5 Implementation Phasing Plan

The existing traffic systems communications network is comprised of numerous network devices and communications media including fiber optic cable, twisted pair copper wire cable, Serial wireless radios, and third-party owned leased copper lines, telephone drops, and cellular service. The analog network is antiquated and incapable of supporting the City's future ITS technology investments due to limited communications capacity. Implementing one seamless state-of-the-art communications network capable of meeting the City's existing and future traffic system needs requires a strategically phased approach.

The highest priorities include establishing a City-owned traffic signal communication system and implementing Ethernet-compatible systems/network. The existing analog lease lines generate high recurring costs and are incapable of serving modern traffic system technology. Existing investments in communication infrastructure, underground systems, signal interconnect cable, and traffic signal cabinets will continue to be utilized. Obsolete legacy network equipment will be upgraded or decommissioned and replaced with new modern communication technologies. Converting existing technologies to Ethernet-based communications through upgrades is the most cost-effective and rapid deployment approach, enabling improvements across wider areas.

Implementation of Master Plan recommendations is divided into three phases over a ten-year period. Deployment for each phase is dependent on availability of funds and accelerated deployment is advantageous for financial, operational, and management purposes. The City should seek grant funding and other opportunities to more quickly complete all implementation phases within 5 years.

5.1 Phase 1: City-Owned Infrastructure (Year 1-3)

Phase 1 of the implementation plan includes providing a wholly City-owned traffic signal communication network, converting from Serial to an all Ethernet-based network, upgrading traffic signal controllers to Ethernet protocol, and establishing video monitoring at the City's highest priority locations. Implementation for Phase 1 is prioritized by proximity to City Hall as well as by street network hierarchy. The downtown area, closest to City Hall, contains the greatest number of signalized intersections operating on costly third-party owned leased communications. The traffic signals in this area are spaced close together and are ideal for implementation of broadband Ethernet wireless radios, which provide cost-effective and rapid communications deployment. Traffic signal equipment will be upgraded to Ethernet-enabled devices and Layer 3 communication hubs will be installed at strategic locations. The following summarizes the Phase 1 traffic signal communications network upgrades:

- Upgrade the existing fiber optic system to Ethernet communications.
- Convert leased copper lines to City-owned wireless Ethernet radio communications.
- Upgrade City-owned copper lines to Ethernet-over-copper communications.
- Install City-owned wireless Ethernet radio communications at all offline traffic signals.

- Convert the leased cellular network for existing Traffic Measurement Devices to City-owned wireless Ethernet radio communications.
- Install video monitoring devices at high priority locations.
- Install fixed Dynamic Message Signs approaching the Chula Vista Amphitheater.
- Obtain 2 portable Dynamic Message Signs for use during planned or unforeseen major traffic impacting events.
- Install a satellite Traffic Management Center at the City's Traffic Operations Maintenance Facility.
- Upgrade all traffic signal equipment to Ethernet-enabled devices Citywide.
- Implement Layer 3 communication hubs at strategic locations.

A summary of the Phase 1 improvements is illustrated in **Figure 5-1**.

5.2 Phase 2: Infrastructure and Priority Corridors Upgrade (Year 4-6)

Phase 2 of the Implementation Plan prioritizes fiber optic communications. Existing communications conduit that has been previously installed throughout Chula Vista will be upgraded to include new fiber optic cable installations. New conduit and fiber optic cable will be installed to resolve all remaining communications gaps and create redundancy. Strategic signalized intersections along priority corridors throughout the City will be upgraded to include type 2070 ATC traffic signal controllers and closed circuit televisions (CCTV) cameras for remote video monitoring. The following summarizes the Phase 2 traffic signal communications network upgrades:

- Upgrade existing empty communications conduit and install fiber optic cable.
- Install conduit and fiber optic cable to resolve communications gaps in the network and create redundant ring topology.
- Upgrade traffic signal equipment on primary fiber optic ring route with fiber devices.
- Upgrade traffic signal equipment on priority corridors with new 2070 ATC controllers and CCTV cameras.

A summary of the Phase 2 improvements is illustrated in **Figure 5-2**.

5.3 Phase 3: Citywide Buildout (Year 7-10)

Buildout of the traffic signal communications network will be completed in Phase 3. Remaining signalized intersections will be upgraded with type 2070 ATC traffic signal controllers and closed-circuit television (CCTV) cameras for remote video monitoring. Signalized intersections with existing analog video detection will be upgraded with analog to Ethernet video encoders to enable remote viewing of the video feeds. A summary of the Phase 3 improvements is illustrated in **Figure 5-3**.

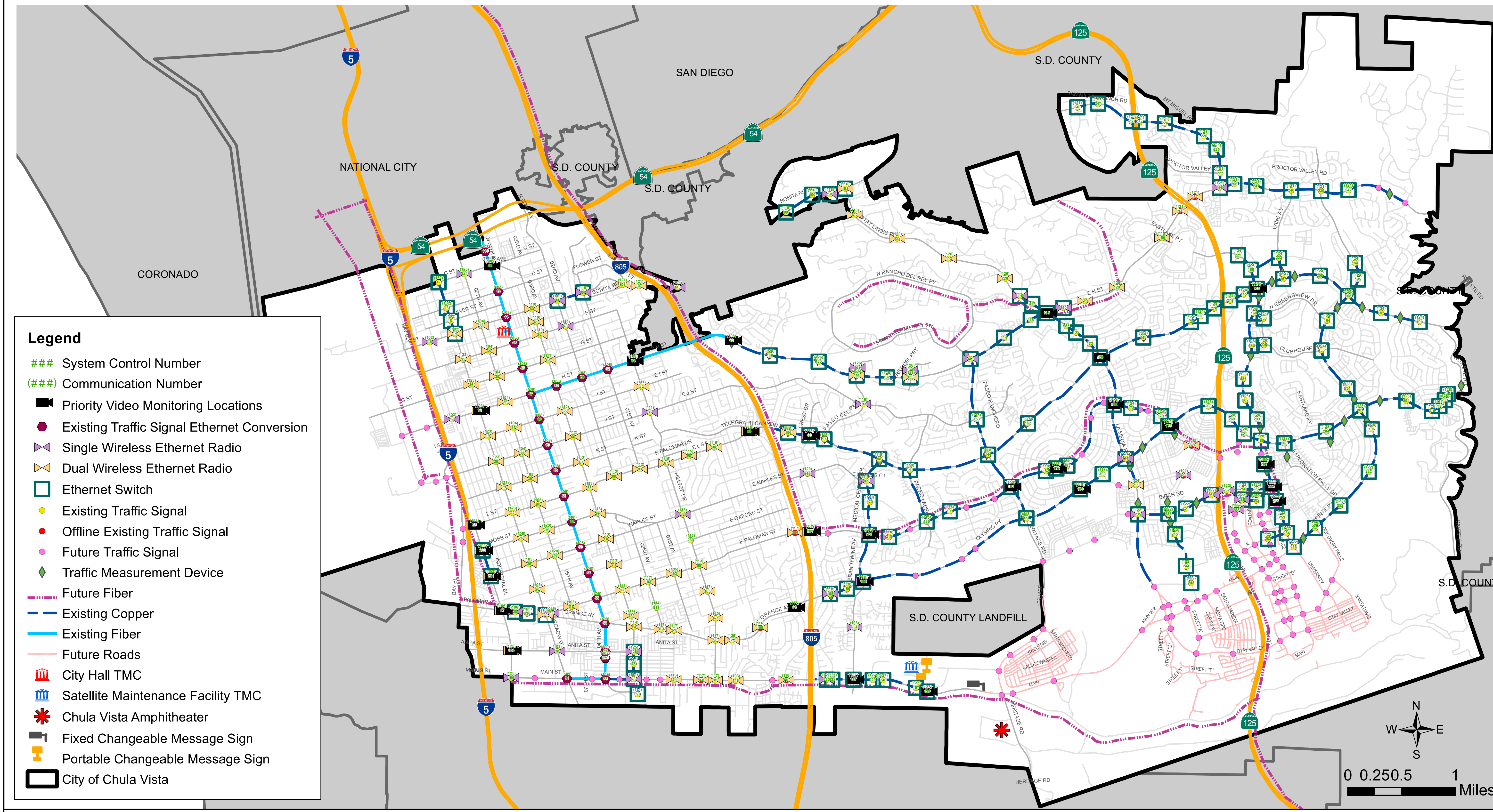


Figure 5-1 Phase 1 Improvements

Document Path: S:\Projects\Chula Vista\0347_Chula Vista Traffic Signal Communications Master Plan\04 Design\GIS\MXD Files\Chula Vista Comm MP Phase Implementation.mxd

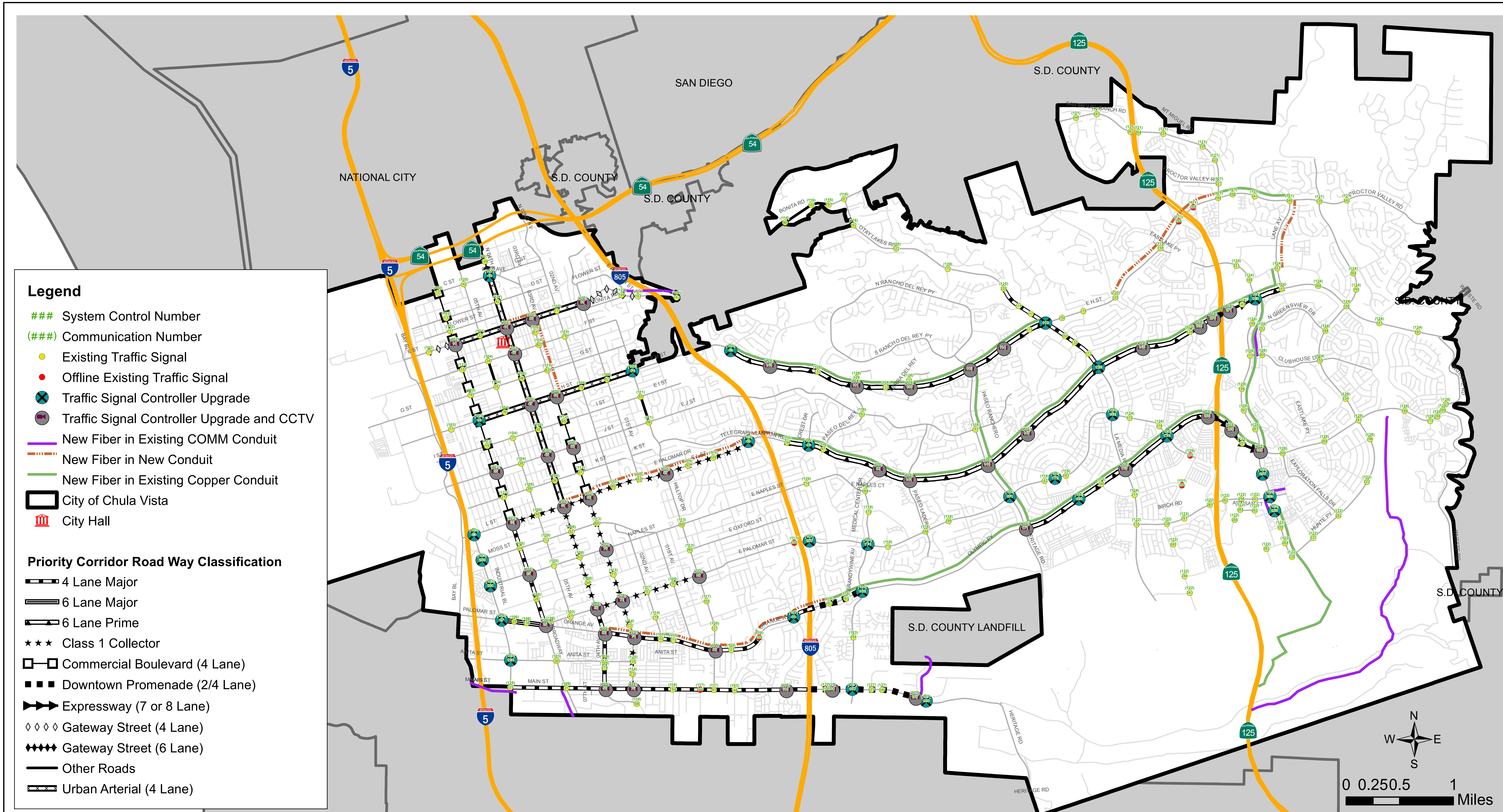


Figure 5-2 Phase 2 Improvements

Document Path: S:\Projects\Chula Vista\0347_Chula Vista Traffic Signal Communications Master Plan\04 Design\GIS\MXD Files\Chula Vista Comm MP Phase Implementation.mxd

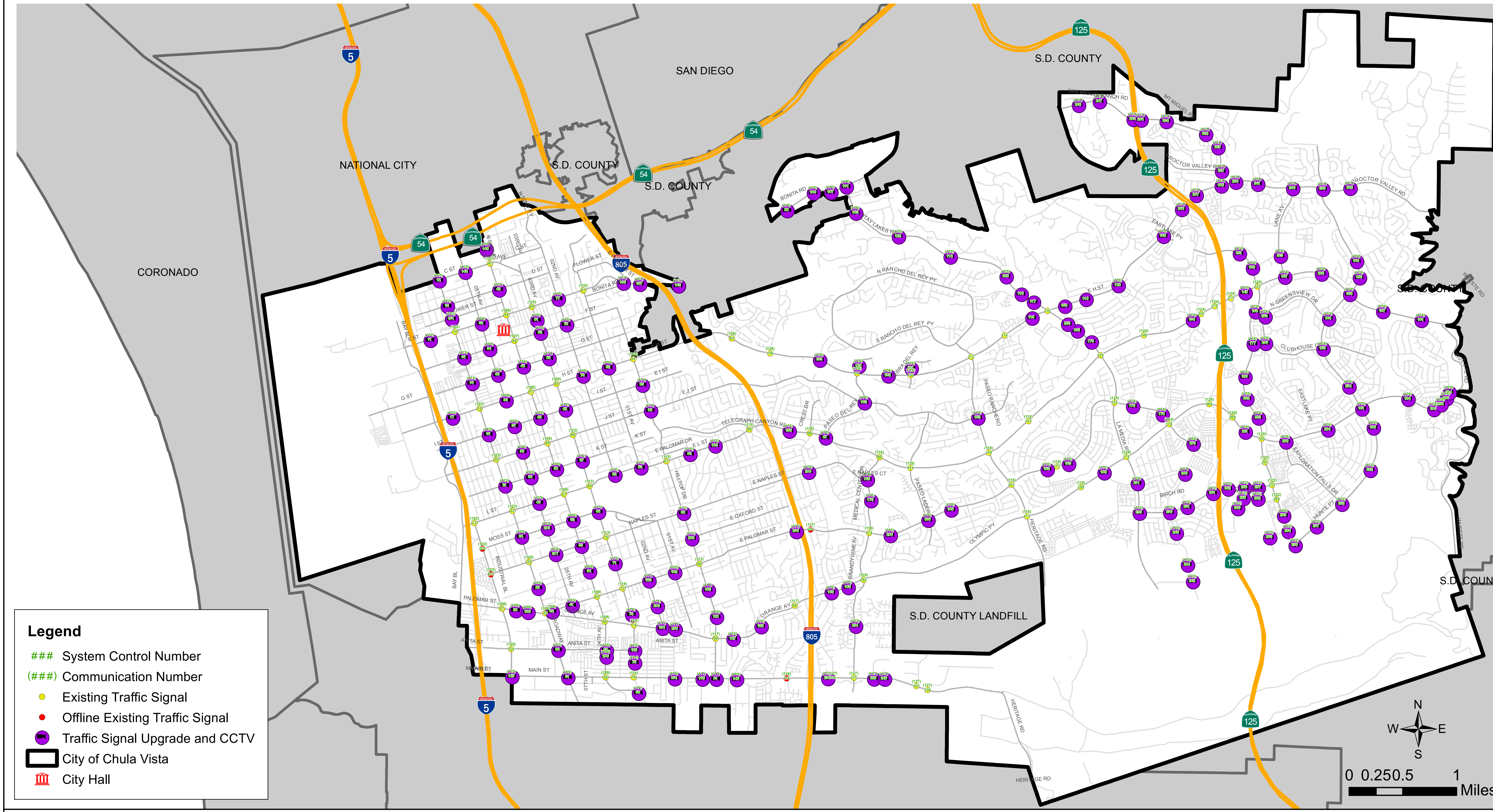


Figure 5-3 Phase 3 Improvements

Document Path: S:\Projects\Chula Vista\0347_Chula Vista Traffic Signal Communications Master Plan\04 Design\GIS\MXD Files\Chula Vista Comm MP Phase Implementation.mxd

5.4 Cell Towers

The City owns cell towers throughout Chula Vista that may be utilized for the traffic systems communications network. The implementation phasing plan does not consider use of the towers and focuses on cable based and point to point wireless communications. The towers may provide opportunities to reach areas not easily accessible by cable based systems. The towers could host broadband wireless and/or cellular radios to close gaps in City-owned infrastructure and/or support future ITS technology applications. Tower use would be determined on a case-by-case basis in engineering design phases.

5.5 Long-Term System Considerations

Additional long-term system considerations are included to provide a more robust and reliable traffic signal communication network. These improvements are not part of the three-phase implementation plan but are recommended should additional funding become available. As opportunities arise, new fiber optic conduit and cable should be installed in place of broadband Ethernet wireless radios and fiber optic communication media should be installed in addition to the City-owned copper plant. Major signalized intersections should be upgraded to include stand-alone battery back-up systems, Global Positioning System (GPS) emergency vehicle preemption (EVP) systems, Ethernet-enabled conflict monitor units (CMU), and Power Cycle Relay Switches.

Table 5-1 Long-Term System Improvement Order of Magnitude Costs

IMPROVEMENT	UNIT COST
Trunk SMFOC Cable	$5/LF
Breakout SMFOC Cable	$2/LF
Fiber Optic Vault	$2,500/Each
Splice Closure	$2,000/Each
Fiber Distribution Unit	$2,000/Each
Standalone Battery Back-Up System	$5,000 /Intersection
GPS based Emergency Vehicle Preemption System	$10,000 /Intersection
Ethernet-Enabled Conflict Monitor Unit	$1,000/Intersection
Power Cycle Relay Switch	$800/Intersection
Adaptive Traffic Signal Deployment	$25,000/Intersection

5.6 Fiber Optic Communication Rings Topology

Fiber optic conduit and cable will be installed during the various implementation plan phases to complete a redundant and self-healing fiber optic communication rings topology around the City. Primary rings, the fiber optic backbone of the communication network, will connect the TMC at City Hall to major roadways throughout Chula Vista including Eastlake Parkway, Fourth Avenue, H Street, L Street, Lane Avenue, Main Street, Olympic Parkway, Orange Avenue, Otay Lakes Road, Proctor Valley Road, and Telegraph Canyon

Road. A secondary ring will provide redundant and robust communications to the future Smart Bayfront area. Linear branches will connect the remaining traffic signals throughout the City to the fiber optic communications network via primary and/or secondary rings. Future development projects that include new traffic signal and roadway improvements should implement new fiber optic communications infrastructure and connect to the rings topology. Future fiber associated with planned development projects, as previously discussed in Section 3 should also connect to the rings topology and be implemented by the Developer per City guidance. The following recommendations are provided for all future fiber optic cable deployments, including existing conduit and new conduit installations:

- Primary rings should be a minimum 144-strand of single-mode fiber optic cable.
- Secondary ring should be a minimum 72-strand single-mode fiber optic cable.
- Linear branches should be a minimum of 36-strand single-mode fiber optic cable.
- Local drop connections, for fiber MFED connections, should be a 12-strand single-mode fiber optic cable.

The fiber optic communications ring topology is depicted in **Figure 5-4**. Buildout of the future traffic systems communications network is summarized in **Appendix F**.

Document Path: S:\Projects\Chula Vista\0347_Chula Vista Traffic Signal Communications Master Plan\04 Design\GIS\MXD Files\Chula Vista Comm MP Phase Implementation.mxd

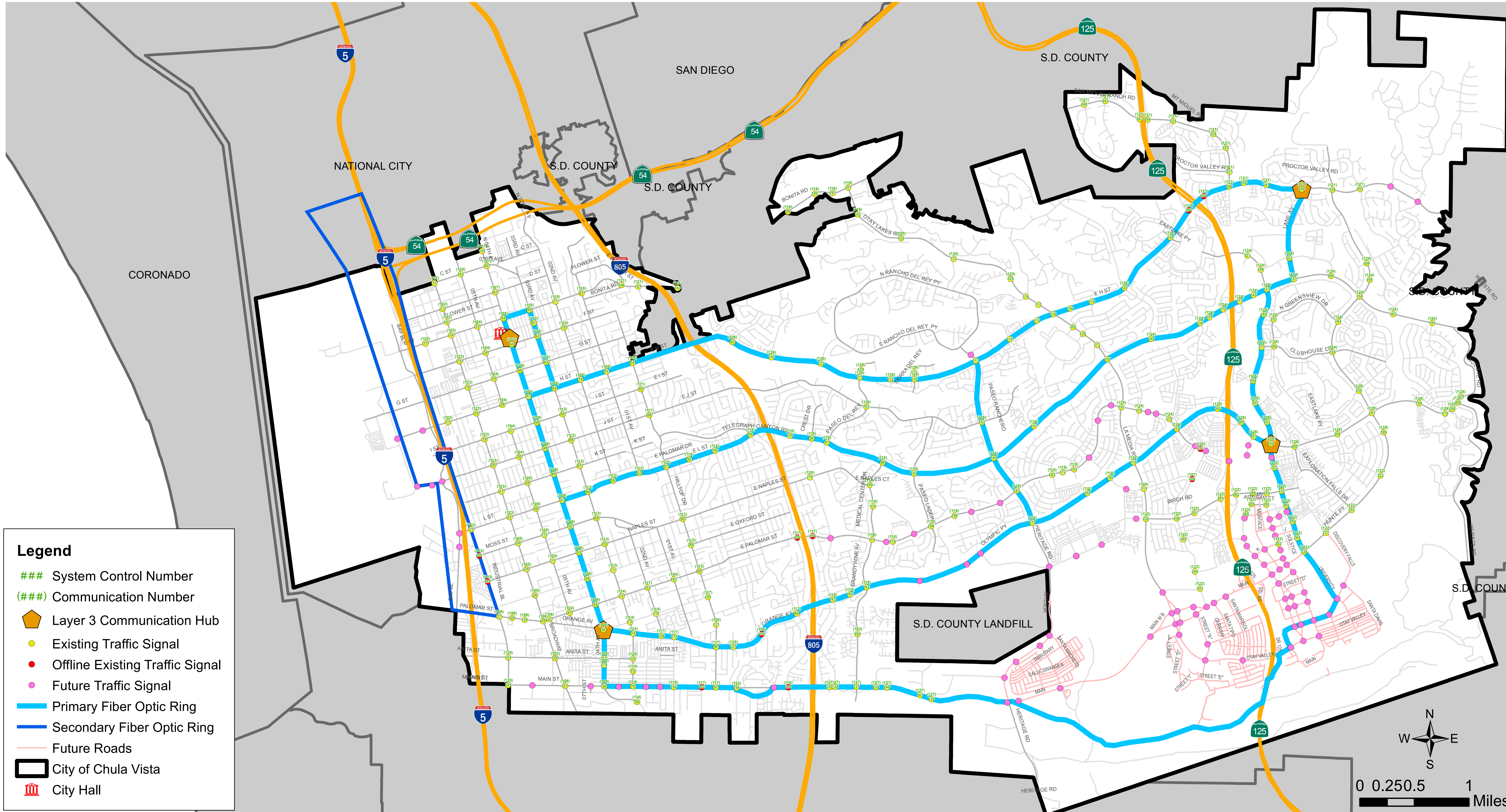


Figure 5-4 Fiber Optic Communication Rings Topology

CITY OF CHULA VISTA

TRAFFIC

5.7 Order of Magnitude Cost Estimate

A summary of the costs for Master Plan deployment, organized by the implementation phase, is shown on the following tables.

Table 5-2 Phase 1 Deployment Cost Estimate

ITEM #	DESCRIPTION	TOTAL
1	Fiber Optic Communications System Conversion to Ethernet	$187,500
2	Leased Copper Conversion to City-Owned Broadband Wireless and Connected City-Owned Copper Conversion to Ethernet	$2,556,000
3	Leased Cellular Traffic Measurement Devices Conversion to City-Owned Broadband Wireless	$558,750
4	CCTV Camera Video Monitoring at Priority Locations	$336,000
5	Dynamic Message Signs	$285,000
6	Satellite Maintenance Facility Traffic Management Center	$111,300
7	Traffic Signal Controller Ethernet Conversion Upgrade	$160,200
8	Communications Hub Installation	$600,000
	Grand Total	**$4,794,750**

Table 5-3 Phase 2 Deployment Cost Estimate

ITEM #	DESCRIPTION	TOTAL
1	Existing Communications Conduit Upgrade	$1,374,375
2	Fiber Optic Communications Rings Topology	$4,610,700
3	Traffic Signal Equipment Upgrade on Priority Corridors	$1,107,000
	Grand Total	**$7,092,075**

Table 5-4 Phase 3 Deployment Cost Estimate

ITEM #	DESCRIPTION	TOTAL
1	Traffic Signal Equipment Upgrade at Remaining Intersections	$3,763,500
2	Video Detection Equipment Upgrade	$186,000
	Grand Total	**$3,949,500**

Table 5-5 Deployment Cost Estimate by Phase

PHASE	TOTAL
1	$4,794,750
2	$7,092,075
3	$3,949,500
Grand Total	**$15,836,325**

The order of magnitude cost estimate for the Master Plan implementation is $15,836,325. The quantities in the estimate were obtained using information from the GIS database and aerial photography. Quantities for conduit were increased by 10% and fiber optic cable by 25% to account for unknown factors. This cost includes a construction contingency of 25% and soft costs such as engineering, project management, and construction management. The breakdown for each phase and item number is included in **Appendix E**.

The goal of the Master Plan is to provide a citywide fiber optic communications network with state-of-the-art traffic signal communications devices and systems. Financial constraints typically necessitate partial phase implementation. If funding is limited, the focus should start at the TMC and move outward. Intersections along major corridors should be prioritized first before implementing upgrades to intersections on less critical streets.

5.8 Connection to City Facilities

Establishing a citywide fiber optic traffic signal communication system provides opportunities to connect other facilities throughout the City. These include City Hall, police stations, fire stations, libraries, and parks. The facilities can be connected to the fiber optic network individually as the system expands to adjacent corridors and intersections. The integration of the facilities by phase are shown in **Figure 5-6**. A cost estimate for the deployment of facility connections is shown in **Table 5-6** below.

Table 5-6 Deployment Cost Estimate of Connection to City Facilities

PHASE	TOTAL
1	$80,850
2	$254,400
3	$641,400
Grand Total	**$976,650**

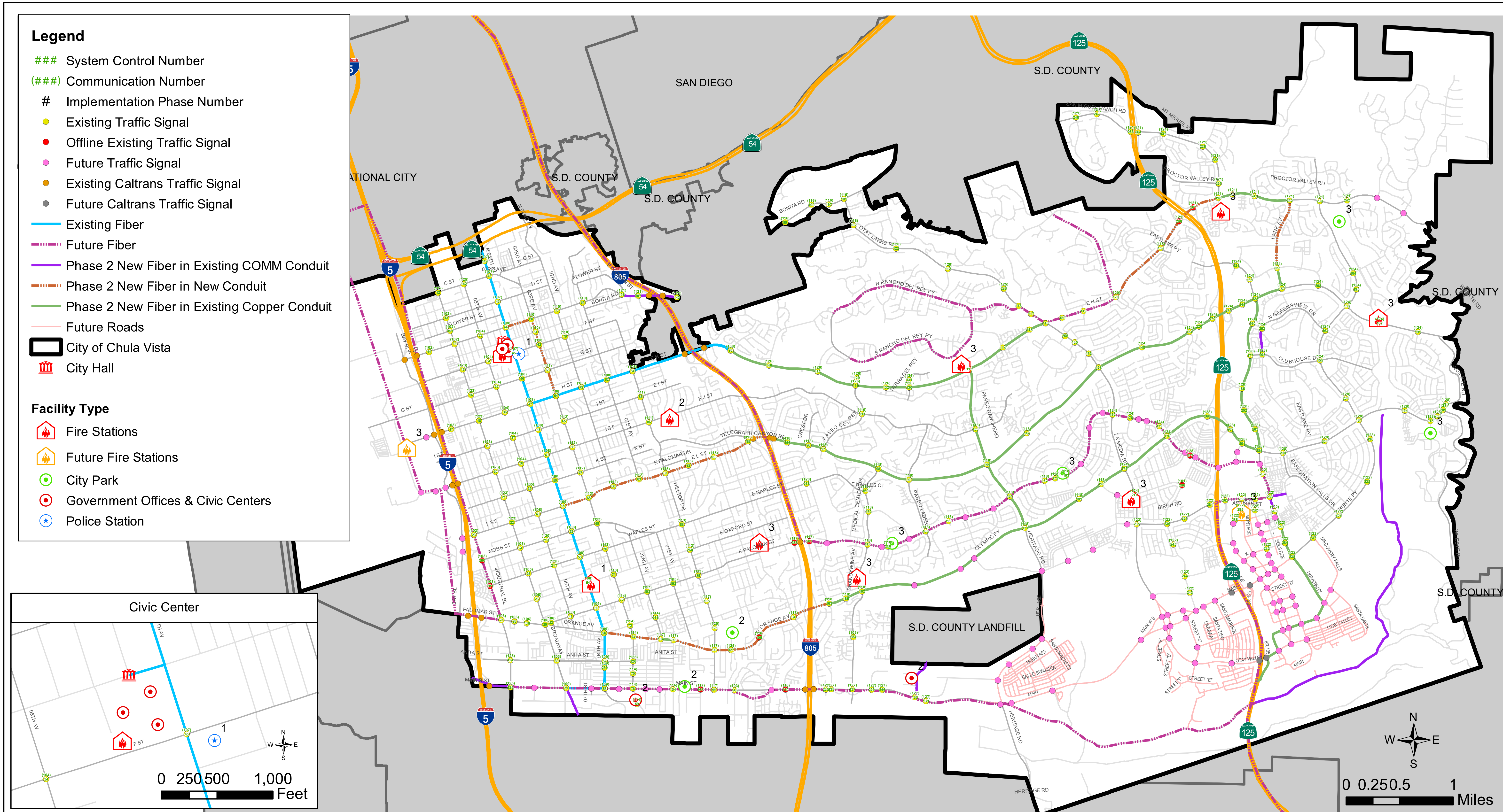


Figure 5-5 Communications System Extension per City Facilities

Document Path: S:\Projects\Chula Vista\0347_Chula Vista Traffic Signal Communications Master Plan\04 Design\GIS\MXD Files\Chula Vista Comm Phase Implementation Figures.mxd

5.9 Funding Sources

The City of Chula Vista's Capital Improvement Program (CIP) budget for traffic signal and street related projects is primarily supported by the Transportation Sales Tax (TransNet) and Gas Tax. The City's Transportation Development Impact fees and Transportation grants from the Active Transportation Program (ATP) and Federal Highway Safety Improvement Program (HSIP) also provide funding. Potential funding sources for the City's Traffic Signal Communications Master Plan are identified in the following.

5.9.1 Transportation Sales Tax (TransNet)

Established in 1988, the Transportation Sales Tax (TransNet) is a half-cent sales tax collected by the State of California that is dedicated to transportation improvements in the San Diego region. The program was extended in 2008 for 40 years for $14 billion. The regional metropolitan planning agency, San Diego Association of Governments (SANDAG), allocates funds to municipalities within San Diego County and supports highway, transit, and local street improvements. SANDAG administers funds, as determined by the SANDAG Board of Directors, based on the locally adopted Regional Transportation Plan (RTP), which is updated every three years[1]. Majority approval from the SANDAG Board of Directors and identification of need, as demonstrated in this document, is required to commit TransNet revenue for future deployment of Traffic Signal Communications Master Plan projects.

5.9.2 General Use Sales Tax

Measure P, a temporary half-cent general use sales tax, was approved by voters in Chula Vista. The tax went into effect April 1, 2017 and is expected to generate about $160 million over a 10-year period to repair, replace, and update failing/obsolete City infrastructure including streets, storm drains, public safety equipment, and parks. The tax revenue will be part of the City's General Fund and a citizen oversight committee will be responsible for annual spending plans, accounting, and advising[2].

5.9.3 Gas Tax

Voters approved Proposition 42, utilizing sales tax on fuel to provide funding for City street improvements. These funds have primarily served to augment the City's annual pavement rehabilitation efforts but has also included street reconstruction projects[3].

5.9.4 Development Impact Fees (DIF)

Development Impact Fees (DIF) are collected to mitigate the impact of new development to maintain existing levels of services throughout the community.

5.9.4.1 Transportation Development Impact Fee (TDIF)

The City of Chula Vista Transportation Development Impact Fee (TDIF) Program was established in 1988 and collects development impact fees to be used for constructing transportation facilities to accommodate increased traffic generated by new development within the City's eastern territories[4].

5.9.4.2 Traffic Signal Fee

The City's Traffic Signal Fee is a trip-based development impact fee associated with the issuance of building permits for new construction. This fee can be utilized for the installation and upgrade of traffic signals throughout the City, including traffic signal modifications and pedestrian improvements[5].

5.9.5 City General Funds/Capital Improvement Program

The City of Chula Vista's proposed budget for fiscal year (FY) 2017-2018 includes a CIP budget of $73,871,967 for capital improvement projects citywide. The forecasted five-year CIP program budget is estimated at $133,310,588. The FY 17/18 CIP budget is larger than typical due to Measure P funds. **Table 5-7** provides a summary of forecasted CIP budgets[6]. However, the CIP budgets are subject to change based on new grant opportunities and/or additional Measure P funds.

Table 5-7 FY 17/18-FY 21/22 Forecasted CIP Budget

FY 17/18	FY 18/19	FY 19/20	FY 20/21	FY 21/22	TOTAL
$73,871,967	$15,846,025	$16,265,806	$15,052,802	$12,273,988	$133,310,588

Roadway infrastructure is a major investment of the CIP funds with the bulk allocated to street repairs and other hardscape improvements. To achieve funding for the improvements identified by the Master Plan, a prioritization and recommendation for adoption in the next fiscal year CIP budget and/or as a reassignment of funds in the current fiscal year's budget is necessary.

5.9.6 Grant Opportunities

Grant opportunities for various types of transportation and roadway related infrastructure improvements are available. The most applicable grants for funding the Master Plan improvements are as follows:

5.9.6.1 Community Development Block Grant (CDBG) Funds

The City receives annual Community Development Block Grant (CDBG) funds for community development activities, including capital improvement projects. The bulk of the funds are allotted to the completion of the Castle Park Infrastructure Projects however, approximately $300,000-$500,000 are available for other capital improvement projects, including roadway related projects, annually for the next 14 years [7].

5.9.6.2 Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD)

The Fixing America's Surface Transportation Act (FAST Act) established the Advanced Transportation and Congestion Management Technologies Deployment Grant Program to develop model deployment sites for large scale installation and operation of advanced transportation technologies. The goal of the program is to improve safety, efficiency, system performance, and infrastructure return-on-investment. Funds are obtained through the Highway Research and Development, Technology and Innovation Deployment, and Intelligent Transportation System Research Programs and $60 million dollars is authorized for each fiscal year from 2016 to 2020. It is recommended that the City apply for future grant funding opportunities for innovative transportation technologies identified in the Master Plan that meet the required criteria[8].

5.9.6.3 Highway Safety Improvement Program (HSIP)

The Map-21 Highway Safety Improvement Program (HSIP) is a data-driven strategic approach to improving highway safety on all public roads. Performance-based, this program achieves a significant reduction in traffic fatalities and serious injuries on all public roadways. A highway safety improvement project is any strategy, activity, or project on a public road that is consistent with the data-driven State Strategic Highway Safety Plan (SHSP) and corrects or improves a hazardous road location or feature or addresses a highway safety problem[9]. It is recommended that the City apply for HSIP funding as improvements recommended in the Master Plan qualify for the grant. Also notable is the staff time required to apply for and administer the grant. Additionally, funding matches by the City may be required dependent on project improvements.

5.9.7 Assembly Bill 1447

Assembly Bill 1447 was passed on August 20, 2014 and clarifies that synchronization projects can qualify for money raised by the California Cap-and-Trade program, which seeks to cut greenhouse gas emissions. The carbon marketplace has generated approximately $5 billion in revenue since initiated in 2012[10]. The Cap-and-Trade program money is held by the Greenhouse Gas Reduction Fund. The Master Plan improvements qualify for funding through this legislation with the recommended technology being proven to reduce Green House Gasses (GHG's). As the process for administering these funds for traffic synchronization projects is determined, the City should present Master Plan improvements for funding.

5.9.8 Partnerships

Rising demand for high speed communication has increased the rate of telecommunication installation and upgrades in both the public and private sectors. Utilizing partnerships with interested parties could advance the Master Plan build. Each entity is unique and the best approach to partnering will depend on the factors involved.

5.9.8.1 Public-Private Partnership

As private companies and public agencies expand their telecommunication networks in Chula Vista, there may be opportunities for the City or private company to partner and cost share the installation and expansion of network infrastructure. The City should develop a policy to review planned installations of utilities within the City and cross reference the Master Plan for overlapping locations or additional routes for redundancy.

It is important that the City maintain control over its facility. Maintenance access, expansion, and future allocations require as high a degree as possible of physical separation. Order of precedence for infrastructure installation through public-private partnerships is as follows:

- Install City-owned conduit, vaults, and cable. This is most desirable and most expensive and unless associated with new construction can be cost prohibitive.
- Install separate cable in shared conduit and separate splice enclosures.
- Install shared cable and for proper segregation and maintenance of the system the minimum granularity of fiber designated for City allocation should be 12 (a complete buffer tube).
- If existing cable and limited fiber strands designate a minimum of 4 fibers for the City.
- The least desirable arrangement is sharing the same fiber with non-City entities.

Development projects should be conditioned to implement communication systems infrastructure as part of the overall facilities improvement requirements. This includes communications ducts, cable, splice vaults, and connectivity to City facilities.

5.9.8.1.1 Small Cell Networks

The telecommunications industry is utilizing small cell networks to expand wireless carrier network coverage and increase capacity for both voice and data across new generation mobile phone technology and Wi-Fi networks. In comparison to traditional cell towers, small cell networks utilize smaller nodes that require lower power and cover smaller areas. Increased node density enables larger coverage areas with more capacity than a traditional cell tower can provide. Nodes are installed on existing infrastructure such as telephone poles or street lights and connected to a central hub by fiber optic cable. This provides local agencies with opportunities to partner with private companies and receive infrastructure improvements in exchange for furthering current telecommunications company pursuits. For example, an agency could allow installation of nodes on City-owned street lights and fiber optic cable in City right-of-way in exchange for City-owned conduit and fiber optic cable installed by the private company. Different agreements of different magnitudes, such as full-funding or shared-cost partnerships, can be made. Small cell network partnerships can provide a good opportunity for an agency to obtain needed infrastructure at reduced costs outside of the CIP process.

5.9.8.2 Public-Public Partnerships

Like public-private partnerships there are opportunities to construct communications infrastructure through public-public partnerships. These would be interdepartmental projects within the City with Parks/Recreation, Wastewater, IT, Police/Fire, and Public Works. These would also be regional or adjacent agency projects such as SANDAG, Caltrans, MTS, Port of San Diego, and the City of San Diego. Any construction that requires opening a trench in the public Right-of-Way is an opportunity for the City to have a conduit and vaults installed at no cost or a shared cost since the cost of construction is already incurred.

Additionally, existing and future street lighting system conduit should also be considered for establishing communications to traffic signals, other City Departments, and/or for Smart City initiatives.

5.10 Procurement and Delivery Methods

The City of Chula Vista's traffic signal communications system procurement choices impact deployment effectiveness and Return on Investment (ROI). Procurement and delivery methods include: best value procurement, design-bid-build, design-build, and system manager-integrator. The challenge associated with choosing the optimum procurement and delivery method lies in tailoring the specific work into bid packages and projects that achieve balance in technical complexity, system quality, cost savings, and deployment schedule. Many of the Master Plan systems are able to be deployed incrementally by system as well as all at once by a given area or group of areas. Contracting options are as follows:

5.10.1 Best Value Procurement

The Best Value Procurement process includes an analysis of technical alternatives to identify potential new systems that flow into a set of system requirements, becoming a technical specification. These technical specifications are incorporated into the "best-value" bid packages for equipment procurement. This typically results in reduced pricing as vendors compete with one other for equipment purchase agreements directly with the agency rather than through a contractor. The best value bid packages and equipment purchase agreements enable rapid system procurement of desired elements, ultimately benefiting the schedule significantly in comparison to typical bid advertisement processes. The systems can be installed and integrated by agency staff, the agency's on-call consultant firm, and/or a contract maintenance company[11].

5.10.2 Design-Bid-Build

Design–Bid–Build (D-B-B) is the traditional project delivery method where the agency contracts with separate entities for the design and construction of a project. The three main phases that occur sequentially during the D-B-B method include: design phase, bidding phase, and construction[12]. This delivery method can be used effectively to deploy physical Master Plan components such as communications infrastructure (conduit systems, fiber optic cable, pull boxes, etc.), foundations, and structure. However, it may not be suited for ITS projects involving software development, computer hardware, system integration, and system configuration. This method may be counterproductive for ITS applications as they cannot be effectively separated into design and construction services. The lowest bid may result in a contractor that is incapable of performing the required ITS-related services.

5.10.3 Design-Build

The Design–Build (D–B) project delivery method includes the contract of design and construction services by a single entity known as the design-build contractor. This contrasts from the Design-Bid-Build project delivery method in that the Design-Build utilizes a single point of contract responsibility, minimizing risks for the project owner and reducing the delivery schedule by overlapping the design and construction phases of the project. One single contract is awarded to a design-build team who is responsible for[13]:

- System engineering, design, and specifications.

- Procurement and provision of all products, systems, and services.
- Construction of all system elements.
- Testing, inspection, and integration of various subsystems.

Proceeding with the Design-Build project delivery method depends on agency policy and implementation timelines, and well-defined functional specifications. Project costs associated with D-B delivery method are typically higher due to the contractor taking on greater responsibility. This method may also result in engineering decisions being influenced by the builder in a contest of best design versus cost.

5.10.4 System Manager – Integrator

The System Manager-Integrator (SM-I) delivery method includes a consultant, under an engineering and design services contract, that performs or oversees the performance of all system/project engineering, design, interface, integration, and configuration functions while one or more contractors, under a construction contract, performs all related construction activities. This project delivery method combines design and implementation of work components under one contract including: testing, integration, configuration, and procurement support. These components of work are the most complex and require advanced expertise but are typically small in terms of total project costs. The System Manager-Integrator services are procured based on qualifications which enables the agency to have a high degree of control through a single point of management [14].

5.11 Master Plan Cost and Benefit Analysis

Implementation of the Master Plan is an investment in traffic systems technology that will improve traffic management, promote an environment for economic growth, and increase quality of life for Chula Vista residents. Implementation phasing costs, travel time, fuel, and emissions benefits were analyzed and a significant return on investment was identified.

5.11.1 Master Plan Costs

The annual Master Plan investment is summarized by phase in **Table 5-8** and on **Figure 5-6**. Phase 1 prioritizes City-owned communications infrastructure and ITS elements including CCTV cameras, fixed and portable CMS's, and a Sattelite TMC at the City's Traffic Signal Maintenance facility. Phase 2 upgrades twisted pair copper in existing conduit and wireless communications to fiber optic communications and upgrades priority corridors with the 2070 ATC controller platform and CCTV cameras. Phase 3 upgrades remaining signals to the 2070 ATC platform and converts analog video detection to Ethernet. ITS elements for Phase 3 also include CCTV cameras.

Table 5-8 Master Plan Spending by Phase

YEAR	PHASE 1		PHASE 2		PHASE 3		TOTAL
	COMM'S	ITS ELEMENTS	COMM'S	ITS ELEMENTS	COMM'S	ITS ELEMENTS	
1	$1,354,150	$244,100	-	-	-	-	$1,598,250
2	$1,354,150	$244,100	-	-	-	-	$1,598,250
3	$1,354,150	$244,100	-	-	-	-	$1,598,250
4	-	-	$1,635,019	$138,000	-	-	$1,773,019
5	-	-	$1,635,019	$138,000	-	-	$1,773,019
6	-	-	$1,635,019	$138,000	-	-	$1,773,019
7	-	-	$1,635,019	$138,000	-	-	$1,773,019
8	-	-	-	-	$544,500	$772,000	$1,316,500
9	-	-	-	-	$544,500	$772,000	$1,316,500
10	-	-	-	-	$544,500	$772,000	$1,316,500
Subtotal	**$4,062,450**	**$732,300**	**$6,540,075**	**$552,000**	**$1,633,500**	**$2,316,000**	**-**
Total	**$4,794,750**		**$7,092,075**		**$3,949,500**		**$15,836,325**

5.11.2 Master Plan Benefits

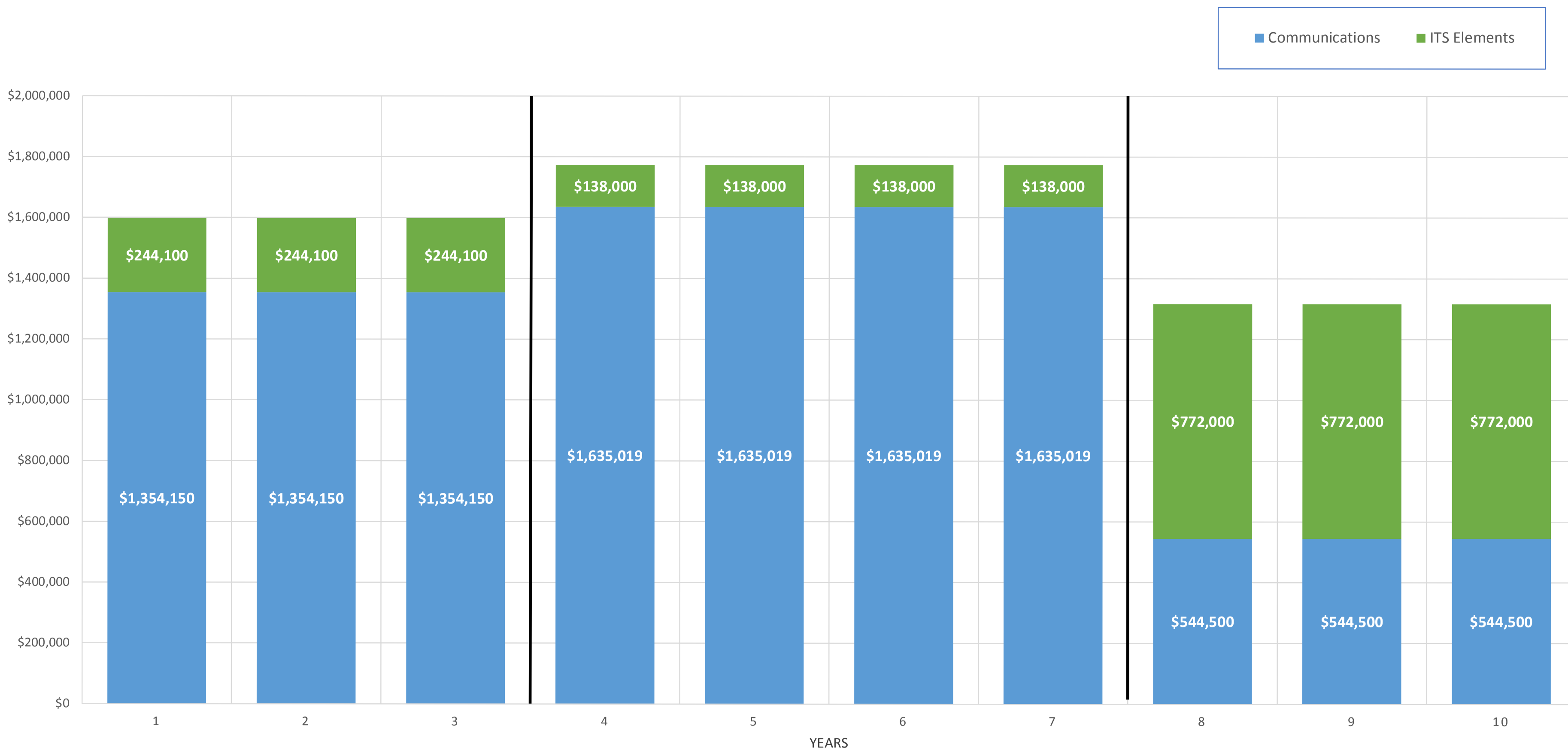
Annual benefits for travel time, fuel consumption, and Carbon Monoxide emissions were estimated based on Phase 1 implementation. **Table 5-9** below provides a summary of the annual Phase 1 monetary benefit saving in comparison with the annual Phase 1 implementation costs.

Table 5-9 Phase 1 Benefit Summary (Per Year)

# OF INT[1]	TT[2] (HR)	FUEL CON[3] (GAL)	CO EMISS[4] (MT CO_{2E})	TT SAVINGS[5]	FUEL SAVINGS[6]	CO EMISS SAVINGS[7]	PHASE 1 ANNUAL SAVINGS	PHASE 1 ANNUAL COST	BENEFIT : COST
267	-1.399M	-34.223M	-28,755	$764,107	$99.931M	$3,306,769	$104.002M	$1.598M	65

INT=Intersections, TT=Travel Time, CON=Consumption, EMISS=Emissions

1. Total number of intersections affected during Phase 1.
2. Hours spend in traffic in Chula Vista (46.2 hours per year per traveler) based on the INRIX 2016 Global Traffic Scorecard. 76% of the City's population drives to work based on data from Zip Atlas. 15% typical improvement in travel time for synchronization per ITE Typical Savings.
3. Fuel saved per intersection of 7,835 gallons/day with 260 work week days based on Fuel Savings from Retiming for 140 traffic signals with existing coordination timing. Typical 12% reduction in fuel usage based on signal synchronization per ITE Typical Savings.
4. Average CO2e of 41,078 lbs per 200 signals based on average savings documented from LADOT and OCTA's signal synchronization projects.
5. Travel Time savings of $16.79/hour of person travel based on 2015 Urban Mobility Report per Texas A&M Transportation Institute.
6. Fuel Consumption savings of $2.92 based on CA State average cost/gallon of gasoline and diesel per US Energy Information Administration.
7. CO emissions savings of $115/ton based on Highway Economic Requirements System Technical Report per US Department of Transportation.



CITY OF CHULA VISTA

Figure 5-6 Annual Master Plan Investment by Phase

TRAFFIC

S:\Projects\Chula Vista\0347_Chula Vista Traffic Signal Communications Master Plan\06 Excel-Calcs\Cost Benefits Analysis

5.11.3 Cost Effectiveness

Based on the cost-effectiveness methodology presented above, the resulting annual benefit-cost ratio for implementing Phase 1 is 65:1. This indicates that improvements would yield benefits of $65 dollars for every $1 dollar spent. With cost savings exceeding the State and National benefit-cost ratio range of 20 to 60:1 ROI for Phase 1 alone, the monetary investments identified in the Master Plan are poised to be recaptured many times over for both economic and social benefit.

5.11.4 Master Plan Maintenance

The Master Plan maps should be kept updated every 6 months to reflect changes in the system topology and architecture. This will require transfer of the GIS files developed for the Master Plan and coordination with the City's Information Technology Services GIS group. A full review and update of the Master Plan should take place every 5 years as an addendum to the original document.