WSDOT

TAMP

Transportation Asset Management Plan

June 2022

Roger Millar, PE, FASCE, FAICP
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

We are pleased to present you with the Washington State Department of Transportation's (WSDOT) 2022 Transportation Asset Management Plan (TAMP). This TAMP outlines our asset management practices by providing an in-depth look at how we maintain and preserve our bridge and pavement assets within a limited budget. It also communicates the anticipated condition of our bridge and pavement assets across the statewide network over a 10-year period as well as how we and our partners are proactively addressing risks to maximize performance within existing resources.

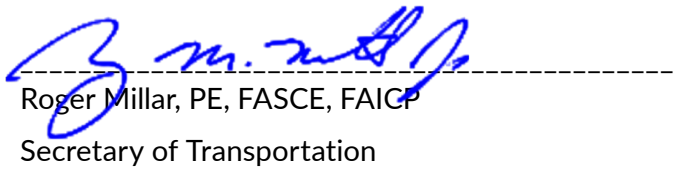
Currently, Washington's transportation system sustains more than 7.7 million people and is estimated to handle almost 603 million tons of cargo annually, worth $707 billion, of which about 57% is moved by trucks. Washington has 5.9 million licensed drivers and more than 8.2 million registered vehicles. To meet these needs, WSDOT manages over 18,600 lane-miles of state highway and more than 4,100 bridges, which includes the world's three longest floating bridges, carrying more than half of all vehicle traffic in the state. We also manage the largest vehicle-ferry system in the U.S., with 21 active vessels moving more than 24 million passengers per year. 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 continues to experience significant growth, placing an increased strain on our aging infrastructure along with an added desire for capacity. Recognizing funding is a finite resource, asset management is a critical practice to ensure WSDOT's investments return the highest amount of benefit at the least amount of cost. Asset management is a fundamental concept which balances investments to achieve and sustain a State of Good Repair for our existing transportation network.

As mentioned throughout the TAMP, the Washington state Legislature passed the Move Ahead Washington transportation revenue package. This revenue package is nearly $17 billion and provides an initial $3 billion investment for preserving and maintaining WSDOT's assets. WSDOT is working to understand the details of this revenue package and the impacts to keeping our pavements and bridges in a State of Good Repair. These details will be incorporated into future TAMPs.

While WSDOT continues to make improvements that build upon a solid foundation of asset management practices, there are additional opportunities for improvement. WSDOT will collaborate with our transportation partners and seek for more effective integration of asset management strategies and how those strategies align with related planning efforts, working towards the long-term goal of an integrated and sustainable transportation network. As required by the Infrastructure Investment and Jobs Act/Bipartisan Infrastructure Law (IIJA/BIL), WSDOT also includes our current efforts to consider extreme weather and resilience in its lifecycle planning and risk analyses for pavement and bridges.

Asset management has been, and will continue to be, a foundational piece of how we and our partners, manage our transportation network. Taking risk, resilience and extreme weather into consideration, this TAMP demonstrates how we maintain our network, prioritize and invest in our capital projects, and communicates the significant funding need for our bridge and pavement assets. 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.



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Washington State Department of Transportation

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 summary of asset management improvements developed since the submission of the initial TAMP.
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 – Life Cycle Planning	Explains WSDOT's asset specific life cycle processes to maximize asset life and condition at the lowest practicable cost.
Chapter 5 – Risk Management & Resiliency	Provides results of WSDOT's bridge and pavement risk workshops and results of the 23 CFR 667 study that requires states to evaluate facilities repeatedly damaged as a result of emergency events.
Chapter 6 – Revenue and Financials	Summarizes WSDOT's financial sources and uses and aligns planned expenditures to bridge and pavement asset needs. Also provides investments activity levels and an estimated replacement value for bridge and pavement assets.
Chapter 7 – Performance Scenarios	Provides results of bridge and pavement condition modeling over the 10-year plan period and evaluates asset management planning with other WSDOT planning efforts.
Chapter 8 – Investment Strategies	Aligns asset specific investment strategies within anticipated funding levels to various WSDOT plans and communicates how asset management informs our capital plans.

TITLE VI, ADA, AND FURTHER INFORMATION

Title VI Notice to Public

It is the Washington State Department of Transportation's (WSDOT) policy to assure that no person shall, on the grounds of race, color, or national origin, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equal Opportunity (OEO). For additional information regarding Title VI complaint procedures and/or information regarding our non-discrimination obligations, please contact OEO's Title VI Coordinator at (360) 705-7090.

Americans with Disabilities Act (ADA) Information

This material can be made available in an alternate format by emailing the Office of Equal Opportunity at wsdotada@wsdot.wa.gov or by calling toll free, 855-362-4ADA (4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711.

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.

WSDOT received a $16.7 billion revenue package from the Washington state Legislature during the 2022 Legislative Session. This package includes investments targeted to preserve and maintain the state's transportation system. The details of this revenue package are still being worked out to include the timing of funding provided to the Pavement and Bridge Programs. As these details are finalized, WSDOT will assess the magnitude of the changes the TAMP will work with our federal partners to determine if an update is necessary.

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, which is WSDOT's policy framework approach to managing the entire transportation system's physical assets. This is done on an ongoing, systematic basis from both a condition and system performance perspective.

The Transportation Asset Management Plan (TAMP) aligns with international standards, and federal directives, and lays the foundation for asset management at WSDOT. This TAMP's primary purpose is to establish and communicate WSDOT's asset management process and organizational framework as part of the National Highway System (NHS). Only pavements and bridges are included in this TAMP. Additionally, results from processes such as gap analysis, trade-off comparisons, life cycle planning, and risk management are included. To develop the TAMP, WSDOT worked with both internal and external stakeholders to develop a shared vision and understanding of asset management and how asset management informs and influences the types of projects across the transportation network.

The TAMP also aligns asset management practices with a strategic way of prioritizing projects, incorporating asset performance scenarios, performance measures, and trade-off analysis. This allows 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.

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 and Sustainable Safety strategies.
- Transportation system management.
- Demand management.
- 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, benefits, and risks 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.

WSDOT is in the process of updating its Strategic Plan goals. This update will likely transition Practical Solutions from a strategic plan goal to a core principle of the agency that is important to WSDOT but not included in the Strategic Plan. Asset Management will remain a critical element of Practical Solutions. With this update, WSDOT is exploring the addition of Resilience as one of its Strategic Plan goals.

Exhibit 1-1 provides an overview of WSDOT's Practical Solutions' framework and presents a general life cycle delivery diagram of the agency's business processes.

Organizational Alignment

WSDOT established a necessary organizational framework, guided by Practical Solutions, for implementation of asset management for two main goals: as a means of managing assets and as a cultural shift within the agency (see Exhibit 1-2). 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 for executive oversight:

- Ferries
- Highways
- Intra-Agency (Facilities, Information Technology, Real Estate, Transportation Equipment Fund)
- Multimodal (Aviation, Public Transportation, Rail)

Exhibit 1-1: WSDOT Practical Solutions Life Cycle

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

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

- 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.
- Providing an interface between broad agency-wide initiatives and asset management analyses and processes.

Each major asset category has an executive steering committee, a 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 and generally support the Asset Stewards. 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.

TAMP Content

WSDOT's TAMP focuses on all state-owned pavement and bridge assets. The TAMP meets minimum NHS pavement and bridge asset system requirements under MAP-21 while also including 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.

Exhibit 1-2: WSDOT Organizational Framework for Asset Management

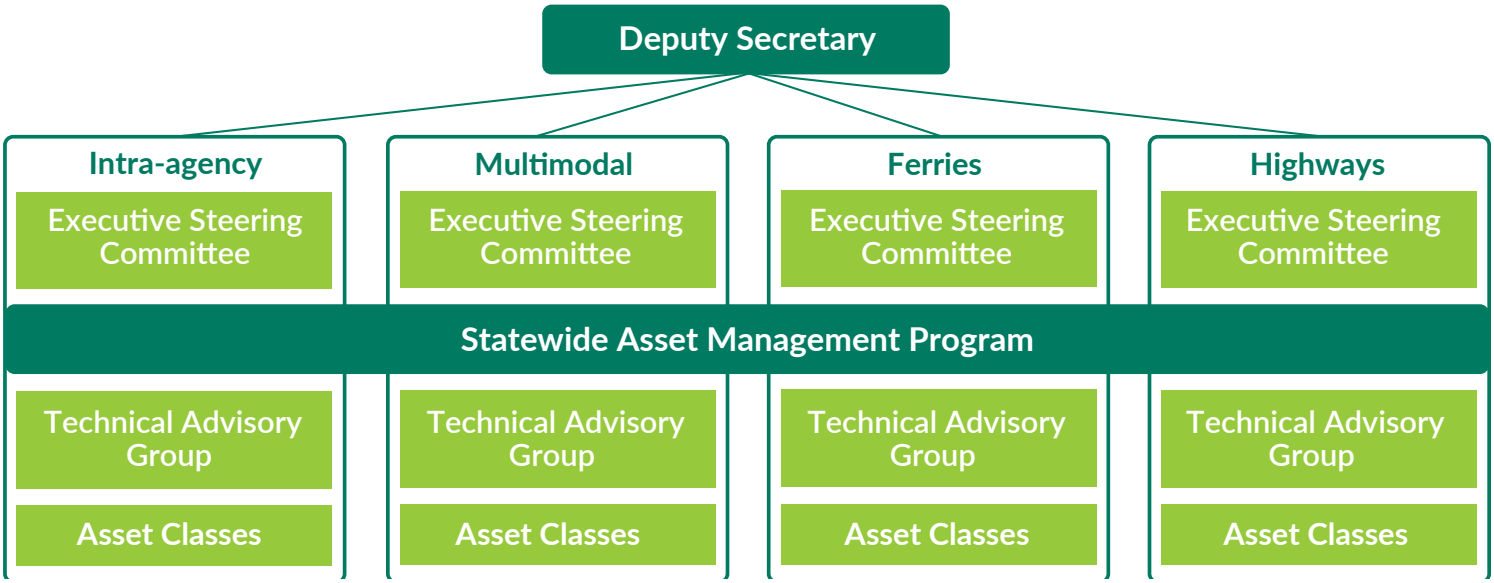


Exhibit Note: Source descriptions are from WSDOT's *Executive Order 1098 – Statewide Transportation Asset Management*.

A state asset management plan must cover, at a minimum, a 10-year period and be in a form 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.
- Incorporates extreme weather and resilience into the lifecycle planning and risk management analyses.
- A 10-year financial plan.
- Investment strategies.

This TAMP serves as a guide for how the organization as a whole will manage its assets and document our best management practices. Descriptions of the TAMP chapter content are reflected in Exhibit 1-3. The 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.
- Gaps between capital investment decisions and budgeting activities for operations and maintenance.
- Data needs and processes or systems to manage the data for each asset.

If the processes or practices referenced above do not exist or are under development, mention will be made as to the development effort or actions that need to occur to develop those processes or practices.

Exhibit 1-3: TAMP Chapter Overviews

Chapter	Description
Objectives and Measures	State transportation asset management goals, Implementing Federal requirements; measures used to track and manage performance and describes how measures support overall goals and objectives; MPO and Local Agency engagement progress.
Asset Inventory and Condition	Description of Washington's NHS; inspection processes, management system descriptions, asset inventory and condition assessments; asset descriptions (e.g. age, materials, components, quantities, location/extent, age, and replacement value); and condition assessments (e.g. methods, rating criteria, performance targets, trends, and gaps).
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 improvements to life cycle planning.
Risk Management and Resiliency	Description of approach to risk management; federal requirements impacting aspects of risk management; risk management strategies; TAMP risk assessment results and risk treatment planning (e.g. Risk summaries for pavement and bridge assets and results of risk planning for assets repeatedly damaged by emergency events).
Revenue and Financials	Description of how the legislative process informs funding levels at WSDOT; 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	Description of cross-asset resource allocation framework; performance scenario tools, analysis, and results; considerations, process, and results for performance gap analysis (e.g. target and planned based).
Investment Strategies	Description of asset prioritization and investment; project delivery planning; and statewide transportation improvement program planning.
Appendices (A to G)	Supporting comprehensive detail includes the TAMP Requirements Matrix, Initial TAMP Process Certification document, Pavement Target Setting process document, Local Engagement Business Plan, Pavement and Bridge Risk Register, 23 CFR 667 Analysis of Recurring Emergency Events, and an FHWA Work Activities to WSDOT Improvement Codes Crosswalk.

CHAPTER 2
OBJECTIVES AND MEASURES

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** - Lower crash potential across the transportation system, 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

State Transportation 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 statutes define 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. In 2021, the Washington State Legislature amended RCW 47.04.280 to put Preservation and Safety as priorities.

WSDOT's asset management process is also closely tied to Washington's Long Range Transportation Plan: 2040 & Beyond. The four policies in the Long Range Plan that support the statewide preservation goals are:

1. Make preservation and asset management of the existing state and local transportation network a funding priority and work to reduce the backlog of deferred infrastructure maintenance.Support optimal asset management strategies
2. Support optimal asset management strategies that keep life-cycle costs as low as possible, including pavement and bridge preservation, ferry vessels and terminal infrastructure preservation, transit system and infrastructure preservation, and technology infrastructure supporting traffic management and operations systems.
3. Promote systemic and cost-effective preservation of essential infrastructure outside the control of local or state transportation agencies, such as river locks and barges, marine terminals, railroads and trestles, and airports.
4. Work to eliminate activities or practices that reduce the integrity of the existing transportation system or which increase life-cycle costs.

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, pavement and bridge conditions, emissions, and system performance (congestion), 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.*

WSDOT MAP-21 Enterprise-level Asset Management Objectives

WSDOT's system-wide Enterprise-level 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

WSDOT is using the MAP-21 condition assessment to assign whether or not a specific asset is in a State of Good Repair (SOGR). 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 Network-level targets for condition in order for the network to achieve a State of Good Repair. Targets for network condition have been set using a Target Setting Framework, described later in this chapter and shown in Exhibit 2-2. Additional information on good, fair, and poor condition measures are included in *Chapter 3: Inventory and Condition*.

WSDOT MAP-21 Network-level Pavement Objectives, Performance Measures, and Targets

WSDOT's pavement Network-level asset management objectives are to:

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

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 two approaches are currently used to meet differing requirements:

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

While these 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. The Interstate Target is set based on the penalty provision in 23 CFR Part 490.317.

WSDOT MAP-21 Network-level Bridge Objectives, Performance Measures, and Targets

WSDOT's bridge Network-level asset management objectives are to:

- Design and preserve resilient structures;
- Minimize the number of load posted or load restricted bridges;
- Minimize the number of bridges in poor condition; and
- Minimize the number of bridge closures due to condition.

WSDOT designs its bridges for 75-year life and to not collapse following 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 2-1 summarizes bridge performance measures and targets related to condition.

Exhibit 2-1: WSDOT Asset Management Integration with National Goals and Performance Management Measures for System Performance[1]

WSDOT MAP-21 *Enterprise-level* Asset Mgmnt. Objectives	**MAP-21 Asset Management Objectives:** • Achieve and sustain a State of Good Repair for transportation assets. • Reduce the vulnerability and increase the resilience of critical infrastructure to the impacts of extreme weather and events.						
WSDOT MAP-21 *Network-level* Asset Class Objectives	**Pavement MAP-21 Asset Objectives:** • Design and preserve long-life pavement structures. • Minimize the number of pavement lane miles in poor condition.				**Bridge MAP-21 Asset Objectives:** • Design and preserve resilient structures. • Minimize the number of load posted or load restricted bridges. • Minimize the number of bridges in poor condition. • Minimize the number of bridge closures due to condition.		
WSDOT Asset Management **WSDOT MAP-21 *Network-level* SOGR Targets**	**1.** % of Interstate NHS Pavements in Good condition.[6] **SOGR Targets** 2-yr: N/A 4-yr: 30%	**2.** Percent of Interstate Pavement on the NHS in Poor condition.[6] **SOGR Targets** 2-yr: N/A 4-yr: 4%	**3.** Percent of non-Interstate Pavement on the NHS in Good condition.[6] **SOGR Targets** 2-yr: 45% 4-yr: 18%	**4.** Percent of non-Interstate Pavement on the NHS in Poor condition.[6] **SOGR Targets** 2-yr: 21% 4-yr: 5%	**1.** Percent of NHS Bridges classified in Good condition.[5,6] **SOGR Targets** 2-yr: 30% 4-yr: 30%	**2.** Percent of NHS Bridges classified in Poor condition.[5,6] **SOGR Targets** 2-yr: 10% 4-yr: 10%	
National Goals & Performance Measures **23 CFR Part 490 *National Performance Management Measures***	**1.** % of Interstate NHS Pavements in Good condition.[2,4]	**2.** % of Interstate NHS Pavements in Poor condition shall not exceed 5%.[2,4]	**3.** % of non-Interstate NHS Pavements in Good condition.[2,4]	**4.** % of non-Interstate NHS Pavements in Poor condition.[2,4]	**1.** % of NHS Bridges in Good condition.[4,5]	**2.** % of NHS Bridges in Poor condition does not exceed 10%.[4,5]	
23 U.S. Code § 150 *NHPP Measures*	**I.** Condition of Pavements on the Interstate National Highway System.[3]		**II.** Condition of Pavements on the National Highway System (excluding the Interstate).[3]		**III.** Condition of Bridges on the National Highway System.[3]		
23 U.S. Code § 150 *National Goal*	**#2 Infrastructure Condition:** To maintain the highway infrastructure asset system in a state of good repair.[3]						

Exhibit Notes:

[1] Source is from: WSDOT Bridge and Structures Office and WSDOT Pavement Office, for use in the December 2021, *Gray Notebook Edition 84*.

[2] Measured in lane-miles.

[3] Final Rule on "National goals and performance management measures": United States Code, 2017 Edition, Title 23 - HIGHWAYS CHAPTER 1 - FEDERAL-AID HIGHWAYS, Sec. 150 - *National Goals and Performance Management Measures*.

[4] Final Rule on "National Performance Management Measures; *Assessing Pavement Condition for the National Highway Performance Program and Bridge Condition for the National Highway Performance Program*": Docket No. FHWA-2013-0053, RIN 2125-AF53, Federal Register - Vol. 82, No. 11, Pg. 5886- January 18, 2017.

[5] Weighted by deck area.

[6] Two-year and four-year target periods for PM2 end October 1, 2020, and October 1, 2022.

Implementing 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 performance based, 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 tracking how federal transportation investments meet the *National Goals and Performance Management Measures* (23 USC § 150(b)) of the system, as established by Congress. National goals are similar to state goals (RCW 47.04.280). Specific NHS performance management requirements for pavement and bridge assets are found in 23 CFR § 490 *National Performance Management Measures*. The *National Highway Performance Program* (NHPP) requires metropolitan planning organizations (MPOs) and states (WSDOT) to develop either joint or separate performance programs as established under 23 USC § 134 and 135 for *Metropolitan Transportation Planning* as well as, *Statewide and Nonmetropolitan Transportation Planning*.

In addition, the *Asset Management Plans* 23 CFR § 515 rule requires each state department of transportation to develop a risk-based Transportation Asset Management Plan (TAMP) for the National Highway System (NHS) and include analysis results for *Periodic Evaluation Of Facilities Repeatedly Requiring Repair And Reconstruction Due To Emergency Events* as specified in 23 CFR § 667. Required emergency event analyses are tied directly to the federal *Emergency Relief Program* 23 CFR § 668 and are intended to conserve Federal resources and protect public safety by determining if reasonable alternatives exist to roads, highways, or bridges that repeatedly require repair and reconstruction activities.

Reasonable alternatives are defined by 23 CFR § 667.3 as:

> *...Reasonable alternatives include options that could partially or fully achieve the following:*
>
> 1. Reduce the need for Federal funds to be expended on emergency repair and reconstruction activities;
> 2. Better protect public safety and health and the human and natural environment; and
> 3. Meet transportation needs as described in the relevant and applicable Federal, State, local, and tribal plans and programs. Relevant and applicable plans and programs include the Long-Range Statewide Transportation Plan, Statewide Transportation Improvement Program (STIP), Metropolitan Transportation Plan(s), and Transportation Improvement Program(s) (TIP) that are developed under part 450 of this title.

Most importantly, rulemaking for *Asset Management Plans and Periodic Evaluations of Facilities Repeatedly Requiring Repair and Reconstruction Due to Emergency Events* and *Statewide and Nonmetropolitan Transportation Planning; Metropolitan Transportation Planning*, focus on integrating transportation planning, performance, and asset management functions. Transportation planning rules for *Planning Assistance and Standards* contained in 23 CFR § 450, are intended to implement the provisions of 23 USC § 134, 23 USC § 135, 23 USC § 150, 49 USC § 5304, 49 CFR § 613 and closely links transportation planning to the NEPA process 42 USC § 4321et seq, 23 CFR § 771, and 23 CFR § 774.

Infrastructure Investment and Jobs Act (IIJA)

The current authorization act, the Bipartisan Infrastructure Law (BIL), enacted as the Infrastructure Investment and Jobs Act (IIJA) was signed in mid-November. The BIL will provide over $1 trillion in funding over five years (2022-2026). For Washington specifically, that means an approximate increase of $1.6 billion in federal funding over the five years of the new act from what the FAST Act provided. The IIJA is the largest federal spending package in history aimed at improving U.S. roadways, bridges, ports, and other transportation infrastructure.

Through the act, funding is being provided on a nationwide level to fix roads and bridges, build out a nationwide electric vehicle charging (EV) infrastructure, improve ports and waterways, fund public transit, boost freight and passenger rail, improve airports, and boost broadband internet

Specific to Asset Management, the IIJA requires state DOTs to consider extreme weather and resilience in their lifecycle cost and risk management analyses for the TAMP.

Metropolitan Planning Organizations and Local Agency Engagement

MAP-21 requires both state DOT's and Metropolitan Planning Organizations (MPOs) to set performance targets and requires collaboration among these responsible agencies to develop local agency NHS needs. State DOTs were required to establish pavement, bridge, system performance, freight, and emissions targets by May 20, 2018. MPOs then had an additional 180 days to either agree to support the state targets or establish separate quantifiable targets. WSDOT reported progress toward these targest in 2018 and 2020. WSDOT is not planning to change the targets that were set in 2018 for the next reporting period. Exhibit 2-2 summarizes progress on MAP-21 asset management implementation activities.

Although WSDOT and Washington state MPOs each had individual responsibilities to take action setting targets, the agencies worked to establish a framework for collaboration in the target setting process. For more complete descriptions of the organizational structure used to facilitate collaborative process, see WSDOT's MAP-21 Collaboration Folio. The folio includes details for the *Target Setting Framework Group*, *Target Setting Working Group*, and *Target Setting Technical Teams* as shown in Exhibit 2-3.

Following sections describe related activities to WSDOT's target setting requirements, developing local agency NHS needs, and analysis required for 23 CFR § 667, *Assets Repeatedly Damaged by Emergency Events*. As mentioned throughout this TAMP, resource limitations related to the global pandemic and other state-level matters have precluded our ability to complete several of the commitments outlined in WSDOT's 2019 TAMP.

Exhibit 2-2: Asset Management Implementation Progress

Activity	Due By	Progress
Determining Local NHS Pavement and Bridge Needs Through MPO Engagement.[1]	**6/30/2022**	**Work is ongoing, see below for work completed through 6/30/2022.**
Local Agency engagement on implementing Federal requirements.	Ongoing Activity	Progress reported in WSDOT's fully compliant TAMP required to be submitted by 6/30/2019.
• WSDOT presentation to the *MPO/RTPO Coordinating Committee* quarterly meeting on: - Update on TAMP progress, - CFRs - Planning's relationship to Asset and Performance Management, - Bridge and pavement investments on the local NHS.	N/A	WSDOT's Capital Program Development and Management Office provided presentation and discussion materials to *MPO/RTPO Coordinating Committee* on 11/16/2021 and 2/22/2022.
• *MAP-21 Technical Team* Meeting on: - Pavement and bridge conditions targets for MAP-21. - 2022 TAMP Submittal Process - Framework approach and performance targets proposed for PM2 reporting. - WSDOT's software configuration progress.	N/A	WSDOT Pavement and Bridge Offices presented to the MAP-21 Technical Team, with representatives from WSDOT, BFCOG, CDTC, Seattle DOT, CRAB, CWCOG, LCVMPO, PSRC, RTC , SCOG, Spokane County, SRTC, TRPC, WCOG, YVCOG, WWVMPO, and FHWA in attendance on 11/30/2021 & 2/22/2022.
• WSDOT development of the MPO/RTPO STIP Pavement Preservation Programmatic Approach, a STIP amendment process to enhance funding flexibility for local Preservation projects. - Approved for statewide use if WSDOT made available a project search engine, on the agency website and include a mapping function. - Project financial and schedule data accessible on the Project Search webpage under the Project Delivery Status tab.	N/A	WSDOT initiated the approach in 2014 with the TRPC by including their programmatic projects in the 2015-2018 STIP. The SRTC approved amending their projects into the STIP in April 2015. The PSRC approved the approach once the search engine was made available externally on 6/10/2015.
Results of 23 CFR part 667 evaluations of NHS pavements and bridges included in TAMP.	**6/30/2022**	**Latest report included as TAMP Appendix F. Work is ongoing for statewide evaluation due 11/23/2022.**
Initial report for 23 CFR 667 Analysis: Assets Repeatedly Damaged by Emergency Events (TAMP Appendix F).	11/23/2018	Initial report for the NHS e-mailed to FHWA Division Office on 11/21/2018.
• GIS application created to combine multiple information layers, filter for emergency event locations meeting defined analysis criteria, and identify capital projects completed within the vicinity.	N/A	GIS application internally available 5/16/2018. Anticipated GIS application available externally in late 2019.
• GIS layer created to aid analysis and identify locations where multiple qualifying Federal Emergency Relief projects have occurred.	N/A	GIS layer available on WSDOT's internal GIS Workbench on 2/14/2019. Anticipated GIS layer available externally in late 2019.
• Report for 23 CFR 667 Analysis: Assets Repeatedly Damaged by Emergency Events.	10/22/2020	The date WSDOT met with FHWA to have an official wrap-up of the Part 667 analysis.
• Report for 23 CFR 667 Analysis: Assets Repeatedly Damaged by Emergency Events.	10/26/2021	The date WSDOT met with FHWA to have an official wrap-up of the Part 667 analysis.

Exhibit Notes:
[1] For more information see the *NHS Planned Pavement and Bridge Expenditures* section of the *Revenue and Financials* TAMP chapter and *Appendix D (Local Engagement Business Plan).*

Exhibit 2-2: Asset Management Implementation Progress (continued)

Activity	Due By	Progress
National Highway Performance Program funding extension letter request.	**11/20/2018**	**Extension request submitted 10/3/2018, FHWA approval received 10/10/2018.**
TPM State Biennial Performance Report for Performance Period 2018-2021: *2018 Baseline Performance Report (Washington)*	10/1/2018	Report form submitted 9/28/2018, FHWA approval received 10/15/2018. Mid Performance Period (MPP) Progress Report by Washington for 2018-2021 – submission on 10-1-2020.
MAP-21 State and Local agency performance targets required to be developed.	5/20/2018	Pavement and Bridge performance targets e-mailed to FHWA Division Office on 5/18/2018.
• The *Target Setting Framework Group* recommended Pavement and Bridge performance targets to the *Highways Executive Steering Committee* for their review and approval.	N/A	Targets presented to the *Highways Executive Steering Committee* for approval on 4/16/2018.
• Pavement and Bridge *Target Setting Technical Teams* proposed framework approach and values for performance targets to the *Target Setting Working Group* and *Target Setting Framework Group.*	N/A	Framework approach and performance targets proposed to the *Target Setting Working Group* and *Target Setting Framework Group* on 2/26/2018.
Initial Transportation Asset Management Plan.	4/30/2018	Initial plan submitted 4/27/2018 FHWA certification received 5/18/2018.
Fully compliant Transportation Asset Management Plan.	5/18/2019	Plan submitted 6/27/2019 FHWA approval received 7/31/2019

PM2 Target Setting

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 2-3 shows the collaborative groups that have been set up between WSDOT, MPOs and local agency representatives.

WSDOT has held continuing meetings with MPOs and local agencies through a pavement and bridge technical committee since 2014. These 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. Since the establishment of these rules, the need to conduct these meeting as frequency has diminished. The technical committee now meets as needed before an update or change to the rules.

Exhibit 2-3: WSDOT MAP-21 Collaboration for Target Setting for Roads and Bridges on the NHS

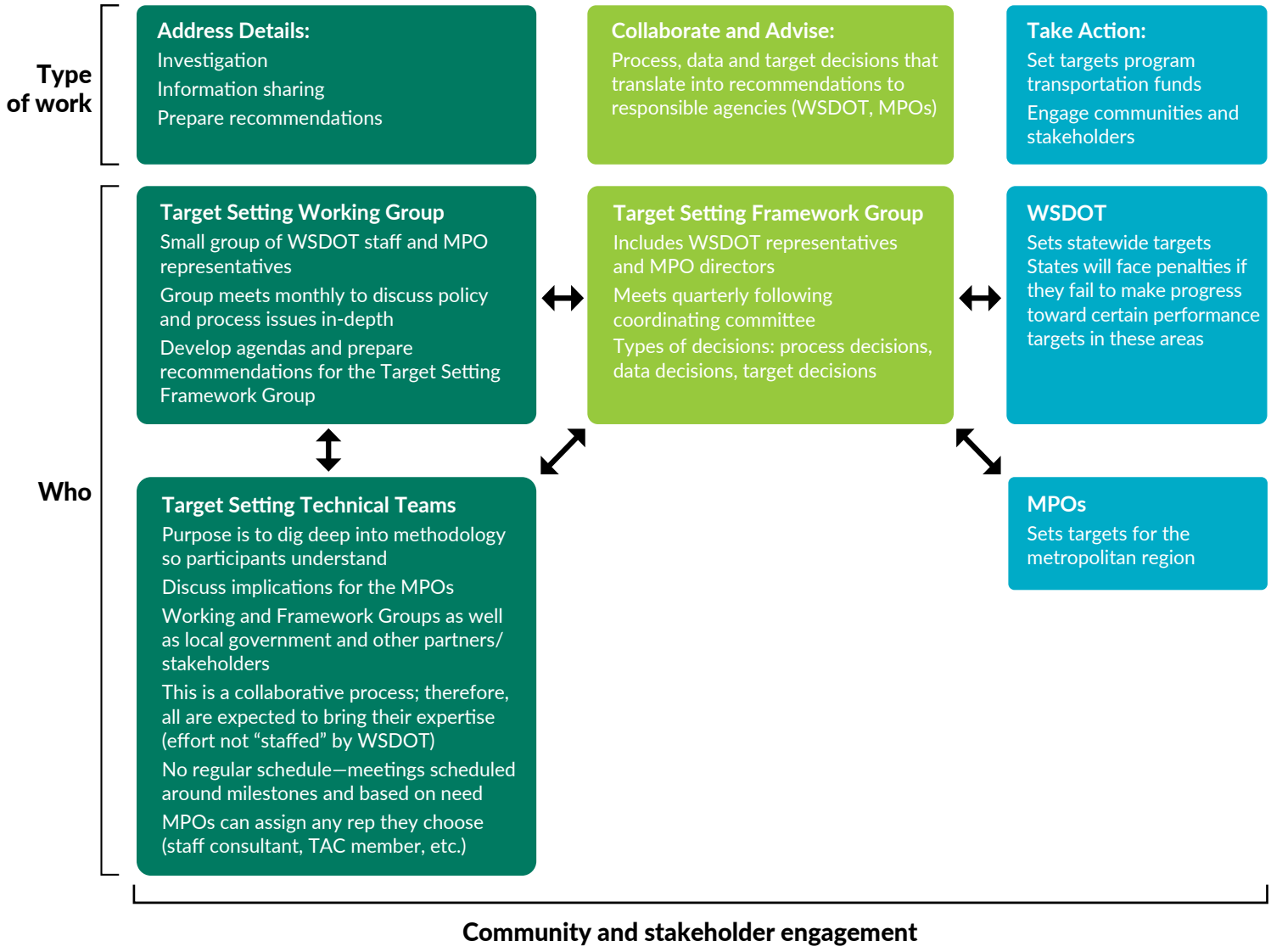


Exhibit Note: Source is from WSDOT's Office of Strategic Assessment and Performance Analysis May, 2015 *MAP-21 Collaboration Technical Folio*.

Developing Local Agency NHS Needs, Investment Strategies, and Funding Levels

As 23% of the NHS is owned by local jurisdictions, the amount of local funding allocated for bridge and pavement preservation on the NHS, as well how those funds are used, has a material impact on the overall performance of the NHS network. With the initial TAMP submitted in April 2018, WSDOT recognized gaps in processes and information availability as it relates to local NHS bridge and pavement needs and funding to address those needs.

As noted in the Puget Sound Regional Council's Regional Transportation Plan 2022-2050, Appendix C – Maintenance and Preservation, estimating regional maintenance and preservation need is a challenge, in particular for local assets where there are gaps in the data and inconsistencies in how the data is collected. There is limited information available on which to base future maintenance and preservation cost estimates for local jurisdictions. Historically, the plan's financial strategy relied upon a series of programmatic models based on historic expenditures to project maintenance and preservation investment costs for cities and counties. This approach was limited by the fact that it relied entirely on past spending and did not account for projected future need or local planning policies.

WSDOT, in partnership with MPOs, has worked to begin addressing those gaps. While WSDOT is making progress towards addressing the process gaps associated with the locally owned NHS, there is still work to be done to fully satisfy the federal requirements. After the submission of the complete TAMP, WSDOT will begin the planning process to address the following areas before the next TAMP is submitted in 2026:

- Evaluate and identify average annual bridge needs on the locally owned sections of the NHS.
- In coordination with MPOs, work with WSDOT's Local Programs and Planning offices to determine ways of reasonably estimating future NHS investment levels for bridge and pavement assets.
- Align local investment activity types to FHWA investment activity types to review general investment strategies on the local NHS and to address the federally required annual consistency review.
- Align planned level of expenditures to funding needs and identify funding gaps.

While these actions are part of the federal requirements of a complete asset management plan, they also support WSDOT's agency wide asset management goals of achieving and sustaining a State of Good Repair for the state's bridge and pavement network.

23 Part 667 Analysis

Working towards WSDOT's asset management objectives of reducing the vulnerability and increasing the resilience of WSDOT's critical infrastructure to the impacts of extreme weather and events, and as part of the requirement of 23 CFR 667, WSDOT conducted evaluations in 2018, 2020, and 2021 documenting the locations across the state where facilities on the NHS have been repeatedly damaged as a result of emergency events. These evaluations included the following elements:

- **2018** – Initial 20+ year analysis and report on pavement and bridge assets on the NHS
- **2020** – Initial 20+ year analysis and individual project summaries for pavement and bridge assets off the NHS, plus subsequent analysis and project summaries adding 2018 and 2019 locations for pavement and bridge assets on the NHS
- **2021** – Subsequent analysis and project summaries adding 2020 locations for pavement and bridge assets on and off the NHS

Additional information on this report may be found in the "Risk Management" chapter of this TAMP as well as a copy of the latest report submitted to the Federal Highway Administration in Appendix F.

To improve the resilience of the infrastructure located in these areas as required by IIJA/BIL, WSDOT has been engaging MPOs/RTPOs and local Public Works Departments to evaluate reasonable approaches for those locations requiring alternative designs and the appropriate time in the design phase of a project as to when those alternative designs should be considered.

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 168,271 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 Appendix B 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 14,749 lane miles of NHS made up of 4,020, 7,395 and 3,334 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.

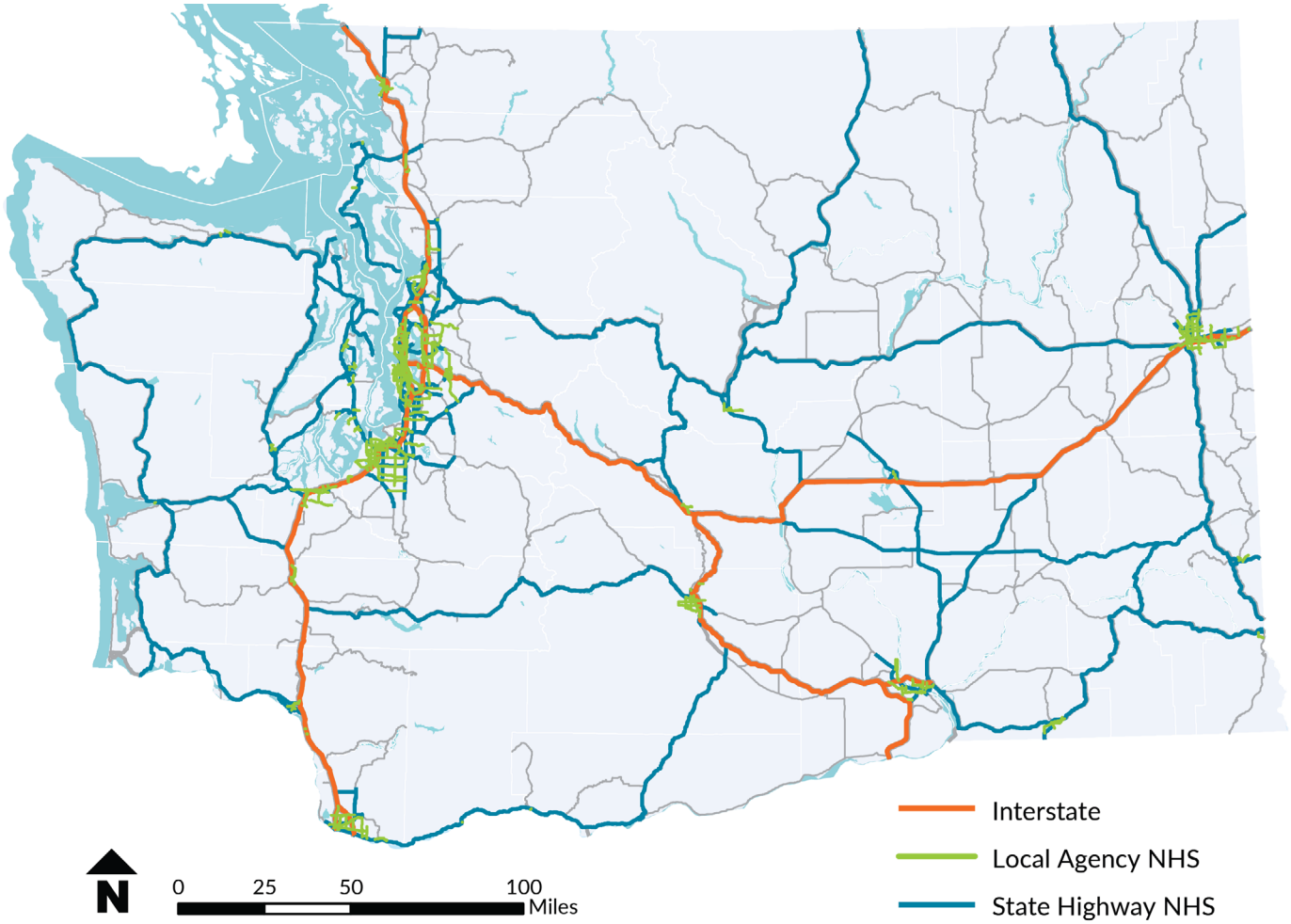


Exhibit Note: Data source is from WSDOT's GeoData Distribution Catalog, maintained by the Office of Information Technology, and represents information collected for 2021.

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 2,200 lane miles of ramps and special use lanes, and over 7,600 lane miles of shoulders. State highways pavement assets have an estimated replacement value of nearly $20 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: 2021 Statewide Pavement Asset Summary

Surface Type	Lane Miles
Chip Seal	7,216[1,2]
Asphalt	9,038[1,2]
Concrete	2,423[1,2]
Mainline Total	**18,677**
Special Use Lanes	2,201[2]
Ramps	
Shoulders	7,652[3]

Exhibit Notes:

[1] Includes bridge deck lane miles.

[2] Source: 2020 State Highway Log v-13; including data from the TRIPS database representative of data collected through the previous year.

[3] Shoulders based on WSPMS calculation of sq. ft. of shoulder, divided by 58,080 (11 ft. x 5,280 ft. = 1 lane mile).

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.[1,2]

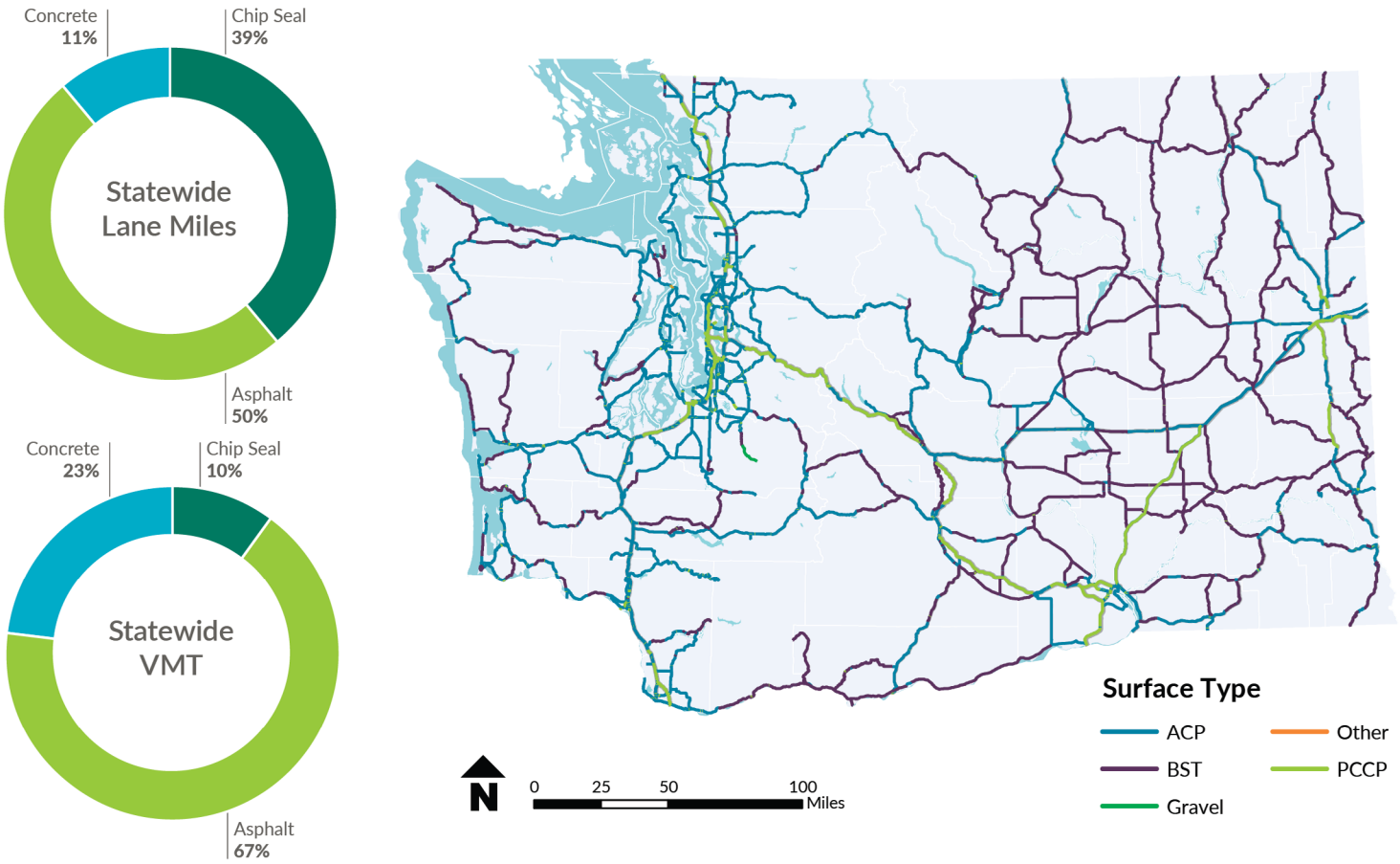


Exhibit Notes:

1) Source is 2022 data queried from the Washington State Pavement Management System (WSPMS)
2) Data source for the Surface Type for is from WSDOT's GeoData Distribution Catalog, maintained by the Office of Information Technology, and represents information collected for 2021

National Highway System Pavement Inventory

MAP-21 requirements focus specifically on the National Highway System. The NHS comprises approximately 61% of WSDOT lane miles and carries 83% 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.

Exhibit 3-4: MAP-21 System Inventory of WA NHS and Statewide Pavement Assets.

Interstate[1,2,3]		Lane Miles	Non-Interstate NHS[1,2,3]	
Surface Type	**WSDOT**		**WSDOT**	**Local**
Asphalt	2,167		4,864	1,687
Chip Seal	40		1,855	1,378
Concrete	1,589		467	213
Total	**3,796**		**7,186**	**3,288**

Exhibit Notes:

[1] Values reflect data submitted to HPMS in 2021 for calendar year 2020.
[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 60% of the concrete pavement structures are more than 40 years old (1,200 lane miles), with 9% of those miles at 60 years or older (200 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 more than 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 $52.7 billion statewide.

There are nearly 6,300 locally owned bridge structures in Washington during 2021, an increase from 2018. 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.

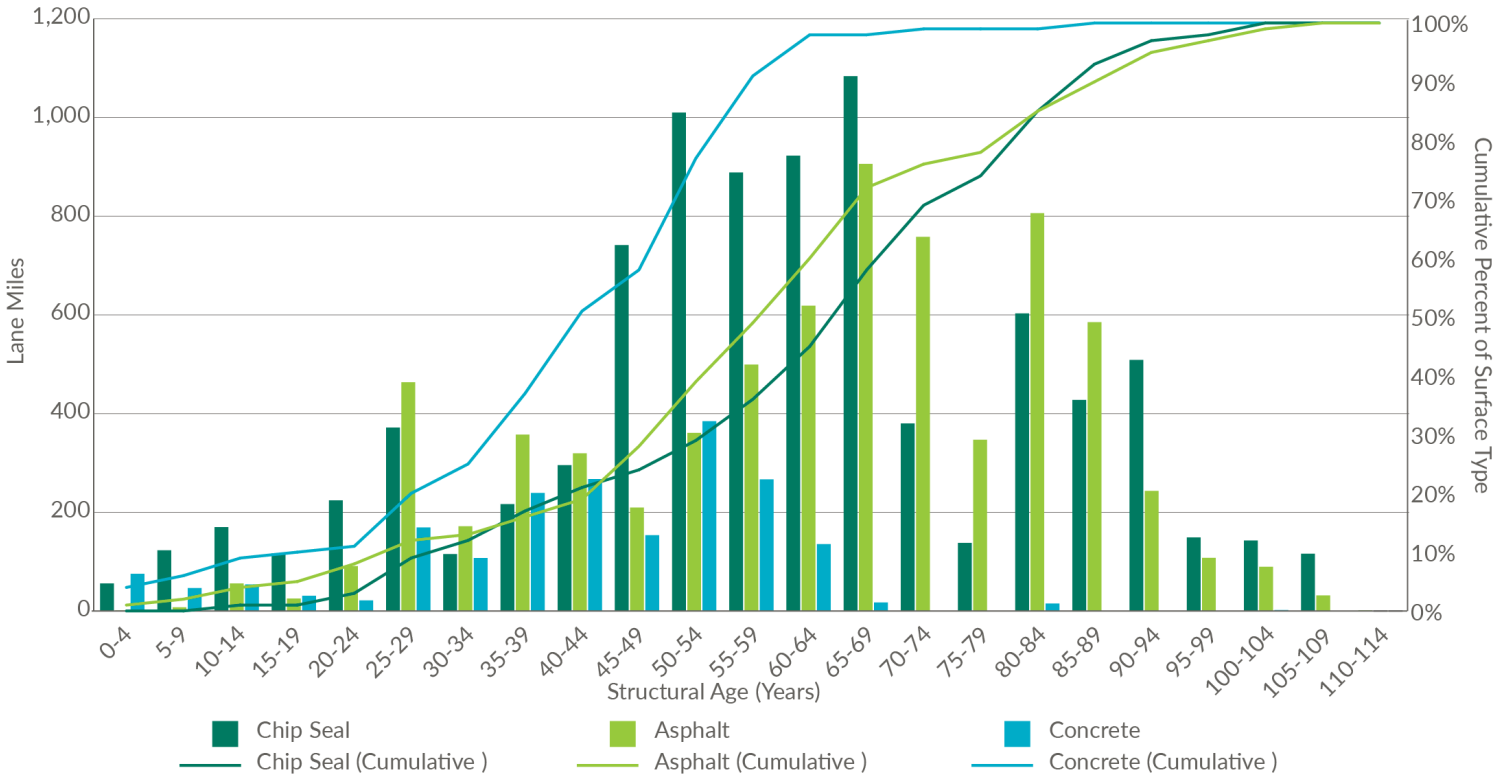


Exhibit Note: Source is 2021 data queried from the Washington State Pavement Management System by WSDOT's Pavement Branch of the Materials Laboratory.

Exhibit 3-6: 2021 Statewide Bridge Asset Summary.[1]

Structure Type	WSDOT	Local
Vehicular Bridges	3,181	4,296
Small Structures (< 20' long)	444	1,455
Culverts (> 20' long)	147	N/A[2]
Pedestrian Structures	127	338
Ferry Terminal Structures	68	11
Tunnels and lids	53	4
Border Bridges[3]	5[4]	1[5]
Railroad Bridges	87	147
Total	**4,112**	**6,251**

Exhibit Notes:

1. Source: WSDOT Bridge and Structures Office and WSDOT Local Programs Office
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 the 11 border bridges shared with Oregon and Idaho.
4. Not included are 10 of the border bridges that are maintained by Oregon and 4 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

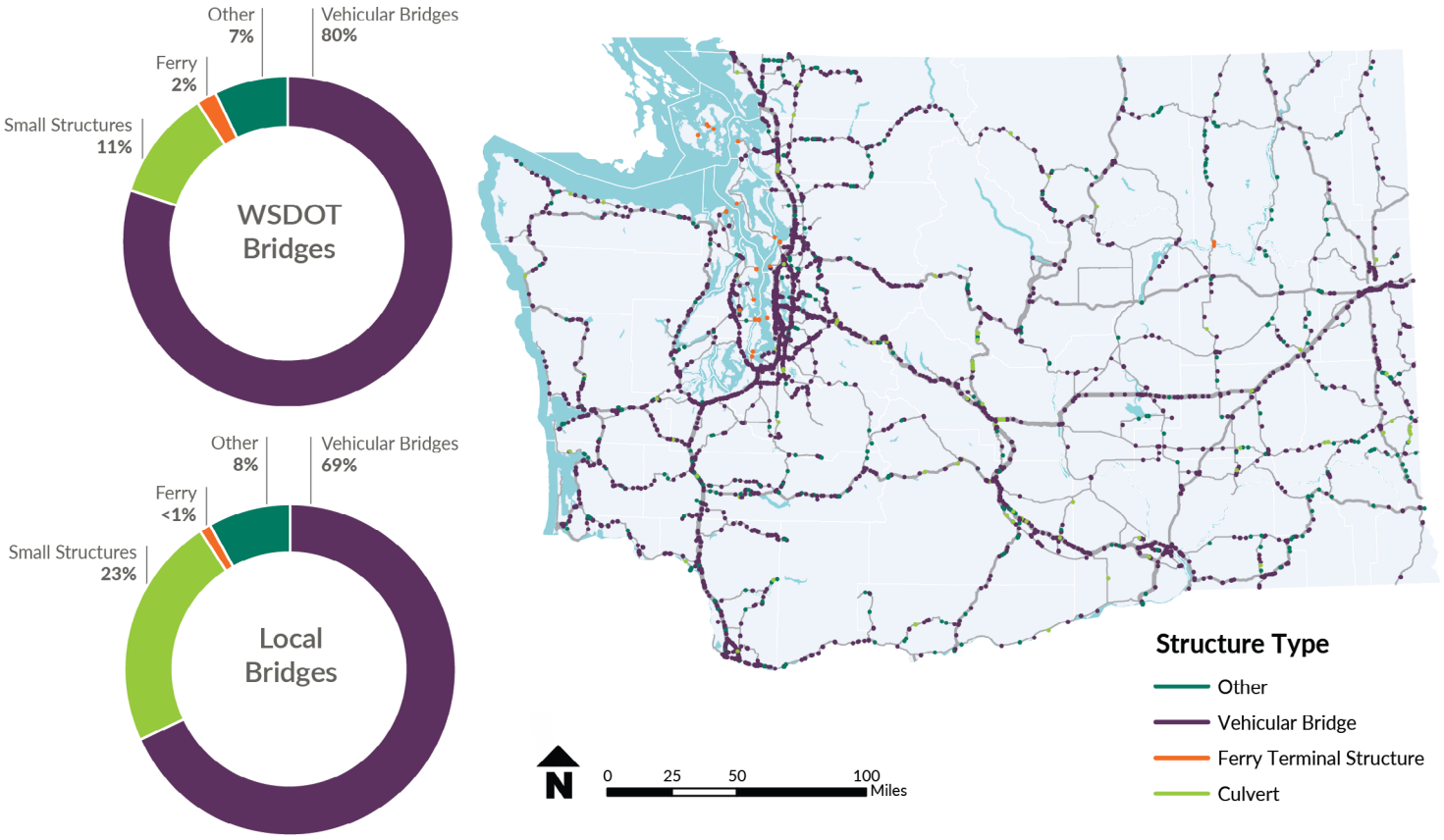


Exhibit Note: Source is from WSDOT Bridge and Structures Office and WSDOT Local Programs Office.

National Highway System Bridge Inventory

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

1. Vehicular bridges,
2. Ferry terminals,
3. Culverts longer than 20 feet,
4. 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 4,100 bridge assets, including structures on interstates, the National Highway System, and state highways. Local governments throughout the state maintain remaining bridge structures. Of the over 10,300 bridges across Washington, nearly 6,300 are locally owned. Washington's NHS network includes 46.5 million square feet of bridge deck area, of which 89.1% is state owned and 10.9% is owned by local agencies. WSDOT and local jurisdictions work together to gather inventory and condition information on bridges in Washington state. Local jurisdictions are responsible for inspecting most bridges on the local network. This information is then input into Washington State's Bridge Information System.

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

	2021 NHS		2021 Statewide	
Owner	Deck Area[1] (Million Sq. Ft.)	Bridges (Number)	Deck Area[1] (Million Sq. Ft.)	Bridges (Number)
WSDOT	46.5	2,764	55.5	4,112
Local[2]	5.7	300	20.4	6,253
Total	**52.2**	**3,064**	**75.9**	**10,365**

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

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 368 bridges that are 80 years old or older. These bridges account for approximately 1.7 million square feet of deck area. Bridges 80 years old or older made up 3.2% of the total 55.6 million square feet of deck area on WSDOT-owned bridge as of March 2022. Replacing these bridges would cost nearly $1.7 billion over the next 20 years, or approximately $85 million per year (in 2022 dollars). Many of these bridges will remain in use during the next 10 years, currently 39 of them (20% 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]

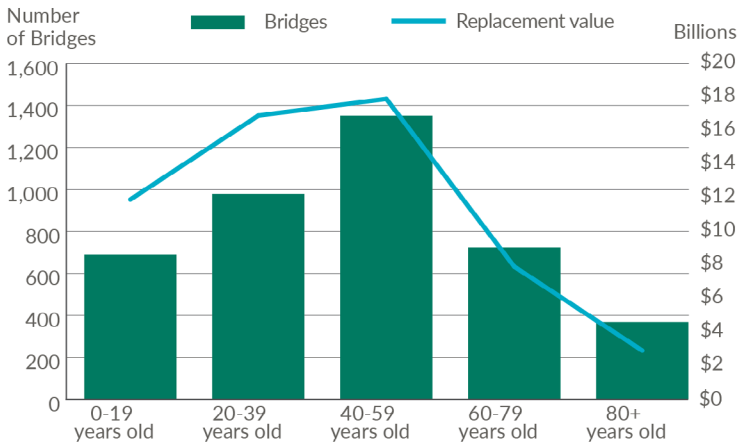


Exhibit Notes:

[1] Source is from WSDOT Bridge and Structures Office.

[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. WSDOT's use of these three indicators is based on more than 50 years of research from WSDOT and AASHTO:

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 2016 and 2020. 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 39% 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 10% of the vehicle miles traveled on WSDOT's roadway network.

Exhibit 3-10: WSDOT Pavement Condition Trends Statewide.[3,4,5]

Percentage of WSDOT's pavement in very poor condition decreases between 2016 and 2020

Actual values for 2016 and 2020; Characteristics of pavement at each condition; Percentage of lane miles and vehicle miles traveled (VMT) by condition category

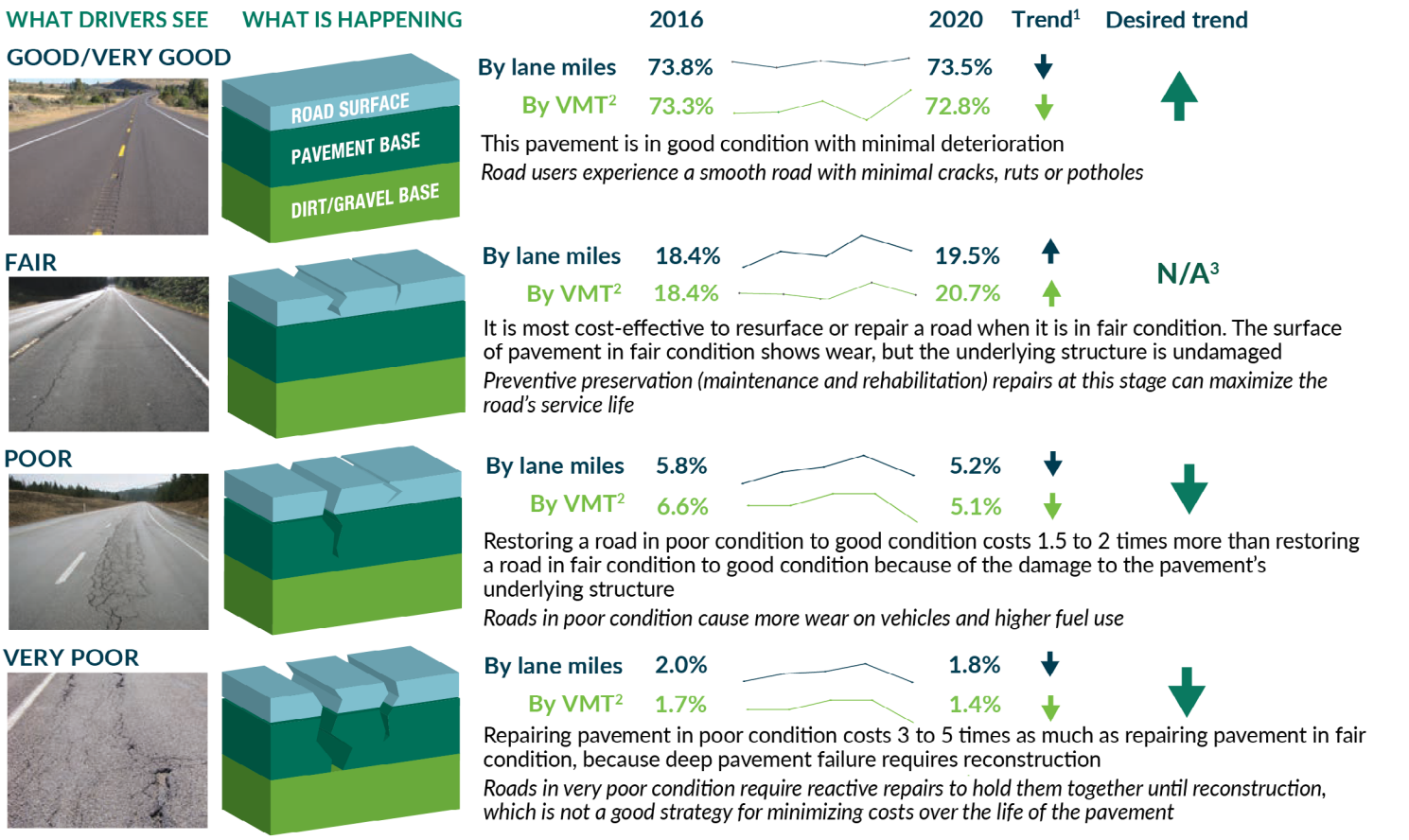


Exhibit Notes:

[1] Trends are based on observed condition trends between 2016 and 2020. Arrows indicate trends by lane mile.

[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] N/A = Not Available. Because pavement in fair condition may have entered that category by either improving from poor condition or deteriorating from good condition, WSDOT does not have a desired trend for the percentage of pavement in fair condition.

[4] Percentages were slightly affected in 2020 due to COVID-19 impacts on data collection. Percentages may not add up to 100 due to rounding. WSDOT collects data on the condition of pavement annually using a van equipped with lasers, cameras and other equipment. Condition figures for 2019 include chip seal pavement, also known as Bituminous Surface Treatment. Chip seal pavement was not evaluated from 2010 through 2016 due to budget restrictions. Chip seal data for 2017 and 2018 was collected, but has not yet been processed.

[5] Source: WSDOT's Pavement Branch of the Materials Laboratory and WSDOT Capital Program Development and Management Office; prepared for December 2021 *Gray Notebook 84th 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, dowel bar retrofit, 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 pavement condition assessments;
- 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* *(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 >15 >20
Rutting *(inches)*	<0.20	0.20-0.40	>0.40
Faulting *(inches)*	<0.10	0.10-0.15	>0.15

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

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.

FHWA's *HPMS Pavement Condition Report Card* provides Washington state the ability 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]

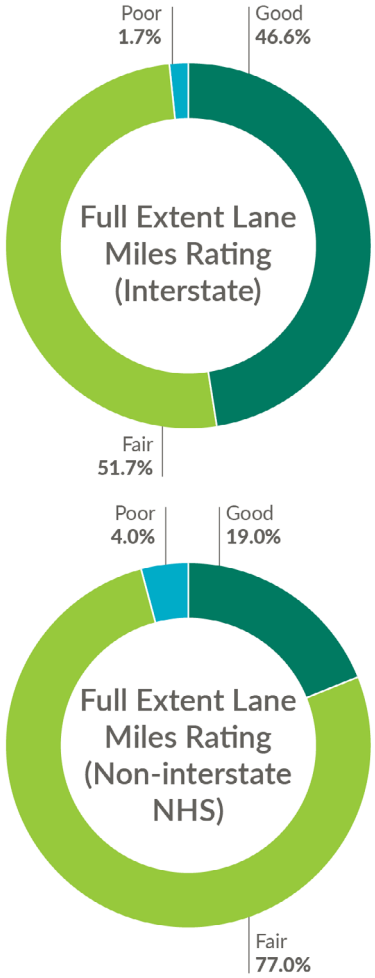


Exhibit Notes:

[1] Local NHS data is incomplete.

[2] Source is from the HPMS Pavement Report Card for Washington state's 2021 data submittal for calendar year 2020 except for Non-Interstate NHS. Non-Interstate State Routes condition data was not collected in 2020 due to COVID-19 resource limitations thus reflects HPMS in 2020 for calendar year 2019.

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. The process for *Performance Gap Analysis* is detailed in *Chapter 7: Performance Scenarios*.

Exhibit 3-13: Pavement Performance Measures and Targets, with Condition.[1,2,3]

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	85% or more	93.2%	No
Percentage of pavements on the Interstate System in poor condition	Interstate		MAP-21	4%	1.7%	No
Percentage of pavements on the Interstate System in good condition				30%	39.8%	No
Percentage of pavements on the NHS (excluding the Interstate System) in poor condition	Non-Interstate NHS			5%	17.4%	Yes
Percentage of pavements on the NHS (excluding the Interstate System) in good condition				18%	45.2%	No

Exhibit Notes:

[1] Source: WSDOT's Pavement Branch of the Materials Laboratory and WSDOT Capital Program Development and Management Office; prepared for December 2021, *Gray Notebook 84th Edition*.

[2] Reflects a 2019 short-term condition information. The 2020 short-term condition information was not collected for chip seal pavement due to COVID-19 restrictions.

[3] Source is from the HPMS Pavement Report Card for Washington state's 2021 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 2021, WSDOT has 93.2% of its bridges by deck area in fair or better condition, meeting agency performance goals. This is an improvement over 2017, when 91.8% 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. State and federal bridge condition measures are nearly identical, and apply only to the 2,361 WSDOT bridges and 217 locally owned bridges on the NHS.

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

Structural condition rating		June 2017	June 2018	June 2019	June 2020	June 2021
Good	Bridge deck area	20.3	20.9	21.3	21.2	20.8
	Percent of deck area	37.3%	38.4%	37.1%	37.5%	37.0%
	Number of bridges	1,699	1,701	1,729	1,726	1,725
Fair	Bridge deck area	29.7	29.4	32.0	31.8	31.5
	Percent of deck area	54.5%	54.1%	55.7%	56.3%	56.2%
	Number of bridges	1,450	1,456	1,457	1,452	1,461
Fair or better[1]	Bridge deck area[2]	49.9	50.3	53.3	53.0	52.3
	Percent of deck area[2]	91.8%	92.5%	92.9%	93.8%	93.2%
	Number of bridges	3,149	3,157	3,168	3,178	3,186
Poor	Bridge deck area	4.5	4.1	4.1	3.5	3.8
	Percent of deck area	8.2%	7.5%	7.1%	6.2%	6.7%
	Number of bridges	163	165	158	164	179
Total	Bridge deck area	54.4	54.4	57.4	56.5	56.1
	Number of bridges	3,312	3,332	3,326	3,336	3,365

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.

[3] Source: WSDOT Bridge and Structures Office; prepared for September 2021 *Gray Notebook 83rd Edition*.

MAP-21 Bridge Conditions

Moving Ahead for Progress in the 21st Century (MAP-21) and the Fixing America's Surface Transportation (FAST) Act requires state DOT's to use inspection data to determine condition ratings about bridges elements and culverts. The condition of individual bridge elements (deck, superstructure, substructure), and culverts (which are measured separately), are rated using a classification method from the National Bridge Inventory and the Highway Bridge Program. This classification method assigns the elements and culverts condition ratings ranging from 0 to 8 where 7 or greater = good; 5-6 = fair; and 4 or less = poor.

For MAP-21, bridges in good condition have all three elements (deck, superstructure, substructure) rated as 7 or higher; bridges in fair condition meet the minimum threshold of 5 or higher; and poor bridges have any of the elements rated as 4 or lower. Exhibit 3-15 shows the condition rating thresholds for each criterion.

The percentage of the total NHS bridge deck area for each classification (good, fair, poor) is calculated as the ratio of the total deck area of NHS bridges in a classification to the total deck area of NHS bridges in the state. The bridge deck condition of a shoulder on a bridge is included in the overall condition rating.

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

National Bridge Inventory condition rating thresholds for National Highway System bridges

	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

Data source: Federal Highway Administration.

Exhibit Note: Source is from WSDOT Transportation Safety and System Analysis, 2022 *Bridge MAP-21 WSDOT Technical Folio*.

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 on the NHS. Washington's NHS network includes 46.5 million square feet of bridge deck area, of which 89.1% is state owned and 10.9% is owned by local agencies. Exhibit 3-16 shows the condition of Washington state bridges.

Exhibit 3-16: MAP-21 Condition Description of WA State Bridges on the NHS.[1]

2021 NHS		
Owner	**Deck Area[1] (Million Sq. Ft.)**	**Bridges (Number)**
WSDOT Owned	46.5	2,764
Amount Poor (%)	3.6 (7.9%)	116
Local Owned[3]	5.7	300
Amount Poor (%)	0.5[4] (8.2%)	17
Total	**52.2**	**3,064**
Total Poor (%)	**4.1 (7.9%)**	**133**

2021 Statewide		
Owner	**Deck Area[2] (Million Sq. Ft.)**	**Bridges (Number)**
WSDOT Owned	55.5	4,112
Amount Poor (%)	4.2 (7.5%)	193
Local Owned[3]	26.9	6,251
Amount Poor (%)	1.7 (6.4%)	309
Total	**82.4**	**10,363**
Total Poor (%)	**5.9 (7.1%)**	**502**

Exhibit Notes:

1 Source: WSDOT Bridges and Structures Office and WSDOT Local Programs Office
2 Due to rounding, some figures are not computable based on numbers in the table.
3 Bridges owned by counties and cities.
4 Approximate deck area

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 131 WSDOT-owned bridges longer than 20 feet were load restricted or posted through June 2021, a slight increase from 130 in 2020 and a 10% increase from 119 in June 2017. 101 of WSDOT's load posted or restricted bridges were on the National Highway System. Of these, 69 were load restricted, two were load posted for local loads and 30 were load posted for emergency vehicles.

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

	June 2017	June 2018	June 2019	June 2020	June 2021
LOAD RESTRICTED[1]	105	109	102	118	120
LOAD POSTED[2]	14	11	9	12	11
TOTAL	**119**	**120**	**111**	**130**	**131**

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] Structures posted for emergency vehicles are not included in these numbers.

[4] Source: WSDOT Bridge and Structures Office, WSDOT Local Programs Office; prepared for September 2021 *Gray Notebook 83rd Edition*.

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 fair or better condition in 2021. In Washington state, 622 locally owned bridges that were load restricted or posted as of 2021 (of which 19 were on the NHS), an increase from 216 in 2017.

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. The process for Performance Gap Analysis is detailed in *Chapter 7: Performance Scenarios*.

Exhibit 3-18: Bridge Performance Measures and Targets, with Condition[2]

Measure	Scope	Target	Current Value	Gap?
Number of load posted bridges	State owned	Not set	11	N/A
Number of load restricted bridges			120	N/A
Percentage of NHS bridges classified as in poor condition[1]	NHS	Less than 10%	7.8%	No
Percentage of NHS bridges classified as in good condition		30%	32.8%	No

Exhibit Note:

[1] The National Highway Performance Program (NHPP) targets require the percentage of NHS bridges classified in poor condition (weighted by deck area) not exceed 10%

[2] Source: WSDOT Bridge and Structures Office; prepared for September 2021 *Gray Notebook 83rd Edition*.

CHAPTER 4
LIFE CYCLE PLANNING

Life Cycle Planning is a key concept of asset management. Implementing asset management practices decreases the total cost of managing transportation infrastructure by considering all phases of an asset's life cycle, as reflected in Exhibit 4-1.

This chapter discusses WSDOT's approach to life cycle planning for Pavement and Bridge assets and how life cycle information is used to help inform project prioritization and network-level investment strategies.

As mentioned in Chapter 1, WSDOT received the Move Ahead Washington revenue package from the Washington state Legislature during the 2022 Legislative Session. This package includes investments to preserve and maintain the state's transportation system which will impact the lifecycle planning for pavement and bridge assets. The details of this revenue package are still being worked out to include the timing of funding provided to the Pavement and Bridge Programs. As these details are finalized, WSDOT will assess the magnitude of the changes and their impacts to this and other relevant chapters of the TAMP and work with our federal partners to determine if an update is necessary.

Additionally, TAMP requirements were amended by the Bipartisan Infrastructure Law (BIL) to require that States take into consideration extreme weather and resilience within their lifecycle cost and risk management analysis. WSDOT has included several instances in this chapter where extreme weather and resilience were considered with the lifecycle cost analysis. WSDOT expects to improve this section in future TAMP updates.

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

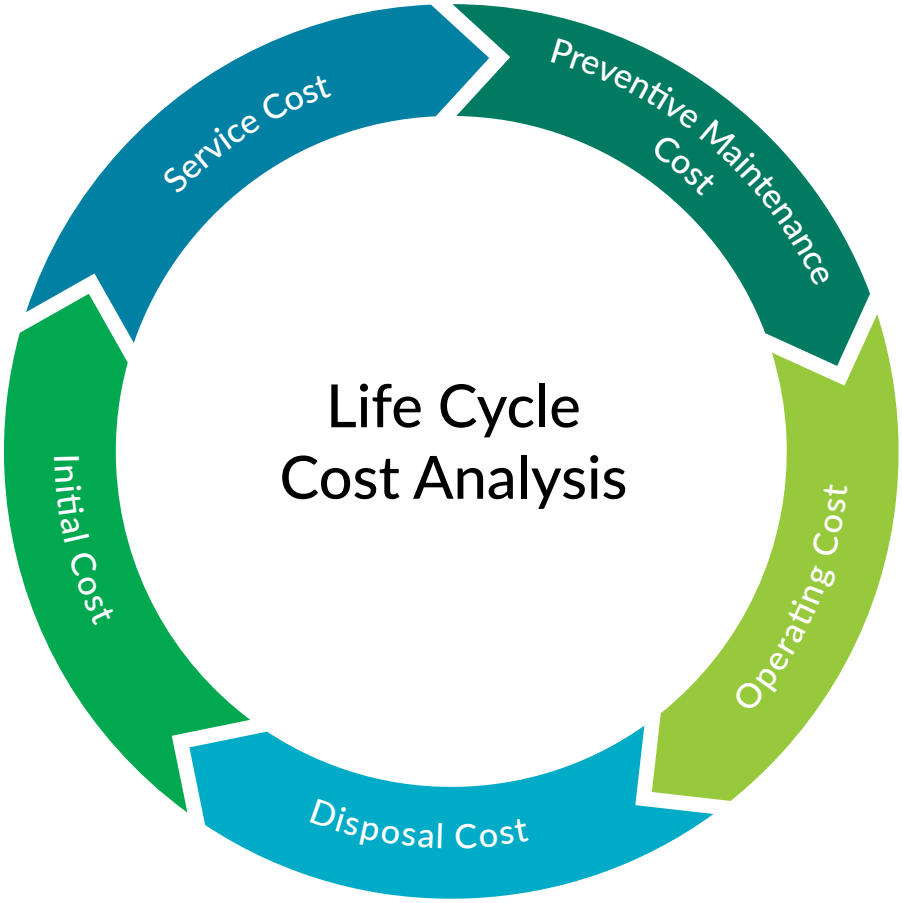


Exhibit Note: Source is from Kenneth Buddha. Prepared for 2016 TRB, *Life Cycle Cost Analysis for Management of Highway Assets*.

Approach to Life Cycle Planning (LCP)

At the most granular scale, WSDOT conducts project-level life cycle cost analyses (LCCA) following practices described in the *Pavement Policy* publication. This complements FHWA's life cycle planning (LCP) process that focuses on network-level asset management, described in the publication, *"Using a Life Cycle Planning Process to Support Asset Management"*. LCP at the network-level uses existing management systems to evaluate and compare the cost-effectiveness of asset strategies that preserve, or improve, asset conditions over the long-term.

WSDOT uses a combination of analysis tools such as Washington State Pavement Management System (WSPMS) and the Bridge Engineering Information System (BEISt), to evaluate the network-level. The LCP approach considers the following types of highway asset information, identified by FHWA, and where available:

- Condition information.
- Condition deterioration rates (models).
- Maintenance and rehabilitation intervals and treatment rules.
- Treatment costs.
- Expected condition improvements, new deterioration rates, or new service life estimates.
- Expected changes in system demand.
- Risks associated with current or future conditions.
- Anticipated budgets.
- Inflation and discount rates.
- System hierarchies (high priority routes vs. low priority routes).
- Constraints that influence investments.
- Desired State of Good Repair and any existing performance gaps.

Life Cycle Planning 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 is 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.

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

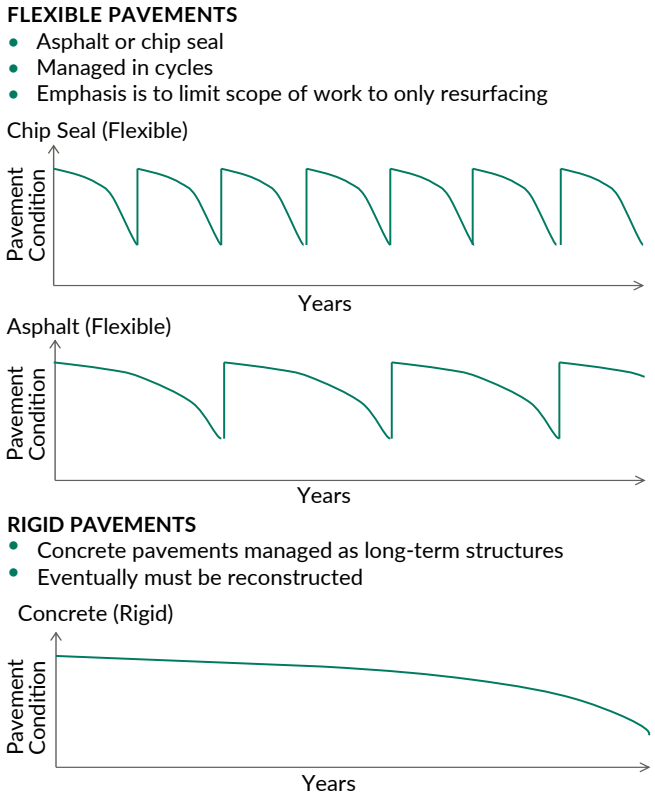


Exhibit Note: Source is WSDOT's Pavement Notebook; Feb., 2016 *Pavement Asset Management*.

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, which include extreme weather and resilience, 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 treatment options are 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 4-3 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[1]	Life Extension[1] (Years)	Agency Cost[1,2] ($ Total/Lane Mile)	$EUAC_{4\%}$[1,3] ($ 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; 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.

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

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

Pavement Life Cycle Planning 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 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. The Move Ahead Washington revenue package is expected to provide an initial investment in preservation that will allow WSDOT to preserve pavements at their lowest lifecycle costs.

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 2,400 lane-miles between 2010 and 2021, and the lane mile percentage changed from 25 percent chip seal to currently 39 percent of the state system. Based on the criteria above, WSDOT may convert up to 600 additional lane miles, 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, 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 when a strong strategic maintenance strategy implementation.

Baseline Life Cycle Planning 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

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.

In 2021, WSDOT selected 43 local agency projects, totaling $89.4 million of federal funding from the NHS Asset Management Program. Since 2017, this program has provided $137 million in federal funding for 66 local agency projects.

Exhibit 4-4: Summary of the WSDOT Pavement Network Savings – Baseline vs. Current Strategy[2]

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**
Avg. Annual Cost Savings[1]				**$80**

Exhibit Notes:
[1] Values reflected show estimated savings between 2010 (baseline) and 2025 (with current strategy implementation) LCP network level evaluations.
[2] Source: Pavement Branch of the Materials Laboratory; Submitted March, 2017 to TRB; *Cost-Effective Performance Management for Washington State Pavement Assets*.

The NHS Asset Management Program highlights the importance of preserving NHS roadways by incentivizing, or provided higher scores to grant applications, to local agencies to use asset management strategies that provide cost-effective solutions to maximize roadway life expectancy. Future calls for projects are planned for 2-year cycles, with total program funding amounts to be determined.

Life Cycle Planning 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.

Regarding Lifecycle Planning for bridges, the Move Ahead Washington revenue package is expected to provide an initial investment in preservation that will allow WSDOT to preserve bridges at their lowest lifecycle costs.

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 the process of implementing AASHTO's BrM Bridge Management System software. This will allow WSDOT's Bridge & Structures Office to efficiently prioritize the timely repair, rehabilitation, and replacement of WSDOT's bridge inventory. It will also allow long-term forecasting of the condition of the bridge inventory under different funding scenarios. 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.

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 will:

1. Review the repair options.
2. Put together a detailed scope of work.
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] (Years)	Total 10 Year Needs[1] ($ 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 #: 1,045 Cost: $12
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	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. $30
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[5] $: 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 January 2021) 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.

Bridge Life Cycle Planning 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). 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.

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 from extreme weather and other influences to the structure through scour mitigation and seismic retrofit. Both of these activities also help to make the network more resilient. 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*.

Improving 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 is planning to deliver $30 million for SPM on bridges during the 2021-23 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, bridge deck patching 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.

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, in Exhibit 4-6.

[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.

Exhibit 4-6: 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.

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 WSDOT's 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 report found WSDOT could refine its pavement management practices by:

1. **Improving:** Giving greater consideration to preventive maintenance treatments for its hot mix asphalt and chip seal pavements. They 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. See Exhibit 4-7 for the full scope of ongoing pavement research activities.

2. **Improving:** 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), JLARC recommended 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 the following section *Pavement Research* and the *Implementation and Systems Appendix B* for more detail.

Pavement Research

WSDOT invests in research supporting advances in managing pavement assets. The efforts listed below in Exhibit 4-7 support improvements to pavement asset management, and address other goals in the agency's strategic plan.

Exhibit 4-7: **WSDOT Pavement Research Activities**[1,2]

Study Title and Description	Research Team
Performance Measures for Bituminous Surface Treatments (BST's) Completed, WA-RD 887.1, Publication Date: 1/14/2019	WSDOT: Materials Lab/Research Offices
Determining Expected Life and Best Practices for Pavement Maintenance Treatments 1. Completed, WA-RD 871.1, Publication Date: 9/3/2017 2. Completed, WA-RD 871.2, Publication Date: 7/24/2018	WSDOT: Materials Lab/Research Offices
Development of a Strategic Pavement Study (SPS-2) Pooled Fund Scheduled Completion: Ongoing	WSDOT: Materials Lab/Research Offices Others: Nichols Consulting Engineers
Performing Forensic Evaluations of Long-Term Pavement Performance (LTTP) Remaining Sections Before They Leave Service Pooled Fund Scheduled Start: 2017[3]	WSDOT: Bridge & Structures/Research Offices Others: TBD
Recycled Asphalt Pavement (RAP) Reset Status: Project Completed, WA-RD 912.1, Publication Date: TBD	WSDOT: Materials Lab/Research Offices Others: Univ. of Nevada – Reno, UW

Exhibit 4-7: WSDOT Pavement Research Activities[1,2] (continued)

Study Title and Description	Research Team
Hot Mix Asphalt (HMA) Reset Scheduled Start: 2018[3]	WSDOT: Materials Lab/Research Offices Others: Univ. of Nevada – Reno, UW
Concrete Pavement Replacement Using Precast Concrete Panels (PCP) Status: Projected Completed, WA-RD #: TBD, Publication Date: TBD	WSDOT: Materials Lab/Research Offices Others: TBD
Ground Penetrating Radar (GPR) to Determine Asphalt Mixture In-Place Density Status: Project Completed. Report unlikely to be published.	WSDOT: Materials Lab/Research Offices
Technology Transfer Concrete Consortium Scheduled Completion: Ongoing[3]	WSDOT: Materials Lab/Research Offices Others: IA State Univ.
Recycled Materials Resource Center (RMRC) – 4th Generation Scheduled Start: TBD[3]	WSDOT: Materials Lab/Research Offices Other: TBD
Long Term Pavement Performance (LTPP) Forensics (Flexible Pavement) Status: Project Completed, WA-RD 905.1, Publication Date: TBD	WSDOT: Bridge & Structures/Research Offices Other: Wood Environmental & Infrastructure Solutions, Inc.

Exhibit Notes:
[1] Source is from the WSDOT Research Office: Prepared for July 2018, *Research Portfolio 2017 – 2019*.
[2] Source is from the WSDOT Research Office: *Approved State Planning & Research Projects for 2019-21*.
[3] Records of status study were not updated since the 2019 TAMP. WSDOT will provide updates to the study records in the next TAMP.

Bridge Management Improvements

Refining Bridge Management

Washington's 2014 JLARC study determined WSDOT meets 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. Please see Exhibit 4-8 for the full scope of ongoing bridge research activities.

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 engineering staff.

   Action: 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.

   WSDOT has been working to develop new tracking software and procedures to incorporate all life cycle costs and make future condition and need projections. See the following section *Bridge Research* for more detail.

Bridge Research

WSDOT invests in research supporting advances in managing of bridge assets. The efforts listed below in Exhibit 4-8 support improvements to bridge asset management and address other goals in the agency's strategic plan.

Exhibit 4-8: WSDOT Bridge Research Activities[1,2]

Study Title and Description	Research Team
Developing Connections for Longitudinal Joints between Deck Bulb Tees 1. Completed, WA-RD 869.2, Publication Date: 6/19/2017 2. Completed, WA-RD 869.1, Publication Date: 10/24/2016	WSDOT: Bridge & Structures/Research Offices Others: WSU, UW
Developing Girder Strands into the Cap Beam for a Positive Moment Connection Completed, WA-RD 867.1, Publication Date: 11/22/2017	WSDOT: Bridge & Structures/Research Offices Others: UW
Seismic Performance of SMA/ECC Columns of SR 99 Bridge Structure Scheduled Completion: 2018[3]	WSDOT: Bridge & Structures/Research Offices Others: Univ. of Nevada - Reno
Evaluation of Risk-Based Asset Management Systems for WSDOT Implementation Completed, WA-RD 880.1, Publication Date: 4/24/2018	WSDOT: Bridge & Structures/Research Offices Others: Dye Mgmt. Group
Develop Analytical Tool for Ranking Existing Bridges Built using Hollow Pile-Columns Scheduled Start: 2017[3]	WSDOT: Bridge & Structures/Research Offices Others: UW
Asset Management: Bridge Elements Deterioration Rates and Curves for WSDOT Bridges Completed, WA-RD 893.1 Publication Date: 9/22/2018	WSDOT: Bridge & Structures/Research Offices Other: Saint Martin's University
Full-Scale Shake Table Testing to Evaluate Seismic Performance of Reinforced Soil Walls Scheduled Completion: 2018[3]	WSDOT: Materials Lab/Research Offices Other: Univ. of CA - San Diego
Probabilistic Liquefaction Hazard Analysis: WSLIQ Expansion & Update 1. Completed, WA-RD 874.1, Publication Date: 4/20/2017 2. Completed, WA-RD 874.2, Publication Date: 4/20/2017	WSDOT: Materials Lab/Research Offices Other: UW
Performance of Steel Jacket Retrofitted Reinforced Concrete Bridge Columns in Cascadia Subduction Zone Earthquakes. Project Completed, WA-RD TBD, Publication Date: TBD	WSDOT: Bridge & Structures/Research Offices Other: WSU
Effects of Cascadia Subduction Zone Magnitude 9 Earthquakes on Bridges in Washington State. Status: Approved, Project Completed, WA-RD 908.1. Publication Date: TBD	WSDOT: Bridge & Structures/Research Office Other: UW

Exhibit Notes:

[1] Source is from the WSDOT Research Office: Prepared for July 2018, *Research Portfolio 2017 – 2019*.

[2] Source is from the WSDOT Research Office: *Approved State Planning & Research Projects for 2019-21*.

[3] Records of status study were not updated since the 2019 TAMP. WSDOT will provide updates to the study records in the next TAMP.

CHAPTER 5
RISK MANAGEMENT

WSDOT must balance a variety of transportation risks on an ongoing basis as part of the overall approach to implementing risk management. 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.

The agency's Transportation Safety, Quality, and Enterprise Risk (TSQER) Division is responsible for managing the enterprise and network-level risk assessment process through its Enterprise Risk Management program. WSDOT's TSQER Division 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 at three different levels:

1. **Enterprise-level risks** - Affect the agency's mission, vision, values, or *Strategic Plan* goals.
2. **Network-level risks** - Affect WSDOT's ability to deliver work and meet performance targets within an asset class. 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.
3. **Project-level risks** - Affect the scope, cost, schedule, and quality of projects. In contrast to network risks, project risks are related to specific projects. They are minimally discussed within this chapter.

For the purpose of WSDOT's TAMP, risk management activities are conducted at the network-level but also have the potential to affect agency enterprise-level 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 using the Pavement and Bridge risk management process at WSDOT's network-level, and explains how the agency continues to evolve its practices in the context of transportation asset management. Enterprise and project-level risk management discussions are omitted here for the purposes of MAP-21.

It is also important to note that as WSDOT works through the details associated with the Move Ahead Revenue Package, some of the risks as well as the likelihood of occurrence and severity may change. As these details are finalized, WSDOT will assess the magnitude of the changes the to this chapter and will work with our federal partners to determine if an update is necessary.

See *Appendix B* for more description regarding all types of WSDOT risk management.

Federal Requirements

Under MAP-21/FAST Act, the Federal Highway Administration (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 National Highway System (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).
  - 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.
- Summary of the evaluations for NHS pavements and bridges and facilities repeatedly damaged by emergency events. (23 CFR Part 667).

In 2021, Congress passed the Infrastructure Investment and Jobs Act (IIJA)/Bipartisan Infrastructure Law (BIL) which added the requirement for state DOT's to consider extreme weather and resilience in the lifecycle cost and risk management analysis.

The requirements outlined in MAP-21/FAST Act and IIJA/BIL are met through WSDOT's approach to risk management and are explained in detail in this chapter and Appendix B.

WSDOT Risk Management Strategies

Additional to asset management planning activities, WSDOT adopts and implements risk management strategies to mitigate certain risk factors. The risk management strategies identified below detail WSDOT's application of Asset Risk Management (ARM) at the network-level.

Network-Level Risks

Prior to the TAMP risk workshops in 2017, WSDOT identified network-level risks potentially affecting pavement and bridge assets from a statewide perspective. In a 2014 Washington's Joint Legislative Audit and Review Committee (JLARC) issued a 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 needs and cost estimates. Two categories of risk were reviewed:

- **Systematic Risks** – Included are market fluctuations, budget restrictions, and insufficient or inaccurate data.
- **Site-Specific Risks** – Included are sudden condition-related failures, natural hazards, climate change impacts, and man-made hazards.

WSDOT held TAMP risk workshops, beginning September of 2021 for Pavement and Bridge assets, which expanded upon the work completed in the 2019 TAMP and the prior network-level risk assessment efforts by JLARC in 2014. Detailed network-level Risk Register results for Pavement and Bridge assets are included as *TAMP Appendix E*.

WSDOT has also considered risk-related impacts resulting from the COVID-19 pandemic for Pavement and Bridge Assets but determined that these impacts are likely to be short-term considering the 10-year analysis required for this asset management plan. Therefore, these risks were not included in the risk matrices. An example of the risks considered includes the following:

- If restrictions around COVID are not contained, then there is a risk that pavements and bridges won't be able to be maintained properly;

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.
- 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, 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 been underfunded for over a decade. 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 three to four 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.

The state Legislature passed the Move Ahead Washington revenue package in 2022 which includes an initial investment in preservation that may manage our pavements at the lowest lifecycle costs. The details of this revenue package are still being worked out to include the timing of funding provided to the Pavement and Bridge Programs. As these details are finalized, WSDOT will assess the magnitude of the changes to the TAMP and will work with our federal partners to determine if an update is necessary.

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 that 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 or fully 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.

Risk Consideration: Extreme weather and resilience

WSDOT considers extreme weather and resilience in its risk analyses process for pavements. Some examples of this include Pavement Type Selection and All Weather Roads.

Pavement Type Selection to identify and select the most durable, cost-effective, highest-performing pavement structure for a new roadway. The goal is to select the best pavement type at the greatest overall value to the taxpayer and with a service life which provides the maximum return on the public's investment.

All weather roads – WSDOT designs its pavements to withstand all weather circumstances and incorporate the localized climate and certain extreme weather circumstances such as heat and cold fluctuations. We routinely review the criteria for adjustment to incorporate an increase or decrease in temperature fluctuations. WSDOT is considering adjusting binder grades in pavement based on potential increases in temperature. More will be discussed on this topic in future TAMPs.

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.
- 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, including a few examples of how WSDOT considers resiliency and extreme weather in asset management planning for bridge assets.

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 from 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 June 2018, more than 900 bridges across the state are a part of the Bridge Seismic Retrofit Program. Because of the program, 435 of the 900 bridges have been either partially or completely retrofitted.

Bridge Scour Mitigation Program

WSDOT's Bridge Scour Mitigation Program is responsible for performing scour specific 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 employs methods developed specific to Washington state (WA-ARD 249.1) and identifies bridges at risk for scour, then monitors, prioritizes and applies mitigation strategies to bridges that have the highest level of scour deficiencies. As of June 2019, there are 1,586 NBI structures over water (955 on NHS / 631 Non-NHS). There are 261 of these structures classified as being Scour Critical (137 on NHS / 124 on Non-NHS). There are 26 structures with unknown foundations (7 on NHS / 19 on Non-NHS).

Since 2005, WSDOT has completed 13 bridge scour repair projects, covering 17 bridges, at a total cost of $12 million. WSDOT has prioritized 12 additional bridges to address through the scour mitigation program over the next 6 years.

TAMP Risk Assessment

In addition to the risk mitigation strategies already developed, WSDOT updated the network-level risk assessment for Pavement and Bridge assets across the state for the purposes of this TAMP. WSDOT's approach focused on risks with the potential to impact agency achievement of Pavement and Bridge MAP-21 goals and objectives and included risks related to resiliency and extreme weather. Additionally, WSDOT considered potential impacts to overarching agency strategic goals and objectives for asset management. This additional level of consideration was applied since network-level risks also have the potential to affect WSDOT at the enterprise-level.

This approach provides opportunities for the agency to relate potential risks across all levels of the agency, from executive leadership to individual asset groups. Additionally, these activities also encourage enterprise-level discussion between different groups at the network-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 reflected in Exhibit 5-1.

Exhibit 5-1: WSDOT Asset Risk Management Integration with Strategic Plan Objectives[1,2]

WSDOT Strategic Plan *Enterprise-level* Goal Area	**Practical Solutions:** Prioritize innovative, timely and cost-effective decisions with our partners to operate, maintain, plan, and build our multimodal transportation system.							
WSDOT Strategic Plan *Enterprise-level* Practical Solutions Strategy	**Asset Management:** Establish asset management plans supported by needs descriptions and funding strategies; manage assets to appropriate service levels.							
WSDOT Strategic Plan *Enterprise-level* Asset Mgmnt. Objectives	# 1: Document an asset management plan for each identified asset class within the four major asset categories identified in our Agency Executive order. Each asset management plan will provide information necessary to perform fundamental investment trade-off analysis.	# 2: Leverage agency work efforts on performance measures and the Performance Framework to begin scenario analysis of investment trade-offs in order to inform policy direction and agency budget requests.	# 3: Integrate operating and capital asset management investment strategies to enhance desired performance outcomes at reduced life-cycle costs.	#4: Expand the factors considered in asset management strategies to more effectively respond to changing circumstances, to refine risk management mitigation efforts, and to provide feedback on the quality or effectiveness of operational and capital delivery strategies.				
WSDOT MAP-21 *Network-level* Asset Mgmnt. Objectives	**Pavement MAP-21 Asset Objectives:** • Design and preserve long-life pavement structures. • Minimize the number of pavement lane miles in poor condition.			**Bridge MAP-21 Asset Objectives:** • Design and preserve resilient structures. • Minimize the number of load posted or load restricted bridges. • Minimize the number of bridges in poor condition. • Minimize the number of bridge closures due to condition.				
WSDOT MAP-21 *Network-level* Asset Risk Mgmnt. Objective	Evaluate risks identified for each of the agency risk categories, as they relate to ability to deliver on Pavement and Bridge MAP-21 Asset Management Objectives over the 10-year planning period.							
WSDOT MAP-21 *Network-level* Asset Risk Category[3]	Current and Future Environmental Conditions	High-Risk, High-Value Assets	Financial	Legal or Policy Compliance	Demand	Information and Decision Risks	Operational	Hostile Acts, Malfeasance, Accidents

Exhibit Notes:

[1] Source is from the WSDOT Transportation Safety, Quality, and Enterprise Risk Division in partnership with the Capital Program Development and Management division.

[2] For further detail about WSDOT's Strategic Plan, see the November 2018 document entitled *Strategic Plan Strategies, Objectives and Measures*.

[3] Categories derived from FHWA's Nov., 2017 document *Guidance on Incorporating Risk Management into Transportation Asset Management Plans*.

Workshops

Through several risk assessment workshops, Pavement and Bridge asset risks were:

- 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, and level of governance.
- Assigned for governance to designated risk owner(s) and risk manager(s).
- Risk response strategies and plans were developed.

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 in Exhibit 5-2, as well as risk monitoring and control implementation activities.

For further details about WSDOT's risk management framework and process steps, see the *Risk Management* chapter within *Appendix B*.

Exhibit 5-2: Risk Management Process Steps

Phase	Step	Description
1	*Pre-Treatment:* Risk Identification	Collection and identification of risks throughout the organization; development of a risk-list.
2	*Pre-Treatment:* Risk Impact 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 & 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.

Results and Risk Treatment Planning

WSDOT has completed work to update the pavement and bridge asset risk registers, including risk responses for the highest priority items identified and considering extreme weather and resilience. In addition, WSDOT completes an annual analysis and results report identifying assets repeatedly damaged by emergency events on the NHS. In the sections that follow, WSDOT discusses the results of the TAMP risk assessment process.

Completion of Risk Registers for Pavement and Bridge Assets

Beginning September 13, 2021, WSDOT held multiple workshops to complete risk assessments for its Pavement and Bridge assets. Follow-up meetings to finalize asset risk registers (*Appendix E*) for Pavements occurred on October 5, 2021, October 27, 2021, November 18, 2021; and for Bridges on October 4, 2021, October 25, 2021, and November 18, 2021.

WSDOT included its Resiliency Workgroup Steering Committee in the Pavement and Bridge 2021 risk workshops. The intent was to have perspectives from extreme weather and resilience better represented throughout these workshops with the goal of having improved language in the risk register that considers these areas.

TAMP risk assessment results and impact mitigation plan summary information is provided in Exhibits 5-3 to 5-8 and 5-9 to 5-14 for Pavement and Bridge assets, respectively. Summary information is included for high and very-high impact risks identified through the previously described *TAMP* risk assessment processes. See *Appendix E* for WSDOT's complete Pavement and Bridge asset risk registers.

Pavement Asset Risk Summary

Exhibit 5-3: Summary of Pavement Asset Risk Management for Studded Tire Impacts

Consideration	Studded Tires
Risk Statement and Impact	If studded tires continue to be used, then premature rutting and wear will occur on bridge and road pavements, reducing life and increasing life-cycle costs.
Asset Risk Category	Operational
Level of Risk	Very High
Risk Treatment Strategy	Active Acceptance
Current Strategy	Support legislation to ban the use of studded tires. Damage to asphalt and concrete pavement on state highways is estimated at $20 to $29 million a year. This estimate is driven by a study performed by the Pavement office. In 2019, legislation (HB 1309) was proposed that would increase the fee associated with studded tire sales, and ultimately phase out the ability to purchase new studded tires. This bill did not pass the Legislature.
Risk Treatment Plan	No additional treatment plan known at this time. In place treatment is to communicate the financial impact of allowing studded tires.
Anticipated Level of Risk Post Treatment	High

Exhibit 5-4: Summary of Pavement Asset Risk Management for Insufficient Funding Impacts

Consideration	Insufficient Funding
Risk Statement and Impact	If funding is insufficient to maintain pavement in a state of good repair, then there may be unplanned failures.
Asset Risk Category	Operational
Level of Risk	Very High
Risk Treatment Strategy	Passive Acceptance
Current Strategy	WSDOT has instituted strategic maintenance on flexible pavements and triage on rigid pavements to extend the pavement life in lieu of larger, more costly rehabilitation projects. This will not prevent all the unplanned failures. To support the implementation of strategic maintenance, WSDOT has an integrated approach that influences the timing and requirements of when future paving projects occur, maximizing the pavement life before a more intensive treatment option is selected. As part of the overarching investment strategies for pavements, WSDOT is actively engaged in implementing Lowest Lifecycle cost strategies through the chip seal conversion program. The Pavement office also has well documented asset management practices as communicated in the Pavement Manual. Pavement performance is actively monitored through performance measures established in the *Gray Notebook*.
Risk Treatment Plan	The *2014 JLARC Audit Report* concluded that more communication about needs would be beneficial. WSDOT has been clear on its unfunded needs regarding the necessary funding to sustainably manage the pavement network. The 10-year funding amounts are well below annual average needs. Additional treatment plans are not identified, but WSDOT continues to seek innovations in pavement practices by keeping apprised of national research projects and the latest trends in pavement technologies.
Anticipated Level of Risk Post Treatment	High

Exhibit 5-5: Summary of Pavement Asset Risk Management for Pavement Treatment Impacts

Consideration	Pavement Treatment
Risk Statement and Impact	If pavement projects are not programmed at the correct time, then life-cycle costs might increase.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	To support the implementation of strategic maintenance, WSDOT has an integrated approach that influences the timing and requirements of when future paving projects occur, maximizing the pavement life before a more intensive treatment option is selected. As part of the overarching investment strategies for pavements, WSDOT is actively engaged in implementing Lowest Lifecycle cost strategies. The pavement office also has well documented asset management practices as communicated in the pavement manual. Pavement performance is actively monitored through performance measures established in the *Gray Notebook*.
Risk Treatment Plan	Improve procedures to make project programming more accurate. More time needs to be spent reviewing the program of projects for completeness and accurate timing.
Anticipated Level of Risk Post Treatment	High

Exhibit 5-6: Summary of Pavement Asset Risk Management for Preventive Maintenance Strategy Impacts

Consideration	Preventive Maintenance Strategy
Risk Statement and Impact	If the preventive maintenance strategy is not effectively implemented, then early resurfacing or reconstruction may need to occur, increasing life-cycle costs.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	The Pavement office works closely with Headquarters and Region maintenance staff to train and identify best practices for pavement strategic maintenance. This is to ensure the most effective implementation of strategic maintenance. Training consists of pavement deterioration identification, appropriate treatment types, and root cause analysis. Maintenance crews also provides feedback on effectiveness of treatment options and successes and challenges experienced in the field. The Pavement office also works to promote consistent implementation of strategies across the Regions.
Risk Treatment Plan	Develop a single approach and implementation strategy that is consistent across Regions. Identify the scenarios and root causes of why strategies were not effective. The effectiveness of a strategy such as risk treatment is measured through pavement life extension.
Anticipated Level of Risk Post Treatment	Medium

Exhibit 5-7: Summary of Pavement Asset Risk Management for Preservation of Pavement Conditions

Consideration	Pavement Conditions
Risk Statement and Impact	If pavement conditions are not preserved in a state of good repair, then an increased crash likelihood may occur.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	Continue to monitor the friction and rutting pavement conditions to determine safety issues that may arise. Program projects that are of concern. We are currently implementing crash mitigation strategies, such as rumble strip installation and reinstallation, during programming.
Risk Treatment Plan	Align agency policy on what is considered to be impactful to crash potential, ensuring the pavement condition metrics considered impactful to crashes are given priority during programming.
Anticipated Level of Risk Post Treatment	Medium

Exhibit 5-8: Summary of Pavement Asset Risk Management for Decreasing Pavement Expertise

Consideration	Decreasing Pavement Expertise
Risk Statement and Impact	If pavement expertise and/or position longevity decreases through turnover and retirement, then statewide pavement program decisions will not be effective.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	Continue to develop employee workforce and competency
Risk Treatment Plan	Develop a recruitment and employee development plan.
Anticipated Level of Risk Post Treatment	Medium

Exhibit 5-9: Summary of Pavement Asset Risk Management for FHWA Targets, Interstate Pavement Condition

Consideration	FHWA Targets, Interstate Pavement Condition
Risk Statement and Impact	If interstate pavement condition does not meet FHWA targets, then WSDOT will be penalized per MAP-21 rules.
Asset Risk Category	Demand
Level of Risk	High
Risk Treatment Strategy	Passive Acceptance
Current Strategy	Continually propose and support funding packages that will help keep pavement condition acceptable in terms of MAP-21 rules.
Risk Treatment Plan	At this time, this risk is not expected to be likely in the immediate future. Chronic underfunding will continue to increase this risk, and when the likelihood increases, a different treatment plan may be proposed.
Anticipated Level of Risk Post Treatment	High

Exhibit 5-10: Summary of Pavement Asset Risk Management for FHWA Targets, Non-Interstate Pavement Condition

Consideration	FHWA Targets, Non-Interstate Pavement Condition
Risk Statement and Impact	If funding is insufficient to maintain non-interstate pavement in a state of good repair, then there may be an increased burden on our maintenance forces.
Asset Risk Category	Demand
Level of Risk	High
Risk Treatment Strategy	Passive Acceptance
Current Strategy	Current funding levels do not allow WSDOT to fund projects on lower volume routes and road sections. There will be an increased burden on maintenance forces.
Risk Treatment Plan	Chronic underfunding of preservation will continue to increase this risk.
Anticipated Level of Risk Post Treatment	High

Exhibit 5-11: Summary of Pavement Asset Risk Management for Maintenance

Consideration	Maintenance
Risk Statement and Impact	If funding is insufficient to maintain pavement in a state of good repair, then roads may be signed for a lower speed or close.
Asset Risk Category	Demand
Level of Risk	Very High
Risk Treatment Strategy	Active Acceptance
Current Strategy	Continue to program projects where we can afford to, projects on lower volume routes may be susceptible to signage or lower speed. At this time, system performance is driven by funding provided to preservation. With decreased funding, system performance is reduced and risk to increased maintenance costs rises.
Risk Treatment Plan	Chronic underfunding will continue to increase this risk. Currently developing a communication plan to the public and interested parties for reduced speed and rough road postings.
Anticipated Level of Risk Post Treatment	Very High

Bridge Asset Risk Summary

Exhibit 5-12: Summary of Bridge Asset Risk Management for Bridge Deterioration

Consideration	Bridge Deterioration
Risk Statement and Impact	If funding is insufficient to maintain bridges in a state of good repair, then there may be unplanned failures.
Asset Risk Category	High-Risk, High-Value Assets
Level of Risk	Very High
Risk Treatment Strategy	Mitigation, Active Acceptance
Current Strategy	WSDOT is currently only receives about 50% of the maintenance and preservation funding needed to keep our assets in a state of good repair. WSDOT identifies and prioritizes bridge preservation needs for a 10 year period. The needs are separated into subcategories such as: border bridges; steel bridge painting; concrete deck rehabilitation; movable/floating bridges; bridge repairs; bridge rehabilitation and replacement. WSDOT will address the highest priority needs first, specifically border bridges, movable/floating bridges, and all preservation needs on T-1 freight routes. If additional funding remains, other lower-priority needs will be addressed (T-2 and below freight routes).
Risk Treatment Plan	The JLARC Audits from 2014 and 2019 concluded that more communication about needs would be beneficial. WSDOT has been clear on its unfunded need communication regarding necessary amounts to sustainably manage the bridge and pavement network. WSDOT will continue to communicate this need to the legislature and the governor's office. Because WSDOT has no control over legislative action, assume no long-term risk reduction.
Anticipated Level of Risk Post Treatment	Very High

Exhibit 5-13: Summary of Bridge Asset Risk Management for Seismic Impacts to Mobility and Recovery

Consideration	Seismic Impacts to Mobility and Recovery
Risk Statement and Impact	If a seismic event occurs, then mobility and recovery may be impacted, due to collapse or closure of bridges
Asset Risk Category	Environmental Conditions
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	WSDOT has completed nearly $200 million on bridge seismic retrofits to date. All retrofitting has been done to the life safety standard. WSDOT has approximately $1 billion in additional need to complete retrofitting of all Western Washington bridges to the life safety standard. There is an additional need to start designing new bridges on lifeline routes to a higher standard (known as “recovery”. Bridge designed to the recovery standard are expected to survive a major seismic event with repairable damage.
Risk Treatment Plan	Provide additional funding to complete retrofitting Western Washington bridges to the life safety standard. Consider designing new bridges to the recovery standard (particularly new lifeline bridges).
Anticipated Level of Risk Post Treatment	Medium

Exhibit 5-14: Summary of Bridge Asset Risk Management for Staff Knowledge, Skill, Ability

Consideration	Staff Knowledge, Skill, Ability
Risk Statement and Impact	If bridge expertise and/or position longevity decreases through attrition, then statewide bridge program decisions will not be effective.
Asset Risk Category	Operational
Level of Risk	High
Risk Treatment Strategy	Mitigation
Current Strategy	WSDOT will document Asset Management procedures and processes to share knowledge in the future. WSDOT may need to establish a cross training process when key personnel get closure to retirement.
Risk Treatment Plan	WSDOT will document Asset Management procedures and processes to share knowledge in the future. WSDOT may need to establish a cross training process when key personnel get closure to retirement. Until employee compensation and benefits improve, it is unlikely that ground will be gained in this area.
Anticipated Level of Risk Post Treatment	Medium

Risk Planning for Assets Repeatedly Damaged by Emergency Events

This section provides the background, approach, and partnerships created for the analysis and subsequent report developed to address assets repeatedly damaged through emergency events on the NHS. The initial report's findings were submitted to FHWA on November 21, 2018, and were updated in November 3, 2021 and are included as *TAMP Appendix F*.

Background

As part of the federal MAP-21 requirements under 23 CFR 667, states are required to track projects receiving Federal Emergency Relief (Federal ER) dollars to determine locations on the NHS where assets were repeatedly damaged through emergency events. Data included in this analysis included information available for the period of 1997 to 2020.

The analysis identified locations on the NHS that had multiple emergency events occur in either the same location or within a 3-mile vicinity of each other. Then a determination was made as to whether or not those locations would benefit from future projects with an alternative design. Such actions would improve the resiliency of the network in those areas and decrease the likelihood of the same assets being damaged again.

Approach and Findings

To identify qualifying projects, project information from our state and local Federal-Aid Tracking Systems were placed into GIS and reviewed for overlapping projects receiving Federal ER dollars.

Since 1997, Washington state has received Federal ER funds for over 1,600 state and local qualifying projects across the state. Of these projects, 38 have been identified as meeting the requirements for additional analysis prescribed by 23 CFR 667 (that is, located on the NHS with assets that have been repeatedly damaged, requiring both repair and replacement). Within the 38 projects, 6 require additional tracking, analysis or consideration for alternative designs. Four out of the six projects requiring tracking for alternative design are on the state-owned portion of the NHS and two are on the locally-owned portion of the NHS.

Exhibit 5-15: 23 CFR 667 Analysis, GIS Screening Tool

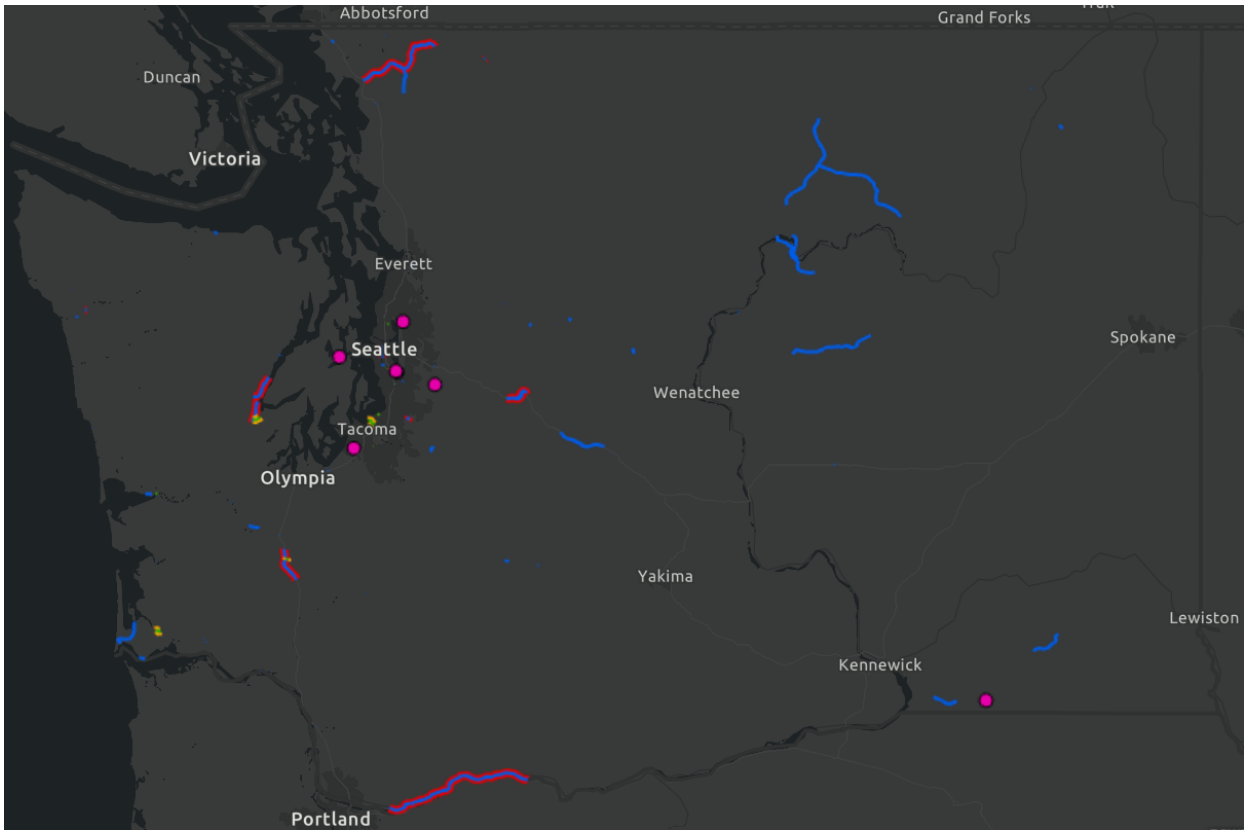


Exhibit Notes: GIS tool created to assist with project analysis. Information represented in image reflects statewide incident locations and capital projects as of October 2020. Due to a data processing error, this represents a subset of the statewide incidents and capital projects.

The analysis required in 23 CFR Part 667 and included in this TAMP does not include a complete data set. WSDOT experienced an issue when processing the data required for this analysis. A a result, the analysis only included approximately 1,000 qualifying projects (278 state and 720 local qualifying projects) that Washington state has received ER funds for and excluded about 600 projects. Because of the timing of when the issue was discovered relative to the TAMP submission deadline, the TAMP will include a partial analysis and plans to correct the analysis for the next Part 667 analysis submission to FHWA as well as future TAMPs.

Exhibit 5-16: Preliminary Findings of the 23 CFR 667 Analysis[1]

Analysis Considerations	Number of State Projects	Number of Local Projects
Total qualifying projects identified	278	720
Successfully mapped	259	343[2]
Total qualifying projects on NHS	133	25
Part of multiple incident location on NHS	10	7
Part of 3 mile proximity query	11	10
Number of projects being tracked that require alternative designs	4	2

Exhibit Notes:

[1] The preliminary findings is based on a partial analysis of approximately 1,000 projects due to an issue with processing the data required in the analysis. The analysis will be corrected in future TAMP updates.

[2] Of the 377 that were not mapped, 262 occurred between 1996 and 1997. Also, degree of accuracy for local projects is less accurate than state projects due to incomplete data and the need to manually place certain projects.

While root-cause events range from earthquakes to fires, the single most common factor triggering a qualifying event in Washington State is water-related. A summary of recurring root cause events on the NHS is reflected in Exhibit 5-17. Whether through flooding, bank erosion, or accelerated degradation of an unstable slope, hydrological factors are a leading cause of recurring qualifying emergency relief events.

Exhibit 5-17: Summary of Recurring Root Cause Events on the NHS

Root Cause Events	Number of State Projects	Number of Local Projects
Bridge Strike	0	0
Drift Accumulation	0	0
Flooding	1	1
Other[1]	1	2
River Bank Erosion	2	0
Unstable Slope	7	7
Total	**11**	**10**

Exhibit Note:

[1] "Other" includes projects resulting from the 2001 Nisqually Earthquake and a 2017 traffic detour from Oregon to Washington resulting from wildfires in Oregon. Values are reflective of the 38 projects requiring additional analysis.

Throughout the partial analysis, it was evident that WSDOT frequently looks for more resilient solutions when rebuilding in areas impacted by emergency events. They have received more than $125 million in federal funding for the projects occurring on the NHS included in the review. However, those dollars were frequently used to address root cause issues that triggered the emergency event, decreasing the likelihood of them occurring in the future.

Partnerships and Next Steps

To assist development of this report, WSDOT's CPDM Division partnered with the Local Programs, Environmental Services Office, Information Technology Division, and the Planning Office.

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's transportation asset management financial plan serves as a roadmap for current and future transportation investment opportunities. In an environment of aging infrastructure and increasing transportation demands, the need for financial plans to guide investment opportunities that preserve our transportation network has become crucial. This financial plan serves to communicate WSDOT's revenue sources and expenditures as they relate to available funding for bridge and pavements assets, and the 10-year outlook of funding relative to asset condition performance targets.

As mentioned in the Introduction, WSDOT received the Move Ahead Washington revenue package from the Washington state Legislature during the 2022 Legislative Session. This package includes investments targeted to preserve and maintain the state's transportation system. The details of this revenue package are still being worked out to include the timing of funding provided to the Pavement and Bridge Programs. Most of the revenue provided by this package has not been incorporated into this chapter as the funding amounts per year has yet to be finalized. As these details are finalized, WSDOT will assess the magnitude of the changes and their impacts to this and other relevant chapters of the TAMP and work with our federal partners to determine if an update is necessary.

Legislative Process Informs Program Funding Levels at WSDOT

WSDOT's agency-wide financial plan for the TAMP outlines anticipated statewide funding sources available to the agency; however WSDOT does not have sole discretion as to how those sources should be used.

During odd calendar years, WSDOT's biennial budget is established through Washington state's legislative session. Supporting the budget development effort is WSDOT's internal budget development process that is submitted to the Governor and the Legislative Transportation Committee. WSDOT's budget development process helps communicate priorities for the agency and serves to recommend a baseline for the upcoming biennial budget setting process.

Exhibit 6-1 is an example of the budget setting timeline for the current budget deliberation process for the 2021-23 biennium. While WSDOT recommends and advocates for investments into various programs (such as Preservation), appropriation setting authority rests solely with the Legislature.

Exhibit 6-1: Overarching Washington State Biennial Budget Development Process

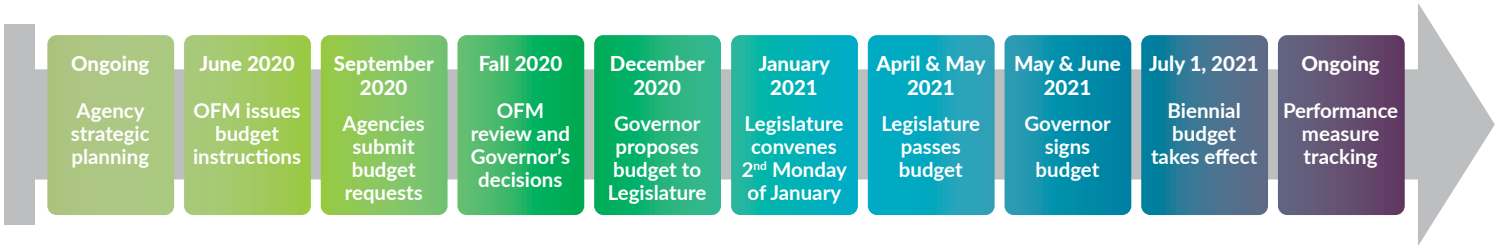


Exhibit Note: Source is from the Washington State Office of Financial Management; July, 2019 *A Guide to the Washington State Budget Process*.

Through the 2021-23 budget setting process (and supplemental budget setting process), the Legislature established a total budget of $8.3 billion, reflected in Exhibit 6-2. Of that budget, the Legislature established $1,132.7 million for highway capital preservation activities. In addition to the $1,132.7 million for preservation activities, WSDOT addresses some preservation needs through the transportation Improvements program. For the 2021-23 biennium, the Improvement program appropriation level is $3.66 billion.

Exhibit 6-2: 2021-23 Budget Levels by Major Spending Categories

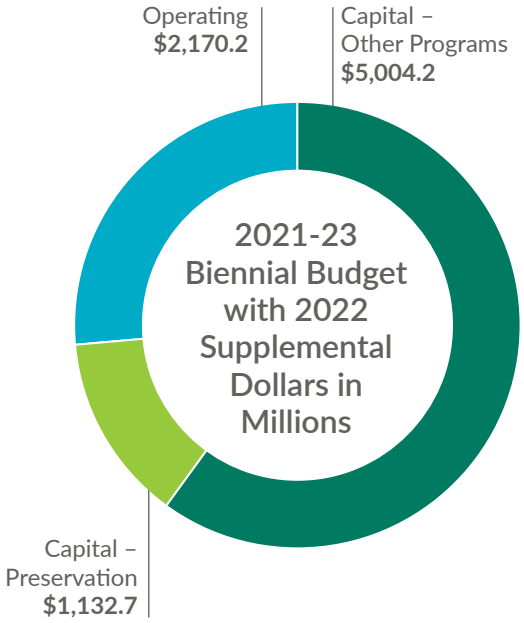


Exhibit Note: Table is based off of ESSB 5689 and assembled by WSDOT's Financial Planning office.

WSDOT systems and processes do not currently breakout the preservation work performed under the Improvement program. Thus, the total level of investment for preservation activities on the bridge and pavement network in this TAMP only represent what is spent through the Preservation[1] program. This likely understates the total amount of investment in preserving WSDOT's bridge and pavement networks, and the impact of the Improvement program spending is not modeled in future condition assessments.

Of the available $1,132.7 million for highway preservation activities, WSDOT has flexibility to determine how those funds should be allocated. As a result, WSDOT distributes funding across its asset programs based on asset needs, priorities and objectives.

Knowing that available revenues for highway preservation activities is less than total needs across all assets, WSDOT must balance short term asset funding with long-term asset condition, performance, and system risks. However, the Move Ahead Washington revenue package provided by the state Legislature will provide additional revenue toward these preservation needs. For additional information on this process, please see the "Investment Strategies" and "Performance Scenario" chapters in the TAMP.

An output of WSDOT's highway asset management strategies established the final 2021-23 investment levels for Bridge and Pavement. Exhibit 6-3 shows those investment levels relative to WSDOT's budget.

Exhibit 6-3: 2021-23 Budget With Preservation Investment Levels by Asset

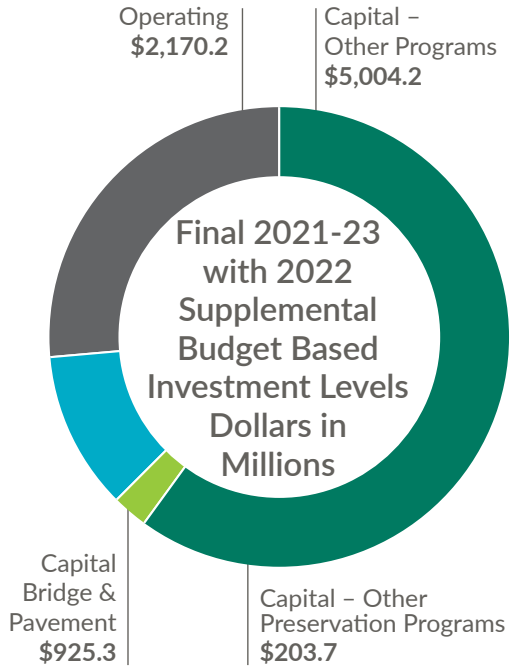


Exhibit Note: Table is based off of ESSB 5689 and assembled by WSDOT's Financial Planning office.

[1] WSDOT's capital Preservation program funding is dedicated towards preserving or replacing existing assets on the highway system through prioritized investment strategies that maximize the useful life of assets at the lowest practicable cost.

It is important to note that WSDOT's levels of capital investments represented in the capital project delivery plan and the remainder of the TAMP financial plan will not align with the appropriation levels established by the 2021-23 budget. WSDOT uses a variety of strategies to program projects that might exceed appropriation levels. This approach offsets the risk of having projects come in under budget (leaving additional appropriation on the table), and places the agency in a position to use any additional funding sources that become available.

While the following section of this chapter discusses statewide revenue sources, those sources are used for the overarching budget setting process. WSDOT's level of investment in Preservation activities is ultimately set by the Legislature.

Revenue Sources

Washington state has a diverse stream of state 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.)
- 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 2021-23 biennium, gross transportation funds from all sources are expected to total approximately $8 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 (e.g., 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. To further understand the forecast process and revenue structure of Washington state, please refer to the "Revenue and Financials" chapter in Appendix B of this document

Financial Plan Revenue Sources

Exhibit 6-4 provides a summary totaling all WSDOT revenue sources. For a break-down of State, Federal, and Local fund source detail, see Exhibits 6-5, 6-6, and 6-7 respectively. To ascertain the total amount of funding available to WSDOT, the following assumptions were made to determine the amount of revenue available over the 10-year financial plan period:

- Total transportation revenues are generally based on the Transportation Revenue Forecast Council's (TRFC) adopted February 2022 forecast.
- Includes all state and federal sources.
- Federal sources align with anticipated Obligation Authority.
- The revenue forecast contains its own set of assumptions which may be found in the published forecast.
- Bond revenue/sale projections are based on WSDOT's financial plan submitted to the Office of Financial Management in 2021.
- 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.
- Statutorily required distributions to cities, counties, and other state agencies.
- Connecting Washington transfers to cities and counties recently added to the revenue forecast.

Exhibit 6-4: All Projected WSDOT Revenue Sources

TOTAL SOURCES 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Total State Funds	$1,929	$2,123	$3,145	$3,123	$2,794	$11,726	$24,840
Total Federal Funds	$943	$549	$552	$557	$661	$3,341	$6,603
Total Local Funds	$40	$40	$40	$30	$30	$38	$218
Total Funds	**$2,912**	**$2,712**	**$3,737**	**$3,710**	**$3,485**	**$15,105**	**$31,661**

Exhibit Note: Revenue sources are net of the distributions outlined in Exhibits 6-5, 6-6, and 6-7. Dollars are in state fiscal years except federal dollars, which are in federal fiscal years. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL) or the 2022 Move Ahead Washington revenue package. Total Local Funds data for state fiscal year 2031 is not represented in the table above.

State Sources

State Revenue Source Considerations

February 2022 Economic Forecast

Based on the February economic forecast, The 2019-21 biennium revenue finished at $6.12 billion, which was down $298 million or 4.65% biennia to biennia due to the 2019-21 biennium incorporating actuals coming in lower due to the pandemic first impacting the last biennium. The current biennium. 2021-23, is showing a recovery for transportation revenues at $6.59 billion in total revenues with a 7.6% growth biennia to biennia.

In FY 2021 baseline total transportation revenues came in at $3.221 billion which was 11% higher than in 2020. In the current fiscal year, baseline total transportation revenues are anticipated to be $3.186 billion, which is a year of year over year increase of 1% but FY 2023 now has a 7% annual growth after FY 2022. This February forecast is only a minor adjustment downward from the November forecast. Overall, during the next 10-year forecast horizon, February's baseline transportation revenues are projected to be $35.98 billion which is down $506 million or 1.4% from the November forecast. Economic factors such as driver population, fuel demand, and new vehicle sales in the forecast may cause variability in future forecasts. The February 2022 Transportation Economic and Revenue Forecasts contains additional information on the 10-year state source outlook.

State Revenue Packages

Past state revenue packages (Nickel, Transportation Partnership Account, and Connecting Washington) approved by the State Legislature have had a strong bias towards mobility projects. Most recently in 2022, Washington state passed the Move Ahead Washington funding package which is expected to generate $17 billion in revenue over a 16-year time period. Of that $17 billion, $3.8 billion is designated for Preservation and Maintenance activities.

Future State Revenue Sources

The Move Ahead Washington revenue package was provided as an initial investment in preservation and maintenance. WSDOT continues to communicate preservation needs as its top priority for any additional funding stream should it come available. The agency recognizes that maintaining and preserving WSDOT's transportation assets is the foundation for keeping the transportation system safe, improving mobility, and supporting economic development.

Exhibit 6-5: Total State Revenue Sources

TOTAL STATE SOURCES 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Motor Vehicle Fuel Tax	$1,214	$1,231	$1,252	$1,267	$1,278	$6,535	$12,777
License, Permits, and Fees	579	679	696	711	725	3,797	7,187
Toll Revenue	187	230	251	258	264	1,438	2,628
Ferry Fares	174	203	224	233	241	1,321	2,396
Other Revenue	146	145	152	155	157	821	1,576
Move Ahead WA Revenue	77	77	168	168	159	817	1,466
General Fund Sales Tax*	55	55	56	56	47	140	409
State Bonds	274	274	1,176	1,176	885	1,938	5,723
Earned Interest	7	7	7	7	7	33	68
less CW Transfers to Cities and Counties	(27)	(27)	(27)	(27)	(27)	(134)	(269)
less Debt Service	(758)	(748)	(746)	(746)	(744)	(3,431)	(7,173)
less Estimated Debt Service	(0)	(4)	(64)	(134)	(197)	(1,550)	(1,949)
Total Available State Funds	**$1,928**	**$2,122**	**$3,145**	**$3,124**	**$2,795**	**$11,725**	**$24,839**

Exhibit Note: State revenue source estimates are based on the February 2022 economic forecast and WSDOT's bond model. Figures in 2023-2031 do not include funding from the 2022 Move Ahead Washington revenue package.

Federal Sources

Federal Revenue Source Considerations

Local Distributions

$1,454 million dollars in federal core program apportionment are expected to be received by the state in FFY 2022. Of this, approximately 28 percent is distributed to local jurisdictions. As local jurisdictions own and maintain 23 percent of the National Highway System, this funding is critical to support the overall health of the NHS across the state.

Federal Funds Received through the Federal Emergency Relief Program

Federal funds received through the federal emergency relief (ER) program are not represented in the federal economic forecast. As part of the study required by states under 23 CFR 667, WSDOT determined that from 2007 through 2020, Washington state received an average of $20 million per year in qualifying federal ER funds. This funding was used across the state to support rebuilding efforts whenever a state or federal emergency was declared. For more information on this study, please see the summary contained in the "Risk Management" chapter of this document. The complete study is also included as part of the TAMP in Appendix E.

Exhibit 6-6: Total Federal Revenue Sources

TOTAL FEDERAL SOURCES 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
NHPP	$330	$332	$329	$329	$328	$1,637	$3,285
STP	44	44	44	44	44	222	442
Carbon Reduction Program	21	22	22	22	23	117	227
Bridge Formula Program	121	123	126	128	131	670	1,299
National Electric Vehicle Program	10	11	11	11	11	58	112
PROTECT	24	25	25	26	26	133	259
Other Federal Programs	495	95	97	99	101	515	1,402
less GARVEE Debt Service	(100)	(100)	(99)	(99)	(0)	(0)	(398)
less Hood Canal Debt Service	(3)	(3)	(3)	(3)	(4)	(11)	(27)
Local Programs Federal Distributions							
NHPP	22	22	22	22	23	112	223
STP	107	114	126	136	147	796	1,426
Other Federal Programs	279	285	292	298	305	1,567	3,026
less Local Distributions	(408)	(421)	(440)	(456)	(475)	(2,475)	(4,675)
Total Available Federal Funds	**$942**	**$549**	**$552**	**$556**	**$660**	**$3,341**	**$6,601**

Exhibit Note: Federal revenue sources are aligned with anticipated OA from February 2022 economic forecast. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL).

Local Sources

Various local revenue allocations round out the remainder of WSDOT's transportation funding. Exhibit 6-7 shows the summary totals for local revenue sources.

Local funds are anticipated in the financial plan as planned reimbursements for work done by WSDOT on the state highway system at the request of other agencies. Local funds 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 6-7: Total Local Revenue Sources

TOTAL LOCAL SOURCES 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Total Available Local Funds	**$40**	**$40**	**$40**	**$30**	**$30**	**$38**	**$219**

Exhibit Note: Local sources are estimated based on anticipated local reimbursements from local jurisdictions. Data for state fiscal year 2031 is not represented in the table above.

Financial Plan Uses

The following expenditure plan is based on the legislatively approved budget for the 2021-23 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.

Note: Actual and planned expenditures by local jurisdictions on locally owned sections of the NHS are 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 bridge and pavement assets. 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 reflected in Exhibit 6-8 are estimates based on the legislatively-approved 2021-23 approved budget. This budget establishes appropriation levels for the various WSDOT operating programs for the 2021-23 biennium.

Capital Expenditures

The capital expenditures reflected in Exhibit 6-9 (for the 10-year financial plan), are based on WSDOT's 2022 Supplemental Transportation Budget and the Move Ahead Washington revenue package which is used to form the basis of the Capital Improvement and Preservation Program (CIPP) and provides intent for delivery.

Exhibit 6-8: Total Projected Operating Expenditures

TOTAL USES - OPERATING 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Total State	$1,034	$987	$987	$1,006	$1,006	$5,286	$10,306
Total Federal	186	55	55	56	56	296	704
Total Local	1	1	1	1	1	4	9
Total	**$1,221**	**$1,043**	**$1,043**	**$1,063**	**$1,063**	**$5,586**	**$11,019**

Exhibit Note: Operating expenditures as legislatively appropriated through ESSB 5689 & SSB 5975. All dollars are based on the 2022 Supplemental Budget Transportation Executive Information System file 22COMBO. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL) or the 2022 Move Ahead Washington revenue package.

Exhibit 6-9: Total Projected Capital Expenditures

TOTAL USES - CAPITAL 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Total State	$2,189	$1,902	$1,902	$1,227	$1,227	$2,902	$11,349
Total Federal	539	498	498	488	488	2,420	4,931
Total Local	40	40	40	30	30	45	225
Total	**$2,768**	**$2,440**	**$2,440**	**$1,745**	**$1,745**	**$5,367**	**$16,505**

Exhibit Note: All dollars are based on the 2022 Supplemental Budget Transportation Executive Information System financial system file 22COMBO. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL) or the 2022 Move Ahead Washington revenue package.

Exhibit 6-10 provides the anticipated capital preservation expenditures across the Preservation program. A summary of WSDOT's total revenue sources and uses is reflected in Exhibit 6-11. For more information on WSDOT's capital program, please refer to the "Revenue and Financials" chapter in Appendix B.

Exhibit 6-10: Projected Capital Preservation Expenditures

Planned Preservation Spending ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Roadway Preservation	$186	$177	$177	$168	$168	$863	$1,739
Structures Preservation	266	253	253	241	241	1,233	2,487
Other Facilities	80	76	76	72	72	370	746
DPS/Program Support - P	34	32	32	33	33	170	334
Total	**$566**	**$538**	**$538**	**$514**	**$514**	**$2,636**	**$5,306**

Exhibit Note: All dollars have been adjusted to reflect year of expenditure and are based on the 2022 Supplemental Budget Transportation Executive Information System file 22CONFCL and 22CONFNL. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL) or the 2022 Move Ahead Washington revenue package.

Exhibit 6-11: Total Revenue Sources and Revenue Uses

TOTAL SOURCES 10-Year Estimate ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Total State Funds	$1,929	$2,123	$3,145	$3,123	$2,794	$11,726	$24,840
Total Federal Funds	$943	$549	$552	$557	$661	$3,341	$6,603
Total Local Funds	$40	$40	$40	$30	$30	$38	$218
Total	**$2,912**	**$2,712**	**$3,737**	**$3,710**	**$3,485**	**$15,105**	**$31,661**
TOTAL USES - OPERATING							
Total State	$1,034	$987	$987	$1,006	$1,006	$5,286	$10,306
Total Federal	186	55	55	56	56	296	704
Total Local	1	1	1	1	1	4	9
Total	**$1,221**	**$1,043**	**$1,043**	**$1,063**	**$1,063**	**$5,586**	**$11,019**
TOTAL USES - CAPITAL							
Total State	$2,189	$1,902	$1,902	$1,227	$1,227	$2,902	$11,349
Total Federal	539	498	498	488	488	2,420	4,931
Total Local	40	40	40	30	30	45	225
Total	**$2,768**	**$2,440**	**$2,440**	**$1,745**	**$1,745**	**$5,367**	**$16,505**

Exhibit Note: Consolidates summary information from Exhibits 6-5 through 6-10. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL) or the 2022 Move Ahead Washington revenue package.

10-Year Needs, Planned Bridge and Pavement Spending

As part of the department's asset funding need process, the Bridge and Pavement offices provide estimates of the total 10-year investment needs, based on asset management practices. The 10-year needs represent the amount of funding required to fully implement lowest life cycle cost strategies across the statewide network.

State Planned Bridge and Pavement Expenditures

Exhibits 6-12 through 6-14 represent the planned level of expenditures for bridge and pavement assets over the next 10 years, further broken out by FHWA work activity type. Exhibit 6-12 looks at the state-owned planned bridge and pavement capital expenditures. Exhibits 6-13 and 6-14 align expenditures to needs and show the investment gap between the two. Investment gaps reflect the difference between the current level of funding and the funding necessary to implement lowest lifecycle cost strategies. As mentioned earlier, this information may change as WSDOT better understands the details associated with the Move Ahead Washington revenue package. WSDOT will work with our federal partners to determine if an update is necessary.

Exhibit 6-12: Planned State NHS and non-NHS Pavement and Bridge Capital Expenditures

Planned Pavement Preservation Spending ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
NHS Pavement Spending	$168	$160	$160	$152	$152	$777	$1,569
Non-NHS Pavement Spending	19	18	18	17	17	86	175
Total	**$187**	**$178**	**$178**	**$169**	**$169**	**$863**	**$1,744**
Planned Bridge Preservation Spending ($ in Millions)	**2022**	**2023**	**2024**	**2025**	**2026**	**2027-2031**	**Total**
NHS Bridge Spending	$240	$228	$228	$217	$217	$1,110	$2,240
Non-NHS Bridge Spending	27	25	25	24	24	123	248
Total	**$267**	**$253**	**$253**	**$241**	**$241**	**$1,233**	**$2,488**

Exhibit Note: All dollars based on the anticipated expenditures for bridge and pavement projects included in 2022 Supplemental Budget Transportation Executive Information System file 22CONFCL and 22CONFNL. Figures in 2023-2031 do not include funding from the new federal revenue (IIJA/BIL) or the 2022 Move Ahead Washington revenue package.

Exhibit 6-13: 10-Year Pavement Needs[1]

Pavement Ten Year Average Need ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Capital Preservation	$318	$318	$318	$318	$318	$1,590	$3,180
Operational Maintenance[2]	38	38	39	39	39	204	397
Total Need	**$356**	**$356**	**$357**	**$357**	**$357**	**$1,794**	**$3,577**
Pavement Ten Year: Planned Spending ($ in Millions)	**2022**	**2023**	**2024**	**2025**	**2026**	**2027-2031**	**Total**
Total Capital Preservation Spending	$186	$177	$177	$168	$168	$863	$1,739
Preservation[3]	*30*	*28*	*28*	*27*	*27*	*138*	*278*
Rehabilitation	*104*	*99*	*99*	*94*	*94*	*483*	*973*
Replacement	*52*	*50*	*50*	*47*	*47*	*242*	*488*
Operational Maintenance Spending	38	38	39	39	39	204	397
Total Spending	**$224**	**$215**	**$216**	**$207**	**$207**	**$1,067**	**$2,136**
Investment Gap	**$(132)**	**$(141)**	**$(141)**	**$(150)**	**$(150)**	**$(727)**	**$(1,441)**

Exhibit Notes:
[1] Operational Maintenance reflects only activities that act upon the short-term condition of the pavement.
[2] Preservation, Rehabilitation, and Replacement activities were aligned to FHWA activity types using WSDOT's improvement type codes.
[3] Funding is in 2021 dollars.

Exhibit 6-14: WSDOT's 10-Year Bridge Needs[1]

Bridge Ten Year Average Need ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
Capital Preservation	$332	$332	$332	$332	$332	$1,661	$3,321
Operational Maintenance[1]	27	27	27	28	28	144	281
Total Need	**$359**	**$359**	**$359**	**$360**	**$360**	**$1,805**	**$3,602**
Bridge Ten Year: Planned Spending ($ in Millions)	**2022**	**2023**	**2024**	**2025**	**2026**	**2027-2031**	**Total**
Total Capital Preservation Spending	$266	$253	$253	$240	$240	$1,233	$2,485
Preservation[2]	*152*	*144*	*144*	*137*	*137*	*703*	*1,417*
Rehabilitation	*85*	*81*	*81*	*77*	*77*	*394*	*795*
Replacement	*29*	*28*	*28*	*26*	*26*	*136*	*273*
Operational Maintenance Spending	27	27	27	28	28	144	281
Total Spending	**$293**	**$280**	**$280**	**$268**	**$268**	**$1,377**	**$2,766**
Investment Gap	**$(66)**	**$(79)**	**$(79)**	**$(92)**	**$(92)**	**$(428)**	**$(836)**

Exhibit Notes:

[1] Operational Maintenance reflects only activities that act upon the short-term condition of the bridge. This reflects an adjustment to what was reported in the April 2018 initial TAMP, and reduces the total amount of operational maintenance need and corresponding planned expenditures.

[2] Preservation, Rehabilitation, and Replacement activities were aligned to FHWA activity types using WSDOT's improvement type codes.

NHS Planned Pavement and Bridge Expenditures

WSDOT has been making progress towards determining needs for the locally-owned sections of the NHS and recently estimated average annual pavement needs (see Appendix C). Average annual needs for bridges specific to the locally owned NHS are not yet available. Similarly, projected funding dedicated to the local NHS network is also not available. This is due to the process of how local projects are selected and funded, and the lack of data around where those projects occur (on or off the NHS). WSDOT will continue to work both internally and externally, leveraging the current MPO engagement framework to obtain baseline funding estimates for the local NHS. It is anticipated this effort will take several years and will be reported in the 2026 TAMP update. A plan for obtaining this information will be developed shortly after this TAMP is submitted to FHWA.

Exhibits 6-15 and 6-16 looks specifically at the planned levels of expenditures, needs, and investment gap for the NHS, representing both state and locally-owned bridge and pavement assets. State investments on the NHS are fully available and are aligned with FHWA work activity types, but local investments are shown as "Not Yet Available."

Exhibit 6-15: State and Local NHS 10-Year Pavement Needs[1]

State NHS Ten Year: Average Need ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
NHS Capital Preservation Need	$286	$286	$286	$286	$286	$1,432	$2,862
Total Planned Capital NHS Spending	168	160	160	151	151	776	1,566
Preservation[2]	*27*	*26*	*26*	*24*	*24*	*124*	*251*
Rehabilitation	*94*	*89*	*89*	*85*	*85*	*435*	*877*
Replacement	*47*	*45*	*45*	*42*	*42*	*217*	*438*
Investment Gap	**$(118)**	**($126)**	**($126)**	**($135)**	**($135)**	**($656)**	**($1,296)**
Local NHS Ten Year: Average Need ($ in Millions)	**2022**	**2023**	**2024**	**2025**	**2026**	**2027-2031**	**Total**
NHS Capital Preservation Need	$44	$44	$44	$44	$44	$220	$440
Planned Capital NHS Spending	Not Yet Available						
Investment Gap	**Not Yet Available**						
Total NHS Investment Gap	**Not Yet Available**						

Exhibit Notes:

[1] State-owned NHS needs are based on WSDOT's pavement condition data and pavement lifecycle models. Planned NHS spending is based on WSDOT's 2022 Supplemental Budget. Local NHS needs are based on local survey data for lifecycle costs, pavement data, and WDOT's lifecycle models. For more information on how local NHS needs were calculated, see Appendix C.

[2] Preservation, Rehabilitation, and Replacement activities were aligned to FHWA activity types using WSDOT's improvement type codes.

Exhibit 6-16: State and Local NHS 10-Year Bridge Needs[1]

State NHS Ten Year: Average Need ($ in Millions)	2022	2023	2024	2025	2026	2027-2031	Total
NHS Capital Preservation Need	$299	$299	$299	$299	$299	$1,495	$2,990
Total Planned Capital NHS Spending	240	228	228	216	216	1,109	2,237
Preservation[2]	*137*	*130*	*130*	*123*	*123*	*632*	*1,275*
Rehabilitation	*77*	*73*	*73*	*69*	*69*	*355*	*716*
Replacement	*26*	*25*	*25*	*24*	*24*	*122*	*246*
Gap	**($59)**	**($71)**	**($71)**	**($83)**	**($83)**	**($386)**	**($753)**
Local NHS Ten Year: Average Need ($ in Millions)	**2022**	**2023**	**2024**	**2025**	**2026**	**2027-2031**	**Total**
NHS Capital Preservation Need	Not Yet Available						
Planned Capital NHS Spending	Not Yet Available						
Investment Gap	**Not Yet Available**						
Total NHS Investment Gap	**Not Yet Available**						

Exhibit Notes:

[1] State-owned NHS needs are based on WSDOT's bridge condition data and bridge investment strategies. Planned NHS spending is based on WSDOT's 2022 Supplemental Budget.

[2] Preservation, Rehabilitation, and Replacement activities were aligned to FHWA activity types using WSDOT's improvement type codes.

Historic Bridge and Pavement Investments by Work Activities

Rounding out the discussion on bridge and pavement expenditures is the comparison of planned to actual expenditures by FHWA work type. Exhibits 6-17 through 6-18 show WSDOT's fiscal year planned and actual expenditures for bridge and pavement assets by work type (statewide and on the NHS) for the 2021 state fiscal year. Tracking expenditures by work type allows WSDOT the ability to monitor if planned levels of investments were followed. Material deviations in expenditures relative to what was planned may indicate shifting priorities by the agency or significant events (e.g., severe storms, worse than expected winter conditions, slides, or earthquakes). Such events place a strain on the highway network and require significant, unanticipated funding.

Exhibit 6-17: 2021 Statewide Pavement and Bridge Investment Levels by FHWA Work Type[1]

Pavement Work Type	Planned Expenditures ($ in Thousands)	Actual Expenditures ($ in Thousands)	Difference
Maintenance	$32,993	$17,045	$15,948
Preservation	96,338	40,130	56,208
Rehabilitation	137,707	61,810	75,897
Replacement	15,212	7,618	7,594
Total Pavement Investment	**$282,250**	**$126,603**	**$155,647**
Bridge Work Type			
Maintenance	$18,452	8,098	$10,354
Preservation	148,734	48,256	100,478
Rehabilitation	75,355	28,293	47,062
Replacement	40,947	14,936	26,011
Total Bridge Investment	**$283,488**	**$99,583**	**$183,905**

Exhibit Notes:

[1] Time frame July 2020 through June 2021.

Exhibit 6-18: 2021 NHS Pavement and Bridge Investment Levels by FHWA Work Type[1]

Pavement Work Type	Planned Expenditures ($ in Thousands)	Actual Expenditures ($ in Thousands)	Difference
Maintenance	Not tracked by NHS	Not tracked by NHS	N/A
Preservation	$36,162	$13,395	$22,767
Rehabilitation	125,909	55,906	70,003
Replacement	15,212	7,618	7,594
Total NHS Pavement Investment	**$177,283**	**$76,919**	**$100,364**
Bridge Work Type			
Maintenance	Not tracked by NHS	Not tracked by NHS	N/A
Preservation	$121,274	$44,917	$76,357
Rehabilitation	49,985	18,068	31,917
Replacement	33,296	11,856	21,440
Total NHS Bridge Investment	**$204,555**	**$74,841**	**$129,714**

Exhibit Notes:

[1] Time frame is July 2020 through June 2021.

Statewide Funding and Performance Analysis

Before the passage of the Move Ahead Washington revenue package, WSDOT anticipated that current funding levels for both Bridge and Pavement would meet the two- and four-year condition targets, but condition for bridges and pavements were expected to drop below the target levels by the ten-year mark if funding levels are not increased. The recently passed revenue package provided additional funding for preservation and maintenance. However, the details and impact from these investments are still being determined. For a more comprehensive discussion on expected condition levels, please see the *Chapter 7: Performance Scenarios*.

As current levels of expenditures for Bridges and Pavements remain to be less than needed to fully utilize an ideal lowest life cycle cost strategy, state bridge and pavement project prioritization were shifted to optimal performance within the current funding environment. Additional information on WSDOT's investment strategies can be found in the "Investment Strategies" chapter.

Funding Necessary for State of Good Repair

As communicated in the "Objectives and Measures" chapter, WSDOT's current definition for State of Good Repair is based on whether or not the entire network of an asset type is meeting its stated condition performance target. Based on current funding levels, bridge and pavement assets are currently meeting their stated performance targets and are anticipated to do so over the next four years. As a result, there is currently no funding gap to achieve and sustain a State of Good Repair for bridge and pavement assets over the next four years.

However, based on future condition modeling that does not take into account the Move Ahead Washington revenue package, WSDOT anticipates that conditions for bridges and pavements will drop below the target levels by the ten- year mark if funding levels are not increased. This will cause a State of Good Repair funding gap in the outer years of the plan. This funding gap is not identified in this financial plan because performance measures will be evaluated, and if necessary, adjusted at the two-year mark to realign the four-year performance measures, funding expectations, and investment strategies. The Move Ahead Washington revenue package provides an initial investment in preservation that is expected to improve pavement and bridge conditions.

Asset Replacement Value

The following section, as well as Exhibits 6-19 through 6-22 provide estimated replacement values for pavement and bridge assets across the Washington state transportation network. They also provide estimated replacement values for those same assets on the NHS. While nearly complete data sets for state-owned pavement and bridge assets exist, replacement information on the locally owned portion of NHS is not as comprehensive. WSDOT continues to refine its processes and work with local partners to obtain more complete asset information.

Pavement Replacement Value

The estimated pavement and bridge replacement value is 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. Data for Exhibit 6-19 was compiled in 2022.

Exhibit 6-19: Estimated Statewide Pavement Replacement Value

PAVEMENT TYPE	Quantity	Units	Average Unit Replacement Value ($)	Replacement Value ($ in Millions)
Asphalt	9,038	Lane Miles	$900,000	$8,134
Chip Seal	7,216		200,000	1,443
Concrete	2,443		2,500,000	6,108
Special Use Lanes	771		700,000	540
Ramps	1,430		900,000	1,287
Shoulders	7,652		270,000	2,066
Total	**28,550**			**$19,578**

Exhibit 6-20: Estimated NHS Pavement Replacement Value (State and Local Agencies)

	Quantity	Units	Average Replacement Value ($)	Replacement Value ($ in Millions)
State Pavements				
Asphalt	7,031	Lane Miles	$900,000	$6,328
Chip Seal	1,895		200,000	379
Concrete	2,056		2,500,000	5,140
Total	**10,982**		**N/A**	**$11,847**
Local Pavements				
Asphalt	1,687	Lane Miles	$900,000	$1,518
Chip Seal	1,378		200,000	276
Concrete	213		2,500,000	533
Total	**3,278**		**N/A**	**$2,327**
Grand Total	**14,260**		**N/A**	**$14,174**

Exhibit Note: Local and state NHS data derived from FHWA's 2020 HPMS database. Excludes bridge deck lane miles and unpaved roads.

Bridge Replacement Value

The estimated bridge replacement value is a product of the bridge type, length, and the average unit replacement value. This replacement value does not consider bridge age or depreciation of the asset over time, but is a snapshot of the estimated cost to replace all of WSDOT's Bridge assets at a set point in time. The estimated bridge network value decreased from the April 2018 submittal. This was due to the removal of the Alaskan Way Viaduct from the bridge network and some minor calculation errors on the initially reported value.

Exhibit 6-21: Estimated Statewide Bridge Replacement Value

BRIDGE TYPE	Quantity	Square Feet	Average Unit Replacement Value ($)	Replacement Value ($ in Millions)
Vehicular Bridges	3,181	52,403,360	$950/SF	$49,783
Small Structures (< 20' long)	444	279,169		265
Culverts (> 20' long)	147	245,367		233
Pedestrian Structures	127	398,281		378
Ferry Terminal Structures	68	1,026,763		975
Tunnels and Lids	53	109,007		104
Border Bridges	5	619,505		589
Railroad Bridges	87	414,003		393
Total	**4,112**	**55,495,455**		**$52,720**

Exhibit Note: Inventory Source: WSDOT Bridge and Structures Office and WSDOT Local Programs Office; Replacement values come from Bridge and Structures Office.

Exhibit 6-22: Estimated NHS Bridge Replacement Value (State and Local Agencies)

State Bridges	Quantity	Square Feet	Average Unit Replacement Value ($)	Replacement Value ($ in Millions)
Vehicular Bridges	2,224	44,218,516	$950/SF	$42,008
Small Structures (< 20' long)	216	165,006		157
Culverts (> 20' long)	94	187,666		178
Pedestrian Structures	75	258,799		246
Ferry Terminal Structures	44	777,359		738
Tunnels and Lids	44	88,467		84
Border Bridges	5	619,505		589
Railroad Bridges	62	206,010		196
Total	**2,764**	**46,521,328**		**$44,196**
Local Bridges	**Quantity**	**Units**	**Average Unit Replacement Value ($)**	**Replacement Value ($ in Millions)**
Vehicular Bridges	216	4,976,554	$950/SF	$4,728
Small Structures (< 20' long)	19	22,107		21
Pedestrian Structures	33	94,366		90
Railroad Bridges	32	592,123		563
Total	**300**	**5,685,150**		**$5,402**
Grand Total	**3,064**	**52,206,478**		**$49,598**

Exhibit Note: Locally-owned bridge information is provided by the Local Bridge office. Average Unit Replacement Value provided from the Bridge Estimating Manual.

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 the process of identifying deficiencies hindering progress toward preserving or improving the statewide network of assets as needed to achieve and sustain 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 them to planned funding amounts, giving a program-wide assessment of their overall effect. WSDOT has experience using varying funding amounts to develop performance scenarios in the context of specific asset classes, such as expected pavement condition, or fish habitat gain. These types of asset-to-asset analyses have helped to shape agency *Budget Requests* and assist WSDOT communication with the Washington State Legislature about the department's needs. These analyses also inform the development of the *Project Delivery Plan,* which is a constrained, project-specific capital work plan for the department for the upcoming six fiscal years.

WSDOT continues to improve cross-asset decision-making practices, leveraging new tools and frameworks to aid this endeavor.

As mentioned in the Introduction chapter, WSDOT received the Move Ahead Washington revenue package from the Washington state Legislature during the 2022 Legislative Session. This package includes investments targeted to preserve and maintain the state's transportation system. The details of this revenue package are still being worked out to include the timing of funding provided to the Pavement and Bridge Programs. As these details are finalized, WSDOT will assess the magnitude of the changes the to TAMP and will work with our federal partners to determine if an update is necessary.

This chapter begins with a discussion on the direction WSDOT is heading to analyze different performance scenarios for future life cycle planning and investment strategy decisions. The chapter ends with a review of target- and plan-based performance gap analysis.

Cross-Asset Resource Allocation Framework

WSDOT develops its cross-asset resource allocation framework in alignment with *NCHRP Report 806: Guide to Cross-Asset Resource Allocation and the Impact on Transportation System Performance*. This guide details five steps:

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

Steps 1 and 2 are already primary functions of WSDOT's asset management. Pavements and Bridges 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** – This 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** – This approach requires defining financial funding scenarios and the developing performance versus investment-level curves for each performance measure defined in Step 2.

Depending on the Performance Scenario analysis, WSDOT uses both the bottom-up and top-down approach for Step 3. When using the bottom-up approach, WSDOT builds the data flow to assess project ranking criteria and the Key Performance Indicators (KPIs) that assess the network level performance of a portfolio of projects in support of Step 3. When using the top-

down approach, WSDOT estimates KPI impact across the network at discrete funding levels in support of Step 3. These approaches are effective at supporting the TAMPs objectives in that the combination of the two approaches fully considers all aspects of project prioritization and ranking to determine the network impacts to the respective KPIs.

WSDOT is using Decision Lens for Steps 4 and 5, and has made decision models and impact dashboards for:

- Pavements
- Bridges
- Unstable Slopes
- Major Electrical Assets

These analyses also influence the development processes for the *Project Delivery Plan*, which serves as the basis for planned investments for the upcoming six years. The Pavement and Bridge Portfolios also were used for the Performance Scenario Analysis.

Performance Scenario Analysis

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 the 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?

Decision Lens

To assist with performance scenario analysis, WSDOT purchased and customized 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. WSDOT used this tool to create performance scenarios for bridge and pavement assets to see the potential impact and trade-offs of choices made between different investment options at varying funding levels.

For the 2019 TAMP, WSDOT developed four scenarios for the ten-year period from 2019-2028 for pavements and bridges. WSDOT did not update these scenario analyses from the 2019 TAMP because the order of magnitude in Preservation investments is roughly the same as it was in 2019. Therefore, WSDOT assumes the overall conclusions remain and can similarly inform continued budget development and investment strategy analyses. The remainder of this section describes the work that was previously completed. However, WSDOT may update these scenarios as the funding details are finalized from the Move Ahead Washington revenue package.

Using the Decision Lens software, four scenarios were created and analyzed for both pavements and bridges. The scenarios included the following options:

1. No Build.
2. Current Investment Levels.
3. Minimum Investment Levels.
4. Current Investment Levels of Less Than $500 million.

The "No Build" scenario sets baseline information assuming no preservation work was completed.

The "No Build" scenario sets baseline information assuming no preservation work was completed.

"Current Investment Levels" were set based on program amounts and then converted into Current Year dollars using the Construction Cost Index (CCI). Obligated costs in the 2019-21 fiscal biennium were subtracted out of current investment levels. "Minimum Investment Levels" were calculated based on the MAP-21 "Poor Condition" penalty thresholds at the end of the 10 years. For pavements, this is just Interstate roads. For bridges, this is all National Highway System deck area.

Key Performance Indicators (KPIs)

For both programs, primary KPIs are based on condition and Deferred Preservation Liability (DPL). All condition and DPL KPIs were calculated at 2022 (four-year time period) and 2028 (10-year time period). A four-year period is important because it aligns with the time period to report MAP-21 pavement and bridge performance measures. It is also a good reference for checking the shorter-term health of each preservation program. The 10-year period is important because it represents the state of the network at the end of the scenario.

Pavements

Pavement condition KPIs are the percentage of the network (weighted by lane-miles) for the Interstate, non-Interstate NHS, and all state highways. Condition was forecast over the network using the deterioration models in the Washington State Pavement Management System (WSPMS).

Pavement DPL for each project was calculated based on a penalty from the Preferred Construction Year. The Preferred Construction Year uses the Due Year information from the WSPMS and is further reviewed by both Region materials engineers and state pavement engineers. For the four- and 10-year time periods, a 7.5 percent additional cost was incurred for each year the Preferred Construction Year occurred prior to 2022 and 2028, respectively. To calculate the No Build DPL, the annual average need ($284 million) was assessed a four-year and 10-year penalty of 7.5 percent per year, less an adjustment for 2019-21 fiscal biennium obligated costs ($241 million and $373 million, respectively).

Bridges

Bridge condition KPIs were only calculated for the NHS, which comprises 89 percent of the WSDOT-owned statewide deck area. Poor condition was forecast at the four and 10-year points based on the current bridge condition and activity year. If the activity year was three years prior to 2022 for the four-year calculation or three years prior to 2028 for the 10-year calculation, the bridge was considered Poor. Additionally, paint and joint activities had no effect on Poor condition, because these elements do not cause the bridge to be categorized as in Poor condition.

Bridge DPL for each project was calculated based on a penalty from the Activity Year. For the four- and 10-year time periods, a 4 percent additional cost was incurred for each year the Activity Year was prior to 2022 and 2028, respectively. The 4 percent penalty was applied to the need, and projects that addressed multiple needs reduced the DPL by the sum of the needs DPL. The No Build DPL was calculated as the sum of the DPL for all bridge needs identified.

To assist with understanding how many of the bridge needs were addressed, WSDOT also calculated the KPIs related to the number of joints remaining, deck areas still needing resurfacing, and deck of bridges needing painted at the end of the 10-year scenario. While it is recognized bridge decks are not painted, due to available information at the time the model was created, bridge decks (as opposed to linear feet of structural steel) were used within the model.

Portfolios

Decision Lens functions by grouping similar projects into "portfolios." This section details the portfolios created for the Performance Scenario analysis for pavements and bridges.

Pavements

The following portfolios were created for Pavements:

1. No Build
2. Chip Seal
3. Chip Seal over Asphalt
4. Asphalt
5. Concrete

All portfolios use the same criteria and ranking methodology. Decision Lens uses a ranking criteria to determine which projects get funding in a specific scenario. WSDOT used the criteria reflected in Exhibit 7-1 to rank Pavement projects.

Exhibit 7-1: Decision Lens, Pavement Project Prioritization

Ranking Criteria	Definition
1. Route Criticality	This criterion assesses the importance of the roadway segment, based on:
a. Freight and Goods Transportation System	Gives an indicator of how important the route is for freight movement.
b. Functional Class	Gives an indicator for the amount or type of travel expected and relative importance.
c. Annual Average Daily Traffic	Directly measures the use of the segment of roadway based on how many vehicles use the section.
d. Speed Limit	Higher speed facilities require better condition. One of the consequences of deteriorated pavement could be to lower the speed limit.
2. Preservation Timing	This criterion prioritizes projects based on proper timing.
a. Rutting	Rutting is the current value and is meant to assess an immediate need for correction. Higher rutting indicates higher priority.
b. Preferred Construction Year	Represents the proper timing to perform the treatment based on lowest life cycle cost. Projects with Preferred Construction Years closer to the beginning of the 10 years have the highest priority.
3. Dollar per Lane-Mile Preserved	This criterion calculates the cost of the preservation per lane mile, favoring more asset coverage for less dollars.

Bridges

The following portfolios were created for Bridges:

1. No Build
2. Bridge Painting
3. Joint Repair
4. Deck Resurfacing
5. Rehab/Repair/Other

All portfolios use the same criteria and ranking methodology. WSDOT used the criteria reflected in Exhibit 7-2 to rank Bridge projects.

Exhibit 7-2: Decision Lens, Bridge Project Prioritization

Ranking Criteria	Definition
1. **Route Criticality**	This criterion assesses the importance of the roadway segment, based on:
a. Freight and Goods Transportation System	Gives an indicator of how important the route is for freight movement.
b. Functional Class	Gives an indicator for the amount or type of travel expected and relative importance.
c. Annual Average Daily Traffic	Directly measures the use of the segment of roadway based on how many vehicles use the section.
2. **Preservation Timing**	This criterion prioritizes projects based on proper timing.
a. Activity Year	Represents the proper timing to perform the treatment based on lowest life cycle cost. Projects with Activity Years closer to the beginning of the 10 years have the highest priority.

Results

The Decision Lens Impact Dashboard was used to set investment levels for each Portfolio. The distribution of the current funding matched a distribution similar to the 2018 Project Delivery Plan. The funding amounts in all portfolios were then adjusted based on each scenario. Exhibit 7-3 shows one example of the Impact Dashboard. The KPIs from each scenario are summarized in Exhibit 7-4 and 7-5.

Exhibit 7-3: Decision Lens, Impact Dashboard Screenshot

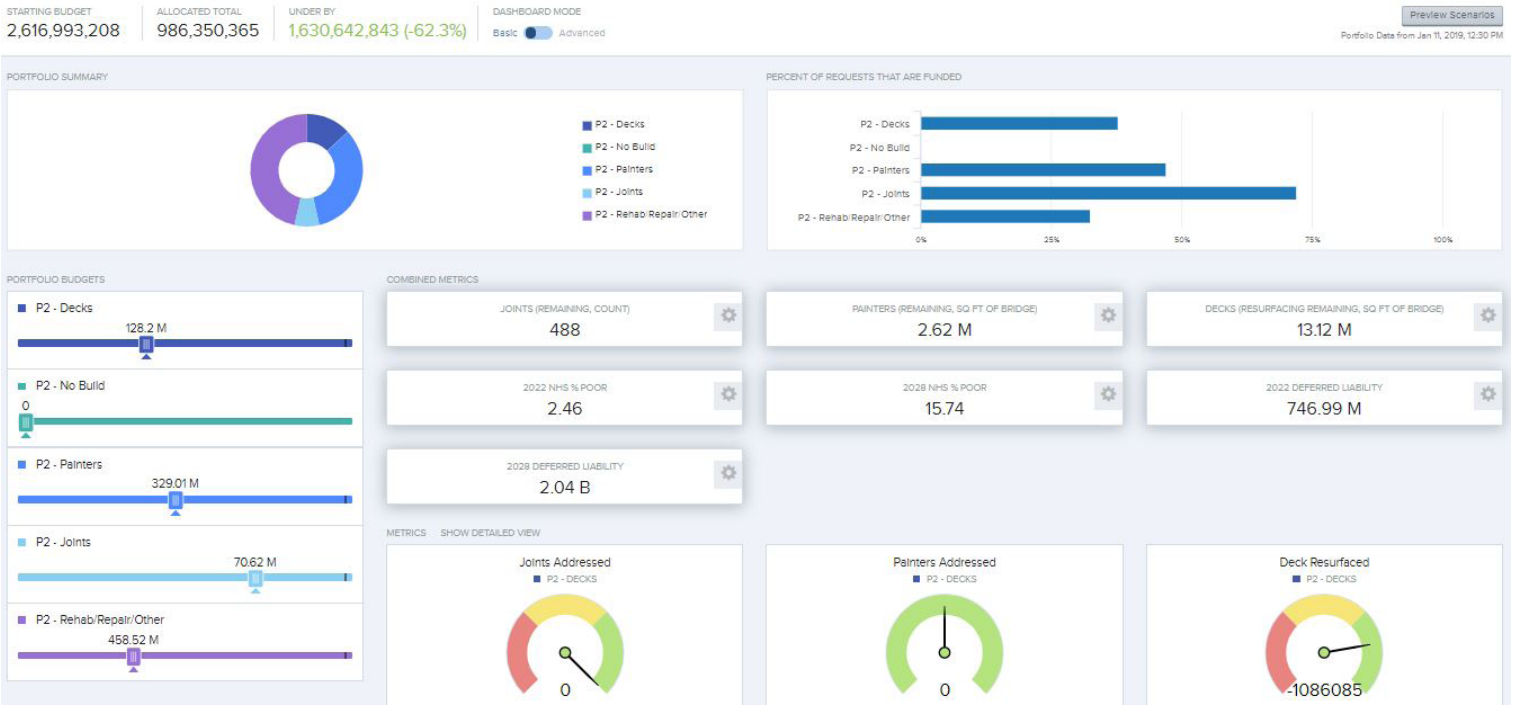


Exhibit 7-4: Decision Lens, Pavement Scenario Analysis Results

Scenario	Current Year Dollars in Scenario (in Millions)	4-Year KPIs				10-Year KPIs			
		Interstate % Poor	Non-Interstate NHS % Poor	All Hwys. % Poor	DPL (in Millions)	Interstate % Poor	Non-Interstate NHS % Poor	All Hwys. % Poor	DPL (in Millions)
No Build	$0	7%	16%	15%	$1,280	21%	53%	44%	$5,480
Current	$1,334	1%	1%	3%	$479	8%	14%	33%	$3,420
Minimum	$1,358	1%	8%	10%	$840	7%	31%	39%	$3,780
Current less $250 M	$1,148	2%	3%	5%	$561	10%	20%	34%	$3,740

Exhibit 7-5: Decision Lens, Bridge Scenario Analysis Results

Scenario	Current Year Dollars in Scenario (in Millions)	Joints (count remaining)	Painters (ft.^{2} of bridges remaining)	Decks (ft.^{2} remaining)	4-Year KPIs		10-Year KPIs	
					NHS % Poor	DPL (in Millions)	NHS % Poor	DPL (in Millions)
No Build	N/A	621	5,380	14,210	9%	$1,160	26%	$2,930
Current	$1,334	484	2,220	12,850	2%	$646	15%	$1,790
Minimum	$515	621	5,380	10,180	4%	$919	10%	$2,470
Current less $250 M	$1,084	488	2,620	13,120	2%	$747	16%	$2,040

After creating the Decision Lens models and reviewing the results, several key points emerged. Key points include:

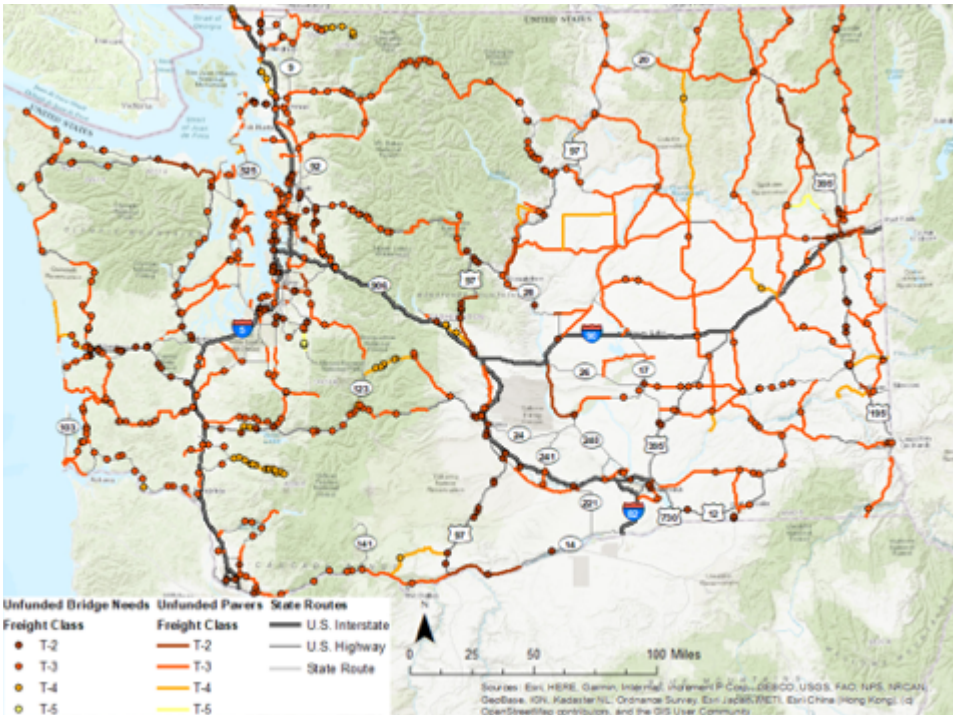
1. The current funding, not including the Move Ahead Washington revenue package, is adequate to meet conditions within a four-year period, but not over 10 years. As we incorporate the funding detail associated with the Move Ahead Washington revenue package, WSDOT expects to be able to meet conditions over the 10-year period.
2. The minimum scenario for Pavements is based on minimizing the Interstate's Poor condition, but the portfolios are not split into Interstate vs. non-Interstate, which would be necessary to truly estimate the minimum cost of just working on the Interstate.
3. There are not enough Pavement projects created to account for all the Interstate Poor condition assumed to deteriorate over the 10-year period. This will likely change as details are finalized with the Move Ahead Washington revenue package.
4. The minimum scenario for Bridges performs better than the current funding distribution when looking at condition. This is because painting and joint preservation are totally ignored, which will reduce long-term structure life (painting) or cause immediate short-term closures (joints), and allows the work to be focused on decks and repairs related to Poor condition.

Overall, the Scenario Analysis confirmed the Preservation funding gap is large without including investments from Move Ahead Washington. Since 2018, WSDOT has been communicating this funding gap to the Washington State Legislature in the annual State of Transportation. The funding gap has also been discussed with the Governor and Legislature during the 2021 budget deliberations. In addition, WSDOT used this funding gap as a basis for developing a $10 billion preservation package that was included in the same budget discussion. Based on this communication, the state Legislature has provided funding for preservation and maintenance for which WSDOT is still working through the details. Funding gaps were also key areas of emphasis through the risk workshops. Both bridge and pavement assets ranked funding as a "very high" level risk. More information on identified risks can be found in the "Risk Management" chapter in the TAMP.

The map below is one scenario of ten-year bridge and pavement needs that could not be funded if we properly preserve our highest used freight routes.

While there could be a myriad of other ways to prioritize the limited funding, it is easy to see the magnitude of the preservation problem WSDOT is facing as similar failures would be expected under any prioritization scheme. The result is a broken and inequitable system, costing citizens now and in the future when repairs are three to five times the amount of the preservation cost.

Exhibit 7-6: Possible Unfunded Needs Scenario by Preserving Highest Used Freight Routes



Performance Gap Analysis Process

WSDOT considered two general methods for identifying performance gaps. They are 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. For example, MAP-21 required and was continued in IIJA/BIL targets to be set for performance of pavement and bridge asset condition on the NHS and be reported in the TAMP. WSDOT is not planning to change the PM2 performance targets for bridge and pavements for this reporting period.
- Plan-based performance gaps may be identified when additional planning efforts recommend changes to existing physical assets. For example, an identification of freight mobility issues in the State Freight System Plan results in recommendations for operational and capital improvements to address freight congestion.

Target-Based Performance Gap Analysis

Target-based Performance Gap Analysis has already been summarized in *Chapter 3: Asset Inventory and Condition*. As noted in Chapter 3, there is no performance gap when compared to the performance targets required under MAP-21 over the next four years. However, the results of the Scenario Analysis indicate a gap for condition after ten years. Primarily related to Preservation funding, this funding gap to achieve and sustain a desired State of Good Repair is recognized for both pavements and bridges.

WSDOT continues to communicate the Preservation funding gap to the Washington State Legislature.

Plan-Based Performance Gap Analysis

The need for consistent and collaborative approaches to building and maintaining the transportation network continues to grow. WSDOT works with transportation partners across the state to identify challenges to moving people and goods safely and efficiently across the state, and to establish a shared vision of the transportation network of the future.

This plan-based performance gap analysis serves as a starting point to assist in planning for a sustainable transportation network in the future. The analysis will identify transportation plans that recommend substantial additions to the network or changes to existing asset inventories. WSDOT is in the beginning phases of integrating asset management with long-range planning efforts and is committed to making improvements towards more meaningful integration as opportunities are presented.

Supporting more effective planning integration is the Plan Alignment Work Group (PAWG). Since 2018, WSDOT has facilitated the PAWG which consists of staff from metropolitan planning organizations (MPOs), regional transportation planning organizations (RTPOs), WSDOT region offices, and WSDOT headquarters divisions. The purpose of this group is to improve how planning at all levels informs transportation decisions in a consistent and coordinated way. This is a key forum for enhancing the coordination efforts to ensure WSDOT priorities are reflected in the regional transportation plans and regional priorities are included in statewide planning efforts. One of the early successes of this group was to ensure WSDOT's pavement and bridge preservation financing needs were available to MPO and RTPO partners as they update their plans so they can paint an accurate picture of long-range regional transportation needs.

WSDOT Planning

Transportation plans that are required by or described in MAP-21 and the FAST Act are required to be integrated, but federal law does not define integration. Jurisdictions in Washington achieve integration in their planning processes through sharing the same:

- Goal to move people and goods on the multimodal transportation system.
- Purpose to demonstrate to the public how they will implement policy direction.
- Commitment to coordinate plans with each other.

Transportation plans have different purposes, requirements and timelines because they are created in federal law, federal rules, federal circulars, state law, state rules, and/or state budget bills. Some plans are primarily policy plans and some are primarily asset management plans. Update cycles are generally dependent on the availability of funding because not all have legally required update cycles. Exhibit 7-6 provides a look at the various transportation planning activities occurring across WSDOT.

Exhibit 7-7: Washington State Planning Activities

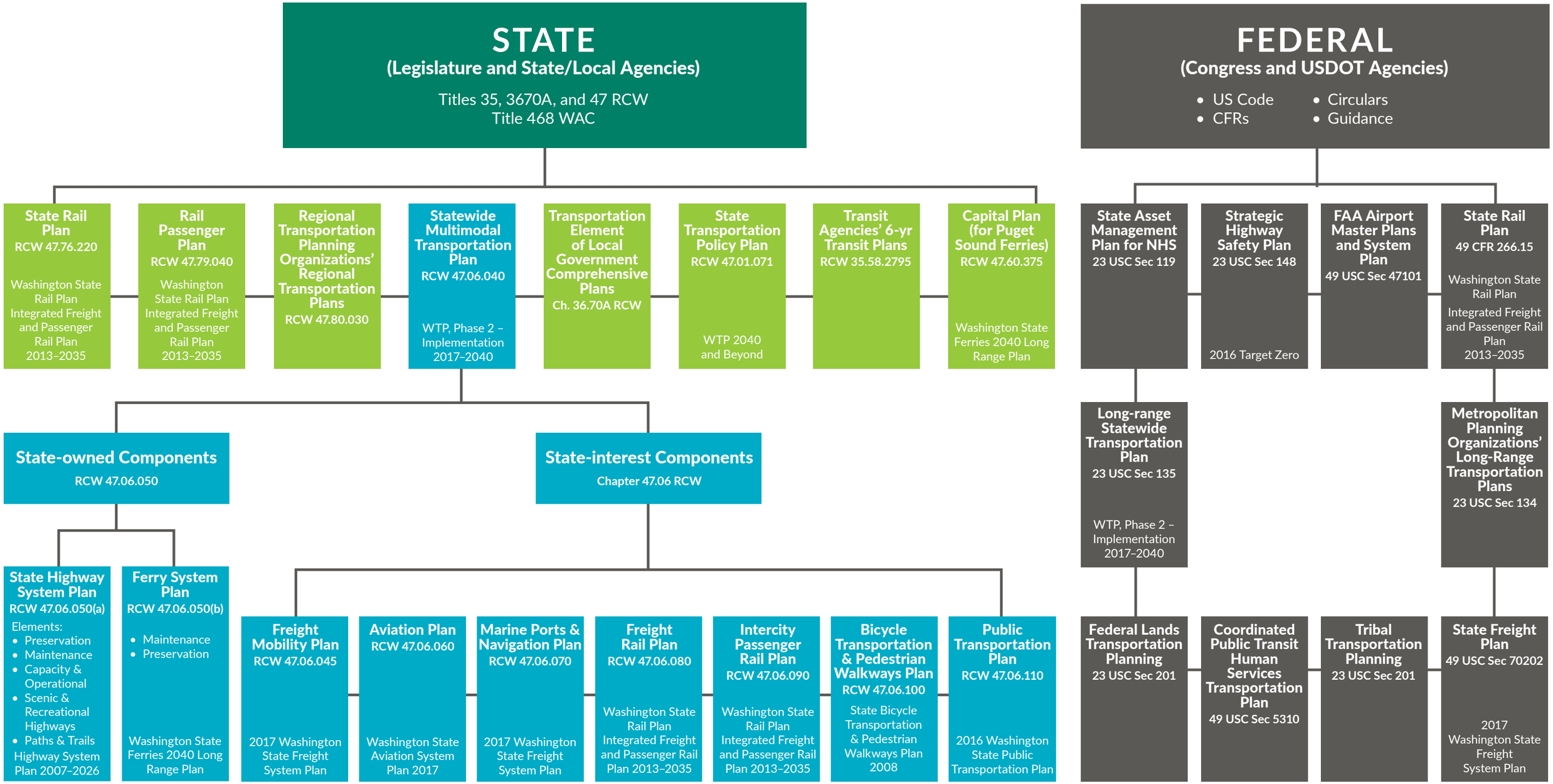


Exhibit Notes:

- The plans are labeled as they appear in law – not necessarily the titles they are given by authors.
- When practical, the plans are combined. For example, the 5 required rail plans are combined into the State Rail Plan; the 2 freight plans are combined into the State Freight Mobility Plan; and the Capital Plan is combined with the Ferry System Plan.
- Projects in the STIP mush be consistent with a federally-compliant Long-range Statewide Transportation Plan (WTP, Phase 2 – Implementation 2017–2040)
- Last updated May 30, 2019

Achieving Greater Alignment between Plans

To begin the effort of aligning and analyzing asset management with other planning efforts, WSDOT is taking the approach of identifying the most relevant planning efforts relative to the potential impact of performance to bridge and pavement assets. The statewide plans identified as having the greatest relevance to the TAMP in this context are the long range statewide transportation plan (Washington Transportation Plan, Phase 2 – Implementation 2017-2040) and the Freight System Plan.

The WTP Phase 2 meets the federal requirements for a statewide transportation plan as per 23 U.S.C. 135 and includes focus areas and action items for WSDOT and its partners to consider. The 2017 Freight System plan, currently being updated, meets the federal requirements for a state freight plan as per 49 U.S.C.70202 and includes forecasts for the movement of goods through Washington, including forecasts for how that is predicted to change over the next 20 years. WSDOT developed Phase 2 and the Freight Plan concurrently and the plan teams combined outreach events which streamlined plan integration efforts.

Washington Transportation Plan, Phase 2 – Implementation 2017-2040

Phase 2 utilizes scenario-planning to achieve network resiliency. It establishes action items that will move Washington toward the vision established in Phase 1, regardless of how an unknown future unfolds.

The Washington Transportation Commission's previous work in Phase 1 established the statewide vision. Building on that work, the Phase 2 explored four focus areas in the plan. Related to asset management, the first focus area is "Maintain and Preserve Assets." The two corresponding action items are:

- Maintain, preserve, and operate assets and manage demand to meet desired performance on multimodal transportation systems before funding expansion projects.
- Support ways to help jurisdictions, transportation asset owners, and transportation service providers prepare for, respond to, and become resilient to emergencies and disasters.

WSDOT's approach to asset management is closely aligned with the focus areas identified in Phase 2. Through community engagement and future plan updates, WSDOT's information on asset management practices can directly support the focus areas of Phase 2. This information also communicates how WSDOT is working to cost-effectively maintain the transportation network.

As Phase 2 places emphases on non-expansion type solutions for enhancing mobility, there is not a plan-based gap between current asset management investment strategies and recommended additions of assets to the transportation network.

2022 Washington State Freight System Plan

WSDOT led the development of the 2017 Washington State Freight System Plan to ensure that the transportation system in Washington supports and enhances trade and sustainable economic growth. In addition, this plan addresses federal and state policies and meets federal and state planning requirements. The plan is undergoing updates and is expected to be completed at the end of 2022.

In the Freight System Plan, transportation partners should continue to address pavement and bridge needs on Truck Freight Economic Corridors and the National Highway Freight Network. Pavement and bridge deterioration affects the efficient movement of freight, especially on Truck Freight Economic Corridors. In addition to major routes, intermodal connector routes provide connectivity. WSDOT will continue to consider freight volume when prioritizing preservation work. The annual number of trucks on a highway segment is a factor in determining priority for preservation investments.

Further supporting WSDOT's asset management efforts, the Freight System Plan relies on Federal Highway Administration's (FHWA) Freight Analysis Framework 5.3, which is based on national trends. While current pavement and bridge modeling techniques used the most recent data collected on truck counts, future consideration will be given as to whether or not forecast freight increases can be incorporated into condition forecasting.

CHAPTER 8
INVESTMENT STRATEGIES

The previous chapters, including *Life Cycle Planning*, *Revenue and Financials*, and *Performance Scenarios*, collectively explain 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, funding targets, current updates to the Project Delivery Plan and STIP, and concludes with a discussion on how the NHS pavements and bridges fit within them.

As mentioned in the Introduction Chapter, WSDOT received the Move Ahead Washington revenue package from the Washington state Legislature during the 2022 Legislative Session. This package includes investments targeted to preserve and maintain the state's transportation system. The details of this revenue package are still being worked out to include the timing of funding provided to the Pavement and Bridge Programs. As these details are finalized, WSDOT will assess the magnitude of the changes and their impacts to this and other relevant chapters of the TAMP.

Prioritization of 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.

Pavement Prioritization

Pavement needs are identified before pavement projects are scoped. Pavement needs are initially identified based on annual condition surveys, which are entered and analyzed in the Washington State Pavement Management System (WSPMS). The foundation of a needs assessment are pavement deterioration models and activities based on lowest life cycle cost management. WSDOT's Capital Program Development and Management Division (CPDM) then issues Regions project scoping instructions that recommend investment funding target levels for each major pavement type. WSDOT Regions use the information to scope projects in WSDOT's Capital Project Management System (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.

All projects are reviewed to ensure that the proposed project is the lowest life cycle cost alternative to meet the needs of the section. Prioritization takes into account three core principles for all projects: avoiding future liability, asset use, and life cycle cost.

Avoiding Future Liability

If deferral of an activity results in a high certainty that more costly work will be needed, such as reconstruction, this type of project becomes a priority. This prioritized decision also avoids having a section of roadway deteriorate into a state that leaves the agency with two choices: worst first management or leaving a section in a very poor state.

Using "Avoiding Future Liability" as the highest priority prioritizes the following work activities: 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 because 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. 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.

Bridge Prioritization

Bridge preservation investment areas take into consideration the condition and age of bridge components, which are then used to create several 10-year needs lists. These needs are ranked based on condition, age, and traffic levels. WSDOT Regions across the state use these ranked needs to scope and create projects.

Needs lists are grouped by activity and include:

- Replacement or Major Rehabilitation
- Expansion Joints
- Concrete Decks
- Bridge Painting
- Scour
- Miscellaneous Repair
- 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 may be found within the *Washington State Enhanced Hazard Mitigation Plan*.

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
- Seismic

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

1. Border bridges are highest priority. This is due to agreements between states to ensure that these bridges remain in acceptable condition.
2. 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.

Funding Levels

Funding levels for sub-programs and associated project-category investment levels are based on asset management analysis and direction from the department's Executive Leadership Team (ELT) within the appropriations provided by the Legislature. Projects selected within the individual investment categories were based on priorities discussed in this chapter, with input from Subject Matter Experts (SMEs) for the various infrastructure assets. The current funding levels and prioritization methodologies are updated and kept current in the Project Delivery Plan. The following sections are from the Prioritization Methodologies section of the 2021 Project Delivery Plan, which is the most current as of the writing of this TAMP.

Pavement Investments

The 2021 Project Delivery Plan recognizes the funding identified by the 2021 Transportation budget is well short of the needs to preserve pavements but does not including any investments from the Move Ahead Washington revenue package. Additionally, it also recognizes that State law mandates preservation of the existing state highway system, not just a portion. This is further underscored by the 2021 Legislative session amending state law to make Preservation a priority. Please see Exhibits 6-13 through 6-16 of the Revenue and Financials Chapter to see the 10-year investment levels by year and work type.

WSDOT works with its partners, stakeholders and the Legislature to deliver on this expectation. With this in mind, WSDOT continued to implement a priority approach focusing on cost-effectively preserving high freight and high-speed routes. The plan also expands on that approach to all high-speed routes. It also allows for exceptions precipitated by previous funding limitations. Finally, WSDOT is preparing to take a prioritized approach for the remaining routes ensuring a multi-modal approach with an emphasis on active transportation users.

Bridge Investments

The 2021 Project Delivery Plan recognizes the funding identified by the 2021 Transportation budget is well short of the needs to preserve bridges but does not including any investments from the Move Ahead Washington revenue package. Additionally, it also recognizes that State law mandates preservation of the existing state highway system, not just a portion. This is further underscored by the 2021 Legislative session amending state law to make Preservation a priority. Please see Exhibits 6-13 through 6-16 of the Revenue and Financials Chapter to see the 10-year investment levels by year and work type.

WSDOT intends to work with its partners, stakeholders and the Legislature to deliver on this expectation. With this in mind, WSDOT continued to implement a priority approach focusing on cost-effectively preserving high freight and high-speed routes. The plan also expands on that approach to all high-speed routes. It also allows for exceptions precipitated by previous funding limitations. Finally, WSDOT is preparing to take a prioritized approach for the remaining routes ensuring a multi-modal approach with an emphasis on active transportation users.

Project Prioritization

The 2021 update to the *Project Delivery Plan* prioritizes projects based on a high-benefit/low-cost philosophy aimed at preserving and improving the system within the previously communicated funding targets. As a result, projects included in the Plan reflect an incremental, tiered approach to ensure every activity 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 investment 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.
3. Highest-cost projects that deliver long-term solutions and corridor-wide benefits.

2021 Project Delivery Plan

The larger Project Delivery Plan ultimately includes the results from pavement and bridge prioritization. WSDOT uses a six-year highway construction planning method to program investments in our transportation infrastructure. The 2021 update to the *Project Delivery Plan* represents a snapshot as of July 1, 2021. It shows our 6-year, project-specific plan for work to be delivered by the department for state fiscal years 2022 through 2027.

Programming Framework

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

- **Aligns with Legislative direction provided in the 2021 Transportation Appropriations Bill (*SSB 5165*).**

  This Plan is consistent with budget proviso requirements, including some areas that the Legislature allows for WSDOT discretion in selecting projects. The Delivery Plan is consistent with overall Legislative investment expectations.

- **Basis for WSDOT's 2022 Supplemental Budget Submittal**

  The projects identified through the development of the 6-year plan are the basis for the department's 2022 Supplemental Budget Submittal. The submittal 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.

Washington State's 2022-25 Statewide Transportation Improvement Program

The *State Transportation Improvement Program* (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, which are developed through local, regional, and state partnerships.

Fixing America's Surface Transportation (FAST) Act guides the policy and programmatic framework for investments. The investments guide the growth and development of the country's vital transportation infrastructure. The Act also creates 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 Organizations (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 2017 - 2040)

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 Statewide Investments in STIP

WSDOT selects projects for the *National Highway Performance Program* and *Highway Safety Improvement Program* funds based on asset performance condition (pavement and bridge) and *Target Zero* priorities. Target Zero's priorities are zero deaths and fatal crashes by 2030. These criteria and priorities act in combination with the performance and economic improvements created by the project (by using life cycle cost and/or benefit cost analysis).

Community Engagement Is Integral To the STIP Process

Metropolitan Planning Organizations coordinate with WSDOT in developing transportation plans and programs for the urbanized areas, consistent with the long-range statewide transportation plan (*2017-2040 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.

APPENDIX A
REQUIRED ELEMENTS

MAP-21 Requirements and Corresponding TAMP Sections

To support TAMP review for consistency with certified process by FHWA, as well as, WSDOT's own management review; Exhibits A-1 and A-2 summarize Required Elements specified in the *Transportation Asset Management Plan Consistency Determination Guidance*, *Transportation Asset Management Plan Development Processes Certification and Recertification Guidance*, and corresponding sections of the TAMP addressing those requirements.

Exhibit A-1: MAP-21 Development and Implementation Consistency Required Elements and Corresponding TAMP Content Locations

Required Elements[2]	Indicators TAMP Meets Element Requirements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
TAMP approved by head of State DOT (23 CFR 515.9(k))	Does the TAMP bear the signature of the head of the State DOT?	Executive Summary	Secretary Millar's signature is included in the executive summary after the cover sheet of the TAMP.
State DOT has developed its TAMP using certified processes (23 CFR 515.13(b))	Do the process descriptions align with the FHWA-certified processes for the State DOT? [If the process descriptions do not align with the FHWA-certified processes, the State DOT must request recertification of the new processes as amendments unless the changes are minor technical corrections or revisions with no foreseeable material impact on the accuracy and validity of the processes, analyses, or investment strategies. State DOTs must request recertification of TAMP development processes at least 30 days prior to the deadline for the next FHWA TAMP consistency determination as provided in 23 CFR 515.13(c).]	Appendix B, TAMP Chapters 2-8	WSDOT is including the initial TAMP submitted in April 2018 as appendix B to the complete TAMP. The initial TAMP was certified in May 2018. As communicated throughout the complete TAMP, WSDOT used previously certified processes to deliver the results communicated in the complete TAMP. WSDOT reviewed and used the previous certified processes included in the initial 2018 TAMP and the 2019 Complete TAMP. These processes were reviewed and deemed accurate for the 2022 TAMP.
State DOT has developed its TAMP using certified processes (23 CFR 515.13(b))	Do the TAMP analyses appear to have been prepared using the certified processes?	Appendix B	The initial TAMP was certified in May 2018. As communicated throughout the complete TAMP, WSDOT used previously certified processes to deliver the results communicated in the 2019 Complete TAMP.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a summary listing of NHS pavement and bridge assets, regardless of ownership?	TAMP Chapter 3, Inventory and Condition	WSDOT includes a full inventory of bridge and pavement assets located on the NHS in the Inventory and Condition chapter. Additionally, WSDOT is providing all state owned bridge and pavements assets as part of the Complete TAMP.

Exhibit A-1: MAP-21 Development and Implementation Consistency Required Elements and Corresponding TAMP Content Locations (continued)

Required Elements[2]	Indicators TAMP Meets Element Requirements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion of State DOT asset management objectives that meets requirements?	TAMP Chapter 2, Objectives and Measures	Exhibit 2-1 in Chapter 2 of the Complete TAMP communicates WSDOTs agency asset management objectives and then connects those objectives to bridge and pavement asset management objectives, as they are supported by the PM2 targets and SOGR.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion of State DOT measures and targets for asset condition, including those established pursuant to 23 U.S.C. 150, for NHS pavements and bridges, that meets requirements?	TAMP Chapter 2 and 3, Objectives and Measures and Inventory and Condition	The Complete TAMP includes the PM 2 targets and the measures used to assess those targets. These are communicated in exhibit 2-1 and exhibits 3-12/3-21.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a summary description of the condition of NHS pavements and bridges, regardless of ownership, that meets requirements?	TAMP Chapter 3, Inventory and Condition	The Complete TAMP provides current condition of bridges and pavements located on the NHS. This is communicated in exhibits 3-12 and 3-21. The condition assessment process is also included in chapter 3.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP identify and discuss performance gaps?	TAMP Chapters 3, 6 and 7, Inventory and Condition, Revenue and Financials and Performance Scenarios	The Complete TAMP communicates performance gaps in three areas. The first is in the Inventory and Condition chapter, Exhibits 3-12 and 3-21. The second is in the Revenue and Financial Chapter, (Statewide Funding and Performance Analysis). The third is in the Performance Scenario chapter (Performance Gap Analysis).
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion of the lifecycle planning that meets requirements, including results?	TAMP Chapter 4, Lifecycle Planning	The Complete TAMP chapter 4 includes discussion on WDSOT's processes and results of lifecycle planning for bridge and pavement assets.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion of the risk management analysis that meets requirements?	TAMP chapter 5, Risk Management and Appendix B and E	The Complete TAMP chapter 5 includes results of bridge and pavement workshops that identified risks to the assets. The complete process of how those risks were identified are included in chapter 5 of Appendix B. The associated risk register is included as Appendix E to the Complete TAMP.

Exhibit A-1: MAP-21 Development and Implementation Consistency Required Elements and Corresponding TAMP Content Locations (continued)

Required Elements[2]	Indicators TAMP Meets Element Requirements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include the results of the evaluations of NHS pavements and bridges pursuant to 23 CFR part 667?	TAMP Chapter 5, Risk Management and Appendix F	Chapter 5 of the Complete TAMP includes the results of the studied required under 23 CFR 667. The entire report generated as a result of the study is included as Appendix F to the Complete TAMP.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion of a 10year Financial Plan to fund improvements to NHS pavements and bridges?	TAMP Chapter 6, Revenue and Financials	Chapter 6 of the Complete TAMP outlines the 10-year financial plan from a statewide sources and uses perspective, as well as planned levels of spending for bridge and pavement assets. Planned local spending for NHS improvements is not yet fully available, but WSDOT is working to gain more complete information in the future.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP identify and discuss investment strategies the State intends to use for their NHS pavements and bridges?	TAMP Chapter 8, Investment Strategies	Chapter 8 of the Complete TAMP outlines the overarching investment strategies used to maintain and preserve bridge and pavement assets. In addition, this chapter communicates the alignment of strategies and investment levels to current funding levels.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving and sustaining a desired state of good repair over the life cycle of the assets?	TAMP Chapter 8, Investment Strategies with support from chapters 4, 6, and 7 – Lifecycle Planning, Revenue and Financials, and Performance Scenario Analysis	Chapter 8 of the Complete TAMP consolidates the processes and information from earlier chapters in the TAMP to help inform investment strategies to maximize bridge and pavement life and condition in the most cost effective manner possible. Chapter 6, Revenue and Financials, communicates that funding levels are anticipated to meet 4 year targets (resulting in a state of good repair for that timeframe), but funding levels are not appropriate to sustain a state of good repair over the 10-year TAMP window.

Exhibit A-1: MAP-21 Development and Implementation Consistency Required Elements and Corresponding TAMP Content Locations (continued)

Required Elements[2]	Indicators TAMP Meets Element Requirements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion as to how the investment strategies make or support progress toward improving or preserving the condition of the assets and the performance of the NHS related to physical assets?	TAMP Chapter 8, Investment Strategies with support from chapters 4, 6, and 7 – Lifecycle Planning, Revenue and Financials, and Performance Scenario Analysis	Chapter 8 of the Complete TAMP consolidates the processes and information from earlier chapters in the TAMP to help inform investment strategies to maximize bridge and pavement life and condition in the most cost effective manner possible. This chapter outlines the priorities to maximize performance across the NHS network with respect to available funding. Chapter 9, Performance Scenarios, also communicates route criticality (functional class) as criteria in deciding project prioritization.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving the State's targets for asset condition and performance of the NHS in accordance with 23 USC 150(d)?	TAMP Chapter 8, Investment Strategies with support from chapters 4, 6, and 7 – Lifecycle Planning, Revenue and Financials, and Performance Scenario Analysis	Chapter 8 of the Complete TAMP consolidates the processes and information from earlier chapters in the TAMP to help inform investment strategies to maximize bridge and pavement life and condition in the most cost effective manner possible. The investment strategies support obtaining the best condition possible with the amount of available funding. Chapter 8, Performance Scenarios, models anticipated condition using MAP-21 criteria over a 10-year time period.
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion as to how the investment strategies make or support progress toward achieving the national goals identified in 23 USC 150(b)?	TAMP Chapters 2, 4, 7, and 8, Objectives and Measures, Life Cycle Planning, Performance Scenarios and Investment Strategies	The Complete TAMP does not address all goals outlined in 23 USC 150(b), but it does directly support goal area 2, infrastructure condition, through defining state of good repair (chapter 2) the use of lifecycle practices (chapter 4), and investment strategies (chapter 8). A discussion on future work areas to create better alignment between planning, performance, and projects through the Plan Alignment Work Group (PAWG) is also contained (chapter 7).

Exhibit A-1: MAP-21 Development and Implementation Consistency Required Elements and Corresponding TAMP Content Locations (continued)

Required Elements[2]	Indicators TAMP Meets Element Requirements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
TAMP includes the required content as described in 23 CFR 515.9(a)-(g) (23 CFR 515.13(b))	Does the TAMP include a discussion as to how the TAMP's life-cycle planning, performance gap analysis, and risk analysis support the State DOT's TAMP investment strategies?	TAMP Chapters 4, 5, 6, 7, and 8, Lifecycle Planning, Risk Management, Revenue and Financials, Performance Scenarios, and Investment Strategies	Chapter 8 consolidates the results of lifecycle planning, financial information, gap analysis, and risk analysis. Information included in chapters 4 through 7 serve as a basis for developing investment strategies.
Inclusion of Other Assets in the TAMP in 23 CFR 515.9 (l)	N/A	N/A	N/A
Integration of TAMP into transportation planning processes that lead to the Statewide Transportation Improvement Program (STIP) (23 CFR 515.9(h))	Do State DOT planning documents or records of planning activities show that the TAMP was integrated into its transportation planning processes that lead to the STIP?	TAMP Chapter 8, Investment Strategies	Chapter 8 of the Complete TAMP communicates how the investment strategies for bridge and pavement assets align and inform projects that are ultimately included in the STIP.
TAMP available to the public (23 CFR 515.9(i))	Has the State DOT made its TAMP available to the public by posting on its website, or distributing in public meetings, or by some other means?	N/A	The TAMP is housed on WSDOT's website once the consistency determination is made. Location is here

Exhibit A-1: MAP-21 Development and Implementation Consistency Required Elements and Corresponding TAMP Content Locations (continued)

Required Elements[2]	Indicators TAMP Meets Element Requirements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
State DOT demonstrates through current and verifiable documentation that it has implemented a TAMP meeting requirements of 23 U.S.C. 119 and 23 CFR part 515 and that the State DOT is following the investment strategies in the TAMP (23 CFR 515.13(b)(2))	Has the State DOT documented evidence that the State DOT is using the TAMP investment strategies? (23 CFR 515.13(b)(2)). The best evidence is that, for the 12 months preceding the consistency determination, there was alignment between the actual and planned levels of investment (in the TAMP) for various work types as defined in 23 CFR 515.5 (i.e., initial construction, maintenance, preservation, rehabilitation and reconstruction) (23 CFR 515.13(b)(2)(i))?	TAMP Chapter 6, Revenue and Financials and separate consistency document	Exhibits 6-17 through 6-20 in chapter 6 of the Complete TAMP align investment levels for the last state fiscal year and the anticipated investment levels for the upcoming state fiscal year. This will also be communicated in more detail through the TAMP companion document required for the consistency determination. Not all local NHS investment levels by work type are currently available.
State DOT demonstrates through current and verifiable documentation that it has implemented a TAMP meeting requirements of 23 U.S.C. 119 and 23 CFR part 515 and that the State DOT is following the investment strategies in the TAMP (23 CFR 515.13(b)(2))	If the State DOT deviated from the TAMP investment strategies, did they document reasons the deviation(s) were necessary due to extenuating circumstances beyond the State DOT's reasonable control3 (23 CFR 515.13(b)(2)(ii)).	N/A	N/A

Exhibit Notes:
[1] Source is from WSDOT's CPDM Office, who is responsible for delivering the initial TAMP to FHWA.
[2] Source is from FHWA's Feb. 2019 document entitled *Transportation Asset Management Plan Consistency Determination Guidance*.

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Performance Gap Analysis (23 CFR 515.7(a))	The TAMP must describe a methodology, with regard to the physical condition of the assets, for: • Identifying gaps affecting the State DOT targets for the condition of NHS pavements and bridges as established pursuant to 23 U.S.C. 150(d).	Appendix B Chapter 7	Process established in Appendix B, Performance Scenario - Performance Gap Analysis Process. Measures and targets were required by PM 2 and established by May 20, 2018. No condition based gaps were identified in this TAMP (however an investment gap exists, outlined in Appendix B, Chapter 6). WSDOT reviewed and used the same PM 2 measures and targets for the Complete TAMP. WSDOT will re-evaluate the measures and targets for future TAMP updates.
Performance Gap Analysis (23 CFR 515.7(a))	The TAMP must describe a methodology, with regard to the physical condition of the assets, for: • Identifying deficiencies hindering progress toward achieving and sustaining the desired state of good repair (as defined by the State DOT).	Appendix B Chapter 5, 6, 8	Process established in Appendix B, Risk Management, Revenue and Financials, and Investment Strategies Chapters collectively. Identification established by risk registers (more than just funding) and financial plan/investment strategies.
Performance Gap Analysis (23 CFR 515.7(a))	The TAMP must describe a methodology, with regard to the physical condition of the assets, for: • Developing alternative strategies that will close or address the identified gaps.	Appendix B Chapter 7	Process established in Appendix B, Performance Scenario - Performance Gap Analysis Process.
Performance Gap Analysis (23 CFR 515.7(a))	The TAMP must describe a methodology for analyzing gaps in the performance of the NHS that affect NHS bridges and pavements regardless of their physical condition, that will: • Identify gaps in the effectiveness of the NHS in providing safe and efficient movement of people and goods. (23 CFR 515.7(a)(2)).	Appendix B Chapter 7, 8, 9	See plan based gaps section in Appendix B, Performance Scenario - Performance Gap Analysis Process.

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations (continued)

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Performance Gap Analysis (23 CFR 515.7(a))	The TAMP must describe a methodology for analyzing gaps in the performance of the NHS that affect NHS bridges and pavements regardless of their physical condition, that will: • Identify strategies to close or address the identified gaps. (23 CFR 515.7(a)(3)).	Appendix B Chapter 7, 8, 9	Appendix B, Performance Scenario - Performance Gap Analysis Process.
Life Cycle Planning Analysis (23 CFR 515.7(b))	The TAMP must describe a methodology for: • Incorporating the State DOT targets for asset condition for each asset class or asset sub-group into the analysis.	TAMP Chapter 2 and Appendix B Chapter 2	TAMP Objectives and Measures Chapter 2 and Appendix B, Objectives and Measures Chapter 2 - Pavement and bridge performance measures and target tables.
Life Cycle Planning Analysis (23 CFR 515.7(b))	The TAMP must describe a methodology for: • Modeling deterioration for NHS bridges and pavements for each asset class or asset sub-group.	TAMP Chapter 7 and Appendix B Chapter 4, 9	TAMP Chapter 7, Performance Scenarios discussions the software and assumptions used to model bridge and pavement condition over a 10-year period of time. Appendix B, Life Cycle Planning - treatment tables in Chapter 4 show life of deterioration models. Further discussion on deterioration models in Appendix B, Implementation and Systems Chapter 9 - Asset Management Systems section. WSDOT is working to populate, calibrate, and test BrM to assist with deterioration modeling.
Life Cycle Planning Analysis (23 CFR 515.7(b))	The TAMP must describe a methodology for: • Analyzing potential work types across the whole life of each asset class or asset sub-group with the general unit costs identified.	TAMP Chapter 4 and Appendix B Chapter 4	TAMP Life Cycle Planning Chapter 4 and Appendix B, Life Cycle Planning Chapter 4 - treatment tables show work types.
Life Cycle Planning Analysis (23 CFR 515.7(b))	The TAMP must describe a methodology for: • Identifying management strategies for each asset class or asset sub-group to minimize the life cycle costs while achieving the 23 U.S.C. 150(d) performance targets for asset condition.	TAMP Chapter 4 and Appendix B Chapter 4	TAMP Life Cycle Planning Chapter 4 and Appendix B, Life Cycle Planning - Treatment tables show minimum life cycle cost choices. Pavements summary of baseline to current strategies show the reduction in life cycle costs with the updated strategies.

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations (continued)

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Life Cycle Planning Analysis (23 CFR 515.7(b))	The TAMP must describe a methodology for: • Identifying any subgroups that have been excluded, with justification for their exclusion.	TAMP Chapter 3 and Appendix B Chapter 3	No sub-groups are excluded for pavements or bridges. Bridge and pavement inventories reflect complete state-wide inventories as well as locally owned NHS assets.
Risk Management Analysis (23 CFR 515.7(c))	The TAMP must describe a methodology for: • Identifying risks that can affect the condition of NHS pavements and bridges, and the performance of the NHS, including the risks listed in 23 CFR 515.7(c)(1).	Appendix E and Appendix B Chapter 5	Appendix B, Risk Management Chapter 5 describes climate change including Climate Impacts Vulnerability Assessment Pilot Project; Seismic in Bridge Seismic Retrofit Program; Scour in Bridge Scour Mitigation Program; and remaining risks were assessed via Risk Register contained in Appendix E.
Risk Management Analysis (23 CFR 515.7(c))	The TAMP must describe a methodology for: • Assessing the identified risks in terms of the likelihood of their occurrence and their impact and consequence if they do occur.	Appendix E and Appendix B Chapter 5	Appendix B, Risk Management Chapter 5 - WSDOT Risk Management Strategies for a discussion on existing risk programs. In addition, Appendix B, Chapter 5 includes information on recently held risk workshops that identified additional network level risks (results included in Appendix E).
Risk Management Analysis (23 CFR 515.7(c))	The TAMP must describe a methodology for: • Evaluating and prioritizing the identified risks.	Appendix E and Appendix B Chapter 5	See Appendix B, Risk Management Chapter 5 - WSDOT TAMP Risk Assessment section (results included in Appendix E).
Risk Management Analysis (23 CFR 515.7(c))	The TAMP must describe a methodology for: • Developing a mitigation plan for addressing the top priority risks that involve potentially negative consequences.	Appendix E and Appendix B Chapter 5	See Appendix B, Risk Management Chapter 5 - WSDOT TAMP Risk Assessment section (results included in Appendix E).
Risk Management Analysis (23 CFR 515.7(c))	The TAMP must describe a methodology for: • Developing an approach for monitoring top priority risks.	Appendix E and Appendix B Chapter 5	See Appendix B, Risk Management Chapter 5 - WSDOT TAMP Risk Assessment section (results included in Appendix E).

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations (continued)

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Risk Management Analysis (23 CFR 515.7(c))	The TAMP must describe a methodology for: • Including in the analysis, and considering, a summary of the results of the 23 CFR Part 667 evaluations of facilities in the State repeatedly damaged by emergency events, including at a minimum the results relating to NHS pavements and bridges.	TAMP Chapter 5 and Appendix F and Appendix B Chapter 5	See Appendix B, Risk Management Chapter 5 - Risk Management Next Steps section. Results from evaluation of 23 CFR 667 are included in TAMP Risk Management Chapter 5 and Appendix F.
Financial Plan Development (23 CFR 515.7(d))	The TAMP must describe a methodology for producing a financial plan that: • Covers at least a 10-year period.	Appendix B Chapter 6	Appendix B, Revenue and Financials Chapter 6 - Financial Plan Revenue Sources section.
Financial Plan Development (23 CFR 515.7(d))	The TAMP must describe a methodology for producing a financial plan that: • Includes the estimated cost to implement the investment strategies by State fiscal year and work type.	TAMP Chapter 6 and Appendix B Chapter 6	Investment levels by FHWA work types are included in chapter 6 of the Complete TAMP. Appendix B, Revenue and Financials Chapter 6 - 10-Year pavement and bridge needs (assumes cost of full LCCA).
Financial Plan Development (23 CFR 515.7(d))	The TAMP must describe a methodology for producing a financial plan that: • Includes the estimated funding levels that are expected to be reasonably available, by fiscal year, to address the costs of implementing the strategies, by work type.	Appendix B Chapter 6	Appendix B, Revenue and Financials Chapter 6 - 10-year planned level of spending for bridge and pavements.
Financial Plan Development (23 CFR 515.7(d))	The TAMP must describe a methodology for producing a financial plan that: • Identifies anticipated sources of available funding.	Appendix B Chapter 6	Appendix B, Revenue and Financials Chapter 6 - Revenue Sources section.
Financial Plan Development (23 CFR 515.7(d))	The TAMP must describe a methodology for producing a financial plan that: • Includes a summary asset valuation for the State's NHS pavement and bridges, including the investment needed on an annual basis to maintain the asset value.	Appendix B Chapter 6	Appendix B, Revenue and Financials Chapter 6 - Asset Replacement Value section.

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations (continued)

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Investment Strategies (23 CFR 515.7(e) and 515.9(f))	Producing investment strategies that collectively make or support progress toward: • Achieving and sustaining a desired state of good repair over the life cycle of the assets.	Appendix B Chapter 4, 7, 8, and 9	Investment strategies to maximize ROI are included in Appendix B, Life Cycle Planning chapter while future enhancements to cross-asset evaluation are discussed in Appendix B, Performance Scenarios and Implementation and Systems chapters.
Investment Strategies (23 CFR 515.7(e) and 515.9(f))	Producing investment strategies that collectively make or support progress toward: • Improving or preserving the condition of the assets and the performance of the NHS relating to physical assets.	Appendix B Chapter 8	See Appendix B, Investment Strategies Chapter 8 for relationships between asset management practices and how those practices inform the STIP, as well as, other long-range transportation plans.
Investment Strategies (23 CFR 515.7(e) and 515.9(f))	Producing investment strategies that collectively make or support progress toward: • Achieving the State DOT targets for asset condition and performance of the NHS in accordance with 23 U.S.C. 150(d).	TAMP Chapter 2 and Appendix B Chapter 4, 8	Appendix B, Life Cycle Planning Chapter 4 as well as, Investment Strategies Chapter 8. Implementation of LCP strategies means bridges and pavement assets are maintained at an optimal condition while maximizing ROI. Condition targets have been set and can be found in the TAMP Objectives and Measures Chapter 2.
Investment Strategies (23 CFR 515.7(e) and 515.9(f))	Producing investment strategies that collectively make or support progress toward: • Achieving the national goals identified in 23 U.S.C. 150(b).	Appendix B Chapter 1, 8	See Appendix B, Investment Strategies Chapter 8. Best practice for bridge and pavement assets are leveraged when developing our capital project list. Also, see Appendix B, Introduction Chapter 1 - Practical Solutions section.
Investment Strategies (23 CFR 515.7(e) and 515.9(f))	Identifying and describing how the investment strategies are influenced by: • Anticipated available funding to implement strategies and estimated cost of future work types associated with investment strategies being considered, based on the TAMP financial plan.	TAMP Chapter 7 and Appendix B Chapter 6, 8	See Appendix B, Investment Strategies Chapter 8. Funding targets are based on around the constrained budget and takes into consideration priority programming, life cycle planning, as well as, tradeoff discussions. TAMP Performance Scenarios Chapter 7 includes results from financial modeling to show relative bridge and pavement performance based on funding levels. Also see Appendix B, Revenue and Financials Chapter 6 for 10-year estimate of planned levels of spending.

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations (continued)

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Investment Strategies (23 CFR 515.7(e) and 515.9(f))	Identifying and describing how the investment strategies are influenced by: • Results of the TAMP risk management, life cycle planning, and performance gap analyses.	Appendix B Chapter 8	See Appendix B, Investment Strategies Chapter 8 - Bridge and Pavement Project Prioritization sections. The Capital delivery plan and STIP incorporate strategies and results from key asset management practices.
Obtaining Data from Other NHS Owners (23 CFR 515.7(f))	The TAMP must describe a methodology for obtaining necessary data from other NHS owners in a collaborative and coordinated effort.	TAMP Chapter 2 and Appendix B Chapters 1, 9 and Appendix D	See TAMP Chapter 2, Working With Other NHS Owners and Stakeholders section. Additionally, Appendix B, Implementation and Systems Chapter 9 - Extending Systems to All of the NHS section. Also, see Appendix B, Introduction Chapter 1 - Working with Other NHS Owners and Stakeholders section and Appendix D, Local Engagement Business Plan.
Use of best available data and bridge and pavement management systems to develop TAMP (23 CFR 515.7(g))	The TAMP must describe a methodology for: • Ensuring that the State DOT uses the best available data for development of the TAMP.	Appendix B Chapter 9	See Appendix B, Implementation and Systems Chapter 9 - Asset Management Systems section for a discussion about the various systems used for asset management purposes.
Use of best available data and bridge and pavement management systems to develop TAMP (23 CFR 515.7(g))	The TAMP must describe a methodology for: • Ensuring that the TAMP is developed using bridge and pavement management systems that meet the requirements of 23 CFR 515.17. If, at the time of the first certification, the State DOT does not have bridge and pavement management systems that fully comply with 23 CFR 515.17 standards, the State DOT process identifies additional means it will use to provide analyses or other information needed to meet all of the requirements in 23 CFR 515.17.	TAMP Chapter 9 and Appendix B Chapter 9	See TAMP Chapter 9 and Appendix B, Implementation and Systems Chapter 9 - Asset Management Systems section for discussion about the various systems used for asset management purposes.

Exhibit A-2: MAP-21 Process Certification Required Elements and Corresponding TAMP Content Locations (continued)

Process[2]	Required Elements[2]	Chapter Reference[1]	Where Is It Met in TAMP?[1]
Use of best available data and bridge and pavement management systems to develop TAMP (23 CFR 515.7(g))	The TAMP must describe a methodology for: • Ensuring the process for using information from the State DOT's Statewide Transportation Improvement Program (STIP) in the development of the State DOT's TAMP is consistent with TAMP process and data requirements. This means that the STIP may be used to provide background information, but cannot be used as a substitute for carrying out the required analyses, or be used to override the results of the required independent analyses of relevant data when developing investment strategies.	Appendix B Chapter 8, 9	See Appendix B, Investment Strategies Chapter 8 and Implementation and Systems Chapter 9. Asset level data derived from WSDOT bridge and pavement systems is bundled into projects. Those projects are then prioritized and used to inform our long and short-term capital project list (including the STIP).

Exhibit Notes:

[1] Source is from WSDOT's CPDM Office, who is responsible for delivering the TAMP update to FHWA. WSDOT's CPDM Office was responsible for delivery the initial TAMP to FHWA in 2019.

[2] Source is from FHWA's Feb. 22, 2018 document entitled *Transportation Asset Management Plan Development Processes Certification and Recertification Guidance*.

APPENDIX B
APRIL, 2018 INITIAL TAMP

WSDOT has reviewed the certified processes outlined in this initial Transportation Asset Management Plan (TAMP) and determined that they are still sufficient for the completion of the 2022 TAMP.

WSDOT has reviewed the certified processes outlined in this initial Transportation Asset Management Plan (TAMP) and determined that they are still sufficient for the completion of the 2022 TAMP.

TAMP

April 2018

Transportation Asset Management Plan

Roger Millar, PE, AICP
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

TITLE VI, ADA, AND FURTHER INFORMATION

Title VI Notice to Public

It is the Washington State Department of Transportation's (WSDOT) policy to assure that no person shall, on the grounds of race, color, national origin or sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities. Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equal Opportunity (OEO). For additional information regarding Title VI complaint procedures and/or information regarding our non-discrimination obligations, please contact OEO's Title VI Coordinator at (360) 705-7090.

Americans with Disabilities Act (ADA) Information

This material can be made available in an alternate format by emailing the Office of Equal Opportunity at wsdotada@wsdot.wa.gov or by calling toll free, 855-362-4ADA(4232). Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711.

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

Contact: Locke Craig-Mickel

Capital Program Development and Management Office, Highway Asset Manager

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CRAIGLO@wsdot.wa.gov

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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.

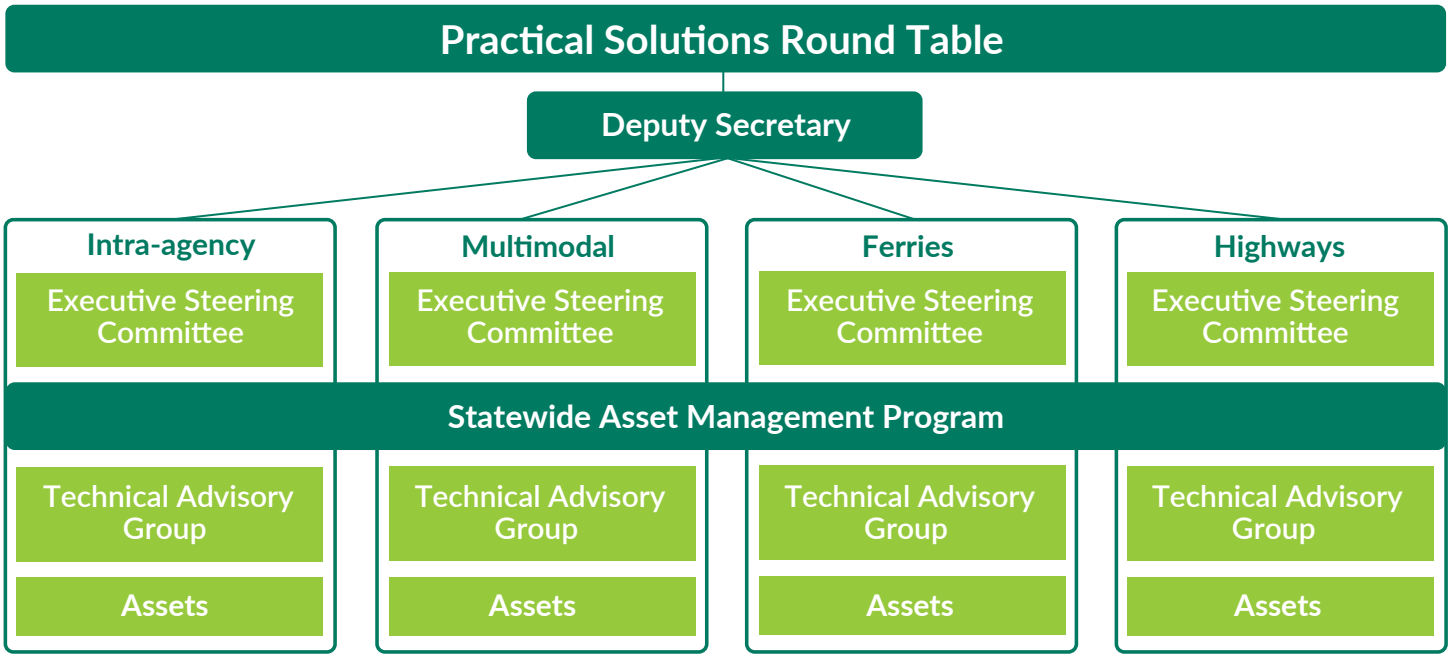


Exhibit Note: Source descriptions are from WSDOT's *Executive Order 1098 – Statewide Transportation Asset Management*.

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.

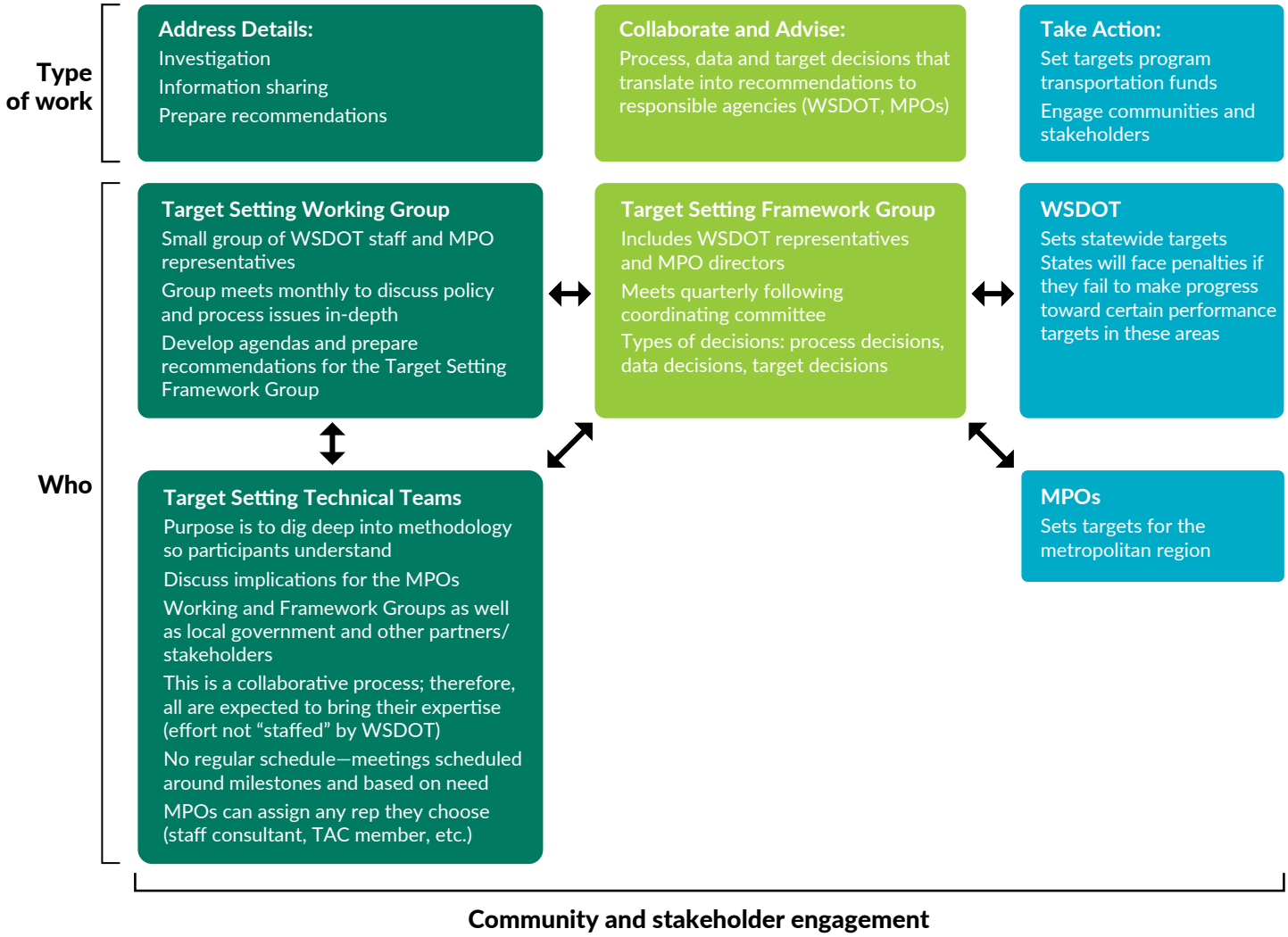


Exhibit Note: Source is from WSDOT's Office of Strategic Assessment and Performance Analysis May, 2015 *MAP-21 Collaboration Technical Folio*.

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.

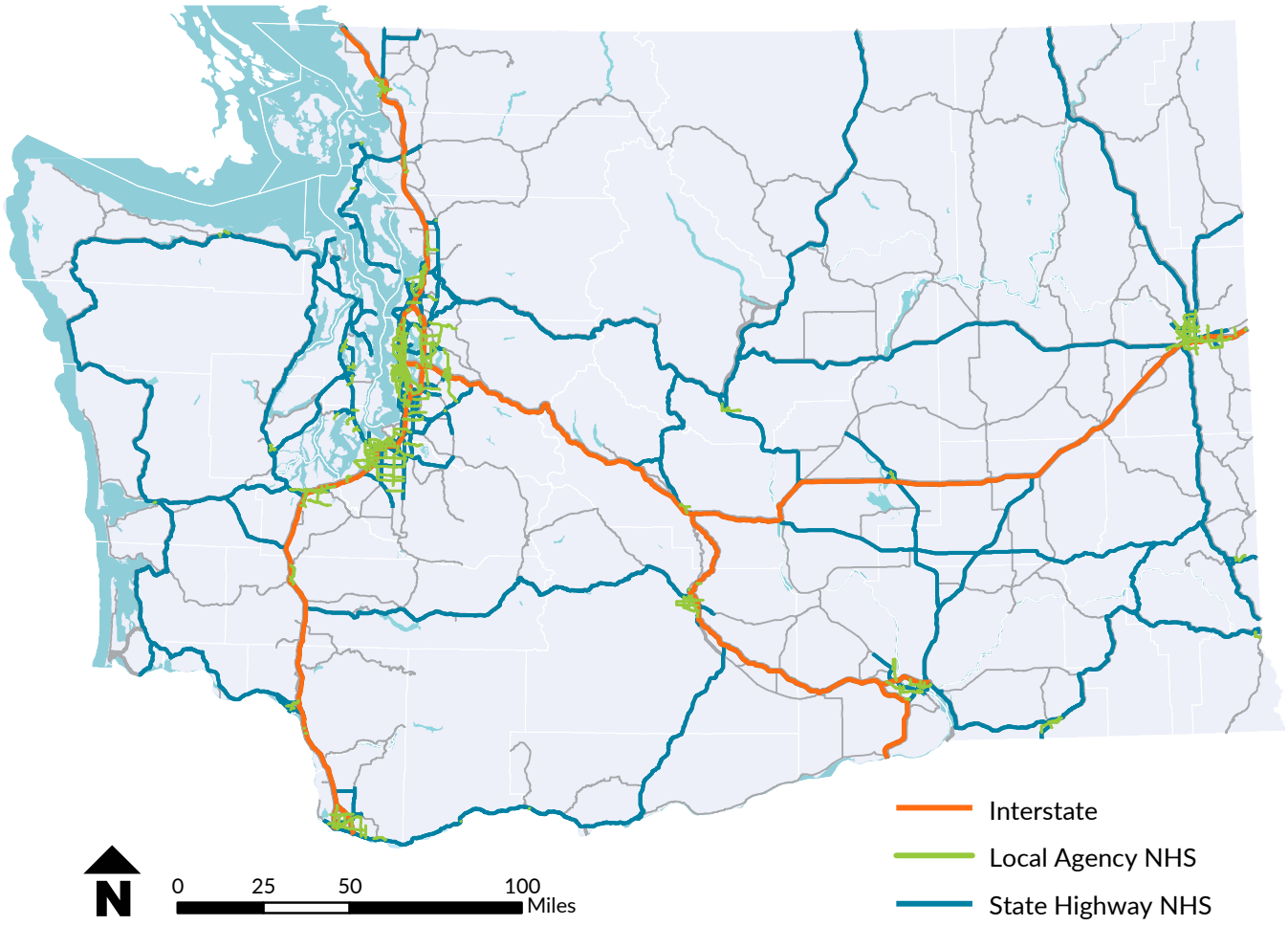


Exhibit Note: Data source is from WSDOT's GeoData Distribution Catalog, maintained by the Office of Information Technology, and represents information collected for 2016.

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.

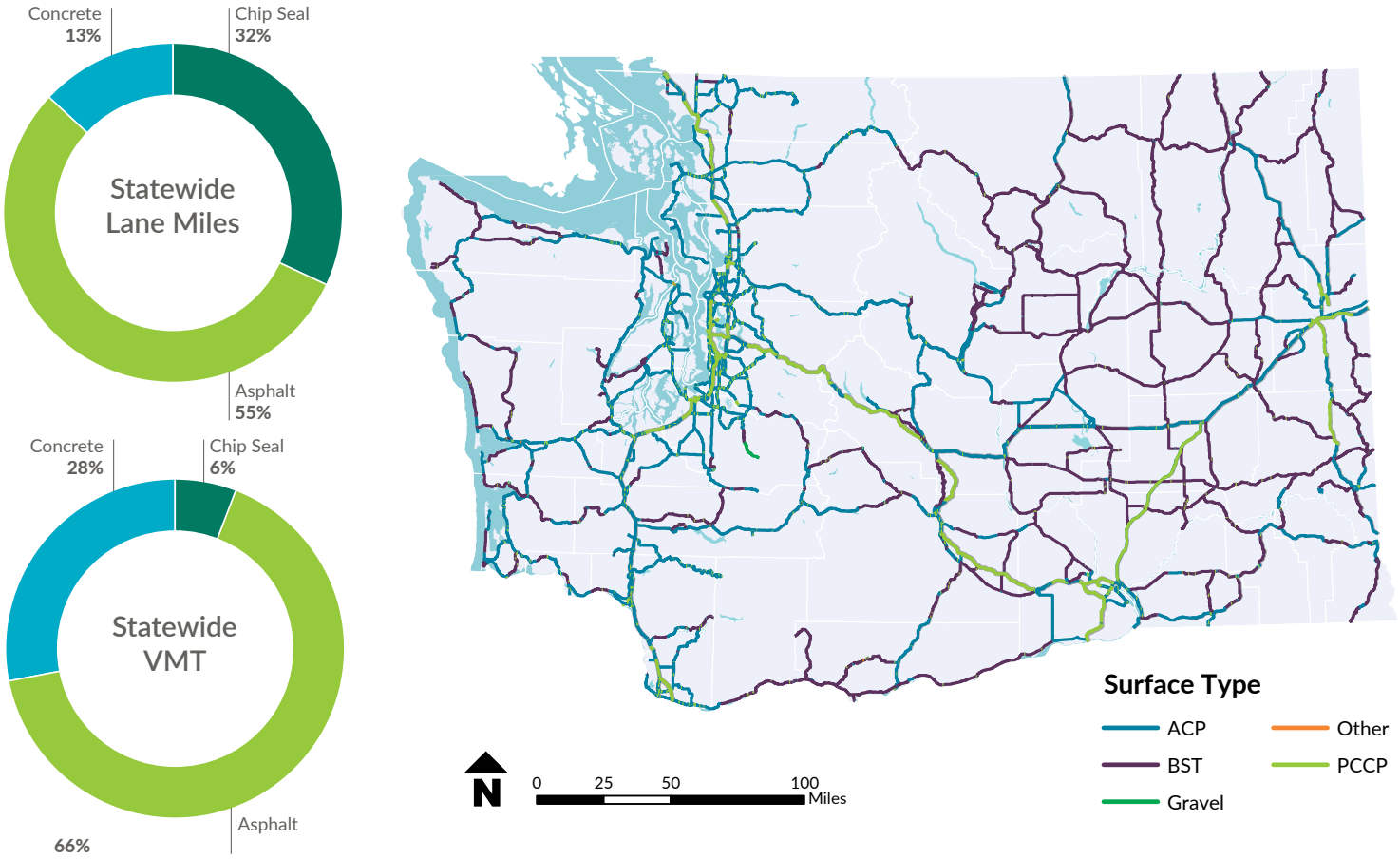


Exhibit Note: Source: WSDOT's *Pavement Notebook*; Feb., 2016 *Pavement Asset Management*.

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.

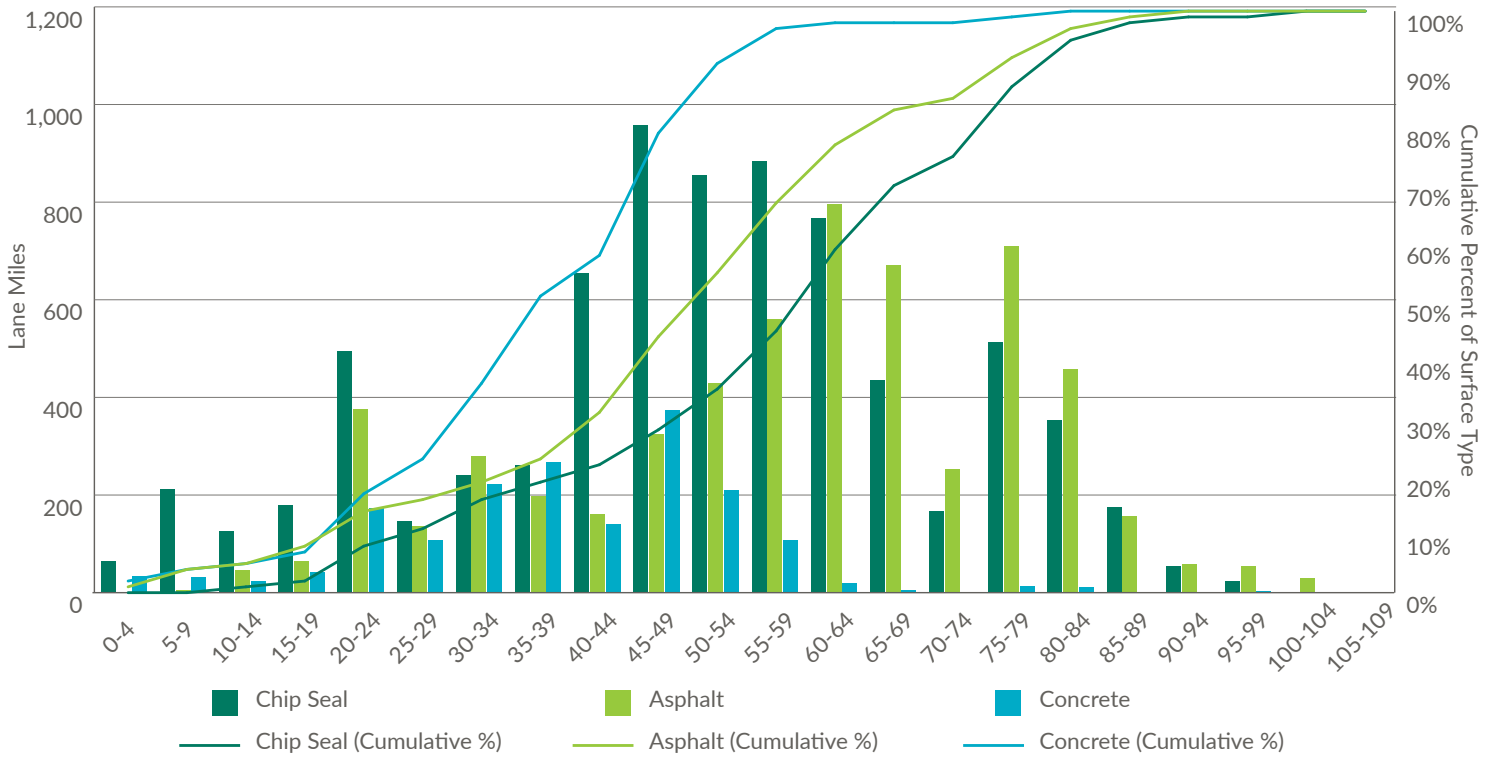


Exhibit Note: Source is 2016 data queried from the WebWSPMS by WSDOT's Pavement Branch of the Materials Laboratory.

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.

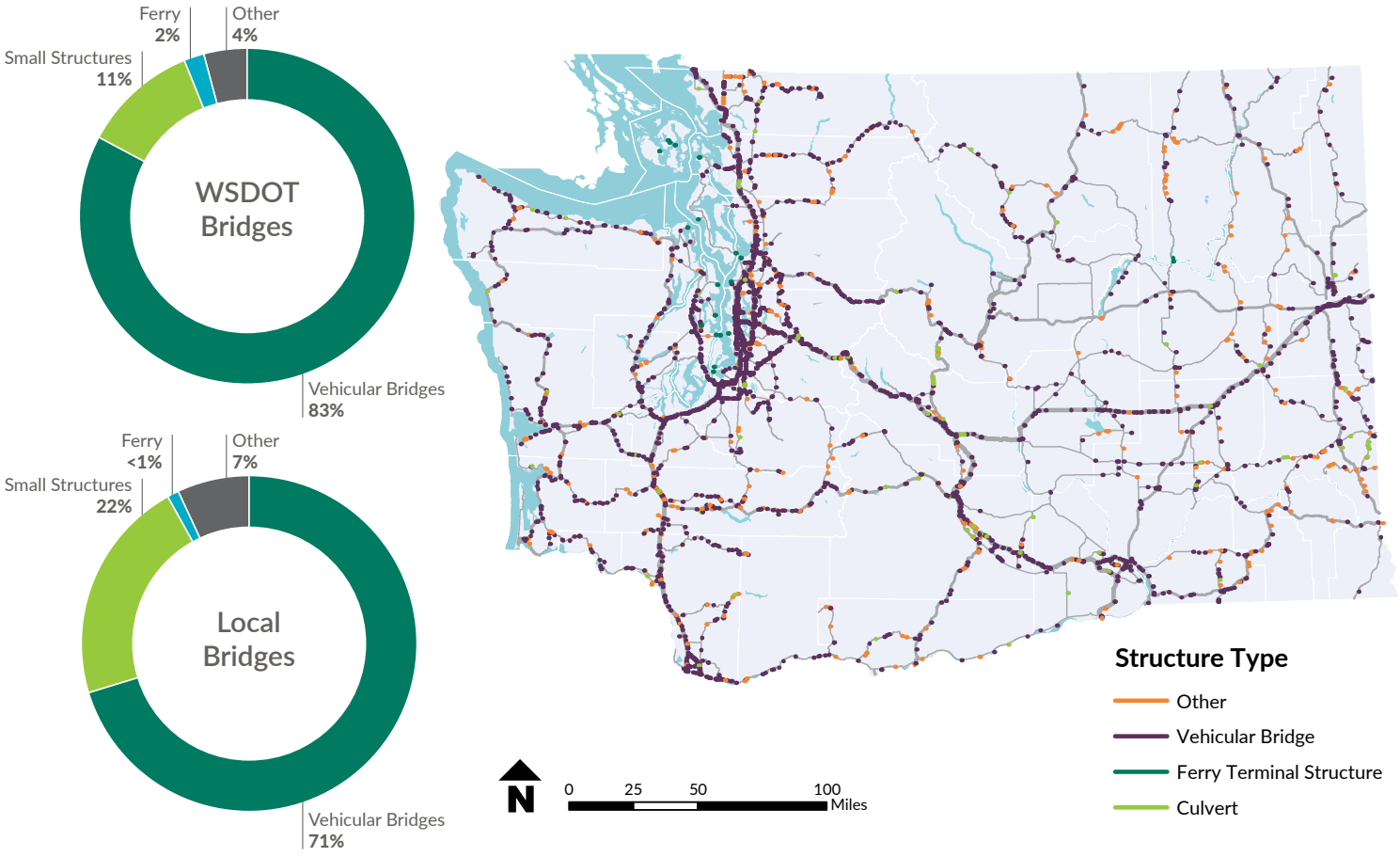


Exhibit Note: Source is from WSDOT Bridge and Structures Office and WSDOT Local Programs Office; prepared for June, 2017 *Gray Notebook 66th Edition*.

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]

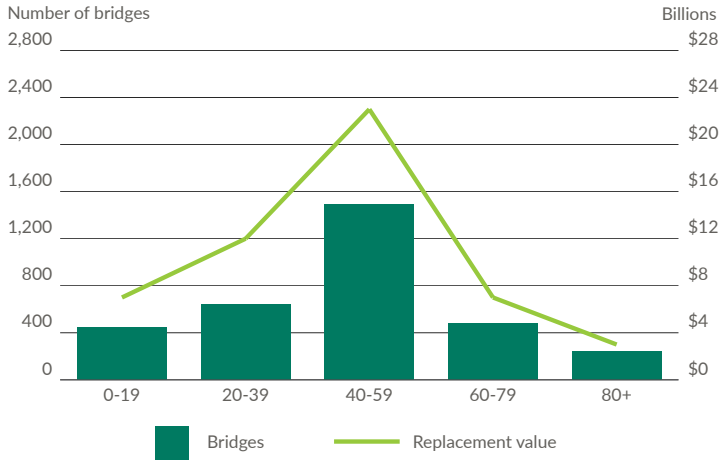


Exhibit Notes:

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.

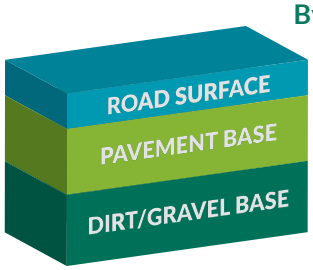
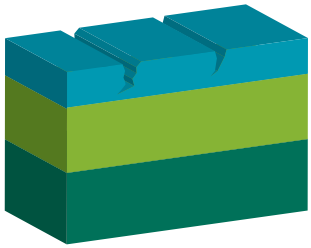
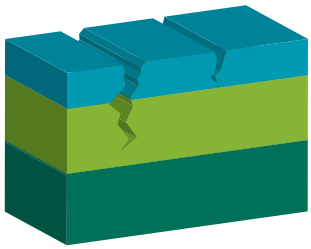
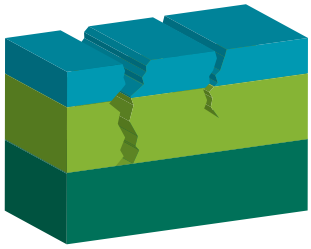
WHAT DRIVERS SEE	WHAT IS HAPPENING	2012	2016	Trend[1]	Desired Trend
GOOD/VERY GOOD	By lane miles	75.8%	73.8%	↓	↑
	By VMT[2]	73.6%	73.3%		
	This pavement is in good condition with minimal deterioration *Road users experience a smooth road with minimal cracks, ruts or potholes*				
FAIR	By lane miles	16.1%	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]

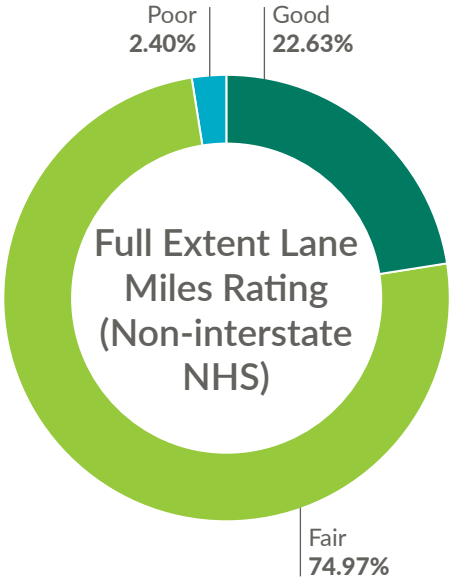


Exhibit Notes:

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.

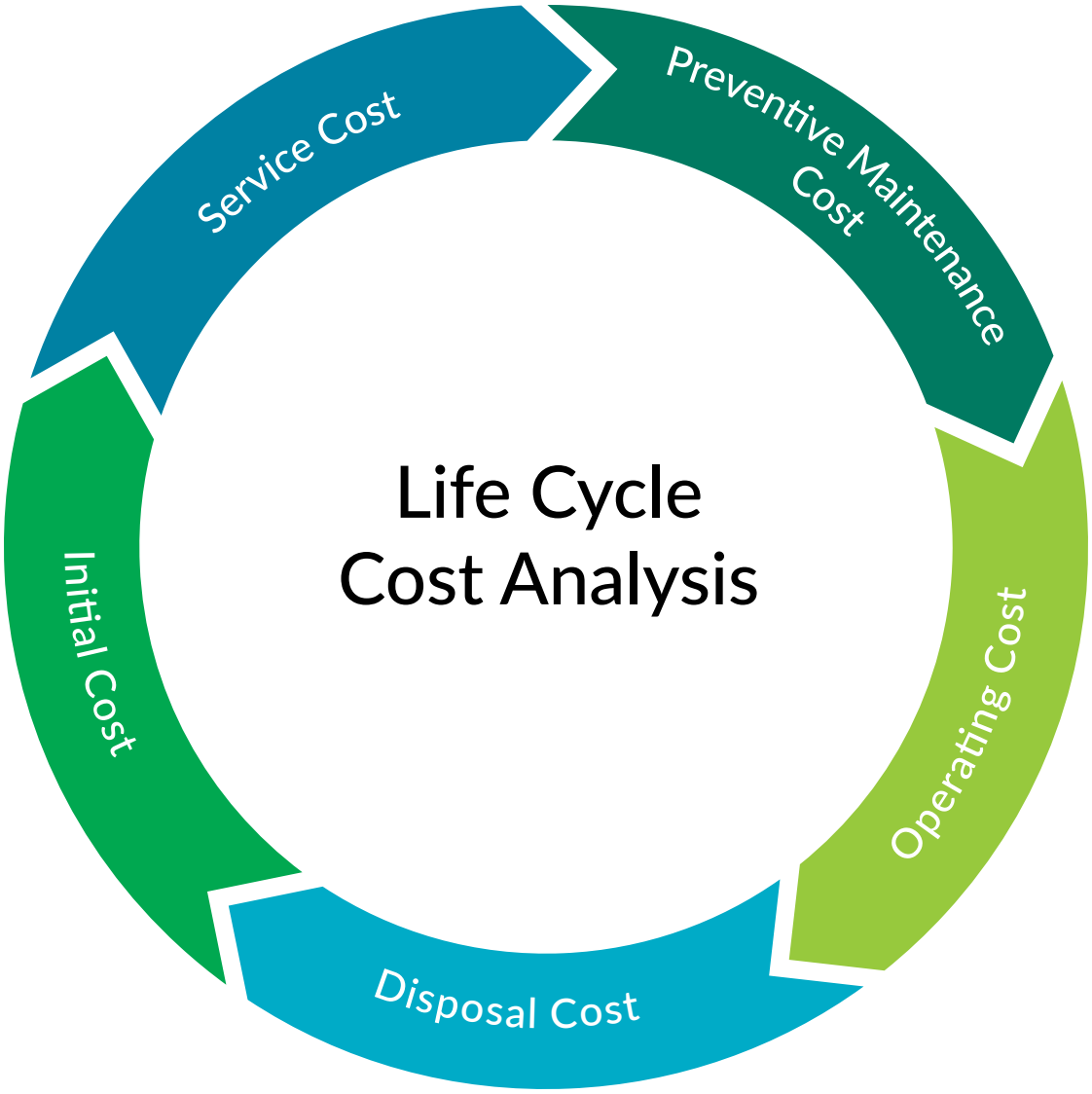


Exhibit Note: Source is from Kenneth Buddha. Prepared for 2016 TRB, *Life Cycle Cost Analysis for Management of Highway Assets*.

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).

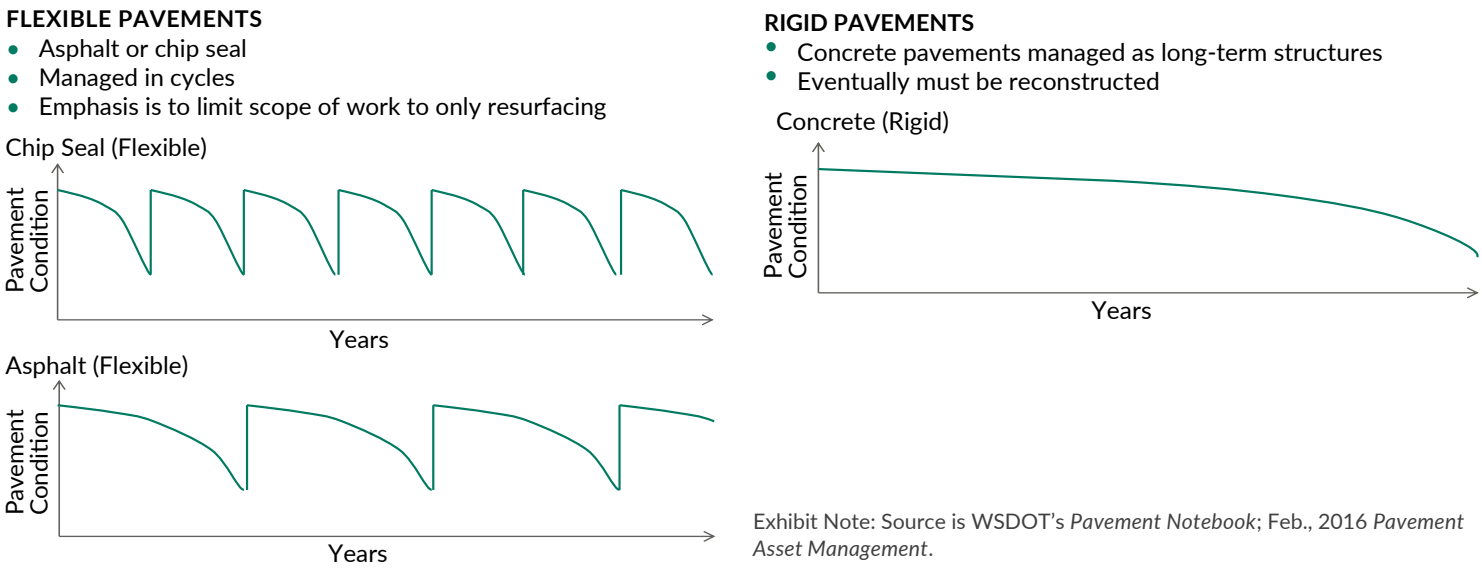


Exhibit Note: Source is WSDOT's *Pavement Notebook*; Feb., 2016 *Pavement Asset Management*.

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 WSDOT's 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.**

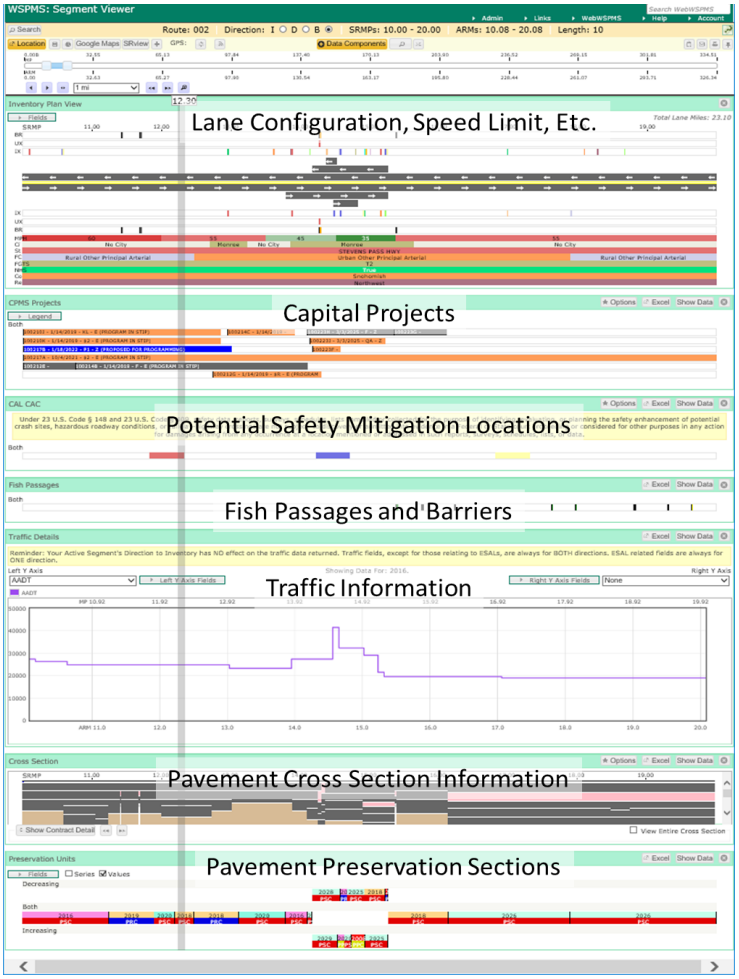


Exhibit Note: Includes Data Components for - Safety, Lane Configuration, Potential Safety Mitigation Locations, Fish Passages and Barriers, and other information; and includes over 40 different data components exist for different analysis.

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.

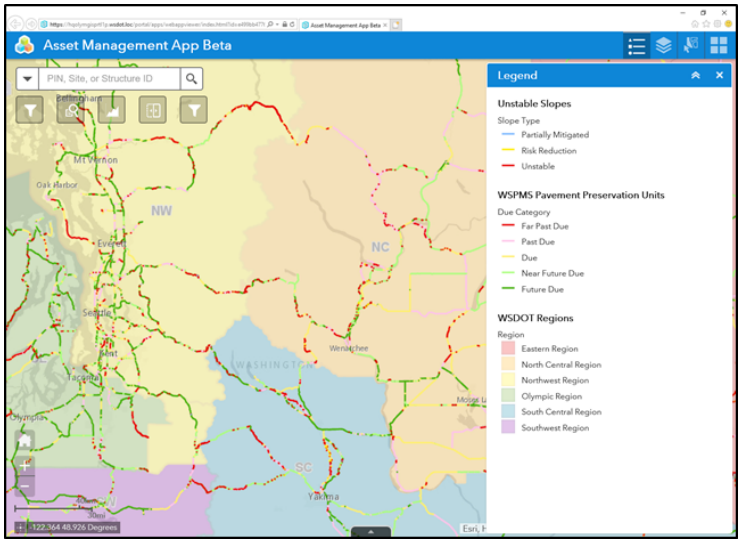


Exhibit Note: Image generated on January 25, 2018 through GIS Asset Management application created by WSDOT's CPDM office.

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.

APPENDIX C
PAVEMENT TARGET SETTING

DEVELOPMENT OF WSDOT MAP-21 PAVEMENT PERFORMANCE TARGETS

Introduction

The Moving Ahead for Progress in the 21st Century Act (MAP-21) was passed by congress on June 29, 2012, and signed into law by President Obama on July 6 the same year. The act was far reaching, and included long-term highway funding authorization, among other items. Part of the act involved the establishment of the National Highway Performance Program (NHPP), which includes a framework for the development of performance targets for highways and bridges on the National Highway System (NHS).

The establishment of performance management requirements for the NHS was new with MAP-21, and the FHWA was tasked with developing rules for the implementation. This originally was to have been completed in 18 months, but after developing initial rules, a review period and response by the states and public, the final rule related to National Performance Management Measures for the NHPP (sometimes called Rule 2) were not issued until January 18, 2017. The new federal administration further delayed implementation, and the final rule was not effective until May 20, 2017, nearly five years from the date it became law. This document describes the development of WSDOT pavement performance targets that are required under Rule 2.

Background

The concept of the National Performance Management Measures is that the federal government will have a uniform standard under which to monitor and supervise the infrastructure of the NHS. Each state is responsible for the management of the NHS within its jurisdiction, but until now states have managed the roadways independent of any national performance measures. These new national measures are not meant to dictate how the roads in each state must be managed, but rather to provide a common reference to compare the performance of transportation infrastructure from state to state, and to set minimum performance standards as mandated by congress.

The categories for pavement performance measures developed by the FHWA include roughness (measured by the International Roughness Index – IRI, in units of inches per mile), rutting (in units of inches), cracking (expressed as percent of pavement area), and faulting for jointed concrete pavements (in units of inches). The range of values in each category of good, fair, and poor performance is shown in Exhibit 1. The three criteria for flexible (asphalt) pavement include IRI, rutting, and cracking. For rigid (concrete) pavement the three criteria are IRI, faulting, and cracking.

Exhibit C-1: Pavement Condition Thresholds

	Good	Fair	Poor
IRI (inches/mile)	<95	95–170	>170
Rutting (inches)	<0.20	0.20–0.40	>0.40
Faulting (inches)	<0.10	0.10–0.15	>0.15
Cracking (%)	<5	5–20 (asphalt) 5–15 (JCP) 5–10 (CRCP)	>20 (asphalt) >15 (JCP) >10 (CRCP)

Exhibit Note: Source is from FHWA.

In addition to the categories in Exhibit 1, the FHWA developed additional requirements that all three criteria need to be satisfied in order for the pavement to be considered in "good" condition. Similarly, two out of three criteria need to be satisfied to be considered in "poor" condition. This concept is summarized in Exhibit 2. WSDOT does not use this concept of multiple criteria for pavement condition categories (WSDOT uses the worst condition to define the condition category). The term "continuous concrete" in Exhibit 2 relates to Continuously Reinforced Concrete Pavement (CRCP), which does not exist on WSDOT roadways.

Exhibit C-2: Calculation of Pavement Measures

	Pavement Type			
	Asphalt and Jointed Concrete	Continuous Concrete		
Overall Section Condition Rating	3 metric ratings (IRI, cracking and rutting/ faulting)	2 metric ratings (IRI and cracking)		Measures
Good	All three metrics rated "Good"	Both metrics rated "Good"	→	Percentage of lane-miles in "Good" condition
Poor	≥ 2 metrics rated "Poor"	Both metrics rated "Poor"	→	Percentage of lane-miles in "Poor" condition
Fair	All other combinations	All other combinations		

Exhibit Note: Source is from FHWA.

For all of the condition measures, the FHWA uses the Highway Performance Monitoring System (HPMS) to define the procedures for making the measurements. In some cases the HPMS procedures are the same as WSDOT procedures (e.g., for measuring IRI). However, for other cases (like the definition of cracking) the procedures are different. HPMS defines cracking in asphalt pavements as only fatigue (alligator) cracking, whereas WSDOT defines longitudinal and transverse cracks in addition to fatigue cracking. Similarly for concrete pavements, HPMS recognizes only transverse cracks, and ignores longitudinal cracking (which WSDOT includes).

Given the differences that exist between the FHWA and WSDOT procedures, data related to the categories of good/fair/poor pavement condition should not be directly compared. WSDOT is able to use the raw data collected from pavement condition surveys to report performance measures for both FHWA and WSDOT methods.

MAP-21 requires that each state, in cooperation with Metropolitan Planning Organizations (MPOs), develop performance targets for the following performance measures:

- Percent of interstate pavements in good condition
- Percent of interstate pavements in poor condition
- Percent of non-interstate pavements in poor condition
- Percent of non-interstate pavements in good condition

A separate requirement determined by FHWA is that the percent of **Interstate pavements in poor condition cannot exceed 5%**. This performance criterion is a special requirement mandated by congress, and is the only performance measure that results in a penalty if it is not met. The penalty is that the State must obligate a specified percentage of its NHPP and Surface Transportation Program (STP) funds to address Interstate pavement conditions.

Cooperation With Local Agencies

The MAP-21 legislation requires the states to implement pavement performance measures for the NHS, regardless of ownership. In Washington, 31% of the non-interstate NHS is owned and operated by local agencies, as shown in the table below.

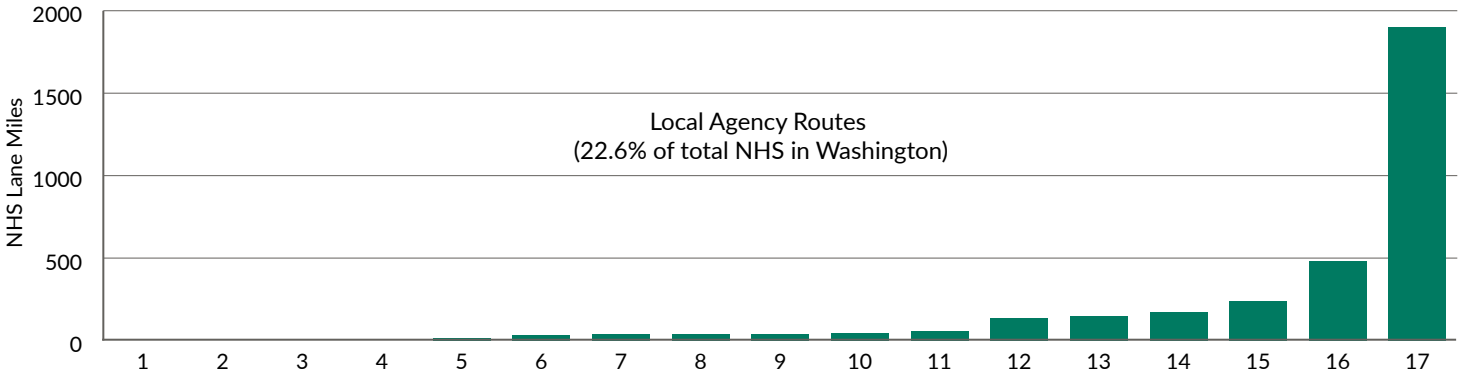
Roadway Type	Lane-miles
Interstate	4,026
Non-Interstate	
Local (31%)	3,337
State (69%)	7,426
Total NHS	**14,789**

It is interesting to note that the percentage of the NHS owned by local agencies varies considerably between states. Washington has the sixth highest percentage of locally owned NHS lane-miles in the country. California has the highest percentage, with almost 37%. Other states in the Pacific Northwest, such as Oregon (6%) and Idaho (7%), have much less local ownership.

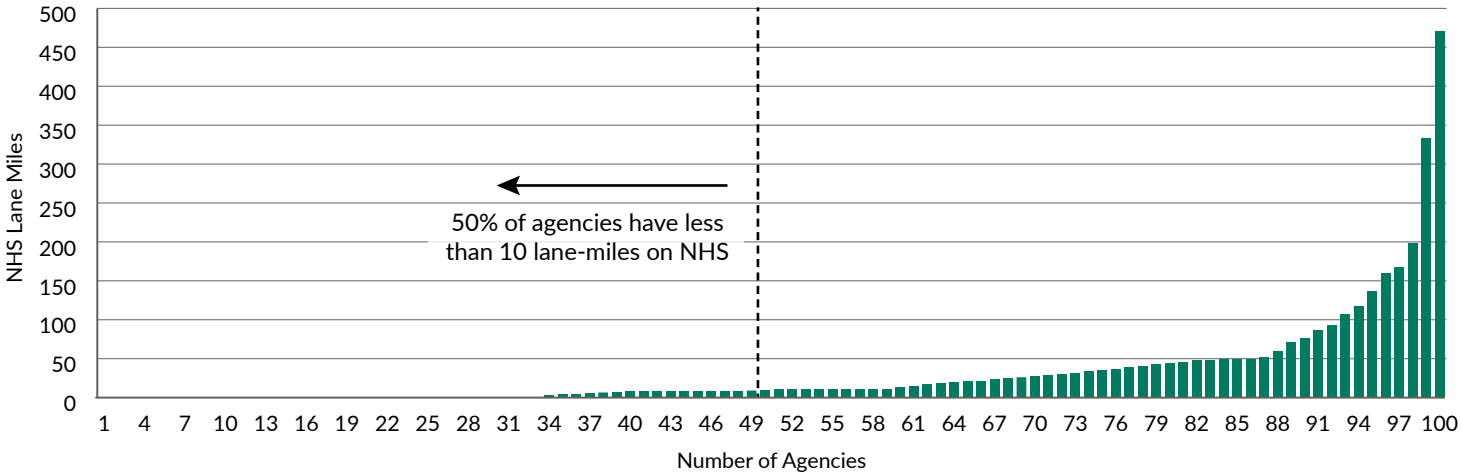
WSDOT has been proactive in working with MPOs and local agencies with regard to the implementation of MAP-21 pavement performance measures. There are 17 MPOs with mileage on the NHS, but these organizations are typically facilitators and planners and are not directly involved with the asset management of the NHS. Instead, it is the local agencies that own the roads and streets that are on the NHS that make the financial and engineering decisions related to pavement asset management. Exhibit 3 notes that there are 103 local agencies in Washington with roads on the NHS.

Exhibit C-3: Distribution of local agency roads on the Washington NHS

WA: Lane-Miles of NHS in MPOs



WA: 103 Local Agencies with NHS Lane-Miles



A Pavement Technical Committee was established with representatives from MPOs, local agencies, and WSDOT to work together to develop plans for the implementation of MAP-21 performance measures. There have been several meetings to date:

1. **August 6, 2015:**
   Online Webinar (WSDOT, MPO's, Spokane County, and City of Seattle)
2. **March 16, 2016:**
   Half-day meeting in Tumwater (WSDOT, Spokane County, MPOs)
3. **April 13, 2017:**
   Half-day meeting in Tumwater (WSDOT, Spokane County, CRAB, MPOs)
4. **July 31, 2017:**
   Online Webinar (WSDOT, MPOs, City of Seattle)
5. **November 14, 2017:**
   Online Webinar (WSDOT, MPOs, City of Seattle)
6. **February 27, 2018:**
   Online Webinar (WSDOT, MPOs)

The schedule for implementing the performance targets is shown below:

- **May 20, 2018:**
  States establish 2-year and 4-year pavement performance targets.
- **November 16, 2018**
  MPOs have 180 days from May 20 to report 4-year targets to state. They may choose to use the state's targets, or develop their own.
- **October 1, 2018:**
  States report to FHWA what the performance targets are, and explain how they were developed.
- **October 1, 2018:**
  States report Baseline pavement conditions from data collected in 2016 and 2017.

Interstate Pavement Target Setting

As stated in the introduction, Rule 2 requires a target for Interstate percent poor, and percent good. The latest data available for interstate pavements in Washington is from the 2015 and 2016 data collection period. Using the criteria shown in Exhibits 1 and 2, a summary of condition is shown below in Exhibit 4. Currently there are 32.5% of interstate pavements in good condition, and 3.6% in poor condition.

Exhibit 4 also shows that the biggest contribution of percent poor is from concrete pavements. This is because of the age of the concrete network (50% of WSDOT concrete pavement is more than 40 years old). The vast majority of the concrete pavement is on the interstate system.

Exhibits 5 and 6 show detailed information regarding the interstate concrete pavements, for IRI and cracking respectively.

Exhibit C-4: Interstate pavement condition from 2015 & 2016 data

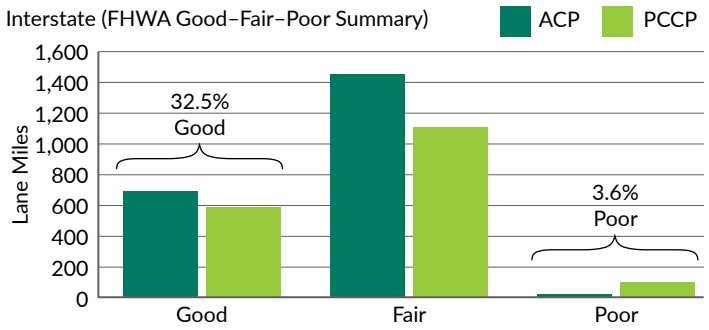


Exhibit C-5: Distribution of IRI values for interstate concrete pavements

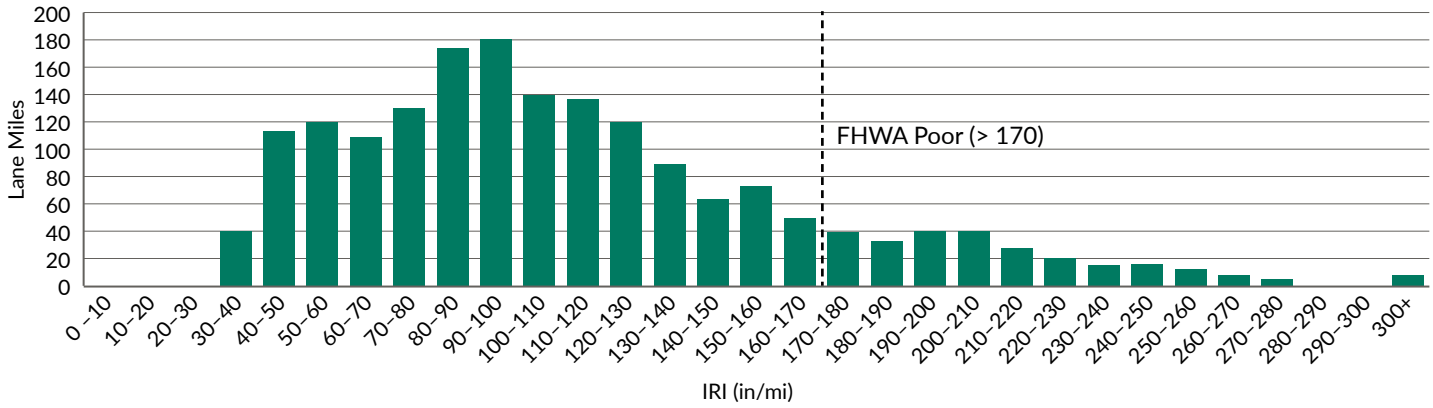
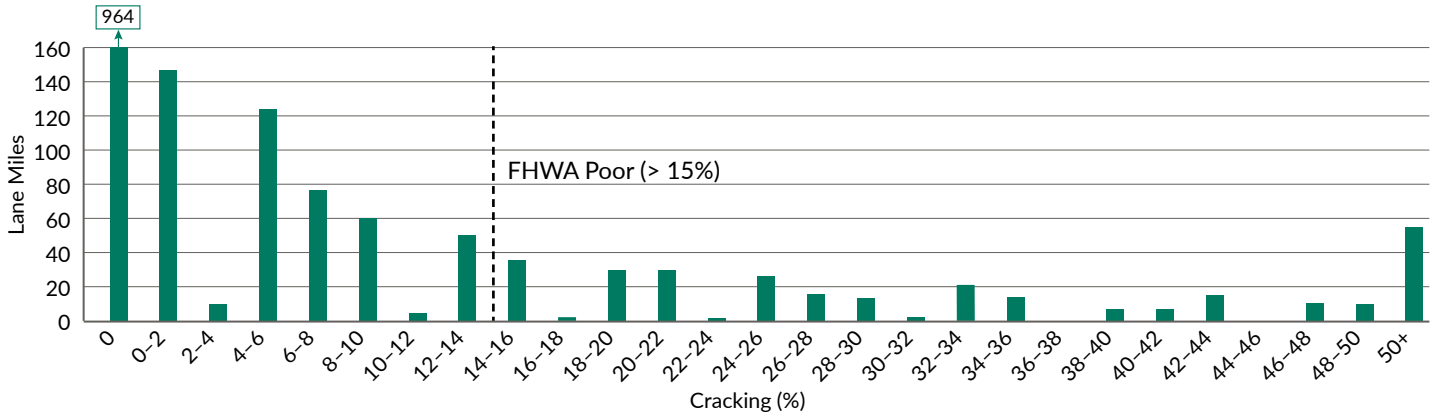


Exhibit C-6: Distribution of cracking values for interstate concrete pavements



The main conclusion from Exhibits 5 and 6 are that additional lane-miles that are currently in fair condition will be moving to poor condition over time. This will require long-term planning by WSDOT to make sure resources are available for reconstructing the aging concrete network.

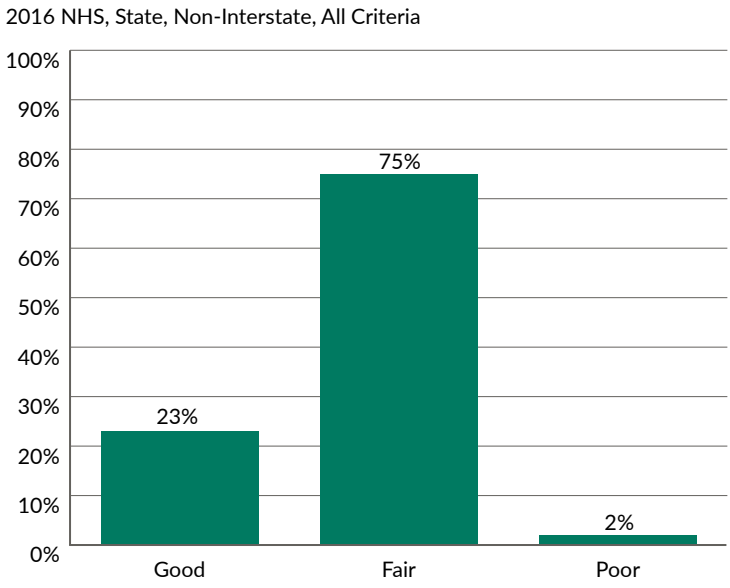
In the short term, an investigation of currently programmed projects shows that projects in the construction plan for 2017 – 2020 will improve the condition of about 70% of the concrete lane-miles currently in poor condition. This will make sure that the FHWA limit of 5% poor is not reached, and the expected percent poor in 2020 should be less than 3%. Given the long term status of aging concrete pavement, a reasonable target for interstate percent poor is 4%.

The combination of asphalt and concrete renewal expected in the future should leave the percent good in relatively stable condition, and a reasonable target for interstate percent good is 30%.

Non-Interstate Targets

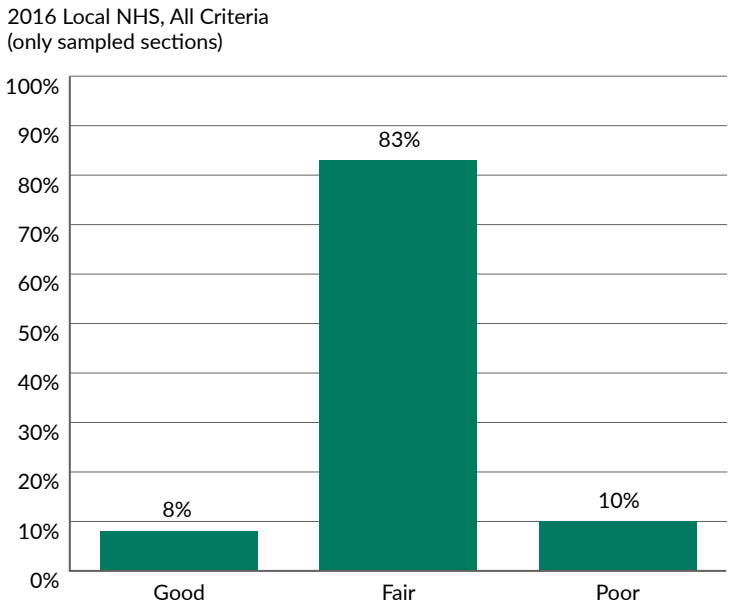
As described earlier in this document, local agency routes make up 31% of the non-interstate NHS, and state routes have 69%. Using the most recent data available (2016), and the condition criteria stated in Exhibits 1 and 2, the condition of state-owned NHS routes are shown in Exhibit 7.

Exhibit C-7: Condition summary for state-owned non-interstate NHS routes



The data for local agency NHS routes was compiled from HPMS sample sections surveyed in 2015 and 2016. Even though when MAP-21 is fully implemented in 2022 there will be no statistical sampling, the existing HPMS data does provide very good estimates for local road conditions. Using the same criteria from Exhibits 1 and 2, the summary of pavement conditions for local agency NHS roads is shown below in Exhibit 8.

Exhibit C-8: Condition summary for locally owned NHS routes

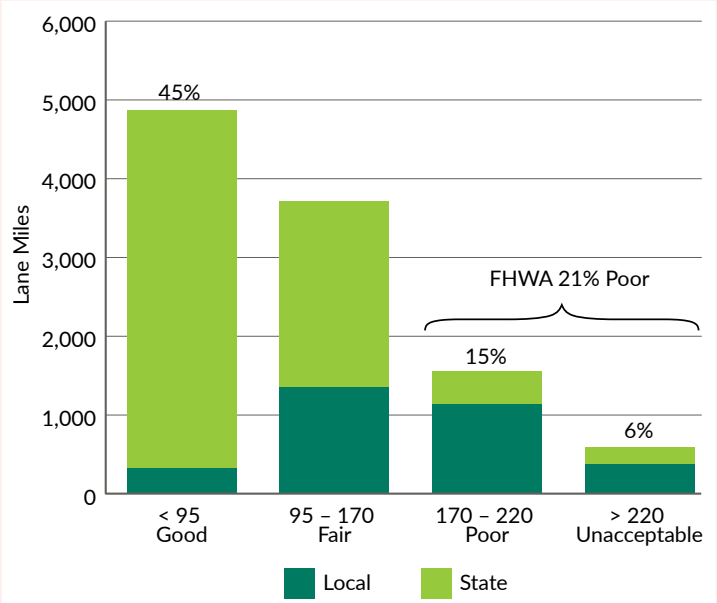


To determine the combined state & local NHS conditions for non-interstate routes, the following weighted condition calculations were performed (using all three condition criteria of cracking, rutting, and IRI), weighting the conditions by the lane-miles in the state and local networks.

Good	(8% * .31) local	+	(23% * .69) state	=	18%
Poor	(10% * .31) local	+	(2% * .69) state	=	5%

Rule 2 asks that initial 2-year targets use IRI only. This is because there is a four-year phase in of the three-criteria condition factors, with IRI only used in the first two years. Exhibit 9 was developed showing data for non-interstate for IRI only.

Exhibit C-9: Condition Summary For Non-Interstate NHS (IRI only)



An evaluation of pavement data collected from the NHS has led to the development of proposed MAP-21 targets for pavement performance. As described above, these targets represent expected values of performance measures given the current funding situation. WSDOT experience has shown that pavement condition indexes calculated over an entire network do not change rapidly, especially in the short term. So, the 2-year and 4-year targets are based on current conditions.

As requested by Rule 2, the 2-year (2020) target is expressed using IRI only (MPOs do not report 2-year targets). The 4-year (2022) target is expressed using all criteria (cracking, rutting, and IRI).

	Condition Rating	Interstate	Non-Interstate
2-year WSDOT target (IRI only)	Good	N/A	45%
	Poor	N/A	21%
4-year WSDOT & MPO target (cracking, rutting and IRI)	Good	30%	18%
	Poor	4%	5%

Exhibit Note: During the phase-in of MAP-21 requirements, only the first 2-year target uses IRI only. MPOs do not report 2-year targets.

MPOs can adopt the same 4-year targets as the state, or have until November 16, 2018 to develop their own targets. Multi-state MPOs have until 180 days from the time the **last State DOT** establishes its targets.

APPENDIX D
LOCAL ENGAGEMENT

SYSTEMS AND PROCESSES FOR IMPROVED STEWARDSHIP UNDER MAP-21, LOCALLY OWNED NHS PAVEMENTS

This document communicates WSDOT's proposed implementation to meet the requirements of 23 CFR 515.17, which establishes the minimum standards States must use for developing and operating bridge and pavement management systems. Additionally, this proposal supports the requirements under 23 CFR 515.9 (asset management plan requirements) by facilitating and coordinating better asset management practices with jurisdictions who own and maintain portions of the NHS. WSDOT currently collects data on, and analyzes, State-owned pavements, and to a lesser extent, locally owned NHS pavements; this paper outlines a process proposal to extend the comprehensive state process to locally owned NHS pavements as well as provide guidance to MPOs via the MPO technical committee on pavement management best practices.

Overview

To adhere to the MAP-21 requirements and achieve a more collaborative and comprehensive management approach to maintaining the locally owned sections of the NHS, WSDOT proposes the following actions:

1. Improve and extend data collected and stored in the Highway Performance Monitoring System (HPMS).
2. Perform analysis on locally owned NHS pavement data to include an estimate of service life and life cycle planning analysis.
3. Develop local agency NHS pavement funding needs based on life cycle planning results.
4. Develop investment strategies based on available funding and needs.
5. Document and communicate results along and any guidance on best practices.
6. Identify local agency top value pavement projects that reflect investment strategies.

The MAP-21 pavement technical committee would develop and communicate these process improvements. The technical committee is an ideal champion because it has members representing WSDOT, MPOs and local agencies.

The following section details each action, along with the action lead to oversee implementation.

Details

1. Action: Improve and Extend Data Collected and Stored in the HPMS.

Action Lead: WSDOT Pavement Office

Primary inputs for a service life assessment are condition, surface type, and year of last activity. HPMS contains the metrics for condition as detailed under 23 CFR. Additionally, the following fields are needed to be input for full extent, even though HPMS only requires them for Sample Panel sections:

- Year of Last Improvement.
- Year of Last Construction.

Other primary fields used to assess service life are:

- Condition Metrics – International Roughness Index (IRI), Rutting, Faulting and Cracking Percent.
- Surface Type.
- Speed Limit.
- Annual Average Daily Traffic.

The primary effort would be working to populate fields for all of the NHS, based on information from local agencies for Year of Last Improvement and Year of Last Construction, while also performing Quality Verification on the other required fields. Information will be obtained from local agencies through the existing HPMS data collection process.

2. Action: Perform analysis on locally owned NHS pavement data to include an estimate of service life and life cycle planning analysis.

Action Lead: WSDOT Pavement Office

In addition to the HPMS database, a separate table detailing service life and preservation strategy is needed to supplement the HPMS data and provide age-based deterioration modeling and needs assessment. It is assumed this would be a table with the following fields:

- **Preservation Strategy** – A preservation strategy, such as asphalt resurfacing with maintenance.

- **Service Life Extension** – The amount of life expected between applications of the strategy.
- **Average Cost** – The cost in current dollars to apply the strategy.
- **Surface Type** – The surface type the strategy is applicable to.
- **MPOs** – The MPO applicable for the strategy. This will allow different strategies/life/cost assumptions across the MPOs. Defaults will be established statewide and for the MPO.
- **Local Agency** - The local agency applicable for the strategy. This will allow different strategies/life/cost assumptions across the local agencies. Defaults will be established statewide and for the local agencies.
- **Additional Assumptions** – An additional filters to apply toward the strategy, such as an AADT threshold or speed limit.

The table will be prepopulated based on default assumptions for all of the NHS (generated by the WSDOT Pavement Office). The initial draft will be based on the local agency survey that was completed by the Pavement Office in early 2018. The initial data can be updated by local agencies over time. This table can be modified by the local jurisdictions to allow local jurisdictions to input their own data and assumptions for the LCP analysis if they choose to override the default values.

3. Action: Develop local agency NHS pavement funding needs based on life cycle planning results.

Action Lead: WSDOT Pavement Office

The HPMS data will be exported annually after data has been submitted and updated. Then, the assumptions detailed from the Preservation Strategy table will be used to assign each record with a Preservation Strategy and likely timeframe the strategy is needed. This will allow for an age-based assessment of needs that will be reviewed in the context of overall condition. This will be a simplified (or more generic) model of WSDOT's existing pavement needs model.

The information generated through this process will ultimately be included as part of the Transportation Asset Management Plan and used to communicate the estimated 10-year needs for the locally owned NHS.

4. Action: Develop investment strategies based on available funding and needs.

Action Lead: Pavement Technical Team

Once the statewide needs are assessed, these can be compared with known available funding amounts. Overarching network level investment strategies for pavements will then be generated to provide a framework to assist in the decision making process to maximize efficiency of pavement investments. These investment strategies will then be communicated and shared with the MPOs for consideration.

5. Action: Document and communicate the results along with any guidance on best practices.

Action Lead: WSDOT Pavement Office and CPDM – Coordinate with Local Programs and Planning Office

The results of all of this analysis will be distributed to MPOs and local agencies. The assumed deliverables include:

- A spreadsheet containing the HPMS information along with needs assessment at 1/10th mile intervals
- The same data in the spreadsheet available in GIS format
- A "best practices" document that communicates any WSDOT and other NHS stakeholder knowledge vetted by the technical committee that will be useful to pavement management practitioners for developing projects and managing pavements on the NHS.

6. Action: Identify local agency top value pavement projects that reflect investment strategies.

Action Lead: WSDOT Local Programs

WSDOT Local Programs will work with local agencies to identify and vet projects. These projects will be communicated back to the technical committee, especially in the context of any grant call for projects. The list of projects can also be used to reassess overall needs or make any assumptions about future condition of the NHS.

Timelines

Exhibit D-1: Project Delivery and Recurring Annual Process Timeline

ACTION 1:	ACTION 2:	ACTION 3:	ACTION 4:	ACTION 5:	ACTION 6:
Request "Yr. of Last Improvement," and "Yr. of Last Construction," from local agencies. This will also become part of the recurring annual process. **8/31/2018**	Pavement Office/CPDM compiles information from survey results into tabular format for presentation at the technical committee meeting. **9/6/2018** MPO/Local agency reviews and finalizes survey table. **11/1/2018**	Pavement Office/CPDM works with local agency survey information and WSDOT Lifecycle pavement approaches to develop local NHS pavement needs. **1/1/2019**	Pavement Office/CPDM discuss pavement investment strategies at technical advisory meeting. **Initial discussion** **1st Quarter/2019**	Pavement Office/CPDM works with TDGMO to develop spreadsheet of HPMS information and incorporate data into public facing GIS portal. Format of data export and process to be developed for preservation strategies from Action 2. **Tentatively scheduled for early Fall 2019**	Identify top value local agency pavement projects. Timing partially dependent on available GIS information. **Results to be included in TAMP due 6/30/2019**
Project Delivery					
Recurring Annual Processes					
ACTION 1:	**ACTION 2:**	**ACTION 3:**	**ACTION 4:**	**ACTION 5:**	**ACTION 6:**
Annual HPMS submittal process. In the future, this process will also include "Yr. of Last Improvement," and "Yr. of Last Construction." **By 4/15 for Interstate,** **6/15 for non-Interstate NHS each Yr.**	Annual updates to the survey. **If necessary, by** **7/1 each Yr.**	Preservation strategies table updated annually. **If necessary, by** **7/1 each Yr.**	Annual discussion of pavement investment strategies. To align with quarterly technical advisory meetings. **If necessary, by** **7/1 each Yr.**	Update HPMS spreadsheet and incorporate data into GIS. **By 8/31 each Yr.**	Identify top value local agency pavement projects. Local Programs Office to coordinate with Local agencies. **Timing: TBD** **Occurs annually**

Exhibit Notes:

Action 1) Improve and Extend Data Collected and Stored in the HPMS.

Action 2) Perform analysis on locally owned NHS pavement data to include an estimate of service life and life cycle planning analysis.

Action 3) Develop local agency NHS pavement funding needs based on life cycle planning results.

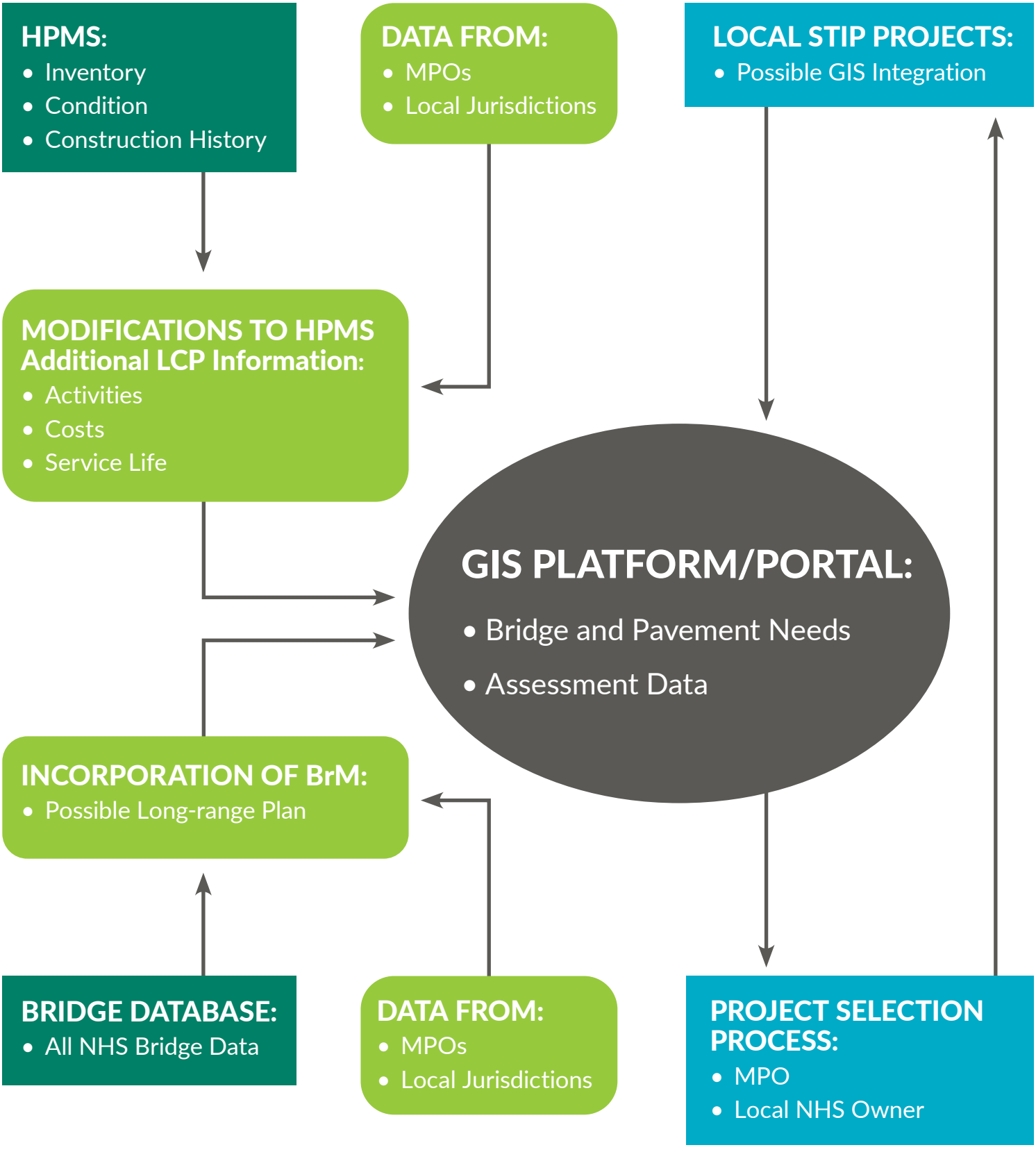
Action 4) Develop investment strategies based on available funding and needs.

Action 5) Document and communicate the results along with any guidance on best practices.

Action 6) Identify local agency top value pavement projects that reflect investment strategies. For more information see the *NHS Planned Pavement and Bridge Expenditures* section of the *Revenue and Financials* TAMP chapter.

Systems Relationships

Exhibit D-2: MAP-21 System and Process Relationships



APPENDIX E
RISK REGISTERS

Exhibit E-1: Pavement Risk Register

PAVEMENT ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Studded Tires	If studded tires are continued to be used	then premature rutting and wear will occur on bridge and road pavements, reducing life and increasing life cycle costs	Operational	Natural Events	High	Passive Acceptance	Support legislation to ban the use of studded tires. Damage to asphalt and concrete pavement on state highways is estimated at $20 to $29 million a year. This estimate is driven by a study performed by the pavement office. In 2019, legislation (HB 1309) was proposed that would increase the fee associated with studded tire sales and ultimately phase out the ability to purchase new studded tires. Link to the studded tire studies: http://www.wsdot.wa.gov/Business/MaterialsLab/Pavements/Default.htm	No additional treatment plan known at this time. In place treatment is to communicate the financial impact of allowing studded tires.	High
Insufficient Funding	If funding is insufficient to maintain pavement in a state of good repair	then there may be unplanned failures.	Operational	Resource, Funding	Very High	Passive Acceptance	We've instituted strategic maintenance on flexible pavements and triage on rigid pavements to extend the pavement life in lieu of larger, more costly rehabilitation projects. This will not prevent all the unplanned failures. To support the implementation of strategic maintenance, WSDOT has an integrated approach that influences the timing and requirements of when future paving projects occur, maximizing the pavement life before a more intensive treatment option is selected. As part of the overarching investment strategies for pavements, WSDOT is actively engaged in Lowest Lifecycle cost strategies and has well documented asset management practices as communicated in the pavement manual. Pavement performance is actively monitored through performance measures established in the gray notebook. Link to the most recent gray notebook pavement article: https://wsdot.wa.gov/publications/fulltext/graynotebook/gray-notebook-Dec20.pdf	The JLARC Audit from 2014 concluded that more communication about needs would be beneficial. WSDOT has been clear on its unfunded need regarding necessary amounts to sustainably manage the pavement network. 10-year funding amounts are well below annual average needs. Additional treatment plans are not identified, but WSDOT continues to seek innovations in pavement practices by keeping apprised of national research projects and the latest trends in pavement technologies.	High

Exhibit E-1: Pavement Risk Register (continued)

PAVEMENT ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Pavement Treatment	If pavement projects are not programmed at the correct time	then life-cycle costs might increase	Operational	Process	Very High	Mitigation	To support the implementation of strategic maintenance, WSDOT has an integrated approach that influences the timing and requirements of when future paving projects occur, maximizing the pavement life before a more intensive treatment option is selected. As part of the overarching investment strategies for pavements, WSDOT is actively engaged in implementing Lowest Lifecycle cost strategies. The pavement office also has well documented asset management practices as communicated in the pavement manual. Pavement performance is actively monitored through performance measures established in the gray notebook.	Improve procedures to make project programming more accurate. More time spent reviewing the program of projects for completeness and accurate timing.	High
Preventive Maintenance Strategy	If the preventive maintenance strategy is not effectively implemented	then early resurfacing or reconstruction may need to occur, increasing life cycle costs	Operational	Process	High	Mitigation	The Pavement office works closely with headquarters and Regional maintenance staff to train and identify best practices for pavement strategic maintenance. This is to ensure the most effective implementation of strategic maintenance. Training consists of pavement deterioration identification, appropriate treatment types, and root cause analysis. Maintenance also provides feedback on effectiveness of treatment options and successes and challenges experienced in the field. The pavement office also works to promote consistent implementation of strategies across the regions.	Develop a single approach and implementation strategy that is consistent across regions. Identify the scenarios and root causes of why strategies were not effective. Progress of implementation of the risk treatment strategy is measured through pavement life extension.	Medium

Exhibit E-1: Pavement Risk Register (continued)

PAVEMENT ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Construction Quality	If construction quality is not to standards	then expected pavement life will not be met and life cycle costs will increase	Operational	QA/QC	Medium	Mitigation	To ensure construction quality WSDOT continues to communicate and enforce construction quality standards (WSDOT Standard Specifications) for pavement rehabilitation and reconstruction projects. When construction quality issues arise the Construction Division determines the causes of poor performance and revises Standard Specifications and construction procedures accordingly to ensure projects are built to contract requirements. Recommended changes and improvements are communicated by HQ Construction to Region design and construction staff so that quality standards can designed into and enforced on future projects.	Increase workforce experience and expertise through training specifically geared towards project engineers and inspectors and early identification of signs indicating lower than acceptable construction quality.	Medium
High Demand for Construction Materials	If high levels of construction in the region and nation occur	then pavement costs may increase because of material shortages.	Demand	Organizational	Medium	Active Acceptance	Continue to monitor and communicate shifts in material and labor costs. Realize the impact of project cost increases on the ability of delivering projects across the state, and if project numbers decrease, the impact of investment strategies and overall performance of the pavement network. Work closely with Headquarters and Region staff to communicate impact of costs to projects relative to available funding.	Track costs and look at potential delay or acceleration of projects, consider lower cost treatments to maintain pavements for a longer time before rehabilitation.	Medium
Higher Weight Limits	If higher weight limits are allowed	then pavements may fail early or thicker structure is needed, increasing life cycle costs.	Operational	Policy	Medium	Passive Acceptance	Continue to support legislation (if introduced) to keep weight limits down to preserve pavement structures.	No additional treatment plan known at this time. In place treatment is to respond to questions with financial impact of allowing higher weight limits.	Medium
Preservation of Pavement Conditions	If pavement conditions are not preserved (e.g., rutting) in a state of good repair	then an increased crash likelihood may occur	Operational	Process	High	Mitigation	Continue to monitor the friction and rutting pavement conditions to determine safety issues that may arise. Program projects that are of concern. We are currently implementing crash mitigation strategies, such as rumble strip installation and reinstallation, during programming.	Align agency policy on what is considered to be impactful to crash potential, ensuring the pavement condition metrics considered impactful to crashes are given priority during programming.	Medium

Exhibit E-1: Pavement Risk Register (continued)

PAVEMENT ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Decreasing Pavement Expertise	If pavement expertise decreases through turnover and retirement	then statewide pavement program decisions will not be effective	Operational	Process	High	Mitigation	Continue to develop employee workforce and competency	Develop a recruitment and employee development plan.	Medium
Pavement Reconstruction or Rehabilitation	If concrete pavement reconstruction or rehabilitation is not completed or performed	then there is a risk of pavement failure	Informational & Decision Risks	Process	Medium	Mitigation	Utilize the Pavement's Office 30 year plan to manage concrete as funding allows	The Pavement Office has developed a 30-year plan to manage concrete preservation under a consistent annual funding amount. There are two remaining steps: 1) Get approval of the plan and 2) Determine levels of funding for concrete compared to recommended amounts in the plan.	Low
FHWA Targets, Interstate Pavement Condition	If interstate pavement condition does not meet FHWA targets	then WSDOT will be penalized per MAP21 rules	Demand	QA/QC	High	Passive Acceptance	Continually propose and support funding packages that will help keep pavement condition acceptable in terms of MAP-21 rules.	At this time, this risk is not expected to be likely in the immediate future. Chronic underfunding will continue to increase this risk, and when the likelihood increases, a different treatment plan may be proposed.	High
Maintenance	If funding is insufficient to maintain pavement in a state of good repair	then roads may be signed for lower speed or closed	Demand	Process	Very High	Active Acceptance	Continue to program projects where we can afford to, projects on lower volume routes may be susceptible to signage or lower speed. At this time, system performance is driven by funding provided to preservation. With decreased funding, system performance is reduced and risk to increased maintenance costs rises.	Chronic underfunding will continue to increase this risk. Currently developing a communication plan to the public and interested parties for reduced speed and rough road postings.	Very High
FHWA Targets, Non-Interstate Pavement Condition	If funding is insufficient to maintain non-interstate pavement in a state of good repair	then there may be an increased burden on our maintenance forces	Demand	Process	High	Passive Acceptance	Current funding levels do not allow WSDOT to fund projects on lower volume routes and road sections. There will be an increased burden on maintenance forces	Chronic underfunding of preservation will continue to increase this risk.	High

Exhibit E-1: Pavement Risk Register (continued)

PAVEMENT ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Agency Communication	If expertise of maintenance is not present (Plan, Scope, Design)	then identification of key needs may not be identified	Operational	Resource, Staffing	Medium	Mitigation	Continue to develop employee workforce and competency. The WSDOT Strategic Plan is the overarching guidance used to increase communication. Practical Solutions are specific enhancements.	Develop a recruitment and employee development plan. Trainings are the primary means where by expertise is.	Medium
Drainage	If pavement drainage is not addressed	then pavement performance will be reduced and premature failure will increase	Operational	Policy	Medium	Mitigation	Current funding levels do not allow WSDOT to fund projects such as these therefore failures will continue to happen. Planned Maintenance inspections are currently happening but are not sustainable due to staffing challenges and competing priorities.	Chronic underfunding will continue to increase this risk. This risk is currently mitigated using preservation fundings	Medium
Preservation/ Maintenance	If the frequency of extreme weather events increases	then increased cost for preservation and maintenance may occur	Operational	Natural Events	Medium	Passive Acceptance	Current funding does not allow WSDOT to fund projects that will built more stout pavements that can withstand extreme weather events.	Chronic underfunding will continue to increase this risk. The WSDOT Resiliency Working Group is working on contingency plans in the case of extreme weather events.	Medium

Exhibit E-2: Bridge Risk Register

BRIDGE ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Bridge Deterioration	If funding is insufficient to maintain bridges in a state of good repair	then there may be unplanned failures.	High-Risk, High-Value Assets	Resources, Funding	Very High	Mitigation, Active Acceptance	WSDOT is currently only receives about 50% of the maintenance and preservation funding needed to keep our assets in a state of good repair. WSDOT identifies and prioritizes bridge preservation needs for a 10 year period. The needs are separated into subcategories such as: border bridges; steel bridge painting; concrete deck rehabilitation; movable/floating bridges; bridge repairs; bridge rehabilitation and replacement. WSDOT will address the highest priority needs first, specifically border bridges, movable/floating bridges, and all preservation needs on T-1 freight routes. If additional funding remains, other lower-priority needs will be addressed (T-2 and below freight routes).	The JLARC Audits from 2014 and 2019 concluded that more communication about needs would be beneficial. WSDOT has been clear on its unfunded need communication regarding necessary amounts to sustainably manage the bridge and pavement network. WSDOT will continue to communicate this need to the legislature and the governor's office. Because WSDOT has no control over legislative action, assume no long-term risk reduction.	Very High
Bridge Deterioration	If funding is insufficient to maintain bridges in a state of good repair	Then there may be unplanned failures	High-Risk, High-Value Assets	Resources, Funding	Medium	Mitigation	WSDOT is currently only receives about 50% of the maintenance and preservation funding needed to keep our assets in a state of good repair. WSDOT identifies and prioritizes bridge preservation needs for a 10 year period. The needs are separated into subcategories such as: border bridges; steel bridge painting; concrete deck rehabilitation; movable/floating bridges; bridge repairs; bridge rehabilitation and replacement. WSDOT will address the highest priority needs first, specifically border bridges, movable/floating bridges, and all preservation needs on T-1 freight routes. If additional funding remains, other lower-priority needs will be addressed (T-2 and below freight routes).	The JLARC Audit from 2014 and 2019 concluded that more communication about needs would be beneficial. WSDOT has been clear on its unfunded need communication regarding necessary amounts to sustainably manage the bridge and pavement network. WSDOT will continue to communicate this need to the legislature and the governor's office. Because WSDOT has no control over legislative action, assume no long-term risk reduction.	Medium

Exhibit E-2: Bridge Risk Register (continued)

BRIDGE ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Construction Quality	If construction quality is not to standards	then expected bridge life will not be met and life cycle costs will increase	Operational	QA/QC	Medium	Mitigation	Bridge construction quality is dependent on WSDOT project management staff inspection and work performed by contractors. WSDOT Construction offices in HQ and Regions continues to provide "Just-in-time" training to new staff in the project offices targeted towards root cause analysis and early identification of construction quality issues. In addition to formal training, the Bridge office, HQ construction office, and HQ materials lab hold meetings to discuss arising issues discovered in the field. Depending on the severity of the issue, the HQ construction office will provide written summary documents to communicate the areas of concern to the regions.	Increase workforce experience and expertise through training.	Medium
Bridge Flooding & Scour	If bridges experience flooding and scour	then bridges may fail	High-Risk, High-Value Assets	Man-Made and Natural Events	Medium	Mitigation	The WSDOT Bridge Preservation office has evaluated all state owned bridges over water. A Plan of Action has been developed on all scour critical bridges. The Bridge Asset Management group has prioritized the bridges with the highest scour risk for a future mitigation project. Current Bridge inspections monitor conditions until mitigation projects are completed based on available funding. Due to the level of risk associated with bridge scour, Washington State has an entire program dedicated towards addressing scour related issues.	Many of WSDOT's scour analyses and Plans of Action are out of date. Consideration needs to also be given to increased scour risk associated with climate change (e.g. larger storm events). The WSDOT Bridge Office is currently seeking approval to hire a scour co-inspector to help address this need. The WSDOT Bridge Office may also seek additional funding to use consultants to perform scour analyses.	Medium

Exhibit E-2: Bridge Risk Register (continued)

BRIDGE ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Seismic – Life Safety	If a seismic event occurs	then bridges may collapse, and there may be loss of life	Environmental Conditions	Natural Events	Medium	Active Acceptance	WSDOT has completed nearly $200 million of bridge seismic retrofits to date, and has additional funding needed to complete life safety retrofitting of the WSDOT lifeline. However, there is approximately $1 billion of non-lifeline retrofitting work that still needs to be completed. The current strategy is to complete the lifeline retrofitting and to continue advocating for additional funding to complete the retrofitting of non-lifeline bridges.	Continue retrofitting work with committed funding, accept the risk of bridge collapse for seismically-vulnerable bridges that aren't funded for retrofitting. As these older bridges are replaced over time at their end of life, this risk will decrease.	Medium
Seismic – Mobility and Recovery	If a seismic event occurs	then mobility and recovery may be impacted, due to collapse or closure of bridges	Environmental Conditions	Natural Events	High	Mitigation	WSDOT has completed nearly $200 million on bridge seismic retrofits to date. All retrofitting has been done to the life safety standard. WSDOT has approximately $1 billion in additional need to complete retrofitting of all Western Washington bridges to the life safety standard. There is an additional need to start designing new bridges on lifeline routes to a higher standard (known as "recovery". Bridge designed to the recovery standard are expected to survive a major seismic event with repairable damage.	Provide additional funding to complete retrofitting Western Washington bridges to the life safety standard. Consider designing new bridges to the recovery standard (particularly new lifeline bridges).	Medium

Exhibit E-2: Bridge Risk Register (continued)

BRIDGE ASSET RISK ASSESSMENT

RISK IDENTIFICATION			RISK ANALYSIS		RISK EVALUATION	RISK RESPONSE PLAN			RESIDUAL RISK EVALUATION
						Risk Treatment Plan			
Risk Name	**Risk Statement**	**Risk Impact Description**	**Asset Risk Categories (Origin/Source)**	**WSDOT Event Groups (Origin / Source)**	**Level of Risk**	**Risk Treatment Strategy**	**Current Strategy**	**Risk Treatment Plan**	**Level of Risk**
Bridge Damage from over height Trucks	If over height trucks continue to strike bridges	then unplanned costs and repairs may occur	High-Risk, High-Value Assets	Man-Made Events	Medium	Passive Acceptance	WSDOT will repair bridge damage from over-height trucks thru Region Maintenance forces or by developing an emergency contract depending on the severity of the damage. WSDOT has developed criteria to determine when a damaged prestress girder could be repaired and when it requires replacement. WSDOT has developed a report (WA-RD 876.1) that identifies 63 state owned steel trusses that could be modified to increase the vertical clearance. WSDOT typically requests Emergency Federal Funds if needed and then pursues reimbursement from the party that did the damage. To reduce the likelihood of bridge strikes occurring, WSDOT has developed a GIS tool called the “Bridge Vertical Clearance Trip Planned Map” to assist with over-height loads selecting routes with appropriate bridge clearances.	While WSDOT has implemented a over-height trip planning tool, there is little more we can do to further mitigate this risk.	Medium
Staff Knowledge, Skill, Ability	If bridge expertise and/or position longevity decreases through attrition	then statewide bridge program decisions will not be effective	Operational	Resources, Staffing	High	Mitigation	WSDOT will document Asset Management procedures and processes to share knowledge in the future. WSDOT may need to establish a cross training process when key personnel get closure to retirement.	Until employee compensation and benefits improve, it is unlikely that ground will be gained in this area.	Medium
Preservation/ Maintenance	If the frequency of extreme weather events increases	then increased cost for preservation and maintenance may occur	Operational	Natural Events	Medium	Passive Acceptance	Training required on how to monitor and identify critical temperature thresholds and response techniques (extreme heat). Cleaning and maintaining functionality of bridge joints is also critical.	For future designs, WSDOT can evaluate parameters like low/high design temperatures, maximum flood events, etc. and make adjustments to design to a more severe standard. It will take a very long time for this approach to reduce the risk to our bridges.	Medium

APPENDIX F
23 CFR 667 ANALYSIS
Assets Repeatedly Damaged by Emergency Events

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November 2021

EXECUTIVE SUMMARY

The Washington State Department of Transportation (WSDOT) and local partners manage over 14,700 lane miles of pavement and over 3,000 bridges on the National Highway System (NHS). These roads and bridges trace winding rivers, push through mountain passes, and follow ocean shores. While these roads are home to some of the most scenic drives in the country, they are also susceptible to emergency events that force their closure. When those events occur, WSDOT works with its Federal partners and the Federal Emergency Relief (Federal ER) program to assist with getting roads open to travelers.

To document those instances where WSDOT has received Federal ER funds and to assist in the journey of good asset stewardship while meeting the requirements of 23 Code of Federal Regulations (CFR) 667, the following report evaluates the NHS project locations where WSDOT and local agencies have received Federal ER funds and where recurring emergency events occur. The results of this analysis demonstrates some of the unique geographical challenges faced by Washington State. In the majority of cases, most emergency events in Washington State are triggered as a result of water flow and bank erosions, ultimately leading to unstable slopes that destroy the foundation of our pavements and supporting highway assets such as shoulders, guardrails, and signs.

This report also demonstrates that when emergency events do occur, WSDOT often seeks a long-range solution to the problem that extends beyond the immediate need of getting roads reopened. Many of the locations that have previously received Federal ER funds already have a more permanent solution in place, and if not, a more permanent solution is part of our ten-year capital plan.

While WSDOT continually plans for a safe, sustainable, and more resilient highway system, there is still much work to be done. To improve the resiliency of our network to withstand future events, we must continue to look to designs that address the root cause of asset failures, not the symptoms; leverage our research on climate change to anticipate what our network will need in ten, twenty, and thirty years from now; and continue to build strong partnerships and communicate the urgency and need for network resiliency with our partners. WSDOT will use this report, along with the results of our statewide Climate Vulnerability Assessment to ensure that our corridor plans and projects understand and address climate change and extreme weather events.

The tools and analysis generated as a result of 23 CFR 667 will be used to enhance design considerations, more effectively manage our portion of the Federal ER program, justify projects that improves network resiliency, and improve our coordination and planning with local partners. But most importantly of all, it will assist with making sure our roads are open, safe, and more resilient in the future.

Roger Millar, PE, FASCE, FAICP
Secretary of Transportation
Washington State Department of Transportation

SUMMARY OF FINDINGS

Identified Projects

Since 1997, Washington State has received Federal ER funds for over 1,000 qualifying projects (278 state and 720 local qualifying projects), the vast majority of which are located on the west side of the state and are reflected in Exhibit F-1. Of these projects, 38 have been identified as meeting the requirements for additional analysis prescribed by 23 CFR 667 (located on the NHS with assets that have been repeatedly damaged, requiring both repair and replacement). While data exists to support a statewide analysis at this time for projects that received Federal ER funding, this report (and results of this report) focuses on events occurring on the NHS

Of the identified 38 projects, it was determined 6 projects require additional analysis or consideration for alternative designs. All other locations have either received a more permanent fix, whether at the time Federal ER funds were received or through a subsequent capital project, or did not meet the more narrowly defined criteria of needing an alternative design. Specific assets repaired and replaced as a result of emergency events are not available unless documented through project notes.

The analysis required in the 23 CFR Par 667 and included in this TAMP does not include a complete dataset. WSDOT experienced an issue when processing the data required for the analysis. As a result, the analysis only included approximately 1,000 qualifying projects (278 state and 720 local qualifying projects) that Washington state has received ER funds for an excluded about 600 projects. Because of the timing of when the issue was discovered relative to the TAMP submission deadline, the TAMP will include a partial analysis and plans to correct the analysis for the next Part 667 analysis submission to FHWA as well as future TAMPs.

Exhibit F-1: Preliminary Findings of the 23 CFR 667 Analysis[1].

Analysis Considerations	Number of State Projects	Number of Local Projects
Total qualifying projects identified	278	720
Successfully mapped	259	343[2]
Total qualifying projects on NHS	133	25
Part of multiple incident location on NHS	10	7
Part of 3 mile proximity query	11	10
Number of projects being tracked that require alternative design	4	2

Exhibit Notes:

[1] The preliminary findings are based on a partial analysis of approximately 1,000 projects due to an issue with processing the data required in the analysis. The analysis will be corrected in future TAMP updates.

[2] Of the 377 that were not mapped, 262 occurred between 1996 and 1997. Also, degree of accuracy for local projects is less accurate than state projects due to incomplete data and the need to manually place certain projects.

Root Cause Findings

While root-cause events range from earthquakes to fires, the single most common factor triggering a qualifying event in Washington State is water related. A summary of recurring root cause events on the NHS is reflected in Exhibit F-2. Whether through flooding, bank erosion, or accelerated degradation of an unstable slope, hydrological factors are a leading cause of recurring qualifying emergency relief events.

Exhibit F-2: Summary of Recurring Root Cause Events on the NHS[1]

Root Cause Events	Number of State Projects	Number of Local Projects
Bridge Strike	0	0
Drift Accumulation	0	0
Flooding	1	1
Other*	1	2
River Bank Erosion	2	0
Unstable Slope	7	7
Total	**11**	**10**

Exhibit Note:

[1] The results above reflect a partial analysis due to a data processing error. WSDOT will look to update the table with a complete analysis in the next TAMP update.

Federal ER Project Financial Summary

WSDOT has received more than $125 million in federal funding for the projects that occurred on the NHS included in the review as reflected in Exhibit F-3. However, those dollars were frequently used to address root cause issues that triggered the emergency event, decreasing the likelihood of them occurring in the future. WSDOT is unable to do a breakdown of ER State and Local expenditures due to a data processing error that only included a partial analysis. WSDOT will include an updated breakdown in future TAMPs.

Exhibit F-3: Summary of NHS Federal ER State and Local Expenditures

Federal ER Expenditures	Amount
State Route (NHS): Total	$120,607,716
Local Route (NHS): Total	$4,815,849
State and Local Routes - (NHS): Combined Total	$125,423,565

Exhibit Note: Figures in this table reflect NHS totals for the projects that were included in this analysis.

Analysis Tools

Lastly, assisting this analysis and future coordination on resiliency and design planning efforts, a Geographic Information System (GIS) tool was created to place and identify locations where recurring Federal ER projects occur. As new Federal ER projects are added to the data set, the GIS tool will identify overlapping locations and help communicate areas requiring additional resiliency planning. A screen image snapshot of the GIS screening tool is reflected in Exhibit F-4.

The remainder of this report focuses on the specific steps performed for the analysis required by 23 CFR 667, review criteria, and details of the project locations where a more in-depth review was performed. A complete list of project details of the analysis results are documented in Appendix F: A, Exhibit F: A-1.

Exhibit F-4: 23 CFR 667 Analysis, GIS Screening Tool

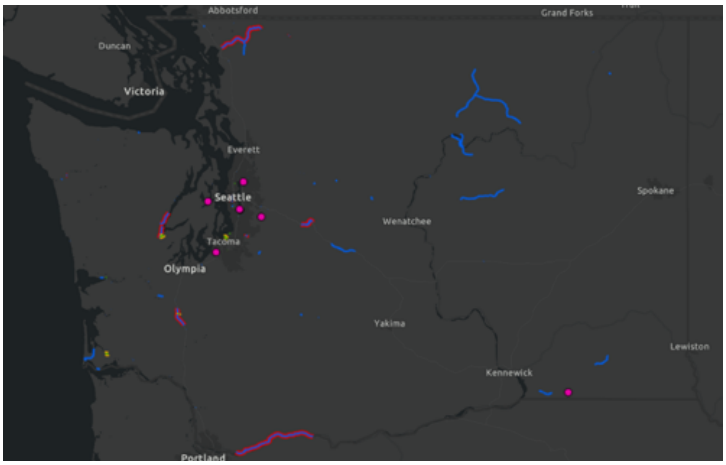

Exhibit Note: GIS tool created to assist with project analysis. Information represented in image reflects statewide incident locations and capital projects as of October 2020. Due to a data processing error, this represents a subset of the project of the statewide incidents and capital projects.

TITLE VI, ADA, AND FURTHER INFORMATION

Title VI Notice to Public

It is the Washington State Department of Transportation's (WSDOT) policy to assure that no person shall, on the grounds of race, color, national origin or sex, as provided by Title VI of the Civil Rights Act of 1964, be excluded from participation in, be denied the benefits of, or be otherwise discriminated against under any of its federally funded programs and activities.

Any person who believes his/her Title VI protection has been violated, may file a complaint with WSDOT's Office of Equal Opportunity (OEO).

For additional information regarding Title VI complaint procedures and/or information regarding our non-discrimination obligations, please contact OEO's Title VI Coordinator at: (360) 705-7090.

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This material can be made available in an alternate format by emailing the Office of Equal Opportunity at: wsdotada@wsdot.wa.gov or by calling toll free at: 855-362-4ADA (4232).

Persons who are deaf or hard of hearing may make a request by calling the Washington State Relay at 711.

Questions Regarding WSDOT's 23 CFR 667 Analysis

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LIST OF EXHIBITS

BACKGROUND

As part of the federal MAP-21 requirements and 23 CFR 667, states are required to develop alternative design solutions for projects that both incorporate assets repeatedly damaged through emergency events and received federal emergency repair funding. To assist with identification of repeatedly damaged assets and root cause analysis, qualifying event data has been compiled from the state maintained Federal Aid Tracking System (FATS) as well as the local federal aid tracking system.

These two systems capture a robust amount of data, but data most relevant for this report include Federal project number, disaster Federal fiscal year, project notes, funding amounts, and when available, project location information. This information was then used to geospatially place qualifying projects on a map to assist with the analysis.

To meet the requirements of 23 CFR 667, analysis was performed to look at where more than one qualifying project had overlapping mileposts or Latitude Longitude coordinates, with a resulting spreadsheet to document the root cause of the event. Additionally, since 23 CFR 667 does not define a segment of roadway, WSDOT expanded the search area by three miles to capture any possible outliers of the original intersect analysis.

The results of the analysis, process to create the spreadsheet, assumptions, and definitions are included in this report.

SCOPE OF ANALYSIS

This initial report is limited to projects on the NHS that received Federal ER funding between calendar years 1997 through 2021. A subsequent evaluation of all projects across the state receiving Federal ER funding is required and was completed by the 2020 deadline and updated in 2021.

23 CFR 667 does not prescribe a format for the end report that communicates alternative design solutions, but the end analysis must consider the following:

1. Whether or not the asset(s) was damaged multiple times through emergency events that received federal funding as the result of a declared state of emergency by either the President of the United States or the Governor of the state;
2. Whether or not the event was caused by weather events/climate change or project design flaws (or designs that are no longer viable as a result of environmental changes);
3. A root cause analysis of why assets have been repeatedly damaged;
4. Whether or not there are reasonable alternatives to reduce the potential for future damage and repair costs that better protect public safety and health and the environment -
    - Reasonable alternatives can be partial solutions to address the root cause issue;
    - It is possible that two incidents in the same area may have different underlying problems that can't be mitigated, but that information should be reflected in the analysis;
5. The risk or likelihood of recurring damage and the cost of future repair under current and predicted future environmental conditions; and
6. The cost of new solutions and how long the new solutions are estimated to last.

APPROACH

Information Needs

Information needed to identify assets repeatedly damaged by emergency events was gathered using WSDOT's federal aid tracking database systems, capital project lists, and available asset inventories. Preliminary information from the systems described below were first used to perform an initial screening of relevant project locations.

Federal Aid Tracking System Query

In order to map the state emergency project locations, WSDOT leveraged its Federal Aid Tracking System (FATS) which tracks all projects receiving Federal ER dollars. Geospatial and project related information was readily available from 2001 through 2020.

Some of the relevant data fields captured through FATS and incorporated into GIS include:

- Unique project ID,
- Project title,
- Disaster FY (based on Federal fiscal year),

- FHWA authorization date,
- Project Identification Number (PIN) if available,
- Project or site location begin and end location (ARM),
  - Also project or site milepost ranges,
- WSDOT Region, and
- Total state and federal funding received (split by funding source).

Additional project information is included in the FATS database (such as project descriptions and notes) and are leveraged through the initial analysis of the site locations to see whether or not sites are required to be part of an alternative design solution.

Local Federal Aid Tracking System Query

To identify project locations receiving Federal ER dollars on the locally owned portion of the NHS, WSDOT's Local Programs office provided data from their local federal aid tracking system. The data available covers 1997 to 2020. Data fields from the local system are less complete than the state system, but more recent project locations are generally able to be mapped. However, local system information is less certain because project's location data varies significantly across projects or was generally not available prior to 1999. Once the data sets were provided, site locations were geospatially placed on a WSDOT base map using ESRI tools.

Historic and Proposed Capital Project List

In addition to Federal ER project information, WSDOTs historic and proposed capital project list (which is also available geospatially) was overlaid with the Federal ER project information. This was done to determine whether or not root cause issues were already addressed through subsequent capital projects occurring after the most recent qualifying Federal ER incident. Historic and planned local projects are not currently available geospatially and are not included in this analysis.

Asset Inventories

Finally, asset data that is geospatially available was incorporated into the map. Assets currently available include pavements, bridges, unstable slopes, and fish passages. This data has limited use with respect to the analysis, but does provide some insight as to assets in the vicinity of the qualifying area. Of more use are project related notes and descriptions that provide some benefit as to which assets may have been damaged or replaced as a result of an event. An updated asset inventory was not done in the 2021 Part 667 Analysis. WSDOT will include an updated asset inventory in the future TAMP and Part 667 updates.

Analysis Questions

To assist with a more detailed analysis and to meet the intent of 23 CFR 667, the following questions were asked:

- Has there been more than one qualifying Federal ER projects in the same location?
- Are there any other Federal ER projects within a 3 mile proximity to locations where recurring qualifying projects have occurred?
- Have there been multiple discreet qualifying Federal ER events around the identified project locations?
- Has the Federal ER project location been remediated through the Federal ER project, state project, or subsequent state or federal projects in that area?
- Did the original qualifying project have both repair and reconstruction activities?
- Did the overlapping project locations have both repair and reconstruction activities?
- Is the root cause of the overlapping projects the same or different?
- Is there an alternative solution that can be developed to address the root cause of the issue?
- If there is not an overlap between project locations, but there is significant Federal ER activity along the corridor, what is a reasonable distance between project locations to determine whether or not they should be grouped for consideration as part of the analysis?
- Both distance and root cause can/should be considered for this evaluation. For example, if project locations are within 0.5 miles of one another, but the root cause is materially different, then the projects should not be grouped for alternative design consideration; and
- Once the project sites meeting the requirement to be included in the report are identified, which assets were repaired or replaced as a result of the event?

METHOD OF ANALYSIS

Geospatial Analysis Steps

Once project locations were mapped during the initial screening, a more detailed geospatial analysis was performed to determine whether or not identified projects require alternative design solutions. These analysis steps and subsequent results are explained below.

- **Determine which State and Local ER projects (within the 20 year window) have overlapping or intersecting locations.**

  Federal ER project locations on the NHS were mapped using GIS tools. Projects with overlap in beginning and ending milepost extents were identified and the related project details were exported from FATS, TEIS, and Local Agency database systems into excel.

- **Identify additional ER projects located within a 3 mile proximity to the previously identified ER projects (those having overlapping or intersecting locations).**

  Additional ER projects, within proximity to projects identified, were included. Related project details were exported from FATS, TEIS, and Local Agency database systems into excel.

- **Determine if there are reoccurring Federal ER events within the analysis grouping or areas of interest.**

  This step was performed by researching projects in WSDOT's FATS, TEIS Capital Projects, and Local Agency database systems and downloading into excel to identify whether or not project locations had multiple discreet events. By default, individual Federal ER projects added during the proximity query in the previous step are not reoccurring Federal ER event locations since these project locations did not have overlapping or intersecting MPs with other State and Local ER projects. Federal ER projects within proximity are only included to provide context for areas of interest and do not trigger the removal of an analysis grouping. Analysis groupings that do not identify the occurrence of multiple discrete Federal ER events within the area of interest are eliminated during this step.

- **Within the analysis grouping areas of interest that remain, perform a more detailed investigation of each Federal ER project site location and determine if Federal ER and/or state money was, or is planned to be spent on a permanent solution.**

  This step was performed by researching past and planned future capital expenditures that have asset repair and replacement elements within WSDOT's FATS, TEIS Capital Projects, and Local Agency database systems and downloading into excel. Analysis groupings that have identified, planned, or built permanent solutions are eliminated during this step. Please note that projects describing a permanent solution may not always prevent the emergency event from reoccurring. Many Federal ER projects result from challenging natural constraints where roadways pass through environments containing complex hydrologic, geologic, and seismic considerations.

- **Within the analysis grouping areas of interest remaining, perform a more detailed investigation of each Federal ER project site location and determine if the original qualifying project had both repair and reconstruction activities.**

  This was done by researching project descriptions of work within WSDOT's FATS, TEIS Capital Projects, and Local Agency database systems and downloading into excel. Descriptions of ER project work were compared to the regulatory definition (see Glossary of Terms) of "repair and reconstruction," as defined in 23 CFR 667.3. ER projects that did not describe both repair and reconstruction activities were eliminated during this step since they are not qualifying projects warranting further analysis according to regulatory definition.

- **Identify which ER project areas resulting from the previous step warrant further analysis and development of an alternative design strategy to address root cause issues.**

  These are the ER project areas remaining after the previous step and comprise the final site list for development of an alternative design strategy, results of this step.

ALTERNATIVE SOLUTION ANALYSIS AND CONSIDERATION FINDINGS

The list in Exhibit F-5 includes identified projects tracked for alternative design solutions to address root cause issue(s) in qualifying ER project areas. Alternative solution analysis and considerations build on the final site list resulting from the sequential geospatial Analysis Steps described in previous sections.

Exhibit F-5: Project Area for Alternative Solution Analysis.

Analysis Grouping	ER. Event	Fed. Project #	ER. Project Title	Disaster FFY	Status	Total Project Budget
MAS-1	Unstable Slope	1101 (022)	Purdy Cut-Off Road MP 0.84-2.37	2011	Closed	$7,600*
MAS-1	Unstable Slope	0701 (022)	SR101 / SLIDE CLEANUP-SLOPE STABILIZATION - MILEPOST 338.00 - EMERGENCY REPAIRS	2007	Closed	$644,108
MAS-1	Unstable Slope	0801 (016)	SR101/MILEPOST 333.50 TO MILEPOST 340.00 - EMERGENCY REPAIRS	2008	Closed	$125,274
PAC -1	Flooding	0801 (130)	UPPER NASELLE RD #19240 DEBRIS RMY	2008	Closed	$9,667*
WCM-1	Flooding	0401 (014)	SR 9/NEAR THE TOWN OF ACME – EMERGENCY REPAIRS – DMA026	2004	Closed	$28,013
WCM-1	Riverbank Erosion	0701 (002)	SR 542/WARNICK BLUFF – MILEPOST 29.00 – EMERGENCY REPAIRS	2007	Closed	$28,013

Exhibit Note*: For the local projects, the amount represents only ER funding.

The list represents a partial list due to a data processing error during the analysis. WSDOT will work to include a more comprehensive list as a part of the update for the next TAMP update.

GLOSSARY OF TERMS

Term	Definition
Additional Analysis and Alternative Design Needed	Yes/No table field identifying whether or not additional analysis and alternative design solutions are necessary. Field will be Yes if the following criteria are met: 1. Overlapping project boundaries with multiple discreet events 2. No federal or state permanent capital solution previously employed or planned in the future 3. Both repair and replacement elements are met 4. No alternative design for the area has been created or is available
Analysis Grouping	Logical grouping of federal emergency event projects based on physical location of events that allow for specific geographic analysis. This has since been updated by adding a county identifier and group number (e.g. KNG-1 for King County Group 1)
Analysis Step	A process used to research and identify federal emergency projects and whether or not project locations require additional analysis or an alternative design solution with subsequent project cost, anticipated life, and future cost of repair under current and future environmental conditions.
Disaster FFY	The federal fiscal year in which the federal emergency event occurred. For purposes of this analysis, federal fiscal year was used for annualization of events. The Federal fiscal year begins October 1 and ends September 30.
ER Event	Identification of root cause creating the federal emergency event. Root cause was determined through analysis of project notes and geographic proximity to environmental hazards such as slopes, rivers, passes, etc.
ER Project Notes	Federal emergency event project notes pulled from multiple databases. Notes help provide context to the cause of the event, project solution (temporary vs. permanent fix), scope of project solution (repair, repair and reconstruction, maintenance), and types of repaired or replaced assets.
ER Project Title	Federal emergency event project title assigned within the state and local federal aid tracking systems.
Fed ER Funds Used for Permanent Fix	One of the criteria used to determine whether or not a project location requires an alternative design. If federal funds were used to develop a “permanent” fix that resolves the root cause issue or improves the overall resiliency of the network within the project area, the project is removed from alternative design considerations.
Fed Project #	Assigned federal project number used to track projects receiving federal emergency event dollars. This is a unique project identifier.
Federal Aid Tracking System (FATS)	WSDOT’s federal aid tracking system used to track federal emergency event project information.

GLOSSARY OF TERMS (continued)

Term	Definition
In 3 Mile Proximity to Overlapping ER Projects	Second round of criteria used to determine whether or not a recurring federal emergency event has occurred. To assist with defining a segment of road, a 3 mile geospatial buffer was placed around federal emergency event projects with overlapping project boundaries. Any federal emergency event projects within the 3 mile buffer were included for analysis consideration purposes to provide additional context to the surrounding area. Projects identified using this criteria are ultimately removed from consideration of requiring alternative designs.
Local Federal Aid Tracking System	WSDOT's local federal aid tracking system used to track local federal emergency event project information.
Multiple Discrete Events	One of the criteria used to determine whether or not a project location requires an alternative design. Multiple discrete events are where a facility and/or assets were damaged through unique events, usually indicating either a passage of time between projects or in cases where passage of time has not occurred, a different root cause triggering the event.
Notes for State Project Permanent Fix	Reflects notes from TEIS if a state project has been performed (or will be performed) that addresses the root cause issue or improves the resiliency of the network in the federal emergency event project area.
Overlap in ER Project MPs	Initial criteria used to determine whether or not a recurring federal emergency event has occurred. If federal emergency events have overlapping project boundaries (identified through milepost and state route or latitude/longitude coordinates), locations and projects were identified as meeting the criteria of recurring event.
Permanent Solution	A solution that improves the resiliency of the network within the project boundaries that is more extensive than maintenance based activities and includes capital reconstruction. To qualify as a permanent solution, additional resiliency measures must have been part of the capital project solution that are more than "like-kind" replacements. It is noted that a permanent solution by this definition is still susceptible to failure through extreme events, but less likely to fail than the original solution.
Planned Solution	A solution that has not been implemented, but would increase the resiliency of the network within the federal emergency event project area. Planned solutions can be programmed projects or planning documents that address the root cause issue impacting the resiliency of the network.
Proximity Query	Geospatial analysis tool to assist in identifying other federal emergency event project locations within a 3 mile proximity to federal emergency event project locations with overlapping project boundaries. This tool was used to provide additional context to the analysis and help with identification of root cause issues.

GLOSSARY OF TERMS (continued)

Term	Definition
Repair and Reconstruction	One of the criteria used to determine whether or not a project location requires an alternative design. Both repair and reconstruction elements must be present in order to trigger the need for an alternative project design. Repair and reconstruction elements were primarily identified through available federal and state project notes. If information from the notes was non-conclusive, the total project budget was used to estimate whether or not the federal emergency event project had both repair and reconstruction elements. 23 CFR 667.3 defines repair and reconstruction as "work on a road, highway, or bridge that has one or more reconstruction elements. The term includes permanent repairs such as restoring pavement surfaces, reconstructing damaged bridges and culverts, and replacing highway appurtenances, but excludes emergency repairs as defined in 23 CFR 668.103."
State Project for Permanent Fix	One of the criteria used to determine whether or not a project location requires an alternative design. If state funds were used to develop a "permanent" fix that resolves the root cause issue or improves the overall resiliency of the network within the project area, the project is removed from alternative design considerations. State funds may be used at the time of the federal emergency event or be a subsequently implemented/ planned state project that addresses the root cause or improves the resiliency of the network in that area.
Total Project Budget	Total amount of approved budget for the qualifying emergency event. This includes both state and federal funds.
Transportation Executive Information System (TEIS)	WSDOT system used to house historic and planned capital project information.

APPENDIX F: A
COMPREHENSIVE RESULTS FOR 23 CFR 667 ANALYSIS

Exhibit F: A-1 Results for 23 CFR 667 Analysis.

Analysis Grouping	ER. Event	Fed. Project #	ER. Project Title	ER. Project Description	Disaster FFY	Total Project Budget ($)	Overlap in ER. Projects?	Proximity to Overlapping ER Projects?	Multiple Discrete Events?	Both Repair & Reconstruction?	Further Analysis & Alternative Design Needed?
KNG-2	Other – Earthquake	0101 (224)	S. Park Br ER (Temp)	**This project provides for the Temporary/Emergency Repair to federal route 1491 (14th Ave S) from the February 28, 2001 Earth Quake. Work included: Realign moveable spans and return bridge to a reliably operational condition.**	2001	298,515	*	**Yes**	**Yes**	**No**	**No**
KNG-2	Other – Earthquake	0101 (225)	S. Park Br (Perm Repair)	**This project provides for the Permanent Repair to federal route 1491 (14th Ave S) from the February 28, 2001 Earth Quake. Work includes: South abutment pavement stabilization and repaving, curb, gutter and sidewalk regrading and joint repair. Repair rail on south approach, install concrete collar on north and south approaches and repair spalls. Epoxy repair of columns and rails, shore south approach and excavate footing. Perform underwater inspection.**	2001	395,560	*	**Yes**	**Yes**	**Yes**	**No**
KNG-7	Unstable Slope	0401 (029)	Rainier Ave So Landslide ER	**Repair the damage which resulted from the 10/03 storm. Work to include temporary slope stabilization, install sandbags and plastic sheeting, prepare geotechnical report, survey, site and project monitoring. Permanent work - rock buttress and cantilever soldier pile wall will be installed, sidewalk and curb will be replaced, new catch basin will be installed, and landscaping will be replanted along sidewalk and slope.**	2004	395,560	*	**Yes**	**No**	**Yes**	**No**
KNG-7	Unstable Slope	0902 (386)	Rainier Ave S. Slide Repair	**Emergency cleanup was conducted by city crews to remove approximately 187 cubic yards of slide debris from the street. As a precautionary measure, City crews placed 20 ecology blocks and traffic control devices to channel traffic away from toe of the slide area until the adjacent slope was stabilized by the property owner.**	2009	25,349	*	**Yes**	**No**	**No**	**No**
MAS-1	Unstable Slope	1101 (022)	Purdy Cut-Off Road MP 0.84 – 2.37	**Remove all slide materials and debris from the culverts, ditches and roadway at six sites along the road and rebuild eroded shoulders.**	2011	7,600	*	**No**	**Yes – The other projects in this group**	**No**	**Yes**
MAS-1	Unstable Slope	0701 (025)	SR 101/Slide Cleanup – Slope Stabilization – MP 338.00 – Emergency Repairs	**This request provides temporary / emergency repairs and preliminary engineering for permanent repairs for this debris slide from steep slopes above SR101**	2007	644,108	*	**No**	**Yes, 0801(016)**	**Yes**	**Yes**
MAS-1	Unstable Slope	0801 (016)	SR 101/MP 333.50 to MP 340.00 – Emergency Repairs	**This temporary / emergency repair construction authorization request provides for placing road closed signs, cleaned up debris, paved the potholes and placed shoulder rock.**	2008	125,275	*	**No**	**Yes, 0701 (025)**	**No**	**Yes**

Exhibit F: A-1 Results for 23 CFR 667 Analysis.

Analysis Grouping	ER. Event	Fed. Project #	ER. Project Title	ER. Project Description	Disaster FFY	Total Project Budget ($)	Overlap in ER. Projects?	Proximity to Overlapping ER Projects?	Multiple Discrete Events?	Both Repair & Reconstruction?	Further Analysis & Alternative Design Needed?
MAS-2	Unstable Slope	0801 (011)	SR 101/MP 329.56 to MP 329.65 – Emergency Repairs	**This temporary / emergency repair construction authorization request provides for the water filled barrier placed along the shoulder of the roadway. The trave lanes will be shifted to the west side of the road. Geologists are working on a design for the repair. Modification No.2: This construction authorization request provides permanent restoration by relocating an existing water main, constructing a soil nail wall, moment slab and C.I.P. barrier, resurfacing, paving with commercial HMA, drainage, guardrail, pavement marking, permanent erosion control.**	2008	800,570	*	**No**	**Yes - 0801(033), 1701(009)**	**Yes**	**No**
MAS-2	Unstable Slope	0801 (022)	SR 119/MP 0.00 to MP 2.00 – Emergency Repairs	**This temporary / emergency repair construction authorization request provides for repair or replace culverts, replace shoulder material and ditch. Clean roadway debris.**	2008	50,034	*	**Yes**	**Yes**	**No**	**No**
MAS-2	Unstable Slope	0801 (033)	Hoodsport to Hamma Hamma	**This construction authorization request provides for acquiring a contractor to remove debris from the road, clean out channels, repair ditches and shoulders to get US101 open.**	2008	709,146	*	**No**	**Yes - 0801(011), 1701(009)**	**Yes**	**No**
MAS-2	Unstable Slope	1701 (009)	US 101 Hoodsport Vicinity Slide	**Heavy rains triggered a debris flow which damaged the existing debris fence and blocked US 101. By repairing this damaged fence, the risk of debris reaching the roadway will be reduced and** motorist safety enhanced.	2017	329,715	*	**No**	**Yes - 0801(011), 0801(033)**	**Yes**	**No**
PAC-1	Flooding	0801 (130)	Upper Naselle Rd. #19240 Debris Removal	**Emergency debris removal to major collector roads to open to the public from damage from the December, 2007 storm event - Upper Naselle Road # 19240**	2008	9,667	*	**No**	**Yes - 9901(021)**	**No**	**Yes**
PIE-2	Unstable Slope	1201 (009)	Marine View Drive 2012 Storm Event	**Downed trees and slide cleanup, additionally the storm caused some trees to become unsafe which required removal. Remove tree debris.**	2012	12,874	*	**No**	**Yes -1701(025), 1701(026)**	**No**	**No**
PIE-2	Unstable Slope	1701 (025)	Marine View (SR 509) 3300-4300 Block Slide Removal A	**Removal of landslide debris from the 3300 Block to 4300 Block of SR 509 (Marine View Drive). Work included hauling slide debris. Also included traffic control and detours.**	2017	83,699	*	**No**	**Yes -1201(009), 1701(026)**	**No**	**No**
PIE-2	Unstable Slope	1701 (026)	Marine View (SR 509) 3300-4300 Block Slide Removal B	**Removal of landslide debris from the 4300 Block to 5600 Block of SR 509 (Marine View Drive). Work included hauling slide debris. Also included traffic control and detours.**	2017	61,925	*	**No**	**Yes -1201(009, 1701(025)**	**No**	**No**
PIE-2	Unstable Slope	1701 (029)	SR 509 / Dash Point Rd. Emergency Slide Repair	**Emergency removal of slide material, rebuild eroded shoulders, re-establish ditches and replace guardrail.**		92,636	*	**Yes**	**No**	**Yes**	**No**
SKM-1	River Bank Erosion	0701 (030)	SR 14/Woodard Creek Streambank Erosion – MP 34.24 – Emergency Repairs	**This request provides temporary / emergency repairs to armor the existing site withriprap, remove woody debris from an upstream flood plain and rebuilding the SR14 embankment. Set boulders and quarry spalls along with needed roadway evacuation, permanent erosion blanket and traffic control**	2007	351,216	*	**No**	**Yes - 1701(006), 1701(044)**	**Yes**	**No**

Exhibit F: A-1 Results for 23 CFR 667 Analysis.

Analysis Grouping	ER. Event	Fed. Project #	ER. Project Title	ER. Project Description	Disaster FFY	Total Project Budget ($)	Overlap in ER. Projects?	Proximity to Overlapping ER Projects?	Multiple Discrete Events?	Both Repair & Reconstruction?	Further Analysis & Alternative Design Needed?
SKM-1	Unstable Slope	1701 (006)	US 14 Debris Fence (MP 25) – Emergency Repair	**Remove debris, replace fence**	2017	712,143	*	**No**	**Yes - 0701(030), 1701(044)**	**Yes**	**No**
SKM-1	Other – Wildfire	1701 (044)	SR 14 Detour for Eagle Creek Fire – Emergency Relief	**Detour for 1-84 closure due to fire**	2017	277,100	*	**Yes**	**Yes**	**No**	**No**
WCM-1	Flooding	0401 (014)	SR 9 / Near the Town of Acme – Emergency Repairs – DMA026	**This request provides for temporary / incidental permanent repairs for emergency traffic control during the flooding followed by slit and debris cleanup from the roadway. Shoulder repair and drainage work will be required to bring the roadway back per pre storm condition.**	2004	28,013	*	**Yes**	**No**	**Yes**	**Yes**
WCM-1	River Bank Erosion	0701 (002)	SR 542 / Warnick Bluff – MP 29.00 – Emergency Repairs	**This request provides temporary / emergency repairs to repair erosion caused by the Nooksack River to within 10 feet of the roadway.**	2007	271,553	*	**No**	**Yes - 1501(006)**	**No**	**Yes**

Exhibit Note: Table contents were extracted from WSDOT's TEIS, FATS, and local agency database systems on June 2020. The Overlap in ER Projects step was combined with the proximity step however WSDOT will look to be possibly separate the two in future updates.

APPENDIX G

FHWA WORK ACTIVITIES TO WSDOT IMPROVEMENT CODES CROSSWALK

Exhibit G-1: FHWA Work Activities to WSDOT Improvement Codes Crosswalk

Asset Type	FHWA Work Types	WSDOT Improvement Codes	WSDOT Work Activity Title	WSDOT Improvement Code Definition	WSDOT Maintenance Codes	WSDOT Maintenance Code Definition
Bridge	Maintenance				4A1	Bridge Deck Repair
Bridge	Maintenance				4A2	Structural Bridge Repair
Bridge	Preservation	EO	Special Bridge Repair - Other	Repair of a deteriorated element of a stationary bridge.		
Bridge	Preservation	EX	Special Bridge Repair - Expansion Joints	Repair or replacement of bridge expansion joint(s).		
Bridge	Preservation	R	Steel Bridge Painting	Painting a steel bridge.		
Bridge	Preservation	S	Seismic	Strengthening of a bridge element to prevent failure in the event of an earthquake.		
Bridge	Preservation	Y	Scour	Repair to the stream bed around a bridge column or repairs to stream banks near a bridge.		
Bridge	Rehabilitation	EM	Special Bridge Repair - Movable	Rehabilitation and/ or repair of a movable element either mechanical or electrical of a movable bridge.		
Bridge	Rehabilitation	E3	3rd Party Damage Bridge Repair	Reconstruction of a WSDOT asset damaged by a third party.		
Bridge	Rehabilitation	V	Concrete Bridge Deck - Rigid Overlay	Repair of a concrete bridge deck followed by a modified concrete overlay.		
Bridge	Rehabilitation	VA	Concrete Bridge Deck - Asphalt Overlay	Repair of a concrete bridge deck and installation of a waterproof membrane followed by an asphalt overlay.		

Exhibit G-1: FHWA Work Activities to WSDOT Improvement Codes Crosswalk (continued)

Asset Type	FHWA Work Types	WSDOT Improvement Codes	WSDOT Work Activity Title	WSDOT Improvement Code Definition	WSDOT Maintenance Codes	WSDOT Maintenance Code Definition
Bridge	Rehabilitation	VB	Concrete Bridge Deck - Asphalt Overlay - Second Generation	Removal of an existing asphalt overlay and waterproof membrane, followed by the repair of the concrete bridge deck as required. Placement of a new waterproof membrane and asphalt overlay. Asphalt Overlay		
Bridge	Rehabilitation	VC	Concrete Bridge Deck - Rigid Overlay - Second Generation	Removal of an existing modified concrete overlay and repair of the concrete bridge deck as required, followed by a new modified concrete overlay. Rigid Overlay		
Bridge	Rehabilitation	ZS	Bridge Rehabilitation - Structural	Rehabilitation of a major portion of an existing bridge, that has a structural deficiency.		
Bridge	Replacement	DO	Bridge Replacement - Functionally Obsolete	Replacement of a bridge that has a narrow width or low vertical clearance or a restrictive waterway opening. If also structural deficiency use code DS.		
Bridge	Replacement	DS	Bridge Replacement - Structural	Replacement of a bridge that has a structural deficiency in a superstructure or substructure element. If also functionally obsolete use code DS.		
Pavement	Maintenance				1A1	Pavement Patching and Repair
Pavement	Maintenance				1A3	Shoulder Maintenance

Exhibit G-1: FHWA Work Activities to WSDOT Improvement Codes Crosswalk (continued)

Asset Type	FHWA Work Types	WSDOT Improvement Codes	WSDOT Work Activity Title	WSDOT Improvement Code Definition	WSDOT Maintenance Codes	WSDOT Maintenance Code Definition
Pavement	Preservation	FC	Pavement Preventive Maintenance	Preventive maintenance is work performed to maintain the condition of the pavement, and is a cost-effective means of extending the useful life. Examples of activities include patching and crack sealing.		
Pavement	Preservation	L	BST - Chip Seal	A layer of asphalt binder followed by a layer of aggregate. This pavement type is placed on roadways with low average daily traffic and less than 500,000 equivalent axle loads per year.		
Pavement	Preservation	LF	BST Over Hot Mix Asphalt (aka ACP)	BST over hot mix asphalt (AKA ACP)		
Pavement	Rehabilitation	F	Hot Mix Asphalt (aka ACP) Overlay	Hot mix asphalt applied over an existing HMA. Overlay depths can vary in thickness.		
Pavement	Rehabilitation	FL	Hot Mix Asphalt (aka ACP) over BST	Hot mix asphalt applied over an existing BST Overlay depths can vary in thickness.		
Pavement	Rehabilitation	1A	Hot Mix Asphalt (aka ACP) Over Concrete	Rehabilitates concrete pavement by placing a hot mix asphalt overlay, typically 4 inches in depth over an existing Portland cement concrete pavement.		
Pavement	Rehabilitation	1D	Dowel Bar Retrofit	Rehabilitates faulted concrete pavement by inserting dowel bars into the existing Portland cement concrete. The pavement is then diamond ground to provide a smooth riding surface.		

Exhibit G-1: FHWA Work Activities to WSDOT Improvement Codes Crosswalk (continued)

Asset Type	FHWA Work Types	WSDOT Improvement Codes	WSDOT Work Activity Title	WSDOT Improvement Code Definition	WSDOT Maintenance Codes	WSDOT Maintenance Code Definition
Pavement	Rehabilitation	1M	PCCP - Minor Concrete Rehabilitation	PCCP - Minor Concrete Rehabilitation. Includes replacement of a few isolated panels		
Pavement	Replacement	1R	PCCP - Concrete Replacement	Rehabilitates distressed concrete pavement by removing the concrete and replacing it with new concrete.		