SELLWOOD BRIDGE
Spanning Willamette River at Tacoma Street
Portland
Multnomah County
Oregon

HAER OR-103

WRITTEN HISTORICAL AND DESCRIPTIVE DATA
REDUCED COPIES OF DRAWINGS
CHARTS and PHOTOGRAPHS

Historic American Engineering Record
National Park Service
Department of the Interior
P.O. Box 37127
Washington, D.C. 20013-7127

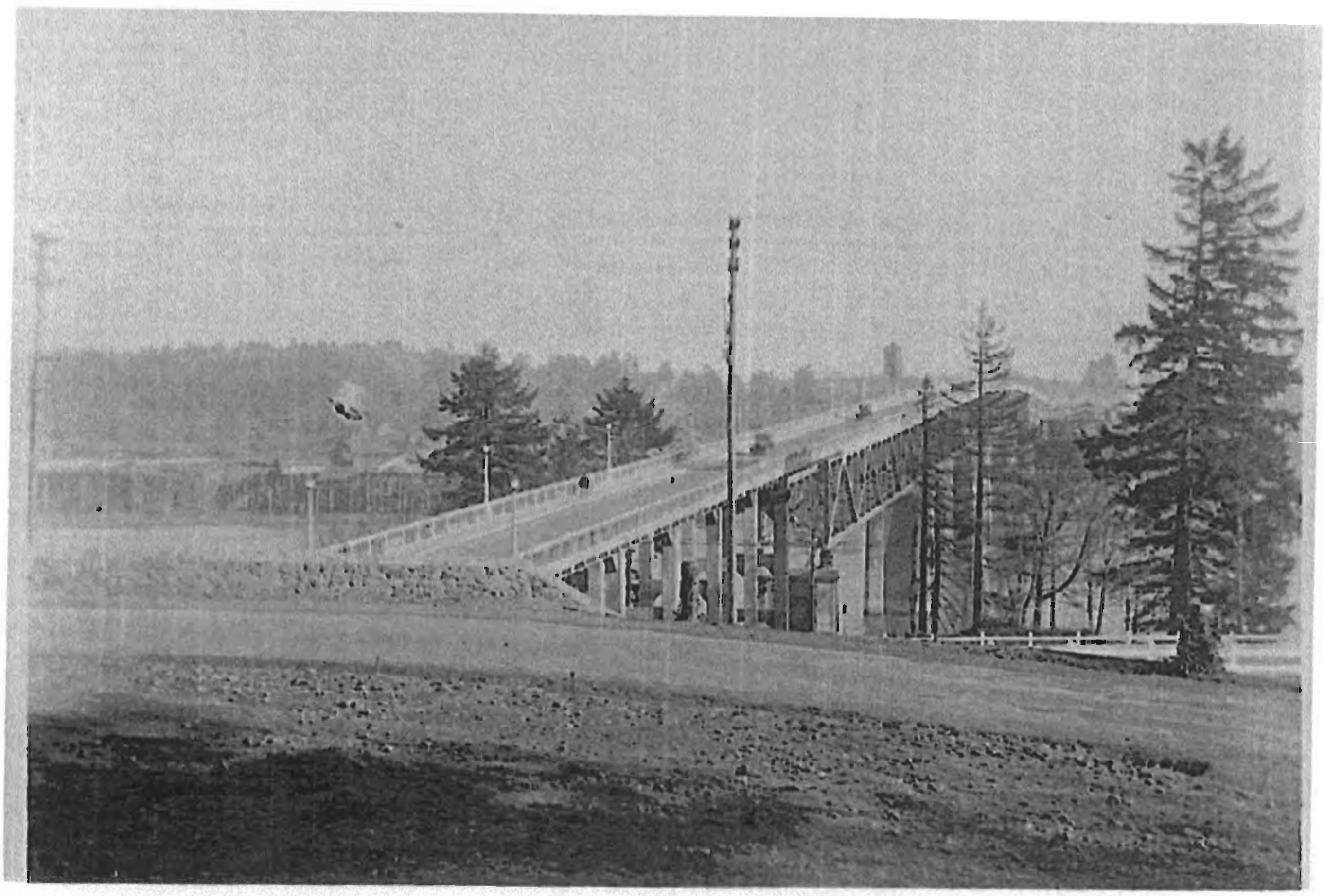
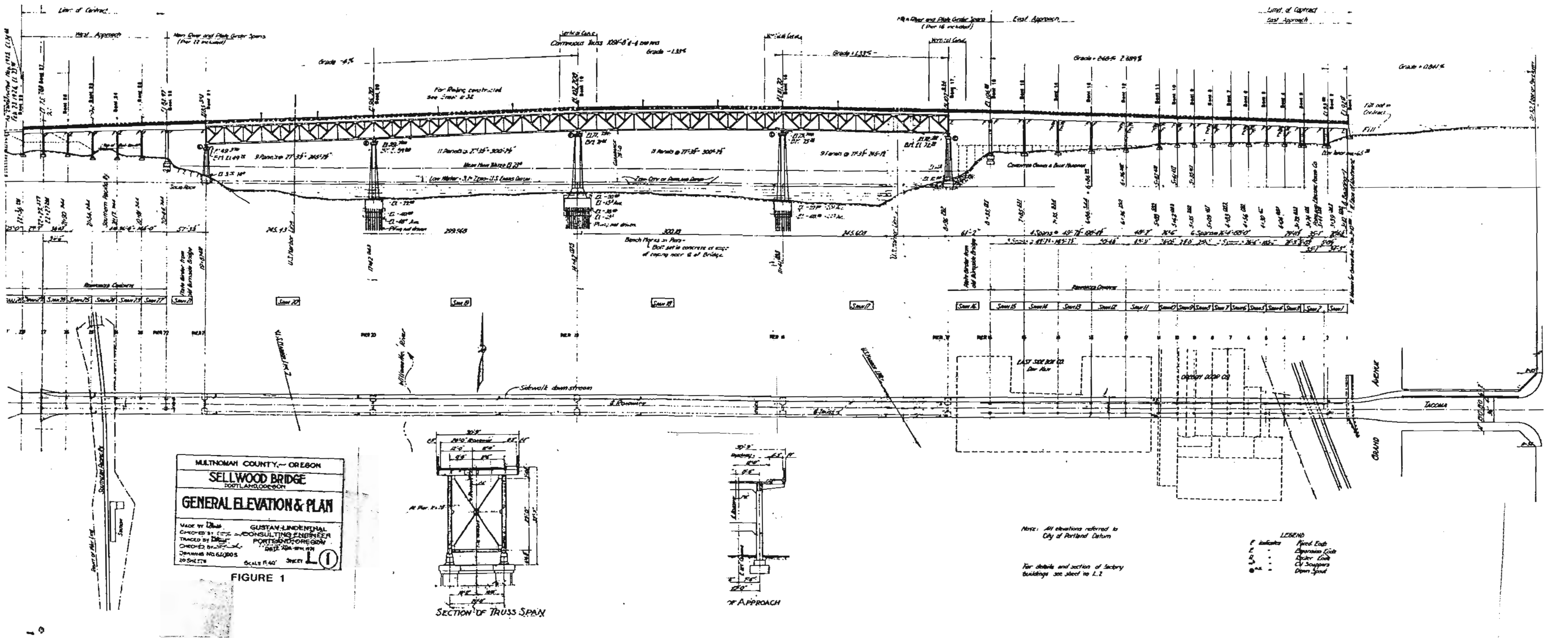


TABLE OF CONTENTS i-ii

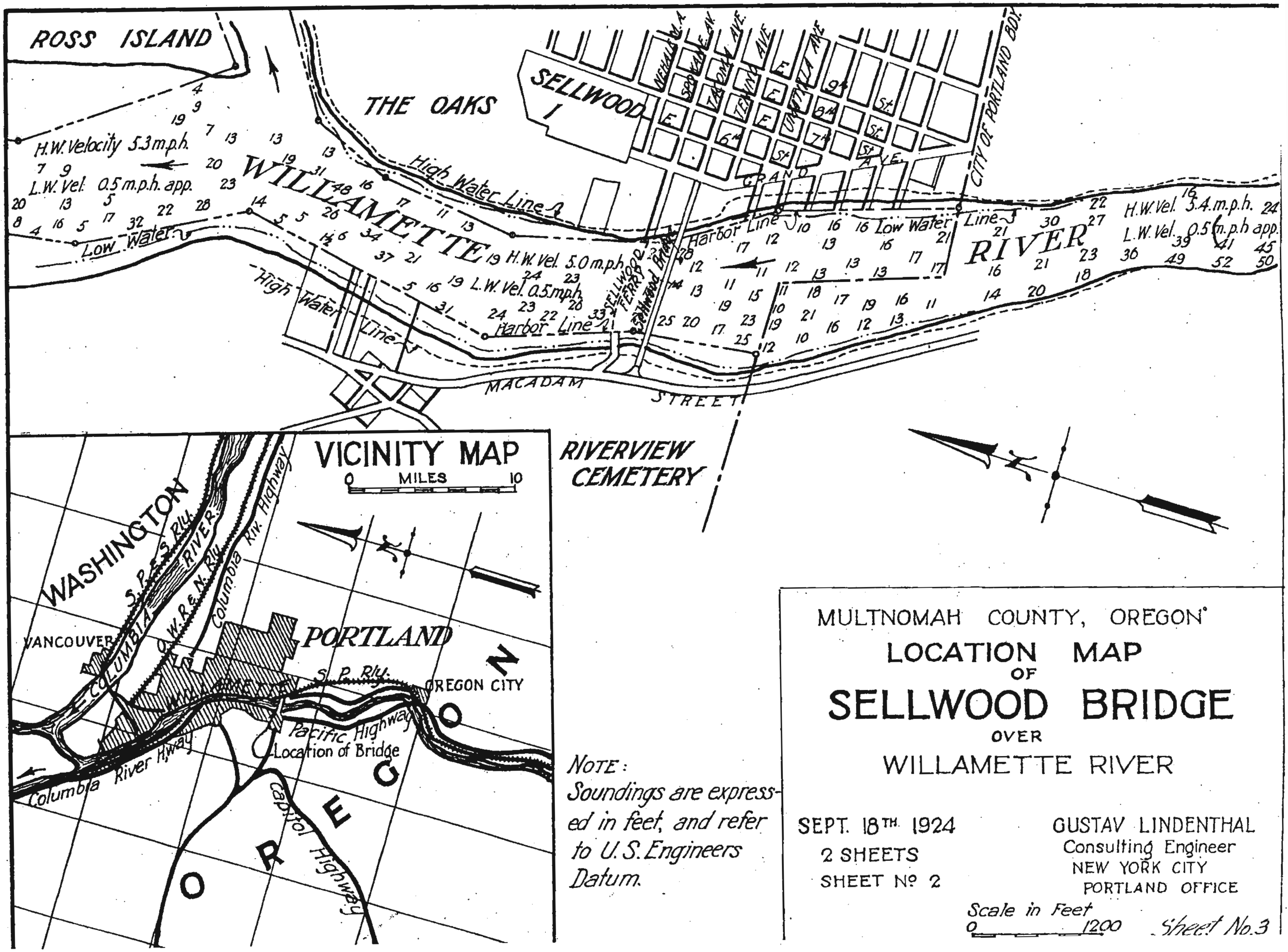
Plates | Following Page

Appendices

Photographs


MULTNOMAH COUNTY, OREGON
SELLWOOD BRIDGE
PORTLAND, OREGON
GENERAL ELEVATION & PLAN
GUSTAV LINDENTHAL
CONSULTING ENGINEER
PORTLAND, OREGON
Limit of Contract
West Approach
East Approach
Continuous Truss
SECTION OF TRUSS SPAN
APPROACH
Notes: All elevations referred to City of Portland Datum
For details and section of factory buildings see sheet no. L 2
LEGEND
Sidewalk downstream
Willamette River
TACOMA
AVENUE
GRAND
FIGURE 1

Copy of tracing filed with Bridge plans E.D. 6371(Multnomah Co.-Will. R.)



HISTORIC AMERICAN ENGINEERING RECORD
SELLWOOD BRIDGE
HAER No. OR-103

Location:	Spanning the Willamette River at S.E. Tacoma Street, Multnomah County, Oregon. UTM: Portland, Ore., Quad. 10.526220.5034380
Date opened:	December 15, 1925
Structural type:	Steel four-span continuous riveted Warren Deck Truss with Verticals (sub-divided).
Engineer(s):	Gustav Lindenthal, New York City, and Ira G. Hedrick, Kansas City
Prime Contractor:	Gilpin Construction Co., Portland and Astoria, Ore.
Steel Fabricator:	Judson Manufacturing Co., San Francisco and Emeryville, Ca.
Owner:	County of Multnomah, Portland, Oregon
Present Use:	Vehicular, pedestrian and bicycle traffic
Significance:	The Sellwood Bridge, the busiest two-lane bridge in Oregon, is the southern-most span in an ensemble of twelve monumental highway bridges across the lower Willamette River at Portland, Oregon. The only four-span continuous truss in the state, it appears to be an extremely rare bridge type anywhere. Sellwood is also: 1) one of only 215 known truss highway bridges of any type or age surviving in Oregon; 2) one of only five known continuous highway trusses (of any type or span length) in Oregon; and 3) the state's only known highway continuous deck truss. In addition, Sellwood is one of five Portland spans associated with Gustav Lindenthal during the period 1924-1928 and is among the last bridges of this master American bridge designer's career. A rare example of a Lindenthal highway-only deck truss, Sellwood is made more significant because of its unusually finely subdivided Warren Truss with Verticals, that part of its superstructure and its entire substructure designed by

Kansas City engineer Ira G. Hedrick, a one-time partner of J.A.L. Waddell. The Sellwood Bridge was Portland's first Willamette River bridge to open without a movable span, and was built without trolley tracks and with only one under-sized sidewalk. As such, it was the first major Portland bridge designed almost exclusively for the automobile. Except for its west end approaches, it remains intact as constructed, with both ends of its superstructure incorporating girders from the 1894 Burnside Bridge--an example of early recycling efforts. Opened in December 1925--the same month and year as the birth of the modern discipline of geotechnical engineering in the United States--the Sellwood Bridge serves as a precise but ironic benchmark because of extensive damage to its west end approach due to significant movement from one or more landslides. The sole vehicular crossing of the Willamette River in a ten-mile stretch between Portland and the cities of Oregon City and West Linn, the Sellwood Bridge particularly reflects challenges faced by local agencies charged with maintaining structurally and functionally obsolete bridges into the twenty first century.

Project Information:

Documentation of the Sellwood Bridge is part of the Willamette River Bridges Recording Project, conducted during the summer of 1999 under the co-sponsorship of HAER and the Oregon Department of Transportation in cooperation with Multnomah County. It extends preliminary work conducted under the Oregon Historic Bridge Recording Project with the same co-sponsors in the summer of 1990.

Researched and written 1999-2000, by Sharon Wood Wortman, HAER Historian, in collaboration with Edward J. Wortman, P.E., Engineering Services Administrator, Multnomah County Transportation Division, Bridge Section.

Introduction: Truss Bridges, Continuous Truss Bridges in Oregon, and the Sellwood Bridge

In his early twentieth century study of truss bridges, J.A.L. Waddell, the inventor of the modern-day vertical lift bridge, noted, "When plate-girders cannot be used on account of the length of span being too great, it is necessary to resort to some form of truss bridge."[1] A truss bridge (a beam or girder bridge which has been opened up to form triangles) is one of three basic bridge types, along with arch and suspension bridges. Truss bridges can be grouped into three types, depending on the location of the roadway: 1) through trusses, where vehicles cross between two or more trusses, 2) pony trusses, where vehicles cross between two or more trusses about half the height of a through truss, and 3) deck trusses, where vehicles cross a deck supported by two or more trusses that are beneath the roadway and out of sight of the driver. A through truss bridge has top bracing, whereas a pony truss is open (no top bracing). Another way to group truss bridges is by structural arrangement. They can be either simple span, cantilever, or continuous. In a simple span truss bridge, each span is independently supported by piers at each end. In a cantilever truss bridge, the trusses extend out past the piers. (Normally there is a simple span suspended between the ends of the two cantilever trusses.) A continuous truss bridge is a structure that extends as one piece over multiple supports with the stresses of the bridge distributed over the entire structure. One analogy would be a log supported by stones at intervals across a waterway. The Sellwood Bridge, as a four-span continuous truss, is supported by five piers, supported, in turn, by timber piling. Constructed with two lanes of traffic 24 feet wide, but more than 1,092 feet in length over piers extending 75 feet high above water, Sellwood is one long, skinny, elevated "log" supported above the Willamette River by logs driven into the riverbed.

Modern bridge technology began with the advent of the truss bridge. The truss bridge was developed and refined in the U.S. in the late 1700s and early 1800s by pioneer bridge builders. Ithiel Town, William Howe, Caleb Pratt and others filed patents for their inventive and varied placement of vertical and diagonal members--the aim of their efforts to find forms that required the least amount of material, therefore the cheapest to build. The Warren truss, invented by British engineer James Warren, was patented in 1848, and like other trusses, played a defining role in the development of American bridge building as component parts

[1]J.A.L. Waddell, Bridge Engineering (New York: John Wiley & Sons, 1916), Vol. 1, 468.

evolved from wood to iron and to steel, with first pinned, then riveted, and finally bolted connections.[2] The members of a Warren truss are in the form of connected, repeating "Ws." In a Warren truss, the diagonals, with alternate diagonals carrying tension or compression, carry all vertical shear. The vertical truss members (posts and hangers) carry only local loads.

Historic Highway Bridges of Oregon includes sketches of 12 truss types described as "Common Historic Bridge Designs in Oregon."[3] Of these, four are varieties of Warrens: Warren (simple), Warren with Verticals, Warren with Polygonal Top Chord, and Double-Intersection Warren (Lattice).[4] The Sellwood Bridge is an example of a Warren with Verticals that has been sub-divided.[5] Declining drastically in number, only 215 truss bridges of all types or age are known to remain on Oregon's highway system among more than 6,500 highway bridges in inventory in 2000. Of the 215 trusses, only 126 are known to remain that were constructed prior to 1951.[6] Of the 126 historic trusses,

---

[2]Kirby, Richard, Early Years of Modern Civil Engineering (New Haven, London, Yale U. Press; H. Milford, Oxford U. Press: 1932), 160 (Vol. 12, 1852-53).

[3]Dwight Smith, James Norman and Pieter Dykman, Historic Highway Bridges of Oregon, (reprinted by Oregon Historical Society Press, 1989), 22. The source for "Common Historic Truss Designs in Oregon" is the Historic American Engineering Record, National Park Service, United States Department of the Interior, Washington, D.C.

[4]According to Smith, "Virtually all trusses manufactured today are variations of the Warren design," 21. According to Waddell, a true Warren requires triangles that are equilateral. However, Waddell also notes, "... later writers generally use the name for any triangular truss," 472.

[5]A distinct aspect of the Sellwood Bridge is the use of vertical posts (sub-verticals) in the truss running from the top chords down to the diagonal intersections, which effected a lightweight deck system. For more about this subject, see section below, "Portland Bridges - Panel Lengths."

[6]Julie Osborne, Cultural Resource Specialist, Environmental Services, Oregon Dept. of Transportation, telephone interview with Sharon Wood Wortman, 9 Nov. 2000. The total number of known or inventoried truss bridges in Oregon has declined from 350 in 1984 to 215 in 2000. (This means a loss of about 8.5 truss bridges in Oregon per year. At this rate, they could all be gone

there are only 32 known deck trusses. Among these 32 is the four-span continuous truss Sellwood Bridge, one of only five known continuous trusses in all of Oregon. It is noteworthy that the other four continuous trusses are all either two-span or three-span continuous trusses of the through truss type, with Sellwood the one and only known continuous highway deck truss.[7]

Oregon's other four known continuous truss bridges include three three-span continuous trusses, all opened in 1929, and one two-span continuous truss, opened in 1950, the latter across the Willamette River at Coburg. The three three-span continuous trusses are: 1) Springfield Bridge, across the Willamette River, designer Conde B. McCullough, 2) Scottsburg Bridge, across the Umpqua River, designer Conde B. McCullough, 3) Columbia River Bridge at Longview, across the Columbia River, designer Joseph B. Strauss. The designer of the Coburg Bridge is unknown.

Gustav Lindenthal and Continuous Truss Bridges

There were only two continuous truss bridges known to exist in the United States by 1917, both designed by Gustav Lindenthal. The five-span Queensboro Bridge opened across the East River in New York City in 1907[8], and in 1917 Lindenthal finished the

---

in 25 years.)

[7]Historic Highway Bridges of Oregon, Smith, 57, 80, and 279.

[8]The main portion of the Queensboro Bridge (originally called the Blackwell's Island Bridge) consists of a 3725'-long five-span truss. From overall elevation drawings and comments in the literature (see below), it appears that the truss is continuous over the five spans. On the other hand, Lindenthal himself did not include this bridge in his brief discussion of multiple-span continuous girder (truss) bridges in a letter to the editor dated 13 Feb. 1929, published in the Engineering News-Record:

> "Sir—Your editorial article on continuous girder bridges in your issue of Jan. 17 is incomplete in its historical references by failing to give credit to C. Shaler Smith, who was the first engineer to use this system. He applied it in his single-track railroad bridge over the Lachine Falls [across the St. Lawrence River near Montreal] in the 80's, a bridge which twenty years later was replaced by a stronger double-track bridge having simple trusses. Even before this I had been an advocate of the continuous girder type of

design and construction for a Chesapeake & Ohio Northern double-track railroad bridge over the Ohio River at Sciotoville, composed of two spans, each 775 feet long, of continuous riveted trusses.[9] In a paper on the Sciotoville Bridge written for the American Society of Civil Engineers, shortly before designing Portland's Sellwood and Ross Island bridges, Lindenthal addressed the arguments for and against continuous truss bridges. Lindenthal first discussed the existing prejudices against this structural type, and then presented his case for its advantages.[10] He summarized the anti-continuous truss arguments as follows:

---

construction. I believe also that I was the first engineer in this country to use continuous girders on a large scale, in the Sciotoville bridge. Since then the Steubenville bridge over the Ohio River, with three spans, was built for the Pennsylvania Railroad; I suggested the continuous system for this bridge and made the check calculations. Only recently I completed two city bridges of the continuous girder type over the Willamette River in Portland, Ore., one of three spans, another of four spans. G. Lindenthal, Consulting Engineer, New York City." ENR, 3 March 1929, 397.

Lindenthal may not have considered Queensboro a "true" continuous structure due to the great variation in truss depth along its length, which results in widely varying stiffness. Or he may have chosen to ignore Queensboro in later years after severe public criticism of its design by an eminent peer, J.A.L. Waddell, who wrote of Queensboro: "...after completion it was deemed so unsatisfactory that the authorities had the stresses refigured at enormous expense by independent computers, with the result that the over-stresses were found to be so great . . . that some of the roadways had to be omitted. A New York engineer connected with the bridge once remarked that the structure is so complicated that, if a man were to stand at the first panel point of the farthest span and were to spit into the river, his doing so would affect the stress in every main truss member of every span in the entire structure - and the statement is actually correct." Waddell's criticism of Queensboro's design continued on for several more sentences. Waddell, Bridge Engineering, Vol. 1, 586.

[9]"Sciotoville Bridge Over the Ohio River," Gustav Lindenthal, Transactions, American Society of Civil Engineers (New York: 1922), Vol. LXXXV, Paper No. 1496, p. 910-953.

[10]Ibid., 915-920.

> "The continuous truss type has nowhere met with more indiscriminate and unqualified condemnation than by engineers in the United States, who have alleged three principal objections against it, none of which is novel or decisive:[11]
>
> 1st - That it is statically indeterminate, that is, its reactions are dependent on the elasticity of its members.
>
> 2nd - That it is subject to stresses from unequal settlements of its supports; and
>
> 3rd - That it is affected by temperature stresses.
>
> "Although these characteristics may be objectionable in certain cases, it can be readily shown that they are entirely unobjectionable in others, and they will be briefly discussed."[12]

Lindenthal then went on to discuss these three objections in detail, arguing that they were not significant concerns in situations such as those where he had chosen to use a continuous truss. For example, with respect to the first objection, he acknowledged that stress calculations are more complicated for continuous structures, but he argued that the extra effort is not significant.[13] Lindenthal next presented five advantages of continuous trusses:[14]

- *Economy:* A continuous structure generally will require less material, particularly in comparison to a series of

---

[11]J.A.L. Waddell may have been one of the engineers referred to by Lindenthal. In Bridge Engineering, Waddell devoted most of a page to criticism of continuous girder (truss) bridges. He started his discussion by saying: "Considerable attention has been given by writers on the subject of bridges to continuous girders, the result being simply a great waste of printers ink." Then later: "It is proper to state though, that not all American bridge engineers agree with the author in his drastic condemnation of continuous spans; for one of the most prominent of them, Gustav Lindenthal, Esq., C.E., has lately proposed a structure of that type for a crossing of the Ohio River at Sciotoville, Ohio..." Bridge Engineering, Vol. 1, 482.

[12]"Sciotoville Bridge over the Ohio River," 915.

[13]Ibid., 915.

[14]Ibid., 918.

simple spans. "For long spans, the saving in cost may be as much as 25 per cent." [Economy was certainly a key objective in design of Sellwood, considering the limited funds available.]

- *Rigidity:* Deflections and vibrations are smaller in a continuous structure, particularly when compared to a cantilever type.

- *Ability to sustain damage without collapse:* A continuous structure is more damage-proof than either a simple span or a cantilever type.

- *Erection:* Portions of a continuous structure can be erected by the cantilever method, thus saving on falsework costs and avoiding interference with river traffic. [This was a major advantage on the Sciotoville Bridge.]

- *Aesthetics:* Continuous trusses can be more attractive than simple spans or cantilevers, as when the continuous structure has a uniform depth without discontinuities in the profile. [The four-span Sellwood Bridge truss unit is an excellent example.]

As a four-span continuous truss, Sellwood is unique in Oregon. It also appears to be an extremely rare structural type nationally or internationally.

Site Description

Portland, Oregon is a seaport in Northwest Oregon first inhabited by European settlers in about 1840 near the confluence of the Willamette and Columbia rivers. The city and the Sellwood Bridge are located near the western edge of the fairly flat Portland Basin. This fault-bounded, northwest-trending basin is bordered by the Tualatin Mountains (also known as the West Hills) on the west and by the foothills of the Cascades on the east. The largest city in Oregon throughout the twentieth century, Portland's population in 2000 numbers about 500,000 within the city limits, with nearly two million in the larger metropolitan area. Nearly 80 percent of the population of the city of Portland proper resides on the east, and flatter side of the Willamette River.[15]

---

[15]E. Kimbark MacColl, The Growth of a City, Power and

The Sellwood Bridge's unsymmetrical vertical curve provides a neat transition from flat land at the east end to steeply sloping forested land at the west end. The bridge was named for the neighborhood at its east end. This area, named for European settler Rev. John Sellwood, lies within Portland city limits about one mile upstream of the Willamette River landmark Ross Island and is one of about 95 Portland urban neighborhoods.[16] The bridge crosses the Willamette River at Tacoma Street, connecting the southeast Portland area, including Sellwood, to Southwest Portland and to Lake Oswego via Macadam Avenue (State Highway 43, formerly called Pacific Highway). The bridge is an extension of Tacoma Street, with its eastern terminus at the intersection of S.E. Sixth Avenue and Tacoma Street. The western terminus intersects Macadam Avenue at Riverview Cemetery, 16.5 miles upriver from the confluence of the Willamette and Columbia Rivers, or four miles upriver from the Burnside Bridge and the Portland Central City Waterfront. Sellwood is the last neighborhood in southern Multnomah County before the Clackamas County line to the southeast, with the Sellwood Bridge the only major bridge over the Willamette River in a ten-mile urban stretch of two of the most populated counties in Oregon. The nearest highway crossings over the Willamette River are the I-205 Abernethy Bridge, eight miles to the south near West Linn and Oregon City at river mile 26, and the Ross Island Bridge, located two miles to the north at river mile 14. (See Plate 1, "Portland's Bridges, Including Railroads & Interstate Highways, Willamette River Mile 0 to 26.") Most river traffic today on the stretch of the Willamette near the Sellwood Bridge is confined to recreational and tour boats.

Even though non-Native Americans had been living at the area near the bridge site since 1850, it was not named Sellwood until 1882. It was annexed to Portland in 1893.[17] Before 1892, the

---

Politics in Portland, Oregon 1915 to 1950 (Portland: The Georgian Press, 1979). MacColl notes (260) that 75 percent of Portland's residents lived on the east side by 1925. Also see Martha Jane Bianco, "Private Profit Versus Public Service: Competing Demands in Urban Transportation History and Policy, Portland, Oregon 1872-1970," dissertation (Portland State University, 1994), 38; Carl Abbott, Portland Planning, Politics, and Growth in a Twentieth-Century City (University of Nebraska Press, 1983), 12.

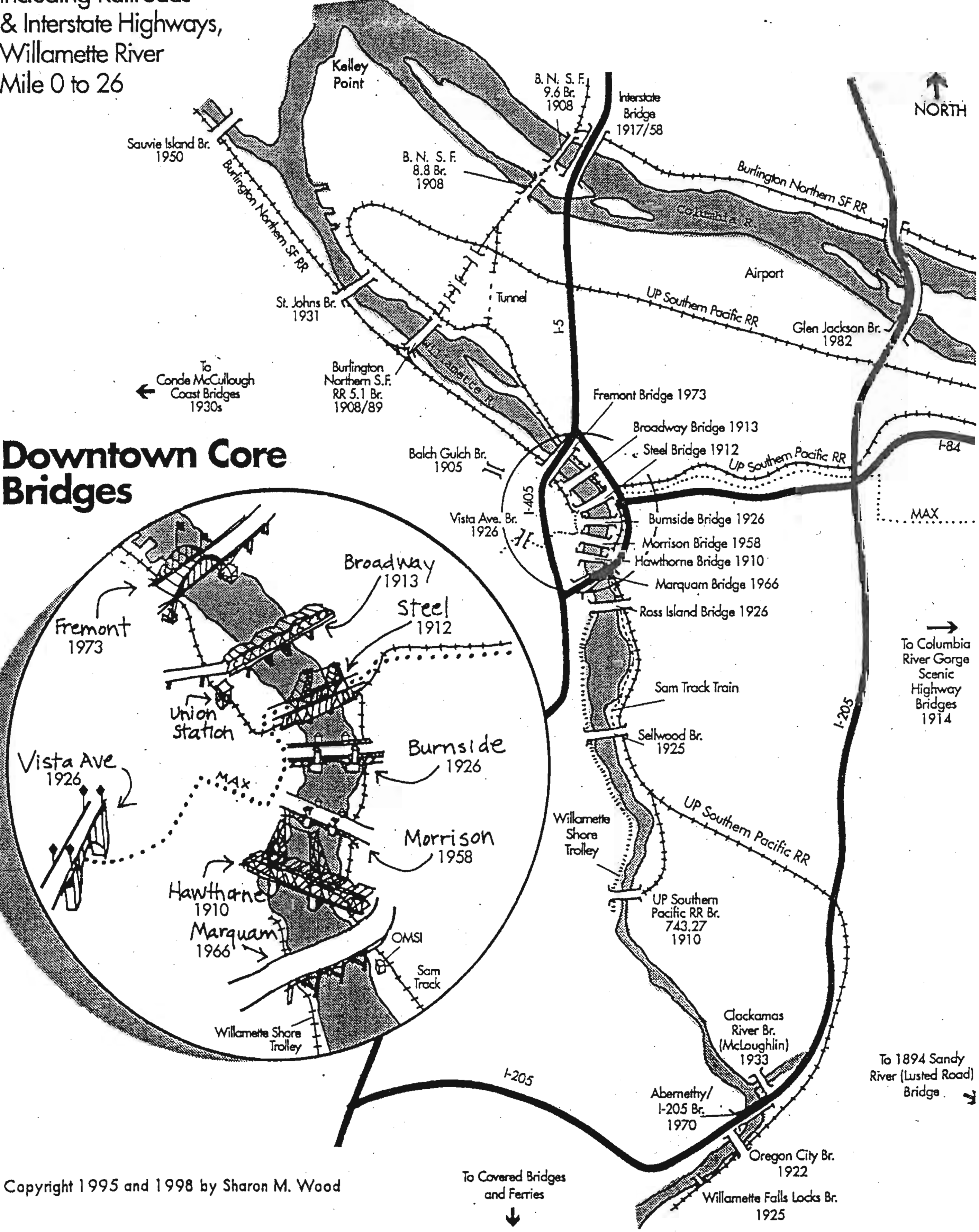
[16]Lewis A. McArthur, Oregon Geographic Names (Oregon Historical Society Press, 5th ed., 1982), 660; City of Portland, Office of Neighborhood Involvement.

[17]Ibid., McArthur.

Portland's Bridges

PLATE 1

Including Railroads
& Interstate Highways,
Willamette River
Mile 0 to 26



main steamboat landing on this part of the river was at the site of what is now S.E. Umatilla Street, two blocks south of S.E. Tacoma Street.[18] The Ferry John F. Caples operated across the Willamette River from the east side at Spokane Street, one block north of S.E. Tacoma Street, until 1925, when the Sellwood Bridge opened.[19] (See Plate 2, "Photograph of the John F. Caples, ca. 1925-26.") The landing slip at this spot is still discernable. Well into the twentieth century, the area near the east end of the Sellwood Bridge served the timber industry.[20] The East Side Lumber Co. went out of business during the Depression of the 1930s, with Oregon Door Manufacturing open until 1958.[21]

Northeast of the bridge is 43-acre Oaks Amusement Park and Skating Rink, opened in 1905, predating the bridge by 20 years. Next to Sellwood's east end approaches today are condominiums, the latest complex finished in 2000. The Willamette Greenway Trail adjoins the riverbank here, with the Western Pacific Railroad track (originally the property of Portland General Electric Co., and its subsidiary, Portland Electric and Power Co., known as PEPCO), passing between bents 2 and 3.[22] The

---

[18]"Tacoma Main Street Plan, A Short Transportation History of S.E. Tacoma Street," Richard Newlands, planner, City of Portland, Office of Transportation (Portland: 2000), p. 1.

[19]The Sellwood Bee, 25 Dec. 1925, n.p.

[20]"Factory Buildings Along East Approach," Sellwood Bridge, Gustav Lindenthal, Sheet L22, Sept. 1924, Files, Multnomah County, Bridge Section. This engineering drawing shows "East Side Lumber Co. Under Lease to East Side Box Co." from Bent 11, with a truss building between bents 11 and 12. A wharf extends west into the river, culminating just east of pier 17. "Oregon Door Co." is shown extending eastward from Bent 11, to Bent 5 and a planked roadway.

[21]A blueprint from 1924 shows there were approximately 15 buildings at the site, including an old saw mill (used for storage), and a blacksmith shop. "Eastside Harbor Survey, S.E. Harney St. to Sellwood Park, East Side Mill and Lumber Co., East Side Box Co., Oregon Door Co," dated 23 Nov. 1926, rev. Feb. 1934, by the Commission of Public Docks; Eileen Fitzsimon, historian, says her research shows as many as 400 men worked at the East Side Mill and Lumber Co. Interviews with Sharon Wood Wortman, 6 April 1997, and 12 Nov. 2000.

[22]The terms "piers" and "bents" are used interchangeably in historic documents relative to the Sellwood Bridge. HAER OR-103,

PLATE 2 - John F Caples

bridge's east end lands at S.E. Sixth Avenue. From here, S.E. Tacoma Street continues east to Sellwood's commercial core between S.E. 13th and 17th avenues, and eventually connects with S.E. McLoughlin Boulevard (Highway 99), a major north-south connector.

Beneath the Sellwood Bridge's west end approaches is Ira Powers Marine Park, an undeveloped linear 12-acre strip of riverfront acquired by Portland Parks in 1926.[23] In March 1925, Multnomah County took three parcels of property owned by River View Cemetery Association for the construction of Sellwood Bridge's west approach. The stone wall south of the main entrance to the cemetery was taken down and rebuilt farther west. As part of the deal, the county agreed that this property would be used solely for public purposes forever, with all portions not actually used by the construction of the bridge, roads or right-of-way, to be kept as a public park, ergo Powers Marine Park.[24]

Adjacent to Powers Marine Park to the north is Sellwood Ferry Road, an entry road from Macadam Ave., which dead-ends at the river at what was a former ferry slip directly cross river from S.E. Spokane Street. The route used by the <u>Caples</u>, Sellwood Ferry Road to Spokane Street, was about 1,200 feet from bank to bank.[25] The west end slip site is now used as a boat ramp by the public and by Staff Jennings Boating Center, a 1-1/2-acre retail store and marina established north of Sellwood Ferry Road in 1929.[26] Moving up the bank from Powers Marine Park is vacant

---

therefore, follows the terminology of each source document. More typical usage today would reflect that piers are bridge supports located in the water while bents are bridge supports located on dry land.

[23]"Parks and Facilities," City of Portland, Portland Parks and Recreation, 20 Nov. 1997, 4. According to Fitzsimon, Powers established and ran several furniture manufacturing operations in several locations in Portland, beginning in the 1870s.

[24]Memorandum of Agreement between River View Cemetery and Multnomah County, 20 March 1925. Files, Multnomah County Yeon facilities. Engineering drawing, "Reinforced Concrete Wall on Pacific Highway," dated Jan. 1927. Files, Multnomah County Bridge Engineering offices.

[25]"General Elevation and Plan, Sellwood Bridge," 28 Aug. 1924. Files, Multnomah County Bridge Engineering offices.

[26]Jeffrey Jennings, owner of Stafford Jennings Boating

land, used as a parking lot or turn-around, and then, passing between bents 24 and 25, tracks for the Willamette Shore Trolley (originally jointly owned by the Southern Pacific Railroad, a corporation of the state of Kentucky and Oregon & California Railroad Co., a corporation of the state of Oregon).[27] After this, the bridge's west end approaches land at a T-intersection with S.W. Macadam Avenue, a main arterial leading south to the city of Lake Oswego. Directly west of S.W. Macadam Avenue is 340-acre River View Cemetery, dating to 1882.[28] Much of the area near the west end of the Sellwood Bridge remains as it was before the bridge opened.

The Sellwood Bridge and Tacoma Street are being studied by the City of Portland for the "Tacoma Main Street Plan," scheduled to be published in mid-2001. Transportation planners are seeking to determine what changes need to be made to the bridge and along Tacoma Street, the only east/west arterial in the Sellwood neighborhood, to upgrade Tacoma Street into a more pedestrian-friendly, neighborhood-oriented, commercial- and residential-oriented street.[29]

Early Portland Bridges

Due to commercial interests that deemed bridges as impediments to navigation, no bridges were built across the lower Willamette near Portland for almost 50 years after Europeans arrived. The first crossing, at river mile 12.8, was the Morrison Bridge, opened in 1887.[30] Other early and extant

---

Center, and grandson of Stafford H. Jennings, founder, telephone interview with Sharon Wood Wortman, 9 Nov. 2000.

[27]Memorandum of Agreement between the Southern Pacific Railroad and Oregon & California Railroad Co. and Multnomah County, dated 23 March, 1925. Files, Multnomah County Yeon facilities.

[28]A contemporary sign at River View, Macadam entrance, dates the cemetery to 1882. However, a newspaper article dates it four years earlier. "Oregonian," 6 Aug. 1879, 3.

[29]Newlands, telephone interview with Sharon Wood Wortman, 9 Nov. 2000. With its one 4-1/2-foot-wide sidewalk (described by Newlands as "a balance beam of a sidewalk"), and high speed bumper-to-bumper traffic, Sellwood is clearly at odds with Portland's and the region's land-use goals for increasing pedestrian, bicycle and mass transit systems.

[30]The Portland Bridge Book, Sharon Wood (Portland: Oregon Historical Society Press, 1989), 31.

bridges soon followed, with Willamette and Columbia river bridges eventually opened, under construction, or being planned in nearly every decade of the twentieth century.[31] (See Plate 3, "Construction History of Portland-Area River Bridges.") The largest-scale public bridge building and planning program occurred in the 1920s, when several bridges made the leap from the era of lightweight through-truss spans of the late nineteenth and early twentieth century, to the modern automobile era that demanded wide bridge decks with uncluttered, truss-free views. Beginning with Sellwood, three "modern" deck trusses opened within six months of each other and all three spaced no more than two and one-half river miles apart (See Plate 4, "Consultant and Contractor History, Burnside, Ross Island, and Sellwood Bridges at Portland, Oregon."):

Sellwood Bridge	Willamette River Mile 16.5	Dec. 15, 1925
Burnside Bridge	Willamette River Mile 12.4	May 28, 1926
Ross Island Bridge	Willamette River Mile 14	Dec. 21, 1926

The three 1920s Willamette River bridges, Sellwood, Ross Island and Burnside, and the 1927 Lovejoy Viaduct were the first spans in Portland built exclusively to accommodate the rapidly growing volume of motor cars and trucks.[32] These new bridges spurred the city's urban expansion and changed the traffic system. They provided improved access across the Willamette River between west Portland, the location of the city's Central Business District, and the city's east and southeast sections. In anticipation of the opportunities afforded by the Sellwood Bridge's opening, Ladd Estate Co., developers of one east side community, ran newspaper ads that began, "Eastmoreland—in 15 minutes, via Sellwood Bridge."[33]

The Sellwood, Ross Island and Burnside bridges also shared similar engineering technology. They were the first steel deck

---

[31]"Construction History of Portland-Area River Bridges," by Sharon Wood Wortman, 2000.

[32]Between 1919 and 1924, trans-Willamette bridge traffic doubled, from 45,000 to 90,000 daily crossings. In the same period of time, county automobile registrations tripled, from 25,000 to 75,000. By 1925, the daily crossings would increase to 130,000 vehicles. MacColl, The Growth of a City, 260.

[33]"And Sellwood is Still Nearer," The Sellwood Bee, 18 April, 1924. The new bridge promised no more ferry commutes, or long rides from Portland to southeast on the interurban.

PLATE 3

CONSTRUCTION HISTORY OF PORTLAND-AREA RIVER BRIDGES

1880 -1889			1900 – 1909			1910 – 1919			1920-1929			1930-1939		
1887	Morrison	(S)	1900	Madison #2	(S)	1910	UPSP	(FS)	1922	Oregon City	(FS	1931	St Johns	(FS)
1888	Oregon City *	(FS-Ped)	1905	Morrison	(S)	1910	Hawthorne	(VL)	1925	Sellwood	(FS)			
1888	Steel	(S)	1908	BN/SF 5.1	(S)	1912	Steel	(VL)	1926	Burnside	(B)			
1891	Madison #1	(S)	1908	BN/SF 8.8	(S)	1913	Broadway	(B)	1926	Ross Island	(FS)			
1894	Burnside	(S)	1908	BN/SF 9.6	(S)	1917	Interstate N/B	(VL)	1927	Lovejoy Viaduct **	(O)			

1940-1949			1950-1959			1960-1969			1970-1979			1980-2000		
	0		1950	Sauvie Island	(FS)	1966	Marquam	(FS)	1970	Abernethy/ I-205	(FS)	1982	Glenn Jackson	(FS)
			1958	Morrison	(B)				1973	Fremont	(FS)	1989	BN/SF 5.1	(VL)
			1958	Interstate S/B***	(VL)									

BASCULE (B) =3 FIXED SPAN (FS) =11 SWING (S) =9 VERTICAL LIFT (VL) =5

* Pedestrian Bridge only ** Major Approach *** Erected adjacent to existing structure of same name

BN/SF = Burlington Northern/Santa Fe Railroad UP/SP = Union Pacific/Southern Pacific Railroad

Shaded areas indicate structures that have been removed

PLATE 4

CONSULTANT AND CONTRACTOR HISTORY

BURNSIDE, ROSS ISLAND, AND SELLWOOD BRIDGES AT PORTLAND, OREGON

BURNSIDE	ROSS ISLAND	SELLWOOD
Opening Date May 28, 1926	Opening Date December 21, 1926	Opening Date December 15, 1925
CONSULTANTS	**CONSULTANTS**	**CONSULTANTS**
HEDRICK & KREMERS ENGINEERS Bridge Design STRAUSS BASCULE BRIDGE CO. HOUGHTALING & DOUGAN ARCHITECTS GUSTAV LINDENTHAL CHIEF ENGINEER Bridge Design Modifications and Construction Supervision HANS RODE* RESIDENT ENGINEER Melville Reed Principal Asst. Engineer John Zoss Assistant Engineer Draftsmen and Field Assistants	GUSTAV LINDENTHAL CHIEF ENGINEER Bridge Design and Construction Supervision HANS RODE* RESIDENT ENGINEER Kurt Siecke** Principal Asst. Engineer N.W. Reese & John Zoss Assistant Engineers Draftsmen and Field Assistants	GUSTAV LINDENTHAL CHIEF ENGINEER Bridge Design and Construction Supervision HANS RODE* RESIDENT ENGINEER Melville Reed Principal Asst. Engineer N.W. Reese Assistant Engineer Draftsmen and Field Assistants
PRIME CONTRACTORS	**PRIME CONTRACTORS**	**PRIME CONTRACTORS**
Pacific Bridge Main Span **Sub:** U.S. Steel: fabrication **Sub:** Booth & Pomeroy: steel erection and bascule machinery **Sub:** Lindstrom & Feigenson: concrete approaches and concrete encasement of east end steel **Sub:** Jaggar-Sroufe: bascule span, electrical	**Booth & Pomeroy** River Spans **Sub:** U.S. Steel: fabrication **Sub:** Pacific Bridge: river pier work **Sub:** Jaggar-Sroufe: electrical	**Gilpin Construction** **Sub:** Judson Co.: steel fabrication
Lindstrom & Feigenson Approach end ramps	**Lindstrom & Feigenson** Approach Structures **Sub:** Parker-Schram: footing excavations **Sub:** Pacific Bridge: river piers	
NePage McKenny Lighting	**Parker-Schram** East Approach Fills	
	Edlefsen-Weygandt West Approach Fills	

*Prior to Hans Rode's arrival in Portland in August 1924, during Rode's summer absences in 1925 and 1926, and after Rode's departure the end of July 1927, Melville Reed was acting Resident Engineer. Reed also did the surveying for the three proposed-but-not-built North Portland bridges for Lindenthal.

**Kurt Siecke resigned in July 1926, and Melville Reed became Principal Assistant Engineer with N.W. Reese and John Zoss assisting on the Ross Island Bridge.

truss highway bridges across the Willamette River near Portland. The Sellwood Bridge was Portland's first Willamette River bridge to open without a movable span. Simultaneous with the erection of Sellwood, investigations and tests were being made to place bridges at St. Johns, Interstate Avenue and Fremont Street.[34]

The Sellwood Bridge replaced the ferry Caples, which carried an average of 582 vehicles and 428 pedestrians a day in 1925. The design capacity of the bridge, as built, was 15,000 vehicles per day.[35] This is the number of vehicles the Sellwood Bridge could accommodate without traffic backing up or causing traffic jams.[36] By 1928, the Sellwood Bridge carried an average of 2,921 vehicles and 99 pedestrians a day.[37] In 1961, the traffic count was 13,948 vehicles per day; in 1970, 21,319 vehicles per day, and in 2000, 31,000 vehicles per day.[38]

Bridge Description

Designated by the Oregon Department of Transportation (ODOT) as Oregon state highway Structure No. 6879, the Sellwood Bridge consists of three distinct units: the west approach, main river spans and the east approach. It was a quickly designed and built structure that borrowed heavily from other Portland bridges being built, rebuilt or designed at the same time in the mid-1920s.

---

[34] "Sellwood Span to be Ready in Early November," The Oregon Sunday Journal, 30 Aug. 1925, p. 16.

[35] City of Portland, Dept. of Public Works' Interoffice memo dated 3 Sept. 1970, signed by Howard Shaw, Assistant Traffic Engineer, citing William D. Albright, Traffic Engineer, Oregon State Highway Commission.

[36] Robert Kaspari, bridge (civil) engineer, David Evans and Associates, telephone interview with Sharon Wood Wortman, 8 Nov. 2000. Design capacity and structural capacity, or load limits, are two different things. Design capacity refers to the number of vehicles; structural capacity refers to the weight of the vehicles.

[37] Handwritten note, undated and unsigned, Multnomah County Highway Department Road Section. Files, Multnomah County Yeon facilities.

[38] "Traffic Volumes on Portland Bridges," 26 May 1978, Bureau of Traffic Engineering, City of Portland. Files, Multnomah County Yeon facilities; Newland, 9 Nov. 2000.

For example, Sellwood's concrete approach spans are similar to the extant Burnside Bridge in design, its finely sub-divided trusses copy the trusses of both the Burnside and Ross Island bridges, and it used plate girders from the old (1894) Burnside Bridge. The following summary description refers, for the most part, to the original design and as-built drawings[39]:

Roadway Deck and Sidewalks: 30'-9" wide overall built of cast-in-place reinforced concrete. Includes: Two 12'-wide traffic lanes (24'-wide roadway), with 6-1/2"-thick slab on steel truss and girder spans and 7-1/2"-thick slab on concrete approach spans; 4'-4" wide sidewalk on the north side only, with 4"-thick slab. The railing is concrete with Gothic arch openings. The balusters are pre-cast, with the top and bottom beams and posts cast-in-place.[40] Seventeen light poles are mounted at regular intervals next to the railing, reducing the usable width of the sidewalk at the light posts to 36".[41]

River Span Superstructure: Four-span continuous Warren deck truss consisting of two steel trusses spaced 20' apart, with top and bottom chords 25' apart. Total length of continuous truss (on slope): 1,091'-8". Spans 18 and 21: 245'-7-1/2" between bearings. Spans 19 and 20: 300'-2-1/2" between bearings. 40 main truss panels each 27'-3-1/2" long between panel points; panels subdivided by sub-verticals, producing 13'-7-3/4" floor system panels. Truss members and bracing built up from rolled sections and plates. Transverse floorbeams: 24" rolled I-beams. Longitudinal stringers: 15" rolled I-beams at 5'-0" spacing. All shop and field connections made with rivets. (Also see section below, "Portland Bridges - Panel Lengths.")

---

[39]From Engineering Drawings as interpreted by Ed Wortman, Multnomah County Bridge Engineering Services Administrator. Files, Multnomah County Bridge Engineering offices. Multnomah County owns 30 full-size ink-on-linen design and as-built plans and one design sketch for Sellwood Bridge, as well as 149 other drawings for the bridge. (See Appendix 1, "Engineering Drawing History, Sellwood Bridge, 1924-1999.")

[40]Lindenthal, "Sellwood Bridge Details of Revised Hand Rail," drawing L32, 30 Oct. 1925. Files, Multnomah County Bridge Engineering offices.

[41]Letter from Ed Pickering, Bicycle Planner, Multnomah County, to Krys Ochia, City of Portland, Transportation Engineering, dated 6 Oct. 1988. Files, Multnomah County Yeon facilities.

All steel for Sellwood's truss spans was fabricated at Judson Manufacturing Co.'s Emeryville plant in Northern California. Angles size 5″x3″ and under and bars 6" wide and their ingots were rolled at Emeryville. Angles larger than 5″x3-1/2" and their ingots were rolled by Pacific Coast Steel Co. Other plates and shapes for the bridge were rolled by United States Steel Products Co.[42]

Steel Girder Approach Spans: Spans 16 and 21 at ends of trusses both use pairs of steel plate girders re-used from 1894 Burnside Bridge. Span 16: 59′-6-5/8″ long between bearings, consisting of two girders with webs 60"x3/8", four flange angles 5"x3-1/2"x3/8" and flange cover plates 12"x1/2". Span 21: 54′10-9/16″ long between bearings, consisting of two girders with webs 51-3/4"x1/2", four flange angles 6"x6"x1/2" and flange cover plates 14"x1/2". Steel angle cross-frames between girders; tension rods for lateral bracing. Transverse floorbeams: 15″ rolled I-beams spaced at 4′-11″. Deck slab supported directly on floorbeams (no stringers). All steel connections made with rivets.

East Side Concrete Approach Spans: East approach: 15 cast-in-place concrete spans (Spans 1-15) consisting of twin longitudinal girders and transverse floor beams. Span lengths vary from 24′-3″ to 50′-4-1/8″. From the design plans, it appears that the span lengths were set to accommodate railroad tracks and mill buildings under the approach. (Several of the east piers actually were built through mill buildings. One pier is still located inside an office building.) Span arrangements vary from single spans to two- and three-span continuous units. Expansion bearings are hidden inside the concrete members and use both bronze and steel slide plates.

West Side Concrete Approach Spans: Design and construction are similar to east approach spans. Original design plans called for five cast-in-place concrete spans (Spans 22-26). Span 27 was added during construction, possibly to reduce the amount of fill needed at the west end. Span lengths vary from 29′-9″ (Span 27) to 36′-6″ (Spans 22-26). Spans 22/23, 24/25 and 26/27 are two-span continuous units.

River Span Substructure and Foundations: Piers 17 and 21 are located at the east and west riverbanks respectively. Piers 18, 19 and 20 are located in the river. Each of the five cast-

---

[42]Copy of letter from Judson Manufacturing Co. to Gilpin Construction Co., 20 Feb. 1925. Files, Multnomah County Yeon facilities.

in-place concrete piers supporting the continuous truss superstructure consists of two rectangular-shaped cast-in-place concrete shafts connected with a shear wall. The piers include steel reinforcing bars inside the pier surfaces. Steel bearing shoes on top of the shafts tie the trusses to the piers. The bearings at Pier 19 in the center of the four-span truss unit are the "fixed" type. Bearings at Piers 17, 18, 20 and 21 are the "expansion" type using multiple rockers. Thus temperature changes in the continuous truss cause the truss unit to expand or contract in each direction east and west from Pier 19.

Main span river piers 18, 19 and 20 sit on concrete footings extending well into the river bottom. Five soil borings taken in the river prior to construction show sand and gravel down to depths ranging to 55' below the City of Portland datum (see design plan sheet L3). The original design plans called for timber piling to be driven into the river bottom under the footings at Piers 18, 19 and 20. However, as-built notes on the plans say "Piling not driven" at 19 and 20. As-built notes also indicate that the footings for Piers 18, 19 and 20 all were extended several feet deeper into the river bottom than originally planned. Final elevations below the City datum are -44' at Pier 18 and -48' at Piers 19 and 20. (See section below, "Sellwood Bridge Changes During Design and Construction.")

Piers 17 and 21 at the riverbanks support the steel girder approach spans as well as the truss span ends. Footings for these piers extend only a few feet into the riverbank, with footing bottom elevations near the City datum. Originally, piling was not called for at 17 or 21. However, as-built drawing sheet L7 indicates that 55 timber piles were driven under Pier 21. This is significant since the original design plan sheet L1 has a note saying "Solid Rock" near Pier 21. During construction of Pier 21, it may have been discovered that the underlying material was not as solid as expected. (See section below, "Ground Movement and Bridge Damage, West End of Sellwood Bridge.")

East Approach Span Substructure and Foundations: Pier 1 at the east end is a reinforced concrete abutment structure on spread footings. Piers 2 through 16 each consists of two cast-in-place rectangular shafts with one or two cross-struts tying the shafts together at mid-height. Piers 2-16 all are cast continuously with the fixed portions of superstructure girders. Pier 16 supports one end of Span 16 steel girders as well as Span 15 concrete girders.

Available documents do not indicate that soil borings or other subsurface investigations were made for the east approach pier foundations. Design plan sheets 1 by Hedrick & Kremers and L1 by Lindenthal have a note under the east approach piers saying "Cemented Gravel & Blue Hardpan." Consistent with this information, Piers 1-16 all are founded on spread footings buried several feet below ground level. While pre-design information on soils under the east approach may have been scanty, the bridge's history includes no indication of foundation distress or weaknesses for the east approach piers.

East Approach Fill: An earth fill extends about 200' east from the east abutment (Pier 1). This fill brings S.E. Tacoma Street to the bridge in a smooth grade.

West Approach Span Substructure and Foundations: Contrary to the east approach, Sellwood's west approach has had a long history of foundation distress. (See section below, "Ground Movement and Bridge Damage, West End of Sellwood Bridge.") Original design plans called for six piers under the west approach: Piers 22 through 27. Pier 28 was added during construction along with Span 27. Design and construction of all seven west side approach piers was similar to the east side approaches: twin-shaft concrete piers on spread footings, with pier tops poured continuously with fixed girders.

The original design (somewhat modified during construction) included a large fill. This fill started at the foot of Pier 25 and extended west past Piers 26, 27 and 28 to Macadam Street. Portions of Piers 26 and 27 and all of Pier 28 were buried in the fill. Depth of the fill apparently varied from about 20' under Spans 25 and 26, to 35' at Pier 28.[43] The plans do not show a typical abutment at the west end of the concrete structure.[44]

In 1961, an additional span (Span 28) was added at the west

[43]"Sellwood Bridge General Elevation & Plan 1", Hedrick & Kremers, 8 Feb. 1924; "Sellwood Bridge General Elevation & Plan L1," Gustav Lindenthal, 28 Aug. 1924; "Foundation Stability Investigation," Dames & Moore, 3 June 1960, 34. Files, Multnomah County Bridge Engineering offices.

[44]The Lindenthal engineering drawings owned by Multnomah County do not clearly show the historic fill dimensions at the west end of the Sellwood Bridge. The "General Elevation and Plan 1" drawing by Hedrick & Kremers, with the trusses and girders of the 1894 Burnside Bridge as part of Sellwood's superstructure, outlines fill 47' high extending past the west end piers of the bridge about 100' to Macadam Road.

end as part of the West Approach reconstruction project. Addition of this span permitted removal of more of the original fill. Span 28 is 24'-6" long between bearings. It was built with precast tee-slab girders with a cast-in-place deck. The span is fan-shaped in plan to provide a wider roadway at the west end.[45]

Contractors

The prime contractor for the Sellwood Bridge was Gilpin Construction Co., an Oregon corporation doing business in Portland at 331 Worchester Building and in Astoria at the Foot of 14th Street. Principals included J.A. McEachern, president; J.F. Gilpin, vice president and manager; C.N. McDonald, vice president; and H.A. Dick, secretary.[46] C.N. McDonald (1862-1929), general manager for the company, lived at 1182 Haight St., and "was in construction for 40 years." Among the well-known structures he erected, according to his obituary, were the dome of the capitol building at Salem, the Steel and Morrison bridges in Portland, the Hood River-White Salmon Bridge, and the Sellwood Bridge.[47] Gilpin Construction was also one of seven contractors for the St. Johns Bridge, opened downriver at Willamette River 5.6 in 1931.

The Judson Manufacturing Co. of San Francisco fabricated the steel for the Sellwood Bridge. Judson was formed in 1882. Between 1917 and 1920, the company built its own open hearth furnaces at Emeryville, Ca. In the late 1920s, Judson merged to become Judson Pacific Murphy of Oakland, Ca., involved with, among other structures, the Marin approach and Presidio High Viaduct approach to the Golden Gate Bridge and the second Interstate Bridge across the Columbia River between Portland and Vancouver.[48]

---

[45]Moffat, Nichol and Taylor, "Sellwood Bridge West Approach Reconstruction," Drawing No. 3, 21 Oct. 1960. Files, Multnomah County Bridge Engineering offices.

[46]"Specifications, Proposal and Contract for the Sellwood Bridge Across the Willamette River at Portland, Oregon," Gustav Lindenthal Consulting Engineer, signed January 20, 1925. Files, Multnomah County Bridge Engineering offices.

[47]"Rites Set for C.N. McDonald Span Builder," Portland Telegram, July 8, 1929, 9.

[48]"Record of the Proceedings of the Columbia River Interstate Bridge Commission," Vol. 1. Files, Multnomah County Ford

Architectural/Aesthetic Details

Except for the west end approach, Sellwood's substructure and superstructure are essentially intact as constructed. The bridge's Gothically inspired balustrades, located on both sides along its entire length, are also original.[49] Among the last bridges in Lindenthal's career, the Sellwood Bridge appears elegant compared to some of his earlier structures, such as the Hell Gate Arch and the Queensboro Bridge in New York City. The Sellwood's bold but graceful unadorned structural form is attained with unusual design features, i.e., a four-span continuous truss, finely subdivided to allow an extremely lightweight deck system. The bridge is now painted green, but records indicate that at the time of construction it was given a coat of grey leaded zinc paint as a substitute for the final black graphite coat originally designated for the bridge's superstructure.[50] A bronze nameplate showing a dedication date

archives; "A Romance of Steel in California," a history of the Pacific Rolling Mills, the Judson Manufacturing Co., the Judson-Pacific Co., and the Judson Pacific-Murphy Corporation (San Francisco: Judson Pacific-Murphy Corp., 1946), 55-60. There are a total of 26 Sellwood Bridge shop drawings made by Judson Manufacturing Co. located at Multnomah County's Bridge Engineering offices. (See Appendix 1, "Engineering Drawing History, Sellwood Bridge 1924-2000.")

[49]Hedrick & Kremers engineering drawing, "Hand Rail," dated 31 Jan. 1924. Multnomah County Central Library, Wilson Room. Lindenthal engineering drawing L9, "Details of Lamp-Post & Hand-Rail," dated 1 Oct. 1924. Files, Multnomah County Bridge Engineering offices. The original design called for railings the length of the bridge composed of concrete posts and gas pipe metal hand rail three inches in diameter, the rails stacked four high. Lindenthal changed the metal piping to the extant concrete balustrade with precast balusters. "Details of Revised Hand Rail," Sheet No. L31, initialed by Hans Rode as "Made by," and dated 4 June 1925 and 10 March 1926. Also see Commissioners Journals, Ross Island and Sellwood Bridge, 15 June 1925. Files, Multnomah County Yeon facilities. Rode notes that the concrete handrail "will greatly improve the appearance of the bridge…." Although one reference is made to services on Ross Island and Sellwood bridges by Portland architects Houghtaling and Dougan in the Commissioners Journals (Ross Island and Sellwood Bridges), none of the drawings show that this architectural firm or any other contributed to Sellwood's design. Commissioners Journals, 9 Sept. 1925. Files, Multnomah County Yeon facilities.

[50]Commissioners Journals, 15 July 1925; copy of letter from

of December 15, 1925 is recessed into the railing and faces traffic at its northeast corner. After "Sellwood Bridge, Multnomah County," Lindenthal is acknowledged first as Engineer in Chief, followed by Hans Rode as Resident Engineer. Multnomah County Commissioners Smith, Taft and Phegley, and District Attorney Stanley Meyers are listed, followed by "Built by The Gilpin Construction Co."

Background and Construction of Sellwood Bridge

Olaf Laurgaard, Portland City Engineer from 1917 to 1933, devised an ambitious plan to simultaneously solve Portland's traffic, narrow street, bridge and dilapidated waterfront problems: Replace the 1894 Burnside Bridge, build five or six other new Willamette River bridges and acquire a mile-long length of west side waterfront property between the four centrally located downtown bridges, from Glisan Street on the north to Jefferson Street on the south. In addition, construct a mile-long concrete seawall along the harbor line of the river as part of a west side intercepting sewer system, fill behind the wall to create a waterfront esplanade, widen Front Street from 50' to 100', remove all the interurban tracks from seven downtown streets (including Front, First and Second), and create a large public market building and a consolidated interurban terminal.[51]

Multnomah County served as a form of regional government in the early twentieth century, and was able to collect taxes from a broader base than just within Portland city limits for building and maintaining the bridges across the lower Willamette River. Accordingly, the Oregon State Legislature authorized the county to issue bonds for the construction or reconstruction of non-

---

Lindenthal to Gilpin Construction Co., 19 Nov. 1925. Files, Multnomah County Yeon facilities.

[51]If this was not enough, Laurgaard was also responsible for renumbering all Portland street addresses at about this same time. Not a more dominating personality than Laurgaard is to be found in Portland's history. He was also Oregon's first licensed professional engineer. Nearly all of what he proposed during his tenure was built, with all the above ideas officially outlined in "The Laurgaard Plan of 1923." Also see "O. Laurgaard," The Blue Book of Portland and Adjacent Cities, Joseph Boswell, 1921, 72. "The Laurgaard Plan" is well covered by E. Kimbark MacColl, The Growth of a City, Power and Politics in Portland, Oregon 1915 to 1950 (Portland: Georgian Press, 1979), 315-320.

railroad bridges across the Willamette River.[52] Thus, the county was in a position to implement Laurgaard's plans for new bridges.

Voters approved $4.6 million in bridge bonds in the general election of November 7, 1922, to construct Sellwood, Ross Island and Burnside bridges, with $350,000 for Sellwood, $1,600,000 for Ross Island Bridge, and the remainder for the Burnside Bridge. After a brouhaha involving misdeeds of the original engineers of record, Hedrick & Kremers, several contractors and the then board of Multnomah County commissioners, Gustav Lindenthal of New York City was hired to finalize design and oversee the construction of Sellwood and Ross Island bridges, and to complete Burnside Bridge, which was already under construction.[53] Lindenthal signed a contract July 11, 1924 with a newly-appointed board of Multnomah County commissioners to plan and supervise the construction of all three bridges across the Willamette River. Subsequently, on Nov. 4, 1924, voters authorized additional bonds for $500,000 for the completion of Ross Island and Sellwood bridges, and to change Hedrick & Kremers scheme for constructing the Sellwood Bridge's river spans using truss spans from the old 1894 Burnside Bridge to its extant design using a four-span continuous truss.[54]

---

[52]ORS 382.335 and 382.34 (O.C.L.A. 100-3291) were originally enacted as 1919 Oregon Law, Chapter 338, Sec. 1, "An Act Authorizing Multnomah County, Oregon to issue bonds for the construction or reconstruction of bridges across the Willamette River, etc." The wording does not directly authorize the county to construct the bridges--the authority is only implied. The authority of Multnomah County to take over, operate and maintain the Willamette River bridges built and owned by the City of Portland was enacted as 1913 Oregon Law, Chapter 141, which became O.C.L.A., Secs. 100-3270 to 100-3275. Also see ordinances 58426, 33720, and 54826. Files, Multnomah County Yeon facilities.

[53]For more about the scandal involving the 1920s bridges, see what will be HAER OR-101, Burnside Bridge. Several consulting fees for the Sellwood Bridge were paid out prior to Lindenthal's involvement. Hedrick & Kremers had been paid $9,943.15 and J.P. Newell, of the Portland City Planning Commission, $1,410. Commissioners Journals, Ross Island and Sellwood Bridges, 23 Feb. 1926.

[54]The vote was 66,832 for and 26,517 against. "Record of the Proceedings of the Board of County Commissioners Pertaining to the Construction of Sellwood Bridge," Ross Island and Sellwood Bridges, 31 Dec. 1924. Also see 15 June 1925. Commissioners

The engineering drawing record shows the Sellwood Bridge is the joint product of two eminent engineers, one the titan Lindenthal and the other Ira G. Hedrick, the latter an eminent engineer in his own right and a former partner of J.A.L. Waddell. (See Appendix 1, "Engineering Drawing History, Sellwood Bridge 1924-2000.")

A comparison of the Lindenthal set of drawings with the Hedrick & Kremers set of drawings shows that Lindenthal's design work was, in great part, a revision of the design for Sellwood that was already completed by Hedrick & Kremers before Lindenthal's involvement.[55] Lindenthal made only minor changes to the Hedrick & Kremers design for the entire substructure, including piers and footings for the approach span superstructure,[56] and for the roadway deck. The most significant change made by Lindenthal was his superstructure redesign for Sellwood's main river spans. The Hedrick & Kremers design included five truss spans, two of them the through-truss fixed spans from the 1894 Burnside Bridge. In addition to the two recycled through trusses, the Hedrick & Kremers design also called for three new deck trusses designed as Double-Intersection (lattice) Warren trusses, subdivided with sub-verticals. This was the same unusual design used for the side truss spans of the 1926 Burnside Bridge, which was built under Lindenthal's supervision, but designed almost entirely by Hedrick & Kremers.

Journals, Ross Island and Sellwood Bridges, Multnomah County Ford Building Archives. The 1924 bond for $500,000 included an additional $100,000, which Lindenthal used to create a new design for Sellwood Bridge's river span trusses using new materials. "A Realization," The Sellwood Bee, 18 Dec. 1925, 1.

[55]The original 26 engineering drawings by Hedrick & Kremers are housed in Multnomah County Central Library's Wilson Rare Book Room, and contained in a bound book titled, "Multnomah County Oregon Board of County Commissioners, Plans for Sellwood Bridge, Hedrick & Kremers Consulting Engineers." These are the drawings that proposed reuse of the through trusses and girders from the 1894 Burnside Bridge as part of the Sellwood Bridge's superstructure. In addition, Multnomah County Bridge Engineering office, 1403 S.E. Water Ave., holds 183 Sellwood drawings, which includes shop drawings, repairs, and 31 Lindenthal drawings. (See Appendix 1.)

[56]Hedrick & Kremers had planned on re-use of two steel plate girder approach spans from the 1894 Burnside Bridge, one at each end of the river truss spans. Lindenthal retained this feature of the original design.

Instead, Lindenthal redesigned Sellwood's main span as a four-span continuous deck truss, but leaving the roadway exactly as designed by Hedrick & Kremers.

Since Lindenthal's deck truss design system required higher approaches, it required raising the entire bridge by amounts varying up to approximately 25' at the high point over the river. Lindenthal also made some of the approach spans somewhat longer than called for in the Hedrick & Kremers design, at the same time decreasing the number of bents.

Given the time and money constraints, why didn't Lindenthal leave Sellwood intact as designed by Hedrick & Kremers, especially since the Hedrick & Kremers design would have been more economical? Perhaps it was Lindenthal's ego and his needing to make the bridge "his" (and earning his consulting fee), or maybe his reasons were due to aesthetics, safety, stability, and ease and speed of erection.[57]

In September 1924, the new board had submitted Lindenthal's modified plans for a bridge across the Willamette River at Sellwood for approval to the War Department. All plans were approved and signed by the Chief of Engineers on October 20, 1924, and by the Secretary of War on October 21, 1924.[58] On January 9, 1925, the board awarded a contract for the construction of the bridge and approaches to the Gilpin Construction Co. and a contract for the lump sum amount of $445,570 was filed with the Multnomah County clerk on January 21.[59] Due to an easement required across the right of way for the Southern Pacific Railway Co. on the bridge's west end, the

---

[57]For more about Lindenthal's reasoning, see Commissioners Journals, "Burnside and Ross Island Bridges," 11 July 1924; Sciotoville Bridge Over the Ohio River," Transactions, 918; and section above, "Introduction: Truss Bridges, continuous Truss Bridges in Oregon, and the Sellwood Bridge."

[58]Letter dated 29 Oct. 1924, to the Board of Multnomah County Commissioners, from R. T. Coiner, Major, Corps of Engineers, District Engineers, Files, Multnomah County Yeon facilities.

[59]"Specifications, Proposal and Contract for the Sellwood Bridge," filed 21 January 1925; "In the Matter of Awarding Bid for Construction of Sellwood Bridge," Board of County Commissioners letter dated 12 Jan. 1925. Files, Multnomah County Yeon facilities.

contract was almost immediately increased to $470,000.[60]

Work began immediately on the river piers (See Plate 5, "Photograph of Sellwood Bridge Under Construction."), but Gilpin soon asked for an extension during pier construction due to a freshet in January that shut down work for seven days on account of high water.[61] In early February, Portland Gas & Coke asked for a permit to place a 16-inch diameter gas pipe across Sellwood, which was approved.[62]

Of special interest are events in February 1925. A letter from the City of Portland Water Bureau refers to fills for the west side approach of the bridge "running from 0 to a depth of 24 or 25 feet over our 24 inch and 30 inch steel water mains, now occupying Macadam Road or vicinity." The city was requesting that the county protect the water mains as a result of bridge construction by enclosing them in concrete conduits or to remove them to a new location on ground that would not be filled, because "these mains are old but in reasonably good condition … but it would not be safe or advisable to have the same buried in fills as contemplated."[63] In August 1925, Gilpin notified Lindenthal that large rocks were being dumped for fill at the bridge's west approach and that Gilpin would not be responsible for "any damage done to the columns or to the approach of the bridge by reason of the construction of this fill."[64] Then in

---

[60]"Specifications, Proposal and Contract for the Sellwood Bridge across the Willamette River at Portland, Oregon, Gustav Lindenthal Consulting Engineer"; Commissioners Journals, Ross Island and Sellwood Bridges, 26 Jan. and 9 Feb. 1925. Files, Multnomah County Ford Building Archives; "Easement Agreement," between Portland Electric Power Co. and Multnomah County," 29 Sept. 1925. Files, Multnomah County Yeon facilities.

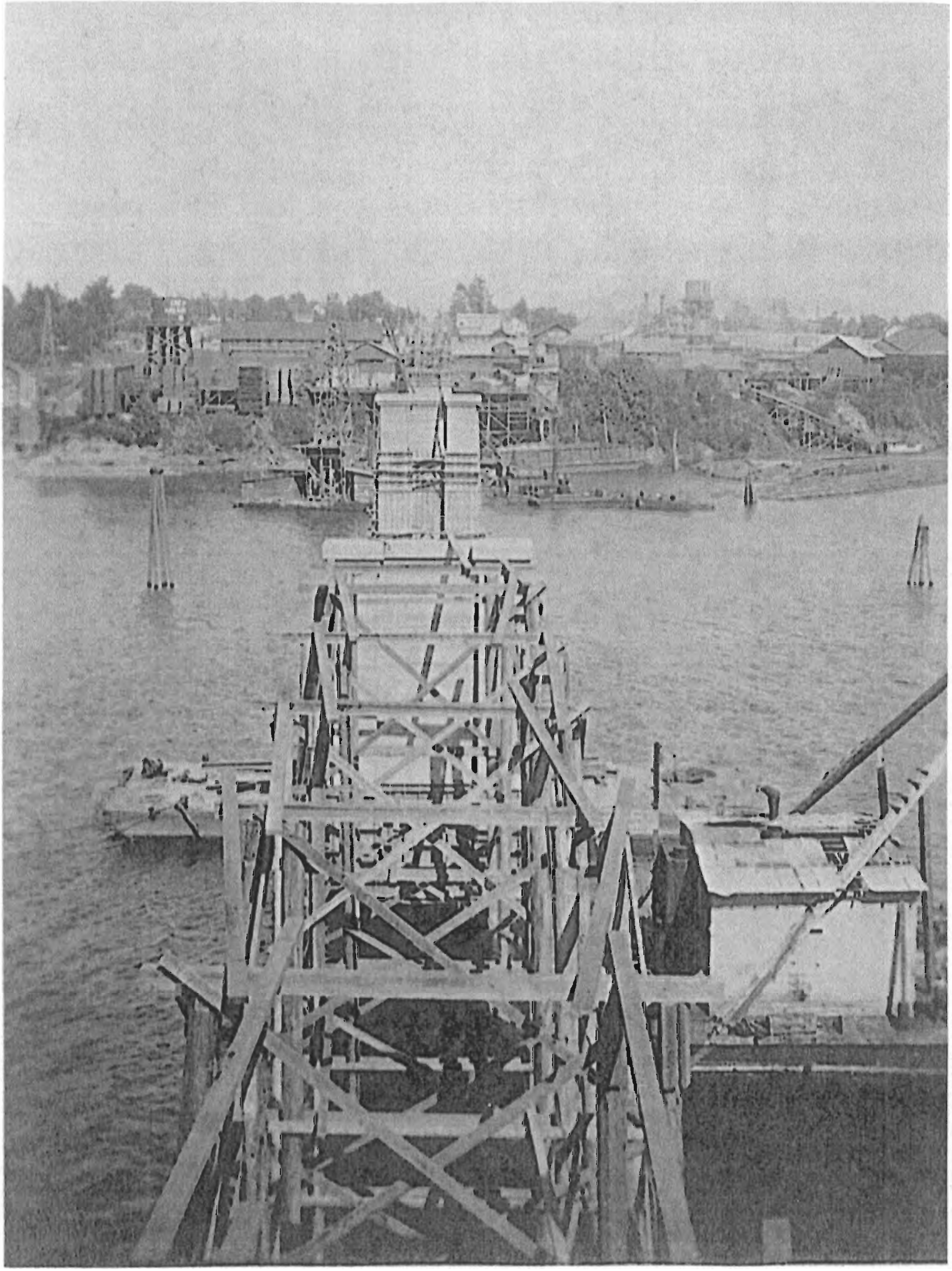
[61]Commissioners Journals, Ross Island and Sellwood Bridges," 9 Feb. 1925. Gilpin also put in for extensions because of other freshets in 1925 in February (12 days), May (eight days), and June (26 days). The Sellwood Bridge preceded the construction of dams on the main stem and tributaries of the Columbia and Willamette rivers. Files, Multnomah County Yeon facilities.

[62]"Memorandum of Agreement between Portland Gas and Coke Co. and Multnomah County," 29 April 1925. Files, Multnomah County Yeon facilities.

[63]Ibid., 11 Feb. 1925.

[64]Copy of letter dated 26 Aug. 1925, from C.N. McDonald to

PLATES - Sellwood Bridge Under Construction



early November, Lindenthal directed Gilpin to, "due to settlement of the west approach of the Sellwood Bridge … make some minor repairs to the roadway slab at Bent 26" and render its bill under the "Extra Work" clause of Gilpin's contract.[65] The effects of construction practices regarding the foundation of the Sellwood Bridge near its west end, combined with subsequent earth movements, created huge problems in years to come. (See section below, "Ground Movement and Bridge Damage, West End of Sellwood Bridge.")

An agreement in March 1925 allowed the construction of the Sellwood Bridge over the Southern Pacific Company and Oregon & California Railroad Co. tracks on property that then belonged to the River Side Cemetery Association.[66] Excavation for Piers No. 19 and No. 20 began in April.[67] By June, the County had an agreement with the Portland Electric Power Company (PEPCO) for an easement and right-of-way over the east approach of the Sellwood Bridge.[68] In August, the installation of navigation lights, required by the government, was authorized under the "Extra Work" clause of the contract.[69] As the bridge neared completion, Shaver Construction Co. of Portland recommended fender dolphins be installed at several Willamette River bridges, including Sellwood, to protect bridge piers from the looming spring 1926 freshet. As a result, Rode obtained an agreement with the U.S. Engineers' office for Sellwood, "for one dolphin consisting of 19 piles, and planing around same, south of piers 18 and 19."[70]

Dr. Gustav Lindenthal, Portland. Files, Multnomah County Yeon facilities.

[65]Copy of unsigned letter dated 7 Nov. 1925, by resident engineer, initials, "M.E. Reed." Files, Multnomah County Yeon facilities.

[66]Op cit., 1 July 1925. "Memorandum of Agreement between Southern Pacific Co. and Oregon and California Railroad Co. and Multnomah County," 23 March 1925. Files, Multnomah County Yeon facilities.

[67]Ibid., 13 April 1925.

[68]At this same time, the county gained an easement and right-of-way with PEPCO for the east end approaches to Ross Island Bridge. Ibid., 10 June 1925.

[69]Ibid., 24 Aug. 1925.

[70]Ibid., 28 Oct., 4 Nov., and 9 Nov. 1925; "Plan of Fender

Except for the second field coat of paint (to be applied in spring 1926), permanent transformers installed instead of temporary ones for the lighting system, and installation of the bronze nameplates, all contract work for the Sellwood Bridge was completed by January 11, 1926.[71] Final net expenditure for the bridge proper totaled $541,637.19.[72] A bid in the amount of $3,700 for improvement of the Tacoma Avenue approach from East Sixth Street to the east end of the bridge was awarded to A.D. Kern Co. six months later. The stairway on the Tacoma Avenue approach on the northeast side of the bridge was constructed at that same time.[73]

Bridge Dedication

Dedication exercises took place at the west end of the Sellwood Bridge on December 15, 1925, beginning at 2:30 p.m., when J.A. McEachran of Gilpin ceremoniously turned over the finished work to engineer Rode, who, in turn, turned over the completed bridge to county commissioner Amedee Smith, who then presented the bridge to the public. A banquet followed at 6:45 p.m. at the International Organization of Odd Fellows Hall, at E. 13th St. and Tenino that evening, sponsored by the Sellwood Board of Trade and Community Club.

Gustav Lindenthal in Portland

Dolphins for Channel Piers," Gustav Lindenthal, 2 Nov. 1925, showing side elevations for piers 18 and 19. Files, Multnomah County Yeon facilities. A copy of a letter from Lindenthal to the Corps of Engineers, dated Dec. 22, 1925, refers to a third dolphin at the west river pier. Lindenthal says, "It was decided to construct this, although not required by your department." Files, Multnomah County Yeon facilities. No dolphins remain anywhere around the bridge today.

[71]The final coat was delayed until spring 1926 because of weather in November 1925. Copy of letter from Gustav Lindenthal to Gilpin Construction Co. dated 19 Nov. 1925. Files, Multnomah County Yeon facilities.

[72]Ibid., 1 Aug. 1927. This account, as of July 20, 1927, was submitted to the board of county commissioners by Rode.

[73]"Specifications and Contract Agreement for County Highway Construction, Tacoma Avenue Approach to Sellwood Bridge," 14 June 1926; Commissioners Journals, 21 June 1926. Files, Multnomah County Yeon facilities.

If J.A.L. Waddell was involved with designing Portland bridges because of his vertical lift technology and Ralph Modjeski because of his railroad connections, then Gustav Lindenthal was in Portland because Multnomah County needed a "big gun" of impeccable reputation, who also was both capable of and willing to: 1) produce three major bridges simultaneously in a short amount of time and, given the financial disorder that had preceded the project, 2) do all the foregoing within a reduced budget. They could not have done better than Lindenthal, called from his offices at Pennsylvania Station in New York City to Portland where he would design the last bridges of his long career when it was really designing a bridge across the Hudson River that interested him most.[74] It does appear Lindenthal was called to Portland rather than calling Portland, according to an entry in the Commissioners Journals, "Burnside and Ross Island Bridges," dated 16 June 1924[75]:

> The following communication was received from Gustav Lindenthal, Pennsylvania Station, New York City, N.Y.: "Just for record, I beg to enclose copies of telegrams received and sent in the matter of the proposed examination of plans for the three bridges named therein. I confess that I at first felt disinclined to undertake this long trip in the midst of pressing engagements, but after reading the

---

[74]Lindenthal's preoccupation with a bridge across the Hudson is well documented. When I spoke with Lindenthal's daughter, Franziska Gebhardt, at her home in Germany by telephone on November 15, 1992, Gebhardt said, "My father thought about that bridge as long as I could remember." Born around 1915, she also remembers being in Portland during the mid-1920s when she was a child while her father worked on the Willamette River bridges. In Engineers of Dreams (New York: Knopf, 1995), 122-216, Henry Petroski devotes a chapter to the life and work of Lindenthal. For more on Lindenthal, see "Gustav Lindenthal, Premier Bridge Designer of the Age of Iron," 16 April 1990, submitted by Kenneth G. Patrick as a requirement for the Degree of Bachelor of Science in Engineering, Princeton University, a paper recommended to me by Princeton professor David B. Billington. For Lindenthal's brief but factual biography, see Eric DeLony, "Gustav Lindenthal," American National Biography, eds. John A. Garraty and Mark C. Carnes, Vol. 13 (New York: Oxford University Press, 1999). An in-depth biography exclusive to Lindenthal, one of the most influential bridge engineers in the U.S. in the late 19th and early twentieth century, waits to be written.

[75]Files, Multnomah County Ford Building Archives.

account of your bridge situation in the Engineering News-Record, to which the Strong & McNaughton [sic] Trust Co. had called my attention in their telegram, I thought the matter important enough to assist you with any professional advice I could give. The telegrams cover all that needs to be said at present in a business way."[76]

Gustav Lindenthal (1850-1935) and Ralph Modjeski (1861-1940), more than any other American bridge engineers, set precedent in designing early Industrial-era long-span steel bridges. As noted in Landmark American Bridges, Lindenthal was a German engineer who emigrated to the U.S., "bringing his talent and technology." In Bridges: Spans of North America, David Plowden writes, "No other man ever designed bridges of such titanic proportions as Lindenthal."[77] Plowden might have been referring to the Hell Gate Arch across the East River in New York City, and the Sciotoville Bridge across the Ohio River near Portsmouth, Ohio--both railroad bridges opened in 1917 and designed by Lindenthal. Lindenthal also served as a mentor to two other titans of the twentieth century, bridge engineers David Steinman, and Othmar Ammann[78]. On June 9, 1924, the Multnomah County Board of Commissioners went on record with a list of the New York engineer's qualifications:

> There is attached hereto a statement of some of the work which has been designed and directed by Mr. Lindenthal. Commr. of Bridges for New York under Seth Low, 1902-3, established practice of architectural designing of city's bridge structures; made plans for Queensborough (sic) and Manhattan Bridges over East River and for reconstruction of old Brooklyn suspension

---

[76]E.B. MacNaughton (1880-1960), a partner in the Strong & MacNaughton Trust Co., was one of Portland's most influential civic leaders before, during and after the 1920s. As a graduate of M.I.T. and former Bostonian, he was certain to know of Lindenthal's reputation and capabilities. For more about MacNaughton, see MacColl, Growth of a City, 187.

[77]DeLony, Eric, Landmark American Bridges (New York: American Society of Civil Engineers, 1992), 82-83; Plowden, Bridges, Long Spans of North America (Norton, N.Y., 1974), 171.

[78]For more about Steinman in Portland, see HAER OR-40, St. Johns Bridge.

bridge, Mrm. Bd. of Consulting engrs. Penna R.R. tunnels under North and East Rivers; also cons. engr., South Ferry rapid transit tunnels. Designed large wharf and steamship piers at Baltimore and Havana, Cuba. Rebuilt Kentucky river high-bridge, 315 ft. high, replacing first cantilever bridge in U.S. (Built by Shaler Smith in 1874). Since 1904 cons. engr. and architect, N.Y. Connecting R.R., designed to connect N.Y., N.H., & H. R.R. with Penna system (most expensive road in world to build per mile of line); especially notable part of this work was bridging of L.I. Sound and Hell Gate, involving deep and difficult foundations and expensive work of const., and several unprecedented eng. problems, the curved approach to Hell Gate making impossible the use of either a suspension or cantilever type of bridge. As completed in 1917, it is a broad steel arch, with span between towers of 1017 ft. long, whose top from mean low water is 305 ft. with clear space below the arch to mean low water of 140 ft., designed for four ry tracks; required three miles of viaducts and a lift bridge over Bronx Kill containing altogether 90,000 tons of steel and costing $25,000,000. Also designing and cons. engr. for double-track bridge of Chesapeake & Ohio Northern R.R. over Ohio River at Sciotoville, Ohio (two spans each 775 ft. long of continuous riveted trusses). Author of many articles on bridges and other eng. subjects in tech journals. Fellow A.A. A.S.; mem. Am. Soc. C.E., Instu. Civil Engrs (London), Can. Soc. Civil Engrs., Am. Inst. Cons. Engrs., Cleveland Eng. Soc., Ingenieur and Architeckten Verein (Vienna).[79]

On June 4, 1924, Lindenthal signed a contract with the newly appointed board of Multnomah County commissioners. He agreed to examine the Hedrick & Kremers engineering plans for Burnside, Ross Island and Sellwood for soundness of design. He was paid $5,000, plus travel expenses for himself and one assistant.[80]

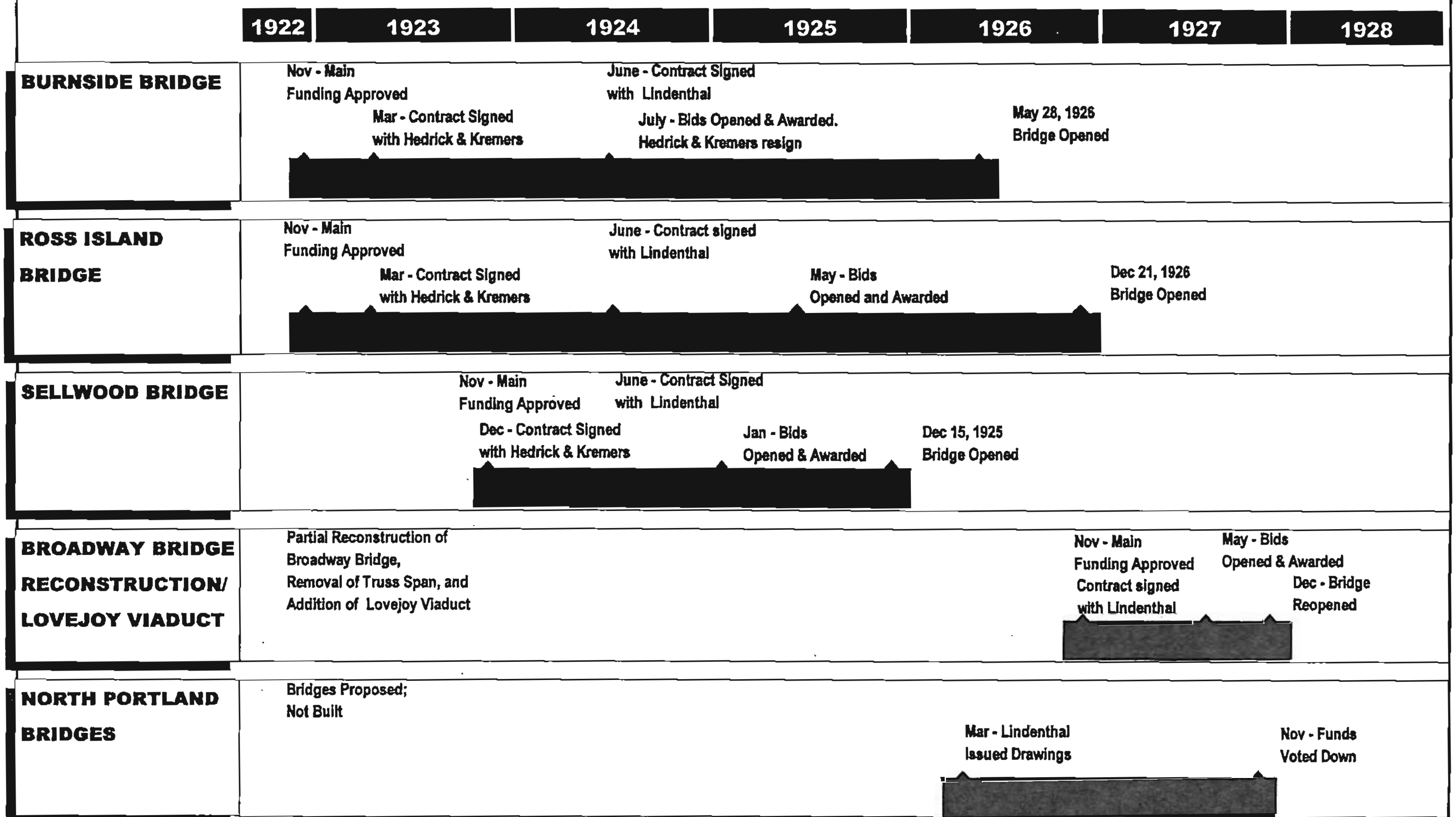
---

[79]Commissioners Journals, "Burnside and Ross Island Bridges," 9 June 1924. Files, Multnomah County, Ford Building archives.

[80]One other mention of an assistant comes from the Commissioners Journals, "Burnside and Ross Island Bridges." Under date of July 21, 1924, as part of his preliminary activities, Lindenthal reported (see full text below): "In the meantime I have sent Mr. Cuneot back to N.Y. with all the necessary data to prepare the redesigning of the two bridges..."

PLATE 6

TIME LINE - 1920s PORTLAND BRIDGE DESIGN & CONSTRUCTION WITH ENGINEER GUSTAV LINDENTHAL



Hedrick & Kremers were the original consulting engineers for the design of Burnside, Ross Island, and Sellwood bridges, but signed a termination agreement in July 1924. A new Board of County Commissioners retained engineer Gustav Lindenthal to assess the Hedrick & Kremers designs. Lindenthal recommended that the design for the Burnside Bridge stand, with changes, and that both the Ross Island and Sellwood bridges be completely redesigned. Lindenthal was awarded the contract for designing the modifications of Burnside, overseeing its construction, and designing Ross Island and Sellwood bridges and overseeing their construction. Multnomah County also awarded a contract to Lindenthal to design the partial reconstruction of Broadway Bridge (originally opened in 1913), and to design the new Lovejoy Viaduct from the Broadway Bridge to N.W. Ninth. In addition, Lindenthal surveyed and made preliminary designs, also for Multnomah County, for three North Portland bridges that were not funded. Lindenthal's work in Portland, the last major bridges in his long career, was finished in December 1928.

The Board entered Lindenthal's qualifications in the record on June 9, as noted above, with Lindenthal arriving in Portland on June 20, staying at the Benson Hotel on S.W. Broadway. On July 9, Hedrick & Kremers, in exchange for $25,000, signed a release of contract with Multnomah County. Two days later, Lindenthal contracted with the county, for $119,000, to complete Burnside's design, to redesign Ross Island and Sellwood, and to supervise construction of all three bridges. (See Plate 6, "Time Line - 1920s Portland Bridge Design & Construction with Engineer Gustav Lindenthal").

On July 21, 1924, upon Lindenthal's recommendation, Multnomah County contracted with Pacific Bridge to take down the draw of the 1894 Burnside, two of its girders to be eventually reused as part of the new Sellwood Bridge, and to begin construction of the new Burnside Bridge. From the Palace Hotel in San Francisco, Lindenthal wrote the following letter to the County Board of Commissioners on July 21, 1924:

> I have just put M.E. Reed, Assistant Engineer, in temporary charge of the engineer's office taken over from Hedrick & Kremers, until Mr. H. Rode, my representative, shall arrive first week in August. In the meantime I have sent Mr. Cuneot back to N.Y. with all the necessary data to prepare the redesigning of the two bridges. Before leaving Portland I asked Mr. Reed to see you and present to the Commission the advisability and reasons for letting the contract for the Burnside bridge without much delay. I will stay here only a few days (as you may see from enclosed clipping). I have also to meet engagements in Chicago and Pittsburgh and expect to reach N.H. about Aug. 1st; but it will cause no delay in the Portland work.[81]

As part of Hedrick & Kremers' termination agreement with the

An "H.C." is shown on the Lindenthal drawings for Burnside in one place, and not at all on Ross Island and Sellwood bridges. How much designing was done in New York and how much in Portland is unknown; however, it appears that the Lindenthal team in Portland produced most of the final design drawings--most of these tracings of the original Hedrick & Kremers drawings. (See Appendix 1.)

[81]Commissioners Journals, "Burnside and Ross Island Bridges," 21 July 1924. Files, Multnomah County, Ford Building Archives. The clipping Lindenthal refers to is missing.

county, Hedrick & Kremers agreed to turn all drawings over to the county. As it turned out, they also turned over their engineering design team as well as their offices, located at what is now the block occupied by the Multnomah County Detention Center, or the Portland Justice Center, at 1130 S.W. Third (formerly 250-1/2 Third Street).[82] Lindenthal took over both team and office the same date he signed his contract with the county, July 11, 1924.[83]

In his July 7, 1924 preliminary report about the three bridges, Lindenthal noted the four conditions he felt must be considered in order to ensure that a bridge is both "appropriate and adequate": "Location, Traffic Capacity, Structural Character, and for a City Bridge the Architectural Features, in the order named." Lindenthal recommended a new design for the Sellwood Bridge river spans, using new steel, to secure better architectural effects; complete redesign of the Ross Island Bridge as a steel span instead of a concrete arch structure; and completion of the Burnside Bridge as designed by Hedrick & Kremers, with some modifications.[84]

Later, in 1926, after construction was well under way on Sellwood and Burnside, Lindenthal was also asked by Multnomah County to submit a study for the erection of new bridges at St. Johns and at Interstate Avenue.[85] In addition, Lindenthal signed

---

[82]It also appears that Lindenthal used some of the former firm's linen drafting sheets for his own drawings--possibly as a convenience as well as a cost saving measure. Noticeable erasures are easily apparent on some of the title blocks for Sellwood and Burnside tracings, a professional no-no. Ed Wortman, of Multnomah County, theorizes that Lindenthal's staff, rushed to get moving on design, used Hedrick & Kremers linen until the linen imprinted with the Lindenthal title block arrived.

[83]Commissioners Journals, "Burnside and Ross Island Bridges," same date.

[84]Commissioners Journals, "Burnside and Ross Island Bridges," 11 July 1924.

[85]During the same bond election held November 2, 1926 that approved the partial reconstruction of Broadway Bridge and the Lovejoy Viaduct addition to the west end of the Broadway Bridge, the $4 million bond issue for St. Johns Bridge was defeated (37,222 votes against, 34,387 votes for), as was the $6.5 million

another contract with the county in 1926, for $42,000, to design a new viaduct (the Lovejoy Viaduct) from Broadway Bridge to the intersection of N.W. Ninth and Lovejoy Streets, and plans for partial reconstruction of Broadway Bridge to improve the roadway. Broadway, designed by Ralph Modjeski of Chicago and including a Rall bascule span, had opened in 1913 just north of downtown. By the 1920s, it, too, was inadequate to deal with the growing number of motor vehicles.[86]

---

bond for a bridge at Interstate Avenue (40,331 votes against, 30,570 for). The Interstate Avenue Bridge would have been about the location of Fremont Bridge, opened in 1973 at about river mile 11.7 (to be HAER OR-104). "Broadway Bridge Reconstruction and Lovejoy Ramp: In the Matter of Report on Canvass of Votes Cast at General Election on Bridge Bond Measures, Submitted to the Board by the County Clerk," Commissioners Journals, 19 April 1926-12 December 1927. Other prominent American civil engineers designed bridges or their opening mechanisms in metropolitan Portland preceding Lindenthal, among them J.A.L. Waddell, John Lyle Harrington, Ralph Modjeski, Conde B. McCullough, Ira Hedrick, and Joseph Strauss. Later in the 1920s, David Steinman, Lindenthal's former assistant for Hell Gate Arch and Sciotoville bridges, would beat out Lindenthal's designs to win the contract for the only major highway suspension bridge built in the Willamette Valley in the twentieth century, the St. Johns Bridge. The latter opened across the Willamette River in North Portland in 1931. See "Proposed New Bridges Over the Willamette River, Gustav Lindenthal 1926," Multnomah County Central Library. These well-preserved Lindenthal drawings, paper backed on linen, show a cantilever bridge and a suspension bridge, both with main spans of 1,120′, proposed between North Tyler Street and St. Helens Road, and a 1,120′ continuous truss, a suspension bridge (with two spans, 960′ each), and an arch (similar to Hell Gate), to be located between North Portsmouth Street and St. Helens Road. All the suspension bridges are drawn with eyebar chains, a favored Lindenthal form. Most interesting is that the continuous truss proposed at North Portsmouth was a near duplicate of Lindenthal's giant Sciotoville Bridge.

[86]Lindenthal's design for the Broadway Bridge replaced the existing wooden deck on the fixed truss spans with concrete. "Broadway Bridge Truss Span Deck," Sheet 6A, rev. 27 Nov. 1927; "Details of Floor and Sidewalk, Broadway Bridge," C4161/2A, rev. 21 May 1912; "Details of Floor and Sidewalk Rall Bascule Span Broadway Bridge," C4161/2B. Files, Multnomah County Bridge Engineering offices. For more about Broadway, see HAER OR-22. Lindenthal's Lovejoy Viaduct opened in 1927 and remained in service until it was closed July 30, 1999 and razed soon

Lindenthal Design Team

From the signatures found on the design drawings made before and during Lindenthal's involvement, it seems that a small group of engineers and drafters comprised the team designing Sellwood, Ross Island, and Burnside bridges and later, the partial reconstruction of Broadway Bridge, and the Lovejoy Viaduct to Broadway Bridge, as well as the proposed bridges in North Portland. Other names in addition to Reed's and Rode's that appear on the original Hedrick & Kremers drawings are the same names that appear on the final drawings for Burnside, Ross Island and Sellwood and other drawings, after Hedrick & Kremers are out and Lindenthal has taken over. Those names that appear on the drawings, before and during Lindenthal's involvement, include: Lloyd Frost, who would become a partner of Hedrick after leaving Portland; John Zoss and N.W. Reese, who would become assistant engineers for Burnside, Ross Island and Sellwood bridges; R. Coventry, W.D. Smith, M.E. Reed and a few others. These are the drafters, tracers and checkers during the life of Lindenthal's work in Portland, from June 1924 until January 1928.

Between August 1924, when the first Lindenthal drawings calling for changes to Burnside are finished and dated, and January 1927, when the final detail drawing is finished and dated for Ross Island, this team produced 89 tracings, 31 for Sellwood, 18 for Burnside, and 40 for Ross Island, with some additional sketches--an extraordinary amount of complicated structural design, drafting and checking.[87] Sellwood's design and drawings were done during the August through October period in 1924, about the same time the Burnside Bridge changes and additions were being made. The bulk of Ross Island's drawings were completed in March and April of 1925.[88] (Refer to previously listed Plate 6,

---

thereafter to make room for housing in the urban renewal project called River District, with ground breaking in 1998. "Briefly," The Oregonian, 29 July 1999, C2. Also, Commissioners Journals, "Broadway Bridge Reconstruction and Lovejoy Ramp," 15 Nov. 1926. Files, Multnomah County Ford Building Archives. Lindenthal's estimate for construction of the Lovejoy Viaduct and reconstruction of Broadway was $920,000, nearly twice as much as the budget he had to work with for a new bridge at Sellwood.

[87]Even with the tracing done for Sellwood's design from the Hedrick & Kremers drawings, the calculations for Sellwood's continuous truss spans would have been very time-consuming.

[88]None of Sellwood's design drawings bear Lindenthal's signature or initials. When reference is made to Lindenthal's

"Time Line - 1920s Portland Bridge Design & Construction with Engineer Gustav Lindenthal.")

In a letter dated Nov. 28, 1931, to the board of Multnomah County commissioners, K.H. Siecke, consulting engineer, describes the roles of Lindenthal's Portland engineering staff[89]:

> The Lindenthal organization in Portland consisted of Mr. Hans Rode, resident engineer, Mr. M.E. Reed, principal assistant engineer in charge of the Sellwood and Burnside bridges, myself as chief draftsman and principal assistant engineer in charge of the Ross Island bridge, assistant engineers N.W. Reese and John Zoss, and quite a number of draftsmen and field assistants, including L.R. Stiger. John Zoss was originally employed as draftsman until construction commenced on the Burnside bridge, when he went into the field as assistant engineer under the supervision of Mr. Reed. N.W. Reese was assistant engineer in similar capacity in charge of work on the Sellwood bridge from start to finish. Mr. Zoss took over the field work on the Ross Island bridge under Mr. Reed in July 1926, after all foundations had been constructed and the first three steel spans erected. I had until that time been in entire charge of this work, generally under the instructions of Mr. Rode, but during his absence I was in independent charge. My resignation was responsible for this change in supervision.[90]

---

design of Portland's bridges, it might be more accurate to say the "Lindenthal team's design of Portland's bridges."

[89]For additional information about Lindenthal's staff and key engineers involved with the Sellwood Bridge, see what will be HAER OR-101, Burnside Bridge.

[90]Siecke was competing in 1931 with Messrs. Zoss and Stiger for a contract with Multnomah County for consulting work as inspector for Burnside, Ross Island and Sellwood bridges, then six and five years old. Siecke lost out, and he sets the board straight about Zoss and Stiger's contention that they were "'in direct charge of construction and all inspection of these bridges under Gustav Lindenthal.'" Files, Multnomah County Yeon facilities. This clipping was provided by Dr. Judith McGaw; she and Linda Dodds, the other HAER historians involved in the 1999-2000 Portland bridges recordation, provided many such insightful references.

Hedrick & Kremers - Ira G. Hedrick

Ira G. Hedrick, born April 6, 1868, already had 31 years experience with large bridges by the time he was involved with Portland's bridges.[91] A native of West Salem, IL., Hedrick received a bachelor's degree in civil engineering in 1892 and a civil engineering degree in 1901 from the Arkansas Industrial University (now the University of Arkansas). He also received B.S., M.S. and D.Sc. degrees from McGill University, Montreal, Canada in 1898, 1899, and 1900, respectively.[92] Hedrick began working with J.A.L. Waddell in 1892 in Kansas City, doing bridge design and construction supervision. In 1899, he formed a partnership with Waddell, under the name of Waddell and Hedrick.[93] Among the structures attributed to Hedrick are the Northwestern Lake Street and Union Loop Viaduct in Chicago, a bridge over the Missouri River at Kansas City, the East Omaha Bridge for the Illinois Central Railroad, the intercity viaduct project at Kansas City, Mo., and the Fraser River Bridge, Westminster, B.C. He was experienced in design and construction of bridges built both of concrete and of steel. According to HAER MO-103, "Hedrick, at the turn-of-the-century, saw the advantages of employing riveted trusses and according to his memoir published by the ASCE, was a pioneer in their development." In 1904 Hedrick designed 300' riveted spans for the 6th Street Viaduct.

Hedrick's name shows up in Portland in at least two other

---

[91]Commissioners Journals, "Burnside and Ross Island Brides," 7 March 1923, Files, Multnomah County, Ford Building Archives. Hedrick's signature is shown first on the contract with Multnomah County. One of the witnesses was Melville (M.E.) Reed who would transition from the Hedrick & Kremers' staff to become a key engineer on the Lindenthal team.

[92]In "East 27th Street Viaduct Spanning Vince Street," HAER MO-103, 18-22, HAER historian Cydney E. Millstein covers most aspects of Ira Hedrick's career, accomplishments, three marriages and the loss of a son who was also a business partner. Justin Spivey, one of the members of a HAER recording project in Chicago during 1999, was also very helpful.

[93]Hedrick was acknowledged by J.A.L. Waddell for his assistance helping Waddell write De Pontibus, the latter's pioneering book on bridge engineering published in 1898 by John Wiley and Sons, New York.

places. In a 1923 report to the City Planning Commission about traffic on the Burnside Bridge, J. P. Newell, the first chairman of the Portland Planning Commission, and a consultant to the county, cites the records of Hedrick's other bridges: "Mr. Hedrick built a viaduct in 1913, in Dallas, Texas, which is over a mile long, and carries a very heavy traffic between that City and Fort Worth."[94] At the time of its construction, the Dallas-Oak Cliff Viaduct was the longest reinforced concrete highway viaduct in the world. It was designed by Hedrick when he was in business as Hedrick & Cochrane, consulting engineers, with M.R. Ash, associate Engineer.[95] Hedrick's design for Portland's Ross Island Bridge as a concrete arch, had it been built, would have been similar in appearance to Hedrick's Dallas-Oak Cliff Viaduct.

Also in 1913, Hedrick & Cochrane, Kansas City, Mo., was one of eight bidders for design of the Interstate Bridge across the Columbia River, between Portland and Vancouver, with engineers Waddell & Harrington winning the contract.[96]

After the problems in Portland, Hedrick left the city and started an engineering practice in New Orleans and Shreveport, LA., with Lloyd Garner Frost, whose name appears on the engineering drawings for the Burnside Bridge.[97] Hedrick moved to Arkansas in 1928,[98] and died in 1937 at his home in Hot Springs,

---

[94]J.P. Newell, "Traffic on the Proposed Burnside Bridge Over Willamette River," 6 June 1923, 20, Files, City of Portland, Office of Transportation, Portland Building.

[95]The Dallas-Oak Cliff Viaduct, also known as the Houston Street Viaduct, was also the first high-level crossing of the Trinity River at Dallas. It was nominated to the National Register of Historic Places in 1984. Robert W. Jackson, "Dallas-Oak Cliff Viaduct," HAER No. TX-33, 1996, 1.

[96]Commissioners Journals, "Columbia River Interstate Bridge Commission," Vol. 1, 29 Nov. 1913-10 Feb. 1920, 1, Files, Multnomah County, Ford Building Archives. The Interstate Bridge opened in 1917.

[97]Frost's signature and initials appear in the title block of drawings for the three Portland bridges before and after Lindenthal took over the Hedrick & Kremers offices, Files, Multnomah County, Bridge Engineering offices.

[98]"East 27th Street Viaduct," 18-22. While in Arkansas, Hedrick's office was located in Hot Springs National Park. During

Ark., at the age of 69. His Portland obituary said he also designed Chicago's first elevated railway.[99]

Robert C. Kremers

A newspaper article states that Robert Kremers was born in Ottawa County, MI. and received a bachelor of science degree in civil engineering from the University of Michigan in 1900. He worked in the City Engineer's office at Salt Lake City, and between 1905 and 1910, was employed in the bridge construction department of the Oregon Short Line Railroad. After the railroad, he helped design the Nisqually power plant in Washington state, arriving in Portland in the fall of 1910. In 1911, he was hired by the city of Portland Building Department and worked as an inspector for two years. He then moved to the city's Engineer's office.[100] During his tenure with the City of Portland, he was chief of the highway and bridges department for three years. When that department was abolished and the Bureau of Construction was formed, Kremers then worked as the head of construction for five years. He resigned from the city effective April 1, 1923, to work on the Multnomah County bridges.[101]

---

these last years of his prolific but unsettled career, Hedrick continued to design significant bridges, including two Arkansas River spans; a bridge over the Atchafalaya River, Simmesport, Louisiana; the Lake Worth and Royal Street Bridges, Fort Worth, Texas; the Back Bay Bridge, Biloxi, Mississippi; and the Main Street Viaduct, North Little Rock, Arkansas."

[99]"Initial Engineer on City Span Job Dead in Arkansas," The Oregon Journal, 29 December 1937, 25.

[100]"Citizens are Reticent on Bridge Plans," The Oregon Daily Journal, 27 Jan. 1923, 1, 7.

[101]"Robert C. Kremers to Resign City Job for Bridge Work," The Oregon Daily Journal, 10 March 1923, 3; "Engineer Resigns as Bureau Chief to Take up Bridge work with County," The Portland Telegram, 10 March 1923, 5. Not much is heard about Kremers after his arrest as a result of his Portland bridge financial misdeeds, but when Hawthorne Bridge's wooden deck was replaced with Irving Subway steel grating in 1945 at a cost of $305,000, Kremers is reported as the project engineer for L.H. Hoffman Co., the latter then and now one of Portland's largest construction firms. Kremers would have been about 60 years old at the time. "3 Companies Lay Grating Bridge Deck," The Daily Journal, 14 June 1945, n.p. There is no local obituary for Kremers, but other

Portland Bridges - Panel Lengths

The use of "sub-verticals" (vertical posts running from the top chords of the truss down to the diagonal intersections) may be unusual, but it is not unique. In his discussion of truss types, J.A.L. Waddell was critical of the arrangement in general, but did note an exception: "In deck trusses such vertical posts are sometimes employed to support floorbeams, thus halving the panel lengths of the floor system; and in this case their use is entirely proper.[102]

Consistent with Waddell's observation, the sub-verticals in all four Sellwood truss spans, as well as Burnside and Ross Island's side spans, do serve to halve the panel lengths of the floor system. "Panel lengths" are the distances between the floorbeams that run across the bridge at right angles to traffic; floorbeams are located at joints in the truss framing called "panel points." The benefit of halving the floor system panel lengths is to substantially reduce the weight of the steel framing that supports the roadway deck and sidewalks. The deck and sidewalks are supported by "stringers" that run lengthways, in the direction of traffic, and connect to the floorbeams. When the panel lengths are cut in half, as by use of the sub-verticals in Sellwood, each stringer will be only half as long and will carry only half as much load. Required size, thus weight, of the stringers will be substantially less than would be required with the longer panel lengths. Similarly, the load on each floorbeam will be only half as great when the panel lengths are cut in half. (However, much of this floorbeam benefit will be offset by the need for twice as many floorbeams.)

The idea of sub-dividing bridge trusses by adding additional members to reduce floor system panel lengths was far from new at the time of Sellwood's design. This technique became common in the late 19th century as bridge trusses became longer and taller. Without subdividing, the panel lengths of larger bridges would have been excessively long, and the weight of stringers and floorbeams would have been uneconomical.

---

newspaper articles that deal with his activities with the Sellwood, Ross Island and Burnside bridges include: The Journal, 27 Jan. 1923, 1; The Portland Telegram, 27 Jan. 1923, 1; The Oregonian, 27 Jan. 1923, 1 and 18 Feb. 1923, 4. For more about Hedrick & Kremers, see what will be HAER OR-101, Burnside Bridge.

[102]Waddell, Bridge Engineering, 471.

What is highly unusual about the sub-dividing of Sellwood, Ross Island and Burnside's trusses is the extremely short panel lengths produced. For most truss bridges built in the first third of the twentieth century (as well as later), floor system panel lengths ranged from about 22′ up to about 30′. For example, see the following list of floor panel lengths for several Portland-area bridges designed between 1909 and 1956. With one exception (Morrison Bridge bascule span), none of the bridges listed has panel lengths shorter than 22′ except for Sellwood, Ross Island and Burnside. For these three, panel lengths are respectively about 14', 16', and 13'. These short panel lengths are extremely unusual, whether looked at from a Portland-area point of view, or a nationwide point of view.

As one example of floor panel lengths that were typical of bridges elsewhere in the U.S. in the period, consider the Queensboro Bridge in New York, a multi-span continuous truss designed by Lindenthal 20 years before his Portland work. Although the Queensboro trusses are sub-divided, panel lengths along this large and complex structure all are in the range of 24′ to 35′.[103]

Floor System Panel Lengths, Portland-Area Bridges
(Dates shown refer to design)

Sellwood (1924)	All four spans	13'-7-3/4"
Burnside (1923-24)	Side spans Bascule	16'-9-5/16" 15'-9"
Ross Island (1925)	Center span	13'-4-1/2"
Hawthorne (1909)	209'-3" spans 244' spans	23'-3" 22'-2-1/2"
Morrison (1956)	Side spans Bascule	25'-10" 18'-8"
Broadway (1912)	Spans 1-7	22′-3″ to 26′-4-1/4″
Steel (1911)	East fixed span	26'-0-15/16"

[103]"Queensboro Bridge Over East River, Rehabilitation Main Span and Approaches, General Elevation and Plan," City of New York, n.d. From the collection of Michael Beard, Portland, Or.

	West fixed span	26'-0-15/16"
	Lift span	30'-2"
Sauvie Island (1949)	Three spans	25'
Interstate (1917)	Northbound span	23'-9-3/4"

Who designed these unusually short panels for Sellwood, Ross Island and Burnside? Lindenthal had spent most of his career designing large railroad bridges, or highway bridges that included railroad tracks. His three largest were the Hell Gate Arch, Sciotoville and Queensboro. From the available records, it appears that Lindenthal's only non-railroad, all-highway bridge prior to Portland was the Smithfield Bridge in Pittsburgh, opened in 1883. This would make the Portland bridges rare or unique examples of Lindenthal-designed highway-only spans. They certainly have the Lindenthal touch, i.e., the cantilevers on Ross Island that look like an arch (similar to an inverted Queensboro), and the continuous truss and statically indeterminate Sellwood (similar to Queensboro and Sciotoville). No doubt, Lindenthal was responsible for the "big picture" design of the Portland bridges. However, because of his travel schedule, the capabilities of his Portland team, the fact that this team was, in large part, comprised of carry-over members from the Hedrick & Kremers team (who had just finished designing Burnside, a Warren truss with finely sub-divided panels), and from what we know comparing the Hedrick & Kremers drawings for Sellwood with the Lindenthal drawings, it is certain that the sub-divided trusses with short floor panels for Sellwood were not Lindenthal's but came from Hedrick, or Reed, first in charge of the Portland work, or perhaps one or all of the Hedrick & Kremers team members.[104]

<u>Sellwood Bridge Changes During Design and Construction</u>

When Lindenthal took over in July 1924, he turned his attention first to the Burnside Bridge, and Sellwood and Ross Island bridges next. In early September that year, Rode

---

[104]Ed Wortman, who refers to the drawings for Sellwood and the other Lindenthal bridges on a daily basis, pointed out the extremely short floor panel lengths for all three Portland Lindenthal bridges. He helped interpret drawings, theorized about Lindenthal and Hedrick & Kremers engineering activities, and collaborated with me for three HAER reports on the County's Lindenthal bridges, i.e., Sellwood, Burnside (to be HAER OR-101), and Ross Island (to be HAER OR-102).

submitted a letter to the county commissioners regarding approval of Sellwood Bridge and referring to Sheet No. L1 ("General Elevation & Plan," 28 Aug. 1924). The letter stated that clearance of the Sellwood Bridge would remain the same [as originally proposed by Hedrick & Kremers], and that two piers would be replaced with one pier. Rode notes that the bridge's grade was limited to a maximum of four percent, which required raising the approaches, and that raising the approaches required wider spans on the east approach. Otherwise, the general arrangement of the approaches was "unchanged."[105] Soon after the War Department approved Sellwood's modified plans, the county commissioners approved Lindenthal drawings sheets L1 to L20, inclusive, for the revised design.[106] Other Lindenthal sheets were added to the design set later.

As-built notes on some of the drawings plus other drawings added during construction document various changes made during construction, including the following:

1. *West Approach:* Drawing L1 originally showed fill beneath the west approaches of Sellwood from Pier 25 to some distance beyond Pier 27. As-built notes on L1 show that, during construction, the depth of the fill was lowered and an additional span, Span 27, was added, apparently to reduce the amount of fill. Span 27 is shown on drawing L31, dated 26 March 1925. (In 1961, Span 28 was added, thereby allowing the removal of more fill.)

2. *River Pier Foundations:* All piling was deleted on Piers 19 and 20. This may have been because the gravel was found to be harder than expected and did not require piling. The river pier footings are deeper in the ground than originally planned, by 4′ at Pier 18, 10′ at Pier 19 and 8′ at Pier 20. Piling was added to Pier 21, possibly because the ground in this area was found to be less solid than expected.

3. *Railings:* As described earlier under "Architectural/ Aesthetic Details," the railing design was changed from one with horizontal metal pipe rails to one with concrete Gothic-arch balusters.

<u>Ground Movement and Bridge Damage, West End of Sellwood Bridge</u>

---

[105]Commissioners Journals, "Burnside and Ross Island Bridges," Vol. 1, 5 Sept. 1924. Files, Multnomah County Yeon facilities.

[106]Ibid., 5 Nov. 1924.

(Also see Appendix 2, "Summary of Significant Events, Sellwood Bridge from 1925.")

The "Bridge Description" section above describes the Sellwood Bridge's west approach as originally designed and as modified during construction. That section also refers briefly to distress in the bridge due to movement of the ground under the west approach and to repairs made to keep the bridge serviceable. Design of the bridge's west approach is attributable largely to the Hedrick & Kremer's team. When Lindenthal took over leadership of the team, only minor changes were made to the west approach.[107]

Records show that there were problems with the west end site even before completion of the bridge. In August 1925, C.N. McDonald of Gilpin Construction Co., contractors for construction of the bridge, notified Lindenthal that large rocks were being dumped for fill at the bridge's west approach (apparently another contractor was placing the fill). McDonald stated that Gilpin would not be responsible for "any damage done to the columns or to the approach of the bridge by reason of the construction of this fill." Two and a half months later, Lindenthal directed Gilpin as follows: "due to settlement of the west approach of the Sellwood Bridge....make some minor repairs to the roadway slab at Bent 26" and render the bill under the "Extra Work" clause of Gilpin's contract.[108]

The fill referred to above was a large mass of rock and earth used to provide a roadway base between the west end of the structure and the new location of Macadam Road. This fill continued to be troublesome from the time of initial construction up to at least the early 1960s. As shown on Lindenthal's design sheet L1, the fill was to start at Pier 25, slope up to the top of Pier 27, then extend at road level roughly 100' to Macadam Road. "Summary of Significant Events, Sellwood Bridge from 1925" (Appendix 2) notes that the size of the fill was reduced during original construction and again during repair work in 1961.

Prior to 1960, there is little direct reference in available

---

[107]"Appendix 1, "Engineering Drawing History, Sellwood Bridge 1924-2000."

[108]Letter dated 26 Aug. 1925, from C.N. McDonald to Dr. Gustav Lindenthal, Portland; letter dated 7 Nov. 1925, from Lindenthal resident engineer "M.E.R." (M.E. Reed), to Gilpin. Files, Multnomah County Yeon facilities.

records to structural defects in the west approach related to movement of the ground under the approach. However, the ground movements and bridge damage apparently progressed slowly over the 35-year period. By 1960, there was substantial distress in the bridge due to the ground movements. In 1960, the consulting firm of Dames & Moore carried out a foundation stability investigation for Multnomah County to determine the cause of the steadily increasing damage to the west approach and other portions of Sellwood Bridge. Dames & Moore's report noted that:

> "Pier 21 has tilted toward the river and has tension cracks in the east side near the base and in the west side near the top of the pier. The movements of the approach spans have resulted in bending, cracking, and some spalling of the columns, and cracking in the tops of the columns where they join the girders. The movements have caused the roadway slab to impose large lateral forces on the main bridge spans and to interfere with the normal expansion and contraction of the bridge. Measurements at Piers 19 and 21 show that these piers are about five inches out of plumb, the main river spans having moved eastward. Observations of conditions at the truss and approach span girder at Pier 21 indicate a relative movement of some 10 inches. Measurements on the approach columns indicate that they are out of plumb by 18 inches or more. Total lateral soil movement [toward the river] is estimated to be in excess of 33 inches since the bridge was constructed."[109]

Dames & Moore concluded that "natural processes" were mainly responsible for the ground movements under the west approach. "While the deep fills at the west end contribute to driving forces on the slope they are not the main cause of movement… we conclude that natural weathering of the underlying soils has resulted in sufficient loss of strength so that slow yield is occurring."[110]

In conjunction with Dames & Moore's investigation, Moffatt, Nichol & Taylor of Portland designed temporary and permanent repairs for the damaged west approach during 1960. The temporary repairs included: pile bracing at Pier 21; diagonal bracing at Piers 21, 24, 26 and 27; and shoring at Piers 26 and 27. Permanent repairs included:

---

[109]"Foundation Stability Investigation," Dames & Moore, Consultants in Applied Earth Sciences, Portland, 3 June 1960. Files, Multnomah County Yeon facilities.

[110]Ibid, 6.

- Major reconstruction of Pier 21, including additional piling around the pier, new concrete buttresses and truss bearing modifications.

- Removal of a section of deck, sidewalk and girders over Pier 21 to relieve pressure between the west approach and the truss spans. As part of this work, the west approach superstructure was jacked to the east to relieve some of the bending in the piers. Diagonal struts were installed at the piers to hold the superstructure in position.

- Ground beams between pier footings.

- New steel pile foundations and new columns for Piers 26, 27 and 28.

- A new Span 28 at the west end. This allowed removal of some the heavy fill.[111]

The repairs were started in 1960 and completed in 1961.

In 1985, OBEC Consulting Engineers of Eugene led another investigation of the west approach conditions, as well as other structural conditions on the bridge. Kelly/Strazer Associates of Portland were geotechnical subconsultants, and Marvin Beeson of Portland was the consulting geologist.[112] Departing somewhat from the 1960 conclusion by Dames & Moore, Kelly/Strazer placed primary blame for the west side ground movement on the weight of the large fill at the west end of the approach: "…it is our opinion that the principal cause of past activity relates to the large fill mass placed under the west approach structure and beyond Bent #28 during the initial bridge construction … In our opinion, the moderately heavy fill loads induced the slippage because of residual strength conditions. Natural seepage and seasonally high groundwater conditions were probably

---

[111]See references to 1960-61 repair drawings by Moffatt, Nichol & Taylor in Appendix 1, "Engineering Drawing History, Sellwood Bridge 1924-2000."

[112]"Sellwood Bridge Structural Investigation," OBEC Consulting Engineers, Eugene, 19 Aug. 1985; "Geotechnical Investigations, Sellwood Bridge Structural Investigations for Multnomah County," report to OBEC Consulting Engineers, by Kelly/Strazer Associates, Portland, 15 Aug. 1985; "Consultation on the geology at the west end of the Sellwood Bridge, letter to Kelly/Strazer, by Marvin Beeson, Portland, 24 June 1985.

contributory."[113]

The Kelly/Strazer and Beeson reports gave insights into the probable behavior of the soil and rock under the west approach. Lindenthal's design sheet L1 (following directly from Hedrick & Kremer's sheet 1) has a note saying "Solid Rock" under the west approach near the river. However, the subsurface investigations by Dames & Moore in 1960 and Kelly/Strazer in 1985 found that the conditions were not as simple and secure as assumed in 1925. The rock below the bridge's west end was not bedrock, but a thin layer of basalt on top of a thick layer of soil and weak weathered rock.[114] During the years after construction, it appears the weathered mass below the basalt layer deformed under the weight of the fill, taking the basalt layer and the bridge with it.

This puts the responsibility for Sellwood's ground movement problems and subsequent bridge damage on the bridge designers, including the Hedrick & Kremers and Lindenthal teams. It now appears that they did not do enough subsurface investigation to confirm their belief that solid rock was close to the surface under the west approach. The failures attributed to the Sellwood Bridge were not so much a problem of poor design as poor investigation--it appears Sellwood's engineers didn't know where the rock was.[115]

In defense of Hedrick, Kremers, Lindenthal and the other engineers of this era, scientific study regarding the behavior of soils and rational design of foundations was in its infancy during the design and construction of the Sellwood Bridge and all other Portland bridges built up to and before the 1930s. It is a precise irony that the Sellwood Bridge opened in December 1925, the very same month and year the paper "Modern Conceptions Concerning Foundation Engineering" was published in the Journal of the Boston Society of Civil Engineers (changed in 1986 to Civil Engineering Practice, Journal of the Boston Society of Civil Engineers).[116]

---

[113] "Geotechnical Investigations," 24.

[114] Ibid, 16.

[115] Ed Wortman, interviews with Sharon Wood Wortman, 20 Nov. and 30 Nov. 2000.

[116] Presented by Karl Terzaghi in Boston on 18 Nov. 1925, this

In the 1985 investigation, the OBEC team found distress and damage throughout the bridge that may have been related to the west approach ground movement. They reported that Bent 1, the abutment at the far east end, was cracked and out of plumb, possibly due to pressure along the full length of bridge from the west approach as it moved toward the river. The most severe problem found in the 1985 inspection was in the steel superstructure over Pier 17 at the east end of the truss spans. The problem was in the steel crossbeam between the vertical end posts of the truss. The function of this crossbeam is to carry the expansion end of the Span 16 girders. OBEC found vertical

---

paper (published under the name Charles Terzaghi) is acknowledged as the genesis for the birth of geotechnical engineering in the U.S. Born in 1883 in Austria, Terzaghi was the founder and guiding spirit of soil mechanics. He was the first to make a comprehensive investigation of the engineering properties of soils, he created or adapted most of the theoretical concepts needed for understanding and predicting the behavior of masses of soil, and he devised the principal techniques for applying scientific methods to the design and construction of foundations and earth structures. Taking a leave of absence as the head of the Department of Civil Engineering, Robert College, Constantinople (now Istanbul), Terzaghi spent a year at the Massachusetts Institute of Technology in 1926 as a lecturer and research associate. Terzaghi eventually taught as a Professor of Soils Mechanics and Foundation Engineering at M.I.T., and was a Professor of Civil Engineering Harvard emeritus from 1956 until he died at the age of 80 in 1963. He also published throughout his life about what he called "earth work engineering," and "earth science." Charles Terzaghi, "Modern Conceptions Concerning Foundation Engineering," Journal of the Boston Society of Civil Engineers, Dec. 1925, Vol. 12, No. 10, 397-439. In the "Discussion" section of the paper, some of the country's most eminent consulting engineers assay the state, or non-state, of soils science in 1925, and credit Terzaghi, with, among other things, "explaining results we have seen and have not been able to explain.", 425. For more about Terzaghi and the history of soils engineering, see Donald T. Cuduto, Geotechnical Engineering: Principles and Practice (Prentice Hall: N.J., 1999), a textbook used in the School of Engineering, University of Portland; From Theory to Practice in Soil Mechanics, Selections from the Writings of Karl Terzaghi, with bibliography and contributions on his life and achievements (Wiley: N.Y., 1960 and 1967); Ralph B. Peck, et al, Foundation Engineering (John Wiley and Sons: New York, 1953), frontispiece; and Who Was Who in America, 933, Vol. 4, 1961-1968 (Marquis-Who's Who, Inc.: Chicago, 1968).

cracks up to 9-1/4" long in the connection angles at the ends of the beam. Three rivets were broken in the same area. This damage appeared to be a product of the pre-1960 west approach movements to the east. As the movement occurred, the truss spans were pushed tight against the east approach and normal expansions were impossible. When the west approach was repaired in 1960-61, the truss unit did not completely spring back, leaving the truss 2-3/4" closer to the Span 16 girders. In the late 1970s, the bottom flange of the floor beam was notched out to allow movement for the girders.[117]

At the time of this writing, there is no evidence that the bridge is undergoing further damage due to earth movement at its west end. Since October 1990, the county has monitored the distances between west side piers, and only slight movement has occurred.[118]

Summary of Events Post-1925

For a list of major inspections, repairs, changes, and studies involving the Sellwood Bridge, see Appendix 2, "Summary of Significant Events, Sellwood Bridge from 1925."[119] This list also includes a description of the bridge's vulnerability to earthquake.

Prior (1984) Burnside Bridge - Sellwood's Girder Spans

Two of the girder spans from the 1894 Burnside Bridge were recycled for use in the Sellwood Bridge. The Secretary of War

---

[117]"Sellwood Bridge Structural Investigation," 2-9.

[118]Office Memorandum, Multnomah County Dept. of Environmental Services, from Stan Ghezzi to Larry Nicholas, 31 Aug. 1989. A request for authorization was approved for a Rocktest, Inc. extensometer to monitor the movement between Pier 21 and Pier 22, as recommended by OBEC consulting engineers in its 1985 Condition Report. Also see references to results of the monitoring in Appendix 2, "Summary of Significant Events, Sellwood Bridge from 1925."

[119]Also see "Cursory Review of Available Information on the Sellwood Bridge, including Previously Made Repairs," an attachment to Office Memorandum, Multnomah County Department of Environmental Services, dated 16 Feb. 1989, from Stan Ghezzi to Bart Bonney. Files, Multnomah County Yeon facilities.

approved the 1894 Burnside Bridge, built by the Bullen Bridge Co., on August 24, 1892.[120] It was located between West Front Street (now S.W. Naito Parkway), and East First Avenue (now occupied by the Union Pacific-Southern Pacific Railroad, formerly the S.P.&S.R.R. main line). W.B. Chase was appointed chief engineer. Chase had worked for the Northern Pacific Railroad Co., and was assistant engineer on the Albina Bridge (1888 Steel Bridge) for Henry Villard, and engineer of bridges for the Oregon Pacific Railroad during its construction from Corvallis to Yaquina.[121]

Opened July 4, 1894, after two years construction, the Burnside Street Bridge was primarily a steel, pin-connected through truss with a 385'-long swing span.[122] (See Plate 7, "Burnside Bridge Elevation and Plan Existing structure 1923," Hedrick & Kremers, dated 9 Sept. 1923.) It had two fixed truss spans over the river in addition to the swing span. Total length of the bridge was 1,621'.[123] It was the fourth bridge built across the lower Willamette within Portland city limits, the first to be constructed as a public bridge, and carried tracks for the Portland Consolidated Street Railway Co. With

---

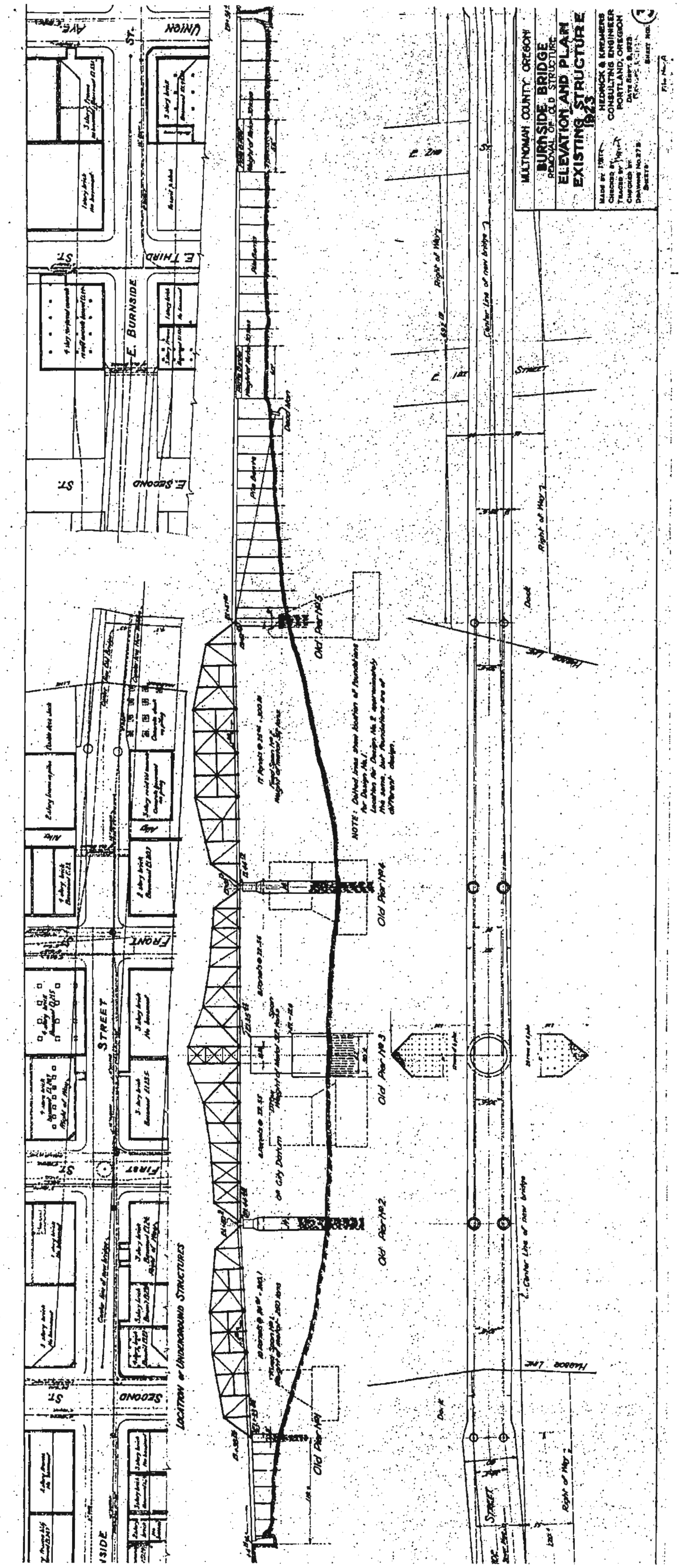
[120]Letter dated August 11, 1904, from Major W.C. Laugfits, United States Engineer Office, Portland, Ore., to George Himes, Assistant Secretary, Oregon Historical Society, Portland, Ore.

[121]The Morning Oregonian, 1 Jan. 1895, 20. Chase, born in 1855, died of a stroke at the age of 53 in 1908. His obituary states that he was born in Ohio and came to Oregon as a young man. Four years after completing the 1894 Burnside Bridge, he served as City Engineer under three mayors: William F. Mason (1898), W.A. Storey (1899), and H.S. Rowe (1900). The Oregonian, 27 Oct. 1908, 10. For more about the 1894 Burnside Bridge, see what will be HAER OR-101.

[122]John T. Labbe, Fares, Please! Those Portland Trolley Years (Caldwell: Caxton, 1980), 80-81. Not many images exist for the first Burnside Street Bridge. Page 81 of Labbe's book shows a close-up of the bridge's deck and wooden sidewalk during an accident, with Car 82 of the Portland Railway Co. off its tracks and pointed toward the railing and the Willamette River.

[123]"Investigation of Burnside Street Bridge, Portland, Oregon," Oregon State Highway Commission, by Conde B. McCullough, Oregon State Bridge Engineer, 1920, 13-23. Wilson Rare Book Room, Multnomah County Central Library.

PLATE 7


MULTNOMAH COUNTY, OREGON
BURNSIDE BRIDGE
REMOVAL OF OLD STRUCTURE
ELEVATION AND PLAN
EXISTING STRUCTURE
1923
HEDRICK & KREMERS
CONSULTING ENGINEERS
PORTLAND, OREGON
E. BURNSIDE
E. THIRD
E. SECOND
UNION AVE.
FRONT
FIRST
SECOND
STREET
LOCATION OF UNDERGROUND STRUCTURES
Old Pier No. 1
Old Pier No. 2
Old Pier No. 3
Old Pier No. 4
Old Pier No. 5
Right of Way
Center Line of new bridge
Dock
Harbor Line

approaches, the 1894 Burnside Bridge cost $315,924.[124] The east approach trestle included two riveted steel girder spans over railroad tracks on First Avenue and Third Avenue (southeast). When the old Burnside Bridge was removed, these two girder spans were taken to the new Sellwood Bridge, where they came spans 16 and 21 at the ends of the truss spans.[125]

---

[124]The Oregonian, 1 Jan. 1895, 5. The contract price was increased from $285,000 when the bridge committee decided to build a bridge of greater width than was planned in the original estimate.

[125]"Sellwood Bridge, General Elevation & Plan," Sheet L1, dated 28 Aug. 1924. Files, Multnomah County Bridge Engineering offices. The "old Burnside Bridge" is also mentioned on the Judson shop drawings and as part of the Hedrick & Kremers drawings.

BIBLIOGRAPHY

Abbott, Carl. *Portland Planning, Politics and Growth in a Twentieth-Century City.* Lincoln, NE: University of Nebraska Press, 1983.

Daily Journal. 14 June 1945.

DeLony, Eric. *Landmark American Bridges.* New York: American Society of Civil Engineers, 1992.

Engineering News-Record. 3 March 1929.

Files, Multnomah County Bridge Engineering offices.

Files, Multnomah County Yeon facilities.

Fitzsimon, Eileen. Interview with Sharon Wood Wortman, 6 April 1997 and 12 November 2000.

Gebhardt, Franziska. Telephone interview with Sharon Wood Wortman, 15 November 1992.

Jennings, Jeffrey. Telephone Interview with Sharon Wood Wortman, 9 November 2000.

Kaspari, Robert. Telephone interview with Sharon Wood Wortman, 8 November 2000.

Labbe, John T. *Fares, Please! Those Portland Trolley Years.* Caldwell: Caxton, 1980.

Laugfits, W.C., Portland to George Himes, Portland, 11 August 1904. Oregon Historical Society, Portland, Oregon.

Lindenthal, Gustav. "Sciotoville Bridge Over the Ohio River," *Transactions.* Vol. 85, Paper No. 1496. New York: American Society of Civil Engineers, 1922.

MacColl, E. Kimbark. *The Growth of a City, Power and Politics in Portland, Oregon 1915-1950.* Portland: The Georgian Press, 1979.

McArthur, Lewis A. *Oregon Geographic Names.* 5th Edition. Portland: Oregon Historical Society Press, 1982.

McCollough, Conde B. "Investigation of Burnside Street Bridge, Portland, Oregon," Oregon State Highway Commission. Wilson Rare Book Room, Multnomah County Central Library, 1920.

Multnomah County Ford Building Archives

Morning Oregonian. 1 January 1895.

Newell, J.P. "Traffic on the Proposed Burnside Bridge Over Willamette River," 20, Files, City of Portland, Office of Transportation, Portland Building. 6 June 1923.

Newlands, Richard. "Tacoma Main Street Plan, A Short Transportation History of S.E. Tacoma Street," City of Portland, Office of Transportation, 2000.

Newlands, Richard. Telephone interview with Sharon Wood Wortman, 9 November 2000.

Oregon. 1919 Oregon Law, Chapter 338, Sec. 1.

Oregon. 1913 Oregon Law, Chapter 141, became O.C.L.A., Secs. 100-3270 to 100-3275.

Oregon Daily Journal. 27 January 1923, 10 March 1923.

Oregon Journal. 29 December 1937.

Oregon Sunday Journal. 30 August 1925.

Oregonian. 6 August 1879, 1 January 1895, 27 October 1908, 27 January 1923, 18 February 1923.

Osborne, Julie. Telephone interview with Sharon Wood Wortman, 9 November 2000.

"Parks and Facilities," City of Portland, Portland Parks and Recreation. 20 November 1997.

Plowden, Bridges. *Long Spans of North America.* New York: W.W. Norton, 1974.

Portland Telegram. 27 January 1923, 10 March 1923, 8 July 1929.

"Queensboro Bridge Over East River, Rehabilitation Main Span and Approaches, General Elevation and Plan," City of New York, n.d. From the collection of Michael Beard, Portland, Oregon.

Sellwood Bee. 18 April 1924, 18 December 1925.

Shaw, Howard. "City of Portland, Department of Public Works' Interoffice memo." 3 September 1970.

Smith, Dwight, James Norman and Pieter Dykman. *Historic Highway Bridges of Oregon.* Reprint. Portland: Oregon Historical Society Press, 1989.

Terzaghi, Charles. Modern Conceptions Concerning Foundation Engineering," *Journal of the Boston Society of Civil Engineers.* Vol. 12, No. 10, December 1925.

Waddell, J.A.L. *Bridge Engineering.* Volume 1. New York: John Wiley & Sons, 1916.

Wood, Sharon. *The Portland Bridge Book.* Portland: Oregon Historical Society Press, 1989.

Wortman, Ed. Interview with Sharon Wood Wortman, 20 and 30 November 2000.

Appendix 1
Engineering Drawing History, Sellwood Bridge 1924-2000

Original Drawings

A bound book of plans measuring 2'x2' and made by Hedrick & Kremers, the original consultants for the design of Sellwood, is housed in the Wilson Rare Book Room, Multnomah County Library. Titled, "Multnomah County Oregon Board of County Commissioners, Plans for Sellwood Bridge, Hedrick & Kremers Consulting Engineers," these are the original 26 engineering drawings that proposed reuse of the through trusses and girders from the 1894 Burnside Bridge as part of Sellwood Bridge's superstructure. The title blocks show the Hedrick & Kremers drawings were made, checked and traced, for the most part, by M.E. Reed, W.D. Smith, C. Wright, John Zoss, N.W. Reese, and a few others. The earliest drawing in the set is dated 29 Aug. 1923, and the latest is dated 9 Feb. 1924. All, except one version of the Elevation and Plan, which is drawn as a blue line rendering, are blueprints.

Titles, in order:

No.	Title
1	Elevation and Plan - Blue line rendering
1	Elevation and Plan (blueprint)
	Index
2	Factory Buildings Along East Approach
3	Record of Borings
4	Retaining Wall East App.
5	Column Schedule
6	Anchor Bolts
7	Piers 18 and 19
8	Piers 20 to 23
9	Piers 24 and 25
10	Concrete Girder Spans
11	Spans 1, 9 Inc'l
12	Spans 10, 17 Inc'l
13	Spans 25 to 28
14	Floor Beams, Concrete App.
15	Hand Rail
16	Stairway to East Approach
17	Steel Girder Spans 18, 24
18	Shoes and Pedestals Spans 19 and 20
19	Concrete Deck Spans 18, 24

20 Fixed Span 19
21 Fixed Span 20 Floor Beam and Stringers
22 Fixed Span 20
23 Laterals and Shoes
24 180' Deck Truss
25 Details of Lamp Posts

A comparison of the Hedrick & Kremers drawings with the Lindenthal drawings shows that they are the same scale (1"=40'-0"), and it appears that many of the Lindenthal drawings are largely traced from the Hedrick & Kremers drawings.

Final Design, Construction, Modifications and Repairs

The following 183 shop, repair and Lindenthal drawings for the Sellwood Bridge are owned by Multnomah County and are housed at the County's Bridge Engineering and Maintenance offices, 1403 S.E. Water Ave., Portland.

1924-1926

- 30 Lindenthal design drawings, ink on linen, and one sketch, ink on linen. The earliest drawing in the set is dated 28 August 1924. The latest, "Details of Revised Hand Rail," is dated 10 March 1926. Sheets are numbered L1 through L34, but three numbers were not used.

- Two J.W. Sadler Co. shop sketches of Pier 19 timber caisson/crib, blueprints, dated Dec. 1924.

- 25 Judson Steel shop drawings, structural steel for trusses and girders, blueprints, dated April 1925.

- One Lindenthal shop drawing, revised expansion joint (L17), blueprint, dated Oct. 1925.

1926

- One Commission of Public Docks survey drawing, "East Side Harbor Survey, S.E. Harney St. to Sellwood Park," shows 15 mill buildings under or near east bridge approach spans, blueprint, dated Nov. 1926, revised Feb. 1934.

1927

- One Multnomah County design drawing, "Reinforced Concrete Wall on Pacific Highway [Macadam]," ink on linen, dated Jan. 1927.

Ca. 1930

- One Multnomah County design drawing for Tacoma Avenue (east end) approach stairway, ink on graph and plain vellum, undated.

1960

- Four Moffat, Nichol & Taylor design drawings, "Temporary Repair Layout" for west approach, pencil on Mylar, dated March and April 1960.

- Four Moffat, Nichol & Taylor design drawings, "Pier 21 Reconstruction," pencil on Mylar, dated May and August 1960.

- 10 Moffat, Nichol & Taylor design drawings, "West Approach Reconstruction," pencil on Mylar, dated Oct. 1960 to March 1961.

1961

- One Multnomah County design drawing, "West Approach Reconstruction," pencil on vellum, dated 14 Feb. 1961.

- One Portland Wire and Iron Works shop drawing, steel components for Pier 21 repairs, black line print, dated 23 Jan. 1961.

- Two Empire Prestressed Concrete shop drawings, pre-stressed tee slabs for Span 28, black line prints, dated 20 Jan. 1961.

- Four Soule' Steel shop drawings, rebar for West Approach reconstruction, black line prints, dated Jan. 1961.

1965

- One Multnomah County design concept drawing, "Plan #3, Proposed Twin Sellwood Bridge & West Interchange," pencil on vellum, dated 25 Oct. 1965.

- Three perspective renderings for three new proposed replacement bridges, by Wanda Moman, for Multnomah County, ink on Mylar (may be photocopies), dated Nov. 1965.

1972

- One Multnomah County design drawing, "Paving and Expansion Joints," pencil on vellum, dated Aug. 1972.

1979

- Two Multnomah County design drawings, gabion installation plan and elevation (to make a flat space between piers 16 and 17, east side, for the Willamette Greenway Trail), ink on Mylar, dated Jan. 1979.

1980

- 33 Oregon Dept. of Transportation design drawings, "Westside Interchange" (two approach bridges added), black line prints, some dated Oct. 1979, others undated.

- Ten Multnomah County miscellaneous working sketches, west side retaining wall at River View Cemetery, blue line prints, undated.

- Eight Young Iron Works shop drawings, miscellaneous metal components for West Interchange, black line prints, dated June 1980.

- 21 Mercer Industries shop drawings, rebar for West Interchange, black line prints, dated May - Dec. 1980.

- One Union Metal Manufacturing shop drawing, steel traffic signal standard for West Interchange, blue line print, dated 12 May 1980.

1985

- Two OBEC design drawings, "Bent 17 Repairs," repairs needed due to truss spans pushing into the ends of Span 16 plate girder span, damaging bracing over Bent (Pier) 17, copied on reproducible paper from Mylar original, undated.

1990

- Nine Multnomah County design drawings, "Overlay and Expansion Joints," ink on Mylar via Computer Aided Design (CAD), dated June 1990.

1995

- Three Multnomah County design drawings, "Overlay," black line prints, dated 21 June 1995.

1998

- Two Multnomah County drawings, "Maintenance Walkway Rehabilitation, CAD on Mylar, dated Feb. 1998.

Appendix 2
Summary of Significant Events, Sellwood Bridge from 1925

The following is a list of studies and repairs of the Sellwood Bridge between 1925 and 2000. Included are dates of studies concerning earth slides and seismic vulnerabilities.[1]

1931 - Consultants inspected Sellwood's entire west approach and concluded that Pier 21 had moved to, or was constructed at, a point approximately 5-1/4" too near fixed Pier 19, located in the center of the river. The bridge's expansion joints and other parts were found to be damaged.[2]

1939 - One 19-pile dolphin was constructed at Pier 18 in the Willamette River at the Sellwood Bridge upstream from the pier on the east side of the channel. Contract amount: $1,668.[3]

---

[1]Also see "Cursory Review of Available Information on the Sellwood Bridge, including Previously Made Repairs," an attachment to Office Memorandum, Multnomah County Department of Environmental Services, dated 16 Feb. 1989, from Stan Ghezzi to Bart Bonney. Files, Multnomah County Yeon facilities.

[2]Report on Inspection Made of Sellwood Bridge November 1931," by John Zoss, L.R. Stiger, Inspectors. Zoss and Stiger, who both worked on Lindenthal's design team for Sellwood, Burnside and Ross Island bridges, concluded that Sellwood Bridge's west end problems were due either to 1) an error during construction of the west approach, with Pier 21 placed in a position 5-1/4" too far east and Pier 20 placed 2-3/8" too far west; or 2) the hillside on the west had moved east and carried the west approach and Pier 21 with it; or 3) a combination of both slippage and misplacement. Files, Multnomah County Yeon facilities.

[3]"Specifications and Contract Agreement for County Highway Construction," dated Oct. 27, 1939. Contractor: Gilpin Construction Co., Portland. The new dolphin replaced an existing dolphin and was made up of 85'-tall old growth Douglas fir tree trunks, with diameters of between 9" and 24". Files, Multnomah County Yeon facilities.

1940 - Traffic pattern change.[4]

1949 - All accessible metal surfaces below the roadway of the Sellwood Bridge were cleaned and painted in compliance with the specifications of the Oregon State Highway Department for "Alkyd Green Finish," including water pipes and steel girders on the end span of each approach adjacent to the steel truss (1,261 tons of steel). Contract amount: $15,132.00.[5]

1952 - The bridge's lighting system was replaced with mercury vapor luminaires with aluminum pendant standards, installed on the north side of the bridge. Contract amount: $17,775.[6]

1960-1961 - The west end approaches and west river pier were investigated and structural engineers Moffat, Nichol and Taylor designed repairs. Subconsultant Dames and Moore, studying soil conditions, found that the entire slope under the west approach had slid toward the river about 33 inches since the bridge was built. As a result of the ground movement, Pier 21 had tilted toward the river by about five inches. Other west approach piers were out of plumb by 18 inches or more. This resulted in bending, cracking and some spalling of the columns and cracking in the tops of the columns where they joined the

---

[4]No other mention or information exists in Multnomah County files about a traffic pattern change on Sellwood Bridge in 1940, referred to only in "Indirect Source Permit Application, West Sellwood Bridge Interchange," a report dated 5 Sept. 1979, by R.W. Hufstader, Asst. Planner, Multnomah County to Dept. of Environmental Quality, Portland. Files, Multnomah County Yeon facilities.

[5]"Specifications and Contract Agreement for County Construction," dated April 8, 1949. Contractor: Saxon Painting Co., Tacoma, Wa. Files, Multnomah County Yeon facilities.

[6]Specifications and Contract Agreement for Multnomah County Construction," dated 24 June 1952. Contractor: W.R. Grasle Co. The contract mandated that "the lamp posts are to be located on the side walk close to the present lamp posts . . . ." Files, Multnomah County Yeon facilities.

girders. Also due to the ground movement, the west approach roadway slab had pushed eastward on the rest of the bridge. The main river spans had moved to the east, pushing Pier 19 five inches out of plumb in the process.[7] Moffatt, Nichol and Taylor completed design of temporary and permanent repairs in 1960, with repairs completed in 1961. Repair work included underpinning, realignment and structural revisions from Bent 21 to Bent 28. The permanent repairs involved reinforcing the west river pier (Pier 21) and making changes to the steel truss resting on this pier; replacing three concrete bents, and constructing a new abutment at the west end of the bridge. The bridge, originally constructed with 28 bents, got a new bent 29 along with new span 28. Contract amount (four separate contracts): $201,291.[8]

---

[7]The report of Dames and Moore found that "total lateral soil movement is estimated to be in excess of 33 inches since the bridge was constructed." The earth movement was located at an average depth approximately 50 feet below the existing surface. It was in a rather large zone undergoing extensive plastic deformation and proceeding "at a very slow rate." Dames and Moore recommended removing some of the fill at the west end (put in place during construction in 1925), or reducing the hydrostatic water pressure by installing a deep drainage well system. "Foundation Stability Investigation, West Approach Spans, Sellwood Bridge," Dames and Moore, 3 June 1960, 2; letter from Irving Olsen, to Multnomah County, dated 3 June 1960. Files, Multnomah County Yeon facilities.

[8]"Agreement for Engineering Services," contract 1143-R-60, dated 19 March 1960, with Moffatt, Nichol and Taylor, not to exceed $9,900, for services to determine temporary repairs to west approaches and Pier 21; letter dated 22 March 1960, to Paul C. Northrop, Multnomah County, from G.S. Paxson, Assistant State Highway Engineer, advising of inspection with Ivan Merchant, state highway engineer, and others; report and drawing of Moffatt, Nichol and Taylor dated 23 March 1960; "Agreement for Engineering Services," contract 1143-R-61, dated 1 June 1960, with Moffatt, Nichol and Taylor, not to exceed $11,900, for services to prepare plans and bidding documents for the permanent repairs of the west approaches and Pier 21; "Sellwood Bridge (Pier 21) Reconstruction," contract 1198-R-61, dated 22 Sept. 1960, with General Construction Co., in the amount of $57,891; "Sellwood Bridge West Approach Reconstruction," contract

1962 - Maintenance painting was applied to the steel superstructure. Contract amount: $29,870.[9]

1965 - The bridge deck asphaltic concrete pavement was repaired and resurfaced with epoxy resin. Contract amount: $27,450.[10]

1965 - By request of the Portland City Planning Commission, the Multnomah County Board of Commissioners ordered the County Roadmaster to make a preliminary study and report to the board about providing additional traffic capacity at the Sellwood Bridge. The study proposed three alternatives, ranging in cost from $3 million to $6.5 million: 1) a new two-lane bridge parallel to the existing bridge; 2) a new four-lane bridge eliminating the existing structure; 3) a four-lane bridge which would become part of a proposed Sellwood-Johnson Creek Freeway, from I-5 on the west to McLoughlin Blvd. and I-205 on the east. The twin two-lane bridge was recommended.[11]

1968 - Western Transportation tug V. Green and barge

1222-R-61, awarded 20 Dec. 1960, to Inland Construction Co. for $121,600. Files, Multnomah County Yeon facilities.

[9]Contract 1400-R-63, with J.I. Hass Co., Inc., Soap Lake, Wash., with its local representative Russell Clark, Portland, to be completed 15 Sept. 1962. Cover sheets in file. Files, Multnomah County Yeon facilities.

[10]Contract 1790-R-66, with Kansas City Natural Slate Co., Kansas City, awarded 8 July 1965. Cover sheets in file. Files, Multnomah County Yeon facilities.

[11]Letter dated 12 Nov. 1965, to Board of County Commissioners; "Staff Report on the Implications of the Multnomah County Roadmaster's report on Proposed Sellwood Bridge Alternatives," 15 Feb. 1966; "County Engineers Outline Three Alternative Plans for Sellwood Span," The Oregonian, 16 Nov. 1965, 16; three drawings dated Nov. 1965, "Proposed Twin Sellwood Bridge," "Proposed New Sellwood Bridge," and "Tentative Plan for Sellwood Freeway Bridge." (Also see Appendix 1, "Engineering Drawing History, Sellwood Bridge 1924-2000.") Files, Multnomah County Yeon facilities and Bridge Engineering offices.

collided with Pier 19.[12]

1968 - The roadway deck was paved with one course of coal tar epoxy overlay. Contract amount: $19,600.[13]

1970 - Milwaukie Sand and Gravel applied to dredge in the Willamette River near the Sellwood Bridge. In response, dredging was limited within 1000 feet of the Sellwood Bridge, upstream or downstream.[14]

1971 - Two signs showing "Men Below, Please Don't Throw" were installed on each end of the bridge for east and west bound traffic.[15] In 1991, the City of Portland,

---

[12]"Damaged portion is approx. 30" long and 8" deep at deepest point tapering to a feather edge at each end. A few small pieces of concrete are knocked out above this on the corner of the pier (SE corner). Damage appears minor but is partially covered by high water." "Accident and Property Damage Report," Multnomah County Dept. of Bridges and Ferries, 11 Dec. 1968. Files, Multnomah County Yeon facilities.

[13]Contract 2270-R-69, with R.E. Beebe Construction Co., nee Commercial Installations, Prairie Village, Kan., awarded 25 July 1968, cover sheets in file; memo from Robert L. Nordlander, Director Dept. of Public Works, and Kenneth Wheatley, bridge engineer, dated 8 April 1971. Files, Multnomah County Yeon facilities.

[14]Letter dated 14 April 1970 to Dept. of the Army from Kenneth Wheatley, regarding Public Notice 70-26; Public Notice 70-26, "Willamette River Approx. River Mile 16 to River Mile 24-Dredging," dated 6 April 1970. Public Notice 071-OYA-1-001333, dated 1 Nov. 1973, shows Willamette Hi-Grade Co., a division of Willamette Western Corp., seeking to dredge between Willamette River miles 14.1 and 25.0. Files, Multnomah County Yeon facilities.

[15]Letter dated 11 May 1971, to James Gix, Oregon State Highway Dept., from Howard Shaw, Multnomah County. Handwritten note on letter says, "6-4-71, signs in place by W. Wilson." Attachment 4 is an illustration showing dimensions of 36"x72"x1/4", black lettering on silver scotchlite or painted white board, 6" standard highway lettering, 1" black flush border with 3" radius corners. Note by Oscar Wright says, "We used ¼" plywood so that sign

Bureau of Community Development, requested the sign be changed to read, "People Below."[16]

1971 - Some of the timbers in the maintenance walkway under the bridge deck were replaced.[17]

1972 - The bridge's expansion joints were modified.[18]

1973 - The entire concrete roadway deck was resurfaced with epoxy asphalt and the expansion joints were reconstructed and sealed.[19] The bond between the two layers of asphalt did not cure properly due to cold weather and when the bond and cohesive test failed in 1973, Multnomah County withheld payment to the contractor until a satisfactory test was completed in June 1974. Total cost: $70,197.96.[20]

---

would be easy to handle." Files, Multnomah County Yeon facilities.

[16]Letter dated 15 July 1991, from Robert Wheatley, Multnomah County, to Linda Berger, City of Portland, noting that the signs at the time were only a year old, but that when the signs needed to be replaced, the County would change the wording of the new signs to "People Below." Files, Multnomah County Yeon facilities.

[17]Letter dated 1 Feb. 1971, from C.A. Roberts, Gas Control Dept., Northwest Natural Gas Co., to R.L. Nordlander, Dept. of Public Works. Files, Multnomah County Yeon facilities.

[18]"Cursory Review of Available Information on the Sellwood Bridge, including Previously Made Repairs." Files, Multnomah County Yeon facilities.

[19]Ed Wortman, a bridge engineer with 40 years experience, said he knows of no other bridge with a concrete deck that has been resurfaced with epoxy asphalt. Developed after the invention of orthotropic decks, epoxy asphalt typically is used on steel decks, not concrete decks. Interview, 30 Nov. 2000.

[20]"Final Report," dated 18 June 1974, signed by Kenneth Wheatley. Contract 2665-R-73, with Adhesive Engineering co., San Carlos, Calif., awarded 21 Sept. 1972. Files, Multnomah County Yeon facilities.

1976 - The series street lighting system on the bridge was replaced with a 480-volt regulator ballast high intensity discharge lighting system.[21]

1976-1981 - The Oregon Transportation Commission approved the new West Approach Interchange for the bridge in 1976. Approval to proceed with the engineering followed in 1977 and the project was completed in 1981. The interchange altered flows for Macadam Avenue traffic, eliminating turn movements across traffic.[22] Contract amount: $810,617.[23] As part of the project, the Willamette Greenway Bike Path was constructed adjacent to the interchange, as per Ordinance 148463.[24]

1977 - Private consultants conducted a subsurface investigation at a five-acre site proposed to be

---

[21] Unsigned letter dated 22 Jan. 1976, from Richard Howard, Multnomah County Service District Engineer, to Portland General Electric Co. Files, Multnomah County Yeon facilities.

[22] "Indirect Source Permit Application," West Sellwood Bridge Interchange, dated 5 Sept. 1979, by R.W. Hufstader, Assistant Planner, Multnomah County, to Dept. of Environmental Quality, Portland, "General Description." Files, Multnomah County Yeon facilities.

[23] Contract 9119, with Shrader Construction Co., Portland, awarded 7 April 1980, cover sheet in file. The Oregon State Highway Dept. shared costs for the West Approach with Multnomah County in a Construction-Finance Agreement, dated 23 Feb. 1977, which concerned construction of the Southbound Off-Ramp Section, and Supplemental Agreement 5941, dated 2 Jan. 1980, defining maintenance responsibilities. Cost for the West Approach project was increased to $923,319.10, "Order for Extra Work," dated 18 Sept. 1980. Also see "Contract and Bond for Highway Construction," showing a specified completion date of 31 May 1981, and "Expected Overrun of Project Authorization," dated 4 March 1981. Files, Multnomah County Yeon facilities.

[24] "Ordinance No. 148463," dated 24 Sept. 1979, signed by Connie McCready, Mayor. Files, Multnomah County Yeon facilities.

developed for condominiums next to and beneath the east end of the Sellwood Bridge. The bridge cut across the northern portion of the site in an east-west direction. The report concluded: "The history of site development, combined with the disclosure of some fill material in the borings and one test pit suggests that isolated pockets of fill may be present everywhere on the site."[25]

1979 - Retaining walls and embankments were constructed and riprap was placed for the protection of the east bank piers. Foundation excavation by a private contractor during construction of a foot/bike path as part of development located on the south side of the east approach had resulted in a slide in the vicinity of Pier 16, undermining the foundation of Pier 16. The investigation of the slide indicated that erosion over the years had removed "considerable material which contributed to the support of the foundations of Piers 16 and 17." Contract amount: $30,190.[26]

1979 - As mandated by the Federal government, biennial inspections of the Sellwood Bridge began.[27]

---

[25]"Preliminary Report Foundation Investigation Sellwood Project," 23 Nov. 1977, by L. R. Squier, Inc., Consulting Engineers, Soil Mechanics and Foundation Engineering. Files, Multnomah County Yeon facilities.

[26]Contract 3207-R-79, with Willamette-Western Corp., Portland, awarded 8 March 1979; letter dated 7 March 1979, from Rena Cusma to Board of County Commissioners. A two-high gabion wall was built above the path grade and gabions were placed below. "Geotechnical Investigations Sellwood Bridge Structural Investigations for Multnomah County," 15 Aug. 1985, 24, by Kelly/Strazer Geotechnical Technical Consultants for OBEC Consulting Engineers, Eugene. Files, Multnomah County Yeon facilities.

[27]Interview with Bruce Johnson, Division Bridge Engineer, Oregon Division, Federal Highway Administration, 13 Dec. 2000. When the Silver Bridge across the Ohio River at Point Pleasant, West Virginia collapsed in December 1967, killing 46 people, the Federal government mandated a national bridge inspection program as a result of legislation enacted in 1970. In Oregon, bridges were inspected until 1988 by the agencies that owned each bridge. About that time, ODOT began administering the

1984 – After a complaint about a bump on the west approach to the bridge, the county's engineering staff inspected and found a "noticeable depression" between the west abutment and Macadam Avenue. A concrete slab below the asphalt topping had settled, with the maximum depression, about two inches, occurring at the center along the west bound lane, and tapering to zero at the bridge abutment. Inspection of the west abutment found no unusual movement or cracking as a result of the settlement. An abutment inspection was ordered and the depressed area filled with asphalt topping.[28]

1985 – OBEC Consulting Engineers, with Kelly/Strazer Geotechnical Engineers, Portland, inspected the bridge and soils. Geologist Marvin H. Beeson of Portland State University was retained by Kelly/Strazer to consult on area bedrock stratigraphy. OBEC's report determined Sellwood to be "functionally obsolete" because of the substandard 24-foot roadway that carried 27,800 vehicles daily. The overall condition of the bridge was rated as "fair." OBEC recommended posting Sellwood with load limits to restrict heavy traffic, and implementation of a maintenance and repair program. Items included repairing steel cross beams at Span 16 and steel girders at Bent 17, installing a permanent system for monitoring movement, repositioning the rocker bearings at Pier 21, injecting epoxy in the west approach columns, painting some of the steel trusses and girders and resurfacing the roadway deck.[29] OBEC's final conclusion was if 1985

---

inspection program, performed on a biennial basis, and the Federal Highway Aid funds.

[28]Office memorandum, Multnomah County Dept. of Environmental Services, from Stan Ghezzi, structural engineer, to Tor Lyshaug, operations and maintenance, dated 5 July 1984. Files, Multnomah County Yeon facilities.

[29]"Sellwood Bridge Structural Investigation," OBEC Consulting Engineers, 19 Aug. 1985, 23; "Geotechnical Investigations," Kelly/Strazer Assoc., 15 Aug. 1985; appraisal by geologist Marvin H. Beeson, 24 June 1985, presented in Figure A-2, Appendix A, 70, "Geotechnical Investigations." Files, Multnomah County Bridge Engineering offices and Yeon facilities.

traffic volumes did not increase, repairs were made, load limits and a maintenance program were implemented, the remaining structural life of the bridge would be about 17 years, or until 2002.[30]

1985 - Based on OBEC's structural analysis, load limits were posted on the bridge in an effort to extend its life. Double-axle vehicles were limited to 15 tons, three-axle vehicles to 31 tons and five-axle vehicles to 32 tons.[31] Tri-Met buses were not affected by the restriction.[32]

1988 - An underwater inspection of piers 18, 19 and 20 found that the underwater condition of the piers was good. It noted that the original timber cofferdam was braced with 12"x12" timbers that extended through the columns and webwalls of all the piers. "These timbers were left in place when the pier concrete was poured and are still embedded in the piers. It was common practice at the time this bridge was built to brace the cofferdam with timber struts through the webwalls, but this is the first structure I have seen where this bracing has been placed in the columns. This is poor construction practice and undoubtedly reduces the strength of the columns."[33]

---

[30]Memorandum from Richard Brandman, Senior analyst, Metro, to Southeast Corridor Citizens Advisory Committee, 10 May 1988. Files, Multnomah County Yeon facilities.

[31]Order, "In the Matter of Imposing Gross Weight Restriction on Vehicles Using the Sellwood Bridge," dated 17 Oct. 1985, signed by Earl Blumenauer, presiding officer, board of Multnomah County Commissioners; Multnomah County News Release, dated 2 Dec. 1985, with restrictions effective 9 Dec. 1985; letter dated 9 Jan. 1986, from Stan Ghezzi, Multnomah County Bridge Engineer, to Martin Nizleic, City of Portland Traffic Engineer; Multnomah County office memorandum dated 24 July 1995, from Jon Henrichsen to Alan Young. Files, Multnomah County Yeon facilities.

[32]"Saving Sellwood Bridge Means Limits for Trucks," The Oregonian, Michael Rollins, 25 Sept. 1985, n.p. Files, Multnomah County Yeon facilities.

[33]"Underwater Inspection Report," by Don Dean, ODOT, 13 Sept. 1988. Files, Multnomah County Yeon facilities. The

1988 - Multnomah County received a request to restrict bicycle riders from riding their bicycles on the 4'4"-wide sidewalk of the Sellwood Bridge. 17 light poles further restrict the narrow sidewalks at intervals across the bridge. Two "Walk Bicycles on Sidewalk" signs were installed, one each on the west and east approach sidewalks, pursuant to MCC: 11.60.[34]

1989 - The county Bridge Section was authorized to purchase an extensometer, a device to measure and monitor the movements between piers 21 and 22 and other points. Purchase price: Not to exceed $1,700.[35]

1990 - The City of Portland contracted with CH2M Hill consulting engineers, Portland, to provide construction cost estimates for replacing the bridge with or without tracks for light rail commuter trains (LRT). Four replacement models were proposed and contrasted: four lanes, sidewalks, bike lanes, no LRT; two lanes (44' roadway), sidewalks, bike lanes, no LRT; double-deck structure, four lanes, sidewalks, bike lanes, two tracks LRT; double-deck structure, two lanes, sidewalks, bike lanes, two tracks LRT. Cost for the four models in 1990 dollars ranged between $39.1 million and $59.43 million.[36]

---

under water inspections are conducted every five years, at the request of Multnomah County, as noted on the inspection reports.

[34]Letter from Larry F. Nicholas, County Engineer/Director, to Paul Yarborough, Director, Dept. of Environmental Services, 11 Aug. 1988; letter from Ed Pickering, County Bicycle Planner, to Krys Ochia, Manager, Alternative Transportation Program, City of Portland, 6 Oct. 1988. Files, Multnomah County Yeon facilities.

[35]Office Memorandum, Multnomah County Dept. of Environmental Services, from Stan Ghezzi to Larry Nicholas, 21 Aug. 1989. Files, Multnomah County Yeon facilities.

[36]"Conceptual Engineering Analysis Light Rail Services for the Sellwood Bridge," prepared by CH2M Hill in association with Kittelson & Assoc. and others for City of Portland, Transportation Planning Div., Nov. 1990; letter from Stuart Gwin, City of Portland, to Susie Lahsene, Multnomah County, 25 April 1990; letter from Dave Moyano, Bridge Manager,

1990 - Old expansion joints and seals were removed, along with epoxy asphalt overlay; new joints and seals and polymer modified asphalt overlay were installed. The bridge deck was cleaned, with floor beam and expansion rocker bearings repaired. Contract amount: $378,445.[37]

1994 - Metro initiated the "South Willamette River Crossing Study" with a series of public meetings and workshops to solicit comments on the nature of crossing problems and potential improvement options. Two issues precipitated the study: 1) the need to identify a strategy for increasing river crossing capacity south of the Ross Island Bridge, and 2) the Sellwood Bridge reaching the end of its design life.[38]

1994 - An underwater inspection of piers 18, 19 and 20 found that the underwater condition of the piers was good.[39]

1994 - Burgess & Niple conducted a regular biennial inspection of the bridge. It was given a sufficiency rating of 47.8, and designated "functionally obsolete." The inspectors made several maintenance recommendations including patching concrete spalls and repainting the structural steel.[40]

CH2M Hill, to Stan Ghezzi, Multnomah County, 17 March 1994. In this last letter, CH2M Hill estimated construction cost inflation between 1990 and 1994 of 15 percent for all four models. Files, Multnomah County Yeon facilities.

[37]Contract 300491, with K-2 Construction, Portland, awarded 6 Aug. 1990. Files, Multnomah County Yeon facilities.

[38]"South Willamette River Crossing Study," May 1999, Metro Regional Services, Portland. Files, Multnomah County Bridge Engineering offices.

[39]"Underwater Inspection Report," by Don Dean, ODOT, 8 July 1994.

[40]"Oregon Department of Transportation Bridge Inspection Report, Bridge No. 06879," by Dale Poorman, 22 July 1994. Files, Multnomah County Yeon facilities.

1994 - Burgess & Niple also carried out a fracture critical inspection of the bridge. A "fracture critical" inspection takes a close look at critical steel members in which a crack (fracture) could lead to collapse of a portion of the bridge. On the Sellwood Bridge, fracture critical members include numerous truss members plus the Span 16 and 21 girders from the 1894 Burnside Bridge. All fracture critical members, including the girders, were found to be in good condition, with no deficiencies noted. Ponding water was evident on the lower truss chord at the east end of Span 18, and severe paint loss and corrosion were typical throughout the lower chords. No significant section loss was noted.[41]

1994 - In a follow-up to its 1985 inspection, OBEC revisited the Sellwood Bridge and concluded that 1) the deck in the main truss spans was deteriorating at a faster rate than either of the approach spans; 2) spalling of the concrete in the deck and girders continued to be a concern for safety beneath the structure as well as for the structural integrity of the members; 3) the underside of the overhangs in the approach spans was deteriorating much more rapidly than the interior bays; 4) the then recently installed asphalt deck wearing surface was not holding up under existing traffic, with water leaking through the cracks in the truss span deck and corroding rebar and structural steel; 5) the paint system on the main truss members was continuing to deteriorate, but not at an accelerated rate; 6) there continued to be no significant sign of movements in the west approach spans since earlier repairs; 7) it appeared the load limits placed in 1985 were being followed; and 8) the load capacity of the overall bridge remained unchanged since the 1985

---

[41] "Fracture Critical Member Inspection Report, Bridge No. 06879," prepared by Burgess & Niple, Ltd., Columbus, Oh., for ODOT, 21 July 1994. Files, Multnomah County Yeon facilities. As part of the biennial inspection process, every six years a Fractural Critical inspection is made of the Sellwood Bridge. The scheduled 2000 Fracture Critical inspection has been moved to early 2001 when the bridge can be washed during high river volumes. Interview with Robert Thompson, Bridge Operations Engineer, ODOT, 18 Dec. 2000; interview with Ed Wortman, 22 Dec. 2000.

inspection.[42]

1995 - The roadway deck was paved with asphaltic concrete. Contract amount: $64,996.[43]

1995-1997 Sverdrup Civil, Inc. completed a seismic evaluation report for the Sellwood Bridge, one of six bridges so evaluated by Sverdrup for Multnomah County. It was determined that Sellwood had several critical areas of vulnerability, which could lead to collapse of portions of the bridge in a major earthquake. Sverdrup noted "the limited capacity of the concrete approach bents, poor stability of the deck trusses on their bearings, inadequate seat widths, and the possibility of unstable soils at the west approach structure." Several seismic retrofit options were suggested, with total retrofit for the Sellwood Bridge estimated at $4.8 million.[44] Also in 1995, ODOT and other agencies with consultant CH2M Hill began a seismic retrofit prioritization study of Oregon's local agency bridges. Sellwood Bridge is one of 4,000 county- and city-owned bridges in Oregon. (On a statewide basis, retrofit construction costs for 3,245 seismically vulnerable bridges were estimated to be $1.6 billion.) Sellwood was rated by CH2M Hill as Vulnerability Group 1A, for its unstable bearings (one of 503 bridges in Oregon in this group).[45]

---

[42] "Sellwood Bridge 1994 Condition Investigation and Evaluation Narrative Report," OBEC Consulting Engineers, 30 Sept. 1994, 2-3. Files, Multnomah County Yeon facilities.

[43] Contract 300476, with Western Paving Co., Portland, awarded 18 Sept. 1995. "Contract Cover Sheet, 1995." Files, Multnomah County Yeon facilities.

[44] "Sellwood Bridge No. 6879 Seismic Evaluation Report," Sverdrup Civil, Inc., Nov. 1995. Files, Multnomah County Bridge Engineering offices.

[45] "Seismic Vulnerability of Local Agency Bridges," ODOT and others, with CH2M Hill, 30 Nov. 1995, 15; "Prioritization of Oregon Bridges for Seismic Retrofit," ODOT and others, with CH2M Hill, Jan. 1997, 9. Files, Multnomah County Bridge Engineering offices.

1996 - The bridge was inspected and evaluated for worker safety as related to Oregon Occupational Safety and Health Division (OR-OSHA) standards. The priority of the recommendations was based on evaluation of the hazard consequences and the likelihood of an injury occurring. Eight recommendations were made to improve safety, with "railings on catwalk and post" ranked number one.[46]

1996 - ODOT divers carried out an underwater inspection of river piers after the February 1996 flood. They reported no flood-related damage.[47]

1996 - Data collected from the extensometer purchased in 1990 for measurements at the bridge's west end showed that the relative movement between nine points on the bridge at piers 21 and 22 and bents 23 and 24 had been nil or minimal. No movement during the six-year period 1990 to 1996 exceeded 3/4-inches.[48]

1998 - Sargent Engineers, Olympia, Wa, conducted the regular biennial inspection of the bridge. It was given a sufficiency rating of 44.5, and once again designated "functionally obsolete."[49]

1999 - Data collected from the extensometer showed that the relative movement between nine points on the bridge at

---

[46]"Sellwood Bridge Safety Evaluation Report," Feb. 1996, v, by Wise Steps, Inc., Salem. Wise Steps, Inc. and subconsultants Sverdrup Civil, Inc. made the inspection investigation and analysis. The Sellwood Bridge was one of six bridges evaluated for worker safety under RFP No. P955-85-0025, April 1995. Files, Multnomah County Yeon facilities.

[47]Office Memorandum, Multnomah County Dept. of Environmental Services, from Kris Engblom to Ed Wortman, 10 April 1996. Files, Multnomah County Bridge Engineering offices.

[48]Office Memorandum, Multnomah County Dept. of Environmental Services, from John Lindenthal to Ed Wortman, 7 Aug. 1996. Files, Multnomah County Yeon facilities.

[49]"Oregon Department of Transportation Bridge Inspection Report, Bridge No. 06879," by Chuck Mayhan, 21 July 1998. Files, Multnomah County Yeon facilities.

piers 21 and 22 and Bent 24 had been greater than found during prior measurements, i.e., between 3/8 inch and one inch. The amount of movement for the period between 1996 and 1998 was about the same as it had been for the period between 1990 and 1995. One likely possibility was that Pier 22 was moving farther east, and that Bent 23 and Bent 24 were moving with it.[50]

1999 - Metro's Transportation Department published its findings and recommendations for the "South Willamette River Crossing Study" in May. This report summarized the findings and presented JPACT (Joint Policy Advisory Committee on Transportation) with recommendations for crossing improvements. Foremost, the existing bridge would remain the only river crossing in the south Metro area for many years to come due to local opposition and land use policy conflicts. The decision to not widen the Sellwood Bridge to four lanes was based in part on Tacoma's designation as a "main street" in local and regional land use policy.[51]

2000 - Maintenance crews from the Multnomah County Bridge Section constructed a new galvanized steel grating walkway with double hand railing under the bridge, replacing a two-plank wooden walk. Ladders were also installed on river piers. The walkway and ladders met OSHA standards and allowed better access for inspections of the bridge proper and utilities suspended on the bridge. Cost: Approximately $36,000.[52]

---

[50]Office Memorandum, Multnomah County Dept. of Environmental Services, to Stan Ghezzi from Ed Wortman, 23 Jan. 1998; ibid, office memorandum from John Lindenthal to Ed Wortman, 6 July 1999. Files, Multnomah County Yeon facilities.

[51]"South Willamette River Crossing Study," May 1999, Metro, Portland, 6; The Oregonian, "Sellwood Bridge Can Stand Alone, Advisers Decide," Gordon Oliver, 9 July 1999, D1; "Tacoma Main Street Plan," A Short Transportation History of S.E. Tacoma Street," by Richard Newlands, Transportation Planner, City of Portland, 2000, 4.

[52]County engineers designed the walkway. "Multnomah County Bridges," Bridge webmaster Chuck Maggio, 6 June 2000, http://www.multnomah.lib.or.us/bridge/sellwood bridge/sellwalkway.html.

2000 - At the end of 2000, Multnomah County was beginning to develop a series of alternative plans for maintenance and rehabilitation of the Sellwood Bridge. The plans are likely to range from minimal level maintenance to major rehabilitation and seismic retrofit.[53]

[53]Interview with Ed Wortman, 18 Dec. 2000.