SMART COUNTY MASTER PLAN

SAN BERNARDINO
SMART COUNTY
...another quality of life enhancement from SBCOG

December 2024

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Abbreviations and Acronyms

Abbreviation or Acronym	Definition
AAM	Advanced Air Mobility
AFV	Alternative Fuel Vehicle
AI	Artificial Intelligence
ALPR	Automated License Plate Readers
ATMS	Advanced Traffic Management System
AQ	Air Quality
BMMN	Broadband Middle-Mile Network
CAD	Computer-Aided Dispatch
Caltrans	California Department of Transportation
CEC	California Energy Commission
CPUC	California Public Utilities Commission
CV	Connected Vehicle
DSRC	Dedicated Short-Range Communication
EVP	Emergency Vehicle Preemption
FAA	Federal Aviation Administration
FHWA	Federal Highway Administration
FSP	Freight Signal Priority
GHG	Greenhouse Gases
HMIS	Homeless Management Information System
IOO	Infrastructure Owner Operators
ITS	Intelligent Transportation Systems
JIS	Joint Information System
JPS	Joint Powers Authorities
LiDAR	Light Detection and Ranging
Mbps	Megabits per second
NEVI	National Electric Vehicle Infrastructure
O&M	Operations and Maintenance
PM	Particulate Matter
RIITS	Regional Integration of Intelligent Transportation Systems
RSU	Roadside Unit
SBCOG	San Bernardino County of Governments
SBCTA	San Bernardino County Transportation Authority
SBVCTSS	San Bernardino Valley Coordinated Traffic Signal System
SCAG	Southern California Association of Governments
SPaT	Signal Phase and Timing
THEA	Tampa Hillsborough Expressway Authority
TMC	Transportation Management Center
TSP	Transit Signal Priority
TTAC	Transportation Technical Advisory Council
UAM	Urban Air Mobility
UAS	Uncrewed Aerial Systems
ViDS	Video Incident Detection Systems
VOC	Virtual Operations Center
VRU	Vulnerable Road User
WIM	Weigh In Motion
ZEV	Zero-Emission Vehicle

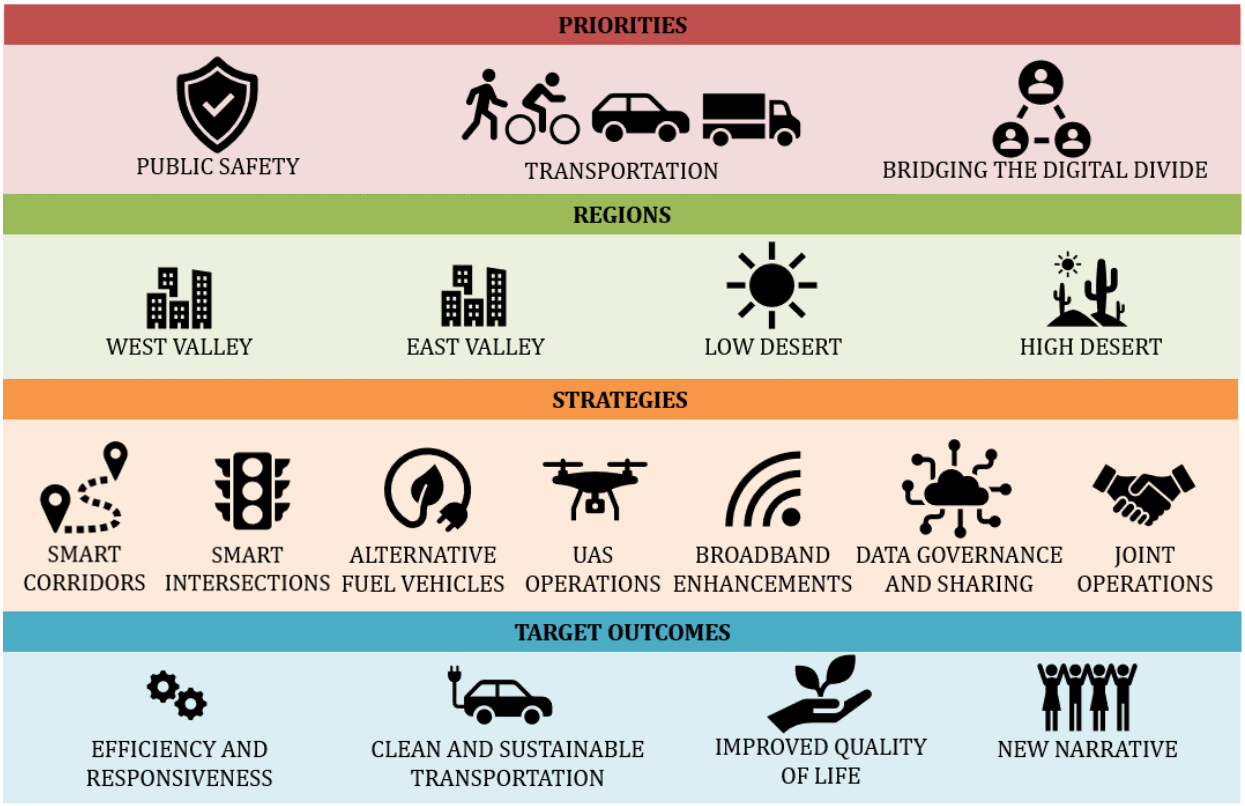
1 Executive Summary

The San Bernardino Council of Governments (SBCOG) initiated this Smart County Master Plan (Smart County MP) to align technology investments and actions in San Bernardino County with the region's overall objectives. To accomplish this, the Smart County MP recommends seven strategies to set the stage for a safer, more efficient, and better connected San Bernardino County. **Figure 1-1** summarizes these strategies**.**

1.1 Smart County Master Plan Summary

This Smart County MP (**Figure 1-1)** prioritizes public safety, transportation, and bridging the digital divide—based on guidance from local government member agencies looking to deliver public services more efficiently and effectively and to support the increased population and commercial activity expected in the future. Seven strategies, all grounded in previously proven and field deployed technologies, are recommended in varying configurations in each of the four regions.

Figure 1-1: San Bernardino Smart County Master Plan Summary



A set of toolkits was developed that align with the proposed strategies. The toolkits support local agencies in developing or furthering their programs in those areas. Four of the strategies – Alternative Fuel Vehicles (AFVs), Uncrewed Aerial Systems (UAS) operations, which refer to aircraft operated without a human pilot onboard and can be operated remotely or autonomously, data governance and sharing, and joint operations – are overarching strategies. For these strategies, the associated toolkit can be used to advance specific projects.

For the other three strategies – smart corridors, smart intersections, and broadband enhancements – potential deployment locations were initially identified based on several factors. The locations identified in **Figure 1-2** and **Figure 1-3** address needs in each of the four regions throughout the county: West Valley, East Valley, Low Desert, and High Desert. For smart corridors, there was an additional level of outreach to local jurisdictions and Omnitrans

that included the potential for investing in “priority transit corridors” in the East and West Valley subregions. A priority transit corridor could include selective application of strategies ranging from Transit Signal Priority (TSP) or “queue jumps” at intersections to full Bus Rapid Transit (BRT). It is expected that a Request For Information (RFI) will be disseminated to Valley cities in Fiscal Year 2024-2025 to assist the SBCTA Board in determining which corridors represent the best multimodal investments on which to spend Valley Measure I funding that has been identified for that purpose. See **Section 5.1** for additional information.

Figure 1-2: Smart County Master Plan Strategies

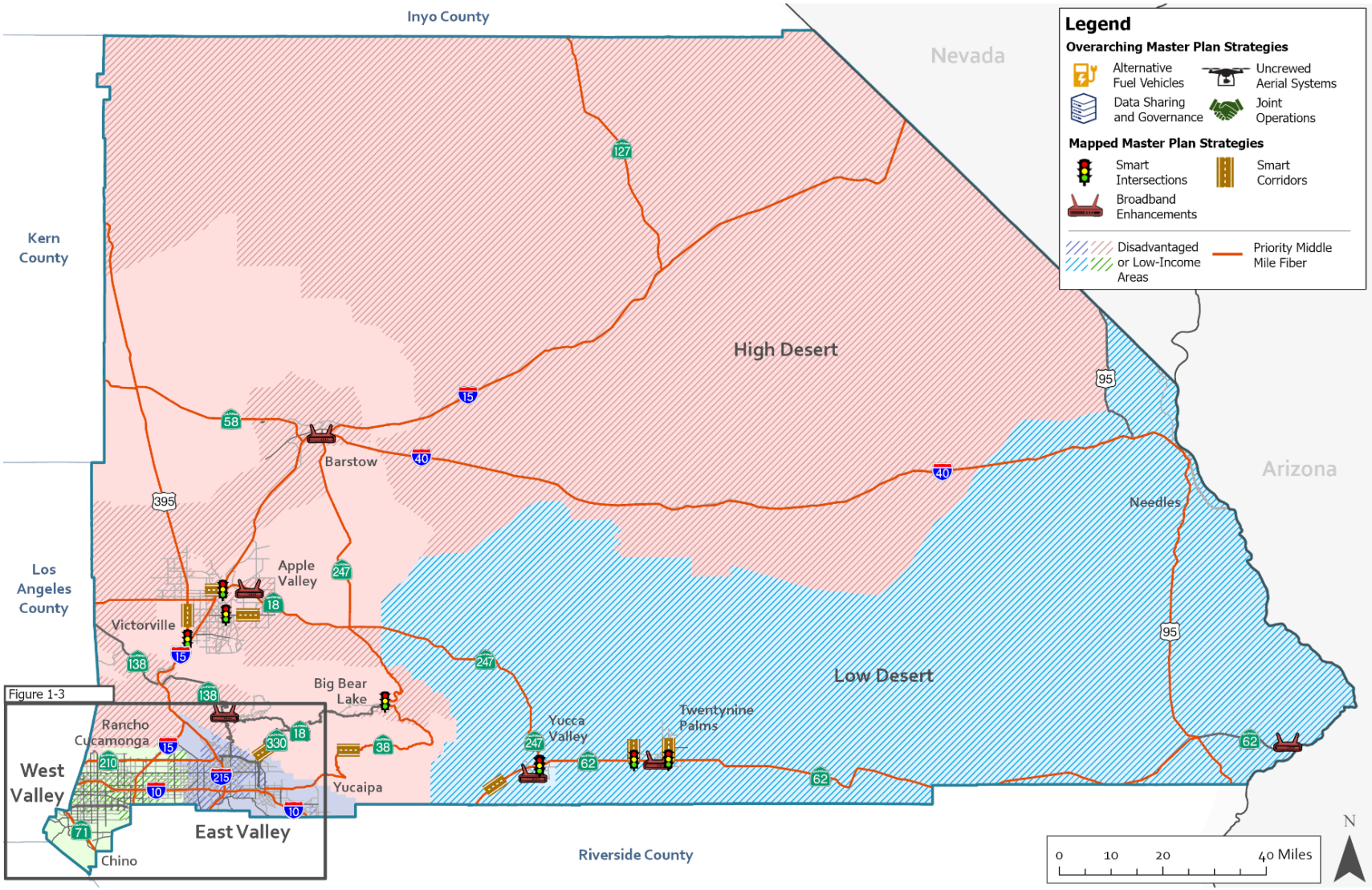
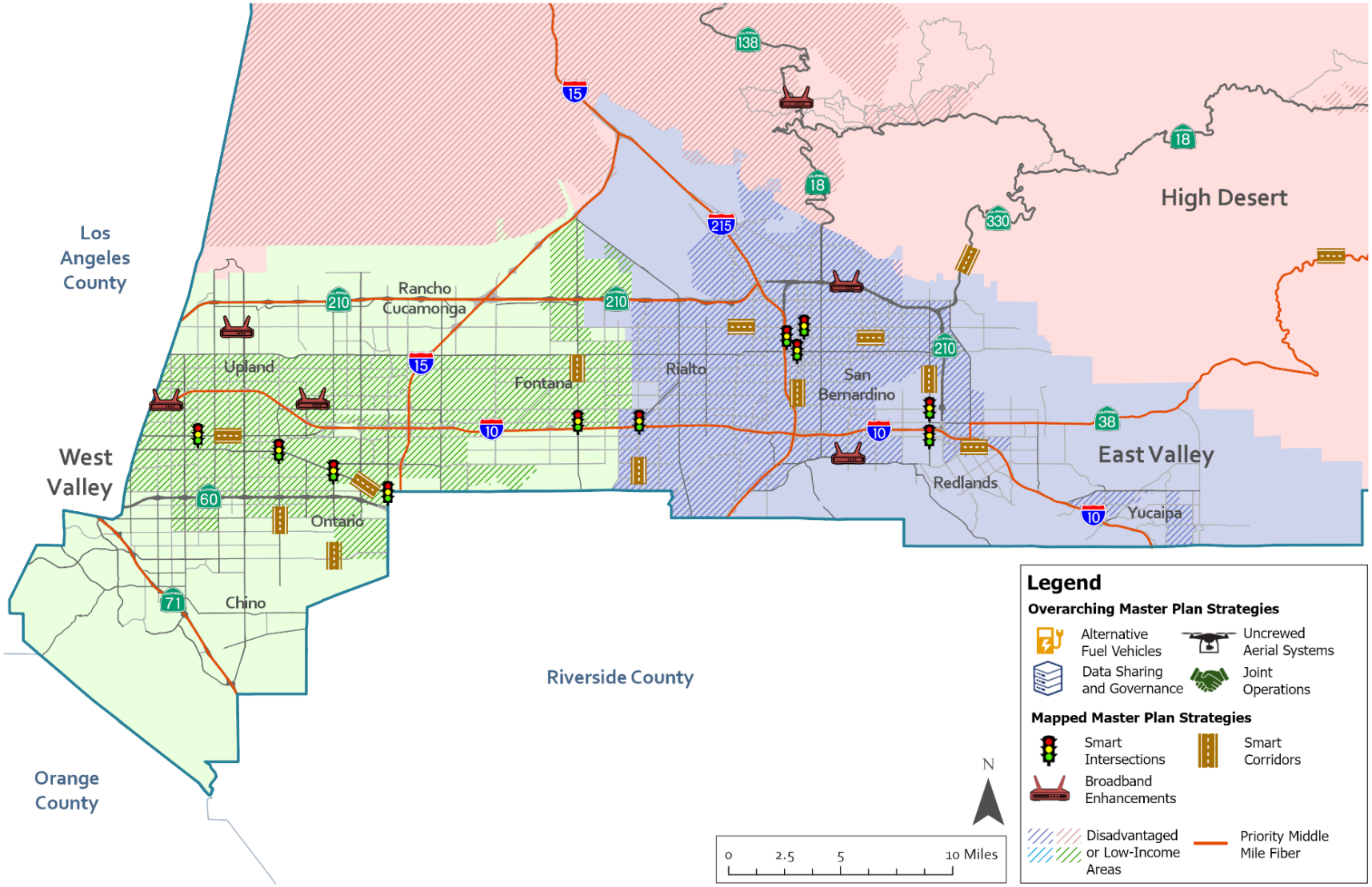


Figure 1-3: Smart County Master Plan Strategies in West Valley and East Valley



1.2 Value to San Bernardino County Region

This plan has benefitted from input from numerous stakeholders across the county and in turn, upon implementation, will benefit these and other stakeholders for years to come. **Table 1-1** summarizes the anticipated benefits by stakeholder group.

Table 1-1: Benefits to Smart County Master Plan Stakeholder Groups

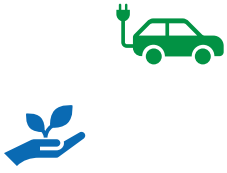
County and SBCTA Member Agencies By leveraging the data governance and data sharing toolkit elements, government agencies within the county can enhance their operational and regional efficiency. Increased data sharing allows agencies to streamline processes, improve decision-making, and ultimately deliver better services to the residents and visitors of San Bernardino County.	**Public-Safety Services Providers** Public-safety services providers will benefit from faster response times through greater information and data sharing enabled by the joint operations strategy. The use of UAS, commonly known as drones, for disaster assessment and rescue operations will enhance public and frontline worker safety. Additionally, they will improve response effectiveness and speed due to better intelligence.
Transportation Service Providers Smart intersection and smart corridor strategies will enhance traffic flow and safety. Transportation service providers will have access to performance data from deployed technologies such as video and light detection and ranging (LiDAR) sensors, broadband communications, and data analytics. Over time, insights derived from this information can inform evaluation of other types of sensors, emerging technologies, or other corridors that would benefit from these types of improvements.	**The General Public** The implementation of electric-vehicle charging stations and smart intersections and corridors will provide the immediate benefits of improved traffic flow and increased convenience. Over time, these strategies will also support better air quality through consistent, large-scale deployments. Additionally, providing broadband connectivity to disadvantaged areas will reduce the digital divide and offer opportunities for underserved populations.

1.3 Next Steps

Each of the seven strategies is mapped to the primary next step, its targeted outcomes, and suggested performance metrics (see **Table 1-2**). Each of the strategies addresses at least two, and often four, of the following goals and target outcomes identified during the early planning process:

- Efficiency and Responsiveness
- Clean and Sustainable Transportation
- Improved Quality of Life
- Support of a New Narrative Focused on Innovation and Opportunity

Table 1-2: Strategies, Next Steps, Target Outcomes, and Performance Metrics

Strategy	Next Steps	Outcomes	Performance Metrics
Smart Corridors	Issue a Request For Information to determine local level of interest. Board to make final determination of corridors where investment is appropriate. Proceed to implement and integrate smart technology within key corridors		▪ Decrease in average commute time on optimized routes ▪ Improvement in roadway and transit level of service post optimization ▪ Reduction in overall corridor congestion ▪ Increase in corridor safety metrics (e.g., fewer accidents, reduced severity of accidents)
Smart Intersections	Implement and integrate smart intersection technology at key intersections based on level of interest by individual jurisdictions and Board concurrence		▪ Hard-braking events, speeding, V2X* interactions ▪ Arrivals on green/red ▪ Clearance interval activity ▪ Pedestrian activity ▪ Turning movement counts ▪ Phase termination detail and summary
Alternative Fuel Vehicles	Identify jurisdictions, assess needs and solutions, develop a funding plan, secure vendor partnerships and funding, and deploy solutions		▪ Number of new alternative fueling/charging stations installed (cars and trucks) ▪ Amount of funding secured to install charging and hydrogen fueling infrastructure ▪ Quantity of greenhouse gas emissions reduced as a result of new fueling/electric-vehicle charging stations installed
Uncrewed Aerial Systems Operations	Conduct inventory of local services and policies, identify shared use opportunities, and determine priority use cases		▪ Reduction in average response time to emergency situations ▪ Number of successful infrastructure inspections conducted using UAS with zero safety violations ▪ Reduction in time required to complete infrastructure inspections
Broadband Enhancement	Leverage Broadband Middle-Mile Network (BMMN) project, assess infrastructure, implement network expansion, and share best practices		▪ Increase in broadband coverage area ▪ Improvement in broadband speed and reliability ▪ Increase in number of households or businesses accessing broadband services ▪ Enhancement in overall digital connectivity and accessibility
Data Governance and Sharing	Establish data governance framework and policies, collaborate through working groups, identify data sharing opportunities, and determine approach. Continue implementation of CAD-to-CAD		▪ Data governance plans completed across agencies ▪ Data sharing agreements executed ▪ Number of successful data integration initiatives across departments or agencies
Joint Operations	Establish working group to identify and prioritize opportunities, develop interagency agreements, and create detailed plans for implementation		▪ Reduction in expenses achieved ▪ Assess enhancements in service delivery quality ▪ Track the number of personnel trained and the effectiveness of joint training programs ▪ Assess improvements in procurement processes ▪ Number of successful Community Outreach and Support Team (COAST) interventions

* V2X (vehicle-to-everything) is wireless communication between a vehicle and any entity that affects, or may be affected by, the vehicle.

Table 1-3 outlines key strategies identified for immediate action within the next 18 months. These strategies represent achievable steps that can be taken in the near term to build momentum and demonstrate progress towards the county's broader vision for a smart future. Each strategy is paired with specific, actionable next steps to ensure alignment with current capabilities and available resources, while laying the groundwork for more complex initiatives in the future.

Table 1-3: Immediate Next Steps

Strategy	Immediate Next Steps
Smart Corridors	▪ Issue a Request for Information to identify candidate corridors and determine priority corridor recommendations.
Smart Intersections	▪ Identify local champions and develop ITS specifications to prepare for sensor implementation at key intersections.
Broadband Enhancement	▪ Assess existing infrastructure, establish local partnerships, and seek ways to leverage the BMMN project.
Data Governance and Sharing	▪ Create a working group to establish a data governance framework. Continue work on the CAD-to-CAD data sharing system.

Table 1-4 provides a generalized overview of the projected timelines and key milestones for the proposed strategies. While the schedule outlines anticipated phases—Policy & Planning, Design & Procurement, Construction & Implementation, and Operations, Maintenance, & Performance Metrics—across all strategies from 2025 to 2029, it is important to note that each project will have a unique implementation schedule. The actual timelines will depend on factors such as funding availability, the readiness of the local jurisdictions involved, and coordination with Caltrans and other relevant agencies. The staggered timelines reflect the prioritization and sequential commencement of these initiatives, ensuring a structured and strategic approach to project development and execution.

Table 1-4: Master Plan Schedule

Policy & Planning

Design & Procurement

Construction & Implementation

Operations, Maintenance, & Performance Metrics

	2025				2026				2027	2028	2029
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4			
Smart Intersections/Corridors: Project 1											
Smart Intersections/Corridors: Project 2											
Smart Intersections/Corridors: Project 3*											
Alternative Fuel Vehicles											
UAS Operations											
Broadband Enhancement: Project 1											
Broadband Enhancement: Project 2											
Broadband Enhancement: Project 3*											
Data Governance and Sharing											
Joint Operations											
Working Group Meetings											

* Note: The timeline is representative, illustrating staggered schedules. Priority projects will commence first, followed by other projects.

1.4 Costs

Table 1-5 includes the general cost data for each strategy. Estimated costs associated with the implementation of each proposed strategy are categorized into preliminary activities, construction, annual operations and maintenance, and other costs such as equipment and software development. Joint operations, which involve coordinated efforts between multiple departments or agencies to improve efficiency and reduce costs, is not shown in the cost table since this strategy will largely depend on the specific areas of focus.

Table 1-5: Cost Estimates

Strategy	Preliminary Activities	Construction/Equipment/ Software Development	Estimated Cost to Implement	O&M (per year)
Smart Corridor Costs	$78,000 per mile	Construction: $880,000 per mile Software Development: $2,000,000	$2,000,000 program costs + $958,000 per mile up-front costs	$50,000 per mile
Smart Intersections	$16,000 - $32,000	Construction: $65,000 Equipment: $5,000 - $100,000	$86,000 - $197,000	$13,000
Alternative Fuel Vehicles	$10,000	$180,000	$190,000	$5,000
Uncrewed Aerial Systems Operations	$5,000 - >$100,000 per drone/operator	Operational cost of $20 per hour per drone	Around $200,000 for 10 drones	Minimal
Broadband Enhancement	$10,000 - $30,000	$60,000 - $100,000	$70,000 - $130,000	$50,000 per mile
Data Governance and Sharing*	$80,000 - $100,000	$250,000	$350,000 for first year	$250,000

* Data Governance and Sharing costs are for the creation of a data portal.

To support implementation of these strategies, several grants were identified to advance the Smart county MP strategies. The Early Action Plan, part of the Smart County MP effort, involved a six-month analysis and stakeholder outreach. Its goal was to identify the focus areas for further study and pinpoint early projects for quick wins. The “120 Days to Win” process recommended in the Early Action Plan can also be followed to help set up the region for success on future grants.

2 Introduction

At over 20,000 square miles, San Bernardino County in California (CA) is the largest county in the contiguous United States (U.S.). It stretches from east of Los Angeles, CA to the Nevada (NV) state border just southwest of Las Vegas, NV. Its region ranges from urban, in the southwestern portion of the county, to extremely remote areas such as the 1.6 million acres Mojave National Preserve in the northeast.

Most of the 2.2 million in population is concentrated in its East Valley and West Valley, which is served by the Ontario International Airport (ONT) – among the fastest growing airports in the U.S. for the past several years. Just a few miles from the airport, Brightline is working to initiate high-speed passenger rail service from Rancho Cucamonga, CA to Las Vegas, NV.

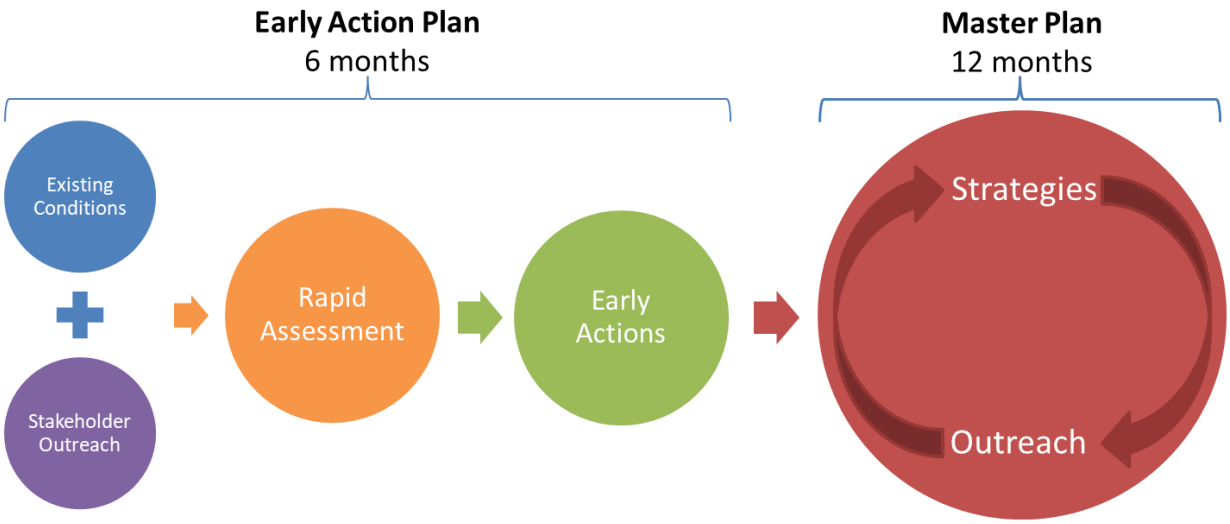
This Smart County Master Plan (Smart County MP) supports the priorities of both SBCOG and San Bernardino County Transportation Authority (SBCTA), under direction of the SBCTA/SBCOG Board. The board comprises representatives from each of the 24 incorporated cities and towns in San Bernardino County, and the five supervisorial districts of San Bernardino County. SBCOG guided this effort, with input from county and city technology representatives.

The project was delivered in two phases, as explained below and in **Figure 2-1**:

- The Early Action Plan phase started with stakeholder outreach and an Existing Conditions Report that identified baseline conditions. A rapid assessment was then conducted which led to recommendations presented in the **Early Action Plan**.
- The Smart County **Master Plan** builds on the Early Action Plan solutions and offers additional strategies that, if supported by member agencies, can improve service, enhancing the quality of life for both residents and visitors to the county.

The Smart County MP recommends a range of strategies to address the initial priorities and enhance the efficiency of government service delivery. These strategies were developed, tested, and reshaped through a more recent series of meetings discussed in **Chapter 4: Outreach Outcomes.** The Smart County MP also provides a toolkit for member agencies with a mix of templates, steps needed to initiate and progress strategies, and resources available online to support delivering the strategies.

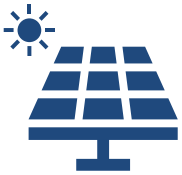
Figure 2-1: Smart County Planning Process



3 Current Market

The market landscape is rapidly evolving, influenced by a variety of factors that are shaping the future. A few of the most significant factors are noted in **Table 3-1**.

Table 3-1: Market Conditions/Drivers

			
The technology landscape is maturing, and the use of advanced analytics is accelerating.	Domestic production is on the rise, contributing to economic growth.	Natural disasters are occurring more frequently, creating public safety challenges, and impacting transportation systems.	The level of grant funding available continues to be unprecedented, providing diverse opportunities.

Maturing Technology and Accelerating Advanced Analytics: As technology continues to mature and the use of advanced analytics accelerates, agencies are increasingly adopting data-driven decision-making approaches. This shift allows for deeper insights, enhanced efficiency, and drives innovation across various sectors. Advanced analytics contribute to the thoughtful deployment of resources, prompt diagnostics of performance problems, and enable timely interventions, thereby maximizing cost-effectiveness.

Similarly, the integration of Machine Learning and Artificial Intelligence (AI) is transforming public safety and transportation systems and infrastructure. The move towards autonomous vehicles and Advanced Air Mobility (AAM) systems highlights the pivotal role of AI in advancing modern transportation infrastructures to be safer, more efficient, and responsive to evolving demands.[1] For example, AI can process sensory information to support real-time decision-making for urban air transport, route planning, and automation of complex processes like take-offs and landings.

Domestic Production: There is a clear recent trend towards increasing domestic production in the U.S. This growth is evident across various sectors. Policy changes are being implemented to make U.S. manufacturing more globally competitive, which is expected to further boost domestic production. The U.S. is investing in new industrial strategies, such as transitioning the auto industry from internal combustion engines to electric and expanding domestic semiconductor design, production, and packaging. These changes are being driven by major legislation[2] such as:

- **The Infrastructure Investment and Jobs Act** $1.2 trillion authorized for transportation and infrastructure spending.
- **The CHIPS and Science Act (CHIPS Act)** $50 billion to strengthen semiconductor research, development, and manufacturing.

[1] https://journals.sagepub.com/doi/abs/10.1177/03611981221095090
[2] https://www.americanprogress.org/article/investing-to-be-competitive-the-new-u-s-industrial-strategy/

Natural Disasters: Natural disasters are occurring more frequently, impacting transportation systems, and creating public safety challenges.[3] Climate change is intensifying issues such as rising temperatures, wildfires, droughts, flooding, and severe weather, which in turn place significant pressure on the nation's emergency services and transportation infrastructure. Recent incidents include the floods in Michigan, the wildfires in California, the deadly snow and ice storm in Texas, and the buckling of I-5 in the Pacific Northwest.[4] These events jeopardize public safety and disrupt transportation networks. In response, agencies are looking to reduce greenhouse gas emissions, enhance infrastructure resiliency, and improve disaster response capabilities to mitigate the impact of natural disasters and ensure continuity of essential services.

Funding: Between the Infrastructure Investment and Jobs Act, providing $1.2 trillion in transportation and infrastructure investment, and the Inflation Reduction Act signed into law in 2022, providing over $5 billion for transportation-related programs, the level of transportation funding at the federal level has been unprecedented. Additionally, through various legislative efforts at the state level, California has created a range of programs for planning and building transportation, safety, and digital infrastructure. These grant programs include the Regional Resilience Planning and Implementation Grant Program that annually awards roughly $20 million to fund climate resilience efforts, and the California Public Utilities Commission (CPUC) Broadband Loan Loss Reserve Fund that annually awards $175 million to assist local entities and nonprofits to secure private broadband financing. As discussed later in **Section 6.4** (Funding), this funding can support implementation of innovative projects, such as the strategies proposed in this Smart County MP, that advance key initiatives benefitting San Bernardino County communities.

[3] https://ppms.trec.pdx.edu/media/project_files/TRB_TRBAM-22-00866_Paper.pdf
[4] Climate Action | US Department of Transportation

4 Outreach Outcomes

As part of the Smart County MP outreach efforts, diverse stakeholders, including city officials and IT professionals, were engaged through surveys, interviews, and meetings. Their feedback was used to establish the Smart County MP priorities and refine the strategies.

4.1 Identification of Priorities

A Success Management Workshop with the Emerging Technology Ad Hoc Committee, including county and city leaders, was held on June 14, 2023. Based on this and other stakeholder discussions and surveys that were part of the Early Action Plan, priorities were pared down to three categories:

- **Public Safety –** Public safety was the top priority for stakeholders. Despite a decrease in overall crime between 2017 and 2021, violent crimes slightly increased, and safety measures need enhancement.[5] Priorities include enhancing law enforcement technology for crime prevention and suspect identification, improving emergency response with Computer-Aided Dispatch (CAD)-to-CAD systems, addressing the increase in homelessness, and promoting interagency information sharing.
- **Transportation –** San Bernardino County residents face longer commute times compared to nearby regions. A shift away from solo commuting was also noticed in 2021 as the region came out of COVID. Solo commuting dropped from 79.9% to 73.2%.[6]

  Despite a decrease in vehicle collisions in 2020, rates have returned to pre-pandemic levels.

  Stakeholders aim to transform transportation by addressing congestion and safety needs through technology, with strategies such as smart intersections and corridors, zero-emission vehicles, and regional data sharing.
- **Bridging the Digital Divide –** The goal of bridging the digital divide is to extend digital connectivity to all residents of San Bernardino County, ensuring equal access and opportunities. Recent CPUC and Federal Communications Commission rulemaking has designated 100 megabits per second (Mbps) download and 20 Mbps upload as the minimum speed as a standard for internet connectivity, up from the previous standard of 25 Mbps download and 3 Mbps upload. This change reflects surges in residential high-bandwidth internet use, such as videoconferencing. Within San Bernardino County, numerous census tracts do not have complete broadband adoption at 25 Mbps download and 3 Mbps upload, thus lagging even farther behind the new state and federal standard.[7]

  Addressing broadband to bridge the digital divide also allows for the enhancement of public safety communications. Police, fire, and other emergency services workers rely on being able to communicate and retrieve information to do their jobs effectively. In areas without access to strong, available digital connectivity, these workers are forced to purchase and transport expensive equipment. This effort will bridge the digital divide for residents and public safety.

4.2 Strategy and Toolkit Refinement

Outreach during the master planning portion of the Smart County effort focused on testing strategies, understanding any strategy gaps, and homing in on the most useful strategies. **Table 4-1** summarizes some of the key outreach meetings and the feedback or outcomes that helped shape what strategies were ultimately recommended.

[5] https://indicators.sbcounty.gov/safety/crime-rate/

[6] DP03: SELECTED ... - Census Bureau Table

[7] https://www.broadbandmap.ca.gov/

Table 4-1: Smart County Master Plan Outreach

Attendees	Date	Feedback/Outcome
City Managers and IT Directors	02/ 01/24	▪ UAS was flagged as a topic that should be added to the Smart County MP. ▪ The importance of training and opportunity for joint training was raised.
Regional Integration of Intelligent Transportation Systems (RIITS) and Southern California Association of Governments (SCAG)	02/20/24 (RIITS) 04/03/24 (SCAG)	▪ It is possible to integrate certain types of regional planning data with the existing RIITS and SCAG platforms.
City of Ontario	03/18/24	▪ Lessons learned from UAS efforts, Broadband deployment at the city level, and the need for toolkits for each was discussed.
City of Victorville	05/29/24	▪ Agreed that data sharing could be beneficial among the County agencies. ▪ Discussed the benefits of joint purchasing agreements between local agencies.
Transportation Technical Advisory Council (TTAC)	06/03/24	▪ Reviewed seven proposed strategies with the TTAC.
San Bernardino County	09/26/24	▪ Discussed County's current data platform project and how SBCTA member agencies may be able to share and use data in the future.
San Bernardino County GIS	07/08/24	▪ Discussed County's current data sharing program with Google/Waze and opportunities to advance it. ▪ Identified need for regional data standards to enable more effective data sharing among the region's agencies.
San Bernardino County Fire and CONFIRE	06/18/24	▪ Shared the many initiatives that the local Fire community is undertaking. ▪ Agreed that a forward-looking strategy will be beneficial – including data sharing.

5 Proposed Strategies

Utilizing an understanding gained through development of the Existing Conditions Report, rapid assessment, and development of early action items, several strategies were developed to support San Bernardino County's future. These strategies were added to and refined through outreach with local agencies and industry. Based on this input, user needs established during the existing conditions work, and the state of practice, seven recommended stategies were agreed upon and are listed in **Table 5-1** and mapped to the three priorities established in the Early Action Plan.

Table 5-1: Proposed Strategies

	Public Safety	Transportation	Bridging the Digital Divide
Smart Corridors: Instrument corridors with technology and infrastructure to improve traffic efficiency and safety. This includes enhanced connectivity, a building block for sustainable broadband enhancement (discussed later).	Secondary	Primary	
Smart Intersections: Implement intelligent traffic signal systems and other technologies at intersections to optimize traffic flow and improve safety for vehicles and vulnerable road users.	Secondary	Primary	
Alternative Fuel Vehicles: Promote the use of AFVs and pursue high-priority grant opportunities to expand access to charging infrastructure equitably.	Secondary	Primary	
Uncrewed Aerial Systems Operations: Invest in UAS technology for operations that address infrastructure inspection, emergency response, and other public safety applications.	Primary	Secondary	
Broadband Enhancements: Improve broadband infrastructure to provide access to underserved communities.		Secondary	Primary
Data Sharing: Establish a working group to discuss protocols and, where necessary, standards for sharing data among government agencies and the public setting the stage for future virtual operations center, traveler information system, and other efforts.	Primary	Secondary	
Joint Operations: Involve collaborative efforts between two or more government agencies to deliver services more efficiently and cost-effectively. By pooling resources and coordinating actions, agencies can enhance service delivery, reduce redundancies, and achieve common goals.	Primary		

The remainder of this chapter provides detail on each of the seven proposed strategies. Each section starts with an overview of the strategy and then covers the following areas:

- **Benchmarking**: Summarizes various other locations, within the U.S., where similar strategies have been deployed and the impact, lessons learned, or benefits realized from the deployment.
- **Potential Strategy Elements**: Introduces technologies or phases that will serve as the building blocks of the strategy.
- **User Needs**: Reviews the stakeholder needs gathered during the Existing Conditions Report and through stakeholder discussions and workshops that apply to the strategy being proposed.
- **Prioritized Strategy Deployments**: Explains how elements of the strategy were prioritized and what the resulting priorities were.
- **Relevant Stakeholders**: Notes the expected stakeholders needed to successfully implement the strategy.
- **Benefits**: Describes the benefits expected to result from employing the strategy.
- **Costs**: Provides estimated cost ranges for various elements of the strategy.

5.1 Smart Corridors

Smart corridors enable favorable traffic flow and safety by using real-time communications to connect intersections across a corridor. Typically, the through movement along a corridor is optimized, but may vary throughout the day. For example, in industrial areas with a higher density of semi-trucks, prioritizing freight movements can improve level of service along the corridor. Additionally, when priority or preemption is used (Freight Signal Priority (FSP), Transit Signal Priority (TSP), Emergency Vehicle Preemption (EVP)), smart corridors utilize recovery strategies that enable a more rapid return to signal coordination when compared to legacy technology. This ability to recover corridor throughput can improve efficiency and safety where railroad preemption is used today or planned for rail freight or passenger routes with nearby at-grade crossings. In addition to strategies such as preemption/priority, smart corridors use Intelligent Transportation Systems (ITS) to improve the mobility of key arterials, often those which feed into the freeway network, or parallel the freeway network as an alternate route in the case of incidents or recurring congestion.

5.1.1 Benchmarking

This section covers the key developments and current applications in smart corridor technology, outlining their contributions to more efficient transportation.

I-75 Florida's Regional Advanced Mobility Elements Gainesville: This project deployed emerging technologies to better manage, operate, and maintain the multimodal transportation system and create an Integrated Corridor Management solution for I-75 and state highway systems in the cities of Gainesville and Ocala. The emerging technologies proposed in this project were Automated Traffic Signal Performance Measures and CV technologies such as Roadside Units (RSU) and On-Board Units for effective traffic operations, TSP and FSP. The goal of the project was to disseminate real-time information to motorists during freeway incidents. The project was implemented using Dedicated Short-Range Communication (DSRC).[8]

Georgia Connected Vehicles: The Georgia Department of Transportation has significantly advanced CV technology in metro Atlanta, notably enhancing traffic signal efficiency and response times for emergency and transit vehicles. The agency upgraded 2,200 traffic signals and 185 ramp meter locations. This setup ensured connectivity across every major intersection in metro Atlanta. Key features of this CV initiative include emergency vehicle preemption

[8] https://www.fdot.gov/traffic/teo-divisions.shtm/cav-ml-stamp/cv/maplocations/i75-frame.shtm

at select signals to improve response times, TSP for smoother operations on specific routes, and FSP to support efficient platooning. These enhancements streamlined vehicle flow and improved safety.[9]

I-80 Smart Corridor, San Francisco Bay Area: The I-80 Smart Corridor improves safety and mobility along one of California's busiest highways. It spans from the Carquinez Bridge to the Bay Bridge, utilizing ITS technologies like adaptive ramp metering, high-occupancy vehicle (HOV) bypass lanes, and dynamic lane management to optimize traffic during incidents. The system improves traffic flow and incident response through the usage of dynamic message signs and real-time travel advisories which provide drivers with up-to-the-minute updates. These technologies have led to smoother traffic operations and reductions in travel delays.[10]

5.1.2 Potential Strategy Elements

Smart corridor functions link smart intersection devices by utilizing high-speed communications infrastructure. These functions include the following:

- **Dynamic Signal Control:** Dynamic signal control enables Transportation Management Center (TMC) operators to respond to incidents or changing traffic conditions nimbly, by using advanced detection systems at and between intersections. Improved vehicle and VRU detection allow traffic managers to better understand and respond to incidents by altering traffic signal timing and/or instituting other pre-planned response plans. This application goes beyond earlier implementation of adaptive signal timing and requires extensive communications and traffic management equipment, typically with a TMC or virtual TMC based central system to adjust signal timing, with various levels of autonomy. An AI-based Decision Support System enhances this dynamic control by leveraging advanced algorithms to process real-time data, enabling more intelligent and rapid decision-making compared to traditional methods. This integration of AI facilitates better predictions and adjustments to traffic conditions, improving overall traffic flow and incident response efficiency.
- **Traffic Signal Coordination:** Traffic signal coordination associates traffic signals so that delays are minimized at each intersection along a given arterial roadway corridor. Proper signal coordination enables each intersection to be phased in a way that benefits the movements along the corridor. Signal coordination enables platooning of vehicles, which is proven to reduce delay.[11] San Bernardino County is no stranger to coordination. In 1999, SANBAG (predecessor to SBCTA and SBCOG), identified the need to perform signal timing coordination in the San Bernardino Valley (East and West). This occurred in four tiers, starting with development of an overarching strategic plan in 1999, and construction in 2006, and lasting through 2014, with over 1,200 intersections coordinated.[12]
- **Signal Pre-empt / Priority**: Connected intersections, including those leveraging CV technology, allow for enhanced operations and safety for emergency responders, transit, and freight management by using detection technologies and/or V2X communications to identify and communicate information between traffic signals and appropriately equipped vehicles. These technologies can also be utilized at locations of railroad preemption to assist in transitioning back to normal operations after a preemption event. Although these devices are installed at intersections and would offer direct benefits to the intersection, they are most effective when connected along a corridor to provide the most impact.
- **Transit Signal Priority (TSP):** TSP enables transit to have an advantage when crossing an intersection to reduce transit trip times and improve transit reliability. Legacy decentralized methods typically involved direct line of sight communication between the approaching transit vehicle and intersection equipment, while newer "cloud-based" implementations allow relay of TSP check-in and check-outs via a virtual phase selector which is connected to both the transit vehicle and traffic signal networks. This requires cross-jurisdictional corridors to

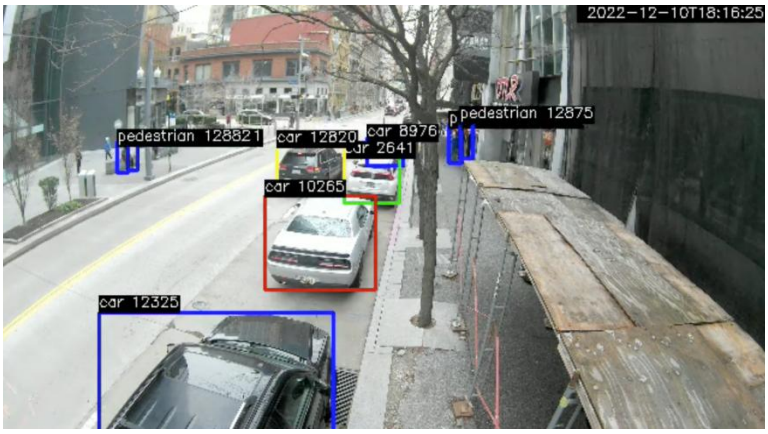
[9] https://transportationops.org/sites/transops/files/GDOT%20V2I%20Update%20-%20July%202019.pdf
[10] https://www.theiotintegrator.com/transportation/california-s-first-smart-highway-project-comes-to-life
[11] https://www.sciencedirect.com/science/article/abs/pii/S0191261505000792
[12] https://www.gosbcta.com/plan/sb-valley-coordinated-traffic-signal-system-plan/

understand each other's system requirements and to work closely with the transit agency to ensure that the TSP calls work without issue.

- **Emergency Vehicle Preemption:** Like TSP, emergency vehicle preemption allows the intersection phasing to favor the phase through which an emergency vehicle will be traveling. However, emergency vehicle preemption typically will have a higher-level priority than TSP. Pre-established operating rules allow efficient restoration of traffic signal coordination. On a smart corridor, peer-to-peer communication can reestablish coordination much faster, minimizing delay to overall traffic flow. Improved EVP enables faster emergency response times and decreased congestion.
- **Freight Signal Priority (FSP):** FSP is a strategy at the intersection level that can have corridor-wide impact. FSP is like EVP and TSP, where a call can be made from the commercial vehicle to the intersection to enable improved movement through the intersection, typically in the form of protected turn phases into warehouse areas for freight vehicles. Corridors that are equipped with FSP can have higher throughput due to the reduction of stopped trucks or trucks blocking traffic through incomplete turn movements, which hinders overall flow. FSP is typically a soft priority, like TSP. FSP can be programmed for certain times at specific intersections, where communication between the vehicle and the intersection can be direct or cloud based.
- **Rail Preemption**: Integrating rail preemption into at-grade rail-roadway crossings provides advanced notification for active crossings and integrates with Advanced Traffic Management System (ATMS) platforms to mitigate traffic disruptions. Such integration may allow vehicles to reroute to avoid active crossings and, by extension, possible conflicts. After the train has passed the grade crossing, nearby intersections can be timed to more effectively clear traffic queues.
- **Freight Applications:** There are many other technology solutions that can be implemented along corridors to improve reliability and safety for freight movements. Weigh In Motion (WIM), thermal brake inspection, and tire pressure anomaly identification are strategies that aid freight carriers in identifying issues early to reduce incidents. This in turn reduces local agency operating expenses associated with responding to emergency situations.
- **Weigh in Motion (WIM)**: WIM is particularly beneficial in regions with mountainous terrain. It allows for the real-time detection of issues such as overheating or defective brakes in moving vehicles. When installed at strategic locations, it allows for routine weight checks for compliance. Examples are the I-15 Weigh Stations in Cajon or Mountain Pass. In addition to WIM, other roadside technologies can be deployed to enhance safety. For example, infrared sensors could be used to identify overheated brakes. These sensors can relay warnings directly to the vehicle's cab (V2X) or through roadside warning signs.
- **Mobile Freight Application**: Another possible freight amenity would be a mobile application focused on travel information targeted for commercial vehicle operators. California Department of Transportation (Caltrans) District 8 will be deploying an ATMS with the capability to support a Truck Parking Availability System. Other useful travel information for commercial vehicle operators might include traffic conditions, and would support routing for efficient, just-in-time delivery. San Bernardino County has an opportunity to partner with Caltrans to deliver mobile application services to commercial vehicle drivers These applications can potentially leverage the various existing freight platforms such as the I-10 Truck Parking Availability System, Sunguide or Lonestar. Commercial vehicle operators have expressed interest in these application services if they are not required to install additional hardware in the vehicle to operate. A ubiquitous, mobile freight application has the possibility of increasing safety, decreasing emissions, and speeding routing across the county.
- **Environmental Monitoring**: Environmental monitoring at its most basic level occurs at the intersection level, however, there are benefits to extending environmental monitoring along a corridor. The more air quality and weather data that is available to decision makers, the more informed the decision can be. Corridor-wide weather data can be useful for evacuations so the coordinating agencies can understand the situation on the ground along an evacuation corridor. Corridor-wide air quality data can inform policy makers where unsafe concentrations of pollutants are located, which can then be used to implement strategies to mitigate or remediate these issues.

- **Public Agency Wi-Fi**: San Bernardino County has slightly less residents with access to high-speed internet relative to the rest of the state.[13] To bridge the digital divide, public Wi-Fi could be offered cost-efficiently along smart corridors at key public gathering points. Parks near intersections, mobility hubs or frequent event locations could offer Wi-Fi to those in the area. As new fiber is deployed by the State's BMMN, municipalities that connect their traffic control devices to fiber may opt to install extra capacity and network equipment to support public Wi-Fi and a virtual local area network. A virtual local area network can be used to provide public Wi-Fi to individuals near the traffic control device, either continuously for areas like a park or intermittently for special events. This can offer new areas of public Wi-Fi that can be used by residents, visitors, and even special event vendors.
- **Off-Pavement Parking Management:** Finding parking can be frustrating. A potential solution to help private and public operators manage parking utilizes AI and smart technologies to facilitate an improved experience. This could include real-time space availability, dynamic pricing, predictive analytics, or user-friendly apps that facilitate reduced congestion, space optimization, and the reduction of greenhouse gases. Ensuring that parking is available when desired can reduce congestion in commercial districts and increase throughput of a corridor.
- **Curb Management Sensors:** Curb space is a valuable commodity in the urban environment with multiple demands such as increased pick-ups, drop-offs, and new alternative transportation modes. Smart sensors built on interactive platforms can support effective curb management, similar to those discussed as part of parking management. These sensors leverage AI to drive turnover, safety, accessibility, and they communicate information to the user. For example, they can display recognized objects and events to help manage curb space more efficiently (**Figure 5-1**). These systems can improve turnover like off-pavement parking management that results in a more efficient use of available space, primarily in commercial districts.

Figure 5-1: Automated Curb Management



- **Speed Indicators:** Reducing speeds can dramatically reduce the severity of collisions, and in many cases, protect VRUs. Speed indicators are "feedback signs" that show drivers the speed at which they are traveling to encourage them to decrease their speed, when appropriate. Speed indicator signs have been proven to reduce speeds by 10-20% and increase speed limit compliance from 30% to 60%.[14] Areas such as school zones, residential areas, or other high-trafficked pedestrian areas can benefit by having vehicles travel at safer speeds that decrease the incidence and severity of collisions.

[13] California Public Utilities Commission (CPUC). 2023. "State of California Fixed Consumer Broadband Deployment." https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/communications-division/documents/broadband-mapping/docs-uploaded-2023/household-deployment-by-county-as-of-dec-31-2021.pdf

[14] https://www.radarsign.com/#:~:text=Speeders%20slow%20down%20up%20to,remarkable%2030%25%20to%2060%25

5.1.3 User Needs

Table 5-2 outlines the needs identified that could be addressed as part of the implementation of a Smart Corridor implementation strategy. Smart Intersection user needs, in **Table 5-9**, also covers user needs that would be met by a Smart Corridor implementation strategy.

Table 5-2: Smart Corridor User Needs

Category	User Needs
Traffic Management	▪ Need for dynamic traffic management on arterial portions of the roadway network. ▪ Need for customized traffic management strategies that consider local factors on key corridors. ▪ Need for real-time traffic data to dynamically address the operational performance of corridors. ▪ Need for high-speed, reliable traffic signal and ITS communications infrastructure.
Freight Management	▪ Need for facilitating freight deliveries through the additional use of urban arterial management. ▪ Need for improved commercial vehicle travel information. ▪ Need for automated commercial vehicle inspection, credentialing, and clearance systems to enable more efficient commercial vehicle operations.
Equity and Environment	▪ Need to increase driver awareness of surroundings and signage around High Injury Network locations (including speed limits, crosswalks, and transit stops). ▪ Need to provide real-time alerts (e.g., location of pedestrians, pedestrian crossings, multimodal travel options/connections, and wayfinding information) to drivers and transit users for better decision-making and trip planning. ▪ Need for technology improvements at rail grade crossings to improve safety. ▪ Need to consider coordination and connection opportunities with existing transit/paratransit services.

5.1.4 Prioritized Strategy Deployment Locations

San Bernardino County has a varied geography and each of the four regions pose unique opportunities and challenges. This means that smart corridor plans may vary slightly between jurisdictions, and from one proposed smart corridor to another. The methodology for corridor identification started by creating four categories (safety, evacuation, freight, and congestion/air quality), to help distinguish and address different needs across the county.

There was an additional level of outreach, outside of the Smart County MP, to local jurisdictions and Omnitrans that included the potential for investing in “priority transit corridors” in the East and West Valley subregions. A priority transit corridor could range from selective application of strategies such as TSP or “queue jumps” at intersections to full BRT. This outreach is occurring as part of SBCTA’s Long Range Multimodal Transportation Plan (LRMTP) and will be factored into the prioritization and funding process subsequent to the completion of the Smart County MP. While the smart corridors identified for the Victor Valley (Bear Valley Road) and Morongo Basin (SR-62) appear firm at this point, additional discussions will be held with local jurisdictions, Caltrans, and the SBCTA Board to confirm that direction.

The identification of the actual corridors for investment in all subareas will be undertaken under SBCTA Board oversight and the following general sequence:

- The full set of candidate smart corridors will be identified based on the combination of Smart County MP input and outreach to the jurisdictions, Caltrans, and transit operators. In other words, the list of corridors and corridor limits may be expanded or modified based on this additional input.

- Potential funding sources will be identified. For the Valley, the Board has already set aside $5 million of Measure I Traffic Management System funds for investment in traffic signal coordination upgrades, and additional funding for the transit portion could come from the Measure I funding set aside for Express Bus/BRT. It should be noted that the first $1 million investment of this funding was made to enhance operations on the Haven Avenue corridor through a joint effort by Rancho Cucamonga and Ontario. Further investment was put on hold until the completion of the Smart County MP. For the Victor Valley

and Morongo Basin, Measure I Project Development and Traffic Management System (PDTMS) funds are potential sources. But in all corridors, grant funding will also need to be pursued, and those opportunities will be identified.

- For the East and West Valley, a Request For Information (RFI) will be disseminated in Fiscal Year 2024-2025 to assist the SBCTA Board in determining which corridors represent the best Smart Corridor/Transit investments on which to spend Valley Measure I funding that has been identified for that purpose.

- Recommendations for Smart Corridors will be drafted based on the responses to the RFI, in coordination with recommended priority transit corridor investments. Inclusion on a priority transit corridor will be a consideration, but not necessarily a requirement for Smart Corridor investment.

- The SBCTA Board will make a final determination on the recommended investments.

In terms of the evaluation of corridors for the Smart County MP, the following four criteria enabled the assessment of potential corridors for consideration:

- **Safety:** The most effective deployment of Smart Corridor technology can be along corridors that have the highest density of collisions. Thus, corridors were selected by determining a novel "collision per mile" statistic using TIMs data[15], which enabled the identification of corridors with the greatest density of collisions. Various elements can be used along these corridors, such as dynamic signal control, coordination, speed indicators and soft priorities for VRU protection. Smart intersection strategies for VRUs can be applied to relevant intersections along the corridor to reduce VRU/vehicle conflicts such as a leading pedestrian interval. Additionally, physical infrastructure improvements can be beneficial for safety such as increased lighting, bike boxes, or curb extensions.[16]
- **Evacuation:** San Bernardino experiences earthquakes, riverine flooding, landslides, wildfires, and mountain area winter weather, among other natural disasters. This is compounded by areas that have low community resilience. Less resilient communities are not as prepared for disasters and face greater disruptions during disaster recovery.[17] Corridors were identified that traversed particularly high-risk census tracts specified by Federal Emergency Management Agency.[18] This aligns with the objectives of the SBCTA/WRCOG Emergency Evacuation Network Resilience Study of improving network resilience and improving emergency access during evacuations with a particular focus on disadvantaged communities. During evacuation events, sudden large influxes of traffic can flood travel corridors, rapidly overwhelming capacity. Evacuation corridors could utilize smart infrastructure monitoring, enhanced redundant communications platforms, public/agency Wi-Fi, changeable message signs, connected vehicle applications, or legacy driver communication technology with the objective of being able to move large numbers of people rapidly and safely, while providing the most up-to-date information to prepare or direct evacuees for adverse conditions.
- **Congestion/air quality:** San Bernardino County has some of the worst air pollution in the nation.[19] Top transportation mitigation methods include improving traffic throughput and reducing idling. Dynamic signal control, coordination, and FSP can mitigate idling to reduce emissions. Corridors were selected by determining census tracts with the worst CalEnviroScreen Scores, developed by the California Environmental Protection Agency, which ranks census tracts on a composite score composed of various health factors. Nearby corridors were then selected based on publicly available traffic data. Corridors were thus selected from areas with the poorest air quality and most significant congestion.

[15] https://tims.berkeley.edu/

[16] https://dot.ca.gov/-/media/dot-media/programs/safety-programs/documents/shsp/shsp-vru-report2-a11y.pdf

[17] Community Resilience | National Risk Index (fema.gov)

[18] Map | National Risk Index (fema.gov)

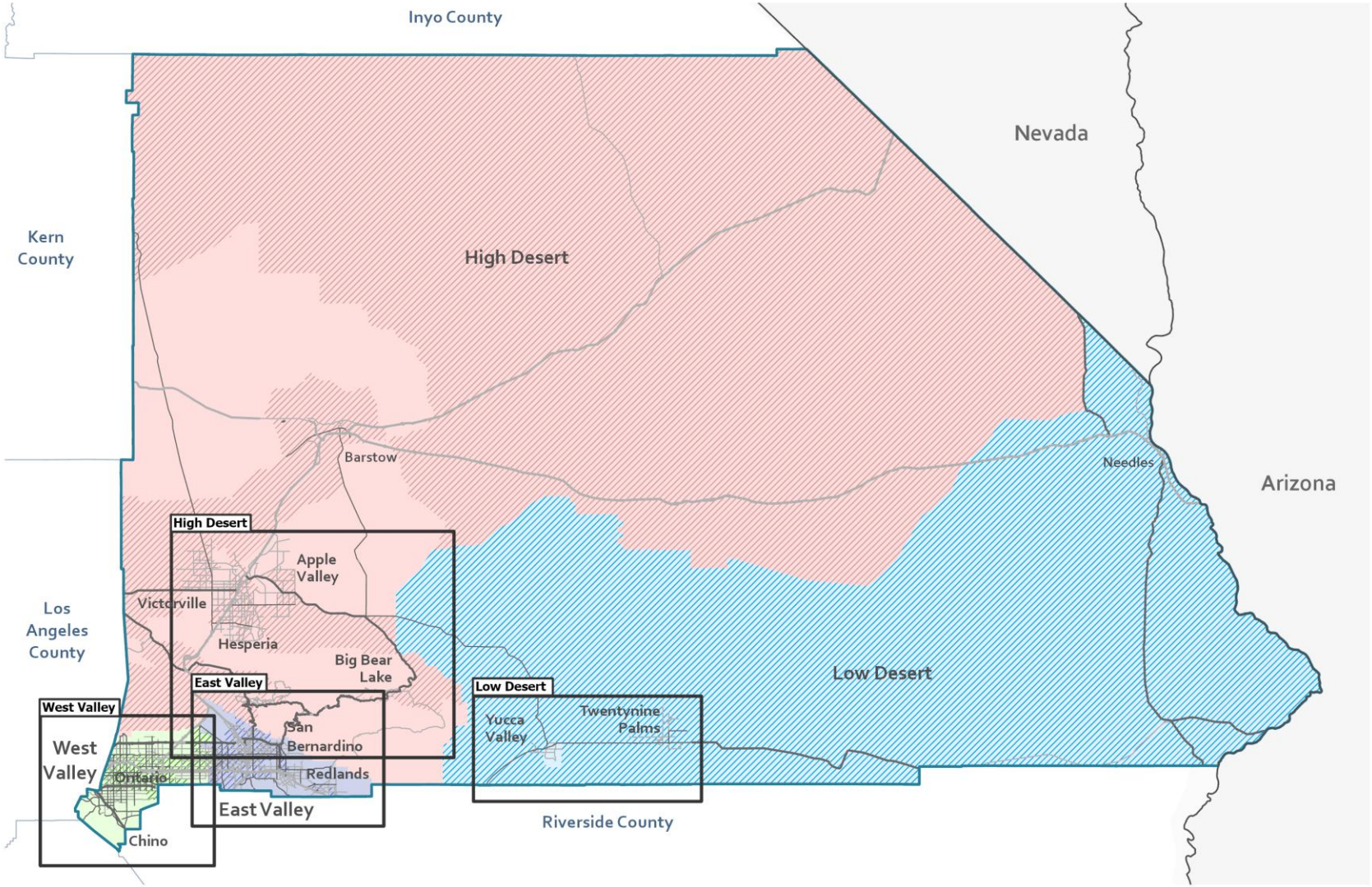
[19] Inland Empire Once Again Ranks As Worst in Nation for Air Quality | Earth Focus | News & Public Affairs | PBS SoCal

- **Freight:** San Bernardino County has numerous important freight routes that stand to benefit from improved signal timing, coordination, driver communication, and FSP strategies. Improvements along these corridors can also reduce truck traffic on local streets by increasing driver awareness of appropriate truck routes and increasing driver trust in infrastructure. Corridors were selected based on expert industry input and literature review. Freight corridors also include rail freight improvements such as at-grade crossing safety improvements to reduce or eliminate costly collisions. Signal coordination between local agencies and railroads can enable the routing of traffic away from at-grade crossings prior to rail freight moving through the crossing to mitigate conflicts. This back-end mitigation can be in addition to in-situ improvements such as double crossing-gates.

Next, corridors were reviewed based on similar work that was already underway or recently completed to align future efforts. This included the work done in the East and West Valley on the San Bernardino Valley Coordinated Traffic Signal System (SBVCTSS) project and the smart corridor work proposed for Archibald Avenue in Ontario and San Bernardino Ave/Alabama St in an unincorporated San Bernardino County Island, encircled within the city of Redlands. In the following figures, corridors marked with an asterisk (*) were included in part or whole in the SBVCTSS Tiers 1-4. Corridors marked with a plus (+) were included in the Early Action Plan, which identified locations that were prioritized for the benefits that these would provide when implemented.

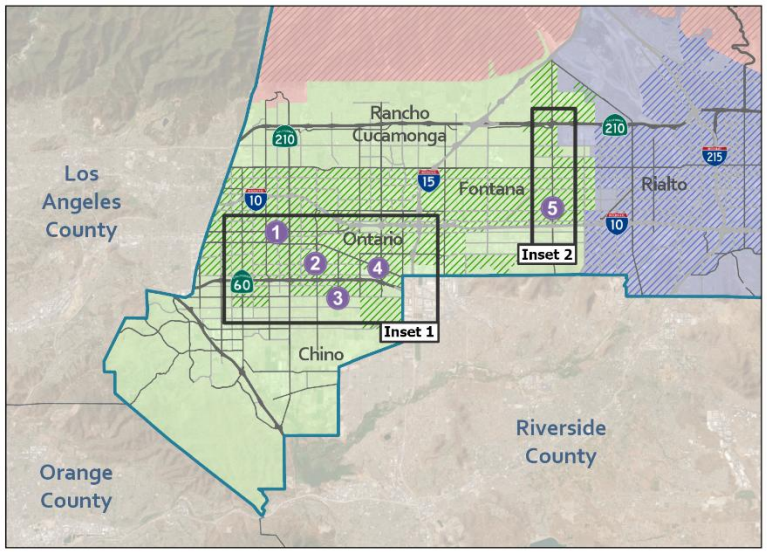
The following figures illustrate the potential smart corridors identified through Smart County MP process and that will be considered in the decision-making framework for investment described earlier in this section across the four regions (West Valley, East Valley, High Desert, and Low Desert).

Figure 5-2: Prioritized Smart Intersections and Corridors Deployment



West Valley

Smart Corridors and Intersections



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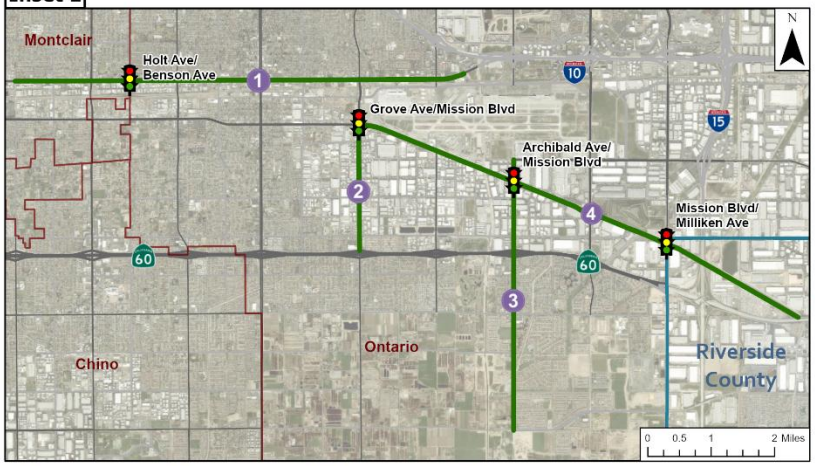


Inset 2

Legend

Proposed Improvements

- Freight
- Evacuation
- Smart Corridor
- Safety
- Congestion/Air Quality
- Smart Intersection
- Corridor ID
- * Included in SBVCTSS Tiers 1-4
- + Included in Early Action Plan

1 * Holt Blvd (Ramona Ave to Convention Ctr Wy)

2 *+ S Grove Ave (E Riverside Dr to E Holt Blvd)

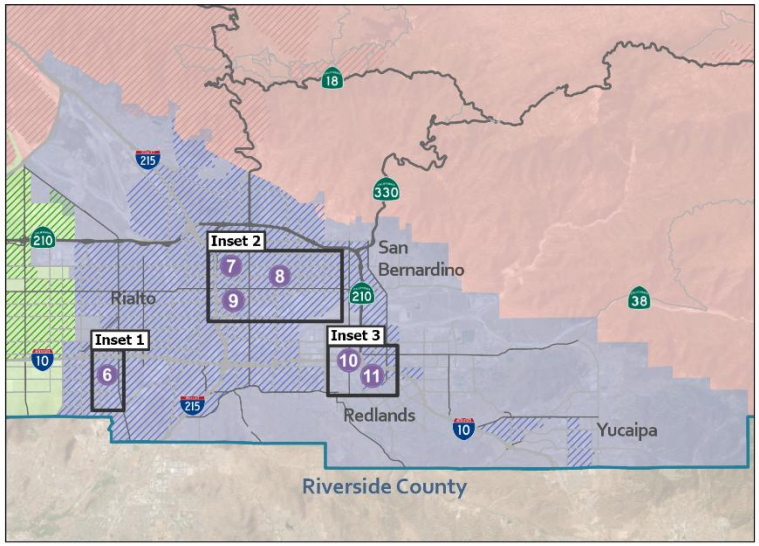
3 * Archibald Ave (Ontario Ranch Rd to E Jurupa St)

4 * Mission Blvd (S Grove Ave to SR-60)

5 * Sierra Ave (Jurupa Ave to SR-210)

East Valley

Smart Corridors and Intersections



6 Cedar Ave (Jurupa Ave to Bloomington Ave)

7 * W Baseline St (N California St to N Arrowhead Ave)

8 W 9th St (Medical Ctr Dr to Palm Ave)

9 N/S E St (West Orange Show Rd to W Baseline St)

10 + Alabama Ave (Palmetto Ave to Redlands Blvd)

11 Redlands Blvd (California St to E Citrus Ave)

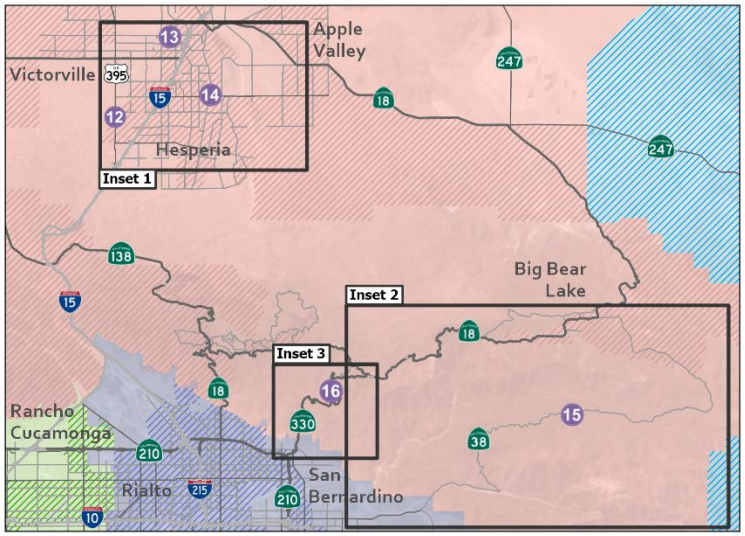
Legend

Proposed Improvements

- Freight
- Evacuation
- Smart Corridor
- Safety
- Congestion/Air Quality
- Smart Intersection
- * Included in SBVCTSS Tiers 1-4
- Corridor ID
- + Included in Early Action Plan

High Desert

Smart Corridors and Intersections



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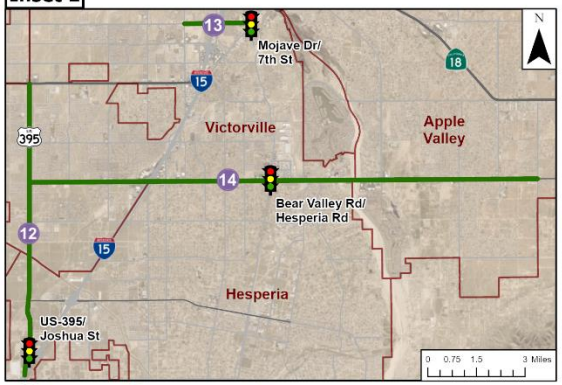

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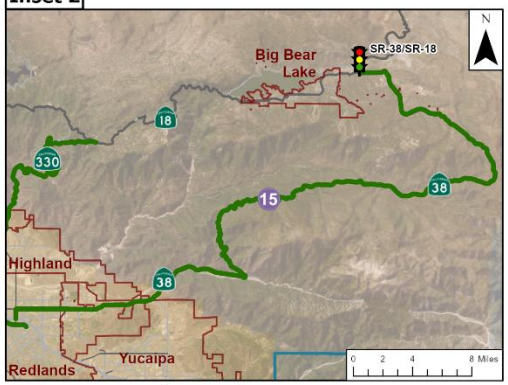

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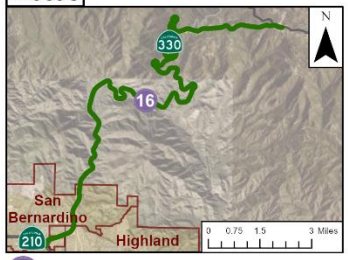


Legend

Proposed Improvements

- Freight
- Evacuation
- Smart Corridor
- Safety
- Congestion/Air Quality
- Smart Intersection
- \+ Included in Early Action Plan
- # Corridor ID

12 US-395 (from I-15 to SR-18)

13 Mojave Dr (Amargosa Rd to 7th St)

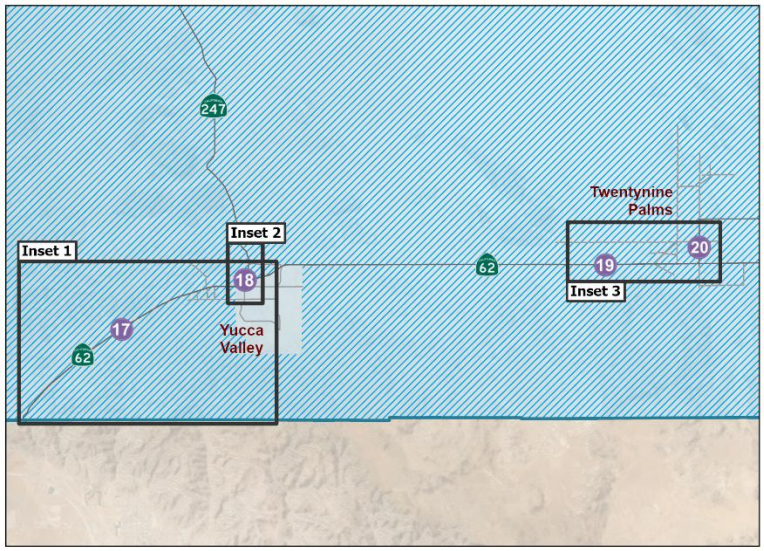
14 + Bear Valley Rd (I-15 to Central Rd)

15 SR-38 (I-10 to SR-18)

16 SR-330 (SR-210 to SR-18/Running Springs)

Low Desert

Smart Corridors and Intersections

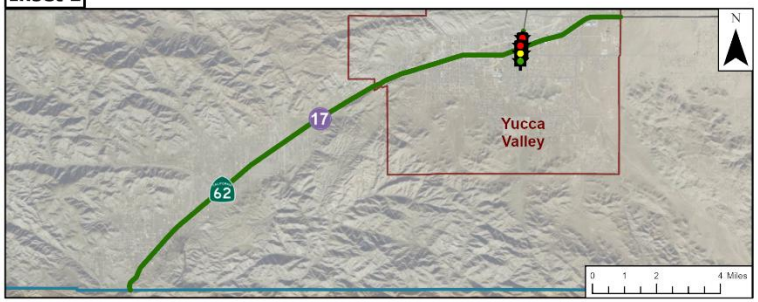


Legend

Proposed Improvements

Freight
Evacuation
Smart Corridor
Safety
Congestion/Air Quality
Smart Intersection
+ Included in Early Action Plan
Corridor ID

Inset 1



17 +

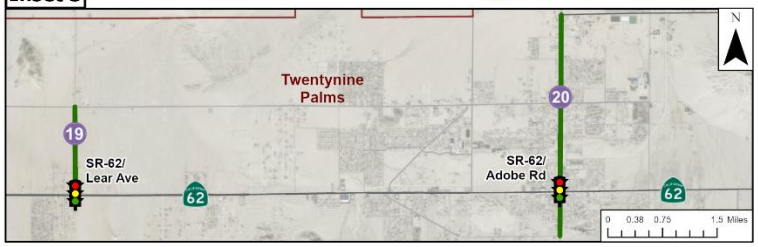
SR-62 (County line to Yucca Mesa Rd)

Inset 2

18

SR-247 (Yucca Trail to Crestview Dr)

Inset 3



19

Lear Ave (SR-62 to 2 Mile Rd)

20

Adobe Rd (Sullivan Rd to Amboy Rd)

5.1.5 Relevant Stakeholders

While Infrastructure Owner Operators (IOO) will hold the primary responsibility for planning and implementation, other stakeholders will be helpful throughout each project. Where the project spans multiple jurisdictions, local agencies, SBCTA/SBCOG and Caltrans can be helpful for planning and coordinating efforts. Caltrans, specifically, will be involved when corridors pass through Caltrans operated intersections or state routes. For the priority or preemption strategies, the IOOs will work with the entities affected by the new technology. This may include transit agencies, freight companies, rail operators, and public safety agencies and may involve entities from multiple jurisdictions based on the corridor.

The community should also be engaged to understand the opportunities smart corridors bring and how any technology implementation will affect them. Their input could help an IOO identify user needs to build out the right solution for their community. Communities who have health concerns may wish to implement FSP to reduce diesel emissions from idling vehicles. Another community may be more interested in TSP and work with the transit agency and SBCTA to implement.

The immediate stakeholders to help develop this strategy further include traffic operations personnel from the IOOs, the SBCTA TTAC, and the IT working group.

5.1.6 Benefits

Smart corridors offer numerous benefits, enhancing overall traffic management, safety, and environmental quality. The following are some of these benefits:

- Reduction in Greenhouse Gases (GHG):
  - Benefits: Residents, Environment
  - Impact: Lower emissions, improved air quality in areas with high ozone, particulate matter 2.5 micrometers and smaller ($PM_{2.5}$), and diesel fumes.
- Reduction in Crashes:
  - Benefits: Travelers, Emergency Services
  - Impact: Increased safety, fewer accidents, and reduced emergency response needs.
- Reduction in Travel Times:
  - Benefits: Travelers, Freight Transport
  - Impact: Faster journeys, reduced congestion, and improved efficiency in freight transport.
- Increased Reliability:
  - Benefits: Travelers, Public Transport
  - Impact: More predictable travel times and improved public transport schedules.
- Improved Management of Traffic Diversion:
  - Benefits: Travelers, Local Businesses
  - Impact: Better handling of freeway incidents, reduced congestion on arterial roads, and minimized disruption to local traffic.
- Dynamic Sign Control and Traffic Signal Timing:
  - Benefits: Drivers, Traffic Management Authorities
  - Impact: Real-time information sharing, optimized traffic flow, and enhanced incident response capabilities.

5.1.7 High-Level Costs

Costs for smart corridor projects will vary greatly depending on the selected technology, the length of the corridor and the number of intersections. Outside conditions including existing transportation technology and the availability of electricity and fiber in the area will also affect the cost.

The following cost estimates have been developed for each corridor by assuming that fiber conduit will be trenched along the length of the corridor, controller upgrades will take place at each of the signalized intersections, and the various amenities included are implemented in the quantities indicated. Some corridors may not require this level of infrastructure, depending on specific applications. The estimates do not include any smart corridors that may be added as a result of the priority transit corridor outreach for the LRMTP. The costs are provided only to give a sense of the overall scale of investment that could be needed. Costs will be refined based on the specific design concept and scope for each corridor as it is developed. Each of the quantities developed is listed on a per corridor basis. Depending on agency need, this may vary in implementation. **Table 5-3**, **Table 5-4**, **Table 5-5**, and **Table 5-6** provide high-level summaries of smart corridor improvement costs in the West Valley, East Valley, High Desert, and Low Desert, respectively.

Table 5-3: Smart Corridor Improvement High-level Cost Summary – West Valley

Cost Elements (S=Short, M=Medium, L=Long)	Corridor						Unit of Measure	Cost per Unit	Total Cost
	1	2	3	4	5	6			
Number of signalized intersections	12	28	18	11	7	8	Each	N/A	N/A
Upgrade Controllers (S)	6	14	9	11	7	8	Intersections (1 Controller per Intersection)	$10,000	$0.55M
Upgrade Detection (veh, bike, ped) (S)	5	14	9	11	7	4	Intersections (4 Upgraded Approaches per Intersection)	$11,000	$0.55M
Upgrade Signal Timing (S)*	12	28	18	11	7	8	Intersections (1 Upgrade per Intersection)	$5,000	$0.42M
Communications (S)**	2.14	6.10	6.40	1.76	1.76	3.30	Miles (Total along corridor)	$812,000/mile	$17.4M
Closed-Circuit Television (S)*	5	7	9	4	2	2	Intersections (1 unit per intersection)	$8,000	$0.23M
Automated License Plate Readers (S)	3	6	9	6	2	4	Intersections (1 unit per intersection)	$20,000	$0.58M
Air Quality Sensors (M)	3	3	3	2	2	3	Intersections (1 unit per Intersection)	$13,000	$0.21M
Connected Vehicle RSUs (M)	5	6	5	4	4	4	Intersections (1 per Intersection)	$10,000	$0.29M
CV Vulnerable Road User App (M)	Lump Sum – Countywide Cost***								-
CV Freight App (M)	Lump Sum – Countywide Cost***								-
Video Management System (M)	Lump Sum – Countywide Cost***								-

Cost Elements (S=Short, M=Medium, L=Long)	Corridor						Unit of Measure	Cost per Unit	Total Cost
	1	2	3	4	5	6			
Enable Broadband Middle-Mile connection (L)	-	2	1	1	1	1	Intersections (1 connection per intersection)	$100,000	$0.60M
Total Cost (M$)	2.20	5.90	6.10	2.10	1.86	3.14	-	N/A	$20.86M

* # of intersections; ** in miles; *** cost included in **Table 5-7**

Table 5-4: Smart Corridor Improvement High-level Cost Summary – East Valley

Cost Elements (S=Short, M=Medium, L=Long)	Corridor					Unit of Measure	Cost per Unit	Total Cost
	7	8	9	10	11			
Number of signalized intersections	11	15	9	13	17	Each	N/A	N/A
Upgrade Controllers (S)	11	15	9	13	17	Intersections (1 Controller per Intersection)	$10,000	$0.65M
Upgrade Detection (veh, bike, ped) (S)	11	15	9	13	17	Intersections (4 Upgraded Approaches per Intersection)	$11,000	$0.71M
Upgrade Signal Timing (S)*	11	15	9	13	17	Intersections (1 Upgrade per Intersection)	$5,000	$0.32M
Communications (S)**	1.52	6.52	4.51	3.10	2.88	Miles (Total along corridor)	$812,000/ mile	$15.05M
Closed-Circuit Television (S)*	5	3	4	6	5	Intersections (1 unit per intersection)	$8,000	$0.18M
Automated License Plate Readers (S)	4	3	3	6	6	Intersections (1 unit per intersection)	$20,000	$0.44M
Air Quality Sensors (M)	2	4	4	3	2	Intersections (1 unit per Intersection)	$13,000	$0.20M
Connected Vehicle RSUs (M)	3	4	2	5	8	Intersections (1 per Intersection)	$10,000	$0.22M
CV Vulnerable Road User App (M)	Lump Sum – Countywide Cost***							-
CV Freight App (M)	Lump Sum – Countywide Cost***							-
Video Management System (M)	Lump Sum – Countywide Cost***							-
Enable Broadband Middle-Mile connection (L)	2	1	1	1	2	Intersections (1 connection per intersection)	$100,000	$0.70M
Total Cost (M$)	2.01	6.03	4.25	3.35	3.36	-	N/A	$18.47M

* # of intersections
** in miles
*** cost included in **Table 5-7**

Table 5-5: Smart Corridor Improvement High-level Cost Summary – High Desert

Cost Elements (S=Short, M=Medium, L=Long)	Corridor					Unit of Measure	Cost per Unit	Total Cost
	12	13	14	15	16			
Number of signalized intersections	9	26	-	-	7	Each	N/A	N/A
Upgrade Controllers (S)	9	26	-	-	7	Intersections (1 Controller per Intersection)	$10,000	$0.42M
Upgrade Detection (veh, bike, ped) (S)	9	26	-	-	7	Intersections (4 Upgraded Approaches per Intersection)	$11,000	$0.46M
Upgrade Signal Timing (S)*	9	26	-	-	7	Intersections (1 Upgrade per Intersection)	$5,000	$0.21M
Communications (S)**	7.37	9.91	15.42	59	1.73	Miles (Total along corridor)	$812,000/mile	$75.87M
Closed-Circuit Television (S)*	3	6	6	6	4	Intersections (1 unit per intersection)	$8,000	$0.20M
Automated License Plate Readers (S)	2	6	2	6	4	Intersections (1 unit per intersection)	$20,000	$0.40M
Air Quality Sensors (M)	3	3	4	6	4	Intersections (1 unit per Intersection)	$13,000	$0.23M
Connected Vehicle RSUs (M)	2	6	2	6	4	Intersections (1 per Intersection)	$10,000	$0.20M
CV Vulnerable Road User App (M)	Lump Sum – Countywide Cost***							-
CV Freight App (M)	Lump Sum – Countywide Cost***							-
Video Management System (M)	Lump Sum – Countywide Cost***							-
Enable Broadband Middle-Mile connection (L)	1	1	0	0	1	Intersections (1 connection per intersection)	$100,000	$0.3M
Total Cost (M$)	6.51	9.23	12.82	48.35	1.96	-	N/A	$78.29M

* # of intersections
** in miles
*** cost included in **Table 5-7**

Table 5-6: Smart Corridor Improvement High-level Cost Summary – Low Desert

Cost Elements (S=Short, M=Medium, L=Long)	Corridor				Unit of Measure	Cost per Unit	Total Cost
	17	18	19	20			
Number of signalized intersections	12	3	2	2	Each	N/A	N/A
Upgrade Controllers (S)	12	3	2	2	Intersections (1 Controller per Intersection)	$10,000	$0.19M
Upgrade Detection (veh, bike, ped) (S)	12	3	2	2	Intersections (4 Upgraded Approaches per Intersection)	$11,000	$0.21M
Upgrade Signal Timing (S)*	12	3	2	2	Intersections (1 Upgrade per Intersection)	$5,000	$0.1M
Communications (S)**	15.08	1.01	1.01	0.67	Miles (Total along corridor)	$812,000/mile	$14.29M
Closed-Circuit Television (S)*	4	2	1	2	Intersections (1 unit per intersection)	$8,000	$0.07M
Automated License Plate Readers (S)	4	1	1	2	Intersections (1 unit per intersection)	$20,000	$0.16M
Air Quality Sensors (M)	3	1	1	1	Intersections (1 unit per Intersection)	$13,000	$0.10M
Connected Vehicle RSUs (M)	1	1	0	1	Intersections (1 per Intersection)	$10,000	$0.03M
CV Vulnerable Road User App (M)	Lump Sum – Countywide Cost***						-
CV Freight App (M)	Lump Sum – Countywide Cost***						-
Video Management System (M)	Lump Sum – Countywide Cost***						-
Enable Broadband Middle-Mile connection (L)	-	1	1	-	Intersections (1 connection per intersection)	$100,000	$0.20M
Total Cost (M$)	12.81	1.10	1.03	0.72	-	N/A	$15.46M

* # of intersections
** in miles
*** cost included in **Table 5-7**

A rough estimate of the overall corridor costs which include the above-mentioned amenities can be found in **Table 5-7.** These are preliminary values, and each interested jurisdiction should develop costs for their specific projects. The number of variable costs and potential differences in scope within these projects poses challenges for creating one estimate that can be used for the entire county.

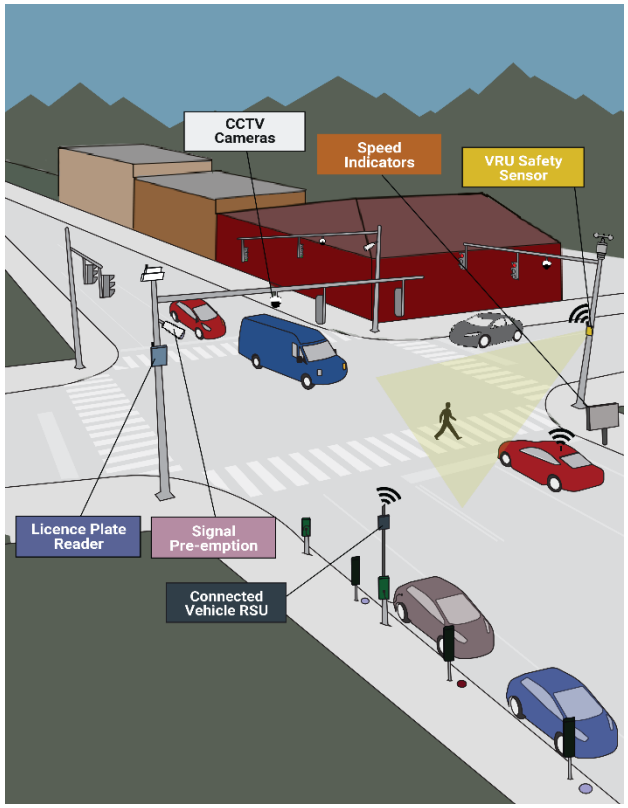
Table 5-7: Smart Corridor Costs

Cost Category	Average Cost
Preliminary Activities	$78,000/mile
Construction	$880,000/mile
Software Development	$2,000,000
Estimated Implementation Cost	$2,000,000 software costs + $958,000 per mile up-front costs
Estimated Ongoing Operations and Maintenance	$50,000/mile/year

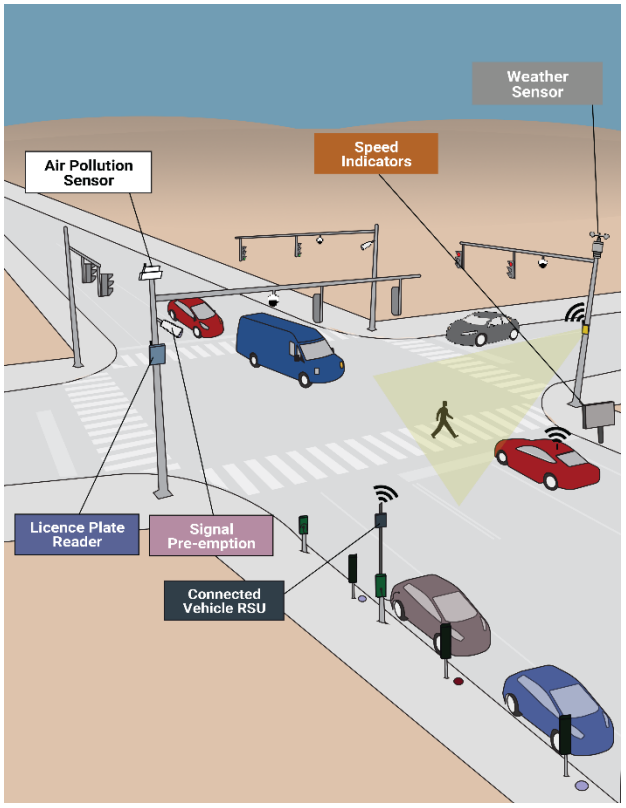
5.2 Smart Intersections

Smart intersections are one of the key building blocks of a smart jurisdiction. Once an intersection has upgraded network communication abilities, the opportunity to pilot new technologies, enhance traffic and safety, gather data, and communicate in real-time with drivers is expansive. Smart intersections can benefit from following a regional template and regional Intelligent Transportation System (ITS) architecture, while having amenities or subsystems tailored to the needs of their specific geography and jurisdiction. **Figure 5-3** illustrates some options addressed in the Early Action Plan for various regions of San Bernardino County.

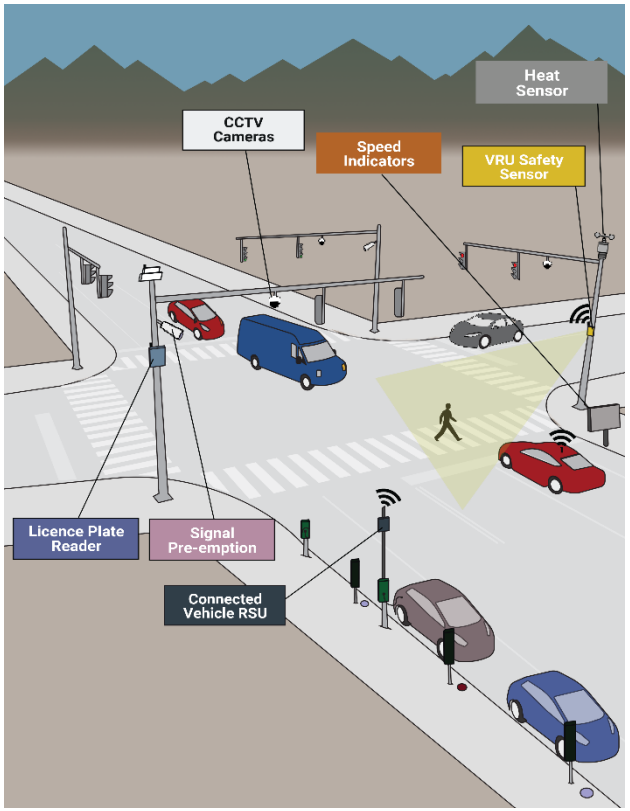
Figure 5-3: Smart Intersection Amenity Examples by Region



East Valley and West Valley



High Desert



Low Desert

5.2.1 Benchmarking

In the rapidly evolving mobility landscape, intersections are where most of the activity and potential for improved efficiency, safety, and information occur within local jurisdictions. Freeways are also an important backbone of the regional transportation system for moving people and freight. SBCTA, in partnership with Caltrans and local jurisdictions, is making great strides to upgrade freeways with High Occupancy Toll (HOT) lanes on I-10 and I-15 to transition them into a truly multimodal network that can be managed and optimized. While the evolution of the freeway network and its technologies are not addressed in the Smart County MP, suffice it to say that this system must work together with the interchanges, arterials, transit, shared-ride systems, and logistics operators to maintain mobility for people and goods. It must work together with emergency service providers who need to get information out to the traveling public about incidents, road closures, transit schedule interruptions, route diversions, and other events. An overview of the current and planned multimodal freeway network for San Bernardino County can be found in the Executive Summary of the 2021 Countywide Transportation Plan at: Draft Countywide Transportation Plan 2021 (gosbcta.com).

This section reviews some successful U.S. intersection technology deployments, providing perspective in advance of the strategies recommended in the next section. These technologies can be implemented in various settings and situations throughout San Bernardino County.

Using Automated License Plate Readers (ALPRs) for Traffic Safety: An ALPR report sponsored by the National Highway Traffic Safety Administration[20] highlights the significant benefits and successful implementations of ALPR technology across various jurisdictions. The dual focus of this technology has been to enhance traffic safety and prevent crime. The research finds ALPR to be a cost-effective tool, demonstrating a quick return on investment—within one week for property crimes and one month for violent crimes. Following the deployment of ALPR in New York City, there was a 31 percent increase in automobile theft arrests. Similarly, Sacramento experienced a reduction in per-capita auto theft rates after local police began utilizing ALPRs to recover stolen vehicles.

The City of Las Vegas Wrong-Way Driving Detection System: To enhance road safety, the city of Las Vegas implemented an advanced wrong-way driving detection system along a stretch of 110-198 E Clark Avenue. The system employs camera and imaging technology to monitor traffic patterns and flows. Utilizing AI, the system analyzes the gathered traffic data to generate valuable insights. The AI technology detected instances of wrong-way driving, and these instances were then provided to the city for further analysis. Based on these insights, the city decided to replace stop signs with traffic signals on busy streets. The introduction of this technology and the subsequent actions taken led to a 90% reduction in wrong-way driving incidents in the study area. This substantial decrease highlights the effectiveness of integrating AI with traffic management systems to enhance road safety and prevent potentially dangerous driving behaviors.[21]

Chattanooga Smart Intersection Expansion: Chattanooga, Tennessee, will add dozens of "smart city intersections" through an ongoing partnership supported by the U.S. Department of Transportation. The Chattanooga Department of Innovation Delivery and Performance, working with Seoul Robotics and the Center of Urban Informatics and Progress at the University of Tennessee at Chattanooga, are installing sensing technology in 86 downtown intersections, building on a testbed established in 2019. The intersections will be equipped with tools, namely light detection and ranging (LiDAR) sensing technology, to gain real-time traffic insights and monitor infrastructure usage. That data can inform future traffic management, alleviate congestion, and map ideal locations for EV charging stations, among other potential benefits. The expansion is expected to result in over 100 tech-equipped intersections across downtown.[22]

[20] https://rosap.ntl.bts.gov/view/dot/55586

[21] https://us.nttdata.com/en/case-studies/city-of-las-vegas-client-story

[22] https://www.smartcitiesdive.com/news/chattanooga-smart-city-intersections-lidar-seoul-robotics-usdot/639799/

Love My Air Denver's Air Quality (AQ) Program: Launched in 2018 with a focus on enhancing community awareness and action regarding AQ, Denver's "Love My Air" program addresses the city's air pollution issues. In collaboration with Denver Public Schools, Love My Air has established a comprehensive citywide AQ monitoring network. This system uses innovative, low-cost air pollution sensors that are solar-powered and equipped with battery storage and data connectivity, making the technology scalable and adaptable for other cities. Focusing on $PM_{2.5}$, the network provides vital real-time data. This data infrastructure underpins the Love My Air app launched in 2022, which offers real-time AQ updates and comparisons across school sites, integrating state and neighboring municipalities' data for a broader AQ assessment. The information from the program supports school staff in making informed decisions about outdoor activities on poor AQ days. Additionally, it empowers students, particularly those with asthma, to take proactive steps in managing their health in response to AQ levels.[23]

5.2.2 Potential Strategy Elements

There are several technologies in use today, as shown in **Figure 5-3,** and described further in **Table 5-8**, that can transform intersection operations within San Bernardino County. Smart Corridor strategy elements, in **Section 5.1.2**, may also be found at the intersection level.

Table 5-8: Smart Intersection Subsystems Inventory

Smart Intersection Subsystem	Key Requirement Coverage	San Bernardino County Applicable Regions
Vulnerable Road User Safety Systems Video Incident Detection Systems / LiDAR / Detection	Public Safety / Transportation	All
Weather / Air Quality Emissions Sensors	Equity	All
Automatic License Plate Readers	Public Safety	All
Connected Vehicle Roadside Unit	Public Safety / Transportation	All

VRU SAFETY SYSTEMS

Video Incident Detection Systems **(ViDS)/LiDAR/Detection:** VRU safety is currently a pressing matter for the California and federal governments. Although San Bernardino County is fifth in population in the state, it has had the third most pedestrian fatalities and serious injuries across all counties in the state in the last four years, only behind San Diego and Los Angeles counties.[24] Within San Bernardino County, the diverse nature of the county is challenging because there is not a "one-size fits all" solution that can be applied countywide. Some traffic treatments may work better or worse than others in a different area. VRU Safety Systems can comprise a variety of sensors such as LiDAR, Video Incident Detection Systems (ViDS), leading pedestrian indicators, or bicycle signals and beacons, all targeting tracking and detecting issues that occur between vehicles and VRUs.

ViDS utilize advanced video cameras and image processing algorithms to monitor and analyze traffic conditions in real-time. ViDS play a crucial role in enhancing the safety of VRUs. By continuously analyzing video footage from strategically placed cameras, ViDS can identify unusual movements, predict risky situations, and facilitate proactive measures to protect VRUs. LiDAR is a technology that uses a visible light laser to measure distance between the sensor and the objects surrounding it. In the context of traffic safety, a LiDAR sensor can track objects and determine conflicts in real-time by creating a precise 3D model of its surrounding environment.[25] **Figure 5-4** shows a pedestrian tracking heat map using LiDAR. Multiple sensors can be strung together to create a holistic picture of

[23] https://denvergov.org
[24] TIMS - Transportation Injury Mapping System (berkeley.edu)
[25] What is lidar? (noaa.gov)

the given areas. The LiDAR-based ViDS can be linked to illuminate roadside beacons or send an alert to RSUs to communicate hazardous conditions to drivers, with the goal of preventing VRU involved crashes.

Figure 5-4: Pedestrian Tracking Heat Map Using LiDAR Sensors between Intersections[26]

WEATHER/AIR QUALITY EMISSIONS SENSORS

Portions of San Bernardino County can face severe weather and AQ conditions, often at the same time. In 2022, the American Lung Association ranked San Bernardino County as the worst county in the United States for ozone pollution.[27] Portions of the East/West Valley suffer from high ozone, diesel PM , and $PM_{2.5}$ levels.[28] AQ sensors, shown in **Figure 5-6**, are a way of monitoring conditions as they occur. Equipped intersections can feed data back to the South Coast Air Quality Management District to be disseminated to the public. AQ sensors can have hardwired communication and use Power Over Ethernet (or use cellular communication and solar power. Sensors can be programmed to measure AQ, wind speed, rainfall, and flooding among other things. Environmental sensors are especially useful in the High Desert, Low Desert, and mountainous areas that are susceptible to dust storms, flash flooding and snowstorms. Given the remote nature of some of these locations, solar-powered, cellular-enabled sensors, as shown in **Figure 5-5**, support the timely detection and communication of adverse conditions.

[26] Low-cost sensors are helping communities find gaps in air quality data | Grist

[27] Inland Empire Once Again Ranks As Worst in Nation for Air Quality | Earth Focus | News & Public Affairs | PBS SoCal

[28] CalEnviroScreen 4.0 Results (arcgis.com)

Figure 5-5: Solar/Cellular-Enabled Environmental Sensor

At smart intersections, similar environmental sensors can be readily connected to the existing communication network so that the Transportation Operations Center can be made aware of any potentially hazardous conditions in real-time; the Transportation Operations Center can then update the relevant entities of the conditions. As more sensors are implemented, a more nuanced and precise understanding of the weather or AQ event will be available to government decision makers and the public.

Figure 5-6: Air Quality Monitor

AUTOMATIC LICENSE PLATE READERS (ALPR)

Public safety was identified as a top priority by many of the city managers during the Early Action Plan outreach. Public safety is a complex issue that can be addressed through a variety of approaches. One technology that can be leveraged to enhance public safety is ALPRs, which are cameras that can identify the license plate numbers of vehicles within the camera's field of vision. These can be used to help find and track stolen vehicles, for AMBER alerts, or for other vehicle-related public safety issues. It is important that agencies review restrictions and use cases for ALPRs, as the collection of data can be a contentious issue. ALPR data can be sent to a public safety CAD system to trigger an alert in the agency's CAD software indicating that a known vehicle of interest has passed

through a given intersection heading in a certain direction. The local agency can then dispatch assets to investigate.

SPEED INDICATORS

Reducing speeds can dramatically reduce the severity of collisions, and in many cases, protect VRUs. Speed indicators are "feedback signs" that show drivers the speed at which they are traveling to encourage them to decrease their speed, when appropriate. Speed indicator signs have been proven to reduce speeds by 10-20% and increase speed limit compliance from 30% to 60%.[29] Areas such as school zones, residential areas, or other high-trafficked pedestrian areas can benefit by having vehicles travel at safer speeds that decrease the incidence and severity of collisions.

CONNECTED VEHICLE (CV) ROADSIDE UNIT (RSU)

CV RSUs allow for the direct, secure, low-latency communication of data between smart intersections and vehicles. **Figure 5-7** displays a message from an RSU on a vehicle dashboard. While the industry is still maturing, future generations of production vehicles are likely to include CV technology based on cellular-vehicle to everything (C-V2X) standards. In the meantime, aftermarket devices can provide immediate benefits to public agencies and consumers. Signal pre-empt and priority, discussed further as part of **Section 5.1** (Smart Corridors), provide day-one benefits. In addition, CV technology allows direct communication of safety data such as crash avoidance information, and signal phase and timing (SPaT) information that can enable more economical trips and reduce greenhouse gas emissions.[30] Finally, in conjunction with the smart corridors to be discussed later, CV can be used to communicate evacuation information.

Figure 5-7: Traffic-Light Information

5.2.3 User Needs

Tailoring the strategy elements to the specific needs of the county is important for the success of the Smart County MP. **Table 5-9** outlines the needs identified in the Existing Conditions Report that have guided planning for smart intersections.

[29] Radar Speed Signs | Driver Feedback Signs | Flashing Beacons (radarsign.com)

[30] UMEC-Final report 051 - C-V2X Research.pdf (morgan.edu)

Table 5-9: Smart Intersections User Needs

Category	Needs
Traffic Management	▪ Need to improve traffic operations using innovative smart technologies. ▪ Need to address growing recurring congestion via the use of increased investment in congestion management strategies. ▪ Need for traffic management solutions with advanced capabilities and functions.
Freight Management	▪ Need for operational support of freight mobility in rural areas and facilitating freight deliveries in urban areas using ITS. ▪ Need for additional relay of traffic information on primary freight corridors to improve routing decisions. ▪ Need for information on alternative freight-specific routes to improve roadway efficiency throughout the county.
Public Safety	▪ Need to provide situation awareness systems to emergency management and response agencies. ▪ Effective movement of assets into areas under emergency operations (e.g., adverse weather events, brush fires, etc.). ▪ Efficient evacuation of the public from areas under emergency operations.
Data Sharing	▪ Need for updated user security in accordance with existing IT security policies and procedures that are applicable to the IT environment of the ITS elements.
Equity and Environment	▪ Need for advanced monitoring equipment to detect and identify vulnerable road users such as pedestrians, cyclists and people who use wheelchairs, to ensure their safety and prioritize their movement. ▪ Need to improve pedestrian visibility and crossing conditions for everyone, especially those with mobility challenges, to create a more inclusive and accessible environment. ▪ Need to ensure equitable access to smart intersection technologies across all neighborhoods, especially in areas historically underfunded or neglected. ▪ Need to enhance air quality monitoring to address environmental justice concerns and improve public health outcomes.
Operations and Maintenance	▪ Need to support agencies in operations. ▪ Need for agencies to maintain their own assets. ▪ Need for active asset management platform to effectively plan and maintain regional assets.
Performance Metrics	▪ Need to develop, assess, and present performance metrics for continuous improvement and reporting. ▪ Need to consider opportunities to share collected data and performance metrics with stakeholders, and public/private sectors.

5.2.4 Prioritized Strategy Deployment Locations

A smart corridor system integrates various technologies and strategies to dynamically manage and optimize traffic, ensuring real-time responsiveness to changing roadway conditions and enhancing overall travel efficiency and safety. To address the issues raised by SBCTA and San Bernardino County stakeholders, the transportation network has been organized into smart corridors. These corridors aim to improve AQ, reduce travel times, decrease vehicle collisions, and increase transportation network resilience.

Within each smart corridor, key intersections, termed “smart intersections,” have been identified and developed to act as critical points for implementing these innovative strategies. These smart intersections serve as crucial elements in transforming the transportation network, with their improvements acting as building blocks to address broader network issues. Smart intersections will be deployed within these smart corridors (See **Section 5.1.4** for details). It should be noted that the selection of smart intersections will be guided by subsequent local jurisdiction outreach and review by the SBCTA Board, just as with the smart corridors. Local interest in smart intersections will be gauged through the RFI process and Board direction described for smart corridors in **Section 5.1**.

A smart intersection location was developed within 19 of the 20[31] smart corridors defined in **Section 5.1**. The 20 smart corridors were categorized by the following four corridor types from which 19 representative Smart intersections were chosen:

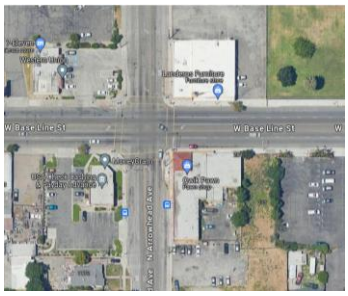
- **Freight Intersection**: the representative smart intersection is either closest to the freeway or the largest intersection along the chosen freight corridor. These are represented in the following matrix with a "".
- **Safety Intersection:** the representative smart intersection is the intersection that historically has the highest number of crashes along the chosen safety corridor. These are represented in the following matrix with a "".
- **Evacuation Intersection**: the representative smart intersections were selected from the corridor's midpoint or endpoint within the identified corridor. These are represented in the following matrix with a "".
- **Congestion/Air Quality Intersection:** the representative smart intersections were determined using Google Traffic data to pinpoint intersections on the chosen corridor with the worst congestion. These are represented in the following matrix with a "".

Table 5-10 illustrates the milestones that are required for each potential component of an upgraded smart intersection. These milestones include:

- **Field Survey:** Prior to any technology installation or upgrade, a field survey, including a detailed asset inventory, needs to be conducted. Mounting locations, location and configuration of other equipment, availability of space in roadside cabinets, power sources, available conduit, network access, etc. should all be documented. As indicated in the matrix, many of the technologies require this step and it is likely one field survey will satisfy the needs for all technologies.
- **Plans, Specifications, and Estimate Design:** As with any new deployment, a detailed design should be completed to ensure:
  - Equipment Installation
  - Equipment Configuration
- **Incorporation of Existing Functions**
- **Software / Firmware Compatibility**
  - Component Validation
  - Local Agency / Stakeholder Coordination

The table below highlights candidate smart intersections throughout the County, outlining potential sensors and technologies that could be implemented to enhance safety, connectivity, and environmental monitoring.

[31] One smart corridor does not have any intersections.

Potential Sensors	Intersection Aerial	Potential Sensors	Intersection Aerial
Holt Ave & Benson Ave, Montclair, *West Valley* ▪ VRU Safety, Public / Agency Wi-Fi, Speed Indicators, CV RSU		Cedar Ave & Valley Blvd Bloomington, *East Valley* ▪ Weather/ Air Quality Sensor, ALPR, CV RSUs, Freight Management	
Sierra Ave & Valley Blvd Fontana, *West Valley* ▪ VRU Safety, Public / Agency Wi-Fi, ALPR, Speed Indicators, CV RSU		W 9th St & H St San Bernardino, East Valley ▪ VRU Safety, Public / Agency Wi-Fi, ALPR, Speed Indicators, CV RSU	
Mission Blvd & Milliken Ave *Ontario, West Valley* ▪ Public / Agency Wi-Fi, Weather/ Air Quality Sensor, CV RSUs, Freight Management		W Baseline St & N Arrowhead Ave *San Bernardino, East Valley* ▪ VRU Safety, Public / Agency Wi-Fi, Weather / Air Quality Sensor, CV RSU, FSP	
S Grove Ave & Mission Blvd *Ontario, West Valley* ▪ VRU Safety System, Public / Agency Wi-Fi, Weather/ Air Quality Sensor		Redlands Blvd & Alabama St *Redlands, East Valley* ▪ VRU Safety System, Public / Agency Wi-Fi, Weather/ Air Quality Sensor	
Archibald Ave & Mission Blvd, *Ontario, West Valley* ▪ Weather/ Air Quality Sensor, ALPR, CV RSUs, Freight Management		S E St & W 5th St San Bernardino, East Valley ▪ VRU Safety System, Public / Agency Wi-Fi, Weather/ Air Quality Sensor	

Potential Sensors	Intersection Aerial
Alabama St & San Bernardino Ave *Alabama, East Valley* ▪ Weather/ Air Quality Sensor, ALPR, CV RSUs, Freight Management	
Bear Valley Rd & Hesperia Rd *Victorville, High Desert* ▪ VRU Safety, Speed Indicators	
SR-38 & SR-18 Big Bear, High Desert ▪ VRU Safety System, Public / Agency Wi-Fi, Weather/ Air Quality Sensor	
Mojave Dr & 7th St High Desert, High Desert ▪ VRU Safety System, Public / Agency Wi-Fi, Weather/ Air Quality Sensor	
395 & Joshua St Hesperia, High Desert ▪ VRU Safety, Weather / Air Quality Sensor, EV Charging, Smart Metering, CV RSU	

Potential Sensors	Intersection Aerial
Adobe Rd & SR-62 Twentynine Palms, Low Desert ▪ VRU Safety, Public / Agency Wi-Fi, Weather / Air Quality Sensor, CV RSU, FSP	
Lear Ave & SR-62 Twentynine Palms, Low Desert ▪ VRU Safety, Public / Agency Wi-Fi, Weather / Air Quality Sensor, CV RSU, FSP	
SR-62 & SR-247 Yucca Valley, Low Desert ▪ VRU Safety System, Weather/ Air Quality Sensor, ALPR, CV RSUs, Freight Management	
SR-247 & Yucca Tr Yucca Valley, Low Desert ▪ VRU Safety System, Public / Agency Wi-Fi, Weather/ Air Quality Sensor	

Table 5-10: Smart Intersection Component Upgrade Matrix

	Field Survey	Plans, Specifications, and Estimate Design	Equipment Installation	Equipment Configuration	Incorporate Existing Functions	Software/ firmware compatibility Check	Component Validation	Local Agency / Stakeholder Coordination
Upgrade Traffic Signal Controllers	✓	✓	✓	✓	✓	✓	✓	
Upgrade Vehicle Detection (from loops)	✓	✓	✓	✓			✓	
Upgrade Bike/Ped Detection	✓	✓	✓	✓			✓	
Deploy Fiber-Optic Communications Infrastructure (local agency)	✓	✓	✓	✓			✓	
Deploy Closed-Circuit Television Cameras at Intersections	✓	✓	✓	✓			✓	
Upgrade Traffic Signal Timing (including Leading Pedestrian Interval (LPI))	✓	✓			✓		✓	
Deploy ALPRs	✓	✓	✓	✓	✓		✓	✓
Deploy Air Quality Sensors	✓	✓	✓	✓			✓	✓
Deploy Connected Vehicle Roadside Units (RSU)	✓	✓	✓	✓		✓	✓	✓
Deploy a Connected Vehicle Application (focused on freight movement)				✓		✓	✓	✓
Interconnect Middle-Mile Broadband Fiber to Local Agency Fiber and/or Last-Mile Fiber (create a demarcation point to MMBB fiber)	✓	✓	✓	✓	✓	✓	✓	✓

5.2.5 Relevant Stakeholders

Typically, smart intersection amenities will be added to existing infrastructure by the IOOs. Depending on location, this could be a city, the county, or Caltrans. The type and level of change will dictate the appropriate level of community outreach.

The immediate stakeholders to help further develop this strategy include IOO traffic operations personnel, the SBCTA Transportation Technical Advisory Committee (TTAC), and the IT working group.

5.2.6 Benefits

Smart intersections provide numerous benefits, the following are some of these benefits:

- Minimized Disruptions and Improved Travel Times:
  - Benefits: Travelers
  - Impact: Provides smoother and faster journeys, reducing congestion and travel delays.
- Higher Level of Service:
  - Benefits: Travelers, IOOs
  - Impact: Enhances the travel experience by improving traffic flow and reducing wait times at intersections.
- Lower Operations and Maintenance Costs:
  - Benefits: IOOs
  - Impact: Reduces expenses associated with the upkeep and operation of intersection infrastructure.
- Reduced Instances of Crashes:
  - Benefits: Travelers, IOOs
  - Impact: Increases safety, leading to fewer accidents and reduced costs related to crash response and management.
- Real-time Monitoring and Control:
  - Benefits: IOOs, Travelers
  - Impact: Enables immediate adjustments to traffic signals and management strategies, improving overall traffic efficiency and response to incidents.
- Regional Benefits:
  - Benefits: Municipalities, IOOs, Travelers
  - Impact: Provides a cumulative advantage as more areas adopt smart intersection technology, leading to widespread improvements in traffic management across the region.
- Data Collection:
  - Benefits: IOOs, Regional Planners
  - Impact: Facilitates the gathering of detailed traffic data, allowing for better-informed decisions and tailored solutions to specific regional and intersection needs.

5.2.7 Costs

Smart intersections will vary in cost depending on the desired sensor suite and upgrades that the interested agency might include. On the high end, implementing two LiDAR sensors at an intersection may cost upwards of $20,000, whereas implementing a weather sensor may cost around $1,000, both barring any needed communication or power upgrades. IOOs must also decide the ITS deployment size; a pilot project is a great proof of concept, but it would have a much higher cost per unit than if numerous IOOs created a large joint purchase order for some sensor that would be prolifically used. The USDOT operates a library of project costs for ITS deployments which is an excellent resource for IOOs to consult for previous ITS deployment costs.[32] **Table 5-11** shows the anticipated expenses for implementing smart intersections (per intersection).

Table 5-11: Smart Intersection Project Costs (per intersection)

Cost Category	Estimated Cost
Preliminary Activities	$16,000-$32,000
Equipment	$5,000-$100,000
Construction	$65,000
Estimated Implementation Cost	$86,000 - $197,000
Ongoing Operations and Maintenance (per year)	$13,000

5.3 Alternative Fuel Vehicles

One of the larger concentrations of electric vehicles in California is in San Bernardino County; the county ranks in the top 10 counties for light-duty EV registrations.[33] California has mandated that all new light-duty vehicles sold beyond 2035 will be zero-emission vehicles.[34] This will drive a demand for EV charging infrastructure.

AFVs run on fuels other than conventional diesel or gasoline. These fuels emit less pollutants and include natural gas, hydrogen, and electricity. AFVs have been gaining popularity due to increasing gasoline prices and environmental concerns like climate change and criteria pollutants. The last few decades have seen a remarkable rise in the adoption of alternative fuels in both commercial and private passenger vehicles nationally and on a state level. AFVs are often known for their efficient energy use and reduced greenhouse gas emissions.

The rising trend in EV usage presents a pivotal opportunity to expand the EV charging infrastructure. Federal and state grant funding plays an important role in accelerating this expansion, making EVs a more feasible option for a larger demographic. The importance of these grants, methods to support agencies to apply for these funds, and guidance on prioritizing which grants to pursue are discussed in **Section 6.4**. The overarching goal is to expedite the expansion of EV infrastructure, contributing to a sustainable future. This section examines the existing trends and electrification efforts to date, setting the stage for a comprehensive understanding of the current landscape and future possibilities.

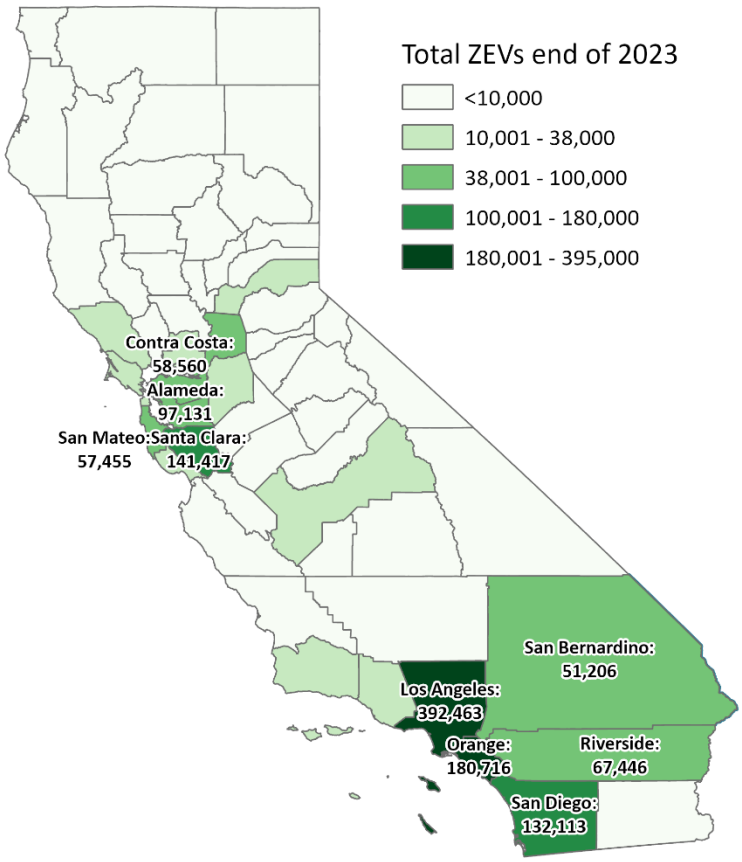
The California Energy Commission (CEC) has partnered with the Department of Motor Vehicles to track the sales and population of light-duty ZEVs (Zero-Emission Vehicles) in California, which include battery-electric (BEV), plug-in hybrid electric (PHEV), and fuel-cell electric vehicles.[35] California has been leading the U.S. in ZEV adoption, with significant policy support at the state level. The State has made considerable efforts to accelerate California's electric and zero-emissions future, which includes surpassing the goal of 1.5 million ZEVs ahead of schedule and proposing new federal emissions standards. The State has achieved 24.7% of all new cars sold in Q4 2023 as ZEVs

[32] Costs | ITS Deployment Evaluation (dot.gov)
[33] Light-Duty Vehicle Population in California
[34] Cars and Light-Trucks are Going Zero - Frequently Asked Questions | California Air Resources Board
[35] Zero Emission Vehicle and Infrastructure Statistics - Collection (ca.gov)

and has offered up to $24,500 in grants and rebates for low-income Californians.[36] These initiatives are part of California's broader commitment to have 100% of new car sales as ZEVs by 2035 and to increase the number of zero-emission trucks on the road. As of June 2024, the state of California has sold more EVs than the next 10 states combined.

The adoption of ZEVs in San Bernardino County is part of a larger trend observed across California. By the end of 2023, there were 51,206 ZEVs on the road in San Bernardino County[37], up from 36,094 in 2022. **Figure 5-8** compares San Bernardino County to other counties across California. San Bernardino ranked as the 9th highest among California's 58 counties in terms of the number of light-duty ZEVs registered. This number is expected to continue to rise over the next several years.

Figure 5-8: Total ZEVs in California Counties



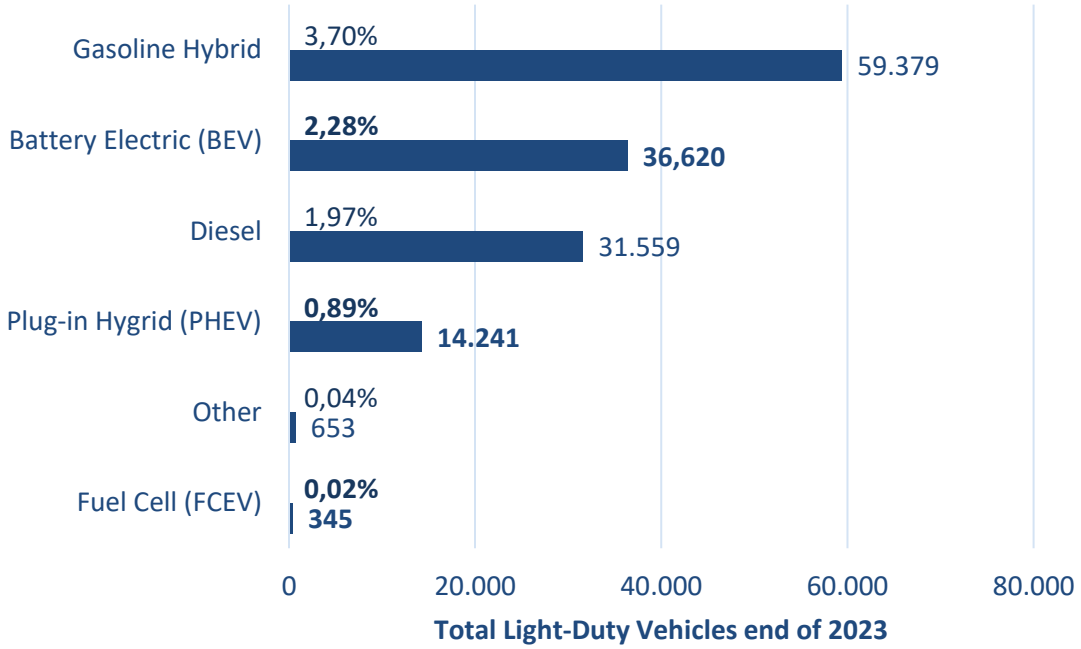
Source: California Energy Commission

San Bernardino County's total percentage of registered ZEVs as of the end of 2023 is 3.19%. This is detailed in **Figure 5-9**, where the ZEVs are broken down into 36,620 BEVs (2.28%), 14,241 PHEVs (0.89%) and 345 fuel-cell electric vehicles (0.02%).

[36] https://www.gov.ca.gov/2023/04/21/california-surpasses-1-5-million-zevs-goal-two-years-ahead-of-schedule/

[37] Light-Duty Vehicle Population in California

Figure 5-9: Total Light-Duty Vehicles Registered in San Bernardino County by End of 2023



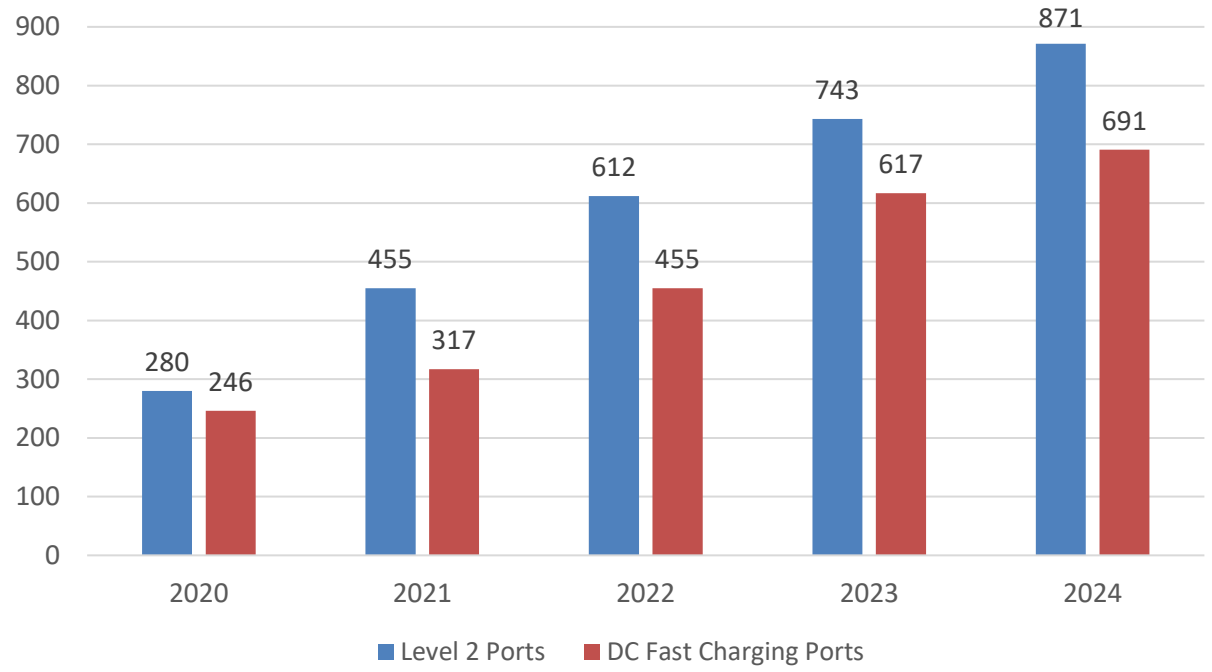
Source: California Energy Commission

San Bernardino County has been proactive in supporting the growing number of ZEVs. The County has developed the Countywide Zero-Emission Vehicle Readiness and Implementation Plan.[38] This plan is aimed at guiding government agencies in the region to develop actionable approaches for removing barriers to ZEV adoption and identifying charging station deployment opportunities, particularly focusing on supporting the projected 82,500 ZEVs by 2025. The plan recommends additional ZEV infrastructure at public agencies, workplaces, destinations, and transit stations, with a particular focus on disadvantaged communities.

As of July 2024, there were 871 public Level 2 ports, and 691 Direct Current (DC) fast-charging ports in San Bernardino. A Level 2 port generally uses a 240-volt power source (like a clothing dryer outlet) to provide for electric vehicle charging of one car at a time. Level 2 stations may have multiple ports. Level 2 ports can fully charge a car in 4 to 8 hours. DC fast-charging ports generally require 480-volt electrical service and can fully charge electric vehicles in 20 to 60 minutes. Level 2 ports are appropriate for workplace and destination charging. DC fast-charging ports are ideal for quick stops during long trips. The number of Level 2 and DC fast-charging ports has steadily increased over the years. **Figure 5-10** shows the cumulative total of ports for each year beginning from 2020.

[38] https://www.gosbcta.com/san-bernardino-countywide-zero-emission-vehicle-readiness-and-implementation-plan/

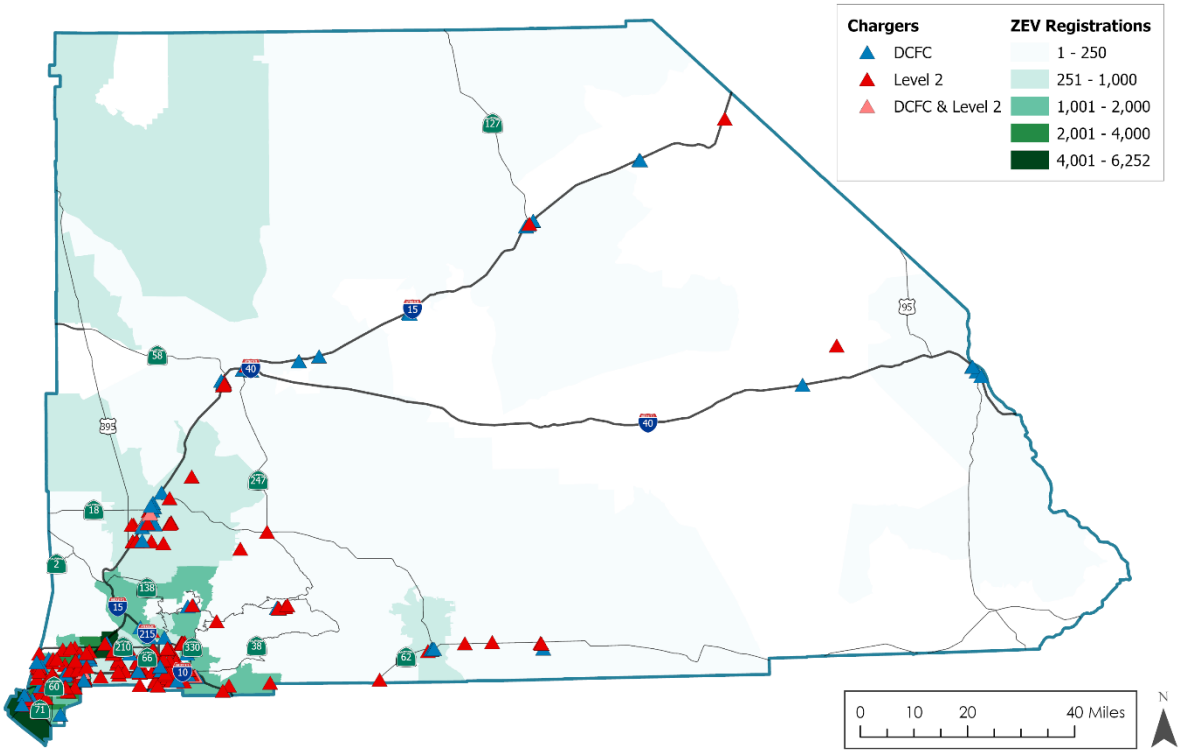
Figure 5-10: San Bernardino County Public Electric Vehicle Infrastructure



Source: Alternative Fuel Data Center, retrieved July 2024

San Bernardino County has experienced a significant increase in the number of ZEVs and charging infrastructure. In Q2 of 2024, the county's ZEV adoption rate was 20.10%, slightly lower than California's overall rate of 25.70%. A large part of this growth is observed in the West and East Valley, for both ZEV registrations and charging infrastructure deployment, as shown in **Figure 5-11**.

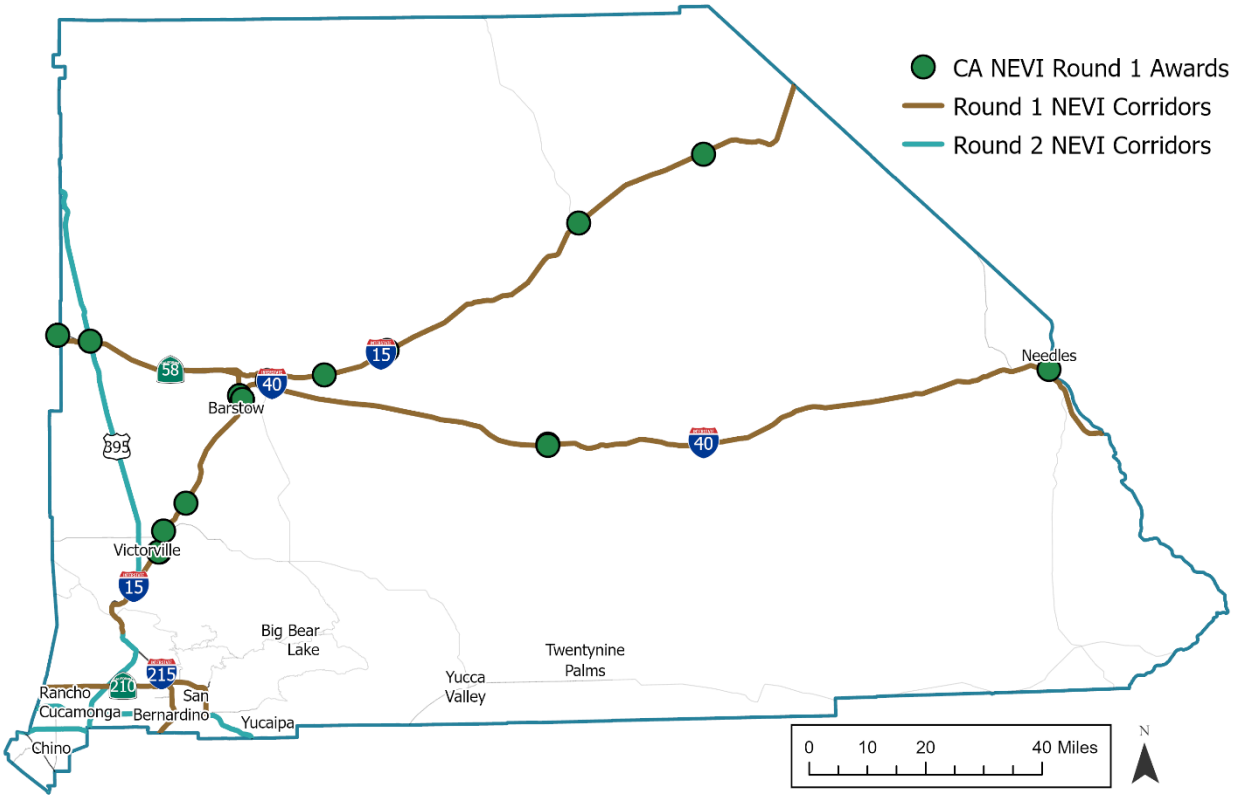
Figure 5-11: ZEV Registrations and Charging Infrastructure in San Bernardino County



Source: California Energy Commission, End of 2023; Alternative Fuels Data Center, November 2024

Caltrans and the CEC are partnering to implement the federal National Electric Vehicle Infrastructure (NEVI) Formula Program. California's share of this program is approximately $384 million over 5 years. In the first round of procurement, California awarded $32,722,295 for nine projects. San Bernardino County will receive 120 DC fast-charging ports that will cover key routes including I-15, I-40, and State Route 58, as illustrated in **Figure 5-12.** Round 2 of the California NEVI program will expand to include sections of I-5, I-10, I-15, and US-395.

Figure 5-12: California NEVI Round 1 Awards in San Bernardino County



Source: California Energy Commission, retrieved December 2024

Given the increasing trend in EV usage, this momentum presents an opportune time to further expand EV charging infrastructure. By leveraging available federal and state grant funding, this expansion can be accelerated, making EVs an increasingly viable option for more people.

5.3.1 Benchmarking

Below are some recent EV efforts that have elements applicable to San Bernardino, highlighting significant advancements in sustainable mobility:

- **Smart Columbus Playbook, Ohio:**[39] The Smart Columbus Playbook serves as a strategic roadmap to foster innovation, enhance mobility, improve sustainability, and stimulate economic growth. A key focus of the playbook is the promotion of EVs, with initiatives aimed at increasing EV adoption, expanding charging infrastructure, and providing EV education.

[39] https://smartcolumbus.com/playbook-assets/our-journey/welcome-to-the-smart-columbus-playbook

- **City of Ontario, California, Smart Ontario:** Ontario is implementing state-of-the-art technologies to create a brighter future for its 176,000+ residents and 11,000 businesses. With solar panel structures, backup battery energy storage systems, EV charging stations, and LED streetlights citywide.[40]
- **St. Paul, Minnesota**: St. Paul launched the largest publicly owned, renewably powered, electric car-sharing program in the nation, Evie Carshare.
- **Orlando, Florida**: Orlando is now requiring all new buildings and major remodel projects to integrate EV charging infrastructure.
- **Charlotte, NC**: the Charlotte city council approved a groundbreaking approach to overcome initial hesitation about up-front costs of transitioning to electric buses. A pilot program enables the city to try out—and train staff on—18 electric buses and charging infrastructure from various manufacturers to collect data on what will fit Charlotte's needs.
- **Detroit, MI**: MDOT worked with technology firm, Electreon Wireless, to install a quarter-mile length of inductive charging to charge electric vehicles as they drive along the roadway. The EVs have to be specially equipped with Electreon hardware and the area will be used as a testing ground for a few years before being opened to the public.
- **Los Angeles, CA**: The University of California, Los Angeles recently won a grant to fund the installation of inductive charging for transit into a campus roadway and at passenger pick-up and drop-off areas and transit depots.

5.3.2 Potential Strategy Elements

The below potential strategy elements can facilitate the expansion of EV infrastructure and increase EV adoption in San Bernardino County:

- **Education and Outreach:**
  - Develop guides and information resources available to jurisdictions for funding pursuits.
  - Raise awareness about the benefits of EVs through public campaigns, workshops, and community events.
  - Provide information on available incentives, charging locations, and cost savings to encourage residents to adopt EVs.
- **Early Coordination:**
  - Convene meetings with local jurisdictions to incentivize early coordination with utilities and private companies to expand EV charging infrastructure.
- **Partnerships and Grant Support:**
  - Provide letters of support for application to federal and state grants earmarked for EV infrastructure developments.
  - Work with private site managers where appropriate, such as managers of multi-family apartment sites, and seek partnerships with private companies, nonprofits, and educational institutions. These collaborations can lead to joint initiatives, research, and funding opportunities.
- **Community Feedback and Planning:**

[40] https://smartontarioca.com/

  - Gather community feedback through surveys to understand community needs and preferences, which can guide the planning and deployment of EV infrastructure.

- **EV Charging at Intersections:**
  - Leverage excess power available at intersections to install on-street charging infrastructure.
  - Deploy traditional Level 2 charging units adjacent to parking stalls.
- **Fleet Electrification:**
  - Collaborate with public and private partners to identify the most suitable options for fleet electrification.
  - Explore potential grants and develop comprehensive resources and guides to assist jurisdictions in their funding pursuits.
- **Assessment and Feasibility:**
  - Evaluate the downtime and utilization of existing charging stations to identify high-demand sites for additional installations.
  - Conduct land use and feasibility studies (e.g., electricity availability) to prioritize potential locations for new EV infrastructure across the county.

In addition to expanding EV infrastructure, it is worth noting that there are existing hydrogen refueling stations and existing initiatives to expand the hydrogen infrastructure in the county. Notably, the California Fuel Cell Partnership[41] initiative to expand hydrogen refueling stations statewide plays a role in developing a diverse and resilient alternative fuel infrastructure. Future strategies should consider integrating hydrogen infrastructure developments to complement the overall sustainable transportation network.

5.3.3 User Needs

The Existing Conditions Report has highlighted the current insufficiency of both the charging infrastructure and its funding to support the anticipated volume of EVs as the State strives to meet zero-emissions goals for cars, passenger trucks, and medium- and heavy-duty vehicles in the county. **Table 5-12** presents the AFVs user needs.

Table 5-12: Alternative Fuel Vehicles User Needs

Category	User Needs
Equity and Environment	▪ Need to accelerate transition to zero-emission freight and passenger vehicles through coordination with private sector on accessible and easy-to-locate zero-emission charging and fueling infrastructure.

5.3.4 Prioritized Strategy Deployments

Expanding EV infrastructure should be focused on high traffic corridors, in disadvantaged communities where at-home charging may be unavailable and in areas where charging does not currently exist. Major routes with high traffic should be considered to help facilitate long-distance travel and for the ease of shorter commutes. Access to disadvantaged communities could also be considered, ensuring that the benefits of EVs are not limited to affluent areas. Other considerations might include areas with multi-unit dwellings, neighborhoods without access to having at-home charging installed, visitor destinations, or regions where the grid can readily support additional load. By

[41] H2Hubs ARCHES_Award Fact Sheet.pdf (energy.gov)

deploying EV infrastructure in this strategic manner, it is possible to create more options for EV drivers, focus infrastructure where it is needed most and promote the adoption of EVs.

Because medium and heavy-duty trucks have significantly greater energy requirements, and travel longer distances, it is critical to consider hydrogen as a fuel source for emerging hydrogen fuel cell (HFC) trucks. Both HFC and EV trucks are beginning to come off the assembly line, and the need for charging/fueling infrastructure is being addressed through significant state and federal grant programs. The California Transportation Commission prepared the Clean Freight Corridor Efficiency Assessment in late 2023 (see: sb671-final-clean-freight-corridor-efficiency-assessment-dor.pdf (ca.gov)), and three of the top six corridors for investment run through San Bernardino County (I-10, I-15, and I-40). See **Figure 5-13** for a map of the priority corridors. SBCTA and other entities are working with the private sector vendors to bring as much of this funding to San Bernardino County as possible. A recent award by EPA of Climate Pollution Reduction Grant (CPRG) funding to the South Coast Air Quality Management District will help considerably with this infusion of funding to accelerate the transition to clean trucks via both electric and hydrogen. In addition, California was awarded $1.2 billion to jump-start a set of hydrogen production hubs under the moniker ARCHES (Alliance for Renewable Clean Hydrogen Energy Systems). See link to the ARCHES fact sheet here: H2Hubs ARCHES_Award Fact Sheet.pdf (energy.gov).

Figure 5-13: Top 6 Priority Corridors for Clean Truck Investment in the CTC's SB 671 Assessment

Table 5-13 outlines the different charging priorities, opportunities, and considerations. The table provides an overview of the various charging priorities but is not exhaustive. There may be other factors and considerations that are not included in this table but could be relevant depending on the specific context.

Table 5-13: Types of Charging

Type of Charging	Description	Opportunities	Considerations
Major Routes	Strategically placed along major highways and travel corridors to facilitate long-distance travel.	▪ Limited funding availability. ▪ Resiliency and redundancy.	▪ Geographical prioritization of stations. ▪ Planning and permitting coordination. ▪ Grid capacity.
Community Charging	Provides accessible EV charging in residential and public areas to support local EV owners.	▪ Convenience. ▪ Economic development. ▪ Ability to focus on underserved areas.	▪ Planning and permitting coordination. ▪ Location selection. ▪ EV education.
Destination Charging	Offers charging at tourist attractions to support the tourism industry.	▪ More chargers for a smaller investment. ▪ Longer duration of stay.	▪ Permitting and planning coordination. ▪ Location selection. ▪ Matching funds. ▪ Grid capacity.
Freight Charging and Hydrogen Fueling	Support commercial fleet electrification and HFC truck fueling with rapid chargers and hydrogen fueling at logistic centers and on freight corridors, especially for long-haul trucks.	▪ Enable lifecycle cost savings. ▪ Emissions reduction.	▪ Initial cost. ▪ Planning horizon for charging infrastructure. ▪ Grid capacity/Power draws. ▪ Cyber and physical security. ▪ Site selection. ▪ Vehicle and cargo weight.
Other Types	Covers specialized needs and innovative technologies.	▪ Accessibility. ▪ Resiliency. ▪ Economic development.	▪ Slower MD/HD adoption rates. ▪ Existing transit ZEB funding. ▪ Training emergency personnel.

5.3.5 Relevant Stakeholders

EV and hydrogen fueling infrastructure stakeholders can be very broad as both the public and private sectors can play a role. **Table 5-14** provides information on the stakeholders and their respective roles in EV permitting, deployment, use, and response situations.

Table 5-14: Alternative Fuel Vehicles Relevant Stakeholders

Agency	Role
SBCOG	▪ Collaborate with local cities, agencies, and representatives to develop strategies for EV infrastructure. ▪ Identify charging station opportunities and support shovel-ready projects.
San Bernardino County Member Jurisdictions	▪ Collaborate with SBCOG and other stakeholders to implement EV infrastructure strategies locally. ▪ Support the permitting and installation of EV charging stations.
Charging Infrastructure Providers	▪ Provide incentives for companies to build and operate charging stations.
San Bernardino County Department of Public Health	▪ Public/community engagement efforts contributing to public well-being and community development by involvement in EV charging initiatives to promote health, safety, and sustainable transportation options.

Agency	Role
Workforce Development Board (WDB)	▪ Focusing on workforce readiness and economic development. ▪ Tribal, utility, and site-specific engagement in support of funding pursuits.
General Public	▪ Participate in community meetings to support the planning and implementation of EV infrastructure.

One key project that was identified in the San Bernardino County Early Action Plan to meet the need of insufficient charging infrastructure is to proactively secure funding for charging and fueling infrastructure for zero-emission passenger vehicles and trucks, through collaboration between SBCTA/SBCOG and local jurisdictions throughout San Bernardino County. Focus on public agency-led grant applications with charging vendor partners, while encouraging local jurisdictions to develop zero-emission charging sites and apply for funding on their own in parallel.

The immediate stakeholder group that will help develop this strategy further is the TTAC and city managers.

5.3.6 Benefits

Adopting AFVs offers a range of benefits that promote environmental sustainability, economic growth, and energy security. The following are some of these benefits:

- Reduction in Greenhouse Gas Emissions:
  - Benefits: Environment, Urban Residents
  - Impact: Improved air quality due to zero tailpipe emissions from EVs.
- Support for Renewable Energy Sector:
  - Benefits: Renewable Energy Industry, Environment
  - Impact: Increased use of electricity generated from renewable sources, promoting cleaner energy.
- Economic Growth:
  - Benefits: Job Seekers, Local Economies
  - Impact: Job creation in EV manufacturing, charging station installation, and maintenance services.
- Reduced Dependence on Fossil Fuels:
  - Benefits: National Energy Security, Consumers
  - Impact: Enhanced energy security and resilience, less reliance on imported fossil fuels.
- Lower Operating Costs for Consumers:
  - Benefits: Consumers
  - Impact: Reduced expenses due to cheaper electricity compared to gasoline and lower maintenance needs for EVs.

5.3.7 Costs

Expanding EV and hydrogen fueling infrastructure, particularly the deployment of DC fast chargers, involves significant costs due to their complex installation and operation requirements. The average cost of a DC fast-charging port typically ranges from $150,000 for a 50-kW port to $250,000 for a 150-kW port, while a Level 2 charging port generally falls within the $3,500 to $10,000 range depending on the size of installation, power availability and upgrades, vendor, trenching needed, and other considerations. The cost of hydrogen fueling

infrastructure varies and the cost of H2 production needs to come down to make the fuel more economically viable. Significant reductions in price are expected between now and 2030 as the demand grows. Costs for H2 fueling are not included since they are so variable at this time.

Table 5-15 breaks down the average cost of deploying and operating a DC fast-charging port and a Level 2 port.

Table 5-15: Average Deployment and Operating Costs of Charging Infrastructure

Cost Category	Estimated Level 2 Port Cost	Estimated DC Fast-Charging Port Cost (150 kW)
Preliminary Activities	$800	$10,000
Construction	$8,000	$180,000
Estimated Implementation Cost	$8,800	$190,000
Operations and Maintenance (per year)	$200	$5,000

The up-front capital costs for fast-charging stations are high. A 150 kW to 350 kW DC fast-charging unit can cost anywhere from $45,000 to over $150,000. Federal grants significantly alleviate the cost associated with expanding EV infrastructure. Typically, grants offer an 80/20 matching program, meaning that for every dollar spent by the grant recipient, the federal government provides an additional four dollars.

5.4 Uncrewed Aerial Systems Operations

AAM is a developing industry that uses smaller aircraft to provide services and move both goods and people. They typically fly shorter distances and can provide access to more remote rural or tighter urban locations than traditional aircraft. AAM focuses on highly automated aircraft that are most often electric and can take off vertically and include smaller UAS aircraft, commonly referred to as drones. These aircraft can be piloted remotely and are increasingly used as eyes in the sky to see infrastructure and situations that are too difficult or dangerous to access by normal means and quickly determine appropriate response needs. UAS are proving to be a tool to de-risk government activities and provide last-mile delivery services.

San Bernardino County can invest in and promote the use of UAS operations in several ways, including investing in the digital communications infrastructure necessary to support operations beyond visual line of sight, as well as critical public safety applications including infrastructure inspection, emergency response, and public safety applications. These efforts would enable more immediate benefits to the community. While the use of larger UAS aircraft for passenger transport is a long-term vision and dependent on overcoming significant regulatory and technological challenges, focusing on current applications will help lay the groundwork for future advancements. In the meantime, the County's role can be centered around fostering innovation, and ensuring that the local infrastructure evolves to support future UAS technologies as they emerge.

San Bernardino County is home to some of the nation’s most cutting edge UAS testing, research, and application, including:

- The UAS Center at SBD International Airport was established in 2020 and holds the Federal Aviation Administration (FAA) Certificate of Authorization that allows for the testing and demonstration of UAS technology.[42] The UAS Center, an enterprise fund under the Inland Valley Development Agency, works in close partnership with the San Bernardino County Fire District.
- The City of Ontario is promoting the use of small UAS to enable the delivery of goods via the adoption of an integrated system that identifies potential hazards, provides real-time authorization of UAS operations, and provides flight monitoring, leveraging the City’s advanced fiber-optic broadband network.

[42] https://uascentersbd.com/

- Via funding obtained through the Urban Areas Security Initiative, the San Bernardino County Fire Protection District is obtaining two small UAS, which will allow improved planning and operational coordination.
- The San Bernardino County Fire Protection District is using drones as first responders for early wildfire detection, leveraging CAD data to determine which calls may require aerial surveillance. These autonomous systems gather information from wildfire videos and can take immediate action by deploying fire suppressants. This technology is currently undergoing pilot testing on Little Mountain.

5.4.1 Benchmarking

This section reviews the key trends in UAS operations and focuses on a pivotal benchmark that illustrates the current state and potential of this emerging field.

LOS ANGELES DEPARTMENT OF TRANSPORTATION (LADOT), CALIFORNIA

LADOT, LA Department of City Planning, and the LA Mayor's office are collectively developing the policies and procedures to regulate Urban Air Mobility (UAM) (Urban Air Mobility) operations in anticipation of greater adoption. The UAM Policy Framework Considerations report considers privacy, workforce development, data, and economic growth while developing policies for site and operation permitting.[43]

TEXAS TRANSPORTATION COMMISSION URBAN AIR MOBILITY COMMITTEE

The Committee explored the intersection of policy and technology to develop a set of recommendations to support the UAM ecosystem development for the State of Texas. The Urban Air Mobility Advisory Committee Report presents a set of recommendations that can be used as a foundation for developing new regulations that can facilitate the development of the State's UAM deployment and adaptation capabilities.[44]

ADVANCED MOBILITY NC[45]

The North Carolina Department of Transportation's Division of Aviation and its Integrated Mobility Division partnered to develop North Carolina's five-year Advanced Transportation Mobility Strategic plan in 2024. The strategic plan envisions future advanced mobility use cases where air and ground mobility come together at hubs in North Carolina, provides a framework for local agencies to prepare for advanced mobility technologies, and details specific action items to support North Carolina's path to an advanced mobility future.

DRIVEOHIO – ADVANCED AIR MOBILITY FRAMEWORK

Ohio developed a statewide AAM Framework to apply AAM for the safe, efficient, and equitable transportation of people and goods throughout the state. Ohio, through DriveOhio's UAS Center, has been working with many stakeholders on AAM and UAS solutions for the state since 2013. The Framework discusses the Ohio's opportunities to allow AAM to increase modality options, safety, and improve transportation resiliency and efficiency. The Framework captures the existing AAM ecosystem, Ohio specific activities, route planning considerations, recommendations for establishing vertiports, and provides a strategic framework for Ohio to support AAM.[46]

5.4.2 Potential Strategy Elements

Potential strategy elements that can facilitate the expansion of UAS operations include the following:

[43] https://ladot.lacity.gov/sites/default/files/documents/ladot-uam-policy-framework-considerations.pdf
[44] https://ftp.txdot.gov/pub/txdot/avn/uam-report.pdf
[45] https://www.ncdot.gov/divisions/aviation/advance-mobility/Pages/advanced-transportation-mobility-plan.aspx
[46] https://drive.ohio.gov/programs/aam/aam-framework

- **Coordination and Education:**
  - SBCTA to convene semi-annual meetings to share latest UAS operations activity, benefits, and lessons learned from partners and provide advice to agency partners working to incorporate UAS into their operations, modeled after similar efforts throughout the country.
  - Seek opportunities to promote use cases for UAS operations and the benefits they may provide to transportation users.
- **Funding and Grant Support:**
  - Provide information on available incentives and grants to lower the barriers to entry and encourage member agencies to adopt UAS operations.
  - Consider opportunities for agencies to work together to support joint grant applications wherein one agency owns and operates the equipment, but it is available for other agencies to use.
  - Provide letters of support for UAS operations funding requests and grant applications.
- **Partnership:**
  - Explore partnerships within SBCTA and with private companies, nonprofits, and research institutions to support economic and workforce development opportunities.

5.4.3 User Needs

The UAS operations strategy addresses the user needs listed in **Table 5-16**.

Table 5-16: Uncrewed Aerial Systems Operations User Needs

Category	User Needs
Public Safety	▪ Need to reduce the time required to reach, identify, and support emergency response situations, including wildfire, search-and-rescue, and police response scenarios. ▪ Need to reduce risks to safety for routine or emergency infrastructure inspection. ▪ Need to develop the digital infrastructure necessary to support reliable and redundant communications networks (i.e., broadband networks). ▪ Need to provide situational awareness systems to Police Departments (e.g., during active shootings).

5.4.4 Prioritized Strategy Deployments

Based on the stakeholder outreach conducted, which included meetings with San Bernardino County Fire, CONFIRE, and the City of Ontario, it was determined that the focus of prioritized deployments should be centered on emergency response and public safety.

UAS have the potential to revolutionize emergency response scenarios. While many companies are exploring the use of drones for delivering goods ranging from groceries to critical medical supplies, the focus here is on their application to aid in preventing, assessing, and assisting in emergency situations.

In diverse landscapes like San Bernardino County, drones can be particularly useful. This region, with its mix of residential and remote areas, is often susceptible to natural disasters. In such situations, traditional vehicle transport can become too dangerous or even impossible.

However, drones can overcome these challenges. They can quickly reach, identify, and provide support in emergency situations, including wildfires, search-and-rescue operations, and police response scenarios. By reducing the time required to respond to these emergencies and the possibility of harm to the responders, drones

can significantly enhance the effectiveness of disaster management strategies. This makes them a valuable asset in ensuring the safety and well-being of communities, particularly those in outlying areas.

In addition to emergency response, UAS can also be used as a tool for infrastructure inspections, where overhead wiring or cabinets/equipment are not easily accessible by vehicles. Drones can provide a quick and efficient way to inspect infrastructure improving service reliability. This use case further demonstrates the versatility and potential of UAS in various sectors.

5.4.5 Relevant Stakeholders

All government agencies within the county can be a stakeholder in this technology whether they provide these services themselves or use a centralized provider (i.e., SBCTA). Within each government agency, there can be multiple stakeholders ranging from police and fire to public service/public works and public utilities.

The immediate stakeholder group that will help develop this strategy further is the TTAC.

5.4.6 Benefits

Implementing UAS technologies provides numerous benefits in various sectors, enhancing efficiency, safety, and innovation. The following are some of these benefits:

- Infrastructure Inspections:
  - Benefits: IOOs
  - Impact: Enhanced safety by reducing human error, mechanical failures, and fuel consumption associated with traditional aviation.
- Emergency Services Response:
  - Benefits: Emergency Responders, Communities
  - Impact: Faster response times, improved efficiency in emergency situations.
- Package Delivery:
  - Benefits: Consumers, Delivery Services
  - Impact: Time savings, cost reduction, and reduced greenhouse gas emissions by relocating goods movement from ground to air.
- Support for Renewable Energy Sector:
  - Benefits: Renewable Energy Industry, Environment
  - Impact: Increased use of electricity from renewable sources to power UAS, promoting cleaner energy.
- Economic Growth:
  - Benefits: Job Seekers, Local Economies
  - Impact: Job creation in manufacturing, training, operations, maintenance, and service roles associated with UAS technologies.
- New Air Corridors for People and Goods:
  - Benefits: Travelers, Businesses, Urban Planners
  - Impact: Development of new transit routes connecting various hubs, promoting efficient transportation and urban development.

5.4.7 Costs

Enabling UAS operations will require capital, operations and maintenance costs. Capital costs for small UAS suited to specific activities can range from thousands to over $100,000 for the aircraft depending on factors including on-board equipment, flight time, and other features. Costs for pilots and other support personnel will include training, certification (for pilots) and labor when performing UAS duties. For small UAS, San Bernardino County can also expect costs associated with minor charging infrastructure. Widespread adoption of larger aircraft and associated operational costs, combined with digital and physical infrastructure costs are not yet easily identified. **Table 5-17** shows the estimated costs of deploying and operating UAS.

Table 5-17: Uncrewed Aerial Systems Project-Related Costs

Cost Category	Estimated Cost
Preliminary Activities (Aircraft and charging infrastructure purchase, pilot certification, training)	$5,000 - >$100,000 per drone/operator
Construction	Incidental costs associated with small UAS operations; According to a recent report documenting 125 UAS deployments, the operational cost for a UAS is $20 per hour.*
Estimated Implementation Cost	The cost of a single UAS for public safety can vary widely and depends on the capabilities and features. Assuming a mid-range drone costing $20,000 each, 10 drones would cost around $200,000.
Ongoing Operations and Maintenance (per year) (Pilot and support personnel labor and any maintenance for aircraft)	Minimal

* https://ops.fhwa.dot.gov/publications/fhwahop20063/fhwahop20063.pdf

5.5 Broadband Enhancement

San Bernardino County residents lag overall broadband access by 5% compared to the state average.[47] Broadband enhancement is crucial for improving internet connectivity and accessibility across various regions. This is particularly relevant for different applications such as home use, business operations, and emergency response services. Home broadband supports online learning, work from home, and digital leisure activities. It enables the use of smart devices, streaming platforms, and video chat tools. Current advancements aim to boost speed and dependability. Business broadband underpins operations like cloud-based computing, data storage, digital marketing, and remote teamwork. Upgrades allow for quicker data transfer, enhanced video call quality, and continuous cloud services. Emergency broadband offers dependable communication channels during emergencies, facilitating real-time information sharing and quicker response times. Developments focus on creating robust networks that can endure various disaster scenarios.

Broadband communication refers to high-speed internet and has historically been given a benchmark speed of 25/3 Mbps (download/upload speeds) by the Federal Communications Commission. However, in 2024, CPUC and Federal Communications Commission rulemaking has revised the benchmark to 100/100 Mbps or 100/20 Mbps where impractical.[48] (These target speeds are an expected outcome of this plan.)

[47] California Public Utilities Commission (CPUC). 2023. "State of California Fixed Consumer Broadband Deployment." https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/communications-division/documents/broadband-mapping/docs-uploaded-2023/household-deployment-by-county-as-of-dec-31-2021.pdf

[48] California Public Utilities Commission (CPUC). 2023. "CPUC Adopts Program Rules To Bring Broadband to Communities Most in Need." CPUC Adopts Program Rules To Bring Broadband to Communities Most in Need

Several efforts are currently underway in California and San Bernardino County to bridge the digital divide:

- In September 2023, Governor Gavin Newson signed the Digital Equity Bill of Rights (AB414), which establishes a framework to ensure all Californians have equitable access to affordable and reliable broadband, devices, digital skills trainings, and technical support.[49]
- The State of California Department of Technology's Middle-Mile Broadband initiative, BMMN, will construct fiber-optic cable trunk lines along the State Highway Network – in conjunction with Caltrans – to provide vital connections between the internet backbone and last-mile providers.
- As part of California's Broadband for All program, multiple grants were awarded in August of 2024 that intend to deliver high-speed internet to thousands of unserved and underserved areas in San Bernardino County[50]
- In September 2024, the San Bernardino Board of Supervisors approved an increase to $2.5 million in grant funds for devices, tablets, smartphones, and hotspots with two-year service plans, technical support, and training for older adults and individuals with disabilities.[51]

In total, these will allow for subsidized broadband internet access for underserved county residents and businesses that are not adequately covered by current commercial broadband service providers. They will also support local agencies in connecting more of their facilities (i.e., government buildings, schools, police/fire stations), Traffic Management Centers, and ITS field devices.

5.5.1 Benchmarking

Broadband enhancement is crucial for improving internet connectivity and accessibility across various regions for home use, business operations, and emergency response services.

This section presents the latest trends and benchmarks in the different broadband applications, highlighting key improvements and their role in expanding digital inclusion.

STARLINK

Starlink is a satellite internet service provided by SpaceX, aimed at delivering high-speed internet globally through a constellation of low-earth orbit (LEO) satellites. This technology allows for the transmission of internet data between ground stations, satellites, and user terminals with minimal latency compared to traditional satellite internet. The advantages of using Starlink are particularly evident in rural and remote areas where traditional broadband infrastructure and cellular service is either non-existent or too costly to deploy. It offers rapid deployment, improved broadband speeds, cellular services, and more reliable internet connectivity. Importantly, a service like Starlink could significantly enhance the operations of emergency responders in rural areas where other connectivity options may be limited or non-existent.

Several corridors in San Bernardino County lack call boxes[52] and/or cellular service, which can be devastating in an emergency. SR 38, a popular tourist destination in the summer, has neither call boxes nor cellular service. In May 2024, two children drowned at Thurman Flats, a mountain destination with very limited cellular service (depending on location and carrier) and no call box at the entrance. The nearest call box is 0.7 miles away. Starlink could provide better coverage for cell phone usage. Instances of Starlink implementation in rural areas include:

[49] California Emerging Technology Fund (CETF). 2023. "Digital Equity Bill of Rights Signed By Governor Newson."

[50] California Public Utilities Commission (CPUC). 2023. "CASF Infrastructure Proposed Project Summaries."

[51] San Bernardino County. 2024. "Bridging the digital divide: County expands older adults' access to technology."

[52] In Fall 2024, San Bernardino County canceled the vendor contract for operation and maintenance of their call box services due to the vendor's inability to perform at an acceptable level.

- In Cuba, New Mexico, the community lacked internet infrastructure, affecting remote learning during the COVID-19 pandemic. Implementing Starlink enabled over 400 households to access online education and other essential services.[53]
- In East Carroll Parish, Louisiana, where lack of internet access hindered educational and job opportunities, the introduction of Starlink to 120 households facilitated remote learning and job applications, enhancing digital accessibility in the community.[54]
- In San Bernardino County, safety agencies have found innovative ways to use Starlink to enhance their operations. In areas where broadband is not available, Starlink has proven to be a valuable tool, helping to identify hazards during search-and-rescue operations led by the Sheriff's department. During incidents, the department can bring in Starlink to create a network, ensuring constant communication. SBC Fire is considering the installation of flat satellite antennas on top of vehicles to maintain uninterrupted communication. Furthermore, they are exploring the use of mesh networks for efficient data transmission. This technology could significantly improve the department's ability to respond to emergencies, particularly in rural and remote areas.

FIRSTNET

FirstNet is a nationwide, interoperable LTE network that provides reliable and secure communication for public safety professionals and first responders. FirstNet provides real, dedicated mobile broadband when needed with always-on priority and preemption for first responders. It was created to help save lives, solve crimes, and keep communities safe, and one of its top priorities is reaching rural areas. More than 25,000 public safety agencies and organizations use FirstNet, including law enforcement, fire services, emergency management services, 9-1-1, and emergency management. Given its proven reliability and wide reach, FirstNet could be a viable communication option to consider.

CHATTANOOGA, TENNESSEE, COMMUNITY-WIDE FIBER-OPTIC NETWORK

Chattanooga's high-speed, community-wide fiber-optic network has delivered economic and social benefits worth over $2.69 billion in its first decade.[55] The network, launched in 2010, was built by the City-owned utility Electric Power Board to support an advanced smart grid power distribution system.[56] There are several other municipal broadband networks in the country, but the Electric Power Board was the first to offer gigabit speeds citywide – at 1,000 Mbps and later 10,000 Mbps.

CITY OF ONTARIO, CALIFORNIA

Ontario is building one of California's very first municipally owned fiber-optic networks, that aims to deliver high-speed fiber internet to all Ontario residents and businesses.[57] Over 1,400 residential + 250 commercial customers are serviced. Given its pioneering efforts in this area, Ontario can serve as a valuable benchmark from which other regions can learn and apply lessons in their own pursuit of establishing high-speed internet infrastructure.

The City of Ontario has been successful in building out their roadside network and has taken several steps that can help other jurisdictions. Below are key highlights:

[53] https://stories.starlink.com/stories/internet-from-space-for-students-in-rural-new-mexico
[54] https://stories.starlink.com/stories/internet-from-space-for-louisiana-students
[55] https://cities-today.com/chattanoogas-municipal-broadband-pays-off-with-2-69-billion-in-benefits/
[56] https://www.tn.gov/content/dam/tn/health/documents/healthy-places/successfulcasestudies/TRRN_CS_Chattanooga_Broadband_Infrastructure_2013.pdf
[57] Ontario Fiber | City of Ontario, California (ontarioca.gov)

- **Network Layout and Expansion**: The City of Ontario has built a network with fiber throughout small neighborhoods and communities. They have started to build into areas that were underserved, aiming to build a resilient network ring.
- **Funding and Partnerships**: The city has a revenue-sharing agreement with Onward, an internet service provider partner for Ontario Net. The city keeps 60% of the revenue, which supports their build-out and operational support.
- **Construction and Infrastructure**: The city has separate contracts for conduit installation and cabling work. They have over 250 miles of fiber throughout the city and aim to accomplish fiber-optic infrastructure throughout the entire city.
- **Wireless Ventures**: The city is venturing into the wireless space, utilizing their streetlights. They are running fiber to their streetlights and have deployed Ubiquiti nodes in a pilot area to test their fixed wireless solution to the home.
- **Metrics of Success**: The city is looking at new metrics on educational attainment and advancement. They are working with different school districts to understand their needs and looking at opportunities to conduct pilots with students having trouble with connectivity.

5.5.2 Potential Strategy Elements

Elements needed to implement broadband enhancement are physical fiber-optic infrastructure components to link the BMMN fiber trunk line with existing local stakeholder communications infrastructure. This includes buried conduit with fiber-optic trunk line cables, vaults, splice enclosures, and fiber-optic pull boxes. Handoff of networks will typically occur at a middle-mile node. **Figure 5-14** shows a typical fiber Caltrans field network node which is likely to take on the same form as an envisioned middle-mile node/demarcation.

Figure 5-14: Typical Broadband Enhancement Node Connection

Where impractical to extend wired internet connectivity, wireless and satellite internet can be used. Rural areas of the county could utilize these methods in the short and medium term, with a long-term goal being to extend fiber connectivity to all parts of the county.

Satellite internet has become a more attractive option as latency has dropped due in part to low-earth orbit and medium-earth orbit satellites, popularly available through Starlink. Starlink can provide internet with latency that is roughly similar to fixed broadband.[58] Although Starlink is more expensive where fixed broadband is available, areas where fixed broadband is not available might be best served by providing subsidized satellite-based internet connections to bridge the digital divide.[59]

In addition to improving broadband infrastructure, San Bernardino County plans to address the high costs and declining usage of approximately 750 existing call boxes by removing them and seeking an alternate solution for areas with little or no cellular service to ensure continued access to emergency services. Replacement options include:

[58] How Starlink's Satellite Internet Stacks Up Against HughesNet and Viasat around the Globe (ookla.com)
[59] Starlink vs. T-Mobile Home Internet: Which Is Better for Rural Internet? - CNET

- New call boxes with satellite or cellular modems,
- Implementing Wi-Fi along highways using poles with solar panels and satellite modems, or
- Increasing cellular coverage by collaborating with public utilities to install additional cell towers.

Ensuring physical security, to prevent theft and vandalism, is a top priority. Measures being researched include using concrete poles, installing underground junction boxes with steel lids and security bolts, using security bolts and screws, hiding above-ground enclosures, mounting equipment high on poles, and relocating poles away from roads or behind fences. Pilot testing is needed and discussions with Caltrans and California Highway Patrol (CHP) are required before field deployment decisions can be made. SBCTA will continue to explore these options further.

5.5.3 User Needs

The Broadband Enhancements strategy addresses the user needs listed in **Table 5-18**.

Table 5-18: Broadband Enhancement User Needs

Category	Needs
Equity	▪ Need for reliable communications network throughout the County. ▪ Need to build upon the State of California's BMMN to bridge the gap with "last-mile" connections. ▪ Need to provide public outreach and education regarding the implementation of emerging technologies (e.g., broadband). ▪ Need to provide enabling infrastructure to support ITS project elements.

5.5.4 Prioritized Strategy Deployment Locations

The challenges and opportunities for broadband deployment are different across the four regions of San Bernardino County so the solution will need to be tailored appropriately. Jurisdictions have the option to build municipal fiber networks like Ontario. Through SBCTA/SBCOG, it is possible to foster partnerships between municipalities to develop the projects, so they do not end at a jurisdiction border.

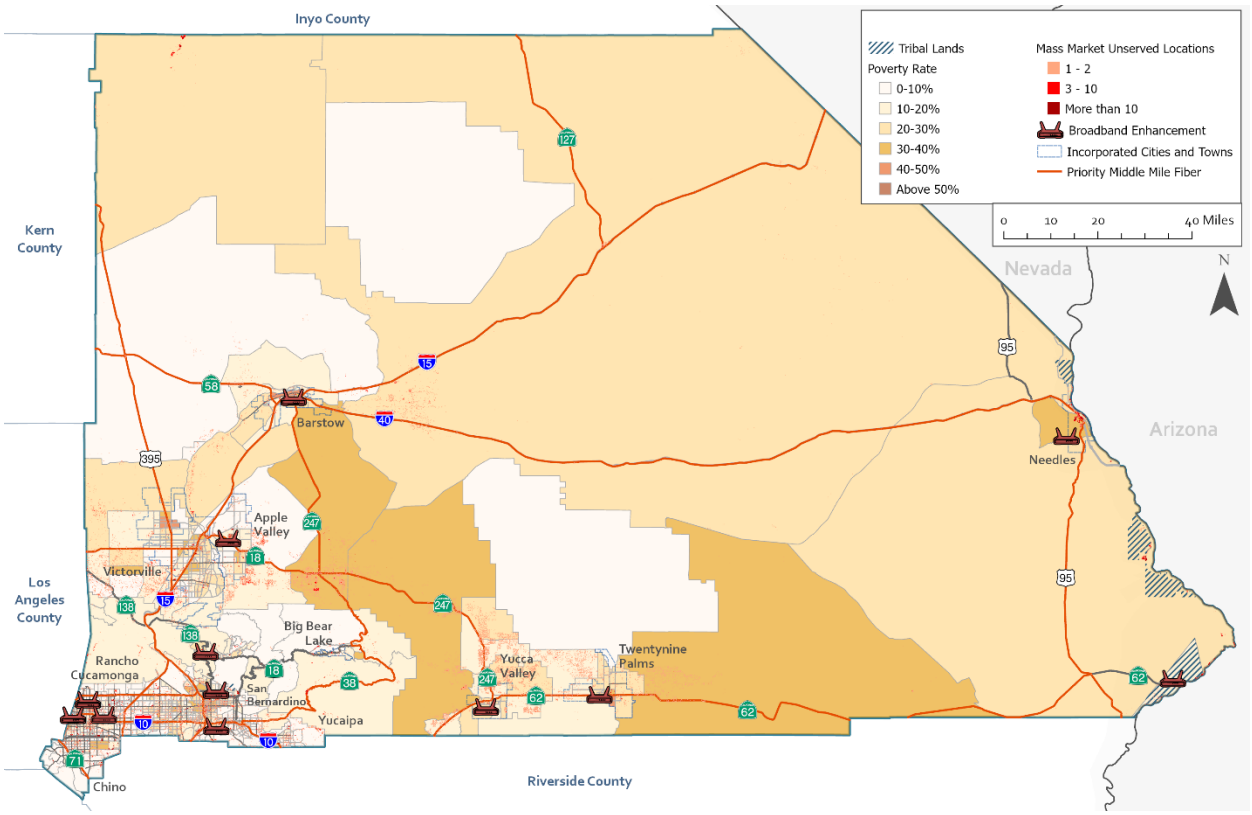
Broadband deployment candidates were identified using CPUC's 2023 data and GIS software, which aggregated and ranked unserved locations based on the number of households without adequate internet speeds. Cross-referencing with additional map layers confirmed fiber-optic conduit installation as the preferred method for bridging the digital divide. The detailed methodology for broadband deployment selection is presented in the Early Action Plan.

The locations below have been identified as potential broadband deployment candidates and are presented in priority order. These are shown in **Figure 5-15**.

- West Valley, City of Upland – from Early Action Plan
- East Valley, City of San Bernardino – from Early Action Plan
- High Desert, City of Barstow – from Early Action Plan
- Low Desert, City of Yucca Valley – from Early Action Plan
- East Valley, City of Montclair – I-10 will have Broadband. Interest was expressed in this location at the February 1 workshop.
- West Valley, City of Ontario – I-10 and I-15 will have Broadband. City already has a public network. This would enhance it.

- East Valley, City of Loma Linda – I-10 and US66 will have Broadband. City already has a public network. This would enhance it.
- High Desert, City of Twentynine Palms
- High Desert, City of Apple Valley
- High Desert, an undeserved area in the mountains
- Low Desert, City of Needles
- Low Desert and East Valley Tribal Areas

Figure 5-15: Potential Broadband Deployment Locations



5.5.5 Relevant Stakeholders

Relevant stakeholders for broadband enhancements include information technology and traffic departments from applicable agencies, Caltrans District 8, and the State of California Department of Technology.

The public in each of these defined locations should also be considered as stakeholders. Beyond sharing their needs, the residents or businesses can provide test environments and feedback on any implementation.

The immediate stakeholder group that will help develop this strategy further is the IT working group.

5.5.6 Benefits

Enhancing broadband infrastructure delivers multiple benefits, driving economic growth, improving connectivity, and supporting advanced technologies. The following are some of these benefits:

- Lower Cost Plans for Residents:
  - Benefits: Residents
  - Impact: Affordable broadband access through municipal networks.
- Grants for Private Broadband Network Development:
  - Benefits: Municipalities, Broadband Providers
  - Impact: Financial support for developing broadband infrastructure.
- Customization and Flexibility:
  - Benefits: Municipalities, Residents, Businesses
  - Impact: Enhanced services and higher speeds not typically available from private providers, as seen with Electric Power Board in Chattanooga, Tennessee.
- Economic Growth and Job Creation:
  - Benefits: Local Economies, Job Seekers
  - Impact: Opportunities in network construction, maintenance, and related services.
- Enhanced Traffic Management Capabilities:
  - Benefits: Municipalities, Traffic Management Authorities
  - Impact: Improved ITS device connectivity and traffic management through municipal broadband networks.
- Partnerships for Cost Reduction:
  - Benefits: Municipalities, Underserved Areas
  - Impact: Economies of scale driving down costs for fiber deployment in underserved areas.
- Risk Minimization:
  - Benefits: Municipalities
  - Impact: Reduced risk from network build-out and operational costs through partnerships with private providers.
- Cost Savings for Future Infrastructure:
  - Benefits: Municipalities, Future Projects
  - Impact: Long-term savings by laying spare conduit for future fiber installations, reducing the need for additional digging and associated costs.
- Enhanced Connectivity for Underserved Areas:
  - Benefits: Motorists and Residents in Unserved or Underserved Areas
  - Impact: Improved access to broadband services.
- Improved Procurement and Technical Understanding:
  - Benefits: Municipalities, Broadband Providers
  - Impact: Better procurement terms and technical insights through shared information and cooperative practices.

5.5.7 Costs

Table 5-19 summarizes the costs associated with broadband infrastructure deployment. These costs would be most applicable for connecting local agency fiber networks to the BMMN.

Table 5-19: Broadband Enhancement Related Costs

Cost Category	Estimated Cost (per mile)
Preliminary Activities (including permits, design, surveys, project management)	$10,000 - $30,000
Construction (trenching, conduit, pulling fiber-optic cables, splice enclosures, and vaults)	$60,000 - $100,000
Estimated Implementation Cost	$70,000 - $130,000
Ongoing Operations and Maintenance (per year) – includes repairs and monitoring the installed fiber-optic infrastructure	$1,000 - $5,000

5.6 Data Governance and Sharing

Data has become a new commodity for governments. For planning, data is invaluable to show needs or predict changes over time. For operations, it allows agencies to monitor system performance and react to potential issues. And for transparency of government action, data has become a powerful public relations tool. To properly harness the power of the collected data, a data governance plan should be created and updated regularly for each agency.

Data governance relates to procedures and standards for managing data including sourcing (collecting, creating, or purchasing), storing, securing, transforming, maintaining, and sharing data both internally and externally. A data governance plan documents the data and systems that an agency owns, describes roles and responsibilities for the agency's staff around the management, use, maintenance, and security of the data, and establishes standards, policies, and procedures for data management. Developing and implementing a data governance plan can be a lengthy process but the result is a better-informed team and higher quality data which can be used in myriad ways including sharing data with regional agencies.

Data sharing involves agencies coming together to identify data sets worth sharing and developing data sharing agreements and protocols to enable such sharing while safeguarding data and privacy. Establishing a data sharing working group to address and resolve data sharing issues across the region is often used to accomplish this. Even when the data each agency collects is used internally, creating standards, processes, and procedures that help public agencies share data with each other will help San Bernardino County member agencies become smarter together.

The rest of this section will focus on data sharing as the data governance aspect will need to be taken up by each agency individually.

5.6.1 Benchmarking

Data sharing is essential for fostering innovation and collaboration. This section outlines the latest trends and benchmarks, emphasizing the significant role that shared data plays.

SMART CITY PDX

- **Data Services (internal to the City of Portland)**: Smart City PDX's Data Services provides centralized, modern data management services that enhance the City of Portland's operations internally. This initiative spans various aspects of data management, from producing visible outputs like interactive dashboards to overseeing the governance, tools, and training that underpin data usage across city services. These comprehensive services improve the usefulness and longevity of data products while also enabling informed decision-making, ensuring that data acts as a powerful asset for the community. The program currently focuses on several strategic projects aimed at refining citywide data practices. These include the City Data Governance Committee, which sets best practices for data management; the Community Leads Cohort that integrates

community feedback into data policies; and the Community Safety Data Project, which improves public safety data systems. Additional initiatives like the Rescue Plan Data and Equity Strategies Team and support for the Transition Team's survey design and data analysis efforts demonstrate Smart City PDX's commitment to leveraging data for better service delivery and policy development, fostering an environment of collaboration and high-quality data governance.[60]

- **Open Data Program in Portland (Internal and External):** This program is designed to elevate transparency and foster a data-driven approach to city governance, thereby enhancing service outcomes. Launched to reduce the workload involved in handling data requests and to stimulate innovative solutions to urban challenges, the program emphasizes the importance of making city data accessible. This openness extends to data generated from various sources including city operations, and collaborations with the private sector, nonprofits, and academic institutions, aiming to support Portland's commitments to open access and extensive data sharing.[61] Originating with the pioneering Open Data Resolution in 2009, the first in the U.S., Portland has been a leader in open data practices. These efforts were expanded in 2017 with a formal ordinance that established a structured Open Data Program, promoting open standards to ensure interoperability and facilitate data exchange across different platforms. This strategic use of open data is intended to enhance community engagement, inform policymaking, and improve the quality of life.

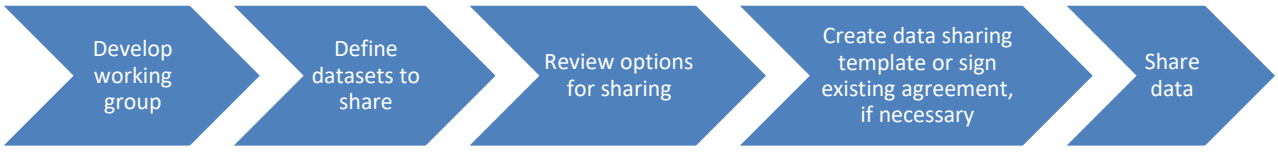
KING COUNTY HOMELESS MANAGEMENT INFORMATION SYSTEM (HMIS)

The HMIS in King County, Washington (which includes the City of Seattle), is a pivotal tool used by the King County Regional Homelessness Authority to optimize homelessness services. This secure online database enhances service delivery by streamlining access to housing and support, thereby advancing efforts to reduce homelessness. It securely stores detailed client information, protected by advanced security features, to facilitate benefits such as reduced duplicate assessments, coordinated case management, and streamlined referrals. Moreover, it aids agency directors in tracking outcomes and enhances public policymakers' ability to evaluate and respond to homelessness trends and needs. HMIS utilizes Bitfocus, Inc.'s Clarity Human Services software for automated and customized processes. This system complies with federal mandates and ensures data privacy. The King County Regional Homelessness Authority leverages its data to generate comprehensive reports. These reports serve to enhance the capacity of local organizations to deliver housing and services, ultimately strengthening regional efforts to eradicate homelessness.[62]

5.6.2 Potential Strategy Elements

At a high level, the data sharing strategy is envisioned to be composed of the following elements shown in **Figure 5-16.**

Figure 5-16: Data Sharing Strategy Elements



When defining datasets to share, the working group needs to identify what datasets are available from each agency and what datasets are valuable to other agencies. As the working group talks through datasets, they can

[60] https://www.portland.gov/bps/smart-city-pdx/data-services
[61] https://www.portland.gov/bps/smart-city-pdx/open-data-program
[62] King County Home (bitfocus.com)

identify categories of data based on value to the agencies. **Table 5-20** highlights examples of datasets that might be available from agencies and their perceived value.

Table 5-20: Examples of Available Datasets from Agencies

Description	High Value	Medium Value	Low Value
Dataset	Fiber Owned by Agency	Fleet Availability	Traffic Data
Reasoning	This can be valuable to understand where interagency connections can be made at jurisdiction borders.	Fleet data can be valuable if a natural disaster or emergency situation leaves one agency's fleet vehicles unusable. Understanding the available fleet of a neighboring jurisdiction can allow for faster mutual aid requests.	Waze data is already available to all agencies so adding another traffic dataset may be less valuable.

Data sharing on a large, organized scale is often easiest with a common data portal. SBCTA member agencies currently have access to two regional data portals (RIITS and SCAG). SCAG is a regional planning organization for all aspects of planning in Southern California and operates a data portal focused on planning data. RIITS is an operational exchange of resources for transportation focusing on real-time information of regional significance as it relates to the ITS architecture for the Los Angeles region. Each of these entities has their own mission for their data portal so inviting both to present their mission and portal abilities at a working group meeting will be advantageous. San Bernardino County has a data portal project underway with two main goals: 1. to create an internal dashboard for the County to have access to decision making data and to provide services more efficiently and 2. to create a data storage, access and sharing system for local agencies within the County. This project is still in the conceptual stage which could allow agencies to give input into what could be helpful to them in a portal. The San Bernardino County project team has shared they are open to working with cities within the County to identify what data could be available and where there are data gaps. If the above three options did not meet the needs of the SBCTA member agencies, a portal could be built to their specific, identified needs.

Table 5-21 lists the details and requirements for the four portal options at a high level.

Table 5-21: SBCTA Data Portal Options

Category	RIITS	SCAG Regional Data Platform and Local Data Exchange Portal	San Bernardino County Portal*	San Bernardino Data Portal*
Website	www.riits.net	Info: www.scag.ca.gov/RDP Landing Page: https://hub.scag.ca.gov/	TBD	TBD
Operated By	Los Angeles County Metro Transit Authority on behalf of RIITS members	SCAG team	San Bernardino County	TBD
Action Needed to Participate	Enter into an interagency membership agreement that includes the exchange of operational data, aligning with established data exchange standards. This membership includes a complete organization structure that provides access to RIITS resources, licenses, and agreements to allows sharing of the members data through RIITS.	An account is required to access the Local Data Exchange (LDX) Portal. The LDX is only accessible to designated staff from SCAG local jurisdictions and key partners.	TBD but expect the agency would need to enter into a data sharing agreement to have access. Also expect each agency would be asked to share data.	Each agency would need to enter into a data sharing agreement and share their data.

Category	RIITS	SCAG Regional Data Platform and Local Data Exchange Portal	San Bernardino County Portal*	San Bernardino Data Portal*
Cost to Share Data	No cost to exchange operational resources through RIITS. This is highly dependent on the operational and programs needs managed by organizations, as participation is dependent on collaboration through RIITS.	No cost to share data with data portal. This may change in the future.	TBD	TBD
Cost to Use Data	Agency personnel time and use of organizations operational and infrastructure resources.	Agency personnel time.	TBD	TBD
Ability to Host Sensitive/Private Datasets	Yes, the goal is to upload shareable datasets, but sensitive datasets can be secured with only authorized users able to access.	Yes, the goal is to upload shareable datasets, but sensitive datasets can be secured with only authorized users able to access.	TBD	Yes, the portal can be designed this way.
Cost to Build and Operate Data Portal	RIITS main benefit is providing the platform for member organizations to build their sharing environment for transportation information. The base costs are currently maintained by RIITS, but build costs are the responsibility of the member.	No expected future cost to build but upgrade costs could be split among members in the future.	TBD	Approximately $350,000 to build and $250,000 each year to operate and maintain

* The portal is currently a concept and not operational.

SBCTA agencies can use one, two or all three of these data portal options to share data as much or as little benefits their agency.

5.6.3 User Needs

Table 5-22 outlines the user needs that the data governance and sharing strategy fulfills.

Table 5-22: Data Sharing User Needs

Category	User Needs
Data Sharing	▪ Need to support standardized data collection, processing, and reporting as part of a centralized County data repository system. ▪ Need for updated communication protocols to exchange requests, responses, and messages with other subsystems and applications. ▪ Need to integrate systems across jurisdictions for better coordinated response to the needs of the homeless population. ▪ Need for updated communication protocols to share data among different jurisdictions. ▪ Need to improve quality, accuracy, and validation processes of collected data. ▪ Need for updated user security in accordance with existing IT security policies and procedures that are applicable to the IT environment of the ITS elements. ▪ Need to secure sensitive data via encryption in accordance with enterprise IT policies on information security. ▪ Need for cloud-based services to host systems/applications.
Operations & Maintenance	▪ Need for active asset management platform to effectively plan and maintain regional assets.

Performance Metrics	▪ Need to develop, assess, and present performance metrics for continuous improvement and reporting. ▪ Need to consider opportunities to share collected data and performance metrics with stakeholders, and public/private sectors.

5.6.4 Prioritized Strategy Deployments

The initial strategy deployment will be activating a Data Working Group. To kick off the agency engagement, a survey will be created to assess the interest, benefits, willingness, and ability of each agency to share data. A series of meetings will allow the working group to walk through an understanding of available data at each agency, create data sharing language, update or build data governance documents, and create a data sharing pilot.

Once data governance and sharing practices are established, other projects will come easier or should be considered as a follow-up to this effort. The following opportunities came from the Early Action Report and numerous conversations with San Bernardino County and the agencies within the county including the February 1, 2024, City Managers, and IT Directors meeting.

- **Data Analysis**: Utilize collected data to identify patterns, trends, and areas of improvement to enhance operational efficiency and decision-making processes.
- **Traveler Information Systems**: Develop and implement systems to provide real-time information to travelers, improving traffic flow and reducing congestion.
- **Virtual Operations Center**: Establish a centralized, virtual hub for coordinating and managing transportation operations across various agencies within the county.
- **Information Sharing**: Promote the exchange of information between agencies to ensure cohesive and integrated transportation management and emergency response.
- **CAD-to-CAD**: Enhance communication and coordination between agencies during incidents and emergencies by integrating CAD systems.
- **Planning for Digital Delivery**: Establish standards and procedures to create, send and receive plans digitally.

DATA ANALYSIS

Data analysis has gone from paper and pen reviews to AI using datasets to create output that would take hours or even days for a human to complete. Each agency should consider what analytics solutions may be available to activate their data into a powerful tool to use for planning and decision-making. Advances in machine learning and AI are continuing to grow. Governments are starting to implement these tools for projects and processes including in the areas of human resources, traffic, and safety. The working group could host presentations from several companies experienced with data analytics to understand how each solution might benefit each agency.

TRAVELER INFORMATION SYSTEMS

Traveler Information Systems refer to any system that collects and analyzes traffic data. Typically, these systems are part of an agency's ITS program. These ITS systems can offer real-time data on traffic conditions, location of incidents, weather, road closures and other relevant information to help travelers reach their destination safely and more efficiently. Caltrans is responsible for managing and operating highway facilities and state routes. Overall, highway facilities are well equipped with Traveler Information Systems. However, most urban arterials and rural routes are not instrumented with these systems and offer little to no usable information other than third-party probe-based data.

This strategy aims to expand the county's existing Traveler Information Systems infrastructure to provide a high-quality traveler information service, focused on the key urban, suburban, and rural routes. This strategy would

ensure the agency-owned sensor infrastructure is deployed on key routes to enhance the granularity of traffic information.

At a high level, this strategy is envisioned to be composed of various key elements:

- Investment in traffic data services, utilizing agency-owned sensors and/or private sector probe data services.
- Consolidation of multiple data sources into a consistent format for each data type, such as road closure information, traffic data, incidents, and route performance, to allow easy data sharing among stakeholders.
- Establishing a trusted API to broadcast data to the public and private data users, within parameters established under the data use guidelines.
- Enhancing Go511 to be an available resource in a mobile application form to encourage adoption, such as by providing routing services for passenger car vs freight versus.

The components to this strategy require data to be successful. As the agencies become more comfortable sharing data across the county, this strategy can take shape.

VIRTUAL OPERATIONS CENTER

Once data sharing has been established, new opportunities for sharing emerge for agencies to gain better access to real-time systems and efficiencies through dashboard information and joint operations. One opportunity is to create a Virtual Operations Center (VOC). A VOC can be utilized as the core for managing multiple systems, where systems and personnel manage information about the transportation network and safety operations to ensure the safe and efficient movement of people and goods. A VOC can help monitor, collect, process, manage and disseminate real-time information without a physical facility. For example, operations would rely on the use of advanced web-based software solutions, cloud computing and Software as a Service. There are several benefits from implementing a VOC, these include but are not limited to:

- Cities with no existing operations center, and limited funding to build or maintain a physical facility.
- Intention to perform joint operations with other agencies – either by starting or merging centers.
- Need to monitor rural areas or specific corridors.
- Enhancement of emergency operations.

Most operations centers are housed in physical facilities and are typically managed by a single entity (e.g., DOT, agency). In San Bernardino, the regional TMC is managed by Caltrans District 8. Regional TMCs may experience challenges coordinating with local TMCs and smaller operations centers, especially during major events, limiting any opportunity for large-scale coordination. Some regions looking to help bridge this gap have elected to invest in a VOC to provide more consistent communication and coordination.

VOCs can benefit from emerging technologies which offer remote system accessibility and opportunities for multi-agency deployments. The VOC model relies more on data communications rather than on physical infrastructure.

In line with this, SBC Fire is piloting AI solutions that will aggregate fire data into one database with Microsoft. They have a minimum viable product and this solution will begin a phased deployment in September 2024 that will take about 3 years. This initiative is an example of how agencies are leveraging technology to enhance their operations and coordination efforts. It also underscores the potential of VOCs in facilitating such advancements. This strategy aims to implement a VOC that will oversee coordination of SBCOG agencies.

HOMELESS INFORMATION SHARING

In San Bernardino County in 2023, over 4,000 adults and children were identified as homeless during the 2023 Point-in-Time Count and Survey which was a 25.9% increase from 2022.[63] The homeless community can interact with many entities to receive services including assistance with food, transportation, jobs, short term shelter, medical treatment, and legal needs. An additional data sharing opportunity lies among social service and public safety agencies to share interaction data. Sharing information on previous services provided or interaction activity for an individual including through which agency the services were provided and the timeline would help an emergency responder know how to help the individual best. SBCTA has initiated conversations with the Homeless Outreach and Proactive Enforcement organization, which has done tremendous work pulling local resources together to serve the homeless more informatively and efficiently. Working with this organization and others in the county to research opportunities to share information should be considered.

COMPUTER-AIDED DISPATCH (CAD)-TO-CAD

Municipal and regional public safety emergency communications centers often lack the technology to efficiently interface with neighboring jurisdictions during emergencies. This may lead to delayed response times from not utilizing closer resources that are in a different jurisdiction or missing critical information necessary for the safety of first responders and the public.

Both San Bernardino County and public safety agencies, such as police, fire, and emergency medical services, utilize CAD systems and software in their dispatch centers to manage and coordinate emergency response. A CAD-to-CAD approach is particularly beneficial for operations centers dispatching services, enabling swift and efficient data exchange across diverse platforms. CAD systems streamline the dispatch process by providing real-time information and automating various functionalities. These systems typically include features such as call-taking, incident creation, unit assignment, mapping and routing, status tracking, and resource management.

While CAD systems offer numerous benefits, there are challenges with their implementation and use, particularly when it comes to use across different jurisdictions. San Bernardino County agencies use different versions and variations of CAD systems, each with its own features and capabilities. As the agencies work through data sharing, they can consider a CAD-to-CAD system for all public safety answering points that can elevate emergency service response. County Fire has initiated a CAD-to-CAD network with nine other agencies and is seeking an expanded set of participants within both San Bernardino and Riverside Counties. The expansion of this system is one of the Smart County Early Action Plan items, and SBCOG could assist by conducting some strategic planning and facilitating a collaboration across jurisdictions to move the process forward.

DIGITAL DELIVERY

Digital delivery, the practice of moving formerly paper-based plans for design, construction and as-builts to digital models to capture the entire lifecycle of a project, is becoming very popular across the United States. Digital delivery has been shown to create efficiencies and save costs, not the least of which is the paper that is used for producing large plan sets. One study showed that using digital delivery and building information modeling (BIM) (the modeling of the design and construction of infrastructure assets) saved 15% in change orders.[64]

This new technology shift requires planning but the data governance steps that are suggested in this plan can align with the governance that needs to be defined for digital delivery. The initial planning phase would include identifying members for a working group, laying out how plan delivery is currently done, understanding use cases and defining standards and procedures for the use of digital delivery.

[63] https://www.sbcounty.gov/uploads/sbchp/content/SBC-2023-Homeless-Count-Report.pdf

[64] https://www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/issues/magazine-issue/article/2023/03/transportation-agencies-shift-toward-digital-delivery

Taking this first planning step will allow the members to understand the technology and opportunities and collectively develop a framework for this technology to move forward.

5.6.5 Relevant Stakeholders

All agencies within San Bernardino County can be stakeholders for data governance and sharing. Villages, cities, and county agencies can share data with a centralized data portal or directly with each other. Specifically, technology department personnel will be effective as this strategy takes shape.

The immediate stakeholder group that will help develop this strategy further is the IT working group.

5.6.6 Benefits

Effective data governance and sharing mechanisms offer significant benefits, improving decision-making, operational efficiency, and funding opportunities. The following are some of these benefits:

- Better-Informed Decisions:
  - Benefits: Government Agencies, Policy Makers
  - Impact: Enhanced decision-making capabilities through access to comprehensive regional data.
- Increased Efficiency and Agility:
  - Benefits: Government Agencies, Residents
  - Impact: Streamlined operations and quicker response times due to efficient data sharing.
- Improved Grant Writing and Justification:
  - Benefits: Municipalities, Nonprofit Organizations
  - Impact: Easier grant applications and stronger justification for funding through detailed and accurate data reporting.

5.6.7 Costs

Costs will depend on which data sharing solution(s) are selected. With RIITS or SCAG, costs will likely be low to no cost but as these data portal options grow or if SCBCTA requests additional services from them to assist with data processing, a cost-share may be requested. The cost of creating a data portal can be split between the agencies using the portal. An estimate of the cost to create a data portal is shown in **Table 5-23**.

Table 5-23: New Data Portal Costs

Cost Category	Estimated Cost	Notes
Preliminary Activities	$80,000-100,000	Includes planning, data discovery, documentation, design, and procurement support, as needed
Construction	$250,000	Includes initial fee to purchase and set up an open data portal solution
Estimated Implementation Cost	$350,000 for first year	
Ongoing Operations and Maintenance (per year)	$250,000	Annual vendor fee to host and maintain solution

5.7 Joint Operations

Government agencies are often seeking opportunities to reduce costs while giving their residents the same high level of service more efficiently. Joint operations are where two or more agencies work together to deliver a service.

5.7.1 Benchmarking

JOINT POWERS AUTHORITIES (JPA)

JPAs in California represent a unique and effective model for public agencies to collaborate and achieve common goals efficiently. Established under the California Government Code section 6500 et seq., JPAs allow two or more public agencies to jointly exercise their powers, enhancing service provision through collective efforts. These entities can take the form of either contractual agreements or separate legal entities, each with distinct legal rights and responsibilities. By pooling resources and coordinating efforts, JPAs can secure better rates and bids for services, optimize resource sharing, and eliminate redundant actions. Through this collaborative framework, JPAs enable public agencies to address mutual challenges, fund projects, and act as a unified entity for specific activities.[65] SBCOG operates as an established JPA.

The SBCOG JPA is made up of representatives from 24 cities and towns and the San Bernardino County Board of Supervisors. The JPA was established to assist with cooperative regional planning.

THE COLUMBUS POLICE TRAINING ACADEMY

This academy, in Columbus, Ohio, exemplifies the principles of joint operations by integrating recruits from various law enforcement agencies into its comprehensive and standardized training programs. By hosting recruits from other police departments, particularly those that may not be large enough to conduct their own training, the academy ensures that all recruits receive appropriate certification. This joint training approach not only provides cost-effective solutions for smaller agencies but also fosters cross-agency networking and builds lasting relationships among personnel from different organizations. An additional benefit is that responders are trained in the same skills, enhancing their effectiveness during joint emergency efforts.[66]

THE BAY AREA JOINT INFORMATION SYSTEM (JIS)

JIS provides a comprehensive framework for coordinating public information and warning systems across the San Francisco Bay Area during emergencies. This system enhances emergency coordination by sharing situational awareness, collaborating on messages to avoid conflicts, monitoring social and traditional media, and addressing misinformation trends. It facilitates the sharing of written materials, supports mutual aid, manages media inquiries, and contributes to after-action reporting. The JIS adapts its coordination based on the emergency level, whether it involves a single Operational Area, multiple areas requiring a regional response, or a catastrophic event necessitating federal resources. A critical aspect of the JIS is the verification of information before dissemination, ensuring accurate and reliable communication. This systematic approach strengthens media confidence, supports effective response efforts, and serves as a model for interagency coordination in emergency management.[67]

JOINT/COOPERATIVE PURCHASING LAKE COUNTY, ILLINOIS

By encouraging other units of government to jointly procure goods and services, Lake County has significantly improved efficiency, generated greater economies of scale, and achieved substantial cost savings. In Fiscal Year 2017, the county leveraged over $8.9 million through cooperative contracts for a wide range of items including vehicles, IT software licensing, facilities maintenance equipment and services, and office supplies. These cooperative efforts include joint bids with local entities for bulk rock salt, elevator inspection services, copy paper, sand, gravel and spoil removal, crack sealing, and pavement marking. Additionally, Lake County has piggybacked on other regional contracts for root control, sewer televising services, and vehicle purchases, demonstrating a strategic approach to maximizing public resources and reducing administrative overhead.[68]

[65] https://www.nevada.courts.ca.gov/system/files/2021-spd-jointpowersauthorities.pdf
[66] Columbus Police Training Academy Training - City of Columbus, Ohio
[67] https://www.bayareauasi.org/jis
[68] https://www.lakecountyil.gov/4061/Joint-Purchasing

5.7.2 Potential Strategy Elements

Potential strategy elements that can facilitate joint operations opportunities between the San Bernardino County agencies include the following:

- **Joint Operations Working Group**
  - Establish a group with representatives from various interested agencies to identify and prioritize joint operation opportunities.
  - Evaluate potential joint operations based on feasibility, impact, resources, and alignment with each agency's strategic goals.
  - When considering new contracts for any joint operations that involve purchasing, review the opportunities presented by the existing SBCOG JPA.
  - Develop detailed plans for selected opportunities with clear timelines and responsibilities.

Once the working group is formed and operational, other potential duties/strategies for consideration are:

- **Interagency Collaboration Framework**
  - Develop interagency agreements to define roles, responsibilities, and resource sharing.
  - Establish task forces with personnel from different agencies to tackle specific challenges.
  - Align missions to ensure all agencies work towards common goals.
- **Group Purchasing**
  - Leverage group purchasing power to negotiate better prices for goods and services.
  - Use standardized contracts to streamline the procurement process across agencies.
  - Achieve cost savings and operational efficiencies through bulk purchasing and shared contracts.
  - Create a list of purchase topics and companies used by each agency to look for opportunities to share past contracts or feedback on service.
- **Joint Training Programs**
  - Conduct regular training sessions involving multiple agencies to improve teamwork and readiness.
  - Host workshops to share best practices and lessons learned.
- **Resource Sharing**
  - Utilize shared spaces to reduce costs and improve communication.
  - Create a joint funding mechanism for common projects.
  - Share technological resources and equipment.

5.7.3 User Needs

The joint operations strategy addresses the user needs listed in **Table 5-24**.

Table 5-24: Joint Operations User Needs

Category	Needs
Improve Government Operations	▪ Need to enhance existing partnerships for more efficient service delivery. ▪ Need to ensure high-quality, cost-effective service delivery. ▪ Need to foster new collaborations to improve the quality of life for residents. ▪ Need to benefit the community with improved resource allocation.

5.7.4 Prioritized Strategy Deployments

The following prioritized strategy deployment ideas were developed over many meetings with the county agencies both in-person and virtually.

GROUP PURCHASING

From pens to computers, most agencies buy the same goods. Coming together to make larger purchases of goods where price can be affected by quantities purchased can bring savings to the agencies involved. In cases where a group purchase does not make sense, sharing procurement requirements, documents, thinking and pricing outcomes will allow agencies to better negotiate future purchases. To move forward with group purchasing, agencies will first need to review their individual procurement laws to ensure it is allowable. It is expected that the department with purchasing needs, the procurement team, and the legal team will be involved in this research and conversation. Next, the agencies would consider whether to use the existing SBCOG JPA or a new contract to establish the purchasing relationship. Terms that are important to consider when purchasing as a group are: What type of items or services can be purchased by the group; who will handle the procurement documentation, review, and award; will contracts be through one agency or will all agencies involved have their own contract; and who can terminate a contract.

COORDINATED TRAINING OPPORTUNITIES

Like data sharing and joint purchasing, there can be sharing opportunities with training. If an agency is hosting training for new or existing software or a special skill, allowing other agencies to attend can create efficiencies and can create a team of users that can be helpful to each other. The first step towards a coordinated training effort is to identify similar training activities across agencies. From the basics like Microsoft Word to how to breach a house on fire, opportunities will exist to jointly train staff. Next the procurement and fiscal team members can review how much it currently costs to educate each student and the training staff can estimate how many additional students can be included and if the training facility can accommodate the larger class size. Finally, a cost benefit analysis can be done to decide which coordinated training makes the most fiscal and/or preparedness sense.

COAST TEAM MODEL

COAST in San Bernardino County provides an excellent model for interagency collaboration, focusing on mental health crises. COAST includes a team of professionals from the San Bernardino Sheriff's Department, San Bernardino County Department of Behavioral Health, and the San Bernardino County Fire Department. This multidisciplinary team, armed with data from each agency, proactively engages with community members experiencing mental health crises, intercepting calls for service before they escalate and require extensive first responder intervention. This approach not only alleviates the burden on first responders but also enhances community relations by providing personalized care and ongoing support to individuals in need. By forming a similar task force across agencies and sharing data, San Bernardino County can streamline crisis intervention efforts, reduce use-of-force incidents, and build trust within the community while creating efficiencies.

OTHER SERVICES

Other services can be jointly pursued. As not all agencies will have the people resources available or the full-time need to train new skills like drone operations, this is an area where another government agency can fulfill that service on an as-needed basis. Like the mutual aid agreements that are in place for San Bernardino County's Fire

and Rescue teams, there can be opportunities to share specialized skills or assets that are acquired by an agency. Sharing storage space in interconnect cabinets could assist an agency that is affected by an emergency incident. Often government agencies must forego new skills or asset opportunities due to a lack of people or fiscal resources. Looking at those opportunities with an eye toward regional growth and experience can allow for a joint option to share the costs and personnel to grow the region's abilities.

5.7.5 Relevant Stakeholders

All agencies can play a role in joint operations. From leading a program or procurement to purchasing equipment that can be jointly used, agencies of every size can participate.

The immediate stakeholder groups that will help develop this strategy further are the IT working group and the TTAC.

5.7.6 Benefits

Joint operations among agencies yield considerable benefits, including increased efficiency, cost savings, and enhanced coordination. The following are some of these benefits:

- Increased Efficiency:
  - Benefits: Participating Agencies
  - Impact: Streamlined operations and improved coordination among agencies.
- Lower Costs:
  - Benefits: Participating Agencies
  - Impact: Cost savings through shared resources and joint efforts.

5.7.7 Costs

Costs will be dependent on how the joint operations are executed but most costs will come in the form of in-kind labor contributions.

6 Master Plan

Together, the seven prioritized strategies and costs presented in **Chapter 5** form the basis of the Smart County MP. This chapter compiles them and provides an overview of the scope, schedule and costs associated with implementing these strategies. Potential funding sources are provided, as identifying, and securing appropriate funding is essential to ensure the successful realization of this Smart County Master Plan's objectives. Overall, this chapter aims to provide a framework for moving forward with the proposed strategies. Together with the toolkit provided in **Chapter 6**, it will support effective execution of the strategies.

6.1 Scope and Schedule

Figure 6-1 and **Figure 6-2** depict the proposed strategies and their recommended locations across the county. The locations cover all four regions in a way that addresses the specific needs and priorities of each region. The map also indicates disadvantaged or low-income areas, as this awareness will help in addressing equity and accessibility.

The schedule for the proposed strategies, shown in **Table 6-1**, provides a high-level plan for implementation of the strategies from 2025 to 2034. In addition to the timing, the schedule also specifies the roles and responsibilities associated with each task, identifying if the county or local government are responsible, supporting, or informed. At key points the schedule also indicates where the general public should be informed. Together with the toolkit materials provided in the next chapter, these materials are intended to support implementation of the proposed strategies.

Figure 6-1: Master Plan Strategies

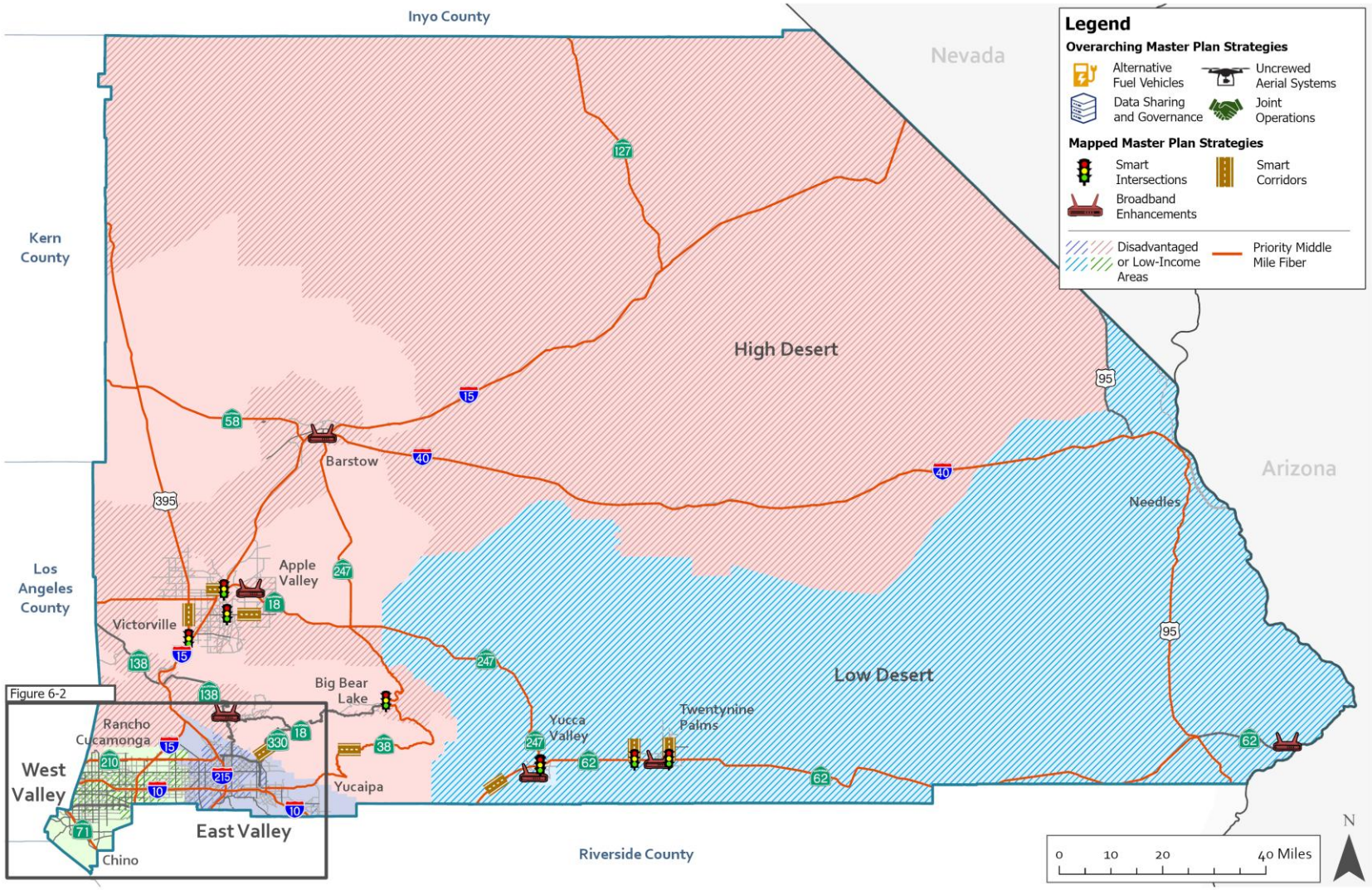


Figure 6-2: Master Plan Strategies in West Valley and East Valley

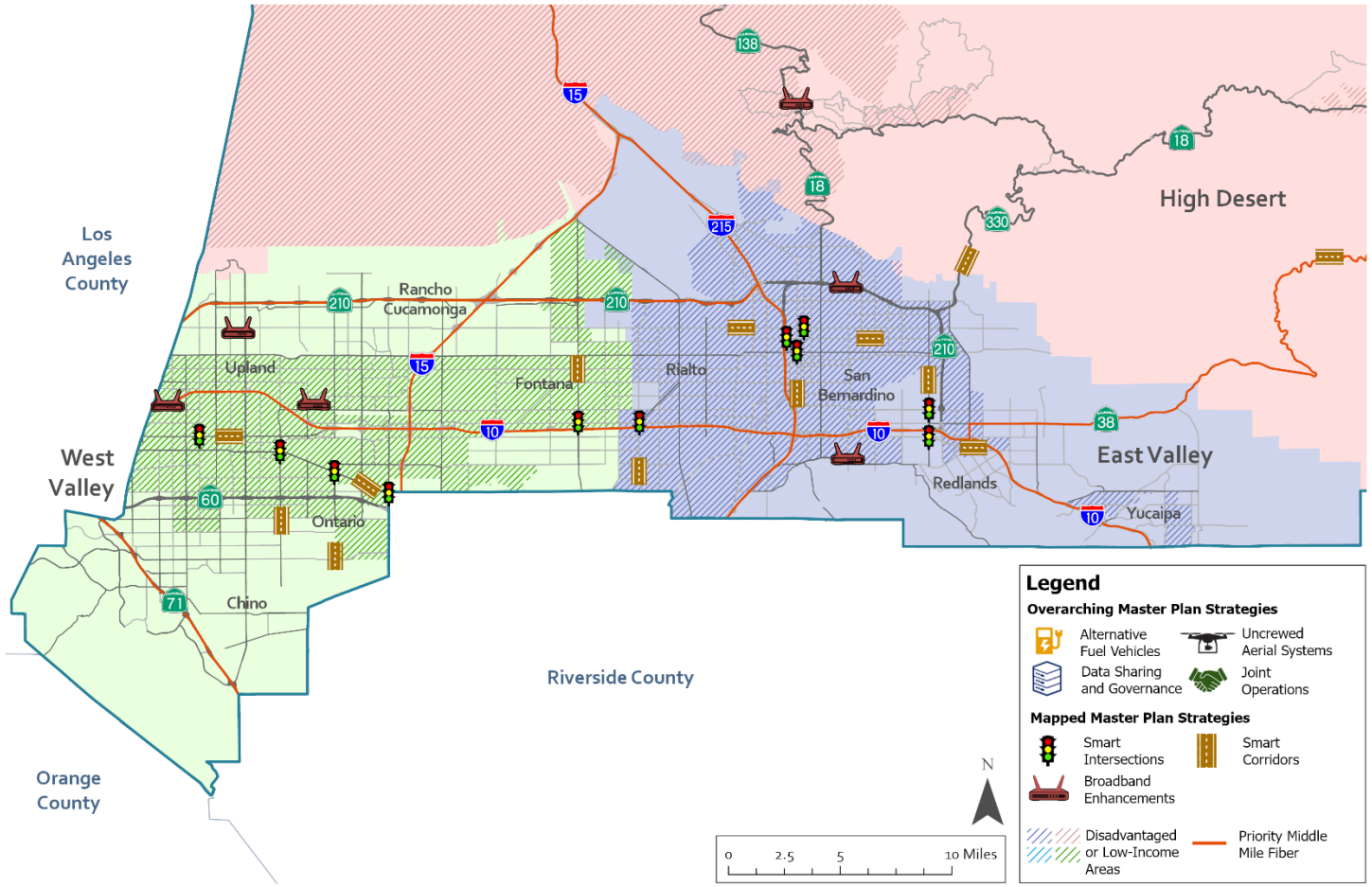


Table 6-1: Master Plan Schedule

	2025				2026				'27	'28	'29	'30-'34	SBCTA	Local Agencies	General Public
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4					Responsible/Supporting/Informed		
Task 1: Smart Corridors															
1.1 Request for Information on Candidate Corridors														R	
1.2 Priority Corridor Recommendations													S	R	
1.3 Development of Corridor System Requirements													R	S	
1.4 Integrate Technology/Agencies along Corridor													I	R	I
1.5 Identify Funding Sources													S	R	
1.6 Develop Plans and Specifications														R	
1.7 Procure Services, Select Vendor, and Issue Contract													I	R	
1.8 Implement, Integrate and Validate Technology														R	
1.9 Maintenance and Operations													S	R	
1.10 Track and Report Performance													S	R	I
Task 2: Smart Intersections															
2.1 Identify Local Champions													S	R	I
2.2 Develop ITS Specifications													R	S	
2.3 Recommend Best Sensors for Each Intersection													I	R	I
2.4 Identify Funding Sources													S	R	
2.5 Develop Plans and Specifications														R	
2.6 Procure Services, Select Vendor, and Issue Contract													I	R	
2.7 Implement, Integrate and Validate Technology														R	
2.8 Maintenance and Operations													S	R	
2.8 Track and Report Performance													S	R	I
Task 3: Alternative Fuel Vehicles															
3.1 Identify Interested Jurisdictions													R	S	
3.2 Identify Local Champions														R	
3.3 Identify Needs and Corresponding Solutions														R	I
3.4 Develop Funding Plan and Identify Partners													S	R	
3.5 Deploy Solutions														R	I
3.6 Track and Report Performance													S	R	I
Task 4: Uncrewed Aerial Systems Operations															
4.1 Inventory of Local AAM and UAS Services													R	S	
4.2 Inventory of Local AAM and UAS Policies/Laws													R	S	
4.3 Identify and Draft Language for Policy Changes/Additions													S	R	
4.4 Identify MOU Opportunities for AAM/UAS Shared Use													S	R	

	2025				2026				'27	'28	'29	'30-'34	SBCTA	Local Agencies	General Public
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4					Responsible/Supporting/Informed		
4.5 Determine Priority Use Cases and Funding Opportunities													S	R	
4.6 Track and Report Performance													S	R	I
Task 5: Broadband Enhancement															
5.1 Leverage BMMN Project															
▪ Identify Stakeholders and Establish Local														R	
▪ Secure Funding and Resources													S	R	
▪ Assess Infrastructure and Develop an Expansion														R	
▪ Procure Services, Select Vendor, and Issue													I	R	
▪ Implement and Integrate the Network														R	
▪ Track and Report Performance													S	R	I
5.2 Creating Broadband Toolkit													R		
▪ Share Toolkit/Best Practices													R		
Task 6: Data Governance and Sharing															
6.1 Establish Data Governance Framework															
▪ Develop Comprehensive Data Governance Policies													I	R	
▪ Implement Data Governance Training for Relevant														R	
6.2 Continue work on the CAD-to-CAD development													I	R	
6.3 Working Group Collaboration (Quarterly)													S	R	
6.4 Data Sharing Activities															
▪ Identify Data to Share (Ongoing)													S	R	
▪ Evaluate Costs and Benefits (Annual)													S	R	
▪ Determine Approach (Annual)													S	R	
6.5 Data Governance Agency Updates (Annual)													I	R	
6.6 Virtual Operations Center (2026 opportunity)													R	S	
6.7 Track and Report Performance													S	R	I
Task 7: Joint Operations															
7.1 Form a Working Group for Opportunity Selection														R	
7.2 Establish Interagency Collaboration Framework													S	R	I
7.3 Implement Joint Programs															
▪ Group Purchasing Program														R	
▪ Joint Training Programs														R	
7.4 Track and Report Performance													S	R	I

6.2 Target Outcomes and Performance Metrics

The SBCTA held a "Success Management Workshop" in June 2023, which aimed to establish a shared vision for the Smart County program, aspiring to transform San Bernardino County into a leading Smart County. The vision encompassed innovative transportation systems, universal broadband connectivity, improved government operations, and enhanced quality of life for all residents.

The workshop identified the following target outcomes:

- **Promote Clean and Sustainable Transportation** **:** Revolutionize transportation within San Bernardino County by championing zero-emission mobility options and paving the way for clean air vehicles. The County aspires to establish itself as a leader in hydrogen and electric fueling infrastructure, underlining its commitment to environmental sustainability.[69]

- **Enhance Traffic Flow and Connectivity** **:** SBCTA is collaborating with local agencies to implement solutions that improve traffic conditions and reduce congestion through improved traffic signal operations. These solutions also improve safety and air quality.

- **Improve Quality of Life through Universal Broadband Access** **:** Bridging the digital divide has been shown to support education and career advancement, wages and standard of living, and public health and safety.[70] Recognizing the digital divide in its communities, SBCTA/SBCOG seeks to provide broadband access to disadvantaged and underserved areas in San Bernardino County to realize these benefits.

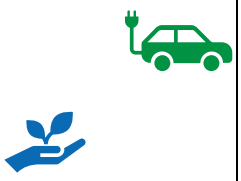
- **Rewrite the Narrative** **:** As noted, San Bernardino County leaders are committed to collaborative efforts, enhancing existing partnerships, and creating new ones to improve residents' quality of life. This goal involves promoting advancements and early wins to incentivize living and working in this region of Southern California.

Each of the seven strategies is mapped to the primary next step, with targeted outcomes the strategy will address, and suggested performance metrics (see **Table 6-2**). The next steps map to the four target outcomes identified during the Success Management Workshop. Each strategy addresses at least two, and often all four of the identified target outcomes.

[69] https://main.sbcounty.gov/2024/04/11/the-future-of-transportation-and-logistics-is-here/

[70] US Department of Education, Office of Educational Technology. 2022. "Advancing Digital Equity for All: Community-Based Recommendations for Developing Effective Digital Equity Plans to Close the Digital Divide and Enable Technology-Empowered Learning". Page 14. September. https://tech.ed.gov/files/2022/09/DEER-Resource-Guide_FINAL.pdf. Accessed on: August 20, 2023.

Table 6-2: Strategies, Next Steps, Target Outcomes, and Performance Metrics

Strategy	Next Steps	Outcomes	Performance Metrics
Smart Corridors	Issue a Request for Information to determine local level of interest. Board to make final determination of corridors where investment is appropriate. Proceed to implement and integrate smart technology within key corridors		▪ Decrease in average commute time on optimized routes ▪ Improvement in roadway and transit level of service post optimization ▪ Reduction in overall corridor congestion ▪ Increase in corridor safety metrics (e.g., fewer accidents, reduced severity of accidents)
Smart Intersections	Implement and integrate Smart Intersection technology at key intersections based on level of interest by individual jurisdictions and Board concurrence		▪ Hard braking events, speeding, V2X interactions ▪ Arrivals on green/red ▪ Clearance interval activity ▪ Pedestrian activity ▪ Turning movement counts ▪ Phase termination detail and summary
Alternative Fuel Vehicles	Identify jurisdictions, assess needs and solutions, develop a funding plan, secure vendor partnerships and funding, and deploy solutions		▪ Number of new alternative fueling/charging stations installed (cars and trucks) ▪ Amount of funding secured to install charging and hydrogen fueling infrastructure ▪ Quantity of GHG emissions reduced as a result of new fueling/EV charging stations installed
UAS Operations	Conduct inventory of local services and policies, identify shared use opportunities, and determine priority use cases		▪ Reduction in average response time to emergency situations ▪ Number of successful infrastructure inspections conducted using UAS with zero safety violations ▪ Reduction in time required to complete infrastructure inspections
Broadband Enhancement	Leverage BMMN project, assess infrastructure, implement network expansion, and share best practices		▪ Increase in broadband coverage area ▪ Improvement in broadband speed and reliability ▪ Increase in number of households or businesses accessing broadband services ▪ Enhancement in overall digital connectivity and accessibility
Data Governance and Sharing	Establish data governance framework and policies, collaborate through working groups, identify data sharing opportunities, and determine approach. Continue CAD-to-CAD development		▪ Data governance plans completed across agencies ▪ Data sharing agreements executed ▪ Number of successful data integration initiatives across departments or agencies
Joint Operations	Establish working group to identify and prioritize opportunities, develop interagency agreements, and create detailed plans for implementation		▪ Reduction in expenses achieved ▪ Assess enhancements in service delivery quality ▪ Track the number of personnel trained and the effectiveness of joint training programs ▪ Assess improvements in procurement processes ▪ Number of successful Community Outreach and Support Team (COAST) interventions

6.3 Costs

Table 6-3 summarizes the costs associated with the implementation of each proposed strategy. Costs are categorized by preliminary activities, construction, annual operations and maintenance, and other costs such as equipment and software development. Joint Operations costs will involve further project definition to determine how this strategy should be bests implemented and which other strategies it will be support.

Table 6-3: Cost Estimates

Strategy	Preliminary Activities	Construction/Equipment/Software Development	Estimated Cost to Implement	O&M (per year)
Smart Corridor Costs	$78,000 per mile	Construction: $880,000 per mile Software Development: $2,000,000	$2,000,000 program costs + $958,000 per mile up-front costs	$50,000 per mile
Smart Intersections	$16,000 - $32,000	Construction: $65,000 Equipment: $5,000 - $100,000	$86,000 - $197,000	$13,000
Alternative Fuel Vehicles	$10,000	$180,000	$190,000	$5,000
Uncrewed Aerial Systems Operations	$5,000 - >$100,000 per drone/operator	Operational cost of $20 per hour per drone	Around $200,000 for 10 drones	Minimal
Broadband Enhancement	$10,000 - $30,000	$60,000 - $100,000	$70,000 - $130,000	$50,000 per mile
Data Governance and Sharing[71]	$80,000 - $100,000	$250,000	$350,000 for first year	$250,000

6.4 Funding

Securing adequate funding will be critical to the successful implementation of the strategies identified in this Smart County Master Plan. Early and thoughtful project planning and messaging will better position applicants to secure financial resources whether this is in the form of budget allocations, public-private partnerships, state or federal grants or other mechanisms. Specific to state and federal grants, **Table 6-4** summarizes those best aligned with the recommended strategies. Support for the joint operations strategy should be tied to one or more of the other strategies and applied for as part of the grants listed for those strategies.

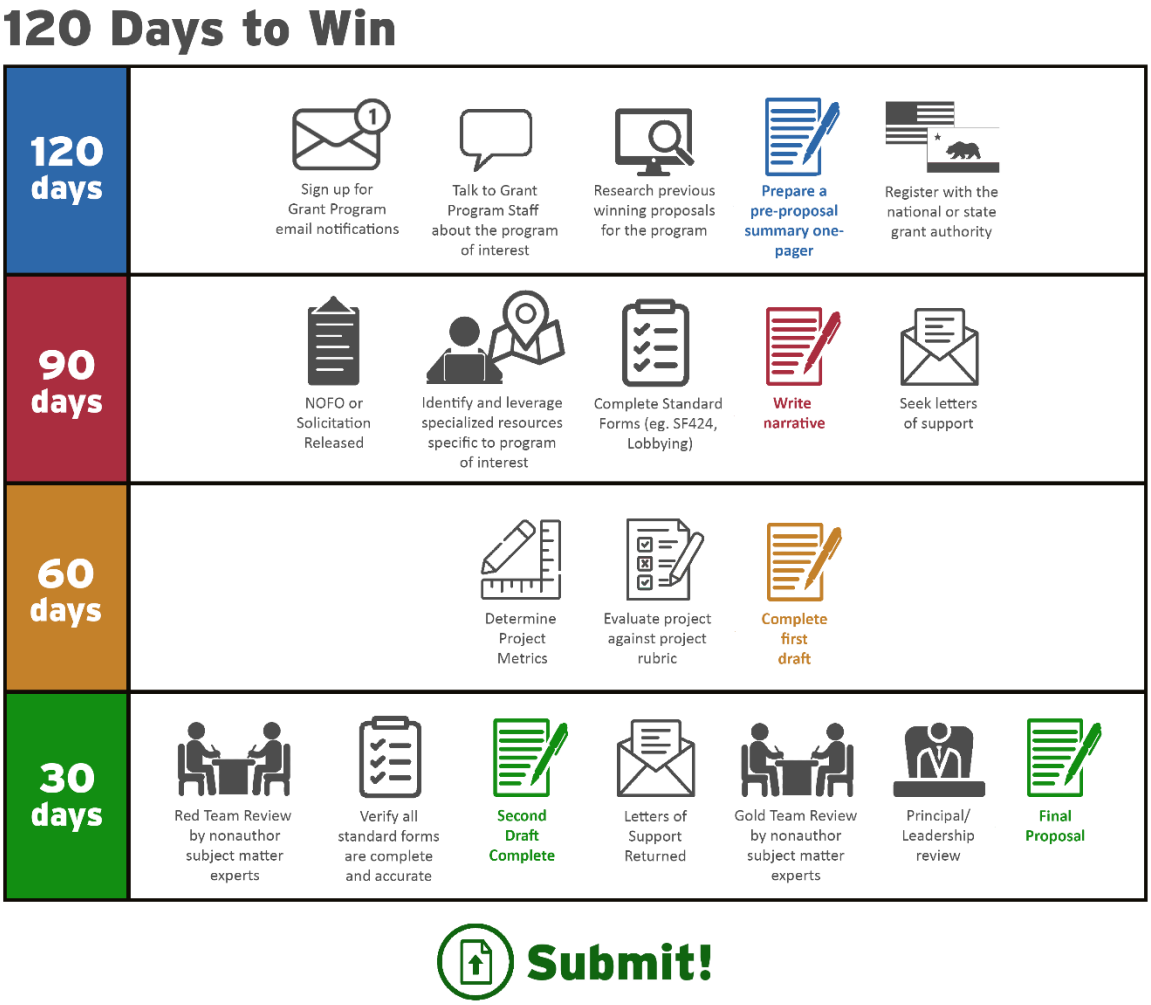
[71] Data Governance and Sharing costs are for the creation of a data portal.

Table 6-4: Relevant Grant Opportunities

Grant	Smart Intersections	Smart Corridors	Alternative Fuel Vehicles	Advanced Air Mobility	Broadband Enhancement	Data Sharing & Governance
Strengthening Mobility and Revolutionizing Transportation (SMART) Grant	✓	✓				✓
Highway Safety Improvement Program (HSIP)	✓	✓				
Caltrans Safe Streets and Roads for All Grant Program	✓	✓				
State Highway Operation and Protection (SHOPP)	✓	✓				
Trade Corridor Enhancement Program (TCEP)		✓				
National Electric Vehicle Infrastructure (NEVI) Program			✓			
Charging and Fueling Infrastructure Program			✓			
Energy Commission Clean Transportation Program			✓			
Charging Reliability and Accessibility Accelerator Program			✓			
USDOE Vehicle Technologies Office (VTO)			✓			
Federal Homeland Security Grants				✓		
UAS Technology Donations				✓		
FAA Aviation Workforce Development Grants				✓		
California Broadband Equity, Deployment, and Access Program					✓	
California Public Utilities Commission (CPUC) Broadband Loan Loss Reserve Fund					✓	
FHWA's Surface Transportation Block Grant (STBG)						✓
California Regional Resilience Planning and Implementation Grant Program	✓		✓		✓	

Figure 6-3 provides general guidance on what steps to take when seeking state or federal grant funds. As noted, a good initial step is to sign up for notifications at http://www.grants.ca.gov/subscribe-to-updates/ or www.grants.gov/connect to receive up-to-date information about future grants. In addition to these options, funding from regional collaborations or private partners should be explored to line up any required matching funds.

Figure 6-3: Process to Seek Grant Funding



6.5 Plan Communication

To date, the agencies of San Bernardino have been thoughtfully engaged through committees and working groups helping to brainstorm ideas and guide the writing of this Master Plan. To help ensure this hard work moves into implementation and so all agencies can build their knowledge base in the technologies outlined herein, a speaker series will be offered. Speakers will be invited to speak on a topic from general education up to experience in implementation and outcomes. The following is a list of possible topics:

- Advanced Air Mobility
- Alternative Fuel Vehicles
- Artificial Intelligence
- Broadband
- Data Sharing/Governance
- Grant Writing
- Smart Corridors
- Smart Intersections

Continuing to elevate the regional understanding of technology options will allow San Bernardino to evaluate new service delivery options from both an individual and joint perspective. This series can also help establish relationships with other government agencies that have implemented these technologies. Hearing lessons learned and best practices can help set San Bernardino agencies up for success when procuring and implementing projects.

6.6 Toolkit

The following toolkit was created to advance the strategies presented in the Smart County MP. It is intended to serve as a practical guide for local governments, communities, and stakeholders. The ten toolkit components are organized to encourage consideration of key questions or topics throughout the lifecycle of project delivery from planning to operations and maintenance. See the left side of the pages for these key questions or topics. On the right side of the page, corresponding resources are linked to help the delivery team progress the projects. For each of the ten toolkit components, the relevant lifecycle topics listed below are addressed:

- **Planning**: This involves setting project goals, defining tasks, and scheduling activities.
- **Policy**: This stage focuses on resolving institutional issues and establishing guidelines for project execution.
- **Funding**: This involves securing the financial resources necessary for the project.
- **Design/Procurement**: This stage includes creating project designs and acquiring necessary materials and services.
- **Implementation**: This involves executing the planned activities to achieve the project goals.
- **Operations & Maintenance (O&M)**: This includes activities required to operate and maintain the project deliverables post-implementation.

The primary goal of the toolkit is to make the adoption of innovative technologies and strategies more straightforward, and to serve as a resource for anyone involved in project development and management. Not all stages may be applicable to each strategy or project. The relevance of each stage depends on the specific requirements and context of the project.

For each strategy, agencies will need to determine the stakeholders within their organization such as IT, public works, police, fire, building permitting, utility permitting, health and planning. For every strategy, it is anticipated that law, finance, and human resources will play a role. It will also be important to determine for each strategy if design, implementation, operation, and maintenance will be the responsibility of each local agency, a coordinated approach, or best with countywide management. This decision will impact policies, funding, and staffing.

6.6.1 Data Sharing

PLANNING

CONSIDER

- Reviewing the data within your own agency to determine what data is available and suitable for sharing with other agencies. What additional data is needed?
- Checking the available data to ensure it is quality data.
- Understand the benefits and challenges of data sharing with another agency.
- Considering which data the agency would be interested in receiving to use for planning or decision-making.
- Meeting with partner agencies interested in sharing data.
- For a specific Smart Initiative, what data is needed or desired to achieve the best result and measure performance?
- Consider data sharing from the perspective of an agency sharing its own data vs trying to acquire more data from another agency.

RESOURCES

Internal resources from the department interested in sharing data to the legal and technology teams should be engaged in planning. Engaging the entire team early will help guide success.

Review the agency's data governance plan to identify the available data.

POLICY

CONSIDER

- What data can and should be shared.
- Contractual or licensing restrictions on purchased data to determine any sharing limitations.
- The legal framework for sharing various types of data with another agency.
- If legislation is necessary to allow for data sharing.
- The leadership framework necessary to manage the Smart Initiative and explore cooperative opportunities to share staff, funding, oversight, etc.
- Implementing data privacy and security measures to ensure the protection of shared data.

RESOURCES

Draft legislation language: Agency A may share the data listed herein with Agency B upon the execution of a data sharing agreement.

FUNDING

CONSIDER

- The necessary staffing, equipment, storage, and associated initial and ongoing costs for obtaining data, storing it, and managing its sharing.

RESOURCES

DESIGN/PROCUREMENT

CONSIDER

- Drafting a data sharing agreement.
- Specifying the type of data to be shared.
- Identifying the type of agreement needed for data sharing.
- Ensuring the agreement includes terms and conditions for personally identifiable information if applicable.
- Verifying whether the licensing agreement prohibits an agency from sharing purchased data.

RESOURCES

A sample county Data Sharing Agreement for California can be reviewed here: California County Example.

Review a sample template for data sharing agreement and use here: Health Information Example.

Data sharing agreement template provides basic example with headings and descriptions.

Read about "Data Governance for Next-Generation Platforms".

IMPLEMENTATION

CONSIDER

- Testing between the agencies that will be sharing data. This will allow the team to understand how long it takes for the data to transfer and if the right data is in the transfer.

RESOURCES

Tampa (THEA) Data Management Plan discusses approach to data sharing, including archives and institutional relationships.

Joint Office of Energy and Transportation maintains EV-ChART to facilitate the standardization and collection of the data submittals.

O&M

CONSIDER

- While data sharing does not specifically require O&M, it is always good to obtain input from partners to evaluate the usefulness of any data sharing.
- What data is required for proper operation of the system and how to ensure local data is collected and shared.

RESOURCES

6.6.2 Data Governance

PLANNING

CONSIDER

- Pulling together all written and unwritten data policies for review, update, and proper documentation.
- Reviewing administrative policies related to data, including data standards for procurement, data handling, training for handling personally identifiable information, and compliance with regulatory policies.
- Reviewing all data that is collected, purchased, and stored to have a complete list of all data that the agency needs to operate.
- Identifying the data residing on all servers, data accessed via online resources, and clarify whether the agency owns the data or has usage rights for a contracted period.
- Identifying the team members that are part of the data life cycle and their roles.
- Who the data owners are and assign responsibilities for reviewing the data as it is received, as well as maintaining and updating the data.
- Discussing the trust that the agency has in the data that is being used.
- Assessing the use of identified data, validate the agency's trust in the data's validity and completeness, ensure all data adheres to the same data standards, and establish a common data architecture.

RESOURCES

The Data Governance Framework and Components.

The Path to Modern Data Governance.

Read About Data governance for next-generation platforms.

POLICY

CONSIDER

- Drafting an overarching data governance policy
- The need for information sharing with the public via a county website/platform for common branding and display of information.

RESOURCES

FHWA Data Governance Plan.

FHWA has resources on Data Quality and Performance metrics.

Federal Highway Administration (FHWA) Data Update Policy.

FUNDING

CONSIDER

- Shared costs:
  - Staffing needs
  - Server/storage/access fees
  - Management of public information sharing

RESOURCES

DESIGN/PROCUREMENT

CONSIDER

- **Existing processes and create new processes to enhance decision-making, comply with regulations and protect privacy.**
- **Who has access to the data and how is access management handled for public versus private data?**
- **Is training available for staff to understand how to effectively handle data?**
- **How often is data reviewed for its value?**
- **How is data erased or removed?**

RESOURCES

IMPLEMENTATION

CONSIDER

- **Creating an actionable plan to remediate any issues identified through the data governance planning exercise.**

RESOURCES

FHWA Enterprise Data Architecture establishes standardized interfaces for linking and processing information.

O&M

CONSIDER

- **Reflecting on the data governance documentation annually for updates.**

RESOURCES

6.6.3 AI Governance

The following toolkit provides considerations when looking to implement AI elements across the project lifecycle. Even more so than many advanced mobility technologies, there is uncertainty around future AI regulation and potential risk associated with its deployment. Scaling machine learning and AI activity without the proper resources or structure in place can inadvertently create inefficiencies rather than eliminate them. Drafting and enacting an AI policy that addresses operational and ethical requirements will help address accountability and transparency, support innovation, and protect privacy and data security. This is crucial to building trust in the technology.

PLANNING

CONSIDER

- **How machine learning and AI are being used within your organization.**
- **How AI can support your goals.**
- **Accountability, transparency, how to support innovation and protect privacy and data security. An agency employee who utilizes AI is responsible for the AI work product and results.**

RESOURCES

The Federal government created a website for AI

The Federal government created a website for AI

POLICY

CONSIDER

- **Establishing an AI policy for all agencies involved in the Smart Initiative that addresses operational and ethical items and can be shared with all employees. It can also be included in any procurement requests to avoid AI being used in inappropriate or unknown ways.**
- **Including data security and privacy measures in the AI policy to ensure the protection of data used and generated by AI systems.**

RESOURCES

The GoVAI Coalition created a draft AI Policy

AI Policy Manual

FUNDING

CONSIDER

- **The funding sources for a new solution.**
- **Assessing the overall cost of using an AI solution, including necessary training and data quality improvement.**
- **Evaluating whether the solution will create efficiencies or eliminate the need for other technology solutions.**
- **Exploring the inclusion of an AI component in existing grant applications.**
- **Investigating the possibility of a joint purchase of an AI solution with another agency in the region.**

RESOURCES

Federal grants have had opportunities for AI funding on https://www.grants.gov/

DESIGN/PROCUREMENT

CONSIDER

- Creating use cases that appropriately utilize AI. Review and vet the use cases with legal and contracts/procurement teams for clarity and compliance.
- Interview companies utilizing AI technology to understand their existing solutions as well as their roadmap.
- Ask companies using AI technology to share how their solution works.
- Documenting your agency's expectations for copyright laws, data security, data privacy, and accountability for the work product involving AI tools and software.

RESOURCES

Use Case Template, examples of available use case templates include the following:

- Agency Chatbot
- Meeting Assistant
- Object Detection

This is a draft agreement for an AI purchase Vendor Agreement.

AI Incident Response Plan.

This template asks potential vendors to complete a fact sheet on their solution. Third-Party AI Fact Sheet.

IMPLEMENTATION

CONSIDER

- Ensuring all employees who work with data for AI purposes or those who work with the data that AI produced are trained and understand the importance of using quality data. The data that is generated from AI is only as good as the data that created it.
- Requiring that all AI systems have a human-in-the-loop who comprehends the AI's processes, validates its methodology, and takes accountability for its outputs and deliverables.

RESOURCES

Training for all employees on all AI policies and on the AI solution.

O&M

CONSIDER

- Coordinating ongoing training and updates for staff of all agencies.

RESOURCES

6.6.4 Smart Intersections/Smart Corridors

PLANNING

CONSIDER

- Assessing the current availability of smart technologies, including existing facilities and potential opportunities.
- Identifying technologies that may enhance safety and accessibility along the corridor.
- Developing a Concept of Operations following FHWA's Systems Engineering Process to guide planning and ensure all stakeholder needs and project objectives are thoroughly addressed.
- What other infrastructure investments are underway and can be leveraged to implement smart intersections/corridors?
- Identifying future projects or initiatives that will benefit from the planned smart intersection/corridor investment.
- Adopting a "dig once" approach to save money and time. Determining the data needed for the successful operation of smart technology both locally and regionally, assess the availability of this data, and identify new data requirements and how to access or develop this data.

RESOURCES

The Intelligent Transportation Systems (ITS) Joint Program Office: Strategic Plan 2020–2025 includes in-depth discussions on strategic goals and programs for accelerating ITS deployment.

FHWA's Systems Engineering Guidebook for ITS provides information to assist with the application of systems engineering in ITS projects.

California's ITS program guidelines include resources for project development, funding, and environmental requirement for Intelligent Transportation Systems (ITS) Projects

POLICY

CONSIDER

- Identifying the considerations needed to facilitate the deployment of smart signal equipment.
- Determining if MOUs or agreements between agencies are required for deployment.
- Establishing considerations for data sharing agreements.
- Assigning responsibility for the maintenance and operation of the smart signal equipment.
- Defining how the associated costs will be shared among the involved parties.
- Ensuring the Concept of Operations document addresses these policy considerations.

RESOURCES

The Intelligent Transportation System Architecture and Standards outlines policies and procedures to comply with section 5206(e) of TEA-21 (Public Law 105-178).

Is additional staffing needed for operation, maintenance, and for data gathering/sharing? What type of staff, licenses or credentials are needed?

FUNDING

CONSIDER

- Developing a plan to mitigate construction costs and maximize the reach of available project funding.
- Establishing funding sources for ongoing operations and maintenance to ensure the long-term sustainability of the deployed smart technologies.
- Creating a plan for replacing equipment at the end of its lifecycle, including setting aside money annually for future replacements or addressing replacements as they arise.
- Determining how local match funding will be covered and shared.

RESOURCES

The SMART Grants Program offers grants to eligible public agencies for demonstration projects, emphasizing advanced smart community technologies.

The ATTAIN program offers grants to deploy advanced transportation technologies to improve safety, mobility, efficiency, connectivity, and infrastructure ROI.

DESIGN/PROCUREMENT

CONSIDER

- Developing performance goals and measures.
- Establishing criteria for choosing appropriate technologies to meet specific needs.
- Designing the system as a regional setup with local agency phasing and associated costs.
- Conducting a site evaluation to verify that the chosen technologies will perform as expected based on existing site conditions.
- Ensuring compatibility and interoperability between new technology and existing systems and determine if existing systems need to be replaced as part of the design plan.
- Ensuring the technologies comply with privacy laws, particularly concerning ALPRs and data collection.
- Verifying if the available communications infrastructure supports the bandwidth requirements for the proposed technology devices and include expanded communications infrastructure in the project if necessary.

RESOURCES

The ITS Joint Program Office define Testing and Development Standards for ITS deployment.

FHWA's webinar on CV Pilot Deployment shares acquisition and installation experiences from the Tampa Hillsborough Expressway Authority (THEA) pilot.

SAE's technical paper describes best practices in OBU antenna procurement for connected vehicle deployments.

IMPLEMENTATION

CONSIDER

- Establish a training and education plan to equip city personnel and stakeholders with information about new technology and their benefits.
- Leverage lessons learned from a pilot or initial implementation to shape a larger rollout.

RESOURCES

Wyoming, New York City, and Tampa (THEA) CV Pilot plans presents a comprehensive installation plan for the software, hardware and maintenance for purchases for CV Pilot projects.

ITS JPO's training video gives instruction on how to set up Roadside Unit (RSU).

The Connected Intersections Implementation Guide provides guidance to setting up and operating a connected intersection.

Connected Intersections Validation Report provides findings from Connected Intersections Project Validation Phase.

O&M

CONSIDER

- Implementing system performance measures designed earlier.
- Implementing the plan for continuous monitoring to ensure the quality of the system during operation.
- Executing an outreach plan to keep the public informed about the changes and benefits of smart intersections and corridors. Communicate updates to elected officials and cooperating agencies to ensure a coordinated message.

RESOURCES

The Intelligent Transportation Systems (ITS) Professional Capacity Building Program offers training and resources to advance transportation workforce about ITS.

SPaT/MAP Message Capture Tool Alternatives for Validation Sites.

FHWA's ITS Standards Field Support Team assists with ITS standards, including assessment, guidance, review, advice, planning, and compliance.

6.6.5 Alternative Fuel Vehicles

PLANNING

CONSIDER

- Identifying a regional champion.
- Assessing the current market share for EVs.
- Evaluating the current and projected EV adoption rates.
- Identifying available incentives for EV adoption.
- Various factors in developing a charging infrastructure plan.
- Identifying high-priority locations for EV charging.
- Identifying underserved communities for charging infrastructure deployment.
- Determining the types and quantities of vehicles to be transitioned to EVs in a fleet.
- Identifying geographic areas that will be difficult to serve, such as isolated locations or areas with extreme conditions.

RESOURCES

The AFDC Station Locator is a tool used to find alternative fueling stations, including EV charging stations.

US DOE's Vehicle Cost Calculator compares the costs of different vehicle types, including EVs, to determine the best fit for a fleet.

California's NEVI Formula Program describes how the state plans to develop a network of DC fast chargers along designated Alternative Fuel Corridors throughout California.

The Assembly Bill 2127 Second Electric Vehicle Charging Infrastructure Assessment examines charging needs to support California's zero-emission vehicles in 2030 and 2035.

POLICY

CONSIDER

- Reviewing local and state regulations regarding EV charging infrastructure.
- Establishing a plan for managing and monitoring EV charging.
- Assessing the impact on the grid and the use of renewable energy.
- Prioritizing projects that provide workforce training and development opportunities and engage with local communities.
- Determining the need for private and public ownership of EV charging infrastructure.
- Establish common requirements for hours of operation and design for personal safety, including lighting, cameras, and emergency phones.

RESOURCES

The AFDC Policy Database is a database of AFV related policies.

FUNDING

CONSIDER

- Identifying available funding opportunities for EV charging infrastructure and fleet transitions.
- Determining the costs associated with purchasing and installing EV charging equipment.
- Utilizing external resources to track and monitor funding opportunities.
- Using cost estimates as part of site prioritization.
- Designating a grant champion to explore public funding availability for private entities for maintenance or upgrades.

RESOURCES

The CEC's Clean Transportation Program funds innovation to accelerate zero-emission transportation and fuel technology development and deployment.

The NEVI Formula Program funds states for deploying EV charging stations, ensuring maintenance, establishing network connections, and facilitating long-term data sharing.

CALeVIP provides incentives for installing EV charging infrastructure at public sites across California.

CALeVIP in California provides incentives for installing EV charging infrastructure at publicly accessible sites throughout California.

DESIGN/PROCUREMENT

CONSIDER

- Confirming the willingness of the site host to add EV charging stations to the site.
- Verifying that the local utility has sufficient power available for charging stations.
- Ensuring that anticipated costs are within the allocated project funding.
- Planning for the visibility, accessibility, and convenience of charging stations.
- Designing the infrastructure to support future expansion and increased capacity needs.
- Developing design guidelines for safety and amenities and determine if branding is needed.

RESOURCES

Accessible EV Parking Requirements and Dimensions specifies parking space and accessibility requirements for EV charging stations.

IMPLEMENTATION

CONSIDER

- Monitoring and evaluating the deployment process to ensure alignment with the initial design and community needs.
- Determining if a public sector inspection and acceptance process is required for this project. If required, will it be local agencies or countywide?

RESOURCES

ENERGY STAR Certification Process ensures that EV charging installed under the CALeVIP program is energy efficient.

California's Guide to EV Charging Station Regulations summarizes state rules from agencies: division of measurement standards, air resources board, Public Utilities Commission etc.

O&M

CONSIDER

- Define performance measures for EV charging stations.
- Assess the utilization of the charging stations.
- Develop a plan for continuous monitoring and maintenance to ensure the quality and reliability of the charging stations.
- Create a public communication plan to keep the public informed about the benefits and availability of EV charging infrastructure.
- Common branding in the county or state?

RESOURCES

The Open Charge Point Protocol Certification process by CEC ensure interoperability and accessibility of EV charging infrastructure in California.

The Electric Vehicle Charging Station Permitting Guidebook assists stakeholders in navigating the permitting process for promoting EV charging station installations in California.

6.6.6 Broadband

PLANNING

CONSIDER

- Assessing the current broadband availability and identifying any gaps.
- Setting clear, achievable goals for broadband deployment and digital inclusion.
- Identifying existing assets that could support broadband deployment.
- Formulating a Broadband Planning Committees and defining their roles and responsibilities.
- Engaging community leaders and establish a leadership framework to guide the broadband initiative.

RESOURCES

California Digital Equity Plan outlines the vision and goals for achieving digital equity among Californians, including strategies and implementation activities.

The Broadband Mapping Program includes resources like California's Interactive Broadband Map, mapping feedback tool, and CPUC's annual broadband data, aiding broadband planning initiatives.

The NTIA Tribal Broadband Planning Toolkit and Planning a Community Broadband Roadmap provide resources for every stage of the broadband planning journey.

POLICY

CONSIDER

- Reviewing the rights-of-way and policies governing access.
- Identifying barriers and streamline processes to incentivize investment.
- Leveraging the regulatory and legislative environment to maximize broadband deployment.
- Assessing local permitting and inspection requirements and determining their similarity within the region. Assessing the need for developing regional requirements.

RESOURCES

The California Senate Bill 156 broadband legislation aims to guide the expansion of the state's broadband fiber infrastructure and to increase internet connectivity.

FUNDING

CONSIDER

- Identifying and securing funding sources and developing financial models to support the project.
- Establishing public-private partnerships to leverage funding, expertise, and resources.
- Ensuring there is funding for operation and maintenance, particularly in underserved or isolated/rural environments.

RESOURCES

California Broadband Equity, Access, and Deployment Program provides funds for planning and infrastructure deployment to expand high-speed internet access.

Local Agency Technical Assistance help tribes and local agencies expand broadband services to Californians with inadequate internet access.

The Last-Mile Federal Funding aims to expand internet access for underserved and unserved communities across California.

DESIGN/PROCUREMENT

CONSIDER

- Designing the broadband network to ensure technical and safety standards are met.
- Establishing criteria to evaluate and select broadband providers for potential partnerships.
- Determining whether ownership will be private or public and assess how this impacts design and expandability.

RESOURCES

The California Local Jurisdiction Permitting Playbook explores actions to enhance permitting processes at all levels of government to support broadband deployment in the State.

Permitting Best Practices: Case Studies provides example case studies and examples of streamlining permitting including Broadband Ready Communities, E-Permitting, and Rights-of-Way.

Data sharing agreement template provides basic example with headings and descriptions.

Read about "Data Governance for Next-Generation Platforms".

IMPLEMENTATION

CONSIDER

- Drafting and circulating Requests for Proposals or Requests for Information to select suitable contractors and service providers.
- Developing a plan for overseeing the construction and deployment process.
- Deciding between local coordination or establishing a regional authority for project management.

RESOURCES

The California Local Jurisdiction Permitting Playbook explores actions to enhance permitting processes at all levels of government to support broadband deployment.

Permitting Best Practices: Case Studies provide case studies and examples of streamlining permitting including Broadband Ready Communities, E-Permitting, and Rights-of-Way.

NEPA Review: Categorical Exclusions and Environmental Assessments provide guidance for compliance with environmental regulations and NEPA analysis for CATEXs.

O&M

CONSIDER

- Manage the expectations of stakeholders and ensure transparent communication.
- Develop metrics to measure the success of broadband initiatives.
- Establish a plan for continuous monitoring to ensure the quality and reliability of broadband services.
- Create a plan for community engagement and marketing to raise awareness of broadband initiatives and their benefits.

RESOURCES

California State Library's Career Pathways provides access to NorthStar and other educational resources to support digital equity, skill building, and job training.

Lessons can be learned from how digital equity has been achieved by Chula Vista, San Francisco, or Los Angeles County.

Local Government Check List for Digital Equity provides a checklist for local government leaders to achieve digital equity.

6.6.7 Uncrewed Aerial Systems Operations

PLANNING

CONSIDER

- Define the goals of integrating AAM services into existing transportation networks, distinguishing between public and private objectives.
- Establish strategies to promote technological innovations and operational safety within the AAM ecosystem.
- Identify ways to improve resident services and enhance energy efficiency through the integration of AAM.
- Develop a plan to minimize or mitigate potential negative impacts of AAM integration and foster public acceptance.
- Explore how AAM systems can aid in search-and-rescue operations.
- Explore the potential applications of drones within the AAM ecosystem.

RESOURCES

The FAA's AAM Implementation Plan outlines steps and components for enabling scalable advanced air mobility operations by 2028.

APA's 2024 PAS Report 606, "Planning for Advanced Air Mobility," provides key insights for planners and policymakers on AAM development impacts.

Read about the Office of Science and Technology Policy commitment to AAM during The White House Summit on Advanced Air Mobility

POLICY

CONSIDER

- Verify the compliance of potential operations and programs with existing federal, state, and local policy and regulatory environments.
- Develop local policies that support the safe and efficient integration of AAM services.
- Ensure consistency in terminology when creating local policies to facilitate understanding and compliance for external users.
- Identify the necessary skill sets required for the effective operation and management of AAM programs.
- Collaborate with educational institutions to develop career paths that align with the emerging AAM industry.

RESOURCES

NASA's AAM Mission Integration, Advanced Air Mobility (AAM): Overview and Integration Considerations.

AAM working ecosystem aims to advance development of safe AAM flight operations through information, and expert opinion and sharing input.

FUNDING

CONSIDER

- Identify and secure funding sources and develop financial models to support the project.

RESOURCES

FAA Aviation Workforce Development Grants are available to eligible entities to help prepare a more inclusive talent pool of pilots and aviation maintenance technicians.

DESIGN/PROCUREMENT

CONSIDER

- Designing UAS operations with public safety as a primary consideration.
- Ensuring the design aligns with existing goals associated with ADA compliance.
- Developing a plan to integrate UAS operations seamlessly with multimodal transportation networks.
- Coordinating the design with existing utility infrastructure to avoid conflicts and ensure safe operation.
- Implementing design principles that promote energy efficiency and sustainability in UAS operations.
- Meeting with vendors in the UAS and AAM space to understand the solutions to better draft procurement

RESOURCES

FAA's Small Unmanned Aircraft Systems guide covers AAM factors like weather, emergency procedures, communication, performance measures, and airport operations. FAA Part 105 guides vertiport development.

IMPLEMENTATION

CONSIDER

- Establishing comprehensive safety protocols for the implementation phase of UAS operations.
- Developing clear operational procedures to guide the safe and efficient implementation of UAS technologies.

RESOURCES

Advanced Air Mobility National Campaign Partners work alongside NASA to test data and evaluate aviation standards.

Advanced Air Mobility National Campaign Partners work alongside NASA to test data and evaluate aviation standards.

O&M

CONSIDER

- Define performance metrics to evaluate the success of UAS operations initiatives.
- Establish a routine maintenance plan to ensure the operational safety and reliability of UAS systems.
- Develop procedures for emergency repairs and incident response to mitigate risks and maintain operational continuity.
- Identify opportunities for program refinement and improvement based on performance data and operational experience.

RESOURCES

FAA's Aircraft Maintenance Division standardizes regulations, directives, policies, certifications, inspections, and surveillance of aviation maintenance.

6.6.8 Performance Measures

Implementing performance measurement throughout the lifecycle of a program is helpful for several reasons. It supports goal alignment, efficiency, risk management, and continuous improvement. If addressed thoughtfully throughout the program, more appropriate and better data will be gathered, which is critical to demonstrating the value and impact of strategies, not just for the agencies participating in the program, but also for the public.

With that in mind, this portion of the toolkit is intended to be used in parallel with each of the proposed strategies. For instance, starting in the planning stage, for AFV, broadband, or other programs, agencies can concurrently refer to the planning portion of the performance measurement table, and then work their way through policy, funding, and so on as the program develops. Integrating performance measurement considerations throughout the program will inform participants and the public and help build trust in the program.

PLANNING

CONSIDER

- **Assessing the alignment of the metric with the organization's desired outcomes.**
- **Evaluating the criticality of the metric in achieving project goals and outcomes.**
- **Verifying that relevant data is readily available, accurate, and reliable.**
- **Confirming the importance of the metric to stakeholders, including citizens, partners, and funding agencies.**
- **Analyzing the practicality and cost-effectiveness of measuring and tracking the metric.**
- **Determining the level of participation required from each agency to support countywide Smart Initiatives.**

RESOURCES

THEA CV Pilot Deployment Program Performance Measurement and Evaluation discusses key indicators related to V2V and V2I deployment.

The Performance Measurement and Evaluation Support Plan demonstrate how to set goal and objectives for CV deployment.

POLICY

CONSIDER

- **Evaluating the extent of stakeholder involvement in the policy shaping process.**
- **Assessing the anticipated impacts of proposed policies on project outcomes.**
- **Highlighting the innovative aspects that the proposed policies bring to the initiatives.**
- **Gauging the level of support for the proposed policies from public officials and agencies.**

RESOURCES

Deployment Readiness Summary – Tampa (THEA) discusses governance documents for planning and execution of the Tampa – THEA CV Pilot.

FUNDING

CONSIDER

- Assessing the long-term financial sustainability of the initiatives.
- Monitoring the adherence of initiatives to allocated budgets and financial plans.
- Utilizing available grants and subsidies effectively.
- Analyzing the diversity of funding sources for each initiative to ensure resilience and sustainability.

RESOURCES

Partnership Status Summary discusses funding for initial implementation and operations and long-term funding commitments for a CV Pilot program.

DESIGN/PROCUREMENT

CONSIDER

- Verify compliance of designs with all relevant standards and specifications.
- Assess the effectiveness of integrating advanced technologies into the design.

RESOURCES

IMPLEMENTATION

CONSIDER

- Monitor the progress of the initiatives according to established timelines and milestones.
- Identify and document innovative approaches being utilized during implementation.

RESOURCES

O&M

CONSIDER

- Evaluate the long-term sustainability of operational practices and systems.
- Assess the effectiveness of maintenance programs in ensuring the long-term functionality of equipment and infrastructure.
- Monitor the efficiency of day-to-day operations to identify potential areas for improvement.

RESOURCES

The Broadband for All Initiative action plan progress tracker provides action plans, and key indicators for measuring the progress made towards achieving digital equity.

Performance indicators for measuring alternative fuel vehicles and electrification success may include achieving charging infrastructure goals, compliance metrics etc.