COLUMBIA RIVER BRIDGE AT GRAND COULEE DAM **HAER No. WA-102**
State Route 155 spanning the Columbia River
Coulee Dam
Okanogan County
Washington

HAER
WASH
24-COUDAM,
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WRITTEN HISTORICAL AND DESCRIPTIVE DATA

PHOTOGRAPHS

HISTORIC AMERICAN ENGINEERING RECORD
NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR
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COLUMBIA RIVER BRIDGE AT GRAND COULEE DAM

HAER No. WA-102

Location:	State Route 155 spanning the Columbia River below Grand Coulee Dam, between Okanogan and Grant counties, beginning at mile point 28.26, Washington UTM: 11/351980/5314160 11/352300/5314180 Quad: Grand Coulee Dam, Wash.
Date of Construction:	1935
Engineer:	Washington Department of Highways, R. W. Finke; and the U.S. Bureau of Reclamation, A. F. Walter and H. R. McBirney
Fabricator:	J. H. Pomeroy Company of San Francisco, steel construction; Western Construction of Spokane, pier excavation and concrete construction
Owner:	1935-59: U.S. Bureau of Reclamation. 1959-present: Washington Department of Highways, since 1977 Washington State Department of Transportation, Olympia, Washington.
Present Use:	Vehicular and pedestrian traffic
Significance:	The U.S. Bureau of Reclamation constructed this structure as part of the Grand Coulee Dam--Columbia Basin Reclamation Project. It is a good example of 1930s steel cantilever bridge design in Washington, and one of the state's collection of cantilever bridges on the Columbia River system.
Historian:	Robert W. Hadlow, Ph.D., August 1993

History of the Bridge

Washington and the United States Bureau of Reclamation constructed the Columbia River Bridge at Grand Coulee in the mid-1930s to provide a crossing for trucks used in the Grand Coulee Dam construction and as part of the growing highway network in the central part of the state. Ferry travel across the Columbia River was common at many points, especially for transporting livestock from pastures on one side to markets on the other. There were few roads in the Grand Coulee region and no regular ferry service across the Coulee until 1921 when increased automobile traffic prompted Grant County to establish one. Previously, travellers crossed the river to the west at Condon ferry or from other points in the Bridgeport region.[1]

United States President Franklin D. Roosevelt, in 1933 saw the Grand Coulee Dam--Columbia Basin Reclamation Project as a means to revitalize the Pacific Northwest's economy, while at the same time harnessing the river's raw power for electricity and irrigation. Construction began on what was then the largest and second tallest dam in the world. It was a Public Works Administration (PWA) project, with thousands of workers and their families swelling the towns along the Columbia River's lower Grand Coulee in 1934 to construct the 550' high, 4,173' long reinforced-concrete gravity dam. It was completed in 1942. Construction costs totaled $300 million. In 1992 it produced over 19 billion kilowatt hours of electricity. It also has the capacity to provide water for 1.2 million acres in the Columbia Basin Reclamation Project.[2]

Franklin D. Roosevelt travelled to the dam site on a hot August day in 1934 to formally dedicate the project as part of his New Deal's public works program for economic recovery. He journeyed over hastily oiled roads and, to the disapproval of the Secret Service, crossed the Columbia on the local rickety ferry at Grand Coulee, the *Chief,* to reach the construction site. Less than two months later, work began on three bridges down river from the dam site that played important roles in the structure's completion.[3]

The contractor, Mason-Walsh-Atkinson-Kier Company (MWAK) required a temporary wooden bridge just below the dam site to carry building supplies north and east of the river to erect the company town, Mason City, for its workers. Its total construction time was just two and one-half weeks. The project needed a permanent railroad bridge. Made from wooden Howe trusses, it also functioned temporarily as a motor vehicle structure.[4]

The highway bridge, a 950' steel through-truss cantilever, was erected 3,000' down river from the dam site between the other structures. It connected the Bureau of Reclamation's "Engineers' Town," on the river's west side, with MWAK's Mason City to the east. It served an important role in the Grand Coulee Dam's construction by carrying truck traffic associated with the project. Later after the dam's completion, the bridge and the adjoining road became part of the state's improved highway system.[5]

Design and Description

The Washington Department of Highways chose the cantilever structure over other options, including steel or reinforced-concrete arches or steel through trusses, at Grand Coulee Dam and other locations on the Columbia River system because it was the most prudent alternative given the geology. For many Columbia River crossings alternative designs were less economical to construct. Arches required falsework, and often deep main channels made them costly. At Grand Coulee Dam, the stream's width, over 600', necessitated a series of at least two deck or through arches, with one or more heavy piers to counter thrust. A series of simple through or deck truss spans also required several piers in the channel, where excavation to firm foundations was costly and time consuming. A prime objective in constructing the Grand Coulee bridge was to erect it in a timely manner so that the Grand Coulee Dam project could use it. The chosen design, with its 950' steel section rested on two stepped concrete piers founded near the edges of the Columbia River's channel.

By October 1934, two months after FDR's visit to Grand Coulee, the Western Construction Company of Spokane was well along with its work on the concrete piers, anticipating their completion by the end of the month. By 18 October, the Bureau of Reclamation planned to open bids for the steel superstructure. All proposals relied heavily on manual labor because as a PWA project one underlying objective was to employ as many workers as possible. The Bureau of Reclamation required the bridge as part of the project, but gave the Washington Department of Highways much responsibility in its design and construction with the long-range goal of it becoming part of the state's road system. The J. H. Pomeroy Company of San Francisco received the construction contract for the superstructure. As a major regional metal bridge builder, it was involved in erecting several large steel spans, including the Longview Bridge on the lower Columbia, with a 1,200' steel cantilever section, in 1927 (HAER No WA-89), and the Crooked River High Bridge (HAER No. OR-35) in central Oregon.[6]

The Columbia River Bridge at Grand Coulee Dam, read from north to south (by compass east to west), consists of:

- one 19'-9" reinforced-concrete T-beam approach span
- one 27'-9" reinforced-concrete T-beam approach span
- one 26'-3" reinforced-concrete T-beam approach span
- one 200' steel through-truss anchor arm
- one 175' steel through-truss cantilever span
- one 200' steel through-truss suspended span
- one 175' steel through-truss cantilever span
- one 200' steel through-truss anchor arm
- one 24' reinforced-concrete T-beam approach span
- total length of steel cantilever and suspended span --550'
- total length of steel structure--950'
- total length of structure--1,066'-5"
- reinforced-concrete deck, width--20' curb-to-curb
- two 5' reinforced-concrete cantilevered sidewalks

Piers were designed having 92'-tall tapered oval pedestals stepped back from 60' tall, 27' x 58' rectangular bases. The steel superstructure consists of thirty-eight 25' panels. The upper chord is horizontal across the cantilever spans and suspended span with a slight drop over the anchor spans. The lower chord slopes upward from the main piers to the anchor span piers and to the suspended span's horizontal lower chord. All major members, upper and lower chords, vertical posts, diagonals, deck beams, and top struts were constructed of pairs of rolled channels riveted together with strap lattice to form light-weight members. Lesser components similarly consist of angle steel connected by a lattice web. The suspended span's configuration is a simple Warren truss.[7]

As much silicon steel as possible was included in the bridge's design because of its working stress of 24,000 pounds per square inch compared to carbon steel with its working stress of 18,000 pounds per square inch gave it greater capacity for the same member dimensions. All connections were riveted except where pins attached the anchor arms to anchorage shoes, where the suspended span met the cantilevered spans, and where the structure rested on the main piers. The four positions where the suspended span attached to the cantilevers were pinned with allowance for structural expansion and contraction. The lower connections, however, were fitted with shear locks to prevent transverse motion.[8]

The state, through G. Stevens, designed the Columbia River Bridge at Grand Coulee Dam. They also designed the Deception Pass and Canoe Pass bridges (HAER Nos. WA-103 and WA-104) connecting

Whidbey Island with Fidalgo Island in Puget Sound at the same time. Striking similarities exist between the Deception Pass Bridge and the Grand Coulee structure. The dimensions of their cantilever arms and suspended spans are identical. Even though the Grand Coulee Dam Bridge is a through truss and the Deception Pass Bridge is a deck truss their bracing patterns were quite similar, if not identical. Both have sloping bottom chords, but the Grand Coulee's becomes horizontal under the suspended section, while the Deception Pass's continues its taper to mid-span. The highway department initially designed both bridges with an H-15 load rating prescribed by the American Association of State Highway Officials for most structures on primary roads. The Grand Coulee Dam Bridge, though, has a floor and floor framing strengthened to an H-20 rating to safely accommodate heavy construction equipment.[9]

High water during the summer of 1934 and continual equipment problems delayed Western Construction's work on the bridge's piers. By early November it had only driven the east pier's caisson half way from elevation 945 to its predicted final depth at elevation 870. Excavations for the west pier were just beginning. By 1 December, the firm had completed excavating both piers and had begun pouring concrete.[10]

Construction on the Grand Coulee Dam bridge progressed without delay once Western Construction finished the piers. By late August the steel superstructure was nearly complete, but workers noticed that the main east pier had tilted toward the river with its top nearly five inches out of plumb. Before they could arrest the movement with jacks, cables, and turnbuckles, the pier had moved another four inches. For some reason, ground pressure had forced it off its bedrock foundations. Luckily, the shift ran longitudinally with the steel span. Pin slots located where the suspension span met the cantilever arms and used to contain temperature-induced changes in the structure contained the movement and prevented damage to the steel members.[11]

An unstable clay hillside caused the pier's tilting by putting uneven pressure on the structure. Bureau of Reclamation engineers knew that the underlying clay on the river's east side was prone to movement. Prior to the bridge's construction, they scrapped a plan to make a bench cut between the approach span pier and the east channel pier for a railroad track. Instead, they relied on a timber trestle there, and had it constructed prior to excavations for the bridge footings. Later, with the span nearing completion, a contractor proceeded with bench cuts at the trestle's approaches. Nevertheless, the underlying hillside clay was so unstable that even this disturbance away from the bridge caused the entire slope near the piers to slip, unbalancing the equilibrium around the pier and causing it to tilt.[12]

The engineers' objectives at this point was to straighten the pier and to stabilize the bank. In the meantime, with the bridge secured from any additional movement, it was opened for traffic on 27 January 1936. Later, in the spring, J. H. Pomeroy, with Bureau engineers, began driving a circle of sheet piling with a 110' diameter around the tilted pier. Within this, workers excavated 80' deep. The caisson that they created had a series of concentric rings placed inside to act as stabilizing hoops. In turn, timbers radiating out from the pier braced the barrier to prevent the clay from collapsing it.[13]

When the excavation neared completion, and the pressure was equalized, the pier began to tilt on its own back to its original position. Then, workers poured over 8,600 cubic yards of concrete around the pier's base to add to its mass, creating a oversized shoe with a face sloped to match the angle of the hill.[14]

Repair and Maintenance

The Bureau of Reclamation built this bridge as part of the Grand Coulee Dam--Columbia Basin Reclamation Project. It held title to both the bridge and its project headquarters village, Engineers' Town, after the dam was completed in the early 1950s. Later in the decade, Engineers' Town and Mason City, the former MWAK company town, incorporated together as Coulee Dam. Also at this time, the state of Washington became owner of the steel cantilever highway bridge as part of the state route connecting Coulee City, to the southwest, with Omak, to the northwest.[15]

Records of the Washington Department of Highways annual inspections for the Columbia River Bridge at Grand Coulee Dam begin in 1959. With that year as a benchmark, the bridge appeared in satisfactory condition throughout the 1960s. Some sway bracing and a portal bent received scratches and dents from high loads, and deck drains were continually plugged and missing protective grates.[16]

Throughout the 1970s and the 1980s, the only persistent problems were poor paint coverage which invited rusting and seam breakdown, deck surface wear, and bent sway bracing from high load impacts. Early 1990s inspections found that concrete sidewalks and T-beam approach spans showed hairline cracking. Fracture critical inspection of the bridge revealed that all pin connections at anchor points were good. No cracks were found in the steel truss members.

For additional information and a comparative study of the evolution of cantilever design in Washington, see:

WASHINGTON KING COUNTY SEATTLE
WASHINGTON STATE CANTILEVER BRIDGES (HAER No. WA-106)

Data Limitations

Trade journals were the primary resource tool in researching the Columbia River Bridge at Grand Coulee Dam. Indices for local and regional newspaper, where available, yielded little about regional press coverage on the bridge. The dam's construction overshadowed progress on related projects like the highway bridge. No records of the bridge's dedication were found. Likely, again, the structure was one of several major components in the overall dam project and merited little enthusiasm to be singled out for recognition. Promotional brochures on the Grand Coulee Dam--Columbia Basin Reclamation Project from the 1930s and 1940s mentioned the bridge in passing.

Project Information

This project is part of the Historic American Engineering Record (HAER), National Park Service. It is a long-range program to document historically significant engineering and industrial works in the United States. The Washington State Historic Bridges Recording Project was co-sponsored in 1993 by HAER, the Washington State Department of Transportation (WSDOT), and the Washington State Office of Archeology & Historic Preservation. Fieldwork, measured drawings, historical reports, and photographs were prepared under the general direction of Robert J. Kapsch, Ph.D., Chief, HABS/HAER; Eric N. DeLony, Chief and Principal Architect, HAER; and Dean Herrin, Ph.D., HAER Staff Historian.

The recording team consisted of Karl W. Stumpf, Supervisory Architect (University of Illinois at Urbana-Champaign); Robert W. Hadlow, Ph.D., Supervisory Historian (Washington State University); Vivian Chi (University of Maryland); Erin M. Doherty (Miami University), Catherine I. Kudlik (The Catholic University of America), and Wolfgang G. Mayr (U.S./International Council on Monuments and Sites/Technical University of Vienna), Architectural Technicians; Jonathan Clarke (ICOMOS/Ironbridge Institute, England) and Wm. Michael Lawrence (University of Illinois at Urbana-Champaign), Historians; and Jet Lowe (Washington, D.C.), HAER Photographer.

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ENDNOTES

[1] Robert H. Ruby and John A. Brown, *Ferryboats on the Columbia River, Including the Bridges and Dams* (Seattle: Superior Publishing Company, 1974), 141, 143-44.

[2] Donald C. Jackson, *Great American Bridges and Dams* (Washington DC: Preservation Press, 1988), 311-12; Department of the Interior, Bureau of Reclamation, *The Grand Coulee Dam and the Columbia Basin Reclamation Project* (1937, reprint edition), 6; Bruce A. Wilson, *Late Frontier: A History of Okanogan County, Washington (1800-1941)* (Okanogan, WA: Okanogan County Historical Society, 1990), 322.

[3] Ruby and Brown, *Ferryboats on the Columbia River, Including the Bridges and Dams*, 142; Wilson, *Late Frontier: A History of Okanogan County, Washington (1800-1941)*, 321-22.

[4] Walter A. Averill, "Grand Coulee Low Dam," *Pacific Builder and Engineer* 40 (6 October 1934): 17.; other bridges were built, including a pedestrian suspension bridge in early 1935 by MWAK Co. for officials and workers. It replaced the temporary trestle constructed in the fall after an ice jam lodged against it. The highway/railway bridge opened by the end of March 1935. A photograph of this last structure is in *Grand Coulee Dam, Columbia River, State of Washington* (Spokane, WA: Shaw and Borden Company, 1935).

[5] Averill, "Grand Coulee Low Dam," 17.

[6] See contract specifications in Department of the Interior, Bureau of Reclamation, *Columbia River Highway Bridge at Grand Coulee Dam: Schedules, Specifications, and Drawings*, Specifications No. 593, (Columbia Basin Project, WA: 1934), 5-8; Averill, "Grand Coulee Low Dam," 17.

[7] "Long Steel Bridges Added to Washington Highway System," *Engineering News-Record* 113 (25 October 1934): 519; Department of the Interior, Bureau of Reclamation, *Columbia River Highway Bridge at Grand Coulee Dam: Schedules, Specifications, and Drawings*, drawings 1-52; "Columbia River Bridge at Grand Coulee, No. 155/101," Kardex Card File, Bridge Preservation Section, Washington State Department of Transportation, Olympia, WA [WSDOT].

[8] "Long Steel Bridges Added to Washington Highway System," *Engineering News-Record* 113 (25 October 1934): 519; Department of the Interior, Bureau of Reclamation, *Columbia River Highway Bridge at Grand Coulee Dam: Schedules, Specifications, and Drawings*, drawings 1-52.

[9] "Long Steel Bridges Added to Washington Highway System," 519.

[10] "Preliminary Construction at Grand Coulee Dam Speeds Ahead," *Pacific Builder and Engineer* 40 (3 November 1934): 26-27; "Scene Changes at Grand Coulee," *Pacific Builder and Engineer* 40 (1 December 1934): 23-24.

[11] "Earth Pressure Tilts Pier of Grand Coulee Bridge," *Engineering News-Record*, 7 November 1935, 646-47.

[12] Ibid., 646.

[13] Ibid.; "History of Grand Coulee Dam Area: From Pioneers to Power." Community Development Study, TMs, 1958, p. 6; the bridge's opening received only one short mention in the local newspaper, and even at that, it had an impatient tone; "Highway Bridge Opens at Last," *Coulee Dam Grand Coulee News*, 23 January 1936, 1; "Welding and Cutting Play Important Roles in Straightening of Tilted Bridge Pier," *Welding Engineer* 21 (June 1936), 34-35; "Concrete Bridge Pier Righted After Slide Causes Tilting," *Engineering News-Record* 117 (17 September 1936): 410-11.

[14] "Welding and Cutting Play Important Roles in Straightening of Tilted Bridge Pier," 34-35; "Concrete Bridge Pier Righted After Slide Causes Tilting," 410-11; earth slides were a continual problem at the Grand Coulee Dam construction site. The first major one, in November 1934, was on hillside excavations west of the river, where seams of soft clay caused rock formations to move when disturbed. Of more significance to the incident involving the bridge's east pier was a plastic clay slide on the river's east side. Engineers made several attempts to contain the sticky mud to prevent it from sliding in on excavation barriers. They solved the problem by running six miles of pipe across formation's face and pumping a refrigeration brine solution through it to cool the clay to zero degrees Fahrenheit. See "Ten Months Construction

Progress," *Engineering News-Record* 115 (1 August 1935): 146; and *Grand Coulee Dam: The Biggest Man Made Structure of All Time* (Tacoma, WA: Pioneer, Inc., 1940), n.p.

[15] Wilson described demographic changes in towns around the dam, including the privatization of Engineers' Town and its bid with Mason City to become Coulee Dam. See Wilson, *Late Frontier: A History of Okanogan County, Washington (1800-1941)*, 124. Washington State Department of Transportation bridge inspection records begin in 1959. Other state records that could confirm the date when the state took over ownership remain illusive. Bureau of Reclamation records are located in the agency's Denver office. Time did not permit a perusal of the files pertaining to the Grand Coulee Dam--Columbia Basin Reclamation Project.

[16] "Columbia River Bridge at Grand Coulee Dam, No. 155/101," Bridge Inspection Reports for 1959-91, Bridge Preservation Section, WSDOT.