SMART REGION

CITY OF ELK GROVE

TECHNOLOGY IMPLEMENTATION PLAN

FINAL

February 2019

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List of Abbreviations

ATMS – Advanced Transportation Management System
ATP – Active Transportation Program
ATSPM – Automated Traffic Signal Performance Measures
CCTV – Closed Circuit Television
CIP – Capital Improvement Program
CMAQ – Congested Mitigation and Air Quality Improvement
CMS – Changeable Message Signs
CV/AV – Connected Vehicle/Automated Vehicle
GIS – Geographical Information System
ITIP – Interregional Transportation Improvement Plan
ITS – Intelligent Transportation Systems
MPO – Metropolitan Planning Organization
MTP – Metropolitan Transportation Plan
O&M – Operations and Maintenance
PTZ – Pan-tilt-zoom
RSTP – Regional Surface Transportation Program
RTIP – Regional Transportation Improvement Plan
SACOG – Sacramento Area Council of Government
SCS – Sustainable Communities Strategy
SHA – State Highway Account
SOV – Single Occupancy Vehicle
STARNET – Sacramento Transportation Area Network
STIP – State Transportation Improvement Plan
TMC – Traffic Management Center
VMT – Vehicle Miles Travelled

SMART REGION SACRAMENTO

City of Elk Grove TECHNOLOGY IMPLEMENTATION PLAN EXECUTIVE SUMMARY

February 2019

Transportation management is growing in terms of technology, software, and applications. The future of transportation includes connected vehicles, autonomous vehicles, decision-making based on performance metrics, and a committed focus on more effective operations and management of systems rather than just capital improvements. There is no way to build the way out of congestion, the only way to effectively improve mobility is to manage it better.

The City of Elk Grove is one of eight agencies that is contributing to the Sacramento Area Council of Governments' (SACOG's) Smart Region Sacramento: Intelligent Transportation System (ITS) Architecture and Future Technology Project (referred to as Smart Region Sacramento). This Technology Implementation Plan provides the City of Elk Grove with the framework necessary to proactively and positively affect how residents and all travelers move within and access the City transportation network. This framework and its resulting tools, if prioritized and managed well by the City, will assist with every aspect of City public service: mobility, incident response, efficient maintenance, and cost savings across the City's bottom line. Because technology investments are low-cost compared to capacity-related projects and offer potentially significant benefits to the broad transportation system and its users, prioritizing technology investments supports the vision of an integrated and reliable transportation system.

Goals and Objectives

The City of Elk Grove participated in the development of this Technology Implementation Plan that follows the Smart Region mission statement intended to clearly define the path toward technology investments and resources moving forward from 2019.

SMART REGION MISSION STATEMENT: To improve system performance, safety, sustainability, and reliability by ensuring efficient investments in regional smart transportation projects.

The City of Elk Grove Smart Mobility Objectives include:

- Identify projects to improve City's communications network to connect all field devices and more effectively manage City's transportation system
- Evaluate ways to improve efficiency of operations and maintenance
- Develop staffing plan to include recommendations on staffing levels and requisite skillsets for engineering and technical staff
- Evaluate the various subsystems (traffic signals and CCTV cameras) and identify strategies to integrate into one centralized system
- Identify implementable strategies to improve coordination and communication with neighboring agencies (Caltrans, City of Sacramento, and Sacramento County) to enhance regional traffic management

The Smart Region Objectives include:

- Accommodate Different Communities Throughout the Region (Urban, Suburban, Rural, and Underserved)
- Adapt the Region to New Technology
- Achieve Consistency and Reliability for all Modes
- Increase Safety
- Improve Traveler Information Dissemination
- Improve Emergency/Disaster Preparedness

System Needs

The City is challenged with significant gaps that are inhibiting the system from addressing operational and management goals. System needs are identified by Infrastructure/Data (D), Operational (O), and Institutional (I) categories:

- D1: Baseline communications infrastructure
- D2: Robust coverage to acquire real-time conditions
- D3: Support active transportation operations
- D4: Reliable communications to prevent system downtime
- D5: Maintainable infrastructure and assets
- D6: Adequate bandwidth in communications for data sharing
- D7: High-resolution traffic data for real-time operational decision making
- D8: Real-time travel time data for operations
- D9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- D10: Reduce impact of light rail preemption on traffic mobility
- D11: Share data between agencies that share a corridor
- D12: Encourage travel mode shift
- D13: Real-time traveler information
- D14: Use data to support planning purposes
- D15: Improve data quality/reliability
- D16: CV/AV technology readiness
- D17: Leverage and bolster private sector traveler information services
- O18: Integrate central systems and subsystems
- O19: 24X7 access to central systems
- O20: Trained staff to support operations
- O21: Share regional operations and maintenance responsibilities
- O22: Improve traffic operations
- O23: Improve special event coordination
- O24: Better incident coordination across jurisdictions and with public safety
- I25: CV/AV policy readiness
- I26: Funding strategy
- I27: Consistent CAD systems across public safety agencies

SMART REGION SACRAMENTO

City of Elk Grove TECHNOLOGY IMPLEMENTATION PLAN EXECUTIVE SUMMARY

February 2019

Determining the Path Forward

Traffic operations and management technology is constantly advancing and evolving, which makes it an important consideration during the formulation of implementation strategies. It is crucial that the implementation process takes full advantage of the existing ITS technologies available while also formulating strategies that align with where technological advancements may be heading. The following are current technology trends that were evaluated for applicability in addressing needs and gaps:

- *Big data* – more data collected from roads, vehicles, and other sources
- *Transportation network carriers* – rideshare services
- *Connected vehicles* – field infrastructure and policies for data sharing
- *Autonomous vehicles* – vehicle fleets, availability, additional data
- *Smart wayfinding and citizen engagement platforms* – smart kiosks
- *Adaptive traffic signal control* – signals that can retime themselves
- *Traffic signal performance metrics* – software that finetunes how traffic signal timing serves the traveling public
- *Vehicle-to-everything communications* – data exchange
- *Internet of things* – connected devices that communicate in new ways
- *Electrification* – electric vehicles and charging stations
- *Multi-modal considerations* – on-board and fleet transit technologies

Determining the priority of which strategies are applicable to the City of Elk Grove requires a careful evaluation of not only the existing conditions of the region (the infrastructure available, the data available, and the propensity for agencies to adopt certain technologies over others) but also the available technology trends that lend themselves toward potentially being solutions to the needs of the City of Elk Grove.

Deployment Strategies

Strategies were developed and prioritized based on the City's conveyed needs and will aid in the phasing of future technology deployments and investments in the future of a Smart Region. Eight foundational project corridors are recommended to be outfitted with technology which generally include enhanced communication infrastructure, deployment of vehicle video detection, installation of traffic monitoring cameras, installation of changeable message signs, installation of connected vehicle radio units, improved signal timing, and traffic signal controller upgrades. Other strategies were developed to improve processes, outline standard operating procedures, or prepare for a future of connected and autonomous vehicles.

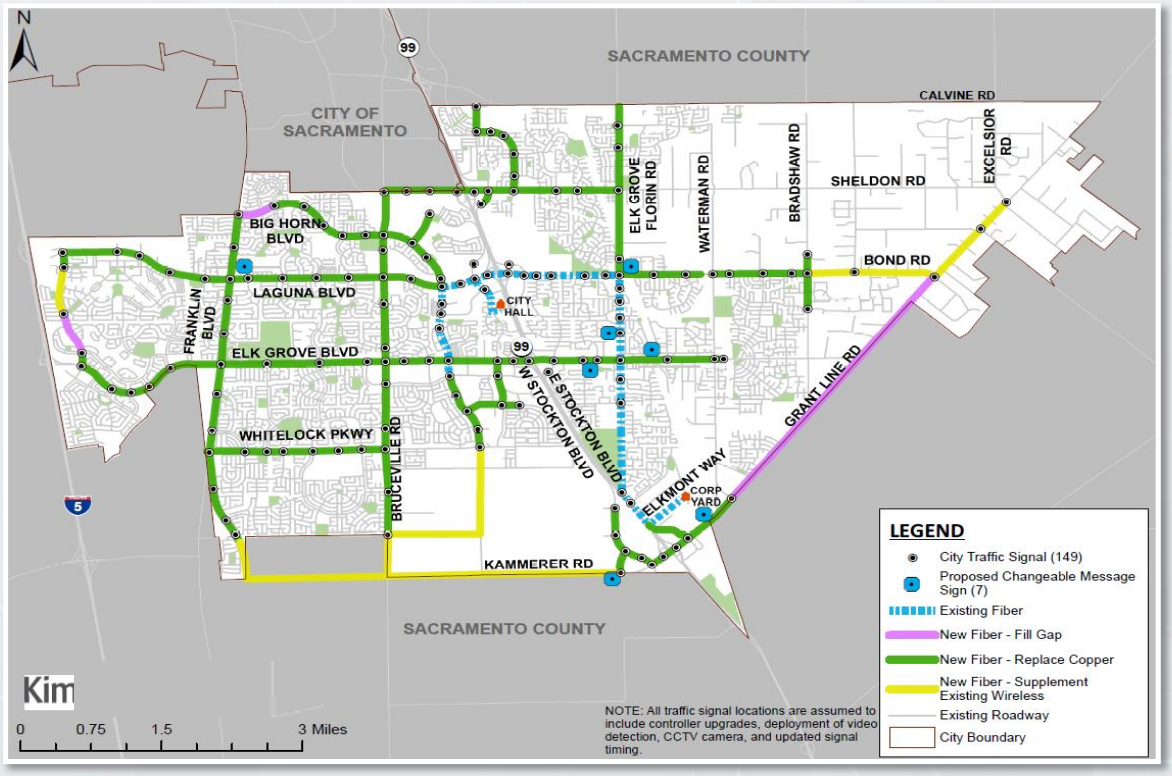
Operations & Maintenance

The major elements of the future network include:

- 44 miles of fiber optic communications
- 123 traffic monitoring cameras
- 8 traffic information signs
- 15 upgraded traffic signal controllers
- 147 traffic detection devices

To effectively operate and maintain the various project elements and projects identified, this Plan includes guidance for staffing resources necessary to support operations and maintenance activities recommended to maximize investment in assets.

Exhibit ES-1– *Ultimate ITS Infrastructure Buildout*



INTRODUCTION

Why Pursue Strategic Investments in Smart Mobility

This Technology Implementation Plan provides the City of Elk Grove with the framework necessary to proactively and positively affect how residents and all travelers move within and access the City transportation network. This framework and its resulting tools, if prioritized and managed well by the City, will assist with every aspect of City public service: mobility, incident response, efficient maintenance, and cost savings across the City's bottom line. Because Intelligent Transportation System (ITS) investments are low-cost compared to capacity-related projects and offer potentially significant benefits to the broad transportation system and its users, prioritizing ITS investments supports the vision of an integrated and reliable transportation system.

Transportation management is growing in terms of technology, software, and applications. The future of transportation includes connected vehicles, autonomous vehicles, decision-making based on performance metrics, and a committed focus on more effective operations and management of systems rather than just capital improvements. There is no way to build the way out of congestion, the only way to effectively improve mobility is to manage it better. Continuing to build lanes and add capacity will become more and more restricted and ITS Programs will continue to mature in their capability to actively manage traffic (both reactive and proactive management), incidents, events, and work zones.

It is acknowledged that there is an expectation from travelers that a City's transportation system is equipped with the tools to move people as efficiently and safety as possible, yet the public rarely understands what is involved in implementing these tools. This Technology Implementation Plan provides the City of Elk Grove with the opportunity to enhance their existing ITS Program with a solid foundation of strategic and necessary infrastructure enhancements, in combination with collaborative growth across the SACOG region, in operations and management capabilities.

This Plan is intended to be a strategic direction for the City to plan for capital and operational investments. External stakeholders will see benefit in this Plan as providing a direction of where development, design standardization, and anticipated technologies and piloting innovation will be part of the City's investments.

City of Elk Grove Technology Implementation Plan

The City of Elk Grove is one of eight agencies that is contributing to the Sacramento Area Council of Governments' (SACOG's) Smart Region Sacramento: ITS Architecture and Future Technology Project (referred to as Smart Region Sacramento). The eight partner agencies participating in this regional program are:

- City of Sacramento
- City of Citrus Heights
- **City of Elk Grove**
- City of Rancho Cordova
- City of Folsom
- Sacramento County
- El Dorado County
- Caltrans District 3

MISSION STATEMENT

To improve system performance, safety, sustainability, and reliability by ensuring efficient investments in regional smart transportation projects.

Development of the Smart Region plan follows a methodical Systems Engineering approach illustrated in **Figure 1**.

The initial discovery phase included a comprehensive review of adopted regional and local plans, existing transportation infrastructure, existing assets, and a definition of program needs. Gaps were then identified for the region and individual agencies based on the existing conditions and input received from agency stakeholders at one-on-one meetings and the Concept of Operations group workshop. These initial phases established a benchmark for what the various agencies currently have and defined the needs and deficiencies for the transportation system for each agency and the region as a whole. This document culminates with a roadmap in the form of a list of implementable projects that close the gaps and fulfill the needs of the City.

On a separate and related path, the Concept of Operations was developed to document the parameters in which the system will function, define stakeholder roles and responsibilities, and outline data usage expectations.

Elk Grove participated in developing this plan and provided input to all stages of the Smart Region Sacramento program development. Information and details presented in this Technology Implementation Plan incorporate and build on the current infrastructure deployment projects and objectives to update the City's overall strategy going forward.

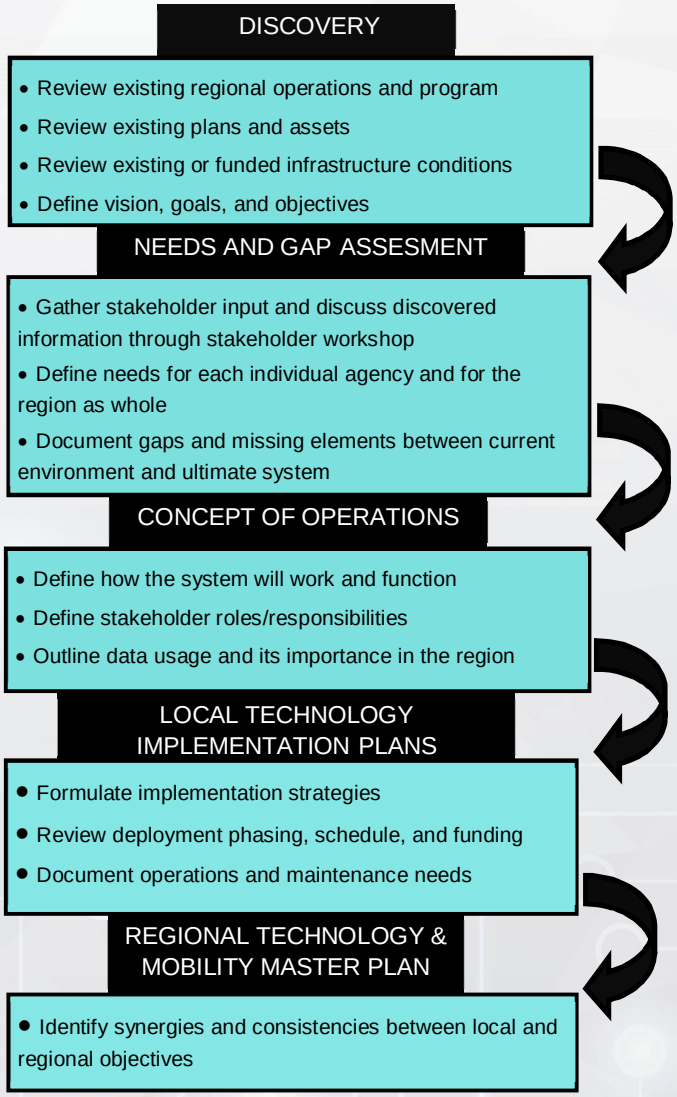


Figure 1 – Smart Region Sacramento Development Process

Additional background information was gathered from the City to enhance the previous work. This included the following:

- **One-on-one and group meetings** – At the one-on-one stakeholder meeting held in March 2018, the City's existing transportation system and ITS infrastructure was discussed. The City expressed its primary vision of the project to ***enhance its transportation system utilizing emerging transportation technologies while leveraging its existing assets to allow staff to be better equipped to proactively manage traffic***. The City has experienced rapid growth in recent years and is seeking opportunities to improve its traffic management strategies along several critical arterial corridors including Elk Grove Boulevard, Laguna Boulevard, and Bond Road.

The City expressed that they have limited resources for proactive management and maintenance of the transportation system infrastructure. This causes inefficient and unreliable system operations.

- **Documents/Plans** – A variety of documents and plans were gathered to support the background understanding of the City's current infrastructure, programs and capabilities. The City's previous Intelligent Transportation Systems Master Plan (November 2004) was reviewed in addition to City provided documentation on CCTV camera locations, GIS maps, network communications diagram, traffic signal locations and inventory information (cabinet, controller, communications). Regional documents that represent multiple jurisdictions were also collected, an example of which is the Caltrans ICM plans. Software systems and applications used by the agencies were also evaluated.

Document Organization

This document includes the following primary sections:

- **Vision, Goals, and Objectives** – Summarizes the guiding principles for developing the Plan.
- **Existing Conditions** – Summarizes existing field devices, system performance, and operations and maintenance performance.
- **Needs and Gaps Assessment** – Discusses and tabulates the City of Elk Grove's Needs and Gaps Assessment.
- **Determining the Path Forward** – Provides a link between needs and gaps assessment and how implementation projects were developed.
- **Implementation Project Development** – Describes the methodology for grouping strategy elements into implementable projects for delivery.
- **Deployment Prioritization** – Provides information on how projects are prioritized based on 10 criteria.
- **Funding** – Describes regional, state, and federal funding opportunities for ITS Projects.
- **Operations and Maintenance** – Describes strategies for staffing and ongoing maintenance.
- **Performance Metrics** – Describes evaluation and performance standards that will be used to evaluate transportation system performance, traffic signal operations, safety, and maintenance.
- **Next Steps** – Describes how to use the results of the Technology Implementation Plan to develop and deliver projects.

PROGRAM GOALS AND OBJECTIVES

The overall regional goal of the Smart Region program is to improve system performance, safety, sustainability, and reliability by ensuring efficient investments in regional smart transportation projects. The goal of this local plan is to define a set of prioritized projects that enables the City of Elk Grove to advance the transportation network and fulfill the regional goal.

The City of Elk Grove has defined the following objectives for the Plan:

- Identify projects to improve City's communications network to connect all field devices and more effectively manage City's transportation system;
- Evaluate ways to improve efficiency of operations and maintenance of City's transportation system;
- Develop staffing plan to include recommendations on staffing levels and requisite skillsets for engineering and technical staff;
- Evaluate the various subsystems (traffic signals and CCTV cameras) and identify strategies to integrate into one centralized system; and
- Identify implementable strategies to improve coordination and communication with neighboring agencies (Caltrans, City of Sacramento, and Sacramento County) to enhance regional traffic management.

The Smart Region Plan has six key regional objectives that emerged as most critical throughout the project process, particularly during the strategy implementation phase. These six key objectives were crucial in guiding the strategy development process. The Smart Region objectives are:

- Accommodate Different Communities throughout the region (Urban, Suburban, Rural, Underserved)
- Adapt the region to New Technology
- Achieve Consistency and Reliability for all modes
- Increase Safety
- Improve Traveler Information Dissemination
- Improve Emergency/Disaster Preparedness

These primary objectives are important considerations throughout Smart Region development and implementation because they provide guidelines for identifying projects and creating performance measures to evaluate program efficacy. In addition, these objectives were helpful in determining strategy prioritization and deployment phasing priorities, which will be discussed in more detail later in this document.

EXISTING CONDITIONS

Traffic Signals

The City of Elk Grove currently owns, operates, and maintains a total of 149 traffic signals, the majority of which are located on key arterial and collector roadways. There are also 15 signals within or at the City limits which are jointly owned by the City and Sacramento County but are maintained by the County. The traffic signal controllers are a combination of Naztec 980 and 2070 controllers. The City recently completed controller replacements of all legacy Multisonic 820 controllers. The City uses Trafficware's ATMS.now traffic signal central management system to manage all traffic signals connected to the City's communications network. In addition to traffic signals, the City owns and maintains one (1) flashing beacon located on Sheldon Road. Key arterial corridors are currently running weekday peak period coordinated plans; however, these corridors have not been re-timed in over eight years. The majority of the City's traffic signals are currently operating free (uncoordinated).

The City's existing traffic signal inventory is provided in **Table 1** of **Appendix A. Exhibit 1** illustrates the locations of the existing traffic signals within the City.

Vehicle detection at signalized intersections is provided primarily using in-pavement loops while 24 intersections throughout the City utilize video detection. All locations with video detection locations use fixed cameras for each approach with the exception of Auto Center Drive and Lotz Parkway, which uses a recently installed Gridsmart fish-eye camera system. Based on the City's estimation, approximately 95 percent of the in-pavement loop detectors are currently functional.

Opticom, an infrared-based emergency vehicle preemption (EVP) system, is present at over 95 percent of the traffic signals in Elk Grove.

Communications Network

The City's existing communications network consists of a combination of 96-strand and 144-strand fiber optic cable (7.2 miles) and legacy copper signal interconnect cable (42.6 miles). The City's fiber optic network currently includes a 144-strand fiber optic cable trunk (backbone) located along Laguna Springs Drive, Laguna Boulevard, Elk Grove-Florin Road, and Bond Road that connects the City Hall building and the City Corporation Yard. There is legacy copper traffic signal interconnect cable along various arterial and collector roadways which provides communications to the City's connected traffic signals. **Table 1** below summarizes the City's existing communications network, including the type and length of the communications media.

Table 1 – Existing Communications Network Summary

Type	No. of Strands	Extent (Miles)
Fiber	96	1.5
Fiber	144	5.7
Wireless	N/A	10.1
Copper	Twisted strand	42.6

Closed Circuit Television (CCTV) Cameras

There is a total of 41 existing CCTV cameras located throughout the City of Elk Grove, with 22 of the CCTV cameras recently installed as part of the City's ITS Phase 4 project and a development project. Only two of the existing CCTV cameras are fixed cameras without pan-tilt-zoom (PTZ) capabilities. **Exhibit 2** of **Appendix A** depicts the location of the City's existing CCTV cameras.

Traffic Management/Operations Center

The City's Traffic Management Center (TMC) is located on the second floor of City Hall. The TMC enables City staff and operators to remotely monitor traffic conditions, implement signal timing changes, and respond to incidents and non-recurring congestion. There are two (2) 70-inch flat panel monitors that display traffic conditions and system status at a single workstation in the TMC. The hours of operation of the TMC are weekdays between 8:00 am and 5:00 pm.

System Performance

The City has communications to all existing traffic signals, but not to all CCTV cameras. Most corridors are currently connected via legacy copper signal interconnect and present limitations with regards to bandwidth, flexibility, and data reliability.

Arterial traffic management is a major component of the performance of the City's overall transportation system. Elk Grove Boulevard, Laguna Boulevard, and Bond Road are key arterials which have experienced significant traffic growth in recent years, and the traffic signals and coordination plans have not been re-timed in over eight years.

Limited resources for management of existing transportation system infrastructure has presented several challenges for the City. Detector failures have contributed to increased congestion along arterial and collector streets. Existing loop detectors occasionally experience issues in the field which require field support for maintenance. The City is migrating to deployment of video detection which is more reliable and offers the capability of remote maintenance and alerts for proactive management. Also, with limited City staff resources and aging and incomplete infrastructure, the City has limited ability to proactively manage its transportation network by monitoring system performance, performing signal re-timing, and collecting real-time traffic data and performance metrics.

NEEDS AND GAPS ASSESSMENT

The City of Elk Grove's Needs and Gaps Assessment process was conducted using a combination of methods. Existing documents and plans related to transportation and technology relevant to the City and the region were thoroughly reviewed. These needs and gaps form the foundation for identifying project solutions. The needs and gaps were identified and categorized by the following distinctions:

- **Infrastructure/Data (D)** – field infrastructure, communications equipment, data, systems/software
- **Operations (O)** – operational enhancement projects and processes, staffing
- **Institutional (I)** – policies, agreements, funding/programming mechanisms, reporting/documenting, training

Table 2 summarizes the City of Elk Grove's Needs and Gaps.

Table 2 – City of Elk Grove Needs and Gaps Summary

ID #	Need	Gap
	Infrastructure/Data	
1	Baseline communications infrastructure	Cannot communicate with all field devices due to lack of complete and robust communications network. Closing the three minor gaps in Elk Grove's communications network will create redundancy in the City's communications and replacing legacy copper communications with fiber will result in a more robust network.
2	Robust coverage to acquire real-time conditions	Lack of device coverage and range of devices to collect different types of data. Lack of video detection and CCTV camera equipment at all signalized intersections prevents the City from providing traffic-responsive signal timing and from adequately monitoring and sharing real-time conditions.
3	Support active transportation operations	Lack of bicycle detection and accessible pedestrian signals (APS) create unnecessary delays.
4	Reliable communications to prevent system downtime	Lack of redundant communications results in system downtime if communications are lost; no regional TMC backup or backup of TMS function capabilities to manage TMC from a remote location. ATMS.now data backup is currently being done by the City every day.
5	Maintainable infrastructure and assets	End-of-life/Legacy equipment with outdated functional capabilities and/or are no longer supported by vendors.
6	Adequate bandwidth in communications to support data sharing	Lack of bandwidth to support data sharing. City ATMS.now is not equipped to incorporate a variety of data large enough to receive automated alert notifications.
7	High-resolution traffic data for real-time operational decision making	Lack of performance measurement and analysis capabilities. Out-of-date signal controllers unable to support ATSPM software development and collect high-resolution traffic data. Lack of ATSPM software for data analytics.
8	Real-time travel time data for operations	Lack of real-time travel time data and of analytics software for real-time operations decision making.
9	Sharing of camera images to support pre-trip, en-route, and incident management purposes	Camera images and video footage are not shared with public or public safety agencies or partner agencies.
10	Share data between agencies that share a corridor	Lack of real-time or planned knowledge of corridor restrictions to operate efficiently across jurisdictions. Lack of regional data sharing policies and guidelines to establish data sharing protocol.
11	Encourage travel mode shift	Limited information available or disseminated to support mode shift. Lack of coordinated TNC locations for last-mile transit connections.
12	Real-time traveler information	Limited real-time traveler information available to public and limited methods to disseminate information. Limited CMS equipment for communication of traveler information.
13	Use data to support planning purposes	Limited data collected and limited use of data that is collected. Lack of Bluetooth readers for data collection at key locations.
14	Improve data quality/reliability	Unreliable uptime of devices to allow for operations. Lack of maintenance tracking system for device management.
15	CV/AV technology readiness	Infrastructure and systems are not currently able to support CV/AV deployments or data. Traffic signal controllers are not equipped to support CV infrastructure.

ID #	Need	Gap
16	Leverage and bolster private sector traveler information services	Inconsistency in data between agency services and third-party services. System data not available for use by other agencies. Lack of open data portal platform.
	Operations	
17	Integrate central systems and subsystems	Limited inter-agency data sharing, especially of speed data, vehicle tracking, and crashes.
18	24X7 access to central systems	Lack of remote access to systems during hours that TMC is not staffed.
19	Trained staff to support operations	Outdated or lack of skill set to support operational or maintenance needs. Lack of sufficient number of staff members to provide adequate IT and project management staffing.
20	Share regional operations and maintenance responsibilities	Agencies conducting traffic operations and maintenance independently causes lack of traffic coordination; lack of adequate staffing; lack of regional maintenance contract.
21	Improve traffic operations	Automate some functions to streamline operations. Current lack of adaptive traffic control and traffic signal coordination along key corridors.
22	Improve special event coordination	Lack of coordination to support better mobility during special events. This includes lack of TNC zones for last-mile connections.
23	Better incident coordination across jurisdictions and with public safety	Lack of multiagency coordination to support better mobility during incidents. Lack of CAD system and TMC connections for automated alerts and notifications, including lack of radio and TV connection in TMC.
	Institutional	
24	CV/AV policy readiness	Policies and codes currently do not support CV/AV.
25	Funding strategy	Lack of reliable funding mechanism to support Smart City or Smart Region initiatives on a regional or agency-by-agency basis.
26	Consistent CAD systems across public safety agencies	Inability and incompatibility to share CAD data and coordinate responses across public safety agencies.

DETERMINING THE PATH FORWARD

There are many directions that SACOG and the region could move toward in implementing solutions to address the needs and gaps. While some gaps point to specific types of strategies that will directly and completely address that gap, other gaps are more difficult to solve and will require a combination of infrastructure, operations, and institutional processes to be implemented to completely address the gap.

Traffic operations and management technology is constantly advancing and evolving, which makes it an important consideration during the formulation of implementation strategies. It is crucial that the implementation process takes full advantage of the existing ITS technologies available while also formulating strategies that align with where technological advancements may be heading. The following are current technology trends that were evaluated for applicability in addressing needs and gaps as defined for the Smart Region Program:

- **Big Data** is becoming readily available as more data is acquired from connected field infrastructure on a near-real-time-basis as well as additional data-rich information from new sources such as probe vehicles, fleet vehicles, and connected vehicles becomes more mainstream. Big Data is

about predictive analytics; or more simply, improving our ability to predict and anticipate outcomes. Historically, transportation data has been difficult and costly to obtain but as it becomes increasingly available through global positioning location tracking, phone apps, and many other sources this is quickly changing. Big Data is already changing the way we plan, analyze, and operate our transportation, and big data will play a large role in affecting the evolution of the Sacramento Transportation Area Network (STARNET).

- **Transportation Network Carriers (TNCs)** – TNCs pair passengers with drivers who provide on-demand service, most often via websites or mobile apps. Services such as Uber and Lyft are examples of the sharing economy. Increasingly, transit providers, including Sacramento Regional Transit (RT), are beginning to provide on-demand transportation services to augment their systems. These services have the potential to address the long-standing challenge of first-mile, last-mile service to expand the reach of existing bus and light rail service.
- **Connected Vehicle (CV)** readiness, both in terms of infrastructure and institutions, was identified as a need and yet full connected vehicle CV deployment is gradually becoming a reality in the industry. As a result, it is important that the partner agencies are equipped with the infrastructure and projects needed to adapt to those changes and needs. It is important to recognize the changing landscape of technology options with connected vehicles because the federal guidelines have not been finalized. Agency adoption of providing data to or collecting data from a connected vehicle will need to have benefits outlined and likely deployed on a scalable basis until more formal guidelines for adoption and expectations are defined.
- **Autonomous Vehicle (AV)** readiness, in terms of institutions and policies, was identified as a need as AVs are being tested on more and more roadways throughout the Country. Although functioning autonomously, there may be a variety of useful data that could be provided to the vehicle, collected by the vehicle, or shared between AVs that could require an agency role and responsibility.
- **Smart Wayfinding and Citizen Engagement Platforms –** Smart kiosks offer new, interactive ways for municipalities, business improvement districts, and marketing organizations to communicate with the public. Citizens and visitors use touchscreen displays to access a wide variety of information ranging from smart wayfinding and transit planning to locating nearby businesses and entertainment. Cities have the ability to broadcast important service announcements and relay emergency alerts enhancing public safety.
- **Adaptive Traffic Signal Control** enables traffic signals to proactively adjust signal timing parameters to accommodate unplanned variances in traffic demand. There are several adaptive systems in the market, each of which tends to accommodate specific corridor needs (e.g., maximize throughput, minimize side-street delay).
- **Automated Traffic Signal Performance Measures (ATSPM)** is a software module add-on to many traffic signal software applications that processes and analyzes traffic signal data to display and report performance metrics of an individual traffic signal, corridor, and/or across the traffic signal network. This feature enables agencies to proactively identify trouble areas, report on corridor performance, and facilitate efficient traffic management.
- **Vehicle-to-Everything (V2X) Communications** is becoming a highly-desirable system feature that establishes an exchange of data between vehicles and field infrastructure. One example

includes Signal Phase and Timing data that enables subscribed vehicles to display when a downstream traffic signal will change. Another example is collecting vehicle location information for collision avoidance or for origin-destination analysis.

- **Internet of Things (IoT)** – Often referred to as "connected devices", items are embedded with technology such that objects can exchange and collect data. From a streetlight bulb that notifies that it needs changing to roadway sensors that monitor traffic speeds, the opportunities to collect and use data to improve the maintenance and operations of the transportation system are rapidly expanding.
- **Electrification** – The transportation sector is responsible for approximately 36 percent of California's Green House Gas (GHG) emissions (50 percent when you include refineries) and more than 80 percent of NOx and particulate emissions. In conjunction with the continued addition of renewable energy sources as the basis for electrification, the positive impact of air quality will be significant. As the location of charging stations continues to expand, electric vehicles will also become increasingly easy to own and operate.
- **Multi-Modal Considerations –** Municipalities and transit providers are also faced with the challenge of embracing technological advancements. These technologies are aimed at improving bicycle and pedestrian safety and mobility, as well as maximizing the efficiency and convenience of transit service. Technological advancements that provide more meaningful real-time and situational awareness information for multi-modal users include detection techniques, minimizing conflicts at traffic signals, fleet management, mobile traveler information, and Automatic Vehicle Location (AVL), among other methods. Multi-modal transportation users are diverse in their ability to provide information as well as receive it, and service providers are already applying technology in equipment as well as systems to provide a greater experience for the user.

Determining the priority of which strategies are applicable to the SACOG region requires a careful evaluation of not only the existing conditions of the region (the infrastructure available, the data available, and the propensity for agencies to adopt certain technologies over others) but also the available technology trends that lend themselves toward potentially being solutions to the needs of the SACOG region.

IMPLEMENTATION PROJECT DEVELOPMENT

The previous information gathering efforts and the needs and gaps assessment influence the development of the City of Elk Grove's implementation projects. The needs and gaps illustrate the foundation for project opportunities to enhance the overall transportation system. The foundation of knowledge and understanding of previously built projects ensures that the implementation projects are realistic and relevant to the City's conditions.

To support development and expansion of the transportation network, several deployment parameters were considered in conjunction with previously discovered information to formulate overarching implementation projects. These include:

- Key Emerging Technologies – Project include provisions for CV/AV technology, multi-modal considerations (including transit), and other important initiatives in the region that are advancing innovative technology deployment.
- Emergency/Disaster Preparedness – Strategies facilitate the ability to improve the effectiveness of emergency and disaster response.
- Data Availability – The type and quality of available data, how data set can be improved and/or expanded, and how data can be effectively leveraged once it has been analyzed.
- Project Dependencies – Certain project elements must be constructed before other elements can be advanced.
- Overlap with Other projects – Other projects within the same project area offer efficiencies for construction.
- Safety – Strategy contributes to improved safety
- Context of Individual Agency – Specifically customized for applicability to each agency.

Overarching project strategies have been developed to identify a broad set of technology solutions that will address infrastructure/data, operations, and institutional stakeholder needs and system gaps; and to satisfy this deployment criteria. The strategy summary format is provided below and is detailed for each strategy in **Appendix B – Strategy Summary Sheets**:

- **ID #** – This is the identification number of the strategy.
- **Title** – This is the title of the strategy.
- **Description** – This is a succinct description of the strategy for context.
- **Relation to Needs** – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.
- **Scope/Limits** – This is a succinct summary of what is included in the strategies and/or locations (if applicable) of where the project would be deployed.
- **Considerations** – This is a bullet listing of other project ID #'s and Titles that are relevant for the City to reference during implementation or that could be packaged together to be implemented as part of a larger project in a particular timeframe.
- **Prerequisite Dependencies** – This is a bullet list summary of the high-level dependencies required to implement the strategies.

When all of these strategies are constructed, the City will have established an overall communications network and field equipment that enables staff to effectively monitor and manage traffic congestion. Infrastructure strategies, inclusive of communications media, CMS, CCTV cameras, detection, and traffic signal controllers, are visually presented in **Figure 2**, which shows the ultimate ITS infrastructure buildout in the City. Key signal timing corridors are presented in **Figure 3**.

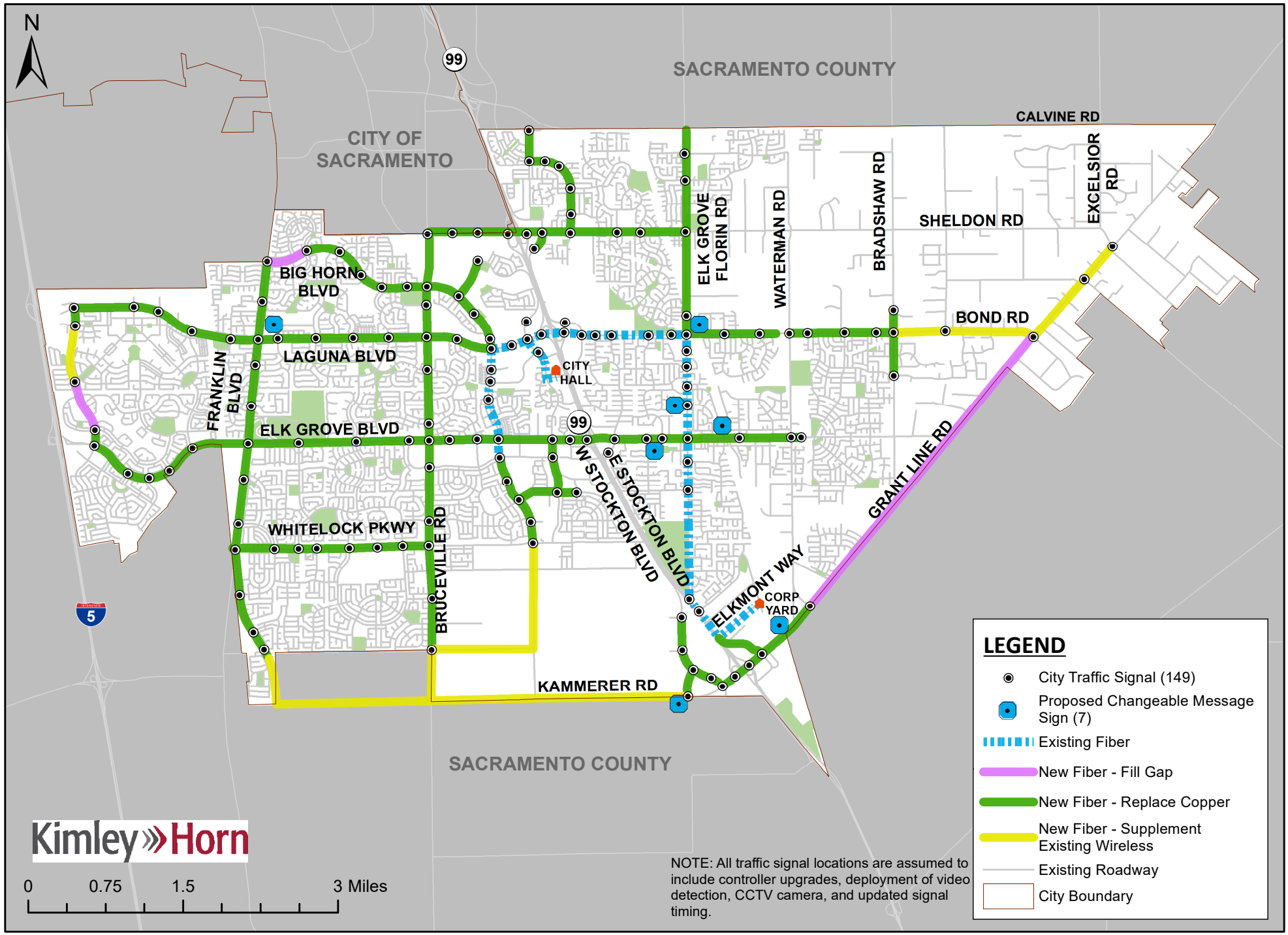


FIGURE 2 - ULTIMATE ITS INFRASTRUCTURE BUILDOUT

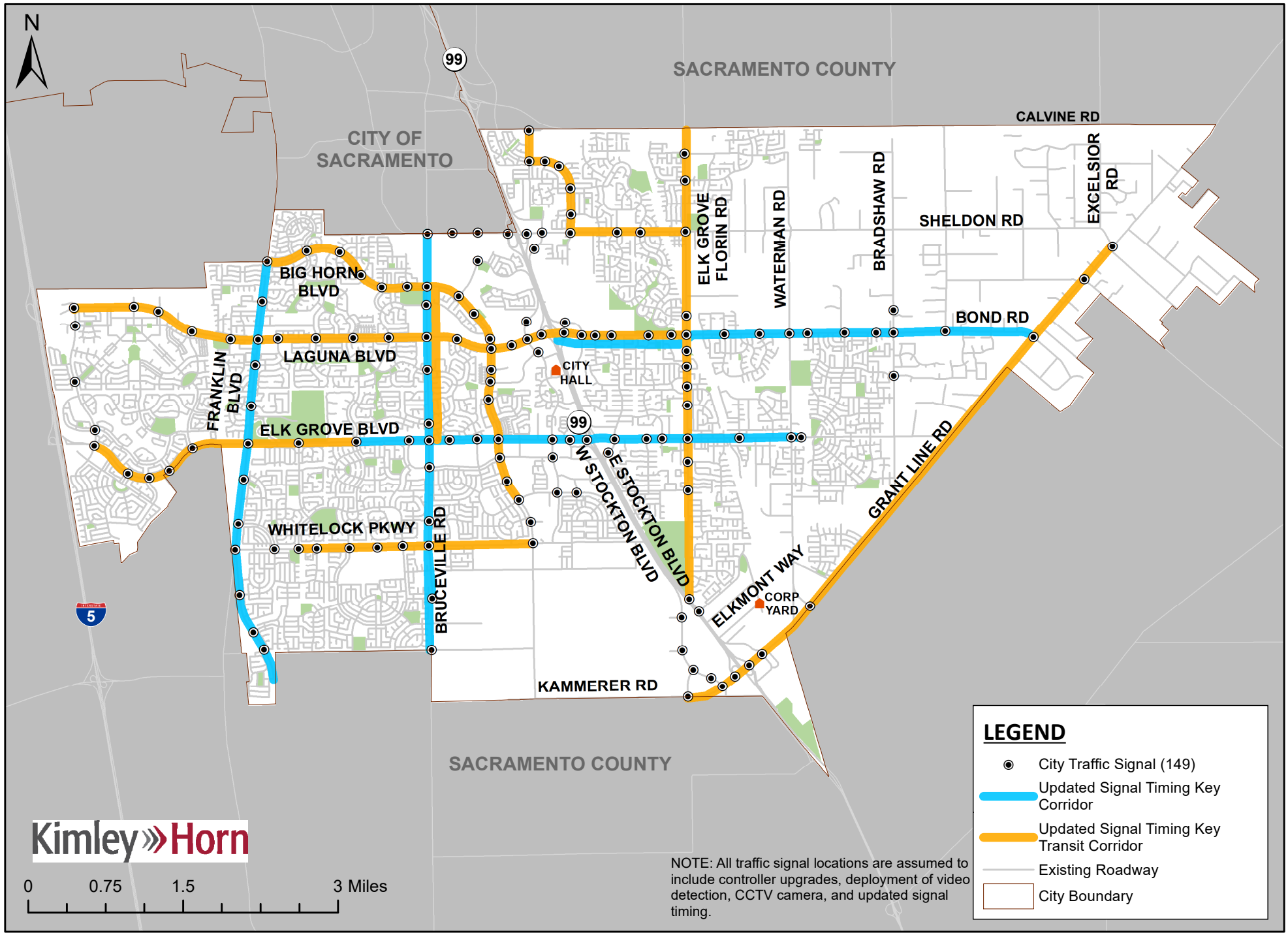


FIGURE 3 - SIGNAL TIMING IMPROVEMENTS

DEPLOYMENT PRIORITIZATION

Specific deployment projects have been identified by selecting and grouping project strategy elements according to similar corridors or geographic areas. The City has a unique set of projects specifically tailored to the priorities outlined above as they relate to the City. The limits of infrastructure projects, which encompass ITS communications media and other devices, along with signal timing updates, are presented in **Figure 4**.

Prioritization

Infrastructure projects are prioritized based on a set of 10 local and regional criteria and emphasize providing the infrastructure foundation; system and data integration to enhance functionality; and innovative advanced technology solutions when other critical elements are in place. Each criterion was weighted to represent some criteria being more important than others. The 10 local objectives and their weighting value are shown below:

1. **Extent that project achieves local objectives (14)** – project emphasizes addressing local needs
2. **Adaptable to new technology (13)** – can handle new technology without needing to be replaced
3. **Safety (13)** – reduces collision risk for all users
4. **Addresses multijurisdictional networking (10)** – contributes to a multijurisdictional solution
5. **Improves reliability and consistency of driver trips (10)** – traveler information to drivers helps them make informed and real-time decisions
6. **Improves traveler information and dissemination (10)** – provides more and better information about roadway conditions and multimodal options
7. **Contributes to operational and institutional efficiency (10)** – enables staff to more efficiently manage the transportation network
8. **Enhances major corridors (10)** – corridors that serve more people than other corridors
9. **Emergency/disaster preparedness (5)** – better information to public and more robust system
10. **Other projects rely on this project (5)** – this project must be done before other projects can begin

Each project was given a subjective score of zero (0) to four (4) for each criteria based on its relevancy to the criteria. Project scores were totaled and ranked to identify the highest priority projects. Prioritization for infrastructure projects is presented in **Appendix C – Prioritization Summary**.

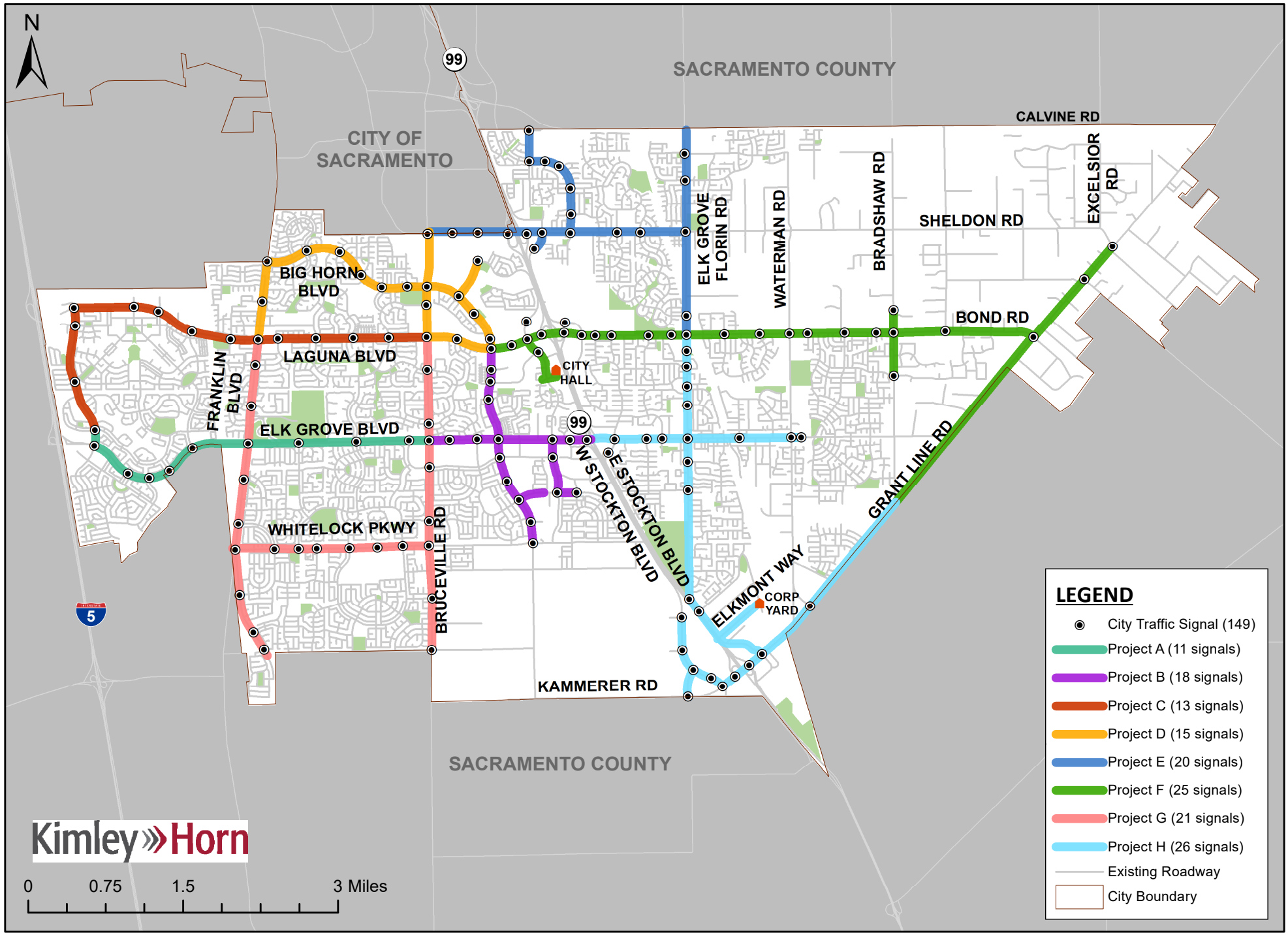


FIGURE 4 - FUTURE PROJECTS

Cost Estimations

Planning level cost estimations were prepared to reflect an order-of-magnitude costs for each project. A summary of specific costs or considerations related to implementing Smart Region elements is provided for each strategy where a cost can be reasonably estimated. **Appendix D – Cost Assumptions** summarizes the cost assumptions that were used to provide planning level cost estimations for each project, if applicable. These assumptions include a detailed breakdown of capital component costs and acknowledges the project development, design, construction, integration, and operations and maintenance costs associated with each project. The cost information is a planning-level estimate to deploy each project, based on available current (2018) pricing information for similar technology projects in the region.

Throughout development of projects, a distinction was made between projects that carry a cost and those that carry little to no cost. Projects that have costs may require initial capital investments and subsequent ongoing operations and maintenance (O&M) costs. Examples of these projects would be the deployment of new field infrastructure or upgrades to existing Traffic Operations System elements. No cost projects tend to fall into the institutional category and can be deployed with little to no cost and no future O&M costs. Examples of these projects would be the creation of a set of security guidelines, an interjurisdictional agreement, changes to a policy, or completing performance measurement analysis.

List of Prioritized Projects

A summary of prioritized projects with corresponding costs is presented in **Table 3**.

Table 3 – Project Summary

Priority No.	Project Corridor	Project Description	Planning Level Cost Estimate
1	Bond Rd (Laguna Springs Dr to Grant Line Rd) including connection to City Hall; Bradshaw Rd (Stone Springs Dr to School Loop Rd); Grant Line Rd (Bond Rd to Sheldon Rd) (*Project F*)	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$3,028,000
2	Elk Grove Blvd (SR-99 to Waterman Rd); Elk Grove Florin Rd (E Stockton Blvd to Bond Rd) including connection to Corp Yard; Promenade Pkwy at Kyler Rd to Kammerer Rd at Mosher Rd, including Lent Ranch Pkwy *(Project H)*	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$3,558,000
3	Laguna Blvd (Harbour Point Dr to Bruceville Rd); Harbour Point Dr (Maritime Dr to Laguna Blvd) *(Project C)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable and replacement of existing copper signal interconnect with fiber optic cable; deployment of vehicle video detection; installation of CCTV cameras; installation of CMS; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$2,765,000
4	Elk Grove Blvd (Maritime Dr to Bruceville Rd); Harbour Point Dr (Maritime Dr to Elk Grove Blvd) (*Project A*)	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$1,860,000

Priority No.	Project Corridor	Project Description	Planning Level Cost Estimate
5	Franklin Blvd (Laguna Blvd to Big Horn Blvd); Big Horn Blvd (Franklin Blvd to Laguna Blvd); Bruceville Rd (Laguna Blvd to Sheldon Rd); Laguna Blvd (Bruceville Rd to Big Horn Blvd); Lewis Stein Rd (Big Horn Blvd to W Stockton Rd) *(Project D)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable and replacement of existing copper signal interconnect with fiber optic cable; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$3,087,000
6	Sheldon Rd (Bruceville Rd to Elk Grove Florin Rd); Power Inn Rd (Sheldon Rd to Auberry Dr); Auberry Dr (Power Inn Rd to Calvine Rd); Elk Grove Florin Rd (Sheldon Rd to Calvine Rd) *(Project E)*	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$3,305,000
7	Elk Grove Blvd (Bruceville Rd to SR-99); Big Horn Blvd (Whitelock Pkwy to Laguna Blvd), including segments on Lotz Pkwy and Laguna Springs Dr (*Project B*)	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$1,967,000
8	Willard Pkwy (Bilby Rd to Whitelock Pkwy): Franklin Rd (Whitelock Pkwy to Bond Rd); Whitelock Pkwy (Franklin Blvd to Bruceville Rd); Bruceville Rd (Bilby Rd to Laguna Blvd) *(Project G)*	Project includes enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$4,112,000
Unprioritized Projects			
N/A	Replacement of end of life/legacy equipment *(Project I)*	Replacement of end of life/legacy equipment including procurement of backup equipment (video detection systems, CCTV cameras)	$117,000
	Upgrade ATMS *(Project J)*	Procurement of upgraded ATMS to incorporate new functionality including integration of multiple existing CCTV video streaming systems onto a centralized transportation management system. Controllers must be upgraded (Projects 1-8) prior to or in conjunction with this project.	$90,000
	Bluetooth Readers *(Project K)*	Deployment of bluetooth devices to collect location, speed and travel time data	$94,500
	Laguna Blvd (Harbour Point Dr to SR-99); Elk Grove Blvd (Harbour Point Dr and Waterman) *(Project L)*	Deployment of Adaptive Signal Control along Laguna Blvd between Harbour point Dr and SR-99, and along Elk Grove Blvd between Harbour point Dr and Waterman	$820,800

Priority No.	Project Corridor	Project Description	Planning Level Cost Estimate
	Active Transportation Detection *(Project M)*	Develop Active Transportation Detection master plan	$24,480
	Analytics software for real-time operations *(Project O)*	Integrate back end software linked to ATMS to analyze data for real-time operations	$180,000
	TNC Standards for Last-Mile Connections *(Project P)*	Establish TNC coordination locations for last-mile transit connections	$40,000
	Staffing *(Project Q)*	Increase Staffing Levels to Improve Real-Time Operations	*Salary-dependent*
	CAD System and TMC Connections *(Project R)*	Establish CAD System and TMC Connections for Automated Alerts/Notifications	$900,000

FUNDING

Implementation of many of the projects identified by this Plan are contingent upon acquiring additional funding. The following are potential funding opportunities for ITS infrastructure and systems that are described in additional detail below:

- Local Funding Programs
- SACOG Funding Programs
- State Funding Programs
- Federal Funding Programs
- Grants/Pilot Programs
- Other Funding Types

Local Funding Programs

The City of Elk Grove has a Capital Improvement Program (CIP) established on an annual basis. Each CIP outlines suggested transportation improvement and a corresponding budget. The 2018-2023 CIP includes signal and striping modifications, streetlight/pole improvements, traffic safety improvements, traffic signal upgrades, etc. While not all projects outlined in the CIP are related to ITS improvements, the CIP indicates budget available for transportation-specific projects. Of note, included in the CIP are the Kammerer Road Extension and Capital SouthEast Connector projects.

SACOG Funding Programs

SACOG offers a variety of different annual funding programs for public agencies within the region. The funding programs relevant to ITS projects are shown in **Table 4**.

Table 4 – SACOG Funding Programs

Program	Funding Amount	Criteria	Performance Outcomes Measured for Selection
Regional Program	$92,586,000 Amount given and to how many projects will vary depending on applicants	• Eligible for CMAQ, RSTP or STIP funds • Listed in recent MTP/SCS or fit within a lump-sum project category • Must match 11.47% of award with non-federal funds • Begin construction or operation before April 2025	• Reduce regional VMT per capita • Reduce regional congestion VMT per capita • Increase multi-modal or alternative travel choices • Provide long term benefits, sustaining both rural and urban economies • Improve movement of goods, in and through the region • Improve safety and security • Maintain and improve upon the existing transportation system

Program	Funding Amount	Criteria	Performance Outcomes Measured for Selection
Green Region	$11,760,000 Amount given and to how many projects will vary depending on applicants	• Eligible for CMAQ, RSTP or STIP funds • Must match 11.47% of award with non-federal funds • Begin construction or operation before April 2021 • Request for construction funding demonstrates that environmental, engineering and right-of-way will be ready by the time funds are requested • Agency is capable of on-going O&M costs	• Reduce regional VMT per capita • Increase multi-modal or alternative travel choices • Advances the use of electric and other zero-emission vehicles • Project exists within at least one of the Green Region Plan program areas.
TDM Innovations Grant	$750,000 Awards of $25,000-$150,000 per project	• El Dorado, Placer, Sacramento, Yuba, Yolo and Sutter Counties • Must match 11.47% of award with non-federal funds • Program must be active within 2 years of an agreement being signed • Include a detailed project budget and how funding will be used • Must demonstrate link between project and grant program's goal to reduce SOV trip and miles • Demonstrate how the project will serve underserved or insecure communities • Demonstrate creativity and appeal to a broad audience	• Innovative and Uniqueness of Project (40pts) • Potential for project to reduce motor vehicle trips and miles (15pts) • Target/Market Audience Development (15pts) • Description of plan to measure VMT reductions, data collection/analysis and project modification/ adaptability (25pts) • Budget & project cost/participant (5pts)
Regional Active Transportation Program	$11,664,000 ($439,560 Statewide) Amount given and to how many projects will vary depending on applicants	• Projects must first complete in Statewide ATP program before being eligible for smaller MPO programs • Must match 11.47% of award with non-federal funds	• Disadvantaged communities • Potential to increase users (biking/walking) • Public participation and planning • Potential to reduce crashes (fatalities and injuries)

Program	Funding Amount	Criteria	Performance Outcomes Measured for Selection
Metropolitan Transportation Improvement Program	Varies based on available federal and state funds	• Projects must be included in the Metropolitan Transportation Plan (MTP) • Application opportunity every odd year	• Prioritized alongside other submitted projects. Funds are allocated based off prioritization.

State Funding Programs

The State Highway Account is essentially a bank account that funds a variety of California programs for transportation and traveler mobility purposes. The SHA receives its funds from the State Base Excise Tax and the Federal Highway Trust Fund. The programs that are relevant to Smart Region projects are described in **Table 5**.

Table 5 – State Transportation Funding Opportunities

Program	Important Dates	Funding Information	Criteria
State/ Regional/ Interregional Transportation Improvement Program (STIP/RTIP/ ITIP)	• Multi-year CIP. • Cycle begins in odd-numbered years with the release of fund estimate in July. • December 15th of odd-numbered years the ITIP/RTIP/STIP is submitted • Next opportunity for this funding will be July 2019	• Local agencies work with their MPO to get their projects included in the RTIP for nomination	• Must include a Project Study Report (PSR) or an equivalent for non-State Highway projects • Caltrans/Regional consultations for projects are to be included in the STIP/RTIP/ITIP • Evaluated on how the project aligns with furthering regional objectives, particularly for Sustainable Communities Strategies • STIP Guidelines
California Transportation Commission Active Transportation Program (CTC ATP)	• Distributed annually	• 40% of funds go to MPO's in urban areas • 10% of funds go to small urban or rural communities and awarded by the Commission on a competitive basis • The remaining 50% is competitively distributed on a statewide basis	• Selected through a competitive process and meet one or more ATP program goals. • Minimum funding request is $250,000 • ATP Guidelines

Other state funding opportunities include the following.

Highway Safety Improvement Program (HSIP): HSIP funds are administered by Caltrans. Caltrans-initiated safety projects are eligible for HSIP funding if they are participating with a local agency. These projects typically included updated traffic signals or other projects that lend themselves to cost sharing

between agencies. The application for HSIP funding must come from the local agency who is partnering with Caltrans on a safety project.

Senate Bill 1 (SB-1): SB-1 is the Road Repair and Accountability Act of 2017, which confirmed a legislative packaged that invests $54 billion over the next decade to fix roads, freeways, and bridges across California, while also addressing safety, congestion, accessibility, economic developed, air-quality and land use issues. Caltrans will receive roughly half of the allotted SB-1 funds, receiving $26 billion for state-maintained transportation projects. The California Transportation Commission administered the funds and evaluates funding allocation.

Federal Grant/Pilot Funding Programs

Many federal programs distribute money directly to the State, which then distributes the funds based on local policies or award programs. One example of this type of funding is described above in the State Highway Account which receives a portion of its funding from federal programs. Other programs are described below.

Surface Transportation Block Grant Program (STBG): The STBG is an approved funding program through at least 2020. Infrastructure-based ITS capital improvements, including the installation of vehicle-to-infrastructure communication equipment, are eligible for the grant. In addition, operational improvements (including capital and operations costs) for traffic operations facilities, environmental measures, and some parking strategies are eligible. The project must be identified in a Statewide Transportation Improvement Program (STIP) and be aligned by long range Metropolitan Transportation Plans. Federal share is generally 80% although there are stipulations that allow for a full 100% share or as low as 50% federal share and is determined by project type per 23 U.S.C. 120.

Transportation Infrastructure Finance and Innovation Act (TIFIA): TIFIA is not a grant or traditional funding program but is a credit assistance program awarded to qualified projects of regional or national significance. TIFIA credit assistance is available to federal ITS projects of at least $15 million and the credit assistance is limited to 33% of the total eligible project costs.

Better Utilizing Investments to Leverage Development (BUILD) Grants: The BUILD program has replaced the Transportation Investment Generating Economic Recovery (TIGER) grant program and grants are awarded on a competitive basis for projects with significant regional or local impacts. These grants are designed to benefit surface transportation systems while providing further support to rural communities. A greater share of BUILD grants will be awarded to projects located in rural areas. $1.5 billion dollars has been made available for BUILD grants through September 2020. BUILD funds may cover up to 80% of project costs in urban areas and 100% of project costs in rural areas. During the 2018 cycle, the maximum project award is $25 million, and a single state cannot receive more than $150 million. The application deadline for BUILD grants is late July of each year.

The Nationally Significant Freight and Highway Projects (INFRA) Program: The INFRA Grants program provides dedicated, discretionary funding for projects that address critical issues facing our nation's highways and bridges. In 2018 approximately $1.5 billion in INFRA Grants will be awarded to projects across the country.

Advanced Transportation and Congestion Management Technologies Deployment (ATCMTD): ATCMTD is a competitive grant program that funds projects related to many ITS objectives. The grant serves to fund installation of transportation technologies that can improve efficiency, safety, and system performance. A state, local, transit, or Municipal Planning Area (MPA) agency is eligible to apply. In addition, a multijurisdictional group can apply with a signed agreement. A maximum of $60 million is available each fiscal year through 2020. A 50% minimum local match is required. Single project awards will not exceed $12 million and there will be between 5 and 10 grants awarded. Applications are invited during the Spring of each year.

Other Funding Types

Other funding opportunities that the City could utilize to help support their ITS Program include:

Safety/Emergency Projects/Initiatives: Partnering with other departments or emergency/safety agencies to include ITS components or to identify additional data that can be obtained from emergency/safety service systems could be mechanisms used to expand the ITS program or data that is available. An example might be a project to upgrade the radio network of the Police Department.

Establishing Open Funding Streams: Some states and MPOs have developed alternative methods for financing congestion reduction efforts, including ITS projects. Supplemental traditional funding sources could include tolling; local/regional sales tax measures, or other fees; and develop partnerships with private industry.

Public/Private Partnerships (P3s): P3s can provide alternative funding sources for transportation projects when a public agency enters into a partnership/agreement with a third party private company. Essentially, the public agency brings in a private-sector firm who provides development, operation, and financing mechanisms for the transportation project. P3s have become more popular as public resources become more limited and the demand for improved transportation systems continues to increase. There are benefits and limitations to engaging in a public/private partnership, so it is important to weigh those factors prior to P3 implementation.

OPERATIONS AND MAINTENANCE

To effectively operate and maintain the various project elements and projects identified in this Implementation Plan, the City of Elk Grove must be adequately staffed and prepared to sustain the system after it is deployed. Operations and maintenance procedures are essential to define the appropriate staffing levels, training, operational processes, and maintenance plans necessary to sustain an effective system.

Staffing

Staffing serves the operations side of the Implementation Plan. The successful implementation of operations strategies is largely dependent on providing appropriate staffing as related to the increase in operational capabilities.

With a population of approximately 171,000, the City of Elk Grove is the second largest City in the Sacramento region and one of the fastest growing cities in the State. While growth in the City is a positive, the City must make sure that it is planning for the projected growth as it takes on more projects, expands its infrastructure and services, and offers more to residents and visitors. The City has a relatively new ITS and transportation system as compared to other cities in the region. With the growth in population, the City has also experienced increased congestion levels throughout the City, especially along primary arterial roadways which provide direct access to I-5 and SR-99. The City is committed to improving the efficiency of the transportation network by leveraging its existing assets while utilizing emerging technologies to enhance the City's overall transportation system.

The inventory of transportation assets in the City has been steadily increasing and the City should review to assure sufficient staff or budget associated with operating and maintaining traffic signal and ITS projects. This has resulted in a situation where the City is understaffed for operations and maintenance of the traffic signal and ITS network infrastructure.

The City currently has 3.5 full time positions in the Traffic Engineering group: a Traffic Engineer, a TMC Manager, Assistant Transportation Engineer, and a Traffic Investigator to operate and maintain the City's transportation system. The City contracts operations and maintenance support to a Contractor as extension of staff.

Staffing the Smart Region Program

The City of Elk Grove should follow a well-crafted staffing plan that addresses five key objectives:

1. Ensure appropriate staffing levels based on increasing and aging assets;
2. Ensure the organization employs staff with the requisite knowledge, skills, ability, and other characteristics in the appropriate positions when needed;
3. Ensure that the organization adapts to changes internally and externally;
4. Provide a systematic approach for human resource management; and
5. Provide a shared vision of human resource functions.

Table 6 provides recommended ratios for the number of devices or signals to warrant one staff person for small, medium, and large jurisdictions based on the total number of devices or signals the jurisdiction is expected to operate and maintain. Operations staff are responsible for daily monitoring and use of transportation management assets. Engineers are responsible for conducting analysis of system performance and developing solutions. Maintenance staff are responsible for preventative and routine servicing of field assets.

Table 6 – Staffing Ratios for Operations and Maintenance

City Size Classification	Number Of:	Small	Medium	Large
Total	Signals	< 50	50 – 200	> 200
Total	Devices	< 100	100 – 300	> 300
Recommended Staffing Ratios	**Number Of:**	**Small**	**Medium**	**Large**
Operations	Devices	25 : 1	50 : 1	75 : 1
Engineer	Devices	100 : 1	100 : 1	100 : 1
Maintenance/Technicians	Signals	40 : 1	40 : 1	40 : 1
Maintenance/Technicians	Devices	100 : 1	100 : 1	100 : 1

** Using ITE recommendations for staffing ratios per device from Traffic Control Systems Operations – Installation, Management and Maintenance which recognizes the difference between large, medium, and small agency size ratios. Values were verified to be consistent with other more recent sources such as Traffic Signal Operations and Maintenance Staffing Guidelines (FHWA-HOP-09-006) and other agency publications around the country.*

With 148 traffic signals and 198 devices, the City of Elk Grove is considered a medium-sized agency. **Table 7** provides a summary of the existing and future number of devices and staff recommendations to support the desired infrastructure and functionality envisioned through this Plan. Full buildout assumes the addition of 20 new traffic signals in the City's transportation network based on projected future development.

Table 7 – Staffing Recommendations for the City of Elk Grove

Elk Grove	No. of Devices*	No. of Operations Staff	No. of Engineering Staff	No. of Traffic Signals	No. of Maintenance Staff (Signals)	No. of Maintenance Staff (Devices)
Existing Conditions	198	4 (50:1)	2 (100:1)	149	4 (40:1)	2 (100:1)
Full Buildout	460	9 (50:1)	4-5 (100:1)	169	4-5 (40:1)	4-5 (100:1)

**ITS equipment includes: traffic signals (with video detection system), CCTV cameras, CMS, DSRC units, and miles of fiber.*

As shown, it is recommended that the City have a staff including up to 9 operations staff, 4-5 engineering staff, and 8-10 maintenance staff dedicated to maintenance of signals and all ITS devices under full buildout conditions.

Engineering staff are typically responsible for management, operations, and design; system checks; analysis and development of modifications to signal timing; collection and analysis of traffic and accident data; development and administration of contracts for the installation or modification of traffic signals and other ITS devices; and supervision of daily activities.

Operations staff are typically responsible for monitoring of real-time traffic conditions at the TOC, monitoring system and device health status, using CCTV cameras for traffic monitoring and incident verification, and implementing changes to signal timing.

Signal maintenance staff are typically responsible for the installation, diagnostics and maintenance of all electronic equipment pertaining to traffic signal operation including programming of traffic controllers, troubleshooting, replacement, and repairs. Other maintenance staff have similar responsibilities for

communications systems, ITS devices (i.e., CCTV cameras, CMS, detectors, uninterrupted power supplies (UPS), data collection devices), and street lighting.

Staffing Considerations

Understanding there is an existing staffing shortage, adding additional ITS infrastructure and functionalities that are desired by the City and recommended in this plan to accommodate future mobility technology will only exacerbate these staffing challenges unless a process is put in place to identify and account for staffing needs for the Smart Region program. To address this challenge, it is recommended that a process be reviewed as part of the capital project programming process for traffic signals and other ITS communications projects that requires consideration of the staffing resources needed to operate and maintain the new infrastructure in addition to existing infrastructure.

There are regional staffing structures for operations and maintenance that are being recommended to SACOG to help support individual local agencies and their ability to support Smart Region initiatives. These regional structures may alleviate some of the need for additional staffing at the City level, but it is recommended that each individual agency evaluate their own staffing needs once additional equipment and infrastructure is implemented.

When planning for additional or adjusted staffing to account for Smart Region improvements, the City should consider the following:

- **Heightened Skill Set** – Central management systems are undergoing fundamental changes, including the introduction of more sophisticated technologies, a shift to integrated operations (multiagency, multimodal), and improvements to customer service capabilities. The increased demand for services and changes to central management system operations affects staffing skill sets. Increasing demand requires more employees and the necessary knowledge, skills, and abilities to handle the demand. In many cases, personnel required to manage multijurisdictional systems have an Information Technology background and skill set that includes network management, software development, database administration, and application troubleshooting. Although engineering skill sets or a professional license may be warranted for specific activities such as signal timing plan development, an engineer may not always be necessary to fulfill other agency functions. Each agency should consider a combination of personnel skill sets as they relate to the individual agency requirements to fulfill operational functions.
- **Redundant Support Structure** – It will be important to foster and maintain staff skills and redundancy through greater training and cross-training so that there is more than one person with the knowledge and skill set required to operate and maintain ITS equipment and systems.
- **Central System Management Architecture** – Another major factor that has a significant impact on staff planning is whether the central management system operations function out of a traditional TMC with workstations and a video wall, or if the central management system is operated on a virtual basis with a few City offices having permissions-level access to certain parts of the system.

Maintenance Plan

Planning for ITS operations and maintenance costs is a critical component when developing an implementation project. Operation and maintenance of ITS technologies and systems extends beyond

simply keeping the equipment working. The City will need to maintain ITS devices and systems, and will require appropriate training to serve in that role. Reacting to emergency failure conditions, maintaining accurate maintenance logs, and conducting preventative maintenance programs all require fully-trained staff. Maintenance of ITS devices will require an allocation of funds within the City budget. A maintenance management system can also be used to track failures and decrease the time needed to repair the failures.

A maintenance plan identifies the criteria for replacement and preventative maintenance and the need for ongoing support for ITS devices and systems. The number of devices and systems that need to be maintained throughout the City will increase in the near-term based on the programmed ITS infrastructure projects. These devices and systems need to be appropriately maintained and effectively operated to provide accurate, reliable, and timely information.

The following three maintenance types are included in this section to recommend maintenance activities based on general guidelines for each type of device, rather than required activities, to allow the City to identify areas where maintenance activities could be introduced based on resource availability:

- **Preventative Maintenance** – What to do to prevent failure – This encompasses a set of checks and procedures performed at scheduled intervals including inspection, record keeping, cleaning, and replacement.
- **Responsive Maintenance** – What to do when something fails – This is the initial reply by field maintenance staff to an ITS subsystem or malfunctioning device. Response maintenance includes minor maintenance activities, major maintenance activities, and major rehabilitation/upgrade activities.
- **End-of-Life Replacements and Upgrades** – What to do when something cannot be fixed – This can be required if the device has experienced frequent malfunctions, failures, or has reached end-of-life and it is more cost-effective to replace the technology rather than continue to maintain it.

Roles and responsibilities, maintenance guidelines, and requirements of City staff should be updated to include preventative maintenance, responsive maintenance, and replacement of ITS devices and systems.

Preventative Maintenance

Preventative maintenance is performed to ensure the reliability and longevity of the mechanical and electrical operations of the system and will reduce equipment failures, response maintenance, road user costs, and liability exposure. Preventative maintenance involves repetitive upkeep to allow devices and systems to operate efficiently and effectively to maximize the operating lifespan of ITS devices. Preventative maintenance includes minor and major maintenance needs, making the frequency of maintenance an important consideration.

The preventative maintenance activities and frequency varies by device, device components, and system, which are outlined in **Table 8**. The City can refer to this table when incorporating new signals, new ITS infrastructure, or new staff. The City should review and revise the preventative maintenance

procedures on an annual basis to ensure new issues are being addressed and equipment is being properly maintained.

Table 8 – Preventative Maintenance Recommendations

Intersection PM Checklist	Recommended Interval
Interior Cabinet Check	
Clean Cabinet Interior Check controller lamp and door switch Check filter Check door fit and gasket Check locks and hinges Check/verify for cabinet timing and log sheet Check field block terminal connections Signal controller battery backup check	Annual
Check conflict monitor indications Check all detectors	Quarterly
Exterior Cabinet Field Check	
Check condition of cabinet exterior Check all signal indications Check all pedestrian indications Check pole conditions and hand hole covers	Annual
Check all signal head back plates and visors Check alignment of signals and pedestrian heads Check condition of pull boxes and lids	Quarterly
Intersection Field Check	
Visual check of all traffic signs at intersection Visual check of intersection luminaries	Monthly
Visual check of all traffic loops	Quarterly
Visual check of other traffic system related cabinets	Annual
Typical CCTV Checklist Items	
Visual check of assembly CCTV receiver Video transmitter Fiber distribution unit Cabinet equipment Pole or exterior condition	Annual
Typical Message Sign Check List Items	
Field intersection Sign panel Pull boxes Cabinet exterior Cabinet interior Re-lamping	Every six-months

Responsive Maintenance

ITS devices and systems have specific maintenance requirements per the manufacturer's maintenance manual of each device. There are three types of maintenance that ITS devices require to fulfill their intended design for operations and lifecycle:

- **Minor Maintenance** – Minor maintenance includes tasks which can be carried out without large scale testing or the use of heavy equipment. It includes visual inspections and checking of many items, elementary testing, cleaning, lubricating, rebooting/resetting, and minor repairs that can be carried out with hand tools or portable instruments.
- **Major Maintenance** – As well as all items normally done under minor maintenance, major maintenance also includes extensive testing, overhauling and replacement of components, which may require a scheduled power outage and the use of bucket trucks or other heavy equipment.
- **Major Rehabilitation** – Major rehabilitation or complete replacement is contemplated for devices that experience frequent or recurring malfunctions or failures.

Table 9 identifies a rule-of-thumb frequency of minor and major maintenance and major rehabilitation for a range of ITS devices that the City will be implementing. These guidelines should be reviewed and updated annually to reflect actual needs in Elk Grove.

Table 9 – ITS Device and Network Communications Maintenance Guidelines

Equipment	Minor Maintenance	Major Maintenance	Major Rehabilitation
Traffic Signal Systems			
Cabinets	26 weeks	2-5 years	10 years
Signal Heads	26 weeks	2-5 years	10 years
Electronics	13 weeks	N/A	N/A
Traffic Signal Controller	26 weeks	2-5 years	10-15 years
Poles	26 weeks	5 years	15 years
Battery Back Up	26 weeks	2-5 years	10 years
CCTV Camera Systems			
PTZ Units	26 weeks	1 years	3 years
Changeable Message Signs			
Sign Case	-	26 weeks	1.5 years
Protective Devices	26 weeks	1 year	2 years
Pixels, Modules and Drivers	-	26 weeks	3 years
Controllers	-	26 weeks	3 years
Vehicle Detection Systems			
Cabinets	-	26 weeks	10 years
Power Supply	26 weeks	5 years	10 years
Emergency Vehicle Preemption (EVP) / Transit Signal Priority (TSP)	26 weeks	2-5 years	10 years
Loop Detection (per approach)	26 weeks	1 year	5 years
Video Detection (per intersection)	26 weeks	1 year	5 years
Travel Time Readers (per location)	26 weeks	1 year	5 years
Pedestrian Detection (per intersection)	26 weeks	1 year	5 years
Grounding	-	2-5 years	10 years
Controllers	-	26 weeks	3 years
Telecommunication Systems			
Fiber Optic Cable Plant	1 year	5 years	25 years

Equipment	Minor Maintenance	Major Maintenance	Major Rehabilitation
Communication Switches (field)	26 weeks	1 year	3 years
Wireless Radio Spread Spectrum	26 weeks	4 years	10 years
TMC Equipment			
Servers	26 weeks	1 year	3 years
Communication Switches (TMC/Hub)	26 weeks	1 year	3 years
Rack Equipment	-	1 year	2 years
Workstations	26 weeks	2 years	2 years
Workstation Displays	26 weeks	1 year	3 years
Uninterruptable Power Supply	1 year	5 years	10 years

Data source: Recommended Practice for Operations and Management of ITS (ITE Publication); and International Municipal Signal Association (IMSA) Preventative Maintenance of Traffic Signal Equipment Program.

Development or integration of a maintenance tracking system would be beneficial to keep an inventory of maintenance activities that have occurred on each device. The City's responsive maintenance tracking should consist of the following maintenance activities:

- Failure detection;
- Work order creation;
- Dispatched resources;
- Response activities;
- Diagnosis;
- Interim repairs; and
- Work order close out.

This tracking will allow the City to identify devices that are not reliable or accurate or have had frequent malfunctions. The tracking will also allow the City to identify appropriate cases for technology replacements where maintenance of an existing technology may be costlier than upgrading to a newer technology. Developing periodic reports and then reviewing those reports are critical to being able to identify frequently failing devices for replacement.

End-of-Life Replacements and Upgrades

End-of-life replacement strategies and upgrades are an important aspect of technology projects because equipment and infrastructure needs to be maintained and/or replaced in a routine manner. Equipment replacement is required if a device has exceeded its life expectancy, either through a sunsetting of manufacturer servicing or a failure in legacy equipment. Equipment upgrades are required when additional functionality is needed that cannot be provided by legacy equipment. This section provides information about what the City of Elk Grove's replacement needs are, recommended equipment lifecycle timeframes, and mechanisms available for procurement and maintenance.

Agency Replacement Needs

The City of Elk Grove should establish an inventory of modernized, supplemental traffic and ITS equipment for replacement of devices in the field as they reach end-of-life or become broken. A typical method for establishing an inventory is to keep 10% of existing field devices for each type. A proper inventory of devices and spare parts that can be accessed to conduct routine and emergency

maintenance also needs to be built into the City's budget cycle. As an example, for every 100 cameras deployed across the transportation network, the City should have at a minimum ten (10) cameras in inventory to be able to be responsive and make repairs/replacements when needed.

Lifecycle Replacement

To adequately prepare for necessary infrastructure updates in the future, the City should consider the estimated lifespan of its infrastructure. Lifecycle replacement mechanisms will need to be developed to stay up-to-date on equipment replacement needs and emerging technology availability. **Table 10** should be used as a reference tool for the City of Elk Grove so that equipment remains current and performs at an optimal level.

Table 10 – Anticipated Technology Lifecycle Timeframes

Equipment	Anticipated Lifecycle Timeframe (Years)
Traffic Signal Systems	
Cabinets	20
Signal Heads	20
Electronics	10
Traffic Signal Controller	15
Poles	50
Signal Battery Back Up	10
CCTV Camera Systems	
PTZ Units	10
Changeable Message Signs	
Sign Case	10
Protective Devices	10
Pixels, Modules and Drivers	6
Controllers	6
Vehicle Detection Systems	
Cabinets	20
Power Supply	20
Emergency Vehicle Preemption (EVP) / Transit Signal Priority (TSP)	10-15
Loop Detection (per approach)	5-15
Video Detection (per intersection)	10
Pedestrian Detection (per intersection)	10
Grounding	25
Controllers	7
Telecommunication Systems	
Fiber Optic Cable Plant	25
Communication Switches (field)	5-8
Wireless Radio Spread Spectrum	20
TMC Equipment	
Servers	5
Communication Switches (TMC/Hub)	5-8
Rack Equipment	5
Workstations	5
Workstation Displays	5
Uninterruptable Power Supply	20

Agency Replacement Strategy

A significant portion of the City's existing traffic signal controllers were deployed 15 years ago and are nearing their end of life based on anticipated lifecycle timeframes. Therefore, the City should initiate a replacement strategy for traffic signal controllers.

It is recommended that the City also consider conducting a traffic signal control systems evaluation prior to procurement of replacement controllers to determine a future path for the central system. As part of this effort, functional requirements and system specifications would be developed to establish standards for the future system.

Considering the date of installation of other existing ITS equipment, and the expected lifespan of each device according to **Table 10**, the City should consider following a replacement strategy based on the anticipated lifecycle described above to proactively procure and install/replace legacy equipment. Actual replacement rates will depend on environmental conditions (i.e., extreme temperatures, dust), actual failures, staff capacity, and funding availability. The following replacement quantities should be a starting point and are based on the end-of-life ITS equipment devices currently operating in Elk Grove. Once more ITS devices are installed and connected to the network these rates should be increased proportionally.

- Replace 8 Cabinets and Controllers per year
- Replace 5 CCTV cameras per year
- Replace 3 Video Detection Units per year
- Replace 1-2 miles of fiber optic cable per year
- Replace 5 communication switches (intersection) per year
- Replace 1 communication hub switch and equipment per year

PERFORMANCE METRICS

Performance metrics are used to evaluate and demonstrate the effectiveness of the City of Elk Grove's implementation projects in addressing local and regional objectives. Recommended data types, data sources, and calculations to evaluate performance of projects are provided in **Table 11**. As projects are delivered, the City of Elk Grove can use these metrics as a guideline to evaluate projects.

Table 11 – Performance Metrics to Perform Project Evaluations

Objective	Performance Metric	Data Type	Source	Calculation
Address **smart** transportation **strategies** for urban, suburban, and rural communities	Reduced Travel Time	Travel Time	Agency TMC	Travel time in minutes between Point A and Point B prior to and after project implementation
	Increased Transit Ridership	Sales/Revenue	Transit TMC and Transit Provider Records	Count ridership levels before and after project implementation, calculate percentage change
	Incident detection by CCTV cameras	CCTV Images	Agency TMC	Count incidents that are detected via CCTV camera before being identified by public
	Accurate Travel Time Estimates (particularly focused on rural and suburban communities w/ commuting needs)	Travel Times	Agency TMC	Compare travel times estimated and actual travel times to verify accuracy for those commuting into urban centers from rural or suburban communities

Objective	Performance Metric	Data Type	Source	Calculation
Prepare for **smart** region **infrastructure** adapting to new technology	Number of hours (in 6-month intervals) of continued education or training completed by staff	Training Hours	CE courses, Vendor Training Seminars, etc.	Count hours staff spent attending new technology trainings or pursuing certifications
	System Readiness for CV/AV Technology Integration	CV/AV Technology (Device and Data)	TMC System	When applicable, monitor CV/AV technology integration and compare qualitatively or quantitively with other region's technology integration experiences
	Increase Capacity of Communications Network	Fiber/Wireless/Bandwidth Usage	TMC System	Measure communications network capacity before and after ITS device deployment
Reduce user frustration by providing **consistency and reliability**	Reduced Downtime	System Errors/Failure	System Operations	Compare Downtime Incident Occurrences before and after project implementation
	Reduced Public Complaints	Public Complaints	TMC and other Operator Records	Compare the amount of public complaints related to inconsistency/ unreliability from before and after implementation project
	Reduce Response Time to Device Failures	Response Time	TMC and Dispatch Records	Measure reduction in response times before and after project implementation
	Increase percent of field device that are operational	Operational Devices	Asset Management System	Calculate percent of devices that are operational based on total devices in the inventory. Compare that figure to the same percentage ratio prior to implementation project
Proactively improve transportation system **safety**	Reduced vehicle-to-vehicle crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced vehicle-to-bicycle crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced vehicle-to-pedestrian crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced Safety Incidents Involving Transit Operations	Transit Incident Records	Transit TMC and Transit Provider Records	Count amount of safety incidents involving transit operations after project implementation and compare to before implementation

Objective	Performance Metric	Data Type	Source	Calculation
Improve **traveler information** and dissemination to public and within region	Reduced vehicle traffic (congestion) due to CMS Message	Traffic Volume	Agency TMC	Difference between Pre/Post CMS Traffic Volumes on Corridor and Alternate Corridor
	Increased Social Media Presence via Agency Managed Apps/Websites	Social Media Posts and Push Notifications (Facebook, twitter)	PR/PIO Records	Track social media outputs, compare to posts prior to implementation strategies
	Increased Partnerships between Third Party Data Companies and Public Agencies	Partnerships	Institutional Policies/Documents	Count the number of private party /public agency data sharing agreements that have occurred since implementing strategies
	Increased 511 Inputs (on all available platforms)	Website Updates, Radio Updates, and Push Notifications	511 System/Records	Count traveler information inputs that are sent out through 511 systems and compare it to counts prior to implementation
	Increased 511 Usage/Subscriptions	App Download/Website Usage	App/Website Management	Count of 511 website views
Emergency / Disaster preparedness	Improved Emergency Response Time	Travel Time	Agency TMC	Time between initial notification to first responder arrival
	Improved Incident Clearing Times	Incident Response and Clearing Times	Agency TMC	Compare time it takes to respond to and clear an incident before and after project implementation

NEXT STEPS

The outcome of this Technology Implementation Plan is a roadmap of prioritized projects that the City of Elk Grove can follow to systematically implement technology projects that achieve local and regional objectives through expansion of infrastructure, integration of systems and subsystems, and deployment and readiness for emerging technologies. The appendices of this Plan contain supporting information on project priority development, costs, project details, and other information that are essential to moving projects into development and deployment.

The City of Elk Grove's Technology Implementation Plan is a dynamic and flexible set of projects that contribute to SACOG's broader Smart Region Plan. The projects set forth are a mix of infrastructure, operations, and institutional projects that are adaptable to changing needs and evolving technologies. This plan and the associated tools should remain a living set of resources that staff can update as projects are implemented or expanded, agency priorities change, or other changes occur that impact the region or the City of Elk Grove. The projects identified in this plan can and should be modified, or priorities adjusted, to accommodate changing priorities, emerging technology opportunities, other construction and development projects, or other initiatives that influence the guidance and recommendations provided in this Plan. In addition, it is particularly important to maintain a process to update the Plan because of the deployment phasing methodology used.

Plan Components to Update

- **Deployment Phasing** – It will be particularly important to update the Plan to reflect projects that have been completed. Priorities across projects may also change and should be reflected in the document. As time goes by and projects change in priority, updating the project list will provide an opportunity to evaluate if new projects are available based on emerging technology, increased staffing levels, and so on.
- **Funding Opportunities** – Funding opportunities are always changing. Existing programs or grants may expire, while new ones may emerge. It is imperative that funding opportunities are kept current to maximize the opportunity to utilize new funding sources. In addition, it will continue to be important to leverage emerging opportunities for third party or private sector support.
- **Equipment Replacement Strategies** – The success of this Plan is largely based on ensuring that all equipment continues to work effectively and efficiently. Legacy equipment should be continuously updated or replaced to accommodate emerging technology and enhanced system functionality.
- **Operations and Maintenance** – Adequate staffing levels allow for optimal functionality. As the plan grows and progresses, staffing levels must continue to reflect the need for sustaining a functioning system.

APPENDIX A – EXISTING CONDITIONS

Table 1: City of Elk Grove Traffic Signal Inventory

No.	Intersection	Connected to ATMS.now	Cabinet	Controller	Comm Type
1	Aizenberg Circle / Halverson Drive & Elk Grove-Florin Road	X	SP	980 ATC	Copper
3	Arborview Drive / Vicino Drive& Big Horn Boulevard	X	SP	980 ATC	Copper
4	Auberry Drive& Geneva Pointe Drive / Monterey Trails High School Driveway	X	P	2070	Copper
5	Bond Road & Laguna Creek Bridge (PED SIGNAL)	X	336	2070L	Copper
5	Auberry Drive Drive & Power Inn Road	X	P	2070	Copper
6	Laguna Boulevard & Elk Grove Creek (PED SIGNAL)	X	336	2070L	Copper
6	Auto Center Drive & Elk Grove Boulevard	X	SP	980 ATC	Copper
7	Babson Drive / Dwight Road & Laguna Boulevard	X	P	2070LNZ	Copper
8	Backer Ranch Drive / Civic Center Drive & Bruceville Road	X	P	2070LNZ	Copper
10	Barrymore Drive / Sheldon North Drive & Calvine Road	-	-	-	-
9	Backer Ranch Drive / Laguna Promenade & Elk Grove Boulevard	X	P	2070LNZ	Copper
12	Big Horn Boulevard & Bruceville Road	X	SP	980 ATC	Copper
11	Big Horn Boulevard & Brockenhurst Drive / Meadowspring Drive	X	SP	980 ATC	Copper
12	Laguna Boulevard & Old Creek Drive	X	P	2070LNC	Copper
13	Big Horn Boulevard & Bus Access	X	P	2070LNC	Copper
13	Big Horn Boulevard & Elk Grove Boulevard	X	P	2070LNZ	Copper
14	Big Horn Boulevard & Laguna Boulevard	X	P	2070LNZ	Copper
15	Big Horn Boulevard & Laguna Gateway	X	P	2070LNZ	Copper
16	Big Horn Boulevard & Laguna Star Drive / Meadowspring Drive	X	SP	980 ATC	Copper
17	Elk Grove-Florin Road & 2nd Avenue	X	SP	980 ATC	Copper and Fiber
17	Big Horn Boulevard & Monetta Drive	X	P	2070LNZ	Copper
42	Bradshaw Road & Sheldon Road	-	-	-	-
18	Big Horn Boulevard & Monterey Oaks Drive	X	P	2070LNZ	Copper
19	Excelsior Road & Sheldon Road	-	-	-	-
19	Big Horn Boulevard & New Country Drive	X	P	2070LNZ	Copper
20	Big Horn Boulevard / Dwight Road & Franklin Boulevard	X	SP	980 ATC	Copper
21	Bilby Road & Bruceville Road	X	P	2070LNZ	Copper
22	Bilby Road & Willard Parkway	X	P	980 ATC	Copper
23	Black Kite Drive / Heritage Hill Drive & Elk Grove-Florin Road	X	SP	980 ATC	Copper
24	Blossom Ridge Drive& Franklin Boulevard	X	P	2070LNZ	Copper
25	Laguna Boulevard & SR 99 SB Ramp	X	332	2070L	Copper
25	Blossom Ridge Drive& Whitelock Parkway Drive	X	P	2070LNZ	Copper
26	E. Stockton Boulevard & Hampton Oak Drive	X	SP	980 ATC	Fiber
26	Blossom Ridge Drive & Willard Parkway	X	P	2070LNZ	Copper
27	Bond Road & Bradshaw Road	X	P	2070LNZ	Copper
40	Bradshaw Road & Calvine Road	-	-	-	-
41	Bruceville Road & Elk Grove Boulevard	X	P	2070LNC	Copper
28	Bond Road & Bus Entrance	X	P	2070 ATC	Copper

No.	Intersection	Connected to ATMS.now	Cabinet	Controller	Comm Type
29	Bond Road & Crowell Drive	X	P	2070LNZ	Copper
30	Bond Road & E. Stockton Boulevard	X	P	2070LNZ	Copper
31	Bond Road & Stonebrook Drive / School Loop Road	X	P	2070LNC	Copper
32	Bond Road & Grant Line Road	X	P	2070LNZ	Wireless
33	Bruceville Road & Sheldon Road / Center Parkway Drive	X	P	2070LNC	Copper
31	Bond Road & Elk Crest Drive	X	P	2070LNZ	Copper
32	Bond Road & Elk Grove-Florin Road	X	P	2070LNZ	Copper
33	Bruceville Road & Whitelock Parkway	X	P	2070 ATC	Copper
33	Bond Road & Emerald Crest Drive	X	P	2070LNZ	Copper
34	E Stockton Boulevard & Market Place 99	X	SP	980 ATC	Copper
41	Bradshaw Road & School Loop Road	X	P	2070LNC	Copper
42	Bruceville Road & Laguna Boulevard	X	P	2070LNC	Copper
43	Bruceville Road & Machado Ranch Drive	X	P	2070LNC	Copper
43	Bruceville Road & Di Lusso Drive / Laguna Crossroads	X	SP	980 ATC	Copper
44	Bruceville Road & Kilconnell Drive / Soaring Oaks Drive	X	P	2070LNC	Copper
45	E. Stockton Boulevard & Sheldon Road Drive	X	P	2070LNC	Copper
46	E. Stockton Boulevard / Emerald Vista Drive & Elk Grove Boulevard	X	P	2070LNC	Copper
47	Bruceville Road & Seasons Drive / Soaring Oaks Drive	X	P	2070LNC	Copper
48	Bruceville Road & Terrazzo Drive / Del Webb Boulevard	X	P	2070LNC	Copper
49	Caldicot Drive / Blue Maiden Way & Power Inn Road	X	P	2070LNC	Copper
56	Castleview Drive / Street Augustine Drive& Franklin Boulevard	X	SP	980 ATC	Copper
57	Elk Grove Boulevard & E / O Waterman Road (PED SIGNAL)	X	336	2070L	Copper
114	Laguna Gateway & W. Stockton Boulevard	X	SP	980 ATC	Cat. 6 Cable
115	Lewis Stein Road / Jocelyn Way &	X	P	2070LNC	Copper
116	Sheldon Road & Whitehouse Road	X	P	2070LNC	Copper
116	Matina Drive & Willard Parkway	X	P	2070LNC	Copper
117	Harbour Point Drive & Longport Court / Renwick Avenue	X	P	2070LNC	Copper
117	Power Inn Road & McPheteridge Drive / Monterey Trails High School Driveway	X	P	2070LNC	Copper
123	Harbour Point Drive & Buckminster Drive	-	-	-	-
118	Power Inn Road / Garrity Drive & Sheldon Road	X	P	2070LNC	Copper
119	Elk Grove Boulevard & Emerald Oak Drive	X	SP	980 ATC	Copper
119	Power Inn Road & Villenueve Drive / Vista Brook Drive	X	P	2070LNC	Copper
120	Sheldon Road & SR 99 NB Ramps	X	332	2070L	Copper
121	Elk Grove Boulevard & Laguna Springs Drive	X	P	980	Copper
120	Sheldon Road Park and Ride Lot & E Stockton Boulevard	X	P	2070LNC	Copper
121	Franklin Boulevard & Laguna Park Drive	X	SP	980 ATC	Copper
127	Whitelock Parkway & 1500' West of Carinata Drive	-	-	-	-
128	Elk Grove Boulevard & SR 99 SB Ramp	X	332	2070L	Copper
121	Sheldon Road & Sheldon Creek Drive / Vytina Drive	X	P	2070LNC	Copper
122	Sheldon Road & W. Stockton Boulevard / SR 99 SB Ramps	X	332	2070L	Copper
124	Lewis Stein Road & W. Stockton Boulevard	X	P	2070LNC	Copper
130	Elk Grove Boulevard & 1st Avenue	-	-	-	-
131	Bond Road & Waterman Road	X	P	2070LNC	Copper

No.	Intersection	Connected to ATMS.now	Cabinet	Controller	Comm Type
125	Big Horn Boulevard & Lewis Stein Road / Ancestor Drive	X	P	2070LNC	Copper
126	Elk Grove-Florin Road & Laguna Creek Bridge (PED SIGNAL)	X	332	2070 ATC	Copper and Fiber
127	Elk Grove Boulevard & Elk Grove - Florin Road	X	P	2070LNC	Copper and Fiber
126	Big Horn Boulevard & Village Tree Drive	X	P	980 ATC	Copper
127	Di Lusso Drive / Laguna Park Drive (E) & Laguna Boulevard	X	P	2070LNC	Copper
128	Harbour Point Drive & Maritime Drive	X	P	980 ATC	Copper
129	Elk Grove Boulevard & Fire Poppy Drive	X	P	2070LNC	Copper
130	Elk Grove-Florin Road & N / O Emerald Park Drive (PED SIGNAL)	X	332	2070 ATC	Fiber
131	Elk Grove Boulevard & Franklin Boulevard	X	P	2070LNC	Copper
128	Bond Road & Quail Cove Drive / Crowell Drive	X	P	2070LNC	Copper
129	E. Stockton Boulevard / Survey Road & Grant Line Road	X	P	980 ATC	Copper
130	Elk Grove-Florin Road & S / O La Haya Drive (PED SIGNAL)	X	332	2070 ATC	Copper and Fiber
131	Elk Grove-Florin Road & W. Camden Drive	X	SP	980 ATC	Copper
132	Galen Drive & Harbour Point Drive	X	P	2070LNZ	Wireless
133	Elk Grove Boulevard & Harbour Point Drive / W. Taron Drive	X	P	2070LNC	Copper
134	Bond Road & Sierra River Drive	X	P	2070LNC	Copper
135	Franklin Boulevard & Laguna Woods Drive / Millstone Drive	X	SP	980 ATC	Copper
136	Franklin Boulevard & Laguna Boulevard	X	P	2070LNZ	Copper
137	Elk Grove Boulevard & Williamson Drive	X	332	2070 ATC	Copper
138	Amber Creek Drive / Frye Creek Drive & Big Horn Boulevard	X	SP	980 ATC	Copper
139	Edward Harris Middle School Driveway & Power Inn Road	X	P	2070LNC	Copper
140	Bond Road & Terra Linda Drive	X	P	2070LNC	Copper
141	Elk Grove Boulevard & E. Taron Drive	X	P	2070LNC	Copper
135	Big Horn Boulevard & Civic Center Drive	X	P	2070LNC	Copper
136	Big Horn Boulevard & Denali Circle (N)	X	P	2070LNC	Copper
137	Elk Grove Boulevard & Four Winds Drive	X	P	2070LNC	Copper
137	Big Horn Boulevard & Lotz Parkway / Denali Cir (S)	X	P	2070LNC	Copper
138	Elk Grove Boulevard & Waterman Road	X	P	2070LNC	Copper
138	Laguna Springs Drive & Civic Center Drive	X	P	2070LNC	Copper
139	Laguna Springs Drive / Wolfpack Ln & Lotz Parkway	X	P	2070LNC	Copper
140	Whitelock Parkway & Franklin High Road / Bellaterra Drive E.	X	P	980	Copper
141	Elk Grove Boulevard & Shorelake Drive	X	P	2070LNC	Copper
141	Whitelock Parkway & Atkins Drive	X	P	980	Copper
142	Kammerer Road. & Promenade Parkway	X	P	980 ATC	Copper
143	Elk Grove Boulevard & Stonelake Club Drive	X	P	2070LNC	Copper
144	Elk Grove Boulevard & School Street	X	P	2070LNC	Copper
143	Grant Line Road & SR 99 NB Ramp	X	332	2070L	Copper
144	Elk Grove Boulevard & Foulks Ranch Drive / Cresleigh Parkway	X	P	2070LNC	Copper
144	Grant Line Road & SR 99 SB Ramp	X	332	2070L	Copper

No.	Intersection	Connected to ATMS.now	Cabinet	Controller	Comm Type
145	Hausmann Street / High Tech Court & Laguna Boulevard	X	P	2070LNC	Copper
145	Promenade Parkway & S Mall Entrance	X	P	2070LNC	Copper
146	Elk Grove Boulevard & Waymark Drive	X	P	2070LNZ	Copper
146	Promenade Parkway & Lent Ranch Parkway	X	P	2070LNC	Copper
147	Laguna Boulevard & Laguna Springs Drive / W. Stockton Boulevard	X	P	2070LNC	Copper
147	Promenade Parkway & Bilby Road	X	P	2070LNC	Copper
148	Promenade Parkway & Kyler Road	X	P	2070LNC	Copper
149	Kammerer Road. & Lent Ranch Parkway	X	P	2070LNC	Copper
150	Big Horn Boulevard & Whitelock Parkway	X	P	2070LNC	Copper
151	Whitelock Parkway & Bellaterra Drive West	X	P	2070LNC	Copper
152	Elk Grove-Florin Road & Brown Road/	X	P	2070LNC	Copper
153	Grant Line Road & Waterman Road	X	P	2070LNC	Copper
154	Laguna Boulevard & Neosho Drive / Santorini Drive	X	P	2070LNC	Copper
154	Calvine Road & Power Inn Road	-	-	-	-
155	Laguna Boulevard & Laguna Crest Way / Laguna Oaks Drive	X	P	2070LNC	Copper
155	Calvine Road & Auberry Drive	-	-	-	-
156	Grant Line Road & Wilton Road	X	SP	980 ATC	Wireless
157	Calvine Road & Vintage Park Drive	-	-	-	-
156	Calvine Road & Cliffcrest Drive	-	-	-	-
157	Laguna Boulevard & Laguna Main Street	X	P	2070LNC	Copper
158	Calvine Road & Waterman Road	-	-	-	-
157	Laguna Springs Drive & Longleaf Drive	X	P	2070LNC	Copper
158	Elk Grove-Florin Road & Valley Oak Lane	X	SP	980 ATC	Fiber
158	Big Horn Boulevard & Longleaf Drive	X	P	2070LNC	Copper
159	Laguna Boulevard & Laguna Park Drive (W)	X	P	2070LNC	Copper
160	Calvine Road & Elk Grove Florin Road	-	-	-	-
161	Calvine Road & Grand Cru/Heritage Hill Drive	-	-	-	-
159	Bradshaw Road & Kapalua Drive/Stone Springs Drive	X	P	2070LNC	Copper
160	Elk Grove-Florin Road & Sheldon Road	X	P	2070LNC	Copper
160	Grant Line Road & Sheldon Road	X	P	2070LNC	Wireless
161	Calvine Road & Jordan Ln/Kingsbridge Drive	-	-	-	-
162	Laguna Boulevard & SR 99 NB Ramp	X	332	2070L	Copper
163	Laguna Boulevard / Harbour Point Drive &	X	P	2070LNC	Copper
161	Elk Grove Florin Road & E. Stockton Boulevard	X	P	2070LNC	Fiber
162	Laguna Boulevard & Trenholm Drive	X	P	2070LNC	Copper
163	Franklin Boulevard & Percheron Drive	X	P	2070LNZ	Copper
162	Bond Road & Bader Road	X	M	980ATC	Wireless
163	Lotz Parkway & Auto City Drive / Porto Bay Drive	X	SP	980 ATC	Copper
164	Franklin Boulevard & Whitelock Parkway	X	P	2070LNZ	Copper
165	Franklin High Road & Whitelock Parkway	X	P	2070LNZ	Copper
166	Franklin High School Driveway & Whitelock Parkway	X	SP	980 ATC	Copper
167	E Stockton Boulevard & SR 99 NB Ramp	X	332	2070	Copper
168	Freesia Drive / Springhurst Drive & Sheldon Road	X	P	2070LNZ	Copper
169	Elk Grove Boulevard & Ginther Drive	X	SP	980 ATC	Copper

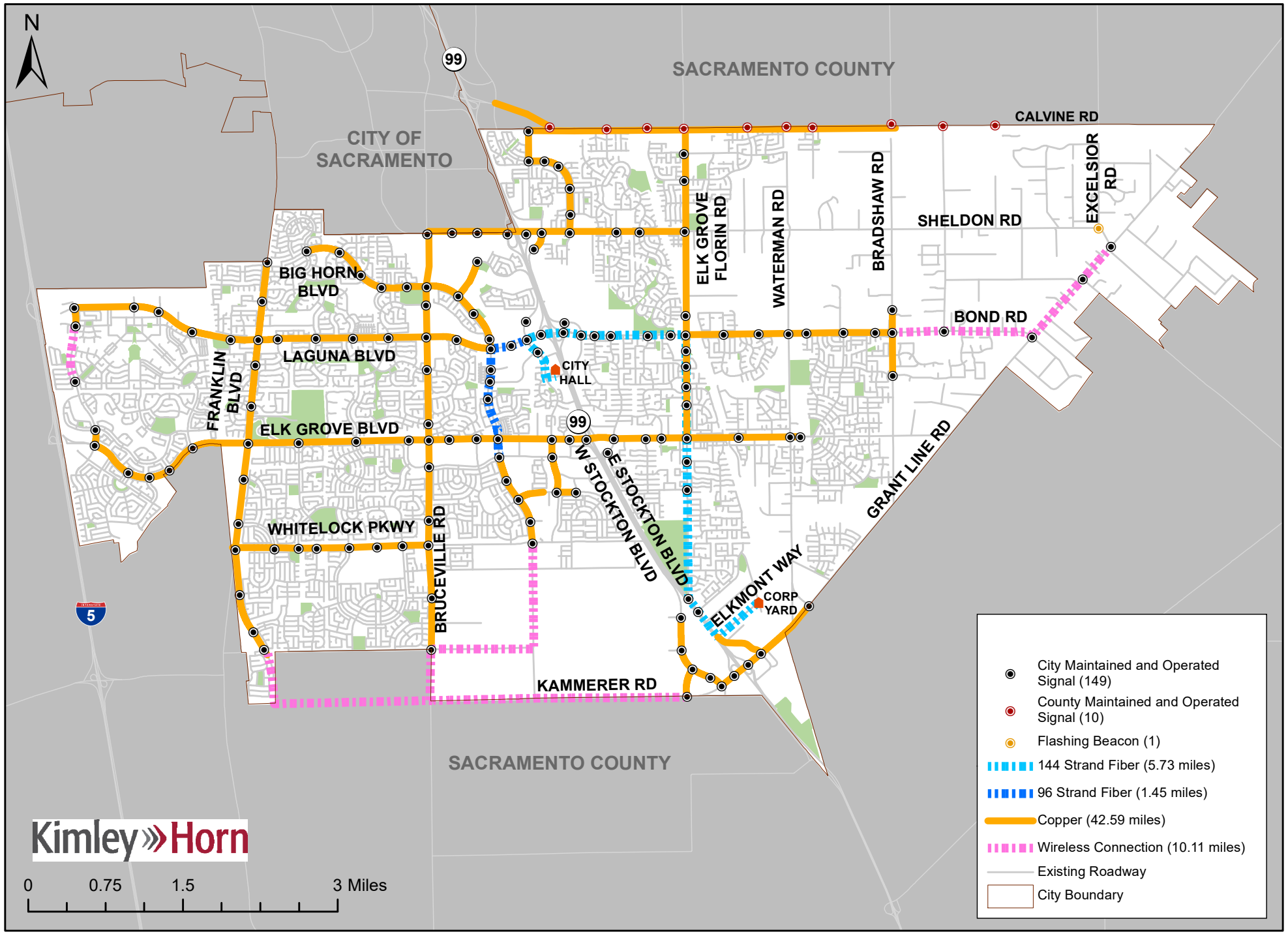


EXHIBIT 1 - TRAFFIC SIGNAL AND COMMUNICATIONS INFRASTRUCTURE

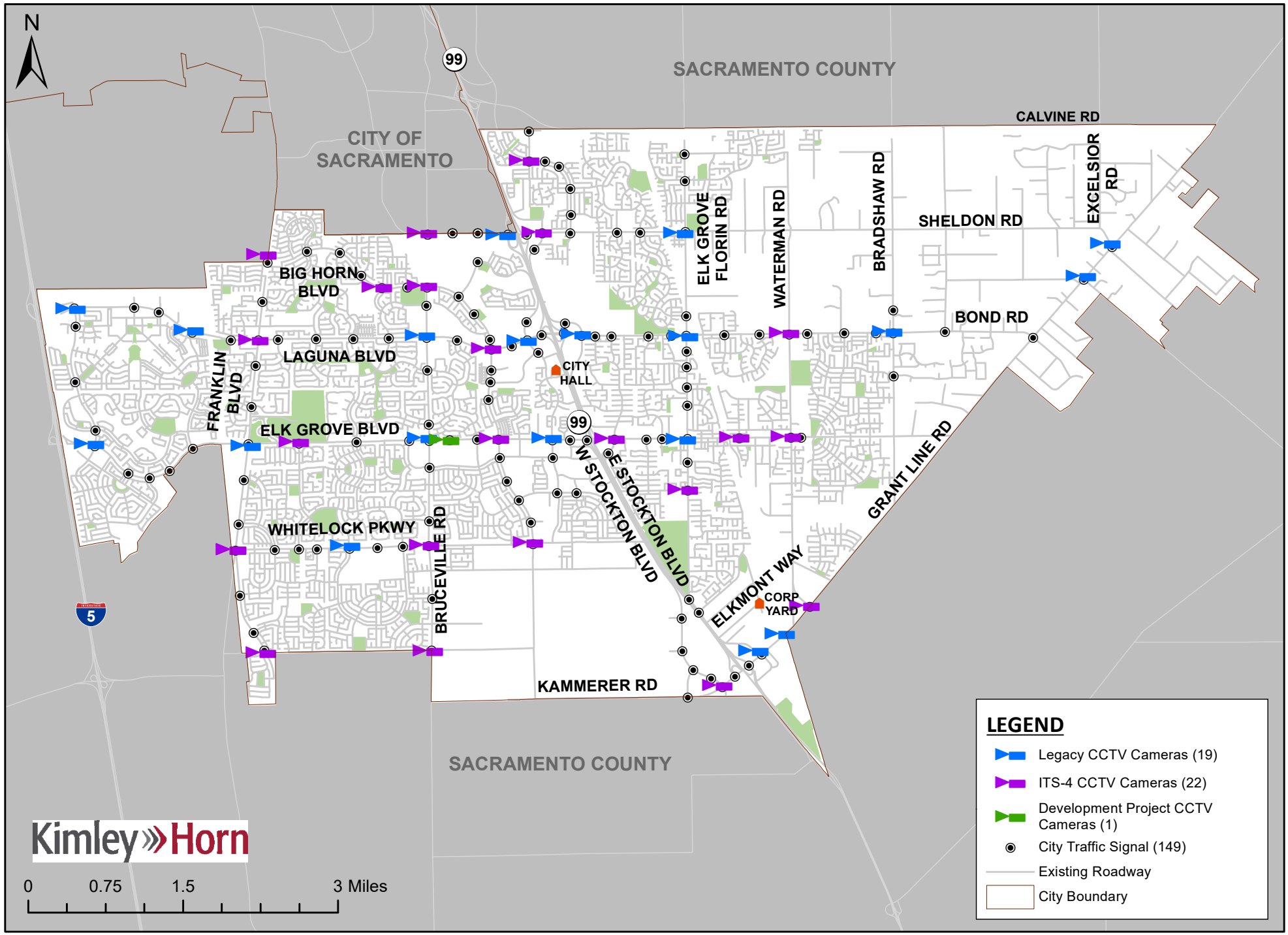


EXHIBIT 2 - EXISTING CCTV CAMERA AND CMS LOCATIONS

APPENDIX B – STRATEGY SUMMARY SHEETS

Strategy # –This is the identification number by strategy.

Title – This is the title of strategy.

Description – This is a succinct description of the strategy for context.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve a variety of needs.

Scope/Limits – This is a succinct summary of what is included in the strategy and/or locations (if applicable) of where the strategy would apply.

Considerations – This is a bullet listing of other strategies that are relevant for the City to reference during implementation or could be packaged together to be implemented in a larger strategy in a particular timeframe.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

Strategy ID #1

Improve Existing Communications Capabilities on Key Corridors

Strategy Description – Eliminate communications gaps and expand communications network along key traffic corridors. Utilize copper/fiber or wireless technologies to achieve more robust communications coverage. Connect communications to devices and traffic signals along the key corridors for remote monitoring and control. This includes upgrading communications from legacy copper lines to more robust agency-owned infrastructure such as fiber or wireless.

Relation to Needs –

- Baseline communications infrastructure (Need #1)
- Reliable communications to prevent downtime (Need #4)
- Adequate bandwidth in communications to support data sharing (Need #6)

Scope/Limits – The following corridors should include installation of fiber optic cable to replace existing legacy copper:

- Sheldon Road from Bruceville Road to Elk Grove Florin Road
- Big Horn Boulevard from Amber Creek Drive to Laguna Boulevard, including Lewis Stein Road from Big Horn Boulevard to W Stockton Road
- Laguna Boulevard from Harbour Point Drive to Big Horn Boulevard
- Harbour Point Drive and Maritime Drive to Elk Grove Boulevard and Waterman Road
- Whitelock Parkway from Franklin Boulevard to Bruceville Road
- Promenade Parkway and Kyler Road to Grant Line Road and Waterman Road
- Willard Parkway and Bilby Road to Franklin Boulevard and Big Horn Boulevard
- Bruceville Road from Bilby Road to Sheldon Road
- Big Horn Boulevard from Whitelock Parkway to Lotz Parkway
- Lotz Parkway and Auto City Drive to Laguna Springs Drive and Elk Grove Boulevard
- Power Inn Road and Sheldon Road to Auberry Drive and Calvine Road
- Elk Grove Florin Road from Bond Road to Calvine Road
- Bradshaw Road from Stone Springs Drive to School Loop Road

The following corridor should include installation of new fiber optic cable to supplement existing point-to-point wireless:

- Harbour Point Drive from Galen Drive to Maritime Drive

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #2 – Deploy New Video Detection Equipment
- ID #4 – Deploy New CCTV Equipment
- ID #17 – Implement Transit Signal Priority
- ID #20 – Deploy New CMS Equipment
- ID #25 – Adaptive Traffic Control

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Deploy projects that connect to the central system (e.g., TMC)
- Existing infrastructure supporting subsequent projects should be functional

Strategy ID #2

Deploy New Video Vehicle Detection Equipment

Description – Deploy new video detection equipment at signalized intersection locations that do not have current detection available. Video detection equipment will require devices to be mounted on all mast arms or overhanging one pole location to be able to view all legs of the intersection, depending on the type of technology procured. Video detection will be able to detect vehicles, bicycles, and pedestrians in zones set up by the traffic management center (TMC) to support signal timing plan implementation. Depending on the type of technology procured, video detection may be able to collect real-time turning movement counts to support more real-time signal timing adjustments required. Additional detection can support more traffic-responsive signal timing to detect the main street and side streets more effectively.

Relation to Needs – The installation of video detection equipment addresses the following needs.

- Robust coverage to acquire real-time conditions (Need #2)
- Support active transportation operations (Need #3)
- Better traffic operations functions (Need #21)

Scope/Limits –127 signalized intersections have vehicle loop detection. It is recommended that the City replace all legacy loop detection devices with video detection.

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #1 – Improve Existing Communications Abilities on Key Corridors
- ID #4 – Deploy New CCTV Equipment
- ID #17 – Implement Transit Signal Priority
- ID #20 – Deploy New CMS Equipment
- ID #25 – Adaptive Traffic Control

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish baseline communication network
- Close communication gaps
- Determine whether real-time detection is appropriate

Strategy ID #3

Third-Party Archived Data

Description – Acquisition of third-party data on a regional level for archived speed data on the transportation network for planning purposes. This strategy may be leveraged by local agencies to use this third-party data for analysis or planning purposes for their jurisdiction within the transportation network.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Subscription to third-party data provider to be procured on a regional level by SACOG.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #4

Deploy New CCTV Equipment

Description – Deploy new CCTV equipment at signalized intersection locations that do not have current video capabilities available. CCTV equipment will require devices to be mounted on one pole location to be able to view all legs of the intersection and, as feasible as possible, to view to the next intersection location. CCTV video will provide real-time streaming video to allow traffic management center (TMC) to view road network conditions and to share information about real-time conditions with partner departments, such as public safety, that may need to respond to an incident or event. The new CCTV will need to be integrated into the agency's central management system for viewing and control.

Relation to Needs – Deployment of new CCTV equipment addresses the following needs:

- Robust coverage to acquire real-time conditions (Need #2)

Scope/Limits – Elk Grove has 19 legacy CCTV cameras and an additional 23 that are being installed as part of the City's ITS Phase 4 project and a development project. The remaining 108 signalized intersections do not have CCTV cameras. It is recommended that the City install a CCTV camera at each of these signalized intersections so that there is one (1) CCTV camera at every signal.

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #1 – Improve Existing Communications Abilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #17 – Implement Transit Signal Priority
- ID #20 – Deploy New CMS Equipment
- ID #25 – Adaptive Traffic Control

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish baseline communication network
- Close communication gaps
- Determine whether real-time vehicle detection is appropriate

Strategy ID #5

Determine Locations to Deploy Active Transportation Detection

Description – Develop a detailed master plan of active transportation technologies for each jurisdiction based on key corridors and how those technologies will be integrated and used within the context of the broader transportation management systems. The estimations provided in this master plan are high-level.

Relation to Needs – Support active transportation operations (Need #3)

Scope/Limits – Project includes up to eighty (80) hours of staff time to develop Active Transportation Detection master plan.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Identify engineering and transportation planning staff to develop master plan
- Identify active transportation network
- Develop policies, performance targets, and design guidelines
- Prioritize projects
- Develop implementation and funding plan

Strategy ID #6

Regional TOC Backup

Description – Establish or identify a Regional TOC including facility/office, systems support, and staffing support. Will include a direct connection either through STARNET or separate communications to each agency ATMS system. Will be developed similar to an Emergency Operations Center such that this Regional TOC will include backup operations procedures and anticipated support requirements for a regional facility in the event of needing to step in for all agency ATMS system operations.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Establishment or identification of a Regional TOC to be procured as a regional project.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #7

Back Up TOC Function Capabilities

Description – Establish VPN or other remote access to be able to control field infrastructure through ATMS system from a minimum of two physically separate locations. It is recommended that one of the locations is not deemed a laptop or tablet, as there may be instances where that device is physically located in the traffic operations center and thus creates a single-failure-point for the ATMS system. Redundant servers in a separate facility is an ideal condition.

Relation to Needs –

- Reliable communications to prevent system downtime (Need #4)
- Access to central systems 24x7 (Need #18)

Scope/Limits – Establish VPN to City workstation in City corporation yard.

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #10 – Upgrade Agency ATMS
- ID #14 – Analytics Software for Real-Time Operations Decision Making

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Secure project funding
- Develop backup TOC goals and objectives
- Configure central management systems

Strategy ID #8

Replace end-of-life/legacy equipment with modernized and upgraded equipment

Description – Utilize existing agency asset management system used by other departments within the agency, such as water or utilities, to track inventory age and characteristics of technology and communications assets. Includes software, installation, integration, and data migration or entry of existing inventory information for all agency assets related to transportation technology. Leveraging an existing platform for use by a new department is a near-term solution to a longer-term need for one agency integrated asset management system for all agency assets.

Relation to Needs –

- Maintainable infrastructure and assets (Need #5)
- Reliable equipment functionality to prevent downtime (Need #4)
- Improve data quality/reliability (Need #14)

Scope/Limits – All legacy controllers in the City are up-to-date and do not need to be replaced. An inventory of supplemental, modernized field devices should be maintained- including, but not limited to, Closed Circuit Television Cameras, Video Cameras, and Changeable Message Signs. A sufficient number of each device category will be kept in the inventory and refilled as the inventory gets low. The recommended number of devices to maintain is 10 percent of the total number of each device. Therefore, with the existing and proposed devices, it would be suggested that the City maintains 15 CCTV Cameras, 15 Video Cameras, 15 signal controllers, and one (1) CMS.

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #2 – Deploy New Video Detection Equipment
- ID #20 – Deploy New CMS Equipment

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a functional baseline communications network

Strategy ID #9

Establish Central Regional Video Management System

Description – Establish a central regional video management system that allows all agencies to view all agency CCTV streaming video for the purposes of real-time operations. This regional video system would need to link to each individual agency video system, whether integrated into their ATMS or as a separate stand-alone system. The regional video system will need to be managed and maintained by one agency, preferably SACOG.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – A Central Regional Video Management System is to be procured on a regional level.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #10

Upgrade Agency ATMS

Description – Upgrade agency ATMS to incorporate new functionality as required by Smart Region initiatives and incorporate a variety of data deemed important by agencies to receive automated alert notifications. Additional data to incorporate into an agency ATMS upgrade include CCTV video streaming, weather notifications from weather devices, emergency notifications, and equipment maintenance status and alerts. Additional modules may be needed to support travel time devices, connected vehicle devices, or other types of devices not currently in use by the agency.

Relation to Needs –

- Adequate bandwidth in communications to support data sharing (Need #6)
- Timely emergency notifications (including weather) (Need #23)
- Share data between agencies that share a corridor (Need #10)
- Access to central systems 24x7 (Need #18)

Scope/Limits – Procurement of upgraded ATMS to incorporate new functionality including integration of multiple existing CCTV video streaming systems onto a centralized transportation management system.

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #7 – Back Up TOC Function Capabilities
- ID #14 – Analytics Software for Real-Time Operations Decision Making

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a functional baseline communications network
- Deploy modernized and compatible CCTV cameras at identified locations

Strategy ID #11

Establish Regional TOC and Regional ATMS System

Description – Establish a regional TOC location and regional ATMS to incorporate all functionality as required by regional and local agency Smart Region initiatives and incorporate a variety of data deemed important by agencies to receive automate alert notifications. This would involve central management and operations of a regional ATMS system that would replace the need for local agency ATMS separate systems or would back up the local agency ATMS separate systems. This regional TOC would be staffed by regional positions and supported with an ongoing operations and management budget to perform its necessary functions. This strategy could also support the purpose of sharing data between agencies that share a corridor.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Development of a regional TOC and regional ATMS to be procured on a regional level by SACOG.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #12

Regional Modernized CAD Integration

Description – Integrate CAD systems across all public safety agencies across the region. This would involve a significant software integration process to upgrade or replace CAD systems with all public safety agencies to use the same CAD system. This strategy will be to modernize the CAD systems used in the region to allow for more data integration in between agency systems as well as more functionality provided to public safety dispatch and responders.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Integration of CAD systems to be procured as a regional project.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #13

ATSPM Software Deployment

Description – Establish an ATSPM software that agencies are able to use to analyze high-resolution traffic condition data for the purpose of better signal timing and coordination. Establish a central agency that owns the software and servers that other agency ATMS systems will connect to in order to provide ATSPM data. As part of this strategy, establish a SACOG or third-party contract to analyze performance metrics related to ATSPM data to provide support to all agencies with reliable metrics to support their individual agency operations. Included in the software procurement and integration will need to be training on the use of ATSPM.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Development of ATSPM software to be procured as a regional project.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #14

Analytics Software for Real-Time Operations Decision Making

Description – Integrate back end software linked to the agency ATMS to analyze data for real-time operations decision making. This will include software, server, and identified staff responsible for verifying system outputs. System should be set up to provide reports and alerts to TOC operators or other personnel regarding real-time decision making that needs to be made based on data analysis completed by the software. Data used as inputs to the software may include speeds, volumes, travel times, or other types of traffic condition data. Comparative travel times should be an output of the analytics software to be able to post to the public via multiple traveler information methods such as CMS, website, or push notification via mobile application.

Relation to Needs –

- Real-time travel time data for operations (Need #8)
- Encourage travel mode shift (Need #11)

Scope/Limits – Development of back end data analytics software for citywide traffic operations.

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #7 – Back Up TOC Function Capabilities
- ID #10 – Upgrade Agency ATMS

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a baseline communications network
- Deploy modernized vehicle detection equipment to receive real-time data

Strategy ID #15

Share CCTV with Individual Agencies

Description – Utilizing a robust communications center-to-center network between agencies, CCTV streaming video images should be shared between agencies. Shared control of CCTV may not be desirable nor feasible, but could be allowed through this center-to-center asset viewing capability.

Relation to Needs – The development of a center-to-center sharing network addresses the following needs.

- Sharing of camera images to support pre-trip, en-route, and incident management (Need #9)

Scope/Limits – A network will be set up on a regional basis to share CCTV imagery between agencies.

Considerations – See regional document for further details.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Deploy modernized CCTV cameras at identified locations
- Establish an inventory of supplemental CCTV cameras

Strategy ID #16

Improve Traffic Signal Timing Along Transit Service Corridors

Description – Complete signal optimization plans along key transit routes that need updated to consider transit mobility needs as well as transit signal priority, if existing. Signal timing plans need to be developed based on current traffic turning movement counts, developed modeling outputs, and uploaded into the signal controllers. Before and after evaluation of the corridor is recommended as many times tweaks are required of signal timing plans prior to completion of a signal timing plan effort. Use performance metrics to analyze throughput and coordinate light rail and heavy rail preemption where necessary with traffic signal operations.

Relation to Needs – Reduce impact of light rail and bus preemption on traffic mobility (Need #9)

Scope/Limits – Develop signal timing coordination plans along the following major transit corridors in the City:

- Laguna Boulevard between Harbour Point Drive and Elk Grove Florin Road (23 signals)
- Elk Grove Boulevard between Harbour Point Drive and Foulks Ranch Drive (8 signals)
- Bruceville Road between Big Horn Boulevard and Elk Grove Boulevard (6 signals)
- Elk Grove Florin Road between Calvine Road and E Stockton Boulevard (14 signals)
- Big Horn Boulevard between Franklin Boulevard and Whitelock Parkway (20 signals)

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #17 – Implement Transit Signal Priority
- ID #25 – Adaptive Traffic Control
- ID #26 – Improve Traffic Signal Timing Along Key Corridors

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a functional baseline communications network

Strategy ID #17

Implement Transit Signal Priority

Description – Implement transit signal priority along key transit routes where signal timing has made mobility and efficiency for the transit service challenging. This involves infrastructure installed at the signalized intersection as well as integration into the existing signal controller for priority requests of the signal timing plan.

Relation to Needs – Reduce impact of light rail and bus preemption on traffic mobility (Need #9)

Scope/Limits – Deploy TSP along the following corridors, so TSP is provided along e-Tran routes within the City:

- Laguna Boulevard (30 signals)
- Elk Grove Boulevard (22 signals)
- Big Horn Boulevard (15 signals)
- Sheldon Road (10 signals)
- Calvine Road (5 signals)
- Franklin Boulevard (3 signals)
- Harbour Point Drive (3 signals)
- Bruceville Road (3 signals)
- Power Inn Road (6 signals)
- Elk Grove Florin Road (13 signals)
- Whitelock Parkway (8 signals)
- Grant Line/Kammerer Road (6 signals)

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #1 – Improve Existing Communications Abilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #4 – Deploy New CCTV Equipment
- ID #20 – Deploy New CMS Equipment
- ID #25 – Adaptive Traffic Control

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a baseline communication network
- Coordinate signals along light rail
- Deploy modernized traffic signal equipment at each involved intersection

Strategy ID #18

Regional Data Sharing Policy, Guidelines, and Standard Agreement

Description – Establish regional data sharing policy and/or guidelines that establish what data will be shared, how the data will be shared, what responsibilities are involved in data sharing, connections to ATMS systems for data sharing purposes, and what kind of standard operating procedures are associated with data use.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – A data sharing policy will be developed on the regional level.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #19

TNC Standards for Last-Mile Connections

Description – Establish TNC coordination locations for last-mile connections between public areas and transit service locations. Drop off and pick up locations can be organized with TNC providers for day-to-day as well as special event purposes. Development codes could be updated to incorporate reduced parking requirements due to TNC drop off/pick up zones. This coordination will improve the accessibility of travel options to travelers.

Relation to Needs – Establishment of TNC coordination locations addresses the following needs.

- Encourage travel mode shift (Need #11)
- CV/AV policy readiness (Need #15)
- Improve special event coordination (Need #22)

Scope/Limits – Identify development codes to allocate parking for TNC drop off zones.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Strategy ID #20

Deploy New CMS Equipment

Description – Deploy new CMS equipment at key locations within the agency jurisdiction either at new locations or as a new function for the agency. CMS equipment will require devices to be mounted cantilever, on a pole, or over the travel lane. CMS provides the traveling public with an en-route message that is pertinent to their travel. The CMS will need to be integrated into the agency's central management system to post messages.

Relation to Needs – The installation of a range of vehicle detection devices addresses the following needs.

- Real-time traveler information (Need #8)

Scope/Limits – Deploy CMS at the following three (3) locations which at key strategic decision locations to relay traveler information:

- Elk Grove Florin Road north of Bond - Northbound
- Kammerer Road west of SR-99 – Eastbound
- Franklin Boulevard north of Laguna Boulevard – Northbound

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #1 – Improve Existing Communications Abilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #4 – Deploy New CCTV Equipment
- ID #17 – Implement Transit Signal Priority
- ID #25 – Adaptive Traffic Control

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a baseline communications network

Strategy ID #21

Deploy Bluetooth Devices

Description – Deploy Bluetooth devices to collect anonymous speed and travel time data for use in real-time operations, real-time traveler information notifications, or for planning purposes. Devices will require mounting at signalized intersections and connection to the agency's communication network for management and data collection from an agency traffic operations center or via third-party vendor service.

Relation to Needs –

- Robust coverage to acquire real-time conditions (Need #2)
- Real-time travel time data for operations (Need #8)
- Use data to support planning purposes (Need #13)

Scope/Limits – Deploy Bluetooth readers at the following 21 intersections:

- Laguna Boulevard/Harbour Point Drive
- Elk Grove Boulevard/Harbour Point Drive
- Franklin Boulevard/Big Horn Boulevard
- Franklin Boulevard/Laguna Boulevard
- Franklin Boulevard/Elk Grove Boulevard
- Franklin Boulevard/Whitelock Parkway
- Bruceville Road/Big Horn Boulevard
- Bruceville Road/Laguna Boulevard
- Bruceville Road/Elk Grove Boulevard
- Bruceville Road/Whitelock Parkway
- Laguna Boulevard/Laguna Springs Drive
- Laguna Boulevard/E Stockton Boulevard
- Elk Grove Boulevard/Laguna Springs Drive
- Elk Grove Boulevard/E Stockton Boulevard
- Kammerer Road/Promenade Parkway
- Kammerer Road/E Stockton Boulevard
- Elk Grove Florin Road/Calvine Road
- Elk Grove Florin Road/Bond Road
- Elk Grove Boulevard/Elk Grove Florin Road
- Bradshaw Road/Calvine Road
- Grant Line Road/Sheldon Road

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a baseline communications network
- Establish power at traffic signal

Strategy ID #22

Deploy Connected Vehicle Infrastructure

Description – Deploy CV equipment (DSRC radios or equivalent) at signalized locations or other key locations through the use of agency-owned infrastructure. This strategy would initiate a pilot program (with option to extend) of key corridors that supports agency-owned CV technology and would require procuring CV equipment that would need to be installed at signalized intersections along priority corridors by the agency. Expansions to this pilot program would be assumed after the pilot project completion. This strategy does not include the push of specific CV data to vehicles using the system, but rather making the CV infrastructure available for agencies or the region to utilize when CV softwares and data are more robust and available.

Relation to Needs – CV/AV technology readiness (Need #24)

Scope/Limits – Deploy DSRC radios infrastructure at all City traffic signals.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Implementation of new signal controllers should be CV infrastructure ready.

Strategy ID #23

Establish Regional Technology and Systems Funding Program

Description – Establish an annual regional funding program for Smart Region initiatives that forecasts for at least five years what the programmed budgeting for technology investments will be. There will need to be a governance structure, prioritization process, and application requirements formalized as recommended in this plan for agencies to pursue individual or cooperative projects to implement using the regional funding program. The funding program should be organized by buckets of project types to maintain funding availability for each of the project types and not all funding goes to one bucket inadvertently in a programmed year.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Establish regional funding program to be procured as a regional project.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #24

Provide Adequate IT and Project Management Staffing for Real-Time Operations and Analysis Processes

Description – Establish new staffing levels to support the operations and maintenance of the transportation network and Smart Region initiatives. Offered in the plan are ratios of devices to the number of staff required to operate or maintain those devices. The agency should consider potential IT or Traffic Engineering staff that would need to be involved in the implementation of Smart Region initiatives such as data access/sharing and project management of infrastructure implementations. Additional staff may be required such a data analysis staff. The agency will need to identify reallocated staff or hire new staff to support operations and maintenance in order to implement Smart Region strategies.

Relation to Needs – Staffing for traffic operations (Need #19)

Scope/Limits – Focus staffing efforts on providing adequate IT and project management staffing to support real-time operations and analysis processes.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Consider staffing and training needs as the City develops their funding plan

Strategy ID #25

Adaptive Traffic Control

Description – Deploy adaptive traffic control on select key corridors that experience variable peak periods. Adaptive traffic control includes additional detection at signalized intersections, installation of adaptive software for signal controller use, and integration into the agency's ATMS system. It is recommended to complete a before and after evaluation of adaptive signal control effectiveness.

Relation to Needs – Implementing adaptive traffic control addresses the need for better traffic operation functions (Need #21)

Scope/Limits – Deployment of adaptive traffic signal control is recommended on the following arterial corridors:

- Laguna Boulevard between Harbour Point Drive and SR-99 (16 signals)
- Elk Grove Boulevard between Harbour Point Drive and Waterman Road (22 signals)

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #1 – Improve Existing Communications Abilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #4 – Deploy New CCTV Equipment
- ID #17 – Implement Transit Signal Priority
- ID #20 – Deploy New CMS Equipment

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a baseline communications network
- Establish connection to central ATMS system

Strategy ID #26

Improve Traffic Signal Timing Along Key Corridors

Description – Complete signal optimization plans along key corridors that need to be updated to consider updated traffic volumes and patterns. Signal timing plans need to be developed based on current traffic turning movement counts, developed modeling outputs, and uploaded into the signal controllers. Before and after evaluation of the corridor is recommended as many times tweaks are required of signal timing plans prior to completion of a signal timing plan effort. Use performance metrics to analyze effectiveness of optimization on travel times, speeds, and delay.

Relation to Needs –

- Better traffic operations functions (Need #21)

Scope/Limits – New/updated signal timing plans is recommended along the following primary arterial corridors:

- Laguna Boulevard between Harbour Point Drive and Elk Grove Florin Road (23 signals)
- Elk Grove Boulevard between Harbour Point Drive and Waterman Road (22 signals)
- Bond Road between SR-99 and Grant Line Road (16 signals)
- Bruceville Road (12 signals)
- Elk Grove-Florin Road between Calvine Road and E Stockton Boulevard (14 signals)
- Big Horn Boulevard between Franklin Boulevard and Whitelock Parkway (20 signals)

Considerations – Other strategies that will require consideration with regard to this strategy are:

- ID #16 – Improve Traffic Signal Timing Along Transit Service Corridors
- ID #17 – Implement Transit Signal Priority
- ID #25 – Adaptive Traffic Control

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Establish a functional baseline communications network

Strategy ID #27

Establish CAD System and TMC Connections for Automated Alerts/Notifications

Description – Establish filtered CAD system access from agency TMCs to be able to see when incidents are restricting lanes and warrant traffic management measures. This strategy will involve communications between the public safety network and the agency TMC. The CAD system will need to be filtered to anonymous data for lane restriction and location information only, and separate monitors and server will be required at the agency TMC because CAD will not be integrated into the agency's ATMS system for viewing.

Relation to Needs – Better incident coordination across jurisdictions and with public safety (Need #23)

Scope/Limits – Integrate City's CAD system with City's ATMS system and TMC. This scope of work includes software integration to update City's CAD and ATMS systems to view the data in ATMS interface. The scope includes purchase, installation, configuration and integration of servers and software required at City's TMC.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Prerequisite Dependencies – The following is a high-level list of prerequisite actions that will need to be taken prior to implementing this strategy.

- Server located at TMC

Strategy ID #28

Establish Regional Technology Procurement Contract

Description – Establish a regional technology procurement contract that will be managed by a single agency and can be utilized by local agencies to procure technology for transportation use such as detection, CCTV, CMS, software, or other technologies. This strategy will alleviate the requirement for all agencies to individually establish procurement specifications for this equipment. This contract is envisioned as a qualified vendor list that offers the agencies multiple vendor options for each type of device, not that a single vendor would be chosen for each type of device. This will expedite the procurement and acquisition of technologies in the region. No dedicated budgeting is anticipated for this contract as it is focused on contractual use by individual agencies.

Relation to Needs – Refer to Regional Implementation Plan.

Scope/Limits – Regional technology contract to be procured as a regional project.

Considerations – Refer to Regional Implementation Plan.

Prerequisite Dependencies – Refer to Regional Implementation Plan.

Strategy ID #29

Establish Agency Network Security Policies and Standards

Description – Network security training will be a requirement for personnel involved in using, accessing, or securing the agency's ATMS system or technologies. This will involve an agency requirement for IT to update security training on a regular basis. This will also involve in procurement specifications that the vendor/firm providing new technology provide training on the new functionality and security standards involved in that new technology. The agency's IT department will need to stay involved in keeping these policies and procedures up to date with current security requirements on the agency enterprise system.

Relation to Needs – Implementing network security policies and standards will address the following need.

- Reliable network security (Need I1)

Scope – The Traffic Department will work with City IT staff to procure a new firewall system and establish standard network security policies for operations and maintenance of traffic assets and the collection, storage, and dissemination of data.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

Strategy ID #30

Real-Time Data Connection between Transit and Transportation Agencies

Description – Establish connection between transit and transportation agencies for sharing data related to transit services. The purpose is for transportation agencies to organize traffic operations to accommodate transit services through collected data, such as vehicle location and on-time schedule performance that can better support the coordination of transit mobility and traffic mobility. This strategy specifically addresses transit signal priority needs and light rail transit needs for better mobility.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Share data between agencies that share a corridor (Need 10)
- Encourage travel mode shift (Need D11)
- Real-time traveler information (Need D12)
- Improve traffic operations (Need O3)
- Improve notification and alerts to travelers (Need O9)

Scope/Limits – Develop inter-agency agreements to share real-time data collected through video detection and CCTV cameras.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #2 – Deploy New Video Detection and CCTV Equipment
- ID #4 – Third Party Real-Time Data
- ID #5 – Perform ATMS Data Back Up
- ID #7 – Establish Central Regional Video Management System
- ID #10 – Share CCTV with Individual Agencies
- ID #11 – Share CCTV with Agency Public Traveler Information Platforms

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Establish CCTV Sharing Agreements between the individual agencies.
- Deploy modernized CCTV cameras at identified locations
- Establish an inventory of supplemental CCTV cameras

Strategy ID #31

Train Staff on Network Security

Description – Network security training will be a requirement for personnel involved in using, accessing, or securing the agency's ATMS system or technologies. This will involve an agency requirement for IT to update security training on a regular basis. This will also involve in procurement specifications that the vendor/firm providing new technology provide training on the new functionality and security standards involved in that new technology. The agency's IT department will need to stay involved in keeping these policies and procedures up to date with current security requirements on the agency enterprise system.

Relation to Needs – This is a mapping of strategies to the original needs, recognizing that one strategy may serve multiple needs.

- Reliable network security (Need I1)

Scope/Limits – Sacramento County will need to consider placing staff through technology training tracks and/or encourage staff to pursue certifications.

Considerations – The following are other strategies that should also be considered in conjunction with this strategy.

- ID #5– Perform ATMS Data Back Up
- ID #23 – Establish Agency Network Security Procedures and Standards

Prerequisite Dependencies – This is a bullet list summary of the high-level steps required to implement the strategy.

- Agency must have a defined set of security procedures and standards in order to train staff

Strategy ID #32

TNC Standards for Last-Mile Connections

Strategy Description – Establish TNC coordination locations for last-mile connections between public areas and transit service locations. Drop off and pick up locations can be organized with TNC providers for day-to-day as well as special event purposes. Development codes could be updated to incorporate reduced parking requirements due to TNC drop off/pick up zones. This coordination will improve the accessibility of travel options to travelers.

Relation to Needs –

- Encourage travel mode shift (Need #8)
- CV/AV policy readiness (Need #17)
- Improve special event coordination (Need #15)

Scope/Limits – Identify development codes to allocate parking for TNC drop off zones.

Considerations – This strategy is not codependent on any other strategy identified for the City and can stand alone in implementation.

APPENDIX C - PRIORITIZATION SUMMARY

Table 1: Prioritization Summary

Project ID	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Disaster preparedness	Contribute to operational and institutional efficiency	Enhances major corridors	Extent that project achieves local objectives	Other projects rely on this project	Total Strategy Score Compared to Objectives	Priority No.
		10	13	10	13	10	5	10	10	14	5	100	
A	**Elk Grove Blvd from Maritime Dr to Bruceville Rd and Harbour Point Dr from Maritime Dr to Elk Grove Blvd:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (11 signals). -Deploy vehicle video detection (11 signals) -Deploy CCTV cameras (7 locations) -Update signal timing (11 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (11 signals)	2	4	3	3	2	3	3	4	4	2	78	4
B	**Elk Grove Blvd from Bruceville Rd to I-99, Big Horn Blvd from Whitelock Pkwy to Laguna Blvd including segments on Lotz Pkwy and Laguna Springs Dr :** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (10 signals). -Deploy vehicle video detection (16 signals) -Deploy CCTV cameras (12 locations) -Update signal timing (16 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (16 signals)	2	4	3	3	2	3	3	4	3	2	75	7
C	**Laguna Blvd from Harbour Point Dr to Bruceville Rd and Harbour Point Dr from Maritime Dr to Laguna Blvd:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (14 signals). -Deploy vehicle video detection (14 signals) -Deploy CCTV cameras (10 locations) -Deploy CMS -Update signal timing (14 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (14 signals)	3	4	2	3	3	3	3	4	4	2	81	3
D	**Franklin Blvd from Laguna Blvd to Big Horn Blvd, Big Horn Blvd from Franklin Blvd to Laguna Blvd, Bruceville Rd from Laguna Blvd to Sheldon Rd, Laguna Blvd from Bruceville Rd to Big Horn Blvd, Lewis Stein Rd from Big Horn Blvd to W Stockton Rd:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (17 signals). -Deploy vehicle video detection (17 signals) -Deploy CCTV cameras (10 locations) -Update signal timing (18 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (18 signals)	3	4	2	3	3	3	3	4	3	2	77	5

Project ID	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Disaster preparedness	Contribute to operational and institutional efficiency	Enhances major corridors	Extent that project achieves local objectives	Other projects rely on this project	Total Strategy Score Compared to Objectives	Priority No.
		10	13	10	13	10	5	10	10	14	5	100	
E	**Sheldon Rd from Bruceville Rd to Elk Grove Florin Rd, Power Inn Rd from Sheldon Rd to Auberry Dr, Auberry Dr from Power Inn Rd to Calvine Rd, Elk Grove Florin Rd from Sheldon Rd to Calvine Rd:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (20 signals). -Deploy vehicle video detection (22 signals) -Deploy CCTV cameras (15 locations) -Update signal timing (22 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (18 signals)	4	4	2	3	3	3	3	3	3	2	77	6
F	**Bond Rd from Laguna Springs Dr to Grant Line Rd including connection to City Hall, Bradshaw Rd from Stone Springs Dr to School Loop Rd, Grant Line Rd from Bond Rd to Sheldon Rd:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (10 signals). -Deploy vehicle video detection (27 signals) -Deploy CCTV cameras (19 locations) -Deploy CMS -Update signal timing (27 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (27 signals)	4	4	3	3	3	4	3	3	3	4	83	1
G	**Willard Pkwy from Bilby Rd to Whitelock Pkwy, Franklin Rd from Whitelock Pkwy to Bond Rd, Whitelock Pkey from Franklin Blvd to Bruceville Rd, Bruceville Rd from Bilby Rd to Laguna Blvd:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (25 signals). -Deploy vehicle video detection (25 signals) -Deploy CCTV cameras (17 locations) -Update signal timing (25 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (25 signals)	0	4	3	3	3	3	3	4	3	2	72	8
H	**Elk Grove Blvd from I-99 to Waterman Rd, Elk Grove Florin Rd from E Stockton Blvd to Bond Rd including connection to Corp Yard, Promenade Pkwy at Kyler Rd to Kammerer Rd at Mosher Rd, including Lent Ranch Pkwy:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (17 signals). -Deploy vehicle video detection (27 signals) -Deploy CCTV cameras (20 locations) -Deploy CMS -Update signal timing (27 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (27 signals)	3	4	3	3	3	4	3	4	3	4	83	2

APPENDIX D - COST ASSUMPTIONS

Table 1: Cost Summary

Project ID	Strategies Addressed	Project Description	*Total Signals*	Video Detection	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	CMS	Communication (Miles)		Communication Hub	Connected Vehicle Technology	TSP/ EVP	Planning Level Cost
										New	Replace				
Infrastructure Projects - Improve Existing Communications Capabilities															
Communication Gap Closures, Communications Equipment Upgrade, Upgrade to Fiber															
A	1, 2, 4, 161 17, 20, 22, 26	Harbour Point Dr from Maritime Dr to Elk Grove Blvd, Elk Grove Blvd from Maritime Dr to Bruceville Rd	11	11	11		11	7	0	0.00	3.61	1	11	11	$ 2,157,000
B		Elk Grove Blvd from Bruceville Rd to I-99, Big Horn Blvd from Whitelock Pkwy to Laguna Blvd including segments on Lotz Pkwy and Laguna Springs Dr	18	16	16		10	13	0	0.00	2.73	1	18	18	$ 2,003,000
C		Harbour Point Dr from Maritime Dr to Laguna Blvd, Laguna Blvd from Harbour Point Dr to Bruceville Rd	13	13	13		13	9	1	0.51	4.20	1	13	13	$ 2,675,000
D		Franklin Blvd from Laguna Blvd to Big Horn Blvd, Big Horn Blvd from Franklin Blvd to Laguna Blvd, Bruceville Rd from Laguna Blvd to Sheldon Rd, Laguna Blvd from Bruceville Rd to Big Horn Blvd, Lewis Stein Rd from Big Horn Blvd to W Stockton Rd	15	7	7		15	11	0	0.41	5.16	1	15	15	$ 2,621,000
E		Sheldon Rd from Bruceville Rd to Elk Grove Florin Rd, Power Inn Rd from Sheldon Rd to Auberry Dr, Auberry Dr from Power Inn Rd to Calvine Rd, Elk Grove Florin Rd from Sheldon Rd to Calvine Rd	20	18	18		20	15	0	0.00	5.93	1	20	20	$ 3,124,000
F		Bond Rd from Laguna Springs Dr to Grant Line Rd including connection to City Hall, Bradshaw Rd from Stone Springs Dr to School Loop Rd, Grant Line Rd from Bond Rd to Sheldon Rd	25	24	24		11	19	1	2.09	5.04	1	25	25	$ 4,941,000
G		Willard Pkwy from Bilby Rd to Whitelock Pkwy, Franklin Rd from Whitelock Pkwy to Bond Rd, Whitelock Pkey from Franklin Blvd to Bruceville Rd, Bruceville Rd from Bilby Rd to Laguna Blvd	21	19	19		19	16	0	0.00	8.08	1	21	21	$ 3,679,000
H		Elk Grove Blvd from I-99 to Waterman Rd, Elk Grove Florin Rd from E Stockton Blvd to Bond Rd including connection to Corp Yard, Promenade Pkwy at Kyler Rd to Kammerer Rd at Mosher Rd, including Lent Ranch Pkwy	26	24	24		10	18	5	1.30	5.67	1	26	26	$ 4,553,000
Asset Management of Field Devices - 10% of Total Devices (Based on Final Buildout)															
I	9	Asset Management of Field Devices - 10% of Total Devices		15		15		15	1						$ 1,017,000

Project ID	Strategies Addressed	Project Description	Planning Level Cost
Non-Infrastructure Projects			
J	10	Upgrade ATMS	$ 90,000
K	21	Bluetooth Deployment (21 devices)	$ 95,000
L	25	Adaptive Traffic Control along Two Primary Arterial Corridors (Laguna Blvd between Harbour point Dr and SR-99, and along Elk Grove Blvd between Harbour point Dr and Waterman)	$ 821,000
M	5	Active Transportation Detection Master Plan	$ 24,000
N	14	Integrate back end software linked to ATMS to analyze data for real-time operations	$ 180,000
O	19	TNC Standards for Last-Mile Connections	$ 40,000
P	24	Increase Staffing Levels to Improve Real-Time Operations	*Salary-dependent*
Q	27	Establish CAD System and TMC Connections for Automated Alerts/Notifications	$ 900,000