CITY OF FREMONT, CALIFORNIA

Citywide Fiber Optic Master Plan

Final: May 2022

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1.1 OVERVIEW OF PROJECT

As technology advances, municipalities are embracing new innovations to aid in every aspect of governance. A vast network of internet-connected devices enables the Smart City, including sensors and automated devices known as the Internet of Things, online permitting, bill paying, and even remote field work. In addition to municipal uses, local governments acknowledge the need to ensure high-speed internet connections are available within their cities, allowing for economic development by retaining businesses and attracting new entities in order to have thriving economies with low unemployment and better taxing structures.

The new systems require high bandwidth internet connections with low latency[1], otherwise known as broadband, defined by the Federal Communications Commission (FCC) as high-speed connections that exceed speeds of 25 Mbps download and 3 Mbps upload, the federal definition is not adequate to support modern networks and smart city applications. These ultrafast connections are enabled by fiber optics, the technology that uses waves of light to transmit data at nearly the speed of light.

These demands are impacting the role of broadband infrastructure for cities, bringing it to the forefront as a new utility. As such, in March 2021, the City of Fremont selected Magellan Advisors to prepare this detailed, actionable Fiber Master Plan. The Plan is a guide for Fremont to implement a City-owned fiber-optic network that serves as a critical investment in the community's future. Development of the Plan included a proven process used by similarly situated municipalities, as shown in the figure below.

Figure 1-1. Master Fiber Optic Planning Methodology

Magellan's team began by collecting data and interviewing City departments to gain an understanding of the City of Fremont's broadband usage and existing infrastructure.

[1] *Latency* refers to the delay in transmitting data

These interviews provided insight about the current City broadband infrastructure that could be used, the need for additional bandwidth, and the goals for future applications. Existing assets assessed include conduit, fiber optic cables and equipment, rack space, towers, and antennas, among other things. Capital improvement projects (CIPs) that involve work in the public right-of-way like road work, intersection upgrades, and water and sewer projects were also identified and incorporated into the Plan to reduce construction costs. Magellan's team also reviewed existing privately-owned assets to identify opportunities for reducing costs and forging partnerships.

Magellan interviewed AC Transit, schools, not-for-profit organizations, healthcare institutions, chambers of commerce, and ISPs to collect additional information about the needs of the community and how they could be addressed with better broadband infrastructure. These interviews provided understanding about current and future goals of businesses, community organizations, and residents within Fremont. Several City facilities, particularly community centers, fire stations, and the co-located Public Works Corporation Yard and Emergency Operations Centers, are prime candidates for better connectivity, as are the numerous parks. Other public entities in Fremont have similar requirements, particularly for transit, Fremont Unified School District (FUSD), and utilities. All these needs complement opportunities for economic development and transportation.

In addition, an online broadband survey was used to collect data from residents and businesses about their broadband's performance, providers, customer service, and overall satisfaction with services being provided. The survey included a built-in speed test to capture real-time data about the performance of current broadband services in Fremont. With a total of 498 responses, the survey revealed that both residents and businesses had sufficient broadband for their current needs. Only about 6% of the residential respondents had slower connections than the FCC's standard 25 Mbps down and 3 Mbps upload, and no specific areas of Fremont were determined to be under-served or unserved. In fact, speeds are relatively high, averaging over 100 Mbps download and 25 Mbps upload, which met the expectations of those surveyed.

1.2 FINDINGS

The outreach, along with Magellan's analysis of existing systems and service availability, determined that much of the City is currently well-served by internet service providers, there are some issues that should be addressed. For example, additional redundancy and resilience is needed to support City operations, as well as to reduce telecommunications costs as the number of supported devices and associated

bandwidth needs continue to rise. Other public entities in Fremont have similar requirements, particularly for transit and utilities.

Fremont has unique opportunities to ensure businesses have the services they need due to its diverse, large-scale manufacturing base consisting of approximately 900 high-tech companies, many of which are relatively small. Lack of options, price, and bad customer service were commonly cited as issues among businesses in Fremont. Businesses responding to the survey rated broadband as a critical component of their operations.

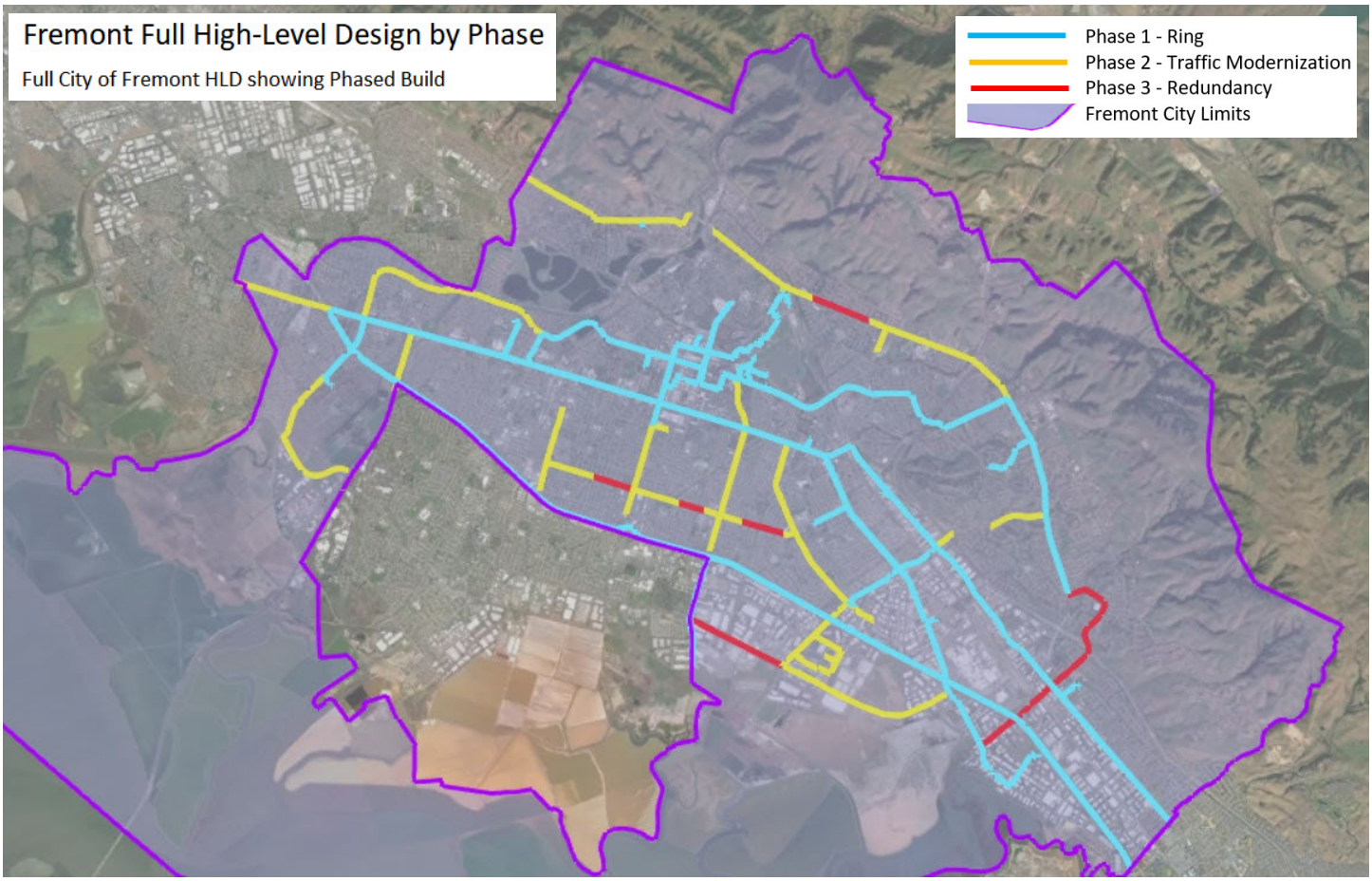
Stakeholder input also indicates it will be important to capitalize on the City's broadband opportunities to include seniors, persons experiencing homelessness, and low-income families. There is a prevalent digital divide in Fremont among the aged and school-aged population. The aged population struggle with using wireless devices, connecting to telehealth services, and general computer knowledge. In some areas, school-aged children lacked the bandwidth needed to do distance learning and homework, especially during the COVID-19 pandemic lockdown. When the pandemic hit, families trying to work remotely, engage in distance learning, and stream videos and online gaming noted that there simply wasn't enough affordable bandwidth to support all of their online activities.

The needs and goals of the City, its residents, businesses, and community groups were assessed to develop a conceptual design and infrastructure requirements that will best serve the needs of Fremont now and into the future. Currently, the City of Fremont owns around 41.89 miles of existing fiber and another 22.54 miles signal interconnect conduit that could be upgraded to accommodate the special needs of fiber-optic cables. The City of Fremont should expand upon these assets, as shown in the figure below, installing new underground fiber-optic cables that create a series of resilient rings to provide always-on broadband throughout Fremont for public agencies and businesses.

The expansion of the assets is planned to be done in three phases: Phase 1 creates a City-owned fiber ring that will supply services to the City facilities, fire stations, and two diverse internet connections. Phase 2 expands on Phase 1 core ring by building to traffic signals in support of the Traffic Signal Modernization project and other City needs and goals. Phase 3 creates redundancy for the network, supports business services and a possible citywide wi-fi network, and provides a robust failure-resistant network, including terrorist activities, earthquakes, or other issues affecting either building.

All three phases, along with Fremont's existing fiber and traffic signal interconnect conduit, are shown in the map below.

Figure 1-2. Network Map



The total cost of the build and associated Equipment and facilities costs is approximately $26,095,629.50 broken into three phases, as shown in the table below.

Table 1-1. Cost Summary

	Construction Cost	Equipment Cost	Buildings	Totals
Phase 1	$ 7,388,362.42	$ 2,549,047.58	$900,000.00	$10,837,410.00
Phase 2	$ 11,928,386.95	$ 849,682.53	$ - N/A	$12,778,069.48
Phase 3	$ 2,480,150.03	$ -N/A	$ N/A	$2,480,150.03
Totals	$ 21,796,899.40	$ 3,398,730.10	$900,000.00	$26,095,629.50

GRAND TOTAL	$ 26,095,629.50

Just like private companies, financing is a major limiting factor in Fremont's ability to create the completed designed network. Operational costs and organizational capacity are also a significant challenge. Therefore, the City should leverage its existing assets to

create a City of Fremont broadband network that is operated through a Private Public Partnership (P3). Magellan recommends that Fremont select a qualified private partner(s) to aid the construction cost and management of the network, and provide services by leveraging the Fremont's infrastructure, conduits, fiber cables, and building space. All of these assets give Fremont a value-added position for an agreement in lieu of some capital.

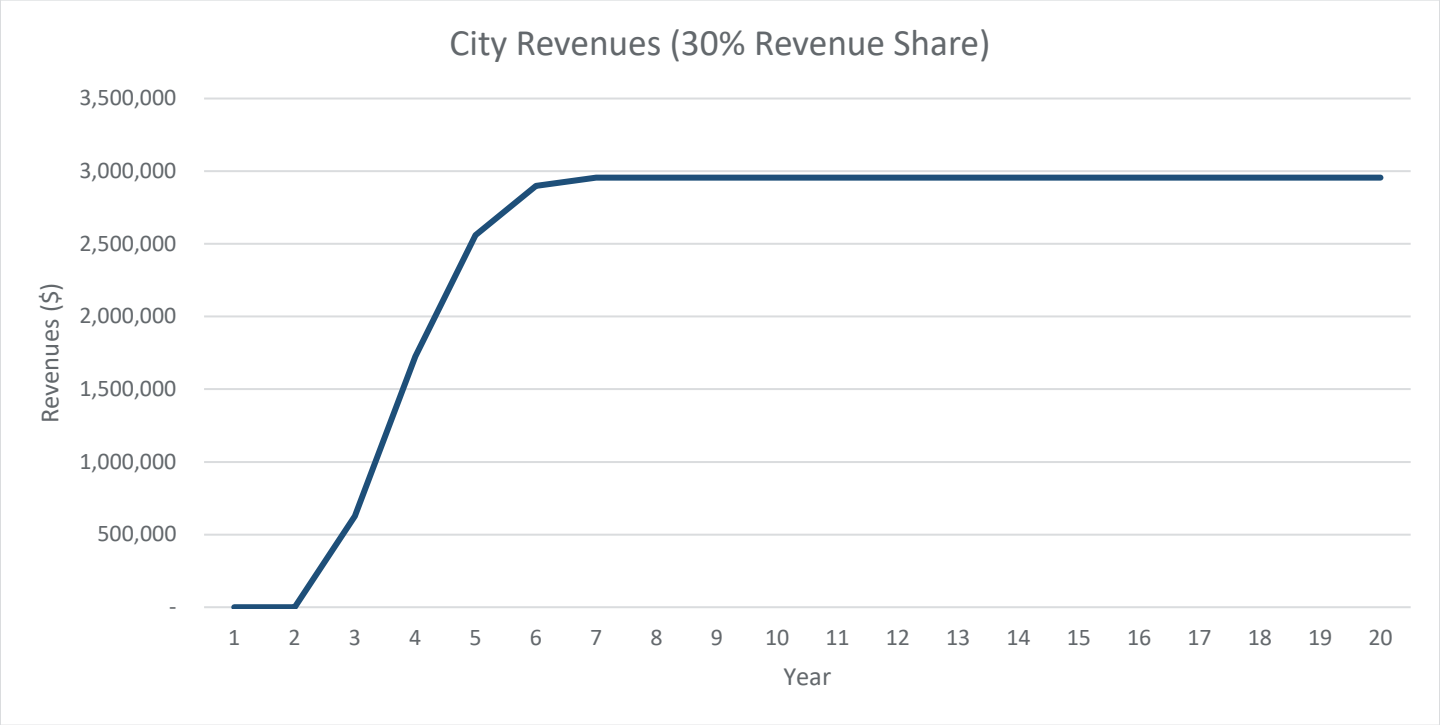
This model allows the City of Fremont to outsource the maintenance and operations of the network to an experienced internet service provider, who will leverage the assets to provide service that meets the current needs and future demands of the residents and businesses. The approach enables enhanced broadband services throughout the City by easing the construction costs for private providers, encouraging competition, and supplying the bandwidth needs for City departments and eliminating considerable leasing costs. A request for proposals (RFP) has been developed by the City of Fremont and a competitive process is currently underway to select a qualified partner.

Based on this model, Magellan Advisors used our Broadband Financial Sustainability Model to analyze the business and financial sustainability of the proposed broadband program. The borrowing scenario includes an interest rate of 1%, which assumes that the City would make use of the Broadband Loan Loss Reserve Fund recently established by the State of California's Treasury to fund costs of financing the deployment of the network deployment. It is early in the process and the California Public Utilities Commission (CPUC) has not yet developed the regulations that will be associated with the Loan Loss Reserve Fund, so we recommend that Fremont track the development of program rules.

The model also assumes a 70/30% revenue share in favor of the selected operational partner, based on common scenarios we have seen in similar public-private partnership agreements. For the purposes of revenue projections, we estimate the network would be able to sell lit services to 30% of businesses within 500 feet of the backbone. Based on these assumptions and the estimated time to build out the network in phases, we estimate that the network will see its first business customers in Year 3 of the program, with a total of 387 subscribers signing up that year. This number continues to increase up to Year 6, when the number of customers levels off to a total of 1,320 subscribers for the life of the program. We included reasonably priced speed tiers of 500 Mbps and 1GB at both best-effort and dedicated rates based on the existing business broadband environment in Fremont.

Based on these inputs and taking into consideration the revenue share in which the City would get 30% of revenues, we estimate gradually increasing revenues that level off at approximately $2,955,744 per year, as shown in the figure below.

Figure 1-3. Annual Revenues



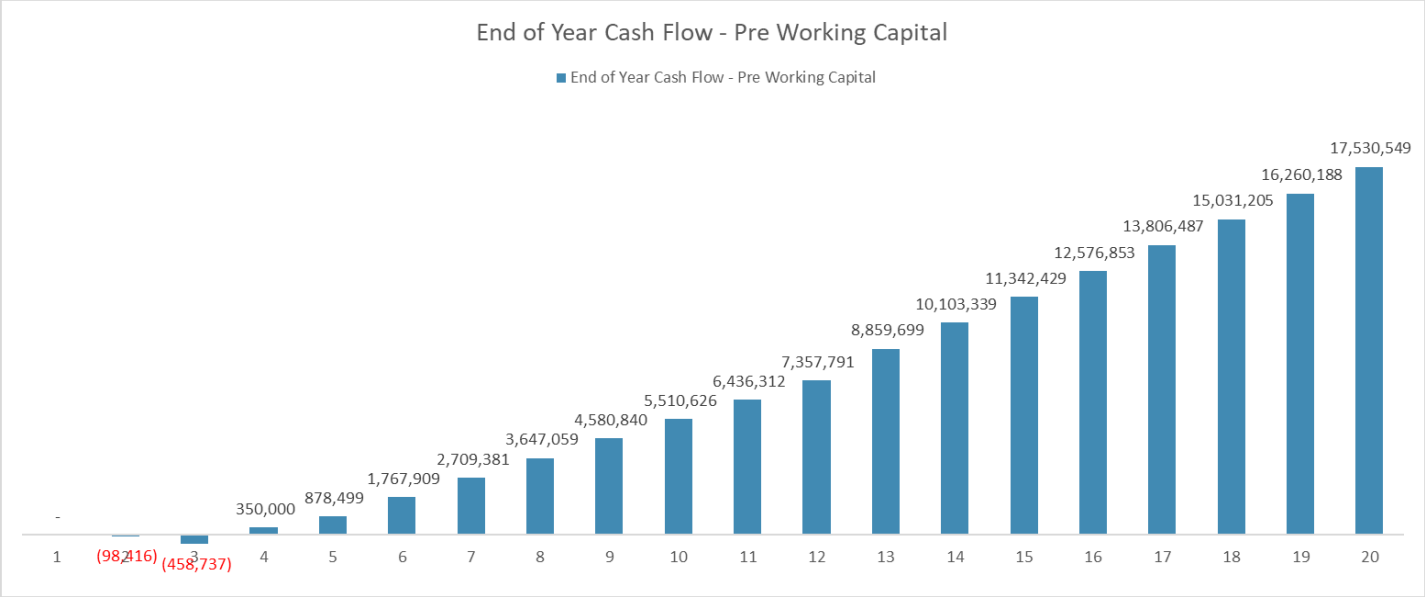
Over this 20-year period, the City can expect approximately $49 million in revenue. Operating expenses, remaining reserves, and debt service for the same time period are displayed in the table below.

Table 1-2. 20 Year Operating Overview

20 Year Operating Recap		
Revenue	$	49,191,528
Op-Ex	$	3,268,783
Remaining Reserves (Operating, Capital Renewal/Replacement)	$	5,435,996
Debt Service	$	27,518,091
Ending 20-Year Cash	$	17,530,549

Our Broadband Sustainability Model shows that the program would break even in Year 3, with an end-of-year cumulative cashflow of $17,530,549 at the end of the 20-year period, as shown in the figure below.

Figure 1-4. End of Year Cash Flow Over 20 Years



In addition to a return on the City's capital investment, there are also a few common goals among almost all interviewed City departments that can be solved with a citywide Wi-Fi network and digital inclusion efforts. Therefore, in addition to the fiber network, the Plan includes governance and Wi-Fi recommendations.

Governance recommendations include the City of Fremont pursuing digital literacy programs to assist in closing the digital divide, particularly in coordination with existing organizations such as the City's Age-Well Centers, Family Resource Center, Youth and Family Services Department, and the Homeless Navigation Center. The City should also continue Dig Once policies and practices, reviewing opportunities for laying additional conduit and fiber at a significant cost savings anytime excavation is planned. We recommend setting up a separate fund for this purpose.

Many stakeholders also saw value in offering Wi-Fi including local information splash pages and support for outdoor markets and festivals. City departments also expressed the need to have a City-wide Wi-Fi that will support supporting connected devices in the field. We recommend including these wireless components as a part of the RFP for a P3 agreement that will leverage City assets to achieve these goals.

1.3 RECOMMENDATIONS

To develop a City of Fremont Broadband Program, next steps for the City include:

1. *Establish an Enterprise Fund for managing capital investments, revenues, and contractual services.*

The City of Fremont should set up a separate fund for the fiber program to manage its capital and operational expenses, track revenues, and fund contractual services. The Enterprise Fund should be overseen by the appropriate staff who will manage the program. The City could consider reinvesting the revenue share it receives as agreed upon with its selected partner(s) to develop additional broadband infrastructure or to support other broadband-related programs including digital literacy efforts. The ultimate goal would be to generate revenue to pay for the buildout as well as the maintenance and running of the network.

2. *Continue dig once practices with capital projects, development agreements and utility encroachment in the PROW for opportunistic joint construction.*

Broadband should be included into the full range of City planning and development activities, and vice-versa. Capitalizing on planned projects in which the ground is being excavated for other purposes can reduce the cost of deploying conduit and fiber by up to one-third. The City should continue coordination between departments as well as with outside organizations to ensure that these opportunities are reviewed on a regular (at least quarterly) basis, allowing for more cost-effective deployment of infrastructure not only for the City but for private entities seeking to expand fiber and conduit in Fremont. We also recommend that the City set aside funds for opportunities for conduit and/or fiber deployment as they arise. A good starting point for this fund is approximately $250,000, to be replenished annually as needed. Should there be an increase in spending needed in any one year, we recommend using unspent capital improvement funds for street maintenance temporarily with repayment during mid-year or year-end budget processes.

3. *Review funding opportunities for broadband and traffic signal improvements.*

Fremont should continue to track grant and loan opportunities to fund broadband and traffic signal improvements from state and federal agencies. Specific programs for which Fremont may be eligible include the Coronavirus Capital Projects Fund, California's Advanced Services Fund (CASF), RAISE Transportation Fund, and California's Loan Loss Reserve Program. While the rulemaking for all of these programs has not yet been released, we expect that the State of California will be providing more details about all four of these programs in the first half of 2022 and encourage Fremont to stay in close contact with state officials about the City's eligibility. Grant and loan opportunities will require the City to provide key details about the project to demonstrate that it is shovel ready; many of these details are provided within this Plan and the City should leverage this document to prepare applications. Submitting applications for funding under these

programs will require letters of support from major employers, senators, assemblymembers, economic development councils, internet service providers, business improvement districts, business chambers, and/or community anchor institutions. The City should begin planning for these efforts early as they require considerable time to collect and compile.

The City of Fremont should continue to apply for the many different transportation grants offered through the US Department of Transportation. Being an urban area, Fremont tends to have a greater competitive advantage for general transportation grants vs. broadband type funding with requirements of under or un-served communities.

4. *Complete solicitation and selection of public-private partner for network marketing, operations and maintenance.*

The City should develop a Private Public Partnership (P3) to build Phase 2 and Phase 3 to connect all traffic lights to the traffic management system and support economic development. This partnership will allow the partner to use the City's network to supply business services through a third party with a revenue share as agreed during negotiations with the selected partner. The City currently has an RFP underway to begin this process.

5. *Complete solicitation and selection of public-private partner for implementing and managing wireless services.*

Fremont should also develop a P3 for the deployment of a wireless network throughout the City to support public safety, economic development, and outdoor markets by using local information splash pages and point of sale service for farmers markets and festivals. It was a prevalent goal and desire of the various City departments to have a City-wide Wi-Fi network supporting a myriad of IoT and other applications. The City should select a qualified, experienced wireless service provider to leverage Fremont's assets to provide this service.

6. *Identify funding for a Network Engineer to manage network implementation, management, ISP and partnership services.*

While a P3 agreement will relieve Fremont of the need to provide complete staffing for the program, we recommend that the City dedicate one half-time (0.5 FTE) Network Engineer to oversee the deployment of the network, management of assets, and P3 agreements and services. This will ensure that the City's assets are tracked and

documented as additional segments are built out, provide a point person for partners, and track the overall status and goals of the program.

7. *Complete the recommended core build to connect all City facilities and fire stations and reduce the monthly operating expenses for broadband circuits.*

The objective of Phase 1 of this Plan is to connect all facilities in order to create efficiencies for the City, as well as to deploy new infrastructure that can be used to provide services to businesses on or near the network in Fremont. The Phase 1 deployment should be overseen by the City's IT Department to ensure broadband is provided for City facilities, fire stations, police, and Emergency Operations Center (EOC). Phase 2, which incorporates the Traffic Signal Modernization project, should be coordinated with the City's Traffic team and IT. At the time the City begins connecting businesses during these phases, the City should have a contract with a P3 to market, operate and maintain the network.

8. *Build two diverse routes for City-owned internet connections including:*

- Route 1: Fremont City Hall to Fremont Bay Area Rapid Transit (BART) station. Use BART fiber to connect to Digital Reality or Cogent Data Centers, among others, offering internet point of presence connections in Oakland. An agreement with BART and one of the Data Centers needs to be acquired. Over time, this option is significantly more cost effective than leasing lit services circuits from the private sector.
- Route 2: Connect Emergency Operations Center/Maintenance yard (EOC) to Silicon Valley Intelligent Transportation Systems (SV-ITS). Use SV-ITS to connect to 11 Great Oaks in San Jose for diversity. Fremont already has rights to use the SV-ITS fiber and should coordinate the route through San Jose's IT Department.
- Connect EOC to City Hall with two diverse circuits using existing City-owned fiber. This allows for the diverse internet connections through City Hall and EOC. If either building suffers an outage, the network can rely on the other for internet. This also creates two diverse circuits from EOC and City Hall, a big concern from City's Public Works and IT Departments.

9. *Increase digital literacy and education.*

The City should support ongoing digital inclusion efforts through various departments such as libraries, schools, Community Development, and Human Services. There are many digital literacy programs and groups such as National Digital Inclusion Alliance

(NDIA) and The International Telecommunications Union (ITU)[2] that have information on how to increase digital inclusion. These programs should be integrated into the governance of the Citywide Wi-Fi network, overseen by an advisory group, to ensure the most community impact. The City's Family Resource Center and the Youth and Family Services Department, Age-Well Centers and Homeless Navigation Center are all well-positioned to lead these efforts in coordination with other City departments and leadership.

[2] Digital inclusion resources include the International Telecommunications Union (https://www.itu.int/en/mediacentre/backgrounders/Pages/digital-inclusion-of-youth.aspx) and the Nation Digital Inclusion Alliance (https://www.digitalinclusion.org/).

2. Inventory of Existing Systems & Service Availability

2.1 CURRENT BROADBAND MARKET

To gain an understanding about the current broadband environment in Fremont, we obtained information about current service offerings and rates in the City. Because a primary goal of this Plan is to enhance economic development and support local industry, the inventory of existing service availability includes information only about business class internet services in Fremont.

Providers of Business Services

Astound Broadband Powered by Wave was formerly known as Wave Broadband and has recently rebranded after unifying several smaller broadband providers. Astound/Wave has residential offerings in Fremont and will also provide business services under the new brand **Astound Business Solutions**. Pricing varies from around $1000-1700 per month for dedicated business class service.

AT&T is the incumbent local exchange carrier (ILEC) serving Fremont. AT&T is one of the world's largest providers of IP-based communications services for businesses, including Virtual Private Network (VPN) and Voice over IP (VoIP), and is very well known for its wireless network.[3] AT&T has recently acquired DirecTV, and the FCC conditioned its approval of the transaction on AT&T extending fiber connections to additional locations as well as offering gigabit connections to E-rate eligible schools and libraries.[4]

BroadbandNow.com states that AT&T can provide services to businesses in about 25% of Fremont. Published speeds for business services are not available as AT&T provides quotes for businesses on a case-by-case basis. Currently there is no AT&T fiber network in Fremont that is dedicated for business use. Costing for fiber services is based on the construction needed and term length of contract (36 month minimum). According to AT&T, the average monthly recurring cost (MRC) is $1300 for 1Gb, plus installation of $1000, plus a percentage of construction costs.

Lumen (formerly Centurylink Business) is a major Digital Subscriber Line (DSL) and fiber internet provider serving residential and business customers nationwide in the United

[3] http://www.att.com/gen/investor-relations?pid=5711

[4] In the Matter of Applications of AT&T Inc. and DIRECTV For Consent to Assign or Transfer Control of Licenses and Authorizations; MB Docket No. 14-90; Memorandum Opinion and Order; FCC 15-94, Released July 28, 2015, at page 148.

States. Lumen's DSL is widely available in rural areas and the company offers fiber internet only in select cities, but their total network coverage includes 37 states. Lumen provides some fiber-based services to the Fremont market at published speeds of up to 940 Mbps for $65.00. Based on these speeds and pricing, we assume that this best-effort service is not fiber-based and is for residents and small businesses only. Lumen provides quotes for business services on a case-by-case basis.

Comcast/Xfinity Business is the business broadband brand for Comcast. Comcast is the largest cable internet provider in the US and the incumbent cable provider in the City of Fremont. BroadbandNow.com states that Comcast provides services to 98% of Fremont. Nominally, Comcast has no fiber business in Fremont, but it does have connections to some facilities such as the Police Department and is looking to expand and offer more services to businesses. They will build on a case-by-case basis depending on availability of fiber strands. Rates vary by area but are typically around $1000-$1500/ month.

Etheric Networks is a California based fixed wireless provider offering service in the Bay Area. They report having service available in 100% of Fremont businesses with published tiered speeds of 15 or 25 Mbps. Etheric also offers fiber service to businesses in nine zip codes throughout northern California. Etheric Networks was awarded Rural Digital Opportunity Fund (RDOF) for census block groups northeast of Highway 238 to Sunol. They are looking to leverage this award to increase fiber presence in Fremont.

Tekify Fiber & Wireless is a California- based internet service provider offering both fiber and fixed wireless services in the Bay Area including Fremont, Hayward, Newark, and Union City. According to publicly available information, Tekify's fiber service is available to approximately 5,000 people in these cities, while their fixed wireless offerings are available to approximately 470,000 people[5]. The company has a small footprint in the Nile Boulevard area in Union City and is looking to expand their fiber service offerings into Fremont. Tekify does not publish its business rate tiers and pricing for the Fremont market but indicates that it can provide fixed wireless service to 100% of the Fremont market with download speeds of up to 1Gb.

Other wired providers including **Crown Castle**, **Sonic**, **Zayo, Level 3, and Lumas** also offer businesses to a small portion of Fremont's businesses (less than 20%). Pricing is not provided.

[5] https://broadbandnow.com/Tekify-Broadband

2.2 PRIVATELY OWNED FIBER ASSETS

There are a number of providers with metro and longhaul fiber assets in Fremont today, as shown in the maps below. The first image, containing local metro networks, includes a substantial amount of assets owned by Crown Castle and CenturyLink. In the second image, longhaul fiber is shown, including routes owned by Level 3, CenturyLink, and Electric Lightwave that run along many of the City's major corridors.

Figure 2-1. Metro Fiber Networks in Fremont

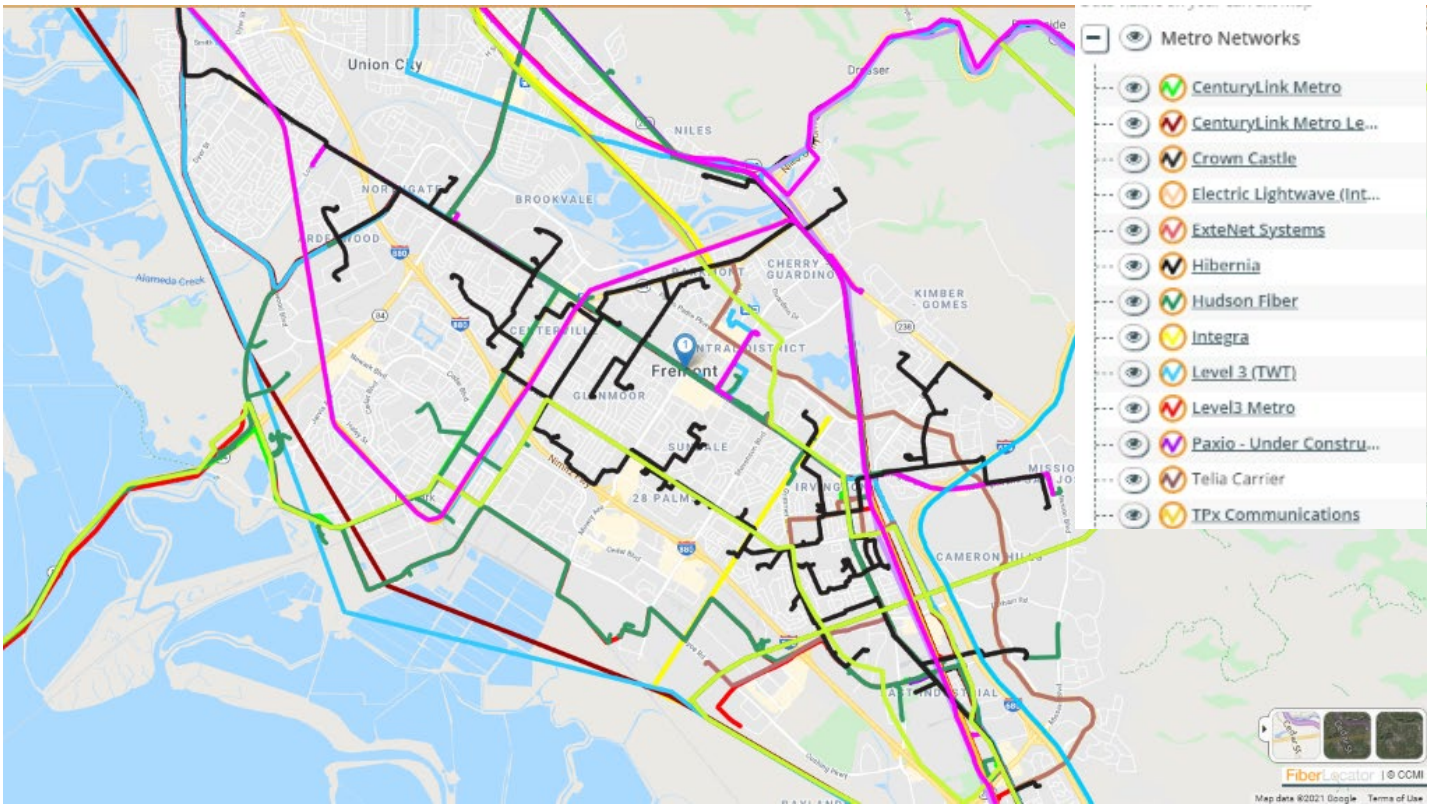
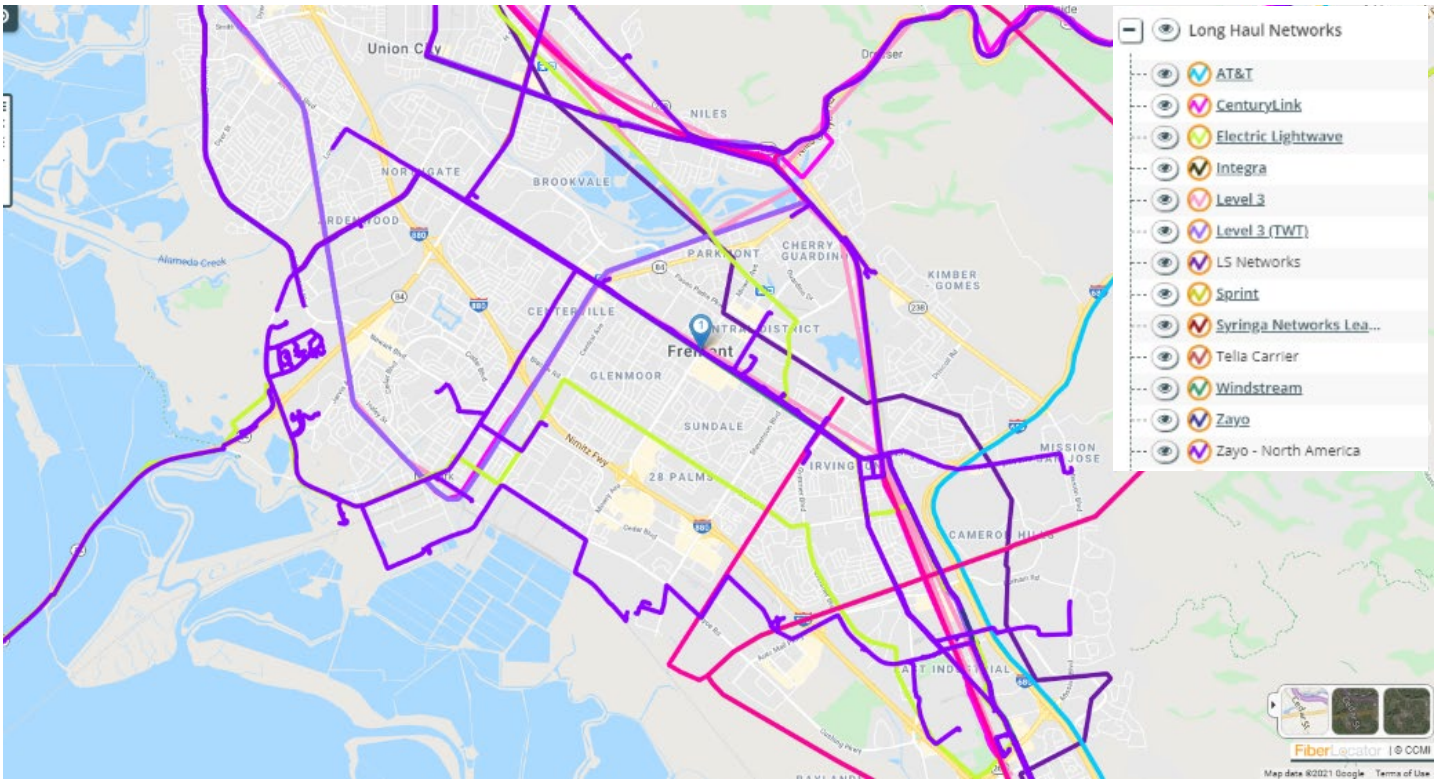


Figure 2-2. Long Haul Fiber Networks in Fremont

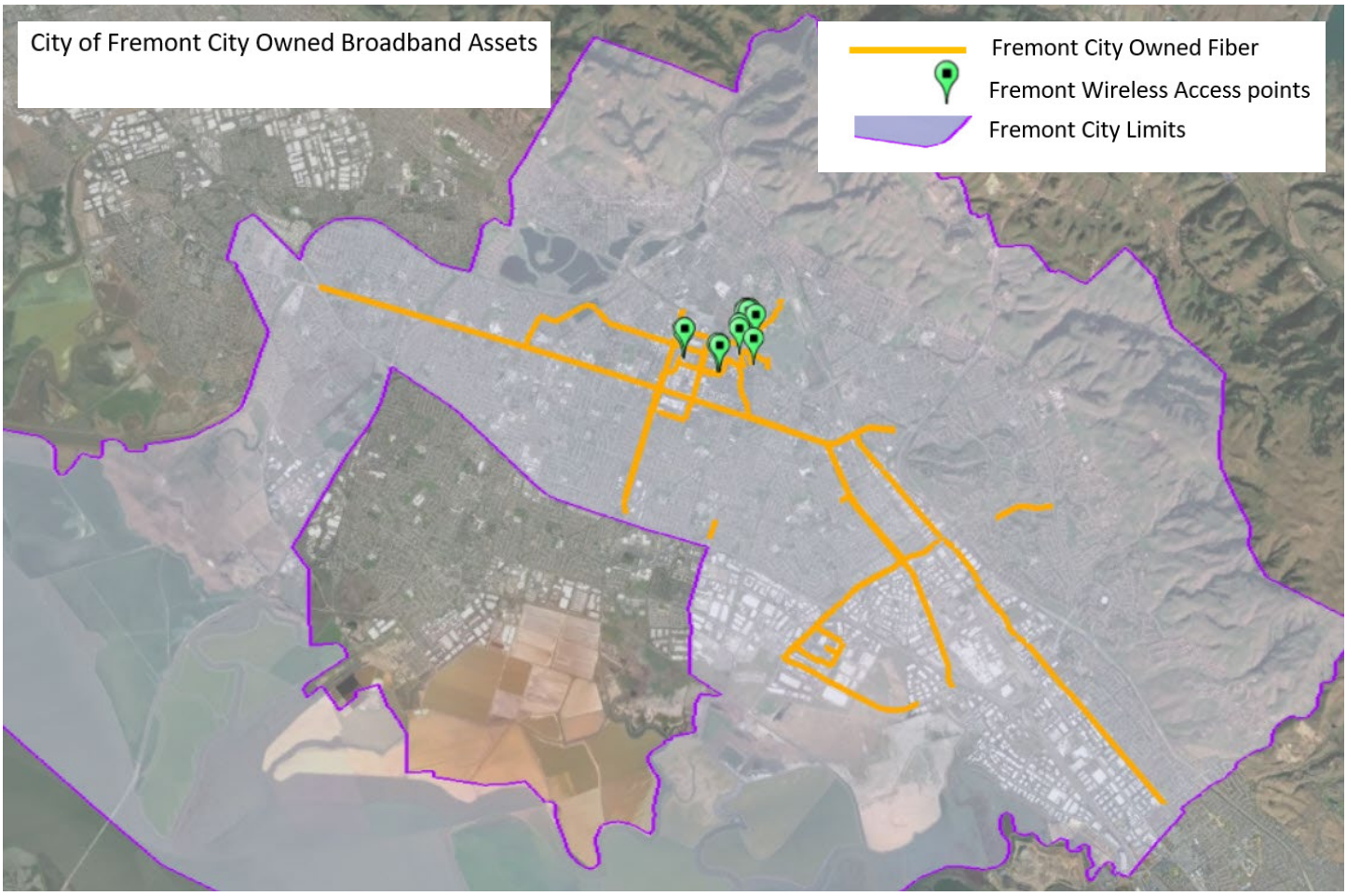


2.3 CITY-OWNED BROADBAND INFRASTRUCTURE

Fiber-Optic Cables

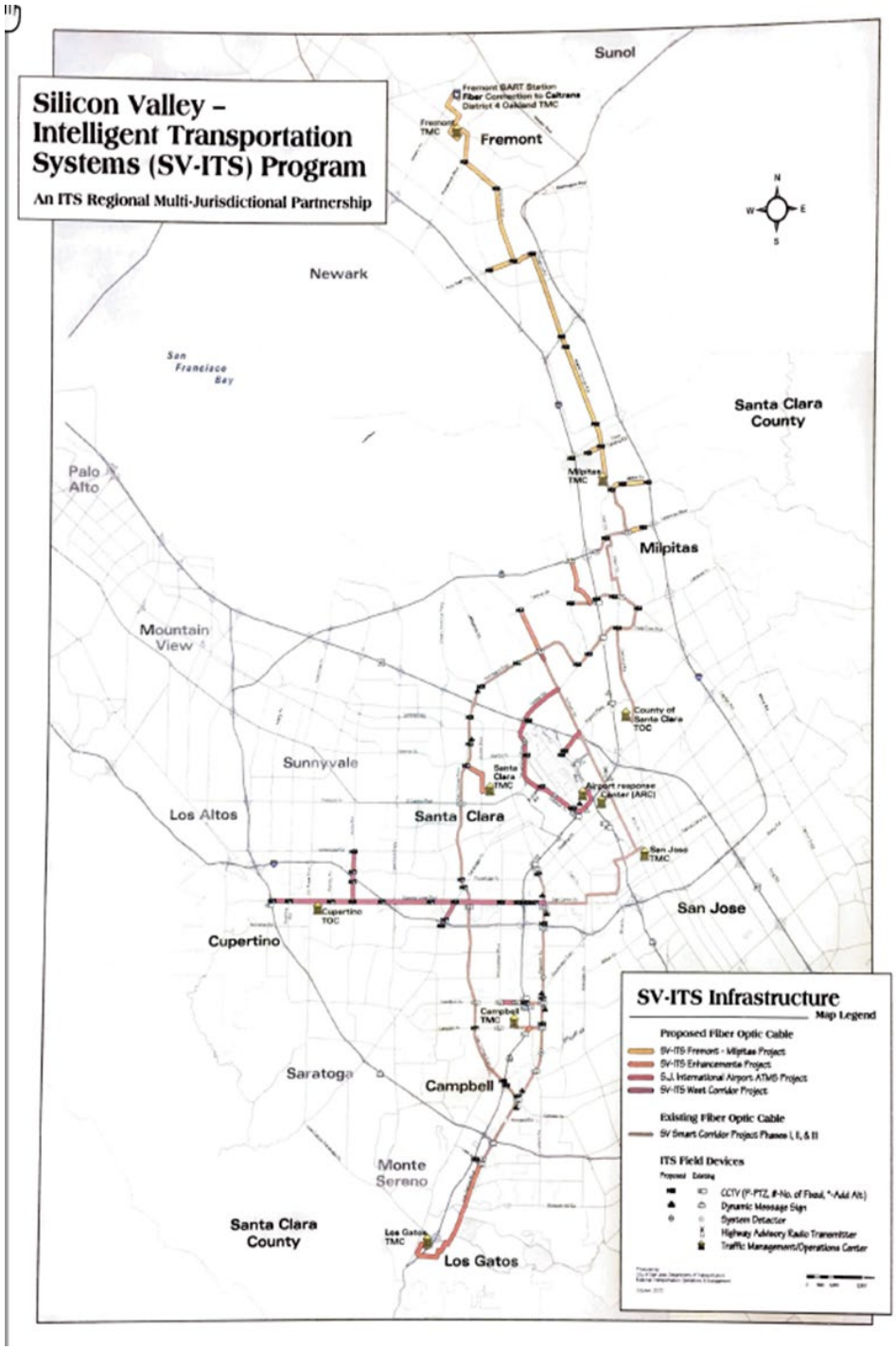
Currently, the City of Fremont has around 41.89 miles of existing fiber, shown in the figure below. This fiber is owned by Fremont's Public Works and IT Departments. The fiber cables vary in size and strand availability, with 96 fiber stand count being the most common. The existing fiber is sufficient to use dense wave division multiplexing (DWDM) with up to 400 Gb technologies to get the utilization that is needed to support City operations and business service offerings.

Figure 2-3. City of Fremont Existing Fiber



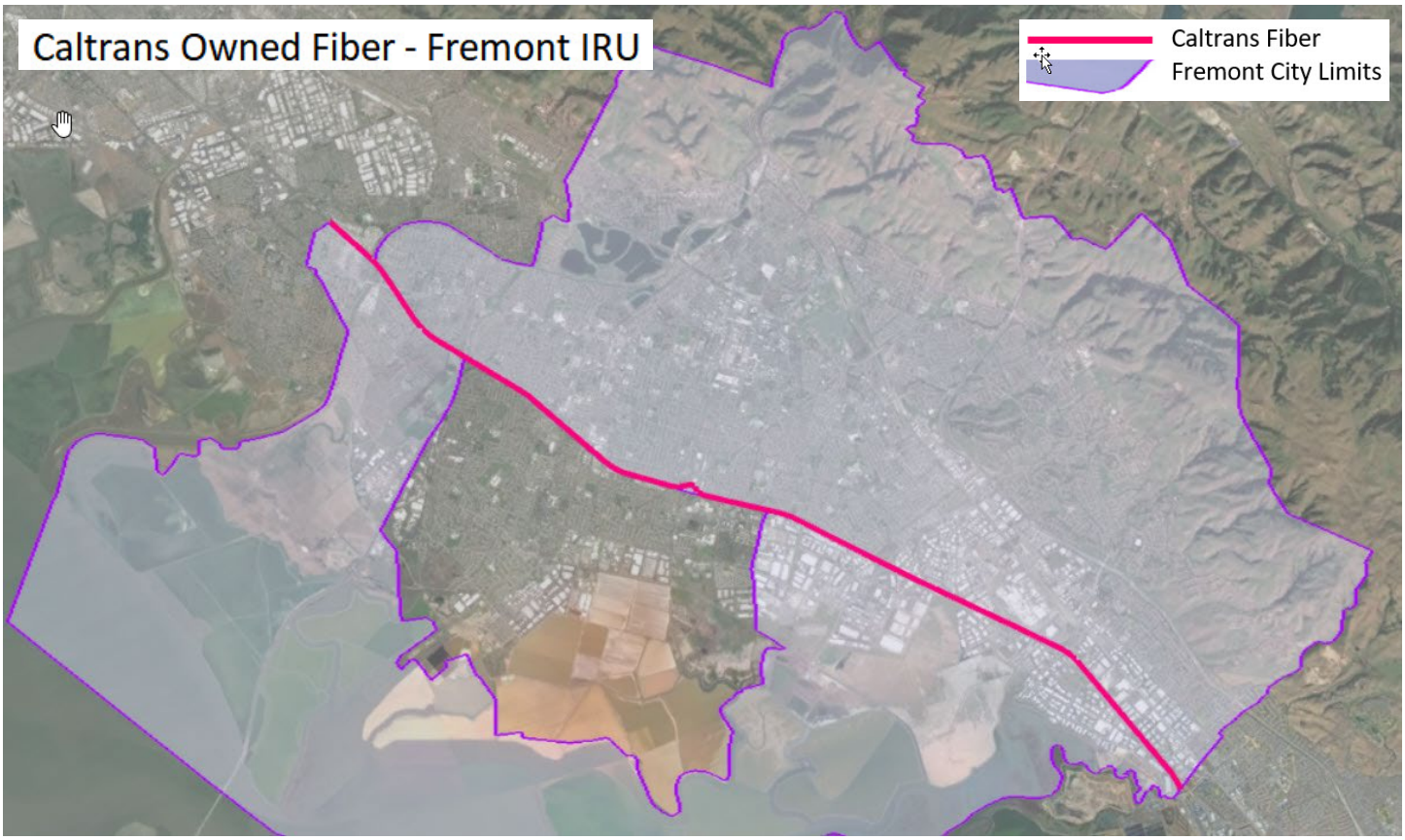
In addition to City-owned fiber, the Silicon Valley Intelligent Transportation Systems (SV-ITS) is a fiber optic network running through Fremont. Completed in the early 2000's, it was a system built to connect an intelligent transportation from southern San Jose to Fremont through all the cities along the path. The cities it passes through, including Fremont, have access to six (6) fibers strands, and can request more if needed. The fibers are managed through San Jose IT Department. According to San Jose, these fibers are free for the City of Fremont to use. San Jose is responsible for the management, assignments, and documentation of the network.

Figure 2-4. SV-ITS



Additionally, Caltrans owns the fiber route shown below, which contains a 288-count fiber running through Fremont. The City has use of four (4) fiber strands.

Figure 2-5. Caltrans 288 Fiber in Fremont

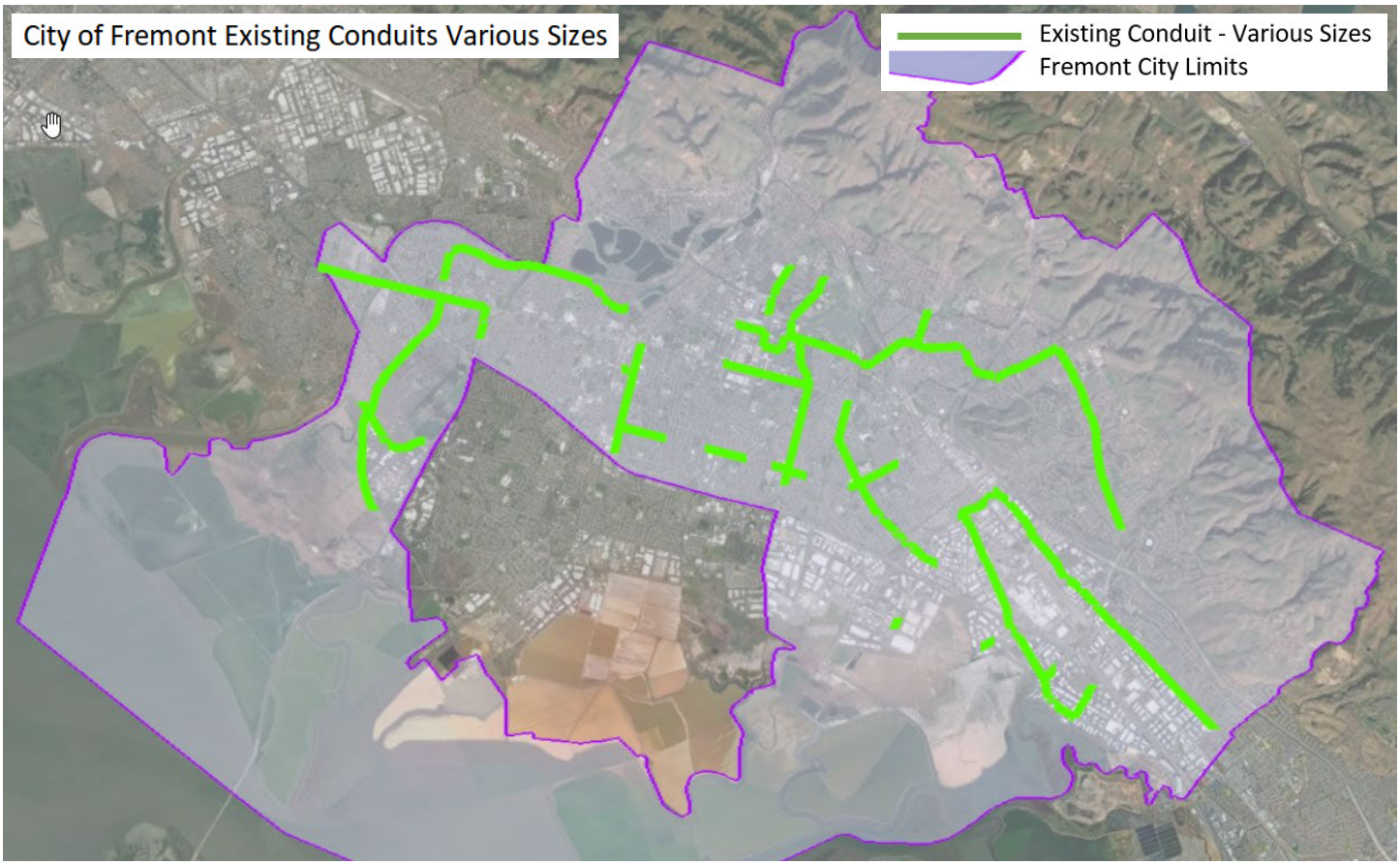


Conduit

Fremont has an existing 22.54 miles of traffic signal interconnect conduit, shown in the figure below. In most cases this conduit is occupied by a copper signal interconnect cable that would have to pulled out and replaced with fiber. The size of the conduits is known (in most cases it is 2”), but the condition is unknown. It is assumed that the handholes and vaults are too small to accommodate the required static bend radius of the fiber cables and will have to be replaced with 30x60x30-foot vaults. The bends on the conduit entering the handholes are typically hard 90-degree elbows and are not compatible with bending of fiber cables; therefore, they would have to be replaced with 90-degree sweeps. It is assumed that if there is existing copper signal interconnect cable in the conduit, that cable can be pulled out and a new fiber cable pulled in.

The placement of these conduits makes them a perfect option for building new fiber, providing cost savings. The cost of new underground construction varies from $110 to $125 per foot and upgrading the signal interconnect is substantially less expensive at $15 - $25 per foot.

Figure 2-6. City of Fremont Existing Conduit



2.4 CONCLUSIONS ABOUT FREMONT'S EXISTING BROADBAND SERVICE AND ASSETS

Fremont is served by several providers with the speeds well above the federal broadband threshold of 25/3 Mbps. The broadband technologies used to service Fremont are coax, DSL, fiber, and fixed wireless.

Businesses, although adequately served today, will rely on additional fiber offerings in the future as their operations increasingly depend on fast symmetrical speeds to keep up with the demands of the economy and data transfer. Additional service options, especially for businesses, could drive down prices and improve customer experiences by creating more competition for fiber-based services.

Fremont has a substantial amount of existing infrastructure, both publicly- and privately-owned, that can be leveraged and expanded to meet these goals. Although the City's conduit likely needs to be upgraded to house fiber, costs of deployment can be substantially lowered by using existing assets to expand fiber into key areas of the City.

3. Needs Assessment & Goal Setting

Magellan Advisors interviewed 31 representatives from City departments and representatives of three external organizations: Alameda County Transit, Alameda County Water District, and Fremont Unified School District. The discussions revealed a wide range of needs and opportunities, many related to Fremont's substantial base of advanced manufacturing companies and its relatively sophisticated approach to traffic management.

The City's plans to develop its Downtown, develop mixed use nodes in its neighborhoods with affordable housing and small business, and concentrate economic development in the Warm Springs Innovation District also create distinct needs and opportunities. Fremont's diverse, technologically advanced industry is both an end and means for much of this development, including broadband. The only element that seems to be missing from Fremont's innovation ecosystem is higher education, particularly translational research activities.

Several City facilities, particularly community centers and the co-located Public Works Corporation Yard and Emergency Operations Centers, are prime candidates for better connectivity, and so are the numerous parks. Other public entities in Fremont have similar requirements, particularly for transit and utilities. All these needs complement opportunities for economic development and transportation. Stakeholder input indicates it will be important to capitalize on the City's broadband opportunities to include seniors, persons experiencing homelessness, and low-income families.

3.1 GENERAL NEEDS AND OPPORTUNITIES

The City has identified numerous specific opportunities for connectivity. The Maintenance Yard and Emergency Operations Center (EOC), which share a location, currently have a Comcast broadband line, a lateral from the traffic signal fiber, and satellite backup. They need redundant connections. The City wants to have digital displays throughout the area, including a digital events calendar and solar dashboard at the Convention Center. Smart buildings, including electric micro-grids, are seen as important for resilience, particularly for power shut offs. The City already has 58 buildings with fire alarm systems, energy management system controllers in 37 buildings, and is using keycard access control. They need telemetry to monitor generators, pump stations, and similar sites. There are numerous cameras at traffic signals for various uses.

The City also wants to use the fiber to support community programs, fire, police, site interconnection, and mobile connectivity for field personnel in various departments to access work orders, reports, plans/inspections, etc. Currently, many public safety cameras, including license plate readers (LPR), which are used daily for criminal investigations, are on cellular and experience substantial lag and recording issues. They would like to add public security cameras to all access/egress points around the City, commercial and residential developments, and expanded intersections.

Other community anchors have similar interests—the schools need to support virtual learning, for example, and the water company is considering smart meters. The City has major industries that embraces and uses technology—including traditional anchors like healthcare and cutting-edge industries like autonomous vehicles—so there are significant local economy benefits. A lot of companies want to deploy private fiber and wireless infrastructure, which can impact other infrastructure. Redundancy is a huge issue. Fiber installed in shallow trenches has been cut several times. The City and partners want to make sure they have diverse and less exposed routes.

The City needs to address issues related to design and construction—Dig Once practices and micro-trenching were specifically mentioned—but also coordinate and facilitate development for redundancy and restoration. They want to connect to the 880 Caltrans fiber but need to build conduit into the Caltrans vaults. The City is also interested in potential revenue from existing assets to cover operating costs and how to capitalize on them to connect those who can't afford private services.

3.2 COMMUNITY AND ECONOMIC DEVELOPMENT

Fremont has unique opportunities due to its diverse, large-scale manufacturing base consisting of approximately 900 high-tech companies, many of which are relatively small. One in four local jobs are in clean tech, auto tech, life sciences, and legacy computer/semiconductor manufacturing ecosystems. Most of the City's tax income comes from these industries, as well. Including the Tesla Factory, the largest manufacturing facility outside of China, the City has 55 million square feet of manufacturing space, much of which can easily adapt to produce various quantities and types of products.

Most of the City's industry is in the Fremont Innovation District (FID), south of Auto Mall Parkway, between Fremont Blvd and Warm Springs Blvd, on both sides of the 880. FID encompasses the Warm Springs Innovation District, which includes the Tesla Factory and is the focus for the City's Manufacturing Innovation Center. Ardenwood Technology Park,

with 2.7 million square feet of space for R&D similar uses, located in the northwest corner of the City at the eastern end of the Dumbarton Bridge from Palo Alto, is another important area for advanced connectivity.

Fremont is a global hotbed for "Industry 4.0," which uses large-scale machine-to-machine communications and a vast number of small, interconnected intelligent devices known as "Internet of Things," to making manufacturing faster, more efficient, flexible, and much less labor-intensive. Because of this, demand for data processing and digital infrastructure has increased dramatically. Connected, intelligent vehicles and similar—essentially free-roaming robots—represents a major opportunity for research and development for the City and its industry. Fremont does not have significant presence of higher education, particularly research centers.

The City's small businesses and support industries are sprawled over 90 square miles with no central concentration because the City grew through annexation and agglomeration. Fremont is 15% to 20% of the way into a multi-year process to develop the Downtown District between the Fremont Bay Area Rapid Transit (BART) Station and the Fremont Hub Mall. The district is centered on the Downtown Event Center & Plaza near the intersection of Capitol Ave and State St, which has an urban park for food trucks. Those plans are basically on hold because of the economic situation, particularly impacts of the COVID-19 pandemic on demand for office space. The City will redevelop the Downtown District with commercial and office space as demand for such facilities recovers.

In the meantime, the City is focusing development on residential, mixed use, and "community-facing" economic development, including retail and services. The City's Age-Well Centers and Homeless Navigation Center are important facilities. The City is focusing on seniors and formerly homeless individuals, launching a rental assistance program, and supporting non-profit developers. Affordable housing is a priority for the City and key partners, including Joint Venture Silicon Valley. There are lower-income households spread throughout the community.

Fremont is also developing smaller scale "town center" mixed use, urban village nodes around transit, with good bike-walk connectivity to get people outside and interacting. Ardenwood Park in the north part of the City, Artist Walk/Centerville, and Warm Springs in southern Fremont were specifically noted for this type of development, although the approach applies throughout the City. Centerville, Five Corners/Irvington, Mission San Jose, and Niles Plaza were noted as examples smaller commercial areas the City wants to promote. The City has several Business Improvement Districts. All these areas/nodes should have public Wi-Fi. 5G and other next generation wireless is an opportunity in these areas as well as in the more industrial areas of Fremont. Despite objections of a

vocal minority, the City may consider integrating 5G with its infrastructure because most people want it and it could benefit economic development via technology trials.

3.3 HEALTH, EDUCATION, AND WELLNESS

There are 62 parks in Fremont and over 60 miles of trails, with plans for nearly 80 more miles. Central Park is the City's largest park, although the East Bay Regional Park District has several large parks in the City as well. Most are neighborhood or plaza parks. The City also has ten community centers, multiple historic parks, and many historic buildings. Most of the buildings and centers have not been updated and have no Wi-Fi or other connectivity. Citizens have asked for more or improved trail infrastructure, particularly loops in parks, which can be prime opportunities to deploy network infrastructure and improve digital connectivity.

Parents often don't want Wi-Fi for kids as it keeps them from being active, but they need it for events and access to information. Connectivity can be a way to enable gathering but also discourage standing while supporting those in need. Emergency communication, event streaming, field work, interactive kiosks, lighting controls, mobile registration (Active.net), security surveillance, and wayfinding are potential applications. The City has numerous partners for parks, many of whom also need better connectivity. It is easier to find sponsors if an event/facility has good connectivity.

The City's Family Resource Center (FRC) houses 25 agencies, including county and state as well as various non-profit enterprises. They have Financial Navigators on staff to help any Alameda County resident and professional counselors to help families through difficult life situations. The Youth and Family Services Department, which has a presence with the Police Department and schools as well as the FRC, provides a range of counseling and evaluation. They use telehealth, are deploying electronic health records system, and working on a variety of ways to connect with medical providers and other services (including discounted rides via Lyft and Uber). Data gathering and services require hardware and network connections that meet HIPAA requirements. There is a large digital divide for the elderly population who often can't afford internet on fixed incomes. Isolation is a health issue for them, and their doctors are online. Their kids get the technology but they often struggle to use it. The City is doing a demonstration project – GrandPad[6] – which uses a cellular telephone connection to support seniors.

The Fremont Unified School District has 47 locations, including administration, adult learning, individualized charter schools, and pre-kindergarten, as well as various schools

[6] GrandPad sells a special device and support services for seniors. For more information, visit https://www.grandpad.net/.

for K-12. One new elementary school building has not yet opened. They are planning to add another early learning center. All schools connect via Crown Castle fiber at 1 Gbps to the schools' central office, which connects to CENIC via a 10 Gbps circuit to the Alameda County Office of Education in Hayward, with dark fiber to another facility for disaster recovery. Their contract for network services ends in 2022 and they are planning to put it out to bid as this Plan is written. All schools have Wi-Fi and use VoIP. They have various online tools for students and their families, including Clever digital learning platform, Google G-Suite, and Infinite Campus student information system.

3.4 PUBLIC SAFETY

Fremont has a single campus for its Police Department and an adjacent jail; BART has offered to allow City police to use its stations if Fremont would split the costs. The Fire Department has eleven stations, a training center and administrative offices located next to City Hall on Capital Ave, and Emergency Operations at Public Works Corporation Yard. Dispatch for the Fremont Fire Department is provided out of Livermore and radio communications is provided by East Bay Radio Communications System Authority (EBRCSA). Fremont Police Department Dispatch center is multi-jurisdictional serving Union City patrol using PSAP, public safety answer point and is in the Police Department. Some Fire stations have basic (10/100 Mbps) Comcast broadband, fire stations #1, #5, #7 have active fiber links, while #3 and #8 will be served by fiber upon completion of the Fremont Smart Corridor project. Fire station #9 has a 1G link using the City's Siklu equipment.

Emergency/public safety vehicles have CradlePoint routers with cellular (via Verizon) and Wi-Fi. There is Wi-Fi at fire stations as well as other City buildings that Police can use. Officers typically download body cam video at the Police station. The Fire Department would like better cellular, radio, and video communication options, specifically for conferencing, field access to GIS (they use Waze to locate incidents on the highway), and training. Generally, the data speeds in the field are not adequate for the Fire Department. Cellular and radio communications are spotty in certain areas in Fremont.

Fremont Police have considered live streaming video, especially for their mobile command vehicle and police body cams during active situations. Drones are currently used with streaming video.

3.5 TRANSPORTATION AND UTILITIES

Generally, traffic management is a major application for the City's network infrastructure. The City has fiber to some traffic signals and cameras and it is a somewhat fragmented system of 96 strand fiber cables. They have an agreement with

Caltrans to use 4 fibers along Highway 880 in exchange for 4 fibers used on Mowery to connect to BART fiber but the City is not currently using any of those fibers. They have been approached by private companies about use of the conduits and fiber. No agreements are in place now. Fremont also owns local streetlight poles, some of which are used for antennas for cellular services.

Traffic Engineering is developing a Smart Corridor via a Traffic Signal Modernization project along Fremont Blvd the entire length of town, working with technology companies LYT (real time traffic signal status) and Pony AI (autonomous vehicle technology). Traffic Engineering is replacing signals, cabinets and connecting fiber from Fremont and 880 on the north to Fremont and 880 on South side of the City. No conduit will be added but old copper cable will be pulled out and replaced with fiber. Planned pedestrian bridge crossings could be designed to include conduit for future use.

AC Transit, which serves 14 cities, including Fremont, and unincorporated areas of western Alameda and Contra Costa counties, is an important partner for transportation. It has connected buses, connected vehicles, and mobility hubs via cellular. The buses are mobile data centers that collect camera, location, passenger, and vehicle data in real time as well as VoIP for operator communications, all via private network infrastructure. They have traffic signal priority via roadside units adjacent to signal cabinets and are planning for collision avoidance technology. They also have public Wi-Fi. The operator can activate covert microphones and alert the Sheriff's department, which can access cameras if there are incidents needing situational awareness. They would like faster, more redundant connections. They are interested in partnering on kiosk to provide transit information and access to micro-mobility at mobility hubs.

Alameda County Water District (ACWD) covers a 105 square mile area, including Newark and Union City as well as Fremont, with 900 miles of pipe, 13 reservoirs, and three treatment facilities. Much of their network infrastructure, equipment, connections, and technologies are old and need to be replaced. They want to improve connections between facilities. They are working with Alameda County to identify possible sites to use microwave connections but not many facilities allow for good line-of-sight. ACWD collaborates with seven other water districts in the Bay Area to ensure water reliability. They are very involved in watershed protection activities and jointly administer the Quarry Lakes Regional Recreation Area in Fremont along with the East Bay Regional Parks District.

Some other Bay Area cities and towns are doing similar studies with varying results. Broadband is becoming the next utility and is being treated with more urgency and needs to be a part of the planning stages of all major projects in city limits. Municipalities are assessing current assets, demands, future goals, and creating ways to

meet those goals. Nearly all these cities, towns, and counties are starting to see the need for a more regional approach in connecting regions together.

The bigger cities seem to have a similar outcome to Fremont's with the city designing a backbone middle-mile to support partnerships and future growth through private companies using city assets as a cost savings measure. The smaller towns have fewer assets and resources, so the approach is a little different leading to more partnership ideas with less revenue for the town.

3.6 GOAL SETTING

Based on stakeholder inputs, broadband development goals for Fremont might include:

- Build broadband into the full range of City planning and development activities, and vice-versa; approach broadband as a strategic enabler as well as infrastructure to be developed and managed.
- Deploy redundant and reliable fiber connections to all key facilities.
- Reduce inconsistencies and fragmentation of fiber infrastructure.
- Establish separation within the fiber infrastructure to support public sector applications, including systems that require "air gap" security, and privately operated public networks. An air gap is a security measure in which computers, computer systems or networks are not connected in any way to any other devices or networks decreasing access and increasing security.
- Design and build fiber infrastructure with best security controls and practices and in mind such as but not limited to controlled physical access to the core network facilities and equipment, clean power and power backup sources, strong physical security, access control, and environmental controls.
- Create high-capacity fiber rings along major corridors, past parks (industrial and recreational), and in other key areas, adjacent to transit and traffic assets.
- Extend fiber infrastructure along secondary routes—focusing on commercial areas, plaza parks, and affordable housing development—and into parks.
- Provide wireless connections for digital divide issues, to support festivals and outdoor markets, and for City operations, including deploying new vertical assets as appropriate.
- Establish objectives for broadband partnerships and sales. These might include:
    - Cost reduction for services, particularly mobile, remote, radio-based connectivity
    - Increases in coverage and throughput for applications
    - Revenue from leasing horizontal and vertical assets
    - Investment by technology and telecom companies

  - Clear and simplified processes of services management and provisioning
  - Provide an avenue for revenue to be captured for some of the construction and maintenance of the network in terms of revenue sharing
  - Find opportunities to lease out infrastructure to 3rd parties to further monetize the network assets
- Develop a marketing/partnership plan; identify and engage prospective customers and partners.
  - Clearly define who will own the responsibility of the marketing
  - Clearly define anchor institutions with specific marketing for those potential clients

4. Broadband Survey

To gain further insight into the need for additional broadband options in the City of Fremont, a survey was conducted to collect information from residents and businesses about their current service and needs. The survey was open for approximately eight (8) weeks and received 498 total responses.

4.1 RESPONDENT CHARACTERISTICS

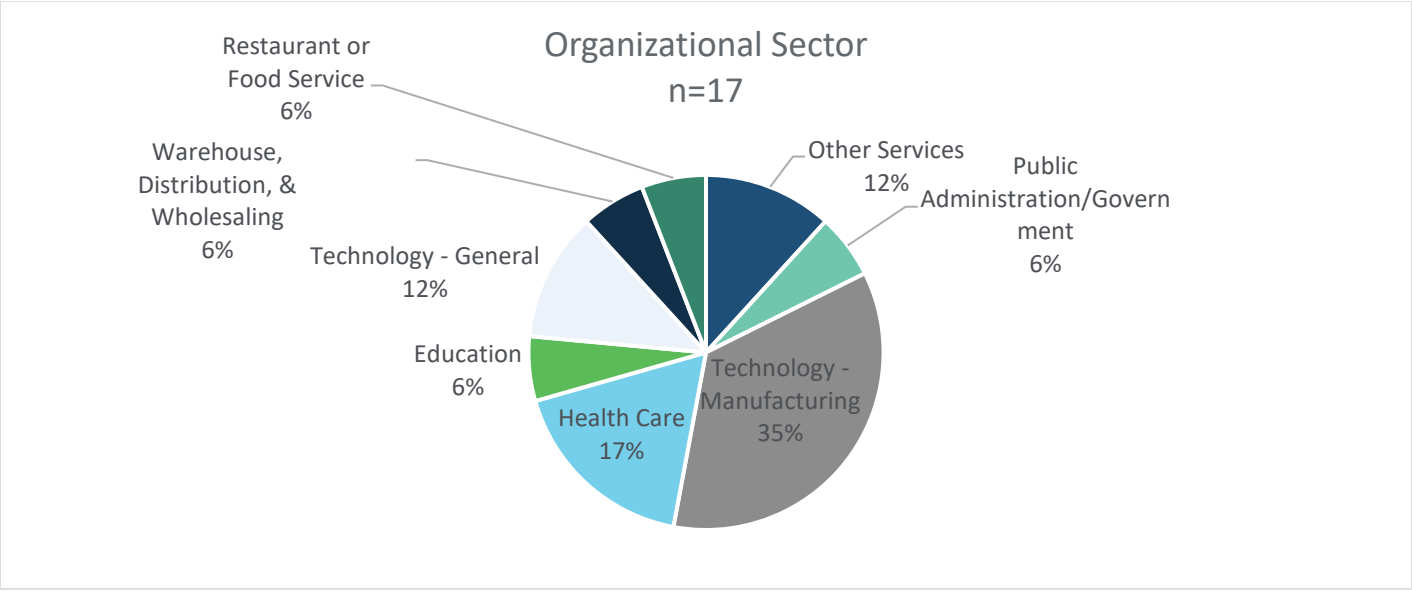
Most responses came from residents, as shown in the table below.

Table 4-1. Survey Responses by Type

RESPONSE TYPE	
HOUSEHOLD: LOCATION IS PRIMARILY A RESIDENCE	460
SMALL OR MEDIUM ORGANIZATION: LOCATION REQUIRES BASIC INTERNET, PHONE, VIDEO	22
LARGE ENTERPRISE ORGANIZATION: LOCATION REQUIRES COMPLEX SERVICES WITH SERVICE LEVEL AGREEMENT	16
TOTAL	498

More than two thirds of organizational responses came from the Technology-Manufacturing sector, followed by Health Care and Technology – General. These sectors tend to be heavy users of broadband, so their responses provide key insight into the current state of internet and future need. Due to the low number of organizational responses, we cannot say that results are statistically valid, although they do provide anecdotal information about the needs of these commercial users.

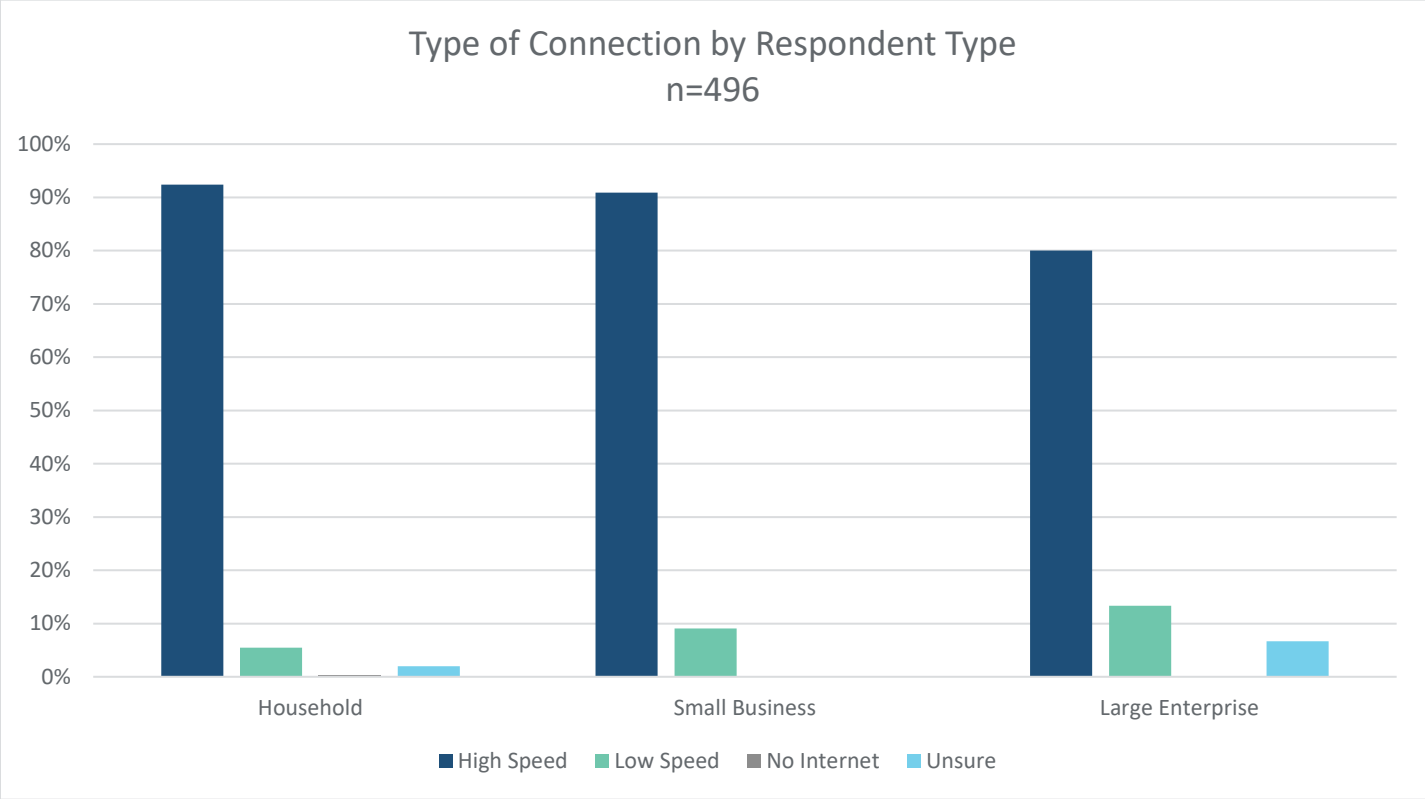
Figure 4-1. Organizational Respondents by Sector



4.2 RESPONDENT CONNECTION TYPES

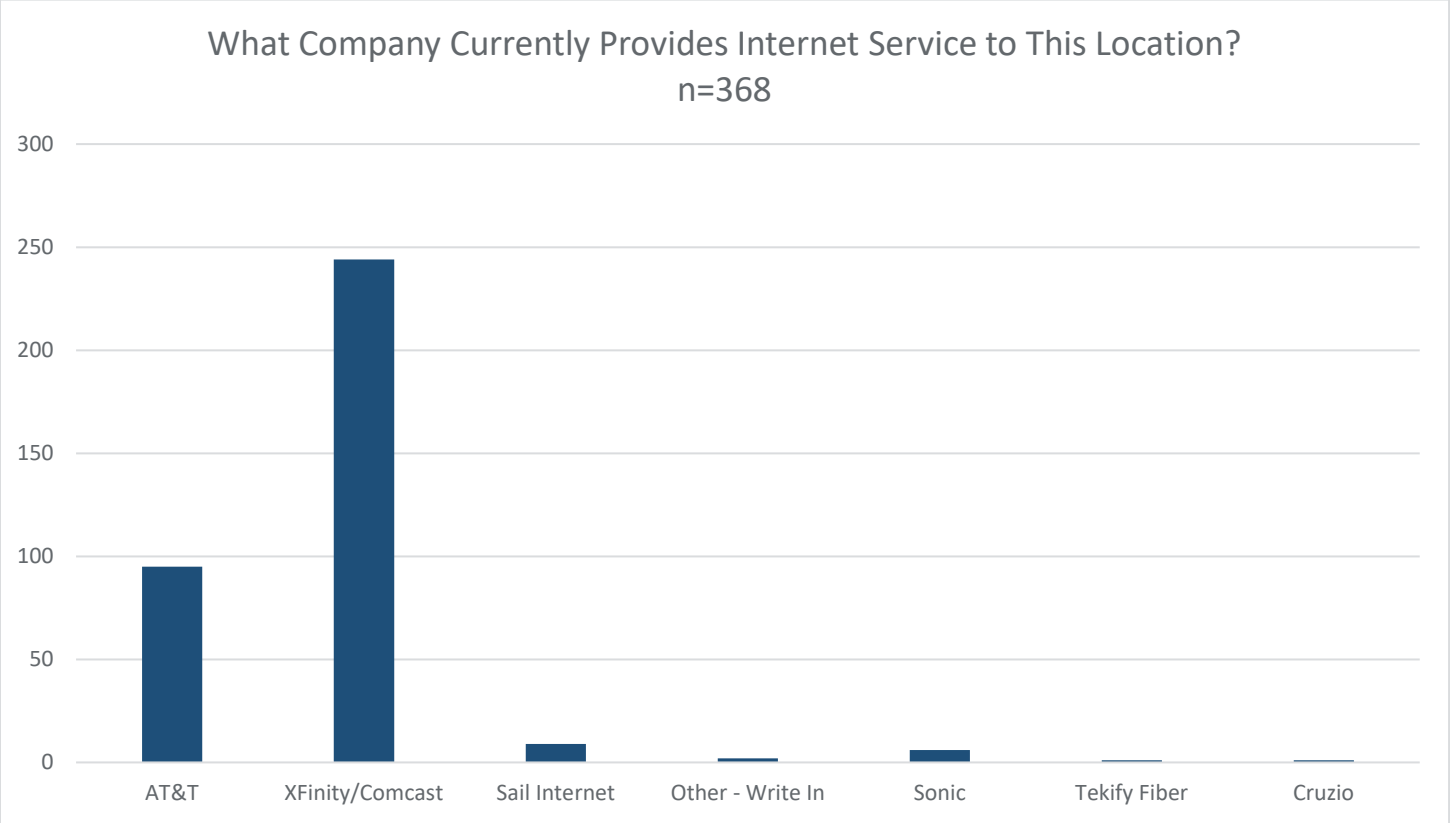
Most respondents reported that they had high-speed broadband connections, with only about 6% reporting slow-speed connections through cellular, dial-up, or satellite and just one respondent reporting no internet service at their location. About 2% were unsure.

Figure 4-2. Respondents' Connection Types



Xfinity/Comcast was the predominant internet service provider, serving about two thirds of respondents, followed by AT&T, serving about one quarter. A handful of respondents reported having service through Sail Internet (9) and Wave (6), while other companies like Tekify and Cruzio served one respondent each. These numbers suggest that the incumbent telecommunications providers – Comcast and AT&T continue to dominate the market, although there are some smaller companies offering service to some areas of Fremont.

Figure 4-3. Survey Respondents' Internet Service Providers



4.3 INTERNET PERFORMANCE AND SATISFACTION

The survey also contained an embedded speed test to gain an understanding of how internet is performing compared to contracted speeds. On average, survey respondents survey respondents were getting close to their contracted speeds, as shown in the chart below. Most respondents were getting speeds well above the 25/3 Mbps speed threshold used to define broadband by the Federal Communications Commission.

Table 4-2. Contracted Speeds Compared to Average Speeds Across all Respondents

	Average (Mbps)	Median (Mbps)
Download (Actual)	317.1044	109.485
Upload (Actual)	182.1285	32.71
Download (Contracted	412.2808	200
Upload (Contracted)	198.6021	20

Among residential respondents, actual speeds were about half of contracted speeds on average. Residents were paying an average of $87.28 per month for their broadband services only, which amounts to approximately $0.27 per Mbps per month based on average actual speeds[7].

Table 4-3. Contracted Speeds, Actual Speeds, and MRC for Residential Respondents

	CONTRACTED DOWNLOAD	CONTRACTED UPLOAD	ACTUAL DOWNLOAD	ACTUAL UPLOAD	MRC
AVERAGE	425.60	206.85	204.44	123.46	$87.28
MEDIAN	275	25	127.53	15.77	$73.00
MODE	1000	10	N/A	5.97	$100.00
MAX	1250	1899	920.29	1069.37	$400.00
MIN	1	1	0.84	0.51	$12.00

Based upon average speeds, Tekify residential users were paying the most per Mbps per month, although this is based on just one response. Residential AT&T users were paying the least at $0.21 per Mbps per month.

[7] Average cost per Mbps per month is calculated by dividing the average MRC by the total actual speed Mbps.

Table 4-4. Average Speeds and Cost per Mbps per Month for Residential Respondents

PROVIDER	AVERAGE DOWNLOAD	AVERAGE UPLOAD	AVERAGE MRC	AVERAGE COST/MBPS/MONTH	NUMBER OF RESPONSES
AT&T	186.10	172.86	$ 74.79	$0.21	66
SAIL	106.78	121.02	$ 52.87	$0.23	9
SONIC	176.22	42.62	$ 77.87	$0.35	6
TEKIFY	16.71	26	$ 49.00	$1.15	1
XFINITY/COMCAST	217.75	111.06	$ 94.25	$0.29	196
OTHER	64.85	34.63	$ 90.00	$0.90	2
ALL	**204.44**	**123.46**	**$ 87.28**	**$0.27**	**280**

Among organizational respondents, actual speeds were higher than contracted speeds. On average, organizational responses were paying $335.57 per month, or about $2.30 per Mbps per month.

Table 4-5. Contracted Speeds, Actual Speeds, and MRC for Organizational Respondents

	CONTRACTED UPLOAD	CONTRACTED DOWNLOAD	ACTUAL UPLOAD	ACTUAL DOWNLOAD	MRC
AVERAGE	30.5	75.5	22.71	93.27	$335.57
MEDIAN	35	50	21.65	52.27	$140.00
MODE	50	50	N/A	N/A	$99.00
MAX	50	200	47.29	245.38	$850.00
MIN	2	2	7.26	18.11	$34.00

Respondents were asked to rate their satisfaction with current services across a variety of factors, as shown in the figure below. Most respondents were at least somewhat satisfied with their current services across the board, although there was some dissatisfaction with Price.

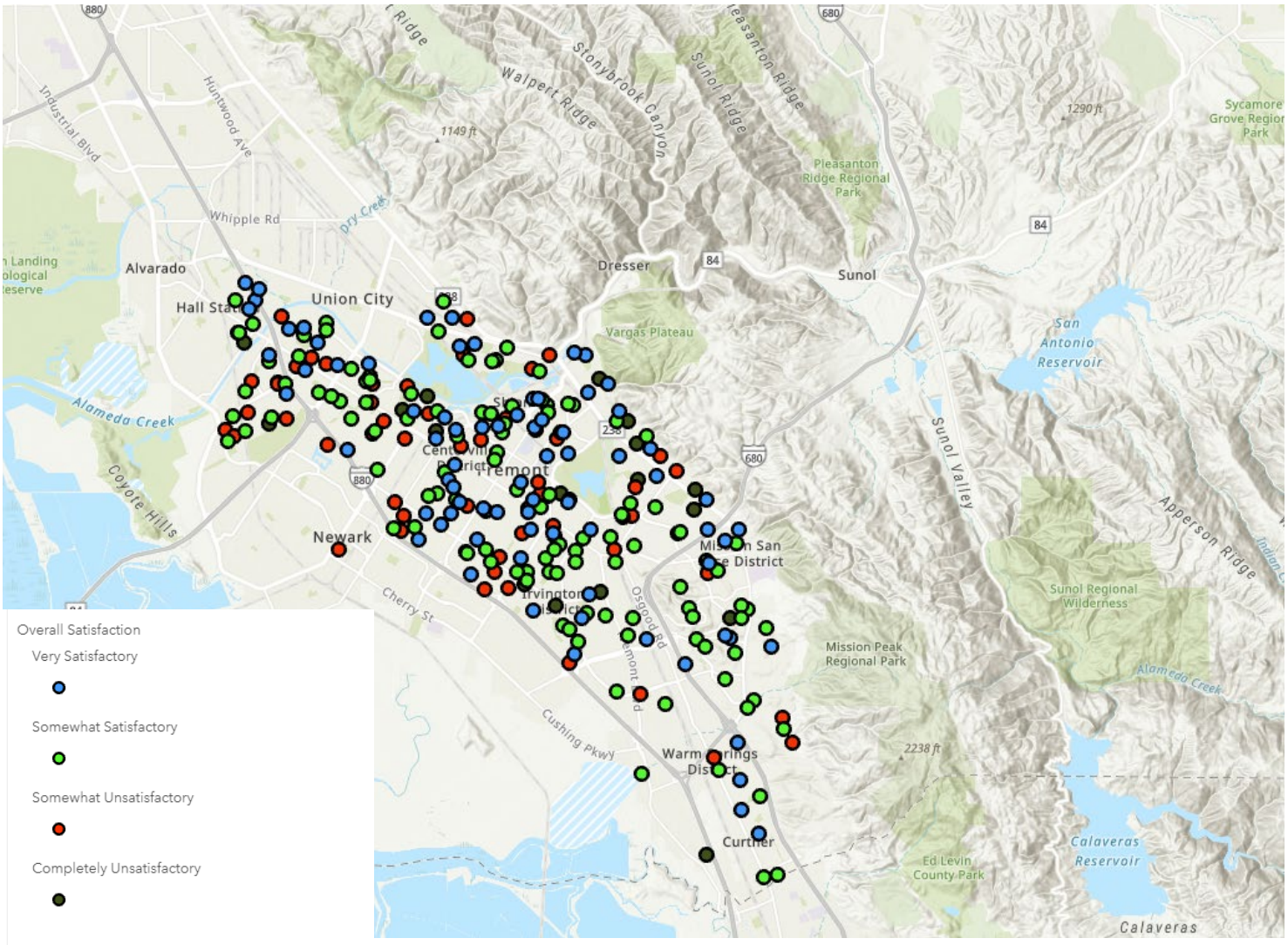
Table 4-6. Respondents Satisfaction with Current Broadband Services

All

	Overall	Speed	Price	Reliability	Support
Very Satisfactory	80	87	38	74	47
Somewhat Satisfactory	126	130	102	121	95
Neither/Not Sure	29	14	26	26	73
Somewhat Unsatisfactory	58	65	91	68	55
Completely Unsatisfactory	19	16	50	14	35
Households					
	Overall	Speed	Price	Reliability	Support
Very Satisfactory	80	87	38	74	47
Somewhat Satisfactory	123	127	99	117	94
Neither/Not Sure	27	14	25	25	70
Somewhat Unsatisfactory	57	62	89	67	53
Completely Unsatisfactory	18	15	49	13	34
Businesses					
	Overall	Speed	Price	Reliability	Support
Very Satisfactory	0	0	0	0	0
Somewhat Satisfactory	2	2	2	3	1
Neither/Not Sure	2	0	1	1	3
Somewhat Unsatisfactory	1	3	2	1	1
Completely Unsatisfactory	1	1	1	1	1

Satisfaction levels were not concentrated in one specific area, but varied across the City, as shown in the mapped survey results below.

Figure 4-4. Overall Satisfaction Levels by Location



Overall, respondents reported that they experienced slowdowns and brief outages every few months to once a year. The service rarely goes out for more than a day.

Table 4-7. Frequency of Outages and Slow Downs

	Never	Once a year or less	Every few months	Every few weeks	Every few days	Daily, everyday	Responses
The service slows down.	38 (10.7%)	62 (17.4%)	88 (24.7%)	66 (18.5%)	57 (16.0%)	45 (12.6%)	356
The service is out briefly	30 (8.4%)	97 (27.2%)	121 (34.0%)	63 (17.7%)	33 (9.3%)	12 (3.4%)	356
The service is out for less than an hour	41(11.5%)	127 (35.7%)	97 (27.2%)	48 (13.5%)	32 (9.0%)	11 (3.1%)	356
The service is out for an hour or two	79 (22.8%)	140 (40.5%)	79 (22.8%)	30 (8.7%)	15 (4.3%)	3 (0.9%)	346
The service is out for several hours	121 (36.0%)	129 (38.4%)	56 (16.7%)	16 (4.8%)	11 (3.3%)	3 (0.9%)	336
The service is out for a day or more	225 (67.2%)	72 (21.5%)	18 (5.4%)	8 (2.4%)	8 (2.4%)	4 (1.2%)	336
Totals							356

4.4 WILLINGNESS TO PAY

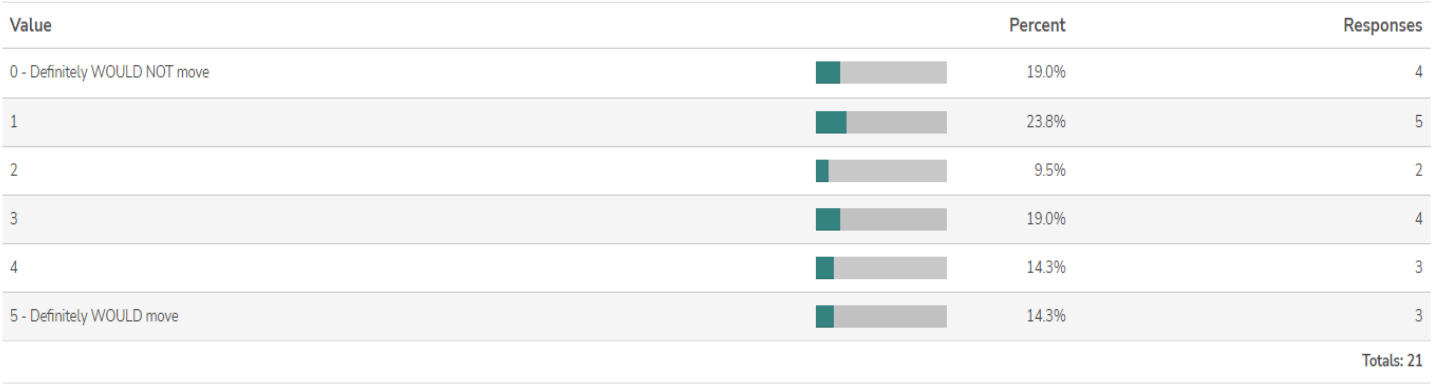
When asked how much they would be willing to pay for broadband services, most respondents would not pay anything for service of 25 Mbps or less. For super-fast 1GB connections, most residential respondents thought that between $50 and $100 per month was an acceptable price range, while business respondents were willing to pay between $100 and $150 for 1GB. Among five (5) enterprise respondents, the average willingness to pay for broadband services overall was $1400 per month.

Table 4-8. Respondents' Willingness to Pay

ALL	10 MBPS	25 MBPS	50 MBPS	300 MBPS	1GB
WOULD NOT PAY ANYTHING	220	156	78	26	17
NO MORE THAN $25	49	106	109	41	14
BETWEEN $25 AND $50	13	21	89	129	71
BETWEEN $50 AND $100	9	6	12	81	138
BETWEEN $100 AND $150	2	3	2	11	54
HOUSEHOLDS	**10 MBPS**	**25 MBPS**	**50 MBPS**	**300 MBPS**	**1GB**
WOULD NOT PAY ANYTHING	216	152	75	25	16
NO MORE THAN $25	48	105	109	41	13
BETWEEN $25 AND $50	13	21	88	129	71
BETWEEN $50 AND $100	9	6	12	79	138
BETWEEN $100 AND $150	1	2	1	9	51
BUSINESSES	**10 Mbps**	**25 Mbps**	**50 Mbps**	**300 Mbps**	**1GB**
WOULD NOT PAY ANYTHING	4	4	3	1	1
NO MORE THAN $25	1	1	0	0	1
BETWEEN $25 AND $50	0	0	1	0	0
BETWEEN $50 AND $100	0	0	0	2	0
BETWEEN $100 AND $150	1	1	1	2	3

Organizational respondents were asked if they would consider moving locations if their organization was able to get much faster and less expensive internet services elsewhere with comparable business characteristics. Respondents were somewhat evenly split, with about 52.3% stating that they definitely or probably WOULD NOT move and about 47.7% stating that the definitely or probably WOULD move.

Figure 4-5. Organizations' Probability of Moving for Better Broadband



Value	Percent	Responses
0 - Definitely WOULD NOT move	19.0%	4
1	23.8%	5
2	9.5%	2
3	19.0%	4
4	14.3%	3
5 - Definitely WOULD move	14.3%	3
		Totals: 21

4.5 RESPONDENT COMMENTS

Finally, respondents were asked to share what better broadband would mean to them, their family, their organization, and the area. Many responses included concerns about a lack of competition or affordability. While some respondents took the opportunity to confirm their satisfaction with current services, others expressed a desire for new options to drive down prices and increased reliability and speeds. A sample of these comments is shown below.

There is no real competition in the area, with only two companies setting prices. As part of Silicon Valley, this is unacceptable. – Respondent #189

Broadband is essential to us but is too expensive. Affordable broadband for all! – Respondent #265

We have only one viable provider where we live, and they know it and charge us more for our slow service than people a few blocks away pay for service that's 20x faster. We need more options and reliable service. – Respondent #355

I would like to have more choices for quality high-speed internet. – Respondent #416

4.6 CONCLUSIONS

Overall, respondents indicate that they are somewhat satisfied with broadband in Fremont. Average speeds far exceed the FCC's broadband definition of 25/3 Mbps, although, at 317/182 Mbps, they are not stellar in the context of Silicon Valley. Services are relatively affordable, and reliability does not seem to be an overwhelming issue.

The biggest concern about the market is a lack of competition, with the cable/telco incumbents (Xfinity/Comcast and AT&T) dominating the market share. Respondents expressed a need for more options for service, including potentially a municipal broadband offering.

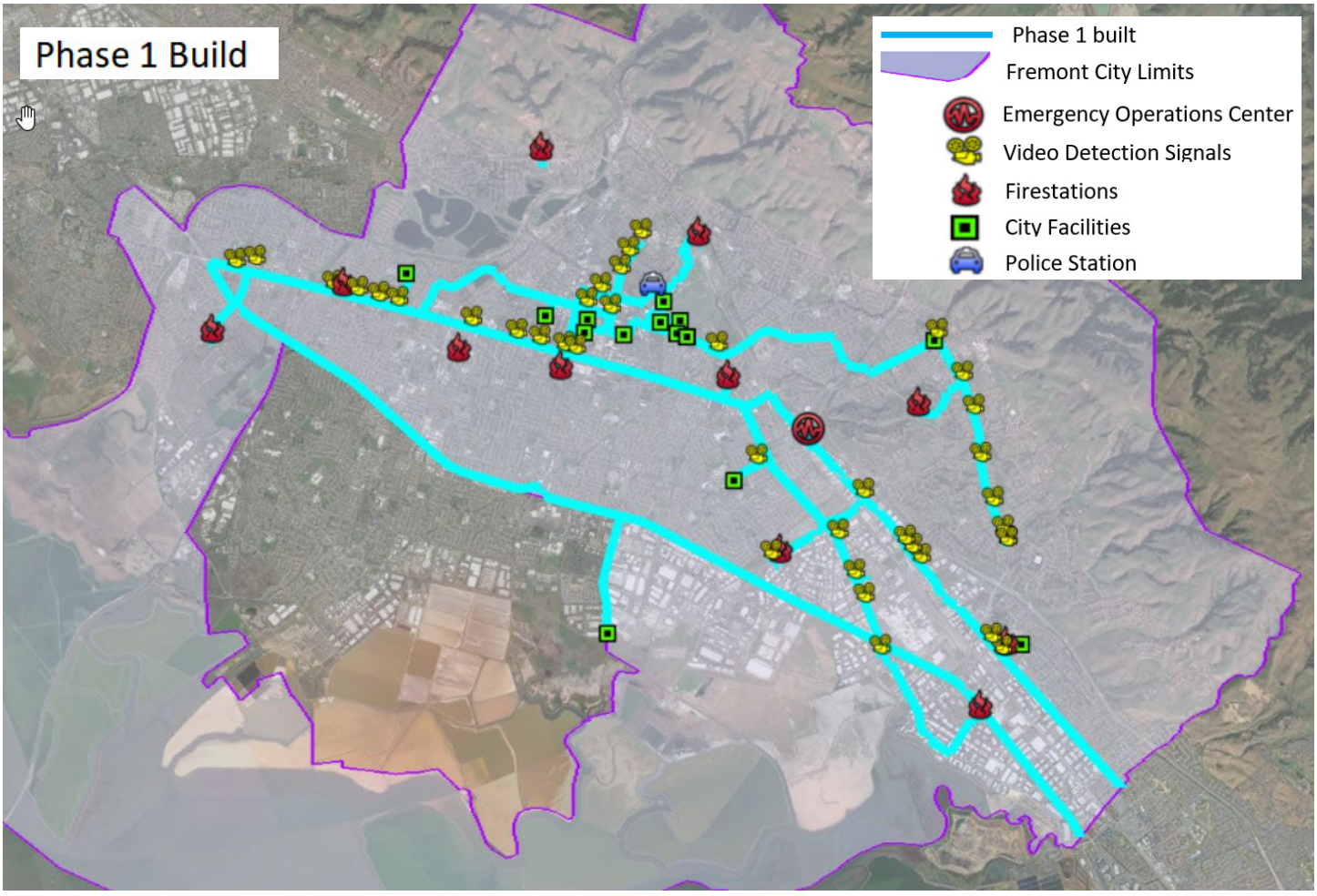
5. Conceptual Network Routes & Infrastructure Requirements

Magellan Advisors developed a conceptual design for a fiber optic network to connect municipal facilities, fire stations, and traffic cameras, as well as to support economic development in Fremont. The network is designed to leverage existing infrastructure, as well as planned projects, including traffic signal modernization plan. The design is broken into three phases to be implemented incrementally, as described below.

5.1 PHASE 1 – CORE RING

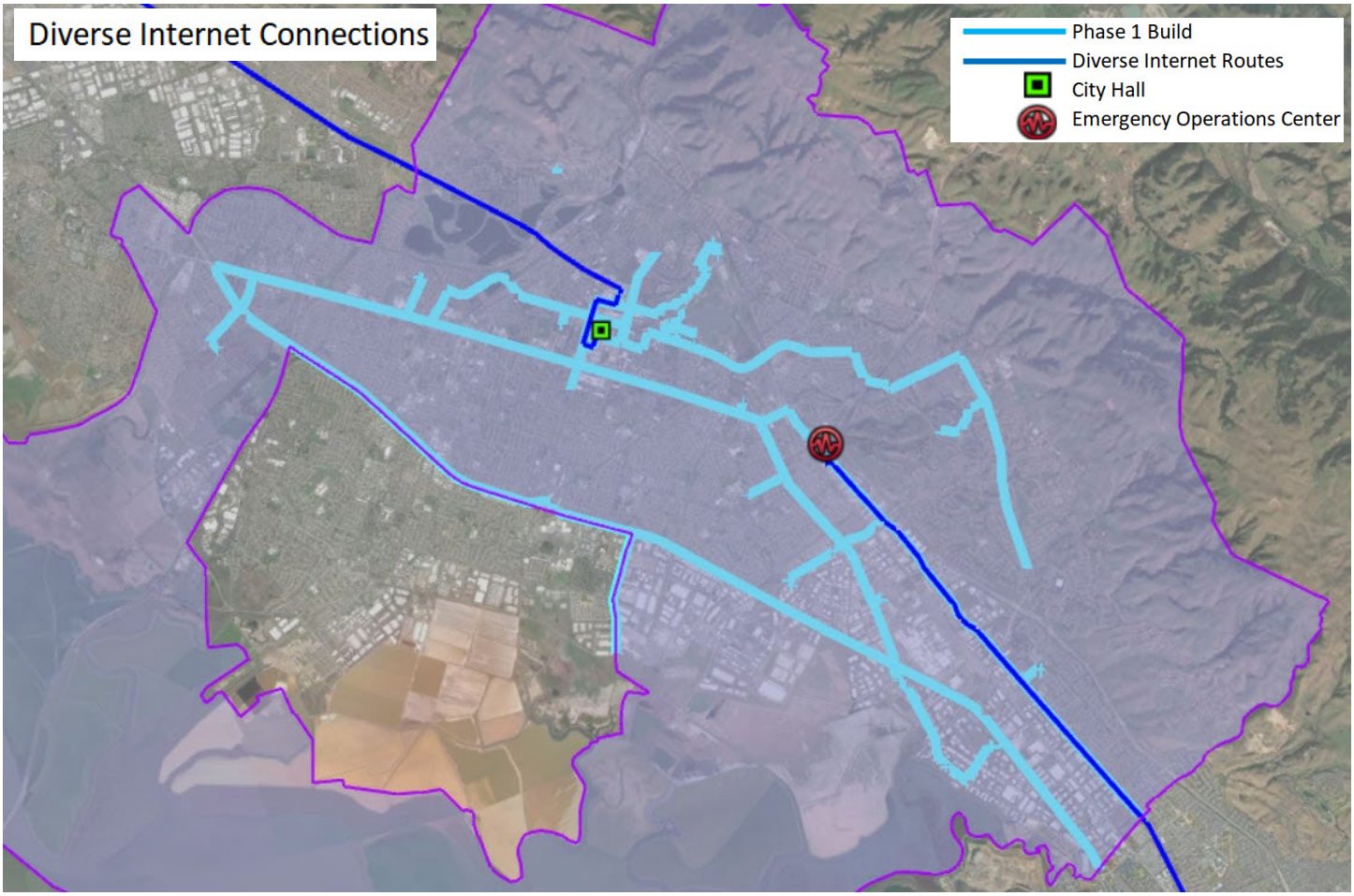
Phase 1 creates a redundant ring around the City using existing infrastructure (shown in yellow in the figure below), upgrading signal interconnect (shown in green) conduit, and filling in the gaps with new construction (shown in red) to connect all City facilities, fire stations, and most traffic cameras.

Figure 5-1. HLD Phase 1



In addition to this new ring, leveraging an existing agreement with Silicon Valley Intelligent Traffic System (SV-ITS), allows Fremont to create a designated internet access (DIA) connection to data centers in San Jose to the emergency operations center at the Public Works maintenance yard. Another DIA is recommended to connect to BART fiber at the Fremont BART station and lease fiber from BART to connect to DAC in Oakland. BART fiber is very cheap if used for City use only. This connection requires a short new underground build bridging the gap between existing City fiber and BART fiber, as shown in the figure below.

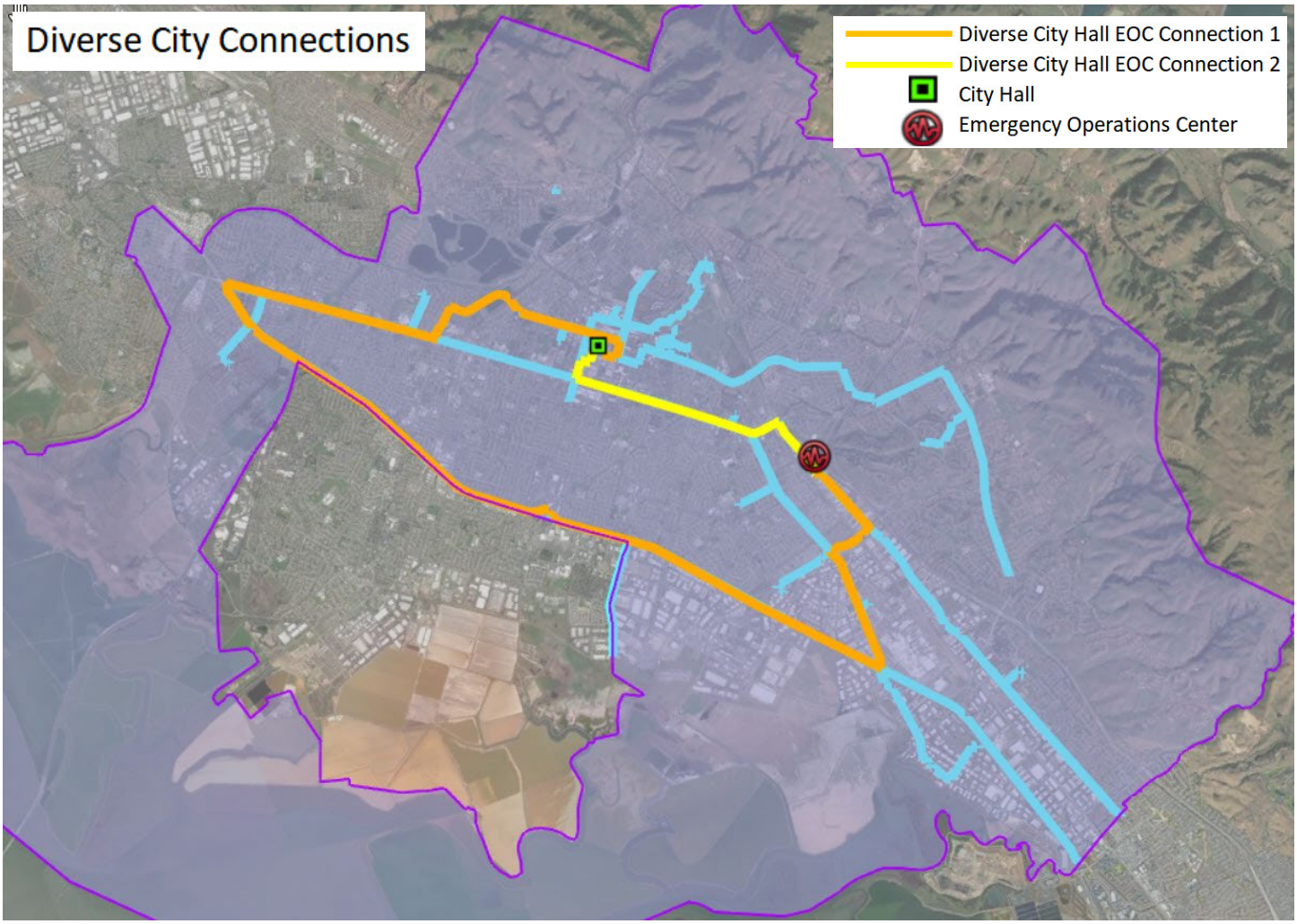
Figure 5-2. Designated Internet Access (DIA) Routing



The last goal of Phase 1 is to create diversity between City Hall and the EOC. During an emergency, it is critical that City Hall and the EOC can communicate; therefore, it is recommended that two diverse routes be created from City Hall and EOC. One DIA located at City Hall and another at the EOC creates an extremely diverse routing that is

nearly outage-proof. These routes require a diverse entry to be constructed into the EOC and splicing existing City fiber to create these paths, as shown in the figure below.

Figure 5-3. Diverse City Hall Emergency Operations Center Paths



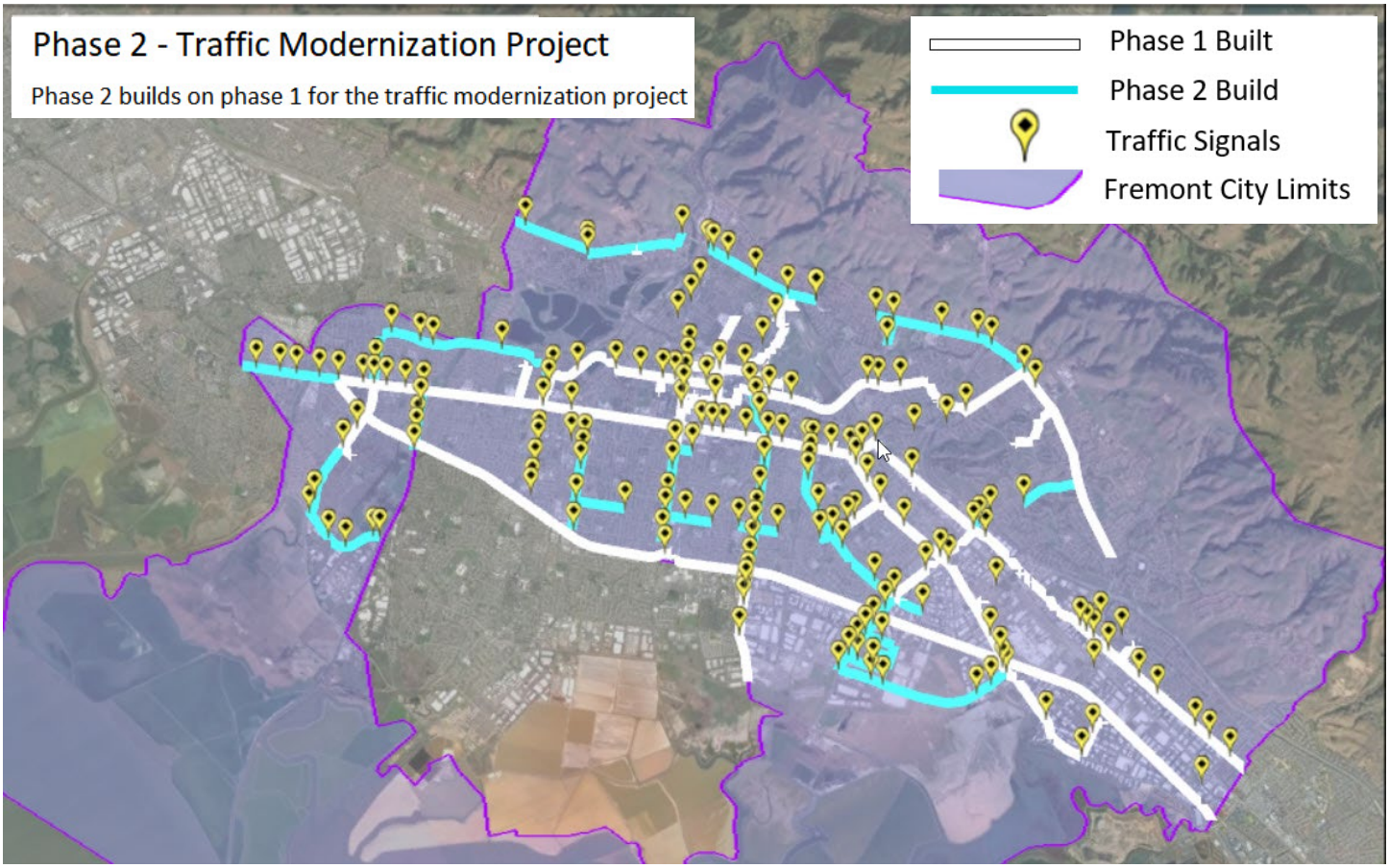
Laterals to all the City facilities will need to be constructed to connect them to the City network. It is Magellan's recommendation that the IT department handle and be responsible for all fiber connections and documentation.

5.2 PHASE 2 – TRAFFIC SIGNAL MODERNIZATION PROJECT

Phase 2 of the build is designed to interconnect traffic signals and support the City's Traffic Signal Modernization project. Fremont has heavily invested in connecting all traffic signals to the traffic control center, with the goal of preventing car accident

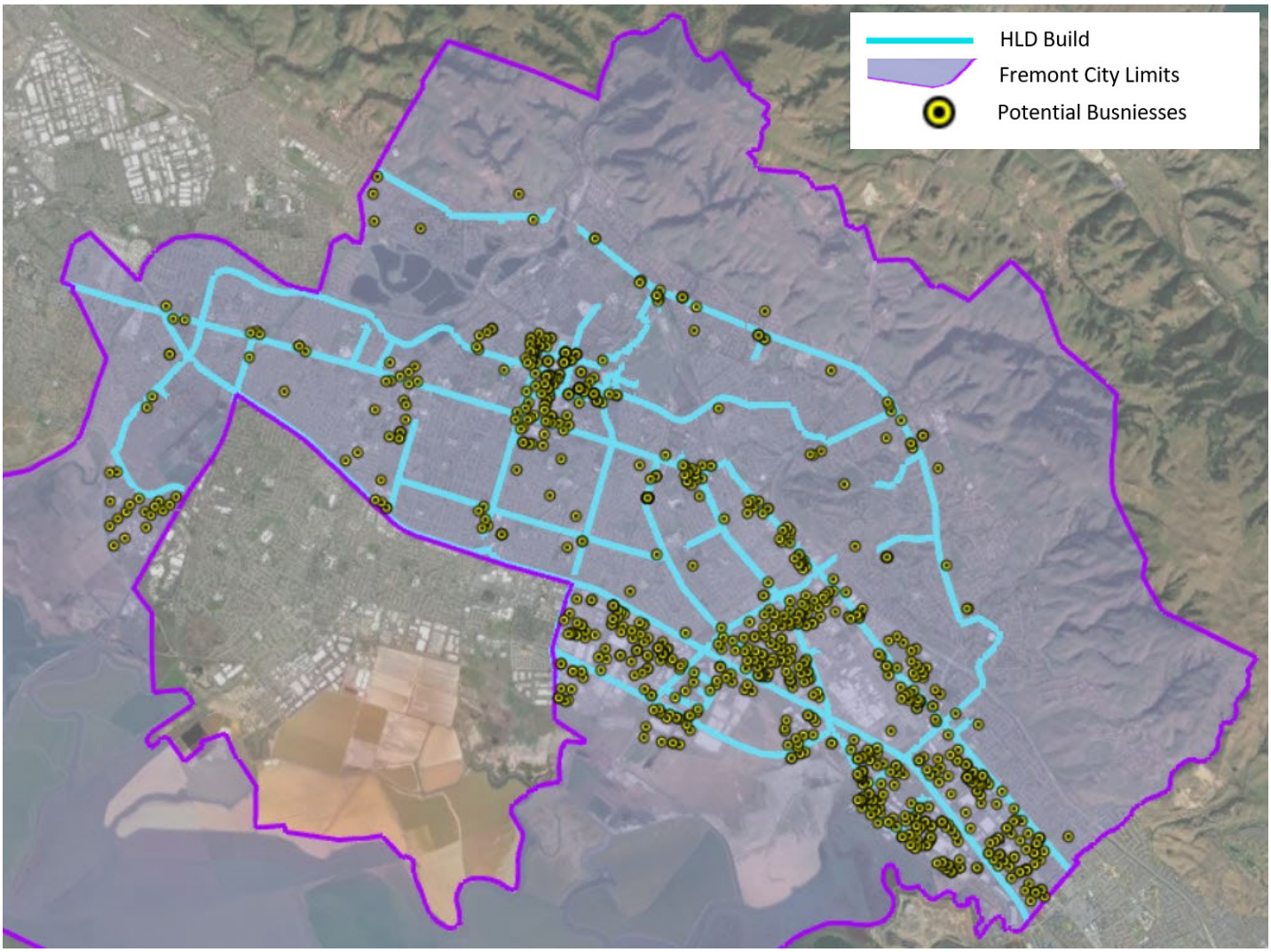
deaths at intersections[8]. The design incorporates the use of existing infrastructure, upgrading signal interconnect conduits, and new underground, as shown in the figure below. The signals on the map that do not show a construction method are on paths in Phase 1. The routes constructed with Phase 2 will also be used for the furthering of the economic development goals of the City by allowing for connections to businesses along these routes.

Figure 5-4. Phase 2: Traffic Signal Modernization and Economic Development



[8] Details about this project can be found at: www.fremont.gov - Fremont Vision Zero Details

Figure 5-5. Business Opportunities

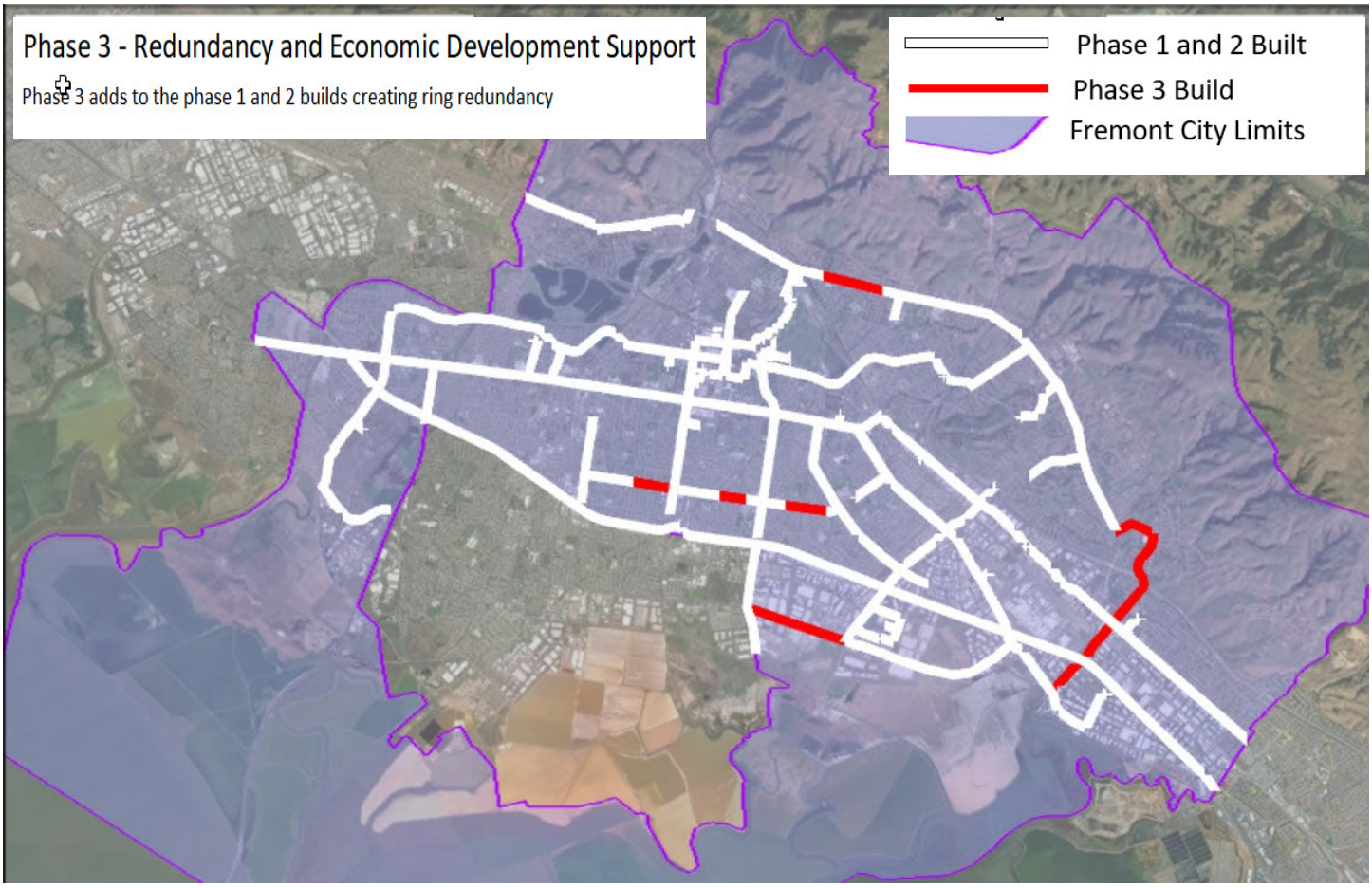


5.3 PHASE 3 – REDUNDANCY

Phase 3 uses new underground construction to place new fiber-optic cables to fill gaps in the network and create redundancy throughout. Networks that support business services need to have a redundant path to limit the amount and lengths of outages. Businesses rely on broadband and internet for many purposes, including data transfers, online accounting, business monitoring, among other processes. When the internet services are not working, it is detrimental to their operations; therefore, all business service agreements include compensation from the provider if that service is interrupted for an extended period of time. It is referred to as (4) 9's or 99.99%, in each month that is only 4-5 minutes of outage, outside of maintenance windows, before costs are incurred. For this reason, it is important for the network to have redundancy built it to it with automatic transfer equipment to re-route data traffic around the outages.

Phase 3 calls for approximately 30,400 feet of new underground construction that will connect Phase 1 and Phase 2 builds, creating redundancy for the network by filling in "gaps" along a few key routes, as shown in the map below.

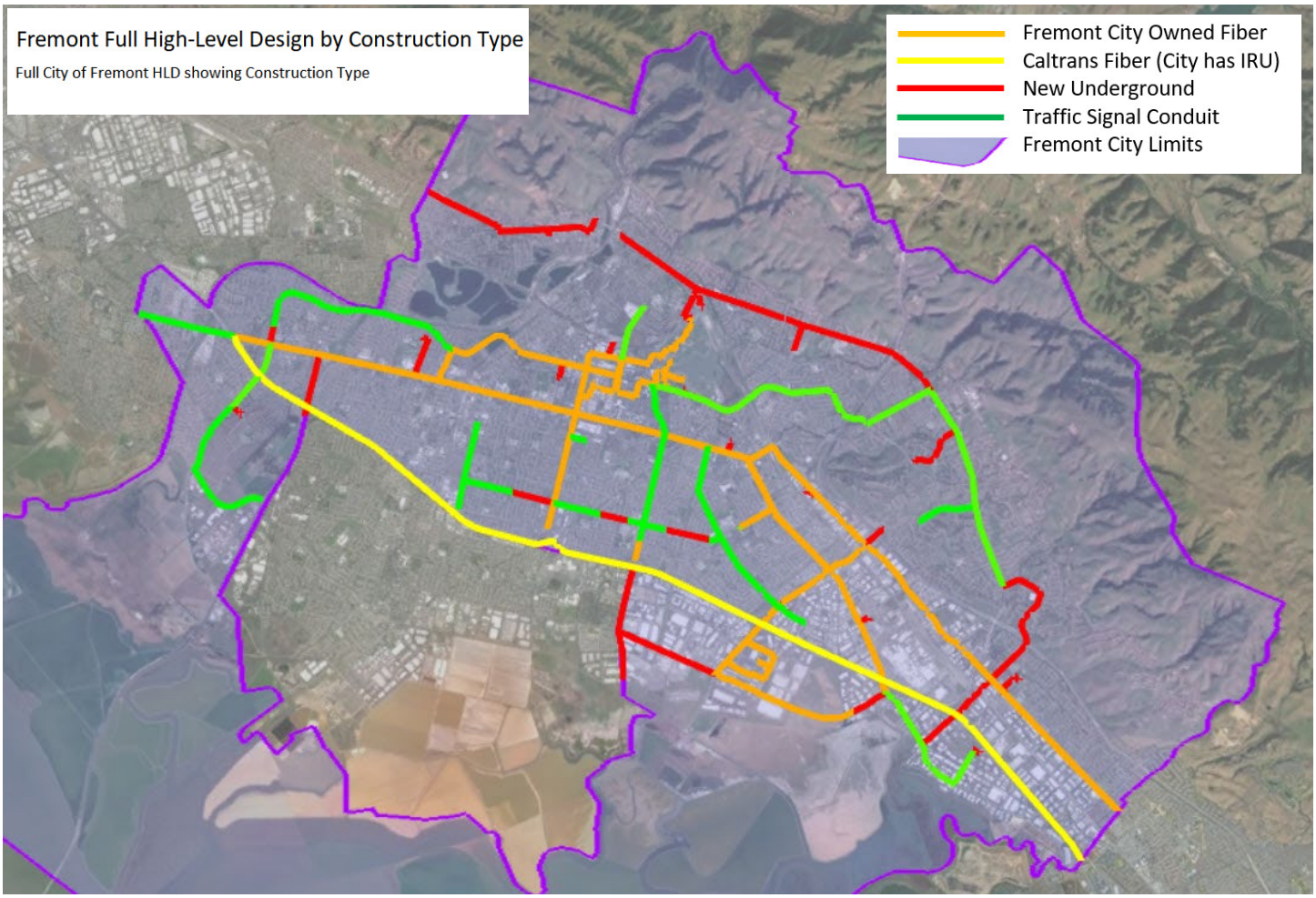
Figure 5-6. Redundancy, Economic Development, Wireless Support



5.4 HLD CONCLUSION

The network build utilizes existing strands of fiber, signal interconnect conduit, and new underground construction. The plan helps the city meet its needs, goals, and future growth for all the departments and community organizations. All three phases, along with Fremont's existing fiber and traffic signal interconnect conduit, are shown in the map below. Businesses are also displayed to indicate how the network affects economic development opportunities.

Figure 5-7. Complete Network Map by Construction Type



The table below shows the approximate footages for construction type in each phase of the build. The build is expected to take 3-5 years to complete. In addition to the construction, there are agreements that need to be put into place for the internet access routes. The first is an agreement with BART to use fiber from the Fremont BART station to downtown to Oakland. Additionally, Fremont will need to work with SV-ITS (San Jose IT Department) for fiber allocations to build a path from the EOC to 11 Great Oaks Data Center in San Jose. Both internet connections require agreements with the data centers for entry into and a separate agreement with a dedicated internet provider at the data center.

The table below shows the approximate footages for construction type in each phase of the build. Costs of the construction are detailed in the next section of this Plan.

Table 5.1 Footages by Phase

Phase	Footages
Phase 1	
New Underground	27,848
Signal Interconnect	54,287
Phase 2	
New Underground	49,684
Signal Interconnect	77,090
Phase 3	
New Underground	14,909
Grand Total	223,818

6. Technical Specifications & Cost Estimation

Fremont should adhere to specific construction methods and equipment to make the network functional for the City's current needs and future partnerships. Section 5 provides an overview of the construction techniques for the network with the associated footages. For the network to have the needed bandwidth with a realistic funded budget, it is necessary to incorporate technologies that allow the use of as much existing infrastructure as possible, upgrade existing conduit structure, and the use of dense wave division multiplexing (DWDM). It is also critical that the network is diverse, providing two separate internet connections between the same two points without sharing any common points. Additional details about technical specifications and costs are provided below.

6.1 TECHNICAL SPECIFICATIONS

DIA (Designated Internet Access)

Currently the city leases internet access from a third party, which comes with substantial costs. Tying into and using BART fiber at the Fremont BART station will allow Fremont to lease fiber from BART at a very low cost, if used for City purposes, enabling Fremont to reduce operational expenses and have a connection going north to Oakland DAC.

To achieve a completely redundant internet connection that would also be owned by the City, Fremont can leverage its use of the 6 SV-ITS fibers. The SV ITS fiber gains a connection to one of many data centers in San Jose, where Fremont can obtain a second DIA route. This fiber current runs on Osgood Road in front of the Emergency Operations Center, which allows Fremont to build a diverse path into the EOC. The diversity is important when dealing with outages, capacity, partnerships, and even emergency situations by allowing an alternate path if one or the other connections experiences an outage, or if more bandwidth is required.

The City will need to acquire a lease agreement from DIA provider at both datacenters. One of the connections should be a 10 Gb circuit; the other, depending on the demand, should be 1 Gb burstable to 10 Gb. Both circuits will require multi-protocol label switching (MPLS) gateways on both ends and routers/switches for distribution onto the network. Burstable speed circuits mean that the City will pay for the contracted speed and when the demand goes over that, the provider will allow for faster speeds for a short period of time. Ideally, a burstable circuit would only be used sparingly due to the high cost of the "burst."

City Hall to Emergency Operations Center

The high-level design incorporates diverse paths between City Hall and the EOC. The diversity is needed for back up of services, additional bandwidth, and communications during an emergency.

It is assumed that the needed power supply, back-up batteries, and generators are already in place at City Hall and the EOC, as well as floor space for racks to house the new equipment. New buss bars for grounding the equipment may be needed.

Core Ring

To connect all the City facilities with diversity that is budgetarily responsible, the core should be built in a ring fashion. Ring architecture means that the main fiber path is built in a circular fashion, with paths being able to be routed in either direction on the network. This ring will allow for shorter outages resulting in a more robust and stable network. When partnering with a third party and providing services to businesses, it is essential and expected that main cabinet and facilities have alternate paths.

As well as the existing fiber, there is new underground construction, and upgrading existing signal interconnect conduit. It is assumed that all facilities will require a new drop to provide the fiber inside the building to the access switch. Because all computers, cell phones, tablets, wi-fi routers, etc., can only communicate using digital signals that are electrical, not light, access switches are required to provide the conversion from light to digital signals for delivery through the facility. Ethernet cords, consisting of twisted pair cables that use 8 total wires, 2 twisted together for total of 4 pairs, will also be required. Twisted pair copper cable are capable of data transfer rates up to 10 Gbps for distances shorter than 1000 feet.

In addition to the construction efforts, the City should undertake documentation of existing fiber connections and available strands, followed by engineering to properly create circuits based on those findings. Future use may require higher bandwidths and depending on the inventory of available fiber strands, dense wave division multiplexing (DWMD) technology may be needed. DWDM saves networks short on fiber availability by using 1 fiber and splitting the light used on that fiber into different wavelengths, thus gaining exponentially more bandwidth with little fiber used. The DWDM can be placed in indoor environments as well as outdoor cabinets with power, battery backup, and if possible, backup generators. At this time, this technology is not needed and is not a part of the costing model but is a potential solution that could be used if existing fiber capacity is found to be insufficient during the detailed design process.

6.2 CONSTRUCTION STANDARDS AND ASSUMPTIONS

Magellan's costing estimations are based on many years of experience of telecom construction, over 15 years of construction in the San Francisco Bay area and many other locations around the US. The standards have been compiled based on this experience and meet the standards set out in California's General Order 128 (GO 128) and General Order 95 (GO 95).[9] All methods, standards, codes, and exceptions provided below should be adhered to for underground deployment.

Signal Interconnect

Fremont has approximately 131,377 feet of conduit that currently houses copper cables that connect many of the City's traffic signals. This conduit is a valuable asset that should be leveraged to lower the cost and effort of deploying the City's network.

The construction of signal interconnect conduits is different from the construction needs of fiber-optic cable. Fiber-optic cables have a static bend radius that has to be maintained; if fiber strands are bent too much, the light can escape the protective coating or the fibers can crack and break, thus making the fibers unable to carry light. To maintain the radius needs, any 90-degree elbows in the conduit must be changed to long sweeps and the handholes/vaults must be replaced with new ones that are at least 30" deep. Additionally, the copper cables must be pulled out and the fiber pulled in its place.

The design assumptions include placement of new pull boxes/handholes/vaults every 600 feet. It is also assumed that any signal interconnect conduit that has a cable in it is usable for fiber after the upgrades to the elbows and handholes are completed. It is assumed that all traffic control cabinets are connected to the signal interconnect conduit system and will not require more connection requirements.

New Underground Construction

Although fiber can be deployed either aerially or underground, the network design calls for only underground deployment. Aerial fiber in the Bay Area has a 25-40% failure rate, depending on the area, and many vertical assets will not accommodate more strand and cable. Additionally, aerial infrastructure is vulnerable to hazards such as squirrels, car accidents, and vandalism.

[9] GO128 is a standard based on the National Electrical Code (NEC), the nationally accepted power infrastructure placement standard, and modified to fit some of California's PUC orders pertaining to all power and communication underground construction and maintenance. GO 95 is the standard for aerial construction and maintenance.

The recommendation for new underground construction is to use directional drilling (boring) in the public right-of-way (ROW), using two 2" high-density polyethylene (HDPE), with a minimum of 36" cover, placing handholes every major intersection. Microtrenching is an optional underground construction method and may be suitable in a few situations; however, the affordable depth is only 12" in the street where the gutter meets the asphalt. Commonly when there is an emergency, first responding dig crews equipped with backhoes, jackhammers, and concrete saws are unable to properly locate the shallow cables and end up cutting through the fiber cables.

Number 6 tracer wire should be installed on all conduits, including those that are empty. In cases where there is more than one conduit placed in an open trench or bore line (a conduit "bank"), only one conduit in a "bank" needs to be located.

Detailed low-level engineering will need to be done to determine correct side of street, cable sizing, running lines, and as-built documentation to accurately record plant for future use. The current design shows side of street of existing structures when known; however, for the new construction the most convenient side of the street is used and may need to be changed during the engineering and construction process. The location of water, gas, sewer, and storm drains are difficult to navigate and make the low-level engineering process critical for proper network buildout.

Existing Fiber Assets

There are four different existing fiber assets referred to in this study including fiber owned by the City's IT Department, fiber owned by Public Works/Transportation, funded CIP projects placing new fiber including the Fremont Blvd traffic signal modernization project, and existing fiber owned by other government agencies where Fremont has rights of use though existing agreements.

The ring will bring all these different fiber cables together to create a unified network. The cables are assumed to be in different conduit structures and handholes and some new construction will be needed to tie these cables together. Engineering will have to be done to determine locations for new construction, pulling cable through existing conduits, combining separate cables into one splice case, or putting cable stubs in between.

Documentation of City-owned existing assets is critical for the success of using existing fiber as a part of the core ring. As of the writing of this Plan, it is unclear what the strand availability is, therefore, we assume that there is 50% strand availability. No documentation of the existing circuits or fiber strand used exists and this must be explored and documented before any engineering can take place. Once the fiber is documented the entire ring can be engineered, constructed, and put into use.

Fremont's use of fiber owned by other government agencies requires agreements to be exercised and coordinated with those agencies. This includes:

- Caltrans has an agreement for the City of Fremont to use 4 Strands of fiber along the 880 Hwy with access points at all the offramps in Fremont.
- SV ITS fiber, coordinated by the city of San Jose's IT Department. Magellan Advisors engaged with them during this project, and they are aware of and looking forward to working with Fremont to use the fibers to obtain access into a datacenter in San Jose for internet access.
- BART fiber that the City of Fremont can gain access for use to get to Digital Reality data center in Oakland. The agreement with BART would need to be put in to place with a minimal cost to Fremont for City use.

6.3 COSTING ESTIMATION

Magellan's costing estimations are based on the same experience and knowledge of local construction companies, standard pricing, and including prevailing wage on all labor as is required by California State Law.

Figure 6-1. Cost Summary by Phase

	Construction Cost	Equipment Cost	Buildings	Totals
Phase 1	$ 7,388,362.42	$ 2,549,047.58	$900,000.00	$10,837,410.00
Phase 2	$ 11,928,386.95	$ 849,682.53	$ -	$12,778,069.48
Phase 3	$ 2,480,150.03	$ -	$ -	$ 2,480,150.03
Totals	$ 21,796,899.40	$ 3,398,730.10	$900,000.00	$26,095,629.50

GRAND TOTAL	$ 26,095,629.50

7. Governance, Ownership, and Management Strategy & Policy

The City of Fremont is evaluating expansion of its fiber optic network to form broadband infrastructure which will connect municipal buildings and facilities, enhance quality of place in Fremont, and support economic development. This expansion would create a more ubiquitous and contiguous fiber network by using City-owned fiber and conduit and adding new infrastructure throughout the City through infrastructure build out or leasing fiber from other parties. The expanded fiber optic network would provide additional lateral connections ("last mile") to fire stations, libraries, and other City facilities which is the crucial connection between "last mile" facilities that connect a residential or business premise to a switch – and the internet backbone (long haul facilities). The City's fiber-optic network including middle-mile facilities would be used for multiple purposes including:

- Provision of services to City departments including fire stations
- Provide connections for schools
- Support middle mile connectivity for lease by third parties and provide a resource for economic development in support of future business needs.

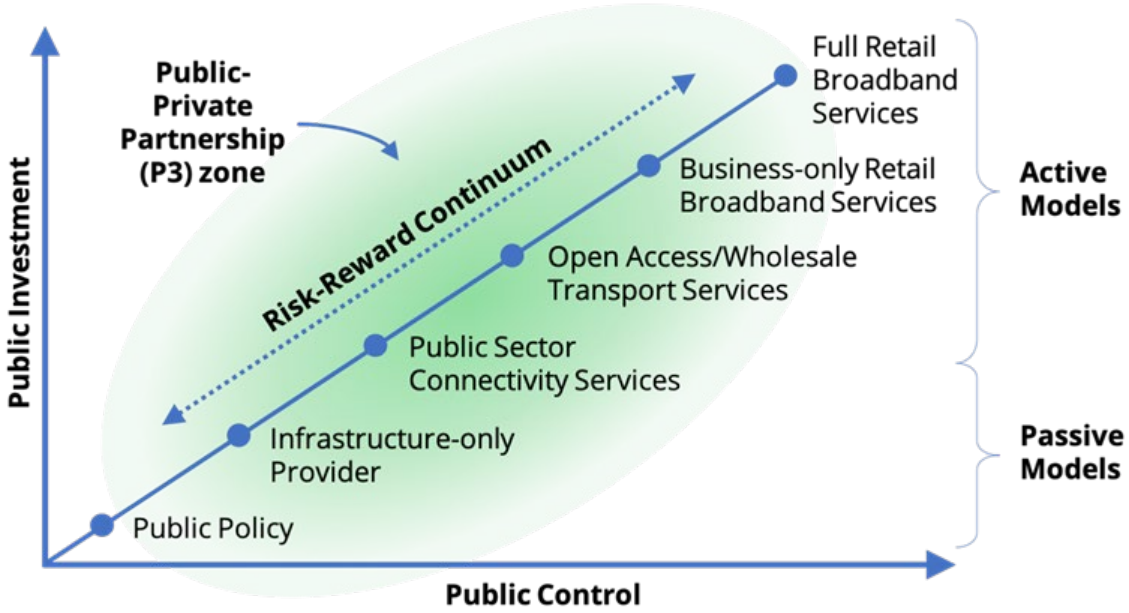
7.1 BUSINESS MODEL AND GOVERNANCE

Selecting the right broadband business model for the City of Fremont is highly dependent on several factors that will suggest the most appropriate option for the City. The work undertaken to develop this Fiber Master Plan provides an understanding of community needs, knowledge of the competitive market factors that suggest what infrastructure options would fit well within the community, and assessment of organizational and operational capabilities of the City's government. Equally important is an understanding of the financial commitments and risk and reward that the City's participating agencies and institutions would be willing to support to fund and sustain a successful broadband initiative.

The commonly implemented business models fall on a continuum that ranges from low risk, low investment options to higher risk, high investment options. The figure below

illustrates this continuum. Moving along the continuum of business model options involves increasing degrees of risk and reward: risks in terms of financial, operational, and regulatory risk; rewards in terms of community benefits, revenue generation, and over potential for profit. Moving "up" the continuum generally requires increasing levels of investment and implies greater local government participation in the delivery of broadband services. Public policy and infrastructure-only options are considered "passive" business models, where the government does not operate a broadband network as compared to "active" models such as Government Services Providers, Open Access Providers, and Retail Provider Options, where the government operates a broadband network. Public-private partnerships are not classified as a specific business model but instead fall along the continuum because these partnerships take many forms. Local governments must determine which business models meet their organization's risk/reward tolerance to achieve the community's broadband goals.[10]

Figure 7-1. Continuum of Municipal Broadband Business Models



Discussions with stakeholders including the City's various agencies suggest that a mid-point public-private partnership business model would fit best for the City of Fremont – providing needed broadband connectivity for City agencies as well as making available fiber optic transport capacity even at peak levels to support economic development opportunities. The City will benefit from rationalizing its various fiber optic and conduit assets, which are currently separate and non-contiguous facilities, into a fiber optic network planned to support connectivity across the City.

[10] See Appendix B for further discussion of the continuum of Municipal Broadband Business Models.

A P3 agreement in which City assets are leveraged to encourage investment in additional infrastructure by the public sector is recommended. Private internet service providers should be encouraged to use City-owned fiber and conduit assets, as well as to make investments in planned assets in order to extend broadband services throughout the City. Such an arrangement allows Fremont to use its fiber and conduit to meet the needs of the community but minimizes the City's capital and operational expenses.

Public sector connectivity needs met under this business model include fiber optic connections for City facilities including fire stations, libraries and other City buildings, support for the City's sophisticated approach to traffic management, camera systems and license plate readers, Smart City and Internet of Things applications, as well as building diversity and redundancy into the City's network in the event of fiber cuts or natural disasters.

Broadband capacity on the City's fiber optic network can also be provided to partners and other users under this business model. Fremont has a substantial base of advanced manufacturing and smaller high-tech companies as well as innovation districts and tech parks. The City is well positioned to provide fiber optic capacity on a non-discriminatory basis to support economic development initiatives and activity for interested telecommunications partners.

Criteria for partnership evaluation

There are several guidelines that the City should consider when evaluating opportunities for partnerships with telecommunications providers. Generally, as discussed above, Fremont should seek provider partners who will actively participate in community and economic development as well as work with the City to achieve its network vision.

Non-Exclusivity: The City should not enter into any exclusive agreements. Non-exclusivity allows for a more competitive environment in which the City can partner with multiple entities to get the most benefit from use of assets.

Cost Savings for City Operations: Proposals that include connecting City facilities to reduce telecommunications expenditures could be highly advantageous. Many partners in similar agreements have been willing to connect City facilities at no cost, sometimes even handing over ownership of assets such as fiber strands. Such arrangements should be strongly considered.

Benefit to the Community: Ultimately, partnerships with the private sector are strongest when they provide as many benefits as possible to the community. Providers may be willing to provide no- or low-cost services to areas in need, small businesses, or public spaces such as libraries that benefit students with no broadband at home. Support for

Smart City applications may also be offered. Community benefits such as these should be weighed heavily during the evaluation process.

New investment and infrastructure: Where possible, the City should give preference to providers who are deploying new infrastructure that follows newly adopted guidelines and follows the City's new standards for wired and wireless infrastructure. The two simple reasons are that (a) this represents new investment rather than milking legacy infrastructure to avoid additional costs and (b) new infrastructure will be better aligned with public interests, higher-capacity, and more reliable.

Construction Methods and Timelines: Some partners may propose quick, minimally invasive construction methods to speed deployment and lower costs. Magellan strongly recommends that Public Works take part in discussions about the specifics of these construction methods and that timeframes for deployment are specifically stipulated in contracts to ensure that City streets are properly restored, and that the community is not inconvenienced by drawn out construction.

Revenue Sharing: As stated earlier in this report, partners may offer revenue sharing for the use of City assets. The percentage will vary depending on the terms of the agreement; Magellan has seen anywhere from 5% to 60% in favor of the City. In any case, as with all proposals, revenue sharing estimates should be heavily vetted including assumptions for take rates and ramp periods and should be evaluated against fair market rates for the use of City assets.

7.2 CALIFORNIA BROADBAND POLICY

Magellan Advisors has analyzed state and federal broadband policies to identify potential policy barriers to the City's expansion of its broadband infrastructure facilities.[11]

State of California broadband policy is very supportive of the City's potential extension of its broadband infrastructure. There are no significant policy barriers to municipal provision of broadband services – wired or wireless. Governor Newsom's Executive Order on broadband policy explicitly directs state agencies to seek to bridge the "Digital Divide", which includes direction to support local government broadband deployments[12].

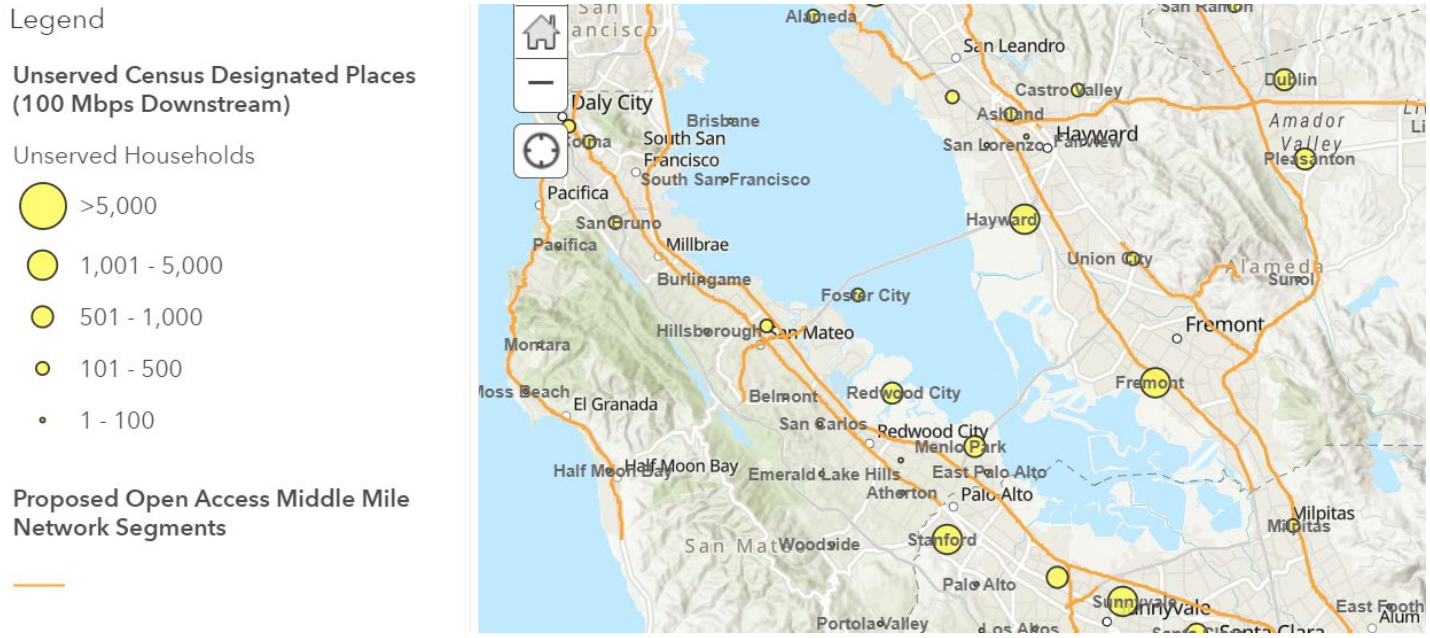
[11] The following discussion does not constitute a legal opinion and should not be construed as such. Questions about interpretation or applicability of these or other provisions of federal or California law should be referred to legal counsel.

[12] The Executive Order directed the California Broadband Council to create a new State Broadband Action Plan, which contains numerous provisions supporting local governments in their efforts to bring faster,

California broadband policy *removes* barriers to provision of middle-mile facilities by Fremont. Just recently signed into law, Senate Bill 156 contains provisions which fund and allow middle-mile facilities to be provided by municipal authorities. California broadband policy is actively engaged in seeking to eliminate the digital divide, in part by promoting the construction of middle-mile networking. National policy is in harmony with this direction as evidenced by provision of funding through the American Recovery Plan Act for California's middle-mile networking.

As directed by SB 156, state agencies including the California Public Utility Commission and California Department of Technology are taking necessary steps to construct the statewide middle-mile network including routes through and adjacent to Fremont. The City should engage in this middle-mile network planning to seek cost efficiencies and opportunities. The CPUC Staff-proposed middle-mile network map is available online.[13] The proposed network segments running through Fremont and in the adjacent area are shown here:

Figure 7-2. California Middle Mile Network



Furthermore, the Broadband Loan Loss Reserve Fund authorized by SB 156 will support necessary borrowing by the City to construct middle-mile facilities although the fund is

cheaper, better broadband service to their residents. See, Broadband Action Plan 2020: California Broadband for All, at https://www.gov.ca.gov/2020/08/14/38666/

13 https://www.arcgis.com/home/webmap/viewer.html?webmap=e17e4e1c88b04792ab0a2c50aa1a19a3&extent=-126.1445,34.5234,-113.5981,41.1113

not yet operational (SB 156 was just recently signed into law) and the CPUC has not yet developed the required rules and regulations.

Additional legislation relevant to broadband was enacted into law in October 2021:

- Senate Bill 378 (the "Broadband Deployment Acceleration Best Practices Act") requires local agencies to allow, except as provided, micro-trenching for the installation of underground fiber if the installation in the micro-trench is limited to fiber. It also requires, to the extent necessary, a local agency with jurisdiction to approve excavations to adopt or amend existing policies, ordinances, codes, or construction rules to allow for micro-trenching. SB 378 defines "Micro-trench" as a narrow open excavation trench that is less than or equal to 4 inches in width and not less than 12 inches in depth and not more than 26 inches in depth and that is created for the purpose of installing a subsurface pipe or conduit.
- Assembly Bill 41 requires the Department of Transportation, as part of those projects that are funded by a specified item of the Budget Act of 2021 and that are located in priority areas, to use the project planning phase to ensure that construction projects include the installation of conduits capable of supporting fiber optic communication cables. It also requires the CPUC, in collaboration with other relevant state agencies and stakeholders, to maintain and update a statewide, publicly accessible, and interactive map showing the accessibility of broadband service in the state.
- Senate Bill 28 repeals certain annual reporting requirements pertaining to broadband and video franchise holders and instead requires the CPUC to collect granular data on the actual locations served by franchise holders (but without disclosure of personally identifying information), adopt customer service requirements for franchise holders, and adjudicate any customer complaints.
- Senate Bill 4 and Assembly Bill 14 pertain to the CASF authorizing an increased surcharge and requiring reporting on remaining unserved areas in the state among several items.

7.3 STATE AND FEDERAL REGULATORY POLICY

Regulatory jurisdiction over telecommunications services traditionally has been divided between the federal and state authorities – primarily the Federal Communications Commission and (in this case) the California Public Utilities Commission (CPUC).[14] The

[14] In one specific area – radio frequency (RF) emissions – the Federal Communications Commission (FCC) has been assigned complete regulatory jurisdiction, under the 1996 Telecommunications Act which preempted local regulation of RF safety standards in favor of a uniform national RF safety standard under FCC jurisdiction. *See*, 47 U.S.C. § 332(c)(7).

FCC has from time to time preempted or attempted to preempt state and local regulatory jurisdiction over wireline and wireless telecommunications. At present there is some agreement on regulation of broadband services – wireless or wireline services are not price or entry-regulated by the CPUC or the Federal Communications Commission. The FCC's brief period of classifying broadband internet services as a telecommunications service regulated under Title II of the Communications Act – "Net Neutrality" regulations – was reversed by the FCC in early 2018.[15]

FCC preemption of state and local regulation has been more prevalent in the wireless sector (especially in recent years). Under federal law, local authorities are allowed to regulate the "placement, construction, and modification" of wireless communications facilities but subject to certain limitations.[16] These limitations and requirements on local regulatory authority include:

- Local regulations may not "prohibit or have the effect of prohibiting the provision of personal wireless services"[17];
- Local regulations may not "unreasonably discriminate among providers of functionally equivalent services"[18];
- A local authority's denial of an application to place, construct, or modify a personal wireless facility must be based on "substantial evidence contained in a written record"[19]; and,
- Local 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 facilities comply with the Commission's regulations concerning such emissions."[20]

In 2014 the FCC adopted rules to implement the "Spectrum Act"[21] which preempted state and local authority over certain aspects of processing and approving modifications to existing towers and base stations used for 3G and 4G wireless service, including application of 60-day "shot clocks" for review and approval of modification applications.

[15] In the Matter of Restoring Internet Freedom, WC Docket No. 17-108, FCC 17-166, Declaratory Ruling, Report and Order, and Order; Released January 4, 2018.
[16] 47 U.S.C. § 332(c)(7)(A).
[17] 47 U.S.C. § 332(c)(7)(B)(i)(I).
[18] 47 U.S.C. § 332(c)(7)(B)(i)(II).
[19] 47 U.S.C. § 332(c)(7)(B)(iii).
[20] 47 U.S.C. § 332(c)(7)(B)(iv).
[21] *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).

More recently, the FCC adopted its "Small Cell Order" in September 2018[22] which sought to limit and preempt local authority over placement of 5G "small cell" facilities. The Small Cell Order 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 has many provisions – the most discussed of which are limitations on fees and rates a local jurisdiction may charge for small cell placements (e.g., $270 per year cap on attachment fees) and preemption of local authority over aesthetic requirements for small cell installations. Numerous parties appealed the Small Cell Order and the Ninth Circuit Court of Appeals opinion[23] largely upheld the FCC's decision on issues including limitations on fees and rates but reversed the FCC's attempted preemption of local authority over aesthetics.

7.4 REVIEW OF CITY WIRELESS POLICIES

Magellan Advisors reviewed the City's policies and practices on "small cell" wireless facilities placement and found them to be aligned with good practices. The City's policies and practices are supported by the Ninth Circuit Court of Appeals decision which allows local authorities to maintain local control over aesthetic requirements for small cell antenna siting and placement. The City has adjusted its regulations and practices to account for 5G deployments by adopting City Design Guidelines for wireless facilities in the public right-of-way and adopting a form of Master License Agreement (MLA) for the non-exclusive installation of small cell facilities on City streetlight poles in the public right of way. Use of MLAs for small cell attachments to City-owned infrastructure is now a common approach for cities to manage small cell attachments. Use of City Design Guidelines for 5G Small Cell facilities is also good practice which avoids embedding specific technology terms, guidelines, and procedures in the City code where it would be burdensome to amend to keep up with changing technology. Instead, the wireless facility design standards and guidelines are contained in the Citywide Design Guidelines document which provides more flexibility over time in how the City administers aesthetic

[22] 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".) See Appendix E, State and Federal Regulatory Jurisdictions, for further discussion.

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

considerations in wireless facilities placement while adapting to rapid change in technology.

The City does not however have a “dig once” policy. The “Dig Once” policy is good practice and serves to achieve many goals including cost effective expansion of broadband services in the City, preservation of the public investment in streets, sidewalks and other infrastructure in the public right-of-way, minimizing traffic congestion and safety issues from repeated excavations, providing infrastructure for City operations, and other goals.

South San Francisco is an example of a nearby city which has implemented a “Dig Once” policy designed to coordinate the installation of telecommunications facilities for certain projects meeting specified conditions in the “Open Trench Notification and Telecommunications Infrastructure Improvements” ordinance. The open trench notification process is triggered by:

- either an encroachment permit application for work in the public right-of-way or approval of specifications for a Public Works project which will result in an excavation that could reasonably include installation of broadband conduit, and,
- spans 900 feet/three city blocks or more or involves terrain that is difficult/expensive to traverse or is an element of a larger project for utility infrastructure.

Notifications are sent to telecommunications service providers and the City’s IT Department each of whom has the opportunity to indicate interest in collocating facilities.

The City could consider implementing a “Dig Once” policy similar to South San Francisco for the public benefits including encouragement of efficient, cost-effective broadband deployment, minimization of traffic and other disruption and public inconvenience from excavations and disturbances of the public right-of-way, and preservation and protection of public investments in streets and sidewalks.

8. Business Model & Financial Analysis

8.1 BUSINESS MODEL

As previously discussed, based on the input of City staff, Fremont's current operational capacity, and the cost to build and operate the network, Magellan Advisors recommends that the City pursue a public-private partnership business model in which a qualified partner uses City-owned assets to serve customers. This flexible model allows for the City to make investments to improve broadband in Fremont without the need to become a full retail internet service provider. A public-private partnership should be established in which an experienced internet service provider uses publicly-owned infrastructure to expand service to Fremont's business community in exchange for a share of the revenue generated, which should be sufficient to cover the City's capital investment in the infrastructure.

The previous section provides some overarching guidance for selecting a partner and the City has already released a request for proposals (RFP) to assess partnership opportunities for the network. Public-private partnership arrangements are quite flexible and can take a variety of shapes; generally, some inputs to the business terms of agreements include:

- Capital contribution: The amount of capital to be provided by the City and how much will be provided by the partner will play a large role in the ownership of the assets as well as any revenue sharing agreements.
- Ownership of assets: This should be directly correlated to the amount of capital that each party contributes to the assets.
- Maintenance and operational roles: Maintenance costs and ongoing operational expenses including marketing, repairs, and other critical tasks will likely be handled by an experienced partner in return for a share of the revenue.
- Revenue share: Magellan has seen wide-ranging variation in revenue sharing agreements, anywhere from five to sixty percent of revenues in favor of the public agency. This is a key piece of contract negotiations with a partner and should ensure that the City can recuperate capital expenditures and that the partner's operational costs are considered. In Fremont's case, we estimate that a reasonable revenue share will be around 30%/70% in favor of the partner.

8.2 FINANCIAL ANALYSIS

Magellan Advisors used our Broadband Financial Sustainability Model to analyze the business and financial sustainability of the proposed broadband program. Cost and

coverage estimates for the financial analysis come from the network design. The purpose of this analysis is to lay out the cost components and potential revenue streams and show how they interrelate. Many key factors including rates for tiered services, revenue sharing details, as well as equipment, labor, and materials are variable. It is necessary, therefore, to make assumptions to cover general factors. Estimates should be updated as new information becomes available regarding the assumptions.

Assumptions:

The basic assumptions are that the network would be deployed per the high-level design, in a phased approach. We assume that the design engineering and permitting will be completed in 2022-2023, following by buildout for Phase 1 in 2023-2024. Phases 2 and 3 are assumed to occur in 2024-2025. Because the Traffic Signal Modernization project in Phase 2 will be funded separately through the City's Traffic Engineering group, we do not include the capital costs for that phase in the overall costs to be bonded.

The borrowing scenario includes an interest rate of 1%, which assumes that the City would make use of the Broadband Loan Loss Reserve Fund recently established by the State of California's Treasury to fund costs of financing the deployment of the first phase of the network deployment. It is early in the process and the California Public Utilities Commission (CPUC) has not yet developed the regulations that will be associated with the Loan Loss Reserve Fund, so we recommend that Fremont track the development of program rules.[24]

8.3 CAPITAL COSTS

The capital costs for the network backbone is broken out by phase, below. We also include estimates for network equipment, as well as building improvements to house appropriate equipment. These costs can vary greatly; for the purpose of this analysis, we generally assume "worst case scenario" for capital costs to provide conservative estimates.

Backbone Construction Costs

The estimated total costs to build the entire backbone, including two underground 2-inch conduits, hand holes or junction boxes, and one 288-strand fiber cable are $21.8M, as shown in the table below. Labor is almost 75% of the costs. Materials, including 288-strand fiber cable, is about 7%. Design and engineering are less than 2%. Thirty two percent of costs are in Phase 1, 52% in Phase 2, and 11% in Phase 3. The estimated

[24] Full text of Senate Bill 156, which established the Broadband Loan Loss Reserve, can be found at: https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=202120220SB156

average cost to build the backbone is $70.28/foot or $371,019 per mile. We also provide a 10% contingency.

Table 8-1. Estimated Backbone Constructions Costs for Two 2-inch Conduits and One 288-strand Fiber Cable

Design, Permitting, and PE Stamps	**$**	**342,313**
Phase 1	**$**	**7,060,836**
P1 Signal Interconnect	*$*	*2,753,939*
P1 Underground Laterals	*$*	*4,306,897*
Phase 2	**$**	**11,398,564**
BB - P2 Signal Interconnect	*$*	*3,716,094*
BB - P2 New Underground	*$*	*7,682,471*
Phase 3	**$**	**2,374,186**
BB - P3 New Underground	*$*	*2,374,186*
Construction Management/Inspections	**$**	**621,000**
		$ 21,796,899

Facility and Equipment Costs

In addition to backbone construction costs, the City of Fremont should budget approximately $900k for building improvements to house equipment. The costs cover retrofitting facilities as needed, which may include adding secondary entrances directly into the equipment room, backup power, environmental controls, and other required modifications. We assume that the capital costs of these upgrades will occur between 2023-2024 and 2024-2025, with the City spending approximately $450k in each year.

The model also assumes that capital costs will be required for additional equipment and services, including:

- Edge routers, Distributed Denial of Service (DDoS) threat mitigation
- Multi-Protocol Label Switching (MPLS)/Ethernet service core
- Access switches
- Switches, Firewalls, Servers
- Element managers, monitoring, out-of-band system
- DHCP, DNS, authentication
- Critical spares and unplanned needs

We estimate capital expenses for these equipment additions and upgrades to be approximately $3,398,730, assuming a 10-year equipment lifespan.

Table 8-2. Additional Capital Expenses

Network Equipment, Systems, Overall Project Management [2]		
Edge and Core Routers, Gateways	$	944,739
Optical Line Terminals	$	1,208,869
Network Management System	$	234,000
Pro Services for Equipment Install and Configuration	$	484,622
Project Turnkey Management	$	526,500
	$	3,398,730
Buildings		
PoP's	$	900,000
	$	900,000
Total	**$**	**4,298,730**

Drop Construction Costs

Sites will require physical connections to the backbone. We estimate the cost of a 500-foot drop would be about $1,781 to add to the backbone using 12 or 6-strand cables, from optical splitters in network hubs, which can be relatively small (less than 24" a side) boxes, to an external termination box at the customer premises. However, we anticipate that the costs of these drops will be covered by Fremont's selected partner and therefore do not include them in the City's capital costs. This should be a key point to discuss and negotiate with the selected partner.

8.4 OPERATING COSTS

A key characteristic of the public-private partnership business model is relatively low overhead and operating costs for the City. Payroll can account for 90% or more of on-going costs for a broadband enterprise. Equipment licenses, maintenance, refresh, and upgrades create recurring costs and large periodic costs. Management and marketing also require ongoing expenses. Partnering with an experienced telecommunications provider will allow the City to rely upon a third party for all of these costs and services, although it will require the City to share any revenue in exchange for this arrangement.

Because the City of Fremont will not directly operate the network, no full-time employees are required, but the financial model does include one staff member at half-time to oversee the program and the agreement with the selected partner. The salary for this half-time staff member starts at $72,100 in 2023-2024, with an annual increase of 3%. Additional operating costs include considerations for network & headend maintenance, outside plan maintenance, facilities maintenance, and utilities, totaling approximately $3.2 million over the 20-year life of the pro-forma.

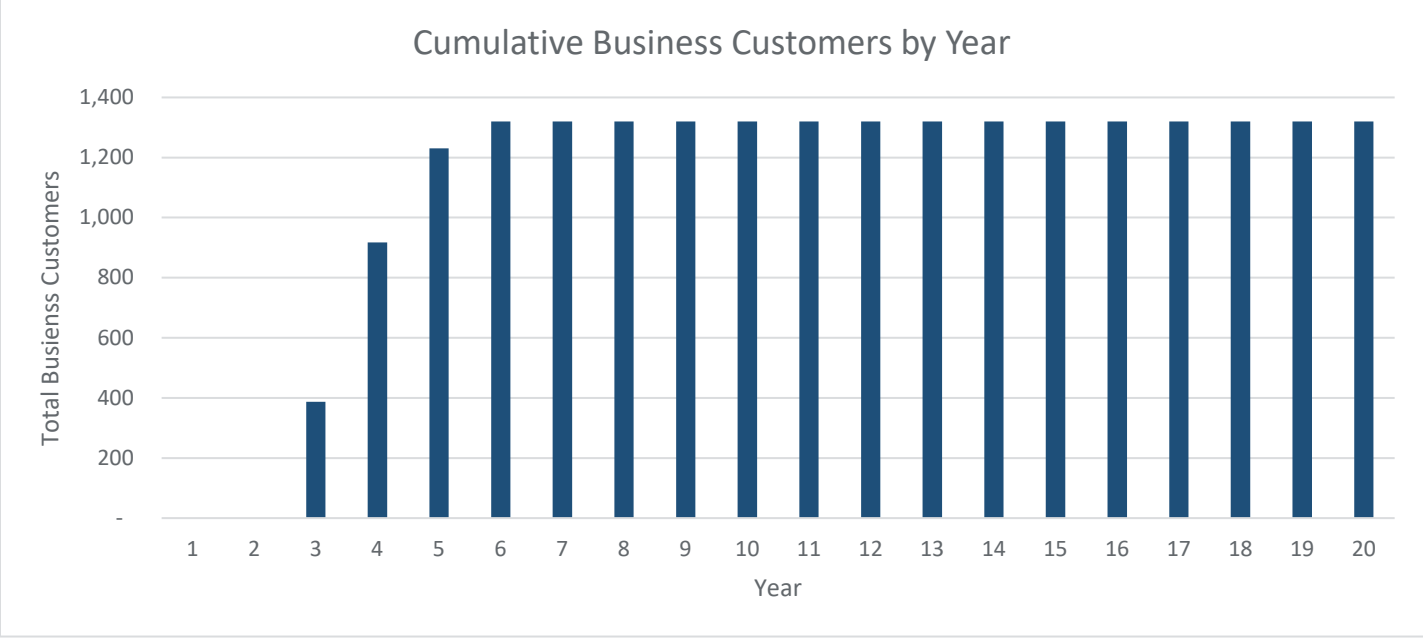
8.5 CUSTOMER SEGMENTATION AND GROWTH

The overall purpose of the Fremont citywide broadband network is to make municipal operations and other aspects of the local economy more flexible, productive, and resilient. It can also generate revenue for the City and provide additional broadband options for the business community.

Through the public-private partnership that will be established as a result of the currently ongoing RFP process, the City's infrastructure should be used to offer services to businesses along the fiber routes. Execution of a strategic marketing plan by the selected partner will be a critical determinant of the revenues; this should be a key consideration as the City decides on which prospective partner to select. For the purposes of revenue projections, we estimate the network would be able to sell lit services to 30% of businesses within 500 feet of the backbone. While we presume that some types of business will value connectivity more highly than others, we do not have enough information for more detailed analysis. For example, businesses with multiple locations that need to be connected and centrally served or managed will find lit services more valuable than single-location businesses that use minimal online services.

Based on these assumptions and the estimated time to build out the network in phases, we estimate that the network will see its first business customers in Year 3 of the program, with a total of 387 subscribers signing up that year. This number continues to increase up to Year 6, when the number of customers levels off to a total of 1,320 subscribers, as shown in the figure below.

Figure 8-1. Cumulative Business Customers by Year



8.6 PROPOSED RATE SCHEDULE

Based on our analysis of the Fremont market and business rates obtained by providers for Fremont, we feel the rates displayed in the table below are reasonable and competitive for speeds of 500 Mbps or 1Gb. Internet services can be priced many different ways, and the City's partner may offer other tiers of service offerings to fit the needs of businesses in Fremont. Two offerings are provided for each speed tier: one is a dedicated service with guaranteed speeds while the other, lower priced option is a best-effort scenario in which actual performance may vary.

Table 8-3. Service Tiers and Take Rates

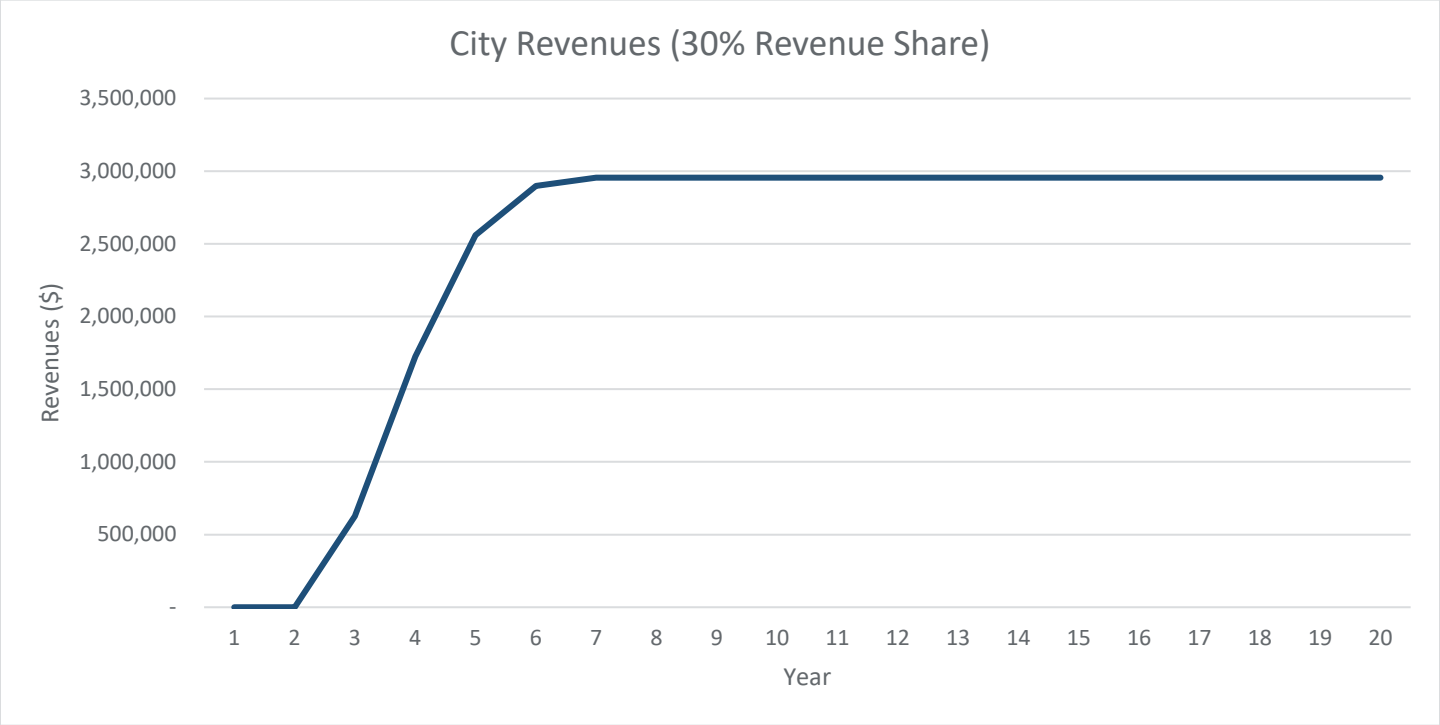
Market Share	*Service Offering*	*Price*	*30% Revenue Share*
30%	*500x500 Mbps Best Effort*	*$150/month*	*$45/month*
30%	*500x500 Mbps Dedicated*	*$800/month*	*$240/month*
10%	*1Gb x 1GB Best Effort*	*$250/month*	*$75/month*
30%	*1Gb x 1Gb Dedicated*	*$1040/month*	*$312/month*

For the purposes of our analysis, we assume that approximately 60% of business customers will take the 500 Mbps speed tier, split evenly between the dedicated and best-effort offerings. An additional 30% of business subscribers are estimated to take a dedicated 1Gb offering, while the remaining 10% take a best effort 1Gb rate.

8.7 FINANCIAL PERFORMANCE

Based on these inputs and taking into consideration the revenue share in which the City would get 30% of revenues, we estimate gradually increasing revenues that level off at approximately $2,955,744 per year, as shown in the figure below.

Figure 8-2. Annual Revenues



Over this 20-year period, the City can expect approximately $49 million in revenue. Operating expenses, remaining reserves, and debt service for the same time period are displayed in the table below.

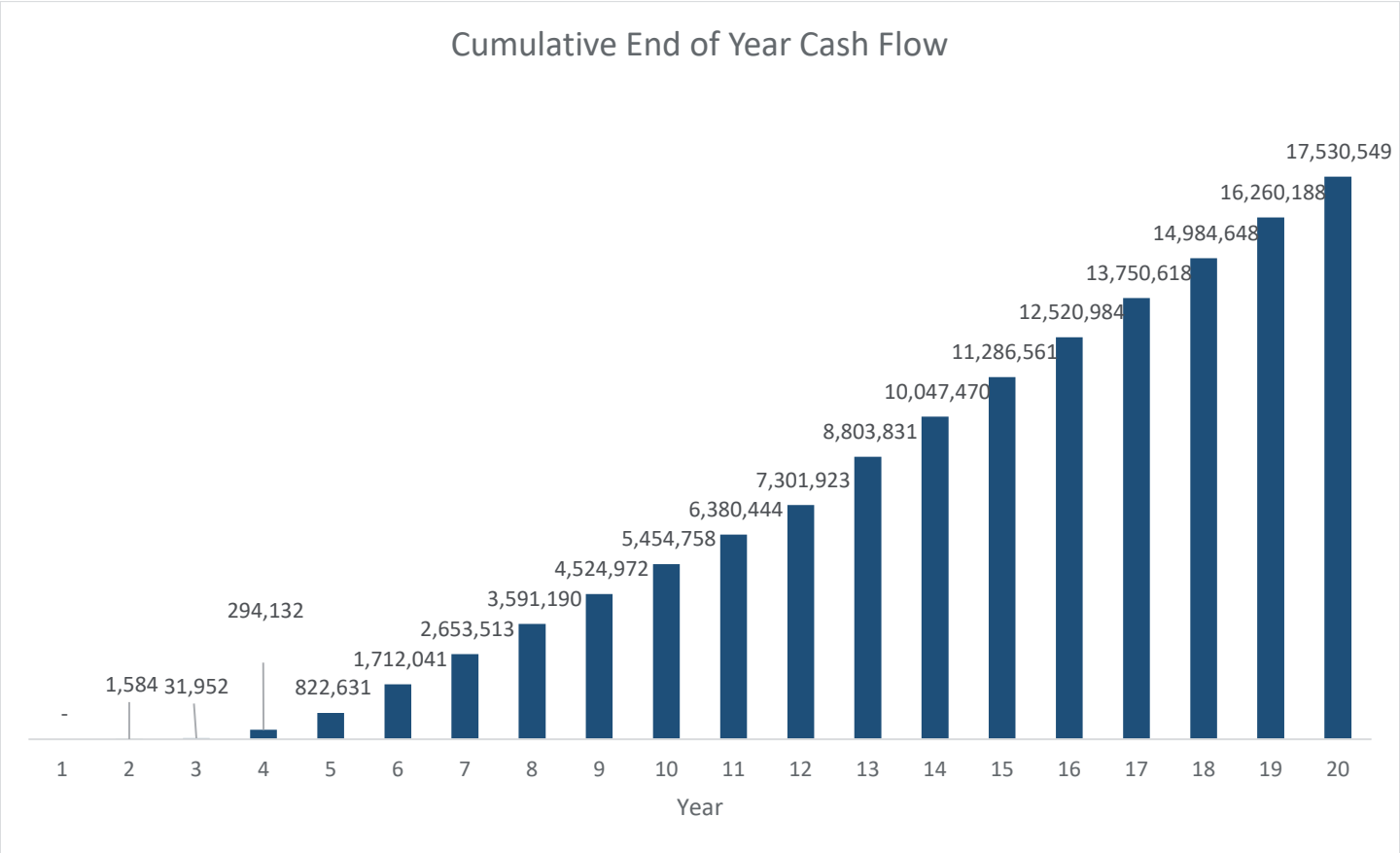
Table 8-4. 20 Year Operating Overview

20 Year Operating Recap		
Revenue	$	49,191,528
Op-Ex	$	3,268,783
Remaining Reserves (Operating, Capital Renewal/Replacement)	$	5,435,996
Debt Service	$	27,518,091
Ending 20-Year Cash	$	17,530,549

Our Broadband Sustainability Model shows that the program would break even in Year 3, with an end-of-year cumulative cashflow of $17,530,549 at the end of the 20-year

period, assuming $600,000 of working capital ($100k in year 2 and $500k in year 3) as shown in the figure below.

Figure 8-3. Cumulative Cash Flow Over 20 Years



9. Phased Implementation Plan

The phased implementation approach of the network build out is key to its success. Utilizing near term projects and existing fiber agreements will help minimize capital expenditures while providing for the immediate needs of the network. The milestones identified below are incremental, obtainable goals that are used as benchmarks by which to realistically judge the success of the network build out. Progress on these milestones should be regularly documented and used as a road map for directing the next steps to keep the project moving forward.

9.1 PLANNING PHASE: MONTHS 0-6

During the planning phase, the City should prepare for the buildout by selecting a partner, managing internal resources to oversee the program, and arranging for funding.

- **Milestone 1. Partner Selection:** The City has already released an RFP to solicit proposals from parties interested in partnering with Fremont for the deployment and use of these assets. Fremont should review the submitted proposals at the end of the submittal window to select the most appropriate partner and begin negotiations including determining capital contributions, revenue share, and services offered to the City.
- **Milestone 2. Allocate Internal Resources:** While the P3 arrangement will not require the City to add any new staff for operating the network, we recommend that Fremont allocate a 0.5 FTE Network Engineer to oversee the program. This individual will be responsible for overseeing network implementation, management, ISP and partnership services.
- **Milestone 3. Arrange Funding:** Fremont should identify funding sources for the program, which may include capital contributions from the City's private sector partner as well as grant and loan opportunities from state and federal resources. Options for grant and loan programs include:
    - Coronavirus Capital Projects Fund
    - California Advanced Services Fund
    - RAISE Transportation Fund
    - California Loan Loss Reserve Program

  Grant and loan opportunities will require the City to provide key details about the project to demonstrate that it is shovel ready; many of these details are provided within this Plan and the City should leverage this document to prepare applications. Submitting applications for funding under these programs will

require letters of support from major employers, senators, assemblymembers, economic development councils, internet service providers, business improvement districts, business chambers and community anchor institutions. The City should begin planning for these efforts early as they require considerable time to collect and compile.

9.2 PHASE 1: MONTHS 1-12

The Phase 1 core network build will be the building block for future network expansions by building a ring through Fremont connecting City facilities, fire stations, and Fremont-owned diverse internet connections.

- **Milestones 1-4:** The initial steps in Phase 1 are creating agreements to use the existing fiber infrastructure with Caltrans, SV-ITS, BART and Public Works to use strands of existing fiber to begin the building of the core network.
    - **Milestone 1. Agreement with Caltrans:** Caltrans has an existing agreement with the City of Fremont for the use of (4) strands of fiber on Hwy 880 requiring coordination and allocations of those strands from Caltrans.
    - **Milestone 2. Agreement with SV-ITS:** Fremont has an existing agreement with SV ITS that is being managed by the City of San Jose IT Department. After the initial contract was signed, SV-ITS is waiting for Fremont to contact them to arrange for the connection and use of those fibers.
    - **Milestone 3. Agreement with BART:** Bay Area Rapid Transit (BART) is a government owned and operated rail system in the bay area. BART has placed fiber cables along all of their rail lines. They lease out the fiber to public and private companies. BART offers fiber to municipalities at low cost if the fiber is used solely for government purposes. Fremont should negotiate pricing and enter into an agreement with BART for leasing fibers to connect to the Digital Realty Data Center in Oakland. This will provide wholesale internet bandwidth to the City network.
    - **Milestone 4. Agreement with Public Works:** Public Works fiber includes a project on Fremont Boulevard upgrading traffic signals and installing new 96 count fiber cable. Public Works and IT should agree upon governance, rights of use, documentation, and coordination for the use of Public Works and IT fiber.
- **Milestone 5. Document fiber stand availability and allocation:** Engineering of the network requires knowing what fiber strands are available, who controls the allocations and use, and determining the equipment needed for services delivered through the network.. This will determine the size of future cables what will be

required to support all the services and connections on the network and provide available strands for leasing and partnership agreements.

- **Milestone 6. Conduit Proofing:** Proofing the signal interconnect conduit will be critical in the overall design and engineering that is needed for completing construction of the network. Proofing should include an assessment of the conduit's readiness for having fiber pulled and any needed additions or remediation.
- **Milestone 7. Low-level engineering for the core network:** Connections need to be made with the different owners and some construction will be needed. Low-level engineering uses the information from the fiber strand availability and signal interconnect proofing data to create the permittable plans and all construction documents to complete the core network.
- **Milestone 8. Construction of the core network:** The low-level engineering produces design and construction bid documents that will enable the City to procure a construction company to physically build the core network, connect all the fibers, and make the fibers ready for use through testing and documentation. The core network should be leveraged to find a partner to run, maintain, and serve the network.

9.3 PHASE 2 MONTHS 13 – 24

Phase 2 focuses on the Traffic Signal Modernization initiative and completes the connection of the traffic signals to one main traffic control center. The fiber constructed in this phase will also be used for other needs like providing business services to enhance economic development, developing a wi-fi network through a public-private partnership, and redundancy of the network constructed in Phase I.

- **Milestone 1. Traffic Signal Connections:** Document existing traffic signal connections and prioritize the order of connecting the traffic signals on the network.
- **Milestone 2. Conduit Proofing:** Proof signal interconnect conduits needed for this phase to ensure fiber readiness. It is recommended that this proofing be done at the same time as the proofing for Phase 1 (Milestone 6) for efficiency and savings, but this can also be done in later stages, either in part or in full.
- **Milestone 3. Low-level Engineering:** The information from Milestones 1 and 2 should be used to develop low-level design engineering for the upgrade of the signal conduit and the construction to be completed. Design engineering should include future plans for use of the network by incorporating economic development and partnership needs.

- **Milestone 4. Prioritized Construction:** The low-level engineering produces design and construction bid documents that will allow the City to procure a construction company to build connections to the traffic signals outlined in Milestone 1 in a prioritized manner.

9.4 PHASE 3 MONTHS 13 – 24

Phase 3 is the final phase that finishes the creation of redundant rings to minimize any outages by creating alternate circuit paths. This phase can be engineered and constructed separately or at the same time as Phases 1 or 2.

- **Milestone 1. Determine weak spots in network connectivity:** The gaps in the network need to be identified to create full redundancy for sites deemed to be critical. Critical sites are those sites that must maintain connection to the network and internet for communication during emergencies and supporting the higher end services provided to businesses by a partner.
- **Milestone 2. Low-level engineering the segments needed:** After the gaps are identified, low-level engineering needs to create permittable plans for the construction efforts to move forward. The engineering must include future plans, partnerships, and support all city initiatives.
- **Milestone 3. Construction, splicing, testing:** Low-level engineering will provide the information needed to complete Phase 3. The construction of Phase 3 will complete construction as outlined by this Fiber Master Plan.

Appendix A: Full List of Interview Groups for Needs Assessment

INTERVIEWEES

City of Fremont

- Kim Beranek, Deputy Director, Community Services
- Geneva Bosques, Director of Communications and Legislative Affairs
- Chris Burgardt, Fire Department
- Arquimides Caldera, Assistant Director, Human Services
- Johanna Canaday, Police Department
- Jeff Edwards, Maintenance Services, Public Works
- Andrew Freeman, Business Manager, Community Services
- Amanda Gallo, Management Analyst, City Manager's Office
- Eric Hu, Traffic Engineering, Public Works
- Pat Kendrick, Maintenance Services, Public Works
- Kelly King, Maintenance Services, Public Works
- Dilip Kishnani, Private Development Engineering, Public Works
- Hans Larsen, Director, Public Works
- Donovan Lazaro, Economic Development Manager
- Wayland Li, Community Development
- Frans Van Der Meer, Construction, Public Works
- Daniel Miller, Traffic Engineering, Public Works
- Clifford Nguyen, Community Development
- Joel Pullen, Community Development
- Candice Rankin, Management Analyst, City Manager's Office
- Michael Sa, Recreation Supervisor, Community Services
- Dan Schoenholz, Community Development
- Karena Shackelford, Assistant City Manager
- Suzanne Shenfil, Director, Human Services
- Michelle Silva-Salinas, Maintenance Services, Public Works
- Michael Tegner, Police Department
- Jason Valdes, Police Department
- Victoria Walker, Traffic Engineering, Public Works
- Sean Washington, Police Department
- Suzanne Wolf, Director, Community Services

Alameda County Transit

- Ahsan Baig, CIO
- Mike Carvalho, Infrastructure
- Leonard P. Crockett
- Ramakrishna Pochiraju, Director Planning and Engineering, AC Transit
- Robert Del Rosario, AC Transit
- Wil Buller, Traffic Engineer, AC Transit

Fremont Unified School District

- Lucus Bogle, Chief Technology Officer

Alameda County Water District

- Ariz Naqvi
- Cathy Nelson

City of Newark

- Soren Fajeau

Appendix B: Broadband Friendly Policy Resources

Broadband-friendly policies serve the public by:

1. Filling broadband gaps in availability or affordability,
2. Enabling services that are financially sustainable, and
3. Promoting economic development and job creation.

Local governments can accelerate broadband deployment by:

- Streamlining and facilitating access to local government owned facilities and properties to include franchising/licensing and use of rights of way, utility pole attachments (lease and rules for adding wires and equipment), zoning (rules for facilities placement, esp. wireless antennas), permitting application process and permit fees based on actual costs.
- Maximizing available assets on public lands and rights of way, particularly conduit and/or fiber installation as part of capital improvement programs to occur simultaneously with utility relocations, road widening, water and sewer installs and lighting projects supported by joint trenching and "dig once" policies.
- Implementing industry specific regulations to include master franchise agreements, broadband development standards incorporated in land development code.
- Facilitating construction with building permits, land development codes, engineering standards).
- Coordinated planning to include mapping and asset management to maximize use and reduce duplication.

Most of these activities do not require additional funding but do require a change in approach which will ensure equitable treatment of all network service providers, including broadband and cellular services. Well-developed policies and guidelines should also serve to preserve public safety and welfare and minimize the overall impact on community aesthetics.

Policies that treat telecommunications the same as any other utility in the rights-of-way subject only to review by engineers, may provide the most expedient avenue for rapid deployment without compromising the needs of the community.

Generally, Magellan Advisors recommends "lightweight" policies that facilitate development while balancing it with social costs and ensuring costs are fully and equitably imputed to service providers. Policies should be consistent across adjacent jurisdictions and should be structured such that broader level policies can be adapted and tailored to smaller scale jurisdictions: County policies should provide elements,

foundation, or a framework for city, town, and village policies. The overall goals are efficiency and flexibility along with a balance between consistency and control.

A.1 HOLISTIC POLICY APPROACHES

Some local governments have taken a holistic approach to facilitating broadband deployment and enhancing telecommunications access. This involves reviewing and amending existing policies, as well as adopting new policies based on changes in technology and community needs. A holistic approach also has standardized agreements and leases and engineering specifications for implementing those policies.

Examples

Mono County, CA developed a plan to increase accessibility, reliability and expansion including construction of infrastructure, collocations and access.

Santa Cruz, CA, developed a comprehensive Broadband Master Plan to address the major policy considerations for maximizing broadband availability. The master plan included a dig once policy, master lease agreement, encroachment permit process, and specifications for conduit, hand holds, fiber huts, and other related equipment. Geographic Information Systems data requirements in the master plan enable the city to map current and proposed broadband assets and paths, and to plan accordingly.

A.2 FOCUSED BROADBAND POLICIES

As opposed to taking a broad-brush approach and implementing a master program or plan, other cities have focused on addressing specific policies to minimize obstacles and promote telecommunications access. For each community, the policies implemented were based upon a review of assets, review of existing policies and the specific needs of the community. The primary policy focus areas include both wireless and wired telecommunication infrastructure with a specific focus on maximizing deployment of these assets, to include:

- Wireless tower regulations (siting and collocation)
- Small cell/distributed antenna systems (DAS) access to rights-of-way
- Wired access to rights of way includes open trench, shadow conduit, dig once, and joint trenching
- Permitting and building codes
- Construction, engineering, and conduit building specifications

A.3 WIRELESS COMMUNICATION (TOWER SITING AND ANTENNA COLLOCATION)

Many local jurisdictions adopted local telecommunication policies commensurate with the 1996 Telecommunications Act to regulate tower location, tower height, and tower design including color, lighting, and screening of base facilities. Antenna collocation is required where possible to reduce costs and time by maximizing the use of existing infrastructure.

Collocation is defined by the FCC as "the mounting or installation of an antenna on an existing tower, building, or structure for transmitting and/or receiving radio frequency signals for communications purposes." Collocation enhances community aesthetics by reducing the number of vertical structures needed for broadband deployment.

The FCC released additional guidelines and regulations in the October 2014 Acceleration of Broadband Deployment Order, which includes final rules implementing Section 6409(a) of the Middle-Class Tax Relief and Job Creation Act of 2012. Section 6409(a) of the Middle-Class Tax Relief and Job Creation Act of 2012 restricts local land use review of modifications and collocations by establishing the "substantial change test" and reduces the processing shot clock from 90 days to 60 days. Distributed antenna systems (DAS) and small cells may also require compliance with these same processes.

Whether a local government is reviewing existing or developing new telecommunication policies to ensure compliance with federal and/or state regulatory changes, local governments should consider:

- Adopting policies that have uniform rules and limitations regarding tower siting to prevent unnecessary delays in approval, high leasing fees, and other red tape associated with new wireless tower infrastructure.
- Including requirements to collocate, if possible, rather than construct a new tower.

Examples:

Several local government organizations have developed model wireless communication ordinances.

The North Carolina League of Municipalities (NCLM) https://www.nclm.org/SiteCollectionDocuments/Resource/WirelessTelecomModelOrdinanceOct13.pdf

The Municipal Research and Services Center (MRSC) references a model ordinance created by the Kenyon Disend PLLC law firm in Issaquah and have made it available for other local governments to use. http://mrsc.org/getmedia/57ba09ad-aae9-4b3c-a2b6-923db84020fc/m58efm.aspx

The National League of Cities and the National Association of Counties (NLC and NACO) worked together with providers and local government to develop a series of resources, online at http://www.naco.org/sites/default/files/Model-Ord-NACo.pdf, including:

1. A model ordinance and application for reviewing eligible facilities requests under Section 6409(a)
2. Wireless siting best practices
3. A checklist that local government officials can use to help streamline the review process

In addition, the following cities are included as they updated existing ordinances to reflect both statutory changes and technology innovations.

Clark County, NV, land use strategy documents regarding communication towers and antennas list situations in which no permit is needed (e.g., an antenna is not visible), an administrative review is available (e.g., location on public property), or exclusive use review is required. With easily accessible documents, the County helps telecommunications carriers avoid public hearings which serves as a major incentive for the providers.

Cumberland County, PA, provides an updated model wireless ordinance to address not only the regulatory changes but the changes associated with modern technology such as distributed antenna systems (DAS).

Other examples:

- Centennial, CO

- Ouray Co, CA
- Princeton, Iowa

Small Cell/ DAS Collocation and Use of Rights-of-Way

The concepts applicable to antenna collocation on towers may also be considered for the latest small cell technology which can be attached to utility poles, streetlights and other structures in the public rights-of-way. The FCC's National Broadband Plan concluded that, "the rates, terms, and conditions for access to rights-of-way (including pole attachments) significantly impact broadband deployment." As with collocation on towers, attaching communications facilities to existing poles, ducts, conduit and other structures lowers costs of infrastructure deployment; ensures efficient use of existing infrastructure and limits impact of multiple structures in the rights-of-way.

Many states are now adopting legislation related to small cell (5G) deployment to regulate the rates, terms, and conditions of use/ lease of poles, ducts, and conduits that are owned by a "utility provider." Local government policies must comply with the state regulations in which the local government resides while protecting the interests and the aesthetics of their community.

The League of Minnesota Cities provides an excellent review with samples of model ordinances and policies addressing DAS/small cell deployment. This document is can be found at https://www.lmc.org/resources/cell-towers-small-cell-technology-and-distributed-antenna-systems/ along with the following referenced cities and respective documents including master leases.

Examples:

- Boston, MA
- Minneapolis, MN
- San Antonio, Texas
- San Francisco, California
- Santa Monica, CA
- Texas City Attorney Association

WIRED (CONDUIT & FIBER) RIGHTS-OF-WAY EXCAVATIONS

Sixty to eighty percent of wired broadband deployment costs are associated with excavating/opening a trench usually in the rights-of-way and/or in burying conduit. Coordination with all interested parties, including telecommunications, for street cuts and excavations, sidewalk and trail improvements, water and sewer, and street lighting projects not only minimizes disruption and damage associated with trenching, but reduces associated costs.

According to the National Broadband Plan (https://transition.fcc.gov/national-broadband-plan/national-broadband-plan.pdf) "the cost of running a strand of fiber through an existing conduit is three to four times cheaper than constructing a new aerial build."

A review of the literature reveals the use of several different terms aimed at managing the rights-of-way more efficiently and effectively, including open trench, shadow conduit, and dig once policies. The overall goals of these policies and procedures is to reduce the number of street excavations and associated costs and ensure equal access to all providers who use the rights-of-way to provide services which meet the needs of the public.

Terminology

Open Trench refers to the digging or excavation of a 'ditch' in the right-of-way for any purpose, including but not limited to deploying fiber. These policies focus on the dimensions, location, safety, signage, etc., for open trenches.

"Dig Once" policies minimize excavation and damage to rights-of-way through coordination efforts involving ALL users of the rights of way including telecommunications when construction is planned which will create an "open trench."

Joint Building or Joint Trenching requires right-of-way users (e.g., telecommunications providers) to utilize a common or joint trench with other utilities (i.e. sewer, water, gas, electric) where a (re)developer or utility company provides a trench for undergrounding of utilities.

Shadow Conduit is used to refer to the installation of empty and/or spare conduit by a public agency when excavations occur in the public right-of-way, with agency costs limited to incremental costs. Some cities also require the installation of fiber when a trench is open for any reason.

Local governments should consider policies and implement practices that encourage:

- Coordinating construction activities in the rights-of-way to minimize disruption thus maximizing public safety and reducing overall costs associated with multiple repeated excavation projects.
- Placing conduit and/or fiber-optic cable when a trench is open for whatever reason in the rights-of-way.
- Establishing clear engineering and construction specifications.

Examples

The following examples are representative of best practices and models for managing the rights-of-way to maximize its use and facilitate broadband expansion in the community.

Berkeley, CA modified its existing code and drafted best practices policies to maximize the use of the Rights of way equitably by all providers, coordinating construction to reduce inconvenience to the public, improve safety and reduce costs.

In 1994, Boston, MA was one of the first cities to put forth a policy that mandated all telecommunications carriers to install underground conduits "in the same trench, at the same time on a shared-cost basis." The policy dictates the establishment of a "lead company" which is any company that approaches the local government first with a build-out request, thus taking the lead in construction coordination. "the lead company and participating telecoms work together to draft the engineering plans, estimate construction costs, and submit the build-out application for review and approval. This approach has worked well in Boston to minimize street excavation and expedite the broadband deployment process."

Gonzales, CA developed a very simple one-page policy to address rights of way excavation and expansion of broadband.

In Mount Vernon, WA, conduit placement requirements were added to the city's code helping to build its open access telecommunications network. Per the city ordinance:

> 12.20.015 Construction standards for the regulation of use of public rights-of-way and public property.
>
> All developments shall be required to construct and install telecommunications conduit on all streets that are affected, disturbed, constructed and/or improved by development unless otherwise approved, pending a review by the city engineer. This conduit shall be for installing telecommunications cable, fiber- optic wiring, or other infrastructure as necessary.
>
> This conduit shall be placed at horizontal and vertical locations as determined by the city engineer. The conduit shall conform to the size, shape, and characteristics as determined by the city engineer based on industry standards. Once installed and accepted by the city, the conduit shall become the property of Mount Vernon.

> Development as defined in this section shall mean the construction of improvements such as buildings, homes, subdivisions, streets, and utilities. (Ord. 2927, 1999).

San Francisco, CA established a "Communication Infrastructure in Excavation Projects" guide to ensure, when feasible, fiber and conduit were included in construction projects and multiple excavations were minimized.

Sandy, OR, passed an ordinance requiring all new development to install underground fiber along with other utilities. Developers are now required to put conduit all the way into a home and to deed that conduit to the city. The code change was an expansion of existing policy adding "broadband (fiber)" to the list of public facilities. Underground communication lines join a list of other required improvements that are to be installed in new developments at no expense to the city. The city also developed a public-private fiber-to-the-premises (FTTP) project.

San Benito, CA, implemented a "dig once" policy as part of its "Complete Streets" policy by including provision for a full range of infrastructure main line and distribution, above and below ground, as appropriate, in initial roadway design and construction and in reconstruction projects involving more than surface pavement treatment.

San Francisco, CA, developed a dig once ordinance that modifies the City's Public Works Code provisions governing all utility excavation. Only plans that include the installation of communications facilities (e.g., conduit) may be approved for permit. All excavators are required to place conduit that can be leased. Specifications for the shadow conduit is required to be placed in a joint trench above the excavator's conduit. The City is mapping communications assets as they are installed.

Santa Cruz County, CA adopted a "dig once" ordinance as part of a broad approach to adopt policies to encourage the development of broadband.

JOINT TRENCH AND JOINT BUILD AGREEMENTS

Agreements for joint trenching/building may be developed with other telecommunications, cable or utility providers. Cost for placement of conduit or fiber may be shared amongst all entities, allowing each to take advantage of the other's trenching. Standardization of these agreements across all potential owners of underground infrastructure can be established to ensure all parties are aware of the joint trenching opportunities as they become available.

Examples:

- Collier County, Florida

- Des Moines, Iowa
- Santa Cruz
- Magellan Joint Build Agreement Template

Permitting and Building Codes

Expedited permitting codes that streamline approvals and eliminate red tape for approval of cable and antenna installation of cable or antennas in rights-of-ways or public structure will speed up the process of expanding telecommunications access in a community. Many localities have simplified the permitting efforts by placing broadband infrastructure projects solely in the Public Works department via encroachment permit processes. Additionally, local governments have reviewed permitting fees to cover costs and reduced overall expenses associated with permitting fees. Finally, local governments have added connectivity requirements to building codes, ensuring that new constructions are equipped with broadband access.

The Virginia Association of Counties (VACO) adopted a Virginia Tech study recommendation for review and update of permitting policies to facilitate broadband delivery. Specifically, VACO recommended issuing an overall project permit as opposed to requiring weekly or daily permits.

The State of Washington published a best-practices guide for local government permitting to streamline approval of infrastructure projects, including broadband.

Clark County, NV land use strategy documents regarding communication towers and antennas list situations in which no permit is needed (e.g., an antenna is not visible). With easily accessible documents, the county helps telecommunications carriers avoid public hearings, which serves as a major incentive for the providers.

Missoula, MT, city council members voted to reduce its fees by more than 75% for permits associated with excavation and placing communication conduit and fiber in rights-of-way.

The following guides are provided herein as models for best practices for permitting that can be implemented to enhance broadband deployment.

Other Examples:

- State of Massachusetts Best Practices Guide to Permitting
- State of Washington Best Practices Guide to Permitting

CONDUIT AND FIBER STANDARDS FOR NEW HOME CONSTRUCTION

Building codes that set standards and require conduit and/or fiber during development have been essential parts of expanding broadband, particularly in underserved and rural areas. The following cities exemplify best practices for this approach.

Brentwood, CA, passed an *advanced technology systems* ordinance in 1999, requiring developers to include conduit and fiber in newly built homes. In 2014, the city reached an agreement with Sonic.net to use the conduit as the basis for a fiber to the home (FTTH) system.

Loma Linda, CA, added language to city building codes, requiring all new commercial and residential developments (or re-models involving greater than 50% of the structure) to equip new structures with fiber and copper cabling. Per the city ordinance:

> In recognition of the need to provide local residents and businesses within the community with additional options to meet their telecommunications needs, as adopted by City council resolution, all new development projects within the City, regardless of whether such new development falls within the fiber-optic master plan area, and additions that exceed more than fifty percent of the original structure that fall within the fiber-optic master plan area, will be required to participate in, and will be bound by, the connected community program and all conditions and requirements contained therein. Further, any conditions or requirements of the connected community program may be required as a condition of approval of any such new development or addition exceeding fifty percent of the original structure. (Ord. 629 § 1, 2004)

In Jerome, ID, all new subdivisions are now required to install fiber-conduit. According to the town's subdivision regulations:

> Fiber Optical Conduit: All developers will be required to pay for and install two-inch (2") SDR11 smooth wall Inner-duct fiber optical conduit, which is orange in color, with pull rope, PG style service boxes, forty-seven inches (47") high by forty-eight inch (48") open bottom and PG style heavy duty cover with support beam. The placement and construction of the fiber optical conduit shall be done in accordance with the Jerome standards and at the discretion of the City engineer. (Ord. 994 §2, 2006).

Sandy, OR, passed an ordinance requiring all new development to install underground fiber along with other utilities. Developers are now required to put conduit all the way into a home and to deed that conduit to the city. The city also developed a public-private FTTP project.

ENGINEERING/CONSTRUCTION SPECIFICATIONS

Engineering standards and specifications identify and define requirements and policies for designing and installing telecommunications infrastructure and substructure at all facilities including conduit placement, type and installation. Conduit-specification documents address capacity, separation of facilities, proper sizing and placement, access to the conduit with detailed provisions for vaults and all access points. Cost sharing or cost recovery stipulations can be put in place for materials and labor assignment. Engineering specifications outline drawings that address conduit sweeps, bend radius and physical placement requirements can be provided with the standard conduit specification.

The following sample guides are included, which may be helpful for guidance on telecommunications infrastructure and specifications.

Examples:

- Boston Excavation Specifications
- Brentwood CA Engineering Procedures
- University of North Carolina Communications Infrastructure Guidelines
- University of Toronto Communications Infrastructure Guidelines

Microtrenching

Micro-trenching is included as a subcategory of engineering specifications as it is construction method being pursued by some cities to minimize impact and damage to roads and sidewalks. Micro-trenching is defined as "a low-impact deployment methodology in which fiber and conduit are inserted into a slot-cut trench less than ¾ inch wide and between 9-12 inches deep – without damaging or disrupting existing infrastructure. The benefits of microtrenching are that it is less disruptive than other broadband expansion methods, offers faster deployment speeds, and has significant cost-savings. Cities which have implemented the techniques include:

Jackson, WY sees a large influx of tourists each year, adding to its 9,800 residents, making reliable broadband a crucial component to economic development for the town. After securing grants from the National Telecommunications and Information Administration (NTIA) and Broadband Technology Opportunities Program (BTOP), a local provider

launched the Teton Broadband Project to upgrade the fiber network of Jackson. As a popular tourist destination, minimal disruption to the environment was important to keep the integrity of the surrounding land. As a result, the project opted to use a provider for fiber installation that employed multiple techniques – directional drilling, conventional trenching, and microtrenching. The microtrenching technology use was planned for the areas within the Jackson City limits to least disrupt residents and businesses, providing a valuable solution for Jackson's issue of expanding broadband in an efficient and minimally invasive fashion.

Loma Linda, CA, installed fiber city-wide using microtrenching technologies. The city used pushable fiber cable and micro ducts in combination with microtrenching to significantly reduce costs associated with deployment of fiber network.

New York City has revised its rules to add a chapter authorizing and regulating the use of microtrenching and launched a pilot program with Verizon to test microtrenching as an efficient alternative to conventional measures. Based on the pilot project, New York has determined that microtrenching is less disruptive to pedestrian and vehicular traffic and to the structural integrity of the streets saving the City both money and time.