

TRANSPORTATION SYSTEM

HIGHWAYS AND ARTERIALS

SOUTHERN CALIFORNIA ASSOCIATION OF GOVERNMENTS



TECHNICAL REPORT

ADOPTED ON SEPTEMBER 3, 2020

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TECHNICAL REPORT

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TRANSPORTATION SYSTEM

Highways and Arterials

EXECUTIVE SUMMARY

Southern California's highway and arterial system plays a significant and vital role in the overall transportation network in the Southern California Association of Governments (SCAG) region and throughout the United States. The SCAG region's regionally significant highway and arterials system has approximately 23,000 centerline miles or 73,000 lane miles. The system serves more than 63 million auto trips on an average weekday and provides access to opportunities to improve the quality of life of our residents. The transportation network serves many modes like automobiles and trucks, but also active transportation (e.g., walking and rolling) and public transit. SCAG region has some of the most congested roadways in the nation. On average, drivers in the SCAG region end up wasting more than 100 hours every single year due to congestion.

This report summarizes the regional significance of Southern California's highway and arterial system, its existing conditions, performance results from SCAG's Regional Travel Demand Model (RTDM), and highlights system preservation investments and operational investments, including project commitments identified by local implementation agencies.

INTRODUCTION

PURPOSE

Millions use the Southern California's highway and arterial system. Therefore it is important to preserve existing and future infrastructure assets by ensuring adequate investments and by utilizing technologies and innovative strategies to combat traffic congestion, increase safety and maximize productivity. As funding limitations, community oppositions and stringent environmental compliance requirements have made the expansion of the highway and arterial system more challenging, SCAG works in partnership with transportation providers and stakeholders to prioritize projects that improve the existing infrastructure condition, close critical gaps and practice transportation system management strategies.

The highway and arterial investments in the Connect SoCal plan attempt to address challenges by following the system management approach as depicted in **FIGURE 1**. The overarching guiding principles of the System Management Pyramid is to protect and preserve our existing system through a "Fix it First" principle, support system preservation funding, maximize strategic investment productivity, close gaps in the system and support policies that will generate more seamless trips for users.

The foundation of the System Management Pyramid approach emphasizes the importance of monitoring and evaluating the existing transportation network, which will allow SCAG to have a clear understanding of how the system currently operates. The evaluation and monitoring of current metrics will inform the development of solutions to improve roadway safety, reliability and mobility of our roadways.

The next element is to protect existing investments through maintenance and preservation of our region's transportation infrastructure to achieve the maximum productivity of the system.

Further up the System Management Pyramid are smart lane use, Transportation Demand Management (TDM) and value pricing strategies, which aim to reduce travel demand. Specifically, these strategies aim to reduce

travel demand, improve the overall efficiency and productivity of our system. Examples of TDM strategies include:

- Increase carpooling and vanpooling
- Increase use of transit, bicycling and walking
- Redistribution of vehicle trips from peak demand periods to non-peak periods by shifting work times/day/locations
- Incentivize carpooling, transit, biking, walking and flexible work schedules
- Telecommuting
- First/Last Mile connections
- Mileage Based User Fees

Smart land use approaches aim to better integrate land use and transportation decisions. By improving the connections between jobs and housing, daily commute trips can be reduced and opportunities for using alternative modes of transportation can increase (e.g. walking, biking and transit). Finally, value pricing strategies, which are essentially a form of TDM, aim to incorporate pricing as part of the highway network in the form of Express/High Occupancy Toll (HOT) lanes to better utilize existing capacity. Express/HOT lanes that are appropriately priced can improve overall throughput in the system. Revenues generated from the Express/HOT lanes can be used to deliver and/or improve upon existing complementary transit service and thereby further reducing Single-Occupancy Vehicle (SOV) trip demand.

The next tier of the System Management Pyramid include Intelligent Transportation Systems (ITS) strategies. ITS strategies seek to optimize the capacity of the system through the use of various technologies that can adapt to changing traffic conditions and inform drivers about driving conditions to enable better informed traveler decisions. Examples of ITS strategies include:

- Traffic Signal Timing and Optimization
- Ramp Metering
- High Occupancy Toll (HOT) Lanes

- Variable Speed Limits
- Collision Avoidance Systems
- Universal Transit Fare Cards
- Improved Data Collection

The next tier of the pyramid are operational improvements. Operational improvements are elements that are added to an existing system with the goal of making the existing system better for its users. Examples of operational improvements include:

- Auxiliary Lanes
- Message Signs
- Improvements to ramps and weaving sections
- Sight Distance Improvements

System expansion and completion are at the top of the System Management Pyramid. System expansion and completion should be considered only when all other options have been considered. However, SCAG recognizes that critical gaps and congestion chokepoints still exist within our system, improvements beyond TDM strategies still should be considered.

The overarching guiding principles are as follows:

- Protect and preserve what we have first, supporting ‘Fix it First’ principle, including the consideration of life cycle costs beyond construction.
- Support continued system preservation funding and augment as necessary.
- Focus on achieving maximum productivity through strategic investments in system management and demand management.
- Focus on adding capacity primarily (but not exclusively) to:
 - Close gaps in the system
 - Improve access, where needed
- Support policies and system improvements that will encourage

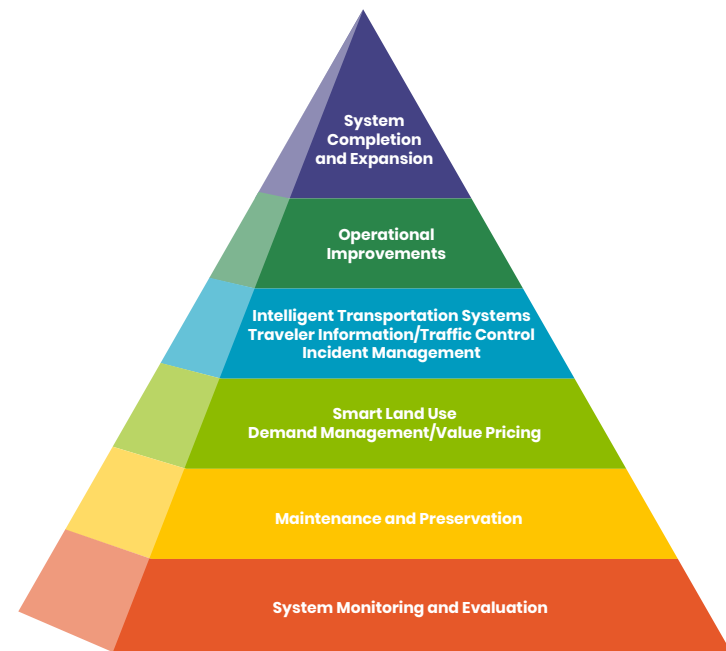
seamless operation of our roadway network from a user perspective.

- Any new roadway capacity project must be developed with consideration and incorporation of congestion management strategies, including demand management measures, operational improvements, transit, and ITS, where feasible.
- Focus on addressing non-recurring congestion with new technology.
- Support Complete Street opportunities.

ORGANIZATION OF REPORT

This report summarizes the regional significance of Southern California’s highway and arterial system, its existing conditions, performance results from

FIGURE 1 System Management Pyramid



Source: Caltrans

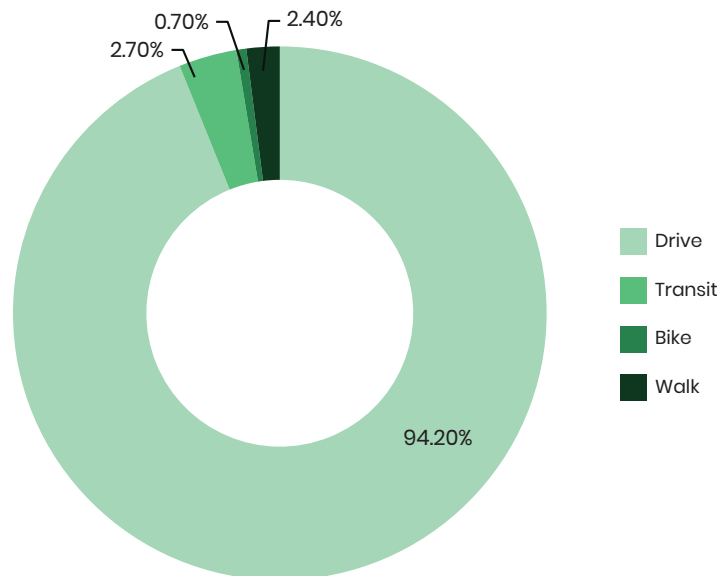
SCAG's RTDM and highlights investments. The report is organized as follows:

- Regional Significance
- Regulatory Framework
- System Condition and Performance Results
- Programmed Commitments
- Other Best Practices to Consider for Future Implementation

REGIONAL SIGNIFICANCE

Southern California's highway and arterial system functions as the backbone of our overall transportation network. The network provide access to employment, health, social and educational services that further supports a high quality of life. In the SCAG region, there are over 73,000 regionally significant lane miles that connect throughout California and to the rest of the United States.

FIGURE 2 Commute Mode Share (2016 Base Year)



Source: SCAG Regional Travel Model

TRANSIT

The transit system in the six-county SCAG region comprises an extensive network of services provided by dozens of operators. The network includes fixed-route local bus, community circulators, express bus, bus rapid transit (BRT), demand response, commuter rail, heavy rail and light rail. Transit operators that serve multi-jurisdictional routes can benefit from managed lanes or dedicated multi-modal lanes to better achieve on-time performance, reliability and customer service satisfaction. According to Federal Highway Administration (FHWA), the concept of managed lane is a “freeway-within-a-freeway” where a set of lanes within the freeway cross section is separated from the general-purpose lanes.¹ Some examples of managed lanes are express lanes, high-occupancy vehicle lanes and special use lanes. For further details about transit, please refer to the Transit Technical Report.

GOODS MOVEMENT

Goods movement is essential to support the economy and quality of life in the region. The extensive goods movement system is a multi-modal, coordinated network that includes deep-water marine ports, Class I rail lines, interstate highways, state routes and local connector roads, air cargo facilities, intermodal facilities and industrial warehouse and distribution clusters. In 2016, nearly 1.8 billion tons of goods valued at over \$2 trillion moved across the region's transportation system—serving local, state, national and international consumer markets. The Ports of Los Angeles and Long Beach represent the largest container port complex in the U.S. for both imports and exports. Los Angeles International Airport handled goods valued at nearly \$122 billion and international ports-of-entry supported the trade of goods valued at approximately \$16 billion. These gateways are supported by over 1.2 billion square feet of industrial warehouse and distribution space throughout the Corridor and almost 1,500 miles of the U.S. Primary Freight Network (PFN). Regional industries and companies are world leaders in commerce and represent a major exchange point for international trade as businesses from

¹ FHWA. (2008). Managed Lanes: A Primer.

across the globe trade using the transportation network. For further details about goods movement, please refer to the Goods Movement Technical Report.

ACTIVE TRANSPORTATION

Currently, a quarter of trips that are two miles or less in the SCAG region are made by walking or bicycling, a number that grows even more for trips under a mile. If gaps in the existing pedestrian and bicycle arterial network are addressed, walking and bicycling mode share for trips could be increased significantly and have the potential to attract choice drivers to gradually switch to active transportation modes.

Active transportation can lower cost, does not emit greenhouse gases, can help reduce roadway congestion and expands transit ridership. Complete streets projects that enhance active transportation infrastructure can also improve safety. Designing an active transportation network that is safe and accessible for everyone can help the region meet its economic, housing, environmental and public health goals.

In the SCAG region, nearly 44 percent of all pedestrian injuries are at intersections.² To improve intersection safety, the California Department of Transportation (Caltrans) and local agencies are now utilizing a complete streets approach to intersections.³ The complete streets approach to intersection design has one controlling assumption: “assume bicyclists and pedestrians will be there.” This complete streets approach involves reducing speed for turning movements, improving sight lines for crosswalks and reducing crossing distances.

Caltrans defines a complete street as a transportation facility that is planned, designed, operated, and maintained to provide safe mobility for all users, including bicyclists, pedestrians, transit vehicles, truckers and motorists, appropriate to the function and context of the facility. Every complete street

² California Highway Patrol (2012). California Statewide Integrated Traffic Records System.

³ California Dept. of Transportation (2010). Complete Intersections: A Guide to Reconstructing Intersections and Interchanges for Bicyclists and Pedestrians.

looks different, according to its context, community preferences, the types of road users, and their needs.

Over the recent years, Caltrans has made strides in the inclusion of Complete Streets policies in the delivery of infrastructure, which have created a safer environment for all users. In particular, Caltrans developed the Complete Streets Elements Toolbox in partnership with their stakeholder. The Toolbox is a focus on the specific roadway elements that can be designed and constructed to provide multi-modal mobility and access. For each of these elements, the Toolbox provides definitions and benefits, links to design guidance, project examples, and SHOPP Tool quantification methods. For further details about active transportation and complete streets policies, please refer to the Active Transportation Technical Report.

HIGH OCCUPANCY TOLL (HOT) LANES/EXPRESS LANE NETWORK

As major expansion of the highway system becomes more challenging for a myriad of reasons discussed earlier, planning efforts have been made to strategically manage demand in the existing system. One of such efforts is the integration of system and demand management to improve travel time reliability. Express lanes when appropriately priced to reflect demand can outperform non-priced lanes in terms of throughput, especially during congested periods. Express lanes operate on the principle of congestion pricing – when more vehicles are using the express lanes, the price increases accordingly to manage congestion in the lanes. Revenue generated by express lanes can be reinvested back into the transportation system.

TRANSPORTATION SAFETY

Policies, infrastructure and mode choice impacts the safety of everyone who travels throughout the region on a daily basis. Traffic related fatalities and serious injuries are a critical and preventable public health and social equity issue in the SCAG region. Providing a safe transportation network is essential for the region to meet its economic, housing, environmental, equity and public

health goals, and will require optimizing the existing system to incorporate complete streets, while supporting a range of other safety strategies.

On average, 1,500 people die, more than 5,200 are severely injured and 136,000 are injured on roadways throughout the SCAG region every year. These collisions are happening in communities all over the region, but 90 percent of collisions occur in urban areas and most collisions occur on local roads, not on highways. In fact, in the SCAG region, 65 percent of fatalities and serious injuries occur on less than 1.5 percent of the roadway network.

Safety is of particular concern to vulnerable users such as children, older adults and people walking, bicycling and on scooters. In recent years, trends for pedestrian and bicycle related collisions have shown an uptick since 2012. For further details about transportation safety, please refer to the Transportation Safety and Security Technical Report.

TRANSPORTATION SECURITY

With regards to security, catastrophic events like earthquakes, floods, fires, hazardous material incidents, dam failures, civil unrest, transportation incidents, tsunamis and terrorism can occur at any moment in the SCAG region. The State of California has experienced 323 state proclaimed emergencies and 267 federally proclaimed disasters since the year 1950. While the threat of disasters cannot be eliminated, good planning can help minimize the impacts from disasters. Disaster incidents were highest between the years of 2000 and 2009 where 59 people died, and 885 people were injured in the State of California. Within the SCAG region, the two most frequent disasters include floods (160 incidents since 1950) and fires (138 incidents since 1950).

While SCAG does not have a direct role as a first responder or emergency management, SCAG can play a role in:

- Providing a policy forum to help develop regional consensus and education on security policies and emergency responses.
- Assisting in expediting the planning and programming of transportation infrastructure repairs from major disasters.

- Leveraging projects and planning functions (including ITS) that can enhance or provide benefits to transportation security efforts and those responsible for planning and responding to emergencies.
 - Integrating security into the regional ITS architecture.
 - Becoming a central repository/mirror for regional geo-data that can be used for planning, training, response and relief efforts of law enforcement personnel and emergency responders.

For further details about transportation security, please refer to the Transportation Safety and Security Technical Report.

REGULATORY FRAMEWORK

MOVING AHEAD FOR PROGRESS IN THE 21ST CENTURY

In July 2012, the Moving Ahead for Progress in the 21st Century (MAP-21) federal transportation authorization legislation was signed into law. MAP-21 was widely considered to be a ground-breaking achievement in that it provided a legislative foundation for the establishment of a national performance-based transportation planning program, which was continued with the subsequent federal authorization program, the Fixing America's Surface Transportation (FAST) Act, in December 2015. MAP-21 states that Metropolitan Planning Organizations (MPOs) are required to establish performance targets focused on performance outcomes supportive of seven key national transportation goals related to transportation investment efficiency. These national performance goals include: 1) transportation system safety, 2) infrastructure condition, 3) congestion reduction, 4) system reliability, 5) freight movement and economic vitality, 6) environmental sustainability, and 7) reduced project delivery delays.

To provide a quantitative basis for evaluating progress toward achieving these seven national goals, MAP-21 also required the Federal Highway Administration (FHWA) to develop a corresponding set of performance measures and performance targets. The performance measures provide a standardized

quantitative metric for evaluating progress toward meeting each of the national goals. Performance targets provide a numeric threshold by which the performance measures can be interpreted as having made acceptable progress toward achieving a specific performance goal.

PERFORMANCE MEASURE

As required under MAP-21, FHWA issued individual packages of rule-makings in 2016 and 2017 to establish a set of national performance measures and guidelines for use in the setting of statewide and regional performance targets. The FHWA rule-makings establish a four-year performance target setting and reporting cycle, with a two-year mid-term progress evaluation point. As provided in the federal rule-making process, SCAG coordinated closely with Caltrans in the establishment of specific performance targets for the state and for our region in the various transportation performance areas established under MAP-21.

MAP-21 requires FHWA to establish rules for implementing transportation system performance management planning at a national level. FHWA rule-making in support of MAP-21 and the FAST Act provides performance management and target-setting guidance for Performance Measure 2: Pavement and Bridge Condition for the National Highway System. The following identifies PM 2 Performance Measure:

Performance Measure 2 - National Highway System Pavement and Bridge Condition

- Percentage of Interstate System pavement in 'Good' condition
- Percentage of non-interstate NHS pavement in 'Good' condition
- Percentage of Interstate System pavement in 'Poor' condition
- Percentage of non-interstate NHS pavement in 'Poor' condition
- Percentage of NHS bridges in 'Good' condition
- Percentage of NHS bridges in 'Poor' condition

PERFORMANCE TARGETS

Just as the MAP-21 performance measures were selected to support the monitoring of each of the national transportation goals, performance targets are established to support the measures. The target values provide a specific and quantifiable objective for achievement for each measure during the performance period. Targets act as quantitative thresholds for determining whether an acceptable level of progress has been achieved for a specific measure. MAP-21 requires that performance targets be set for each of the designated federal metrics at the statewide and regional levels. SCAG coordinated closely with Caltrans throughout the process of developing initial statewide performance targets for PM 2.

MAP-21 rule-making provides MPOs with the option to either accept the statewide performance targets or to develop a separate set of targets specific to the region. Since SCAG has been actively involved in the development of the statewide targets for MAP-21 performance management packages, SCAG opted to support the statewide targets for the initial performance monitoring period, which started in January 2018. MAP-21 establishes a 4-year performance target setting and reporting cycle, with a 2-year mid-term progress evaluation point. The initial 4-year MAP-21 reporting cycle will end on December 31, 2021. The statewide and/or regional performance targets may be revised at the 2-year mid-term evaluation if re-calibration is determined to be appropriate. Targets for the first cycle through December 2021 were established by SCAG's Transportation Committee in September 2018 as depicted by **TABLE 1** and **TABLE 2**.

ASSEMBLY BILL 1358

AB 1358, the Complete Streets Act of 2008, requires cities and counties to incorporate the concept of Complete Streets in the circulation element of the local jurisdiction's general plan update. The circulation element is required to identify a balanced multi-modal transportation network that meets the needs of all users of streets, roads and highways for safe and convenient travel.

SENATE BILL 1

Senate Bill 1 (SB-1), the Road Repair and Accountability Act of 2017, was signed into law on April 28, 2017. This legislative package raises the State gas tax and links it to inflation. It also increases Department of Motor Vehicle (DMV) fees. SB-1 invests the proceeds, estimated at \$54 billion over the next decade, to fix roads, freeways and bridges in communities across California and puts more dollars toward transit and safety. Specifically, over the first ten years, it

is projected to provide \$15 billion to local streets and roads plus \$19 billion to State Highway System for preservation. Over the life of this RTP/SCS (25 years), this new funding source addresses a large gap in funding to address preservation needs in the region. SB-1 also sets targets for counties and Caltrans to achieve as follows:

- Each county's average Pavement Condition Index (PCI) meets or exceeds 80 (good – excellent)

TABLE 1 Statewide NHS Pavement and Bridge Condition (PM 2) Targets

PM 2 Performance Measures	Baseline (2017)		2-Year Targets				4-Year Targets			
			(1/1/18 - 12/31/19)				(1/1/20 - 12/31/21)			
	Good	Poor	Good	Change	Poor	Change	Good	Change	Poor	Change
NHS Pavement (Total)	30.4%	6.1%	32.4%	2.0%	6.3%	0.2%	33.5%	3.1%	6.4%	0.3%
Interstate Pavement	47.9%	3.1%	45.1%	-2.8%	3.5%	0.4%	44.5%	-3.4%	3.8%	0.7%
Non-Interstate NHS Pavement	25.5%	7.1%	28.2%	2.7%	7.3%	0.2%	29.9%	4.4%	7.2%	0.1%
NHS Bridges	66.5%	4.8%	69.1%	260.0%	4.6%	-0.2%	70.5%	4.0%	4.4%	-0.4%

Source: SCAG

TABLE 2 SCAG Region NHS Pavement and Bridge Condition (PM 2) Targets

PM 2 Performance Measures	Baseline (2017)		2-Year Targets				4-Year Targets			
			(1/1/18 - 12/31/19)				(1/1/20 - 12/31/21)			
	Good	Poor	Good	Change	Poor	Change	Good	Change	Poor	Change
Non-Interstate NHS Pavement	3.7%	14.4%	4.0%	0.3%	13.8%	-0.6%	4.7%	1.0%	12.7%	-1.7%
NHS Bridges	36.1%	14.8%	37.9%	1.8%	14.0%	-0.8%	41.4%	5.3%	12.4%	-2.4%

Source: SCAG

- Not less than 98 percent of pavement on the state highway system in good or fair condition
- Not less than 90 percent of the transportation management system units in good condition
- Fix not less than an additional 500 bridges

The compromised condition of our highways and bridges is expected to improve significantly moving forward, primarily due to the new SB-1 funding allocated to preservation.

SB 1 funding programs include the Solutions for Congested Corridors Program (SCCP), Trade Corridor Enhancement Program (TCEP), Local Streets and Roads Program (LSRP), Local Partnership Program (LPP), as well as augment funds for Active Transportation Program (ATP), State Highway Operation and Protection Program (SHOPP) and State Transportation Improvement Program (STIP). Eligibility and requirements vary dependent on the specific program. In the case of Solutions for Congested Corridor Program (SCCP), SB 1 requires preference to be given to comprehensive corridor plans that demonstrate collaboration as well as a comprehensive planning approach. For more information and guidelines, please refer to the California Transportation Commission (CTC) website.

ANALYTICAL APPROACH

SCAG developed the Regional Travel Demand Model (RTDM) that covers the SCAG region, which encompasses 6 counties and 11,267 Tier 2 Transportation Analysis Zones (TAZs). The RTDM is composed of three main components:

1. Coordinated Travel-Regional Activity Modeling Platform, which stimulates daily activity participation and scheduling of each individual
2. Network assignment model that estimates traffic data of all vehicle modes by using origin-destination inputs, and
3. Other per-calculated origin-destination input matrices

For more details on RTDM methodology, please refer to the Transportation Conformity Analysis Technical Report.

The model and selected inputs were developed in collaboration with the Community, Economic and Human Development (CEHD) Policy Committee, Technical Working Groups (TWG), California Department of Finance (DOF), sub-regions, local jurisdictions, County Transportation Commissions (CTCs) and other stakeholders.

The RTDM uses synthetic population and household as main inputs to forecast the mobility performance of the region’s highway and arterial system. Mobility performance measures commonly rely on the measure of delay. Delay is the difference between the actual travel time and the travel time at some pre-defined reference or “optimal” speed for each mode alternative. It is measured in vehicle-hours of delay (VHD), which then can be used to derive person-hours of delay.

The mobility measures used to evaluate the scenario alternatives include:

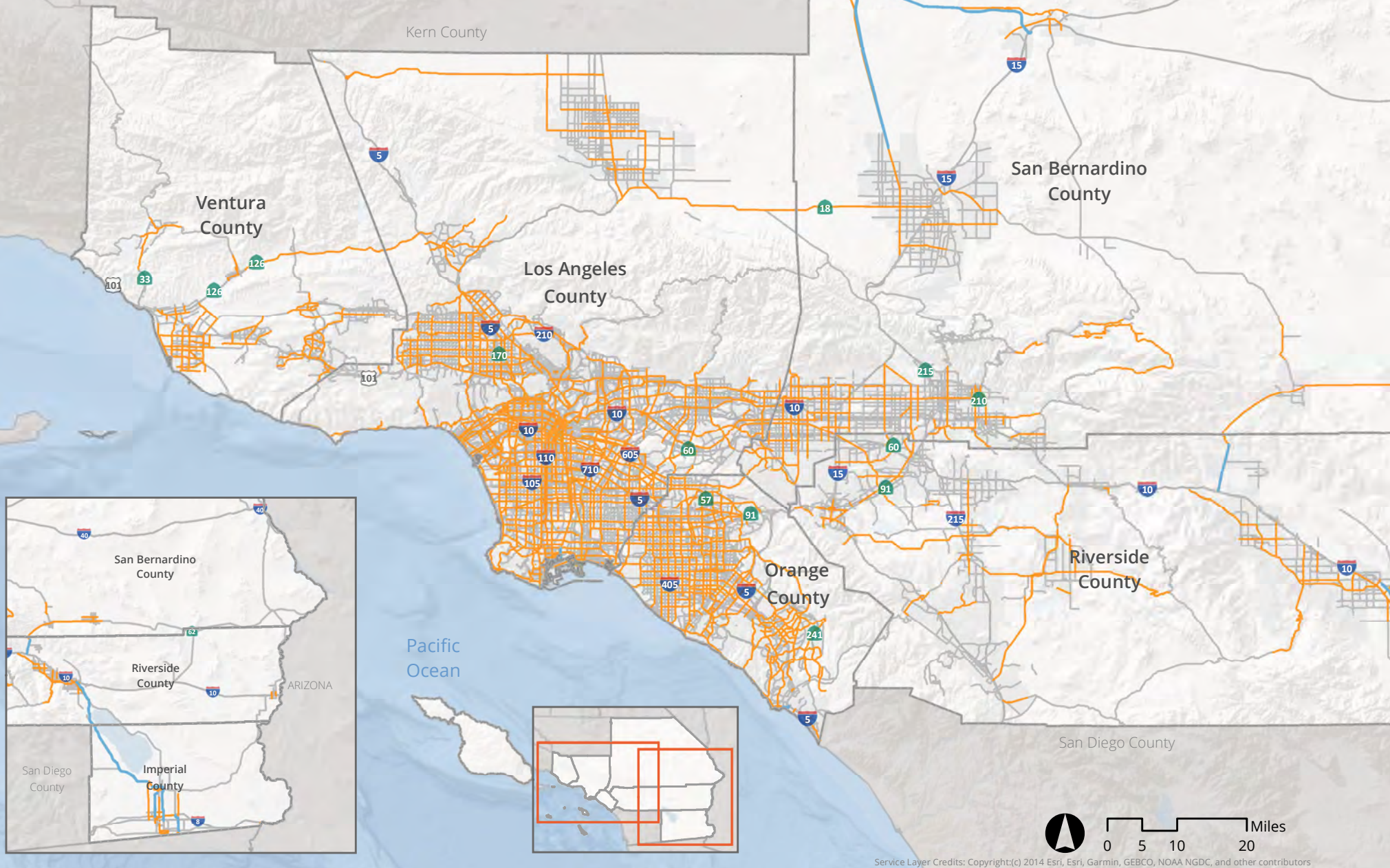
- Person Delay by Facility Type
- Person Delay per Capita
- Truck Delay by Facility Type

SYSTEM CONDITION

ARTERIAL NETWORK

Our region’s local arterial system is composed of all local streets and roads, which provide residents in our region with connections to homes, schools, jobs, healthcare, recreation and retail. As shown in **EXHIBIT 2** (Base Year) and **EXHIBIT 3** (Plan Year), many local arterials also parallel major highways, therefore providing alternate routes to the highway during peak travel times. The arterial network is important for mobility in our region due to its ability to serve essentially all users - pedestrians, bicyclists, personal mobility device users, transit users and motorists. A total of \$20.7 billion is estimated to be invested into our region through Connect SoCal.

EXHIBIT 3 Plan Year 2045 Regionally Significant Arterial System



Expressway / Parkway Principal Arterial Minor Arterial

REGIONAL EXPRESS LANE NETWORK

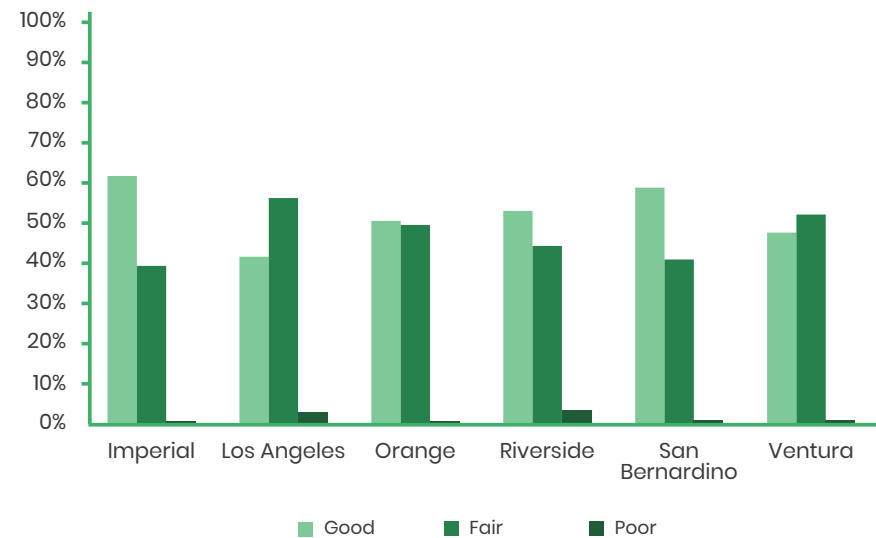
The regional express lane network included in Connect SoCal builds on the success of the I-10 and I-110 Express Lanes in Los Angeles County and the recent extension of the SR-91 Express Lanes between Orange and Riverside Counties. Additional efforts underway include planned Express lanes on the I-15 in Riverside County, the I-15 and the I-10 in San Bernardino County, the I-405 in Orange County/Los Angeles County and the I-105 in Los Angeles County.

SYSTEM PRESERVATION

Maintaining and managing our transportation system was a major challenge in the 2016 RTP/SCS. Chronic underinvestment in system preservation accumulated over many years resulted in unacceptable levels of poor pavement and bridge conditions that would only get worse if the trends were not reversed. So, 2016 RTP/SCS identified significant needs and proposed new funding sources, including increase in excise tax on gasoline, part of which were allocated to system preservation and system management. Partly because of the awareness that was raised on this issues through the 2016 RTP/SCS, SB-1 was passed in 2017. SB-1 materializes some of the ambitious assumptions that were included in the 2016 RTP/SCS as part of the constrained plan.

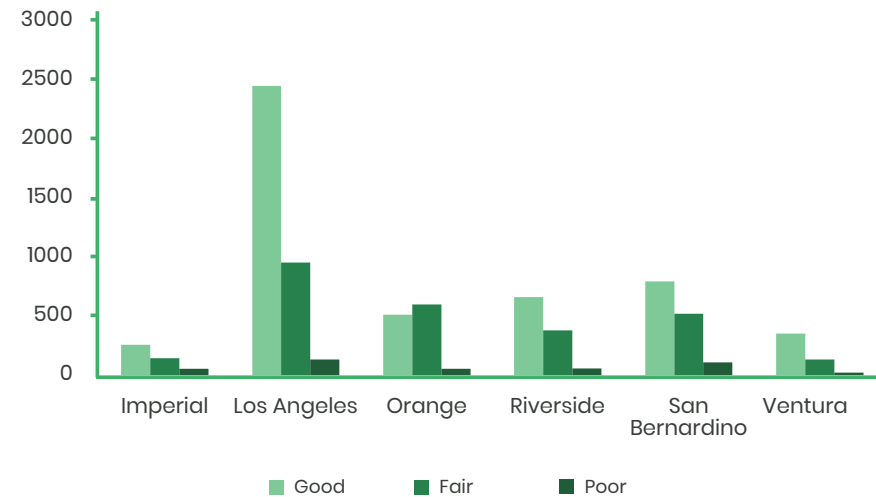
The results of SB-1 are already evident on the ground and we are in a much better place than we were four years ago. However, because our needs were so great, SB-1 alone does not fully cover the need that was identified in the 2016 RTP/SCS. Furthermore, SB-1 does not fully address the revenue loss that will likely result over the course of our plan due to transitioning of our vehicle fleet to more efficient, clean and non-fossil fuel based vehicles. Therefore, the Connect SoCal (2020 RTP/SCS) will continue to emphasize the importance of system preservation and system management, and advocate for additional funding sources. Consistent with the pavement and bridge condition targets that were established for the calendar year 2019 pursuant to the requirements of MAP-21/SAFTEA-LU, proposed plan will result in significant improvement in our transportation asset condition over the plan horizon. **FIGURE 3** displays the pavement condition of the state highway system. **FIGURE 4** reflects bridge conditions in the SCAG region.

FIGURE 3 Pavement Condition of State Highway System (2015)



Source: Caltrans Automated Pavement Condition Survey 2015-2016

FIGURE 4 Bridge Conditions in the SCAG Region

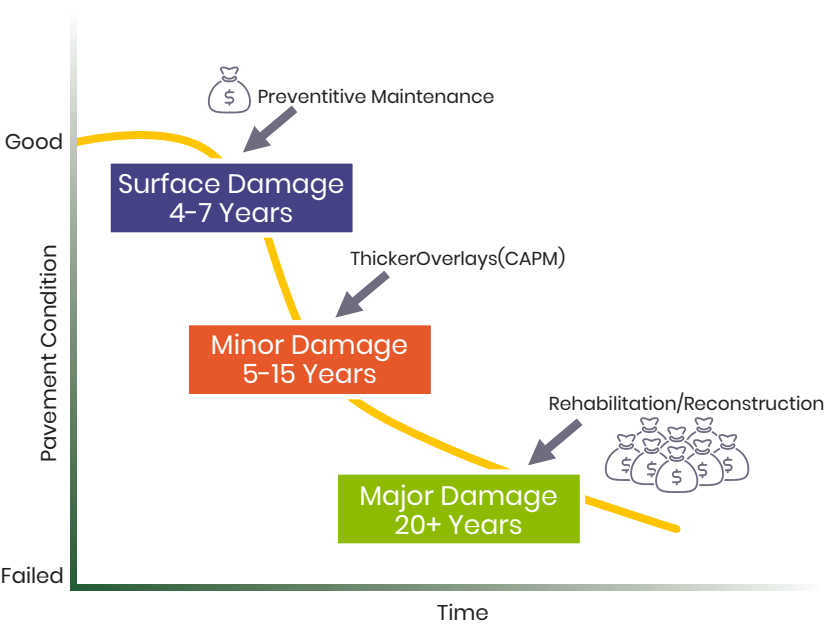


Source: FHWA Bridge Inventory

Connect SoCal identifies approximately \$68 billion to address preservation, operation and resilience needs of the state highway infrastructure system. As shown in **FIGURE 5**, deferred maintenance leads to much costlier repairs in the future. Repairs to keep roadways in a state of good repair cost on average \$115,000 per lane mile for preventative maintenance with major rehabilitation work being eight times more expensive⁴. Therefore, in keeping with the “Fix-it-First” principle, Connect SoCal supports prioritizing earlier preventive maintenance work. Connect SoCal also allocates over \$47.5 billion for operations and maintenance of regionally significant local streets and roads.

4 2015 – 2016 State Highway System Automated Pavement Condition Survey Report

FIGURE 5 Cost Effectiveness of Pavement Treatment



Source: 2015 – 2016 State Highway System Automated Pavement Condition Survey Report

TRANSPORTATION SYSTEM RESILIENCE

Transportation System Resiliency, which is closely related to system preservation, is another priority area that emphasized in the plan. As we experience earthquakes, wildfires, storm surges with greater frequency and intensity, investing adequately and strategically in our transportation system will be critical in order to minimize the impact of these events, and when the impacts are unavoidable, facilitating swift recovery from these events. Clearly, preserving and securing critical evacuation routes, investing in and maintaining auxiliary facilities such as storm drains, levies, retaining walls, culverts etc. that mitigate some of these climate related events will be very important for the region to function well over the long horizon. Additional funding of approximately \$5 billion is embedded in the Connect SoCal to implement and accelerate strategies that will support transportation system resilience, including vulnerability assessment studies, risk assessments and other related studies that will be pursued in partnership with our state and local partners.

CORRIDOR SYSTEM MANAGEMENT PLANS

A Corridor System Management Plan (CSMP) is used to outline the multi-jurisdictional and multi-modal management of a corridor experiencing delay due to congestion. A CSMP consists of a list and phasing plan of recommended operational improvements, ITS strategies, and system expansion projects to preserve or improve performance measures within the corridor. CSMPs are required for all projects receiving Proposition 1B (2006) Corridor Mobility Improvement Account (CMIA) funding.

Due to the multi-jurisdictional nature of the corridors, Caltrans, SCAG, Counties and others partner agencies together for CSMPs. Several CSMPs have been developed for various corridors throughout the SCAG region.

The CSMPs include several key components:

1. A comprehensive corridor description and understanding
2. A performance assessment and bottleneck identification

3. Identification of operational and minor infrastructure improvements to relieve congestion, and
4. Development of simulation models to estimate improvements from those projects and strategies

The recommended improvements include Transportation Systems Management (TSM) investments such as ramp metering and enhanced incident management. The recommendations also include small infrastructure improvements such as auxiliary lanes and ramp and interchange improvements.

INTEGRATED CORRIDOR MANAGEMENT

The Integrated Corridor Management (ICM) Initiative was first introduced by the U.S. Department of Transportation (USDOT) in 2006. Under the ICM approach, all elements within a corridor are considered when evaluating opportunities to move people and goods in the most efficient manner feasible, while simultaneously ensuring that the greatest operational efficiencies are achieved. Since the introduction of ICM, great progress has been made in Los Angeles and Orange County. In Los Angeles County, the I-210 ICM project aims to minimize congestion due to accidents and is referred to as the Connected Corridors Initiative. In Orange County, Caltrans has started implementing the North Orange County Triangle ICM, which include the I-5, SR-57 and SR-91. Partner agencies also aim to integrate their systems with Caltrans' system.

LA Metro also prepared the Regional ICM Assessment that analyzed all freeways and adjacent arterials in Los Angeles County for potential ICM implementation. This study is being further evaluated by Caltrans District 7 for prioritization of future ICM corridors. Over the next 10 years Caltrans plans to implement similar projects on 25 additional congested corridors statewide, which support the overarching goals and objectives of Connect SoCal and therefore should be considered as an integral part of this plan.

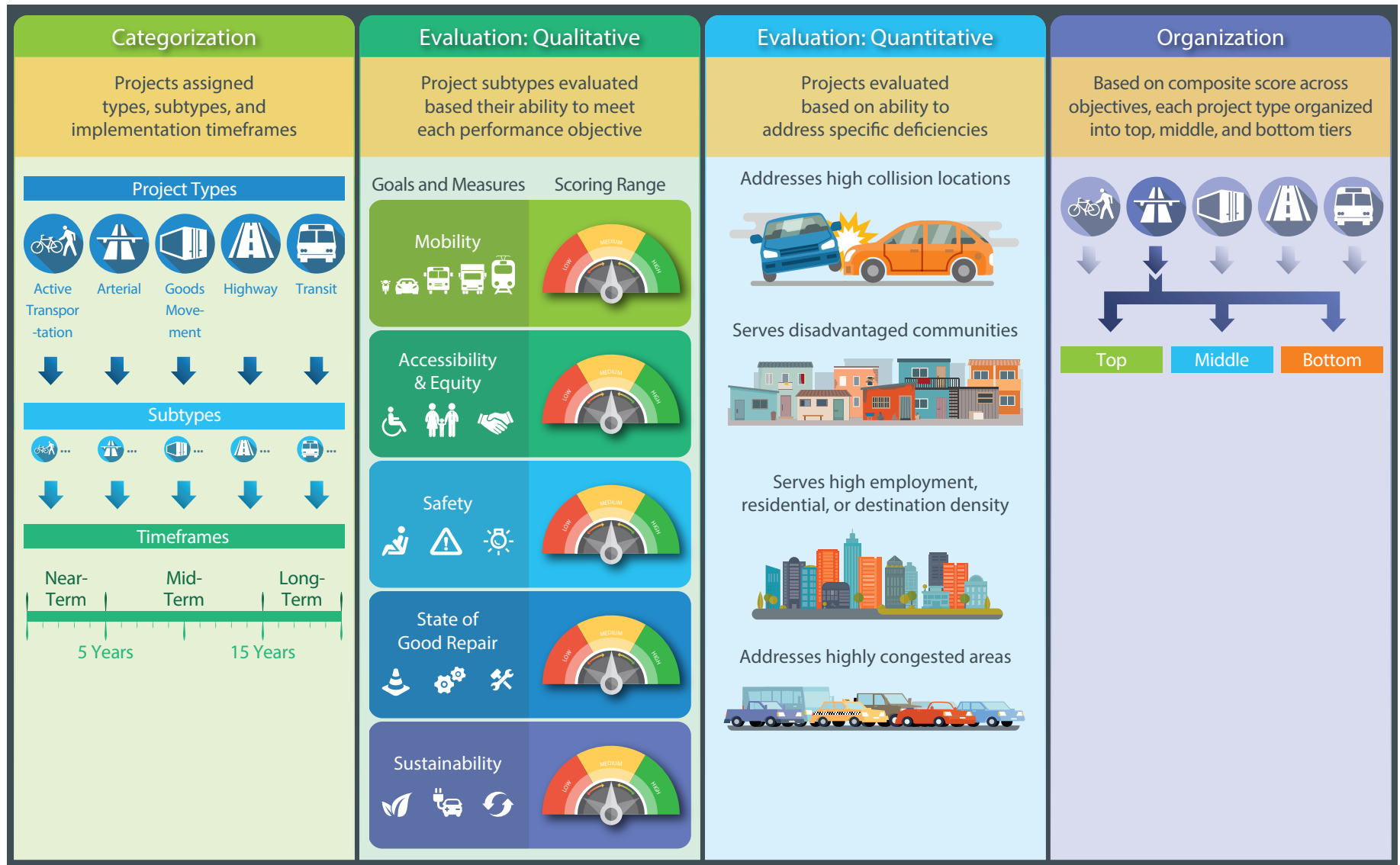
PLANS TO HIGHLIGHT

I-105 CORRIDOR SUSTAINABILITY STUDY (2019)

The Interstate 105 (I-105) is a major east-west freeway located in the southern portion of Los Angeles County. It provides both interregional and intraregional access to several major north-south corridors, including the I-405, I-110, I-710 and I-605. The City of El Segundo (west of I-405) and Studebaker Road in the City of Norwalk are the boundaries of the I-105. The freeway spans 18 miles and ranges from six to eight lanes, including general purpose and high-occupancy vehicle lanes with auxiliary lanes between most on-ramps and off-ramps. It provides connection to the Los Angeles International Airport, which is one of the busiest airports in the world. On a typical day, this freeway carries more than 270,000 vehicles at its most heavily traveled location with 17,000 vehicles during the peak hour. On an annual basis, it is estimated that drivers experience 3.7 million hours of delay. The study area itself is defined to include 3 miles on each side of the I-105.

The purpose of this study was to examine the I-105 corridor from a multi-modal and sustainability perspective to address mobility, sustainability and safety challenges within the corridor study area. The study steps included data collection, continuous stakeholder engagement and a framework for evaluation of existing conditions, future baseline and future built conditions and estimates potential costs and funding sources for proposed improvements. **FIGURE 6** shows the evaluation framework for potential I-105 CSS improvements. **TABLE 3** highlights the summary of key identified deficiencies and the types of projects that would address those deficiencies. For a detailed list of projects proposed in study, please refer to Appendix B of the I-105 Corridor Sustainability Study.

FIGURE 6 Performance Evaluation Process for I-105 Corridor Sustainability Study



Source: I-105 CSS

TABLE 3 Summary of I-105 Deficiencies and Key Project Recommendations

I-105 Corridor System Deficiencies	Key Project Types to Address I-105 Corridor System Deficiencies
Peak Period Congestion	System Improvements, such as ExpressLanes, spot operation improvements, ramp improvements, interchange improvements and integrated corridor management
High Congestion and VMT on Arterials: Firestone, Vermont, Western, Van Ness, Rosecrans, Sepulveda, Lakewood, Manchester, Artesia, Imperial Highway	Intelligent Transportation Systems, such as traffic signal synchronization, spot intersection improvements, arterial/rail grade separations and access management projects
Low Transit Mode Share	Major transit projects such as West Santa Ana Branch Transit Corridor Project, Green Line Extension, Vermont Transit Corridor
	Metrolink Commuter Rail Program Enhancements
	Green Line capital and operational improvements
	Tram link to Inglewood Stadium
	Local transit service improvements
	Enhanced airport express bus service
Lack of bicycle routes	Park and Ride Expansion
	Implement city bike plans
	First/Last Mile Projects
	Bike/Pedestrian Bridges
	Eco-Rapid Transit Bike Lane
Bicycle Collision Concentrations	Rails to Trails Corridor
	Implement City and County Bike Projects
Truck Collision Concentrations	Freeway ramp terminus pedestrian and bicycle enhancements
	Grade Separation and Crossing Projects
Arterial Roadway Pavement Deterioration	Truck-oriented intersection improvements, such as curb return widening and signal improvements oriented to trucks, etc.
	Resurface and reconstruction projects

Source: I-105 CSS

I-105 ACTIVE TRAFFIC MANAGEMENT CONGESTION RELIEF ANALYSIS STUDY (2014)

Active Traffic Management (ATM) is a proactive traffic management approach which uses various strategies to dynamically manage traffic based on prevailing conditions for recurrent and non-recurrent congestion. Examples of ATM include, speed harmonization, queue warning, junction control, part-time shoulder use, dynamic re-routing and traveler information. The goal of these strategies is to improve highway operations resulting in improved mobility and safety. This study was conducted by Caltrans in 2014.

The purpose of the 105 Active Traffic Management Congestion Relief Analysis Study was to establish a framework for how to make good decisions when considering ATM strategies along I-105. The tasks included literature reviews, qualitative screening of freeway corridors, qualitative evaluation of ATM strategies, analysis of the corridor and development of an implementation and deployment plan. The study illustrates conceptual diagrams, recommended operational conditions, recommended operational components for numerous ATM strategies including, but not limited to hard shoulder running with dynamic lane management, queue warning, variable speed limit, dynamic corridor adaptive ramp metering and more. This study offers decision makers the tools to explore ATM strategies. For more information, please refer to the Caltrans Active Traffic Management Congestion Relief Study (2014).

PERFORMANCE RESULTS

A summary of performance results for Connect SoCal related to highways and arterials is provided below. A comprehensive discussion of all performance results for Connect SoCal is provided in Chapter 5 of the main document and the Performance Measures Technical Report. The mobility performance measures rely on the commonly used measure of delay. Delay is the difference between the actual travel time and the travel time at some pre-defined reference or 'optimal' speed for each mode alternative under analysis. It is measured in vehicle-hours of delay (VHD), which can then be used to derive person-hours of delay. This is a relatively straightforward measure to calculate using real-world and modeled data, is understandable by both

transportation professionals and the general public, and can be forecasted for the 2045 future scenarios.

In the discussion of performance outcomes, three scenarios are referenced: Base Year, Baseline and Plan.

- Base Year represents existing conditions as of 2016 – that is, the transportation system as it was on the ground and in service in 2016. The year 2016 was selected as the Base Year for this analysis because it is the year of the most recent previous RTP/SCS.
- Baseline assumes a continuation of the development trends of recent decades. This scenario represents a future in 2045 in which the following have been implemented: projects currently under construction or undergoing right of way acquisition; those programs and projects programmed and committed in the 2019 Federal Transportation Improvement Program (FTIP); and/or projects that have already received environmental clearance.
- The Plan represents future conditions in 2045, in which investments and strategies detailed in the 2020 RTP/SCS are fully realized.

The mobility measures used to evaluate alternatives for this outcome include:

- Daily Person-Hours of Delay by Facility Type
- Daily Person Delay per Capita by County
- Daily Heavy-Duty Truck Hours of Delay

PERSON DELAY BY FACILITY TYPE

As the transportation system can be differentiated based on the characteristics of highway/expressway, HOV and arterials, we are able to forecast anticipated delays by facility type based on the base year, baseline and plan year. **FIGURE 7** showcases the expected decrease in daily person hours of delays by facility type when investments in Connect SoCal are implemented by 2045. In summary, Connect SoCal plan investments are estimated to decrease daily person-hours of delay by 25.7 percent on the highway and 24.1 percent on arterials compared to Baseline conditions.

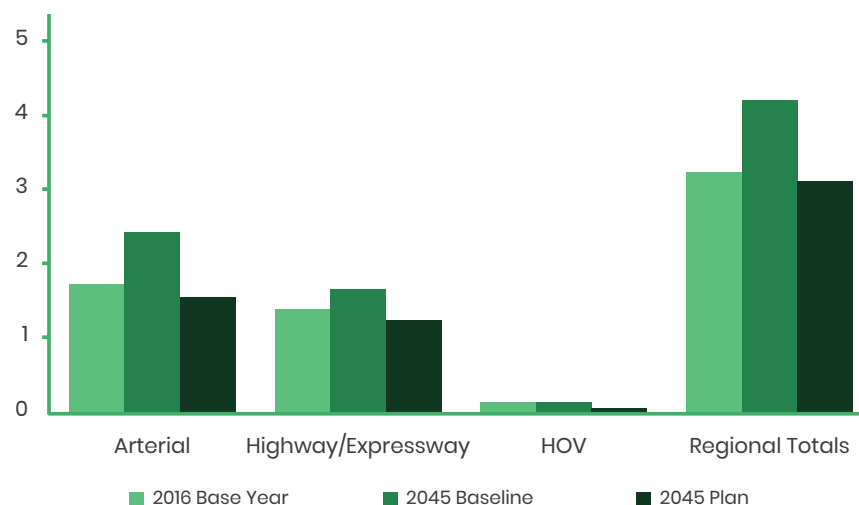
PERSON DELAY PER CAPITA

Normalizing delay by the number of people living in the area demonstrates how the system is performing as a whole in light of anticipated population growth. As shown in **FIGURE 8**, it is expected that implementation of Connect SoCal would substantially reduce person delay per capita. The region’s daily person delay per capita under Baseline conditions is estimated to be 11.3 minutes and 8.4 minutes by Plan conditions – a decrease of 3 minutes daily person delay per capita. In summary, the daily person delay per capital is expected to decrease by 25.7 percent under the Plan versus Baseline conditions.

TRUCK DELAY

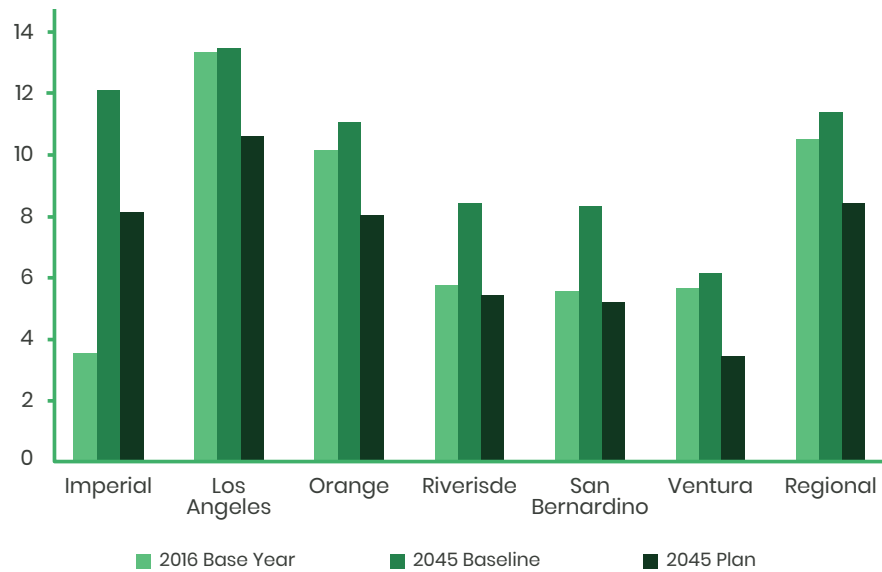
FIGURE 9 shows the estimated average daily truck delay by facility type. Connect SoCal is estimated to reduce truck delay by 22.3 percent over Baseline conditions for the category of highway/expressway, with 26.6 percent over Baseline conditions for the arterials.

FIGURE 7 Daily Person-Hours of Delay by Facility Type (Millions)



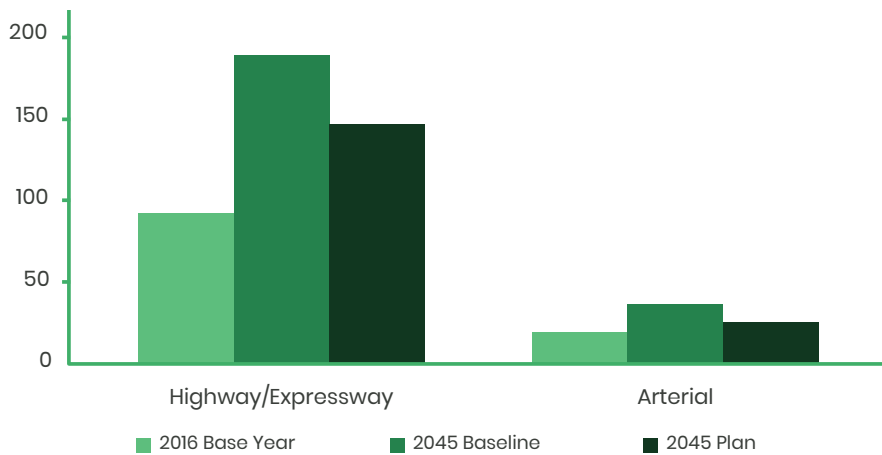
Source: SCAG

FIGURE 8 Daily Person Delay per Capita by County (Minutes)



Source: SCAG

FIGURE 9 Daily Heavy-Duty Truck Hours of Delay (Thousands)

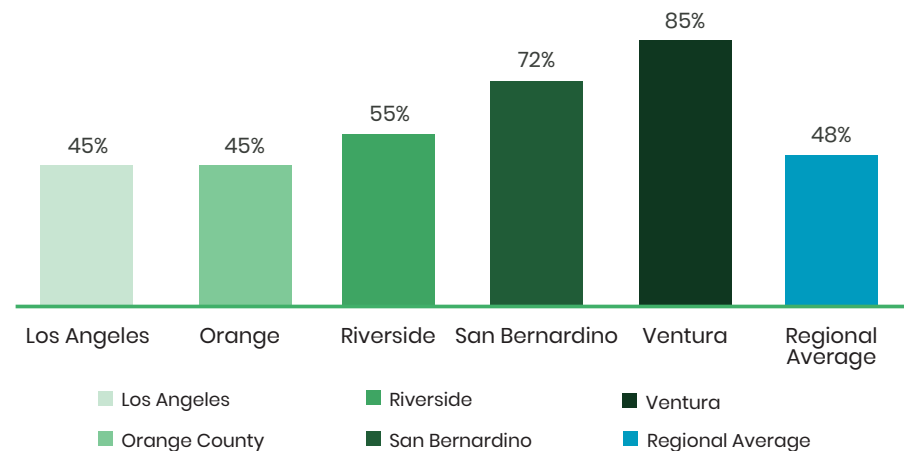


Source: SCAG

NON-RECURRENT DELAY

FIGURE 10 shows the percent of non-recurrent congestion by county on a typical day (5:00 AM through 8:00 PM) in 2015. While recurring congestion is the “day-to-day” traffic congestion when the number of vehicles traveling along a roadway exceeds the available capacity, which therefore results in slower speeds and delays, non-recurring congestion is the congestion caused by collisions, weather, special events or other unforeseen events. Data from the 2015 Caltrans Performance Measurement System (PeMS) was used to assess levels of non-recurrent delay. Non-recurrent delay can be categorized into two major components: “Accidents” or “Miscellaneous”. Using the Caltrans Traffic Accident Surveillance and Analysis System (TASAS), increases in congestion levels can be compared to whether an accident was reported. If an accident was reported during the time of increases in congestion, then that would be categorized as accident-related congestion. If there was an increase in congestion, without a reported accident, then it would be categorized as miscellaneous-related congestion. In summary, PeMS indicates 48 percent of congestion in the SCAG region was related to non-recurrent events, such as collisions, weather, special events, or other unforeseen events.

FIGURE 10 Percent Non-Recurrent Congestion by County (2015)



Source: Caltrans Performance Measure System (PeMS), 2015

PROGRAMMED COMMITMENTS

The Federal Transportation Improvement Program (FTIP) is a federally mandated four year program of all surface transportation projects that will receive federal funding or are subject to a federally required action. The FTIP is a comprehensive listing of such transportation projects proposed over the first six-years of the Connect SoCal Plan for the SCAG region. As the Metropolitan Planning Organization (MPO) for the region, SCAG is responsible for developing the FTIP for submittal to the California Department of Transportation (Caltrans) and the federal funding agencies. The FTIP for the SCAG region is developed in partnership with the six County Transportation Commissions (CTCs) of Imperial, Los Angeles, Orange, Riverside, San Bernardino, and Ventura as well as Caltrans Districts 7, 8, 11, 12 and Headquarters. The projects vary by type and range from highway improvements, transit, rail and bus facilities to high occupancy vehicle (HOV) lanes, signal synchronization, intersection improvements, and freeway ramps. The FTIP project list can be found in the RTP/SCS Project List Technical Report.

EXHIBIT 4-5 display sample projects ranging from high occupancy vehicle (HOV) lanes, auxiliary lanes and highway ramp improvements.

Each of the six CTCs within the SCAG region also identified committed projects through the year 2045. These projects have been identified either through countywide long-range transportation plans (LRTPs) or in part by voter approved sales tax initiatives. **TABLE 5** shows a sample of major projects committed by Counties.

TABLE 4 shows Connect SoCal’s highway investments by category. Connect SoCal commits more than \$37 billion for various highway improvements, including mixed-flow and interchange improvements, HOV/Express lanes and transportation system management. In addition, Connect SoCal commits more than \$65 billion toward goods movement improvements, of which a portion of these funds are allocated specifically toward highway and local arterial improvements.

TABLE 4 Plan Highway Investments

Type	Purpose	Cost (\$, Billions)
Mixed-Flow and Interchange Improvements	To close critical gaps in the highway network to provide access to all parts of the region.	\$10.3
High-Occupancy Vehicle (HOV)/Express Lanes	To close gaps in the HOV/Express Lane network.	\$13.4
Transportation System Management	To improve traffic efficiency and reliability.	\$13.7

Source: SCAG

TABLE 5 Sample Major Highway Projects Committed by Counties

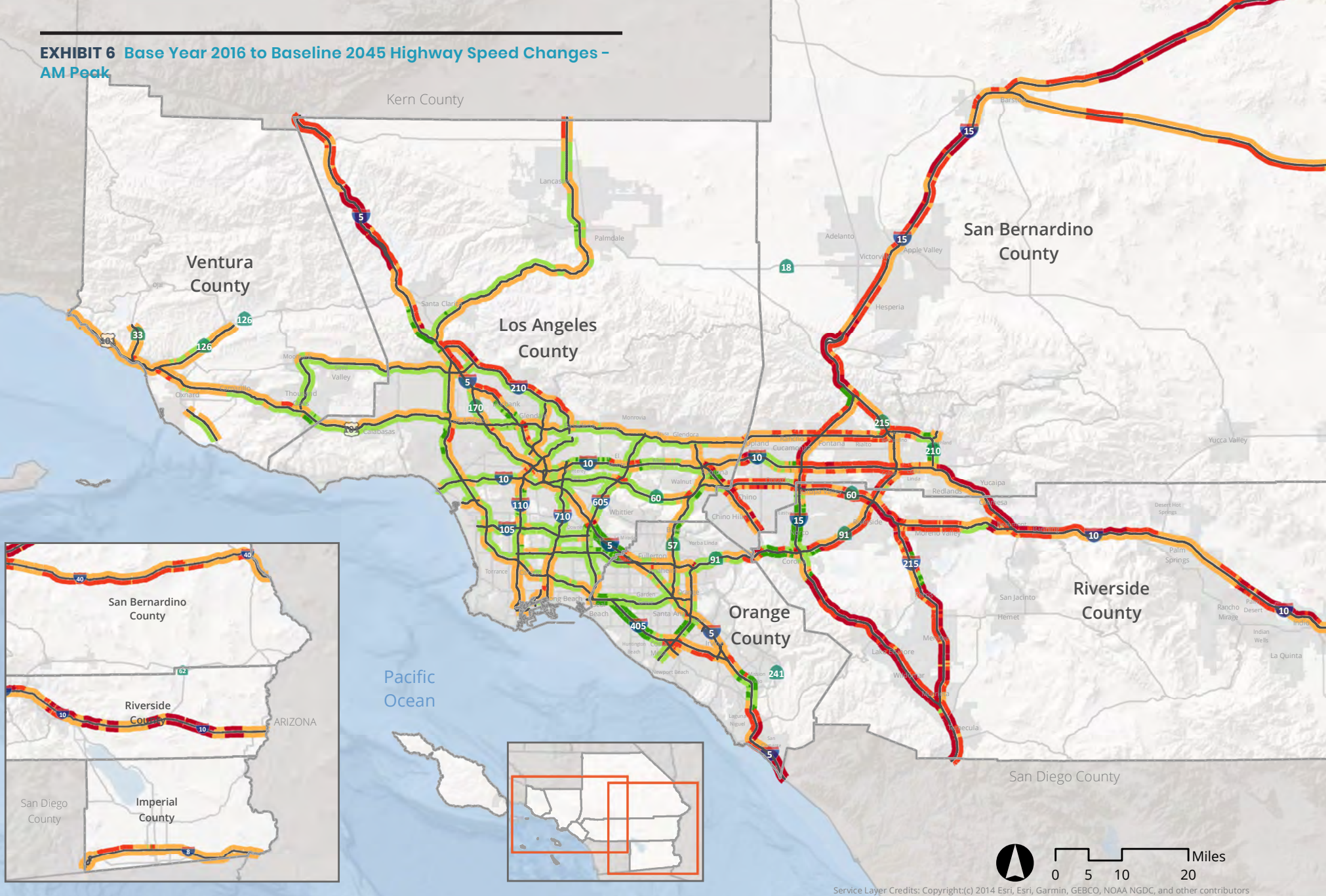
	County	Route	Description	Completion Year	Project Cost (\$1,000's)
MIXED-FLOW LANES	Imperial	SR-111	Widen and improve to six-lane freeway with interchanges at Heber, McCabe, and Jasper and overpass at Chick Rd.	2030	\$999,136
	Los Angeles	SR-57/SR-60	Route 57/60 Confluence Chokepoint Relief Program.	2026	\$300,000
	Los Angeles	I-710	Add one mixed-flow lane in each direction between Shoreline Dr and SR-91 and between I-105 and SR-60, plus add 2 truck lanes between Willow St and Del Amo Blvd.	2035	\$5,941,000
	Orange	SR-55	Add one mixed-flow lane in each direction and fix chokepoints from I-405 to I-5 and add one auxiliary lane in each direction between select on/off ramps and operational improvements through project limits.	2025	\$410,907
	Orange	SR-91	Add eastbound mixed-flow lane from SR-57 to SR-55, add one westbound mixed-flow lane from Kraemer to State College, improve interchanges and merging from Lakeview to Raymond, and auxiliary lanes in certain segments.	2030	\$456,190
	Orange	I-405	Add one mixed-flow lane in each direction from I-5 to SR-55 and southbound auxiliary lane from SR-133 to Irvine Center Drive.	2034	\$323,600
	Orange	I-405	Add one mixed-flow lane in each direction, convert existing HOV lane to HOT lane, add one additional HOT lane in each direction from SR-73 to I-605.	2026	\$1,900,000
	Ventura	SR-118	Add one lane each direction from RT-23 to Tapo Canyon Rd.	2031	\$216,463

TABLE 5 Sample Major Highway Projects Committed by Counties - Continued

	County	Route	Description	Completion Year	Project Cost (\$1,000's)
EXPRESS LANES	Los Angeles	I-405	Add I-405 Express Lanes from I-105 to I-110.	2028	\$71,560
	Los Angeles	I-405	Add I-405 Express Lanes from I-110 to LA/Orange County Line.	2028	\$110,390
	Los Angeles	I-105	Add I-105 Express Lane from I-405 to Studebaker.	2027	\$520,900
	Los Angeles	I-405	Sepulveda Pass (Ph 1) ExpressLanes.	2027	\$260,000
	Los Angeles	I-10	Add I-10 Express Lanes from I-605 to LA/San Bernardino County Line.	2028	\$196,840
	Los Angeles	I-405	Add I-405 Express Lanes from I-10 to I-105.	2028	\$70,880
	Los Angeles	I-605	I-605 Express Lanes from I-105 to Orange County Line.	2031	\$100,850
	RIVERSIDE	I-15	Add two Express Lanes in each direction from Cajalco Rd to SR-74.	2027	\$544,000
	San Bernardino	I-15	Add two Express Lanes in each direction from I-215 to US-395	2040	\$687,994
	San Bernardino	I-15	Add one Express Lane in each direction from US-395 to High Desert Corridor (Segment 5)	2045	\$194,662
	San Bernardino	I-10	Implement 2 Express Lanes from I-10/I-15 interchange to California St. and 1 Express Lane from California St. to Ford St.	2024	\$1,214,607
	Los Angeles	SR-71	Add one HOV lane and one mixed-flow lane from Rt-10 to SB County Line.	2028	\$326,392
	Riverside	I-15	Add one HOV lane in each direction from SR-74 to I-15/I-215 interchange.	2039	\$375,664
	San Bernardino	I-215	Add one HOV lane in each direction from SR-210 to I-15.	2035	\$249,151
	Ventura	US-101	Add one HOV lane in each direction from LA/VEN County Line to SR-33.	2040	\$700,000

Source: SCAG

EXHIBIT 6 Base Year 2016 to Baseline 2045 Highway Speed Changes - AM Peak



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Speed in Miles per Hour

- ↘ Decrease by 10.0 or more
- ↘ Decrease by 5.0 to 10.0
- ↘ Decrease by 0.0 to 4.9
- ↗ Increase by 0.0 to 4.9
- ↗ Increase by 5.0 or more

Source: SCAG, 2019

OTHER BEST PRACTICES TO CONSIDER FOR FUTURE IMPLEMENTATION

Good information is critical to good decision making. This section summarizes some best practices that may be helpful in maximizing the productivity of our roadway system with minimal capital investments.

PREVENTATIVE MAINTENANCE AND PRESERVATION PROGRAM

Billions have already been spent to build the existing system. Ignoring maintenance needs of our valuable transportation asset will be inefficient and cost-prohibitive in the long term. A reasonable approach to a productive system in the long run is to adopt preventative maintenance and preservation measures as an integral part of the life cycle cost of the project. As defined by U.S. Department of Transportation (DOT), maintenance describes work that is performed to maintain the condition of the transportation system or respond to specific conditions or events that restore the highway system to a functional state of operations. Preservation is defined as actions or strategies that prevent, delay, or reduce deterioration of key elements of the system.⁵ The U.S. DOT identifies how to develop a preventative maintenance and preservation program through a series of steps: 1) identify agency goals and objectives; 2) identify assets to preserve; 3) develop a list of actions; 4) establish rules for the actions; 5) develop life cycle plans; 6) develop performance measures; 7) dedicate funds; 8) implement projects; 9) monitor performance; and 10) fine-tune program to meet targets and/or to further improve.

⁵ U.S. Department of Transportation. (2018). Bridge Preservation Guide.

ADAPTIVE TRAFFIC CONTROL SYSTEMS

According to the AASHTO Sustainability Peer Exchange Briefing Paper (2009), Caltrans implemented Adaptive Traffic Control Systems (ATCSs) on seven corridors in Los Angeles County as a demonstration project. Traffic signal systems that respond in real-time to changes in traffic patterns are known as “adaptive.” ATCSs continuously detect vehicular traffic volume, compute “optimal” signal timings based on detected volume and simultaneously implement them. Reacting to these volume variations generally results in reduced delays, shorter queues and decreased travel times. ATCSs are designed to overcome the limitations of pre-timed control and respond to changes in traffic flow by adjusting signal timings in accordance with fluctuations in traffic demand. The purpose of Caltrans’ demonstration project is to deploy and evaluate the effectiveness of the future ATCS on the State arterial street network that experiences both recurrent and non-recurrent delay. The ATCS system was shown to reduce travel time by 12.7 percent, reduce average stops by 31 percent, and decrease average delays by 21.4 percent.⁶

VARIABLE SPEED FACILITIES

As part of Washington State Department of Transportation (WSDOT) and the Seattle area’s Sound Transit’s I-90 Two-Way Transit and High Occupancy Vehicle (HOV) Operations Project,⁷ crews installed 14 electronic speed limit signs, which will allow varying speed limits to be displayed. WSDOT expects these signs will increase safety, decrease collisions and keep traffic moving during construction on westbound I-90 by alerting drivers to reduce their speed when backups or collisions are on the road ahead. WSDOT uses variable speed limit signs on US-2 at Steven Pass and on I-90 at Snoqualmie Pass to alert drivers to slow down during icy, snowy and congested driving conditions. Similar signs installed on European urban roadways increased safety and decrease congestion-related collisions by 30 percent or more.

⁶ AASHTO. (2009). Sustainability Peer Exchange Briefing Paper.

⁷ Ibid

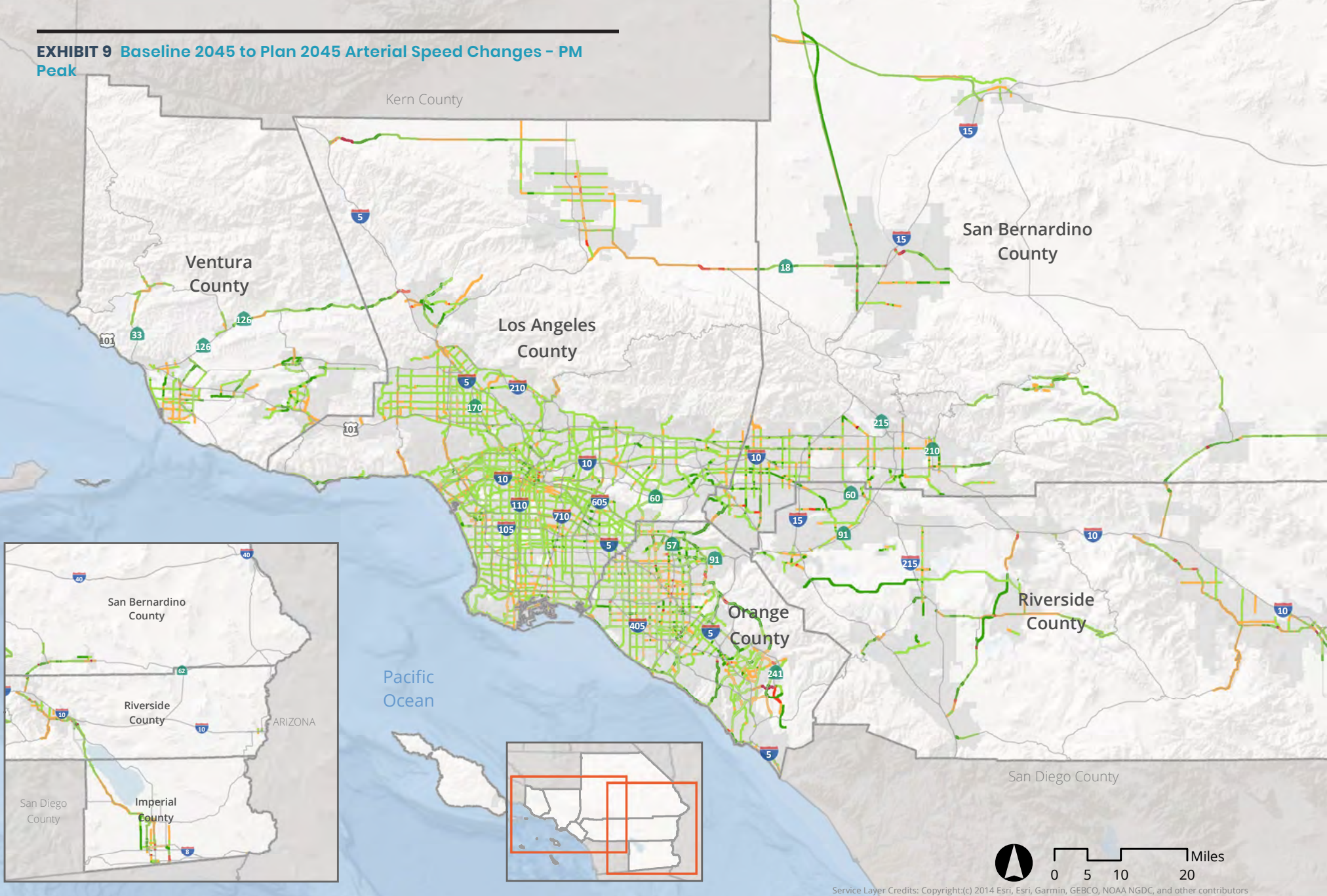
EXHIBIT 7 Base Year 2016 to Baseline 2045 Highway Speed Changes - PM Peak



Speed in Miles per Hour

- ↘ Decrease by 10.0 or more
- ↘ Decrease by 5.0 to 10.0
- ↘ Decrease by 0.0 to 4.9
- ↗ Increase by 0.0 to 4.9
- ↗ Increase by 5.0 or more

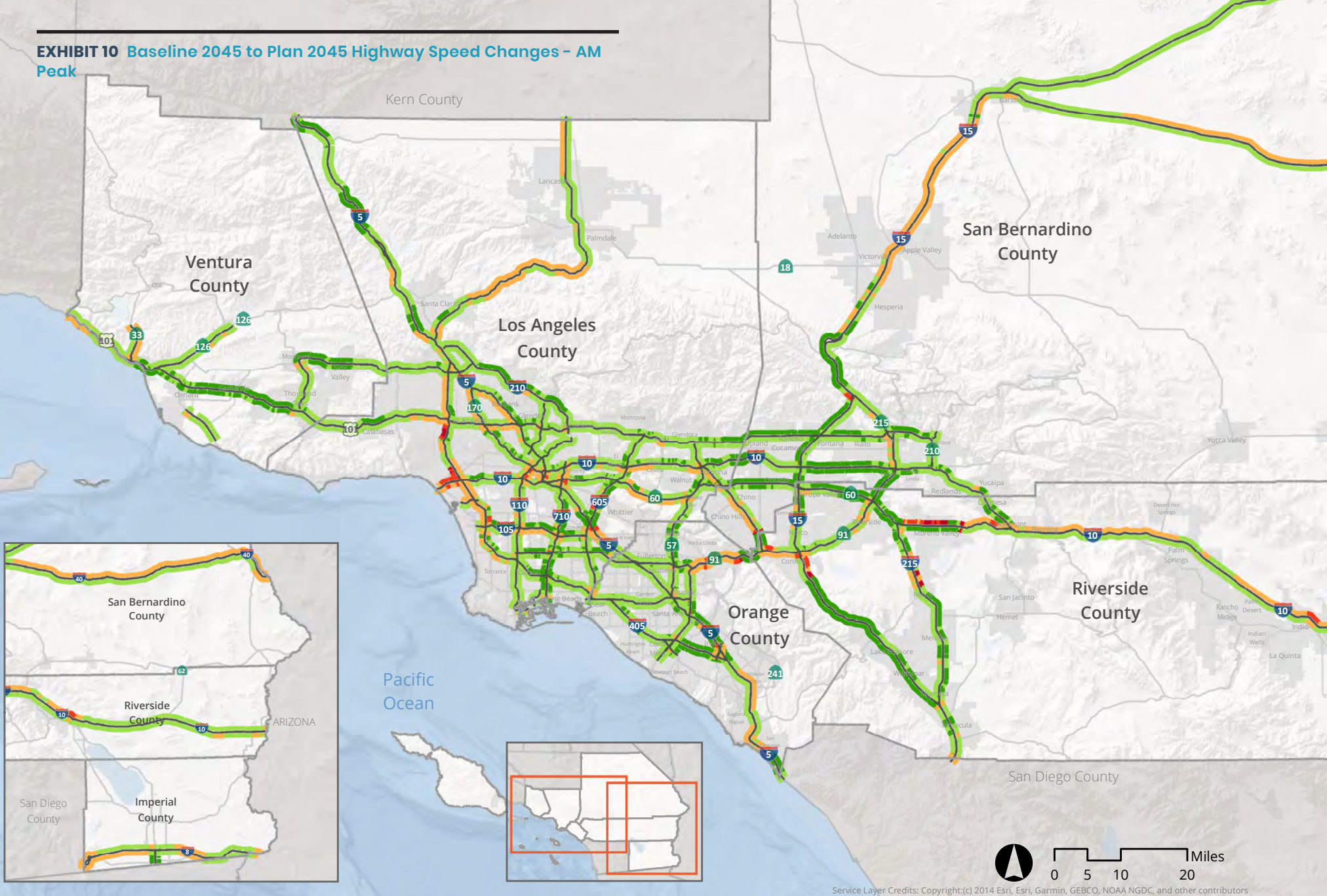
EXHIBIT 9 Baseline 2045 to Plan 2045 Arterial Speed Changes - PM Peak



Speed in Miles per Hour

- ↘ Decrease by 10.0 or more
- ↘ Decrease by 5.0 to 10.0
- ↘ Decrease by 0.0 to 4.9
- ↗ Increase by 0.0 to 4.9
- ↗ Increase by 5.0 or more

EXHIBIT 10 Baseline 2045 to Plan 2045 Highway Speed Changes - AM Peak



Speed in Miles per Hour

- ▾ Decrease by 10.0 or more
- ▾ Decrease by 5.0 to 10.0
- ▾ Decrease by 0.0 to 4.9
- ▾ Increase by 0.0 to 4.9
- ▾ Increase by 5.0 or more

EXHIBIT 11 Baseline 2045 to Plan 2045 Highway Speed Changes - PM Peak

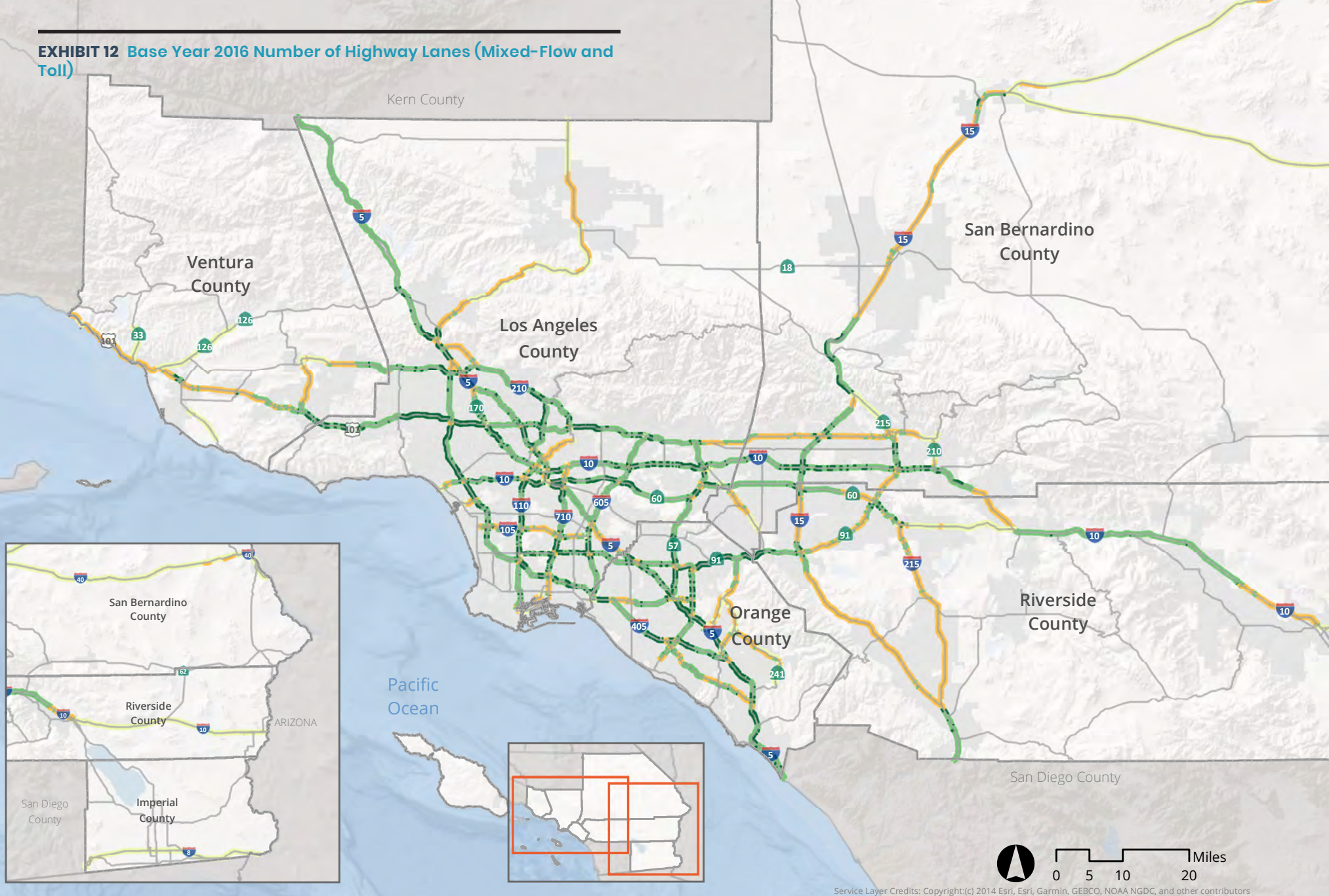


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Speed in Miles per Hour

- ▾ Decrease by 10.0 or more
- ▾ Decrease by 5.0 to 10.0
- ▾ Decrease by 0.0 to 4.9
- ▾ Increase by 0.0 to 4.9
- ▾ Increase by 5.0 or more

EXHIBIT 12 Base Year 2016 Number of Highway Lanes (Mixed-Flow and Toll)



Number of Lanes in Each Direction

↗ 2 or fewer
 ↗ 3
 ↗ 4
 ↗ 5 or more



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TECHNICAL REPORT

HIGHWAYS AND ARTERIALS

ADOPTED ON SEPTEMBER 3, 2020

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