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United States Department of the Interior
National Park Service

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NAT. REGISTER OF HISTORIC PLACES
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National Register of Historic Places Multiple Property Documentation Form

This form is for use in documenting multiple property groups relating to one or several historic contexts. See instructions in *Guidelines for Completing National Register Forms* (National Register Bulletin 16). Complete each item by marking "x" in the appropriate box or by entering the requested information. For additional space use continuation sheets (Form 10-900a). Type all entries.

__X__ New Submission ____ Amended Submission

A. Name of Multiple Property Listing

BRIDGES AND TUNNELS BUILT IN WASHINGTON STATE, 1951 TO 1960

B. Associated Historic Contexts

(name each associated historic context, identifying theme, geographic area, and chronological period for each)

C. Form Prepared by

name/title OSCAR R. "BOB" GEORGE AND CRAIG HOLSTINE

organization WASHINGTON STATE DEPARTMENT OF TRANSPORTATION date DEC. 2001

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D. Certification

As the designated authority under the National Historic Preservation Act of 1966, as amended, I hereby certify that this documentation form meets the National Register documentation standards and sets forth requirements for the listing of related properties consistent with the National Register criteria. This submission meets the procedural and professional requirements set forth in 36 CFR Part 60 and the Secretary of the Interior's Standards for Planning and Evaluation. (_ See continuation sheet for additional comments.)

Allyson [signature] 2-5-02

Signature of certifying official Date

Washington State Historic Preservation Officer

State or Federal agency and bureau

I, hereby, certify that this multiple property documentation form has been approved by the National Register as a basis for evaluating related properties for listing in the National Register.

Signature of the Keeper of the National Register Date of Action

Table of Contents for Written Narrative

Provide the following information on continuation sheets. Cite the letter and the title before each section of the narrative. Assign page numbers according to the instructions for continuation sheets in *How to Complete the Multiple Property Documentation Form* (National Register Bulletin 16B). Fill in page numbers for each section in the space below.

E. Statement of Historic Contexts

(If more than one historic context is documented, present them in sequential order.)

(See Section H of this MPD for a glossary of bridge terms).

Setting the Stage

With the arrival of the 1950s, the State of Washington was experiencing a severe case of "growing pains," along with a measure of uncertainty. The end of World War II brought hope that the vitality of the state's wartime efforts would translate into immediate and long-range benefits for the state's peacetime economy. However, the "cold war" and the start of the Korean War in 1950 placed a high emphasis on continued activities related to the national defense.

Sparked by the influx of workers to Seattle's Boeing Aircraft Company, Bremerton's Puget Sound Navy Yard, and Hanford Engineer Works in the Tri-Cities during the war years, the state's population surged. Major construction projects by the U.S. Army Corps of Engineers on the Chief Joseph and McNary dams on the Columbia, and on dams being constructed in Whatcom County for the City of Seattle Lighting Department, furnished further opportunities for workers. Many of those who arrived liked what they saw in the beauty and diverse landscape of Washington, recognizing a unique opportunity for building a better future for their families. But with the population growth in the state many challenges followed, one of the greatest of which involved improving the adequacy of the highway system.

The concept of a national system of key, high-volume highways had been introduced in the Federal-aid Highway Act of 1938. The Public Roads Administration (later to be re-named the Bureau of Public Roads) recommended, in a report to President Franklin Roosevelt, the improvement of a 75,000-mile system of connected highways identified by the military as strategically important for national defense. As a result in 1944, a Federal-aid Highway Act was passed. It required the designation of a "National System of Interstate Highways," not to exceed 40,000 miles in extent, to connect as directly as possible principal urban and industrial centers, to serve the defense of the nation, and to connect those roads with roads of continental importance at the borders of Canada and Mexico. The Act further stipulated the need for a secondary road system to be selected by the states. Federal-aid funding for highways across the nation was increased to a total of $500 million per year, with designations of 45percent for the primary system, 30 percent for the secondary system, and 25 percent for extension of primary roads into urban areas. By 1949, the nation had selected 34,799 miles of rural roads, 2,882 miles of urban streets and 2,319 miles reserved mainly as bypasses around cities (Borth 1969:243-47).

The Public Roads Administration worked closely with the American Association of State Highway Officials (AASHO) to develop design standards for the new interstate system. The adopted standards did not call for uniform design for the entire system, but rather uniformity where conditions such as traffic, population density, topography and other factors were similar. Designs would be based on 20-year traffic

E. Statement of Historic Contexts (cont'd.)

projections from the time of construction. These actions would set the stage for bridge and tunnel building in the state of Washington in the 1950s.

Bridge Designers

To meet the challenge of designing hundreds of bridges and tunnels across the state in the 1950, several large to medium sized structural engineering design firms established offices around the state. Prominent among these was the Bridge Division of the Washington State Department of Highways, with a staff of about 30 bridge engineers. The City of Seattle's Engineering Department maintained another well-staffed design office. Several bridge and tunnels designs came from federal agencies such as the U. S. Army Corps of Engineers' Seattle office and the Public Roads Administration's (later to be called the Bureau of Public Roads or BPR) San Francisco Office.

During the 1950s, many counties and cities across the state did not have an engineer on staff. They relied heavily on assistance from the state's Bridge Division or from engineers from the private sector. Prominent among the private structural engineers were Cecil C. Arnold, Homer M. Hadley, and Harry R. Powell, all with offices in Seattle.

One of the more notable private engineers was Arthur R. Anderson, from Connecticut who moved to Tacoma in 1950. His work centered around a new technique for bridge building, pre-stressed concrete. His designs made a significant contribution to the future of bridge engineering in Washington.

While the Washington bridge building program was not large enough to encourage the larger engineering consulting firms to establish offices in the state, many firms outside of the state were consulted. One of the more prominent firms was the Tudor Engineering Company from San Francisco who contributed a number of significant bridge designs in the 1950s.

Challenges

In the 1950s the new AASHO design standards placed an emphasis on safety and focused on meeting the demands of traffic projected twenty years into the future. The result was that engineers designed bridges and tunnels with increased vertical and horizontal clearances, and for heavier traffic loads.

The federal mandate to build a National System of Interstate Highways led to a need for more grade separation bridges, and for increased urban construction. Additionally the plan called for many large

E. Statement of Historic Contexts (cont'd.)

bridges across the Columbia River. Despite the obvious disruption that would accompany such a large construction program, the new bridges and tunnels would require longer spans and faster construction methods, and would need to be adaptable to future traffic demands. Engineers met these daunting challenges with new designs and technologies.

Bridges and Tunnels for the Future

The more notable bridges and tunnels of the 1950s speak to the complex engineering, financial and political hurdles that had to be overcome at the time. They reflect the breadth of philosophies among bridge engineers, some seeking to improve on concepts developed in the past; others pioneering concepts for the future. In many cases the structures are the result of prolonged efforts by individuals and communities for the common good, achieved through hard work, collaboration, and compromise. Most of all, they represent a legacy of the best efforts of dedicated professionals towards excellence in bridge engineering.

One of the major bridge and tunnel projects constructed in the 1950s involved a primary north-south highway on the west side of the Cascades. This entailed a significant improvement of Primary State Highway 1 (PSH1, later to be known as Interstate 5), from the Columbia River at Vancouver north to the Canadian border. The project resulted in numerous bridge and tunnel projects along the route. Five of these projects are notable. Perhaps the most significant was a new 3,538-foot long toll bridge across the Columbia River between Washington and Oregon at Vancouver. Designed by the Bridge Department of the Oregon State Highway Department, it was constructed parallel to an existing 1917 bridge. The new bridge was designed to carry three lanes of southbound traffic, while the existing 1917 bridge was modified to carry three lanes of traffic heading north. The new bridge also accommodated an adjacent, modernized version of the old bridge's lift span for ship navigational traffic. During construction of the new (southbound) bridge, modifications were made to the 1917 structure's truss spans immediately south of the lift span.

Further improvements to PSH1 along its length included four bridges designed by the Washington State Department of Highway's Bridge Division. Among them was a new grade separation structure at Custer Way in Olympia, which was arched over the Deschutes River to complement an historic arch bridge to the south. The design of a bypass route along the Seattle industrial area and waterfront was a collaborative effort between the State's Bridge Division and the City of Seattle's Engineering Department. This resulted in two very innovative bridges and a creative tunnel. The first bridge, a state record setting bascule span over the Duwamish River, rests on a floating foundation; the second consists

E. Statement of Historic Contexts (cont'd.)

of a mile-and-one-half long double-deck concrete viaduct section (known as the Alaskan Way Viaduct) which runs along Seattle's historic waterfront. At the north end of the Viaduct, the Battery Street Tunnel connects with Aurora Avenue to the north. In conjunction with this project a pedestrian bridge was built at North 102nd Street, to allow elementary school children to safely cross over the Avenue to their adjacent school. This pedestrian bridge was designed by a creative ex-City of Seattle bridge engineer, Bruce Christy. As a private consultant, Christy used innovative techniques and new materials to allow construction of the pedestrian bridge with minimal disruption to traffic.

Another innovative bridge was a double-deck concrete and steel span Lake Washington Ship Canal Bridge located in Seattle. The bridge had a carrying capacity of twelve lanes of traffic across the historic ship canal. As PSH1 headed north beyond Everett it provided as part of its improved alignment, a bypass around the then heavily congested city of Marysville. This bypass required a second lift-bridge over the Snohomish River, and a second swing bridge over Steamboat Slough.

While the focus of new bridge construction west of the Cascades was on the improvement of PSH1, projects in other areas provided notable bridge designs. One of these was the Port Washington Narrows Bridge at Warren Avenue in Bremerton, designed by the Tudor Engineering Company of San Francisco. The much needed bridge brought relief to the City of Bremerton from traffic problems that had plagued the city since the wartime expansion of the Puget Sound Naval Shipyard. Another notable bridge was built to the southwest of Bremerton in Aberdeen. This new bascule bridge built over the Chehalis River was designed by the State's Bridge Division to replace a narrow swing bridge. Upon completion the bridge, it stimulated the Grays Harbor economy by providing improved access to and from the Olympic Peninsula. In 1955, just east of Newhalem a road was extended to provided worker access to the City of Seattle's Gorge, Ross and Diablo dams. There a notable three-hinged deck truss was designed by Cecil C. Arnold to carry the road over a narrow canyon carved by Gorge Creek.

At the local level, as the state's western counties worked to improve their local road systems, a number of notable bridges and tunnels were constructed during the 1950s. Some of the designs were based on innovations or improvements to older bridge types, others reaching out to and beyond the state of the art of 1950s bridge engineering technology. Six notable bridges fit into the former category. These include Cecil Arnold's steel three-hinged through arch Dalles Bridge designed for a Skagit County road crossing the Skagit River; the Red Bridge, a steel Parker through truss in Snohomish County and the Conrad Lundy Jr. Bridge, a two-span steel Warren deck truss bridge in Skamania County. The latter two projects were designed by the Bureau of Public Road's San Francisco Office to improve access to National Forest highways.

E. Statement of Historic Contexts (cont'd.)

In King County, three notable steel truss bridges were constructed on secondary roads using older bridge types. Two of these were riveted steel trusses: the Stossel Bridge, a Warren through truss over the Snoqualmie River near Carnation, designed by Cecil Arnold to replace an earlier crossing; and the Foss River Bridge, a pony truss, in the Snoqualmie National Forest. The third bridge was the Mount Si Bridge, a pin-connected Parker truss, originally constructed in 1904 to span the White River in Buckley. This bridge had been carefully disassembled in 1955, and reassembled to span the Middle Fork of the Snoqualmie River near North Bend. The structure is probably the oldest pin-connected Parker truss in the state, and is one of the oldest bridges still in service in Washington.

Five bridges constructed west of the Cascade Mountains in the 1950s represent designs that were on the leading edge of bridge engineering technology. The first, the Portage Canal Bridge was designed by Homer Hadley to provide access to Indian and Marrowstone islands in Jefferson County. Always the innovator, Hadley included a drop-in steel box girder segment as part of the main span, the second use of this pioneer design in North America. The other four bridges were designed by Seattle engineer Harry Powell, a native of Canada with an ability to include beauty in his bridges. Three of the four bridges have won prestigious national awards as outstanding steel bridge designs. Among the award winners was the Rainbow Bridge over the Swinomish Channel in La Conner in Skagit County. It was the first fixed through arch span in Washington State, and pioneered the use of high strength structural steel in the state. The Modrow and B-Z Corner bridges in Cowlitz and Klickitat counties are three-hinged open spandrel rib deck arch spans, incorporating extensive use of welded steel. The fourth notable bridge, not a design winner, was the two-span pre-stressed concrete Klickitat River Bridge in Klickitat County. The structure was the first pre-stressed girder bridge constructed on either the Washington State Department of Transportation or local agency highway system, and was the forerunner of many bridges of this type that followed. During the design and construction phases, Powell collaborated with pre-stressed concrete and pre-casting pioneer Arthur Anderson. This provided further innovations of the bridge design.

Many highway and bridge construction projects were also completed in Eastern Washington during the decade. These included three major toll bridges across the Columbia River. The first bridge, crossing the Columbia between Washington and Oregon, at The Dalles, culminated an almost 100-year effort by citizens and public officials in urging for such a crossing. The Tudor Engineering Company designed the bridge for Wasco County in Oregon. After construction had started, the bridge design had to be revised and the bridge was relocated to a new site to eliminate conflicts with portions of the proposed Dalles Dam. The second bridge, located in the Tri-Cities area between the cities of Pasco and Kennewick, was designed by the Washington State Department of Highways Bridge Division to replace an existing bridge overburdened by the sudden population growth and traffic tied to the rapid expansion of the Hanford Engineer Works.

E. Statement of Historic Contexts (cont'd.)

This bridge was the first use of a steel tied arch design in the state, and resulted in a greatly improved appearance over the through truss structures previously used for long river crossings. The third of the Columbia River crossings, east of the Cascades was located at Umatilla. The new bridge, designed by Tudor Engineering Company for Umatilla County in Oregon, coupled with the completion of the John Day Dam just downstream, would stimulate the success of increased agricultural development on adjacent lands in Washington and Oregon.

In 1958 in Douglas County, Washington construction was proceeding on a continuing phase of the Chief Joseph Dam project. As part of a dam access road project, the Seattle District Office of the Corps of Engineers included as the main span of the Chief Joseph Dam Bridge a Howe deck truss span, which at the time of this writing remains as the last of its kind in the state.

In the central part of the state, by 1950 traffic congestion had become an issue for many cities. In the City of Wenatchee this led to the construction of a second bridge to carry southbound traffic on Wenatchee Avenue over the Wenatchee River, leaving the adjacent 1933 steel through truss to carry northbound traffic. The new steel plate girder bridge was designed by the Washington State Department of Highways Bridge Division. Built in 1955 at the time of its construction it was the longest span of its type in the state, a record it still holds today.

In eastern Washington traffic congestion was also becoming an issue in the 1950s. In Spokane, this resulted in the construction of two notable bridges, each crossing over the Spokane River and intended to divert traffic away from the downtown business area. The first, the Maple Street Bridge, a long steel plate girder structure, was built as a toll bridge designed for the City by the Tudor Engineering Company to carry Maple Street over the river and Peaceful Valley. The second, a concrete multiple deck arch bridge, was designed by the City's Engineering Department to replace an old and narrow steel truss bridge unable to carry existing truck traffic loads.

One of the most unusual bridges built in the 1950s in the state is a unique design by Homer Hadley. Its design would set a national precedent. Hadley presented his proposal for a steel and concrete "Tied-Cantilever" bridge crossing the Yakima River between Benton City and Kiona to the Benton County Board of County Commissioners in 1955. The Benton City-Kiona Bridge with its towers and stays eventually became an American prototype for what would later be called "cable-stayed" bridges.

Bridge and tunnels such as these kept the state on track for future development. And the adaptation of old designs sometimes blended with new concepts and technological improvements, keeping bridge engineers and designers in the state at the forefront of the profession.

E. Statement of Historic Contexts (cont'd.)

Trends of Change

Many factors contributed to changes in Washington State bridge engineering technology in the 1950s. The changes began with shortages in steel in the early part of the decade. The Federal-aid Highway Act and a federal mandate to build a National System of Interstate Highways resulted in new AASHO design standards emphasizing safety, including greater horizontal and vertical clearances, and the need to design for future traffic demands, and heavier traffic loads. Increased construction in urban areas would dictate the need for more grade separation bridges, faster building methods and the use of new materials to keep traffic moving. These factors were to lead to a decline in, or discontinued use of, some traditional bridge types and construction techniques, and the emergence of new ones.

Although a number of steel truss bridges were built during the decade, three previously popular truss types, the Howe, the Parker, and the Pennsylvania-Petit were to make their final appearances on Washington State Department of Transportation or local highways systems. During the 1950s those familiar truss types were replaced by Warren truss type designs, preferred because its geometrics allowed simplified connections. The once popular pony truss also had its "last hurrah" in 1951 when the last of its type, the Foss River Bridge, was constructed on a secondary road in King County. New design standards calling for wider roads and greater load-carrying capabilities spelled the end of new pony truss designs.

Another previously popular bridge type, the concrete arch, also experienced a decline as the emphasis in bridge building shifted to simpler, more functional, utilitarian designs. Only two concrete arch bridges, built in the 1950s remain on the inventory.

A trend of stationary bridges begun in the mid-1940s continued as the use of movable bridges declined, reflecting changes in patterns of marine commerce and the costs associated in operating and maintaining these bridges. In many cases during the 1950s, movable bridges were replaced by high-level fixed spans. Only five new movable bridges were built in the 1950s, and three of these were built adjacent to existing movable bridges.

The decade did see however a large increase in the design of both continuous concrete and steel girder bridges. Designed for continuity, these truss types enabled a more efficient use of materials and longer spans providing a reduction in substructure costs and increased horizontal clearances. Continuous steel plate girder bridges designed in the 1950s would stretch span lengths to 260 feet, providing a viable option to the steel truss for long spans. The introduction of composite design enabled the concrete deck slab to work with the steel girders in carrying traffic loads leading to more slender spans and even more

E. Statement of Historic Contexts (cont'd.)

efficient designs.

Another technological development, the use of welding, increased further interest in the design of steel girder bridges. Until the end of World War II, welding had not been permitted on major structural members of bridges on the Federal-aid system. This provision was due to the lack of toughness (and resultant welding inadequacy) of most structural steel used for bridges. At BPR's urging, steel producers in the early 1950s developed a weldable steel for bridges that had sufficient chemical controls to produce a tougher steel. In 1954 the American Society of Testing and Materials (ASTM) adopted a Specification for Structural Steel for Welding (A373). As a result the availability of this steel rapidly expanded the scope and volume of welded structures, eventually replacing the riveted plate girder in the 1960s. During the same period high strength steel bolts were being developed for use as an option (and eventual replacement) for rivets in the connection of structural members. Both of these developments would lead to increased use of steel girder designs for bridges (*America's Highways 1976-1996*:434).

The most significant development in Washington State bridge engineering technology in the 1950s was the advent of pre-stressed concrete. At the beginning of the 1950s, steel shortages that began during World War II continued. Also, because of the Korean War, the National Defense Program permitted only small quantities of critical materials, such as steel, to be used on non-military projects.

The modern development of prestressed concrete is credited to Eugene Freyssinet of France, who in 1928 started using high-strength steel wires for pre-stressing. However, it was not until the end of World War II in 1945, at a time of critical shortages in steel, that the potential of pre-stressed concrete became evident as a new construction material to help rebuild the European transportation systems destroyed in the war. Although France and Belgium led European development of prestressed concrete, England, Germany, Switzerland, Holland, the Soviet Union and Italy quickly followed. By 1963, 80% of all new bridges built in Germany were pre-stressed concrete (Anderson 1979).

In the United States, the use of prestressed concrete for bridges began in 1950 with the construction of the Walnut Lane Memorial Bridge, in Philadelphia, Pennsylvania. That bridge was designed by noted Belgian Professor Gustave Magnel. In 1949, Arthur R. Anderson (future Washington State private engineering consultant), then a consulting engineer in Connecticut, had assisted Magnel in tests on a prototype girder. Following a 1950 trip to visit prestressing plants, construction sites, and research laboratories in Europe, Arthur joined his father Eivind, and brother, Thomas, in Tacoma, Washington, where they opened a contracting business together (Lin 1963). Eventually this led to the first prestressed concrete bridge in the state the Klickitat River Bridge. Built in 1954, the design is attributed to fellow engineer Harry Powell.

E. Statement of Historic Contexts (cont'd.)

Several months after the Powell design had been completed, the Washington State Department of Highways Bridge Division began the design of its first of many prestressed concrete girder bridges.

The widespread use of pre-stressed concrete in bridges was achieved through the vision of individuals who took a new idea and maximized its potential by modifying and improving existing methods and inventing new devices, all with a focus on mass production techniques (PCI Design Handbook 1992:1-2). As a result of such ingenuity and technology, thirty-seven percent of all Washington bridges currently in-service, on state, county, and city highways are constructed of prestressed concrete. As part of this study, one hundred and eighteen prestressed concrete highway bridges built from 1951-60 remain in service today.

As the bridge engineering community reached the end of the 1950s, designers began to experiment with new tools that had been added to their design arsenal: hand-held calculators and computers. Although a computer was used in the substructure design for the Lake Washington Ship Canal Bridge in Seattle in 1958-59, many years elapsed before computers and hand-held calculators replaced slide rules in bridge engineering. Nonetheless, their introductions at the end of a decade of unprecedented innovation were harbingers of more dramatic advances yet to come.

A Note on Tunnels

This MPD includes one tunnel, the Battery Street Tunnel in Seattle. Connected to the north end of the Alaskan Way Viaduct, it functions as an extension of that structure, and is thus, for purposes of nomination to the National Register of Historic Places, considered to be a contributing element to that property's significance. So far as is known, the Battery Street Tunnel was the only tunnel constructed on the state system in the 1950s. By then nearly all of the state's primary highway tunnels had been built.

The last major tunneling effort in the state had also occurred in Seattle just over a decade before. Like the Battery Street project, the earlier tunnel had been an integral component of another bridge project on another major arterial. In 1940 opening of the Mt. Baker Ridge Tunnel was equaled in engineering achievement only by completion of the Lake Washington Floating Bridge on Interstate 90. Both structures served to connect Seattle with the inland Pacific Northwest. The Battery Street Tunnel and Alaskan Way Viaduct, on the other hand, provided a continuous highway connection through Seattle, linking southern and northern Puget Sound. Designed and built by the Washington State Department of Highways, the Mt. Baker Ridge Tunnel was actually two parallel, modified horseshoe-shaped concrete tunnels. At 1,466 feet long, each was dug through unstable clay, at a cost of just over $1.3 million. Dug in a completely different, although equally innovative, fashion, the Battery Street Tunnel was constructed using rectangular reinforced double concrete boxes, at a cost of slightly over $2.3 million. It was the first tunnel designed and built by the City of Seattle. Both structures stand today as monuments to tunnel engineering.

F. Associated Property Types

(Provide description, significance, and registration requirements.)

Bridges nominated under this multiple property (MPD) nomination are constructed of reinforced concrete, pre-stressed concrete, steel, or timber elements or a combination thereof. Specifically, the following bridge types are nominated with this MPD. A description of the primary span(s) and materials used in the primary span(s) are noted. (See Section H of this MPD for a glossary of bridge terms).

1. Concrete Arch Bridges:

a. Upper Custer Way Bridge: Single open-spandrel rib deck arch constructed of reinforced concrete.
b. Greene Street Bridge: Multiple span open-spandrel rib deck arch constructed of reinforced concrete.

2. Concrete Viaduct:

a. Alaskan Way Viaduct: Multiple span double-deck tee-beam with rigid frame piers, all constructed of reinforced concrete.

3. Concrete Tunnel:

a. Battery Street Tunnel: Double-box rectangular tunnel constructed of reinforced concrete with steel pile supports.

4. Prestressed Concrete Girder Bridges:

a. Klickitat River Bridge: Two-span deck girder constructed of prestressed concrete on reinforced concrete supports.
b. North 102nd Street Pedestrian Bridge: Multiple-span tee-girder constructed of prestressed concrete and reinforced concrete.

5. Steel Arch Bridges:

a. Modrow Bridge: Three-hinge open spandrel rib deck arch constructed of steel with a reinforced concrete deck slab and supports.
b. B-Z Corner Bridge: Three-hinge open spandrel rib deck arch constructed of steel with a reinforced concrete deck slab and supports.
c. Rainbow Bridge: Fixed through arch constructed of steel with a reinforced concrete deck slab and supports.
d. Dalles Bridge: Three-hinge trussed rib through arch constructed of steel with a reinforced concrete deck slab and supports.

F. Associated Property Types: (cont'd.)

(Provide description, significance, and registration requirements.)

- e. Gorge Creek Bridge: Three-hinge truss deck arch constructed of steel with reinforced concrete supports.
- f. Pioneer Memorial Bridge (Blue Bridge): Through tied arch constructed of steel with a reinforced concrete deck slab and supports.

6. Steel Girder Bridges:

- a. Wenatchee Avenue South Bound Bridge: Multiple-span plate girder constructed of steel with a reinforced concrete deck slab and supports.
- b. Port Washington Narrows Bridge: Multiple-span plate girder constructed of steel with a reinforced concrete deck slab and supports.
- c. Maple Street Bridge: Multiple-span plate girder constructed of steel with a reinforced concrete deck slab and supports.
- d. Portage Canal Bridge: Steel box girder suspended in a multiple-span concrete box girder, constructed with a combination of steel and reinforced concrete.
- e. Benton City-Kiona Bridge: Tied cantilever with steel girders suspended in a multiple-span concrete box girder, constructed with a combination of steel and reinforced concrete.

7. Steel Movable Bridges:

- a. Southbound Interstate 5 Columbia River Bridge: Vertical lift span, with multiple-spans constructed of steel, with a reinforced concrete deck slab, counterweights, and pier supports with prestressed concrete or timber piling.
- b. Duwamish River Bridge at 1st Avenue South: Double-leaf bascule span, with multiple spans e constructed of steel, with reinforced concrete counterweights and floating cellular pier.
- c. Chehalis River Bridge: Double-leaf bascule span, with multiple spans constructed of steel, with a concrete-filled steel grid deck, reinforced concrete counterweights, and support piers founded on timber piling.
- d. Snohomish River Bridge: Vertical lift span, with multiple spans constructed of steel, with a reinforced concrete deck slab and counterweights, and support piers founded on timber piling.
- e. Steamboat Slough Bridge: Swing unit, with multiple spans constructed of steel, with a reinforced concrete deck slab, and piers on timber piling.

F. Associated Property Types (cont'd.)

(Provide description, significance, and registration requirements.)

8. Steel Truss Bridges:

a. Lake Washington Ship Canal Bridge: Six combination Warren through and deck truss spans, with multiple spans constructed of steel, with reinforced concrete deck slabs, and piers founded on timber piling.
b. Columbia River Bridge at Umatilla: Five Warren through truss spans, multiple spans constructed of steel, with a reinforced concrete deck slab and support piers.
c. Columbia River Bridge at The Dalles: Five Warren through truss spans, multiple spans constructed of steel, with a reinforced concrete deck slab and support piers, with one pier supported on steel piling.
d. Stossel Bridge: Warren through truss span constructed of steel with a reinforced concrete deck slab and support piers.
e. Mount Si Bridge: Pin-connected Parker through truss span constructed of steel with a reinforced concrete deck slab and support piers.
f. Foss River Bridge: Warren pony truss span constructed of steel with an asphalt-covered timber deck.
g. Conrad Lundy Jr., Bridge: Two continuous Warren deck truss spans including a central framed tower pier constructed of steel with a reinforced concrete deck slab and end piers.
h. Red Bridge: Riveted Parker through truss constructed of steel with a reinforced concrete deck slab, and support piers founded on timber piling.

9. Timber Truss Bridge:

a. Chief Joseph Dam Bridge: Howe timber deck truss with concrete pedestal and reinforced concrete column span supports, and timber trestle approaches and concrete abutments, with an asphalt-covered deck.

Significance

Each of the above properties conveys, through their design, materials, methods of construction, and/or historical significance, a sense of their historical character peculiar to the period 1951-1960. As the most significant examples of their property types, selected from 812 bridges on the State inventory of structures dating to the decade of the 1950s, all of the bridges are considered to be of exceptional significance. Some of these properties warrant eligibility under Criterion consideration G for properties not yet 50 years of age but eligible as having achieved exceptional significance within the past 50 years.

Bridges eligible for inclusion in this MPD under Criterion A are directly associated with bridge building

F. Associated Property Types (cont'd.)

(Provide description, significance, and registration requirements.)

in Washington in the 1950s. Bridges included in the MPD are products of what were then the State's large design offices such as the Bridge Division of the Washington State Department of Highways, the City of Seattle's Engineering Department, the U.S. Army Corps of Engineers' Seattle Office, the U.S. Bureau of Public Roads' San Francisco Office, and smaller private firms headed by prominent bridge engineers such as Cecil C. Arnold, Homer M. Hadley, Harry R. Powell, and Arthur R. Anderson. Bridges built in the 1950s characterized new standards for construction, represented in increased vertical and horizontal clearances, and designs for heavier traffic loads. Federal mandates associated with the National System of Interstate Highways resulted in large bridges across the Columbia River, increased urban bridge construction, and requirements for more grade separation. Longer spans, faster construction methods minimizing traffic disruption, and economically feasible solutions required complex engineering of unprecedented degrees. Some bridges included in the MPD represent cutting-edge, state-of-the-art designs and uses of materials and construction methods for their era. Other bridges in the MPD represent innovative modifications to older styles, particularly on rural road systems where improvements called for wider roads and greater load-carrying capacity of bridges.

To meet the many challenges presented, bridge engineers responded by designing structures using engineering tools and techniques, and materials, not previously available. Bridges included in the MPD are eligible under Criterion C because they embody those characteristics of type, period, materials, and methods of construction reflective of the period. Increased use of continuous concrete and steel girder bridges enabled the building of longer spans providing increased horizontal clearances and reductions in substructure costs. The advent of pre-stressed concrete proved to be the most significant development in bridge engineering in the 1950s. Since the first bridge was constructed of prestressed concrete in Washington in the early 1950s, the state, counties, and cities have relied upon the material to such a degree that today pre-stressed concrete bridges comprise thirty-seven percent of all bridges in service. Innovative modifications of older bridge designs, incorporating modern engineering and materials, were also hallmarks of the decade.

Registration Requirements

To be eligible for inclusion in this multiple property submittal, bridges must be directly associated with bridge building in Washington in the 1950s (Criterion A), and must possess high degrees of integrity of design and materials in their main span(s) (Criterion C). Criterion A eligibility can be enhanced by a bridge's importance to the transportation, economic, industrial, or social development of the region, state, or locality; or by its association with a significant event, a public effort to encourage bridge construction, and/or a federal project of local and regional importance.

F. Associated Property Types (cont'd.)

(Provide description, significance, and registration requirements.)

Criterion C eligibility rests on one of the following factors, or a combination thereof:

- Unique or unusual bridge type in the State inventory;
- Innovative structural design features;
- Representative of a specific type of bridge;
- One of a few remaining examples of a specific type of bridge;
- Creative or economical use of construction materials;
- Innovative or unusual construction methods;
- Structural integrity, i.e., original fabric (materials) and appearance of the main span(s);
- Aesthetics of the design in relation to the site and setting.

Some degree of modification to eligible bridges is acceptable so long as the significant engineering design is intact and the historic character of the bridge is preserved. Usually a bridge's engineering significance is concentrated in its main span(s); replacement or alteration of approach spans does not normally deprive bridges of their engineering significance.

G. Geographical Data

The geographic area for the multiple property nomination encompasses the entire State of Washington. Three structures cross the state's borders into Oregon.

H. Summary of Identification and Evaluation Methods

(Discuss the methods used in developing the public property listing.)

Introduction

The evaluation of bridges and tunnels in Washington State built from 1951 to 1960 consisted of an inventory and review of 812 bridges constructed between 1951 and 1960 on the state, county, and city highway systems. The goal was to identify bridges of engineering and/or historical significance worthy of listing in the National Register of Historic Places. Privately owned bridges, those under the jurisdiction of state agencies other than WSDOT, and bridges built and maintained by federal agencies were not considered within the scope of this evaluation. Nominations for 31 structures were prepared to accompany this MPD nomination, Bridges and Tunnels Built in Washington State, 1951-1960.

Personnel

Oscar R. (Bob) George, P.E.:
A licensed civil and structural engineer in Washington State, Mr. George holds Bachelor and Master of Science degree in civil engineering. His 40 years of experience in civil engineering include six years with the California Department of Highways in bridge construction and design; four years with Hardesty and Hanover, Consulting Engineers in New York City in the design of fixed and movable bridges; and 30 years with the Washington State Department of Transportation (WSDOT) including supervision in bridge design, project development, assistance to local agencies, bridge program planning, bridge inspection and bridge preservation. From 1988 until his retirement from WSDOT in 1998, Mr. George served as State Bridge Preservation Engineer managing the bridge inventory and inspection program, risk management programs for bridge rating and scour, and the movable bridge maintenance and rehabilitation program. In this position he served a significant role in building the current programs for bridge replacement, rehabilitation, and seismic retrofit for both state and local agency bridges.

Mr. George's work on this project included review of available information for all 812 bridges in the inventory of bridges built 1951-1960; identification of bridge candidates worthy of listing on the National Register of Historic Places; collection and review of documents related to the design, construction and historical background of each candidate; and preparation of a National Register nomination for each of the 30 bridges and one tunnel selected for nomination detailing its engineering and historical significance. In addition he prepared a significant portion of the final report for the project.

Craig Holstine:
As Cultural Resources Specialist with the Environmental Affairs Office, Olympia Service Center of WSDOT, Craig Holstine participated in the initial project development, including contacting local agencies with bridges on the Inventory. He assisted with research efforts aimed at documenting the historical aspects

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

of bridges selected for Phase 2 evaluation and for those finally nominated to the National Register. Mr. Holstine also edited the nominations, and assisted in preparation of the final report and MPD submittal. Mr. Holstine has over 20 years experience evaluating and documenting historic properties, some of which have been listed in the National Register. As a consultant to WSDOT in 1991-1992, he directed the efforts of bridge engineers and historians in evaluating and nominating bridges built in Washington State in the 1940s.

Additional Staff

Providing valuable research assistance at various stages in the project have been Brenda Kent and Heather Zolzer in the Environmental Affairs Office, and Richard Hobbs, Ph.D., and J. Jeffery Creighton, M.A., historians in private consulting roles. At WSDOT, Ed Henley in the Lacey Bridge and Structures Office, Al King and Greg Kolle in the Highways and Local Programs Office, and Harvey Coffman, Duane Stone, Jerald Dodson and Cheryl McNamara in the Bridge Preservation Office have provided invaluable support and assistance. Rick Singer and Sandie Turner in the Environmental Affairs Office have provided administrative assistance and support without which the project would not have been completed.

Process

WSDOT manages the State Inventory of Bridges and Structures incorporating information provided by federal, state, county and city agencies owning bridges. Using this inventory as a resource, two sorted listings were made of all bridges constructed from 1951 through 1960, one list of those under the jurisdiction of WSDOT, and the second list of those owned by counties and cities. A total of 812 bridges fit these criteria: 450 state bridges and 362 county or city bridges.

Two screening phases were conducted to identify bridges worthy of inclusion in the National Register. They are described below as Phase 1 and Phase 2 Screening. The third and final phase of the project consisted of documentation of structures determined eligible for inclusion in the National Register of Historic Places (Table 1).

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Phase 1 Screening

WSDOT's Bridge Preservation Office maintains an extensive file of information on each bridge under WSDOT jurisdiction. The file includes correspondence, photographs, and inspection information covering the full life of the bridge. In addition, that office maintains files containing more limited information on city and county bridges under contract for state inspection services, or previously under state jurisdiction. Other information available through the Bridge Preservation Office includes a digitized database, containing as-constructed plans on most state bridges and a "Kardex" file containing additional information on state bridges in service.

WSDOT's Highways and Local Programs Service Center serves as the Department's contact point with cities and counties. That office maintains a growing digitized photo database now including many of the local agency bridges.

In May 2000 a search began of all of the above information available through WSDOT on each of 812 bridges in the study group. Near the end of June, a letter was sent to each local agency having jurisdiction over bridges in the study group, advising of the project, listing the agency bridges involved, types of information needed and general criteria to be used in selecting nominees for the National Register. Members of the study team made follow-up telephone calls or visits to the agencies to further explain project objectives and types of information needed. As a result, information was provided by all of the 33 counties and 19 cities with bridges in the study group.

Bridges identified from this information as having no unusual engineering design or construction features and no known historical significance were eliminated from further consideration. Fifty-two WSDOT bridges and twenty-six county or city bridges (9.6 percent of the study group) were selected for further consideration.

Phase 2 Screening

An evaluation form was developed to provide a tool to qualitatively and quantitatively evaluate the engineering and historical significance of the 78 remaining bridges. Ten factors were identified to evaluate the engineering and historical significance of each bridge, using criteria suggested by the U.S. Department of the Interior's National Park Service as a guide. Each factor was scored from 1 to 10, or "U" ("unknown") if information was not available.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Letters were sent to historical groups and libraries located in the areas of the remaining bridges to solicit additional historic information on the bridges. In order to complete the evaluation forms, a more in-depth look was taken at information gathered on these bridges during the Phase 1 Screening. This included a thorough review of as-built bridge plans, of engineering and agency publications relating to Washington bridges built in the 1950s, and of inventory information for all bridges in the state, sorted by bridge type. Bridge type sorts helped to determine the number of bridges of a given type on the inventory, to compare construction dates and to identify maximum or comparative span lengths. This enabled identification of rare, pioneer or record-setting bridges. For example, this process enabled identification of the first pre-stressed concrete bridge built on the state or local agency highway system. The Phase 2 Screening also included the review of historical information received in response to our letter to historical groups and libraries.

Following completion of all 78 evaluation forms, a determination was made to recommend the nomination of bridges scoring 50 points or higher.

Phase 3 Documentation

Summaries of engineering and historical significance and a completed nomination form have been prepared for each of the 31 structures recommended for listing in the NRHP. Because of their close connection physically and historically, the Alaskan Way Viaduct and the Battery Street Tunnel have been combined into one nomination. A list of the 31 recommended properties follows. Of the 31 structures, 3 are now 50 years of age; the remaining structures meet the threshold of eligibility established by Criteria Consideration G for properties not yet 50 years old. Of the 31 candidates, 18 are state and 13 are local agency bridges (3.8 percent of the study group).

H. Summary of Identification and Evaluation Methods (cont'd)

(Discuss the methods used in developing the public property listing.)

WSDOT Bridges and Tunnels:	
Agency Number	**Bridge/Tunnel Name**
5/1W	Southbound Interstate 5 Columbia River Bridge
5/316	Upper Custer Way Bridge
5/570	Lake Washington Ship Canal Bridge
20/323	Gorge Creek Bridge
82/280S	Columbia River Bridge at Umatilla
99/530E	Duwamish River Bridge at 1st Avenue South
99/540NB&SB	Alaskan Way Viaduct
99/541	Battery Street Tunnel
101/115	Chehalis River Bridge
* 116/5	Portage Canal Bridge
142/9	Klickitat River Bridge
197/1	Columbia River Bridge at The Dalles
225/1	Benton City-Kiona Bridge
285/20W	Wenatchee Avenue SB Bridge
303/12	Port Washington Narrows Bridge
395/40	Pioneer Memorial Bridge *(Blue Bridge)*
529/10W	Snohomish River Bridge
529/20E	Steamboat Slough Bridge

Table 1: Bridges Recommended for Listing in the National Register of Historic Places

Local Agency Bridges and Tunnels:	
Agency Number	**Bridge/Tunnel Name**
35350001	Modrow Bridge – Cowlitz County
26.5ENE	Chief Joseph Dam Bridge – Douglas County
1023A	Stossel Bridge – King County
2550A	Mount Si Bridge – King County
2605A	Foss River Bridge – King County
000000127	North 102nd Street Pedestrian Bridge – City of Seattle
110	B-Z Corner Bridge – Klickitat County
40090	Dalles Bridge – Skagit County
40039	Rainbow Bridge- Skagit County
207	Conrad Lundy Jr., Bridge – Skamania County
537	Red Bridge – Snohomish County
359100816	Maple Street Bridge – City of Spokane
533000802	Greene St Bridge over Spokane R. – City of Spokane

Table 2: Bridges Recommended for Listing in the National Register of Historic Places

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Bridge Glossary

Abutment – A substructure element supporting each end of a single span or the extreme ends of a multi-span superstructure and, in general, retaining or supporting the approach embankment.

Anchor Span – The span that counterbalances and holds in equilibrium the cantilevered portion of an adjacent span during construction.

Approach Span – The span or spans connecting the abutment with the main span or spans.

Arch Rib – The main support element used in open spandrel arch construction; also known as arch ring.

Bailey Bridge – A pony truss bridge consisting of prefabricated metal components, assembled on-site, usually to provide temporary crossing until a permanent structure can be built.

Baltimore Petit Truss – A variation of a Pratt truss with sub-struts and/or sub-ties providing greater rigidity and permitting longer spans.

Balustrade – A rail and the row of posts that support it along a stairway or on a bridge deck.

Bascule Bridge – A bridge over a waterway with one or two leaves that rotate from a horizontal to a near vertical position, providing unlimited vertical clearance for marine traffic.

Beam – A linear structural member designed to span from one support to another.

Bearing – A support element transferring loads from superstructure to substructure, capable of permitting rotation or longitudinal movement.

Bent – A substructure unit supporting each end of a bridge span; also called pier; made up of two or more columns or column-like members connected at their top most ends by a cap, strut, or other member holding them in their correct positions.

Box Beam/Girder – A hollow structural beam or girder with a square, rectangular, or trapezoidal cross-section.

Buffer – A dampening device used to reduce loads on machinery during the seating process in movable bridges (i.e., return of deck spans to their roadway positions).

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Cable-Stayed Bridge – A bridge in which the superstructure is directly supported by cables or stays, passing over or attached to a tower or towers located at the main pier(s).

Camber – Slight convex or concave curvature provided in beams to compensate for dead load deflection.

Cantilever – A structural member that has a free end projecting beyond its support; length of span overhanging the support.

Cast-In-Place – Concrete poured within formwork on site to create a structural element in its final position.

Centerlock – In decks of bascule bridges, devices used to secure movable leaves (spans) in position and to transfer live (traffic) loads.

Chord – A horizontal member of a truss.

Compression Members – Structural members that withstand forces due to applied loads tending to compress them.

Continuous Beam – A general term applied to a beam that spans uninterrupted over one or more intermediate supports.

Continuous Spans – Spans designed to extend without joints over one or more intermediate supports.

Counter – Cross members in steel truss bridges used to balance live (traffic) loads.

Counterweight – A weight used to balance, and to minimize resistance of, movable members or spans.

Cross Brace – Transverse brace between two main longitudinal members.

Dead Load – A static load due to the weight of the structure itself.

Deck – The portion of a bridge that provides direct support for vehicular and pedestrian traffic.

Deck Bridge – A bridge in which the supporting members are all beneath the roadway.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Deck Truss – A bridge whose roadway is supported from beneath by a truss.

Diagonal – A sloping structural member of a truss or bracing system.

Diaphragm – A member placed within a member or superstructure system to distribute stresses and improve strength and rigidity.

Drawrest – On a swing span bridge, a timber piling structure protecting the pivot pier and swing span in its open position.

Endlock – In lift and swing bridges, devices used to secure movable spans in position and to transfer live (traffic) loads.

Expansion Joint – A joint designed to provide means for expansion and contraction movements produced by temperature changes, load, or other forces.

Falsework – A temporary wooden or metal framework built to support the weight of a structure during the period of its construction and until it becomes self-supporting.

Fatigue – Cause of structural deficiencies, usually due to repetitive loading over time.

Fixed Span – A superstructure span having its position practically immovable, as compared to a movable span.

Flange – The horizontal parts of a rolled I-beam or built-up girder extending transversely across the top and bottom of the web.

Footing – The enlarged, lower portion of a substructure that distributes the structure load either to the earth or to supporting piles; the most common footing is the concrete slab; "footer" is a colloquial term for footing.

Girder – A flexural member that is the main or primary support for the structure and usually receives loads from floor beams and stringers; any large beam, especially if built up.

Girder Bridge – A bridge whose superstructure consists of two or more girders supporting a separate floor system, as differentiated from a multi-beam bridge or a slab bridge.

Gusset – A plate connecting the members of a structure and holding them in correct position at a joint.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Hanger – A tension member serving to suspend an attached member.

Haunch – An increase in the depth of a member usually at points of support; the outside areas of a pipe between the spring line and the bottom of the pipe.

H-Beam – A rolled steel member having an H-shaped cross section and commonly used for piling.

Hinge – A point in a structure at which a member is free to rotate.

Howe Truss – A type of bridge truss having parallel chords, vertical (tension) rods at the panel points, and diagonals forming an X-pattern.

I-Beam – A structural member with a cross-sectional shape similar to the capital letter "I."

Joint – In stone masonry, the space between individual stone; in concrete, a division in continuity of the concrete; in a truss, the point at which members of a truss frame are joined.

Laminated Timber – Small timber planks glued together to form a larger member.

Lattice Truss – A truss having two or more web systems composed entirely of diagonal members at any interval and crossing each other without reference to vertical members.

Leaf – The movable portion of a bascule bridge that forms the span of the structure.

Live Load – Vehicular traffic.
Live Load Shoes – Bearings carrying live loads to the foundation when a movable bridge is in the closed position.

Lower Chord – The bottom horizontal member of a truss

Luten Arch – Named for Daniel B. Luten, usually refers to the concrete filled spandrel barrel arch, probably the most popular of his more than 30 bridge patents.

Main Beam – A beam supporting the spans and bearing directly onto a column or wall.

Member – An individual angle, beam, plate, or built piece intended to become an integral part of an assembled frame or structure.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Moment – The couple effect of forces about a given point.

Movable Span – A general term applied to a superstructure span designed to be swung, lifted or otherwise moved longitudinally, horizontally or vertically.

Open Spandrel Arch – A bridge having open spaces between the deck and the arch members allowing "open" visibility through the bridge.

Panel – The portion of a truss span between adjacent points of intersection of web and chord members.

Parker Truss – A Pratt truss with a polygonal top chord.

Pennsylvania Petit Truss – A Parker truss with sub-struts and/or sub-ties.

Pier – A substructure unit that supports the spans of a multi-span superstructure at an intermediate location between its abutments.

Pile – A shaft-like linear member that carries loads through weak layers of soil to those capable of supporting such loads.

Pile Bent – A row of driven or placed piles with a pile cap to hold them in their correct positions; see Bent
Pin – A cylindrical bar used to connect chords and web members.

Pin-Connected Truss – A general term applied to a truss of any type having its chord and web members connected at the panel points by pins.

Plate Girder – A large I-beam composed of a solid web plate with flange plates attached to the web plate by flange angles or fillet welds.

Pony Truss – A bridge consisting of a low through truss that has no overhead truss members.

Portal – The clear, unobstructed space of a through-truss bridge forming the entrance to the structure.

Post – A member resisting compressive stresses located vertical to the bottom chord of a truss and common to two-truss panels; sometimes used synonymously with vertical column.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Post-Tensioning – A method of externally prestressing concrete in which the tendons are stressed after the concrete has been cast.

Pratt Truss – A truss with parallel chords and a web system composed of vertical posts with diagonal ties inclined outward and upward from the bottom-chord panel points toward the ends of the truss; also known as N-truss.

Precast Concrete – Concrete that has been cast and cured before being placed into position in a bridge or other structure.

Prestressed Concrete – Concrete in which cracking and tensile forces are greatly reduced by compressing it with tensioned cables or bars.

Pretensioning – A method of prestressing concrete in which the cables are held in a stretched condition until the concrete has hardened, then the pull on the cable is released inducing internal compression into the concrete.

Reinforced Concrete – Concrete with steel reinforcing bars bonded within it to supply increased tensile strength and durability.

Rib – Curved structural member supporting a curved shape or panel.

Rigid Frame Bridge – A bridge with moment-resistant connections between the superstructure and the substructure to produce an integral, elastic structure.

Riveted Connection – A rigid connection of metal bridge members that is assembled with rivets. Riveted connections increase the strength of the structure.

Roller – A steel cylinder intended to provide longitudinal movements by rolling contact.

Safety Hangers – Back-up for original connections to provide redundancy; often added for seismic retrofit.

Seat – A base on which an object or member is placed.

Simple Trunnion – Type of movable bridge consisting of a forward cantilever arm out over the channel and a rear counterweight arm, allowing for the leaf to rotate about the trunnion.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Slab Bridge – A bridge having a superstructure composed of a glue-laminated timber slab or a reinforced concrete slab constructed either as a single unit or as a series of narrow slabs placed parallel to the roadway and spanning the space between the supporting abutments.

Span – The distance between piers, towers, or abutments.

Spandrel – The space bounded by the extrados (exterior curves) of arches and the horizontal member above.

Spandrel Column – A column constructed on the rib of an arch span and serving as a support for the deck of an open spandrel arch.

Spread Footing – A wide footing usually made of reinforced concrete, ideally suited for foundation material with moderate bearing capacity.

Stay – Diagonal brace installed to minimize structural movement.

Suspended Span – A simple span supported from the free ends of cantilevers.

Stirrup – U-shaped bar providing a stirrup-like support for a member in timber and metal bridges; U-shaped bar placed in concrete construction to resist diagonal tension (shear) stresses.

Stringer – A longitudinal beam supporting the bridge deck.

Strut – A piece or member acting to resist compressive stress.

Suspension Bridge – A bridge in which the floor system is supported by catenary cables that are supported upon towers and are anchored at their extreme ends.

Sway Bracing – Diagonal bracing located at the top of a through truss, perpendicular to the truss itself, usually in a vertical plane, and designed to resist horizontal forces.

Swing Span Bridge – A movable bridge in which the span rotates in a horizontal plane on a pivot pier to permit passage of marine traffic.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Tee Beam – A rolled steel section shaped like a T; part of a reinforced-concrete floor in which the beam projects below the slab.

Tension Members – Slender members of a bridge that resist forces that pull them apart.

Three-Hinged Arch – An arch that is hinged at each support and at the crown.

Thrie Beam – Steel plate rolled to form three ridges; used as guardrail.

Through Bridge – A bridge where the floor elevation is nearly at the bottom and traffic travels between the supporting parts.

Tie – A member carrying tension.

Tied Arch – A through arch bridge in which the deck is tied to (suspended from) the arch.

Trestle – A bridge structure consisting of spans supported upon frame bents.

Trunnion – A heavy pin around which rotates leaves and/or counterweights in a movable bridge.

Truss – A jointed structure made up of individual members arranged and connected, usually in a triangular pattern, so as to support longer spans.

Truss Bridge – A bridge having a pair of trusses for the superstructure.

Tunnel – An underground passage open to daylight at both ends.

Turnbuckle – A long, cylindrical, internally threaded nut used to connect the elements of adjustable rods and bar members.

Two-Hinged Arch – A rigid frame that may be arch-shaped or rectangular but is hinged at both supports.

Upper chord – The top longitudinal member of a truss.

Viaduct – A series of spans carried on piers at short intervals.

Vertical Lift Bridge – A movable bridge which can be raised vertically, with the movable span in a horizontal position, by weights and pulleys operating in towers at each end of the structure.

H. Summary of Identification and Evaluation Methods (cont'd.)

(Discuss the methods used in developing the public property listing.)

Warren Truss – A triangular truss consisting of sloping members between the top and bottom chords and having no vertical members; members form the letter W.

Web – The portion of a beam located between and connected to the flanges.

Web Members – The intermediate members of a truss, not including the end posts, usually vertically or inclined.

Welded Joint – A joint in which the assembled elements and members are united through fusion of metal.

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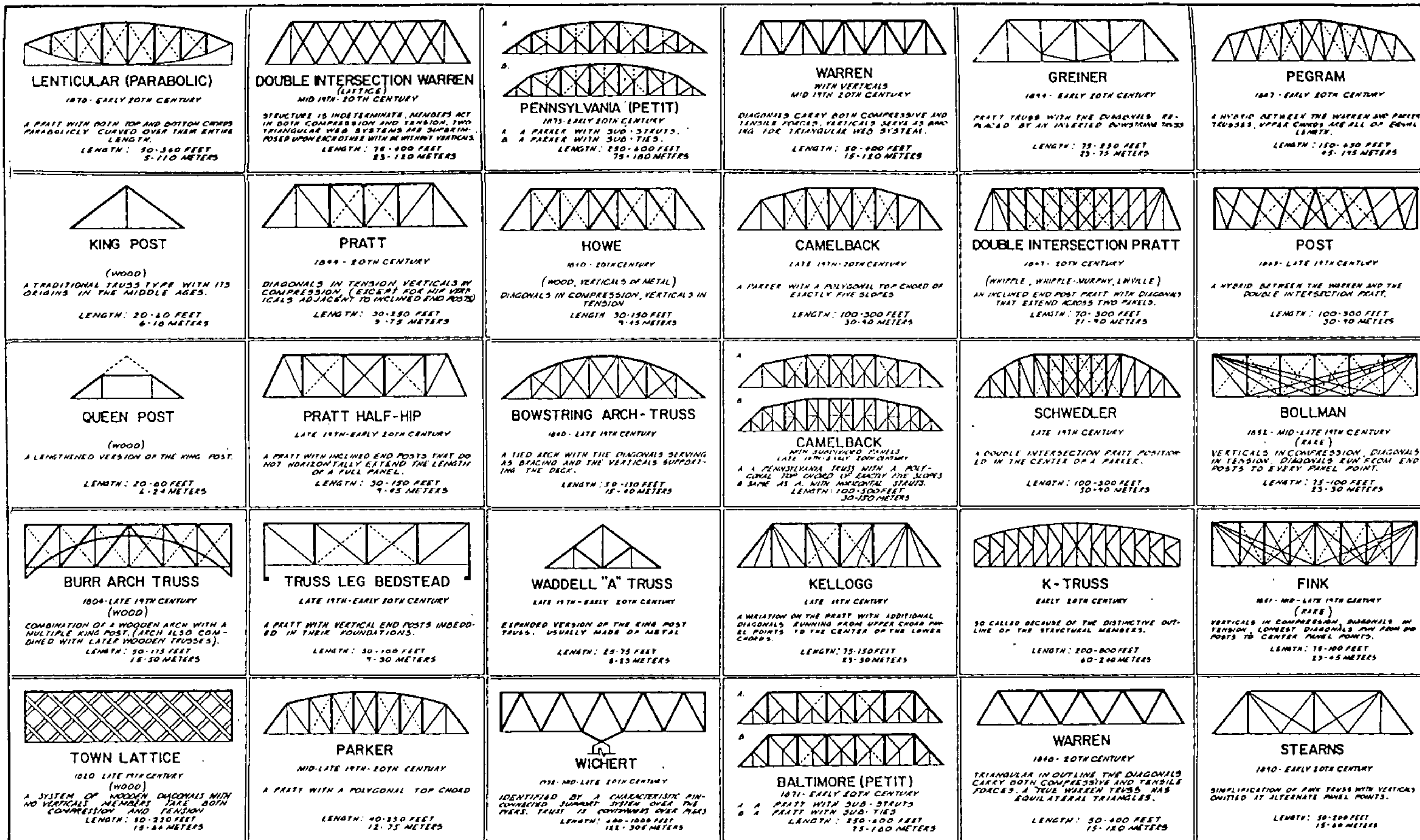

TRUSSES

A STUDY BY THE

HISTORIC AMERICAN ENGINEERING RECORD

OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION
TECHNICAL INFORMATION PROJECT

TRUSS IDENTIFICATION: BRIDGE TYPES

HAER

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