WSDOT

TAMP

Transportation Asset Management Plan

April 2018

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Secretary of Transportation

Communicating how WSDOT preserves bridge and pavement networks to achieve MAP-21 goals

Maintaining, preserving, and improving highway assets for our current and future generations

EXECUTIVE SUMMARY

The Washington State Department of Transportation (WSDOT) has the challenging task of managing and sustaining a multi-faceted transportation network, boasting one of the world's largest ferry networks, the world's largest floating bridge (SR 520 floating bridge), nearly 18,700 lane miles of state highways, and over 3800 different state owned bridges and structures. This network reflects the vibrant and diverse citizens of Washington State and serves to connect communities and families while supporting the state's world class economy.

Washington State has experienced significant growth in recent years, placing an increased strain on our aging infrastructure along with an added desire for capacity. Recognizing funding is a finite resource, asset management is critical to ensure WSDOT's investments return the highest amount of benefit at the least amount of cost. Asset management is a fundamental component of the agency's *Practical Solutions* framework which balances investments to achieve and sustain a State of Good Repair for our existing transportation network against strategic system expansions that meet the need of added demand.

To support transportation asset management practices, the Secretary of WSDOT signed *Executive Order 1098* in November 2017 providing direction on the development of a risk-based asset management plan as well as creating an Executive Steering Committee responsible for setting the direction for major asset categories. While the long-term vision of an asset management plan is to include all statewide assets that are part of our transportation network, this initial Transportation Asset Management Plan (TAMP) highlights our statewide bridge and pavement networks.

WSDOT has a long and storied history of managing its bridge and pavement networks. This TAMP serves to connect and align existing asset specific strategies to WSDOT's strategic goals. This TAMP also meets and exceeds the Moving Ahead for Progress in the 21st Century (*MAP-21*) requirements of developing a TAMP that includes all National Highway System (NHS) bridges and pavements by including a more comprehensive look at our state-wide bridge and pavement assets.

The TAMP documents and communicates the following content:

Chapter	Content
Chapter 1 – Introduction	Provides an overview of WSDOT's asset management framework, alignment with Practical Solutions, and overview of the TAMP content.
Chapter 2 – Objectives and Measures	Communicates asset management objectives, performance measures, and targets as well as a history of how WSDOT has measured asset condition.
Chapter 3 – Inventory and Condition	Details total inventory, age, and condition of bridge and pavement assets as well as MAP-21 condition measures.
Chapter 4 – Lifecycle Planning	Explains WSDOT's current asset specific investment strategies to maximize asset life and condition at the lowest practicable cost.
Chapter 5 – Risk Management	Details WSDOT's risk framework, existing risk management practices, and recently held bridge and pavement risk workshops.
Chapter 6 – Revenue and Financials	Summarizes WSDOT's financial sources and expenditures, and aligns planned expenditures with bridge and pavement asset needs. Also provides an estimated replacement value for bridge and pavement assets.
Chapter 7 – Performance Scenarios	Discusses differences between target-based performance gaps and plan-based performance gaps. Also highlights WSDOT's efforts to develop a cross-asset resource allocation framework.
Chapter 8 – Investment Strategies	Aligns asset specific investment strategies to various WSDOT plans and communicates how asset management informs our capital plans.
Chapter 9 Implementation and Systems	Discusses various asset management efforts undertaken by WSDOT as well as work currently underway to enhance WSDOT's asset management practices. Also details systems used in support of asset management and future enhancements of those systems.

While this TAMP serves to communicate our current asset management practices, WSDOT acknowledges asset management is an evolving field and is working on an implementation plan to improve our processes by:

- Improving how asset management data for asset inventory and condition information is collected, stored, and managed
- Creating a stronger alignment between our projects and the assets contained within those projects
- Continuing development on our cross-asset investment trade-off decision capabilities
- Researching and clarifying the role of performance target-setting in asset management
- Providing business process support to regions implementing additional asset management practices
- Continuing risk strategy and asset management alignment

Asset management has been, and will continue to be, a foundational piece of how we manage our transportation network. This TAMP demonstrates how we have maintained our network, prioritized and invested in our capital projects, provided the strategic framework for more robust asset management implementation, and presents new ideas and processes to assist with sustaining our highway network. But most importantly of all, this TAMP supports WSDOT's vision of being the best in providing a *sustainable* and integrated multi-modal transportation system that meets not only our current needs, but provides the framework and blueprints to meet the transportation needs for generations to come.

Signature on File

Roger Millar, PE, AICP, Secretary of Transportation
Washington State Department of Transportation

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Questions Regarding WSDOT's MAP-21 Transportation Asset Management Plan

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CHAPTER 1
INTRODUCTION

The Washington State Department of Transportation (WSDOT) has the responsibility and challenging task of maintaining, preserving and improving transportation assets for current and future generations and doing so in a financially constrained environment. A further challenge is that our assets continue to age and deteriorate, and while proper maintenance can extend the life of our assets, they eventually require costly reconstruction or replacement.

Asset management is a strategic, risk-based approach to cost-effectively and efficiently manage the physical assets of Washington's statewide transportation system. Asset management is a fundamental component of Practical Solutions, WSDOT's policy framework approach to managing the entire transportation system's physical assets on an ongoing, systematic basis from both a condition and system performance perspective.

Sound asset management practice requires the development of long-term, statewide asset management plans to ensure assets such as ferry vessels, pavements, locomotives, bridges and information technology systems have a long, useful life cycle and there is a clear course for achieving agency level performance outcomes. These plans are key management tools that facilitate decisions about where and when to invest limited funds in the transportation system in order to maintain a State of Good Repair at lowest practicable cost across the entire network.

Asset Management Goals

WSDOT's asset management process is tightly linked to the department's mission and its framework outlined in the transportation system policy goals. This framework is defined in the Revised Code of Washington (RCW) 47.04.280. State law defines WSDOT's transportation goals that guide the allocation of resources. As a result, these policy goals contain information vital to the implementation of asset management at WSDOT. For further detail regarding WSDOT's Transportation Policy, see *Chapter 2: Objectives and Measures* as well as, supplemental information in the *Technical Guide*.

Purpose of the TAMP

This initial Transportation Asset Management Plan (TAMP) complies with federal requirements and lays the foundation for asset management at WSDOT. However, it is not the comprehensive asset management plan that WSDOT is moving toward under its Statewide Transportation Asset Management Plan (STAMP). The primary purpose of this initial plan is to establish and communicate WSDOT's asset management process and organizational framework, especially for pavements and bridges as part of the National Highway System (NHS). For this reason, only pavements and bridges are included in this initial TAMP. Additionally, several of the results from processes such as gap analysis, trade-off comparisons, life cycle planning, and risk management are purposefully omitted while WSDOT works with both internal and external stakeholders to develop a shared vision and understanding of asset management.

The asset management plan WSDOT submits in June, 2019 will meet all federal requirements under 23 CFR 515. It will include results from the processes agreed upon from the initial TAMP submission. It will also align asset management practices to a strategic way of prioritizing projects, incorporating asset performance scenarios, performance measures, and trade-off analysis. This will allow WSDOT to demonstrate how asset management practices are used to maintain our existing infrastructure at the lowest practicable cost to achieve a desired State of Good Repair. WSDOT continues to enhance its asset management practices across all asset classes and intends to address all assets managed by the department in the STAMP.

Agency Overview

Practical Solutions

Over the past 15 years Washington's transportation infrastructure has faced challenges from budget shortfalls, an unstable economy, and fluctuating construction costs. These conditions eventually led to organizational change in agency processes, initially called Moving Washington, and more recently termed Practical Solutions. Simply stated, with Practical Solutions we collaborate with our partners to make the right investments, in the right places, at the right time, while using the right approach. Practical Solutions approaches include:

- Lowest life cycle cost to preserve the system in a State of Good Repair,
- Target Zero strategies for safety,
- Transportation system management,
- Demand management, and
- Capital project investment.

Practical Solutions' methods aid WSDOT in project prioritization by selecting the appropriate preservation work at the right time and effectively managing agency assets to minimize life cycle costs. WSDOT's asset management planning reflects the costs and benefits of assets to lengthen their service life when used in conjunction with preservation activities and timely maintenance. To this end, WSDOT uses preventative maintenance to extend the useful life of its assets while keeping them operating effectively. This strategy helps defer costly rehabilitation or reconstruction projects. Exhibit 1-1 provides an overview of WSDOT's Practical Solutions framework and presents a general life cycle delivery diagram of agency business processes.

Exhibit 1-1: WSDOT Practical Solutions Life Cycle.

Exhibit Note: Source is from WSDOT's Practical Solutions webpage, Version 3 posted 8/9/2017.

Organizational Alignment

WSDOT is establishing a necessary organizational framework, guided by Practical Solutions, for implementation of asset management as both a means of managing assets and as a cultural shift within the agency (see Exhibit 1-2 below). This framework, along with other definitions and direction related to asset management, was memorialized in WSDOT'S *Executive Order 1098 – Statewide Transportation Asset Management*.

Using this approach will allow WSDOT to implement the statewide asset management program across all modes of the transportation system. This framework defines four major asset categories and allows for significant executive oversight:

- Intra-Agency (Facilities, Information Technologies, Transportation Equipment Fund, Human Resources, Real Estate),
- Multimodal (Local Programs, Rail, Aviation, Public Transportation),
- Ferries, and
- Highways.

The following asset management framework components are intended to be developed over time and applied, where reasonable, to each of the major asset categories:

- Developing and managing an inventory and condition assessment of assets;
- Developing performance measures that relate to the transportation system policy framework;
- Defining and establishing State of Good Repair standards for each asset relating condition to cost efficiency and performance;
- Establishing targets and performing gap analysis between measures and targets;
- Assessing and establishing strategies to achieve the lowest life cycle cost management;
- Integrating risk management and financial planning into the asset management structure;
- Determining a replacement value for each asset;
- Providing an interface between categories for cross-asset tradeoff analysis; and
- Providing an interface between broad Practical Solutions initiatives and asset management analyses and processes.

Note: Supplemental Information in the TAMP Technical Guide, *provides additional detail on WSDOT's governance structure and definitions related to asset management.*

Exhibit 1-2: WSDOT Organizational Framework for Asset Management.

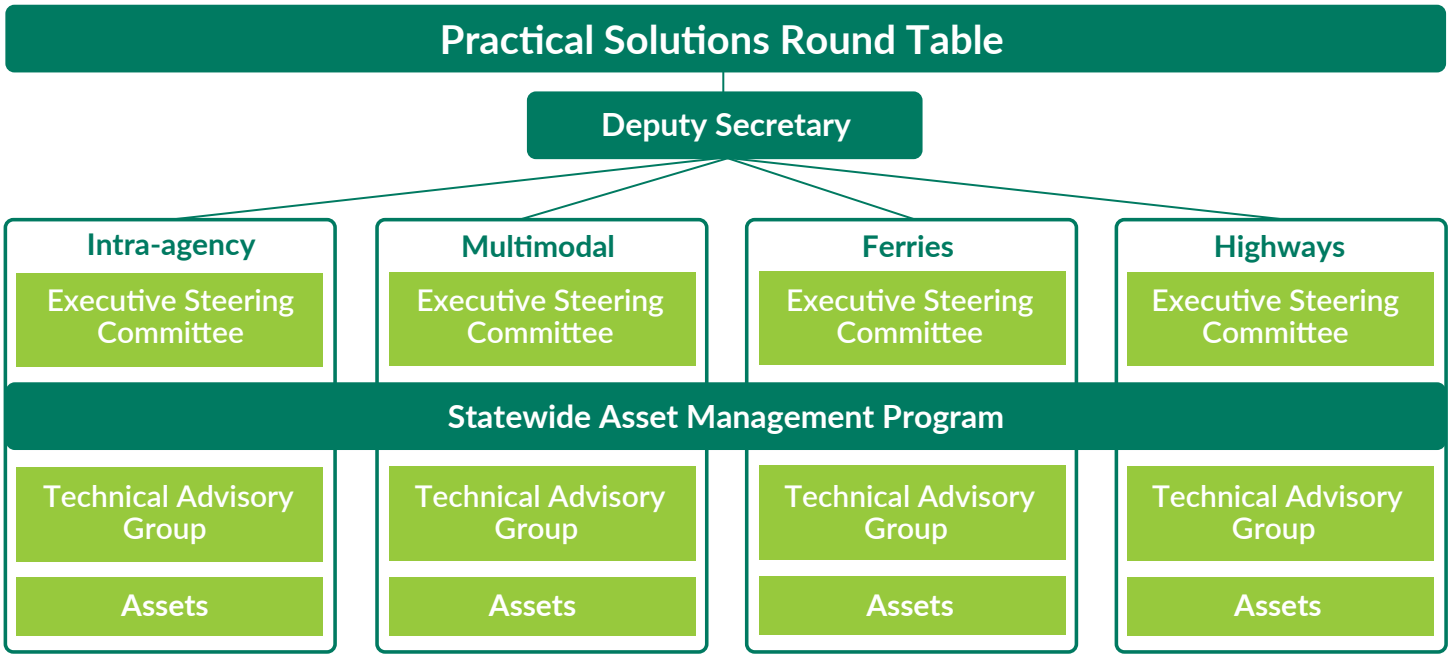


Exhibit Note: Source descriptions are from WSDOT's *Executive Order 1098 – Statewide Transportation Asset Management*.

Each major asset category has an executive steering committee, technical advisory group, and asset classes. Within a class, *asset stewards* lead the management of centralized planning and network analysis. *Asset Managers* are responsible for the site, project specific design, or maintenance of assets. It is not uncommon for activities completed by an asset steward or asset manager to overlap, making the definition of rigid roles by position sometimes problematic. This fluidity is recognized and accepted within the framework, just as a position may function both in a technical and executive role at times.

WSDOT is taking a systematic and comprehensive approach to maturing transportation asset management, as evidenced in the framework. Future versions of the TAMP may include additional asset classes as they mature to the point of meeting federal requirements for inclusion.

Working with Other NHS Owners and Stakeholders

The TAMP is required to address the entire NHS, of which approximately 23 percent is managed by local agencies and in partnership with Metropolitan Planning Organizations (MPOs). WSDOT has been proactive in setting up cross-agency groups, including MPOs and local agencies, to discuss, plan and implement asset management across the NHS. To date, this work has primarily been related to Target Setting, a central piece of both asset management and the performance management frameworks under MAP-21. Exhibit 1-3 shows the collaborative groups that have been set up between WSDOT, MPOs and local agency representatives.

Exhibit 1-3: WSDOT MAP-21 Collaboration for Target Setting for Roads and Bridges on the NHS.

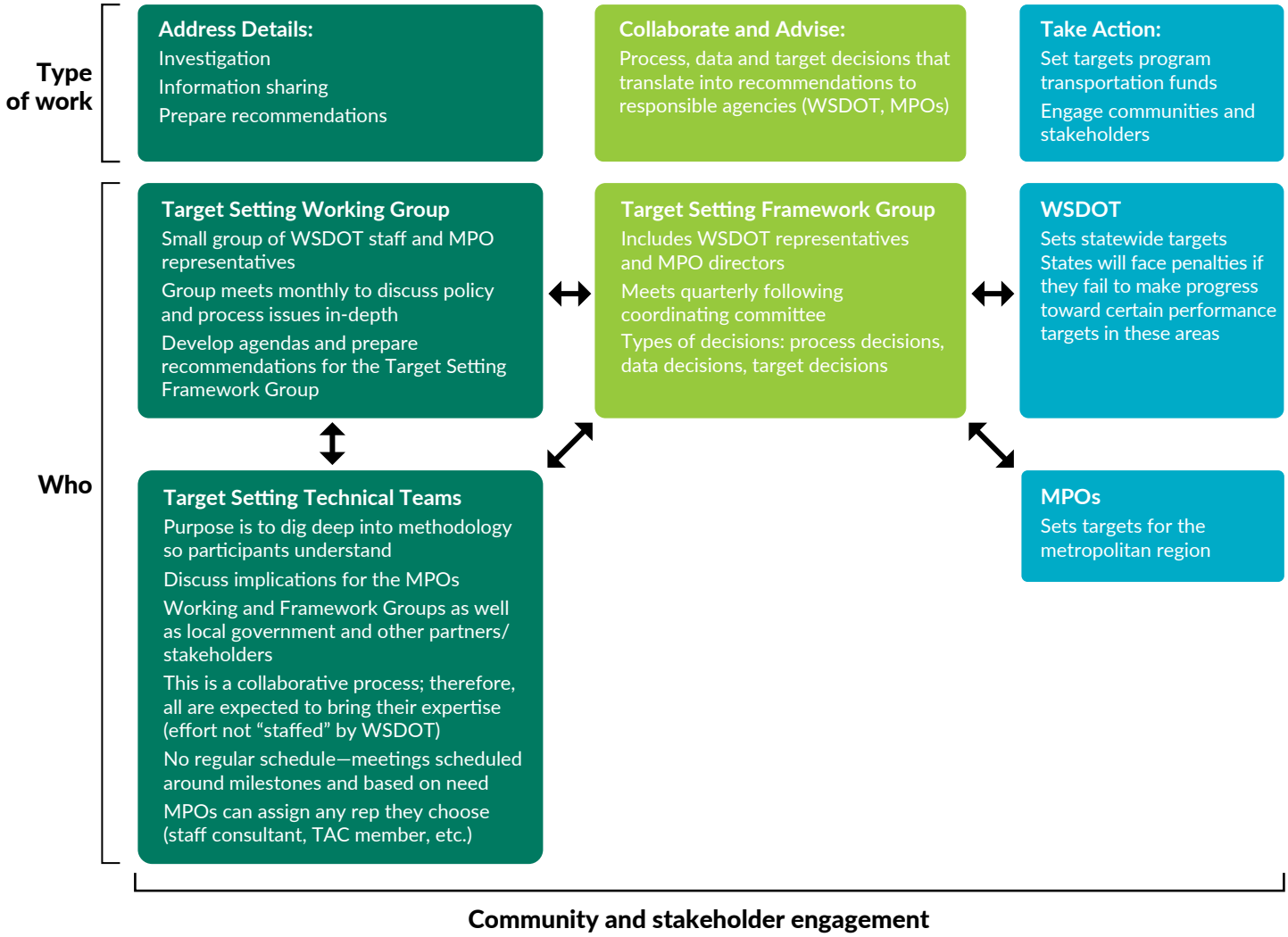


Exhibit Note: Source is from WSDOT's Office of Strategic Assessment and Performance Analysis May, 2015 *MAP-21 Collaboration Technical Folio*.

TAMP Reporting

All states are required to develop and submit a TAMP under federal MAP-21 requirements. States must submit their initial asset management plans for Federal Highway Administration (FHWA) review by April 30, 2018. State DOTs will then have until June 30, 2019, to submit an asset management plan meeting all requirements of federal code, 23 USC 119. There are penalty provisions that may apply if a state does not develop and implement an asset management plan consistent with federal rules, including reduced federal funding participation through the federal National Highway Performance Program. Processes described within the federally approved TAMP will be submitted for recertification at least every 4 years thereafter.

Initial Scope and Future Updates of the TAMP

WSDOT's initial TAMP focuses on pavement and bridge asset plans and will consider including additional assets in subsequent versions of the TAMP. WSDOT's desire is to start with the two highway infrastructure assets of highest significance to WSDOT and systematically expand to include additional assets over time. The initial TAMP exceeds the minimum NHS pavement and bridge asset system requirements under MAP-21 as it includes all state owned pavement and bridge assets. It addresses pavement and bridge assets as follows:

- Pavements - NHS and other state owned pavements
- Bridges - NHS and other state owned bridges

WSDOT is developing a list of additional assets within the highway right-of-way to include in future asset management planning cycles; currently the data requirements to support such inclusions are not available. WSDOT has partial data sets for signals, intelligent transportation system equipment, sign trusses, guard rails, cable barriers, crash attenuators, sound walls, shoulders, high mast lighting and signs; however, these data sets will require further refinement to allow for addition into the TAMP.

TAMP Content

A state asset management plan shall cover, at a minimum, a 10-year period and be in a form that the Secretary of Transportation determines to be appropriate and include:

- A summary listing of pavement and bridge assets on the NHS, regardless of ownership. A condition description of those assets, with pavement listings separated for interstate and non-interstate;
- Asset management objectives and measures;
- Performance gap identification;
- Life cycle cost analysis used to manage preservation;
- Risk management analysis with the results of the periodic evaluations of facilities requiring repair or reconstruction due to emergency events;
- A 10-year financial plan; and
- Investment strategies.

This initial TAMP serves as a guide for how the organization as a whole will manage its assets and document best management practices. Descriptions of the initial TAMP chapter content are reflected below in Exhibit 1-4. The initial TAMP will formalize and document the following:

- Asset management strategies and processes;
- Assets to be included in the TAMP;
- Levels of service or performance targets for each type of asset, where available;
- Current condition or performance of each asset;
- Risk management strategies and assessment process for selected asset types;
- Strategies and methods for managing assets through their life cycle;
- Gap between capital investment decisions and budgeting activities for operations and maintenance; and
- Data needs and process or system to manage the data for each asset.

Exhibit 1-4: Initial TAMP Section Overviews

Section	Description
Objectives and Measures	Federal and state requirements impacting aspects of the TAMP; measures used to track and manage performance; and describes how measures support overall goals and objectives.
Asset Inventory and Condition	Description of Washington's NHS; federal requirements impacting asset inventory and condition assessments; asset descriptions (e.g. materials, components, quantities, location/extent, age, and replacement value); and condition assessments (e.g. methods, rating criteria, and performance trends).
Life Cycle Planning (LCP)	Description of approach to life cycle planning; economic evaluation of treatment options (e.g. management strategies, work type, service life extension, and costs); LCP strategies; WSDOT's participation in the federal NHS Asset Management Program life cycle.
Risk Management	Description of approach to risk management; federal and state requirements impacting aspects of risk management; risk management strategies; TAMP risk assessment (e.g. process, methods, assessment criteria, impact assessment, mitigation planning, response governance, and implementation of mitigation); and TAMP risk management current status and next steps.
Revenue and Financials	Description of approach to financial planning; federal and state requirements impacting aspects of financial planning; revenue sources (e.g. forecasting, financial plan sources at the federal and state level); revenue uses (e.g. operating & capital expenditures and planned spending for 10 year asset needs); and asset replacement values.
Performance Scenarios	Considerations and process for performance gap analysis (e.g. target and planned based); performance scenarios; and cross-asset resource allocation framework.
Investment Strategies	Description of asset prioritization methodologies; project delivery planning; statewide transportation improvement program planning; and proposed investments to the state Legislature from WSDOT's unfunded priority list.
Implementation and Systems	Description of self-assessment (e.g. methods, results, and improvements); external legislative review (e.g. summary of methods, results, needed improvements, and implementation progress); asset management systems and development activities underway.
Technical Guide (Appendices)	Supporting detail for content contained in TAMP chapters: Introduction, Objectives and Measures, Asset Inventory and Condition, Life Cycle Planning, Risk Management, Revenue and Financials, Performance Scenarios, and Implementation and Systems. *Note: A corresponding Technical Guide chapter for Investment Strategies has been omitted since supporting detail is provided in the Life Cycle Planning, Revenue and Financials, and Performance Scenarios chapters.*

CHAPTER 2
OBJECTIVES AND MEASURES

The Washington State Department of Transportation (WSDOT) is recognized as a leader in performance management and accountability. Taking performance management seriously, and integrating it into day-to-day work, has enabled WSDOT to deliver expected performance and build public confidence and trust. WSDOT is committed to working with the federal government to build a reporting and accountability system that is relevant and adds value to the delivery of critical state transportation services and projects.

WSDOT believes that performance management and accountability will help build a transportation system of the future that is:

Reliable - Improved travel times for drivers; more choices for travelers; increased inter-city transit opportunities.

Responsible - Safer roads, and fewer fatalities and serious injuries; cost-effective asset maintenance and preservation; more integrated highway, transit, and ferry travel options; increased special needs transportation and access to jobs and lifeline services.

Sustainable - Cleaner air and water; strategic and balanced approach to climate change; predictable funding and affordable improvements and operations.

Trustworthy - Honest, no-surprises reporting; demonstrated commitment to open and accountable business practices to both citizens and government.

Federal and State Requirements

Federal Requirements

Federal highway programs have embraced performance management through MAP-21 (P.L. 112-141) and FAST Act (P.L. 114-94) provisions to transform and provide a means for more efficient Federal transportation fund investments by:

- Focusing on national transportation goals,
- Increasing the accountability and transparency of the Federal highway programs, and
- Improving transportation investment decision making through performance-based planning and programming.

The acts established the National Highway Performance Program (23 USC § 119) with the goal of improving how federal transportation funds are allocated amongst states. In addition, they require each state department of transportation to develop, at a minimum, a risk-based Transportation Asset Management Plan (TAMP) for the National Highway System (NHS) to improve or preserve the condition of the assets and meet the National Goals and Performance Management Measures (23 USC § 150(b)) of the system.

States must address pavement and bridges but are encouraged to include in their TAMP other infrastructure assets within the highway right-of-way such as tunnels, ancillary structures, and signs. States also can include roads other than those on the National Highway System (NHS), but it is important to note rules specify that any asset included in the plan must be managed under the same provisions as pavement and bridges.

State Requirements

At WSDOT, the TAMP provides the framework for making management and investment decisions in support of our state transportation strategic goals (Results WSDOT), Legislative direction (contained in RCWs 47.04, 47.05, and 47.06) as well as federal requirements. Results WSDOT aligns with the Governor's strategic framework and performance management system (Results Washington). WSDOT and other Washington state agencies are working hard to implement reporting systems that will meet the Governor's performance goals.

Note: Supplemental Information in the TAMP Technical Guide, provides additional detail on federal and state requirements, as well as, statewide planning efforts related to Washington state highways.

Asset Management Objectives, Performance Measures and Targets

Asset management has a critical role in meeting the national and state goals by defining objectives, measures and targets that support them. While MAP-21 required several performance measures, including those related to safety, congestion, air quality, and system performance, the focus of the objectives and performance measures in the TAMP are related to asset condition and the performance of the NHS. Under MAP-21, the performance of the NHS:

> *...refers to the effectiveness of the NHS in providing the safe and efficient movement of people and goods where that performance can be affected by physical assets.*

FHWA summarizes the overall objective of asset management in 23 CFR Part 515.9, stating objectives:

> *Must be consistent with the purpose of asset management, which is to achieve and sustain the desired State of Good Repair over the life cycle of the assets at a minimum practicable cost.*

System-wide Asset Management Objectives

WSDOT's system-wide asset management objectives are to:

- Achieve and sustain a State of Good Repair for transportation assets; and
- Reduce the vulnerability and increase the resilience of critical infrastructure to the impacts of extreme weather and events.

State of Good Repair

Nationally, there is no standardized definition of State of Good Repair for highway transportation. In fact, each state transportation department is to develop its own asset-specific definition that is agreed upon with FHWA. For the initial TAMP, WSDOT is using the MAP-21 condition assessment to assign whether or not a *specific asset* is in a State of Good Repair. A State of Good Repair for a specific asset is defined as a section of pavement or bridge being in fair or good condition. For an *inventory of assets* to be considered in a State of Good Repair, WSDOT must meet its targets for network condition in order for the network to achieve a State of Good Repair. Finally, the performance measures and targets related to financial or network health determine how financially sustainable the inventory is.

Pavement Objectives, Performance Measures, and Targets

WSDOT's pavement-related asset management objectives are to:

- Design and preserve long-life pavement structures, and
- Minimize the number of pavement lane miles in poor condition.

Designing and preserving long-life pavement structures is fundamental to minimizing life cycle costs. In the initial TAMP, WSDOT is excluding financial performance measures that help communicate pavement performance including: *Remaining Service Life*, the *Asset Sustainability Ratio*, and *Deferred Preservation Liability*; even though WSDOT has reported on these for statewide pavement assets as part of the *Gray Notebook*. Additional information on these measures is included in the *Future Performance Measures* section later in this chapter.

WSDOT has been monitoring pavement condition since the mid-1960s and has reported conditions annually in the Gray Notebook since the early 2000s. However, how WSDOT assesses condition varies based on requirements. The following three approaches are currently used to meet those requirements:

- An historical condition assessment methodology;
- A GASB-34 requirements methodology (this largely aligns with the historical condition methodology); and
- A Results Washington methodology.

While all three methodologies are similar, there is enough difference that WSDOT will look to unify condition assessment and reporting in the future. Exhibit 2-1 details the pavement performance measures and targets related to condition. Except for the percentage of poor condition pavements on the Interstate System, targets are yet to be determined (TBD). The Interstate Target is set based on the penalty provision in 23 CFR Part 490.317.

Exhibit 2-1: Pavement Performance Measures and Targets.

Measure	Scope	Metrics Considered	Requirement	Target
Percentage of pavement in fair or better condition	All state owned pavement	Cracking, rutting, faulting, roughness	GASB-34	85% or more
Percentage of pavement in poor condition	NHS	Roughness	Results Washington	10% or less by 2020
Percentage of pavement on the Interstate System in poor condition	Interstate	Cracking, rutting, faulting, roughness	MAP-21	Less than 5%
Percentage of pavement on the Interstate System in good condition				TBD
Percentage of pavement on the NHS (excluding the Interstate System) in poor condition	Non-Interstate NHS			TBD
Percentage of pavement on the NHS (excluding the Interstate System) in good condition				TBD

Exhibit Note: WSDOT is working to establish a 4-yr. target for Interstate System pavement condition measures, as well as 2-yr and 4-yr targets for non-Interstate NHS pavement condition measures, in response to 23 CFR 490.105(E)(7).

Bridge Objectives, Performance Measures, and Targets

WSDOT's bridge-related asset management objectives are to:

- Design and preserve resilient structures,
- Minimize the number of load posted or load restricted bridges, and
- Minimize the number of bridges in poor condition (Structurally Deficient).

WSDOT designs its bridges for 75 year life and to be able to withstand a 1,000-year seismic event. WSDOT assumes an average bridge service life of 80 years. More information on the age of bridges can be found in *Chapter 3: Asset Inventory and Condition* while, additional information on resilience is contained in *Chapter 5: Risk Management* of the TAMP.

The objectives to minimize load posted/restricted bridges, and minimize bridges in poor condition, are interrelated. Keeping bridges in a *State of Good Repair* minimizes the need to load post or restrict bridges. As the bridge network deteriorates in an environment of less than lowest life cycle cost funding, tradeoff decisions must occur regarding acceptable numbers of load posted or restricted bridges relative to the condition of bridges throughout the network. Because of this, WSDOT is not setting targets for load posted/restricted bridges as part of the TAMP. However, it is setting targets for condition, as required for MAP-21 in May 2018. Exhibit 2-2 summarizes bridge performance measures and targets.

Exhibit 2-2: Bridge Performance Measures and Targets.

Measure	Scope	Target
Number of load posted bridges	State owned	Not set
Number of load restricted bridges		
Percentage of NHS bridges classified as in poor condition	NHS	Less than 10%
Percentage of NHS bridges classified as in good condition		To Be Determined

Exhibit Note: WSDOT is working to establish 2-yr and 4-yr targets for NHS bridge condition measures, in response to 23 CFR 490.105(E)(7).

Setting Performance Targets

Targets are required to be set for the MAP-21 pavement and bridge condition performance measures by May 20, 2018 and are to be reported in the Baseline Performance Report due October 1, 2018. Due to timing, these targets are not required to be set as part of the initial submission of the TAMP. However, WSDOT has held continuing meetings with MPOs and local agencies through a pavement and bridge technical committee for over a year, as MAP-21 rules have been proposed and finalized. These quarterly meetings help all NHS stakeholders communicate and agree upon how to best comply with both the Pavement and Bridge Performance rules and the Asset Management rules.

As of the latest quarterly meeting held in November 2017, the following principles are agreed upon for moving forward with target setting framework proposals:

- Use the federally imposed percentage thresholds for penalties as the bases for determining target percentages for
  - percentage of Interstate pavement in poor condition, no more than 5%, and
  - percentage of NHS bridges in poor condition, no more than 10%;
- The percentage of *good* pavements and *good* bridges is primarily a byproduct of lowest life cycle cost investment strategies. In other words, managing the network of assets to lowest life cycle cost naturally creates a certain percentage of pavement and bridge assets in good condition according to MAP-21 standards. WSDOT is taking lowest life cycle cost investment strategies into consideration while working towards setting target measures; and
- WSDOT will lead the effort to comply with minimum pavement and bridge management system requirements, and use the results of these processes to inform expected condition deterioration based on performance scenarios.

Once the pavement and bridge technical team has developed a recommended framework and values for the MAP-21 targets, these will be proposed to the Highway Executive Steering Committee (see *Chapter 1: Introduction, Organizational Framework* section) and MAP-21 Target Setting Framework Group for input, then seek final approval from the WSDOT Secretary of Transportation.

Future Performance Measures

Performance measures related to condition only communicate half the asset management objective about State of Good Repair. The other half, which is equally important, is achieving this State of Good Repair *at a minimum practicable cost*. To this end, WSDOT is evaluating the inclusion of additional performance measures as part of the TAMP. These performance measures are: *Remaining Service Life*, *Asset Sustainability Ratio*, and *Deferred Preservation Liability*.

All three of these performance measures have been used by WSDOT for pavement asset management practices. Additionally, these types of performance measures have been used for transportation asset management by other countries, and have also been reviewed and recommended by the Federal Highway Administration (FHWA). Incorporating them for state and locally owned bridges will require a careful analysis which, is planned over the coming months in preparation for the TAMP June 2019 update.

Performance Measure Considerations

One important aspect of an asset inventory is its age profile. When an inventory is young, network wide performance measures will have different acceptable targets than when an inventory has matured. In the case of transportation assets, the type of inventory that is often most readily understandable is a mature inventory with an evenly distributed age profile. This allows a transportation agency to plan stable annual budgets and needs to preserve the inventory of assets. In the case of an inventory with a non-uniform age profile, certain years will require much less or much more preservation than the average, which is difficult to budget for.

Later sections of the TAMP communicate the age profiles of the statewide and NHS pavement and bridge inventories. It is important to keep these age profiles in mind when evaluating the following proposed performance measures.

Proposed Performance Measure: Remaining Service Life

Remaining Service Life (RSL) is often communicated as the percentage of the remaining useful life of an asset relative to the expected useful life. This is helpful to understand how much usefulness is "left in the tank" for a given asset. For an inventory with an evenly distributed age profile, ideal values tend toward 50%. This reflects approximately equal amounts new, old, and middle-aged assets. Based on the maturity of the NHS bridge and pavement networks, it is expected targets would range between 45% and 55%. When the percentage of life is translated into the ratio of depreciated value relative to the as-new, or replacement value, this is also referred to as the *Asset Consumption Ratio*.

To successfully implement *Remaining Service Life* as part of the TAMP, WSDOT and NHS stakeholders will work to establish standards regarding assessment of useful life and deterioration models for each major subgroup of assets making up the inventory.

Proposed Performance Measure: Asset Sustainability Ratio

Asset Sustainability Ratio (ASR) indicates the replenishment of useful life relative to its consumption. In terms of a network of assets, one year of useful life is consumed annually. The preservation activities performed in the same year replenish useful life. For example, replacing one bridge (designed for an 80 year life) would replenish 80 years of useful life over the network. While WSDOT strives to time lowest life cycle activities based on condition and age, the maturity of NHS pavement and bridge inventories would tend to require approximately an equal number of life replenished to consumed, or an ASR between 0.9 and 1.1, to manage the network sustainably.

The *Asset Sustainability Ratio* can also be expressed as the dollar amount invested to the total depreciated value over a time period. To successfully implement the ASR, WSDOT and NHS stakeholders will work to establish standards regarding estimated life replenished by activity and/or depreciation, while also agreeing on the proper timeframe(s) to report the ASR over.

Proposed Performance Measure: Deferred Preservation Liability

The Deferred Preservation Liability (DPL) is the estimated cost to perform all past-due preservation or rehabilitation work in order to manage the network in a State of Good Repair. This is also often referred to as the "backlog" of work needed to be completed. In a sufficiently mature network, extended time periods with an *Asset Sustainability Ratio* less than one are expected to have a growing DPL. Moreover, often the window to perform the lowest life cycle activity is missed, and a more costly rehabilitation activity is required. For example, if a pavement resurfacing is delayed too long, the entire pavement structure is likely to be compromised, and a much more costly rehabilitation or reconstruction is now needed to restore the State of Good Repair for the asset.

In a network funded at amounts close to lowest life cycle planning, the *Deferred Preservation Liability* approaches zero. To successfully implement the DPL, WSDOT and NHS stakeholders will work to establish standards regarding an assessment of what is past-due for useful life, and also agreed assumptions related to the types of activities and costs needed to restore the assets to a State of Good Repair.

CHAPTER 3
ASSET INVENTORY AND CONDITION

Washington's roadway system includes the Interstate System, the National Highway System (NHS), state highways, county roads, and city streets. According to the FHWA Office of Highway Policy Information statistics, there are an estimated at 171,031 lane miles of roadways in Washington state. This system enhances mobility for Washington's citizens and moves goods for the social and economic vitality of Washington.

Note: Supplemental Information in the TAMP Technical Guide, provides additional detail on WSDOT's pavement and bridge inspection process and development activities to automate asset register reporting.

National Highway System (NHS)

The National Highway System consists of roadways important to the nation's economy, defense, and mobility. It is divided into the following subsystems: Interstate, Other Principal Arterials, Strategic Highway Network (STRAHNET), Major Strategic Highway Network Connectors, and Intermodal Connectors. Washington state has 14,319 lane miles of NHS made up of 3,812, 7,220 and 3,287 lane miles of Interstate, non-Interstate State Highways, and Local Agency, respectively; shown in Exhibit 3-1 and Exhibit 3-4.

Exhibit 3-1: Washington State NHS Lane Miles of Interstate, non-Interstate State Highways, and Local Agency.

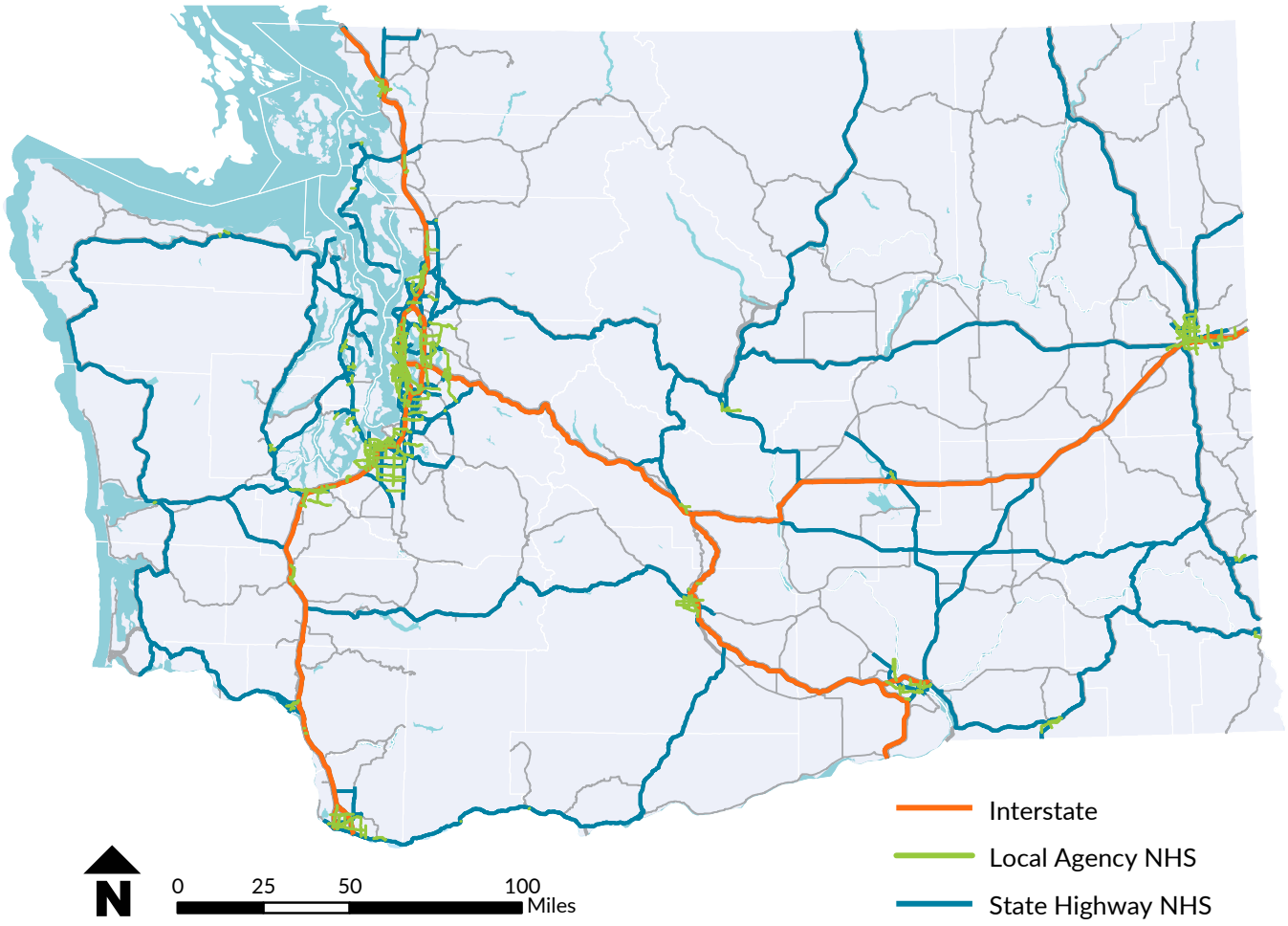


Exhibit Note: Data source is from WSDOT's GeoData Distribution Catalog, maintained by the Office of Information Technology, and represents information collected for 2016.

Federal and State Requirements

Federal Requirements

MAP-21 requires an inventory of pavement and bridge assets on the National Highway System. Additional inventory information is required to be reported according to the standards of the *HPMS Field Manual*, which is a good reference for the types of attributes stored for pavement and bridge assets throughout Washington state.

State Requirements

While there is no specific state requirement to maintain an inventory of assets, the long history of implementing asset management at WSDOT has necessitated the production of inventories.

Pavement Asset Inventories

Statewide Inventory

WSDOT manages approximately 18,700 lane miles of state highways (including bridge decks), nearly 2,100 lane miles of ramps and special use lanes, and just over 7,500 lane miles of shoulders. State highways pavement assets have an estimated replacement value of over $19 billion.

WSDOT generally characterizes pavements into three surface type categories: chip seal, asphalt and concrete. This is because the surface type of a road is correlated to the level of traffic it carries, its surface life, and life cycle cost implications. Surface type inventory values shown below in Exhibit 3-2 and are also shown in Exhibit 3-3.

Exhibit 3-2: Statewide Pavement Asset Summary.

Surface Type	Lane Miles
Chip Seal	6,865[1,2]
Asphalt	9,382[1,2]
Concrete	2,444[1,2]
Mainline Total	**18,691**
Special Use Lanes	2,097[2]
Ramps	
Shoulders	7,526[3]

Exhibit Notes:

1 Includes bridge deck lane miles.

2 Source: 2017 *State Highway Log v-14*; including data from the TRIPS database representative of data collected through the previous year.

3 Source: 2016 WSDOT Self-Assessment Results. Shoulder information was calculated into equivalent lane miles, which is the area of the shoulder divided by 12 (as 12 ft. is a standard lane width).

WSDOT Pavement Surface Types

Chip seal and asphalt pavements are part of a broader category called flexible pavement, whereas concrete is categorized as rigid pavement. For WSDOT, this is important because most flexible pavement structures can be managed perpetually by properly timed resurfacing applications. On the other hand, concrete pavement must be reconstructed when it has reached the end of its life. Exhibit 3-3 shows pavement surface types statewide in Washington. For all pavements, WSDOT maximizes life with maintenance and rehabilitation activities including crack sealing and patching for flexible pavements and diamond grinding and panel replacement for concrete.

Exhibit 3-3: Pavement Surface Types on the Washington Statewide System.

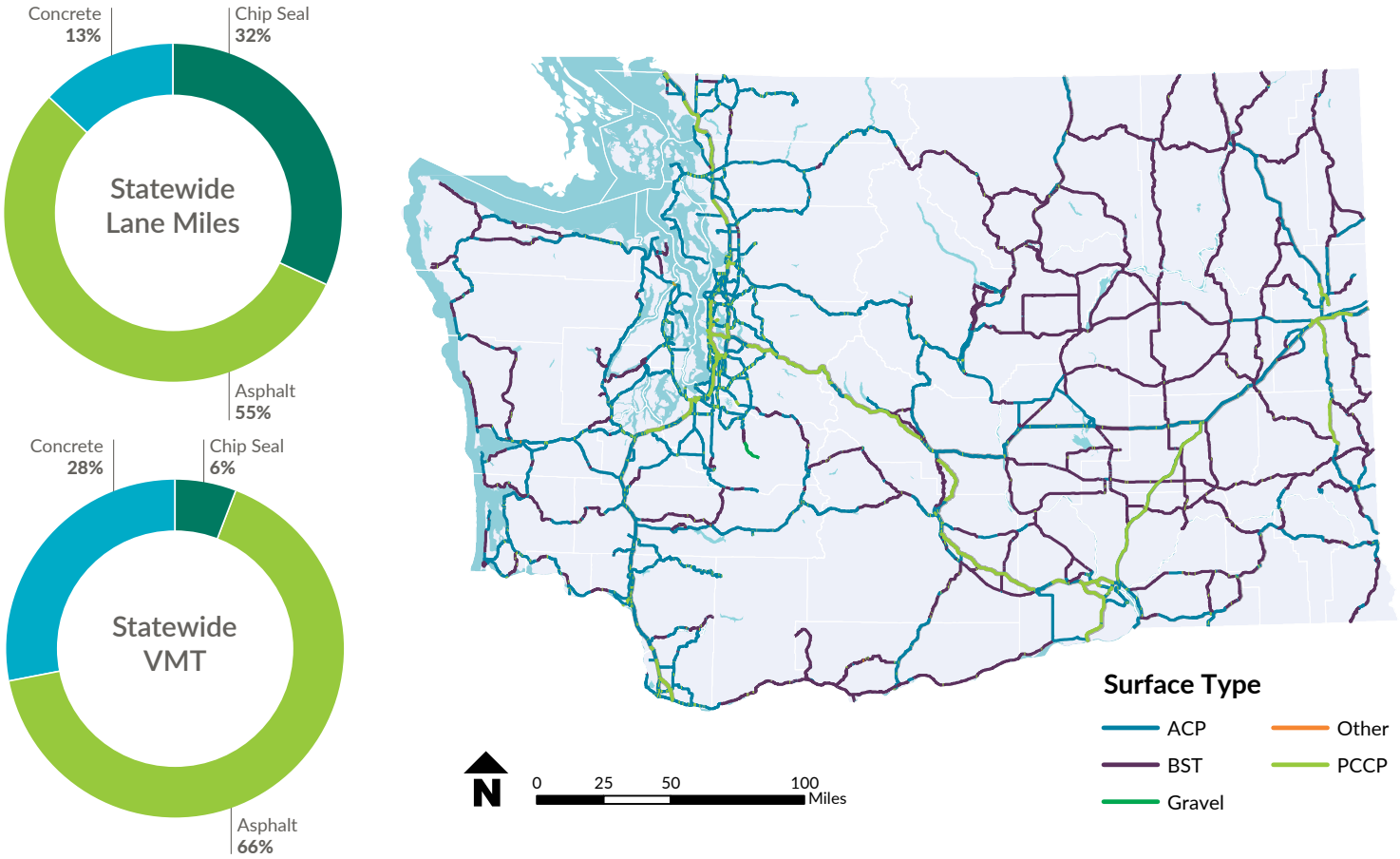


Exhibit Note: Source: WSDOT's *Pavement Notebook*; Feb., 2016 *Pavement Asset Management*.

National Highway System Pavement Inventory

MAP-21 requirements focus specifically on the National Highway System. The NHS comprises approximately 62% of WSDOT lane miles and carries 89% of the Vehicle Miles Traveled (VMT) statewide. In addition, approximately 23% of the NHS is managed by local agencies and not WSDOT. Exhibit 3-4 shows the ownership by lane miles and surface type. Future progress will be reported in the spring of 2018, *Gray Notebook 68.*

Exhibit 3-4: MAP-21 System Inventory of WA NHS and Statewide Pavement Assets.[1,2,3]

	Interstate[1,2]		Non-Interstate NHS	
Surface Type	WSDOT		WSDOT	Local
Asphalt	2,131	Lane Miles	5,121	1,800
Chip Seal	40		1,628	1,279
Concrete	1,641		471	208
Total	**3,812**		**7,220**	**3,287**

Exhibit Notes:

1. Values reflect from data submitted to HPMS in 2017 for calendar year 2016.
2. Excludes bridge deck lane miles and unpaved roads.
3. Local non-Interstate NHS was adjusted based on WSDOT internal data for surface type, since only samples were reported to HPMS.

Age of the WSDOT Pavement Network

The age distribution of an asset inventory is essential to understand the life cycle management and investment strategies that can be used to keep it in a State of Good Repair. For this reason, the age of WSDOT's pavement network is discussed within this section of the TAMP.

Distribution of structure age (years since initial or re-construction) amongst each surface type is shown in Exhibit 3-5. Over 50% of the asphalt and chip seal pavement structures are more than 50 years old, which is the typical "design" life for pavements. With proper monitoring, maintenance, and rehabilitation, a significant number of these roadways are not expected to fail or require reconstruction. However, Exhibit 3-5 shows approximately 50% of the concrete pavement structures are more than 40 years old (1,000 lane miles), with 3% of those miles at 60 years or older (100 lane miles). This is a risk WSDOT must manage in the immediate future since concrete requires replacement at the end of its useful life and requires substantial capital resources to do so.

Bridge Asset Inventories

Statewide Inventory

WSDOT's bridge asset inventory includes nearly 4,000 structures statewide. Additional to WSDOT's over 3,000 vehicular bridges greater than 20 feet long, the entire inventory includes structures that are less than 20 feet long and structures not open to vehicular traffic (i.e. additional structures the FHWA does not require be inspected), see Exhibit 3-6 below. Replacement value of all WSDOT-owned bridges is estimated at $58.2 billion statewide.

There are over 5,700 locally owned bridge structures in Washington during 2017, a decrease from 2016. This decrease is due to duplicate entries being removed when the state and local inventories were combined into one database. Vehicular bridges longer than 20 feet account for the majority of the local bridge inventory.

Exhibit 3-5: Distribution of Pavement Structural Life for Each Surface Type.

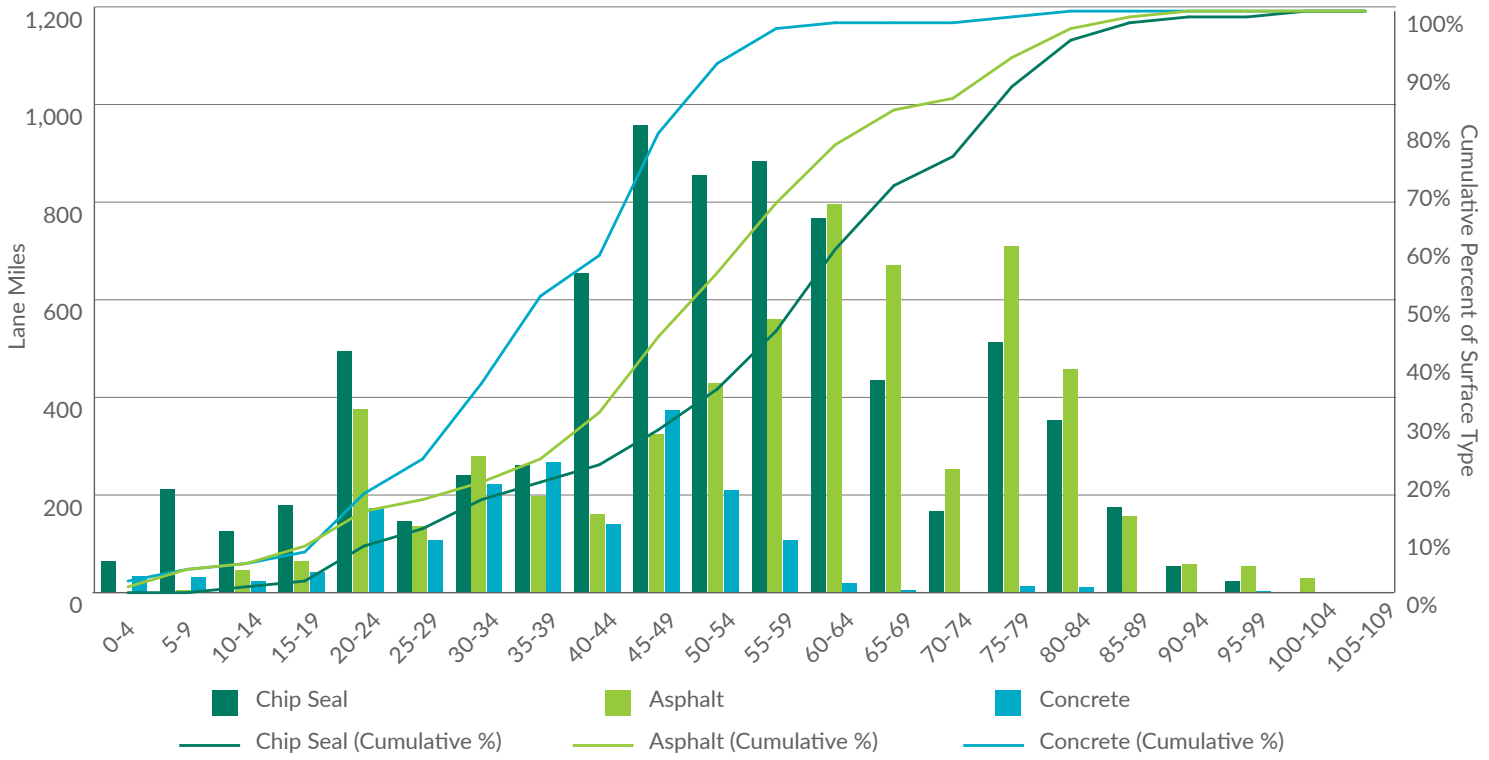


Exhibit Note: Source is 2016 data queried from the WebWSPMS by WSDOT's Pavement Branch of the Materials Laboratory.

Exhibit 3-6: 2017 Statewide Bridge Asset Summary.[1]

Structure Type	WSDOT	Local
Vehicular Bridges	3,124	4,061
Small Structures (< 20' long)	431	1,251[2]
Culverts (> 20' long)	130	N/A[2]
Pedestrian Structures	80	264
Ferry Terminal Structures	69	9
Tunnels and lids	47	8
Border Bridges[3]	11[4]	1[5]
Railroad Bridges	5	141
Total	**3,897**	**5,734**

Exhibit Notes:

1. Source: WSDOT Bridge and Structures Office and WSDOT Local Programs Office; prepared for June, 2017 *Gray Notebook 66th Edition*.
2. Locally owned culverts longer than 20 feet are included in the number of vehicular bridges longer than 20 feet.
3. WSDOT funds 50% of preservation for 11 border bridges.
4. Five of the border bridges are maintained by Oregon and one by Idaho.
5. The locally owned border bridge count is included in the number of vehicular bridges longer than 20 feet; therefore the one locally owned border bridge is not included in the total bridge structures count.

WSDOT Bridge Structure Types

WSDOT bridges are constructed using three primary materials: concrete, steel or timber. Over the past ten years, seven out of ten bridges built have been pre-stressed or post-tensioned concrete structures. For all bridge structures, WSDOT maximizes life with a combination of cost effective actions such as repairs and rehabilitation, steel bridge painting, concrete deck rehabilitation, and bridge replacement. Exhibit 3-7 shows all bridge structures managed by WSDOT statewide.

Exhibit 3-7: Bridge Asset Types on the Washington Statewide System.

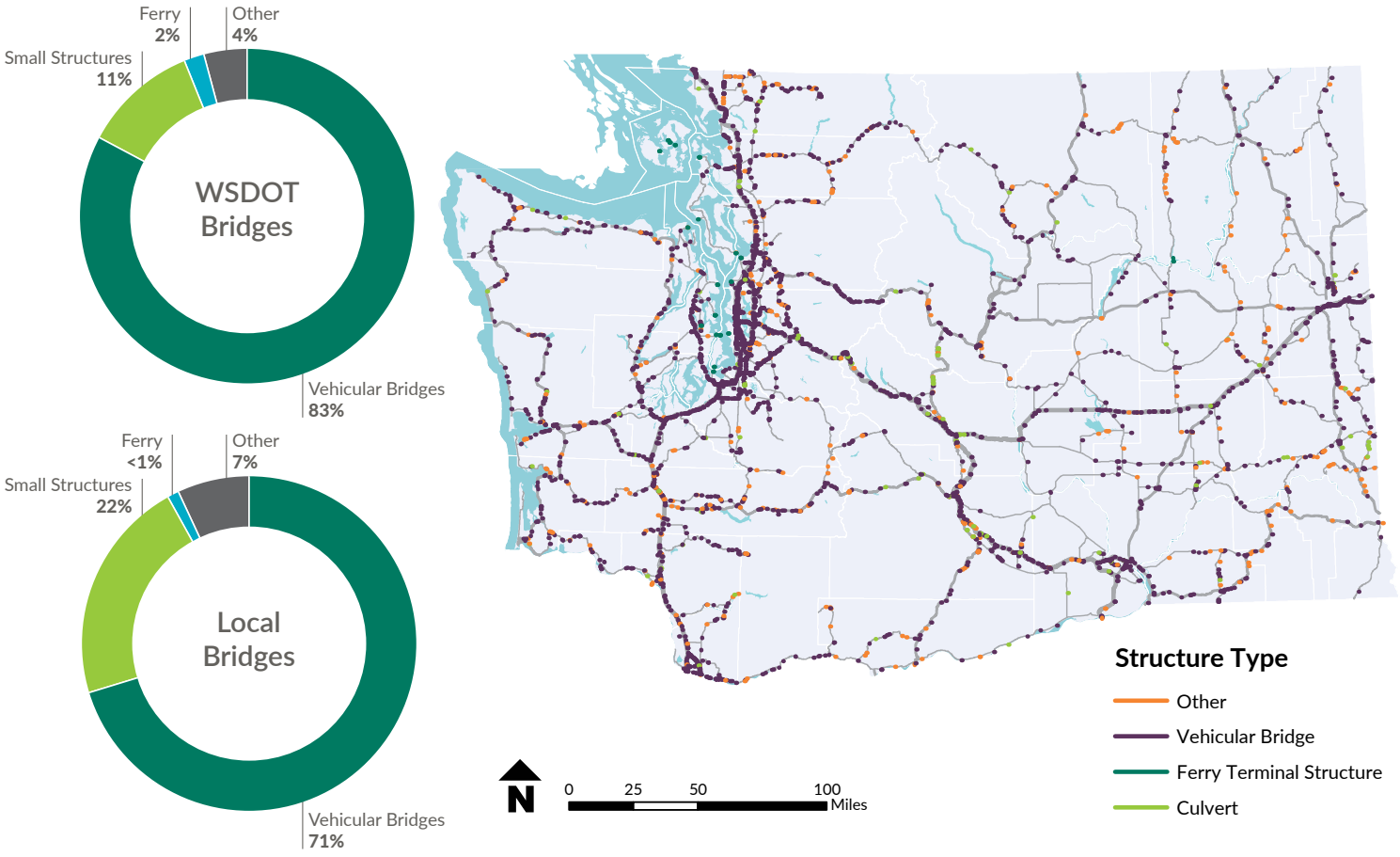


Exhibit Note: Source is from WSDOT Bridge and Structures Office and WSDOT Local Programs Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

National Highway System Bridge Inventory

FHWA directs states to report on bridge structure conditions for only a portion of their entire inventory including:

- Vehicular bridges,
- Ferry terminals,
- Culverts longer than 20 feet,
- All specifically on the National Highway System.

Exhibit 3-8 (below) summarizes bridge assets and deck area by system, and includes structure types required to be inspected for Map-21.

WSDOT is responsible for maintaining over 3,300 bridge assets, including structures on interstates, the National Highway System, and state highways. Local governments throughout the state maintain remaining bridge structures. Of the nearly 7,400 bridges across Washington, just over 4,000 are locally owned and support an average of 10 million crossings per day. Washington's NHS network includes 49.7 million square feet of bridge deck area, of which 90.9% is state owned and 9.1% is owned by local agencies.

Exhibit 3-8: MAP-21 System Inventory of WA NHS and Statewide Bridge Assets.[3]

	2017 NHS		2017 Statewide	
Owner	Deck Area[1] (Million Sq. Ft.)	Bridges (Number)	Deck Area[1] (Million Sq. Ft.)	Bridges (Number)
WSDOT	45.1	2,272	54.4	3,312
Local[2]	4.5	204	17.7	4,061
Total	49.7	2,476	72.1	7,373

Exhibit Notes:

1 Due to rounding, some figures are not computable based on numbers in the table.

2 Bridges owned by counties and cities.

3 Source: WSDOT Bridge and Structures Office and WSDOT Local Programs Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

Age of the WSDOT Bridge Inventory

Exhibit 3-9 shows the distribution of structure age (years since initial or reconstruction) amongst all WSDOT-owned bridges. WSDOT owns 246 bridges that are 80 years old or older. Replacing these bridges as they near 100 years of age would cost nearly $2.6 billion over the next 20 years, or approximately $130 million per year (in 2017 dollars). Many of these bridges will remain in use during the next 10 years, currently 24 of them (6% by deck area) are in poor condition, and WSDOT will continue to focus on their preservation.

Exhibit 3-9: Distribution of Remaining Structural Life for All WSDOT Owned Bridges.[1,2]

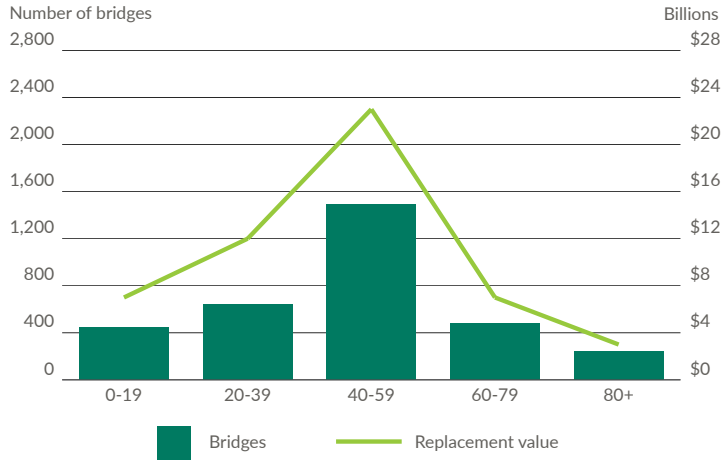


Exhibit Notes:

1 Source is from WSDOT Bridge and Structures Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

2 Replacement value describes the cost to replace all bridges in each age range.

Pavement Conditions

WSDOT Pavement Condition Assessment

WSDOT conducts annual condition evaluations on state managed roadways using three indicators:

1. Surface cracking (an indicator of structural deterioration),
2. Rutting (which is monitored for safety and structural reasons), and
3. Smoothness (measured using the International Roughness Index).

These indicators are used to classify pavement conditions into five categories: very good, good, fair, poor and very poor. Categories for very good, good, and fair show pavement conditions that are considered adequate. Pavement in poor condition is deficient and needs repair, while very poor condition indicates failure and the need for substantial restoration and possibly reconstruction.

The most cost-effective and efficient approach to managing pavement assets is characterized by evenly distributed conditions amongst the fair, good, and very good categories with a small percentage (3% or less) in poor or very poor condition. Anticipated poor and very poor conditions can arise from the lag between preservation activities and condition measurement. These short-term condition indicators provide a snapshot of the current status of the pavement network, but do not inform WSDOT about long-term trends or capture impacts of long-term investments on the pavement network.

Statewide pavement condition trends are displayed in Exhibit 3-10. Actual values are included below for 2012 and 2016. Additionally, condition figures do not include chip seal pavement, also known as Bituminous Surface Treatments (BST). Future assessments will include chip seal conditions. Chip seal pavement accounts for 33% of lane miles on the state's highway network, yet because chip seal roads have less traffic than asphalt or concrete, they account for only 6% of the vehicle miles traveled on WSDOT's roadway network.

Exhibit 3-10: WSDOT Pavement Condition Trends Statewide.[3,4]

Percentage of WSDOT's pavement in good condition decreases; percentage in poor condition increases

Actual values for 2012 and 2016; Percent of lane miles and vehicle miles traveled (VMT) by condition category; Characteristics of pavement at each condition.

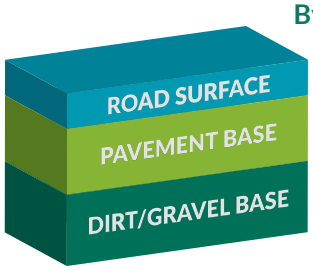
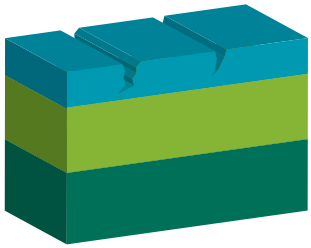
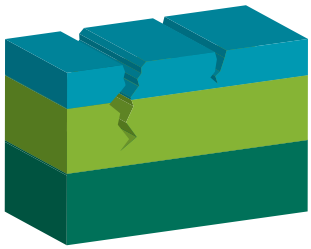
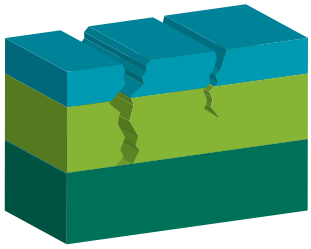
WHAT DRIVERS SEE	WHAT IS HAPPENING	2012	2016	Trend[1]	Desired Trend
GOOD/VERY GOOD	By lane miles	75.8%	73.8%	↓	↑
	By VMT[2]	73.6%	73.3%		
	This pavement is in good condition with minimal deterioration *Road users experience a smooth road with minimal cracks, ruts or potholes*				
FAIR	By lane miles	16.1%	18.4%	↑	*
	By VMT[2]	18.4%	18.4%		
	Managing pavement by lowest life cycle cost (LLCC) means choosing the most cost-effective time to resurface or repair a road—when the surface shows wear, but before the underlying structure is damaged *Preventive preservation (maintenance) repairs at this stage can maximize the road's service life*				
POOR	By lane miles	5.2%	5.8%	↑	↓
	By VMT[2]	5.9%	6.6%		
	Waiting to repair a road until it is in poor condition costs more, because damage to the underlying structure requires more expensive pavement restoration (1.5 to 2 times the LLCC) *Poor and very poor roads cause more wear on vehicles and higher fuel use*				
VERY POOR	By lane miles	3.0%	2.0%	↓	↓
	By VMT[2]	2.1%	1.7%		
	Delaying rehabilitation of pavement in poor condition can lead to deep pavement failure which requires more expensive reconstruction (3 to 4 times the LLCC) *This road requires reactive repairs to hold it together until reconstruction, which is not a good long-term cost saving strategy*				

Exhibit Notes:

1 Trends are based on observed condition trends between 2012 and 2016.

2 When pavement condition is weighted by VMT, roadways with more traffic are weighted more heavily than less traveled roads. Weighting pavement condition by VMT better accounts for the higher costs to maintain and preserve roads with more traffic.

3 Percentages may not add to 100 due to rounding. Condition figures do not include chip seal pavement, also known as Bituminous Surface Treatments (BST), which has not been evaluated since 2010 due to budget reductions. Chip seal pavement accounts for 35% of lane miles on the state's highway network (up from 33% in 2015), yet because chip seal roads have less traffic than asphalt or concrete, they account for only 7% of the vehicle miles traveled on WSDOT's roadway network. Projections of future conditions are not included.

4 Source: WSDOT's Pavement Branch of the Materials Laboratory and WSDOT Capital Program Development and Management Office; prepared for Dec., 2017 Gray Notebook 68th Edition.

MAP-21 Pavement Conditions

Like WSDOT's pavement condition assessment, MAP-21 also uses cracking, rutting and roughness. Exhibit 3-11 shows the thresholds for each criterion. However there are notable differences, including:

- MAP-21 excludes rutting and includes faulting for concrete pavement. WSDOT includes reconstruction, DBR, and grinding (faulting is included in these measures);
- MAP-21 assumes rutting will not occur in concrete. This generally true, except for studded tire damage. Since studded tires are allowed in Washington, WSDOT includes rutting in the assessment;
- MAP-21 uses stricter thresholds to categorize pavements into Poor, Fair, and Good classifications. Two criteria must be in Poor condition for a section to be rated as poor, as opposed to one for the WSDOT assessment; and
- MAP-21 methodology results in less pavement categorized into Poor condition even though individual criteria are stricter.

Exhibit 3-11: MAP-21 Pavement Condition Rating Thresholds.[1,2]

RATING	GOOD	FAIR	POOR
IRI (Inches/Mile)	< 95	95-170	> 170
PSR[3] (0.0-5.0 value)	≥ 4.0	2.0-4.0	≤ 2.0
Cracking Percent (%)	< 5	CRCP: 5-10 Jointed: 5-15 Asphalt: 5-20	> 10 > 10 > 20
Rutting (Inches)	< .20	.20-.40	> .40
Faulting (Inches)	< .10	.10-.15	> .15

Exhibit Notes:

1 Source: FHWA, May 31, 2017 Pavement and Bridge Condition Presentation.

2 In urbanized areas where the population is one million or more.

3 PSR may be used only on routes with posted speed limit <40mph.

FHWA's *HPMS Pavement Condition Report Card* has been provided to Washington state to assess the MAP-21 condition assessment for both the Interstate and non-Interstate NHS. However, because the local agency NHS did not previously have all three metrics submitted because samples were only previously required, 28% of the sections for non-Interstate NHS are considered incomplete, and the values shown in Exhibit 3-12 are primarily for the state maintained NHS.

Exhibit 3-12: Statewide NHS MAP-21 Condition Assessment.[1,2]

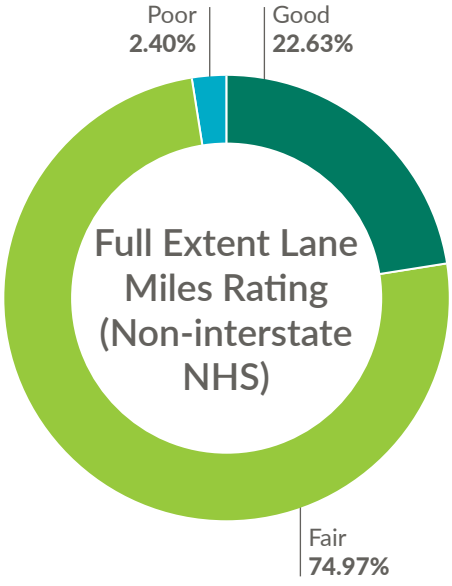


Exhibit Notes:

1 Local NHS data is incomplete.

2 Source is from the HPMS Pavement Report Card for Washington state's 2017 data submittal for calendar year 2016.

Pavement Performance Summary

Exhibit 3-13 summarizes the established performance measures from *Chapter 2: Objectives and Measures*, and indicates the current status comparing it to the target, if one exists. Since many targets are still in the development phase, some target values remain to be determined (TBD) and a performance gap analysis is not completed or communicated as part of this initial TAMP. The process for *Performance Gap Analysis* is detailed in *Chapter 7: Performance Scenarios*.

Exhibit 3-13: Pavement Performance Measures and Targets, with Condition.

Measure	Scope	Metrics Considered	Requirement	Target	Current Value	Gap?
Percentage of pavements in fair or better condition	All state owned pavements	Cracking, rutting, faulting, roughness	GASB-34[1]	85% or more	93.1%	No
Percentage of pavements in poor condition	NHS	Roughness	Results Washington[1]	10% or less by 2020	7%	No
Percentage of pavements on the Interstate System in poor condition	Interstate	Cracking, rutting, faulting, roughness	MAP-21[2]	Less than 5%	3.2%	No
Percentage of pavements on the Interstate System in good condition				TBD	33.9%	TBD
Percentage of pavements on the NHS (excluding the Interstate System) in poor condition	Non-Interstate NHS			TBD	2.4%	TBD
Percentage of pavements on the NHS (excluding the Interstate System) in good condition				TBD	22.6%	TBD

Exhibit notes:

[1] Source: WSDOT's Pavement Branch of the Materials Laboratory and WSDOT Capital Program Development and Management Office; prepared for Dec., 2017 *Gray Notebook 68th Edition*.

[2] Source is from the HPMS *Pavement Report Card* for Washington state's 2017 data submittal.

Bridge Conditions

WSDOT Bridge Condition Assessment

Conditions for WSDOT-owned bridges, culverts, and ferry terminals longer than 20 feet that carry vehicular traffic are reflected in Exhibit 3-14. Statewide bridge condition trends show that for 2017, WSDOT has 91.8% of its bridges by deck area in fair or better condition, meeting agency performance goals. This is an improvement over 2016, when 91.2% of bridges by deck area were in fair or better condition. The agency's performance goal is to maintain the percent of National Highway System bridges, both state and locally owned, in fair or better condition for at least 90% of deck area by 2020. State and federal bridge condition measures are nearly identical, and apply only to the 2,272 WSDOT bridges and 204 locally owned bridges on the NHS.

Exhibit 3-14: WSDOT Bridge Condition Trends Statewide.[1,2,3]

STRUCTURAL CONDITION		2012	2016	2017	Trend (2016-17)	Desired trend
GOOD/VERY GOOD Bridges in good condition range from those with no problems to those having some minor deterioration of structural elements.	Bridge deck area	17.4	19.8	20.3	↑	↑
	Percent of deck area	33.1%	36.9%	37.3%		
	Number of bridges	1,547	1,678	1,699		
FAIR Primary structural elements are sound; may have minor section loss, deterioration, cracking, spalling or scour. This is the most cost-effective time to rehabilitate before the underlying structure is damaged.	Bridge deck area	33.0	29.1	29.7	↑	*
	Percent of deck area	63.0%	54.3%	54.5%		
	Number of bridges	1,581	1,462	1,450		
GOOD/VERY GOOD & FAIR TOTALS: Goal = 90% or more deck area in fair or better condition	Bridge deck area	50.4	48.9	49.9	↑	↑
	Percent of deck area	96.1%	91.2%	91.8%		
	Number of bridges	3,128	3,140	3,149		
POOR (Structurally Deficient) A bridge in poor condition has advanced deficiencies such as section loss, deterioration, scour, or seriously affected structural components, and may have weight restrictions A bridge in poor condition is still safe for travel.	Bridge deck area	2.1	4.7	4.5	↓	↓
	Percent of deck area	3.9%	8.8%	8.2%		
	Number of bridges	117	154	163		

Exhibit Notes:

1 Deck area in millions of square feet. Measuring bridge conditions by deck area incorporates bridge size, giving a more comprehensive picture of conditions than counting the number of bridges alone.

2 All numbers shown in the table above are based on the revised "out-to-out" calculation method (which includes curbs and rails on the bridge) instead of the bridge width from curb to curb. The 2012 data was updated using this revised calculation method.

3 Source: WSDOT Bridge and Structures Office and WSDOT Local Programs Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

MAP-21 Bridge Conditions

Like WSDOT's Bridge condition assessment, MAP-21 also uses inspection data to determine ratings and whether a bridge is structurally deficient, functionally obsolete, and sufficient to serve its intended purpose. Exhibit 3-15 shows the condition rating thresholds for each criterion. Condition rating criteria are as follows, MAP-21 includes:

- **Sufficiency Rating** for the bridge's overall ability to serve its intended purpose on a scale of zero to 100; lower values indicate higher need of repair or replacement.
- **Structurally Deficient Rating** for the bridge's deterioration as indicated by a superstructure, deck, and/or substructure rating of four or less (substandard) on a scale of zero to nine. A bridge is also classified as structurally deficient if its load-carrying capacity or potential for flooding indicates a priority of replacement; WSDOT's rating does not include these because they are not indicators of the bridge's structural condition.
- **Functionally Obsolete Rating** for the bridge's functional capacity and design standards. This rating is applied if a bridge's approach roadway alignment, deck geometry, under clearance, load-carrying capacity, or flood potential is rated three or less (substandard) on a scale of zero to nine.

Exhibit 3-15: MAP-21 Bridge Condition Rating Thresholds.

	9-8-7 Good	6-5 Fair	4-3-2-1-0 Poor
Deck	≥ 7	5 or 6	≤ 4
Superstructure	≥ 7	5 or 6	≤ 4
Substructure	≥ 7	5 or 6	≤ 4
Culvert	≥ 7	5 or 6	≤ 4

Exhibit Note:

Source: WSDOT Office of Strategic Assessment and Performance Analysis (OSAPA), 2015 *Bridge MAP-21 WSDOT Technical Folio*. Contains criteria derived from notice of proposed rulemaking (NPRM) published at 80 FR 326 on January 5, 2015; final rule effective Feb. 17, 2017.

Federal targets require Washington to maintain its bridges so less than 10% of bridges, weighted by deck area, are rated in poor condition. Washington performed better than the federal standard of not greater than 10% rated poor (Structurally Deficient) on the NHS. Washington's NHS network includes 49.7 million square feet of bridge deck area, of which 90.9% is state owned and 9.1% is owned by local agencies. Exhibit 3-16 shows the condition of Washington state bridges.

Exhibit 3-16: MAP-21 Condition of WA State Bridges.[3]

2017 NHS		
Owner	**Deck Area[1] (Million Sq. Ft.)**	**Bridges (Number)**
WSDOT Owned	45.1	2,272
Amount Poor (%)	4.0 (8.9%)	106
Local[2] Owned	4.5	204
Amount Poor (%)	0.3 (5.7%)	23
Total	**49.7**	**2,476**
Total Poor (%)	**4.3 (8.6%)**	**129**

2017 Statewide		
Owner	**Deck Area[1] (Million Sq. Ft.)**	**Bridges (Number)**
WSDOT Owned	54.4	3,312
Amount Poor (%)	4.5 (8.2%)	163
Local[2] Owned	17.7	4,061
Amount Poor (%)	1.0 (5.9%)	207
Total	**72.1**	**7,373**
Total Poor (%)	**5.5 (7.6%)**	**370**

Exhibit Notes:

1 Due to rounding, some figures are not computable based on numbers in the table.

2 Bridges owned by counties and cities.

3 Source: WSDOT Bridge and Structures Office and WSDOT Local Programs Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

Load Restricted and Load Posted Bridges

In WSDOT's *Bridge Inspection Manual* critical finding/ critical damage is defined as: *A condition that necessitates closing, posting, or restriction of a bridge or a portion of a bridge due to an identified structural deficiency requiring structural repair before it can be reopened to unrestricted traffic in the structure's original configuration.* A total of 119 WSDOT-owned bridges longer than 20 feet were load restricted or posted at the end of 2017, down from 126 in 2016. Nearly half (56) of WSDOT's load posted or restricted bridges are on the National Highway System, and 13.4% (16) were considered structurally deficient in 2017, shown below in Exhibit 3-17. Two bridges were replaced in 2017, removing the need for load restriction; the other five were repaired by either WSDOT maintenance crews or through contracts.

Reflected in Exhibit 3-16 are conditions for all locally owned bridges, both on and off the NHS. The majority of locally owned bridges were in good condition in 2017. Reported in the *Gray Notebook* are 216 locally owned bridges in Washington that were load restricted in 2017 (of which 14 were on the NHS), an increase from 186 in 2016.

Exhibit 3-17: Statewide Number of WSDOT Bridges (Longer than 20 ft.) with Weight Restrictions.[1,2,3]

	FY2014	FY2015	FY2016	FY2017
LOAD RESTRICTED[1]	124	109	118	105
LOAD POSTED[2]	13	11	8	14
TOTAL	**137**	**120**	**126**	**119**

Exhibit Notes:

1 A "load restricted" bridge cannot be legally used by an overloaded truck.

2 A "load posted" bridge limits the allowable weight of trucks to below typical legal weights.

3 Source: WSDOT Bridge and Structures Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

Bridge Performance Summary

Exhibit 3-18 summarizes the established performance measures from *Chapter 2: Objectives and Measures*, and indicates the current status, and compares it to the target, if one exists. Since many targets are still in the development phase, some target values remain to be determined (TBD) and a performance gap analysis is not completed or communicated as part of this initial plan. The process for *Performance Gap Analysis* is detailed in *Chapter 7: Performance Scenarios*.

Exhibit 3-18: Bridge Performance Measures and Targets, with Condition.

Measure	Scope	Target	Current Value	Gap?
Number of load posted bridges	State-owned	Not set	14	N/A
Number of load restricted bridges			105	N/A
Percentage of NHS bridges classified as in poor condition	NHS	Less than 10%	8.6%	No
Percentage of NHS bridges classified as in good condition		To Be Determined	32.5%	TBD

Exhibit Note: Source: WSDOT Bridge and Structures Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

CHAPTER 4
LIFE CYCLE PLANNING

During 2009, WSDOT began developing tools and procedures to change agency processes, centralize project prioritization, and allocate preservation funds on a statewide basis. Agency processes are currently being refined to focus on cost-effective preservation strategies that deliver acceptable service at the lowest life cycle cost. When the number of WSDOT preservation projects decline, maintenance activities must increase to manage aging assets.

Implementing asset management practices decreases the total cost of managing transportation infrastructure by considering all phases of an asset's life cycle, shown below in Exhibit 4-1.

Note: Supplemental Information in the TAMP Technical Guide, provides additional detail on life cycle planning information needs and process.

Exhibit 4-1: Typical Costs Associated with Life Cycle Cost Analysis.

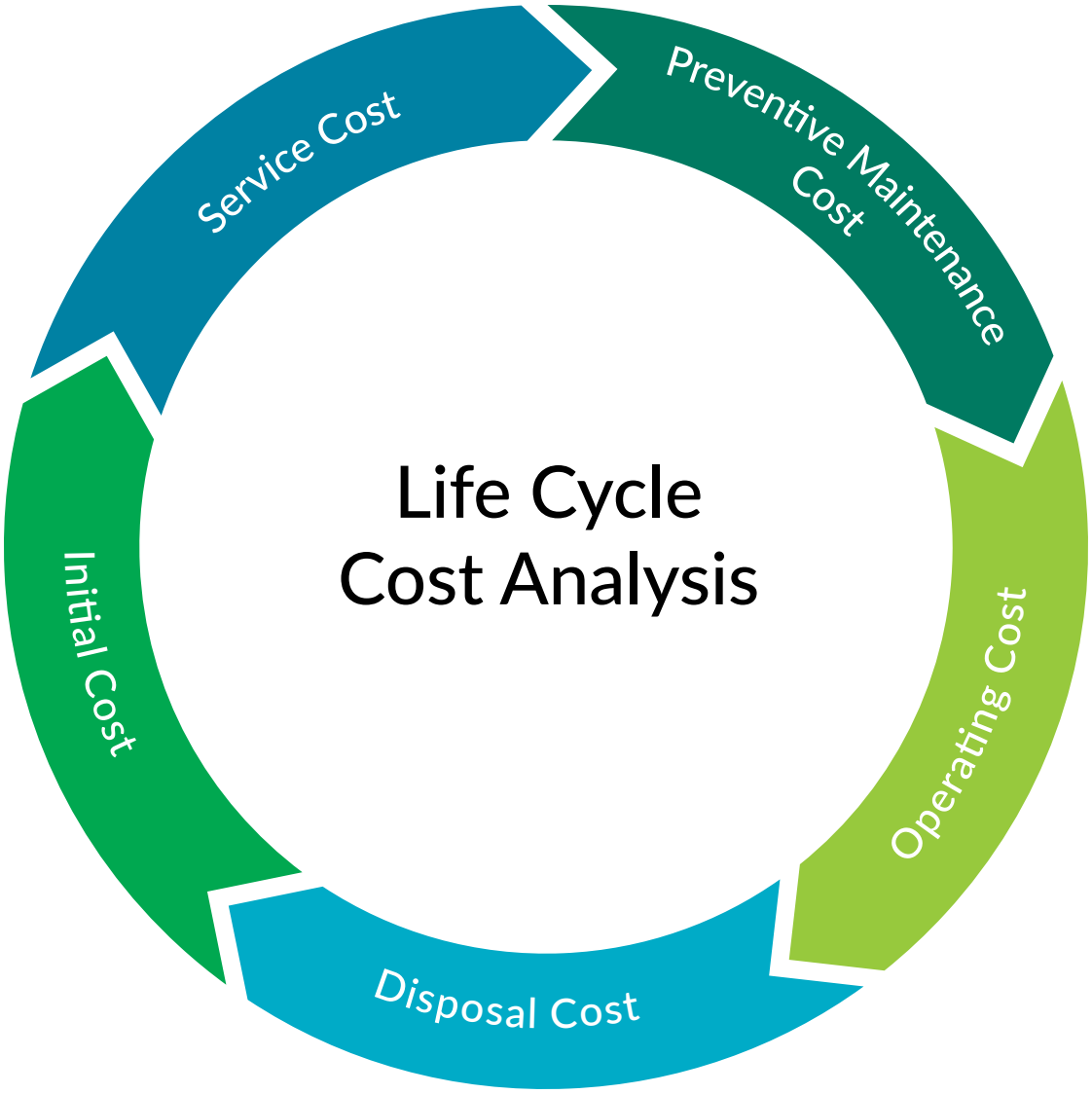


Exhibit Note: Source is from Kenneth Buddha. Prepared for 2016 TRB, *Life Cycle Cost Analysis for Management of Highway Assets*.

Approach to Life Cycle Planning (LCP)

LCP for Pavements

WSDOT manages life cycle planning for pavements according to the general type of material of the pavement structure, categorized as either flexible or rigid pavement. Understanding the basic life cycles of flexible and rigid pavements is an essential starting point for understanding cost effective pavement management.

Pavement Sub-Groups

Flexible Pavement

Flexible pavement includes chip seal and asphalt materials. When a flexible pavement structure is put into place, it is designed with enough thickness to carry expected traffic loads for fifty years, as long as there are periodic surface renewals. When sufficient structure is in place to carry traffic loads for fifty years, WSDOT has found that these structures can essentially be modeled perpetually as long as they are monitored and resurfaced at the right time. This results in the Lowest Life Cost for these structures.

Rigid Pavement

Rigid pavement is referred to solely by "concrete" at WSDOT, and are comprised of jointed concrete pavement. Concrete pavements are also designed to carry traffic loads for fifty years. Unlike flexible pavements, there are currently no cyclical resurfacing strategies for concrete, and at some point a type of reconstruction or major overlay is inevitable. Exhibit 4-2 shows the 50-year life cycle comparison for flexible and rigid pavements experienced by WSDOT.

Life Cycle Cost Analysis (LCCA)

When WSDOT needs to construct or reconstruct the entire pavement structure, a formal LCCA is completed to pick the proper pavement type. LCCA includes site-specific assumptions about the cost to construct and preserve the pavement over a 50-year design life as well as a cost impact of these activities on the users of the roadway. This complements the LCP strategies presented here, which are focused on general network-level asset management strategies. For a more complete description of the LCCA, please see WSDOT's *Pavement Policy* publication.

Economic Evaluation of Pavement Treatment Options

Economic evaluation determines how cost-effectiveness of treatment options by a comparison of the Equivalent Uniform Annual Cost (EUAC) for each option, expressed in terms of dollars per lane-mile per year ($/LMY). It is used to compare the long-term costs of one pavement preservation strategy versus another, and to determine the best management practices relative to risk of pavement failure. The significant advantage of using the annual cost as a measure of cost-effectiveness is that it allows direct comparison of multiple treatment alternatives with different service lives.

Exhibit 4-2: Pavement models: Flexible and Rigid (50-year Pavement Comparison).

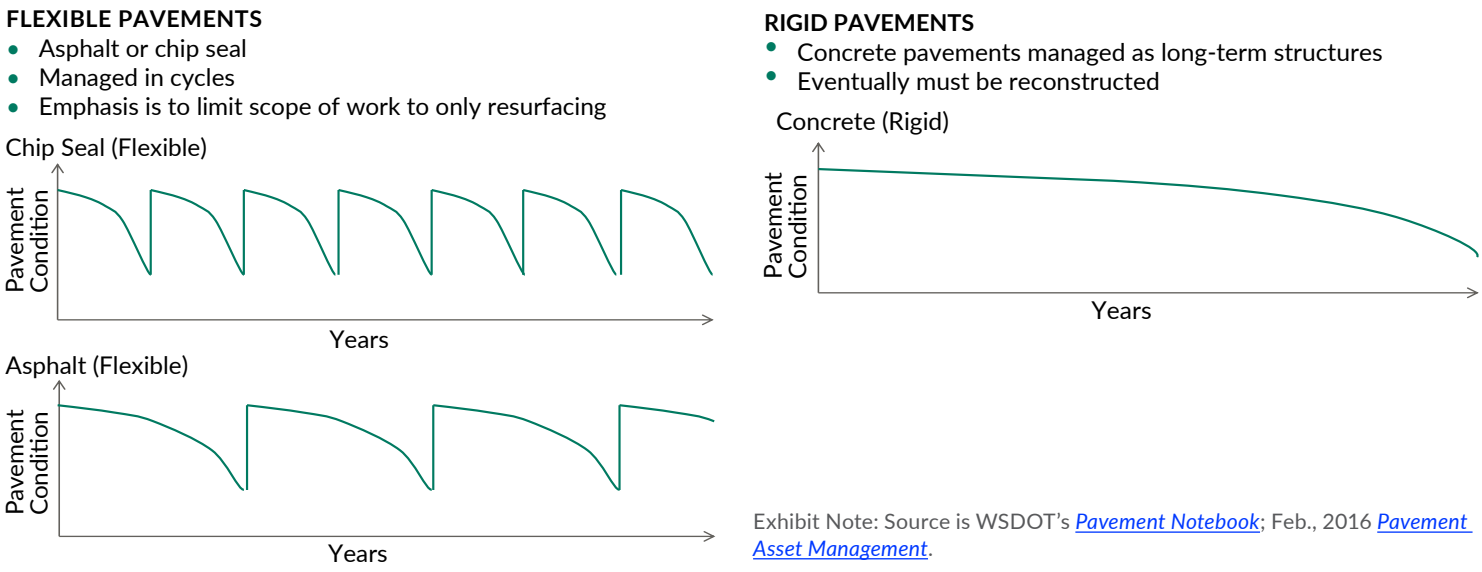


Exhibit Note: Source is WSDOT's *Pavement Notebook*; Feb., 2016 *Pavement Asset Management*.

Exhibit 4-3 shows WSDOT's typical pavement treatment options including: management strategies, types of work, service life extension, and costs. Cost and life values represent generalized averages used at WSDOT for network-level analyses. The annual costs are costs needed to keep the pavement performance at an acceptable level, which is established by condition index thresholds for cracking, rutting, roughness, and friction. The calculated annual costs include the consideration of the Discount Rate, which WSDOT assumes to be 4%. This process follows recommended procedures for LCCA, described in the FHWA, Office of Asset Management August, 2002 *Life Cycle Cost Analysis Primer* publication.

Exhibit 4-3: WSDOT Pavement Treatment Options.

Surface Type	Management Strategy[1]	Work Type[2]	Life Extension[2] (Years)	Agency Cost[2,3] ($ Total/Lane Mile)	$EUAC_{4\%}$[2,4] ($ Annual/Lane Mile)
Flexible Pavements (Chip Seal and Asphalt)	**Maintenance:** Most cost-effective option, and used to extend time between resurfacing activities.	**Minor Repair:** • Patching • Crack sealing	Chip Seal: 2 Asphalt: 3	Chip Seal: $2,500 Asphalt: $5,000	Chip Seal: $1,325 Asphalt: $1,802
	Rehabilitation: Properly timed resurfacing activities to preserve pavement structure.	**Resurface:** • Add surface layer or mill and inlay • Hot-seal & hot-mix asphalt	Chip Seal: 7 Asphalt: 15	Chip Seal: $45,000 Asphalt: $225,000	Chip Seal: $7,497 Asphalt: $20,237
	Reconstruction: Most expensive option, generally avoided by properly timed resurfacing.	**Reconstruction + Resurfacing:** • Every 9 yrs. (Chip Seal) • In yrs. 20 & 35 (Asphalt)	Chip Seal: 54 Asphalt: 50	Chip Seal: $200,000 + $45,000 each Asphalt: $1,000,000 + $225,000 each	Chip Seal: $13,100 Asphalt: $53,985
Rigid Pavements (Concrete)	**Rehabilitation:** Opportunities for further life-extending treatments are limited.	**Resurface/retrofit:** • Diamond grinding • Dowel bar retrofit • Selective slab replacement	Concrete: 15	Concrete: $400,000	Concrete: $35,976
	Reconstruction: Most expensive option. Required at end of concrete pavement life.	**CSOL + Resurfacing:** • In yrs. 20 & 35 **Resurfacing methods include:** • Asphalt Replacement • Unbonded Concrete Overlay	CSOL Concrete: 50	CSOL Concrete: $900,000 + $225,000 each	CSOL Concrete: $49,330
		Reconstruction	Concrete: 50	Concrete: $2,500,000	Concrete: $116,376

Exhibit Notes:

[1] Source: Pavement Branch of the Materials Laboratory; Prepared for Dec., 2016 *Gray Notebook 64th Edition*.

[2] Source: Pavement Branch of the Materials Laboratory; Submitted March, 2017 to TRB; *Cost-Effective Performance Management for Washington State Pavement Assets*. Life extension years reflected in the table above are "typical" values; life extension values are not fixed.

[3] Agency cost is total and includes engineering, contract administration, and traffic control, in addition to construction costs.

[4] Equivalent Uniform Annual Cost (EUAC) is expressed as dollars per lane mile per year discounted at 4% per year.

LCP Strategies

As an agency, WSDOT is continuously evaluating strategies to minimize life cycle cost while maintaining a State of Good Repair. This section communicates a baseline LCP, which incorporates some of the specific strategies listed described in the following sections, and the current LCP, which incorporates all of the specific strategies described.

Long-Life Pavements

Exhibit 4-4 shows that resurfacing is much more cost-effective than reconstruction, so pavement management should be focused on delaying or avoiding reconstruction as long as possible. Establishing a strategy that determines the most effective way to rehabilitate a pavement, which makes sure that the integrity of the pavement structure is not compromised, will lead to a result where the pavement will not need frequent reconstruction. Fortunately, this has been the experience at WSDOT over several decades of pavement management.

For flexible pavements, properly timed resurfacing activities for structures with sufficient thickness has proven to be a very cost-effective strategy. One of the primary reasons this is possible is due to the predominance of top-down cracking in WSDOT pavements, which means that cracks for thicker pavements start at the surface. This allows for pavement renewal by milling and replacing only the surface of the pavement structure without resorting to more costly repairs to the pavement base or foundation.

For concrete pavements, WSDOT has monitored and kept concrete in service without any type of activity for over forty years in some sections, which is when it was initially built as part of the Interstate system. In the late 1990s and early 2000s, dowel bar retrofit with diamond grinding was used to further extend the life of the pavement structure. Most recently, WSDOT has used a triage approach, including surface grinding and select panel replacement, to extend the life of the pavement to fifty or more years.

WSDOT has relied on long-life pavement management practices for decades. Therefore, the baseline LCP includes the overall effect of this strategy.

Chip Seal "Conversion"

As shown in Exhibit 4-4, WSDOT has determined that, under the right conditions, pavements with chip-seal surfacing are more cost-effective than pavements with an asphalt surface. This is because the overall life cycle cost of an asphalt pavement is roughly 2.5 times the life cycle cost of a chip-seal pavement. Because of this cost savings, it has been a priority of WSDOT pavement preservation to resurface using chip-seals where appropriate. This is typical for road locations having less than 10,000 Annual Average Daily Traffic (AADT), which are not in an urban area, nor where there are frequent truck turning movements. Under these criteria, a substantial number of sections that are currently, or have traditionally been, managed with an asphalt resurfacing strategy are candidates for chip seal. When a chip-seal surfacing is placed on existing asphalt pavements, WSDOT refers to this as "chip-seal conversion".

WSDOT has used chip-seal conversion for approximately 2,000 lane-miles between 2010 and 2016, and the lane mile percentage changed from 25 percent chip seal to currently 33 percent of the state system. Based on the criteria above, WSDOT plans to convert at least another 1,000 lane miles over the next six years, at which point chip-seal surfacing will account for approximately 42 percent of the state maintained network. Therefore, the major effect of this strategy on the annual network cost is to shift 3,000 lane miles from asphalt to chip-seal resurfacing by 2024, and result in an annual savings of over $40 million per year.

Crack, Seat and Overlay with Asphalt (CSOL)

The construction cost is significantly less for CSOL compared with traditional concrete reconstruction, and the long-term annual cost is roughly half the cost of concrete reconstruction (see Exhibit 4-4). However, for locations such as mountain passes, extremely high traffic areas, bridges, or barriers, the concrete reconstruction will be preferred based on site-specific LCCA. When possible, WSDOT will use CSOL instead of concrete reconstruction because it requires less capital and has a substantially lower annual cost.

Strategic Maintenance

Budget constraints in Washington state necessitated the development of new strategies with regard to maintenance. These activities are also sound asset management practices, and are now considered standard when managing pavement assets. The types of maintenance strategies are:

- **Addressing early distress -** Premature distress may occur relatively early in the performance period due to construction problems, reflection cracking, or other factors, but if those premature distresses are not addressed, then an early rehabilitation may be required which substantially increases the life cycle costs.
- **Maintaining sections that are currently due for rehabilitation** - Under the constrained budget, even if the optimum long-term rehabilitation plan for a particular section of roadway calls for a pavement rehabilitation project, there may not be funds available to program the project. This situation resulted in the development of maintenance strategies for the purpose of delaying or avoiding pavement rehabilitation.
- **Holding the past-due sections together until funds are available for rehabilitation -** When the funding is further constrained, even past-due sections cannot be funded for rehabilitation. In these situations maintenance has to be applied to hold the pavement together until the rehabilitation can be performed.

It is recognized that applying preventive maintenance treatments early in a performance period is far more effective than applying it to a pavement in poor condition. In most cost evaluations, the maintenance cost is small in comparison to rehabilitation, so it seldom controls the long-term costs. However, if the effect of maintenance on pavement service life is taken into consideration, then the effect of maintenance on life cycle costs becomes significant. WSDOT estimates an annual savings of approximately $15 million with a strong strategic maintenance strategy implementation.

Baseline LCP Compared to Current LCP

Estimating the overall change by implementing the several strategies previously discussed can be accomplished by comparing the annual average network cost for the WSDOT network before and after implementation. This provides a reasonable magnitude for the amount of savings and is easy to communicate. However, it ignores actual system conditions and specific needs by year, which is a much more sophisticated analysis and often produces results that are more difficult to determine the overall effect of cost-effectiveness strategies because information may be masked by a backlog of work and an uneven distribution of expected types of work over a specific time period.

The baseline LCP is defined as the year 2010, which represents a year before the strategic maintenance, chip seal conversion, and CSOL strategies were implemented statewide. The current LCP is referred to as the 2025 LCP because much of the strategies are expected to be substantially implemented by this time.

To estimate the average annual network cost of maintaining the network without implementing these strategies (or the baseline) the applicable lane miles by treatment type can be divided by average service life (time between treatments) and multiplied by average construction cost. The same is done after implementing these strategies, but the change in applicable lane miles, service life, and/or construction cost must be accounted for. Exhibit 4-4 shows the (before) baseline annual average network cost based on standard lane mile distribution and management strategies for WSDOT in 2010. It then shows the overall effect of implementing the new strategies moving forward (a combined cost savings of $80 million per year), with a full implementation realized by 2025.

National Highway System (NHS) Asset Management Program

WSDOT announced the availability of up to $75 million of National Highway Performance Program (NHPP) federal funding for improvements to roadways that are part of the NHS. These funds will be awarded during two calls for projects. A call for projects having $30-40 million in available funding is limited to local agencies with NHS

Exhibit 4-4: Summary of the WSDOT Pavement Network Savings – Baseline vs. Current Strategy.

Treatment Type	Applicable Lane Miles	Average Service Life (years)	Average Cost ($/Lane-Mile)	Average Annual Network Cost ($ Millions)
Average Annual Network Cost – 2010 Baseline				
Chip Seal Resurfacing	4,580	6	$45,000	$34
Asphalt Resurfacing	11,570	14	$225,000	$186
Concrete Reconstruction	2,080	50	$2,500,000	$104
Total Annual Average Network Cost - Baseline				**$324**
Average Annual Network Cost – 2025 (With Strategy Implementation)				
Chip Seal Resurfacing with Maintenance	7,580	9	$47,500	$40
Asphalt Resurfacing with Maintenance	8,570	17	$230,000	$116
Concrete Reconstruction with Triage	1,820	65	$2,900,000	$81
Triage then CSOL	260	50	$1,350,000	$7
Total Annual Average Network Cost – After Implementation				**$244**
Average Annual Cost Savings (Difference of After and Baseline)				**$80**

Exhibit Notes:

Values reflected above show estimated savings from 2010 to 2025 (baseline).

Source: Pavement Branch of the Materials Laboratory; Submitted March, 2017 to TRB; *Cost-Effective Performance Management for Washington State Pavement Assets*.

roadways closed on May 26, 2017. A second call for projects is planned for 2018-2019 to award the remaining funds is open to all agencies with NHS roadways. Awarding the funds over two calls for projects will allow adjustments to selection criteria, if necessary, based on results from the first call for projects.

NHPP funds are required to support progress toward the achievement of performance targets established in a state's asset management plan for the NHS. NHS roadways encompass both local and state owned NHS facilities, and Washington state has one of the highest percentages of locally owned NHS facilities. It is therefore imperative that both state and local agencies collaborate to manage the NHS; and this type of program will encourage collaboration and asset management principles across the NHS.

The objective of NHS Asset Management Program is to highlight the importance of preserving the roadway system by incentivizing agencies to use asset management strategies that provide cost-effective solutions to maximize the life expectancy of a roadway. To meet this objective, the program will evaluate an agency's use of pavement management strategies and an agency's level of investment to preserve and maintain their roadway system, placing emphasis on cost-effectiveness and pavement rehabilitation over reconstruction.

LCP for Bridges

Bridge Sub-Groups

WSDOT currently builds bridges using two primary material types: concrete and steel. Some older bridges were built with timber, however timber built bridges are rarely, if ever, built in today's environment. Bridge design methods include beams or girders, arches, and boxes and trusses. The most common type of bridge today is a pre-stress concrete girder. Each of these materials and design types have different rates of deterioration that can affect the overall service life of a bridge. WSDOT addresses bridge deterioration through several preservation activities such as bridge repairs, painting steel bridges, concrete bridge deck rehabilitation, and bridge rehab or replacement.

Bridge Repairs

WSDOT considers two main categories of bridge repair:

- **Maintenance repairs** – Systematic preventive maintenance is a cost-effective asset management strategy that supports Practical Solutions. Applying

bridge preservation treatments at the appropriate time can extend a bridge's useful life at a lower lifetime cost. WSDOT regional crews perform the day-to-day maintenance of bridges, but these repairs are temporary.

- **Element repairs** - WSDOT performs major preservation repairs by addressing specific bridge elements to improve bridges with low condition ratings. Specific bridge elements requiring repair beyond what WSDOT Region Maintenance can address (due to complexity and funding) are prioritized for replacement or repair in this category.

A special category of bridge repair is moveable bridges. Moveable bridge repair includes corrective work on moveable bridge electrical and mechanical systems.

Steel Bridge Painting

Steel bridge elements need periodic painting to protect against corrosion in order to maintain their structural integrity. Bridge painting is intended to paint a bridge when it is due, before serious deterioration of the coating system occurs. Waiting until significant corrosion attacks the steel is more expensive. Painting steel bridges supports Practical Solutions by minimizing bridge life cycle cost. Painting a steel bridge extends its service life by 20 to 25 years, and costs approximately 20-25% as much as replacing it.

Concrete Deck Repair and Overlay

By rehabilitating concrete bridge decks using modified concrete overlays rather than replacing them with new decks, WSDOT saves approximately $220 per square foot of bridge deck area. This method is another example of preservation techniques that support Practical Solutions.

Replacement or Rehabilitation of Bridges

WSDOT considers a bridge in need of replacement or rehabilitation when it is in poor condition. WSDOT performs an analysis of repair options and compares the total repair costs to the cost of total bridge replacement. If the total cost of repairs or bridge rehabilitation is 60% or more compared to total replacement, then a replacement option will be considered. WSDOT uses pre-stress bridge options in nearly 8 out of 10 new bridges.

Border Bridges, Scour and Seismic Retrofit

WSDOT uses the previously described activities to categorize life cycle planning for bridges, along with a few additional categories. First are border bridges. Washington shares the responsibility for preserving, maintaining and operating bridges with Oregon and Idaho. Both states make the future preservation of these bridges a top priority in their bridge programs.

WSDOT also identifies activities to reduce risk to the structure through scour mitigation and seismic retrofit. Scour describes the erosion of stream bed material from under bridge foundations; bridges are classified as scour critical if they have the potential for scour depth to be lower than the foundation. Mitigating scour risk is a high priority due to safety concerns and also to avoid an emergency repair. For seismic retrofit, more information can be found in *Chapter 5: Risk Management*.

Life Cycle Cost Analysis

WSDOT is currently working to develop methods, analytical tools, and long-term measures for bridge life cycle projected performance. WSDOT is in progress of implementing AASHTO's BrM Bridge Management System software. This will allow WSDOT's Bridge & Structures Office to assign costs to existing risk and assign monetary value to efficiently prioritize the WSDOT bridge inventory for timely repair, rehabilitation, and replacement. More detail is contained in sections that follow. WSDOT has a temporary system that uses Microsoft Access® databases to store information used to identify and prioritize individual needs in each subcategory of work. See the *Chapter 9: Implementation and Systems* for more detail.

Economic Evaluation of Bridge Treatment Options

WSDOT maintains a detailed bridge inventory and bridge element condition database that provides a solid base for estimating current bridge needs. From this inventory and condition data, WSDOT undertakes a biennial process relying on professional judgment and engineering knowledge of bridge preservation treatments to develop project lists, prioritize needs, and estimate future performance. If a repair is deemed necessary (following inspection) engineers 1) review the repair options; 2) put together a detailed scope of work; and 3) recommend a time frame for when the repair should be addressed, specific to the individual structure. For each bridge, the preservation need in each subcategory of work is prioritized and ranked against all bridge needs statewide according to the degree of risk and damage.

Exhibit 4-5 summarizes the treatment options, along with a 10-year needs assessment. The 10-year needs assessment was calculated using either existing deficiencies, or an expected deficiency using age-based deterioration assumptions based on activity.

Exhibit 4-5: **WSDOT Bridge Treatment Options.**

Management Strategy[3,4]	Work Type[3,4]	Life Extension[2,4] (Years)	Total 10 Year Needs[1,4] ($ in millions)
Maintenance: Day-to-day temporary maintenance repairs keeping bridges in service. **Bridge Cleaning Program**: Intended to keep structure coatings free of debris buildup and extend the life of the coating.	**Minor Repair:** • Clean fracture critical steel bridges prior to inspection • Deck Patching & crack sealing • Small movement expansion joints	1 to 3	Current backlog of Repairs #: 1,589 Cost : $16
Steel Bridge Painting Program: Intended to perform work when it's due to prevent corrosion, extend service life, and keep the bridge in fair or better condition.	**Steel element preservation:** • Remove existing paint • Apply new paint system	Bridges - Steel Truss: 20 to 25 Steel Girder: 30 to 40	Structures #: 184 Cost: $ 781.1
Concrete Deck Overlay Program: Intended to repair and overlay concrete decks to provide corrosion protection for steel reinforcing and roadway surface, prolong service life, and avoid expensive replacements.	**Concrete Deck Repair and Overlay:** • Hydro-Milling of the deck • Deck repair and overlay: - Hydro-mill deck surface (1") - Apply modified concrete - Polyester Concrete	25 to 30	Structures #: 303 Cost: $ 867.9
Bridge Scour Mitigation Program: Mitigate risk of bridge failure by designing, permitting, and constructing bridge scour repairs under contract. Top 20-30 candidates will be addressed over the next 10 years.	**Retrofit:** • Protect foundations with rip-rap • Install barbs in river to channel river flow • Repair voids under footings and pilings with concrete fill	N/A	Structures #: 268 Cost $: N/A Included in rehabilitation & reconstruction total.
Bridge Seismic Retrofit Program: Intended to address bridges not meeting current seismic design standards. WSDOT will address highest priorities on Interstate and selected state routes in the central Puget Sound Area	**Retrofit:** • Concrete columns with steel or composite material • Strengthen existing crossbeams with new bolsters • Address abutments/intermediate piers with girder stops between girders	N/A	Structures #: 593 *Includes partial retrofits Cost $: N/A Included in rehabilitation & reconstruction total.
Element Repair and Replacement: Repair and replace specific deteriorated bridge elements, performing major preservation repairs to improve low condition ratings.	**Element repair:** • Anchor cables • Expansion joints • Other bridge elements • Mechanical elements • Concrete columns	Up to 25	Structures #: 94 Cost $: 589.7
Reconstruction: Replace or rehabilitate bridges in poor condition. An evaluation of rehabilitation option is compared to full bridge replacement. If rehabilitation costs exceed 60% of new bridge, then bridge replacement is recommended.	**Replace/Rehabilitate:** • Selected timber bridges • Replace selected steel and concrete bridges in poor condition • Replace selected concrete bridge deck	New Bridge: 75+	

Exhibit Notes:

1 Unit costs are variable based on structure size and type. Total projected 10 year needs (as of June 2017) are reflected since, engineers prepare individual structure cost estimates based on quantities calculated for each bid item of structure work.

2 Values are approximate. Each bridge design type and material has different rates of deterioration affecting the overall service life of a bridge.

3 Source: WSDOT Bridge and Structures Office; prepared for Oct., 2014 *Washington State Bridge Preservation and Asset Management*.

4 Source: WSDOT Bridge and Structures Office; prepared for June, 2017 The *Gray Notebook 66th Edition.*

LCP Strategies

WSDOT prioritizes activities planned for border bridges and scour mitigation as high priorities. Seismic retrofit is analyzed as part of WSDOT's resilience efforts (more information in the *Chapter 5: Risk Management*). The remaining activities are ranked based on condition, age and traffic levels.

One strategy recently implemented by WSDOT is strategic bridge preservation, or systematic preventive maintenance (SPM). WSDOT has allocated $6.0 million to perform SPM on bridges during the 2017-2019 biennium. SPM is an asset management strategy that focuses on using planned maintenance treatments to extend the useful life of existing bridges in a cost-effective way. Work completed as part of SPM may include sealing bridge deck joints on steel truss bridges, filling in ruts on bridge decks, and spot-painting steel bridges. WSDOT will continue to right-size its strategic bridge preservation as it matures in asset management.

WSDOT is working on several additional improvements for life cycle planning for bridges. Additional information on these improvements may be found in the *Implementation and Systems* chapter.

Inclusion of Locally Owned NHS Bridges and Pavements in LCP

Until this time, LCP for bridges and pavements has focused on WSDOT practices for bridge and pavement asset management. In order to make best use of resources available to the state, and to comply with MAP-21 requirements, WSDOT is working with MPOs and local agencies to manage all of the NHS using Life Cycle Planning. See more information in the *Chapter 9: Implementation and Systems* for how WSDOT plans to work together with its NHS partners to develop a Life Cycle Planning asset management approach for all bridges and pavements as part of the NHS.

CHAPTER 5
RISK MANAGEMENT

As part of the overall approach to implementing risk management, WSDOT must balance a variety of transportation risks on an ongoing basis. The application of risk management within a transportation agency supports effective decision making for future investments and the ability to plan for possible negative impacts to the transportation network.

Like many disciplines related to asset management, WSDOT has a long history of incorporating risk management into its business practices. The agency's Transportation Safety, Quality, and Enterprise Risk (TSQER) Division is responsible for managing *enterprise* and *program level risks* through its Enterprise Risk Management program and works in partnership with the Design Office to manage *project level risks* through use of the *Project Risk Management Guide*. At WSDOT, risk is considered in three different tiers:

1. **Enterprise risks** - Affect agency mission, vision, values, or *Strategic Plan goals*;
2. **Program risks** - Affect WSDOT's ability to deliver work and meet performance targets within a program. These may include organizational and systemic issues as well as revenue and economic uncertainties causing work to be delayed. Causes are not related to specific projects; and
3. **Project risks** - Affect scope, cost, schedule, and quality of projects. In contrast to programmatic risks, project risks are related to specific projects.

For the purpose of WSDOT's TAMP, risk management activities are conducted at the *program level* but also have the potential to affect agency enterprise functions. WSDOT's risk-based asset management plan builds on this concept by further integrating risk management principles directly with asset management systems. This chapter details risk management practices at WSDOT and explains how the agency continues to evolve its practices in the context of transportation asset management.

Federal and State Requirements

Federal Requirements

Under MAP-21, the FHWA defines risks as the "positive or negative effects of uncertainty or variability upon agency objectives." Risk Management is defined as "the processes and framework for identifying, evaluating and managing potential risks." In 23 CFR 515.7.c.1-6, FHWA requires states to establish a process for developing a risk management plan. WSDOT's process must include:

- Identification of risks affecting NHS pavement and bridge asset conditions and performance of the NHS, such as
  - risks associated with current and future environmental conditions,
  - financial risks (e.g. budget uncertainty),
  - operational risks (e.g. asset failure), and
  - strategic risks (e.g. environmental compliance);
- Risk assessments considering likelihood of occurrence, impact, and consequence if they do occur;
- Risk evaluation and prioritization;
- Mitigation plans for addressing top priority risks;
- Risk monitoring approach for top priority risks; and
- Summary of the evaluations for NHS pavements and bridges and facilities repeatedly damaged by emergency events (23 CFR Part 667).

These requirements are either met, or will be met, through WSDOT's approach to risk management, explained in detail throughout the chapter.

State Requirements

The role of Washington's Legislature, with respect to risk management, is to establish statutory authority and consistent policy related to the principles and definitions of risk management statewide. Legislatively described powers and duties provide an organizational framework

for how Washington state, and more specifically WSDOT, implements risk management. Governance includes oversight for: tort claims, risk finance, loss prevention, loss prevention review team, and local government self-insurance activities conducted by state agencies.

The following Revised Code of Washington (RCW) statutes specify Washington's risk management governance structure and oversight functions:

- *Actions and Claims Against the State* - RCW 4.92;
- *Risk Management and Loss Prevention* - RCW 43.19 (760 - 783); and
- *Local Government Insurance Transactions* - RCW 48.62.

Note: Supplemental Information in the TAMP Technical Guide, provides additional detail on federal and state requirements as well as additional policy and risk management resources.

Transportation Risk in Washington State

A number of risk factors could negatively impact Washington's transportation system. These risk factors arise both internally and externally to WSDOT. Thematic examples of risks representing WSDOT's *Risk Event Groups* include:

- Resiliency and vulnerability of the transportation system due to events (both man-made and natural);
- Availability and quality of data, models and information;
- Changes in organizational alignment, political and agency policy initiatives;
- Errors associated with quality assurance/quality control of asset evaluation;
- Lack of resources (equipment, funding, software, staffing, and systems) to maintain expected level of service for the transportation infrastructure; and
- Inadequate training of staff.

Without adequately accounting for risk factors, consequences can arise affecting programs' ability to reach their respective goals and performance targets, potentially affecting the agency at an enterprise level. Consequences are based on the major severity descriptions contained in WSDOT's risk ranking definitions. Such consequences can include, but are not limited to:

- Compromise in safety performance for roadway users and agency workers leading to serious injury or loss of life;
- Substantial financial repercussions;
- Harm to public health and the environment;
- Mobility, accessibility and other impacts to system performance;
- Waste of agency resources;
- Legal, compliance or contractual impacts; and
- Poor agency reputation and a loss of confidence by the public and elected officials.

WSDOT Risk Management Strategies

Additional to asset management planning activities, WSDOT has a strong history of adopting and implementing risk management strategies to mitigate certain risk factors. The risk management strategies identified below, detail the application of risk management at WSDOT.

Enterprise Risk Management

In 2007 WSDOT established its Enterprise Risk Management Division (a.k.a. TSQER Division), in response to Governor Gary Locke's *Executive Order (EO) 01-05*. The purpose of the TSQER Division is to facilitate discussion throughout the agency regarding potential risk events and impacts that could hinder the delivery of agency initiatives. The office provides guidance through enterprise risk assessments, risk consultation, and executive outreach, helping agency programs identify risks and potential treatment strategies to address such risks. In May of 2016, Governor Jay Inslee's *Executive Order (EO) 16-06* took effect and superseded Executive Order 01-05.

Enterprise Risk Management Manual (M 72-01.06)

This manual provides guidance on the procedures and practices related to risk management. The manual,

developed by WSDOT's TSQER division, identifies efforts made by the agency to incorporate risk into daily activities as programs address future investments.

Program Risk Management

Prior to recent TAMP risk workshop development in 2017 (detailed in sections that follow), WSDOT identified program-level risks potentially affecting pavement and bridge assets from a state network perspective. In a 2014 Joint Legislative Audit and Review Committee (JLARC) report entitled *WSDOT's Estimate of Long-Term Highway Maintenance and Preservation Needs*, practices were independently assessed regarding how the agency quantifies risk to its pavement and bridge asset need and cost estimates. Two categories of risk were reviewed:

- **Systematic Risks** - Including market fluctuations, budget restrictions, and insufficient or inaccurate data; and
- **Site Specific Risks** - Including sudden condition related failure, natural hazards, climate change impacts, and man-made hazards.

Recently held TAMP risk workshops, beginning October of 2017 for pavement and bridge assets, expand upon prior *program-level* risk assessment efforts by JLARC in 2014. Additionally, WSDOT implements risk management strategies throughout other asset classes and programs which support Pavement and Bridge asset management and are briefly mentioned below.

Pavement Risk Management Strategies

Fundamental to WSDOT's approach is systematic management of risk affecting pavement asset lowest life cycle cost recovery. The 2014 JLARC report found:

- WSDOT considers systemic risk in its long term estimates of pavement needs;
- The department does not consider site specific risks in its long term estimates, which is appropriate;
- Site specific risks are localized and, in the rare circumstances where catastrophic failure occurs, have little to no impact on network level conditions; and
- WSDOT is exceptional among state Departments of Transportation in its integration of risk into its pavement project prioritization process.

More details regarding systematic risk considerations affecting pavement asset lowest life cycle cost recovery, are described in sections that follow.

Risk Consideration: Variability in Pavement Life

A number of factors influence pavement life including construction quality, environment, materials and subgrade, traffic loads and maintenance. These factors lead to variability in the number of years needed between activities, such as resurfacing. If rehabilitated too early, the life is wasted. If rehabilitated too late, then more costly activities are likely needed to restore the pavement structure. WSDOT is taking advantage of the variability in pavement life through annual monitoring of its pavement conditions and communicating that information in its pavement management system. This data is integral for the proper timing of the strategic maintenance and properly timed resurfacings for the life cycle planning activities and lowering the overall annual preservation need for pavements.

Risk Consideration: Unnecessary Pavement Structure Loss

Pavement preservation has recently gone through a little over a decade of underfunding. During this time, the risk has been mitigated by the pavement preservation prioritization process, which puts the roadways at risk for needing reconstruction if immediate action is not taken at the highest priority. Economic ramifications of unnecessary reconstruction are costly. Each lane mile of unnecessary reconstruction costs an additional 3-4 times the amount of a resurfacing activity. The likelihood of this risk always increases during times of inadequate funding and cannot be avoided after extended periods of underfunding. This scenario would have been immediately present if pavement preservation funding had not substantially increased with the passage of Connecting Washington.

Risk Consideration: Aging Concrete Network

WSDOT's concrete roads must be reconstructed near the end of their service life. Moreover, a large portion of these roadways are or will be in need of reconstruction within the next 10 years. Prior to Connecting Washington, WSDOT planned to maximize grinding and panel replacement activities, commonly referred to as "triage." To further mitigate this risk, WSDOT is committed to evaluating concrete activities over the

next six years, given the recently passed Connecting Washington revenue package allows for significantly greater investment in concrete roadways. How WSDOT decides to manage this risk will ultimately keep it as partially mitigated or mitigated.

Risk Consideration: Unexpected Interruption in Service

When pavements reach a point of deterioration where some type of treatment (maintenance or rehabilitation) is required, it is usually necessary to interrupt service to traffic in order to complete the required treatment. However, if sudden pavement failure occurs that doesn't have a planned course of treatment, critical consequences can occur, resulting in an interruption to service. For interstate highways, a sudden failure at a time of day with high traffic volumes can be catastrophic. WSDOT mitigates this risk by closely monitoring pavement condition and giving high priority for pavement preservation projects to routes with high traffic volumes.

Bridge Risk Management Strategies

Risk management activities for bridge assets are conducted at the program-level, agency wide. The 2014 JLARC report found:

- WSDOT considers systemic risk in its long-term estimates of bridge needs;
- WSDOT has projects and processes to address major site-specific risks from structural deficiency, scour, and earthquakes;
- WSDOT does not have a process for estimating risks from man-made hazards such as collisions and truck overloads;
- WSDOT does not consider risk in bridge project priority setting;
- WSDOT would benefit from an objective process to determine how much it should spend on earthquake and scour projects and similar site-specific risk projects. Such a process would consider other department priorities and fiscal constraints. This is not yet common practice, but it is best practice; and
- WSDOT should develop a bridge risk register and quantitative tools for risk assessment and risk management to enable it to consider risk in a priority setting.

Individual risk management programs for bridge assets are described in sections that follow.

Bridge Seismic Retrofit Program

WSDOT's *Bridge Seismic Retrofit Program* evaluates and mitigates potential risks with bridge structures related to seismic activity. Earthquakes pose a substantial threat to infrastructure, WSDOT seeks to minimize and avoid catastrophic bridge failure by improving the resiliency of bridges and structures to future earthquakes. This program identifies, assesses and assists in prioritizing efforts to keep bridge structures functional. WSDOT has invested nearly $194 million since 1991 to strengthen bridge structures to endure earthquake forces. As of 2016, more than 900 bridges across the state are a part of the Bridge Seismic Retrofit Program. As a result of the program, 435 of the 900 bridges have either been completely or partially retrofitted.

Bridge Scour Mitigation Program

WSDOT's *Bridge Scour Mitigation Program* is responsible for performing inspections of bridges and responding to scour damage across Washington state. Historically scour is one of the leading causes of bridge failures across the nation as well as Washington state. Addressing scour is a priority at WSDOT in order to preserve and maintain bridge structures. The program identifies bridges at risk for scour, then monitors, prioritizes and applies mitigation strategies to bridges that have the highest level of scour deficiencies. Over the last 10 years, WSDOT has completed 13 bridge scour repair projects, covering 17 bridges, at a total cost of $12 million. WSDOT has prioritized 23 additional bridges to address through the scour mitigation program over the next 10 years. Because the process to complete scour repairs is lengthy and expensive, WSDOT can only address a few scour repairs each biennium.

Other TAM Risk Management Strategies

Statewide Highway Safety Program

WSDOT's *Statewide Highway Safety Program* is responsible for identifying opportunities to lower crash potential for all modes by reducing the potential for fatal and serious crashes. WSDOT uses analytical safety tools to prioritize locations where safety improvements may reduce the likelihood of a crash. The program

uses both reactive and proactive assessments of crash potential to identify locations that have a higher probability to reduce the frequency and severity of crashes. *The Highway System Plan* outlines WSDOTs long-term strategies to remove vehicular fatalities by 2030, also known as the *Target Zero* program. Through this program, from 2000 through 2014, Washington state's traffic fatalities decreased by 27%, even though population growth increased 18%.

Highway Safety Improvement Program

In addition to the statewide Target Zero program, WSDOT also supports local safety measures by providing up to 60-70% of its *Highway Safety Improvement Program* funding for local agency projects. WSDOT also uses state funding for highways in excess of the federal appropriation. This approach to the program incentivizes local agencies and the state to identify, assess and mitigate risks where safety is the greatest concern.

Information Technology Security Program

Transportation systems are becoming increasingly dependent on information technology (see *Chapter 9: Implementation and Systems* for a detailed discussion), and with increased dependence comes increased potential for cyber-attack. WSDOT's security policy is incorporated into all business functions to help protect the state's transportation systems and head off potential cyber security threats.

Chapter 900 of the IT Security Manual (M 3017), specifies the standard to identify and describe elements of an agency-wide IT Security Program. This standard applies to anyone who accesses WSDOT IT resources. The level of system protection warranted is based upon results of a risk analysis process. The size, complexity, and potential business exposure determines necessary detail.

The analysis includes:

- Identify critical IT systems and issues to include when conducting an IT risk analysis;
- Review current and future risks to those systems;
- Prioritize risks;
- Implement procedures to reduce those risks within business requirements and funding availability; and
- Monitor risks related to IT system vulnerability and threats.

The roles and responsibilities of risk management in the IT Division are also explained.

Project Risk Management

At the lowest level of risk management, WSDOT has a well-documented practice of anticipating and planning for project level risk. For nearly all projects, more events may happen than will happen and outcomes vary and cannot be guaranteed to 100% certainty. This is particularly true when a project is early in the design process and not fully defined. While it's not possible to guarantee certainty, through *risk-based estimating*, WSDOT can provide probability.

WSDOT's project development teams, external risk experts, cost experts and subject matter experts work to identify uncertainty ranges and possible risk events that can affect project objectives. Risk evaluation is conducted for a given project that matches with the level of project development and anticipated project cost. Project risk management relies on sound estimating practices for both cost and schedule, as well as sound risk assessment practices to fully convey the project characteristics during the time of analysis. The analysis output reflects the inputs provided for a given project. Even more important than the risk evaluation process output is the communication and greater project understanding fostered through this process.

Project Risk Management Process

The Cost Risk Estimating Management (CREM) Unit, part of WSDOT's *Strategic Analysis and Estimating Office (SAEO)*, delivers the *project-level* risk assessment and risk-based estimating program for WSDOT. Projects vary in terms of size, location, and complexity. The process can be tailored to the needs of a given project.

Risk management, as an integral part of project management, occurs on a daily basis. With proactive risk management, WSDOT looks at projects in a

comprehensive manner and assesses and documents risks and uncertainty. The steps for risk management are provided below in Exhibit 5-1.

Project Risk Management and Risk-Based Estimating

It is WSDOT's policy to conduct risk-based estimating workshops for all projects costing over $10 million (for preliminary engineering - PE, right of way acquisition - R/W, and construction phases of project development). These workshops provide information to Project Managers that can help control scope, cost, schedule, and risks (see Exhibit 5-2). These efforts reaffirm the requirement that a Risk Management Plan is a component of every Project Management Plan.

Exhibit 5-1: WSDOT Project Level Risk Management Steps.

Phase	Step	Project Risk Assessment Step Description
1	**Pre-Treatment:** Risk Management Planning	Risk management planning is the systematic process of deciding how to approach, plan, and execute risk management activities throughout the life of a project. It is intended to maximize the beneficial outcome of the opportunities and minimize or eliminate the consequences of adverse risk events.
2	**Pre-Treatment:** Identify Risk Events	Risk identification involves determining which risks might affect the project and documenting their characteristics. It may be a simple risk assessment organized by the project team, or an outcome of the Cost Risk Assessment (CRA)/Cost Estimate Valuation Process (CEVP®) workshop process.
3	**Pre-Treatment:** Qualitative Risk Analysis	Qualitative risk analysis assesses the impact and likelihood of the identified risks, and develops prioritized lists of these risks for further analysis or direct mitigation. Project teams assess each identified risk for its probability of occurrence and its impact on project objectives. Teams may elicit assistance from subject matter experts or functional units to assess the risks in their respective fields.
4	**Pre-Treatment:** Quantitative Risk Analysis	Quantitative risk analysis is a way of numerically estimating the probability that a project will meet its cost and time objectives. Quantitative analysis is based on a simultaneous evaluation of the impacts of all identified and quantified risks.
5	**Pre-Treatment:** Risk Response	Risk response is the process of developing options and determining actions to enhance opportunities and reduce threats to the project's objectives. It identifies and assigns parties to take responsibility for each risk response. This process ensures each risk requiring a response has an "owner." The Project Manager and the project team identify which strategy is best for each risk, and then select specific actions to implement that strategy.
6	**Post-Treatment:** Risk Monitoring & Control	Risk monitoring and control tracks identified risks, monitors residual risks, and identifies new risks—ensuring the execution of risk plans and evaluating their effectiveness in reducing risk. Risk monitoring and control is an ongoing process for the life of the project.

Exhibit Note: Source is from the WSDOT *Project Risk Management Guide* as adapted from the WSDOT *Project Management Online Guide*.

Exhibit 5-2: Levels of Risk-based Estimating, in Support of Project Risk Management.

Project Size ($ Millions)	Required Process[4]
Less than $10M	Qualitative spreadsheet in the *Project Management Online Guide*[1]
$10M to $25M	Informal workshop using the self-modeling spreadsheet[1,3]
$25M to $100M	Cost Risk Assessment (CRA) workshop[1,2]
Greater than $100M	Cost Estimate Validation Process® (CEVP®) workshop[2]

Exhibit Notes:

[1] In some cases, it is acceptable to combine a *Value Engineering* Study with a *Risk-Based Estimating Workshop*.

[2] Projects $25 million and over should use the self-modeling spreadsheet and corresponding self-modeling guide in the scoping phase of the risk-based estimating process, followed up by the more formal CRA or CEVP® process during the design phase.

[3] An informal workshop is composed of the project team (or key project team members); other participants may be included as the Project Manager/ project team deem necessary.

[4] Project Managers can use a higher-level process if desired.

Through WSDOT's strong history of project risk identification and mitigation strategy planning, program and *enterprise-level* risk factors are more confidently addressed knowing risk considerations are managed at the lowest level. Managing risk at the *project-level* provides for creation of realistic mitigation strategies at the *program* and *enterprise-levels* since cost, schedule, and scope have already been considered for each project.

WSDOT TAMP Risk Assessment

In addition to the risk mitigation strategies already developed, WSDOT is performing *program-level* risk assessments for all of its assets across the state, with the TAMP content focusing on bridges and pavements. The TAMP risk assessment is focused on reducing potential consequences to WSDOT's strategic goals and objectives for asset management as programmatic risks also have the potential to affect WSDOT at the *enterprise-level*. WSDOT's TAMP risk assessment process consists of two-tiers and incorporates five distinct phases.

The two-tiered assessment process begins with an initial meeting where the WSDOT TSQER office introduces concepts and processes for a successful risk assessment. The introductory meeting is followed by two risk assessment workshops of 3 to 4 hours each. During scheduled workshops, five phases of risk assessment work are completed, including:

1. Risk identification,
2. Qualitative evaluation of the risk,
3. Risk analysis,
4. Risk response planning and implementation, and
5. Monitoring and control.

This approach provides opportunities for the agency to relate potential risks across all levels of the agency, executive leadership to individual asset groups. Additionally, these activities also encourage *enterprise level* discussion between different groups at the *program level* to determine whether any potential risks are shared by others. Enterprise risk management activities must align information gathered for risk categories with current *WSDOT Strategic Plan goals*, this alignment is shown in Exhibit 5-3.

Exhibit 5-3: WSDOT Risk Assessment Category Alignment with Strategic Plan Goals.

	WSDOT Strategic Plan	WSDOT Risk Categories
Goal 1	Strategic Investment	Departmental Performance
		Financial
Goal 2	Modal Integration	Health & Safety
		Transportation System Performance
Goal 3	Environmental Stewardship	Environmental
Goal 4	Organizational Strength	Core Workforce & Competency
		Legal & Compliance
Goal 5	Community Engagement	Reputation & Credibility
Goal 6	Smart Technology	Smart Technology

Exhibit Note: Source is from the WSDOT Transportation Safety, Quality, and Enterprise Risk Division.

Note: Supplemental Information in the TAMP Technical Guide, identifies and provides additional detail on WSDOT's Risk Assessment definitions and criteria. In addition, WSDOT is considering three new goal areas (Practical Solutions, Inclusion, and Workforce Development) at the time of this writing and the TSQER Division is currently reviewing for alignment with established WSDOT Risk categories. If the new goal areas are implemented, the June 2019 TAMP submission will include updated alignment and policy framework supporting future risk workshops.

Phase 1: Risk Identification

The first phase is identifying all risks that could have an impact on a given asset class. Risks are identified in the form of risk statements. Each statement consists of two parts: 1) the risk event, and 2) the impact description. Risk statements are in the form of "If/Then" to help participants prepare for determining risk response plans, created later in the assessment. Risk statements are then related to one of the nine WSDOT risk categories, shown above in Exhibit 5-3. Participants are asked to perform the following tasks:

- Identify risk triggers (events) that can affect the condition and performance of assets;
- Describe consequences if the events occur;
- Associate asset risks with their respective WSDOT risk category; and
- Specify risk event group(s) within WSDOT business processes impacted by their respective risks.

WSDOT has also found that sub-classifying risk categories into risk event groups helps to articulate contributing factors leading to potential risk impacts. In doing so, the risks are better understood and can be classified for potential mitigation treatments.

Phase 2: Qualitative Evaluation of the Risk

The second phase involves qualitative evaluation of risk and entails participants ranking the likelihood of a risk event occurring and severity of impact that could result. Risk event ranking is as follows:

Likelihood	Severity
1. Very Unlikely	1. Minimal
2. Unlikely	2. Minor
3. Possible	3. Moderate
4. Likely	4. Significant
5. Very Likely	5. Major

WSDOT's TSQER Division implements an internal quality control (QC) process on the results to conclude this phase. The Division QC process focuses on risk descriptions, ranking, categorization, and event groupings after completing the initial qualitative assessment.

TSQER's QC process includes the following steps:

- Risk descriptions are reviewed for clarity and to identify potential for misinterpretation;
- TSEQR then reviews risk categorization and event grouping assignments, makes modifications within the risk description or reassigns it to a different category or grouping if there is disagreement; and
- Lastly, risk severity and likelihood rankings are reviewed for wide variance or unusual distribution patterns as discrepancies can indicate misunderstanding or disagreement about the specific context (goals and objectives) of the risk being assessed.

Phase 3: Risk Analysis

The third phase refers to assessing the overall level of risk and governance priority based on a combination of likelihood and severity rankings, shown in Exhibit 5-4. Risk evaluation results from *Phase 2* are plotted on a heat map and used to establish a Very-Low to Very-High level of risk and corresponding governance level. Exhibit 5-5 aligns the level of risk to the corresponding governance level associated with the risk.

Exhibit 5-4: **Risk Heat Map, Indicating Overall Level of Risk and Governance Priority.**

Likelihood Ranking (1-5)	Minimal	Minor	Moderate	Significant	Major
Very Likely	Low	Medium	Medium	Very High	Very High
Likely	Low	Medium	Medium	High	Very High
Possible	Very Low	Low	Medium	Medium	High
Unlikely	Very Low	Low	Medium	Medium	High
Very Unlikely	Very Low	Very Low	Low	Medium	High
	Severity Ranking (1-5)				

Exhibit Note: Source is from the WSDOT Transportation Safety, Quality, and Enterprise Risk Division.

While some agencies weigh likelihood rankings at much higher levels than severity, WSDOT does not use this approach. In lieu of a weighted matrix, WSDOT has developed a non-symmetrical risk heat map that favors severity over likelihood in assigning higher levels of governance. The reasoning is that the higher the potential severity impact, the greater the likelihood that the goals and objectives of the program may be impacted. At very high levels this is particularly important to an agency achieving appropriate levels of performance.

Exhibit 5-5: **Risk and Governance Level Alignment.**

Risk Level	Governance Level Description
Very High	The consequence requires intervention from *Executive Management*, the *Secretary of Transportation*, or the *Governor*; requires prompt action by the Secretary of Transportation to implement new *Department Level* controls to treat the risk.
High	The consequence affects the ability of WSDOT to carry out its *mission and strategic plan*; existing controls must be effective and requires additional action to be managed at the *Executive Management Level*.
Medium	The consequence impacts completion of a *critical WSDOT function*; existing controls must be effective and possibly additional action implemented, to be managed at the *Division Management Level*.
Low	The risk is managed within *current practices and procedures*; impacts are dealt with by routine operations at the *Director/Office Level* to monitor routine practices and procedures for effectiveness.
Very Low	The risk is managed within *current practices and procedures*; impacts are dealt with by routine operations at the *Office Level* to monitor routine practices and procedures for effectiveness. Active and passive acceptance of these risk are common.

Exhibit Note: Source is from the WSDOT Transportation Safety, Quality, and Enterprise Risk Division.

Important outcomes from the third phase of risk assessment are:

1. Identifying risks deemed the highest priority; and
2. Necessary level of governance required to respond to the risks.

This phase of assessment aims to help workgroups evaluate how risks compare to each other, as well as identify potential ownership and responsibility to address the risks. Decisions to assign risk category governance are ultimately determined by the level of risk, with preference given to severity of impact. WSDOT is engaged in ongoing discussions on the relative weight between risk tradeoffs and will continue to incorporate best risk management practices into future TAMP submissions.

Phase 4: Risk Response and Treatment Implementation Planning

Once the risk statements are assessed and prioritized, the next phase is to: select risk treatment strategies, develop risk response plans, and finalize the initial risk register. WSDOT uses five risk treatment strategies to manage risks:

- **Passive Acceptance** - Accept the consequences;
- **Active Acceptance** - Develop a contingency plan to execute should the risk event occur;
- **Transfer** - Shift the risk to a third party;
- **Mitigation/Reduction** - Implement actions to reduce the probability a risk event will occur and/or reduce the impact should it occur; and
- **Avoidance** - Eliminating a specific risk, usually by removing the potential cause.

Risk treatment plans consist of specific activities WSDOT may implement to treat the potential risk impact. Once risk treatment plans are determined, each risk is evaluated for post-treatment likelihood and severity. This helps guide decision makers on implementing risk treatment plans considered to have a high potential for risk reduction. A preliminary risk register is created upon completion of phases one through four in WSDOT's TAMP risk assessment process.

Phase 5: Risk Monitoring and Control

While WSDOT's TAMP risk assessment process consists of four initial phases to develop a preliminary risk register, the process does not stop once the first four phases are complete. A component of risk response includes monitoring and internal control activities to keep track of risk treatment plan implementation effectiveness. As a result, WSDOT's last phase includes iterative risk register and treatment plan updates. Risk monitoring and control activities provide continual refinements to the risk register and treatment plans while asset groups gain better understanding of the risks associated with their respective assets.

TAMP Risk Assessment Workshops

Through several workshops, continuous risk based asset management includes tasks where asset risks are:

- Elicited and composed from asset stewards;
- Collected and documented;
- Analyzed for correlation to WSDOT asset and strategic goals;
- Analyzed for risk source and consequence, prioritization, level of risk, level of governance;
- Assignment for governance to a designated risk owner and risk manager;
- Risk response strategies and plans are developed and include possible opportunities; and
- The asset leadership team and program staff communicate regularly to remain aware of risks throughout asset class operation and support system activities.

Workshops include the following steps shown below in Exhibit 5-6.

Exhibit 5-6: **Risk-Based Asset Management Process Steps.**

Phase	Risk Assessment Step	Risk Assessment Step Description
1	**Pre-Treatment:** Risk Identification	Collection and identification of risks throughout the organization; development of a risk-list.
2	**Pre-Treatment:** Risk Qualitative Evaluation	Score the likelihood (frequency) and severity (degree of impact) for each risk and the degree of detriment and risk tolerance. Quality control process is then performed after completion of the initial evaluation.
3	**Pre-Treatment:** Risk Analysis	Rank and prioritize the risks, determine the level of risk, and assign responsibility for management of risks.
4	**Pre-Treatment:** Risk Response and Treatment Implementation Planning	Determine the risk treatment strategy and actions needed to: address risks and develop treatment plans, implement treatment plans; monitor implementation effectiveness; and sustain treatment best-practices iteratively. Perform a qualitative risk assessment of potential risk level after treatment strategies are determined; and evaluate for residual/retained level of risk and risk-tolerance, as determined by the likelihood (frequency) and severity (degree of impact) for each risk. Complete the initial risk register.
5	**Post-Treatment:** Risk Monitoring & Control	Iteratively update the risk register, maintain risk teams, monitor risk treatment progress, and maintain communication with leadership.

Exhibit Note: Source is from the WSDOT Transportation Safety, Quality, and Enterprise Risk Division.

As part of the initial pavement and bridge risk assessment workshops, WSDOT's TSQER Division performed quality assurance reviews of preliminary risk registers to identify potential errors or concerns related to the risk assessment process. Two potential issues were identified:

- *Issue 1* - Relates to which goals and objectives were considered for the purposes of the risks assessment; and
- *Issue 2* - Relates to governance definitions.

In both cases, follow up meetings were held to address concerns. The TSQER Division reiterated Federal performance targets are being used by WSDOT for initial risk register creation to define the Goals and Objectives with the risk assessment participants. The assignment of governance question required WSDOT TSQER Division to write a combined definition of Asset Steward/Risk Owner, and Asset Manager/Risk Manager.

TAMP Risk Management Next Steps

WSDOT is continuing work to finalize the pavement and bridge asset risk registers, including risk responses for the highest priority items identified. In addition, WSDOT continues working towards identification of assets repeatedly damaged by emergency events. Sections that follow discuss WSDOT's next steps to finalize the TAMP risk assessment process.

Completion of Risk Registers for Pavement and Bridge Assets

Beginning October 30th 2017, WSDOT held multiple workshops to complete risk assessments for its pavement and bridge assets. Completed workshops, the resulting risk register, and treatment plans are not yet ready to be included in this initial TAMP but will be included in the June 2019 submittal. WSDOT will take the following actions to complete the risk registers by the June 2019 submission deadline:

- Seek executive steering committee approval of the identified risk items for pavement and bridge assets (see *Chapter 1: Introduction*, for more information on WSDOT's structure for asset management);
- Work with the TSQER office and asset stewards to develop risk responses for each identified risk item;
- Seek executive steering committee approval of the risk response strategies; and
- Incorporate risk strategies into the TAMP.

Risk Planning for Assets Repeatedly Damaged by Emergency Events

State DOTs are required by a related rule (23 CFR Part 667) to conduct a statewide evaluation of existing roads, highways and bridges eligible for federal-aid funding that have needed repair and/or reconstruction on two or more occasions because of emergency events. The evaluation determines whether reasonable alternatives to any of the roads, highways and bridges exist and consider the risk of recurring damage and cost of future repairs given current and future environmental conditions.

WSDOT is currently reviewing its data sources and will complete statewide evaluation of the National Highway System (NHS) by November 23, 2018, and will complete for all other remaining federal-aid eligible roads, highways and bridges by November 23, 2020.

Recent Advances

WSDOT is working to refine statewide risk evaluation processes and develop new methods where needed. Recent advances include:

- SharePoint site development to facilitate enhanced planning, coordination, information collection, and tracking of emergency event project efforts statewide, beginning in 2015; and
- Incorporating climate vulnerability considerations and greenhouse gas (GHG) emission evaluations during project development, beginning in 2009. See the following for further detail.
  - *NEPA/SEPA Project-level Climate Change Evaluations*,
  - *Considering Impacts of Climate Change in WSDOT Plans*, and
  - *Project-Level Greenhouse Gas Evaluations under NEPA and SEPA*.

Additionally, WSDOT has completed two FHWA climate change pilot projects:

- Skagit Basin pilot report (2015) - *Creating a Resilient Transportation Network in Skagit County: Using Flood Studies to Inform Transportation Asset Management*; and
- Statewide pilot report (2011) - *Climate Impacts Vulnerability Assessment Report*.

WSDOT has since incorporated climate change into the *Results WSDOT (2014-2017 Strategic Plan)*, which directs risks related to climate change and extreme weather vulnerability be incorporated into decision making. The strategic plan addresses a cross-agency initiative to identify the risks that climate change can have on the state transportation infrastructure and future investments.

Upcoming Implementation Actions

By November 23, 2018 WSDOT plans to:

- Refine evaluation techniques;
- Identify all needed information and sources;
- Research emergency repair information sources from 1997 to present;
- Compile information needed for evaluation, and document any assumptions regarding the data set or evaluation;
- Conduct evaluation of NHS routes; and
- Hold risk-management workshop to develop potential solutions / reasonable alternatives addressing identified risks.

And by November 23, 2020:

- Complete similar work for remaining routes (non-NHS) excluding tribally owned and federally owned (per law).

CHAPTER 6

REVENUE AND FINANCIALS

WSDOT's financial plans serve to inform decision makers with the intent of driving financial investments that return the highest value for Washington state's citizens and support state performance measures and goals.

WSDOT has a long history of developing financial plans. WSDOT's Budget and Financial Analysis Division works in partnership with the Office of Financial Management and the Legislature to create long-term plans that inform the agency's financial investments and direction while incorporating economic forecast data from the Economic and Revenue Forecast Council, operating expenditures, and capital spending plans.

Continuing the long history of financial planning efforts, WSDOT's transportation asset management financial plan serves as a roadmap for current and future transportation investment opportunities. In an environment of aging infrastructure and ever growing political pressure, the need for financial plans to guide investment opportunities that preserve our transportation network has become more critical.

This chapter serves to communicate WSDOT's revenue sources and expenditures while aligning current levels of spending to the anticipated statewide bridge and pavement needs to reach a State of Good Repair.

Note: Supplemental Information in the TAMP Technical Guide, identifies and provides additional detail on financial planning and analysis process, methods, and assumptions.

Federal and State Requirements

Federal Requirements

A critical component of the TAMP required by MAP-21 is the financial plan. The Federal Highway Administration defines a TAMP financial plan in 23 CFR 515.5 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 key components of the financial plan include:

- Sources and amount of revenue available to the agency for investing towards achieving asset management condition targets and managing risks;
- Full range of funding needs to support achieving agency goals, objectives, and targets;
- Description of the agency's investment strategy to achieve State of Good Repair during the TAMP time period;
- Estimated annual cost of implementing the agency's investment strategy during the TAMP time period; and
- Estimate of the value of the agency's NHS pavement and bridge assets and the annual cost to maintain the value of these assets.

State Requirements

Washington state's long-term transportation goals are outlined in Revised Code of Washington (RCW) 47.04.280. One of the core tenets of Washington state's long-term transportation goals is preservation, defined as: *maintaining, preserving, and extending the life and utility of prior investments in transportation systems and services.*

To meet this legislative goal, WSDOT implements multiple strategies (discussed in other chapters throughout the TAMP) to maximize the return on investment of our highway transportation assets. To assist with marrying asset investment needs to possible funding sources, the TAMP financial plan included in this section outlines available funds, replacement value of the NHS bridge and pavement assets, and planned investments over the next 10 years.

Since asset management is a cost-effective way to manage WSDOT's existing infrastructure, a financial plan supporting this practice; 1) assists with ensuring Washington state's transportation network is maintained as efficiently and effectively as possible, and 2) informs stakeholders and policy makers of investments necessary to preserve the network for years to come.

Revenue Sources

Washington state has a diverse stream of revenues supporting the transportation network including:

- Motor vehicle fuel tax (MVFT)
- Motor vehicle taxes - license, permits, and fees (LPF);
- Tolls;
- Ferry fares;
- Financial instruments (Bonds, Certificates of Participation, TIFIA loan, etc.); and
- Other transportation related fees.

In addition to state generated revenues, Washington state's transportation network is also supported by federal and local revenue sources. For the 2017-19 biennium, gross transportation funds from all sources are expected to total approximately $8.3 billion.

While there is a collective pool of total revenue, not all revenue is available for consideration for highway asset management. As an example, some revenues are statutorily distributed to cities and counties while other revenue sources are restricted to maintaining specific assets (i.e. ferries and tolled facilities). Another restriction to available revenue is motor vehicle fuel tax pledged towards the repayment of debt service for previously issued bonds, discussed in more detail later on in this section.

To further understand the forecast process and revenue structure of Washington state, the sections below discuss WSDOT revenue forecast process and the breakout of state transportation taxes and fees, as well as federal and local funding sources used in the financial plan.

Revenue Forecasting

Washington law mandates the preparation, adoption of economic, and revenue forecasts. Organizations primarily responsible for revenue forecasts are the Economic and Revenue Forecast Council and the Office of Financial Management. The Office of Financial Management has the statutory responsibility to prepare and adopt those forecasts not made by the Economic and Revenue Forecast Council (RCW 43.88.020). The Office of Financial Management carries out its forecast responsibilities for transportation revenues through the Transportation Revenue Forecast Council. Each quarter, technical staff of the Department of Licensing, Department of Transportation, Washington State Patrol and the Office of Forecast Council produce forecasts. The revenue forecasts agreed upon by the Transportation Revenue Forecast Council members become the official estimated revenues under RCW 43.88.020.

To develop the transportation revenue forecast, multiple economic variables are used. Some of these variables include:

- Washington real personal income,
- Driver age population,
- Driver-in population,
- Inflation,
- Employment,
- Oil price index,
- Fuel efficiency,
- US sales of new light vehicles, and
- Various employment sectors.

The forecast also takes into consideration policy and legal changes such as a new tax or fee packages and distribution of revenue changes. Actual performance of revenue receipts to previously forecast revenues are also evaluated when developing the forecast, and when appropriate, the forecast is adjusted to more accurately reflect actual experience.

Once the forecast is compiled and reviewed, the forecast is adopted and posted to the Office of Financial Management's website. The adopted forecast is then incorporated into the WSDOTs financial plans, creating the baseline source revenue information used when evaluating available funding for asset investment. Additional information on Washington state's forecast process may be found in the published Economic Forecasts.

Financial Plan Revenue Sources

Understanding the available revenue for asset management is a core tenet of developing an asset management financial plan. Since not all transportation revenue is available for highway maintenance and preservation activities, assumptions must be made to determine how much the agency is able to invest in its assets. Key high-level assumptions made in determining amount of available revenue over the 10-year financial plan period include:

- Total transportation revenues are generally based on the Transportation Revenue Forecast Council's adopted November 2017 forecast.
  - Includes all state and federal sources;
  - WSDOT appropriated federal revenue sources are aligned with planned federal expenditures based on the 2017 Transportation Appropriations Bill (ESB 5096); and
  - The revenue forecast contains its own set of assumptions which may be found in the published forecast
- Beginning account balances are not included, but are assumed to be approximately $900M.
- Bond revenue/sale projections are based on WSDOT's financial plan submitted to the Office of Financial Management.
- Total available revenue is reduced by the following factors:
  - Current and projected debt service payments;
  - Toll revenue that is not used for maintenance and preservation activities on the tolled facilities;
  - Hood Canal and GARVEE debt service that is pledged against future federal obligation authority levels; and
  - Statutorily required distributions to cities, counties, and other state agencies.

Note: For more details on the assumptions that went into this financial plan, please see the technical guide that accompanies this chapter.

Exhibit 6-1: All Projected WSDOT Revenue Sources.

TOTAL SOURCES 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
Total State Funds	$1,779	$2,309	$2,369	$2,391	$2,217	$10,811	$21,875
Total Federal Funds	$648	$648	$513	$513	$415	$1,899	$4,636
Total Local Funds	$36	$36	$11	$11	$5	$98	$197
Total	**$2,463**	**$2,993**	**$2,893**	**$2,915**	**$2,637**	**$12,808**	**$26,709**

Exhibit Note: Revenue sources are net of the distributions outlined in the corresponding technical guide.

State Sources

Tax, Fare, and Fee Related Sources

State revenue is derived from numerous taxes, fees, permits, tolls, and other revenues. Washington's fuel taxes (gasoline, diesel, biodiesel, etc.) comprise the largest share of all transportation revenue. Licenses, permits and fee revenues comprise the second largest share of all transportation revenues. This revenue is related to motor vehicle registrations, weight fees, license plate replacement fees, title fees, and dealer permits. The remaining consists of ferry fares, toll revenue, and driver/other transportation related revenue. This revenue reflects the usage of the ferries, toll facilities, vehicle sales and use taxes, rental car sales taxes, filing fees, etc.

Bond Related Sources

Over the past decade, Washington has significantly increased its reliance on motor fuel tax bonds to support legislative spending plans associated with fuel tax increases. Leveraging revenues from the fuel tax increases of the 2003 Nickel Act and the 2005 Transportation Partnership Act increased the state's annual motor fuel tax bond issuance from $65 million in the 1990s to over $500 million by 2013. In 2015, the Legislature approved further increases in fuel taxes and license, permits, and fees in the Connecting Washington transportation package and directed these revenues to specific projects.

In fiscal year 2018, debt service on motor fuel tax bonds is anticipated to rise to nearly $684 million, representing 30 percent of state transportation revenues, and half of pledged motor vehicle fuel tax revenues. This is more than triple the $215 million paid with only 20 percent of motor vehicle fuel tax revenues in 2007.

As motor fuel tax bonds are pledged against motor fuel tax revenues, the revenue required to make debt service payments on these bonds are removed from the total available revenue.

Exhibit 6-2: Total State Revenue Sources.

TOTAL STATE SOURCES 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
Motor Vehicle Fuel Tax	$1,282	$1,297	$1,309	$1,319	$1,327	$6,734	$13,269
License, Permits, and Fees	$500	$507	$515	$521	$514	$3,071	$5,628
Toll Revenue	$190	$193	$204	$200	$202	$1,076	$2,065
Ferry Fares	$198	$203	$207	$209	$212	$1,096	$2,125
Other Revenue	$97	$99	$101	$103	$105	$551	$1,057
General Fund Sales Tax	$0	$0	$55	$55	$55	$260	$425
State Bonds	$188	$685	$730	$730	$641	$2,659	$5,632
Earned Interest	$8	$8	$8	$8	$8	$38	$75
less Debt Service	($678)	($679)	($665)	($660)	($654)	($3,221)	($6,556)
less Estimated Debt Service	($6)	($6)	($94)	($94)	($192)	($1,453)	($1,844)
Total State Funds	**$1,779**	**$2,309**	**$2,369**	**$2,391**	**$2,217**	**$10,811**	**$21,875**

Exhibit Note: State revenue source estimates are based on the November 2017 economic forecast and WSDOT's bond model.

Federal Sources

WSDOT uses the forecast for Obligation Authority when it budgets and programs projects. WSDOT estimates the funding targets for the highway construction program by fund type—federal, state and local. Within these funding types are specific amounts with unique requirements attached specifying how, when and where the funds can be spent. Federal-aid funds are distributed in programmatic categories with differing limitations on their usage. This approach allows WSDOT flexibility to meet the changing demands and eligibility requirements of the federal program. WSDOT's financial practice is to use the most restrictive federal programs when initially programming a project. This allows more flexible programs to be available later in the budget and programming process.

Of the Federal funds received, Washington has a unique approach to distributing funds between state and local government. There is a requirement to sub-allocate approximately half of the Surface Transportation Block Grant Program funding to local entities based on population, and there is metropolitan planning money for local organizations. Beyond that, generally speaking, there is no requirement for the state to sub-allocate the rest of the FHWA formula funds it receives each year.

Exhibit 6-3: WSDOT's Total Federal Revenue Sources.

TOTAL FEDERAL SOURCES 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
NHPP	$268	$268	$312	$312	$210	$816	$2,187
STP	$147	$147	$96	$96	$80	$492	$1,057
Other Federal Programs	$337	$337	$208	$208	$229	$908	$2,226
less GARVEE Debt Service	($100)	($100)	($100)	($100)	($100)	($298)	($797)
less Hood Canal Debt Service	($4)	($4)	($4)	($4)	($4)	($18)	($36)
Total Federal Funds	**$648**	**$648**	**$513**	**$513**	**$415**	**$1,899**	**$4,636**

Exhibit Note: Federal revenue sources are aligned with federal expenditures outlined in ESB 5096.

Local Sources

Various local revenue allocations round out the remainder of WSDOT's transportation funding. Local funds anticipated in the financial plan are planned reimbursements for work done by WSDOT on the state highway system at the request of other agencies. They come from sources other than the Motor Vehicle Fund. For example, sources for these funds are local agencies (such as cities or counties), or funds received directly from a developer. These funds are only eligible to be spent on the projects specified by the local entity.

Exhibit 6-4: WSDOT's Total Local Revenue Sources.

TOTAL LOCAL SOURCES 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
Total Local Funds	**$36**	**$36**	**$11**	**$11**	**$5**	**$98**	**$197**

Exhibit Note: Local sources are estimated based on anticipated local reimbursements from local jurisdictions.

Financial Plan Revenue Uses

The following expenditure plan is based on the legislatively approved budget for the 2017-2019 biennium and outlines the anticipated 10-year expenditures across operating and capital programs. It also aligns state bridge and pavement spending to state bridge and pavement needs.

It is important to note that actual and planned expenditures by local jurisdictions on locally owned sections of the NHS is not yet fully available. In addition, maintenance spending is not currently tracked by spending on the NHS and is only available for total state maintenance expenditures on bridges and pavement. WSDOT continues to work with the 17 MPOs and over 100 local agencies who maintain a section of the NHS to obtain better estimates of planned NHS spending.

Operating Expenditures

The 10-year financial plan operating expenditures are estimated based on the legislatively approved 2017-2019 approved budget. This budget establishes appropriation levels for the various WSDOT operating programs for the 2017-19 biennium and those values are then extrapolated over the remaining eight years of the financial plan using a set inflation rate of ½ the IPD[1]. For more information on the budget setting process, see the corresponding chapter technical guide.

Exhibit 6-5: WSDOT's Total Projected Operating Expenditures.

TOTAL USES - OPERATING 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
Total State	$900	$900	$918	$918	$943	$4,880	$9,458
Total Federal	$34	$34	$35	$35	$36	$186	$361
Total Local	$.3	$.3	$.4	$.4	$.4	$2	$4
Total	$934	$934	$953	$953	$980	$5,068	$9,461

Exhibit Note: Operating expenditures as legislatively appropriated through ESB 5096.

Capital Expenditures

WSDOT's overall capital program is referred to as its Capital Improvement and Preservation Program ("CIPP"). The CIPP is a rolling 10-year investment plan divided into five biennia. The first two years of the CIPP are funded by the Legislature. The remaining eight years of the 10-year CIPP are project specific. Projects in this eight-year window have been scoped and the solutions have been approved by WSDOT. For certain types of projects, the last two biennia of the CIPP are conceptual solutions. They may be shown with less detail using parametric estimates or as lump sum funding levels proposed for various categories of work.

[1] Implicit Price Deflator indices set by the Economic and Revenue Forecast Council through 2023 and IHS-Markit for the outer years of the plan.

The capital expenditures for the 10-year financial plan are based on WSDOTs 2017 Project Delivery Plan which is used to form the basis of the CIPP and provides intent for delivery. Capital expenditures are inflated from current year dollars to year of expenditure dollars using preliminary engineering, right of way, and construction inflation factors[2]. For additional information on the assumptions of the capital plan, please see the corresponding chapter technical guide.

Exhibit 6-6: WSDOT's Total Projected Capital Expenditures.

TOTAL USES - CAPITAL 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
State	$1,366	$1,366	$1,502	$1,502	$1,377	$6,176	$13,288
Federal	$614	$614	$477	$477	$379	$1,713	$4,275
Local	$35	$35	$11	$11	$5	$96	$193
Total	$2,015	$2,015	$1,990	$1,990	$1,761	$7,985	$17,756

Exhibit Note: All capital expenditures have been inflated to year of expenditure dollars.

Exhibit 6-7: WSDOT Total Revenue Sources and Revenue Uses.

TOTAL SOURCES AND USES 10-Year Estimate (millions)	2018	2019	2020	2021	2022	2023-2027	Total
Total State Funds	$1,779	$2,309	$2,369	$2,391	$2,217	$10,811	$21,875
Total Federal Funds	$648	$648	$513	$513	$415	$1,899	$4,636
Total Local Funds	$36	$36	$11	$11	$5	$98	$197
Total	$2,463	$2,993	$2,893	$2,915	$2,637	$12,808	$26,709
TOTAL USES - OPERATING							
Total State	$900	$900	$918	$918	$943	$4,880	$9,458
Total Federal	$34	$34	$35	$35	$36	$186	$361
Total Local	$.3	$.3	$.4	$.4	$.4	$2	$4
Total	$934	$934	$953	$953	$980	$5,068	$9,461
TOTAL USES - CAPITAL							
State	$1,366	$1,366	$1,502	$1,502	$1,377	$6,176	$13,288
Federal	$614	$614	$477	$477	$379	$1,713	$4,275
Local	$35	$35	$11	$11	$5	$96	$193
Total	$2,015	$2,015	$1,990	$1,990	$1,761	$7,985	$17,756

Exhibit Note: For a full list of assumptions that were used to create the financial plan, please see the corresponding technical guide.

[2] Preliminary Engineering index based on Global Insight forecast for engineering, architectural, and surveying salaries. Right of way phase index based on Moody's analysis forecast of the Federal Housing and Finance Administration housing price index for the state of Washington. Construction phase index based on Global Insight forecast of Construction Cost Index.

10-Year Needs, Planned Bridge and Pavement Spending

As part of the department's asset funding need process, the pavement and bridge offices provide an estimate of the total 10-year investment need as part of the unfunded priority process. More information on the unfunded priority process can be found in *Chapter 8: Investment Strategies* of the TAMP. The 10-year need represents the amount of funding required to achieve and sustain a State of Good Repair for the bridge and pavement networks.

The following Exhibits 6-8 through 6-10 provide estimated programmed levels of spending, statewide 10-year pavement and bridge need, and the resulting investment gap. The need estimates reflected below are based on state needs. Needs specific to the NHS are currently under development and will be incorporated into the TAMP submitted June of 2019.

Investment gaps reflected in the tables below highlight the difference between the planned level of spending and what is required to achieve and sustain a State of Good Repair for the pavement and bridge asset networks. The level of investment necessary to meet the national standards of less than 10% of bridges on the NHS in poor condition and 5% of Interstate pavements in poor condition would reduce the investment gap, but the estimated impact has yet to be determined. Multiple funding scenarios will be included with the June 2019 TAMP submission.

WSDOT continues to work with MPOs to determine the level of need for the locally owned bridges and pavement on the NHS. Additional information on this process can be found in *Chapter 9: Implementation and Systems* of the TAMP.

Exhibit 6-8: WSDOT's Planned State NHS and non-NHS Expenditures.

Planned Pavement Preservation Spending ($ in Millions)							
Fiscal Year	**2018**	**2019**	**2020**	**2021**	**2022**	**2023-2027**	**2018-2027**
NHS Pavement Spending	$221	$221	$134	$134	$127	$512	$1,349
Non-NHS Pavement Spending	$68	$68	$59	$59	$42	$186	$481
Total	**$289**	**$289**	**$193**	**$193**	**$169**	**$698**	**$1,830**
Planned Bridge Preservation Spending ($ in Millions)							
Fiscal Year	**2018**	**2019**	**2020**	**2021**	**2022**	**2023-2027**	**2018-2027**
NHS Bridge Spending	$112	$112	$159	$159	$122	$408	$1,070
Non-NHS Bridge Spending	$30	$30	$22	$22	$11	$114	$228
Total	**$142**	**$142**	**$180**	**$180**	**$133**	**$521**	**$1,298**

Exhibit Note: Anticipated expenditures are based on bridge and pavement projects included in the 2017 project delivery plan.

Exhibit 6-9: WSDOT's 10-Year Pavement Needs.

Pavement Ten Year Average Need (in $ millions)							
Fiscal Year	**2018**	**2019**	**2020**	**2021**	**2022**	**2023-2027**	**2018-2027**
Capital Preservation	$284	$284	$284	$284	$284	$1,420	$2,840
Operational Maintenance*	$31	$34	$34	$35	$36	$190	$361
Total Need	$315	$318	$318	$319	$320	$1,610	$3,201
Capital Preservation Spending	$289	$289	$193	$193	$169	$698	$1,830
Operational Maintenance Spending	$31	$34	$34	$35	$36	$190	$361
Total Spending	$320	$323	$227	$228	$205	$888	$1,571
Investment Gap	**$5**	**$5**	**$(91)**	**$(91)**	**$(115)**	**$(722)**	**$(1,329)**

Exhibit Notes:

10-year pavement needs assumes an annual pavement backlog of $40M.

*Operational Maintenance includes activities such as patching & repair and pavement marking maintenance.

Exhibit 6-10: WSDOT's 10-Year Bridge Needs.

Fiscal Year	2018	2019	2020	2021	2022	2023-2027	2018-2027
Bridge Ten Year Average Need (in $ millions)							
Capital Preservation	$270	$270	$270	$270	$270	$1,350	$2,700
Operational Maintenance*	$19	$19	$20	$20	$21	$110	$209
Total Need	**$289**	**$289**	**$290**	**$290**	**$291**	**$1,460**	**$2,909**
Bridge Ten Year Planned Spending							
Capital Preservation Spending	$142	$142	$180	$180	$133	$521	$1,298
Operational Maintenance Spending	$19	$19	$20	$20	$21	$110	$209
Total Spending	**$161**	**$161**	**$200**	**$201**	**$153**	**$631**	**$1,108**
Investment Gap	**$(128)**	**$(128)**	**$(90)**	**$(90)**	**$(137)**	**$(829)**	**$(1,520)**

Exhibit Note: *Operational maintenance includes activities such as bridge deck repair and structural bridge repair.

Asset Replacement Value

The following section provides estimated replacement values for pavement and bridge assets across the Washington state transportation network, as well as estimated replacement values for those same assets on the NHS. While nearly complete data sets for state owned bridge and pavement assets exist, bridge and pavement asset replacement information on the locally owned portion of NHS is not as comprehensive. WSDOT continues to refine its processes and work with its local partners to obtain more complete asset information.

Pavement Replacement Value

The estimated pavement replacement values, reflected in exhibits 6-11 and 6-12, are a product of the pavement type, number of lane miles, and the average unit replacement value. This replacement value does not consider pavement age or depreciation of the asset over time, but is a snapshot of the estimated cost to replace all of WSDOT's pavement assets at a set point in time. Additional information on WSDOT's asset depreciation methodology may be found in the corresponding chapter of the technical guide.

Exhibit 6-11: Statewide Estimated Replacement Value of Pavement Assets.

PAVEMENTS	Quantity	Units	Average Unit Replacement Value	Replacement Value (Millions of $)
Asphalt	10,155	Lane Miles	$900,000	$9,140
Chip Seal	6,171		$200,000	$1,234
Concrete	2,086		$2,500,000	$5,215
Special Use Lanes	759		$700,000	$531
Ramps	1,400		$900,000	$1,260
Shoulders	7,526		$270,000	$2,032
Total	**28,097**			**$19,412**

Exhibit Note: Lane Mile quantities exclude concrete bridge deck lane miles. Information is derived from the 2015 State Highway Log, but modified to exclude bridge decks and minor pavement type updates.

Exhibit 6-12: Estimated NHS Pavement Replacement Value (both local and state agencies).

Row Labels	Quantity	Units	Average Replacement Value	Replacement Value ($ in Millions)
Local				
Asphalt	2,667	Lane Miles	$900,000	$2,400
Chip Seal	646		$200,000	$129
Concrete	23		$2,500,000	$58
Total	**3,336**			**$2,587**
State				
Asphalt	7,354	Lane Miles	$900,000	$6,619
Chip Seal	1,668		$200,000	$334
Concrete	2,429		$2,500,000	$6,073
Total	**11,451**			**$13,025**
Grand Total	**14,787**			**$15,612**

Exhibit Note: Local and state NHS data derived from 2016 HPMS database.

Bridge Replacement Value

Exhibits 6-13 and 6-14 outline the estimated replacement value of all WSDOT owned bridges as well as bridges located on the NHS for both local and state agencies. We continue to work with our local partners to improve asset inventory data as it relates to locally owned bridge structures on the NHS.

Exhibit 6-13: Statewide Estimated Replacement Value of Bridge Assets.

BRIDGES & STRUCTURES	Quantity	Units	Average Unit Replacement Value	Replacement Value (Millions of $)
Vehicular Bridges	3,124	Each	Variable - Based on Structure Size and Type	$52,400
Border Bridges	5			$3,150
Small Structures (< 20' long)	431			$900
Pedestrian Structures	80			$1,700
Keller Ferry	1	System		$18
Total	**3641**			**$58,168**

Exhibit Note: Statewide bridge data generated from WSDOT Bridge office.

Exhibit 6-14: Estimated NHS Bridge Replacement Value (Local and State Agencies).

State Owned Bridges on the NHS	Quantity	Units	Average Unit Replacement Value	Replacement Value (Millions of $)
Vehicular Bridges	2257	Each	Variable - Based on Structure Size and Type	$47,191
Culverts	79			$436
Border Bridges	5			$3,150
Total	2,341			$50,776
Locally Owned Bridges on the NHS	**Quantity**	**Units**	**Average Unit Replacement Value**	**Replacement Value (Millions of $)**
Vehicular Bridges	212	Each	Variable - Based on Structure Size and Type	$4,750

Exhibit Note: Locally owned bridge data provided by the Local Bridge office.

CHAPTER 7
PERFORMANCE SCENARIOS

Developing performance scenarios is an important part of cross-asset decision making. This chapter communicates WSDOT's considerations and processes related to performance gap analysis and performance scenarios.

Performance gap analysis is required under MAP-21 and is the process of identifying deficiencies hindering progress toward preserving or improving the NHS and achieving and sustaining a desired State of Good Repair. After these deficiencies are identified, alternative strategies are developed and considered to address the identified gaps.

Performance scenarios take one or more alternative strategies and relate it to planned funding amounts, giving a program wide assessment of their overall affect. WSDOT has experience developing performance scenarios in the context of specific asset classes, such as expected pavement condition or fish habitat gain under varying funding amounts. These types of intra-class analyses have helped to shape agency *Budget Requests*. They also shape the *Unfunded Priority List* (to be updated in 2018), which WSDOT has used to communicate with the Washington state Legislature its unconstrained needs. These analyses also shape the development of the *2017 Project Delivery Plan*, which is a snapshot of the project specific capital plan (*CIPP*).

Development is currently underway to improve cross-asset decision-making practices. WSDOT is leveraging new tools and frameworks to aid this endeavor. This chapter ends with a discussion on the direction WSDOT is heading to analyze different performance scenarios for future life cycle planning and investment strategy decisions.

Note: Supplemental Information in the TAMP Technical Guide, identifies and provides additional detail on performance gap analysis and performance scenario definitions, processes, and methods.

Performance Gap Analysis Process

Two general methods for identifying performance gaps are considered, *target-based and plan-based* as follows:

- *Target-based* performance gaps result when comparing measured asset performance with formally instituted asset performance measures and targets. Example - MAP-21 requires performance of pavement and bridge asset condition on the NHS have targets set and be included in future versions of the *TAMP*.
- *Plan-based* performance gaps may be identified when additional planning efforts recommend changes to existing pavements, bridges, or other physical assets. Example - Assessment of mobility in a freight plan, resulting in recommendations for additional lanes.

Target-Based Performance Gap Analysis

Target-based performance gaps will be identified in future versions of the TAMP. See *Chapter 2: Objectives and Measures* for a description of the performance measures, and *Chapter 3: Asset Inventory and Condition* for a summary of performance gaps. For this TAMP submittal, evaluating performance gaps on the NHS (i.e. the safe and efficient movement of goods and services) performance measures and targets have yet to be agreed upon. Therefore, no performance gaps have been identified in this initial version of the *TAMP*. However, a funding gap to achieve and sustain a desired State of Good Repair is recognized for both pavements and bridges. Please see *Chapter 6: Revenue and Financials* for more information on identified funding gaps.

Performance Measure Development Process

In order to set performance measures and targets, WSDOT is carrying out the following steps:

1. Performance measures are proposed, reviewed and approved for inclusion in the TAMP. Such measures should align with asset management policies, strategies, and objectives;

2. Target values related to each performance measure are proposed, reviewed, and approved for inclusion in the TAMP; and
3. When gaps between the measured performance and targets exist, alternative strategies to close or address identified gaps are proposed, reviewed, and approved.

WSDOT will leverage its organizational framework to complete the three primary components for each above identified process including:

- **Propose** - This will primarily occur at the Asset Technical Advisory Group level, along with any related MAP-21 target setting team (technical comprised of WSDOT, MPOs and local agency representatives – see *Chapter 1: Introduction*).
- **Review** - Once the proposal and initial review has occurred from the technical teams, a second review and approval will be necessary from the asset Executive Steering Committee and Target Setting Framework Group.
- **Approve** - Final approval will be ultimately held by the Practical Solutions Round Table.

Plan-Based Performance Gap Analysis

When other planning efforts recommend substantial additions or changes affecting asset inventories, a discussion on the overall effect of these performance gaps will be included in future TAMP versions. If needed, a brief summary of the proposal, review and approval process will be documented.

At this time, additional performance gap analyses for plan-based gaps affecting NHS performance are not included in the TAMP. WSDOT is currently refining its Improvement Project planning to better communicate impacts on existing preservation needs (see section *Strengthen the Relationship between Assets and Transportation Projects* in the TAMP *Chapter 9: Implementation and Systems*) while also assessing additional operation and maintenance needs that system additions bring. When these planning efforts mature, WSDOT will include analyses as warranted. Finally, an overall list of funding gaps is included in the *Unfunded Priority List* (see *TAMP Chapter 8: Investment Strategies*); however, the direct effect on the *NHS* pavements and bridges of these funding gaps has not been analyzed.

Performance Gaps

As identified in the two previous sections, no performance gaps have been identified as part of the initial TAMP submittal. This section is reserved to list performance gaps identified and analyzed in future TAMP versions.

Performance Scenarios

Performance-based scenario analysis plays an important role in asset management planning. *Performance-based scenario analysis* is when a transportation agency changes one or more assumptions and models overall effects on performance measure outcomes. Any assumptions applied through life cycle planning, risk management, funding amounts or investment strategies may be changed to analyze a new scenario result.

As such, modeled performance scenarios allow WSDOT to conduct a performance-based analysis for many "What-If" scenarios. Examples of these "What-If" questions include:

- What if we invest more in one asset class compared to another?
- What if we are able to secure more funding?
- What if we invest more in one type of preservation activity compared to another, such as the right amount of bridge joint preservation to steel bridge painting?

This initial TAMP communicates WSDOT's current approach to asset management, and can be considered a baseline or current scenario. WSDOT is developing a framework to mature its cross-asset resource allocations. Future versions of the TAMP are anticipated to include results from scenario analysis within this framework.

Cross-Asset Resource Allocation Framework

WSDOT is developing a cross-asset resource allocation framework similar to what is proposed in *NCHRP Report 806: Guide to Cross-Asset Resource Allocation and the Impact on Transportation System Performance*. The guide details five steps:

1. Goals and objectives identification,
2. Performance metric evaluation,
3. Project impact assessment,
4. Decision science application, and
5. Trade-off analysis.

Steps 1 and 2 are already primary functions of WSDOT's asset management. These are communicated in *Chapters 2 and 3 Objectives and Measures and Inventory and Condition*, respectively. Step 3 can be completed in a *bottom-up* (project-level) or *top-down* (network-level) technique as follows:

- **Bottom-up** - Approach involves the agency supplying a comprehensive list of cost-effective projects, and then additionally applying before and after assessments of all performance measures defined in Step 2.
- **Top-down** - Approach requires defining financial funding scenarios and the developing performance versus investment-level curves for each performance measure defined in Step 2.

WSDOT is using agency processes and software to develop steps one through three. Step 3 is being done from a *bottom-up* approach. WSDOT is building the data flow to assess, at the project level, both the criteria to rank projects and the Key Performance Indicators (KPIs) to assess the network level performance in support of Step 3. The result from steps one through three will be the basis to apply steps four and five. Steps four and five are being developed simultaneously with steps 1-3, in the form of decision models being developed using software called Decision Lens.

At this time, WSDOT is working to customize Decision Lens by developing portfolios, or multiple portfolios for asset sub-groups, in the following categories:

- Pavements,
- Bridges,
- Other Highway Assets,
- Safety, and
- Environmental.

Ultimately, WSDOT is working to develop and implement a comprehensive trade-off framework across all major asset classes. Due to the data intensive nature and technical requirements for sophisticated asset deterioration and performance modelling, this effort is a long-term goal. WSDOT's near-term goal is to have Decision Lens asset sub-group portfolios developed for the above identified categories and influence budget development processes for the 2019-21 biennium. WSDOT anticipates including information for pavements and bridges based on this decision framework in the more comprehensive TAMP to be submitted in June, 2019.

CHAPTER 8
INVESTMENT STRATEGIES

The results from the previous chapters including *Life Cycle Planning*, *Revenue and Financials*, and *Performance Scenarios* collectively work together to set the direction for WSDOT's investment strategies. From a statewide perspective, investment strategies are communicated annually as part of the Project Delivery Plan, which in turn meets requirements for the Statewide Transportation Improvement Program (STIP). This chapter details prioritization methodologies for pavement and bridges, the current updates to the Project Delivery Plan and the STIP, and concludes with a discussion on how the NHS pavements and bridges fit within them.

Prioritization of Pavement and Bridge Projects

WSDOT uses the results from *Life Cycle Planning*, *Revenue and Financials*, and *Performance Scenario Analysis* as the foundation for setting the direction in its investment strategies. For state-maintained pavements and bridges, the results from these analyses are directly incorporated as part of project prioritization. This section details WSDOT's current practice for pavement and bridge project prioritization and investment.

Pavements

Before pavement projects are scoped, pavement needs are identified. Pavement needs are initially identified based on annual condition surveys, which are input and analyzed in the Washington State Pavement Management System (WSPMS). Pavement deterioration models and activities based on lowest life cycle cost management are the foundation of needs assessment. WSDOT regions then use the information to scope projects in CPMS with a parametric cost for all identified needs. Once the pavement project list has been identified, projects are then grouped by investment areas.

Pavement preservation investment areas are based on primary material type and includes three areas: asphalt, chip seal, and concrete (reflected in Exhibit 8-1). Strategic maintenance is reported as part of the asphalt investment. Chip seal over asphalt is reported as part of the chip seal investment area. Crack, seat and overlay with asphalt is reported as part of the concrete investment area.

Exhibit 8-1: Roadway Preservation Investment Areas.

Investment Area	Primary Activities
Asphalt	Asphalt Resurfacing; Strategic Maintenance; Asphalt Reconstruction
Chip Seal	Chip Seal Resurfacing; Chip Seal Conversion (Chip Seal on Asphalt); Strategic Maintenance
Concrete	Diamond Grinding; Select Panel Replacement, Concrete Reconstruction; Crack, Seat and Overlay with Asphalt; Dowel Bar Retrofit; Strategic Maintenance

Exhibit Note: Source is from the WSDOT Pavement Branch of the Materials Laboratory.

Priority lists are developed for asphalt, chip seal and concrete projects. All projects are reviewed to ensure that the proposed project is the lowest life cycle cost alternative to meet the needs of the section. For all projects, prioritization takes into account three core principles of avoiding future liability, asset use and life cycle cost.

Avoiding Future Liability

If deferral of the activity results in a high certainty that will need more costly work, such as reconstruction, this is the highest priority. This also avoids having a section go into a deteriorated state that leaves the agency with two choices: worst first management or leaving a section in very poor state.

Having this as the highest priority puts the following activities as the highest priority: strategic maintenance (crack sealing, patching), chip seal conversions, and any project that reduces the near-term risk of needing reconstruction.

Asset Use

The next primary consideration is asset use. This is done by normalizing the life cycle cost by the annual truck use. While both life cycle cost and asset use are used in one

metric (dollars per lane mile year per truck), annual trucks have a dominating effect on this metric. This tends to prioritize projects based on functional class (Interstate, etc.), NHS status, and Freight and Goods Transportation System (FGTS) Classification (T1, T2, etc.).

Life Cycle Cost

As noted previously, each project is vetted to ensure that it is the lowest life cycle cost solution for the given section. However, there may not be funding to apply to all of these solutions. When two sections have similar asset use, sections that have the ability for a lower life cycle cost will be prioritized higher.

Trade-offs between the three investment areas are necessary as a singular prioritization of pavement projects is problematic to meet all performance expectations within available funding. For example, concrete projects may rarely prioritize well compared to asphalt projects. However, because concrete roadways are necessary for high volume or special consideration sections (such as mountain passes), it is necessary to devote some resources to this type of activity.

More recently, the need for a balanced, long-term approach related to concrete pavement preservation resulted in the development of a 30-year concrete preservation plan. This is necessary as concrete preservation is capitally intensive, and an unbalanced approach is likely to lead to short time periods requiring significant investment that would be difficult to fund and deliver.

By following these pavement investment strategies and leveraging a strong inventory of pavement asset condition, WSDOT has been able to strategically plan projects that maximize pavement condition within an environment of constrained resources.

Bridges

Bridge preservation investment areas take into consideration the condition and age of bridge components, which are then used to create several ten-year needs list. These needs are ranked based on condition, age and traffic levels. WSDOT regions across the state then use these ranked needs to scope and create projects.

Needs lists are grouped by activity and include:

- Replace or Major Rehabilitation,
- Expansion Joints,
- Concrete Decks,
- Bridge Painting,
- Scour,
- Miscellaneous Repair, and
- Moveable Bridge Repair.

Chapter 4 of the *Bridge Inspection Manual* provides detailed descriptions of bridge elements and how condition states are assigned during the inspection process.

Due to the risk associated with seismic activity within Washington state, seismic needs are identified separately from condition. Both a statewide seismic needs estimate and a subset of these called "seismic lifeline" have been defined. WSDOT is using the seismic retrofit funding identified by the Washington State Legislature to address seismic needs along the seismic lifeline. Additional information on WSDOT's Seismic Retrofit Program may be found within the Seismic Lifeline Routes folio.

Once the bridge needs have been identified, and the WSDOT regions have scoped the needs into projects, bridge project investments are prioritized based on four major investment areas, which include:

- Bridge Repairs,
- Bridge Replacement,
- Scour, and
- Seismic.

The dollar amount assigned to the different investment areas follow these general rules:

- Border bridges are highest priority. This is due to agreements between states to ensure that these bridges remain in acceptable condition; and
- Bridges with a high risk of scour are second priority. Scour failure is one of the highest risk factors for potential bridge collapse in Washington State.

Engineering judgement is used to categorize the remainder of the activities, primarily based on condition and an assessment of risk of failure. If funds are exhausted on bridges, or elements considered at risk for failure, the remaining funds are used based on a judgement of life cycle cost impact.

2017 Project Delivery Plan

The results from pavement and bridge prioritization are ultimately included as part of the larger Project Delivery Plan. WSDOT uses a long range, eight-year highway construction planning method to program investments in our transportation infrastructure. The *2017 Project Delivery Plan* represents a snapshot as of September 23, 2017 of our eight-year project specific plan for work to be delivered by the Department for state fiscal years 2018 through 2026.

Programming Framework

The Project Delivery Plan is based on the following assumptions and concepts:

- **Aligns with Legislative direction provided in the 2017 Transportation Appropriations Bill (*ESB 5096*)**
  This plan is consistent with budget proviso requirements; including some areas that the Legislature allows WSDOT discretion in selecting projects. The Delivery Plan is consistent with overall Legislative investment expectations.

- **Basis for WSDOT's 2018 Capital Improvement and Preservation Plan (*CIPP*) Supplemental Budget Submittal**
  The projects identified through the development of the eight-year plan are the basis for the Department's 2018 supplemental budget submittal, which also includes additional proposals in program and project delivery for Governor and Legislative consideration.

- **Provides intent for delivery**
  The plan supports the Federal Highway Administration's requirement for the state to program four years of projects in the *State Transportation Improvement Program* (*STIP*). By exceeding the STIP time-based requirements, the delivery plan provides an opportunity for improved communication and coordination with local governments. Specifically, it allows for improved planning and timing with regards to project delivery and mitigating traffic disruptions in corridors due to roadway construction.

- **Over-programming the Roadway Preservation (P1) program**
  The *Delivery Plan* includes over-programmed projects in anticipation of favorable bids, the continued receipt of federal funds redistribution, and as a strategy if projects are inadvertently delayed due to circumstances outside WSDOT's control. The Delivery Plan includes over $200 million in over-programming in federal fiscal years 2018 and 2019.

  Over-programming helps ensure we meet legislative delivery expectations and the use of the federal funds made available to Washington State, avoiding having funds redistributed back to other states. This approach also positions WSDOT to be eligible to receive unused funds from other states and/or federal programs.

Project Prioritization

The *2017 Project Delivery Plan* prioritizes projects based on a high benefit, low cost philosophy aimed at improving the operating efficiency of the system. As a result, projects included in the plan reflect an incremental, tiered approach to ensure every improvement builds upon previous work and that no work is wasted. This approach separates strategies into three investment tiers to be implemented incrementally to maximize every dollar invested.

The three tiers are:

1. Low-cost projects that deliver high return on capital investment and have short delivery schedules;
2. Moderate to higher-cost projects that provide additional benefits for both highways and local roads; and
3. Highest-cost projects that deliver long-term solutions and corridor-wide benefits.

Funding Targets

Target funding levels for sub-programs and associated project-category investment levels were based on direction from department's Executive Leadership Team (ELT) within the appropriations provided by the Legislature in the *2017-19 Biennium Budget*. Projects selected within the individual categories are based on priorities listed below with input from Subject Matter Experts (SMEs) for the various infrastructure assets. Investment tradeoff decisions were made by the Executive Leadership Team to align with legislative performance expectations. Project delivery schedules generally follow the priority of the project in the priority array; higher priority projects are scheduled to proceed before lower priority projects.

Washington State's 2018-2021 Statewide Transportation Improvement Program

The *State Transportation Improvement Plan* (STIP) is a multi-modal, four-year, prioritized program of federally funded transportation projects as well as regionally significant state and local transportation projects. The STIP identifies the multimodal strategic investments, developed through local, regional, and state partnerships. *Fixing America's Surface Transportation (FAST) Act* guides the policy and programmatic framework for investments to guide the growth and development of the country's vital transportation infrastructure along with creating a streamlined, performance based, and multimodal program to address the many challenges facing the U.S. transportation system. The FAST Act continues to promote the role of the Metropolitan Planning Organization (MPO) and requires that each designated MPO develop a Transportation Improvement Program (TIP), and the state to develop a Statewide Transportation Improvement Program.

Consistency with the Washington Transportation Plan (Phase 2, WTP 2035)

The STIP is consistent with the *Washington Transportation Plan* (WTP). The WTP is the federally compliant long-range statewide transportation plan first presented to the Governor and the state Legislature in November 2006. The WTP is a 20-year plan that outlines the service objectives and strategies for maintaining, operating, preserving, and improving the statewide transportation system. It also outlines a financial funding strategy that identifies the responsibilities for implementation and establishes needs for the system.

Federal Program Fund Source Requirements Drive the Statewide Investments in the STIP

For the *National Highway Performance Program* and *Highway Safety Improvement Program* funds, projects are selected by WSDOT based on asset performance condition (pavement and bridge) and *Target Zero* (zero deaths and fatal crashes by 2030) priorities in combination with the performance and economic improvement created by the project (by using life cycle cost and/or benefit cost analysis).

Community Engagement Is Integral To the STIP Process

MPOs coordinate with WSDOT in developing transportation plans, and programs for the urbanized areas consistent with the long-range statewide transportation plan (*2007-2026 Washington Transportation Plan* (WTP). In addition to the requirement for MPOs to address the federal planning factors, future transportation plans will need to address the national performance goals. All transportation plans in Washington must address the six transportation system policy goals in *RCW 47.04.280*.

Unfunded Priority List

To communicate proposed investments for consideration during legislative new revenue discussions, WSDOT has published an Unfunded Priority List in 2013 and 2015, and plans to produce another update to the list in 2018.

The 2015 list was built around several key assumptions:

- A majority of the projects reflect estimates and scopes of work based on minimal scoping efforts. As indicated in the 2010 Joint Legislative Audit and Review Committee report, "*WSDOT's Scoping and Estimating for Highway Projects*," significant clarity to scope and budget on projects is achieved through a project's design;
- This list builds on the assumptions reflected in the *Governor's 2015-17 budget request*;
- The list is not financially constrained and does not tie to any revenue scenario or financial plan;
- Estimated toll revenues are provided for informational purposes and do not reduce the expenditures incurred to deliver a project; and
- Only significant stand-alone mobility and economic initiative projects are specifically identified as line item projects. Maintenance, operations, safety, fish barrier removal and preservation are shown programmatically.

For the 2018 update, assumptions used to produce this list are based on the same life cycle planning strategies presented in *Chapter 4: Life Cycle Planning*. This allows WSDOT to clearly communicate with the Legislature additional funding needs to achieve and sustain a State of Good Repair.

CHAPTER 9
IMPLEMENTATION AND SYSTEMS

Washington state has a rich history of transportation asset management dating back to the early 1960s when RCW 47.05, *Priority Programming for Highway Development*, was first established. State Legislation established the first pavement condition monitoring that is continued by the agency today. RCW 47.05 was subsequently updated and provides the statutory framework for asset management. Additionally, WSDOT updated the budget structure for improved investment tracking of major work items. This was also a forward-looking asset management practice. An excellent summary of this history is in the Federal Highway Administration (FHWA) publication *Comprehensive Transportation Asset Management: The Washington State Experience*.

WSDOT strives for continuous improvement in its asset management implementation. Most recently, this resulted in a new organizational structure focused on statewide transportation asset management. This chapter focuses on the implementation of asset management including organizational alignment, assessments, and systems.

Note: Supplemental Information in the TAMP Technical Guide provides additional detail on WSDOT's self-assessment and ongoing research activities.

Organizational Alignment

WSDOT has realigned its organization to implement Practical Solutions and Asset Management. This is summarized in the Agency Overview section from *Chapter 1 - Introduction* and its corresponding chapter *Technical Guide*.

Currently, technical advisory groups and executive steering committees are formed and have been meeting since the summer and fall of 2017. However, the Highways Asset Management Technical Advisory Group (HAMTAG) has been meeting regularly since early mid-2016. Coordination across the groups is facilitated by the Statewide Asset Management Program. WSDOT's *Executive Order 1098* further defines roles and responsibilities in WSDOT.

Highway Asset Class Self-Assessment

In 2016, asset stewards that are part of the Highway Asset Management Technical Advisory Group (HAMTAG) conducted a self-assessment in order to help guide asset management activities. As part of a highway asset management system assessment, twelve assessment areas were identified and ranked on a scale of 1-5, with a rank of 1 representing no available information or direction and 5 representing complete information with strategies fully implemented. Further process description and detailed ranking criteria are presented in this chapter's corresponding *Technical Guide*. Over twenty different highway asset classes completed their assessment. Exhibit 9-1 shows the results grouped by Pavement and Bridge asset categories.

Results from WSDOT's self-assessment helped guide agency investments starting in the 2017-19 biennium by:

- Increasing funding to the pavement office to allow for full network chip seal rating and periodic multi-lane assessment; and
- Adding a full-time employee for bridge asset management to start implementing AASHTO BrM.

Exhibit 9-1: 2016 Self-Assessment Results for Pavement and Bridge Asset Classes.

Exhibit Note: Source is from WSDOT's Highway Asset Management Technical Advisory Group, 2016 Self-Assessment Summary. Methods and tools adapted from the NCHRP Project No. 08-90 August, 2015 Transportation Asset Management Gap Analysis Tool and August, 2014 User's Guide.

Improving Asset Management

Over the last several years, WSDOT has developed strategies to increase efficiency of our highway system, counteract the effects of economic shortfalls, and take actions to assess the state of asset management for highways. As a result of these strategies and assessments, and recognizing asset management is an evolving practice, WSDOT acknowledges opportunities for growth and continually looks for ways to improve our processes.

Joint Legislative Audit and Review[1] Committee Report - 2014

Through Engrossed Substitute Senate Bill 5024, the Legislature in the 2013-15 biennium directed the Joint Legislative Audit and Review Committee (JLARC) to review the methods and systems used by WSDOT to develop asset condition and maintenance service level needs and subsequent funding requests for highway preservation and maintenance programs. This culminated in a report provided in late 2014, with results summarized below, in Exhibit 9-2.

Exhibit 9-2: Assessment Results From JLARC Report, Provided Late Fall of 2014.

JLARC Assessment Topics What should a long-term bridge and pavement needs estimate include?	WSDOT's Capacity for Pavement	WSDOT's Capacity for Bridges
Expected asset deterioration.	Yes	Partial. Estimated for steel coating systems and short term concrete deck deterioration.
Expected effectiveness of maintenance and preservation work.	Yes	Partial. With a few exceptions, effectiveness of maintenance and preservation work not measured.
Investment options and predicted conditions based on different funding scenarios.	Yes	No. Predicted condition is not based on validated, quantitative analysis of bridge deterioration and the effectiveness of alternative treatments.
Investment recommendations based on life cycle cost analysis.	Yes	No
Risk	Yes	Partial
Bottom line	**Reliable.** Developed using industry best practices.	**JLARC's consultants could not verify accuracy.** Estimates were not developed using best practices. WSDOT's estimate may be: Low, because they do not estimate most future deterioration, and High, because estimates not based on life cycle cost analysis.

Exhibit Note: Source is from JLARC staff analysis of consultant's report.

[1] The Joint Legislative Audit and Review Committee (JLARC) carries out oversight, review, and evaluation of state-funded programs and activities on behalf of the Legislature and the citizens of Washington state. JLARC's statutory authority is established in RCW 44.28.

Results from this independent assessment have guided planned improvements, especially for bridge asset management. WSDOT is working to ensure stakeholder confidence in its cost estimates for both pavement and bridges by establishing a routine and consistent cost estimating process. Currently development work is underway to implement recommendations made in the 2014 JLARC report - see the following sections for *Pavement and Bridge Management Improvements* for more detail.

The following sections outline ongoing activities to improve our asset management practices. Each improvement described below is designed to either accomplish transportation goals at a lower cost, mitigate risk, or extend the asset service life for a given set of conditions.

Pavement Management Improvements

Refining Pavement Management

Washington's 2014 JLARC study found WSDOT could refine its pavement management practices by:

1. Giving greater consideration to preventive maintenance treatments for its hot mix asphalt and chip seal pavements that can be placed earlier in the life of the pavement to further extend service life and defer costly rehabilitation and reconstruction.

   Action: WSDOT is working to evaluate and implement additional pavement surfacing techniques. Please see this chapter's corresponding *Technical Guide* for the full scope of ongoing pavement research activities.

2. Including the cost of routine or reactive maintenance in WSDOT's life cycle cost analysis process. Although these maintenance costs are difficult to extract and are also relatively small (in comparison with other life cycle cost elements), they recommend it be included within the cost analysis.

   Action: WSDOT has been working to develop new tracking software and procedures to incorporate routine maintenance costs, see below sections *Pavement Research* and *Improved Tools to Optimize Asset Management* for more detail.

Bridge Management Improvements

Refining Bridge Management

Washington's 2014 JLARC study determined WSDOT meets or exceeds industry standards in its collection of bridge inventory and condition data. The accuracy of its bridge data means WSDOT has a strong foundation upon which it can build. JLARC found WSDOT could refine its bridge management practices by:

1. Improving estimation of projected long-term bridge maintenance and preservation needs and ensuring management results in the lowest life cycle costs by considering risk in project prioritization.

   Action: WSDOT is currently reviewing a draft instructional letter detailing a policy for strategically managing bridge structures. The instructional letter will then become a part of the agency-wide asset management and plan.

2. Improving need projections with stronger analytical systems and capability. Projections about the impact of funding reductions on bridge conditions reflect the professional judgment of WSDOT staff.

   Action: WSDOT has been working to develop new tracking software and procedures to incorporate all lifecycle costs and make future condition and need projections. Please see this chapter's corresponding *Bridge Research* section of the *Technical Guide* for the full scope of ongoing research activities and below in the *Improved Tools to Optimize Asset Management* section for more detail.

Asset Management Systems

This section provides an overview of the software and information that support transportation asset management. Descriptions that follow include:

- A history of pavement and bridge management systems at WSDOT,
- Provide an overview of complying with MAP-21 requirements for pavement and bridge management systems,
- Processes for obtaining necessary data from other NHS owners, and
- System improvements to optimize asset management.

Pavement Management System

WSDOT developed its first pavement management system in coordination with an FHWA grant in the late 1970s. WSDOT has improved upon this initial mainframe application, but many of the concepts and ideas that were included are still in use today. The current version of the Washington State Pavement Management System (WSPMS) is a web-based intranet application called WebWSPMS.

As shown by the results from the Highway Class Self-Assessment, and confirmed by the JLARC report from 2014, WSDOT's pavement management system meets and exceeds the requirements for developing and operating a pavement management system. More in-depth information about frequency of condition collection, deterioration models, budget needs, and strategies are in the document *Pavement Asset Management*.

Bridge Management System

Washington state is required by 23 CFR 650.315 to maintain an inventory of all bridges (structures) subject to the National Bridge Inspection Standards (NBIS), from which selected data is reported to FHWA as requested for entry into the National Bridge Inventory (NBI). The Washington State Bridge Inventory System (WSBIS) is maintained to meet this and other federal requirements and is updated daily as bridge inspection information is processed. Bridge element level data is stored in WSBIS and an effort is currently under way to translate the element level data into Bridge Management Software (BrM). More information on WSBIS is located on page 2-4, section 2-3 of WSDOT's *Bridge Inspection Manual*. Both state and locally owned bridges on the NHS are included in WSBIS. Additionally, WSDOT has developed an internal web application called the Bridge Engineering Information System (BEISt). BEISt accesses data from WSBIS along with plans, inspection reports, photographs, and related files for bridge structures in the WSDOT bridge inventory.

Highway Activities Tracking System

The Highway Activities Tracking System (HATS), a tool designed to support staff in documenting maintenance activities and maintaining asset inventory, has become integral in many maintenance tasks. Maintenance personnel can access HATS at the worksite via tablets and record information about field work as it is completed in real time. As the use of HATS is refined and employees become comfortable and proficient with the system, data entry times decrease, making WSDOT more effective and efficient at tracking maintenance activities.

Decision Lens

WSDOT has purchased and is currently customizing a software package called Decision Lens. Decision Lens is a priority and resource optimization software used to aid decision making in capital planning and budget processes. This software can be used for identifying, prioritizing, analyzing, and measuring which investments, projects, or resources will deliver the highest returns to an organization. With this tool, WSDOT will be able to see the impact and trade-offs of choices made between different investment options.

Decision Lens uses an Analytic Hierarchy Process (AHP), which is a structured technique for organizing and analyzing complex decisions based on mathematics and psychology. The elements of the hierarchy can relate to any aspect of the decision problem; tangible or intangible, carefully measured or roughly estimated, well or poorly understood. Decision makers at WSDOT can use concrete data about the elements, but they typically use their judgment to vote on an element's relative meaning and importance. Through pairwise comparisons, a numerical weight or priority is derived for each element of the hierarchy. For example, transportation elements in the hierarchy could be safety, congestion reduction, and environmental sustainability. Finally, numerical priorities are calculated for each of the decision alternatives.

Other Systems Related to Asset Management

There are several other systems WSDOT uses to manage assets. These include:

- **Capital Program Management System (CPMS)** - CPMS is the primary tool WSDOT utilizes to establish, monitor, and deliver the statewide Highway Capital Construction Program;
- **Transportation Executive Information System (TEIS)** – TEIS provides data to managers at WSDOT and the Office of Financial Management for the process of planning and executing the agency's capital projects program;
- **GIS** – WSDOT has developed several data sets available in a GIS format. This data is made readily accessible to agency personnel via ESRI software via an extension called the GIS Workbench and also by leveraging ArcGIS Online platform to develop custom web applications; and
- **Other Management Systems** – WSDOT has custom management systems for other assets including Unstable Slopes, Signals, Signs, and Fish Passages.

Improved Tools to Optimize Asset Management

Add Other Asset Information into WebWSPMS

Starting in 2017, the Capital Program Development and Management (CPDM) Office has partnered with the Pavement Office to integrate all types of agency asset data into the WebWSPMS platform. This provides WSDOT with a solution for certain asset management analyses, primarily to provide a project or route-based assessment of many different kinds of preservation and performance needs within a corridor.

WebWSPMS is a unique tool that allows for an in-depth analysis of a segment. This integration is intended to improve the efficiency and effectiveness for scoping and reviewing all types of asset needs, while providing additional benefits to ease cross-asset opportunities. See Exhibit 9-3 for an example of how the WSPMS Segment Viewer helps WSDOT to visualize cross-asset needs relative to planned projects and other information such as roadway configuration, jurisdictions, traffic, speed limits, etc.

Exhibit 9-3: **Screenshot from WebWSPMS.**

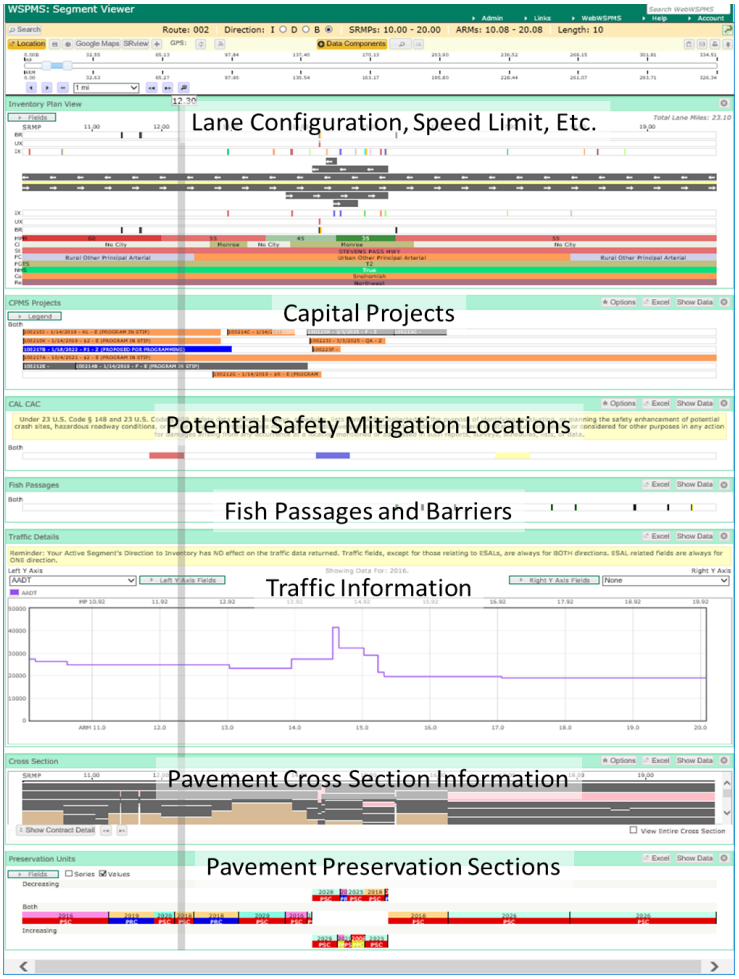


Exhibit Note: Includes Data Components for - Safety, Lane Configuration, Potential Safety Mitigation Locations, Fish Passages and Barriers, and other information; and includes over 40 different data components exist for different analysis.

Create GIS Asset Management Web Application

While WSDOT has a long history of using GIS as a key analysis tool, to extend the utility of this information, a GIS web application specifically for asset management (shown below in Exhibit 9-4) is currently in the testing portion of the system development phase. It is expected to be available for general use in early 2018. Current layers include:

- Pavement preservation needs from the WSPMS,
- Bridge preservation needs from the Bridge Management Office,
- Fish Passages and Barriers,
- Unstable Slopes,

- Geographic boundaries including Legislative Districts, MPOs/RTPOs, Counties and WSDOT Regions, and
- Projects from the CPMS system.

WSDOT is evaluating initial business needs to leverage GIS and asset management including:

- Opportunities to most cost-effectively address asset needs within a corridor by coordinating and communicating across technical specialists. In other words, provide information for decision makers in regards to bundling work for cost and construction efficiencies;
- A review of the coverage of proposed or programmed work relative to asset needs; and
- Summarize asset management information by geographic area based on common information requests.

Exhibit 9-4: Screenshot of GIS Asset Management Web Application.

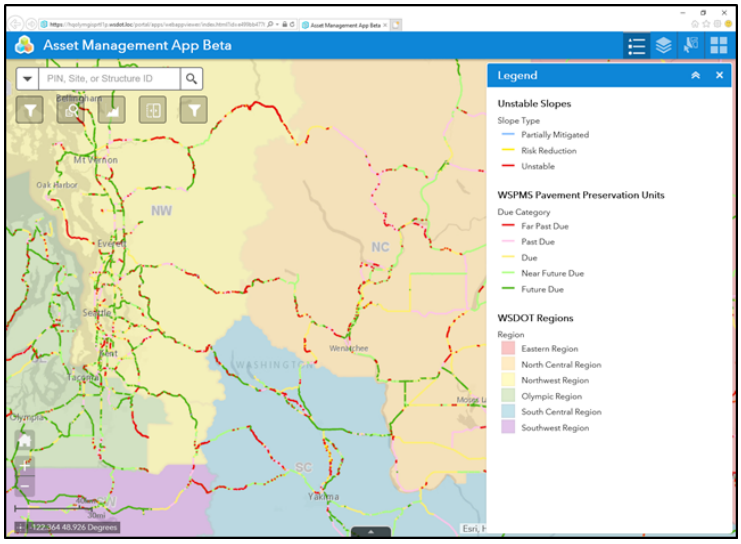


Exhibit Note: Image generated on January 25, 2018 through GIS Asset Management application created by WSDOT's CPDM office.

Address Bridge Recommendations from the 2014 JLARC Study

One of the major gaps from a bridge management system perspective is the lack of deterioration models. This was noted as part of the JLARC study from 2014. The Bridge and Structures Office developed a two-step approach to address this gap. First, an age-based assessment of need was implemented in Microsoft Access to analyze and communicate the 10-year bridge preservation needs. The results of this analysis were included in agency scoping processes and also communicated in the *Gray Notebook 62*. Second, a research project was commissioned to study and recommend a bridge asset management system, the recommendation of which is described the following section.

Implement AASHTO Bridge Management Software (BrM)

One of the major improvements planned for bridge management is the analysis and assumed implementation of AASHTO's Bridge Management Software (BrM). This decision was reviewed and recommended by a research project led by Dye Management Group, Inc., which analyzed several asset management software solutions to meet WSDOT's business needs. At the time of this writing, WSDOT has procured the BrM software and hired an employee in the Bridge office to manage the data flow and assumptions needed to fully implement the deterioration models in BrM.

Strengthen the Relation between Assets and Transportation Projects

WSDOT's systems for creating and managing capital projects were not initially designed to relate specific assets to projects. In 2018, WSDOT is implementing improvements to the TEIS software to track specific assets and activities within a transportation project. This will ease the analysis as multiple transportation assets are often preserved or improved within a single transportation project.

Increase HATS Functionality

WSDOT's Maintenance Office is working to expand its management system (HATS) capabilities compared to the previous maintenance tracking system, including improved accuracy and details for performance management data, as well as resources needed for task completion. The data collected is building a strong information baseline which can be leveraged by maintenance program managers to create more efficient and effective maintenance strategies. By better understanding the current condition of highway assets and the impact maintenance has on the network, program managers will be better equipped to target maintenance activities where they are most needed. Future progress will be reported in the spring of 2018.

Implement Use of Priority and Resource Optimization Software

WSDOT plans to use Decision Lens for prioritizing the various subcategories of the transportation Improvement and Preservation capital programs, using the AHP process to judge their relative importance in the budget. CPDM also plans to apply Decision Lens to capital program subcategories that have extensive engineering data available to determine priorities within that subcategory on a project-by project basis.

Extending Systems to All of the NHS

The systems listed in the previous section apply to state owned assets. However, it is important that this functionality is extendable to include all NHS assets, as required by MAP-21. This section details how WSDOT, MPOs, and local agencies are working together to manage data related to all of the NHS and comply with these pavement and bridge management system requirements.

Process for Obtaining Data from Other NHS Owners

WSDOT is using two approaches to obtain data from other NHS Owners. First, the existing data frameworks that are in-place for the Highway Performance Monitoring System (HPMS) and National Bridge Inventory (NBI) are leveraged. Second, beginning in 2015 WSDOT established a framework for working

Exhibit 9-5: **Pavement Condition Survey of Local Agencies with NHS Miles.**

Purpose: The National Highway System (NHS) is a federally designated system of roads in the U.S. that incorporates the Interstate Highway System, Principal Arterials, roads important to the Nation's defense, major network connectors, and intermodal connectors. This survey relates to roads in your agency that are on the NHS.

Question No.	Questions	Local Agency Response
1	Are you aware of road sections in your jurisdiction that are officially designated as part of the National Highway System (NHS)?	
2	Do you manage NHS road segments any differently than other parts of your local agency network?	
3	Are you aware that certain types of federal funding may be available for preservation of the NHS segments in your jurisdiction?	
4	What inventory / construction records do you have for roads that are classified as NHS?	
5	For *all* of your arterials and major connectors (not just NHS):	
a)	What typical pavement rehabilitation treatments do you use (e.g. overlay, mill and fill, etc.)?	
b)	How much do they typically cost ($/lane-mile of $/ Square Yard)?	
c)	On average, how long do they typically last until the next rehabilitation?	
6	For *all* of your arterials and major connectors (not just NHS):	
a)	How much does a typical reconstruction project cost ($/ lane-mile of $/Square Yard)?	
b)	How long do reconstructed pavements typically last until a rehabilitation is needed?	

Exhibit Note: Source is from the November, 2017 MAP-21 Pavement and Bridge Technical Committee Meeting presentation.

with MPOs and local agencies through quarterly meetings of the Pavement and Bridge Technical Committee. This committee establishes the data flow and needs to comply with MAP-21 requirements. One example of this process is the survey (shown in Exhibit 9-5) related to life cycle planning and other information about how local agencies manage the NHS, which will be used to implement pavement management system requirements.

Pavements on the NHS

WSDOT manages the inventory of, and collects condition for, all pavements that are on the NHS. This is reported annually as part of the HPMS requirements. This meets part (a) of 23 CFR part 515.17, and will serve as the foundation for developing pavement management system for all of the NHS.

Planned Improvement: Further Leverage HPMS to Meet Pavement Management System Requirements

WSDOT has proposed to build on the information in HPMS by working with MPOs and local agencies while using its own pavement management processes to develop a pavement management system that meets all requirements. Through the Pavement and Bridge Technical Committee, MPO's will be able to provide input on processes such as parametric unit costs and lifecycle management practices for the locally owned sections of NHS routes that will be incorporated into HPMS.

Bridges on the NHS

As stated previously, local agency bridge information is already standardized into WSBIS and reported as part of the National Bridge Inventory (NBI) standards. This meets the inventory and condition requirements. When WSDOT is able to implement AASHTOWare BrM, the plan is to import data for local agency NHS bridges as well and leverage BrM (containing both NBI and bridge element level data) to meet the remaining requirements for a bridge management system that will assist in identifying and managing our bridge needs and condition forecasts.