Asset Management: Bridge Assessment Annual Report

Bridge Condition Ratings

Bridge Preservation Highlights

- For FY 2010, 98% of WSDOT's bridges are in good or fair condition.
- WSDOT's bridge inventory increased from 3,630 to 3,658 total structures between FY 2009 and FY 2010.
- The contract for the replacement of the SR 303 Manette bridge in Bremerton was awarded in July 2010.
- WSDOT has 12 "load posted" and 129 "load restricted" bridges as of June 30, 2010.
- WSDOT painted 5 steel bridges since July 2009; 92 steel bridges are due or past due for repainting.
- More than 1,200 sign support structures are past due for inspection.
- WSDOT's Bridge Office has begun inspecting radio tower structures for the Facilities Office.

WSDOT is responsible for managing state-owned bridges and related structures on state routes. These bridges carry a wide variety of freight and goods and allow the public to commute to work and to travel safely all across Washington. Over the years, WSDOT vehicular bridges have been constructed using a variety of materials including timber, steel, and concrete. The current number of bridges, by type of material each is built from, is summarized in the table below. Nearly 78% of WSDOT bridges are built using standard reinforced concrete and prestressed concrete, with about 22% made of steel. Only a small percentage of timber bridges are still in service. An inventory of all WSDOT bridges and structures is on page 13.

WSDOT bridges by construction material

Vehicular bridges greater than 20 feet long

	Number	Total deck area (in square feet)	Percent of total
Standard concrete	1,243	15,373,037	34.2%
Prestressed concrete	1,388	19,281,322	43.0%
Steel	315	9,982,703	22.3%
Timber	85	238,343	0.5%
Total	**3,031**	**44,875,405**	**100%**

Data source: WSDOT Bridge and Structures Office.

Bridge condition update: 98% of WSDOT bridges in good or fair condition

In monitoring bridge condition, WSDOT classifies bridges as good, fair, or poor, using the National Bridge Inspection Standards (NBIS) bridge superstructure and substructure codes as the performance measure, because they provide the best direct means to assess the structural condition of the bridge. Each year, WSDOT reports on the condition of its bridges to Washington's Office of Financial Management in accordance with reporting standards set by the Governmental Accounting Standards Board (GASB). The Governor's Government Management Accountability and Performance (GMAP) goal is to maintain 97% of all bridges statewide at a rating of good or satisfactory (fair). This measure is consistent with data provided in the Comprehensive Annual Financial Report (CAFR).

For FY 2010, 90% of WSDOT bridges were in good condition and 8% were in fair condition, meeting the governor's goal. Roughly 2% of bridge structures (2.1%) had a condition rating of poor, a decrease compared to FY 2009 (2.5%). No bridge that is open to traffic and rated as poor is unsafe for public travel. Another way to look at bridge condition ratings is by deck area, which shows 8.5% of WSDOT's bridges in poor condition, see page 13 for details.

Bridge structural condition ratings

Condition ratings by fiscal year (based on the number of bridges)

	Description	2005	2006	2007	2008	2009	2010
Good	A range from no problems to some minor deterioration of structural elements.	89%	88%	88%	88%	89%	**90%**
Fair	All primary structural elements are sound but may have deficiencies such as minor section loss, deterioration, cracking, spalling, or scour.	9%	9%	9%	9%	8%	**8%**
Poor	Advanced deficiencies such as section loss, deterioration, cracking, spalling, scour, or seriously affected primary structural components. Bridges rated in poor condition may have truck weight restrictions.	2%	3%	3%	3%	3%	**2%**

Source: WSDOT Bridge and Structures Office.

Bridge Inventory

On SR 539 Guide Meridian – Deer Creek culvert.

Bridge inventory increases during FY 2009

The number of vehicular bridges 20 feet or longer has increased from 3,023 to 3,031 since July 2009. This increase is primarily due to new bridges being built within the highway system. The number of pedestrian bridge structures has increased from 65 to 67. WSDOT has 21 ferry terminal locations, but for inspection purposes, 56 structures that carry vehicles and 15 that do not carry vehicles are also included in the inventory. The average age of all WSDOT vehicular bridges is 42 years, with 217 bridges that are 75 years old or older.

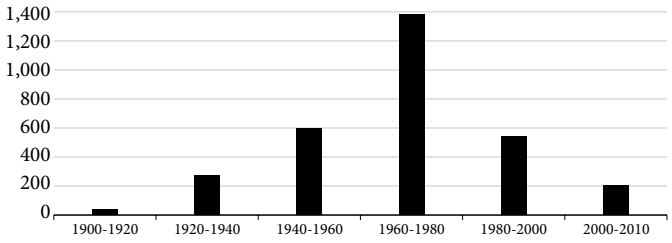
WSDOT inventory of bridges and structures
As of June 30, 2010

	Number	Square feet
Vehicular bridges greater than 20 feet long	3,031	44,875,419
Structures less than 20 feet long	346	n/a
Border bridges maintained by the border state*	6	n/a
Culverts greater than 20 feet	97	n/a
Pedestrian structures	67	309,773
Tunnels and lids	40	n/a
Ferry terminal structures	71	819,726
Buildings (I-5 Convention Center)	1	n/a
Railroad bridges	5	n/a
Totals of all structures	**3,658**	**45,885,253**

Data source: WSDOT Bridge and Structures Office.

*Note: The total number excludes bridges maintained by border states.

Summary of Washington bridges by year built
1900 – 2010



Data source: WSDOT Bridge and Structures Office.

Bridge preservation program aims to maintain a safe bridge network through cost-effective actions

WSDOT's bridge preservation program consists of categories of work that ensure state-owned bridges remain safe and operational. Inspections are performed by trained WSDOT inspectors. Bridge preservation work is normally designed by engineers in the Bridge and Structures Office and then advertised for contractors to bid on and construct. State maintenance crews also complete some types of repairs to preserve the state's bridge network. Preservation activities include:

- **Inspection** – Perform Federally required inspections on state-owned bridges and structures.
- **Asset management** – Identify, prioritize, and plan to address the work required to preserve the bridge and structure network based on review of the inspection data.
- **Replacement and rehabilitation** – Rehabilitate and replace bridges when needed. Repair deteriorated bridge elements such as concrete columns, expansion joints, or anchor cables.
- **Preservation** – Extend bridge service life by repainting steel structures; also repair and overlay concrete bridge decks.
- **Risk reduction** – Seismic retrofit of bridges and scour repair of bridge piers in rivers proactively minimizes damage to bridges due to earthquakes and flooding.

Bridge condition ratings by deck area show 8.5% of WSDOT bridges in poor condition

A different way to look at bridge condition ratings is by deck area rather than by the number of structures. Currently there are 68 bridges, 2.1%of the total inventory, or 8.5% of the total deck area rated in poor condition.

For fiscal year 2010, while the number of bridges in poor condition has declined, the percentage of total deck area in poor condition has increased 2.8% compared to fiscal year 2009.

Bridge structural condition ratings by deck area
2007 - 2010

Year	Number of bridges	Deck area (in square feet)	Percentage of deck area in poor condition
2010	68	3,821,066	8.5%
2009	78	2,554,872	5.7%
2008	94	2,245,235	5.1%
2007	82	2,609,176	5.6%

Data source: WSDOT Bridge and Structures Office.

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Bridge Inspections

Bridge inspection program helps WSDOT manage bridge assets

Inspecting the state's bridges and structures is vital to ensure public safety, determine the condition of the asset, and to provide a basis to determine future maintenance and preservation needs. The Federal Highway Administration (FHWA), WSDOT, and cities and counties work together to ensure the quality of inspections. Joint agency bridge inspection classes are available each year to train and update bridge inspectors. The FHWA also conducts National Bridge Inspection (NBI) quality assurance inspection reviews of a few local agencies one week each year.

About 60 WSDOT engineers and support staff, including specialized teams, support the inspection of state-owned bridges and structures. The latter includes elements along state highways such as pedestrian bridges, short span bridges and culverts (less than 20 feet long), sign support (cantilever and sign bridges), high mast luminaires, ferry terminals, and – new for 2010 – radio towers, previously the responsibility of WSDOT's Facilities Office.

Bridge deck inspections by video camera

In FY 2010, WSDOT performed bridge deck inspections on 51 bridges using a specialized van from the agency's Materials Lab. Engineers review the footage captured by three cameras mounted on the van to give forward and shoulder views and two Linescan instruments that use laser pointers to render images of the pavement view. This information is combined with inspection notes on the other parts of the bridge. This process minimizes traffic lane closures, reducing the risk of injury to inspectors and the traveling public. The FHWA allows video bridge deck inspections if the bridge averages more than 10,000 vehicle crossings daily; it must also be physically inspected every six years.

US101 Simpson Ave bridge near Hoquiam closed following in-depth inspections

The 83-year-old bridge carries 15,000 vehicles a day over the Hoquiam River. In late July, 2010, WSDOT engineers observed excessive movement in the bascule span that opens for marine traffic. Commercial divers from NW Underwater Construction were hired to perform an in-depth underwater inspection of the Pier 2 foundation. It was found that scour and marine borers had caused severe deterioration to 77 of 176 timber piles supporting the bascule span, compromising the bridge's structural integrity.

The bridge was closed on August 5th and traffic has been detoured to the Riverside Bridge, which has been reconfigured to accommodate two-way traffic. Short-term temporary repairs using cables to anchor the pier to new piles installed behind the bascule pier will help stabilize the bridge but will not provide enough support to re-open the bridge to traffic. A permanent repair solution is being designed and repairs allowing for the bridge to be opened to traffic are expected to be complete in November 2010. Ongoing work to fully implement the repairs will occur over the next year.

Nearly 2,000 bridge inspections scheduled for 2010

For 2010, The Bridge and Structures Office has scheduled 1,949 bridges to be inspected. Under bridge inspection trucks (UBIT) will be required on 381 of those inspections. WSDOT will perform 192 inspections for local agency-owned bridges. Additionally, there are 74 underwater dive inspections planned for this year. An emerging issue for inspections is the need to obtain temporary lane restrictions to perform the inspections. This has created a backlog of 1,200 sign support structures that are now past due for inspection and will not be inspected in 2010. This backlog is estimated to cost about $2.4 million, the average cost for a sign support structure inspection is about $2,000.

Asset management: a tool to document WSDOT's bridge and structure conditions

Asset management is an important activity for WSDOT's bridge program. It is used to document the number of bridges and structures within the state's highway network, determine their conditions, and forecast their preservation needs along with the cost to preserve them for future generations. WSDOT bridge engineers review bridge inspection data and develop a prioritized list of needs used to build funding plans for the two, 10, and 20 year periods.

Bridge Replacement and Rehabilitation

Replacement and rehabilitation

The bridge preservation program (also known as P2) includes funding for the replacement and rehabilitation of selected bridges. To qualify for federal funds for replacement, a bridge must have a sufficiency rating of less than 50 and be classified as Structurally Deficient (SD) or Functionally Obsolete (FO). For rehabilitation, the criteria is similar except the sufficiency rating must be less than 80. (Definitions of SD and FO are available in the June 2009 *Gray Notebook* 34, page 22).

WSDOT mainly considers those bridges with a sufficiency rating less than 50 and classified as SD when prioritizing future replacement candidates. As of June 30, 2010, 142 bridges more than 20 feet long are classified as SD, roughly 4.7% of the total inventory of bridges over 20 feet. About 40 of these bridges are considered good candidates for future replacement.

FHWA reports that amount of structurally deficient deck area in Washington is growing

According to FHWA's inventory of over 7,000 bridges in Washington, which includes both state and local agency owned structures, 405 or 5.3% of the total were classified as structurally deficient in 2009. These 405 structurally deficient bridges make up approximately 8.5% of the bridge deck area in the state. Between 2007 and 2009 the percentage of structurally deficient deck area has increased by 1%.

FHWA inventory of structurally deficient (SD) bridges
For Washington, 2007 – 2009

	Number of SD bridges	SD deck area (in square feet)	Percentage of SD deck area
2009	405	576,246	8.5%
2008	422	548,544	8.2%
2007	400	502,030	7.5%

Data source: WSDOT Bridge and Structures Office, FHWA.

$140.9 million to be used to address bridge rehabilitation and replacement in the 09 - 11 biennium

The 2005 Transportation Partnership Account (TPA) funding package included funding for the replacement of 20 bridges and the SR 104 Hood Canal bridge. To date, five of these TPA-funded bridges and the east half of the Hood Canal bridge have been replaced, two bridges have been rehabilitated, and five bridges are under contract. Twenty-five additional bridges identified and prioritized for replacement or rehabilitation will be paid for with pre-existing funds. This list of bridges was prioritized based on their traffic volumes, structural condition, and any load restrictions in place. The bridge replacement and rehabilitation budget for the 2009-2011 biennium is $140.9 million.

Five bridge replacement projects now under contract

P2–funded bridge replacement projects under contract include:

- US 12 Tieton River bridges No 1 and No 2 (near Naches)
- SR 27 Pine Creek (near Palouse)
- SR 303 Manette Bridge (Bremerton)
- SR 525 Ebey Slough Bridge (near Marysville)
- SR 532 Gen Mark W. Clark Bridge (near Stanwood)

WSDOT received $17 million to address bridge repairs

The major repair category of the bridge preservation program includes corrective work that cannot be accomplished within typical maintenance programs and must be done through contracts. This work addresses a specific bridge element in need of repair and is not intended to upgrade all deficiencies to current standards. The most common types of repairs include: expansion joint replacement, concrete column repair, floating bridge anchor cable replacement, and bridge rail replacement.

A prioritized list of major repair needs for bridges is developed each biennium. If an unexpected problem arises on a bridge that needs to be repaired as soon as possible, an emergency contract may be needed. WSDOT has been provided $17 million for the 2009-2011 biennium to address repair needs; most of the funds will be used on the I-90 Homer Hadley floating bridge, to replace expansion joints and selected anchor cables, and the SR 520 Evergreen point floating bridge, to replace selected anchor cables. The total list of bridge repair needs has 90 items and is estimated to cost nearly $100 million. With a budget of $17 million per biennium it will take WSDOT about 12 years to complete all the work on this list.

SR 532 – General Mark W. Clark Bridge, in Stanwood. This aerial picture is of the new bridge that WSDOT began constructing in 2009 to replace the old bridge that was built in 1949.

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Bridge Preservation

Floating bridges and anchor cables

WSDOT operates and maintains four concrete floating bridges which includes the world's longest span on SR 520.

Each floating bridge is held in place through a series of anchor cables. WSDOT schedules replacement of cables either if a dive inspection finds significant corrosion or after 30 years of service. Additional cable replacements are scheduled within the next four years.

Floating bridge anchor cable counts

	Total number of cables	Number replaced in 2010	Planned to replace in 2013-15 biennium
I-90 Lacey V Murrow	56	0	10
I-90 Homer Hadley	53	10	10
SR 104 Hood Canal	44	0	18
SR 520 Evergreen Pt.	58	15	0

Data source: WSDOT Bridge and Structures Office.

Steel bridge painting

WSDOT owns 279 existing painted steel bridges that require routine painting. WSDOT also shares painting costs for bridges on the Oregon and Idaho borders. Protective paint coatings on steel bridge elements are essential to prevent corrosion and extending the service life. Bridge painting is likely to be a major project with significant costs due to the complexity of safety, environmental, and containment system requirements. Bridge inspection data is used to determine the condition of the paint coatings on steel bridges. During routine bridge inspections, the inspectors visually rate the condition of the paint; if 2% or more of the steel area is no longer covered by paint, the bridge is programmed for repainting, which is typically every 15 to 20 years. The original paint system on new steel bridges can last 30 to 40 years before it needs to be repainted.

Existing paint systems too old and brittle for overcoating, full paint removal now required

Nearly all of the bridges on WSDOT's future paint list will need full paint removal, because most have been overcoated three or more times and the existing paint systems are now old, brittle, and no longer a good base for new paint. Full paint removal requires the construction of a containment system around the bridge to to keep old paint and the abrasive material used to remove it from entering the wider environment. An emerging issue is how to balance the added weight of the containment system with the need to maintain traffic across the bridge.

WSDOT painted five steel bridges in 2009 and 2010

There are 94 WSDOT steel bridges either due or past due for painting. WSDOT painted five bridges in 2009 and 2010, and shared the expense of painting portions of the US 101 Astoria Bridge and the SR 433 Lewis and Clark bridge. The final phase on the Lewis and Clark bridge – painting the main truss – was awarded in June 2010 for $33.7 million.

Status of WSDOT steel bridge painting needs

	Number of bridges	Cost to repaint
Past due for painting	29	$142 million
Due for painting	65	$184 million
Not due for painting	183	$367 million

Data source: WSDOT Bridge and Structures Office.

Steel bridge painting

SR 542 Nooksack River – Crews have more than half of the containment system required to complete the bridge painting in place.

SR 433 Lewis and Clark – The containment area during Phase 2 of construction to clean and paint the piers in the Columbia River and bridge towers on the Washington side.

I-5 Capitol Blvd. – A containment system in place so crews can repaint this busy bridge over I-5.

Bridge Preservation

Bridge deck repair and overlay

WSDOT has been working since the early 1980s on a systematic program to prevent concrete deck deterioration which is very costly to fix and can lead to significant disruptions to traffic during the repair process. New bridges, built after 1980, are constructed with epoxy-coated rebar that resists corrosion caused by winter de-icing salts. Bridge inspections identify pre-1980 bridges with deteriorated concrete deck areas so WSDOT can rehabilitate them by applying a concrete overlay.

WSDOT bridge by deck overlay material

Overlay type	Number of bridges	Deck area (square feet)	Repair cost (per square foot)	Percent of total
None - Concrete	1,301	19,898,238	$75	44.4%
None - Steel	5	37,351	$250	0.1%
Concrete	575	14,112,064	$75	31.5%
Asphalt	1,065	9,387,479	$25	20.9%
Polymer	85	1.402,097	$75	3.1%
Total	**3,031**	**44,875,405**		**100%**

Data source: WSDOT Bridge and Structures Office.

The average cost to repair and apply a traditional modified concrete overlay to a bridge deck is $75 a square foot. This is about 25% of the cost to completely replace a bridge deck or 10% of the cost to replace an entire bridge.

WSDOT will program a bare concrete deck for repair and overlay when 2% or more of the area is deteriorated or has previous maintenance repairs. Currently, 28 bridges with a concrete overlay have been added to a prioritized list for a new overlay in the future depending on funding.

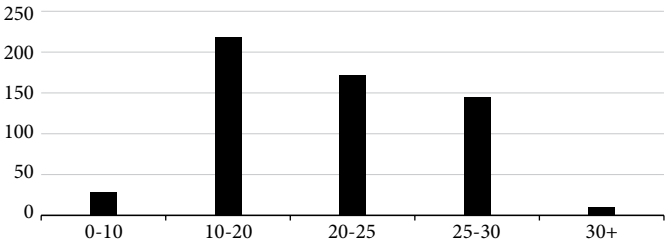
Modified concrete overlays are the primary overlay type used by WSDOT to rehabilitate concrete bridge decks: the first such repair was made in 1979. The average service life of a concrete overlay on bridges is about 25 years. It is very likely that more of these concrete overlays will require replacement in the future.

Bridges with asphalt deck overlay have traditionally been addressed within roadway paving projects. More of these bridges will likely need to be addressed in stand-alone projects since more roadway paving projects are now using bituminous surface treatments (BST's) which cannot be used on a bridge deck. Bridge decks require Hot Mix Asphalt (HMA) along with a membrane to provide a smooth ride surface and to protect the rebar in the bridge deck from winter deicing.

For the 2009-11 biennium, the concrete bridge deck rehabilitation budget is $5.3 million to repair and overlay five bridge decks; three are scheduled to go to contract in 2010. WSDOT has prioritized 62 bridges that need a future repairs and overlay at an estimated cost of $77 million.

WSDOT bridges: concrete overlay age

Number of bridges, by age in years



Data source: WSDOT Bridge and Structures Office.

WSDOT's local bridge program

WSDOT through the Highways and Local Programs division manages the Federal Aid Highway Bridge program for local agencies. The program follows policy guidance found in federal statute, Washington state legislation and the Washington Transportation Plan and provides approximately $35 million per year to local government for assistance in addressing our state's infrastructure renewal needs. Due to limited funding, only structures that are structurally deficient with low ratings are considered for replacement or rehabilitation. Seismic retrofit and scour repair projects are eligible as risk reduction projects and limited painting of steel structures is also funded to reduce the risk of further deterioration.

Local governments are responsible for the preservation of 3,960 bridges statewide. The condition ratings for FY 2010 are detailed in the table below.

Condition and inventory of city and county (local agency-owned) bridges in Washington

FY 2010

	County-owned	City-owned
Good	85%	79%
Fair	11%	14%
Poor	4%	7%
Total inventory	3,239	721

Data source: WSDOT Highways and Local Programs Office.

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Bridge Risk Reduction

Seismic retrofit of selected bridges and scour repair of bridge piers in rivers are proactive approaches to minimizing the risk of damage to bridges due to earthquake and flooding.

Seismic retrofit

The 2005 Transportation Partnership Account provided $87 million to retrofit high– and moderate–risk bridges in the Puget Sound area. The planned bridge seismic retrofit budget for the 2009-11 biennium is $38.2 million.

Bridge seismic retrofit status
FY 2010

Completely retrofitted	256
Partially retrofitted	139
Needs retrofitting	472
Under contract	13
Total	**880**

Data source: WSDOT Bridge and Structures Office.

WSDOT has collaborated with federal, state and local agencies to prioritize bridges in the Puget Sound region that require a seismic retrofit using a risk-based approach which incorporates WSDOT's strategic disaster response plan. The prioritization plan for the top eight lifeline route segments is shown in the table below.

Top 8 lifeline route segments

Priority	
1	Complete remaining bridges with single column piers in the Puget Sound vicinity
2	I-5 Ship Canal Bridge approaches
3	Bridges carrying I-5 traffic from Joint Base Lewis-McChord base to I-90 (mainline)
4	Bridges carrying I-5 traffic from Paine Air Field to I-90 (mainline)
5	Bridges over I-5 from Joint Base Lewis-McChord to I-90
6	Bridges over I-5 from Paine Air Field to I-90
7	Bridges on I-405
8	Bridges over I-405

Data source: WSDOT Bridge and Structures Office.

Bridge engineers will perform a seismic analysis of each bridge to determine the exact scope of the retrofit. The analysis looks at all the bridge elements above the foundations and compares the *capacity* of those elements to the forces applied by an earthquake (the *demand* placed on the structure). Generally, if the *capacity* to *demand* ratio is less than 1.0, then the bridge element is retrofitted. The most common type of retrofit of most bridges includes adding steel jackets around the columns and adding more concrete-and-steel reinforcing to the pier caps (also known as a "bolster"). WSDOT uses the American Association of State Highway and Transportation Officials (AASHTO) adopted 1,000 year return period (7% probability of exceeding in 75 years) to determine the forces (stress) the bridge must resist.

Scour mitigation

"Scour" is defined as the eroding away of the stream bed material from under bridge foundations. Scour generally happens when a river is experiencing high water flows. Nationally, as in Washington, more bridges have collapsed from the scour of bridge foundations than from any other cause (43 documented WSDOT bridges since 1923). There are:

- More than 1,500 WSDOT bridges and culverts longer than 20 feet in length are over water
- 318 WSDOT bridges and culverts longer than 20 feet are classified as "scour critical"

The term "scour critical" is used by the FHWA to classify those bridges with a calculated potential scour depth that is lower than the existing bridge foundations. WSDOT has developed a plan of action for each of these bridges. Once funding has been authorized for a repair, it generally takes two to four years to design a scour repair and obtain the environmental permits to complete a scour repair. The planned bridge scour repair budget for the 2009-11 biennium is $2 million. WSDOT completed one scour repair in the 2009-11 biennium and has six bridges under design for future scour repair.

SR 202 Tokul Creek Bridge emergency scour repair

The SR 202 Tokul Creek Bridge is just north of Snoqualmie Falls at milepost 24.55. Tokul Creek has eroded away the banks and could potentially affect the foundations of the bridge. If the bridge foundations become exposed, engineers may need to close the bridge to ensure public safety. On May 13, 2010, the Northwest Region Administrator signed a declaration of emergency summarizing the need to perform a scour repair prior to potential flooding in winter 2010/spring 2011. WSDOT is working with resource agencies to allow a scour repair to be completed in the fall of 2010.