Rio Puerco Bridge
Petrified Forest National Park Mainline Road
spanning Rio Puerco [River]
Holbrook vicinity
Apache County
Arizona

HAER No. AZ-13

HAER
ARIZ,
1- HOLB.V,
1-

PHOTOGRAPHS
HISTORICAL AND DESCRIPTIVE DATA

Historic American Engineering Record
National Park Service
Western Regional Office
Department of the Interior
450 Golden Gate Avenue
P.O. Box 36063
San Francisco, California 94102

HISTORIC AMERICAN ENGINEERING RECORD

INDEX TO PHOTOGRAPHS

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Documentation: 16 exterior photos (1988)
6 photocopies of photographs (1931-32)
7 photocopies of construction drawings (1931, 1965)
22 data pages (1988)

Clayton B. Fraser, **Fraserdesign**, photographer, October 1988.

AZ-13-1 OVERALL VIEW OF BRIDGE AND DRY BED OF RIO PUERCO. VIEW TO NORTHEAST.

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AZ-13-17 Photocopy of photograph (photographer unknown, March 1932, original print in possession of National Park Service, Petrified Forest National Park), BRIDGE UNDER CONSTRUCTION.

AZ-13-18 Photocopy of photograph (photographer unknown, July 1932, original print in possession of National Park Service, Petrified Forest National Park), BRIDGE IMMEDIATELY AFTER COMPLETION.

AZ-13-19 Photocopy of photograph (Frashers Fotos, Pomona California, 3 July 1932, original print in possession of National Park Service, Petrified Forest National Park), "DEDICATION CEREMONIES RIO PUERCO BRIDGE, PETRIFIED FOREST, ARIZONA - JULY 3, 1932."

AZ-13-20 Photocopy of photograph (Frashers Fotos, Pomona California, 3 July 1932, original print in possession of National Park Service, Petrified Forest National Park), "ST. JOHN[S] HIGH SCHOOL BAND, DEDICATION RIO PUERCO BRIDGE, PETRIFIED FOREST, ARIZONA - JULY 3, 1932."

AZ-13-21 Photocopy of photograph (Frashers Fotos, Pomona California, 3 July 1932, original print in possession of National Park Service, Petrified Forest National Park), "RIO PUERCO BRIDGE, PETRIFIED FOREST, ARIZONA - DEDICATED JULY 3, 1932."

AZ-13-22 Photocopy of photograph (photographer unknown, date unknown, original print in possession of National Park Service, Petrified Forest National Park), EROSION CONTROL IN RIVER NEAR BRIDGE.

[Note: Photos AZ-13-23 to AZ-13-29 are 8x10 enlargements from 4x5 negatives.]

AZ-13-23 Photocopy of original construction drawing, dated April 1931, from original in possession of Federal Highway Administration, Denver Colorado. SHEET 1: LAYOUT.

AZ-13-24 Photocopy of original construction drawing, dated April 1931, from original in possession of Federal Highway Administration, Denver Colorado. SHEET 2: SUPERSTRUCTURE.

AZ-13-25 Photocopy of original construction drawing, dated April 1931, from original in possession of Federal Highway Administration, Denver Colorado. SHEET 3: SUPERSTRUCTURE.

AZ-13-26 Photocopy of original construction drawing, dated April 1931, from original in possession of Federal Highway Administration, Denver Colorado. SHEET 4: SOUTH ABUTMENT AND PIERS.

AZ-13-27 Photocopy of original construction drawing, dated April 1931, from original in possession of Federal Highway Administration, Denver Colorado. SHEET 5: NORTH ABUTMENT.

AZ-13-28 Photocopy of original construction drawing, dated April 1931, from original in possession of Federal Highway Administration, Denver Colorado. SHEET 6: BULKHEAD.

AZ-13-29 Photocopy of original construction drawing, dated February 1965, from original in possession of Federal Highway Administration, Denver Colorado. PIER #3 REPAIRS.

HAER
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Historic American Engineering Record

Rio Puerco Bridge
HAER No. AZ-13

Location:	Spanning Rio Puerco on Petrified Forest National Park Mainline Road; Holbrook vicinity; Apache County, Arizona; NE1/4 of Section 9, Township 19N, Range 24E.
USGS Quadrangle:	Little Lithodendron Park [15 minute series, 1972]
Date of Construction:	1931-32
Engineer:	U.S. Bureau of Public Roads, San Francisco Office
Builder:	W.E. Callahan Construction Company, Dallas Texas
Present Owner:	National Park Service Petrified Forest National Park, Arizona 86028
Present Use:	Two-lane highway bridge [scheduled for replacement in 1989]
Significance:	The Rio Puerco Bridge was built as part of an extensive improvement program for the Petrified Forest National Monument in the early 1930s. It is historically significant for its pivotal role in the development of the park. The bridge is technologically noteworthy as the most visually striking vehicular girder in Arizona. It is not coincidental that the bridge was constructed in a unit of the national park system at a time in which government was acutely concerned with the aesthetic impact of its buildings and structures. The Rio Puerco Bridge represents the aesthetic potential of what must be considered an essentially mundane structural type.
Report Assembled by:	Clayton B. Fraser Principal, **FRASER**design Loveland Colorado 80537 January 1989

President Theodore Roosevelt formed Petrified Forest National Monument in 1906 primarily as a conservation measure. Citing the Antiquities Act, he sought to protect the fossilized remains strewn picturesquely across the desert from depredations by commercial developers and curio marketers.[1] The designation soon accrued a significant side effect, however, as tourists came in increasing numbers to see the natural features. The monument's dirt roads were generally serviceable to handle the traffic, but the Rio Puerco at the north edge of the monument formed a troublesome barrier that was generally inconvenient, sometimes dangerous and all too often impassable. The National Park Service would wait thirty years to bridge the river. When completed, the Rio Puerco Bridge provided a dependable all-weather crossing: a strategic link to the monument's access. And in so doing, it permitted a dramatic expansion of the facility's boundaries.

The concept of a Petrified Forest National Park had circulated for years before Roosevelt could acquire the authority to act on it. "For twenty years continual efforts were made to have the Petrified Forest National Parks created," Navajo County official W.H. Clark stated. "At one time it was learned the bill creating the park was held up in the Committee on Public Lands by an attorney named Parker and a senator named Berry from Arkansas. When it transpired that the word 'forest' appeared in the bill, certain interests were determined to obtain timber lands for those they were to relinquish to the government within the limits selected for the Park."[2] Bills to create the park were introduced in Congress each year from 1901 to 1905; they passed the House but died in the Senate. Finally, in 1906 Representative John F. Lacey of Iowa introduced an "Act for the Preservation of American Antiquities", commonly referred to as the Antiquities Act. Both houses passed the Antiquities Act on June 8, 1906.[3] Six months later, on December 9, 1906, Roosevelt used the Act's authority to establish the Petrified Forest and Montezuma Castle National Monuments in Arizona and El Morro National Monument in New Mexico.[4]

The director of the National Park Service had opposed formation of a national park at Petrified Forest, and the agency did little to improve the monument, once designated.[5] No museum or visitor facilities were built. Little was done to interpret the fossilized remains. Vandalism and pilferage were widespread, and a single honorary custodian was assigned to protect the trees from wholesale theft.[6] With a monthly salary of $1, the early

custodians operated alternately as professional tour guides. They escorted train parties from the Santa Fe railhead at Adamana through the First and Second Forests, Agate Bridge and sometimes as far as the Third Forest.

To reach the monument from the north, visitors drove across a poorly graded dirt road that branched south from the Santa Fe Highway [later U.S. Highway 66] and crossed a ford of the Rio Puerco. Spanish for "dirty river", the Rio Puerco was notorious for its radical shifts in character.[7] It could range from barely perceptible trickle to violent flood and back within a day's time. The river's steep banks, wide channel and sandy bed made fording at flood stage virtually impossible.[8] Thus, difficult and unreliable access, park service indifference and lack of support from commercial tourism interests combined to limit attendance to the Petrified Forest during its early years.

By the mid-1910s the pattern of tourism in the region shifted perceptibly, due in large part to two disparate factors. First, World War I diverted many tourists from the traditional playgrounds in Europe to destinations closer to home. Added to this was a national wave of nostalgia, especially for the Old West: a precipitant of the trouble overseas. Of more lasting impact, though, was the emergence of the automobile as a principal form of transportation. The great democratizer, the car allowed a degree of mobility never before experienced by America's middle class, and it brought previously remote locations to within the range of a vastly expanded number of visitors.

Made more accessible by a developing network of transcontinental and regional highways, western parks such as Yellowstone and Yosemite experienced significant attendance increases in the 1910s. Additionally, several new national monuments and four major national parks were formed in the West: Glacier [1910], Rocky Mountain [1915], Zion [1919] and Grand Canyon [1919].[9] Petrified Forest benefited modestly from the tourist boom, as well. Despite the minimal facilities, poor roads and the erratic nature of the Rio Puerco, visitation at the monument increased throughout the period.

Almost 43,000 people entered the Petrified Forest in 1924, the first year that the park service maintained attendance figures for the monument.[10] Many left laden with chunks of fossilized materials stolen from the park to be used as curios or in stone patios and fireplaces.[11] In 1925 over 55,000 people visited the facility. Travel continued to expand over the following years at a steady, if unremarkable, rate as concessionaires and the park service slowly developed the monument.[12] Without a bridge over the Puerco, however, visitation at the monument remained tied uneasily to the vagaries of the river. "The travel in this Monument has kept up wonderfully through the month," Monument Custodian Charles J. Smith reported in October 1929,

"exceeding that of September by nearly 1000 people. This in spite of the fact that the Puerco River has consistently blocked the travel from Highway #66 more than three fourths of the time."[13] Smith reported again in June 1930, "Soon after the month got under way the summer travel was upon us with a rush and I think the figures show the greatest total in the history of the Monument... The Rio Puerco has been passable all the month which is one reason for the large travel. It will readily be seen what an enormous amount of travel is lost to us when this river is impassable which is liable to happen at any time."[14]

Motor tourism in the park took on a greater significance - "a new era in the development of this Monument," according to Smith - in June 1930 when the first excursion car of the Santa Fe Transportation Company entered the park. Named for their owner, western restaurant and hotel entrepreneur Fred Harvey, these so-called Harveycars were famous nationally for their far-flung excursions across the West.[15] Visitors to the Petrified Forest could make a 24-hour stopover at Winslow from the railroad and stay at La Posada Hotel.[16] From the hotel they toured the park in a Harveycar, typically a big Cadillac or Packard Eight. Although most visitors came in private vehicles, the Harveycars brought hundreds of people to the monument each month, "many of whom were personages of international importance," according to Smith.[17]

Graded dirt roads were still the norm in the sparsely developed West of the 1920s, especially in the rugged terrain of the national parks. Among the rangers' primary duties at Petrified Forest was maintenance of the monument road, and the men performed rudimentary grading and repaired minor washouts after each rain. There was not much the rangers could do about the Rio Puerco ford, however. When the river was down, vehicles could pass with only minor difficulty. But when the Puerco was in flood - which tended to happen often in the busy summer season - the road was impassable. The Arizona Highway Department recognized this problem in 1923, when it constructed steel trusses at nearby Sanders and Allentown to carry the Santa Fe Highway over the Puerco. Before construction of these bridges, traffic often was forced to wait as long as 24 hours for the river to subside enough to permit fording.[18] In a June 1930 report to Superintendent of Southwestern National Monuments Frank Pinkley, Smith reiterated what he had been saying for years:

> **The end of the fiscal year finds the roads in very poor condition and it is devoutly to be hoped that with the exchange of lands which will take place soon, something may be done to make travel a little more pleasant through this area. The fact that 1,358 automobiles came in from the north with this 19 miles of road in its present condition, this month, shows what may be expected in the way of travel from Highway No. 66 if the Rio Puerco were bridged and a good highway was built through the Monument.**[19]

The following month illustrated dramatically the direct effect the Puerco had on visitation. Traffic was heavy for the first two weeks, when the river

ford was passable due to low water. But for the remainder of the month the Puerco was flooded and the ford blocked, constricting traffic by an estimated 200 cars a day.[20] Despite these impediments, park attendance reached an unprecedented level in 1930. That year some 105,000 people entered the Petrified Forest, up over 50% from the previous year, prompting Arizona officials to begin pushing the park service to develop the facility fully.[21] The tourists complained to Smith about the rutted dirt track through the park and Smith complained to Pinkley: Clearly something needed to be done about the road and the river ford.

In the spring of 1929 Guy Edwards, an engineer for the San Francisco office of the U.S. Bureau of Public Roads [BPR], had conducted a preliminary survey for a new trans-monument road to connect U.S. Highways 66 and 70.[22] The road was to be part of an extensive improvement program contemplated for the park, which included construction of an administration building, three ranger residences, an equipment shed, a new road and permanent vehicular bridges over Dry Creek and the Rio Puerco. For the route, Edwards recommended a relatively straight line through the park, with spurs to Agate Bridge and the Second Forest. It would cross the Puerco at Adamana. "This plan did not present a very good plan for the ultimate development of the monument," according to Charles Smith, and the custodian spent the following winter planning an alternate route.[23] In 1930 National Park Service Director Horace Albright ordered a full-scale survey for the road along Smith's route. From November to February, BPR surveyors labored through sub-freezing temperatures to stake the route. They situated the Rio Puerco bridge on a broad easterly curve of the river at "the only place down there that you could jump a bridge across," Smith later said.[24]

The Puerco here was wide and swift in flood, but not particularly deep, and was floored by an extremely thick layer of loose sand and silt. The logical structure to carry vehicular traffic over such an intermittent waterway was therefore a series of medium-length spans - either trusses or beams - founded on driven pile foundations. BPR engineers in San Francisco designed a bridge for the Rio Puerco crossing in April 1931. (They produced a nine-sheet set of construction drawings, sheets 1-6 of which are reproduced in this report as figures 1-6. Originals for these are located at the Denver office of the Federal Highway Administration. Sheets 7-9 referenced on the set's cover sheet cannot be located.) Delineated by BPR senior highway bridge engineer H.R. Anguire, the bridge was a relatively straightforward structure consisting of six riveted plate girders supported by massive concrete piers on pile foundations. Each of the girders spanned 80 feet, for a total structure length

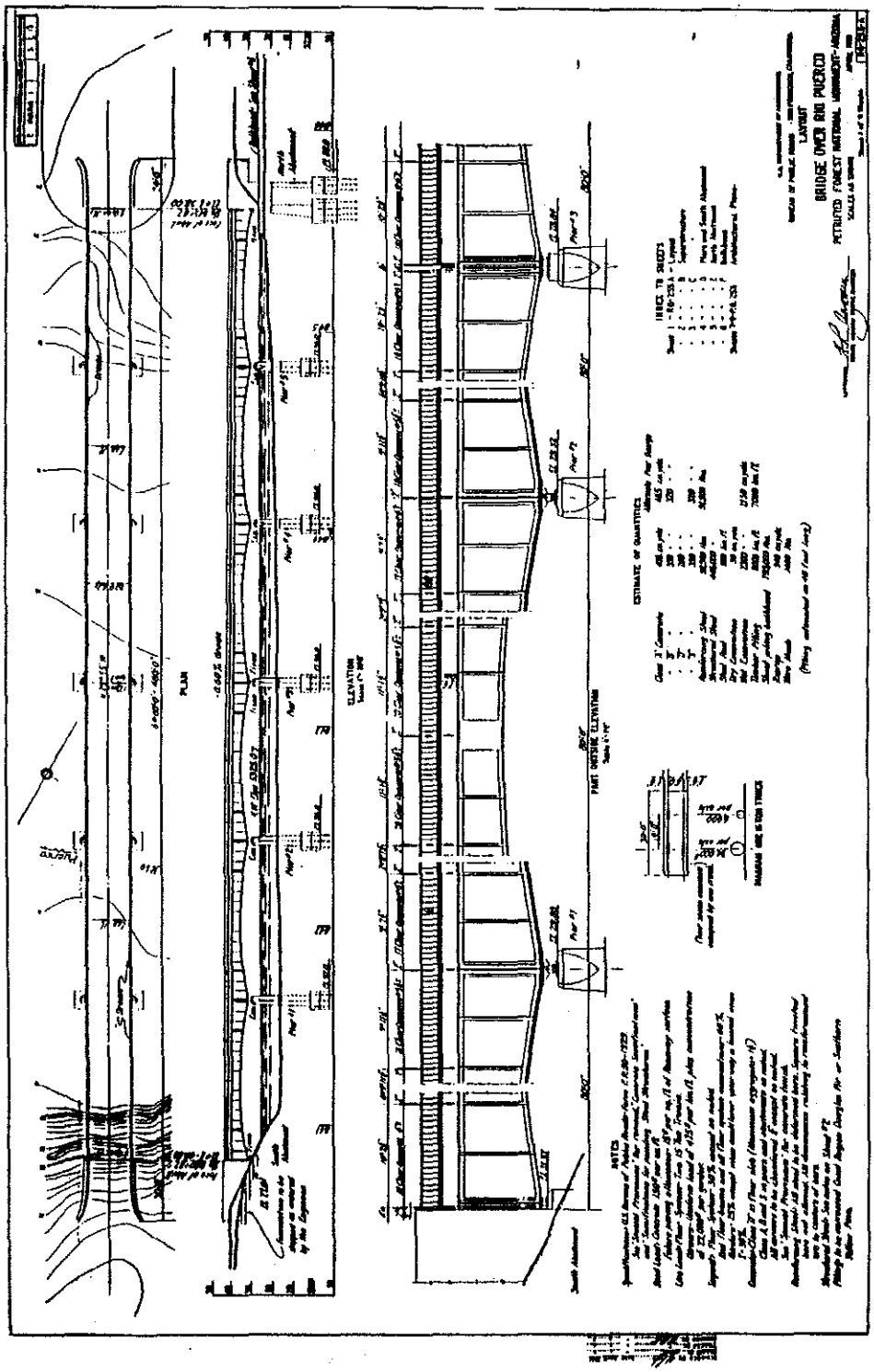


Fig. 1 Original construction drawing, prepared by U.S. Bureau of Public Roads, April 1931. Located at Federal Highway Administration, Denver Colorado.

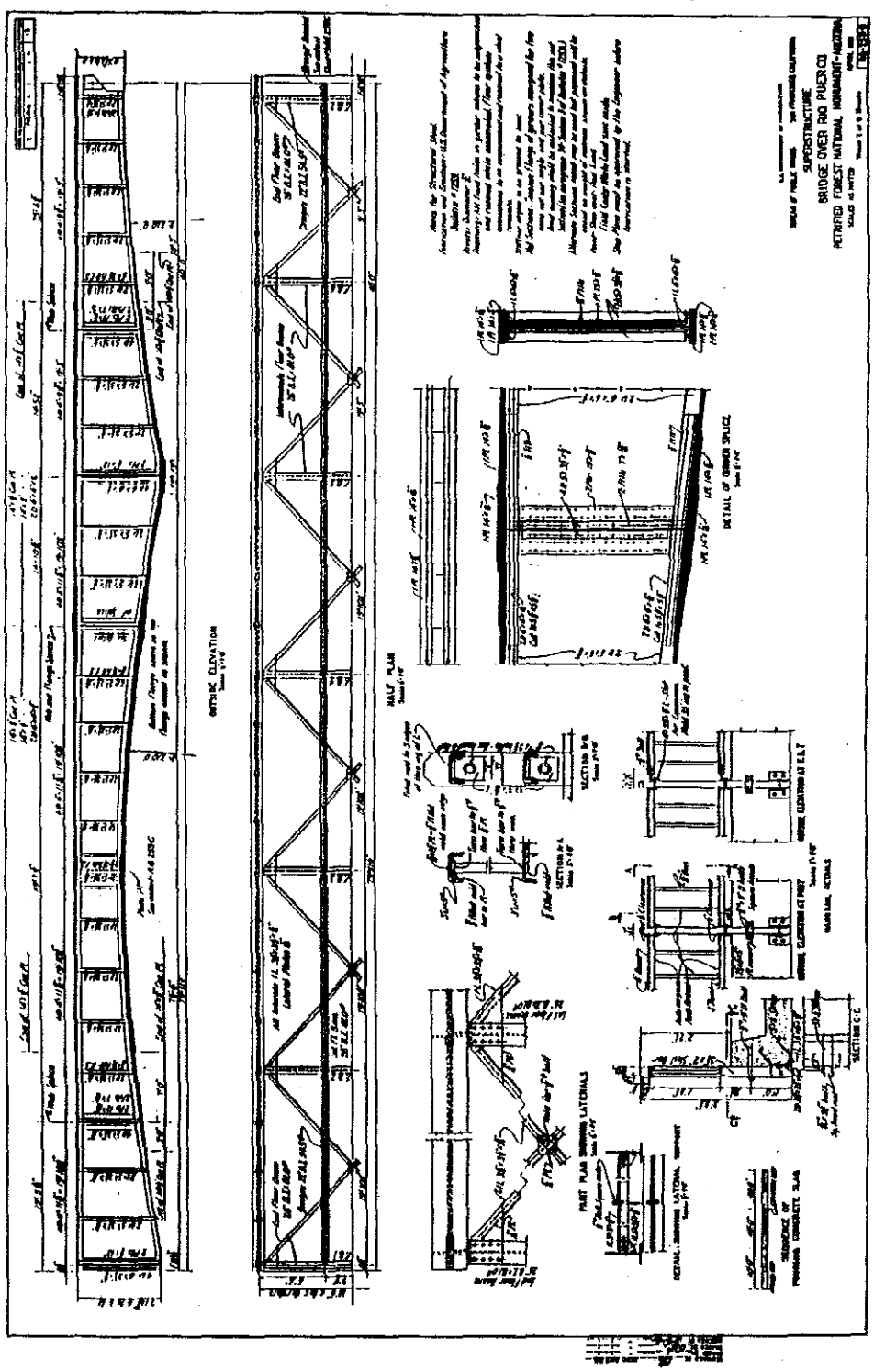


Fig. 2 Original construction drawing, prepared by U.S. Bureau of Public Roads, April 1931. Located at Federal Highway Administration, Denver Colorado.

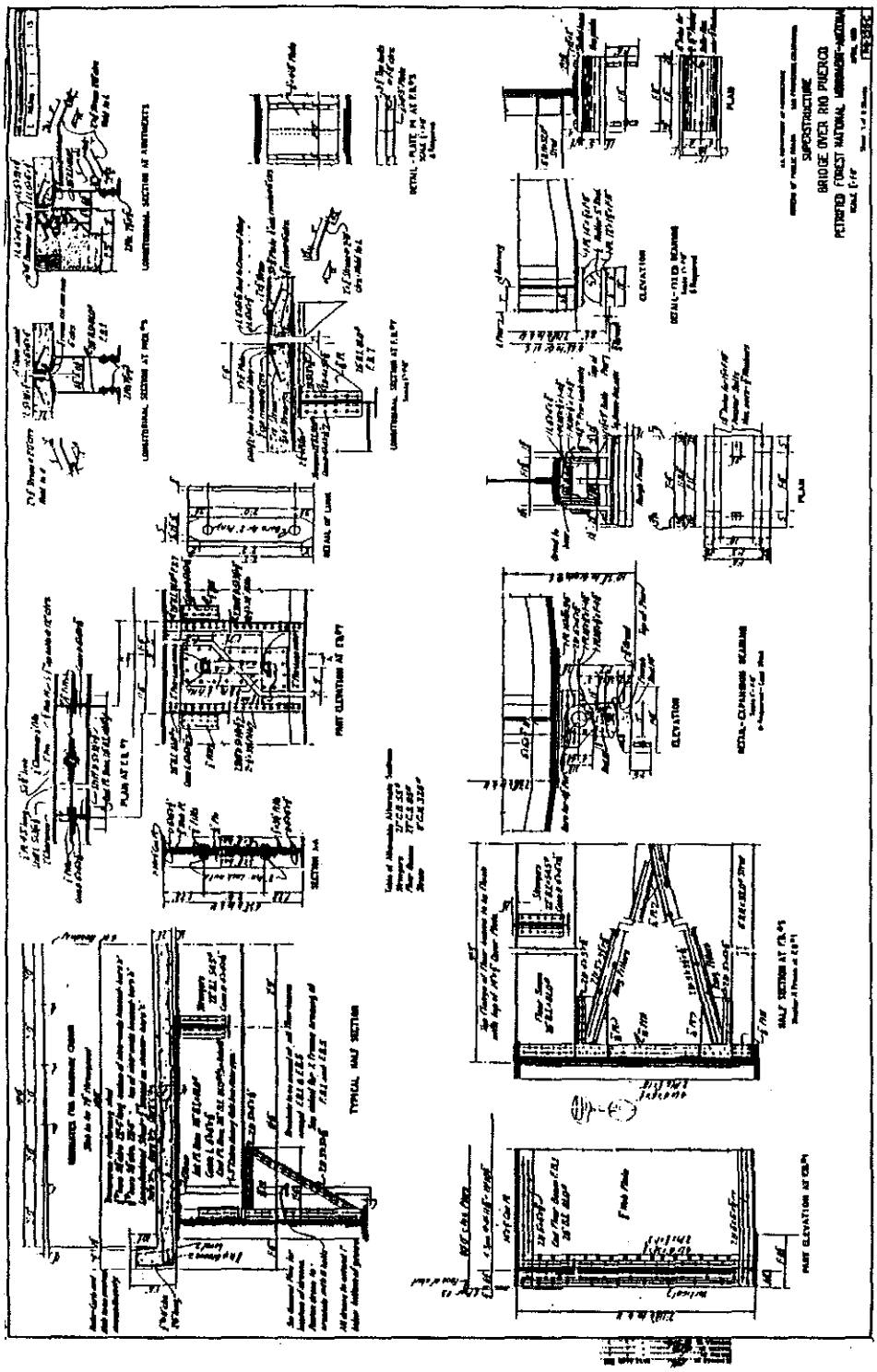


Fig. 3 Original construction drawing, prepared by U.S. Bureau of Public Roads, April 1931. Located at Federal Highway Administration, Denver Colorado.

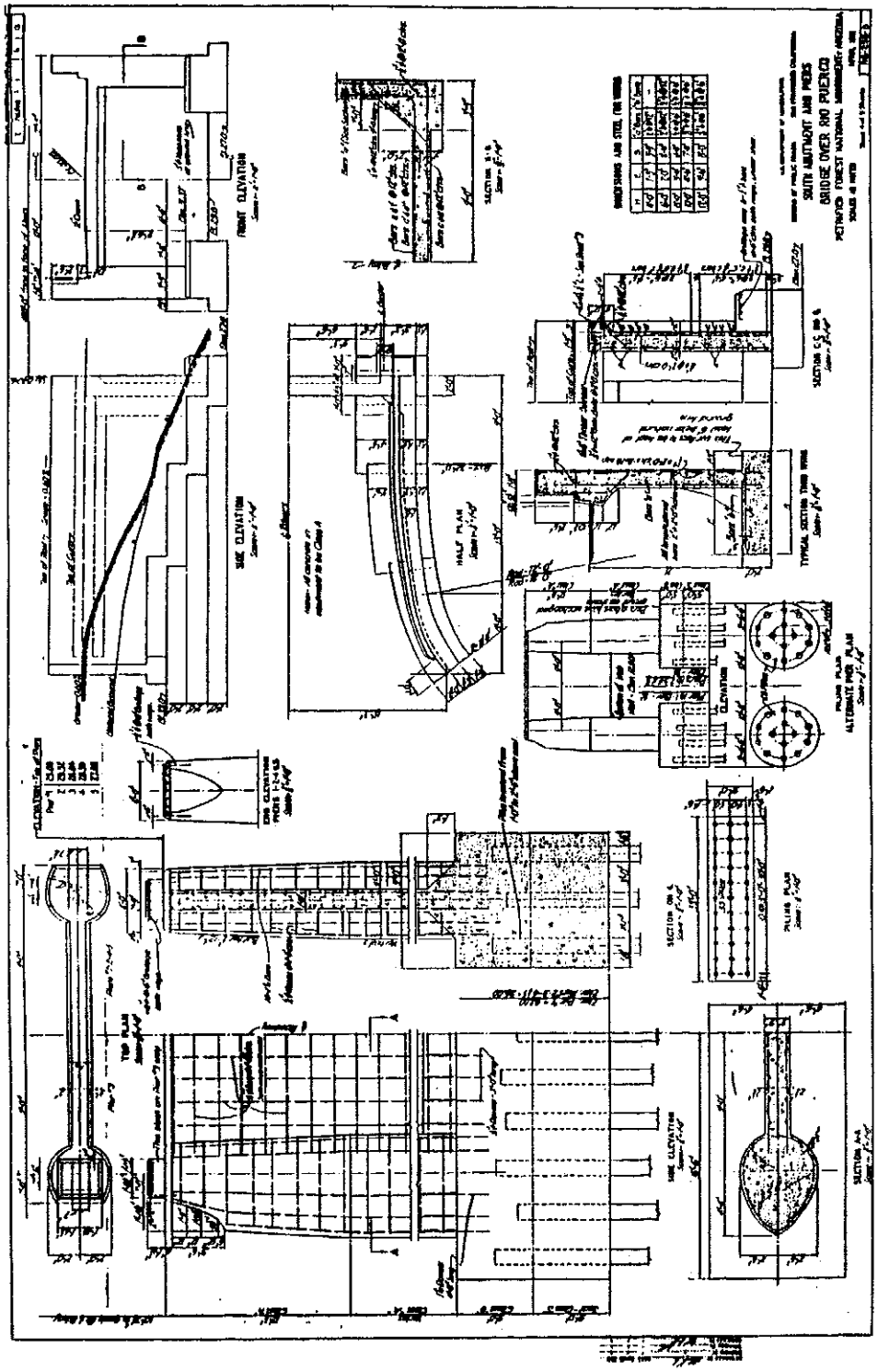


Fig. 4 Original construction drawing, prepared by U.S. Bureau of Public Roads, April 1931. Located at Federal Highway Administration, Denver Colorado.

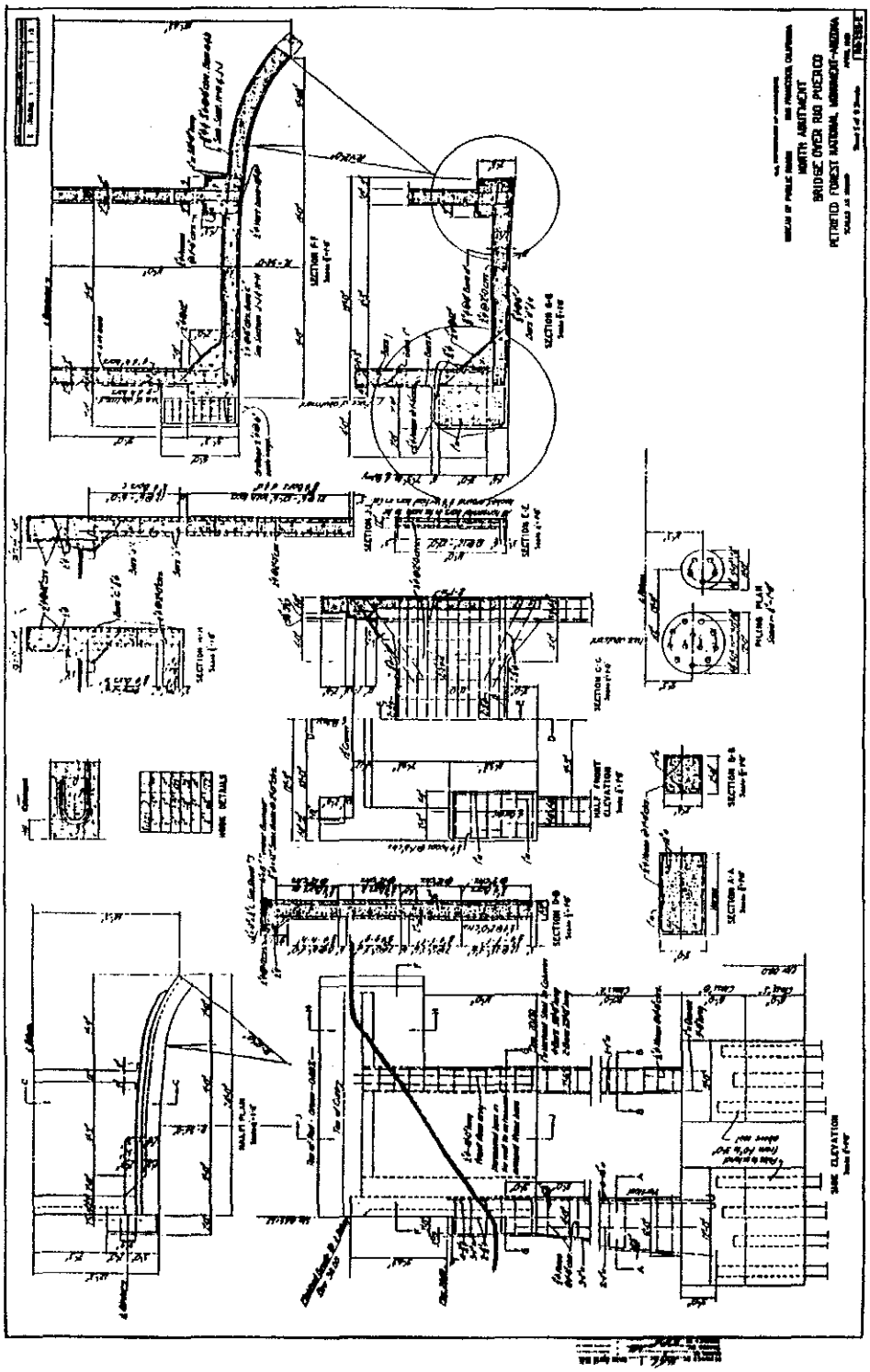


Fig. 5 Original construction drawing, prepared by U.S. Bureau of Public Roads, April 1931. Located at Federal Highway Administration, Denver Colorado.

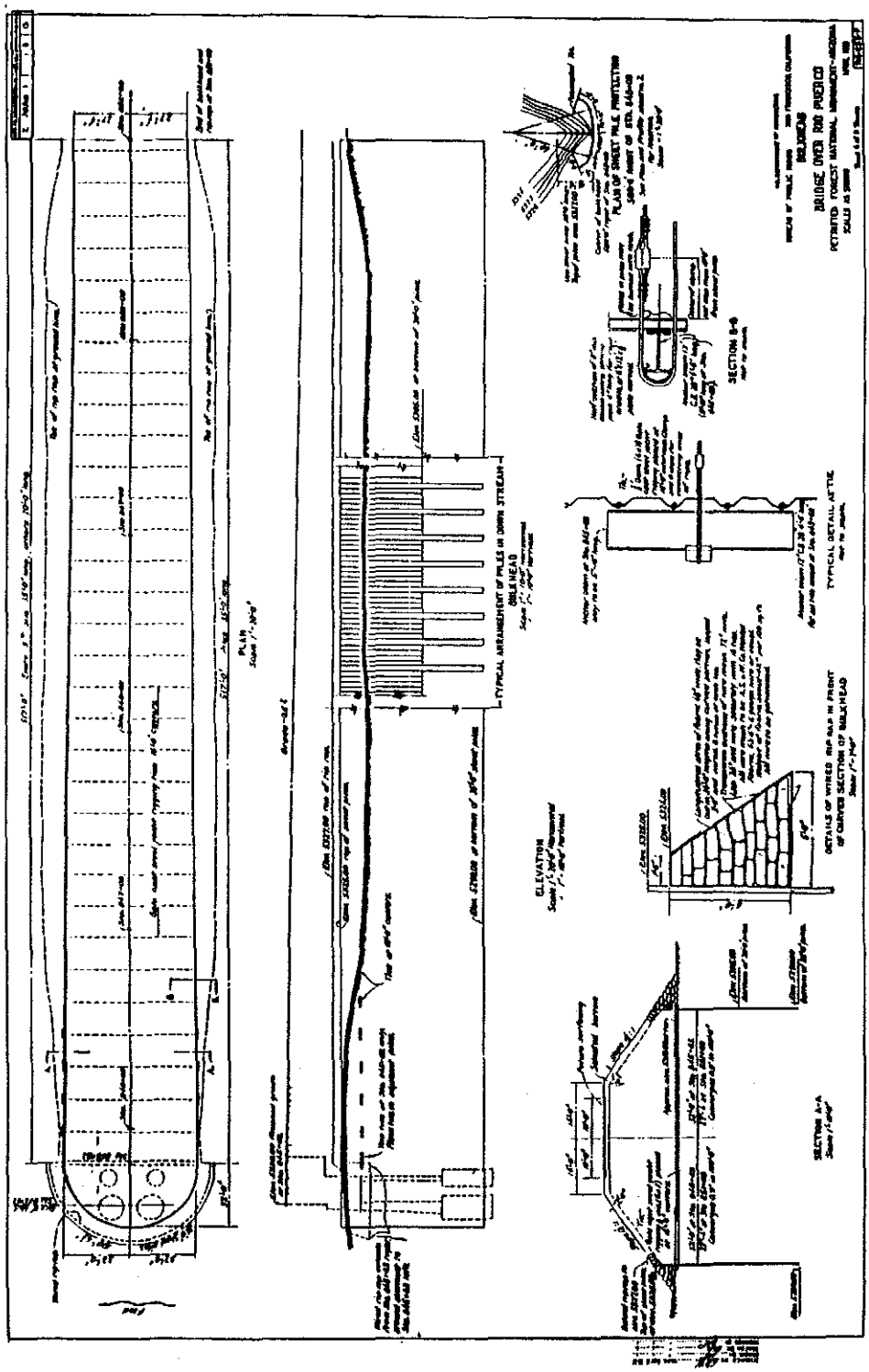


Fig. 6 Original construction drawing, prepared by U.S. Bureau of Public Roads, April 1931. Located at Federal Highway Administration, Denver Colorado.

of 534 feet, including abutment wingwalls. With midspan hinges on spans 2 and 5 and a joint in the main girder at Pier 3, the bridge was made up of an alternating series of simply supported spans and propped cantilevers.

The most visually distinctive feature about the structure is the graceful curve of the girders. Each of the segmentally arched girders measures almost 8 feet at its maximum depth over the pier and tapers to a minimum depth of 4' 5-1/2" at midspan. They use typical riveted, built-up construction, with 3/8" thick steel plate webs and riveted angle/plate flanges. Steel angle/plate web stiffeners are spaced at regular intervals along the lengths of the girders and are used to strengthen the cantilever splices. All rivets are 3/4" in diameter, passed through punched and reamed holes. The girders are set apart transversely by 18'6" and have pin bearings on cast steel rocker pedestals for the expansion bearings and semi-cylindrical fixed bearings at Pier 3 and the abutments. The floor beams consist of 26" deep steel I beams, the stringers 22" I beams; all are positioned with their top flanges flush with those of the girders to carry the 7-1/2" thick concrete deck slab directly. The girders are braced laterally at each panel point by steel brackets riveted from the inside of their web to the underside of the floor beam and by I-beam struts and diagonal steel angles. The concrete roadway is 20' wide between the curbs. Simple steel balusters and rails form the guardrails.

Each of the five massive, reinforced concrete piers consists of two 5' thick columns joined by a 1'6" thick continuous concrete diaphragm. The columns are tear-shaped to form cutwaters on both the upstream and downstream faces, and they have tapered caps to carry the steel bearing shoes. The columns and diaphragm are doweled into a 10'x 9'x 33' unreinforced concrete base, which encases the tops of the piles. Thirty-three untreated timber piles, approximately 40' long, are driven into the riverbed sand to support each pier. The north abutment and wingwalls use a similar substructural configuration, with a concrete base resting on driven piles. The south abutment, on the other hand, uses a concrete spread footing foundation.

The floor system of the bridge was designed to carry two 15-ton trucks. The girders were engineered to carry 475 pounds per linear foot, plus a concentrated load of 22,000 pounds per girder. The immense structure consumed some 8000 linear feet of timber piling, 1455 cubic yards of concrete, 92,500 pounds of reinforcing steel and 445,000 pounds of structural steel, for a total weight (excluding piles) in excess of 380 tons. To protect the piers and abutments from the considerable scour of the river, BPR engineers called for sheet steel piling bulkheads and 940 cubic yards of rip rap held in place by 1400 pounds of wire mesh.

On June 2, 1931, the BPR opened contractors' bids for the road and bridge projects. Everly and Allison of Des Moines, New Mexico, were the lowest bidders for the road construction at $115,000. The agency awarded the construction contract for the Rio Puerco and Dry Creek bridges to the W.E. Callahan Construction Company of Dallas, Texas, for $155,000. Work on both contracts was to commence on June 17th.[25] By the end of July the road builders were well underway, but Callahan had yet to begin on the Puerco bridge. The Texas firm instead waited until the summer floods subsided before beginning full-scale construction on the abutments and piers in September.[26] Charles Smith reported later that month, "The wet weather has bothered the bridge contractors considerably, but they are now going ahead in earnest."[27] Fabricated by the Roanoke-based Virginia Bridge and Iron Company, the girders had arrived and were stored near the bridge site. Under the direction of BPR Resident Engineer E.F. Strickler and NPS Chief Landscape Architects Herbert Kreinkamp and Thomas C. Vint, the contractors pushed construction on both bridges throughout the rest of the autumn. By the end of October the men had virtually completed the Dry Creek Bridge.[28]

Callahan's crew continued driving piles and forming concrete for the piers of the Puerco bridge throughout November, until they were stopped by snow and sub-zero temperatures just before Thanksgiving.[29] At the end of the year the Bureau reported that the bridge was 50% complete, despite numerous weather-related delays. "Rio Puerco Bridge construction has gone steadily ahead," Smith stated in January 1932, "and the contractor expects to have it finished by scheduled time, May 1st."[30] The south abutment and all of the piers except one had been placed by the end of February. The steelworkers had erected approximately 25% of the superstructure.[31] But delays again beset the crew in March; they missed the May 1st deadline. Meanwhile, the river was all but impassable, and the Harveycar tours through the park were suspended until completion of the bridge.[32]

By the end of May the bridge was almost complete, and the crew poured the last concrete for the deck on June 20th. Park officials and the Holbrook Chamber of Commerce began planning a dedication ceremony for July 3, 1932, to mark the structure's opening.[33] "Were there no other attractions the unique scenery of the Forest and Painted Desert is well worth the trip," the *Holbrook Tribune* announced, "besides which the occasion has historic interest as it marks another barrier of the old west pierced by civilization, making safe the crossing of a dangerous waterway over a modern bridge and road, connecting two of the wonder spots of the west."[34]

Although the structure was not quite complete by July 3rd, the park service staged the dedication ceremony anyway. About 700 people stood in the sunny 98 degree heat to attend the opening festivities. A rattlesnake sought refuge under the temporary stage at one end of the new bridge as National Park Service Director Horace Albright, Arizona Governor W.P. Hunt and several local

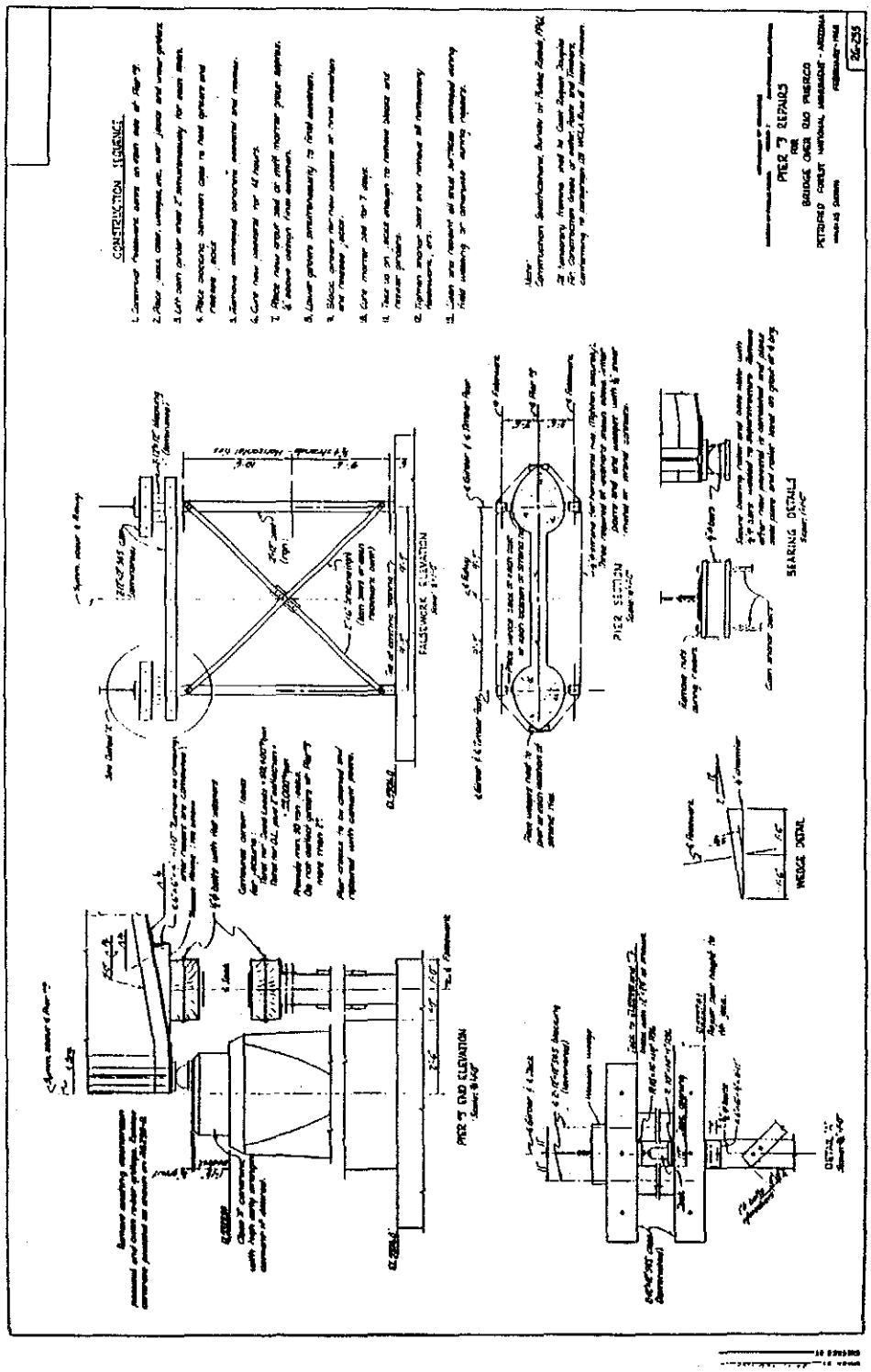


Fig. 7 Original construction drawing for repair of Pier 3, prepared by U.S. Bureau of Public Roads, February 1965. Located at Federal Highway Administration, Denver Colorado.

dignitaries spoke to the milling crowd. "I have done considerable scrapping in the past with various Government Agencies," Hunt told the group, "but I want to state, here and now, that it doesn't go as far as the National Park Service is concerned. Our relations are, and will continue to be, most cordial." The Saint Johns High School Band, some three dozen strong, provided the musical accompaniment. After the speechmaking had concluded, the people formed a 147-car motorcade, with Hunt, Albright and Smith in the lead car, and drove back and forth across the bridge. The crowd then ate barbecue at tables set up near the south abutment before dispersing.[35]

The Rio Puerco Bridge's impact on the monument was immediate and dramatic. "For the first time on record so far as we have them," Smith reported three weeks later, "the travel figures for the month of July exceeded those of June. This is, of course, due to the fact that always before the Rio Puerco has been impassable for at least part of the month thereby shutting off travel from U.S. Highway 66 on the north."[36] More importantly from administration standpoint, with the crossing of the Puerco now secured, the park service could consider expanding the boundaries of the monument to include the beautiful Painted Desert north of the river. Officials in Washington wasted no time. Less than three months after the bridge was opened, negotiations for land had been concluded and 53,300 acres were added to Petrified Forest National Monument, more than doubling the facility's size.[37]

The Rio Puerco Bridge carried increasingly heavier traffic through the park in unaltered condition over the next thirty years. By the mid-1960s the structure had begun to show a weakness that has plagued many of Arizona's multi-span bridges: its piers were settling due to inadequate foundations and excessive scour by the river. By 1965 Pier 3 had sunk some thirteen inches. That year the Bureau of Public Roads jacked the girders on either side of the pier and installed thicker concrete pedestals for the bearing shoes to compensate for the settlement. [See Figure 7, original construction drawings for repair of Pier 3.] But now Pier 2 has begun to settle, causing stress cracking and a visible sag in the bridge railing.[38] Faced with this and other problems relating to the bridge's geometry, the park service now plans to replace the bridge.

The Rio Puerco Bridge is historically significant for its pivotal role in the development of the Petrified Forest National Monument.[39] Its construction eliminated the major impediment to park traffic and enabled the park service to expand the facility's boundaries to encompass the Painted Desert section of the monument. Though threatened with replacement, the bridge continues to function as a strategic link in the park's Mainline Road.

Technologically, the Rio Puerco Bridge can hardly compare with some of the major bridges built in America in 1931-32. Bridges such as the 3,500' Hudson River suspension bridge, the 750'-span Croton Lake steel arch and the 1,652' Kill van Kull steel arch in New York, the St. Johns Bridge in Portland and the 1,060' Ohio River suspension bridge at Maysville, Kentucky represented milestones in civil engineering.[40] The 80' girders of the Rio Puerco Bridge

seem modest compared with the record-setting 154' girders erected in September 1931 as part of the Maumee River Bridge in Ohio.[41] But within the context of Arizona bridge construction, the Rio Puerco Bridge is noteworthy. Of the sixteen vehicular girders identified in the recently completed statewide bridge inventory, this is the only one designed by the Bureau off Public Roads and is clearly the most visually striking. Its arched girders atop handsomely proportioned and colored concrete piers reflect a prevailing aesthetic of the time which held the arch to be the highest form of bridge design. It is not coincidental that the bridge was constructed in a unit of the national park system at a time in which the government was acutely concerned with the aesthetic impact of its buildings and structures. The bridge thus represents the aesthetic potential of what must be considered an essentially mundane structural type.

ENDNOTES

1 These incursions into the park had begun in the late 19th century after the first public exhibition of petrified wood was made at the New Orleans Exposition in 1885. By the early 1890s petrified wood was in vogue for its decorative value, and logs were being blasted apart and shipped by railroad to the Tiffany Company and other eastern manufacturers. In 1895 the Arizona Territorial Legislature sent a memorial to Congress petitioning for formation of a national park called either Petrified Forest or Chalcedony Park. "Ruthless curiosity seekers are destroying these huge trees and logs by blasting them in pieces in search of crystals, which are found in the center of many of them," the memorial stated, "while carloads of the limbs and smaller pieces are being shipped away to be ground up for various purposes." In response, the land was withdrawn from public entry by the Department of Interior in 1896, but the trees were still threatened by developers. That same year the Armstrong Abrasive Company of Denver shipped a stamp mill to nearby Adamana to crush petrified wood for use as an abrasive under the name of the Angell Abrasive Company. The only thing that saved the trees from wholesale harvesting was the fact that competing Canadian companies priced emery low enough to make the Arizona operation unprofitable.

In 1897 the Department of Interior canceled mineral claims on the withdrawn lands. Over the following years agents of the U.S. Geological

Survey and General Land Office conducted several studies of the area, as private and commercial collectors hauled hundreds of tons of material from the withdrawn lands. "A firm in South Dakota has shipped from the park about 400 tons," George Grosvenor stated in the *Arizona Gazette* in 1898, "and has used it in architectural and decorative work. Sections of trees, four feet in diameter, and large enough for the tops of tables, have been cut and polished. The stone is unapproachable in quality. The removal of the stone by the South Dakota Company has made no visible impression on the amount in the park. There is nothing, however, except freight rates and other expenses, to prevent the park from being robbed of its treasure, and I am of the opinion that the areas occupied by them should be reserved by the general government."
Golden Anniversary of the Establishment of Petrified Forest National Monument: 1906 - 1956 (Northern Arizona Printers & Publishers, 1956) n.p.

2 W.H. Clark, Navajo County Commissioner of Immigration, *Who's Who in Arizona*, 1913, pages 106-108.

3 Harold J. Brodrick, Park Naturalist, "A History of Petrified Forest National Monument, Arizona," unpublished manuscript located at Petrified Forest National Park, 1955, page 23; *Golden Anniversary of the Establishment of Petrified Forest National Monument: 1906 - 1956.*

4 **By the President of the United States of America, a Proclamation.**
Whereas, it is provided by Section 2 of the Act of Congress, approved June 8, 1906, entitled, "An Act for the Preservation of American Antiquities", that the President of the United States is hereby authorized, in his discretion, to declare by public proclamation historic landmarks, historic and prehistoric structures, and other objects of historic or scientific interest to be National Monuments.
And, whereas the mineralized remains of Mesozoic forests, commonly known as the "Petrified Forest" in the Territory of Arizona, situated upon the public lands owned and controlled by the United States, are of the greatest scientific interest and value, and it appears that the public good would be promoted by reserving these deposits of fossilized wood as a national monument, with as much land as may seem necessary for the proper protection thereof;
Now, therefore, I, Theodore Roosevelt, President of the United States of America, by virtue of the power vested in me by Section 2 of the aforesaid Act of Congress, do hereby set aside as the Petrified Forest National Monument subject to any valid and existing rights, the deposits of mineralized forest remains situated in Gila and Apache Counties, Arizona, more particularly located and described as follows, to wit:
[legal description of lands]

Warning is hereby given to all unauthorized persons not to appropriate, excavate, injure or destroy any of the mineralized forest remains hereby declared to be a National Monument or to locate or settle upon any of the lands reserved and made a part of said monument by this proclamation.

5 Text of address by Charles J. Smith to 50th Anniversary Celebration of Petrified Forest National Monument, 8 December 1956.

6 Beginning in 1906, the first honorary custodian was Al Stevenson, who operated a hotel in Adamana and ran excursion tours through the monument. In 1912 he sold the hotel and tour business to Chester Campbell; with it went the custodianship. Campbell later hired William Nelson as a tour driver, and in 1918 Nelson succeeded him as custodian. Nelson built three frame buildings, including a house and a makeshift museum near the site of the present Rainbow Forest Museum, and became the first full-time custodian of the monument. He was succeeded in 1925 by the first appointive custodian, Edgar Rogers.
Harold J. Brodrick, Park Naturalist, "A History of Petrified Forest National Monument, Arizona," pages 24-25.

7 Byrd Howell Granger, *Arizona's Names (X Marks the Place)* (Tucson: Falconer Publishing Company, 1983), page 503.

8 Arizona Good Roads Association, *Illustrated Road Maps and Tour Book* (Prescott: Arizona Good Roads Association, 1912), page 93.

9 National Park Foundation, *The Complete Guide to America's National Parks* (New York: Prentice Hall, 1988) pages 25, 70, 179, 289.

10 Annual attendance figures for the park were reported by the National Park Service as:

1924 . . .	42,781	1934 . . .	90,365	1944 . . .	40,729
1925 . . .	55,227	1935 . . .	70,511	1945 . . .	100,694
1926 . . .	53,345	1936 . . .	94,899	1946 . . .	286,507
1927 . . .	61,761	1937 . . .	105,396	1947 . . .	341,599
1928 . . .	75,225	*1938 . . .	212,547	1948 . . .	343,160
1929 . . .	69,350	1939 . . .	189,421	1949 . . .	347,961
1930 . . .	105,353	1940 . . .	199,420	1950 . . .	352,889
1931 . . .	94,411	1941 . . .	245,640	1951 . . .	335,608
1932 . . .	83,630	1942 . . .	73,029	1952 . . .	374,333
1933 . . .	80,720	1943 . . .	34,791	1953 . . .	403,562

* Painted Desert entrance opened

Golden Anniversary of the Establishment of Petrified Forest National Monument: 1906 - 1956.

18 *Fifth Biennial Report of the State Engineer, Arizona*, 1920-1922 (n.p., 1922), pages 54, 93-94. In 1929-30 the Arizona Highway Department rerouted U.S. 66 between Sanders and Lupton in Apache County to avoid the Rio Puerco entirely. "Department Closed Brilliant Construction Year," *Arizona Highways*, July 1931, page 3.

19 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 27 June 1930.

20 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 27 July 1930.

21 *Golden Anniversary of the Establishment of Petrified Forest National Monument: 1906 - 1956* (Northern Arizona Printers & Publishers, 1956) n.p.

22 This proposed road was part of a nationwide effort undertaken by the National Park Service to upgrade the highway system within the parks. By July 1932 the NPS had planned an aggregate 1800 miles of park roads, for a projected total cost of some $25 million. Only about a third of these had then been constructed, according to BPR deputy chief engineer L.I. Hewes. "Western Engineering Problems Discussed by Civil Engineers," *Engineering News-Record*, 14 July 1932, page 51.

23 Harold J. Brodrick, Park Naturalist, "A History of Petrified Forest National Monument, Arizona," unpublished manuscript located at Petrified Forest National Park, 1955, page 30.

24 Text of address by Charles J. Smith to 50th Anniversary Celebration of Petrified Forest National Monument, 8 December 1956.

25 "Bureau of Public Roads Projects," *Arizona Highways*, July 1931, page 26.

26 "Bureau of Public Roads Projects," *Arizona Highways*, September 1931, page 22.

27 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 29 September 1931.

28 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 28 October 1931; "Bureau of Public Roads Projects in Arizona," *Arizona Highways*, November 1931, page 22.

29 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 27 November 1931.

30 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 28 January 1932; "Bureau of Public Roads Projects in Arizona," *Arizona Highways*, January 1932, page 23.

31 H. Langley, Assistant Landscape Architect, "Report to Chief Landscape Architect on Inspection of Route 1 Grading, Rio Puerco and Dry Creek Bridges, Petrified Forest National Monument," 7 March 1932.

32 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 28 March 1932.

33 "Bureau of Public Roads Projects in Arizona," *Arizona Highways*, June 1932, page 15; U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 28 May 1932.

34 "Dedication New Bridge Will be Held Next Sunday," *Holbrook Tribune*, 1 July 1932.

35 "Rio Puerco Bridge Dedicated Sunday," *Holbrook Tribune*, 8 July 1932; U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 28 July 1932.

36 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 28 July 1932.

37 U.S. Department of Interior, National Park Service, "Petrified Forest National Monument Superintendent's Monthly Report," by Charles J. Smith, 29 October 1932.

38 U.S. Department of Transportation, Federal Highway Administration, Office of Western Bridge Design, Denver Colorado, "Bridge Safety Inspection Report," 2 February 1978.

39 The unit was upgraded from monument to national park in 1962.

40 "An Editorial Survey," *Engineering News-Record*, 4 February 1932, page 154.

41 "Shipping and Erecting 154-Ft. Plate Girders," *Engineering News-Record*, 17 September 1931, pages 452-53.

HAER NO. AZ-13-1

HAER No. AZ-13-2





HAER No. AZ-13-3

HAER NO. AZ-13-6



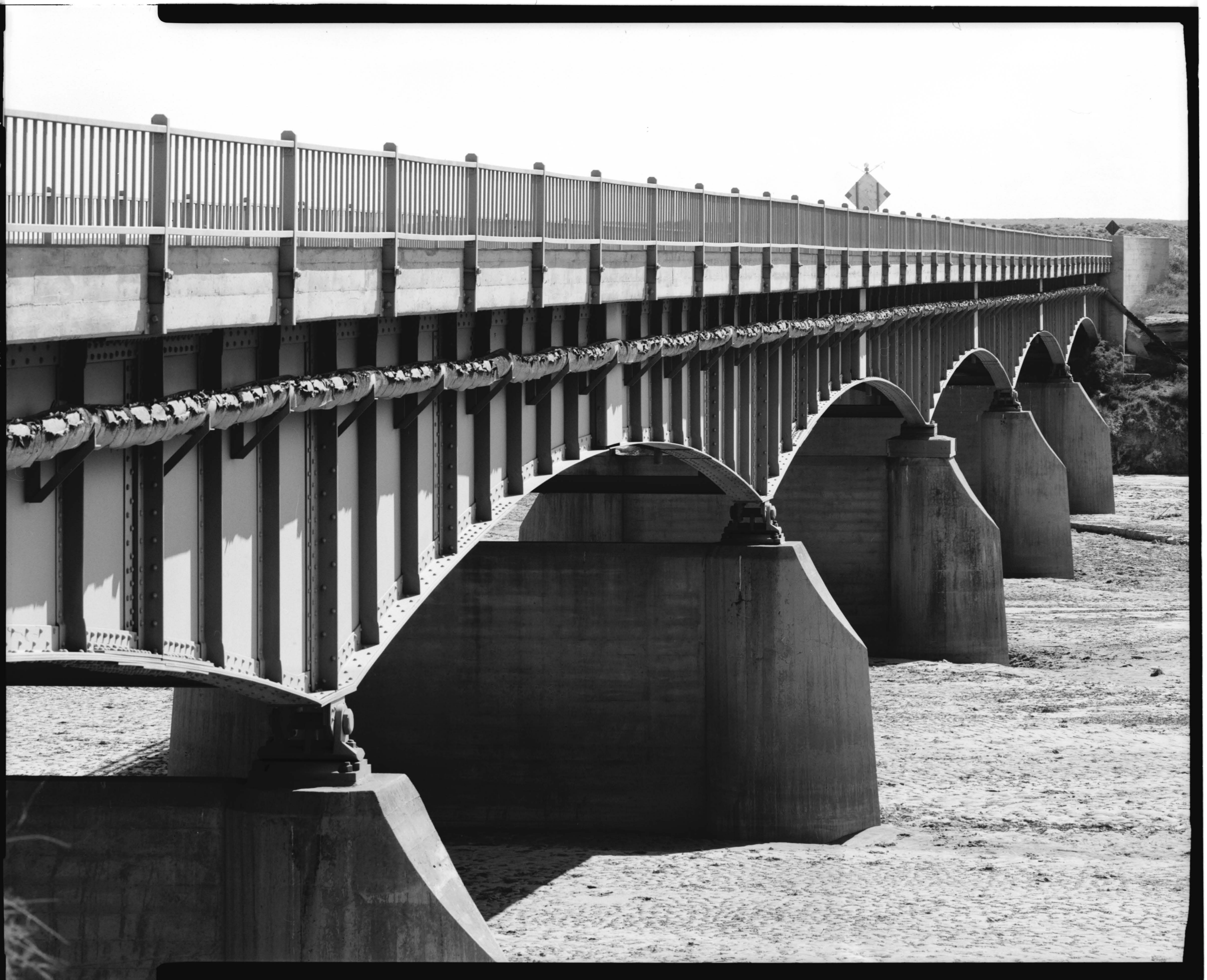


HAER No. AZ-13-5

HAER NO. AZ-13-6



HAER No. AZ-13-7





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HAER NO. AZ-13-10



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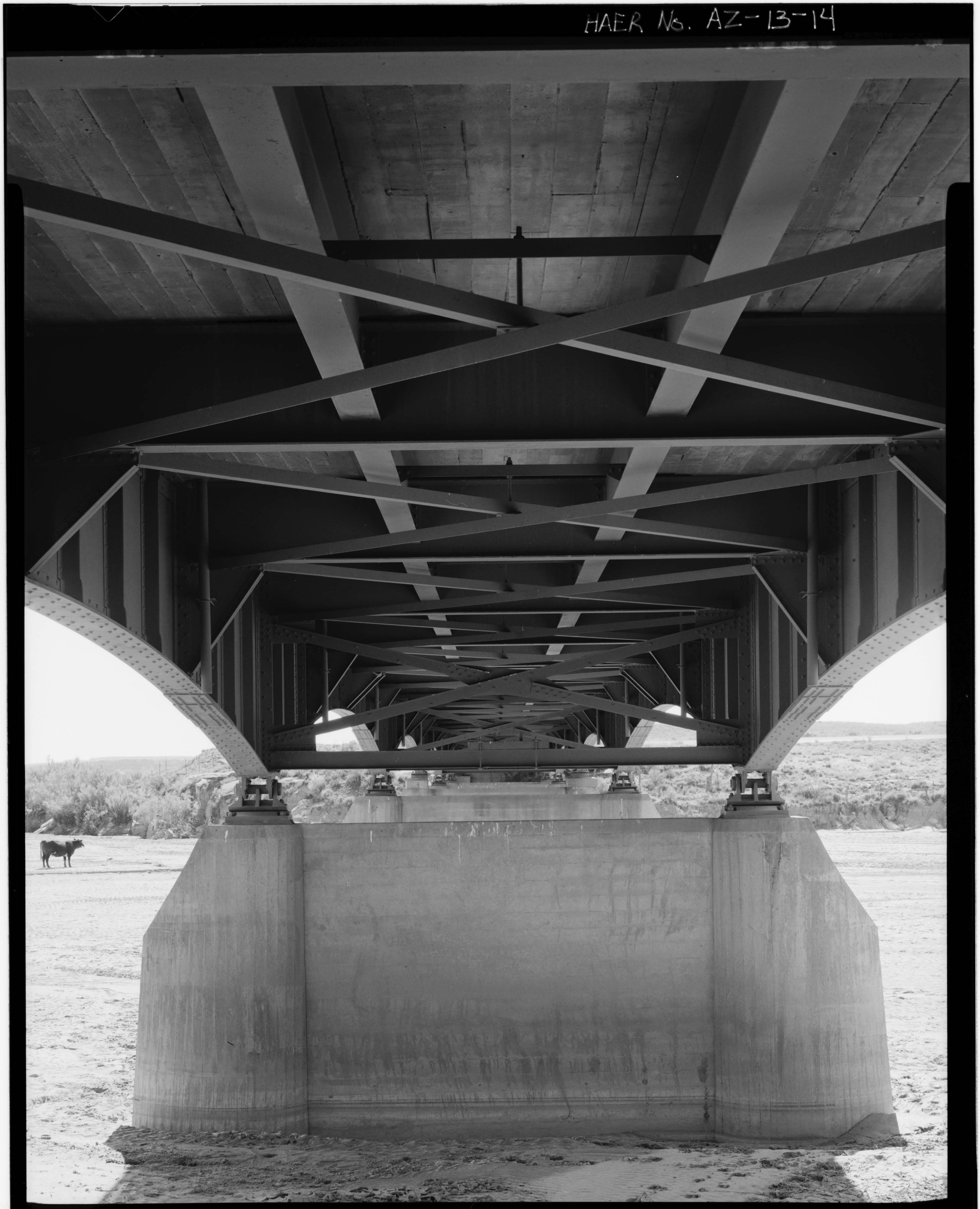

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HAER No. AZ-13-16





HAER NO. AZ-13-17



HAER NO. AZ-13-18


HAER NO. AZ-13-19



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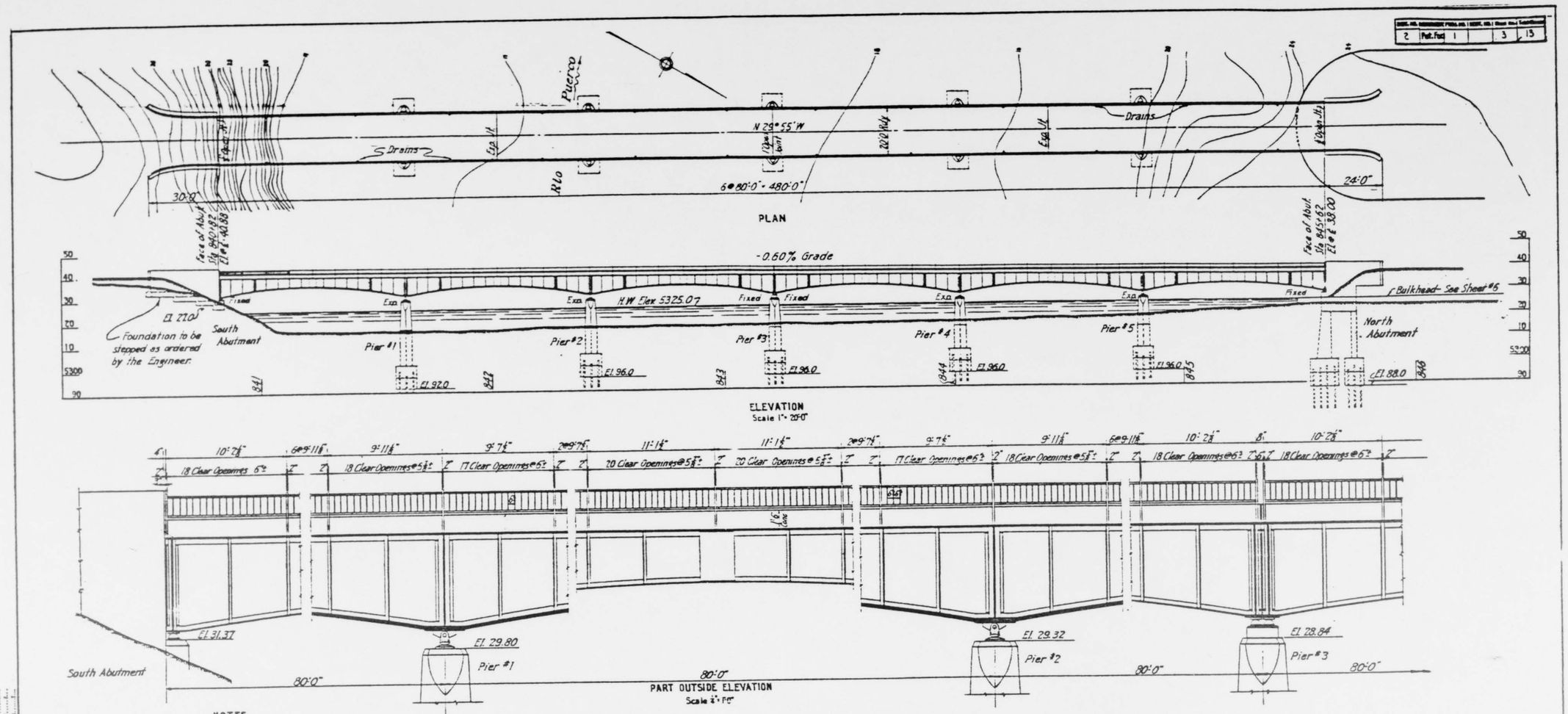
HAER NO. AZ-13-21

HAER NO. AZ-13-22





NOTES

Specifications:- U.S. Bureau of Public Roads - Form F.P.50-1929.
See "Special Provisions" for revised "Concrete Specifications" and "Specifications for painting Steel Structures."

Dead Load:- Concrete 150# per cu. ft.
Future paving allowance - 15# per sq. ft. of Roadway surface.

Live Load:- Floor System - Two 15 Ton Trucks.
Girders - Uniform load of 475# per lin. ft. plus concentration of 22,000# per girder.

Impact:- Floor System - 30% except as noted.
End floor beams and all floor system connections - 60%.
Girders - 25% except when cantilever span only is loaded when I = 30%.

Concrete:- Class "D" in floor slab (Maximum aggregate - 1½")
Class A, B and S in piers and abutments as noted.
All corners to be chamfered ¾" except as noted.
See "Special Provisions" for concrete finish.

Reinforcing Steel:- All steel to be deformed bars. Square twisted bars not allowed. All dimensions relating to reinforcement are to centers of bars.

Structural Steel:- See notes on Sheet #2

Piling:- to be untreated Coast Region Douglas Fir or Southern Yellow Pine.

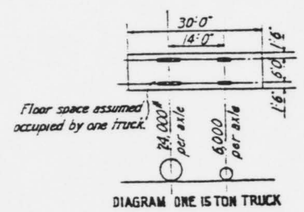


DIAGRAM ONE 15 TON TRUCK

ESTIMATE OF QUANTITIES

		Alternate Pier Design
Class 'A' Concrete	435 cu. yds	465 cu. yds.
" 'B' "	350 " "	320 " "
" 'D' "	250 " "	
" 'S' "	350 " "	320 " "
Reinforcing Steel	92,500 lbs.	91,500 lbs.
Structural Steel	445,000 "	
Steel Rail	360 lin. ft.	
Dry Excavation	90 cu. yds.	
Wet Excavation	2300 " "	2150 cu. yds.
Timber Piling	8000 lin. ft.	7000 lin. ft.
Sheet piling bulkhead	795,000 lbs.	
Riprap	340 cu. yds.	
Wire Mesh	1400 lbs.	

(Piling estimated as 40 feet long)

INDEX TO SHEETS

Sheet 1 - RG-255 A - Layout
" 2 - " - B Superstructure
" 3 - " - C "
" 4 - " - D Piers and South Abutment
" 5 - " - E North Abutment
" 6 - " - F Bulkhead
Sheets 7-9-P.G. 255 Architectural Plans.

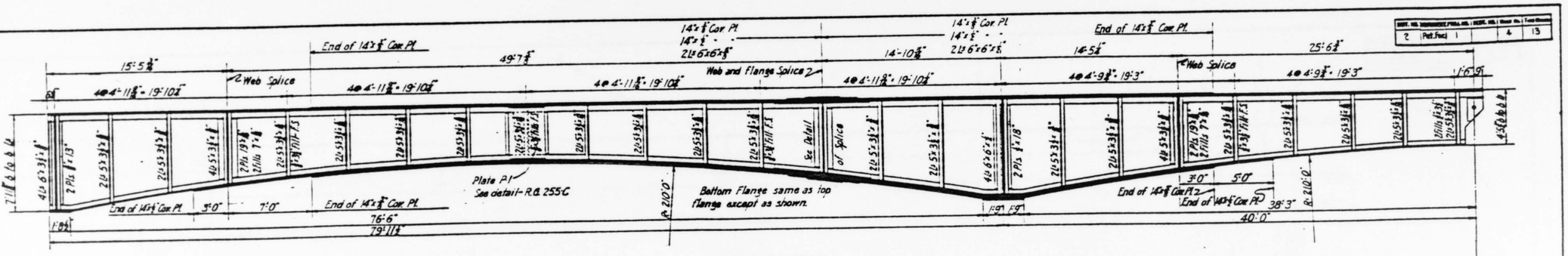
U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS · SAN FRANCISCO, CALIFORNIA

LAYOUT
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT - ARIZONA

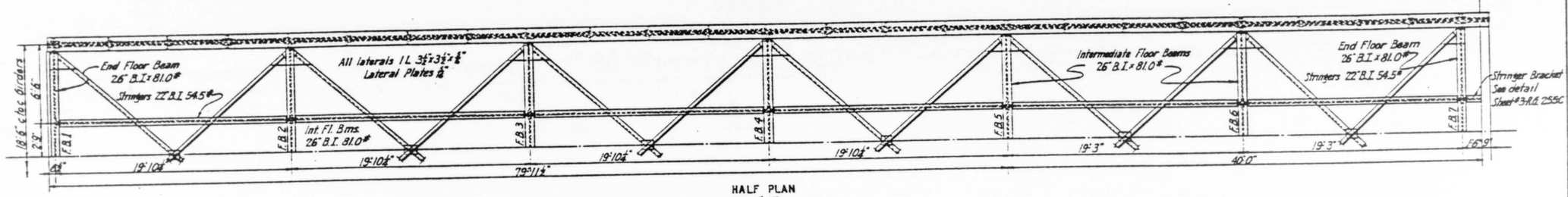
APPROVED: H. R. Cagwin
SENIOR HIGHWAY BRIDGE ENGINEER

APRIL 1931
SCALES AS SHOWN
Sheet 1 of 9 Sheets
RG-255-A

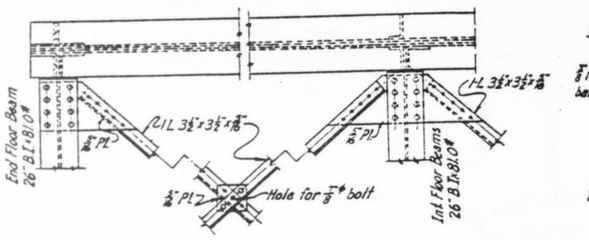
HAER No. AZ-13-23



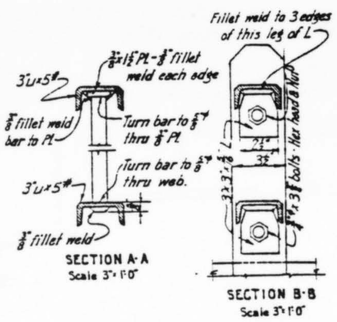
OUTSIDE ELEVATION
Scale ¼"=1'0"



HALF PLAN
Scale ¼"=1'0"

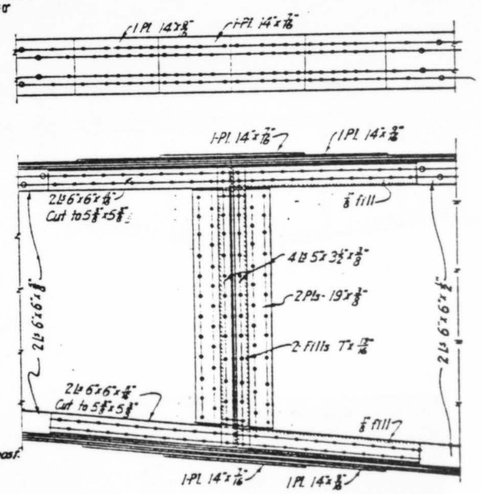


PART PLAN SHOWING LATERALS
Scale ½"=1'0"

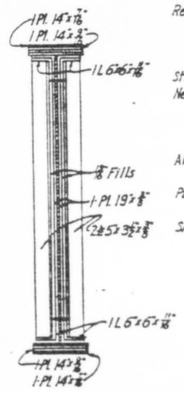


SECTION A-A
Scale 3"=1'0"

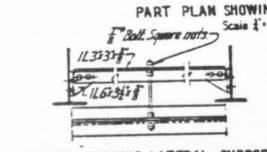
SECTION B-B
Scale 3"=1'0"



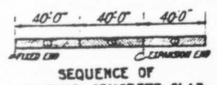
DETAIL OF GIRDER SPLICE
Scale ½"=1'0"



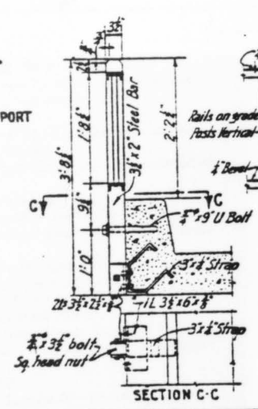
Notes for Structural Steel.
Fabrication and Erection:- U.S. Department of Agriculture Bulletin # 1259.
Rivets:- Diameter ⅞".
Reaming:- All field holes in girder splices to be subpunched and reamed while assembled. Floor system connections to be subpunched and reamed to a steel template.
Stiffner angles to be ground to bear.
Net Sections: Tension flange of girders designed for two holes out per angle and per cover plate. Rivet spacing shall be detailed to maintain this net Section (See paragraph 34- Section 3 of Bulletin # 1259.)
Alternate Sections noted may be used but payment will be based on weight of sections shown on details.
Paint:- Shop coat:- Red Lead.
Field Coats:- White Lead zinc oxide.
Shop Plans must be approved by the Engineer before fabrication is started.



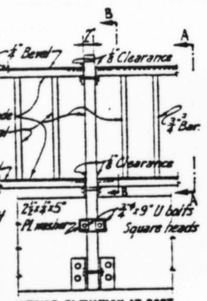
DETAIL: SHOWING LATERAL SUPPORT
Scale ½"=1'0"



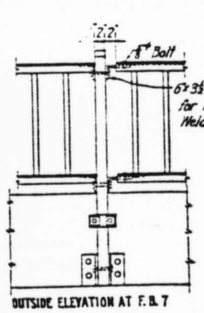
SEQUENCE OF POURING CONCRETE SLAB



SECTION C-C



OUTSIDE ELEVATION AT POST



OUTSIDE ELEVATION AT F.B. 7

Scale 1"=1'0"

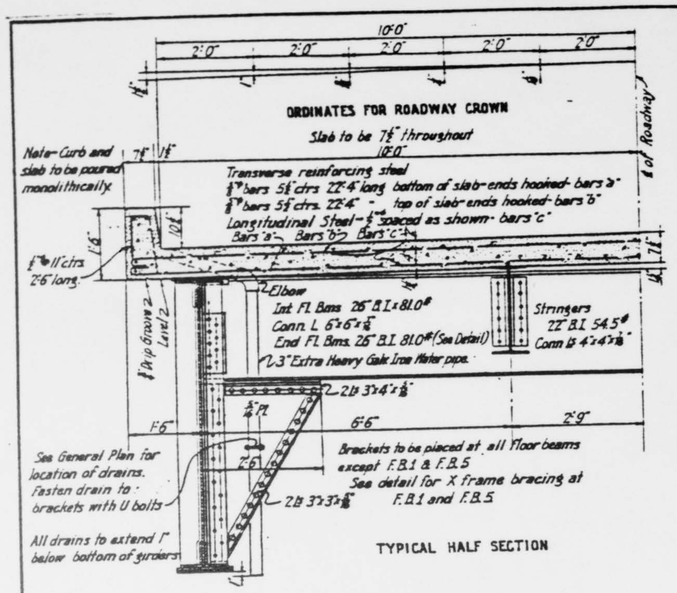
HANDRAIL DETAILS

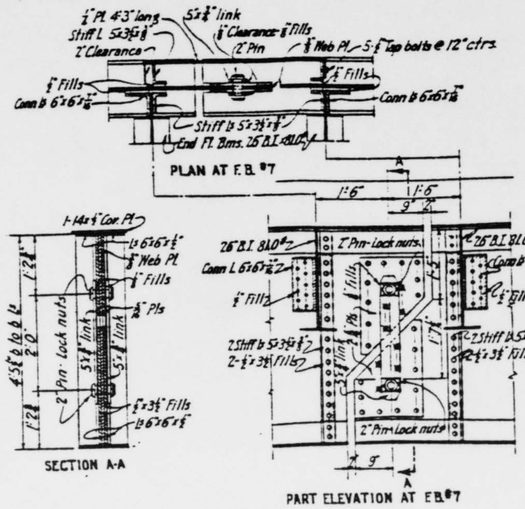
DESIGNED BY: ... DATE: April 1938
DRAWN BY: ...
TRACED BY: ...
CHECKED BY: ...

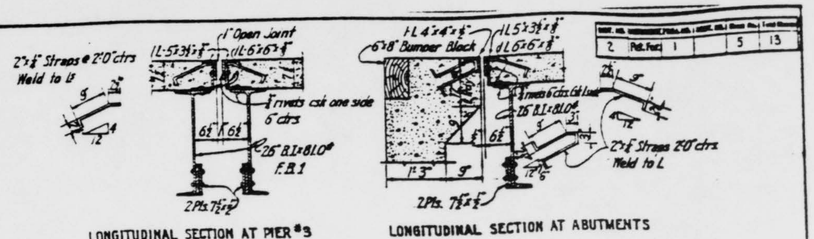
U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS SAN FRANCISCO, CALIFORNIA

SUPERSTRUCTURE
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT - ARIZONA
SCALES AS NOTED APRIL 1938
Sheet 2 of 9 Sheets RG-255-B

HAER No. AZ-13-24







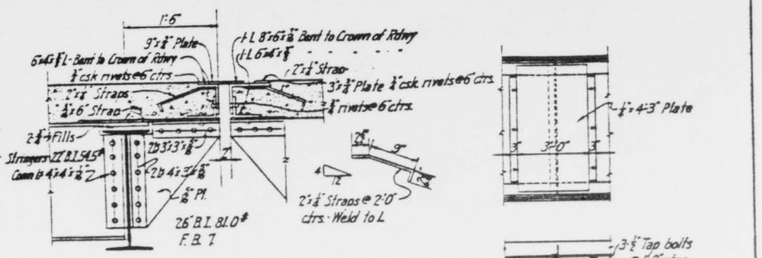
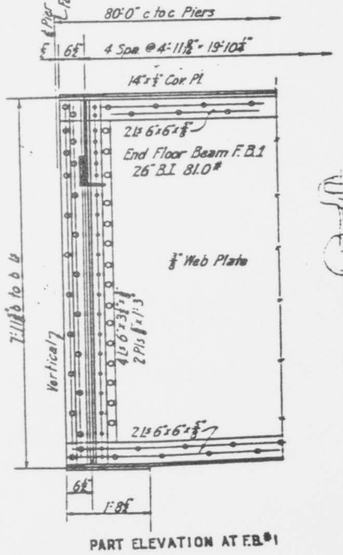
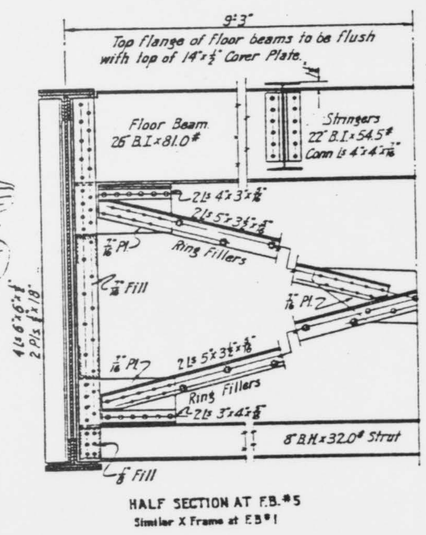
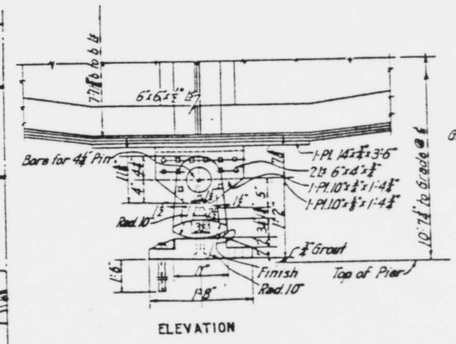


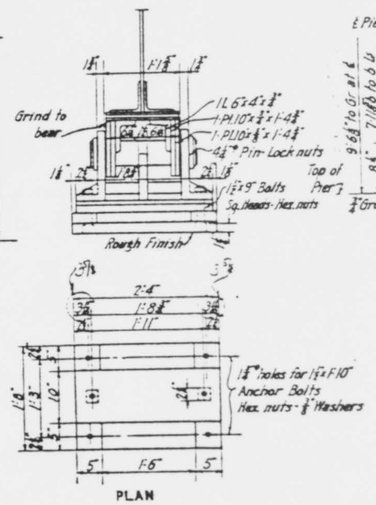
Table of Allowable Alternate Sections

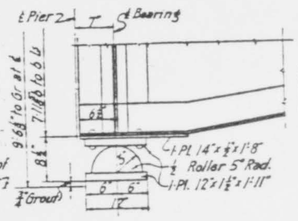
Stringers	21" C.B. 55#
Floor Beams	27" C.B. 85#
Struts	8" C.H. 326#

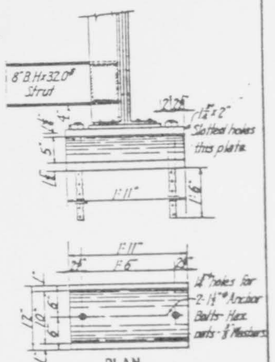












U.S. DEPARTMENT OF AGRICULTURE
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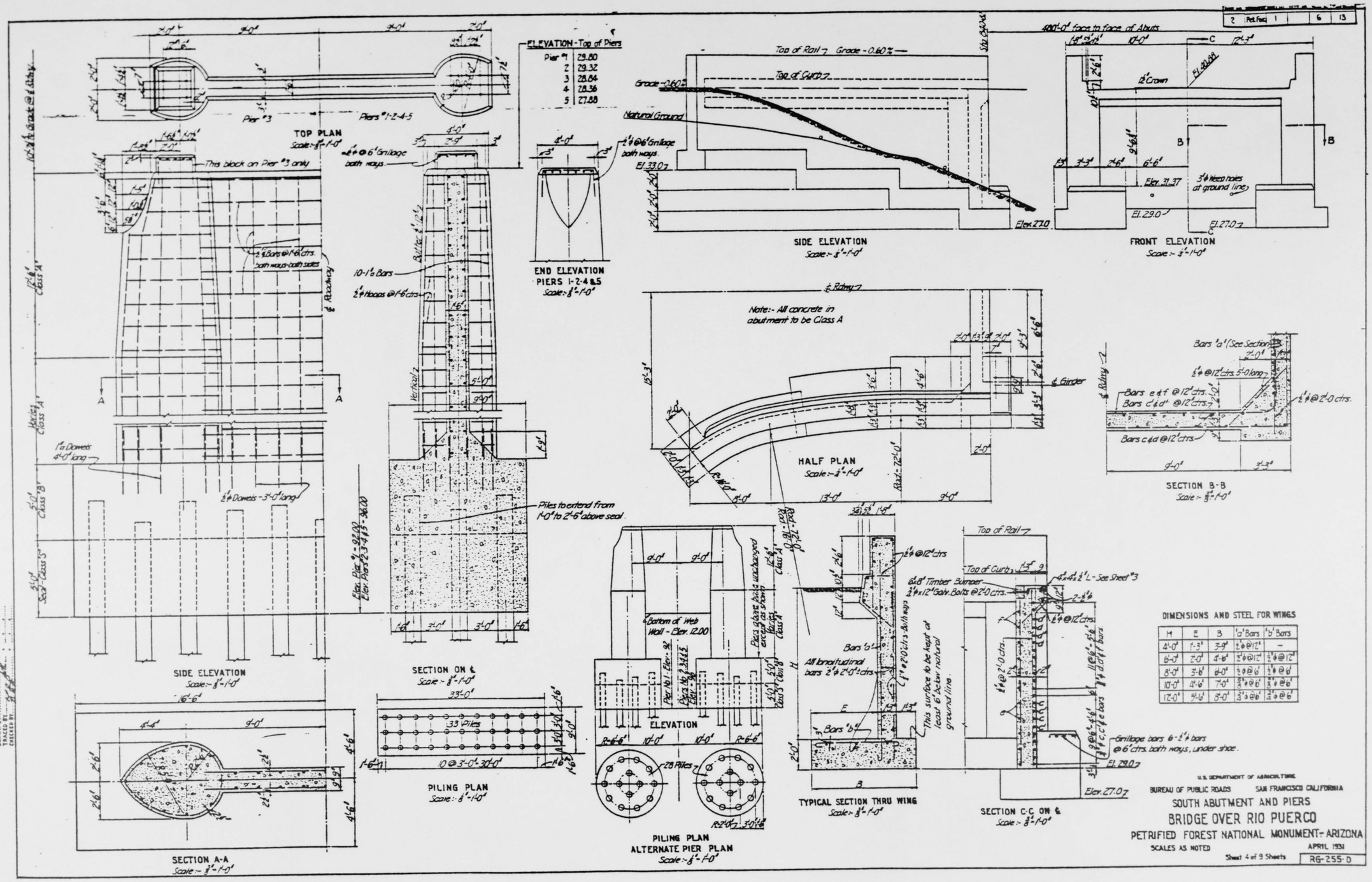
SUPERSTRUCTURE
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT-ARIZONA
SCALE ½"=1'0" APRIL 1951
Sheet 3 of 9 Sheets RG-255-C

HAER NO. AZ-13-25



DIMENSIONS AND STEEL FOR WINGS

H	E	B	'a' Bars	'b' Bars
4'-0"	1'-3"	3'-9"	1/2"ϕ @ 12"	–
6'-0"	2'-0"	4'-6"	1/2"ϕ @ 12"	1/2"ϕ @ 12"
8'-0"	3'-6"	6'-0"	1/2"ϕ @ 6"	1/2"ϕ @ 6"
10'-0"	4'-6"	7'-0"	5/8"ϕ @ 6"	5/8"ϕ @ 6"
12'-0"	5'-6"	8'-0"	3/4"ϕ @ 6"	3/4"ϕ @ 6"

U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS SAN FRANCISCO CALIFORNIA

SOUTH ABUTMENT AND PIERS
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT - ARIZONA

SCALES AS NOTED APRIL 1931

Sheet 4 of 9 Sheets RG-255-D

HAER No. AZ-13-26

HALF PLAN
Scale ⅛"=1'-0"

HOOK DETAILS

SECTION H-H
Scale ½"=1'-0"

SECTION F-F
Scale ½"=1'-0"

SECTION J-J

SECTION E-E
Scale ½"=1'-0"

SECTION G-G
Scale ½"=1'-0"

SECTION D-D
Scale ½"=1'-0"

HALF FRONT ELEVATION
Scale ½"=1'-0"

SECTION C-C
Scale ½"=1'-0"

SECTION A-A
Scale ½"=1'-0"

SECTION B-B
Scale ½"=1'-0"

PILING PLAN
Scale :- ⅛"=1'-0"

SIDE ELEVATION
Scale ½"=1'-0"

DESIGNED BY ..... DATE April 1931.
DRAWN BY .....
TRACED BY .....
CHECKED BY .....

U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS SAN FRANCISCO, CALIFORNIA

NORTH ABUTMENT
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT-ARIZONA

SCALES AS SHOWN APRIL 1931

Sheet 5 of 9 Sheets RG-255-E

HAER No. AZ-13-27

517'-0" Every 5th pile 35'-0" long, others 20'-0" long.

Wired rip-rap.

Toe of rip rap at ground line.

Sta 845+62

Sta 845+83

Sta. 846+00

Sta. 847+00

Sta. 848+00

Sta 849+00

Sta 850+00

Sta. 851+00

32'-0"

42'-6"

32'-0"

35' Steel piles

Flow

A.

B.

Galv. cast steel yacht rigging ties 16'-0" centers.

27'-4"

27'-4"

End of bulkhead and rip rap at Sta. 851+00

Toe of rip rap at ground line.

32'-0"

517'-0" Piles 35'-0" long.

PLAN
Scale 1"=20'-0"

Elev. 5338.00 finished grade at Sta 845+62.

Grade -0.6%

Elev. 5327.00 top of rip rap.

Elev. 5325.00 top of sheet piles.

Wired rip rap extends from Sta. 845+83 right around abutment to Sta. 845+83 left.

Two ties at Sta. 845+83 only. Place ties in adjacent piles.

Ties at 16'-0" centers.

Elev. 5305.00 at bottom of 20'-0" piles.

Elev. 5290.00 at bottom of 35'-0" sheet piles.

TYPICAL ARRANGEMENT OF PILES IN DOWN STREAM BULKHEAD
Scale 1"= 10'-0" Horizontal
" 1"= 10'-0" Vertical.

ELEVATION
Scale 1"= 20'-0" Horizontal
" 1"= 10'-0" Vertical

16'-0"

14'-0"

10'-0"

10'-0"

Future surfacing

Selected borrow

Slope 1½:1

Slope 1:1

Extend rip rap to elev. 5327.00 Top of sheet piles at elev. 5325.00

Tie,- ⅞" Diam. (6x7) Galv. cast steel yacht rigging & dia. (6x7) placed at 16'-0" centers.

Approx. elev. 5318.00 at tie

32'-0" at Sta. 845+83
27'-4" at Sta 851+00
Converges 0.9' in 100'-0"

32'-0" at Sta. 845+83.
27'-4 at Sta. 851+00
Converges 0.9' in 100'-0"

Elev. 5305.00
Bottom of 20'-0" piles.

Elev. 5290.00

Elev. 5290.00
Bottom of 35'-0" piles.

SECTION A-A
Scale 1"=10'-0"

Elev. 5325.00

1'-6"

Elev. 5326.00

6'-0"

5'-0"

Longitudinal strip of fabric 48" wide. May be cut in 24'-0" lengths along curved portion, lapped 3'-0" and wired. 8 times at each lap.
Transverse sections of wire mesh 72" wide. Lap 28" and wire securely with 18 ties.
All wire mesh to be A.S. & W. Co. Welded Fabric, 6x6"-6 gauge wire or equal.
Weight of fabric about 42" per 100 sq. ft.
All wire to be galvanized.

DETAILS OF WIRED RIP RAP IN FRONT OF CURVED SECTION OF BULKHEAD
Scale 1"= 2'-0"

Anchor beam at Sta. 845+83 only to be 5'-10" long.

Tie,- ⅞" Diam. (6x7) Galv. cast steel yacht rigging placed at 16'-0" intervals. Clamp and 6 clips for connecting ends of rope.

Anchor beam 12" C.B 28# 4'-6" long for all ties except at Sta. 845+83

TYPICAL DETAIL AT TIE
Not to scale.

Half section of 8" dia. double extra strong pipe 6' long for rope cradle, or 6"x12"x⅝" plate curved.

Holes in piles may be burned with torch.

Anchor beam 12" C.B 28# 4'-6" long (5'-10" long at Sta. 845+83)

Center of clamp

Not less than 10'-0" from sheet piles.

SECTION B-B
Not to scale.

5314
5312
5310

40'-0"

Use sheet piles 35'-0" long - Top of piles elev. 5327.00

Fabricated Tee.

Center of bulkhead 580'-0" right of Sta. 845+00

PLAN OF SHEET PILE PROTECTION
580'-0" RIGHT OF STA. 845+00
See Plan and Profile sheet no. 2 for location.
Scale - 1"= 20'-0"

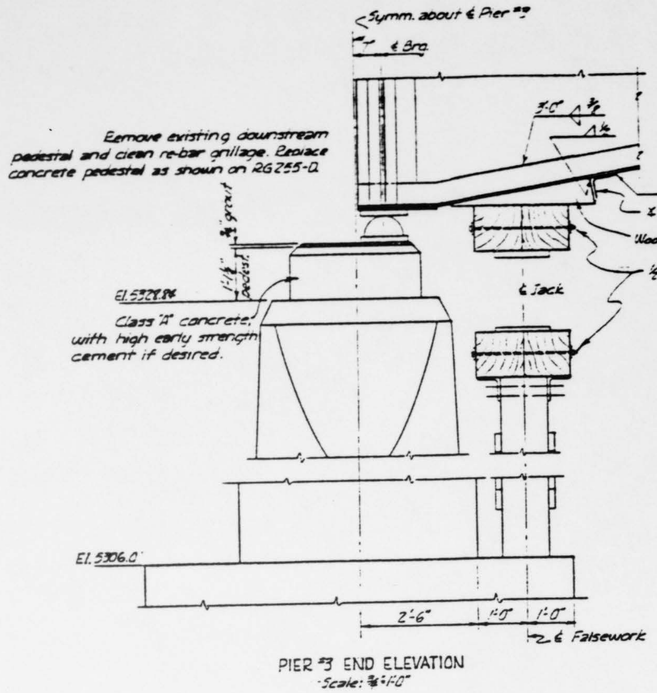
DESIGNED BY ..... DATE April 1931
DRAWN BY .....
TRACED BY .....
CHECKED BY .....

U.S. DEPARTMENT OF AGRICULTURE
BUREAU OF PUBLIC ROADS SAN FRANCISCO, CALIFORNIA

BULKHEAD
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT - ARIZONA
SCALES AS SHOWN APRIL 1931

Sheet 6 of 9 Sheets R6-255-F

HAER NO. AZ-13-28

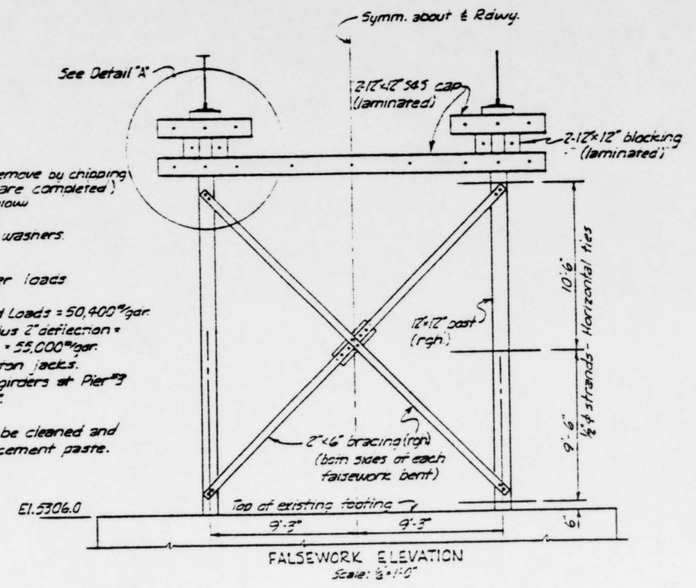


PIER #3 END ELEVATION
Scale: ⅜"=1'-0"

Computed girder loads for jacking:
Total for Dead Loads = 50,400#/gir.
Total for D.L. plus 2" deflection = = 55,000#/gir.

Provide min. 30 ton jacks.
Do not deflect girders at Pier #3 more than 2".

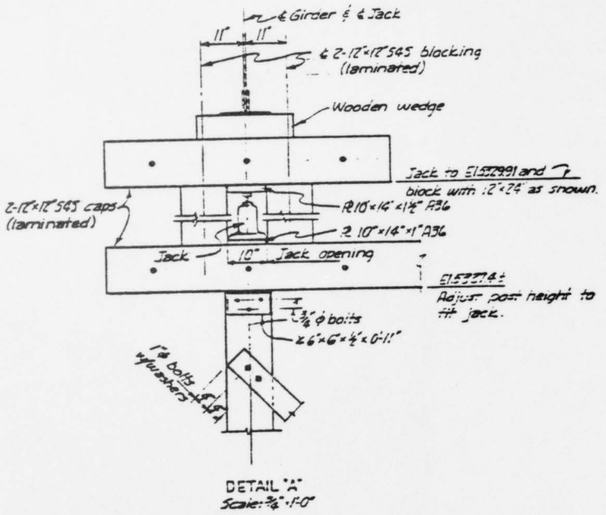
Pier cracks to be cleaned and repaired with cement paste.



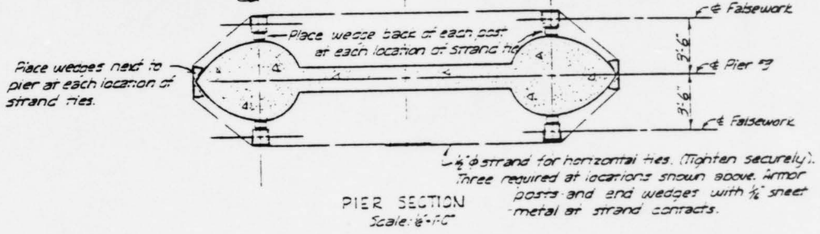
FALSEWORK ELEVATION
Scale: ⅛"=1'-0"

CONSTRUCTION SEQUENCE

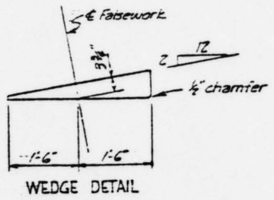
1. Construct falsework bents on each side of Pier #3.
2. Place jacks, caps, wedges, etc. over jacks and under girders.
3. Lift both girder ends 2" simultaneously for each span.
4. Place blocking between caps to hold girders and release jacks.
5. Remove damaged concrete pedestal and replace.
6. Cure new pedestal for 48 hours.
7. Place new grout pad of stiff mortar grout approx. ¼" above design final elevation.
8. Lower girders simultaneously to final elevation.
9. Block girders for new pedestal at final elevation and release jacks.
10. Cure mortar pad for 7 days.
11. Take up on jacks enough to remove blocks and reseat girders.
12. Tighten anchor bolts and remove all temporary falsework, etc.
13. Clean and repaint all steel surfaces damaged during field welding or otherwise during repairs.



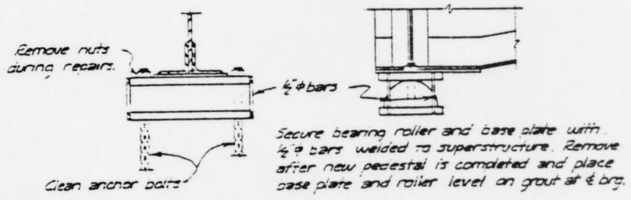
DETAIL "A"
Scale: ⅜"=1'-0"



PIER SECTION
Scale: ⅛"=1'-0"



WEDGE DETAIL



Secure bearing roller and base plate with ½"ϕ bars welded to superstructure. Remove after new pedestal is completed and place base plate and roller level on grout at ℄ brg.

BEARING DETAILS
Scale: 1"=1'-0"

Note:
Construction Specifications, Bureau of Public Roads, FP'61.

All temporary framing shall be Coast Region Douglas Fir, Construction Grade or better. Posts and Timbers, conforming to paragraph 125 WCLA Rule 15 latest revision.

DEPARTMENT OF COMMERCE
BUREAU OF PUBLIC ROADS REGION 7 SAN FRANCISCO, CALIFORNIA

PIER #3 REPAIRS
FOR
BRIDGE OVER RIO PUERCO
PETRIFIED FOREST NATIONAL MONUMENT - ARIZONA

SCALE: AS SHOWN FEBRUARY - 1965

2G-255

DRAWN BY
CHECKED BY

HAER NO. AZ-13-29