TREATMENT REPORT: PROMONTORY TRESTLE STABILIZATION AT GOLDEN SPIKE NATIONAL HISTORIC SITE

PREPARED FOR THE NATIONAL PARK SERVICE

by

THE SCHOOL OF ENGINEERING / UNIVERSITY OF VERMONT

THE SCHOOL OF ARCHITECTURE AND PLANNING

UNIVERSITY OF NEW MEXICO

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Cover photo: Promontory trestles no. 1 (right) and no. 2 (left), Golden Spike National Historic Site. Photo courtesy Mike Oestreich, NPS, May 2012.

EXECUTIVE SUMMARY

The Promontory Trestles at Golden Spike National Historic Site (GOSP) are a pair of wood trestles constructed by the Southern Pacific Railway in the late 19th and early 20th centuries. The trestles span washes located along a portion of the 1869 Union Pacific Grade, located within the boundaries of Golden Spike National Historic Site. Both trestles have stringer assemblies of timber girders with tie decking, supported on wood piles with bracing, and the framing configurations reflect their different construction dates.

Both trestles, which are important contributing elements to the park's National Register status, were in poor condition in 2011, were dangerous for visitors to approach, and were in imminent danger of collapse. The park was in the process of planning for temporary shoring of Trestle #1 to prevent its collapse. Ultimately, the park hoped to complete repairs and to expand visitation and interpretation of these two important structures.

The National Park Service, the School of Engineering at the University of Vermont, and the School of Architecture at the University of New Mexico collaborated in the condition assessment, HABS / HAER – level documentation, repair design development, and stabilization of the Promontory Trestles. One of the chief goals of assessment and planning was to determine whether the trestles could be stabilized by repairing key structural elements (rather than by adding external shoring), so that stabilization directly advanced the repair objectives and left the park better positioned in their effort to reopen the site to the public.

These tasks were conducted over the course of three site visits in 2011 and 2012, and the park and the university participated fully in all aspects of the work. The first site visit (07/13/2011 – 07/16/2011) was focused on documentation of Trestle #2, condition assessment and analysis of both trestles, and presentation to the park of treatment strategies representing varying levels of intervention. Based on the park's preferred approach, a plan for stabilization was developed. Repair work was begun during a second site visit (10/03/2011 – 10/11/2011), organized as a field school. Students and GOSP staff worked with a crew of professional timber framers affiliated with the university to shore Trestle #1, remove the stringer assemblies from both trestles, and complete the repairs to Trestle #2. In a third site visit (05/14/2012 – 05/21/2012), repairs were made to Trestle #1 and both trestles were reassembled.

This report describes the assessment results and the repairs that were made and is divided into seven parts, including a description of the trestle structures and a consideration of their history and significance; a summary of the wood investigation and condition assessment of the trestles; a presentation of the repair strategies; a section each on the repairs made to Trestles #1 and #2; and appendices relating to resistance drill results and documentation of the trestles.

In the first section, the construction of Promontory Trestles #1 and #2 is described in the context of site history and period technology. The significance of each structure is also considered in this section.

Section Two describes the wood investigation and the condition assessment of the trestles, including a description of field procedures, and the assessment results on which the subsequent treatment was based. Section Three focuses on repair strategies and techniques, and presents a rationale for stabilization of the trestles while retaining the maximum amount of historic material by using traditional techniques including scarfed splices and dutchman repairs; unsalvageable elements were to be replaced in kind. This section also discusses recommendations for streambed restoration at both trestles to extend the period of service.

The fourth and fifth sections present a summary of the repairs performed in the treatment of each trestle. Appendices include the results of resistance drilling tests performed during the wood investigation along with maps of resistance drilling and sample locations, annotated drawings of repair locations and details, annotated photographs of the repair work, and a set of HABS Level 2 drawings and photographs of Trestle #2 completed prior to treatment. Annotation consists of captioned drawings and / or photographs depicting typical or specific repairs and repair work.

HISTORY AND SIGNIFICANCE

After its completion in 1869, the Transcontinental Railroad Line required continuous repair and rebuilding. The trestles, located on the Engineer Mountain grade west of Corrine, characterize the evolution of construction techniques used by the railroad during the period the site was active, from 1868 until 1942. Trestle #1 was originally constructed in 1889, of timber brought to the site from the west coast of the US, and is the oldest trestle in the park and contributes to the National Register status of the Golden Spike National Historic Site.

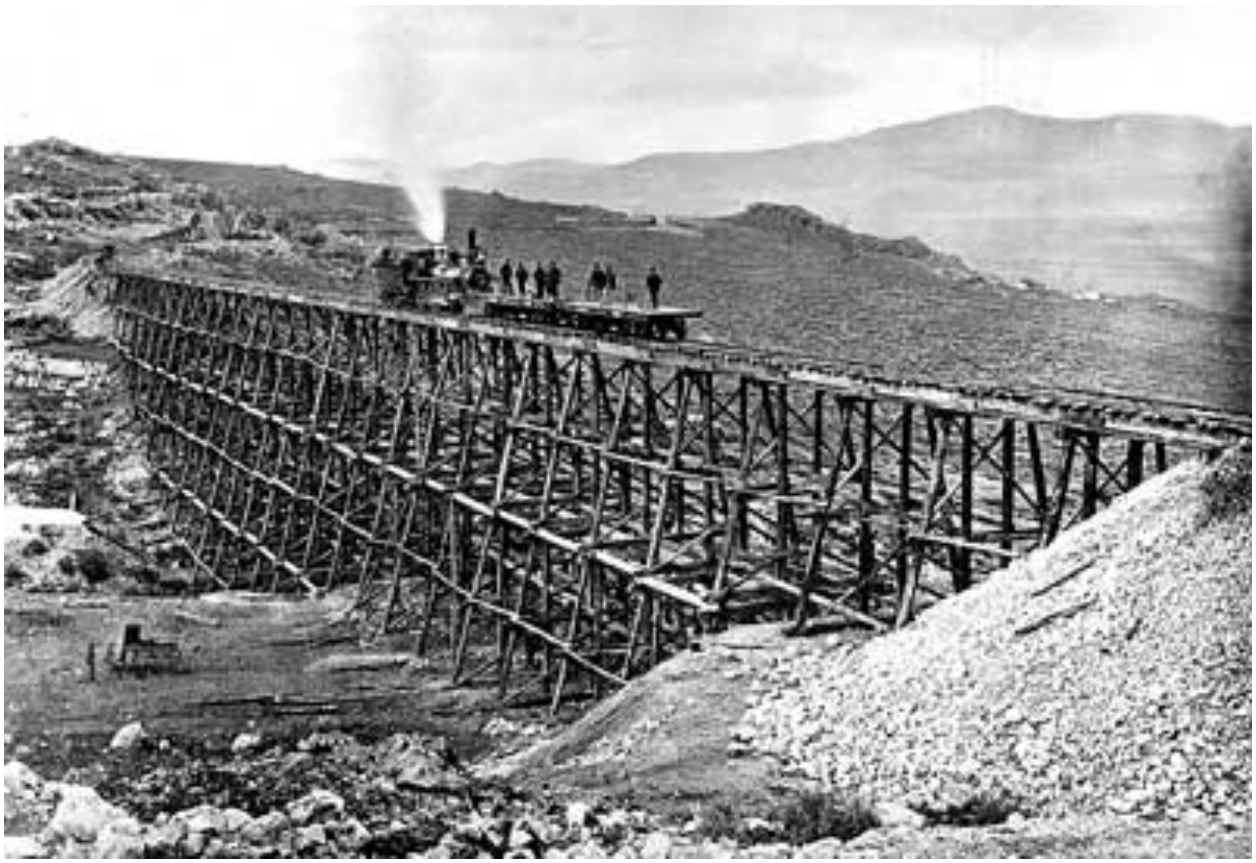

Figure 1: Wood proved to be an inexpensive way for rail companies to bridge obstacles during the construction of the transcontinental rail line. While many of the trestles erected during this time were small pile structures like the Promontory Trestles of this project, others were far larger and more complex, like the Big Trestle that once stood on the Union Pacific Grade a few miles southwest of the project site. Photo courtesy Utah State History, <http://history.utah.gov/experience_history/ visit_historic_places/golden-spike.html>.

Trestle #2 was constructed in 1938 as a replacement for Trestle #1. The original drainage channel of Trestle #1 is believed to have eroded the foundation significantly, making replacement impractical. A railroad tie diversion structure was constructed by the railroad upstream from Trestle #2 to realign the drainage channel, bypassing the first structure. The railroad abandoned the line shortly after the construction of Trestle #2, and the older trestle was never removed.[1] While the construction date of Trestle #2 lies outside of the period of significance for Golden Spike (1868-1914), it is historically significant as part of the ongoing railroad maintenance program, and is a contributing structure in the district. The construction of Trestle #2 appears to be based on the Common Standard design adopted by the Southern Pacific Lines in 1904[2].

Both trestles are likely to have been built by the Mormon firm of Benson, Farr, and West, who held the grading contract of the Central Pacific line from Ogden to Promontory. In 1904, the completion of the Lucin Cut-off across the Salt Lake eliminated this section of track from the main line. However, the track was still used to carry maintenance trains for the transcontinental telegraph that continued to follow the original route, and both trestles remained in operation until the rail line was abandoned in the 1940s.

Both trestles are now located within the boundaries of Golden Spike National Historic Site (April 2, 1957). Golden Spike National Historic Site is considered significant under National Register Criteria A, C, and D. It commemorates the joining of the Central Pacific and Union Pacific Railroads in 1869, and provides information on railroad construction techniques, westward expansion, and American social development. The National Register nomination (NRIS #66000080) was approved on May 23, 1988.[3,4] The trestle site is remote and the structures are not protected from the weather in any way, and prior to this project several key elements were in danger of collapse.

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[1] *Historic Preservation Plan for Trestles No. 1 and No. 2*. Golden Spike National Historic Site, Promontory Summit, Utah. CX-1200-5-A023. 1985. P. 4. While the preservation plan suggests the construction of the railroad tie diversion structure by the railroad as evidence of the intended removal of Trestle #1, the author adduces no documentation in support of this version of events. The issue is not specifically addressed in other known texts.

[2] Southern Pacific Lines. *Open Deck Pile and Frame Trestles, E-50 Live Load*. Common Standard. Adopted Sept. 27, 1904. Revised Apr. 22, 1958.

[3] National Park Service. *Southern Pacific Wood Trestle #2, Structure No. S 779.89.* List of Classified Structures. 2008.

[4] National Register of Historic Places. *Golden Spike National Historic Site, Promontory Summit, Box Elder County, Utah*. National Register #66000080. 1957.

WOOD INVESTIGATION AND CONDITION ASSESSMENT

In 2011, the species, condition, and structural grade of the timbers used in the construction of the two trestles were unknown. Both trestles had areas of visible wood deterioration, but the extent of the deterioration caused by wood decay fungi and/or wood boring insects was not known (see Figures 2 and 3). Through visual examination, probing, moisture content measurements, resistance drilling, species identification, and lumber grading, it was possible to determine whether the wood members in the structural assemblies of the trestles were (a) generally unfit to remain in service, (b) deteriorated and in need of repair or replacement or (c) generally in sound condition and suitable for continued use.

Figure 2: Many of the members of Trestle #1 were badly deteriorated.

The wood assessment included the following tasks:

- Removing 23 wood samples (17 from Trestle #1; 6 from Trestle #2) to identify the wood species or wood species groups for select structural elements including piles, stringers, abutment planks, ties, and mudsills.
- Identifying and visually inspecting locations that had potential insect or decay damage.
- Determining the allowable structural grade based on a visual assessment of accessible structural members.
- Taking moisture content measurements of a representative sample of structural timbers to determine whether conditions are favorable to deterioration of the wood, as well as to determine the potential impact on long-term performance of the timber.
- Conducting selected resistance drilling in structural timbers at key locations and in areas of

Figure 3: The stringers of Trestle #2 had extensive decay pockets along their length.

visible moisture damage, to determine the extent of decay or insect damage.

- Providing recommendations on the suitability of continued use of the wood elements and structural timbers and repair or replacement options based on their condition.

FIELD PROCEDURES

The assessment team included the Resources Chief at Golden Spike National Historic Site (Whitesides), the Vanishing Treasures Historical Architect (Skeirik), the Principal Investigator (Porter), a wood science consultant (Anthony), a professional timber framer (Cotroneo), and an interning architect (Stevenson). An on-site meeting was conducted at the beginning of the investigation to verify the scope and objectives. Through visual inspection, probing, moisture content measurements and limited resistance drilling, it was possible to determine the wood species, develop a general sense of the applicable structural grade, and form opinions about the general condition of the timbers in the two trestles. Information from the wood investigation facilitated decisions on the structural integrity of the timbers. A description of the methodology is found below.

Nomenclature

Trestle #1 spans 15'-9" and is comprised of an east bent with five piles, with five piles, which is adjacent to and supports the east bulkhead, and a west bent with four piles, which similarly supports the west bulkhead planking. Two stringer assemblies span 16 feet from east to west. They are comprised of four 7-inch by 16-inch beams with bolted connections. All of the structural elements are labeled according to 2005 HABS/HAER documentation.

Trestle #2, which did not have HABS/HAER documentation at the time of the investigation, was labeled using similar terminology. It spans approximately 46 feet, and has east and west bulkheads, and freestanding east and west bents, each having five piles. The stringer assembly is labeled in an identical manner as Trestle #1. For more information on the nomenclature for both trestles, refer to Figures 1 through 6 in Appendix B.

Species Identification

Identifying wood species makes it possible to determine material properties for conducting a structural analysis and to identify compatible material for repairs. Wood species were identified by removing small samples from various components (see Figure 4), from which the species or species group were determined under microscopic examination. Samples were removed from structural elements of concern to the inspection team (see Appendix B for sample locations).

Figure 4: Removing a sample from a tie for species identification.

Timber Grading

The design values given in the building code for solid wood products are established by the American Forest & Paper Association[5] and published as the National Design Specification for Wood Construction. The published design values are based on test data and procedures published by the American Society for Testing and Materials (ASTM)[6] that demonstrate the engineering performance of the material. Wood products are graded in accordance with procedures promulgated by one of several forest products industry associations, such as the Western Wood Products Association (WWPA)[7] or the Southern Pine Inspection Bureau (SPIB).[8]

For existing structures, designers often rely on available species and current standards to determine the adequacy of the wood members to remain in service. Since many older constructions were built before building codes or design values for wood products were established (and, thus, before grade stamps were used), designers are often in a quandary when determining what design values are appropriate. Frequently an assumed species and grade are assigned, only to show that the wood members are structurally deficient. The result is often an overly conservative estimate of design values and unnecessary replacement, repair, and retrofit decisions with the associated unnecessary project costs.

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5 American Forest & Paper Association and American Wood Council. *National Design Specification for Wood Construction*. Washington, D.C. 2005.

6American Society for Testing and Materials, , *Annual Book of Standards, Vol. 04.10: D245, Standard Practice for Establishing Structural Grades and Related Allowable Properties for Visually Graded Lumber; D2555, Standard Test Methods for Establishing Clear Wood Strength Values*. ASTM: West Conshohocken, Pennsylvania. 2006.

7 Western Wood Products Association. *Western Lumber Grading Rules*. Portland, Oregon. 2011.

8 Southern Pine Inspection Bureau. *Standard Grading Rules for Southern Pine Lumber*. Pensacola, Florida. 2002.

The inspection team conducted in-situ visual grading of key structural wood elements to provide data for the establishment of appropriate design values (see Figure 5). Grade information was based on visual inspection and direct measurement of grade-limiting characteristics such as knots and slope of grain, where possible.

Visual Inspection and Probing

Visual examination of the wood allows for identifying components that are missing, broken, or in an advanced state of deterioration. Missing components are those that have been removed or have fallen away because of deterioration, structural failure, or vandalism. If missing components were intended to provide structural support or protection from the elements (e.g., to prevent moisture intrusion), their replacement may be essential to prevent long-term damage to the structure. Visual inspection also allows for the detection of past or current moisture problems, as evidenced by moisture stains on the exposed surface of the wood. Further, visual inspection enables detection of external wood decay fungi or insect activity as determined by the presence of decay fruiting bodies, fungal growth, insect bore holes or wood substance removed by wood-destroying insects.

Figure 5: Example of an edge knot on the north strut of Trestle #1.

Figure 6: An awl can easily be inserted into the mudsill, east bent, Trestle #1.

Internal decay and insect damage are often difficult to detect due to the lack of evidence on the exposed surface of the wood. Probing the wood with an awl enables rapid detection of voids in the wood that may not be visible on the surface (see Figure 6). It can also indicate the approximate depth of any deterioration that is visible on the surface. Visual inspection and probing provides a rapid means of identifying areas that may need further investigation. As the bearing areas are hidden from view, it is important to determine the condition of this visually inaccessible wood when assessing structural integrity.

Moisture Content Determination

Prolonged exposure to moisture can produce undesirable conditions and long-term maintenance issues for wood in a structure. Excessive shrinkage or swelling, checking, loose connections, and decay are typical problems. Moisture content measurements were taken using a resistance-type moisture meter and/or a capacitance moisture meter at various locations, including areas prone to moisture intrusion such as near connections and at or below ground line, to gain insight into the moisture levels throughout the trestle structures (see Figure 7). This information is also useful for potentially adjusting allowable design values.

Figure 7: Determining the moisture content of a top strut, Trestle #1.

In addition to having a potential impact on design values, moisture content measurements can provide information on the condition of the wood as well. Moisture content measurements identify wood with favorable moisture levels for the growth of wood-decay fungi. Generally, if the moisture content is less than 20 percent, wood-decay fungi are unable to grow. While fungi may be present at lower moisture contents, they are unable to continue to deteriorate the wood without sufficient moisture. Moisture contents from 20 to 30 percent indicate areas of concern where sufficient moisture is present for fungi to grow but not sufficient to indicate advanced decay. Moisture contents above 30 percent can indicate advanced decay with internal voids and/or surface deterioration.

Resistance Drilling

Limited resistance drilling was conducted to ascertain general wood conditions (see Figure 8). Resistance drilling is a quasi-nondestructive technique for determining the relative density of wood. It is best suited for determining internal problems in timbers that do not show obvious signs of deterioration. Voids, areas of early-stage, or incipient, decay, and areas of insect damage can be identified and quantified by determining the relative density profile of the wood compared to sound wood. The relative density is recorded on a strip of paper as a small diameter ($^1/_8$-inch) needle penetrates the wood. The technique is very reliable for quantifying the extent of voids when used in combination with other techniques to rapidly locate areas of probable deterioration. Given the obviously advanced state of deterioration of both trestles, resistance drilling was used, in part, to identify salvageable portions of partially decayed timber (see Appendices A and B for resistance drilling results and locations).

Figure 8: Using the resistance drill in a top strut, Trestle #1.

FINDINGS

General Observations

Based on the findings of the wood investigation, the conditions of the wooden elements could be classified into one of four descriptive groups: excellent, good, fair, and poor. For wood with no deterioration due to decay or insect damage and showing minimal effects of weathering (primarily discoloration), a rating of excellent could be applied. Very few of the wood members in the trestles, with the exception of the piles and other substructure members in Trestle #2, could be classified as being in excellent condition. For wood with severe weathering but no deterioration due to decay or insect damage, a rating of good could be applied. For wood with minor deterioration (early stages of decay) or severe checking or splitting, a rating of fair could be applied. For wood with advanced decay or insect damage such that the member is in danger of failure, a rating of poor could be applied. The wood used to construct Trestles #1 and #2 appeared to be, in general, in poor condition, and the majority of wood was found unsuitable for continued service without repair.

Trestle #2 was constructed in the 1930s; Trestle #1 is believed to have historic components that date to 1889. Because of the historical significance of both trestles, one of the primary project goals was maximum retention of historic fabric. The NPS also had an interest in repairing and upgrading the trestles to provide increased public access.

In general, the wood elements in Trestle #1 were found to be in poor condition; most timbers did not have enough sound material to be salvaged for repair, including most of the piles and pile caps. Some elements, such as the north curb, were missing altogether. Elements that could be retained in service with repair were limited to mudsills, three of the piles, and portions of some of the stringers.

The timbers in Trestle #2 ranged from excellent to poor condition; the round piles for the bents were creosote-treated and showed few signs of deterioration, while many of the remaining timbers (most notably the stringers) were severely deteriorated. Deck planking, ties, and curbs no longer survived on Trestle #2. (Additional information on the condition of timbers prior to treatment can be found in the “Condition” portion of this section.).

Species Identification

Wood species from both trestles were identified by removing small samples from which the species or species group was identified using microscopic features of the wood (see Appendix B for sample locations). The locations of the samples are given in Table 1. The samples were removed in order to provide data on the species of key structural elements and to aid in developing historical documentation, conducting structural analysis, and specifying repairs.[9]

Table 1. *Wood Species from Trestles #1 and #2*

Sample #	Trestle	Member[10]	Species
1	1	E-5	cedar *Chamaecyparis* spp.
2	1	APE-5, between E-4 and E-5	Douglas-fir (*Pseudotsuga menziesii*)
3	1	E-3	redwood (*Sequoia sempervirens*) or sequoia (*Sequoiadendron giganteum*)
4	1	E-2	cedar

[9] The appearance of several wood species in Trestle #1 is thought to indicate at least two repair campaigns, with the Douglas-fir elements appearing last. However the dates of the repairs are unknown, leaving open the possibility that some or all of them were made by the railroad as part of their maintenance of this line until 1942.

[10] See Appendix C for graphic description of member designations.

Sample #	Trestle	Member[10]	Species
5	1	W-3	redwood or sequoia
6	1	south strut	redwood or sequoia
7	1	APW-7	redwood or sequoia
8	1	W-2	Douglas-fir
9	1	north lower horizontal	redwood or sequoia
10	1	east mudsill	cedar
11	1	pile 2W	redwood or sequoia
12	1	west lower horizontal	redwood or sequoia
13	1	stringer 8	Douglas-fir
14	1	tie 11	Douglas-fir
15	1	north side running board	Douglas-fir
16	1	east pile cap	Douglas-fir
17	1	south curb	Douglas-fir
18	2	stringer 4-W	Douglas-fir
19	2	stringer 7-E	Douglas-fir
20	2	east pile cap (east bulkhead)	Douglas-fir
21	2	east abutment plank	Douglas-fir
22	2	round pile W-5	Douglas-fir
23	2	sway brace, west bent	Douglas-fir

Knots and slope of grain tend to be the grade-limiting defects for lumber in older structures, i.e., the size of the knots or the severity of the slope of grain determines how the lumber can be classified. Some of the structural lumber and timbers used in the construction of Trestle #1 contained large knots or slope of grain and cannot be assigned an overall high structural grade (see Figure 9). To be assigned a

Figure 9: West bent of Trestle #1 showing slope of grain (W2, center) and large knots (W3, adjacent, left).

particular grade, 95 percent of the pieces graded should fall within the grade. Since there are limited wood members of any type, the percentage within a grade can fall below the 95 percent level even if only a few members fail to meet the higher grade. In these cases, the structural engineer may elect to use engineering judgment and apply a higher grade if knowledge of the wood condition and structural loads warrants it, particularly if individual members were graded.

Trestle #1 Timber Grade

Based on in-situ grading, the stringers were assigned the grade of Douglas-fir Select Structural within the current *National Design Specification for Wood Construction* (NDS), while the piles were assigned the grade of Redwood No. 2 and Better.

Figure 10: Clear wood stringers on Trestle #2 consistent with a high structural grade.

Trestle #2 Timber Grade

The stingers of Trestle #2 were assessed for grade. Based on visual inspection and measurement of grade limiting characteristics, the stringers were considered Douglas-fir Select Structural (see Figure 10).

The assignment of a structural grade is based on visual characteristics of the lumber (or timbers). Lumber that had deterioration limited to the ends or the top or bottom surface of the member was included in the grading on the assumption that the member could be repaired or reinforced, if the full dimension was needed to meet load requirements. Further, connections were not considered during the grading process but often control the ability of a structure to withstand applied loads.

Moisture Content

Moisture content measurements of structural members were recorded from both of the trestles. Moisture contents below 20 percent are insufficient for the growth of active wood decay. Moisture contents above 30 percent are indicative of likely severe deterioration due to decay fungi and would be considered unusual for a dry climate such as Promontory Summit. Moisture contents, which are given in Table 2, ranged from 7 percent to 29 percent.

Trestle #1 Moisture Content

Moisture contents of Trestle #1 were, in general, under 20 percent, the threshold for active wood decay fungi. Areas with moisture contents ranging from 10 to 17 percent were located near or below the ground-line on the east and west ends of the structure, while the majority of above-grade elements throughout the rest of the trestle had moisture contents ranging from 7 to 10 percent.

Trestle #2 Moisture Content

Moisture contents of Trestle #2 were similar to those in Trestle #1, with a range of readings from 9 to 29 percent. The majority of moisture content readings for Trestle #2 were taken at or below grade.

Table 2. *Moisture Content Summary For Trestles #1 And #2*

Trestle	Member[11]	Moisture Content (%)	Comments
1	Mudsill	23 - 26	Between E3 and E4
1	Pile E3	8	3’ above ground level
1	East pile cap	10	
1	South strut	7	East end
1	Pile E3	8	3” from top
1	Pile W2	11	Below mudsill
1	Pile W3	17	Below grade
1	Pile W4	8	12” above mudsill
2	Pile E5	11	At grade
2	Pile E4	11	At grade
2	Pile E4	16	Just below grade
2	Pile E4	29	18” below grade
2	Pile E3	20	10” below grade
2	Pile E3	9	30” above grade

[11] See Appendix C for graphic description of member designations.

Figure 11: Deteriorated ties on Trestle #1.

Figure 12: Deterioration at the bearing areas of the stringers.

Figure 13: East pile cap (foreground) with severe deterioration.

TRESTLE #1 CONDITION

Trestle #1 Deck, Curbs, and Ties

At the time of the investigation, Trestle #1 had 14 ties. None of the ties were completely sound (see Figure 11). Ten of the ties had 50 percent or more missing or severely decayed. From the results of the investigation, it was thought that it might be possible to salvage short lengths (approximately 38 inches) of ties 3, 4, 9, and 14.[12] The investigation found none of the deck planking to be salvageable. The single remaining curb (south) was found to have losses at each end.

Trestle #1 Stringers

Over the east and west pile caps, there was no sound wood found in the stringers and no way deemed to make serviceable connections because of extensive deterioration around the fasteners (see Figure 12). All of the stringers had some amount of deterioration; the amount of salvageable wood found for each stringer is listed in Table 3.

Trestle #1 Pile Caps

The pile caps at the east and west ends were too deteriorated to salvage (see Figure 13).

[12] However, during the course of the repair work, the project team judged the ties to be unsalvageable because all or nearly all of the salvaged length would be required for cutting the spliced joints.

Table 3. *Trestle #1, Stringer Deterioration*

Stringer Number[13]	Salvageable Wood (In Feet)
1	0
2	0
3	0
4 (moved to position 5 after repair)	5 feet
5 (moved to position 4 after repair)	11 feet
6 (moved to position 8 after repair)	11 feet
7	0
8 (moved to position 1 after repair)	13 feet

Trestle #1 Bent Piles

Of the five east bent piles, three seemed to have salvageable wood near the top of the element (see Figure 14). The four bent piles in the west bent were similar in condition; three piles had at least some salvageable wood (see Figure 15). The amount of salvageable wood by pile can be seen in Table 4.

Figure 14: East bent piles with severe deterioration.

Trestle #1 Sills

The intermediary sill of the west bent and the timber mudsill of the east bent were largely exposed, most likely as a result of the periodic scouring of the drainage channel by heavy rainstorms (see Figure 16). The 1985 Historic Preservation Plan prepared for the park describes the channel as approximately four to five feet below its original grade at that time. Any

Figure 15: West bent piles with visible deterioration.

[13] See Appendix C for graphic description of member designations.

Figure 16: West bent intermediary sill with some decay. The two supporting piers to the left were replacements, and the older piers to the right were largely lost to decay.

seeming improvement in the current exposure of the foundation elements appeared to be superficial and the result of some silting of the wash, which would likely not provide adequate bearing weight.

The west bent sill was supported by four piers, two of which were installed by the NPS in the late 1970s.[14] The two older piers were badly decayed. It was unclear whether the current hinged configuration was original to the structure[15], however the difference in angle between W1 and W4 suggested southward movement of the sill as a result of decreasing support of the piers below and an overall weakening of the bulkhead and bent. The west sill showed some signs of decay, but appeared to be largely intact. The east sill was located mostly below grade. A test excavation at the base of E3 exposing a section of the sill revealed significant decay in that area.

Table 4. *Trestle #1, Piles*

Pile Number[16]	Salvageable Wood (In Feet)
E1	4 – 6 feet
E2	5 – 6 feet
E3	Intact
E4	0
E5	6 – 6 ½ feet
W1	4 – 6 feet
W2	Intact
W3	0
W4	4 – 6 feet

[14] *Historic Preservation Plan.* P. 13.

[15] The intermediary sill is installed approximately at the level of the historic streambed and is currently above grade as the result of streambed scour. It seems unlikely that the bent was originally configured this way, and the intermediary sill and short piers supporting it probably replace deteriorated portions of the original columns. However, it is not clear when the repairs were made, or by whom.

[16] See Appendix C for graphic description of member designations.

Trestle #1 Wing Walls

The northeast wing wall was made up of 7-inch by 16-inch timbers oriented perpendicular to the trestle axis and extending approximately 13 feet north of the eastern-most pile cap (E1). The ends and surfaces of the wing wall timbers were deteriorated but because of the timber thickness, the bulkhead was found to be still functional (see Figure 17).

Figure 17: Northeast wing wall with surface and end deterioration.

The northwest wing wall was framed with two piles and a canted girt supporting random width 3-inch thick bulkhead planks. The wall was overloaded and out of plumb with decay evident in the piles (which were completely deteriorated below grade) and the girt (see Figure 18).

Figure 18: The northwest wing wall.

The southeast wing wall had severe deterioration at the ends of the timbers. The lower bulkhead member had been lost to decay. However, the bank had been stabilized with gabions and the loads on the wall appeared to be negligible (see Figure 19).

Figure 19: Southeast wing wall.

The southwest wing wall had no salvageable timber (see Figure 20), and erosion on this side was only partially managed by gabions at the edge of the wall.

Figure 20: The southwest wing wall.

Trestle #1 Drainage Channel and Erosion Control

Erosion of the channel that flows under Trestle #1 has long been a concern in the continuing stability of the structure17. In 1969 the NPS diverted the water in this channel so that it crosses the railroad grade upstream of both trestles.[18] Nevertheless, heavy rains occasionally wash large quantities of soil from the area around the trestles.

Figure 21: Gabions at the east bulkhead.

In the late 1970s, the NPS installed several gabion cages on the southeast and southwest banks as a method of erosion control. Major rainstorms in the mid-1970s had washed away much of the backfill from behind the bulkheads of Trestle #1, structurally compromising the trestle. The gabions acted as a replacement for the fill and to provide additional support for the structure.[19]

At the time of the wood investigation, the gabions located behind the east bulkhead appeared to be in fair to good condition, with some surface rusting and little significant crushing or deformation (see Figure 21). Gabions in the area of the southwest wing wall were found to be in fair to poor condition. Several of the cages were crushed or twisted, and some no longer contained fill. Erosion of the soil under some of the upper gabions and the consequent lack of adequate support appeared to have contributed to their failure, and some of the cages below were likely crushed by rock fall from the gabions above. Continued degradation of the gabion erosion control seemed likely to

[17] Battle. P. 9-10.

[18] In 1969, the NPS redirected the flow of surface runoff to a concrete box culvert approximately 200 yards upstream from the trestles. *Historic Preservation Plan.*. P. 23.

[19] *Historic Preservation Plan.* P. 11-13.

lead to a serious risk to the structure's support system and the eventual failure of the trestle. Additional measures were also deemed critical to inhibit further erosion of the drainage channel.

TRESTLE #2 CONDITION

Trestle #2 Stringers

Although the stringers of Trestle #2 initially appeared to be in good condition, close visual inspection and resistance drilling results indicated that all of the stringers had some amount of internal deterioration (Figures 22 and 23); the deterioration was primarily on the west end of the structure, with at least some solid wood in all of the stringers at the east ends. Table 5 provides additional details on the amount of deterioration found in each stringer.

Figure 23: Trestle 2 stringers appeared sound when viewed from below, but all had internal deterioration.

Figure 22: Trestle #2 stringers showing pockets of deterioration on the top faces.

Table 5. *Trestle #2, Stringer Deterioration*

Stringer Number	Salvageable Wood (In Feet)
1	30 feet
2	15 feet
3	15 feet
4	15 feet
5	15 feet
6	< 15 feet
7	< 15 feet
8	< 15 feet

Figure 24: Creosote-treated west bent piles, Trestle #2.

Trestle #2 Bent Piles

The timber piles in Trestle #2 were creosote-treated prior to installation. They appear to have been treated to refusal (i.e. maximum retention), based on the amount of creosote that has leached from the bases of the piles and the strong creosote odor associated with the piles. The heavy creosote treatment has protected the piles from deterioration and all of the timbers were found in good to excellent condition (see Figure 24).

Trestle #2 Drainage Channel

The bed of the drainage channel at Trestle #2 was found to have eroded to a point significantly below original grade level. Original grade was determined by the rings of accumulated creosote around the piles where the preservative leaked out onto the surrounding soil shortly after installation. Both the 1971 Historic Structures Report and the 1985 Historic Preservation Plan for the trestles noted significant erosion of the channel, and described some of the pile tips as being covered by only one or two feet of soil.[20] No significant intervention has been made since that time, and it is likely the piles still lack adequate support from the soil.

CONDITION SUMMARY

The findings can be summarized as follows:

Trestle #1

- The deck planking, ties, and curbs had significant decay and were not salvageable.
- The stringers were in poor condition with large voids, channelization, and deterioration at the connections.
- The timber piles of both the east and west bents were in poor condition with limited amounts of salvageable timber near the top ends.

[20] *Historic Preservation Plan*. P. 21-22.

- The wing walls and abutments were generally in poor condition and were not sufficiently inhibiting erosion.
- The continued scouring of the streambed by periodic heavy rainstorms was leading to unacceptable exposure and degradation of trestle support elements, and erosion was only partly managed by gabions at the southeast and southwest bulkheads.

Trestle 2

- The stringers were in poor condition on the west ends; most stringers had some salvageable wood on the east ends.
- The timber piles of the east and west bents were in excellent condition due to the amount of preservative treatment present.
- Several of the trestle piles may have lacked adequate support due to the continued erosion of the drainage channel and their subsequent exposure.

STABILIZATION / PRESERVATION STRATEGIES

In managing and maintaining the trestles, the park is broadly guided by the Secretary of the Interior's Standards for the Treatment of Historic Properties. Because of the historical and technological significance of the structures, the project team has been additionally guided by the ICOMOS Principles for the Preservation of Historic Timber Structures, and the ISCARSAH Principles and Guidelines.[21]

In proposing stabilization options, thought was given to preservation goals as they apply to existing fabric, the original structural configuration of the railroad trestles, and the craft practices that were used to produce the structure. When fully exposed to weather, wood is an ephemeral material. For exposed structures, replacement in kind is typically included as a repair strategy, and preservation goals in these circumstances are frequently focused on retention of the historic structural configuration and the traditional craft practices involved in making replacements. The team also considered access and the obstacles to routine maintenance of the structure.

The rail line that traverses the park was abandoned in 1942, so the trestles no longer function in their original capacity. Park goals for the trestles include interpretation and pedestrian access, so that recovering the original structural capacity (for supporting train traffic) is not essential. Recommendations for treatment of the two trestles were focused on stabilization and based on funding restrictions and the desires of the park. For Trestle #1, the project team proposed a stabilization strategy based primarily on recovery of enough of the piles and pile caps to support repaired stringer assemblies. For Trestle #2, the strategy included HABS / HAER documentation of the structure prior to intervention, followed by repair of the stringer assemblies.

Trestle #1 was in danger of collapse largely because of extensive decay of the stringer assemblies at road level, of the bent assemblies supporting them, and of scouring of the streambed at mudsill level. The stabilization strategy proposed by the project team included the replacement in-kind of both pile caps and both guard timbers, all of which had been nearly entirely lost to decay. To support pile caps and spreader beams, three of five piles on the east bent and two of four piles on the west bent, would be replaced in kind. The project team proposed to extend the two piles on the west bent past the intermediary sill to the ground in

[21] International Council on Monuments and Sites (ICOMOS) and the International Scientific Committee on the Analysis and Restoration of Structures of Architectural Heritage (ISCARSAH)

order to eliminate the hinge at the sill. This was thought to result in a conjectural configuration that the park felt did not meet the Secretary's Standards. As an alternative, the project team proposed to install a tie-back at the level of the intermediary sill on the downstream pile, and agreed to propose a conceptual-level plan for streambed restoration (included in this report).

After excavation, the surviving bulkhead planking on the west bent would be reinforced from behind, and missing or excessively decayed planking would be replaced in kind. Gabions on the downstream (south) side of the west bulkhead, installed by the park in the 1970s, would be repaired or replaced where possible to improve bank stability. Salvageable wood in the stringer assemblies would be scarfed to new timber so that connections to the understructure could be made; two girders in each assembly would be replaced in kind. The result would be a frame capable of supporting stringer assemblies with more than enough structural capacity for the pedestrian traffic anticipated by the park.

A particular area of concern at Trestle #1 was the intermediary sill located at the west bent. The four piles of the west bent rest on top of this sill, which in turn rests on four short piers that extend to the mudsill. The existence of the intermediary sill may have been part of the original configuration, may have been part of a repair campaign by the railroad, or may have been part of the repair work conducted by the park in the 1970s. This configuration has created a hinge at the west bent, and erosion, decaying members of the west bent and bulkhead, and increasing pressure from the fill behind the west bulkhead have contributed to what appears to be significant southward movement of the west bent and associated members. The project team discussed options for eliminating the hinge at the intermediary sill, including a proposal for installing full-length columns. However, in the absence of documentation or fabric evidence indicating the original configuration of the bent, the repair was deemed too conjectural. As an alternative, the project team proposed improving the existing stabilization, installing two tie-backs to the area behind the west bulkhead, and the inclusion in this report of a proposal to recover the historic streambed level of the drainage channel (see Drainage Channel Restoration, this section).

Despite scouring of the streambed at Trestle #2, the pile bents and bulkheads were in good condition. Stabilization required repair of several of the girders in the stringer assemblies; many of the members had significant pockets of decay along their lengths, and deformation of individual timbers was visible from above. As proposed by the project team, repairs of the girders were to consist primarily of replacement in-kind of decayed members. To maximize the retention of original material, localized decay at fastener locations was to be addressed by installation of dutchman repairs bonded to the original material using an adhesive and / or mechanical fasteners.

Because HABS / HAER-level documentation had never been completed for this trestle, the trestle was measured and photographed prior to treatment. The measurements were used to produce Level II drawings of the trestle; drawings and photography are included as appendices to this report.

DRAINAGE CHANNEL RESTORATION

Both Trestles #1 and #2 were constructed with timber piers founded on mudsills below grade to prevent lateral movement of the bulkheads and bents toward the middle of the stream. This, along with the connection of the stringer assemblies, allows the bulkheads to resist loads imposed by the grade.

Earlier assessment reports[22] document changes in streambed level affecting structural performance of the trestles. By 2011, the streambed level at Trestle #1 was approximately four feet lower than when the trestle was constructed. This change had undermined both bulkheads on the downstream side. In the 1970s, the NPS installed a sill / spreader to stabilize the upstream columns and piled riprap behind and below the timber to prevent further scouring of the streambed. This intervention worked on the upstream side, but provides inadequate support for the bulkheads and downstream banks. Similarly, creosote deposits on Trestle #2 framing bents indicate substantial scour of the streambed between the bents since the time of construction, though the banks between the bents and bulkheads remain close to historic levels.[23]

The placement of riprap between the bulkheads of Trestle #1 and the bents of Trestle #2 would constrain the framing, improving the longevity of the trestles and addressing the loss of grade at Trestle #1 bulkheads, and would help to recover the historic streambed levels. Because most of the drainage is now handled by a culvert located upstream of both trestles, it is anticipated that impacts of the repairs on water flow would be negligible.

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[22] Battle. p. 9-10, and *Historic Preservation Plan.* P. 11-13, 21-22.

[23] Creosote on the bulkhead and bent columns indicate historic streambed / bank levels.

Interventions aimed at streambed stabilization at both trestle sites are not likely to require extensive design work. At each site, it would be possible to move a small excavator into the streambed to place the stone. Dump trucks could deliver material (10-12 inch riprap) by dumping over one of the banks. Riprap should be brought to historic streambed levels between the bulkheads and allowed to fall toward the main drainage canal on the downstream side. The quantity of silt that has accumulated at the mouth of each wash indicates that over time the riprap is likely to silt in and blend in visually with the rest of the streambed. The end result would be low-cost, reversible repairs that could add decades to the service life of each of the trestles.

REPAIR TECHNIQUES

When considering traditional repair techniques for the trestles, it is important to note that the railroad would likely not have repaired portions of the structures by splicing in new timber to replace deteriorated material, but rather replaced deteriorated or damaged sections entirely. However, because of the historic significance of the trestles, the park and project team collaboratively determined that any intervention should conserve as much historic fabric as possible while recovering the historic structural system to achieve stabilization goals. If we consider the tradition of heavy timber framing, of which the trestles are certainly examples, then in this broader context scarfed splices and Dutchman inserts can certainly be considered traditional. In addition, they constitute a means by which a substantial portion of the surviving historic material can be retained while meeting the reduced structural requirements associated with pedestrian traffic.

Scarfed Splices

Traditional scarf forms were used to splice new timber into deteriorated members. These repairs are not invisible, but the visual impacts are not obtrusive or unattractive, and the joinery is interesting to look at. Limited replacement of decayed portions of members using traditional joinery had the advantages of preserving the salvageable portions of historic elements as well as the historic craft tradition that originally produced the structures.

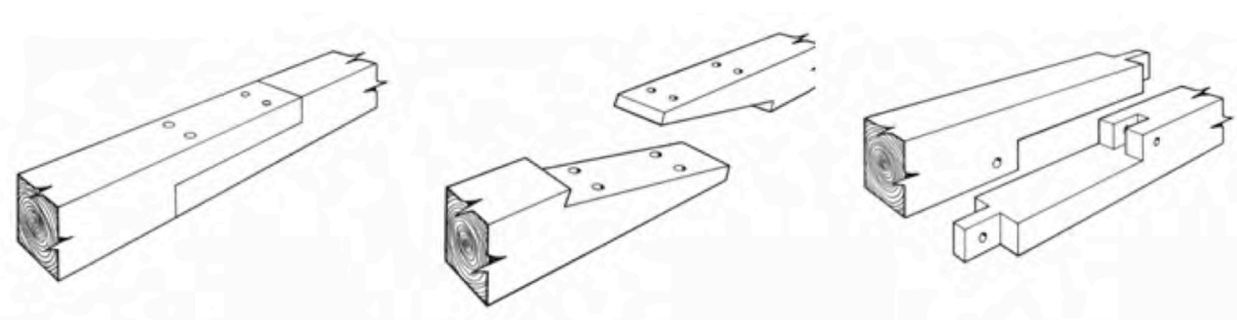

Figure 25: Three forms of a scarfed splice: halved, splayed, and bridled. Hirst, et al. “The Structural Performance of Traditional Oak Tension and Scarf Joints.” 2008.

Dutchman Repairs

Wooden dutchman repairs were let into deteriorated portions of historic elements where decay was limited in extent. Dutchman inserts were used to improve the bearing area of deteriorated members, improve the performance of connections, and to fill recesses and cavities that might otherwise collect water. Using wood to make the repairs had the advantage of introducing repair materials that had physical and mechanical properties that are similar to the original material while maintaining aesthetic continuity.

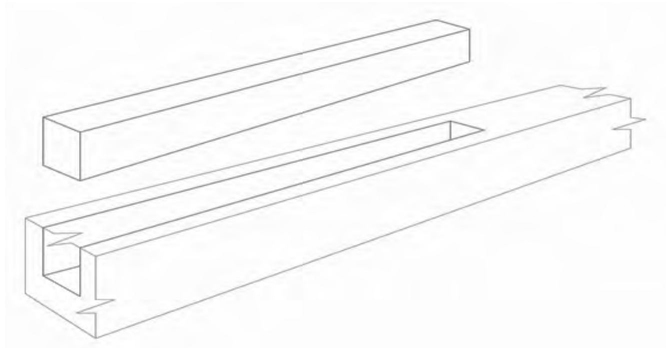

Figure 26: Typical dutchman repair. The decayed portion of the existing member is removed, and a new piece is cut to fit tightly into the void. The repair may be secured with mechanical fasteners and/or an adhesive.

Replacement In-kind

Some of the structural timber was so thoroughly deteriorated that the only way to recover adequate capacity was by replacement in-kind. In replacing the wooden elements of an historic structure, guidelines often urge the use of material matching the original in species and of at least equal quality. In this case, the species used historically (cedar, redwood, Douglas-fir) were matched in the replacement timbers. While high-quality timber was not used in every instance in the original construction of the trestles, an argument was made for using it in the repairs. High-quality materials will have greater structural capacity and improved durability, meaning that for a given repair the investment in making the repair will yield better performance and longer-lasting results.

In addition to the craft-related aspects of the repair work, there were also logistical problems to be solved. One challenging aspect of the project was moving crew and material to the site. Daily travel between the nearest available accommodations and the site was impractical, so the repair crew camped onsite, and food, water, and shelter were brought in by park and crew vehicles. Materials and equipment were brought to the site by commercial trucking contractors.

Most of the timbers used in the construction and repair of the Promontory Trestles are large and extremely heavy, so that finding appropriate solutions to material handling challenges was essential to completing the work in the short timeframes available. Heavy machinery, including a crane, a forklift, and an excavator, were brought in to assist with the removal of deteriorated timber, excavation behind bulkheads, and the re-setting of repaired / replaced members and assemblies.

REPAIR WORK: TRESTLE #1

Because of the level of deterioration in bulkheads and bents of Trestle #1, these had to be shored before dismantling the trestle. Shoring included cross bracing and lateral bracing of bulkheads and piles so that piles could be removed individually for repair. Lateral bracing of the upper and lower bulkheads also provided staging for conducting the repairs. Shoring was completed and stringer assemblies were removed during the second site visit (10/03/2011 - 10/11/2011).

Timber repairs took place over a period of approximately one week in May 2012. A crew of professional timber framers associated with the university worked with National Park Service staff and students from the University of New Mexico School of Architecture and Planning to make repairs and document the process.

Figure 27: One of the original stringer assemblies removed from Trestle #1. Portions of two of the girders were salvaged and repaired for reinstallation.

The grade behind the west bulkhead was excavated to unload the bulkhead, expose gabions on the downstream bank to the level of the intermediary sill on the west bulkhead, and provide access to the badly deteriorated bulkhead planking. The east bulkhead, which was not as severely damaged, was excavated to approximately 18-inches below the bottom of the east pile cap. While the sitework was being done, stringer assemblies were dismantled for repair (see Figure 27).   Additional exploration with the resistance drill helped to identify salvageable material and determine the geometry of joints used in their repair. Pile caps, largely lost to decay and unsalvageable, were removed and retained for layout of replacement members. Trestle pilings at positions E1, E4, E5, W1, W3, and W4 (see Figure 28) were removed individually for replacement in kind. (See Appendix C for keys to members replaced and repaired.

PILES AND PILE CAPS

At the east bent, the piles at positions E1, E4, and E5 were replaced in-kind. The replacements were set into position with a crane, and then adjusted for fit and alignment (see Figure 29). Temporary bracing was attached to the replacements to secure their positions as repair work continued. At the west bent, piles W1, W3, and W4 were also replaced in-kind. As with the east bent piles, the replacements were set into position with a crane, adjusted for fit and alignment, and braced while repair work continued. Positioning of the replacement piles was based on fastener locations, ghosts left by original members on the bulkhead planks, and the 2004 HABS drawings of Trestle #1.[24]

Figure 28: A decayed pile is removed from the east bent.

A portion of the sill under W1 was found to be soft as the result of mild decay. A section approximately 3" deep, 14" long, and the width of sill was removed and the resulting mortise filled with a block cut from material of the same species as the original.

Figure 29: A new pile is lowered into the west bent.

Once the piles were replaced, new pile caps for both the east and west bents were fabricated using timbers cut to match the dimensions and pile spacing of the original members (see Figure 30). Dimensions were based on surviving remnants of the original members, the 2004 HABS drawings, and photodocumentation produced as part of the wood assessment. Replacement pile caps were set into place by crane. To secure the caps, new ¾" x 24" drift pins were driven through into each of the piles, matching the original hardware configuration as closely as

[24] See section 3, Condition Assessment and Wood Investigation, for the results of the wood investigation and species identification.

Figure 30: Squaring a mortise in a replacement pile cap with a chisel. The joints are laid out to fit the tops of the piles.

possible. Piles were also tied back to bulkheads using ¾" x 24" drift pins.

DOWNSTREAM BANK AND WEST BULKHEAD

The west bulkhead is composed of a primary bulkhead parallel to the west bent and two wing walls that extend back and away from the structure at roughly 45 degrees to the northwest and southwest. Erosion of the streambed and the downstream bank, along with the general deterioration of the structure, resulted in displacement of several of the west bent piles that was described in earlier assessment documents.[25] The Park Service placed gabions on the downstream (south) banks at east and west bulkheads in the 1970s as a stabilization measure, but the overall condition of the bank and structure continued to decline. In 2011, much of the west bulkhead planking was badly deteriorated and unsalvageable; planking at the northwest wing wall was badly deteriorated while the planking of the southwest wing wall was completely missing; and the cap at the northwest wing wall was largely lost to decay.

To repair the west bulkhead, the project team removed unserviceable planking and replaced it in-kind; salvageable planking was re-installed. A second layer of planking was added over the back (bank side) of the entire bulkhead, secured with structural screws (see Figure 31). The new bulkhead planking was used to support the existing northwest wing wall planking, and a second layer of planking was added there as well.

Figure 31: Installing the second layer of planking at the west bulkhead.

In order to help control the erosion of the west bank, the project team replaced or reinstated the gabions

[25] Battle. p. 9-10, and *Historic Preservation Plan.* P. 11-13, 21-22.

originally installed by NPS. Salvageable gabion frames were straightened, reassembled, and recovered in a double layer of wire netting. New gabion frames to replace unsalvageable cages were welded from #4 rebar. A layer of large rock and gravel was placed directly behind the west bent sill, at the bottom of the west bulkhead, in order to facilitate drainage. Gabion cages were placed in terraced rows and filled as the west bulkhead was backfilled (see Figure 32).

Figure 32: Setting new gabions at the south end of the west bulkhead.

To discourage hinging of the west pile bent at the intermediary sill, the project team installed a tie-back through the downstream pile on the west side to anchor the structure to a deadman buried in the backfill. Because the piers that support the west wing wall were completely deteriorated below grade, it was treated similarly. Tie-backs consist of 1" threaded rod fastened with an ogee washer and square nut on the framing side, and anchored to gabions set approximately 12-feet behind the bulkhead and buried at approximately 8-feet and 5-feet below grade respectively (see Figure 33).

Figure 33: Tie-backs installed at the northwest wing wall.

The west bulkhead cap was replaced in-kind and trimmed flush with the planking below. The cap was secured with ¾" x 24" drift pins to the west bent pile cap and, later, to the west end of the stringer assemblies (see Figure 45 in Appendix C for the approximate locations of hardware).

EAST BULKHEAD PLANKING

At the east bulkhead, planking ends were badly deteriorated and the lower bulkhead member had been lost to decay. However, planking was originally 7-inches thick and resistance drill

Figure 34: One of the lower planks on the east bulkhead was replaced to provide added support to prevent additional erosion of the fill material behind the bulkhead. The plank was later cut flush with the existing bulkhead planking.

results indicated that the surviving sections at many of the drill sites were substantial. Gabions installed by the NPS in the 1970s behind the bulkhead along the downstream side were in serviceable condition. The missing plank at the bottom of the bulkhead was replaced in kind to provide to prevent erosion of the fill material behind the bulkhead (see Figure 34). The plank was cut flush with the existing bulkhead planking.

The east bulkhead cap was replaced in-kind and trimmed flush with the planking below. The cap was secured with ¾” x 24” drift pins to the east bent pile cap and, later, to the east end of the stringer assemblies (see Figure 45 in Appendix C for the approximate locations of hardware).

STRUTS

At some point subsequent to original construction, struts were added below the stringer assemblies, presumably to shore the bent assemblies and prevent their rotation toward the middle of the stream. These timbers, approximately 12”x12”, were found to be in good condition, and were removed during the repair work in order to facilitate the repair of piles and pile caps. Following installation of pile caps, these were returned to their original positions.

STRINGERS

Four of the eight stringers at Trestle #1 were salvageable in part, and were repaired using traditional woodworking techniques. Three of the stringers were repaired by splicing new wood in place of decayed portions using splayed scarfs. The fourth stringer was salvaged by hollowing intact portions of the timber surface and laminating over a core of new timber. Joints were secured by through-bolts (¾” square-head bolts and structural washers). Hardware was largely salvaged from the existing stringer assemblies and reassembled (where applicable) to match the original hardware configuration (see Figures 49 - 52 in Appendix C for details of repair conditions).

After stringer repairs were completed, stringers were grouped in sets of four, arranged with replacement members to the interior of each set and repaired members to the outside.[26] The stringer sets were then drilled for ¾" bolts and assembled using the original washers and spacers (the sequence is captured in the HABS drawings of this trestle; also see Figure 35). Once repair of the substructure was complete, the stringer assemblies were laid on top of the pile caps and secured with ¾" x 24" drift pins to both the bulkhead caps and the pile caps (see Figure 45 in Appendix C for approximate location of hardware). The position of the stringer assemblies was determined by sighting down the grade from Trestle #2, and mirroring the stringers along the centerline.

Figure 35: Hardware salvaged from an original stringer assembly.

[26] While this arrangement does not match the original configuration of the stringers, it maximizes the visibility of the historic material.

REPAIR WORK: TRESTLE #2

Prior to making repairs to Trestle #2, the structure was field-measured and extensively photographed in order to collect information to provide the park with a set of HABS Level II documentation. Existing documentation consisted of some photographs and sketch drawings produced for the 1971 Historic Structures Report on the two Golden Spike railroad trestles. The park also possessed copies of Common Standard drawings used by the Southern Pacific Railroad in the early part of the 20th century in the construction of wooden trestles[27]. Comparison of the drawings with the actual configuration of the trestle showed them to be almost identical, and it was concluded similar drawings were used in the trestle's construction in 1938. However, there existed no detailed as-built drawings of the trestles, and little documentation of their existing condition. HABS documentation consisted of measured drawings of the trestle before stabilization, development of a written history and significance statement, and high-resolution, perspective-corrected, black and white photography of the structure. These are included as appendices to this report.

Most of the wooden members of Trestle #2, with the exception of the trestle stringers, were found to be in good to excellent condition, largely due to the preservative treatment the wood had received. However, many of the stringer girders were extensively decayed at fastener locations and along drying checks on upper surfaces. These resulted in deep decay pockets that in some cases left only bottom and side surfaces intact (see Figure 36). Many of the stringers appeared sound along their bottom surfaces, and the full extent of the decay was only realized after testing the members through resistance drilling (see Resistance Drilling Results, Appendix A). Repair at Trestle #2 consisted primarily of replacement in-kind of unserviceable girders, along with dutchman repairs of localized decay at connection locations (see Figure 53 in Appendix C for locations of member replacements and repairs).

Figure 36: Extensive decay was found along the stringers of Trestle #2.

[27] Southern Pacific Lines.

As built, each girder in each stringer assembly was made up of two timbers, one measuring approximately 15 feet in length and the other measuring approximately 30 feet in length; joints were staggered and fell over bent locations. These two-piece girders were grouped in sets of four and through-bolted along their length to create the stringer assemblies. This configuration allowed the salvage of any surviving pieces at least 15 feet in length; in-kind replacements were inserted where original members were unserviceable.

Stringers were repaired during a 7-day field school in October 2011. Stringers were rigged and removed from the trestle with a crane. Badly decayed material was removed from the assemblies and replaced with salvaged timber provided by the park. Areas of localized or limited decay were removed and filled with dutchman repairs using an epoxy adhesive and mechanical fasteners (see Figure 37). Stringers were reassembled on leveled bunks laid out according to the spacing of bulkheads and pile caps. Each girder was leveled by adzing excess material from the bottom surface, replicating the historical process. Once each of the stringers was laid out in a flat, level assembly, they were bored for bolts and spacers and re-assembled using hardware salvaged from the original assemblies.

Figure 38: A dutchman repair on the third stringer from the left, Trestle #2.

Figure 37: Lowering the second stringer assembly onto the trestle.

Reinstallation of the repaired assemblies occurred during the May 2012 field school. Stringer assemblies were returned to the trestle, and fastened with bolts and ¾" x 24" iron drift pins (see Figure 38). (See Figure 54 in Appendix C for approximate location of hardware.)

RECOMMENDATIONS FOR ADDITIONAL TREATMENT

The original goals of assessing the condition of wood trestle elements and designing and implementing repairs to prevent their collapse have been realized. Through a detailed inspection and assessment of the surviving woodwork, a repair plan was developed that maximized the retention of historic material and provides adequate support for the repaired stringer assemblies so that collapse was averted. Furthermore, the plan made minimal use of temporary shoring (the shoring that was used doubled as staging) so that nearly all of the available funds went into repair of the historic material rather than into shoring fabrication.

In addition to stabilizing the trestles, the work generated HABS-level II documentation of Trestle #2 and resulted in the training of NPS staff and university students in the documentation, assessment, and repair of heavy timber structures. In addition to the NPS Resources and Facilities staff that participated in the project, a graduate student enrolled in the Historic Preservation and Regionalism Graduate Certificate Program at the University of New Mexico and an interning architect participated in the assessment, planning, documentation, and implementation aspects of the work.

There is still work to be done. Both the *Historic Structures Report*[28] and the *Historic Preservation Plan for Trestles No. 1 and No. 2*[29] call attention to the impacts of streambed scour on Trestle #1. By 2011, it was apparent that a similar situation might be developing at Trestle #2. A remedy has been outlined in this report, and implementation should be considered the highest priority for the next phase of work.

In addition, the ways that visitors access the trestles has not been defined in detail, and will almost certainly have an impact on further work to be done at the site. Access to the site to view the trestles and interpretive material from a viewing area near the access road, for example, may not require additional intervention on the trestles. If the intention is to allow pedestrians to cross the trestles, however, walkways with guardrails will be required, which should be designed to achieve public safety goals while minimizing impacts on historical integrity. The park may elect to detail the approaches to provide ADA-compliant access to one or both of the trestles and / or to prevent pedestrian access to the streambed. Under any scenario in which visitors

[28] Battle, David G. *Historic Structures Report: Railroad Trestles.* Golden Spike National Historic Site, Promontory, Utah. 1971.

[29] *Historic Preservation Plan.*

have direct access to the trestles, a structural engineer should be consulted to calculate the current structural capacities of the trestles and compare these values with the anticipated loads.

The trestles continue to be exposed to sunlight and weather, and so continue to be subject to processes of deterioration. Inspection should be made annually following the wettest time of the year, and after heavy rains or flood conditions. Inspectors are especially looking for undermining of the mudsills under framing bents caused by scouring of the streambed, and movement of bulkheads and/or gabions due to shifting of soil loads.

Most of the timber used in the construction of the trestles is large in cross section and losses to decay will tend to occur slowly. Inspectors should watch for signs of decay at or near grade, and at junctures between timbers where contact between two or more members slows their drying. A sharp pick (like an icepick or awl) will help to locate soft areas with incipient decay. Trestle #1 retains a large quantity of historic members, many of which are partially decayed. Support for the structure, however, is provided by repaired / replaced members and the presence of decayed areas in some of the historic members does not necessarily indicate an approaching collapse. Inspectors should be alert to changes in the structure that tend to indicate the development of new deterioration conditions.

Weathering is the result of depolymerization of the lignin component of the wood by ultraviolet exposure, resulting in the formation of water-soluble free radicals that are removed from the surface by rainwater (continually exposing new surface area to the deterioration process), and erosion of the wood through wind-blown debris (a process similar to sand blasting). Weathering is typically not a significant factor in the failure of wood components and the collapse of structures; most wood structures deteriorate due to the action of wood decay fungi or insect attack. However, severe weathering can affect the bolted connections on braces and other members that are relatively small in cross section; loss of relish at the bolted connections can result in reductions in stiffness of the structure.

At some point, the park may elect to reconstruct roadbeds and permit pedestrian access to the trestles. The roadbeds are made of many intersecting members, typically smaller in section than the substructure, and forming a large horizontal surface exposed to weather. Roadbed elements will decay faster than substructure timbers because of the level of exposure and the reduced cross section, and will require periodic replacement. Once installed, these should be included in annual inspections. Periodic inspection and routine maintenance will help to prevent potential problems or unsafe conditions caused by deterioration going unnoticed. Problems can then be addressed before they become serious. Preventative care will help to protect the park's investment and extend the life of the trestles, and will help to preserve them for the continued enjoyment of park visitors.

APPENDIX A

RESISTANCE DRILLING RESULTS

Table A-1. *Resistance Drilling Results*

Drill #	Trestle	Member	Location	Drilling Direction	Comments
D1	1	north strut	3" from top, midspan	N-S	no void
D2	1	stringer 1	4" from top, midspan	N-S	no void
D3	1	stringer 2	center, midspan	T-B	no void
D4	1	stringer 3	center, midspan	T-B	9" void, then solid
D5	1	stringer 3	2" from north, midspan	T-B	9" void, then solid
D6	1	stringer 4	center, midspan	T-B	1" deterioration, then solid
D7	1	stringer 5	center, midspan	T-B	4" void, then solid
D8	1	stringer 6	center, midspan	T-B	no void
D9	1	tie 4	under north running board, center	T-B	1" deteriorated, tie good; 1" deteriorated, stringer good
D10	1	E-5	10" below top, center	W-E	3" void near center
D11	1	E-5	10" below top, center	S-N	4" void near center
D12	1	E-4	12" below top, center	W-E	7" solid wood
D13	1	APE-5	between E-4 and E-5	W-E	3.5" good wood
D14	1	APE-4	between E-4 and E-5	W-E	4.5" good wood
D15	1	APE-3	between E-4 and E-5	W-E	6" good wood
D16	1	APE-2	between E-4 and E-5	W-E	2" void, 4" good wood
D17	1	APE-1	between E-4 and E-5	W-E	2" void, 4" good wood
D18	1	W-3	15" below top, center	E-W	no solid wood
D19	1	mudsill E	south of E-3, 3" below top	W-E	no void

Drill #	Trestle	Member	Location	Drilling Direction	Comments
D20	1	mudsill E	south of E-3, center	T-B	2.5" deteriorated, 14.5" solid/det.
D21	1	W-4	10" from top, center	N-S	no void
D22	1	W-1	12" from top, west of center	S-N	minor void less than 1"
D23	1	APW-7	between W-1 and W-2	E-W	no solid wood
D24	1	APW-6	between W-1 and W-2	E-W	0.5" shell, then void
D25	1	APW-5	between W-1 and W-2	E-W	no solid wood
D26	1	APW-4	between W-1 and W-2	E-W	0.5" shell, then void
D27	1	APW-3	between W-1 and W-2	E-W	no solid wood
D28	1	APW-2	between W-1 and W-2	E-W	no solid wood
D29	2	stringer 8	9" from west, near center	T-B	1" solid, then void
D30	2	stringer 8	11" from west, 7" from top	S-N	3" solid, 4.5" void, 0.5" solid
D31	2	stringer 8	19' from west, 2" from north edge	T-B	0.5" solid, then void
D32	2	stringer 8	32' from west, 3" from north edge	T-B	2" internal void
D33	2	stringer 8	41' from west, center	T-B	no void, visible channeling at 38-39 feet
D34	2	stringer 7	9" from west, center	T-B	no void
D35	2	stringer 7	11' from west, center	T-B	void 12"
D36	2	stringer 7	8' from west, center	T-B	2" solid, then void
D37	2	stringer 7	18' from west, center	T-B	void 12"
D38	2	stringer 7	29' from west, center	T-B	no void

Drill #	Trestle	Member	Location	Drilling Direction	Comments
D39	2	stringer 7	39' from west, center	T-B	no void
D40	2	stringer 6	31' from west, center	T-B	no void/west timber not salvageable
D41	2	stringer 6	44' from west, center	T-B	no void
D42	2	stringer 5	24' from west, center	T-B	2" solid, then void
D43	2	stringer 5	31' from west, center	T-B	6.5" solid, 3" void
D44	2	stringer 5	36' from west, center	T-B	4" internal incipient decay
D45	2	stringer 5	43' from west, center	T-B	1" solid, then void
D46	2	stringer 5	43' from west, 8" from top	N-S	2" solid, 4" void, 2" solid
D47	2	stringer 5	42' from west, center	B-T	no void/solid
D48	2	stringer 4	16'-6" from west, center	T-B	void; 15' at west end unsalvageable
D49	2	stringer 4	22' from west, center	T-B	2" solid, 8" void, then solid
D50	2	stringer 4	22' from west, center	S-N	2" solid, 4" void, 2" solid
D51	2	stringer 4	30' from west, center	T-B	0.5" internal void
D52	2	stringer 4	38' from west, center	T-B	no void
D53	2	stringer 3	9" from west, center	T-B	2" solid, incipient decay
D54	2	stringer 3	9" from west, center	T-B	2" solid, small void, solid
D55	2	stringer 3	16' from west, center	T-B	2" solid, 6" void, solid/west 15' not salvageable

APPENDIX A: RESISTANCE DRILLING RESULTS

Drill #	Trestle	Member	Location	Drilling Direction	Comments
D56	2	stringer 3	28' from west, center	T-B	void
D57	2	stringer 3	32' from west, center	T-B	0.5" solid, then void
D58	2	stringer 3	43'-6" from west, center	T-B	no void
D59	2	stringer 2	9" from west, center	T-B	no void
D60	2	stringer 2	14' from west, center	T-B	no void
D61	2	stringer 2	30' from west, center	T-B	(drill in 4" channel) 13" channel then solid
D62	2	stringer 2	34' from west, center	T-B	1.5" solid, 7" void, then solid
D63	2	stringer 2	44'6" from west, center	T-B	surface deterioration, then solid
D64	2	stringer 1	16'-6" from west, center	T-B	(west 15' not salvageable) 0.5" solid, then void
D65	2	stringer 1	16'-6" from west, 7.5" from top	N-S	1" shell on each side, void in center
D66	2	stringer 1	29' from west, center	T-B	no void
D67	2	stringer 1	31' from west, center	T-B	no void
D68	2	stringer 1	37' from west, center	T-B	(next to decay pocket) no void
D69	2	stringer 1	45' from west, 2" from north edge	T-B	no void
D70	2	E-4 (east bent)	10" below grade, mid-width	W-E	no void
D71	2	E-3 (east bent)	6" below grade, mid-width	W-E	no void

APPENDIX B

RESISTANCE DRILLING AND SAMPLE LOCATIONS

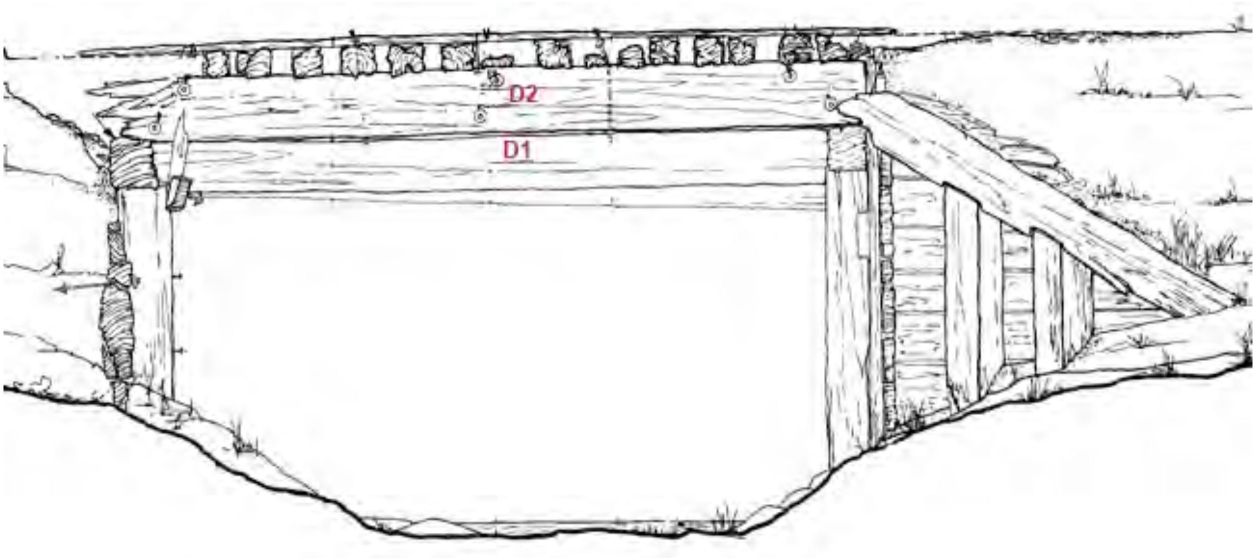

Figure 39: Trestle #1, North Elevation, with resistance drilling locations (red).

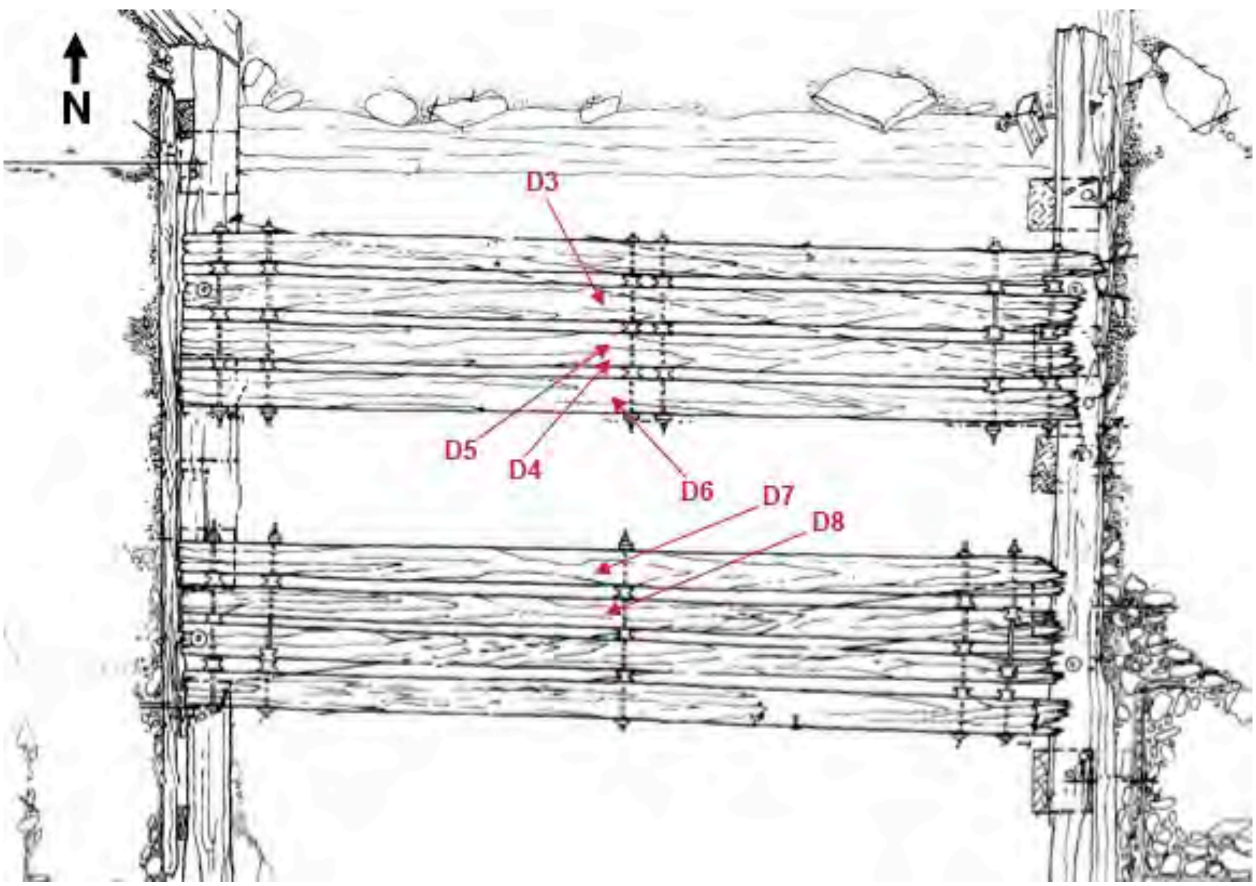

Figure 40: Trestle #1 Plan (deck removed) with resistance drilling locations (red).

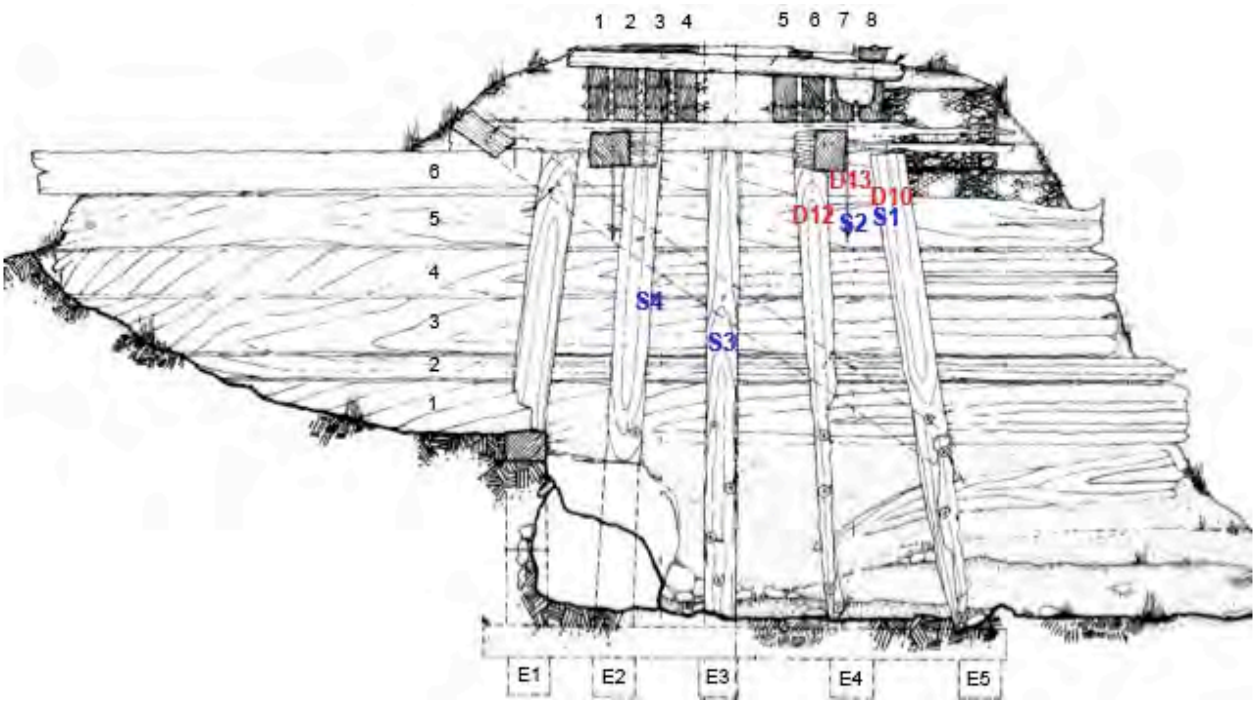

Figure 41: Trestle #1, east bent and bulkhead, showing nomenclature (black), resistance drilling locations (red), and species identification sample locations (blue).

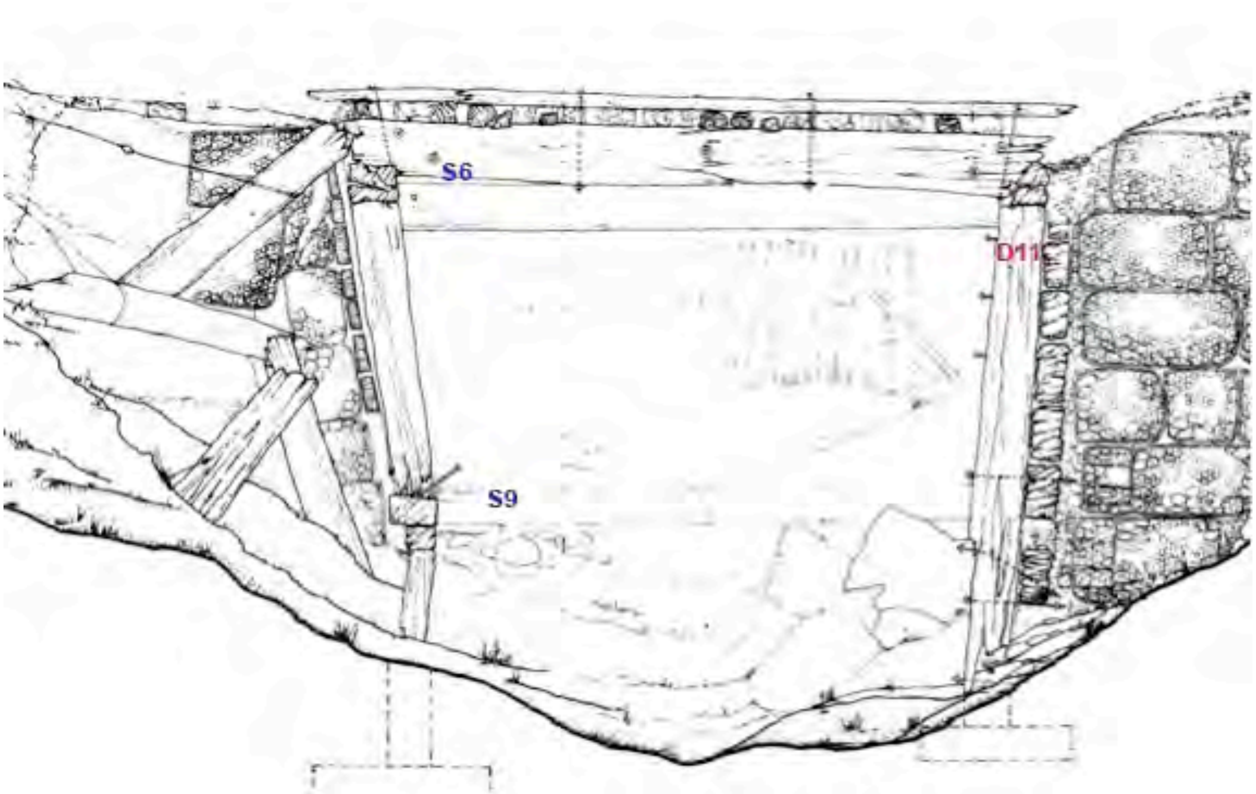

Figure 42: Trestle #1, south elevation, with resistance drilling locations (red) and species identification sample locations (blue).

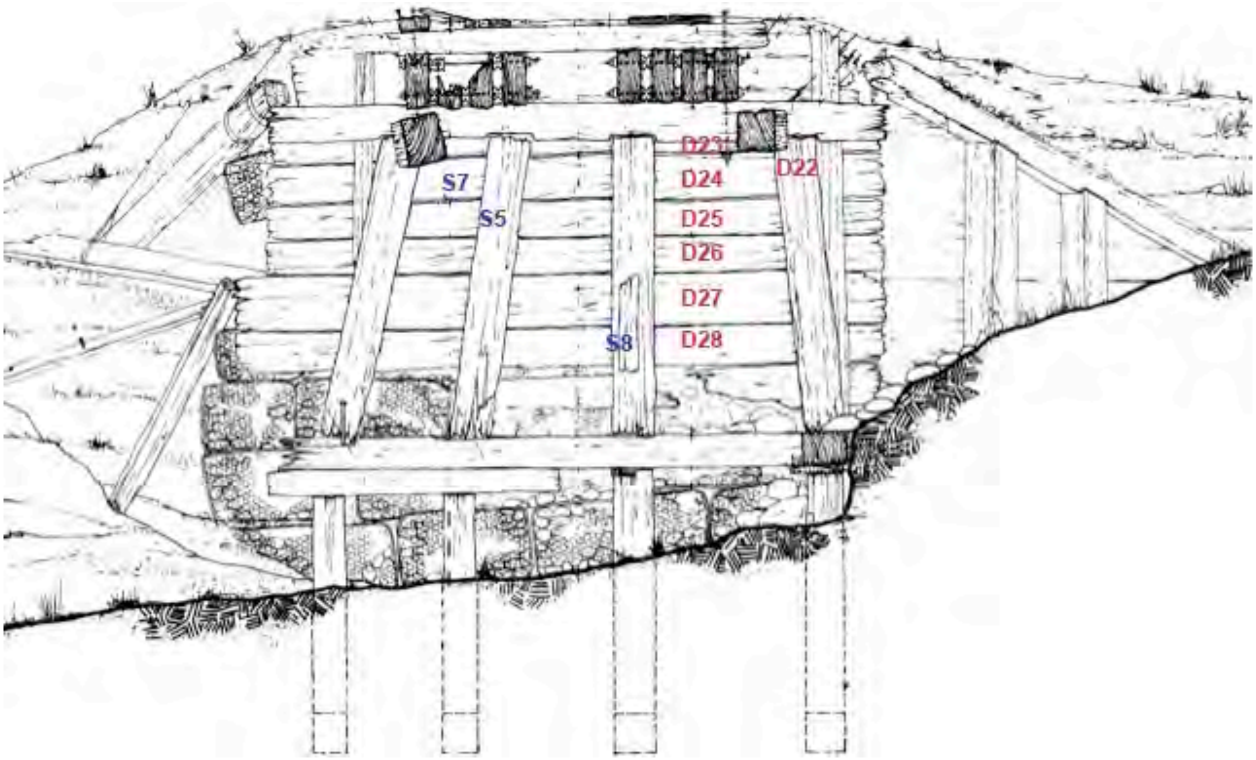

Figure 43: Trestle #1, west bent and bulkhead, with resistance drilling locations (red), and species identification sample locations (blue).

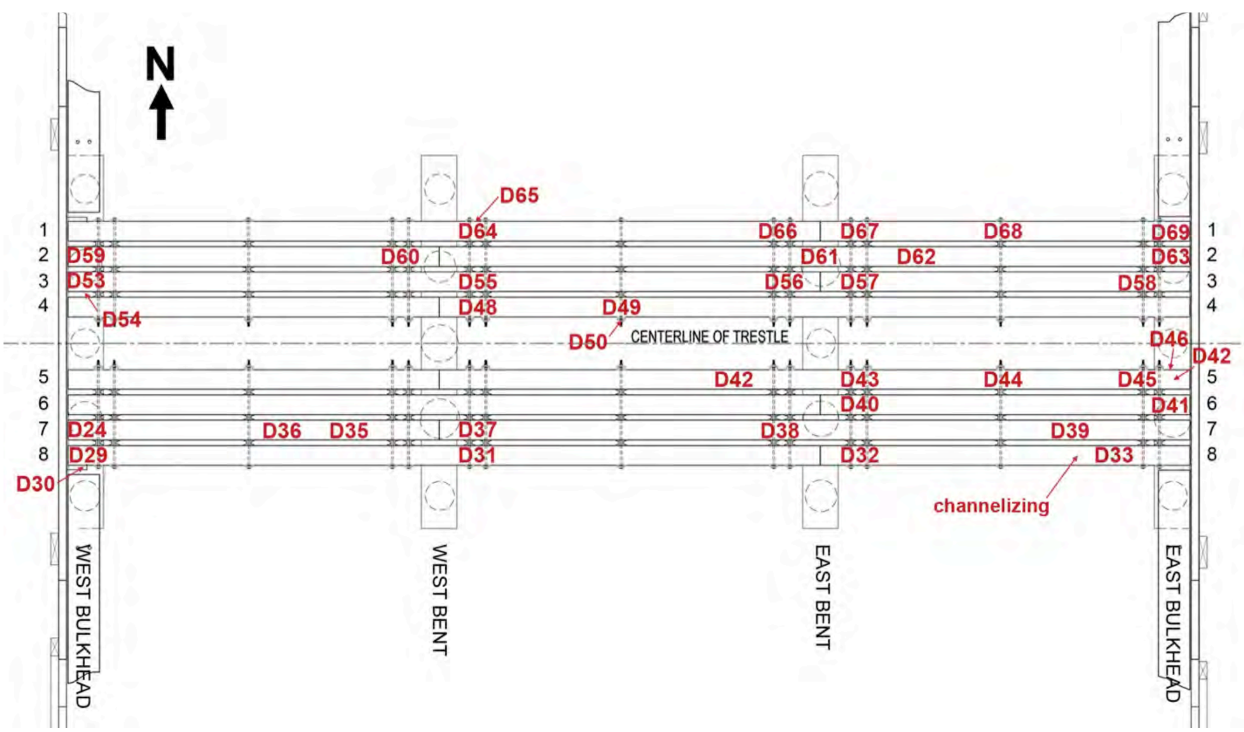

Figure 44: Trestle #2 plan with nomenclature (black), and resistance drilling locations (red).

APPENDIX C

ANNOTATED DRAWINGS OF EXISTING AND REPAIR CONDITIONS

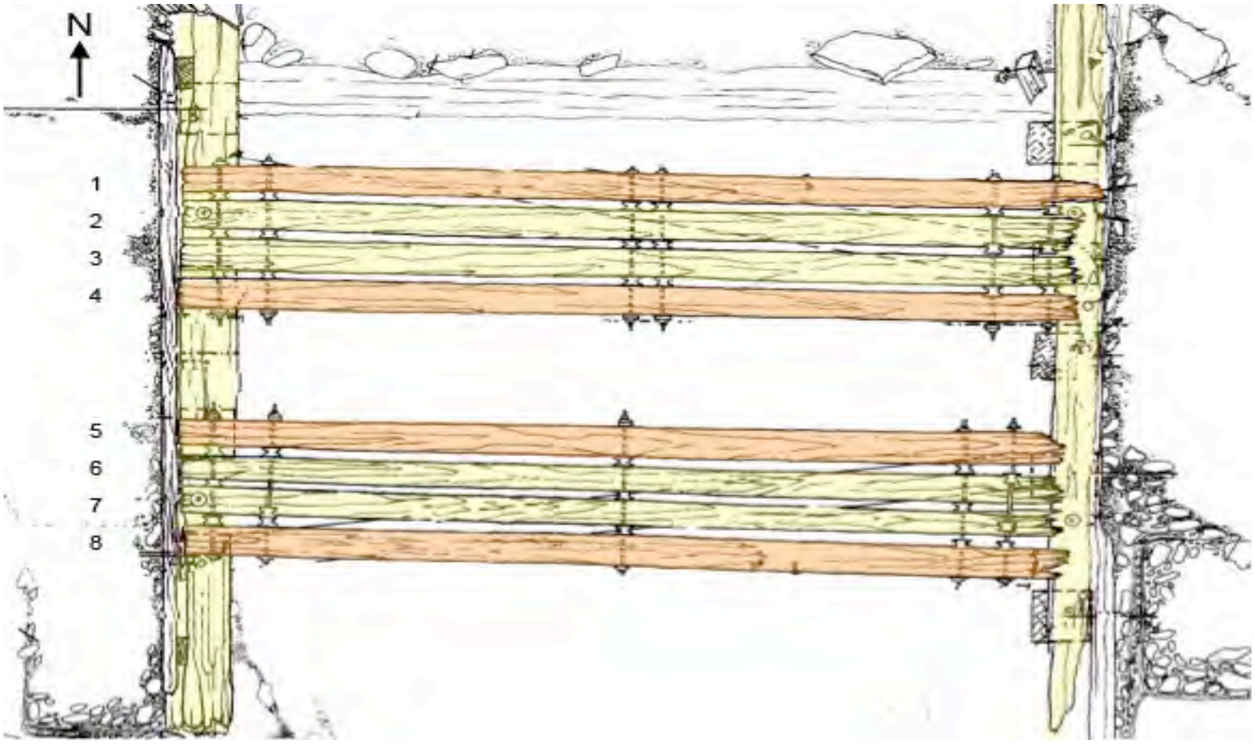

Figure 45: Trestle #1, plan. Members shaded in yellow were replaced in-kind in entirety. Members shaded in orange were repaired. See Figures 41 - 44 in this appendix for details of repair conditions.

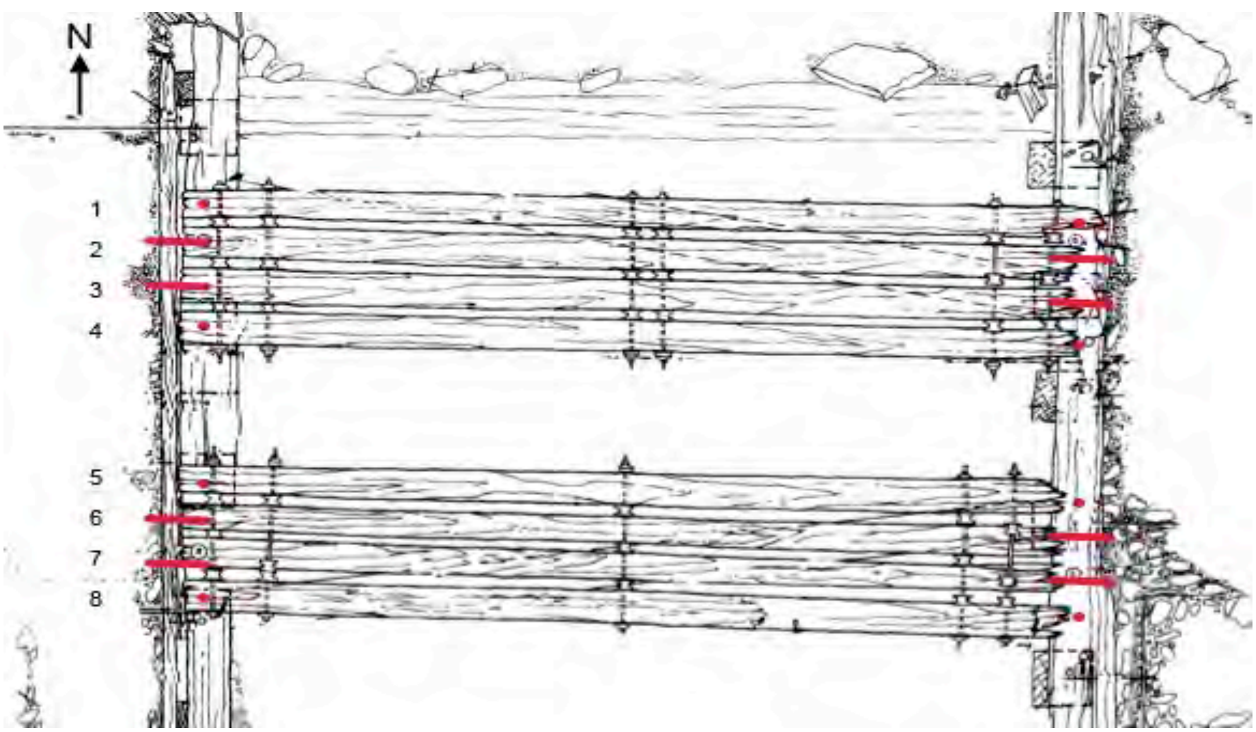

Figure 46: Trestle #1, plan. Approximate location of drift pins used to secure stringer assemblies indicated in red.

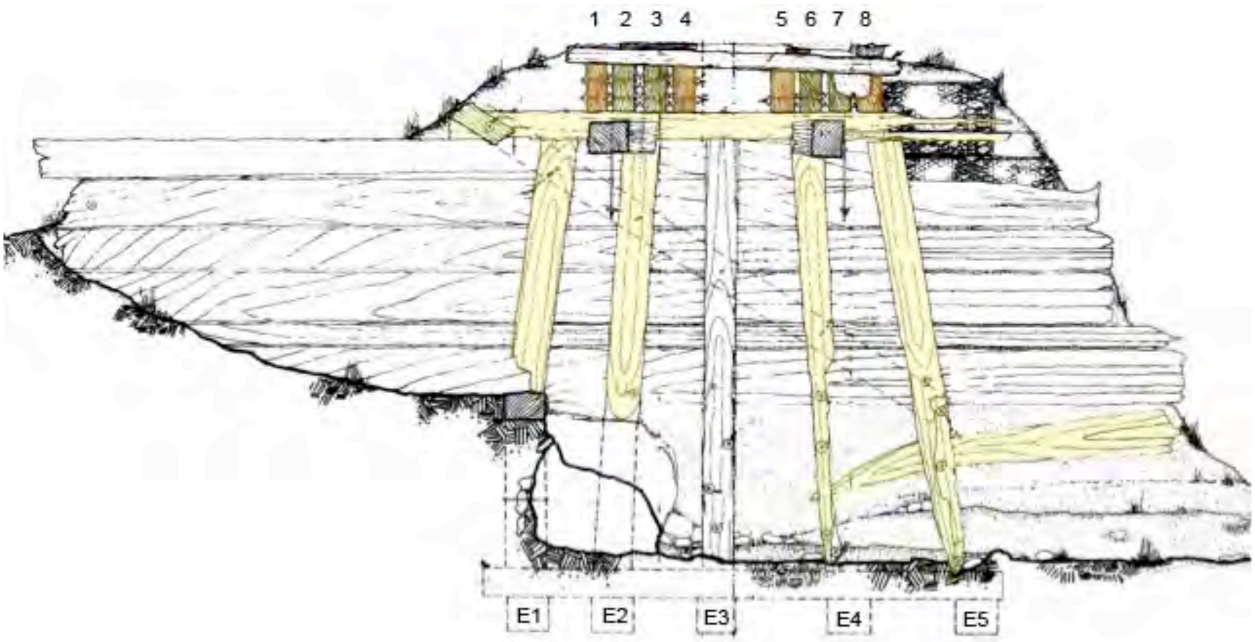

Figure 47: Trestle #1, east bent and bulkhead. Members shaded in yellow were replaced in entirety. Members shaded in orange were repaired. See Figures 42 - 45 in this appendix for details of repair conditions.

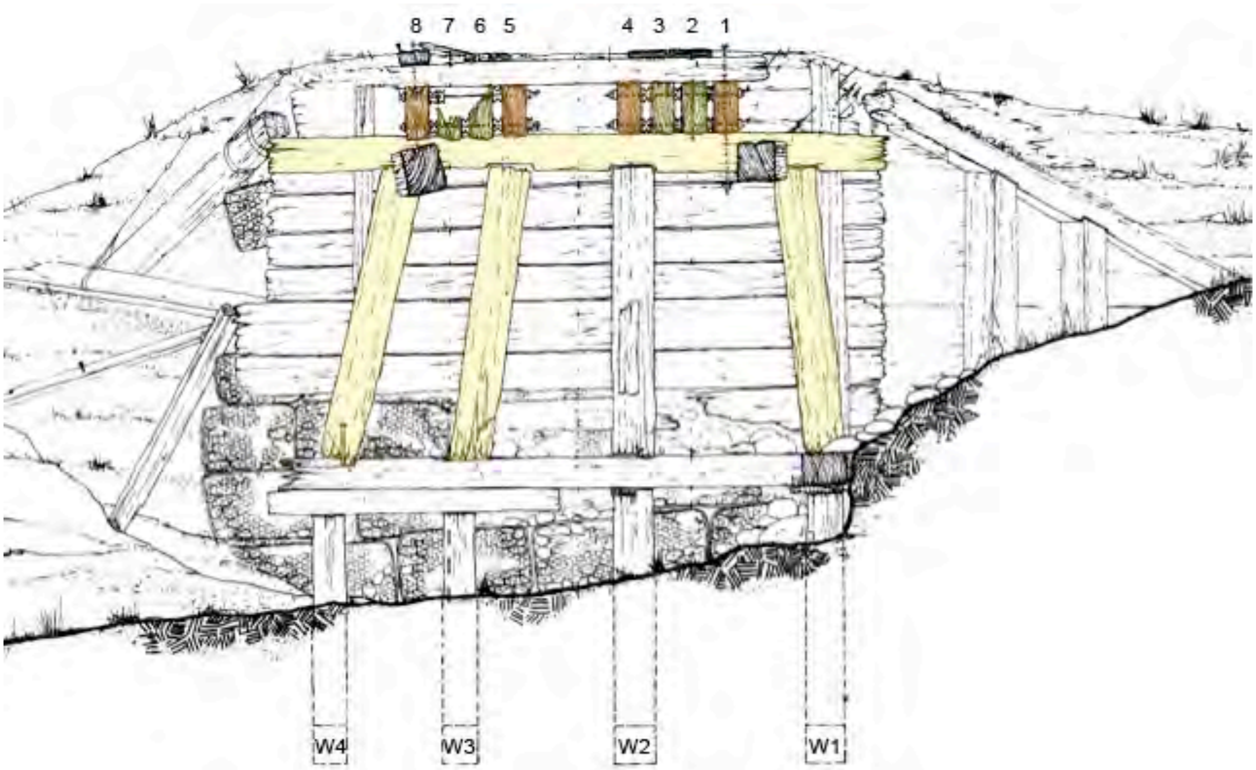

Figure 48: Trestle #1, west bent and bulkhead. Members shaded in yellow were replaced in-kind in entirety. Members shaded in orange were repaired. Much of the west bulkhead planking behind was also replaced in-kind. See Figures 42 - 45 in this appendix for details of repair conditions.

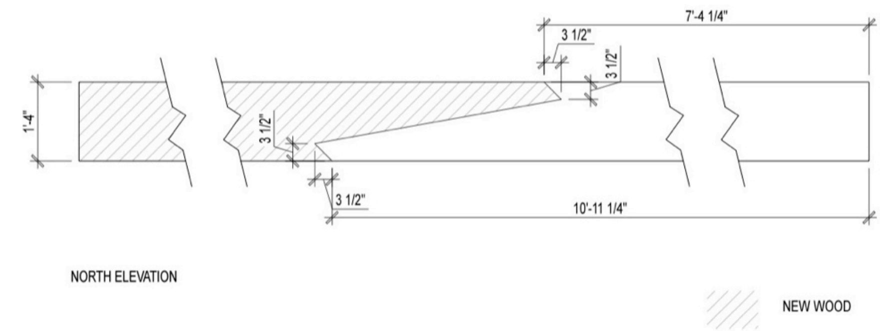

Figure 49: Repair for stringer at position 1, Trestle #1.

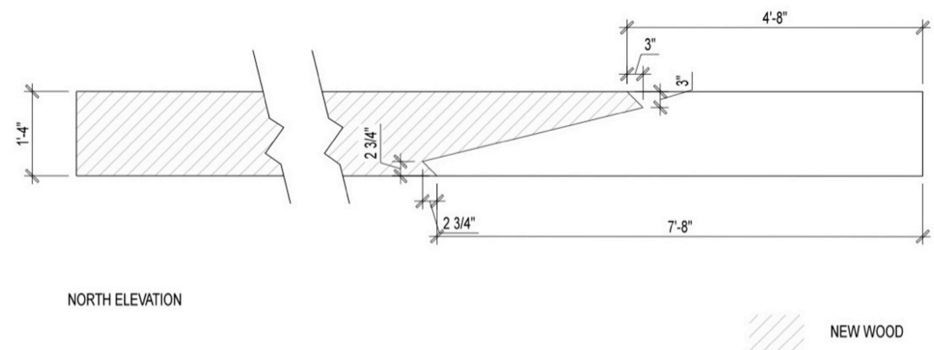

Figure 50: Repair for stringer at position 4, Trestle #1.

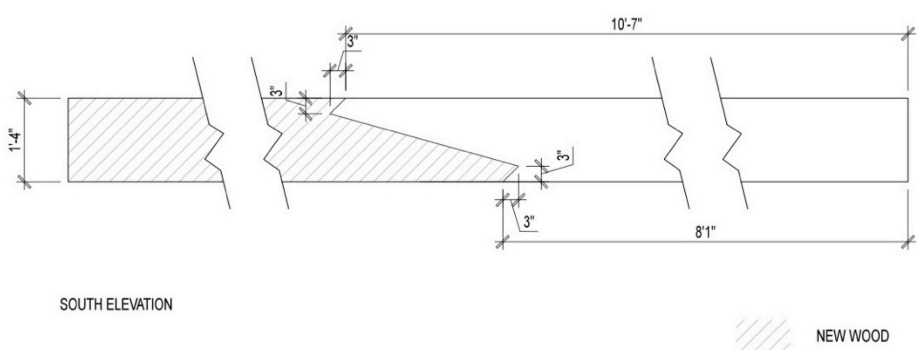

Figure 51: Repair for stringer at position 8, Trestle #1.

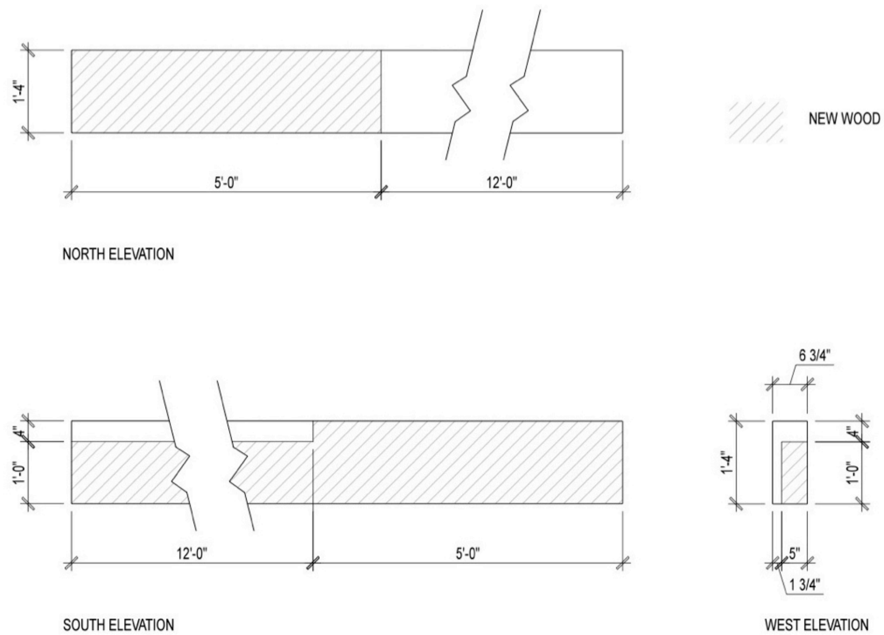

Figure 52: Repair for stringer at position 5, Trestle #1.

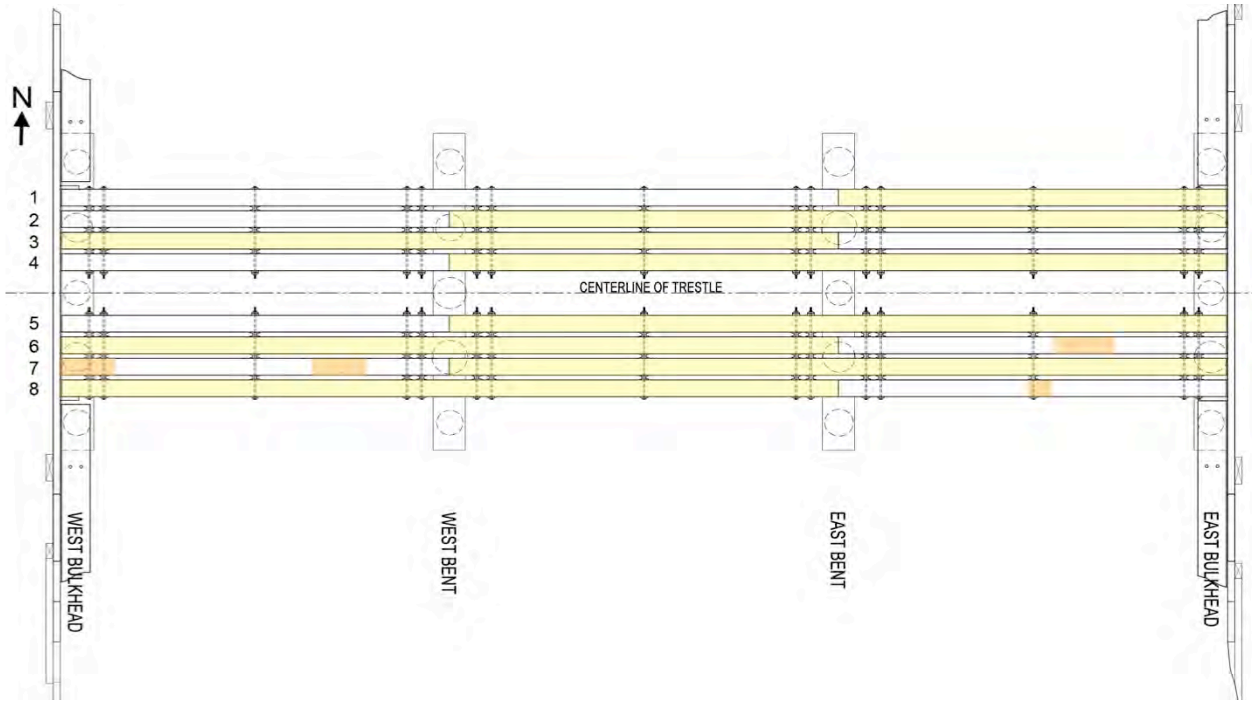

Figure 53: Trestle #2, plan. Members shaded in yellow were replaced in-kind in entirety. Areas shaded in orange are dutchman repairs.

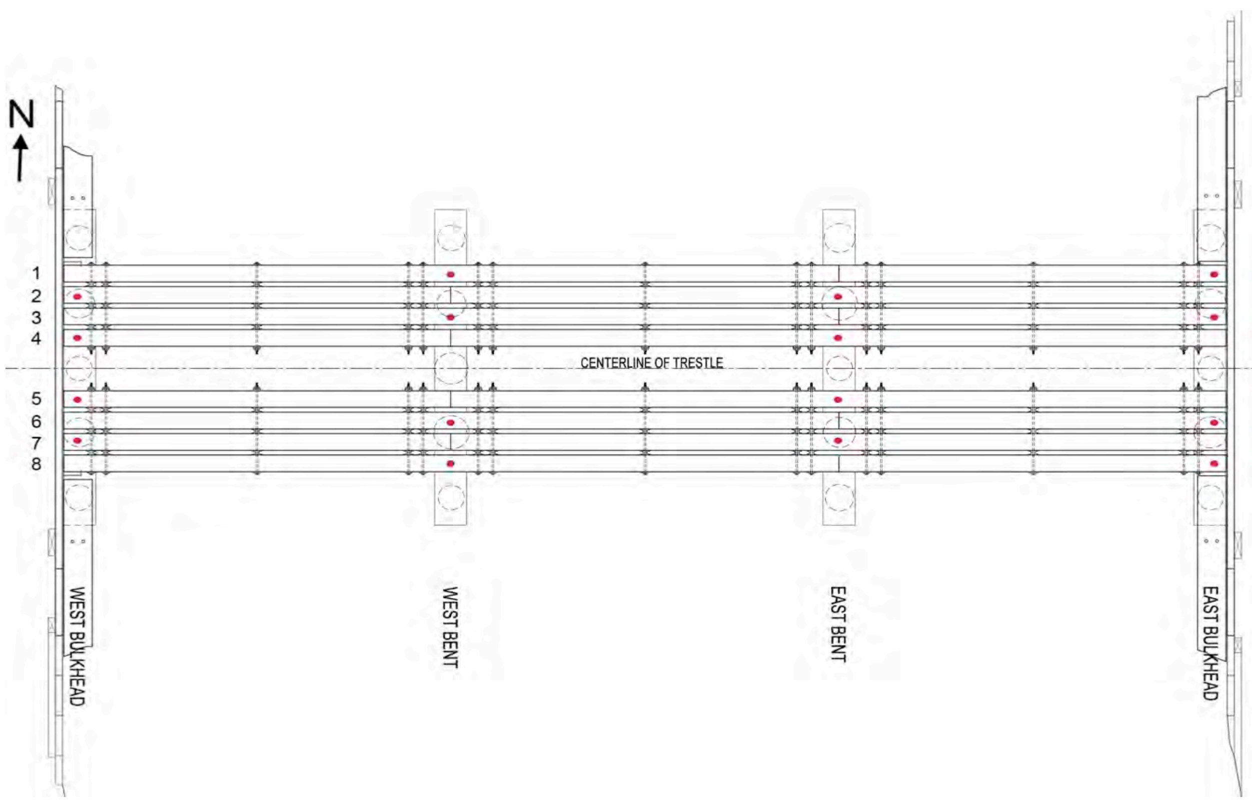

Figure 54: Trestle #2, plan. Approximate location of drift pins used to secure stringer assemblies indicated in red.

APPENDIX D

ANNOTATED PHOTOGRAPHS OF REPAIR WORK AT TRESTLE #1

Figure 55: Trestle #1 before stabilization.

Figure 56: The west bulkhead after excavation. Note the extreme deterioration of the bulkhead planking.

Figure 57: Removing an unsalvageable pile from the west bent.

Figure 58: Lowering a replacement pile into position at the east bent.

Figure 59: The replacement pile is tacked to the surrounding structure and then braced until a new pile cap is installed.

Figure 60: A scarf has been cut to repair one of the stringers of Trestle #1.

Figure 61: Adjusting the fit of a scarf joint.

Figure 62: These scarf joints have been bolted together and the stringers are ready to be stacked into sets.

Figure 63: The repair for this stringer was a lap scarf that acts as a veneer over the new timber.

Figure 64: A section of the intermediary sill at the west bent was found to be soft as the result of decay. The section was removed with a reciprocating saw and later filled with an in-kind replacement block.

Figure 65: A replacement pile cap is positioned on the west bent.

Figure 66: Drilling holes for the stringer hardware.

Figure 67: Stringers were stacked in sets of four and fitted with hardware salvaged from the original assemblies.

Figure 68: Starting the second layer of planking at the west bulkhead.

Figure 69: A second layer of planking was also applied to the back of the northwest wing wall to provide additional stability for the remaining original members.

Figure 70: Large rocks were added behind the bottom of the west bulkhead to facilitate drainage.

Figure 71: Gabion cages that could be salvaged were straightened and rewired.

Figure 72: Replacement gabions were welded from #4 rebar and covered with two layers of wire netting.

Figure 73: A deadman was installed behind the west bulkhead to add stability and to help prevent further twisting of the west bent.

Figure 74: The deadman was loaded with rock and then buried in the fill behind the bulkhead.

Figure 75: Gabions were replaced along the south slope behind the west bulkhead.

Figure 76: Filling the gabions with stone salvaged from the originals.

Figure 77: A second deadman was installed behind the northwest wing wall.

Figure 78: Rabbeting the pile cap for the east bent.

Figure 79: Replacement timbers were extremely heavy, often weighing several hundred pounds, and took several people to move them safely.

Figure 80: Drilling for hardware to secure the pile cap to the bent below.

Figure 81: Drift pins were originally used to secure several of the trestle members to each other. These are replacements fashioned to duplicate the originals.

Figure 82: Driving drift pins through a pile cap into the piles below.

Figure 83: The crane lowers one of the completed stringer assemblies onto the trestle.

Figure 84: The last pieces to be installed are the top planks of the bulkheads.

Figure 85: Trestle #1 after stabilization.

APPENDIX E

ANNOTATED PHOTOGRAPHS OF REPAIR WORK AT TRESTLE #2

Figure 86: The stringers of Trestle #2 had significant pockets of decay along their length.

Figure 87: Planking was installed on either side and between the stringers assemblies to facilitate access and to act as guides for their eventual replacement.

Figure 88: A crane was used to remove the assemblies from the trestle structure.

Figure 89: The assemblies were then set on timber beds for repair.

Figure 90: A dutchman repair.

Figure 91: Rigging for the crane after repair and reassembly.

Figure 92: A stringer assembly is lowered back onto the trestle.

Figure 93: Adjusting the position of the assemblies to match the original.

Figure 94: Removing the planking from around the stringers.

Figure 95: Stringer assemblies were secured to the trestle structure using a mixture of bolts and drift pins. Holes were drilled and the hardware was then driven through the stringers into the structure below.

Figure 96: Trestle #2 after stabilization.

APPENDIX F

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WORKS CITED

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APPENDIX G

HABS / HAER DOCUMENTATION OF TRESTLE #2[30]

HAER-UT-64-I

[30] Drawings included in this document are reproduced at half size. Full size drawings and printed photographs have been transmitted separately to the park along with the final report.

HISTORIC AMERICAN ENGINEERING RECORD
PROMONTORY ROUTE RAILROAD TRESTLES, S. P. TRESTLE 779.89 (TRESTLE #2)

HAER-64-UT-I

Location: Promontory Trestle #2 is located one mile southwest of the junction of State Highway 83 and Blue Creek, in the vicinity of Corinne, in Box Elder County, Utah.

Promontory Trestle #2 is located at 12N 377835 4613204. This coordinate was obtained in 2008 as part of a survey for the trestle's entry into the National Park Service's List of Classified Structures database, using a GPS mapping grade unit accurate to +/- 3 meters after differential correction. The coordinate's datum is North American Datum 83. Promontory Trestle #2's location has no restriction on its release to the public.

Date of Construction: 1938

Engineer: The construction of the trestle was likely overseen by the firm of Benson, Farr, and West, who held the grading contract of the Central Pacific line from Ogden to Promontory, although this is not known for certain.[31]

Builder: Southern Pacific Railroad crew

Original Owner and Use: Southern Pacific railroad; railroad bridge

Present Owner and Use: National Park Service, Golden Spike National Historic Site; trail bridge/vacant

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[31] Stephen E. Ambrose. *Nothing Like It in the World: The Men Who Built the Transcontinental Railroad, 1863-1869*. New York: Simon & Schuster. 2000. P. 290.

Significance:

The Southern Pacific Railroad Trestle #2 is significant as a feature of the first transcontinental railroad and is one of only two remaining trestles in the Golden Spike National Historic Site (NHS). The trestle is listed as a contributing feature to the Golden Spike NHS, which was listed in the National Register on May 23, 1988.[32]

Description:

Trestle #2 is an open deck wood pile and frame trestle, and originally consisted of stringer sets with tie decking, supported by four sets of wood piles with diagonal bracing. The ties are no longer present on the structure, and the track was torn up for scrap when this section of the rail line was abandoned in 1942, but all remaining members were present prior to stabilization in 2012. The stringer sets are not treated, nor were the ties that sat underneath the original railroad track. Stringer assemblies are held together with a series of ¾" x 42" – long metal bolts, washers, and spacers, connecting four sets of stringers for each of two assemblies. Each of the two center pile bent supports is constructed from five creosote-treated wood piles braced with a diagonal plank on both sides and topped with a 12'-long pile cap. Every pile is topped with a sheet metal pile cap and identified by a numeral formed using cut nails. There is also a 1938 date nail on the northern end of the structure. The two bulkhead supports at either end are constructed similarly to the central bents but lack the diagonal bracing. Creosote-treated bulkhead planking is attached to the backs of the bulkhead piles. Timber riprap was laid on the downstream side of both the east and west drainage channel banks to help stabilize the eroding wash.

History:

The Transcontinental Railroad Line was completed in 1869 with the joining of the Central Pacific and Union Pacific railroads. Heavy use and harsh climates meant the line required almost continuous upkeep and repair, and the Southern Pacific Railroad Trestle #2 is historically significant as part of this ongoing railroad maintenance program. The trestle was constructed in 1938 on the drainage channel, and

[32] National Register of Historic Places, Golden Spike National Historic Site, Promontory Summit, Box Elder County, Utah. National Register #66000080. 1957.

was intended to replace an existing trestle to the east constructed in 1889, known as Southern Pacific Railroad Trestle #1 (see HAER No. UT-64-H). The original drainage channel of Trestle #1 may have eroded the foundation of that structure significantly, making replacement impractical. Instead, a railroad tie diversion structure was constructed by the railroad upstream from Trestle #2 to realign the drainage channel, bypassing the first trestle. The railroad abandoned the line shortly after the construction of Trestle #2, and the older trestle was never removed.[33]

The construction of both trestles was likely overseen by the firm of Benson, Farr, and West, who held the grading contract of the Central Pacific line from Ogden to Promontory.[34] The trestle is a well-preserved example of early railroad construction and appears to be based on the Southern Pacific Railroad's Common Standard drawings[35] for Open Deck Trestles, which were adopted by the railroad in the early 1900s.

In 1904, the completion of the Lucin Cut-off across the Great Salt Lake by the Southern Pacific Railroad Company eliminated this section of track from the main line. However, the track was still used to carry maintenance trains for the transcontinental telegraph that continued to follow the original route. Despite the fact that Trestle #2 was originally intended to succeed Trestle #1, both Trestles #1 and #2 continued in operation until the rail line was abandoned in 1942, and are now contained within the boundaries of Golden Spike National Historic Site.[36]

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[33] *Historic Preservation Plan for Trestles No. 1 and No. 2* (Promontory Summit, UT: Golden Spike National Historic Site, CX-1200-5-A023, 1985. P. 4. While the preservation plan suggests that the construction of the railroad tie diversion structure by the railroad is evidence of the intended removal of Trestle #1, the author adduces no documentation in support of this version of events. The issue is not specifically addressed in other known texts.

[34] Ambrose, p. 290.

[35] *Open Deck Pile and Frame Trestles, E-50 Live Load. Common Standard.* Southern Pacific Lines. Adopted Sept 27, 1904. Revised Apr 22, 1958.

[36] National Register, section 7.

Sources:

Ambrose, Stephen E. *Nothing Like It in the World: The Men Who Built the Transcontinental Railroad, 1863-1869*. Simon & Schuster: NY. 2000. P. 290.

Battle, David G. *Historic Structures Report: Railroad Trestles.* Golden Spike National Historic Site: Promontory, Utah. 1971. PP. 9-10.

Historic Preservation Plan for Trestles No. 1 and No. 2. Golden Spike National Historic Site: Promontory Summit, Utah. CX-1200-5-A023. 1985. P. 23.

National Park Service. Southern Pacific Wood Trestle #2, Structure No. S 779.89. List of Classified Structures. 2008.

National Register of Historic Places. Golden Spike National Historic Site, Promontory Summit, Box Elder County, Utah. National Register #66000080. 1957.

Historians:

Doug Porter and Keri Stevenson, 2012

Project Information:

The Historic American Engineering Record (HAER) is a long-range program that documents and interprets historically significant engineering sites and structures throughout the United States. HAER is part of Heritage Documentation Programs (Richard O'Connor, Acting Chief), a division of the National Park Service, United States Department of the Interior.

This project was undertaken by the National Park Service Intermountain Regional Office – Denver, under the direction of the Historical Architect Randall Skeirik. Documentation was prepared during mid-2011 to early 2012 by the School of Engineering, University of Vermont, under the general supervision of Park Archaeologist and Curator Scott M. Whitesides, MA, RPA. Documentation was completed by project manager Douglas Porter, with assistance from wood scientist Ronald Anthony, and Michael Cotroneo. Intern architect Keri L. Stevenson contributed to the field work and delineation. Drawings for the HAER documentation of Trestle #2 are based on field measurements taken in July 2011 and

May 2012; and in part on the Southern Pacific Lines Common Standards drawings for Open Deck Pile and Frame Trestles E-50 Live Load, adopted September 27, 1904, and revised April 22, 1958; as well as the Historic Structures Report for the Railroad Trestles at Golden Spike National Historic Site, F 834 .P76 H57 1971. Photographs were taken by Neil Dixon in October of 2011.

Figure 97: UT-64-1, General area of Trestle #2.

Figure 98: UT-64-2, South elevation.

Figure 99: UT-64-3, North elevation.

Figure 100: UT-64-4, Southwest view of trestle showing timber riprap installed by the National Park Service in the late 1970s.

Figure 101: UT-64-5, Southeast view of the trestle, showing timber riprap installed by the National Park Service in the late 1970s.

Figure 102: UT-64-6, Grade level view to the east, showing the trestle's stringers.

Figure 103: UT-64-7, Southern view of east bent and bulkhead.

Figure 104: UT-64-8, Northern view of east bent and bulkhead.

Figure 105: UT-64-9, East bulkhead.

Figure 106: UT-64-10, Southern view of west bent and bulkhead.

Figure 107: UT-64-11, Northern view of west bent.

Figure 108: UT-64-12, West bulkhead.

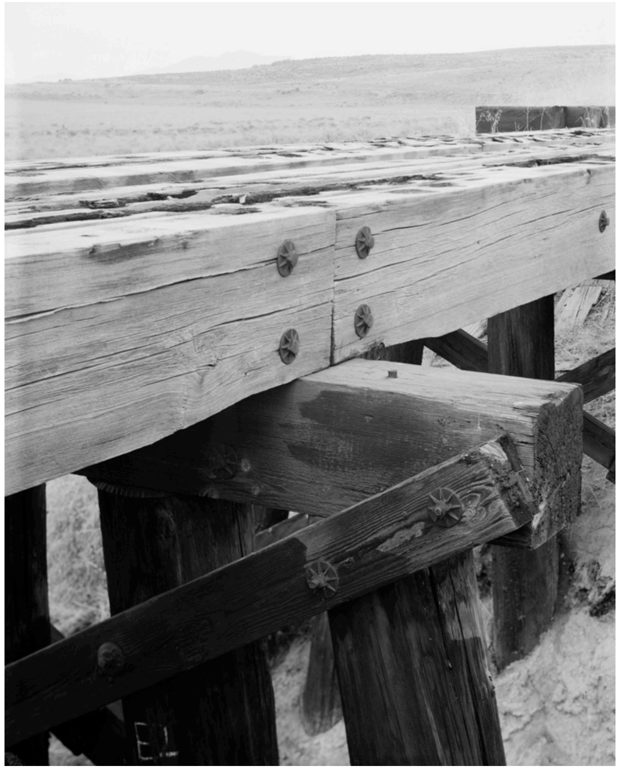


Figure 109: UT-64-13, Detail of stringers and pile cap.

PROMONTORY TRESTLE #2

GOLDEN SPIKE NATIONAL HISTORIC SITE

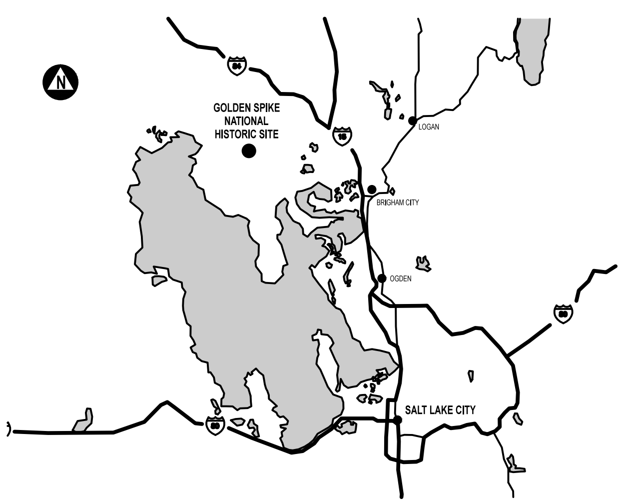
BOX ELDER COUNTY, UTAH

SHEET INDEX

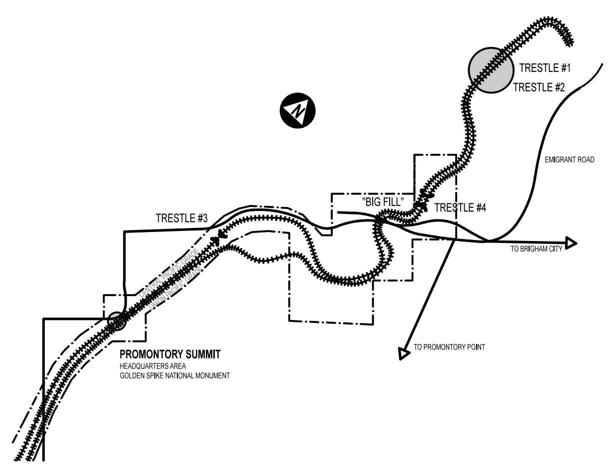
FIELDWORK AT PROMONTORY TRESTLE #2, GOLDEN SPIKE NATIONAL MONUMENT, 2011. PHOTO BY KERI STEVENSON.

THE TRANSCONTINENTAL RAILROAD LINE WAS COMPLETED IN 1869 WITH THE JOINING OF THE CENTRAL PACIFIC AND UNION PACIFIC RAILROADSAT PROMONTORY POINT. HEAVY USE AND HARSH CLIMATES MEANT THE LINE REQUIRED ALMOST CONTINUOUS UPKEEP AND REPAIR, AND THE SOUTHERN PACIFIC RAILROAD TRESTLE #2 IS HISTORICALLY SIGNIFICANT AS PART OF THIS ONGOING RAILROAD MAINTENANCE PROGRAM. IT WAS CONSTRUCTED IN 1938 ON THE DRAINAGE, AND WAS INTENDED TO REPLACE AN EXISTING TRESTLE TO THE EAST CONSTRUCTED IN 1889, CALLED SOUTHERN PACIFIC TRESTLE #1, WHICH WAS TO BE REMOVED. BOTH TRESTLE #1 AND #2 CONTINUED IN OPERATION UNTIL THE RAIL LINE WAS ABANDONED IN 1942 AND NOW ARE CONTAINED WITHIN THE BOUNDARIES OF THE GOLDEN SPIKE NATIONAL HISTORIC SITE.

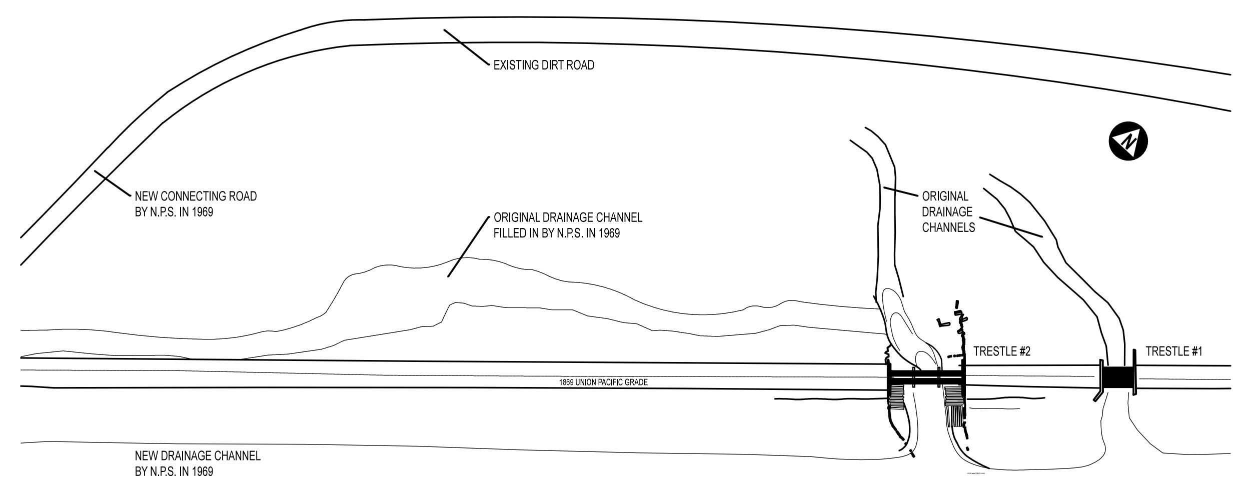
THIS PROJECT WAS UNDERTAKEN BY THE NATIONAL PARK SERVICE INTERMOUNTAIN REGIONAL OFFICE - DENVER, UNDER THE DIRECTION OF THE HISTORICAL ARCHITECT RANDALL SKEIRIK. DOCUMENTATION WAS PREPARED DURING MID-2011 TO EARLY 2012 BY THE SCHOOL OF ENGINEERING, UNIVERSITY OF VERMONT, UNDER THE GENERAL SUPERVISION OF PARK ARCHAEOLOGIST AND CURATOR SCOTT M. WHITESIDES, MA. RPA. DOCUMENTATION WAS COMPLETED BY PROJECT MANAGER DOUGLAS PORTER, WITH ON-SITE ASSISTANCE FROM WOOD SCIENTIST RONALD ANTHONY, AND MICHAEL COTRONEO. INTERN ARCHITECT KERI L. STEVENSON CONTRIBUTED TO THE FIELD WORK AND DELINEATION. DRAWINGS IN THIS SET ARE BASED ON FIELD MEASUREMENTS TAKEN IN JULY 2011 AND MAY 2012; AND IN PART ON THE SOUTHERN PACIFIC LINES COMMON STANDARDS DRAWINGS FOR OPEN DECK PILE AND FRAME TRESTLES E-50 LIVE LOAD, ADOPTED SEPT 27, 1904, AND REVISED APR 22, 1958; AS WELL AS THE HISTORIC STRUCTURES REPORT FOR THE RAILROAD TRESTLES AT GOLDEN SPIKE NATIONAL HISTORIC SITE, 1971.



VICINITY MAP



LOCATION MAP



SITE MAP

SCALE: 1" = 50'

DELINEATED BY: KERI L. STEVENSON

PROMONTORY TRESTLE PROJECT 2011-12
GOLDEN SPIKE NATIONAL HISTORIC SITE
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

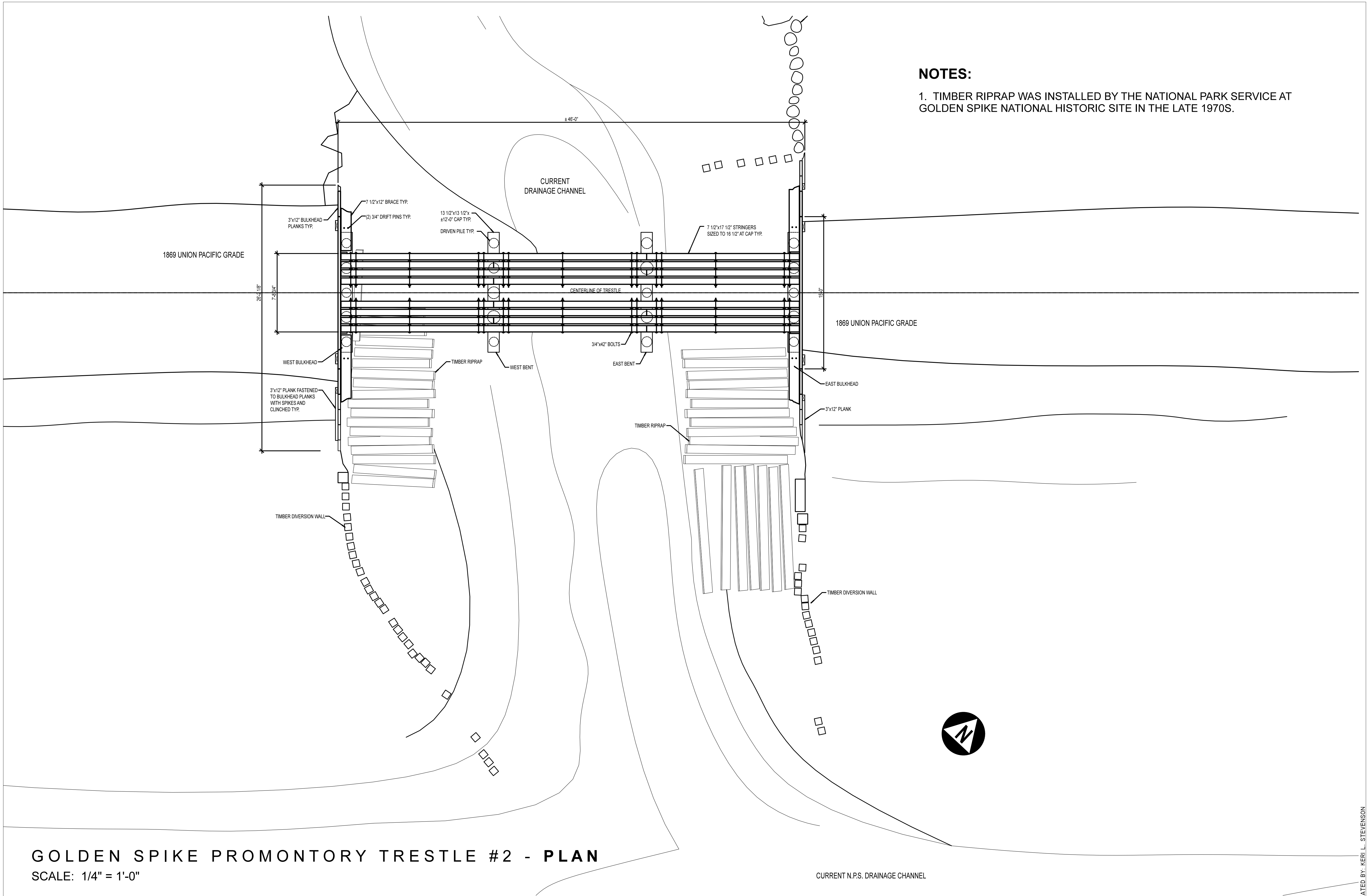
PROMONTORY ROUTE RAILROAD TRESTLES, S.P. TRESTLE 779.89 (TRESTLE #2)
ONE MILE SOUTHWEST OF JUNCTION OF STATE HIGHWAY 83 AND BLUE CREEK
BOX ELDER COUNTY
CORRINNE VICINITY
UTAH

SHEET 1 OF 6

HISTORIC AMERICAN ENGINEERING RECORD
UT-64-I

NOTES:

1. TIMBER RIPRAP WAS INSTALLED BY THE NATIONAL PARK SERVICE AT GOLDEN SPIKE NATIONAL HISTORIC SITE IN THE LATE 1970S.



GOLDEN SPIKE PROMONTORY TRESTLE #2 - **PLAN**

SCALE: 1/4" = 1'-0"

DELINEATED BY: KERI L. STEVENSON

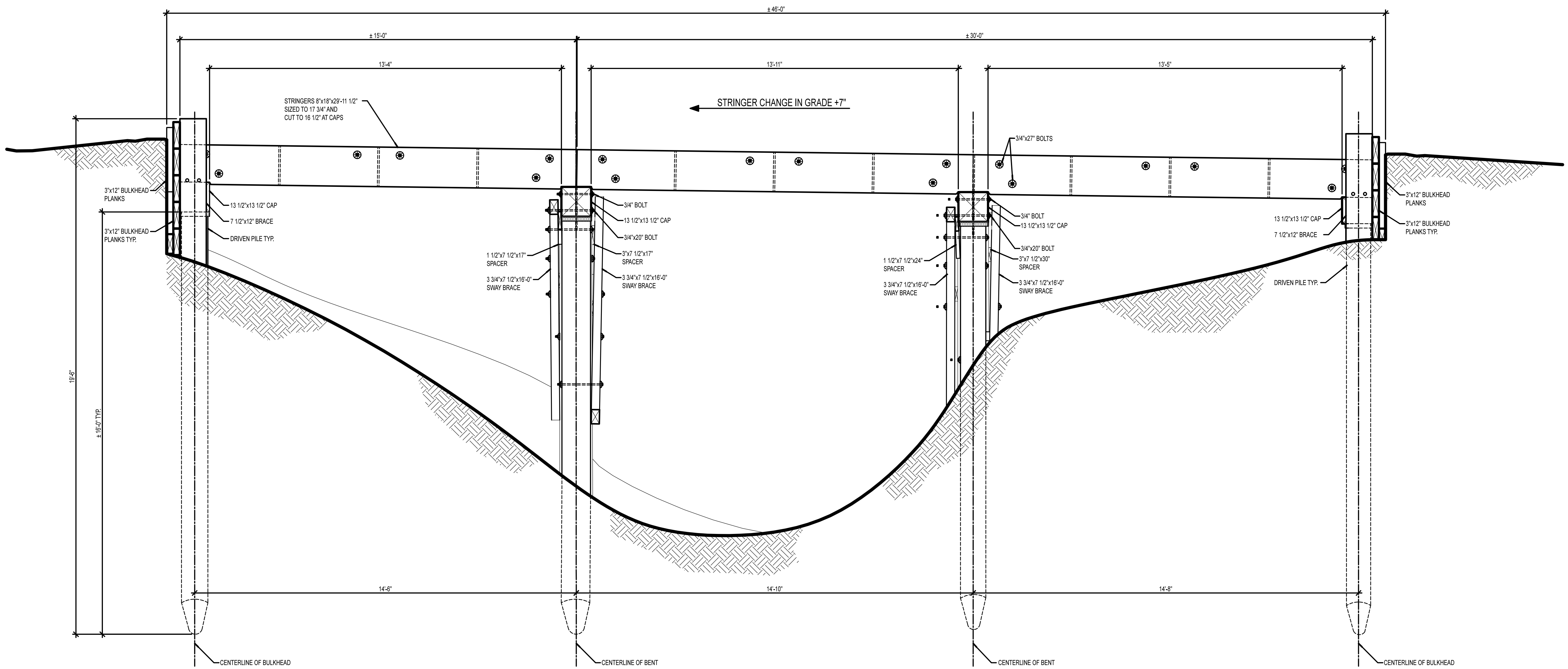
PROMONTORY TRESTLE PROJECT 2011-12
GOLDEN SPIKE NATIONAL HISTORIC SITE
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

PROMONTORY ROUTE RAILROAD TRESTLES, S.P. TRESTLE 779.89 (TRESTLE #2)
ONE MILE SOUTHWEST OF JUNCTION OF STATE HIGHWAY 83 AND BLUE CREEK
CORRINNE VICINITY BOX ELDER COUNTY UTAH

SHEET 2 OF 6

HISTORIC AMERICAN ENGINEERING RECORD
UT-64-1

LIBRARY OF CONGRESS INDEX NUMBER



(1) PROMONTORY TRESTLE #2: **NORTH ELEVATION**
SCALE: 1/2" = 1'-0"

NOTES:

1. OVERALL PILE LENGTHS ARE ESTIMATED BASED ON DRAWINGS PROVIDED BY GOLDEN SPIKE NATIONAL HISTORIC SITE DATED 1971 AND ON THE SOUTHERN PACIFIC LINES COMMON STANDARD DRAWINGS FOR OPEN DECK PILE AND FRAME TRESTLES, E-50 LIVE LOAD, ADOPTED SEPT 27, 1904, REVISED APR 22, 1954.

GOLDEN SPIKE PROMONTORY TRESTLE #2 - **ELEVATIONS**

SCALE: 1/2" = 1'-0"

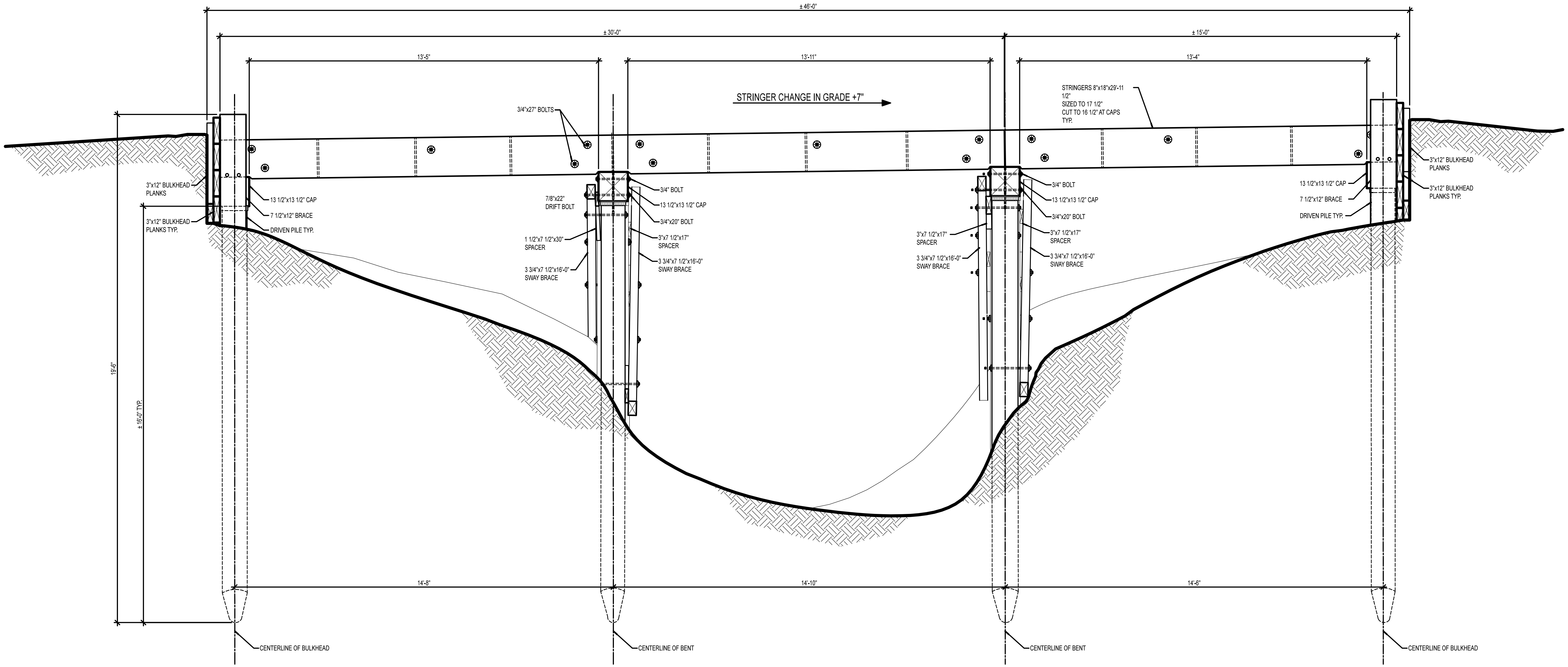
DELINEATED BY: KERI L. STEVENSON

PROMONTORY TRESTLE PROJECT 2011-12
GOLDEN SPIKE NATIONAL HISTORIC SITE
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

PROMONTORY ROUTE RAILROAD TRESTLES, S.P. TRESTLE 779.89 (TRESTLE #2)
ONE MILE SOUTHWEST OF JUNCTION OF STATE HIGHWAY 83 AND BLUE CREEK
BOX ELDER COUNTY
CORRINNE VICINITY
UTAH

SHEET 3 OF 6

HISTORIC AMERICAN ENGINEERING RECORD
UT-64-I



1 PROMONTORY TRESTLE #2: **SOUTH ELEVATION**
SCALE: 1/2" = 1'-0"

NOTES:

1. OVERALL PILE LENGTHS ARE ESTIMATED BASED ON DRAWINGS PROVIDED BY GOLDEN SPIKE NATIONAL HISTORIC SITE DATED 1971 AND ON THE SOUTHERN PACIFIC LINES COMMON STANDARD DRAWINGS FOR OPEN DECK PILE AND FRAME TRESTLES, E-50 LIVE LOAD, ADOPTED SEPT 27, 1904, REVISED APR 22, 1954.

GOLDEN SPIKE PROMONTORY TRESTLE #2 - **ELEVATIONS**

SCALE: 1/2" = 1'-0"

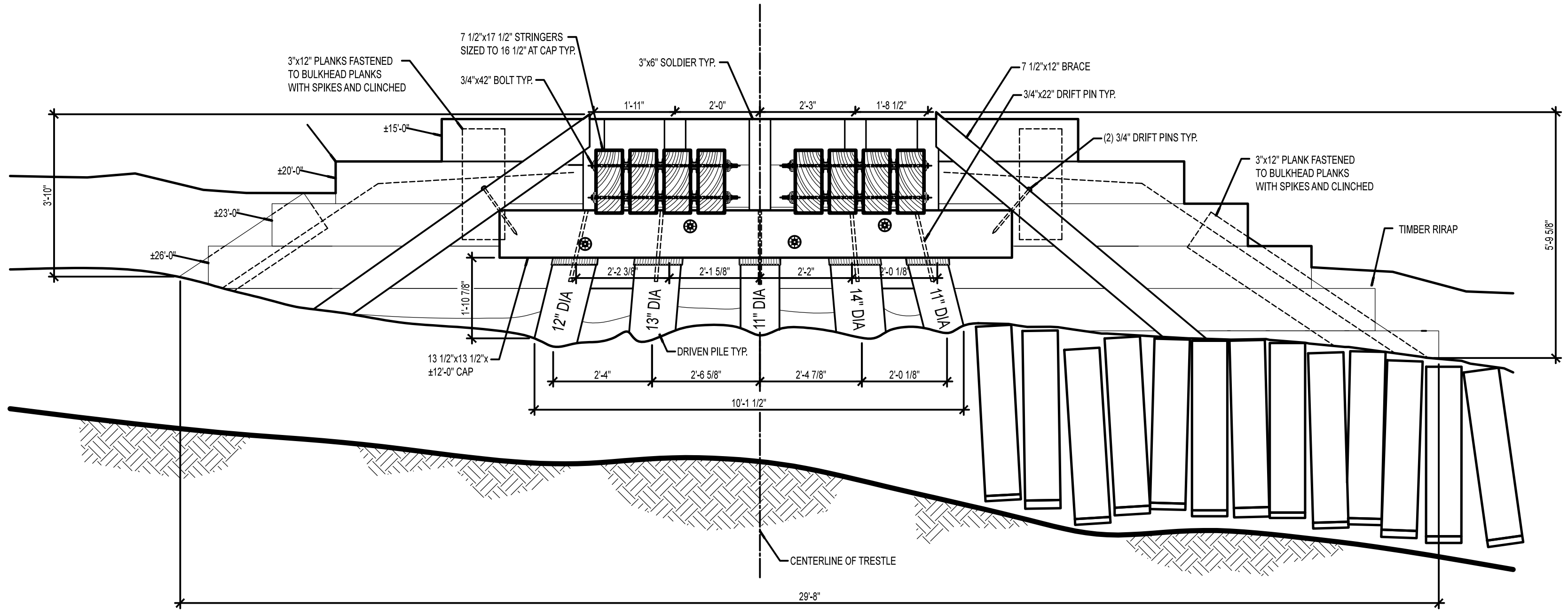
DELINEATED BY: KERI L. STEVENSON

PROMONTORY TRESTLE PROJECT 2011-12
GOLDEN SPIKE NATIONAL HISTORIC SITE
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

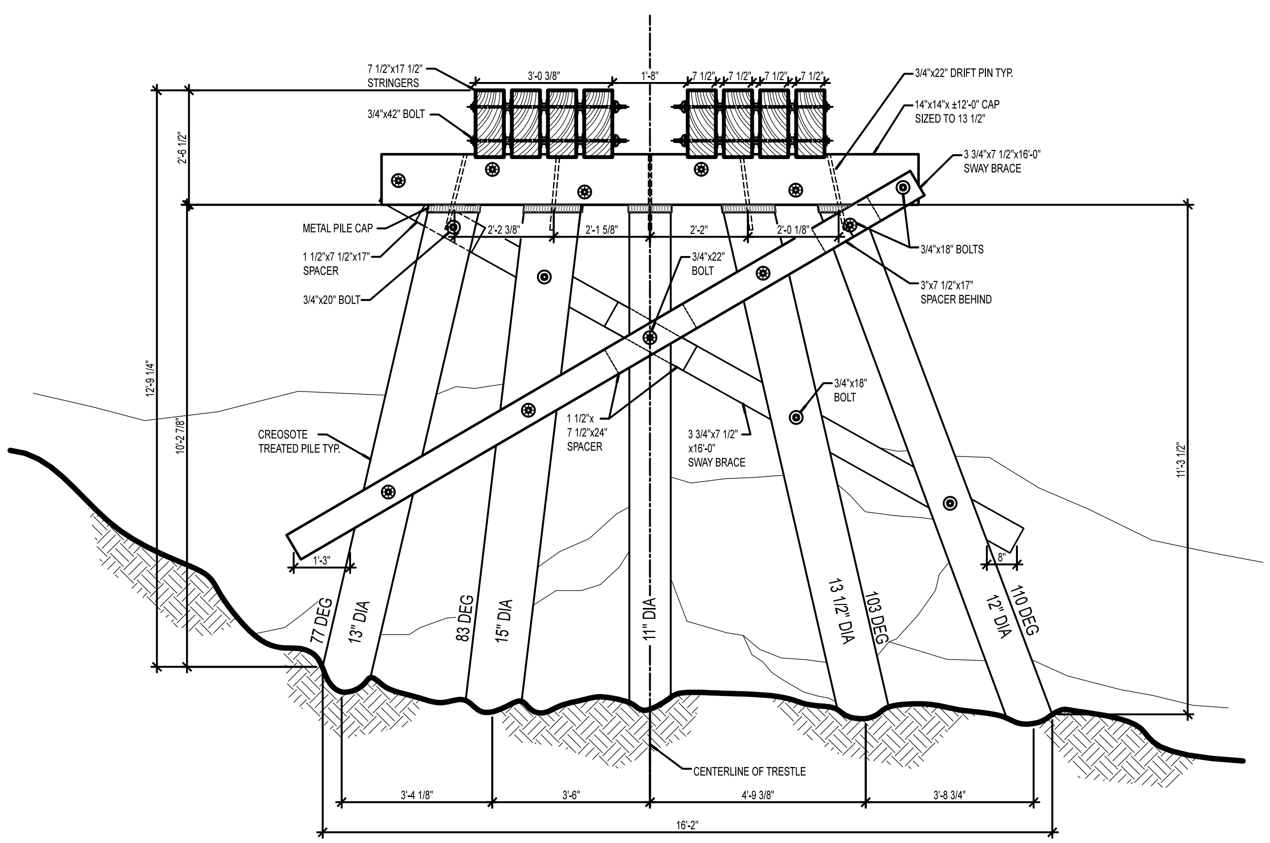
PROMONTORY ROUTE RAILROAD TRESTLES, S.P. TRESTLE 779.89 (TRESTLE #2)
ONE MILE SOUTHWEST OF JUNCTION OF STATE HIGHWAY 83 AND BLUE CREEK
CORRINNE VICINITY
BOX ELDER COUNTY
UTAH

SHEET 4 OF 6

HISTORIC AMERICAN ENGINEERING RECORD
UT-64-I



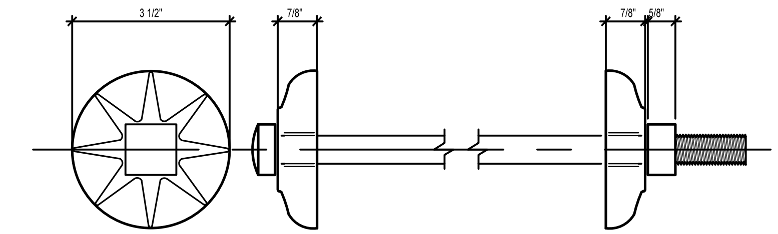
1 EAST BULKHEAD: **ELEVATION**
SCALE: 1/2" = 1'-0"



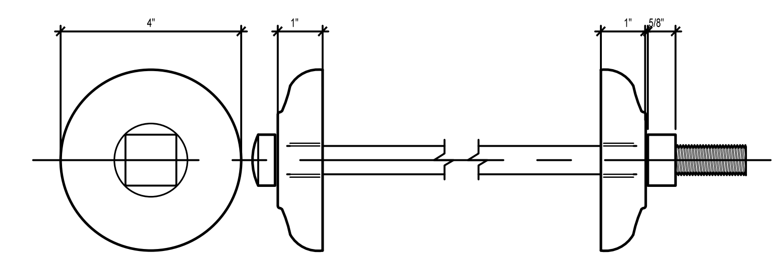
2 EAST BENT: **WEST ELEVATION**
SCALE: 1/2" = 1'-0"

NOTES:

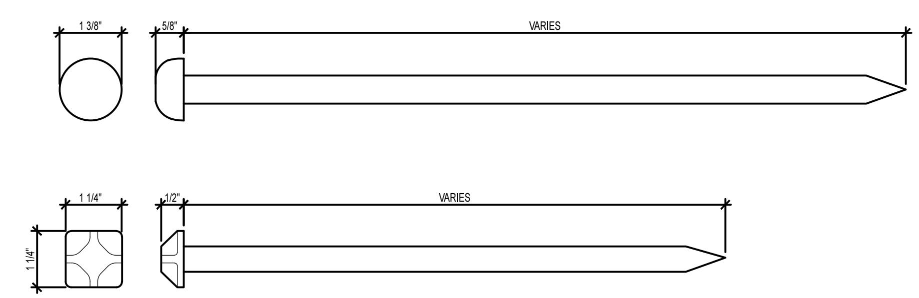
1. TIMBER RIPRAP WAS INSTALLED BY THE NATIONAL PARK SERVICE AT GOLDEN SPIKE NATIONAL HISTORIC SITE IN THE LATE 1970S.



3 TYPICAL BOLT WASHER, AND NUT - **DETAILS**
SCALE: HALF SCALE



4 TYPICAL BOLT WASHER, AND NUT - **DETAILS**
SCALE: HALF SCALE



5 TYPICAL DRIFT PINS - **DETAILS**
SCALE: HALF SCALE

GOLDEN SPIKE PROMONTORY TRESTLE #2 - **ELEVATIONS AND DETAILS**

SCALE: 1/2" = 1'-0" OR AS NOTED

DELINEATED BY: KERI L. STEVENSON

PROMONTORY TRESTLE PROJECT 2011-12
GOLDEN SPIKE NATIONAL HISTORIC SITE
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

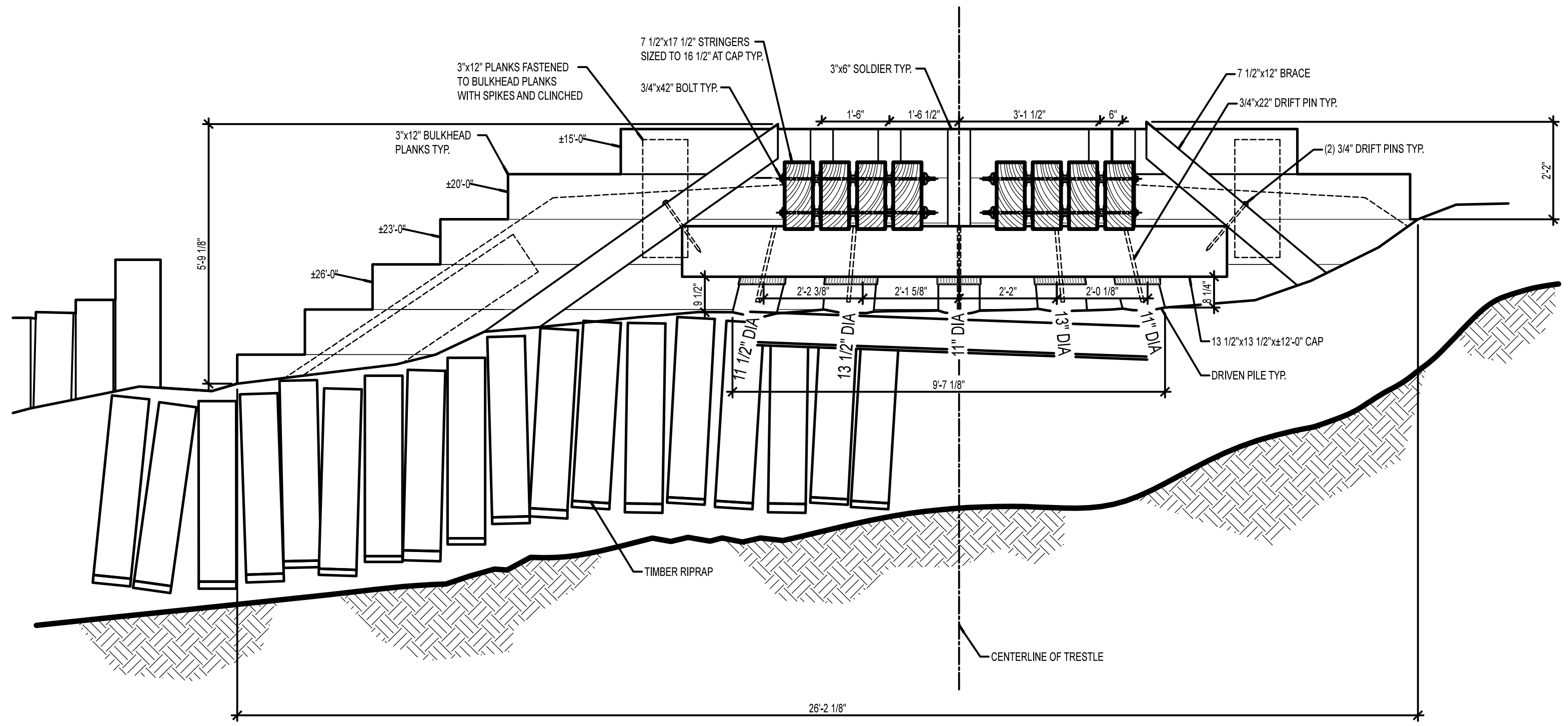
PROMONTORY ROUTE RAILROAD TRESTLES, S.P. TRESTLE 779.89 (TRESTLE #2)
ONE MILE SOUTHWEST OF JUNCTION OF STATE HIGHWAY 83 AND BLUE CREEK
CORRINNE VICINITY
BOX ELDER COUNTY
UTAH

SHEET 5 OF 6

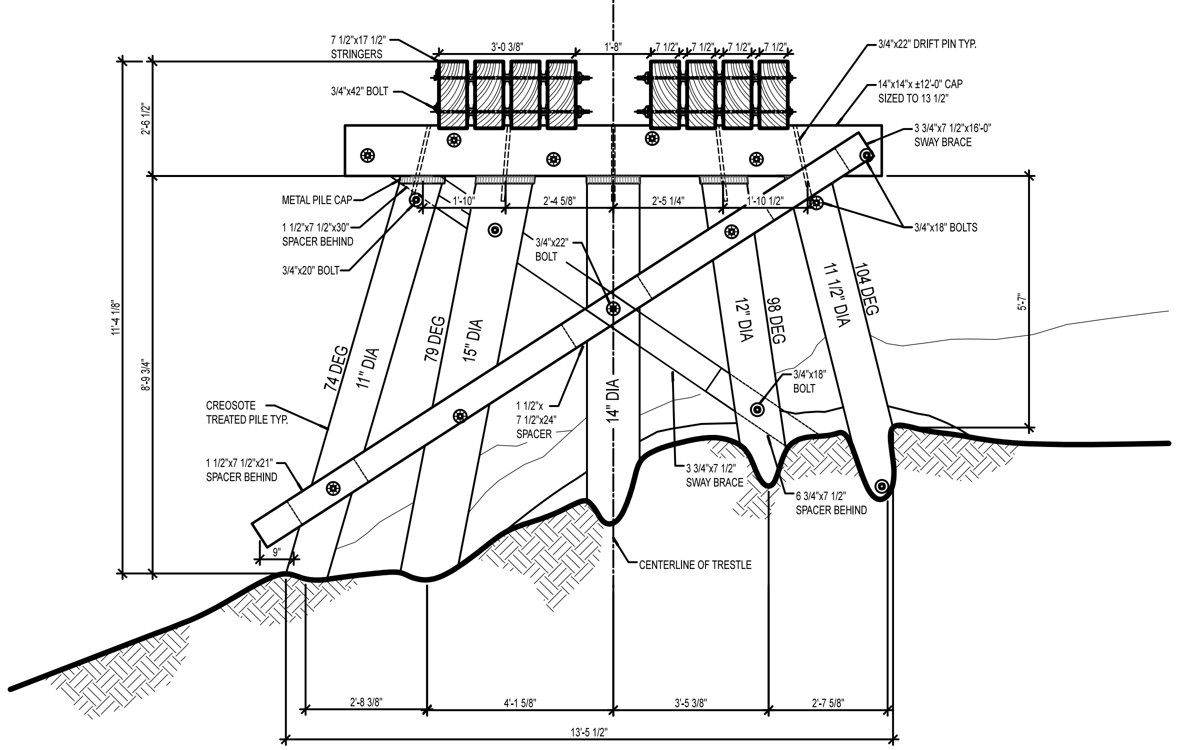
HISTORIC AMERICAN ENGINEERING RECORD
UT-64-I

NOTES:

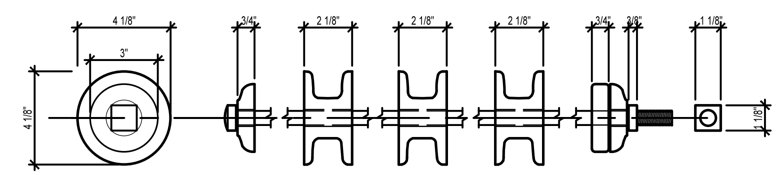
1. TIMBER RIPRAP WAS INSTALLED BY THE NATIONAL PARK SERVICE AT GOLDEN SPIKE NATIONAL HISTORIC SITE IN THE LATE 1970S.



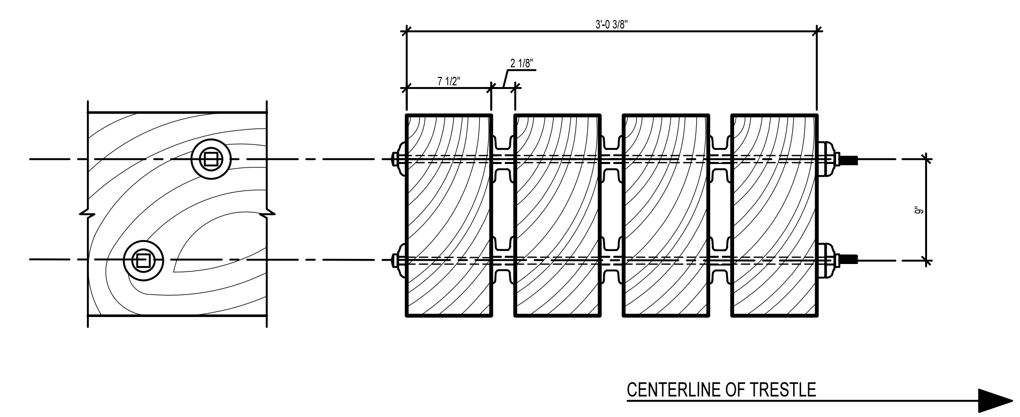
① WEST BULKHEAD: **EAST ELEVATION**
SCALE: 1/2" = 1'-0"



② WEST BENT: **EAST ELEVATION**
SCALE: 1/2" = 1'-0"



③ STRINGER BOLT ASSEMBLY - **DETAILS**
SCALE: 3" = 1'-0"



④ STRINGERS AND STRINGER BOLT ASSEMBLY - **DETAILS**
SCALE: 1 1/2" = 1'-0"

GOLDEN SPIKE PROMONTORY TRESTLE #2 - **ELEVATIONS AND DETAILS**

SCALE: 1/2" = 1'-0" OR AS NOTED

DELINEATED BY: KERI L. STEVENSON

PROMONTORY TRESTLE PROJECT 2011-12
GOLDEN SPIKE NATIONAL HISTORIC SITE
NATIONAL PARK SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR

PROMONTORY ROUTE RAILROAD TRESTLES, S.P. TRESTLE 779.89 (TRESTLE #2)
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