

**National Register of Historic Places
Inventory Nomination Form:
Chittenden (Hiram M.) Locks and
Related Features of the Lake
Washington Ship Canal**

25N 3E 2, 10, 11, 13
25N 4E 16, 17, 18, 19, 20, 21

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NATIONAL REGISTER OF HISTORIC PLACES INVENTORY -- NOMINATION FORM

SEE INSTRUCTIONS IN HOW TO COMPLETE NATIONAL REGISTER FORMS
TYPE ALL ENTRIES -- COMPLETE APPLICABLE SECTIONS

1 NAME

HISTORIC Chittenden (Hiram M.) Locks and Related Features of the Lake Washington Ship Canal

AND/OR COMMON

2 LOCATION

STREET & NUMBER

CITY, TOWN Seattle
STATE Washington
VICINITY OF 1st - Hon. Joel Pritchard
CODE 53
COUNTY King
CODE 033

NOT FOR PUBLICATION

CONGRESSIONAL DISTRICT

3 CLASSIFICATION

CATEGORY	OWNERSHIP	STATUS	PRESENT USE
<input type="checkbox"/> DISTRICT	<input checked="" type="checkbox"/> PUBLIC	<input checked="" type="checkbox"/> OCCUPIED	<input type="checkbox"/> AGRICULTURE
<input checked="" type="checkbox"/> BUILDING(S)	<input type="checkbox"/> PRIVATE	<input type="checkbox"/> UNOCCUPIED	<input type="checkbox"/> COMMERCIAL
<input checked="" type="checkbox"/> STRUCTURE	<input type="checkbox"/> BOTH	<input type="checkbox"/> WORK IN PROGRESS	<input type="checkbox"/> EDUCATIONAL
<input type="checkbox"/> SITE	PUBLIC ACQUISITION	ACCESSIBLE	<input type="checkbox"/> ENTERTAINMENT
<input type="checkbox"/> OBJECT	<input type="checkbox"/> IN PROCESS	<input type="checkbox"/> YES: RESTRICTED	<input type="checkbox"/> GOVERNMENT
	<input type="checkbox"/> BEING CONSIDERED	<input checked="" type="checkbox"/> YES: UNRESTRICTED	<input type="checkbox"/> INDUSTRIAL
		<input type="checkbox"/> NO	<input type="checkbox"/> MILITARY
			<input type="checkbox"/> MUSEUM
			<input type="checkbox"/> PARK
			<input type="checkbox"/> PRIVATE RESIDENCE
			<input type="checkbox"/> RELIGIOUS
			<input type="checkbox"/> SCIENTIFIC
			<input checked="" type="checkbox"/> TRANSPORTATION
			<input checked="" type="checkbox"/> OTHER: Recreation

4 OWNER OF PROPERTY

NAME U. S. Army Corps of Engineers, Seattle District
STREET & NUMBER North Pacific Division
4725 East Marginal Way South

Montlake Cut not owned by Corps but held in perpetual lease from State.

CITY, TOWN Seattle
STATE Washington
VICINITY OF
98134

5 LOCATION OF LEGAL DESCRIPTION

COURTHOUSE, REGISTRY OF DEEDS, ETC. Real Estate Division, Seattle District, U. S. Army Corps of Engineers

STREET & NUMBER 4725 East Marginal Way South

CITY, TOWN Seattle
STATE Washington
98134

6 REPRESENTATION IN EXISTING SURVEYS

TITLE Inventory authorized by Executive Order 11593
"Protection and Enhancement of the Cultural Environment"

DATE April 4, 1972
 FEDERAL STATE COUNTY LOCAL

DEPOSITORY FOR SURVEY RECORDS Department of the Army, Office of the Chief of Engineers

CITY, TOWN Washington
STATE D.C.
20314

7 DESCRIPTION

CONDITION		CHECK ONE	CHECK ONE
<input type="checkbox"/> EXCELLENT	<input type="checkbox"/> DETERIORATED	<input type="checkbox"/> UNALTERED	<input checked="" type="checkbox"/> ORIGINAL SITE
<input checked="" type="checkbox"/> GOOD	<input type="checkbox"/> RUINS	<input checked="" type="checkbox"/> ALTERED	<input type="checkbox"/> MOVED DATE _____
<input type="checkbox"/> FAIR	<input type="checkbox"/> UNEXPOSED		

DESCRIBE THE PRESENT AND ORIGINAL (IF KNOWN) PHYSICAL APPEARANCE

SUMMARY STATEMENT

By making a continuous waterway of man-made channels and inland bodies extending nearly eight miles between Puget Sound and Lake Washington, the Lake Washington Ship Canal opened up a vast fresh-water harbor to ocean-going vessels and thus complemented Seattle's deep-water port facilities in Elliott Bay. The project was conceived and planned over a period of years in cooperation with private enterprise and local government and was completed under auspices of the U. S. Army Corps of Engineers and dedicated in 1917. Its primary components are a fixed dam and double locks and a 17-acre reservation at Salmon Bay in the Ballard District; a channel slightly more than a mile long known as the Fremont Cut, which connects the Salmon Bay Waterway to Lake Union; and a half-mile long channel known as the Montlake Cut, which in turn joins Lake Union to Lake Washington. These engineering features have been little altered since their completion sixty years ago, except for repairs and a normal amount of upgrading, and they have remained under the jurisdiction of the Department of the Army. At the locks site, now officially designated the Hiram M. Chittenden Locks, approximately half of the structures supporting the operation of the locks have been added since the 1940s. However, the initial complex of ten or twelve concrete accessory buildings is intact. Moreover, for the most part, the Corps of Engineers Master Plan for the project provides for the preservation and enhancement of historical elements.

LEGAL DESCRIPTION

The Hiram M. Chittenden Locks of the Lake Washington Ship Canal are located in SE $\frac{1}{4}$ Sec. 10, T.25N., R.3E. and in SW $\frac{1}{4}$ Sec. 11, T.25N., R.3E., of the Willamette Meridian. The engineering feature straddles the Salmon Bay Waterway, and the accompanying government reservation is sited amidst the Ballard Tide Lands on the north shore and the Seattle Tide Lands on the south shore.

The Fremont Cut of the Lake Washington Ship Canal is located in NW $\frac{1}{4}$, NE $\frac{1}{4}$ and SE $\frac{1}{4}$ Sec. 13, T.25N., R.3E., and in SW $\frac{1}{4}$ Sec. 18, T.25N., R.4E., of the Willamette Meridian. The engineering feature traverses the Ross Addition and Denny and Hoyt's Addition to the Plat of Seattle.

The Montlake Cut of the Lake Washington Ship Canal is located in S $\frac{1}{2}$ Sec. 16, T.25N., R.4E., of the Willamette Meridian. The engineering feature is bordered by the University of Washington tract on the north shore and, on the south shore, by the Montlake Park Addition to the Plat of Seattle.

GENERAL CHARACTERISTICS OF THE SITE

The locks and dam are situated athwart the foot of Salmon Bay, originally a tidal inlet, which gives into Shilshole Bay north of Magnolia Head in Puget Sound. To the south of the headland, in Elliott Bay, lies Seattle's principal harbor. Oriented northwest to southeast, the locks and dam span the narrowest section of the Salmon Bay Waterway, where it is some 400 feet across, approximately a mile and a half east of the entrance to Shilshole Bay. When these features raised and stabilized its water level, Salmon Bay ultimately became a freshwater body and the harbor of a sizable fishing fleet. As is pointed out in the Lake Washington Ship Canal Master Plan, lands adjoining the eight-mile waterway between Puget Sound and Lake Washington have been developed for commercial,

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industrial, residential, park and other public purposes, but shoreline use of the canal is predominantly related to the maritime industry. As a consequence, boat ramps and marinas; piers, docks and wharves; marine repair shops and shipbuilding yards are typical developments in the near vicinity of the three separate parcels proposed for nomination. The first parcel of 49 acres embraces the locks and their guide piers, the spillway dam and fish ladder, and grounds owned in fee simple by the U. S. Army Corps of Engineers. The second and third parcels of 38.5 and 20 acres, respectively, are limited to the Corps' fee-owned holdings along the Fremont and Montlake Cuts.

The preponderance of the 17-acre reservation which accompanies the locks lies on the north shore of the waterway, where maintenance and administrative facilities are arranged on a modified grid perpendicular to the waterway. The westerly portion of the reservation rises to an elevation of 45 feet, and sited atop this plateau is the Lock-keeper's House, which currently serves as the residence of the District Engineer. In front of the house, a terraced embankment of dredge spoils falls off toward water grade in 5-foot intervals. A paved concourse parallel with the waterway extends the length of the lawn-covered plateau, and at its westerly end is a viewing platform or overlook with solid concrete railing. This secondary concourse is linked to a private gateway in the northwest corner of the reservation by curvilinear road segments which encompass the residential knoll. In this informally landscaped westerly section of about seven acres is a luxuriant array of mature ornamental and specimen trees, shrubs and bedding plants introduced by grounds-keeper Carl S. English and others in the 1930s and 1940s.

The high ground of the reservation slopes off gradually on the east to level terrain about 20 feet in elevation. Here the maintenance campus is laid out along the main concourse, which is essentially on axis with the spillway dam. Included in this more-or-less formal complex of classically-styled concrete structures designed by the eminent local firm of Bebb and Gould are the administration building, which is the focal point, the machine shop, office and shop building, and mechanics shop. Each of these is clustered around a courtyard which opens onto the locks. Other initial structures, the gas and oil building, carpenter and blacksmith shops and transformer house, are sited to the north in the direction of the east gateway which serves as the visitors' entrance. In the 1940s a number of new structures, some of them temporary in nature, were added on the north and on the less public easterly margin of the maintenance core. Among the newer structures are the boathouse, greenhouse, steel shop, and two large metal-clad warehouses, one of which currently serves as a district garage. An employees' parking lot was developed inside the east entrance and was well screened by plantings. The Master Plan calls for its removal eventually. The grounds are lighted by electroliers on tapered and chamfered concrete standards. However, the original single globe fixtures have been replaced with modern lamps. Public parking is provided outside reservation boundaries along Burlington Northern Railway right-of-way. Reservation boundaries which are not contiguous with the waterway are lined with security fencing.

Little over an acre of the reservation is located at the far end of the spillway dam, on the south shore of the waterway, where a rehabilitated fish ladder and new underwater

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fish viewing room were completed a year ago. Adjoining the westerly end of this segment of the reservation is city-owned land which is being developed for day-use park purposes. In turn, Commodore Park will be linked by trails to the city's Discovery Park, which occupies portions of the Fort Lawton Military Reservation on Magnolia Bluff.

Lake Union is a comparatively small body covering an area of nearly one and a half square miles. Further to the interior, Lake Washington, on the other hand, has an area of 39 square miles and depths that exceed 200 feet. The Fremont Cut, like the Salmon Bay Waterway which it connects to Lake Union, also is angled to the southeast. It follows, generally, the course of an old stream bed between the Fremont District on the north shore and the base of Queen Anne Hill on the south. Taking its name from the former district, the channel is 5800 feet in length and 100 feet wide, although the Corps of Engineers' fee-owned right-of-way is 300 feet wide. The authorized depth of the channel is 30 feet. Concrete revetments on either side of the channel are here and there bolstered by rip-rap. The low banks are lined with single rows of Lombardy poplars which have been aptly described as "colonnades" because they are nearly uninterrupted from the Northern Pacific Railway Bridge on the westerly end to the Fremont Drawbridge on the east. Subsidiary landscaping of an informal nature was undertaken along the banks as a beautification project by the Seattle Garden Club in the 1950s.

The Montlake Cut follows a compass-oriented easterly course of 2500 feet through a narrow neck of land between Lake Union's Portage Bay and Union Bay in Lake Washington. The channel takes its name from the residential district on the south shore. The Montlake District is connected to the University of Washington campus on the north shore via the Montlake Drawbridge, which crosses the canal at right angles near the center. The channel width is 100 feet, although the right-of-way controlled by the Corps of Engineers is typically 325 feet wide. It is dredged to an authorized depth of 30 feet. The tops of the concrete revetments are used as waterside walks, and there are trails also about midway up either steep embankment rising to a height of about 65 feet. On the south shore a recreational trail was recently improved and developed by the Corps of Engineers in cooperation with the Seattle Garden Club. It extends from West Montlake Park on the extreme west end of the channel to Horace McCurdy Park on the east end, and it continues through and beyond the marches of Foster Island to Washington Park.

HIRAM M. CHITTENDEN LOCKS

Construction of the locks and dam was carried out within the protection of two independent coffer dams. The locks were constructed without piles on a bed of hard clay. Concrete work, generally held to have been of exceptionally durable quality, was composed of one part Portland cement, three parts sand, and six parts gravel. The concrete was mixed, lowered into the forms by bottom dump buckets, spread in layers and spaded, but no tamping was required. Particular care was taken to protect the concrete from the action of salt water during the curing process. Detailed descriptions of construction and operating methods are given in W. J. Barden and A. W. Sargent's 1926 paper published by the American Society of Civil Engineers, which is listed among the bibliographical references.

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The following general description is quoted from Lake Washington Ship Canal Master Plan, Design Memorandum 5 (Seattle: Seattle District, U. S. Army Corps of Engineers, April 1976), Section 2, page 7, and Section 4, page 1.

The locks provide a navigation passage between the freshwater portion of the project, at a mean elevation of 21 feet above sea level, and Shilshole Bay, the level of which is determined by tidal action. Depending on the tide, the lift provided by the locks varies from 6 to 20 feet. The structure incorporates two locks, the larger of which is 825 feet long between the upper and lower miter gates, and is 80 feet in width. This lock can be divided into two smaller chambers by an intermediate miter gate. Ocean-going vessels, up to 30 foot draft, can be accommodated through this lock. A salt-water barrier, hinge-mounted to the floor of the lock, is air-operated via manual push-button controls located in the central control tower. The barrier is manually left in a raised position to reduce the intrusion of saltwater into Salmon Bay but is lowered to permit passage of deep-draft vessels. Saltwater which passes into Salmon Bay but is lowered to permit passage of deep-draft vessels. Saltwater which passes into Salmon Bay during lockage settles into a saltwater basin immediately upstream of the large lock. A saltwater drain conduit returns the saltwater by gravity to Shilshole Bay. The saltwater drain conduit inlet is at the bottom of the saltwater settling basin. Flow through the conduit is controlled by an electrically-operated sluice gate at the fishladder.

The small lock, adjacent to and south of the large lock, has a chamber 150 feet long by 30 feet wide, and is used by smaller vessels with drafts up to 16 feet. Floating mooring bitts on both the south and north walls limit the usable width to 28 feet.

The dam which forms the barrier between the small lock wall and the south shore is 235 feet long and has six 32 foot wide spillway openings in which steel radial gates are installed. The three spillway gates located near the south shore are raised and lowered by an electrically-operated, movable hoist, while the three spillway gates located near the locks are equipped with individual electrically-operated gate hoists. Maximum discharge capacity of the spillway at full gate opening is approximately 16,000 c.f.s. (Note: The three south gates are scheduled for automation, and the hoist house will have to be removed.)

A rehabilitated fish ladder on the south shore, complete with a fish viewing room, was recently opened to the public . . . The original fish ladder at the locks was constructed in 1917 . . . It has been undergoing rehabilitation since 1973, at which time the underwater fish viewing room, pedestrian ramps and rest room facilities were planned.

ACCESSORY STRUCTURES

1. Lockkeeper's House (1913). First permanent building completed on the reservation. Two sheets of drawings for the building among project records stored on the site are dated December 1912. Not prepared by local architect Carl F. Gould as once supposed, the plans evidently were the concept of C. A. D. Young, "Jun. Engineer". A simple, rectangular construction with stuccoed hollow tile walls. Originally measured 26 x 35 feet. Two

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stories with shingled gable roof and overhanging eaves with exposed rafters. Certain details apparently derived from the Craftsman Bungalow, cross-axial frontal gable; shed-roofed rear dormer. Brick end chimneys with corbelled caps. Porches have hipped roofs with shaped outriggers. Regular fenestration. Single and coupled double-hung sash windows with nine lights over one.

In 1966 the interior was remodeled; partitioning was revised and one of the fireplaces was removed. Externally, the upgrading was discreet. Among the results: new roof cover of composition shingles, conversion of front ground story windows to bay windows within original openings, addition of a bedroom and carport to the rear pantry and stoop. In 1967 the house was dedicated as the official residence of the Seattle District Engineer and renamed in honor of Colonel James B. Cavanaugh, U. S. Army Corps of Engineers District Engineer during the construction of the Lake Washington Ship Canal 1911-1917. The Master Plan calls for no further changes except possible additional buffer planting to increase privacy.

2. Administration Building (1914-1915). The solitary initial multi-purpose public building on the reservation and the focal point, it called for extraordinary design effort. Ten sheets of plans and elevations dated 1914 and prepared by Carl F. Gould of the eminent local firm of Bebb and Gould are among project records stored on the site. Rectangular plan measuring 47 x 67 feet. Reinforced concrete construction. Two stories and basement. Tile-clad hipped roof with central deck. Second Renaissance Revival Style. Basement contains the pumping plant for unwatering or emptying the locks for annual repairs and the original electrical distribution panel, which is intact but functionally superseded. Ground story has cross-axial corridors with central lobby space and principal offices in each corner. Lobby is open to second story gallery. Oval ceiling light of textures and colored glass. Terrazzo floor with geometric trim of Alaska and verde antique marble. Centered in lobby floor is a brass plaque in the form of the battlemented structure which serves as the logogram of the U. S. Army Corps of Engineers. Further federal iconography is found in the lobby entablature, which is decorated with shields, and in the wrought iron gallery railing, where cast iron American eagle emblems are centered in each section. Interior walls and ceilings, including coved cornices, are plaster-finished. Woodwork, including door and window trim, baseboards, pilasters, ogee wall panel moldings, and Ionic stave columns flanking the main entry vestibule, is varnished oak. Second story storerooms open onto the central gallery.

Each exterior elevation has tripartite organization. Walls are topped with a decorative concrete parapet. Second story windows are covered with cast-iron grilles. Ground story arcuated windows and central pedimented doorways are in panels of concrete set off from the major wall surface by special texturing with a bush hammer. The main entry on the southwest, or waterway face is recessed behind a two-story portal arch and surrounded by plate glass fronted by cast iron grilles. Surmounting either bulkhead of the concrete steps of this entrance are light globes mounted on fluted concrete drums with dolphin-supported bronze fittings. These are noteworthy because they are the only external lighting fixtures on the reservation which have remained wholly intact.

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The building has been only superficially altered, mostly on the interior. The Master Plan calls for some restoration and upgrading, including the replacement of window sash to match the original, cleaning and sealing masonry, and refinishing woodwork as required. While primary visitor-information functions will be shifted elsewhere, the building's basement pumping plant will be open to the public as an exhibit area. A basement stairway access from the exterior and additional interior lighting are among the few improvements planned.

3. Operating Houses, Nos. 1, 2, 3, and 4 (1914). Nos. 1 through 3 are on the north lock wall. No. 4 is situated on the middle lock wall. Single-story structures of reinforced concrete measuring 14 x 21 feet. Rectilinear domed roofs. Wrap-around corner window bays with transom grilles. Original purpose was to control locks. Functionally superseded by central Control Tower but still operable. Master Plan calls for retention and reconditioning.

4. Mechanics Shop (1914). Single story structure of reinforced concrete measuring 18 x 56 feet. Built up roof. Base mold, entablature and other details in the classical tradition conform to the simple utilitarian style of the original group of accessory buildings. Current use: storage and locker room.

5. Transformer House (1914). Single story structure of reinforced concrete measuring 25 x 33 feet. Built up roof. Contains transformers and emergency generator. The only one of the original accessory buildings to have a compass orientation rather than conforming to the grid perpendicular to the waterway. Openings of the west facade are outlined with continuous plain moldings under segmental arch heads. Entablature, belt molds and base in the classical tradition conform to the simple utilitarian style of the original group of accessory buildings. Pedimented hood over central doorway. Master Plan calls for minor restoration and cleaning.

6. Office and Shop Building (1916). Warehouse of the original group of accessory buildings. Reinforced concrete construction measuring 36 x 80 feet. Two stories. Built up roof. Details in classical tradition conform with established pattern. Later single story paint shop additions on north end doubled the building's length. Aluminum window sash has been substituted for original and is to be replaced.

7. Machine Shop (1916). Reinforced concrete construction measuring 30 x 85 feet. Two stories. Built up roof. Entablature, belt molds and base in classical tradition conform to the simple utilitarian style of the original group of accessory buildings. Aluminum window sash has been substituted for original and is to be replaced.

8. Gas and Oil Building (1916). Single story structure of reinforced concrete measuring 14 x 22 feet. Built up roof. Contains 600 and 315-gallon gasoline tanks. Exterior details in classical tradition conform to the simple utilitarian style of the original group of accessory buildings.

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9. Carpenter and Blacksmith Shops (1921). Reinforced concrete construction measuring 31 x 91 feet. Two stories. Built up roof. Entablature, belt molds and base in classical tradition conform to the pattern established by the original accessory buildings. This building appears to have replaced temporary frame structures on the site. Master Plan calls for interior renovation as a visitors' interpretive center, and nearly all improvements will be confined to the interior. However, the exterior will be cleaned and sealed and doors and window sash will be replaced along original lines.
10. Emergency Dam Hoist House (1922). Single story structure of reinforced concrete measuring 20 x 20 feet exclusive of bayed south elevation. Built up roof. Contains emergency dam hoists and saltwater barrier air compressor. Entablature and base in classical tradition conform to pattern established by the original group of accessory buildings. Minor restoration or reconditioning is planned.
11. Steel Shop (1941). Metal-clad steel frame construction measuring 40 x 102 feet. Built-up roof. Used for steel fabrication, locker room.
12. Warehouse No. 2 (1941). Metal-clad steel frame construction measuring 50 x 160 feet. Built-up roof. Used as storage and office space.
13. District Garage (1941). Metal-clad steel frame construction measuring 50 x 160 feet with 20 x 25 foot washrack addition on SE corner. Built up roof. District garage and maintenance shops.
14. Public Comfort Station (1947). Single story reinforced concrete construction measuring 14 x 58 feet. Master Plan proposes that built up roof be developed as viewing deck. Situated west of Administration Building overlooking locks.
15. Boathouse (1949). Wood frame construction measuring 55 x 79 feet. Exterior stuccoed and painted grey to achieve certain compatibility with neighboring structures of concrete. Houses steam-powered sternwheeler snagboat W. T. Preston and other vessels under Corps jurisdiction used in snagging and dredging operations.
16. Greenhouse (1949). Single story wood frame construction with double-pitched roof measuring 15 x 15 feet. Adjoining 15 x 34 foot glass panel structure.
17. Gatehouse (1949). Single story 7 x 7 foot wood frame structure at visitors' entrance. Master Plan calls for eventual removal and replacement with a new guard office to be coordinated with a re-designed entry way.
18. Open Storage Shed (1940s?). 25 x 125 feet. Adjacent to east boundary. Not highly visible. Compass orientation nonconforming with majority of maintenance complex.
19. Quonset Hut (1949). 36 x 60 feet. Located in NE corner of maintenance area. Not highly visible. Compass orientation nonconforming with majority of maintenance complex.

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Master Plan calls for removal to allow development of less visible parking area.

20. Control Tower (1969). On middle lock wall. 19 x 24 feet. Base, or ground story of reinforced concrete. Overhanging, glass-enclosed steel-frame observation story. Purpose is to centralize control of locks. Master Plan calls for retention as primary communications and navigation control structure. However, extensive modifications are contemplated to make its angular lines visually conformable with the early concrete buildings.

8 SIGNIFICANCE

PERIOD	AREAS OF SIGNIFICANCE -- CHECK AND JUSTIFY BELOW			
<input type="checkbox"/> PREHISTORIC	<input type="checkbox"/> ARCHEOLOGY-PREHISTORIC	<input type="checkbox"/> COMMUNITY PLANNING	<input checked="" type="checkbox"/> LANDSCAPE ARCHITECTURE	<input type="checkbox"/> RELIGION
<input type="checkbox"/> 1400-1499	<input type="checkbox"/> ARCHEOLOGY-HISTORIC	<input type="checkbox"/> CONSERVATION	<input type="checkbox"/> LAW	<input type="checkbox"/> SCIENCE
<input type="checkbox"/> 1500-1599	<input type="checkbox"/> AGRICULTURE	<input type="checkbox"/> ECONOMICS	<input type="checkbox"/> LITERATURE	<input type="checkbox"/> SCULPTURE
<input type="checkbox"/> 1600-1699	<input checked="" type="checkbox"/> ARCHITECTURE	<input type="checkbox"/> EDUCATION	<input checked="" type="checkbox"/> MILITARY	<input type="checkbox"/> SOCIAL/HUMANITARIAN
<input type="checkbox"/> 1700-1799	<input type="checkbox"/> ART	<input checked="" type="checkbox"/> ENGINEERING	<input type="checkbox"/> MUSIC	<input type="checkbox"/> THEATER
<input type="checkbox"/> 1800-1899	<input checked="" type="checkbox"/> COMMERCE	<input type="checkbox"/> EXPLORATION/SETTLEMENT	<input type="checkbox"/> PHILOSOPHY	<input checked="" type="checkbox"/> TRANSPORTATION
<input checked="" type="checkbox"/> 1900-	<input type="checkbox"/> COMMUNICATIONS	<input type="checkbox"/> INDUSTRY	<input checked="" type="checkbox"/> POLITICS/GOVERNMENT	<input type="checkbox"/> OTHER (SPECIFY)
		<input type="checkbox"/> INVENTION		

SPECIFIC DATES 1906-1917

BUILDER/ARCHITECT District Engineers: Hiram M. Chittenden (planning and promotion) and James B. Cavanaugh (supervisor of construction). A. W. Sargent was Assistant Engineer in Charge of Construction during the construction phase 1911-1917.

STATEMENT OF SIGNIFICANCE

SUMMARY STATEMENT

The Lake Washington Ship Canal is significant to Seattle, the state and the nation as a major engineering achievement completed under government auspices which added more than 90 miles to the city's waterfrontage accessible to ocean-going vessels. Following decades of visionary planning and failed attempts along such lines, the project realized by the U. S. Army Corps of Engineers in 1917 connected Puget Sound with a series of inland bodies free from tidal fluctuations and destructive marine life. The resulting fresh-water harbor extending over some 25,000 acres combines with Seattle's saltwater harbor in Elliott Bay to provide navigational facilities rated among the finest of any port in the country.

The workable plan for the canal and locks was delineated and promoted by Major Hiram M. Chittenden, Seattle District Engineer 1906-1908. Both the project endorsed by the Department of the Army and various alternative schemes were embraced by the business community with an enthusiasm which epitomized the booster spirit of Seattle in the early years of the century. That ocean-going freighters and barges could be permitted to load and unload near industrial sites developing on the shores of Lake Union and Lake Washington was felt to enhance the city's growing image as the transportation center of the Puget Sound region and a break-of-bulk point for domestic, coastal and international trade. The project was executed under the supervision of Colonel James B. Cavanaugh, District Engineer 1911-1917, and Arthur W. Sargent, Assistant Engineer in charge of construction. Among local figures closely associated with the project were Charles Herbert Bebb and Carl F. Gould, partners in a leading architectural firm which laid out the maintenance campus on the government reservation at the locks.

With its fixed dam and double locks and right-of-way stretching nearly eight miles, the Lake Washington Ship Canal for many years was generally regarded second in scope only to the multiple locks and 50-mile-long canal completed across the Isthmus of Panama by the U. S. government 1904-1914. While the size of Seattle's locks has since been superseded in the continental United States (on the Ohio and Mississippi River, for example), few, if any, of the later locks are believed to handle more vessels in a given year. The facilities officially designated the Hiram M. Chittenden Locks in 1956 are operated on a 24-hour daily basis. While naval and commercial craft, fishing boats and log rafts play a significant role in locks usage, pleasure craft, which have proliferated since the Post War years, now make up the bulk of traffic.

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BACKGROUND OF THE PROJECT

As is repeatedly pointed out, the notion of a navigable waterway joining Puget Sound to Lake Union and Lake Washington is nearly as old as settlement in the area. Seattle pioneer Thomas Mercer is credited with the first documented public expression on the subject. In 1854, during a Fourth of July picnic, he cited the advantages of such a canal and, referring to the union of lakes and bays, he proposed names ultimately associated with the inland bodies.

The concept first received federal recognition in 1867 when a Board of Engineers for the Pacific Coast, headed by Lieutenant Colonel Barton S. Alexander, was charged with recommending a site for a naval station in Puget Sound waters. One location under consideration was the freshwater basin of Lake Washington, access to which would require the construction of a ship canal. From that point forward sporadic attempts were made by local citizens to gain the support of the Department of the Army and Congress for construction of the canal. Private improvement companies were formed, founded and dissolved. Meanwhile, the selection of a route - whether northerly via Salmon Bay and Lake Union, or to the south via the mouth of the Duwamish River - remained controversial.

In 1890 Congress made its first appropriation for the proposed commercial waterway in Seattle, and a survey was authorized to locate the most feasible route. The government survey report, dated December 15, 1891, considered five possibilities, of which the present general route beginning at Shilshole Bay was preferred as having the best alignment and potential for being the least costly. The City of Seattle and King County proceeded to acquire right-of-way while further investigations and reports on appropriate routings were made.

The involvement of the U. S. Army Corps of Engineers in the project on a lasting basis is marked from the beginning of Major Hiram Chittenden's term as District Engineer. In 1906 Congress authorized the construction by private capital of a canal with a single timber lock at Salmon Bay proposed by local citizen James A. Moore. In a report on the Moore proposal dated December 1906, Chittenden itemized the government's interest in the matter. In essence, the government would be concerned with the commercial promise of a navigable waterway and would benefit indirectly from the lowering of the waters of Lake Washington. The latter would facilitate flood control and drainage of swamp lands. In his report Chittenden also recommended significant changes in the nature and placement of the lock, advocating a double lock of more permanent masonry construction. If located at the narrows near the outlet of Salmon Bay, it would raise Salmon Bay out of tidal influence and lower Lake Washington waters to the level of the intervening body, Lake Union. Chittenden provided arguments which reversed the Army's prior negative findings on the feasibility of the project. The absence of tidal action would simplify cargo loading and unloading on the inland waters; Lake Union would offer a placid winter refuge for the fishing fleet, and fresh water would cleanse destructive teredos and barnacles from the hulls of ocean-going vessels without the expense of dry-docking. Thus, the notion that the federal government would assume primary responsibility for the undertaking was firmly implanted.

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The existing project was based on the detailed annual report on the proposed Lake Washington Canal filed by Chittenden in December 1907. Because the government-endorsed northerly route was attacked by Ballard lumber mill operators who did not wish to relinquish their tideland sites and by partisans of the southerly route through newly filled and platted tidelands along the Duwamish estuary, the canal routing controversy dragged on for several years. The stalemate was eventually broken, but not before Chittenden's forced retirement due to disability early in 1910. Reginald H. Thompson, the City Engineer who master-minded Seattle's grandest public improvement schemes, and the Chamber of Commerce were important advocates of Chittenden's initial recommendations. The cause was finally won in June 1910, when Congress appropriated \$2,275,000 for construction according to specifications in the District Engineer's annual report of 1907.

Construction was commenced under the direction of a successor, Colonel James B. Cavanaugh, in September 1911. Ground was broken for the locks on November 10 of that year. In February 1913 the first concrete was deposited in the forms. The gates of the completed locks were closed July 12, 1916, and the filling of Salmon Bay began. Lake Washington was lowered to the level of Lake Union by October of that year. The Fremont Cut was opened between Salmon Bay and Lake Union in the same month. On May 8, 1917 the Montlake Cut between Lakes Union and Washington was opened in the near vicinity of the abandoned portage excavated by the Lake Washington Improvement Association. The entire project was dedicated with due ceremony on July 4, 1917, during which time the 184 foot Roosevelt, the flagship of Commodore Robert E. Perry's Arctic Expedition of 1907, led a parade of traffic through the locks.

At the time of the dedication the cost of the project was reported to have reached a total of \$5,000,000. In addition to right-of-way acquisition costs, the City of Seattle bore the expense of building new bridges, sewer and water tunnels and regrading streets where necessary. The major costs were divided between the State of Washington and King County, for acquisition of right-of-way and excavation and construction upstream from the locks, and the federal government, which constructed the locks and accessory works.

HIRAM M. CHITTENDEN - CHAMPION OF THE LAKE WASHINGTON SHIP CANAL

Hiram M. Chittenden (1858-1917), a native of New York, was graduated from West Point with high honors as a second lieutenant of engineers in 1884. Thereafter he completed a three year course in the Engineer School of Application, was made a first lieutenant, and was ordered to Omaha as engineer officer of the Department of the Platte. Thus embarked upon a lifetime career as an army engineer, he would soon gain recognition as a conservationist and historian. Chittenden first achieved national acclaim in 1897 for a massive report advocating federal construction of irrigation dams which is said to have become the basis of the Newland Act of 1902. After serving in the Spanish-American War he was returned to Yellowstone Park, where he took charge of completing the road system he earlier had helped lay out. In 1904 he was promoted to the rank of major, and soon after was appointed to the federal commission to locate the boundaries of Yosemite Park. Chittenden was an early advocate of the concept of multiple-purpose

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resource use which is widely applied today. Among his substantial publication credits are The Yellowstone National Park (1895), The History of Early Steamboat Navigation on the Missouri River (1903), The Life, Letters and Travels of Father Pierre Jean de Smet (1905), and, his monumental work, The American Fur Trade of the Far West (1902).

Among the projects which Chittenden directed during his active period as Seattle District Engineer, 1906-1908, next in importance to the Lake Washington Ship Canal was planning and construction of 14 miles of the 25 mile tourist road from the western boundary of Mount Rainier National Park to Camp of the Clouds. From his predecessor he inherited the on-going task of constructing fire control towers for the coastal artillery batteries at Forts Flagler, Casey and Worden which comprised the defenses for Seattle and its harbor in Elliott Bay.

Throughout his later years Chittenden suffered from a debilitating paralysis (locomotor ataxia), but his astonishing capacity for work seldom flagged. By the middle of 1908, however, his condition had worsened to such an extent that he was forced to withdraw from normal duty. At the urging of several of his associates in the Ship Canal project, including City Engineer Reginald Thompson, Secretary of the Interior Richard Ballinger, a former Seattle Mayor, and others interceded on his behalf and succeeded in securing Chittenden's promotion to the rank of brigadier-general prior to his disability retirement on February 10, 1910. Despite his frail health, Chittenden continued to write (War or Peace, Flood Control, and a revised and expanded edition of his guidebook to Yellowstone National Park) and to take part in public life as president of the Seattle Port Commission, 1911-1915.

A NOTE ON THE ARCHITECTURAL FIRM OF BEBB AND GOULD

Charles Herbert Bebb (1856-1942) and Carl F. Gould (1873-1939) were leaders of the architectural community in Seattle. Their selection to lay out and design the complex of concrete accessory buildings on the government reservation at the ship canal locks was fitting. The ten or more initial buildings on the site have a range of refinement along classical lines, but they are solid and straightforward in a manner appropriate to their function and setting along the massive lock walls.

Bebb, a native of England, was educated at Kings College, London, and the University of Lausanne, Switzerland, where he studied engineering. He emigrated to the United States in 1880 and was first employed as a construction engineer by the Illinois Terra Cotta Company of Chicago. From 1885 to 1890 he served as supervisor of construction for the eminent architectural firm of Adler and Sullivan. Bebb was the first Washington architect to be elected a Fellow of the American Institute of Architects. He helped organize the Washington State Chapter of the AIA in 1894 and served several terms as its president. From 1911 to 1935 Bebb served as Consulting Architect for the State Capitol Group in Olympia. In 1915, a year or two after he and Gould commenced a long and fruitful partnership, the firm was given charge of the University of Washington Campus Plan. Gould helped found the University of Washington's School of Architecture and was first chairman of the department.

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Gould, a native of New York City, was graduated from the Harvard School of Architecture in 1898 and thereafter spent four years (1899-1903) at the Ecole des Beaux Arts in Paris. On his return to the United States he was employed by the eminent New York architects McKim, Mead and White. Later, he became a member of the New York firm of Carpenter, Clair and Gould. He arrived in Seattle around the time of the Alaska-Yukon-Pacific Exposition of 1909, or shortly before. Gould too became active in the affairs of the Washington State Chapter of the AIA. Among other noted works by Bebb and Gould in Seattle are the Modernistic Seattle Art Museum (1932), the annex of the Rainier Club (1929), the U. S. Marine and Virginia Mason Hospitals, and the Olympic Hotel, designed in cooperation with the George B. Post Company of New York.

9 MAJOR BIBLIOGRAPHICAL REFERENCES

- Interview, February 9, 1977: Jim Newman, Environmental Planner, Seattle District, U. S. Army Corps of Engineers.
Interview, February 22, 1977: Robert Frey, Real Estate Division, Seattle District, U. S. Army Corps of Engineers.
Lake Washington Ship Canal Master Plan, Design Memorandum 5 (Seattle: Seattle District, U. S. Army Corps of Engineers, April 1976). Includes summary history, early view and

(continued on attached sheet)

10 GEOGRAPHICAL DATA

ACREAGE OF NOMINATED PROPERTY Locks, 49.09; Fremont Cut, 38.5; Montlake Cut, 20.3.
UTM REFERENCES Total acreage of three parcels: 107.89.

A	ZONE	EASTING	NORTHING	B	ZONE	EASTING	NORTHING
C	ZONE	EASTING	NORTHING	D	ZONE	EASTING	NORTHING

VERBAL BOUNDARY DESCRIPTION

See attached sheet

LIST ALL STATES AND COUNTIES FOR PROPERTIES OVERLAPPING STATE OR COUNTY BOUNDARIES

STATE	CODE	COUNTY	CODE
STATE	CODE	COUNTY	CODE

11 FORM PREPARED BY

NAME / TITLE

Elisabeth Walton Potter, Historic Preservation Specialist

ORGANIZATION

Office of Archaeology and Historic Preservation

DATE

March 1977

STREET & NUMBER

111 West 21st Avenue

TELEPHONE

(206) 753-4117

CITY OR TOWN

Olympia

STATE

Washington 98504

12 STATE HISTORIC PRESERVATION OFFICER CERTIFICATION

THE EVALUATED SIGNIFICANCE OF THIS PROPERTY WITHIN THE STATE IS:

NATIONAL

STATE

LOCAL

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the National Park Service.

STATE HISTORIC PRESERVATION OFFICER SIGNATURE

TITLE

DATE

FOR NPS USE ONLY

I HEREBY CERTIFY THAT THIS PROPERTY IS INCLUDED IN THE NATIONAL REGISTER

DATE

DIRECTOR, OFFICE OF ARCHEOLOGY AND HISTORIC PRESERVATION
ATTEST:

DATE

KEEPER OF THE NATIONAL REGISTER

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ITEM NUMBER 9 PAGE 2

- plot plans of the project. For the most part, proposed developments are designed to preserve and promote public appreciation of the historical features.
- Larson, Suzanne B., "Dig the Ditch!" The History of the Lake Washington Ship Canal (Boulder, Colorado: Western Interstate Commission for Higher Education, 1975). Useful distillation of secondary sources, including annual reports of the Chief of Engineers, pertinent Congressional documents, special reports, monographs, and articles. Includes selective bibliography and identifies pertinent material in local repositories.
- Lake Washington Ship Canal and Hiram M. Chittenden Locks (Seattle: Seattle District, U. S. Army Corps of Engineers, July 1974). Interpretive brochure.
- Carl S. English, Jr. Gardens at the Hiram M. Chittenden Locks, Lake Washington Ship Canal (Seattle: Seattle District, U. S. Army Corps of Engineers, December 1974). Interpretive brochure.
- The Lake Washington Ship Canal Fish Ladder (Seattle: Seattle District, U.S. Army Corps of Engineers, 1976). Interpretive brochure.
- Barden, W. J., and A. W. Sargent, "The Lake Washington Ship Canal, Washington." Presented at the meeting of the Waterways Division in Seattle July 15, 1926. Published as paper No. 1679 in Transactions of the American Society of Civil Engineers. Also found in American Society of Civil Engineers Proceedings, Vol. 53, No. 2 (August 1927), 1227-1255. Detailed description of project features and methods of construction.
- Lake Washington Ship Canal (Seattle: Seattle District, U.S. Army Corps of Engineers, 1939.) Illustrated typescript updating history and description of design and construction features. Format based upon Barden and Sargent's report.
- Purvis, Neil H., "History of the Lake Washington Canal," Washington Historical Quarterly, Vol. 25, No. 2 (April 1934), 114-127; Vol. 25, No. 3 (July 1934), 210-213.
- Dodds, Gordob N., Hiram Chittenden: His Public Career (Lexington, Kentucky: The University Press of Kentucky, 1973). Especially Chapter 6, pages 128-154, pertaining to Chittenden's span as Seattle District Engineer 1906-1910 and the planning of the project.
- Chittenden, Gen. H. M., U.S. Army, Retired, The Lake Washington Canal: What it Will Mean to the People (Seattle: Chamber of Commerce, ca. 1914). 4 pages. Written during his term as president of the Port Commission of Seattle, this is a synthesis of arguments in favor of the project which Chittenden earlier developed as the Army Corps of Engineers' Seattle District Engineer. Published as a promotional leaflet by the Chamber of Commerce, the canal's most ardent supporter in the private sector.
- Johnson, Allen, and Dumas Malone, eds., Dictionary of American Biography (New York: Charles Scribner's Sons, 1958), Vol. 2, C177-178. Note on Hiram Martin Chittenden.
- Illustrated souvenir invitation to the formal observance of the opening of the Lake Washington Canal, July 4, 1917. Data prepared and printed by the Publicity Bureau, Seattle Chamber of Commerce and Commercial Club.
- McDonald, Lucile, "Now the Name is 'Hiram M. Chittenden Locks': Change Honors Designer of Marine Landmark at Ballard," Seattle Sunday Times Magazine Section (Sept. 16, 1956), 2.
- Rumley, Larry, "The Ballard Locks: How they Work", Seattle Sunday Times Magazine Section (April 25, 1965), 10-11.

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VERBAL BOUNDARY DESCRIPTION

Hiram M. Chittenden Locks

Beginning at a point on the SW corner Lot 1, Block 13 of Ballard Tide Lands; thence southeasterly along the southerly lot lines of Lots 1 through 5 of said Block 13 to the SE corner of Lot 5 of said Block; thence north to the southerly boundary of the Great Northern Railway* right-of-way; thence northeasterly along said railway right-of-way boundary to a point approximately 7 feet east of the projection north of the east lot line of Lot 2, Block 11, Ballard Tide Lands; thence north 17.5 feet to the southerly boundary of the Great Northern Railway right-of-way; thence northeasterly along said railway right-of-way boundary to the projection north of the east lot line of Lot 4, Block 11, Ballard Tide Lands; thence south along said projected line to the SE corner of Lot 4; thence east in a perpendicular direction along the U.S. Pierhead Line 1050 feet to the projection south of the west boundary of 26th Avenue N.W.; thence south across the Salmon Bay Waterway 750 feet to the State Harbor Line; thence west along the State Harbor Line and northwesterly along the north lot lines of Lots 1 through 4 of Block 7, Seattle Tide Lands to a point approximately 45 feet west of the projection north of the east boundary of 31st Avenue West; thence southwesterly in a line perpendicular to the Waterway 100 feet; thence northwesterly in a line parallel with the Waterway 535.88 feet; thence north approximately 105 feet to the U.S. Pierhead Line; thence northwesterly along said Pierhead Line to the projection south of the east boundary of 34th Avenue N.W.; thence north along said projected line approximately 350 feet across the Salmon Bay Waterway to the point of beginning.

*Burlington Northern Railway current owner

Fremont Cut Parcel

Beginning at a point on the northerly State Harbor Line of the Lake Washington Ship Canal approximately 25 feet southeast of the Northern Pacific Railway Bridge right-of-way (which point is the SW corner of Lot 8, Block 1, Seattle Tidelands); thence southeasterly along said State Harbor Line 5540 feet to a point approximately 280 feet southeasterly of the Fremont Bridge right-of-way; thence southwesterly 300 feet across the canal to a point on the southerly State Harbor Line which is approximately 105 feet southeasterly of the Fremont Bridge right-of-way; thence northwesterly along said State Harbor Line 5810 feet to a point 7.98 feet southeasterly of the NE corner of Lot 12, Block 13, Ross Addition; thence southeasterly in a line parallel with the northerly lot line of said Lot 12 approximately 200 feet; thence northeasterly 266.59 feet to the point of beginning.

Montlake Cut Parcel

Beginning at the SE corner of Block 18-A of the 2nd Supplement, Lake Union Shore Lands; thence south to a point 48.56 feet south of the north U.S. Bulkhead and Pierhead

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Line of the Lake Washington Ship Canal; thence in a southeasterly direction 552.73 feet to a point 151.76 feet south of said U.S. Bulkhead and Pierhead Line; thence east along a line parallel with said U.S. Bulkhead and Pierhead Line 2069.44 feet; thence in a southwesterly direction approximately 485 feet across the canal to a point on the south boundary line of Section 16, T.25N., R.4E., W.M., approximately 240 feet east of the quarter corner of Section 16; thence west along said Section boundary line 2229.76 feet; thence in a northwesterly direction approximately 510 feet across the canal to a point on the north U.S. Bulkhead and Pierhead Line approximately 55 feet west of the point of beginning; thence east along said U.S. Bulkhead and Pierhead Line to the point of beginning.

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HISTORIC Chittenden (Hiram M.) Locks and Related Features of the Lake Washington
Ship Canal

AND/OR COMMON

2 LOCATION

CITY, TOWN Seattle VICINITY OF COUNTY King STATE Washington

3 MAP REFERENCE

SOURCE Kroll Map Company Atlas of Seattle. Pages 10E and 11W (Locks); 21W, 21E and
22W (Fremont Cut); 24W and 24E (Montlake Cut).
SCALE 1 inch = 200 feet DATE undated

4 REQUIREMENTS

TO BE INCLUDED ON ALL MAPS

1. PROPERTY BOUNDARIES
2. NORTH ARROW
3. UTM REFERENCES

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3 PHOTO REFERENCE

PHOTO CREDIT Elisabeth Walton Potter DATE OF PHOTO February 1977

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P.O. Box 1128, Olympia, WA 98504

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PHOTO NO. 2 thru 10

- 2 of 13 Salmon Bay Waterway. Looking northwest from south bank past City of Seattle's Commodore Park development toward Shilshole Bay and Puget Sound.
- 3 of 13 Hiram M. Chittenden Locks. Looking southeast at large lock. Control Tower (1969) on right.
- 4 of 13 Hiram M. Chittenden Locks. Looking north from lock wall at Administration Building (1914) and Operating House No. 2 (1914). Machine Shop (1916) is in the distance.
- 5 of 13 Hiram M. Chittenden Locks. Administration Building (1914), northeast and northwest elevations.
- 6 of 13 Hiram M. Chittenden Locks. Left to right: Administration Building (1914), Control Tower (1969), Spillway Dam and Housing for Spillway Gate Hoisting Machine, and Fish Ladder ramp (1976).
- 7 of 13 Hiram M. Chittenden Locks. Looking southeast at Operating House No. 1 (1914), Emergency Dam Hoist House and Emergency Dam Storage (1922).
- 8 of 13 Hiram M. Chittenden Locks. Transformer House (1914), west face. District Garage (1941) in background. Steel Shop (1941) on right.
- 9 of 13 Hiram M. Chittenden Locks. Carpenter and Blacksmith Shops (1921), southeast corner view.
- 10 of 13 Hiram M. Chittenden Locks. Locks Superintendent's Residence (1913), southwest view.



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LAKE WASHINGTON SHIP CANAL, SEATTLE
KING COUNTY, WASHINGTON

HIRAM M. CHITTANDAM LOCKS
LOOKING EAST TOWARD SALMON BAY, BALLARD BRIDGE,
AND CANAL TO LAKE UNION BEYOND.

M.(?) AND S. PHOTO NO. 59124 CIRCA. 1919-1920

LEFT TO RIGHT IN LOCKS COMPLEX:

TRANSFORMER STATION, TAMPORARY SHOP BUILDINGS,
LOCKS SUPERINTENDANT'S RESIDENCE, MACHINE SHOP,
OFFICE AND SHOP BUILDING, ADMINISTRATION BUILDING,
LARGE AND SMALL LOCKS, SPILLWAY DAM.

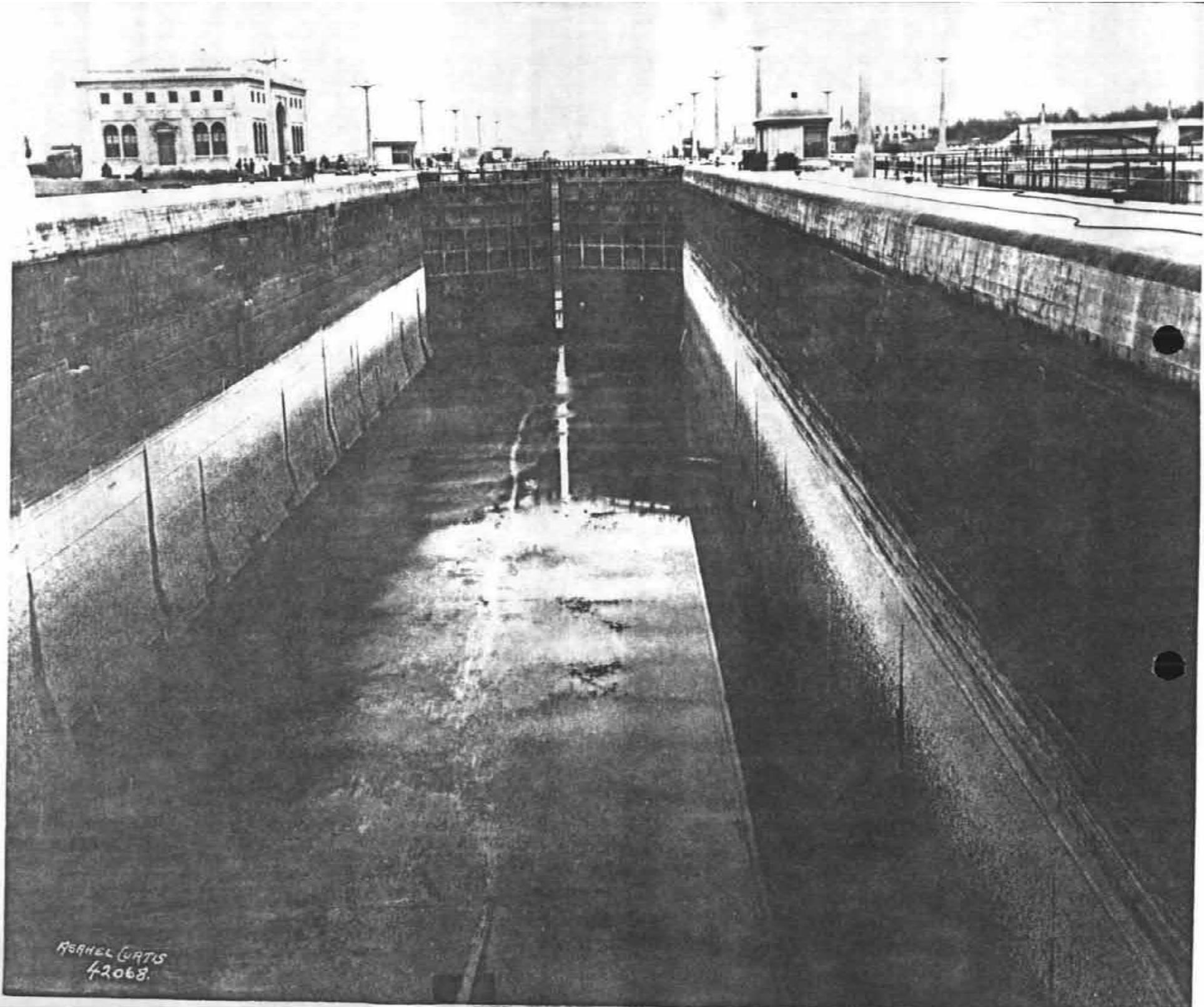
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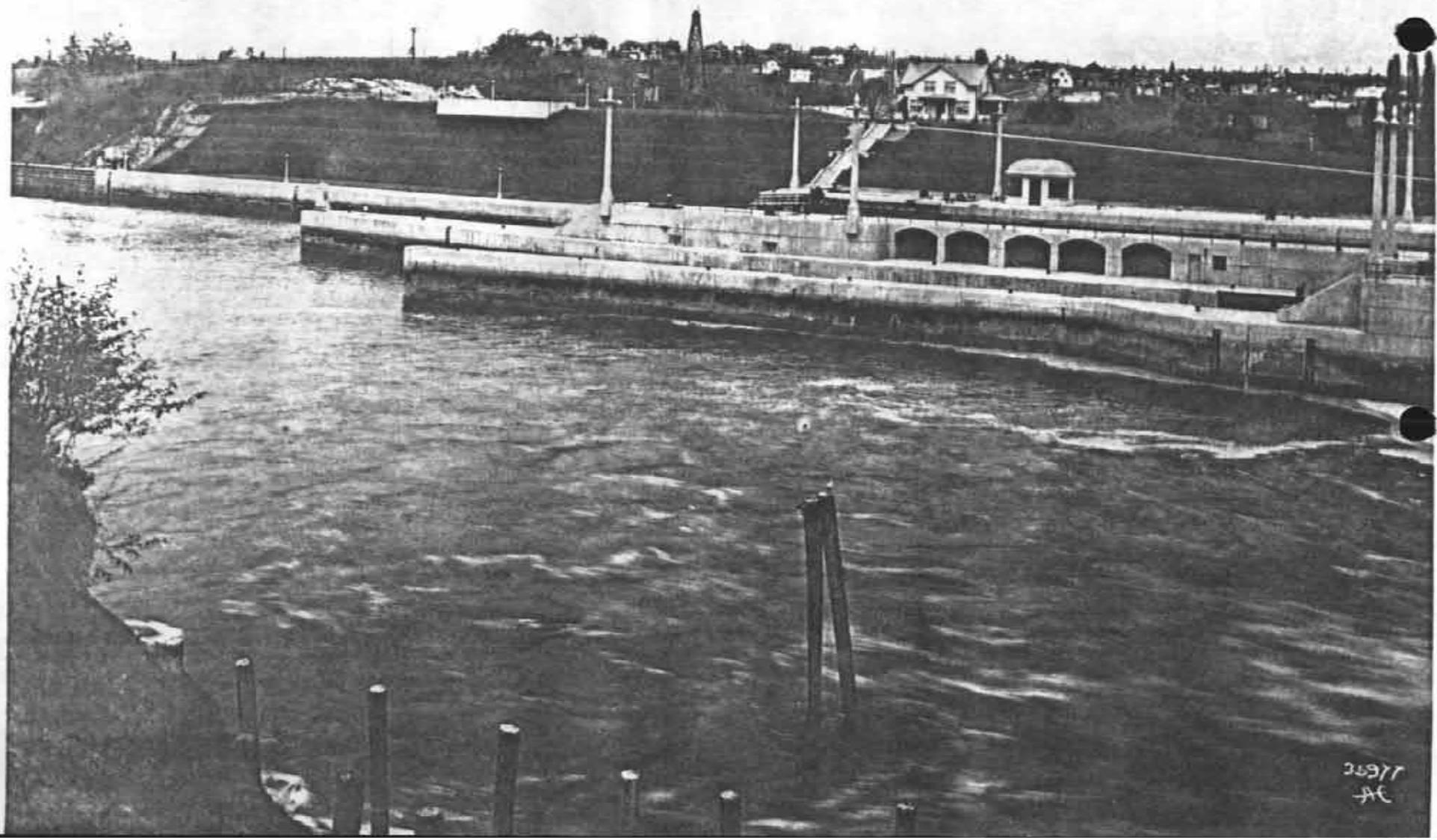
LARGE LOCK, EMPTY, VIEWED FROM
CENTER OF WEST GATE.

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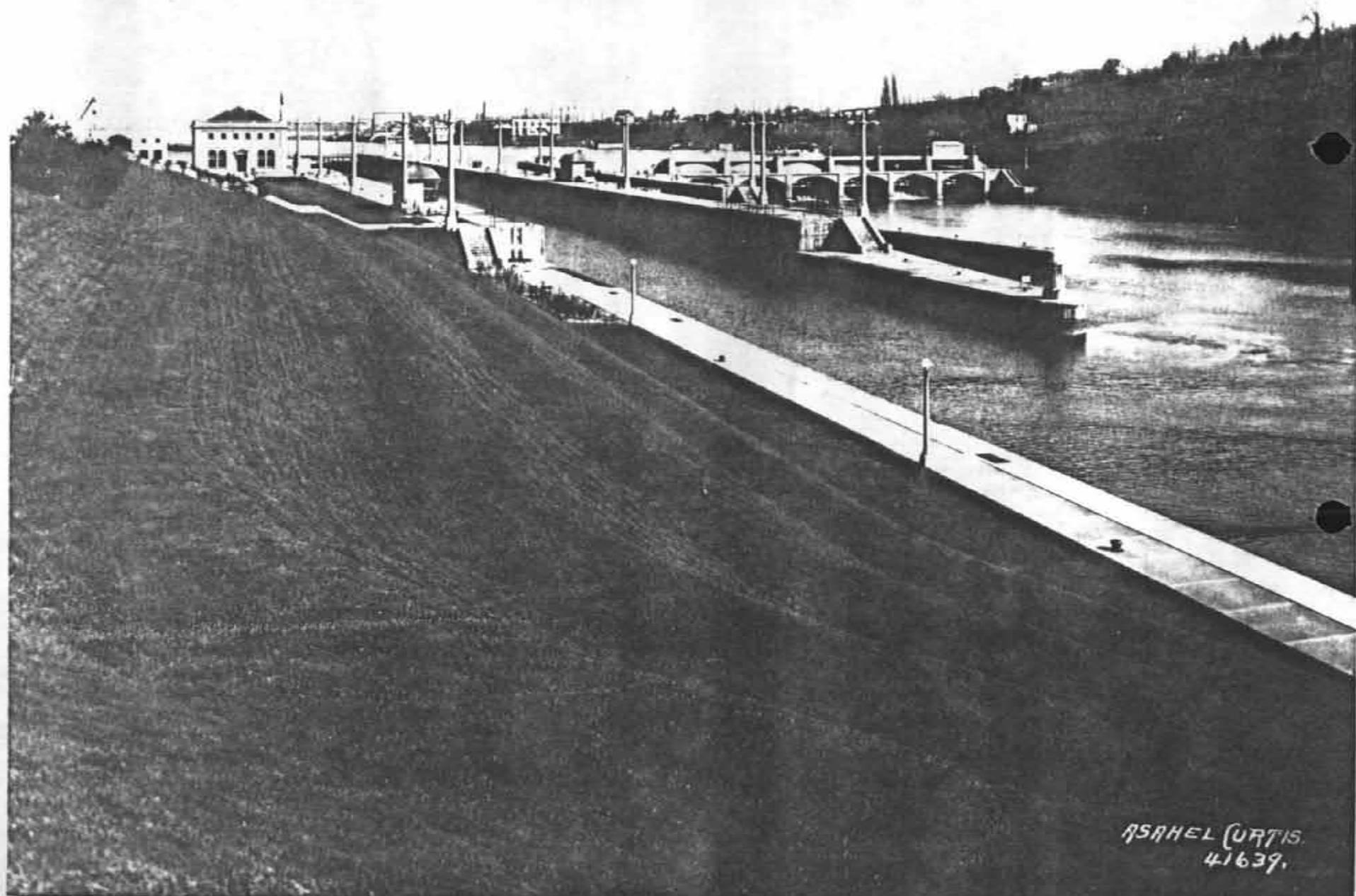
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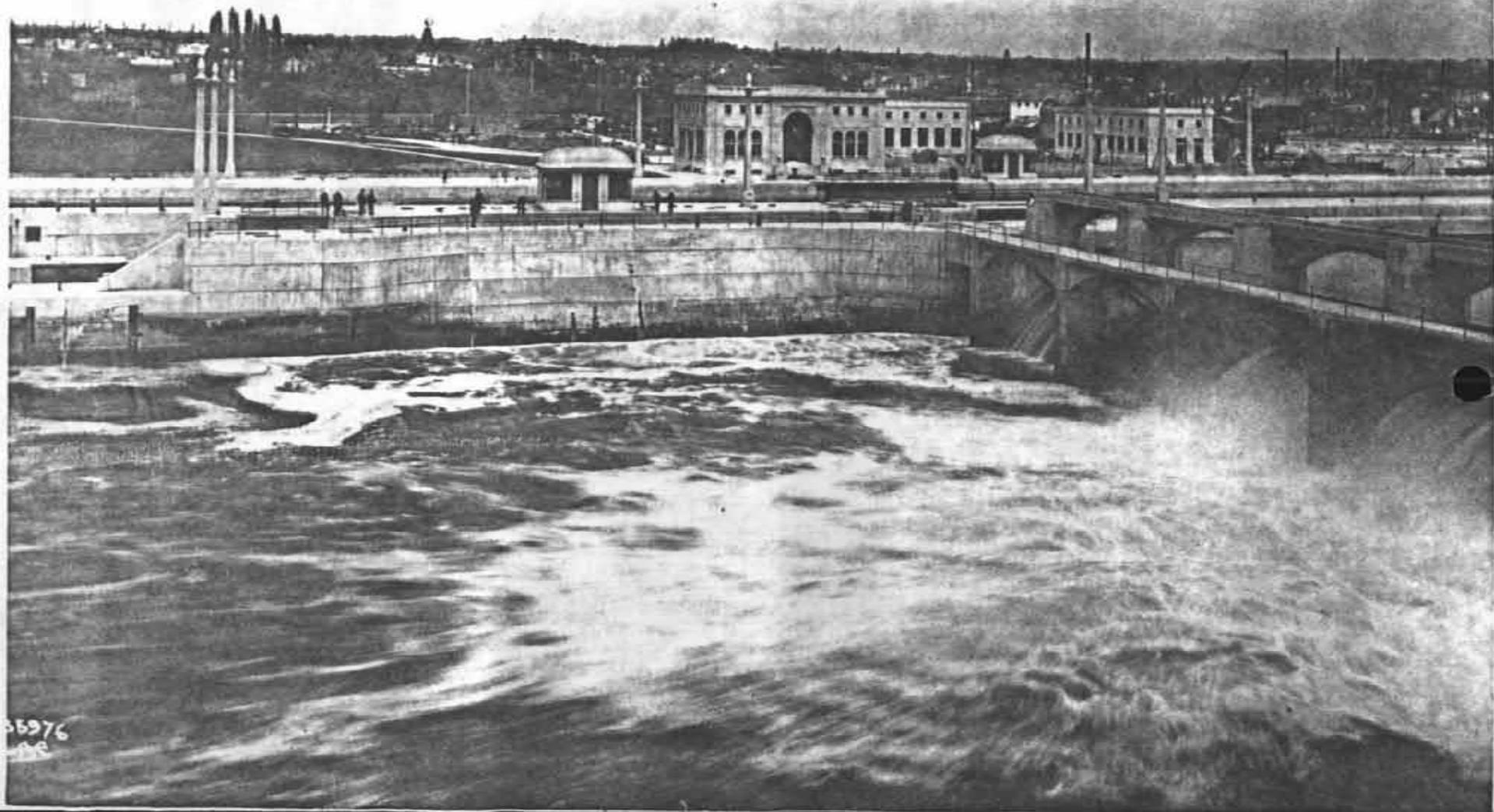


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NORTH BANK

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Rumley, Larry, "The Ballard Locks: How They Work," Seattle Sunday Times Magazine Section (April 25, 1965), 10-11.

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PHOTO NO. 1 of 13

Lake Washington Ship Canal and Hiram M. Chittenden Locks. Looking east toward Salmon Bay Waterway, Ballard Bridge and canal to Lake Union beyond. Left to right in government locks reservation: Transformer House (1914), temporary carpenter and blacksmith shops, Residence of the Locks Superintendent (1913), Machine Shop (1916), Office and Shop Building (1916), Administration Building (1914), large lock, small lock, and spillway dam.

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1 NAME

HISTORIC

Chittenden (Hiram M.) Locks and Related Features of the Lake Washington
Ship Canal

AND/OR COMMON

2 LOCATION

CITY, TOWN

Seattle

___ VICINITY OF

COUNTY

King

STATE

Washington

3 PHOTO REFERENCE

PHOTO CREDIT Elisabeth Walton Potter

DATE OF PHOTO February 1977

NEGATIVE FILED AT

Washington State Office of Archaeology and Historic Preservation
P.O. Box 1128, Olympia, WA 98504

4 IDENTIFICATION

DESCRIBE VIEW, DIRECTION, ETC. IF DISTRICT, GIVE BUILDING NAME & STREET

PHOTO NO. 11 thru 13

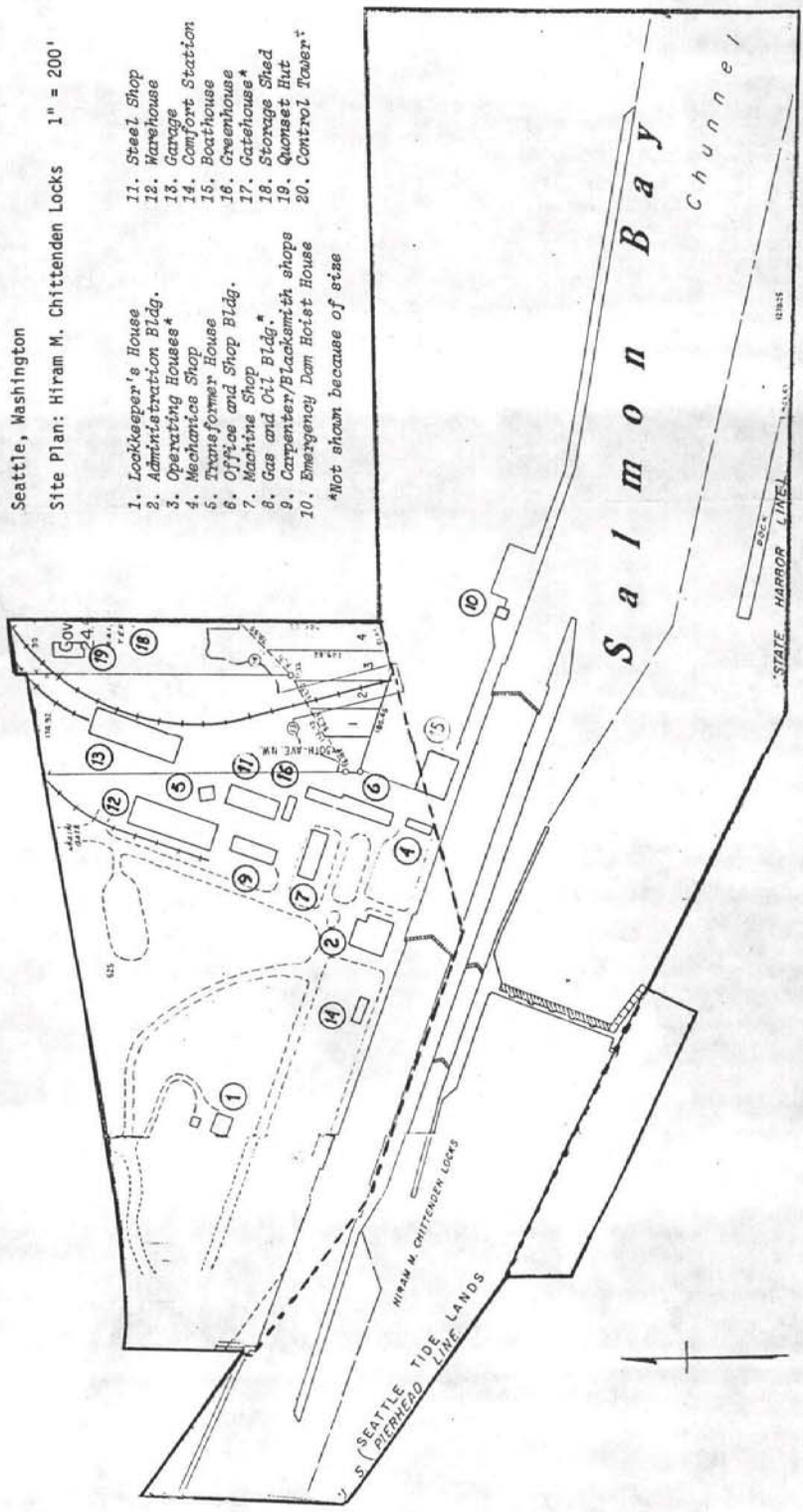
- 11 of 13 Lake Washington Ship Canal. General view of Fremont Cut, looking northwest from the Fremont Bridge.
- 12 of 13 Lake Washington Ship Canal. General view of Montlake Cut, looking east from south bank of canal toward Montlake Bridge and Union Bay beyond.
- 13 of 13 Lake Washington Ship Canal. Montlake Cut, looking west from south bank of canal at Montlake Bridge with draw spans open for sailboat.

Hiram M. Chittenden Locks and Related Features
of the Lake Washington Ship Canal

Seattle, Washington

Site Plan: Hiram M. Chittenden Locks 1" = 200'

- | | |
|-------------------------------|---------------------|
| 1. Lookkeeper's House | 11. Steel Shop |
| 2. Administration Bldg. | 12. Warehouse |
| 3. Operating Houses* | 13. Garage |
| 4. Mechanics Shop | 14. Comfort Station |
| 5. Transformer House | 15. Boat House |
| 6. Office and Shop Bldg. | 16. Greenhouse |
| 7. Machine Shop | 17. Gatehouse* |
| 8. Gas and Oil Bldg.* | 18. Storage Shed |
| 9. Carpenter/Blacksmith shops | 19. Quonset Hut |
| 10. Emergency Dam Hoist House | 20. Control Tower* |
- *Not shown because of size



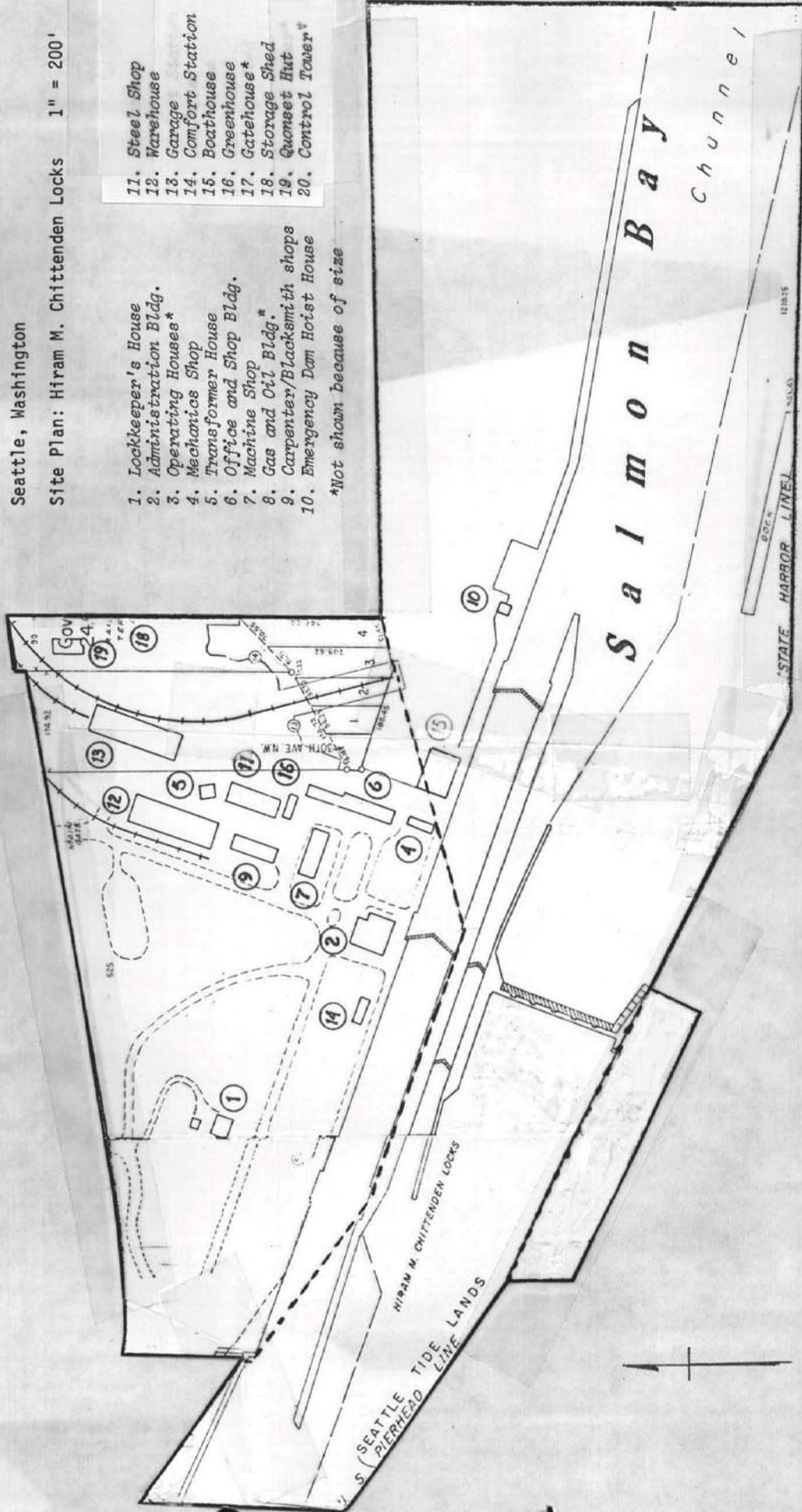
Hiram M. Chittenden Locks and Related Features
of the Lake Washington Ship Canal

Seattle, Washington

Site Plan: Hiram M. Chittenden Locks 1" = 200'

- | | |
|-------------------------------|---------------------|
| 1. Lockkeeper's House | 11. Steel Shop |
| 2. Administration Bldg. | 12. Warehouse |
| 3. Operating Houses* | 13. Garage |
| 4. Mechanics Shop | 14. Comfort Station |
| 5. Transformer House | 15. Boathouse |
| 6. Office and Shop Bldg. | 16. Greenhouse |
| 7. Machine Shop | 17. Gatehouse* |
| 8. Gas and Oil Bldg.* | 18. Storage Shed |
| 9. Carpenter/Blacksmith shops | 19. Quonset Hut |
| 10. Emergency Dam Hotel House | 20. Control Tower* |

*Not shown because of size



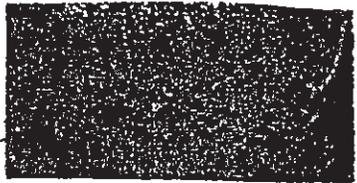
**National Register of Historic Places
Inventory Nomination Form: Historic
Bridges and Tunnels**

- **Montlake Bridge**
- **Arboretum Aqueduct**

United States Department of the Interior
Heritage Conservation and Recreation Service

**National Register of Historic Places
Inventory—Nomination Form**

See instructions in *How to Complete National Register Forms*
Type all entries—complete applicable sections



1. Name

historic Historic Bridges and Tunnels in Washington State

and/or common

2. Location

street & number see individual inventory forms not for publication

city, town _____ vicinity of _____ congressional district _____

state _____ code _____ county _____ code _____

3. Classification

Category	Ownership	Status	Present Use	
<input type="checkbox"/> district	<input type="checkbox"/> public	<input type="checkbox"/> occupied	<input type="checkbox"/> agriculture	<input type="checkbox"/> museum
<input type="checkbox"/> building(s)	<input type="checkbox"/> private	<input type="checkbox"/> unoccupied	<input type="checkbox"/> commercial	<input type="checkbox"/> park
<input checked="" type="checkbox"/> structure	<input checked="" type="checkbox"/> both	<input type="checkbox"/> work in progress	<input type="checkbox"/> educational	<input type="checkbox"/> private residence
<input type="checkbox"/> site	Public Acquisition	Accessible	<input type="checkbox"/> entertainment	<input type="checkbox"/> religious
<input type="checkbox"/> object	<input type="checkbox"/> in process	<input type="checkbox"/> yes: restricted	<input type="checkbox"/> government	<input type="checkbox"/> scientific
<input checked="" type="checkbox"/> thematic	<input type="checkbox"/> being considered	<input type="checkbox"/> yes: unrestricted	<input type="checkbox"/> industrial	<input checked="" type="checkbox"/> transportation
<input type="checkbox"/> group		<input type="checkbox"/> no	<input type="checkbox"/> military	<input type="checkbox"/> other:

4. Owner of Property

name Multiple Ownership

street & number

city, town _____ vicinity of _____ state _____

5. Location of Legal Description

courthouse, registry of deeds, etc. State Department of Transportation;

street & number county courthouses;

city, town _____ state _____

6. Representation in Existing Surveys

title Historic Bridge Survey has this property been determined eligible? yes no

date January 1979 - April 1980 federal state county local

depository for survey records State Office of Archaeology and Historic Preservation

city, town 111 West 21st Avenue, Olympia state Washington 98504

UNITED STATES DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

**NATIONAL REGISTER OF HISTORIC PLACES
INVENTORY -- NOMINATION FORM**

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CONTINUATION SHEET

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Bridges Already Listed in the National Register of Historic Places:

- Baker River Bridge
- Cascade Tunnels: Stevens Pass Historic District
- Devil's Corner
- Grays River Covered Bridge
- Jack Knife Bridge
- Lower Custer Way Crossing: Tumwater Historic District
- Monroe Street Bridge
- Rock Island Railroad Bridge
- Waitsburg Bridge: Waitsburg Historic District

Bridges Determined Eligible for Listing in the National Register of Historic Places:

- Lacey V. Murrow Bridge
- Pasco-Kennewick Bridge
- Prosser Steel Bridge
- Washington Street Bridge
- Orient Bridge
- "F" Street Bridge
- West Monitor Bridge

7. Description

Condition		Check one	Check one
<input type="checkbox"/> excellent	<input type="checkbox"/> deteriorated	<input type="checkbox"/> unaltered	<input type="checkbox"/> original site
<input type="checkbox"/> good	<input type="checkbox"/> ruins	<input type="checkbox"/> altered	<input type="checkbox"/> moved date _____
<input type="checkbox"/> fair	<input type="checkbox"/> unexposed		

Describe the present and original (if known) physical appearance

The legacy of existing bridges throughout the State of Washington is one of diverse structural types - as diverse as the vast and varied terrain that they were built to traverse. The primary intent of this nomination is to outline the legacy set forward by these extant structures, and to place them within the context of bridge engineering history, or within the context of their role in the social, economic, and industrial development of the locality, state, region, or nation.

The nomination is the result of a systematic inventory of historic bridges throughout the State, conducted by the State Office of Archaeology and Historic Preservation (SOAHP) in cooperation with the Washington State Department of Transportation (WSDOT) and the Historic American Engineering Record (HAER) of the Department of the Interior. The inventory, which was authorized by the Surface Transportation Act of 1978 (Public Law 95-599), was funded by the WSDOT. As a result, emphasis was placed on the recording of highway bridges. However, railroad bridges and other privately-owned bridges also were inventoried.

Before the information retrieval process could begin, it was necessary to establish bottom-line criteria for the selection of historic bridges. In consultation with HAER, the SOAHP decided that all existing bridges built during or prior to 1940 would be considered for inclusion in the HAER inventory. Although this cut-off date includes bridges less than the National Register's age guideline of 50 years, it was believed that it was essential to give the WSDOT leeway to facilitate future long-range planning decisions. In addition, Washington State's context of history is much more recent than that of other areas in the United States, and it is important that the boundaries of the historic bridge inventory reflect that context. These same boundaries were used to select the bridges eligible for listing in the National Register. Because it was not possible to photograph every culvert in the State, and there are only a few rare examples of bridges less than 50 feet in length that possess engineering or historical significance, it was decided that in almost all instances only bridges greater than 50 feet in length would be included in the inventory.

In conducting the historic bridge inventory (which provided the information base for the nomination) the SOAHP attempted to evaluate all bridges built during or prior to 1940, and greater than 50 feet in length, and to place each of them in one of the following three categories:

Category I. The first category of bridges includes those bridges eligible for listing in the National Register of Historic Places. It must be emphasized that Category I bridges were not selected until the inventory was completed. The bridges were evaluated according to the general criteria stated in 36 C.F.R. Part 60.6. More specifically, those bridges included in the nomination are bridges that:

1. are significant in the history of bridge engineering, in the history of bridge design principles, and in the development of bridge construction techniques;
2. are significant in the social, economic, and industrial development of the locality, state, region, or nation;
3. are significant examples of bridges designed or built by renowned engineers;

**United States Department of the Interior
Heritage Conservation and Recreation Service**

**National Register of Historic Places
Inventory—Nomination Form**

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date entered

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4. are significant examples of structural designs associated with the efforts of historic individuals or groups;
5. are significant examples of an early bridge engineering effort commonly used throughout the State of Washington for a specific purpose or reason;
6. are significant early examples, or significant representative examples, of a specific bridge type;
7. are rare examples of a specific bridge type within the state;
8. possess architectural or artistic significance.

Category II includes those properties which are of historical and engineering interest, are worthy of recording through photographic and written documentation, but are not eligible for inclusion in the National Register of Historic Places. It includes the following bridge types which were constructed during or prior to 1940, and are greater than 50 feet in length: trussed bridges; arches; moveable bridges; suspension bridges; aqueducts; cantilever bridges; tunnels; steel and cast and wrought iron girders; steel viaducts. Concrete and timber slabs, beams, girders, viaducts, or trestles are included in Category II only when they are of unusual length or height; when they are socially and economically significant to the locality, state, or region; when they are particularly early examples of the bridge type; when they possess architectural or artistic significance; or when innovative design principles or building techniques have been used in bridge construction.

Category III consists of all other bridges that were constructed during or before 1940 and are greater than fifty feet in length, but are not of such quality as to be included in either Category I or II. Category III includes all concrete and timber slabs, beams, girders, viaducts, and trestles unless they are particularly early examples of the bridge type, or are of unusual length or height, or are socially and economically significant to the locality, state, region, or nation, or demonstrate the use of innovative design principles or construction techniques, or possess architectural or artistic significance.

An Historic American Engineering Record inventory card was prepared for all properties identified under Category I and II. A brief form outlining basic structural information was used to record Category III bridges. Although the individual Category III bridges are not significant enough to warrant substantial documentation, they have furnished valuable statistics on when and where builders, contractors, and fabricators worked which provided insights into bridge construction history throughout the State, and helped to formulate the context in which Category I and II bridges were built.

The examination of the WSDOT computer print-out list was the first step in the lengthy information gathering process. The list provided basic structural data on all state, county, and city-owned highway bridges that were built during or prior to 1940, and were greater than 20 feet in length. By Federal standards, any structure less than 20 feet long is not considered a bridge. Although it had been decided that the historic bridge inventory would include bridges greater than 50 feet in length, the computer print-out provided enough information to determine which bridges less than 50 feet in length had potential engineering significance, and should be included in the inventory.

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The inventory and evaluation process was conducted on a county-by-county basis. After the raw structural data was attained, the state, county, and local highway commission files were tapped for information regarding the names of bridge builders, contractors, fabricators, and designers. The files provided recent photographs, occasionally old construction photographs, original contractual agreements, plans and drawings, and more extensive structural and design information on the bridges listed on the computer print-out sheet. This information formed the basis for determining whether the bridge would fall into Category II or III. When the inventory was completed, Category I bridges were selected from those bridges listed in Category II.

In addition to researching the state, county, and local highway commission files, bridge lists were acquired from the Burlington Northern Railroad, Inc., the Chicago, St. Paul, Milwaukee, and Pacific Railroad, and the Union Pacific Railroad. Information also was gathered on Forest Service bridges, as well as privately-owned bridges, including abandoned logging structures. However, the information gathering process for the privately-owned bridges was arbitrary, and by no means comprehensive. Because the majority of the railroad bridge records are lodged in the midwest, and there are no records remaining for many of the other privately-owned bridges, it was often necessary to rely heavily on contemporary articles about the bridges, rather than on original blueprints.

Contemporary newspaper articles, engineering journals, and bridge engineering books provided valuable source material. The national journals, Engineering News-Record and Railway Age Gazette, and the regional magazine, Western Construction News, were systematically examined for articles on the construction of bridges in Washington.

After the inventory cards were completed, and the highway commission files were integrated with the literature source material, statistical information was compiled to define the statewide context for the individual bridges. Approximately 1400 bridges were inventoried, 218 of which are railroad bridges. Ninety-five bridges have been included in the nomination, and about 500 have been listed on the HAER Inventory. Of the 1400 bridges, roughly seven percent were constructed before 1910, and approximately 20 percent were built before 1920. There are only five bridges on the inventory that were constructed before 1900.

When the 95 bridges included in the nomination are discussed individually, they will be compared to other bridges within the State of a similar type. However, the following tables provide a general overview and a statewide context, by relating the bridge types included in the nomination to all bridges surveyed:

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RAILROAD BRIDGES: BREAKDOWN OF TYPES

TYPE	100 CONCRETE		200 CONTINUOUS CONCRETE		300 STEEL		400 CONTINUOUS STEEL		500 PRESTRESSED CONCRETE		600 PRESTRESSED CONTINUOUS CONCRETE		700 TIMBER	
	@	&	@	&	@	&	@	&	@	&	@	&	@	&
020	13													
-01	1													
-02	2		1		9								6	1
-03			1		35		1							
-04			2											
-05														
-06														
-07					1									
-08														
-09					8	3							2	2
-10					80	4							5	3
-11	3	3			2	2								
-12	1													
-13														
-14														
-15					1	1								
-16					2	1								
-17					10	4								
-18	30	3												
-19														
-20					7	2								

@ Surveyed
& Listed in National Register

Total number of railroad bridges surveyed: 218
Total number of railroad bridges recommended for listing in the National Register: 29
(includes those already listed, and those determined eligible)

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HIGHWAY BRIDGES: BREAKDOWN OF TYPES

TYPE	100 CONCRETE		200 CONTINUOUS CONCRETE		300 STEEL		400 CONTINUOUS STEEL		500 PRESTRESSED CONCRETE		600 PRESTRESSED CONTINUOUS CONCRETE		700 TIMBER	
	@	&	@	&	@	&	@	&	@	&	@	&	@	&
020	21	1												
-01	33		24						1				2	
-02	48		8		52		5		3				186	
-03	7		9	1	28		6						2	
-04	83	1	87				1		2		1		1	
-05	8				4						1			
-06	5	1	3	1	2									
-07	1	1							2				18	
-08													1	1
-09	1		2		14	3	3							
-10	1	1	1	1	233	9	1	1					20	4
-11	111	8	14	1	3	3	2	2						
-12	8	5	2		1									
-13					1	1	1	1					10	1
-14														
-15					9	2								
-16					9	7								
-17					4	1	2							
-18	13												1	
-19	5												1	
-20	15		2		10				1				17	

@ Surveyed
& Listed in National Register

Total number of highway bridges surveyed: 1173
Total number of highway bridges recommended for listing in the National Register: 58
(includes those already listed, and those determined eligible)

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KEY TO BRIDGE TYPES

FIRST DIGIT

- 1 Concrete
- 2 Concrete Continuous
- 3 Steel
- 4 Steel continuous
- 5 Prestress concrete
- 6 Prestress concrete continuous
- 7 Timber
- 8 Masonry
- 9 Aluminum, wrought iron
or cast iron
- 0 Other

SECOND AND THIRD DIGITS

- 01 Slab
- 02 Stringer/Multi-beam or girder
- 03 Girder and Floorbeam system
- 04 Tee beam
- 05 Box beam or girders - multiple
- 06 Box beam or girders - single or spread
- 07 Frame
- 08 Orthotropic
- 09 Truss-deck
- 10 Truss-through
- 11 Arch-deck
- 12 Arch-through
- 13 Suspension
- 14 Stayed girder
- 15 Movable-lift
- 16 Movable-bascule
- 17 Movable-swing
- 18 Tunnel
- 19 Culvert
- 20 Other or Combination

8. Significance

Period	Areas of Significance—Check and justify below			
<input type="checkbox"/> prehistoric	<input type="checkbox"/> archeology-prehistoric	<input type="checkbox"/> community planning	<input type="checkbox"/> landscape architecture	<input type="checkbox"/> religion
<input type="checkbox"/> 1400-1499	<input type="checkbox"/> archeology-historic	<input type="checkbox"/> conservation	<input type="checkbox"/> law	<input type="checkbox"/> science
<input type="checkbox"/> 1500-1599	<input type="checkbox"/> agriculture	<input type="checkbox"/> economics	<input type="checkbox"/> literature	<input type="checkbox"/> sculpture
<input type="checkbox"/> 1600-1699	<input type="checkbox"/> architecture	<input type="checkbox"/> education	<input type="checkbox"/> military	<input type="checkbox"/> social/
<input type="checkbox"/> 1700-1799	<input type="checkbox"/> art	<input type="checkbox"/> engineering	<input type="checkbox"/> music	<input type="checkbox"/> humanitarian
<input type="checkbox"/> 1800-1899	<input type="checkbox"/> commerce	<input type="checkbox"/> exploration/settlement	<input type="checkbox"/> philosophy	<input type="checkbox"/> theater
<input type="checkbox"/> 1900-	<input type="checkbox"/> communications	<input type="checkbox"/> industry	<input type="checkbox"/> politics/government	<input type="checkbox"/> transportation
		<input type="checkbox"/> invention		<input type="checkbox"/> other (specify)

Specific dates

Builder/Architect

Statement of Significance (in one paragraph)

PREFACE: EXPLANATION OF METHODOLOGY

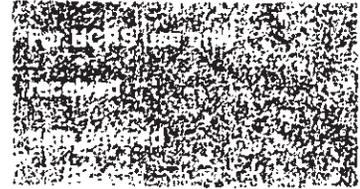
The existing historic bridges and tunnels throughout Washington transmit a legacy that is multifaceted. The structural systems of the individual bridges poignantly reveal the evolution of bridge design and technology from both a national and regional perspective. In addition, each individual structure cannot be isolated from the transportation system of which it is an integral part. The significance of the bridges and tunnels has been interpreted within this dual context.

Early bridge construction within the state is tightly linked to the development of the railroads within the State. There are seventeen bridges and tunnels in the nomination that have been a significant part of the State's early railroad development, and were discussed within this context. Four structures were treated from the perspective of their association with the early highway bridge construction over the Columbia River. And five structures were discussed in terms of their role in logging and mining transportation systems. Most of the twenty-six bridges and tunnels that were evaluated primarily in terms of the transportation systems of which they were a significant part, also were discussed in terms of their structural significance.

The nomination does include a number of structures that are less than fifty years old. As was stated earlier, the nomination mirrors the criteria set by the initial inventory. There is only one structure that was constructed after 1940, the cut-off date set by the inventory. This is a 250 foot log cable-stayed girder bridge, and is one of the first of its type to be constructed within the United States. Its parts are composed of untreated logs which are extremely susceptible to the ravages of time. Consequently, it is essential that this unusual structure is acknowledged and documented without delay.

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Heritage Conservation and Recreation Service**

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TABLE OF CONTENTS

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B. Great Northern Railroad
 Rock Island Railroad Bridge 3
 Cascade Tunnel 1911-1913. 4
 Cascade Tunnel 1925-29. 5
 Penstock Bridge 6

C. Spokane, Portland, and Seattle Railway
 Klickitat River Bridge. 7
 Box Canyon Viaduct. 8
 Cow Creek Viaduct 9
 Vancouver-Hayden Island Bridge 10

D. Oregon Trunk Railway
 Celilo Bridge 11

E. Union Pacific Railroad
 Joso Viaduct 12

F. Milwaukee Railroad
 Beverly Railroad Bridge 13

II. BRIDGES THAT REFLECT EARLY HIGHWAY DEVELOPMENT IN WASHINGTON STATE

Wenatchee/Columbia River Bridge 14
 Vancouver-Portland Interstate Bridge. 15
 Pasco-Kennewick Bridge. 16
 Longview Bridge 17

III. SPECIALIZED STRUCTURES: MINING AND LOGGING BRIDGES

Little Sheep Creek/Red Mountain Railroad Bridge 18
 Winslow Railroad Bridge 19
 Vance Creek Bridge. 20
 High Steel Bridge 21
 Chow Chow Bridge. 22

IV. REPRESENTATION OF BRIDGE TYPES

A. Trestles: Timber
 Wilburton Trestle 23

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B. Trusses:

1. Timber

Dungeness River Railroad Bridge	24
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North 4th and Dock Street Bridge	26

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Wishkah River Bridge	32
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Curlew Bridge	35
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--------------------------------------	----

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F. Suspension Bridges

Devil's Corner	87
Yale Bridge	88
Tacoma Narrows Bridge	89

9. Major Bibliographical References

Condit, Carl W., American Building Art, 2 Vols., New York: Oxford University Press, 1961.
 Tyrrell, Henry Grattan, History of Bridge Engineering, Chicago: H.J. Tyrrell, 1911.
 Waddell, J.A.L., Bridge Engineering, 2 Vols., New York: John Wiley and Sons, 1916.
 Refer to individual inventory forms for additional references.

10. Geographical Data

Acreage of nominated property _____ refer to individual inventory forms.

Quadrangle name _____

Quadrangle scale _____

UMT References

A
 Zone Easting Northing

B
 Zone Easting Northing

C

D

E

F

G

H

Verbal boundary description and justification

List all states and counties for properties overlapping state or county boundaries

state code county code

state code county code

11. Form Prepared By

name/title Lisa Soderberg, Historian

organization Office of Archaeology and Hist. Pres.

date August 1980

street & number 111 West 21st Avenue

telephone (206) 754-2395

city or town Olympia

state Washington 98504

12. State Historic Preservation Officer Certification

The evaluated significance of this property within the state is:

___ national ___ state ___ local

As the designated State Historic Preservation Officer for the National Historic Preservation Act of 1966 (Public Law 89-665), I hereby nominate this property for inclusion in the National Register and certify that it has been evaluated according to the criteria and procedures set forth by the Heritage Conservation and Recreation Service.

State Historic Preservation Officer signature

title

date

For NCHS use only
 I hereby certify that this property is included in the National Register

 date

 date

 date

HISTORIC BRIDGES AND TUNNELS
IN WASHINGTON STATE

Lisa Soderberg
Washington State Office of
Archaeology and Historic
Preservation
Olympia, Washington
November, 1980

I. BRIDGES THAT REFLECT RAILROAD DEVELOPMENT IN WASHINGTON STATE

The construction of the earliest bridges and tunnels of major proportions within the State is associated with the construction of the transcontinental railroads. It was in 1864 that the Northern Pacific Railroad was chartered by Congress to build a mainline from Lake Superior to Puget Sound. However, it was not until 1883 that the Northern Pacific established a route between Duluth and Puget Sound by means of connecting its line to the existing Oregon Railroad and Navigation Company line along the south bank of the Columbia River. The two systems were linked by two car ferries: a car ferry across the Snake River which connected with a short railway spur that ran to Wallula, and a car ferry across the Columbia River between Portland and Kalama which connected with the Northern Pacific line that ran between Kalama and its terminus at Tacoma. This circuitous route to Puget Sound was feasible only because of daring financial manipulations made by the northwest railroad magnate, Henry Villard. Although the railroads retained their individual corporate identities, Henry Villard obtained control of both systems. However, in January of 1884 Villard's empire collapsed, and the two railroads reverted to separate control.¹

Once again cut off from Puget Sound, the Northern Pacific immediately began work on a route across the mountains. The Pasco-Kennewick Bridge (1), the first bridge to be built across the Columbia River, was constructed as a temporary structure in 1888 as part of the Northern Pacific's effort to redirect its route across the mountains. By 1887, a treacherous, temporary switchback was in service over the mountains through Stampede Pass. The completion of the two mile tunnel (2) in May, 1888 initiated the first adequate and direct through railroad service to Puget Sound.

Five years after the completion of the Northern Pacific route, the Great Northern Railroad, under the direction of James J. Hill, was operating a transcontinental line from Minneapolis to Seattle. In 1893, a complex system of switchbacks across the Cascades at Stevens Pass was opened to service, and a large steel truss (3) was erected across the Columbia. The completion of the

¹D.W. Meinig, The Great Columbia Plain, (Seattle, 1968), p. 268.

Cascade Tunnel (4,5) in 1900, confirmed that the historic focus of the whole northern portion of the interior of the state, which had been oriented down the Columbia River to Portland had finally been diverted to Puget Sound.² And it was the Great Northern Railroad that provided Seattle with the vital rail connections that were instrumental in turning the new focus on Puget Sound, specifically towards Seattle.

The last transcontinental line to be built across Washington to Puget Sound was the Chicago, Milwaukee, and St. Paul Railroad's route to the coast through the interior of the state (13). The line was completed in 1909, more than 15 years after the beginning of transcontinental railroad construction through Washington.

The Milwaukee Railroad was the first railroad to electrify a substantial portion of its line. The Beverly Bridge carries vestiges of the superstructure used to support the copper cables. The advantages of railroad electrification were particularly apparent in the increased load capacity of the freight trains. Railroad electrification also alleviated the dangerous conditions within the long mountain pass tunnels. The Penstock Bridge (5) played an integral role in the water transportation system that powered the Great Northern trains through one of the early Cascade Tunnels.

Competition and power plays between the major railroad companies plagued and profoundly influenced railroad and bridge construction throughout the state. In 1900, James J. Hill surreptitiously purchased the rights of way for a new trunk line between Spokane and Portland on the north bank of the Columbia River in the hopes of obtaining a direct outlet to Portland for the rapidly growing traffic of Spokane and the southern portion of the interior. It was a venture to be shared by the Great Northern and the Northern Pacific. However, it directly competed with the Oregon Railroad and Navigation Company (OR&N) on the south bank of the river, which had been subsumed by the Union Pacific Railroad under the direction of Edward H. Harriman. Harriman valiantly attempted to thwart the construction of the Spokane, Portland, and Seattle Railway (SP&S) by using a variety of ploys. While the court battles raged, "construction crews fought with fists, rocks, pickhandles, and dynamite." The last court encounter ended in victory for

²Ibid., p. 270.

Hill in 1906.³

The line from Spokane to Portland was finally completed and in operation by 1909. "As a transportation route it represents the highest result of the railroad builder's art," reported an engineer before a meeting of the Pacific-Northwest Society of Civil Engineers in 1925.⁴ Because the Great Northern and Northern Pacific desired a high capacity railroad with low operating costs, they did not make use of the existing Northern Pacific line between Spokane and Pasco. Instead, they constructed a new low grade roadbed with a minimum of curves. Their aim was "to make the roadbed of the most permanent character."⁵ The bridges on the line certainly reflect this aim. Permanent steel viaducts or earth fills were built initially, rather than temporary timber structures. From Spokane, the line makes its only west-bound ascent of 375 feet. It follows Cow Creek through Adams County. "At the junction of Cow Creek and the Palouse River, the Portland and Seattle encounters the most expensive stretch of railroad construction, except that in Devil's Canyon, ever known in Washington. The valley is crooked and entered frequently by steep, narrow gulches; the road is built across a succession of 'hog backs' and gulches. Eighty-foot cuts are followed by 90-foot fills in alternation; short tunnels are frequent; high steel trestles are necessary in many places."⁶ Of the steel trestles built in this area the Cow Creek Viaduct (9) is the longest and the highest. The line passes through the Washtucna Coulee and follows the east bank of the Snake River through Devil's Canyon. Here the treacherous terrain is traversed by four enormous steel viaducts, the highest of which is the Box Canyon Viaduct at 250 feet (8). The route makes use of the Northern Pacific tracks at only one point: the Columbia River crossing between Pasco-Kennewick (1). It follows the north bank of the Columbia across an early reinforced concrete arch (7) at Lyle, and eventually reaches Vancouver crossing the Columbia River to Portland by means of a large steel pinconnected swing bridge (10).

³Charles and Dorothy Wood, Spokane, Portland, and Seattle Railway, (Seattle, 1974), p. 23.

⁴"Cascade Tunnel Route," extracts from a paper read before the Pacific-Northwest Society of Civil Engineers, Seattle, Washington, October 1925.

⁵W.P. Hardesty, "The Construction of the Portland and Seattle Railway," Engineering News, Vol. 59, No.7, p. 161.

⁶Railroad Gazette, 27 September 1907.

Because of the success of the Spokane, Portland, and Seattle Railway, the Oregon-Washington Railroad and Navigation Company (O-WRN) moved quickly to upgrade its line between Portland and Spokane. The largest structure on the O-WRN's new low grade line was the 3,920 foot Joso Viaduct (12) over the Snake River at Lyons Ferry. The completion of the new Union Pacific line was yet another example of the continuing competition between the Hill and Harriman interests to dominate and control the major railroad routes of the Northwest.

In 1912, the Oregon Trunk Railway, a subsidiary of the Spokane, Portland, and Seattle Railway, was completed, representing one of the first steps in the entry of the Hill lines into Oregon, a territory which previously had been associated exclusively with the Harriman lines. In his virtual autonomy over the railroads in Oregon and California, Harriman had effectively controlled the major railroad links to tidewater. However, Hill's entrance into Oregon made his dream of stretching the Great Northern empire from Spokane to San Francisco plausible. Although the Great Northern did not reach the Pacific coast of California until 1931, long after Hill's death, the completion of the Oregon Trunk Railway represented a significant step towards the fulfillment of Hill's dream. The Celilo Bridge (13), the largest of ten steel bridges built on the Oregon Trunk Line, was a major link in connecting the SP&S to Union Pacific Territory.

The legacy of extant structures associated with railroad development within the state span a vast, varied, and often treacherous topography, and stand as a fitting testimony to the grand schemes and boundless ingenuity of the early railroad magnates in their efforts to dominate the major routes of the Northwest.

II. BRIDGES THAT REFLECT EARLY HIGHWAY DEVELOPMENT

In 1911, the Washington State Highway Commissioner proclaimed that: "A system of State roads is today the livest [sic] issue before the people of Washington or any other state. We are living in a transition period and changes come rapidly. Evolution in transportation methods affects road construction in no less a degree than a deepening of waterways, and the construction of easier grades and easier curves on the trunk railways."¹ With the proliferation of the automobile, the engineer was confronted with a new and complex range of urgent structural demands. As the Washington State Highway Commissioner observed, the foremost demand was the rapid construction of highways, of which the building of adequate highway bridges was an integral part. The heavy load capacities required by railroad traffic had previously shaped the development of bridge design. Automobile traffic, however, exerted different demands and design requirements on the bridge construction engineer which eventually shifted existing patterns and changed the direction of American bridge building. Although there are examples of concrete structures, the railroad bridge has been almost exclusively built in steel, and is characterized by the heavy riveted steel truss. The lower highway loadings enabled the engineer to use a range of bridge types and materials which resulted in a vast number of concrete structures on the highways. However, the dominance of the steel truss did not diminish on the roadways. And steel remained the most suitable material for extremely long spans over navigable waterways.² It is interesting to note that the design of the earliest highway structures of major proportions in Washington were based on a technology that originated in railroad bridge construction of the 19th century.

The first highway bridge to be constructed across the Columbia River was a pinconnected steel cantilever truss at Wenatchee (14). It was built in 1908 to transport automobiles and water to east Wenatchee in order to develop the land for the expanding apple industry. Like most of these large,

¹W.J. Roberts, "System of Roads: Routes, Mileage and Costs," Pacific Builder and Engineer, 18 November 1911, p. 337.

²Carl Condit, American Building Art, 2 Vols., (New York, 1961), 2: 5-6.

early highway structures, the Wenatchee Bridge was privately financed, though subsequently purchased by the State Highway Department in 1909.

In 1916, construction began on a bridge between Vancouver and Portland (15). This enormous structure which consists of a series of simple trusses was financed by Clark and Multnomah Counties. In 1929, Washington and Oregon purchased the bridge from the counties.

A highway bridge was built across the Columbia between Pasco and Kennewick (16) in 1922. It was the first of five steel structures, and the first of four cantilever trusses to be constructed across the Columbia River during the 1920's, marking the beginning of a proliferation of major bridge construction in this new transportation era. The State Highway Department purchased the bridge from its private owners in 1931.

Though the construction of the Longview Bridge (17) was entrenched in controversy, its completion represented another effort to bridge the Columbia River with highway structures. It formed an important connecting link in the Pacific Highway extending from Vancouver, B.C. to Tia Juana, Mexico. The Longview Bridge was the last privately-financed bridge to be constructed across the Columbia River, and represented a turning point in the financing of bridge construction in the State. Soon after this time, the State purchased all privately-owned toll bridges. The construction of bridges throughout the State became increasingly dependent upon, and influenced by state and federal aid programs.

III. SPECIALIZED STRUCTURES: LOGGING AND MINING BRIDGES

The State's abundant resources have always been unattainable and useless without a transportation network to retrieve the minerals and vast supplies of timber, and a means of depositing them at a location where they can be processed for public consumption. The structures that are a part of these transportation systems embody an important segment of bridge construction history within the State.

These grand transportation schemes often involved the construction of large structures in remote, inaccessible territory. The earliest bridge associated with the development of logging and mining interests remaining within the State, is a timber deck Howe truss (18) over the Little Sheep Creek in Stevens County. It was constructed in 1896 as part of the Red Mountain Railroad which ran between Northport and Rossland. The railroad was conceived and financed by D.C. Corbin to link the untapped Canadian mineral deposits in the Kootenay district to the smelters in the United States. At Newport, the Red Mountain spur line connected to another one of D.C. Corbin's railroads, the Spokane Falls and Northern mainline. Through D.C. Corbin's initiative, the mining of the Kootenay district brought great, though momentary wealth to Spokane during the late nineteenth century.

The earliest extant bridge associated with the logging industry is the Winslow Railroad Bridge (19). It is a timber deck Howe truss which was constructed in 1916-17 by the Winslow Lumber Manufacturing Company as part of a 25 mile track system used to transport logs to the company's mill in Orin. As the logging industry developed, there became a growing separation between the logging and milling businesses. However, the Winslow Railroad, like most of the earliest logging railroads, was built by operators of the lumber mill who needed a dependable supply of logs.

Two enormous steel arches (20,21) rising almost 400 feet above wooded gorges were constructed by the Simpson Logging Company in 1929. They were built during a time when high costs were bringing an end to the era of logging railroads. By the 1930's, the West's most accessible timber had been logged,

and the initial investment of construction and equipment costs for even the shortest railroad lines was becoming prohibitive.¹ It was only the largest corporations, such as the Simpson Logging Company, that would find that the unit cost of hauling logs by rail was cheaper than that by truck. The Vance Creek Bridge remains in use as a railroad bridge, while the High Steel Bridge was converted for use by vehicular traffic approximately 20 years ago. The awesome permanence of the steel structure over Vance Creek belies its seemingly anachronistic function, and reflects a changing era in the use of logging railroads. During the late 19th and early 20th centuries, the logging railroad bridges were usually timber structures. Although the mainline of the logging railroads were in service for a number of years, the structures on the spur lines, which often included extremely long and high timber trestles, were temporary, and were abandoned or reused at different locations as soon as the specific area was logged. However, as construction costs increased, enormous structures like the Vance Creek and High Steel Bridges were only economically feasible if they could be used over a long period of time. As a case in point, after a period of more than fifty years, both the Vance Creek Bridge and the High Steel Bridge remain in use. The alterations which have been made to the High Steel Bridge reflect the inevitable changes in the transportation of timber -- the gradual disappearance of the logging railroads and their replacement by trucks.

The magnificent raw power of the 250 foot log cable-stayed girder bridge (22) spanning the Quinault River is undeniable. It was designed and constructed by the Aloha Logging Company's Superintendent in 1952 to support the weight of a loaded logging truck, as part of the road system built to retrieve the company's timber from the dense forests of the Olympic Peninsula. The Chow Chow Bridge, which was constructed from a 12 foot scale model, was designed by a man who had unusual constructive ability, but who had no formal engineering background. Although the existing timber structures associated with logging and mining industries within the State span a period of almost sixty years, the bridge builders shared a common trait; they shared an intuitive constructive ability. The logging superintendent's spirit and inventive genius can be compared to the American bridge builders of the 18th and early 19th centuries who were

¹Kramer Adams, Logging Railroads of the West, (Seattle, 1961), p. 54.

"practical men...who depended upon their own resources and natural instinct, experimenting with models and profiting by previous failures, but who had no accurate knowledge of the strains produced on the various members of a structure by the exterior forces."² Practice always preceded the science; consequently structural systems were invented long before the theory was developed. The Chow Chow Bridge is indeed an example of a structural system that was used to solve a problem before the formal theory was developed. It is one of the first examples of a cable-stayed girder bridge within the United States. Although there are numerous European applications of the cable-stayed design, the bridge type has not been used in the United States until very recently, because it is a statically indeterminate system, and has been difficult to analyze with any reasonable degree of accuracy.

²C. Schneider, "Evolution of Bridge Building," Engineering News-Record, 22 June 1905, p. 649.

IV. REPRESENTATION OF BRIDGE TYPES: TRESTLES

There still remains within Washington a sparse sampling of structures that are representative of bridge types which once predominated the landscape. The timber trestle which has evolved as a distinctly American structure, characterized railroad construction in Washington during the late 19th and early 20th centuries. The 984 foot Wilberton Trestle (23) which rises to a height of 98 feet above Mercer Slough, demonstrates the magnitude of the length and height of the early timber trestles that once traversed the varied and seemingly formidable topography of Washington. It is a rare surviving example within the State of a bridge type that once dominated transcontinental railroad construction. During this period, when the railroad's primary objective was to cross the continent rapidly, steel construction became a luxury, both in time of construction, and in initial expense. Timber, however, was abundant throughout western Washington, and was free for the taking.

After the transcontinental route was completed, the looming timber structures were often replaced by solid earth fills or permanent steel viaducts. The steel viaduct which was also a distinctly American structure associated with railroad construction, is best represented in the two long steel Spokane, Portland and Seattle Railroad viaducts over Cow Creek (9) and Box Canyon (8), and in the Union Pacific Joso Viaduct. (12).

IV. REPRESENTATION OF BRIDGE TYPES: TRUSSES

As exemplified in the table of bridge types, the truss is clearly the most common bridge form constructed in Washington between 1880 and 1940 for both railroad and highway structures. Because Washington was settled long after the major experimentation with truss types had occurred, there is not a vast representation of truss forms.

The earliest truss form represented is the timber Howe truss which was patented in 1840. The Little Sheep Creek Railroad Bridge (18) constructed in 1896 and the Winslow Railroad Bridge (19) constructed in 1916-17 are the oldest extant examples within the State of this once common truss type. Timber continued to be used for the construction of railroad bridges throughout Washington during the first quarter of the century due to the abundance of the resource, and its initial economic advantages. The use of treated timber also extended the life of these structures. There is one Milwaukee Railroad standard timber Howe through truss remaining within the State (24). Although it was constructed in 1930, it replaced an identical structure built in the teens.

There are two examples of timber trusses within the State that are of the Pratt configuration (25,26). In the Howe truss, the vertical members resist the load in tension, while the diagonal members resist the load in compression. The tensile strength of steel or iron coincides with the function of the vertical members, and the compressive qualities of wood coincide with the function of the diagonal members. However, in the Pratt truss, the function of the vertical and diagonal members is reversed; consequently the vertical components are timber, and the diagonal components are steel. Although the Pratt truss was patented in 1844, the Howe truss design continued to be the most common form in timber construction. It was not until the introduction of all steel and iron trusses that the Pratt truss design prevailed.

These untreated timber structures had a life span of approximately 10 to 15 years. In an effort to extend the life of the bridges, the timber components were protected by constructing housing around them. There are four covered bridges remaining within the State. The oldest is a highway structure, a two span Howe truss constructed across Grays River (27) in 1905. In 1918 a covered timber Howe truss (28) was constructed across the Palouse River

outside of Colfax as part of the Spokane and Inland Empire Railroad, an expansive interurban electric railroad line scheme that extended from the Palouse to Spokane. Because it was necessary to provide for the connection between the locomotive and the overhead electric lines, the top of the bridge was left uncovered. Over the Chehalis River at Doty stands the last standard Milwaukee Road covered bridge (29). At one time several of these stark, utilitarian structures, constructed by company forces, spanned the waterways of Washington. A short-spanned timber Howe pony truss covered with corrugated metal (30) was constructed across the Chehalis River in 1934.

The seemingly endless source of timber throughout much of Washington, providing a cheap building material, may account for the fact that a number of timber highway trusses continued to be built throughout the 1930's. Because most of the early bridge construction in Washington occurred long after the technology of iron or steel truss construction had been developed, the timber and steel truss existed within the State simultaneously. The predominance of timber construction over that of steel or iron was not a matter of technology, but rather one of economy and accessibility. However, the iron or steel truss provided a strength, durability, and resistance to fire that the timber truss would never be able to attain.

There is a limited representation within Washington of the early steel truss forms which consisted of complex systems of triangulation. These early truss forms are demonstrated in the lattice or triple-intersection Warren truss over the Spokane River (31) and the double-intersection Warren truss over the Wishkah River (38). The double-intersection Pratt truss (1) over the Columbia River is similar to the lattice truss, and was a common truss form in railroad construction in the late nineteenth century. These three bridges share this multiple system of triangulation which was claimed to create an "unavoidable ambiguity in stress distribution."¹ These complex truss forms have been replaced almost exclusively by two other nineteenth century designs: the simple system of verticals and diagonals of the Pratt truss and the straightforward single system of triangles of the Warren truss. It is interesting to note that in contrast to the east coast, there are very few examples within Washington

¹J.A.L. Waddell, Bridge Engineering, 2 Vols., (New York, 1916), 1: 476.

Washington of trusses with a multiple system of triangulation which in itself may shed light on the evolution of the truss form. Even during the early years of bridge construction within the State, the superiority of the Warren and Pratt configuration had been confirmed.

During the early twentieth century, the Pratt truss was claimed to be the most commonly used bridge type in America for spans under 250 feet. The two earliest and least altered examples of this truss type remaining within Washington are the F Street Bridge in Palouse (33) and the West Monitor Bridge (34). Both of these are pinconnected structures which preceded the more rigid riveted truss. With the improvement of riveting techniques, and the development of the pneumatic riveter during the early twentieth century, the pinconnected truss soon became a rarity.

During the mid-nineteenth century, the Parker truss was developed. In contrast to the uniform depth of the parallel chords of the basic Pratt truss, the polygonal top chord of the Parker truss which reaches its greatest height at the center panels, reflects the increase in bending moment that occurs from the ends of the truss to the center. The use of the arched top chord increased the rigidity of the structure, and enabled the construction of longer spans. The earliest, least altered examples of the Parker truss within the State are the Curlew Bridge (35), the Orient Bridge (36), and the Prosser Steel Bridge (37).

In an effort to construct longer spans, the Pratt truss configuration was adapted and modified by sub-dividing the panels with additional subtrusses and subties. The development of the Petit truss during the 1870's represented a major advance in strengthening the standard Pratt truss form. The Middle Fork Nooksack River Bridge (38) is the longest pinconnected modified Petit highway truss within the State, while the White River Bridge (39) constructed in 1908, is the oldest pinconnected modified Baltimore Petit structure.

In 1913, Clallam County constructed a two-span deck truss over the Elwha River (41). Its Warren truss configuration was patented in 1848, and is composed of diagonals which are placed alternately in tension and compression. The Elwha River Bridge is the oldest Warren truss in the State constructed for highway use. Like the Pratt truss, this single system of triangles continues to be used by engineers in modern steel trusses.

The largest truss bridges are cantilever structures which consist of a combination of anchor spans, cantilevers, and suspended spans. The oldest cantilever truss within the State is a pinconnected structure constructed across the Columbia River in 1908 (13). The Pasco-Kennewick Bridge (16), the Lyons Ferry Bridge (42), and the Longview Bridge (17) all represent cantilever construction that occurred during the 1920's. The George Washington Memorial Bridge (43), the Grand Coulee Bridge (44), and the Deception Pass Bridge (45) were built during the 30's and reflect a departure in form from the cantilever structures built in Washington during the previous decade. They reflect the refinement and progressive simplification of the cantilever truss form in the twentieth century.² The George Washington Memorial Bridge and the Deception Pass Bridge demonstrate the final merging of a functional and aesthetic form in the cantilever truss.

²Carl Condit, American Building Art, 2 Vols., (New York, 1961), 2: 104.

IV. REPRESENTATION OF BRIDGE TYPES: MOVEABLE BRIDGES

A very specific bridge technology evolved from the necessity of spanning navigable waterways. The earliest moveable bridges within the State are swing bridges, and are essentially steel trusses which rotate around a center pier. The Spokane, Portland, and Seattle Railway Bridge (10) which spans the Columbia River is the oldest swing bridge remaining within the State. Its 462 foot pinconnected draw span was long for its day, and was even acknowledged by the bridge engineer, Henry G. Tyrrell, in his book, History of Bridge Engineering. The Puyallup Waterway Crossing (47) is an example of a pinconnected swing span which was once frequently visible on the navigable waterways of the late nineteenth and early twentieth centuries.

In his authoritative volume on Bridge Engineering, J.A.L. Waddell remarks that in 1916, the swing bridge remained the most common type of moveable bridge. However, it was during this period that many of the early swing bridges spanning the waterways were being replaced by bascule structures. The bascule bridge, whose prototype is the medieval drawbridge, derives its name from the French word meaning balance. The bascule span is opened and closed much more rapidly than the swing bridge by means of a counterweight system. The absence of a central pivot pier in the bascule bridge was a great asset. The timber structure extending from the pier which served to protect the draw span was a dangerous obstruction in narrow channels, and often usurped valuable dock space. The advantages of the bascule structure over that of its predecessor were numerous, and particularly apparent in the populated, congested cities where both roadway and waterway traffic were heavy.³

Methods of refining and improving the counterweight system in the bascule spans absorbed the energies of many bridge engineers during the late nineteenth and early twentieth centuries. The earliest examples of bascule bridge design within Washington are of the trunnion type. The Salmon Bay Great Northern Railroad Bridge (48) constructed in 1913 is an early example of the Strauss heel trunnion single leaf bascule bridge. The single leaf bascule was preferred for railroad traffic due to its greater rigidity. The heel trunnion, single leaf bascule bridge was patented by

³J.A.L. Waddell, Bridge Engineering, 2 Vols., (New York, 1916) 1: 664, 700-702.

J.B. Strauss of the Strauss Bascule Bridge Company of Chicago in 1911, and consists of an overhead counterweight which is pivoted on a fixed trunnion by a parallelogram of linkages. The structure's center of gravity does not move either vertically or horizontally as the bridge opens and closes. Consequently, this design enabled the construction of simple economical foundations. The heel trunnion design was a modification of, and eventually superseded earlier Strauss designs. In 1914, a single leaf Strauss heel trunnion bascule bridge (49) was constructed across the Ebey Slough in Everett. It was the first of its type to be used within the State as a highway structure.

The construction of several moveable spans was incorporated into the design of Seattle's Lake Washington Ship Canal. Between 1915 and 1919 three double-leaf trunnion bascule bridges of the transverse cross-girder type were constructed to span the new waterway (50-52). These bridges, which are the earliest examples within the State of a double-leaf bascule bridge, were designed by the City of Seattle, and followed a general design developed by the Chicago Department of Public Works in 1898. In 1924-25 a fourth double-leaf trunnion bascule bridge (53) was constructed across the canal on foundations that had been constructed when the ship canal was first built. A unique feature of the Montlake Avenue Bridge was that the trunnions were supported on a cantilever projection extending from the pier which eliminated the need for the transverse cross-girder used in the earlier canal bridges. In contrast to the three earlier bascule bridges constructed over the canal, ornate towers loom over the piers of the Montlake Avenue Bridge, evoking an aura of monumental dignity.

The Hoquiam River Bridge (54) was designed by the Strauss Bascule Bridge Company of Chicago, and was constructed in 1928. It is a patented Strauss trunnion double-leaf bascule bridge.

The 14th Avenue South Bridge (55) which was constructed across the Duwamish River in Seattle in 1931 is the only Scherzer rolling lift bascule bridge within the State. The bridge type was developed by William Scherzer in 1895. In this type, the leaf rotates on a quadrant which rolls along horizontal track girders. In contrast to the fixed position of axis rotation of the trunnion bascule, the axis of rotation of the Scherzer Bridge has a "motion of translation longitudinally with the structure."

Consequently, the Scherzer Bridge generally provides a greater clear opening for any total length of span than that provided by the fixed trunnion type. However, because the rolling action constantly changed the location of the center of pressure of the load on the abutment, solid rock foundations were necessary.

J.A.L. Waddell's synthesis of the significance of the bascule bridge is apt. He states that all bascule bridges are "inherently ugly, and for all but comparatively short spans are uneconomic in comparison to the vertical lift; but they are scientific and they represent, probably, the best and most profound thought that has ever been devoted to bridge engineering."⁴

The vertical lift bridge developed simultaneously with the bascule bridge. The earliest vertical lift highway structure remaining within the State is the City Waterway Bridge (56) which was constructed by the renowned early twentieth century bridge engineering firm of Waddell and Harrington. The Vancouver-Portland Interstate Bridge (15), designed in 1916 by the newly formed firm of Harrington, Howard, and Ash is another early example of a vertical lift bridge.

In 1914, the Northern Pacific constructed a Strauss direct vertical lift bridge over Steilacoom Creek (57). The design, which replaced the usual counterweight cables, chains, sheaves, and winding drums of the vertical lift bridge with a system of counterbalanced levers and rack and pinion gearing, was patented by J.B. Strauss of Chicago, and was put on the market by the Strauss Bascule Bridge Company in 1912. The Steilacoom Creek Bridge was one of the first of this design to be constructed. The Strauss direct lift bridge possesses many of the design elements of the Strauss heel trunnion bridge. Like the Strauss bascule, the lifting mechanism of the direct lift bridge consists of a parallel link counterweight which moved on fixed trunnions, or pivot points. The stark steel form is blatant in its bold adherence to its functional purpose. Although the design of the Steilacoom Creek Bridge was limited to short spanned structures, it is significant in its demonstration of the evolution and experimentation of bridge design during the early twentieth century, in its demonstration of the way in which the concepts of bascule bridge design were merged with the design concepts of the vertical lift bridge.

⁴J.A.L. Waddell, Bridge Engineering, 2 Vols., (New York, 1916), 1: 713-14.

In 1916, J.A.L. Waddell accurately interpreted the importance of the vertical lift bridge in relation to other moveable structures. He wrote that the type had come to stay, and that it would continue to be used more and more as time went on, "for not only is it inexpensive in first cost comparatively speaking, but it is also simple, rigid, easy to operate, and economical of power. It has met with considerable opposition up to the present time, mainly from the owners of bascule patents; but it has overcome that opposition most satisfactorily and unequivocally, consequently the future of the type may be counted upon as assured."⁵

The design of the Lake Washington Floating Bridge (58) which includes an unusual moveable span was unprecedented within the United States. Because piers could not be constructed in the 150 to 200 foot depths of Lake Washington, under which lies almost 100 feet of soft mud, it was not possible to bridge the 7800 foot crossing with a more conventional long span structure. A bridge of pontoon construction eliminated the problem of pier construction. The 6561 foot deck is anchored to a series of floating reinforced concrete boxes which lie only a few feet beneath the surface of the lake. A total of 64 cables secure the floating structure transversely and horizontally to anchors on the lake bottom. The required 200 foot channel is provided by the horizontal movement of a portion of the floating deck into a recess in an adjacent fixed pontoon.

⁵Ibid., p. 746.

IV. REPRESENTATION OF BRIDGE TYPES: ARCHES

During the early twentieth century the steel arch was not extensively used in the United States in comparison to other bridge forms. In his book, Bridge Engineering, J.A.L. Waddell explains the reason for the paucity of arches in the United States. "Arches are employed very generally in Europe on account of their superior appearance as compared with simple truss bridges, and because of the powerful influence of the old masonry arch upon the minds of European bridge designers, regardless of the consideration of economy. American engineers, on the other hand, have been indifferent to the question of aesthetics, and have preferred simple spans to arches mainly for reasons of simplicity and economy, but sometimes on account of their rigidity."⁶

The Twelfth Avenue West Bridge on Dearborn Avenue (60) was constructed by the City of Seattle in 1911 and is the oldest extant steel arch within the State. Of the earliest steel arches within the State, it is the only example of a spandrel-braced arch. There are two examples within the State of a three-hinged lattice arch, one built over Ravenna Park (61) in 1912-13 by the City of Seattle, and one built over the Carbon River (62) in 1921 by the State and Pierce County. The three-hinged arch, with a hinge at the crown and at the two abutments, was widely used by American engineers. Although it is the least rigid of all arch structures, there is no ambiguity of stress distribution, and the method of stress calculation is relatively simple. A solid-rib two-hinged parabolic steel arch dramatically spans a steep wooded ravine on North Queen Anne Hill (63). This attenuated striking steel form was designed by the Seattle Engineering Department in 1935. It is the only one of its type within the State that was constructed before 1940. The Canoe Pass Bridge (46) constructed in 1935, and the two high steel arches erected by the Simpson Logging Company (20, 21) in 1929 are more recent examples of the spandrel-braced arch.

There has been little change in the form of the steel arch since the last decade of the nineteenth century. The essential components of ribs, stiffening trusses, and spandrel posts must always be present, and

⁶J.A.L. Waddell, Bridge Engineering, 2 Vols., (New York, 1916), 1: 617.

have left little scope for variations. The design innovations in the arch bridge were linked to the developments of reinforced concrete.⁷

The earliest extant reinforced concrete arches within the State are the Washington Street Bridge (65) constructed over the Spokane River in 1908, and the Klickitat River Bridge (7) constructed by the Spokane, Portland, and Seattle Railway during the same year. The Arboretum Sewer Trestle (66) which was built in 1910 by the City of Seattle demonstrates how many of the earliest reinforced concrete bridges were park bridges, which were "notable more for their artistic design than for their large proportions."⁸ The solid-barrel arch rings which were used in the Klickitat River Bridge and in the Arboretum Sewer Trestle were predominant in the earliest reinforced concrete arch designs. Often these early structures were constructed as monoliths, and the metal reinforcing acted more as a binding element than as reinforcing. The Washington Street Bridge is an early example of a ribbed arch. The flattened form of the ribs of the Washington Street Bridge reflected future developments in concrete arch design.

When the Monroe Street Bridge (67) was completed in 1911, its monolithic arch was hailed as the largest concrete arch in the United States. The Monroe Street Bridge was similar to the Walnut Lane Bridge of Philadelphia, constructed in 1906-8, which was an important forerunner in the design of long-span fixed arches. The great size of the massive arched ribs of these two structures reveals the limits of unreinforced concrete in long span structures. However, the open spandrels and flattened ribs of the Monroe Street's central arch pointed toward the future in concrete arch design. The Latah Creek Bridge (68) was the second of Spokane's grand monumental concrete arches, and is an early example within the State of a long-span fixed-end reinforced concrete arch.

The commanding monumental form of the Rosalia Bridge (69) constructed by the Milwaukee Railroad in 1915 rivals that of the two Spokane arches. The Rosalia Bridge is the only multiple span concrete arch railroad bridge within the State. Because of the high impact of railroad loads, concrete arches were never widely used in the construction of railroad bridges,

⁷Carl Condit, American Building Art, 2 Vols., (New York, 1961), 2: 128.

⁸Henry Grattan Tyrell, History of Bridge Engineering, (Chicago, 1911), p. 427.

particularly in long span structures.

The Lower Custer Way Crossing (70) is an early example within the State of a Luten arch. The Luten arch was introduced to the United States from Germany in 1900, and was one of the early scientific solutions to bar reinforcing in concrete. Unlike many of the earliest solutions to arch reinforcing which indiscriminately placed steel shapes throughout the concrete, the Luten system pointed to later techniques which distributed the steel primarily in the tension zones. In the Luten system, several bars forming a complete loop were laid transversely through the vault and invert of the arch. These series of loops were also laid throughout the length of the structure at regular intervals. The bars were bent to conform to the semicircular section of the vault, and were placed near the surfaces of maximum tension under live load.⁹

As the reinforcing of concrete became better understood, the rigid concrete and the elastic steel were scientifically designed to function together organically, and it became possible to build lighter, more attenuated forms. The minimal, graceful form of the 34th Street Bridges (74, 75) in Tacoma and the Cowen Park Bridge (73) in Seattle reveal the capabilities of reinforced concrete, and reflect the progressive reduction in the quantity of structural material used in concrete arch design. However, the bold, dynamic innovative concrete forms of the European designers, Maillart and Freyssinet have never been equalled in the United States. "The scarcity of advanced designs in concrete bridges has arisen in part from the necessities of American practice: lower working stresses than are the rule in Europe; much higher traffic loads, both rail and highway; the higher cost of formwork, chiefly because of high labor costs; and in many places, higher wind and snow loads."¹⁰

During the 1920's and 30's five reinforced concrete tied arches were constructed within the State (76-80). In these arches, the deck slab is hung by suspenders from a pair of arch ribs above the roadway. In most arches, massive abutments and foundations are necessary to resist the horizontal thrust exerted by the arch on the skewbacks. However, in the tied arch, the horizontal thrust is resisted by longitudinal ties

⁹Ibid., 2: 197.

¹⁰Ibid., 2: 195-196.

which extend between the hinged springing points. In most of the five tied arches in Washington, the deck slab itself acts as a tie. The double function of the deck slab was an economical solution, and it eliminated the need of massive abutments. Although there are examples of tied arches that were built throughout the 20's and 30's, the tied arch has remained a rare concrete arch form.¹¹

¹¹Ibid., 2: 206.

IV. REPRESENTATION OF BRIDGE TYPES: CONCRETE BEAMS, GIRDERS, AND TRUSSES

The concrete girder has become a predominant feature in the landscape of the American highway. The two earliest examples within the State of concrete girder highway bridges are the North 23rd (81) and the North 21st (82) Street Bridges in Tacoma. Both bridges were designed by Waddell and Harrington. The North 23rd Street Bridge was built in 1909, and is an early example of a concrete rigid frame girder bridge. The concrete beams are massive and overdesigned. The rigid frame was not adopted on any extensive scale, until after World War I. The 21st Street Bridge constructed in 1910 is a continuous concrete rigid frame girder bridge. It was built almost simultaneously with the 950 foot Asylum Avenue Viaduct in Knoxville, which Carl Condit documented in American Building Art, as the first continuous concrete girder bridge to be constructed.¹²

There are three concrete structures within the nomination which are early American applications of the European innovation of concrete hollow-box construction. In cellular construction, the concrete is poured around hollow box forms thus reducing to a minimum the amount of material used. The steel and concrete is placed only at those points where it functions actively under live load. This economical hollow-box form was used extensively throughout Europe, but was not widely used in the United States. The Purdy Bridge, constructed over Henderson Bay in 1936, is one of the few box-girder bridges within the United States, and has the longest single span among concrete-girder forms.¹³ The design features and layout of the bridge were suggested by Homer M. Hadley, and was one of several unique concrete bridge designs of cellular constructions conceived and carried out by Mr. Hadley throughout Washington during his lifetime.

Homer Hadley also designed the McMillan Bridge (87), a reinforced concrete truss of hollow-box construction. At the time that it was built, its 170 foot main span was the longest beam span within the United States. The

¹²Carl W. Condit, American Building Art, (New York, 1961), 2:207.

¹³Ibid., p. 209.

organic strength of concrete that is so frequently revealed through the arch form, is shrouded by the massive breadth and scale of this truss at McMillan. The McMillan Bridge demonstrates the use of concrete for a design that traditionally evolved and conformed to the structural properties of timber and steel.

The Seattle Engineering Department introduced hollow box construction in the design of concrete rigid frame bridges when it built a concrete structure in Schmitz Park (86) in 1935.

There are two concrete beams within the nomination that are included for their architectural merits. The Johnson Bridge (83), is a three-span concrete T-beam. The engineers have used a straightforward, commonplace bridge type, and through the addition and integration of simple, subtle geometric shapes have transformed the structure into one which has an aesthetically compelling visual impact. As the most impressive of several short spanned structures with similar ornamental motifs throughout Walla Walla County, the Johnson Bridge reflects the impact of a single creative engineer on regional bridge design. The Capitol Boulevard Crossing (84) is one of the best examples within the State of the influence of Art Deco and Modernistic Architecture on bridge design. The concrete viaduct exemplifies the way in which decoration was used to transform an ordinary structure into an entrance-way into the Capital City.

IV. REPRESENTATION OF BRIDGE TYPES: SUSPENSION BRIDGES

The thin parabolic cables of the suspension bridge stretching between two towers has an unyielding visual force. "The principle of the suspension bridge is simple," stated the bridge engineer, David B. Steinman. "It consists of three essential parts: the towers, the anchorages, and the cables. The roadway and the stiffening construction have local importance, but both may be wholly or partially destroyed without causing the collapse of the bridge. In all other types of bridge construction, the failure or buckling of a single member will precipitate the collapse of the entire structure. A suspension bridge is the safest type of construction in that any local overloading or structural deficiency will not jeopardize the safety of the whole."¹ However at the beginning of the 20th century the bridge engineering profession did not have this same confidence in the suspension bridge. In 1911, the bridge engineer, Henry Tyrrell wrote that although the suspension bridge is one of the oldest bridge forms, it has not been adopted as rapidly as other bridge types, because of its lack of rigidity and the absence of correct theory for proportioning stiffening trusses.² Mr. Tyrrell's cautiousness is perhaps explained by the fact that he was writing during the era of the railroad. Because of the flexibility of the suspension bridge design, it was not widely used for the heavier railroad loadings. It was the advent of the automobile that initiated the proliferation of the suspension bridge, particularly for long-spanned structures.

The oldest extant suspension bridges within the State are a series of timber suspension bridges crossing deep lateral gorges in the North Cascades at Devil's Corner (87). They were built by miners in the 1890's to provide access to their claims, and stand as a testimony to man's ingenuity and to the dogged persistence of the early miner's in breaching the formidable mountain barrier.

Although there are numerous examples of timber suspension bridges throughout the State, the Yale Bridge (88) is the only example of a short-spanned steel suspension bridge. Steel suspension bridges of moderate length

¹David B. Steinman and Sara Ruth Watson, Bridges and their Builders, (New York, 1941) p. 326.

²Henry Grattan Tyrrell, History of Bridge Engineering (Chicago, 1911), p. 254.

have remained rare because cost factors have prevented them from competing with simple steel trusses, cantilevers, or arches for ordinary highway structures.

The suspension bridge was primarily used for the very longest spans. When the graceful, ribbonlike Tacoma Narrows Bridge (89) was opened to traffic on July 1, 1940, it was the third longest suspension bridge in the world. The design of the Tacoma Narrows Bridge followed the mainline of development in the evolution of the suspension bridge. It represented a culmination of the trend to increase the span length, to reduce the width of the deck and to minimize the depth of the stiffening components, which simplified and distilled the bridge form; it represented the epitome of a move towards a suspension bridge of slender proportions that placed a premium of economy on flexible design.

However, on November 7, 1940 only four months after the opening of the bridge, the design ended in disaster. Gale force winds created torsional oscillations in the bridge that eventually reached catastrophic proportions causing the sinuous main span to break away from the undulating mass and plunge into the water below. The collapse of the bridge initiated a deluge of scientific investigation. Studies revealed that the bridge was destroyed by a combination of factors, factors that were more pronounced in the Tacoma span than in any other modern suspension bridge.

One critical factor was the vertical slenderness and resulting vertical flexibility of the structure which was caused by the construction of high flexible towers and a thin suspended span. Another flaw in the design of the bridge was the use of slender, solid web plate girders to stiffen the deck rather than the use of the complex and conventional truss. The steel truss acts like a sieve to the forces of the wind. However, the wind could not penetrate the solid wall of the girder. Because the span was highly flexible, the cross-section of the solid plate girders in combination with a solid floor was particularly sensitive to aerodynamic forces. The characteristics of this cross-section caused small undulations of the bridge to amplify. There was a tendency for these undulations to change into a twisting motion which would generate harmonic movements of dangerous magnitude. It was these harmonic motions that eventually proved fatal to the bridge.³

³Steinman, op. cit., pp. 353-357.

Other bridge designs did benefit from the mistakes made in the construction of the Tacoma Narrows Bridge. The noted engineer, Ottmar H. Amman, who had designed the recently completed Bronx-Whitestone Bridge in New York with stiffening girders, quickly replaced them with trusses. The knowledge gained from the research following the disaster was valuable to the entire engineering profession in terms of understanding the importance of aerodynamics in suspension bridge design.

V. THE ROLE OF THE BRIDGE ENGINEER

The singular role of the bridge engineer in the development of Washington is undeniable. This role was probably most pronounced in the construction of the grand transportation schemes of the transcontinental railroads. The awesome scale of the land demanded structures of equal proportion. The bridge and tunnel engineers of this era were men who had more than unusual constructive abilities; they were men with vision; they were dreamers, planners, managers, and builders who built on an enormous scale.

These qualities were exemplified in men like Mr. Nelson Bennett who completed the two mile long Stampede tunnel through the "backbone of the Cascade range" under unyielding odds. The immensity of the projects in which these engineers were involved is reflected in the career of John Frank Stevens. Stevens surveyed the Great Northern route over the Cascades which resulted in the construction of the Cascade Tunnel, and then went on to play a major role in the construction of the Panama Canal.

There were a handful of prominent, prolific bridge engineers who devoted their early careers to railroad bridge construction. For example, there was Ralph Modjeski who contributed to the design and construction of several major spans during the 20's and 30's including the San Francisco Bay Bridge. His early years were spent as chief bridge engineer of the Oregon Trunk Railway, and it was he who was responsible for the construction of the Celilo Bridge across the Columbia River in 1911-12.

The impact of the bridge engineer is visible throughout Washington. There are numerous examples of the influence of a single creative engineering talent on a particular region. For example, E.R. Smith's tenure as county engineer during the 20's and 30's has left its impact throughout rural Walla Walla County. Through the addition of simple, softly colored geometric shapes, several short-spanned concrete T-beams were transformed into visually compelling structures.

During the period between 1909 and 1914, two enormous multiple spanned concrete arches were constructed in the city of Spokane. There are few bridges within the State that are monuments of such a grand scale. It was the foresight and perserverance of a few individuals within the city engineering department who were responsible for the construction of these

forceful, concrete forms. An abundant number of concrete arches were built throughout the city of Spokane during this era by the engineering department directly impacting the visual countenance of the city. However, it is the magnitude of the Monroe Street Bridge and the Latah Street Bridge that make them particularly unique. Their rhythmic arch forms are commanding architectural focal points within the city. Morton McCartney, who was a key individual in the construction of the Monroe Street Bridge, supervised the design and construction of the Latah Creek Bridge as City Engineer.

The engineer, Homer Hadley, designed several unique concrete bridges throughout the state of Washington during his lifetime. The Purdy Bridge and the McMillin Bridge were both designed by Mr. Hadley. They are early American applications of the European innovation of concrete hollow-box construction. This economical method of construction was used extensively throughout Europe, but was not widely used in the United States. It was Homer Hadley who originally conceived the design of a floating bridge across Lake Washington. He visualized a floating roadway made up of a series of hollow concrete barges. Mr. Hadley's unusual work reveals the effects of a single innovative engineer on bridge design within the State.

There are other examples of bridge builders within Washington who forged outside of the mainstream of American bridge design practices. The 250 foot log cable-stayed girder bridge that was constructed across the Quinault River by the Logging Superintendent, Frank Milward, in 1952 is a prime example of a bold design that did not conform to American design patterns. It was the tenacious pioneering spirit of Mr. Milward, who constructed one of the first examples of a cable-stayed girder bridge within the United States. A segment of the history of bridge construction within Washington is revealed by the fact that structures were built in the mid-20th century by an individual whose background and methods of building closely paralleled those of 19th century engineers. Pioneering mavericks with little formal education were building innovative structures within the State simultaneously with engineers who used the most contemporary scientific analyses to determine appropriate bridge designs.

The history of bridge construction, and the role of the bridge engineer in the development of Washington is indeed multifaceted. Throughout the State's bridge construction history, there are repeated demonstrations of the resourcefulness and persistence of talented individuals who sought to

direct "the great sources of power in nature for the use and convenience of man."¹ Without question, the bridge engineer's role is a significant one. In some respects, the bridge engineer played an indispensable role in the development of the state. Several of the earliest bridge engineers built structures that were integral parts of vast transportation systems which made Puget Sound and an inscrutable wilderness accessible to large numbers of people, directly impacting the course of settlement patterns within the State. The influence of the bridge engineer is pervasive; the construction of even the shortest spans affect people's lives, easing their ability to move from one location to another. This pervasive influence of the bridge engineer is reflected in the extant historic bridges and tunnels remaining within Washington.

¹Julius Adams, "The Dinner," Proceedings of the American Society of Civil Engineers, I (1874), 175; as quoted from Raymond H. Merritt, Engineering in American Society, Lexington, 1969, p. 3.

