HISTORIC AMERICAN ENGINEERING RECORD

MORRISON BRIDGE

HAER No. OR-100

Location:	Spanning the Willamette River from Belmont and East Morrison Streets to Washington and Alder Streets, Portland, Multnomah County, Oregon UTM:10/525940/5040330 Quad: Portland, Oregon
Structural Type:	Type: Double-leaf fixed trunnion bascule, Chicago style
Date of Construction:	1954-58
Engineers:	Sverdrup & Parcel, St. Louis, MO/San Francisco, CA and Moffatt, Nichol & Taylor, Portland, OR
Builder:	Superstructure - American Bridge Division, United States Steel, Portland, Oregon; Substructure, Manson Construction & Engineering, Seattle, Washington
Present Owner:	Multnomah County, Oregon
Present Use:	Vehicular and pedestrian bridge

Significance:

The Morrison Bridge embodies the mid-twentieth century transition in bridge engineering. The last bascule bridge built on the Willamette in Portland, it replaced the last of the earlier swing spans to carry vehicular traffic. The Morrison had been on the drawing board since 1927; thirty years later it essentially embodied the 1920s consensus. But it was also the first local Willamette span to emerge from corporate design rather than from a small consulting firm led by a nationally prominent individual engineer. Innovative open bascule piers permit the river to flow through, minimizing the hydraulic effects of their exceptional size. It is the only non-freeway bridge integrated with Portland's freeway system.

Historian:

Researched and written by Judith A. McGaw

Project Information:

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

Related Documentation:

See also HAER No. OR-20 and HAER No. OR-101.

Overview

Portland's Morrison Bridge illuminates an era of transition in bridge construction. It is a product of compromise both politically and technologically, constrained by the assumptions of earlier eras while simultaneously incorporating new materials, construction methods, management practices, and visions of the future. It is the last movable bridge to be built across the Willamette in Portland, replacing the last of the city's early swing spans, completing a process begun fifty years earlier with the 1910 Hawthorne Bridge. At the same time, it embodies traffic engineering and architectural aspects reflecting the influence of aeronautical engineering and freeway design. Although hardly devoid of innovative features, the bridge is most important as an embodiment of the halting, equivocal process by which change generally occurs, a process obscured when we document and preserve only strikingly innovative structures.

Pre-1950 Roots

Understanding the 1958 Morrison begins with understanding earlier Portland bridge history. It was the last of Portland's Willamette River crossings erected at the site of an existing bridge. Constructing a bridge where the city's first trans-Willamette structure had stood meant that everyone involved in decision making arrived with assumptions and concerns founded in local bridge and transportation history. In particular, because it was the last local bridge to replace an existing swing span, engineers and politicians repeatedly adduced the examples of earlier swing bridge replacements: the Hawthorne (1910), Steel (1912), and Burnside (1926) bridges.[1]

Although plans to bridge the Willamette in Portland date to 1872, the earliest bridge linking Portland and East Portland, then a separate municipality, opened at Morrison Street in 1887. Construction had begun in 1880, but the slow pace of litigation challenging any bridge as an illegal obstruction of navigation, (not to mention a threat to established ferry operators' revenues,) halted construction for more than five years. Finally, the Willamette Iron Bridge Company simply reorganized as a new corporation, thus evading the original 1881 injunction that federal courts took seven years to lift.[2]

The 1887 Morrison Street Bridge was the largest west of the Mississippi in overall length: 1,650 feet including approaches. It consisted of three 260 foot long wooden Pratt truss spans, one 160 foot long wooden Howe truss span, and a 310-foot long iron draw span of the swing type. It rested on tubular piers wrapped in iron cylinders. As with several of Portland's early bridges, the Pacific Bridge Company designed the structure and supervised its construction. Pacific Bridge, a San Francisco firm, had garnered the original 1880 contract. Its owner, Charles Gorrill, sent his 25-year-old nephew Charles F. Swigert to Portland in 1886 to open a branch

[1] See HAER No. OR-20, HAER No. OR-21, HAER No. OR-101.

[2] Fred Lockley, *History of the Columbia River from The Dalles to the Sea* (Chicago: S. J. Clarke Publishing Company, 1928) I, 534-536.

office and supervise construction. Swigert also helped design the structure.[3]

Capitalizing on this on-the-job training, Swigert went on to become a dominant figure in Portland bridge history, influencing local political decisions as president of both the Port of Portland Commission and the Chamber of Commerce and shaping technological demands on new structures as general manager of the city's first electric street railway. Ultimately, he managed the monopoly that controlled all of the city's street railways as well as its electric light and power generation. By the mid-1890s, Swigert had moved Pacific Bridge's headquarters to Portland, although complex financial arrangements allowed him to direct half the firm's profits to Pacific Construction of San Francisco, a new firm organized by his uncle. The convoluted financial dealings between these firms and others in which Swigert had a hand managed to baffle even the most ardent local journalists.[4]

Among its many major local construction projects, Pacific Bridge won the 1904 contract for a new Morrison Bridge, the earlier wooden structure having shown the ill effects of traffic far surpassing its intended load. The new, 1905 Morrison, a steel Pratt truss swing span of the Pennsylvania Petit variety was originally bid at $331,343, but extra expenses of $52,000 won the City Executive Board's approval without requiring any further bid. Moreover, Pacific's original bid had won out despite being far from the lowest. As with other large public works of the era, Portland's politicians took for granted that the new bridge's construction would serve to enrich its private capitalists. But as the new bridge began carrying traffic, Progressive Reform, embodied in the administration of Mayor Harry Lane, began altering the face of Portland politics. In consequence, the 1905 Morrison Bridge represented the end of an era politically as well as technologically.[5]

This is not to say that engineers and contractors building subsequent bridges devoted themselves to the public interest. As was true nationally, Portland and Oregon Progressives sought to moderate excesses rather than to alter radically customary political and economic activity. They did so mostly through strategies that divided power and encouraged public disclosure. By the early 1910s, when three new Willamette bridges took shape in Portland, this meant seeking a greater diversity of players by separating engineering bids from construction bids, seeking talent from outside the Portland area, and taking greater care to review every phase of the process and to enforce regulations. In consequence, all three bridges completed between 1910 and 1913 all engaged the talents of nationally distinguished engineers and none employed Pacific Bridge for construction. Each introduced a new bridge type as well.[6]

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[3] E. Kimbark MacColl, *The Shaping of a City: Business and Politics in Portland, Oregon, 1885-1915* (Portland: The Georgian Press, 1976), 80, 95-96, 151.

[4] MacColl, *Shaping of a City*, 95-96, 283-286.

[5] MacColl, *Shaping of a City*, 283-286, and *passim*.

[6] HAER No. OR-20, HAER No. OR-21 and HAER No. OR-22 document the histories of these three bridges, the Hawthorne, Steel, and Broadway Bridges, respectively. The history of local progressive reform is well covered in MacColl, *Shaping of a City* and E. Kimbark MacColl with Harry H. Stern, *Merchants, Money, and*

Although the 1920s bridge building campaign that resulted in four new trans-Willamette structures also saw a re-emergence of political scandal and the reappearance of Pacific Bridge as a repeatedly successful contractor, the work of earlier reformers manifested itself in the prompt action taken when irregularities surfaced. In accord with the Progressive strategy of dividing power, state regulations now vested Portland's Willamette bridge building responsibility in Multnomah County, although traffic engineering remained a City function, adding further to the series of political hurdles any bridge proposal had to jump. County Commissioners continued the practice of employing distinguished outside consulting engineers and, once again, these men introduced new bridge types to the local scene.[7]

By the mid-1920s, only the Morrison remained of downtown Portland's early swing spans. Because the bridge was low and because swing spans needed to open fully for any craft to pass, the bridge interrupted traffic an average of 98 minutes a day. By contrast, the 1910 Hawthorne's vertical lift needed to be open only 22 minutes a day. The higher Burnside opened less frequently, but its bascule mechanism took longer to open and close, resulting in an average 24 minutes traffic interruption daily. With traffic increasing rapidly as more and more Portland citizens purchased autos, lived on the River's east side, and commuted to work on the West side, the Morrison Bridge's swing technology looked increasingly unacceptable. Many local voices, including that of the leading scholar of local river history and that of the city's preeminent professional engineer, called for its replacement.[8]

In 1927, the City Planning Commission went so far as to hire J. P. Newell to prepare a report studying an appropriate type and location for a new Morrison Bridge. Newell understood the transportation needs of Portland's citizens personally as well as professionally. Born in the East side home his parents built in the mid-nineteenth century, he managed to attend Portland High School only by walking three-and-a-half miles and taking the ferry to the Willamette's West side. After graduating from Oregon's only high school, Newell went on to become Oregon's first M.I.T. graduate, one of only two from the West coast. Like most successful contemporary engineers, Newell extended his training by working for various railroads. He

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Power: The Portland Establishment, 1843-1913 (Portland: The Georgian Press, 1988).

[7] Sharon Wood Wortman provides an overview of the 1920s bridge building campaign in HAER No. OR-101. Although completed in 1931, the St. John's Bridge was, with the Burnside, Ross Island, and Sellwood, a product of this campaign. See also, Carl Abbott, *Portland: Planning, Politics, and Growth in a Twentieth-Century City* (Lincoln: University of Nebraska Press, 1983) 98-100; E. Kimbark MacColl, *The Growth of a City*, 259-266, 347-353.

[8] Fred Lockley and J. P. Newell were the historian and engineer respectively. By 1920, more than 70 per cent of the city's residents lived on the East side. Between 1917 and 1925, Multnomah County motor vehicle registrations increased between 14 and 23 per cent annually. J. P. Newell, Consulting Civil Engineers to The City Planning Commission, Portland, "Report on Type and Location of Proposed New Bridge at Morrison Street," June 1927, Yeon Annex Records Center, Multnomah County Department of Environmental Services, Division of Transportation, Portland (hereinafter Yeon Records Center; Lockley, *Columbia River Valley*, 542; MacColl, *Growth of a City*, 39.

especially embodied the influence of reform on the engineering profession. After 1907 he devoted himself to private practice, emphasizing public service. He represented the state public service commission in a variety of rate cases, most notably the Columbia River differential case that ultimately benefitted Portland at the expense of Seattle. An expert in complex transportation valuation issues, he performed the calculations upon which the Canadian government relied in its arbitration of the Canadian Northern and Grand Trunk Railroad acquisitions, at the time the world's two largest property transfers ever arbitrated. In 1918, Newell became the first chairman of Portland's City Planning Commission; thereafter, he served it regularly as a consultant.[9]

Newell's report on the Morrison was exactly what one would expect from a man whose ethics had earned as much local esteem as his engineering expertise. After issuing cautions warranted by the haste with which he had complied with the Commission's request, Newell began with a judicious review of the existing bridge's structural soundness. Conde McCullough, Bridge Engineer for the State Highway Department, had examined the bridge in 1920, recommended a little over $200,000 worth of repairs, and concluded that once repaired "the structure will, without question, render excellent service for from ten to fifteen years under the heaviest traffic loading that may be reasonably expected." The County had heeded State calculations showing "it is the part of wisdom to repair rather than rebuild," and completed the work under McCullough's direction. When County officials found one west pier cylinder undermined in 1924, prompt repair followed. Newell also reported his assessment of the excessive vibration some had complained of; he discovered only vibration considered normal in a swing span.[10]

As an expert in planning, Newell then turned to the larger picture. After assessing both the growth of traffic and its recent redistribution thanks to the opening of three new bridges, he concluded that overall bridge capacity would probably meet Portland's needs until 1935. But, Newell continued, adequate total carrying capacity of the city's bridges did not assure that the needs of particular sections of the city would be met. After reviewing the fact that a few city bridges, including the Morrison, carried most of the city's traffic and documenting the substantially greater delays experienced on the bridge, Newell also called on the Commissioners to recognize that "Delays as frequent and as long as those on Morrison Bridge require that users of the bridge shall always take into account the probability of interruption and allow time for it whether it occurs or not. Their actual loss of time is therefore much greater than is represent[ed] by the time of opening."[11]

Especially revealing are Newell's plans for a new bridge. They reflect directly Portland's

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[9] Lockley, *Columbia River Valley*, 745-746; "Death Calls J.P. Newell of Portland," *Oregonian*, 12/7/1938, 8; "J. P. Newell; Able Engineer," *Portland Journal*, 12/6/1938, 12. Newell was also an extremely active Prohibitionist.

[10] Oregon State Highway Commission, *Investigation of Morrison Street Bridge, Portland, Oregon* (State Highway Engineer, 1920), 4-5; Newell, "Morrison Bridge Report," 1.

[11] Newell, "Morrison Bridge Report," 1-4.

experience with new bridges during the two decades since the 1905 Morrison was completed. Newell recommended consideration of two possibilities. One was a six-lane deck truss bascule "like Burnside," the new downtown bridge that had replaced the swing span just downstream from the Morrison. The accompanying drawing shows a structure whose design virtually replicates that of the new bridge, although the architectural similarities are hardly surprising given that L. L. Dougan, former partner in the architectural firm employed on the Burnside, served as Newell's architect for the report. (Figure 1, Appendix.)[12]

But Newell preferred a second option: a two-level vertical lift bridge, technologically mirroring the 1912 Waddell & Harrington Steel Bridge that crossed the Willamette next downstream from the Burnside. Newell's proposed bridge would have two independently movable decks each carrying four lanes of traffic. As befit a planner, Newell's preferences rested on the structure's greater carrying capacity; its segregation of commercial traffic, including horse-drawn vehicles, on its lower deck; its better grades; and the better distribution of traffic it provided to the more congested West side streets. The report's extremely detailed treatment of location, approaches, and street capacity undergirds this assessment. Recognizing that aesthetic preferences had changed substantially in the decade and a half since the Steel Bridge's construction, Newell addressed directly what he expected to be the principal objection to a new lift span. "The lift-spans of the Hawthorne and Railroad [Steel] Bridges are unsightly to the last degree, but this is not a necessary condition. By the use of towers made of steel columns encased in reinforced concrete, a massive, monumental structure may be produced which will be as pleasing to the eye as the graceful lines of the Ross Island Bridge, or the broad open spaces of Burnside." The accompanying drawing shows concrete-clad towers with a Mediterranean architectural motif quite in keeping with the new Burnside.[13]

In the event, neither bridge was built. The City Planning Commission and, in all probability, the County Commissioners must have found Newell's assessment of adequate overall capacity reassuring as they faced competing demands and a slowing economy. North Portland residents had long argued for a bridge downstream from the 1913 Broadway, a structure that continued to carry more than a quarter of all Portland trans-Willamette traffic. As Newell noted, traffic over the Broadway diminished imperceptibly after the opening of the new Burnside upstream, a marked contrast to the other downtown bridges and sure evidence that North Portland's needs remained unmet.[14]

Quibbling over a proposed location delayed and ultimately defeated the North Portland structure. Instead, highly organized business interests lobbied effectively for a bridge linking

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[12] Newell, "Morrison Bridge Report," 9-10 and drawings; HAER No. OR- 101 discusses Dougan's relationship to the Burnside project.

[13] Newell, "Morrison Bridge Report," 4-11.

[14] Abbott, *Portland*, 98-100; Newell, "Morrison Bridge Report," 2-3. Calls for a North Portland bridge went back to the first decade of the century when it was one option Ralph Modjeski considered when sketching alternatives for what became the Broadway Bridge. See HAER No. OR-22.

two peripheral villages. The resulting St. Johns Bridge sported a Gothic style that nicely symbolized its utter irrelevance to the realities of Portland's contemporary transportation needs. Although a favorite with bridge buffs, it carried virtually no traffic when it opened in 1931 and still carries proportionately less than other Willamette crossings. More important, its extravagant $4 million price tag, equal to the combined bond issue for the much needed Burnside and Ross Island Bridges, managed to exhaust most of the County's bonding capacity. The onset of the Depression simply aggravated the situation, delaying any prospect for a North Portland bridge or new Morrison Bridge until after World War II.[15]

Still, Newell's report remains important because it expressed convictions widely shared. It captures the 1920s consensus that survived to shape the 1950s structure. Its clarity also helped lay to rest several ill-conceived alternatives. For example, because the 1910 Hawthorne Bridge was also considered outdated, the idea of a "Super Bridge," simultaneously replacing the Morrison and the adjacent Hawthorne, had, according to Newell, "frequently" been expressed. As he noted, one major objection came as a result of the "diversion of the streams of traffic to new channels" with consequent adverse effects on existing property values and longer term "loss of confidence." This issue had concerned Portland's business and real estate interests ever since the traffic revolution wrought by the 1913 Broadway Bridge. The lessons learned in 1913 encouraged the location of new bridges either at existing sites or on the city's periphery. Newell's assessment reaffirmed that wisdom. It also documents the inadequacy of downtown thoroughfares to carry the heavy traffic a "Super Bridge" would deliver.[16]

Newell's report also succinctly expressed other areas of consensus: the importance of replacing the Morrison's oblique trajectory with a direct river crossing, the desirability of an East side viaduct to eliminate railroad level crossings and separate local warehouse traffic from through traffic, and the advantages of using Belmont Street as an East side approach. Most important, the report reveals that local bridge experience profoundly shaped local thinking about a new bridge. Both locally and nationally the use of swing spans for highway bridges had fallen from favor over the preceding decades. Portland had gradually eliminated its swing bridges, a choice Newell's report took for granted. But nationally, the vast preponderance of new movable highway spans were bascules, with fixed trunnions, such as the Burnside, gaining precedence over rolling lifts, such as the Broadway. Yet in Portland, where two of the nation's earliest vertical lift bridges flanked the Burnside and Morrison and continued to give excellent service, the option of using vertical lift technology looked appealing. Newell even considered it

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[15] Abbott, *Portland,* 99-100, 109. Portland's demographic and economic growth slowed substantially beginning in the mid-20s, a phenomenon Newell recognized when 1926 figures for the percentage increase in motor vehicle registrations scored in the single digits for the first time in nine years. Newell, "Morrison Bridge Report," 1-3.

[16] Newell, "Morrison Bridge Report," 12; HAER No. OR-22. Newell also nicely laid to rest the notion that the grade crossings might better be eliminated by waiting for the railroad to build an elevated structure.

worthwhile to spend more money to gain the advantages of vertical lift technology.[17]

Decision-Making in the 1950s

Despite the tumultuous events that had intervened since the mid 1920s, when the Multnomah County Commissioners began discussing a new Morrison Bridge in the early 1950s, surprisingly little had changed. The context for the new structure, supplied by the City's decisions about traffic and streets, reflected Portland's essential conservatism abetted by the aging of the city's population as its growth had slowed. In post-war Portland, crucial political positions, such as leadership of the Port of Portland Commission, the agency that exercised the State's bridge review prerogatives, remained in the hands of men who had assumed power in the 1920s. Other influential figures such as William Bowes, Public Works Commissioner from 1939 to 1969, represented the loyal Republicanism and close ties to local real estate interests that had long characterized the politically powerful in Portland. Like many of the city's business leaders, Bowes endorsed the approach of Robert Moses, whose 1943 plan for Portland was commissioned by the Bowes-appointed Portland Area Postwar Development Committee, headed by an influential realtor and dominated by ship-builder and industrialist Edgar Kaiser. The plan, embodying concepts quite familiar by the 1920s, called for extensive public works, mostly designed to make the city more hospitable to the automobile. A freeway running along the Willamette's East bank played a central role; the need for a new Morrison Bridge was made abundantly clear.[18]

Conservative consensus did little to assure action on the Moses plan. Sectional politics such as those that had skewed bridge distribution by the end of the 1920s doomed the plan's major features. For example, two attempts to fund civic center construction went down to defeat as Portlanders fought over location. West side movers and shakers assumed a West side location, albeit one that provoked further controversy, while a preponderance of citizens

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[17] Newell, "Morrison Bridge Report," passim; Otis Ellis Hovey, *Movable Bridges: Volume I.--Superstructures* (New York: John Wiley & Sons, 1926), 27-33; Donald N. Becker, "Development of the Chicago Type Bascule Bridge," *Proceedings of the American Society of Civil Engineers* (February, 1943), 263-293; Jeffrey A. Hess, "The Development of Wisconsin Movable Highway Bridges with an Emphasis on Bascule-Bridge Design Prior to 1940," in Jeffrey A. Hess and Robert M. Frame, III, *Historic Highway Bridges of Wisconsin, Volume 3: Movable Bridges* (Wisconsin Department of Transportation, 1996), 5-60.

Bruce Sinclair identified the importance of looking at local influences shaping twentieth-century engineering in "Local History and National Culture: Notions on Engineering Professionalism in America," in *The Engineer in America: A Historical Anthology from Technology and Culture*, ed. Terry D. Reynolds (Chicago: University of Chicago Press, 1991), 249-259. For a splendid demonstration of localism's salience see Matthew W. Roth, "Mulholland Highway and the Engineering Culture of Los Angeles in the 1920s," *Technology and Culture* (July, 1999), 545-575.

[18] Abbott, *Portland*, 135-152 and *passim*; "Record of County Commissioners Pertaining to the Construction of MORRISON STREET BRIDGE and HAWTHORNE BRIDGE APPROACHES," Multnomah County, Ford Building Archives, Portland, Oregon, 6/24/1954, hereinafter "Morrison Bridge Journal." I thank Sharon Wood Wortman for calling this and other "Bridge Journals" to my attention and Dwight Wallis, Records Administrator, for facilitating my access. For a discussion of various agencies exercising bridge approval power on the lower Willamette see HAER No. OR-21.

espoused a location on the East side where most of them lived. The absence of new leadership or a new vision made it even less likely that local citizens would overcome longstanding differences.[19]

Local political apathy reflected the anemic postwar economy. Despite its wartime industrial growth and a burst of immediate postwar prosperity fueled by delayed consumer spending, the Portland metropolitan area attracted relatively few Korean war dollars and few significant new economic ventures. Between 1949 and 1958, jobs grew slowly, unemployment remained near 5 per cent, and retail business stagnated. Not surprisingly, the County Commissioners approached public works decisions cautiously.[20]

A new Morrison Bridge gained approval because it had been on the agenda for a quarter of a century and because it threatened no significant changes in traffic distribution and real estate values. The Commissioners' call for a $12 million bond election reiterated the reasons why the bridge was needed in terms Newell had essentially enumerated more than twenty-five years earlier. "[T]he Morrison Bridge...is now fifty years old, and by reason thereof and its design, it is becoming increasingly expensive to maintain and is being rapidly outgrown in usefulness and becoming obsolete, the flow of traffic thereon is obstructed and impeded by frequent openings of its low draw, by its inadequate approaches subject to interference by crossing of trains and cross vehicular traffic, and with its limited clearances in height and width, the excessive present day traffic load thereon presents a constant danger of serious damages that could render this bridge unusable for an indefinite time." Citizens who had recently suffered through a month-long closure of the Morrison after the 1948 Vanport flood threw the low bridge out of commission readily endorsed the 1954 County bond issue.[21]

Because everyone, including the voting public and City, County, and State agencies, viewed the new Morrison through a perspective established in the 1920s, its essential features were set before discussions with consulting engineers began. The bridge was expected to be a deck truss bascule like the Burnside. And it was envisioned as speeding trans-Willamette traffic by offering six lanes, also like the Burnside. Equally important, it would assure enhanced traffic flow through improved approach and ramp design, including, especially, viaducts to carry automobile traffic over the East side railroads and warehouse district.[22]

Given local economic conditions, cost further constrained thinking about a new Morrison Bridge. Although shipping interests seeking greater horizontal clearance asked that a lift span be

[19] Abbott, *Portland*, 151-155.

[20] Abbott, *Portland*, 147-149.

[21] "Morrison Bridge Journal," 4/8/1954. On flood damage to the Morrison Bridge see Sharon Wood, *The Portland Bridge Book* (Portland: Oregon Historical Society Press, 1989), 31; Harry Stein, Kathleen Ryan and Mark Beach, *Portland: A Pictorial History* (Virginia Beach, VA: The Downing Company, 1980), 166.

[22] "Morrison Bridge Journal," 11/24/1953 through 7/20/1954; Sverdrup & Parcel Inc. and Moffatt, Nichol & Taylor, Consulting Engineers, "Preliminary Report No. 1: Morrison Bridge, Portland, Oregon, for Board of County Commissioners, Multnomah County, Oregon," 11/10/1954, *passim*.

considered, they agreed on cost as the principal arbiter. When 1954 calculations showed a bascule to be $360,000 cheaper for the same 220-foot opening, the choice of movable span was finalized. Likewise, although traffic speed and flow were established values that had grown even more highly prized since the 1920s, design of ramps and approaches was performed with an eye to keeping property acquisition costs down. And because no one could prove the future need for seven or eight traffic lanes, the added cost for a wider structure (approximately $650,000 more for a seventh lane) defeated suggestions for more than the six lanes Newell had envisioned.[23]

The years between 1927 and 1954 had not been entirely uneventful, although most new transportation developments simply underscored realities Newell's contemporaries had recognized. The most notable new development was the 1943 Harbor Drive Freeway, built along the Willamette's West bank on land cleared during the 1920s harbor improvement that removed aging docks and erected a seawall (a structure that would necessitate special treatment when it came to design the new Morrison's western pier). The Freeway's principal connections were with the Hawthorne and Steel Bridges, so the new Morrison, only a quarter mile down river from the Hawthorne, could be planned as a "local" traffic conduit in its West side connections. More generally, the dramatic increase in the Steel Bridge's traffic capacity that resulted from its new ramps underscored that approaches and ramps influenced bridge traffic capacity even more than did bridge width. New strategies, notably the use of one-way couplets of approach streets rather than the single streets Newell had envisioned, grew more common as Portland experienced the benefits of its early divided highways. Again, financial constraints played a role; even in the 1920s, Newell had anticipated the need to widen his single approach streets, requiring costly property acquisition. Existing pairs of three-lane streets, Alder and Washington on the West side and Belmont and Morrison on the East, could accommodate direct one-way bridge traffic without costly widening. Harbor Drive also exemplified the much greater role the Oregon State Highway Department now played in Portland's transportation system. State money and planning were largely responsible for the Harbor Drive Freeway and State opposition effectively blocked the proposed East Bank freeway from becoming a reality in the foreseeable future, allowing the new Morrison to be planned without costly provision of freeway ramps.[24]

A struggling local economy also generated repeated calls for the County Commissioners to favor "local professional people in the field of architecture, engineering and construction in the planning, design and construction of . . . projects which will be financed by local tax payers for the betterment of our community and our country," in the word of the Oregon Building Congress. More pointedly, the Multnomah Sheet Metal Works noted, "when other bridges were built, Multnomah County got men from out of town, but Portland men should get the Morrison bridge job." Other similar letters came from local engineering professors, labor unions,

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[23] "Preliminary Report No. 1," 2, 6.

[24] HAER No. OR-20 discusses the relationship of Harbor Drive to various bridges; on Lindenthal's recognition that approaches rather than width most influenced bridge traffic capacity see HAER No. OR-22 "Preliminary Report No. 1," 3-5; "Morrison Bridge Journal," 7/7/1954.

individual citizens, and prospective job applicants. Attuned to these concerns, both Hardesty & Hanover and Howard, Needles, Tammen & Bergendoff, successor firms to Waddell & Harrington, consulting engineers on both the Hawthorne and the Steel Bridges, teamed up with Oregon firms before tendering their services.[25]

When the County Roadmaster proposed that the Commissioners take advantage of a recent law requiring the State Highway Department to prepare and furnish plans and specifications without cost to other Oregon government entities, he also encountered the local Oregon Technical Council's opposition. The State agency was not local. The County Commissioners managed to resolve the conflicting demands to save money and to support the local economy when they learned that prior commitments would delay any State assistance at least nine months. Anxious to replace the failing bridge without delay, they asked the Roadmaster to solicit proposals from interested engineers. Roughly three weeks later they "ordered that the firm of Moffatt, Nichol & Taylor, 607 Concord Bldg., Portland, Oregon, be hereby invited to confer with regard to a contract for complete engineering services."[26]

A Conventional Bridge for a New Era: The Consulting Engineers

The Morrison Bridge was designed by a partnership between a local firm with diverse and extensive civil engineering and construction experience and a nationally prominent firm with extensive bridge credentials. This choice set the Morrison Bridge apart from every other bridge along the Willamette in Portland. Whether built by the City, the County, or the Railroad, all had been designed by nationally prominent individuals: J. A. L. Waddell, John Lyle Harrington, Ralph Modjeski, Ira G. Hedrick, Gustav Lindenthal, and David Steinman. As befit the decade of The Organization Man, the Morrison Bridge would, instead, be a corporate product. The different approach also made sense because local citizens and County officials had already made virtually all major decisions about the bridge. They wanted someone to design a conventional, cost-effective bridge to be smoothly integrated into the local transportation infrastructure. They did not seek guidance from a brilliant innovator intent on creating something novel.

Nonetheless, when the County Commissioners tapped Portland's Moffatt, Nichol & Taylor in conjunction with Sverdrup & Parcel of St. Louis and San Francisco to design the new bridge, they chose a group of engineers with a distinctive view, fundamentally different from the one previous consulting engineers had brought to Portland bridges. The great men who left their imprint on other local bridges had come of age in the late nineteenth century. Like Newell, they mostly learned their trade working for the railroads, source of most great civil engineering projects of that era. By contrast, the engineers of both Moffatt and Sverdrup had spent their prime years engineering the aviation and naval facilities of World War II and the Cold War. As organization men, they happily complied with Multnomah County's request, which assumed a relatively unimaginative structure, but they inevitably reshaped Newell's 1927 bridge in ways

[25] "Morrison Bridge Journal," 6/15/1954, 6/22/1954, 6/24/1954, 6/29/1954, and *passim*.

[26] "Morrison Bridge Journal," 6/22/1954, 6/24/1954, 7/20/1954, 8/12/1954, and *passim*.

that reflected their different experience.[27]

Moffatt, Nichol & Taylor emerged directly in response to postwar engineering opportunities. Founded in 1945 as a Long Beach, California, corporation, the firm also established itself as a Portland partnership in 1946. Moffatt's six principals brought a diversity of experience especially relevant to the bridge approaches and ramps for which they would take primary responsibility. Guy Taylor, in charge of their work in the Pacific Northwest, had come directly from active duty with the Army Corps of Engineers to join the new firm in 1946. The firm's portfolio included extensive work for private, municipal, and federal clients, all involving close collaboration with the heavy construction industry such as the Morrison Bridge would entail. In addition to the considerable waterfront construction one might expect of a firm based in Long Beach, Moffatt presented a long list of Air Force projects from Alaska to southern California and Arizona and a number of U. S. Naval Air Missile Test Center contracts. Locally, Moffatt had engineered the State Office Building, several industrial facilities, and portions of the Portland Air Force Base. A mid-sized firm with a technical staff of roughly fifty engineers, architects, and draftsmen, Moffatt also had substantial experience collaborating with firms that supplied specialties it lacked.[28]

Sverdrup & Parcel offered an even more extensive list of projects serving the postwar military-industrial complex. Its brochure highlighted the firm's recent or current engagement with "the expansion of a major steel plant, with the work being conducted and planned to have the least possible adverse effect on current production; the management from design through construction of a 230 KV electric transmission line for a group of public utilities; the design of major portions of an enormous hydroelectric development; and the planning and design of unprecedented aviation test facilities for the United States Air Force." Although its more than 600 employees, 90 per cent of them technically trained, encompassed an array of engineering and architectural specialties, its founding fathers set the tone. Even before Pearl Harbor, L. J. Sverdrup had been supervising the construction of Pacific air bases under a U.S. Army Corps of Engineers contract. He entered the Corps as a colonel in 1942, continuing in the southwestern Pacific until 1945, when he retired with the rank of major general. In the interim he supervised the building of 200 airstrips as well as innumerable roads and bridges. His earlier experience encompassed work for the Minnesota and Missouri State Highway Departments. In 1928, John

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[27] Here and in the discussion that follows I use "Newell's bridge" as a convenient shorthand for the 1920s consensus view of a new Morrison that remained essentially intact in the 1950s. Newell's vision was probably conveyed to Sverdrup and Moffatt only indirectly.

"Qualifications of Consulting Engineers," Submitted jointly by Moffatt, Nichol & Taylor and Sverdrup & Parcel, Inc., 1958 Morrison Bridge Construction Files, Yeon Records Center. As noted below, Moffatt also had headquarters in Long Beach, CA, but Morrison Bridge records indicate that the Portland office handled this local job. I have listed both the St. Louis and San Francisco offices of Sverdrup because personnel from both were involved; St. Louis as the main office and San Francisco as the regional office. Both offices show up on at least some of the Consulting Engineers' reports. Sverdrup also had Washington, DC offices to serve East Coast and International clients.

[28] "Qualifications of Consulting Engineers," *passim.*

I. Parcel joined Sverdrup in forming the new consulting engineering venture. The two had met when Sverdrup was Parcel's student at the University of Minnesota. Parcel represented the best in established steel bridge engineering practice, having coauthored a major textbook in the field and consulted on important projects such as the re-design of the Tacoma Narrows Suspension Bridge, still one of the longest spans in the world in the 1950s.[29]

Not surprisingly, Sverdrup's portfolio included both a long list of bridges and considerable work in the newer fields of aviation and defense contracting. Talented senior personnel included Carl J. Wenzinger, a pioneer of aerodynamics during his sixteen years with the National Advisory Committee for Aeronautics, who left Fairchild Aircraft in 1949 to head Sverdrup's aerodynamics section. The firm's architectural section was led by Edgar R. Kimball, who had come directly from military service in 1946. His experience as Engineer in Charge of projects such as the Willow Run and Romulus Air Fields well-prepared him for Sverdrup's array of Cold War architectural commissions including barracks, bombproof shelters, hangars, and research laboratories as well as industrial and civic structures. Guided by Kimball, Sverdrup understood architecture as broadly functional rather than decorative; the section's statement emphasized that it "designed for varying requirements of permanence, use, climate, and cost."[30]

Aviation-minded engineers and architects made two significant changes in the conventional 1920s bascule bridge that Portland and Multnomah County were committed to building. The first is apparent when one compares Sverdrup's earliest sketches of its proposed bascule with the drawing that accompanied Newell's proposal. (Figures 1 and 2, Appendix.) Whereas Newell's sketch incorporated the aesthetic that shaped the Burnside, an approach to bridge design in which historically-inspired decorative treatment was added to the structure, Sverdrup's Morrison is the resolutely modern product of men whose forms conveyed their functions. The Morrison's operator's houses are simple vertically elongated boxes that serve to lift the horizontal expanse of window that tops them high enough for a good view. Lest one doubt the origin of these characteristics, the final drawings, while including the bridge-oriented general label "operators' houses," show the individual structures with the labels "control tower." Essentially identical forms graced the many airports Sverdrup designed as well as other facilities such as a rail yard depicted in their brochure. Moreover, as though to emphasize their function, the Morrison operators' houses are placed asymmetrically on the pier faces next to the lift span, as if to underscore their connection with the opening, a marked contrast with the Burnside houses, placed symmetrically on the pier face so as to please those imbued with a traditional aesthetic. (Figure 3, Appendix.)[31]

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[29] Sverdrup & Parcel Corporate Brochure included in "Qualifications of Consulting Engineers," 4-5, 8-9.

[30] Sverdrup & Parcel Corporate Brochure, 10, 12.

[31] "Preliminary Report No. 1," 2 and "Perspective Study, Exhibit B"; "River Superstructure: Operator's House, Architectural Details," Morrison Bridge Drawing Number C32 of 72, 3/30/1956, Bridge Engineering and Maintenance Offices, Multnomah County; Sverdrup & Parcel Corporate Brochure, see photographs printed in the Aerodynamics, Architecture, and Miscellaneous Construction sections; HAER No. OR-101 provides a discussion of

Other features of Sverdrup's earliest Morrison sketch developed more fully in its final drawings. (Figure 4, Appendix.) They suggest that extensive experience with aviation shaped aesthetic preferences that went well beyond function. In their modern simplicity, the vertical striations that embellish the sides of the bascule piers manage to emphasize lift in a structure with essentially horizontal lines; Burnside's pier-side decoration, by contrast, ends up adding another horizontal element through its division into discrete arch and flat panels that parallel the deck and the truss chords. At the same time, whereas Burnside's architectural treatment breaks up the massive piers into smaller units, Morrison's decorative bascule pier treatment does nothing to diminish the substantial size that embodies the piers' function: to house substantial counterweights while carrying the load of both movable and fixed spans.[32]

But the Morrison's most striking nod to an aviation-minded aesthetic of lift is also its most subtle. In contrast to the Burnside fixed truss spans' bottom chords which simply parallel the horizontal lines of the deck and top chords, the bottom chords of the Morrison's fixed truss spans curve upward to their midpoints, an entirely aesthetic choice since structural demands would call for the truss to deepen at its center if anything. Sverdrup's selection of an austere Pratt truss also emphasizes lift through repeated diagonals, mirror images of the open bascule leaves. By contrast, the Burnside's complex lattice truss displays the same decorative impulse that shapes its piers and operators' houses. Subsequent drawings refined but did not essentially alter Morrison's aesthetic statement.[33]

Experience with aeronautics and maritime construction also prepared the Morrison's engineers to address hydraulic issues. Whereas railroad engineers concentrated on arranging earth and steel, paying relatively little attention to such flowing media as water and air, building naval and aviation facilities made fluid dynamics central to the engineering of the 1940s and 50s. Building an underneath counterweight bascule, the Burnside, on the Willamette had made highly visible the problem of ignoring flow around structures. Water tended to pile up around the two huge piers built to contain the counterweights, operating machinery, and heels of the moving bascule leaves. It rose as much as three feet higher than the surrounding river surface, making navigation through the bridge opening more difficult. As river operators pointed out to Moffatt and Sverdrup, the problem was complicated further because the river was only a few feet above

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Burnside Bridge architecture. Sverdrup's preliminary report described the result of their efforts as "clean, modern architectural lines." Although neither recommended nor built, Sverdrup's sketch of a vertical lift span also shows these aesthetic preferences. Newell's decorative concrete is gone and decoration comes from the deployment of functional elements such as cross-bracing. See Exhibit C and its Perspective Study in "Preliminary Report No. 1." All comparisons with Newell's work refer to his report cited earlier. Comparison of Figures 2 and 4, Appendix, shows that the operators' houses became mu ch more like air traffic control towers as the design developed.

[32] "Preliminary Report No. 1," Perspective Study, Exhibit B; "River Piers: General Elevation and Plan," Morrison Bridge Drawing A2 of 26, 8/30/57, Bridge Engineering and Maintenance Office; HAER No. OR-101.

[33] "Preliminary Report No. 1," Perspective Study, Exhibit B; "River Piers: General Elevation and Plan," Morrison Bridge Drawing A2 of 26, 8/30/57, Bridge Engineering and Maintenance Office; HAER No. OR-101. I am indebted to Ed Wortman, Multnomah County bridge engineer for helping me recognize the importance of the Morrison's curved bottom chords.

mean sea level at the Morrison Bridge site, so Columbia River tidal flow moved in against the Willamette's current twice daily. And, in addition to the Willamette's November to April freshets, the site felt the effects of the Columbia's April to July high water backing up the Willamette to raise the river level as much as twenty-six feet. Little wonder shipping interests preferred the more slender piers of vertical lift bridges![34]

Sverdrup's proposal, first sketched in Moffatt and Sverdrup's November 1954 preliminary report, responded to the Roadmaster's and river operators' concerns over further complicating Willamette River flow by installing the Morrison's even larger piers. The engineers' solution was to open up the piers between the tops of the footings and the upper portions housing counterweights and bascule mechanism. The resulting piers rested on a solid block of concrete at least twenty feet deep. Each extended eighty-six feet perpendicular to the river and sixty-seven-and-a-half feet parallel to the river, potentially creating a substantial obstacle to river flow had they continued upward to the river's surface. Instead, two ten-foot concrete shafts continued upward, one at each end of the underwater block. (Figure 5, Appendix.) Each ten-foot shaft measured sixty-four-and-a-half feet in width, paralleling the river's flow. Curved noses on the ten-foot shaft faces further reduced hydraulic obstruction, much as airplanes' curves directed air flow. The open section of the pier extended to twenty-two feet above mean low water, leaving ample room for the huge counterweights pits that filled the enclosed pier upper portions, while still creating an opening that accommodated normal Willamette River freshets. The shafts also responded to the river in each containing six hollow five by seven-and-a-half foot cells that filled or emptied to river level through drain holes as the river rose and fell.[35]

A final significant departure from earlier Morrison Bridge plans suggests that Sverdrup engineers were increasingly intrigued with the ever-widening potential of reinforced concrete. While continental European engineers had explored the new material for several decades, creating new forms and enhancing its structural characteristics through the technique of prestressing, Americans were only beginning to recognize these possibilities in the early 1950s. Their tentative steps in new directions are nicely exemplified by the Morrison Bridge's reinforced concrete beam, an integral part of the bascule pier structure. (Figures 5 and 6, Appendix.) Placed with its top at a 62.7 foot elevation, the beam served as a "trunnion support frame," to use the words of the engineering drawing. It replaced the steel cross girder that had been used to improve underneath counterweight bascules of the Chicago type (1908) and Strauss bascules of

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[34] It is worth noting that the famed "streamlining wars" that created sleek designs such as the Twentieth Century Limited took place in the 1930s under the influence of an aviation aesthetic. *Popular Mechanics* (February, 1934) 169-173, called it "Air-Minded Railroading," using the term widely employed in the 1920s and 30s to refer to aviation enthusiasm. John R. Stilgoe, *Metropolitan Corridor: Railroads and the American Scene* (New Haven: Yale University Press, 1983), 57 and *passim*; "$8.5 Million Buys a Bascule Bridge across Willamette," *Pacific Builder and Engineer* (February, 1958), 75. HAER No. OR-20 offers a fuller discussion of railroads as the great training ground of early twentieth century bridge engineers.

[35] "Preliminary Report No. 1," 1; "$8.5 Million Buys a Bascule Bridge," 75.

In the absence of much scholarship on 1950s movable bridges, it is impossible to assess how innovative this solution was.

roughly the same vintage (1905). The resulting patent litigation had made this feature of the Chicago-style bascule a focus of innovation. The Morrison's reinforced concrete beam lacked the strength the new prestressing technology might have supplied, but it has successfully carried its load for decades, a criterion that satisfied the engineers of the era. Unlike their early twentieth century predecessors, these World War II veterans had sufficient experience with the fragility of all structures not to expect their designs to be permanent.[36]

Sverdrup's engineering was shaped by what it lacked as well as by what it brought to the problem of creating a new movable bridge. Although its initial proposal supplied a list of movable bridge jobs completed or pending, a close examination suggests that Sverdrup had distinctly limited movable bridge experience. The list includes several repair jobs on existing structures and one design job for fixed spans that might later be converted to vertical lift bridges. Setting these aside, the firm had actually designed only ten movable spans. Sverdrup's movable bridge experience was notable only for its conservatism; most of its experience involved swing bridges and the remainder concentrated on vertical lift spans. The firm had designed only two bascules, both of them rather small. In consequence, Sverdrup was undoubtedly more comfortable sticking with established solutions devised by others, mostly engineers working for the City of Chicago.[37]

On the other hand, Sverdrup's relative inexperience with bascule bridges may have helped

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[36] On European developments see David P. Billington, *The Tower and the Bridge: The New Art of Structural Engineering* (New York: Basic Books, 1983), 147-212 passim. T. Y. Lin's 1955 text responded to American engineers' preliminary work with prestressed concrete. The first Portland bridge to incorporate the technology was the 1957-1959 Hawthorne Bridge West approach, also a Moffatt project. See HAER OR-20 Addendum for a discussion of why the shift occurred then, and also for treatment of early twentieth century engineers' concern with permanence. My appreciation of how mid-twentieth century military experience undermined confidence in permanence owes much to my uncle, Herbert Echols, who served with the Marines in China in the 1940s. He described helping build the longest bridge the Corps had ever constructed while simultaneously knowing that the bridge would be demolished by the enemy almost immediately after it was completed.

"River Piers: Piers 2 and 3, Concrete Outlines," Morrison Bridge Drawing A10 of 26, 7/18/1958, and "River Superstructure: Bascule Span, Assembled Layout," Morrison Bridge Drawing Number C37 of 72, 3/30/1956, Bridge Engineering and Maintenance Office. The beam is also well documented in the photographic progress reports, Morrison Bridge Construction Files, Yeon Records Center. J. B. Strauss, "Bascule Bridges," *Proceedings of the Second Pan American Scientific Congress: Section V: Engineering* (Washington: Government Printing Office, 1917), 311; Becker, "Chicago Type Bascule Bridge," 279-280, 286-287. Ed Wortman, bridge engineer, Multnomah County, helped me understand important features of the concrete beam and of the American adoption of prestressed concrete.

As noted earlier, until we have more scholarship treating the post 1940s history of movable bridges, the significance of this Morrison Bridge feature will remain unclear.

[37] "Movable Bridges Designed by Sverdrup & Parcel, Inc." included in "Qualifications of Consulting Engineers." The firm's prior bascule bridge design experience included a single leaf bascule over the Sacramento Barge Canal, a span 136 feet long with a 28 foot wide roadway, and a highway bascule in Brunswick, Georgia built for Jekyll Creek's modest 100 foot channel clearance. The firm's heavy reliance on earlier Chicago bridge engineering is discussed at length below.

foster one notable innovation. Historically, movable bridges had relied on DC motors when they used electric power; existing AC motors failed to supply adequate torque (rotational force). By the 1950s, though, new types of AC motors provided adequate torque and conformed better to the system of electric power distribution that had evolved in the interim. Sverdrup designed the Morrison with AC motors, a choice that was quite innovative at the time. Whereas firms accustomed to designing bascule bridges tended to stick with established practice, Sverdrup's lack of experience meant the lack of such a commitment. Moreover, the firm's extensive work with the electric power industry gave it greater confidence in using the newer electric technology.[38]

Construction Challenges

The Morrison Bridge presented enough construction challenges to be featured in the *Journal of the Construction Division of the American Society of Civil Engineers* as well as in several West Coast engineering journals. Moffatt and Sverdrup assumed joint responsibility for oversight, with Sverdrup supplying both the Resident Engineer, R. D. Bane, and his assistant, B. R. Smith, Jr., while Moffatt furnished a staff of one Chief Inspector, R. J. McKeown, and three Inspectors. When Smith left for another assignment in August 1957, McKeown assumed the position of Assistant Resident Engineer. Both Moffatt and Sverdrup brought to the project extensive experience supervising heavy construction, enabling them to suggest creative strategies to expedite the work and reduce its cost.[39]

Among the most important was Moffatt's persuasive argument that savings of time and money would accrue from using the same engineers and contractors on a new Hawthorne Bridge east approach that the County authorized shortly after the Morrison Bridge engineering contracts were signed. When Moffatt got the Hawthorne design contract and Kuckenberg Construction Company of Portland won the construction bids for both bridges' east approaches, the two structures were designed to incorporate similar components, reducing design costs, permitting reuse of forms and savings on equipment rental, and shortening construction time. Similar savings resulted when Manson Construction and Engineering Co. of Seattle, the river substructure contractor, proceeded sequentially, reusing cofferdam materials at each pier,

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[38] On the deep commitment to DC power for movable bridges even in the 1970s, see HAER No. OR-20. My sense of the innovativeness of Sverdrup's choice and the changes in electric motors that informed it is based largely on discussions with Multnomah County engineers. Until we have more study of bascule bridges built after 1950 it will not be possible to specify how innovative the decision was.

[39] R. D. Bane, "Construction of Morrison Bridge," *Journal of the Construction Division; Proceedings of the American Society of Civil Engineers* (May, 1960) Part 1, 1-8; "Piers Go Down for Portland Bridge," *Western Construction* (October, 1956), 64-65; "$8.5 Million Buys a Bascule Bridge," 75-78; Sverdrup & Parcel, Inc., and Moffatt, Nichol & Taylor, "Final Construction Report: Morrison Bridge and Approaches," 12/15/1958, Morrison Bridge Construction Files, Yeon Records Center, 2; "Qualifications of Consulting Engineers," *passim.*

including the two east approach piers for which it served as Kuckenberg's subcontractor.[40]

Moffatt and Sverdrup's most striking construction innovation kept the County from bearing the substantial hostility motorists vented when bridge construction projects created detours, crowding other river crossings and imposing delays. Moffatt and Sverdrup realized that the nature of the Morrison Bridge project created an opportunity to keep the old bridge in service throughout construction. This was an option because the new bridge would connect with an entirely new set of West side approaches in order to eliminate the oblique crossing that had narrowed the effective draw opening on earlier structures. Thus, the old West approach would remain accessible. On the East side, though, new construction had to take place where the easternmost span of the existing bridge and the existing approaches were located. The engineers offered a plan to construct a new, temporary path for the old Morrison at relatively modest added expense. Once the County Commissioners approved the added cost, General Construction Co. of Portland, subcontractor to U. S. Steel Corporation on the river superstructure, completed a new, temporary East side approach. Then, after stiffening the old bridge's easternmost span, General disconnected its east end from its seat and floated that end upstream on two barges to new temporary piers. Then, two short additional spans were inserted linking the newly angled old span to the temporary approaches. (Figure 7, Appendix.) The result was a bridge closing that lasted only six days rather than the projected nine month closure originally anticipated.[41]

Manson Construction & Engineering Co. of Seattle won the $1,908,516 contract for the river substructure, the greatest construction challenge on the bridge and the most hotly contested bidding competition. Walter Petersen served as general superintendent for Manson, with Clyde Sherman as superintendent and William Booth, project engineer. Local firms voiced their objections at the selection of a Seattle firm and attempted to challenge the choice. Manson's reliance on local workers, except for some supervisory positions, and the County's selection of local firms for the approach contracts helped reduce ill feeling. Manson's challenges included planning work around the Willamette's two high water periods and creating bascule pier cofferdams of unprecedented size.[42]

The west and east river piers supporting landward ends of the fixed spans (piers number 1 and 4) made no unusual construction demands. Because of its proximity to the West harbor wall

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[40] The records indicate that there was some dispute over whether Moffatt was initially the low bidder on the Hawthorne east approach contract; its competitor argued, by contrast, that having several different engineers at work would generate more diverse and innovative solutions, an argument comparatively unattractive in 1950s Portland. The County Commissioners mention only that Moffatt was the low bidder when ordering the contract award. "Morrison Bridge Journal," 11/30/54, 12/9/54, 12/14/54, 1/11/55, 7/3/56. Kuckenberg changed its pile-driving subcontractor to Manson to help realize these savings. "Final Construction Report," *passim*; Bane, "Construction of Morrison Bridge," 2; "Piers Go Down for Portland Bridge," 65.

[41] Bane, "Construction of Morrison Bridge," 6-7; "Final Construction Report," 33. Bane estimated that the temporary structure cost $70,000 including maintenance.

[42] "Morrison Bridge Journal," 10/6/55; "Final Construction Report," 4, 7; "Piers Go Down for Portland Bridge," 64; "$8.5 Million Buys a Bascule Bridge," 76-76.

and the need to avoid damaging that 1920s structure, pier 1 was located atop cemented gravel and rested on a spread footing, whereas the other three bridge piers were founded on fourteen inch steel H-piles driven into sand and dense gravel to penetrate thirty to forty feet below the seal course. Proximity to land also allowed pier 1 to be built using equipment delivered to the seawall; the remaining piers relied on a timber trestle running from the east bank, allowing heavy equipment to travel to and operate at the pier sites. Pier 1 also differed in its incorporation of a weather gauge, float well, and instrument shelter to serve the needs of the U. S. Geological Survey's Water Bureau Branch, the U. S. Weather Bureau, and the Portland District of the Army Corps of Engineers.[43]

That even relatively routine construction involved hazards was underscored on each of the fixed span piers. One of three serious accidents took place on pier 1 when a foreman fell twenty feet from a platform inside the cofferdam and spent several days in the hospital before returning to work. Pier 4 was poured without personal injury, but created a crisis when workers noticed the failure of steel struts inside the cofferdam as they were pumping out the water. While the water level was maintained to avoid altering pressure on the cofferdam, new struts were welded alongside the old. When the river continued to rise, the contractor placed additional struts near the tops of the side wales. The reinforced structure successfully withstood pressure from a river that came within an inch of overtopping it.[44]

The bascule piers (numbers 2 and 3) made the greatest construction demands. According to Pacific Builder and Engineer, their cofferdams were "probably . . . the largest single wall types ever to be constructed in this country," ninety feet long and seventy-six-and-a-half feet wide. Pier 2 was especially hazardous, requiring the deepest excavation (about seventy-eight feet below mean low water) and the most substantial seal course (a twenty-six foot deep layer of concrete). Its construction was also delayed by unusually high water. The procedure Manson used began with assembling the cofferdam's two lowest rings of internal framing on top of a barge, floating the barge to the pier location, driving steel guide piles through the frame's corners where they overhung the barge, and filling the barge with water to lower it, permitting its removal. Then, the two upper rings were built atop the structure, it was lowered into position, and sheet piles were driven to create a perimeter extending from more than eighty feet below to more than ten feet above low water. Next, 154 fourteen-inch piles were driven to a tip elevation more than 120 feet below low water.[45]

Transit mix trucks then brought concrete along the timber trestle for a thirty-four hour continuous pour of concrete through five nine-inch diameter tremie pipes to create a seal course incorporating over 5,500 cubic yards of concrete. Seven days later this was pumped dry and

[43] "Piers Go Down for Portland Bridge," 64-65; "$8.5 Million Buys a Bascule Bridge," 75-77; "Final Construction Report," 10-17; "Morrison Bridge Journal," 7/12/55.

[44] "Final Construction Report," 7, 13.

[45] "8.5 Million Buys a Bascule Bridge," 76; Bane, "Construction of the Morrison Bridge," 2; "Final Construction Report," 14.

cleaned of any water-damaged surface material. A ten foot deep concrete footing was poured inside the dry cofferdam, followed by pouring of the ten-foot wide end shafts, the counterweight pit slab that rested atop the shafts, the bascule walls, trunnion beam, control house and top slabs. Although Manson exercised considerable care, anchor bolts and thrust key frame built into the concrete for attaching the machinery varied as much as 3/8 of an inch from the plans for pier 2, so Manson made templates of bolt and key frame positions and shipped them to the superstructure contractor for use in establishing machinery frame holes. As pier 2 neared completion, a second serious accident took place when a carpenter fell eighteen feet from staging high on the pier. He spent several weeks in the hospital and never returned to the project. Once pier 2 shafts were complete, the cofferdam was removed and its rings floated to pier 3's location for reuse. Manson completed pouring pier 3 on 7 June 1957 and the Resident Engineer adjudged the structure ready for steel erection 12 July 1957.[46]

The Portland office of U. S. Steel Corporation's American Bridge Division garnered the superstructure contract for a bid of $2,270,433, a much less controversial award because the only other bid came from a California firm and because virtually all of the work save for the steel fabrication went to four local subcontractors. American Bridge had originated in 1900 when financier J. P. Morgan consolidated many existing bridge companies into a single firm. In 1901 when U. S. Steel, the nation's largest structural steel producer, acquired American Bridge, the firm controlled half the nation's bridge fabricating capacity. On a project that otherwise brought a host of new firms to Portland bridge construction and engineering, U. S. Steel was the sole case of continuity. Its previous local work included fabricating the 1912 Steel and the 1926 Burnside Bridges.[47]

River superstructure construction was relatively uneventful technically, but punctuated by unrest that characterized the era's labor relations. Most dramatic was a nationwide steel strike that began 30 June 1956, shortly after American Bridge received the Morrison contract. Again, the experience Sverdrup brought to construction management paid off. The Resident Engineer quickly revised plans. Work on the superstructure began in August 1957 with electrical work and operators' houses in lieu of steel erection. Combined with effective mobilization of local A. F. of L. affiliated workers once structural steel began arriving, changes in the erection sequence meant the bridge opened only two and a half months late despite a six month delay in receipt of structural steel. Part of this delay resulted when a second strike in 1957 hit U. S. Steel's oxygen supplier. Plants in Gary, Indiana, and Memphis, Tennessee, fabricated structural members. Brief work stoppages also took place locally when the area laborers' union struck in May 1958. A final strike by the Portland area operators' union delayed for over a month the various tasks involved in clearing the site after the new bridge had opened. The Resident Engineer deemed the

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[46] Bane, "Construction of the Morrison Bridge," 2; "Final Construction Report," 7, 14-17.

[47] "Final Construction Report," 29; Bruce Clouette and Matthew Roth, *Connecticut's Historic Highway Bridges* (Connecticut Department of Transportation, 1991), 9-10; HAER No. OR-21; HAER No. OR-101.

contract fulfilled on 31 October, 1958.[48]

American Bridge erected the Morrison superstructure using methods already well-honed by this established firm. Ironworkers built the two fixed truss spans on shore and floated them into position. The bascule was erected in place in the closed position, thus blocking mid-river passage, so the river was left open between piers 1 and 2 by delaying the west fixed span's seating until after the bascule could operate. Northwest Marine & Iron Works of Portland built the bascule machinery, assembling the racks and testing pinion gear tolerances before the rack sections were match-marked and disassembled for shipment to the Gary truss fabricator. There they were shop-positioned using undersized bolts and holes to permit final adjustment in the field. In the event, only an eighth of an inch adjustment needed to be made in pier 2's upstream rack before final reaming of holes allowed full-sized turned bolts to attach the racks to the sides of the trusses. Balanced bascule erection took place by alternately placing steel truss members and pouring counterweight concrete. (Figure 5, Appendix.) Temporary timber supports held the counterweight frame until the pour was finished.[49]

Although the sidewalk superintendents who gathered daily on the old bridge focused their attention on the new Morrison's growing river spans, the largest single contract was that of Kuckenberg Construction Co. of Portland for the East approaches. The award came for a bid of $3,031,572 in April 1956, reduced by $60,000 after Kuckenberg received the Hawthorne East approaches contract and deducted a total of $90,000 from its two bids to represent savings from combining the two projects. Save for its use of Manson to drive piles and construct the approach spans' river piers, Kuckenberg relied exclusively on local subcontractors and employed a workforce drawn from various A. F. of L. locals. Despite initial fears of strike delays, structural steel arrived somewhat ahead of schedule and no other job actions occurred. Test piles repeatedly revealed the need for deeper excavations, longer piles, and deeper penetrations. Irving Olsen, representing local soil experts, Dames & Moore, guided these decisions and helped develop inspectors' guidelines for pile driving.[50]

Kuckenberg's work gained special attention in the technical press thanks to its development of several custom-built machines to expedite the job. One was a concrete roller-finisher used on the approach decks. It operated on rails attached at precisely the right elevation on the sides of the deck forms. The machine struck off and partially finished the slab in a single operation so that only minor finishing operations remained. Kuckenberg also devised end dump trucks that speeded work by hauling up to ten cubic feet of gravel at a time and a hoist that

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[48] "Final Construction Report," 30-37; Bane, "Construction of the Morrison Bridge," 5.

[49] "Final Construction Report," 35-37; Bane, "Construction of the Morrison Bridge," 6. When American Bridge helped create Portland's 1912 Steel Bridge it used many of the same techniques. See HAER No. OR-21 Addendum. See HAER No. OR-20 and HAER No. OR-22 for other examples of continuity. American Bridge was represented on the project by W. J. Grosz, district manager, and Jack Turnipseed, superintendent. "8.5 Million Buys a Bascule Bridge," 78.

[50] Bane, "Construction of the Morrison Bridge, 5, 7; "Final Construction Report," 18-19, 22-25.

combined components of standard fork-lift, hydraulic hoist, and tower to allow rapid placement and removal of forms under the elevated structure. Merrill Henderson and Aandy Spooner provided Kuckenberg's engineering; R. A. Mortensen and Cliff Briggs superintended.[51]

The smallest and least challenging contract went to Donald M. Drake Co. of Portland, whose $1,178,360 bid earned it the West approaches contract in July 1956. Better known for erecting buildings, Drake was a newcomer to bridge construction and it had the ill-fortune to experience the project's sole fatality. On 22 October 1956, a Mr. Davies, employed by Portland-based subcontractor, Mercer Steel Company, was checking reinforcing steel placement when an earth slide buried him. In other respects the Drake contract was mostly distinguished by features attributable to Portland's habitual deference to its more influential West side residents. Unlike the East approaches contract in which lawn sprinklers supplied the only nod in the direction of organic beautification, the West approaches contract included several thousand dollars for a landscaper as well. And, reflecting the relatively greater power of West side businessmen, several West side property owners managed to delay demolition work by challenging County vacation schedules.[52]

All things considered, the Morrison Bridge construction project proceeded remarkably smoothly. The bridge opened to traffic after a dedication ceremony on 24 May 1958. The old bridge closed right afterwards; its demolition began two days later. Following a planned shakedown period during which County personnel learned maintenance and operating procedures from the superstructure contractor, the entire structure was declared complete on 5 December 1958. From a vantage more than forty years later, the project's finances are even more impressive than the engineers' ability to keep close to schedule. Both Manson and American Bridge tendered final estimates slightly under their original bids. Kuckenberg ran over by a modest 4 per cent and Drake by a slightly greater 6 per cent. The final cost as of the Engineers' 15 December 1958 report was $8,479,726.19, less than 1.5 per cent over total bid costs. The County Commissioners had managed to get what they had bargained for.[53]

The 1958 Morrison Bridge

The 1958 Morrison Bridge was essentially a Chicago-type simple-trunnion, underneath-counterweight bascule bridge. It departed from the earliest (1900-1910) Chicago bascules in few and predictable ways, notably in being a deck truss bridge and in using a concrete counterweight

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[51] "$8.5 Million Buys a Bascule Bridge," 77-78; "Final Construction Report," 26; Bane, "Construction of the Morrison Bridge," 5.

[52] "Final Construction Report," 38-41, 44, 56; "$8.5 Million Buys a Bascule," 78. James Nelson superintended for Drake while Leo Schalansky served as project engineer. "Morrison Bridge Journal," provides extensive and detailed documentation of the very time-consuming and expensive process of acquiring land for the new approaches. On bridge features revealing County deference to West side clout see HAER No. OR-20.

[53] "Final Construction Report," 30, 34, 50-56. Bane, "Construction of the Morrison Bridge," 1, supplies a total cost figure of over $13 million which includes real estate acquisition costs and building demolition.

whose size required greater pier accommodation, features in common use by the 1920s. It also benefitted from Chicago's engineers' continued development of the type; it especially incorporated refinements worked out in the 1920s and 1930s. In true 1950s spirit it aimed to deliver the most "bang for the buck." It succeeded in being a relatively inexpensive but highly functional structure largely because it used technology so familiar as to ease its design and construction and because it substituted lighter materials wherever possible. It added to the Chicago package several items that 1950s Portlanders particularly sought: approaches and dimensions suited to eventual integration with the "modern" freeway system Portland aspired to, while leaving the actual freeway connections to be built at predictably greater cost once state and federal funding became available.[54]

The bridge crossed the river in three spans, two fixed Pratt deck-trusses, each 206 feet 8 inches long and 90 feet wide, and a 262-foot double-leaf bascule span providing a 220-foot clear horizontal channel and unlimited vertical clearance when open. When closed it provided a 225-foot horizontal opening between the inside faces of its bascule piers, and its relatively high upward-curving bascule deck trusses afforded 67 feet of vertical clearance above mean low water. A 78-foot wide roadway topped the trusses, divided into six lanes, while two 5-foot sidewalks accommodated pedestrians. Its West approaches carried traffic over three cross streets to and from two three-lane one-way approach streets: Washington and Alder. On and off ramps also connected to Front Street which paralleled the river. The East approaches extended roughly 1,900 feet beyond the East bank, carrying traffic over five cross streets to continue on two three-lane one-way approach streets: Morrison and Belmont. On and off ramps supplied connections with the one-way couplet, Union and Grand, that paralleled the Willamette comprising Highway 99E. Additional on and off ramps descended to provide commercial vehicles access to and from Water Avenue, which paralleled Union and Grand close to the river. (Figure 7, Appendix shows

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[54] With the exception of bridge features treated earlier, the features of the bridge supporting these generalizations will be discussed in what follows. I am indebted to Jeffrey Hess for his willingness to examine several Morrison Bridge drawings and for several e-mail discussions that helped confirm that the Morrison is a Chicago-style bascule. This was especially important since knowledge of the distinctions among simple trunnion bascules has ceased to be common among consulting engineers. Several more recent documents referred to the Morrison as a Strauss bascule, including a 1985 report produced by the two firms that originally built the bridge. The principal difference is that in the Chicago-style bascule the counterweight is rigidly affixed to the rear of the truss; in Strauss bascules the counterweight is connected through a series of pin-connected structural members that form a parallelogram, allowing the counterweight to remain parallel to its original position and maintain a balance as the leaf revolves. Unlike Chicago-style bascules, Strauss bascules take a variety of forms, including overhead, underneath, and heel trunnion types. This diversity made them the most common trunnion bascule by the 1920s, probably explaining the propensity of late twentieth-century engineers to assign the label indiscriminately. Sverdrup & Parcel and Associates in association with Moffatt, Nichol & Bonney, Inc. and Milton C. Stafford, "Morrison Bridge Investigation: Engineering Report," 6/1986, especially "Morrison Bridge Summary," 1, Yeon Records Center; Hess, "Wisconsin Movable Highway Bridges," *passim* and electronic correspondence with author, 7/12/1999 and 11/24/1999; Becker, "Chicago-Type Bascule," 263-293; Hovey, *Movable Bridges*, 115-128.

many of these features.)[55]

The bridge's arc over the river not only accommodated shipping, but also enabled the engineers to design maximum 5 per cent grades on the approaches and ramps; 4 per cent on the Water Avenue on ramp that carried heavy truck traffic. The bridge's curve permitted design speeds of slightly over 40 miles per hour, while approaches had 40 m.p.h. minimum design speeds. Ramps had design speeds as low as 20 m.p.h., a consequence of the County's need to keep property acquisition costs reasonable. Design speeds reflected extensive discussions between the City Traffic Engineer and the Oregon Highway Department. The all-welded steel girder approach superstructure rested on reinforced concrete bents that varied widely in their spacing to permit access to the various streets and buildings below. (Figure 7, Appendix.) While current traffic was relatively well-served, only one ramp, the Morrison "on" ramp, was placed to permit ready connection to the proposed East side freeway. Nonetheless, the bridge was the first designed in anticipation of an adjacent freeway so the engineers at least did nothing to impede its eventual integration.[56]

Several framing panels comprised each bascule leaf. Starting from the bridge's center break, each leaf included two plate girder panels 18 feet 11 inches and 18 feet 8 inches long, followed by four 18 foot 8 inch Pratt truss panels. To create the upward arch along the bottom of the bascule span, the panels had shorter verticals nearer the span's center. (Figure 4, Appendix.) Surrounding the trunnion and comprising the heel were four additional truss panels of 18 feet, 10 feet 9.5 inches, 9 feet 8.75 inches, and 11 feet. Like all Chicago-style bascules, the bridge's roadway break occurred on the river side of the trunnion, permitting the open leaf to serve as a traffic barrier. (Figure 8, Appendix.) Because the fixed span deck surface extended over the heel of the bascule leaf, the heel carried no live load, making heel locks unnecessary. Two center shear locks were attached to the west bascule leaf; the east leaf held the lock mouths. In all this, the only notable departure from Chicago practice was the use of the plate girders at the tip of each bascule leaf, a feature that allowed the structure to narrow for added river clearance. Continuing the trusses to the tips of the leaves would have required shorter panel lengths to achieve the upward curve; girders were, therefore, more cost effective. The same feature had been used on Portland's 1920s downtown bridges: the Burnside and the Ross Island.[57]

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[55] Bane, "Construction of Morrison Bridge," 1-2; "8.5 Million Buys a Bascule Bridge," 77; "Preliminary Report No. 1," 2-6.

[56] Preliminary Report No. 1," 2-6. The East approach bents reveal the limited bridge engineering experience that the Moffatt firm brought to its task. Recalculations by the Oregon Department of Transportation as part of its periodic inspection system revealed that they had not been designed in conformance with the then-current ASHO design code. Multnomah County had to carefully recalculate and ultimately, in 2000, strengthened three of the bents as a result.

[57] Ed Wortman, Multnomah County bridge engineer, helped me understand the function of the central plate girder and recognize its prior local presence. London's Tower Bridge offered a much earlier exemplar of this technical choice. "River Superstructure: Bascule Span, Truss Diagrams and Stress Table," Morrison Bridge Drawing Number C10 of 72 and "River Superstructure: Bascule Span, Assembled Layout," Morrison Bridge

Four 100-horsepower AC electric motors powered the bridge, each with a motor brake rated at 1000 lbs. ft. torque and a machinery brake rated at 6000 lbs. ft. torque available to slow the process. Each set of motors and brakes became part of one of four separate sets of machinery (two sets for each leaf). Together with shafting and gearing, they were set in cast steel frames that were keyed and bolted to the concrete substructure at a location about fifteen feet above the floor of the counterweight pit. (Figure 8, Appendix.) Anchoring the machinery to the masonry was an improvement that had been suggested in 1900 when a Board of Consulting Engineers, including Ralph Modjeski, reviewed the earliest Chicago bascule bridge proposal. The improvement had finally made its way into a Chicago bridge in 1924 during the type's 1923-1941 "refinement period," from which the Morrison Bridge benefitted in several additional ways.[58]

Another such refinement involved the bridge's segmental rack, which formed a segment of a circle of 28 feet 6 inch pitch diameter. Like all Chicago bascules, the bridge operated when its machinery activated a pinion that transmitted power to the rack. Each of the Morrison's four racks was mounted on the outside of the truss behind the trunnion rather than being attached on the very back of the truss so as to operate in the same plane. (Figure 8, Appendix.) This change had also been introduced on a 1924 Chicago bridge as part of the City's decision to avoid using any patented component. As on the Morrison, this meant that Chicago engineers also devised a novel trunnion support structure, albeit a very different one than the Morrison's reinforced concrete beam. Of the various Chicago mechanisms, Morrison's beam was most like the cross girder that Chicago bridges of the 1910s incorporated; it passed through the trusses and supported the inside trunnion journals, although as an integral part of the substructure it differed considerably from the Chicago innovation.[59]

When the four pinion gears moved against the four racks' sets of teeth, they caused the Morrison's two 900-ton concrete counterweights to descend. The Morrison counterweights, like those on all Chicago-style bascules, were rigidly affixed to the back of the leaf trusses. As they moved downward and inward toward the bridge's center, the counterbalancing leaves moved

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Drawing Number C37 of 72, Bridge Engineering and Maintenance Office; Hess to author, 7/12/1999 and 11/24/1999; Becker, "Chicago-Type Bascule," *passim.*

[58] "River Superstructure: Bascule Span, Leaf Machinery Assembly," Morrison Bridge Drawing Number C38 of 72, "River Superstructure: Bascule Span, Assembled Layout," Morrison Bridge Drawing Number C36 of 72, and "River Piers: Piers 2 and 3, Concrete Outlines," Morrison Bridge Drawing Number A10 of 26, Bridge Engineering and Maintenance Office; Becker, "Chicago-Type Bascule," 271, 286-287. The term "refinement period" and the periodization are Becker's.

[59] "River Superstructure: Bascule Span Truss Details, Panels 10-11, Rack Details," Morrison Bridge Drawing Number C20 of 72 and "River Superstructure: Bascule Span, Assembled Layout," Morrison Bridge Drawing Number C37 of 72, Bridge Engineering and Maintenance Office; Hess to author, 11/24/1999; Becker, "Chicago-type Bascule," 280, 286-287 and passim. Strauss, "Bascule Bridges," 311, claims the cross-girder innovation, although Becker seems more to the point when he notes that European precedent long antedated both Chicago and Strauss.

upward and away from the bridge's center. The Morrison provided for a maximum 73 degree opening, although 71 degrees was deemed normal on the 1958 bridge. As had been true on the earliest Chicago bascules, bumper blocks on the inside bridge-center walls of the counterweight pits helped cushion the leaf's arrival at a fully open position. Air buffers and heel rests on the heel-side inner walls served to slow and hold the trusses as the leaf reached its closed position, again following early Chicago precedent. (Figure 8, Appendix.)[60]

At the center of all this movement, resting about forty feet above the floor of the counterweight pit, was the cast steel trunnion whose shaft revolved within fixed cast steel bearings lined with bronze alloy bushings. Unlike earlier rolling bascules, such as the Broadway Bridge, downstream but within sight of the Morrison, fixed trunnions kept the weight of the moving leaf concentrated at a constant location. On the Willamette, as in Chicago, this was a distinct advantage; creating "unyielding foundation" on soft, local riverbeds required very costly substructure work.[61]

In general, then, Sverdrup and Moffatt combined to give Multnomah County the best bridge for its money by reaping the advantages of "being second." Chicago had already borne the cost of innovation, both in design and in construction. The Morrison Bridge also incorporated another important cost saving approach. Its lift span deck used 5" AmBridge I-Beam-Lok, a steel flooring manufactured by the bridge's superstructure contractor. By installing a lightweight open-grate deck, the County saved about $110,000; a concrete-filled deck, whose use on bascules the neighboring Burnside Bridge had pioneered, would have required added costs for trusses, counterweights, and operating machinery. The two side span decks were also lightened, in their case by using a lightweight aggregate, expanded shale, to produce concrete with a dry weight of only 103 pounds per cubic foot. Neither of these choices was pioneering. The selection of steel grate decking once again followed Chicago precedent, that of the 1943 South Canal Street Bridge, the last span erected during the era of bascule technology refinement. More generally, the drive to create increasingly light bridges had engaged leading American and European engineers throughout the interwar years.[62]

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[60] "River Superstructure: Bascule Span, Assembled Layout," Morrison Bridge Drawing Number C37 of 72 and "River Superstructure: Bascule Span, Truss Diagrams and Stress Table," Morrison Bridge Drawing Number C10 of 72, Bridge Engineering and Maintenance Office; Hess to author, 11/24/1999; Becker, "Chicago-Type Bascule," passim. From the beginning, the Morrison was equipped with concrete blocks that could be placed in the counterweights to increase and decrease their weight as conditions warranted.

[61] "Morrison Bridge Superstructure: Bascule Span, Assembled Layout," Morrison Bridge Drawing Number C37 of 72 and "River Super Structure: Bascule Span, Leaf Machinery, Trunnions and Bearings," Morrison Bridge Drawing Number C42 of 72, Bridge Engineering and Maintenance Office; Becker, "Chicago-Type Bascule," 270-272; "Final Construction Report," passim.

[62] "Preliminary Report No. 1," 2; J. H. Long, General Contracting Manager, American Bridge to P. B. Northrup, County Engineer and Roadmaster, 10/18/1966 and enclosed I-Beam-Lok Catalogue, Morrison Bridge Deck File, Yeon Records Center; Bane, "Construction of the Morrison Bridge," 6; Becker, "Chicago-Type Bascule," 290, 292; Billington, The Tower and the Bridge, passim; HAER No. OR-101. Open web steel decking had replaced

The Morrison Bridge in 2000

More than forty years after it opened, the Morrison Bridge remains essentially the same. Its only significant alterations have been associated with the completion of Interstate 5 through Portland in 1966. Completion of the long-anticipated East Bank freeway finally gave concrete form to a plan that preoccupied local transportation officials for more than a generation and, at the same time, placed the final link in a highway that extended from southern California to northern Washington. As expected in the early 1950s, the Morrison was chosen for integration with the new structure and new ramps were readily incorporated into the already extensive East side approaches. They linked the bridge to the I-84 Banfield Expressway as well. In altering the traffic patterns for which the bridge had been designed, though, integration with the freeway system aggravated wear of the lightweight concrete truss span decks, especially the East river span (between piers 3 and 4). The deck was replaced with a concrete-filled steel deck in 1981 and required an asphalt overlay in 1994. Replacement of the West river span's deck (between piers 1 and 2) was foreseeable as early as 1986 and performed in 1994. The West approach decks were renovated at the same time; East approach renovation is slated for 2001.[63]

Conclusion

The 1958 Morrison Bridge exemplifies bridge construction in a conservative era. It incorporates a bascule technology first devised in Chicago in 1902 and draws on many of the refinements Chicago engineers worked out in the 1920s and 1930s. It did so in part because the bridge had been on the drawing board since the 1920s and the Multnomah County Commissioners of the early 1950s were not disposed to innovate. A Chicago-style bascule also made sense to local decision-makers in the context of Portland's extensive local bridge history; here, as in many other ways, the Morrison Bridge reflected prior experience with the adjacent 1926 Burnside Bridge in particular. And the Morrison's essential form and mechanism made perfect sense as a choice for engineers with a mandate to keep costs low.

But the 1958 Morrison also shows that even conservative bridge design inevitably expresses the recent history of technological change within which engineers and politicians make their decisions. Most specifically, the Morrison's unusual concrete trunnion support beam came from engineers otherwise engaged with innovative use of reinforced concrete. Most of the

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older wooden decks on Multnomah County's Hawthorne and Broadway bridges in the 1940s.

[63] I am indebted to Ed Wortman, Multnomah County bridge engineer for information about plan for the East approaches. As noted earlier, three East approach bents were strengthened in 2000.

Since the original construction, only other substantial contracts for the bridge involved fender replacement and electrical upgrades, mostly designed to enhance safety and reduce operating expenses. Wood, Portland Bridge Book, 43-48. Morrison Bridge Files, passim, especially, Sverdrup et. al., "Morrison Bridge Investigation," 6/1986; L. F. Pierce, Chief Engineer, Oregon Bridge Engineering Co., to Oliver J. Domreis, Multnomah County Engineer, 6/20/1977; Agreement, County of Multnomah and OBEC Consulting Engineers, Engineering Study, Concrete Deck, Morrison Bridge, 9/29/1977, all at Yeon Records Center.

Morrison's modern features, though, reflected broader patterns of technological change. The bridge took shape at the hands of large corporate entities; its engineers remained anonymous, a manner of doing business utterly foreign to the men who had designed Portland's other Willamette bridges. Nonetheless, they placed their generation's signature on the bridge by building a span with the functional aesthetic of the Cold War structures in which they specialized and designing with an aviation-inspired flourish that spoke of their common World War II heritage. Lest anyone miss the connection, the bridge's dedication festivities began with a color guard from the 337th Fighter Group at Portland's U. S. Air Force Base and concluded with a performance by the F-102 Jets from the Tacoma Base's Air Force Fighter Wing. In between, in a tableaux rich in 1950s traditionalism, the three County Commissioners' wives used gold scissors to cut the ribbon, opening the long-awaited bridge.[64]

Like much American discussion of technology, professional and popular, HAER inventories have generally concentrated on bridges that were pioneering or have become rare and quaint survivals. Such histories are certainly important, but most technology and most bridges are not pioneering and will never be quaint. Lacking the high profile of other, path-breaking Portland bridges, the Morrison quietly speaks volumes about the ordinary course of technological change, a story we have mostly failed to tell.[65]

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[64] Program, Morrison Bridge Dedication, Portland, Oregon, 24 May, 1958 Morrison Bridge Construction Files, Yeon Records Center.

[65] Several individuals deserve my special thanks for helping me tell the story. Mary Hardy presides over the bridge materials at the Yeon Records Center with a combination of enthusiasm and expertise that is tough to beat. Jeffrey Hess gave the clear explanations and leads to crucial further reading that only an expert on bascules could have supplied and he did so in a heartening spirit of comradeship. Matt Roth taught me just about everything I know about freeways and planning and 1950s' history; more remarkably, he helped me care about them. Ed Wortman enabled me to see features of the bridge I would never have recognized unaided, while consistently demonstrating that it is possible to discuss complex technology in standard English. Sharon Wood Wortman was unfailingly generous with her findings and genuinely supportive of mine; she also gives great Morrison Bridge tours! Needless to say, these people are not responsible for anything I got wrong.

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APPENDIX

Figure 1: J. P. Newell's 1927 Morrison Bridge, Bascule Version, L. L. Dougan, Architect. [from J. P. Newell, Consulting Civil Engineers, to the City Planning Commission, Portland, Oregon, "Report on Type and Location of Proposed New Bridge at Morrison Street, "June 1927, Morrison Bridge Files, Yeon Records Center.]

Figure 2: Sverdrup & Parcel Preliminary Sketch for the Morrison Bridge, 1954. [from Sverdrup & Parcel, Inc. and Moffatt, Nichol & Taylor, Consulting Engineers, "Preliminary Report No. 1: Morrison Bridge, Portland, Oregon, for Board of County Commissioners, Multnomah County, Oregon," 10 November 1954, Perspective Study, Exhibit B, Morrison Bridge Construction Files, Yeon Records Center.]

Figure 3: 1926 Burnside Bridge Elevation. [from Engineering Drawing reproduced in HAER No. OR-101 by Sharon Wood Wortman]

Figure 4: 1958 Morrison Bridge Elevation. [form Moffatt, Nichol & Taylor and Sverdrup & Parcel, "River Piers: General Elevation and Plan" Morrison Bridge Drawing Number A2 of 26, 30 August, 1957, Bridge Engineering and Maintenance Office, Multnomah County]

Figure 5: Pier 3 Truss Erection, Morrison Bridge: Trunnion Support Beam Visible between Lower Portions of Trusses. [from "River Superstructure Morrison Bridge: Progress Report, 1957-1958," Construction Photograph, "River Superstructure, No. 503,"Progress Report No. 3, 15 January 1958, Morrison Bridge Construction Files, Yeon Records Center]

Figure 6: Morrison Bridge, Pier 3 Counterweight Pit: Trunnion Support Beam Visible Mid-to-Lower Left, Trunnion Journal Box behind Ladder Mid-Left. [from "River Superstructure Morrison Bridge: Progress Report, 1957-1958," Construction Photograph, "Looking Downstream, Pier 3, Counterweight Pit," 15 January, 1958, Morrison Bridge Construction Files, Yeon Records Center.]

Figure 7: Morrison Bridge Construction, Aerial View West: Old Bridge, Left, Angled East Span near East Bank; Water Ave. Off Ramp near River to Left of Left Approaches; Water Ave. On Ramp near River to Right of Right Approaches; Temporary Approach Emerges on Right from beneath Left Approach. [from Sverdrup & Parcel and Moffatt, Nichol & Taylor, "Final Construction Report: 28 and 29, Morrison Bridge Construction Files, Yeon Records Center.]

Figure 8: Morrison Bridge, Engineering Drawing: Assembled Layout, Bascule Pier, Interior Elevation. [Moffatt, Nichol, & Taylor and Sverdrup & Parcel, "River Superstructure: Bascule 72, March 30, 1956, Bridge Engineering and Repair Office, Multnomah County.]

Figure 1: **J. P. Newell's 1927 Morrison Bridge, Bascule Version, L. L. Dougan, Architect**

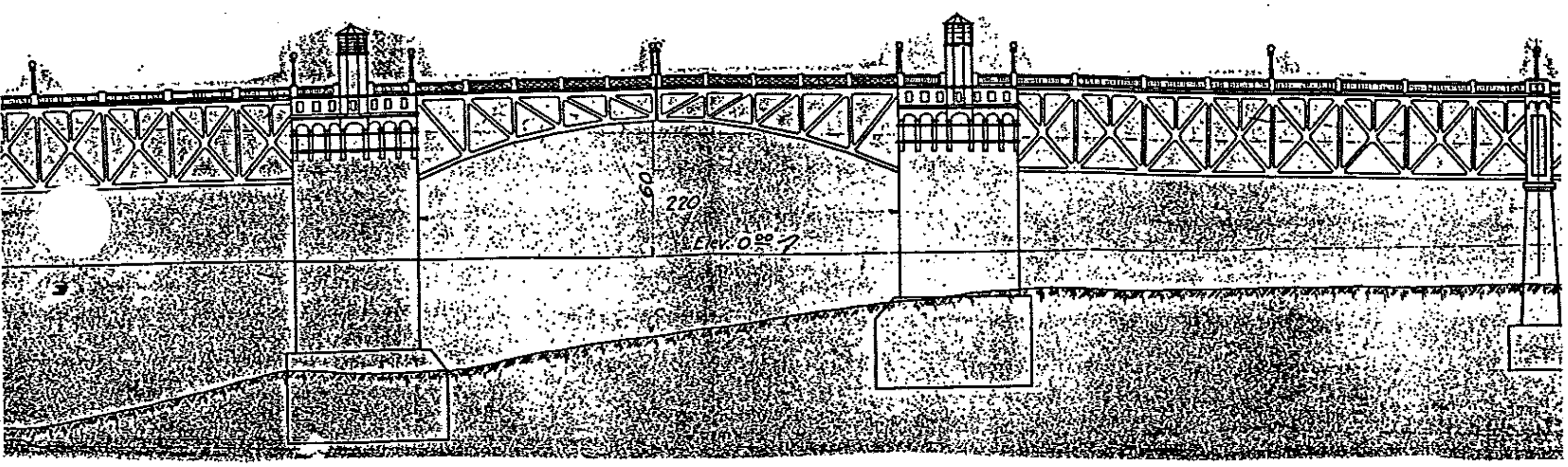


Figure 2: **Sverdrup & Parcel Preliminary Sketch for the Morrison Bridge, 1954**

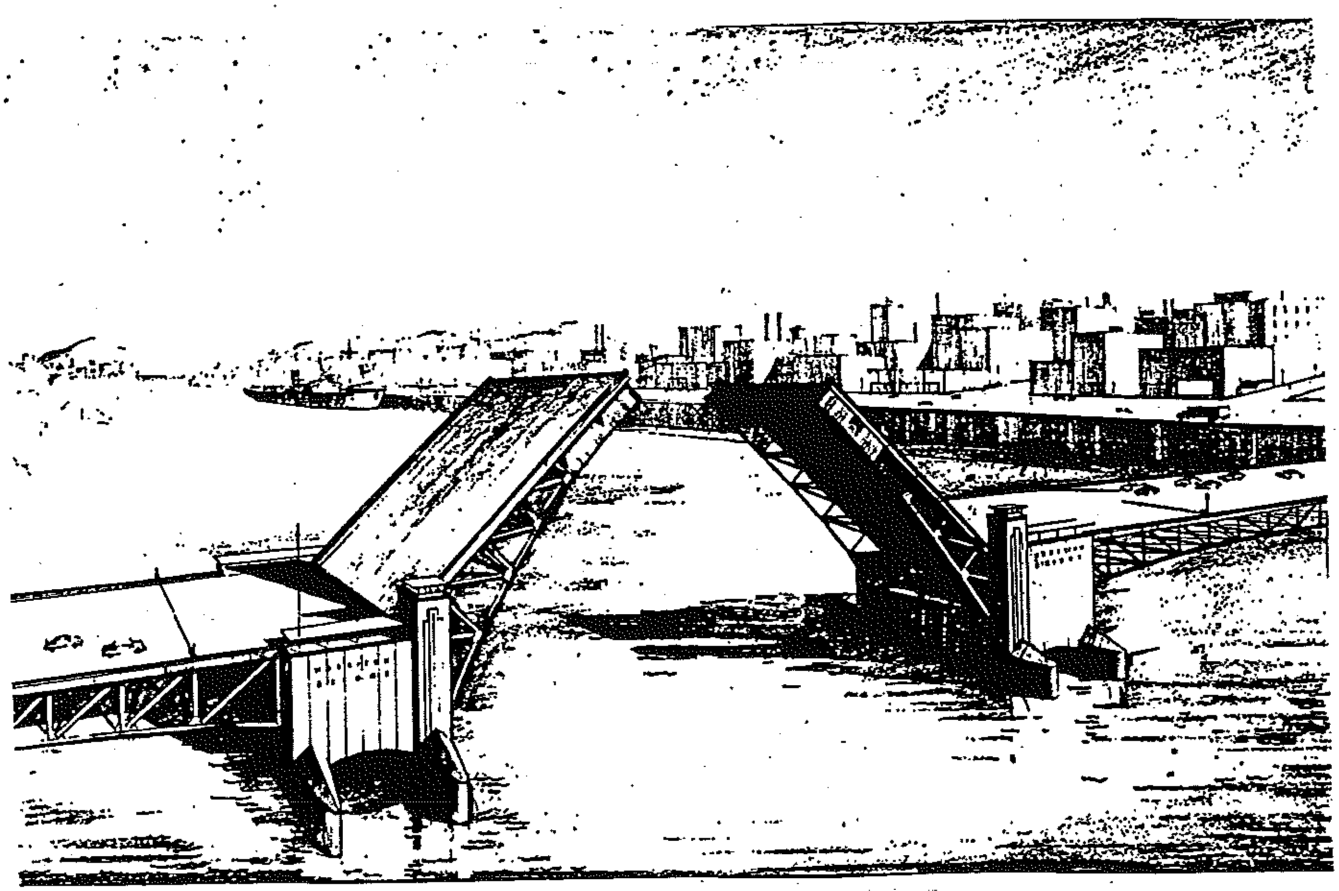


Figure 3: **1926 Burnside Bridge Elevation**

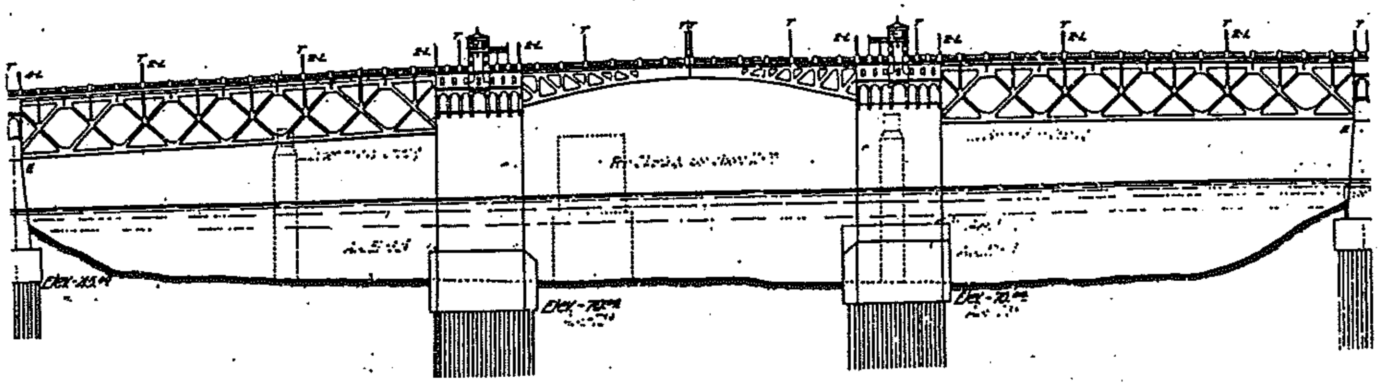


Figure 4: **1985 Morrison Bridge Elevation**

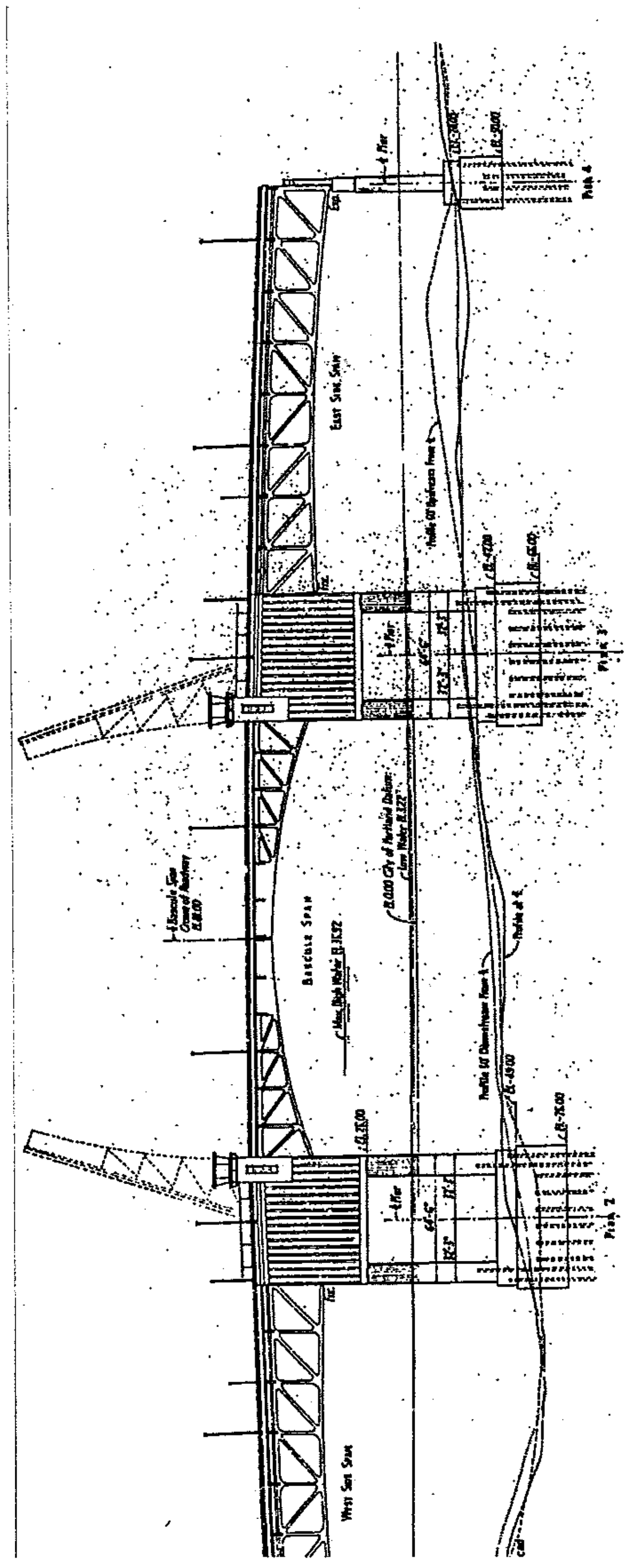


Figure 5: **Pier 3 Truss Erection, Morrison Bridge: Trunnion Support Beam Visible between Lower Portions of Trusses**

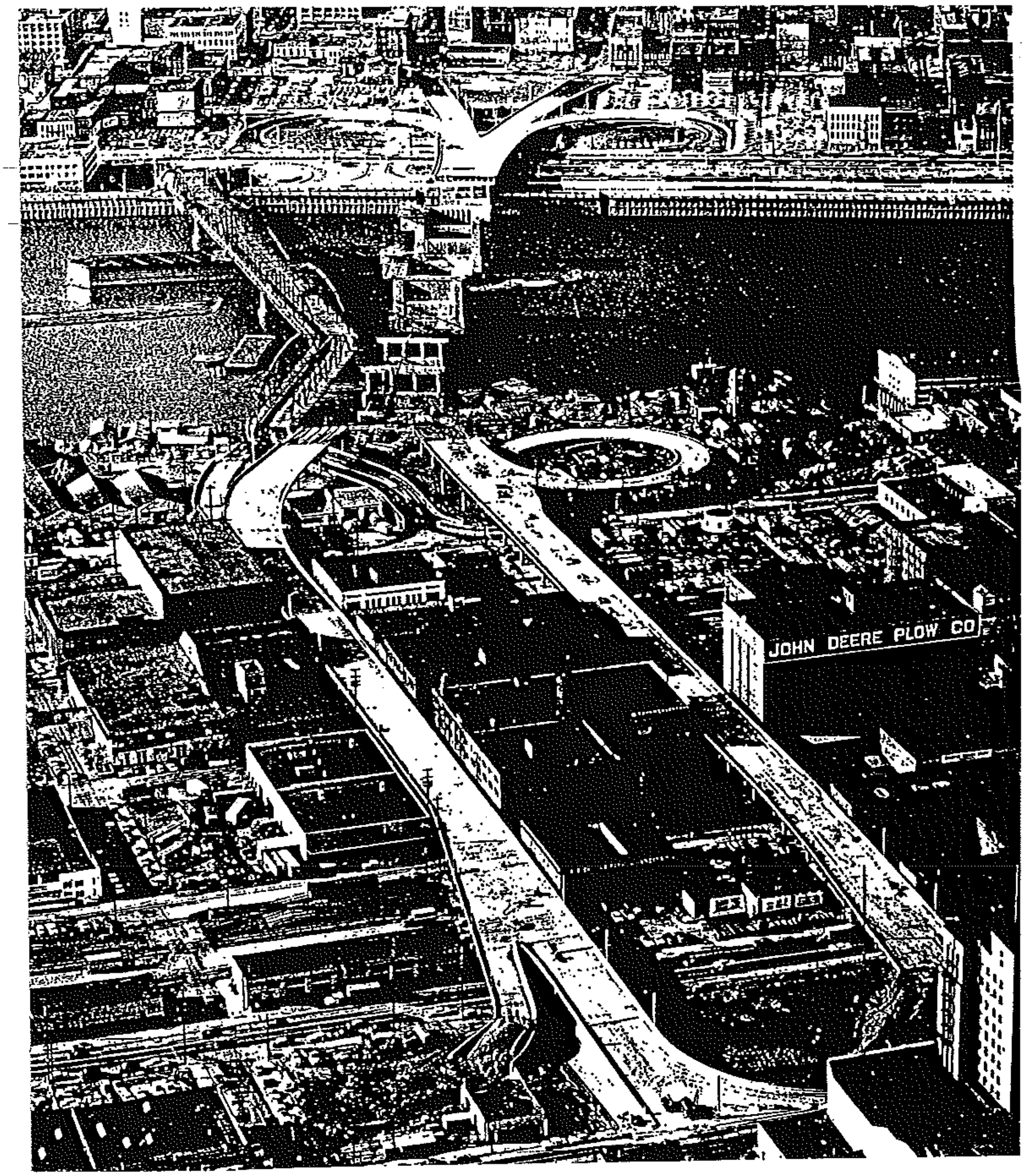


Figure 6: **Morrison Bridge, Pier 3 Counterweight Pit: Trunnion Support Beam Visible Mid-to-Lower Left, Trunnion Journal Box behind Ladder Mid-Left**

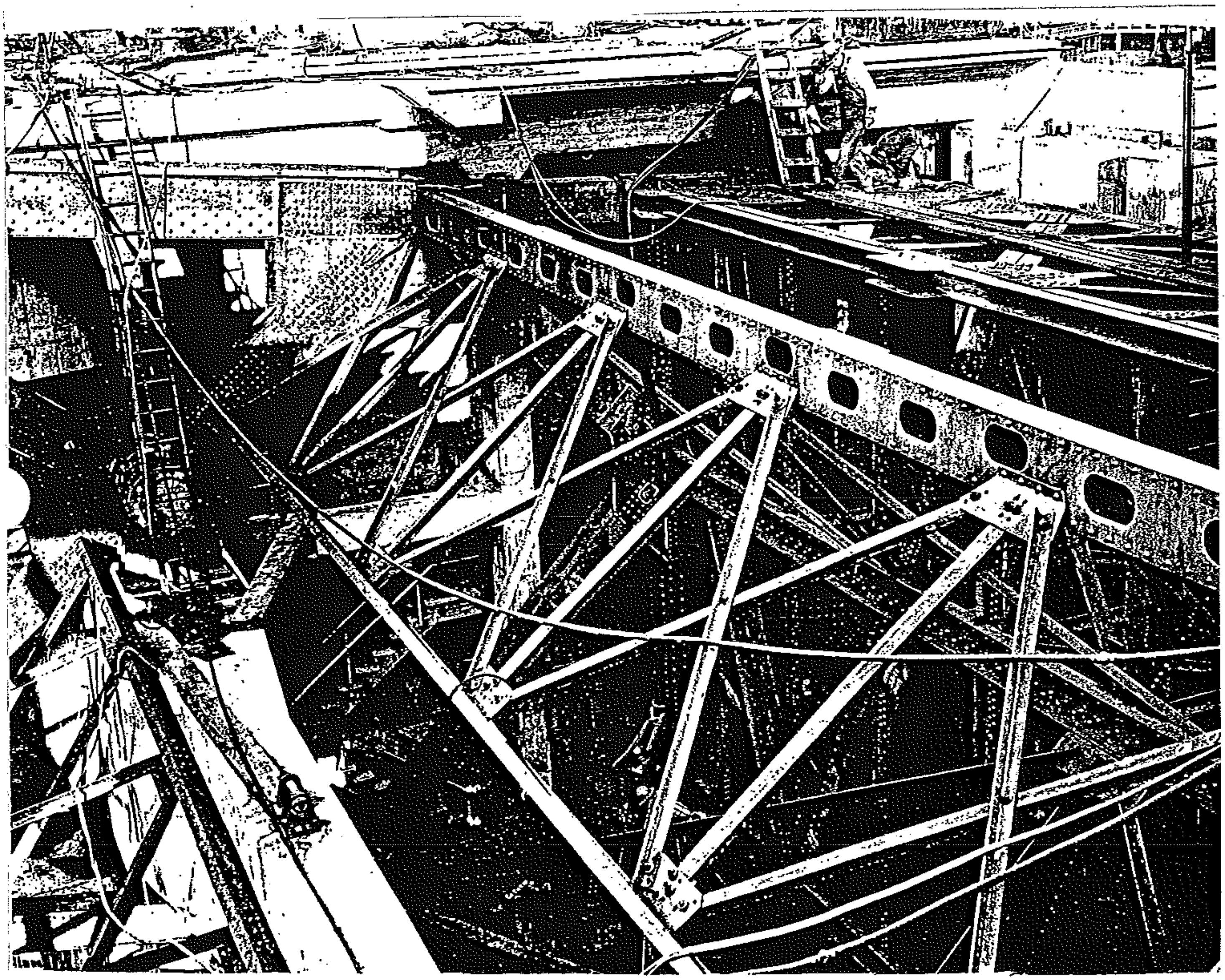


Figure 7: **Morrison Bridge Construction, Aerial View West: Old Bridge, Left. Angled East Span near East Bank; Water Ave. Off Ramp near River to Left of Left Approaches, Water Ave. On Ramp near River to Right of Right Approaches; Temporary Approach Emerges on Right from beneath Left Approach.**

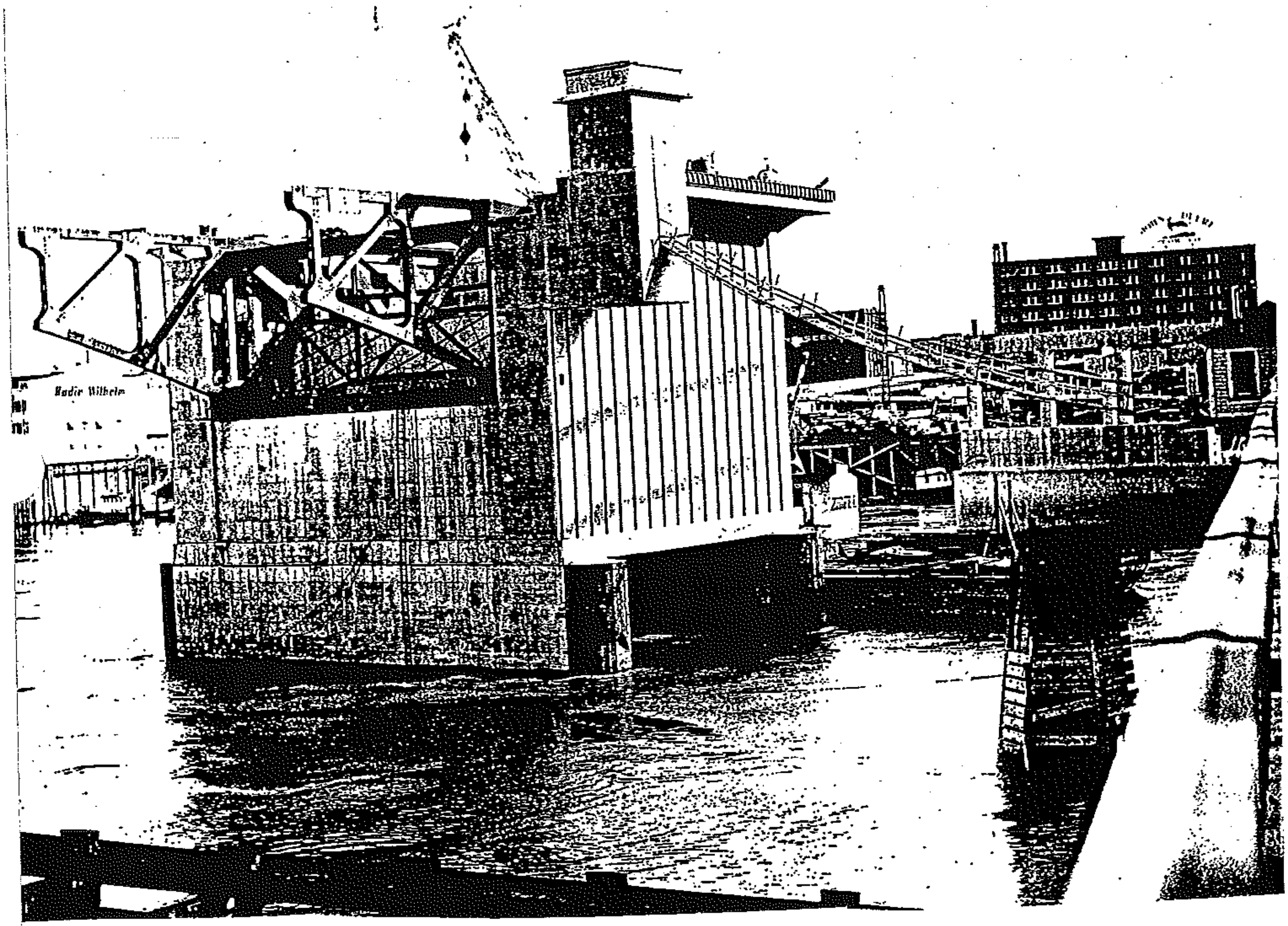
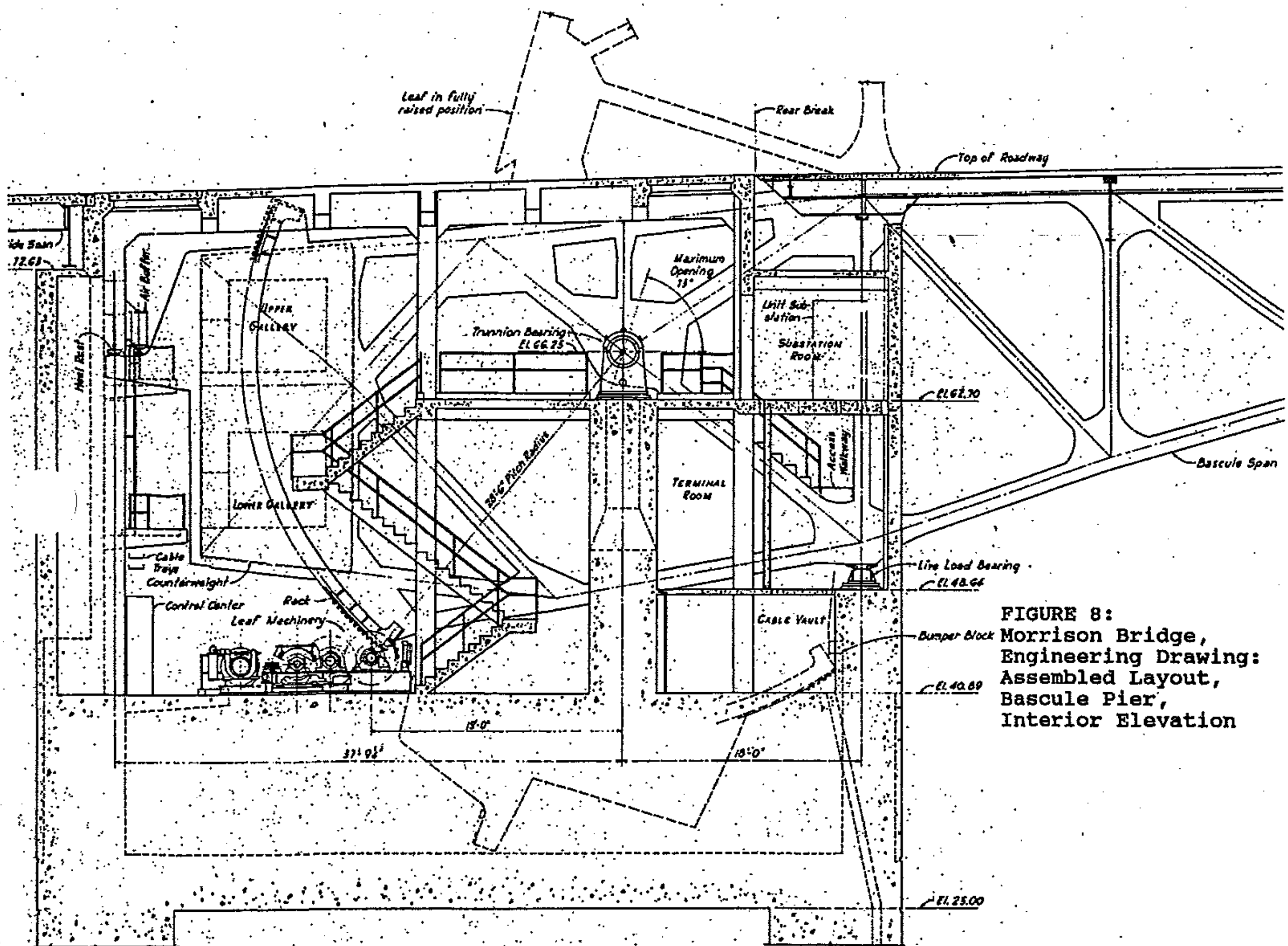


Figure 8: Morrison Bridge, Engineering Drawing: Assembled Layout, Bascule Pier, Interior Elevation



PART LONGITUDINAL SECTION A - A

FIGURE 8:
Morrison Bridge,
Engineering Drawing:
Assembled Layout,
Bascule Pier,
Interior Elevation

BURNSIDE BRIDGE
Willamette River Bridges Recording Project
Spanning the Willamette River at Burnside Street
Portland
Multnomah County
Oregon

HAER No. OR-101

PHOTOGRAPHS

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BURNSIDE BRIDGE
Spanning the Willamette River
At Burnside Street
Portland
Multnomah County
Oregon

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INDEX TO BLACK AND WHITE PHOTOGRAPHS

James Norman, Photographer Summer 1999

OR-101-1	GENERAL TOPOGRAPHIC VIEW OF BURNSIDE BRIDGE, LOOKING NORTH (DOWNSTREAM).
OR-101-2	GENERAL VIEW OF BURNSIDE BRIDGE, LOOKING NORTHEAST.
OR-101-3	GENERAL VIEW OF BURNSIDE BRIDGE, LOOKING NORTHEAST, WITH RIVERFRONT PARK IN FOREGROUND.
OR-101-4	GENERAL VIEW OF BURNSIDE BRIDGE, LOOKING NORTHEAST, ACROSS THE WILLAMETTE RIVER.
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