Historic Structure Assessment Report

Rumbaugh Creek Bridge

Prepared on March 20, 2015

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Table of Contents

Executive Summary **3**

Introduction **3**

History **4**

A Brief History of the WPA Projects in Colorado **5**

Water Plant Complex Description **8**

Materials Descriptions, Conditions and Treatments Summary **10**

SUBJECT PROJECT FOR THIS RFP REQUEST: Stone Masonry Arch Bridge

Stone Masonry Arch Bridge Description

Stone Masonry Arch Bridge Conditions

Stone Masonry Arch Bridge Treatments

Appendix—Photographs and and Wall Elevation Diagrams

Executive Summary

The complex of the historic Water Works includes: the Water Plant, the Tanks in which sedimentation occurred, and **the Stone Arch Bridge** and associated retaining walls. The critical condition issues for each of these are as follows:

1. **SUBJECT PROJECT FOR THIS RFP REQUEST**: The Stone Masonry Arch Bridge and Associated Retaining Walls: The bridge is a real gem; a true stone arch bridge. Its current condition is perilous and collapse in the very near term, one month, is of concern and quite likely. A number of emergency stabilization methods are strongly recommended for immediate implementation. The associated high retaining walls to the east of the bridge are in similar perilous conditions with the top half overhanging the bottom half, six inches or more out of plumb. Emergency stabilization is recommended for immediate implementation. The methods for full stabilization and redevelopment of structural integrity are fully set forth for both the bridge and the retaining walls.

Introduction

The purpose of this Condition Assessment is to evaluate the current condition of the historic Old Pagosa Springs Water Plant and the Rumbaugh Creek Bridge, to determine the extent of deterioration of building materials, to describe the causes of the deterioration, to set forth remedial treatments to arrest or reverse deterioration and reduce the underlying causes as practical, and to estimate the probable costs of the treatments. All of the recommended treatments have been put forth after review for compliance with the Secretary of The Interior's Standards for Rehabilitation of historic properties.

Research Background

The history of the building and its occupants has been developed by the City of Pagosa Springs and limited new research was a part of this report effort.

Participants

John Feinberg, APTI, overall project principal, Architectural Conservator, Dean Brookie, Historic Architect, both of the Collaborative inc. of Boulder, Colorado, and Dave Woodham, structural engineer, of Atkinson Noland and Associates also of Boulder, Colorado.

Client

The client representative is Margaret Gallegos, Building and Planning Department, Town of Pagosa Springs, Colorado.

Site Visit

Date (Time): March 16, 2015 (11:00 AM) to March 17, 2015 (8:30 AM)
Weather Conditions: Sunny, 65 degrees.

History

In the 1930s, following the Great Depression, came several New Deal relief and recovery programs, which were designed to put people to work. Most of the projects, particularly in Colorado, aimed to spend funding on labor wages, so mostly only local materials and few power machines were used for projects. Most of the labor began as unskilled, but as workers gained experience, so did the quality of the projects, which included masonry structures such as bridges, water plants, and retaining walls.

The subject structures of this report were built by the Works Progress Administration (WPA), beginning in 1938. According to an article by Ann Oldham, *The Pagosa Springs Waterworks*, the stone and masonry building had a "wooden roof supported by massive steel beams, to enclose the metal paddle wheel. Three water-settling tanks with stone and masonry foundation and walls were attached to this structure. … Water from the San Juan River flowed into the first of the settling tanks where sand and dirt settled to the floor of the tank. Clear water flowed over gaps in the tops of the walls to fill the second and third tanks, with more particles settling out each time. Water from the third tank was pumped (through the Waterworks Building) through a pipeline to a water tower on the west side of town." (p. 23) On p. 24 of this same document, "The original 'hourly-wage schedule' … is on display in the museum. This beautiful rustic building with settling tanks still stands at the corner of First and Pagosa Streets beside the river. A picturesque stone bridge spans Rumbaugh Creek to the east of the settling tanks. The skill of the workmen can still be viewed and appreciated in the second room of the San Juan Historical Society's Pioneer Museum and the Rumbaugh Bridge. … The total cost of this WPA project to provide domestic water to the Pagosa Springs was $4,630.00." According to the web site http://www.historycolorado.org/oahp/wpa-modernist, typical projects of the WPA in Colorado had these elements in common:

1. Use of local materials
2. Simple building forms
3. Lack of ornamentation
4. Flat or barrel roofs
5. Smooth exteriors
6. Vertical orientation- tall windows grouped in sections
7. Linear building elements
8. Sharp, angular square corners

A Brief History of the WPA Projects in Colorado[1]

Although the early programs of President Roosevelt's New Deal relieved the suffering of some Americans, as 1934 ended the economic depression and problems of unemployment continued. The Roosevelt administration proposed to create a broader relief and recovery program known as the "Second New Deal." Central to this new phase was a work relief program for the unemployed, established as the Works Progress Administration (WPA) on May 6, 1935. The WPA modified and expanded previous federal work relief to become the major source of public jobs for the unemployed during the latter part of the thirties.

The WPA sought to put the unemployed to work and remove them from the relief rolls. "Small useful projects" provided employment for a maximum number of needy "employable" workers in the "shortest time possible." The WPA construction projects were intended to provide employment to a large number of unskilled workers, but they also used skilled and semi-skilled workers. The WPA called for the majority of project costs to be wages rather than construction materials. The federal government paid virtually the entire expense of WPA projects, with relatively small sums supplied by sponsors making up the difference. The WPA eventually grew into the largest provider of work relief in the nation during the remainder of the Depression. The construction projects brought about the most widespread and significant change in public capital improvements ever witnessed by the state and nation.

The WPA provided temporary jobs for thousands of Colorado residents, both rural and urban, and resulted in the construction of public works projects in every county and virtually every community across the state. The agency formed the single largest construction and employment program in the state during the thirties.

By early November 1936, 9,000 Coloradans labored in WPA projects, and by late December more than 40,000 had received jobs. The numbers of WPA employed rose to 43,200 by March 1937, the peak of its working force in Colorado. Budget cuts brought periodic retrenchments, forcing the state program to cut back the number of jobs. Many of these occurred when Colorado experienced economic recession, such as in the summer of 1937. By early 1938, the unemployment and relief situation in Colorado nearly reached that of the desperate times of early 1933. With one in five people in the state on relief, Colorado WPA administrator Paul D. Shriver initiated an emergency work program and rehired 15,000 workers in early 1938. When the WPA finally received additional federal funds, the program expanded again, particularly in southern Colorado, which had the highest percentage of unemployed in the state.

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[1] http://www.historycolorado.org/sites/default/files/files/OAHP/Guides/Builders_WPA.pdf

WPA construction projects made the greatest impact on reducing depression unemployment and on the improvement of the state's public infrastructure. Highways, roads and streets consumed 35 percent of WPA funds in Colorado. Other expenditures included 12 percent for buildings; 8 percent to water, sewer systems and other utilities; 6 percent on conservation projects and a similar percentage for airports and runways; 4 percent on recreational facilities (excluding buildings); 1.3 percent for sanitation; just under 1 percent used on engineering surveys; and 2.1 percent on all other projects. Roads and public buildings constituted the bulk of WPA construction projects in Colorado. New and better roads allowed the state to take advantage of its tourist and recreational potential. Eastern Colorado came to depend on an essential network of WPA enhanced "farm to market" roads for the recovery of its agricultural and ranching economy. Statewide, WPA workers built or improved over 9,400 miles of highways, roads or streets, nearly 3,400 bridges and viaducts, and more than 21,000 culverts.

Schools constituted another major category of WPA construction projects in Colorado. Schools in eastern Colorado were in particularly poor shape. Many districts had been unable to keep up with the enrollment growth of the first three decades of the twentieth century. The Depression halted all hopes of new construction and existing schools fell into disrepair. Many rural schools were crowded, outdated and unsafe. Throughout the state, the WPA newly built or expanded 113 schools. Additionally, the agency "reconstructed or improved" 381 schools.

The WPA erected or expanded a total of 583 public buildings across the state, and 764 other public buildings experienced reconstruction or improvements. WPA laborers built or improved 119 Colorado parks, 195 playground and athletic fields, and 32 swimming or wading pools. Public utility enhancement also constituted important WPA projects, particularly in smaller communities. The WPA constructed or improved 78 utility plants, 279 miles of water mains or distribution pipes, and 224 miles of new storm and sanitary sewers. Associated with the issue of sewage sanitation, but often constructed on private properties, the agency built an astounding 31,991 sanitary privies across the state.

While construction made up a large portion of WPA activities, non-construction service projects constituted wide variety of efforts providing employment women as well as white-collar professionals. Projects relating to adult education and the arts (including writing, music, performance, and the visual arts), as well as records and research projects provided jobs to people who had lost related work in similar professions. Rural women were given jobs sewing, gardening, canning, distributing commodities, and serving school hot lunches – thereby providing project employment for women while distributing the goods produced to the needy.

By the time it dismissed its last 1,700 employees in December 1942, the Colorado WPA program had given jobs to approximately 150,000 people statewide generating 195,518,207 worker hours. The federal government expended $120,102,731 in Colorado, 89 percent going directly to wages. About 15 percent of the $33,489,704 contributed by the sponsors went to wages. Colorado WPA workers received the highest wages paid by the agency nationwide, ranging from $40 a month for non-skilled workers, to $94 for

skilled labor.

Statewide, the WPA expended $1,644,458 for non-construction projects, the products and services produced went to needy Coloradans. WPA workers produced 6,730,092 garments and over 5 million quarts of preserved food. Others served over 22 million school hot lunches, placing Colorado in the top five in the nation. The majority of these service occurred in existing buildings, but occasionally a WPA construction project built a special purpose facility.

Of all the New Deal work relief programs resulting in the construction of public facilities, the WPA most impacted the built environment of the cities, towns, and small communities in hard hit eastern Colorado. While other New Deal programs assisted with soil conservation, farm subsidies, and loans – all of which helped the residents of the plains region to survive the decade – the WPA built the region's schools, roads, and public utilities. A majority of these resources remain in use – marking the many achievements made during a most difficult period of Colorado's history.

The Water Plant in Pagosa Springs, Colorado, was built in 1938 as one of the projects built under the auspices of the federal New Deal's Works Progress Administration. The rustic stone building and its three associated water-settling tanks, which cost $4,630.00, provided domestic water to the residents of the town from the San Juan River. "Water … flowed into the first settling tank where sand and dirt settled to the floor.... Clear water flowed over the gaps in the tops of the walls to fill the second and third tanks…. Water from the third tank was pumped (through the Waterworks Building) through a pipeline to a water tower on the west side of town. Then it moved by the force of gravity through pipes into the homes and businesses of the town."[2]

[2]Oldham, Ann. The Pagosa Springs Waterworks, pp. 23-25.

Water Plant Complex Description

The complex has three structures: **<u>the stone arch bridge</u>** to the northeast and the associated retaining walls, three stone masonry settlement basins or called in this report "tanks," and the stone masonry water plant. The stone arch bridge construction date pre-dates the water treatment plant construction dates of 1935-1938. Based upon materials of the bridge (lime mortar), and its construction typology (stone arch), the bridge construction date is likely attributed to the late 19th century.

Building Location/Vicinity Plan/Site Plan

Water Plant : Block 25, Pagosa Springs Townsite Plat

Materials Descriptions, Conditions and Treatments

SUBJECT PROJECT FOR THIS RFP REQUEST: Stone Masonry Arch Bridge

Stone Masonry Arch Bridge Description

During the on-site investigations on March 16, 2015, engineer David Woodham from Atkinson-Noland & Associates and John Feinberg from the Collaborative measured and inspected the stone masonry bridge over Horse Gulch in Pagosa Springs. The bridge is a semicircular arch bridge with a span of 7 ft. 10 in. and a width of 23 ft. 8 in. at the stream level. The voussoirs are 14 to 16 in. deep and are typically between 8 and 12 inches in width. The barrel vault appears to be the same depth of approximately 16 in. The spandrel walls are 10 ft. 8 in. wide and are 2 ft. 5 in. above the extrados at the arch crown on the west elevation and 3 ft. 3 in. above the arch crown on the east elevation (Figures 1 and 2).

Figure 1. Bridge as viewed from the West.

Figure 2. Bridge and adjacent retaining wall (image left) as viewed from the East. The spandrel wall is partially collapsed at the south abutment and has collapsed beyond the north abutment. The north wing wall and retaining walls have also collapsed and masonry fragments are visible in the bushes (image right).

Stone Masonry Arch Bridge Conditions

Both the north and south bridge abutments have been undermined, resulting in complete loss of vertical support for the barrel vault (Figures 3 and 4). This is the most serious threat to the bridge and will likely lead to total collapse if not mitigated in the near future (1 to 6 months). Without support, the barrel vault is not in compression and hangs from the remaining masonry by the weak tensile strength of the mortar, perhaps an occasional bond stone between the vault and the abutments and some friction produced by the arch thrust. Stabilization is required to save what is left of the barrel vault and prevent collapse.

The ring and spandrel wall on the east elevation are separating from the vault. The separation is minor at the north spring line and propagates over the crown to a width of 2 to 3 in. in width. The voussoirs on the south spring line are missing as is the remainder of the spandrel wall at this location. A crack has developed between the voussoirs and the spandrel wall on the west elevation which reportedly was not present last summer.

Figure 3. South abutment is completely undermined and lower portion of the vault has fallen into the streambed.

Figure 4. Undermined South and North abutments.

The retaining walls on the east elevation of the bridge have either failed or are in danger of failing. The South retaining wall is founded on a battered stone wall below but from the bearing on the lower wall to the top of the wall, the upper wall is out of plumb by as much as 2 ft. over the 8 ft. height of the wall (Figure 5). As a result, the center of gravity of the retaining wall is outside the exterior face of the wall – a condition that is highly unstable.

Figure 5. South retaining wall on east elevation of the

Stone Masonry Arch Bridge Treatments Summary

The following recommendations are prioritized beginning with those requiring immediate implementation to repairs that can be conducted in the longer term (next several years).

1. Emergency shoring of the barrel vault to prevent collapse: It is recommended to first place protection under the bridge to allow for workers' safety. Envisioned is a series of timber beams and columns to prevent the collapse of the vault. Further, wooden 4 x 4 in. posts should be placed between the shale streambed and the lowest courses of the vault at a spacing not to exceed 2 feet. The posts should be cut carefully to length and secured with opposing wedges that can be driven tight to eliminate any play in the supports.

2. Confine the flow to the center of the channel: In the near term, remove failed masonry pieces from the creek bed, as one large masonry element is currently directing water flow toward the north abutment. In addition, use sandbags to protect the north and south abutments from further scour and confine the flow to the center of the creek bed and prevent debris from impacting the shoring.

3. Shore the large retaining wall South of the east spandrel wall of the bridge. A series of diagonal steel braces attached to a steel whaler that is placed horizontally against the wall is needed. The whaler would have to be shimmed with wood wedges to ensure even bearing over the irregular surface of the wall. The diagonal braces will require pilings, small caissons or some other means of anchorage to provide sufficient reaction to resist the horizontal loads.

4. Remove vegetation from the top and sides of the bridge: Roots from small trees and shrubs are damaging the masonry and should be removed. Use root killer to prevent regrowth.

5. Rebuild failed portions of the bridge: Rebuild the masonry abutments to support the barrel vault and restore the original appearance of the bridge. Rebuilt the failed portion of the west spandrel wall. Rebuild the east spandrel wall and voussoirs.

6. Deconstruct and rebuild stone retaining wall emanating from the southeast corner of bridge and the wing wall and retaining wall beyond the northeast corner of the bridge. The top eight feet of the south wall is severely out of plumb and should be documented, photographed and stones numbered prior to deconstruction to the level of the battered wall below. Excavation of the soil behind the wall is recommended and a retaining structure such as a mechanically stabilized earth (MSE) wall should be built to retain the soil. The masonry retaining wall would then be rebuilt, essentially facing the MSE wall. The remnants of the northeast wing and retaining walls should be used to rebuild the walls at this location. Photographs or other documentation should be consulted to determine the configuration of these walls.

7. Permanent scour mitigation and bank stabilization: Consult with a hydraulic engineering firm to develop methods of preventing future scour from damaging the reconstructed stone masonry bridge. Develop a plan for stabilizing the stream banks to prevent erosion of the banks. Scour and stabilization methods should consider the historic nature of the site and be compatible in appearance.

Appendix—
Photographs and Wall Elevation Diagram

412: Upstream face of bridge

413: Upstream face of bridge

414: Upstream face, north face, stone units lost at arch spring point

415: View through bridge arch looking from upstream face east, north face is at photo left

416: North face at upstream end. See photo 415

417: Whole arch from midpoint east

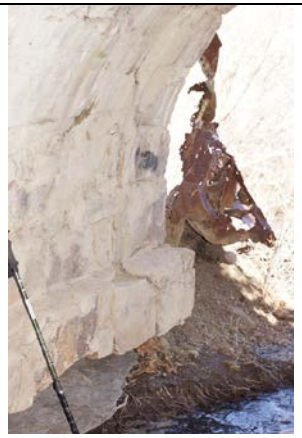
418: South face, east half

419: South face upstream portion at base

420: South face upstream portion at base

421 Roof of arch looking upstream

422: North face looking upstream



423: Shelf over bedrock at north face by downstream elevation

424: Typical collapse

425: Upstream of bridge creek view

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