SMART REGION

CITY OF CITRUS HEIGHTS

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
STIP – State Transportation Improvement Plan
TMC – Traffic Management Center
TOC – Traffic Operations Center
VMT – Vehicle Miles Travelled

SMART REGION SACRAMENTO

City of Citrus Heights 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 Citrus Heights 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 Citrus Heights 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 Citrus Heights 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 goal of this local plan is to define a set of prioritized projects that enables the City of Citrus Heights to advance the transportation network and fulfill the regional goal.

The City of Citrus Heights Smart Mobility Objectives include:

- Identify projects to improve City's communications network to connect all field devices and better manage City's transportation system
- Evaluate ways to improve efficiency of operations and maintenance of City's transportation system, particularly along primary arterial roadways
- Develop staffing plan and concept of operations to include recommendations on staffing levels and requisite skillsets for engineering and technical staff
- Identify implementable strategies and projects that pave the way for adoption of key emerging technologies Improve data open access
- Identify grant and funding opportunities to implement projects

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:

Infrastructure/Data (D):

- 1: Baseline communications infrastructure
- 2: Robust coverage to acquire real-time conditions
- 3: Reliable communications to prevent downtime
- 4: Maintainable infrastructure and assets
- 5: Programmatic planning for assets and maintenance of assets
- 6: Reliable equipment functionality to prevent downtime
- 7: Share data between agencies that share a corridor
- 8: Encourage travel mode shift
- 9: Real-time traveler information
- 10: Use data to support planning purposes
- 11: CV/AV technology readiness

Operational (O):

- 12: Sufficient environment for TOC operations
- 13: Trained staff to support operations
- 14: Improve traffic operations
- 15: Improve special event coordination
- 16: Better incident coordination across jurisdictions and with public safety

Institutional (I):

- 17: CV/AV policy readiness
- 18: Funding strategy

SMART REGION SACRAMENTO

City of Citrus Heights 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 Citrus Heights 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 Citrus Heights.

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. Six 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.

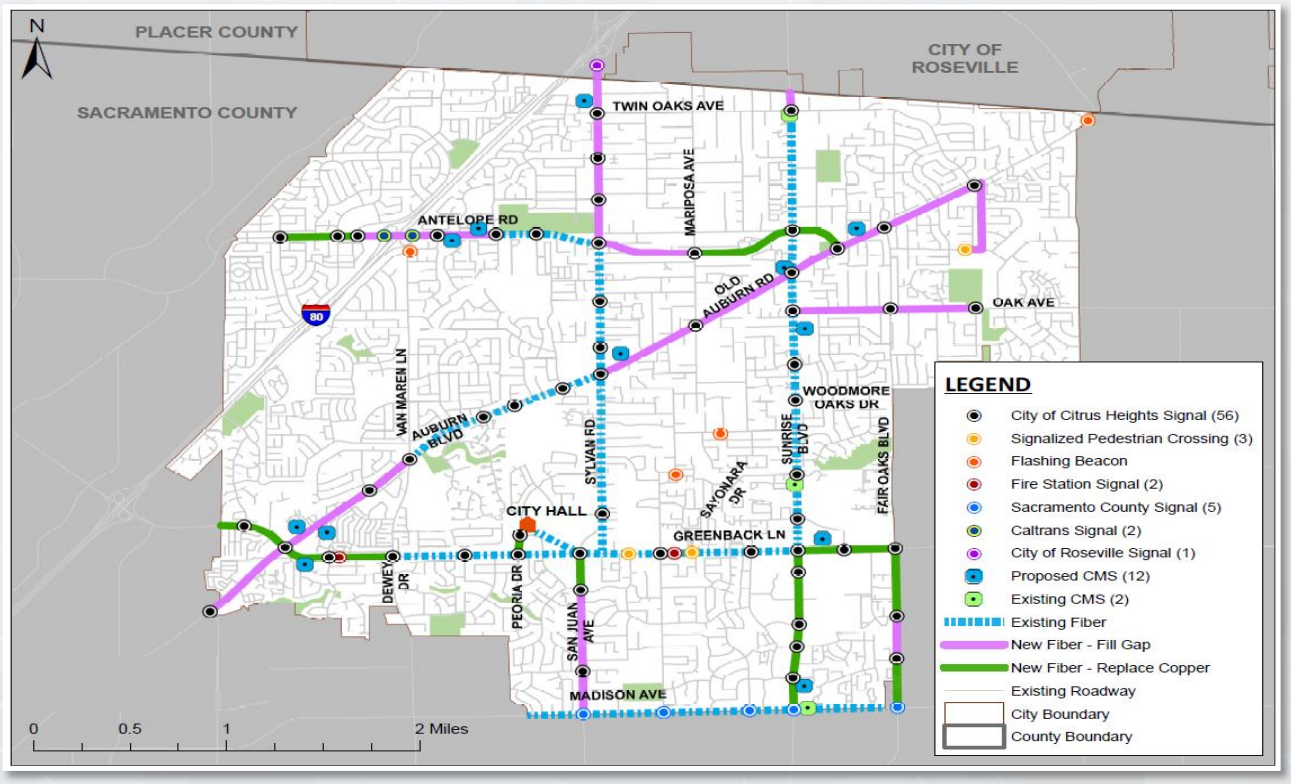
Operations & Maintenance

The major elements of the future network include:

- 8.5 miles of fiber optic communications
- 40 traffic monitoring cameras
- 13 traffic information signs
- 11 upgraded traffic signal controllers
- 65 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 Citrus Heights 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 Citrus Heights 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 Citrus Heights Technology Implementation Plan

The City of Citrus Heights 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 identified within 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 City currently has and defined the needs and deficiencies for the transportation system. 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.

The City of Citrus Heights 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 define the City's overall strategy going forward.

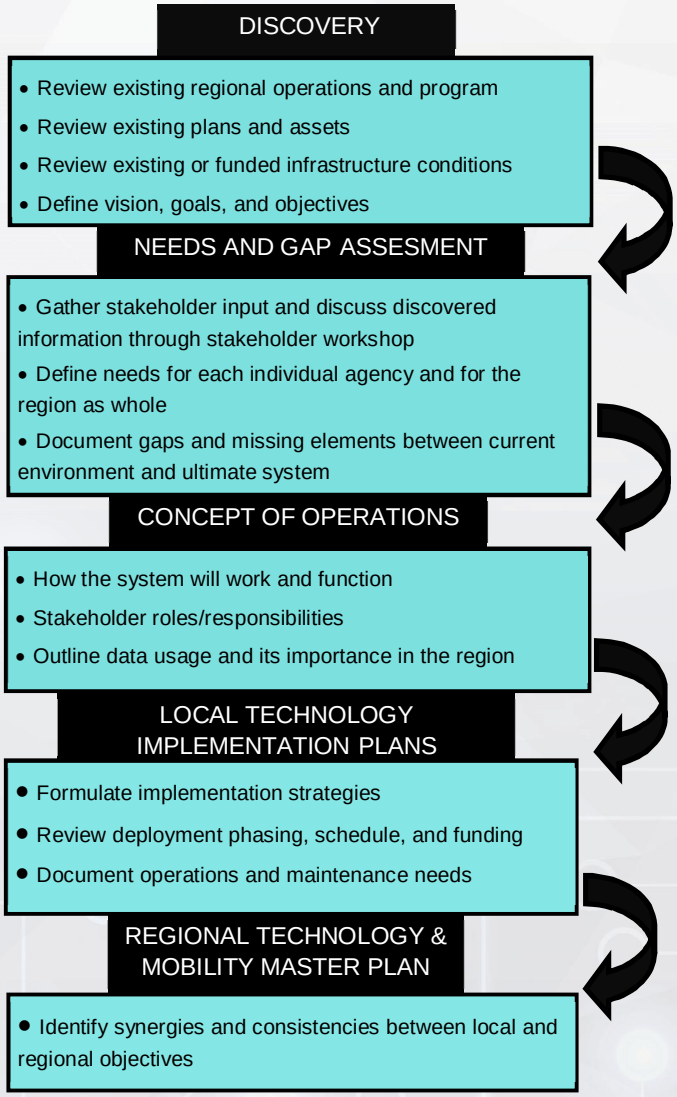


Figure 1 – Smart Region Sacramento Development Process

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 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.***

  A majority of the City's traffic signal and communication network is outdated and in need of upgrades. The City's communications network has largely been installed using a "piece-meal" approach and thus has resulted in several gaps in the system as well as an unstable network. Communications to traffic signals is not reliable as signals which are connected to the central system go offline intermittently for various reasons. The traffic signals along Greenback Lane

and Sunrise Boulevard, which are the key arterial roadways in the City that experience significant cut-through traffic, are currently operating traffic responsive timing. The City has expressed the desire to improve traffic operations along these critical corridors by evaluating deployment of adaptive signal timing control, which offers greater flexibility in proactively managing corridors that experience greater variability in traffic levels during peak and non-peak times. The City has limited staff to continuously monitor traffic operations and implement signal timing adjustments needed to improve traffic flow and reduce delay across the City's transportation network.

The City expressed that they have limited resources for proactive management and maintenance of the transportation system infrastrucure. 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 previously completed Transportation Planning Guidelines for the City of Citrus Heights Traffic Control System and TOC (*April 1999)* was reviewed in addition to other City provided documentation on CCTV camera locations, GIS maps, network communications diagram, traffic signal locations and inventory information (cabinet, controller, communications, detection type). Regional documents that represent multiple jurisdictions were also collected. Software systems and applications used by the agencies were also evaluated. The City has not previously prepared an ITS or Technology Plan.

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 Citrus Height'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 Citrus Heights to advance the transportation network and fulfill the regional goal.

The City of Citrus Heights has defined the following objectives for the Plan:

- Identify projects to improve City's communications network to connect all field devices and better manage City's transportation system;
- Evaluate ways to improve efficiency of operations and maintenance of City's transportation system, particularly along primary arterial roadways;
- Develop staffing plan and concept of operations to include recommendations on staffing levels and requisite skillsets for engineering and technical staff;
- Identify implementable strategies and projects that pave the way for adoption of key emerging technologies; and
- Identify grant and funding opportunities to implement projects.

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 Citrus Heights currently owns, operates, and maintains 56 traffic signals, the majority of which are located on key arterial and collector roadways. The City also owns, operates, and maintains three (3) traffic signals located at pedestrian crossings and two (2) traffic signals for emergency vehicles at fire stations. The City has executed a Memorandum of Understanding (MOU) with both

Sacramento County and Caltrans which details operating and maintaining agencies for several traffic signals. The City operates and maintains the two (2) Caltrans owned traffic signals at the I-80/Antelope Road Interchange intersections. The City also operates and maintains the traffic signals along Fair Oaks Boulevard which are Sacramento County owned. Sacramento County operates and maintains five (5) signals on Madison Avenue between San Juan Avenue and Fair Oaks Boulevard which are within City right-of-way.

Seven (7) traffic signals, two (2) pedestrian crossings and one (1) fire station signal do not have a battery backup system; all other City owned and maintained traffic signals have a battery backup system. Existing traffic signal controllers within the City are a combination of Naztec 980 and Multisonic 820 controllers. The City uses Trafficware's ATMS.now traffic signal central management system software. 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.

Of all City owned and maintained traffic signals, 36 are interconnected along Greenback Lane, Sunrise Boulevard, and Antelope Road. In addition, there are four (4) flashing beacons located on Purslane Way, Mariposa Ave, Highland Avenue, and Old Auburn Road.

Vehicle detection at signalized intersections is provided primarily using in-pavement loops, although video detection is the current City standard for vehicle presence detection. While most of the locations with video detection are fixed video detection cameras, there are three intersections with a Gridsmart detection system (fisheye camera lens for monitoring all approaches with one camera).

Communications Network

The City's existing traffic signal communications network consists of a combination of fiber optic cable (10.5 miles), legacy copper signal interconnect cable (7.4 miles), and empty conduit (1.4 miles). **Exhibit 1** of **Appendix A** depicts the location and extent of the City's existing communications infrastructure. The City's fiber optic communications network currently consists of a 96-strand fiber optic cable trunk (backbone) located along segments of Greenback Lane, Sunrise Boulevard, and Fountain Square Drive. There is fiber optic cable installed along Sunrise Boulevard between Woodmore Oaks Drive and Twin Oaks Avenue that is planned to be connected in the next four months. Installation of fiber optic cable in the existing gap in the network along Sunrise Boulevard between Woodmore Oaks Drive and Sayonara Drive is currently under construction. Additionally, there is legacy copper signal interconnect cable along Greenback Lane, Sunrise Boulevard, Antelope Road, and a segment of Sylvan Road, north of Greenback Lane.

Table 1 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	10.5
Copper	Twisted Pair	7.4
Empty Conduit	N/A	1.4

Closed Circuit Television (CCTV) Cameras

The City of Citrus Heights has 22 active CCTV cameras located primarily along Greenback Lane, Sunrise Boulevard, and Antelope Road. There are also 11 inactive (offline) CCTV cameras in the City. **Exhibit 2** of **Appendix A** depicts the location of the City's existing CCTV cameras.

Changeable Message Signs (CMS)

The City has two (2) changeable message signs (CMS) located on Sunrise Boulevard near the intersections of Twin Oaks Avenue and south of Sayonara Drive. **Exhibit 2** of **Appendix A** shows the location of the City's two existing CMS.

Traffic Management/Operations Center

The City's Traffic Management Center (TMC) is located in the office of the City's Traffic Engineer, on the first floor of City Hall. The TMC enables City staff and operators to perform monitoring functions, remotely implement signal timing changes, and respond to incidents and non-recurring traffic congestion. The TMC has one (1) workstation and two (2) flat panel monitors. There is not a dedicated space for a standalone TMC in the current City Hall building but the City may desire. The hours of operation of the TMC are weekdays between 8:00 am and 5:00 pm.

System Performance

The City's communication network is not reliable and results in traffic signals and CCTV cameras going offline intermittently, thus necessitating significant field support for maintenance. The mix of copper signal interconnect and fiber optic cable infrastructure, and incomplete fiber optic cable installation and termination, has contributed to the limitations and reliability of the communication network.

The City operates traffic responsive signal timing along key arterial roadways including Greenback Lane and Sunrise Boulevard. The existing traffic responsive signal timing is not consistently effective in managing the variability in traffic levels during peak and non-peak times.

Limited resources in 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. Detector failures go unnoticed until complaints. By default, detectors that fail go into Max Recall so it creates unnecessary delay. This is especially problematic when loops on side streets fail and side streets get Max green even when no demand present, resulting in increase in delays on major approaches. Existing loop detectors frequently experience issues in the field which require field support for maintenance. Moreover, the loop failures often go unnoticed due to inability to

receive real-time failure alerts. The City is migrating to deployment of video detection which is more reliable and offers capability of remote maintenance and alerts for proactive management.

Technology Trends

Intelligent Transportation Systems (ITS) and traffic operations technology is constantly advancing and evolving, which makes it an important consideration during the formulation of implementation strategies. Therefore, implementation strategies need to be adaptable to changing technology throughout the deployment phasing process.

Today, the City has begun deploying electric vehicle (EV) charging stations in City buildings. Microtransit efforts in the City are going well; Sacramento Regional Transit District (SacRT) recently launched its microtransit pilot project, SmaRT Ride, in Citrus Heights. At signalized intersections, the City hopes to replace all legacy loop detection with video detection.

It is crucial the Implementation Plan takes full advantage of the existing ITS technologies available while also formulating projects that align with where technological advancements may be heading. The following are current technology trends being considered 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 Geographical Positioning Systems, phone apps, and many other sources this is quickly changing. Big Data is already changing the way we plan, analyze, and operate our transportation.
- **Transportation Network Carriers (TNCs) –** TNC's pair passengers, most often via websites or mobile apps, with drivers who provide on-demand service. Services such as Uber and Lyft are examples of the sharing economy. Increasingly transit providers, including 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/AV 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 cities, 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** is a traffic operations strategy that is having a wider prominence across the country. Adaptive 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).
- **Traffic Signals & Parking –** Through integration with IoT and Big Data, traffic signal controllers are evolving to respond to real time conditions and ultimately communicate with Connected and Autonomous Vehicles. Parking meters and lots are also evolving to use real time occupancy data, mobile payment and reservation applications to make them easier to find and use, dramatically reducing the number of vehicles looking for parking (which can be as much as a third of the traffic in a downtown area).
- **Automated Traffic Signal Performance Measures (ATSPM)** is a software module add-on that processes and analyzes traffic signal data to display and report performance characteristics throughout a traffic signal network. This feature enables agencies to proactively identify trouble areas, report on corridor performance, and create 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.

NEEDS AND GAPS ASSESSMENT

The City of Citrus Heights' 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 Citrus Heights' Needs and Gaps.

Table 2 – City of Citrus Heights 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. There are large gaps in the existing Citrus Heights communications network between signalized intersections. Closing these gaps, replacing legacy copper communications with fiber, and creating redundant connections will result in a more complete and robust communications infrastructure.
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	Reliable communications to prevent downtime	Lack of redundant communications results in system downtime if communications are lost; no regional TOC backup, ATMS data backup, or backup of TMC function capabilities to manage TMC from a remote location.
4	Maintainable infrastructure and assets	End-of-life/Legacy equipment with outdated functional capabilities and/or are longer supported by vendors.
5	Programmatic planning for assets and maintenance of assets	Lack of asset management software program to track inventory data and maintenance in real time.
6	Reliable equipment functionality to prevent downtime	Lack of asset management software program to track inventory data in real-time.

ID #	Need	Gap
7	Share data between agencies that share a corridor	Lack of real-time or planned knowledge of corridor restrictions to operate efficiently across jurisdictions. Need to share CCTV camera images for incident and congestion management. Lack of regional data sharing policies and guidelines to establish data sharing protocol.
8	Encourage travel mode shift	Limited information available or disseminated to support mode shift. Lack of coordinated TNC locations for last-mile transit connections.
9	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.
10	Use data to support planning purposes	Limited data collected and limited use of data that is collected
11	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.
	Operations	
12	Sufficient environment for TOC operations	Poor ergonomics and layout (or lack) of TOC to serve operational functions. Lack of functional workstation layout at TOC.
13	Trained staff to support operations	Lack of sufficient number of staff members to provide adequate IT and networking staffing.
14	Improve traffic operations	Automate some functions to streamline operations. Current lack of traffic signal coordination along key corridors. Lack of ability to share CCTV camera images for incident and congestion management.
15	Improve special event coordination	Lack of coordination to support better mobility during special events. This includes lack of TNC zones for last-mile connections.
16	Better incident coordination across jurisdictions and with public safety	Lack of multiagency coordination to support better mobility during incidents. Lack of CAD system and TOC connections for automated alerts and notifications, including lack of radio in TOC.
	Institutional	
17	CV/AV policy readiness	Policies and codes currently do not support CV/AV.
18	Funding strategy	Lack of reliable funding mechanism to support Smart City or Smart Region initiatives on a regional or agency-by-agency basis.

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 system 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 Citrus Heights' 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 established 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 criteria. 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 project 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 strategy and/or locations (if applicable) of where the strategy 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 strategy in a particular timeframe.
- **Prerequisite Dependencies** – This is a bullet list summary of the high-level dependencies required to implement the strategy.

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**.

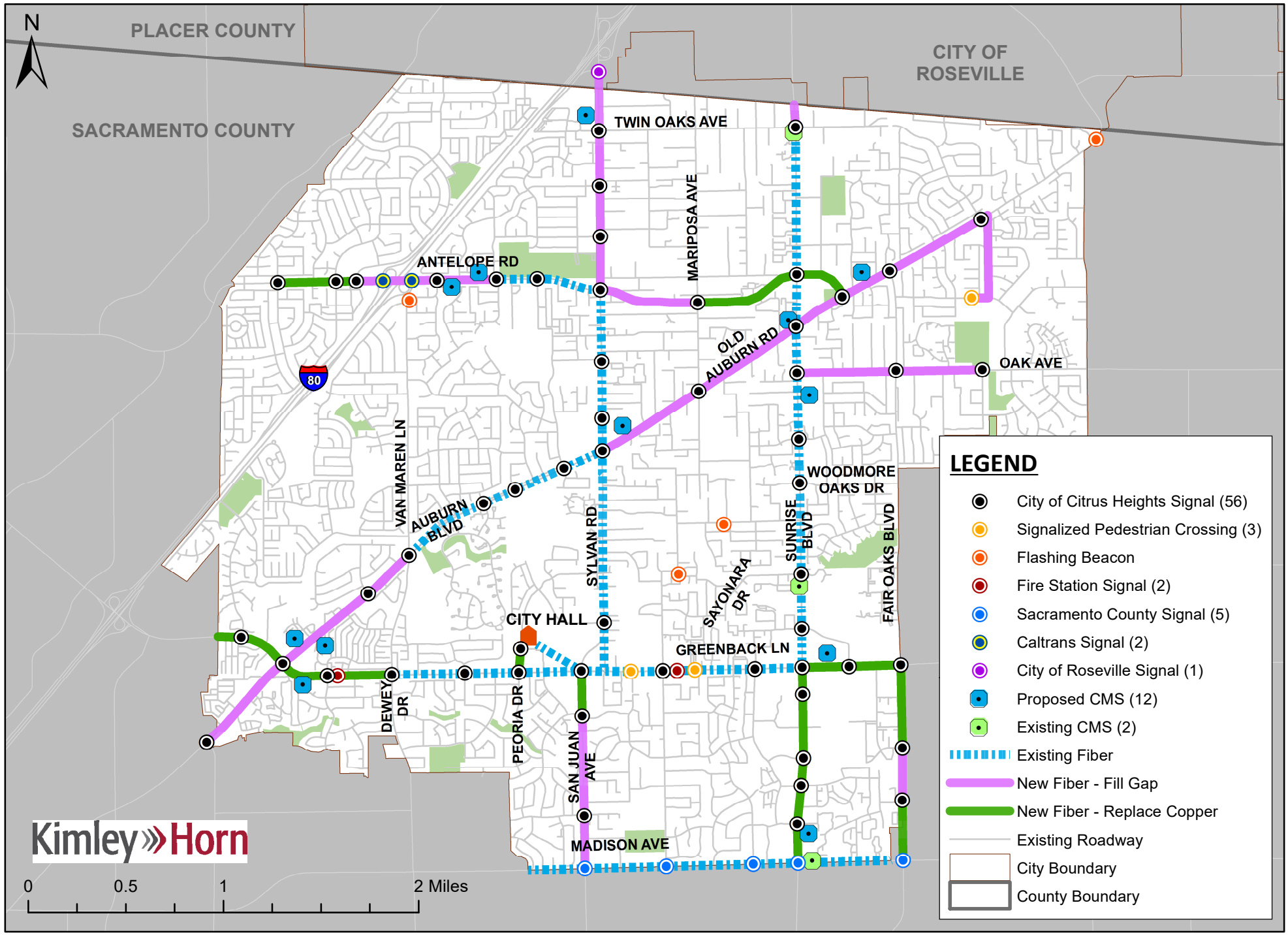


FIGURE 2 - ULTIMATE ITS INFRASTRUCTURE BUILDOUT

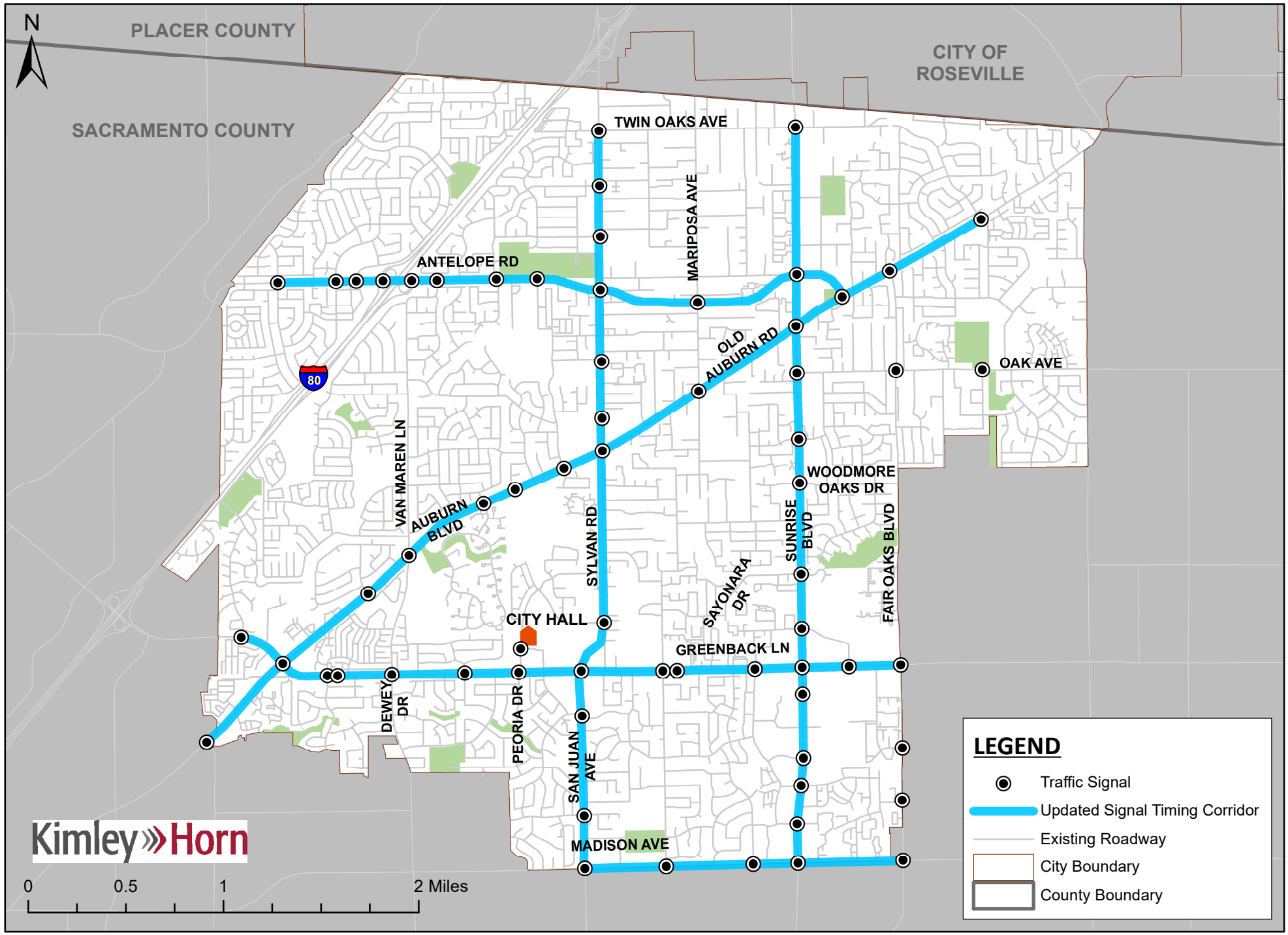


FIGURE 3 - SIGNAL TIMING IMPROVEMENTS

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

Projects are prioritized based on a set of 10 local and regional criteria and emphasize providing an 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)**
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**.

This Plan is intentionally structured to be agile and flexible in its implementation to enable the City to quickly identify a candidate project with a concise set of actions and next steps as funding becomes available and opportunities arise, or to reprioritize projects based on specific areas of emphasis.

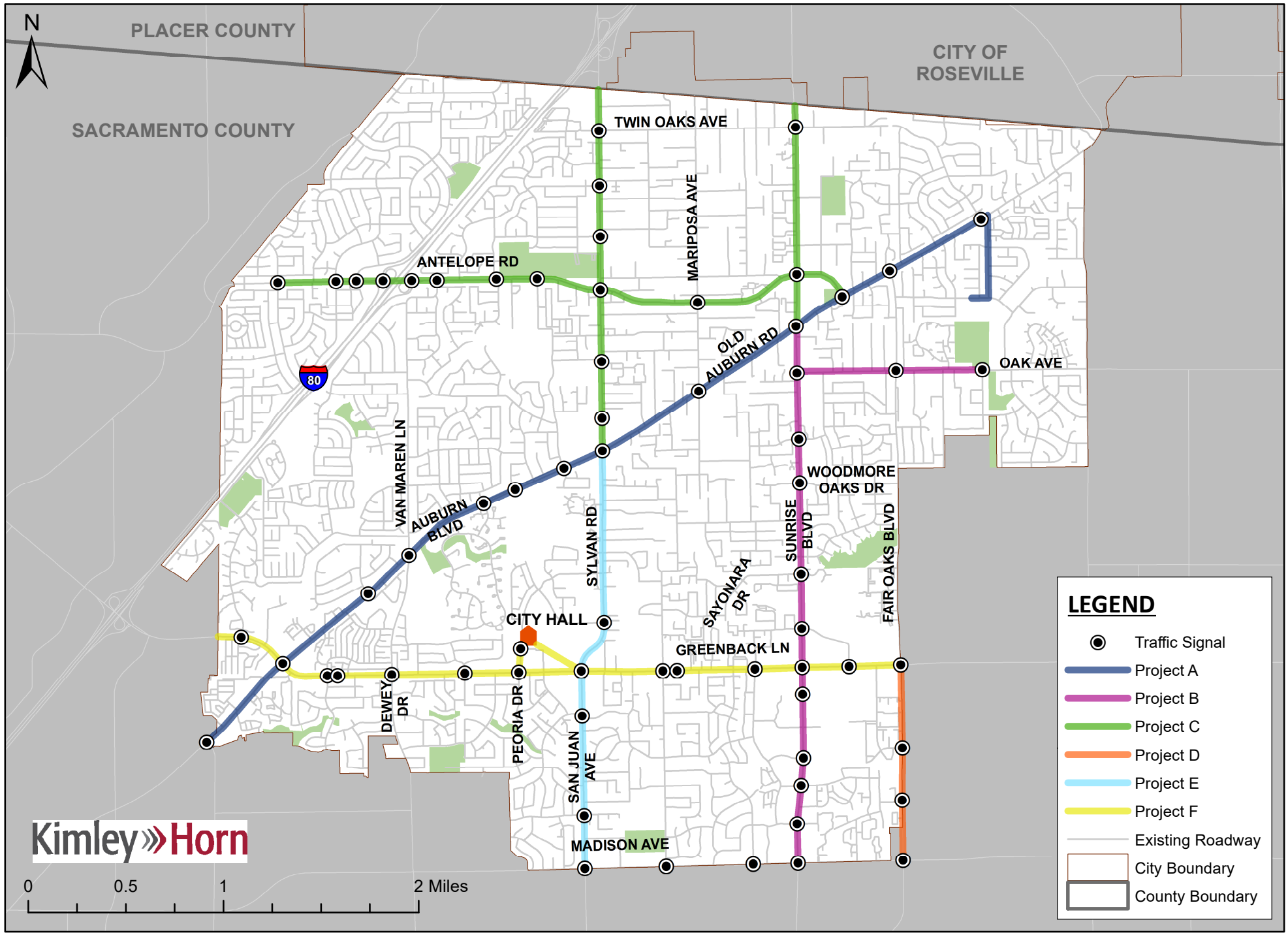


FIGURE 4 - FUTURE PROJECTS

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 is presented in **Table 3**.

Table 3 – Project Summary

Priority No.	Project Corridor	Project Description	Planning Level Cost Estimate
1	Auburn Blvd/Old Auburn Rd from Van Maren Ln to Twin Oaks Ave; Wintergreen Dr at Old Auburn Rd to Villa Oak Dr at Woodside School *(Project A)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable to fill gaps along Auburn Blvd from western City limits to Van Maren Ln and Old Auburn Rd from Auburn Blvd to Twin Oaks Ave; 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.	$5,041,000
2	Sunrise Blvd from Madison Ave to Old Auburn Rd; Oak Ave from Sunrise Blvd to Melva St *(Project B)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable to fill gaps (Oak Ave) and replace existing copper signal interconnect (Sunrise Blvd from Greenback Ln to Madison Ave); deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$2,023,000
3	Antelope Rd from Saybrook Dr to Old Auburn Rd; Sylvan Rd from Old Auburn Rd to Twin Oaks Ave; Sunrise Blvd from Old Auburn Rd to Twin Oaks Ave *(Project C)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable to fill gaps (Antelope Road between I-80 and Rosswood Dr/Amsterdam Ave) and replace existing copper signal interconnect (Antelope Rd between Mariposa Ave and Old Auburn Rd); signal controller upgrades; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$3,886,000
4	Fair Oaks Blvd from Madison Ave to Greenback Ln *(Project D)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable to fill gaps and replace existing copper signal interconnect along Fair Oaks Blvd; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$718,000
5	San Juan Ave; Sylvan Rd from Madison Ave to Auburn Blvd *(Project E)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable to fill gaps and replace existing copper signal interconnect along San Juan Ave; deployment of vehicle video detection; installation of CCTV cameras; study and implementation of updated signal timing and coordination; and installation of DSRC radio units.	$1,102,000
6	Greenback Ln, including connections to City Hall *(Project F)*	Project includes enhanced communication infrastructure through installation of new fiber optic cable to replace existing copper signal interconnect along Greenback Ln from western City limits to Dewey Dr and from Sunrise Blvd to Fair Oaks Blvd; 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.	$1,152,000

Priority No.	Project Corridor	Project Description	Planning Level Cost Estimate
Unprioritized Projects			
N/A	Asset Management of Field Devices *(Project G)*	Maintain inventory of 10% of field devices	$499,00
	ATMS Data Back Up Server and Back Up TOC Function Capabilities *(Project H)*	Establish ATMS data back-up server	$162,000
	SOPs for Equipment Status and Maintenance Activities *(Project I)*	Develop Standard Operating Procedures for the maintenance of infrastructure other than traffic signals	$43,000
	TNC Standards for Last-Mile Connections *(Project J)*	Establish TNC coordination locations for last-mile transit connections	$40,000
	Upgrade Agency TOC *(Project K)*	Upgrade Agency TOC	$90,000
	Staffing *(Project L)*	Increase Staffing Levels to Improve Real-Time Operations	*Salary-dependent*
	CAD System and TOC Connections *(Project M)*	Establish CAD System and TOC 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 in subsequent sections of this document:

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

Local Funding Programs

The City of Citrus Heights has a Capital Improvement Program (CIP) established on an annual basis. The CIP outlines transportation improvements and includes a corresponding budget. The 2018-2019 CIP includes signal and striping modifications, streetlight and 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.

SACOG Funding Programs

SACOG offers a variety of different 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 • Construction or operation begin before April 2025	• Reduce regional VMT per capita • Reduce regional congest 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 • Construction or operation begin 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: o EV public charging program o EV car share program, EVs in regional car rental companies, analysis of EVs in TNC fleets o Incentivize EV shuttles in public fleets, bring private microtransit providers using EVs into the region o Plan and provide funding for zero emission buses and required fueling infrastructure o Light, medium, and heavy-duty ZEV fleets o Mobility Hubs in disadvantaged communities
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 of 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 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

Program	Funding Amount	Criteria	Performance Outcomes Measured for Selection
	projects will vary depending on applicants		• Potential to reduce crashes (fatalities and injuries)
Metropolitan Transportation Improvement Program	Varies based on federal and state funds available	• Projects must be included in the Metropolitan Transportation Plan (MTP) • Application opportunity every odd year	• Projects must be included in the Metropolitan Transportation Plan (MTP) then 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 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 goes to MPO's in urban area • Funded by the SHA • 10% of funds goes to small urban or rural communities and awarded by the Commission on a competitive 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 Funding Programs

Many federal programs distribute money directly to the State, which distributes the funds based on local policies or award programs. An 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 Citrus Heights 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 as the operations side of the Implementation Plan. The successful implementation of operations strategies is largely dependent on providing appropriate staffing relative to the increase in operational capabilities.

The City of Citrus Heights has experienced a steady population growth over the last two decades. Per the U.S. Census Bureau, the population was recorded at just over 83,300 in 2010; as of 2017, it is just over 87,900. While the City is largely built out and has aging ITS infrastructure, 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 City currently has one staff member, a Senior Civil/Traffic Engineer, who oversees traffic operations. The City contracts traffic signal maintenance services to a Contractor.

The City of Citrus Heights has experienced steady development and population growth. 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.

To date, there has not been clear recognition of the staff time and costs associated with traffic signal and ITS projects. Inventory of transportation assets in the City has been steadily increasing without a corresponding increase in staff to operate and maintain them. This has created a situation where the City is understaffed for operations as well as for maintenance of the traffic signal and ITS network infrastructure based on staffing ratios contained in ITE's *Traffic Control Systems Operations – Installation, Management and Maintenance*.

Staffing the Smart Region Program

The City of Citrus Heights 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 68 traffic signals (including flashing beacons, traffic signals at pedestrian crossings and fire stations) and 94 devices, the City of Citrus Heights is considered a small- to 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.

Table 7 – Staffing Recommendations for the City of Citrus Heights

Citrus Heights	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	94	2 (50:1)	1 (100:1)	68	2 (40:1)	1 (100:1)
Full Buildout	206	6 (50:1)	2 (100:1)	68	2 (40:1)	2 (100:1)

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

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 put in place 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 pursuing 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 Smart Region systems have an Information Technology background and skill set that includes network management, software development, database administration, or 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.

The 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 their existing 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 Citrus Heights.

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
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
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	2 years
Communication Switches (TMC/Hub)	26 weeks	1 year	3 years
Rack Equipment	-	1 year	2 years
Workstations	26 weeks	2 years	2 years

Equipment	Minor Maintenance	Major Maintenance	Major Rehabilitation
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 need 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 Citrus Heights' replacement needs are, recommended equipment lifecycle timeframes, and mechanisms available for procurement and maintenance.

Agency Replacement Needs

The City of Citrus Heights 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 Citrus Heights 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
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 over 15 to 20 years ago and are close to or beyond their end of life based on anticipated lifecycle timeframes. Therefore, the City will need to plan for traffic signal controller replacements.

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 will 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 identifying 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 Citrus Heights. Once more ITS devices are installed and connected to the network these rates should be increased proportionally.

- Replace 4 Cabinets and Controllers per year
- Replace 3 CCTV camera per year
- Replace 4 Loop Detection systems with Video Detection per year
- Replace 1-2 miles of fiber optic cable per year
- Replace 4 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 Citrus Heights' 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 Citrus Heights 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 strategy implementation
	Increased Transit Ridership	Sales/Revenue	Transit TMC and Transit Provider Records	Count ridership levels before and after strategy implementation, calculate percentage change
	Incident detection by CCTV	CCTV Images	Agency TMC	Count incidents that are detected via CCTV cameras 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 strategy implementation
	Reduced Public Complaints	Public Complaints	TMC, TOC and other Operator Records	Compare the amount of public complaints related to inconsistency /unreliability from before and after implementation strategy
	Reduce Response Time to Device Failures	Response Time	TOC and Dispatch Records	Measure reduction in response times before and after strategy implementation
	Increase percent of field devices 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 strategy
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 strategy implementation and compare to before implementation
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

Objective	Performance Metric	Data Type	Source	Calculation
	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 strategy implementation

NEXT STEPS

The outcome of this Technology Implementation Plan is a roadmap of prioritized projects that the City of Citrus Heights 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 Citrus Heights' 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 Citrus Heights. 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 shift from phase to phase, updating 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 Citrus Heights Traffic Signal Inventory

I/S No.	City ID#	TYPE	LOCATION	CONTROLLER	ITS COMMENTS
1	339	SIGNAL	Alta Sunrise/Uplands at Sunrise Blvd.	Naztec 980	Interconnect & CCTV
2	240	SIGNAL	Antelope Rd. at Mariposa Ave.	MultiSonics 820	
3	117	SIGNAL	Antelope Rd. at Auburn Blvd.	Naztec 980	Interconnect & CCTV
4	340	SIGNAL	Antelope Rd. at Lauppe Ln.	Naztec 980	Fiber
5	755	SIGNAL	Antelope Rd. at Lichen Dr.	Naztec 980	R.I Fiber Video Detection
6	87	SIGNAL	Antelope Rd. at Old Auburn Rd.	Naztec 980	
7	238	SIGNAL	Antelope Rd. at Sunrise Blvd.	Naztec 980	Fiber CCTV
8	394	SIGNAL	Antelope Rd. at Tupelo Dr./Zenith Dr.	Naztec 980	Fiber Video Detection
9	753	SIGNAL	Antelope Rd. at Saybrook Dr.	Naztec 980	Fiber Video Detection
10	373	SIGNAL	Antelope Rd. at Garden Gate Dr.	Naztec 980	R.I
11	268	SIGNAL	Antelope Rd. atI-80 (E.B.)	Naztec 980	R.I CCTV
12	269	SIGNAL	Antelope Rd. atI-80 (W.B.)	Naztec 980	R.I CCTV
13	281	SIGNAL	Arcadia Dr. at Greenback Ln.	Naztec 980	Interconnect
14	667	SIGNAL	Arcadia Dr. at Sunrise Blvd.	Naztec 980	Interconnect & CCTV
15	385	SIGNAL	Auburn Blvd. at Carriage Dr./Chivalry	Naztec 980	Fiber
16	750	SIGNAL	Auburn Blvd. at CostCo	Naztec 980	Fiber & Interconnect CCTV
17	170	SIGNAL	Auburn Blvd. at Grand Oaks Blvd.	MultiSonics 820	
18	134	SIGNAL	Auburn Blvd. at Greenback Ln.	Naztec 980	Interconnect & CCTV
19	270	SIGNAL	Auburn Blvd. at Halifax St	Naztec 980	
20	701	SIGNAL	Auburn Blvd. at Kanai Ave.	Naztec 980	Fiber CCTV
21	87	SIGNAL	Auburn Blvd. at Old Auburn Rd./Sylvan Rd.	Naztec 980	Fiber & Interconnect CCTV
22	348	SIGNAL	Auburn Blvd. at Rollingwood Dr.	MultiSonics 820	
23	751	SIGNAL	Auburn Blvd. at San Tomas Dr.	Naztec 980	Interconnect
24	228	SIGNAL	Auburn Blvd. at Twin Oaks Ave.	MultiSonics 820	
25	239	SIGNAL	Auburn Blvd. at Van Maren Ln.	Naztec 980	Interconnect
26	382	SIGNAL	Birdcage St at Greenback Ln.	Naztec 980	Interconnect & CCTV
27	288	SIGNAL	Bremen Dr./Parkoaks Dr. at Greenback Ln.	Naztec 980	Interconnect
28	421	SIGNAL	Chesline Dr. at San Juan Ave.	Naztec 980	
29	241	SIGNAL	Dewey Dr./Van Maren Ln. at Greenback Ln.	Naztec 980	Fiber & Interconnect CCTV
30	601	SIGNAL	Fair Oaks Blvd. at Old Auburn Rd.	Naztec 980	
31	549	SIGNAL	Fair Oaks Blvd. at Oak Ave.	Naztec 980	
32	602	SIGNAL	Fair Oaks Blvd. at Sunrise East Way	Naztec 980	Interconnect
33	603	SIGNAL	Fair Oaks Blvd. at Treecrest Ave.	Naztec 980	Interconnect
34	741	SIGNAL	Fountain Square at Sam's Club Dr.	Naztec 980	
35	639	SIGNAL	Greenback Ln. at Binet Dr./Brookhaven Way	Naztec 980	Interconnect
36	756	SIGNAL	Greenback Ln. at E/O Burich Ped	Naztec 980	Fiber & CCTV
37	277	SIGNAL	Greenback Ln. at Fair Oaks Blvd.	Naztec 980	Interconnect & CCTV
38	562	SIGNAL	Greenback Ln. at Indian River Dr.	Naztec 980	Interconnect & CCTV
39	201	SIGNAL	Greenback Ln. at Mariposa Ave.	Naztec 980	Interconnect
40	412	SIGNAL	Greenback Ln. at Peoria Dr./Fountain Sq.	Naztec 980	Interconnect & CCTV
41	25	SIGNAL	Greenback Ln. at San Juan Ave.	Naztec 980	Fiber & Interconnect CCTV
42	80	SIGNAL	Greenback Ln. at Sunrise Blvd.	Naztec 980	Fiber & Interconnect CCTV
43	341	SIGNAL	Kingswood Dr. at Sunrise Blvd.	Naztec 980	Interconnect
44	290	SIGNAL	Macy Plaza at Sunrise Blvd.	Naztec 980	Interconnect Fiber
45	752	SIGNAL	Oak Ave. at Melva/C-Bar-C	Naztec 980	
46	190	SIGNAL	Oak Ave. at Sunrise Blvd.	Naztec 980	Fiber & CCTV
47	273	SIGNAL	Old Auburn Rd. at Mariposa Ave.	Naztec 980	

I/S No.	City ID#	TYPE	LOCATION	CONTROLLER	ITS COMMENTS
48	191	SIGNAL	Old Auburn Rd. at Sunrise Blvd.	Naztec 980	Fiber & CCTV
49	754	SIGNAL	Old Auburn Rd. at Twin Oaks/Wintergreen	Naztec 980	
50	522	SIGNAL	San Juan Ave. at Sperry Dr.	Naztec 980	Interconnect
51	626	SIGNAL	Stock Ranch Rd. at Sylvan Rd.	Naztec 980	Fiber & I.C.
52	289	SIGNAL	Sunrise Blvd. at Birdcage Center	Naztec 980	Interconnect
53	434	SIGNAL	Sunrise Blvd. at Sayonara Dr.	Naztec 980	Interconnect & CCTV
54	350	SIGNAL	Sunrise Blvd. at Twin Oaks Ave.	Naztec 980	
55	391	SIGNAL	Sunrise Blvd. at Woodmore Oaks	Naztec 980	
56	288	Remote FIRE(1)	Greenback Ln. E.O. Bremen Dr. (Fire)	Naztec 980	Controlled at Bremen/Parkoaks
57	35	PED/ SCHOOL	Greenback Ln. at Wilkins Way/San Juan HS	Naztec 980	Interconnect
58	178	PED/ SCHOOL	Auburn Blvd. at Sylvan School X-ing	Naztec 980	Fiber
59	553	PED/ SCHOOL	Villa Oak Dr. W.O. Sun Terrace Way (PED)	Naztec 980	
60	801	I.T.S.	Sunrise Blvd South of Sayonara Dr.	Naztec 980	Fiber & Cms
61	636	FLASHER	Old Auburn Rd. at Linda Crk. (F)	Naztec 980	
62	393	FLASHER	Mariposa Ave. at Mariposa Glen Way	Naztec 980	
63	392	FLASHER	Mariposa Ave. at Rosa Vista Ave.	Naztec 980	
64	263	FLASHER	Van Maren Ln. at N/O Navion	Naztec 980	
65	262	FIRE	Greenback Ln. E.O. Mariposa Ave. (Fire)	Naztec 980	

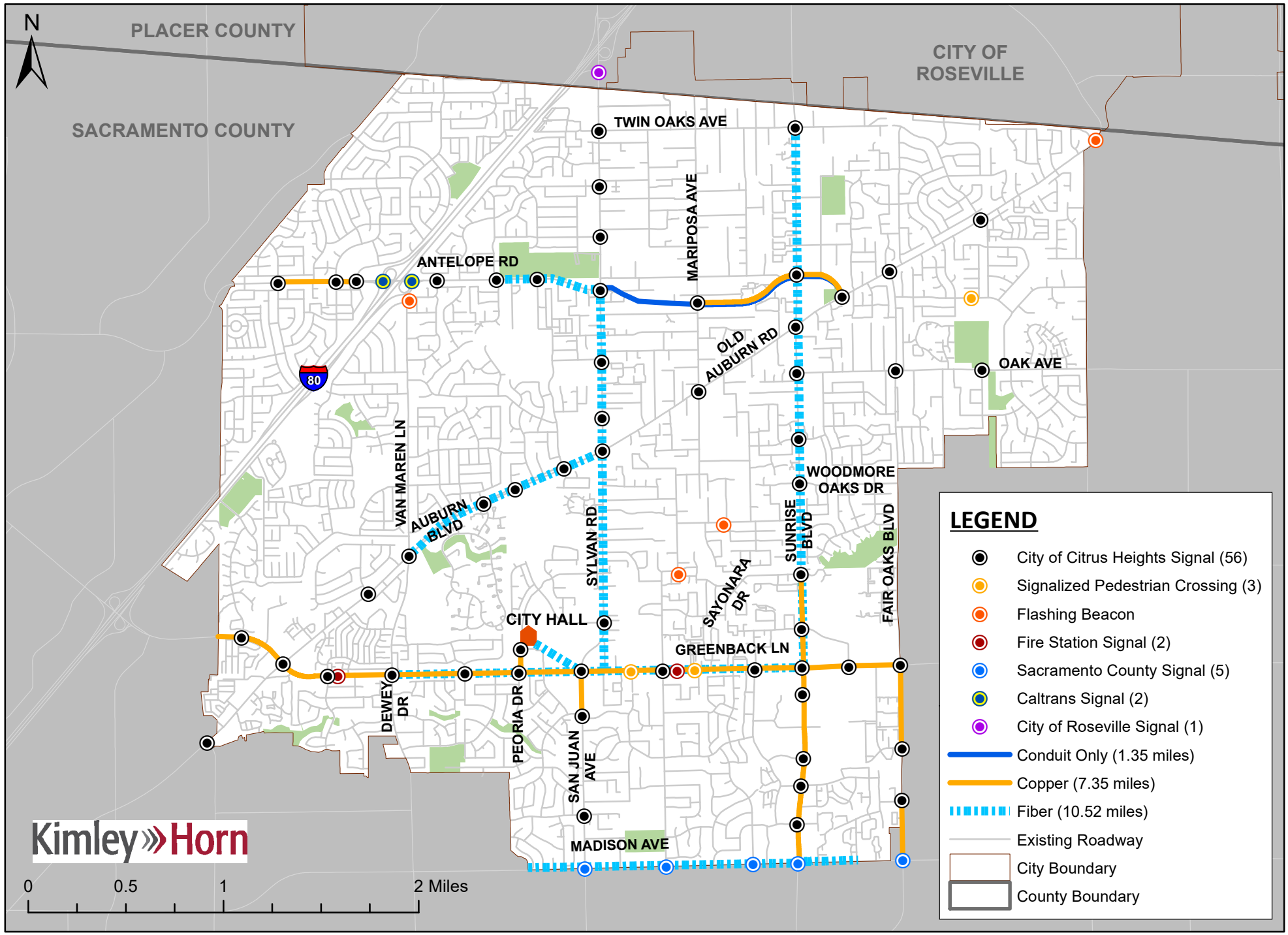


EXHIBIT 1 - TRAFFIC SIGNAL AND COMMUNICATIONS INFRASTRUCTURE

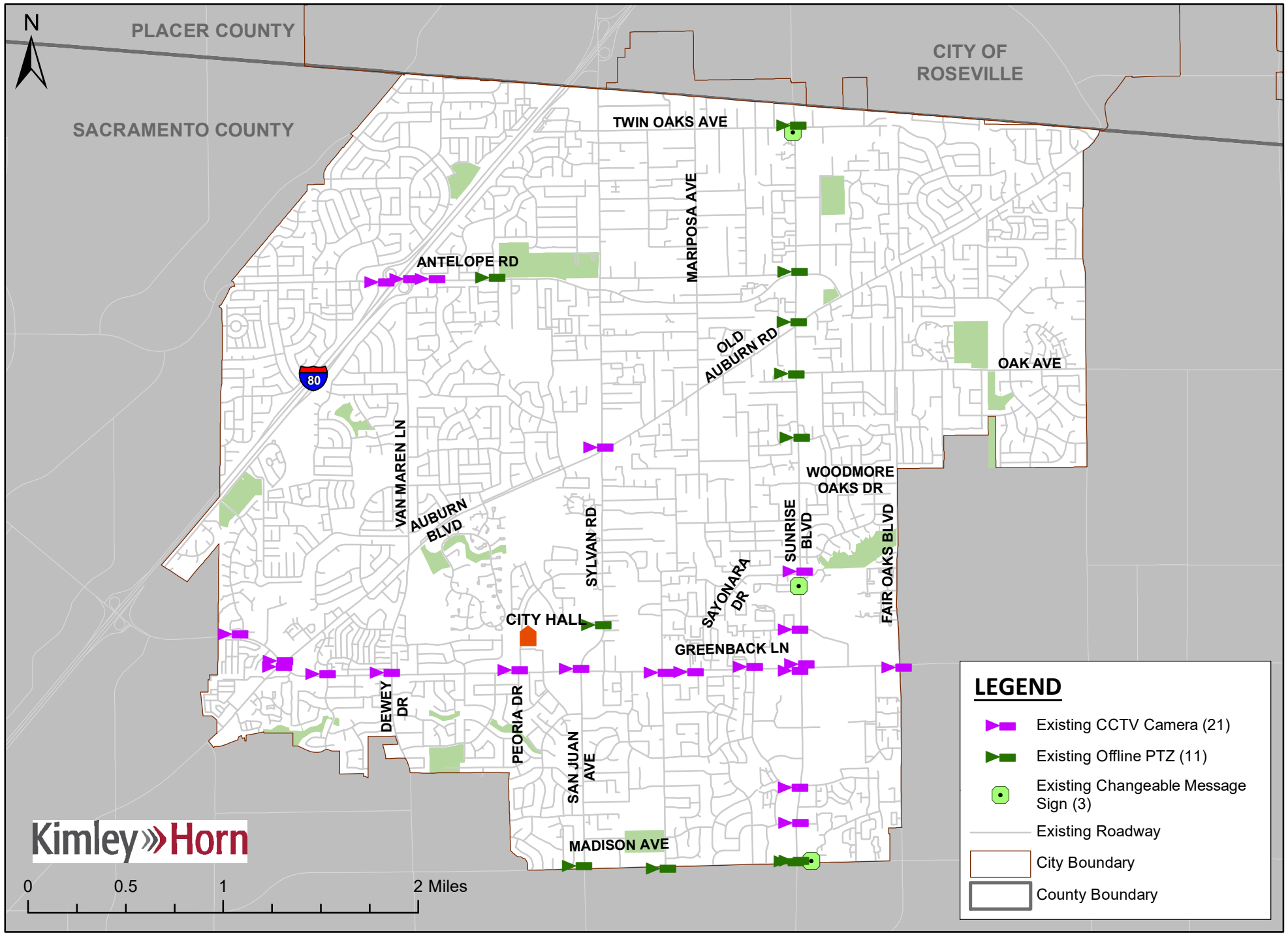


EXHIBIT 2 - EXISTING CCTV CAMERAS AND CMS LOCATIONS

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 that exist along key traffic movement corridors. Utilize copper/fiber or wireless technologies in order to achieve more robust communications coverage. Connect communications to devices and traffic signals along the key corridors. This includes upgrading communications from legacy copper or T1 leased 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 #3)
- Adequate bandwidth in communications to support data sharing (Need #7)

Scope/Limits – The following corridors should include installation of new fiber optic cable to eliminate communications gaps:

- Auburn Blvd from Manzanita Ave to Van Maren Ln
- Old Auburn Rd from Sylvan Rd to Wintergreen Dr
- Oak Ave from Sunrise Blvd to Melva St
- Madison Ave from Almaden Way to Fair Oaks Blvd
- Fair Oaks Blvd from Madison Ave to Sunrise E Way
- Sylvan Rd from Stock Ranch Rd to Auburn Blvd
- San Juan Ave from Madison Ave to Sperry Dr
- Sunrise Blvd from Sayonara Dr to Woodmore Oaks Dr
- Antelope Rd from Zenith Dr to Lauppe Ln
- Auburn Blvd from Antelope Rd to Twin Oaks Ave
- Wintergreen Dr from Villa Oak Dr to Old Auburn Rd

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

- Greenback Ln from Arcade Creek to Dewey Dr
- San Juan Ave and Sylvan Rd from Lucky Ln to Stock Ranch Rd
- Sunrise Blvd from Madison Ave to Greenback Ln
- Fair Oaks Blvd from Sunrise E Way to Greenback Ln
- Greenback Ln from Sunrise Blvd to Fair Oaks Blvd
- Antelope Rd from Mariposa Ave to Old Auburn Rd
- Antelope Rd from Saybrook Dr Lichen Dr
- Auburn Blvd from Van Maren Ln to Sylvan Rd

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 #10 – Signal Controller Upgrades for Future Functions
- ID #14 – 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
- Identify order of implementation based on priority of the city

Strategy ID #2

Deploy New Video Vehicle Detection Equipment

Strategy 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 operations center to support signal timing plan implementation. Also, 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 –

- Robust coverage to acquire real-time conditions (Need #2)
- Better traffic operations functions (Need #14)

Scope/Limits –65 signalized intersections have vehicle loop detection and three (3) signals have video 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 Capabilities on Key Corridors
- ID #4 – Deploy New CCTV Equipment
- ID #8 – Replace end-of-life/legacy equipment with modernized and upgraded equipment
- ID #10 – Signal Controller Upgrades for Future Functions
- ID #14 – 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 baseline communication network
- Close communication gaps
- Determine whether real-time detection is appropriate

Strategy ID #3

Third-Party Archived Data

Strategy 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

Strategy 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 operations centers 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 – Robust coverage to acquire real-time conditions (Need #2)

Scope/Limits – Citrus Heights has 21 existing CCTV cameras and an additional 11 offline PTZ cameras. It is recommended that the City install a CCTV camera at each signalized intersections so that there is one (1) CCTV camera at every signal. This includes connecting the offline PTZ cameras to the central system.

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

- ID #1 – Improve Existing Communications Capabilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #8 – Replace end-of-life/legacy equipment with modernized and upgraded equipment
- ID #10 – Signal Controller Upgrades for Future Functions
- ID #14 – 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 baseline communication network
- Close communication gaps
- Determine whether real-time detection is appropriate

Strategy ID #5

Regional TOC Backup

Strategy 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 #6

Perform ATMS Data Back Up

Strategy Description – Establish an agency ATMS data backup method and location to be able to store an archive of the ATMS system in the event of an outage or breach. This is anticipated to be performed by the agency IT Department or by other TOC processes as they relate to other TOCs or neighboring agencies. It is important to establish a physically separate location for this back up data so as to not create a single-failure-point for the ATMS system management. A key benefit of this project is the ability to get alerts for maintenance needs.

Relation to Needs – Reliable communications to prevent downtime (Need #3)

Scope/Limits – Procure and configure ATMS backup server at City corporation yard.

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

- ID #7 – Back Up TOC Function Capabilities
- ID #16 – Upgrade Agency TOC

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

- Revisit ATMS back-up procedures of City's TOC
- Work with IT department to come up with necessary back-up procedures, staff time required and equipment necessary for the back-up functionality
- Purchase additional servers and other equipment as required
- Extend ATMS back-up access through VPN, laptops, phone and tablets to have redundant access

Strategy ID #7

Back Up TOC Function Capabilities

Strategy 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 downtime (Need #3)

Scope/Limits – Establish VPN to City workstation in City Hall.

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

- ID #6 – Perform ATMS Data Back Up
- ID #16 – Upgrade Agency TOC

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

Strategy 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 #4)
- Reliable equipment functionality to prevent downtime (Need #6)
- Improve data quality/reliability (Need #10)

Scope/Limits – Inventory of supplemental, modernized field devices includes but is 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 devices, it would be suggested that the City maintains 7 CCTV Cameras, 7 Video Cameras, 7 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 #10 – Signal Controller Upgrades for Future Functions
- ID #14 – 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

SOPs for Equipment Status and Maintenance Activities

Strategy Description – Develop Standard Operating Procedures for the maintenance of infrastructure, including the preventative, responsive, and upgrade/replacement requirements that technicians and electricians are required to perform for their maintenance duties. Establishing a formal SOP and schedule for maintenance procedures will lengthen the life and reduce costs for asset maintenance and need for replacement.

Relation to Needs –

- Maintainable infrastructure and assets (Need #4)
- Programmatic planning for assets and maintenance of assets (Need #5)
- Reliable equipment functionality to prevent downtime (Need #6)

Scope/Limits – Development of Standard Operating Procedures for the maintenance of infrastructure, including the preventative, responsive, and upgrade/replacement requirements

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

- ID #11 – Utilize asset management system to track inventory and age and characteristics

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

- Identify staff to prepare SOPs
- Document make and model of ITS infrastructure to identify recommended maintenance best practices from manufacturer(s)

Strategy ID #10

Signal Controller Upgrades for Future Functions

Strategy Description – Upgrade traffic signal controllers in order to support ATSPM software deployment and collection of high-resolution traffic condition data as well as future connected vehicle infrastructure. This may also include upgrading detection for this specific purpose if detection is not already available at signalized intersections.

Relation to Needs – Reliable equipment functionality to prevent downtime (Need #6)

Scope/Limits – Controller upgrades will consist of replacement of legacy controllers and firmware upgrades for existing controllers with advanced functionality.

Most City traffic signals have Naztec 980 controllers, which are up-to-date and can support ATSPM software deployment. The following MultiSonics 820 traffic signal controllers should be updated:

- 1 – City ID 240 – Antelope Rd. at Mariposa Ave.
- 17 – City ID 170 – Auburn Blvd. at Grand Oaks Blvd
- 22 – City ID 348 – Auburn Blvd. at Rollingwood Dr.
- 24 – City ID 228 – Auburn Blvd. at Twin Oaks Ave.

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

- ID #1 – Improve Existing Communications Capabilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #4 – Deploy New CCTV Equipment
- ID #8 – Replace end-of-life/legacy equipment with modernized and upgraded equipment
- ID #14 – Deploy New CMS Equipment
- ID #15 – Deploy Connected Vehicle Infrastructure
- ID #18 – 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.

- Upgrade traffic signal controllers in conjunction with video detection and CCTV upgrades
- Upgrade traffic signal controllers at critical locations that might be benefitted with CV/AV readiness.

Strategy ID #11

Utilize asset management system to track inventory and age and characteristics

Strategy 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 #4)
- Reliable equipment functionality to prevent downtime (Need #6)
- Improve data quality/reliability (Need #10)

Scope/Limits – Inventory of supplemental, modernized field devices includes but is 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.

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

- ID #9 – SOPs for Equipment Status and Maintenance Activities

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 #12

Regional Data Sharing Policy, Guidelines, and Standard Agreement

Strategy 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 #13

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.

Strategy ID #14

Deploy New CMS Equipment

Strategy 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 – Real-time traveler information (Need #9)

Scope/Limits – Deploy CMS at the following two (2) locations which at key strategic decision locations to relay traveler information:

- Auburn Blvd north of Greenback Ln – Southbound
- Greenback Ln east of Auburn Blvd – Eastbound

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

- ID #1 – Improve Existing Communications Capabilities on Key Corridors
- ID #2 – Deploy New Video Detection Equipment
- ID #4 – Deploy New CCTV Equipment
- ID #10 – Signal Controller Upgrades for Future Functions

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 #15

Deploy Connected Vehicle Infrastructure

Strategy 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 #11)

Scope/Limits – Deploy CV roadside technology infrastructure at all City traffic signals.

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

- ID #10 – Signal Controller Upgrades for Future Functions

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
- Deploy modernized traffic signal and ITS device equipment at all signalized intersections

Strategy ID #16

Upgrade Agency TOC

Strategy Description – Upgrade existing agency TOC including a video wall, extra screens for view only, network equipment, workstation layouts, workstation equipment, file storage, communication wiring, network room rack space, cooling and fire suppression systems, and other characteristics of a TOC that require consideration. This also includes providing public safety radios in agency TOC to allow for the real-time incident management notifications to be heard by the TOC directly rather than through a CAD system or dispatcher. This requires the procurement of a radio configured for the public safety radio network for the agency TOC. If the agency desires, public safety personnel could train the agency TOC operators or managers to be able to participate in radio relaying of information during an incident, maintaining NIMS protocol. Additional staff may need to be accommodated and access to systems warrants a redesign or reallocation of space within an existing TOC. This strategy includes design, procurement, installation, and integration of new TOC components to upgrade the agency's existing TOC to modern standards and functionality to be able to support Smart Region initiatives.

Relation to Needs –

- Staffing for traffic operations (Need #13)
- Proper environment for TOC operations (Need #12)

Scope/Limits – See strategy description.

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

- ID #6 – Perform ATMS Data Back Up
- ID #7 – Back Up TOC Function Capabilities
- ID #16 – Upgrade Agency TOC
- ID #19 – Establish CAD System and TOC Connections for Automated Alerts/Notifications

Strategy ID #17

Increase Staffing Levels to Improve Real-Time Operations

Strategy 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. Adequate information technology and project management staffing should be provided for real-time operations and analysis processes. 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 #13)

Scope/Limits – Establish staffing levels to support the operations and maintenance of the transportation network and Smart Region initiatives.

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 required staffing levels and available funds to support staffing
- Identify experience and skill requirements for position(s)

Strategy ID #18

Improve Traffic Signal Timing Along Key Corridors

Strategy 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 #14)

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

- Antelope Rd, between Saybrook Dr and Auburn Blvd (12 signals)
- Greenback Ln between Indian River Dr and Fair Oaks Blvd (16 signals)
- Madison Ave (5 signals)
- Auburn Blvd-Old Auburn Rd between Greenback Ln and Twin Oaks Ave (12 signals)
- Sunrise Blvd between Twin Oaks Ave and Madison Ave (14 signals)

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

- ID #10 – Signal Controller Upgrades for Future Functions

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

Strategy ID #19

Establish CAD System and TOC Connections for Automated Alerts/Notifications

Strategy Description – Establish filtered CAD system access from agency TOCs 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 TOC, 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 TOC 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 #16)

Scope/Limits – Integrate Sacramento County Sheriff CAD system with City's ATMS system and TOC. This scope of work includes software integration to update Sacramento County Sheriff CAD system and City's ATMS system to allow data push from sheriff CAD system to ATMS system and view the data in ATMS interface. The scope includes purchase, installation, configuration and integration of servers and software required at City's TOC.

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

- ID #6 – Perform ATMS Data Back Up
- ID #7 – Back Up TOC Function Capabilities
- ID #16 – Upgrade Agency TOC

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 #20

Establish Regional Technology Procurement Contract

Strategy 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 – 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 #21

Establish Regional Technology and Systems Funding Program

Strategy 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 #22

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 #23

Improve Traffic Signal Timing Along Key Transit Corridors

Description – Complete signal optimization plans along key transit routes that need updating 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 – Optimizing traffic signal timing along transit corridors will address the following needs.

- Reduce impact of light rail preemption on traffic mobility (Need D12)

Scope/Limits – The City of Sacramento will develop signal optimization plans for corridors that run adjacent to or intersect Sacramento RT light rail transit corridors. Once signals optimization plans are developed at these locations, the City will prioritize bus transit corridors for retiming based on recommendations from Sacramento RT. Complete signal optimization will be implemented on these corridors based on signal infrastructure capabilities such as detection and communications.

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

- ID #2 – Modernize Signal Controllers and Cabinets
- ID #16 – Implement Transit Signal Priority

- **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 #24

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 #25

Standardize Traffic Signal Equipment

Description – Based on the Smart Region initiative, it is recommended that traffic signal controller equipment be standardized across the region. The Caltrans standards may be looked at by other agencies as a regional standard. Standards to consider include collection of high-resolution traffic condition data and future connected vehicle infrastructure. During the development of signal standards, Caltrans should review its current deployments to verify interoperability with defined standard.

Relation to Needs –

- N23: Standards-based deployments

Scope/Limits – All traffic signals within the District

Considerations –

- Upgrade Agency ATMS
- Coordinate Ramp Meters and Arterial Signal Timing Plans
- Enhance Detection at Traffic Signals

Prerequisite Dependencies –

- Document existing inventory of traffic signal equipment (controllers, detection, signal heads, video monitoring, Emergency Vehicle Preemption, others)
- Coordinate with partner agencies in the region through a SACOG-lead working group to understanding range of current infrastructure and determine, as a region, the desired functionalities for traffic signals and the types of equipment that would address that function
- As a group, work with vendors to identify equipment and system options that would address desired functions and that would maximize interoperability of existing devices and central management systems
- Develop a report or white paper on the findings from the existing equipment inventory, vendor research and agreed-upon standards
- Caltrans may be an appropriate partner to set up a region-wide procurement contract with qualified vendors that other agencies can use to procure systems and equipment that meets identified standards
- Over time, as equipment reaches end-of-life or requires replacement, replace any equipment not within the standards to equipment that meets standards

Strategy ID #26

Implement Transit Signal Priority

Strategy 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 – Implementing transit signal priority addresses the following needs:

- Reduce impact of light rail preemption on traffic mobility (Need D10)
- Encourage travel mode shift (Need D12)
- Improve traffic operations (Need O2)

Scope/Limits – The Gold Line, part of the Sacramento Regional Transit light rail system, passes through ten (10) signalized intersections in the City of Folsom. These signals are on Folsom Boulevard between Iron Point Road and Greenback Lane. Signal modification will be implemented at each of these ten locations.

Considerations – The following is a list of other projects within Folsom's Technology Implementation Plan that should be considered along with this project.

- ID #1
- ID #2
- ID #4

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

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

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	Emergency / 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	**Auburn Blvd and Old Auburn Rd from Van Maren Ln to Twin Oaks Ave, Wintergreen Dr at Old Auburn Rd to Villa Oak Dr at Woodside School:** -Enhanced communication infrastructure through installation of new fiber optic cable (9 signals) and replacement of existing copper signal interconnect (5 signals). -Deploy vehicle video detection (14 signals) -Deploy CCTV cameras (11 locations) -Update signal timing (14 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (14 signals)	4	4	4	4	4	4	4	4	4	3	98.75	1
B	**Sunrise Blvd from Madison Ave to Old Auburn Rd, Oak Ave from Sunrise Blvd to Melva St :** -Enhanced communication infrastructure through installation of new fiber optic cable (4 signals) and replacement of existing copper signal interconnect (6 signals). -Deploy vehicle video detection (14 signals) -Deploy CCTV cameras (5 locations) -Update signal timing (14 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (14 signals)	4	4	4	4	4	4	4	4	4	2	97.5	2
C	**Antelope Rd from Saybrook Dr to Old Auburn Rd, Sylvan Rd from Old Auburn Rd to Twin Oaks Ave, Sunrise Blvd from Old Auburn Rd to Twin Oaks Ave:** -Enhanced communication infrastructure through installation of new fiber optic cable (8 signals) and replacement of existing copper signal interconnect (11 signals). -Deploy vehicle video detection (14 signals) -Deploy CCTV cameras (12 locations) -Update signal timing (19 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (19 signals)	4	4	4	4	4	4	4	4	3	2	94	3
D	**Fair Oaks Blvd from Madison Ave to Greenback Ln:** -Enhanced communication infrastructure through installation of new fiber optic cable (3 signals) and replacement of existing copper signal interconnect (3 signals). -Deploy vehicle video detection (8 signals) -Deploy CCTV cameras (4 locations) -Update signal timing (8 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (8 signals)	4	4	4	4	4	3	4	4	3	2	92.75	4

Project ID	Strategy Description	Address multijurisdictional networking	Adapt to new technology	Improve reliability and consistency of driver trips	Safety	Improve traveler information and dissemination	Emergency / 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	**San Juan Ave and Sylvan Rd from Madison Ave to Auburn Blvd:** -Enhanced communication infrastructure through installation of new fiber optic cable (3 signals) and replacement of existing copper signal interconnect (3 signals). -Deploy vehicle video detection (6 signals) -Deploy CCTV cameras (2 locations) -Update signal timing (6 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (6 signals)	4	4	3	4	3	3	4	3	3	2	85.25	5
F	**Greenback Ln, including connections to City Hall:** -Enhanced communication infrastructure through installation of fiber optic cable to replace existing copper signal interconnect (6 signals). -Deploy vehicle video detection (17 signals) -Deploy CCTV cameras (6 locations) -Update signal timing (17 signals) -Deploy CV/AV intersection infrastructure (DSRC radios) (17 signals)	4	4	3	4	3	4	3	3	3	2	84	6

APPENDIX D - COST ASSUMPTIONS

Table 1: Cost Summary

Infrastructure Projects - Improve Existing Communications Capabilities													
New Project ID	Strategies Addressed	Project Description	No. Signals	Video Detection	Updated Signal Timing	Controller Upgrade	Intersection Fiber Equipment Upgrade	CCTV	CMS	Communication (Miles)		Communication Hub	Connected Vehicle Technology	Planning Level Cost
										New	Replace			
Communication Gap Closures, Communications Equipment Upgrade, Upgrade to Fiber														
A	1, 2, 4, 10, 14, 15	Auburn Blvd and Old Auburn Rd from Van Maren Ln to Twin Oaks Ave, Wintergreen Dr at Old Auburn Rd to Villa Oak Dr at Woodside School	13	13	13		13	10	4	4.23	0.00	1	13	$ 5,041,000
B		Sunrise Blvd from Madison Ave to Old Auburn Rd, Oak Ave from Sunrise Blvd to Melva St	12	12	12		6	5	2	0.95	1.00	1	12	$ 2,023,000
C		Antelope Rd from Saybrook Dr to Old Auburn Rd, Sylvan Rd from Old Auburn Rd to Twin Oaks Ave, Sunrise Blvd from Old Auburn Rd to Twin Oaks Ave	17	17	17	4	11	11	4	2.34	1.24	1	17	$ 3,886,000
D		Fair Oaks Blvd from Madison Ave to Greenback Ln	3	3	3		3	2		0.26	0.74	1	3	$ 718,000
E		San Juan Ave and Sylvan Rd from Madison Ave to Auburn Blvd	4	4	4		3	2		0.78	0.24	1	4	$ 1,102,000
F		Greenback Ln, including connections to City Hall	9	9	9		6	3	2	0	1.59	1	9	$ 1,152,000
Asset Management of Field Devices - 10% of Total Devices (Based on Final Buildout)														
G	8	Asset Management of Field Devices - 10% of Total Devices		7		7		7	1					$ 499,000

Non-Infrastructure Projects			
Project ID	Strategies Addressed	Project Description	Planning Level Cost
H	7	ATMS Data Back Up Server and Back Up TOC Function Capabilities	$ 162,000
J	13	TNC Standards for Last-Mile Connections	$ 40,000
K	16	Upgrade Agency TOC	$ 90,000
L	17	Increase Staffing Levels to Improve Real-Time Operations	*Salary-dependent*
M	19	Establish CAD System and TOC Connections for Automated Alerts/Notifications	$ 900,000