Application of the Methodology to Identify High, Medium, and Low Priority Historic Bridges

Colorado Historic Bridge Management Plan

Prepared for

Colorado Department of Transportation

Prepared by

Mead & Hunt

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Table of Contents

Figures

Tables

Appendices

1. Introduction

The Colorado Department of Transportation (CDOT) initiated the Colorado Bridge Management/ Preservation Ranking Plan with a scope of work issued in August 2017. Mead & Hunt, Inc. (Mead & Hunt) contracted for the scope of work as a subconsultant to Alpine Archaeological Consultants for the study period from October 2017 to June 2019. The scope of work addresses a pool of historic bridges that are eligible for, or listed in, the National Register of Historic Places (National Register).

CDOT's project goals included developing a methodology to determine whether historic bridges may or may not be suitable for preservation in place. Having such determinations will assist CDOT with improving and streamlining the delivery of projects involving historic bridges. The scope of work also included convening a multi-disciplinary historic bridge committee of CDOT and Colorado State Historic Preservation Office (SHPO) historians and structural engineers from CDOT and the Federal Highway Administration (FHWA). The committee met six times during the study period to review and provide comments on the draft methodology and evaluations of the bridges. Historians Dianna Litvak and Christina Slattery and engineer John Rathke from Mead & Hunt, Inc. (Mead & Hunt), participated in the meetings. Committee members were as follows:

- Lisa Schoch, CDOT Environmental Programs Branch (EPB) Senior Historian
- Hannah Braun, CDOT EPB Historian
- Lauren Cooper, CDOT EPB Historian
- Jason Marmor, CDOT Region 4 Senior Historian
- Barbara Stocklin-Steely, CDOT Region 1 Senior Historian
- Mike Collins, CDOT State Bridge Engineer, Branch Manager
- Tyler Weldon, CDOT State Maintenance Engineer
- Scott Burger, CDOT Division of Highway Maintenance
- Lynn Croswell, CDOT Staff Bridge Inspection Program Manager
- Andy Pott, CDOT Senior Design and Construction Engineer
- Patrick Holinda, CDOT Bridge Enterprise Deputy Program Manager
- Matt Greer, FHWA Colorado Division Bridge Engineer
- Stephanie Gibson, FHWA Colorado Division Environmental Program Manager
- Jason O'Brien, Colorado SHPO Section 106 Compliance Manager
- Joe Saldibar, Colorado SHPO Architectural Services Manager

The following data provided by CDOT is the basis for this study:

- Microsoft Access database with historic bridge data from 2002 (pre-1959 bridges).
- Structure Data Microsoft Access databases from the CDOT Bridge Unit, dated April 13, 2018.[1]

[1] Changes in condition occur to bridges over time. Updated NBI data was not obtained during the study period but will be requested during later study phases.

- Structure inspection reports, plans, photographs, and other documents on the subject bridges from the CDOT Bridge Unit.

- Historic site forms or National Register nominations for the subject bridges from the SHPO's Compass database and CDOT files.

The initial scope of work included National Register-listed and eligible on-system (CDOT-owned) historic bridges selected by CDOT built before 1969 and National Register-listed off-system (non-CDOT-owned) bridges. CDOT provided a list of 77 bridges to Mead & Hunt in December 2017. The list included 54 on-system bridges (owned by CDOT) that were determined to be eligible for and/or listed in the National Register and 23 listed off-system bridges (non-CDOT owners).

Once Mead & Hunt began gathering information on the bridges, the list was refined by removing 12 bridges as follows:

- Bridges found to be nonextant.

- Railroad bridges and one snow shed tunnel that would have required a separate methodology to evaluate.

- Abandoned bridges without current inspections.[2]

To supplement the initial list, CDOT reviewed historic bridge inventories and added bridges as follows:

- Six on-system bridges based on CDOT's review of the post-1945 historic bridge inventory for structures constructed in the 1970s that had been determined eligible for the National Register in the 1980s.

- Sixty-one National Register-eligible, off-system bridges representing bridge types that have been subject to attrition through the years, including steel pony and through trusses, stone masonry arch culverts, steel plate stringers, concrete slabs, timber stringers, concrete arches, and Luten arches.

As a result, Mead & Hunt applied the methodology described in this report to a pool of 132 historic bridges. After applying the methodology, each bridge was placed into one of three categories based on its preservation potential: High Priority, Medium Priority, or Low Priority.

[2] Appendix C includes a list of all bridges that were initially considered for the study but were not evaluated.

2. Regulatory Background

This section summarizes the regulations, legislation, and preservation standards that apply to historic bridges.

Section 106

All federally funded CDOT projects are subject to evaluation under Section 106 of the National Historic Preservation Act of 1966 (NHPA), a procedural law that requires federal agencies to take into account the effects of their undertakings on historic properties. The process, as codified in 36 Code of Federal Regulations (CFR) 800, involves consultation with the SHPO, Advisory Council on Historic Preservation (ACHP), and other interested consulting parties; identification of historic properties (those properties listed in, or eligible for listing in, the National Register); evaluation of effects; and resolution of adverse effects through mitigation. In general, properties that are 50 years or older are evaluated for historical and/or architectural or engineering significance using the National Park Service's (NPS's) National Register Criteria for Evaluation, which is as follows:

> The quality of significance in American history, architecture, archeology, engineering, and culture is present in districts, sites, buildings, structures, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association and
>
> (a) That are associated with events that have made a significant contribution to the broad patterns of our history; or
>
> (b) That are associated with the lives of persons significant in our past; or
>
> (c) That embody distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or
>
> (d) That have yielded, or may be likely to yield, information important in prehistory or history.[3]

Historic bridges may also be considered eligible as contributing structures within a historic district.

Two documents were developed by the ACHP in cooperation with the FHWA to streamline Section 106 review for bridges. The first is the *Exemption Regarding Historic Preservation Review Process for Effects to the Interstate Highway System* (Interstate Highway Exemption), approved in 2005, before the 50th anniversary of the Interstate Highway System in 2006. The agreement relieves federal agencies from taking into account the effects of their undertakings on the Interstate Highway System through Section 106 consultation, with the exception of individual elements or structures that have been determined to have engineering or historic significance. CDOT, in consultation with the Colorado SHPO and FHWA, identified bridges on the Interstate Highway System in Colorado that are exceptional examples; several of the bridges that are on Colorado's list were included in the study pool and were noted as such on the consideration checklists.

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[3] National Park Service, *How to Apply the National Register Criteria for Evaluation* (Washington, D.C.: Department of the Interior, 1997).

The second document is the *Program Comment for Post-1945 Concrete and Steel Bridges* (Program Comment), issued in November 2012, which recognizes that most bridges built after 1945 throughout the United States utilized standard concrete or steel designs. As such, most common bridges are undistinguished examples and not considered good candidates for preservation in place or relocation. The Program Comment provides a process that allows states to eliminate the Section 106 review of common concrete and steel bridges and culverts, including various forms of reinforced-concrete slab bridges, reinforced-concrete beam and girder bridges, steel multi-beam or multi-girder bridges, and culverts and reinforced-concrete boxes. CDOT committed to conducting Section 106 consultation on common bridge types built after 1945 if they had been determined eligible prior to the initiation of the Program Comment. Several of these bridges were also included in the study pool and were noted as such on the consideration checklists.

Section 4(f)

Section 4(f) of the U.S. Department of Transportation Act of 1966 stipulates that the FHWA cannot approve the "use" of land from publicly owned parks, recreational areas, wildlife and waterfowl refuges, or public and privately owned historical sites unless there is no feasible and prudent alternative to the use of the land, and the action includes all possible planning to minimize harm to the property. Section 4(f) is a substantive law that requires environmental staff and engineers to evaluate a variety of alternatives that avoid National Register-listed or eligible historic properties.

Section 4(f) has the potential to result in preservation of historic bridges because if there is a feasible and prudent alternative that avoids the historic property, it must be selected. All federally funded transportation projects are evaluated under both Section 106 and Section 4(f). Definitions of feasible and prudent are included in the glossary in Appendix A.

Colorado Historic Register Act

CDOT also reviews state-funded projects under the Colorado Historic Register Act (CRS 24-80.1). This process is similar to Section 106 but does not require consultation with the ACHP or the preparation of an agreement document to outline mitigation when there are adverse effects.

Federal surface transportation legislation

The basis of this methodology is to promote historic bridge rehabilitation and reduce project delivery delays. This methodology conforms to current federal surface transportation legislation by providing a framework for the preservation of historic bridges statewide. One of the goals of federal legislation and executive orders is to accelerate project completion through elimination of delays in the project development and delivery process.[4] To that end, this methodology was developed to streamline the project delivery process involving historic bridges by providing guidance for historic bridges in Colorado. Project delays involving historic bridges and the Section 106 process can be eliminated, or greatly reduced, through the application of this methodology. This is accomplished by determining preservation potential for historic bridges before a project is initiated. In the project development process, the initiating

[4] This was specifically articulated in previous federal transportation legislation including Moving Ahead for Progress in the 21st Century Act (MAP-21) and FAST ACT.

entity recognizes in advance the existence of a historic bridge and the acceptable disposition of that bridge. This eliminates or reduces delays that may have occurred previously as each historic bridge was handled on a case-by-case basis within the individual project development process.

This methodology also reinforces federal legislative goals through a systematic review process that emphasizes safety, infrastructure condition, system reliability, freight movement, and environmental sustainability. The process developed reviews each historic bridge individually to achieve those goals. Those bridges that are considered the most suitable for preservation are expected to have preservation plans developed to identify acceptable and recommended maintenance activities, as well as scheduled rehabilitation activities to be systematically implemented over the life of that asset.

Secretary of the Interior's Standards

The Secretary of the Interior's Standards for the Treatment of Historic Properties (SOI Standards) set the foundation for federal preservation activities. The SOI Standards are a series of concepts related to maintaining, repairing, and replacing historic materials and designing new additions or altering a historic property in a way that retains its historic integrity. Four approaches to the treatment of historic properties are provided in the SOI Standards: Preservation, Rehabilitation, Restoration, and Reconstruction.

The SOI Standards for Preservation and Rehabilitation provide the basis for recommended treatments for historic bridges. The SOI Standards for Restoration and Reconstruction are less useful because bridges need to fulfill an ongoing transportation function and these standards allow fewer changes. As a result, the SOI Standards for Preservation and Rehabilitation are provided here because they were applied to the bridge evaluations in this methodology.

As defined by the NPS, preservation is defined as:

> The act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property. Work, including preliminary measures to protect and stabilize the property, generally focuses upon the ongoing maintenance and repair of historic materials and features rather than extensive replacement and new construction. New additions are not within the scope of this treatment; however, the limited and sensitive upgrading of mechanical, electrical, and plumbing systems and other code-required work to make properties functional is appropriate within a preservation project.[5]

Rehabilitation is defined as:

> The act or process of making possible a compatible use for a property through repair, alterations, and additions while preserving those portions or features which convey its historical, cultural, or architectural values.[6]

[5] National Park Service, "Preservation as a Treatment," Technical Preservation Services, available at http://www.nps.gov/tps/standards/four-treatments/treatment-preservation.htm.

[6] National Park Service, "Rehabilitation as a Treatment," Technical Preservation Services, available at http://www.nps.gov/tps/standards/four-treatments/treatment-rehabilitation.htm.

The SOI Standards for Rehabilitation acknowledge the need to alter and/or make additions to a historic property to meet continuing or changing uses while retaining the property's historic character. As such, the SOI Standards for Rehabilitation provide the most appropriate guidance for historic bridges when repairs or replacement of deteriorated historic materials are required.

The SOI Standards have been interpreted and applied largely to buildings rather than engineering structures. Because of this, the Virginia Transportation Research Council adapted the SOI Standards to address the special requirements of historic bridges. Table 1 illustrates each individual standard's relationship to the Standards for Rehabilitation.

Table 1. Secretary of the Interior's Standards for Rehabilitation, as adapted for Historic Bridges

1	Every reasonable effort shall be made to continue an historic bridge in useful transportation service. Primary consideration should be given to rehabilitation of the bridge on site. Only when this option has been fully exhausted shall other alternatives be explored.
2	The original character-defining qualities or elements of a bridge, its site, and its environment should be respected. The removal, concealment, or alteration of any historic material or distinctive engineering or architectural feature should be avoided.
3	All bridges shall be recognized as products of their own time. Alterations that have no historical basis and that seek to create a false historical appearance shall not be undertaken.
4	Most properties change over time; those changes that have acquired historic significance in their own right shall be retained and preserved.
5	Distinctive engineering and stylistic features, finishes, and construction techniques or examples of craftsmanship that characterize an historic property shall be preserved.
6	Deteriorated structural members and architectural features shall be retained and repaired, rather than replaced. Where the severity of deterioration requires replacement of a distinctive element, the new element should match the old in design, texture, and other visual qualities and where possible, materials. Replacement of missing features shall be substantiated by documentary, physical, or pictorial evidence.
7	Chemical and physical treatments that cause damage to historic materials shall not be used. The surface cleaning of structures, if appropriate, shall be undertaken using the most environmentally sensitive means possible.
8	Significant archaeological and cultural resources affected by a project shall be protected and preserved. If such resources must be disturbed, mitigation measures shall be undertaken.
9	New additions, exterior alterations, structural reinforcements, or related new construction shall not destroy historic materials that characterize the property. The new work shall be differentiated from the old and shall be compatible with the massing, size, scale, and architectural features to protect the historic integrity of the property and its environment.
10	New additions and adjacent or related new construction shall be undertaken in such a manner that if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

The SOI Standards are not technical or prescriptive but are intended to promote responsible preservation practices by providing advice and consistency to the work on historic bridges. They helped inform rehabilitation decisions made as part of this methodology.

Identifying character-defining features

Application of the methodology required an understanding of why a bridge possesses significance as well as identification of its character-defining features. The character-defining features are prominent or distinctive aspects, qualities, or characteristics of a historic property that contribute significantly to its physical character. Such features may include materials, engineering design, and structural and decorative details that are essential to a bridge's historic identity. Character-defining features are those that convey a bridge's distinctive design or method of construction.

Compliance with the SOI Standards requires retention of a bridge's significance and most, if not all, of its character-defining features. Historians identified character-defining based on the historic bridge inventory forms, the "Highway Bridges of Colorado" Multiple Property Submission (Fraserdesign, 2000), and inspection reports and photographs provided by the CDOT Bridge Unit. An engineer and historian collaboratively reviewed historic and engineering significance for each bridge and identified work needed to determine whether the bridge could be preserved or rehabilitated in keeping with the SOI Standards.

Not all bridge components should be considered equally significant, and the relative importance of bridge components must be determined to help inform rehabilitation of a historic bridge. Under this consideration, historians and engineers discussed which character-defining features must be preserved to maintain the bridge's historical and engineering significance, and which original and non-original features can be replaced in accordance with the SOI Standards without adversely affecting the bridge.

Because many historic bridges are significant examples of their bridge type, such as metal truss, concrete arch, or a steel beam and girder, the superstructure of a bridge is often the character-defining feature. Rails were typically noted if they were original to the structure but have not been identified for this study as character-defining features. Further research of individual bridges is needed to determine if rails are character-defining features.

3. Overview

Colorado's historic bridges were previously identified through four statewide historic bridge inventories conducted between 1984 and 2014. These studies found 302 bridges that qualify as historic, which means they were determined eligible for or are listed in the National Register. This methodology for Colorado's historic bridges considers eligible and listed bridges equally since they have all been determined to be significant under one or more of the National Register Criteria and the Section 106 requirements apply equally to eligible and listed bridges. No distinction is made for which criterion applies or what level of significance a bridge may have. Similarly, a bridge that is eligible or listed under National Register *Criterion A* for its association with significant events is treated equal to a bridge that is eligible under *Criterion C* for its design.[7] The methodology did not include revising or re-evaluating previous eligibility determinations. Instead, historians summarized the historic and/or engineering significance of each bridge based on historic background, statements of significance, and integrity assessments that were completed as part of earlier inventories. As such, questions about whether one bridge has more significance than another bridge were not considered as part of this methodology.

This study evaluated 132 of the state's historic bridges selected from the state's historic bridge pool. This includes bridges built prior to 1976, 53 of which are owned by CDOT, 78 County and City-owned bridges, and one privately owned bridge. A summary of study bridges by bridge types and subtypes to which the methodology was applied is presented in Table 2.

Table 2. Summary of historic bridges in study by type

Bridge type	In current study
Concrete arch	20
Concrete box girder continuous	1
Concrete I-beam (including continuous)	11
Concrete prestressed girder continuous	1
Concrete rigid frame	9
Concrete slab	4
Concrete slab and girder (including continuous)	21
Culvert*	7
Riveted girder (including continuous)	8
Rubble arch	1
Steel arch	1
Steel box girder continuous	2
Steel deck girder	1
Steel deck truss	5
Steel pony truss	7
Steel rigid frame	1
Steel stringer timber floor	2
Steel through girder	1
Steel through truss	14
Suspension	1
Timber/steel combination pony truss	1
Timber stringer	5
Welded girder continuous	8
Total	**132**

** includes three rubble arch, two steel arch, one masonry arch, and one concrete arch culvert.*

[7] The National Register evaluation includes determining if an eligible or listed historic property has local, state, or national significance, but for the purposes of Section 106, all properties with significance are treated equally.

For each historic bridge subject to this methodology, a Condition Score (CS) was calculated as an initial screening tool. The CS calculation used National Bridge Inventory (NBI) inspection and appraisal data to quantify a bridge's geometry, structural capacity, and other safety factors considered important for preservation of a bridge. A bridge's CS is an indicator of preservation potential that is then confirmed through further analysis. This analysis looked at any deficiencies in the bridge and how rehabilitation can address these, together with consideration for the bridge's geometry, load capacity, detour, and hydraulics. A bridge has greater preservation potential if it can continue in use with or without a rehabilitation effort. After evaluating these considerations, each bridge can be placed into its appropriate category of High Priority, Medium Priority, or Low Priority.

Historic bridges ranked as High Priority are better candidates for preservation based on their present condition or suitability for rehabilitation and potential to remain in vehicular use for years into the future. Low Priority Bridges are less desirable candidates for preservation based on their present condition and challenges to rehabilitation. These bridges are less suitable for preservation in-place or relocation or storage for future use and would require more significant rehabilitation effort. Low Priority status does not preclude a bridge from being preserved, but it does indicate that a greater effort would be required to keep the bridge in service. Low Priority Bridges, even if rehabilitated, may not achieve the required functionality and/or meet safety standards and may require design exceptions if they remain in vehicular use.

Medium Priority Bridges fall into an intermediate group that recognizes potential for preservation if further analysis deems it feasible and prudent (definitions of feasible and prudent are included in the glossary in Appendix A). Medium Priority Bridges may require further evaluation to assess suitability for preservation in place or relocation for future use. This level of evaluation is typically conducted in a project development phase.

The steps undertaken to arrive at the categorization of each bridge are described in Section 4. Figure 1 illustrates the overall process, and Appendix A provides a glossary of engineering and preservation terms.

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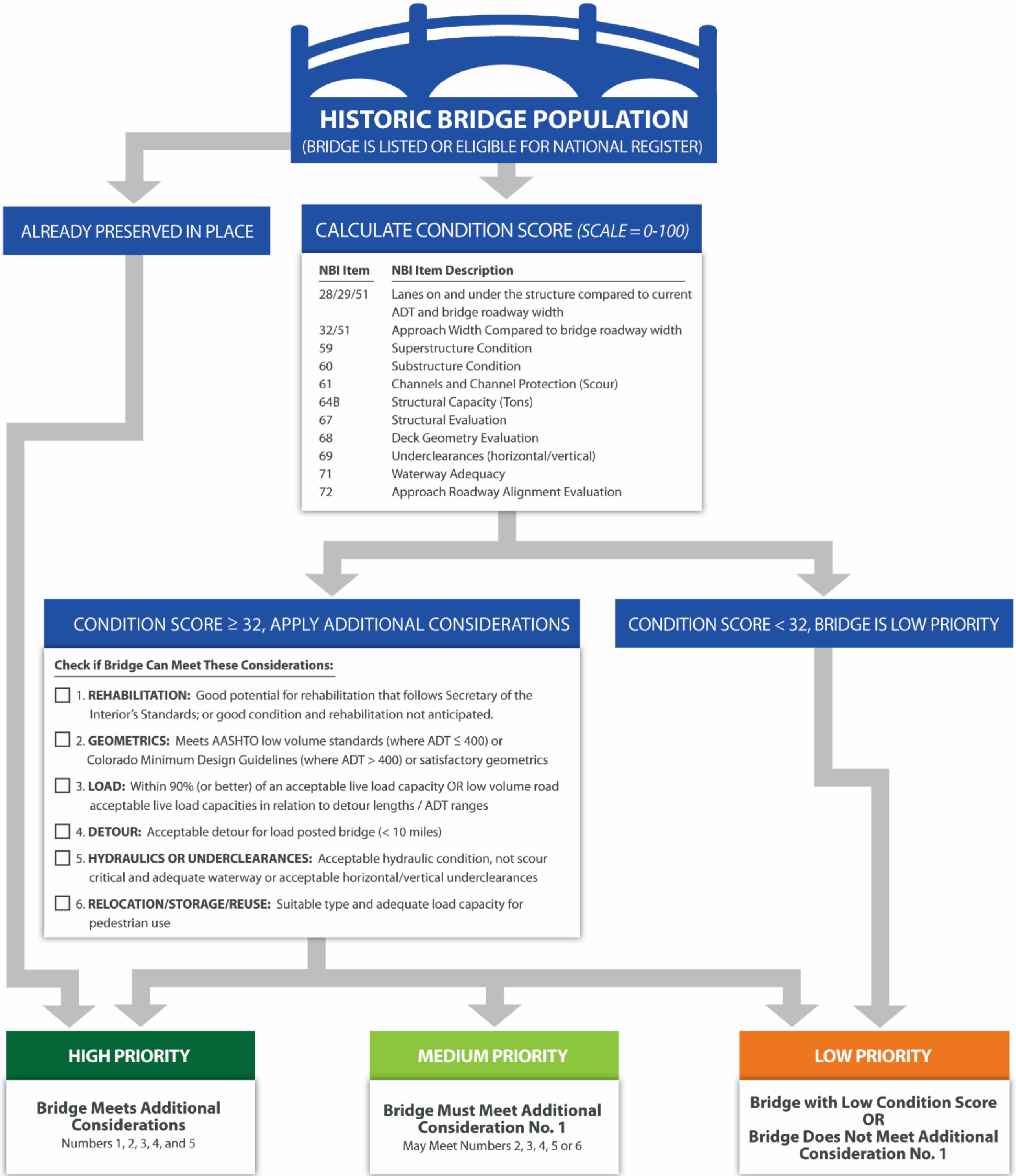

Figure 1. Overview of High/Medium/Low Priority methodology.

4. Step-by-step Methodology

Step 1: Identify bridges preserved in-place

Historic bridges included on the list in Appendix B that have already been preserved were categorized as High Priority Bridges because a commitment has already been made toward their preservation. No further evaluation of these bridges was needed as part of this study, but individual management plans might be necessary in the future to ensure the continued preservation of these bridges. Bridges in this category are used for vehicular and non-vehicular (pedestrian and bicycle) transportation. The remaining bridges followed the step-by-step method outlined below.

Step 2: Calculate Condition Score for each bridge

The CS is an evaluation tool used to identify bridges for preservation potential based on their current condition. It isolates factors from bridge inspection data, as reported in the NBI, that typically indicate whether preservation is prudent and feasible. The CS is also used to compare bridges and their preservation potential based on their relative scores.

To develop the CS, engineers reviewed the NBI component ratings and assigned points proportionately based on the NBI condition code.[8] In the NBI-reported data, bridge inspectors assign the primary components of bridges a condition code from a high of 9 to a low of 0 (see Table 3 for code descriptions). Ratings of 5 and above indicate a bridge component is in fair to excellent condition. A rating of 4 indicates a component is in poor condition. Ratings below 4 indicate a component is in serious to failed condition. An NBI bridge condition rating of 4 or higher received CS points because current inspection data indicated the bridge either already had an acceptable condition (5 or better) or preservation or rehabilitation activities could be done to improve a bridge's condition (if rated 4). NBI condition rating items below 4 did not receive CS points since the component has been rated to be in serious to failed condition and therefore would create challenges for rehabilitation.

[8] See the FHWA's *Recording and Coding Guide for the Structure Inventory and Appraisal of the Nation's Bridges* (https://www.fhwa.dot.gov/bridge/mtguide.pdf) for more information on NBI component ratings.

Table 3. NBI codes and condition descriptions

Code	Description
9	Excellent condition.
8	Very good condition – No problems noted.
7	Good condition – Some minor problems.
6	Satisfactory condition – Structural elements show some minor deterioration.
5	Fair condition – All primary structural elements are sound but may have some minor section loss, cracking, spalling, or scour.
4	Poor condition – Advanced section loss, deterioration, spalling, or scour.
3	Serious condition – Loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.
2	Critical condition – Advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present, or scour may have removed substructure support. Unless closely monitored, the bridge may have to be closed until corrective action is taken.
1	Imminent failure condition – Major deterioration or section loss present in critical structural components, or obvious vertical or horizontal movement affecting structure stability. Bridge is closed to traffic, but corrective action may put it back in light service.
0	Failed condition – Out of service. Bridge is beyond corrective action.

Details on the CS calculation, including the NBI items that it isolates, and the formulas used are provided in Table 4. Assigned scores for each NBI item were combined to arrive at a composite score. The highest possible CS was 100 points, which is based on a maximum of 10 points for each factor. Four factors involved safety and infrastructure condition totaling a maximum of 40 points (NBI Items 64B, 59, 60, and 67), and three factors involved system performance totaling a maximum of 30 points (NBI Items 28/29/51, 32/51, and 68). Three elements involved a single factor for up to 10 points each, totaling a maximum of 30 points: waterway adequacy (NBI Item 71) or underclearances (horizontal/vertical) (NBI Item 69),[9] whichever is applicable; approach roadway alignment (NBI Item 72); and channel condition and channel protection to evaluate scour issues or lack thereof (NBI Item 61). The summation of these factors arrives at a CS for each bridge, which ranged from 0 to 100.

The CS was calculated using some of the same NBI data as Sufficiency Rating (SR). However, the CS was developed to focus on those factors that contribute most to a structure's preservation potential. In this way, CS differs from the SR, which evaluates a broader range of factors related to bridge function and condition. In this methodology, the SR was compared to the calculated CS as a check. Since both provide information on the condition of the structure, they are correlated.

[9] Waterway adequacy applies where a bridge is over water; horizontal/vertical clearances applies where a bridge is over a road, railroad, recreational path, or other transportation feature.

Table 4. Condition Score calculation

NBI Item	NBI Item description	Formula to calculate CS	Aligned with federal transportation legislation and executive order goals
28/29/51	Lanes on and under the Structure compared to Current ADT and Bridge Roadway Width	The CS calculation reflects the suitability of bridge lane widths compared to the ADT per lane. This is defined by the Factor H in the SR formula. For the SR Factor H calculation, the overall bridge width is divided by the number of lanes and this width is compared to the traffic volume per lane on the bridge. The SR Factor H value increases from 0 to 15 as conditions deteriorate. A Factor H value of 0 indicates that the bridge lane widths are adequate for the traffic on the bridge; this is converted in the CS calculation to 10 points, which is the maximum points possible. A Factor H value above 0 indicates that the bridge lane widths are not adequate to some degree for the traffic volume on the bridge. Less adequate roadway widths receive point values between 0 and 10 according to the following formula: 10-10xH/15. An SR Factor H value of 15 converts to a value of 0 in the CS calculation.	Safety and system reliability
32/51	Bridge Roadway Width compared to Approach Roadway Width	If the bridge roadway width is greater than the approach roadway width plus 2 feet, the CS value is 10 points since this indicates the bridge roadway width compared to the approach roadway width is adequate. Otherwise, 0 points are assigned because the bridge roadway width is not adequate compared to the approach roadway width, creating a "pinch point" in the roadway at the bridge. The basis for this comparison is derived from the Serviceability and Functional Obsolescence Factor 2.b.(1) in the Sufficiency Rating Formula.	Safety and system reliability
59	Superstructure Condition	If 8 or greater value = 10; If 4-7 then CS value = actual rating; if less than 4 CS value = 0.	Infrastructure condition
60	Substructure Condition	If 8 or greater value = 10; If 4-7 then CS value = actual rating; if less than 4 CS value = 0.	Infrastructure condition
61	Channels and Channel Protection (Scour)	If 8 or greater CS value = 10; If 4-7 then CS value = actual rating; if less than 4 CS value = 0. If not applicable, a CS value of 10 is assigned to indicate an absence of risk for the particular structure.	Infrastructure condition
62	Culverts	If 8 or greater CS value = 10; If 4-7 then CS value = actual rating; if less than 4 CS value = 0.	Infrastructure condition

Table 4. Condition Score calculation (continued)

NBI Item	**NBI Item description**	**Formula to calculate CS**	**Aligned with federal transportation legislation and executive order goals**
64B	Structural Capacity (Tons)	If structural capacity is greater than or equal to the standard load rating vehicle, an HS-20-44 truck that weighs 36 tons, the CS value = 10, otherwise the CS value is calculated to be a value equal to a percentage of the actual capacity to required capacity of 36 tons = 10X Current Structural Capacity/36.	Infrastructure condition, system reliability, and freight movement
67	Structural Evaluation	If 8 or greater CS value = 10; If 4-7 then CS value = actual rating; if less than 4 CS value = 0.	Infrastructure condition, system reliability, and freight movement
68	Deck Geometry Evaluation	If 8 or greater CS value = 10; If 4-7 then CS value = actual rating; if less than 4 CS value = 0.	Safety, congestion reduction, system reliability, and freight movement
69	Underclearance (horizontal/vertical)	If 8 or greater CS value = 10; If 4-7 then value = actual rating; if less than 4 value = 0. This factor is 0 if not applicable.	Safety, congestion reduction, system reliability, and freight movement
71	Waterway Adequacy	If 8 or greater value = 10; If 4-7 then value = actual rating; if less than 4 value = 0. This factor is 0 if not applicable.	Infrastructure condition and system reliability
72	Approach Roadway Alignment Evaluation	If 8 or greater value = 10; If 4-7 then value = actual rating; if less than 4 value = 0.	Safety, congestion reduction, system reliability, and freight movement

Step 3: Sort Condition Scores from high to low

Bridges are next sorted by CS from high to low. Sorting bridges allows for appropriate initial focus on the best candidates for preservation. To find CSs with the best potential for preservation, a threshold score was chosen. A threshold score of 32 was selected as the basis for further study to consider for the bridge's preservation potential. The *Guidelines for Historic Bridge Rehabilitation and Replacement* (Guidelines), accepted by the American Association of State Highway and Transportation Officials (AASHTO) in November 2008, informed the identification of this threshold.

The Guidelines recommend that a bridge generally has preservation potential when it meets these criteria: NBI ratings of 5 (fair) or above for substructure and superstructure condition, satisfactory structural capacity, and satisfactory roadway geometry or geometric conditions that can be improved.[10] Further, the Guidelines note: "A condition code value of 4 (poor) will require further study to determine if

[10] Lichtenstein Consulting Engineers, Inc., *Guidelines for Historic Bridge Rehabilitation and Replacement*, requested by the American Association of State Highway and Transportation Officials, November 2008, A-30-31.

there are feasible and prudent options for rehabilitation." This formed the basis of the CS threshold to differentiate between High Priority, Medium Priority, and Low Priority Bridges.

A minimum score of 32 resulted when the ratings described have a value of 4, indicating minimum acceptable conditions for component ratings, combined with the lowest acceptable geometric conditions and structural capacity. Any bridge with a CS of 32 or above has some preservation potential, and the higher the score, the better the potential. These bridges moved on to Step 4 and may be categorized as High Priority or Medium Priority depending on the results of further analysis.

A bridge with a CS of less than 32 generally has an accumulation of issues including poor condition ratings and poor geometric conditions that indicates poor preservation potential; the lower the score, the less likely it would be prudent and feasible to preserve the bridge. Therefore, bridges with a CS below 32 are categorized as Low Priority.

Step 4: Apply additional considerations

In this step of the methodology, bridge engineers, with input from professional historians, analyzed every bridge with a CS equal or greater than 32 to assess preservation potential. Consideration was given to a bridge's existing condition and function, as well as its potential condition and function, including whether future rehabilitation activities can be accomplished without compromising historic integrity. Bridges that met the first five of the additional considerations in this step were recommended as High Priority. If the results of the analysis indicated it is prudent and feasible to preserve a particular bridge but certain deficiencies would remain, the bridge was recommended as Medium Priority. High and Medium Priority Bridges were evaluated for pedestrian load capacity in place, or for suitability for relocation, storage, and future reuse. It should be noted that certain High Priority or Medium Priority Bridges may require a design exception to remain in vehicular use.

The following six additional considerations were applied:

1. **Rehabilitation** – The engineer and historian discussed whether the bridge has good potential for rehabilitation for continued vehicular use that follows the SOI Standards or rehabilitation is not needed to keep the bridge in continued vehicular use.

2. **Geometrics** – Bridge met applicable geometric standards or was otherwise considered minimally acceptable.

3. **Load** – Bridge was within 90 percent (or better) of acceptable live load capacity. This is based on live load capacity equal to or greater than 90 percent of AASHTO HS20-44 live load (36-ton vehicle), which is equivalent to a load posting of 25-40. Or, for low-volume roads with an ADT of 400 or less, bridge met minimum acceptable live load capacities in relation to detour lengths for specified ADT ranges.

4. **Detour** – Acceptable detour for load-posted bridge of less than 10 miles. If a bridge is not load posted, this consideration did not apply.

5. **Hydraulics or underclearances** – Acceptable hydraulic condition, not scour critical, and adequate waterway; or acceptable horizontal/vertical underclearances, if over road.

6. **Relocation/storage/reuse and pedestrian load capacity** – Bridge is suitable for relocation and/or storage for future reuse based on its type and suitability for conversion to a non-vehicular bridge in place.

This guidance details how each consideration was applied to a historic bridge.

Consideration 1: Rehabilitation
In consideration 1, the rehabilitation needs of a bridge were assessed by the collaborative team of a historic bridge engineer and a bridge historian. The historian reviewed historic documentation (e.g., historic bridge inventory form, National Register Nomination, and other available documentation) to understand the bridge's historic and engineering significance. Character-defining features were noted; these are the prominent or distinctive aspects, qualities, or characteristics of the bridge that contribute to its physical character.

At the same time, the bridge engineer reviewed structural engineering data and photographs of the bridges obtained through CDOT's inspection process to assess the condition of the bridge. The engineer and historian jointly discussed rehabilitation options and formulated recommendations to improve the condition of the bridge while preserving character-defining features and meeting the SOI Standards. This collaboration balanced historic preservation needs (for retaining a bridge's character-defining features and historic integrity) with engineering needs (for correcting deficiencies and conditions).

Consideration 1 was met in one of two ways. First, if a historic bridge's superstructure and substructure condition were already satisfactory (i.e., superstructure and substructure are appraised as satisfactory with an NBI condition rating of 5 or better), and the bridge has satisfactory geometry and load capacity, it met this consideration because rehabilitation is not needed to remain in use in the near future. The second way to meet the consideration was if the engineer and historian decided that the bridge's deficiencies can be addressed by a rehabilitation effort that, in their joint professional judgment, adhere to the SOI Standards and engineering standards. This included bridges with identified poor or serious issues if the collaborative evaluation concluded that these deficiencies could reasonably be improved through rehabilitation activities. This professional judgment was informed by the Virginia Transportation Research Council's *Secretary of the Interior's Standards for the Treatment of Historic Properties, as Adapted for Historic Bridges* (see Table 1 and also included as a reference in Appendix D), *Guidelines for Historic Bridge Rehabilitation and Replacement* (AASHTO, March 2007), applicable design manuals (see manuals referenced in Appendix D), and past experience rehabilitating historic bridges.

Bridges determined to need rehabilitation present existing deficiencies and/or deteriorated conditions that vary between bridge types. Recommended rehabilitation activities range from addressing corrosion by cleaning and painting steel components to more extensive measures such as addressing structural deficiencies caused by cracks or section loss in main members and rehabilitating the substructure to address the undermining of abutments and piers. It should be noted that identified rehabilitation needs may be expanded, modified, or otherwise changed based on subsequent analysis. Certain rehabilitation activities are dependent on current and future project purpose and need, which could not be determined as part of this project due to its large scale and program-level focus.

Rehabilitation activities identified for a bridge would not necessarily address or remove all deficiencies. For example, widening of bridges was generally not recommended, even where a bridge's current width may be deficient. Many historic bridge types are difficult to widen, and the current width may be considered acceptable based on further engineering analysis. The widening of bridges is identified as a potential need only in select cases when correcting geometric deficiencies could be accomplished according to the SOI Standards and without compromising the overall historic integrity of the structure (e.g., concrete girders that can be widened on one side with similar structural members). Certain High Priority or Medium Priority Bridges may require a design exception to remain in vehicular use.

Rehabilitation activities could also include addressing safety deficiencies, including repair or replacement of original bridge rails or parapets. These original features provide clues to the construction date of a historic bridge and help understand the era in which the bridge was constructed. CDOT will preserve and repair original historic bridge rail and parapet when possible. In addition to repair of original bridge materials, acceptable bridge preservation activities may include placing crash-tested rails on the inside of the bridge rail to leave the original rails in place. When required to meet safety requirements, original rails and parapets may be replaced in-kind with a rail that matches or is similar in appearance, materials, and design to the original rail to meet the SOI Standards.

Identification of rehabilitation activities was not based on an independent bridge inspection or field survey. The development of management plans for each bridge, which include field inspection and current condition assessment, would be needed in order to fully determine the scope of necessary rehabilitation activities, including the estimated cost.

Consideration 2: Geometrics

In consideration 2, the geometrics of the bridge were reviewed to assess whether it has minimally adequate geometrics (width and/or vertical and horizonal clearances) in relation to the roadway functional classification. A number of NBI Items are considered including the number of lanes on the bridge, current ADT, roadway width, approach roadway width and the functional classification of the roadway. In addition, the evidence of crashes was also considered to discover if there is a site-specific safety issue as seen in skid marks or damage to the railing or parapet. This review balanced whether or not the bridge can maintain safety and system performance based on its geometrics. Consideration 2 was met in several ways:

- If the bridge meets current CDOT Geometric Design Standards, it has adequate geometrics and meets this consideration.[11]

[11] The CDOT Geometric Design Standards refer to the latest revision of the AASHTO *Policy on the Geometric Design of Highways and Streets* (PGDHS), the *Standard Specifications for Highway Bridges*, and the CDOT *Standard Plans – M & S Standards*. For this consideration, Table 5-7 of the PGDHS is utilized since it provides minimum clear roadway widths for bridges to remain in place.

- If the current ADT on the bridge is less than or equal to 400, the AASHTO low-volume standards apply and the bridge is evaluated for its ability to meet this standard. The low-volume standards allow for acceptance of current geometrics if the bridge does not have a site-specific safety problem. Bridges that meet the AASHTO low-volume standards meet this consideration.

- The engineer reviews whether the bridge's width is adequate based on professional judgment. This professional judgment considers bridge width compared to approach width, evidence of crashes and potential safety problems, roadway functional classification, average daily traffic (ADT), and number of lanes, and is informed by past experience rehabilitating historic bridges.

- The engineer recommends that the bridge's geometric deficiencies contributing to a site-specific safety standard can be addressed through rehabilitation. The bridge can be widened to have adequate geometrics and this rehabilitation activity would comply with the SOI Standards (also informed by consideration 1).

Consideration 3: Load
In consideration 3, the live load capacity of the bridge for the roadway system was reviewed. This consideration was met if the bridge has a live load capacity equal to or greater than 90 percent of AASHTO HS20-44 live load (36-ton vehicle), which is equivalent to a load posting of 25-40. For bridges where the live load capacity is less than 90 percent of AASHTO HS-20-44, consideration was given to the potential for rehabilitation of the deficient substructure or superstructure component to increase the live load capacity for the functional classification of the roadway to at least a posting of 25-40. If the bridge has adequate load capacity or can be rehabilitated to achieve adequate load capacity in a manner that complies with the SOI Standards (also informed by consideration 1), it met this consideration.

If a bridge on a low-volume road (ADT of 400 or less) does not have a live load capacity equal to or greater than 90 percent of AASHTO HS20-44, the following matrix was utilized to further evaluate if the bridge meets minimum acceptable live load capacities in relation to detour lengths for specified ADT ranges (see Table 5). To meet this consideration a bridge must have the specified load capacity, or greater, for a given ADT and detour length.

Table 5. Minimal acceptable live load capacities matrix

	Detour Length < 5 mi		5 mi ≤ Detour Length < 10 mi		Detour Length ≥ 10 mi	
Current Year ADT	< 100	100 ≤ ADT ≤ 400	< 100	100 ≤ ADT ≤ 400	< 100	100 ≤ ADT ≤ 400
AASHTO Loading	H-15	HS-15	HS-15	HS-15	HS-15	HS-20
Required Capacity	15 tons	27 tons	27 tons	27 tons	27 tons	36 tons

Consideration 4: Detour

In consideration 4, the bridge was reviewed to analyze if the structure is load posted and if so, does it have an acceptable detour length that can be used by vehicles over the load posting. Consideration 4 was met in one of the following ways:

- If the bridge is load posted and there is an available bypass/detour route of less than 10 miles, the bridge would meet this consideration.
- If the bridge is on a low-volume road and has a detour of 10 miles or more, it can meet this consideration if it has the required load capacity as defined above in consideration 3.
- If the bridge is not load posted, the bypass/detour length criteria of less than 10 miles is not applicable because all vehicles can use this crossing and the bridge meets this consideration.

Consideration 5: Hydraulics or underclearance

In consideration 5, the adequacy of hydraulic condition was reviewed if a bridge is over a waterway or underclearance is reviewed if a bridge is over a road, railroad, recreational path, or other transportation feature. Consideration 5 can be met in one of the following ways:

- A bridge over a waterway meets this consideration if it is not identified to be scour critical and it has an adequate waterway (if the bridge opening size is adequate for the waterway).
- For a bridge that is scour critical, counter measures can be implemented to address and it has an adequate waterway.
- If a bridge is over a road, a bridge meets this consideration if horizontal/vertical underclearances are adequate or the bridge can be rehabilitated to achieve adequate clearances in a manner that complies with the SOI Standards (also informed by consideration 1).

The codes for NBI items waterway adequacy, underclearance, and scour critical bridges are included on the Application of High Priority/Medium Priority/Low Priority Methodology checklists in Appendix G.

Consideration 6: Relocation/storage/reuse and pedestrian load capacity

In consideration 6, the Medium and High Priority bridges were considered for potential for re-use in place as non-vehicular bridges, or for potential relocation, storage, and future reuse. Check 6 was not completed for Low Priority bridges based on deficiencies that would hinder their re-use in place or in new locations.

This consideration included evaluating adequacy of pedestrian load capacity and suitability of converting bridges to non-vehicular use in their original locations, as well as indicating if the bridge type was suitable for relocation (see the definition for Pedestrian Load Test in the glossary in Appendix A).

Only certain historic bridge types are suitable for reuse at a new location due to size and/or construction method. The following types are most suitable for relocation and/or storage:

- Trusses – Deck, pony, and through truss bridges are good candidates for relocation and have been successfully moved and preserved. A truss span up to 160 feet can be reasonably relocated. One or more truss spans from a bridge could be considered for relocation. Pony trusses can be moved more easily due to their lack of overhead bracing and in some cases pony trusses with short span lengths can often be moved without disassembly. The design and fabrication of pinned trusses makes disassembly and reassembly, when required, more feasible than it is for rigid connection trusses. Connections on riveted trusses are not easily undone and present different challenges for relocation than a pinned truss. Trusses may be partially disassembled by removing floorbeams (and overhead bracing if applicable) for easier transport. Other factors to consider when relocating a truss include weight restrictions, truck and trailer sizes, and the specific method used for holding bridge members together.

- Steel beam or girder/stringer – These bridges are candidates for relocation if the superstructure is not integral with the substructure of the bridge. For these types, the structural support system, deck, and railings could be moved. A beam or girder/stringer bridge up to 100 feet in span length can be reasonably relocated.

The following types are typically not suitable for relocation and/or storage as their construction method is not suitable for relocation and the cost associated with moving the bridge is high.

- Concrete arch
- Concrete arch culvert
- Concrete slab
- Concrete rigid frame
- Concrete beam or girder
- Masonry arch
- Masonry arch culvert
- Steel arch
- Tunnel
- Rubble arch
- Rubble arch culvert
- Steel arch culvert/multi-plate culvert
- Timber beam or stringer

Consideration 6 can be met if either the bridge is a type that is suitable for relocation or if it was identified to be suitable for conversion to pedestrian use.

Step 5: Select category for each bridge

Following the analysis in Step 4, each bridge was categorized as follows:

- High Priority – A historic bridge that met additional considerations 1, 2, 3, 4, and 5 was recommended as High Priority. These are bridges recommended for preservation in-place but evaluations included suitability for conversion to non-vehicular use in their original location or as relocated bridges (if the bridge type is suitable for relocation).

- Medium Priority – A historic bridge that has a CS of 32 or greater, meets additional consideration 1, and may meet additional considerations 2, 3, 4, 5, and/or 6 are recommended as Medium Priority. Medium Priority Bridges require further evaluation to recommend suitability for preservation in-place or for relocation for future use including ability to meet design standards. This evaluation is typically conducted in a project development phase and would consider site-specific issues such as trail connections and transferring ownership.

- Low Priority – A historic bridge that has a CS less than 32 or does not meet additional consideration 1 was recommended as Low Priority. These bridges are less suitable for preservation in-place or relocation or storage for future use and would require more significant rehabilitation effort. Categorization of a bridge as Low Priority does not preclude it from preservation, but it does indicate that a greater effort would be needed to restore the structure for vehicular or non-vehicular use. Low Priority Bridges, even if rehabilitated, may not achieve the required functionality and/or meet safety standards and may require design exceptions if they remain in vehicular use.

5. Results and Next Steps

Results

This section provides the results of the application of the methodology to the study pool with the categorization of historic bridges as either High Priority, Medium Priority, or Low Priority. The relatively good state of preservation of historic bridges in the study pool is seen with two-thirds of the bridges in the High Priority category. All of the bridge types evaluated have examples in the High or Medium Priority category.

The results of the evaluations are summarized in Table 6.

Table 6. Summary of evaluation results

Priority Category	Total	On-system	Off-system	Percentage
High	91	46	45	68.9%
Medium	34	6	28	25.7%
Low	7	1	6	5.3%
Total	**132**	**53**	**79**	**---**

To facilitate use by CDOT and off-system bridge owners, a summary of the results is included in tables organized into several broad categories, including by bridge type/subtype for CDOT owned bridges (40 percent of the bridges in the study pool; see Table 7), bridge type/subtype for off-system bridges (60 percent of the bridges in the study pool; see Table 8), and summary of ranking category based on CDOT Engineering regions (see Table 9).

More detailed information about each bridge and listings of the entire pool of historic bridges and corresponding results are included in a series of appendices that consist of the following:

- Appendix B: List of historic bridges in the study pool with recommended category.
- Appendix C: Historic bridges removed from the study pool. Historic bridges not addressed by the methodology include railroad bridges, snow shed/tunnel, abandoned bridges without current inspections.
- Appendix F: List of bridges in the study pool by CDOT region.
- Appendix G: Individual evaluations for bridges in the study pool that outline the application of additional considerations (for bridges with a CS of 32 or greater), CS calculations, pedestrian test calculations, and location maps. Historic bridges that have already been preserved for vehicular or non-vehicular use were categorized as High Priority Bridges and individual evaluations were not prepared.

Table 7. On-system bridges by type and priority (40 percent of study pool)

Bridge Type	Total bridges	High Priority	Medium Priority	Low Priority
Concrete Arch	**5**	4	0	1
Concrete Arch Culvert	**1**	1	0	0
Concrete Box Girder Continuous	**0**	0	0	0
Concrete on I-beam (includes continuous)	**3**	2	1	0
Concrete Prestressed Girder Continuous	**1**	1	0	0
Concrete Rigid Frame	**6**	3	3	0
Concrete Slab	**3**	3	0	0
Concrete Slab and Girder (includes continuous)	**4**	4	0	0
Masonry Arch Culvert	**0**	0	0	0
Riveted Girder (includes continuous)	**7**	6	1	0
Rubble Arch	**0**	0	0	0
Rubble Arch Culvert	**0**	0	0	0
Steel Arch	**1**	1	0	0
Steel Arch Culvert/Multiplate Arch Culvert	**2**	2	0	0
Steel Box Girder Continuous	**2**	2	0	0
Steel Deck Girder (includes Continuous)	**0**	0	0	0
Steel Deck Truss	**1**	1	0	0
Steel Pony Truss	**1**	0	1	0
Steel Rigid Frame	**1**	1	0	0
Steel Stringer Timber Floor	**1**	1	0	0
Steel Through Girder	**0**	0	0	0
Steel Through Truss	**4**	4	0	0
Suspension Bridge	**0**	0	0	0
Timber/Steel Combination Pony Truss	**0**	0	0	0
Treated Timber Stringer with Timber Deck	**2**	2	0	0
Welded Girder (Continuous and continuous and composite)	**8**	8	0	0
TOTALS	**53**	**46**	**6**	**1**

Table 8. Category results by CDOT Engineering Region (on-system bridges only)

Region	Total bridges	High Priority	Medium Priority	Low Priority
1	**6**	2	4	0
2	**18**	16	1	1
3	**15**	14	1	0
4	**8**	8	0	0
5	**6**	6	0	0
Total	**53**	**46**	**6**	**1**

Table 9. Off-system bridges by type and priority (60 percent of study pool)

Bridge Type	Total bridges	High Priority	Medium Priority	Low Priority
Concrete Arch	**15**	12	3	0
Concrete Arch Culvert	**0**	0	0	0
Concrete Box Girder Continuous	**1**	1	0	0
Concrete on I-beam (includes continuous)	**8**	6	0	2
Concrete Prestressed Girder Continuous	**0**	0	0	0
Concrete Rigid Frame	**3**	3	0	0
Concrete Slab	**1**	0	1	0
Concrete Slab and Girder (includes continuous)	**17**	11	3	3
Masonry Arch Culvert	**1**	0	1	0
Riveted Girder (includes continuous)	**1**	0	1	0
Rubble Arch	**1**	0	1	0
Rubble Arch Culvert	**3**	3	0	0
Steel Arch	**0**	0	0	0
Steel Arch Culvert/Multiplate Arch Culvert	**0**	0	0	0
Steel Box Girder Continuous	**0**	0	0	0
Steel Deck Girder (includes Continuous)	**1**	1	0	0
Steel Deck Truss	**4**	1	3	0
Steel Pony Truss	**6**	2	4	0
Steel Rigid Frame	**0**	0	0	0
Steel Stringer Timber Floor	**1**	0	1	0
Steel Through Girder	**1**	0	1	0
Steel Through Truss	**10**	3	7	0
Suspension Bridge	**1**	1	0	0
Timber/Steel Combination Pony Truss	**1**	0	0	1
Treated Timber Stringer with Timber Deck	**3**	1	2	0
Welded Girder (Continuous and continuous and composite)	**0**	0	0	0
TOTALS	**79**	**45**	**28**	**6**

Next steps and recommendations

The results of this study should be reviewed and vetted by stakeholders who will assist CDOT and the historic bridge committee in making decisions on historic bridge preservation in Colorado and define future phases of historic bridge management. These partners could include the CDOT Executive Director, Deputy Executive Director, and Chief Engineer; the Transportation Commission; Region Transportation Directors; engineers and environmental staff; as well as outside partners with an interest in preserving historic bridges including local agencies, scenic and historic byway organizations, and statewide and local historic preservation advocates including Colorado Preservation, Inc., and local historic societies.

The historic bridge committee should continue to meet to determine the goals and priorities for future phases of historic bridge preservation and management at CDOT. This study provides baseline data on the overall condition of 132 bridges, but CDOT should consider future data needs related to historic bridges. These data needs include:

- Developing separate historic bridge management plans for on- and off-system bridges. The initial focus could be on on-system bridges that CDOT has responsibility for. Off-system bridges are not under CDOT's management and local agencies make independent decisions on their historic bridges. CDOT could provide guidance and tools to local agencies in the form of historic bridge management plans.

- Making final determinations of eligibility for bridges with "possibly eligible" determinations based on attrition of eligible and listed historic bridge types.

- Defining character-defining features for bridge types and subtypes in Colorado.

- Updating the numbers of extant eligible and listed bridges since the last inventory in 2014.

- Combining the data from past historic bridge inventories into one data management system that can be used and dynamically updated by CDOT historians, Colorado Bridge Enterprise (CBE), and CDOT Staff Bridge.

The following items have been discussed by the historic bridge committee as potential elements of the next phase of historic bridge preservation and management:

- Due to the large number of High and Medium Priority bridges identified in the study pool, a second level of screening may be needed to identify a smaller pool of historic bridge candidates that can be the focus of individual management plans. The historic bridge committee should continue to discuss priorities for future historic bridge preservation.

- Several of the historic bridges evaluated in the study pool have been transferred as assets to the CBE program. Options for funding individual management plans for these structures should be explored further with CBE.

- The historic bridge committee should provide background information and seek buy-in from CDOT Region engineering and environmental staff and local agencies of the bridges in their jurisdiction and the recommended categories as part of the study.

- Region staff should be consulted to provide feedback on the impacts to the delivery of projects and programs.

- Consider developing a plan that addresses acceptable options for in-kind or sympathetic replacement of bridge rail or parapet that can meet the SOI Standards. The plan could research AASHTO or CDOT standards for bridge rail, or AASHTO's *Manual for Assessing Safety Hardware* (MASH-tested) guidance to develop recommendations for bridge rail repair or replacement based on the following parameters:
  - National Highway System (NHS) bridge or non-NHS bridge.
  - Classification of roadway.
  - Geometry and design speed.
  - Research into similar types of in-kind rail that have been crash tested and whether the findings are applicable to Colorado.