Oregon Department of Transportation

2019
Bridge Condition Report
& Tunnel Data

Oregon Department of Transportation

2019 BRIDGE CONDITION REPORT & TUNNEL DATA

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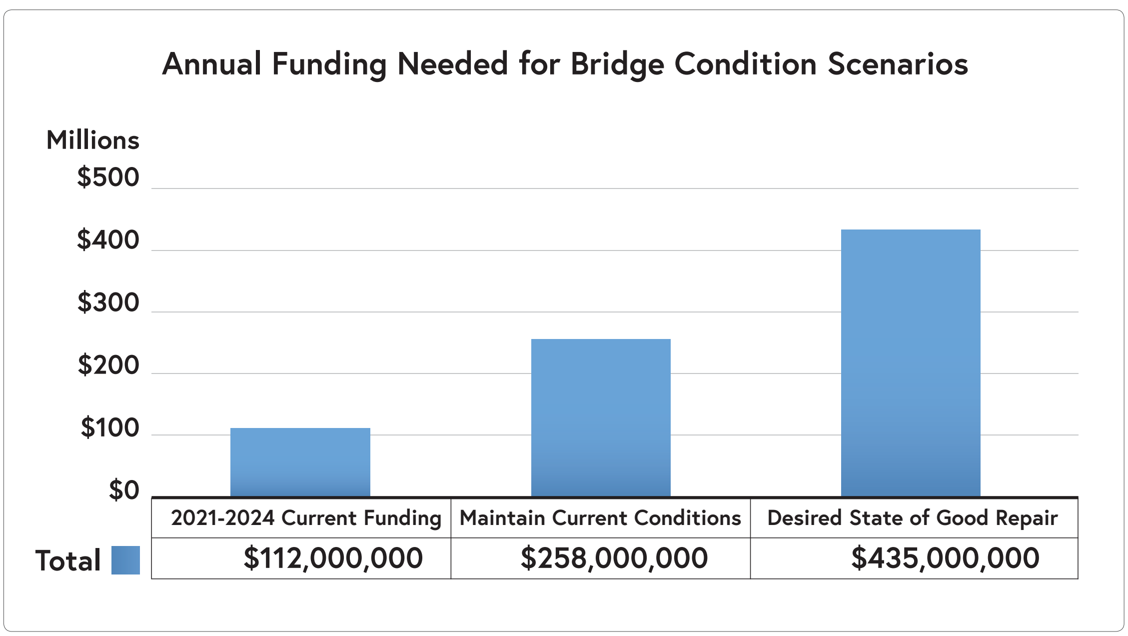
EXECUTIVE SUMMARY

OREGON'S BRIDGES ARE AGING

Bridges connect our communities. They allow us to get where we're going and help Oregon businesses move products from our farms, forests and factories to markets around the nation and world.

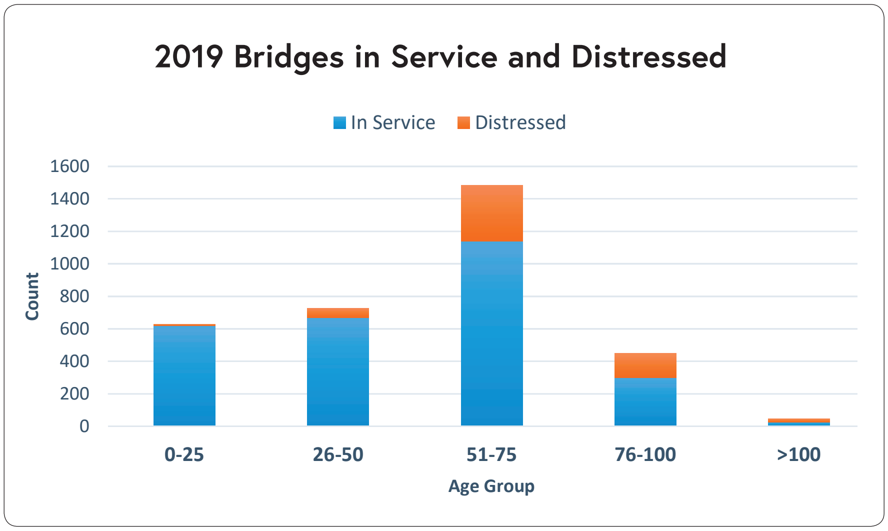
Yet over half of the 2,755 bridges maintained by the Oregon Department of Transportation were built prior to 1970, including more than 1,000 bridges that were built during the Interstate-era. These bridges were designed for loads smaller than allowed by state law since the mid-1980's. Current funding levels pay on average for only three bridge replacements a year. At that rate, an Oregon bridge will need to stay in service for over 900 years.

The table below compares the current funding to estimates for the amount needed to preserve them. Oregon would have to more than double the investment just to maintain current bridge conditions, and more than triple it to get to a state of good repair.



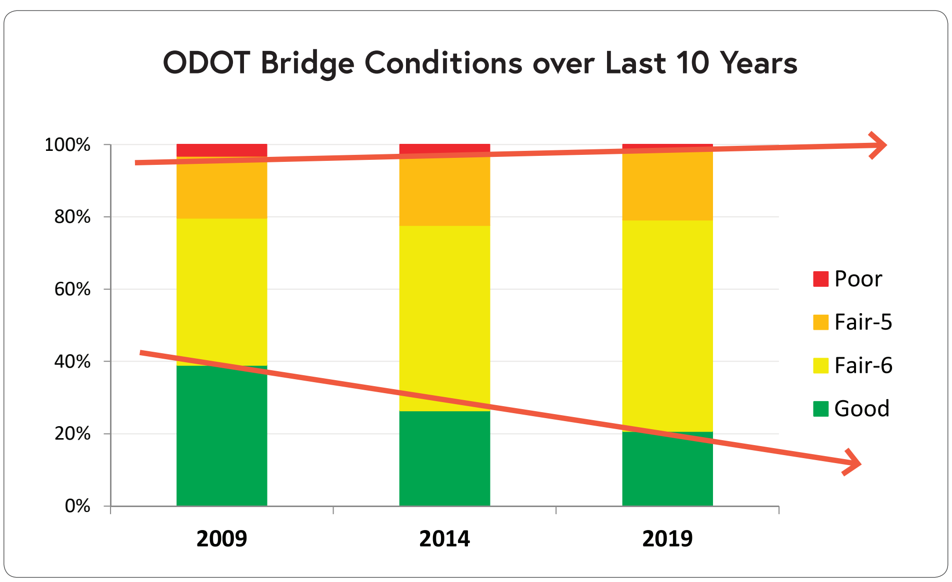
OREGON'S BRIDGES ARE DETERIORATING

Over time, bridge decks, superstructures and substructures fall prey to erosion, leaks, corrosion, scouring and other forces. Both the Federal Highway Administration and ODOT rate bridges for their condition, structural capacity and function. When a bridge has structural or other deficiencies, ODOT bridge engineers rate it as "distressed". The table below shows the number of Oregon bridges in distress by age group. The greatest number of distressed bridges is in the 51 – 75 year age group.



ODOT Distressed bridges by age group.

While ODOT has been able to keep the number of poor bridges to a minimum, the overall trend line shows a sharp decline in bridges in good condition, and an increase in bridges in fair condition—with a large number on the cusp of falling to poor.



Bridge conditions over last 10 years.

BRIDGE PROGRAM FUNDING

HB 2017 provided some additional funding for bridge system preservation, but not enough to meet the need. The 2021-2024 State Transportation Improvement Program provides $112,000,000 annually for bridges and seismic work. As a result, ODOT focuses funding on repairs that extend bridge life, add strength, and keep the surface, or deck, of the bridge in good condition. Fixing things like deck cracks and joints is much less expensive than if the problem gets down into the substructure.

Because we aren't replacing bridges as they wear out, bridge conditions will decline over time and ODOT bridge engineers will need to place weight limits on more bridges. This will restrict heavy trucks from moving about the state and cause impacts to Oregon's trade-dependent economy.

UNMET SEISMIC NEEDS

While new bridges are built to be usable after the Big One hits, most of the state's bridges were built before geologists gained a full understanding of the threat of a Cascadia Subduction Zone earthquake. As a result, many bridges will fail if Oregon experiences a major seismic event.

The 2021-2024 STIP funding includes $10,000,000 annually for seismic work as part of HB 2017. At the current funding level, it will take more than 20 years to complete the initial phase of ODOT's seismic plans, which connects Eugene to Portland along I-5 and Portland east to The Dalles along I-84.

ABBREVIATIONS AND DEFINITIONS

Distressed Bridge – A bridge condition rating used by the Oregon Department of Transportation to indicate that the bridge has been identified as either structurally deficient or as having other deficiencies. A classification of “distressed bridge” does not imply that the bridge is unsafe.

Functionally Obsolete (FO) – A bridge assessment rating used by the Federal Highway Administration to indicate that a bridge does not meet current (primarily geometric) standards. The rating is based on bridge inspection appraisal ratings. Functionally obsolete bridges are those that do not have adequate lane widths, shoulder widths, vertical clearances, or design loads to serve traffic demand. This definition also includes bridges that may be occasionally flooded.

Key Performance Measure (KPM) – A measure used to evaluate the progress of an organization in managing to a particular goal.

Major Bridge Maintenance (MBM) – One of three funding approaches the Bridge Program uses to manage the bridge system. The MBM program typically addresses smaller scale bridge preservation needs and emergency bridge repairs that are outside the scope of work that can be accomplished by an ODOT District.

National Bridge Inventory (NBI) – The aggregation of structure inventory and appraisal data collected to fulfill the requirements of the federal National Bridge Inspection Standards (NBIS).

National Bridge Inspection Standards (NBIS) – Federal regulations establishing requirements for inspection procedures, frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of a state bridge inventory. The NBIS apply to all structures defined as bridges located on all public roads

National Highway System (NHS) – The National Highway System comprises approximately 225,000 miles of roadway nationwide, including the Interstate Highway System as well as other roads designated as important to the nation’s economy, defense, and intermodal mobility. The NHS was developed by the United States Department of Transportation in cooperation with the states, local officials and metropolitan planning organizations. Congress approved the NHS in 1994.
National Tunnel Inspection Standards (NTIS) – Federal Highway Administration guidelines for the inventory, inspection and load rating of tunnels.

Non-National Highway System (NNHS) – Routes not designated as part of the NHS.

Other Deficiencies (OD) – A bridge condition rating used by the Oregon Department of Transportation to indicate that a bridge has identified needs in one or more of nine factors and is a candidate for repair or replacement. This condition rating is specifically designed to address specific bridge needs such as freight mobility, deterioration, serviceability, and safety. A classification of “other deficiencies” does not imply that the bridge is unsafe.

Types of ODs include:
- **Rail = Bridge Rail**
- **LC = Load Capacity**
- **LSL = Low Service Life**
- **MB = Movable Bridge**
- **DG = Other Geometric Clearances (Deck Geometry)**
- **Paint = Paint**
- **Scour = Scour**
- **TS = Timber Structures (Substructure)**
- **VC = Vertical Clearance**

Poor Detail Bridge – Bridges identified in the State Bridge Inventory that have critical design issues related to rail, decks, and reinforcement locations. Bridges with poor details have a higher incidence of shear cracking that may grow rapidly, holes in thin bridge decks developing without warning, low reserve load capacity, and instability during seismic events.

Scour Critical Bridge – A scour critical bridge is one with an abutment or pier foundation rated as unstable due to (1) observed scour at the bridge site or (2) a scour potential as determined by an engineering scour evaluation study.

Service Life – The time duration during which the bridge element, component, subsystem, or system provides the desired level of performance or functionality, with any required level of repair and/or maintenance.

State Transportation Improvement Program (STIP) – Oregon’s four-year transportation capital improvement program. The STIP document identifies the funding for, and scheduling of, transportation projects and programs.

Structure Condition Abbreviations –
- **VG = Very Good**
- **GD = Good**
- **FR = Fair**
- **PR = Poor**
- **VP = Very Poor**

Structurally Deficient (SD) – A bridge condition rating used by the Federal Highway Administration to indicate deteriorated physical conditions of the bridge’s structural elements (primarily deck, superstructure, and substructure) and reduced load capacity. Some of these bridges are posted and may require trucks of a certain weight to detour.

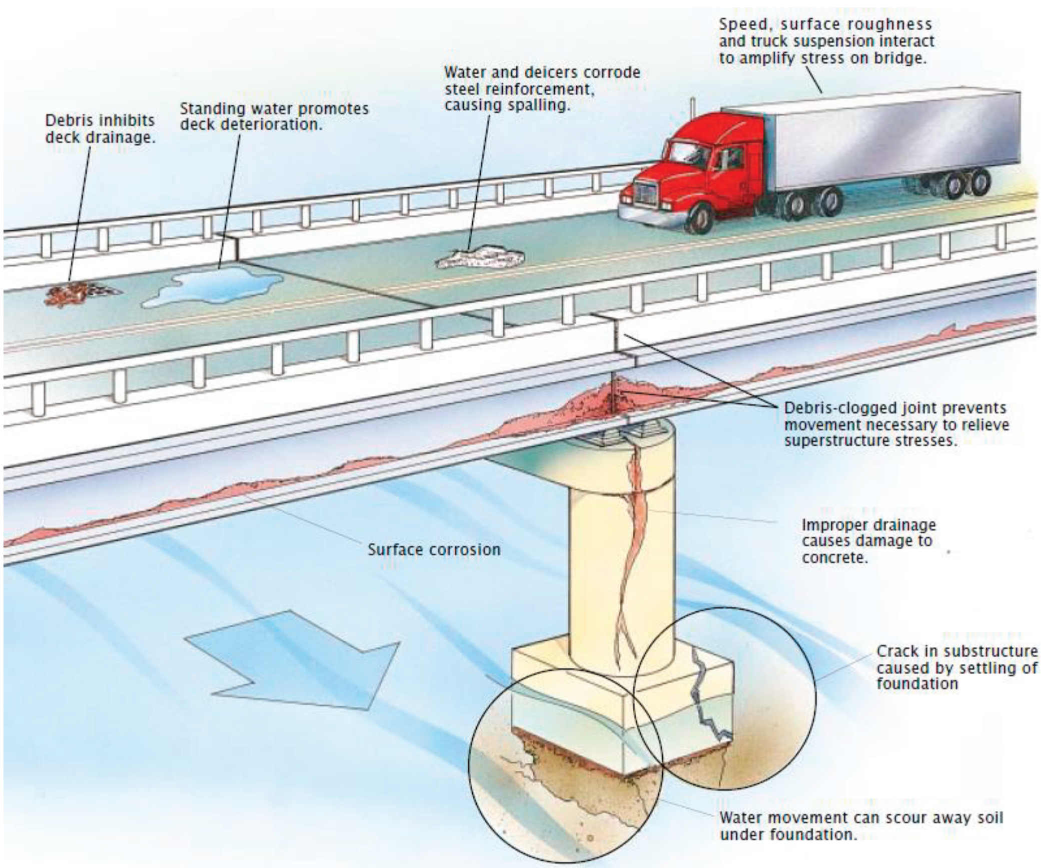
A classification of “structurally deficient” does not imply that bridges are unsafe. When an inspection reveals a safety problem, the bridge is posted for reduced loads, scheduled for repairs, or in unusual situations, closed until repairs can be completed. Structural deficiency is one of the many factors that are used in the ODOT State Bridge Program for project ranking or selection.

BRIDGES 101

General Deterioration Factors

Experience has shown that bridge deterioration is dependent on complex interactions of multiple factors as shown.

Extreme events (earthquakes, flooding, vehicle impacts) are another cause of bridge distress not considered as general deterioration, but result in the need for quick response and investment to restore mobility.

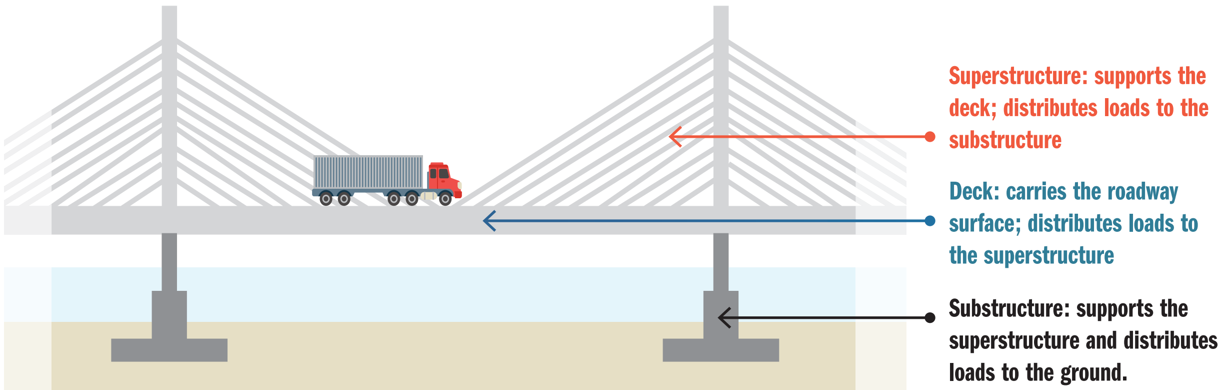


Adapted from "Why America's Bridges are Crumbling," by K.F. Dunker and B. G. Rabbat, 1993, March, Scientific American, 268, no. 3, p. 69. Permission for use courtesy of Jana Brenning, illustrator.

Bridge Condition Ratings

Bridge conditions are categorized by evaluating bridge components (deck, superstructure, and substructure) as shown in the graphic.

National bridge inspection standards (NBIS) were established in 1968 to monitor existing bridge performance to ensure the safety of the traveling public. The NBIS regulations apply to all publicly owned highway bridges longer than twenty feet located on public roads. To comply with the NBIS and assess bridge conditions, ODOT manages a statewide bridge inspection program that includes both routine and specialized inspections. Bridge condition ratings are described on the next page.



The NBI ratings provide simple tools for agencies to describe the overall conditions of their bridge populations and the overall effectiveness of their bridge programs. The critical rating is when a highway bridge is classified as **structurally deficient (SD).**

NBI Component	NBI Rating	Condition Rating Description
• Deck • Superstructure • Substructure • Culvert Rating (if applicable)	Lowest Condition NBI Rating of All Components (Scale = 0-9)	8-9: Very Good Condition 7: Good Condition 5-6: Fair Condition **4: Poor Condition** **≤ 3: Very Poor Condition**

Bridge condition rating description.

Beginning in 2018, a bridge is classified as structurally deficient only if any component (deck, superstructure, substructure) has an NBI rating of 4 or less. Previously load capacity and hydraulic opening below the bridge could result in an SD classification.

Maintenance Needs and Cost Impacts

Keeping a bridge in fair to good condition requires routine inspections, proactive maintenance and preservation treatments. Examples of proactive maintenance are:

- Sealing or replacing leaking joints to minimize the deterioration of superstructure and substructure elements beneath the joints;
- Painting/coating or overcoating structural steel to protect against corrosion;
- Installing scour countermeasures to protect the substructure from undermining and failure due to scour below the bridge.

Timing is critical when performing the work since the longer the deterioration occurs, the more extensive/expensive the required treatment.

2019 BRIDGE CONDITIONS

> "ODOT ADDED 26 NEW BRIDGES TO THE INVENTORY IN 2019 – ONLY ONE AS A RESULT OF DETERIORATING CONDITIONS."

ODOT's 2019 Bridge Condition Report summarizes bridge condition ratings on state highways and performance measures based on National Bridge Inventory and ODOT data. As a consistent reference point for evaluation, ODOT uses the bridge conditions snapshot provided annually to the Federal Highway Administration. Data from the April 2019 submittal is the basis of this report.

Bridge conditions are reported in a number of different measures, none of which stands alone in the communication of bridge conditions for decision making purposes. The most common and those presented here, are the NBI ratings for the three major structural components of the bridge (deck, superstructure, and substructure, or the culvert rating), deficient bridge classification, and structural condition rating.

The structural condition rating ranging from 'Very Good' to 'Very Poor' is based on the lowest of the deck, superstructure, substructure, or culvert ratings.

Inventory Changes

ODOT currently manages 2,755 bridges. This year, 26 newly constructed bridges were added to the inventory. In comparison to 2018, based on updated jurisdiction or classification information, the net change to the inventory was 18 bridges.

Of the 26 newly constructed bridges added to the inventory, only two were to replace existing bridges. See details in the graphic below. Current funding levels pay on average for only three bridge replacements a year. At that rate, an Oregon bridge will need to stay in service for over 900 years which is well beyond an expected service life of 80 to 100 years.

24 New Bridges

10 Bridges:

OR 18 | Newberg Dundee Bypass

8 Bridges:

OR62 | Corridor Solutions

6 Bridges:

To address fish passage/ culvert conditions

2 Bridge Replacements

1 Bridge: To improve function

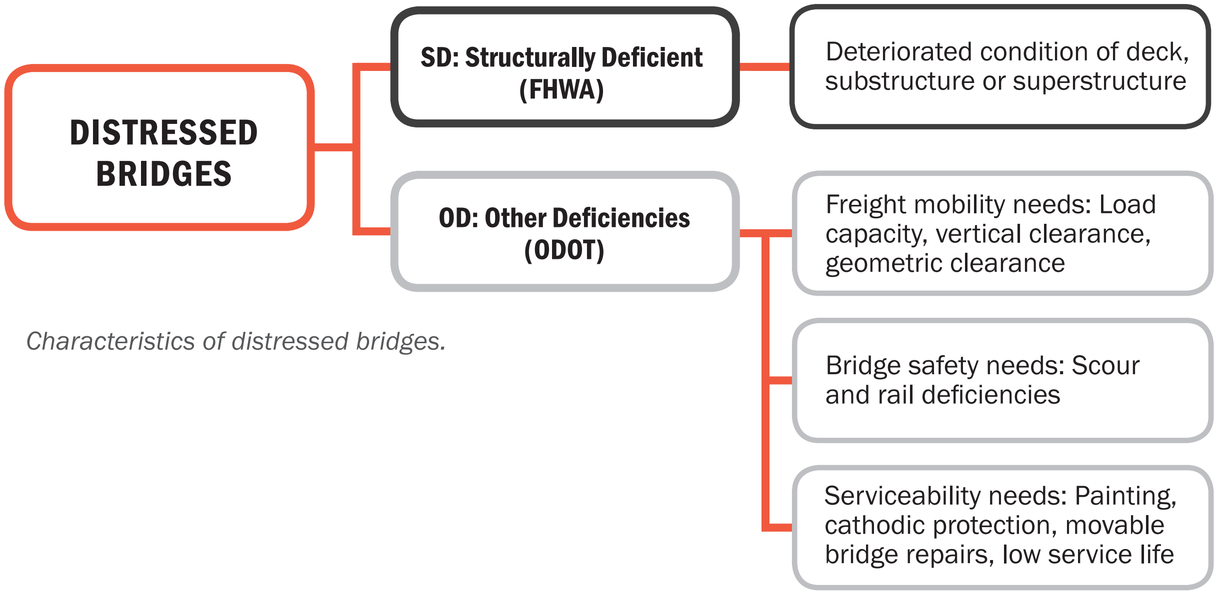
1 Bridge: Based on condition

Bridge Key Performance Measure

(Percent of Bridges Not Distressed)

ODOT measures bridge conditions based on the Bridge Key Performance Measure (KPM) – Percent of Bridges Not Distressed (%ND). The KPM includes two categories of bridges: 1) the percent of bridges not structurally deficient (SD) as defined by FHWA and 2) the percent of bridges without other deficiencies (OD) as defined by ODOT. SD and OD components capture different characteristics of bridge conditions as shown.

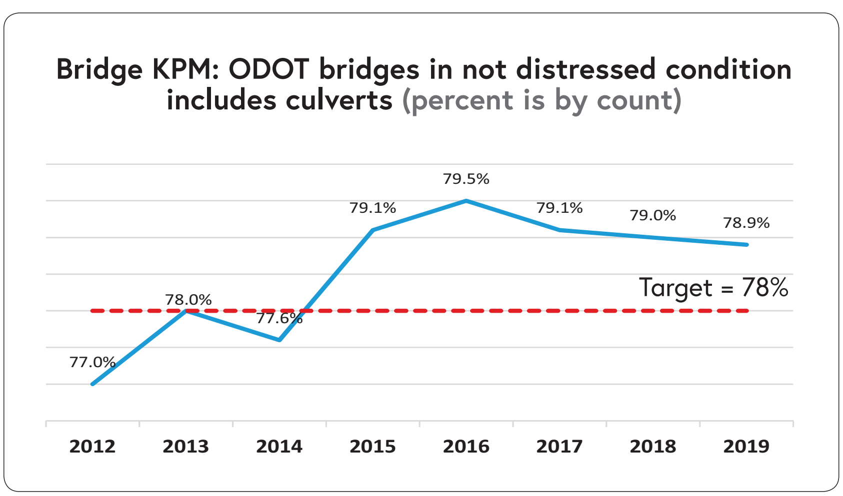
A condition of distressed indicates that the bridge is rated as SD or has at least one OD. ODOT considers both SD and OD aspects in determining bridge needs and selecting projects for the statewide Transportation Improvement Program (STIP).



Characteristics of distressed bridges.

For 2019, the Bridge KPM equals 78.9% indicating a 0.1% drop from 2018 exceeding the target of 78%. While the KPM indicates that bridge conditions exceed the target, 2019 marks the third year of a measurable decline.

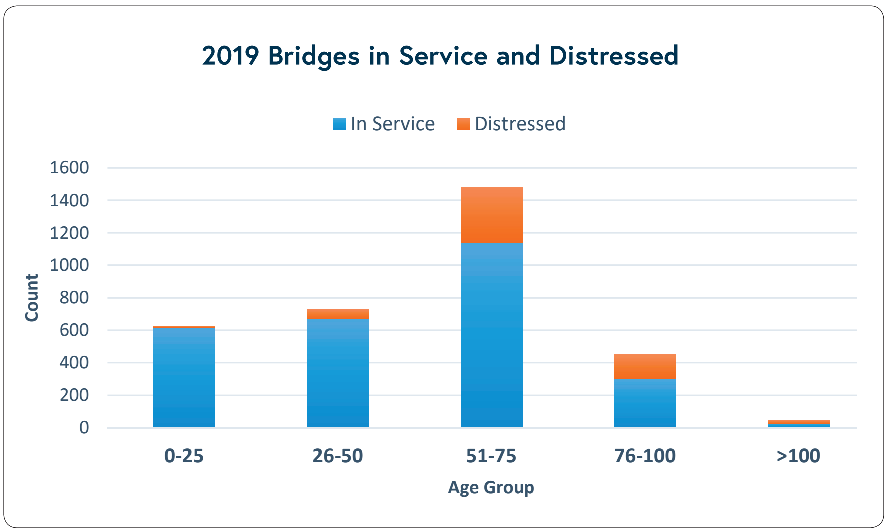
The number of bridges with other deficiencies fluctuates with time due to bridges being repaired where a deficiency is removed or deteriorating where a deficiency is added. Notable net increases, however, were observed in two categories. First in the low service life (LSL) deficiency which captures the overall condition and function of the bridge. Increases have also been noted in the deck geometry (DG) deficiency based on the bridge width, minimum vertical clearance over the bridge roadway and traffic volumes on NHS or Oregon Freight Routes. The DG category indicates that the traffic volumes on several bridges is above optimal bridge capacity.



ODOT bridges Not Distressed condition. Larger percentages are better.

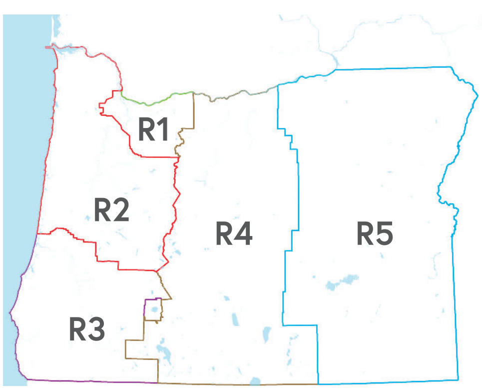
“CURRENT EVALUATIONS INDICATE A DECLINE IN BRIDGE CONDITIONS FOR THE THIRD STRAIGHT YEAR.”

The population of bridges in service and distressed is shown below for five age groups. The largest number of in service bridges is 51-75 years old (built between 1944 and 1968) which corresponds with the largest number of distressed bridges (12.5% of the entire population). The predominant distresses in the 51-75 year old bridges are low service life and distresses associated with bridge functionality like deck geometry and vertical clearance. The distresses represent the aging infrastructure and reduced bridge function.



ODOT Distressed bridges by age group.

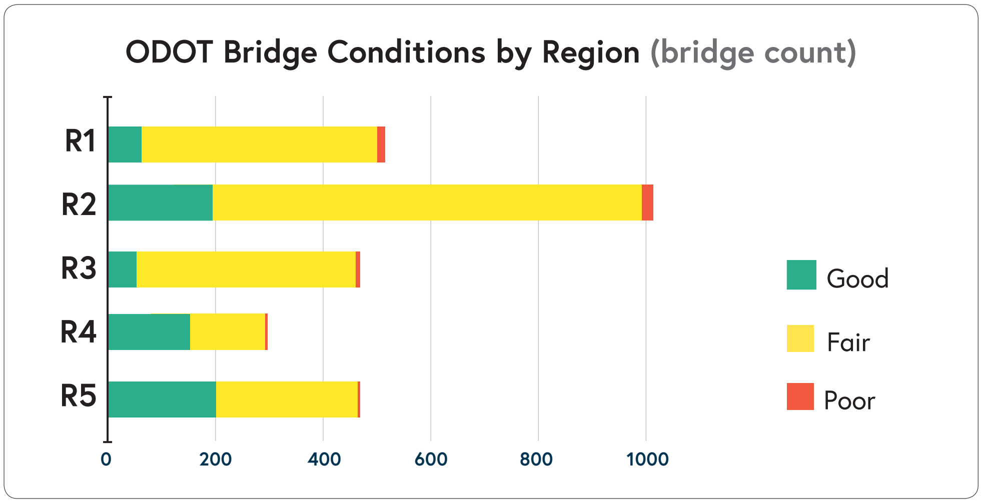
Of note in the 51-75 years old group are 36 distressed timber structures that are an average of 62 years old. Depending on the structure location, they carry anywhere from 20 to 23,100 vehicles a day. These bridges are kept in service by replacing one timber pile at a time. While they remain safe and are regularly inspected, there will come a time when repairs cannot keep up with deterioration and the bridge will either be posted for loads or closed.



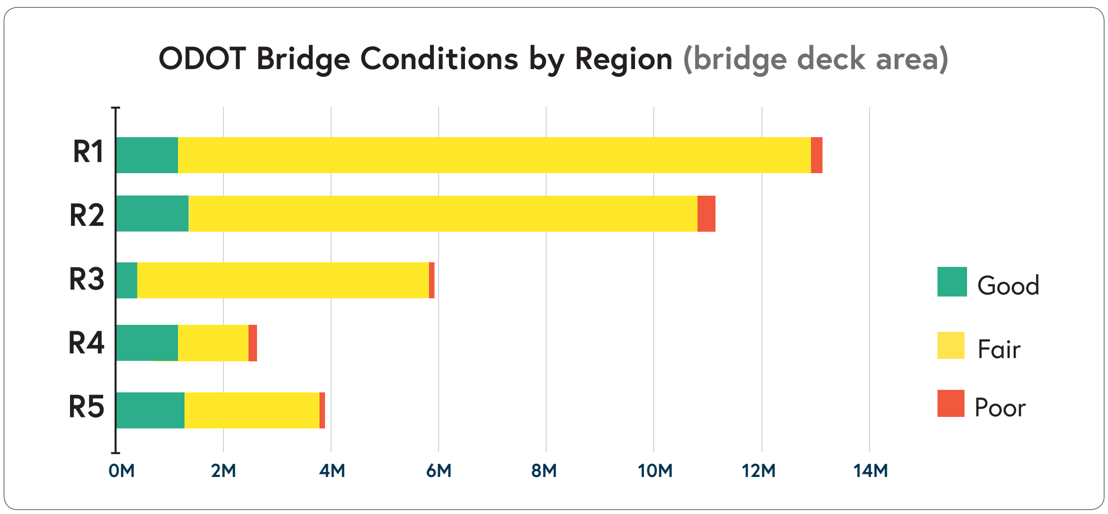
Bridge Conditions By Region

The distribution of bridges by bridge count and deck area are shown in the two graphics following for comparison. Region 1 which includes the Interstate Bridge over the Columbia, the Marquam and Fremont bridges over the Willamette in downtown Portland has more deck area than Regions 2 and 3 combined.

While the bridge system includes only 43 bridges in poor condition (structurally deficient), bridge conditions are slowly declining as noted by the Bridge KPM.



ODOT bridge conditions by count.

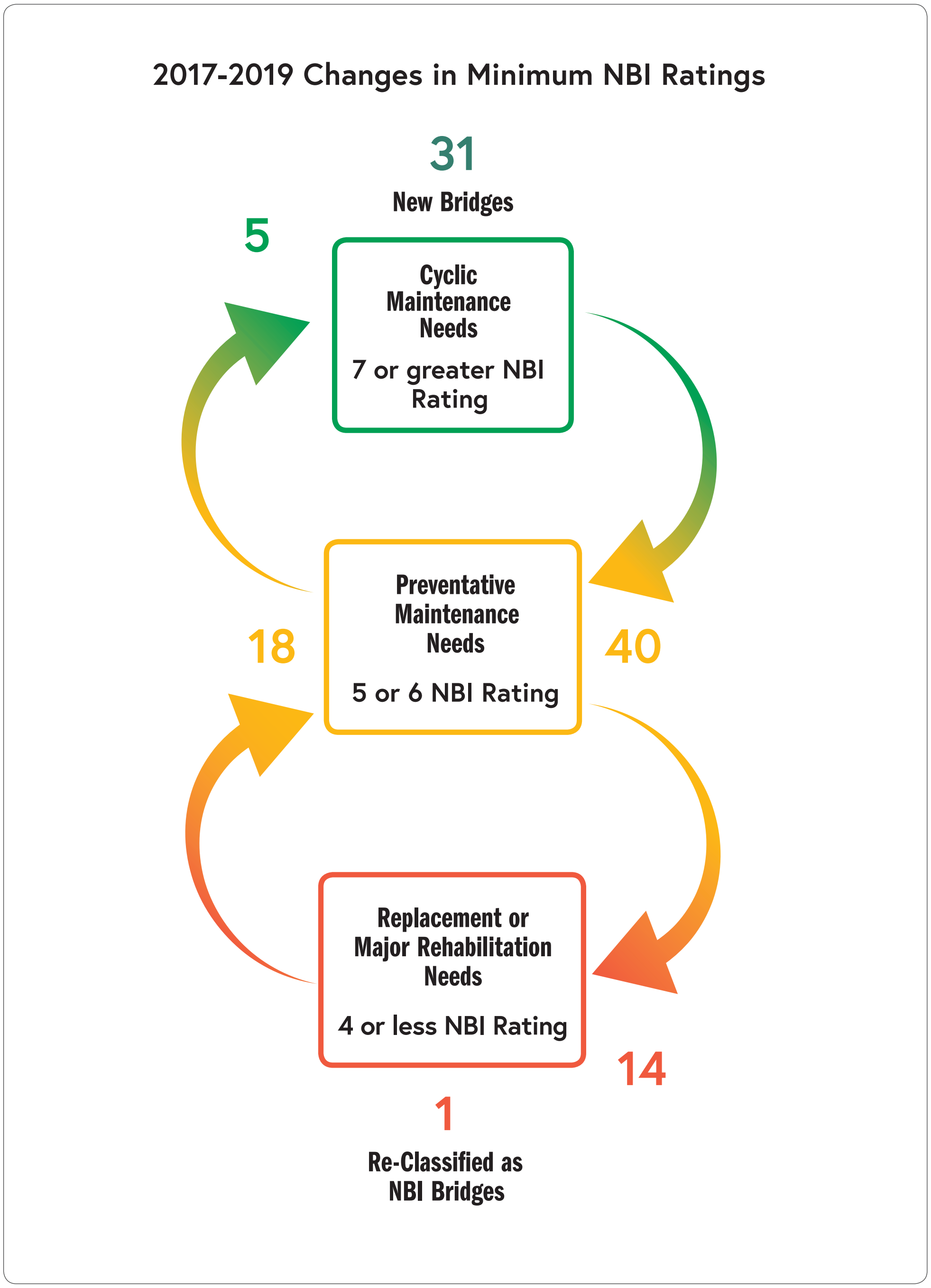


ODOT bridge conditions by 1,000 square feet of deck. Note that Region 1, which includes the Portland Metro area, includes the greatest quantity by bridge deck area.

2017-2019 Changes In Condition Ratings

The following chart shows both the dynamic nature of bridge conditions and the growing backlog of work, for those bridges that have changed conditions. The period from 2017 to 2019 reflects bridge conditions over one full inspection cycle (24 months). In a balanced state, the number of bridges moving from green to yellow and red (deteriorating conditions) would be equal to the number moving from red to yellow and green (improving conditions).

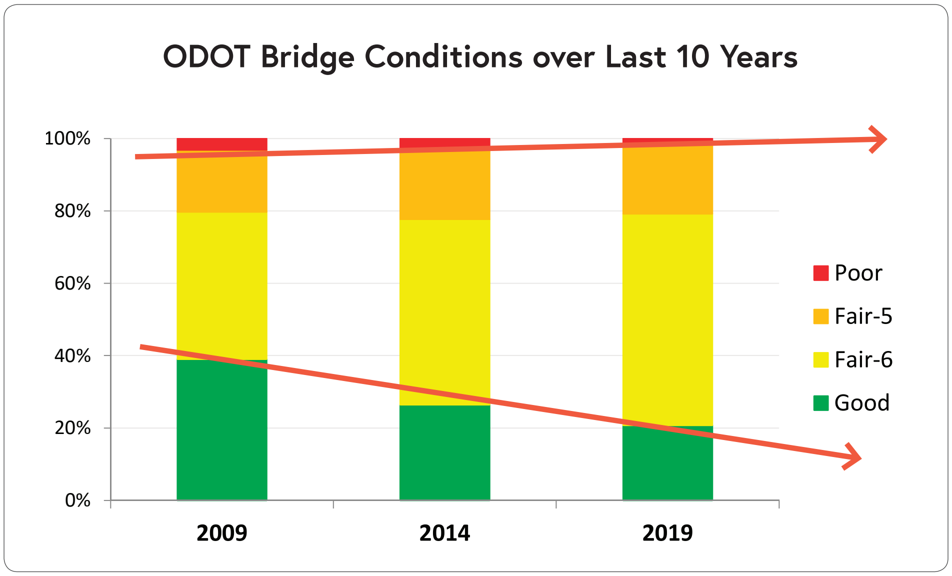
The chart shows that we are managing the Poor (Red) bridges reasonably well, but the number of bridges moving from Good (Green) to Fair (Yellow), indicates that bridge preventative maintenance actions are not occurring at a rate necessary to maintain current conditions. Overall in the last two years, 54 bridges had lower (declining) overall condition ratings versus only 23 bridges with higher (improved) condition ratings.



> "MORE THAN TWICE AS MANY BRIDGES HAD DETERIORATING CONDITIONS THAN BRIDGES WITH IMPROVING CONDITIONS."

Condition Changes Over The Last 10 Years

An overall assessment of bridge condition changes can be determined by comparing previous to current NBI ratings. The chart below provides the percentage of bridges in good, fair and poor condition in the last ten years. Bridges are classified as fair if the NBI value is 5 or 6, however, a value of NBI=5 indicates more distress.



Bridge conditions over last 10 years.

Of concern is the increasing number of bridges moving out of good condition into fair condition and the slightly increasing number of bridges in fair (NBI=5) condition which are the bridges most at risk of becoming structurally deficient.

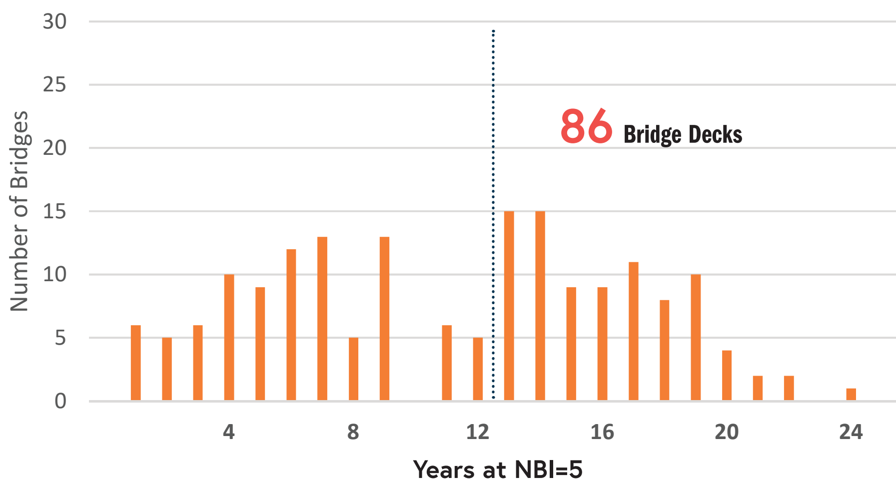
Bridges on the "Cusp" of Becoming Poor

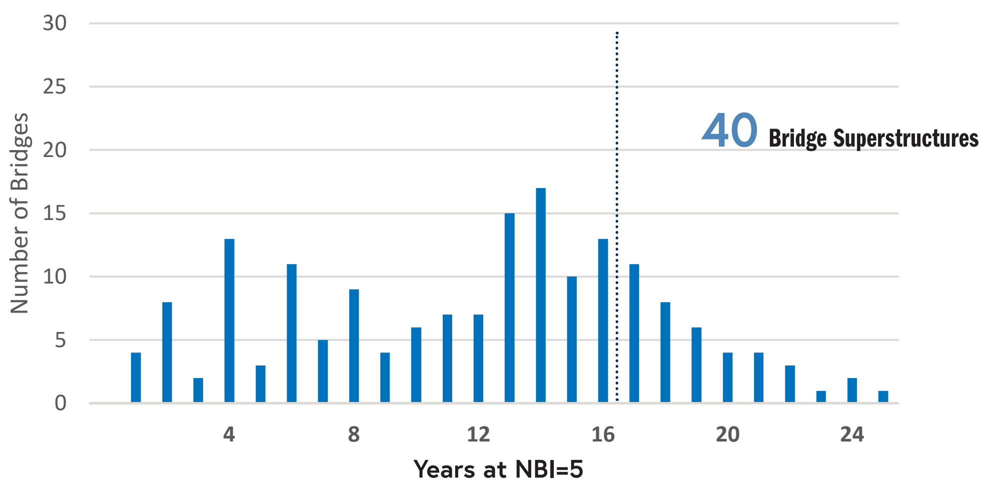
Bridges in fair condition with an NBI rating of 5 are termed cusp bridges as in they are on the "cusp" of becoming poor. Cusp bridges are reviewed as part of the STIP development process to identify potential projects as they typically include the most distress like cracking or spalling. Statistically, Oregon bridge components deteriorate on average:

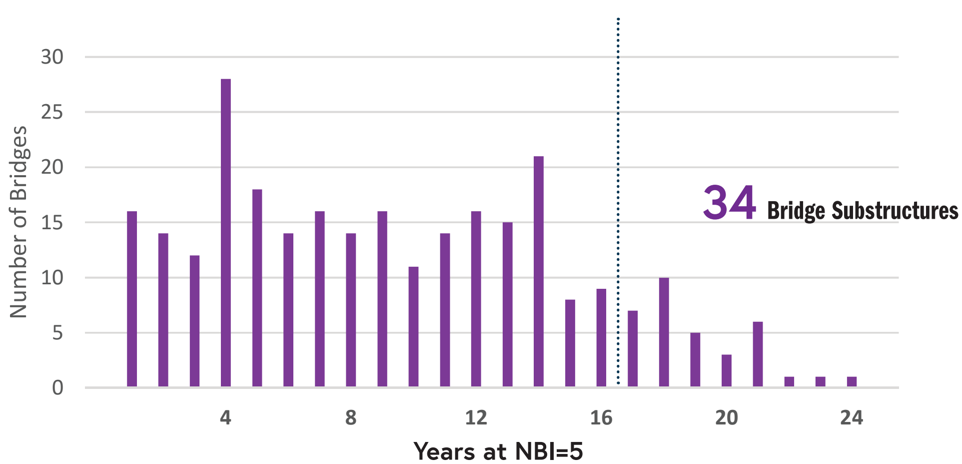
Decks	1 NBI Point every 12 years
Superstructure	1 NBI Point every 16 years
Substructure	1 NBI Point every 16 years

Several bridges have exceeded the average time expected in fair condition (NBI=5) as shown. While it is common for bridge conditions to do better than average, the high number of bridges exceeding the average indicates a potential for repair needs exceeding the resources and funding available.

Bridges on the "Cusp" of Becoming Poor (by component)



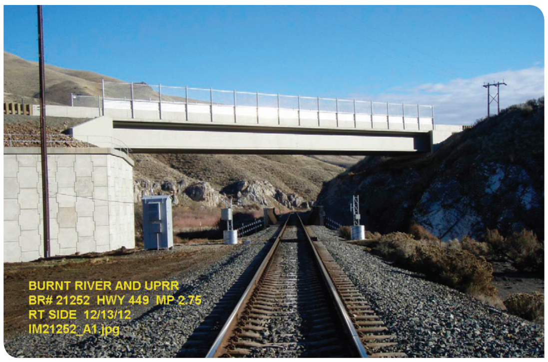




NATIONAL BRIDGE PERFORMANCE MEASURE

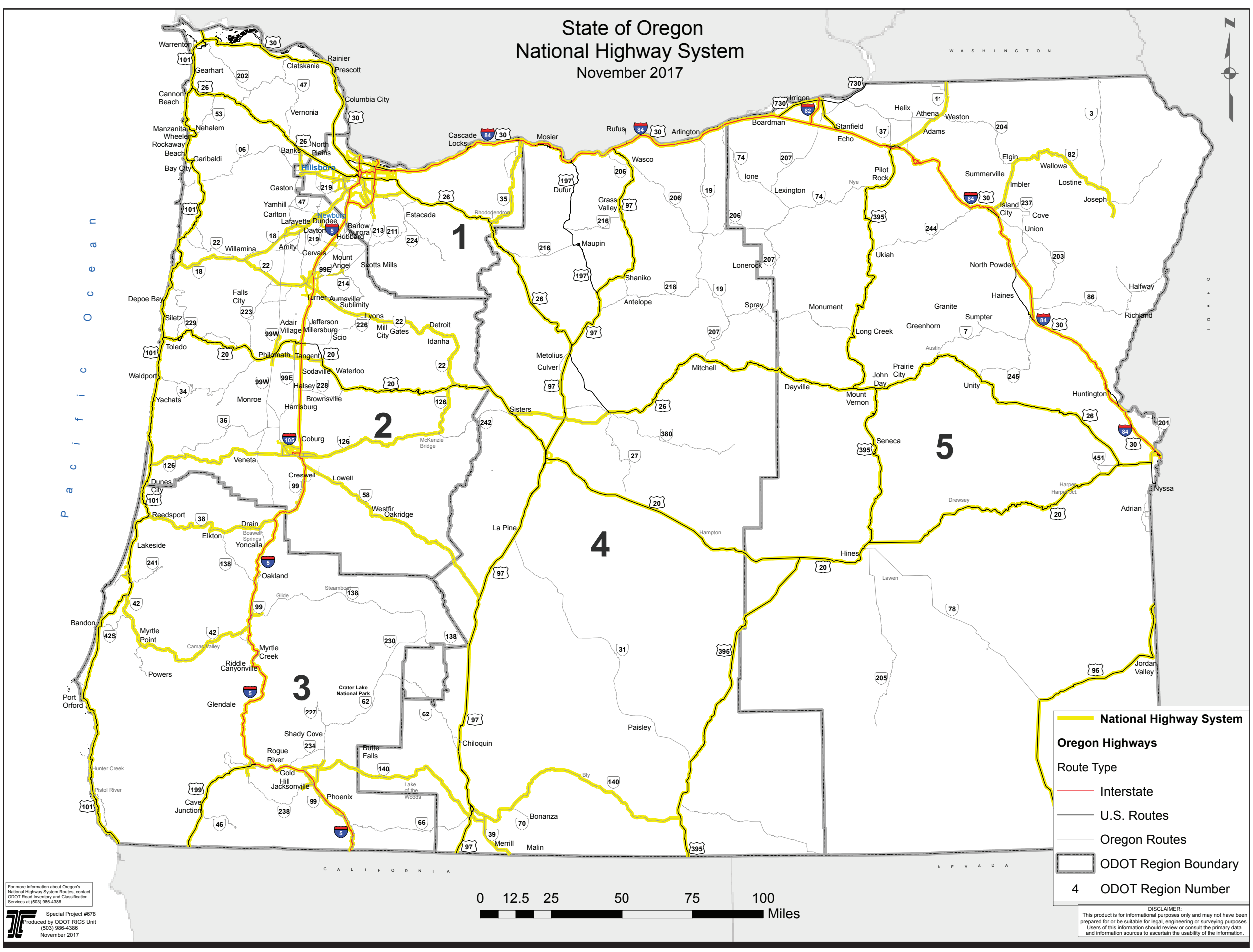
Condition Based Performance

The Moving Ahead for Progress in the 21st Century Act (MAP-21) requires states to establish bridge condition targets and report conditions based on specified performance measures including:



1. Percent of NHS bridges by deck area classified as in Good condition

2. Percent of NHS bridges by deck area classified as in Poor condition

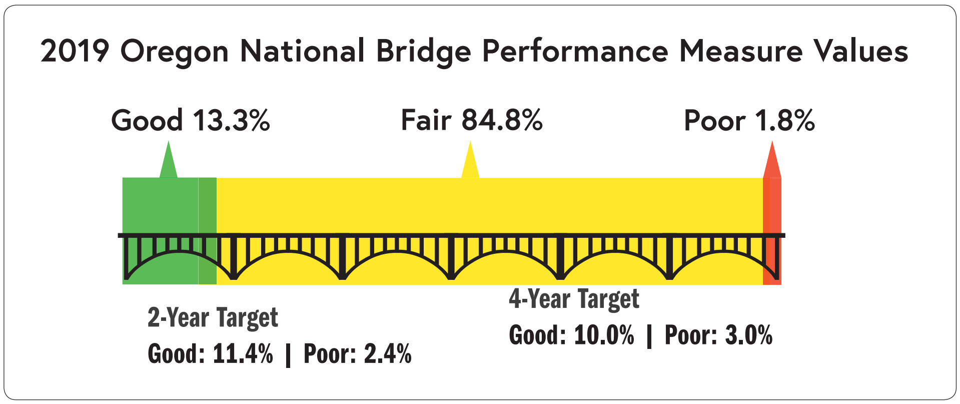


National Highway System

National Bridge Performance Measure Details

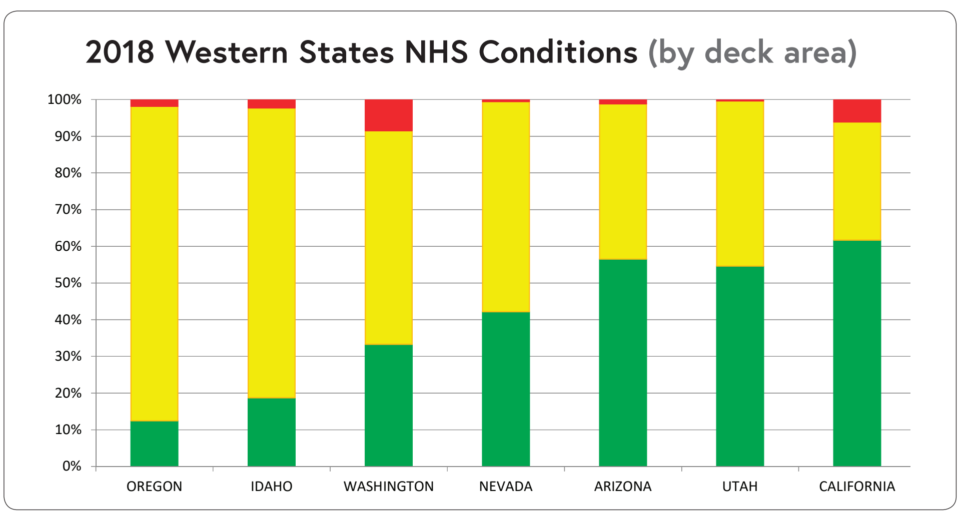
Oregon is required to develop condition targets determined from asset management analyses and procedures that reflect investment strategies that work toward achieving a state of good repair over the life cycle of assets at minimum practicable cost. Penalties are assessed if for 3 consecutive years more than 10.0% of a state DOT's NHS bridges are classified as poor.

Oregon expects NHS bridge conditions to decline but be under the 10% threshold for poor bridges in the near future. However, with so many bridges in fair condition on the "cusp" of becoming poor, maintaining bridge conditions in the future will be challenging. Oregon's NHS bridge conditions and 2 and 4 year targets are shown below.



The 2019 performance value calculated for good bridges increased by 0.6% from 2018 due to the addition of thirteen new bridges on the NHS.

For perspective, a comparison of the Northwest states' NHS bridge conditions was developed using 2018 data submitted to FHWA. While Oregon ranks among the best for the least percentage of poor bridge conditions, it includes the smallest percentage of bridges in good condition as a result of few bridge replacements.



The NPM does not include penalties around the percent of good condition bridges; it does recognize the importance of having a range of bridge conditions in the statewide inventory providing a balanced approach to managing the bridge system.

BRIDGE PROGRAM UPDATES

		FOCUS
1	2021-2024 STIP Development	Bridge STIP Project Development
2	Major Bridge Maintenance	• Funding • Accomplishments • Repair of Older Bridges
3	Bridge Preservation	• Painted Steel Bridge Inventory • Steel Bridge Painting Needs
4	Seismic Program Status	• Phase 1 Seismic Plus Bridges • Region 3 Triage Program • Coordination with Counties
5	Bridge Load Rating	• History • Basics • SHVs and EVs

Retrofitted bridge rail.

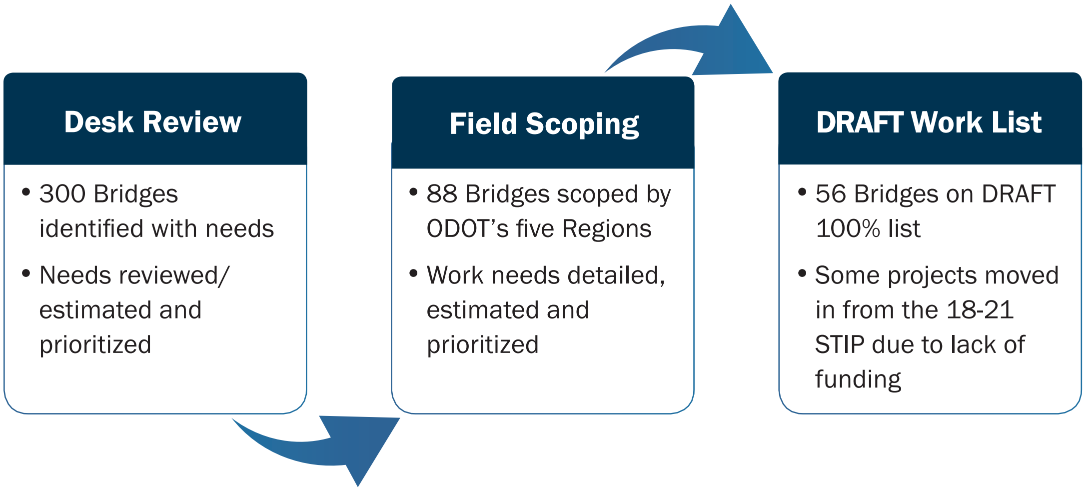
Painting preparation on the Astoria Megler Bridge.

Failed paint on steel member.

Distressed bridge deck.

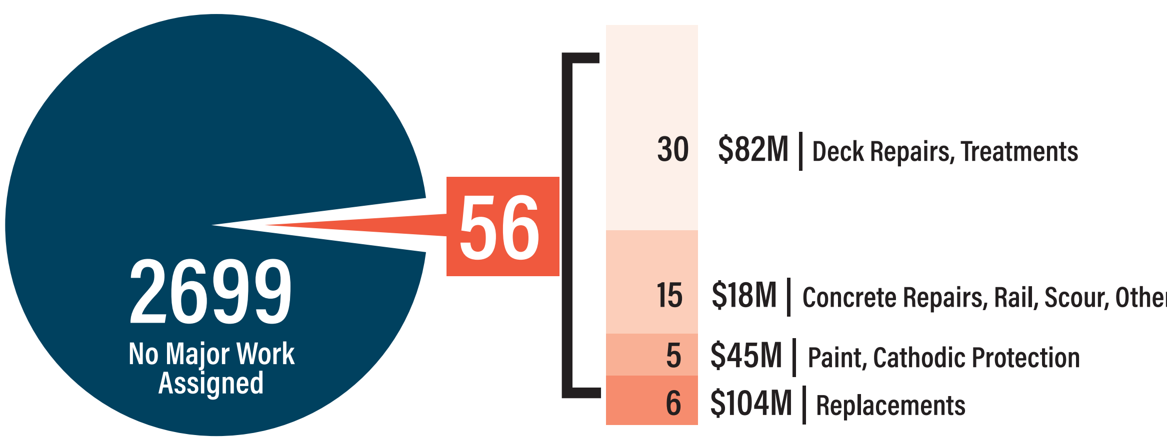
1 2021-2024 STIP Development

Bridge Program funding was allocated in December 2017 as part of the ODOT Fix-It Program. The allocation includes $269M for bridge projects and $36M for Major Bridge Maintenance. The process for identifying work is shown below.



The major project work as identified in the DRAFT 100% list can be generalized as noted in the graphic below. The associated total estimated cost is also shown. In many cases multiple work types are included on a project like rail replacements with deck work. The table categorizes only the primary work type associated with the project.

2021-2024 DRAFT STIP Bridge Project Categories



Note: Graphic does not include bridge work done as part of paving or planning projects funded by the Bridge Program. The estimated costs are current as of 09/01/2019.

With increasing costs, the Bridge Program budget is able to address fewer bridge needs. Also, as noted, the number of bridges being replaced is well below the estimated sustainable rate of 27 bridges per year. Current funding levels pay on average for only three bridge replacements a year. At that rate, an Oregon bridge will need to stay in service for over 900 years which is well beyond an expected service life of 80 to 100 years.

2 Major Bridge Maintenance

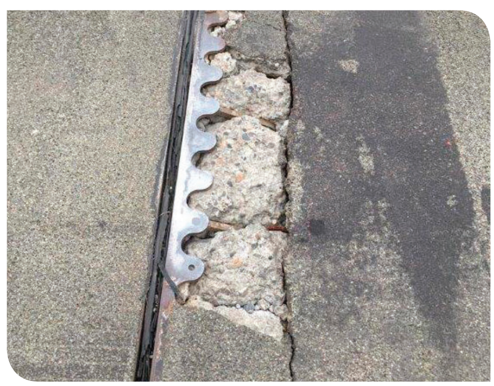
In 1990, the state of Oregon established the Major Bridge Maintenance (MBM) Program, to specifically address major and emergency bridge repairs. These repairs are typically large enough to be outside the scope of work that can be funded at the district level, but are too small or can't wait to be included in the STIP. MBM highlights include:

- Approximately 200 projects are selected annually.
- Starting in 2018, funding increased to $10,000,000/year.
- Starting in 2021, funding will increase to $12,000,000/year.

Significant effort goes into deck treatments as the deck is typically the highest value item on a bridge. It is also at the highest risk due to its exposure to weather, de-icing chemicals, and wear from traffic. When concrete decks are cracked, the risk to the deck is elevated because there are now pathways for water and de-icing chemicals to get deep into the concrete to the level of the reinforcing steel. Once the reinforcing steel begins to corrode costly deck rehab or replacement will be required.

Typical Distresses Addressed by MBM

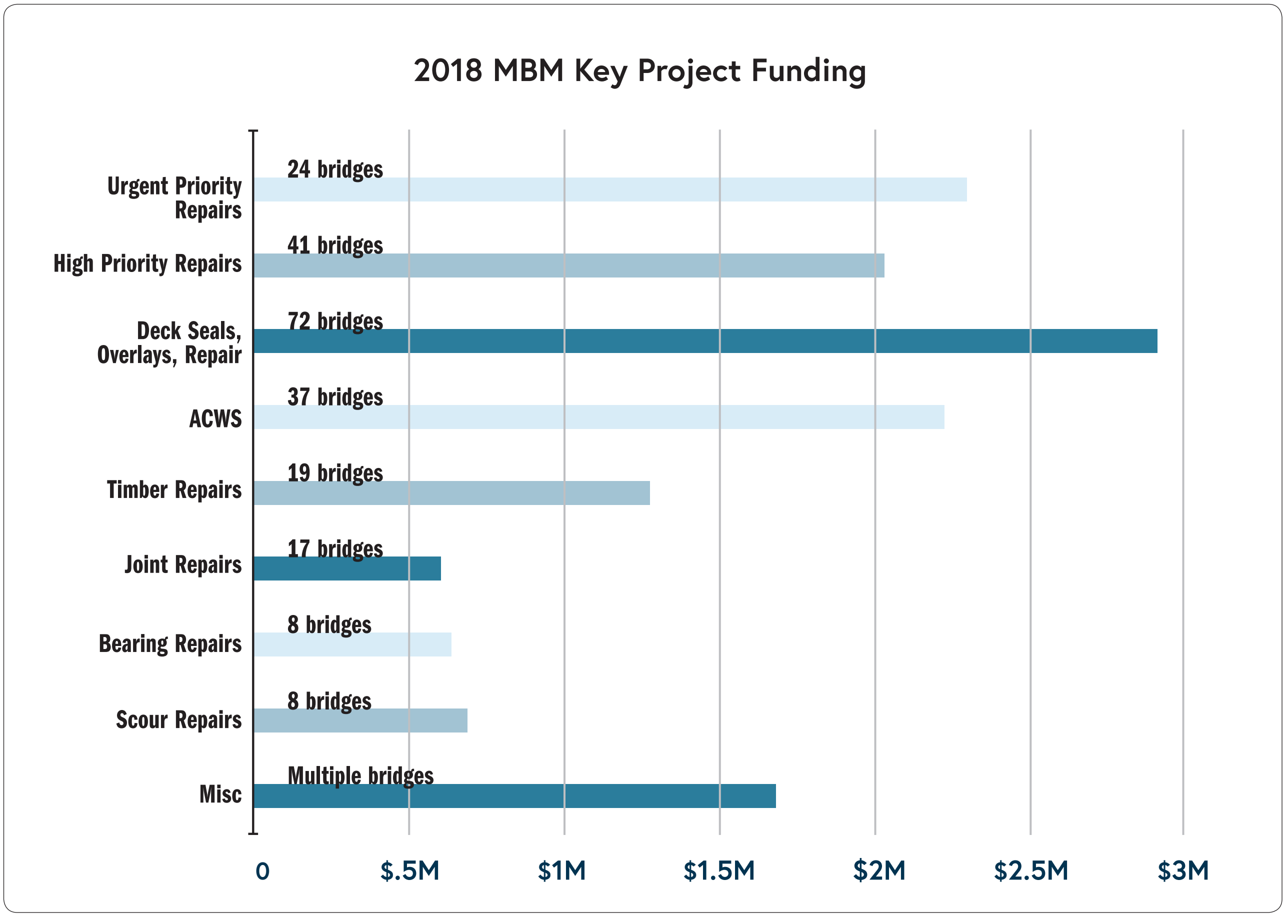
Failed Deck



Damaged Bridge Joint

Distressed Timber

Foundation Scour



Joint Repair

Bearing Ledge Failure

Repairing Older Bridges is Challenging

Each year the MBM program funds approximately 200 bridge repair projects. These projects are typically in response to a localized defect on the bridge:

- damaged joints,
- frozen bearings,
- rotted timber pile,
- spalling concrete, etc.

Localized MBM repairs can raise the bridge condition rating from poor to fair; however, the rise is only temporary as the bridge will continue to deteriorate. These repair projects aren't intended to rehabilitate the entire structure, but rather just address the defects that must be corrected.

Maintaining Bridges Needing Replacement

Before a bridge even gets constructed, it is designed and detailed with an idea of how long it will need to remain in service. Historically the designer assumed the structure would have a design life of 50 years. The bridge's actual service life is typically longer than the design life. *Service Life is defined as the time duration during which the bridge element, component, subsystem, or system provides the desired level of performance or functionality, with any required level of repair and/or maintenance.* (SHRP 2 Design Guide for Bridges for Service Life, 2013)

The type of construction materials (steel, timber, concrete), construction quality, environmental exposure, and type of traffic all impact how quickly the bridge deteriorates. As the bridge deteriorates, maintenance is required to keep the bridge in service and eventually, the bridge is replaced.

A few bridges in Oregon's inventory are significant enough to warrant maintaining the bridge indefinitely. These bridges typically have historical significance and/or are so large that the replacement cost is astronomical. The iconic McCullough Bridge that spans Coos Bay is an example of a bridge that makes sense to maintain indefinitely. Bridges of lesser significance will eventually reach a level of deterioration where replacement becomes the most cost effective long term solution.

McCullough Bridge construction, 1936.

Nearly 1,500 state owned bridges have exceeded their original design life. As these bridges continue to age they require an ever increasing level of maintenance and repair to keep them safe and in service. Bridges with timber foundations are a particularly challenging bridge subset as they require constant repairs once the bridge exceeds the 50-year design life.

Engineers have tools to help determine if replacement or maintenance is the most cost effective decision for a deteriorating bridge. A life-cycle cost analysis is one way to compare alternatives which takes into account the current bridge value, the deterioration rate, the anticipated maintenance cost, and potential roadway user impacts due to restrictions. However, it is common for bridges to be maintained even when the life-cycle cost analysis indicates replacement is a cheaper long term solution due to limited budgets and a large population of bridges needing repair. The upfront replacement costs simply aren't available as funding is allocated to higher priority bridges and spread around to keep more bridges in service. As an example, the current DRAFT 2021-2024 STIP program includes six bridge replacements for $104M versus 30 bridge deck/rehabilitation projects for $82M.

> **"EVENTUALLY BRIDGES ON LOWER PRIORITY ROUTES WILL NOT BE SERVICEABLE LEADING TO LOAD RESTRICTIONS OR EVEN CLOSURES."**

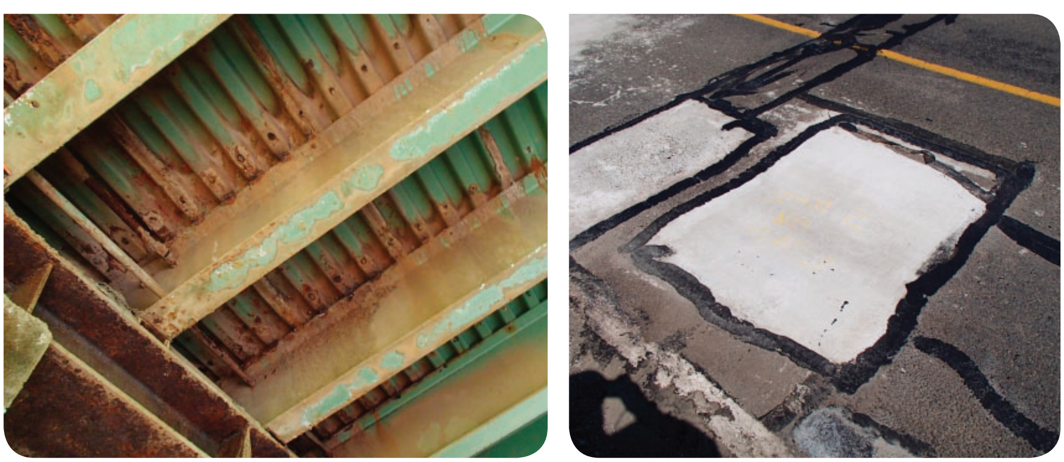
As resources continue to shift toward maintaining deteriorating bridges that should be replaced, fewer resources are available for cost effective preservation and maintenance treatments. This cycle has been termed the "worst-first" approach. Eventually bridges on lower priority routes will not be serviceable leading to load restrictions or even closures posing a significant risk to Oregon's mobility in the coming decades.

The following examples are of recent projects that are intended to highlight the challenges facing Oregon's bridge population.

Pedee Creek Bridge

Background: The bridge was originally built in 1926. In 1960 the main span was widened and the approach superstructure was replaced with precast slabs. The bridge is located on OR 223 (Kings Valley Highway) and has an average daily traffic count of 670 vehicles.

Defects: The steel decking has reached the end of its service life and requires replacement in the near future. In addition to a poor deck, the bridge was analyzed and found to be deficient to safely support current truck loads.



Pedee Creek Bridge steel decking from underneath the bridge and deck surface.

Cost Comparison: A preliminary estimate put the bridge replacement cost at $4,000,000. This was compared against the cost to repair, strengthen, and continue to maintain the bridge into the foreseeable future. The replacement was identified as the lower long term cost option. But with limited funding, a replacement project would have required canceling other projects on higher priority routes. Although the long term cost of a full replacement was lower than the cost of maintaining the bridge, the upfront cost for a replacement was 3-4 times the cost of the immediate maintenance needs.

Maintenance Plan: In 2019 a strengthening project was executed at a cost of $310,000 to avoid restricting truck traffic. A deck replacement project will follow in 2020/2021 at an estimated cost of $500,000. Despite these significant investments, the bridge has poor substructure details that is expected to require continual maintenance until a replacement is funded.

Pedee Creek Bridge Strengthening

Yamhill River Overflow Bridge

Background: This Bridge is 300' in length and carries two lanes of traffic. It was built in 1963 and consists of a concrete deck and beams supported by a timber substructure. This bridge is on the NHS (OR 18) and carries 22,900 vehicles a day.

Defects: The reinforcement within the deck wasn't placed at the proper depth which has led to significant spalling (potholing). An in depth evaluation of the deck was performed which confirmed that a major deck rehabilitation project would be required to extend the life of the bridge.

Cost Comparison: A deck rehabilitation project was estimated to cost $2,000,000. Once complete, the bridge would still be supported by a timber substructure that doesn't meet current design standards and will require continual maintenance as it has significantly exceeded its design life. The cost of a full bridge replacement was estimated at $12,000,000.

Yamhill River Overflow Bridge Timber Substructure

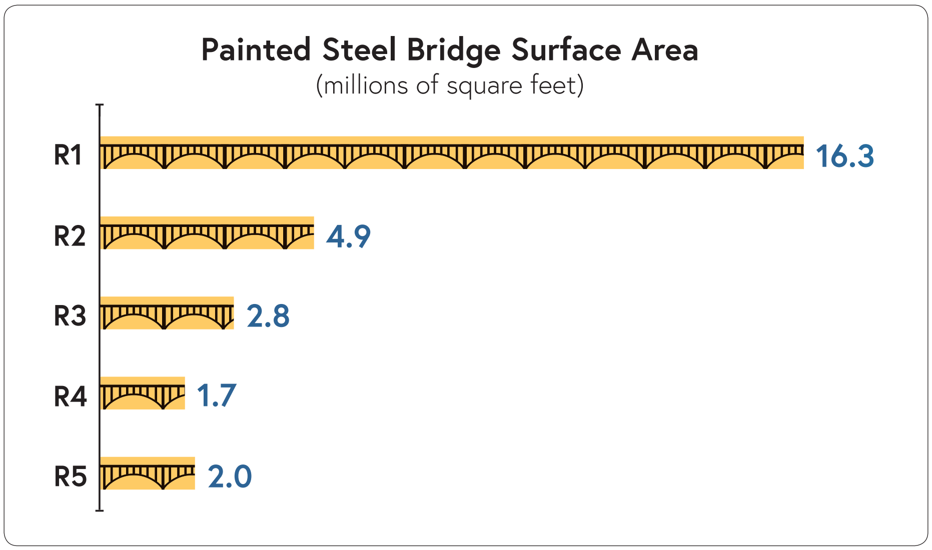
> "FUNDING ISN'T AVAILABLE FOR A REPLACEMENT; MAINTENANCE FORCES CONTINUE TO PATCH THE DECK TO KEEP THE STRUCTURE IN SERVICE."

Maintenance Plan: A project to rehabilitate the bridge deck was canceled due to the desire to avoid significant investment in a structure that would still require substantial long term maintenance. Funding for a complete replacement isn't available for the foreseeable future. Until one of the projects moves forward, maintenance forces continue to patch the deck to keep the structure in service.

Yamhill River Overflow Bridge Deck and Patching

3 Bridge Preservation: Painted Steel Bridges

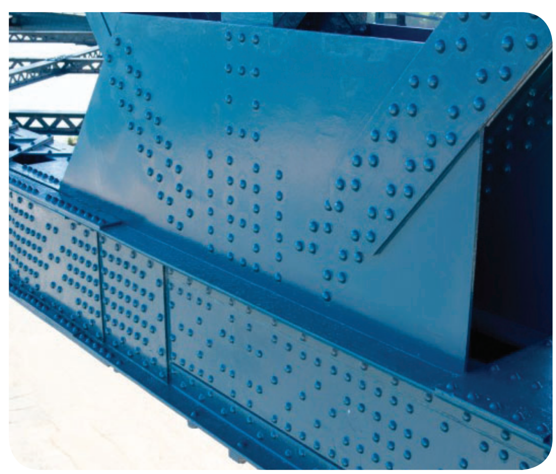
ODOT is responsible for more than 370 painted steel bridges with over 27 million square feet of surface area. Painting steel bridges (applying a protective coating) is vital to preserving and extending the service life of the state's bridge system. Timely applications of protective coatings prevent steel corrosion and any subsequent structural capacity loss. The current steel bridge surface area distribution is shown.



When Do We Paint Our Bridges?

The factors that determine whether or not a bridge needs to be painted include the corrosion location, the paint failure mechanism, and the bridge environment. For long term planning purposes the bridge inspection element, Element 390 Painted Steel, was selected to track paint conditions on regular intervals.

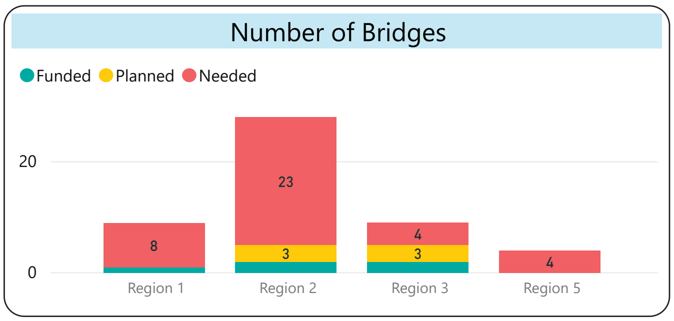
The threshold for painting needs is when 15% of the total area of painted steel is at Condition State 3 (poor) or 4 (failed). Once 15% of the painted steel has moved to Condition State 3 or 4, the entire bridge's surface area is added to the list of in-need bridges.

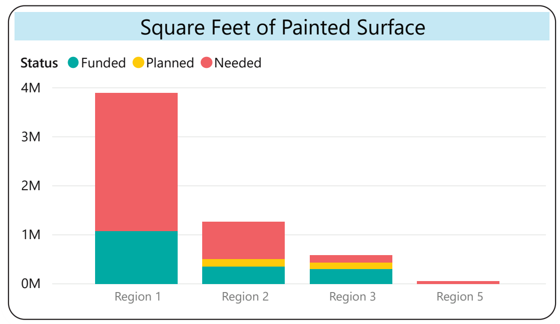


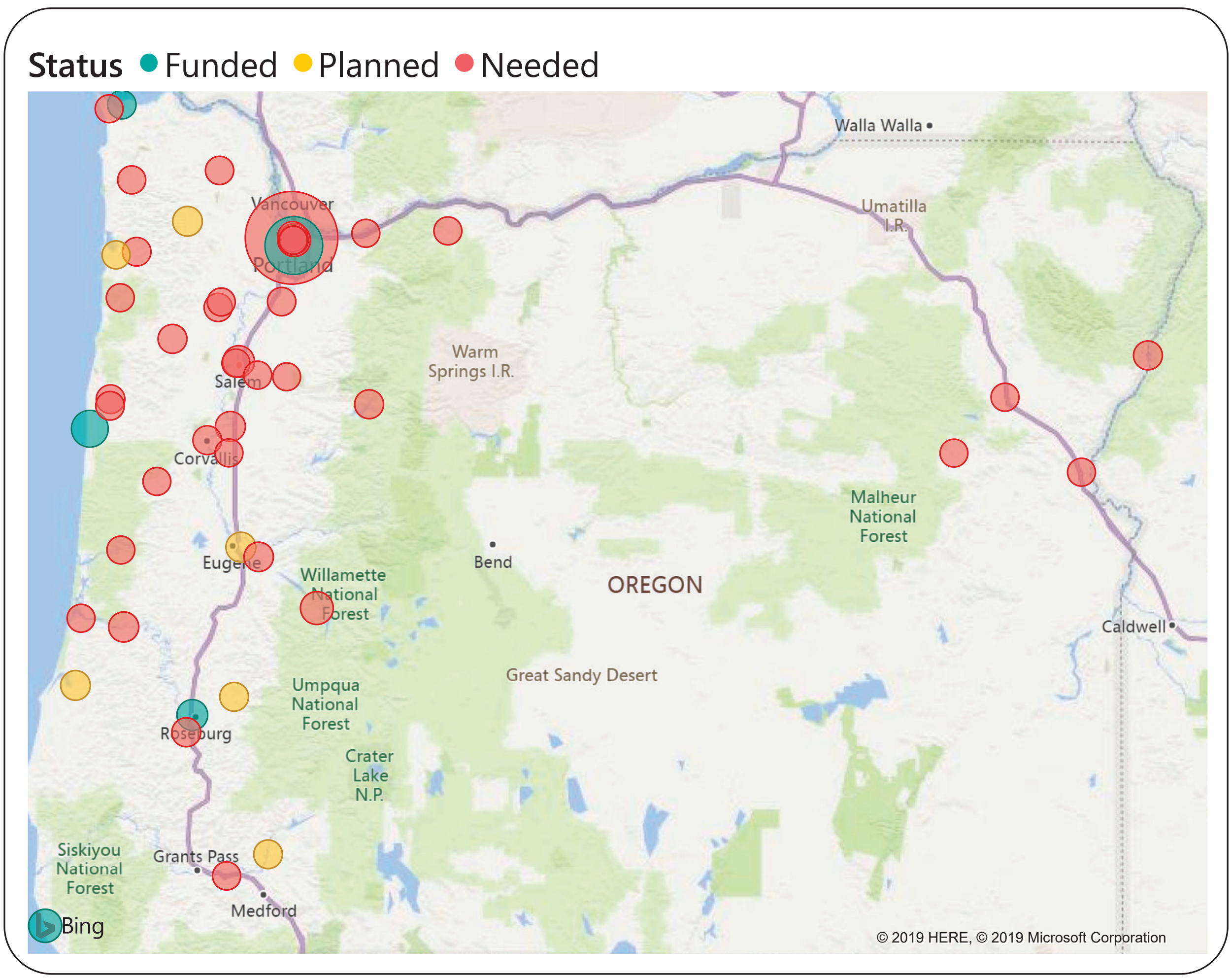
Newly painted Ross Island Bridge

The following graphics provide additional information for the location and program status of painted steel bridges. As with other bridge needs, painting needs exceed available funding levels. During each STIP cycle, assessments are made to prioritize the most critical needs to minimize deterioration. ODOT continues to make progress, with plans to eventually get to the steel bridges in the valley which have not been painted since they were constructed, in some cases, more than 50 years ago.

Bridge Painting Needs







Size of circle is proportional to the total square feet of painted surface of the bridge

4 Seismic Program Status

The 2014 Seismic Plus report identified five phases of bridge seismic work to "provide the maximum degree of mobility with reasonable investments spread over several decades." The goal of the phasing is to retrofit all seismically vulnerable bridges and address unstable slopes on key lifeline routes in a strategic and systematic program to allow for rescue and recovery following a major earthquake.

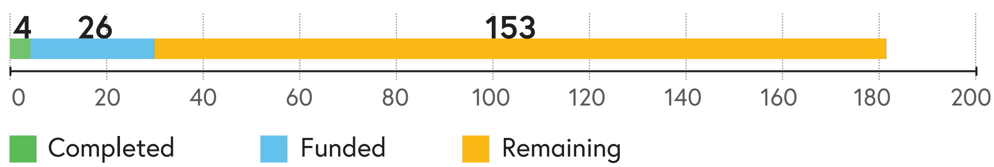
Additional funding to address seismic improvements related to highways and bridges is included with the HB 2017 transportation package at about $10M/year. With the new funds, ODOT planned to work on Phase 1 bridges moving from Eugene, north on I-5 and finishing up on I-84 moving from east to west in 20 to 30 years. Projects were recently scoped for seismic work on I-5 near Eugene for the 2021-2024 STIP. Phase 1 Seismic Routes are shown on the next page.

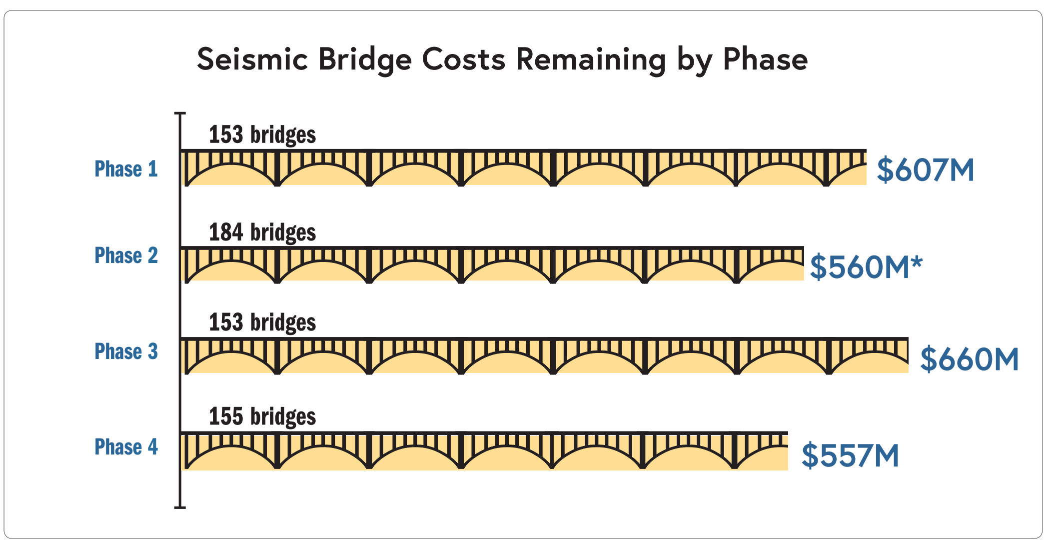
Phase 1 **Provides a connection to the Redmond Airport; east-west freight movement and a north-south corridor on US97 -- the cornerstone of the program.**

ODOT Phase 1 Seismic Routes

Phase 1 Bridges Remaining:

Estimated Cost $600 M

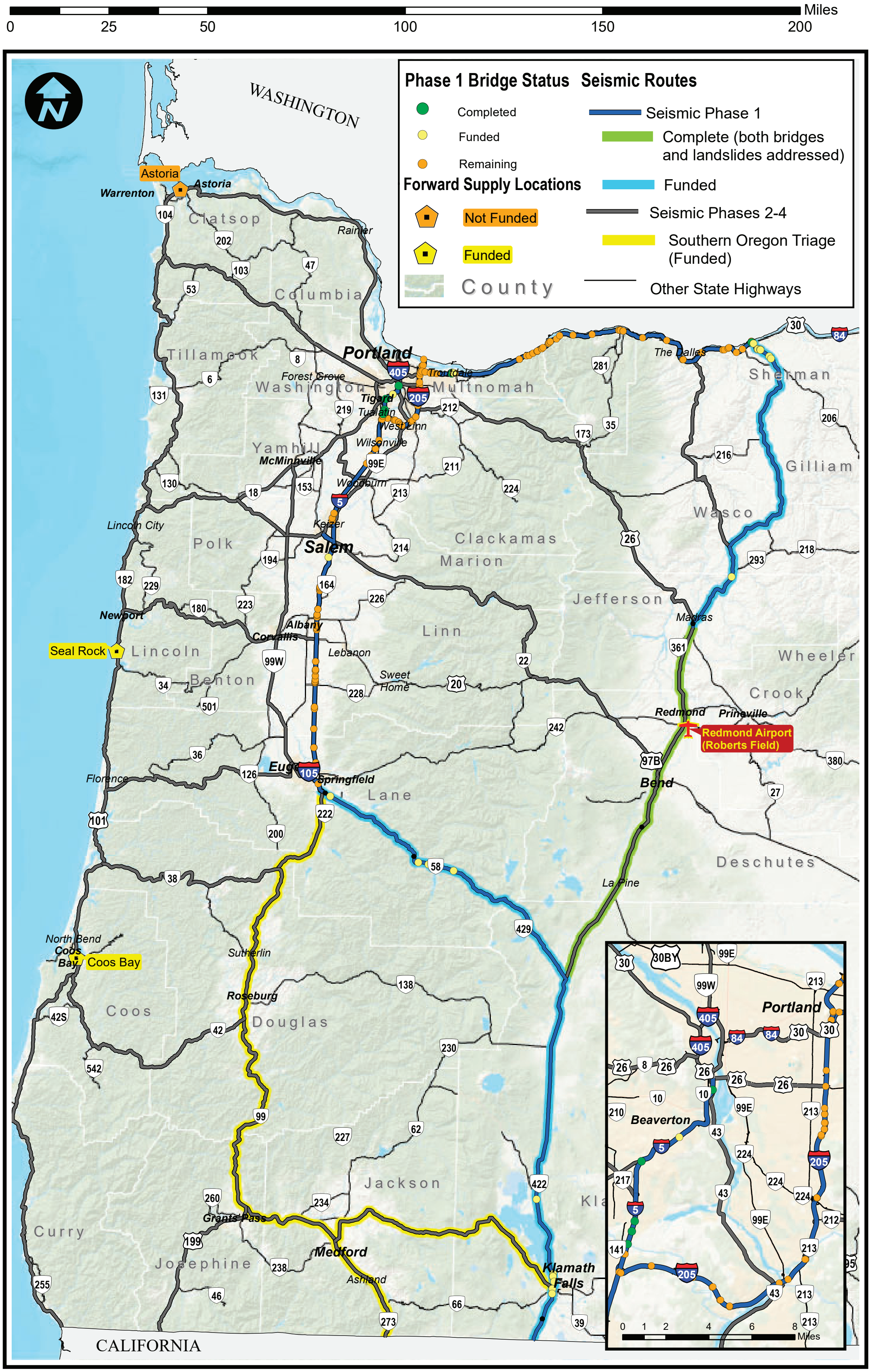




*Estimate dropped by $70M as a result of the HB 2017 funding for the Van Buren bridge replacement in Corvallis.

Phase 5 includes 12 bridge replacements like the Medford Viaduct, the Ross Island Bridge, several historic coastal bridges and other large bridges. The estimated replacement costs total $1.5 billion.

ODOT Phase 1 Seismic Routes



Seismic Strategy Update

The 2021-2024 STIP funding includes $31M to address ODOT bridge seismic needs. The STIP cycle is the first time any of the seismic program work has been field scoped providing updated costs. The scoping results were much higher than the planning level estimates previously calculated due to:

- More detailed level estimates that capture site specific costs associated with staging and foundation work; and
- A recent trend of increasing construction costs noted for all work types across the Agency.

Based on the estimated costs, it would take decades to complete Phase 1 of the Seismic Plus Program at which time many of the bridges that were initially retrofitted would be reaching the end of their service life. Also, to address seismic resiliency bridges still in relatively good condition would need to be replaced.

Discussions are continuing around options to maximize the value of the HB 2107 seismic funding. The first priority will be on retrofitting major river crossings. The major I-5 river crossings between Eugene and Portland include the Boone Bridge which will be evaluated as directed by the 2019 Legislature, and the Santiam River Bridge. To address the seismic resiliency of the Southbound Santiam River Bridge, the plan is to include retrofit work as part of the 2021-2024 STIP.

The second priority will be around evaluating alternate lifeline routes by addressing the portion of I-5 north of Eugene similar to the Southern Oregon Triage project. The process of identifying a route south of Eugene, involved a triage strategy that included the use of local roads and bridges to provide a lifeline following a Cascadia seismic event.

HB 2017 Seismic funding available after the Southbound Santiam River Bridge retrofit is funded will be used to address bridges identified for work as part of an updated strategy. Every effort will be made to optimize funding to address overlapping bridge needs like replacing deteriorating structures on lifeline routes.

“THE 2021-2024 STIP FUNDING INCLUDES $31M TO ADDRESS ODOT BRIDGE SEISMIC NEEDS.”

Other Funded Seismic Projects

HB 2017 provided funding for an additional seismic project entitled the Southern Oregon Triage strategy. The strategy focuses on mitigating seismic impacts along Interstate 5 south of Eugene, and OR 140 which are key lifeline routes to and from the Rogue Valley. Most of the seismic impacts on the routes are expected to be addressed through quick repairs or temporary detours. The funding will be used to address those bridges and potentially unstable slopes that are more problematic or where a feasible detour does not exist.

Right of way funding is available for Coastal Maintenance Stations at Seal Rock and Coos Bay; an additional facility at Astoria is being considered but is not currently funded. Each station will be supplied with seismic response kits. The purpose of the kits is to stockpile key materials and supplies that can be used to assist local communities in the early days following a seismic event. The kits will include culvert pipes of various sizes; construction materials; solar power generators and trailer mounted solar light panels; diesel and unleaded fuel storage tanks; survival supplies (water, field rations, first aid supplies); power tools; batteries; portable boats; flat railroad cars; and satellite phones and Ham radios.

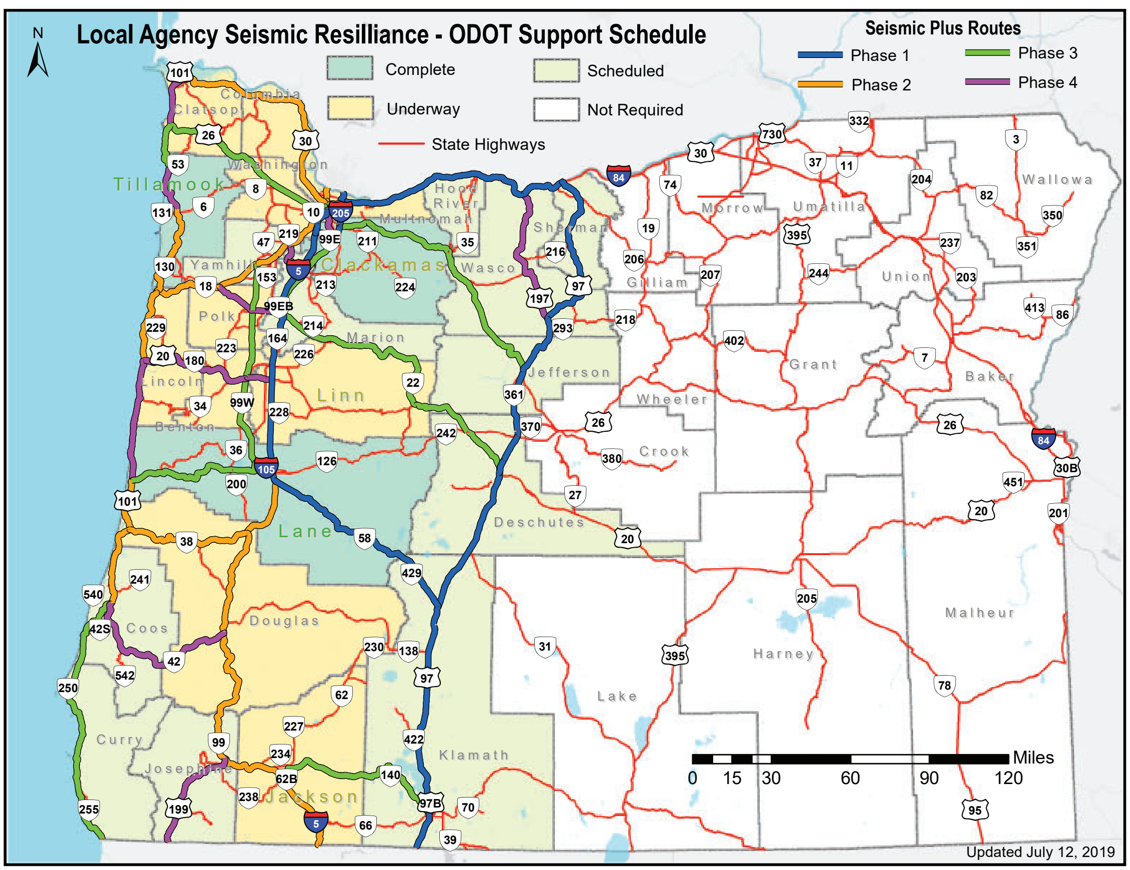
Bridge damage caused by historic earthquakes. Photos courtesy of USGS.

Local Agency Seismic Resilience Support

The Bridge Seismic Standards Engineer and other ODOT leadership, is working collaboratively with Oregon counties to develop planning reports documenting county routes and priorities for seismic resiliency. ODOT provides bridge data and technical support and the counties provide information about their network. While the information is useful for county planning, a comparison can be made to the state seismic bridge priorities to determine possible state highway detour routes that may be more cost effective to seismically retrofit or replace. Eventually the planning reports may provide an opportunity for seismic resiliency funding from either state or federal funds.

The status of the Local Agency work is provided below and on the map.

Complete	Underway	Scheduled
Clackamas	Benton	Coos
Lane	Clatsop	Curry
Tillamook	Columbia	Deschutes
	Douglas	Hood River
	Jackson	Jefferson
	Lincoln	Josephine
	Linn	Klamath
	Multnomah	Marion
	Polk	Sherman
	Washington	Wasco
		Yamhill



5 Bridge Load Rating

Trucks continue to evolve to improve the efficiency of freight movement and emergency response. The result is modern trucks travelling over older bridges designed for much smaller loads. To ensure bridges can safely support the trucks, ODOT evaluates each bridge to determine the safe load capacity based on a load rating.

ODOT is currently including the Specialized Hauling Vehicles (SHVs), and Emergency Vehicles in all new load ratings. Due to the concentrated loading, it is expected that there will be a need in the near future to strengthen or place load restrictions on many state and local agency bridges.

Load Rating History

In Ohio in 1967, 46 people died as a result of a bridge collapse. An investigation identified issues with the bridge design, materials used, poor maintenance and that the bridge was carrying heavier loads than designed for. The tragic event prompted the federal government to pass the 1968 Federal-Aid Highway Act that included the National Bridge Inspection Standards (NBIS) for bridge inspection and load rating. The legislation has evolved over time and was updated in 1978. To comply with the legislation, ODOT has been developing load ratings for all National Bridge Inventory (NBI) bridges since 1978.

Bridge Load Rating Basics

The capability of a bridge to carry loads is determined through the Load Rating analysis. The analysis calculates Rating Factors (RF) at many points to determine the bridge's weakest member. A Rating Factor is simply the ratio of the load the bridge can carry to the load produced by the vehicle considered.

The load capacity of a bridge takes into account the following factors:

- The weight of the bridge since the bridge must hold itself up,
- The bridge configuration like length of the bridge spans,
- The strength of the concrete, steel, or timber that was used to construct the bridge,
- The bridge condition – are steel members corroded or damaged? Is the concrete cracked? Are portions of the timber decayed?

Using the bridge related factors identified above, different truck loading configurations are evaluated. The analysis is based on the national Bridge Formula established in 1975 to limit the weight-to-length ratio of a vehicle. There are four categories of loads evaluated that cover different truck configurations.

Legal Loads
(includes SHVs)

Common semi-trucks, construction and waste management trucks with short wheel bases (SHVs)

≤80,000 lbs GVW

Continuous Trip Permits

Log trucks, milk tank trucks

≤105,500 lbs GVW

Single Trip Permit Loads

Non-divisible loads like vehicles hauling wind mill components; self-propelled cranes

Variable weights

Emergency Vehicle Loads

Fire trucks and other vehicles equipped to mitigate hazardous situations

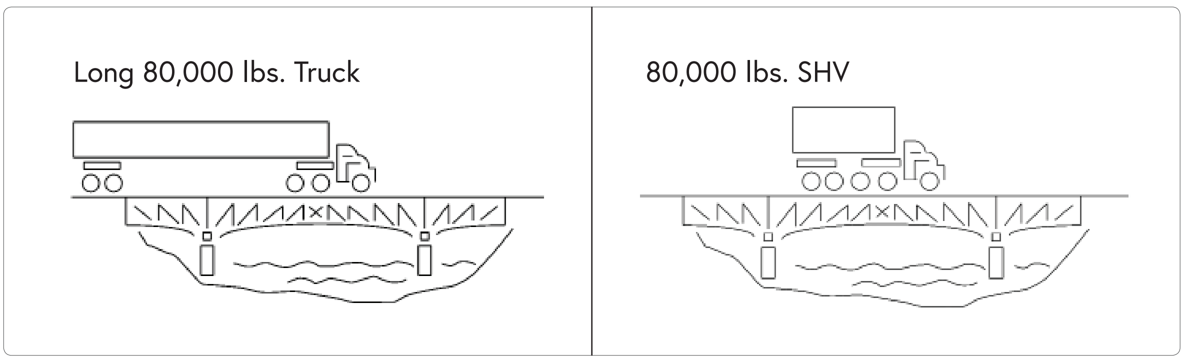
Up to 86,000 lbs GVW with short wheel bases that create highly concentrated loads

Concentrated Loading from SHVs and EVs

As trucks grew heavier in the 1950's and 1960's, something had to be done to protect bridges. The solution was to link allowable weights to the number and spacing of axles with limitations established by the Bridge Formula. Limiting the weight-to-length ratio of a vehicle crossing a bridge is accomplished by either spreading the weight over additional axles or by increasing the distance between axles. One unintended consequence of the Bridge Formula is a new class of trucks that are called Specialized Hauling Vehicles (SHVs). These trucks are a single-unit with many axles spaced closely together to comply with the requirements of the Bridge Formula.

Specialized Hauling Vehicles (SHV)

As shown in a FHWA publication on the Bridge Formula (excerpt shown below), the loading on bridges can be considerably more for an 80,000 pound Specialized Hauling Vehicle than for an 80,000 pound semi-truck.



The national concern with SHVs resulted in the requirement to update all load ratings to include these vehicles. While this effort was underway, the loading on bridges due to emergency vehicles was also identified as a concern.

The firetruck shown on the next page provides an example of an emergency vehicle of concern. The weight on the two rear axles of this firetruck is equal to the weight that a dump truck carries on five axles that are spread over 22 feet. Not only is this loading much more concentrated than the SHVs, it is almost twice the concentrated load that was used to design the Interstate Era bridges built in the 1950's and 1960's.

It Gets More Complicated

The load ratings for the majority of Oregon bridges need to be updated due to the changes in vehicles, and also to use the current method for analysis.

Firetruck (Emergency Vehicle)

The engineering aspect of an analysis can be complicated. In some cases, the plans for older bridges are not available. Instead of being archived, they may have been placed in an unknown location, or inadvertently discarded as office locations and personnel changed. The challenge is that bridge details like the location of reinforcing steel is not known so a load rating is assigned based on the condition and length of the bridge spans.

Another complication can be that a basic analysis may show the need for load posting or strengthening when the bridge shows no signs of distress. For these situations, a load rating using more advanced analysis is done to determine the strength of the bridge. If the load rating for a bridge in good condition still shows the need for load posting or strengthening, material testing or an on-site load test may be performed to determine the strength of the bridge.

What happens when a bridge can't carry the truck load?

Oregon's economy depends on goods being moved efficiently and communities depend on emergency vehicles having ready access so every effort is made to ensure bridges are safe and reliable. If a load rating indicates that one or more loads exceed the bridge capacity, ODOT uses the Under Capacity Resolution Process to address the load rating. Actions include:

- Coordination with local agencies, the freight industry, stakeholders including FHWA;
- Monitoring by the Region Bridge Inspector (if not already begun);
- Review of the impacts of a load restriction, and alternate routes;
- For state owned bridges, assembly by ODOT maintenance of a response team to generate an action plan;
- If the bridge cannot be restricted, a bridge crew is mobilized to complete repairs or a contract is prepared to either repair or replace the bridge, depending on timing and overall needs.

Previously, if there was no readily available means to address the load rating, ODOT had 90 days to resolve the load capacity issue. If there was no resolution after 90 days, when the load capacity was less than legal loads, a load posting sign was added at the bridge. For other types of loads, Motor Carrier managed the notifications.

The process listed was recently changed as the FHWA updated the time requirement for installing load posting signs. Starting on October 1, 2019, load postings are to be made as soon as possible but no later than 30 days after a load rating identifies the need for posting.

Van Buren Bridge (Corvallis) load posting sign.

2019 TUNNEL DATA

Oneonta Tunnel following the 2017 Eagle Creek Fire

Tooth Rock Tunnel being inspected following the 2017 Eagle Creek Fire

Keeping ODOT tunnels functioning with regular monitoring and timely maintenance is critical to ensure safe passage for all users. In addition, minimizing tunnel closures is critical to prevent hardship for the travelling public in the area served by the tunnel.

ODOT manages nine state-owned vehicular tunnels and is responsible for all inspection, maintenance, and major rehabilitation of the structures. ODOT also provides inspection of two pedestrian tunnels that were formerly vehicular tunnels and starting in 2017, five vehicular tunnels owned by other road agencies.

Inspections have been performed on ODOT tunnels for more than 20 years based on the National Bridge Inspection Standards (NBIS), modified by Oregon DOT Tunnel Inspection Procedures. Under the ODOT program, tunnels were on a two-year regular inspection cycle, with in depth inspections on a 10-year cycle and drainage inspections each year by the ODOT district maintenance crews.

New National Tunnel Inspection Standards (NTIS) Implementation

Federal Highway Administration (FHWA) guidelines require state DOTs to follow the new National Tunnel Inspection Standards (NTIS) for the inventory, inspection and load rating of tunnels. ODOT is annually required to provide a snapshot of Oregon tunnel conditions to the FHWA.

The data provided in the following table is based on the new NTIS standards. As a result of updating to the new standards, ODOT has developed a revised assessment of the structural condition for the tunnels.

Putting the element condition information together to determine the overall tunnel condition (good, fair or poor) provides a new challenge as there is no established national standard. The old method of rating generally considered one tunnel element, the liner. With the new NTIS implementation additional elements are individually assessed like ceiling slab, anchors, ceiling girder, wearing surfaces, etc.

To classify the tunnel condition with the updated Oregon data, ODOT borrowed a bridge condition parameter termed Health Index (HI) with values ranging from 0 to 100. The HI, in general, incorporates the condition of each element with a weighted average based on the importance of the element to the tunnel and the unit of measurement. The 2019 tunnel condition information reported is based on the updated HI method calibrated with a general assessment of the tunnel conditions and engineering judgement.

Tunnel near Bonneville, 1937

Salt Creek Tunnel

TUNNEL CONDITIONS AS OF June 2019

Region	District	MP	Tunnel	Tunnel Name	Year	Length, ft	Materials	Condition	Owner/Notes
1	22	73.5	09103	Vista Ridge Tunnel, Hwy 47 EB	1969	1002	Reinforced Concrete	Good	ODOT
1	22	73.6	9103B	Vista Ridge Tunnel, Hwy 47 WB	1970	1048	Reinforced Concrete	Good	ODOT
1	23	41.2	04555	Tooth Rock Tunnel, Hwy 2 EB	1936	827	Reinforced Concrete	Fair	ODOT
1	23	20.2	20318	Oneonta Tunnel (Bike/Ped), Hwy 100 at MP 20.15	2008	115	Shotcrete	Closed	ODOT (Pedestrian traffic only)
2	01	35.7	02247	Arch Cape Tunnel, Hwy 9	1937	1228	Shotcrete/ Concrete	Good	ODOT
2	01	40.9	02552	Sunset Tunnel, Hwy 47 (Dennis L Edwards Tunnel)	1940	772	Shotcrete/ Concrete	Good	ODOT
2	05	56.1	02539	Salt Creek Tunnel, Hwy 18	1939	905	Reinforced Concrete	Fair	ODOT
2	05	178.5	03961	Cape Creek Tunnel, Hwy 9	1931	714	Shotcrete/ Concrete	Fair	ODOT
2	05	19.7	07139	Knowles Creek Tunnel, Hwy 62 at MP 19.68	1958	1430	Reinforced Concrete	Good	ODOT
3	07	39.8	03437	Elk Creek Tunnel, Hwy 45	1932	1090	Shotcrete	Good	ODOT
4	09	56.0	00653	Mosier Tunnels	1920	369	Shotcrete	Good	ODOT (Pedestrian traffic only)
Other Agency Tunnels			51C26	W Burnside Tunnel	1940	230	Reinforced	Fair	PDX
			51C32	Rocky Butte Tunnel	1939	400	Reinforced Concrete	Fair	PDX
			25B125	Cornell Tunnel #1, NW Cornell Rd	1940	497	Reinforced Concrete	Fair	PDX
			25B127	Cornell Tunnel #2, (W), NW Cornell Rd	1941	247	Reinforced Concrete	Fair	PDX
			22476	Owyhee Tunnel, Owyhee Lake Rd	1929	200	Rock	Fair	Malheur County

2019 OREGON TRANSPORTATION ASSET MANAGEMENT PLAN: Bridge Information

As part of a federal requirement, each state department of transportation is required to develop an asset management plan for the National Highway System (NHS) to improve or preserve the condition and performance of the system. In addition, ODOT chose to include analyses beyond the NHS routes. The plan was submitted to FHWA in June 2019 for review and certification. The full content of the plan can be found at ODOT_TAMP. The following section includes a portion of the information related to bridges and projected conditions.

Bridge Conditions Overview

Bridges on Oregon's state and national highway systems face a number of complex factors that affect condition. These include, but are not limited to:

- Construction defects;
- Increased deterioration due to winter maintenance;
- Potential for reductions in bridge maintenance and rehabilitation funding to address capacity needs;
- Potential that funding will be needed to strengthen bridges for emergency vehicles which will reduce the funding available for rehabilitation and replacements;
- Increased deterioration from increases in truck sizes and weights;
- Bridge hits.

In addition to the factors listed, the bridge system continues to age. The average age of all bridges in the inventory is 48 years. Also:

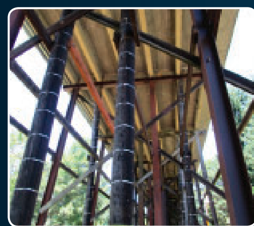
In 2019, over 1500 bridges are at the end of their design life.

By 2029, nearly 500 bridges will be at or nearing the end of their service life.

While bridges on the NHS system are generally newer than those on the total state system, NHS bridges are impacted by higher traffic volumes and heavier truck loads.

Within the population of aging bridges, many bridges on Oregon's highway system require constant attention due to the construction materials, the location, and/or the significance of the bridge. These bridges often are the most expensive to maintain and require regular maintenance.

More than 600 bridges in the inventory (about 22%) fall into one of the following categories shown in the figure below. Programming work for these bridges in addition to other high priorities adds to the complexity of managing a diverse bridge system.



483 Poor Detail Bridges

216 Timber Bridges

94 Historic Bridges

19 Border Bridges

Poor Detail Bridges: Bridges identified in the State Bridge Inventory that have critical design issues related to rail, decks, and reinforcement locations. Bridges with poor details have a higher incidence of shear cracking that may grow rapidly, holes in thin bridge decks developing without warning, low reserve load capacity, and instability during seismic events.

Timber Bridges: Bridges with one or more timber elements including piles, decks, girders, stringers, pier caps, etc. Typically, bridges with timber piles are the most problematic.

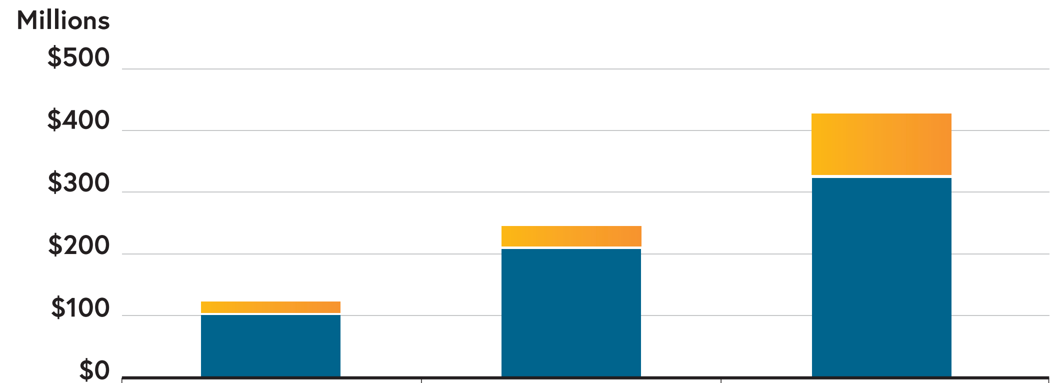
Historic Bridges: Bridges either on the National Register of Historic Places or Eligible for the National Register of Historic Places. An additional 45 bridges may be eligible following further investigation.

Border Bridges: Bridges connecting Oregon with Washington or Idaho.

Bridge Funding Gap Analysis

Using 2018 data, an analysis was done to determine the funding needed to maintain current bridge conditions and to reach a Desired State of Good Repair (DSOGR) based upon the Oregon Transportation Commission Investment Strategy available at OTC_Investment_Strategy. The results shown in the figure on the next page compare current funding with the funding needed to maintain or improve conditions.

Funding Scenario Annual Needs Estimate



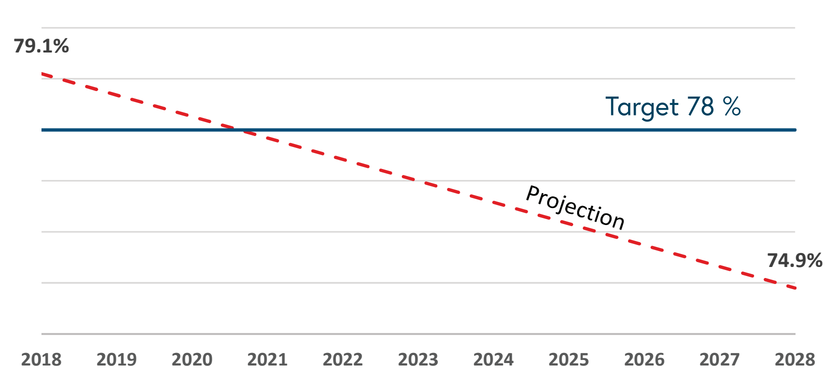
	Current Funding	Maintain Current Conditions	Desired State of Good Repair
Non-NHS	$11,000,000	$39,000,000	$96,000,000
NHS	$101,000,000	$219,000,000	$339,000,000

The analysis confirmed that the bridge program is significantly underfunded to even maintain current conditions. While NHS bridges need more than double the funding available to maintain current conditions, the non-NHS bridges need three and a half times the current funding available.

Bridge Key Performance Measure Projection

An analysis was performed to project the Bridge KPM (percent of bridges not distressed) over the next 10 years with current funding. As noted below, the HB 2017 funding is expected to slow the decline of the % Not Distressed bridges; however, this decline will continue under the latest funding projections. The decline in the Bridge KPM is primarily due to the aging bridge system and a long history of lack of funding for bridge replacements.

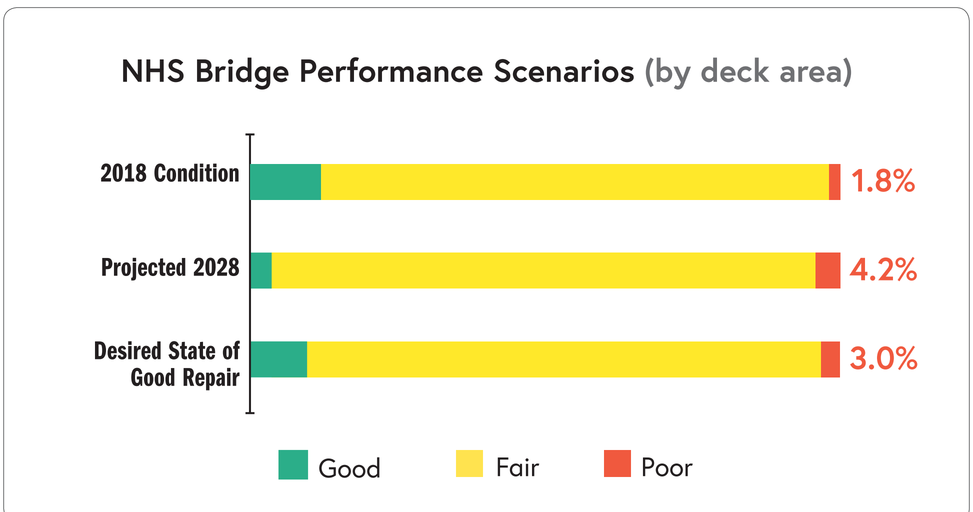
Projected Bridge KPM (percent by count)



Bridge Performance - National Performance Measure Metrics

As shown in the graph, NHS bridge condition projections indicate the percentage of *bridges in good condition will continue to decline* even with the new HB 2017 funding. By 2021 the percentage is predicted to dip below the Desired State of Good Repair, which has been established to be 10%. Given the age of Oregon's NHS bridges, the decline is inevitable as bridge replacement is taking place at a much slower rate than the decline in conditions. Bridge preservation or rehabilitation actions generally cannot raise a bridge rating from a fair condition to a good condition. Bridge replacement, by contrast, is the primary action that results in a good rating. In addition, there is a recent trend showing that new bridge decks are slipping from good to fair much earlier than expected, which reflects a construction quality issue in concrete mixtures and placement.

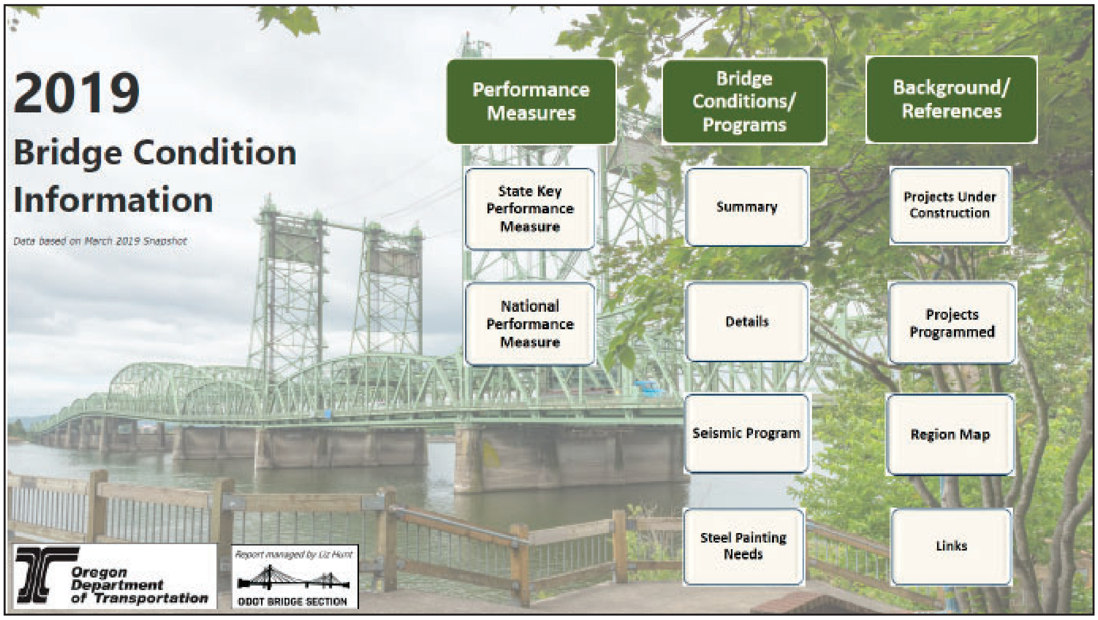
Projections for the percent of bridges by *deck area becoming poor shows a steady increase* in the next 10 years. However, HB 2017 funding is projected to slow this increase. By 2028, the percentage is predicted to exceed the Desired State of Good Repair, which has been established at 3%.



The increase in poor bridge conditions is expected to be managed with the use of Major Bridge Maintenance (MBM) funding which addresses the immediate repairs needed to keep an at-risk bridge from being classified as poor, as well as the prioritization of bridge work on Fix-It corridors. The strategy of relying on MBM, continually increases the number of bridges with repairs that have a higher risk of additional deterioration and the need for future emergency actions to preserve public safety. As the number of bridges with less than optimal repairs and less predictable conditions grows, overall risks of bridge load restrictions and closures will increase.

> **"AS AGING BRIDGES DETERIORATE, CONDITIONS BECOME LESS PREDICTABLE INCREASING THE RISKS OF LOAD POSTINGS AND CLOSURES."**

Top: Newly constructed Siuslaw River Bridge, 1936.
Bottom: Recently rehabilitated Siuslaw River Bridge, 2019.



More information is available online through the *2019 Interactive Bridge Condition Report.* The report includes detailed bridge condition information by Region, County, District and Route with tables and an interactive map. The front page of the report is shown above.

Oregon Department of Transportation

2019

Bridge Condition Report & Tunnel Data