HISTORIC AMERICAN ENGINEERING RECORD
ROSS ISLAND BRIDGE HAER No. OR-102

Location:	Spanning the Willamette River at Powell Boulevard, Portland, Multnomah County, Oregon
	UTM: 10/526290/5038480 Quad: Portland, Oregon
Date opened:	21 December 1926
Structural type:	Steel cantilever deck truss with Warren truss side spans (sub-divided)
Engineer:	Gustav Lindenthal, New York City
Architect:	Railings: Houghtaling & Dougan, Portland
Prime Contractors:	(All Portland) Booth & Pomeroy, Main River Spans Lindstrom & Feigenson, Approach Structures Parker-Schram, Approach Fill Edlefsen-Weygandt, Approach Fill
Sub-Contractors:	(All Portland) Pacific Bridge, River Piers Jaggar-Sroufe, Electrical Parker-Schram, Excavations
Steel Fabricator:	American Bridge Company
Built by:	County of Multnomah, Portland, Oregon
Present owner:	Oregon Department of Transportation (since 1975)
Present use:	Vehicular, pedestrian and bicycle traffic
Significance:	The Ross Island Bridge is one in an ensemble of twelve monumental highway bridges across the lower Willamette River. It is one of five Portland spans (with Burnside, Sellwood, Lovejoy Viaduct, and the Broadway Bridge) associated with Gustav Lindenthal during the period 1924-1928. The Portland bridges were the last of this master engineer's career, with Ross Island a rare example of a Lindenthal highway-only deck truss. In Oregon, Ross Island is also: 1) one of 215 known highway truss bridges of any type or age surviving; 2) one of seven known cantilever highway trusses; 3) the only known cantilever highway deck truss, made further unique among cantilever trusses because it was designed without a suspended center span, thereby incorrectly appearing to be an arch bridge. Ross Island is also significant because of its unusually finely subdivided Warren truss side spans. Created almost exclusively for motor vehicles, Ross Island was the first fixed-span (designed not to raise for river traffic) Willamette River bridge in downtown Portland, and was the first river bridge

in the central city's history to be designed without trolley tracks.

Historian: Researched and written 1999-2001, by Sharon Wood Wortman, HAER Historian, in collaboration with Edward J. Wortman, P.E., Engineering Services Administrator, Multnomah County Transportation Division, Bridge Section.

Project Information: Documentation of the Ross Island 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 (ODOT) 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.

Introduction: Truss Bridges, Cantilever Truss Bridges in Oregon and the Ross Island 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, like Ross Island, 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, for example, each span is independently supported by piers at each end. In a cantilever truss bridge, the trusses extend out past the piers. In a continuous truss bridge, the trusses span over multiple piers without hinges or expansion joints.[2]

One of only seven steel cantilever highway trusses of any type in Oregon, Ross Island is also the only known steel highway deck cantilever truss bridge in the state. Normally there is a simple span suspended between the ends of the two cantilever trusses. Ross Island's cantilever design is unusual because the suspended span was omitted to achieve maximum height and clearance for river traffic. (Further unique, Ross Island Bridge is the only bridge to carry Bull Run water across the Willamette River in pipes located on its superstructure. This qualifies Ross Island as an aqueduct.)

Modern bridge technology began with the advent of the truss bridge, with the truss bridge 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 evolved from wood to iron and to steel, with first pinned, then riveted, and finally bolted connections.[3] The members of

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

[2] Please see Historic American Engineering Record, National Park Service, U.S. Department of the Interior, "Sellwood Bridge," HAER No. OR-103.

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

a Warren truss are in the form of connected, repeating "Ws." In a Warren truss, the diagonals carry all vertical shear, with alternate diagonals in tension or compression. The vertical truss members (posts and hangers) carry only local loads.

Historic Highway Bridges of Oregon includes sketches of twelve truss types described as "Common Historic Bridge Designs in Oregon."[4] Of these, four are varieties of Warrens: Warren (simple), Warren with Verticals, Warren with Polygonal Top Chord, and Double-Intersection Warren (Lattice).[5] The side spans on the Ross Island Bridge are examples of Warrens with Verticals that have been sub-divided.[6] 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 2001. Of the 215 trusses, only 126 are known to remain that were constructed prior to 1951.[7] Of the 126 historic trusses, there are only 32 known deck trusses.[8]

Oregon's other six known cantilever truss bridges include four on the Columbia River, all between Oregon and Washington, one on the Oregon Coast and one across the Willamette River: Columbia River (Astoria) Bridge, Columbia River (Lewis and Clark) Bridge, Columbia River (Bridge of the Gods), Columbia River (Umatilla) Bridge, Coos Bay Bridge and the Marquam Bridge, the latter in the central city waterfront directly downstream of the Ross Island Bridge, at Portland, Oregon.[9]

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[4] 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.

[5] 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.

[6] A distinct aspect of the Ross Island Bridge is the use of vertical posts (s-verticals) in the trusses 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."

[7] Julie Osborne, Cultural Resource Specialist, Environmental Services, Oregon Department of Transportation, telephone interview with Sharon Wood Wortman, 9 November 2000, and in-person interview 22 February 2001. 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 in 25 years.

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

[9] The Oregon Department of Transportation does not maintain a database that sorts truss bridges by cantilever type. This is a list of the known cantilever truss bridges of any type in Oregon. Osborne, interview with Sharon Wood Wortman, Salem, Oregon, 22 February 2001.

Location and Context of Ross Island Bridge

Portland, Oregon, incorporated on the banks of the Willamette River in 1851, is a seaport in Northwest Oregon and the largest city in Oregon. The Willamette River travels 310 miles northward from its farther-most reach in the high Cascades through the northwestern part of Oregon. It is navigable for about 100 miles upstream from Portland, south to Eugene.[10] Willamette River mile 0, or the mouth of the river, is located at the confluence with the Columbia River, about 12 miles north, or downriver, of Portland central city waterfront. The Willamette-Columbia junction is located between Sauvies Island and Kelley Point Park, in close proximity to Vancouver, Washington. Portland-Vancouver harbor is about 110 river miles east of the Pacific Ocean, where the Columbia River ends near Fort Stevens, at Astoria, Oregon, designated Columbia River mile 0. Portland, the only major city on the 1,200-mile-long Columbia River, shares an inland river deep-water port geography with only a few U.S. cities, among them Baton Rouge, Baltimore, Houston, Savannah, Sacramento, New Orleans and Wilmington, Delaware.[11] In Portland's case, such navigable conditions resulted in the erection of 21 movable or high-span bridges across the Willamette River, all built or rebuilt between 1887 and 1989, when in the latter year the draw span of a railroad swing bridge located at river mile 6.9 was replaced with a vertical lift draw span. (See Plate 1, Sharon Wood Wortman, "Construction History of Portland-Area River Bridges" and Plate 2, Sharon Wood Wortman, "Map: Portland's Bridges, Including Railroads & Interstate Highways, Willamette River Mile 0 to 26")

The Ross Island Bridge is one of seven fixed spans in a collection of 14 large extant highway and railroad bridges located across the lower 26 miles of the Willamette River near Portland, Oregon. Portland is the seat of Multnomah County, the most populated of Oregon's 36 counties. In addition to six HAER study bridges, ODOT owns and maintains 2,650 bridges located throughout Oregon, with the Willamette River bridges among its largest bridge structures. (ODOT also administers the biennial federal highway bridge inspection program for all Oregon bridges and, for certain spans, splits maintenance responsibilities with cities and counties for surface repair, snow removal and drainage problems.) The 14 lower trans-Willamette River bridges include six highway bridges owned by ODOT, four movable bridges and one fixed span bridge owned by Multnomah County, and three railroad bridges, one owned by the Burlington Northern-Santa Fe Railway Co., and two owned by the Union Pacific-Southern Pacific Railway Co. One of the U.P.-S.P. bridges also serves as a highway bridge, for a total of 12 lower Willamette River highway spans. None of the bridges across the Willamette are owned

[10] Eugene is the second largest city in Oregon. Vessels traveling above Willamette Falls, located south of Portland at Willamette River mile 26, are limited by the Willamette Falls Navigational Locks and Canal to six-foot drafts and may not be longer than 175', or wider than 37'.

[11] Portland, with Sacramento (Sacramento River), Stockton (San Joaquin River), and Longview (Columbia River) are the four major inland deep-water port river cities on the West Coast of the United States.

by the City of Portland.[12]

Site Description

The city and the Ross Island Bridge are located near the western edge of the fairly flat Portland Basin, and are bordered by the Tualatin Mountains (also known as the West Hills) on the west and by the foothills of the Cascades on the east. Portland's population in 2001 numbers about 500,000 within 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.[13]

The Ross Island Bridge, with two lanes for westbound traffic and two lanes for eastbound traffic, is part of the state's Mount Hood Highway system, known as U.S. Highway 26. It crosses the Willamette River at river mile 14, upstream from the Portland Harbor Wall and Eastbank Esplanade and about halfway between the Hawthorne Bridge and the Sellwood Bridge. At mid-span, Mount Hood is 66 miles to the east. U.S. 101, along the Oregon Coast, intersects with U.S. 26 near Seaside. The bridge also serves Pacific Highway, known as 99W, and part of Powell Boulevard. Powell extends 13.9 miles from the bridge's east end, in the Brooklyn neighborhood, to Burnside Street in the City of Gresham, Oregon. A southbound off-ramp at the east end of the main span leads to S.E. McLoughlin Boulevard. Beneath the east end approaches of the bridge are the tracks of the Oregon Pacific Railroad Co. and the Ross Island Sand and Gravel Co.

In a no-man's land for pedestrians, the Ross Island's west end leads due west to connect southbound with Barbur Boulevard. Instead of connecting to Barbur, motor vehicle traffic may also turn right one block off the west end of the bridge at S.W. Water Avenue at the intersection of S.W. Woods, located in the Corbett-Lair Hill Neighborhood. Westbound traffic may also, staying in the far right-hand lane, exit to S.W. Corbett, headed northbound for downtown Portland, or loop beneath the Ross Island Bridge's westerly approach spans to travel south on

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[12] As part of the$30 million Eastbank Esplanade project, opened in 2001, the City of Portland, Office of Transportation (PDOT), built several pedestrian bridges parallel to the Willamette River in the central city waterfront, including a 1,000' -long floating bridge. ODOT also designed and built RiverWalk, a $2.5 million pedestrian and bicycle walkway cantilevered off the south side of the bottom deck of the Steel Bridge, loacted downstream from the Ross Island Bridge.

[13] E. Kimbark MacColl, *The Growth of a City, Power and Politics in Portland, Oregon 1915 to 1950.* (Portland: The Georgian Press, 1979). MacColl note (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.

Interstate 5. Interstate 5, oriented north-south, is located beneath the Ross Island Bridge's west end approach spans. Between I-5 and the Willamette River are S.W. Moody Street, the Zidell Companies, the 136-acre North Macadam District and tracks for the Willamette Shore Trolley. Powell Boulevard, McLoughlin Boulevard and Barbur Boulevard are among the busiest arterials in the state.

Most river traffic today on the stretch of the lower Willamette near the Ross Island Bridge is confined to recreational and tour boats.

Namesake

The Ross Island Bridge takes it name from the 304-acre island group located just south of the bridge's center span. The three-island group was named Oak Islands in 1841, but Oak Island did not prevail. Sherry Ross, a pioneer settler from Indiana, filed a land claim in 1850 to farm the largest island, and it soon took his name.[14]

1920s 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.[15] Other early and extant bridges soon followed, with Willamette and Columbia river bridges eventually opened, under construction, or being planned in nearly every decade of the twentieth century. (Refer to previously listed Plate 1, "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 the Sellwood Bridge, 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 3, "Consultant and Contractor History, Burnside, Ross Island, and Sellwood Bridges at Portland, Oregon"):

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

The three 1920s Willamette River bridges, Ross Island, Burnside and Sellwood, and the 1927 Lovejoy Viaduct were the first spans in Portland built exclusively to accommodate the

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[14] Lewis A. McArthur, *Oregon Geographic Names* (Oregon Historical Society Press, 6th ed., 1992), 723; City of Portland, Office of Neighborhood Involvement.

[15] Sharon Wood, *The Portland Bridge Book*, 2nd ed., rev. (Portland: Oregon Historical Society Press, 2001).

rapidly growing volume of motor cars and trucks.[16] These new bridges spurred the city's urban expansion and changed the traffic system. They provided improved access across the Willamette River between the city's central business district in west Portland and the city's east and southeast sections.[17] (For more about this subject, see section below, "Background History.")

The Ross Island, Burnside and Sellwood bridges also shared similar engineering technology. They were the first steel deck truss highway bridges across the Willamette River near Portland. The Sellwood Bridge was the first Willamette River bridge near Portland to open without a movable span, followed a year later by the Ross Island, the first central city fixed span.

Description of Bridge as Originally Built

Now designated by ODOT as Oregon state highway Structure No. 05054, the Ross Island Bridge consists of three distinct units: the west approach, main river spans and the east approach. Three ramps added in later years are listed by ODOT as separate bridges. These are: north off-ramp at west end (added in 1948), designated Structure No. 06857; south on-ramp at west end (added in 1948), designated Structure No. 06943; and south off-ramp at east end to McLoughlin Boulevard (added in 1956), designated Structure No. 06767.[18] The following summary description is based primarily on the original design and as-built drawings by Gustav Lindenthal[19]

<u>Total Length</u>: 3,705' on structure, plus approach fills

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[16] 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.

[17] "Two New Bridges, Costing About $5,100,000 Will Span Willamette," *The Morning Oregonian*, 1 January 1923, 1. As shown by this story, new bridges during this time period were locally funded and always resulted from the strong lobbying efforts of business owners and politicians. "In the campaign for the Ross Island Bridge, seven community clubs joined forces, financed the campaign and sent speakers into every section of the city and county to urge votes for the projects...." Modern-day bridge construction is more complicated due to reliance on federal funding.

[18] For more about bridges 06767, 06857 and 06943, see Appendix, "Summary of Significant Events, Ross Island Bridge and Approaches, Post 1926," 1, 2.

[19] From Lindenthal design drawings as interpreted by Ed Wortman, Multnomah County Bridge Engineering Services Administrator. When the ownership of the Ross Island Bridge was transferred from Multnomah County to the Oregon State Highway Department (now Oregon Department of Transportation, or ODOT), the original ink-on-linen drawings also transferred. The original Lindenthal plans for Ross Island Bridge, identified as bridge structure 05054, are kept in archives maintained by the State of Oregon, in Salem. There are 44 drawings numbered L-1 through L-41, including three "A" sheets. The "General Location" map is dated 27 February 1925, and the last drawing, for iron ladders, is dated 26 January 1927. The cover sheet says, "1925 Multnomah County Oregon Plans Ross Island Bridge Gustav Lindenthal." Most of the drawings are ink on linen. ODOT also maintains a drawings list for the history of Ross Island.

Roadway Deck and Sidewalks:

Overall width of deck:	51'-7-1/2" except wider at west end
River spans and typical approach spans:	Four traffic lanes and two sidewalks 38'-wide roadway; 5'-wide sidewalks
Spans 1,2&3 (west end):	Six traffic lanes and two sidewalks 58'-wide roadway; 5'-wide sidewalks

River Span Superstructure:
Total length: 1,823'
Five steel deck truss spans with reinforced concrete deck:
Spans 1 and 5: 321' long simply-supported Warren trusses (sub-divided)
Spans 2 and 4: 321' long Warren trusses (subdivided). Outer ends continuous with Span 5 cantilevers
Span 5: 535' long arch-shaped truss span consisting of two cantilevers joined at mid-span

River Span Substructure:
Five reinforced concrete piers on concrete footings. Timber piling under footings.

West Approach Span Superstructure:
Total length: 1,482'
23 reinforced concrete spans ranging in length from 30' to 81'-6". Structure consists of longitudinal girders, transverse floorbeams, longitudinal stringers and deck. Most spans continuous for two or three spans. Cast in place.

East Approach Span Superstructure:
Total length: 400'
Six reinforced concrete spans ranging in length from 52'-6" to 76'-6". Construction similar to west approach.

Approach Span Substructure:
29 reinforced concrete bents on concrete footings; 23 bents under west approach, six bents under east approach. Typical bents have two columns and footings. Five bents at west end have three columns and footings due to wider roadway. Timber piling under footings at eight west approach bents closest to river.

West Approach Fill (not shown on Lindenthal plans):
Total area: Approximately 200' square.[20]

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[20] Ross Island Bridge's West approach fill, from the bridge to Corbett Street, was built by the City of Portland, thus the plans do not show up on any Multnomah County or ODOT drawing inventory. The contract was

East Approach Fill:
Total length: 342'
Earth fill with retaining wall on north side

Railings:
Reinforced concrete with precast balusters

Design of the Ross Island Bridge – Overview

Later sections of this report give details of the history of the bridge's design and describe various parts of the structure. The purpose of this section is to give an overview of the design history for context.

In 1923, the firm of Hedrick & Kremers (H&K) was formed to design and supervise construction of three bridges for Multnomah County: new Ross Island and Sellwood bridges and a replacement for the then-existing Burnside Bridge, opened in 1894. For the Ross Island Bridge, H&K produced a design consisting of six concrete arch spans for the main river crossing and multiple concrete girder spans for the east and west approaches.

Early in 1924, bids were submitted for construction of the three bridges. Contracts were awarded, but then were nullified due to irregularities in the design and construction process. County commissioners, members of the design team and potential contractors for the bridges

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awarded to the low bidder Edlefsen-Weygandt Co, for $146, 365. The plans for this west end fill were not found, so the amount of fill can only be estimated from the Lindenthal and Hedrick & Kremers (H&K) plans for the bridge proper, and from notes found in the Record of the Proceedings of the Board of the Multnomah County Commissioners of Ross Island and Burnside Bridges. See Vol. II 15 September 1926, 306, hereafter referred to as the Commissioners Journals. [These bridge journals are owned by the Multnomah County. This writer referred to a number of Multnomah County bridge journals during the course of research for HAER's Willamette River bridges recording project. The journals were found at different times at the county's Yeon facilities, 1600 S.E. 190th and at the county's Records Center (Ford Building), 2505 S.E. 11th. The journal most relevant to HAER No. OR-102 (Ross Island Bridge) is titled, "Record of the Proceedings of the Board of County Commissioners Pertaining to the Construction of Ross Island and Burnside Bridges." In two legal-sized volumes, Volume One contains entries dated from 9 August 1922 to 24 December 1924 (pps. 1-400), and Volume Two contains entries dated 24 December 1924 to 12 December 1927 (pps. 1-376), for a total of 776 pages covering a period of about four and one-half years. Each of the journals' entries refer internally to other bridge journals and page numbers, but for the purpose of footnoting HAER OR-102, the write refers only to page numbers as stamped in the upper right-hand corner of all 776 pages.] This other information indicates the west end fill, about 200' square and extending west of the bridge structure, made a big flat area. This level apron made easier access for Corbett, Kelly, Grover and Woods Streets. A safety island with lights and planter was located in the middle of the apron, creating a traffic circle (see Plate 7, phootgraph, "West Approach (as Built) Ross Island Bridge). As discussed in the next section, "Design of the Ross Island Bridge - Overview." Lindenthal changed the axis of the bridge as originally proposed by H&K, compliacting connections with local streets. The west end approach was completely changed in 1948 when tunnels and cloverleaves were added (see Appendix, "Summary of Significant Events, Ross Island Bridge and Approaches, Post 1926," and section below, "Design and Construction Chronology for the Ross Island Bridge.")

found themselves in serious legal difficulties. The commissioners were quickly replaced. The new commissioners were concerned about the feasibility and safety of H&K's designs. To help them out of their dilemma, they brought in Gustav Lindenthal, a world-famous bridge engineer based in New York.

Lindenthal first reviewed H&K's designs for the three bridges, then was asked to complete the design process and supervise construction for all three structures. After reviewing H&K's design for Ross Island, Lindenthal recommended against the concrete arch design for the river spans. Following is Lindenthal's evaluation of H&K's Ross Island design from his report entered verbatim into the minutes of the meetings of the Board of County Commissioners.[21]

> The plans for this bridge provide for a structure of six reinforced concrete arches of 267 ft. span rising to 135 ft. clear height above the river, joined on each side by approaches of the Girder and post type and with a total length of 4129 feet including a fill 400 ft. long. It is intended to have four lines of traffic including two lines of trolley tracks, 40 feet between curb lines and two sidewalks of 5 feet each, making a total width on bridge of 50 feet. I recommend that the plans for this bridge be entirely redesigned for the following reasons:
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> 1. It is doubtful whether the bridge on the present plans could be built within the amount appropriated for it.
> 2. The borings in the river bottom disclose an irregular stratification of sand and gravel, which in my judgment, does not offer sufficient security against uneven settlement of the pier foundations proposed to be sunk by the air-process. A slight settlement, which would not endanger a low structure, may be enough to seriously endanger high piers and high concrete arches which require a greater degree of safety for their foundations. No chances should be taken with the foundations for high concrete arches.
> 3. The axis of the bridge should, if possible, be on a straight line and for better appearance the hump in the roadway over the river should be taken out. For that purpose the clear height over the channel should be reduced from 135 feet to about 80 feet.
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> I find, on inquiry, that ocean vessels have hardly ever gone as far up the Willamette river and that no adequate wharf facilities now exist for them above that location. It is the concensus *[sic]* of opinion of those whom I consulted and who can judge this situation correctly, that the height of the bridge need not be greater than about 80 feet above the water. I am informed that an act of Congress authorizing such lowered height will be

[21] Commissioners Journals., "In the Matter of the Preliminary General Report of Gustav Lindenthal, Consulting Engineer, on the Appropriateness and Adequacy of Design of the Foundations and Construction of the Proposed Burnside Street, Ross Island and Sellwood Bridges," 11 July 1924, 263.

necessary, but that it can be obtained without much delay when desired by the people.

As to the roadway 40 ft. wide between curbs, I would advise that it be kept free from Trolley tracks, although it may be designed for their loads, and that the sidewalks (now only five feet on the plans) should be widened to 8 ft. each. It may come to pass, also for this bridge as already mentioned for the Burnside Bridge, that the sidewalks may be used by many pedestrians for their health as are the promenades on the long East river bridges in New York.

As noted above, Lindenthal was hired to redesign Ross Island after his evaluation report was submitted. Following is a summary of how some of his recommendations fared during the redesign:

- H&K's overall design was largely superseded, although Lindenthal's structural arrangement for the approach spans was quite similar to H&K's.
- Lindenthal replaced the concrete arches over the river with a steel truss structure, which probably would be less sensitive to settlement of the piers. To minimize the chance of settlement, his new design also added piling under the river span piers. These were the primary changes made in the new design.
- The horizontal axis of the bridge was straightened out as Lindenthal recommended. H&K's design included a horizontal curve in the west approach to fit the alignment of the street at the west heading. Lindenthal's design shifted the west heading one half block to the south. This change complicated the traffic pattern somewhat but undoubtedly saved substantial cost in construction of the approaches.
- Lindenthal managed to reduce the "hump" (vertical curve) in the bridge, but only by about 12'. Clearance over the channel at mid-span was now about 123' versus the 135' in H&K's design. At the edges of the navigation channel, the new design provided the 80' clearance recommended by Lindenthal.
- The new design has a slightly narrower roadway, 38' versus 40' in the H&K design.
- Sidewalks remained 5' wide rather than being widened to the 8' recommended by Lindenthal.
- As suggested by Lindenthal, the new design did not accommodate trolleys. The live load assumed for design was based on 25-ton trucks, rather than trolleys. Lindenthal deleted stringers provided in H&K's design to support the trolley rails.

There is no cost estimate available for the H&K design; thus, no easy comparison can be made with the cost of the Lindenthal design. Certainly some of Lindenthal's changes noted above would have produced cost savings: straightening the west approach; deleting the trolley tracks; lowering the hump; narrowing the roadway. Use of the steel truss superstructure over the river in place of the concrete arches may have reduced cost, although that is uncertain. Other definite cost saving measures by Lindenthal were to: (1) change design of some of the piers from solid boxes to twin shafts to reduce concrete volume; (2) delete stairways inside two of the piers;

(3) simplify the architectural detailing, particularly on some of the piers (elaborate curved surfaces were replaced with straight planes). On the other hand, much of these savings most likely was offset by the substantial cost of adding piling under the river span piers.

Foundations

The Portland Basin is filled with hundreds of feet of sediments that washed down the Columbia and Willamette rivers over the past several million years. A large portion of the uppermost sediments were deposited in the post-glacial floods that roared down the Columbia at the end of the last Ice Age.[22] These sediments consist of a mixture of sand, gravel, clay and silt. The resulting situation poses a difficult challenge to designers of foundations for bridges over the Willamette in and near Portland. In most areas, bedrock is hundreds of feet below the river bottom, too deep to reach with conventional bridge foundation methods. Also, the types and characteristics of sediments vary widely from site to site, and even within the limits of a single bridge site.

As is typically done, soil borings were taken along the proposed route of the Ross Island Bridge at the beginning of the design process. Sheet 6 "Record of Borings" in the H&K plan set, dated 13 June 1923, shows the locations of 22 borings and gives the "boring log" for each one. Five of the borings were in the river. Boring depths varied down to elevation –86' below the low water level. Maximum river depth along the bridge alignment is shown as 30' below low water.

Under the approach spans away from the river, the boring logs show firm ground with designations such as "Hardpan and Gravel" and "Cemented Gravel." Closer to the river and in the river bed, the ground was found to be softer. Designations for sediments at shallow depths include varieties and combinations of sand, silt, clay and gravel.

For the approach spans, the H&K and Lindenthal designs called for similar foundations for the bridge support bents. Spread footings were used away from the river where the ground was firm. Closer to the river, where sediments were softer, piles were used to support the structure. Typical approach bents include two footings with 25 timber piles under each footing. Piles were driven up to 60' into the ground under the footings.

For foundations under the river span piers, Lindenthal's design differed substantially from the H&K design. H&K's drawings show concrete footings under the seven piers supporting the six proposed concrete arch spans. No piles are shown. Based on comments by Lindenthal in his report to the County Commissioners (see "Design of the Ross Island Bridge – Overview" above), it appears that H&K's intent was to embed the footings in the river bottom using the pneumatic caisson method ("air-process" in Lindenthal's words). This method had been used

[22] Elizabeth L. Orr and William N. Orr, *Geology of the Pacific Northwest* (McGraw-Hill, New York, 1996), 304, 334-335.

successfully for the Broadway Bridge's river span piers several years previously.[23] However, as Lindenthal explained to the commissioners, he did not think this design was suitable for the Ross Island site, particularly for a concrete arch structure. In his report to the commissioners, quoted above, Lindenthal said:

> The borings in the river bottom disclose an irregular stratification of sand and gravel, which in my judgment, does not offer sufficient security against uneven settlement of the pier foundations proposed to be sunk by the air-process. A slight settlement, which would not endanger a low structure, may be enough to seriously endanger high piers and high concrete arches which require a greater degree of safety for their foundations. No chances should be taken with the foundations for high concrete arches.[24]

To support his steel cantilever truss structure for Ross Island, Lindenthal called for timber piling under the concrete footings. Piers 3 and 4 at the arch-shaped center span used the most: 252 piles at Pier 3 and 294 piles at Pier 4. Pile tops were embedded in the concrete footings. Footing sizes are 75' by 43'-6" at Pier 3 and 75' by 50'-6" at Pier 4.

River Span Structure

The most distinctive visual feature of the Ross Island Bridge is the graceful arch shape of the main span over the navigation channel at the middle of the river. Despite its shape, this is not a true arch from the standpoint of structural behavior. It actually is made up two cantilever-type trusses reaching out from the piers and connecting in mid-span. Following is a description of the entire river superstructure, starting with the spans closest to shore and working toward the center span:

As noted in the "Bridge Description" above, the river span superstructure consists of five truss spans. The five-span unit is symmetrical about its mid-point, with the arch-shaped twin-cantilever center span (River Span 3) flanked at each end by two side spans (River Spans 1, 2, 4 and 5). All truss spans have their two main trusses spaced 30' apart.

The two end-most side spans, Spans 1 and 5, are simple spans 321' long between bearings. Top and bottom truss chords are parallel, 30' apart. The trusses are Warrens with Verticals, and are subdivided to give unusually short floor beam spacings of only 13'-4½" (see section below on "Portland Bridges – Panel Lengths"). Overall design of these two spans is quite similar to the individual spans on Lindenthal's Sellwood Bridge, except that the Ross Island spans are simply supported rather than continuous. The shoreward ends of Spans 1 and 5 are supported in conventional fashion at Piers 1 and 6 on fixed bearings under the bottom chord.

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23 See Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Broadway Bridge," HAER No OR-22

24 Commissioners Journals, 11 July 1924, 268.

However, their riverward ends are supported in an unusual way. There is a large vertical post pinned to the end of each top chord and hanging down. The bottom ends of these posts are pin-connected to the end of the adjoining truss spans (Spans 2 and 4). Thus the posts serve to carry loads from the end spans to the piers in compression, and also to allow for expansion and contraction in the spans via their pinned connections. This unusual "compression link" design is similar but opposite of the "tension link" or "hangar" design commonly used at the ends of suspended spans in standard cantilever bridges.[25]

Spans 2 and 4 also are 321' long between bearings. At their shoreward ends at Piers 2 and 5, they are supported on rocker-type expansion bearings under the bottom chords. At their riverward ends at Piers 3 and 4, Spans 2 and 4 are joined continuously at their top and bottom chords with the Span 3 cantilevers. Thus Spans 2 and 4 serve as anchor spans for the adjoining cantilevers. The trusses are supported at Pier 3 by rocker-type expansion bearings and at Pier 4 by fixed bearings. This bearing combination is necessary because the two Span 3 cantilevers are joined rigidly together at mid-span (see below).

The Span 2 and 4 trusses are 30' deep chord-to-chord at their shoreward ends, matching adjoining Spans 1 and 5. The trusses remain 30' deep over half their span lengths, then deepen in curved shapes to 80' deep at Piers 3 and 4 to match the Span 3 cantilevers.

As noted above, arch-shaped Span 3 actually consists of two cantilever trusses reaching out from Piers 3 and 4. Each cantilever is 267'-6" long, producing a total span of 535' for Span 3. The structural arrangement of the cantilevers varies. Over most of the length of each cantilever, "Pratt truss" framing is used with tension diagonals between top and bottom chords.[26] However, to fit the arch-shape of the cantilevers, "K-type" bracing is used in one truss panel. As in the side span trusses, each of the truss panels is sub-divided to support the deck (see "Portland Bridges – Panel Lengths" below).

At the top of the "arch" at the middle of Span 3, the tips of the cantilevers are only 6'-8" deep in order to maximize navigation clearance. Because of the shallow structure at the cantilever tips, Lindenthal chose to use plate girder construction rather than trusses for the outermost 40' of each cantilever.[27] Continuation of the truss-type framing to the cantilever tips would have been awkward due to the panel proportions.

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[25] Lindenthal's design sheet L36 refers to the compression links at the ends of Spans 1 and 5 as "rocker verticals."

[26] Smith, *Historic Highway Bridges of Oregon*, 22.

[27] The same truss/girder combination is used in two other Portland bridges having arch-shaped cantilevers with shallow tips. See the bascule spans on Burnside and Morrison bridges.

The section below on "Design and Construction Chronology" documents how the arch-shaped cantilever truss design concept initiated for the Ross Island Bridge. As noted there, it is not clear from available records who first proposed the idea. It was first documented in a report from the "Committee of Engineers" that included City Engineer Olaf Laurgaard; Hans Rode, Principal Assistant Engineer under Lindenthal for Ross Island; and J.P. Newell, the first chairman of the Portland Planning Commission and a consultant to the county.[28] Regardless of who first suggested the concept, it is clear from the record that Lindenthal quickly picked up and developed it.

Factors in favor of the cantilevered arch truss idea were aesthetics, navigation clearance, vertical profile (roadway slopes) and economics. From the standpoint of aesthetics, the arch shape has proven to be aesthetically pleasing over thousands of years of bridge history. Lindenthal had made history of his own with the Hell Gate Arch in New York. Commenting on the proposed shape for Ross Island, Lindenthal said, "The bridge on the proposed plan will have a symmetrical, pleasing appearance, and be an architectural asset to the City."[29]

The spirited debate over navigation clearance for the Ross Island Bridge is documented in the "Chronology" section below. As reported there, the debate focused on the question of future shipping requirements upstream of the bridge site. The advantage of the arched truss concept was that it provided the highest navigation clearance for a given roadway elevation. As finally built, the roadway at mid-span is only about ten feet above the bottom of the structure.

Lindenthal had originally suggested a continuous truss for Ross Island, similar to his design that was actually used for the Sellwood Bridge. With that design, Ross Island's roadway at mid-span would have been about 18' higher than with the arched truss design for the same under-bridge clearance. The added roadway height would have required steeper deck grades or longer approaches, either of which would have increased costs substantially.[30]

As for all bridges over navigable waters, it was necessary to get approval from the U.S. Army Corps of Engineers in order the build the bridge. In March 1925, Lindenthal's Portland

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[28] Commissioners Journals, 22 September 1924, 337, 338. Also see Rode's minority report to the commissioners on the same day. While the Committee report doesn't say who first proposed the cantilever truss concept, it is quite obvious that Rode was not the one considering the negative comments on the idea in his report. The "Chronology" section below describes proposed design alternatives and quotes Rode's criticisms of the cantilevered truss.

[29] Commissioners Journals., 29 September 1924, 343.

[30] It is interesting to note that Lindenthal initially proposed two very similar structures for the river spans at Ross Island and Sellwood, whereas they ended up quite different. From available records, it appears that Lindenthal "west with the flow" of public and political opinion at Ross Island, whereas at Sellwood he seems to have been freer to follow his own engineering preferences.

office prepared two standard sketches for submittal to the Corps, one a "Location Map" and the other an "Elevation & Plan." The Elevation sketch shows navigation clearances as follows[31]:

- 123' vertical clearance at crown of "arch" (mid-span)
- 120' vertical clearance for a clear width of 100'
- 90' vertical clearance for a clear width of 330'
- 515' wide between Piers 3 and 4 (490' clear perpendicular to navigation channel, due to slight skew of bridge)

These vertical clearances were measured to "Low Water" on the U.S. Engineers datum (about 3.1 feet higher than City of Portland datum used on Lindenthal's design drawings). Actual elevation of the river at the Ross Island Bridge site is nearly always higher than the Corps official "Low Water" datum, which was established farther downstream. The Lindenthal sketch submitted to the Corps shows "Ordinary Boating Water =6.5'", which would give a maximum mid-span clearance under the bridge of 116.5'. A note attached to the sketch copy says: "1971 Corps Water Surface Profiles shows 5.7' as low water and 23.2' as 20 year flood. This gives vertical clearances of 114.3' at low water and 96.8' at high water (20 year flood) for 100' horizontal."

Yet another likely design objective would have been to optimize the total cost of superstructure plus substructure. This is consistent with the design decision to bring the superstructure down close to the water at Piers 3 and 4. This arrangement appears to have had two advantages. First, it provided the truss depth needed to cantilever 267' over the river at a reasonable cost for the structural steel framing.[32] Second, it minimized the cost of Piers 3 and 4 by making them as short as practical.

A pertinent question is why an arched-shape cantilever design was proposed for Ross Island's main spans rather than a true arch. One apparent reason is the proportions of Span 3, where the "arch" rises only 82' in the 535' span. This rise-to-span ratio of 1:6.5 (or 0.15) is

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[31] "Approval of Location and Plans of Bridge," U.S. Engineers Office, Second District, 3 April 1925, by H. Taylor, Major General, and Dwight F. Davis, Acting Secretary of War.

[32] Cantilever bridge trusses typically are made deeper at the piers than out over the water. This is done to reduce stresses in truss members at the piers, where bending load are greatest. Designers opt for different ways to deepen the trusses, based on economic and aesthetic choices as well as location of the roadways. For example, in the Bridge of the Gods at Cascade Locks and the McCullough Bridge at Coos Bay, the through trusses are deepened both above and below the roadway. Two other through truss cantilevers touching Oregon, the Astoria-Megler Bridge near the mouth of the Columbia River and the Lewis & Clark Bridge between Rainier, Oregon and Longview, Washington, have deeper trusses only above the roadways.

relatively flat, which would mean an uneconomical design for a true arch.[33] Considering the flatness of Span 3, a true arch here would likely have required much larger lower chord members in Spans 2, 3 and 4 (since there were no solid abutments at Piers 3 and 4, the anchor spans would have had to resist the thrust from the main span arch). Another possible reason for not using one or more true arches may have been the concern raised by Lindenthal about the potential for settlement of foundations at the Ross Island site.

As reported above in "Design of the Ross Island Bridge – Overview," Lindenthal was concerned about the safety of an arch structure, particularly a concrete one, because of the "irregular stratification of sand and gravel" in the river bottom. Adding piles under the piers, as in Lindenthal's final design, would have reduced the risk of settlement, but at substantial added cost for multiple piers in the river.

As just discussed, the use of two cantilevers connected at mid-span makes sense in this situation as opposed to a true arch. However, it is a highly unusual structural arrangement for a fixed-span bridge.[34] Normally, a twin-cantilever bridge has a suspended span hanging between the ends of the cantilevers.[35] In addition to simplifying construction, one advantage of the standard cantilevers-plus-suspended-span arrangement is that the suspended span allows freedom of movement between the two cantilevers. This is normally accomplished by hanging the suspended span from the cantilevers with tension links, as was noted above.

Apart from Ross Island, the writer is aware of only one or two other major fixed-span bridges that employ connected cantilevers without suspended spans. In *Bridges: The Spans of North America*, David Plowden lists two structures of this type: the Queensboro Bridge in New York City and the Minnehaha Bridge between Minneapolis and St. Paul.[36] Like Ross Island, Queensboro was designed by Gustav Lindenthal. This monumental structure (called Blackwell's Island Bridge in early references) is a five-span through truss over the East River in New York

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[33] The flat proportions of the Ross Island "arch" were pointed out to the write in a telephone conversation on 6 March 2001 with Charles Seim, a well-known West Coast-based bridge engineer. Also see Conde B. McCullough and Edward S. Thayer, *Elastic Arch Bridges* (John Wiley & Sons, New York, 1931), 72: "Experience has shown that a rise of from one-fifth to one-third the span is the most economical one for open spandrel arches, a value of from 0.25 to 0.30 being a very satisfactory figure." In contrast to Ross Island's ratio of 0.15, the true arch of the Fremont Bridge main span has a ratio of 0.27 (341' rise in 1255' span), in the middle of the range cited by McCollough and Thayer.

[34] Double-leaf bascule bridge leaves typically function as cantilevers connected at their tips via "span locks" that are engaged when the two leaves are closed and ready to carry traffic. Examples in Portland are Burnside, Morrison and Broadway bridges.

[35] Marquam Bridge is an example close by in Portland, although the suspended span is not clearly obvious on Marquam. More obvious examples in the region are the Bridge of the Gods and the Lewis and Clark Bridge.

[36] David Plowden, *Bridges: The Spans of North America* (New York: W.W. Norton & Co., 1974), 184.

City. It opened for traffic in 1909. The two main spans over arms of the river are shaped like suspension bridge spans but actually consist of cantilevered trusses connected at mid-span without suspended units, much like Ross Island. In fact, Ross Island is essentially an upside-down version of Queensboro.

The Queensboro Bridge design was not considered a great success by all. In fact, J.A.L. Waddell, Lindenthal's eminent contemporary, was highly critical of the design in his *Bridge Engineering*. Following are his comments quoted at length since they are pertinent to Ross Island. Waddell begins with reference to the cantilevers-without-suspended-span concept in general, then proceeds to Queensboro:

> Of course, it is practicable to omit the suspended spans and connect to each other in a vertical direction ... the meeting ends of the cantilever arms; but such construction is unscientific, uneconomic, and exceedingly faulty, in that the stresses are rendered indeterminate except by making assumptions which are only approximately correct. Besides, the work involved in finding such stresses is complicated and excessive.
>
> The Blackwell's Island Bridge [Queensboro] over the East River at New York City ... is of this type; and 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 overstresses were found to be so great (due to both ambiguity of stress distribution and overrun of dead load) 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 ... the damage done to the bridge by the omission of the suspended span is measured by millions of dollars. This is a good illustration of the ill effects of violating Principle No. I of "The First Principles of Designing," given in Chapter XV, viz., "Simplicity is one of the highest attributes of good designing." No more effective example of its correctness than this structure affords could be desired.[37]

Regardless of what Lindenthal himself may have thought of his Queensboro design after it was built, he continued to use similar statically-indeterminate concepts in his later bridges.[38] His mighty two-span continuous truss Sciotoville Bridge over the Ohio River,

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[37] Waddell, *Bridge Engineering*, 586. Waddell's Principle No. II for bridge design "was "The Easiest Way's the Best." ibid, 368.

[38] In a statically-determinate structure, such as a simply-supported truss, the designer can determine the reaction forces supporting the structure in a straightforward fashion by solving a few equations based on statics. In an indeterminate structure, such as Queensboro or Ross Island, there are more unknown reaction forces than there

opened in 1917, was one of the first fully-continuous truss bridges in North America. For his 1924/25 design of the Sellwood Bridge in Portland, Lindenthal extended the continuous-truss concept to an exceedingly rare four-span continuous unit. Immediately following the Sellwood design, he reprised Queensboro's cantilevers-without-suspended-span concept in the final design for Ross Island.

As indicated by Waddell's comments quoted above, the use of statically-indeterminate structural arrangements in bridge design was a controversial topic in the early twentieth century. Waddell was critical of complex bridge designs in general, and of Lindenthal's use of them in particular. Lindenthal, on other hand, did not shy from using complex designs when he thought the results were desirable.[39] He addressed the topic of indeterminate structures and continuous truss/girder structures in some of his technical papers. For example, in a letter to *Engineering News-Record* magazine in 1929, he acknowledged Ross Island as a continuous structure: "Only recently I completed two city bridges of the continuous girder type over the Willamette River in Portland, Oregon, one of three spans [Ross Island], another of four spans [Sellwood]."[40] In a 1922 paper for the American Society of Civil Engineers, Lindenthal presented the arguments against continuous structures, and then argued that they were not significant concerns where circumstances were favorable. He also presented five advantages of continuous structures. These advantages, any of which could apply to the Ross Island Bridge, were: (1) economy, (2) rigidity; (3) ability to sustain damage without collapse; (4) erection with minimum falsework and minimum interference to navigation; and (5) aesthetics.[41]

Since Ross Island has no suspended span, Lindenthal had to connect the tips of the two cantilevers in order to provide a continuous, smooth roadway for traffic. Otherwise, "steps" would have occurred in the deck profile as the two cantilevers deflected upward and downward

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are static equations available. To determine the reactions, the designer must include evaluation of how much the members of the structure deflect (i.e., stretch, shorton or bend) under their loads. This makes the structural analysis considerably more complex and time-consuming, particularly if electronic computers are not available.

[39] The differing design philosophies of these two great bridge engineers may have reflected their different eduactional backgrounds. Waddell studied engineering at McGill University in Montreal, where the emphasis may have been on the practical, construction-orientated approach to design as was typical of American engineering practice. Lindenthal, on the other hand, was trained in Europe, where mathmatical complexity in bridge design was encourgaed. For more on their debate over determinate vs. indeterminate trusses, see Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Sellwood Bridge," HAER No. OR-103.

[40] *Engineering News-Record*, 3 March 1929, 397.

[41] "Sciotoville Bridge Over the Ohio River," Gustav Lindenthal, *Transactions,* American Society of Civil Engineers (New York: 1922), Vol. LXXXV, Paper No. 1496, 915-920.

relative to each other under the effects of traffic weight and temperature.[42]

In the Ross Island Bridge, the ends of the cantilevers are rigidly attached to each other. Lindenthal's design called for a large (16" diameter) steel pin in each truss to tie the cantilevers together at mid-span during erection of the steelwork. However, once construction was finished, steel plates were riveted across the joint, making the plate girders continuous over the center section of the span.

It is not clear why Lindenthal called for the center joint to be made rigid rather than leaving the pins alone to connect the cantilever tips. Use of large-diameter pins in steel bridge joints has long been common. However, corrosion (rusting) of the pins and adjoining plates frequently "freezes" the pins in place, thus preventing free rotation of the plates on the pins as assumed in the design. Bridge pins are constant concerns for bridge maintenance and safety. This may have been a factor in Lindenthal's decision to immobilize the pins with riveted plates.

As explained above, a cantilever bridge with no suspended span is statically-indeterminate by its nature. This would be true even with pinned connections between the cantilevers. Making the plate girders continuous across the center joint by immobilizing the pins, as was done at Ross Island, added to the degree of indeterminacy. This increased the complexity of the calculations needed to analyze the structure and determine forces and stresses in the various truss members.

Lindenthal apparently recognized the extra difficulty that immobilizing the pins posed for his design team on the Ross Island project. A note on his design sheet L36 says: "Box girder ends are pin-connected and fully riveted up at 68 [center joint]; but in computing trusses only pin connection is assumed." In other words, to simplify the design work, Lindenthal chose to ignore the minor effects of a rigid (rather than pinned) joint on the structure as a whole.

Portland Bridges – Panel Lengths

The Ross Island, Sellwood and Burnside bridges were designed within a short period of time by a team of engineers and drafters working first under the direction of Ira Hedrick and Robert Kremers, then under Gustav Lindenthal. The steel trusses in all three bridges are similar in that the trusses are finely-sub-divided. As discussed below, this produced unusually-short floor system panel lengths, resulting in an economical floor system design.

"Sub-dividing" in a truss refers to the addition of short diagonal and vertical members between the primary truss members. The purpose of sub-dividing is to carry the weight of the deck and deck traffic to the primary truss. In the case of deck truss bridges such as Ross Island, Sellwood and Burnside, short vertical posts, called "sub-verticals," run from the top chords of the

[42] The span locks at the juncture of leaves in double-leaf bascule bridges are intended to serve this purpose of maintaining a smooth roadway.

trusses down to the primary diagonals. "Sub-diagonals" then connect these intersection points back to the top chords.

The use of "sub-verticals" is not typical of all deck trusses, but is done in some situations. In J.A.L. Waddell's discussion of truss types, he was critical of the arrangement in general; however, he 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."[43]

Consistent with Waddell's observation, the sub-verticals in all five Ross Island truss spans, as well as in Sellwood's four truss spans and Burnside's two truss 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 lengthwise, 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 Ross Island, 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 Ross Island, Burnside and Sellwood's design. This technique became common in the late nineteenth 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.

What is highly unusual about the sub-dividing of Ross Island, Burnside and Sellwood'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 Ross Island, Burnside and Sellwood. For these three, panel lengths are respectively about 13', 16', and 14'. These short panel lengths are extremely unusual, whether looked at from a Portland-area point of view, or a nationwide point of view.

[43] Waddell, *Bridge Engineering*, 471.

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'.[44]

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

Ross Island (1925)	All five spans	13'-4-1/2"
Burnside (1923-24)	Side spans Bascule	16'-9-5/16" 15'-9"
Sellwood (1924)	All four spans	13'-7-3/4"
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)	Side spans Lift span	26'-0-15/16" 30'-2"
Sauvie Island (1949)	All three spans	25'
Interstate (1917)	Northbound span	23'-9-3/4"

Who designed the unusually short panels for Ross Island, Burnside and Sellwood? 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, Sciotoville and Queensboro bridges. 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

[44] "Queensboro Bridge Over East River, Rehabilitation Main Span and Approaches, General Elevation and Plan," City of New Yor, nd. From the collection of Michael Beard, Portland, Oregon.

arch (similar to an inverted Queensboro), Ross Island's statically indeterminate design (similar to Queensboro) and Sellwood's continuous trusses (similar to 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 H&K team (who had just finished designing Burnside using Warren trusses with finely sub-divided panels), and from what we know comparing the H&K drawings for Sellwood with the Lindenthal drawings, it is certain that the sub-divided trusses with short floor panels for Ross Island and the other two bridges were not Lindenthal's but came from Hedrick, or Reed, first in charge of the Portland work, or perhaps one or all of the H&K team members.[45]

Contractors

The first two prime contracts for the Ross Island Bridge were awarded by Multnomah County to Booth & Pomeroy for the main river spans and Lindstrom & Feigenson for the approach structures. Parker-Schram later won a contract for the east approach fill, while Edlefsen-Weygandt (under a separate contract with the City of Portland) provided the west approach fill work from the bridge to Corbett Street.

There were several sub-contractors. Pacific Bridge sub-contracted under Booth & Pomeroy for the river span foundations, including Piers 1 through 6, and the concrete deck, and also sub-contracted under Lindstrom & Feigenson for excavation work. Parker-Schram also sub-contracted under Lindstrom & Feigenson for footing excavations. Jaggar-Sroufe was the electrical sub-contractor under the Booth & Pomeroy contract.[46] (Refer to previously listed Plate 3, Sharon Wood Wortman, "Consultant and Contractor History Burnside, Ross Island and Sellwood Bridges at Portland, Oregon.")

All the companies were based in Portland. Little is shown in the record for Booth & Pomeroy. The 1926 City Directory shows, "Booth & Pomeroy Inc. S.R. Booth pres JH Pomeroy

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[45] Ed Wortman, who refers to the drawings for Sellwood and other Lindenthal bridges on a daily basis, pointed out the extremely short panel lengths for all three Portland Lindenthal bridges. He helped interpret drawings, theorized about Lindenthal and Hedrick & Kremers engineering activities, and collaborated with the write for three HAER reports on the Lindenthal bridges including Burnside Bridge, Ross Island Bridge, and Sellwood Bridge.

[46] Everybody was working for each other. Booth & Pomeroy, the prime contractor for Ross Island was also a sub-contractor under Pacific Bridge for the Burnside Bridge main span. Lindstrom & Feigenson, the prime contractor for Ross Island's approaches, was also the prime contractor for Burnside's approach end ramps, and held another contract as a sub-contractor under Booth & Pomeroy for the concrete approaches and concrete encasement of the east end steel of Burnside Bridge. Gilpin, the runner-up for Ross Island, was the prime contractor for the Sellwood Bridge. ibid., 15 June, 82-83. ibid., 6 July, 106 and 10 August, 132.

v-pres Harry Stopp sec-treas bridge contrs 336 Ry exch." (Railway Exchange Building "ss Stark bet 3d and 4th.")[47]

In addition to working in either a prime or sub-contracting capacity on the Burnside, Ross Island, and St. Johns bridges, Lindstrom & Feigenson also worked on the McCullough Bridge at Waldport, OR., and the Strauss bridge at Longview, Washington. Lindstrom & Feigenson were also the sub-contractors for the pump station roof slab and control building for the Ankeny Street Pump Station, opened 7 June 1929 as part of the Portland Harbor Wall. Oscar J. Lindstrom, founder of Lindstrom & Feigenson, general contractors with headquarters in Portland, was born in Umea, Sweden in 1878, emigrating in 1903. The company quit business in 1937, a year after the death of William H. Feigenson, Lindstrom's partner, and president of the business.[48]

Edlefsen-Weygandt, the company that had a separate contract with the City of Portland to complete the west end approach of the Ross Island Bridge to Corbett Street, was also the contractor for the construction of McLoughlin Boulevard. The company formed in the early teens of the twentieth century, and went out of business in the 1930s. Peter Edlefsen was the financial partner in Edlefsen-Weygandt, while Weygandt furnished the work crews. Peter Edlefsen, with two brothers, John and Anton, emigrated from Germany to Portland. Edlefsen originally lived in North Portland, developing the St. Johns waterworks, and later moved to Portland Heights in the West Hills.[49]

Pacific Bridge, a sub-contractor for Ross Island Bridge, did the marine work, including excavation and foundations for the river piers. The company was established in California in 1869 by W.H. and C.H. Gorrill, and moved to Portland in 1880. As reported in the newspaper stories for the opening ceremonies of the Burnside Bridge a year before the Ross Island Bridge finished, Pacific Bridge also built the first Morrison Bridge in 1887 (the first highway bridge across the lower Willamette River near Portland). Charles F. Swigert, born in Ohio in 1862, worked for Pacific Bridge in California, migrated with the company to Portland, and then bought the firm in 1886. Pacific Bridge did not fabricate steel, but it did erect steelwork and maintained

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[47] Names are Sumner R. Booth (Isabella) h Dunthorpe, Jno H Pomeroy (Bertha) h 524 E. 18th N. No obituary exists in any local newspaper index for Booth. An obituary was published for John Pomeroy, 1933 "Oregonian," 15 October 1933, sec. 2, pg 2, age 59, but the article, situated on an inside margin, did not microfilm well.

[48] Oscar Lindstrom died 7 December, 1945. "Oscar J. Lindstrom," *The Oregon Journal*, 7 December 1945, 6; "W.H. Feigenson, Contractor, Dies," *The Oregonian*, 26 January 1936, sec. 2, 1. Feigenson was 56 at the time of his death. He was also president of Albina Fuel Co., another prominent Portland company.

[49] Telephone interview, Sharon Wood Wortman with Tom Edlefson, nephew of Peter Edlefson and son of John Edlefson, 21 March 2001. Also see Commissioners Journals, 15 September 1926, 306.

a corps of engineers who designed "when requested."[50] Pacific Bridge also contracted for the substructure work on the Interstate Bridge, its northbound span opened in 1917 across the Columbia River between Portland and Vancouver, Washington, and did the marine work, dredging and foundations for the Portland Harbor Wall. (For the harbor wall, Pacific Bridge was a sub-contractor under J.F. Shea Co., earlier the prime contractor for the Thomas Creek Sewer Relocation project as a result of the construction of the Ross Island Bridge.)[51]

The Parker-Schram Co. listed its address at 515 Couch Building, Portland.

Construction Methods

Records available to the writer did not extensively document the construction methods used by the contractors to build the Ross Island Bridge. However, reports of interest were found on some subjects:

Erection of Structural Steel

Kurt Sieke was one of the engineers on Gustav Lindenthal's staff during design and construction of the Ross Island, Burnside and Sellwood bridges (see "Lindenthal Design Team" below). In May 1954, Sieke applied to Multnomah County for a position on design and construction of a new Morrison Street Bridge. In addition to information on his own background, Sieke's application packet included photos and captions on construction of bridges including Ross Island.[52] For Ross Island, the photos were of steel erection work on the trusses.

One of Sieke's photos shows an erection derrick on top of the truss over Pier 3 on the west side of the navigation channel. (See Plate 4, photograph of "Erection Derrick, Pier 3") One of the derrick's two booms is about to lift a truss chord member from a supply barge. This photo documents that the overall approach to the steel erection work on Ross Island was typical for the time and for the type of structure. For example:

- The side span truss steel was assembled in place, with support for the structure provided by a forest of timber falsework.

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[50] Fred Lockley, "Charles F. Swigert, "*History of the Columbia River Valley, From the Dalles to the Sea* (Chicago: S.J. Clarke, 1928), 3 Vol., 618.

[51] The company also operated outside Portland. In 1931, Pacific Bridge was the contractor for the superstructure of the Lake Union Bridge over the Lake Washington Canal at Aurora Avenue, Seattle, Washington. "News of the Week, Lake Union Bridge, Seattle, Washington," *Engineering-News Record,* 16 July 1931, 111. Construction began on the Lake Union Bridge in late 1929. "The Portland Harbor Wall," interpretive panel, Eastbank Esplanade, 2001.

[52] "Experience Record, Kurt H. Siecke," application for work, with resume, 1954. Files, Multnomah County Yeon facilities. For more about Siecke's application see section below, "Lindenthal Design Team."

- The cantilever truss over the channel span was assembled in place by cantilevering without falsework.
- The steel was erected by a steam-powered "traveler"-type derrick on top of the truss.
- Barges were used to transport the truss members to the erection site.

The work shown in this first photo would most likely be done in similar fashion today. Steel falsework probably would be used instead of timber. Also, the steam-powered traveling derrick probably would be replaced by a diesel-powered mobile crane on the deck or by a barge-mounted crane. Otherwise, the operation would be the same.

Sieke's other photo is a close-up showing an erection crew assembling a bottom truss chord member. (See Plate 5, photograph of "Erection Crew") Sieke's caption describes the operation, which is being done in essentially the same way it would be done today. Even the wrenches being used by the crew are the same as today's. One difference from today's work approach is the lack of safety equipment: the men in the photo are not wearing hardhats or safety belts, and there are no safety railings evident. With respect to the structure itself, the main difference from late twentieth century/early twenty first century technology is the method used for making up the final connections. Whereas high-strength bolts would be used today, Ross Island used hot rivets, as was standard practice until the late 1950s and early 1960s. Sieke provided a detailed description of the procedure for aligning the steel pieces and then riveting them together.

On 19 December 1926, *The Sunday Oregonian* featured a front-page illustrated article on the Ross Island Bridge, which was about to open for traffic two days later.[53] Two of the photos are close-ups showing placement of the last section of cantilever steelwork at mid-span. This is a piece of the plate girder portion at the tip of the cantilever. The wire rope rigging used to lift the piece shows clearly, as does the base of the traveling derrick. One of the crew can be seen standing on a "float," a lightweight wooden platform traditionally used by steel erectors. Except for a few details, these photos could have been taken in the 1960s as well as in 1926. (Safety requirements that have come into effect in recent decades would make the operation look quite different today, although the general process would be similar.)

Closure of the "Arch" at Mid-Span

An article in *Engineering News-Record* Magazine described the method used by Booth & Pomeroy, the prime contractor, to join the two cantilevers together over the middle of the river.[54]

[53] "Great Ross Island Bridge Ready for Traffic," by Arthur D. Sullivan, *The Sunday Oregonian*, Vol. XLV, No. 51, 19 December 1926.

[54] "Steel Arch-Closure Effected with Aid of Temperature Changes," *Engineering News-Record*, Vol. 97, No. 20, 11 November 1926; 796-797; copy of letter from Hans Rode to Gustav Lindenthal, 22 September 1926. Files, Multnomah County Yeon facilities.

The west side span and cantilever were deliberately built 2-1/2" shoreward from final position to allow clearance for erection of all the steelwork. The final step was to insert the 16"-diameter pins to join the cantilever tips. To bring the pinholes into alignment, the west side span was blocked into position; then, as the steel heated up during the day, expansion of the side span and cantilever closed the 2-1/2" gap. The article reported that the process worked, although it apparently took two days of expansion cycles to fully-close the joint so the pins could be installed. Also, the traveling derricks on both cantilevers were moved close to the end so their weight would help close the joint. The *Engineering News-Record* article includes an informative photo of the two derricks in place, with one of them lifting a final cantilever section from a barge.

Placement of Concrete for the Roadway Deck and Sidewalks

Two issues of *Engineering News-Record* had articles with photos reporting on methods used to place concrete for Ross Island's roadway deck and sidewalks.[55] *Engineering News-Record* apparently considered both the methods to be innovative, since the reports were in the section of the magazine titled "From Job and Office; Hints That Cut Cost and Time."

For the over-land portion of the bridge, a wooden trestle about eight to ten feet tall was built along the bridge. The concrete apparently was mixed in a plant on the ground below the bridge. When mixed, the concrete was lifted up a tower in hoppers, then moved by chutes to other hoppers sitting on wheels on the trestle. These hoppers rolled along the trestle to the placement points, where the concrete was distributed by chutes.

The *Engineering News-Record* article reported that 10,400 cubic yards of concrete were placed with this system. It also said the system had been used successfully on four bridge projects. Based on a photo that the writer has seen, one of the other projects was the Burnside Bridge, finished just prior to Ross Island.[56]

For the over-water portion of the bridge, the concrete mixing plant was located on a barge. The plant included storage tanks and bunkers for cement, sand and gravel as well as the mixers themselves. Another barge moored alongside supported a 150'-tall tower that lifted the concrete to the bridge deck in hoppers. From there, hand buggies were used to move the concrete to the placement points on the deck. A total of 2,434 cubic yards of concrete were placed by this method, extending along 1,800' of bridge deck. In the process, the floating plant

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[55] "Concrete Floor on Bridge Poured from Plant Floating Alongside," *Engineering News-Record*, Vol. 97 No. 26' 1046. "Concrete Delivery for Pouring Floor System on Bridges," *Engineering News-Record*, Vol. 98, No. 6; 248.

[56] See Historic American Engineering Record, National Park Service, U.S. Department of the Interior "Burnside Bridge," HAER OR-101, Burnside Bridge. Plate 4, photograph, "Concrete Encasement of Burnside Bridge East Approach Steel Girders, ca. 1926," courtesy Steve Dotterrer, 22.

was positioned at five different locations along the bridge. Throughout the operation, cement, sand and gravel were delivered to the plant by supply barges.

Architectural and Aesthetic Details

Although it is not a true arch, the arch shape of the Ross Island makes it one of three "gateway" arch bridges into the heart of Portland: Fremont Bridge, to the north; Vista Bridge, to the west, and Ross Island Bridge to the south.

Ross Island's graceful unadorned structural form is attained with unusual design features, i.e., a cantilever truss without a suspended center span, and with trusses that are finely subdivided to allow an extremely lightweight deck system. Among the last bridges in Lindenthal's career, the Ross Island Bridge appears elegant compared to his railroad-oriented bridges. Its substructure and superstructure are essentially intact as constructed.

The bridge's balustrades, located on both sides of the deck along its entire length, were replaced in a rehabilitation project in 2000-2001. (See Appendix, "Summary of Significant Events, Ross Island Bridge and Approaches, Post 1926.") These balustrades (railings) with circular arch openings were designed by Houghtaling & Dougan (H&D—see "Architects" below). As part of the Hedrick & Kremers design effort for Ross Island, H&D produced architectural drawings not only for the balustrades, but also for light poles and ornate styling on several of the bridge piers. However, when Lindenthal redesigned the bridge, much of H&D's work was modified or deleted. (These changes probably were made to reduce construction costs, as noted above in "Design of the Ross Island Bridge – Overview.") Only the balustrades were built as designed by H&D.

In 1962 Portland architect Lewis Crutcher, A.I.A., was retained by Multnomah County to recommend the colors to be used in the repainting of all the county's Willamette River bridges. At that time, Crutcher chose the color blue, applied to the superstructure in 1965.[57] In bid documents, the formula called for pigment made up of "titanium dioxide, Phthalo blue, Phthalo green, lamp black, magnesium silicate, calcium carbonate, and aluminum stearate." The result is

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[57] Letter from P.C. Northrop to Board of County Commissioners, 4 June 1962, files; Multnomah County Contract Agreement with J.E. Brown Co., 1 July, 1965; position paper from Kenneth Gervais, dated 21 March 1975, files; "Commission Opens Bids on Span Paint Project," *Oregonian*, 2 July, 1965, nd. The McLoughlin Avenue off-ramp on the east side, a separate bridge owned by ODOT, was left green, as it remains today. "Board Decides Not to Paint," ibid., 26 May 1965.

a deep color of blue.[58] With both the paint and superstructure hidden beneath the highway deck, the Ross Island Bridge is best appreciated from the river.

[58] "Addendum No. 1 Ross Island Bridge Maintenance Painting," 24 June 1965, Multnomah County Road Dept., addition to bid document, project #564, files, Yeon facilities. Also see Appendix, "Summary of Significant Events," 2.

Architects

The Portland architectural firm of Houghtaling and Dougan (H&D) was hired by Multnomah County to provide architectural services for the Ross Island and Burnside bridges. For both bridges, H&D designed railings, light poles and ornamentation for some of the piers. Much of their detailing showed European influences. On Burnside, H&D's designs were built essentially as proposed. However, as noted above, only the railings on Ross Island were built as designed by H&D.

A Portland Historical Landmarks Commission report on another H&D structure noted, "The firm was formed in 1914 and by 1921 had become a well patronized and respected firm as a result of their excellent work and reliable dealings."[59] Chester A. Houghtaling, the senior member of the firm, was a native of Cleveland, OH., born 27 October 1882. He studied construction engineering at the Lewis Institute of Chicago, after which he worked for the firm of Purdy and Henderson Engineers for two years in Chicago. He moved to Portland in 1913. In addition to the Burnside and Ross Island bridges, the firm was the architect for the Elks's Temple (Old), and the Fitzpatrick Building, all in Portland. Houghtaling died on 31 March 1940.[60]

Leigh L. Dougan, the junior partner, was born in Princeton, IN., on 28 July 1883. He studied architecture at the Armour Institute of Technology in Chicago, withdrawing in his junior year to gain practical experience in Tulsa, Oklahoma. He arrived in Portland in 1911. In 1925, when the partnership dissolved, Dougan went into private practice. Among some of the buildings he designed after his partnership with Houghtaling were the Medical Dental Building and the Studio Building in Portland and the First National Bank Building of Salem. "Dougan gained a reputation for his authoritative scholarship, enabling him to draw upon the classical styles for usage in large design and ornamentation."[61]

Perhaps the best-known work of the firm of Houghtaling and Dougan in the Italian

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[59] George A. McMath, "Elks Temple (Old)," Portland Historical Landmarks Commission Inventory Form 3-20, April 1970, Files, City of Portland.

[60] Houghtaling's obituary said he attended the first officers' training camp at the Presidio in San Francisco and served in the army as captain in the engineers corps, and that he was also the architect for Washington High School and the Fitzpathrick Building, both in Portland, "C.A. Houghtaling Taken by Death," *The Oregon Daily Journal*, 2 April 1940, 13.

[61]Dougan's obituary said he also designed the Civic Building in The Dalles, Oregon, "Architect Dougan Dies," *The Oregonian*, 12 October, 1983, D14. In a profile of Dougan published in 1979, at the time of the renovation of the Medical Dental Building at 833 S.W. 11^{th} in Portland, he is quoted as saying that he had run away from home at the age of 15 because he did not want to take over the family farming and food brokerage business as his father wished. "To support his training at the Armour Institute of Chicago, Dougan worked at odd jobs, including ones as office boy in the firms of architects Frank Lloyd Wright and Louis Sullivan." He also claims credit for design of Washington High School, and Oswego Grade School. "In Salem, he designed the Oregon State Office Building, the State Tuberculosis Hospital and the First National bank Building." Fran Jones, "Renovations Please Building Architect," *The Oregonian*, 8 December 1979, D2.

Renaissance idiom is the Elks Temple (1923) in Portland, "a full-blown imitation of Florentine palace architecture."[62] Dougan, who was also an artist and illustrator, died 9 October 1983 in Palos Verdes Estates, CA. at the age of 100.[63]

Name Plate

A solid brass nameplate from the Ross Island Bridge was mounted in 2000 for an exhibit held at the Portland chapter of the American Institute of Architects.[64] The plate, 24" wide by 30" tall, provides the following information:

1926
Ross Island Bridge
Multnomah County
Board of County Commissioners
Amedee M. Smith, Chairman
Erwin A. Taft, Commissioner
Grant Phegley, Commissioner
Stanley Myers, District Attorney

Gustav Lindenthal, Engineer in Chief
Hans H. Rode, Principal Assistant Engineer
M.E. Reed, Principal Assistant Engineer
N.W. Reese, Assistant Engineer
John Zoss, Assistant Engineer
Houghtaling & Dougan, Architects

Booth & Pomeroy, Inc., Contractors
Lindstrom & Feigenson, Contractors
Parker-Schram Co., Contractors
Pacific Bridge Co., Sub-contractors

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62 John Tess, "Medical Arts Building," National Registry of Historic Places Inventory Nomination Form, Portland, 1983, 5. The Burnside Bridge certainly reflects Mediterranean architecture.

63 Tess, "Medical Arts Building," 5.

64 "Rediscovering Portland's Willamette River Bridges," 3-25 February 2000, American Institute of Architects Gallery, Portland featuring architectural drawings and artifacts produced by HAER team members in 1999. The exhibit was sponsored by ODOT, the Portland Chapter of AIA, HAER, and Multnomah County. The mounted name plate continues to travel; this writer seeing it in February 2001 at ODOT Region 1 offices just before it was scheduled for an exhibition to be held in Salem.

Jaggar-Sroufe Co., Sub-contractors
American Bridge Company, Steel Fabricators

Background History

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.[65]

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. With the completion of the Broadway Bridge and Lovejoy Viaduct in 1913, Multnomah County assumed the responsibility for maintaining and building bridges across the Willamette River in Portland. Accordingly, the Oregon State Legislature authorized the county to issue bonds for the construction or reconstruction of non-railroad bridges across the Willamette River beginning in the early 1920s.[66] Thus, the county was in a position to implement Laurgaard's plans for new bridges.[67]

Voters approved $4.6 million in bridge bonds in the general election of 7 November 1922, to construct Ross Island, Burnside and Sellwood bridges, with $1,600,000 for Ross Island, $350,000 for Sellwood, 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

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[65] 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 MacColl, *The Growth of a City,* 315-320.

[66] ORS 382.335 and 382.34 (O.C.L.A.) were originally

[67] An early scheme for Ross Island shows a three-span continuous truss, with standard piers, as well as trussed-steel piers, and a tiny vertical lift span on the east end. See "Tentative Drawing of Proposed Ross Island Bridge to be Voted on Tuesday," *The Portland Telegram*, 4 November 1922, 1.

Bridge, which was already under construction.[68] Lindenthal signed a contract 11 July 1924 with newly appointed Board of Multnomah County commissioners to plan and supervise the construction of all three bridges across the Willamette River. Subsequently, on 4 November 1924, voters authorized additional bonds for $500,000 for the completion of Ross Island and Sellwood bridges, and to change H&K's 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.[69]

The record shows that Lindenthal made only minor changes from the H&K design for the Burnside Bridge. For Sellwood, Lindenthal made only minor changes to the H&K design for the entire substructure, including piers and footings for the approach span superstructure, and for the roadway deck. The most significant change made to Sellwood was Lindenthal's superstructure redesign for Sellwood's main river spans. For the Ross Island Bridge, drawings and other records show that Lindenthal basically redesigned the entire bridge, although the approaches are similar to the H&K design.

As described above in "Design of the Ross Island Bridge – Overview," H&K had proposed that Ross Island be built as a six-span arch bridge. The original drawings of this design scheme are located in the Wilson Room, Multnomah County Central Library, Portland. These consist of one elevation drawing and 59 design drawings. The elevation drawing is a blue line print on white background, with the piers and water filled in by hand with watercolor. It is 7-1/2'-long by 18"-high. The front of the drawing is labeled with a title in white lettering on blue background paper that says, "Ross Island Bridge." The elevation drawing's title block says, "Multnomah County, Sheet No. 5, Ross Island Bridge, General Elevation and Plan, Hedrick & Kremers Consulting Engineers, Portland, Oregon, Nov. 1st, 1923. Scale 1"=40'." The 60 sheets are bound and labeled, "Multnomah County Oregon, Board of County Commissioners, Plans for Ross Island Bridge." The title block elevation drawing shows "Made by Smith, checked by L. Frost, traced by Coventry, and checked by Frost."

The plans provide for a structure of six reinforced concrete arches of 267' span rising to 135' clear height above the river, joined on each side by approaches of the girder and post type with a total length of 3,724', not including fills. It provides four lanes of traffic including two lines of

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[68] For more about the scandal involving the 1920s bridges, see what will be Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Burnside Bridge," HAER No. OR-101, and MacColl, *Growth of a City*, 264-265. 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, 23 February 1926.

[69] The vote was 66,832 for and 26,517 against. Commissioners Journals, 31 December 1924, 4. Also see 15 June 1925, Commissioners Journals, Ross Island and Sellwood Bridges, Multnomah County, Ford Building. 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 December 1925, 1.

trolley tracks, 40' between curb lines and two sidewalks of five feet each, making a total bridge width of 54', including railings.

A single elevation drawing made by Lindenthal is also located in the Wilson Room, Multnomah County Central Library. Drawn on paper backed with linen, this drawing is also water colored by hand. It shows a high-level steel cantilever bridge, closely approximating the bridge as built. The title block shows a maximum clearance of 123', and that the drawing was made in New York on 6 Oct 1924 and stamped as "Issued Oct. 15, 1924, G. Lindenthal."

A comparison of the H&K elevation drawing and the Lindenthal elevation drawing shows identical span lengths for both bridges on the west side, from Span 1 through Span 25. Here the Hedrick arch bridge begins its rise, with all six open-spandrel arches at 90 feet high. Each arch had 11 support points for the roadway along the arch. The highest point is at River Span 2 with the centerline of the roadway at elevation 141'. The slope (grade) of the roadway varies from 2.86 percent on the west approach to 4.1 percent on the east approach. (The ground at the location of the Ross Island Bridge is higher to the west than on the east side. Therefore, the east side of the bridge would slope down more because the ground is lower.) The H&K design shows 39 spans total. No piling are shown under the footings for the river piers. Elevations at the bottoms of the footings range from –60' to –64'.

Lindenthal's design differs from the H&K design at Span 26, with a height of 65'-5-1/4", proceeding east with Pier No. 1 – 11'; three steel truss side spans 267'-6" each; main span 535'; three steel truss side spans 267'-6" each; Pier No. 8 – 11'; Span 27 – 60'-10-1/2"; Span 28 – 58'; Span 29 – 56'-10-1/2"; Span 30 – 9'-9"; Span 31 – 40'-6"; and span 21 – 9'-9". The maximum grade on the steel truss side spans is 2.24 percent, with the east approach 4.1 percent (the same as the H&K), and the west approach 2.24 percent.

On the west side of the H&K design, the approach begins on the east side of Corbett Avenue, extending 75' to the beginning of the bridge structure, passing over (from west to east) Kelly, Hood, Macadam and Moody streets. The plan view shows a horizontal curve in the west approach spans in order to align the west end of the bridge with Woods Street. The drawing also shows a gravel fill that began on the east side of Corbett extending east to Hood Street, a distance of about 400'. The drawing shows a gully existed between Corbett and Hood, and that the gully was filled in. It is not clear what this filling did to Kelly Street, but it appears Kelly Street would have been blocked. Another gully, also filled in, is shown east of Hood Street, from Hood to Macadam.

One major change in Lindenthal's design was to straighten the west approach spans. This moved the west end of the bridge about one-half block south, between Woods and Grover streets.

At the east end of the bridge, the drawings show fill from west of East 7th to the east side of Grand Avenue. The end of the approach is at Brooklyn Street.

Both designs show the same designs for the railings and streetlights. The lighting is decorative, with several light pole clusters on the main spans and approaches (see cover photograph).

Bridge Dedication

The bridge was opened and dedication exercises were held 21 December 1926. A program with a front page titled, "Willamette River Ross Island Bridge built by Multnomah County," shows Commissioner Erwin Taft presided, with Grand Marshall Hiram U. Welch and the Bealey Military Academy Cadets Bridge Guard. Hans Rode represented Lindenthal. In between music provided by Handzlik's Band, Oregon Governor Walter Pierce, State Highway Commissioner H.B. VanDuzer, and Portland Mayor George Baker had their say. The inside of the program shows that George Himes of the Oregon Pioneers' Association introduced Mary Barlow Wilkins, president of the association, who spoke for Mary J. Woodward, donor of the bronze table placed on the bridge in memory of Woodward's father, Sherry Ross, first settler on the island bearing Ross's name. Bishop W.T. Sumner made the invocation, with christening of the bridge with "pure water" by Rosina Corbett, the latter age seven. Ceremonies began on the east approach at 2 p.m.[70]

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 sign a contract to design the last bridges of his long career when it was really designing a bridge across the Hudson River in New York City that interested him most.[71] It does appear Lindenthal was called to Portland rather than calling Portland, according to an entry in the Commissioners Journals, "Ross Island and Burnside Bridges," dated 16 June 1924[72]

The following communication was received from Gustav Lindenthal, Pennsylvania Station,

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[70] Files, Yeon facilities; "Ceremony to Open Ross Span Today," *The Oregonian*, 21 December 1926, n.p.

[71] Lindenthal's preoccupation with a bridge across the Hudson is well documented. When the writer spoke with Lindenthal's daughter, Franziska Gebhardt, at her home in Germany by telephone on 15 November 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 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 by Princeton professor David B. Billington. For Lindenthal's brief but factual biography, see Eric Delony, "Gustav Lindenthal," *American National Biaography,* 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 nineteenth and early twentieth century, waits to be written.

[72] Commissioners Journals, 16 June 1924, 254.

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 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."[73]

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."[74] 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.[75] On 9 June 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 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

[73] 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.

[74] 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.

[75] For more about Steinman in Portland, see Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Addendum to St. Johns Bridge," HAER No. OR-40.

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).[76]

On 4 June 1924, Lindenthal signed his first contract with the newly appointed Board of Multnomah County commissioners. He agreed to examine the H&K 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.[77] The Board entered Lindenthal's qualifications in the record on 9 June, as noted above, with Lindenthal arriving in Portland on 20 June, staying at the Benson Hotel on S.W. Broadway. On 9 July, H&K, in exchange for $25,000, signed a release of contract with Multnomah County. On 11 July, 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 21 July 1924, upon Lindenthal's recommendation, Multnomah County contracted with Pacific Bridge to take down the draw of the 1894 Burnside, two of its steel girder spans 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 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,

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[76] Commissioners Journals, 9 June 1924, 251.

[77] One other mention of an assistant comes from the Commissioners Journals, 21 July 1924, 283. 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..." 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, but Lindenthal's drawing for Ross Island that exists at Central Library shows "Gustav Lindenthal. New York, 6 October 1924," and stamped "Issued 15 October, 1924, Gustav Lindenthal,"

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.[78]

As part of H&K's termination agreement with the county, H&K 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). Lindenthal took over both team and office the same date he signed his contract with the county, 11 July 1924.[79]

In his 7 July 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 H&K, with some modifications.[80]

In 1926, after construction was finished on the Sellwood Bridge and well under way on Ross Island 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.[81]

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[78] Commissioners Journals, 21 July 1924, 283. The clipping Lindenthal refers to was not made part of the public record.

[79] Commissioners Journals.

[80] Commissioners Journals, 11 July 1924.

[81] During the same bond election held 2 November 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 bond for a bridge at Interstate Avenue (40, 331 votes against, 30, 570 for). The Interstate Avenue Bridge would have been near the location of the extant Fremont Bridge, opened in 1973 at river mile 11.7. "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 Cle rk," 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 Hendrick, 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

In addition, Lindenthal signed 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.[82]

Design and Construction Chronology

Based largely on reports entered into the bridge journals of the Multnomah County Board of Commissioners, the following is an account of the design and construction of the Ross Island Bridge, the last to open of Lindenthal's three bridges across the Willamette River. These three projects were running simultaneously during much of Ross Island's construction. (Refer to previously listed Plate 3, "Consultant and Contractor History.")

On 11 July 1924, Lindenthal signed a contract to complete design of the Burnside Bridge, to redesign Ross Island and Sellwood, and to supervise construction of all three bridges.[83]

On 17 September 1924, the Board received a letter from Lindenthal in New York reporting on progress on the three bridges. He said that Ross Island and Sellwood both were being redesigned as continuous truss bridges (as Sellwood was actually built):

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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.

[82] 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 November 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 Braodway, see Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Broadway Bridge," HAER No. OR-22. Lindenthal's Lovejoy Viaduct opened in 1927 and remained in service until it was closed 30 July 1999 and razed soon 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 November 1926. Lindenthal's estimate for construction of the Lovejoy Viaduct and reconstruction of Broadway was $920,000, about half as much as the cost for a new bridge at Ross Island.

[83] Commissioners Journals, Ross Island and Burnside Bridges, vol. 1, 11 July 1924, 270.

> The redesigning of Ross Island and Sellwood bridges is under way to bring their cost within the appropriation for some. There will be in both bridges continuous steel girders [trusses] for the superstructure. They will save falseworks in erection and give more rigid structures. As their computation and design requires more time than ordinary trusses, I will not wait till these are completed, but am preparing to invite, as soon as possible, tenders for the approaches, foundations and masonry for the river piers of both bridges ahead of the steel work, for which separate tenders can be afterwards invited directly from the bridge works as being the more economical method anyway. I enclose a diagram showing on distorted scale the change of grade over the two bridges.[84]

On the same day (17 September), J.P. Newell reported on the question of substituting a low-level bridge at Ross Island for the high-level arch bridge originally proposed by H&K. With a channel sufficient for sea-going vessels, the Southern Pacific Railroad and others upriver of the Ross Island Bridge situated to benefit by the transfer of goods from rail to ship were not happy with the idea of impeding navigation by a low bridge, thereby closing navigation upriver to large vessels. The clearance required by the U.S. Army Engineers at the time was 135'. A bridge at this height would cost "approximately a quarter of a million dollars more than one at a height sufficient only to clear river traffic."[85] In order to determine whether development might better take place farther down river, Newell had made a survey of the harbor from the bridge site to all the riverfront south of Guild's Lake and Mock's Bottom. He reported that although Portland had been a seaport for three-quarters of a century, less than half of the eight and one-half miles of frontage covering the business section of the city was being used for shipping at that time. He also compared Portland harbor to the harbors of New Orleans and Philadelphia, recommending that a bridge at Ross Island be built without provision for passage of deep-sea vessels.[86]

On 22 September, the Board ordered a bond election to fund Ross Island and Sellwood bridges an additional $500,000.[87] (Bonds for $1,600,000 had been approved by the voters in November of 1922.)

Also on 22 September 1924, the Board received two letters regarding design of the Ross Island Bridge. One was from Leonard Marshall of Portland asking for adequate clearance for pile driving barges with heights up to 85' above water. The other was from the East Side Business

[84] Commissioners Journals, 17 September 1924, 328.

[85] Commissioners Journals, 17 September 329; Report on Ross Island Bridge Low Level vs. High Level," J.P. Newell, nd.

[86] Commissioners Journals, 17 September, 331.

[87] Commissioners Journals, 22 September, 333.

Men's Club recommending either a high bridge with 135' clearance or a low bridge with a draw or lift span.[88]

The Board heard more on 22 September about the height of Ross Island: An official "Committee of Engineers," including Laurgaard and Newell, submitted its report. The report recommended application for a bridge with a minimum clearance of 120' above low water, and for a channel width of 100'. They listed three alternatives, a low bridge with a draw span; a fixed continuous truss bridge with a clearance of 120', a maximum grade of 3.8 percent, and an estimated cost of $2 million; and a fixed bridge similar to the preceding, "except for a cantilevered arch truss over the channel span, with the same clearance, but with the floor lowered about 12 feet, reducing the grade to 3 percent." The latter structure would cost $1,950,000. Note: This is the first mention in the records of a cantilevered arch truss. There is no indication of who initially proposed this design concept, which was eventually used for the Ross Island Bridge with some changes in dimensions.[89]

On the same day, 22 September 1924, Lindenthal's resident engineer Rode also submitted a report on the study by the "Committee of Engineers," made up of city, county, Port of Portland and Dock Commission officials.[90] Apparently he was a member of the committee. He said: "The report of the committee has not been signed by me, because I hold a somewhat divergent view; In my opinion, the immediate necessity of 100 clearance above a 20 foot flood stage has not been shown." Rode's report included a cost estimate of $2,000,000 for a bridge that would give 120' clearance, but not including the cost of water mains. Rode agreed with Laurgaard that a movable bridge should be excluded.

Rode's report also commented on the cantilevered arch truss concept, "a bridge with curved bottom chords, so as to reduce the truss depth over the channel span." He acknowledged that this design would improve grades with a slight reduction of cost. However, he also noted that, "This advantage is secured at a considerable sacrifice of appearance, and the bridge would not possess the desirable stiffness." Rode concluded that the best solution might have to be a continuous truss deck bridge with parallel chords, "even if a grade of 4% cannot then be avoided. In any case, it is impossible to construct a really satisfactory bridge within the present Port and Government requirements." Rode's cost estimate for the continuous truss concept included six 25'-deep steel

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[88] Commissioners Journals, 22 September, 336-337.

[89] Commissioners Journals., "In the Matter of Report of Committee of Engineers on Height of Ross Island Bridge," 22 September 1924, 337-338

[90] "Across the Willamette-Seventh of Ten Parts, City's First Two "High Bridges' Opened Southeast Region," Jack Ostergren, *Oregon Journal,* 9 July 1968, 3M.

truss spans, each 267' in length. This design would have been very similar to the Sellwood Bridge. As noted earlier, Rode's cost estimate for this design was $2,000,000.[91]

On 24 September 1924, Rode submitted another report to the Board with cost estimates for four more alternatives for Ross Island. Alternate I, estimated at $1,690,000, was for a six-span deck truss structure similar to the one in his report of 22 Sept., but with clearance reduced from 120' to 80'. Alternate II, estimated at $1,947,000, was similar to Alternate I, with provisions included for adding a lift span later in place of one of the fixed spans. Alternate III, estimated at $2,127,000, was the same as Alternate II, but with the lift span installed at the time of original construction. Alternate IV, estimated at $1,865,000, was essentially a repeat of the 22 September estimate, but without allowance for engineering costs and contingencies. Rode ended this report with a recommendation for Alternate I – continuous truss spans with 80' clearance – based on "economy, usefulness and appearance."[92]

Rode's reports of 22 and 24 September 1924 show that he himself was not giving serious consideration to the cantilevered arch truss idea for Ross Island. However, it appears that Lindenthal was already shifting interest to the cantilevered truss. On 24 September, Lindenthal sent a telegram from New York, informing the Board he had that same day sent a letter and plans for a high Ross Island Bridge, and asked the commissioners to take no action until they had his plans.[93]

Lindenthal's letter was entered into the journal on 29 Sept. While Lindenthal did not refer explicitly to the cantilevered arch truss, his description and later developments indicate that this was what he was talking about. He stated that because of the opposition to a bridge with 80' clearance, he intended to "recast" the plan, and enclosed a diagram (not found by the writer). He intended to retain the same location for the river piers as in the old design, except removing one pier, thereby giving the advantage of a wider channel and a clear height of 135' at the center, a clear height of 120' for a width of 200' feet and 80' feet clear for a width of 400'. He stated that the proposed plan would have "a symmetrical, pleasing appearance, and be an architectural asset to the city." It would also have the advantage of being erectable without falsework. He promised to have cost estimates to the commissioners by 10 October 24, and asked that they postpone any decision until his report is received.[94]

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[91] Commissioners Journals, 22 September, 338-339. The final vote of the bridge committee was 15-1 for a high bridge with no draw span. Ostergren, "Across the Willamette."

[92] Commissioners Journals, 24 September 340-343.

[93] Commissioners Journals, 24 September, 343.

[94] Commissioners Journals, 24 September, 343-344.

By the last of October 1924, the Board ordered a final payment of $2,500 to Ira Hedrick and Robert Kremers for a total payout of $25,000 for release from their contract.[95]

The Board entered a resolution showing that the bond election of 4 November 1924 passed. Of 106,000 votes cast, 66,832 were in favor of the bonds.[96]

Bids for Ross Island had not been let by the end of the year, and various improvement clubs in Southeast Portland were writing to the Board urging action.[97]

In early January 1925, the Associated Industries of Oregon recommended that the Ross Island Bridge be constructed entirely of concrete. The letter cited 11 reasons, among them the fact that "steel bridge construction has been almost entirely abandoned by the Oregon State Highway Commission."[98]

As a result of the lobby for a concrete bridge, rather than a steel bridge, the manager of the structural bureau of the Portland Cement Association of Chicago asked to call on Lindenthal in person in New York to place "arguments in behalf of the construction of a concrete bridge." Lindenthal met almost immediately with the representative, afterwards sending a report to the Board. "The result of our conference was a complete agreement that the proposed steel structure in this case is preferable to a concrete masonry arch bridge, because of much lower cost." The representative also reported to the commissioners, ". . . my report of the situation is that Multnomah County, Oregon, is well advised in its bridge problems. Instead of being opposed to concrete, I found Mr. Lindenthal a real booster for concrete bridges. . . ."[99]

Also in January 1925, Newell reported to the commissioners with a blueprint showing the proposed west approach to the Ross Island Bridge. The plan stayed with the earlier plans proposed for the H&K design, namely: the diversion of northbound highway traffic under the west approach and provision for traffic from the industrial district on Macadam Street to reach the bridge on grades not exceeding five percent. This proposal changed former plans in that the bridge proper would end at Hood Street with an embankment from there to Kelly Street where a 50' viaduct would carry the traffic over Pacific Highway. The blueprint [not attached] omitted the future highway and reportedly showed only the work required at that time. Newell noted that the roadway under the approach and

[95] Commissioners Journals, 29 October, 367.

[96] Commissioners Journals, vol. II, 31 December 1924, 4.

[97] Commissioners Journals, 22 December, 397. Both the Sellwood and Burnside bridges were under construction at this time, with negotiations in process for the approach right-of-way for Burnside.

[98] Commissioners Journals, 12 January 1925, 8.

[99] Commissioners Journals, 12 January 1925, 11. The persuasive and reputable Lindenthal was earning his fee. The last thing the commissioners wanted was a lobby that might have slowed the construction of Ross Island.

the diagonal street from Kelly to Corbett did not need to be built until the improvements were made further south that "required making Kelly Street suitable for highway traffic." Newell also reported, "It is desirable that Corbett Street be widened as far as Porter at the present time so that both streets may serve to carry traffic to the bridge without undue congestion." The plan also provided for the leveling of the intersection between Corbett and Porter in order to remove the danger then existing from sloping pavement.[100]

On 5 February 1925, a public hearing for Lindenthal's revised plans for the Ross Island Bridge was held at the Customs House. Even before the hearing, Lindenthal instructed the Board to make application to the War Department for a permit to construct the Ross Island Bridge per his design.[101]

A few days later, the Board noted that Rode had submitted a letter approving Portland Gas & Coke Co.'s permit to place gas pipes on both the Ross Island and Sellwood bridges, with the mains to be carried across Ross Island's steel spans.[102]

In March 1925, another delegation appeared before the Board inquiring into the status of the Ross Island. Nothing could be done until the approval of the plans by the War Department, and the county was still negotiating with the city regarding the city's proposal to use the bridge for its water mains from Bull Run.[103]

Rode next submitted two blueprints of a sketch sheet that had been dated 23 January 1925, showing the layout of the west approach to the bridge [not shown]. The Board ordered the blueprint filed until it was time to make a formal request to the City Engineer to acquire the necessary right-of-way.[104]

In March, City Engineer Laurgaard wrote that the city couldn't proceed with acquiring right-of-way until it knew the location of the approaches. M.E. Reed, Ross Island's principal assistant engineer, submitted a correct copy of the description for the right-of-way to be acquired for the west approach.[105]

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[100] Commissioners Journals, 21 January, 15.

[101] Commissioners Journals, 26 January 15-16; 2 February, 18.

[102] Commissioners Journals, 9 February, 22. The gas company eventually withdrew its request to run mains on Ross Island, citing carrying costs as too high. Ibid, 16 March, 29.

[103] Commissioners Journals, 2 March, 26.

[104] Commissioners Journals , 9 March, 27.

[105] Commissioners Journals, 27 March 34; 6 April, 35. The right-of-way legal description is included.

In April, the Board noted approval from the U.S. Army Corps of Engineers for the revised plans for Ross Island.[106]

Also in April, the Board entered the petition of citizen Kenneth Brown to make provision in the plans for the building of a ramp or inclined approach from the Ross Island Bridge to its namesake island. Brown said in his letter, "Inasmuch as an urgent request has been made to the City Council of Portland to purchase Ross Island for a public park and recreation resort...." Rode responded to the Board, "Such a connection can hardly be recommended because it would greatly disfigure the bridge and interfere with traffic. Besides, the connection would be very costly on account of the great height of the bridge. Even with a 5% grade, it would require a ramp more than two thousand feet long to get down."[107]

On 24 April 1925, the Board entered an order approving the printed specifications for the construction of Ross Island Bridge, as prepared by Lindenthal. The detail plans consisted of 36 sheets, numbered consecutively L1 to L36, inclusive, with the plans filed at the County Clerk's office that same date. As part of the order, bids were called for. Copies of the plans could be picked up from Lindenthal's field office at 250-1/2 Third Street, Portland, by paying $100 deposit, $60 to be refunded to the unsuccessful bidders.[108]

In May, Rode submitted the description for the right-of-way required for the west approach across the property owned by the OWR&N Co., east of Moody Street.[109]

The bids for Ross Island construction were opened on 26 May 1925 and turned over to Rode for tabulation. The Board was notified within a few days in a letter from Lindenthal that the work would be let in two contracts, the lowest bidder Booth & Pomeroy of Portland for the main river spans, and Lindstrom & Feigenson of Portland for the approaches. The Booth & Pomeroy bid was $1,135,843, about $93,000 lower than the next lowest bidder, Gilpin Construction Co. The Lindstrom & Feigenson bid was $505,550, about $14,000 lower than the next lowest bidder, Grant Smith & Co. The combined Booth & Pomeroy and Lindstrom & Feigenson bid total was $1,642,393. Contracts were soon signed.[110]

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[106] Commissioners Journals, 13 April, 46-47. Apparently, two plans had been submitted to the U.S. Army Corps of Engineers, one dated 20 January 1925, and a second, dated 20 March, 1925.

[107] Commissioners Journals, 20 April, 49, and 27 April, 57. Ross Island, the land mass, would finally be turned over to the city, in a much altered condition, and not until early in the next millennium.

[108] Commissioners Journals, 24 April, 55

[109] Commissioners Journals, 6 May, 62.

[110] Commissioners Journals , 28 May, 73-74; 29 May, 76-77; 8 June, 79.

Easements were granted about this same time from the Portland Electric Power Co. across its property at the east approach of Ross Island Bridge and at Sellwood Bridge.[111]

In the middle of June 1925, Lindenthal signed another agreement with the County Commissioners, increasing his contract for the three bridges from $117,000 by an additional $27,000. This was to cover the $500,000 bond increase.[112]

Two days later, the Board entered a letter from Lindenthal stating that Rode was going to be gone during the months of July and August. Engineering work during that time was allotted as follows: M.E. Reed, Assistant Engineer, to have general supervision of the construction work for the Burnside and Sellwood bridges. Reed was also in charge of surveys for three sites for proposed bridges to be located between the Broadway Bridge and St. Johns. Kurt Siecke, Assistant Engineer, was being put in charge of office work and the Ross Island Bridge.[113]

Toward the end of June, Rode approved the easements from the Oregon Electric Company for crossing of tracks on Hood Street and from the United Railways Company for crossing its tracks on Macadam Street, both under the west approach of Ross Island.[114]

Also in June, the Board received a letter from Rode stating that the location of the Thomas Creek Sewer on Woods Street was interfering with the construction of the footings of Ross Island for a distance of about 500 feet east of Moody Street. Rode recommended that the sewer be reconstructed from a point on Moody Street, and that the Woods Street gulch sewer be extended to connect with the newly located sewer. Rode was to negotiate with Lindstrom & Feigenson for the sewer construction, to be performed under its "Extra Work" clause, or under a special contract.[115]

Approaches for the Ross Island Bridge continued to be a community discussion during the summer of 1925. The president of the South Portland Improvement Neighborhood wrote the Board, noting that the group had met with A.L. Barbur, then Commissioner of Public Works, and City Engineer Laurgaard regarding approval of the plans for "an adequate west side approach" to the Ross

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[111] Commissioners Journals, 25 May, 71.

[112] Commissioners Journals, 15 June, 84.

[113] Commissioners Journals, 17 June, 85.

[114] Commissioners Journals, 22 June, 86.

[115] Commissioners Journals, 24 June, 91. The relocation of the Thomas Creek Sewer on Moody and Woods streets and a 30-inch connecting sewer on Woods Street, were awarded to low bidder J.F. Shea Co. ibid. 1 August, 123.

Island Bridge. The letter notified the Board the group was calling for "a mass meeting at the Failing School . . . to support plans for adequate approaches."[116]

Houghtaling & Dougan Architects dissolved in May 1925, and Rode submitted a letter to the Board asking if he was supposed to be making payments to Houghtaling alone. The architect's contract, for $10,000 total, had been half paid by this time, with $250 a month to be paid after the Burnside and Ross Island contracts had been let until the contract was completed.[117]

In July 1925, a delegation of property owners from South Portland appeared before the Board about the west approach of the Ross Island. Various property owners were opposed to the diagonal cut for the west approach to the bridge, stating that they wanted Woods Street from Corbett Street to Front Street instead. The Board advised the group that the location of the approach was not a county matter, but rested with the city through the City Planning Commission. (See Plate 7, photograph of "West Approach (as Built) Ross Island Bridge") Later, a petition was presented to the Board by Coast Steel & Machinery Co. for a ramp or viaduct to be constructed at the west end of Ross Island Bridge to open a street and access to the property under the west end of the bridge to be called South Harbor Way.[118]

In August, Siecke reported on cost for a proposed ramp. The total, $10,500, included changing the struts, increasing the width of the bridge deck, building a stairway from Moody to the deck, and widening the deck for a proposed bus stop. Siecke commented, "When one considers the advisability of modifying the bridge plans in accordance with the desires of the petitioners, it is well to remember that this district is only very little developed at present, that prosperous industrial plants do not spring up over night, and that the proposed use of the Ross Island Bridge for heavy trucking will result in impeding the rapid flow of light vehicular traffic for which the bridge is primarily intended."[119] Newell proposed a ramp in early January 1926, with a proposal to build the ramp on Grover Street. The last notation on the matter was the end of January, when the Board approved Rode's recommendation to use Newell's design that allowed egress and ingress to 8,000 feet of south harbor river frontage. Rode reported it would be desirable to have the project completed at the same time as the bridge and the north and south arterials were completed.[120]

In July 1925, Southern Pacific submitted an agreement to the Board for an easement across

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[116] Commissioners Journals, 29 June, 96.

[117] Commissioners Journals ,. 6 July, 105, and 27 July, 114.

[118] Commissioners Journals, 6 July, 106 and 3 August, 125-126.

[119] Commissioners Journals, 31 August, 158-159.

[120] Commissioners Journals, 4 January, 210; 11 January, 211; 13 January, 212; 20 January, 218-219.

its right-of-way on Moody Street.[121]

During the summer of 1925, the underwater foundation work was being done by Pacific Bridge Co., with Pier 6 and Bents 25 and 26 underway near the east shore of the river. Booth & Pomeroy had to do extra drilling at the site of Bent 26 to determine the ability of the river bottom to support the load of the pier. Siecke, in charge during Rode's absence, wrote to the Board informing them that the right of way for the east approach of the Ross Island Bridge had been purchased and wanted to get the contract started. Siecke also reported with the estimate for the cost of constructing Bent 26, explaining that it was necessary to carry the base of Bent 26 down to elevation –35', increasing the footing thickness to 20' and omitting the piling.[122]

In early August, the District Attorney approved assignment from Booth & Pomeroy to United States Steel Products Co., Pacific Coast Dept., for $475,000 for the purchase of structural steel for the Ross Island Bridge. [The contract was signed with United States Steel, with American Bridge doing the fabrication. American Bridge was then a division of United States Steel.][123]

Under its sub-contract with Lindstrom & Feigenson, Parker-Schram excavated for footings for Bents 1 to 23, built the concrete footings for Bents 1 to 23, and constructed precast concrete balusters for the bridge's railing, for approximately 2967' of rail at $4 per cu. foot, and also constructed 34 precast concrete lampposts at $4 each. On the east approach, they excavated for footings for Bents 27 to 29, built the concrete footings for Bents 27 to 29, and constructed reinforced abutment and concrete wall, of about 416 cu. yards. They also precast the concrete railing balusters for about 1183' of railing, and constructed 13 lamp posts, for the same price as the west side. In addition, they excavated to elevation –33' for Pier No. 1 at the west end of the main river spans, and placed about 1293 yards of concrete. Last, Parker-Schram placed all reinforcing steel in footings for Bents 1 to 23 inclusive, for Bents 27 to 29 inclusive, and for Pier No. 1, approximately 43 tons at $10 a ton.[124]

Bills submitted by Booth & Pomeroy for work on the main river spans during the month of August 1925 were approved by Rode and submitted to the Board, as were the statements of Lindstrom & Feigenson for the approach work.[125] In November, an easement agreement was executed with the Southern Pacific Railway Co. for right-of-way over its Newberg Branch for

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[121] Commissioners Journals, 8 July, 107.

[122] Commissioners Journals, 15 July, 109; 20 July, 110; 27 July, 117.

[123] Commissioners Journals, 5 August, 127.

[124] Commissioners Journals , 10 August, 132.

[125] Commissioners Journals , 14 September, 163 and 164.

construction of Ross Island.[126] A bill from the Port of Portland for rock delivered at Ross Island to be used as riprap around the bridge piers was approved and submitted by Rode.[127] Also in November, the Board drew on the Ross Island Bridge fund to pay $13,100 to the City of Portland, the county's share for right-of-way and widening of S.W. Woods Street for the bridge's west approaches.[128]

In February 1926, Rode submitted an estimate of total cost for Ross Island. In addition to the contract for the main river spans and three approaches, in the amount of $1,641,393, engineering was estimated at $3,433.48 (J.P. Newell), $42,944 (H&K), $111,516.87 (Lindenthal preliminary report, travel expenses and engineering fees), and $3,478.26 (Houghtaling & Dougan Architects). With extra work, which included relocating Thomas Creek sewer, right-of-way for Woods Street, additional struts at Pier 27, replacing lighting system with a series lighting system and 12 additional lamp posts, and other items, Rode estimated the total cost for Ross Island to be $1,940,000.[129]

Approaches were still a huge topic of discussion as late as May 1926. Rode and Laurgaard made a joint report to the Board, adopted by both the Board and City Council. The cost of completing the approach on the east side, from the west line of 7th to the east line of Grand Avenue, was about $28,000, that cost to be paid by Multnomah County. The County agreed to contribute almost $17,000 to the fill and connection to Corbett Street on Ross Island's west side, and to depress Grand Avenue, estimated to be about $9,400. The city agreed to pay a claim to homeowner Huthman for loss of property, in the amount of $2,772. It was agreed that the city would construct an artery from the west end of the bridge to connect with Front [now S.W. Naito Parkway] and First on Arthur Street. Part of the funding was to come from a May 1926 primary election. Powell was to be widened 90' from S.E. 7th to Milwaukie Ave., and to be widened 80' from Milwaukie Ave. to S.E. 50th. The election would pay for widening Powell to 60', with the remainder to be paid by local assessment.[130]

By June, four bids had been received for completion of the east approach to Ross Island, including the depression of Grand Avenue, with Parker-Schram the low bidder at $25,840, and Lindstrom & Feigenson second low at $26,584.50. Rode recommended the contract be awarded to Parker-Schram, and a contract was signed.[131]

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126 Commissioners Journals, 9 November, 186.

127 Commissioners Journals, 12 November, 195.

128 Commissioners Journals, 25 November, 195.

129 Commissioners Journals, 23 February 1926, 240-241.

130 Commissioners Journals, 5 May, 262-263; 10 May, 263-264; and 12 May, 265-266.

131 Commissioners Journals, 10 June, 285; 28 July, 290.

In August 1926, City Engineer Laurgaard notified the Commissioners that one or more of the piling for the falsework for the west approach to Ross Island had broken a 10-inch city sewer, causing sewage to run over the surface of the ground in Woods Street gulch. The matter was turned over to Lindenthal's office.[132] About this same time, Lindenthal sent a letter to Lindstrom & Feigenson, with a copy to the commissioners, about the slow progress of work on Ross Island. "I wish to call your attention to the very small force at work on the Ross Island Bridge. I find no reinforcing steel workers at all working on the deck of the east approach and only a small gang placing steel in the columns. The forms are in place for several hundred feet ready for placing the reinforcing steel of the deck, but none being placed." Lindenthal's letter insisted Lindstrom & Feigenson increase its work force "at once."[133]

The Board received a letter from the International Hod Carriers and Building Laborers' Union in September. The union complained that Lindstrom & Feigenson was paying $3.50 a day for bridge laborers, instead of $5.40, the prevailing day rate.[134] The commissioners turned the matter over to Reed, in charge during one of Rode's trips to Norway. Rode responded to the commissioners with a letter showing a list of interviews he had conducted with ten contractors to determine the prevailing wage scale for laborers. He noted that Pacific Bridge Co. was paying $5.40 or better for all labor on the Burnside and Ross Island bridges, and that Parker & Banfield was paying $5.40 minimum on the Ford Street Viaduct and $5.50 for work for the Gas Company. Rode concluded, "The fact seems to be that practically all contractors doing building work are paying $5.40 per day or better for labor, no matter what work the laborers are doing. . . ."[135] The County District Attorney ruled Lindstrom & Feigenson were required by its contract with the county, per Paragraph 37, General Provisions, to pay $5.40 per day. The Board ordered Rode to require the contractor to comply, and that the bonding company be notified.[136] Attorney B.A. Green, representing the laborers, filed a letter dated 2 December 1926 with the commissioners. Green wanted the county to withhold payment to Lindstrom & Feigenson until accounts with the laborers were settled. A letter from Green was entered in the Board minutes in January stating that Lindstrom & Feigenson and their sub-contractors had complied with the order, and that he wanted his objections rescinded. "I feel that I should inform you that every courtesy that could be shown was done so by Lindstrom

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[132] Commissioners Journals, 9 August, 296.

[133] Commissioners Journals, copy of letter from Gustav Lindenthal to Lindstrom & Feigenson," 9 August, 296.

[134] Equivalent laborers make about $30 hour (including fringe benefits) in 2001, or about $240 a day, nearly 45 times the 1926 rate of $5.40 per day. "Hourly Union Pay Scales, December 2000," *Engineering News-Record,* 18 December 2000, 122.

[135] Commissioners Journals, 13 September, 302-303; 4 October, 311-312.

[136] Commissioners Journals, 20 October, 314.

& Feigenson. They not only opened their own books to me for re-checking, but also assigned their chief engineer to check the records of each sub-contractor and had checks prepared accordingly. Particularly, it has been due to Mr. Feigenson that a speedy adjustment has been brought about in this case.[137]

Bridge approach construction prompted complaints for other loss of private property, including Benjamin L. Davison, 564 E. 6th St., Portland. Davison wrote the commissioners asking for compensation because "an old mansion located on lot 3, block 5 Raffety's Addition" lost 4' by 104' across the south side of its lot." The letter stated that the approach retaining wall, running west and seven to ten feet in height would "completely close up East 6th Street in front of the residence." The commissioners referred the matter to Reed. Later entries in the Commissioners Journals show that Davison had originally negotiated a right-of-way payment of $252 for the loss of the 4' x 100' section, and that it was the Board's opinion this additional claim was no longer a matter for the county, but one for the city.[138]

Also in September, Laurgaard notified the commissioners that the city had awarded a contract for the west approach fill work from the west end of the bridge to Corbett Street to low bidders Edlefsen-Weygandt, the contract in the total amount of $146,365. The opening of Ross Island Bridge was only three months away. By law, the city could not proceed with the work for 30 days, the remonstrance period; however, the city passed an emergency ordinance to allow the contractor to begin immediately on the fill work. This would give the material -- to be excavated from the Willamette River -- chance to settle some before the pavement was laid. Laurgaard asked the county to immediately honor its agreement to pay its contribution of $16,942 toward improvement of Corbett Street so that Edlefsen-Weygandt could begin. The commissioners ordered a warrant drawn immediately.[139]

Periodic tests of Ross Island's cement were carried out. Bills from Dr. E.W. Lazell showed sampling and testing 4004-1/2 barrels of Haccourt Portland Cement at a cost of $120.14 in September, and 3,414 barrels in October. Bills for tests performed through November on an additional 12,400 barrels were submitted in December.[140]

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[137] Commissioners Journals, 12 January 1927, 341-342.

[138] Commissioners Journals, 15 September, 304-305; 20 September, 308; 27 September, 342.

[139] Commissioners Journals , 15 September and 20 September, 306. The Edlefsen-Weygandt contract mentioned in the Commissioners Journals in the amount of $146,365 was not located during this study. However, a microfilm of the contract to begin the work, in the amount of $16, 942. 90, or Multnomah County's contribution toward the completion of the approach fill to Corbett Street, is located at the City of Portland's Stanley Parr Archives. See "#2184, Contract and Bond of Edlefson Weygandt Co. re const. of Corbett Street, per Ord. #50406," 23 September 1926, by George Baker (for the city) and P.T. Edlefson.

[140] Commissioners Journals , 20 September, 309; 13 October, 312; 15 December, 327.

The biggest event in September 1926 was the closing of the cantilever ends of the bridge.[141]

In October, the city of Portland conducted compression tests of Ross Island's concrete prisms, and sent bills for repair of the sewer at Kelly Street, total for both $119.97. The city also charged $57.40 for "relaying and lowering house branch at southeast corner of Grand Avenue and Brooklyn," which included labor and service.[142] The contractors and subs were also being paid during this time, in somewhat greater amounts. Rode submitted estimates as of 10 December for work on the bridge and approach work, as follows, with the Board ordering full payment[143]:

Booth & Pomeroy, 18th partial estimate	$398.05
Pacific Bridge, 15th partial estimate	$14,104.41
Lindstrom & Feigenson, 18th partial estimate	$20,577.56
Parker-Schram, 4th partial estimate	$10,128.05

In January 1927, the Department of Public Works submitted a bill for patch paving for Ross Island at Grand Avenue, Brooklyn, Woodward and East Sixth streets in the amount of $78.[144]

Also in January 1927, a letter from Lindenthal was entered into the Board minutes requesting $30,000. "All the three bridges, Sellwood Bridge, Burnside Bridge and Ross Island Bridge, having been completed, I request final payment for my engineering services under my contracts of July 11, 1924, and June 14, 1925, as per enclosed bill. If you could do so before January 15th, it would be a great accommodation in that it would enable me to pay off by that date my indebtedness incurred for this work." Payment could not be made per Lindenthal's request, because District Attorney Myers was then in Washington, D.C., but payment was authorized by the Board per order entered 31 January.[145]

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[141] Copy of letter from Hans Rode to Gustav Lindenthal, 22 September 1926. Files, Multnomah County Yeon facilities.

[142] Commissioners Journals, 13 October, 312-313.

[143] Commissioners Journals, 15 December 326-327.

[144] Commissioners Journals, 10 January 1927, 339-340.

[145] Commissioners Journals, 12 January, 340-341; January 345-346. The entry noted that in the contract of 11 July 1924, the county agreed to a fee of $119,000 for work on Burnside, Ross Island and Sellwood bridges, with $106,000 already paid out and a balance due of $13,000. Under the 14 June 1925 contract, for additional work for Ross Island and Sellwood bridges, the contract was for $27,000, of which all but $17,000 had been paid, leaving a total due, as per Lindenthal's figures, of $30,000. Another bill by Lindenthal, Room 738, Pennsylvania Station, New York City, was submitted at this same time, for professional services under an agreement signed 15 November 1926, for $4,000. It , too, was ordered paid. ibid.

In mid-January, Myers recommended payment for the final estimate to Parker-Schram in the amount of $4,918.50 for work on east approach fill and regrade.[146]

Also in January, the War Department requested the county to remove obstructions between the two main river piers of Ross Island. A letter from R.T. Coiner, District Engineer, Portland, said that sweepings of the channel between the piers found an obstruction thought to be a pile at a depth of seven feet below low water at a point 20' west of the face of the east channel pier and ten feet downstream from the pier. The letter also said what appeared to be a cofferdam was found at about ten feet out from the east face of the west pier at a depth of eight feet below low water, extending up and downstream for the full length of the pier.[147]

No bills for Ross Island show up again in the Commissioners Journals until April 1927, when Rode submitted a letter to the commissioners that approved bills from Lindstrom & Feigenson for construction and lighting the safety island at the west end of the bridge per an agreement of 7 December 1926. The safety island cost $915, with $431.11 charged for "changing location of and building curb around safety island."[148]

Rode submitted a statement of expenditures for Ross Island Bridge as of 20 July 1927 showing expenditures of $1,937.468.44. This money came from two different funds.[149]:

City Planning Commission, Newell	3,433.48	
Hedrick & Kremers	42,944.00	
G. Lindenthal	46,939.39	
		93,316.87
Houghtaling & Dougan		3,489.15
E.W. Lazell, cement testing		1,318.91
Preliminary investigations (borings, etc.)		7,984.00
Lindstrom & Feigenson		453,194.41
Booth & Pomeroy (incl. Pacific Bridge and Bank of California)		497,148.51
Pacific Bridge (Booth & Pomeroy Contract)		139,264.76
U.S. Steel		305,736.44
Parker-Schram		30,776.82
J.F. Shea		9,158.24

[146] Commissioners Journals, 17 January, 343.

[147] Commissioners Journals, 19 January, 344.

[148] Commissioners Journals, 27 April, 354.

[149] Commissioners Journals, 1 August, 360-364.

Jaggar-Sroufe, changes to lighting	4,613.20
Lindstrom & Feigenson, safety island and ornamental lighting post	1,346.11
Independent foundry	140.00
Portland Electric Power, lamps	142.05
Portland Wire & Iron Works, transformers	1,070.00
Pacific Bridge, extending expansion joints and welding expansion plates	158.60
J.C. Bayer, filling expansion joints	59.75
A. Garrow, painting traffic strips/downspouts	314.00
Ryner & Porter, replacing handrail	491.91
Jacob Losli, covering roofs of buildings	460.75
Port of Portland, rock for riprapping	10,569.00
City of Portland, adjusting manholes, water service, sewer repair	281.32
Oregon Brass Works, bronze nameplates	165.00
Jones Lumber Co., lumber	11.40
Inman-Poulsen Co., lumber	48.55
Zoss Ladder Works, ladder	8.05
Muirhead & Muirhead, plumbing	83.21
City of Portland, landscaping east end of bridge	1,000.00
East Side Transportation Co., hauling	6.00
A. Destourdore, labor	85.05
County's contribution to Corbett Street Approach	16,972.90
County's share of right-of-way (Woods)	16,528.50

The last entry in the Commissioners Journals for Ross Island Bridge takes up the matter of a letter from A.L. Barbur, writing as City Commissioner of Public Works, in reference to the traffic circle around the safety island at Ross Island's west approach. "Since the completion of the bridge it has been my custom to travel over same in going to and from my home, and I have discovered that this circle has taken up more room than is convenient for the purpose of regulating traffic." Barbur wanted the circle removed.[150]

Lindenthal Design Team

[150] Commissioners Journals, 10 June, 367.

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 Ross Island, Burnside and Sellwood 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 H&K drawings are the same names that appear on the final drawings for Ross Island, Burnside and Sellwood and other drawings, after H&K 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 were finished and dated, and January 1927, when the final detail drawing was finished and dated for Ross Island, this team produced 93 tracings, 31 for Sellwood, 18 for Burnside, and 44 for Ross Island, with some additional sketches--an extraordinary amount of complicated structural design, drafting and checking. 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.[151] (Refer to previously listed Plate 6, "Time Line – 1920s Portland Bridge Design & Construction with Engineer Gustav Lindenthal.")

In a letter dated 28 November 1931, to the Board of Multnomah County commissioners, K.H. Siecke, consulting engineer, describes the roles of Lindenthal's Portland engineering staff[152]:

> 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

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[151] None of Ross Island's design drawings bear Lindenthal's signature or initials. When reference is made to Lindenthal's design of Portland's bridges, it might be more accurate to say the "Lindenthal team's design of Portland's bridges."

[152] For additional information about Lindenthal's staff and key engineers involved with the Ross Island, see Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Burnside Bridge," HAER No. OR-101 and Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "Sellwood Bridge," HAER No. OR-103.

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.[153]

Hans Henrik Rode

Hans Rode, born in Norway in 1885, graduated in 1908 as a civil engineer from the Polytechnical College of Hannover, in Germany.[154] His first position was as a designer in the bridge department of the firm Louis Eilers, in Hannover, and, at the same time, he was also Assistant in Statics and Steel Structures at the Polytechnical College. Rode was granted membership in the American Society of Civil Engineers in August 1925, during the time the Burnside and Sellwood bridges were under construction, and the same month he was in Portland supervising Lindstrom & Feigenson's construction of Ross Island Bridge's approaches. He was in every way Lindenthal's lieutenant during all but the last five months of Lindenthal's bridge dealings in Portland: Except for summer vacations, Rode was in Portland from August 1924 until 30 July 1927. (Lindenthal's work was finished with the Broadway Bridge on 31 January 1928.) For the most part, it was Rode who corresponded and communicated with the Multnomah County Board of Commissioners, keeping the exchange open between the commissioners, contractors, the other engineering staff, and Lindenthal, whose office was located in New York City during this time. It was also Rode that wrote the final report for Burnside Bridge, dated 21 May 1926, a week before Burnside opened. We do not know how much of the bridge design work in Portland was Rode's, but he was certainly capable. In a letter to Lindenthal dated 22 Sept. 1926, addressing Lindenthal at Pennsylvania Station in New York City, Rode reported about the upcoming bond election for funding bridges at Interstate Avenue and at St. Johns. He added a "P.S." about what was the mighty accomplishment of joining Ross Island Bridge's cantilevered center span: "The Ross Island arch was closed successfully about a week ago [13 Sept. 1926]. The cantilever ends came together within about a quarter of an inch. I shall soon write you a report on the progress of the work."[155] For two months each summer during 1925 and 1926, Rode left Portland to spend time in Norway, with the Portland office staffed by Reed and

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[153] Siecke was competing in 1931 with Messrs., Zoss and Stiger for a contract with Multnomah County for consulting work as inspector for Burnside Bridge, Ross Island Bridge and Sellwood Bridge, 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 1999-2001 Portland Bridges Recording Project, provided such insightful references.

[154] Gustav Lindenthal, "Hans Henrik Rode, M. A,. Soc. C.E., Died 18 July, 1930," *Transactions of the American Society of Civil Engineers* New York: 1931, vol. 95, 1594.

[155] Files, Multnomah County, Yeon Facilities.

Siecke as noted in Siecke's letter above.

In 1929, two years after leaving Portland for the last time, Rode, age 45 at the time, and his wife died in an automobile accident. Their car went out of control, and into a river in northern Italy's mountainous Tyrol. Rode's memoir, written by Lindenthal for the American Society of Civil Engineers Transactions, said, in part, that Professor Rode, who taught up until the time of his death at Polytechnical College of Technical Mechanics in Hannover, "appealed greatly to his students because of his happy blending of a keen theoretical insight and practical executive ability." Lindenthal added that he highly regarded Rode for the same reasons. In addition to the thesis for his doctorate, granted in 1916, Rode had written a textbook on mechanics and articles for Norwegian technical magazines. His association with Lindenthal dated to 1909. Shortly after emigrating to the U.S. that year, Rode worked for three years as "Assistant to Gustav Lindenthal." The memoir goes on:

> He was engaged as a Supervisor of Design with the McClintic-Marshall Company, Pittsburgh, Pa., on the design of the New York Connecting Railroad, including the Hell Gate Bridge, and on the design and field inspection of the Kentucky River High Bridge. He also took active part in developing the plans of Mr. Lindenthal's unique, competitive design for the Quebec Bridge, a braced three-hinged suspension bridge with a center span of 1758 ft.

In 1913, Rode had returned to Germany, as Chief Engineer for the Steel Bridge Department of Steffens and Oelle, Berlin-Tempelhof. In 1914, the Norwegian government appointed him Professor of Technical Mechanics at Polytechnical College in Tronkhem (Nidoros). He also spent two years in Germany on a government scholarship, and earned his doctorate. Lindenthal further notes:

> From 1924 to 1926, Professor Rode was in the United States, this time as Resident Engineer in charge of the Burnside, Ross Island, and Sellwood bridge, which were built for Multnomah County, in Portland, Oregon. Of these the Burnside Bridge has a large bascule span; the Ross Island Bridge is characterized by its graceful appearance and its ingenious cantilever scheme; and the Sellwood Bridge has the distinction of having continuous girders over four openings.[156]

Melville E. Reed

M.E. Reed was a witness to H&K's partnership agreement in March 1923, and his initials appear on key drawings for Burnside Bridge prior to Lindenthal's participation.[157] Reed proved to be one of the top three engineers for Lindenthal's team, serving as assistant engineer on Burnside, and as principal assistant engineer on both Burnside and Sellwood when Lindenthal's resident

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[156] Commissioners Journals. Rode actually left Portland 1 August 1927, according to the Commissioners Journals, "Ross Island and Burnside Bridges," 27 July 1927, 360.

[157] See, for example, "Main Web Members," Hedrick & Kremers drawing T37, 28 January 1924, with Reed initials under "Made By."

engineer Rode was in Europe during the summer months.[158] Reed was also author of one of the more comprehensive articles about Burnside's construction, "The New Burnside Bridge, Portland, Oregon," published by *Western Construction News*, in July 1926.[159] Some time after the Broadway work and the Lovejoy projects were completed, Reed worked as a Multnomah County bridge engineer for some unknown length of time.[160] Reed wrote an article, also for *Western Construction News*, published in 1936, about the Yaquina Bay Bridge on the Oregon Coast wherein he is identified as "Resident Engineer Inspector Public Works Administration, Newport, Oregon."[161] He was born in 1865, graduated from the University of Minnesota in 1888, and obtained his engineering training on the job. Reed worked on the Pacific extension for the Great Northern Railroad, built between 1890 and 1893, and for the reclamation service in Montana.[162] He lived for thirty six years in Portland, at the end of his life employed by the Kaiser Company. Reed died at the age of 81 on 12 October 1946.[163]

Kurt Siecke

Kurt Siecke was another carry-over from the H&K team. His name appears under both "made by" and "checked by" during design and construction of Burnside Bridge for both H&K and Lindenthal, and, for Lindenthal, under "made by" and "checked by" for Ross Island Bridge, and under "made by" for Sellwood Bridge.[164] According to letters written by Siecke in 1931 to the Board of County Commissioners, he served as the principal assistant engineer and chief draftsman on Ross Island Bridge, except during Rode's summer absences. During July and August 1925, when Reed

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[158] Wood Wortman, "Engineering staff and Contractors for the 1920s Willamette River Bridges."

[159] Melville E. Reed, "The New Burnside Bridge at Portland, Oregon," *Western Construction News*, 10 July 1926, 20-24.

[160] Reed does not show up in Multnomah County file records in the Yeon facilities as being either "the" or "a" Multnomah County engineer. However, at Multnomah County Bridge Section offices, a design drawing for revisions to the approaches to Hawthorne Bridge, dated 1930, shows "M.E. Reed Bridge Engineer." Reed's obituary, published in 1946, identifies him as having, among other things, "served as county bridge engineer." *The Oregon Journal* 13 October 1946, 12A.

[161] Building the Yaquina Bay Bridge on the Oregon Coast Highway," *Western Construction News*, May 1936, 133-136. In another article, published the same year and month, "Yaquina Bay Bridge," by C.B. McCullough (publication title unknown), Reed is identified as "Resident Engineer Inspector."

[162] Ralph W. Hidy and others, *The Great Northern Railway* (Boston: Harvard Business School Press, 1988), 78-85.

[163] *Oregon Journal*, 9 July 1968, 3M.

[164] Drawings made for Burnside and Sellwood, Files, Multnomah County Bridge Section; drawings for Ross Island, ODOT Bridge Engineering offices, Region 1, and Salem. The earliest signed Siecke drawing during Hedrick & Kremers designing for Burnside was "Operator House Support," T-15, dated 20 February 1924, showing "K.H. Sieckem" under "made by."

took over for Rode as general supervisor of the construction for Burnside and Sellwood (and also the surveying for Lindenthal of three sites for proposed bridges between Broadway and St. Johns), Siecke was put in charge of "office work and Ross Island Bridge."[165] He also wrote, "My position on the staff of Gustav Lindenthal afforded me the opportunity of designing the concrete structure of the Ross Island Bridge and serving as principal assistant engineer on its construction, as well as design of the east approaches to the Burnside Bridge, and checking the design of the Sellwood Bridge."[166]

Seicke's obituary at the time of his death, 18 March 1965, reported he had been a consulting engineer and associate professor of structural engineering at the University of Portland; that he was licensed for civil, structural and mechanical engineering in Oregon, Washington, California, Missouri, Illinois and Iowa; and that he had been born in Freeport, Illinois on 7 July 1895 and had graduated from the University of Illinois in 1921.[167]

Hedrick & Kremers

Ira G. Hedrick

Ira G. Hedrick, born 6 April 1868, and already had 31 years experience with large bridges

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[165] A letter from Lindenthal, to the Board of Multnomah County Commissioners, Commissioners Journals, "Burnside and Ross Island Bridges," 17 June 1925, 85; copy of letter from K.H. Siecke to the Board, dated 28 November 1931, files, ibid.

[166] Copy of letter from K.H. Siecke to the Honorable Board of Commissioners, dated 17 July 1931, Files, Multnomah County, Yeon facilities. Siecke's name does not appear on Ross Island or Burnside nameplates.

[167] "Kurt Siecke Dies at 69," *The Oregonian*, 18 March 1965, 17C. More revealing than the obituary is Siecke's "Experience Record, Kurt H. Siecke," sent to Multnomah County to solicit consulting work in the 1950s. Siecke's letterhead shows his office at the time of application at 429 S.W. Fourth Avenue, Portland. Although the letter is not dated, the report is titled 1954. In addition to enclosing original construction photos of the Burnside, Ross Island and other bridges, Siecke lists an employment history that shows he was an inspector and draftsman for the Illinois Central Railroad in Chicago, where he designed and detailed concrete and structural steel railroad bridges in the office. According to his resume, he left the Illinois Central Railroad in May 1923, that same month becoming "the designer" for Hedrick & Kremers, Consulting Engineers, Portland, Oregon. "The work consisted of designing 250 foot concrete arches." No location is given for the concrete arch work, but on the next line, Siecke is shown as beginning work in August 1924 as "Chief Draftsman, Principal Asst. Engineer, Gustav Lindenthal, Consulting Engineer." Siecke writes, "The applicant prepared the plans for approaches and was in charge of the field work on the $2,000,000 Ross Island bridge in Portland, Oregon." The line after this shows Siecke resigned from the Lindenthal team in July 1926 to go to work in August 1926 for the general contractors on construction of the Vantage Ferry Bridge over the Columbia River, a position he said he accepted because of the opportunity for pneumatic caisson experience. In 1927, he worked for Parker & Banfield, the same firm that had been indicted for illegal bidding activities on the Willamette River bridges during the H&K regime. (Siecke's work was cut short as estimator and engineer for Parker & Banfield when C.J. parker was killed in an airplane crash.) "Professional Record Kurt Hugo Siecke," included in "Experience Record," Files, Multnomah Vounty, Yeon Facilities. For more about Parker & Banfield, read MacColl, *The Growth of a City*, 199.

by the time he was involved with Portland's bridges.[168] A native of West Salem, Illinois, 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 (Waddell's alma mater), Canada in 1898, 1899, and 1900, respectively.[169] Hedrick began working with J.A.L. waddell in 1892 in Kansas City, doing bridge design and construction supervision. Between 1899 and 1906, he was in partnership with Waddell, under the name of Waddell and Hedrick.[170] 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, Missouri, 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 "East 27th Street Viaduct Spanning Vince Street," 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, during the time he was a Waddell partner, Hedrick designed 300' riveted spans for the 6th Street Viaduct, located in Kansas City, Missouri.

Hedrick's name shows up in Portland in at least two other 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 very heavy traffic between that city and Fort Worth."[171] 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 & Cochrame, consulting engineers, with M.R. Ash, associate Engineer.[172] 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.

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168 Commissioners Journals, "Ross Island Burnside Bridges," 9 March 1923, 35. 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 engineer on the Lindenthal team.

169 In Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "East 27th Street Viaduct Spanning Vince Street," HAER No. 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.

170 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 & Sons, New York.

171 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.

172 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.

Also in 1913, Hedrick & Cochrane, Kansas City, Missouri, 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.[173]

After the problems in Portland, Hedrick left the city and started an engineering practice in New Orleans and Shreveport, Los Angeles, with Lloyd Garner Frost, whose name appears on the engineering drawings for all the Willamette River bridges.[174] Hedrick moved to Arkansas in 1928, and dies in 1937 at his home in Hot Springs, Arkansas at the age of 69.[175] His Portland obituary said he also designed Chicago's first elevated railway.[176]

Robert C. Kremers

A newspaper article states that Robert Kremers was born in Ottawa County, Michigan 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 Engineer's office.[177] 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 head of construction was formed, Kremers then worked as the head of construction for five years. He resigned from the city effective 1 April 1923, to work on the Multnomah County bridges.[178]

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[173] Commissioners Journals, "Columbia River Interstate Bridge Commission," vol. 1, 29 November 1913-10 February 1920, 1, Files, Multnomah County, Ford Building. The Interstate Bridge opened in 1917.

[174] 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.

[175] Historic American Engineering Record (HAER), National Park Service, U.S. Department of the Interior, "East 27th Street Viaduct," 18-22. While in Arkansas, Hedrick's office was located in Hot Springs National Park. During 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.

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

[177] "Citizens are Reticent on Bridge Plans," *The Oregon Daily Journal*, 27 January 1923, 1,7.

[178] "Robert C. Kremers to Resign City Job for Bridge Work," *The Oregon Daily Journal*, 10 March 1923, 3; "Engineer Resigns as Bureau in 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 Bridges's wooden deck was replaced with Irving Subway steel grating in 1945 at a cost of

Summary of Significant Events, Post 1926 (including bridge expansion/new Ross Island Bridge, and seismic):

For a detailed list and elaboration of this section (with citations), see Appendix, "Summary of Significant Events, Ross Island Bridge and Approaches, Post 1926," 1-10.

Between 1926, when the Ross Island Bridge opened, and the end of the twentieth century, not much had ben changed on the bridge proper. However, as part of a major 19-month rehabilitation involving deck and drainage upgrading by ODOT ending in the fall of 2001, the bridge's crumbling railings were replaced and crash-resistant steel safety barriers were installed.

Four years after it opened, two water mains were installed across Ross Island's superstructure to carry Bull Run water across the Willamette River. As part of the major rehabilitation project mentioned above, the inspection cart (called a trolley) that ran along the water mains was removed, the water mains inspected since then from atop the highway deck by a "snooper" truck and crane.

Major changes have taken place on both the west and east approaches to the bridge: In 1948, the street connection system at the west end of the bridge was completely changed. The original safety island and traffic circle on the approach fill were removed. A cloverleaf-type interchange, including tunnels at Grover and Woods streets, was built to provide direct bridge connections to Front Avenue (now S.W. Naito Parkway), Harbor Drive and Barbur Boulevard. Also, two new on/off ramps were added to improve bridge connections to local streets. In 1956, the state built an off-ramp at the east end to provide access to S.E. McLoughlin Boulevard. (Additional east end approach work was completed in 1968 when the east end was widened and extended as an initial step in widening McLoughlin.)

In 1958, the type of street lighting changed, the same year the south sidewalk was removed to provide greater width for vehicles; as a result, the street lighting on the south side of the bridge was also removed. (For more about increasing capacity of the bridge, see sections below.)

The bridge has had at least two major repainting jobs, in 1948 and 1965. In the latter year, Ross Island's color was changed to "Phthalo Blue," chosen by architect Lewis Crutcher as part of a new color scheme for all the central city Willamette River bridges. This deep blue is approximately the superstructure color seen below the highway deck at the turn of the millenium.

The bridge's expansion joints and water drainage have repeatedly worn out, these systems addressed again most recently in the 2000-2001 rehabilitation project.

$305,000, Kremers is reported as project engineer for L.H. Hoffman Co., a large construction firm. Kremers would have been about 60 years old at the time. "3 Companies Lay Grating Bridge Deck," *The Daily Journal*, 27 January 1923, 1; *The Portland Telegram*, 27 January 1923, 1; *The Oregonian*, 27 January 1923, 1 and 18 February 1923, 4. For more about H&K, see Historic American Engineering Record (HAER), National Park Service, U.S. Department of Engineering, "Burnside Bridge," HAER No. OR-101.

The roadway deck has been resurfaced and repaired, with changes over time from asphalt (1926), to epoxy asphalt (1972). To latex-modified concrete (1985), and to microsilica concrete (2001).

The bridge has been wired, first for cable television (1981) and then for fiber optic (1997).

Of major significance is the increase in vehicular traffic over the bridge's life, and the change in the bridge's ownership and maintenance, in 1975-1976 transferred from Multnomah County to ODOT.

Bridge Expansion/New Ross Island Bridge

In the late 1950s, about the time the south sidewalk on Ross Island was removed to accommodate vehicles, Multnomah County commissioners considered rebuilding the bridge for six traffic lanes instead of four. Another idea was to build a second and parallel Ross Island Brodge just north of the existing span. The commissioners voted 2-1 to put a $7 million bond issue on the ballot for such a bridge, but it was voted down in November 1958. The county also briefly considered the possibility of double-decking the Ross Island Bridge, and idea abandoned when the county roadmaster advised that the bridge would not stand the additional load. In 1994, in response to an inquiry from Metro, Portland-area regional government, ODOT advised that the Ross Island Bridge could not be widened for more traffic/bike lanes nor could its load be increased to accommodate light rail transit. In 1966, the Marquam Bridge opened just downstream from the Ross Island Birdge. As a link in the I-5 freeway system carrying vehicles from the west side of the Willamette to the east side, Marquam did nothing to relieve the Ross Island Bridge's congestion. In 1999, Metro (Portland-area regional government) published a study to investigate options for increasing the river-crossing traffic capacity in the Willamette River corridor from Portland to Oregon City, with focus on traffic normally using the over-loaded Sellwood Bridge. Study options involving the Ross Island Bridge included addition of traffic lanes to the bridge itself and improvements to the west approach roadway system. Estimated costs of the Ross Island upgrades ranged from $113 million to $131 million. The "South Willamette River crossing Study" concluded that the Ross Island upgrades offered some public benefits, but would not significantly reduce traffic on the Sellwood Bridge.

Seismic

As part of the 1994 Metro study, ODOT determined that the bridge is "very vulnerable to damage due to earthquakes," and that the seismic rehabilitation would be "very costly." Ross Island Bridge has not been ranked for seismic upgrade due to its complexity and structural type.

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Summary of Significant Events
Ross Island Bridge and Approaches, Post 1926

1930-31 Water Mains

Two steel water mains 24" in diameter were placed, one on each side of the bridge below the sidewalks, across the Willamette River from Bent No. 29 on the east side to Pier No. 1 on the west side. The city prepared the plans and paid $25,000 for the right to place, inspect, repair, maintain and renew the mains "during the entire period of the existence of said bridge." Copy of agreement Agr 7-5, 31 December 1930, by George Baker, for the city; Fred German, Grant Phegley, for the county. Files, Multnomah County, Yeon facilities, Portland.

1948 West Approach/Tunnel Construction

To eliminate cross traffic at the bridge's west approach, a series of cloverleaves and underpasses were completed as part of the City of Portland's Harbor Drive/Front Avenue Project [Front since renamed S.W. Naito Parkway]. An underpass to the north of the bridge was constructed to handle one-way traffic from the bridge to Front Avenue and southbound to Barbur Boulevard. A middle underpass was constructed for one-way traffic from Front to the east side across the bridge. The south underpass was designed mainly for trolley coaches and to handle traffic from S.W. First Ave. to Corbett Avenue. The safety island located at the end of the bridge at the west end was removed at this time. City of Portland "Grover Street Subways, Front Ave. Project" engineering drawings #8367-8376 and #8453, 16 November 1945, ODOT Br. #06895; "Wood St. Subway, Front Ave. Project," #8296-8299 and #8452, 13 November 1945, ODOT Br. #06896. Also see Plate 7, photograph, "West Approach (as Built) Ross Island Bridge. The West Approach/Tunnel Construction also included addition of two new ramp structures, one a northbound off-ramp to S.W. Corbett and the other an eastbound on-ramp from S.W. Kelly. These two ramps were structurally connected to the sides of the first few spans of the original Lindenthal-designed structure. Their addition required removal of sections of original railings and sidewalks. It appears these are inventoried at the Oregon Department of Transportation (ODOT) as structures #06857 and 06943. Photographs at the Oregon Historical Society Library (OHS), Portland, show that the West Approach/Tunnel Construction was a massive project. Oregon Journal photo, 8 June 1947, OrHi 100197; Oregon Journal photo 18 August 1948, OrHi #1709.

1948 Painting-General

Multnomah County contract #Special Request No. 2-6016/4. "List of Contracts and General Files," attachment to letter of transmittal, 7 November 1991, from Cheryl Strubb, Multnomah County, to ODOT, files, Yeon facilities. The contract was let to Antonsen Painting Co., 1711 Center St., Tacoma 3, Wn., 8 July 1948, memo from P.C. Northrup, 12 July 1960, files, ODOT, Region 1 Maintenance offices, Milwaukie.

1955 Loose Stone Revetment

Multnomah County contract #684-R-56. Willamette Tug and Barge Co. installed loose stone on a pier of the Ross Island Bridge under a $15,000 contract, which included revetment of one pier of the Hawthorne Bridge. *The Oregonian*, "Tug Firm Low on Bridge Bid," 2 September 1955, np; Strubb, "List of Contracts and General Files."

1956 McLoughlin Avenue Off-Ramp (ODOT Br. 06767)

An 18'-wide by 1,287'-long single-lane concrete and steel girder ramp on the south side of the bridge, built to ease traffic, exits southbound to McLoughlin Boulevard, located on the east side of the Willamette. Oregon State Highway Department (now ODOT) and Multnomah County shared the cost, about $480,000. Oregon State Highway Dept. "Plans for Proposed Project, Ross Island Bridge Ramp, Mt. Hood Highway, Multnomah County, May 1955," drawings #12040-12062. Files, ODOT Region 1 Bridge Maintenance offices, Milwaukie. *Oregon Journal* photo, OrHi #1709, 8 September 1956. Files, OHS.

1958 Roadway Widening/Sidewalk Removal

The south sidewalk was removed, widening the roadway an additional 3-1/2' to make a total roadway width of 41' (base of curb). Contract for $131,940 was awarded to Inland Construction Co., Milwaukie, the cost shared between the city and county. Bicyclists and pedestrians cross on a 5'-wide sidewalk (clear) located on the north side of the bridge. Oregon State Highway Dept. engineering drawing #13277, "Ross Island Bridge Roadway Widening," 2 April 1957, files, ODOT, Region 1, Maintenance offices. "Contract Sets Widening for Ross Island Bridge," *The Oregonian,* 28 June 1957, 7. For more about expansion of the bridge to accommodate increasing traffic, and proposals to build another bridge adjacent to Ross Island, see section below, "1994 Survey for Additional Carrying Capacity," and section in HAER OR-102 Ross Island Bridge main report, "Summary of Significant Events, Post 1926 (including Bridge Expansion/New Ross Island Bridge, and Seismic)."

1958 Roadway Relighting

Multnomah County contract #854-R-66, Kelly & Assoc., 23 April 1957. Cheryl Strubb, "List of Contracts and General Files"; Multnomah County two-page handwritten document, "Ross Island Bridge" (Repair and Engineering Drawing History), ca. 1975, files, Multnomah County Bridge Engineering offices, Portland.

1965 Painting (Main Span Superstructure)

Contract #1782-R-66, between Multnomah County and J.A.E. Brown Co., 1 July 1965, for $148,777. Project called for painting 5,125 tons of bridge steel and 150 tons of steel castings between Pier No. 1 on the west side and Pier No. 6 on the east side, with the finish coat the color "Phthalo Blue." The color for Ross Island was chosen by Portland architect Lewis Crutcher as part of his paint color scheme for all the downtown Portland Willamette River bridges, per Multnomah County Commissioners Board Order 5 June 1962. The city water mains and tramway beams from the ground near McLoughlin Blvd. to the ground near Pier 6 were included (additional tonnage), but not the McLoughlin Blvd. off-ramp, owned by the Oregon State Highway Commission. Paint materials included Type II Basic lead silico chromate base iron oxide linseed oil alkyd, as specified by Interim Federal Specification TT-P-615b, 12 Sept. 1961, and red lead sealing paste, Washington State Highway Dept. formula A-3-57. Contract addendum, "Description of Work Proj. 564," files, ODOT Bridge Section, Salem. "Commission Opens Bids on Span Paint Project," *The Oregonian*, 2 July 1965, np. Strubb, "List of Contracts and General Files." Memorandum from Kenneth Wheatley to F.C. Northrop, 18 May 1965, files, ODOT Bridge Section, Salem.

1965 Numbering of Spans

"Ross Island Bridge" (Repair and Engineering Drawing History), ca. 1975, op cit.

1966-67 Deck Repair, Off-Ramp

Bents No. 21 and 22 were repaired for spall on bridge structure 06767 (Ross Island Bridge east end off-ramp opened in 1956 to southbound McLoughlin Blvd.). "Remove broken concrete, clean and sandblast ends of deck, repl. Spalls with Concresive 1064 and pea gravel grouts. Seal entire joint w/Thiokol sealant (plus signing and flagging for detour), $900." Oregon State Highway Dept. "Bridge History Record of Maintenance Repairs and Renewals," files, ODOT, Region 1, Maintenance offices, Milwaukie.

1968 East End Extension and Shoo-fly (temporary)

Schrader Construction Co. won a contract for $639,347 for undercrossing work and widening of the east end approach to the Ross Island Bridge. The project was an initial step involved in widening S.E. McLoughlin Blvd. into six lanes. "State Assigns Job on Bridge," *The Oregonian*, 23 December 1968, np; "Road Work Completed on Ross Island Bridge," ibid., nd. np. As part of the east end extension project, a large "shoo-fly" diversion at the north side of Ross Island's east approach was constructed as a temporary structure to reroute west bound traffic across the bridge. According to an *Oregon Journal* photograph and caption, "Turn-out curve will enable engineers to remove portion of bridge, chisel out six-lane highway route." *Oregon Journal* photo, OrHi #1709, ca. 1968, files, OHS.

1971 Drain Installation

Contract #2564-R-71, dated 10 June 1971. Strubb, "List of Contracts and General Files."

1971 Jacking Beam Pier #2

"Ross Island Bridge," (Repair and Engineering Drawing History), ca. 1975. A letter from Kenneth Wheatley, Multnomah County bridge engineer, to Zidell, Inc., 26 April 1972, said, "Bridge bearings at Pier 2 have been jacked and realigned and there is no further need for the excavation on the west side of the pier. The hole may be refilled to the level of the surrounding area." File, "Ross Island Bridge 1960-."

1972 Deck Resurfacing and Expansion Joints

A new type epoxy surface material was used to pave the deck of Ross Island Bridge, replacing worn asphalt. Contractor Adhesive Engineering Co., San Carlos, CA., used "Concresive Epoxy Asphalt" one-inch thick. Problems developed after two lanes had been paved and the binding glue failed. Contract 2642-R-72 for $160,000 was signed 4 May 1972, and included repaving the highway deck of the Broadway Bridge with the same material. Letter dated 25 May 1972, from W.F. Connolly, Adhesive Engineering, to Walter Hart, Oregon State Highway Dept., file, "Ross Island Bridge 1960-"; "Repair Work to Shut Down Bridge," *The Oregonian*, 28 July 1972, nd.

1973 Epoxy Deck Wear

"Ross Island Bridge," (Repair and Engineering Drawing History), ca. 1975.

1973 Relighting

The street lighting system was revised, with the lamps and poles removed from the south side of the bridge. The new lighting system was a 480-volt parallel system comprising 8-400 watt General Electric luminaires and 20-400 watt high-pressure sodium vapor luminaires. Letter from Oliver Domreis to Freda Gibbons, 16 November 1973; Letter from Richard Howard to Frank Godwin, Portland General Electric, 2 Nov. 1973, file "Ross Island Bridge 1960-"; "Ross Island Bridge," (Repair and Engineering Drawing History), ca. 1975.

1975 Transfer of Bridge Ownership

Arguing that the Ross Island Bridge was part of the Oregon State Highway system, then Multnomah County Environmental Services Director Ken Gervais proposed lobbying the Oregon State Legislature's Ways and Means Committee in the spring of 1975. As a result, ownership and maintenance of Ross Island and St. Johns Bridge, also built and owned by Multnomah County, transferred from county to state ownership on 1 September 1975. (See Chapter 436, Section 4, Oregon Laws 1975, H.B. 5045). The county paid the state $300,000 for both bridges as part of the deal, per Multnomah County Board Order dated 8 April 1976, from file "Ross Island Bridge 1960-," ODOT Region 1, Maintenance office. Letter of Warrant Transfer, 29 August 1975, from John McCincy to Fred Klaboe. The agreement between the state and county was signed 6 May 1976, with several signatures, including Gervais and Don Clark for the county and Fred Klaboe for the state. Files, ODOT Region 1, Maintenance, Milwaukie. "Selling Two Bridges," by Ken Gervais, an interview with Sharon Wood Wortman, March 1999, edited for "Bridge Stories," part of *Bridging the City* Exhibit, Oregon Historical Society, Portland Square, March 1999-May 2001.

1976 Improved Access for Bicyclists and Pedestrians

Letter from Donald Colville, Ore. Dept. of Public Works, to Robert Johnson, Multnomah County traffic engineer, 19 August 1976; City of Portland, Dept. of Public Works, engineering drawing "Improvement of Ross Island Bridge Bikeway," Job. No. 12592, nd., files, ODOT Region 1, Maintenance office. The bridge is not striped for bicylists, with riders either using the regular traffic lanes, or riding on the north sidewalk.

1978 Joint Repair

Records show joint repair, "RCDG, steel deck girder, RC box beam," in May and November 1978. Oregon State Highway Division, "Bridge History Record of Maintenance Repairs and Renewals."

1979 Safety Platform Installed

Oregon State Highway Division, "Bridge History Record of Maintenance Repairs and Renewals."

1979 Drain Pipe Installation

Oregon State Highway Division, "Bridge History Record of Maintenance Repairs and Renewals."

1979 Joint Repair

Oregon State Highway Division, "Bridge History Record of Maintenance Repairs and Renewals."

1980 Deck Inspection

A memo from Ken Wheatley to Clair Kuiper, Oregon State Highway Division, dated 30 September 1980, and accompanied by photographs, noted problems with paving and overlay, especially at bents 30, 29, and 26, and piers 6, 5 and 2. "Main problem seems to be in the paving. The overlay is badly worn." Files, ODOT, Bridge Section, Salem.

1981 Wiring for Cable Television

To bring cable television to 13,000 eastside Portland homes, roadway wiring belonging to a cable television system was pulled through conduit on the Ross Island Bridge. Portland City Council had awarded Cablesystems Pacific a 15-year east side franchise, the wiring on Ross Island part of a 940-mile system to be complete by 1984. "East Portland Cable Television Wiring Begins, *Oregon Journal*, 16 September 1981, 3.

1985 Deck Resurfacing

Latex-modified concrete, the same material used for resurfacing of the downstream Marquam Bridge in 1984, was used to completely overlay the surface of the Ross Island's bridge deck. John Hyland Construction Co., Eugene, was low bidder at $654,481. "Resurfacing Poses Obstruction for Ross Island Bridge Use," by Stan Federman, The Oregonian, 22 March 1985, np. Plan, Elevation and Deck sections engineering drawing, "Ross Island Bridge Section Deck Overlay," January 1985, ODOT Bridge Section, Salem.

1987 Expansion Joint Repair

The strip seals in expansion joints located at Piers 2 and 5 were cleaned, inspected and replaced. "Order for Work Force," Contract No. 9991, $7,500, 19 February 1987. Files, ODOT Bridge Section, Salem.

1994 Survey for Additional Carrying Capacity

In 1994 Metro, the area's regional government, asked ODOT if it was feasible and/or cost effective to 1) widen Ross Island for more traffic/bike lanes 2) increase load capacity for light rail transit (LRT) and 3) retrofit for seismic. Metro also wanted to know where Ross Island was in ODOT's priorities for seismic upgrade in Oregon. ODOT responded that it was not economically feasible to widen or to rehabilitate the bridge for light rail; that the bridge was designed and constructed when vehicle loads were much lighter (for a 20-ton truck compared to current truck loading of 50 tons, approximately equivalent to LRT loading). "This significant difference, coupled with the unique structure features, would make widening or rehab very difficult and costly, if possible at all." About earthquake, ". . . the structure is very vulnerable to damage due to earthquakes, and the seismic rehabilitation would also be very costly. We have not ranked this bridge with the other state bridges for seismic rehab because of its complexity and the time and effort required to determine how to rehabilitate it." Interoffice memorandum from Terry Shike, Oregon State Bridge Engineer, 25 July 1994; 2 August 1994, letter from Terry Shike to Kim Dilorio, Metro, 2 August 1994, files, ODOT Bridge Section, Salem.

1997 Fiber Optic Cable

SP Construction Services applied for a permit to install Qwest Communications fiber optic cable across the Willamette River on the bridge. ODOT responded with four requirements for proper installation, to be placed below the sidewalk. Interoffice memorandum from Ron Bornemeier, permit specialist, to Gary Bowling, Bridge Section, et al, 11 September 7; ibid., from Ivan Silbernagel, maintenance design engineer, to Bornemeier, 4 November 1997, files ODOT Bridge Section, Salem.

1999 South Willamette River Crossing Study

Metro issued the final report on their "South Willamette River Crossing Study." The study investigated options for increasing the river-crossing traffic capacity in the Willamette River corridor from Portland to Oregon City, with focus on traffic normally using the over-loaded Sellwood Bridge. Study options involving the Ross Island Bridge included addition of traffic lanes to the bridge itself and improvements to the west approach roadway system. Estimated costs of the Ross Island upgrades ranged from $113 million to $131 million. The study concluded that the Ross Island upgrades offered some public benefits, but would not significantly reduce traffic on the Sellwood Bridge.

1998-2001 Major Rehabilitation

By 1998, Ross Island Bridge was carrying 70,000 vehicles a day, and in serious need of repairs. The bridge deck needed paving and the joint seals had failed. This allowed moisture to seep through, causing rust and on-going deterioration undermining the structure. The drainage system was permanently clogged and storm water was pooling on the bridge and falling into the Willamette River. Portions of the sidewalks were crumbling and the concrete railing was crumbling and not up to modern standards for crash resistance. The bridge was repaired in a 19-month project that cost $12.5 million. During construction, the bridge stayed open for traffic, with some lanes and hours restricted. As part of the rehabilitation project, the Portland Water

Bureau's inspection cart (called a trolley) that ran along the water mains was removed. The water mains are now inspected from atop the highway deck by a state-of-the-art "snooper" truck and crane. In addition, two 6'-square steel access platforms designed to provide access to the navigation lights at the center span were added, one each on both sides of the bridge. Both access platforms are equipped with a ladder that extends above the bridge rail and climbs down approximately 10' below the bridge deck.

For a complete list of repairs and changes to Ross Island Bridge as a result of the 2000-2001 rehabilitation, see Contract No. 12323, awarded to Mowat Construction Co., 29 October 1999, "FAP# X-BRF-S026(17) CONO1316, ODOT, "Contract and Bonds for Highway Construction." About 90 engineering drawings for this project are inventoried at ODOT. The traffic statistic comes from Kittelson & Assoc., Inc., "Ross Island Bridge Rehabilitation Traffic Management Plan," Executive Summary, May 1999. Files, ODOT Region 1, Portland.

Other sources for Summary of Significant Events, Ross Island Bridge and Approaches, Post 1926: "Across the Willamette—Seven of Ten Parts, City's First Two 'High Bridges' Opened Southeast Region," Jack Ostergren, *Oregon Journal,* 9 July 1968, 3M. Also telephone interview by Sharon Wood Wortman, with Wayne Normand, project coordinator, Ross Island Bridge Rehabilitation Project, ODOT Region 1, 26 March 2001; and several telephone interviews with Christie Holmgren, ODOT Public Affairs.

SELLWOOD BRIDGE
Willamette River Bridges Recording Project
Spanning the Willamette River at SE Tacoma Street
Portland
Multnomah County
Oregon

HAER No. OR-103

PHOTOGRAPHS

PAPER COPIES OF COLOR TRANSPARENCIES

WRITTEN HISTORICAL AND DESCRIPTIVE DATA

HISTORIC AMERICAN ENGINEERING RECORD
National Park Service
U.S. Department of the Interior
1849 C St. NW
Washington, DC 20240

HISTORIC AMERICAN ENGINEERING RECORD

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SELLWOOD BRIDGE HAER No. OR-103
Spanning the Willamette River at Milepost 16.5
Portland
Multnomah County
Oregon

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James Norman, Photographer August 1999

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OR-103-2	GENERAL VIEW OF SELLWOOD BRIDGE, LOOKING NORTHEAST, SOUTH SIDE OF STRUCTURE.
OR-103-3	GENERAL PERSPECTIVE VIEW OF SELLWOOD BRIDGE, VIEW FROM WEST LOOKING EAST ACROSS THE WILLAMETTE RIVER, NORTH SIDE OF STRUCTURE.
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Leslie Schwab, Photographer August 1999

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All color xerographic copies were made from a duplicate color transparency.

James Norman, Photographer, August 1999

OR-103-17 (CT) GENERAL PERSPECTIVE VIEW OF SELLWOOD BRIDGE, LOOKING NORTHEAST.

OR-103-18 (CT) GENERAL PERSPECTIVE VIEW OF SELLWOOD BRIDGE, LOOKING NORTHEAST.