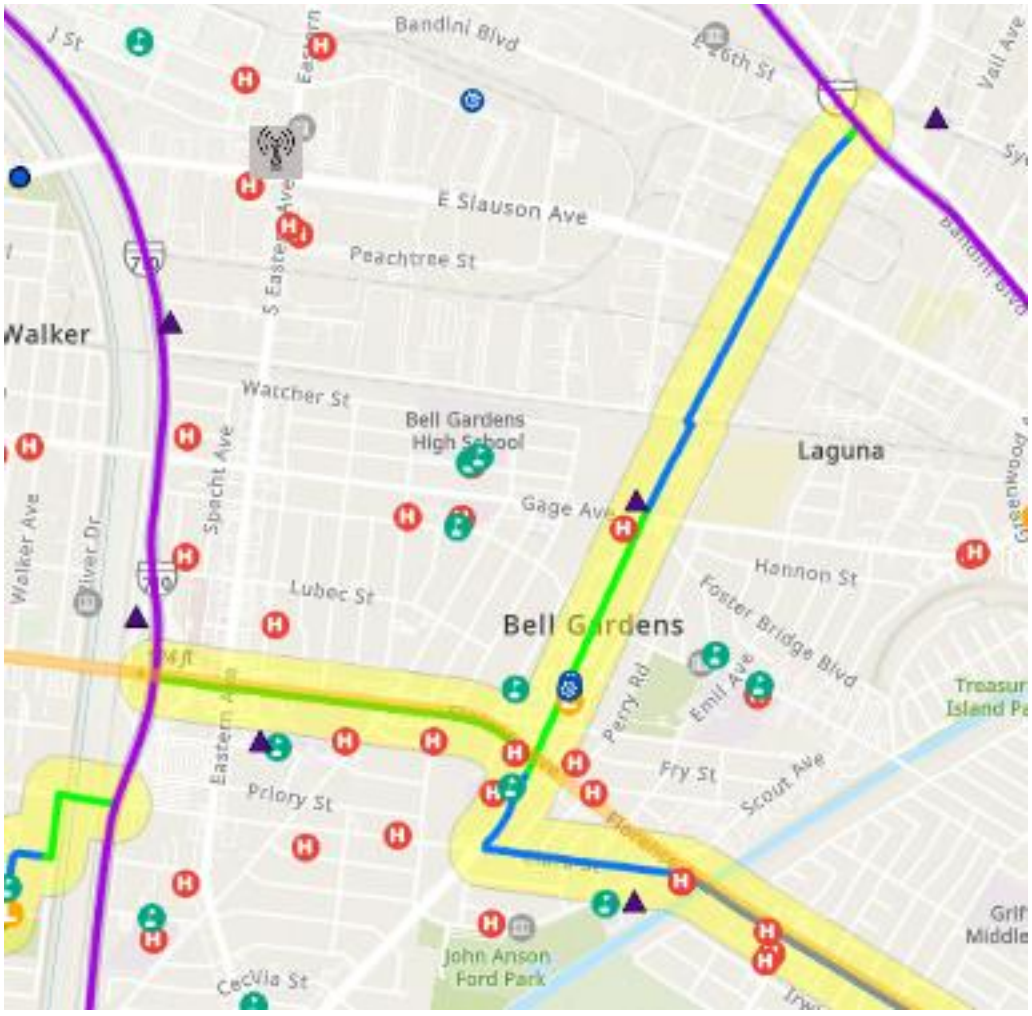
BELL-CUDAHY-MAYWOOD



Feet	16,195.60
Estimated Cost	$1,376,626
Total Locations	1,984
Total Units	4,556
Units/Mile	1,485
Cost/Unit	$302

Total Residential Units	4,002
Total Non-Residential Units	554
Unserved Locations	35
Unserved Units	55
Unserved Residential Locations	13
Unserved Residential Units	23
Unserved Non-Residential Locations	22
Unserved Non-Residential Units	32

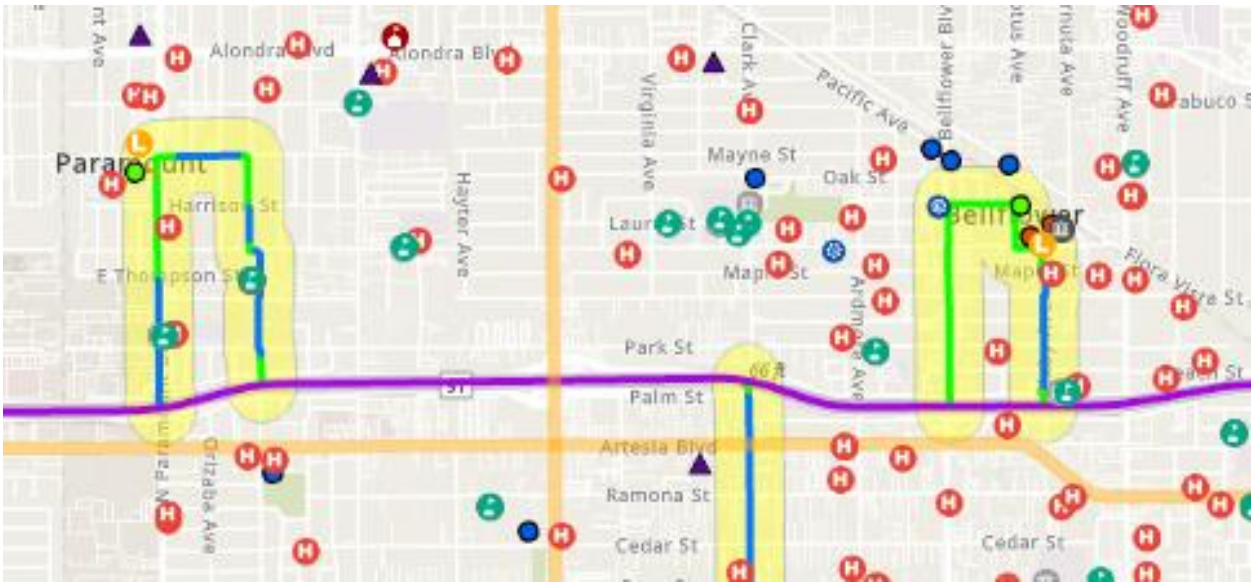
BELL GARDENS



Feet	31,425.64
Estimated Cost	$2,671,179
Total Locations	2,076
Total Units	5,116
Units/Mile	860

Cost/Unit	$522
Total Residential Units	4,648
Total Non-Residential Units	468
Unserved Locations	137
Unserved Units	218
Unserved Residential Locations	50
Unserved Residential Units	110
Unserved Non-Residential Locations	87
Unserved Non-Residential Units	108

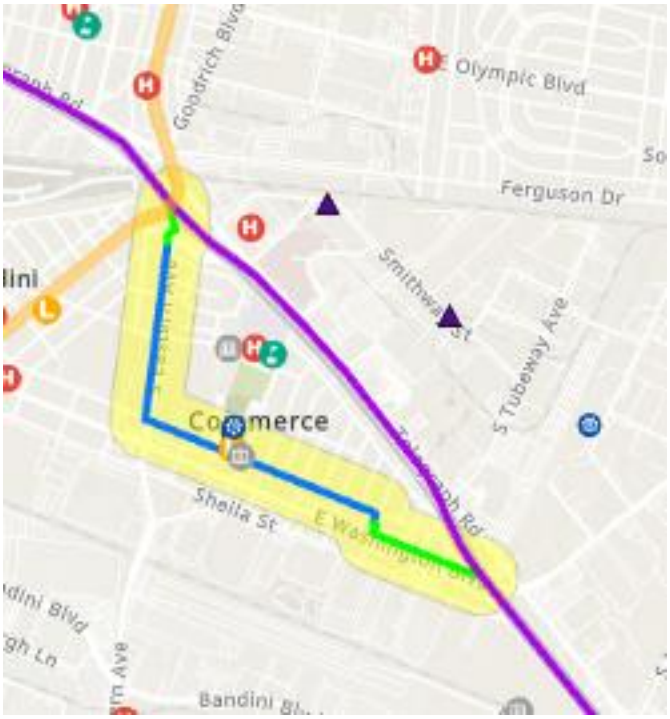
BELLFLOWER AND PARAMOUNT



	Bellflower	Paramount
Feet	6,976.83	8,185.43
Estimated Cost	$593,031	$695,762
Total Locations	950	737
Total Units	3,217	1,582
Units/Mile	2,435	1,020
Cost/Unit	$184	$440
Total Residential Units	2,970	1,479
Total Non-Residential Units	247	103
Unserved Locations	20	21
Unserved Units	20	23
Unserved Residential Locations	-	-
Unserved Residential Units	-	-
Unserved Non-Residential Locations	20	21

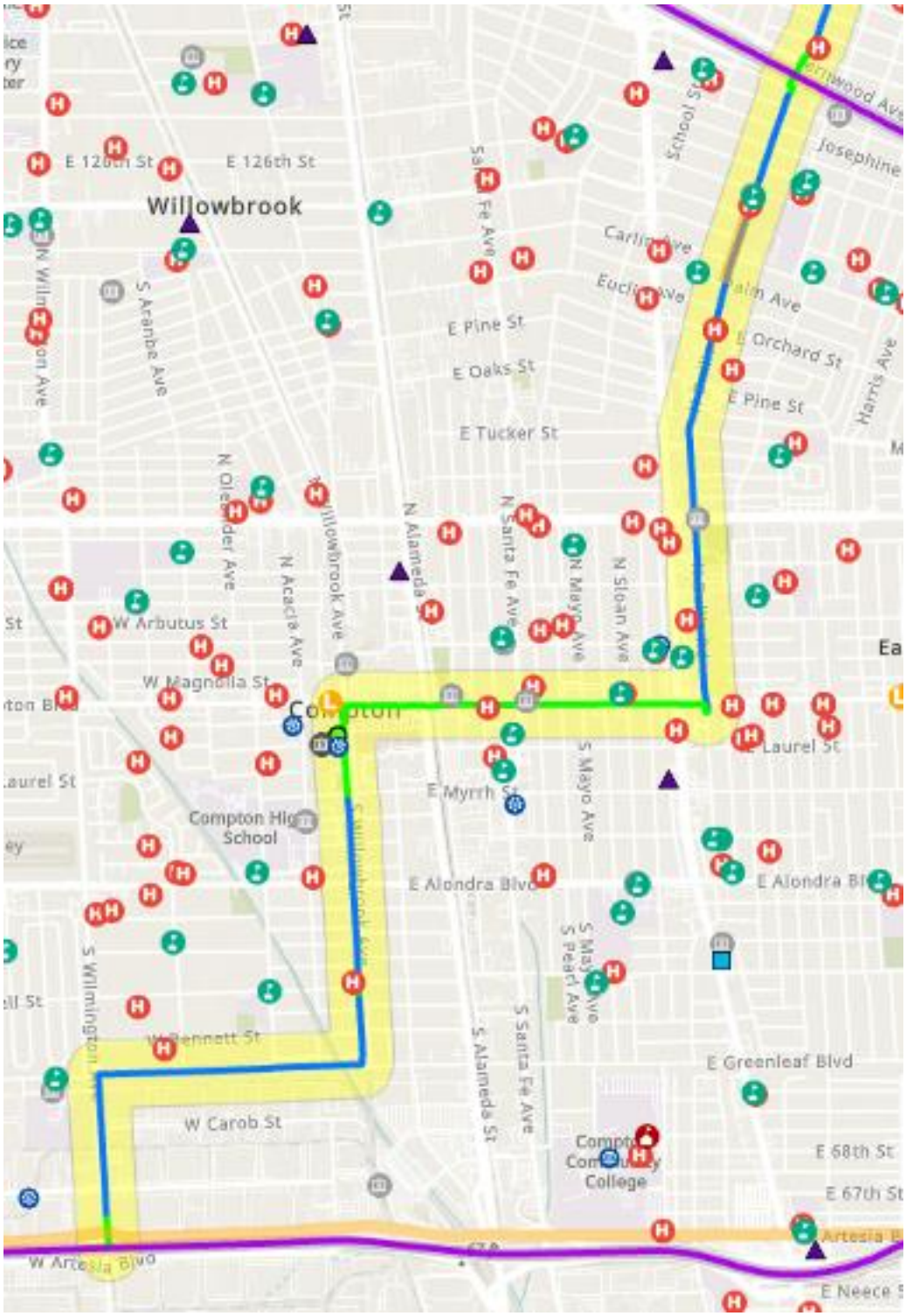
Unserved Non-Residential Units	20	23

COMMERCE



Feet	8,829.34
Estimated Cost	$750,494
Total Locations	665
Total Units	963
Units/Mile	576
Cost/Unit	$779
Total Residential Units	848
Total Non-Residential Units	115
Unserved Locations	74
Unserved Units	74
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	74
Unserved Non-Residential Units	74

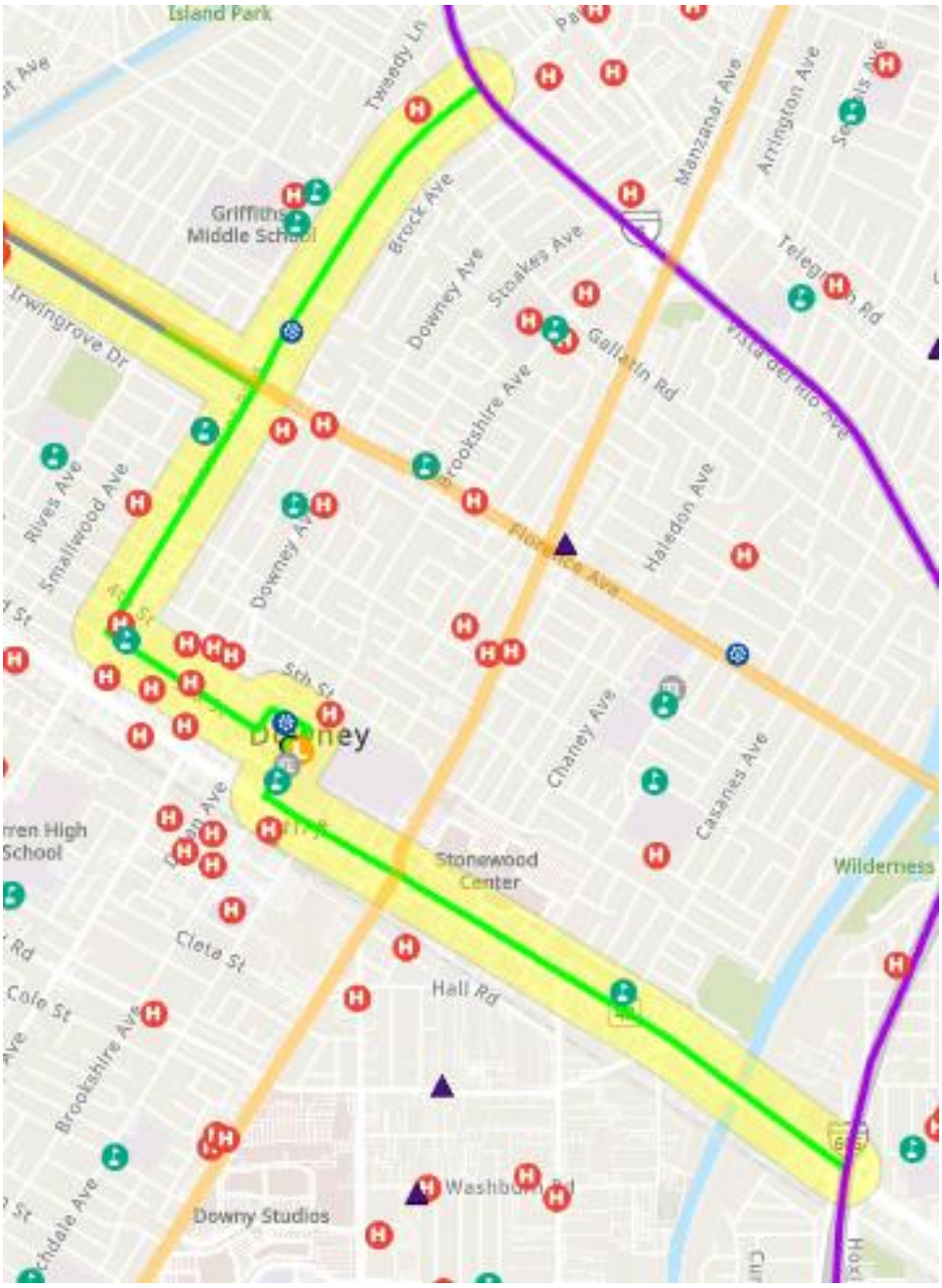
COMPTON



Feet	29,280.66
Estimated Cost	$2,488,856
Total Locations	1,448

Total Units	2,538
Units/Mile	458
Cost/Unit	$981
Total Residential Units	2,096
Total Non-Residential Units	442
Unserved Locations	36
Unserved Units	38
Unserved Residential Locations	1
Unserved Residential Units	1
Unserved Non-Residential Locations	35
Unserved Non-Residential Units	37

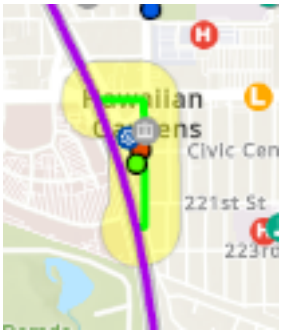
DOWNEY



Feet	35,799.25
Estimated Cost	$3,042,936
Total Locations	5,834
Total Units	11,500
Units/Mile	1,696
Cost/Unit	$265
Total Residential Units	10,433

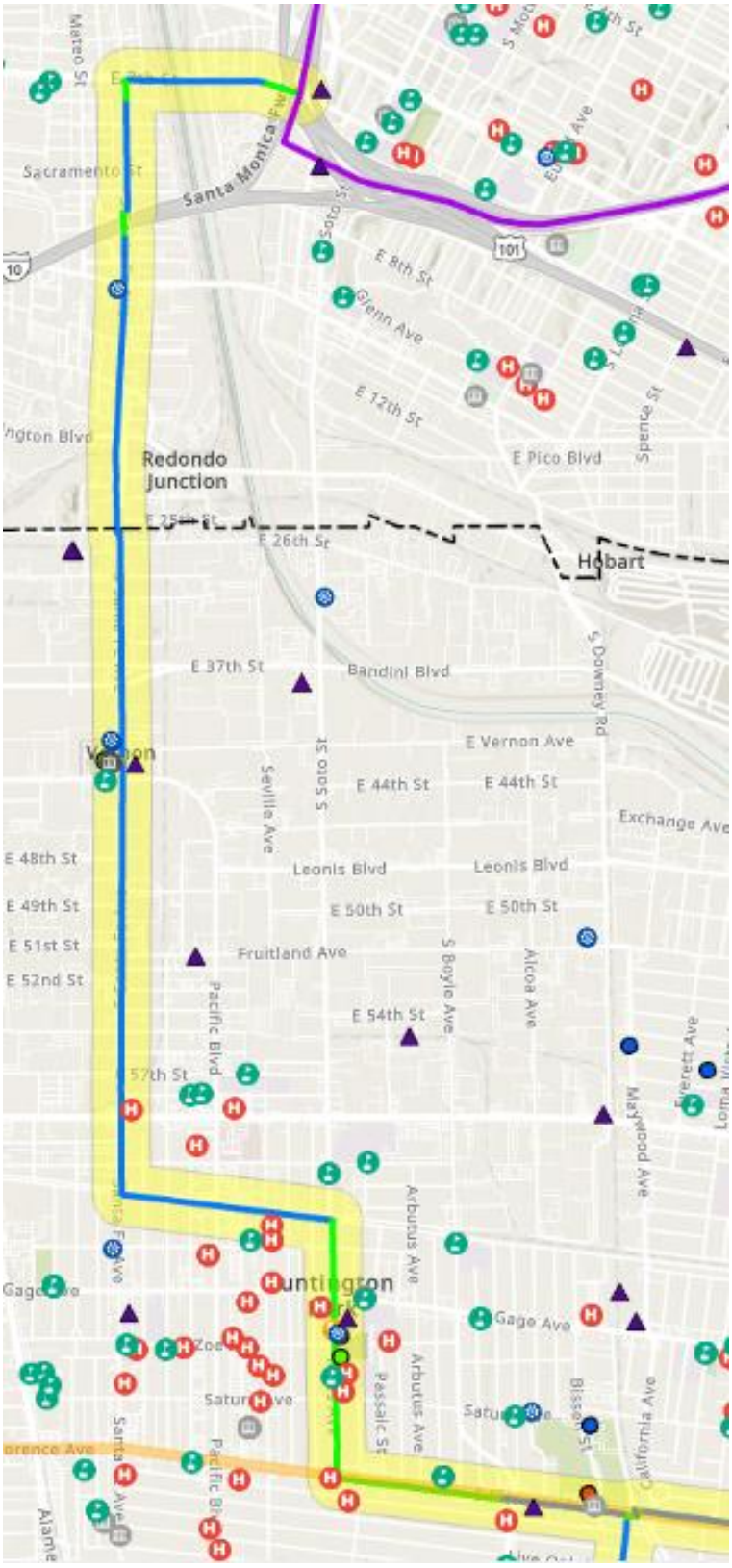
Total Non-Residential Units	1,067
Unserved Locations	166
Unserved Units	488
Unserved Residential Locations	7
Unserved Residential Units	61
Unserved Non-Residential Locations	159
Unserved Non-Residential Units	427

HAWAIIAN GARDENS



Feet	2,499.46
Estimated Cost	$212,454
Total Locations	321
Total Units	511
Units/Mile	1,079
Cost/Unit	$416
Total Residential Units	492
Total Non-Residential Units	19
Unserved Locations	3
Unserved Units	3
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	3
Unserved Non-Residential Units	3

HUNTINGTON PARK-VERNON



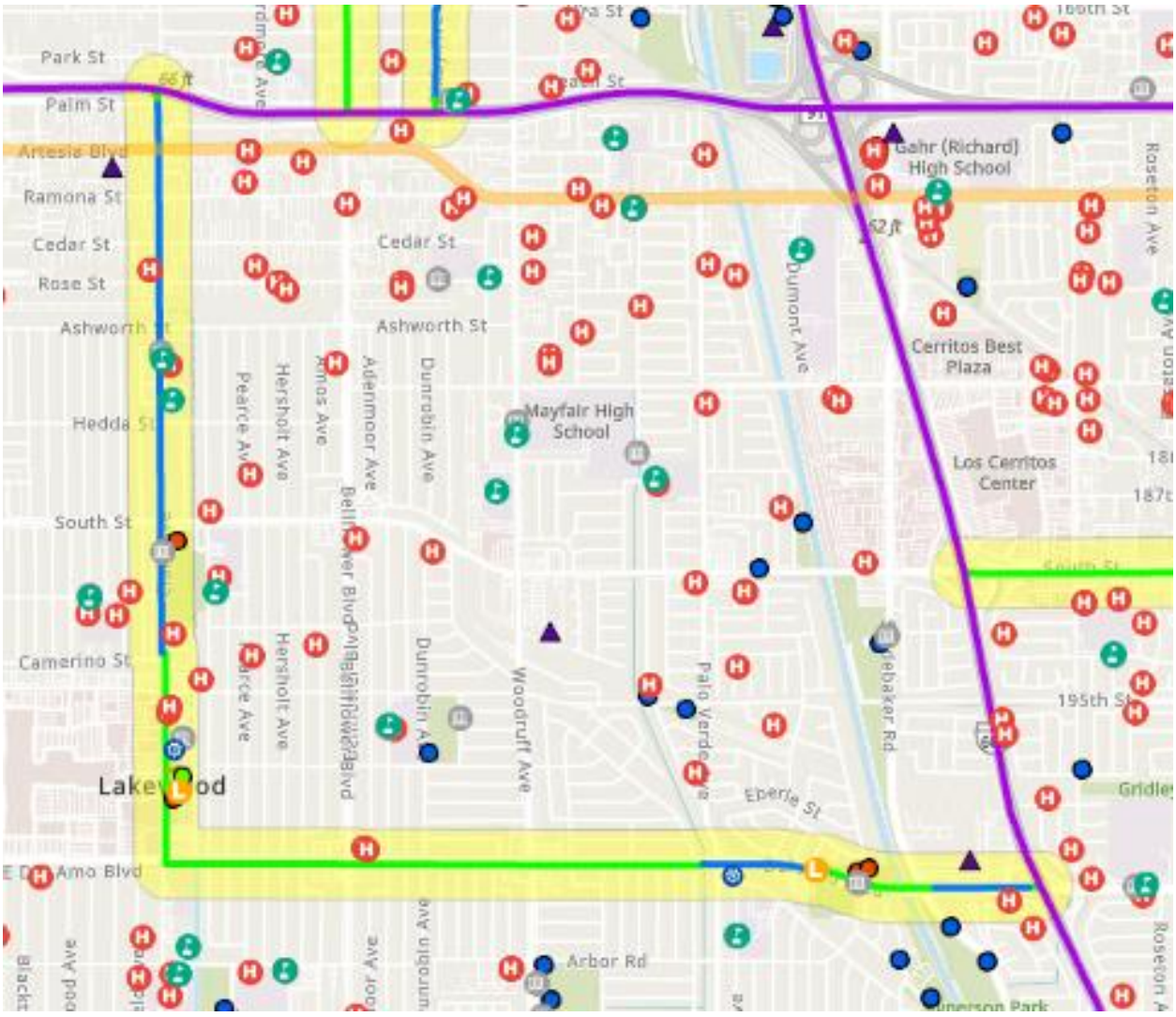
Feet	35,174.24
Estimated Cost	$2,989,810
Total Locations	1,313
Total Units	3,749
Units/Mile	563
Cost/Unit	$797
Total Residential Units	3,446
Total Non-Residential Units	303
Unserved Locations	46
Unserved Units	54
Unserved Residential Locations	4
Unserved Residential Units	11
Unserved Non-Residential Locations	42
Unserved Non-Residential Units	43

INDUSTRY

Feet	15,145.51
Estimated Cost	$1,287,368
Total Locations	584

Total Units	692
Units/Mile	241
Cost/Unit	$1,860
Total Residential Units	591
Total Non-Residential Units	101
Unserved Locations	2
Unserved Units	2
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	2
Unserved Non-Residential Units	2

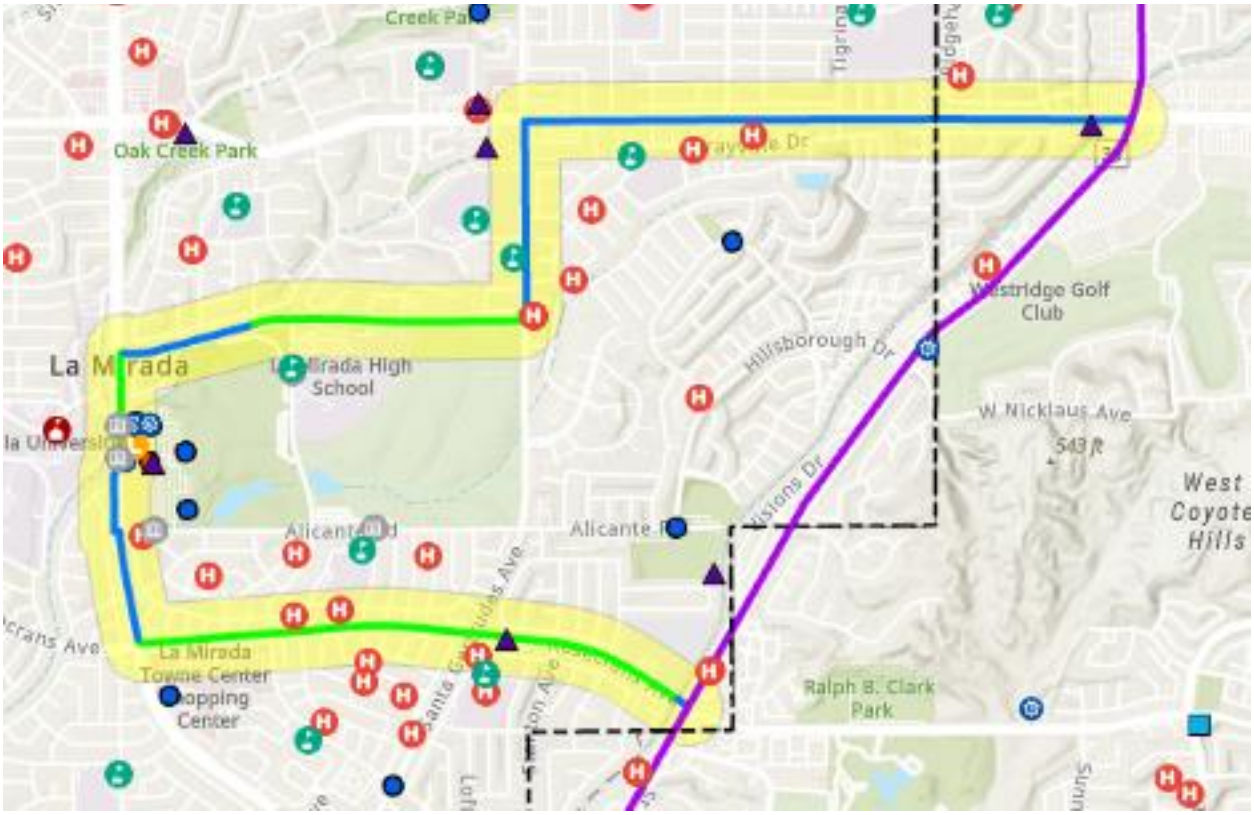
LAKEWOOD



Feet	26,190.05

Estimated Cost	$2,226,154
Total Locations	4,576
Total Units	5,097
Units/Mile	1,028
Cost/Unit	$437
Total Residential Units	4,968
Total Non-Residential Units	129
Unserved Locations	36
Unserved Units	77
Unserved Residential Locations	1
Unserved Residential Units	1
Unserved Non-Residential Locations	35
Unserved Non-Residential Units	76

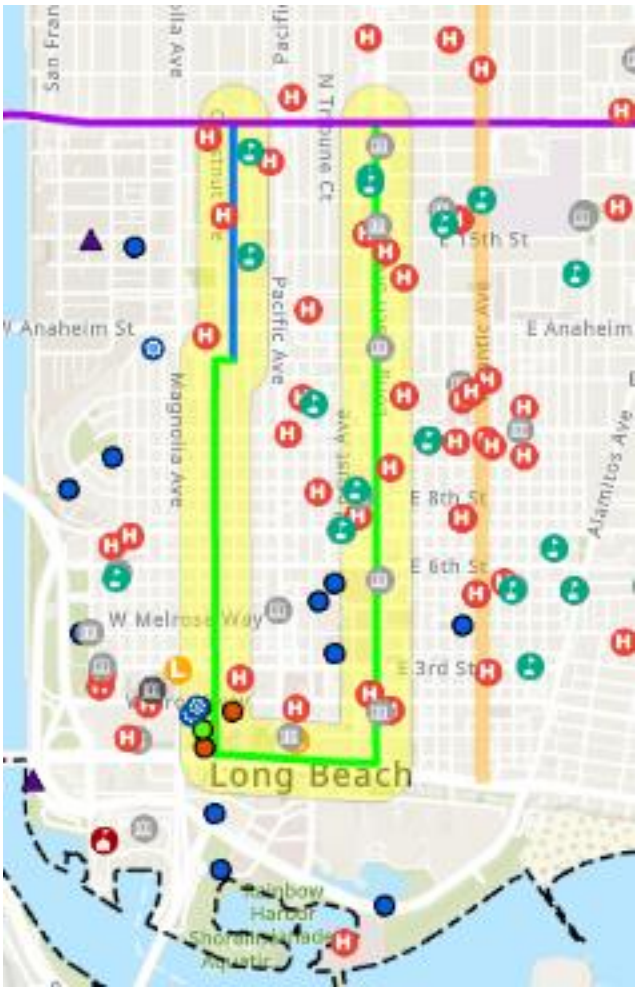
LA MIRADA



Feet	31,293.01
Estimated Cost	$2,659,906
Total Locations	3,731
Total Units	4,817
Units/Mile	813

Cost/Unit	$552
Total Residential Units	4,507
Total Non-Residential Units	310
Unserved Locations	88
Unserved Units	252
Unserved Residential Locations	1
Unserved Residential Units	1
Unserved Non-Residential Locations	87
Unserved Non-Residential Units	251

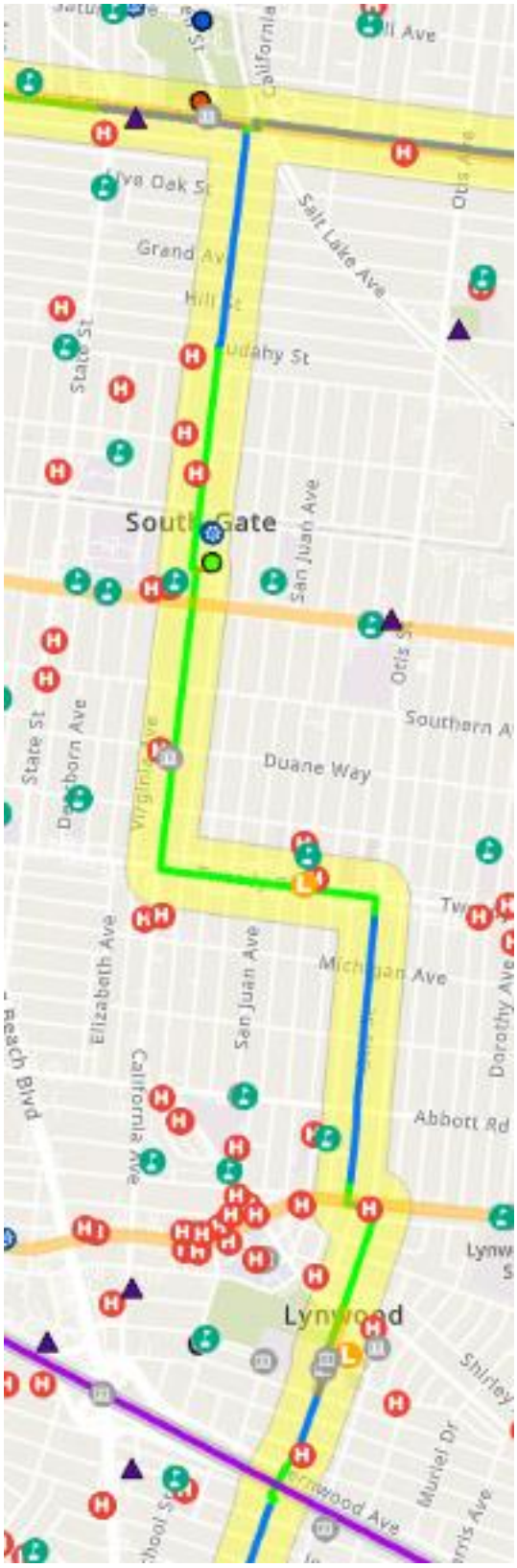
LONG BEACH



Feet	19,380.83
Estimated Cost	$1,647,371
Total Locations	2,399
Total Units	13,543
Units/Mile	3,690

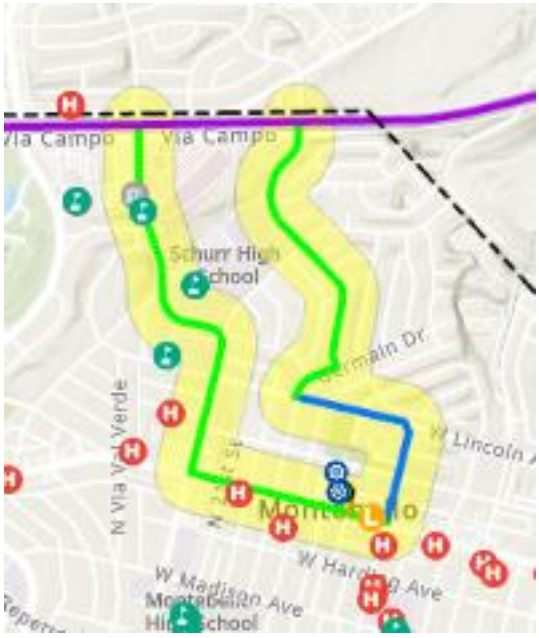
Cost/Unit	$122
Total Residential Units	10,513
Total Non-Residential Units	3,030
Unserved Locations	138
Unserved Units	1,165
Unserved Residential Locations	10
Unserved Residential Units	17
Unserved Non-Residential Locations	128
Unserved Non-Residential Units	1,148

LYNWOOD-SOUTHGATE



Feet	22,608.92
Estimated Cost	$1,921,758
Total Locations	1,388
Total Units	2,122
Units/Mile	496
Cost/Unit	$906
Total Residential Units	2,014
Total Non-Residential Units	108
Unserved Locations	19
Unserved Units	19
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	19
Unserved Non-Residential Units	19

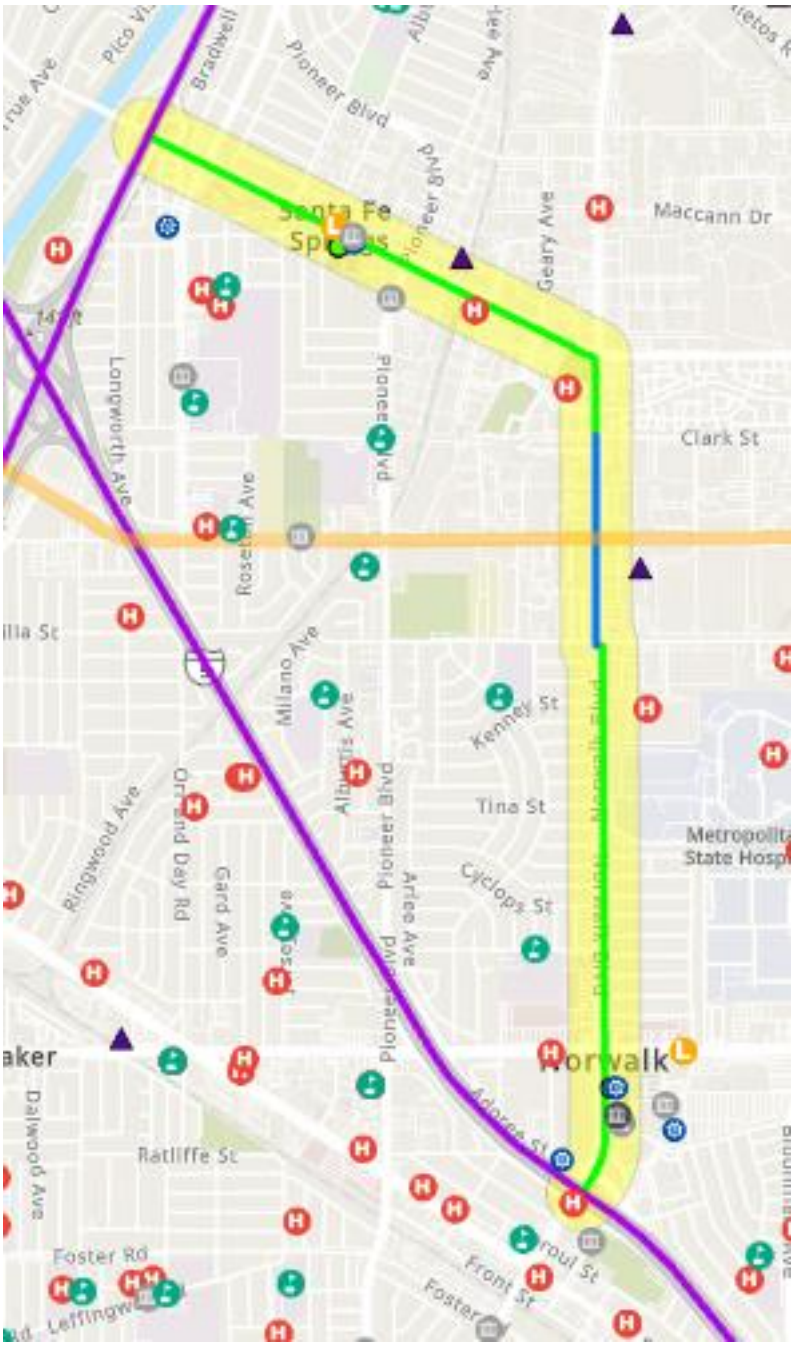
MONTEBELLO



Feet	16,143.44
Estimated Cost	$1,372,192
Total Locations	2,283
Total Units	5,050
Units/Mile	1,652
Cost/Unit	$272
Total Residential Units	4,246
Total Non-Residential Units	804

Unserved Locations	40
Unserved Units	47
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	40
Unserved Non-Residential Units	47

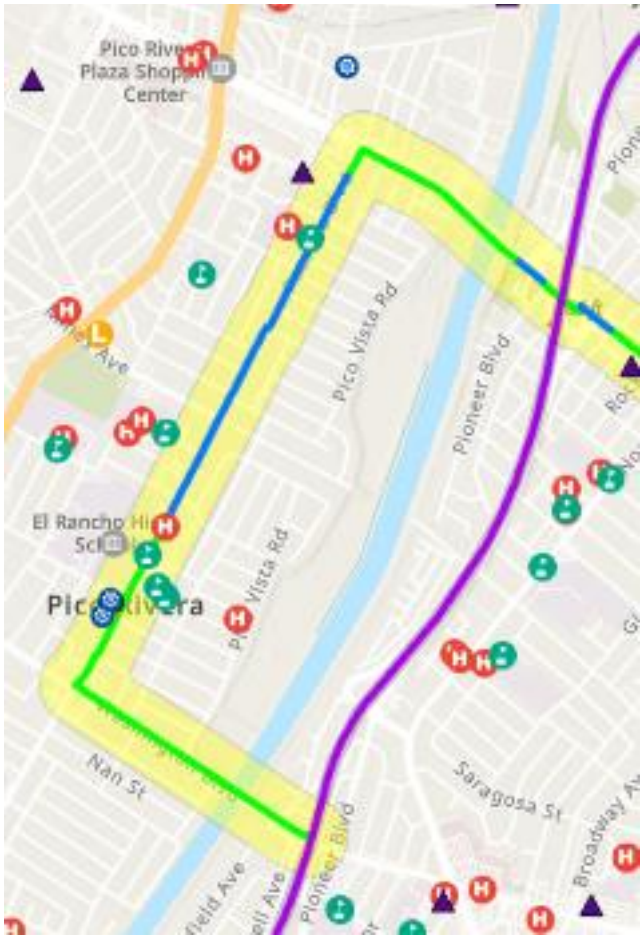
NORWALK-SANTA FE SPRINGS



Feet	18,616.15
Estimated Cost	$1,582,373
Total Locations	2,955
Total Units	5,027
Units/Mile	1,426
Cost/Unit	$315

Total Residential Units	4,734
Total Non-Residential Units	293
Unserved Locations	177
Unserved Units	619
Unserved Residential Locations	87
Unserved Residential Units	439
Unserved Non-Residential Locations	90
Unserved Non-Residential Units	180

PICO RIVERA



Feet	16,602.94
Estimated Cost	$1,411,250
Total Locations	2,644
Total Units	3,744
Units/Mile	1,191
Cost/Unit	$377
Total Residential Units	3,386

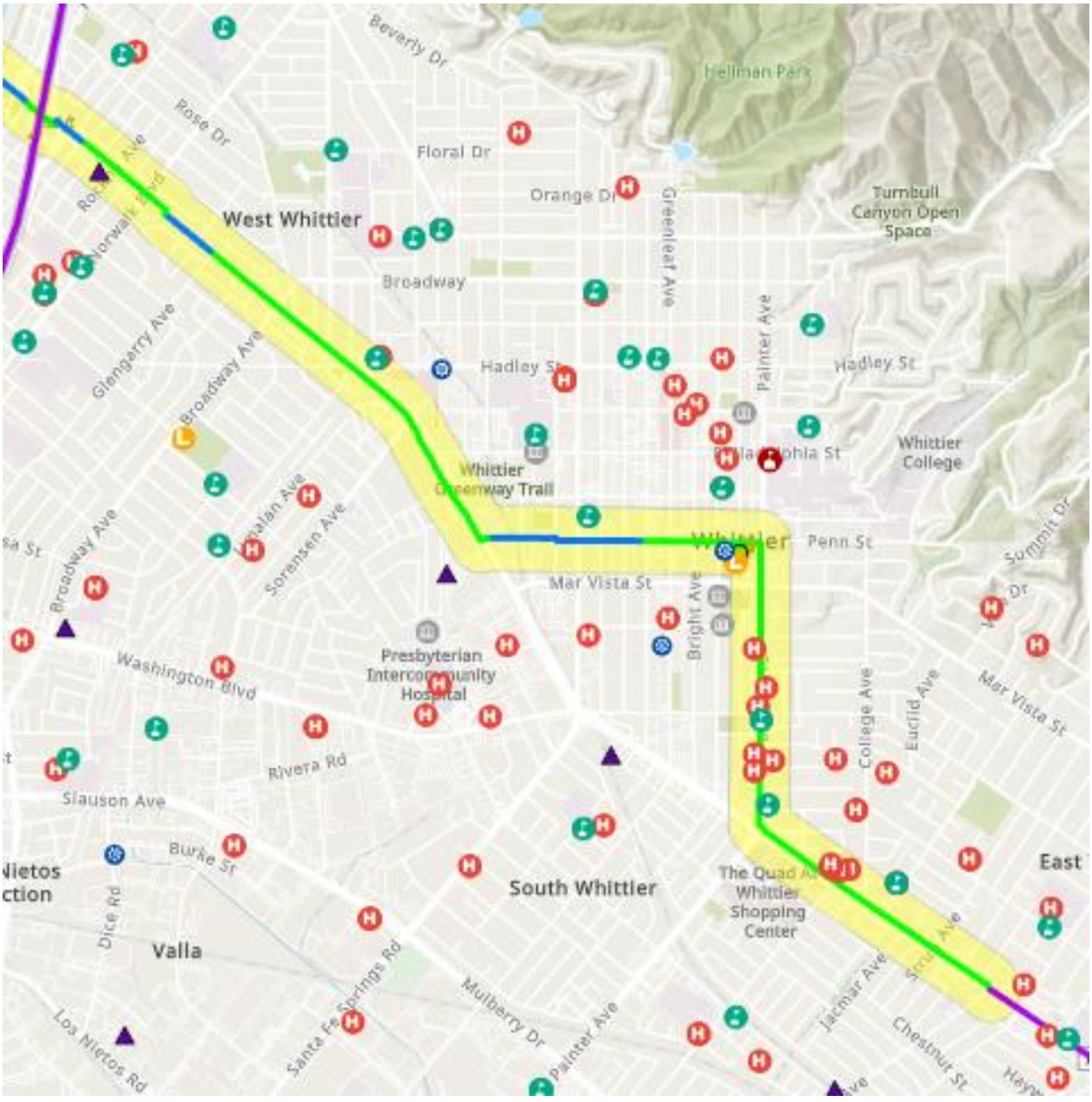
Total Non-Residential Units	358
Unserved Locations	43
Unserved Units	48
Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	43
Unserved Non-Residential Units	48

SIGNAL HILL

Feet	10,380.43
Estimated Cost	$882,337
Total Locations	647
Total Units	1,341
Units/Mile	682
Cost/Unit	$658
Total Residential Units	892
Total Non-Residential Units	449
Unserved Locations	180
Unserved Units	197

Unserved Residential Locations	-
Unserved Residential Units	-
Unserved Non-Residential Locations	180
Unserved Non-Residential Units	197

WHITTIER



Feet	25,262.70
Estimated Cost	$2,147,330
Total Locations	5,542

Total Units	10,193
Units/Mile	2,130
Cost/Unit	$211
Total Residential Units	8,983
Total Non-Residential Units	1,210
Unserved Locations	131
Unserved Units	167
Unserved Residential Locations	40
Unserved Residential Units	76
Unserved Non-Residential Locations	91
Unserved Non-Residential Units	91

Appendix B: California's Broadband Policy

GOVERNOR NEWSOM'S EXECUTIVE ORDER

Governor Newsom issued **Executive Order N-73-20**[40] on **August 14, 2020**, which found:

- Over 2 million Californians do not have access to broadband at benchmark speeds of 100 Mbps (download) including 50 percent of rural housing units.
- 23 percent of California housing units, housing 8.4 million residents, do not have broadband subscriptions (as of December 2018).
- 34 percent of adults over age 60 do not currently use the Internet.
- "The COVID-19 pandemic has amplified the extent to which broadband is essential for public safety, public health, and economic resilience".
- "The COVID-19 pandemic has caused schools to shift to distance learning".

The Executive Order directed state agencies to bridge the Digital Divide and ordered:

1. California state agencies to pursue a minimum broadband speed goal of 100 Mbps download speed to guide infrastructure investments and program implementations; and,
2. The California Broadband Council to create a new State Broadband Action Plan[41] for a roadmap accelerating state agency deployments and supporting local government deployments, providing information on federal and state funding, and maximize inclusion of tribal lands.

The Executive Order also directed state agencies to collaborate regarding broadband mapping and data, funding, deployment, and adoption:

1. Undertake regular research with private sector companies to understand and predict current and future demand for broadband to better manage policies, programs and resources for continued leadership in broadband innovation (mapping and data).

[40] *See*, https://www.gov.ca.gov/2020/08/14/38666/.

[41] *See*, https://broadbandcouncil.ca.gov/wp-content/uploads/sites/68/2020/12/BB4All-Action-Plan-Final.pdf

2. Office of Business and Economic Development is to identify funding opportunities for broadband deployment and adoption (funding).
3. Department of Technology is to seek leveraging opportunities for state contracting authorities to further broadband access and adoption (funding).
4. Transportation agencies to include placement of fiber and conduit in all appropriate and feasible state transportation projects along strategic corridors (deployment).
5. Provision of an inventory of state property for use in broadband infrastructure by the Department of General Services (deployment).
6. Coordination by the Office of Emergency Services to expand broadband infrastructure when implementing Next Generation 9-1-1 (deployment).
7. Identification and support for new broadband projects that support precision agriculture by the Department of Food and Agriculture (deployment).
8. Housing agencies are to provide recommendations to the CPUC for increased free or low-cost broadband connectivity serving subsidized housing units (deployment).
9. Office of Business and Economic Development to coordinate outreach informing residents of affordable internet service, including tools developed by CPUC for easy identification and subscription to affordable broadband plans, promotion of affordable home internet service to recipients of School Lunch program benefits by California Emerging Technologies Fund, and promotion of affordable home internet services by the California State Library (adoption).
10. Department of Education to lead statewide effort to ensure students have computers and connectivity necessary for distance learning (adoption).
11. Department of Aging to analyze needs of people over 60 for access to broadband and opportunities to close the digital divide among older Californians (adoption).

The Executive Order directed the **California Public Utilities Commission** (CPUC) to take specific actions regarding broadband mapping and data, and deployment:

1. Lead mapping and data gathering efforts to provide information on locations without broadband access, private and public broadband network infrastructure, state owned infrastructure and rights of way, costs of middle mile and last mile deployments (mapping and data).

2. Provide information supporting development of local broadband infrastructure deployment and digital equity plans (mapping and data).
3. Use programs under its jurisdiction to accelerate broadband deployment and leverage utility infrastructure (deployment).

RULEMAKING REGARDING BROADBAND INFRASTRUCTURE DEPLOYMENT AND TO SUPPORT SERVICE PROVIDERS IN THE STATE OF CALIFORNIA

The CPUC opened a rulemaking proceeding [42] to begin implementation of the **Executive Order**. Both the Governor's Executive Order and the CPUC rulemaking were written prior to availability of COVID-19 vaccines, amid pandemic-related shut-down requirements. The CPUC Order states:

> Communities across California face a multitude of barriers for the deployment of resilient and accessible networks. Broadband internet access service in urban communities varies by neighborhood, with great discrepancies in infrastructure technology. Communities in rural areas often lack sufficient wireline and wireless broadband internet access service, as well as the backhaul infrastructure to provide broadband services.
>
> The COVID-19 pandemic has highlighted the extent to which broadband access is essential for public safety, public health and welfare, education, and economic resilience. The pandemic adds greater urgency to develop new strategies and expand on existing successful measures to deploy reliable networks with affordable service. Universal connection to the internet at reliable speeds is crucial to California's economic recovery from the impact of COVID-19. More Californians are telecommuting from their places of residence and millions of children are attending classes remotely. Additionally, with unprecedented growth in unemployment caused by COVID-19 and the need to participate in society from home, the demand for low-cost broadband internet access service will increase as millions of additional

[42] Order Instituting Rulemaking Regarding Broadband Infrastructure Deployment and to Support Service Providers in the State of California; R.20-09-001; September 18, 2020.

> Californians need affordable plans to get through the pandemic and recover.[43]

The CPUC Rulemaking is to "identify strategies and tactics to facilitate expeditious deployment of reliable, fast, and affordable broadband infrastructure as well as services to connect all Californians." The issues included are "infrastructure deployment models and strategies, economic vitality and recovery strategies, and strategies to support specific communities, public safety, and other critical uses."[44]

Senate Bill 156, Funding for a State-Operated Open-Access Middle-Mile Network, Last-Mile Facilities, and a Broadband Loan Loss Reserve Fund

The State of California built on the Executive Order's direction to eliminate the Digital Divide when **Senate Bill 156** was signed into law on July 20, 2021. This bill implements significant broadband provisions for the 2021-22 budget, including creation of a Federal Funding Account to use American Rescue Plan Act (ARPA) funds. The major elements of the broadband budget are:

1. $3.25 billion in funding (all from ARPA) for construction of a state-owned open-access middle mile network designed to provide connectivity for rural and urban areas to achieve the greatest reductions in the number of households unserved by broadband service under state and federal standards.
2. $2 billion in funding ($1.072 billion from ARPA) for "last mile" projects, funded through the Broadband Infrastructure Grant Account program, divided between rural and urban counties.
3. $750 million (general funds) to assist local governments and non-profit organizations in financing broadband projects.

Other major provisions of SB 156 include:

1. Establishment of the Office of Broadband and Digital Literacy at the Department of Technology, with duties including oversight of the acquisition and management of the statewide open-access middle-mile network.
2. Requirement for CPUC to identify and prioritize statewide open-access middle-mile locations according to specified priorities, including:

[43] *Id.*, at page 6.

[44] *Id.*, at page 9.

   a. Locations where there is no known open-access affordable middle-mile networking, that would enable last mile connections.
   b. Areas unserved or unserved by open-access middle-mile networks where such networking can be built expeditiously.
   c. Locations that would enable last mile connections to unserved residences and community anchor institutions and tribal lands.
3. Requirement for CPUC to prioritize state highway rights-of-way for open-access middle mile network construction.
4. Stipulates that the open-access middle-mile network if for a public purpose and can be leased for less than fair market value.
5. Exempts certain broadband projects from CEQA requirements.
6. Removes limitations on local governments receiving grant funding.

The CPUC added SB 156 issues to the scope of Rulemaking 20-09-001 regarding broadband infrastructure deployment on August 2, 2021. The added issues address the implementation of SB 156 and the historic funding for middle-mile and last-mile broadband deployment contained in the American Rescue Plan Act.[45]

State Operated Open-Access Middle-Mile Network

"Middle-mile refers to the high-capacity fiber-optic cables that traverse long distances (i.e., 10s – 100s of miles) to connect communities to the Internet backbone."[46] Middle Mile networking connects the "last mile" distribution facilities connecting households and businesses to the network, with the backbone long haul facilities that comprise the Internet backbone between large cities such as San Francisco and New York.

Development of open-access middle-mile networking is crucial for unserved households in both rural and urban areas. "Lack of Middle Mile is a barrier to deployment and affordability"[47] of broadband services. The CPUC indicates middle mile networking is expensive to build for smaller providers, and either expensive to

[45] Assigned Commissioner's Second Amended Scoping Memo and Ruling, R.20-09-001; August 2, 2021.

[46] "Middle Mile Locations Outreach Briefing" presented to California State Association of Counties, California Public Utilities Commission, August 20, 2021.

[47] *Id.*

lease or unavailable from existing providers due to competitive position and proprietary networks.[48]

SB 156 prioritizes middle mile construction for a "geographically diverse group of projects in rural and urban areas of the state to achieve the greatest reductions in the number of households unserved by broadband internet access service meeting federal and state standards".[49] Under SB 156, the State of California plans to spend $3.25B from the state's American Rescue Plan funds to build a statewide open access middle-mile network.

SB 156 provides that the newly-established Office of Broadband and Digital Literacy in the California Department of Technology (CDT) will oversee the acquisition and management of contracts for development, construction, maintenance, and operation of the middle-mile network. The state middle-mile network effort is well underway, and CDT has retained CENIC California Middle Mile Broadband Initiative LLC as the third-party administrator for the network.[50] The network will be built by a new organization, GoldenStateNet (GSN), spun out from CENIC,[51] in Caltrans rights-of-way. All projects are to be completed by December 2026.[52]

The specific design for GSN was still in flux at the time of this research. Figure 15, on page 42, shows the most current location of GSN routes in the Gateway Cities area. The stated intention of GSN is to allow very flexible access, placing hand holes and splice cases wherever needed for making full use of the GSN fiber. See the California All Middle-Mile Broadband Initiative webpage, https://middle-mile-broadband-initiative.cdt.ca.gov/, for further information.

[48] *Ibid*.

[49] SB 156 Senate Floor Analysis, July 11, 2021.

[50] https://www.govreport.org/news/california-selects-nonprofit-third-party-administrator-as-broadband-partner/ The third-party administrator "will develop the fiber network and partner with CalTrans to manage construction of the middle-mile infrastructure along state highways and rights of way. CENIC will also collaborate with the [CPUC] on locations for middle-mile infrastructure and last-mile connectivity."

[51] CENIC operates the state's education and research network, CalREN.

[52] Middle Mile Broadband Initiative, State of California. https://middle-mile-broadband-initiative.cdt.ca.gov/#project-descriptions.

RM 20-09-001 Decision Adopting Federal Funding Account Rules

California's new Federal Funding Account establishes a two-billion-dollar grant program "focused on building broadband internet infrastructure to communities without access to Internet service at sufficient and reliable speeds."[53] The Rules and Guidelines contained in the Commission's Decision address:

- Eligible areas: CPUC will publish priority areas.
- Funding criteria and CPUC evaluation of applications, which will consider proposed matching funds, project technology choice, type of partnership, inclusion of Lifeline service, pricing commitments, low-cost broadband plans, coverage of existing broadband needs, applicant capacity and performance, project plan and budget, and leveraging of state middle-mile network.
- Entities eligible to receive funding include those possessing CPUC certification, other facilities based broadband providers, local government agencies, electric utilities, non-profits, cooperatives, and California tribes.
- Middle-mile infrastructure may be funded if it is needed to achieve proposed last-mile connections, but use of the state middle-mile network is expected. CPUC will verify if state middle-mile network could be used. In any event, open access, interconnection, and just, reasonable and non-discriminatory pricing is required.
- Performance criteria include project completion deadlines, minimum speeds and maximum latency, data caps are disfavored, commitment to "serve all" customers at specified prices, and participation in affordability programs.
- Required information from applicants, including description of applicant's current broadband infrastructure, project location data, deployment schedule, proposed expenditures, economic life of assets, letters of credit/funding sources and financial qualifications, five-year business plan demonstrating project viability, pricing commitments, marketing and outreach plan, and government and community support.
- Application submission, timelines and objections process.
- Reporting requirements consistent with US Treasury rules on compliance and reporting guidance for state and local ARPA funds and other identified information.
- Payments based on submittal of progress reports.

[53] Decision Adopting Federal Funding Account Rules; Rulemaking Regarding Broadband Infrastructure Deployment and to Support Service Providers in the State of California; R.20-09-001; D. 22-04-055 dated April 21, 2022. ("Federal Funding Account Decision")

- Execution and performance including commencement of project at agreed time and following the project plan.
- Provisions for sale or transfer of assets during the construction and post-construction phases.
- Penalties.

The decision addresses "**affordability**" requirements where affordability is defined as "the impact of essential utility service charges on a household's ability to pay for non-discretionary expenses".[54] The Decision requires Federal Funds Account grantees to participate in the FCC's Affordable Connectivity Program[55] (which provides a discount of up to $30 per month on broadband service) or other broad based affordability program. The Decision also encourages applicants to provide a low-cost broadband plan which is less than $40 per month, without data caps, 50/20 Mbps speeds, no charge for installation, no minimum term and includes a free modem or router.

The Loan Loss Reserve

SB 156 establishes the Broadband Loan Loss Reserve Fund in the State Treasury to fund costs of financing the deployment of broadband infrastructure by local agencies or non-profits, including payment of costs of debt issuance, obtaining credit enhancement, and establishing and funding reserves for payment of interest and principal. Revenue bonds issued by joint power authorities can be supported by the Broadband Loan Loss Reserve.

SB 156 provides that the CPUC may establish eligibility requirements, financing terms and conditions, and allocation criteria, for infrastructure projects deployed in whole or in part using financing supported by the reserve fund. It also authorizes the CPUC to require information from the local agency or non-profit demonstrating the ability to reasonably finance and implement the broadband project using financing supported by the reserve fund.

It is anticipated that CPUC staff will provide a proposal for implementing the Loan Loss Reserve Fund in Fall 2022.[56]

[54] Federal Funding Account Decision, at page 66.

[55] https://www.fcc.gov/acp

[56] https://www.cpuc.ca.gov/industries-and-topics/internet-and-phone/broadband-implementation-for-california

Appendix C: Federal Communications Commission

WIRELESS SERVICES POLICIES

The placement of wireless facilities is governed by an interrelated legal framework characterized by shared jurisdiction between state (e.g., cities and counties, and the California Public Utilities Commission) and federal authorities (the Federal Communications Commission or FCC, and Congress).[57] However from time to time, the Federal Communications Commission (and Congress) has preempted or sought to preempt the authority of state and local jurisdictions over wireless matters.

Federal law provides the basis for federal preemption where it allows local authorities to regulate the "placement, construction, and modification" of wireless communications facilities but subject to certain limitations.[58] Those limitations include:

- City regulations may not "prohibit or have the effect of prohibiting the provision of personal wireless services"[59];
- City regulations may not "unreasonably discriminate among providers of functionally equivalent services"[60];
- Any denial of an application to place, construct, or modify a personal wireless facility must be based on "substantial evidence contained in a written record"[61]; and,
- City regulations may not "regulate the placement, construction, and modification of personal wireless service facilities on the basis of the environmental effects of radio frequency emissions to the extent that such

[57] The following discussion does not constitute a legal opinion and should not be construed as such. Questions about interpretation or applicability of these or other provisions of federal or California law should be referred to legal counsel.

[58] 47 U.S.C. § 332(c)(7)(A).

[59] 47 U.S.C. § 332(c)(7)(B)(i)(I).

[60] 47 U.S.C. § 332(c)(7)(B)(i)(II).

[61] 47 U.S.C. § 332(c)(7)(B)(iii).

> facilities comply with the Commission's regulations concerning such emissions.[62]"

With the emergence of 5G, the large national wireless service providers pushed the Federal Communications Commission to preempt the authority of state and local jurisdictions regarding siting of wireless facilities, while pressing state legislatures for legislation to limit local authority over matters pertaining to small cell deployment. Such legislation has been considered in California in 2017 but ultimately did not become law due to Governor Brown's veto.

FCC Regulation of Radio Frequency Emissions

In one specific area – radio frequency (RF) emissions – the Federal Communications Commission (FCC) has been assigned complete regulatory jurisdiction, under the 1996 Telecommunications Act. TA96 preempted local regulation of RF safety standards in favor of a uniform national RF safety standard under FCC jurisdiction.[63] Local authorities can require compliance with these national FCC RF standards be demonstrated in evaluating 5G siting applications. Applicants often make this demonstration part of the application package, and many cities have ordinance or standards and guidelines provisions that require RF compliance be demonstrated by applicants. Local authorities may not however deny wireless communications facilities siting applications based on RF emissions – Congress has preempted local authority on this subject and placed jurisdiction in the hands of the FCC.

The FCC determined in 2019 that no update to its guidelines for exposure to RF emissions was required for 5G equipment.[64] This decision was appealed, and the Court of Appeals for the District of Columbia remanded that decision back to the FCC to provide "a reasoned explanation for its determination that its guidelines adequately protect against harmful effects of exposure to radiofrequency radiation unrelated to cancer."[65] The FCC has not yet made any decisions and findings on 5G RF emissions so there is a potential for change to the RF emission standards.

[62] 47 U.S.C. § 332(c)(7)(B)(iv).

[63] 47 U.S.C. § 332(c)(7).

[64] *Resolution of Notice of Inquiry, Second Report and Order, Notice of Proposed Rulemaking, and Memorandum Opinion and Order*, FCC 19-26, released December 4, 2019.

[65] Environmental Health Trust, et al. v. Federal Communications Commission and United States of America, No. 20-1025, Decided August 13, 2021 (DC Cir.), at page 30.

See the FCC's A Local Government Official's Guide to Transmitting Antenna RF Emission Safety for further information on the FCC's current RF emission rules.[66]

The FCC Small Cell Order

One of the most recent examples of FCC preemption is the FCC's 2018 "Small Cell Order".[67] There the FCC sought to limit and preempt local authority over placement of small cell facilities. It broadly interpreted the "effective prohibition" provisions of the Telecommunications Act Sections 253(a) and 332(c)(7) to find that a state or local government need only "materially inhibit" placement of "small wireless facilities" to have an effect of prohibiting the provision of wireless service. The Small Cell Order:

- permits fees only to the extent they are non-discriminatory ("no higher than the fees charged to similarly-situated competitors in similar situations") and are a "reasonably approximation" the government entity's "objectively reasonable costs" specifically related to the deployment.[68]
- sets out "safe harbor" fee levels which are "presumptively reasonable" – $270 per small wireless facility per year, $500 application fee for up to five facilities, plus $100 for each facility beyond five.[69] Higher fees can be charged if the state or local government entity can show the higher fees are a reasonable approximation of cost and the costs themselves are reasonable and being assessed in a non-discriminatory manner.[70]
- appears in a footnote to preclude "in-kind" services or contributions stating such services or contributions "are not cost-based" and "they inherently have 'the effect of prohibiting' service".[71]

[66] A Local Government Official's Guide to Transmitting Antenna RF Emission Safety: Rules, Procedures, and Practical Guidance; Local and State Government Advisory Committee, Federal Communications Commission, June 2, 2000. https://wireless.fcc.gov/siting/FCC_LSGAC_RF_Guide.pdf

[67] Declaratory Ruling and Third Report and Order; In the Matter of Accelerating Wireless Broadband Deployment by Removing Barriers to Infrastructure Investment; WT Docket No. 17-79; In the Matter of Accelerating Wireline Broadband Deployment by Removing Barriers to infrastructure Investment; WC Docket No. 17-84; Released by the Federal Communications Commission, September 27, 2018. ("Small Cell Order" or "Order".)

[68] Small Cell Order, at paragraph 50.

[69] *Id.*, at paragraphs 78-79.

[70] *Id.*, at paragraph 80.

[71] *Id.*, at footnote 252. The footnote cites no evidence beyond comments of service providers.

- States aesthetic requirements must be reasonable, objective, non-discriminatory and published in advance, or they are subject to possible preemption.[72] Undergrounding requirements are subject to similar criteria.[73]

Additional provisions of the Small Cell Order include:

- Shortened shot clocks pertaining to small wireless facilities:
    - 60 days for siting on preexisting structures;
    - 90 days for siting requests the involve construction of a new qualifying structure;
- Shot clocks are applied to all authorizations, e.g., zoning permits, building permits, electrical permits, road closure permits, and engineering permits;[74]
- Permits fees paid to consultants and third-party contractors to be passed through as long as they are reasonable.[75]
- Conflicting provisions of state small cell laws would evidently be preempted by the FCC; [76] and,
- Conflicting provisions of preexisting contracts could be preempted by the FCC, depending on facts and circumstances.[77]

The Small Cell Order was appealed to the Ninth Circuit Court of Appeals, which issued its Opinion[78] largely upholding the FCC's Small Cell Order <u>but</u> with one exception, <u>where it upheld local authority over aesthetic regulations</u>:

> The exception is the Small Cell Order provision dealing with the authority of local governments in the area of aesthetic regulations. We hold that to the extent that provision requires small cell facilities to be treated in the same manner as other types of communications services, the regulation is contrary to the congressional directive that

[72] Id., at paragraphs 84-89.

[73] Id., at paragraph 90.

[74] *Id.*, at paragraph 144.

[75] Id., at paragraph 70.

[76] *Id.*, at paragraph 6.

[77] *Id.*, at paragraph 66.

[78] City of Portland v. United States, 969 F.3d 1020, 1049-1053 (9th Cir., 2020).

> allows different regulatory treatment among types of providers, so long as such treatment does not "unreasonably discriminate among providers of functionally equivalent services." 47 U.S.C § 332(c)(7)(B)(i)(I). We also hold that the FCC's requirement that all aesthetic criteria must be "objective" lacks a reasoned explanation.

And:

> In sum, the requirement that aesthetic regulations be "no more burdensome" than those imposed on other technologies is not consistent with the more lenient statutory standard that regulations not "unreasonably discriminate." The requirement that local aesthetic regulations be "objective" is neither adequately defined nor its purpose adequately explained. On its face, it preempts too broadly. We therefore hold those provisions of Paragraph 86 of the Small Cell Order must be vacated.

The Spectrum Act and "Eligible Facilities Requests"

Prior to the Small Cell Order, the "Spectrum Act" enacted by Congress in 2012[79] added new requirements and directives to the Federal Communications Commission (FCC) for processing and approval of wireless deployments. Following the Spectrum Act, the FCC issued new regulations to interpret and implement the Section 6409(a) requirements and directives of the Act related to local authorities processing of applications for wireless communications facilities. In brief, the Act tightens the application of "shot clock" timelines, and requires local jurisdictions to approve certain collocations and modifications to existing wireless communications facilities under shortened explicit deadlines, if it is an "eligible facilities request" – any request for modification of an existing tower or base station that does not *substantially change* the physical dimensions of such tower or base station, involving (1) collocation of new transmission equipment; (2) removal of transmission equipment; or (3) replacement of transmission equipment. The new FCC regulations established defined standards for what for "substantial change" and implemented the statutory changes to "shot clock" regulations. In short, under these rules, a State or local government shall approve within 60 days any request for modification of an existing wireless tower or base station that does not substantially change the physical

[79] *See* Middle Class Tax Relief and Job Creation Act of 2012, Pub. L. No. 112-96, 126 Stat. 156, § 6409(a) (2012) ("Spectrum Act"), *codified at* 47 U.S.C. § 1455(a).

dimensions of such tower or base station. The Rules adopted by the FCC are preemptive and apply to cities and other local authorities.

The FCC's "5G Upgrade" Declaratory Ruling

After the Small Cell Order, the FCC made a Declaratory Ruling which expands preemption of local authority regarding placement of wireless facilities. The Declaratory Ruling[80] was issued on June 10, 2020, and "clarifies" existing FCC rules originally adopted in 2014 to implement the "eligible facilities requests" defined in the Spectrum Act.

> Specifically, our Declaratory Ruling clarifies our rules regarding when the 60-day shot clock for State or local government review of modifications of existing structures commences.[8] We also clarify what constitutes a "substantial change" in the physical dimensions of wireless infrastructure under our rules, and the extent to which certain elements of a proposed modification to existing infrastructure affect the eligibility of that proposed modification for streamlined State or local government review under section 6409(a).[81]

Under the Declaratory Ruling, applicants can now start the shot clock with the first procedural step required by the City (e.g., a pre-application meeting) and submission of documentation demonstrating the proposed modification is an eligible facilities request.[82] The Declaratory Ruling also provides additional interpretation on what constitutes "substantial change" for height increases for towers outside the public

[80] *In the Matter of Implementation of State and Local Governments' Obligation to Approve Certain Wireless Facility Modification Requests Under Section 6409(a) of the Spectrum Act of 2012*, WT Docket No. 19-250 and RM-11849, FCC 20-75 (released Jun. 10, 2020)

[81] Id., at paragraph 4.

[82] If a city does not have a Section 6409 process in place, the applicant can start the shot clock by filing documents that are typically required for a zoning or siting review.

right of way[83], details on equipment cabinets[84], further explanation regarding "defeat" of concealment elements[85], and siting approval conditions[86].

Assembly Bill 537

Assembly Bill 537 amends state law to reflect FCC shot clock requirements and clarify that small wireless facility applications must be processed and approved in accordance with applicable FCC shot clock rules, effective January 1, 2022. AB 537 places the start of the shot clock in line with FCC rules with the primary clarification being that the shot clock starts if or when an agency requires a pre-application meeting, communication, or similar step before submission. AB 537 clarifies that an agency must notify an applicant of an incomplete application within the time periods established by FCC rules.

The FCC's Site Modification Report and Order[87]

Based on petitions from the wireless industry, in November 2020 the FCC revised the definition of "substantial change" for modifications of existing towers outside the public right of way. An eligible facilities request may now include a modification of

[83] Section 6409 defines substantial change pertaining to modification of a tower located outside of public rights-of-way as one which "increases the height of the tower by more than 10% or by the height of one additional antenna array with separation from the nearest existing antenna not to exceed twenty feet, whichever is greater." The Declaratory Ruling clarifies that "separation from the nearest existing antenna" means the distance from the top of the highest existing antenna on the tower to the bottom of the proposed new antenna to be deployed above it.

[84] The Declaratory Ruling clarified that small pieces of equipment such as remote radio heads/remote radio units, amplifiers, transceivers mounted behind antennas and similar devices are not "equipment cabinets" if they are not used as physical containers for smaller, distinct devices. Also, the maximum number of additional equipment cabinets that can be added under the rules is measured for each separate eligible facilities request, rather than the cumulative number of equipment cabinets on the site.

[85] The Declaratory Ruling stated to "defeat concealment," the proposed modification must cause a "reasonable person" to view the structure's intended stealth design as no longer effective after the modification.

[86] The Declaratory Ruling clarifies a municipality may not impose and enforce conditions on approvals for wireless facilities that then prevent future modifications or upgrades that are otherwise eligible facilities requests.

[87] *In the Matter of Implementation of State and Local Governments' Obligation to Approve Certain Wireless Facility Modification Requests Under Section 6409(a) of the Spectrum Act of 2012*, WT Docket No. 19-250, Report and Order, FCC 20-75 (Rel. Nov. 3, 2020) ("Site Modification Report and Order").

an existing tower outside the public rights-of-way that entails ground excavation or deployment of transmission equipment up to 30 feet in any direction outside the boundaries of a site. Other eligible support structures besides towers outside the public right of way are not affected by this revised definition. This change by the FCC is intended to facilitate addition of equipment to existing towers to expand 5G capacity. It is expected this rule change will allow additional providers to collocate on towers and allow additional equipment (fiber terminations, cabinets and power supply, backup power, etc.) to be placed to expand 5G services.

The FCC also expanded on the definition of a "site" such that it "refers to the boundary of the leased or owned property surrounding a tower and any access or utility easements currently related to the site as of the date that the tower or base station was last reviewed and approved by a state or local government".[88]

This decision was uniformly opposed by cities, counties and other local authorities and is subject to requests for reconsideration.

BROADBAND MAPPING

The FCC has administered a broadband mapping process for a decade that is known to be inaccurate in that it overreports broadband availability due to its data and methodology. The data is self-reported by broadband providers and is not verified by the FCC. But the bigger issue is that if one home in a census block can get broadband service, the whole census block is considered to be "served". Thus, a consumer is not able to tell from the FCC's broadband map with any certainty whether broadband is actually available or not at a particular address.

Congress recognized the problematic nature of existing FCC broadband maps, which becomes an even more urgent issue when policymakers desire to identify areas without broadband availability to fund deployment of broadband infrastructure. Thus, the Broadband Deployment Accuracy and Technological Availability (S. 1822), or "Broadband DATA act" was passed in 2020. Among other things the Broadband DATA Act directs the FCC to collect granular service availability data from wired, fixed wireless and satellite broadband providers, set parameters for service availability data collected from mobile wireless broadband providers, permits the FCC to collect verification data, requires the FCC to establish a crowdsourcing process for data

[88] "Small Entity Compliance Guide", Implementation of State and Local Governments" Obligation to Approve Certain Wireless Facility Modification Requests Under Section 6409(a) of the Spectrum Act of 2012, Report and Order, FCC 20-153, WT Docket No. 19-250, Released November 3, 2020, dated January 4, 2021.

collection, and requires the use of these new maps for new awards of broadband funding. The FCC implemented a Broadband Data Collection program to improve the accuracy of broadband maps and create the "broadband serviceable location fabric" for the maps.[89]

The first public version of the FCC's National Broadband Map was released on November 18, 2022.[90] Significant critique and commentary will follow.

AFFORDABLE CONNECTIVITY PROGRAM

The Infrastructure Investment and Jobs Act (IIJA) extends the Emergency Broadband Benefit to provide $30 per month discounts for broadband service to eligible households which enroll in the Affordable Connectivity Program[91]. "Eligible households" are defined as those with incomes at or below 200% of the poverty level or meets other stated criteria.[92] The minimum speed to be offered by participating providers has been increased to 100 Mbps download.[93]

The ACP is intended to ensure that low-income households have broadband connections for work, school, healthcare and other needs. In addition, under the ACP there is a one-time discount available up to $100 to purchase a laptop, desktop or tablet device.

[89] Broadband Data Collection, Federal Communications Commission. https://www.fcc.gov/BroadbandData

[90] "FCC Releases Broadband Map, Opens Public Challenge Process"; Nicole Ferraro, Light Reading, November 18, 2022. https://www.lightreading.com/digital-divide/fcc-releases-broadband-map-opens-public-challenge-process/d/d-id/781847

[91] "Affordable Connectivity Program", A Guidebook to the Bipartisan Infrastructure Law for State, Local, Tribal, and Territorial Governments, and Other Partners. The White House, at page 392. Available at https://www.whitehouse.gov/wp-content/uploads/2022/01/BUILDING-A-BETTER-AMERICA_FINAL.pdf

[92] These criteria include participation in other assistance programs such as SNAP, Medicaid, Federal Public Housing Assistance, WIC, Supplemental Security Income, Veterans Pension or Survivor Benefits, or the FCC's Lifeline program; benefiting from the free and reduced-price school lunch program or school breakfast program; federal Pell Grant participation; or meets the criteria of the participating broadband provider's program. See, "Affordable Connectivity Program", Federal Communications Commission, https://www.fcc.gov/acp

[93] "Get Internet", The White House. https://www.whitehouse.gov/getinternet/?utm_source=getinternet.gov However, the FCC has so far declined to set a specific minimum speed requirement for the ACP program.

Various wireless and landline broadband internet providers participate in the ACP. The participating providers will be different in each area.

The ACP is a new program and so far, it "flies under the radar". The FCC is seeking ways to expand community and marketing outreach so that those who will benefit are aware of the program and sign up.[94] Cities can benefit from the ACP by gaining awareness of program details and communicating them to their low-income residents and program managers for services provided to the low-income communities.

[94] "Broadband Subsidies Fly Under the Radar", The Wall Street Journal. May 9, 2022. Page A6.

Appendix D: Infrastructure Investment and Jobs Act (IIJA) Broadband Infrastructure Grants

Provisions regarding state broadband infrastructure grants ($42.45 billion):

- Funds will be disbursed based on a competitive grant process administered by each state under rules promulgated by the National Telecommunications and Information Administration (NTIA).
- New FCC mapping of broadband availability must be completed before proposals will be accepted. FCC maps are expected early to mid-2022.
- Priorities and specific allowed uses of funds:
  - First, infrastructure for areas without 25/3 Mbps service.
  - Then infrastructure for areas without 100/20 Mbps service. Then eligible community anchor institutions.
  - Multi-Dwelling Units (MDUs): Installing internet and Wi-Fi infrastructure or providing reduced-cost broadband within a multi-family residential building, prioritizing those with a substantial share of qualified low-income households.
  - Programs for broadband adoption including provision of affordable internet-capable devices.
  - Broadband data collection, broadband mapping and planning.
- Project requirements for funding:
  - Speeds of at least 100/20 Mbps with low latency. Higher speeds will receive priority.
  - 25% match required from non-federal sources, such as in-kind contributions, unspent COVID relief funds or provider investment.
  - Projects prioritized based on higher speed, greater scalability, faster buildout and service coverage for high poverty areas.
  - Projects must be completed within four years.
  - Projects must offer at least one low-cost broadband option (rates are not regulated, but determined by state, approved by NTIA).

- Additional requirements included regarding service quality, reliability, cyber rules, prohibition on using gear manufactured in China, required technical and operational capacity for the subgrantees.

Appendix E: Developer Agreement Conditions Example

BUILDING DEPARTMENT CONDITIONS:

1. Fiber Optic Installation for Dwelling Units: Owner agrees to install in each dwelling unit the following fiber optic requirements:
    a. Install a dedicated City Fiber Enclosure adjacent to the other utility enclosures or a Common Communication Enclosure (collectively "Utility Enclosure") for the proposed communications utilities (phone, cable, fiber, etc.). The enclosure type shall be Benner-Nawman 14326W-UL or as approved by the City. The Utility Enclosure may face the garage exterior or interior and shall include one 120-volt, 15-amp convenience receptacle mounted inside the enclosure on either side wall with the outlets facing horizontally. The receptable power shall be protected by a ground fault circuit interrupter (GFCI).
    b. Install a wireless-transparent 28-30 inch or 42-inch Structured Media Enclosure ("Media Enclosure") of type Legrand 30" ENP3050 or 42" ENP4250, Leviton 30" 49605-30W, Primex Verge 30" P3000 or 42" P4200 or as approved by the city in a master bedroom closet wall or a laundry room wall furthest from the water supply and maintain a minimum 48-inch horizontal clearance between and 24-inch clearance above any metallic appliances or accessories. The enclosure shall include one 120-volt, 15-amp convenience receptacle located inside the enclosure.
    c. Install a conduit pathway from the Utility Enclosure to the Media Enclosure with a minimum of one (1) 1-inch diameter non-metallic, flexible conduit which shall maintain a minimum 36-inch bend radius and protrude a minimum of 6-inches into the enclosures. The conduit shall be marked with orange Tyvek or plastic tags, labeled "City Fiber Use Only" and "661-746-5000", tie wrapped to the conduit in plain view within the enclosures.
    d. Install a continuous conduit without breaks or couplings from the existing City Fiber Distribution Enclosure located in the right-of-way ("Distribution Enclosure") to the bottom side of the Utility Enclosure. The conduit shall be installed a minimum of 36-inches below grade, protrude a minimum of 12-inches into the Utility Enclosure, be orange in color, and be factory labeled "City of Shafter 661-746-5000." If the

conduit does not have an integrated tracer wire, a continuous external #12 AWG solid conductor tracer wire with high-density polyethylene insulation rated for direct burial shall be installed along with the conduit leaving a minimum 15-feet of slack coiled in the Distribution Enclosure and 3-feet of slack coiled in the Utility Enclosure. The conduit and tracer wire shall be inspected by a City of Shafter Public Works Department representative before shading and backfilling.

i. After backfilling, the conduit shall be mandrel tested between the Distribution Enclosure and the Utility Enclosure. All conduits 1/2-inch or larger shall require mule tape or equivalent installed. Mule tape shall be slack (no tension) and fastened to the plug or cap. Innerducts and Microducts shall have the pull string completely removed before being tested with a ball bearing. The testing process shall be witnessed by a City of Shafter Public Works Department representative.

ii. Couplings shall be used to repair damaged or short conduit only if approved by the City. Conduit couplings shall be an air-tight, water-tight, push-on compression fitting approved by the City. Tracer wire couplings shall be an airtight, water-tight, twist or compression connector approved by the City. Coupling integrity shall be inspected by a City of Shafter Public Works Department representative.

e. Category 6 Unshielded Twisted Pair (CAT 6 UTP) cable (or as approved by the City) shall be installed according to industry standards and the requirements below and shall not be pinched, stapled, bent sharply, or crossing any sharp, unprotected edges:

i. Install minimum of three (3) cables from the Utility Enclosure to the Media Enclosure.

ii. Install the following connection points terminated to a CAT 6-rated 8P8C (RJ-45) jack within a single-gang low voltage wall box, using the ANSI/TIA-568 T568A termination standard:

1. Minimum of two (2) connection points to every entertainment center, kitchen, master bedroom, kitchenette, office, den, etc.

i. Install one (1) or more Wi-Fi Access Point (WAP) ceiling mounting locations (as approved by the City) on each floor such that no exterior wall is more than 30- feet from any WAP mounting location. Each WAP mounting location shall include a single-gang, low voltage wall box through which a

single CAT 6 UTP cable with a minimum three (3) feet of slack shall be terminated with a CAT 6-rated 8P8C (RJ-45) plug for connecting to a WAP.

ENGINEERING DEPARTMENT CONDITIONS:

1. Developer shall design and install a system of conduits, terminal enclosures, distribution enclosures, splice enclosures, connection points, and hand holes for a fiber optic network to each buildable lot within the development. Design and material specifications are available from the City of Shafter. Plans shall be submitted and approved by the City of Shafter, prior to recordation of the final map, showing the proposed utility trench and all appurtenant hardware. The design shall include the following minimum specifications:
    a. A combination of fiber optic conduits shall minimally include 4" SDR-11 HDPE, 2" SDR-11 HDPE, 7-Way bundled HPDE innerduct with attached tracer wire, and direct-bury HDPE Microduct with attached tracer wire. Fiber optic conduits may be joint trenched with other utility company pipes and/or conduits.
    b. All underground fiber optic conduits, innerduct bundles, Microducts, etc. shall be factory-labeled "City of Shafter 661-746-5000." Conduits shall be identified by a permanent marking, with the address number of the residence they serve, within the distribution enclosures.
    c. All underground fiber optic conduit paths shall have tracer wire. If the conduit does not have an integrated tracer wire, a continuous external #12 AWG solid-conductor tracer wire with high-density polyethylene insulation rated for direct burial shall be installed along with the conduit leaving a minimum 15-feet of slack coiled in the endpoint enclosures.
    d. The ends of all fiber optic conduits, innerducts, and Microducts shall be plugged or capped to prevent dirt, debris, or foreign objects from entering.
    e. After backfill and compaction, all conduits shall be checked for obstructions, and reexcavated and repaired or replaced as required. Conduits 1/2-inch or larger shall require mule tape or equivalent installed. Mule tape shall have a minimum 2' slack at each end which shall be fastened to a tie-off loop on the inside of the plug or cap. Mule tape tie-off and tension check to be witnessed shall be witnessed by a City of Shafter Public Works Department representative. Innerducts and Microducts shall be mandrel tested while being witnessed by a City of Shafter Public Works Department representative.

f. A combination of underground utility enclosures shall minimally include 36” W x 60” L x 36” D polymer concrete enclosures with dual torsion covers, 36” W x 36” L x 24-36” D and 24” W x 36” L x 24-36” D High Density Polyethylene (HDPE) enclosures.

g. All underground utility enclosures shall be factory-stamped “City Fiber.”

TRACT MAP CONDITIONS (NOT FULLY MODIFIED TO ALIGN WITH THE MORE RECENT DEV. AGREEMENT CONDITIONS ABOVE):

1. Minimum 24 inch bending radius on all service drop conduits.
2. Minimum 48 inch bending radius on all 2 inch hdpe conduits and futurepath.
3. Minimum 96 inch bending radius on all 4 inch hdpe conduits.
4. All couplings and caps shall be approved by the city.
5. Couplings shall be eliminated for all futurepath and service drop conduits (except to join the r.o.w. segment to the p.u.e. segment).
6. Any couplings used in the fiber optic conduit shall be installed in accordance with city direction. Detection wires at couplings shall be wired together in an approved manner. Detection wires shall not carry tension.
7. All coupling locations shall be documented as length (ft) of conduit from nearest vault.
8. Ends of all conduits shall be capped to prevent dirt, foreign objects, or debris from entering the conduit. ½” and larger shall have a cap or plug with a ring for fastening the mule tape so that it does not retract into the conduit. Innerducts and microducts shall be capped with ...
9. Microducts shall have a minimum of 50' of rolled up conduit at the property line of each home for future connection to homes.
10. All conduits 2" or greater shall be capped and have mule tape or equivalent installed. Mule tape shall be slack (no tension) and secured to the cap to prevent loss of the mule tape within the conduit.
11. All 2" hdpe conduit shall be accompanied by 12 gauge insulated solid copper tracer wire (or copper-clad stainless steel), to be approved by city. All end points including box locations will have 25' minimum of rolled up tracer wire.
12. Make & model of all vaults and boxes shall be approved by the city prior to use or installation.

13. All fiber optic vaults and boxes shall be located outside sidewalk and a minimum of 12 inches clearance from water mains and wall foundations. Clearance from other utility boxes shall be 36" minimum.
14. All vault and box locations shall be backfilled and well compacted with vibratory or equivalent prior to placing the box.
15. All 36x60 boxes shall be set on a minimum of 10 inches of gravel. All 36x36 and 24x36 boxes shall be set on 8 inches of gravel.
16. Conduits shall come into each box from below and shall terminate as close to the top of the box as possible while still allowing the lid to close. Conduits shall be cut to their final length by others just before fiber is placed.
17. Fiber optic conduits coming from the same direction shall be bundled closely to each other within the vault or box. Where possible, bundled conduits shall occupy the portion of the box or vault that identifies the direction from which the conduits came. For instance, conduits coming in from the south shall be bundled and placed within the south side of the box. Same for all other directions.
18. Microducts within the distribution box shall be tagged to identify the address of the residence they serve. Tag shall be permanently fixed to the microduct within the box. Tag shall be waterproof and corrosion resistant. Product shall be approved by the city.
19. Backfill around box perimeter shall be well compacted with vibratory.
20. All microduct and future path shall be mandrel tested. Microduct shall be tested with a 5 millimeter bb. Futurepath shall be tested with a 7 millimeter bb.
21. All microduct and futurepath shall have a detection wire factory-bundled external to the microduct(s).

FTTH INSTALLATION PROCESS RECENTLY CHANGED TO MOVE AWAY FROM MICRODUCT BUT NOT PLACED IN DEV. AGREEMENTS OR MAP CONDITIONS:

New Tracts - Service Drops from Distribution boxes to home Utility boxes:

a. Install Orange 1-1/4" SDR-11 conduit.
    a. NOTE: If this conduit specification cannot be obtained for the start of a new tract, the “Sleeve” conduit used on the “Active Tracts” may be used for the full tract or until the specified conduit arrives and the Sleeve conduit is exhausted (e.g., Tract 7388).

   b. Standard factory labeling (not branded for any provider)
   c. No tracer wire is required for the service drop conduit paths
   d. May terminate conduit at the edge of PUE to the homes covered with a box or capped conduit to protect all communications utilities' conduits until later extension to the homes.
   e. Couple with non-metallic push-on, compression fit, translucent-center connectors rated airtight to 250 psi, watertight, 700# pull-out, and direct burial.

1. Call for City inspection before any shading
   a. Shade with minimum 6" of sand. 12” preferred
   b. Backfill and compact
   c. Install 1/2" 1200+ lb polyester mule tape. Tape must be slack and tied to the inside of conduit caps in the Distribution box and tied to or screwed down with in the Utility box.
   d. Call to coordinate mule tape tie-off and tension check to be witnessed by City inspector.