SMART REGION

CALTRANS DISTRICT 3

TECHNOLOGY IMPLEMENTATION PLAN

FINAL

February 2019

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List of Abbreviations

ATCMTD – Advanced Transportation and Congestion Management Technologies Deployment
ATMS – Advanced Traffic Management System
ATSPM – Automated Traffic Signal Performance Measures
AVL – Automatic Vehicle Location
AVMS – Advanced Variable Message Signs
BTR – Bluetooth Reader
BUILD – Better Utilizing Investments to Leverage Development
CAD – Computer-Aided Dispatch
CCTV – Closed Circuit Television
CHP – California Highway Patrol
CMM – Capability Maturity Model
CMS – Changeable Message Signs
CV/AV – Connected Vehicle and Autonomous Vehicle
EMS – Extinguishable Message Signs
EVP– Emergency Vehicle Preemption
GHG – Green House Gas
GPS – Global Positioning System
HAR – Highway Advisory Radios
HSIP – Highway Safety Improvement Program
ICM – Integrated Corridor Management
INFRA – Infrastructure for Rebuilding America
IoT– Internet of Things
ITS – Intelligent Transportation Systems
MPA – Municipal Planning Area
O&M – Operations and Maintenance
P3 – Public/Private Partnerships
PeMS – Performance Measurement System
RMS– Ramp Metering System
RT– Sacramento Regional Transit
RTIP – Regional Transportation Improvement Program
RWIS – Road Weather Information Systems
SACOG – Sacramento Area Council of Governments
SB-1– Senate Bill 1
SCCP – Solutions for Congested Corridors Program
SCS – Sustainable Communities Strategy
SHA – State Highway Account
SHOPP – State Highway Operation and Protection Program
SR – State Route
STARNET – Sacramento Transportation Area Network
STBG – Surface Transportation Block Grant Program
STIP – State Transportation Improvement Program
TCEP – Trade Corridor Enhancement Program
TIFIA – Transportation Infrastructure Finance and Innovation Act
TIGER – Transportation Investment Generating Economic Recovery
TMC – Traffic Management Center
TMS – Traffic Management System
TNC – Transportation Network Carriers
TSP – Transit Signal Priority
V2I – Vehicle-to-Infrastructure
V2X – Vehicle-to-Everything

SMART REGION SACRAMENTO

Caltrans District 3 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. Managing congestion on the existing transportation system is a vitally important tool in the toolbox to address congestion. Encouraging mode shift, operational improvements, and strategies that reduce vehicle miles traveled on the system also help. The way to effectively improve mobility is to manage the existing transportation system better.

Caltrans District 3 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 District 3 with the framework necessary to proactively and positively affect how residents and all travelers move within and access the District's transportation network. This framework and its resulting tools, if prioritized and managed well by District 3, will assist with the aspects of public service involved in transportation: mobility, incident response, efficient maintenance, and cost savings across District 3'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

Caltrans District 3 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.

District 3 envisions a transportation network that is more seamlessly connected and integrated. This vision includes having communications connectivity to all of District 3 traffic signals, but it also includes sharing real-time data between agencies and integration of central management systems of the various partner agencies in the region. Caltrans wants to be a key player in a regional vision of fully coordinated and shared operations and management of the transportation network. Caltrans sees itself as a partner who can provide support for 24/7 operations that are centered around ICM concepts. The Smart Region Objectives include:

- Accommodate Different Community Types 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

There are many directions that SACOG and the region could move toward in implementing solutions to address the needs and gaps identified on the right. While some gaps point to specific 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. 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.

System Needs

District 3 is challenged with significant gaps that are inhibiting the system from addressing operational and management goals. System needs are identified by Infrastructure/Data, Operational, and Institutional categories.

Infrastructure/Data:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition data/information
- N3: Support Active Transportation
- N4: Reliable communications and systems to prevent downtime
- N5: Programmatic planning for assets and maintenance assets
- N6: Central system management of tools and data to support operations
- N7: High-resolution traffic data for real-time operational decision making
- N8: Real-time travel time data for operations
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N10: Timely emergency notifications (including weather)
- N11: Share data between agencies that share a corridor
- N12: Better manage parking and drayage to reduce impact on traffic mobility
- N13: Improve ramp metering operation
- N14: Leverage and bolster private sector traveler information services

Operations:

- N15: Integrate central systems and subsystems
- N16: Trained staff to support operations
- N17: Standard operating and maintenance procedures for incident management purposes
- N18: Share regional operations and maintenance responsibilities
- N19: Better traffic operations
- N20: Better incident coordination across jurisdictions and with public safety
- N21: Access to additional capacity when needed during special events or incidents

Institutional:

- N22: Reliable network security
- N23: Standards-based deployments

SMART REGION SACRAMENTO

Caltrans District 3 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 District 3 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 District 3.

Deployment Strategies

Strategies were developed and prioritized based on the District's conveyed needs and will aid in the phasing of future technology deployments and investments in the future of a Smart Region. Project corridors recommended to be outfitted with technology generally include enhanced communication infrastructure, deployment of vehicle video detection, new traffic monitoring cameras, new or upgraded ramp meters, installation upgrade of intersection fiber equipment, new connected vehicle radio units, 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.

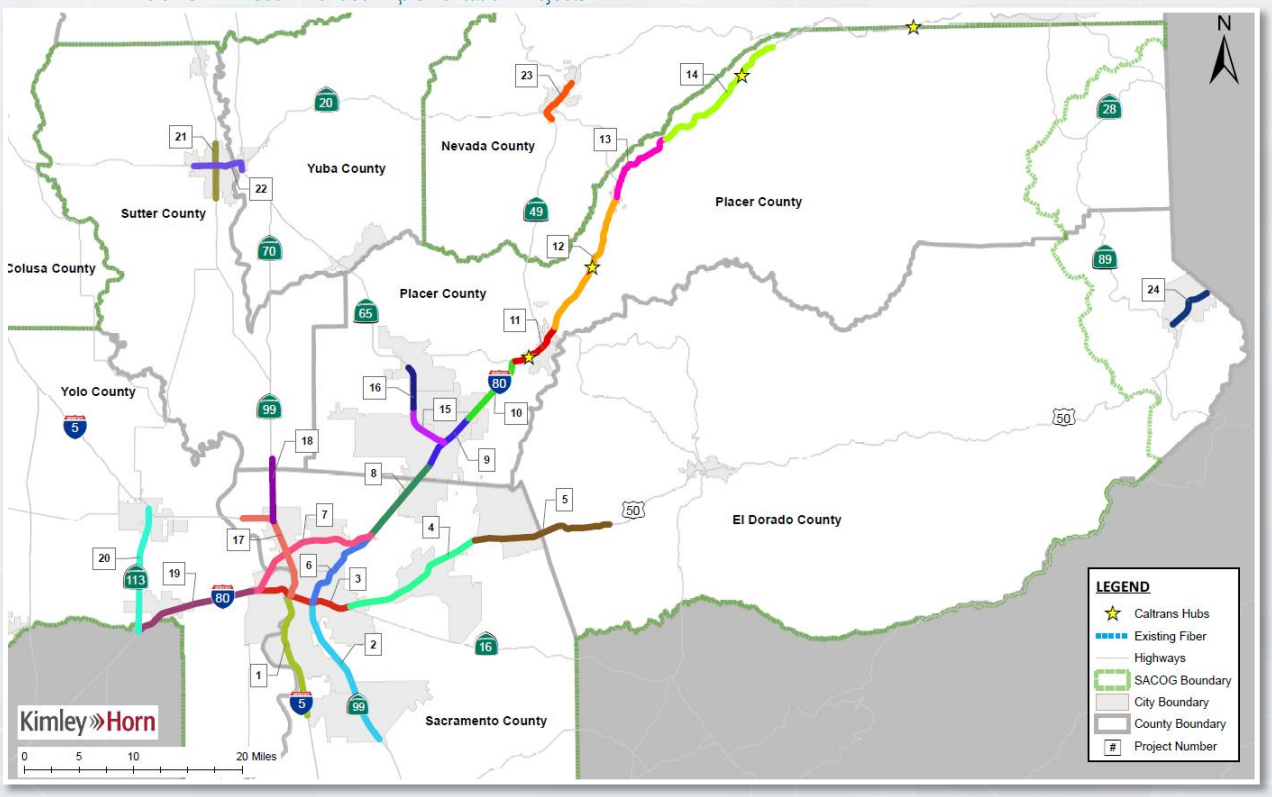
Operations & Maintenance

The major elements of the future network include:

- 160 miles of fiber optic communications
- 69 traffic monitoring cameras
- 137 updated signal timings, upgraded traffic signal controllers, and new traffic detection devices
- 93 new ramp meters
- 48 new connected vehicle technology 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 – *Recommended Implementation Projects*



INTRODUCTION

Why Pursue Strategic Investments in Smart Mobility

This Technology Implementation Plan provides Caltrans District 3 with the framework necessary to proactively and positively affect how residents and all travelers move within and access the District transportation network. This framework and its resulting tools, if prioritized and managed well by the District, will assist with every aspect of District public service: mobility, incident response, efficient maintenance, and cost savings across the District 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 District'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 Caltrans District 3 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 District 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 District's investments.

Caltrans District 3 Technology Implementation Plan

Caltrans District 3 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 for the region and individual agencies based on the existing conditions and input received from agency stakeholders at one-on-one meetings and the Concept of Operations group workshop. These initial phases established a benchmark for what Caltrans 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 Caltrans District 3.

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.

Caltrans is unique in its role within the SACOG region, as it does not have a specific concentration of facilities, but instead the owner and operator of the highway facilities that create the backbone for regional travel and travel to and from the region. The District participated in developing this plan and provided input to all stages of the Smart Region Sacramento program development. Information and details presented in this Technology Implementation Plan incorporate and build on the current infrastructure deployment projects and objectives to update the District's overall strategy going forward.

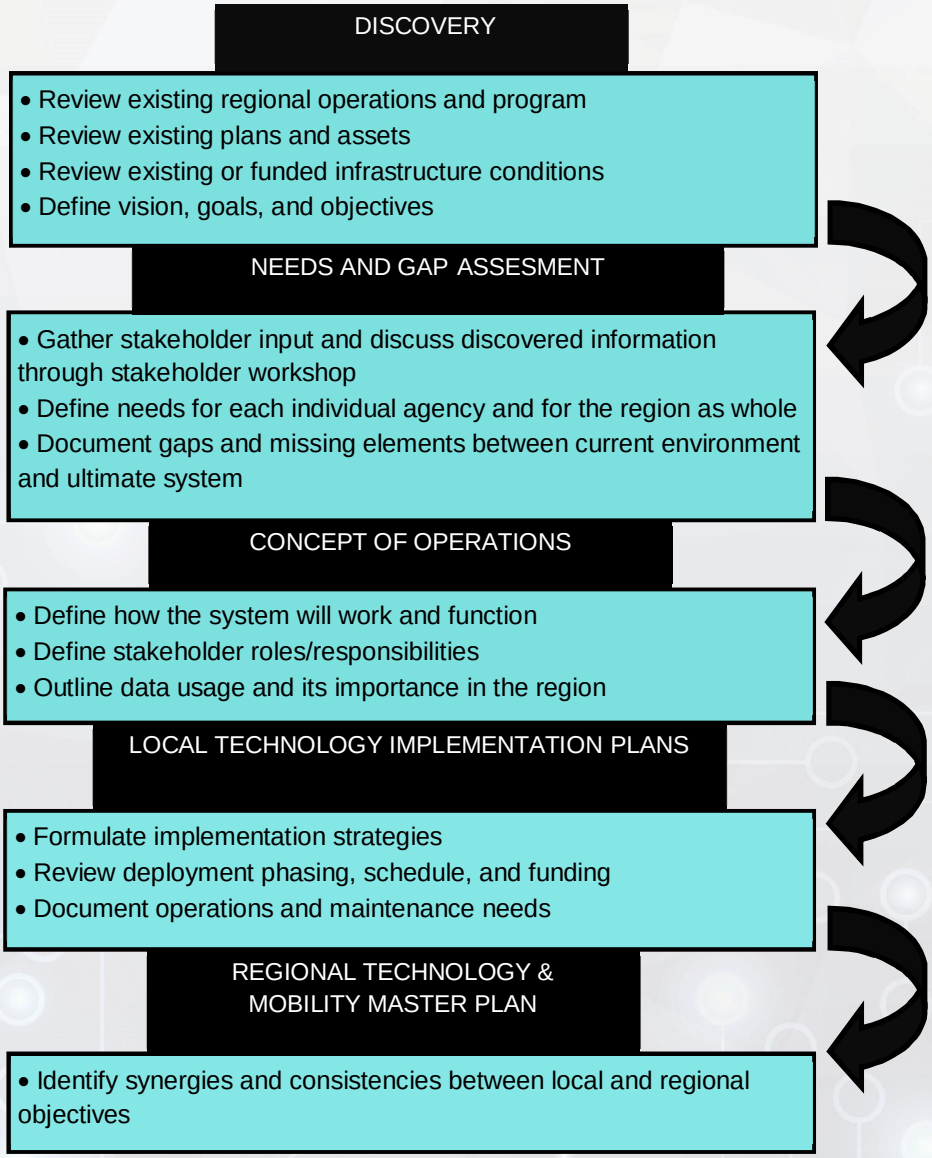


Figure 1 – Smart Region Sacramento Development Process

Within SACOG region, the I-80, US 50, and I-5/ SR 99 freeways as well as numerous State Route (SR) corridors are considered priority corridors by Caltrans. Each of these corridors have their own opportunities, challenges and priorities based on the characteristics of the surrounding communities and the larger areas beyond the SACOG region that these corridors connect. Emphasizing safe and efficient operations of Caltrans facilities is essential to the success of the regional transportation system.

The development of the SACOG Smart Region Plan, and specifically the Caltrans District 3 Technology Implementation Plan, involved a series of data-gathering activities to collect information on the current

state, needs and goals in District 3 and the SACOG region as a whole. Background information was gathered from the District to enhance the previous work. This information included the following:

- **One-on-one meeting** – A one-on-one Kickoff Meeting was conducted on March 12, 2018 with Caltrans District 3 Operations staff to get specific input on: the current state of the Caltrans network (including infrastructure, technology/systems, general operations and staffing); the District's future vision and goals for the operation and management of the Caltrans roadway network; and key needs at the District and regional-level for management of the region's transportation network. A summary of key items from this meeting included:
    - Caltrans has made significant investment in upgrading or replacing field technologies and systems in the past two years, including Closed Circuit Television (CCTV) cameras, Road Weather Information Systems (RWIS), Highway Advisory Radios (HAR), Changeable Message Signs (CMS), vehicle detection equipment, the Traffic Management Center (TMC), and a central video management system.
    - A key need in the District is for staff to support maintenance of the intelligent transportation systems (ITS) devices and communications.
    - Caltrans would like to be a partner in a more regionally-focused operations and management environment for the transportation system, especially in light of the emphasis on Integrated Corridor Management (ICM) in the region. A big part of this involves connecting agency central management systems, deploying more shared fiber, and sharing real-time data and video between agencies.
- **Documents/Plans** – A variety of documents and plans were gathered to support the background understanding of the District's current infrastructure, programs and capabilities. The documents reviewed during this effort included:
    - US 50 ICM Plan (2017)
    - Caltrans District 3 TSM&O Capability Maturity Model (CMM) for US-50 Corridor Action Plan (2016)
    - DRAFT Upstate California Regional ITS Plan (2018)
    - District 3 ITS/Operational Improvement Plan (2014)
    - District 3 Regional Concept of Transportation Operations (RTCO)

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 Folsom'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 Smart Region Plan has six 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

District 3 envisions a transportation network that is more seamlessly connected and integrated. This vision includes having communications connectivity to all of their traffic signals, but it also includes sharing real-time data between agencies and integration of central management systems of the various partner agencies in the region. Caltrans wants to be a key player in a regional vision of fully coordinated and shared operations and management of the transportation network. Caltrans sees themselves as a partner who can provide support for 24/7 operations that are centered around ICM concepts.

The vision and objectives are important to consider 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

Caltrans District 3 owns 463 traffic signals, half of which are located at entrance and exit ramps along US-50, I-80, and SR-99. The state operates and maintains a majority of the District 3-owned traffic signals and an additional 20 traffic signals owned by local agencies. The traffic signals in District 3 are not managed by the Caltrans ITS group but are managed by a separate traffic signal section. Existing Caltrans traffic signal controllers are a combination of McCain 170 and 2070 controllers. Most controllers operate using the Traffic Signal Control Program (TSCP) and C8 software.

Only a portion of the traffic signals in the District are connected to the Transcore central management system. The traffic signals are connected with a variety of different communications media including dial-up modems, Global Positioning System (GPS), wireless, fiber, modem to master, cellular, and DSL. Most signals communicate via traffic signal interconnect, especially along the US 50 corridor.

Caltrans District 3's existing signal traffic signal network is presented in **Exhibit 1a and 1b** of **Appendix A**.

Communications Network

The District currently has a limited amount of existing communications infrastructure, with forty-seven (47) miles of fiber optic cable installed across five (5) freeway segments:

- I-80 at Truckee Scales
- I-80 at Kingvale
- I-80 at Applegate
- I-80 at Whitmore
- US 50 at Sunrise

These fiber corridors are supplemented by five (5) communications hubs located along I-80.

See **Exhibit 1a and 1b** of **Appendix A** for the locations of existing communications deployments.

Closed Circuit Television (CCTV) Cameras

There are currently 130 CCTV cameras deployed around the District for traffic monitoring. The CCTV cameras are concentrated in the urban center of the District, but also cover most of the I-80 and US 50 routes. All cameras were upgraded and replaced in 2017. The cameras are mostly interconnected with DSL, but some utilize District fiber, cellular connections, or non-leased wireless connections.

The existing camera locations are shown in **Exhibit 2a and 2b** of **Appendix A**.

Ramp Metering System (RMS)

The District currently has ramp metering systems installed on freeway entrance ramps in 209 locations, with an extensive ramp metering system within the urban core of the District where traffic congestion is most significant. The RMS are located on I-5, US 50, I-80, and State Routes 51, 65, and 99. RMS are utilized to control traffic entry onto congested routes during peak traffic times. The majority of the RMS currently in place utilize loop detection, while three locations use video detection. The RMS utilize DSL, fiber, wireless, cable, or cellular communications.

The existing locations of ramp metering systems are shown in **Exhibit 3a and 3b** of **Appendix A**.

Real-Time Data

The availability of real-time traffic data is critical to allowing Caltrans to manage traffic in real-time and collect data to support future planning. It is also critical to provide real-time information to travelers and other agencies who are impacted by Caltrans facilities. Caltrans uses different devices to gather real-time traffic and weather information.

The District's data collection needs are served by its robust **Traffic Management System (TMS)**, which consists of a network of 288 vehicle detection devices located on District roadways. Detection technologies are a mixture of loops, radar, video, and tubes (as previously discussed) to collect vehicle data. The TMS is dense within the urban core and in the Tahoe Basin. Many of the loops, radar, and video detection devices have been recently upgraded. The detectors, much like the other elements, utilize a mixture of cellular, DSL, fiber, wireless, and telephone landline communications. A majority of the data obtained from these vehicle detection devices is stored in the Performance Measurement System (PeMS) database.

There are seven existing **Bluetooth** readers (BTR) installed in Caltrans District 3 along the US 50 corridor through El Dorado and Sacramento Counties. they are used to capture travel times along US 50 leading up to the Tahoe Basin. About half of the locations were installed in 2011.

The District currently utilizes 129 **counting tubes** deployed on freeway ramps for vehicle data collection. These tubes collect vehicle count information and are manually deployed by two (2) dedicated Census staff on an as-needed basis. Deploying the tubes does not require permanent infrastructure, creating flexibility for District 3 to meet its data collection needs on freeway ramps.

The District currently has 17 existing **Road Weather Information System (RWIS)** locations. Caltrans has deployed several RWIS along routes within the more rural portion of the District, including I-5, US 50, and State Routes 28, 51, 99, and 267. The RWIS system can measure condensation and other weather conditions and report presence of rain, snow, and fog. This information may be used to advise District staff of possible messages that could be displayed on CMS or broadcast via the Highway Advisory Radio (HAR) system. All RWIS in the District were replaced in 2017.

The traffic data components of the Caltrans transportation network can be seen in **Exhibit 4a and 4b** of **Appendix A**.

Traveler Information

Caltrans District 3 has a series of field infrastructure and systems to support the dissemination of real-time information to travelers on Caltrans facilities.

The District has 75 existing **Changeable Message Signs (CMS)** on Caltrans roadways. The District is currently working on a project to upgrade all the CMS; about half have already been upgraded to the new Advanced Variable Message Signs (AVMS). Similar to the location of CCTV cameras, the CMS/AVMS are largely concentrated within the urban center of the District, with many located along the I-80 and US 50 corridors approaching Lake Tahoe. The CMS are used to display traffic messages and amber alerts and had been managed using the District's antiquated Delcan Advanced Traffic Management System (ATMS) software.

District 3 currently has one **Curve Warning Sign**, located along I-80 in Placer County. The sign warns travelers of upcoming curves and/or speed reductions, utilizing a tool similar to a speed gun. The messages are defined and are programmed by Caltrans staff. The typical message advises motorists of their speed and the recommended speed ahead based on existing road and weather conditions.

There are currently 60 locations with **Extinguishable Message Signs (EMS)**. EMS within the District are mainly located along US 50, I-80, and SR-99, with a few located on State Routes 28, 70, 89, 149, 191, and 267. The EMS typically have a pre-set message, such as "Tune Radio to 1610 AM" or "All Trucks exit at scales." These signs are controlled remotely via cellular, DSL, fiber, or telephone landline communications.

Currently, there are 30 **Highway Advisory Radio (HAR)** locations within the District. The HAR system mainly covers I-80 and US-50, with a few located on State Routes 70, 89, 99, 267, and I-5 and utilizes telephone landline, non-leased wireless, fiber, DSL, and cellular communications to establish connectivity. The District's HAR system was recently upgraded in 2017.

The existing locations of traveler information devices are shown in **Exhibit 5a and 5b** of **Appendix A**.

Traffic Management/Operations Center

Caltrans District 3 recently completed a project to upgrade its Traffic Management Center (TMC). The TMC houses operations staff and is co-located with California Highway Patrol (CHP) personal at the CHP Sacramento Communications Center in the City of Rancho Cordova. The TMC is comprised of a large video wall for displaying video feeds and their future ATMS. Caltrans is currently replacing their existing ATMS with a new system. The video management system provides remote monitoring of the CCTV camera feeds throughout the District and is capable of analytics for monitoring, remote viewing, and is capable of video sharing.

The co-location of the Caltrans District 3 TMC and the CHP Dispatch supports improved coordination and data sharing between the two state agencies for traffic incident management and emergency management. Because of this co-location, Caltrans' TMC operators have greater access to real-time incident information from CHP through the CHP Computer-Aided Dispatch (CAD) feed, and in turn, CHP can obtain real-time traffic information to support improved response and management on State freeways.

System Performance

The District's freeway corridors are the backbone of the Sacramento region. These facilities link the region's housing with employment areas and serve a critical role as linking major population areas with recreational/tourist destinations. Many of these facilities are prone to recurring congestion (magnified during peak commute periods), predictable recreational travel patterns (i.e., westbound I-80 and US 50 on Sunday evenings in the winter), and during special events. Freeway-to-Freeway connections persist as the primary congested areas while regional destinations such as Sacramento State University, Sacramento International Airport, the Golden 1 Center, the downtown Sacramento employment center, and other regional retail centers emphasize the need for Caltrans' facilities to operate efficiently and, at a minimum, include technologies to effectively disseminate traveler information.

There are two key maintenance challenges that impact the performance of the Caltrans network. Caltrans struggles with their current method of obtaining traffic count data for ramps, which involve deployment of Census tubes. There are not enough existing staff to support the current counting program, and the program does not provide the type and frequency of data that the District needs to optimize performance of the network. The second challenge is related to maintenance of the fiber optic and communications network that is currently used to provide communications connectivity between field devices and the TMC. In addition to having gaps in the communications connectivity to Caltrans field devices, which limits the ability of the TMC to remotely operate devices in real-time, the current maintenance contract that is in place to support maintenance of the communications network has posed some limitations that prevent the District from

NEEDS AND GAPS ASSESSMENT

The Caltrans District 3 Needs and Gaps Assessment process was conducted using a combination of methods. Existing Caltrans and regional documents and plans related to transportation and technology 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 1 summarizes District 3's Needs and Gaps Assessment.

Table 1 – Caltrans District 3 Needs and Gaps Summary

Need	Gap
Infrastructure/Data	
N1: Baseline communications infrastructure	Some devices rely on wireless communications to connect to the TMC, very few devices are connected by fiber, and many devices, including most traffic signals, are not connected at all.
N2: Robust real-time condition data/information	Shortage of real-time data availability (speed and volume data) for off ramps, interchanges and some portions of the mainline to support real-time operations.
N3: Support Active Transportation	Caltrans-owned traffic signals do not currently have the ability to accommodate bicycles in a way that would allow integration with local active transportation efforts. This is especially true in areas where the Caltrans facility is also the main street of a community, especially in more rural areas.
N4: Reliable communications and systems to prevent downtime	Lack of redundancy in communications and systems so that a single point of failure can be catastrophic. This includes a general lack of redundant fiber connectivity along Caltrans facilities and no operational redundancy if the District 3 TMC becomes compromised or inaccessible.
N5: Programmatic planning for assets and maintenance assets	System and processes to support and track maintenance activities for Caltrans devices, especially for preventative maintenance and upgrade. Many of the Caltrans devices were recently upgraded, making it a good time to initiate a proper maintenance program.
N6: Central system management of tools and data to support operations	Caltrans legacy ATMS that centralizes management of CMS and vehicle speed information is not meeting District's operations needs. The District would like to be able to directly integrate with and share data with partner agencies to support real-time, 24/7 transportation operations and decision making.
N7: High-resolution traffic data for real-time operational decision making	Lack of data to allow real-time performance measurement that would inform operational decision making for ramp metering operations, interchange signal timing, and the need for ICM responses along a corridor (signal timing changes, implementation of alternate routes).
N8: Real-time travel time data for operations	Lack of real-time travel time data that can be shared with travelers and supports real-time and historical decision making for operations.
N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes	Caltrans camera images are shared with partner agencies via QuickMaps, but the functionality is limited and Caltrans cannot see local agency camera images.
N10: Timely emergency notifications (including weather)	Local agency public safety does not inform Caltrans of incidents that may impact freeway operations, hindering Caltrans' ability to respond promptly.
N11: Share data between agencies that share a corridor	Caltrans often does not know if an adjacent locally-owned corridor is closed or restricted due to a planned or unplanned event, and local agencies do not often know about freeway restrictions; this inhibits agencies from making operational timely adjustments to support corridor-wide traffic management.

Need	Gap
N12: Better manage parking and drayage to reduce impact on traffic mobility	Good and real-time information is not provided to the public and freight operators about location and availability of parking at park-and-ride lots and freight parking and drayage at the Port or other transfer stations.
N13: Improve ramp metering operation	Freeway ramp meters cause queues onto arterials.
N14: Leverage and bolster private sector traveler information services	Caltrans does not have real-time data on all of its facilities, and it is costly to purchase and maintain devices that provide real-time data. Caltrans does not currently use third-party probe data for real-time operations.
Operations	
N15: Integrate central systems and subsystems	Limited data sharing between agencies, including real-time data (and camera images), information on planned events, and historical data.
N16: Trained staff to support operations	Outdated or lack of skill set to support operational or maintenance needs, especially for fiber and communications maintenance along Caltrans facilities.
N17: Standard operating and maintenance procedures for incident management purposes	Inconsistency in procedures for incident management across agencies and facilities.
N18: Share regional operations and maintenance responsibilities	Agencies conducting traffic operations and maintenance independently causes lack of traffic coordination; lack of adequate staffing.
N19: Better traffic operations	Automate some functions, such as ramp metering, traffic signal timing and coordination and traveler information dissemination, to conduct operations based on real-time conditions.
N20: Better incident coordination across jurisdictions and with public safety	Lack of coordination between local agency operations/public safety and Caltrans in cases where other agency facilities are impacted by an event on a facility; one example is having better coordination with local public safety when Caltrans needs to close (and later re-open) a ramp or when a freeway restriction will cause an increase in traffic on an adjacent arterial.
N21: Access to additional capacity when needed during special events or incidents	Minimal availability to add capacity on Caltrans facilities and lack of coordination between Caltrans and local agencies that operate arterials adjacent to the freeway.
Institutional	
N22: Reliable network security	Caltrans staff can be better informed on how to reduce threat/ exposure of systems and data.
N23: Standards-based deployments	Systems deployed throughout the region limits ability for regional system integration and data sharing. Additionally, Caltrans traffic signal equipment is often located along key arterial corridors, making it important to integrate with local-agency traffic signals to share traffic signal data with local agencies.

DETERMINING THE PATH FORWARD

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

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

- **Big Data** is becoming readily available as more data is acquired from connected field infrastructure on a near-real-time-basis as well as additional data-rich information from new sources such as probe vehicles, fleet vehicles, and connected vehicles becomes more mainstream. Big Data is about predictive analytics; or more simply, improving our ability to predict and anticipate outcomes. Historically, transportation data has been difficult and costly to obtain but as it becomes increasingly available through GPS, 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.

Caltrans District 3 is also actively investigating or piloting the following advanced technology solutions:

- Utilizing emerging technology and partnerships to improve operations of their facilities. District 3 utilizes information from Waze, a crowd source data application, to identify irregular events in real-time, such as roadway hazards or incidents. The District has an interest in expanding their use of this kind of data, including using private sector probe data instead of deploying detection devices, as it becomes available to explore how it can be used to continue to improve real-time operations.

- Conducting a Managed Lanes Feasibility Study to assess the applicability of managed lanes in District 3.
- Conducting a Recreational Hot Spot Study from on US 50 from Placerville to the Nevada State line at South Lake Tahoeto assess areas that are candidates for roadway technology improvements to relieve congestion.
- Migrating to adaptive ramp metering within District 3 to improve the efficiency of ramp metering operations. Currently, ramp metering is only done on a time-of-day traffic responsive application, but District 3 is currently investigating an expansion of operations throughout the day and week based on dynamic conditions.
- Caltrans is developing the US 50 ICM program that will deploy and integrate freeway and arterial elements from West Sacramento to Placerville over multiple phases.
- As part of the US 50 ICM effort, Caltrans is considering ways to improve their ability to efficiently disseminate information during freeway events that trigger the use of ICM strategies. Currently, Caltrans is testing the use of 'Virtual CMS', which utilizes connected vehicle/vehicle-to-infrastructure (V2I) technologies to provide information rather than using field devices and signs that require significant maintenance and upgrades. While Caltrans is not currently testing or using CV/AV technologies, they are open to learning more about different applications that are available and how the technologies can be integrated and supported into the existing Caltrans systems and processes.

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 Caltrans District 3's implementation strategies. The needs and gaps illustrate the foundation for strategy opportunities to enhance the overall transportation system. The foundation of knowledge and understanding of previously established projects ensures that the implementation strategies are realistic and relevant to the District's conditions.

Several deployment parameters were considered in conjunction with previously discovered information to formulate overarching implementation projects. These include:

- Key Emerging Technologies – Project includes 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 – Projects 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.

Caltrans District 3 has a few concurrent studies and projects that are taking a deeper look into some of the specific needs and gaps that are identified in the Smart Region plan. These projects include District-wide ramp metering and managed lanes studies, as well as a recreational "hot spot" study, and the ongoing efforts for US 50 ICM planning and implementation.

Understanding that each of these studies will be taking a focused look at Caltrans' facilities and will be identifying recommendations and strategies, many of the implementation projects found in this Smart Region plan will refer to those efforts and the outcomes of those studies. This approach is anticipated to ensure consistency in recommendations and avoid duplication of efforts.

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**:

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

When all of these strategies are constructed, Caltrans District 3 will have established an overall communications network and field equipment that enables staff to effectively monitor and manage recurring and non-recurring traffic congestion.

DEPLOYMENT PRIORITIZATION

Each strategy consists of an identification of segments or locations that pertain to the associated strategy. These segments and locations are grouped into specific projects that will be prioritized for implementation. Caltrans has a unique set of projects specifically tailored to the priorities outlined above as they relate to the District.

Prioritization

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

1. **Extent that project achieves local objectives (14)** – project emphasizes addressing local needs
2. **Adaptable to new technology (13)** – can handle new technology without needing to be replaced
3. **Safety (13)**
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 criterion based on its relevancy to the criteria. Project scores were totaled and ranked to identify the highest priority projects.

This Plan is intentionally structured to be agile and flexible in its implementation to enable Caltrans 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.

Cost Estimations

Planning level cost estimations were prepared to reflect an order-of-magnitude cost for each project. A summary of specific costs and considerations related to implementing Smart Region elements is provided for each strategy where a cost can be reasonably estimated. **Appendix C – 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

Table 2 provides a summary of the prioritized strategies. Prioritization for infrastructure projects is presented in **Appendix D – Prioritization Summary**. Detail descriptions of each project can be found in **Appendix B**.

Table 2 – Caltrans District 3 Prioritized Strategy Summary

Priority No.	Strategy # and Title	Strategy Description	Planning Level Cost Estimate
1	Project 33: SOPs for Incident Management and Response	Develop standard operating procedures for the use of infrastructure and collaboration between agencies to support incident management.	Staff time for SOP development and training
2	Project 34: ICM Corridor Concept of Operations	Develop a Concept of Operations to understand what type of infrastructure is necessary, how that infrastructure will be used, and what roles and responsibilities there are associated with ICM operations.	Staff time for participation (funded by SACOG)
3	Project 27: Upgrade Agency ATMS	Upgrade agency ATMS to incorporate new functionality such as CCTV video streaming, weather notifications from weather devices, emergency notifications, and equipment maintenance status and alerts.	$20,000 per new module
4	Project 3: I-80 Business/US 50 from Enterprise Blvd to Howe Ave	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$9,470,000
5	Project 4: US 50 from Howe Ave to Folsom Blvd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$11,591,000
6	Project 5: US 50 from Folsom Blvd to Cameron Park Dr	Add fiber communications, CCTV cameras, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$11,507,000
7	Project 6: SR 51/I-80 Business to I-80	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$8,044,000
8	Project 7: I-80 Loop through Downtown	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$10,975,000
9	Project 8: I-80 from I-80 Business to Douglas Rd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$7,490,000
10	Project 17: I-5 from I-80 Business to Airport Blvd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$8,923,000
11	Project 24: US 50/Lake Tahoe Blvd from US 50 to Pioneer Trail	Add fiber and wireless communications, upgrade traffic signal detection and controllers, deploy connected vehicle devices to CMS	$4,000,000

Priority No.	Strategy # and Title	Strategy Description	Planning Level Cost Estimate
12	Project 30: Communications Sharing to Support Local Agencies	Sharing Caltrans fiber or other communications infrastructure to access local agency field devices.	No additional costs if using existing fiber
13	Project 29: Share CCTV with Individual Agencies	Better utilize ActiView video management system to provide enhanced video sharing functionality so that other agencies can see the streaming video images of any Caltrans CCTV.	Infrastructure costs included in other projects
14	Project 2: SR 99 from US 50 to Grant Line Rd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$12,726,000
15	Project 19: I-80 from Enterprise Blvd to Hwy 113	Add wireless communications, CCTV cameras, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$380,000
16	Project 1: I-5 from I-80 Business to Elk Grove Blvd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$9,889,000
17	Project 10: I-80 from Sierra College Blvd to Hwy 193	Add wireless communications, CCTV cameras, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$457,000
18	Project 11: I-80 from Hwy 193 to Foresthill Rd	Add fiber communications, CCTV cameras, upgrade traffic signal detection and controllers,	$4,278,000
19	Project 38: Standardize Traffic Signal Equipment	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.	Staff time to participate; infrastructure costs included in other projects
20	Project 28: Analytics Software for Real-Time Operations Decision Making	Integrate back end software linked to the agency ATMS to analyze data for real-time operations decision making (such as a decision support system).	$3,000,000 for design, development, testing and integration; $200,000 annually for maintenance and upgrades
21	Project 12: I-80 from Foresthill Rd to Hwy 174	Add CCTV cameras, upgrade traffic signal detection and controllers, deploy connected vehicle devices to CMS	$308,000
22	Project 14: I-80 from Magra Rd to Nyack Rd	Add CCTV cameras, deploy connected vehicle devices to CMS	$200,000

Priority No.	Strategy # and Title	Strategy Description	Planning Level Cost Estimate
23	Project 18: SR 99 from I-5 to Riego Rd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$4,847,000
24	Project 15: Hwy 65 from I-80 to Sunset Blvd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals	$4,123,000
25	Project 16: Hwy 65 from Sunset Blvd and Farrari Ranch Rd	Add fiber and wireless communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$3,381,000
26	Project 31: Real-Time Data Connection between Transit and Transportation Agencies	Establish connection with transit agencies for sharing data related to vehicle location, on-time schedule performance, and other data that can support calculation of transit travel times.	$20,000 for ATMS module; infrastructure costs included in other projects
27	Project 9: I-80 from Douglas Rd to Sierra College Blvd	Add fiber communications, upgrade traffic signal detection, controllers, and signal timing, upgrade ramp metering detection and integrate with traffic signals, deploy connected vehicle devices to CMS	$4,847,000
28	Project 13: I-80 from Hwy 174 to Magra Rd	Add fiber communications, CCTV cameras, deploy connected vehicle devices to CMS	$6,486,000
29	Project 20: Hwy 113 from I-80 to I-5	Add fiber and wireless communications, CCTV cameras, upgrade traffic signal detection and controllers,	$6,100,000
30	Project 35: Dynamic Shoulder Use Along Key Corridors	Prepare Caltrans roadways for dynamic shoulder use (either for all vehicles or transit-only shoulder use) in key locations that need additional capacity during incidents or special events.	Washington State DOT estimates a cost of $2.7 million per mile
31	Project 21: SR 99 from Bogue Rd to Pease Rd	Add fiber and wireless communications, CCTV cameras, upgrade traffic signal detection and controllers	$5,075,000
32	Project 32: Provide Park-and-Ride Availability and Port Drayage Wait Time Information	Provide traveler information along highways using existing CMS to provide Park-and-ride lot availability and port drayage wait time for Port of Stockton.	Incorporated within infrastructure project costs
33	Project 22: SR 20 from George Washington Blvd to 1st St	Add fiber and wireless communications, CCTV cameras, upgrade traffic signal detection and controllers	$4,130,000
34	Project 23: Hwy 49 from McKnight Way to Gold Flat Rd	Add fiber and wireless communications, CCTV cameras, upgrade traffic signal detection and controllers	$3,677,000
35	Project 25: Back Up TMC Function Capabilities	Establish VPN or other remote access to be able to control field infrastructure through ATMS system from a minimum of two physically separate locations.	$40,000

Priority No.	Strategy # and Title	Strategy Description	Planning Level Cost Estimate
36	Project 36: Establish Agency Network Security Policies and Standards	Establish network security policies and standards for accessing the ATMS system, device data, archive/back-up systems, and access from outside entities such as other vendors testing equipment.	Staff time
37	Project 37: Train Staff on Network Security	Develop network security training that will be required for personnel accessing or securing the agency's ATMS system or technologies	Staff time for development and training
38	Project 26: SOPs for Equipment Status and Maintenance Activities	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.	Staff time; may involve costs for trainings

FUNDING

Implementation of many of the strategies identified by this Plan are contingent upon acquiring additional funding. Being apprised of annual funding schedules will provide the District with adequate time to prepare the necessary materials and applications to capitalize on regional funding opportunities. The following are potential funding opportunities for ITS infrastructure and systems that are described in additional detail below:

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

State Funding Programs

The State of California offers a variety of funding programs used for transportation and traveler mobility purposes. This section outlines some of the major funding opportunities administered by the state and available to Caltrans projects.

State Transportation Improvement Program (STIP): The State Transportation Improvement Program receives state and federal funds that are allocated throughout the state. STIP funds new construction projects that add capacity to the transportation network. Transportation projects on and off the state highway system are typically funded from a variety of sources, including the Interregional Transportation Improvement Program (ITSP) and the Regional Transportation Improvement Program (RTIP), and others. Projects are evaluated based on how well the project aligns with furthering regional objectives, particularly for Sustainable Communities Strategies.

State Highway Operation and Protection Program (SHOPP) is the state's "fix-it-first" program that provides funds for pavement rehabilitation, operation, and safety improvement on state highways and bridges. All projects funded by the SHOPP are limited to capital improvements that do not add capacity (no new highway lanes) to the state highway system, though some new auxiliary lanes are eligible for SHOPP funding. The SHOPP project portfolio is updated every two years, carrying forward projects programmed in the last two years and then add projects based on the needs identified in the State Highway System Management Plan (SHSMP) and projects that help reach performance targets per the Transportation Asset Management Plan (TAMP). Operational projects eligible for SHOPP funding include ITS elements identified in this study. SHOPP funds may not fund new MAINLINE highway lanes. Other lanes that serve to improve operations are allowable including auxiliary lanes, truck climbing lanes, and transition lanes. The Minor program is for low cost SHOPP projects under $1,250,000 under discretion of the Caltrans District.

Part of the SHOPP program is the Minor Program. This Program provides Caltrans with funding to implement relatively low-cost capital projects to quickly address small-scale needs that are beyond the

scope of what the Caltrans Maintenance Program can address but are also of a scale that does not necessitate an extensive project development process.

The State Highway Account (SHA): 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 and the funding is allocated to three programs:

- Local streets and roads (44%)
- STIP (44%)
- SHOPP (12%)

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 administers the funds and evaluates funding allocation.

Funding allocation is divided up into several programs that are supported by SB-1. SB-1 has dedicated the appropriate amount of funds to support a target of 90 percent of traffic management systems being in good working order by 2027 and is committed to repair or replace necessary ITS devices to reach that target. **Table 3** identifies of the programs supported by SB-1 that are most relevant to Caltrans Smart Region objectives:

Table 3 – Summary of SB-1 Programs Relevant to 'Smart Region' Objectives

Program	Program Cycle	Funding Amount	Eligibility and Projects
Trade Corridor Enhancement Program (TCEP)	5 year cycle. First cycle is 2015-2020 with a subsequent program being adopted in 2020 to align with the CA Freight Mobility Plan update.	Approximately $300 million per year	Projects must significantly impact the CA freight system and/or relieve congestion on the freight system. If applicable, project must be included in RTP and align with Sustainable Communities Strategy (SCS) guidelines. Projects evaluated by freight system factors, including congestion reduction, interregional benefits and deployment of ITS devices.
Solutions for Congested Corridors Program (SCCP)	4-year program cycle, first cycle 2017-2021 then will run for 3 subsequent cycles.	$250 million over program lifespan	Projects must be included in a Multimodal Corridor Plan and address safety, congestion and accessibility. The California Transportation Commission evaluates projects based on multi-jurisdictional coordination to maximize resources. If applicable, projects should be included in RTP and be consistent with SCS guidelines.
Maintain and Rehabilitate State Highway System	No specific program cycle, this is an allotted fee throughout ten-year funding period.	$1.8 billion	Eligible projects include repairing and resurfacing hundreds of miles of highways to extend the service life of CA roads. Improvement of lane visibility and motorist safety with new striping.
Active Transportation Program	Four-year funding cycle, new cycle starting FY 2019	$100 million	Caltrans projects must be coordinated and aligned with local and regional priorities to be eligible. Funding available for infrastructure projects, plans or non-infrastructure projects. Projects must promote and support increase in active transportation networks. Must be included in RTP when eligible and align with SCS guidelines.

Federal Grants/Pilot Funding Programs

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

Surface Transportation Block Grant Program (STBG): The STBG is an approved funding program through at least 2020. Infrastructure-based ITS capital improvements, including the installation of vehicle-to-infrastructure communication equipment, are eligible for the grant. In addition, operational improvements (including capital and operations costs) for traffic operations facilities, environmental measures, and some parking strategies are eligible. The project must be identified in a 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.

Infrastructure for Rebuilding America (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 Caltrans 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, or dynamic emergency vehicle routing.

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, Caltrans District 3 must be adequately staffed and prepared to sustain the system after it is deployed. Operations and maintenance procedures are essential to define the appropriate staffing levels, training, operational processes, and maintenance plans necessary to sustain an effective system.

Staffing

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

The SACOG region has experienced rapid development and population growth and anticipates that this growth will continue into the future. While growth is a positive, Caltrans must make sure that it is planning for the projected growth as it takes on more projects, expands its infrastructure and services, and offers more to residents and visitors.

The *Caltrans District 3 Goods Movement Study* from 2015 includes research from the California Department of Finance that anticipates Caltrans District 3 counties will experience approximately 25% increase in population between 2012 to 2032, which is roughly a rate of 1.1% per year. This rate is 6% above the average statewide growth rate. Currently, Sacramento County houses over half of the Districts entire population.

The Caltrans District 3 operations group is currently staffed by eight engineers and 2 personnel dedicated to managing the Census detection. The group is in the process of a hiring a technician, but no other additional staff are anticipated. Operations and maintenance of the existing communications network within the District is completed as part of a maintenance contract with a contractor. Operation and maintenance specifically for traffic signals, separate from ITS devices, is the responsibility of a separate signal section at Caltrans instead of the ITS group.

Staffing the Smart Region Program

Caltrans District 3 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 4 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 should 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 4 – Staffing Ratios for Operations and Maintenance

Caltrans District 3 Total Values	Number Of:	Small	Medium	Large
District 3 signals: 463	Signals	< 50	50 – 200	> 200
District 3 ITS devices*: 863	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

** ITS devices include: vehicle detection devices, CMS/EMS, CCTV cameras, HAR, RWIS, ramp meters and miles of fiber.*

*** 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.*

Based on the guidelines, Caltrans District 3 is considered a large agency.

Table 5 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. As shown, recommended staff under full build out conditions includes up to 11 ITS Engineer staff, 15 ITS

operations staff, 11 ITS device maintenance staff, 6 traffic signal operations staff, and 11 traffic signal maintenance staff.

Table 5 – Staffing Recommendations for Caltrans District 3

Caltrans	# of ITS Devices*	# of ITS Engineer Staff**	# of ITS Operations Staff	# of ITS Maintenance Staff	# of Traffic Signals	# of Signal Operations Staff	# of Signal Maintenance Staff
Municipalities							
Existing Conditions	863	8	8	-	463	3	-
Full Build-out Conditions	1,121	11	15	11	463	6	11

** ITS devices include: vehicle detection devices, CMS/EMS, CCTV cameras, HAR, RWIS, ramp meters and miles of fiber.*

*** Staff dedicated to the ramp counting tubes were not included in the calculation of engineer staff at Caltrans*

Staffing Considerations

Currently, District 3 has a sufficient number of ITS Engineer staff to operate the existing ITS devices deployed within District 3. If the full buildout of ITS devices is completed, as described in the Implementation Strategies in Appendix B, there will need to be an additional 3 Engineering staff members to support ITS operations.

The ITS group in District 3 ITS group does have a current shortage of maintenance staff. Because of the age and complexity of some of the equipment used by the District, such as the entrance ramp counting tubes, there is not enough staff to for maintenance of this equipment. Additionally, the District has a need for expanded and additional support for management of the District's communications network, specifically sighting the need for an IT-type position with operations and maintenance skills that can bridge the gap between engineers and electricians.

In the future buildout conditions, District 3 will need 11 ITS maintenance staff to sufficiently maintain and manage the ITS infrastructure envisioned in the future.

For traffic signals, the future buildout does not include construction of additional traffic signals; however, it does envision an elevation of the functionality of existing traffic signal equipment to provide more data in support of more real-time operations and management. This will likely elevate the operational responsibilities of signal operations and maintenance staff, and thus may warrant additional staff in the future.

Understanding there is an existing staffing shortage, adding additional ITS infrastructure and functionalities that are desired by the District and recommended in this plan to accommodate future mobility technology will only exacerbate these staffing challenges unless operations and maintenance staff are hired to 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.

When planning for additional or adjusted staffing to account for Smart Region improvements, District 3 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. Increasing demand requires more employees and the necessary knowledge, skills, and abilities to handle the demand. In many cases, personnel required to manage multijurisdictional systems have an Information Technology background and skill set that includes network management, software development, database administration, and application troubleshooting. Although engineering skill sets or a professional license may be warranted for specific activities such as signal timing plan development, an engineer may not always be necessary to fulfill other agency functions. Each agency should consider a combination of personnel skill sets as they relate to the individual agency requirements to fulfill operational functions.
- **Redundant Support Structure** – It will be important to foster and maintain staff skills and redundancy through greater training and cross-training so that there is more than one person with the knowledge and skill set required to operate and maintain ITS equipment and systems.
- **Central System Management Architecture** – Another major factor that has a significant impact on staff planning is whether the central management system operations function out of a traditional TMC with workstations and a video wall, or if the central management system is operated on a virtual basis with a few City offices having permissions-level access to certain parts of the system.

Maintenance Plan

Planning for ITS operations and maintenance costs is a critical component when developing an implementation project. Operation and maintenance of ITS technologies and systems extends beyond simply keeping the equipment working. The ITS group 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 District maintenance 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 in the District 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 Caltrans 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 the ITS group maintenance 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 6**. District 3 staff can refer to this table when incorporating new signals, new ITS infrastructure, or new staff. The District should review and revise the preventative maintenance procedures on an annual basis to ensure new issues are being addressed and equipment is being properly maintained.

Table 6 – 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 7 identifies a rule-of-thumb frequency of minor and major maintenance and major rehabilitation for a range of ITS devices that District 3 may be implementing. These guidelines should be reviewed and updated annually to reflect actual needs for Caltrans facilities.

Table 7 – 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

Equipment	Minor Maintenance	Major Maintenance	Major Rehabilitation
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
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 District'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 District 3 to identify devices that are not reliable or accurate or have had frequent malfunctions. The tracking will also allow the District to identify appropriate cases for technology replacements where maintenance of an existing technology may be costlier than upgrading to a newer technology. Developing periodic reports and then reviewing those reports are critical to being able to identify frequently failing devices for replacement.

End-of-Life Replacements and Upgrades

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

Agency Replacement Needs

The District 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 District'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, District 3 should consider the estimated lifespan of its infrastructure. **Table 8** summarizes industry standards for equipment lifecycle timeframes so that equipment remains current and performs at an optimal level. Lifecycle replacement mechanisms should also be reviewed and updated to accommodate emerging technology availability so that are opportunities to either replace out-of-date infrastructure with the most up-to-date technologies.

Table 8 – Anticipated Technology Lifecycle Timeframes

Equipment	Lifecycle Timeframe (Yrs)
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

Much of the exiting ITS infrastructure in District 3 was upgraded or replaced in 2017, including CCTV cameras, HAR, RWIS, half of the CMS and vehicle detection. The remaining CMS are scheduled to be replaced in 2018. As each device gets replaced, the new device is given a 'born on' date in the District's asset database. As such, District 3 should not have to replace any of that equipment in the near-term and should be able to use their asset database to track and plan for their replacement.

PERFORMANCE METRICS

Performance metrics are used to evaluate and demonstrate the effectiveness of District 3's implementation projects in addressing regional goals and objectives. Recommended data types, data sources, and calculations to evaluate performance of projects for the SACOG region are provided in **Table 9,** and those identified in **grey** are specifically important for Caltrans to measure and track. As projects are delivered, Caltrans can use these metrics as a guideline to evaluate projects.

Table 9 – Performance Metrics to Perform Project Evaluations

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

Objective	Performance Metric	Data Type	Source	Calculation
	Increase Capacity of Communications Network	Fiber/Wireless/Bandwidth Usage	TMC System	Measure communications network capacity before and after ITS device deployment
Reduce user frustration by providing **consistency and reliability**	Reduced Downtime	System Errors/Failure	System Operations	Compare Downtime Incident Occurrences before and after project implementation
	Reduced Public Complaints	Public Complaints	TMC and other Operator Records	Compare the amount of public complaints related to inconsistency/ unreliability from before and after implementation project
	Reduce Response Time to Device Failures	Response Time	TMC Records	Measure reduction in response times before and after project implementation
	Increase percent of field device that are operational	Operational Devices	Asset Management System	Calculate percent of devices that are operational based on total devices in the inventory. Compare that figure to the same percentage ratio prior to implementation project
Proactively improve transportation system **safety**	Reduced vehicle-to-vehicle crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced vehicle-to-bicycle crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced vehicle-to-pedestrian crashes	Crash Records	Crash Record System	Calculate percentage change of crashes before and after implementation
	Reduced Safety Incidents Involving Transit Operations	Transit Incident Records	Transit TMC and Transit Provider Records	Count amount of safety incidents involving transit operations after project implementation and compare to before implementation
Improve **traveler information** and dissemination to public and within region	Reduced vehicle traffic (congestion) because of CMS Message	Traffic Volume	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

Objective	Performance Metric	Data Type	Source	Calculation
	Increased Partnerships between Third Party Data Companies and Public Agencies	Partnerships	Institutional Policies/Documents	Count the number of private party /public agency data sharing agreements that have occurred since implementing strategies
	Increased 511 Inputs (on all available platforms)	Website Updates, Radio Updates, and Push Notifications	511 System/ Records	Count traveler information inputs through 511 systems and compare to counts prior to implementation
	Increased 511 Usage/Subscriptions	App Download/Website Usage	App/Website Management	511 website views
Emergency / Disaster preparedness	Improved Emergency Response Time	Travel Time	Agency TMC	Time between initial notification to first responder arrival
	Improved Incident Clearing Times	Incident Response and Clearing Times	Agency TMC	Compare time it takes to respond to and clear an incident before and after project implementation

NEXT STEPS

The outcome of this Technology Implementation Plan is a roadmap of prioritized projects that Caltrans District 3 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.

District 3's Technology Implementation Plan is a dynamic and flexible set of projects that contribute to SACOG's broader Smart Region Plan. The projects set forth are a mix of infrastructure, operations and institutional projects that are adaptable to changing needs and evolving technologies. This plan and the associated tools should remain a living set of resources that staff can update as projects are implemented or expanded, agency priorities change, or other changes occur that impact the region or the District. 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 have been completed. Priorities across projects may also change and should be reflected in the document. As time goes by and projects change in priority, updating the project list will provide an

opportunity to evaluate if new projects are available based on emerging technology, increased staffing levels, and so on.

- **Funding Opportunities** – Funding opportunities are always changing. Existing programs or grants may expire, while new ones may emerge. It is imperative that funding opportunities are kept current to maximize the opportunity to utilize new funding sources. In addition, it will continue to be important to leverage emerging opportunities for third party or private sector support.
- **Equipment Replacement Strategies** – The success of this Plan is largely based on ensuring that all equipment continues to work effectively and efficiently. Legacy equipment should be continuously updated or replaced to accommodate emerging technology and enhanced system functionality.
- **Operations and Maintenance** – Adequate staffing levels allow for optimal functionality. As the plan grows and progresses, staffing levels must continue to reflect the need for sustaining a functioning system.

APPENDIX A – EXISTING CONDITIONS EXHIBITS

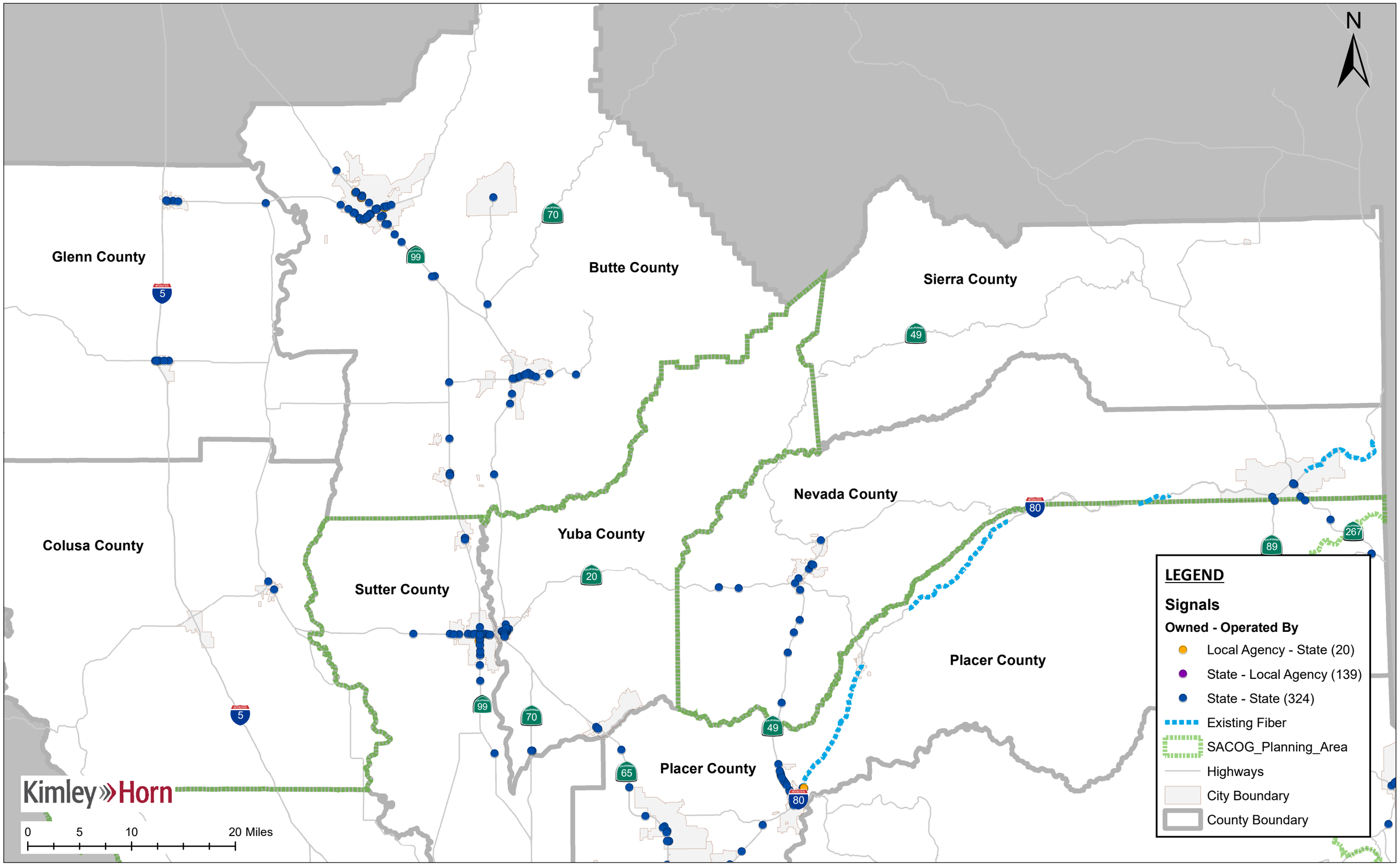
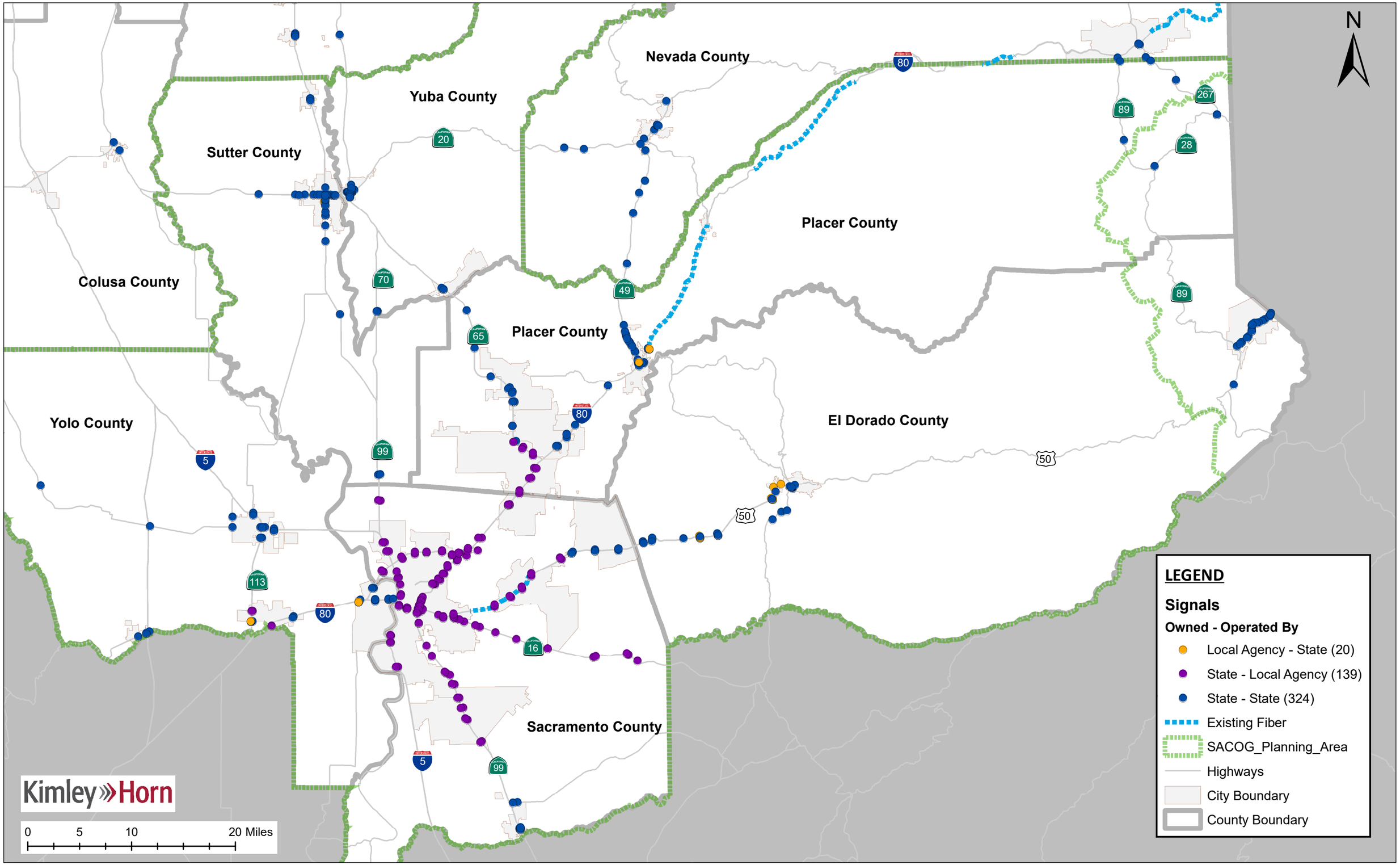


EXHIBIT 1: TRAFFIC SIGNALS AND EXISTING FIBER



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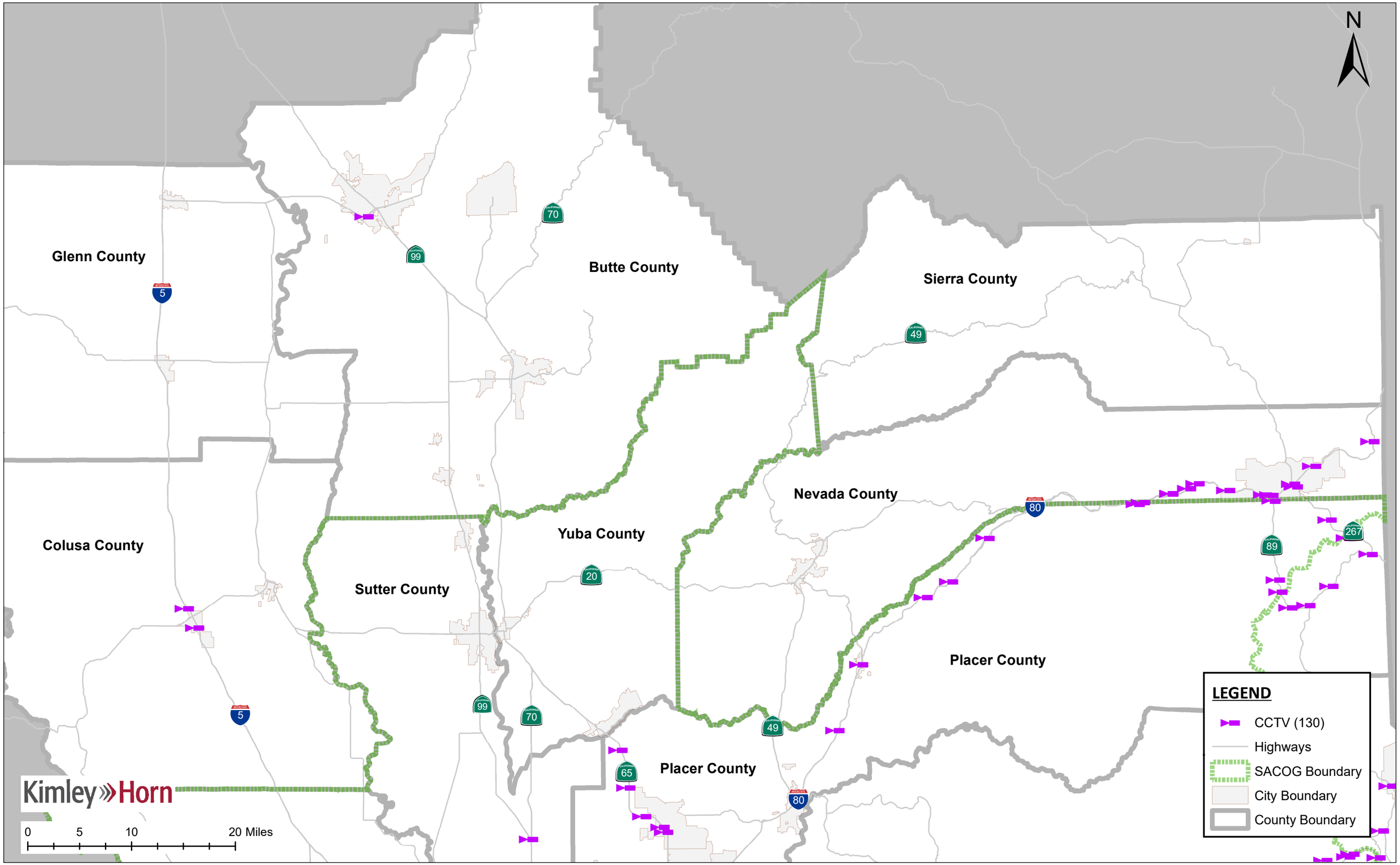
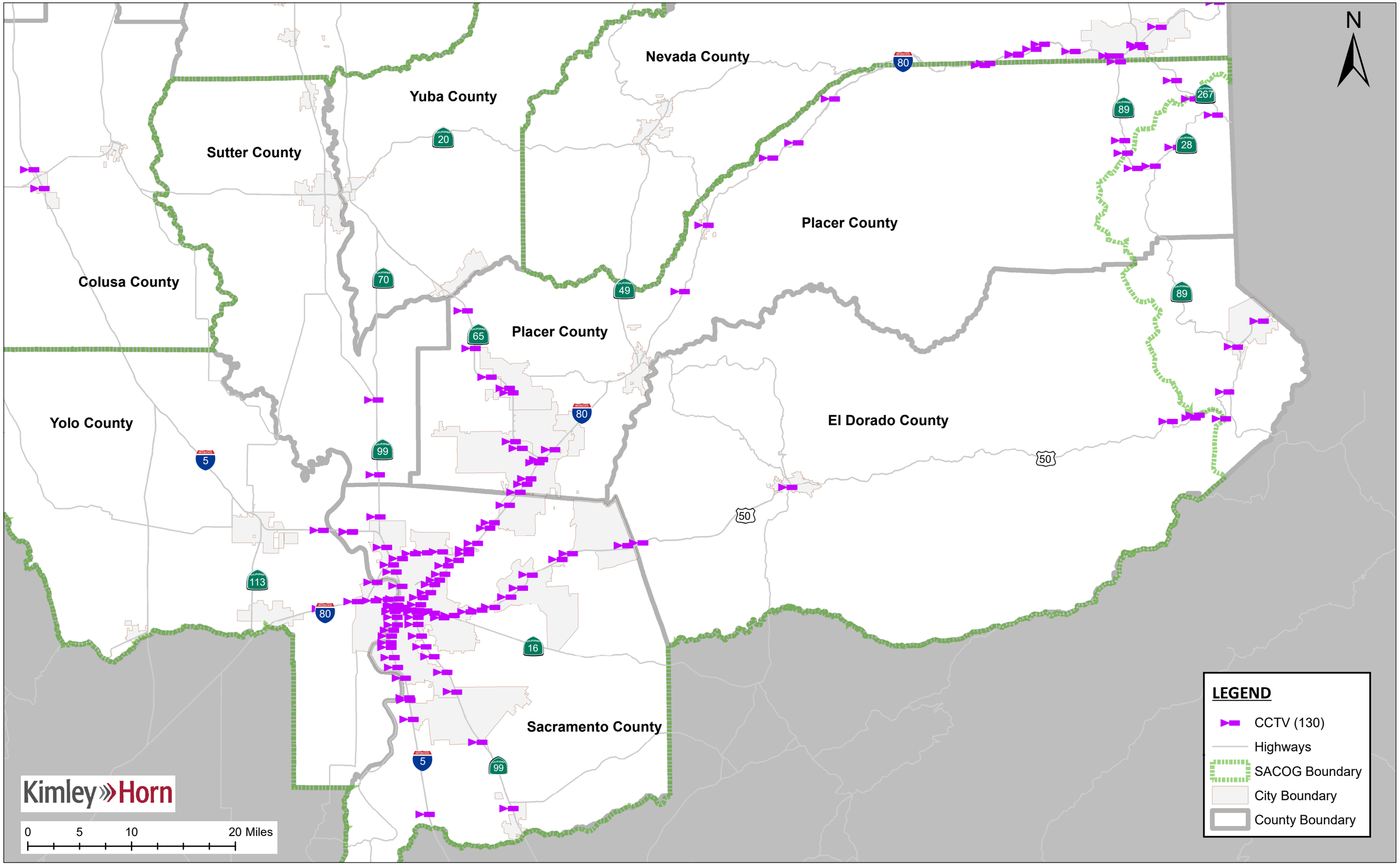


EXHIBIT 2: EXISTING CCTV NETWORK



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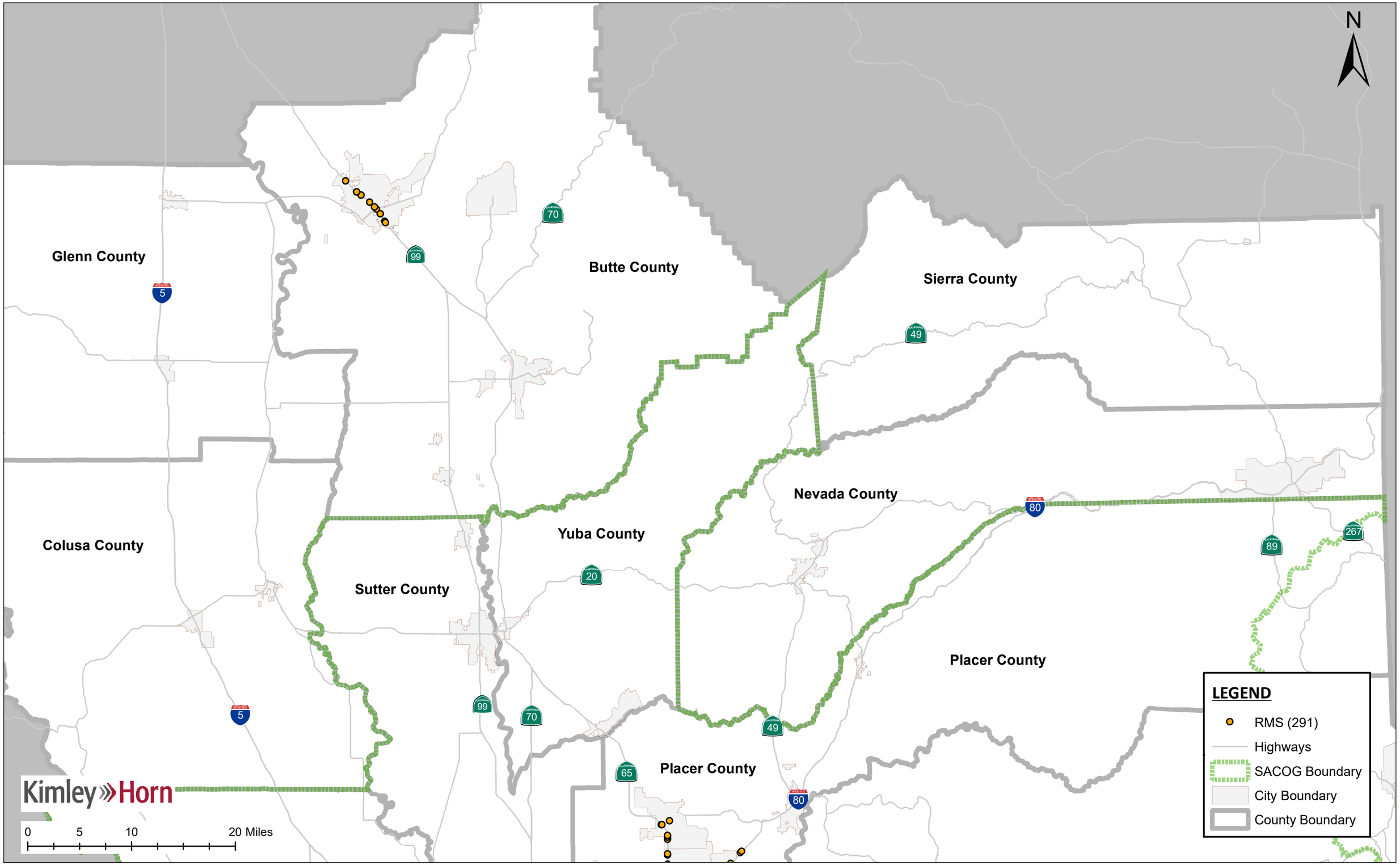


EXHIBIT 3: EXISTING RMS

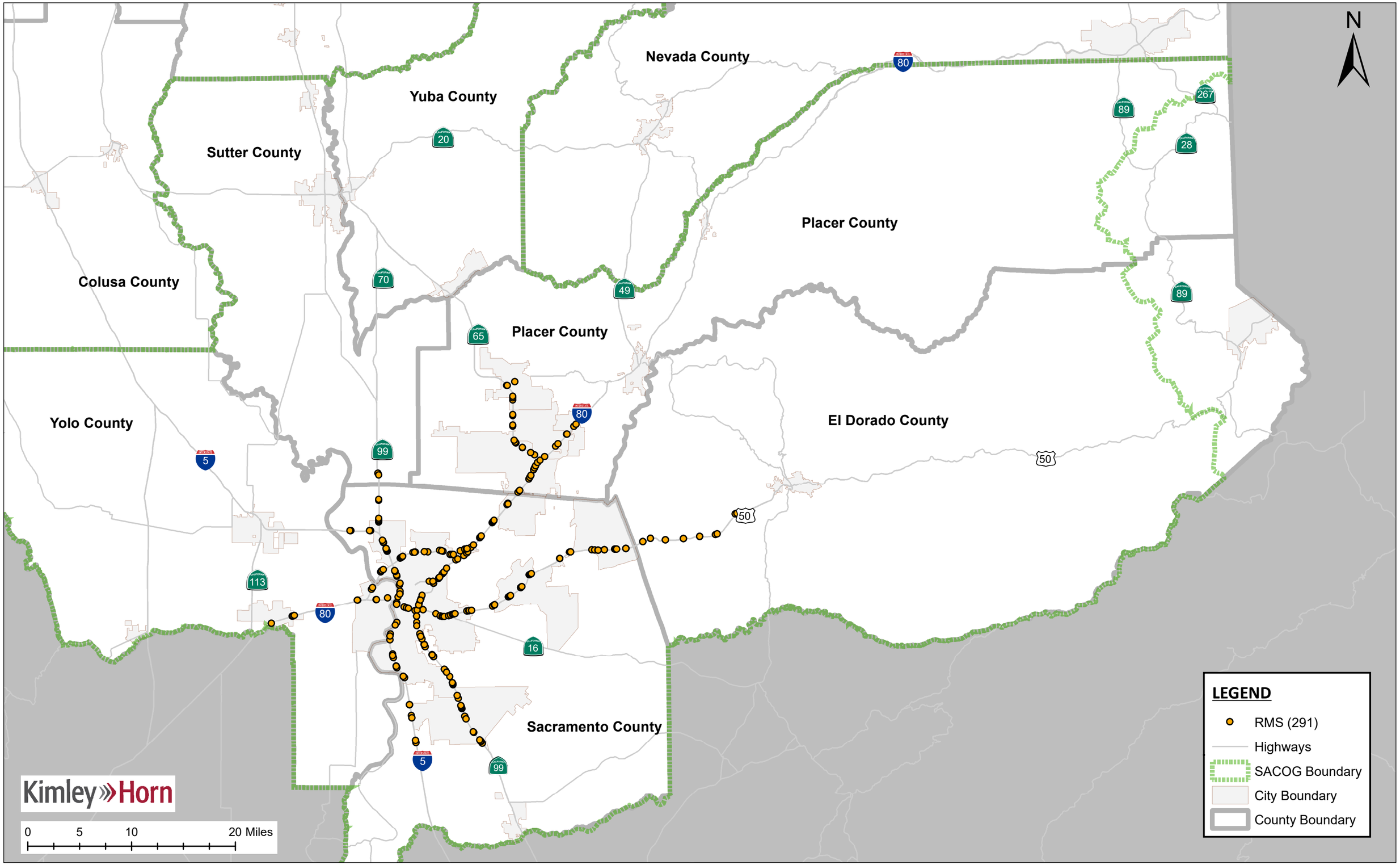


EXHIBIT 3: EXISTING RMS

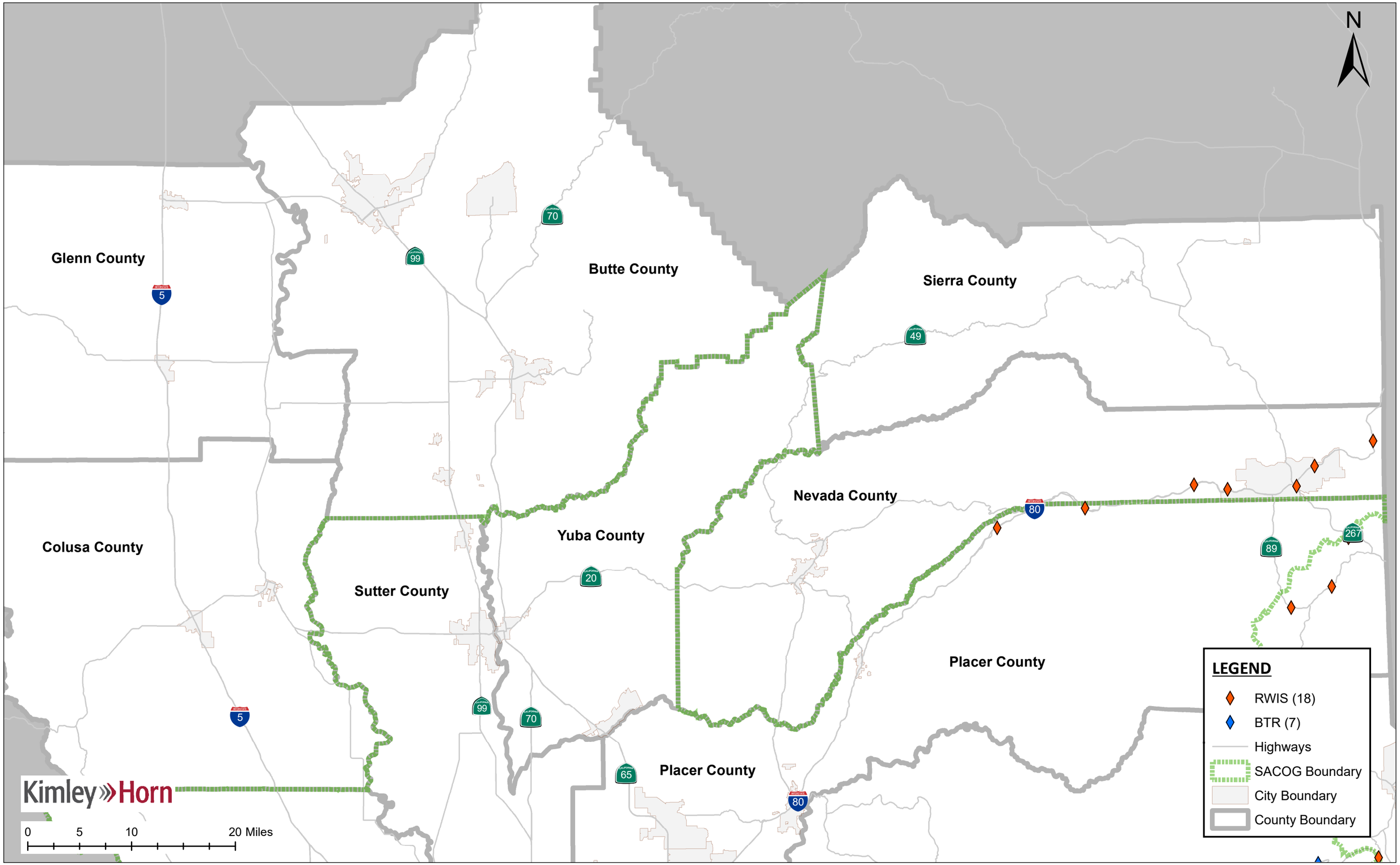
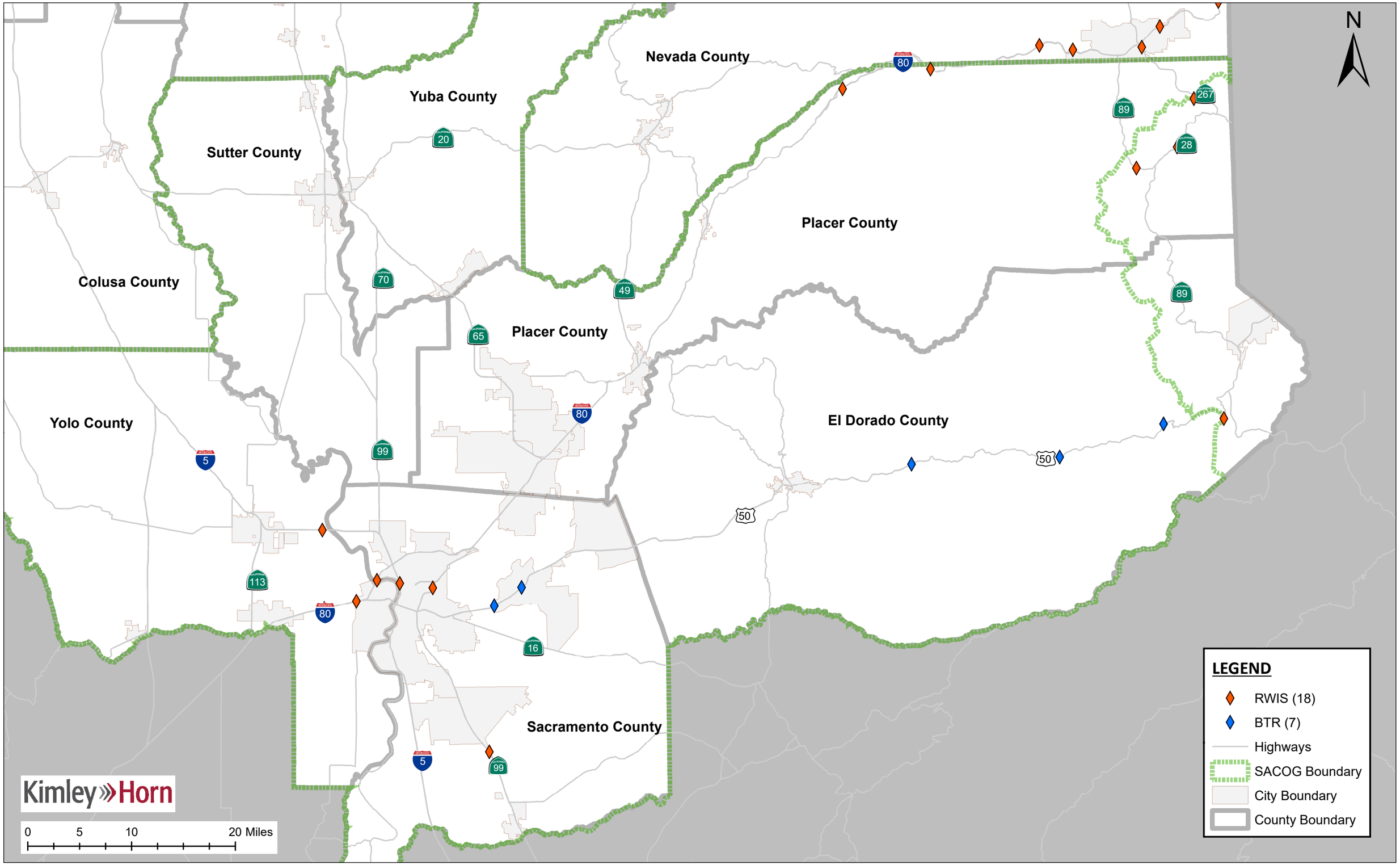


EXHIBIT 4: EXISTING RWIS and BTR



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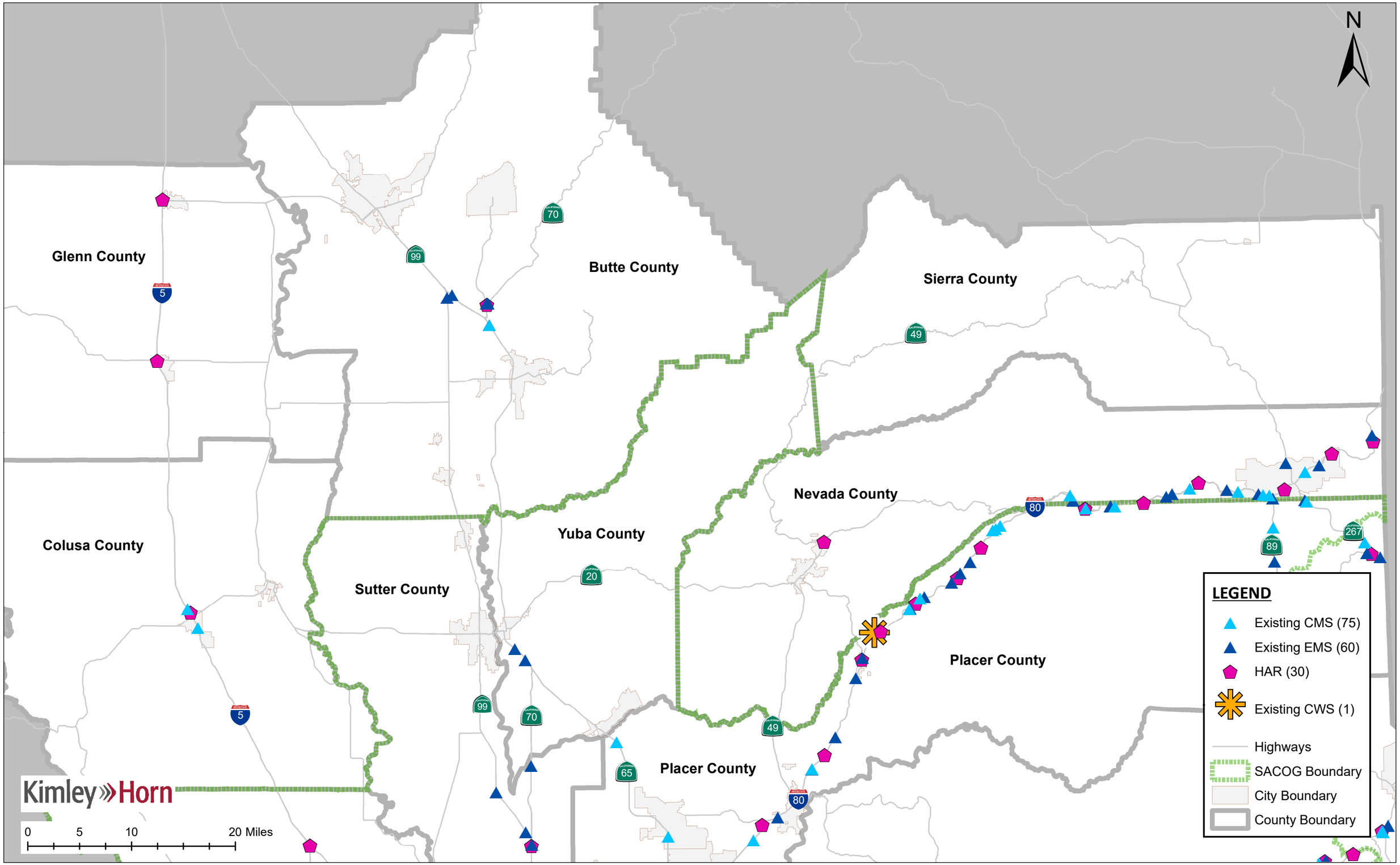


EXHIBIT 5: EXISTING CMS, EMS, and HAR

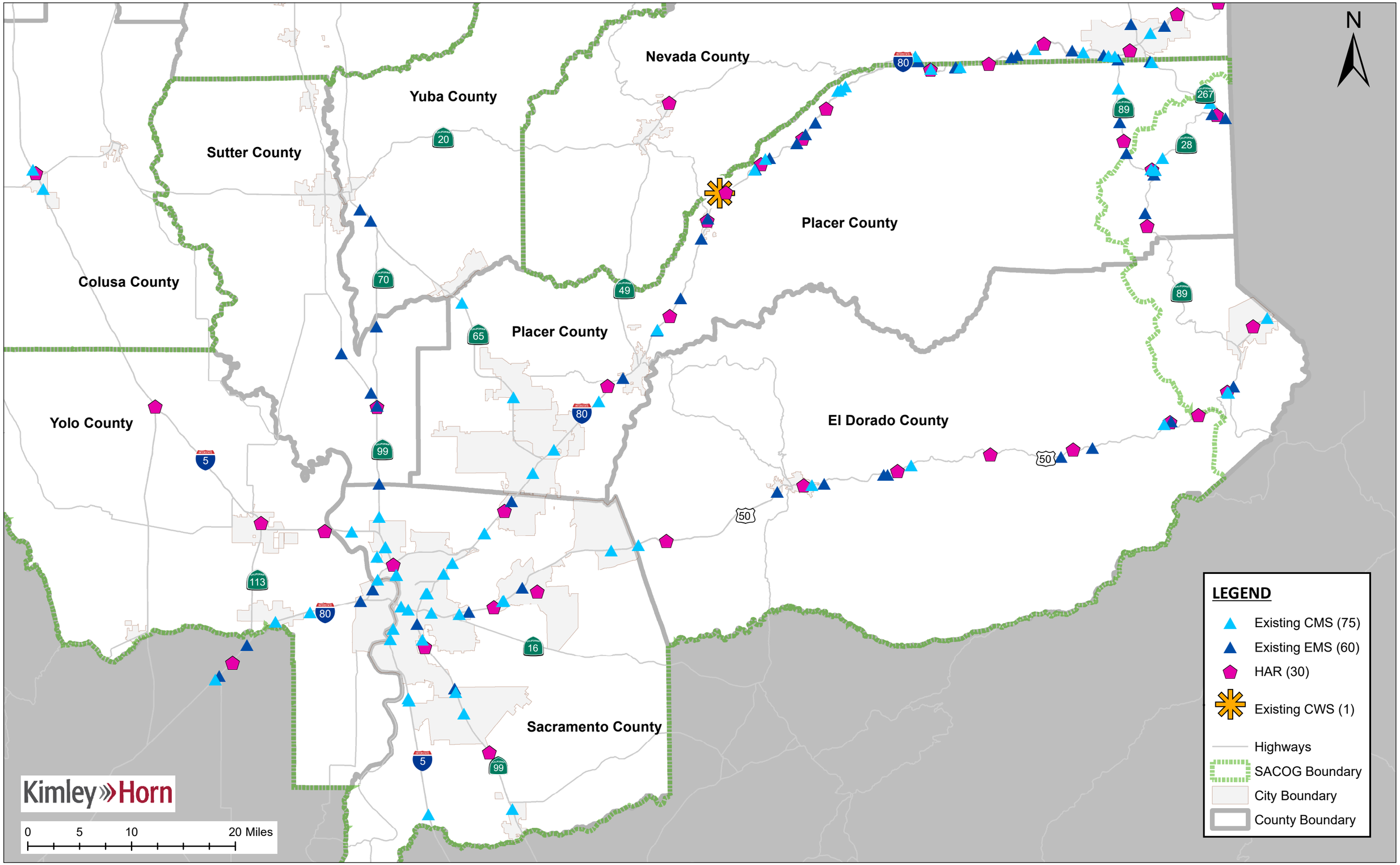


EXHIBIT 5: EXISTING CMS, EMS, and HAR

APPENDIX B – STRATEGY SUMMARY SHEETS

The **Implementation Projects** shown on the next page outlines the 24 infrastructure projects that are recommended on District 3 facilities to create a connected ITS network within the District and implement devices that will facilitate improved situational awareness, data collection and integration of Caltrans and local agency operations. Strategy sheets organized by the Map ID in the figure can be found after the map.

In addition to the 24 Implementation Projects, additional strategy descriptions are included that outline operational and institutional strategies that are recommended for District 3 in order to address the needs and gaps identified.

N

Sutter County

Yuba County

Nevada County

Placer County

Colusa County

Placer County

Yolo County

El Dorado County

Sacramento County

20 Miles

LEGEND

- Caltrans Hubs
- Existing Fiber
- Highways
- SACOG Boundary
- City Boundary
- County Boundary
- # Project Number

Kimley»Horn

IMPLEMENTATION PROJECTS

Strategy ID #1

I-5 South of Downtown ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-5 corridor south of Downtown.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-5 south of Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-5 from I-80 Business to Elk Grove Boulevard

This project includes:

- **11.7 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **three** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **22** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **three** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **three** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **four** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies

- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #2

SR 99 south of Downtown ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the SR 99 corridor south of Downtown.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along SR 99 south of Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – SR 99 from Downtown to Grant Line Rd

This project includes:

- **14.3 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **ten** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **38** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **ten** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **ten** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **three** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #3

I-80 Business/US 50 ITS Improvements – ICM Corridor Segment 1

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 Business/US 50 corridor through Sacramento.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 Business/US 50 Corridor Segment 1 looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-80 Business/US 50 from Enterprise Blvd to Howe Ave

This project includes:

- **10.4 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **12** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **25** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **12** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **12** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **four** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- US 50 Integrated Corridor Management Implementation Plan
- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies

- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- This project is meant to be coordinated with the US 50 ICM efforts that are outlined in the ICM Implementation Plan. The Implementation plan considers schedule, procurement strategies, funding sources, and operations and maintenance, among other things.

Strategy ID #4

US 50 ITS Improvements – ICM Corridor Segment 2

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the US 50 corridor through Sacramento.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along US 50 ICM Segment 2 looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – US 50 from Howe Ave to Folsom Blvd

This project includes:

- **13.4 miles** of fiber within Caltrans right-of-way and one wireless radio backhaul
- Upgrading the controller and adding video detection to the traffic signals at **7** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **28** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **7** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **7** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **three** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- US 50 Integrated Corridor Management Implementation Plan
- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies

- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- This project is meant to be coordinated with the US 50 ICM efforts that are outlined in the ICM Implementation Plan. The Implementation plan considers schedule, procurement strategies, funding sources, and operations and maintenance, among other things.

Strategy ID #5

US 50 ITS Improvements – ICM Corridor Segment 3

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the US 50 corridor east of Sacramento.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along US 50 ICM Segment 3 looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – US 50 from Folsom Blvd to Cameron Park Dr

This project includes:

- **13 miles** of fiber within Caltrans right-of-way
- Deploying **nine** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at 10 traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **25** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **ten** interchanges to allow coordination of timing plans so metering rates can be updated to flush ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **ten** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **two** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- US 50 Integrated Corridor Management Implementation Plan
- Consideration for deployment of dynamic shoulder use/hard shoulder running

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study
- Project 24: US 50/Lake Tahoe Blvd ITS Improvements – when this project goes in, a wireless radio backhaul will need to be installed in the location of this project to provide communications connectivity back to the Caltrans TMC

Prerequisite Dependencies –

- This project is meant to be coordinated with the US 50 ICM efforts that are outlined in the ICM Implementation Plan. The Implementation plan considers schedule, procurement strategies, funding sources, and operations and maintenance, among other things.

Strategy ID #6

SR 51 ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the SR 51 corridor in Sacramento.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along SR 51 in Sacramento looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – SR 51 from I-80 Business to I-80

This project includes installing:

- **8.5 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **12** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **27** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **12** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **12** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **four** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #7

I-80 through Downtown ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 corridor through Downtown.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 through Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-80 through Downtown Sacramento (from I-80 Business to SR 51)

This project includes installing:

- **12.4 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **ten** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **28** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **ten** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **ten** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **two** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #8

I-80 in North Sacramento County ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 corridor in northern Sacramento County.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Douglas Road to Sierra College Blvd looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-80 from SR 51 to Douglas Road

This project includes installing:

- **8.7 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **four** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **18** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **four** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **four** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **two** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #9

I-80, Douglas Road to Sierra College ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 corridor between Douglas Road and Sierra College.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Douglas Road to Sierra College Blvd looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-80 from Douglas Road to Sierra College Blvd

This project includes installing:

- **5.4 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **five** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **13** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **five** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **five** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **two** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #10

I-80, Sierra College to Highway 193 ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 corridor between Sierra College Blvd and Highway 193.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Sierra College Blvd to Highway 193 looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-80 from Sierra College Blvd to Highway 193

This project includes:

- Deploying **five** wireless radios to provide communications connectivity to the traffic signals along the segment;
- Deploying **six** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **three** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **6** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **three** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **three** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **one** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment

- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study

Prerequisite Dependencies –

- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #11

I-80, Highway 193 to Foresthill ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 corridor between Highway 193 and Foresthill Rd.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Highway 193 to Foresthill Road looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes

Scope/Limits – I-80 from Highway 193 to Foresthill Rd

This project includes installing:

- **5.1 miles** of fiber within Caltrans right-of-way
- Deploying **five** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **five** traffic interchanges to support controller equipment standardization and active transportation.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;

- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #12

I-80, Foresthill Rd to Highway 174 ITS Improvements

Description –Deploy new devices to improve real-time operations and coordination with local agency networks on the I-80 corridor Foresthill Road and Highway 174.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Foresthill Rd to Highway 174 looks to address the following needs identified for Caltrans District 3:

- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N12: Better manage parking as to not impact traffic mobility

Scope/Limits – I-80 from Foresthill Rd to Highway 174

This project includes installing:

- Deploying **12** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **two** traffic interchanges to support controller equipment standardization and active transportation.
- Deployment of connected vehicle technology at **three** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standards-based deployment for traffic signal equipment in the region

Prerequisite Dependencies –

- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #13

I-80, Highway 174 to Magra Road Communications Improvements

Description – Improve ITS communications connectivity to improve real-time operations on the I-80 corridor between Highway 174 and Magra Road.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Highway 174 to Magra Road looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N12: Better manage parking as to not impact traffic mobility

Scope/Limits – I-80 from Highway 174 and Magra Road

This project includes:

- **8.2 miles** of fiber within Caltrans right-of-way
- Deploying **six** CCTV cameras to allow for real-time monitoring of the corridor
- Deployment of connected vehicle technology at **one** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Communications sharing to support local agencies

Prerequisite Dependencies –

- Work with vendors to identify desired equipment and costs to accommodate desired functionalities and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #14

I-80, Magra Road to District Border Improvements

Description – Improve ITS communications connectivity to improve real-time operations on the I-80 corridor between Magra Rd and the District 3 border.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 from Magra Road to the District border looks to address the following needs identified for Caltrans District 3:

- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N12: Better information on parking and/or drayage wait times as to not impact traffic mobility

Scope/Limits – I-80 from Magra Rd to the District 3 border

This project includes:

- Deploying **nine** CCTV cameras to allow for real-time monitoring of the corridor
- Deployment of connected vehicle technology at **seven** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

Prerequisite Dependencies –

- Work with vendors to identify desired equipment and costs based on regional standards, to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #15

Highway 65, I-80 to Sunset Blvd ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the Highway 65 corridor between I-80 and Sunset Blvd.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 through Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N13: Improve ramp metering operation

Scope/Limits – Highway 65 between I-80 and Sunset Blvd

This project includes:

- **4.7 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **four** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **6** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **four** interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **four** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #16

Highway 65, Sunset Blvd to Farrari Ranch ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the Highway 65 corridor Sunset Blvd and Farrari Ranch.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along Highway 65 to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – Highway 65 between Sunset Blvd and Farrari Ranch

This project includes installing:

- **3.8 miles** of fiber within Caltrans right-of-way and **three** wireless radios to connect to additional traffic signals in between.
- Upgrading the controller and adding video detection to the traffic signals at **four** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **seven** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **three** metered interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **four** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **one** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #17

I-5 Downtown ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-5 corridor connecting Downtown and the airport.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-5 in Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-5 between I-80 Business and Airport Blvd

This project includes installing:

- **10.2 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **five** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **25** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **five** metered interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **five** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **five** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Consideration for deployment of dynamic shoulder use/hard shoulder running
- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source, including partnering with the airport, for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #18

SR 99 North of Downtown ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the SR 99 corridor north of Downtown.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-5 in Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – SR 99 between I-5 and Riego Rd

This project includes installing:

- **5.8 miles** of fiber within Caltrans right-of-way
- Upgrading the controller and adding video detection to the traffic signals at **two** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **eight** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **two** metered interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **two** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **one** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #19

I-80 west of Downtown ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the I-80 corridor west of Downtown.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along I-80 west of Downtown looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes
- N12: Better manage parking as to not impact traffic mobility
- N13: Improve ramp metering operation

Scope/Limits – I-80 from Enterprise Blvd to Highway 113

This project includes:

- Deploying **four** wireless radios to connect to additional traffic signals in between.
- Deploying **five** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **three** traffic interchanges to support controller equipment standardization and active transportation.
- Installing additional detection at **four** ramp meters to provide better traffic data to support improved ramp metering operations, including adaptive ramp metering
- Installing communications between the ramp meter controller and traffic signal controller at **two** metered interchanges to allow coordination of timing plans so metering rates can be updated to flush a ramp queue faster and avoid spillback onto the arterial during congested peak periods.
- Updating the signal timing at the traffic signals of **three** traffic interchanges to coordinate signal timing plans between ramp meters and traffic signals to minimize the impact of the ramp meters onto the arterial roadways during congested peak periods.
- Deployment of connected vehicle technology at **two** CMS along the corridor to support traveler information related to park-and-ride availability and drayage wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies

- Results of District 3 Ramp Metering Study
- Results of District 3 Managed Lanes Feasibility Study

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #20

Highway 113 ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the Highway 113 corridor.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along Highway 113 looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes

Scope/Limits – Highway 113 from I-80 to I-5

This project includes installing:

- **6.1 miles** of fiber (between I-80 and Road 29 and between Road 24 and Gibson Dr) and **four** wireless radios to connect to additional traffic signals in between.
- Deploying **five** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **five** traffic signals to support controller equipment standardization and active transportation.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;

- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #21

SR 99 through Yuba City ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the SR 99 corridor through Yuba City.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along SR 99 through Yuba City looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes

Scope/Limits – SR 99 from Bogue Road to Pease Road

This project includes:

- **5 miles** of fiber and **three** wireless radios to connect to additional traffic signals;
- Deploying **four** CCTV cameras to allow for real-time monitoring of the corridor
- Deploying **two** wireless radio backhauls to connect this project to the closest Caltrans fiber that connects to the TMC;
- Upgrading the controller and adding video detection to the traffic signals at **six** traffic signals to support controller equipment standardization and active transportation.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Fiber projects implemented that provide backhaul connectivity to TMC
- Project 22: SR 20 through Yuba City ITS Improvements

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;

- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #22

SR 20 through Yuba City ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the SR 20 corridor through Yuba City.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along SR 20 through Yuba City looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes

Scope/Limits – SR 20 from George Washington Blvd to 1st Street in Marysville

This project includes:

- **4.5 miles** of fiber (between George Washington Blvd and Sutter St and between Featherside Way and 1st Street) and **three** wireless radios to connect to additional traffic signals;
- Deploying **four** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **twelve** traffic signals to support controller equipment standardization and active transportation.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Project 21 – SR 99 through Yuba City ITS Improvements

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;

- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #23

Highway 49 through Grass Valley ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on the Highway 49 corridor through Grass Valley.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along Highway 49 through Grass Valley looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes

Scope/Limits – Highway 49 from McKnight Way to Gold Flat Rd

This project includes:

- **4.4 miles** of fiber and **four** wireless radios to connect to additional traffic signals;
- Deploying **two** wireless radio backhauls to connect this project to the closest Caltrans fiber that connects to the TMC;
- Deploying **four** CCTV cameras to allow for real-time monitoring of the corridor
- Upgrading the controller and adding video detection to the traffic signals at **three** traffic signals to support controller equipment standardization and active transportation.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

- Standardize traffic signal equipment
- Communications sharing to support local agencies
- Fiber projects implemented that provide backhaul connectivity to TMC

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;

- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems
- Identify a funding source for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #24

US 50 South Lake Tahoe ITS Improvements

Description – Improve ITS communications connectivity and deploy new devices to improve real-time operations on US 50 corridor through South Lake Tahoe.

Relation to Needs – Improving ITS communications connectivity and deploying new devices along US 50 through South Lake Tahoe looks to address the following needs identified for Caltrans District 3:

- N1: Baseline communications infrastructure
- N2: Robust real-time condition information
- N3: Support active transportation
- N7: High-resolution traffic data for real-time operational decision making
- N12: Better manage parking and congestion to not impact traffic mobility

Scope/Limits – US 50/Lake Tahoe Blvd from US 50 to Pioneer Trail

This project includes:

- **4.5 miles** of fiber and **two** wireless radio backhauls to connect this project to the closest Caltrans fiber that connects to the TMC;
- Upgrading the controller and adding video detection to the traffic signals at **ten** traffic signals to support controller equipment standardization and active transportation.
- Deployment of connected vehicle technology at **one** CMS along the corridor to support traveler information related to parking availability and wait times.

Considerations – The following is a list of other projects within this Caltrans District 3 Technology Implementation Plan that may either implicate the viability or timeliness of this project.

Prerequisite Dependencies –

- Identify if there are other Caltrans projects being pursued along the corridor that can be leveraged to support this project, such as roadway/shoulder widening, pavement reconstruction, or anything that involves having to trench and/or repave the road;
- Work with local agency partners, including those in Nevada, which has direct connection to this stretch of roadway, to coordinate on traffic signal upgrades and re-timing; the equipment purchased for the traffic signals should be compatible with what local agencies plan to deploy; signal re-timing should be completely coordinated with the relevant local agency;
- Work with vendors to identify desired equipment and costs based on regional standards that are set (for traffic signal controllers or active transportation detection), to accommodate desired functionalities, and compatibility of equipment with Caltrans central systems

- Identify a funding source, including partnering with local tourism agencies, for equipment and/or construction; include project in Caltrans and regional planning documents to support programming, and submit project for funding during appropriate programming cycle
- Coordinate and implement project when funding becomes available, being sure to coordinate with all appropriate Caltrans departments and local agencies
- Make sure all new equipment and devices are included in asset management system and maintenance schedules.

Strategy ID #25

Back Up TMC Function Capabilities

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

Relation to Needs –

- N4: Reliable communications and systems to prevent downtime

Scope/Limits – At a location that has communications connectivity, locate a server and firewall that can remotely access the main TMC servers to provide live backup and act as a secondary TMC location in case access to the main facility is compromised

Considerations –

- Establish Agency Network Security Policies and Standards
- Communications Sharing to Support Local Agencies
- Improve Existing Communications Capabilities on Key-Corridors

Prerequisite Dependencies –

- Identify a location that has existing communications and can serve traffic management functions
- Consider opportunities to partner with another agency, such as City of Sacramento, to identify the location - there may be opportunities to share fiber to provide the necessary connectivity
- Engage Caltrans IT to procure a server and firewall equipment to be installed at the back up location
- Coordinate with IT to have the server perform live back ups of the main TMC system and provide VPN access to the main server from the backup facility
- If necessary, develop an IGA with partner agency for the facility sharing and establish an agreement for roles and responsibilities related to performing back up operations and define thresholds for activation
- Include new equipment into asset management system and maintenance budget/procedures

Strategy ID #26

SOPs for Equipment Status and Maintenance Activities

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 –

- N5: Programmatic planning for assets and maintenance assets

Scope/Limits – Includes inventory of existing and near-term device types and identifying appropriate responsive, preventative and replacement maintenance for each. Document these findings as part of SOPs and a maintenance schedule.

Considerations –

- Utilize Existing Agency Asset Management System

Prerequisite Dependencies –

- Reference the Technology Implementation Plan's Table 4 to identify device lifecycle timeframes and Table 8 and 9 for preventative and responsive maintenance that should be performed on devices
- Identify training that may be necessary to complete maintenance activities and identify a mechanism to provide the training (cross-training with another department or a partner agency; IMSA; ATSSA; others)
- Document the specific maintenance tasks that should be undertaken, at what frequency, and by whom (what staff position), for all ITS devices in the District
- Identify a tracking mechanism for maintenance activities - this may start as an excel document, but should ultimately be handled by an asset management system
- Document procedures for how staff should track and document maintenance activities that are performed, including a schedule
- Get approval from maintenance management on the document
- Distribute SOPs to all maintenance staff, based on role, and provide necessary training, including training on how to use an asset management system for tracking
- Check-in with staff on how well SOPs are being implemented/followed and update as necessary
- Use system to inform staffing requests and budget requests for asset replacements

Strategy ID #27

Upgrade Agency ATMS

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

Relation to Needs –

- N6: Central system management of tools and data to support operations

Scope/Limits – District 3 is in the process of procuring a new ATMS system, providing an opportunity consider adding modules that support near-term advanced functions, such as travel times, connected vehicles and adaptive ramp metering

Considerations –

- Deploy detection for adaptive ramp metering

Prerequisite Dependencies –

- Inquire with ATMS provider about availability of modules to add to ATMS
- Work with vendor to integrate new module
  Integrate relevant devices for each module
- Update operator SOPs to include use of new modules and relevant devices

Strategy ID #28

Analytics Software for Real-Time Operations Decision Making

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

Relation to Needs –

- N8: Real-time travel time data for operations

Scope/Limits – US 50 ICM corridor

Considerations –

- US 50 ICM Implementation Plan
- ITS Improvement Projects 3-5

Prerequisite Dependencies –

- Based on the US 50 ICM effort, consider needs identified for automation of ICM functions via a Decision Support System (DSS)
- Partner with other US 50 ICM agency stakeholders to complete Systems Engineering documentation (Concept of Operations, Analysis, Modeling and Simulation Plan, Systems Requirements) for a DSS to support ICM operations - consider ways that the DSS can support future expansion to other future ICM corridors
- Identify funding source for software development and submit project for programming
- Develop and release RFP for software development, testing and integration
- Select contractor and execute contract
  Organize US 50 ICM stakeholders, including Caltrans IT staff, to provide project input and guidance during development process
- Coordinate with Caltrans IT and developer to complete software development, testing and integration;
  Develop a maintenance agreement with contractor and/or IT to maintain and upgrade software, as needed
- Develop operations agreements with ICM partners for DSS use and data sharing;
  Develop software user manuals and provide training to Caltrans and other partner agencies on using the DSS

Strategy ID #29

Share CCTV with Individual Agencies

Description – Utilizing a robust communications center-to-center network between agencies and the existing functionalities of the ActiView video management system, provide enhanced video sharing functionality so that other agencies can see the streaming video images of any Caltrans CCTV deployed in the District. 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 –

- N9: Sharing of camera images to support pre-trip, en-route, and incident management purposes

Scope/Limits – Need connectivity to all existing CCTVs in the District

Considerations –

- ITS Improvement Projects 1 - 24

Prerequisite Dependencies –

- Make sure there are reliable communications to all existing CCTV cameras in the District - install communications where needed to provide connectivity between CCTV and the District TMC
- Work with ActiView vendor to understand the video sharing functionalities included with the VMS
- Work with SACOG during STARNET modernization efforts to improve connectivity to other agencies for camera sharing

Strategy ID #30

Communications Sharing to Support Local Agencies

Description – Eliminate communications gaps that exist along key regional corridors by considering sharing Caltrans fiber or other communications infrastructure to access local agency field devices. Utilize copper/fiber or wireless technologies to achieve more robust communications coverage, for example using dark fiber not currently in use.

Relation to Needs –

- N11: Share data between agencies that share a corridor

Scope/Limits – Depends on partner agency needs

Considerations –

- ICM Corridor Concept of Operations
- Connect Ramp Meter Signals to Arterial Signals

Prerequisite Dependencies –

- Identify locations where there is available fiber capacity that can be shared;
- Develop a fiber sharing agreement/IGA with any partner agencies that identifies roles and responsibilities related to fiber use and maintenance

Strategy ID #31

Real-Time Data Connection between Transit and Transportation Agencies

Description – Establish connection with transit agencies for sharing data related to vehicle location, on-time schedule performance, and other data that can support calculation of transit travel times. This strategy will specifically support implementation of comparative travel times as part of ICM deployments

Relation to Needs –

- N11: Share data between agencies that share a corridor

Scope/Limits – US 50 ICM corridor

Considerations –

- ICM Concept of Operations
- ITS Improvement Projects 3-5

Prerequisite Dependencies –

- Identify contact at transit operations center who can provide information on the transit central management system;
- Identify needs to support real-time data sharing between Caltrans and agency -needs might include communications connectivity, ATMS upgrades to be able to send and receive data from transit system to calculate travel times;
- Consider an interim solution that involves manual coordination for transit travel times;
- Make necessary connections and upgrades to receive real-time transit data and travel times;
- Update CMS procedures to allow for posting of comparative travel times for both freeway and transit along corridor

Strategy ID #32

Provide park-and-ride availability and port drayage wait time information

Description – Provide traveler information along highways to provide Park-and-ride lot availability and port drayage wait time for Port of Stockton. Information can be provided via existing CMS, new CMS and/or a mobile application. New CMS could be a hybrid static-dynamic sign that provides space availability. Signs should be provided in in key locations along routes that have access to park-and-rides or the Port of Stockton. Mobile application functionality can be integrated into the existing Mobile Quickmap using virtual CMS functionalities.

Relation to Needs –

- N12: Better manage parking and drayage to reduce impact on traffic mobility

Scope/Limits – All District roadways with CMS

Considerations –

- ITS Implementation projects 1 – 10, 12 – 14, 16 -19, and 24

Prerequisite Dependencies –

- Provide traveler information along highways to provide Park-and-ride lot availability and port drayage wait time for Port of Stockton. Information can be provided via existing CMS, new CMS and/or a mobile application.
- New CMS could be a hybrid static-dynamic sign that provides space availability. Signs should be provided in in key locations along routes that have access to park-and-rides or the Port of Stockton.
- Mobile application functionality can be integrated into the existing Mobile Quickmap using virtual CMS functionalities.

Strategy ID #33

SOPs for Incident Management and Response

Description – Develop standard operating procedures for the use of infrastructure and collaboration between agencies to support incident management. SOPs should be organized around NIMS procedures and account for TIM Coalition coordination responsibilities. Establishing formal SOPs related to incident management will improve incident response and clearance time in the region or along key corridors.

Relation to Needs –

- N17: Standard operating and maintenance procedures for incident management purposes

Scope/Limits – SOPs should be put in place for all TMC Operators and maintenance staff who may have a role in supporting incident management and response

Considerations –

- ICM Corridor Concept of Operations

Prerequisite Dependencies –

- Consult US 50 ICM Plan as a framework for what should be included in the Caltrans-specific SOPs
- Identify specific roles and responsibilities of different Caltrans staff (TMC Operators; PIO; Maintenance; Signals) during incidents on the freeway
- Compile into SOPs or 'playbooks' for each type of role that identify specific actions that should be taken in sequence, including who should be notified by whom, who should operate specific device and how - include information such as contact information for notifications, placement of barrier equipment, detour routes or CMS messages, and other details
- Formalize the SOPs (including receiving approval from necessary parties) and provide in hard-copy to relevant Caltrans staff
- Conduct table-top exercise in coordination with law enforcement

Strategy ID #34

ICM Corridor Concept of Operations

Description – ICM involves freeway and arterial networks working together to move traffic during recurring and non-recurring conditions. It is important to develop a Concept of Operations to understand what type of infrastructure is necessary, how that infrastructure will be used, and what roles and responsibilities there are associated with ICM operations. It is recommended that Caltrans lead these efforts and involve as many local agencies as will be impacted by ICM operations.

Relation to Needs –

- N19: Better traffic operations

Scope/Limits – Caltrans should be a primary partner to SACOG in supporting the development of ICM plans for major regional corridors that do not already have an ICM Plan, including, at a minimum, I-80, I-5. Caltrans should identify a corridor manager (similar to US 50) and should participate in the development and ultimate deployment of ICM strategies

Considerations –

- SOPs for Incident Management and Response

Prerequisite Dependencies –

- Develop a prioritized list of freeway segments for which ICM should be pursued and provide list to SACOG to support programming of the plans
- Use the framework and partnerships identified for US 50 to support development of ICM plans for other routes
- Update TMC operator SOPs based on outcomes of the ICM plan (ex: if there are process changes identified in the plan, such as notification procedures or data entry that operators are responsible for)

Strategy ID #35

Dynamic Shoulder Use Along Key Corridors

Description – Prepare Caltrans roadways for dynamic shoulder use (either for all vehicles or transit-only shoulder use) in key locations that need additional capacity during incidents or special events. It can be used to get incident responders to the scene faster and then allow for additional capacity to move traffic through the area more efficiently. This involves detection to monitor shoulder use, CCTV cameras to monitor shoulder use, and lane control signage to notify the traveling public of the shoulders that can be used. Hard shoulder running is recommended only for locations where capacity constraints has severely limiting the traffic mobility and incident response capabilities.

Relation to Needs –

- N21: Access to additional capacity when needed during special events or incidents

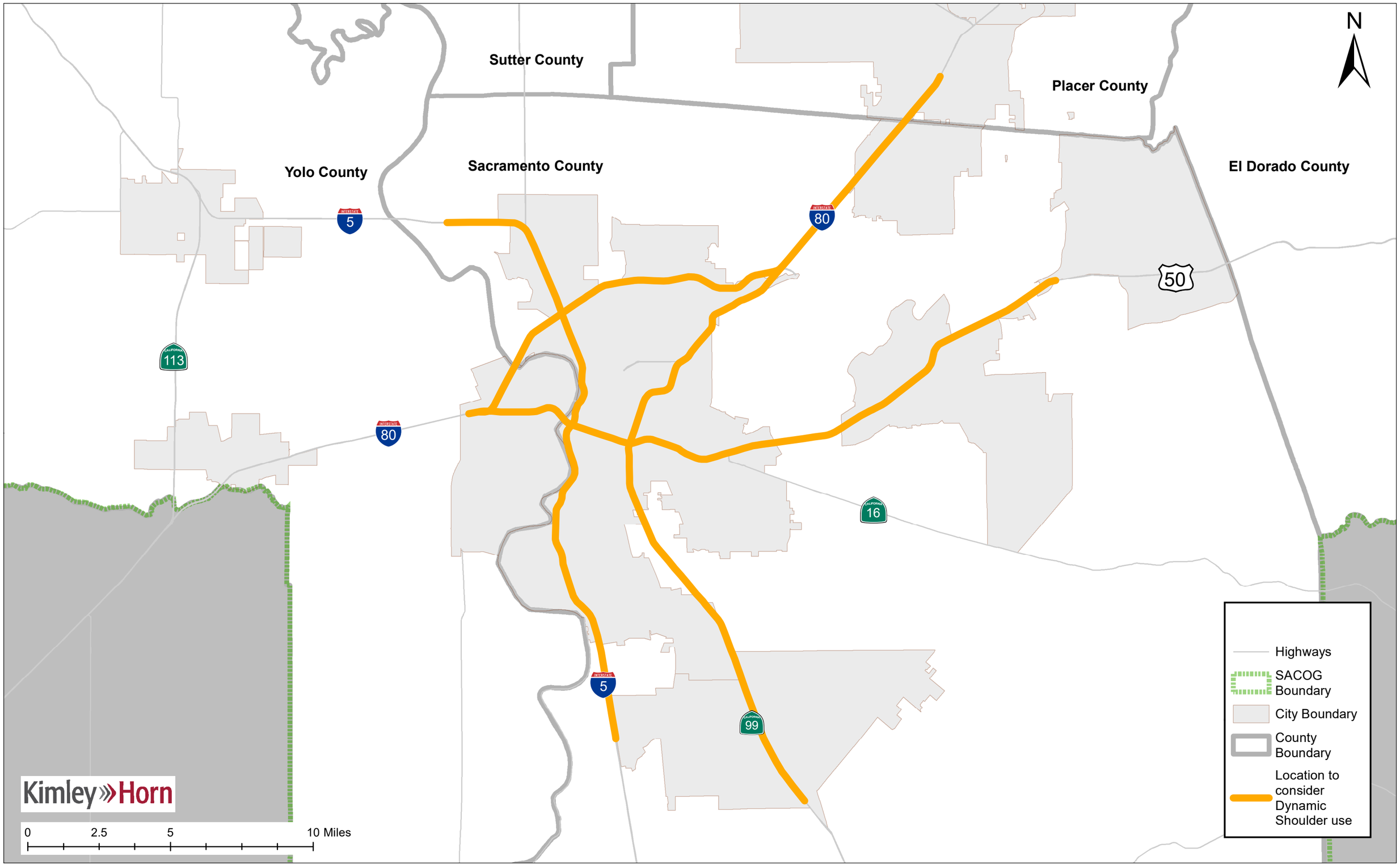
Scope/Limits – See **Figure 3** on the next page

Considerations –

- District 3 Managed Lanes Feasibility Study (MLFS) - currently in progress
- ICM Corridor Concept of Operations
- Improve Existing Communications Capabilities on Key-Corridors

Prerequisite Dependencies –

- Conduct an inventory of the shoulder widths and conditions for candidate roadways, per the District's Managed Lanes study currently in progress
- Use the 'Preliminary Engineering' section, including Table 1 and Table 2, at the following link as a back check for readiness - https://ops.fhwa.dot.gov/publications/fhwahop15023/ch2.htm#s21
- For roadways where dynamic shoulder use is deemed appropriate and desired, develop a Concept of Operations (to define the system functionalities), System Requirements (to define software requirements that will need to be met) and Project Assessment (to define the project scope, cost and schedule) with a group of stakeholders, including CHP
- Identify funding source for desired project and submit project for programming
- Develop an RFP for the system/software components based on the Requirements and an RFP for construction
- Select vendor(s), execute the contract and implement project
- Update TMC Operator SOPs or manual to include procedures and roles/responsibilities related to the temporary shoulder deployment
- Include all new equipment and systems into the agency asset management system



CORRIDORS TO CONSIDER DYNAMIC SHOULDER USE

Strategy ID #36

Establish Agency Network Security Policies and Standards

Description – Establish network security policies and standards for accessing the ATMS system, device data, archive/back-up systems, and access from outside entities such as other vendors testing equipment. This would be established in the form of a standard operating procedures or a formal policy developed by Caltrans and used at the agency's TMC to outline access to systems.

Relation to Needs –

- N22: Reliable network security

Scope/Limits – SOPs or policies that result should be applicable to all District 3 staff and other's (contractors, other agencies) who will be given access to the Caltrans ATMS system or associated field equipment

Considerations –

- Train Staff on Network Security

Prerequisite Dependencies –

- Identify staff member(s) who will lead security initiative
- Identify partners in IT who will participate and provide input
- Gather input from staff where gaps in existing security networks are in order to identify strategies and policies for improvement
- Determine if funding is needed for certain strategies that may require equipment procurement or upgrades
- Determine training guidelines that will be administered to staff in order to standardize security procedures
- Conduct follow up meetings to determine performance of new security measures
- Based on follow up meeting, make changes to procedures where necessary

Strategy ID #37

Train Staff on Network Security

Description – Develop network security training that will be required for personnel accessing or securing the agency's ATMS system or technologies. Agency IT will need to update security training on a regular basis and keep policies and procedures in line with current security requirements at the agency enterprise level. Procurement specifications should be set for vendors/firms deploying new technology to provide training on functionality and security standards for any new technology.

Relation to Needs –

- N22: Reliable network security

Scope/Limits – All staff

Considerations –

- Establish Agency Network Security Policies and Standards

Prerequisite Dependencies –

- Task will occur after establishment of agency network security policies and standards procedures are complete
- Using training guidelines determined by new security standards processes, determine procedures for training
- Allocate time for staff training sessions, track hours spent training and track process of staff
- Conduct follow up meetings after staff are routinely implementing new security measures in order to determine if any changes to security procedures need to change

Strategy ID #38

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 #39

Utilize Existing Agency Asset Management System

Description – Utilize existing agency asset management system to maintain existing information for all agency assets related to transportation technology.

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

- Reliable equipment functionality to prevent downtime (Need D3)
- Maintainable infrastructure and assets (Need D4)
- Programmatic planning for assets and maintenance of assets (Need D6)
- Interactive Regional GIS based Inventory (Need D13)
- Standard operating and maintenance procedures for incident management (Need O6)
- Share regional operation and maintenance responsibilities (Need O7)

Scope/Limits – Sacramento County currently has an existing system for asset inventory and maintenance activity tracking but have not been fully utilizing it. The scope of work includes Sacramento County's transportation operations and maintenance group to explore capabilities of the existing system, and revise operations and maintenance procedures as necessary to maximize the functionalities of the asset management system.

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

- ID #6 – Replace End-Of-Line/Legacy Equipment with Modernized and Updated Equipment

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

- Explore full functionality of the agency owned asset management system
- Revise the existing operations and maintenance procedures if necessary
- Utilize existing agency asset management system is day to day operations and maintenance

APPENDIX C – COST ASSUMPTIONS

Table C1: Cost Summary

Infrastructure Projects - Improve Existing Communications Capabilities														
Project ID	Needs Addressed	Project Description	Video Detection	Updated Signal Timing	Controller Upgrade	Interchange with Ramp Meter	Detection on Ramp Meters	CCTV	CMS	Communication (Miles)	Wireless Communication		Connected Vehicle Technology	Planning Level Cost
										New	Backhaul	Intersection		
Communication Gap Closures, Communications Equipment Upgrade, Upgrade to Fiber														
1	1, 2, 3, 7, 12, 13	I-5 from I-80 Business to Elk Grove Blvd	3	3.0	3	3	22			11.70			4	$ 9,889,000.00
2		SR 99 from US 50 to Grant Line Rd	10	10.0	10	10	38			14.30			3	$ 12,726,000.00
3		I-80 Business/US 50 from Enterprise Blvd to Howe Ave	12	12.0	12	12	25			10.40			4	$ 9,470,000.00
4		US 50 from Howe Ave to Folsom Blvd	7	7.0	7	7	28			13.40			3	$ 11,591,000.00
5	1, 2, 3, 7, 9, 12, 13	US 50 from Folsom Blvd to Cameron Park Dr	10	10.0	10	10	25	9		13.00			2	$ 11,507,000.00
6	1, 2, 3, 7, 12, 13	SR 51/I-80 Business to I-80	12	12.0	12	12	27			8.50			4	$ 8,044,000.00
7		I-80 Loop	10	10.0	10	10	28			12.40			2	$ 10,975,000.00
8		I-80 from I-80 Business to Douglas Rd	4	4.0	4	4	18			8.70			2	$ 7,490,000.00
9		I-80 from Douglas Rd to Sierra College Blvd	5	5.0	5	5	13			5.40			2	$ 4,847,000.00
10	1, 2, 3, 7, 9, 12, 13	I-80 from Sierra College Blvd to Hwy 193	3	3.0	3	3	6	6				5	1	$ 457,000.00
11	1, 2, 3, 7, 9	I-80 from Hwy 193 to Foresthill Rd	5	5.0	5	0	0	5		5.10			0	$ 4,278,000.00
12	3, 7, 9, 12	I-80 from Foresthill Rd to Hwy 174	2	2.0	2	0	0	12					3	$ 308,000.00
13	1, 2, 9, 12	I-80 from Hwy 174 to Magra Rd	0	0.0	0	0	0	6		8.20			1	$ 6,486,000.00
14	9, 12	I-80 from Magra Rd to Nyack Rd	0	0.0	0	0	0	9					7	$ 200,000.00
15	1, 2, 3, 7, 13	Hwy 65 from I-80 to Sunset Blvd	4	4.0	4	4	9			4.70			0	$ 4,123,000.00
16	1, 2, 3, 7, 12, 13	Hwy 65 from Sunset Blvd and Farrari Ranch Rd	4	4.0	4	3	7			3.80		3	1	$ 3,381,000.00
17		I-5 from I-80 Business to Airport Blvd	5	5.0	5	5	25			10.20			5	$ 8,923,000.00
18		SR 99 from I-5 to Riego Rd	2	2.0	2	2	8			5.80			1	$ 4,847,000.00
19		I-80 from Enterprise Blvd to Hwy 113	3	3.0	3	2	4	5				4	2	$ 380,000.00

Infrastructure Projects - Improve Existing Communications Capabilities														
Project ID	Needs Addressed	Project Description	Video Detection	Updated Signal Timing	Controller Upgrade	Interchange with Ramp Meter	Detection on Ramp Meters	CCTV	CMS	Communication (Miles)	Wireless Communication		Connected Vehicle Technology	Planning Level Cost
										New	Backhaul	Intersection		
20	1, 2, 3, 7, 9	Hwy 113 from I-80 to I-5	5	5.0	5	0	0	5		6.10		4	0	$ 5,075,000.00
21		SR 99 from Bogue Rd to Pease Rd	6	6.0	6	0	0	4		5.00	2	3	0	$ 4,276,000.00
22		SR 20 from George Washington Blvd to 1st St	12	12.0	12	0	0	4		4.50		3	0	$ 4,130,000.00
23		Hwy 49 from McKnight Way to Gold Flat Rd	3	3.0	3	0	0	4		4.40	2	4	0	$ 3,677,000.00
24	1, 2, 3, 7, 12	US 50/Lake Tahoe Blvd from US 50 to Pioneer Trail	10	10.0	10	0	0			4.50	2		1	$ 4,000,000.00

Non-Infrastructure Projects			
Project ID	Needs Addressed	Project Description	Planning Level Cost
25	4	Back up TMC Function Capabilities	$40,000
26	5, 18	SOPs for Equipment Status and Maintenance Activities	Staff time
27	6	Upgrade Agency ATMS	$20,000 for adaptive ramp metering module
28	8, 14	Analytics Software for Real-Time Operations Decision Making	$3,000,000 for DSS design and development $200,000 annually for DSS maintenance and upgrades
29	9, 11, 15	Share CCTV with Individual Agencies	Staff time
30	11, 19	Communications Sharing to Support Local Agencies	No additional costs if using existing fiber
31	7, 11, 15	Real-Time Data Connection between Transit and Transportation Agencies	$20,000 for ATMS module
32	12	Provide Park-and-Ride Availability and Port Drayage Wait Time Information	All CMS within Sacramento County
33	10, 17, 20	SOPs for Incident Management and Response	Staff time
34	19	ICM Corridor Concept of Operations	No cost except for staff time if funded by SACOG
35	21	Dynamic Shoulder Use Along Key Corridors	Depends on availability and condition of existing infrastructure (pavement, CMS, fiber) and extent of dynamic shoulder deployment
36	22	Establish Agency Network Security Policies and Standards	Staff time
37	16, 22	Train Staff on Network Security	Staff time
38	23	Standardize Traffic Signal Equipment	Staff time

APPENDIX D – PROJECT PRIORITIZATION SUMMARY

Table D1: Prioritization Summary

Rank	Project Title	Project Type (Infrastructure/ Data, Operations, Institutional)	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 Project Score Compared to Objectives
			10	13	10	13	10	5	10	10	14	5	100
1	Project 33: SOPs for Incident Management and Response	Operations; Institutional	4	3	4	4	3	4	4	4	4	3	93
2	Project 34: ICM Corridor Concept of Operations	Operations; Institutional	4	2	4	4	4	4	4	4	4	3	92.25
3	Project 27: Upgrade Agency ATMS	Operations	3	3	4	3	4	3	4	4	4	4	89.75
4	Project 3: I-80 Business/US 50 from Enterprise Blvd to Howe Ave	Infrastructure	4	2	4	3	4	4	4	4	4	3	89
5	Project 4: US 50 from Howe Ave to Folsom Blvd	Infrastructure	4	2	4	3	4	4	4	4	4	3	89
6	Project 5: US 50 from Folsom Blvd to Cameron Park Dr	Infrastructure	4	2	4	3	4	4	4	4	4	3	89
7	Project 6: SR 51/I-80 Business to I-80	Infrastructure	4	2	4	3	4	4	4	4	4	3	89
8	Project 7: I-80 Loop through Downtown	Infrastructure	4	2	4	3	4	4	4	4	4	3	89
9	Project 8: I-80 from I-80 Business to Douglas Rd	Infrastructure	4	2	4	3	4	4	4	4	4	2	87.75
10	Project 17: I-5 from I-80 Business to Airport Blvd	Infrastructure	4	2	4	3	4	4	4	4	4	2	87.75
11	Project 24: US 50/Lake Tahoe Blvd from US 50 to Pioneer Trail	Infrastructure	4	2	4	3	4	4	4	4	4	1	86.5
12	Project 30: Communications Sharing to Support Local Agencies	Institutional	4	3	3	3	4	3	4	4	3	4	86.25
13	Project 29: Share CCTV with Individual Agencies	Operations	4	3	3	3	4	4	4	4	3	2	85
14	Project 2: SR 99 from US 50 to Grant Line Rd	Infrastructure	4	2	4	3	4	4	4	4	3	2	84.25
15	Project 19: I-80 from Enterprise Blvd to Hwy 113	Infrastructure	4	2	4	3	4	4	4	4	3	2	84.25
16	Project 1: I-5 from I-80 Business to Elk Grove Blvd	Infrastructure	4	2	4	3	4	3	4	4	3	2	83

Rank	Project Title	Project Type (Infrastructure/ Data, Operations, Institutional)	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 Project Score Compared to Objectives
			10	13	10	13	10	5	10	10	14	5	100
17	Project 10: I-80 from Sierra College Blvd to Hwy 193	Infrastructure	4	2	4	3	4	4	4	4	3	1	83
18	Project 11: I-80 from Hwy 193 to Foresthill Rd	Infrastructure	4	2	4	3	4	4	4	4	3	1	83
19	Project 38: Standardize Traffic Signal Equipment	Infrastructure; Institutional	4	3	3	3	3	3	4	4	3	3	82.5
20	Project 28: Analytics Software for Real-Time Operations Decision Making	Infrastructure	4	2	4	3	4	4	4	4	3	0	81.75
21	Project 12: I-80 from Foresthill Rd to Hwy 174	Infrastructure	3	2	4	3	4	4	4	4	3	1	80.5
22	Project 14: I-80 from Magra Rd to Nyack Rd	Infrastructure	3	2	4	3	4	4	4	4	3	1	80.5
23	Project 18: SR 99 from I-5 to Riego Rd	Infrastructure	4	2	4	3	4	4	4	3	3	1	80.5
24	Project 15: Hwy 65 from I-80 to Sunset blvd	Infrastructure	4	2	4	3	4	4	4	3	2	2	78.25
25	Project 16: Hwy 65 from Sunset Blvd and Farrari Ranch Rd	Infrastructure	4	2	4	3	4	4	4	3	2	1	77
26	Project 31: Real-Time Data Connection between Transit and Transportation Agencies	Infrastructure/Data	4	4	4	1	4	2	1	4	2	2	70.75
27	Project 9: I-80 from Douglas Rd to Sierra College Blvd	Infrastructure	4	2	1	3	2	4	4	4	3	1	70.5
28	Project 13: I-80 from Hwy 174 to Magra Rd	Infrastructure	3	2	1	3	2	4	4	4	3	1	68
29	Project 20: Hwy 113 from I-80 to I-5	Infrastructure	4	2	1	3	2	4	4	3	3	1	68
30	Project 35: Dynamic Shoulder Use Along Key Corridors	Infrastructure; Operations	3	1	4	3	2	4	4	4	2	0	67.5
31	Project 32: Provide Park-and-Ride Availability and Port Drayage Wait Time Information	Infrastructure	3	3	2	2	4	1	2	2	4	1	65.25
32	Project 21: SR 99 from Bogue Rd to Pease Rd	Infrastructure	4	2	1	3	2	4	4	3	2	1	64.5

Rank	Project Title	Project Type (Infrastructure/ Data, Operations, Institutional)	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 Project Score Compared to Objectives
			10	13	10	13	10	5	10	10	14	5	100
33	Project 22: SR 20 from George Washington Blvd to 1st St	Infrastructure	4	2	1	3	2	4	4	3	2	1	64.5
34	Project 23: Hwy 49 from McKnight Way to Gold Flat Rd	Infrastructure	4	2	1	3	2	4	4	3	2	1	64.5
35	Project 25: Back Up TMC Function Capabilities	Infrastructure	2	2	4	3	2	4	3	2	2	0	60.75
36	Project 36: Establish Agency Network Security Policies and Standards	Institutional	2	3	0	4	0	4	4	0	3	2	55.75
37	Project 37: Train Staff on Network Security	Institutional	2	3	0	4	0	4	4	0	3	0	53.25
38	Project 26: SOPs for Equipment Status and Maintenance Activities	Institutional	1	3	0	2	2	2	4	2	2	3	52