Management Plan for Historic Bridges in Minnesota

Report prepared for

Minnesota Department of Transportation

Report update prepared by

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Foreword

Managing Minnesota's historic bridges

The historic bridges of Minnesota represent a variety of engineering advances, aesthetic styles, and transportation system expansions through time. Minnesota is home to more than 200 historic bridges, identified through more than 30 years of study. What began as an initiative to streamline the environmental review process (which has been a great cost and time savings to local agencies, as well as to the Minnesota Department of Transportation [MnDOT]) has developed into a deeper understanding of and commitment to preserve the engineering heritage in the state.

Through the work on this *Management Plan for Historic Bridges in Minnesota*, MnDOT, along with the Federal Highway Administration (FHWA) and the State Historic Preservation Office (SHPO), has acknowledged its commitment to the people of Minnesota to protect, conserve, or enhance the natural and man-made environment. Following these principles, owners, planners and designers are encouraged to incorporate, to the extent feasible, the preservation of a community's historic resources, including bridges, in transportation projects. By adopting this approach, MnDOT has committed to a proactive transportation planning process that considers the importance of the state's environmental and historic resources, including historic bridges.

What does a historic bridge in Minnesota look like? Some examples are readily apparent. The Stillwater Lift Bridge, perhaps one of Minnesota's most recognizable bridges, is an exceptional example of a lift bridge structure, while the Lester River Bridge, located on Duluth's scenic Trunk Highway (TH) 61 drive, demonstrates the craftsmanship and aesthetics of the Depression-era relief programs. The Third Avenue Bridge in Minneapolis is a significant engineering example for its use of the Melan reinforced-concrete construction method, while the Sorlie Memorial Bridge in East Grand Forks is significant for its exceptional engineering design to meet the unusual site conditions of the meandering and flood-prone Red River of the North. However, there are also more modest structures that are just as important, many of which are owned by local agencies. The Kern Bridge in Blue Earth County, constructed in 1873, is the oldest extant truss bridge in the state and the only example of a wrought-iron, bow-arch truss in Minnesota. A rare structure in St. Paul known as the Seventh Street Improvement Arches is significant for the technically demanding nature of its skewed, helicoidal, double stone-arch design. At the time of its construction in 1884, the bridge was thought to be one of few of its type in the United States. Today it is the only example in Minnesota.

The Third Avenue Bridge in Minneapolis.

The Sorlie Memorial Bridge in East Grand Forks.

The Kern Bridge in Blue Earth County.

The Seventh Street Improvement Arches in St. Paul.

While it is easy to see why these bridges are significant, it may not be as easy to see that their preservation is important. Preserving and maintaining historic bridges can present many challenges in regards to funding, maintenance, and engineering standards. It is our hope, however, that through the examples of the individual bridge management plans and bridge reports that we have developed for the state's historic bridges and through this *Management Plan for Historic Bridges in Minnesota*, you will have some extra tools in your toolbox for preserving important bridges under your jurisdiction or in your community.

Maintaining historic properties, including bridges, provides a sense of place and helps people to understand the community's past, what previous engineers and communities hoped for, and what they were able to achieve. By protecting these reminders of the state's engineering and transportation legacy, the present and the future can be built, since their preservation can save valuable taxpayer dollars and recall a community's goals and dreams. Instead of losing the work of talented craftsmen, these important structures can be maintained, thereby helping communities remember their past and retain their unique, local flavor. Imagine what Duluth would be without the Aerial Lift Bridge or Hanover without the wrought-iron truss bridge that leads into town, or what Redwood Falls would be without the swayback bridge in Alexander Ramsey Park or Lanesboro without the Historic Coffee Street Walking Bridge.

Preserving Minnesota's historic bridges can also save valuable taxpayer's dollars. Not only has MnDOT's identification of historic bridges resulted in savings on specific projects, but maintaining an existing bridge can sometimes cost much less than removing and replacing a structure. By identifying early on which bridges are significant and applying higher levels of maintenance, it is possible to save more tax dollars in the end. With historic bridges, an ounce of prevention can truly go a long way and save money in the end.

This *Management Plan for Historic Bridges in Minnesota* recommends practices that are consistent with the needs of transportation and preservation, which can be applied to your historic bridges. The plan draws upon lessons learned from other state transportation agencies and incorporates input received from the MnDOT Cultural Resources Unit (CRU), the MnDOT Bridge Office, the MnDOT State Aid Office, MnDOT Districts, the FHWA, and the SHPO staff. Review and consideration of the concepts presented in this general plan can be a first step in preserving a bridge in your community.

As partners in historic bridge preservation in the state, we encourage you to think about proactive ways to maintain and preserve these important resources in your communities.

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Acronyms

AASHTO	American Association of State Highway and Transportation Officials
ACHP	Advisory Council on Historic Preservation
ADT	Average Daily Traffic
BPIRG	The Minnesota Department of Transportation's *Bridge Preservation, Improvement, and Replacement Guidelines*
CRU	Cultural Resources Unit (within MnDOT)
FHWA	Federal Highway Administration
FO	Functionally Obsolete
HAER	Historic American Engineering Record
HBRRP	Highway Bridge Replacement and Rehabilitation Program
HPDP	Highway Project Development Process
LRFD	Load and Resistance Factor Design
MAP-21	Moving Ahead for Progress in the 21st Century Act
MHC	Minnesota Highway Commission (predecessor of MnDOT)
MHPR	Minnesota Historic Property Record
MHS	Minnesota Historical Society
MnDOT	Minnesota Department of Transportation
MOA	Memorandum of Agreement
NBI	National Bridge Inventory
NBIS	National Bridge Inspection Standards
NHS	National Highway System
NPS	National Park Service

OES	Office of Environmental Services (within MnDOT)
OTS	Office of Technical Support (within MnDOT)
RDM	Road Design Manual
SEE	Social, Economic and Environmental Impacts
SHPO	State Historic Preservation Office
SP	State Project, used when referring to State Project Number
SPR	Special Project Research
STP	Surface Transportation Program
TAP	Transportation Alternatives Program
USC	United States Code

Executive Summary

The *Management Plan for Historic Bridges in Minnesota* was prepared by Mead & Hunt, Inc. (Mead & Hunt) and the HNTB Corporation in 2006 as part of an extensive historic bridge management initiative by the Minnesota Department of Transportation (MnDOT) and updated in 2014 by Mead & Hunt and LHB Inc. (LHB). This plan provides information and guidance on the general management and long-term preservation of historic bridges in Minnesota. Additionally, this document functions as a useful reference for contacts, funding information, and rehabilitation options.

Minnesota has more than 200 bridges identified as historic, meaning they are listed in, or eligible for listing in, the National Register of Historic Places (National Register). MnDOT owns 26 percent of the state's historic bridges, while local agencies and others (including counties, cities, townships, railroad, private owners, and other state agencies) own the remaining 74 percent. This plan is intended to aid all owners of historic bridges. Other individuals and organizations involved in the preservation of historic bridges, such as transportation and engineering professionals, statewide and local historical and preservation organizations, state agencies whose work may involve historic bridges, and interested members of the public, will also find the plan relevant and useful.

Requirements relating to regulatory processes and funding programs for transportation projects, especially for historic bridges, are complex. An overview of the applicable laws, regulations, and standards is provided in Section 2. Available funding options are summarized in Section 6.

Since its first statewide study of historic bridges in 1985, MnDOT's work to identify historic bridges built before 1970 (to take into account bridges currently, or soon to be, over 50 years in age) is now complete. This three-decade series of projects is summarized in Section 3. As historic bridges were identified, efforts turned increasingly to issues of bridge management. MnDOT's innovative approach to historic bridge management using the collaborative method is described in Section 4. The collaborative method is a team approach that pairs a professional historian with a professional engineer. Working interactively, they survey a historic bridge and prepare an individual bridge management plan or a bridge report which is much similar to the individual bridge management plan in scope but often less detailed. For the purposes of this document, "individual bridge management plan" will be used to refer to both individual management plans and bridge reports. A management plan summarizes pertinent historical and engineering data, records current conditions, and recommends specific treatments for stabilization, preservation, and annual maintenance.

Additional technical guidance on specific bridge preservation topics is presented in Section 5. Section 7 identifies agencies and organizations to contact for additional information on topics covered in this plan. The appendices include a glossary and a list of applicable standards. The current list of historic bridges in Minnesota can be found on MnDOT's website at http://www.dot.state.mn.us/historicbridges/about.html.

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1. Introduction

MnDOT has long supported the preservation of historic bridges through research, survey, and inventory efforts, as well as education and awareness initiatives. While MnDOT recognizes that historic bridge preservation is an important part of preserving Minnesota's heritage, elements of bridge preservation also are mandated by federal law. The identification and preservation of historic bridges in the United States has become part of the overall process of funding and maintaining the nation's transportation infrastructure.

MnDOT completed the first systematic review of the state's bridges in 1985, which served as the foundation for survey and evaluation efforts that, in turn, led to historic bridge preservation projects. Ongoing efforts have established a statewide inventory of historic bridges, incorporated historic bridge management into the environmental review process through the MnDOT Cultural Resources Unit (CRU), and demonstrated best practices for the appropriate treatment of historic bridges.

The responsibility for managing Minnesota's historic bridges depends on the state, counties, cities, and, in cases where bridges are privately owned, the private bridge owner. When state or federal funding is used, government agencies are required to follow appropriate legislation regarding the treatment of historic bridges. The state has more than 200 bridges listed, or determined eligible for listing in, the National Register. Of these, approximately 74 percent of the state's historic bridge population is owned by local government agencies (including townships, cities, and counties), other state agencies, railroads, or other private owners. MnDOT owns the remaining 26 percent. The state's historic bridges, including location maps, management plans, and all available historical documentation, can be found at MnDOT's website at http://www.dot.state.mn.us/historicbridges/.

To assist owners, engineers, and contractors in managing historic bridges, and to inform others with interest in Minnesota's historic bridges, MnDOT prepared this *Management Plan for Historic Bridges in Minnesota*. It functions as a useful reference for contacts, funding, and rehabilitation options. This plan provides background and guidance of interest to state and local preservation organizations, and community advocates for preservation. Additionally, the plan provides helpful background to supplement an owner's or member of the public's understanding of an individual bridge management plan.

To efficiently satisfy requirements under Section 106 of the National Historic Preservation Act (Section 106), the Federal Highway Administration (FHWA), Advisory Council on Historic Preservation (ACHP), Minnesota State Historic Preservation Office (SHPO), U.S. Army Corps of Engineers − St. Paul District (Corps), and MnDOT developed a Programmatic Agreement for addressing projects that will affect historic bridges. The Programmatic Agreement, originally signed in 2008, satisfied the FHWA responsibility to identify and evaluate historic bridges for federally funded projects or undertakings sponsored by local agencies and MnDOT Districts. Under this agreement, MnDOT is committed to preserving and performing a higher level of maintenance on selected state-owned historic bridges, and working to encourage preservation efforts for bridges controlled by local agencies.

A. Plan overview

This plan is intended primarily for the use of owners of historic bridges. In many instances, an individual management plan exists for a particular bridge. In this case, this plan serves as needed background information, as a resource for funding options and contact information, and as a source for other rehabilitation alternatives should conditions change whereby an owner needs to explore options.

Other individuals and organizations involved in the preservation of historic bridges will also find parts of the plan informative and useful. This may include transportation and engineering professionals and organizations, statewide and local historical and preservation organizations, others in state agencies whose work may involve historic bridges, and members of the general public with an interest in historic bridges as part of the state's and nation's heritage. In addition to this introduction, the plan includes the following sections:

Section 2. Applicable Laws, Standards, and Definitions
This section provides an overview of federal and state historic preservation and transportation laws and programs that pertain to historic bridge identification and management. Historic bridges are afforded a degree of protection under historic preservation laws that require agencies to take into account the effect of projects on historic properties. Flowcharts outlining pertinent review processes and key terms used in the management plan are also provided in Section 2.

Section 3. Background Data and Analysis
This section reviews the development of MnDOT's planning process for historic bridges from 1985 to the present. Through this chronological list of survey, evaluation, and management projects, the progression from identification efforts to management efforts becomes clear. For most of this period, the focus of effort was the identification of historic bridges to determine eligibility for the National Register and to facilitate compliance with federal requirements such as Section 106. The now-complete identification process resulted in a list of more than 200 historic bridges in Minnesota built before 1970. Recent initiatives, including this management plan, have shifted attention to preservation and maintenance techniques, which are addressed in Section 5.

Section 4. Management of Historic Bridges
This section focuses on the preparation of the individual management plan for a historic bridge. The discussion begins with explanations of the five basic options for historic bridge preservation, ranging from the most preferred (rehabilitation for continued vehicular use on-site) to the least preferred (major alteration while preserving historic fabric).

To decide on an appropriate option for a historic bridge, MnDOT has introduced a collaborative approach for field survey and evaluation. In the collaborative approach, a professional bridge historian is paired with a professional bridge engineer and together they conduct an on-site survey of a bridge. Using the bridge's Determination of Eligibility or National Register documentation as a starting point, the historian develops a list of character-defining features, while the engineer makes a variety of technical observations using MnDOT inspection data as a starting point. Using their documentation and on-site

observations during the field survey and in follow-up analytical reviews, the historian and engineer together determine the appropriate preservation approach for the bridge.

Still working as a team, with their deliberations guided by the Secretary of the Interior's *Standards for the Treatment of Historic Properties* (Secretary's Standards) and professional engineering standards, they prepare sets of technical recommendations for bridge stabilization, preservation, and maintenance.

Section 5. Technical Guidance
This section offers guidance to owners and engineers on how to preserve and maintain historic bridges. Recommended stabilization, preservation, and maintenance efforts are presented, categorized by bridge material and/or type. Guidance on inspection frequency is offered. This section also presents special technical considerations such as disassembly and re-erection of truss bridges, agreements to transfer ownership, guidance on mortar analysis, and the use of exceptions to design standards.

Section 6. Funding Options
Because the preservation of historic bridges is expensive and often requires funding beyond the levels used for non-historic structures, this section presents an overview of many potential sources for preservation dollars. A particular bridge project may take advantage of one, several, or none of the possibilities presented, depending on its particular circumstances.

Section 7. Contacts
This section identifies Minnesota and national agencies and organizations that can provide information and expertise on historic bridges, historic preservation, and local historical issues.

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2. Applicable Laws, Standards, and Definitions

Historic bridges are those listed in, or eligible for listing in, the National Register. Historic bridges are afforded a degree of protection under state and federal historic preservation laws and transportation laws, which require agencies to take into account the effect of projects on historic properties. These laws recognize the value of preserving physical components of the nation's history. This section describes laws, regulations, programs, standards, and definitions that apply to the management of historic bridges.

A. Laws and regulations

(1) Section 106 of the National Historic Preservation Act of 1966 (as amended)

Section 106 requires federal agencies and owners seeking federal assistance to take into account the effects of their undertakings on historic properties, including historic bridges, and afford the ACHP a reasonable opportunity to comment on such undertakings. The historic preservation review process mandated by Section 106 is administered by the ACHP under regulations at 36 CFR Part 800. The process includes identifying historic properties, determining project alternatives to avoid or reduce harm to historic properties, and developing agreements that specify measures to deal with any adverse effects. To comply with Section 106, appropriate consultation among the federal agency, project sponsor, SHPO, tribes, the public, and other interested parties is required.

The FHWA delegates, to a certain extent, its authority to the professionally qualified historians and archaeologists in MnDOT's CRU to conduct the Section 106 review on its behalf. For FHWA undertakings involving historic bridges, MnDOT CRU either makes a finding of "no adverse effect" or works with the project sponsor, SHPO, and other parties to avoid adverse effects using the preservation options discussed in Section 4. Findings are forwarded to SHPO for concurrence. MnDOT and SHPO letters and any agreements are included in environmental documentation to document the completion of the Section 106 process. Adverse effects are addressed through preparation of appropriate documentation and a Memorandum of Agreement (MOA) or project-specific Programmatic Agreement between the FHWA, SHPO, ACHP (when it chooses to participate), and consulting parties to address the effect through mitigation measures.

(2) Section 4(f) of the U.S. Department of Transportation Act of 1966

This law was enacted as part of the U.S. Department of Transportation Act of 1966, as now codified in 49 USC Section 303. The law only applies to transportation agencies (e.g., FHWA, Federal Transit Administration [FTA], and Federal Railroad Administration [FRA]). The FHWA administers its Section 4(f) obligations under regulations at 23 CFR Part 774. Section 4(f) applies to undertakings that require the "use" of a Section 4(f) resource, including historic properties. The FHWA must ensure that the provisions of Section 4(f) are met before approving a federally funded or permitted project for letting. Projects, including appropriate rehabilitation, that do not impair the historic integrity of a bridge are not subject to Section 4(f).

Programmatic Section 4(f) approval applies to bridges to be replaced or rehabilitated as part of an undertaking by any United States Department of Transportation agency, including state Departments of Transportation (DOTs), provided that the projects include appropriate planning. The Programmatic

Section 4(f) Evaluation recognizes that certain bridges are unique because they are historic, yet they are also part of a highway system. Even though these structures are eligible for or listed in the National Register, they must perform as an integral part of a modern transportation system. When they do not or cannot, they must be rehabilitated or replaced in order to ensure public safety while maintaining system continuity. For the purpose of the Programmatic Section 4(f) Evaluation, a proposed action "uses" a historic bridge when the action would impair the historic integrity of the bridge either by rehabilitation or demolition. Such impairment to historic integrity constitutes an adverse effect under Section 106.

In the event of an adverse effect, the Programmatic Section 4(f) Evaluation and approval may be used. Programmatic Section 4(f) Evaluation is applicable only for projects where the FHWA Division Administrator ensures that the proposed action includes all possible planning to minimize harm. This has occurred when:

- For bridges that are to be rehabilitated, the historic integrity of the bridge is preserved to the greatest extent possible (yet resulting in Section 106 adverse effect), consistent with unavoidable transportation needs, safety, and load requirements.
- For bridges that are to be rehabilitated to the point that the historic integrity is affected or that are to be moved or demolished, the FHWA ensures that the bridge is adequately documented (see discussion of the Documentation in Section 4).
- For bridges that are to be replaced, the existing bridge is made available for an alternative use, provided a responsible party agrees to maintain and preserve the bridge.
- For bridges that are adversely affected, agreement is reached through the Section 106 process on measures to minimize harm, and those measures are incorporated into the project.

(3) Minnesota Historic Sites Act of 1966

This law set forth at Minnesota Statutes 138.661-138.669 requires state agencies to assess the effects of their projects on State Register- and National Register-listed properties, including bridges. Unlike federal law, which affords protection to properties both listed in or eligible for listing in the National Register, the state law only considers effects to properties listed in the State Register or National Register. Before carrying out any undertaking that will affect designated or listed properties, or funding or licensing an undertaking by other parties, the state department or agency must consult with the Minnesota Historical Society (MHS) pursuant to the society's established procedures to determine appropriate treatments and to seek ways to avoid and mitigate any adverse effects on designated or listed properties. If the state department or agency and the MHS agree in writing on a suitable course of action, the project may proceed. If an agreement cannot be reached, the act outlines the steps to take to achieve resolution. This act applies to MnDOT for its own projects and projects sponsored by others (e.g., counties and cities) where MnDOT provides state funding.

(4) Minnesota Transportation State Statute Chapter 165

Minnesota legislation pertinent to bridges is contained in Chapter 165 of the State Statutes (165.01-165.15). The statutes address a variety of issues, including general requirements for bridge load capacity, bridge inspections, inspection records, bridge geometrics, ownership issues, and funding issues. A majority of the content pertains to bridges over public roads or carrying public roads.

(5) Applicable Procedures

MnDOT has established four alternative paths to follow for historic bridge rehabilitation projects. The paths are:

- Path 1: FHWA undertaking on a historic bridge (typically with an individual management plan) where the proposed project consists of rehabilitating the bridge according to the Secretary's Standards.
- Path 2: FHWA undertaking on a historic bridge where the preferred alternative (i.e., rehabilitation or replacement) is not known.
- Path 3: The project is not an FHWA undertaking, but will require a federal permit, license, or approval. In this instance, the federal agency issuing the permit, license, or approval will be the lead agency to complete the Section 106 process.
- Path 4: There is no federal undertaking (i.e., no federal funding, permit, license, or approval) but the project involves a bridge that is listed in the National Register. State agencies will need to comply with the Minnesota Historic Sites Act.

For historic bridge projects following Paths 1 or 2, MnDOT CRU determines whether the proposed project meets the Secretary's Standards (these are further discussed below). If the proposed rehabilitation meets the Secretary's Standards, MnDOT CRU makes a finding of no adverse effect, and the SHPO reviews for concurrence. If the proposed rehabilitation would adversely affect the bridge, MnDOT CRU consults with the project sponsor and the SHPO to avoid or lessen adverse effects. If adverse effects cannot be avoided, MnDOT CRU makes a finding of adverse effect and negotiates mitigation measures, which are outlined in an MOA as described above. Refer to Figures 1 and 2 for an overview of Paths 1 and 2, respectively.

The review process differs slightly for Paths 3 and 4. Under Path 3, the federal agency issuing the permit, license or approval—most often the Corps—will lead the Section 106 process. That agency's review process must be followed. The federal agency will make an effect finding and consult with the SHPO to complete the review process. Figure 3 presents an overview of Path 3.

Under Path 4, MnDOT is responsible for compliance with the Minnesota Historic Sites Act. The Minnesota Historic Sites Act requires that before carrying out any undertaking that will affect designated or listed properties, the state department or agency shall consult with the MHS (via the SHPO) pursuant to their established procedures to determine appropriate treatments and to seek ways to avoid and mitigate any adverse effects on designated or listed properties. This applies to projects in which MnDOT is the owner and for projects which MnDOT funds, licenses or permits. It does not apply for projects in which MnDOT's only role is to assist in project administration for counties and local agencies. In a case where MnDOT is not involved or only administratively assists and where there is no other state agency funding involvement the county/local agency only has an obligation to "cooperate" with the MHS and does not need to follow Path 4. Figure 4 presents an overview of Path 4.

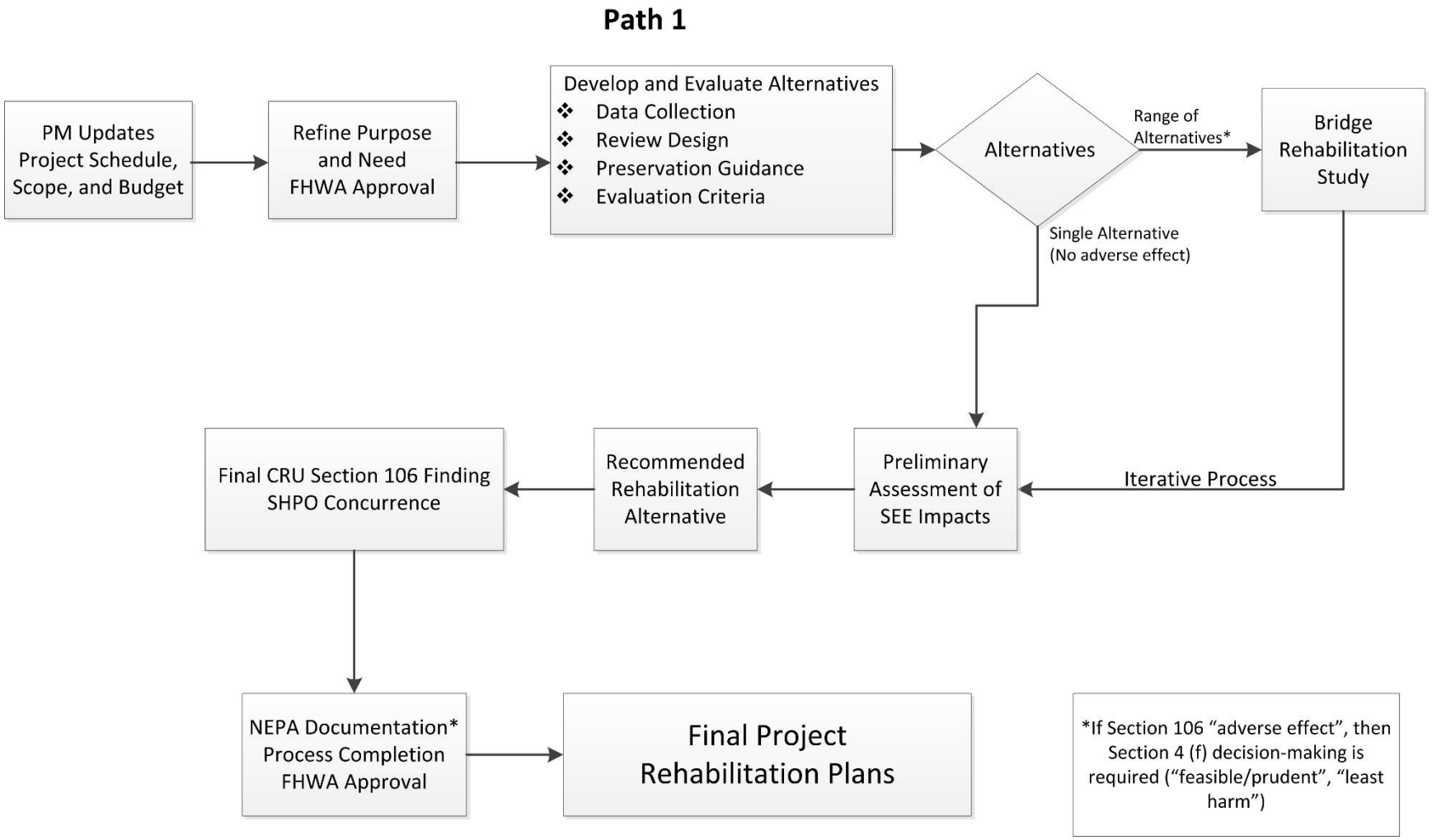

Figure 1. Overview of Path 1: applies to FHWA undertaking where historic bridge will be rehabilitated following the Secretary of the Interior's Standards.

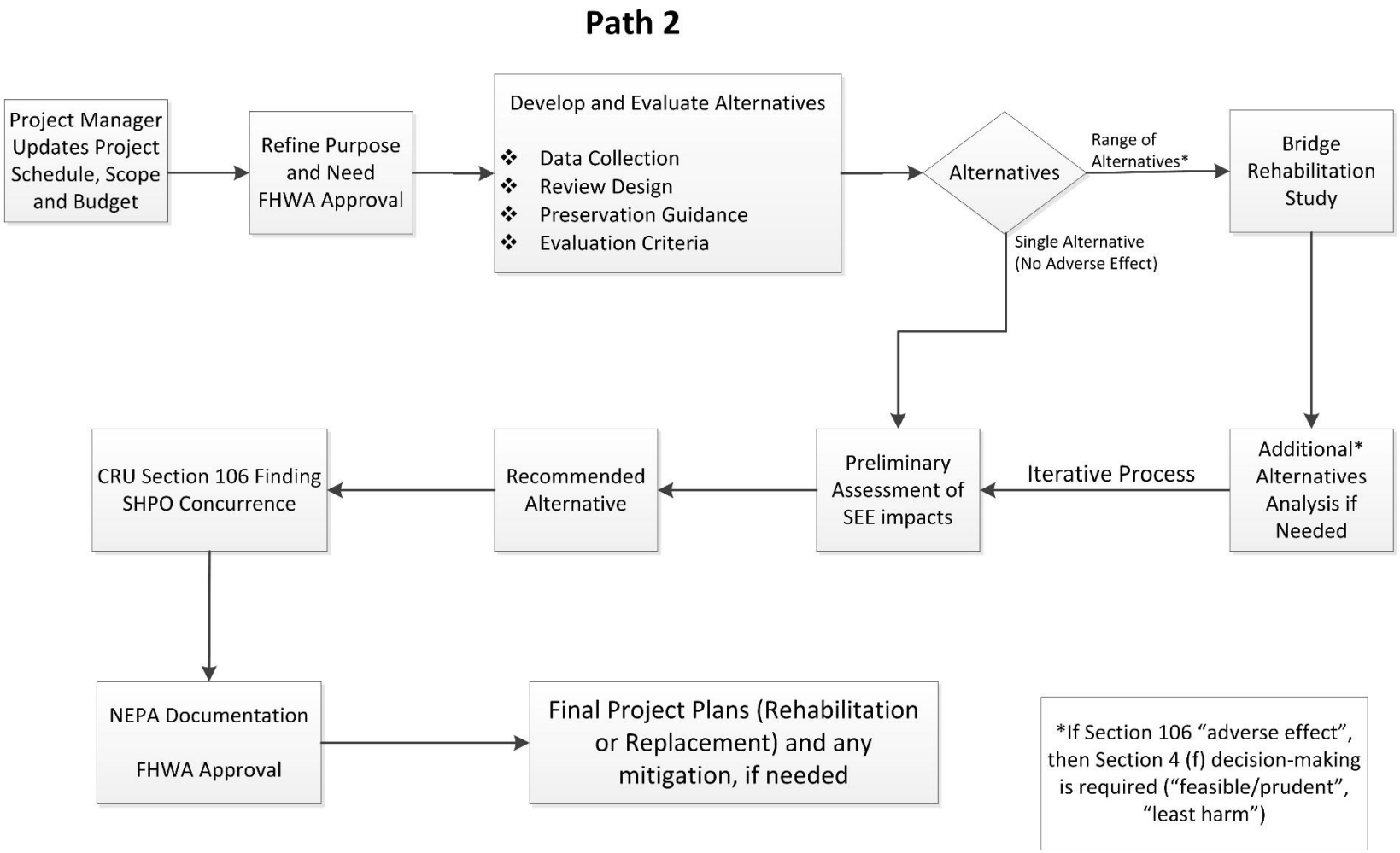

Figure 2. Overview of Path 2: applies to FHWA undertaking on a historic bridge where the preferred alternative (i.e., rehabilitation or replacement) is not known.

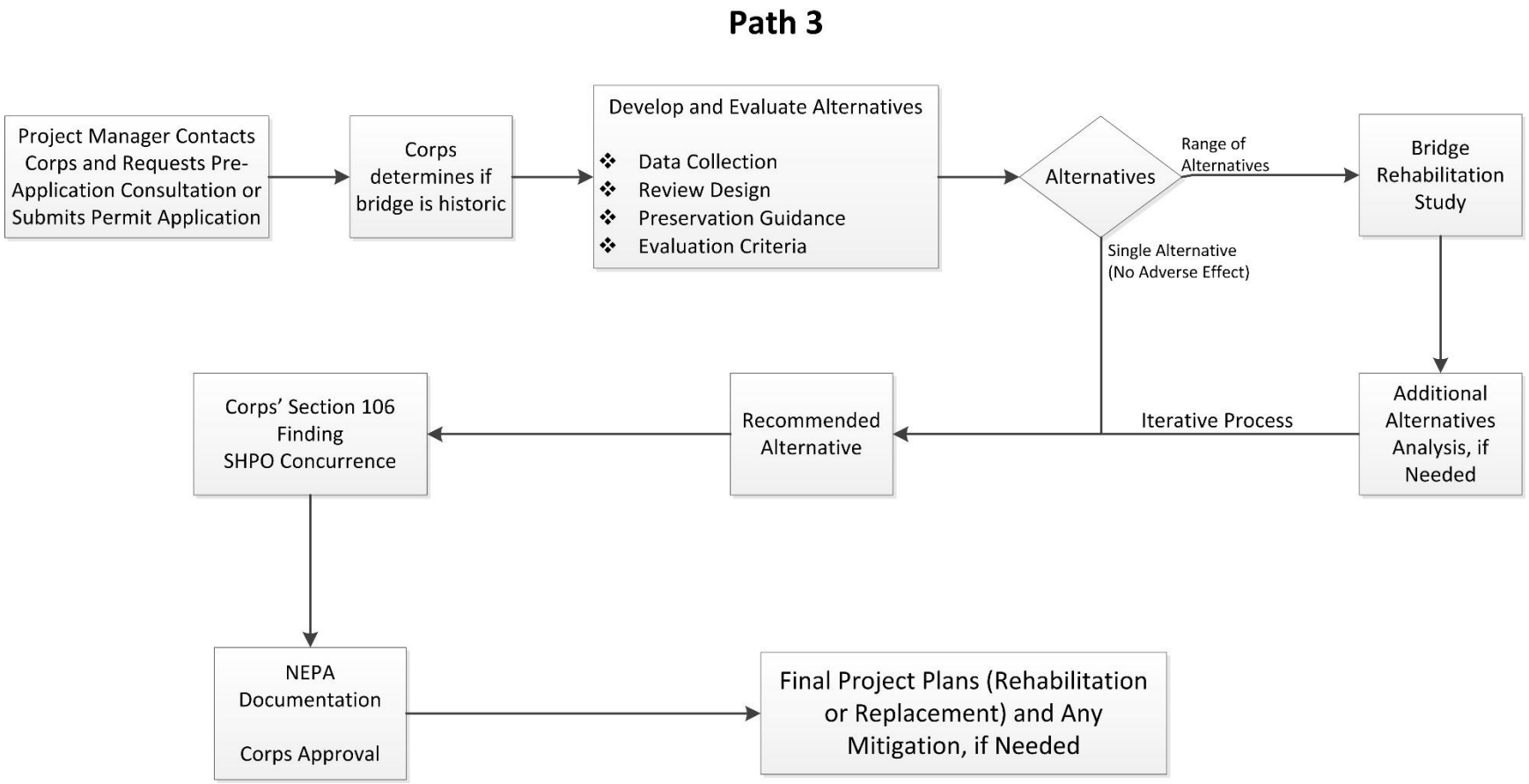

Figure 3. Overview of Path 3: applies to project that is not an FHWA undertaking, but will require a federal permit, license, or approval. In this instance, the federal agency issuing the permit will be the lead agency to complete the Section 106 process. With bridge projects, the federal agency is most often the U.S. Army Corps of Engineers.

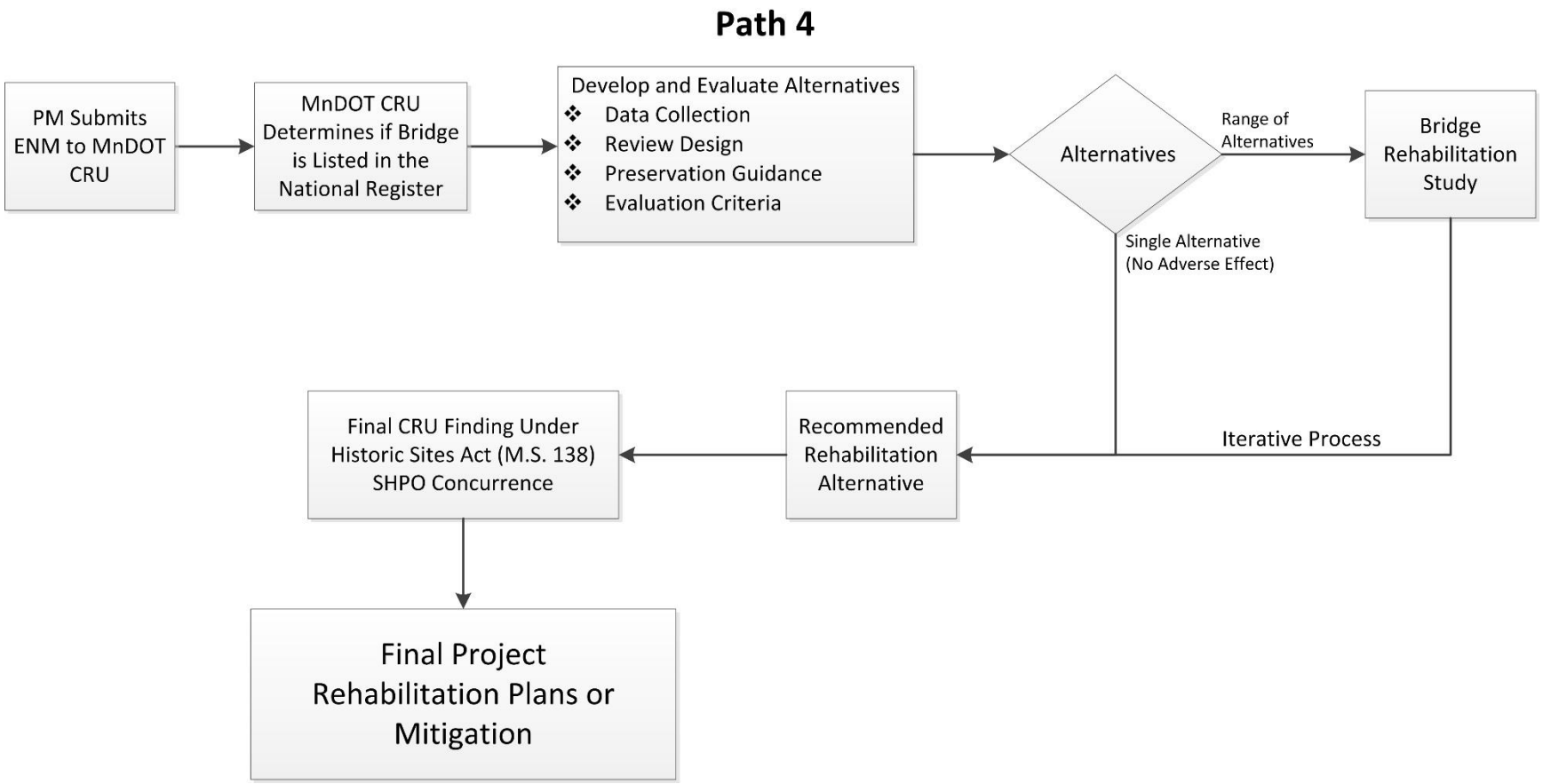

Figure 4. Overview of Path 4: applies when there is no federal undertaking. MnDOT is responsible for compliance with the Minnesota Historic Sites Act for projects in which MnDOT is the owner and for projects which MnDOT funds, licenses or permits. It does not apply for projects in which MnDOT's only role is to assist in project administration for counties and local agencies. In a case where MnDOT is not involved or only administratively assists and where there is no other state agency funding involvement the county/ local agency only has an obligation to "cooperate" with the MHS and does not need to follow these steps.

B. Programs and standards

(1) National Register and State Register of Historic Places

Authorized under the National Historic Preservation Act of 1966 and administered by the National Park Service (NPS), the National Register is the official list of historic properties deemed worthy of preservation. Properties listed in the National Register include districts, sites, buildings, and structures (including bridges), and objects. These properties are included in the National Register due to their significance to American history, architecture, archaeology, engineering, and culture. Properties listed in the National Register are given consideration in the planning for federal undertakings.

The State Register is the official listing of historic properties worthy of preservation in Minnesota due to their significance at the state level and importance to historical developments, architecture, and engineering within the state.

(2) Secretary of the Interior's Standards for the Treatment of Historic Properties[1]

The Secretary of the Interior's *Standards for the Treatment of Historic Properties*, referred to in this document as the Secretary's Standards, are a series of concepts related to maintaining, repairing, and replacing historic materials, as well as designing new additions or altering a historic property. The Secretary's Standards are not technical or prescriptive, but are intended to promote responsible preservation practices by providing advice and philosophical consistency to the work. The NPS produced and promulgated the Secretary's Standards and codified them as 36 CFR Part 68 in the Federal Register (July 12, 1995, Vol. 60, No. 133). In certain cases, the Secretary's Standards are regulatory, including in the application of Section 106 of the National Historic Preservation Act.

Four distinct treatment approaches are included in the Secretary's Standards:

- *Preservation* – The act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property.[2]
- *Rehabilitation* – The act or process of returning a property to a state of utility and of making possible a compatible use for a property through repair, alterations, and additions which makes possible an efficient contemporary use while preserving those portions or features that convey its historical, cultural, or architectural values.[3]
- *Restoration* – The act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time by means of the removal of features from other periods in its history and reconstruction of missing features from the restoration period.

[1] Terminology used in the Secretary's Standards differs from the terminology used in MnDOT's *Bridge Preservation, Improvement, and Replacement Guidelines* (BPIRG).

[2] The word "preservation" has a different meaning in the Secretary's Standards than as used in MnDOT's BPIRG. MnDOT's BPIRG definition of preservation focuses on repairing or delaying the deterioration of a bridge without significantly improving its function and without consideration for its historic integrity.

[3] This terminology does not encompass bridge replacement. However, MnDOT's BPIRG describes rehabilitation and replacement in similar terms.

- *Reconstruction* – The act or process of depicting by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location.

The Virginia Transportation Research Council adapted the Secretary's Standards to address the special requirements of historic bridges and to identify specific applications to bridges. These guidelines are included in Appendix B and provide useful guidance to anyone involved in bridge maintenance and/or preservation and rehabilitation projects. Refer to Section 4 for more information about applying the Secretary's Standards to historic bridges.

C. Definitions

The following definitions apply to this document:

- **Design exception** – A deviation from standard highway and/or bridge design practices that takes into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. A design exception is used for federally funded projects where federal and state standards are not met. Approval requires appropriate justification and documentation that concerns for safety, durability, and economy of maintenance have been met.
- **Design variance** – A deviation from standard roadway and/or bridge design practices (as defined by Minnesota State Statute) that takes into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. A design variance is used for projects using state aid funds. Approval requires appropriate justification and documentation that concerns for safety, durability, and economy of maintenance have been met.
- **Historic bridge** – A bridge that is listed in, or eligible for listing in, the National Register. The National Register is the official federal list of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, engineering, and culture.
- **Inspections** – Periodic field assessments and subsequent consideration of the fitness of a structure and the associated approaches and amenities to continue to function safely.
- **Maintenance** – Work of a routine nature to prevent or control the process of deterioration of a bridge.
- **Preservation** – The act or process of applying measures necessary to sustain the existing form, integrity, and materials of an historic property.[4]
- **Stabilization** – The act or process of sustaining a bridge by means of making minor repairs until a more permanent repair or rehabilitation can be completed.

Refer to the glossary in Appendix A for additional term definitions that are applicable to historic bridges.

[4] As defined by the Secretary's Standards. MnDOT's BPIRG definition of preservation focuses on repairing or delaying the deterioration of a bridge without significantly improving its function and without consideration for its historic integrity.

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3. Background Data and Analysis

Historic bridges are identified through a rigorous process established in the procedures for the National Register, which was authorized by the National Historic Preservation Act of 1966. This Act, and other federal and state laws (see Section 2), govern federal, state, and local agency activities involving historic bridges in Minnesota.

Through this process, which evaluates the significance of bridges in terms of defined criteria, a state's total population of bridges is methodically studied to find a core group of bridges that are determined to be historic. These bridges are listed in or eligible for the National Register. The National Register status of a bridge is important because the application of other laws and regulations depends on it. If a project involves a bridge listed in or eligible for the National Register, the project sponsor is required to follow certain procedures before the project can be approved and carried forward.

The identification of a bridge as historic or not historic is a matter of significant consequence. For three decades, MnDOT has worked in cooperation with the FHWA and SHPO to establish a list of historic bridges in Minnesota. The identification process has resulted in a list of more than 200 determined eligible or listed historic bridges in Minnesota built before 1970. Beginning with the first systematic review of the state's publicly owned bridges in 1985 and continuing through the preparation of individual management plans for state and locally owned bridges, the process has moved steadily from identification to management. The focus of this work has been publicly owned bridges and those that cross over or under public roads. Some private bridges were included in the most recent study, completed in 2015. It is also important to remember that while this list is an accurate reflection of the historic bridges in the state, the studies have some limitation. Previous studies focused primarily on individual National Register eligibility based on a bridge's engineering significance. It is possible that some bridges could be eligible as part of a historic district that has yet to be evaluated, or eligible individually for historical significance. The scale of the previous studies simply could not address all aspects of every bridge. In limited cases, additional study of a bridge not included on the list may be needed to address aspects such as its contributing status to a historic district or to evaluate it under another area of significance.

The series of MnDOT historic bridge studies is described below to help bridge owners and others understand how the inventory of historic bridges was produced and how the process evolved into the current management efforts. The study descriptions also highlight the rigorous evaluation process and show that a bridge is not determined to be historic through informal or arbitrary means.

A. Historical studies and results

Beginning in 1985, MnDOT conducted a number of studies to identify the state's historic bridges. The studies are described below. As of 2015, more than 200 bridges have been determined-eligible or listed in the National Register through these efforts. A current list of historic bridges can be found on MnDOT's website at http://www.dot.state.mn.us/historicbridges/about.html. It is expected that the list of historic bridges will change over time through further identification efforts or demolition. Bridges will typically be added to the list through the establishment of new historic districts. Further, bridges built after 1970 that are not subject to the

FHWA and ACHP *Program Comment for Common Post-1945 Concrete and Steel Bridges*, which limits Section 106 review for certain bridge types constructed after 1945, may qualify over time.

(1) Historic Bridge Project

Prepared by Robert M. Frame, 1985

In this first systematic review of historic bridge information, Frame examined MnDOT files for 887 bridges, including iron and steel truss bridges, concrete arch bridges, and masonry arch bridges. It was a research project and did not include field survey. The final report included a contextual overview of the history of bridge building in Minnesota and of Minnesota bridge engineers, fabricators, builders, and contractors.

(2) Report of the Minnesota Historic Bridge Survey: Part 1 and Part 2

Prepared by Jeffrey A. Hess, et al. of Hess, Roise and Company, 1988

In this follow-up to Frame's 1985 project, a team of historians associated with Hess, Roise and Company conducted a field survey of a sample of the 887 historic bridges identified in 1985. Part 1 includes a list of bridges that were surveyed. Part 2 includes the three National Register Multiple Property Documentation Forms that were prepared as part of the survey effort. Each documentation form includes a historic context and registration requirements to assist in evaluating the eligibility of bridges for the National Register.[5]

Each context identifies bridges first by construction material (masonry, metal, or concrete) and second by design type (truss, arch, beam, girder, slab, or other type), and includes a history of the type in Minnesota. The contexts have several limitations. They do not cover all design types within their particular construction material; for example, the iron and steel context does not include beam and girder designs and the concrete context does not include culvert designs. The contexts focus on highway bridges and do not include railroad or pedestrian bridges. There are no Minnesota contexts for timber bridges or movable bridges. The three contexts are further described as follows:

- "Minnesota Masonry-Arch Highway Bridges, 1870-1945"
  Prepared by Jeffrey A. Hess of Hess, Roise and Company, 1989
  The context for masonry-arch bridges addresses Minnesota's oldest and smallest population of historic bridges that were located on, carried, or crossed a highway. It includes a single design type, the arch, and three masonry subtypes: stone, brick, and composite. Some bridges appearing to be masonry are actually concrete or metal arch bridges with a stone veneer added for aesthetic purposes. Masonry-veneer bridges are covered in the contexts for reinforced-concrete bridges and iron and steel.

  Minnesota's 45 known extant public masonry-arch bridges on public highways (as of 1988) were divided into three geographical categories: 29 country bridges, 12 city bridges, and four park bridges. The country bridges were constructed of rubble stone masonry between 1878 and 1920 and are clustered in the southeastern counties. The city bridges were built between 1885 and

[5] Publicly owned bridges were included in these studies; however, non-highway bridges, such as those carrying railroads that do not cross a public road or those bridges that are privately owned, were not included in these studies.

1915 in four municipalities: Carver, Duluth, Minneapolis, and St. Paul. They are larger and display more architectural elements than country bridges. The four urban park bridges were built from the late nineteenth century through the 1930s. They generally have more decorative or architectural elements and were designed to be ornamental landscape features in addition to serving as transportation structures.

- "Historic Iron and Steel Bridges in Minnesota, 1873-1945"
  Prepared by Fredric Quivik, 1989
  The iron and steel bridge context extends from 1873 (the date of Minnesota's earliest surviving metal truss bridge, as of 1988) to the end of World War II. This period includes the pre-Minnesota Highway Commission (MHC) era of independent bridge companies and the post-1911 era of standard plans and specifications. The context includes iron and steel truss bridges (including pony, through, and deck variations), metal arch bridges, and multi plate arch bridges (a patented, corrugated-metal-plate design). The context's discussion of truss bridges includes many truss configurations and sizes erected over eight decades, through the work of numerous engineers, fabricators, and builders. The multi plate arch bridge is a single type utilized during the New Deal era, from 1933 to 1942, and is sometimes found with a stone veneer aesthetic treatment. The context does not include steel beam, girder, or rigid-frame bridges.

  Truss bridges with wrought-iron members are extremely rare and are identified by their pre-1890 construction date. Most extant Minnesota trusses were built after 1890 and have steel components. Factors contributing to the significance of a post-1890 truss bridge include truss configuration; the involvement of an important engineer, fabricator, or builder; or a construction date between 1905 and 1911, placing it under the new MHC programs. Deck trusses and metal-arch bridges are rare in Minnesota and therefore considered significant. A truss bridge exhibiting exceptional engineering design to meet unusual site conditions may also be significant.

- "Reinforced-Concrete Highway Bridges in Minnesota, 1900-1945"
  Prepared by Robert M. Frame, 1989
  Minnesota had three major eras of reinforced-concrete highway bridge construction. The period from the 1890s through 1911 included early experimental, non-standardized design; 1912 to 1921 involved early standard plans issued by the MHC; and 1921 to 1945 reflected the influence of the Minnesota Highway Department, the Trunk Highway System, and the construction of major urban bridges. Reinforced-concrete bridge subtopics include the influence of the MHC on the expanded use of concrete, major concrete-arch bridges built in the 1920s and 1930s, the design of park bridges, and the construction of concrete bridges under the federal-relief programs of the New Deal.

  Most reinforced-concrete bridge designs and innovations, including arch, slab, beam, and girder bridges, were established by World War I. Reinforced-concrete arch subtypes include the barrel arch, rib arch, and rainbow arch, sometimes called a through-arch or Marsh arch after a major builder. The concrete rigid-frame design was first used in the 1920s. Not included in the reinforced-concrete context are culverts, railroad bridges, and post-1945 construction techniques such as prestressed concrete.

Reinforced-concrete bridges built prior to 1912 and MHC standardization may incorporate early reinforcing designs, such as the Melan system. Bridges built after the MHC initiated standard plans are significant when they have very large spans (exceeding 100 feet) or are designed at the outer recommended limits for the span type. Additional elements adding to the significance of a reinforced-concrete bridge include the involvement of an important engineer, architect, or firm; the use of outstanding architectural style or ornamentation; and the involvement of a New Deal agency. The Twin Cities area was a center of advanced reinforced-concrete bridge design and construction in the 1920s and 1930s, resulting in several major arch bridges and two bridges of world-record dimensions: the Cappelen Memorial Bridge and the Mendota Bridge.

(3) Strategic Plan and List of Bridges for Field Survey

Prepared by Jeffrey A. Hess of Hess, Roise and Company, 1990 and 1991

This was a two-part project. The 1990 effort designed a strategic approach to developing a comprehensive survey sample, including an extension of the cutoff date from 1945 to 1956. The 1991 effort used the strategic approach to select a survey sample from MnDOT's 5,200 pre-1956 bridges, including bridges excluded from the previous projects. The analysis determined that 1,800 bridges were potentially eligible because they met minimum criteria of date of construction and span length.

(4) Historic Highway Bridge Inventory: The Survey Sample

Prepared by Jeffrey A. Hess of Hess, Roise and Company, 1995

This effort applied historic contexts and National Register criteria to further refine the list of 1,800 potentially eligible bridges created in the 1991 *List of Bridges for Field Survey*. The project also compensated for the attrition of historic bridge types that had occurred since 1991. A list of 857 bridges was developed for field survey and evaluation for National Register eligibility.

(5) Management Plan for Minnesota's Historic Bridges

Prepared by Jeffrey A. Hess of Hess, Roise and Company, 1997

This report presented the results of the field survey and evaluation of the 857 bridges identified in the 1995 report. It integrated and superseded the findings of previous studies listed above, as well as the *Historic Bridge Survey of Fillmore County, Minnesota* (1993) and the *Evaluation of 27 Bridges in Rock County, Minnesota* (1994). This report presented a list of 231 bridges considered to be eligible for the National Register as a result of the field survey and evaluation. The bridges did not represent a comprehensive list of all historic bridges in Minnesota because it did not include all bridges previously listed in the National Register.

(6) Management Plan for Historic Bridges in Minnesota

Prepared by Mead & Hunt and HNTB, 2006

The original *Management Plan for Historic Bridges in Minnesota*, which the present version serves to update, was part of a major initiative started by MnDOT in 2004 to provide information and guidance on the general management and long-term preservation of historic bridges in Minnesota. MnDOT's innovative approach to historic bridge management using the collaborative method that pairs a professional historian with a professional engineer was developed at this time. The initiative also involved preparation of individual management plans for certain state-owned bridges.

(7) Local Historic Bridge Study – Phase 1

Prepared by ONE and Mead & Hunt, 2012

The Local Historic Bridge Study is a multi-phase project spearheaded by MnDOT to focus on the state's historic bridges that are not MnDOT-owned, or those bridges owned by counties, townships, other state agencies, railroads (where such bridges cross over public roads), and certain private owners. Phase 1 of the project focused on engaging bridge owners about their concerns and questions relating to their historic bridges. Additionally, the project team collected available data on each bridge and identified gaps in historic and engineering assessments. This work made great strides in identifying needs and interests of local owners, leading the way for the second phase of the project.

(8) Minnesota's Bridges, 1955-1970

Prepared by Mead & Hunt, 2013

MnDOT built on earlier efforts by continuing to study bridges constructed in the post-World War II era. The era was characterized by rapid expansion of the state's infrastructure and new technical advancement in bridge construction leading to standardization in bridge design. As a result, thousands of bridges were constructed in 25 years. Rather than focusing on individual bridge types by material, this study evaluated bridges of a certain era, specifically addressing highway, pedestrian, and railroad bridges that carried or crossed a vehicular road and were constructed from 1955 through 1970. The study found 40 bridges from this period to be eligible for listing in the National Register. As of 2014 certain eligible bridges from the 1955-1970 period are being reviewed in light of the FHWA and ACHP *Program Comment for Common Post-1945 Concrete and Steel Bridges*.

(9) Local Historic Bridge Study – Phase 2

Prepared by LHB, Mead & Hunt and 106 Group, 2013-2015

In the second phase of the Local Historic Bridge Study, MnDOT prepared individual bridge reports (similar to the state management plans) for 126 historic bridges not owned or maintained by MnDOT. Historians reviewed or clarified National Register eligibility recommendations for 74 of the study bridges to provide needed historical background and documentation of the significance of the bridges. Findings were presented in detailed evaluations, known as Phase II evaluations, that document the National Register eligibility of these bridges. In addition, as part of the project, historians prepared eight National Register nominations at the request of bridge owners. Maintenance, Stabilization and Preservation recommendations are presented within individual bridge reports, as described in Section 4 of this plan. The assessments and recommendations are a collaborative effort between a bridge historian and bridge engineer.

(10) Midtown Greenway Corridor Bridge Evaluation

Prepared by ONE and Gemini Research, 2014-2015 (ongoing)

Hennepin County, in cooperation with MnDOT, is conducting a study of 27 bridges located within the Chicago, Milwaukee and St. Paul Railroad Corridor Historic District. The railroad corridor consists of a series of nearly identical overpass bridges constructed from 1912 to 1916 by the railroad to eliminate at-grade crossings. The railroad corridor was listed in the National Register in 2005 and currently serves as a pedestrian and bicycle trail. The study provides an engineering assessment of each bridge with recommended rehabilitation, stabilization, and maintenance activities. The assessments and recommendations are a collaborative effort between a bridge historian and bridge engineer.

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4. Management of Historic Bridges

Following the historic bridge identification process, MnDOT's attention turned to the management of this population of pre-1971 historic bridges. MnDOT has taken a proactive approach to management and preservation of historic bridges so that it can take advantage of the streamlining benefits of the Programmatic Agreement. These benefits are also available to non-MnDOT bridge owners who need to comply with federal and state laws regarding treatment of the bridges. Historic bridge management is designed to identify the specific issues for each historic bridge, streamline the process, and reduce the time and expense of fulfilling regulatory requirements.

This section begins with a summary of MnDOT's recent efforts to manage the state's population of historic bridges and continues with a detailed description of the process of developing a management plan for a historic bridge, centered on the selection of an option that will allow for long-term preservation. Since long-term preservation is the overarching purpose, demolition of a bridge following documentation of its historic features is not addressed as a recommended option. Following the review of options is a discussion of the collaborative approach, including the roles of the historian and the engineer and the nature of the ongoing dialogue that makes this approach valuable.

A. MnDOT's historic bridge management efforts

In 2004 MnDOT initiated a multi-part management project for Minnesota's historic bridges, including development of the first version of this plan. This early effort focused on developing individual management plans for some of the state-owned bridges. In 2013-2014 MnDOT continued its management efforts, this time with a focus on assisting other historic bridge owners.

(1) Preparation of individual management plans for state-owned historic bridges

Between 2004 and 2006 MnDOT commissioned individual management plans for state-owned historic bridges. Each individual management plan provided guidance for the long-term preservation of a single bridge, including specific maintenance, stabilization, and preservation recommendations. The objective of the plan is to preserve the structural and historic integrity and serviceability of a bridge while following the Secretary's Standards. Each plan includes a statement of historic significance, identification of character-defining features, observations on current conditions, a recommended option for long-term preservation, and recommended treatments for stabilization, preservation, and maintenance.

The individual management plan for Bridge 5827 in Zumbro Falls recommends continued vehicular use on-site. This metal, multi-plate, arch culvert features concrete headwalls, sidewalls, and stepped wingwalls that are veneered with ashlar limestone masonry executed in the Rustic style of the New Deal era. The engineering assessment found the structure to be in fair to good condition. No rehabilitation work is required, but activities to stabilize and maintain the structure, especially its masonry veneer, are presented in the plan.

The process for developing an individual management plan is described in detail in Section 4.B below. The MnDOT CRU can provide additional information about developing a plan and the individual plans already completed.

(2) Preparation of individual bridge reports for the Local Historic Bridge Study

In 2012-2014 MnDOT CRU and State Aid began a multi-year, multi-phased project focused on bridges not owned or maintained by MnDOT. Ultimately, the study aimed to provide local owners with useful management tools and ease the path forward for the continued preservation of their historic bridge, while at the same time engaging and facilitating public education. Phase I of the project (2012) focused on engaging bridge owners, data collection, and preparing general reports on each bridge. Phase II of the project (2013-2014) resulted in the preparation of 126 bridge reports (a related but separate effort is being conducted to address bridges crossing over the Midtown Greenway). The reports present historical evaluation and current engineering condition documentation for each bridge. Additionally, the reports provide recommendations for maintenance, stabilization, and preservation of the structure, as well as cost estimates for the work. The individual bridge reports are similar to the individual management plans for state-owned bridges.

(3) Documentation of historic bridges

Archival documentation of a historic bridge is completed for a variety of reasons, and may be required as a measure to minimize harm.[6] The NPS set a standard for documentation of historic properties, which was established by the Historic American Building Survey/Historic American Engineering Record (HABS/HAER). The standard for bridges is HAER documentation. The Minnesota Historic Property Record (MHPR) documentation guidelines were developed by MnDOT and SHPO as an alternative to HAER documentation. This was due to a misunderstanding that the NPS no longer wanted to receive HABS/HAER documentation unless a property was significant on a national level.

In 2003 MnDOT, in consultation with the SHPO, selected a number of bridges (state and locally owned) for MHPR documentation. Each MHPR meets the Secretary of the Interior's *Standards for Architectural and Engineering Documentation* and includes a historical report, which provides contextual property information and a reference to additional sources, and large- or medium-format photography. MHPRs are maintained in the manuscript collections of the MHS, where they are available to the public. Information in the MHPR reports are based on three historic contexts for Minnesota bridges: "Minnesota Masonry-Arch Highway Bridges, 1870-1945," "Historic Iron and Steel Bridges in Minnesota, 1873-1945," and "Reinforced-Concrete Highway Bridges in Minnesota, 1900-1945."

Subsequent to the completion of the MHPR documents described above, the NPS clarified its official policy of accepting any HABS/HAER documentation. They further noted that documentation of historic properties as part of a federal undertaking requires HABS/HAER documentation. State-funded projects that adversely affect a historic bridge may use MHPR or HAER documentation.

[6] The *Programmatic Section 4(f) Evaluation and Approval for FHWA Projects that Necessitate the Use of Historic Bridges* states as one measure to minimize harm, "For bridges that are to be rehabilitated to the point that the historic integrity is affected or that are to be moved or demolished, the FHWA ensures that, in accordance with the Historic American Engineering Record (HAER) standards, or other suitable means developed through consultation, fully adequate records are made of the bridge." This approval is made Pursuant to Section 4(f) of the Department of Transportation Act of 1966, 49 U.S.C. 303, and Section 18(a) of the Federal-Aid Highway Act of 1968 23 U.S.C. 138.

B. MnDOT's process

In sponsoring individual management plans for the state's historic bridges, MnDOT initiated an innovative approach to historic bridge management. At its heart is the collaborative process, in which a professional engineer is paired with a professional historian. In conventional bridge management, each of these professionals evaluates a bridge separately and submits separate findings and recommendations. Others are subsequently responsible for bringing the separate reports together to develop rehabilitation proposals. In the collaborative approach, the major steps in the process—survey, evaluation, and recommendations—are conducted jointly, requiring an ongoing dialogue between the engineering and historical perspectives. Refer to Figure 5 for an overview of this collaborative process.

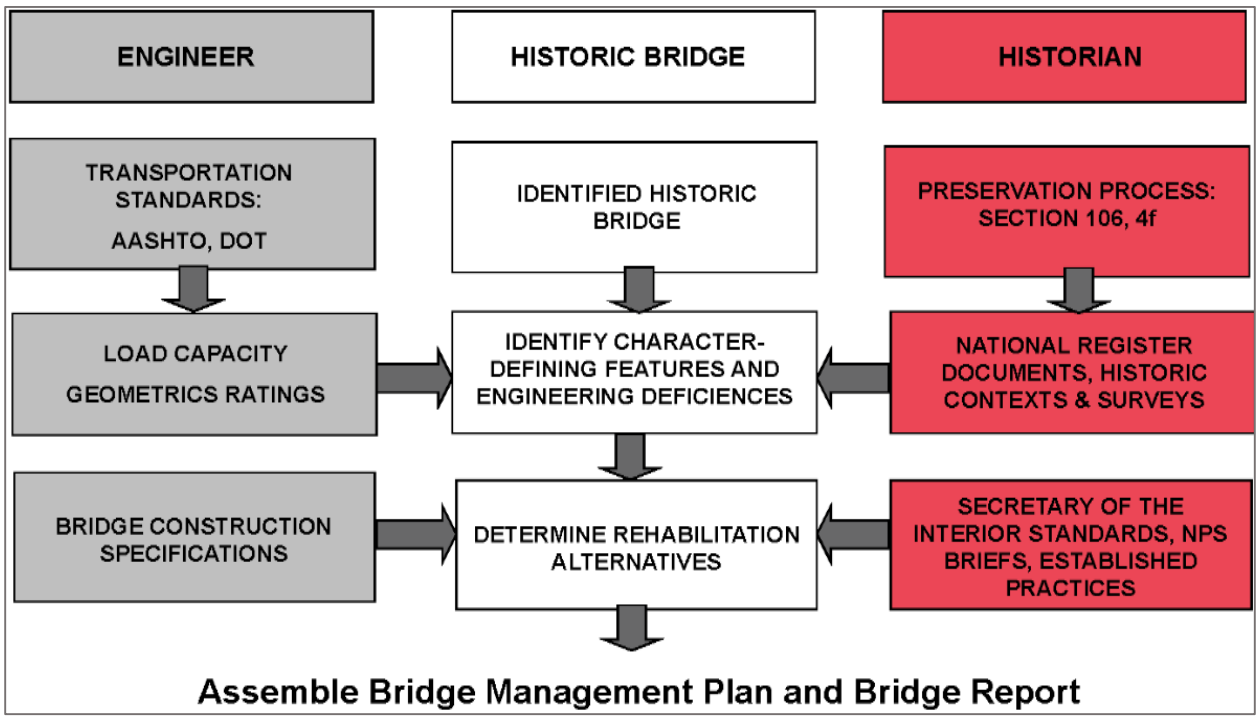


Figure 5. Chart outlining historian/engineer collaborative process.

C. Options for long-term preservation and future use

The goal of the individual management plan is to preserve a historic bridge in the way that best retains the qualities that give it historic significance while meeting transportation needs. MnDOT has identified five options for bridge preservation, one of which will be recommended as the preservation goal within an individual bridge management plan. The option selected is based on balancing the needs and regulatory requirements of transportation and preservation along with cost considerations. Once an option is selected, a plan is developed that recommends activities in keeping with the Secretary's Standards that allow the bridge to fulfill the requirements of the selected option for at least 20 years. Recommended activities to stabilize, preserve, and maintain a historic bridge once an option has been selected are addressed in Section 5.

Five basic options for historic bridge preservation are discussed below, arranged from most-preferred to least-preferred. The preferred option is retaining the bridge for continued vehicular use in its original location, because continued use provides the best opportunities for maintenance and funding. Certain historic bridges were designed with widths and load limits that cannot be adapted to current design standards without major alterations. In those cases, less-preferred options may be required to ensure a bridge's long-term preservation.

Federal and state policies recognize that existing bridges with less than desirable geometric criteria (width, horizontal alignment, and vertical clearance) can be retained when transportation needs are met. An owner should make every effort to avoid options that cause an adverse effect to the historic bridge. If an adverse effect cannot be avoided (i.e., a character-defining feature is altered or removed), mitigation may be required.

(1) Rehabilitation for continued vehicular use on-site

This is the preferred option because it represents the best combination of retaining historical features while meeting transportation needs. It can be less expensive than other options, including construction of a new bridge. A bridge is a good candidate for on-site rehabilitation if it can continue to fulfill a transportation need without extensive alteration or loss of its significant historic features. To continue in vehicular use at its current site, a bridge must meet the current and projected transportation needs. In this option, existing geometrics of the bridge and original historic fabric are retained to the maximum extent possible. For bridges with continued vehicular use, key guidance is provided in MnDOT's *LRFD Bridge Design Manual* (this acronym refers to Load and Resistance Factor Design) and MnDOT's *Bridge Preservation, Improvement and Replacement Guidelines* (BPIRG). Both documents are available at www.dot.state.mn.us/bridge/. Deviations from standard MnDOT practices related to bridge rehabilitation may be granted through design exceptions and variances as described in Section 5.

Constructed in 1912, Bridge L8505 is one of several reinforced-concrete arches clad in native Duluth gabbro on Seven Bridges Road. The bridge is significant for its aesthetics and is a contributing resources to the National Register-eligible Skyline Parkway. The bridge was rehabilitated in 2001 for continued vehicular use on-site. Rehabilitation efforts included reconstruction of the bridge parapet and repairs to mortar and concrete.

(2) Rehabilitation for less-demanding use on-site

This option allows the bridge to remain in its original location, but with reduced transportation requirements in order to avoid major and unacceptable alterations to historic features. In this option, demands on the bridge may be reduced by making it one of a pair of bridges, each of which could serve traffic in one direction, or by rerouting heavy truck traffic. Either a relocated historic bridge or newly constructed bridge could be erected adjacent to the historic bridge to serve additional traffic. For example, an existing two-lane bridge would carry one-direction traffic with the twin structure carrying traffic in the other direction. A drawback of this option is cost, because it usually involves the construction of a second bridge. Another approach is to remove vehicular traffic and rehabilitate the bridge for less-demanding pedestrian and bicycle traffic.

An example of a historic bridge successfully converted to bicycle and pedestrian use at its original site is the Walnut Street Bridge (Bridge R0412) in Mazeppa, Wabasha County. The 1904 Pratt truss bridge had been closed prior to its rehabilitation. Work included replacing the existing timber walkway, bearings, truss members, stringers, piers, abutments, and hand railing. The bridge provides access from the downtown to a city park and ball fields. In 2002 the rehabilitation project was recognized by the Preservation Alliance of Minnesota and received an Honor Award.

(3) Relocation and rehabilitation for less-demanding use

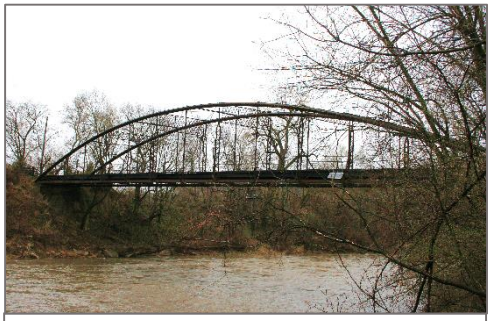
If an on-site option would require unacceptable alteration or loss of historic features, relocation becomes an alternative solution. It may be possible to reuse a bridge at a new location, such as on a private road, or other less-demanding vehicular or non-vehicular route. A site over water where the bridge serves a transportation function, such as carrying a pedestrian trail, is more desirable than a non-transportation site. Several truss bridges in Minnesota have been moved to other locations during their normal service life. Individuals, organizations, and state or local agencies may be interested in assuming ownership of a historic bridge if they have a need for a bridge or have a strong commitment to preservation. Disadvantages for this option include the need for a new location and owner, and the cost of relocation. This option has a narrow application because most bridges are not candidates for relocation due to their size, design, and construction materials. Special considerations for bridge relocation are identified in Section 5.

An example of a historic bridge successfully moved to a new location for less-demanding use is Bridge 1482 in Rock County. Originally located over the Rock River between Luverne and Clinton Townships, this king-post pony truss with A-shaped truss configuration was relocated to Schoneman Park just south of Luverne on Highway 75 in 1990. The bridge currently spans a small pond and the approaches are unpaved.

(4) Closure and stabilization, pending future use

This option may be considered a variation on Option 3 (relocation), since eventual relocation is desired, but not immediately available for reasons of funding, ownership, or site selection. If a future use is expected when funding is available, the bridge can be closed and stabilized until further action is taken. However, if a bridge does not fulfill a transportation need at its original site and it is not feasible to relocate the bridge to a new site due to structural limitations, lack of funding, inability to identify a viable

new owner, or lack of public support, it may be possible to construct a bypass structure and close and stabilize the existing bridge in place.

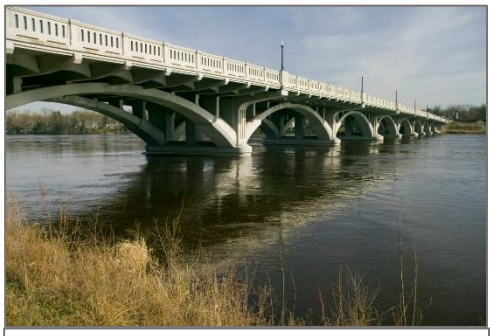


Bridge L5669, or the Kern Bridge, is significant for its wrought-iron bowstring construction. Constructed in 1873, it is one of the earliest extant bridges in Minnesota. The bridge is planned to be removed and relocated to a new crossing. Prior to this effort the bridge should be stabilized in place to ensure its continued preservation.

In this situation, procedures should be adopted to reduce liability and to monitor the condition of the bridge. Minimal maintenance (washing and spot painting) and periodic inspections should continue. The bridge closure should be clearly posted and a vehicle barrier should be installed to limit pedestrian and vehicle access to the bridge. Removal of the bridge deck may also be appropriate as a means of limiting access to the structure. Vandalism of an out-of-service structure is a serious concern and protective measures should be implemented. A serious liability for this option, if the closure becomes long-term or indefinite, is the decreasing likelihood of funding and maintenance and the increasing possibility of the loss of the historic structure through deterioration and neglect.

(5) Major alteration while preserving substantial historic fabric

In this option, a deficient bridge is altered to incorporate improvements that allow the bridge to fulfill a transportation need. Major alteration is the least-preferred option because it results in the greatest loss of historic fabric. New materials and features may need to be introduced to allow the bridge to meet design standards and continue in vehicular use. For example, an adjacent span may be required to accommodate widening the bridge. However, this option keeps the bridge in service and may be the only available preservation option for a bridge that cannot be relocated. It avoids long-term closure. The following are important considerations: retention of as much historic fabric as possible, compatibility of reconstructed elements with the retained historic elements, and preservation of the original design integrity of the bridge. With careful planning and execution this option can meet the Secretary's Standards.



Bridge 4380, known as the Anoka-Champlin Bridge, exemplifies the preservation option of major alteration while preserving as much of the bridge's historic fabric as possible. One of the major historic reinforced-concrete-arch highway bridges in the Twin Cities, the bridge features an open-spandrel, rib-arch design that provided a typical solution to the engineering challenge of spanning a large river crossing. Because the bridge was an important urban highway crossing, it received Classical embellishment. In the 1996 rehabilitation, the bridge's Classical Revival details were either preserved or reconstructed.

D. Individual plan preparation

The overall goal of an individual management plan is established by the preferred option for a historic bridge. Included in the plan are recommendations for stabilization, preservation, and maintenance activities that support the selected option for a 20-year period. In order to determine the appropriate option, however, the bridge is first field-surveyed and evaluated by a historian and an engineer. The initial result of the survey and evaluation is the selection of

the best management option, followed by the preparation of recommendations and the compilation of all the bridge data, history, observations, and recommendations into a final management plan.

The historical and engineering survey and evaluations can be conducted separately (the conventional approach) or jointly (the collaborative approach). Both are discussed below and the advantages of the collaborative approach, as identified in MnDOT's experience, are noted.

(1) Survey and evaluation: the conventional approach

In the conventional approach, the historical survey and the engineering survey are completed separately and independently of each other. A historian, who is trained and experienced in engineering and bridges, travels to the bridge site and examines the structure in light of its description and significance as established in the Phase II evaluation, also known as a Determination of Eligibility, or National Register documentation. In particular, the historian notes the distinctive features that contribute to the bridge's significance. This information is delivered to the bridge owner and, in turn, to the SHPO for integration with any existing historical data in its records. Meanwhile, the engineer compiles the standard engineering data about the bridge through the MnDOT inspection process. The engineering evaluation assesses the condition of the bridge and present determinations about the bridge's future. Through a variety of conversations and negotiations among the various parties (owner, SHPO, MnDOT offices, consultants) the historical and engineering evaluations are brought together into a work plan for the bridge's future.

Because the conventional approach has separate field surveys and evaluations, the process can be lengthy and inefficient. The different goals and regulations for the historian and the engineer may not be mutually understood and appreciated. The historian is focused on historical issues and regulations and the engineer is focused on transportation issues and regulations. The collaborative approach, discussed below, with the historian and engineer working together on the management issues can prove more efficient and successful.

(2) Survey and evaluation: the collaborative approach

In developing individual management plans, MnDOT integrated the separate historical and engineering efforts into a single endeavor.[7] In the collaborative approach, a professional historian and a professional engineer, both experienced in historic bridge evaluation, conduct the field surveys together. Following field survey, they review issues and discuss stabilization, preservation, and maintenance recommendations together for each bridge. A management plan for each bridge is prepared that includes the analyses and recommendations of this interactive approach.

The collaborative approach to field survey and evaluation is not only more efficient than the conventional approach, it also makes better use of the skills and experiences of the historian and engineer by allowing ongoing, interactive consultations. The overall purpose—management of a historic bridge for ongoing transportation purposes—remains at the center of the process from beginning to end. Each professional evaluates the bridge with the other's interests, concerns, and regulations in mind. They interact regularly

[7] Plans commissioned by MnDOT between 2004 and 2006 were prepared using the collaborative approach. One plan (Bridge 5557) prepared for MnDOT successfully followed the conventional approach.

with the understanding that any final recommendations must accomplish the combined purpose of historic bridge management.

The collaborative approach also places the two processes in the same timeframe. Rather than have the historical regulatory review occur at the end of the planning and engineering process, the efforts are tightly integrated into a common schedule. The integration provides predictability for the bridge owner, who can have a better understanding of the regulatory outcome earlier in the process, for the historic bridge. See Section 2 for a description of regulatory requirements and applicable review processes.

E. The historian's role

In the field survey and evaluation process, the bridge historian is guided by the bridge's Phase II evaluation or National Register documentation, which was created in the identification process (see Section 3). In particular, the historian evaluates the bridge for its character-defining features, which are based on the statement of significance.

(1) Understanding significance

As introduced in Section 2, the National Register is the official list of historic properties deemed worthy of preservation. Historic properties, including bridges, are evaluated for National Register eligibility under four criteria—A, B, C, and D—and may be eligible under one or more criterion. A property can be eligible under *Criterion A* for an association with general trends and patterns of history or *Criterion B* for an association with a significant person. Properties eligible under *Criterion C* are significant for their design or construction. Eligibility under *Criterion D* recognizes a property's potential to yield information important in prehistory or history. Determining which criteria apply is key to understanding a historic bridge's particular significance.

Criteria B and *D* rarely apply to bridges and no examples in Minnesota have been determined eligible under these criteria. To be eligible under *Criterion B*, a bridge would need to illustrate the important achievements of a significant person. Significant works of important artisans and engineers are recognized under *Criterion C*, instead of *Criterion B*. *Criterion D* is typically applied to archaeological remains from which information may be gleaned.

Bridge 4969 is significant under *Criterion A* for its association with the founding and history of Camp Ripley. Its historical importance can be understood within the context of the development of Camp Ripley, which opened to Minnesota Guard units in 1931. The bridge served to connect the new Camp Ripley with existing railroad and highway transportation systems. Bridge 4969 also has significance under *Criterion C* for its unusual engineering solution to a bi-modal transportation problem by combining a railroad bridge with a vehicular bridge in a single structure.

Criterion A recognizes bridges that have an important association with single events, a pattern of events, repeated activities, or historic trends that are significant within the context of Minnesota's transportation and bridge-building history. Some Minnesota bridges are significant under *Criterion A*, such as Bridge 4969, the Camp Ripley Bridge. The creation of Camp Ripley in 1929 was contingent on the rail and highway access provided by this bridge, which provided both in a single structure.

Criterion C recognizes bridges that have distinctive design or construction characteristics that demonstrate the following: (1) the pattern of features common to a particular class of resources, (2) the individuality or variation of features that occurs within the class, (3) the evolution of that class of resources, and/or (4) the transition between classes of resources. Most historic bridges in Minnesota have been determined to be significant under *Criterion C*. For example, Bridge 27552, a steel rigid-frame bridge constructed in 1968 in Hennepin County, is significant for its high artistic value and as an uncommon type in the state. The next topic, establishing character-defining features, is closely tied to understanding why a bridge is significant.

(2) Establishing character-defining features

During field survey and evaluation, the historian's task is to identify the bridge's 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. Features may include structural or decorative details and materials. Such features may include materials, engineering design, and structural and decorative details that are essential to a bridge's historic identity. Under *Criterion A*, physical features that convey the bridge's appearance during the historic period would be considered character-defining. Under *Criterion C*, character-defining features are those that convey a bridge's distinctive design or method of construction.

Bridge L5245, located in Jackson County, is the only example of a laced top chord bridge in Minnesota. The superstructure of the bridge, including the laced bridge members, is a character-defining feature.

The architectural detailing of the Robert Street Bridge (Bridge 9036), which spans the Mississippi River in downtown St. Paul, is a character-defining feature. Minnesota architect Roy Childs Jones added architectural detail to the surfaces of the arches and piers to create highlights and shadows that served, in his words, "in place of the unattainable color interest" inherent in concrete. This feature includes the 12, large, concrete medallions mounted on the piers, floor-beam ends, reconstructed ornamental railing, and bronze dedication plaques. The overall stylistic effect is Moderne.

Because many historic bridges are significant under *Criterion C* as examples of their bridge type, such as metal truss, deck truss, concrete arch, or masonry arch, the superstructure of a bridge is often a character-defining feature in itself. For example, Bridge 4190, the Fort Snelling-Mendota Bridge over the Minnesota River, is significant under National Register *Criterion C* for its continuous concrete-arch design and the arch ribs constitute a character-defining feature. The wrought-iron Pratt truss superstructure of Bridge 89852 in Washington County (formerly Bridge 5721) is a character-defining feature both for its truss design and for its wrought-iron material.

Smaller elements, such as ornamental railings, also may be character-defining features. Bridges built during the New Deal era are often significant under *Criterion C* for their distinctive craftsmanship that features ornamental stone masonry veneer over a reinforced-concrete superstructure. In those cases, stone masonry work can be identified as character-defining. Architectural detailing was used for urban gateway bridges because the design elements could be formed in the concrete used for piers, abutments, and railings. Examples of architectural and aesthetic detailing as character-defining features include the Robert Street Bridge (Bridge 9036), with Moderne styling, and Bridges 5151 and 5083 in Marshall, which received Classical Revival detailing specifically because they were in urban sites on a state highway route.

Finally, site and setting may be considered character-defining features when they are major elements contributing to the significance of a bridge. The Stone Arch Bridge (Bridge 27004) and Third Avenue Bridge (Bridge 2440) in Minneapolis are historic components within the larger St. Anthony Falls Historic District. The setting for these bridges includes the falls and a dam system that channeled water into mill ponds that provided water power for the flour-milling district.

A character-defining feature for Bridge 6263 is its location within the National Register-listed Forestville Historic District. The district is significant as a frontier settlement beginning in the 1850s.

(3) Applying the Secretary's Standards

As introduced in Section 2, the Secretary's Standards are central to the dialogue between the historian and the engineer. Use of these standards can connect the requirements of historic preservation laws with transportation needs and guide the engineer's recommendations for bridge stabilization, preservation, and maintenance.

The Secretary's Standards provide four general approaches to the treatment of historic properties: Preservation, Rehabilitation, Restoration, and Reconstruction. Because the standards for rehabilitation acknowledge the need to alter or add to a historic property to meet continuing or changing uses while retaining the property's historic character, they provide appropriate general guidance for bridges. Provided below are the basic concepts of the Secretary's Standards for Rehabilitation.

- Use the property as it was used historically or find a new use that requires minimal change to distinctive features.
- Preserve the historic character (continuum of property's history).
- Do not make changes that portray a false sense of historical development.
- Repair deteriorated historic materials and features. Replace a severely deteriorated feature, using to the greatest extent possible, matching new materials.
- New additions and alterations (i.e., elements that were not part of the original bridge but may need to be added for modern safety standards) should not destroy historic materials or character. New work should be visually compatible with the old, yet be differentiated from it (i.e., the form, features, and detailing of the historic structure should not be replicated in the new work).

The management plan for Bridge 3589 over the Stewart River north of Two Harbors presents preservation recommendations that draw upon the Secretary's Standards. Built in 1924 and widened in 1939, this single-span structure features side-by-side, filled-spandrel, reinforced-concrete arch barrels and Classical Revival architectural details. The bridge does not meet current design and safety standards. To keep it in service, additional widening is recommended. Recommendations call for the 1924 spandrel wall to be preserved by widening the bridge on the 1939 side and recreating original details on the new spandrel wall.

Because the Secretary's Standards were designed primarily for buildings, the Virginia Transportation Research Council prepared guidelines for bridge maintenance and rehabilitation, based on the Secretary's Standards, to address the special requirements of historic bridges. Published in the Council's *2001 Final Report: A Management Plan for Historic Bridges in Virginia*, these guidelines provide useful direction for undertaking historic bridge preservation and are included in Appendix B.

In the individual management plan, the Secretary's Standards are used to guide the preservation of character-defining features, historic fabric and, where appropriate, setting.

F. The engineer's role

The role of the engineer is to conduct an engineering survey and evaluation to confirm general bridge information found in conventional resources (construction plans, inventory reports, inspection reports, and engineering studies) and in historical documents (Phase II evaluations, Minnesota Architecture/History Inventory Form, National Register nomination forms). The survey also records the physical condition and setting of the bridge. The engineering survey and evaluation is used to prepare recommendations for the selected option for future use. These recommendations include stabilization, preservation, and maintenance activities (see Section 5 for technical guidance). The engineer also is responsible for estimating costs of the recommended activities and suggesting cost-benefit analyses for the plan while being mindful of the bridge's National Register status and preservation goals. Elements of the engineering survey and evaluation are described below.

(1) Assessing transportation needs at the site

As an integral component of a transportation network, a bridge requires the physical characteristics that permit the safe passage of goods and people on the highway system. This includes adequate geometrics (deck width and vertical clearance), adequate load capacity (inventory and operating ratings), and adequate safety features. In general, the requirements are based on those published in MnDOT's BPIRG and Section 2 of MnDOT's *LRFD Bridge Design Manual* (abbreviation in title stands for Load and Resistance Factor Design). Requirements for some of the design parameters vary with Average Daily Traffic (ADT) volumes, posted speed, and other variables. Limited deviations from MnDOT's normal requirements, known as design exceptions and variances, may be granted as presented in Section 5. Data for traffic accidents in the vicinity of the bridge should also be reviewed. If the number of accidents is unusually high, the engineer should evaluate the features of the bridge for contributing factors. In cases where truck traffic is greatly influencing roadway safety or the bridge's structural capacity cannot be increased to facilitate heavy truck posting loads, the presence of an alternate route with minimal detour length for trucks makes it easier to apply exceptions.

(2) Assessing bridge condition

The assessment of the bridge's physical condition follows procedures used for conventional bridge inspection as described in MnDOT, FHWA, and other documentation. Assessment relies heavily on existing inspection reports because access to all areas of the structure during the field survey may not be possible without specialized equipment. The engineer will also provide overarching observations, addressing such questions as:

- Is there embankment erosion or movement?
- Is roadway drainage reaching and damaging the bridge?
- Is the bridge scour susceptible or has the waterway channel migrated?
- What is the water level during a 100-year flood event?

Many site and bridge-specific characteristics should be combined to assess the condition of the bridge and its capacity for continued use and preservation.

(3) Assessing rehabilitation needs

Some rehabilitation needs are obvious and can be readily observed at the site or found in inspection reports (e.g., replacing embankments that have eroded away). Other needs are more subtle and may require additional analysis (e.g., refined load rating methods) or testing (e.g., chloride contamination of concrete elements) to confirm a rehabilitation need. The rehabilitation needs for a specific bridge are directly related to the recommended preservation option. For example, a bridge recommended to be rehabilitated for a less-demanding use (Option 2), such as a bicycle path, may have reduced crash and structural criteria for railings or overall bridge load-carrying capacity and not require the level of rehabilitation necessary for continued vehicular use on-site (Option 1).

(4) Estimating costs

The engineer may use multiple sources to estimate costs for stabilization, preservation, and maintenance activities. Some activities require specialized equipment, techniques, and materials to preserve or repair character-defining features (e.g., use of rivets or button-head bolts adds expense due to the limited number of skilled professionals able to perform the work). Customized activities required for preserving a historic structure may be more costly than repairs to a non-historic bridge because the efforts are often more labor intensive and require unique skills. Past bid tabulations, cost-estimating manuals, and local engineering, architectural, and construction contractor resources may be utilized to develop cost estimates. Cost estimates for preservation efforts require detailed investigations and associated repair plans. Therefore, until investigations and repair plans are completed, cost estimates are considered gross estimates that are appropriate only for determining programming project cost. The development of preliminary plans based on detailed fieldwork will improve the precision of cost estimates. Finally, actual costs may vary significantly from early cost estimates. Prudence suggests the inclusion of contingency funds for unanticipated costs and to account for the construction contractor's indirect costs associated with specialized work.

G. Conclusion

The five options presented in this section are not equally viable for all bridges. The engineer and the historian need to assess the feasibility of each option for a particular bridge following field survey. For example, relocation is a realistic possibility for a small truss bridge, but unrealistic for a large, monumental bridge such as the Stone Arch Bridge in Minneapolis. Site constraints might make construction of a bypass or parallel structure difficult due to expensive right-of-way acquisitions in an urban location or a lakeside setting with insufficient room for a second bridge.

Once the team comes up with its recommendation, it is up to the bridge owner, in consultation with appropriate regulatory agencies, to determine a course of action. Figures 1, 2, 3, and 4 (see Section 2) illustrate the process for complying with state and federal regulations, as applicable based on the source of funding. If demolition of a historic bridge is ultimately selected after other options have been considered and determined not to be feasible, mitigation of the adverse effect to the historic bridge would be required.

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5. Technical Guidance

Preserving a historic bridge requires the specialized knowledge of experienced engineers and historians. Maintenance and preservation activities vary depending on the bridge's structural system and material. MnDOT has extensive experience maintaining and rehabilitating bridges. This experience has been incorporated into documents assembled and maintained by the MnDOT Bridge Office. While not specifically tailored to historic bridges, the following MnDOT documents should be referenced when undertaking a project:

- *Bridge Preservation, Improvement, and Replacement Guidelines*
- *LRFD Bridge Design Manual*
- *Standard Specifications for Construction*
- *Bridge Special Provisions*
- *Bridge Standard Plans*
- *Bridge Details Manual*
- *Aesthetic Guidelines for Bridge Design Manual*

For further information or to obtain documents, contact the MnDOT Bridge Office (see Section 7).

The following guidelines are intended to provide engineers with technical guidance to deal effectively with different bridge types and materials. Special considerations for relocating bridges and applying design exceptions or variances are described in Section 5.E. MnDOT's policy and program for context-sensitive solutions is also introduced.

For bridges with individual management plans, engineering recommendations for maintenance, stabilization, and preservation are specifically tailored to a bridge. See the individual management plan for specific guidance for the bridge activities. For bridges without individual management plans, this section can provide guidance on various engineering recommendations. Recommendations presented in this section are typically general in nature. Individual management plans will provide more details as to the appropriate method of maintenance and stabilization techniques. Further collaboration between the historian and engineer is necessary prior to undertaking recommended activities.

A. Recommended stabilization activities

As noted in the definitions for this plan, stabilization is the process of sustaining a bridge in its present state by means of making minor repairs until a more permanent repair or rehabilitation can be completed. Stabilization activities associated with a given bridge should be completed prior to preservation and maintenance activities in the interest of extending the life of the historic fabric. Common stabilization activities that may be employed include the following:

- Prepare and spot-paint corroded elements with section loss.
- Reattach masonry or concrete members, which could fall from structure or be lost, prior to performing preservation work.
- Lubricate bearings, rollers, and other slide elements.
- Seal or patch cracks in pavement.

- Remove vegetation growing in masonry or concrete joints.
- Remove soil and vegetation accumulated adjacent to piers, wingwalls, steel elements, bearings etc.
- Install slope and scour revetment materials to decrease or arrest scour potential.
- Secure to prevent unwanted access.

B. Recommended inspections

Maintaining a historic bridge also includes activities such as inspections and monitoring. As noted in the definitions for this plan, inspections are periodic field assessments and subsequent consideration of the fitness of a structure and the associated approaches and amenities for safe function. Monitoring involving periodic evaluations by bridge maintenance personnel may be used for bridges with significant deficiencies.

Any structure defined as a "bridge" (per Minnesota State Rule 8810.8000, Subpart 2) must be inspected in accordance with the National Bridge Inspection Standards (NBIS). This definition includes any structure with a span of 10 feet or greater that carries or crosses a public roadway. The type and frequency of inspections will vary according to the type, function, and condition of the bridge. Inspections can range from routine (visual examination from ground level) to in-depth (close-up inspection using specialized equipment).

"Fracture critical" bridges, such as truss bridges, that lack structural redundancy, or bridges with unique structural features, have more stringent inspection requirements. Bridges with severe structural deterioration may require more frequent inspections or special monitoring. Bridges with submerged substructure components (that cannot be inspected with waders) require underwater inspections. Bridges designated as "scour critical" require monitoring during high water conditions.

Bridges typically receive a routine inspection annually. Under certain conditions, an owner can petition to have routine inspections conducted on a two-year cycle. Specialized inspections for bridges that are performing well are usually conducted in four- or five-year cycles. An increased frequency of inspection may be used to monitor bridges with significant deficiencies.

Due to the small population of historic bridges in Minnesota and a desire to address observed deficiencies quickly (to minimize the amount of historic fabric lost), it is recommended that routine inspections for historic bridges be conducted annually. Inspections of historic bridges should be completed by qualified individuals who understand the Secretary's Standards and have knowledge of the bridge's character-defining features. If an individual management plan has been prepared for the bridge being inspected it should be consulted for specific guidance regarding inspections.

Inspections are used to confirm bridge inventory data (e.g., geometrics and safety features), to assess the current condition of components (e.g., railings, deck, superstructure, and substructure), and to evaluate appraisal items (e.g., roadway alignment, waterway adequacy). Deficiencies noted during the inspection are recorded and in many cases become maintenance work items for the bridge owner.

Bridge inspections must be performed in accordance with MnDOT requirements, which specify training for inspectors and the format in which inspection data must be collected and reported. MnDOT is required to provide the FHWA with annual inspection updates for the state's bridges. For further information, contact the MnDOT Bridge Office (see Section 7).

C. Recommended preservation activities

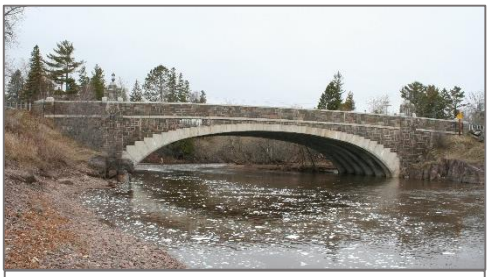
As noted in the definitions for this plan, preservation means the act or process of applying measures to sustain the existing form, integrity, and material of a historic property. Such measures, as described in this section, may involve repair, strengthening, or replacement of bridge components directed at keeping historic bridges in long-term use. For practical purposes, "long-term" is taken to mean 20 years into the future. A 20-year window was chosen as an upper limit of how far reasonable predictions can be made regarding how any given bridge will react to its existing and proposed environment with the information that is available at the time preservation activities are planned.

It is important to reiterate that MnDOT's BPIRG, which typically guide bridge projects in Minnesota, describe preservation differently in that they do not include considerations for maintaining historic integrity. However, these guidelines will be updated to address this discrepancy in the future. The Secretary's Standards, as discussed in Section 2, should guide decision-making when determining which actions are required. In addition, the NPS provides technical guidance in its series of preservation briefs (see Section 7).

Many methods of preservation are available and selection of actions required will depend on condition, function, and bridge type, among other factors. Figure 6 shows the relative cost of the various methods for preservation. Prior to implementing preservation activities, material testing, supplemental fieldwork, and engineering studies may be warranted. The following describes preservation efforts that may be employed, categorized by bridge material and/or type.

(1) Masonry bridges – recommended activities

- Mortar analysis − A mortar analysis should be conducted by a qualified professional prior to implementing preservation activities for purposes of specifying the mortar mix to be used during rehabilitation. The analysis should be consistent with the intent of the NPS *Preservation Brief 2: Repointing Mortar Joints in Historic Masonry Buildings*. The fundamental goals of the mortar analysis should be to (a) match the historic mortar in color, texture, and tooling; (b) match the repointing mortar sand with the historic mortar to the extent possible; (c) specify a repointing mortar of greater vapor permeability and less compressive strength than the stone masonry; and (d) specify a repointing mortar as vapor permeable and with the same, or less, compressive strength as the historic mortar.



The Lester River Bridge (Bridge 5772), located along Highway 61 on the North Shore of Lake Superior north of Duluth, is a reinforced-concrete arch with character-defining features that include a distinctive stone masonry veneer and railings. The bridge was hit by a truck in 2005, destroying most of the south railing. The south railing reconstruction, accomplished in 2005, used salvaged stone and followed original plans but was designed with a reinforced-concrete core to meet current standards. A mortar analysis determined the appropriate mix for use in repointing joints. The remainder of the bridge was rehabilitated and north railing reconstructed in accordance with the Secretary's Standards in 2010.

- Repointing of mortar joints – Repointing is essential to maintaining strength, preserving masonry work, and limiting moisture infiltration. Repointing of mortar should be consistent with the findings of the mortar analysis. A historically appropriate material must be used and the joint must be tooled consistent with original joints. For further guidance, refer to NPS *Preservation Brief 2: Repointing Mortar Joints in Historic Masonry Buildings*.
- Masonry replacement – When the condition of the original masonry is so deteriorated that it precludes repair, replacement is a durable method of repair. To the extent possible, masonry should be replaced in-kind. Mismatching of materials may result in visual incongruence and may weather differently. Replaced masonry should match the size, composition, and coursing pattern of the original components.
- Masonry re-anchoring – Re-attachment of loose masonry wall stones and cap stones may be a necessary repair. Often, drilled through and dowel anchor pins or embedded epoxy screen anchors are employed. Regardless of method used it is important the system be entirely compatible with the in-place masonry and that it be concealed so as not to alter the aesthetics of the historic fabric.
- Coating (use with caution) – Applying a penetrating (clear) coating may provide an effective means of protecting friable masonry with little or no change in visual appearance. However, it requires complete understanding of in-situ materials and coating materials because, if the coating traps moisture within the masonry, future freeze-thaw cycles can result in accelerated deterioration of the masonry. Chemicals within some masonry coatings can also be incompatible with and harmful to certain masonry components. As a result of this, careful in-field testing and thorough assessment is recommended if use of coatings is considered. For further guidance, refer to NPS *Preservation Brief 1: The Cleaning and Waterproof Coating of Masonry Buildings*.
- Cementitious patches (use with caution) – These applications will not be compatible with existing masonry and may spall masonry adjacent to the patch. A careful mix design may result in color similar to existing masonry. This method should be considered temporary and is recommended only if other means of repair are not possible.

(2) Masonry arch bridges – recommended activities

- Internal reinforcement of arch barrel – As a method to restore solid interaction between adjacent stones, which is imperative to the strength of an arch, use of grouted steel reinforcement anchors can be considered. This method utilizes a proprietary system consisting of steel reinforcement positioned within a confining tube of fabric and grouted in place. The anchors are strategically placed within voids and regions where it is observed adjacent materials may be soft and are also often placed in a systematic grid formation. This repair should have little or no visual effect.
- Distribution overslabs – Adding a reinforced concrete slab over the top of an arch structure allows for more even distribution of vehicle wheel loads with little or no change in visual appearance. This method of repair typically requires that a bridge be closed while the slabs are added.
- Lateral restraint of filled spandrel walls – Adding proprietary grouted steel rods internally or anchored steel rods externally will provide bridge structures with lateral restraint and may have little or no effect on the visual appearance of the bridge.

- Masonry stitching – Restoration of structural integrity can be accomplished with the addition of proprietary grouted steel rods placed internal to the bridge, radial to the arch, or normal to the centerline. This technique can also be applied diagonally to cracks to restore structural integrity.
- Replacement of fill with concrete – Replacing fill with reinforced concrete provides an effective method of strengthening structural support for filled arch bridges. This technique typically does not alter the visual appearance of the bridge structure.
- External reinforcement of arch barrel (use with caution) – Used as a last resort to improve stability or structural capacity, the external reinforcement of the arch barrel changes the overall appearance of the bridge. Steel rings encased in concrete, reinforced concrete, or steel framework are added to the bridge to provide support of the external arch at the spring-lines.

(3) Metal bridges – recommended activities

- Cracking or fractures – Cold stitching can be used to restore the strength of casting while retaining its historic appearance. Although cast and wrought iron can be used to replicate historic elements, they should not be used to replace structural elements. When performed by certified fabricators in their welding facilities, or in the field with proper precautions, steel members may be repaired by means of welding.
- Section loss – Replacing a member in-kind is an effective way to retain the original appearance of the bridge. Riveting or welding new (supplemental) plates to a bridge member can also be an acceptable activity depending on the location and size of the repair and its resulting impact to the component's appearance. Extensive welding or plating should be avoided, if possible, since it is likely to substantially alter the historic appearance.
- Surface corrosion – Subjecting members to a power wash or abrasive blast cleaning at an appropriate psi (typically not higher than 400 psi) so not to damage the historic elements is an effective means of addressing existing surface corrosion. If lead paint is present, proper containment and disposal is required. This should be conducted prior to painting, metallizing, or galvanizing.
- Straightening (use with caution) – Straightening is an appropriate means to repair deformations, if deemed to be necessary. The application of heat-straightening techniques by experienced personnel is a viable alternative for repair.
- Rivet replacement – Replacement of corroded, damaged, or otherwise deficient rivets should be completed using hot-formed steel button-head rivets of equal shank diameter. If replacement of rivets in-kind is cost-prohibitive, button-head bolts of similar shank diameter should be used to replace those rivets that require replacement. However, consideration needs to be given to clearances needed for the installation of button-head bolts. If the use of button-head bolts is not feasible, conventional structural steel bolts may be used.

(4) Concrete bridges – recommended activities[8]

- Seal cracks – Repairing cracks protects the bridge structure. By identifying the origin or the mechanism of the crack, the appropriate and approved repair techniques can be applied. When performing crack repairs with injected materials it is important to utilize a material that matches the adjacent material color to the extent possible, and to use application techniques that limit the spread of material onto the adjacent surfaces.
- Special surface finish – Applying a special surface finish may provide an effective means for protecting the bridge; however, it should be considered only on a case-by-case basis and is not permitted as a general rule. In general, only historic bridges with pre-existing special surface finishes may be treated with new special surface finishes to match what is already there. MnDOT CRU approval and SHPO concurrence will be necessary before applying any special surface finishes. The finish typically consists of an acrylic or latex base mixed with elements of Portland cement tinted to match the existing surface finish. The special surface finish creates an overall uniform appearance for the structure, which is *not* a desired goal in historic bridge concrete repair. Future maintenance will be required at 25-year intervals due to cracking and spalling.
- Replace concrete with a patch repair – Replacing a deteriorated concrete surface protects the steel reinforcement that is underneath; however, it may promote the corrosion of reinforcement in concrete adjacent to the repair if the repair is not performed properly. Upon removal of the deteriorated concrete, any exposed reinforcing should be sandblasted, cleaned, and coated with a rust inhibiting product. The replacement concrete material should be selected to be compatible in composition with the adjacent concrete and should be formed and finished to match the surrounding historic concrete in color and texture (including any necessary exposed aggregate). There are multiple techniques available for this matching.
- Reconstruct in-kind – Depending on the extent of damage, in-kind replacement or reconstruction of concrete components may be necessary instead of repair. Reconstructed elements may have greater structural capacity and durability than the original or repaired element. The decision to replace rather than repair should be made collaboratively by the engineer and the historian.
- Electrochemical chloride extraction – Electrochemical chloride extraction is an appropriate remediation technique for chloride-laden concrete elements containing uncoated reinforcing steel. A DC current is applied to the outer mat of reinforcement to drive chloride ions out of the cover concrete. After chloride extraction is completed, concrete repairs are completed and surfaces are typically sealed. Determination of the appropriate use of this treatment may require additional analysis and consultation between the engineer and the historian.
- Cathodic protection – This technique effectively prevents or stops the corrosion of steel reinforcements in concrete elements by providing sacrificial anodes. Depending on the area being protected, the presence of the anodes may change the appearance of the bridge. The decision to use this technique should be made collaboratively by the engineer and the historian.

[8] Note that penetrant coatings have not been approved by MnDOT CRU or SHPO for use on historic bridges.

(5) Metal deck girder bridges – recommended activities

- Strengthen main girders/beams – Replacing girders/beams with higher-strength material, but members that are geometrically in-kind, and/or erecting supplemental girders and/or beams between existing members reinforces the structural support of the existing bridge. Providing supplemental steel plates to flanges and/or webs will strengthen the structure. Determination of the appropriate use of these treatments may require additional analysis and consultation between the engineer and the historian to ensure that the most appropriate treatment with the least impact to historic features is utilized.

(6) Concrete deck girder bridges – recommended activities

Due to the individual design and composition of each concrete deck girder structure, determination of preservation activities is often site-specific. As such, individual activities should be addressed on a case-by-case basis and should take engineering attributes and existing conditions into account.

- Strengthen main girders/beams (use with caution) – Adding structural elements such as beams or columns, reinforcing, and/or post-tensioning through cored holes or slots cut in the concrete, are all techniques that may be used to reinforce the structural support of the existing bridge. External post-tensioning can be added to supplement the existing structure. The visual consequences of these techniques should be carefully reviewed by the engineer and the historian before any undertaking because the results may not conform to the Secretary's Standards.

(7) Concrete walkways – recommended activities

Historic bridge concrete walkways may be structural or more simply cast concrete on fill similar to traditional roadway sidewalk. Depending on the bridge, structural concrete walkways are those that are directly supported by or integral to the bridge features and they typically include embedded reinforcing steel or other embedded structural shapes. For structural concrete walkways, the recommended preservation activities will be very similar to those listed in Section 5.C.(4) for concrete bridges. Preservation activities for non-structural concrete walkways would include:

- Replace concrete with a patch repair – The replacement concrete material should be selected to be compatible in composition with the adjacent concrete and should be formed and finished to match the surrounding historic concrete in color and texture (including any necessary exposed aggregate). There are multiple techniques available for this matching.
- Reconstruct in-kind – Depending on the extent of damage, in-kind replacement or reconstruction of components may be necessary instead of repair. Reconstructed elements may have greater durability than the original or repaired element. The decision to replace rather than repair should be made collaboratively by the engineer and the historian.

(8) Railings and parapets – recommended activities

Railings and parapets on historic bridges vary based on the type of structure and include: stone parapets; concrete balustrades; painted, galvanized and unpainted steel railings; and timber railings, among other types. For treatments of specific railing or parapet materials, refer to the preservation and maintenance recommendations in Sections 5.C. and 5.D. The following should be considered when preservation activities involve railings or parapets:

- Safety implications of using a bridge with the current railings that do not meet current minimum height requirements should be considered as part of future preservation activity planning. Safety implications of using a bridge with no railings present should also be considered.
- Where railings do not meet current structural or geometric standards, future improvements may require a structural and/or geometric variance from current bridge railing standards. These exceptions have been granted in the past for historic bridges in certain settings.
- Any railing modifications should be designed to be compatible with the historic character of the structure and should be completely reversible. Original railing features, the determined future use, code safety requirements for the future use, and potential variances and exceptions from current safety code requirements should all be considered.
- When preservation of the existing parapets or railings is not feasible, the original design should be replicated to the extent possible while conforming to current standards to the extent determined necessary.
- Where the height of the parapet or railing does not meet current standards, it may be acceptable to increase the height of the parapet or railing by embedding a new rail to allow the rail to meet current standards.
- For railings with openings that are too large to meet current standards, it may be acceptable to install a cable or other slender non-obtrusive element across the opening. The cable should be a reversible addition.

(9) Setting and associated features

- Repair or replace light fixtures – Historic light fixtures should be repaired rather than replaced. Replacement of ornamental light fixtures should be in-kind to the extent possible. In some instances, the original ornamental fixture manufacturer remains in business and may be able to supply identical or similar fixtures, as well as parts. That possibility should be checked first. Replication of the light device inside the ornamental fixture is not required and the light source should comply with current requirements. The design of the ornamental fixture may need to change to accommodate the new light source. Any modifications to the design of a historic light fixture should be accomplished in a manner acceptable to meet the Secretary's Standards.
- Repair or replace signage – Historic signs and plaques should be replicated as close to the original as possible, such as the use of a compatible stone for the base or mounting.
- Retaining walls – Any walls located adjacent to bridge abutments or along the stream channel that were a component of the original bridge design should be repaired in-kind. Also refer to treatments for specific materials in Section 5.C. and 5.D.

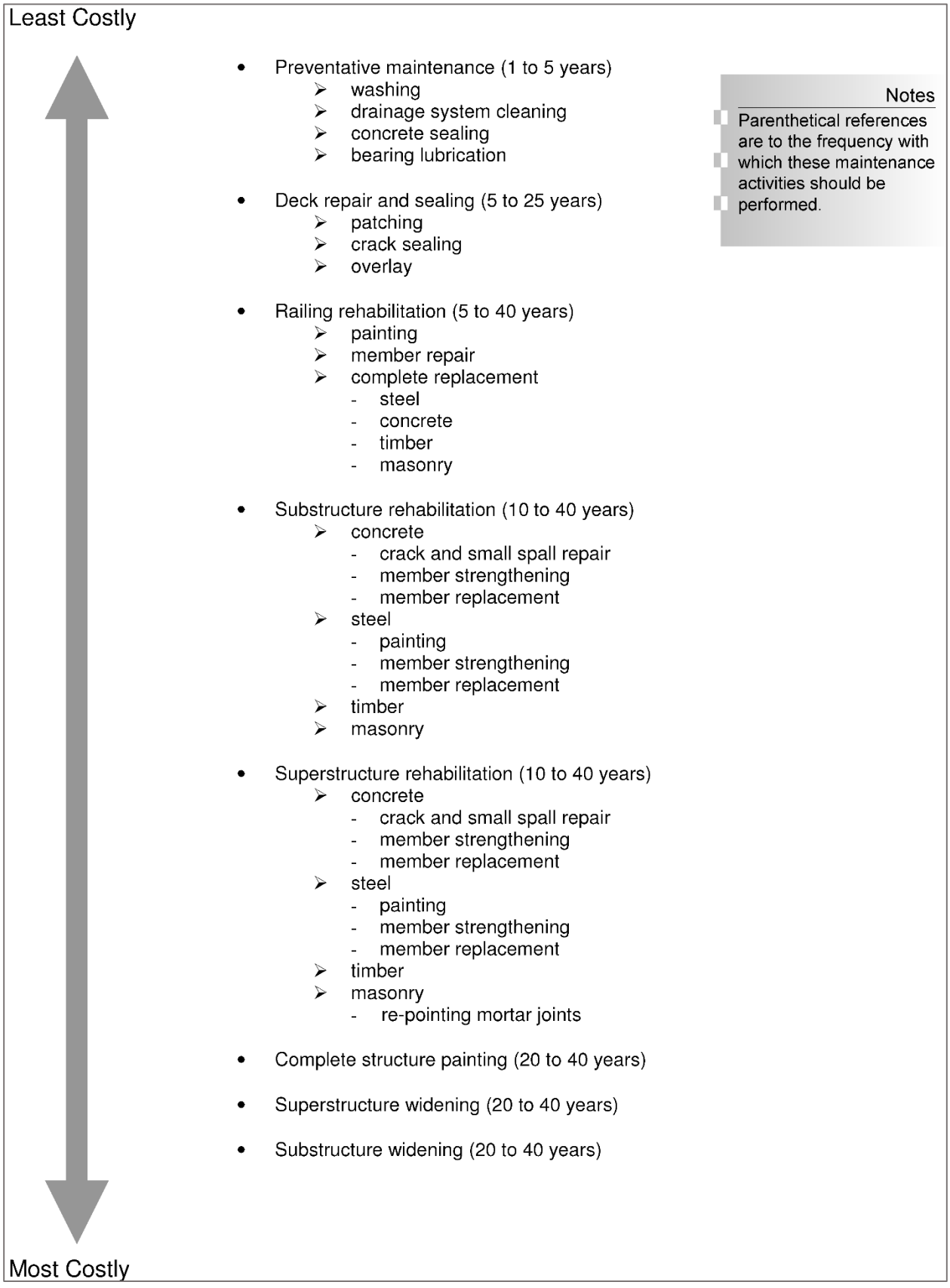


Figure 6. Relative costs of stabilization, preservation, and maintenance activities.

D. Recommended maintenance activities

Once preservation activities are completed, the bridge should be maintained to extend the useful life of the bridge. As noted in the definitions for this plan, maintenance is work of a routine nature to prevent or control the process of deterioration of a bridge. Routine structural maintenance is essential in ensuring the safety and functional life of a bridge. Bridge owners should consult MnDOT's *Bridge Construction Manual* for specific instructions regarding bridge maintenance. If additional guidance is needed, appropriate trades people or bridge engineers should be consulted. In general, maintenance of historic bridges should include the following activities as applicable to any given bridge.

(1) Superstructure – general

- Replace neoprene strip seal glands if damaged. Repair or replace expansion joint hardware if more than the gland is damaged.
- Patch and seal bridge deck cracks.
- Lubricate and re-set expansion bearings.
- Spot paint or repaint metal railings and lighting features to lengthen their life spans and improve the appearance of the bridge.
- To accommodate movement, adjust connections between guardrails and moving portions of the superstructure as necessary.
- Clean bridge's drainage system.
- Remove graffiti – Methods utilized for graffiti removal must be carefully selected to ensure they do not abrade, discolor, or damage surfaces that are to remain. Careful testing of cleaning products and mechanical abrasion systems will be necessary to determine if a method can be found that will not result in marring, discoloration, or damage to surfaces to remain. Such products should only be used by an operator whose skill and experience can be documented. Use of high-pressure water is not recommended because of potential surface damage. In some cases it may be better to leave the graffiti in place due to potential for damage to surfaces. In such instances, a paint color that closely matches the surrounding surface should be used.
- Power wash and flush bridge components such as decks, sidewalks, railings, and those surfaces exposed to salt-laden water or snow. Utilize an appropriate psi to ensure that historic elements are not damaged.

During the rehabilitation of the Holmes Street Bridge (also called the Shakopee Bridge and Bridge 4175) MnDOT employed micro-abrasive blasting to remove graffiti from concrete surfaces. The micro-abrasive material abraded the graffiti from the surface down to the original concrete substrate. This technique limited erosion of the concrete, which can occur if using pressurized water to remove graffiti.

(2) Substructure – general

- Repair slope paving – In some instances the slope paving is a character-defining feature or historic fabric. Care should be taken with the reuse of the original paving. Further investigation on alternatives and historical significance of existing slope paving should be performed prior to any work.
- Power wash and flush bridge components such as abutments, wing walls, and piers – Particular attention should be paid to cleaning the bridge seats. Utilize an appropriate psi to ensure that historic elements are not damaged.
- Repair scour damage to substructure units.

(3) Concrete bridges

- Replace concrete with a patch repair – Replacing a deteriorated concrete surface protects the steel reinforcement that is underneath; however, it may promote the corrosion of reinforcement in concrete adjacent to the repair if the repair is not performed properly. Upon removal of the deteriorated concrete, any exposed reinforcing should be sandblasted, cleaned, and coated with a rust inhibiting product. The replacement concrete material should be selected to be compatible in composition with the adjacent concrete and should be formed and finished to match the surrounding historic concrete in color and texture (including any necessary exposed aggregate). There are multiple techniques available for this matching.
- Flush and clean exposed surfaces – This can typically be accomplished with use of a low pressure water spray. Inconspicuous areas should be tested to ensure the pressure utilized and method used does not harm (abrade or inappropriately discolor) the historic surfaces. In some instances a very mild cleaning product may be acceptable but use of any such product should be thoroughly vetted to ensure it will not contaminate or harm the surfaces to remain.
- Seal cracks – Repairing cracks protects the bridge structure. By identifying the origin or the mechanism of the crack, the appropriate and approved repair techniques can be applied. When performing crack repairs with injected materials it is important to utilize a material that matches the adjacent material color to the extent possible, and to use application techniques that limit the spread of material onto the adjacent surfaces.

(4) Steel bridges

- Spot paint the steel superstructure following standard MnDOT procedures at 5-year intervals.
- Repaint the steel superstructure with standard MnDOT procedures at 40-year intervals.
- Straighten deformed members.
- Use existing color when painting as part of maintenance.

(5) Masonry bridges

- Repoint mortar joints using historically correct mortar – A mortar study should be performed to ensure selection of a mortar that is compatible in composition, strength, color, texture, and

tooling. To maintain historic integrity it will also be necessary for the project construction details to fully define the repointing requirements including, but not limited to, such items as joint preparation, mortar finish and tooling, mortar curing, and preparation of repointing test panels.

- Flush and clean exposed surfaces – This can typically be accomplished with use of a low pressure water spray. Inconspicuous areas should be tested to ensure the pressure utilized and method used does not harm (abrade or inappropriately discolor) the historic surfaces. In some instances a very mild cleaning product may be acceptable but use of any such product should be thoroughly vetted to ensure it will not contaminate or harm the surfaces to remain.
- Seal cracks – Repairing cracks protects the bridge structure. By identifying the origin or the mechanism of the crack, the appropriate and approved repair techniques can be applied. When performing crack repairs with injected materials it is important to utilize a material that matches the adjacent material color to the extent possible, and to use application techniques that limit the spread of material onto the adjacent surfaces.

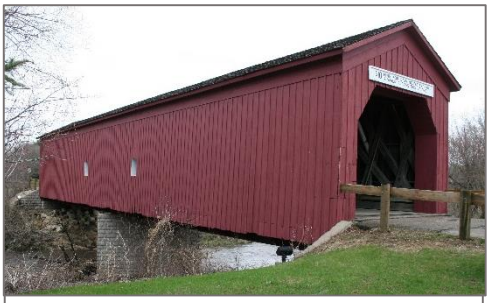
(6) Setting and associated features

- Remove overgrown vegetation adjacent to the bridge.
- Remove obstructions from the waterway.
- Repair and update approach guardrails as needed to ensure public safety.

E. Special considerations for relocating bridges

(1) Identifying new owners

It may be necessary to transfer a historic bridge from the current owner to a new owner. New owners should be solicited in newspapers and journals, on the Internet, over the radio, and through local television special interest stories or professional contacts. Local preservation organizations may have information regarding individuals in their community that are interested in rehabilitating a historic bridge. Trail and park owners are frequently interested in obtaining historic bridges for their trail systems. Refer to Section 7 for contact information that can help to conduct effective outreach.



An appropriate setting should be found if a bridge is to be relocated. The 1869 Zumbrota Bridge (Bridge 25580), a National Register-listed covered bridge in Goodhue County, originally spanned the Zumbro River. It was moved to inappropriate sites twice between 1932 and 1997, the first time being placed in county fairgrounds and, later, in a city park. It was successfully moved a third time to an appropriate site over water.

(2) Location

It is important to consider, to the extent possible, that the new bridge site maintain a similar setting and use to its original site. For example, maintaining a water crossing or a grade separation of another road.

(3) Transporting bridges

An important factor to consider in relocating a bridge is ease of disassembly and transport, which depends on type, length,

and condition of the bridge, as well as route and distance to the new location. The following considerations apply:

- Trusses – Both pony and through truss bridges are good candidates for relocation and have been successfully moved and preserved. Pony trusses can be moved more easily due to their smaller size and lack of overhead bracing; pony trusses with short span lengths can often be moved without disassembly. 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. 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 floor beams (and overhead bracing if applicable) for easier transport.

Bridge 82524 has been relocated twice. Currently the 1873 wrought-iron through truss carries a pedestrian and equestrian trail (Gateway Trail) over Manning Avenue. The bridge was originally erected in Sauk Center. It was first relocated in 1937 to Highway 65 in Koochiching County (then named Bridge 5721). Again in 2011 the bridge was moved, this time to Washington County.

- Steel or concrete beam or girder, timber beam – 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. As with truss bridges, relocation is generally appropriate for smaller bridges of these types.
- Concrete arches – Concrete arch bridges are not normally good candidates for relocation due to their construction and the high cost associated with moving the bridge. Concrete arches cannot be disassembled and must be relocated intact. An exception is the Rock Rapids Bridge located 4.5 miles southeast of Rock Rapids in Lyon County, Iowa. The bridge was moved 4 miles from its original location to a roadside park for preservation. This 30-foot-span, arch bridge, which uses the Melan reinforcing system, was constructed in 1893-94 and is one of the first reinforced concrete bridges built in the United States.
- Masonry arches – These bridges are not normally candidates for relocation due to their construction methods and the high cost associated with relocating the bridge. However, masonry arch bridges can be disassembled and reassembled, similar to a stone building. Note that some apparent stone arch bridges are actually concrete arch or metal-arch bridges with stone veneer.
- Piers and abutments – These substructure components do not lend themselves to relocation and will require, in most cases, reconstruction at the new site. Piers and abutments are typically not character-defining features of a historic bridge, which is a mitigating factor in accepting their loss.

(4) Construction phasing

Relocating a bridge may involve two construction phases. The initial phase would include removal from the original site and moving the historic bridge to the permanent site or to temporary storage (see storage considerations below). The second phase of construction involves development, restoration, and re-erection of the historic bridge at its new site. Once the bridge is re-erected at its new site, regular maintenance will be required (see maintenance guidelines earlier in this section). If the bridge is listed in or eligible for listing in the National Register, formal discussion with the SHPO is necessary to ensure that the move will not negatively affect the historic integrity of the bridge. After the bridge has been moved to its new location, the Minnesota Architecture/History Form and any National Register nomination form should be updated to reflect the bridge's new location.

(5) Disassembling a truss

The following considerations are particularly important when disassembling a truss.

- Documentation – Documenting the general features and details of the bridge with plans, sketches, and photographs prior to disassembly or moving will aid in the reassembly or re-erection of the bridge.
- Temporary support or bracing – During a move, strengthening, supplementing, or providing temporary support of the existing members is necessary when the bridge is supported at temporary points that will experience a different type of stress. Installing temporary bracing prior to moving may be required to provide stability and accommodate forces resulting from the removal of an existing feature, such as removing the deck to reduce the dead load. Temporary support or bracing may require evaluation by a structural engineer.
- Disassembly and marking – Categorizing and systematic marking should be undertaken of all pieces to be dismantled to ensure that each piece is reassembled in the same configuration and location. Prior to marking and disassembly a disassembly plan should be developed. Some connections will remain as units throughout the relocation process. Careful identification and labeling of historic components, including primary truss members, portals, top and bottom bracing, floorbeams, bearing assemblies, and railings, is necessary for later reassembly.

(6) Storage (pending future use)

If re-erection of a bridge is delayed while funds are raised or the new site is made ready, storage considerations will apply. Bridges, especially metal bridges, should not be stored unless there is a good chance that they will be restored and re-erected. If a bridge will not be re-erected immediately, it may be necessary to identify temporary storage facilities. Considerations for suitable storage facilities include security, space, and cost. If corrosion has already occurred, the bridge needs to be protected from further exposure to the elements. Metal bridges should be stored in a position that promotes free drainage to avoid ponding of moisture. Members should be painted prior to storage, if they are to be stored for more than five years, and kept a minimum distance of 12 inches off the ground and inclined to enable free draining of moisture. Minimum necessary work to stabilize the bridge and prevent further damage or deterioration during storage should be considered on a case-by-case basis.

(7) Transfer agreements and owners' liability

Any necessary agreements and transfer of property should be executed between the parties involved in the transfer.

(8) Re-erection of truss or girder bridges

The following considerations apply when re-erecting a truss or girder bridge at a new site.

- Railings – On a relocated truss, a new railing meeting the design requirements for the future use of the bridge should be installed. In compliance with the Secretary's Standards, the material, form, and construction of the railing should be compatible with the historic character of the bridge, including compatibility with the spacing of the truss panel points. If the new owner has no railing design requirements, American Association of State Highway and Transportation Officials (AASHTO) railing requirements should be employed. Design exceptions may be granted in particular situations.
- Abutments – New abutments should be constructed in a manner consistent with standard practices. Apply architectural treatment to the abutments as deemed appropriate by the SHPO and the MnDOT CRU to comply with the Secretary's Standards.
- Repair damaged members – Iron and steel truss members, elements, and bearing assemblies should be repaired as deemed necessary by detailed structural inspection. Members and elements that cannot be repaired should be replaced in-kind to the extent possible. It is recognized that rolled wrought-iron sections are not readily available. Therefore, steel should be considered an acceptable replacement for existing wrought iron members and elements.

F. Application of design exceptions and variances

The application of design exceptions for federally funded projects or variances for state aid-funded projects may be considered if the transportation needs and condition or features of the structure limit a bridge's ability to meet proposed project standards. This section provides direction on where design exceptions or variances can be applied. The following examples describe design exceptions that have been granted for three historic bridges in Minnesota.

Holmes Street Bridge (Bridge 4175)

Design exception for reuse of the historic railing on the Homes Street Bridge (Bridge 4175) was granted during the rehabilitation of the bridge in 2010. The ornamental Neoclassical style railing did not meet current safety standards for height. Bicycle traffic was limited to the center of the bridge in the rehabilitation design process to reduce potential safety hazards.

Bridge 6679
In 2012 MnDOT rehabilitated Bridge 6679. Work included replacement of curb, expansion joints, bearings, wingwalls, and the bridge deck. The deteriorated railings also did not meet current crash test requirements and needed to be replaced. A design exception was granted to allow for a lower crash rating in order to meet preservation standards by replicating the Modernist style of the original rail. MnDOT cast a prototype of the new railing in order to compare it to the original railing before approving the new railing design.

Ramsey Park Swayback Bridge (Bridge 89859)

Redwood County restored the Ramsey Park Swayback Bridge (Bridge 89859) in 2013 following flood damage. The County applied for and received a design exception for the 6-inch-high railings, leaving this feature as it has been for 80 years. To add taller modern railings would have created an adverse effect under preservation regulations. This railing modification would also run counter to the design of this bridge, in which it was intended to have water and debris flow over the bridge during flooding. As part of the rehabilitation work, the masonry was repointed and missing stones were replaced with in-kind material, concrete slab spans were replaced in-kind, new floor drains were installed, and the roadway approach was improved to smooth the transition to the new deck.

(1) Definitions and documentation

As defined earlier, design exceptions and variances are deviations from standard bridge design practices that take into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. Approval of either an exception or variance requires appropriate justification and documentation.

A design variance is a formal request by a local agency to modify or deviate from established Local State Aid Route Standards, State Aid Operations Chapter 8820, for projects using state aid funds. The variance is generally a written request in the form of a resolution to the Minnesota Commissioner of Transportation. The request should include information listed on the design element variance checklist (see http://www.dot.state.mn.us/stateaid/variance/variance-justification-checklist.pdf) describing the economic, social, safety, and environmental impacts that may result from the requested variance. The Commissioner will either approve or disapprove of the request based on the recommendations of the Advisory Committee on Variances. The Commissioner may require a resolution by the recipient of the variance that indemnifies, saves, and holds harmless the state and its agents and employees from claims or causes of action arising out of the granting of the variance.

A design exception is similar to a variance, but is used for federally funded projects where federal and state standards are not met. Design exceptions must be approved by the State Design Engineer, as delegated by the Minnesota Commissioner of Transportation, or the FHWA on federal-oversight projects, depending on project specifics. Design exceptions must be justified and adequately documented, with documentation answering two questions:

- Why is the exception appropriate?
- Why is there no other practical alternative?

(2) Applicability

While it is MnDOT's procedure to at least meet standard design criteria for a project, MnDOT recognizes that there may be some situations where exceptions to design standards are allowable. Where appropriate, design exceptions or variances may be granted for deviation from the accepted design standard. The design exception or variance process allows designers to deviate from normal practice and consider non-standard options in order to safeguard environmental or historic resources.

The need for bridge-specific design exceptions will be based on the magnitude of the preservation efforts to be implemented. For example, there is no need for design exceptions when undertaking maintenance efforts. However, if a substantial portion of a bridge is to be reconstructed, the standard design criteria are more stringent; hence, the greater potential for design exceptions in these circumstances.

A deficient bridge may be allowed to remain in vehicular use if it can be improved to meet applicable design standards or if a design exception is approved for the deficiency. MnDOT's BPIRG provides lists of possible design exceptions. In general, retention of a historic bridge can be justified when crash history indicates that safe operations are possible. Additional MnDOT guidance is available in the *Road Design Manual* and *Highway Project Development Process Handbook*, available from the MnDOT Office of Technical Support (see Section 7).

Design exceptions and variances may be applied in the following situations:

- Horizontal and vertical alignment – Existing alignment may be retained or alignment changes made in the roadway rather than the bridge.
- Vertical and lateral clearance – Existing vertical clearance may be retained depending upon the type of roadway the bridge serves and the volume of traffic.
- Geometric elements – Individual geometric elements, including smaller radii and short stopping sight distance, may be adopted.
- Bridge roadway width – Narrower widths for lanes and shoulders, and reduced horizontal distance to obstructions, can be considered.
- Load rating – Minimum acceptable structural capacity can be considered, depending on the classification of the roadway.
- Type of railing – Historic railings may be retained provided they meet the minimum design criteria based on several factors include design speed of the roadway and whether existing railing is planned to be repaired or replaced.

(3) Design criteria considerations

Variables that should be considered when evaluating the need for, and applicability of, design exceptions or variances include:

- Transportation needs for the bridge.
- Degree to which design standards would be reduced.
- Effect of exception or variance on safety and operation of the bridge and compatibility with approach roadway.
- Cost of attaining full standards, including environmental, cultural, or historic consequences.
- Whether other design factors would lessen the effect of the exception.
- Risk particular to site conditions such as crash history, geometrics, vertical clearance, and facilities crossed.
- Measures that may be implemented to reduce the risks or safety impacts of the requested exception or variance. Examples would be installation of cautionary signs to warn motorists of sharp non-compliant horizontal or vertical curves. In cases of reduced railing height, signs requiring bicyclists to walk their bikes over the bridge can be considered. Cautionary signs alerting pedestrians to low-height railings can also be considered.

G. Context-sensitive solutions

MnDOT's policy and program advocating the sensitive integration of projects into the context and setting coincides with the philosophy of preserving historic bridges. Context-sensitive solutions, also referred to as "context-sensitive design," is a broadly inclusive transportation, planning, design, construction, operations, and maintenance approach that integrates and balances scenic, aesthetic, historic, environmental, and community values with project- or corridor-specific transportation safety, mobility, and performance goals. Context-sensitive solutions include early public and stakeholder involvement and utilize a collaborative, interdisciplinary approach to finding flexible designs that accommodate specific project circumstances, different perspectives, and diverse contexts.

The City of St. Paul salvaged the railing and stone from the piers and abutments of the Smith Avenue High Bridge for later use. The Smith Avenue High Bridge was a wrought-iron Warren deck truss built in 1889 and removed in 1985. A portion of the decorative metal railing was installed in Summit Lookout Park at the intersection of Summit Avenue and Ramsey Hill and stones were reused to repair an adjacent retaining wall.

The original 1890s Lyndale Avenue Bridge was replaced in 2012 with a new single-span prestressed-concrete girder. The design for the new bridge was achieved through a community-design review process. Ultimately, the new bridge was designed with an arch-shaped facade and tall abutment walls in keeping with the original bridge's form and setting within the historic Minnehaha Parkway.

Since November 2000 it has been MnDOT's policy to use a context-sensitive approach to create excellence in transportation project development. MnDOT's goal is to construct, operate, and maintain excellent transportation facilities that satisfy stakeholders and leave a positive and lasting public works legacy. MnDOT is trying to incorporate context sensitivity into all aspects of transportation project development through advocacy, networking, policies, research, training programs, guidance documents, and technical support. Minnesota continues to develop implementation resources to support context-sensitive solutions, many of which can be found online at http://www.contextsensitive.umn.edu/index.html.

Context sensitivity requires broadly informed and imaginative planning and project development to assess and meet transportation, community, and environmental needs and goals within established transportation project budgets and schedules. Early and continued involvement from multidisciplinary professionals and stakeholders is critical to achieving success in moving people and goods safely and efficiently in harmony with the natural, social, economic, and cultural environment. For more information about context-sensitive solutions in other states and from a national FHWA and AASHTO perspective, go to www.contextsensitivesolutions.org.

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6. Funding Options

The majority of funding for the rehabilitation and reuse of historic bridges in the state of Minnesota is available through federal funding programs. The current legislation authorizing the various federal transportation programs is Moving Ahead for Progress in the 21st Century Act (MAP-21). The MAP-21 program was authorized through September 30, 2014, after which time it received a short-term extension. A six-year bill is the historical cycle for new federal transportation legislation but recent legislation has had a shorter timeframe due to hesitancy to make major funding commitments. See the FHWA website for up-to-date information related to MAP-21 and upcoming funding authorization, available at https://www.fhwa.dot.gov/resources/legsregs/.

A. Surface Transportation Program funds

The Surface Transportation Program (STP) apportions money to states based on a formula established under MAP-21. STP funds can be used for a wide array of transportation projects on any federal-aid highway, such as construction, reconstruction, resurfacing, restoration, rehabilitation, and operational improvements for highways and bridges. STP funds may be used for bridge projects on any public road. According to FHWA guidance, projects that accommodate other transportation modes (such as adding bicycle and/or pedestrian lanes) can also qualify. The STP may be included under future authorization.

B. Transportation Alternatives Program

The Transportation Alternatives Program (TAP) is the current funding program for historic preservation projects under MAP-21 (previously referred to as the Transportation Enhancement [TE] program). The TAP includes other transportation alternative programs, including Safe Routes to Schools and Scenic Byways, and may be included under future authorization.

This legislation sets aside STP dollars for TAP projects. Funds are available through this program for historic preservation activities, including bridge rehabilitation. TAP funds can be used to rehabilitate historic bridges for both vehicular and non-vehicular uses. For most projects, the TAP program includes 80-percent federal funding with the remaining 20 percent a mixture of state and local funds.

To strengthen partnerships between state and regional agencies and increase the public role in transportation planning, Congress left the details of selecting eligible projects to the states.

Though the federal statute describes eligible categories for the TAP program with interpretive guidance from the FHWA, state transportation agencies have most of the responsibility for the TAP program.

The restoration of the National Register-listed Stone Arch Bridge (Bridge 27004) in Minneapolis exemplifies the use of transportation enhancement funds. Constructed in 1883, this former railroad bridge crosses the Mississippi River at the only waterfall, St. Anthony Falls. Over $2 million of TE funds were used to improve drainage, repair the bridge structure, remove the railroad tracks, and add a bituminous surface, lighting, and railing. Restoration of the bridge was made possible by the partnership between the MnDOT, Minnesota Historical Society, and the local St. Anthony Heritage Board.

C. State Bridge Bond Funds

Local bridge rehabilitation and replacements may be funded with local, local bridge bond, state aid, township, or federal funds. The Local Bridge Replacement Program (Minnesota Statutes 174.50) was created to assist local agencies with costs associated with replacing or rehabilitating deficient bridges throughout the state. The program is funded with state transportation general obligation bond funds appropriated by the legislature as part of specific session law and is normally part of a larger state bonding bill. The amount of local bridge bond funds will vary from year to year and is dependent on the legislature passing a law with an appropriation dollar amount identified for the bridge program.

These funds are often leveraged with other local funding sources to cover the entire cost of rehabilitating or replacing a bridge. Local bridge bond funds do not pay for costs associated with right-of-way, engineering/design, and removal of the old bridge. These funds cannot be spent on new bridges where one did not previously exist or on MnDOT (state)-owned trunk highway bridges.

MnDOT's State Aid for Local Transportation Office (State Aid) administers the program and approves all bridge projects for the funding. Counties and cities identify and prioritize, by resolution, their five-year bridge replacement and improvement priorities and submit them to State Aid. These resolutions are combined to create a master bridge replacement and improvement priority list used to demonstrate and promote the "needs" of bridge replacement and improvement program to the legislature and general public. State Aid prepares the legislative budget requests for the governor and legislature before each session.

Local bridge bond funds may be used for funding the eligible "abutment-to-abutment" construction bridge costs on publicly owned local bridges or culverts longer than 10 feet (clear span as measured along the roadway centerline) or when a roadway in lieu of a bridge can be constructed. Projects receiving funds must follow Minnesota Rules 2011, State Aid Operations that defines criteria for funding, design, and construction of local state aid projects. Eligible bridges must be structurally deficient, functionally obsolete, or hydraulically deficient and have a sufficiency rating of 80 or less and recommended for replacement or rehabilitation by the MnDOT State Aid District Engineer.

Trunk Highway bridges may be partially funded using state Trunk Highway bridge bonds. The funds usually are associated with a funding program such as Corridors of Commerce or Trunk Highway Bridge Bonding (Ch. 152). Typically these programs are only used on bridges that meet criteria developed for a specific program (e.g., the Ch. 152 program addressed fracture critical and structurally deficient bridges). These state Trunk Highway bridge bonds are usually available only for a short time and finite in amount.

D. Town Bridge Funds

Town Bridge Funds are available only to townships and are allocated by a formula to the individual counties based upon the proportion of deficient township bridges in their respective counties. A statewide fund is also created for use by counties that have depleted their town bridge allocation. Money is allocated to these accounts each calendar year from the Highway User Tax Distribution Fund. This fund is administered by MnDOT and distributed to counties, cities, and townships on a yearly basis through the State Aid Systems Fund Program. For assistance, contact the State Aid Office (see Section 7 for contact information).

Town Bridge Funds will cover the following:

- 100 percent of costs of the bridge structure or culvert.
- Approach grading and bridge removal costs over $10,000.
- Engineering costs over $10,000 or 100 percent of engineering costs if a township has a net tax capacity of less than $300,000. Township net tax is determined by the Minnesota Department of Revenue on a yearly basis.
- 100 percent of all costs to abandon a bridge or build a road-in-lieu of a bridge, up to the cost of a replacement bridge.

E. State Planning and Research Funds

For FHWA undertakings, State Planning and Research (SPR) funds may be used for historic bridge planning and feasibility studies, typically through an 80-20 cost share to hire a consultant. Contact MnDOT CRU to see if your project qualifies for SPR funds (see Section 7).

F. State Capital Project Grants-in-Aid

This program supports restoration or historic preservation projects of a capital nature. In general, the expenditure funded must be for a public purpose, used for a locally owned property (i.e., state-owned properties are not eligible), and must meet the Secretary's Standards. This grants program provides an excellent opportunity for local public works departments to obtain funding for bridge rehabilitation projects since the competition is limited to public agencies. For more information, access http://www.mnhs.org/shpo/grants/state_capital_grants/. For more information about grants administered by the SHPO, contact its office (see Section 7).

The Split Rock Bridge (Bridge 5744) carries County Road 54 over Split Rock Creek in Pipestone County. Constructed of locally quarried Sioux Quartzite between 1937 and 1938, this segmental arch bridge with random-ashlar spandrel walls features the largest stone-arch span of any active highway bridge in Minnesota. The county received a State Capital Project Grant in 2001 to repoint the mortar.

G. Clean Water, Land and Legacy Amendment Grants

In 2008 Minnesota's voters passed the Clean Water, Land and Legacy Amendment (Legacy Amendment) to the Minnesota Constitution. In addition to protecting drinking water sources; protecting, enhancing, and restoring wetlands, prairies, forests, and fish, game, and wildlife habitat; supporting parks and trails; and protecting, enhancing, and restoring lakes, rivers, streams, and groundwater, the act preserves arts and cultural heritage. The Legacy Amendment increases the state sales tax by three-eighths of one percent, continuing until 2034. The Arts and Cultural Heritage Fund (ACHF), administered by the MHS, receives 19.75 percent of the additional sales tax revenue. ACHF funds have been used to preserve historic bridges. For more information, access http://www.legacy.leg.mn/funds/arts-cultural-heritage-fund.

Legacy Amendment funds were used to explore rehabilitation options for the Dodd Ford Bridge (Bridge 1461) in Blue Earth County. The bridge is listed in the National Register under *Criterion C* for its association with an important Minnesota bridge engineer Lawrence Johnson and under *Criterion A* as an example of government funding of public works projects in the county. It will be rehabilitated in 2015.

7. Contacts

Numerous agencies and organizations, both governmental and private, are available to assist in preserving historic bridges in Minnesota. These groups can provide bridge owners with technical information, financial assistance, advocacy, and overall guidance for properly maintaining and preserving a historic bridge. The following resources are available:

A. MnDOT

(1) Cultural Resources Unit

The MnDOT CRU in the Office of Environmental Services (OES) should be contacted for questions on this *Management Plan for Historic Bridges in Minnesota*. For assistance contact:

Minnesota Department of Transportation
Office of Environmental Stewardship, Cultural Resources Unit
395 John Ireland Boulevard
St. Paul, MN 55155
Telephone: (651) 366-3600
Website for OES: http://www.dot.state.mn.us/environment/

For current information regarding historic bridge management efforts, refer to the MnDOT CRU website at http://www.dot.state.mn.us/historicbridges/.

(2) Bridge Office

The Bridge Office is available to answer questions on bridge rehabilitation techniques and design standards. This office assembles and maintains documents that capture MnDOT's extensive experience maintaining and rehabilitating bridges. For assistance contact:

Minnesota Department of Transportation
Bridge Office
3485 Hadley Avenue North
Oakdale, MN 55128
Telephone: (651) 366-4500
http://www.dot.state.mn.us/bridge/

(3) State Aid Office

The State Aid Office provides additional assistance for local governments and assists municipalities in understanding the process for development, design, and construction of federal-aid projects. The State Aid Office coordinates and prepares legislative budget requests based on needs submitted by local government agencies. For assistance contact:

Minnesota Department of Transportation
State Aid for Local Transportation
395 John Ireland Boulevard
St. Paul, MN 55155
Telephone: (651) 366-3800
http://www.dot.state.mn.us/stateaid/

(4) State Aid Bridge Office

The State Aid Bridge Office resides in the Bridge Office and reviews plans for county, township, and municipal bridge projects and ensures project compliance with current MnDOT and AASHTO design criteria. For assistance contact:

Minnesota Department of Transportation
State Aid Bridge Office
395 John Ireland Boulevard
St. Paul, MN 55155
Telephone: (651) 366-3800
http://www.dot.state.mn.us/stateaid/bridge/index.html

(5) Districts

MnDOT has eight District offices to coordinate projects and assist local governments. Contacts include:

- District Bridge Maintenance Engineers and Supervisors – Serve as liaisons between local engineers, maintenance departments, OES, Bridge Office staff, and the MnDOT Central Office.
- District Planning Units – Serve as liaisons between local engineers, maintenance departments, OES, Bridge Office staff, and the MnDOT Central Office.
- District State Aid Offices – Manage local projects.

Web links to the District offices can be found at: http://www.dot.state.mn.us/information/districts.html.

Two MnDOT publications of special interest to owners pursuing projects are:

- *Highway Project Development Process (HPDP) Handbook* outlines the project development process, or steps that must occur before construction. The handbook is available online at http://www.dot.state.mn.us/planning/hpdp/scoping.html.
- *Road Design Manual* (RDM) establishes uniform design practices statewide and provides enough flexibility to encourage independent, cost-effective, aesthetically pleasing, and environmentally sensitive design. The RDM, which is frequently updated as design practices and technology changes, is available online at http://roaddesign.dot.state.mn.us/.

B. State Historic Preservation Office

As part of the MHS, the SHPO provides statewide leadership on preservation initiatives and helps carry out the nation's historic preservation program. The SHPO identifies and evaluates Minnesota's historic

and archaeological properties, encourages the development of local history organizations and activities, and assists government agencies in carrying out their historic preservation responsibilities. The SHPO offers assistance in meeting the Secretary's Standards and through administration of grant programs. For assistance contact:

Minnesota State Historic Preservation Office
Minnesota Historical Society History Center
345 Kellogg Boulevard West
St. Paul, MN 55102
Telephone: (651) 259-3450
http://www.mnhs.org/shpo/

C. National Park Service

The NPS in the U.S. Department of the Interior directs historic preservation activities throughout the nation by providing a broad range of products and services, financial assistance, educational guidance, and technical information. The NPS works with the SHPOs, local governments, tribes, federal agencies, and nonprofit organizations to preserve historic properties. The NPS administers the following programs that are applicable to the preservation of historic bridges:

(1) Secretary of the Interior's Standards

The Secretary's Standards are guiding principles for maintaining, repairing, and replacing historic materials, designing new additions, or altering a historic property. For more information, access http://www.nps.gov/tps/standards/rehabilitation/rehab/guide.htm.

(2) Preservation Briefs

The NPS publishes a technical series known as Preservation Briefs to provide owners and developers of historic properties with expert advice on recognizing and resolving common preservation and maintenance problems. Specific briefs are cited in Section 4. Refer to the NPS website at http://www.nps.gov/tps/how-to-preserve/briefs.htm for more information.

(3) National Register of Historic Places

The National Register, as discussed in Section 2, is the official list of the nation's historic properties deemed worthy of preserving. For more information, access http://www.nps.gov/nr/.

D. American Association of State Highway and Transportation Officials

AASHTO advocates transportation-related policies and provides technical services to states. State highway departments work through AASHTO to develop design standards through a series of committees and task forces. The resulting publications provide guidance on design standards.

AASHTO's Center for Environmental Excellence bills itself as a "one-stop source of environmental information for transportation professionals." The Center promotes environmental stewardship and streamlining of the transportation delivery process. The Center serves as a resource for transportation

professionals seeking technical assistance, training, information exchange, partnership-building opportunities, and quick and easy access to environmental tools.

The Center's website is arranged into sections that focus on specific environmental topics. The "Historic Preservation" section summarizes historic preservation issues and programs applicable to the transportation community. The "Historic Bridges" section provides information, guidance, best practices, and new developments in the identification, evaluation, and management of historic bridges. For assistance contact:

AASHTO
444 North Capitol Street NW, Suite 249
Washington, D.C., 20001
Telephone: (202) 624-5800
Center for Environmental Excellence: environment@aashto.org.
http://environment.transportation.org/environmental_issues/historic_cultural/recent_dev.aspx

E. National Trust for Historic Preservation

The National Trust for Historic Preservation (National Trust) is a nonprofit organization that aims to revitalize communities through education and advocacy for preservation efforts. For information or assistance, please contact:

Minnesota Field Representative
National Trust for Historic Preservation
Midwest Office
53 West Jackson Boulevard
Suite 350
Chicago, IL 60604
Telephone: (312) 939-5547
http://www.nationaltrust.org

F. Preservation Alliance of Minnesota

The Preservation Alliance of Minnesota is a private, nonprofit organization advocating the preservation of Minnesota's historic resources. This organization works to educate citizens about preservation and develops networks among people and organizations like the SHPO and the National Trust to help increase awareness of state history, community preservation, and important community values. The Alliance's Easement Program provides guidance on establishing preservation easements. The Alliance holds easements for many historic properties in Minnesota. For information or assistance, please contact:

Preservation Alliance of Minnesota
416 Landmark Center
75 West Fifth Street
St. Paul, MN 55102-1406
Telephone: (651) 293-9047
www.mnpreservation.org

G. Local historical and preservation organizations

Local historical and preservation organizations can be instrumental in advocating and supporting efforts to preserve historic resources, including bridges. Local groups in particular may be aware of the importance of a bridge to a community's history. Considerations of local significance may support the preservation of a bridge, whether for continued vehicular use on site or for less-demanding use, such as a pedestrian or bicycle trail bridge. Active participation of such organizations can be useful in the Section 106 process as they may be able to suggest ways in which adverse effects may be reduced or avoided.

For a complete list of historical and preservation organizations in Minnesota, access the MHS website at http://www.mnhs.org/localhistory/mho/.

H. Outreach and training

Successful bridge preservation involves generating public interest in the history and significance of historic bridges and implementing appropriate guidance and training of historic bridge owners, maintenance personnel, engineers, and associated professionals. Public outreach and documentation of historic bridges can help preserve Minnesota's engineering and transportation legacy, be a catalyst for saving other bridges, and/or mitigate the effects of a salvaged or demolished bridge. Conferences, professional organizations, and technical training programs provide professionals with the opportunity to exchange ideas on successes, failures, and emerging technologies available for bridge projects.

In addition to conferences, professional training programs provide an opportunity to disseminate available information on historic bridge preservation issues and emerging technologies. Existing training programs on historic bridge maintenance and preservation that may be helpful to engineers, owners, and contractors include:

- *Minnesota Historic Bridge Training* – MnDOT offers a historic bridge training seminar to interested professionals and bridge owners. The program on the "nuts and bolts" of bridge preservation offers a brief overview of historic bridges and the importance of preservation, and provides specifications for how to maintain and rehabilitate bridges while retaining historic integrity.
- *Minnesota Local Technical Assistance Program* – This program provides workshops for Minnesota's local transportation agencies. Access http://www.mnltap.umn.edu/ for more information.
- *Structural Engineering Seminar Series*, College of Continuing Education and Department of Civil Engineering, University of Minnesota – These seminars address issues concerning the design and construction of buildings, bridges, and other structures. Access http://cce.umn.edu/Structural-Engineering-Seminar-Series/ for more information.
- *Context Sensitive Design for Local Governments*, Center for Transportation Studies, University of Minnesota – Based on MnDOT's principles for Context Sensitive Design, this workshop provides an opportunity for engineers, managers, planners, landscape architects, and other local government professionals to apply the principles through working case studies. Access http://www.contextsensitive.umn.edu/index.html for more information.

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Appendix A. Glossary

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Glossary

Abutment – Component of bridge substructure at either end of bridge that transfers load from superstructure to foundation and provides lateral support for the approach roadway embankment.

Appraisal ratings – Five National Bridge Inventory (NBI) appraisal ratings (structural evaluation, deck geometry, under-clearances, waterway adequacy, and approach alignment, as defined below), collectively called appraisal ratings, are used to evaluate a bridge's overall structural condition and load-carrying capacity. The evaluated bridge is compared with a new bridge built to current design standards. Ratings range from a low of 0 (closed bridge) to a high of 9 (superior). Any appraisal item not applicable to a specific bridge is coded N.

Approach alignment – One of five NBI inspection ratings. This rating appraises a bridge's functionality based on the alignment of its approaches. It incorporates a typical motorist's speed reduction because of the horizontal or vertical alignment of the approach.

Character-defining features – Prominent or distinctive aspects, qualities, or characteristics of a historic property that contribute significantly to its physical character. Features may include structural or decorative details and materials.

Condition, fair – A bridge or bridge component of which all primary structural elements are sound, but may have minor deterioration, section loss, cracking, spalling, or scour.

Condition, good – A bridge or bridge component which may have some minor deficiencies, but all primary structural elements are sound.

Condition, poor – A bridge or bridge component that displays advanced section loss, deterioration, cracking, spalling, or scour.

Condition rating – Level of deterioration of bridge components and elements expressed on a numerical scale according to the NBI system. Components include the substructure, superstructure, deck, channel, and culvert. Elements are subsets of components, e.g., piers and abutments are elements of the component substructure. The evaluated bridge is compared with a new bridge built to current design standards. Component ratings range from 0 (failure) to 9 (new) or N for (not applicable); elements are rated on a scale of 1-3, 1-4 or 1-5 (depending on the element type and material). In all cases condition state 1 is the best condition with condition state 3, 4 or 5 being the worst condition. In rating a bridge's condition, MnDOT pairs the NBI system with the newer and more sophisticated Pontis element inspection information, which quantifies bridge elements in different condition states and is the basis for subsequent economic analysis.

Corrosion – The general disentegration of metal through oxidation.

Cutwater – The wedge-shaped end of a bridge pier, designed to divide the current and break up ice.

Decay – Deterioration of wood as a result of fungi feeding on its cell walls.

Delamination – Surface separation of concrete, steel, glue laminated timber plies etc. into layers.

Deck geometry – One of five NBI appraisal ratings. This rating appraises the functionality of a bridge's roadway width and vertical clearance, taking into account the type of roadway, number of lanes, and ADT.

Deficiency – The inadequacy of a bridge in terms of structure, serviceability, and/or function. Structural deficiency is determined through periodic inspections and is reflected in the ratings that are assigned to a bridge. Service deficiency is determined by comparing the facilities a bridge provides for vehicular, bicycle, and pedestrian traffic with those that are desired. Functional deficiency is another term for functionally obsolete (see below). Remedial activities may be needed to address any or all of these deficiencies.

Deficiency rating – A nonnumeric code indicating a bridge's status as structurally deficient (SD) or functionally obsolete (FO). See below for the definitions of SD and FO. The deficiency rating status may be used as a basis for establishing a bridge's eligibility and priority for replacement or rehabilitation.

Design exception – A deviation from federal design and geometric standards that takes into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. A design exception is used for federally funded projects where federal standards are not met. Approval requires appropriate justification and documentation that concerns for safety, durability, and economy of maintenance have been met.

Design load – The usable live-load capacity that a bridge was designed to carry, expressed in tons according to the AASHTO allowable stress, load factor, or load resistance factor rating methods. An additional code was recently added to assess design load by a rating factor instead of tons. This code is used to determine if a bridge has sufficient strength to accommodate traffic load demands. A bridge that is posted for load restrictions is not adequate to accommodate present or expected legal truck traffic.

Deterioration – Decline in condition of surfaces or structure over a period of time due to chemical or physical degradation.

Efflorescence – A deposit on concrete or brick caused by crystallization of carbonates brought to the surface by moisture in the masonry or concrete.

Extant – Currently or actually existing.

Extrados – The upper or outer surfaces of the voussoirs which compose the arch ring. Often contrasted with intrados.

Footing – The enlarged, lower portion of a substructure which distributes the structure load either to the earth or to supporting piles.

Fracture Critical Members – Tension members or tension components of bending members (including those subject to reversal of stress) whose failure would be expected to result in collapse of the bridge.

Functionally obsolete – The Federal Highway Administration (FHWA) classification of a bridge that does not meet current or projected traffic needs because of inadequate horizontal or vertical clearance, inadequate load-carrying capacity, and/or insufficient opening to accommodate water flow under the bridge. An appraisal rating of 3 or less for deck geometry, underclearance, approach alignment, structural evaluation or waterway adequacy will designate a bridge as functionally obsolete.

Gusset plate – A plate that connects the horizontal and vertical members of a truss structure and holds them in correct position at a joint.

Helicoidal – Arranged in or having the approximate shape of a flattened coil or spiral.

Historic fabric – The material in a bridge that was part of original construction or a subsequent alteration within the historic period of the bridge (i.e., more than 50 years old). Historic fabric is an important part of the character of the historic bridge and the removal, concealment, or alteration of any historic material or distinctive engineering or architectural feature should be avoided if possible. Often, the character-defining features include important historic fabric. However, historic fabric can also be found on other elements of a bridge that have not been noted as character-defining.

Historic bridge – A bridge that is listed in, or eligible for listing in, the National Register of Historic Places.

Historic integrity – The authenticity of a bridge's historic identity, evidenced by the survival and/or restoration of physical characteristics that existed during the bridge's historic period. A bridge may have integrity of location, design, setting, materials, workmanship, feeling, and association.

Inspections – Periodic field assessments and subsequent consideration of the fitness of a structure and the associated approaches and amenities to continue to function safely.

Intrados – The innner or lower surface of an arch. Often contrasted with extrados.

Inventory rating – The load level a bridge can safely carry for an indefinite amount of time expressed in tons or by the rating factor described in design load (see above). Inventory rating values typically correspond to the original design load for a bridge without deterioration.

Keystone – Wedge-shaped stone, or voussoir, at the crown of an arch.

Load Rating – The determination of the live load carrying capacity of a bridge using bridge plans and supplemented by field inspection.

Maintenance – Work of a routine nature to prevent or control the process of deterioration of a bridge.

Minnesota Historic Property Record – A documentary record of an important architectural, engineering, or industrial site, maintained by the Minnesota Historical Society as part of the state's commitment to historic preservation. MHPR typically includes large-format photographs and written history, and may also include historic photographs, drawings, and/or plans. This state-level documentation program is modeled after a federal program known as the Historic American Buildings Survey/Historic American Engineering Record (HABS/HAER).

National Bridge Inventory – Bridge inventory and appraisal data collected by the FHWA to fulfill the requirements of the National Bridge Inspection Standards (NBIS). Each state maintains an inventory of its bridges subject to NBIS and sends an annual update to the FHWA.

National Bridge Inspection Standards – Federal requirements for procedures and frequency of inspections, qualifications of personnel, inspection reports, and preparation and maintenance of state bridge inventories. NBIS applies to bridges located on public roads.

National Register of Historic Places – The official inventory of districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture, which is maintained by the Secretary of the Interior under the authority of the National Historic Preservation Act of 1966 (as amended).

Non-vehicular traffic – Pedestrians, non-motorized recreational vehicles, and small motorized recreational vehicles moving along a transportation route that does not serve automobiles and trucks. Includes bicycles and snowmobiles.

Operating rating – Maximum permissible load level to which a bridge may be subjected based on a specific truck type, expressed in tons or by the rating factor described in design load (see above).

Pack rust – Rust forming between adjacent steel surfaces in contact which tends to force the surfaces apart due to the increase in steel volume.

Pier – A substructure unit that supports the spans of a multi-span superstructure at an intermediate location between its abutments.

Pointing – The compaction of mortar into the outermost portion of a joint and the troweling of its exposed surface to secure water tightness and/ or desired architectural effect (when replacing deteriorated mortar).

Pony truss – A through bridge with parallel chords and having no top lateral bracing over the deck between the top chords.

Posted load – Legal live-load capacity for a bridge which is associated with the operating rating. A bridge posted for load restrictions is inadequate for legal truck traffic.

Pontis – Computer-based bridge management system to store inventory and inspection data and assist in other bridge data management tasks.

Preservation – Preservation, as used in this report, refers to historic preservation that is consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Properties for Preservation*. It is the act or process of applying measures to sustain the existing form, integrity, and material of a historic building or structure, and its site and setting. MnDOT's *Bridge Preservation, Improvement and Replacement Guidelines* describe preservation differently, focusing on repairing or delaying the deterioration of a bridge without significantly improving its function and without considerations for its historic integrity.

Preventive maintenance – The planned strategy of cost-effective treatments that preserve a bridge, slow future deterioration, and maintain or improve its functional condition without increasing structural capacity.

Reconstruction – The act or process of depicting, by means of new construction, the form, features, and detailing of a non-surviving site, landscape, building, structure, or object for the purpose of replicating its appearance at a specific period of time and in its historic location. Activities should be consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Properties for Reconstruction.*

Rehabilitation – The act or process of returning a historic property to a state of utility through repair or alteration which makes possible an efficient contemporary use, while preserving those portions or features of the property that are significant to its historic, architectural, and cultural values. Historic rehabilitation, as used in this report, refers to implementing activities that are consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Properties for Rehabilitation*. As such, rehabilitation retains historic fabric and is different from replacement. MnDOT's *Bridge Preservation, Improvement and Replacement Guidelines* describe rehabilitation and replacement in similar terms.

Restoration – The act or process of accurately depicting the form, features, and character of a property as it appeared at a particular period of time. Activities should be consistent with the Secretary of the Interior's *Standards for the Treatment of Historic Properties for Restoration.*

Ring stone – One of the separate stones of an arch that shows on the face of the headwall, or end of the arch. Also known as a voussoir.

Scaling – The gradual distentegration of a concrete surface due to the failure of the cement surface caused by chemical attack or freeze-thaw cycles or rebar too close to the surface and oxidizing from exposure to chlorides.

Scour – Removal of material from a river's bed or bank by flowing water, compromising the strength, stability, and serviceability of a bridge.

Scour critical rating – A measure of a bridge's vulnerability to scour (see above). MnDOT utilizes letter designations to represent specific descriptions of a bridges susceptibility and/ or present condition in

regards to scour. Range in condition and scour susceptibility does not necessarily correlate alpha numerically to the MnDOT scour code letters so it is important to understand the specifc scour description for each MnDOT scour code. The scour codes and descriptions can be found in the ”MNDOT Bridge Inspection Field Manual”.

Section loss – Loss of a member’s cross sectional area and resulting strength usually by corrosion or decay.

Serviceability – Level of facilities a bridge provides for vehicular, bicycle, and pedestrian traffic, compared with current design standards.

Smart flag – Special Pontis inspection element used to report the condition assessment of a deficiency that cannot be modeled, such as cracks, section loss, and steel fatigue.

Spall – Depression in concrete caused by a separation of a portion of the surface concrete, revealing a fracture parallel with or slighty inclined to the surface.

Spring line – The imaginary horizontal line at which an arch or vault begins to curve. As example, the point of transition from the vertical face of an abutment to the start of arch curvature extending from abutment face.

Stabilization – The act or process of stopping or slowing further deterioration of a bridge by means of making minor repairs until a more permanent repair or rehabilitation can be completed.

Stringcourse – A horizontal band of masonry, generally narrower than other courses and sometimes projecting, that extends across the structure’s horizontal face as an architectural accent. Also known as belt course.

Structural evaluation – Condition rating of a bridge designed to carry vehicular loads, expressed as a numeric value and based on the condition of the superstructure and substructure, the inventory load rating, and the ADT.

Structurally deficient – Classification indicating NBI condition rating of 4 or less for any of the following: deck condition, superstructure condition, substructure condition, or culvert condition. A bridge is also classified as structurally deficient if it has an appraisal rating of 2 or less for its structural evaluation or waterway adequacy.. A structurally deficient bridge is restricted to lightweight vehicles; requires immediate rehabilitation to remain open to traffic; or requires maintenance, rehabilitation, or replacement.

Sufficiency rating – Rating of a bridge's structural adequacy and safety for public use, and its serviceability and function, expressed on a numeric scale ranging from a low of 0 to a high of 100. It is a relative measure of a bridge's deterioration, load capacity deficiency, or functional obsolescence. MnDOT may use the rating as a basis for establishing eligibility and priority for replacement or rehabilitation. Typically, bridges which are structurally deficient and have sufficiency ratings between 50 and 80 are eligible for federal rehabilitation funds and those which are structurally deficient with sufficientcy ratings of 50 and below are eligible for replacement.

Through truss – A bridge with parallel top and bottom chords and top lateral bracing with the deck generally near the bottom chord.

Under-clearances – One of five NBI appraisal ratings. This rating appraises the suitability of the horizontal and vertical clearances of a grade-separation structure, taking into account whether traffic beneath the structure is one- or two-way.

Variance – A deviation from State Aid Operations Statute Rules that takes into account environmental, scenic, aesthetic, historic, and community factors that may have bearing upon a transportation project. A design variance is used for projects using state aid funds. Approval requires appropriate justification and documentation that concerns for safety, durability and economy of maintenance have been met.

Vehicular traffic – The passage of automobiles and trucks along a transportation route.

Voussoir – One of the separate stones forming an arch ring; also known as a ring stone.

Waterway adequacy – One of five NBI appraisal ratings. This rating appraises a bridge's waterway opening and passage of flow under or through the bridge, frequency of roadway overtopping, and typical duration of an overtopping event.

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Appendix B. Guidelines for Bridge Maintenance and Rehabilitation Based on the Secretary of the Interior's Standards

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The Secretary's Standards with Regard to Repair, Rehabilitation, and Replacement Situations

Adapted from:

Clark, Kenneth M., Grimes, Mathew C., and Ann B. Miller, *Final Report, A Management Plan for Historic Bridges in Virginia*, Virginia Transportation Research Council, 2001.

The Secretary of the Interior's Standards for the Treatment of Historic Properties, first codified in 1979 and revised in 1992, have been interpreted and applied largely to buildings rather than engineering structures. In this document, the differences between buildings and structures are recognized and the language of the Standards has been adapted to the special requirements of historic bridges.

1. Every reasonable effort shall be made to continue an historic bridge in useful transportation service. Primary consideration shall 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.