California Transportation Asset Management Plan

Fiscal Years 2017/18-2026/27

Caltrans

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Executive Summary

California Transportation Asset Management Plan

Caltrans and its transportation partner agencies are responsible for supporting safe and efficient travel on California's transportation network.

Maintenance and preservation of transportation infrastructure are critical aspects of this responsibility. Pavements, bridges, and other infrastructure assets require ongoing investment to sustain a state of good repair. This document presents a coordinated plan by Caltrans and its partner agencies to maintain California's highway infrastructure assets today and into the future.

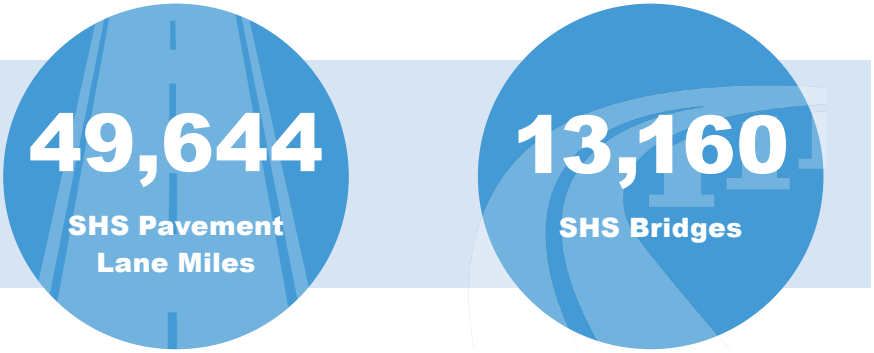
Caltrans

California's Transportation Assets

California's multimodal transportation system consists of a wide variety of physical assets. The most significant assets on the system, in terms of their cost and extent, are pavements and bridges. However, many other interconnected systems are needed to support mobility and improve safety, as depicted in the illustration below.

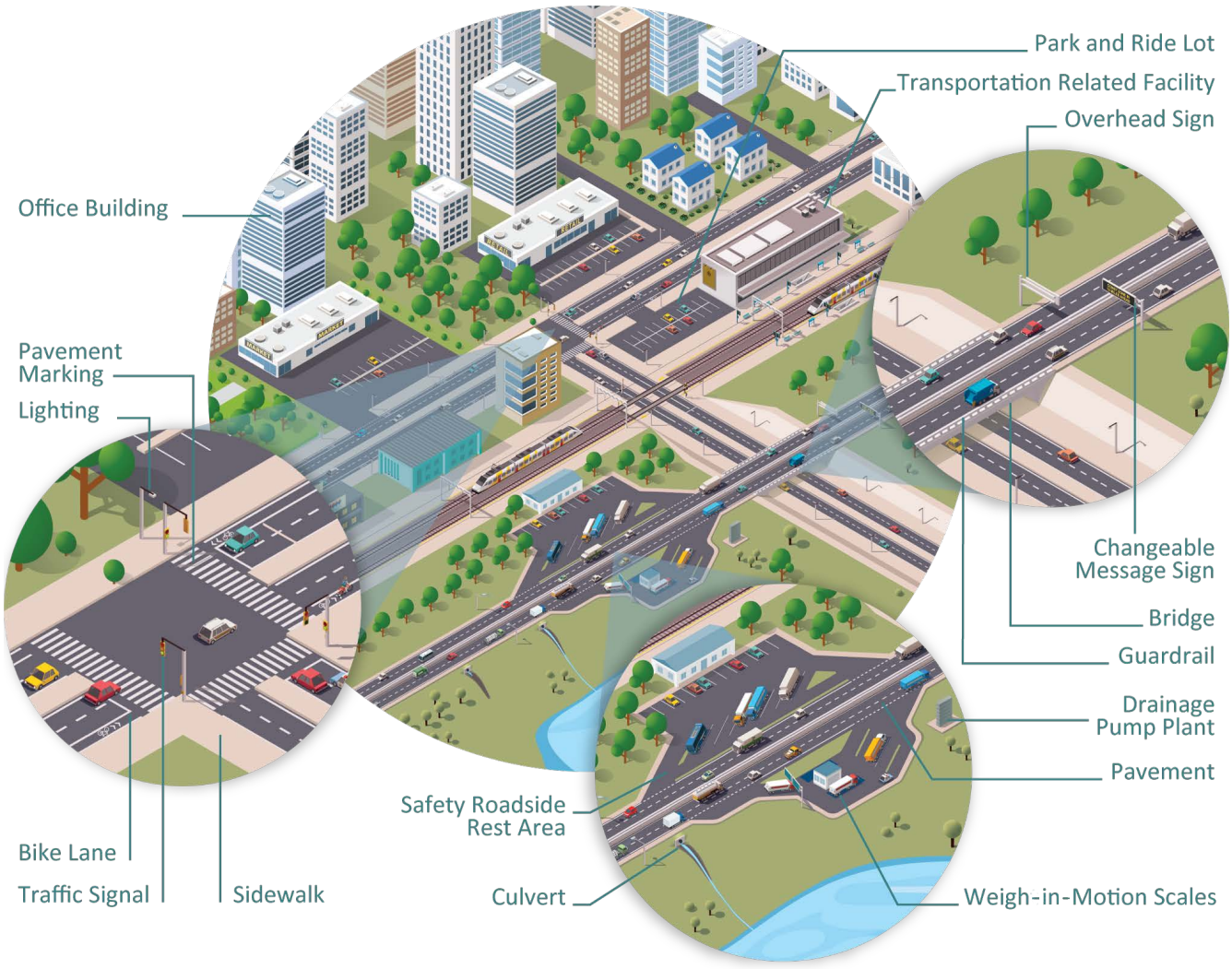
California's State Highway System

The California State Highway System (SHS) includes all assets within the boundaries of the highway system including 49,644 lane miles of pavements, 13,160 bridges, 205,000 culverts and drainage facilities, and 18,837 Transportation Management System (TMS) assets. Caltrans is the state agency responsible for planning, developing, maintaining and operating the legislatively designated SHS.



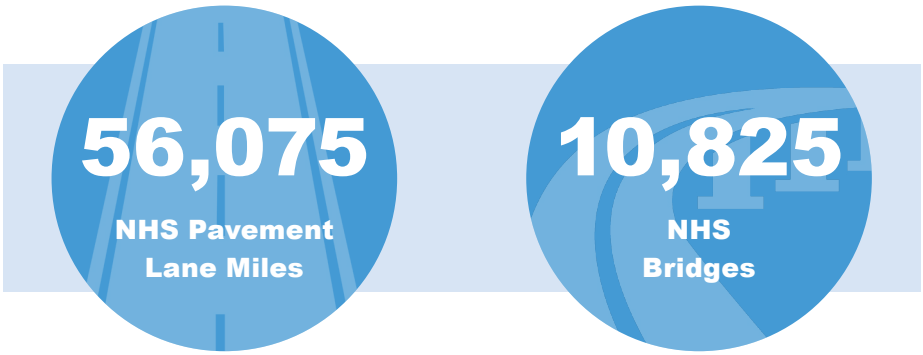
California's Multimodal Transportation System

The highway assets described in the California TAMP are an integral part of California's multimodal transportation system



The National Highway System

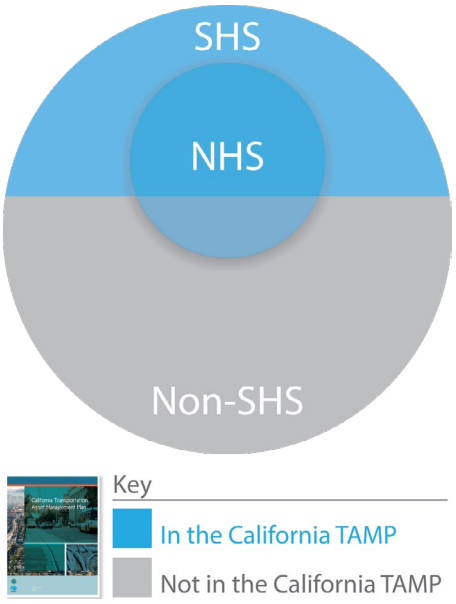
The National Highway System (NHS) in California is owned by Caltrans as well as local, tribal governments, federal, and other state agencies. The system consists of 56,075 lane miles of pavements and 10,825 bridges totaling 234,285,883 square feet of bridge deck area.



A Coordinated Approach

California's transportation system includes assets owned by the state, cities and counties, toll authorities, tribal governments, and state and federal agencies. These assets intersect across federal, state and local ownership, meaning that a statewide-view of the system is critical to maintaining and improving asset condition and meeting national and state performance goals. In particular, a significant number of NHS bridges and pavements are under local control in California. Caltrans and its partners can maximize limited resources by understanding the inventory and condition of the California transportation system.

California TAMP Scope



The scope of the California Transportation Asset Management Plan (TAMP) is primarily determined by federal and state requirements.

The California Transportation Commission (Commission) adopted TAMP guidelines in 2017, following the requirement of Senate Bill 486. These guidelines require that the California TAMP include pavement, bridge, drainage, TMS, as well as a list of supplementary assets on the SHS.

The Federal Highway Administration (FHWA) requires that California's TAMP include a summary listing of NHS pavements and bridges, including a description of the condition of these assets.

Managing California's Transportation Assets

Transportation asset management (TAM) is defined by United States Code (23 U.S. Code § 101) as "a strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost."

Caltrans and its transportation partners have long recognized the importance of asset management, using asset performance targets to drive investment decisions as part of performance management and asset management best practice. State law requires the development of a state highway system needs assessment that uses performance targets to estimate current needs. Performance measures and targets are used to track progress and guide state and local agencies towards short, medium, and long-term objectives.

Strong asset management practices help to ensure Caltrans and its partners continue to make the best use of resources by carefully balancing multiple competing needs for infrastructure preservation and improvement.

Federal & State Requirements

FHWA requires that a state's TAMP include pavements and bridges on the NHS. The Commission requires inclusion of pavements, bridges, drainage, and TMS, in addition to nine supplementary SHS asset classes. The Commission's approval authority in the TAMP is limited to assets on the SHS.

System	Asset Class				
	Pavement	Bridges	Drainage	TMS	Supplemental Assets
NHS Federal Requirements	✔	✔			
SHS State Requirements	✔	✔	✔	✔	✔

Roles & Responsibilities

Four key stakeholders (Caltrans, MPOs/RTPAs, Commission, and FHWA) play a coordinated role and share a common vision in assuring that strategies for achieving performance targets in the TAMP are sound.

FHWA

- Establish national standards for performance measures for bridges and pavement.
- Adopt targets and performance measures reflecting state transportation goals and objectives.
- Review and approve the TAMP.
- Monitor progress of the State towards achieving 2 and 4 year performance targets.

Caltrans

- Prepare a robust TAMP to guide transportation investments through the SHOPP to achieve performance targets.
- Ensure the TAMP is consistent with applicable state and federal requirements.
- Establish 10-year performance targets to support long-range investment strategies.
- Develop 2 and 4-year performance targets.
- Plan, design, and oversee construction of projects.

Commission

- Approve SHS assets for inclusion in the TAMP.
- Adopt targets and performance measures.
- Review and approve the TAMP.
- Report progress to the state legislature on Caltrans' progress towards meeting SHS performance targets.
- Review and adopt the SHOPP, consistent with the TAMP.

MPOs/RTPAs/Local Agencies

- Establish 4-year performance targets, or adopt the state DOT's performance targets.
- Develop long-range transportation plans relective of TAMP goals.
- Plan, design, and oversee construction of local projects.

Asset Condition at a Glance

California's transportation asset information is summarized in two ways: for the entire Caltrans-maintained SHS (portions of which are on the NHS), and for the entire NHS (which includes a portion of the state system and a portion of the local system managed by regions, cities, counties as well as tribal governments). This approach is used to provide a complete picture of SHS assets to meet state mandates, as well as to meet federal requirements for all NHS pavements and bridges in the TAMP.

Inventory and Conditions for NHS and SHS Assets in California

Whether based on age, condition, level of service, or simply frequency of repair, a performance measure is critical to actively managing the preservation of an asset. In the California TAMP, asset performance refers to asset condition and performance measures to report on the percentage of the asset classes in good, fair, and poor condition.

NHS	Asset Inventory	Good	Fair	Poor	
Pavement	56,075 Lane Miles	30.4%	63.5%	6.1%	
Bridges	234,285,883 Square Feet	66.5%	28.7%	4.8%	
SHS	**Asset Inventory**	**Good**	**Fair**	**Poor**	
Primary Asset Classes					
Pavement	49,644 Lane Miles	40.8%	53.5%	5.7%	
Bridges	245,756,328 Square Feet	74.9%	21.8%	3.3%	
Drainage	10,647,900* Linear Feet	65.0%	23.5%	11.5%	
TMS	18,837* Assets	58.8%	n/a	41.2%	
Supplementary Asset Classes					
Drainage Pump Plants	290 Locations	24.1%	29.3%	46.6%	
Highway Lighting	89,829 Assets	40.2%	13.9%	45.9%	
Office Buildings	2,778,299 Square Feet	41.9%	31.6%	26.5%	
Overhead Signs	16,470 Assets	74.4%	21.8%	3.8%	
Roadside Rest Facilities	86 Locations	32.6%	38.4%	29.0%	
Sidewalks, Park & Ride and ADA Infrastructure	208,216 Locations	0.0%	n/a	100.0%	
Transportation-Related Facilities	3,986,339 Square Feet	21.2%	15.1%	63.7%	
Weigh in Motion Scales	176 Stations	2.8%	97.2%	0.0%	

**Inventory incomplete.*

Risks to the System

Managing transportation assets entails managing risk. California must balance a wide variety of transportation related risks on an ongoing basis. This includes day-to-day concerns such as risks that assets will deteriorate faster than expected or projects will cost more than budgeted, to the potentially catastrophic risks of asset failure caused by factors such as natural disasters. Climate change also presents a looming risk that will exacerbate all weather-related damage. Caltrans and its partners are undertaking a number of activities to better characterize and help reduce or potentially avoid risk to the transportation system such as vulnerability assessments to identify potential stressors.

California's Investment Strategies

Asset management best practices emphasize the use of performance management for transportation programs, shifting the decision-making framework towards data-driven, proactive, goal-oriented investment choices. Asset management investment strategies are the policies for resource allocation that will deliver the best asset performance given available funds and the goals and objectives of state and local agencies. Strategies documented in the California TAMP represent an investment philosophy of prioritizing preservation activities, seeking progress towards broad goal areas, focusing on selected asset classes, implementing sustainable practices, and promoting bicycle, pedestrian and transit modes. Caltrans' investment strategies are:

- Focus on preventive maintenance through Stewardship activities, also known as a "fix it first" approach.
- Focus on selected asset classes: pavement, bridge, drainage, and TMS. These were designated as focus areas by the Commission, as they represent a significant portion of SHS maintenance and rehabilitation investments in California. (A cumulative analysis for all Commission-approved assets will be included in the 2020 TAMP.)
- Leverage investments to support the full range of Caltrans goals: Safety and Health; Stewardship and Efficiency; Sustainability, Livability and Economy; System Performance; and Organizational Excellence.

TAMP documents complementary strategies for local transportation agencies:

- Implement sustainable pavement practices (e.g., using reclaimed or recycled pavements).
- Adopt Complete Streets policies, requiring that roadways be designed for all users.

Making an Impact

California, through the recent passage of Senate Bill 1 (SB1) in 2017, has provided Caltrans and its partners with critically-needed resources, increasing funding specifically for system preservation to help support an asset management approach. Through SB1, California is providing a significant new consistent funding source for transportation, investing $54 billion over the next decade for infrastructure, maintenance, and public transit.

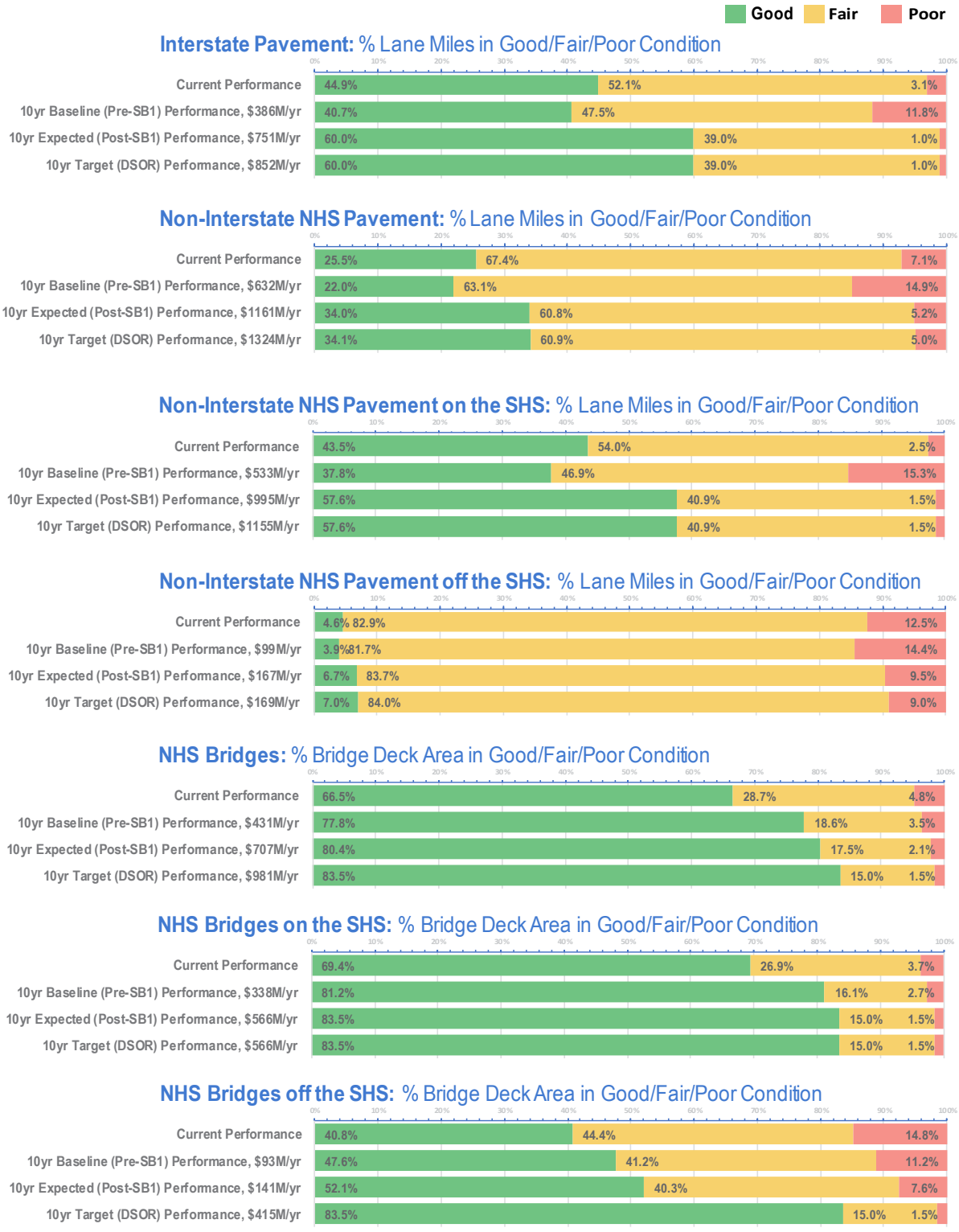
California's NHS and SHS will require substantial investment to achieve established Desired State of Repair 10-Year Targets. However, California is on track to achieve these targets for all of its SHS while narrowing the gap for NHS pavements and bridges under current funding expectations. The additional investment in preservation provided by SB1 is crucial to attaining these ambitious targets; the performance projections show the impact of SB1 funds over a 10-year timeframe.

The development of the TAMP will help California to direct this major investment in its transportation infrastructure assets and will also help to wisely achieve established performance objectives.

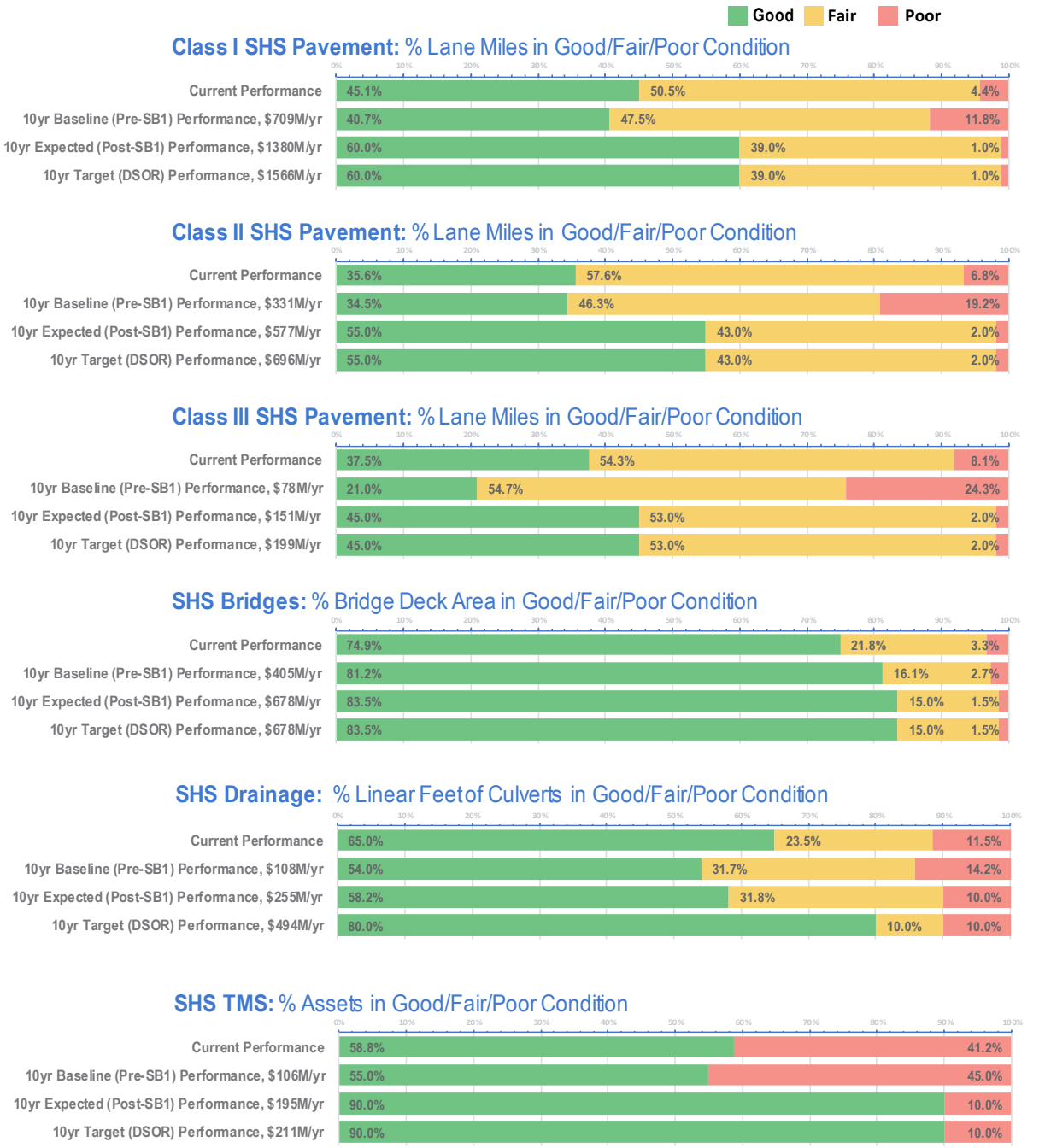
National Highway System and State Highway System Projected Asset Conditions

Current Performance, 10-Year Baseline (Pre-SB1) Performance, 10-Year Expected (Post-SB1) Performance, and 10-Year Target Desired State of Repair (DSOR) Performance are summarized for NHS and SHS asset classes. Note, the 10-Year Target includes additional maintenance funding required to sustain the target level of performance over the long term.

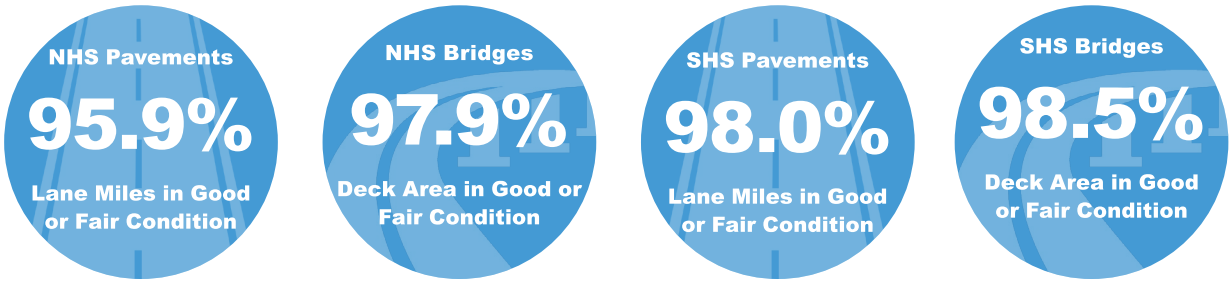
Summary of NHS Projected Asset Conditions



Summary of SHS Projected Asset Conditions



Expected Accomplishments of SB1: 10-Year Projections



About the California TAMP

The California TAMP describes the vision for how good asset management will help to deliver broad transportation goals and fundamental objectives supported by information on current asset conditions, the desired conditions in the future, and the likely conditions given future funding scenarios.

The TAMP is also a key requirement of federal regulation and Calilfornia law. Federal regulation (23 CFR 515) requires an asset management plan by April 30, 2018, for pavements and bridges on the NHS, including those owned by Caltrans and other federa, state and local agencies. California law (Senate Bill 486) requires Caltrans to develop an asset management plan by 2020 for the SHS. This document is intended to meet both sets of requirements.

The TAMP was produced through the collaborative effort of numerous stakeholders, structured around a regular series of workshops, and a robust feedback loop with our transportation partner entities. The TAMP is a living document. It will be regularly reviewed and updated, using performance outcomes and drawing from the 10-year project plan coming from the State Highway System Management Plan.

Improving Asset Management Practice

Good transportation asset management is a continuously improving set of practices. California has been improving TAM programs and data, making progress towards aligning them with state goals and targets. Several opportunities for future improvements were identified and documented in the course of developing the California TAMP:

- Strengthening local, regional, and state coordination
- Improving transportation infrastructure management through better information, more transparent sharing of information, and collaboration
- Addressing the need for better data and software tools
- Achieving better reporting of transportation expenditure information
- Enhancing asset modeling capabilities

Progress in these areas, along with subsequent improvements to TAM processes, will be documented in future updates to the California TAMP.

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1. Introduction

California's state highway and local roadway network serves as the transportation backbone that supports a $2.6 trillion economy, greater than any other state, and places California as having the world's sixth largest economy. This transportation infrastructure connects communities serving approximately 40 million residents and over 35 million registered vehicles, providing vital links that move goods through some of the busiest ports in the United States.

The demands on the transportation system lead to ongoing deterioration of our roadways and bridges that must be repaired, rehabilitated or replaced to preserve the integrity and reliability of the transportation system. Transportation managers must continually evaluate system safety, performance, condition, and vulnerabilities in the context of available funding to make good transportation investment decisions. Although varied in their approach, most California jurisdictions have been managing pavement assets for a long time. The use of formal bridge management systems by local agencies is much less common than for pavement.

The ongoing costs associated with preserving the condition and performance of existing transportation assets are significant. Billions of dollars are spent each year by state and local government agencies to hold deterioration at bay, so the transportation system can continue to support its users reliably, safely, and with minimal disruption. Similar to maintaining a home or an automobile, doing the right preventative maintenance at the right time can significantly extend the service life and avoid costlier repairs in the long run. The need to efficiently manage transportation system investments has led to a recognition of the benefits of managing assets using a data-driven systematic approach generally referred to as Transportation Asset Management (TAM).

To maximize the benefit of available federal transportation funding, the United States Congress established regulations that require each state to develop an initial Transportation Asset Management Plan (TAMP) by April 30, 2018, for all roadways on the National Highway System (NHS) and a state-approved TAMP meeting all requirements by June 30, 2019. The NHS is a collection of significant routes that includes all interstate highways and many non-interstate routes managed by Caltrans and many cities and counties. Federal regulations require state departments of transportation (DOT) to coordinate with local transportation agencies in the development of the TAMP, addressing both state and local pavement and bridge assets using national performance metrics. The NHS in California includes portions of the State Highway System (SHS) and the local road network.

California Government Code (pursuant to Senate Bill 486, Statutes of 2014[1]) requires the development of a TAMP by 2018 to guide the investments made on the SHS. Maintenance, rehabilitation and operation of the entire SHS are the responsibility of Caltrans. Though the scope of the transportation system addressed by federal and state regulations differs, both exist to improve transportation investment decision making through the implementation of sound asset management principles to achieve state goals and objectives.

1.1. What is in the TAMP?

The TAMP documents current system conditions, establishes condition targets, quantifies the gaps in condition, evaluates risks that could impact the system condition or reliability, documents life cycle planning strategies, defines available transportation funding, evaluates funding scenarios relative to established targets, and identifies areas of potential improvement in the management of transportation assets.

Long-term performance targets for both state and local NHS stakeholders were established in the TAMP through a collaborative process. The resulting shared vision for maintaining the transportation system is expected to bring about opportunities for improved coordination in transportation planning and investment.

Transportation Asset Management

A strategic and systematic process of operating, maintaining, and improving physical assets, with a focus on both engineering and economic analysis based upon quality information, to identify a structured sequence of maintenance, preservation, repair, rehabilitation, and replacement actions that will achieve and sustain a desired state of good repair over the lifecycle of the assets at minimum practicable cost.

The financial plan for California has recently changed dramatically with the passage of the Road Repair and Accountability Act of 2017, Senate Bill 1 (SB 1)[2] and with passage of local transportation funding measures. The additional funding has provided the California State Department of Transportation (Caltrans or the Department) and its local partners with critically-needed resources and increased funding for system repair and rehabilitation to help support an asset management approach. Through SB 1, California is providing a significant new consistent funding source for transportation, investing $54 billion over the next decade for infrastructure, maintenance, and public transit.

[1] Senator DeSaulnier, Senate Bill 486, Statutes of 2014, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB486

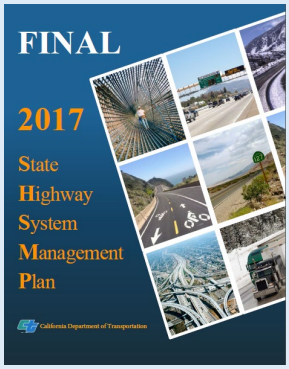
[2] Senator Beall, "Road Repair and Accountability Act of 2017", SB 1 , 2017, https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1

The TAMP aligns with strategic investment strategies by taking a network view of assets and evaluating investment decision trade-offs over a 10-year period. The systematic framework put forth in the TAMP provides a solid basis for decision making that is transparent and defensible.

1.2. Making Progress

Significant progress has already been made towards the development and implementation of asset management in California. New processes and changes to business practices have been put in place to bring greater transparency to the decision-making process. Federal and local agencies have been actively engaged to strengthen partnerships which will facilitate the transition towards improved asset management practices.

The *2017 State Highway System Management Plan* (SHSMP)[3] was published by Caltrans, implementing a performance management framework for the SHS. The SHSMP integrated maintenance and rehabilitation activities performed on the SHS through a performance-based approach that aligns with Caltrans' strategic goals from the *Caltrans Strategic Management Plan 2015-2020*[4]. The SHSMP defined the inventory and condition of assets, established condition targets, determined the magnitude of condition gaps, developed cost estimates to close the gaps and defined a constrained investment plan for the entire State Highway Operation and Protection Plan (SHOPP). The SHSMP addressed the majority of the asset management requirements for a TAMP. The SHSMP went beyond the TAMP requirements to implement a performance-driven approach for SHOPP, reflective of the contributions being provided by the *2015 Five-Year Maintenance Plan*[5]. All project planning initiated after July 2017 is based on SHSMP performance objectives. This ensures that projects that begin the planning process will collectively accomplish enough work to achieve the condition goals established by SB 1 which are included in this TAMP.



The ***State Highway System Management Plan*** implements a performance management framework for the SHS.

Caltrans has also made structural changes to how funding is distributed within SHOPP programs. The silo-based funding approach that had been in place for decades has been replaced with a performance-driven allocation methodology that facilitates more comprehensive project solutions by combining numerous assets into a corridor-type project. This approach provides the opportunity to develop projects that have less negative impact to users with better economies of scale for traffic control and environmental costs. The new structure of SHOPP has also led to earlier collaboration with local partners and opportunities to find mutually beneficial project opportunities to avoid potentially overlapping work, enhance efficiency, and maximize the effectiveness of limited funding.

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[3] Caltrans, "2017 State Highway System Management Plan", 2017, http://www.dot.ca.gov/assetmgmt/documents/SHSMP.pdf

[4] Caltrans, "Caltrans Strategic Management Plan 2015-2020", 2015, http://www.dot.ca.gov/perf/library/pdf/Caltrans_Strategic_Mgmt_Plan_033015.pdf

[5] Caltrans, "2015 Five-Year Maintenance Plan", 2015, http://www.dot.ca.gov/docs/2015_Five-Year_Maintenance_Plan.pdf

The application of multi-objective decision analysis (MODA) methods to project selection processes was explored and tested in the 2014 and 2016 SHOPP cycles[6]. MODA provides an objective and transparent basis for decision-making, accounts for benefits of multi-asset project solutions, and provides a mechanism to communicate the alignment of project priorities with strategic objectives. Work is currently underway to refine MODA methodology and establish a SHOPP project prioritization process that aligns with Caltrans' performance-based asset management approach.

Federal requirements for the TAMP have led to a significant increase in collaboration with local and regional transportation partners. Caltrans has hosted a number of workshops over the past 18 months to bring federal, state, regional and local transportation managers together to discuss key aspects of asset management. A list of those workshops and the transportation partner entities represented is available in Appendix A.

Feedback and information gathered from these workshops provided a foundation for the draft TAMP. Once the final draft was prepared, it too was sent out for review. The public comment period began October 31, 2017, and continued through November 24, 2017. Caltrans' Public Information Office issued a press release announcing the availability of the draft TAMP and requested public input through a dedicated online survey tool, accessible through the Caltrans Asset Management website[7]. Caltrans' Local Assistance Program sent an announcement to all statewide partners, and the Caltrans' Asset Management Office reached out to all prior workshop attendees to submit feedback online.

Caltrans also established a Transportation Asset Management Advisory Committee (TAMAC) with our transportation partners and has worked closely with a majority of the stakeholders on the NHS. These workshops and meetings have provided a platform for on-going dialog between transportation stakeholders in California.

1.3. Transportation Asset Management Plans are Living Documents

TAMPs are intended to evolve over time as changes in condition, budgets, risks, constraints, and strategic priorities are identified. Throughout the development of this TAMP for California, opportunities for potential improvement were identified. As these improvements are realized, the TAMP will be updated to reflect better information or improved processes. Code of Federal Regulation (CFR) (23 CFR 515.13(c))[8] requires that the TAMP and its development processes be updated at least every four years to incorporate improvements and re-evaluate conditions, targets, and performance. This provision in federal regulation ensures that close collaboration between state and regional planning agencies continues.

The California TAMP presents a coordinated plan by Caltrans and its partner agencies to maintain California's highway infrastructure assets today and into the future. This TAMP meets the requirements of both federal and

[6] Caltrans, 2014 and 2016 SHOPP cycles, http://www.dot.ca.gov/assetmgmt/multi-objective.html

[7] Caltrans Asset Management website, http://www.dot.ca.gov/assetmgmt/

[8] Federal regulation (23 CFR 515.13), https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

state regulations for TAM and provides a solid foundation to build upon and improve the management of transportation in California into the future.

1.4. Implementing the TAMP

The TAMP forms the basis of Caltrans' asset management framework and initiates a cycle of dependent business processes as shown in Figure 1-1. The SHSMP and the California Statewide Local Streets and Roads Needs Assessment Report (Local Needs Assessment)[9] become important next steps in operationalizing the TAMP. For Caltrans owned assets on the SHS, the SHSMP documents the gap analysis and investment planning process, which are in turn used to develop district level performance plans. The performance plans define the performance targets and budget for each of 12 Caltrans' Districts. Districts develop 10-year project portfolios to meet their performance targets within financial constraints which are updated and published quarterly in a 10-year SHOPP project book. For locally-owned assets, the Local Needs Assessment has begun to incorporate NHS pavement and bridge data as an outcome of TAMP development.

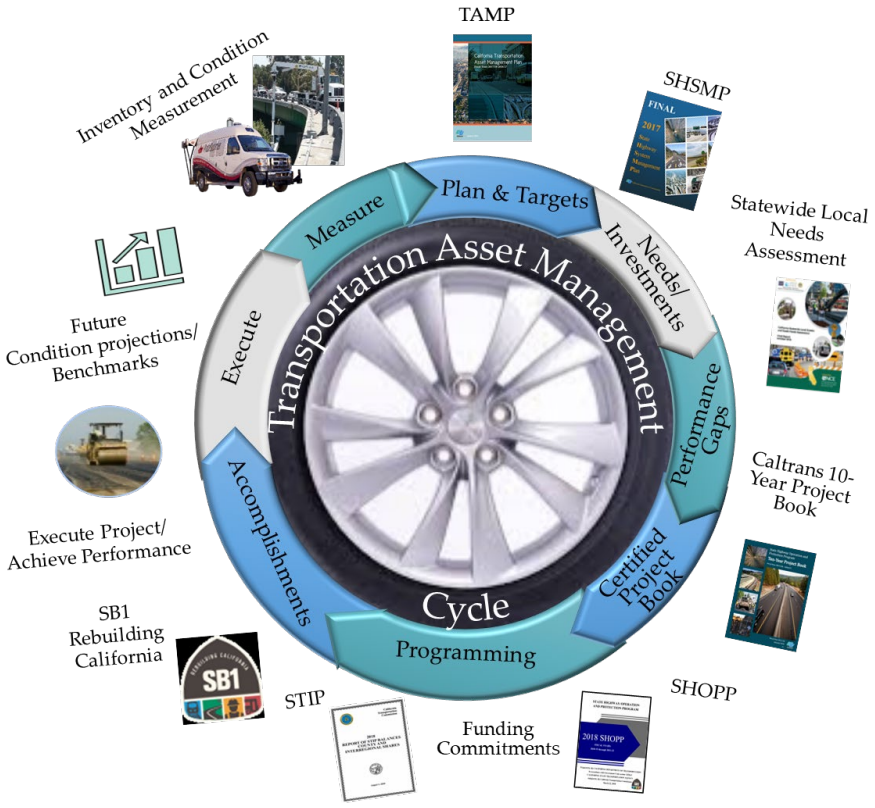

Figure 1-1 Transportation Asset Management Cycle

Through current transportation programming processes, both state and local projects are prioritized and committed for funding to ensure projects are developed and constructed to improve the SHS and NHS. Caltrans and Metropolitan Planning Organizations (MPO) also commit to furthering asset management through Memorandums of Understanding (MOU) that improve upon the coordination of federal performance management including NHS pavement and bridge data collection, target development, transportation programming, and the reporting of progress towards performance goals and outcomes. According to federal regulation 23 CFR 515.13(b)(2), "a state DOT must demonstrate implementation of their TAMP but may determine the most suitable approach so long as the information is current, documented and verifiable. The state DOT must show that the investment strategies are being used to make progress towards achievement of its

[9] NCE, "California Statewide Local Streets and Roads Needs Assessment", 2016, http://www.savecaliforniastreets.org/wp-content/uploads/2016/10/2016-CA-Statewide-Local-Streets-and-Roads-Needs-Assessment-Final-Report.pdf

targets for asset condition and performance of the NHS and supports progress towards national goals defined in 23 U.S.C. 150(b).

- FHWA considers the best evidence of plan implementation be that for the 12 months preceding the consistency determination, that funding allocations are reasonably consistent with the investment strategies in the asset management plan. This demonstration takes into account the alignment between the actual and planned levels of investment for various work types (i.e., initial construction, maintenance, preservation, rehabilitation and reconstruction).
- FHWA may find a state DOT has implemented its asset management plan even if the state has deviated from the investment strategies included in the asset management plan, if the state DOT shows the deviation was necessary due to extenuating circumstances beyond the state's reasonable control."[10]

Annual benchmarks are developed and included as part of the asset management cycle to compare 10-year projections of asset conditions developed from project portfolios to actual measured performance, providing opportunities for adjustments and assuring that long-term targets are achieved. Asset condition is measured and reassessed according to program guidance which establishes the basis for beginning the asset management cycle again creating a performance driven continuous evolution of transportation system improvement.

[10] Federal Regulation (23 CFR 515.13(b)(2)), https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

2. Asset Inventory and Conditions

California's transportation system contains a wide variety of asset classes, including pavements, bridges, drainage, transportation management system (TMS), signs, bicycle/pedestrian infrastructure, signals, and others. California's TAMP addresses pavement and bridge assets on the NHS, and, on the SHS expands the asset core to include drainage, TMS, and supplementary assets. This chapter presents summary information on asset inventory and conditions for these assets.

2.1. Overview

Asset inventory and condition data are the foundation for managing transportation assets. Inventory and condition data are essential for communicating the extent of California's transportation infrastructure assets and their current condition state. These data are also the building blocks for other asset management processes. Accurate inventory and condition data are needed for supporting asset management processes, such as life cycle planning, projecting funding needs, prioritizing projects, and monitoring asset performance.

California's transportation system includes assets owned by cities and counties, toll authorities, tribal governments, and state and federal agencies. These assets intersect across federal, state and local ownership, meaning that a statewide-view of the system is critical to maintaining and improving asset condition and meeting national and state performance goals. In particular, a significant number of NHS pavements and bridges are under local control in California. Caltrans and its partners can maximize limited resources by understanding the inventory and condition of the California transportation system.

2.2. Federal and State Requirements

Federal Requirements

The Federal Highway Administration (FHWA) requires that a state's TAMP include a summary listing of NHS pavements and bridges, including a description of asset condition. FHWA defines NHS pavements and bridges as "Interstate System pavements; NHS pavements (excluding the Interstate System); and NHS bridges carrying the NHS." Interstate pavements are part of the Interstate Highway System, a highway network which is part of the NHS.

FHWA requires that a state's TAMP include a summary listing of NHS pavements and bridges, including a description of asset condition.

States are encouraged to include other assets on the NHS or other public roads in the TAMP. If a state chooses to include additional assets, the TAMP must include all assets in the following chapters: inventory and condition, performance measures, targets, performance gap analysis, life cycle planning, risk management, financial plan, and investment strategies.

In addition to providing inventory and condition data, states must also have documented procedures for collecting, processing, storing, and updating inventory and condition data for NHS pavement and bridge assets. States are required to use pavement and bridge management systems that, in addition to other capabilities, collect, process, store, and update inventory and condition data. These procedures and systems are discussed in Chapter 4. Life Cycle Planning.

State Requirements

As required by Senate Bill 486 (SB 486), the California Transportation Commission (Commission) developed and published draft TAMP Guidelines in May 2017, conferred with the Department to address comments and concerns, and subsequently adopted the TAMP Guidelines in June 2017. The Commission is an independent public agency responsible for programming and allocating funds for the construction of highway, passenger rail, transit and active transportation improvements throughout California[11]. The Commission also advises and assists the California State Transportation Agency (CalSTA)[12] Secretary and the Legislature in formulating and evaluating state policies and plans for California's transportation programs. The Commission is an active participant in the initiation and development of State and Federal legislation to secure financial stability for the State's transportation needs.

Commission guidelines define the four primary and nine supplementary SHS asset classes to be included in the TAMP.

The TAMP Guidelines developed by the Commission, attached in Appendix C, require that the California TAMP include selected assets on the SHS.

[11] Commission, http://www.catc.ca.gov/

[12] CalSTA, https://calsta.ca.gov/

Commission TAMP Guidelines state that the TAMP must include the same analysis for primary assets on the SHS as for pavements and bridges on the NHS.

Commission TAMP Guidelines defined the four primary and 16 supplementary SHS asset classes to be included in the TAMP. In June 2017 the Department requested and the Commission approved consolidation of the 16 classes into nine classes. The primary asset classes are subject to all analyses required of NHS assets in the TAMP.

Primary Asset Classes

- Pavements
- Bridges
- Drainage
- TMS

Supplementary assets located on the SHS are included in the TAMP to a limited extent and are not required for a federally-compliant TAMP. Supplementary asset classes reflect highway components that collectively account for a relatively small portion of funding invested annually. Additionally, these assets have less mature data and condition assessment systems. In light of the data maturity and annual costs associated with these items, the TAMP is limited to reporting progress towards achieving targets. Thus, while the four primary asset classes on the SHS are included in all chapters of the TAMP, the supplementary assets are only included in selected chapters. Commission TAMP Guidelines require only inventory, conditions (shown in Chapter 2. Asset Inventory and Conditions), performance targets, and performance gaps (shown in Chapter 3. Asset Performance Targets) for the nine supplementary assets.

Supplementary Asset Classes

- Drainage pump plants
- Highway lighting (poles, foundations, luminaries, etc.)
- Office buildings
- Overhead signs (structures that support overhead sign panels)
- Park and Ride facilities (These assets are grouped and referred to as “Sidewalks and Park and Ride Americans with Disabilities Act (ADA) Infrastructure” in the California TAMP. This asset group refers to pedestrian facilities on the SHS currently noncompliant with ADA regulations.)
- Roadside rest facilities
- Sidewalks (These assets are grouped and are also referred to as “Sidewalks and Park and Ride ADA Infrastructure” in the California TAMP. This asset group refers to pedestrian facilities on the SHS currently noncompliant with ADA regulations.)
- Transportation-related facilities
- Weigh-in-motion scales

2.3. California's Transportation System

California's multi-modal transportation system consists of a wide variety of physical assets, as depicted in Figure 2-1. The most significant assets on the system, in terms of their cost and extent, are pavements and bridges. However, many other supporting systems are needed to support mobility and improve safety. In many cases, replacement or rehabilitation of roads and bridges includes replacement or upgrades to other supplementary assets depicted in Figure 2-1. For instance, the cost of reconstructing or replacing a bridge includes the cost of guardrail, and pavement projects often include upgrades to associated traffic and safety assets. Where applicable, costs associated with these supplementary assets are included in the costs of maintaining pavements and bridges.

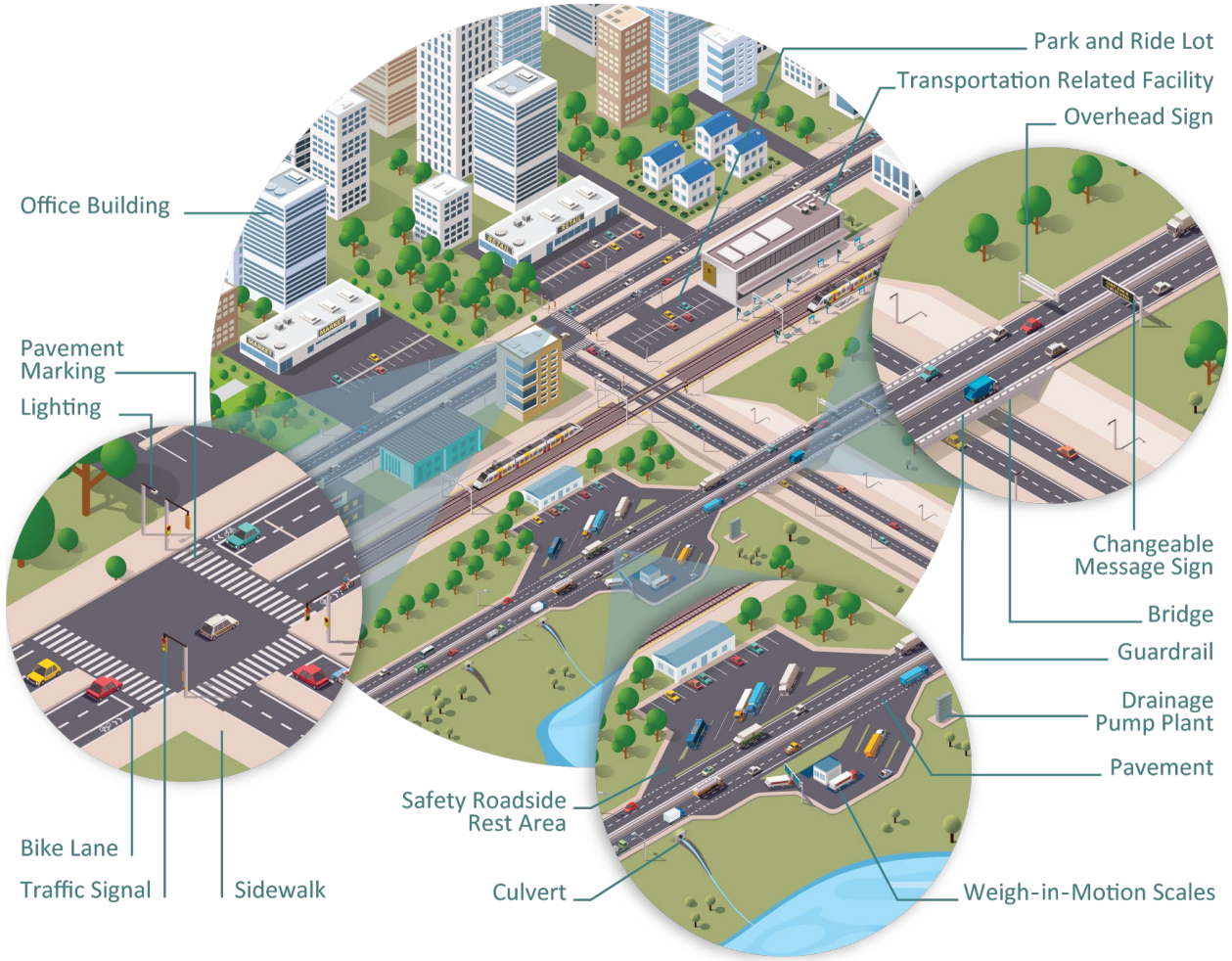

Figure 2-1. Typical Highway Assets

The TAMP addresses assets on two overlapping highway systems: SHS and NHS. The SHS is the highway system managed by Caltrans. The SHS includes all assets within the boundaries of the highway system and is largely managed through Caltrans maintenance and SHOPP[13]. The NHS includes portions of the SHS, as well as roads and bridges managed by a variety of other owners, including California cities and counties, toll

[13]SHOPP , http://www.dot.ca.gov/hq/transprog/shopp.htm

authorities, tribal governments and federal agencies. Roads on the NHS are defined by FHWA to be important to the nation's economy, defense, and mobility, and may include:

- Interstates
- Principal arterials
- The Strategic Highway Network (STRAHNET), another federally-defined network
- Major strategic highway connectors
- Intermodal connectors

FHWA requirements dictate that the TAMP includes all NHS pavements and bridges. State TAMP Guidelines from the Commission require that the California TAMP include selected asset classes on the SHS. As stated earlier in this chapter, the Commission approved four primary asset classes and nine supplementary asset classes for inclusion in the TAMP. The four primary asset classes on the SHS are subject to the same analysis as the NHS pavements and bridges. The supplementary asset classes on the SHS are included to a limited degree. The overlapping federal and state requirements for this plan are depicted in Figure 2-2.

	Asset Classes				
System	Pavement	Bridge	Drainage	TMS	Supplementary Assets
NHS Federal Requirements	✓	✓			
SHS State Requirements	✓	✓	✓	✓	✓

Figure 2-2. Federal and State TAMP Requirements

Throughout the TAMP document, asset information is summarized in two ways: (1) the entire Caltrans-maintained SHS, portions of which are on the NHS; and (2) the entire NHS, which includes a portion of the state system and a portion of the local system managed by regions, cities, counties as well as tribal governments. This approach is used to provide a complete picture of SHS assets to meet state mandates, as well as to meet federal requirements for all NHS pavements and bridges in the TAMP.

In addition, all performance data for NHS pavements and bridges presented in the tables throughout the TAMP (i.e., good, fair, and poor condition) are based on the Final Rule under 23 CFR 490.

National Highway System

The NHS in California is owned by Caltrans as well as local, tribal governments, federal, and other state agencies. The system consists of 56,075 lane miles of pavement and 10,825 bridges totaling 234,285,883 square feet of bridge deck area. A map of the NHS is shown in Figure 2-4.

State Highway System

The California SHS includes all assets within the boundaries of the highway system including 49,644 lane miles of pavement, 13,160 bridges, 205,000 culverts and drainage facilities, and 18,837 TMS assets. Caltrans is the state agency responsible for planning, developing, maintaining and operating the legislatively designated SHS.

These inventories are based on the best information available as of August 2016 when the 2017 SHSMP was developed.

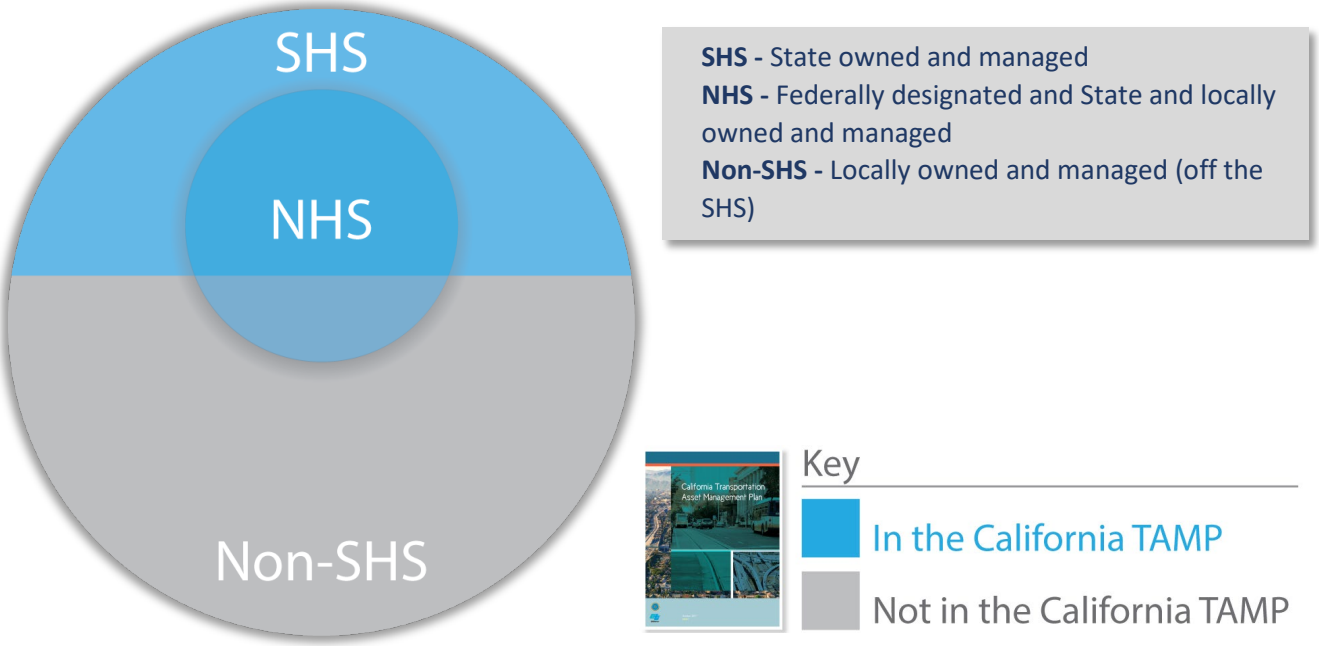

Figure 2-3. Assets Included in the California TAMP

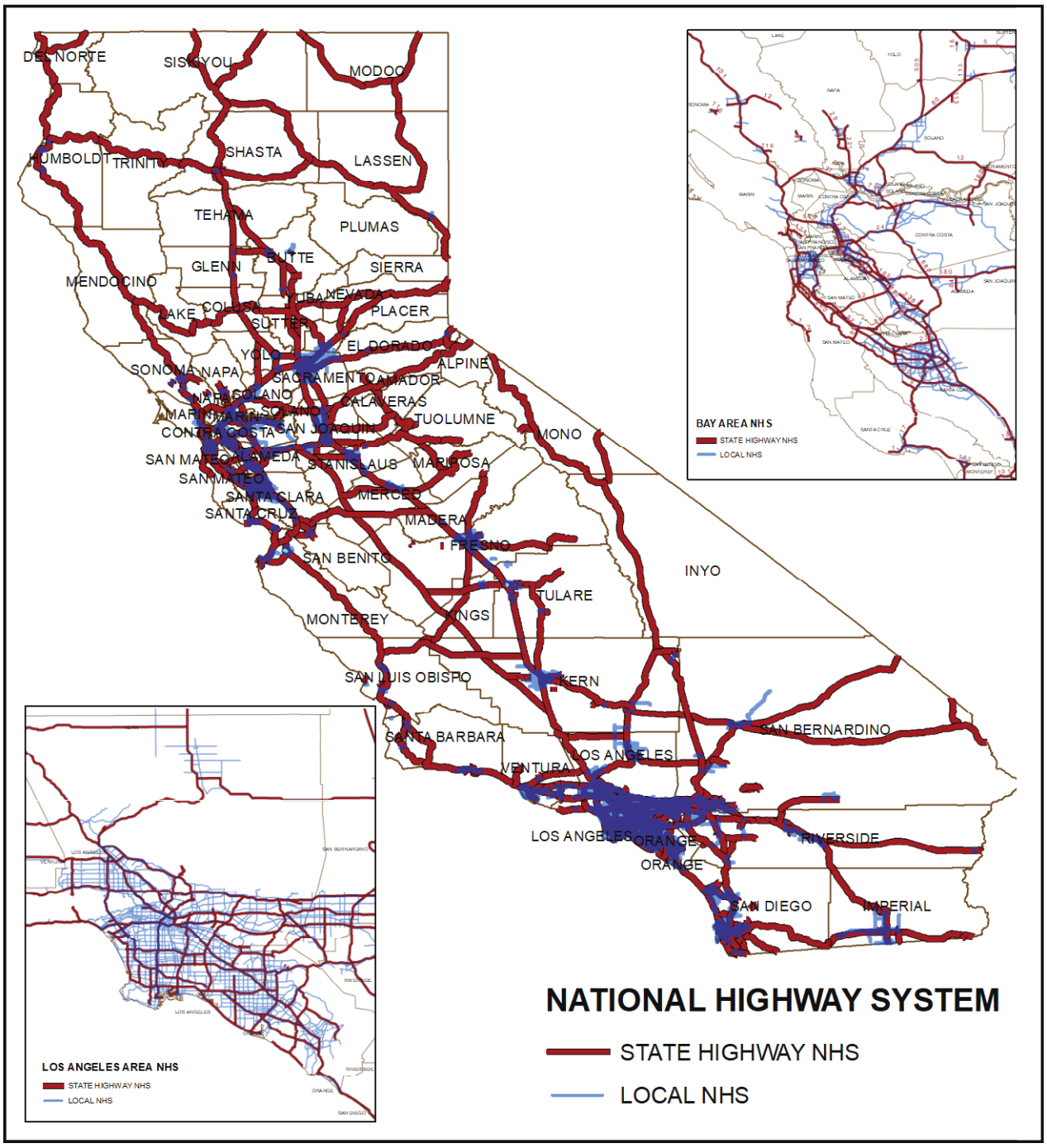

Figure 2-4. California NHS Map

2.4. Inventory and Condition

Monitoring and measuring transportation asset condition helps California's transportation agencies assess the performance of the transportation system, predict future needs, allocate funding, and schedule projects. Asset condition is also an important public-facing measure in which users of the transportation network notice and experience every day. Users can be very responsive to changes in asset condition.

FHWA developed national-level condition performance measures for NHS pavements and bridges outlined in the Pavement and Bridge Performance Management Final Rule (23 CFR Part 490[14]). Caltrans recommended and the Commission adopted the national performance measures for SHS pavements and bridges. Caltrans recommended and Commission also established state performance measures for other assets on the SHS such as drainage, TMS, and supplementary assets. Federal and state performance measures are explained in greater detail for each asset in this chapter.

Condition data collection cycles vary depending on the asset. Pavement condition data are collected annually and bridges are inspected and their condition measured every two years. Caltrans inspects 8,000-12,000 drainage assets and performs roughly 52,000 preventive maintenance checks on TMS asset annually.

Primary Assets

Table 2-1 summarizes asset inventory and conditions in California for the four primary asset classes of this TAMP. The table is organized by system and by asset class. Data for pavements on the NHS came from the 2017 Highway Performance Monitoring System (HPMS) submittal reflecting pavement inventory and condition as of December 31, 2016. Data for bridges on the NHS came from the 2017 National Bridge Inventory (NBI) data and reflects bridge inventory and condition as of April 1, 2017. Data for all assets on the SHS came from the 2017 SHSMP and reflects available data as of June 26, 2017.

Table 2-1 Inventory and Conditions for NHS and SHS Assets in California

Primary Assets	Inventory	Good	Fair	Poor	
On the NHS (State and local)					
Pavements	56,075 Lane Miles	30.4%	63.5%	6.1%	
Bridges	234,285,883 Square Feet	66.5%	28.7%	4.8%	
On the SHS (State)					
Pavements	49,644 Lane Miles	40.8%	53.5%	5.7%	
Bridges	245,756,328 Square Feet	74.9%	21.8%	3.3%	
Drainage	10,647,900 Linear Feet	65.0%	23.5%	11.5%	

[14] Federal Regulations in 23 CFR Part 490, https://www.federalregister.gov/documents/2017/01/18/2017-00681/national-performance-management-measures-assessing-performance-of-the-national-highway-system

Primary Assets					
	Inventory	Good	Fair	Poor	
TMS	18,837 Assets	58.8%	n/a	41.2%	

Supplementary Assets

Commission TAMP Guidelines require the inclusion of supplementary asset classes in the California TAMP. The TAMP Guidelines require inventory, condition, performance targets, and gaps for these assets. Inventory and condition are presented in this section. Performance targets and gaps are presented in Chapter 3. Asset Performance Targets. Table 2-2 summarizes asset inventory and conditions for the supplementary asset classes based on data from the 2017 SHSMP.

Table 2-2 Inventory and Conditions for State Supplementary Asset Classes

Supplementary Assets					
On the SHS (State)	Inventory	Good	Fair	Poor	
Drainage Pump Plants	290 Each Location	24.1%	29.3%	46.6%	
Highway Lighting	89,829 Each Asset	40.2%	13.9%	45.9%	
Office Buildings	2,778,299 Square Feet	41.9%	31.6%	26.5%	
Overhead Signs	16,470 Each Asset	74.4%	21.8%	3.8%	
Roadside Rest Facilities	86 Each Location	32.6%	38.4%	29.0%	
Sidewalks and Park and Ride (Including ADA Infrastructure)*	208,216 Each Location	0.0%	n/a	100.0%	
Transportation-Related Facilities	3,986,339 Square Feet	21.2%	15.1%	63.7%	
Weigh in Motion Scales	176 Each Station	2.8%	97.2%	0.0%	

*Combined asset categories

2.5. Pavements

Pavements are designed to support anticipated traffic loads and provide a safe and relatively smooth driving surface. Keeping pavements in good condition lengthens their life, enhances safety and helps reduce road users' operating costs and reduces vehicle emissions. On the other hand, rough roads cause more wear and tear on vehicles, increasing user costs and in some cases reducing mobility.

Pavement Data

Caltrans collects pavement inventory and condition data for all NHS and SHS pavements through an Automated Pavement Condition Survey (APCS)[15]. The APCS uses high definition images and lasers to measure pavement condition for every 0.1 mile for NHS and SHS pavements. Caltrans began this data collection effort in 2015. Caltrans reports pavement data to HPMS[16], a national database maintained by FHWA with data on the nation's highways and their conditions. Additional discussion of data collection is included in Chapter 4. Life Cycle Planning.

Pavement Performance Measures

Caltrans recommended and the Commission has adopted FHWA's four pavement condition performance measures:

- Percentage of pavements on the Interstate System in Good condition
- Percentage of pavements on the Interstate System in Poor condition
- Percentage of pavements on the NHS (excluding the Interstate System) in Good condition
- Percentage of pavements on the NHS (excluding the Interstate System) in Poor condition

Caltrans uses these performance measures on both NHS and SHS pavements. Each of the performance measures can be calculated based on data reported in HPMS. The four measures are calculated using quantitative data on the following metrics:

- **Pavement roughness,** an indicator of discomfort experienced by road users traveling over pavements, is measured using the International Roughness Index (IRI).
- **Rutting** is quantified for asphalt pavements by measuring the depth of ruts along the wheel path. Rutting is commonly caused by a combination of heavy traffic and heavy vehicles.
- **Cracking** is measured in terms of the percentage of cracked pavement surface. Cracks can be caused or accelerated by excessive loading, poor drainage, frost heaves or temperature changes, and construction flaws.

Caltrans collects pavement inventory and condition data for all NHS and SHS pavements through APCS.

[15] APCS, http://dot.ca.gov/hq/maint/Pavement/Offices/Pavement_Management/index.html

[16] HPMS, https://www.fhwa.dot.gov/policyinformation/hpms.cfm

- **Faulting** is quantified for concrete pavements. Faulting occurs when there is loose base material at the transverse joints and fine aggregates are pumped up onto the pavement surface, resulting in non-uniform slab support. It can also be caused by slab curling and warping.

A graphic depiction of the four pavement condition metrics is shown in Figure 2-5.

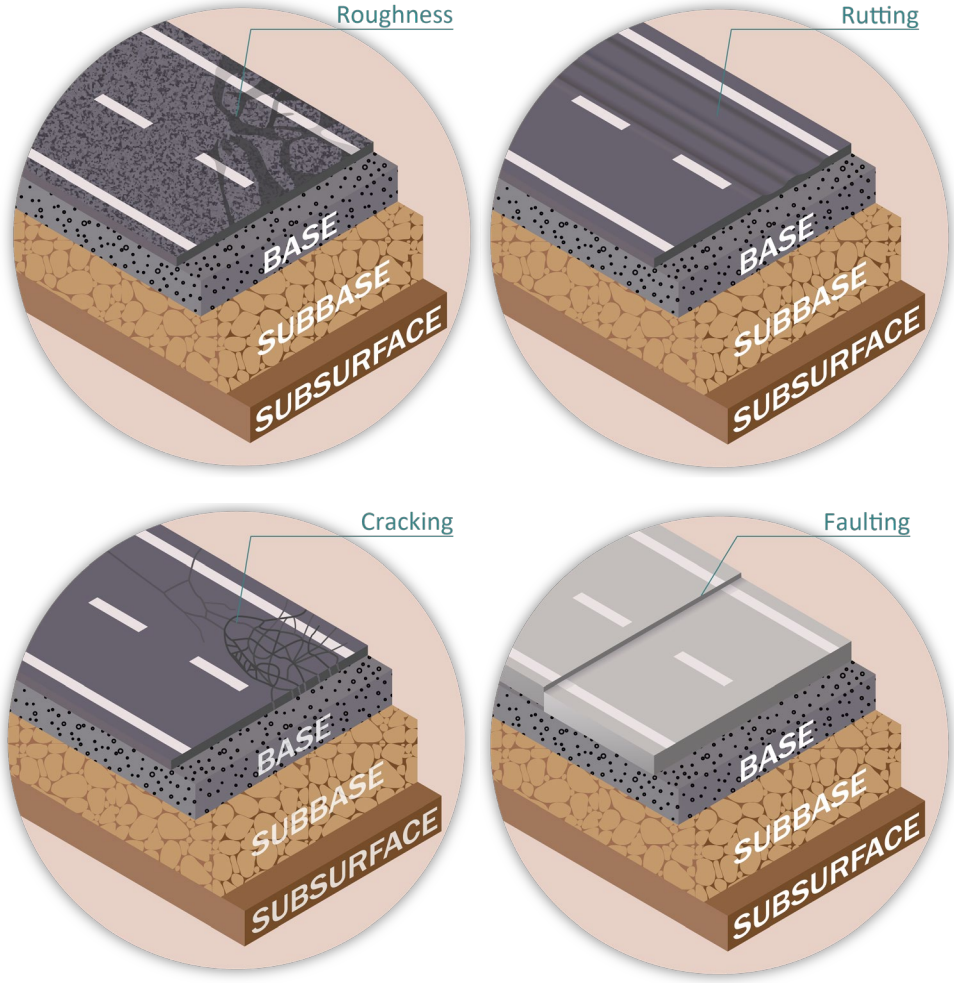

Figure 2-5. Pavement Condition: Four Metrics

For each of the above metrics FHWA has established thresholds for good, fair and poor condition. The pavement condition metrics are used to calculate FHWA performance measures for pavement condition. Conditions are assessed using these criteria for each 0.1 mile long pavement section. An individual section is rated as being in good overall condition if all of the metrics are rated as good, and poor when two or more are rated as poor. All other combinations are rated as fair. Lane miles in good, fair and poor condition are tabulated for all sections to determine the overall percentage of pavement in good, fair and poor condition. These thresholds are summarized in Table 2-3.

Moving Ahead for Progress in the 21st Century (MAP-21) pavement metrics are new requirements and have not historically been used by either Caltrans or local agencies in the management of pavement.

In addition to the federal performance measures summarized in Table 2-3 (below), Caltrans recommends and Commission sets targets for fair condition for assets on the SHS, as required by Commission TAMP Guidelines, using condition thresholds set by FHWA.

The majority of local jurisdictions in California utilize an alternative performance measure called the Pavement Condition Index (PCI) to measure pavement condition. PCI is a numerical index between zero and 100 used to indicate the general condition of a pavement section. Because FHWA metrics for NHS pavements do not include PCI as a performance measure, local agencies expressed concern that this may be causing inaccurate reflection of condition on the locally-owned system. Their concern is that PCI is more effective in monitoring conditions on local streets and roads because of slower speed and other physical features that impact condition. Chapter 9. TAMS Process Improvements, has listed this item for further action.

Table 2-3 NHS Pavement Condition Thresholds

Condition Thresholds			
Metric	**Good**	**Fair**	**Poor**
IRI (inches/mile)	**<95**	**95-170**	**>170**
Cracking (%)			
- Asphalt	<5	5-20	>20
- Jointed Concrete	<5	5-15	>15
- Continuously Reinforced Concrete	<5	5-10	>10
Rutting (inches)	**<0.20**	**0.20-0.40**	**>0.40**
Faulting (inches)	**<0.10**	**0.10-0.15**	**>0.15**

Note: This table reflects final pavement condition thresholds for NHS pavements only.

Pavement Inventory and Conditions

Pavement inventory is organized by system, divided into NHS and SHS pavements. The NHS is broken down into Interstate and Non-Interstate NHS pavements. Interstate pavements are part of the Interstate Highway System, a highway network which is part of the NHS. All other pavement subsystems on the NHS are represented as “Non-Interstate NHS.”

SHS pavements are owned by Caltrans. “Non-SHS” or “locally-owned” refers to pavements owned by other agencies, including cities, counties, tribal governments, federal agencies and other state agencies. Figure 2-3 shows the ownership and network of the assets included in the California TAMP.

The NHS in California consists of 56,075 lane miles of pavement. 36,649 of those lane miles are also on the SHS, representing 65.4 percent of NHS lane miles in California. The remaining 19,427 lane miles are owned by local agencies and represent 34.6 percent of NHS lane miles in California.

Table 2-4 summarizes California's NHS pavement inventory and conditions by lane miles, organized by owner and system from the 2017 HPMS. A centerline mile is a measure of the total length (in miles) of pavement, as measured along the roadway centerline. A lane mile is the federal and state required unit of measure for performance and is a measure of the total length of traveled pavement surface for each lane. Lane miles is the centerline length (in miles) multiplied by the number of lanes. Lane miles is a more complete metric of pavement surface, because it reflects the area of the pavement and is used for calculating performance measures and targets.

California pavement condition is presented in terms of the percent of pavements in good, fair and poor condition, weighted by lane miles. As indicated in Table 2-4, 30.4 percent of pavements on the NHS are in good condition, 63.5 percent in fair condition, and 6.1 percent are in poor condition. Of the SHS pavements on the NHS, 44 percent are in good condition, 53.2 percent are in fair condition, and 2.7 percent are in poor condition, while 4.6 percent of the non-SHS pavements on the NHS are in good condition, 82.9 percent are in fair condition, and 12.5 percent are in poor condition.

Table 2-4 Inventory and Conditions of NHS Pavements in California, by Lane Miles

Pavements on the NHS					
	Lane Miles	Good	Fair	Poor	
On the SHS (State NHS)					
All NHS	**36,649**	**44.0%**	**53.2%**	**2.7%**	
Interstate	14,159	44.9%	52.1%	3.1%	
Non-Interstate NHS	22,490	43.5%	54.0%	2.5%	
Off the SHS (Local NHS)					
Non-Interstate NHS	19,427	4.6%	82.9%	12.5%	
Total (State and Local NHS Pavements)					
All NHS	**56,075**	**30.4%**	**63.5%**	**6.1%**	
Interstate	14,159	44.9%	52.1%	3.1%	
Non-Interstate NHS	41,917	25.5%	67.4%	7.1%	

Table 2-5 presents inventory and condition of locally-owned NHS pavements. These data correspond to the "Off the SHS (Local NHS) Non-Interstate NHS" row in Table 2-4. The table is organized by geographical jurisdiction, grouping pavement by Metropolitan Planning Organization and Regional Transportation Planning Agency (RTPA). A large portion of the locally-owned NHS pavements is in the areas covered by the Southern California Association of Governments (SCAG) or Metropolitan Transportation Commission (MTC). SCAG has jurisdiction over 11,658 lane miles of NHS pavements,

which represent 20.8 percent of total NHS lane mileage in California. MTC has jurisdiction over 2,995 lane miles of NHS pavements or 5.3 percent of total NHS lane mileage in California.

Pavements under SCAG's jurisdiction, 3.7 percent are in good condition, 81.9 percent are in fair condition, and 14.4 percent are in poor condition. Pavements under MTC's jurisdiction, 1.7 percent are in good condition, 87.2 percent are in fair condition, and 11.1 percent are in poor condition. Of all non-SHS NHS pavements, 4.6 percent are in good condition, 82.9 percent are in fair condition, and 12.5 percent are in poor condition.

Table 2-5 Inventory and Conditions of Non-SHS NHS Pavements, Listed by Geographical Jurisdiction

Locally-Owned Pavements on the NHS					
Jurisdiction	Lane Miles	Good	Fair	Poor	
MPO / RTPA					
Butte County Association of Governments (BCAG)	69	7.3%	80.0%	12.7%	
Fresno Council of Governments (FCOG)	479	13.3%	82.4%	4.3%	
Glenn County Transportation Commission (GCTC)	6	9.8%	90.2%	0.0%	
Humboldt County Association of Governments (HCAOG)	35	100.0%	0.0%	0.0%	
Kern Council of Governments (Kern COG)	586	19.4%	76.7%	4.0%	
Kings County Association of Governments (KCAG)	35	16.2%	83.8%	0.0%	
Lassen County Transportation Commission (LCTC)	8	100%	0%	0%	
Madera County Transportation Commission (Madera CTC)	3	0.0%	89.6%	10.5%	
Merced County Association of Governments (MCAG)	87	2.1%	82.6%	15.3%	
Metropolitan Transportation Commission (MTC)	2,995	1.7%	87.2%	11.1%	
Association of Monterey Bay Area Governments (AMBAG)	218	7.8%	84.0%	8.3%	
Sacramento Area Council of Governments (SACOG)	1,149	3.2%	82.3%	14.5%	
San Diego Association of Governments (SANDAG)	991	2.1%	89.1%	8.8%	

Locally-Owned Pavements on the NHS					
Jurisdiction	Lane Miles	Good	Fair	Poor	
MPO / RTPA					
San Joaquin Council of Governments (SJCOG)	545	7.2%	86.1%	6.7%	
San Luis Obispo Council of Governments (SLOCOG)	43	10.4%	78.1%	11.6%	
Santa Barbara County Association of Governments (SBCAG)	131	3.8%	88.3%	7.9%	
Shasta Regional Transportation Agency (SRTA)	9	13.3%	71.3%	15.4%	
Southern California Association of Governments (SCAG)	11,658	3.7%	81.9%	14.4%	
Stanislaus Council of Governments (StanCOG)	219	13.1%	73.4%	13.5%	
Tahoe Metropolitan Planning Organization (TMPO)	5	100%	0%	0%	
Tulare County Association of Governments (TCAG)	102	14.4%	83.2%	2.4%	
Other	54	16.7%	81.5%	1.9%	
Total					
All Locally-Owned NHS	**19,427**	**4.6%**	**82.9%**	**12.5%**	

Caltrans defines three classes of pavement on the SHS based on usage and other considerations. Caltrans reports pavement condition and targets based on this classification. Table 2-6 presents an inventory of SHS pavements by class, using data from the 2017 SHSMP.

Class I, which includes Interstates, other principal arterials, and urban freeways and expressways, represents 52 percent of the network. Class II, which includes: rural freeways and expressways, and minor arterials and represents 34 percent of the SHS network. Class III, major and minor collector routes, represents 14 percent of the network. The NHS includes all Class I roads, and a portion of the Class II roads.

Table 2-6 also presents the conditions of SHS pavements, as reported in the 2017 SHSMP. Of the pavements on the SHS, 40.8 percent are in good condition, 53.5 percent are in fair condition, and 5.7 percent are in poor condition.

Table 2-6 Inventory and Condition of SHS Pavements

Pavements on the SHS	Lane Miles	Good	Fair	Poor	
Pavement Class					
Total	**49,644**	**40.8%**	**53.5%**	**5.7%**	
Class I	26,014	45.1%	50.5%	4.4%	
Class II	16,759	35.6%	57.6%	6.8%	
Class III	6,871	37.5%	54.3%	8.1%	

2.6. Bridges

Bridges provide road network connectivity, spanning water bodies and other natural features, rail lines, and other roadways. New bridges are designed to last at least 75 years, and in practice, many bridges remain in service for much longer. However, bridges require periodic maintenance to replace individual components (such as decks) that have a shorter life than the bridge as a whole. If preservation work on a bridge is deferred, the deterioration may accelerate to the point where more costly repairs are needed. In extreme cases deteriorated conditions may require restricting the loads the bridge can carry or closing the bridge until needed repairs are complete–which can mean costly detours for road users. Thus, maintaining bridges in good condition pays off–resulting in the lowest long-term costs both to transportation agencies and road users. Bridges in good condition allow access to essential services and have a positive impact on the economy.

Bridge asset data are reported by Caltrans annually to FHWA to support NBI, an FHWA database that includes data on all bridges and culverts longer than 20 feet on public roads in the nation.

Bridge Data

Bridge asset data are reported by Caltrans annually to FHWA to support NBI[17], an FHWA database that includes data on all bridges and culverts longer than 20 feet on public roads in the nation. Bridges with a span shorter than 20 feet are excluded from NBI.

Caltrans also records an inventory of bridges in the SHSMP. This inventory has minor differences from NBI data. Notably, SHSMP inventory includes shorter bridges and pedestrian bridges that don't meet NBI requirements. The California TAMP uses NBI data as the source of NHS bridge inventory and condition and uses SHSMP data as the source of SHS bridge inventory and condition.

[17] National Bridge Inventory (NBI), https://www.fhwa.dot.gov/bridge/nbi.cfm

Bridge Performance Measures

FHWA has established two measures of bridge condition:

- Percentage of NHS bridges classified as in good condition (weighted by deck area)
- Percentage of NHS bridges classified as in poor condition (weighted by deck area)

FHWA requires that states use these measures in their TAMP to describe condition, set targets, and analyze performance gaps of NHS bridges. All other bridges are considered fair.

Caltrans and local agencies follow FHWA NBI standards for inspecting all California bridges. Caltrans staff perform inspections for all Caltrans bridges and many of California's locally-owned bridges. Inspectors record overall ratings for a bridge's deck, superstructure and substructure on a scale from zero (worst condition) to nine (best condition). Structures classified as culverts are included in the inventory if they span more than 20 feet. For these structures, a single culvert rating is recorded using the same zero to nine scale.

Figure 2-6. NBI Ratings for Bridge Condition

Bridge condition ratings are used to classify the bridge as being in good, fair or poor condition. The lowest of the three ratings for deck, superstructure, and substructure determines the overall rating of the bridge. If this value is seven or greater, the bridge is classified as being in good condition. If it is five or six, the bridge is classified as being in fair condition, and if it is four or less, the bridge is classified as being in poor condition. A bridge in poor condition is considered structurally deficient (SD). Thus, if any major component is classified as being in poor condition, the bridge will be considered SD. Note that the fact that a bridge is classified as SD does not imply that the bridge is unsafe, just that deficiencies have been identified that require maintenance, rehabilitation or replacement. A graphical depiction of the three bridge components is shown in Figure 2-7.

Caltrans also performs element-level inspections that provide additional detail on what portions of a bridge are deteriorated. Element-level information can be used to derive the NBI deck, superstructure, and substructure ratings.

In addition to the federal performance measures above, Caltrans also measures fair condition for assets on the SHS using the condition thresholds set by FHWA. The California TAMP includes fair condition targets to focus on the preservation of bridges in addition to the rehabilitation and replacement of poor bridges.

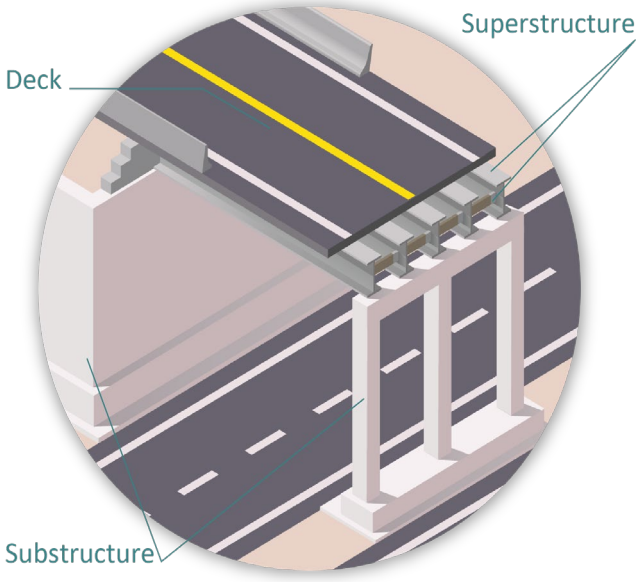

Figure 2-7. Bridge Components

Bridge Inventory and Conditions

Table 2-7 summarizes California's NBI bridge inventory by bridge count and by deck area, organized by owner and system. Including deck area in addition to bridge count helps account for differences in bridge size, and is consistent with FHWA TAMP requirements. NBI excludes all non-vehicle bridges (pedestrian/railroad crossings, etc.) and bridges less than 20 feet in length that are still Caltrans' maintenance responsibility.

Based on 2017 NBI data, Caltrans manages 12,413 bridges, 9,196 of which are on the NHS, representing 90 percent of total NHS deck area in California. There are 1,629 locally-owned NHS bridges in California, representing 10 percent of total NHS deck area in California. In total, there are 10,825 bridges on the NHS in California. Table 2-7 excludes non-NBI bridges.

Table 2-7 also summarizes the condition of California's NBI bridge inventory in terms of the percent of bridges in good, fair and poor condition, weighted by deck area. On the NHS, 66.5 percent of bridge deck area is in good condition, 28.7 percent is in fair condition, and 4.8 percent is in poor condition.

Table 2-7 Inventory and Conditions of NBI Bridges on the NHS, Weighted by Deck Area

NBI Bridges on the NHS						
System	Count	Deck Area (ft^2)	Good	Fair	Poor	
On the SHS (State)						
NHS	9,196	210,774,774	69.4%	26.9%	3.7%	
Off the SHS (Local)						
NHS	1,629	23,511,109	40.8%	44.4%	14.8%	
Total (State and Local Bridges)						
NHS	**10,825**	**234,285,883**	**66.5%**	**28.7%**	**4.8%**	

Table 2-8 shows a breakdown of locally-owned NHS bridges by regional transportation agencies. These data correspond to the "Off the SHS (Local) NHS" row in Table 2-7. The table organizes the assets by geographical jurisdiction, grouping the bridges by MPO and RTPA. A large portion of the bridges listed in the table is in areas under the jurisdiction of SCAG or MTC. SCAG has jurisdiction over 13,766,178 square feet of bridge deck area (963 bridges), which represents 5.9 percent of total NHS bridge deck area in California. MTC has jurisdiction over 4,641,759 square feet of bridge deck area (288 bridges), which represents two percent of total NHS bridge deck area in California.

Table 2-8 also summarizes the condition of locally-owned NHS bridges in California. It shows percent of bridges in good, fair and poor condition, weighted by deck area, with bridges grouped by jurisdiction. As indicated in the table, 40.8 percent of non-SHS NHS bridges are in good condition, 44.4 percent are in fair condition, and 14.8 percent are in poor condition.

Table 2-8 Inventory and Conditions of Non-SHS NHS Bridges, Listed by Geographical Jurisdiction

Locally-Owned Bridges on the NHS						
Jurisdiction	Count	Deck Area (ft^2)	Good	Fair	Poor	
MPO / RTPA						
Butte County Association of Governments (BCAG)	7	40,085	23.3%	76.7%	0.0%	
Fresno Council of Governments (FCOG)	33	389,427	31.2%	68.0%	0.8%	
Humboldt County Association of Governments (HCAOG)	2	5,113	0.0%	100.0%	0.0%	
Kern Council of Governments (Kern COG)	70	859,612	63.2%	31.9%	4.9%	
Merced County Association of Governments (MCAG)	10	52,958	33.3%	65.0%	1.7%	
Metropolitan Transportation Commission (MTC)	288	4,641,759	45.7%	33.4%	20.9%	
Association of Monterey Bay Area Governments (AMBAG)	11	121,969	11.1%	88.9%	0.0%	
Sacramento Area Council of Governments (SACOG)	97	1,272,986	51.9%	44.6%	3.5%	
San Diego Association of Governments (SANDAG)	68	1,265,363	33.7%	45.7%	20.6%	
San Joaquin Council of Governments (SJCOG)	33	539,939	77.8%	12.4%	9.8%	
San Luis Obispo Council of Governments (SLOCOG)	5	33,497	0.0%	100.0%	0.0%	
Santa Barbara County Association of Governments (SBCAG)	27	167,659	48.1%	33.7%	18.2%	
Shasta Regional Transportation Agency (SRTA)	3	133,860	94.1%	5.9%	0.0%	
Southern California Association of Governments (SCAG)	963	13,766,178	36.1%	49.1%	14.8%	
Stanislaus Council of Governments (StanCOG)	9	188,185	24.6%	60.7%	14.7%	
Tulare County Association of Governments (TCAG)	3	32,518	100.0%	0.0%	0.0%	
Total						
All Locally-Owned NHS	**1,629**	**23,511,109**	**40.8%**	**44.4%**	**14.8%**	

Table 2-9 presents an inventory of bridges on the SHS, as reported in the 2017 SHSMP. Bridge data in the SHSMP vary slightly from the NBI because they include all bridges managed by Caltrans whether they are in NBI or not. According to the SHSMP, 13,160 bridges are on the SHS, representing 245,756,328 square feet of bridge deck area.

Table 2-9 also presents the conditions of SHS bridges, as reported in the 2017 SHSMP. Of the bridges on the SHS, 74.9 percent are in good condition, 21.8 percent are in fair condition, and 3.3 percent are in poor condition.

Table 2-9 Inventory and Conditions of SHS Bridges

Bridges on the SHS (State)						
	Count	Deck Area (ft^2)	Good	Fair	Poor	
Total	**13,160**	**245,756,328**	**74.9%**	**21.8%**	**3.3%**	

Bridges, like all transportation assets, are constantly deteriorating, which is reflected in decreasing condition ratings. Other threats to bridge operation include seismic activity and scour. These risks and others are discussed further in Chapter 8. Risk Management.

2.7. Drainage

Drainage, including culverts and other related assets, is one of the four primary SHS asset classes selected by the Commission for inclusion in the California TAMP. As such, drainage assets are subject to the same data requirements and analysis as NHS assets and other primary SHS assets in the TAMP.

Drainage assets channel rainwater, streams, rivers, and other waterways away from roads via structures that direct water flow under the road. These assets prevent water from flooding roadways and interrupting the transportation system and damaging public and private property.

Drainage Performance Measures

Caltrans' Maintenance Program is responsible for the inspection of drainage on the SHS. Drainage assets are inspected during and after each major storm. Inspectors assess drainage asset condition as good, fair, or poor. This asset class is not required under federal regulation and has no defined national performance metric. Caltrans developed three performance measures for drainage assets which the Commission has adopted:

- Percentage of drainage assets in good condition, weighted by linear feet
- Percentage of drainage assets in fair condition, weighted by linear feet
- Percentage of drainage assets in poor condition, weighted by linear feet

Drainage Inventory and Conditions

Caltrans is currently building the inventory of drainage assets that run under or drain the SHS. The typical drainage asset is a 12- to 60-inch diameter (or width) steel or concrete pipe or box culvert. Any culvert with a width that spans 20 feet or longer is classified as a bridge and recorded on the NBI.

According to the 2017 SHSMP, roughly 110,000 drainage assets totaling 10,647,970 linear feet have been inspected and inventoried to date, but the network includes an estimated 205,000 systems totaling almost 20.3 million linear feet. Ongoing inspections are adding between 8,000 and 12,000 drainage assets to the statewide inventory annually and should be complete by 2027.

Performing a drainage asset inspection involves taking inventory of drainage assets and doing a condition assessment of those assets. The condition assessment is based on a visual inspection of five attributes:

1. Waterway adequacy
2. Joints
3. Material
4. Shape
5. Alignment

Each attribute is scored on a five-point scale from zero to four, where zero is new condition, one is good condition, two is fair condition, three is poor condition, and four is attribute failure. Asset condition is calculated using a weighted average of the attribute scores.

According to the 2017 SHSMP, 65 percent of the drainage network, measured in linear feet, is in good condition, 23.5 percent is in fair condition, and 11.5 percent is in poor condition. Table 2-10 shows the current condition of Caltrans drainage assets.

Table 2-10 SHS Drainage Asset Inventory and Conditions

Drainage Assets on the SHS (State)					
	Linear Feet	Good	Fair	Poor	
Total	**10,647,970**	**65.0%**	**23.5%**	**11.5%**	

2.8. Transportation Management Systems

TMS are one of the four primary asset classes selected by the Commission for inclusion in the California TAMP. As such, TMS are subject to the same data requirements and analysis as NHS assets and other primary SHS assets in the TAMP.

TMS are a broad class of technology assets on the highway system dedicated to improving operational efficiency and user interactions. FHWA defines TMS as complex, integrated amalgamations of hardware, technologies, and processes for performing an array of functions, including data acquisition, command and control, computing, and communications. Disruptions or failures in the performance of these functions can impact traffic safety, reduce system capacity, and ultimately lead the traveling

public to lose faith in the transportation network. System failures also have the potential to cause measurable economic loss and increase congestion, fuel consumption, pollutants, and traffic crashes. The problem is further complicated by the fact that today's systems, subsystems, and components often are highly interdependent, meaning that a single malfunction can critically impact the ability of overall systems to perform their intended functions. Examples of TMS assets include vehicle detection, ramp meters, changeable message signs, highway advisory radios, fiber optic line, and software that powers traffic management centers. As defined by the Commission, Intelligent Transportation Systems (ITS) is a subset of TMS; a narrower class of technology assets dedicated to improving the efficiency and safety of the highway system. ITS are a small subset of the assets under TMS measured by count, but ITS represents the bulk of TMS asset value and ongoing expenditures. The Commission originally approved ITS assets for inclusion in the TAMP. For the purposes of the TAMP, this document will consider TMS in its entirety.

TMS assets help reduce traveler delay, enhance safety, improve communication, and collect data on traffic behavior. These assets are an integral part of the SHS, performing critical functions that keep people, vehicles and goods moving. TMS assets also support Integrated Corridor Management (ICM) and help to move freight around the state efficiently. The TAMP includes information on TMS assets on the SHS.

TMS Performance Measures

To monitor TMS conditions, each asset is classified as in good or poor condition. Good condition indicates the asset is operational and not obsolete. Poor condition indicates the asset is obsolete or non-operational. Fair condition is not used for TMS assets because condition is binary: an asset is either operational; not obsolete and thus in good condition, or the asset is obsolete or non-operational and thus in poor condition.

TMS Inventory and Conditions

According to the 2017 SHSMP, there are 18,837 TMS assets on the Caltrans system. This includes:

- Closed circuit televisions
- Changeable message signs
- Traffic monitoring detection stations
- Highway advisory radios
- Freeway ramp meters
- Roadway weather information systems
- Traffic signals
- Traffic census stations
- Extinguishable message signs

According to the 2017 SHSMP, 58.8 percent of TMS assets are in good condition and 41.2 percent are in poor condition. Table 2-11 shows the current condition of Caltrans' TMS assets.

Table 2-11 Caltrans TMS Inventory and Conditions

TMS on the SHS (State)					
	Assets	Good	Fair	Poor	
Total	**18,837**	**58.8%**	n/a	**41.2%**	

2.9. Asset Valuation

FHWA requires state DOTs to include an estimate of asset value for NHS pavements and bridges in the TAMP. The following tables summarize NHS pavement and bridge asset values, as well as asset values for the four primary asset classes on the SHS, as required by Commission-adopted TAMP Guidelines. California uses a replacement value methodology for asset valuation: asset inventory multiplied by unit replacement cost equals asset replacement value.

Table 2-12 shows a breakdown of pavement asset value on the NHS. Unit replacement costs by SHS pavement class from the 2017 SHSMP are used to estimate asset value for NHS pavements on the SHS. Interstate pavements are entirely Class I SHS. Non-Interstate NHS includes the remainder of Class I SHS, as well as a portion of Class II SHS. Total estimated asset value for NHS pavements on the SHS is $42 billion. Non-SHS NHS pavements use a unit replacement cost based on the 2016 Local Streets and Roads Needs Assessment with an estimated asset value of $7.2 billion. The estimated asset value of NHS pavements in California is $49.3 billion.

Table 2-12 NHS Pavement Asset Valuation

Pavements on the NHS			
System	Lane Miles	Unit Replacement Cost	Replacement Value
On the SHS (State)			
All State NHS	**36,649**		**$42,025,520,400**
Interstate	14,159	$1,323,600	$18,740,852,400
Non-Interstate NHS (Class I portion)	11,855	$1,323,600	$15,691,278,000
Non-Interstate NHS (Class II portion)	10,635	$714,000	$7,593,390,000
Non-Interstate NHS (Combined)	22,490		$23,284,668,000
Off the SHS (Local)			
Non-Interstate NHS	**19,427**	**$372,768**	**$7,241,763,936**

Pavements on the NHS			
System	Lane Miles	Unit Replacement Cost	Replacement Value
Total (State and local)			
All NHS (State and Local)	**56,075**		**$49,267,284,336**
Interstate	14,159		$18,740,852,400
Non-Interstate NHS	41,917		$30,526,431,936

Table 2-13 shows a breakdown of bridge asset value on the NHS, using unit replacement costs from the 2017 SHSMP and from the *2016 California Statewide Local Streets and Roads Needs Assessment Report*[18]. Total estimated asset value for NHS bridges on the SHS is $133.8 billion. Non-SHS NHS bridges have an estimated asset value of $14.9 billion. The estimated asset value of NHS bridges in California is $148.8 billion.

Table 2-13 NHS Bridge Asset Valuation

Bridges on the NHS			
System	Deck Area (ft^2)	Unit Replacement Cost	Replacement Value
All NHS (State and Local)	**234,285,883**	**$635**	**$148,771,535,521**
On the SHS (State)	210,774,774	$635	$133,841,981,448
Off the SHS (Local)	23,511,109	$635	$14,929,554,073

[18] NCE, "California Statewide Local Streets and Roads Needs Assessment", 2016, http://www.savecaliforniastreets.org/wp-content/uploads/2016/10/2016-CA-Statewide-Local-Streets-and-Roads-Needs-Assessment-Final-Report.pdf

Table 2-14 shows asset valuations for the four primary asset classes on the SHS, using unit replacement costs from the 2017 SHSMP. Note that replacement values for drainage and TMS assets vary from the SHSMP, because this estimate uses current inventory, while the SHSMP uses projected inventory in 2027.

Table 2-14 SHS Asset Valuation

SHS			
	Inventory (unit)	Unit Replacement Cost	Replacement Value
All SHS (State)			**$229,245,313,047**
Pavement Class I	26,014 Lane Miles	$1,323,600	$34,432,130,400
Pavement Class II	16,759 Lane Miles	$714,000	$11,965,926,000
Pavement Class III	6,871 Lane Miles	$480,000	$3,298,080,000
Pavement Subtotal	49,644 Lane Miles		$49,696,136,400
Bridge	245,756,328 Deck Area (ft^2)	$635	$156,055,268,280
Drainage	10,647,900 Linear Feet	$2,000	$21,295,800,000
TMS	18,837 Assets	$116,691	$2,198,108,367

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3. Asset Performance Targets

Asset management best practices emphasize the use of performance management for transportation programs, shifting the decision-making framework towards data-driven, proactive, goal-oriented investment choices. FHWA defines transportation performance management as "a strategic approach that uses system information to make investment and policy decisions to achieve national performance goals."

3.1. Overview

The cornerstone of FHWA's highway program transformation is the transition to a performance and outcome-based program. States now must measure condition and set performance targets for their transportation assets. These targets should be aligned with state goals and objectives, as well as national goals. The targets will help states make investment decisions that achieve individual targets while making progress toward national goals.

There are seven national goals defined in federal regulations: safety, infrastructure condition, congestion reduction, system reliability, freight movement and economic vitality, environmental sustainability, and reduced project delivery delays. These national goals [19]are broken into three performance management areas that are part of the overall Transportation Performance Management[20] program. Performance Management 2 (PM2) covers the condition of NHS pavement and bridges. Performance Management 1 and 3 (PM1 and PM3) are areas that focus on the other national goals for

[19] http://uscode.house.gov/view.xhtml?req=(title:23%20section:150%20edition:prelim)

[20] https://www.fhwa.dot.gov/tpm/

California. The process of establishing PM 1, PM2, and PM3 performance targets and related reporting is available online[21].

California uses asset performance targets to drive investment decisions as part of performance management and asset management best practice. California law requires the development of an SHS needs assessment that uses performance targets to estimate current needs. Performance measures and targets are used to track progress and guide state and local agencies towards short, medium, and long-term goals.

3.2. Federal and State Requirements

Federal Requirements

FHWA requires states to include asset management measures and state DOT targets for asset condition for NHS pavements and bridges in their TAMPs, as defined in 23 CFR Part 490.313[22]. States may choose to include additional measures as well. Any asset included in the TAMP must have accompanying measures and targets.

Using the measures of condition defined by FHWA, state DOTs must specify their desired state of repair (DSOR) for the 10-year analysis period of the TAMP consistent with state asset management objectives. The DSOR must also support progress towards achieving national goals.

As part of a separate FHWA final rule on performance management, under 23 CFR Part 490.105[23], states must set 2- and 4-year asset condition performance targets. These targets shall be included in the TAMP, but will also be reported separately to FHWA. As part of this performance management rule, states are also required to maintain NHS pavements and bridges to meet federally-established minimum condition levels:

- States must maintain bridges on the NHS so that the percentage of deck area of bridges classified as SD does not exceed 10 percent of the overall deck area in a state. (Note that according to FHWA NBI standards for bridge inspection, a bridge in poor condition is considered SD.)
- States must ensure that no more than five percent of pavement lanes miles on the interstate system are in poor condition.

California currently meets these minimum requirements for NHS pavements and bridges.

[21] http://www.dot.ca.gov/fed-liaison/

[22] 23 CFR Part 490.313, https://www.federalregister.gov/documents/2017/01/18/2017-00550/national-performance-management-measures-assessing-pavement-condition-for-the-national-highway

[23] 23 CFR Part 490.105, https://www.federalregister.gov/documents/2017/05/19/2017-10092/national-performance-management-measures-assessing-performance-of-the-national-highway-system

State Requirements

In addition to federal requirements regarding the NHS, SB 1 and Commission-adopted TAMP Guidelines require that the California TAMP include performance measures and targets for the four primary assets and nine supplementary assets on the SHS.

SB 1 and the Commission-adopted TAMP Guidelines also include two additional targets that are not required under federal regulations. These additional targets include:

- **A requirement to "fix an additional 500 bridges" over the 10-year period 2017-2027.** This performance metric most closely aligns with the bridge condition measure adopted by the Commission prior to the passage of SB 1. The Department plans to track these accomplishments on a project by project basis and report progress to the Commission as required by Commission Guidelines.
- **A requirement to maintain a minimum level of service (LOS) for pavement potholes, spalls and cracking.** The Department has an existing program to measure the maintenance LOS of highways. Visual assessments are conducted annually on a sample of the highway system. The pothole metric applies exclusively to flexible pavements (asphalt) and the spalling metric applies only to concrete pavement segments. Pavement cracking is applicable to both pavement materials although at different thresholds of cracking.

3.3. Asset Performance

Whether based on age, condition, LOS, or simply the frequency of repair, a performance measure is critical to actively managing the preservation of an asset. By understanding the impact of investment of that performance measure, policy makers are able to establish funding priorities and set targets they can reasonably expect to achieve. In this TAMP, asset performance means asset condition. California uses performance measures to report condition for the four primary asset classes as well as the supplementary asset classes in this TAMP. Condition information is presented in Chapter 2. Asset Inventory and Conditions, in Table 2-1 through Table 2-11.

3.4. Asset Performance Targets

Asset performance targets specify conditions California seeks to achieve and sustain over a 10-year period to support agency goals and objectives and meet federal requirements. California's targets reflect state priorities and will be used to guide strategic planning decisions. The 10-year DSOR targets align with the 10-year scope of the TAMP. Targets presented in this chapter serve as fixed benchmarks against which present and future performance can be evaluated.

Federal regulations require state DOTs establish 2- and 4-year performance targets for pavements and bridges by May 20, 2018. Within 180 days after this date, MPOs must document with Caltrans whether they: 1) agree to plan and program projects so that they contribute toward the accomplishment of the established statewide target for that performance measure; or 2) commit to a quantifiable 4-year target for that performance measure for their metropolitan planning area.

To further California's efforts in achieving targets, Caltrans and MPOs established an addendum to the Planning and Programming MOU[24] that documents additional requirements of performance management that will support implementation of the TAMP and achieving NHS performance targets. These MOUs describe roles and responsibilities for performance-based planning and programming and include:

- Coordination on target setting
- Data collection
- Data analysis
- Reporting on progress toward target achievement
- Integration of performance goals, objectives, measures and targets in the State's and MPO's planning and programming process

On-going communication with MPOs occurs through various Caltrans Offices but primarily are carried out through the Caltrans Office of Federal Liaison, Regional Planning, Transportation Programming, Office of Traffic Safety and the Director's Office of Asset Management.

3.5. NHS Asset 10-Year Performance Targets

Caltrans' August 2017 Target Setting Workshop assisted in establishing statewide 10-year performance targets for all of California's NHS pavements and bridges. Materials from TAMP workshops are available online and provide further information on the process used to establish targets.[25] MPOs and RTPAs who have NHS pavements and bridges within their jurisdictions provided valuable information in the workshop. There were three potential methods presented for setting the statewide performance targets, but the outcome of the workshop by consensus of the participants was to use a hybrid approach that allows agencies to tailor their target-setting method to the available resources and to the extent of the NHS each agency owns. A formal request was sent to MPOs and RTPAs asking that they select a reporting method for determining the statewide 10-Year performance targets and submit their preferred method to Caltrans by September 20, 2017. Agencies had three reporting methods to choose from:

1) Adopt the statewide targets based on the weighted average of NHS performance targets provided by MPOs and RTPAs.

2) Provide financial information to Caltrans which would be paired with statewide deterioration rates and statewide unit costs to estimate appropriate targets.

3) Perform a full financial deterioration and target setting analysis and submit that analysis to Caltrans to set their own condition targets. Additional information would be required of the agency including the methodology used, unit costs, deterioration rates, prior year funding and condition, and the 10-years of planned condition for their respective NHS inventories.

[24] http://meetings.sbcag.org/Meetings/SBCAG/2018/April%2019/Item%204B-%20MOU%20Amendment%20Staff%20Report.pdf

[25] Caltrans, Transportation Asset Management Home Page, http://www.dot.ca.gov/assetmgmt/

Since most local transportation agencies own less than two percent of NHS pavements and less than half a percent of NHS bridge deck area, MPOs and RTPAs unanimously elected to adopt the statewide weighted-average NHS performance targets through this collaborative process.

Factors for Setting NHS Performance Targets

- Starting or initial conditions
- Available funding
- Cost of repair
- Deterioration rates
- Likelihood of improvement
- Reasonableness of improvement

Not only were targets set by considering the factors above, the effects of different funding levels and the maximum amount of funding that could be reasonably expected for local pavements was a key factor which contributed to the difference in the 10-year DSOR for non-Interstate NHS pavement on the SHS (1.5 percent poor) versus off the SHS (nine percent poor). In addition, the difference in the targets was set acknowledging that MAP-21 pavement condition measure tends to result in a fair classification for urban pavements off the SHS that would otherwise be classified as being in good condition, primarily due to the threshold for roughness. For further information on predicting future conditions, see Chapter 5. Performance Scenarios and Gaps.

Table 3-1 below presents the statewide asset performance targets for NHS pavements and bridges. NHS pavements are broken down into Interstate and Non-Interstate NHS. All Interstate pavements are also SHS Class I pavements and thus have the same target as SHS Class I pavements. Targets are also broken out by ownership. Non-Interstate NHS pavements are owned by state and non-state entities and use a weighted average performance target, as described above.

Table 3-1 NHS Asset Performance Targets

10-Year Desired State of Repair				
Asset (unit of measure)	**Good**	**Fair**	**Poor**	
Interstate Pavement (lane miles)	**60.0%**	**39.0%**	**1.0%**	
Non-Interstate NHS Pavement (lane miles)	**34.2%**	**60.9%**	**5.0%**	
On the SHS	57.6%	40.9%	1.5%	
Off the SHS	7.0%	84.0%	9.0%	
NHS Bridge (deck area)	**83.5%**	**15.0%**	**1.5%**	
On the SHS	83.5%	15.0%	1.5%	
Off the SHS	83.5%	15.0%	1.5%	

3.6. Asset 10-Year Performance Targets

SHS Targets

As part of the TAMP development process, Caltrans recommended asset performance targets for the four primary assets on the SHS. The Commission adopted the targets and they were published in the 2017 SHSMP.

SHS asset targets were influenced by a number of factors, including the rate of inventory growth, deterioration rates, cost-performance curves, project delivery time frames, and consequence of inaction. The targets, which reflect statewide stewardship objectives, are consistent with safety, system performance and sustainability objectives.

Poor condition targets consider the potentially negative consequences of inaction along with practical realities that makes realizing a zero-percent poor condition impossible.

Fair condition targets were established by considering the rate of new inventory and needs being identified, project delivery timeframes and cost versus performance analysis. Activities targeting fair condition assets have a strong preservation focus that serve to delay major rehabilitation or replacement and minimize the life cycle costs of the assets.

As an example, a 10-year cost performance chart for SHS bridges is shown below in Figure 3-1. Costs reflect SHOPP and major maintenance investments needed to achieve fair and poor targets.

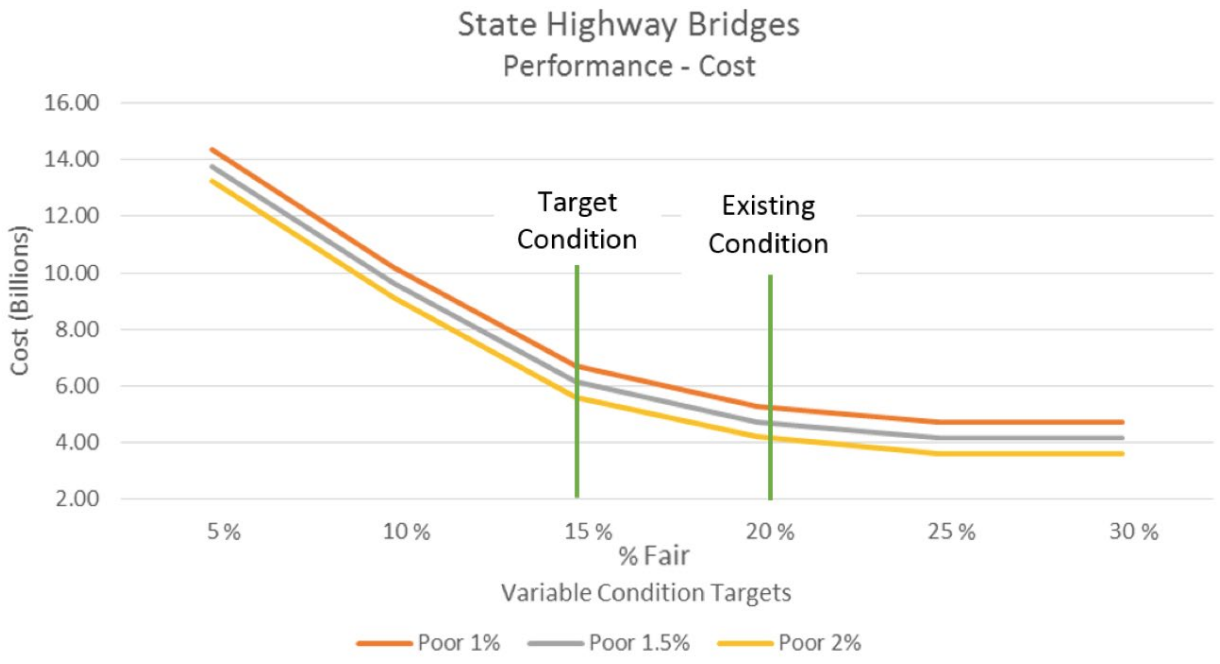


Figure 3-1. Example Performance – Cost Curve for SHS Bridges

Fair targets also have a practical minimum level. For example, in the bridge chart above, the five percent fair performance level has an associated cost of approximately $14 billion. This performance level is not achievable, because of the rate of needs being identified annually and typical project delivery

time frames. Finally, the estimated costs to achieve the targets were calculated to assess the impact on statewide needs. All of these factors were considered in the asset performance targets.

The 10-year DSOR performance targets shown in Table 3-2 represents for SHS assets developed by Caltrans and accepted by the Commission.

Table 3-2 SHS Asset Performance 10-Year Targets

10-Year Desired State of Repair				
Asset (unit of measure)	**Good**	**Fair**	**Poor**	
Pavement Class I (lane miles)	60.0%	39.0%	1.0%	
Pavement Class II (lane miles)	55.0%	43.0%	2.0%	
Pavement Class III (lane miles)	45.0%	53.0%	2.0%	
Bridge (deck area)	83.5%	15.0%	1.5%	
Drainage (linear feet)	80.0%	10.0%	10.0%	
TMS (assets)	90.0%	n/a	10.0%	

Other Transportation Performance Management Targets

The asset management plan needs to consider operational objectives established in performance rules 1 and 3. The performance management rules for safety and congestion have targets established for the transportation system in California. Safety targets are shown in Table 3-3 and some of the congestion targets are shown in Table 3-4.

Table 3-3 Safety Targets

Performance Management Targets for Safety			
Performance Metric	Baseline 5-Year Average 2011-2015	Target 5-Year Rolling Average	Percent Reduction 2019
Number of Fatalities (traffic fatalities – all public roads)	3,033.4	3,445.4	3%
Fatality Rate (traffic fatalities per 100 million VMT – all public roads)	0.916	0.995	3%
Number of Serious Injuries (serious injuries – all public roads)	11,014.4	12,688.1	1.5%
Rate of Serious Injuries (serious injuries per 100M VMT – all public roads)	3.336	3.661	1.5%
Number of Non-motorized Fatalities and Serious Injuries (Non-motorized fatalities and serious injuries – all public roads)	4,087.6	3,949.8	3% for Fatalities and 1.5% Serious Injuries

Table 3-4 Congestion Targets

Performance Management Targets for Congestion	
Performance Metric	4-Year Target 2018-2021
Annual Hours of Peak Hour (AHPH) Excessive Delay per Capita (Urbanized Area 1)	51.2
AHPH Excessive Delay per Capita (Urbanized Area 2)	16.1
AHPH Excessive Delay per Capita (Urbanized Area 3)	14.7
AHPH Excessive Delay per Capita (Urbanized Area 4)	18.0
AHPH Excessive Delay per Capita (Urbanized Area 5)	30.0
AHPH Excessive Delay per Capita (Urbanized Area 6)	26.4

Caltrans implements the TAMP through the development of the SHSMP. The SHSMP also has defined objectives for safety and delay reduction. The operational objectives and constrained investment are fully defined within the SHSMP for the SHS.

Additional State Performance Targets

Maintain a Minimum LOS for Pavement Potholes, Spalls and Cracking

LOS scores Table 3-5 are expected to improve over time through the completion of highway crew work, major maintenance projects, and SHOPP projects. LOS measures will reflect the combination of work done through all of these three preservation channels shown in Table 3-5

Table 3-5 Level of Service Metrics

Existing Level of Service Scores and Target Levels Established by SB 1 in 2017		
Level of Service Metric	Existing Score (100 max)	Target Score
Cracking (combined)	43	90
Spalling	53	90
Potholes	88	90

Fix an Additional 500 Bridges over the 10-Year Period 2017-2027

Prior to the passage of SB 1, Caltrans was fixing an average of 126 bridges per year becoming the baseline for counting towards the additional 500 bridges to be fixed as presented in Table 3-6.

Table 3-6 Fix Additional Bridge Metrics

Fix 500 Additional Bridges in 10 Years Established by SB 1 in 2017		
Metric	10-Yr Baseline	10-Yr Target
Bridges Fixed	1260	1760

Projects that improve the condition of the bridge from a lesser condition to a better condition, mitigating seismic or scour vulnerabilities, or replacing bridge rail not meeting current federal crash test standards are counted towards the target.

3.7. Supplementary Asset 10-Year Performance Targets

Table 3-7 shows 10-Year DSOR performance targets for the supplementary assets on the SHS. These targets come from the 2017 SHSMP. In general, we are striving to have no poor-condition assets and to manage the assets in good and fair conditions. Target percentages are based on expert judgment and in some cases, have minimal historic data for target development at this time. In the case of Sidewalks and Park and Ride, Caltrans maintenance field crews address ongoing needs of poor locations unless Caltrans

has a delegated maintenance agreement with its local partners. ADA Infrastructure inventory reflects the number of deficient locations with respect to ADA regulations. These deficiencies are usually addressed on an ongoing basis, for example, through pavement, bridge, and many other projects. The ADA Infrastructure target is set to reduce 25 percent of deficient locations to ensure that we address a court settlement related to accessibility.

Table 3-7 Supplementary SHS Asset Performance 10-Year Targets

10-Year Desired State of Repair				
Asset (unit of measure)	Good	Fair	Poor	
Drainage Pump Plants (each location)	80.0%	20.0%	0.0%	
Highway Lighting (each asset)	100.0%		0.0%	
Office Buildings (square feet)	60.0%	40.0%	0.0%	
Overhead Signs (each asset)	100.0%		0.0%	
Roadside Rest Facilities (each location)	80.0%	20.0%	0.0%	
Sidewalks, Park and Ride and Pedestrian facilities (locations)	60.0%	40.0%	0.0%	
ADA Infrastructure (locations)	Reduce current deficiencies by 25%			
Transportation Related Facilities (square feet)	60.0%	40.0%	0.0%	
Weigh in Motion Scales (each station)	90.0%	10.0%	0.0%	

3.8. NHS Assets 2- and 4-Year Performance Targets

To monitor progress in achieving performance targets, annual targets or benchmarks (future condition projections) are established for both SHS and NHS to assess the progress towards longer-term targets. 2- and 4-year projections for NHS are reported to FHWA, and annual SHS projections are reported to the Commission.

Benchmarking Framework

Caltrans' annual benchmarks are developed using a calculation framework that relies on the initial baseline inventory and condition data, deterioration models, and project-level accomplishments for all work completed within a 10-year performance period. A four-step calculation is carried out for each year's performance to determine anticipated asset conditions, as summarized in Figure 3-2.

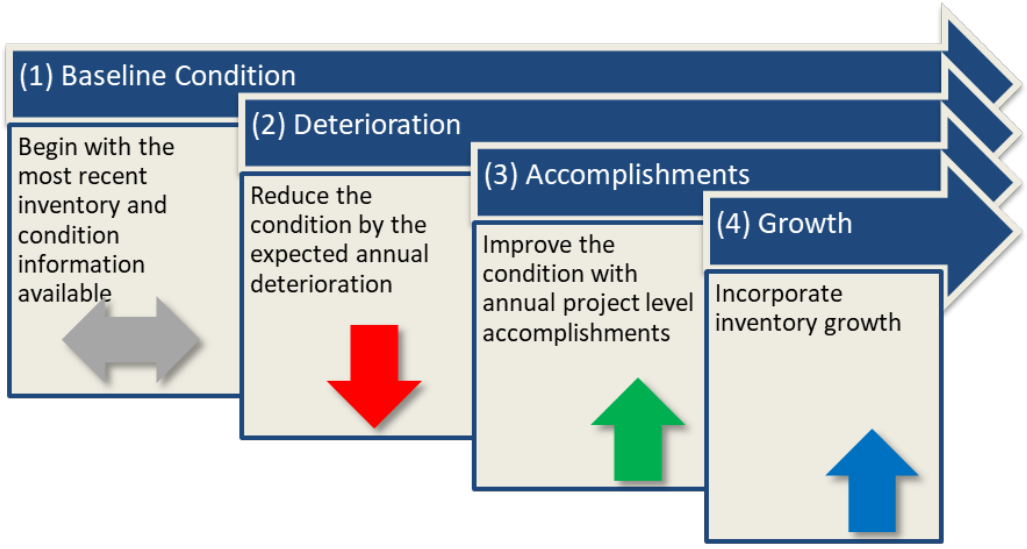


Figure 3-2 Steps in Calculating Benchmark Projections

The benchmarks account for the projected condition of the assets at the completion of the project when the improvements are realized. This is at the end of construction activity and the opening of the highway facility to the traveling public. This approach to condition accounting differs from a project portfolio planning framework, where fiscal balancing requirements necessitate the use of contract execution dates. The benchmark analysis relies on several project-level variables and assumptions that in aggregate contribute to uncertainties in future performance projections. The combined uncertainties generally become larger in the later years of the analysis period as deterioration projections and project-level uncertainties grow which are reflected in the analysis using a Monte Carlo simulation and uncertainty bands.

Establish 2- and 4-Year NHS Performance Targets

State-owned NHS benchmark analysis in combination with MPO/RTPA expected conditions for NHS pavement and bridges was the basis for the resulting 2- and 4-year performance targets. These combined targets were calculated using a quantity weighted approach that utilized Caltrans and regional agency condition expectations in statewide aggregate targets as presented in Table 3-8.

Table 3-8 Statewide Targets

Statewide Targets				
Pavement and Bridge Performance Measures	2-Year NHS Targets (1/1/2018 - 12/31/2019)		4-Year NHS Targets (1/1/2018 - 12/31/2021)	
	Good	Poor	Good	Poor
Pavements on the NHS				
Interstate	**45.1%**	**3.5%**	**44.5%**	**3.8%**
Non-Interstate	**28.2%**	**7.3%**	**29.9%**	**7.2%**
Bridges on the NHS	**69.1%**	**4.6%**	**70.5%**	**4.4%**

These 2- and 4-year statewide targets for NHS pavement and bridges were submitted to FHWA on October 1, 2018.

By November 16, 2018, MPOs were required by federal regulations to decide whether they: 1) agree to plan and program projects so that they contribute toward the accomplishment of the established statewide target for that performance measure; or 2) commit to a quantifiable 4-year target for that performance measure for their metropolitan planning area. Caltrans sent MPOs and RTPAs a formal letter that requested a form be filled out that designated which method the Agency elected to utilize for the establishment of the 4-year NHS pavement and bridge targets. MPOs were notified of the required timeline to submit their documentation to Caltrans. If the Agency elected to adopt statewide targets, no other information was required. For those Agencies that elected to submit one or more of their own targets, a form was required that included the methodology for establishing targets, the planned funding for their pavement and bridges on the NHS, the unit costs for fair and poor improvement which included the cost of construction, engineering and administration, the deterioration rates that changes condition from good to fair and fair to poor condition, the planned condition, and expected performance targets. Caltrans received documentation from all MPOs by the deadline of November 16, 2018 that they would support the statewide targets.

4. Life Cycle Planning

One of the core principles of asset management is making investment decisions that consider the full life cycle and associated costs of an asset or system of assets. Transportation asset management involves developing life cycle plans for pavements, bridges, and other assets included in the TAMP.

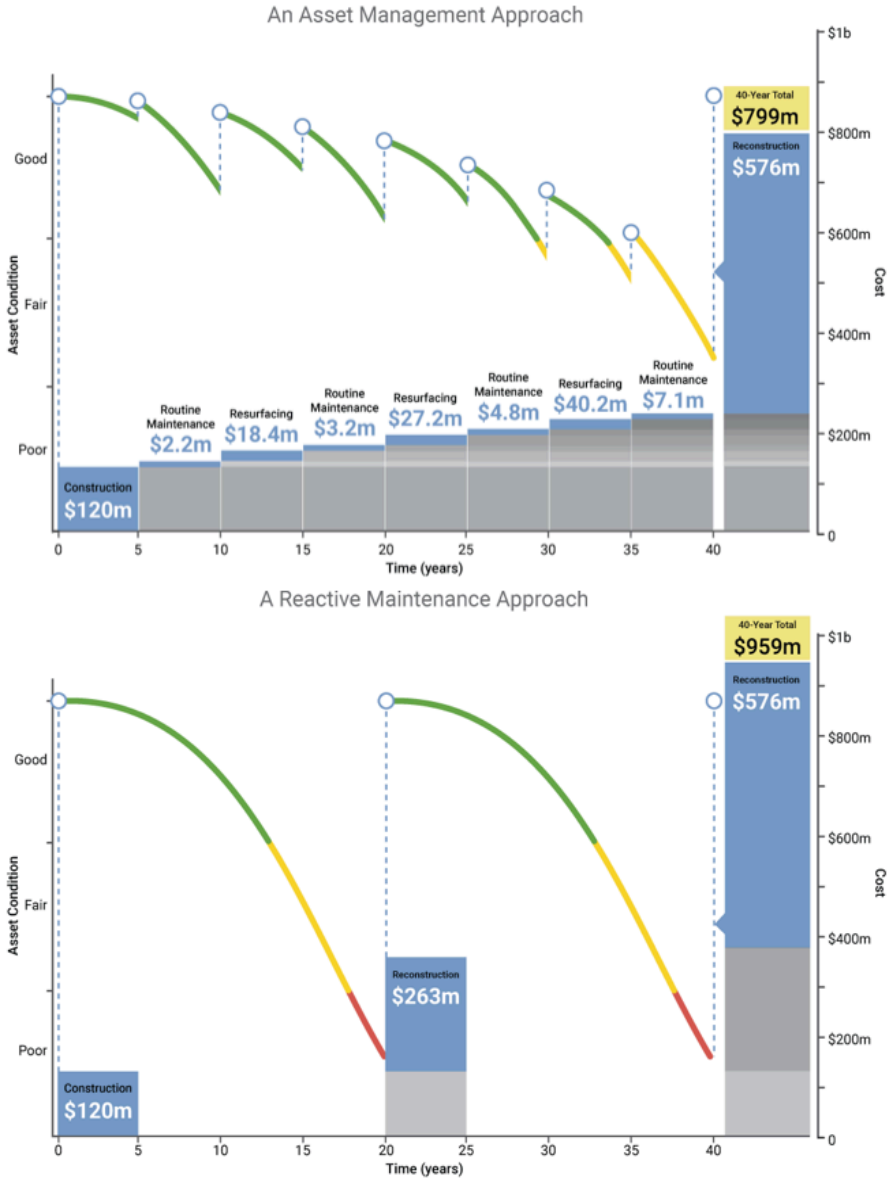
4.1. Overview

This chapter describes California's life cycle planning (LCP) for its pavement, bridge, drainage, and TMS assets. A life cycle plan is a strategy for managing an asset over its life to achieve a target level of performance while minimizing life cycle costs.

LCP focuses on general network-level asset management strategies that is, the best sequence of maintenance and rehabilitation treatments for a given asset type. Life cycle cost analysis (LCCA) complements LCP. LCCA is a technique for comparing cost alternatives over the life cycle of a project, allowing agencies to minimize life cycle cost. FHWA defines life cycle cost as "the cost of managing an asset class or asset sub-group for its whole life, from initial construction to its replacements."[26] LCCA can be utilized for project level decisions to select the design option that minimizes the initial and discounted future agency, user, and other relevant costs over an analysis time period. The basic principle underlying both LCP and LCCA is fundamental to asset management: timely investments in an asset can result in improved condition and lower long-term cost. This principle is illustrated by Figure 4-1 below. The graphs show condition and costs over time for two example scenarios: an asset

[26] Asset Management Plan Definitions. 23 CFR § 515.5. October 24, 2016, https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

management approach of regular preventive maintenance (top panel) and a more costly reactive approach (bottom panel).



Asset Management saves money: Performing preventive maintenance keeps assets in better condition – at a lower cost over the long term.

Deferring maintenance costs more: Higher-cost reconstruction or replacement is needed when assets are not maintained in a state of good repair.

Figure 4-1. Proactive Maintenance vs. Reactive Maintenance

Source: Rhode Island DOT, Investing in Rhode Island's Future: A 10-Year Plan to Strengthen Our State's Transportation Systems. 2014. Based on an analysis published by TXDOT. Texas DOT, Typical Life Cycle Costs of a Highway, 2014. http://ftp.dot.state.tx.us/pub/txdot-info/tpp/2040/Life Cycle-costs-of-a-highway.pdf

LCP should be based on a good understanding of the costs and lives of different types of treatments. It involves use of predictive models for how assets will deteriorate following different types of treatments. Ideally, these models are developed based on several years of data on treatments applied and measured condition. In practice, they are typically based on a combination of data and expert judgment.

Caltrans uses a *Physical Asset Model* based on the principle of deterioration. Deterioration is the physical degradation of an asset because of a combination of factors, including age, construction materials, environment, accidental damage, and traffic load. A set of deterioration rates (good-to-fair and fair-to-poor) are determined for each asset type to account for expected future conditions. The deterioration rates are expressed as an annual percentage rate and are used to quantify the proportion of the asset inventory that will degrade from good-to-fair and fair-to-poor condition states. The analysis has both a system preservation (good-to-good; fair-to-good) and rehabilitation/ replacement (fair-to-good; poor-to-good) goal to ensure a balanced management approach. Figure 4-2 illustrates the cycle of physical asset deterioration and improvements.

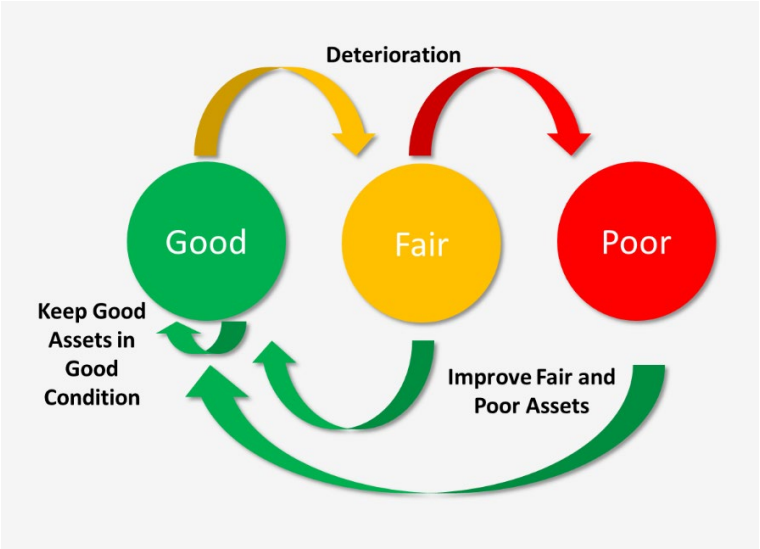


Figure 4-2 Deterioration and Improvement Cycle for Physical Assets

4.2. Federal and State Requirements

Federal Requirements

FHWA requires that state DOTs establish a process for conducting LCP at the network level for NHS pavements and bridges. FHWA defines LCP as "a process to estimate the cost of managing an asset class, or asset sub-group over its whole life with consideration for minimizing cost while preserving or improving the condition." The following elements must be included in an LCP process:

- Identification of deterioration models
- Potential work types (i.e., initial construction, maintenance, preservation, rehabilitation and reconstruction), including treatment options and unit costs
- A strategy for minimizing life cycle costs and achieving performance targets
- Asset performance targets

In addition, LCP should include future changes in traffic demand, information on current and future environmental conditions including extreme weather events, climate change and seismic activity.

Federal regulations also state that bridge and pavement management systems must be used in analyzing pavement and bridges for purposes of developing and implementing their TAMP. This Chapter describes the state of the practice for pavement and bridge modelling and use of current systems in place. Future enhancements to both systems to meet minimum requirements are expected to be completed by 2027.

State Requirements

The Commission requires the California TAMP include LCP for the four primary asset classes on the SHS (pavement, bridge, drainage, and TMS). Caltrans currently uses a real discount rate of four percent in carrying out the net present value (PV) calculations for each asset.

4.3. Key Life Cycle Planning Strategies for Maintaining State Highway Systems

Caltrans strives to preserve the condition of the SHS and state-owned NHS in the most economical means possible through carefully planned preservation strategies (i.e., preventive maintenance, corrective maintenance, and minor rehabilitation) and rehabilitation, replacement, or retirement when necessary. Caltrans manages the condition of the SHS and state-owned NHS by performing the right treatment at the right time through a combination of three types of work categories and projects: Field Maintenance Crews, Major Maintenance projects, and SHOPP projects. Each plays a key role in the overall management and preservation of the transportation system.

The combination of these three strategies allows Caltrans to effectively preserve the highway infrastructure in the most cost-effective manner. Caltrans Field Maintenance Crews carry out work to address minor needs before they grow into major and more expensive repairs. Highway Maintenance (HM) contracts in the Major Maintenance category are initiated to carry out work at the right time to extend the useful life of assets at the lowest possible long-term cost and to delay future rehabilitation or replacement activities. And finally, SHOPP capital improvement projects are used to invest in major asset rehabilitation or replacement projects when the end of an asset's useful life has been reached. This tiered approach maximizes transportation preservation investments.

Preventive maintenance is the most cost-effective means of protecting the State's infrastructure investment; these activities focus on keeping good condition assets in good condition. Caltrans recommends strategies to slow deterioration and extend pavement, bridge, and drainage life in fair or good condition.

Table 4-1 presents Caltrans work categories related to FHWA work types and the funding programs associated with strategies that address SHS needs.

Table 4-1 Work Types, Funding Programs and Strategies to Address the State Highway System Needs

Maintenance, Preservation, and Rehabilitation Strategies						
FHWA Work Types	Initial Construction	Maintenance	Preservation	Rehabilitation	Reconstruction	
Caltrans Work Types/Funding Programs	Initial Construction	Field Maintenance Crews	Preventive/ Corrective Maintenance	Minor/Major Rehabilitation	Reconstruction /Replacement	Condition Focus
Field Maintenance Crews		■	■			Good/Fair
Highway Maintenance			■			Good/Fair Poor
SHOPP	■		■	■	■	New/Fair Poor
STIP	■				■	New
Local	■				■	New Fair/Poor

Field Maintenance Crews

Caltrans Field Maintenance Crews regularly address the day-to-day demands of the SHS and state-owned NHS. These field activities are the first line of defense in Caltrans' SHS maintenance, and are reactionary in nature. The Field Maintenance Crews collectively perform many aspects of ongoing maintenance of highways and assets. Crews address minor maintenance, repairs, and preservation work. This typically includes pothole repair, crack sealing, cleaning of drains, servicing lighting and signs, structural painting, minor facility repairs, irrigation repairs, and more. Crews also provide rapid response to repair minor accident damage.

Preventive maintenance is applied to assets in good condition and some fair condition assets when appropriate, with the goal of maintaining their condition. For example, a bridge preventive maintenance activity is the painting of steel structures. Field maintenance strategies are important tools for extending asset service life in a cost-effective manner.

Major Maintenance Projects

Major maintenance projects are funded through the HM program at Caltrans. HM projects help further prolong the life of existing infrastructure. These projects include preventive and corrective maintenance strategies that exceed the scope of what Field Maintenance Crews typically manage. Corrective maintenance typically applies to assets in fair condition; however, it can also be applied to some assets in poor condition, with the goal of restoration to good condition. For example, one pavement corrective maintenance activity is crack sealing. Since deterioration (degradation of materials over time) can accelerate, the longer the asset is in fair condition, the timely application of corrective maintenance can

often prevent the need for more costly treatments later. Caltrans executes HM projects through contracts. HM work is designed to extend the life of physical assets, delay rehabilitation or replacement of assets, and is performed on pavement, bridges, culverts, facilities, traffic management systems, and more. HM projects, which may be preventive or corrective in nature, include thin pavement overlays, bridge joint seals, and culvert repairs. This category of projects repairs but does not upgrade or replace facilities.

SHOPP Projects

When field maintenance and more extensive HM project activities are no longer cost-effective or viable, Caltrans considers asset rehabilitation or reconstruction/replacement. This work, which applies to assets in both fair and poor condition, is typically funded through SHOPP. SHOPP projects are more complex capital construction projects that use private construction contractors obtained through a competitive bidding process. These projects, which may involve complex upgrades, overhaul infrastructure nearing the end of its lifespan. They may involve extensive planning and design, environmental permitting and even right-of-way acquisition. Rehabilitation and replacement activities are performed on pavement, bridges, culverts, buildings, overhead signs, lights, roadside elements, and safety roadside rest areas. SHOPP invests available funds to implement safety improvements, rehabilitate or replace physical assets, improve the operation of the highways, improve system resiliency, and mitigate transportation-related environmental impacts.

Each of these programs plays key roles and works together in the overall management of the transportation system. Using the three-pronged approach to asset preservation, Caltrans can make timely repairs at the right time to extend the useful life of the assets at the lowest possible long-term cost and to delay future rehabilitation and replacement activities.

Additional Strategies

In addition to SHOPP and the Maintenance Program, there are other funding programs that address additional SHS and state-owned NHS needs. Beyond asset management's objective of taking care of existing assets, there are needs for upgrading and expanding facilities to accommodate increased freight movement, broader economic growth, population increases, new transportation technologies and evolving land use patterns. These are beyond the scope of SHOPP and the Maintenance Program and are instead addressed through a variety of other funding programs, such as Fixing America's Surface Transportation (FAST) Act, the State Transportation Improvement Program (STIP), state transportation bond programs, local transportation tax measures, and other funding programs. These programs all invest in the NHS, and they sometimes address NHS preservation needs at the same time. As projects are developed and constructed through these other funding programs, it is essential the project development process incorporates life cycle and asset management considerations. Projects should be as efficient and cost-effective as possible to maintain, preserve, and, when the time comes, rehabilitate assets on the transportation system. These changes to inventory and/or condition are accounted for through regular data collection methods and are used to conduct an updated needs assessment and gap analysis supporting continuous progress towards 10-year performance targets.

4.4. Life Cycle Planning for Pavements

Current California LCP practices for pavements, bridges, drainage, and TMS are summarized below. For each asset class, there are well-established processes starting with inspection and condition assessment, assignment of appropriate treatments, modeling of future asset condition based on realistic funding assumptions, and life cycle strategies for managing assets.

Data Collection

Since the late 1970s, the pavement program at Caltrans has used a matrix of pavement distresses and treatments to assess the funding needs for pavement maintenance on the SHS. Caltrans used this matrix and the best available knowledge to identify the lowest life cycle cost strategy for a given condition to plan pavement needs.

In 2007, Caltrans began to use life cycle cost analysis in planning pavement projects. In 2015, the Caltrans pavement program began collecting annual pavement condition data for every through lane mile on the NHS and the SHS by the APCS.

Figure 4-3. Automated Road and Pavement Condition Survey Van

Data collected through APCS includes pavement type, profiles, smoothness, distresses, and images. Caltrans publishes the Caltrans 2015 State of the Pavement Report[27] that summarizes pavement inventory and conditions on the SHS. The Caltrans 2015 State of the Pavement Report was based on visual Pavement Condition Survey data while future reports will use data collected through APCS.

Modeling Approach

Data from APCS are used in Caltrans' Pavement Management System (PaveM). PaveM is a software tool at Caltrans used to model pavement deterioration and prioritize pavement treatment priorities. With the implementation of the PaveM system in 2015, Caltrans can analyze and predict needs for each mile of the SHS based on its own unique conditions, and evaluate funding scenarios. PaveM supports decision-making based on a project optimization tool that uses pavement condition, pavement type, climate, traffic, and project history to propose the right repair treatment at the right time.

Data collected through APCS takes into account a number of variables which impact pavement life and preservation and creates different deterioration rates for different locations, routes, and even lanes within the same route. PaveM allows Caltrans to model deterioration differently for each lane mile depending on these variables and identifies the needs of each lane of a highway independently. PaveM information was used to develop the summaries in Appendix B of the SHSMP.

Treatments

California's approach to modeling pavement condition includes assumptions about treatments, their impacts on condition, and their costs. Caltrans has developed California-specific pavement maintenance and rehabilitation (M&R) schedules for LCP. The whole life approach to the management of pavements begin with the initial construction of "new pavement" through repeated maintenance and minor rehabilitation treatments until the pavement requires rehabilitation or reconstruction or in rare circumstances removal which could be due to realignment or relinquishment. These California-specific pavement schedules are based on four factors: California roadway classification, existing pavement type, final surface type, and climate grouped into five climate regions: All Coastal, Inland Valley, High Mountain and High Desert, Desert, and Low Mountain and South Mountain. The schedules include treatments, unit costs, and present values. PaveM uses treatments and cost assumptions to prioritize pavement work while minimizing costs. Further work is done analyzing life cycle costs during the project planning phase where additional factors such as traffic handling are quantified.

Unit costs for the treatments are based on an average of costs from actual construction and maintenance projects over a five-year period. Unit costs include cost of material, traffic handling, and other required costs to place pavements including related mobilization, contingency, and supplemental work. Unit costs include a 15 percent support cost, except for rehabilitation (which includes a 20 percent support cost), and seal surface (which has no additional support cost).

The following four tables in Table 4-2, Table 4-3, Table 4-4, and Table 4-5 show examples of life cycle treatment schedules for Class I pavements in an average climate incorporating the deterioration models described previously, as well as data on treatment costs and effects. Additional treatment schedules

[27] Caltrans, "2015 State of the Pavement Report", 2015, http://www.dot.ca.gov/hq/maint/Pavement/Offices/Planning_Programming/PDF/2015_SOP-7-9_12-22-15_FINAL_revised_1-4-15.docx

have been developed for each combination of pavement type and climate zone. Of all the climate zones used in California, the Inland Valley is the closest to the average climate for the entire State. A net present value is provided to compare whole life costs for different treatment schedules.

Table 4-2 Example A- Life Cycle Treatment for Roadway Class I in Average Climate

Rubber Asphalt Treatment (20 Year Design)				
Treatment	Work Type	Schedule (years)	Cost ($/Lane Mile)	PV ($/Lane Mile)
New Pavement	Initial Construction	0	$720,000	$720,000
Seal Surface	Preventive Maintenance	4	$6,000	$5,129
Crack Seal & Seal Coat	Preventive Maintenance	9	$57,000	$40,047
Seal Surface	Preventive Maintenance	13	$6,000	$3,603
Digout (2%), Crack Seal, & Seal Surface	Corrective Maintenance	17	$76,000	$39,016
Medium Overlay	Minor Rehabilitation	21	$325,000	$142,621
Thick Overlay	Major Rehabilitation	26	$720,000	$259,696
Seal Surface	Preventive Maintenance	30	$6,000	$1,850
Crack Seal & Seal Coat	Preventive Maintenance	35	$57,000	$14,445
Seal Surface	Preventive Maintenance	39	$6,000	$1,300
Digout Crack Seal, & Seal Surface	Corrective Maintenance	43	$76,000	$14,073
Medium Overlay	Minor Rehabilitation	47	$325,000	$51,442
Thick Overlay	Major Rehabilitation	52	$720,000	$93,670
Seal Surface	Preventive Maintenance	56	$6,000	$667
Net Present Value				**$1,387,559**

Table 4-3 Example B-Life Cycle Treatment for Roadway Class I in Average Climate

Rubber Asphalt Treatment with Sacrificial Wearing Surface (40 Year Design)				
Treatment	Work Type	Schedule (years)	Cost ($/Lane Mile)	PV ($/Lane Mile)
New Pavement	Initial Construction	0	$1,002,000	$1,002,000
Seal Surface	Preventive Maintenance	4	$6,000	$5,129
Thin Mill & Overlay	Corrective Maintenance	8	$152,000	$111,065
Seal Surface	Preventive Maintenance	12	$6,000	$3,748
Thin Mill & Overlay	Corrective Maintenance	16	$152,000	$81,154
Seal Surface	Preventive Maintenance	20	$6,000	$2,738
Thin Mill & Overlay	Corrective Maintenance	24	$152,000	$59,298
Seal Surface	Preventive Maintenance	28	$6,000	$2,001
Thin Mill & Overlay	Corrective Maintenance	32	$170,000	$48,460
Digout, Crack Seal, & Seal Surface	Corrective Maintenance	36	$76,000	$18,519
Medium Overlay	Minor Rehabilitation	40	$325,000	$67,694
Digout, Crack Seal, & Seal Surface	Corrective Maintenance	45	$76,000	$13,011
Thick Overlay (Rehabilitation)	Major Rehabilitation	50	$1,002,000	$140,994
Seal Surface	Preventive Maintenance	55	$6,000	$694
Thin Mill & Overlay	Corrective Maintenance	60	$152,000	$14,449
Net Present Value				**$1,570,954**

Table 4-4 Example C - Life Cycle Treatment for Roadway Class I in Average Climate

Jointed Plain and Precast Concrete Pavements (40 Year Design)				
Treatment	Work Type	Schedule (in years)	Cost ($/Lane Mile)	PV ($/Lane Mile)
New Pavement	Initial Construction	0	$1,750,000	$1,750,000
Seal Joints	Preventive Maintenance	10	$30,000	$20,267
Seal Joints	Preventive Maintenance	20	$30,000	$13,692
Seal Joints	Preventive Maintenance	30	$30,000	$9,250
Seal Joints & Spall Repair	Corrective Maintenance	40	$40,000	$8,332
Slab Replacement	Minor Rehabilitation	45	$60,000	$10,272
Grind and Slab Replacement	Minor Rehabilitation	50	$330,000	$46,435
Slab Replacement	Minor Rehabilitation	60	$150,000	$14,259
Lane Replacement (Rehabilitation)	Major Rehabilitation	65	$2,600,000	$203,145
Net Present Value				**$2,075,651**

Table 4-5 Example D - Life Cycle Treatment for Roadway Class I in Average Climate

Continuously Reinforced Concrete Pavements (40 Year Design)				
Treatment	Work Type	Schedule (in years)	Cost ($/Lane Mile)	PV ($/Lane Mile)
New Pavement	Initial Construction	0	$1,920,000	$1,920,000
Seal Joints	Preventive Maintenance	10	$15,000	$10,133
Seal Joints	Preventive Maintenance	20	$15,000	$6,846
Seal Joints	Preventive Maintenance	30	$15,000	$4,625
Seal Joints	Preventive Maintenance	40	$15,000	$3,124
Seal Joints	Preventive Maintenance	50	$15,000	$2,111
Grind and Punchout Repair	Minor Rehabilitation	55	$130,000	$15,035
Punchout and Medium Overlay	Minor Rehabilitation	65	$475,000	$37,113
Net Present Value				**$1,998,987**

Note in Tables 4-2, 4-3, 4-4, and 4-5: Unit costs come from the latest (2015) State of Pavement Report and PaveM unit costs. Unit costs are based on average of costs from actual construction projects and maintenance costs (seal surface) over a 5-year period. Unit costs include cost of material, traffic handling, and other required costs to place

pavement including related mobilization, contingency and supplemental work. Unit costs include 15% support cost except for rehabilitation which is 20% and seal surface which is 0%.

Because of the wide range of costs for the various concrete and asphalt treatments, the 2017 SHSMP treatment cost assumptions for SHS pavements are expressed in terms of the unit cost of improving condition from fair to good, from poor to good, and adding new pavement. Table 4-6 presents the unit costs from the SHSMP. The values in the SHSMP for pavements were determined by summarizing more detailed PaveM results.

Table 4-6 Unit Costs for SHS Pavements

Costs Per Lane Mile			
	Fix Fair to Good	Fix Poor to Good	Add New
Class I	$814,335	$1,400,894	$1,323,600
Class II	$292,050	$734,621	$714,000
Class III	$124,848	$480,000	$480,000

Targets

LCP is intended to help state DOTs achieve asset performance targets. California's pavement performance targets and the target-setting process are discussed in detail in Chapter 3. Asset Performance Targets.

Strategy

FHWA's guidance on using LCP to support asset management defines an LCP strategy as "a collection of treatments that represent the entire life of an asset class or sub-group." Given that definition, the treatment schedules shown previously in Table 4-3 represent life cycle strategies for four asset sub groups. More broadly, the strategy in California is to treat pavements when they are in fair condition to prevent them deteriorating to poor condition. Assets in poor and fair condition with poor cracking are targeted for more aggressive rehabilitation treatments.

PaveM influences both funding distribution and project selection. APCS data are loaded into PaveM to predict pavement deterioration. Based on predicted pavement condition and a series of decision trees, PaveM recommends the best type of project to maintain the pavement at lowest cost. There are currently three basic types of pavement projects:

- Highway Maintenance
- Minor Rehabilitation, referred to in California as Capital Preventive Maintenance (CAPM)
- Rehabilitation

The Caltrans Highway Maintenance Program focuses on preservation to slow deterioration, minimize future costs, and maximize pavement service life. Maintenance projects are intended to extend service life for three to ten years. Treatments performed through Maintenance include seal coats, cold in-place recycling, digouts, then asphalt overlays for asphalt pavement, and for concrete pavement, joint seal installation or replacement, grinding and slab replacement.

As described in the 2017 SHSMP, CAPM projects use minor rehabilitation strategies for pavements that exhibit deterioration which is more than what can be addressed with maintenance projects. CAPM projects are intended to extend service life for five to 15 years. CAPM strategies typically include pavement grinding to improve smoothness, isolated slab replacements, asphalt overlays and cold-in-place recycling.

Rehabilitation projects include major rehabilitation and replacement of pavements that have significant structural distress. Rehabilitation is intended to extend service life for 20-40 years.

Demonstration of Strategy Analysis

To illustrate Caltrans LCP approach for pavement at the network level, three different scenarios are presented for Interstate and Non-Interstate NHS Pavement that resulted in the following "Good" and "Poor" condition states in 10 years. Although PaveM analysis extends beyond 10 years, the results are displayed for the TAMP 10-year period:

Scenario 1: Preservation Focus (Maintain Condition)

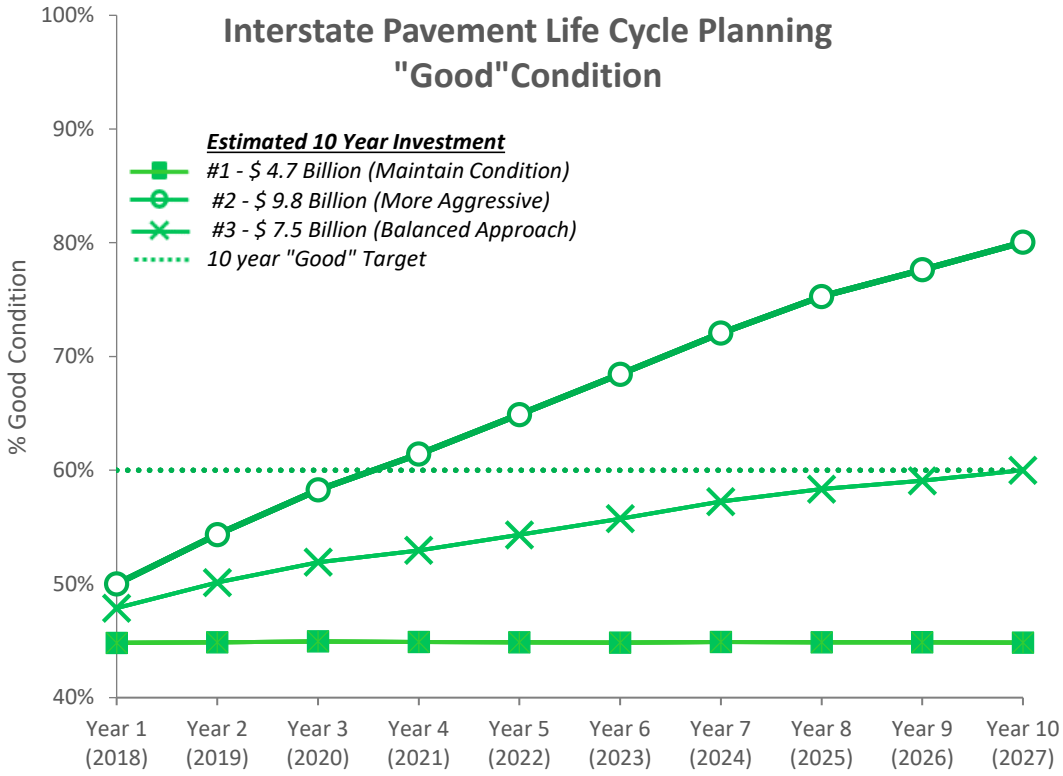
This scenario focuses on pavement treatments to fix all fair and poor pavements. Recommended preservation strategies include dig-outs, crack sealing, surface sealing, and thin overlays. Poor pavement would be rehabilitated. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to fix fair and poor pavement but was primarily focused on lower cost preservation work and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 4.7 Billion (Interstate); $ 4.4 Billion (Non-Interstate NHS)

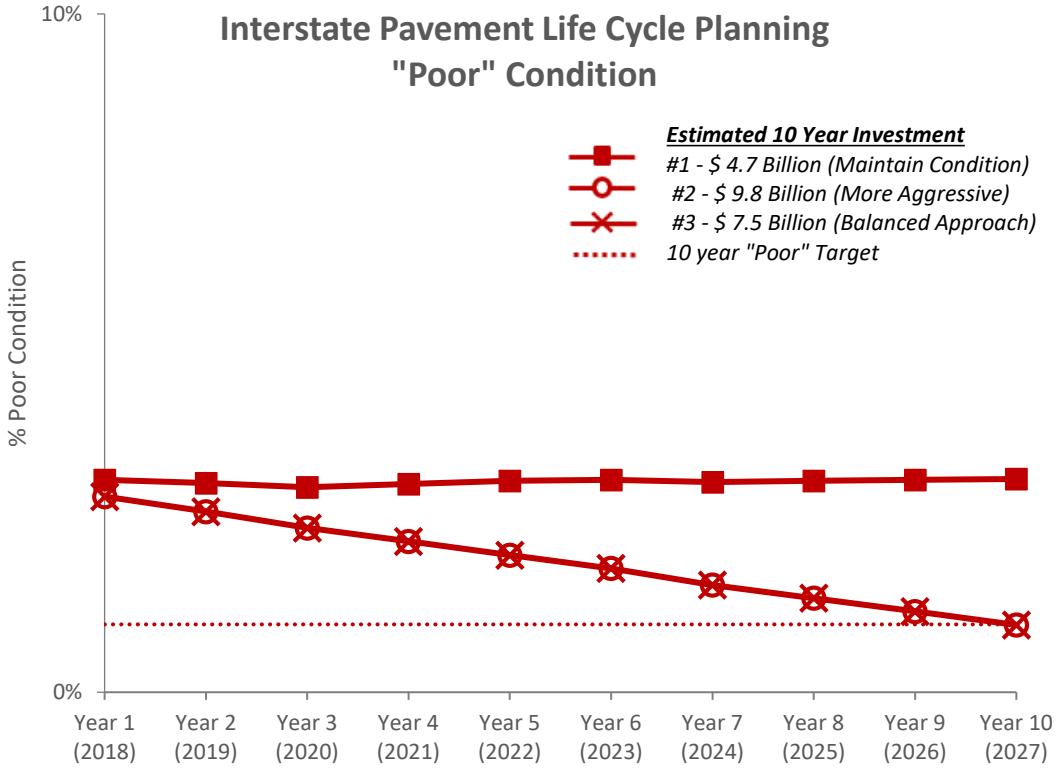
Scenario 2: Major Rehabilitation and Reconstruction Focus (More Aggressive Strategy)

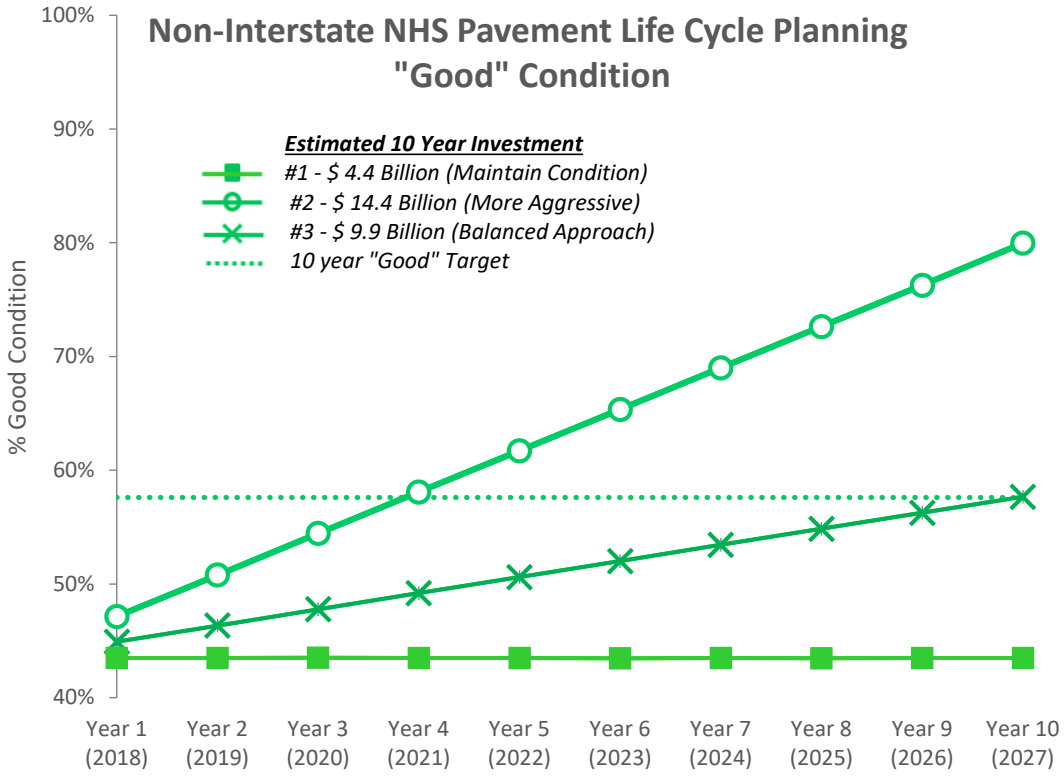
This scenario adopts a more aggressive pavement strategy to fix all poor and most fair pavement and includes a focus on major rehabilitation and reconstruction work. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments but primarily focused on higher cost rehabilitation type work and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 9.8 Billion (Interstate); $14.4 Billion (Non-Interstate NHS)

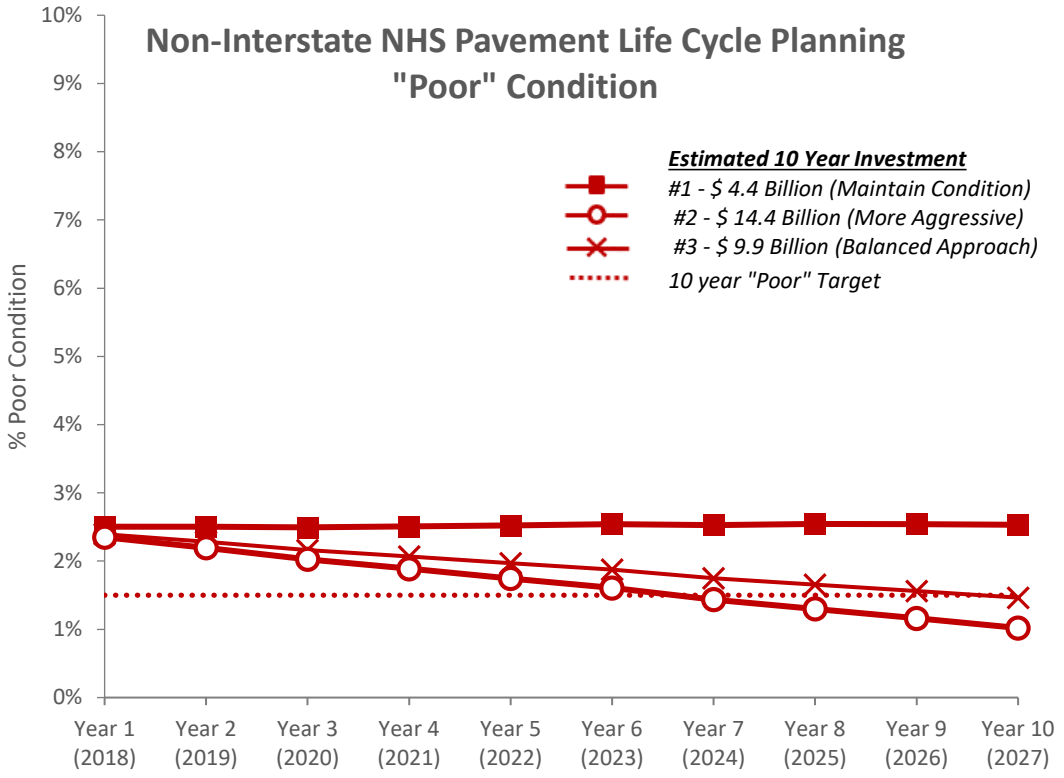
Scenario 3: Balanced Approach

This scenario provides a balanced approach to pavement life by considering a mix of preservation and major rehabilitation type work. This scenario was implemented as Caltrans preferred Pavement Scenario to meet performance targets established by the Commission. The LCP analysis included deterioration rates from the SHSMP, a statewide unit cost that was based on a balanced mix of treatments, and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 7.5 Billion (Interstate); $9.9 Billion (Non-Interstate NHS)


Interstate Pavement Life Cycle Planning
"Good"Condition
Estimated 10 Year Investment
#1 - $ 4.7 Billion (Maintain Condition)
#2 - $ 9.8 Billion (More Aggressive)
#3 - $ 7.5 Billion (Balanced Approach)
10 year "Good" Target
% Good Condition
100%
90%
80%
70%
60%
50%
40%
Year 1 (2018)
Year 2 (2019)
Year 3 (2020)
Year 4 (2021)
Year 5 (2022)
Year 6 (2023)
Year 7 (2024)
Year 8 (2025)
Year 9 (2026)
Year 10 (2027)


Interstate Pavement Life Cycle Planning
"Poor" Condition
Estimated 10 Year Investment
#1 - $ 4.7 Billion (Maintain Condition)
#2 - $ 9.8 Billion (More Aggressive)
#3 - $ 7.5 Billion (Balanced Approach)
10 year "Poor" Target
% Poor Condition
10%
0%
Year 1 (2018)
Year 2 (2019)
Year 3 (2020)
Year 4 (2021)
Year 5 (2022)
Year 6 (2023)
Year 7 (2024)
Year 8 (2025)
Year 9 (2026)
Year 10 (2027)


Non-Interstate NHS Pavement Life Cycle Planning
"Good" Condition
Estimated 10 Year Investment
#1 - $ 4.4 Billion (Maintain Condition)
#2 - $ 14.4 Billion (More Aggressive)
#3 - $ 9.9 Billion (Balanced Approach)
10 year "Good" Target
% Good Condition
100%
90%
80%
70%
60%
50%
40%
Year 1 (2018)
Year 2 (2019)
Year 3 (2020)
Year 4 (2021)
Year 5 (2022)
Year 6 (2023)
Year 7 (2024)
Year 8 (2025)
Year 9 (2026)
Year 10 (2027)


Non-Interstate NHS Pavement Life Cycle Planning
"Poor" Condition
Estimated 10 Year Investment
#1 - $ 4.4 Billion (Maintain Condition)
#2 - $ 14.4 Billion (More Aggressive)
#3 - $ 9.9 Billion (Balanced Approach)
10 year "Poor" Target
% Poor Condition
10%
9%
8%
7%
6%
5%
4%
3%
2%
1%
0%
Year 1 (2018)
Year 2 (2019)
Year 3 (2020)
Year 4 (2021)
Year 5 (2022)
Year 6 (2023)
Year 7 (2024)
Year 8 (2025)
Year 9 (2026)
Year 10 (2027)

Other strategies for improving the life cycle of pavements in California include applying LCCA in planning and design, following appropriate three to 20 year cycle of preventive maintenance, changing minimum standards for rehabilitation from 10 years to a 20 to 40-year design life, and using recycled materials in pavement.

Caltrans also has a strong leadership structure for the management of pavements and partnerships with the pavement industry and FHWA through the Rock Products Committee. The SHSMP provides greater detail on life cycle management activities for pavements on the SHS.

4.5. Life Cycle Planning for Bridges

Data Collection

All bridges in the State of California (both state and locally owned) are inspected through both routine and specialty investigations in accordance with mandated federal guidelines by Caltrans Structure Maintenance and Investigation (SM&I) staff or local agency inspectors. Routine inspections are typically performed biennially (unless documented exceptions are approved) and specialty inspections (such as hydraulics, fracture critical or underwater) occur when a bridge meets the appropriate specialty criteria.

During a routine inspection, a registered engineer is responsible for performing element level inspections of all structural members of the deck, superstructure, and substructure of the bridge. The conditions of the structural members are documented following the guidelines provided in the *Caltrans Bridge Element Inspection Manual*[28] which replaces the *AASHTO Guide to Commonly Recognized Structural Elements* and the *AASHTO Guide Manual for Bridge Element Inspection* as a reference for standardized element definitions, element quantity calculations, condition state definitions, element feasible actions and inspection conventions. During a specialty inspection, a registered engineer is responsible for performing inspections for those bridge elements identified with specialized requirements.

All data collected during the inspection process are documented and maintained in the SMART (Structure Maintenance Automated Report Transmittal) bridge management system. The data are then compiled and submitted annually to FHWA based on the FHWA *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges*[29] manual. When condition defects are identified during the inspection process, the bridge inspector develops work recommendations to address the defect(s).

Bridge inspection staff receive continued training to provide consistent information on the best practices to address condition defects found during the inspection process. The result of every bridge inspection (whether routine or specialty) is also documented in a formal Bridge Inspection Report that is signed and sealed (with an engineer stamp) and archived on the state managed Bridge Inspection Report Information System (BIRIS) for historical purposes.

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[28] Caltrans, "Caltrans Bridge Element Inspection Manual", Revised 2016, http://www.dot.ca.gov/hq/structur/strmaint/elem_man.pdf

[29] FHWA, "Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges", Report No. FHWA-PD-96-001, 1995, https://www.fhwa.dot.gov/bridge/mtguide.pdf

Modeling Approach

Work recommendations from the inspection process drive bridge maintenance and rehabilitation projects. Work recommendations developed to address condition defects are documented for all structures (both state and locally owned). Information regarding condition defects for locally-owned bridges are provided to local agencies in monthly reports. SHS bridge work recommendations are typically either categorized as preventive maintenance (addressed through either maintenance field staff or the Caltrans HM Program) or major rehabilitation (addressed through SHOPP). Caltrans' objective is to manage the bridge inventory safely and economically to limit operational restrictions and prevent sudden closure or collapse. Major rehabilitation, often caused by lack of preventive maintenance, is more costly than preventive maintenance and has the potential to cause significant long-term disruptions.

The current network level life cycle model for the structural integrity of bridges is included in the Bridge Health model in Appendix B of the SHSMP. The model incorporates planned work generated by work recommendations and estimates additional bridge needs based on the identification of defects during the inspection process. This model is based on percentage of total deck area of the SHS bridge inventory in good, fair or poor condition and does not directly correlate to the number of bridges in these condition states. Modeling assumptions include a 0.45 percent annual deterioration rate from good to fair which assumes that annually less than half a percent of the deck area of the total SHS bridge inventory would be added to the minor rehabilitation needs. The model also includes a 0.75 percent annual deterioration rate from good or fair to poor which assumes that annually less than one percent of the deck area of the total SHS bridge inventory would be added to the major rehabilitation or replacement needs.

This model has been the standard maintenance practice for bridges because of funding limitations. With the availability of additional funding, the bridge program would like to transition this modeling approach to a systematic LCP strategy which would routinely apply preservation strategies to a structure prior to the identification of defects to maintain the structures in good condition consistently (as shown in Table 4-10).

Treatments

Typical bridge treatments and unit costs for a concrete bridge are shown below in Table 4-7.

Table 4-7 Typical Concrete Bridge Treatment Costs

Activity Costs		
Activity	**Unit**	**Unit Cost**
Methacrylate Deck	Square Feet	$4
Replace Joints	Linear Feet	$200
Polyester Concrete Overlay	Square Feet	$25
Deck on Deck	Square Feet	$125
Rail Replacement	Linear Feet	$250

Activity Costs		
Activity	Unit	Unit Cost
Replace Bridge	Square Feet	$635

Because of the wide range of costs for the various bridge preservation and rehabilitation treatments, the 2017 SHSMP treatment cost assumptions for SHS bridges included a calculated average treatment cost for condition improvement from fair to good, from poor to good, and adding new bridge deck area. Table 4-8 presents the unit costs from the SHSMP.

Table 4-8 Unit Costs for SHS Bridges

Costs Per Square Foot			
	Fix Fair to Good	Fix Poor to Good	Add New
SHS Bridge	$344	$483	$635

Targets

LCP is intended to help state DOTs achieve asset performance targets. California's bridge performance targets and the target-setting process are discussed in detail in Chapter 3. Asset Performance Targets.

Strategy

An example of Caltrans' condition and systematic-based LCP strategies are shown below for a typical concrete bridge with an average daily traffic (ADT) volume of 12,000 (five percent trucks) in a non-aggressive environmental zone. In this example, the bridge has a deck area of 12,000 square feet, rail length of 620 linear feet and joint length of 80 linear feet. Table 4-9 includes the treatment schedule and costs for a condition-based strategy.

Table 4-9 Condition-Based LCP Strategy for an Example Concrete Bridge

Costs Per Square Foot				
Activity	**Work Type**	**Year**	**Cost**	**PV**
New Construction	Initial Construction	0	$7,620,000	$7,620,000
Methacrylate Deck Replace Joints	Preventive Maintenance	15	$64,000	$35,537
Polyester Concrete Overlay and Repla Joints	Minor Rehabilitation	30	$316,000	$97,429
Replace Bridge	Reconstruction /Replacement	75	$7,620,000	$402,211
Net Present Value				**$8,155,177**

Treatment schedules and costs, shown in Table 4-10 are for a systematic-based strategy.

Table 4-10 Alternative Systematic-Based LCP Strategy for a Concrete Bridge

Costs Per Square Foot				
Activity	**Work Type**	**Year**	**Cost**	**PV**
New Construction	Initial Construction	0	$7,620,000	$7,620,000
Methacrylate Deck Replace Joints	Preventive Maintenance	10	$64,000	$43,236
Polyester Concrete Overlay Replace Joints	Minor Rehabilitation	20	$316,000	$144,218
Deck on Deck Rail Replacement	Major Rehabilitation	40	$1,655,000	$344,718
Methacrylate Deck on Deck Replace Joints	Preventive Maintenance	50	$64,000	$9,006
Polyester Concrete Overlay Replace Joints	Minor Rehabilitation	70	$316,000	$20,293
Replace Bridge	Reconstruction /Replacement	90	$7,620,000	$223,334
Net Present Value				**$8,404,805**

The current strategy in California is to perform bridge work according to the work recommendations generated by inspections. These work recommendations typically identify two types of work: preventive

maintenance (preservation) or rehabilitation (non-preservation). Preventive maintenance work extends bridge service life by addressing minor defects before they worsen to more extensive damage. Preventive maintenance bridge work includes joint repairs, spall repair, minor paint needs, as well as some deck repairs. As described in the 2017 SHSMP, bridges exhibiting more serious deterioration or damage, which include bridges in poor condition and a portion of the bridges in fair condition, are addressed with more extensive rehabilitation or replacement activities funded through SHOPP.

Demonstration of Strategy Analysis

To illustrate LCP approach for state-owned NHS Bridges at the network level, three different scenarios are presented that resulted in the following "Good" and "Poor" condition states at the end of 10 years:

Scenario 1: Fix All Fair and Poor Bridge Decks (Maintain Condition)

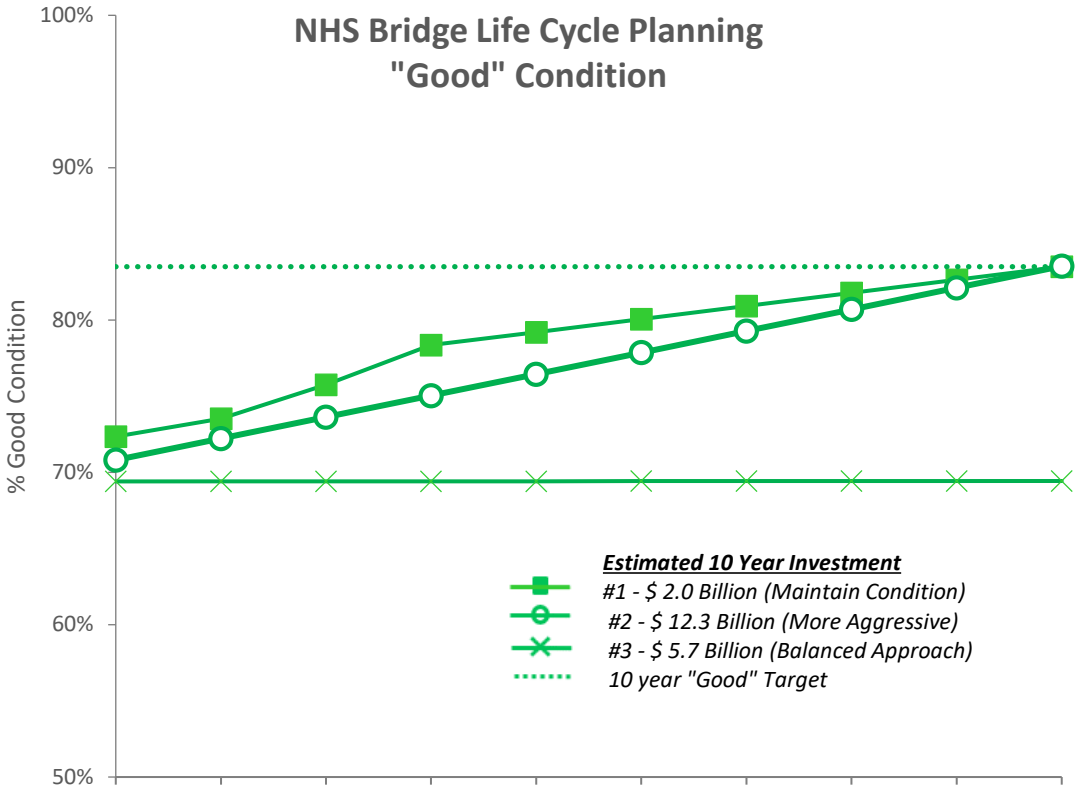
This scenario focuses on bridge treatments that would fix fair and poor bridge decks. Recommended preservation strategies include methacrylate bridge deck treatment and replacing joints. Poor bridge decks would include thicker overlays. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to fix fair and poor bridge decks but was primarily focused on lower cost preservation work, and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 2.0 Billion

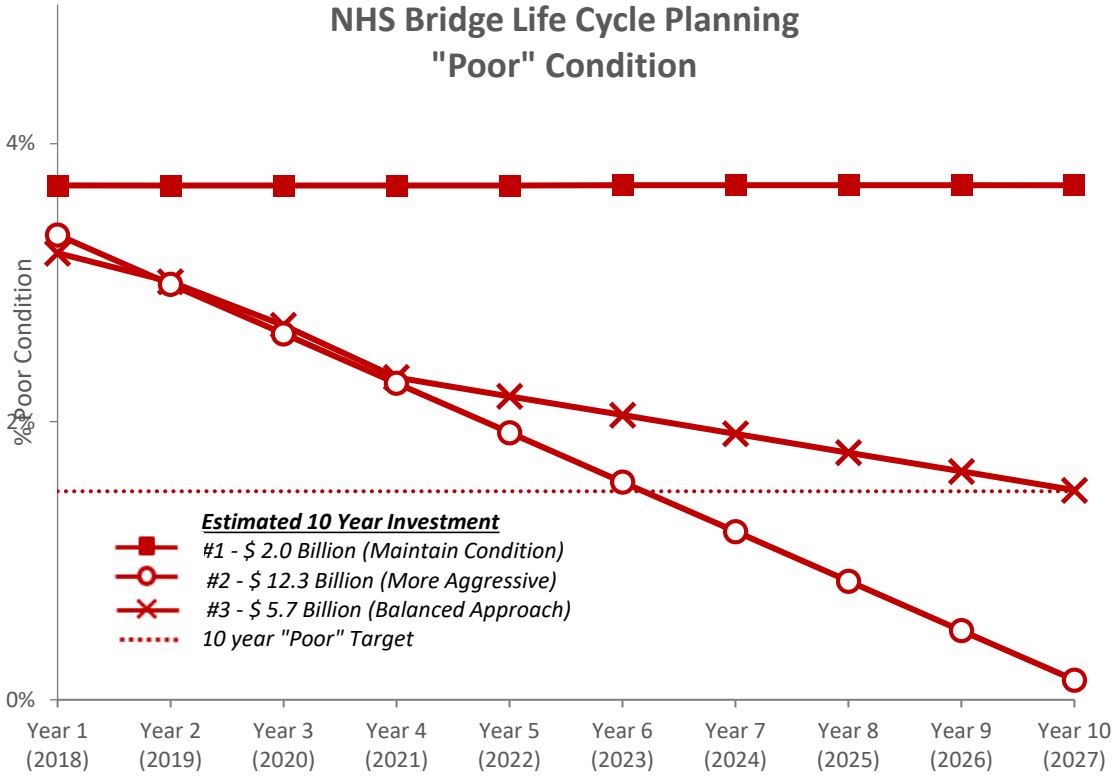
Scenario 2: Replacement of All Bridges over 75 years old (More Aggressive Strategy)

This scenario replaces all bridges over 75 years old as of 2017. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on replacing all bridges over 75 years old and the amount of work predicted to be accomplished annually to fix fair and poor bridge decks to an acceptable level of service. Total estimated investment: $ 12.3 Billion

Scenario 3: Balanced Approach

This scenario provides a balanced approach to bridge life by considering a mix of preservation, major rehabilitation and reconstruction/replacement type work. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to fix fair and poor bridge decks but was primarily focused on higher cost rehabilitation type work, and the amount of work predicted to be accomplished annually for the life span of the asset. This scenario was implemented as Caltrans preferred Bridge Scenario to meet performance targets established by the Commission. Total estimated investment: $ 5.7 Billion


NHS Bridge Life Cycle Planning
"Good" Condition
100%
90%
80%
70%
60%
50%
% Good Condition
Estimated 10 Year Investment
#1 - $ 2.0 Billion (Maintain Condition)
#2 - $ 12.3 Billion (More Aggressive)
#3 - $ 5.7 Billion (Balanced Approach)
10 year "Good" Target


NHS Bridge Life Cycle Planning
"Poor" Condition
4%
2%
0%
% Poor Condition
Estimated 10 Year Investment
#1 - $ 2.0 Billion (Maintain Condition)
#2 - $ 12.3 Billion (More Aggressive)
#3 - $ 5.7 Billion (Balanced Approach)
10 year "Poor" Target
Year 1 (2018)
Year 2 (2019)
Year 3 (2020)
Year 4 (2021)
Year 5 (2022)
Year 6 (2023)
Year 7 (2024)
Year 8 (2025)
Year 9 (2026)
Year 10 (2027)

Other strategies for improving the life cycle of bridge assets include using new materials that last longer and are easier to apply, implementing policies to ensure that new projects are built with cost-effective and easily maintained elements, and using accelerated bridge construction techniques.

Best management practices include centralized statewide management of all bridge assets, on-going training for state and local inspectors, bridge strategy meetings that provide a uniform approach to recommended maintenance strategies and scour and seismic vulnerability screening to ensure that bridges with the most critical needs are addressed.

Additionally, California local bridge owners receive federal funding for local NHS bridges through a program administered by Caltrans. Caltrans develops local policies and procedures for this program by working with a local bridge advisory committee made up of city and county organizations, FHWA, and the Commission that provides a forum to confer with cities and counties on local bridge funding and programming matters. Currently, California receives approximately $300 million a year in federal funding for local bridges.

4.6. Life Cycle Planning for Drainage

Data Collection

Starting in 2005, Caltrans initiated a process to assess the health of all of the State's drainage assets through a systematic district level inspection program. Each drainage asset is inventoried and given a unique number, as its condition is evaluated. These assessments are then added to a growing database in the office for identification and prioritization of maintenance and rehabilitation. Drainage assets are assessed as good, fair or poor. The current Culvert Inspection Program (CIP) plan reflects the completion of the inventory of drainage assets on the SHS by 2027.

Modeling Approach

The 2017 SHSMP includes a network level LCP model for drainage assets. The model includes deterioration rates, treatments, and unit costs for drainage assets on the SHS.

Treatments

Typical treatments and unit costs are shown below in Table 4-11 for drainage assets based on recent historical costs. This treatment schedule is for a drainage rehabilitation project.

Table 4-11 Typical Treatments and Unit Costs for Drainage Systems

Typical Activity Costs for Culverts	
Activity	**Cost per Culvert**
Maintenance	$400
Invert Paving/Plating	$124,000
Culvert Restoration/Liner	$63,000
Bore and Jack New Pipe	$180,000

The 2017 SHSMP presents treatment cost assumptions for drainage systems on the SHS. Instead of unit costs for individual treatments, the SHSMP calculates unit costs for improving condition from fair to good, from poor to good, and adding new drainage systems. Table 4-12 presents the unit costs from the SHSMP.

Table 4-12 Unit Costs for Drainage Systems

Costs Per Linear Foot			
	Fix Fair to Good	Fix Poor to Good	Add New
Culverts	$558	$2,000	$2,000

Targets

LCP is intended to help state DOTs achieve asset performance targets. California's drainage performance targets and the target-setting process are discussed in detail in Chapter 3. Asset Performance Targets.

Strategy

Caltrans' culvert inspection program identifies drainage systems in need of immediate attention so they can be restored to perform their function and provide the expected level of service. Once identified for restoration, the Caltrans Highway Design Manual[30] and other design guides advise the Project Engineers at the project level in restoration strategies. The final design is selected in cooperation and consultation with the public, private organizations, and State and Federal agencies. This ensures the selected restoration method is; safe, cost efficient, environmentally friendly, and resilient.

A cost estimate is done for each drainage system restoration that looks at:

- Constructability costs--both for the contractor and impacts to the public during construction, i.e., traffic, and creek diversions, etc.
- Selected repair type cost--and any other costs incurred by the repair. If a repair cannot be made, then replacement strategies are determined.

Cost alone may not be the final word on ultimate selection. Other factors such as environmentally sensitive areas, fish passage, legal, or safety impacts may determine the final repair selection and cost.

Three LCP strategies for drainage systems are presented in Table 4-13, Table 4-14 and Table 4-15 below. The first treatment schedule is for drainage system rehabilitation. The second lists the treatments and costs for drainage system replacement and the third lists the treatments and costs for failed road and drainage system replacement.

[30] Caltrans, "Highway Design Manual". Revised 2016. http://www.dot.ca.gov/design/manuals/hdm.html

Table 4-13 Typical LCP Strategies for Culvert Rehabilitation

Culvert Life Cycle Treatment Schedule			
Activity	Schedule (in years)	Cost*(each)	PV (each)
New Culvert Installation	0	$20,000	$20,000
Maintenance	5	$400	$329
Maintenance	10	$400	$270
Maintenance	15	$400	$222
Maintenance	20	$400	$183
Maintenance	25	$400	$150
Rehabilitation (Invert Paving/Plating)	30	$124,000	$38,232
Maintenance	35	$400	$101
Maintenance	40	$400	$83
Maintenance	45	$400	$68
Preservation (Culvert Restoration/Liner)	50	$63,000	$8,865
Net Present Value			**$68,503**

Table 4-14 Typical LCP Strategies for Culvert Replacement

Culvert Life Cycle Treatment Schedule			
Activity	Schedule (in years)	Cost*(each)	PV (each)
New Culvert Installation	0	$20,000	$20,000
Maintenance	5	$400	$329
Maintenance	10	$400	$270
Maintenance	15	$400	$222
Maintenance	20	$400	$183
Maintenance	25	$400	$150
Rehabilitation (Invert Paving/Plating)	30	$124,000	$38,232
Maintenance	35	$400	$101
Maintenance	40	$400	$83
Maintenance	45	$400	$68
Reconstruction (Bore & Jack New Pipe)	50	$180,000	$25,328
Net Present Value			**$84,967**

Table 4-15 Typical LCP Strategies for Culvert Failed Road and Replacement

Culvert Life Cycle Treatment Schedule			
Activity	**Schedule (in years)**	**Cost* (each)**	**PV (each)**
New Culvert Installation	0	$20,000	$20,000
Maintenance	5	$400	$329
Maintenance	10	$400	$270
Maintenance	15	$400	$222
Maintenance	20	$400	$183
Maintenance	25	$400	$150
Rehabilitation (Invert Paving/Plating)	30	$124,000	$38,232
Maintenance	35	$400	$101
Maintenance	40	$400	$83
Maintenance	45	$400	$68
Maintenance	50	$400	$56
Maintenance	55	$400	$46
Reconstruction (Replace Road and Culvert)	60	$1,000,000	$95,060
Net Present Value			**$154,801**

*Note for Tables 4-13, 4-14 and 4-15: Costs come from historical projects and are based on average of costs from actual construction and maintenance costs including the cost of material, traffic handling, and other required costs to construct drainage systems including 60% support cost. Present value costs include a cumulative escalation factor of 4.2%.

Beyond maintaining a drainage system there may be a need for restoration after its estimated 50-year service life. Typically over the life of a drainage system there are two major cost points, initial installation cost and repair or restoration cost. Existing ongoing inspections of the State's drainage systems has shown there is an estimated 12 percent of a drainage system being found will be in a poor state of health after reaching a 50-year service life, and about 24 percent will be in fair condition after 50 years of service. Once identified as poor, each District then determines the restoration or replacement strategy.

To return any drainage system to a good state of health, many variables influence the restoration cost; they include length, diameter, water diversions, traffic control, repair/restore strategy, fish passage, access, slope, expected bed load, to name a few.

One of the main reasons for drainage system replacement is deterioration (typically because of corrosion, abrasion, erosion, piping, storm damage or poor initial installation). If a drainage system fails,

a Department Director's Order may be initiated to accelerate and address the problem. If the drainage system has not yet failed, but is in poor condition, Maintenance will program it for repair, rehabilitation, or replacement.

Demonstration of Strategy Analysis

To illustrate LCP approach for Drainage at the network level, three different scenarios are presented that resulted in the following "Poor" condition states at the end of 10 years:

Scenario 1: Clean-out all Clogged Culverts and Replace Failed Culverts (Maintain Condition)

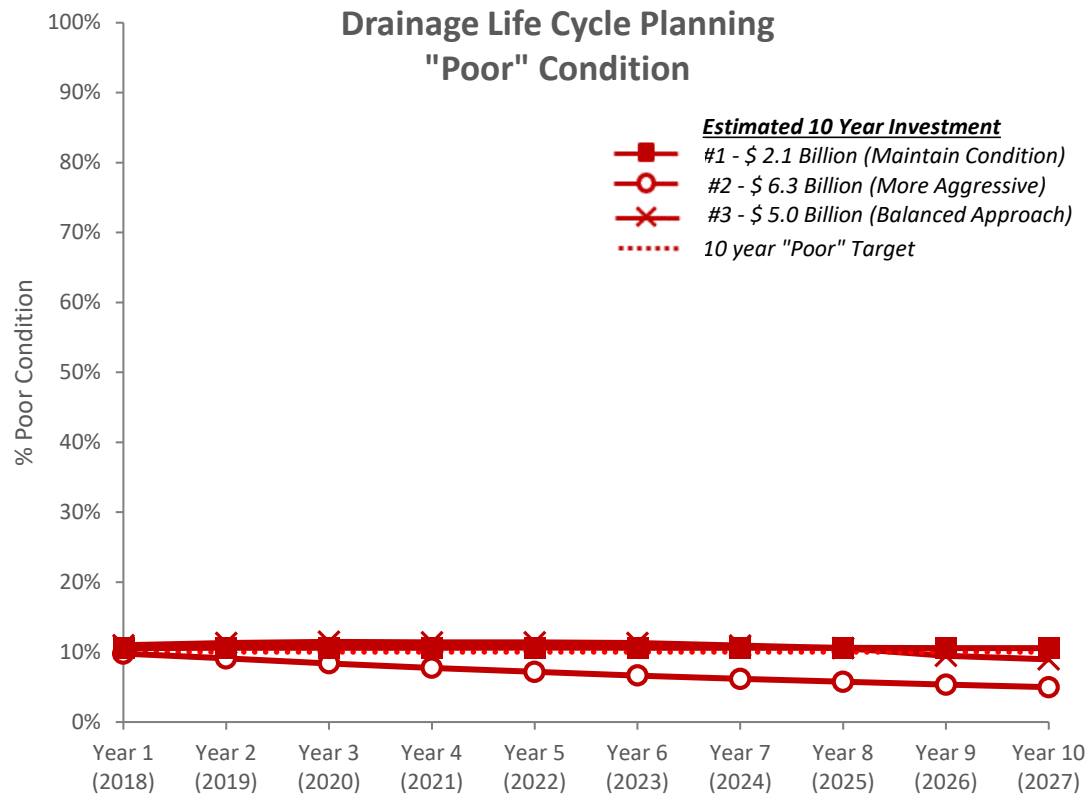
This scenario focuses on cleaning out all clogged culverts through Caltrans Maintenance Crews and HM Contracts. Any failed culverts with no remaining service life would be replaced. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to fix clogged and failed culverts, but was primarily focused on lower cost maintenance work, and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 2.1 Billion

Scenario 2: Fix Fair Culverts with Highway Maintenance and SHOPP funding and Replace All Poor Culverts (More Aggressive Strategy)

This scenario focuses on fixing fair and poor culverts to achieve 90% good condition in 10 years. Poor culverts with no remaining service life would be replaced. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to fix fair and poor culverts but was primarily focused on higher cost reconstruction work, and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 6.3 Billion

Scenario 3: Balanced Approach

This scenario provides a balanced approach to culvert life by considering a mix of preservation and major rehabilitation type work. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments and unit costs to fix fair and poor culverts, and the amount of work predicted to be accomplished annually for the life span of the asset. This scenario was implemented in the 2017 SHSMP as Caltrans preferred Drainage Scenario to meet performance targets established by the Commission. Total estimated investment: $ 5.0 Billion



Other strategies for improving the life cycle of drainage systems include using remote controlled cameras to complete drainage system inspections, trenchless drainage system replacement techniques, and lining replacement techniques.

4.7. Life Cycle Planning for Transportation Management Systems

Data Collection

Caltrans currently uses a TMS Inventory Database to track all statewide TMS assets. This database is populated by district personnel, who provide information on each system, such as system type, location, and installation date. Fact sheets on each TMS element that are updated every few years inform designers on replacement costs, compared to new costs, and give guidance on the most cost-effective solution, as well as give information on expected service life. This service life, along with the installation dates, can be used to provide an assessment or prediction of replacement needs.

Caltrans Traffic Operations and Maintenance staff are involved in managing the health of the TMS network. Traffic Operations provides engineering support, initial problem troubleshooting, and maintains central systems, including software updates. District Maintenance is responsible for repair of TMS field elements and communication linkages to the Transportation Management Centers (TMC). Maintenance forces place first priority on critical safety needs, such as traffic signal and lighting repair work.

As of August 2017, Caltrans has a network of over 19,000 field systems, as well as an extensive network of computer servers running software that helps to manage the SHS. These systems, which have become more advanced over the years, are connected by a network of fiber, wireless communications, and leased communications systems which provide remote access and management capabilities.

One of the primary reasons why LCP is challenging is that estimating the life cycle of a TMS unit can be difficult, because not all components of the system will have the same installation date or service life. Some components may be replaced as part of a larger project, such as controller or modem upgrades, or other portions may be replaced by a service contractor or Caltrans maintenance forces.

An example of a TMS unit is the traffic count station. The components in the controller cabinet, the communication infrastructure, inductive loops and various interconnects contribute to the determination of the life cycle of a traffic count station. The installation date, mean time before failure (MTBF), warranty, manufacturer support of device and milestones in the advancements in technology are all factors in determining expected service life. Knowing the installation date and the MTBF provides the simplest way to determine the life cycle duration. Warranty, manufacturer support, and technological advancement are a horizontal deviation in the life cycle of the electrical equipment.

TMS elements represent a significant investment need for Caltrans as a large portion of the current inventory is past its expected service life and will require replacement. Complicating the issue is the fact that if any one of these components fail, it would need to be replaced quickly to bring the system back to an operational state. TMS require replacement for a variety of reasons: some require more maintenance than is reasonable, some become technically obsolete, and others become a network security risk.

Modeling Approach

The 2017 SHSMP includes a network level LCP model for TMS assets. The model includes deterioration rates, treatments, and unit costs for TMS assets on the SHS. Figure 4-4 displays an estimate of TMS needs over the next ten years.

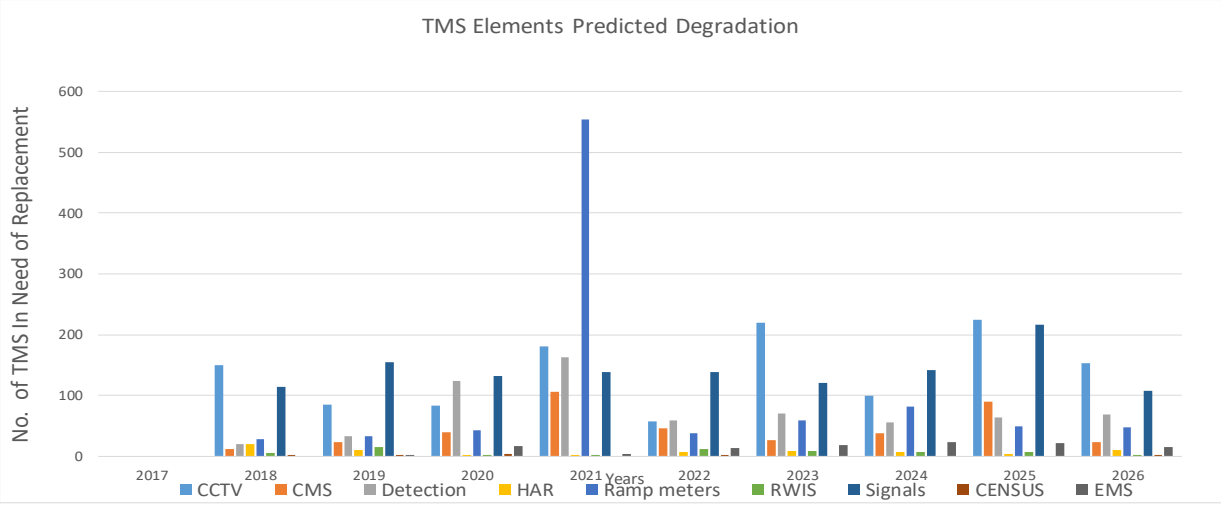


Figure 4-4. Estimate of TMS Elements in Need of Replacement over the next 10 Years

Treatments

The 2017 SHSMP presents treatment cost assumptions for TMS assets on the SHS. Instead of unit costs for individual treatments, the SHSMP calculates unit costs for improving condition from poor to good and adding new assets. Table 4-16 presents the unit costs from the SHSMP.

Table 4-16 Unit Costs for TMS Assets

Costs Per Element		
	Fix Poor to Good	Add New
TMS Elements	$116,691	$116,691

Targets

LCP is intended to help state DOTs achieve asset performance targets. California's TMS performance targets and the target-setting process are discussed in detail in Chapter 3. Asset Performance Targets.

Strategy

As described in the 2017 SHSMP, the Maintenance Program is responsible for maintaining TMS assets. TMS elements on the SHS require over 80,000 preventive maintenance checks and repairs annually to ensure maximum operability. A combination of state and contract service addresses the maintenance needs. Assets which are at end of life, obsolete, or otherwise non-functional are addressed through systemic repairs, replacements, or upgrades.

Caltrans is developing strategies to better manage the health of the TMS network by performing more extensive system health assessments, as well as greater collaboration with maintenance staff. The TMS database, which stores records of all district systems, is constantly being improved, and records are being audited and checked for clarity and completeness.

Demonstration of Strategy Analysis

To illustrate LCP approach for TMS at the network level, three different scenarios are presented that resulted in the following "Poor" condition state at the end of 10 years. An average life span was used for each TMS:

Scenario 1: Maintain Condition

This scenario focuses on maintaining the current condition of good and poor TMS. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to maintain good and fix poor TMS, and the amount of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 1.2 Billion

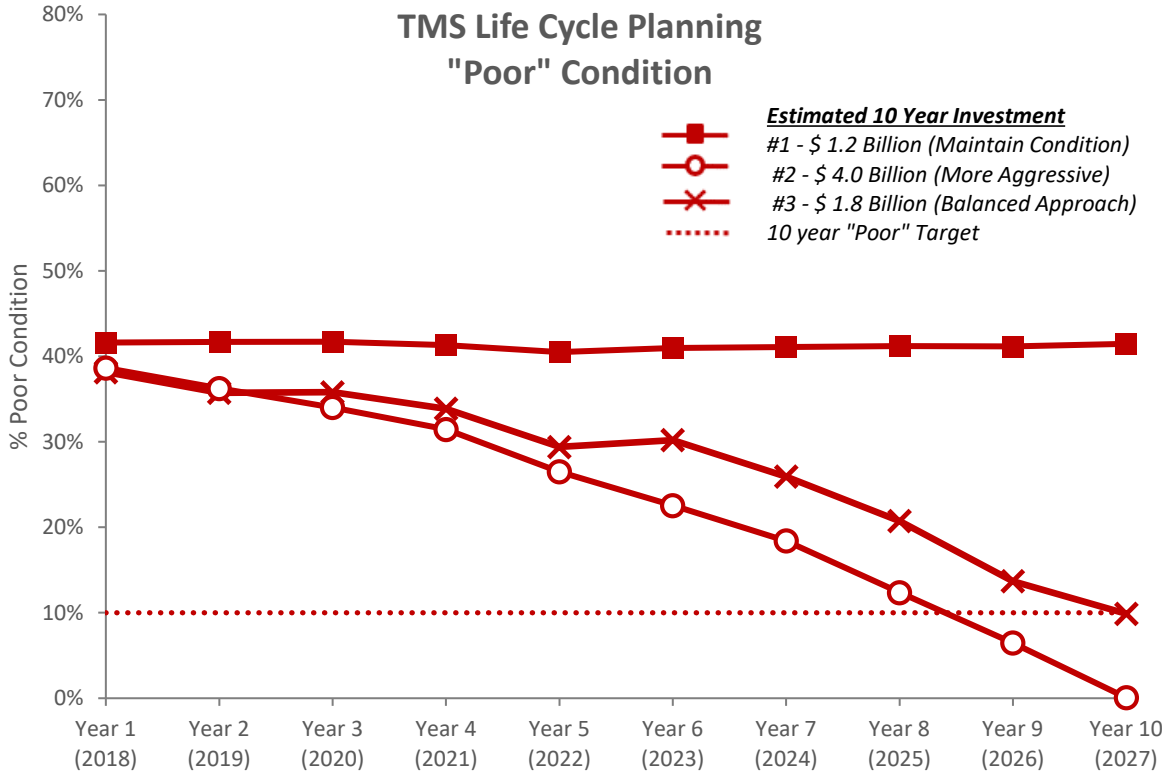
Scenario 2: Focus on Replacing all Poor TMS (More Aggressive Strategy)

This scenario focuses on replacing all poor TMS elements. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on replacing poor TMS, and the amount

of work predicted to be accomplished annually for the life span of the asset. Total estimated investment: $ 4.0 Billion

Scenario 3: Balanced Approach

This scenario provides a balanced approach to TMS life by considering a mix of major rehabilitation or replacement type work. The LCP analysis included deterioration rates from the SHSMP, a statewide average unit cost that was based on a mix of treatments to fix poor TMS, and the amount of work predicted to be accomplished annually for the life span of the asset. This scenario was implemented in the 2017 SHSMP as Caltrans preferred TMS Scenario to meet performance targets established by the Commission. Total estimated investment: $ 1.8 Billion



With the need for TMS expansion in California, additional maintenance and operations staff will be required to preserve the TMS inventory. Table 4-17 presents an estimate of additional TMS maintenance and operations (M&O) needs. It is expected that over the next 10 years, the increase in average cost to maintain and operate TMS will be over $18.5 million.

Table 4-17 Estimate of Additional Maintenance and Operation Needs Over 10 Years

TMS Maintenance and Cost Estimates							
TMS Element	Inventory	Service Life	Annual M&O Cost per Element	Total Annual M&O Costs	Expected New TMS per Year	Increase in Annual M&O Costs	10-Year Increase in Estimated M&O Costs
Closed Circuit Television (CCTV)	2,825	10	$4300	$12,147,500	61	$262,300	$2,623,000
Changeable Message Signs	896	25	$5,600	$5,017,600	19	$106,400	$1,064,000
Traffic Monitoring Detection Stations (Detection)	5,216	25	$3,100	$16,169,600	113	$350,300	$3,503,000
Highway Advisory Radios (HAR)	186	15	$6,200	$1,153,200	4	$24,800	$248,000
Freeway Ramp Meter	2,855	25	$4,700	$13,418,500	62	$291,400	$2,914,000
Roadway Weather Information System (RWIS)	149	10	$5,300	$789,700	3	$15,900	$159,000
Traffic Signals	6,262	25	$5,700	$35,693,400	135	$769,500	$7,695,000
Traffic Census Stations (CENSUS)	128	20	$2,200	$281,600	3	$6,600	$66,000
Extinguishable Message Signs (EMS)	539	25	$2,000	$1,078,000	12	$24,000	$240,000
Total	**19,056**			**$85,749,100**	**412**	**$1,851,200**	**$18,512,000**

Average estimated Maintenance and Operations costs include materials, equipment, training, lifecycle, and support costs. Does not include energy costs. Estimate for new TMS elements based on SHOPP funded projects only. Assumed M&O costs for traffic signals are the same for state and local; Inventory and new elements estimate as of November 2017.

4.8. LCP for NHS Pavements and Bridges Owned by Other Federal, State and Local Agencies

The above paragraphs detail LCP practices for the SHS, as well as for NHS pavements and bridges owned by Caltrans. To develop the TAMP Caltrans made the following additional assumptions regarding LCP for pavements and bridges owned by other Federal, State and local agencies:

- For NHS pavements owned by other agencies, the network level model for Class II pavements detailed in Appendix B of the 2017 SHSMP was applied using treatment costs described in the California Statewide Local Streets and Roads Needs Assessment.
- For NHS bridges owned by other agencies, the network level model for SHS bridges detailed in Appendix B of the 2017 SHSMP was applied. The treatment costs in this model were found to be comparable to those described for bridges in the California Statewide Local Streets and Roads Needs Assessment.

Other Local LCP Pavement Practices and Initiatives

The University of California Pavement Research Center (UCPRC) Cities and Counties Pavement Improvement Center (CCPIC) was established in 2018 to help local agencies manage their pavements to be cost-effective, last longer, and be more sustainable. The founding members include UCPRC, Universities of California, Davis and Berkeley, California State Universities Chico, Long Beach, and Cal Poly, along with the Mineta Transportation Institute, California State Association of Counties, and the League of California Cities.[31] The mission of CCPIC is to work with local government to increase pavement technical capability through relevant, timely, and practical support, training, outreach and research.

The latest California Statewide Local Streets and Roads Needs Assessment reports that over 472 cities and counties (88% of those surveyed) use sustainable pavement practices including reclaimed AC pavement, cold in place, hot in place, and cold central plant recycling, warm mix asphalt, permeable/pervious pavement, full depth reclamation, subgrade stabilization, rubberized AC and pavement preservation with an average cost savings reported of 41% in 2018. Recycling and pavement preservation strategies were reported to have the highest cost savings. The survey also reported that 86 percent of the responding local governments have a pavement management system with 51 percent utilizing StreetSaver. The other system widely used is PAVER at 19%. It was also stated that 96% of the total lane miles owned by local agencies are included in a pavement management system.

[31] http://www.ucprc.ucdavis.edu/ccpic/Governance.aspx

4.9. Accounting for Changes in Traffic Demand, Natural Hazards and Environment

Managing transportation assets include evaluating whether assets will deteriorate faster or will have higher than anticipated costs due to changes in traffic demand, extreme climates, natural disasters or the impacts due to environmental conditions. These risks and costs to transportation infrastructure are further discussed in Chapter 8. Risk Management of the TAMP, but they are also considered in the development of life cycle plans in California. Some examples of the factors considered in current LCP practice are: climate and traffic demand in the determination of pavement treatments; scour and seismic vulnerability screening for all bridges; the design of drainage systems for flood probability, frequency, and severity; and the consideration for life cycle replacement and full build out of TMS elements to reduce Daily Vehicle Hours of Delay and Green House Gas (GHG) emissions. In 2018, Caltrans conducted district by district vulverability assessments. These assessments, expected to be complete in 2019, will be used to identify vulnerabilities and assess impacts and risk to the SHS. It will help guide future planning and programming processes and the actions needed to achieve long-term highway system resiliency.

4.10. Life Cycle Planning Maturity

In review of LCP maturity for primary and supplementary assets in California, pavements have the highest level of maturity owing to the progress that has been made in optimizing pavement performance. Other asset classes are in various stages of developing life cycle cost considerations and life cycle plans. In 2018, Caltrans implemented District Performance Plans (DPP) for each of the 12 Districts in the State. These plans guide districts to achieve target expectations within budget constraints. They articulate how life cycle planning will be incorporated to minimize long term costs of asset ownership and document the decision making process relative to less expensive short term repairs versus more expensive long term fixes. Prior to the DPPs, Caltrans developed a LCP maturity model to perform a self-assessment. The result of the self-assessment is shown below in Figure 4-5. The model represents LCP maturity in California across all primary and supplementary asset classes.

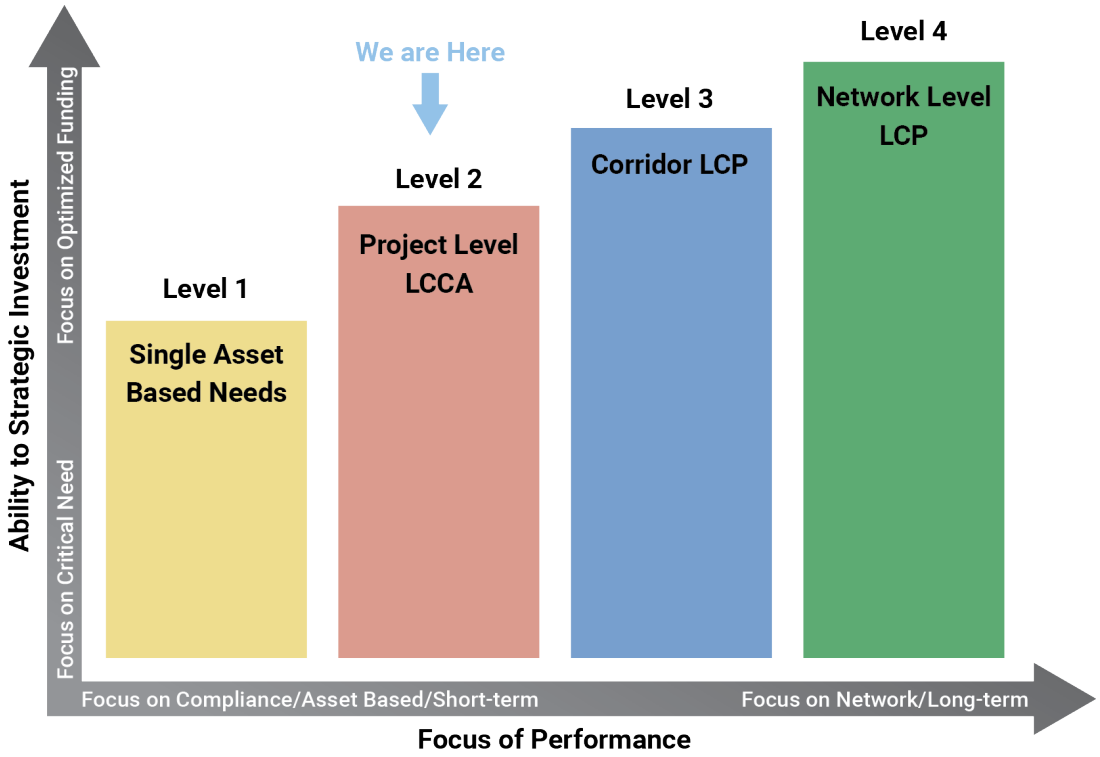


Figure 4-5. California's LCP Maturity

The primary elements of the LCP Maturity Model are described below:

LEVEL 1 - Single Asset Based Needs include the inventory and condition assessment of a single asset over the useful life of the asset considering the cost of the treatment and deterioration that occurs over time.

LEVEL 2 - Project Level LCCA includes performing a project level LCCA that is compliant with environmental, economic and legislative requirements and considers treatments evaluated over an analysis period taking into account traffic and user costs. A strong LCCA policy would be strategically implemented across all assets and programs.

LEVEL 3 - Corridor LCP includes elements of Level 2, but includes a strong LCP Policy that will focus on improving and preserving major corridors and STRAHNET routes. Investment strategies are considered for long-term asset investment needs and maximizes performance with constrained funding. At this level, multi-asset investment decisions are incorporated and performance gaps are eliminated. Internal and external stakeholders are emphasized. Reducing the annual cost of preservation through more research and innovated practices is prevalent and risk sharing is stressed between public and private sector.

LEVEL 4 - Network Level LCP includes Level 2 and 3 elements, but considers long-term focus on improving and preserving the system and network conditions achieved through different levels of funding where conditions are optimized with multi-asset investment. Improvements to policy through research and partnerships are emphasized.

5. Performance Scenarios and Gaps

California's asset management focus involves managing transportation assets throughout their life cycle. This requires looking to the future and projecting asset performance. California's state and local transportation agencies use expected funding to predict future conditions, compare against targets, define funding gaps, and inform resource allocation decisions.

5.1. Overview

This chapter presents performance scenarios for bridges, pavements, drainage systems, and TMS asset performance over a 10-year period. A primary objective of the federal requirement to develop a TAMP and adopt asset management processes is to improve or preserve the condition of transportation assets. Progress towards this objective is measured against national, state, and local goals.

Projecting conditions allows California to see whether or not asset performance will meet goals, including the 10-year DSOR. This requires an assumption about the level of funding allocated to assets over the 10-year time frame of the TAMP. To project conditions, varying funding levels are assumed to show the differences in performance depending on the expenditure amount. More detailed information about the funding levels themselves is provided in Chapter 6. Revenues and Financial Projections and Chapter 7. Investment Strategies. Projecting conditions is also informed by the Life Cycle Planning strategies provided in Chapter 4. Life Cycle Planning.

Based on the revenue projections described in the Revenues and Financial Projections chapter of this TAMP, three scenarios were defined: a pre-SB 1 scenario representing the expected funding levels prior to the passage of SB 1, a current expected funding scenario that reflects the impact of SB 1 funds on current funding expectations, and a target scenario that represents the desired state of good repair.

5.2. Federal and State Requirements

Federal Requirements

State DOTs are required to establish a process for conducting a gap analysis, evaluating any gaps between current and target condition, and suggesting strategies to close the gaps pursuant to 23 CFR Part 515.7(a)(3)[32]. FHWA defines a performance gap as "the gaps between the current asset condition and State DOT targets for asset condition, and the gaps in system performance effectiveness that are best addressed by improving the physical assets." Specific requirements for the process are listed below.

Performance Gap Analysis Process Requirements

- State DOT targets for asset condition of NHS pavements and bridges, using FHWA's performance measures
- NHS performance gaps
- Alternative strategies to close or address the gaps

As part of the gap analysis, states must compare current asset performance to established target performance levels, but they may also compare projected asset performance to target performance to calculate an expected gap. The gap analysis is presented following the discussion of performance projections in this chapter.

State Requirements

State regulations require the development of a robust TAMP that meets federal guidelines. The California TAMP must also include performance gap analysis for assets on the SHS.

The California Streets and Highway Code (SHC) requires the development of an SHS Needs Assessment, that defines program areas and costs associated with achieving condition and performance targets. The majority of the SHS needs are determined through a gap analysis.

The Needs Assessment approach is comprised of a series of five key steps, as described in Figure 5-1. This process begins by establishing an inventory of assets, determining current and future projected

Figure 5-1 Steps to Carry Out the Needs Assessment

[32] 23 CFR Part 515.7(a)(3), https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

conditions, calculating gaps relative to performance targets, and concluding with the calculation of the total cost in closing the gap. While this approach is readily applied to performance objectives associated with physical assets and their state of repair, the same approach is applied to the other performance objectives that focus on needs beyond the condition of physical assets.

5.3. Baseline (Pre-SB 1) Performance

The baseline pre-SB 1 performance scenario is based on average annual revenues prior to the passage of SB 1, maintained over a 10-year period. This funding scenario is described in detail in Chapter 6. Revenues and Financial Projections.

Pre-SB 1 funding levels from the SHSMP and pre-SB 1 performance accomplishments from Caltrans are used to develop pre-SB 1 performance projections for SHS assets. For NHS assets on the SHS, weighted averages based on the portion of NHS on the SHS are used to develop performance projections and estimate funding levels.

The asset projection model from the SHSMP was adapted to predict future conditions for non-SHS assets. The model assumes that the local investment in NHS pavement is proportional to the magnitude of the NHS, relative to the total local road network. Local NHS pavements account for five percent of the total local roadways. Multiplying the $1.98 billion local road annual expenditure identified in the 2016 Local Needs Assessment by five percent yields an estimated NHS spending for pavement of $99 million per year. Although this assumption likely underestimates the local investment in NHS pavement based on limited MPO feedback, it serves as a reasonable lower bound for purposes of this analysis.

Having determined the baseline NHS spending, the percentage of pavement spending applied to fair and poor condition pavements was estimated at 15 percent for fair pavements and 85 percent for poor condition pavements, based on expert judgement and discussions between Caltrans and MPO staff. This reflects a current focus by local agencies on reducing the percentage of pavements on the NHS that are in poor condition.

The model includes an 8.78 percent annual deterioration rate from good to fair and a 3.37 percent rate from fair to poor. The unit cost assumptions are $111,408 per lane mile to fix fair to good and $166,320 per lane mile to fix poor to good.

Given these assumptions, the model predicts a gradual worsening of pavement conditions over time with Pre-SB 1 funding.

For non-SHS local bridges, the model assumes that the local investment in bridge repairs, $93 million per year, is in proportion to the square footage of bridge deck of non-SHS local bridges on the NHS to the total of all non-SHS local bridges, which is 32 percent.

The local bridge funding is assumed to be applied 15 percent to fair condition bridges and 85 percent to poor condition bridges, based on analysis done for the 2017 SHSMP. The model includes a 0.45 percent annual deterioration rate from good to fair and a 0.75 percent rate from fair to poor. The unit cost assumptions are $344 per square foot of bridge deck area fixed fair to good and $483 per square foot of bridge deck area fixed poor to good.

NHS Assets

Table 5-1 presents the 10-year pre-SB 1 performance projection for NHS pavements and bridges.

Table 5-1 NHS Pavement and Bridge 10-Year Performance in Baseline Funding Scenario

NHS Assets	Annual Funding ($M)	Good	Fair	Poor	
Pavements					
Interstate (lane miles)	**$386**	**40.7%**	**47.5%**	**11.8%**	
Non-Interstate NHS (lane miles)	**$632**	**22.0%**	**63.1%**	**14.9%**	
On the SHS	$533	37.8%	46.9%	15.3%	
Off the SHS	$99	3.9%	81.7%	14.4%	
Bridges					
NHS (deck area)	**$431**	**77.8%**	**18.6%**	**3.5%**	
On the SHS	$338	81.2%	16.1%	2.7%	
Off the SHS	$93	47.6%	41.2%	11.2%	

SHS Assets

The 10-year pre-SB 1 performance projection for SHS pavements, bridges, drainage systems and TMS assets are shown in .

Table 5-2 SHS Primary Asset Performance in Baseline Funding Scenario

SHS Assets	Annual Funding ($M)	Good	Fair	Poor	
Pavements					
Class I (lane miles)	$709	40.7%	47.5%	11.8%	
Class II (lane miles)	$331	34.5%	46.3%	19.2%	
Class III (lane miles)	$78	21.0%	54.7%	24.3%	
Bridges					
SHS Bridges (deck area)	$405	81.2%	16.1%	2.7%	
Drainage					
SHS Drainage (linear feet)	$108	54.0%	31.7%	14.2%	
TMS					
SHS TMS (assets)	$106	55.0%	n/a	45.0%	

5.4. Maintain NHS Asset Performance

To maintain NHS pavements and bridges at current performance levels (as presented in Chapter 2, Table 2-4 and Table 2-7), it is expected that approximately $1.85 billion annually would be needed for 10 years. Because conditions are expected to improve with the passage of SB 1, a full presentation of this scenario was not included in the TAMP.

5.5. Expected (Post-SB 1) Performance

The expected post-SB 1 funding performance scenario is based on average annual revenues after the passage of SB 1, maintained over a 10-year period. This funding scenario is described in detail in Chapter 6. Revenues and Financial Projections.

SB 1 funding levels and performance accomplishments from the SHSMP are used to develop expected performance projections for SHS assets which is demonstrated in the life cycle planning analysis Balanced Approach Scenario in Chapter 4. For NHS assets on the SHS, weighted averages were utilized, based on the portion of NHS to the total SHS, to develop performance projections and estimate funding levels.

The asset projection model described in the previous section was used to predict future conditions for non-SHS assets.

SB 1 is expected to provide $1.5 billion annually for local roads and bridges. SB 1 funding is adequate to close all local NHS performance gaps, if applied to the NHS in sufficient quantity. Preliminary feedback gathered through TAMP workshops with local agencies indicates that SB 1 funding is planned to more closely align with the inventory proportion of the NHS to total local roadways. Workshop feedback also indicated that approximately 90 percent of SB 1 funds ($1.35 billion) would be applied towards pavement and 10 percent ($150 million) towards bridges. As with the earlier scenarios presented, the model assumes that local agencies will continue to apply new SB 1 funds in proportion of NHS assets to total non-SHS inventory. The local NHS comprises five percent of total local pavements and 32 percent of total local bridges.

For pavements, this results in an increase in funding from SB 1 of $68 million per year (or $167 million total annual funding), with 40 percent spent on work improving pavements in fair condition and 60 percent spent on improving pavements in poor condition. An increased emphasis on treating pavements in fair condition is assumed for this scenario given that additional funds would be available for pavement preservation through SB 1.

For non-SHS bridges, this results in an increase in funding from SB 1 of $48 million per year (or $141 million total annual funding), with 15 percent spent on work improving bridges in fair condition and 85 percent spent on improving bridges in poor condition.

Assuming that local agencies invest SB 1 funds in NHS assets proportional to their overall local asset inventory, the model predicts improved local NHS pavements and bridge conditions over the baseline condition.

NHS Assets

The expected funding performance scenario is based on current expected revenues over a 10-year period. presents the 10-year expected funding performance projection for NHS pavements and bridges.

Table 5-3 NHS Pavement and Bridge 10-Year Performance in Expected Funding Scenario

NHS Assets	Annual Funding ($M)	Good	Fair	Poor	
Pavements					
Interstate (lane miles)	**$751**	**60.0%**	**39.0%**	**1.0%**	
Non-Interstate NHS (lane miles)	**$1,161**	**34.0%**	**60.8%**	**5.2%**	
On the SHS	$995	57.6%	40.9%	1.5%	
Off the SHS	$167	6.7%	83.8%	9.5%	
Bridges					
NHS (deck area)	**$707**	**80.4%**	**17.5%**	**2.1%**	
On the SHS	$566	83.5%	15.0%	1.5%	
Off the SHS	$141	52.1%	40.3%	7.6%	

SHS Assets

The 10-year expected funding performance projection for SHS pavements, bridges, drainage systems and TMS assets are shown in Table 5-4.

Table 5-4 SHS Primary Asset Performance in Expected Funding Scenario

SHS Assets	Annual Funding ($M)	Good	Fair	Poor	
Pavements					
Class I (lane miles)	$1,380	60.0%	39.0%	1.0%	
Class II (lane miles)	$577	55.0%	43.0%	2.0%	
Class III (lane miles)	$151	45.0%	53.0%	2.0%	
Bridges					
SHS Bridges (deck area)	$678	83.5%	15.0%	1.5%	
Drainage					
SHS Drainage (linear feet)	$255	58.2%	31.8%	10.0%	
TMS					
SHS TMS (assets)	$195	90.0%	n/a	10.0%	

5.6. Desired State of Repair

The performance scenario for DSOR is based on annual funding required to meet performance targets over a 10-year period. This scenario includes the additional maintenance funding required to sustain the state of repair further into the future as captured in the SHSMP.

For assets on the SHS, the target funding scenario uses financial data from the SHSMP. For NHS assets on the SHS, weighted averages, based on the portion of NHS to the total SHS, are used to develop performance projections and estimate funding levels. As with the earlier scenarios presented, the model assumes that local agencies will apply funds in proportion of NHS assets to total non-SHS inventory. The local NHS comprising five percent of total local pavements and 32 percent of total local bridges.

The asset projection model suggests local agencies are within a $2 million annual increase in funding over the expected SB 1 scenario for local NHS pavements to achieve the statewide target. To close the performance gap for NHS bridges, the bridge model calculates an increase in funding of $274 million per year over the expected scenario, resulting in $415 million in annual funding for local NHS bridges.

Funding for these gaps could be closed by shifting funding to the NHS in greater proportion than assumed in this analysis or by augmenting with funding from local sources.

NHS Assets

The DSOR target scenario represents the requirements for meeting the 10-year targets described in Chapter 3. Asset Performance Targets. Table 5-5 presents the 10-year target funding performance projection for NHS pavements and bridges.

Table 5-5 NHS Pavement and Bridge 10-Year Performance in Target Funding Scenario

NHS Assets	Annual Funding ($M)	Good	Fair	Poor	
Pavements					
Interstate (lane miles)	**$852**	**60.0%**	**39.0%**	**1.0%**	
Non-Interstate NHS (lane miles)	**$1,322**	**34.1%**	**60.9%**	**5.0%**	
On the SHS	$1,153	57.6%	40.9%	1.5%	
Off the SHS	$169	7.0%	84.0%	9.0%	
Bridges					
NHS (deck area)	**$981**	**83.5%**	**15.0%**	**1.5%**	
On the SHS	$566	83.5%	15.0%	1.5%	
Off the SHS	$415	83.5%	15.0%	1.5%	

SHS Assets

The 10-year target DSOR performance for SHS pavements, bridges, drainage systems and TMS assets are shown in Table 5-6.

Table 5-6 SHS Primary Asset Performance in Target Funding Scenario

SHS Assets					
	Annual Funding ($M)	Good	Fair	Poor	
Pavements					
Class I (lane miles)	$1,566	60.0%	39.0%	1.0%	
Class II (lane miles)	$696	55.0%	43.0%	2.0%	
Class III (lane miles)	$199	45.0%	53.0%	2.0%	
Bridges					
SHS Bridges (deck area)	$678	83.5%	15.0%	1.5%	
Drainage					
SHS Drainage (linear feet)	$494	80.0%	10.0%	10.0%	
TMS					
SHS TMS (assets)	$211	90.0%	n/a	10.0%	

5.7. Asset Performance Gap Analysis

California's gap analysis includes two gap calculations: *current gap* and *projected gap*.

- **Current gap** is the gap between current performance and the 10-year desired state of repair.
- **Projected gap** is the gap between the expected (Post-SB 1) performance projection and the 10-year target DSOR.

Both current and projected gaps are shown in terms of the change in performance required to meet DSOR. For measures of good condition, a gap indicates the need to increase good conditions by the specified amount. For measures of poor or fair conditions a gap indicates the need to reduce poor conditions or fair conditions by the specified amount. Gaps are reported as zero in cases where the projected performance exceeds the target performance; no "negative" gaps are reported in these cases.

Caltrans' gap analysis is performed to quantify the difference between the projected condition with pipelined projects and the target DSOR condition at the end of the 10-year Plan period. Pipelined projects are comprised of planned and programmed projects, or other work underway resulting in a change in condition from the baseline. The resulting change is assumed to be realized when the construction contract is advertised. Figure 5-2 shows the calculations for both poor and fair gaps.

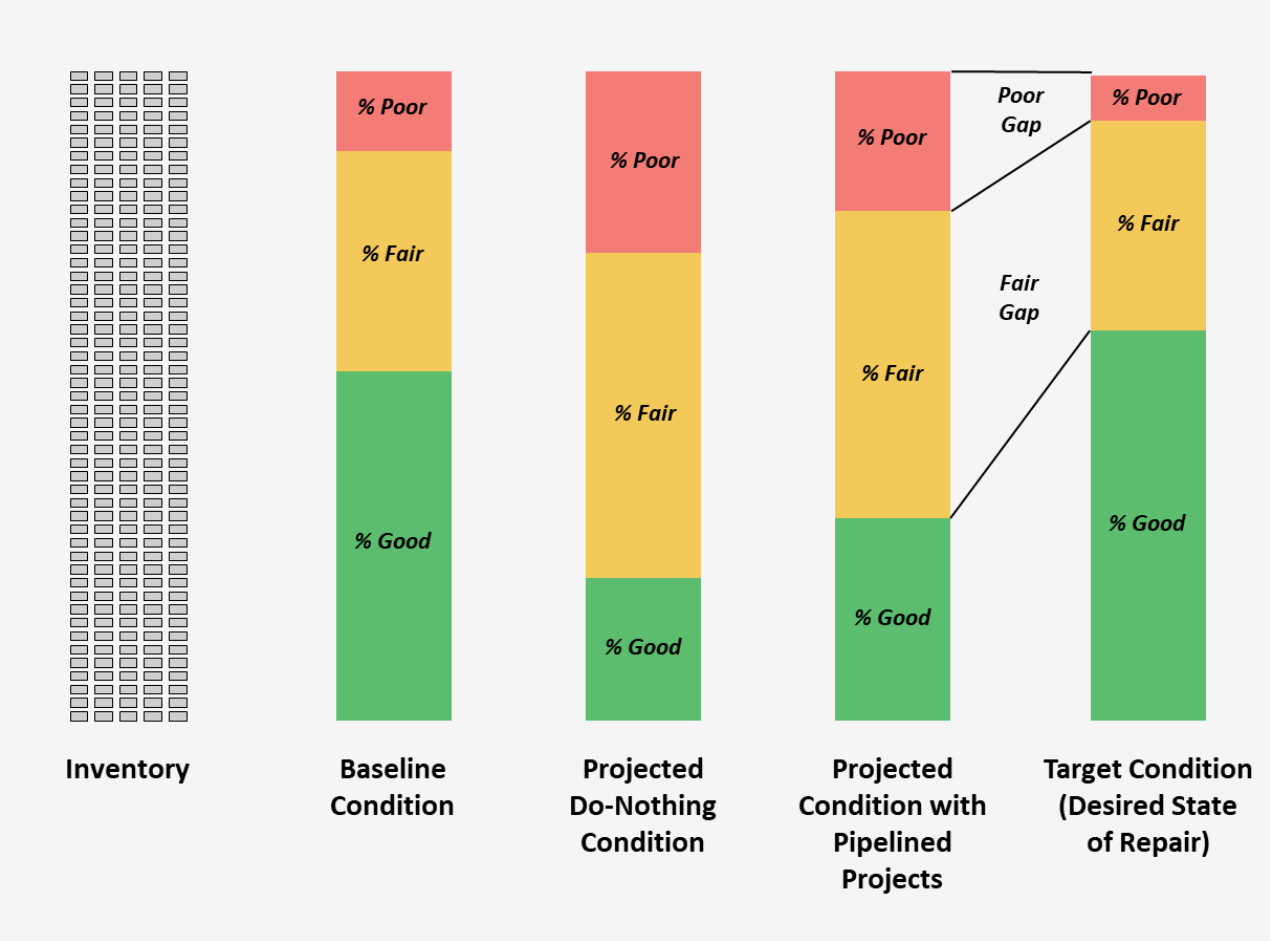


Figure 5-2 Gap Analysis

NHS Assets

Table 5-7 presents the gap analysis for NHS pavements and bridges. There is a current gap presented for each asset and performance measure combination. No gap is projected for Interstate pavements, because Caltrans expects to achieve DSOR with expected funding from SB 1. The intention of SB 1 was to close the performance gap on the SHS. Non-Interstate NHS pavements are owned by both state and local agencies; the combined subsystem is not expected to meet DSOR unless an additional portion of the local SB 1 or other funding sources is applied to the local NHS.

NHS bridges are owned by both state and local agencies. There is a projected gap for NHS bridges at the assumed investment percentages for local NHS bridges. To the extent local agencies increase the proportion of SB 1 funding applied to NHS bridges, the identified gap could be minimized or eliminated. Strategies for closing gaps are discussed in subsequent chapters of the TAMP.

Predicted condition and resulting performance gaps for local NHS pavement and bridge assets are founded on the assumption that local investment priorities are proportional to the NHS and non-NHS inventory quantities. While this assumption provides a consistent and unbiased basis for analyses, it is within the discretion of local agencies and the funding capacity of SB 1 to focus a larger share of funds on NHS assets to close these gaps.

Caltrans utilizes a deficiency model to improve or correct infrastructure issues on the SHS and state-owned NHS. A gap analysis is conducted between the current deficiency and the performance target similar to the physical asset model described above. These needs do not have a condition breakdown like the physcial assets as they are either deficient or not. The performance effectiveness of NHS pavement and bridges is impacted by these deficiencies. In conducting a gap analysis for safety, bridge scour, bridge seismic and highway operations among others, SHOPP funding is provided to make progress towards closing these gaps and is included as part of the SHSMP process.

Table 5-7 Performance Gaps for NHS Assets

NHS Assets	Good	Fair	Poor	
Interstate Pavements (lane miles)				
Current Performance	44.9%	52.1%	3.1%	
10-Year Expected (Post-SB 1) Performance	60.0%	39.0%	1.0%	
10-Year Target (DSOR) Performance	60.0%	39.0%	1.0%	
Current Gap	15.1%	13.1%	2.1%	
10-Year Projected Gap	0.0%	0.0%	0.0%	
Non-Interstate NHS Pavements (lane miles)				
Current Performance	25.5%	67.4%	7.1%	
10-Year Expected (Post-SB 1) Performance	34.0%	60.8%	5.2%	
10-Year Target (DSOR) Performance	34.1%	60.9%	5.0%	
Current Gap	8.7%	6.5%	2.2%	
10-Year Projected Gap	0.1%	0.0%	0.2%	
Non-Interstate NHS Pavements on the SHS (lane miles)				
Current Performance	43.5%	54.0%	2.5%	
10-Year Expected (Post-SB 1) Performance	57.6%	40.9%	1.5%	
10-Year Target (DSOR) Performance	57.6%	40.9%	1.5%	
Current Gap	14.1%	13.1%	1.0%	
10-Year Projected Gap	0.0%	0.0%	0.0%	
Non-Interstate NHS Pavements off the SHS (lane miles)				
Current Performance	4.6%	82.9%	12.5%	
10-Year Expected (Post-SB 1) Performance	6.7%	83.8%	9.5%	
10-Year Target (DSOR) Performance	7.0%	84.0%	9.0%	
Current Gap	2.4%	0.0%	3.5%	

NHS Assets	Good	Fair	Poor
10-Year Projected Gap	0.3%	0.0%	0.5%
NHS Bridges (deck area)			
Current Performance	66.5%	28.7%	4.8%
10-Year Expected (Post-SB 1) Performance	80.4%	17.5%	2.1%
10-Year Target (DSOR) Performance	83.5%	15.0%	1.5%
Current Gap	17.0%	13.7%	3.3%
10-Year Projected Gap	3.1%	2.5%	0.6%
NHS Bridges on the SHS (deck area)			
Current Performance	69.4%	26.9%	3.7%
10-Year Expected (Post-SB 1) Performance	83.5%	15.0%	1.5%
10-Year Target (DSOR) Performance	83.5%	15.0%	1.5%
Current Gap	14.1%	11.9%	2.2%
10-Year Projected Gap	0.0%	0.0%	0.0%
NHS Bridges off the SHS (deck area)			
Current Performance	40.8%	44.4%	14.8%
10-Year Expected (Post-SB 1) Performance	52.1%	40.3%	7.6%
10-Year Target (DSOR) Performance	83.5%	15.0%	1.5%
Current Gap	42.7%	29.4%	13.3%
10-Year Projected Gap	31.4%	25.3%	6.1%

SHS Assets

Table 5-8 presents the gap analysis of SHS assets. There is a current gap for each asset and performance measure. However, there are no projected gaps, as Caltrans expects to achieve DSOR with future funding. Strategies for closing gaps are discussed in subsequent chapters of the TAMP.

Table 5-8 Performance Gaps for SHS Assets

SHS Assets	Good	Fair	Poor	
Pavement Class I (lane miles)				
Current Performance	45.1%	50.5%	4.4%	
10-Year Expected (Post-SB 1) Performance	60.0%	39.0%	1.0%	
10-Year Target (DSOR) Performance	60.0%	39.0%	1.0%	
Current Gap	14.9%	11.5%	3.4%	
10-Year Projected Gap	0.0%	0.0%	0.0%	
Pavement Class II (lane miles)				
Current Performance	35.6%	57.6%	6.8%	
10-Year Expected (Post-SB 1) Performance	55.0%	43.0%	2.0%	
10-Year Target (DSOR) Performance	55.0%	43.0%	2.0%	
Current Gap	19.4%	14.6%	4.8%	
10-Year Projected Gap	0.0%	0.0%	0.0%	
Pavement Class III (lane miles)				
Current Performance	37.5%	54.3%	8.1%	
10-Year Expected (Post-SB 1) Performance	45.0%	53.0%	2.0%	
10-Year Target (DSOR) Performance	45.0%	53.0%	2.0%	
Current Gap	7.5%	1.3%	6.1%	
10-Year Projected Gap	0.0%	0.0%	0.0%	
SHS Bridges (deck area)				
Current Performance	74.9%	21.8%	3.3%	
10-Year Expected (Post-SB 1) Performance	83.5%	15.0%	1.5%	
10-Year Target (DSOR) Performance	83.5%	15.0%	1.5%	
Current Gap	8.6%	6.8%	1.8%	
10-Year Projected Gap	0.0%	0.0%	0.0%	

SHS Assets	Good	Fair	Poor	
SHS Drainage (linear feet)				
Current Performance	65.0%	23.5%	11.5%	
10-Year Expected (Post-SB 1) Performance	58.2%	31.8%	10.0%	
10-Year Target (DSOR) Performance	80.0%	10.0%	10.0%	
Current Gap	15.0%	13.5%	1.5%	
10-Year Projected Gap	21.8%	21.8% *	0.0%	
SHS TMS (assets)				
Current Performance	58.8%	n/a	41.2%	
10-Year Expected (Post-SB 1) Performance	90.0%	n/a	10.0%	
10-Year Target (DSOR) Performance	90.0%	n/a	10.0%	
Current Gap	31.2%	n/a	31.2%	
10-Year Projected Gap	0.0%	n/a	0.0%	

*The SHS drainage performance gap is based on an estimated end-state condition in 10 years using a projected inventory quantity that continues to grow.

The gap analysis in Table 5-9 represents Supplementary Assets on the SHS. There is a current gap for each asset and performance measure. Strategies for closing gaps are discussed in subsequent chapters of the TAMP.

Table 5-9 Performance Gaps for Supplementary Assets on the SHS

Supplementary Assets on the SHS	Good	Fair	Poor	
SHS Drainage Pump Plants (locations)				
Current Performance	24.1%	29.3%	46.6%	
10-Year Expected (Post-SB 1) Performance	63.8%	26.9%	9.3%	
10-Year Target (DSOR) Performance	80.0%	20.0%	0.0%	
Current Gap	55.9%	9.3%	46.6%	
10-Year Projected Gap	16.2%	6.9%	9.3%	

Supplementary Assets on the SHS	Good	Fair	Poor	
SHS Highway Lighting (assets)				
Current Performance	40.2%	13.9%	45.9%	
10-Year Expected (Post-SB 1) Performance	46.3%	13.8%	39.9%	
10-Year Target (DSOR) Performance	0.0%	100.0%*	0.0%	
Current Gap	0.0%	0.0%	45.9%	
10-Year Projected Gap	0.0%	0.0%	39.9%	
SHS Office Buildings (square feet)				
Current Performance	41.9%	31.6%	26.5%	
10-Year Expected (Post-SB 1) Performance	57.4%	16.6%	26.0%	
10-Year Target (DSOR) Performance	60.0%	40.0%	0.0%	
Current Gap	18.1%	0.0%	26.5%	
10-Year Projected Gap	2.6%	0.0%	26.0%	
SHS Overhead Signs (assets)				
Current Performance	74.4%	21.8%	3.8%	
10-Year Expected (Post-SB 1) Performance	64.9%	23.7%	11.4%	
10-Year Target (DSOR) Performance	0.0%	100.0%*	0.0%	
Current Gap	0.0%	0.0%	3.8%	
10-Year Projected Gap	0.0%	0.0%	11.4%	
SHS Roadside Rest Facilities (locations)				
Current Performance	32.6%	38.4%	29.0%	
10-Year Expected (Post-SB 1) Performance	26.7%	22.1%	51.2%	
10-Year Target (DSOR) Performance	80.0%	20.0%	0.0%	
Current Gap	47.4%	18.4%	29.0%	
10-Year Projected Gap	53.3%	2.1%	51.2%	

Supplementary Assets on the SHS	Good	Fair	Poor
SHS Sidewalks, Park and Ride and ADA Infrastructure (locations)			
Current Performance	0.0%	n/a	100.0 %
10-Year Expected (Post-SB 1) Performance	7.3%	n/a	92.7%
10-Year Target (DSOR) Performance	25.0%	n/a	75.0%
Current Gap	25.0%	n/a	25.0%
10-Year Projected Gap	17.7%	n/a	17.7%
SHS Transportation-Related Facilities (square feet)			
Current Performance	21.2%	15.1%	63.7%
10-Year Expected (Post-SB 1) Performance	17.2%	17.7%	65.1%
10-Year Target (DSOR) Performance	60.0%	40.0%	0.0%
Current Gap	38.8%	0.0%	63.7%
10-Year Projected Gap	42.8%	0.0%	65.1%
SHS Weigh in Motion Scales (stations)			
Current Performance	2.8%	97.2%	0.0%
10-Year Expected (Post-SB 1) Performance	27.3%	40.9%	31.8%
10-Year Target (DSOR) Performance	90.0%	10.0%	0.0%
Current Gap	87.2%	87.2%	0.0%
10-Year Projected Gap	62.7%	30.9%	31.8%

*The 10-year target performance for SHS highway lighting and overhead signs is to have the entire inventory in a good or fair condition.

5.8. Closing the Performance Gap

California's NHS and SHS will require substantial investment to achieve established DSOR 10-Year Targets. However, California is on track to achieve these targets for all of its SHS while narrowing the gap for NHS pavements and bridges under current funding expectations. The additional investment in preservation provided by SB 1 is crucial to attaining these ambitious targets.

In addition to tracking progress towards the long-range planning 10-year targets established in the TAMP, performance gaps for 2- and 4-year performance targets are required under FHWA's Pavement and Bridge Performance Management Final Rule (23 CFR Part 490). The FHWA will assess progress towards achieving performance targets over the 4-year baseline performance period (defined as the "Baseline Performance Period"), measuring against biennial reports submitted by Caltrans. If FHWA finds that significant progress towards state targets has not been achieved in two consecutive two-year reporting periods, the state must include a plan for improving performance in its next progress report. Significant progress is defined as current performance exceeding baseline performance or equaling or exceeding the performance target.

NHS Assets

The gap analysis for NHS assets, as required by 23 CFR Part 515.7(a)[33], produced several key outcomes for the NHS assets:

- No gap is projected for Interstate pavements, as Caltrans expects to achieve DSOR with funding from SB 1.
- Non-Interstate NHS pavements are not expected to meet DSOR unless an additional portion of the local SB 1 or other funding sources is applied to the local NHS.
- There is a projected gap for NHS bridges at the assumed investment percentages for local NHS bridges. To the extent local agencies increase the proportion of SB 1 funding applied to NHS bridges, the identified gap could be minimized or eliminated.

A number of strategies will need to be pursued by local, regional, and state partners in order to assure that the performance gaps for local pavements and bridges identified in the TAMP are addressed. SB 1 funds coupled with local measure funds bring additional financial resources to bear that will help close these gaps. A shift in prioritization of investments towards NHS assets by local agencies could further advance achieving performance goals. Better informed investment decisions are possible through improved coordination and information sharing amongst local, regional, and state partners. Additional discussion of these strategies for closing gaps are discussed in subsequent chapters of the TAMP.

SHS Assets

With the additional funding provided by SB 1, Caltrans anticipates closing all performance gaps for the four primary SHS asset classes. Performance gaps are expected to persist or widen, however, for the supplementary asset classes, as there is insufficient funding at the projected levels over the 10-year period ahead. It is possible that as improvements in condition of the primary asset classes are realized and long-term maintenance costs go down, funds could be redirected towards improving the condition of the supplementary asset classes.

[33] 23 CFR Part 515.7(a)(3), https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

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6. Revenues and Financial Projections

The TAM financial plan underpins and enables the implementation of asset management practices. This chapter details the revenues and financial projections for asset management activities in California.

6.1. Overview

California's transportation funding is derived from a variety of sources. The majority of state and federal transportation funding is collected through fuel taxes. At the state level, revenues are directed towards a set of transportation-related state accounts for California. Major accounts related to asset management are the State Highway Account (SHA) and the recently-created Road Maintenance and Rehabilitation Account (RMRA). These accounts are used to fund maintenance, operations, and capital projects, including asset management-related activities. The two programs most closely related to asset management are HM and SHOPP. The HM program and SHOPP fund maintenance, preservation, rehabilitation, and replacement projects; all are intended to maintain or improve asset condition. SHOPP and HM funds are used for the SHS, and by extension, the portions of the NHS on the SHS.

For the portion of NHS owned by local agencies, revenues are derived from a variety of sources, including federal and state sources, as well as additional local funding sources, such as local sales taxes, development impact fees, property taxes, and traffic impact fees. Funding sources used by local agencies are further detailed in the *2016 California Statewide Local Streets and Roads Needs Assessment*. Note: local agencies must fund all of the roads and bridges on the local system, not just the portion on the NHS. One challenge in developing a financial plan that meets FHWA's requirements is to determine the portion of transportation funds projected to be used on the NHS.

In 2017 California adopted new legislation significantly increasing funds for asset management. SB 1, The Road Repair and Accountability Act of 2017, includes a number of provisions that, over time, will provide increased revenues for roads and bridges. SB 1 is projected to increase average annual funding

for local pavements and bridges by approximately $1.5 billion. This additional funding will be instrumental in helping California achieve its asset condition targets for the SHS and NHS.

The following subsections present the TAMP financial plan, summarizing funding sources and uses, and detailing the projected funding available for asset management uses over the next 10 years. The financial plan is an estimate of projected revenue, detailing the resources available for helping meet the condition targets presented previously. Note that the financial plan is focused on funds available for selected asset types on the SHS and NHS. Other documents provide a more comprehensive description on topics such as sources of transportation funding, how California projects future revenues, and what constraints exist on use of funds for different purposes. *Transportation Funding in California (2017)*[34], an annual report by Caltrans, provides detail on transportation revenue sources. 2018 STIP Fund Estimate details projected funding and programming capacity for different programs and asset types.

6.2. Federal and State Requirements

Federal Requirements

FHWA requires each state DOT to include a financial plan that spans at least 10 years and identifies funding and costs over that time in their TAMP. FHWA defines financial plan as "a long-term plan spanning 10 years or longer, presenting a state DOT's estimates of projected available financial resources and predicted expenditures in major asset categories that can be used to achieve State DOT targets for asset condition during the plan period, and highlighting how resources are expected to be allocated based on asset strategies, needs, shortfalls, and agency policies." The plan should provide a summary of financial resources and needs for pursuing asset management objectives and achieving performance targets.

FHWA also requires that states establish a process for developing a financial plan as part of the transportation asset management plan. Specific requirements for the process are listed below.

Financial Plan Process Requirements

- Estimated cost of expected future work to implement the investment strategies of the asset management plan, by fiscal year and work type
- Estimated funding levels to address the costs of future work types, by fiscal year
- Identification of anticipated funding sources
- Asset valuation estimate for NHS pavements and bridges assets and the needed annual investment to maintain asset value (Note: asset valuation is included in Chapter 2. Asset Inventory and Condition.)

[34] Caltrans, "Transportation Funding in California", *2017*, http://www.dot.ca.gov/hq/tpp/offices/eab/fundchrt_files/2017_Transportation_Funding.pdf

State Requirements

State regulations require that California develop a robust asset management plan which meets the federal TAMP requirements and also includes assets on the SHS. The financial plan should include the four primary asset classes on the SHS.

6.3. Funding Sources

California receives transportation funding from both federal and state sources. At the state level the majority of funding is from state sources. This section details California's sources of revenue and future funding outlook, broken out by state and federal sources.

Table 6-1, Table 6-2, and Table 6-3 below are adapted from the *2018 STIP Fund Estimate*[35] (Fund Estimate) approved by the California Transportation Commission on August 16, 2017. The Fund Estimate is a biennial projection of all available transportation resources and establishes funding levels for STIP and SHOPP. The 2018 Fund Estimate covers the period from FY 2018 to FY 2023 and includes funding provided by SB 1, which covers 10 years of committed funding.

Federal Funding Sources

Federal funding for transportation is provided through the Highway Trust Fund (HTF), which is funded by the federal gas tax supplemented with additional revenues from SHA or other funds. For a detailed explanation of federal funding support, refer to *Funding Federal-Aid Highways*[36], a 2017 publication of FHWA.

Congress is responsible for authorizing federal funding. Federal transportation funds are typically authorized in advance to allow states to support capital planning. Once authorized, funds are apportioned or allocated to states or programs. Apportioned funds must then be obligated, or committed, to specific projects in a state before the HTF outlays cash to pay eligible recipients.

Table 6-1 shows the ten-year summary of California's expected funding from federal sources. In the table obligation authority is the total federal commitment to a state in each year. Obligation authority constitutes the majority of California's federal transportation funding. Over 10 years, it will provide $37 billion in funding. The August redistribution is funding from other states that was unobligated, or not committed. FHWA redistributes uncommitted funds to states able to obligate additional funding. The August redistribution is expected to provide $1.6 billion in funding over 10 years. Other federal resources represent transfers of federal funding for uses outside of SHA. Caltrans has $2.9 billion in projected transfers. In total, federal funding is projected to provide $35.8 billion to Caltrans from state FY 2017-2018 (18) to FY 2026-2027 (27).

[35] Caltrans, "2018 State Transportation Improvement Program Fund Estimate", August 16, 2017, http://dot.ca.gov/budgets/docs/FINAL%202018%20STIP%20FE%20Book.pdf

[36] FHWA, "Funding Federal-Aid Highways", January 2017, https://www.fhwa.dot.gov/policy/olsp/fundingfederalaid/

Table 6-1 Summary of Funding from Federal Sources

Federal	Value by FY ($M)										
Description	18	19	20	21	22	23	24	25	26	27	FY 18-27
Obligation Authority	$3,340	$3,416	$3,498	$3,575	$3,655	$3,736	$3,818	$3,902	$3,988	$4,076	$37,004
August Redist-ribution	$162	$162	$162	$162	$162	$162	$162	$162	$162	$162	$1,620
Other Federal Resources	($313)	($284)	($284)	($284)	($284)	($284)	($284)	($284)	($284)	($284)	($2,869)
Federal Total	**$3,190**	**$3,294**	**$3,376**	**$3,454**	**$3,533**	**$3,614**	**$3,696**	**$3,780**	**$3,866**	**$3,954**	**$35,755**

Source: FY 2018—FY 2023, 2018 State Transportation Improvement Program Fund Estimate

State Funding Sources

Expected funding from state sources is shown in Table 6-2. This table is organized by account, showing state funds in SHA and newly-created SB 1 RMRA.

The SHA includes revenue sources such as fuel taxes, transfers, rental and sale of excess property, and outdoor advertising licenses, permit fees, and fines. Total estimated SHA funding over the 10-year period is $42 billion.

Table 6-2 Summary of Funding from State Sources

SHA	Value by FY ($M)										
Description	18	19	20	21	22	23	24	25	26	27	FY 18-27
Beginning Balance	$1,812	$0	$0	$0	$0	$0	$0	$0	$0	$0	$1,812
Fuel Excise Taxes (Base)	$2,124	$2,111	$2,092	$2,184	$2,215	$2,273	$2,376	$2,483	$2,596	$2,713	$23,167
Fuel Excise Taxes (Price-Based)	$1,454	$1,645	$1,915	$1,980	$2,011	$2,055	2,148	2,245	2,347	2,453	$20,253
Misc. Revenues	$371	$371	$371	$371	$365	$367	370	370	370	370	$3,696
Transport-ation Loans	$75	$75	$75	$1,498	$0	$0	$0	$0	$0	$0	$1,723
Net Transfers - Others	($162)	($165)	($167)	($1,668)	($165)	($165)	($166)	($168)	($169)	($170)	($3,165)
Expenditures - Other Departmental	($539)	($541)	($543)	($545)	($547)	($550)	($552)	($554)	($556)	($558)	($5,486)
SHA Total	**$5,134**	**$3,496**	**$3,744**	**$3,820**	**$3,879**	**$3,979**	**$4,175**	**$4,376**	**$4,587**	**$4,808**	**$41,999**
RMRA	**Value by FY ($M)**										
Description	18	19	20	21	22	23	24	25	26	27	FY 18-27
Bridges & Culverts	$400	$400	$400	$400	$400	$400	$400	$400	$400	$400	$4,000
Maintenance & SHOPP	$370	$1,085	$1,100	$1,191	$1,252	$1,314	$1,353	$1,411	$1,468	$1,526	$12,070
RMRA Total	**$770**	**$1,485**	**$1,500**	**$1,591**	**$1,652**	**$1,714**	**$1,753**	**$1,811**	**$1,868**	**$1,926**	**$16,070**

Source: FY 2018—FY 2023, 2018 State Transportation Improvement Program Fund Estimate

SB 1 is expected to raise a total of $54 billion over 10 years. The revenue increase is the result of higher gasoline and diesel taxes, additional vehicle and emissions fees, and savings through efficiency measures. SB 1 created RMRA to fund work on deferred maintenance for pavements, bridges, TMS, and drainage systems, primarily through increased fuel taxes. Total estimated RMRA funding over the 10-year period is $16 billion, as shown in Table 6-2.

Table 6-3 is a 10-year funding summary which includes the summary of Table 6-1 and Table 6-2 of the 2018 STIP Fund Estimate. SB 1 RMRA funds are shown as State fuel tax funds. Total projected asset management funding from FY 2018 to FY 2027 is $93.8 billion.

Local Funding Sources

The *2016 California Statewide Local Streets and Roads Needs Assessment* discusses sources of funding for local roads and bridges, in addition to the federal and state sources described previously. This report lists the following local funding sources:

- Local sales taxes
- Traffic and development impact fees;
- Transportation mitigation fees
- General funds
- Various assessment districts–-lighting, maintenance, flood control, special assessments, community facility districts
- Traffic safety/circulation fees
- Utilities e.g., stormwater, water, wastewater enterprise funds
- Parking and various permit fees
- Flood control districts
- Enterprise funds (solid waste and water)
- Investment earnings
- Parcel/property taxes
- Indian reservation roads
- Indian gaming funds
- Vehicle registration fees
- Vehicle code fines
- Underground impact fees
- Solid waste funds
- Transient Occupancy Taxes (TOT)
- CIP Reserves/Capital Funds

This report estimates that future funding available for pavements will total approximately $1.98 billion per year, with approximately 49 percent of this total derived from local funding sources. It further estimates future funding of $290 million per year for bridges, as well as $1.1 billion per year for other essential roadway components. SB 1 is expected to add $1.5 billion of funding annually for local roads and bridges.

6.4. Funding Uses

This section summarizes how available transportation funds are used. Caltrans programs work for a four-year period. These commitments draw on state and federal funding to address a wide range of transportation needs.

Table 6-3 shows Caltrans' planned spending commitments in upcoming years, organized by account and funding source. In total, $5.6 billion of available funds is committed to operations, representing 17 percent of the $32.2 billion total; $9.9 billion is committed to maintenance, representing 31 percent of the total; $9.1 billion is committed to local assistance, representing 28 percent of the total; $6.4 billion is committed to SHOPP, representing 20 percent of the total; and $1.3 billion is committed to STIP, representing four percent of the total.

Table 6-3. Summary of Caltrans Planned Commitments

Value by FY ($M)							
	FY18	FY19	FY20	FY21	FY22	FY23	FY 18-23
SHA + Federal							
Operations	$845	$872	$898	$925	$953	$981	$5,475
Maintenance	$1,301	$1,333	$1,367	$1,401	$1,436	$1,472	$8,309
Local Assistance	$1,456	$1,476	$1,501	$1,579	$1,591	$1,516	$9,119
SHOPP Capital Outlay Support	$929	$734	$544	$413	$283	$191	$3,093
SHOPP Capital Outlay	$1,961	$405	$262	$129	$102	$94	$2,953
STIP	$472	$354	$228	$105	$59	$40	$1,259
SHA+Federal Total	**$6,964**	**$5,174**	**$4,800**	**$4,552**	**$4,424**	**$4,294**	**$30,208**
RMRA							
Operations	$17	$18	$18	$19	$19	$20	$114
Maintenance	$421	$400	$400	$120	$120	$120	$1,581
SHOPP Capital Outlay Support	$20	$30	$20	$0	$0	$0	$70
SHOPP Capital Outlay	$293	$0	$0	$0	$0	$0	$293
RMRA Total	**$752**	**$448**	**$439**	**$139**	**$140**	**$140**	**$2,059**
Total							
Operations	$862	$890	$916	$944	$972	$1,001	$5,589
Maintenance	$1,722	$1,733	$1,767	$1,521	$1,556	$1,592	$9,890
Local Assistance	$1,456	$1,476	$1,501	$1,579	$1,591	$1,516	$9,119
SHOPP	$3,203	$1,169	$826	$542	$385	$285	$6,409
STIP	$472	$354	$228	$105	$59	$40	$1,259
Total	**$7,716**	**$5,623**	**$5,238**	**$4,694**	**$4,563**	**$4,433**	**$32,268**

Source: 2018 State Transportation Improvement Program Fund Estimate

Table 6-4 presents a summary of estimated SHOPP spending based on the 2018 STIP Fund Estimate. Existing commitments to SHOPP total $5.5 billion over the next six years. Target capacity for SHOPP, which accounts for these existing commitments, is $24.7 billion over the same period.

Table 6-4. Summary of Expected SHOPP Spending

Value by FY ($M)							
	FY18	FY19	FY20	FY21	FY22	FY23	FY 18-23
Commitments	$3,203	$1,169	$826	$542	$385	$285	$5,480
Target Capacity	$2,713	$4,200	$4,300	$4,400	$4,500	$4,600	$24,713

Source: 2018 State Transportation Improvement Program Fund Estimate

The above tables detail SHS funding uses. For the portion of the NHS owned by other federal, state and local agencies besides Caltrans, funding has been estimated based on the 2016 *Statewide Local Streets and Roads Needs Assessment*, with adjustments to account for additional funding from SB 1.

6.5. Funding Available for Asset Management

Spending on NHS assets in California is not tracked as a separate item. In lieu of spending records, the TAMP includes funding estimates for NHS assets that are expected to be reasonably available by FY to address the costs of future work types (i.e., initial construction, maintenance, preservation, rehabilitation and reconstruction). These funding estimates were calculated based on the percentage of state pavements and bridges assets located on the NHS. Funding for NHS pavements and bridges, organized by owner, is presented in Table 6-8. The table presents three funding scenarios: The baseline (pre-SB 1) funding scenario represents NHS asset management funding before the passage of SB 1; the expected (post-SB 1) funding scenario represents NHS asset management funding after the passage of SB 1, and the achieving targets scenario represents funding required to achieve the 10-year DSOR.

For Caltrans, 100 percent of Class I pavements and 63 percent of Class II pavements are located on the NHS. Multiplying these percentages by the funding for the respective pavement classes yields an estimate of spending on NHS pavements located on the SHS. This NHS estimate is broken down into Interstate and Non-Interstate estimates based on the assumptions that 100 percent of Interstate is Pavement Class I, the remainder of Pavement Class I is Non-Interstate NHS, and the remainder of Non-Interstate NHS is Pavement Class II. Pre-SB 1 funding for NHS pavements on the SHS is estimated to be $919 million per year. SB 1 funding for NHS pavements on the SHS is estimated to be $1,746 million per year, an annual increase of $827 million.

83 percent of SHS bridge deck area is on the NHS. Projected spending for SHS assets was multiplied by the percent of SHS assets located on the NHS to estimate future spending for NHS assets on the SHS. Pre-SB 1 funding for NHS bridges on the SHS is estimated to be $338 million per year. SB 1 funding for NHS pavements on the SHS is estimated to be $566 million per year, an annual increase of $228 million.

For local agencies, pre-SB 1 annual spending was estimated using the 2016 California Statewide Local Streets and Roads Needs Assessment report, which estimates $1.98 billion spent on local pavements

and $0.29 billion on local bridges annually. This is prorated based on the percent of assets located on the NHS, where approximately five percent of local pavements and 32 percent of local bridges are on the NHS. Table 6-5 summarizes baseline pre-SB 1 annual spending assumptions used in the analyses throughout this report.

Table 6-5. Baseline Spending Assumptions for Local Pavements and Bridges

Annual Spending for Local Pavements and Bridges			
Baseline Funding ($M)			
All Local Pavements		All Local Bridges	
$1,980		$290	
NHS Local Pavements (5%)	Non-NHS Local Pavements (95%)	NHS Local Bridges (32%)	Non-NHS Local Bridges (68%)
$99	$1,881	$93	$197

An estimate of $1.5 billion additional funding annually was projected for locally-owned roads and bridges. It is assumed that local agencies will continue to apply new SB 1 funds in proportion of NHS assets to total non-SHS inventory. Feedback from local agencies from TAMP workshops indicated that approximately 90 percent of SB 1 funds would be applied towards pavement and 10 percent towards bridges. Table 6-6 summarizes the model assumptions on the distribution of additional funding provided by SB 1.

Table 6-6. SB1 Funds Applied to Local Pavements and Bridges

Annual Spending for Local Pavements and Bridges			
SB 1 Additional Funds ($M)			
$1,500			
All Local Pavements		All Local Bridges	
$1,350		$150	
NHS Local Pavements (5%)	Non-NHS Local Pavements (95%)	NHS Local Bridges (32%)	Non-NHS Local Bridges (68%)
$68	$1,282	$48	$102

Table 6-7 summarizes estimated NHS asset management funding uses. Total estimated annual funding for asset management on the NHS is $1.9 billion for pavements and $707 million for bridges. Achieving performance targets for NHS pavements and bridges requires annual investment of $2.2 billion for pavements and $981 million for bridges.

Table 6-7. Summary of Estimated NHS Asset Management Funding Uses, by Owner

Pavements	Baseline (Pre-SB 1)		Expected (Post-SB 1)		Desired State of Repair	
	10-Year Total ($M)	Average Annual Funding ($M)	10-Year Total ($M)	Average Annual Funding ($M)	10-Year Total ($M)	Average Annual Funding ($M)
On the SHS						
All NHS	**$9,192**	**$919**	**$17,458**	**$1,746**	**$20,077**	**$2,008**
Interstate	$3,859	$386	$7,509	$751	$8,523	$852
Non-Interstate NHS	$5,333	$533	$9,949	$995	$11,553	$1,155
Off the SHS						
Non-Interstate NHS	$990	$99	$1,665	$167	$1,690	$169
Total						
All NHS	**$10,182**	**$1,018**	**$19,123**	**$1,912**	**$21,767**	**$2,177**
Interstate	$3,859	$386	$7,509	$751	$8,523	$852
Non-Interstate NHS	$6,323	$632	$11,614	$1,161	$13,243	$1,324
Bridges	**Baseline (Pre-SB1)**		**Expected (Post-SB1)**		**Desired State of Repair**	
	10-Year Total ($M)	Average Annual Funding ($M)	10-Year Total ($M)	Average Annual Funding ($M)	10-Year Total ($M)	Average Annual Funding ($M)
On the SHS						
NHS	$3,377	$338	$5,658	$566	$5,658	$566
Off the SHS						
NHS	$928	$93	$1,408	$141	$4,150	$415
Total						
NHS	**$4,305**	**$431**	**$7,066**	**$707**	**$9,808**	**$981**

Caltrans' two major funding programs for asset management activities are the HM Program and SHOPP. HM projects are preventive or corrective work intended to extend the life of physical assets. SHOPP projects are capital construction projects to rehabilitate or repair assets in fair or poor condition. Both the HM Program and SHOPP provide funds for improving or preserving the condition of pavements, bridges, drainage systems, and TMS assets. Caltrans strategically determines the amount of funding or split of SHOPP and HM funding needed to preserve or improve the condition from the initial construction of the asset to the preservation, rehabilitation and reconstruction work required. Maintenance funds, including state field crews, are used to maintain condition until the next recommended construction work activity.

Table 6-8 shows SHOPP and HM funding for the four primary asset classes on the SHS included in this TAMP: pavements, bridges, drainage systems, and TMS. These funding totals were taken from the 2017 SHSMP. The table presents three funding scenarios: the pre-SB 1 funding scenario represents SHS asset management funding before the passage of SB 1; the post-SB 1 funding scenario represents SHS asset management funding after the passage of SB 1; and the achieving targets scenario represents funding required to achieve the 10-year desired state of repair.

Pre-SB 1 funding for the primary assets on the SHS is $1.3 billion per year through SHOPP and $417 million through the HM Program, totaling $1.7 billion per year. SB 1 funding for the primary assets on the NHS is $2.8 billion per year through SHOPP and $417 million per year through the HM Program, totaling $3.2 billion per year. Achieving performance targets for SHS assets requires annual funding of $2.5 billion for pavements, $678 million for bridges, $494 million of drainage, and $211 million for TMS, totaling $3.8 billion.

Table 6-8. Summary of SHS Asset Management Funding Uses, by Program

	Baseline (Pre-SB 1)		Expected (Post-SB 1)		Desired State of Repair	
	10-Year Total ($M)	Average Annual Funding ($M)	10-Year Total ($M)	Average Annual Funding ($M)	10-Year Total ($M)	Average Annual Funding ($M)
SHOPP						
All SHS Pavements	**$8,757**	**$876**	**$18,647**	**$1,865**	**$18,647**	**$1,865**
Pavement Class I	$5,810	$581	$12,516	$1,252	$12,516	$1,252
Pavement Class II	$2,493	$249	$4,950	$495	$4,950	$495
Pavement Class III	$454	$45	$1,181	$118	$1,181	$118
Bridges	$2,736	$274	$5,470	$547	$5,470	$547
Drainage	$845	$85	$2,318	$232	$2,318	$232
TMS	$864	$86	$1,745	$175	$1,745	$175
Total	**$13,202**	**$1,320**	**$28,180**	**$2,818**	**$28,180**	**$2,818**
Highway Maintenance (HM)						
All SHS Pavements	**$2,430**	**$243**	**$2,430**	**$243**	**$5,960**	**$596**
Pavement Class I	$1,280	$128	$1,280	$128	$3,140	$314
Pavement Class II	$820	$82	$820	$82	$2,010	$201
Pavement Class III	$330	$33	$330	$33	$810	$81
Bridges	$1,310	$131	$1,310	$131	$1,310	$131
Drainage	$230	$23	$230	$23	$2,620	$262
TMS	$200	$20	$200	$20	$360	$36
Total	**$4,170**	**$417**	**$4,170**	**$417**	**$10,250**	**$1,025**
Total (SHOPP + HM)						
All SHS Pavements	**$11,187**	**$1,119**	**$21,077**	**$2,108**	**$24,607**	**$2,461**
Pavement Class I	$7,090	$709	$13,796	$1,380	$15,656	$1,566
Pavement Class II	$3,313	$331	$5,770	$577	$6,960	$696
Pavement Class III	$784	$78	$1,511	$151	$1,991	$199
Bridges	$4,046	$405	$6,780	$678	$6,780	$678
Drainage	$1,075	$108	$2,548	$255	$4,938	$494
TMS	$1,064	$106	$1,945	$195	$2,105	$211
Total	**$17,372**	**$1,737**	**$32,350**	**$3,235**	**$38,430**	**$3,843**

Source: 2017 State Highway System Management Plan

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7. Investment Strategies

Asset management investment strategies are the policies for resource allocation that will deliver the best asset performance given available funds and the goals and objectives of state and local agencies. Generating an asset management investment strategy involves assessing various funding scenarios designed to achieve and sustain a desired state of repair and deliver the program efficiently.

7.1. Overview

The investment strategies presented in this chapter build a foundation for TAM financial decisions by connecting the TAMP to ongoing funding and programming processes, examining TAM-eligible revenue sources, and allocating those resources amongst the major assets. California's investment strategies are shaped by earlier chapters of the TAMP, including Chapter 3. Asset Performance Targets, Chapter 4. Life Cycle Planning, Chapter 6. Revenues and Financial Projections, and Chapter 8. Risk Management. The investment strategies support progress towards achieving national and state goals and targets, as well as closing any performance gaps. The strategies incorporate asset modeling, treatments, and impacts, as well as risks and financial constraints.

The TAMP will help to ensure short and long-term resource allocation decisions are based on data and analysis, including consideration of engineering, life cycle cost, and risk analysis with investment strategies being developed to best manage the physical assets with the limited funding available and anticipated funding in the future. Many factors influence the magnitude of investments that are made towards maintaining and improving the NHS. In some cases, investment decisions are governed by law or the outcome of court settlements. In other cases, investments are dictated by terms of permits or policy-driven requirements for expenditures on specific transportation related activities.

Caltrans' investment strategies are presented in the 2017 SHSMP, which acts as the 10-year plan for SHOPP and the five-year plan for the maintenance program. The SHSMP's investment plan details strategies for asset classes, including pavements, bridges, drainage systems, and TMS. The SHSMP refers to Caltrans-owned assets, but this TAMP assumes that the investment strategies in the SHSMP are applicable to all NHS assets. Investment strategies for local agencies are discussed in the California Statewide Local Streets and Roads Needs Assessment, published in 2016.

7.2. Federal and State Requirements

Federal Requirements

FHWA requires that states include investment strategies as part of their transportation asset management plan. FHWA defines investment strategies as "a set of strategies that results from evaluating various levels of funding to achieve State DOT targets for asset condition and system performance effectiveness at a minimum practicable cost while managing risks." The asset management plan must discuss how the investment strategies make progress towards achieving DSOR over the life cycle of the assets in the plan, improving or preserving asset condition, achieving 2- and 4-year state DOT targets for NHS asset condition and performance, and achieving national performance goals. "Desired state of good repair" means the desired asset condition over the 10-year period of the TAMP, also referred to as 10-year DSOR in this plan.

FHWA requires that states establish a process for developing investment strategies as part of the transportation asset management plan. Specific requirements for the process are listed below.

Investment Strategies Process Requirements

The process must describe how investment strategies are influenced, at a minimum, by:

- Performance gap analysis
- Life cycle planning
- Risk management analysis
- Anticipated available funding and estimated cost of future work

State Requirements

State regulations require that California develop a robust asset management plan which meets the federal TAMP requirements and also includes assets on the SHS. The investment strategies should cover the four primary asset classes on the SHS.

7.3. Strategies

The alternative strategies in this chapter are high-level investment policies for California's transportation agencies. These strategies were generated from the strategies presented in the 2017 SHSMP, the strategies presented in the 2016 Local Streets and Roads Needs Assessment, and the current Caltrans Strategic Management Plan. These broad strategies are not mutually exclusive; the TAMP Final Rule

refers to a "set of strategies." The strategies in the California TAMP represent an investment philosophy of prioritizing preservation activities, seeking progress towards broad goal areas, focusing on selected asset classes, implementing sustainable pavement practices, and adopting Complete Streets[37].

Underlying the investment strategies are the performance targets and projections, life cycle planning, risk management analysis, and anticipated funding and cost of future work described in other chapters of the TAMP. The performance gap analysis, enabled by life cycle planning, helps define the investment needs of the system. Life-cycle plans use the estimated cost of future work to establish network level strategies for managing assets. Available funding is a constraint for performance modeling, allowing California to more accurately predict future scenarios. Risk management tempers the analysis, adjusting potential outcomes based on positive and negative risks. As described in Life Cycle Planning, vulnerability assessments are being conducted across all Caltrans Districts. Once completed, Caltrans will be able to identify and prioritize investments to the most vulnerable transportation assets. These asset management processes are required in the TAMP and contribute to the investment strategies continued below. But the strategies are what make the technical details meaningful at a network level and help communicate California's message of preserving asset condition and making progress towards state and national goals.

Fix It First

In 2014, Caltrans announced five new goal areas as part of the 2015-2020 Strategic Management Plan: Safety and Health; Stewardship and Efficiency; Sustainability, Livability and Economy; System Performance; and Organizational Excellence. Caltrans' asset management investment strategy, discussed in detail in the 2017 SHSMP, is to focus on preventive maintenance through Stewardship activities, also known as a "fix it first" approach. Preventive maintenance is intended to improve or preserve the condition of existing assets, rather than to expand system capacity. The benefit of this strategy is that it maintains asset condition at low cost over the life cycle of assets. However, it does not focus on system expansion and has an indirect focus on other goal areas.

System capacity expansion is largely funded through STIP, a federally-required capital improvement program that includes at least four years of projects. A STIP is a statewide effort that includes input from MPOs, tribal governments, and local governments. While STIPs are intended for capital improvements, many states use STIP funding to capitalize maintenance costs. In contrast, California draws a clear line between capital improvement projects and preservation projects. Instead of using STIP for stewardship activities, California uses SHOPP, a separate major capital program dedicated to rehabilitation and repair work.

SHOPP's 10-year investment plan is laid out in the SHSMP. The SHOPP investment plan follows a "fix it first" approach that prioritizes maintenance, rehabilitation, and safety improvements of the SHS. Stewardship activities performed through SHOPP include maintaining, rehabilitating, or replacing pavements, bridges, drainage systems, and TMS assets.

Caltrans puts significantly more money in SHOPP ($3.9 billion committed in FY 2018) than in STIP ($472 million committed in FY 2018), signaling the statewide focus on preservation over expansion. As noted

[37] Complete Streets, http://www.dot.ca.gov/transplanning/ocp/complete-streets.html

in the SHSMP, $30.2 billion of projected SHOPP funding is dedicated to Stewardship, representing 68 percent of all SHOPP funding over a 10-year period. The remaining $14.4 billion over a 10-year period will address other goal areas and will contribute to managing California's transportation assets.

The SHSMP also includes a maintenance investment plan. The maintenance investment plan focuses on preventive maintenance activities. Selecting and applying maintenance treatments can help preserve asset condition and extend asset life at low cost. Spending more on preventive maintenance for assets in good and fair condition can yield cost savings by avoiding or delaying the need for expensive rehabilitation or replacement of those assets. The SHSMP presents a baseline funding scenario in which Caltrans spends $4.2 billion over 10 years on maintenance of pavements, bridges, drainage systems, and TMS assets. That level of spending is projected to result in SHOPP cost avoidance of $1.9 billion over 10 years.

SB 1 also created RMRA for investing in infrastructure rehabilitation, signaling additional emphasis on a Fix It First approach. RMRA includes over $1 billion in annual funding for pavements and TMS maintenance and rehabilitation and $400 million in annual funding for bridges and drainage systems repair and maintenance. This investment strategy supports the five federal work types: maintenance, preservation, rehabilitation and reconstruction activities. Initial construction activities are primarily those that support operational improvements of the existing system.

Leverage Investments

The second Caltrans investment strategy is to leverage investments to support the full range of Caltrans and national goals. The SHSMP reorganized key activities into categories that align with the goal areas established in Caltrans' Strategic Management Plan and which also support national goals. Projects funded through SHOPP are not solely intended to improve or preserve asset condition. The benefit of this strategy is that California can make progress towards multiple goal areas with each investment. The drawback is a lack of focus on any specific goal area.

As explained in the SHSMP, SHOPP investment size by goal area is determined based on current and projected inventory, current condition, programmed work, expected deterioration rates, mandated funding levels, risks of inaction, historic investment levels, and the varying importance of preservation and rehabilitation needs.

Caltrans calculates performance targets for each objective in each goal area. The SHOPP investment plan allocates available funding to these objectives. Caltrans districts then develop multi-year project portfolios intended to achieve the stated performance targets for each goal area and objective. These project portfolios make up the project pool through which SHOPP programming is executed. Alignment with the goal areas means that SHOPP funding advances Safety, Sustainability, Performance and other goal areas in addition to Stewardship while also aligning with national goals.

Focus on Selected Asset Classes

The third Caltrans investment strategy is to focus on selected asset classes. As mentioned previously, the Commission designated pavements, bridges, drainage systems, and TMS as focus areas. The Commission selected these four asset classes as focus areas because they represent a significant portion of SHS maintenance and rehabilitation investments in California. The benefit of this strategy is to focus

on some of the most important assets on the highway system in California, as measured by vehicle-miles traveled and by asset value. The drawback is that supplementary assets on the SHS may need additional funding to meet performance targets.

The SHSMP has a projection of 10-year needs for a variety of assets beyond the four selected classes. To the extent that funds are limited, increased spending has been allocated for meeting the needs of the four selected asset classes. SB 1 also has funding dedicated to preserving those assets, directed through RMRA.

Sustainable Pavement Practices

An investment strategy for local transportation agencies in California is to implement sustainable pavement practices. As described in the 2016 Local Streets and Roads Needs Assessment, sustainable pavement practices include using reclaimed or recycled pavements. These technological efficiencies can result in cost savings, environmental benefits, increased pavement life, and other benefits. The benefit of this strategy is to reduce environmental impact, increase cost savings, and improve pavement life. The drawbacks include lack of experienced personnel, higher up-front costs, constructability issues, not enough technical information available, and more inspections from agency staff.

Complete Streets Policies

Another investment strategy for local transportation agencies is to adopt Complete Streets policies. As described in the 2016 Local Streets and Roads Needs Assessment, many local agencies have adopted Complete Streets policies, requiring that roadways be designed for all users. This ensures that investment in local pavements and bridges will make progress towards broad California transportation goals. The benefit of this strategy, similar to the benefit of leveraging investments, is that California can make progress towards multiple goal areas with each investment. The drawback is that Complete Streets projects may have higher costs and be more difficult to program.

Implementing Investment Strategies

Caltrans' Investment Plan utilizes all five Investment Strategies defined above as well as others to establish funding levels for each performance objective on the SHS. These performance objectives include not only the performance of NHS pavement, bridge, and other physical highway infrastructure asset condition, but also include performance deficiencies in safety, bridge seismic, bridge scour, and storm water mitigation. Unplanned needs such as emergency response is also considered and funded off the top, followed by triggered safety projects, and court ordered requirements. The four core assets are expected to meet 10-year performance targets as adopted by the Commission. Funding levels for all other performance objectives are established through trade-off analysis, which considers investment strategies, Caltrans strategic goals, statutory and funding constraints, and transportation priorities. The resulting investment allocation across objectives, inclusive of state-owned NHS pavements and bridges, represents an optimal balance, while assuring key performance targets are met.

The investment level in each performance objective is also determined by programmed work, current condition, judicial or legislatively-mandated funding levels, consequences of inaction, past investment

levels, and preservation needs versus rehabilitation consideration. Investment level establishment also considers the investment's impact on the system, existing pipeline of work, expected deterioration rates, and expected growth in inventory.

With investment levels established for each performance objective, a comprehensive Investment Plan is developed that sets performance targets and funding constraints for each of Caltrans' 12 districts. The Investment Plan development process is shown in Figure 7-1.

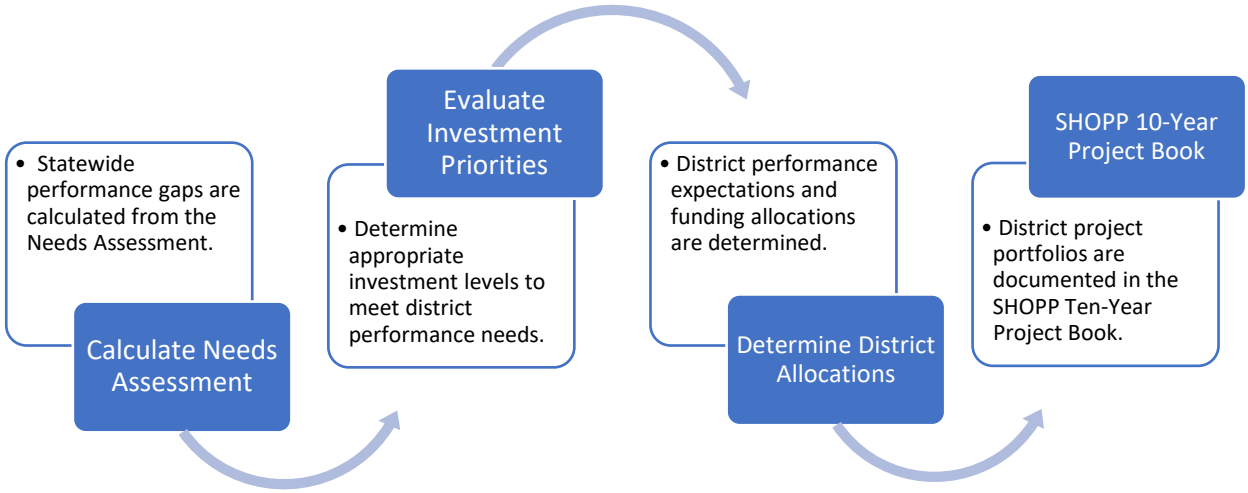

Figure 7-1 Development of the Investment Plan

Investment levels for each objective are converted to performance expectations and proportioned out to each of the Caltrans districts. Headquarters formalizes the 10-year performance expectations and associated funding allocations with each of the districts. Caltrans districts then use this information to develop multi-year project portfolios that collectively address the performance expectations within given funding constraints. The funding need for each asset type is calculated using average statewide unit costs but vary significantly through various regions and asset types. It is expected that through multi-objective project planning and efficiencies found in environmental and design processes, the districts can deliver on performances expectations and meet transportation system needs. These district project portfolios are updated to continually balance performance and available funding and are published on the Caltrans Asset Management website[38] in the SHOPP 10-Year Project Book. District-proposed projects advance through formal planning processes for programming in SHOPP. This approach ensures that the project portfolios proposed in future SHOPP cycles are consistent with statewide goals and objectives and align with and make progress towards the TAMP and SHSMP targets.

[38] Caltrans, SHOPP Ten-Year Project Book, http://www.dot.ca.gov/assetmgmt/cpp.html

8. Risk Management

Managing transportation assets entails managing risk. In the context of asset management, FHWA defines risk as "the positive or negative effects of uncertainty or variability upon agency objectives."

8.1. Overview

California must balance a wide variety of transportation related risks on an ongoing basis. FHWA defines risk management as "the processes and framework for managing potential risks, including identifying, analyzing, evaluating, and addressing the risks to assets and system performance." This includes day-to-day concerns such as risks that assets will deteriorate faster than expected or projects will cost more than budgeted, to the potentially catastrophic risks of asset failure caused by factors such as natural disasters. Climate change also presents a looming risk that will exacerbate all weather-related risks. Figure 8-1 depicts the risk management process and products as defined by FHWA's Asset Management Final Rule in 23 CFR Part 515.

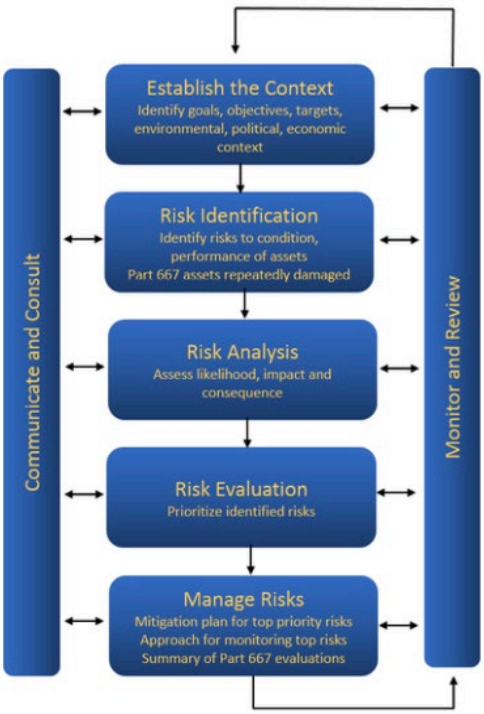

Figure 8-1. Risk Management Process and Products

Source: Federal Highway Administration (modified from ISO and the *AASHTO Guide for Enterprise Risk Management*)

Every transportation system faces a range of general types of risks, such as those listed below, as well as risks specific to the individual system and state. California is no exception and faces a number of risks because of the size of the transportation system, the varying geography and climate of the state, and the potential for extreme weather. For the purpose of the TAMP, Caltrans has defined seven basic categories of risks that may impact the TAMP, presented in Figure 8-2. These categories are explained in greater detail in the discussion of risk identification.

Figure 8-2. California Transportation Asset Management Risk Categories
Source: Caltrans

Considering risk is important in developing a TAMP for the simple reason that transportation agencies often must spend significant resources responding to and/or mitigating risks. Reacting to the uncertainty presented by risks can be more expensive than proactive management. Risk management strengthens asset management by explicitly recognizing that any objective faces uncertainty. Being proactive rather than reactive in managing risk, and avoiding "management by crisis," helps the State to best use available resources to minimize and respond to risk, as well as to further build public trust.

8.2. Federal and State Requirements

Federal Requirements

FHWA requires that states establish a risk management planning process for transportation asset management plans. Specific requirements for the process are listed below.

Risk Management Planning Process Requirements

- Identification of risks that can affect condition of NHS pavements and bridges and NHS performance, including risks associated with current and future environmental conditions
- Assessment of the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur
- Evaluation and prioritization of the identified risks
- Mitigation plan for addressing the top priority risks
- Approach for monitoring the top priority risks
- Summary, for NHS pavements and bridges, of the evaluations of facilities repeatedly damaged by emergency events

FHWA also developed guidance for integrating risk management into transportation asset management plans and processes. The guidance suggests seven keys to success:

1. High-level or top-down support
2. Robust analysis that demonstrates the long-term consequences of investment scenarios
3. An asset management program that incorporates risk into tradeoff scenarios
4. An asset management process that anticipates and mitigates external risks such as natural disasters
5. Integration of risk into asset and performance management processes
6. Communicating risks and engaging stakeholders
7. Continuous improvement of risk management skills and processes

State Requirements

State regulations require the development of a robust transportation asset management plan that meets the federal requirements and also includes four primary assets on the SHS. As part of meeting federal and state requirements, California's TAMP must include risk management for NHS pavements and bridges and SHS pavements, bridges, drainage systems, and TMS assets.

8.3. Risk Management Approach

Caltrans and local agencies are actively engaged in improving their approaches to risk management. This chapter identifies risks to the transportation system, discusses the approach to risk management in California, and discusses the initial risk assessment, evaluation, and prioritization.

Transportation Risk in California

California faces common risks to its transportation system. These risks, both internal and external, are listed below.

Common California Transportation System Risks

- Consistency, reliability of state, federal revenue over the decade of the plan
- Construction inflation, which can increase costs and reduce buying power
- Reliable project delivery
- Natural events such as floods, fires, earthquakes and similar climate events
- Lack of asset management maturity
- Changing agency, political priorities
- Availability and quality of data, models, information

The passage of SB 1 has provided a significant new consistent funding source for transportation in California. The influx of funding itself increases risks associated with project delivery and construction demands, as increased construction demand could drive up construction costs and impede project delivery if supply does not expand.

Natural events such as floods, fire, and earthquakes are unpredictable and have the potential to cause extensive damage, endangering California residents, crippling transportation systems, and in some cases severing vital links in the State's network of highway and rail lines. On January 17, 1994, the Los Angeles area experienced the 6.7-magnitude Northridge earthquake. This tragic event resulted in 57 deaths and over 8,000 injuries. As a result of the earthquake, a number of buildings collapsed or caught on fire, and there was extensive damage to highways, bridges and other infrastructure. This included the collapse of a portion of Interstate 5.

Geo-hazards are a particular concern in California, because of the topography and precipitation in certain parts of the state. Roads and bridges cutting across slopes are at risk for rock falls and landslides, especially when soaked by rain. On May 20, 2017, a landslide near Big Sur buried Highway 1, as shown in Figure 8-3, under an estimated 1.5 million tons of rock and mud, covering a section of the highway a third of a mile long. The landslide has left Big Sur isolated, creating extensive economic impacts, as the detour around the landslide requires an additional four hours of travel time per vehicle. It was the latest in a series of weather-related incidents in California beginning in the winter of 2016-2017, causing an estimated $1.3 billion worth of damage as of May 20, 2017 (not including the landslide).

Figure 8-3. SHS Big Sur, Highway 1 landslide May 20, 2017
Source: John Madonna, Caltrans

Climate change is both a risk itself and an accelerating factor for other TAM risks. Climate change increases uncertainty and variability, making it more difficult to manage opportunities and threats. The uncertainty of changing climate and rising seas poses numerous risks to the transportation network, including increased flooding and unpredictable and powerful weather systems. These negative effects could have a cascading effect, increasing erosion rates, exacerbating bridge scour, intensifying and enlarging geo-hazards, expanding areas vulnerable to flooding, and causing huge relocation, resilience, and reconstruction costs.

Other risks include a lack of asset management maturity, changing agency or political priorities, and availability and quality of data and models. These risks all have the potential of negatively impacting decision making, either through underdeveloped processes, misaligned priorities, or lack of supporting data.

To proactively address these risks, California state and local agencies have participated in a number of risk management efforts to identify, assess, prioritize, mitigate, and monitor risks. This TAMP risk management chapter is part of a broader risk management strategy in California.

The passage and signing of SB 1 by the legislature and governor are indicators of high-level support for risk management, as is statewide agency participation in Safeguarding California. The transportation asset management plan includes processes such as investment scenario analysis that incorporate consideration of risk. California is a clear and effective communicator of risks, using reports like *Safeguarding California* [39]to educate and engage stakeholders.

[39] California Natural Resources, "Safeguarding California Plan: 2017 Update", 2017, http://resources.ca.gov/climate/safeguarding/

Risk Management at Caltrans

Independently of developing the California TAMP, Caltrans practices risk management in many of its offices. These offices focus on specific categories of risk such as IT risk, emergency risk, and safety risk. The following summarize these existing efforts.

Risk Management at Caltrans

- **Enterprise Risk Management**–Director's Office of Innovation, Risk, and Strategic Management
- **Project Risk Management**–Project Delivery
- **Information Technology Security**–Information Technology
- **Emergency Risk Management**–Maintenance and Operations
- **Safety Risk Management**–Office of Health and Safety

Caltrans established the Office of Enterprise Risk Management in 2013 to perform biennial enterprise risk assessments and to consult with internal clients. As part of that work, Caltrans develops an Enterprise Risk Profile every two years using the *International Standards Organization (ISO) 31000 Risk Management Standard*[40]. Caltrans identifies the risks by district or program and evaluates the likelihood and impact of each risk. Caltrans most recently updated the Enterprise Risk Profile in 2015. Caltrans also has management approaches for project delivery risks, information technology security risks, emergency risks, and safety risks. Caltrans' risk management approach is codified in handbooks, guidance, and tools. The Office of Enterprise Risk Management evaluates TAM risks as well as other Caltrans risk areas.

TAM-Related Risk Mitigation Programs

Risk mitigation is a vital piece of any risk management approach. State and local agencies in California have a number of TAM-related risk mitigation programs. These programs deal with specific risk categories such as project risk, seismic risk, and climate change risk. A selection of these programs is presented below.

[40] ISO, "{International Standards Organization (ISO) 31000 Risk Management Standard", https://www.iso.org/iso-31000-risk-management.html

TAM-Related Risk Mitigation Programs

- Safeguarding California
- Project Risk Management Handbook
- Seismic Safety Retrofit Program
- Local Bridge Seismic Safety Retrofit Program
- Local Highway Bridge Program
- Local Bridge Preventive Maintenance Program
- Highway Safety Improvement Program
- Climate Change Resilience Pilots
- Transportation Vulnerability Assessments with Criticality Scoring and Adaptation Plans

Caltrans and local agencies have developed strong internal risk management cultures and codified risk management processes and programs in response to the risks to the California's vast transportation network.

Safeguarding California

California established a cross-agency effort to identify, assess, and mitigate climate change risks across the state. Directed by the state government, the Natural Resources Agency leads a process to update the state's climate change adaptation strategy every three years. The 2017 iteration, *Safeguarding California Plan: 2017 Update*[41], includes input from 26 state agencies representing 10 sectors: agriculture, biodiversity, emergency management, energy, forests, land use and community development, ocean and coast, public health, transportation, and water. The plan consists of a series of recommended adaptation strategies for each sector, as well as seven comprehensive state strategies.

The recommendations for adapting the transportation system to climate change were developed with the help of CalSTA, California High Speed Rail Authority (HSRA), and Caltrans. *Safeguarding California* lists the following five transportation recommendations:

1. Understand climate trends that impact transportation.
2. Complete analysis of vulnerability assessments, and prepare adaptation plans to address identified vulnerabilities.
3. Inform the transportation decision-making processes.
4. Improve transportation system resiliency.
5. Maintain and enhance information sharing and education.

Additionally, one of the comprehensive state strategies is to "increase investment in climate change vulnerability assessments of critical built infrastructure systems."

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[41] California Natural Resources, "Safeguarding California Plan: 2017 Update",2017, http://resources.ca.gov/wp-content/uploads/2017/05/DRAFT-Safeguarding-California-Plan-2017-Update.pdf

State and local agencies are already making progress towards these recommendations. According to *Safeguarding California*, Caltrans is studying climate change and conducting vulnerability assessments for the SHS, using projections of climate change. Climate stressors to the SHS include flooding, landslides, sea level rise, washouts, pavements deterioration, increased wildfires, and the buckling and rutting of roads due to extreme heat. The regional transportation assessments take into account the exposure of transportation assets to climate stressors as well as their criticality, or relative importance, based on use, stakeholder input, health and safety functions, and replacement costs. Caltrans is conducting vulnerability assessments and adaptation reports for all twelve Caltrans districts. This effort uses the most recent climate models and analysis methods and will include an update of District 1's vulnerability study in Humboldt County, conducted with FHWA, using new data and methods. By 2020, Caltrans will complete prioritization of the vulnerable portions of the SHS within each District.

Caltrans is supporting adaptation research and pilot projects, including a study of State Route 37 in the San Francisco Bay Area, a green infrastructure study on State Route 1 at Elkhorn Slough in Monterey, and adaptation plans in Humboldt County for Highway 101. To promote information sharing and education, Caltrans convenes and participates in climate adaptation workshops with local, regional, and federal partners, academia, and other transportation stakeholders. Caltrans also created an Integrated Planning Team with the California Coastal Commission to coordinate policy implementation between the agencies.

Increased funding from SB 1 includes support for local risk management efforts. SB 1 includes $20 million over three years for transportation adaptation planning grants, $25 million in annual funding for local growth planning, and $35 million for advanced environmental mitigation.

Project Risk Management Handbook

Caltrans' Project Risk Management Handbook[42] provides guidance to project managers and teams on risk management methodologies, techniques, and tools; identifies data requirements for risk management; and explains the role of risk management in the overall project management process. Project teams can use these resources to identify, assess, prioritize, and monitor project risks.

[42] Caltrans, "Project Risk Management Handbook: A Scalable Approach", 2012, http://www.dot.ca.gov/hq/projmgmt/documents/prmhb/PRM_Handbook.pdf

Seismic Safety Retrofit Program

The Seismic Safety Retrofit Program[43], created in the wake of widespread bridge failure during the 1989 Loma Prieta earthquake, identifies and retrofits existing state highway bridges to achieve compliance with current seismic safety standards. As of 2017, the Program had completed the retrofit of 2,202 of the 2,203 state highway bridges with identified seismic vulnerabilities at a cost of more than $12.2 billion. Figure 8-4 depicts typical improvements made as part of seismic retrofitting of freeway structures.

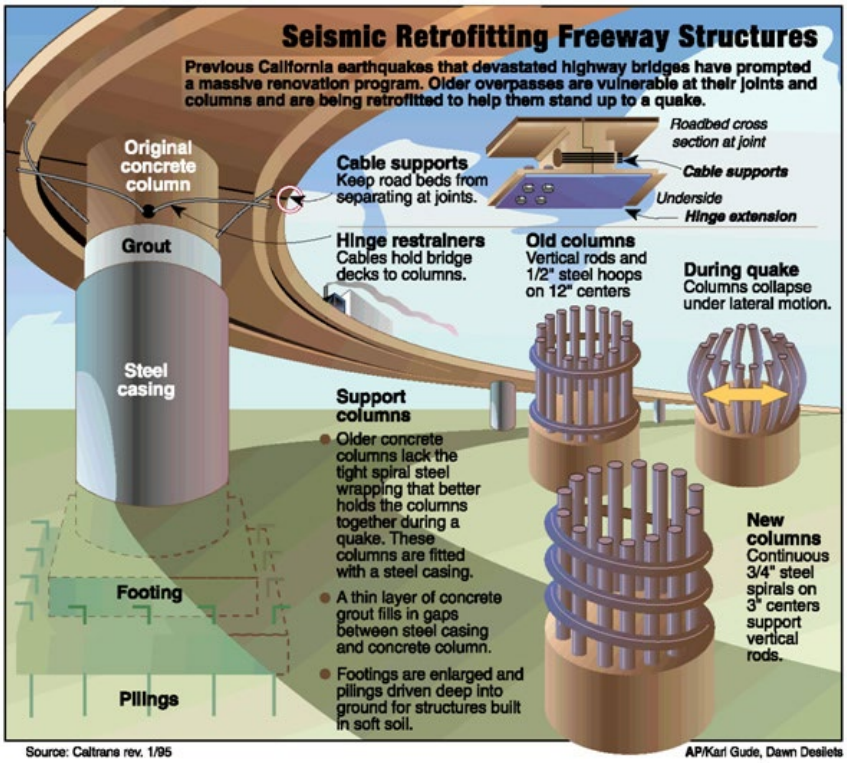

Figure 8-4. Seismic Retrofitting Freeway Structures Infographic
Source: Caltrans

Local Bridge Seismic Safety Retrofit Program

The Local Bridge Seismic Safety Retrofit Program[44] was established to provide funding assistance for public bridges owned by local agencies to achieve compliance with current seismic safety standards. As of October 2017[45], seismic retrofit work has been completed on 310 of the 376 bridges with identified seismic vulnerabilities.

Local Highway Bridge Program

This program funds the replacement or rehabilitation of locally-owned public highway bridges. Bridges are eligible for funding if they are rated as SD or functionally obsolete (FO) with a sufficiency rating of 80 or below. Roughly $300 million of federal funds are made available to local agencies annually for work including replacement, rehabilitation, painting, scour countermeasure, bridge approach barrier and railing replacement, low water crossing replacement, ferry service replacement, and preventative maintenance activities.

Local Bridge Preventive Maintenance Program

The Local Bridge Preventive Maintenance Program is part of the Local Highway Bridge Program and funds preventive maintenance activities. The purpose of the program is to maintain bridges in good or

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[43] Seismic Safety Retrofit Program, http://www.dot.ca.gov/hq/paffairs/about/retrofit.htm

[44] Caltrans, Local Bridge Seismic Safety Retrofit Program, http://www.dot.ca.gov/hq/LocalPrograms/seispage/main.htm

[45] California Transportation Commission, Local Seismic Safety Retrofit FY 2016-17 Fourth Quarter Report, 2017, https://bondaccountability.dot.ca.gov/MainMenuAction.do?>&page=SEISMIC

fair condition, mitigating the risk of accelerating bridge deterioration and rising costs. By completing preventive maintenance activities, local agencies can extend the service life of their assets and reduce costs over the life cycle of the assets.

Highway Safety Improvement Program

Highway Safety Improvement Program (HSIP) is a federal aid program which provides funds for making safety improvements to locally-owned public roads. HSIP guidelines dictate that states give special consideration to projects on high risk rural roads. The HSIP program incentivizes local agencies to identify and mitigate their greatest safety risks.

Climate Change Resilience Pilots

In 2011, the San Francisco Bay Area Transportation Vulnerability and Risk Assessment[46] Pilot Project was conducted to test a conceptual risk assessment model developed by FHWA to assess the climate change and sea level rise risks. The result of FHWA pilots was a climate change vulnerability assessment framework.

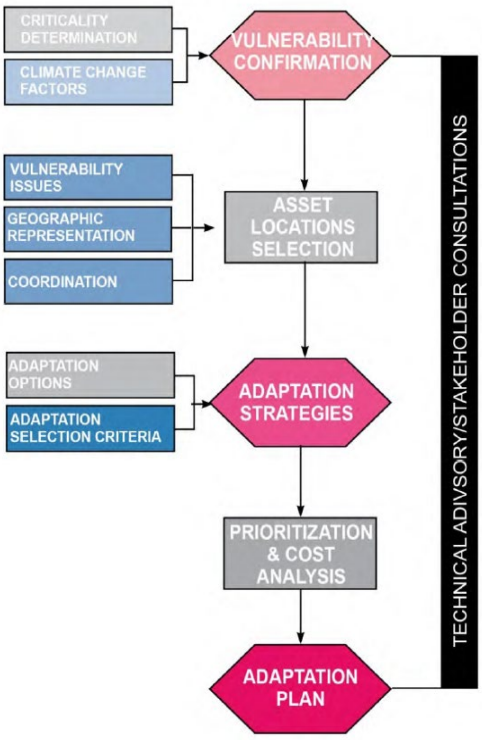

Figure 8-5. Asset Vulnerability Evaluation Process
Source: Final Report: District 1 Climate Change Vulnerability Assessment and Pilot Studies

In 2013, Caltrans Activities to Address Climate Change[47] documented GHG emission and adapting to impacts report. Later in 2014, California partnered with FHWA in a project to conduct climate change vulnerability assessments in District 1[48] and at four pilot sites. The pilots built on FHWA's climate vulnerability assessment framework and incorporated climate data and California site conditions. The project yielded a process for evaluating the vulnerability of transportation assets because of various climate change factors and the development of a tool to assess adaptation strategies for vulnerable assets. The process for assessing asset vulnerability is depicted in .

Transportation Vulnerability Studies with Criticality Scoring and Adaptation Plans

Caltrans is conducting vulnerability assessments and adaptation reports for all twelve Caltrans districts. This effort uses the most recent climate models and analysis methods and will include an update of District 1's (Eureka) vulnerability study, conducted with FHWA, using new data and methods. By 2020, Caltrans will complete prioritization of the vulnerable portions of the SHS within each district.

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[46] San Francisco Bay Conservation and Development Commission, "Adapting to Rising Tides: Vulnerability and Risk Report, 2012, http://www.adaptingtorisingtides.org/wp-content/uploads/2015/04/ART_Project_VR_Report_all_sm.pdf

[47] Caltrans, "Caltrans Activities to Address Climate Change", April 2013, http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/Caltrans_ClimateChangeRprt-Final_April_2013.pd

[48] Caltrans, "District 1 Climate Change Vulnerability Assessments and pilot studies FHWA Climate Resilience Pilot Final report", December 2014, http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/ccps.pdf

Other TAM Risk Reports

In addition to the risk mitigation programs list above, California agencies have developed the following reports which assess TAM-related risks.

Caltrans Activities to Address Climate Change

This report provides an overview of activities undertaken by Caltrans statewide to reduce GHG emissions and adapt the SHS to prepare for the impacts of climate change. This document also identifies activities that could yield further reductions in emissions and advances in climate change adaptation.

Sea Level Rise for the Coasts of California, Oregon, and Washington

The National Resource Council conducted this projection of sea level rise on the west coast for years 2030, 2050, and 2100. *Sea Level Rise for the Coasts of California, Oregon, and Washington*[49] is a valuable resource for state and local agencies preparing for the impacts of climate change, such as sea level rise, increased extreme weather, and higher storm surges.

8.4. Risk Identification

As part of the TAMP development process, Caltrans initiated and held a workshop specific to Risk that included NHS owners and stakeholders, to identify additional risks not otherwise addressed through existing processes or programs. As noted above, these have been organized into seven categories. These categories were defined based on the approach presented in the final report of *NCHRP Project 08-93, Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation*[50]. Table 8-1 details these risk categories, including a description of each category with example risks, and elements of risk management practices that could mitigate related risks.

Table 8-1 Caltrans Transportation Asset Management Risk Categories

Risk Cat.	Category Description	Elements of Risk Management
Asset Performance	Risks associated with asset failure (whether acute and complete or incremental). Areas of failure can include: • Structural • Capacity or utilization • Reliability or performance • Obsolescence • Maintenance or operation	• Regular, documented inspection programs • Documented allocation of funding for repair and maintenance • Documentation of competing resource demands • Determined intervention levels • Prioritization actions and documented reasoning

[49] The National Academies of Sciences Engineering and Medicine, "Sea Level Rise for the Coasts of California, Oregon, and Washington Past, Present and Future", 2012, https://www.nap.edu/catalog/13389/sea-level-rise-for-the-coasts-of-california-oregon-and-washington

[50] The National Academies of Sciences Engineering and Medicine, NCHRP Project 08-93, "Managing Risk Across the Enterprise: A Guidebook for State Departments of Transportation", June 2016, http://apps.trb.org/cmsfeed/TRBNetProjectDisplay.asp?ProjectID=3635

Risk Cat.	Category Description	Elements of Risk Management
Highway Safety	Risks to highway safety related to the asset management program: • Highway crash rates, factors and countermeasures • Safety performance of assets, maintenance and rehabilitation treatment options • Safety in project selection, coordination and delivery	• Safety-focused asset management programs (e.g., pavement friction program) • Network screening for safety hotspots for consideration within asset maintenance, rehabilitation and upgrade programs • Consideration of safety benefits/costs in asset management decision making (e.g., safety cost of repeated lane closures for maintenance) • Safety-related product evaluation (e.g., National Cooperative Highway Research Program (NCHRP)-350/Manual for Assessing Safety Hardware (MASH) product evaluation/approval program
External Threats	External threats include both human-induced and naturally occurring threats, such as: • Climatic or seismic events (e.g., extreme weather, flooding, earthquakes, slope failures and rock falls, lightning strikes) • Climate change • Terrorism or accidents • Paradigm-shifting technologies (e.g., automated vehicles)	• Incorporate potential impacts of climate change and new technologies into long term planning (sea level rise, extreme weather events, changing asset needs to support automated and connected vehicles etc.) • Identify and inventory external risks to existing infrastructure (e.g., seismic evaluations, security assessments, bridge scour programs) • Infrastructure inspection, replacement or retrofit programs to mitigate risks (e.g., slope stabilization, alarms to deter copper theft, operational changes to reduce wind loading) • Implement operational and emergency response programs to minimize impacts of asset failures because of external threats (e.g., staff training and planning, staging resources for response) • Programs to review and evaluate construction standards to ensure reasonable incorporation of resiliency to external threats
Finances	Risks to the long term financial stability of the asset management programs, including: • Unmet needs in long-term budgets • Funding stability • Exposure to financial losses	• Programs to forecast changes in revenue and costs (e.g., impacts of fuel efficient vehicles, flat tax structure, etc. on gas tax revenue) • Programs to maximize available fund sources for asset management (e.g., federalization of program) • Exploration of innovative financing opportunities for asset management programs (such as public-private partnerships, tolling, Energy Savings Contracts, etc.) • Exploration of innovative technologies to reduce maintenance and operational costs (e.g., LED lighting)
Information and Decisions	Risks related to the asset management program include: • Lack of critical asset information • Quality of data, modeling or forecasting tools for decision making • Security of information systems	• Enterprise data management programs and strategies • Robust information technology solutions emphasizing risk prevention, preparedness and recovery • Programs to address model risks (e.g., premature failure of pavements from underestimation of truck loading)

Risk Cat.	Category Description	Elements of Risk Management
Business Operations	Risks due to internal business functions associated with asset management programs, such as: • Employee safety and health • Inventory control • Purchasing and contracting	• "Safety first" culture within asset management programs–routine safety meetings, documented safety and standard operating procedures, workforce training, etc. • Robust systems and tools for work force, equipment, inventory, and contract management to reduce risks of theft, misuse, unnecessary storage or inaccurate estimates of program costs
Project and Program Management	Project and program management is a very mature area in U.S. transportation sector	Many programs and products exist here–extensive discussion of these risks and related programs, policy and procedure is likely not necessary

As described in FHWA's guidance for integrating risk management into a TAMP, there are multiple levels of risk for an agency: enterprise, program, project, and activity. The final report of NCHRP Project 08-93 defines these four levels of risk as shown in Figure 8-6. The risk categories shown in Table 8-1 cut across these risk levels. The risks presented in California's risk register are not currently organized by level of risk management.

On April 19, 2017, Caltrans convened a risk management workshop to support the TAMP risk management process. Caltrans had already developed a preliminary TAM risk register based on materials compiled previously by Caltrans' Office of Enterprise Risk Management. The workshop was held to refine the preliminary risk register, prioritize risks listed in the register, perform an initial, qualitative risk assessment, and based on this assessment, identify potential mitigation strategies and actions.

Figure 8-6. Levels of Risk

8.5. Risk Assessment

Caltrans developed a TAM risk register by performing an initial assessment of the risks identified through enterprise risk management efforts. A risk register is a simple spreadsheet or matrix that summarizes an organization's risks, how they are analyzed, and records how they will be managed. Risk registers can be customized for any organization. The risk register also can include a summary of how the risks will be managed, and by whom. The California TAM risk register uses a simple table format to capture risks, illustrate their estimated likelihood and impact, and record risk mitigation strategies and actions.

Risks are identified by category and risk statements in the risk register. These statements consist of two elements: a description of the risk event and a summary of its potential impact. For example:

Risk Event (if) *If California does not have reliable asset performance models (including reliable decay rates and reasonable goals)*

Potential Impact (then) *Then investment decisions will not be optimal*

In performing the assessment, workshop participants, including Caltrans staff and representatives of local agencies, used the risk matrix shown in Figure 8-7 to classify risks in terms of their likelihood and consequence, as well as to score each risk. The matrix includes five categories for likelihood (listed in the left column of the figure) and five categories for consequence (listed in the bottom row). The score of a risk is specified as "Very Low," "Low," "Medium," "High," "Very High" or "Ultra High" based on the combination of likelihood and consequence.

The same basic approach can be applied to assessing opportunities, but the focus of the workshop was to identify threats (risks with negative consequences). By definition these are the risks that should be mitigated.

Likelihood	Very Low (Insignificant)	Low (Minor)	Medium (Moderate)	High (Major)	Very High (Catastrophic)
Very High (>1x/Year)	Medium	Medium	High	Very High	Ultra High
High (~1x/Year)	Medium	Medium	Medium	High	Very High
Medium (1x/3 Years)	Low	Medium	Medium	High	High
Low (1x/10 Years)	Very Low	Low	Medium	Medium	High
Very Low (<1x/10 Years)	Very Low	Very Low	Low	Medium	Medium

Impact

Figure 8-7. Risk Matrix

8.6. Risk Prioritization, Potential Actions, and Mitigation Strategies

Table 8-2 presents the highest priority risks identified during the revision of the preliminary risk register. Workshop attendees reviewed the likelihood, consequence, and score of each risk in the register, and selected risks for further evaluation based on consideration of these and other factors, including the feasibility of mitigating the risk.

Federal regulations require that the TAMP include a mitigation plan for addressing top priority risks and an approach for monitoring those risks. The risks in this plan were generated as part of the risk management workshop. Following identification of highest priority risks, representatives of state and local agencies evaluated potential risk mitigation options and developed potential actions. A combination of stakeholder feedback and expert judgment will be used to select owner, completion date, and first steps. The risks are presented in descending priority order.

Table 8-2 High Priority Risks, Potential Mitigation Actions, and Mitigation Strategies

Rank	Category	Risk	Risk Score	Potential Mitigation Actions	Strategy
1	Highway Safety	If accident reporting is not modernized, we may not accelerate some factors of safety improvements.	High	• Improve the timeliness of reporting through process improvement and automating data sharing with partners • Identify ways to work with partners to more accurately account for accidents involving pedestrians and bicyclists that may be under reported as a proportion of accidents	• Streamline business processes to improve the timeliness of reporting, include other modes and automate data sharing with partners
2	Finances	If new dollars are not spent quickly enough, then the dollars could be redirected to other transportation needs.	Medium	• Innovative contracting • Increase staffing levels • Develop better narrative to educate/communicate with legislature about changes in performance management included in the TAMP	• Develop narrative to educate/communicate with legislature about changes in performance management included in the TAMP
3	Finances	If projects do not federalize and use state-only funds, we may lose federal dollars and may lose our redistribution.	High	• Innovative contracting • Increase staffing levels • Develop better narrative to educate/communicate with legislature	• Develop better narrative to educate/communicate with legislature

Rank	Category	Risk	Risk Score	Potential Mitigation Actions	Strategy
4	External Threat	If we don't plan for extreme weather events, then bridges, roadways, and structures will be damaged.	Very High	• Accelerate Safeguarding California five recommended actions (see page 8-7) • Plan for addressing identified vulnerabilities • Get data compiled and model • Drainage system cleaning (combine with other efforts)	• Get data compiled and modeled
5	Finances	If money is spent on the four core assets (bridges, pavements, drainage systems, ITS) most in need, there may not be money for assets later down the road and there may not be enough money to maintain the system as a whole.	Medium	• Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain the system as a whole	• Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain the system as a whole
6	Project and Program Management	If the Department and regions are unable to use innovative project delivery tools with the new funding, then it may take longer to deliver needed transportation work.	High	• Establish periodic review of expected vs actual projects delivered relative to TAMP projections	• Establish periodic review of expected vs actual projects delivered relative to TAMP projections
7	Business Operations	If we don't train and mentor employees, then we will have large knowledge gaps in the workforce.	High	• Improve risk training and mentoring programs • Improve knowledge transfer for risk management	• Improve training and mentoring programs
8	Asset Performance	If we make projects more complex (by the addition of multiple assets) and involve complete streets, etc., project delivery may be delayed.	High	• At project planning, use performance reporting and tracking to consider all issues and use 10 year plan and interim targets to set more realistic timeframes (reliability of schedule targets)	• At project planning, use performance reporting and tracking to consider all issues and use 10 year plan and interim targets to set more realistic timeframes (reliability of schedule targets)

Rank	Category	Risk	Risk Score	Potential Mitigation Actions	Strategy
9	Asset Performance	If we do not coordinate the needs of each asset class or project work, we may not be as efficient as possible (e.g., may be removing new pavements to place new culvert).	Medium	• At project planning, use performance reporting and tracking to consider all issues and use 10 year plan and interim targets to set more realistic timeframes (reliability of schedule targets)	• At project planning, use performance reporting and tracking to consider all issues and use 10 year plan and interim targets to set more realistic timeframes (reliability of schedule targets)
10	Information and Decisions	If we don't conduct succession planning and knowledge transfer, then Caltrans will lose efficiency and have greater exposure to error.	Ultra High	• Train broader set of staff and accelerate training • Improve mentorship opportunities • Find other organizations addressing succession and knowledge transfer	Train broader set of staff and accelerate training •
11	Information and Decisions	If we do not have reliable asset performance models (including reliable decay rates and reasonable goals), then investment decisions will not be optimal.	Very High	• Establish periodic review of TAMP performance models	• Establish periodic review of TAMP performance models
12	Finances	If the available funding does not cover our needs, then we still will have some deferred maintenance and operation's needs.	Medium	• Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain and operate the system	• Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain and operate the system
13	Information and Decisions	If we don't incorporate climate change into system planning models, assets may be permanently damaged, negatively impacting the transportation system.	High	• Coordinate needs for consideration of climate change with Caltrans staff responsible for resilience analysis	• Coordinate needs for consideration of climate change with Caltrans staff responsible for resilience analysis

Rank	Category	Risk	Risk Score	Potential Mitigation Actions	Strategy
14	Asset Performance	If we don't include ITS elements into roadway planning, then we may experience increased congestion, reduced freight mobility and impacts to the economy.	Medium	• Raise awareness • Involve more entities/stakeholders • Align IT with ITS risks • Coordinate info better • Improve project coordination to include ITS performance management in planning and project delivery of projects	• Improve project coordination to include ITS performance management in planning and project delivery of projects
15	Asset Performance	If SHOPP is not inclusive of congestion, relief benefits then mobility projects may receive less SHOPP funding.	High	• There is funding in the SHOPP focused on congestion and mobility that is balanced with other competing needs to consider alternative scenarios that address mobility performance measures	• Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios that address mobility performance measures

8.7. Summary of Transportation Assets Repeatedly Damaged by Emergency Events

As part of a separate rule issued by FHWA, state DOTs must perform periodic evaluation of facilities repeatedly requiring repair and reconstruction due to emergency events. According to FHWA, state DOTs "shall conduct statewide evaluations to determine if there are reasonable alternatives to roads, highways, and bridges that have required repair and reconstruction activities on two or more occasions due to emergency events." Evaluation is defined as "an analysis that includes identification and consideration of any alternative that will mitigate, or partially or fully resolve, the root cause of the recurring damage, the costs of achieving the solution, and the likely duration of the solution." Reasonable alternatives are defined as "options that could partially or fully achieve the following:

1. Reduce the need for Federal funds to be expended on emergency repair and reconstruction activities;
2. Better protect public safety and health and the human and natural environment; and
3. Meet transportation needs as described in the relevant and applicable Federal, State, local, and tribal plans and programs."

According to federal regulations 23 CFR part 667, this evaluation must consider the risk of recurring damage and cost of future repairs under current and future environmental conditions and how the evaluation can best inform the TAMP and STIP. Caltrans' SHOPP funds major damage, permanent restoration and protective betterment work as part of the SHSMP asset management process.

Department policy changes also includes removal of wood posts in fire prone areas for guard railing and signs; bridges are being raised for sea level rise, and culverts are sized for 100-year storms. Caltrans is collecting more information on locations repeatedly damaged including reasonable detour route locations and associated declared emergencies. Evaluations will be updated every four years as required by federal regulations.

Beyond the part 667 regulation, Caltrans also has legal authority by state contract law 10122 to set aside normal procedures for the advertising, bidding, and awarding of construction contracts due to an emergency or urgent situation through a formal document called a Director's Order (DO). This allows Caltrans to respond quickly and repair or reconstruct the facility that has been damaged. It may also be used to forestall an imminent threat or catastrophic damage. Federal funding reimbursement is requested under the Emergency Relief federal funding program and every effort is made to maximize federal participation, but a DO may move forward without it if it is deemed in the public's best interest to avoid delays and funding approvals.

Table 8-3 presents a list of bridges in California subject to multiple high load hits. Caltrans has evaluated DOs for major bridge damages from 2013 through 2017. This table is a summary of locations that had multiple emergency contracts on the same counties and routes for high load hits.

Table 8-3 Bridges Subject to Multiple High Load Hits

District	County	Structure	Route
2 - Redding	Siskiyou	KLAMATH RIVER	96
3 - Sacramento	Butte	GARDEN DRIVE OC	70
	Yuba	MARYSVILLE UP	70
4 - San Francisco	Napa	LINCOLN AVENUE OC	29
	San Francisco	BAYSHORE VIADUCT	101
	Solano	SPRINGS ROAD OC	80
5 - San Luis Obispo	Santa Barbara	CLARK AVENUE OC	101
6 - Fresno	Tulare	AVENUE 152 OC	99
	Tulare	COUNTY ROAD 164 OC	198
7 - Los Angeles	Los Angeles	SCHUYLER HEIM LIFT BRIDGE	47
	Los Angeles	E91-N710 CONNECTOR OC	91
	Los Angeles	ROUTE 210-710/E210 SEPARATION	210
	Los Angeles	210-134/E210 SEPARATION	210
8 - San Bernardino	Riverside	THEODORE STREET OC	60
	Riverside	MCCALL BLVD OC	215
	San Bernardino	GHOST TOWN ROAD UC	15

District	County	Structure	Route
	San Bernardino	MONTE VISTA AVENUE OC	60
	San Bernardino	BARTON ROAD OC	215
	San Bernardino	WASHINGTON AVENUE OC	215
9 – Bishop	Mono	SOUTH LANDING ROAD OC	395
10 - Stockton	Merced	APPLEGATE ROAD OC	99
	San Joaquin	SAN JOAQUIN RIVER (GARWOODS)	4
	San Joaquin	ROUTE 26/99 SEPARATION	26
	San Joaquin	FARMINGTON ROAD OC	99
	San Joaquin	WILSON WAY OC	99

Source: Caltrans

Figure 8-8 shows the same summary of locations in a map that had multiple emergency contracts in the same counties and routes for high load hits and other repeatedly damaged assets between 2006-2018.

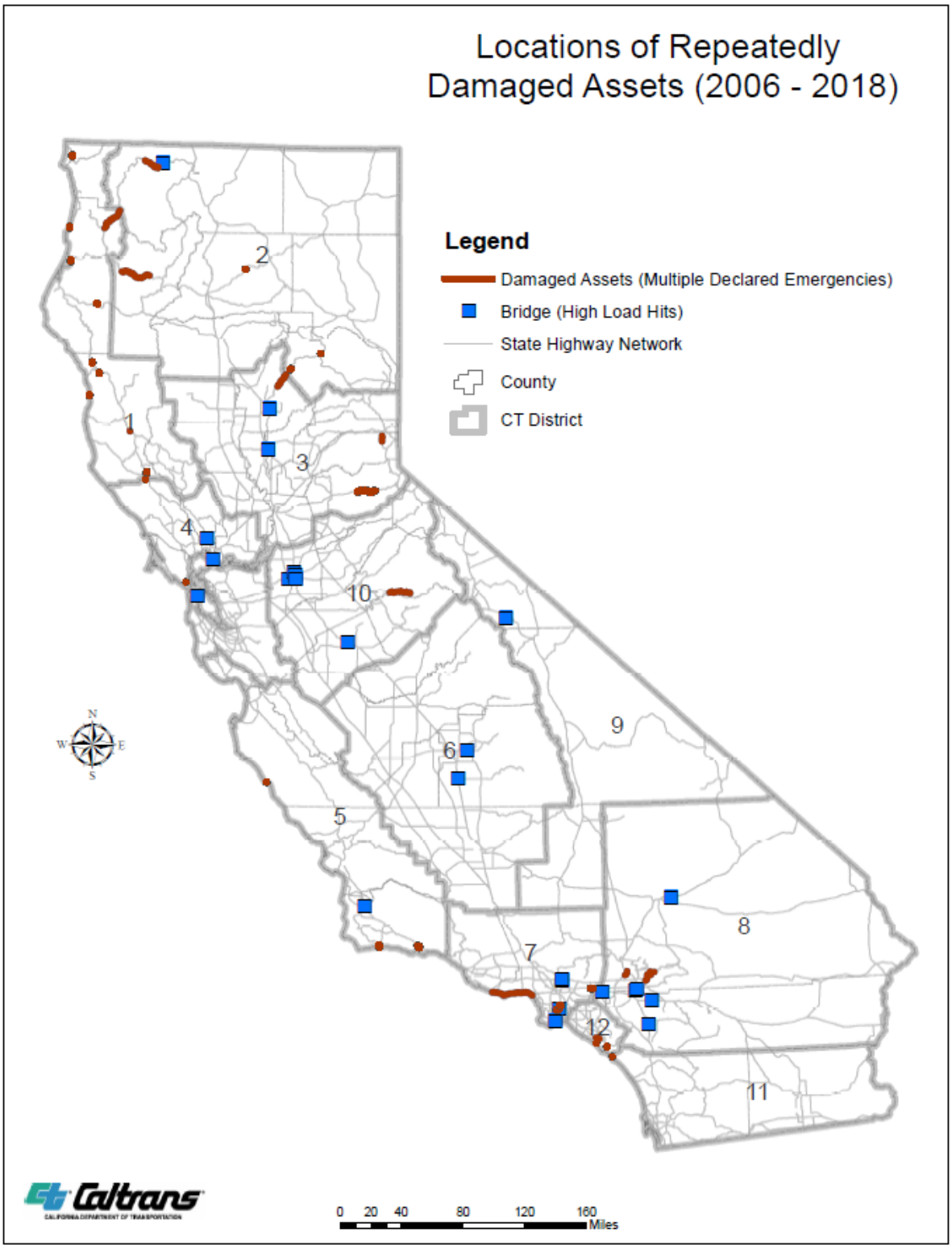

Figure 8-8. Repeated Damage Locations

Caltrans has evaluated repeatedly damaged assets including NHS pavement and bridges caused by landslides, rockfall, flooding, and erosion that have occurred due to more than one declared emergency associated with the location. Table 8-4 presents assets repeatedly damaged statewide. Figure 8-8, on the previous page, shows the same summary of these locations in a map that had multiple emergency contracts in the same counties and routes for major damage during this period.

Table 8-4 Repeatedly Damaged Assets by Location

District	County	Route	Emergency Event Type
1 – Eureka	Del Norte	197	Storms
	Humboldt	36, 96 & 101	Storms
	Mendocino	1 & 101	Storms
2 – Redding	Butte	70	Fire, Storms
	Plumas	70 & 89	Fire, Storms
	Shasta/Trinity	299	Storms
	Siskiyou	96	Storms
3 – Marysville	El Dorado	50	Storms
	Nevada	49	Storms
	Placer	89	Storms
4 – San Francisco	Marin	1	Storms
	Sonoma	128	Storms
5 – San Luis Obispo	Monterey	1	Storms
	Santa Barbara	101 & 154	Storms
7 – Los Angeles	Los Angeles	1, 10, 91, 105	Storms
8 – San Bernardino	San Bernardino	15, 330	Fire, Storms
10 – Stockton	Tuolumne	120	Fire, Storms
12 – Santa Ana	Orange	5, 73, 133	Fire, Storms

Source: Caltrans

8.8. Risk Mitigation Plan

Federal regulations require that the TAMP include a mitigation plan for addressing top priority risks and an approach for monitoring those risks. In addition to the mitigation efforts discussed in the previous section, Caltrans has also initiated research to help develop a statewide normalized risk scale so that we can begin to capture and consolidate system vulnerabilities and make investment decision for high priority locations.

As described in FHWA's guidance on incorporating risk management into asset management plans, risk monitoring and communication is an ongoing, continuous process. California is committed to transparency throughout the TAMP development process and has made efforts to include stakeholders at every step of the process, including at the risk management workshop where the risks were identified and prioritized. California's risk monitoring approach includes publishing the risks in the TAMP, reviewing and revising the risk register, and evaluating repeatedly damaged facilities due to emergency events.

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9. TAM Process Improvements

This chapter supplements the discussion of the current state of asset management practice in California with a set of planned future asset management-related improvements. Transportation asset management is a process of continual improvement. The TAMP will evolve and be updated alongside California's asset management-related business processes and activities.

9.1. Overview

Good transportation asset management is a continuously improving set of practices. California has been improving TAM programs and data, making progress towards aligning them with state goals and targets. This chapter of the TAMP details how California will implement TAM performance improvements in the TAMP and focus on specific initiatives to achieve better TAM performance. The improvements listed in this chapter were developed collaboratively by a group of federal, state, regional and local stakeholders to benefit agencies throughout California.

9.2. Federal and State Requirements

Federal Requirements

FHWA requires that a state DOT update its asset management plan and development processes every four years. FHWA recommends that state DOTs conduct periodic self-assessments of asset management capabilities. As written in the TAMP Final Rule, "based on the results of the self-assessment, the State DOT should conduct a gap analysis to determine which areas of its asset management process require improvement. In conducting a gap analysis, the State DOT should:

1. Determine the level of organizational performance effort needed to achieve the objectives of asset management,
2. Determine the performance gaps between the existing level of performance effort and the needed level of performance effort, and
3. Develop strategies to close the identified organizational performance gaps and define the period of time over which the gap is to be closed."

Subsequent improvements to TAM processes will be documented in future updates to this TAMP.

9.3. TAM Process Improvements

Throughout the process of developing the California TAMP, workshops were held with stakeholders including regional and local agencies responsible for parts of the NHS, FHWA, and representative members of Caltrans from headquarter offices and districts. In the first workshop held on December 15, 2016, the participants focused on identifying strategies that will link asset management with the overall California transportation goals and fundamental objectives. The group also determined actions that will support the gaps between current practice and desired practice.

On September 21, 2017, California TAMP project stakeholders participated in a workshop in Sacramento to build agreement on potential TAM process improvements. At the workshop, the building blocks for the TAMP were presented along with outstanding issues for the chapters of the TAMP. After this presentation, this interactive workshop included an exercise to develop TAM improvement initiatives.

California TAMP stakeholders identified priority TAM improvements that would support the defined objectives in the chapters of the draft TAMP. The results of the workshop are shown below. They represent the initiative areas that will be undertaken to make progress on TAM performance resulting in a better transportation system for California and to meet federal and state requirements.

Data and Tools

Data-driven decision making is well understood and a part of many of the business processes that exist for TAM in California. Developing the TAMP identified areas of weakness and many opportunities to strengthen investment decisions in the future. An effort to make progress on data improvements and tool availability to support TAM will be initiated. This effort will prioritize and sequence the set of data and tool improvement actions. It will also identify the coordination needed to ensure that the data will be aligned across assets and jurisdictions. The following are highlights of needs raised by the stakeholders.

- Bicycle and pedestrian program data and technology
- Consistent data about local needs, systems, and assets
- Crowdsourced asset condition information
- Common terminology
  - Data definitions/dictionary
- Data quality and accuracy
  - Data updating
- Data collection

  - Shared services
  - Crowdsourcing
  - Greater efficiency
- Data access portal
  - California clearing house for NHS data
- Data sharing
- New data to related TAM with other transportation objectives and risk
- Geographic Information System (GIS) support of TAM data

Local, Regional, and State Coordination

The need to better coordinate local, regional, and state decision-making about assets was apparent throughout the workshops. The participants saw this as an opportunity to seed improved coordination across agencies to deliver a better transportation experience to California's travelers. The following are highlights of needs raised by the stakeholders.

- Ability to see a holistic view of assets throughout the state
- Integration of local needs with state investment decision-making
  - Establish a process to capture in a consistent way local project data needs and priorities on the NHS (e.g., a process to drive TAM investment based on equity)
- Sharing project plans
- MAP-21/FAST Act performance measurement coordination (PCI vs IRI)
- Coordination on a common permitting process
- Determine roles and governance
- Define communication and coordination process and protocol
- Define working groups and process for moving forward with this initiative
- Coordinate with the data improvement initiative
- Coordinate development of improved LCP practices

Asset Modeling

Investment decision-making is based on an understanding of asset behavior given funding availability and choices of actions to improve asset condition and meet other transportation objectives. Making the right choices at the right time is an important tenet of TAM. California's transportation agencies have been at the forefront of developing asset models to make good life cycle management decision during the resource allocation process. Stakeholders identified the need to continue to improve the understanding of pavement and bridge assets and the need to better understand other asset classes as they are included in the TAMP. The first set of additional assets will be drainage and TMS assets. Many other assets are planned to be included in the upcoming years. The following are highlights of needs raised by the stakeholders.

- Climate change projections and return periods for climate events
- LCP improvements to reach optimum maturity
- Improve LCP treatments and costs based on environmental changes and laws
- Make deterioration models for assets more accurate
- Support decision-making at the network level and at the project level

TAM Support for Broader Transportation Objectives

California's transportation goals and fundamental objectives address support for improvements in areas such as safety, mobility, economic development, social equity, sustainability, and environmental mitigation. Understanding where and how transportation assets can better support these areas is important during the planning, programming, and implementation process. Some of these opportunities include how asset condition influences safety, support active transportation, provide access to disadvantaged communities, and allow for goods movement. A better understanding of these relationships is needed and integrated into the investment decision-making process. The following are highlights of needs raised by the stakeholders.

- Determine performance measures that help understand these relationships
- Gather information about the objective areas and relate them to TAM
- Prioritize the relationships where TAM will have greater impact

Corridor View of TAM Investment Decision-Making

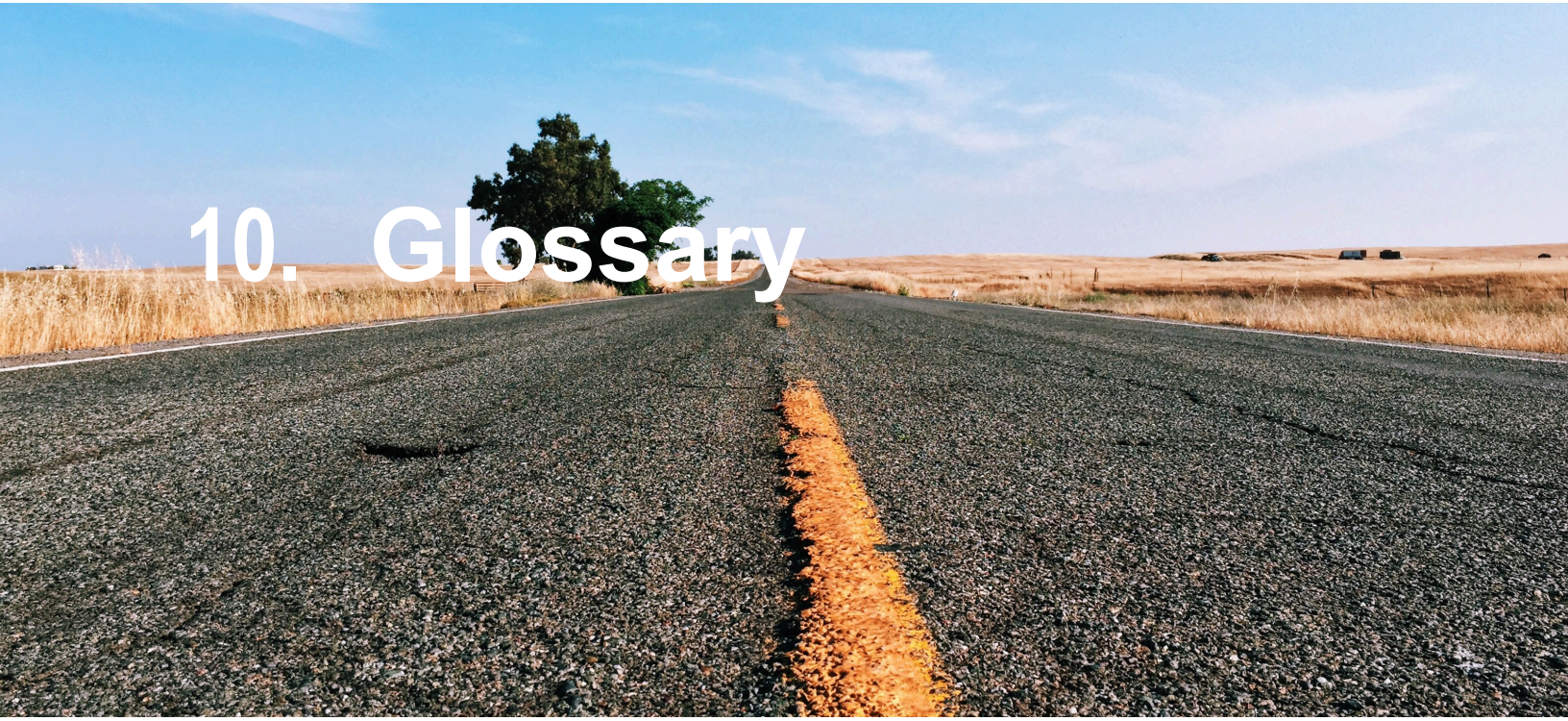
Many California travelers move via existing high-volume corridors. Investment decision-making related to assets can be enhanced using corridor planning and management. Corridor views will support the NHS focus of the federal requirements and support collaborative decision-making across local, regional, and state agencies. Moving forward with this priority we will first look at existing corridor planning and management processes and explore how these can be enhanced with the addition of asset needs. Other activities will look at identification of other corridors based on travel volume and asset needs.

Risk Mitigation

Much has been done across the state through various risk mitigation programs to safeguard California for a more resilient transportation system as discussed in Chapter 8. Integrating risk management decisions with assets has been an ongoing practice with project delivery. More is being done to evaluate risk with life cycle planning. Work is ongoing to establish implementation next steps, owners and completion dates for how the risk mitigation plan will be implemented. The integration of risk into asset management is critical to achieve a resilient system of assets.

TAM Communications

The stakeholders involved in the TAMP development process recognized the value and importance of better communicating TAM needs and accomplishments. Ideas for improved TAM communications include the sharing of data, success stories and providing templates for communications with the various media that exist for communicating to constituencies.



10. Glossary

AASHTO	American Association of State Highway and Transportation Officials
ADA	Americans with Disabilities Act
ADT	Average Daily Traffic
AMBAG	Association of Monterey Bay Area Governments
APCS	Automated Pavement Condition Survey
BCAG	Butte County Association of Governments
BIRIS	Bridge Inspection Report Information System
CalSTA	California State Transportation Agency
Caltrans	California State Department of Transportation
CAPM	Capital Preventative Maintenance
CCTV	Closed Circuit Television
Census	Traffic Census Station
CHP	California Highway Patrol
CIP	Culvert Inspection Program
CMS	Changeable Message Sign
CFR	Code of Federal Regulation
Commission	California Transportation Commission
Detection	Traffic Monitoring Detection Station
DOT	Department of Transportation
DPP	District Performance Plans
DSOR	Desired State of Repair
EMS	Extinguishable Message Sign
FAST Act	Fixing America's Surface Transportation Act
FCOG	Fresno Council of Governments
FHWA	Federal Highway Administration
FO	Functionally Obsolete
GCTC	Glenn County Transportation Commission
GHG	Greenhouse Gas
GIS	Geographic Information System
HAR	Highway Advisory Radio

HCAOG	Humboldt County Association of Governments
HM	Highway Maintenance Program
HPMS	Highway Performance Monitoring System
HSIP	Highway Safety Improvement Plan
HSRA	California High Speed Rail Authority
HTF	Highway Trust Fund
ICM	Integrated Corridor Management
IRI	International Roughness Index
ISO	International Standards Organization
ITS	Intelligent Transportation Systems
KCAG	Kings County Association of Governments
Kern COG	Kern Council of Governments
LCCA	Life Cycle Cost Analysis
LCP	Life Cycle Planning
LCTC	Lassen County Transportation Commission
LM	Lane Mile
LOS	Level of Service
M&O	Maintenance and Operations
M&R	Maintenance and Rehabilitation
Madera CTC	Madera County Transportation Commission
MAP-21	Moving Ahead for Progress in the 21st Century
MASH	Manual for Assessing Safety Hardware
MCAG	Merced County Association of Governments
MODA	Multi-Objective Decision Analysis
MOU	Memorandum of Understanding
MPO	Metropolitan Planning Organization
MTBF	Mean Time Before Failure
MTC	Metropolitan Transportation Commission
NBI	National Bridge Inventory
NCHRP	National Cooperative Highway Research Program
NHS	National Highway System
PaveM	Pavement Management System
PCI	Pavement Condition Index
PID	Project Initiation Document
PV	Present Value
RMRA	Road Maintenance and Rehabilitation Account
RTPA	Rural Transportation Planning Authority
RWIS	Roadway Weather Information System
SACOG	Sacramento Area Council of Governments
SANDAG	San Diego Association of Governments
SB 1	Senate Bill 1
SB 486	Senate Bill 486
SBCAG	Santa Barbara County Association of Governments
SCAG	Southern California Association of Governments
SD	Structurally Deficient
SHA	State Highway Account
SHC	California Streets and Highway Code
SHOPP	State Highway Operation and Protection Program

SHS	State Highway System
SHSMP	State Highway System Management Plan
SJCOG	San Joaquin Council of Governments
SLOCOG	San Luis Obispo Council of Governments
SM&I	Structure Maintenance and Investigation
SMART	Structure Maintenance Automated Report Transmittal
SRRA	Safety Roadside Rest Area
SRTA	Shasta Regional Transportation Agency
StanCOG	Stanislaus Council of Governments
STIP	State Transportation Improvement Program
STRAHNET	Strategic Highway Network
TAM	Transportation Asset Management
TAMAC	Transportation Asset Management Advisory Committee
TAMP	Transportation Asset Management Plan
TCAG	Tulare County Association of Governments
TMC	Transportation Management Center
TMPO	Tahoe Metropolitan Planning Organization
TMS	Transportation Management System
TOT	Transient Occupancy Taxes
VMT	Vehicle Miles Traveled

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11. Appendix A. Workshops

To be successful, California's Transportation Asset Management Plan must combine the best ideas, needs, and practices of the state's many transportation professionals, as well as transportation users, and transportation interest group members. Without the participation of the transportation community, no plan could reflect the needs and goals of the people most affected by changes in transportation planning and funding. As the plan records statewide asset inventory and condition, the identification of gaps and target setting requires the input of local transportation managers in every area. Local contributions to asset condition and performance goals will build the complete state picture mandated by the federal government.

Workshops

Appendix A discusses the workshops used to collect this information from our partners statewide and Appendix B discusses the feedback tools and processes used to collect information and displays a summary of the input received, the organizations which responded, and the changes made to the draft Plan.

To make sure information was obtained from as broad a perspective as possible, workshops were held in different parts of the state. Project stakeholders from around the state were invited and encouraged to participate. Workshops focused on collecting input on goals and objectives, risk management,

financial planning, and building the transportation asset management plan. Input from the workshops helped build agreement on shared transportation goals, objectives and priorities.

Following are the location, date, and goal of each workshop, along with a list of the many entities represented at each. Further details on these workshops can be found at the following link: http://www.dot.ca.gov/assetmgmt/workshop_surveys.html

Goals and Objectives Workshop

December 15, 2016
Holiday Inn Downtown Sacramento, California

A kick-off workshop was held with stakeholders to build agreement on shared transportation goals, objectives, and priorities. The workshop resulted in an improved collective understanding of California's TAM goals and objectives, clearer, more focused strategic direction for the development of the TAMP, and identification of prioritized immediate actions. Workshop attendees generated and prioritized a set of TAM strategies as well as prioritized TAM improvements and a list of "quick hit" improvements that could be implemented in the short term.

Workshop Attendees

Caltrans
Federal Highway Administration
California Transportation Commission
California Bicycle Coalition
Alameda County Public Works
Association of Monterey Bay Area Governments
Colusa County Transportation Commission
El Dorado County Transportation Commission
Placer County Transportation Planning Agency
San Joaquin Council of Governments
Santa Barbara County Association of Governments
Shasta Regional Transportation Agency
Sonoma County Transportation Authority
Stanislaus Council of Government
Tahoe Metropolitan Planning Organization
Transportation Agency for Monterey County
Tuolumne County Transportation Council

Risk Management Workshop

April 19, 2017
Caltrans District 7, Orange County, California

This workshop focused on developing the initial risk register and risk mitigation strategies for California. As part of the workshop, attendees analyzed the preliminary risk register and identified potential risk mitigation strategies and actions. The workshop resulted in an improved understanding of California's TAM risks and a revised risk register with prioritized risks, strategies, and actions.

Workshop Attendees

Caltrans
Federal Highway Administration
California Transportation Commission
Association of Monterey Bay Area Governments
City of Bakersfield
City of Riverside
City of Stockton
County of Riverside Transportation
Fresno Council of Governments
Kern Council of Governments
Kings County Association of Governments
Madera County Transportation Commission
Mendocino council of Governments
Merced County Association of Governments
San Benito County Council of Governments
San Joaquin County
San Diego Association of Governments
Santa Clara Valley Transportation Authority
Santa Barbara County Association of Governments
Southern California Association of Governments
Shasta Regional Transportation Agency
San Louis Obispo Council of Governments
Tulare County Association of Governments
Tuolumne County Transportation Council

Financial Plan and Investment Strategies

June 14, 2017
Caltrans District 4, Oakland, California

Stakeholders met to review available transportation funding and asset performance projections, recommend funding assumptions for NHS assets, and influence the development of the financial plan and investment strategies components of the TAMP. Workshop attendees developed and prioritized a series of questions and recommendations on the investment prioritization process.

Workshop Attendees

Caltrans
Federal Highway Administration
California Transportation Commission
California Bicycle Coalition
Association of Monterey Bay Area Governments
City of Bakersfield
Contra Costa County
Fresno Council of Governments
Los Angeles County
Metropolitan Transportation Commission
Santa Barbara County Association of Governments
Santa Clara Valley Transportation Authority
Sonoma County Transportation Authority
Southern California Association of Governments
Tulare County Association of Governments
U.S. Department of Transportation Maritime Administration

Pavement and Bridge Performance Management Target Setting Workshop

August 31, 2017
Holiday Inn Downtown Sacramento, California

This educational workshop was held to help stakeholders understand state and federal processes for setting pavement and bridge performance targets as required by the TAMP development process. This workshop, one of the largest to date, included 50 attendees in person with another 40 attending on line.

Workshop Attendees

Caltrans
Federal Highway Administration
California Transportation Commission
Association of Monterey Bay Area Governments
Fresno County Association of Governments
Kern County Association of Governments
Metropolitan Transportation Commission
Placer County Transportation Authority
San Diego Association of Governments
Santa Barbara Council of Governments
Shasta Regional Transportation Association
Southern California Association of Governments
Stanislaus Council of Governments
Tulare Council of Governments

Building the California TAMP Workshop

September 21, 2017
Holiday Inn Downtown Sacramento, California

This workshop focused on the major accomplishments of the TAMP development effort. This interactive strategic session resulted in a shared understanding of the building blocks of the TAMP that have been developed to date, open issues and gaps, based on input from workshop attendees, and key themes, messages, and the overall "story" for communicating the TAMP.

Workshop Attendees

Caltrans
Federal Highway Administration
California Transportation Commission
City of Bakersfield
Association of Monterey Bay Area Governments
Fresno County Association of Governments
Kern County Association of Governments
Los Angeles County Public Works
Mendocino Council of Governments
Metropolitan Transportation Commission
San Diego Association of Governments
Santa Clara Valley Transportation Authority
California Association of Council of Governments

12. Appendix B. Feedback

To be successful, California's transportation asset management plan must combine the best ideas, needs, and practices of the state's many transportation professionals, as well as transportation users, and transportation interest group members. Without the participation of the transportation community, no plan could reflect the needs and goals of the people most affected by changes in transportation planning and funding. As the plan records statewide asset inventory and condition, the identification of gaps and target setting requires the input of local transportation managers in every area. Local contributions to asset condition and performance goals will build the complete state picture mandated by the federal government.

Input from Partners and Stakeholders

Appendix A discusses the workshops used to collect this information from our partners statewide and Appendix B discusses the feedback tools and processes used to collect information and displays a summary of the input received, the organizations which responded, and the changes made to the draft Plan.

As workshops concluded, the workshop presentations and hand-out materials were posted to the Caltrans Asset Management webpage. Information gathered in the workshops helped in drafting the TAMP. Once the draft TAMP was prepared, it was sent out for public review. The public comment period began on October 31, 2017, and continued through November 24, 2017. The public comment

period was announced to the public in various formats. The draft TAMP public review period was first announced at a presentation in October 2017 at a California Transportation Commission meeting. The Caltrans Public Information Office issued a press release that was sent to media outlets, the Caltrans Local Assistance Program posted an announcement on their blog that was distributed to their partners statewide, and the Caltrans Asset Management Office emailed a link to the draft to those that had participated in prior workshops. Caltrans developed a survey for collecting responses and posted both the survey and the draft TAMP on the Caltrans Asset Management webpage.

Correspondence

One of the formal letters prepared by Caltrans to MPOs for the establishment of 2 and 4-year NHS pavement and bridge targets is included below:

STATE OF CALIFORNIA—CALIFORNIA STATE TRANSPORTATION AGENCY EDMUND G. BROWN Jr., Governor

DEPARTMENT OF TRANSPORTATION
OFFICE OF THE DIRECTOR
P.O. BOX 942873, MS-49
SACRAMENTO, CA 94273-0001
PHONE (916) 653-2572
FAX (916) 653-5776
TTY 711
www.dot.ca.gov

Making Conservation a California Way of Life.

May 21, 2018

California Regional Transportation Planning Agencies:

In accordance with Federal Regulation (23 U.S.C. 150), the California Department of Transportation (Caltrans) hereby establishes the California statewide National Highway System (NHS) 2 and 4-year pavement and bridge condition targets.

Information provided by the California Metropolitan Planning Organizations (MPOs) and Regional Transportation Planning Agencies (RTPAs) was combined with targets for the state owned NHS to develop the results shown in the table below. Statewide targets were calculated using a quantity weighted approach that considers Caltrans and regional agency condition expectations in statewide aggregate targets. The agency specific targets submitted by each MPO/RTPA are shown in the attached spreadsheet.

Statewide Targets				
Pavement and Bridge Performance Measures	2-Year NHS Targets (1/1/2018 - 12/31/2019)		4-Year NHS Targets (1/1/2020 - 12/31/2021)	
	Good	Poor	Good	Poor
Pavements on the NHS				
Interstate	45.1%	3.5%	44.5%	3.8%
Non-Interstate	28.2%	7.3%	29.9%	7.2%
Bridges on the NHS	69.1%	4.6%	70.5%	4.4%

With the availability of Senate Bill 1 (SB1) and local measure funds, the California Transportation Asset Management Plan (TAMP) anticipates improved condition over the next 10-year time horizon. Given the project planning, design and construction timeframes involved, in a number of cases, this improved performance falls outside of the 2 and 4-year window being reported. The full benefits of this additional funding is expected to be realized beyond a 4-year time horizon in many cases.

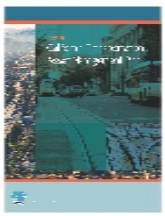
"Provide a safe, sustainable, integrated and efficient transportation system to enhance California's economy and livability"

Asset Management Plan Press Release

New Transportation Asset Management Plan Out for Public Comment

Plan Shows Stark Differences in Future Highway Conditions With & Without SB 1 Funding

Date: November 3, 2017
District: Headquarters
Contact: Vanessa Wiseman
Phone: (916) 654-2936
Contact: Tamie McGowen
Phone: (916) 657-5060



SACRAMENTO — Caltrans has released for public comment the draft California Transportation Asset Management Plan (TAMP), a new data-driven policy that will inform future investment decisions for maintaining California's highway infrastructure today and into the future. The TAMP lays out substantial performance targets for California's transportation system, but shows that California will be on track to meet those targets, thanks to the impact of anticipated funds from the Road Repair and Accountability Act of 2017 (SB 1).

> "The snapshot given in the TAMP shows what years of deferred maintenance and underfunding have done to California's transportation infrastructure. Fortunately, the TAMP also illustrates that we can get our infrastructure system back on track thanks to the help of anticipated SB 1 funding."
>
> Malcolm Dougherty, Director, Caltrans

The TAMP is California's new asset management-based framework for investment decisions, representing a move from a "silo" based project funding approach to a system-wide assessment and a performance driven approach to investment. This system-wide assessment using asset management provides an alternative approach in which agencies strike a balance between reconstructing parts of the transportation system in poor condition and preserving those in good condition so that they do not become poor. This balanced approach extends the useful lives of the state's transportation assets and is more cost-effective in the long run.

Data-driven and goal-oriented investment choices are key foundations of the TAMP. The document summarizes the current inventory of transportation assets such as roads and bridges and details their condition. From there, it lays out performance targets for these assets based on requirements set both by FHWA and California law. The investment decisions that will be made to meet defined performance targets take into consideration all the costs associated with those assets over the course of their life cycle, from design to upkeep.

The additional investment in infrastructure preservation provided by SB 1 is crucial to attaining the ambitious performance targets mandated for the TAMP. The plan lays out several transportation funding scenarios—including one representing funding levels prior to the passage of SB 1 and another that reflects the impact of SB 1—and projects the impact of those funding levels over the next 10 years. Those projections show that, with SB 1 funding, California will be on track to achieve its asset condition targets.

The scope of the plan includes the assets on two overlapping highway systems: the State Highway System (SHS) and the National Highway System (NHS). The SHS is the highway system managed by Caltrans that includes all Interstate and State Highways. The NHS includes portions of the SHS, as well as roads and bridges managed by California cities' and counties' transportation agencies. Roads on the NHS are defined by the FHWA to be important to the nation’s economy, defense and mobility.

FHWA requirements dictate that the TAMP includes all NHS pavements and bridges. State TAMP Guidelines from the California Transportation Commission (Commission) require that the California TAMP include not only the condition of pavements and bridges on the SHS, but culverts and traffic management system elements, as well as information pertaining to nine supplementary asset classes.

Throughout the process of developing the California TAMP, workshops were held with stakeholders that are responsible for parts of the NHS. The TAMP process and the development of asset management performance targets on the SHS and local NHS systems to evaluate scenarios and financial investments was an opportunity to improve coordination across agencies to deliver a better transportation system and experience to Californians. The TAMP will be the first integrated performance-based asset management plan for California.

Additionally, SB 1 is already being put to use by Caltrans. The epartment broke ground on 13 pavement projects across the state this summer and is expediting the design of an additional 50 projects that will break ground over the next year. To date, Caltrans has advanced more than $5 billion in “fix-it-first” projects for earlier completion because of SB 1.

The draft TAMP can be read and comments submitted at http://www.dot.ca.gov/assetmgmt/tam_plan.html. Comments are due by November 24, 2017. The final version of the TAMP will be submitted to FHWA in April 2018 for compliance with federal requirements.

For more information about the department's activities: PIO Contact Info.

Caltrans Local Assistance Blog

Draft California Transportation Asset Management Plan (TAMP) Open for Public Comment

October 25, 2017 by Pauline Cueva

The *Draft* California Transportation Asset Management Plan is open for public comment. Comments are due by November 24, 2017 at 5:00 p.m. and should be submitted using the survey link below:

Draft TAMP Survey

For more information on the *Draft* California Transportation Asset Management Plan, please visit the Caltrans Transportation Asset Management webpage at http://www.dot.ca.gov/assetmgmt/

Transportation Asset Management Office

Request for Feedback

The following e-mail was sent to CalSTA, Commission, FHWA, MPOs, RTPAs, cities, counties, advocacy groups, and tribal governments. A special effort was made to ensure a copy went to all attendees of the asset management workshops held over the previous year and a half.

External Email

The California Department of Transportation (Caltrans) is pleased to announce the draft California Transportation Asset Management Plan (TAMP). You are receiving this message because you have either attended a workshop or have shown interest in the development of the TAMP.

The California TAMP describes the vision for how good asset management will help deliver broad transportation goals and fundamental objectives supported by information on current asset conditions. The TAMP is a key requirement of California law and of federal regulations. It was produced through the collaborative effort of numerous stakeholders and is considered a living document that will be regularly reviewed and updated.

Comments will be accepted through ***November 24, 2017***.

Link to the draft California TAMP and comment survey: http://www.dot.ca.gov/assetmgmt/

Summary of Feedback

The Office of Asset Management used a Survey Monkey tool to collect the feedback. Following is a summary of comments and a list of organizations who responded. We thank all of you who contributed to ensuring this plan is as inclusive and accurate as possible. We look forward to continuing to work together on this iterative process.

Table 12-1 Summary of Feedback

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	Executive Summary	Clearly define in the executive summary of the TAMP: • The scope of the TAMP as it relates to statutory responsibilities and authorities for transportation assets on the SHS and the NHS, • The state and federal requirements addressed in the TAMP, including timeframes and phases, • The assets included in the TAMP that are subject to Commission approval, • The assets in the TAMP that are not on the SHS and the responsibility of regions, cities, counties, tribal governments, or private agencies, and • The ten year period covered by the TAMP.	The following revisions were made to the Executive Summary: • A "Federal and State Requirements" section was added which summarizes FHWA and Commission statutory responsibilities and includes the graphic from Figure 2-2. • The section, "About the California TAMP," was amended to cite the timeframe for the TAMP approval by FHWA and the Commission. The following text was added: "The TAMP is also a key requirement of federal regulation and California law. Federal regulation (23 CFR 515) requires an asset management plan by April 30, 2018, for pavements and bridges on the NHS, including those owned by Caltrans and other federal, state and local agencies. California law (Senate Bill 486) requires Caltrans to develop an asset management plan by 2020 for the SHS. This document is intended to meet both sets of requirements." • The 10-yr period covered by the TAMP (FYs 2017/18 – 2026/27) was added to the front cover of the document.
California Transportation Commission	Executive Summary	Clearly identify in the Executive Summary that the Commission's responsibilities include: • Approving SHS assets for inclusion in the TAMP, • Adopting targets and performance measures reflecting state transportation goals and objectives, • Reviewing and approving the TAMP, including the final version of the first phase and the complete plan prepared by the Department, • Reviewing and reporting progress to the state legislature on Caltrans' progress towards meeting SHS asset performance targets established in Senate Bill 1 and in Commission-adopted performance targets, and • Reviewing and adopting the SHOPP if it is determined that the SHOPP is consistent with the TAMP.	Commission responsibilities were included as recommended. A new graphic element was added to the Executive Summary titled, "Roles & Responsibilities". This graphic provides a list of roles and responsibilities for FHWA, Commission, Caltrans, and MPOs/RTPAs/Local Agencies.

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	Executive Summary	Clearly identify in the executive summary that Caltrans' responsibilities include: • Preparing, in consultation with the Commission, a robust TAMP to guide the selection of SHOPP projects as required by Government Code section 14526.4, • Utilizing the TAMP to recommend how and where to invest transportation resources in the SHOPP to achieve intermediate and long-term performance targets, • Ensuring the TAMP is consistent with any applicable state and federal requirements, and • Preparing the complete TAMP for all asset classes no later than the 2020 SHOPP.	Caltrans responsibilities were included as recommended. A new graphic was added to the Executive Summary that outlines FHWA, Commission, Caltrans, and MPOs/RTPAs/Local Agencies roles and responsibilities
California Transportation Commission	Executive Summary	Revise the description under "California TAMP Scope" on page 3 to define what assets on the SHS are selected to include in the California TAMP scope.	The description under "California TAMP Scope" was revised to include the following: "pavement, bridge, drainage, TMS as well as a list of supplementary assets on the SHS".
California Transportation Commission	Executive Summary	Revise the discussion on page 4 under "California's Investment Strategy" to clearly explain the expectations that all asset classes will be incorporated into the TAMP by 2020 and that investments support the full range of state goals and objectives. In addition, update the graphic on the same page to include all SHS assets addressed in the TAMP.	In the Executive Summary under "California's Investment Strategies", the second bullet was revised to acknowledge the requirement for analysis of all Commission-approved asset classes. This bullet now reads, "Focus on selected asset classes: pavement, bridge, drainage, and TMS. These were designated as focus areas by the Commission, as they represent a significant portion of SHS maintenance and rehabilitation investments in California. (A cumulative analysis for all Commission-approved assets will be included in the 2020 TAMP.)" In addition, the graphic labeled "Inventory and Conditions for NHS and SHS Assets in California" was updated to include all primary and supplementary asset classes.
California Transportation Commission	Executive Summary	Revise the discussion on page 4 under "Risks to the System" to recognize that risks can not only be reduced, but also potentially avoided.	Commission recommendation was included in the Executive Summary.
California Transportation Commission	Executive Summary	Revise the last sentence under "Making an Impact" on Page 5 to add that the development of the TAMP will also help to wisely achieve established performance objectives.	Commission recommendation was included in the Executive Summary.

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	Executive Summary	Include on Page 6 a discussion of the phases of the TAMP culminating in a TAMP that incorporates all asset classes by 2020 as required by state law.	Although SB 486 allowed the TAMP to be rolled out into phases, the document as presented, constitutes the complete TAMP. In the Executive Summary under "California's Investment Strategies", the second bullet was revised to acknowledge the requirement for analysis of all Commission-approved asset classes. This bullet now reads, "Focus on selected asset classes: pavement, bridge, drainage, and TMS. These were designated as focus areas by the Commission, as they represent a significant portion of SHS maintenance and rehabilitation investments in California. (A cumulative analysis for all Commission-approved assets will be included in the 2020 TAMP.)" In addition, the graphic labeled "Inventory and Conditions for NHS and SHS Assets in California" was updated to include all primary and supplementary asset classes.
California Transportation Commission	1-Introduction	Add to the end of the first sentence of paragraph 2 on page 1-2, “to achieve state goals and objectives.”	Commission recommendation was included in the Introduction.
California Transportation Commission	Executive Summary	Explain the phasing of the TAMP on page 1-2 at the end of paragraph 2.	Although SB 486 allowed the TAMP to be rolled out into phases, the document as presented, constitutes the complete TAMP. In the Executive Summary under "California's Investment Strategies", the second bullet was revised to acknowledge the requirement for analysis of all Commission-approved asset classes. This bullet now reads, "Focus on selected asset classes: pavement, bridge, drainage, and TMS. These were designated as focus areas by the Commission, as they represent a significant portion of SHS maintenance and rehabilitation investments in California. (A cumulative analysis for all Commission-approved assets will be included in the 2020 TAMP.)" In addition, the graphic labeled "Inventory and Conditions for NHS and SHS Assets in California" was updated to include all primary and supplementary asset classes.
California Transportation Commission	1-Introduction	Explain on page 1-2 in the section titled “What is in the TAMP?” the opportunities for interfacing with other transportation systems and investment plans to increase efficiency.	The following text was added to the Introduction, under "What is in the TAMP?": "Long-term performance targets for both state and local NHS stakeholders were established in the TAMP through a collaborative process. The resulting shared vision for maintaining the transportation system is expected to bring about opportunities for improved coordination in transportation planning and investment."

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	1-Introduction	Add the words, "and the five-year maintenance plan" to the fifth sentence in paragraph one on page 1-3.	Added the Commission's recommended text to the Introduction.
California Transportation Commission	1-Introduction	Add the words, “to avoid potentially overlapping work, enhance efficiency, and maximize the effectiveness of limited funding” to the end of the last sentence in paragraph 2 on page 1-3.	Added the Commission's recommended text to the Introduction.
California Transportation Commission	1-Introduction	Include in the first paragraph under the section “Transportation Asset Management Plans are Living Documents” on page 1-3, that the TAMP must be updated to address all assets by 2020, and state requirements for reviewing and updating the TAMP.	In the Introduction, under the section “Transportation Asset Management Plans are Living Documents”, the following text was added: "All updates to the TAMP will require Commission approval as defined in California Government Code section 14526.4 and the Commission’s Transportation Asset Management Plan Guidelines."
California Transportation Commission	1-Introduction	Include in the first paragraph under the section “Transportation Asset Management Plans are Living Documents” on page 1-3 the requirements identified by the Commission as outlined in the adopted TAMP guidelines.	In the Introduction, under the section “Transportation Asset Management Plans are Living Documents”, the following text was added: "All updates to the TAMP will require Commission approval as defined in California Government Code section 14526.4 and the Commission’s Transportation Asset Management Plan Guidelines."
California Transportation Commission	1-Introduction	Describe in the second paragraph on Page 1-4 how specifically the TAMP addresses state requirements.	The following text was added to the Introduction under the section “Transportation Asset Management Plans are Living Documents” “...by providing a defined inventory, current conditions, established targets, determination of performance gaps and development of investment strategies to close the gaps. Investment strategies consider risks to the system condition and long term costs of ownership."
California Transportation Commission	2-Asset Inventory & Condition	Revise the first sentence on page 2-2 under State Requirements as follows, “Following the requirements of Senate Bill 486, the Commission developed and published draft TAMP guidelines in May 2017, conferred with Caltrans to address comments and concerns, and subsequently adopted the guidelines in June 2017.”	Revised the text to reflect the Commission's recommendation.

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	2-Asset Inventory & Condition	Replace the second sentence on page 2-2 under State Requirements with the following, “The California Transportation Commission is an independent state commission responsible for programming and allocating funds for the construction of highway, passenger rail, transit and active transportation improvements throughout California. The Commission also advises and assists the California State Transportation Agency Secretary and the Legislature in formulating and evaluating state policies and plans for California’s transportation programs. The Commission is an active participant in the initiation and development of State and Federal legislation to secure financial stability for the State’s transportation needs.”	Replaced the text to reflect the Commission's recommendation.
California Transportation Commission	2-Asset Inventory & Condition	Correct spelling in the first paragraph on page 2-3, describe why supplemental assets are addressed in the TAMP to a limited extent and describe the plan for addressing and reporting on the progress towards achieving performance targets.	In Chapter 2, the first sentence in the paragraph after "Primary Asset Classes" was revised as follows: "Supplementary assets located on the SHS are included in the TAMP to a limited extent and are not required of a federally-compliant TAMP."
California Transportation Commission	2-Asset Inventory & Condition	The second sentence in paragraph 2 in the section “California TAMP Scope” refers the reader to **Figure 2-1** for “ancillary assets”. However figure 2-1 does not depict the full range of assets on the SHS included in the TAMP. Correct either the statement or the diagram.	The text was revised to read "supplementary" assets. Figure 2-1 was also revised to include all supplementary assets.
California Transportation Commission	2-Asset Inventory & Condition	Describe actions in the first paragraph of page 2-7 recommended by Caltrans and taken by the Commission to adopt performance measures and targets for pavements, bridges, TMS, drainage, and supplementary assets on the SHS.	Changed to: "Caltrans recommended and Commission adopted…"
California Transportation Commission	2-Asset Inventory & Condition	Include on page 2-9 in the section titled “Pavement Performance Measures” the performance measures adopted by the Commission.	The text was changed to reflect: "Caltrans recommended and the Commission has adopted FHWA’s four pavement condition performance measures"
California Transportation Commission	2-Asset Inventory & Condition	Clarify in the second paragraph on page 2-10, is it Caltrans or the Commission that set the fair condition pavement targets for the SHS?	The text was clarified to say “In addition to the federal performance measures summarized in Table 2-3 below, Caltrans recommends and Commission adopted targets for fair condition for assets on the SHS.
California Transportation Commission	2-Asset Inventory & Condition	Correct the reference to RTPAs in the third paragraph on page 2-12.	Changed "Authority" to "Agency"

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	2-Asset Inventory & Condition	Clarify on page 2-14 in the first paragraph that the Commission sets targets based on pavement classification.	This paragraph was revised to read: “Caltrans reports pavement condition and targets based on this classification.”
California Transportation Commission	2-Asset Inventory & Condition	Describe the Commission’s role on page 2-21 for the approval of performance measures and targets for drainage systems.	Revised text under the TMS and Drainage sections to read: "This asset class is not required under federal regulation and has no defined national performance metric. Caltrans developed a performance metric and target that was approved by the Commission."
California Transportation Commission	2-Asset Inventory & Condition	Describe on page 2-23 Caltrans’ recommendation to the Commission for the definition of technology assets included under the asset class for TMS, the recommendation by Caltrans for TMS performance measures and goals and the responsibility of the Commission for approving performance measures and goals.	The following was added to the TAMP under TMS: FHWA defines TMS as complex, integrated amalgamations of hardware, technologies, and processes for performing an array of functions, including data acquisition, command and control, computing, and communications. Disruptions or failures in the performance of these functions can impact traffic safety, reduce system capacity, and ultimately lead the traveling public to lose faith in the transportation network. System failures also have the potential to cause measurable economic loss and increase congestion, fuel consumption, pollutants, and traffic crashes. The problem is further complicated by the fact that today's systems, subsystems, and components often are highly interdependent, meaning that a single malfunction can critically impact the ability of the overall systems to perform their intended functions.
California Transportation Commission	2-Asset Inventory & Condition	Clarify on page 2-25 if the guidelines referenced in the first paragraph are the Commission- adopted TAMP guidelines, state statutes, or other state regulations.	In Chapter 2, Page 2-23, the first paragraph under "Asset Valuation", the following text was added: "Commission- adopted TAMP guidelines."
California Transportation Commission	3-Asset Performance Targets	Correct the statement on page 3-2 under State Requirements that communicates that it is the Commission-adopted TAMP guidelines, and not state regulations, that require performance measures and targets for the four primary and nine supplementary assets on the SHS.	In Chapter 3, Page 3-2.the first sentence under "State Requirements", the following text was added: "Commission-adopted TAMP guidelines"
California Transportation Commission	3-Asset Performance Targets	Clarify if the statement on page 3-3 under NHS Asset Performance Targets applies to all NHS pavements and bridges or only sections of the NHS not on the SHS.	In Section 3.5 NHS Asset 10-Year Performance Targets, the text was revised to reflect "all" NHS asset performance targets.
California Transportation Commission	3-Asset Performance Targets	For all asset classes on the SHS approved by the Commission, include a gap analysis and discuss risks and alternatives to close performance gaps for any asset class on the SHS with a gap between targeted performance and condition.	Table 5-9. Performance Gaps for Supplementary Assets on the SHS was added to Chapter 5.

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	3-Asset Performance Targets	Describe how the targets and performance measures in the TAMP will be used by Caltrans to inform the project selection process SHOPP and for determining consistency between the TAMP and the 2018 SHOPP (reference Government Code section 14526.5 (a)).	The general approach for implementing a performance-based asset management approach to inform SHOPP project selection is described in Chapter 1, "Making Progress", where it states: "The SHSMP went beyond the TAMP requirements to actually implement a performance-driven approach for the SHOPP. All project planning initiated after July 2017 is based on SHSMP performance objectives. This ensures that projects that begin the planning process will collectively accomplish enough work to achieve the condition goals established by SB 1 and included in this TAMP." In Chapter 7, "Fix It First" a description is provided of SHOPP priorities: "The SHOPP's 10-year investment plan is laid out in the SHSMP. The SHOPP Investment Plan follows a "fix it first" approach that prioritizes maintenance, rehabilitation, and safety improvements of the SHS. Stewardship activities performed through the SHOPP include maintaining, rehabilitating, or replacing pavements, bridges, drainage systems, and TMS assets." The following text was added to Chapter 1, to reference the role of MODA and its implementation in the SHOPP. "The application of multi-objective decision analysis (MODA) methods to project selection processes was explored and tested in the 2014 and 2016 SHOPP cycles. MODA provides an objective and transparent basis for decision-making, accounts for benefits of multi-asset project solutions, and provides a mechanism to communicate the alignment of project priorities with strategic objectives. Work is currently underway to refine the MODA approach and establish a SHOPP project prioritization process that aligns with Caltrans' performance-based asset management approach."
California Transportation Commission	3-Asset Performance Targets	Include a discussion to address the development of a ten-year performance baseline plan for each asset, intermediate annual benchmarks, and interim progress reporting to the Commission towards meeting the targets and performance measures established in Senate Bill 1 and the TAMP (reference Government Code section 14526.7 and Interim SHOPP Guidelines).	The following text was added to Section 3.4, Page 3-4: "In accordance with the SB 1 and the Commission approved TAMP Guidelines, Caltrans will provide reporting for mandated targets and performance measures. Caltrans will establish milestones following the adoption of the TAMP, by March 2018. This will include milestones for federal 2- and 4-year performance targets.."

Reviewer	Chapter	Comments	Resolution
California Transportation Commission	3-Asset Performance Targets	Describe any potential significant performance gaps on the National Highway System that effect pavement and bridges and alternative strategies to close or address the identified gaps (*reference 23 Code of Federal Regulations section 515.7(a)(3)*).	A new section was added to the end of Chapter 5, titled "Closing the Performance Gap." This new section summarizes the performance gaps for both the NHS and SHS. In addition, it provides discussion on closing the NHS gap for the local pavement and bridge assets as well as the gaps for the SHS supplementary asset classes.
California Transportation Commission	3-Asset Performance Targets	Describe future changes in demand and associated impacts on the transportation system (*reference 23 Code of Federal Regulations section 515.7(b)*).	A section titled "Considering Changes in Traffic Demand, Natural Hazards, and Environment" was added to Chapter 4.
California Transportation Commission	6-Revenues and Financial Projections	Incorporate a 10-year financial plan for the TAMP (*reference 23 Code Federal Regulations section 515.7(d)*).	A 10-year financial summary was incorporated into Table 6-1, 6-2, and 6-3 of Chapter 6.
California Transportation Commission	Front Cover	Identify the 10-year period covered by the TAMP (*reference 23 Code of Federal Regulations section 515.9(e)*).	The 10-year period covered by the TAMP was added to the front cover.
California Transportation Commission	Appendix B	Describe the easily accessible formats, timeframes, and processes employed by Caltrans to make the initial TAMP available to the public for review and comment and include or summarize comments received and Caltrans' response (reference 23 Code of Federal Regulations section 515.9(i)).	These items are all addressed in Appendix B of the TAMP.
California Transportation Commission	Appendix C	Include as attachments to the TAMP the June 2017 Commission approved TAMP Guidelines and Supplementary Asset Classes.	The Commission approved TAMP Guidelines (revised June 29, 2017) can be found in Appendix C of the TAMP.
Humboldt County Association of Governments	8-Risk Management	High Priority Risks and Potential Mitigation Actions Rank 4 – External Threat, "Potential Mitigation Actions" column: First bullet also sounds more like an objective than an action, "Accelerate recommended actions." How can we accelerate?	Text in Chapter 8 under High Priority Risk and Potential Mitigation Actions Table 8-2 was to read: "Accelerate Safeguarding California five recommended actions
Humboldt County Association of Governments	8-Risk Management	High Priority Risks and Potential Mitigation Actions Rank 7 – Business Operations. Here, too, "Improve knowledge transfer" sounds more like an objective than an action.	Chapter 8, Table 8-2 was revised as follows: • Continue to do risk training • Improve knowledge transfer for risk management
Humboldt County Association of Governments	8-Risk Management	High Priority Risks and Potential Mitigation Actions Risks seem to be the same under Rank 7 and Rank 10 categories (Business Ops, and Info and Decisions).	Chapter 8, Table 8-2, rank #7 was revised to read: "Improve training and mentoring programs"

Reviewer	Chapter	Comments	Resolution
Humboldt County Association of Governments	8-Risk Management	High Priority Risks and Potential Mitigation Actions Risks under “Finances” in both Rank 5 and 12 seen the same. Under 12 it says “See action under Item 6” but you might have meant Item 5.	The question mark was removed. Chapter 8, Table 8-2, rank #5 was changed to read: "Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain the system as a whole" Changed Tables 8-2 and 8-5 rank #12 to read: "Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain and operate the system"
Humboldt County Association of Governments	8-Risk Management	High Priority Risks and Potential Mitigation Actions Rank 14, Asset Performance: “Coordinate info better,” “Coordinate projects better,” and particularly “Raise awareness,” also seem more like objectives.	Chapter 8, Table 8-2, rank #14 was revised as follows: "Improve project coordination to include ITS performance management in planning and project delivery of projects"
Humboldt County Association of Governments	8-Risk Management	High Priority Risks and Potential Mitigation Actions Rank 15 – Asset Performance: Typo w/ “benefits.” The language for the Action is awkward.	Chapter 8, Table 8-2, rank #15 was revised to read the following: " There is funding in the SHOPP focused on congestion and mobility that is balanced with other competing needs to consider alternative scenarios that address mobility performance measures".
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #1 Action – How about including data collected for other modes?	Chapter 8, Table 8-5, rank #1 was revised as follows: "Streamline business processes to improve the timeliness of reporting and include other modes and automate data sharing with partners".
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #2 Action – Educate (spur?) the legislature to do what in this regard? To expand program years?	Chapter 8, Table 8-5 rank #2: Develop narrative to educate/communicate with legislature about changes in performance management included in the TAMP.
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #5 – Risk is same as #12. (Delete question mark?) The recommended action would not, in and of itself, mitigate the risk.	The question mark was removed. Changed Chapter 8, Table 8-5 rank #5 to read: "Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain the system as a whole" Chapter 8, Table 8-5 rank #12 was revised to read: "Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios to maintain and operate the system".
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #7 and #10 are the same. #7 Action is an objective.	Chapter 8, Table 8-5 rank #7 was changed to read: "Improve training and mentoring programs".
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #8 and #9 – What can we do to “consider all issues and set more realistic timeframes”?	Chapter 8, Table 8-5 rank #8 was changed to read: "At project planning, use performance reporting and tracking to consider all issues and use 10 year plan and interim targets to set more realistic timeframes (reliability of schedule targets)"

Reviewer	Chapter	Comments	Resolution
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #14 – "Improve project coordination" sounds more like an objective.	Chapter 8, Table 8-5 rank #14 was changed to read: "Improve project coordination to include ITS performance management in planning and project delivery of projects."
Humboldt County Association of Governments	8-Risk Management	Risk Mitigation Plan #15 "If SHOPP is does not inclusive of fund congestion benefits, then projects that improve mobility may receive less funding." May receive less funding than what? Will the recommended action make SHOPP fund congestion projects?	Changed Chapter 8, Table 8-5 rank #15: "Establish periodic review of TAMP financial plan relative to actual expenditures and Caltrans goals and objectives to consider alternative scenarios that address mobility performance measures"
Humboldt County Association of Governments	8-Risk Management	Rank 1 – Hwy Safety, "Risk" column: Typo: "If we modernize accident reporting ~~for~~ then we…" Additionally, I am not clear what the risk is "If we modernize accident reporting" and "accelerate safety improvements."	Chapter 8, Tables 8-2 and 8-5 rank #1 were corrected to read, "If accident reporting is not modernized, then we may not accelerate some factors of safety improvements."
Humboldt County Association of Governments	8-Risk Management	Rank 1 – "Potential Mitigation Actions" column: Says "Improve the timeliness of reporting through process improvement." This is vague; can you be more specific? Also, improving the timeliness of reporting sounds more like an objective than an action.	Chapter 8, Tables 8-2 and 8-5 rank #1 were corrected to read, "Improve the timeliness of reporting through process improvement and automating data sharing with partners • Identify ways to work with partners to more accurately account for accidents involving pedestrians and bicyclists that may be under reported as a proportion of accidents"
Humboldt County Association of Governments	8-Risk Management	Rank 1 – One of the current risks is that reporting practices vary greatly for accidents involving pedestrians and bicyclists. The proportion of these accidents that go unreported are also a risk.	The following action was added to Chapter 8, Table 8-2 rank #1: "Identify ways to work with partners to more accurately account for accidents involving pedestrians and bicyclists that may be under reported as a proportion of accidents"
Metropolitan Transportation Commission	4-Life Cycle Planning	The section provides a good overview of the various challenges related to collecting TMS data. However, it would be helpful to get more details on how Caltrans got the figure for 19,000 field systems. Did each district submit their own figure? Did HQ gather the data from a central database?	Each district submitted their own TMS inventory into a central database, maintained by Caltrans Headquarters staff. This central database is used for assessments and forecasting.
Metropolitan Transportation Commission	4-Life Cycle Planning	The report lists that the unit costs for fixing an element (from poor to good) or adding a new item is the same. Can the Department elaborate on the reasons for using the same cost figure for fixing an element and replacing the element?	It was forecasted that the ratio of new/fix elements would be the same in future years as was used in the years of data used for the cost estimate. The 2017 SHSMP used this estimate for both new and fix. If future SHOPP 10-year plans request a different estimate for both new and fixed elements, this can be done.
Metropolitan Transportation Commission	4-Life Cycle Planning	Under the Total Annual M&O Costs column of Table 4-12, Estimate of Additional Maintenance and Operation Needs Over 10 years, does it include costs to move the existing inventory from 58.8% to the 90% good level? Has any escalation factor been included to account for inflation?	The increase in M&O costs for TMS are for adding "new" elements to the transportation system. An escalation factor has been included to Chapter 4, Table 4-6.

Reviewer	Chapter	Comments	Resolution
Metropolitan Transportation Commission	4-Life Cycle Planning	Since the text refers to average additional TMS M&O costs "over the next ten years," as does the Table 4-12 Title, Please add columns that show the "Total 10-Year M&O Costs" as well as increase in 10-Year M&O Costs.	The 10-year total for Annual M&O costs to indicate the additional cost to M&O for TMS was added to Chapter 4, Table 4-16.
Metropolitan Transportation Commission	5-Performance Scenarios	In the section of asset performance gap analysis, what is the expected funding projection being used to do the comparison? Is it post SB-1 funding level or pre-SB 1 funding level?	Gap calculations for local agencies are explained in Chapter 5.
Metropolitan Transportation Commission	8-Risk Management	These tables identify some risk mitigation strategies and actions, respectively. Please describe how these strategies and actions will be implemented (e.g., updates to Standard Operating Procedures and overarching business processes).	Much has been done across the state through various risk mitigation programs to safeguard California for a more resilient transportation system as discussed in Chapter 8. Integrating risk management decisions with assets has been an ongoing practice with project delivery. More is being done to evaluate risk with life cycle planning. The TAMP includes a risk mitigation plan. Work is ongoing to establish implementation next steps, owners and completion dates for how the risk mitigation plan will be implemented. The integration of risk into asset management is critical to achieve a resilient system of assets.
Metropolitan Transportation Commission	1-Introduction	The Introduction could have touched on the general practice of asset management in local jurisdictions. Although varied in their approach, the majority of California jurisdictions have been managing pavement assets for a long time. The use of formal bridge management systems by local agencies is much less common than for pavement.	Included the following text in the Introduction: "Although varied in their approach, the majority of California jurisdictions have been managing pavement assets for a long time. The use of formal bridge management systems by local agencies is much less common than for pavement."
Metropolitan Transportation Commission	2-Asset Inventory & Condition	Over a third of NHS pavements are locally owned. While MAP-21 and the FAST Act require a specific methodology for calculating performance measures using metrics including pavement roughness, rutting, cracking, and faulting, these measures have not been adopted by the vast majority of local jurisdictions in California and are in most cases, not effective for monitoring conditions on local streets and roads. The majority of local jurisdictions in California utilize the PCI, which is more appropriate for slower speed roadways with standard features typical of local roadways. This discrepancy can cause confusion when comparing condition assessments across plans such as the State TAMP and the California Local Street and Road Needs Assessment. In addition, use of inappropriate	MTC's recommendation was included in Chapter 2.

Reviewer	Chapter	Comments	Resolution
		measures leads to an inaccurate reflection of conditions on the locally owned system. While nothing may be done at this time about the federal requirement, the Draft TAMP seems to be missing a perfect opportunity to explain the discrepancy between the federally required performance measures and those utilized by local jurisdictions. An explanation about the differences in performance metrics appropriate for highways vs. local roadways could go a long way towards alleviating confusion at the state level and in building a case for greater flexibility in the federal requirement.	
Metropolitan Transportation Commission	4-Life Cycle Planning	As with the Introduction, the Life Cycle Planning chapter could have touched on the practices and requirements of local jurisdictions in this area	Chapter 2 has been updated to reflect the PCI performance measure for local NHS and a TAM Process Improvement item was included.
Metropolitan Transportation Commission	5-Performance Scenarios	The draft TAMP states that it is assumed that since 5% of the total local street and road network statewide is on the NHS, that 5% of the local street and road annual expenditure identified in the 2016 Local Needs Assessment would be spent on the NHS pavements. This is not likely given that NHS routes are likely to be more heavily utilized than a majority of locally owned roadways and will likely require more frequent maintenance treatments. In the MTC region, our modeling indicates that although 7% of the region's locally-owned roadways are on the NHS, 12% of funds available for pavement maintenance will be spent on these routes. Consider increasing your assumption of the amount of local funding that is anticipated will be spent on locally-owned NHS routes by the ratio indicated above.	Revised Chapter 5 to include the following statement: "The asset projection model from the SHSMP was adapted to predict future conditions for non-SHS assets. The model assumes that the local investment in NHS pavement is proportional to the magnitude of the NHS, relative to the total local road network. Local NHS pavements account for 5% of the total local roadways. Multiplying the $1.98 billion local road annual expenditure identified in the 2016 Local Needs Assessment by 5% yields an estimated NHS spending for pavement of $99 million per year. Although this assumption likely underestimates the local investment in NHS pavement based on limited MPO feedback, it serves as a reasonable lower bound for purposes of this analysis."
Metropolitan Transportation Commission	5-Performance Scenarios	The statement in the first paragraph, "This reflects a current focus by local agencies on improving pavements in poor condition" is too broad and indicates that local agencies are practicing "worst first" strategies for managing their local pavements. We know this is not the case. Consider modifying this statement to say "This reflects a current focus by local agencies on reducing the percentage of pavements on the NHS that are in poor condition."	MTC's recommendation was included in Chapter 5.

Reviewer	Chapter	Comments	Resolution
Metropolitan Transportation Commission	6-Revenues & Financial Projections	The draft TAMP states that it is assumed that since 5% of the total local street and road network statewide is on the NHS, that 5% of the local street and road annual expenditure identified in the 2016 Local Needs Assessment would be spent on the NHS pavements. This is not likely given that NHS routes are likely to be more heavily utilized than a majority of locally owned roadways and will likely require more frequent maintenance treatments. In the MTC region, our modeling indicates that although 7% of the region's locally-owned roadways are on the NHS, 12% of funds available for pavement maintenance will be spent on these routes. Consider increasing your assumption of the amount of local funding that is anticipated will be spent on locally-owned NHS routes by the ratio indicated above.	Revised paragraphs in Section 5.3 Baseline (Pre-SB 1) Performance to include a statement about 5% likely underestimates local NHS pavement investments. The following text was revised: "The asset projection model from the SHSMP was adapted to predict future conditions for non-SHS assets. The model assumes that the local investment in NHS pavement is proportional to the magnitude of the NHS, relative to the total local road network. Local NHS pavements account for 5% of the total local roadways. Multiplying the $1.98 billion local road annual expenditure identified in the 2016 Local Needs Assessment by 5% yields an estimated NHS spending for pavement of $99 million per year. Although this assumption likely underestimates the local investment in NHS pavement based on limited MPO feedback, it serves as a reasonable lower bound for purposes of this analysis."
Southern California Association of Governments	General	Federal Guidelines for Performance Measures allow for MPOs to choose their own targets within 180 days of state setting their targets. Although the initial TAMP does not include 2 and 4-year targets, what will the process be to coordinate with MPO's to establish 2 and 4-year targets as part of the final TAMP due June 2019? In addition, if MPOs were to establish targets that are different from the ones set by the state DOT, how would those MPO targets be coordinated and incorporated into the TAMP? An explanation of how this provision might work in California would be helpful.	The following paragraph was inserted into Chapter 3: "Federal regulations allow MPOs to establish their own condition targets for pavements and bridges. Caltrans has discussed this opportunity with our partners, and they are evaluating internally if they plan to exercise this ability or not. MPOs are given six months for the establishment of state condition targets to complete the necessary analysis and provide documentation to Caltrans. To the extent that California MPOs establish their own condition targets, the NHS target for pavements and bridges will be influenced according to the proportion of the NHS inventory that MPOs manage."
Southern California Association of Governments	2-Asset Inventory & Condition	SCAG understands that the federal rules call for collection and reporting based IRI. However, much of data collected and available in California, especially on local roads, are based on PCI. It would be helpful to provide a brief explanation in the TAMP as to how this is being reconciled to comply with the federal rules.	The following improvement item was added to Chapter 9: "• MAP-21/FAST Act performance measurement coordination (PCI vs IRI)"
Southern California Association of Governments	6-Revenues & Financial Projections	The local funding sources list could be consolidated. For example, development impact fees, traffic impact fees, and transportation mitigation fees should be a single bullet.	The traffic impact and development impact fees in the local funding sources were consolidated in Chapter 6.

Reviewer	Chapter	Comments	Resolution
Southern California Association of Governments	8-Risk Management	Table 8-2, under item #14 regarding ITS elements. There is also the need to incorporate ITS elements into roadway planning to address connected vehicles, to maximize the benefits of this technology. Comment applies to Table 8-5 also.	Chapter 8, Tables 8-2 and 8-5 rank #14 were revised to read: "Improve project coordination to include ITS performance management in planning and project delivery of projects"
Southern California Association of Governments	8-Risk Management	Table 8-2, one risk factor that was not considered is the economic impact as related to increased congestion and reduced freight mobility by not maintaining our infrastructure assets (i.e., ITS, bridge, and pavement). Please consider incorporating impacts to the economy as a potential risk factor.	Chapter 8, Tables 8-2 and 8-5 rank #14 were revised to read: "If we don't include ITS elements into roadway planning, then we may experience increased congestion, reduced freight mobility and impacts to the economy."

13. Appendix C. Asset Management Regulations and Guidelines

The Transportation Asset Management Plan incorporates guidance from many sources. Summaries or links to the most influential guiding documents for preparing California's Transportation Asset Management Plan are included in this Appendix. It includes federal legislation such as MAP-21, PM2 regulations, state legislation including Senate Bills 1 and 486, and the Commission TAMP Guidelines and Actions which directed the state specific aspects of the Plan.

Federal Requirements

Moving Ahead for Progress in the 21st Century Act, Public Law (PL) 112-141

MAP-21 PL 112-141 was signed into law by President Obama on July 6th, 2012. MAP-21 authorizes the federal surface transportation programs for highways, highway safety, and transit and provides funding of over $105 billion for the federal FYs 2013 and 2014. It covers a variety of transportation related issues including financing, state and metropolitan transportation planning, congestion relief, improved safety, expedited project delivery, consolidation of federal programs, goods movement, and transportation related research and studies.

Link to federal legislation:

https://www.gpo.gov/fdsys/pkg/PLAW-112publ141/html/PLAW-112publ141.htm

Fixing America's Surface Transportation Act, PL 114-94

On December 4, 2015, the Fixing America's Surface Transportation Act, or "FAST Act" was signed into law. It is the first law enacted in over ten years that provides long-term funding certainty for surface transportation, meaning States and local governments can move forward with critical transportation projects, like new highways and transit lines, with the confidence that they will have a Federal partner over the long term. The FAST Act continues asset management requirements and added critical infrastructure to the considerations a State may include in its asset management plan [23 U.S.C. 119(j)(2)].

Link to federal legislation:

https://www.gpo.gov/fdsys/pkg/PLAW-114publ94/html/PLAW-114publ94.htm

23 Code of Federal Regulations Part 515

The TAMP Final Rule establishes the processes State department of transportations must use to develop a TAMP. Each state is required to develop a risk-based TAMP for the NHS to improve or preserve the condition of the assets and the performance of the system in accordance with MAP-21 § 1106(a), codified as 23 U.S.C. 119 (e) and (t).

Link to the federal legislation:

https://www.federalregister.gov/documents/2016/10/24/2016-25117/asset-management-plans-and-periodic-evaluations-of-facilities-repeatedly-requiring-repair-and

23 Code of Federal Regulations Part 490

The Pavement and Bridge Performance Management Final Rule was established to implement MAP-21 and FAST Act performance management requirements.

Link to federal legislation:

https://www.federalregister.gov/documents/2017/01/18/2017-00681/national-performance-management-measures-assessing-performance-of-the-national-highway-system

State Requirements

Senate Bill 486

SB 486, Section 6, Statutes of 2014, requires that Caltrans in consultation with the California Transportation Commission prepare a robust asset management plan to guide the selection of projects in the State Highway Operation and Protection Program.

Link to SB 486 legislation:

https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201320140SB486

Senate Bill 1

SB 1, Chapter 5, Statutes of 2017, Road Repair and Accountability Act of 2017 that provides the first significant, stable, and on-going increase in state transportation funding in more than two decades. SB 1 provides funding and created new programs.

Link to SB 1 legislation:

https://leginfo.legislature.ca.gov/faces/billTextClient.xhtml?bill_id=201720180SB1

California Transportation Commission Transportation Commission Guidelines (Revised June 29, 2017)

The Commission adopted TAMP Guidelines to implement the provisions of SB 486 and SB 1, and expanded the State Highway System asset classes beyond the federal requirements.

These Guidelines are included below:Link to California Transportation Commission Transportation Commission Guidelines (Revised June 29, 2017):

http://catc.ca.gov/programs/shopp/docs/TAMP_Guidelines_062917_FINAL.pdf

CALIFORNIA TRANSPORTATION COMMISSION

Transportation Asset Management Plan Guidelines

(Revised June 29, 2017)

STATE OF CALIFORNIA CALIFORNIA TRANSPORTATION COMMISSION

CALIFORNIA TRANSPORTATION COMMISSION

TRANSPORTATION ASSET MANAGEMENT PLAN GUIDELINES

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STATE OF CALIFORNIA CALIFORNIA TRANSPORTATION COMMISSION

TRANSPORTATION
ASSET MANAGEMENT PLAN GUIDELINES

A. TRANSPORTATION ASSET MANAGEMENT PLAN

Senate Bill 486 (DeSaulnier, 2014) requires that the California Department of Transportation (Caltrans), in consultation with the California Transportation Commission (Commission), prepare a "robust" transportation Asset Management Plan (TAMP) to inform and guide the project selection process for the State Highway Operation and Protection Program (SHOPP). Specifically, the legislative intent in support of an asset management plan is that it serves as a policy document to inform future transportation investment decision making.

Subject to Government Code Section 14526.5, the Commission adopts the SHOPP and may decline to adopt the SHOPP if the Commission determines that the SHOPP is not sufficiently consistent with the TAMP. Government Code Section 14526.4 also establishes the requirements for the development of the TAMP and the Commission's roles and responsibilities. Section 14526.4 sets forth the following:

Caltrans responsibilities include:

- Preparing, in consultation with the Commission, a robust TAMP to guide selection of SHOPP projects required by Section 14526.5.
- Ensuring the TAMP is consistent with any applicable state and federal requirements.
- If necessary, preparing the TAMP in phases, with the first phase to be implemented with the 2016 SHOPP, and the complete TAMP to be prepared no later than the 2020 SHOPP.

Commission responsibilities include:

- Adopting targets and performance measures reflecting state transportation goals and objectives.
- Reviewing and approving the TAMP.

The Commission adopted the TAMP Guidelines on June 28, 2017 at its June Commission meeting.

B. STATE GOALS AND OBJECTIVES & ADOPTION OF PERFORMANCE MEASURES AND TARGETS

Government Code Section 14526.4(c)(1) requires that the Commission, in connection with the TAMP, "adopt targets and performance measures reflecting state transportation goals and objectives." The Commission's adoption of targets and performance measures reflects state transportation goals and objectives as identified in substantive part in State Legislation, Governor Executive Orders, and the California Transportation Plan. The Commission's adoption of targets and performance measures is also informed by Federal laws and regulations. Therefore, the Commission expects that Caltrans will submit target and performance measure recommendations for Commission approval that align with these authoritative laws and policies and provide for the following:

<u>Preserve the Existing Transportation Infrastructure</u>

- Ensure existing assets are adequately maintained

<u>Improve the Safety of the Transportation System</u>

- Support projects that minimize fatalities, injuries and reduce property damage

- Provide for emergency preparedness and response

Support State Environmental Goals

- Conserve natural, agricultural and cultural resources
- Reduce greenhouse gas emissions and other pollutants

Support a Vibrant Economy

- Enhance freight mobility, reliability, and global competitiveness

Foster Livable and Healthy Communities

- Support projects that address public health considerations
- Support multimodal and/or active transportation elements

In addition to establishing an TAMP in compliance with the state's transportation goals and objectives, the Road Repair and Accountability Act of 2017, Senate Bill (SB) 1, provides the first significant, stable, and on-going increase in state transportation funding in more than two decades. In providing this funding, the Legislature has increased the Commission's role in a number of existing programs, and created new programs for the Commission to oversee. Specific to the implementation of the TAMP, the legislative intent of SB 1 includes but is not limited to the following:

- Improving the condition of the state's road system will have a positive impact on the economy as it lowers the transportation costs of doing business, reduces congestion impacts for employees, and protects property values in the state.
- Well-maintained roads benefit all users, not just drivers, roads are used for all modes of transport, whether motor vehicles, transit, bicycles, or pedestrians.
- Well-maintained roads additionally provide significant health benefits and prevent injuries and death due to crashes caused by poorly maintained infrastructure.
- Relative to this account, SB 1 states that "it is the intent of the Legislature that the Department of Transportation and local governments are held accountable for the efficient investment of public funds to maintain the public highways, streets, and roads, and are accountable to the people through performance goals that are tracked and reported."
- SB 1 further states that it is the intent of the Legislature that Caltrans meet the following preliminary performance outcomes for additional state highway investments by the end of 2027, in accordance with applicable state and federal standards:
  - Not less than 98 percent of pavement on the state highway system in good or fair condition.
  - Not less than 90 percent level of service achieved for maintenance of potholes, spalls, and cracks.
  - Not less than 90 percent of culverts 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.

While State Legislation, Governor Executive Orders, the California Transportation Plan, and Federal laws and regulations serve as natural direction for establishment of state goals and priorities. Given limited transportation funding, the Commission expects that Caltrans will recommend targets and performance measures that reflect federal and state goals and objectives, where applicable, through a policy lens that prioritizes high-traffic routes and corridors and identifies opportunities to maximize state funds with matching funds.

C. TRANSPORTATION ASSET MANAGEMENT PLAN COMPONENTS

While Government Code Section 14526.4 defines an asset management plan to mean a "document assessing the health and condition of the state highway system with which the department is able to determine the most effective way to apply the state's limited resources," it provides no rubric for the development of such a plan. For this, Caltrans and the Commission have relied on the federal requirements established in both the Moving Ahead for Progress in the 21st Century (MAP-21) and the Fixing America's Surface Transportation (FAST) Acts, respectively, to formulate what constitutes the TAMP.

According to federal requirements, each State is required to "develop a risk-based Asset Management Plan for the National Highway System to improve or preserve the condition of the assets and the performance of the system" (23 U.S.C. 119(e) (1), MAP-21 § 1106). Under the federal requirements, States are required to address pavements and bridges in their asset management plans but are "encouraged" to include all infrastructure within the transportation system right-of-way. Therefore, to ensure consistency with the Federal Highway Administration (FHWA) specifications, the Commission expects that the Caltrans submitted TAMP shall, at a minimum, include the following components:

a. A summary listing of the State's assets;

b. A description of the condition of the assets identified in section (a);

c. Objectives and measures for asset management;

d. Performance gap identification;

e. Lifecycle cost and risk management analysis*

(* With respect to life cycle cost planning, the Commission and Caltrans will assess the efficacy of the investment strategies outlined in the TAMP from a network perspective, and not a project-based perspective)

f. A financial plan; and

g. Investment strategies.

While the federal requirements require the components described above to be applied to the pavements and bridge asset classes on the National Highway System (NHS), SB 486 is clear in its requirement that from the State's perspective the TAMP contemplate this analysis for all asset classes within the State Highway System (SHS). It is the expectation of the Commission that, pursuant to SB 486, a compliant TAMP will include the narrative or analysis for components a-d above for each asset class approved by the Commission, unless the Commission approves a different level of detail for such asset class based upon the recommendation of Caltrans and approval by the Commission at a Commission meeting. A compliant TAMP will also include a global or cumulative analysis for all Commission approved asset classes that includes components e-g, unless otherwise modified and approved by the Commission.

D. TRANSPORTATION ASSET MANAGEMENT PLAN SAMPLE OUTLINE

The FHWA Office of Asset Management, Pavements and Construction has included a number of sample outlines for State Departments of Transportation to use as they develop their transportation asset management plans. Subject to State and federal requirements, the Commission expects Caltrans to follow the FHWA framework, in pertinent part, in developing the TAMP and presenting it for Commission approval. The FHWA outline for the State Departments of Transportation to utilize in the development of their respective asset management plans is included below:

	FHWA Outline for State Departments of Transportation Asset Management Plan Framework	
a.	Summary listing of SHS Assets	Summarize the inventory.
b.	Asset Inventory and Conditions	Summarize the inventory and condition of the SHS assets.
c.	Asset Management Objectives and Measures	▪ Define the objectives of the asset management program. ▪ Define levels of service and measures. ▪ Define short term and long term condition targets.
d.	Performance Gap Assessment	▪ Define asset management planning assessment horizons. ▪ Describe traffic growth and demand on the system. ▪ Present an analysis of future funding versus condition scenarios. ▪ Illustrate the performance gap between existing condition levels and future condition levels.
e.	Lifecycle Cost Considerations and Risk Management Analysis	▪ Define "lifecycle costs" and explain why they are important. ▪ Describe the methodology used to address life cycle costs in the TAMP. ▪ Set the context for risk management. ▪ Define key programmatic risks associated with implementation of the TAMP (e.g., cost escalations, budget cuts and environmental delays.) ▪ Define system risks that could adversely affect the SHS (e.g., asset failure and external events such as floods, earthquakes, and hurricanes.) ▪ Provide a map showing the SHS assets most at risk. ▪ Include a risk register that provides the following for each programmatic risk – likelihood of occurrence, consequences of occurrence, and mitigation activities.
f.	Financial Plan	▪ Summarize historic funding levels for asset management. ▪ Define the amount of funds expected to be available for asset management and describe where funds will come from. ▪ Define how funds will be allocated in the short term. ▪ Define how funds will be allocated in the long term, as part of the asset management long term planning horizon. ▪ Determine current value of the assets and describe the implications of various funding levels in terms of asset valuation and financial sustainability.
g.	Investment Strategies	▪ Describe key work strategies resulting from the above analyses. The strategies should include typical unit costs and typical timing. ▪ Identify priorities for asset management improvement.

E. COMMISSION APPROVED TRANSPORTATION ASSET MANAGEMENT PLAN CLASSIFICATIONS

At the March 2015 Commission meeting, Caltrans recommended the approval of four asset classes that comprise the majority of the SHOPP physical asset expenditures for inclusion in the TAMP. A summary listing of 15 additional assets not recommended for inclusion in the TAMP were listed in Caltrans' book item for a total of 19 asset classes. The Commission requested that office buildings be added to the list of asset classes. The Commission approved the primary and supplementary asset classes for inclusion in the

TAMP, consisting of 20 asset classes identified below and expects that these asset classes will be included in the final TAMP.

Furthermore, in the event there are any deletions, additions, or refinements to the list of approved asset classes, Caltrans will seek approval by the Commission prior to incorporating any changes to the final list of both primary and supplementary asset classes. The following primary and supplementary asset classes have been approved by the Commission and subject to inclusion in the TAMP:

Compliant Transportation Asset Management Plan Components*	Asset Inventory (a)	Condition Assessment (b)	Performance Measures and Targets (c)	Performance Gap Identification (d)
Primary Asset Classes **				
Bridges	☑	☑	☑	☑
Culverts	☑	☑	☑	☑
ITS Elements	☑	☑	☑	☑
Pavements	☑	☑	☑	☑
Supplementary Asset Classes				
Drainage Pump Plants	☑	☑	☑	☑
Highway Lighting	☑	☑	☑	☑
Office Buildings	☑	☑	☑	☑
Overhead Signs	☑	☑	☑	☑
Park and Ride Facilities ***	☑	☑	☑	☑
Roadside Rest Facilities	☑	☑	☑	☑
Sidewalks ***	☑	☑	☑	☑
Transportation Related Facilities****	☑	☑	☑	☑
Weigh in Motion Scales	☑	☑	☑	☑

* A compliant TAMP will also include a global or cumulative analysis for all Commission approved asset classes that includes lifecycle cost and risk management analysis, where applicable, a financial plan, and Investment strategies.
** For primary asset classes, Caltrans will perform a life cycle/risk management assessments
*** For this asset class, Caltrans will perform accessibility analysis.
**** Transportation Related Facilities include maintenance stations, traffic management centers, equipment shops and transportation laboratories)

F. SCHEDULE FOR SUBMISSION OF THE TRANSPORTATION ASSET MANAGEMENT PLAN PHASES INCLUDING PERFORMANCE MEASURES AND TARGETS

Attachment A (Commission Actions as of March 2017) includes a summary of items submitted to the Commission by Caltrans and actions taken, if any, by the Commission related to the TAMP. The Commission acknowledges that Caltrans must submit a compliant TAMP that addresses certain components outlined in these TAMP Guidelines for the purpose of compliance with state and federal regulation that includes how California will address asset management principles for the NHS and SHS. On or before the October 2017 Commission meeting, Caltrans shall present an updated TAMP to the Commission for review and approval that includes the following components for all Commission approved asset classes as specified in Section C of the TAMP Guidelines. For the purposes of the October 2017 draft TAMP, components e-g identified in Section C may be presented for Commission review and approval if such components are substantially completed by Caltrans. Caltrans' proposed schedule for the submission of the October 2017 draft TAMP is as follows, and may be modified subject to mutual agreement:

- October/2017: October 2017 draft TAMP published by Caltrans for stakeholder comments.

- January/2018: October 2017 draft TAMP submitted to the Commission for formal comments.
- March/2018: Commission adopted of the October 2017 TAMP.
- April/2018: Submission of October 2017 TAMP to FHWA for compliance with federal requirements.

G. REPORTING/ACCOUNTABILITY

The Commission understands that Caltrans is currently working on various components and phases of the TAMP. The Commission expects that as Caltrans completes various components and phases of the TAMP, that Caltrans will submit the TAMP revisions to the Commission for formal approval. At a minimum, and no less frequently than on a quarterly basis, the Commission expects that Caltrans will provide reporting to the Commission on the development of components or phases of the Commission approved TAMP and on the implementation and achievement of the Commission approved and SB 1 mandated targets and performance measures.

The final update to the TAMP after the 2020 roll-out will be submitted to the Commission no later than January 31, 2021. It is the expectation of the Commission that the final TAMP that is approved by the Commission is updated on odd years similar to the submission of the Ten Year SHOPP Plan. Thereafter, at a minimum, and no less frequently than on a quarterly basis, the Commission expects that Caltrans will provide reporting to the Commission on the achievement of the Commission approved and SB 1 mandated targets and performance measures.

STATE OF CALIFORNIA CALIFORNIA TRANSPORTATION COMMISSION

ATTACHMENT A

COMMISSION ACTIONS AS OF MARCH 2017

As of March 31, 2017, the following actions have been taken by the Commission with respect to the Asset Management Plan:

January 2015

Caltrans Submission: Caltrans informed the Commission of the Federal asset management plan rule-making process and indicated that the first phase of the Asset Management Plan is likely to include four asset classes: Pavement, Bridges, Culverts, and Intelligent Transportation System (ITS) Elements. Caltrans indicated a more detailed Asset Management Plan would be presented at the March 2015 Commission meeting. Commission staff requested a listing of all asset classes and an Asset Management Plan implementation timeline.

Commission Action: This item was noticed and presented as an information item only and, therefore no actions were taken by the Commission.

March 2015

Caltrans Submission: Caltrans presented the following Phase I Asset Management Plan milestones:

March 2015. Identification of the asset classes recommended for inclusion in the Phase I Asset Management Plan (Pavement, Highway Structures (bridges & tunnels), Culverts, and Highway Operations (ITS Elements).

March 2015. Recommendation of performance measures (Good, Fair, Poor) for the Pavement, Bridges and Culvert asset classes and (Operational or Not) for the ITS Elements asset class.

October 2015. Establishment of the baseline conditions and performance targets for the four Phase I asset classes.

At the meeting, Caltrans recommended four state highway system asset classes for inclusion in the TAMP: Pavement, Bridges, Culverts, ITS Elements. Caltrans also presented fifteen supplementary asset classes which would be "excluded" from the TAMP.

Commission Action: The Commission approved the following four asset classes for inclusion in Phase I of the Asset Management Plan: Pavement, Bridges, Culverts, and ITS Elements. The Commission also approved Good, Fair, and Poor performance measures for the Pavement, Bridges, and Culverts asset classes and Operational or Not Operational performance measures for the ITS Elements asset class. After much discussion, the Commission approved the supplementary classes and added office buildings to the list as well. The Commission approved 20 asset classes (primary and supplementary) in total which included Pavement, Bridges, Culverts, ITS Elements. Overhead Signs, Pump Houses, Closed Circuit Television (CCTV) Cameras, Weigh in Motion Scales, Highway Barriers, Bridge Barriers, Roadside Rest Facilities, Park and Ride Facilities, Highway Lighting, Highway Signs, Sidewalks, Traffic Management Centers, Equipment Shops, Labs, and Maintenance Stations, and office buildings.

October 2015

Caltrans Submission: Caltrans requested that the Commission approve the use of existing performance measures and targets for the Pavement and Bridges asset classes until such time as the Federal asset management rule-making process is finalized, in place of the Good, Fair, Poor performance measures adopted by the Commission at the March 2015 meeting. Caltrans requested to use the amount of distressed pavement for the Pavement asset class and the number of distressed bridges for the Bridges asset class. For the four Phase I asset classes, Caltrans presented the baseline conditions and requested that the unconstrained targets be set as follows: Pavement baseline condition 84% good and unconstrained target 90% good, Bridges baseline condition 93% good and unconstrained target 90 % good, Culverts baseline condition 86% good and unconstrained target 90% good, ITS Elements baseline condition 68% good and unconstrained target 90% good. Caltrans further requested that the Commission approve the development of performance targets based on a fiscally constrained budget over a four year time horizon.

Commission Action: The Commission approved the use of the existing performance measures and targets for the Pavement and Bridges asset classes only until such time as the Federal asset management rule-making process is finalized. The Commission approved the following unconstrained targets: Pavement 90% good, Bridges 96% good, Culverts 90% good, and ITS Elements 90% good.

March 2016

Caltrans Submission: To meet the SB 486 requirements for a Phase 1 of the TAMP required to accompany the 2016 SHOPP, Caltrans presented a 2016 Asset Management Performance Report ahead of the Commission adoption of the 2016 SHOPP. Caltrans stated the "report is provided to meet the Phase I requirement of the TAMP" and to address "the expected performance of the four core asset classes; pavement, bridges, culverts and ITS elements resulting from the 2016 SHOPP project portfolio as well as how each of the core assets are represented as they relate to the adoption of the proposed 2016 SHOPP."

Commission Action: The Commission requested that Caltrans return at the May 2016 Commission meeting to request an extension from the Commission for the approval of the TAMP performance measures and targets if the Federal rule-making process was not finalized by then. This item was noticed as information item only and no action was taken by the Commission.

May 2016

Caltrans Submission: Caltrans requested an extension through August 2016 for Commission approval of Asset Management Plan performance measures and targets because the specific technical criteria proposed by the Federal government to determine Good, Fair and Poor performance measures for the Pavement and Bridges asset classes was still in the Federal rule-making process.

Commission Action: The Commission approved the extension request with the stipulation that Caltrans was to return in August 2016 with recommendations for Asset Management Plan performance measures and targets either derived under Federal rules or Caltrans technical expertise.

August 2016

Caltrans Submission: At the May 2016 Commission meeting, Caltrans committed to provide recommended performance targets for the four approved Asset Management Plan asset classes in time for the August meeting. Unfortunately, the technical details for the Pavement and Bridge asset classes' performance measures were still pending final Federal rules. Caltrans developed the requested performance targets based on the draft Federal rules. However, Commission staff requested that Caltrans

include the fiscal impacts of the proposed performance targets and to further explain the basis for the targets. In lieu of a book item, Caltrans submitted a letter requesting postponement of the performance target discussion until the October 2016 meeting to allow time to produce the fiscal impacts of the proposed targets.

Commission Action: Although, this item was noticed on the agenda as an action item, the Commission took no action after reviewing the Caltrans letter requesting a postponement of the performance target discussion.

October 2016

Caltrans Submission: Caltrans presented *fiscally unconstrained* performance targets for the four Phase I Asset Management Plan asset classes: Pavement, Bridges, Culverts and ITS Elements. In addition, Caltrans subdivided the Pavement asset class into three subclasses: Class 1 Pavement (interstate freeways and other principal arterial and urban freeways/expressways), Class 2 Pavement (rural freeways/expressways and minor arterials), and Class 3 Pavement (major and minor collector routes). Caltrans also presented the technical criteria used to determine the Good, Fair and Poor performance measures.

Commission Action: The Commission approved the proposed fiscally unconstrained targets.

January 2017

Caltrans Submission: Caltrans presented an overview of its 2017 State Highway System Management Plan (SHSMP). The SHSMP is a new Caltrans integrated plan that combines the Ten-Year SHOPP Plan and the Five-Year Maintenance Plan and implements a number of key asset management requirements.

Commission Action: This item was noticed as information item only, the actual 2017 SHSMP document was not provided to the Commission for its consideration and no action was taken by the Commission.

March 2017

Caltrans Submission: Caltrans formally submitted the SHSMP dated March 8, 2017 to the Commission at the March 2017 Commission meeting.

Commission Action: The Commission postponed action on the proposed SHSMP because the Commission was not provided adequate time to respond with its comments. Commission directed staff to provide comments to the SHOPP plan portion of the SHSMP at the May 2017 Commission meeting.

PASSED BY
CTC
MAR 21 2018
CALIFORNIA
TRANSPORTATION COMMISSION

CALIFORNIA TRANSPORTATION COMMISSION

Approval of the Transportation Asset Management Plan
March 21, 2018

RESOLUTION G-18-12

1.1 WHEREAS, Government Code section 14526.4 (a) requires the Department of Transportation (Department), in consultation with the California Transportation Commission (Commission), to prepare a robust Transportation Asset Management Plan (TAMP) to guide the selection of projects for the State Highway Operation and Protection Program (SHOPP); and

1.2 WHEREAS, the TAMP shall be consistent with any applicable state and federal requirements and Commission approved guidelines; and

1.3 WHEREAS, at the October 2017 Commission meeting, the Department presented its draft TAMP; and

1.4 WHEREAS, at its December 2017 meeting, the Commission transmitted its comments on the draft TAMP to the Department; and

1.5 WHEREAS, at the January 2018 meeting, the Department addressed most of the Commission comments in the updated TAMP; and

1.6 WHEREAS, the Commission conditionally approved the TAMP at the January 2018 meeting with the condition that the following information be presented for Commission approval at the March 2018 meeting: (1) annual performance benchmarks for the four primary asset classes (bridges, pavements, drainage systems and transportation management system elements) and (2) annual performance targets for all supplemental asset classes on the state highway system; and

1.7 WHEREAS, the Department presented and the Commission approved annual performance targets for all supplemental asset classes on the state highway system at the March 2018 meeting under Agenda Tab # 27; and

1.8 WHEREAS, the Department presented and the Commission approved annual performance benchmarks for the four primary asset classes (bridges, pavements, drainage systems and transportation management system elements) at the March 2018 meeting under Agenda Tab # 28.

2.1 NOW THEREFORE BE IT RESOLVED, that the Commission approves the TAMP.

U.S. Department of Transportation
Federal Highway Administration

California Division

650 Capitol Mall, Suite 4-100
Sacramento, CA 95814
(916) 498-5001
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March 15, 2018

In Reply Refer To:
HDA-CA

Ms. Laurie Berman
Director, California Department of Transportation
P.O. Box 942873
Sacramento, CA 94273-0001

Subject: Initial Transportation Asset Management Plan Certification

Dear Ms. Berman:

The California Department of Transportation's (Caltrans) February 13, 2018 letter forwarded the initial Transportation Asset Management Plan (TAMP) for the Federal Highway Administration's (FHWA) development process certification.

We have reviewed the TAMP and find it complete. The process you followed meets or exceeds the requirements for developing the initial TAMP set forth in 23 U.S.C. 119 (e)(6), 23 CFR 515.11(a) and 515.11(b). Therefore, your initial TAMP is certified.

Please note the following minor edits:

p. 4, lower left, in the blue box, delete "…review and approve the TAMP…" and insert "…review for completeness and process certification."

p. 9, left box, second paragraph, second sentence: add an 'l' to 'federa' to give 'federal'.

Page 4-4, just below Figure 4-2, second sentence, after State of the Pavement Report delete '23'.

Page 5-16, under NHS Assets, first sentence: delete the (3) from 23 CFR 515.7(a)(3).

In the next TAMP, please include the following:

1. The requirements in 23 CFR 450.34(h)(1) for cooperatively developing and sharing transportation performance data are incorporated in Caltrans/MPO agreements to be executed on or about May 31, 2018. If possible, follow the progress of the agreements

and include a summary in the next TAMP. This would fulfill at least a portion of the data improvement initiative cited on page 9-3 of the TAMP.

2. Section 6.1 of the TAMP includes the following: "…One challenge in developing a financial plan that meets FHWA's requirements is to determine the portion of transportation funds projected to be used on the NHS." Please include an update on this in the final TAMP, to be submitted to FHWA by June 30, 2019.

Caltrans is to be commended for developing an excellent TAMP, including the optional performance targets, life-cycle planning analysis, risk management analysis and financial plan analysis.

Please feel free to contact Steve Healow (916-498-5849) with questions on this matter.

Sincerely,

For: Vincent P. Mammano
Division Administrator

Acknowledgements

This document is a culmination of input from a variety of sources and would not have been possible without the contribution of many people, past and present, from department staff and managers, consultants, partner agencies to key stakeholders, and advocacy organizations.

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Caltrans Program Support

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Division of Maintenance
Division of Traffic Operations
Division of Design
Division of Transportation Planning
Division of Local Assistance
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Partners and Stakeholders

We would like to acknowledge the valuable input received from numerous local and regional transportation agency attendees of many TAMP development workshops held throughout California. We would like to thank several partners and stakeholders individually that worked extremely close in the development of the TAMP as well as provided comments on the draft TAMP.

Federal Highway Administration
California Transportation Commission
Southern California Association of Governments
Metropolitan Transportation Commission
Humboldt County Association of Governments
City of Yountville

All photography provided by Caltrans unless otherwise noted.

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Caltrans, Director's Office of Asset Management

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