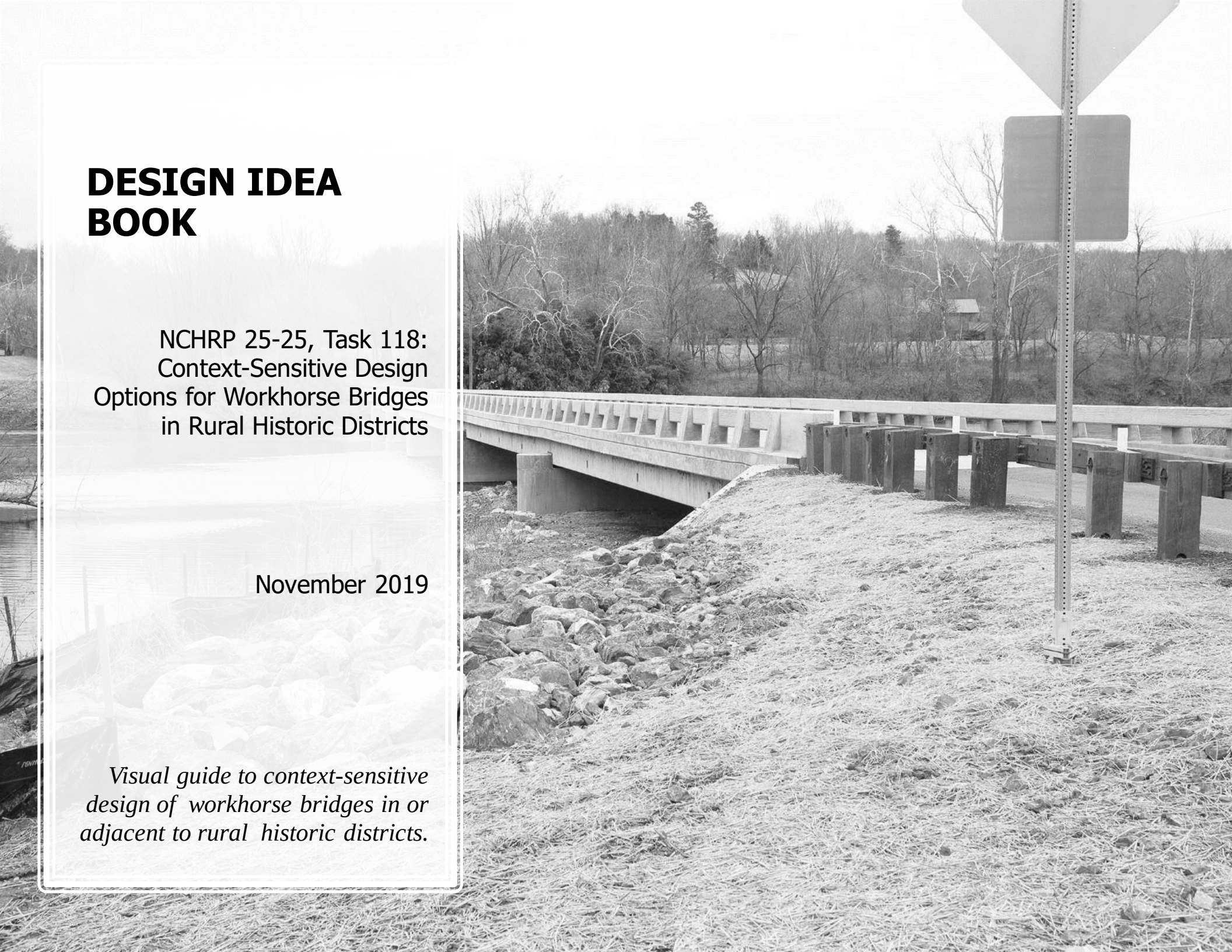
DESIGN IDEA BOOK

NCHRP 25-25, Task 118:
Context-Sensitive Design Options for Workhorse Bridges in Rural Historic Districts

November 2019

Visual guide to context-sensitive design of workhorse bridges in or adjacent to rural historic districts.



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DISCLAIMER

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Urban Engineers
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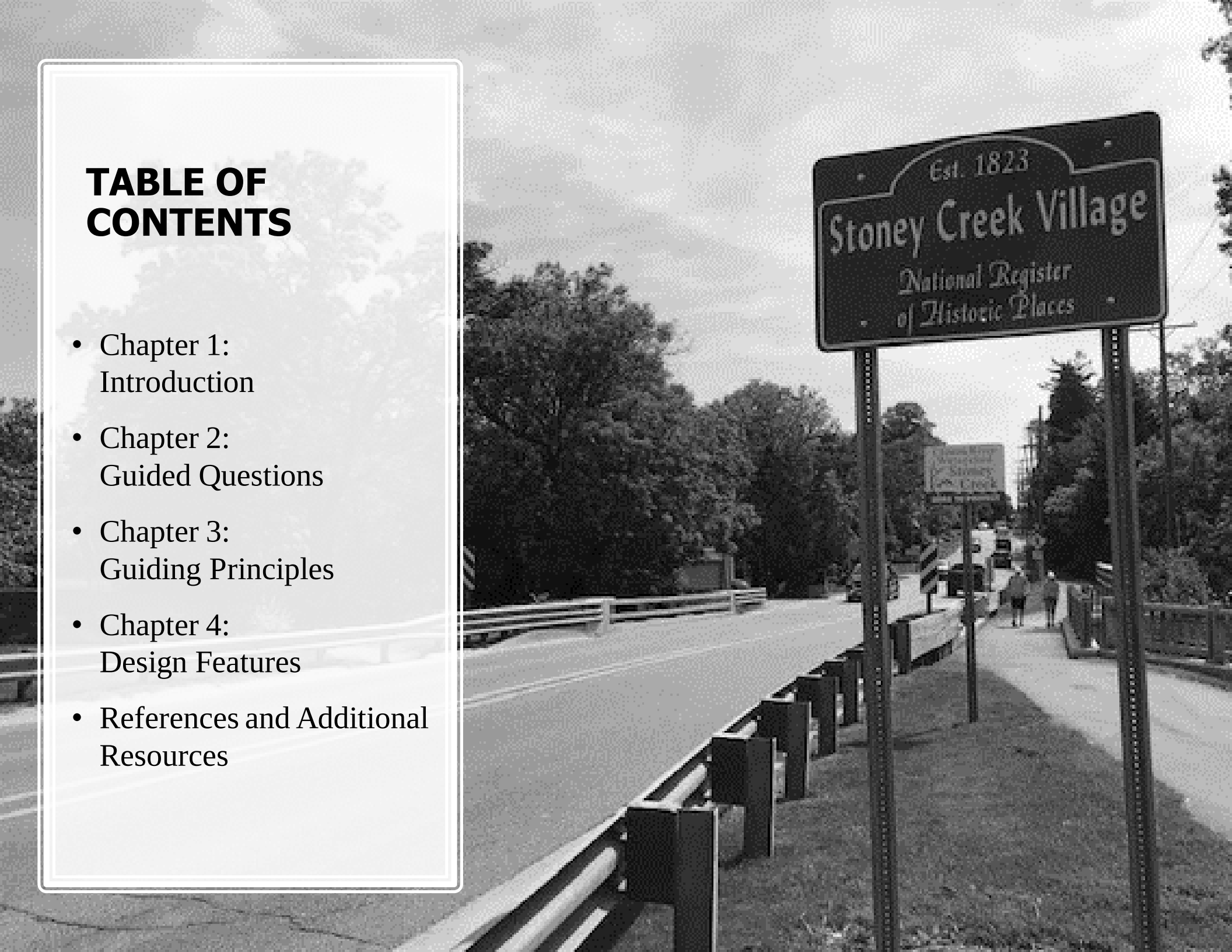
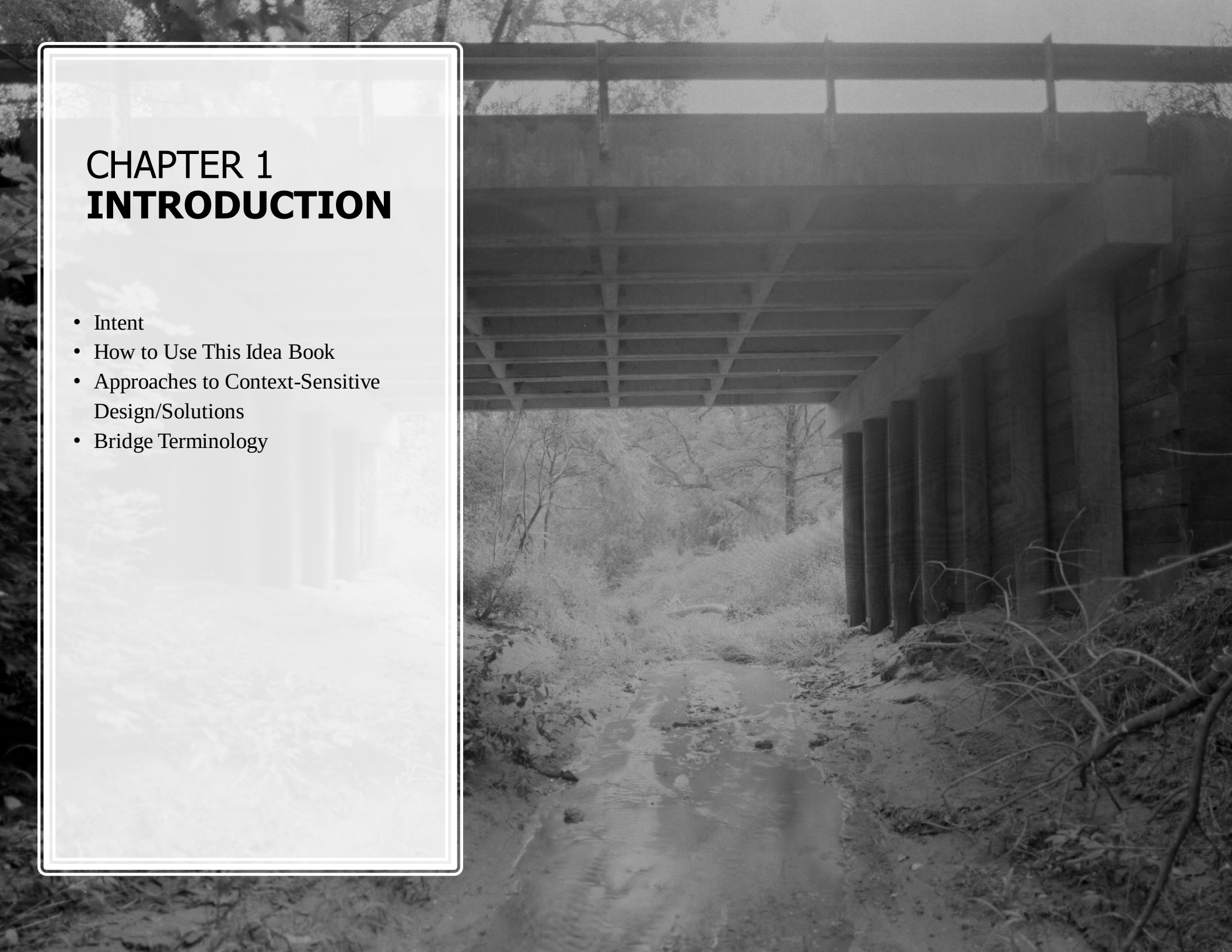


CHAPTER 1
INTRODUCTION

- Intent
- How to Use This Idea Book
- Approaches to Context-Sensitive Design/Solutions
- Bridge Terminology



INTRODUCTION

Intent

The intent of this design idea book is to present design features that have been used to achieve context-sensitive designs in or adjacent to rural historic districts through illustrations of successful workhorse bridge designs exhibiting features that might be used in typical rural settings.

It is laid out for use during the design and public involvement process to provide a range of possible bridge designs and approaches to the CSD/S of workhorse bridge replacements.

"Context Sensitive Design (CSD) is design process that not only considers physical aspects or standard specifications of a transportation facility, but also the economic, social, and environmental resources in the community being served by that facility." (FHWA)

Workhorse bridges can be defined as spans of less than 300 feet, generally constant girder-type structures assembled from standard structural components and systems.

How to Use This Idea Book

This Design Idea Book can be used as a visual guide during design and public meetings to aid in making compatible design choices for workhorse bridge replacements in or adjacent to rural historic districts.

The bridge designs highlighted in this book are not *all* appropriate for *all* rural historic districts. When considering the design of a bridge in or adjacent to any historic district, decisions must be made in conjunction with an understanding of the local historic context as well as current engineering and safety standards.

Chapters 2 and 3 of this design book provides guided questions and guiding principles designed to steer practitioners and stakeholders to a successful replacement design.

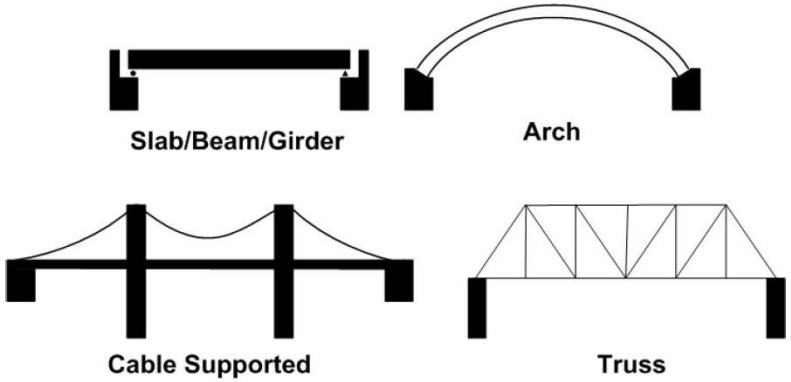
Chapter 4 details the most common design elements or features that contribute to successful workhorse bridge replacements in rural historic districts.

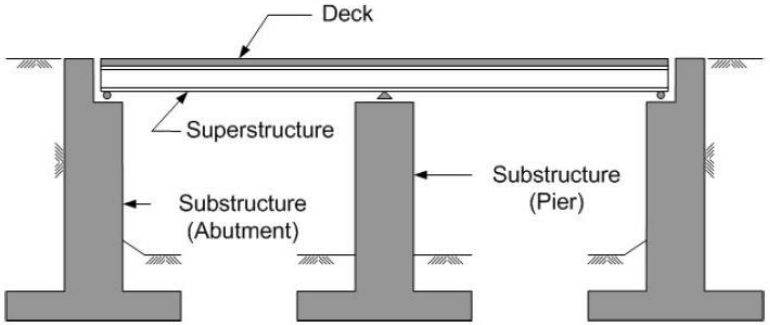
Approaches to Context Sensitive Design/Solutions

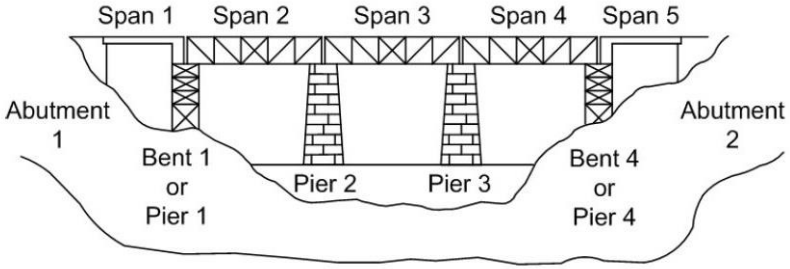
Research conducted as part of NCHRP 25-25, Task 118, revealed five general approaches to Context-Sensitive Design/Solutions (CSD/S) for replacement bridges in or adjacent to rural historic districts. Although each bridge replacement is unique, most projects will follow one of these approaches:

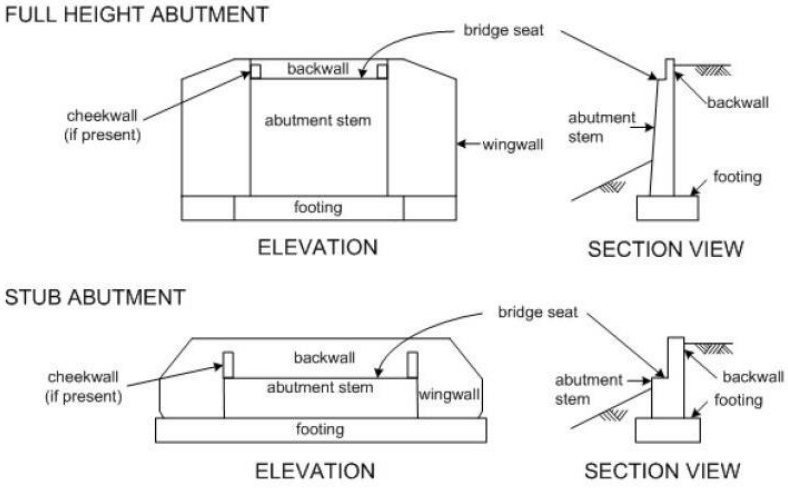
- ***Regional*** – This approach draws influence from regional bridge styles as well as from a desire to create a modern, regional tradition.
- ***Replication*** – This approach is straightforward in its name; replacing a bridge with a replica design.
- ***Previous Bridges*** – This approach draws design influence from previous iterations of the existing bridge.
- ***Stakeholder-Driven*** – This approach is centered on the public involvement process and uses stakeholder input as a driving factor in proposed design elements.
- ***Design/Safety Driven*** – This approach stems from the necessity of a replacement design to address design and safety issues of the existing bridge.

Bridge Terminology









From Bridge Inspector's Reference Manual, U.S. Department of Transportation, 2002.

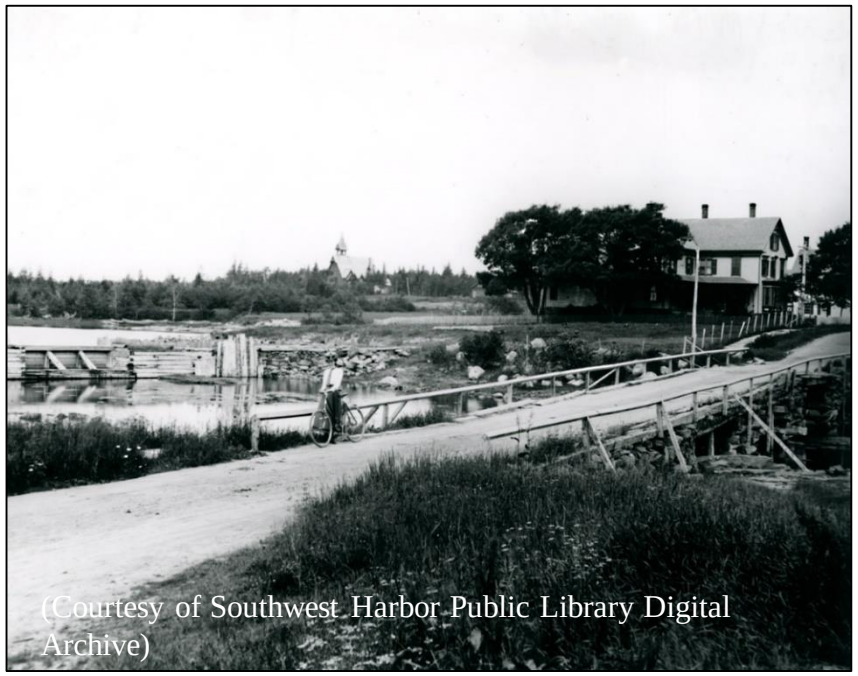
CHAPTER 2
GUIDED QUESTIONS

- Topics
  - Setting/Context
  - Significance
  - Design
  - Safety
  - Public Involvement
- Choosing a CSD/S Approach
  - Regional
  - Replication
  - Previous Bridge
  - Stakeholder-Driven
  - Design/Safety-Driven

TOPICS

Setting/Context

Historically, how many bridges have been at the site?



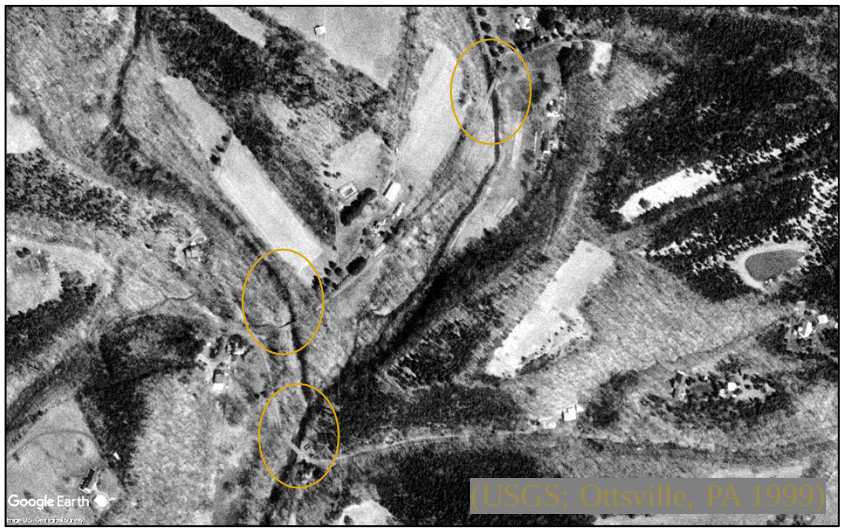
(Courtesy of Southwest Harbor Public Library Digital Archive)

Do previous bridges have more of a historical connection to the historic district than the current bridge?

(© Google 2011)

Setting/Context

Why was the site historically chosen for a bridge?



Natural/advantageous river crossing?

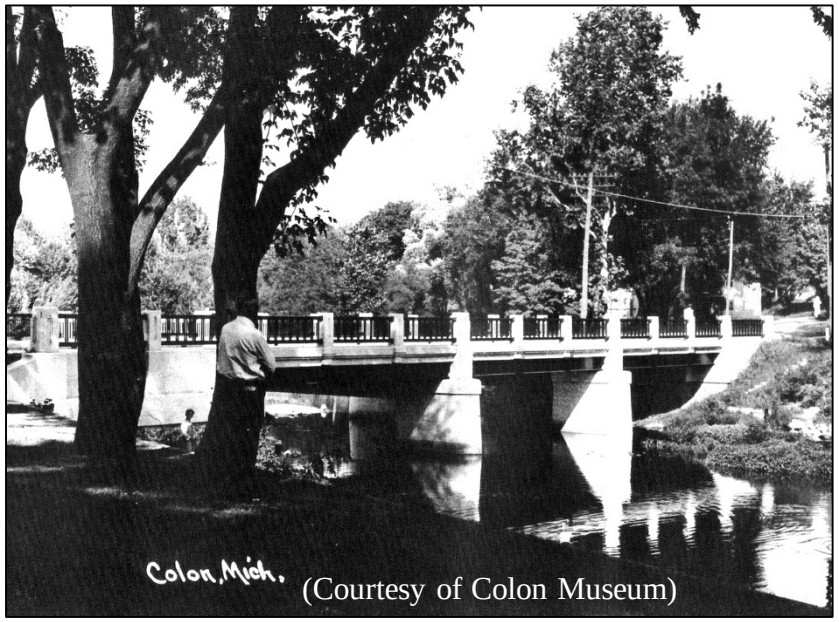
Part of a scenic route/parkway?

Part of an engineered road network?

Agricultural (farm to market) network?

Setting/Context

What was the historic function of the bridge within the HD circulation network?



(Courtesy of Colon Museum)


(HAER HI-75-33)


(Courtesy of VDOT)

- *Gateway*
- *Transportation Link*
- *Utility Bridge*
- *Waterway or Land Feature Crossing*

Setting/Context

Was the workhorse bridge designed to blend with the landscape or stand out?

(Courtesy IH Engineers, April 2005)

(HAER HI-71-4)

Significance

Is the bridge individually significant as well as contributing to a historic district?

(Courtesy of Benesch Engineering)

(Courtesy of VDOT)

How is the bridge contributing to the historic district?

Significance

Does the bridge share any aesthetic qualities (materials, form, etc.) with buildings or structures, particularly other bridges, within the historic district?


(Courtesy of IH Engineers, September 2010)

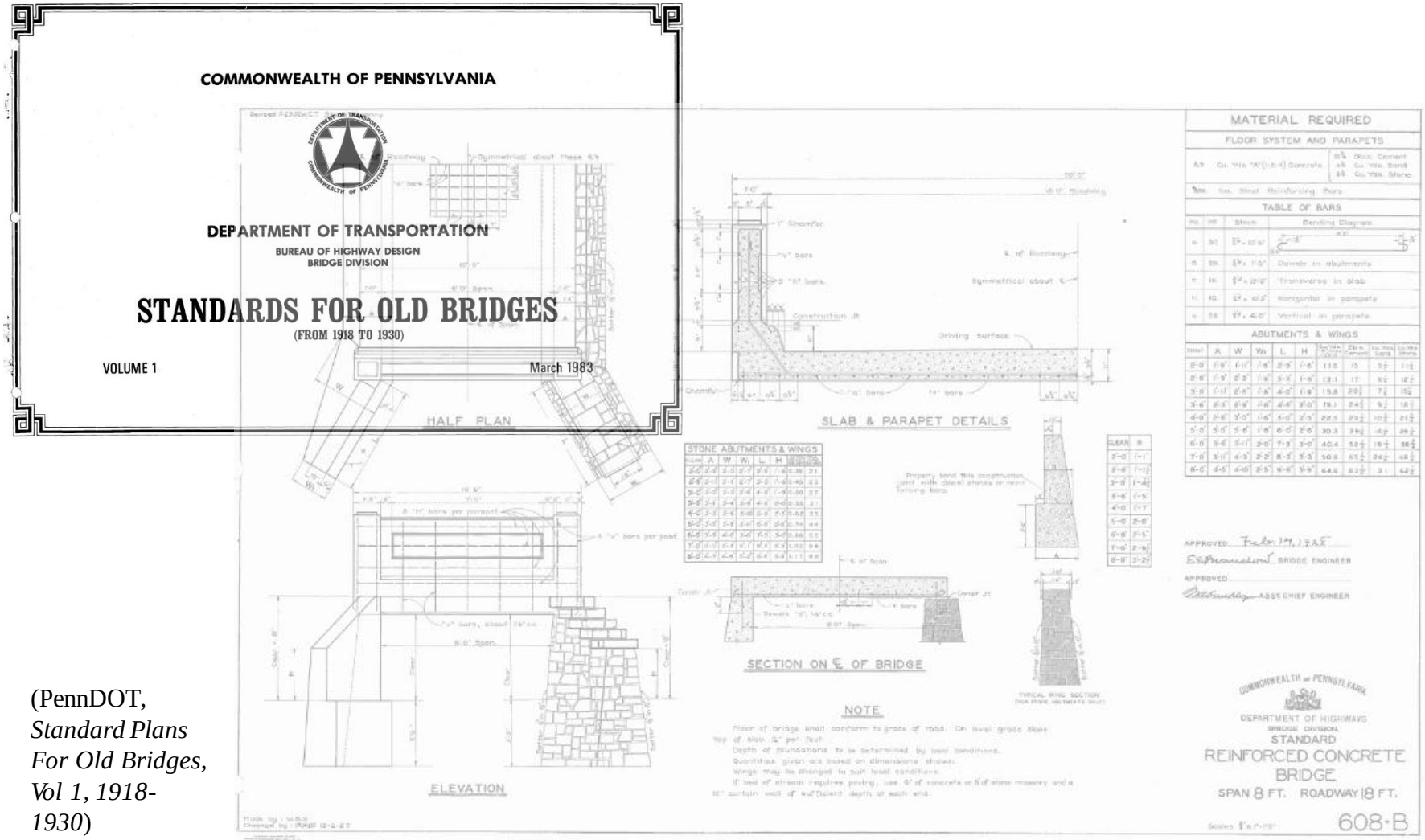

(alpsroads.net)


(NJDOT)

The Rosedale Road Bridge (replacement pictured above) shared continuity of material with nearby bridges in Princeton, NJ (right).

Design

Is the bridge a standard state highway design?



(PennDOT, *Standard Plans For Old Bridges, Vol 1, 1918-1930*)

Design

Are there other workhorse bridges within the historic district or nearby?

Do they share common design features?

Five Fisher Road Bridges of varying sizes with matching rail designs.(Images Courtesy of Nathan Holth, Historicbridges.org)

Design

What are the design details/character-defining features of the workhorse bridge?

Design

Are there any other community/area – specific design parameters to consider?

Flood Resiliency

Large machinery crossing in agricultural area

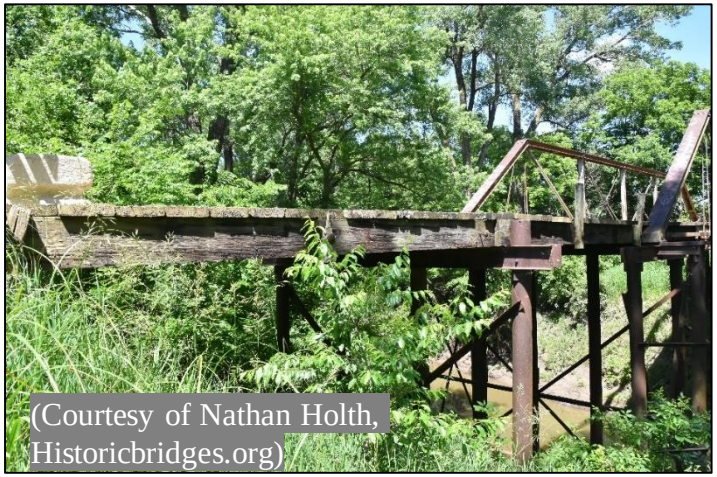
Pedestrian Crossing

Safety

What is the posted speed of the roadway that the bridge carries?

(HAER OR-36-A)

Does the existing bridge to be replaced have substandard design elements?


(Courtesy of Nathan Holth, Historicbridges.org)

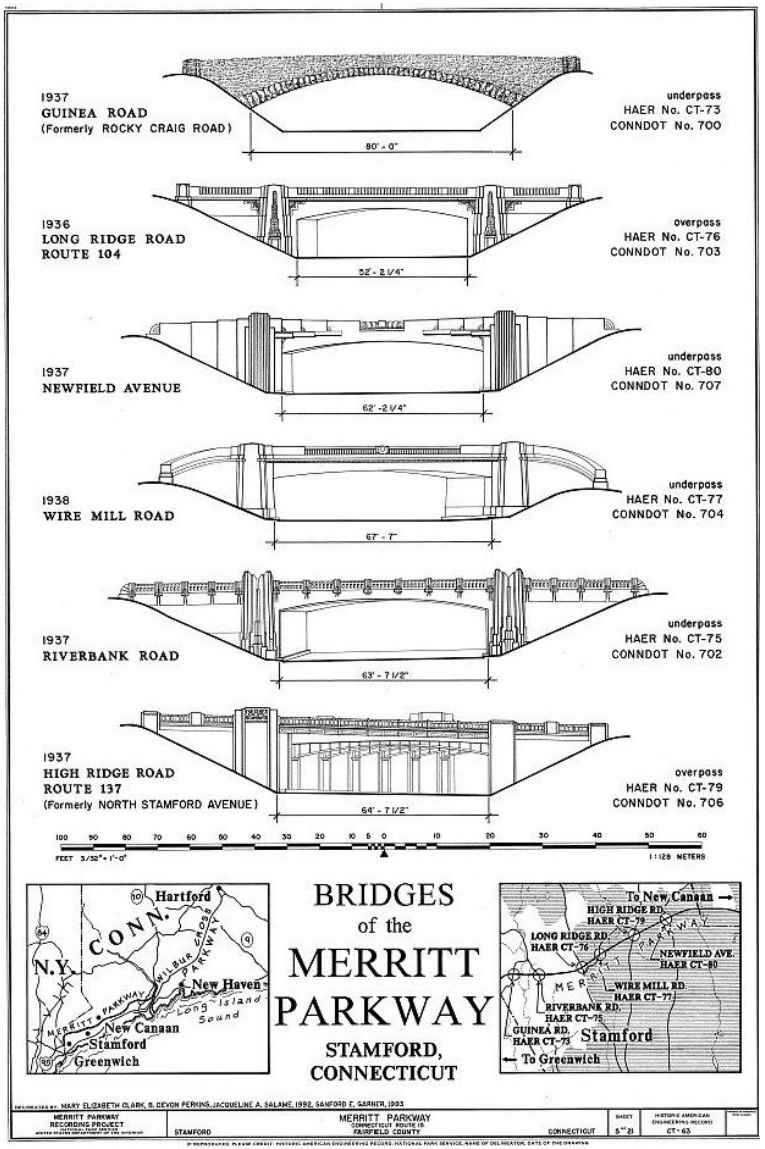
Does the existing bridge to be replaced have any critical safety hazards?


(Ohio DOT)

CHOOSING A CSD/S APPROACH

Regional

- Regional bridge designs
- Regional architectural tradition
- Common design trends and characteristics of an area
- Relate to significance of the region
- Create a continuity of design



(HAER CONN, 1-GREWI,2- (sheet 5 of 21))

Regional

Columbia River Highway, Chenoweth Creek Bridge Before (top) and After (bottom); Existing regional architectural traditions (below) used as inspiration for replacement railing design.

Regional

(Plenary Group | Walsh Group | Granite | HDR)

(Plenary Group | Walsh Group | Granite | HDR)

Pennsylvania Rapid Bridge Replacement Program (RBRP), Conwego Creek Bridge Before (top) and After (bottom); Creation of a modern regional tradition inspired by historic Pennsylvania Turnpike bridges (below) and other 1920s examples.

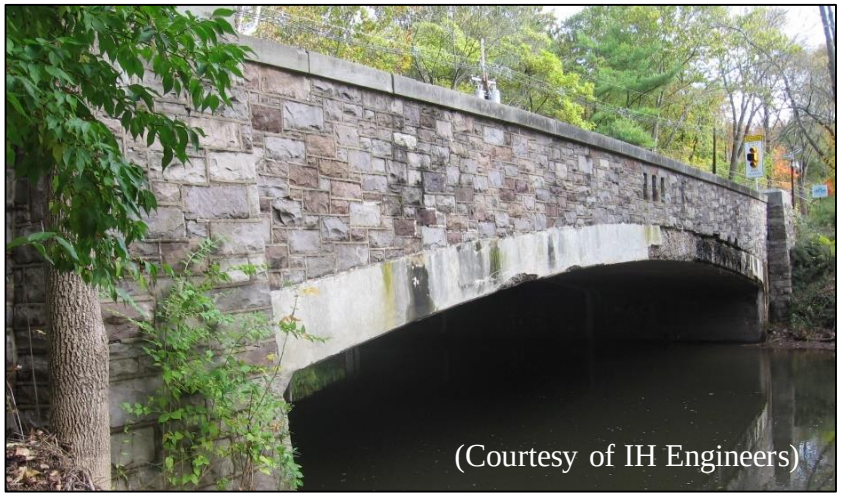
(Library of Congress)

Replication

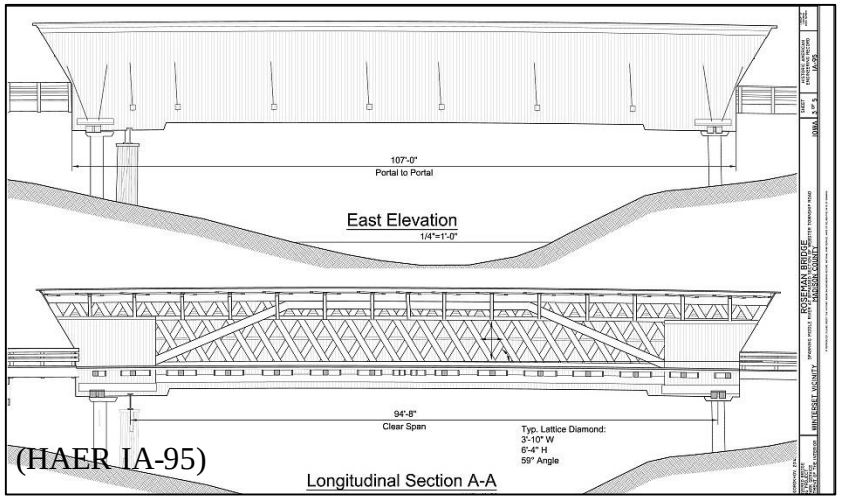
- Replica using modern technology
- New differentiated from the old
- Compatible
- Bridge integral to historic landscape or district
- Use of engineering design exceptions

Hope Road Bridge, Blairstown, New Jersey

Replication



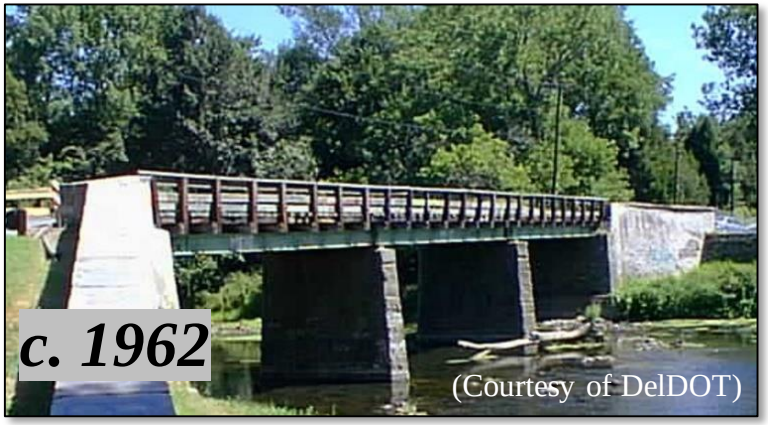
Rosedale Road Bridge Before (top) and After (bottom) Replacement , Princeton, New Jersey

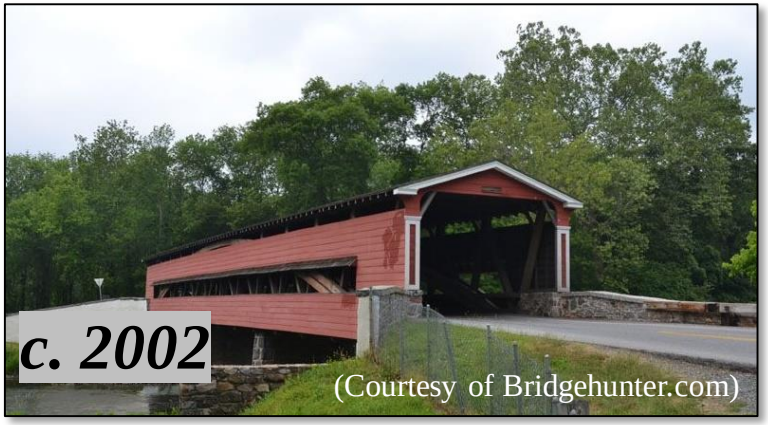


Cedar Bridge HAER Drawings (top) and replacement (bottom), Madison County, Iowa

Previous Bridge

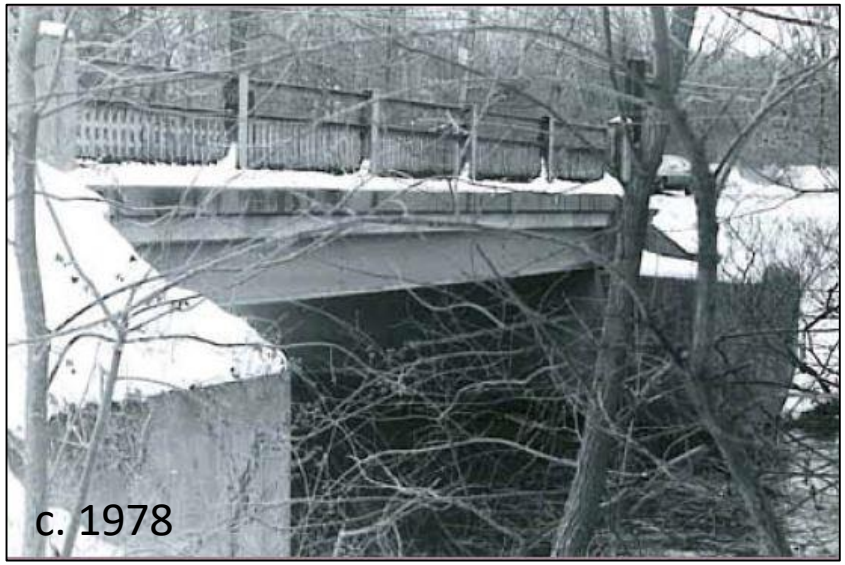
- Previous design at same location
- Historical research
- Value in previous design
- Not exact replication
- Use of engineering design exceptions
- Public Input

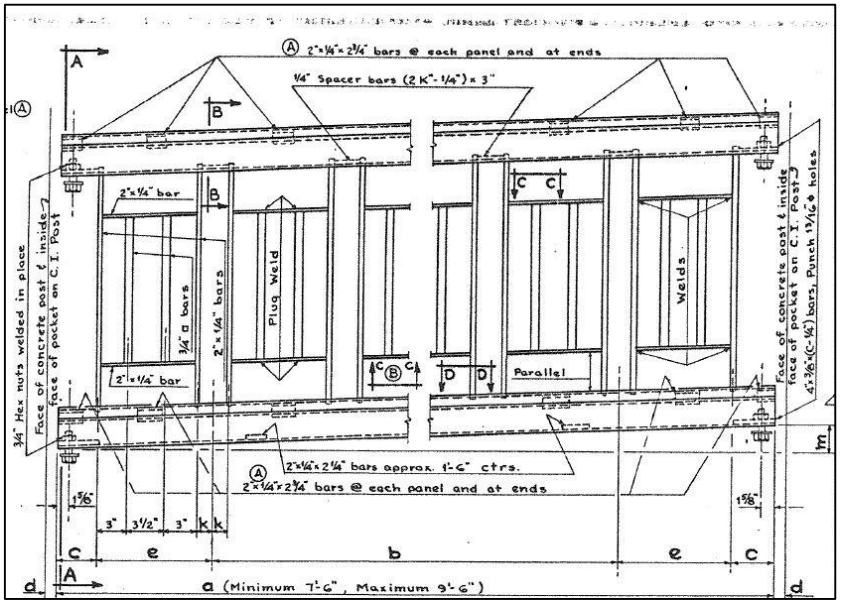




Smith's Bridge, Delaware

Previous Bridge

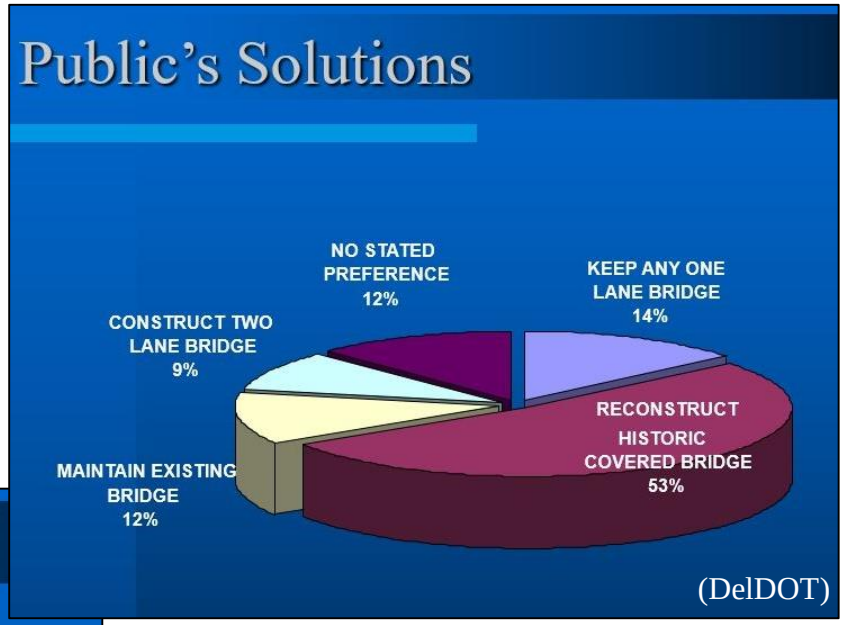


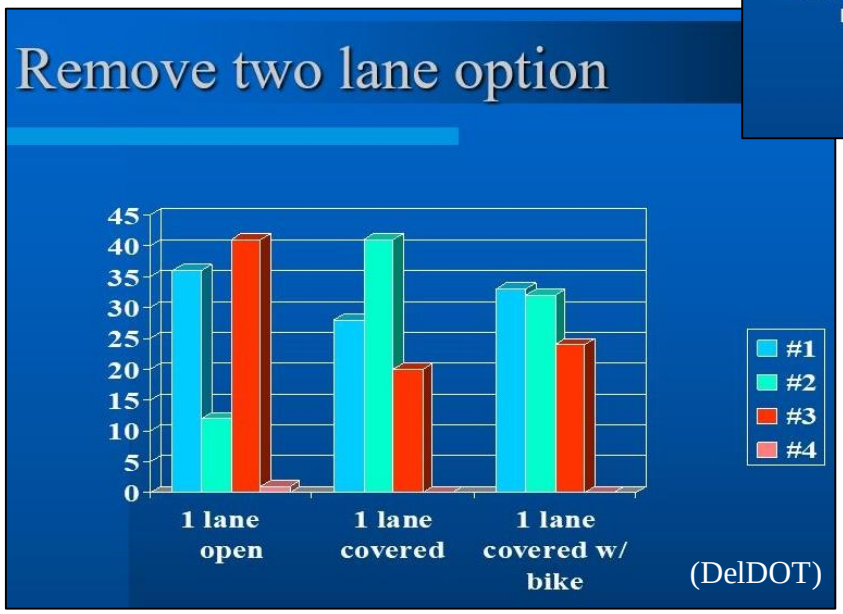


- Previous bridge (top left) was a standard state plan
- Michigan DOT used a similar standard plan railing (top right) from a salvaged bridge in replacement (bottom right)

Stakeholder-Driven

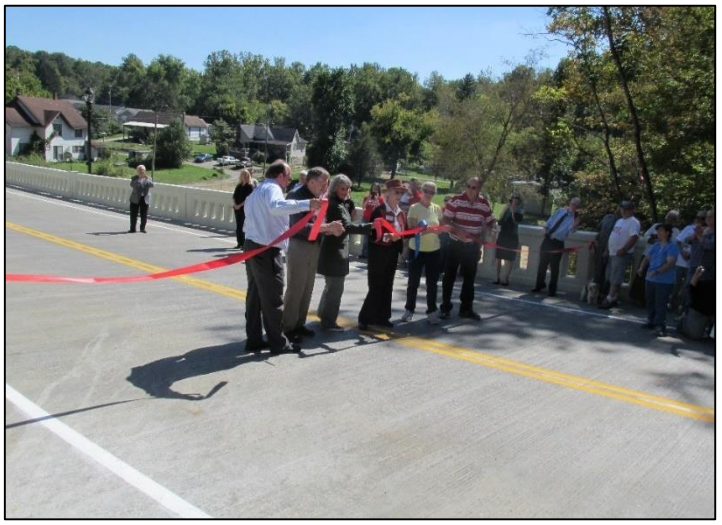
- Public involvement and Input
- Flexible design features
- Design options





Stakeholder-Driven

- Mix of rural and urban settings
- Public wanted a signature gateway bridge
- Stinesville history of limestone quarrying
- Use of simulated stone form liners on retaining wall



Stinesville Road Bridge, Monroe County, Indiana. (All images courtesy of Beam, Longest and Neff).

Design/Safety-Driven

- Preferred design for public comment
- Address critical safety hazards and substandard features
- Design and Safety issues prioritized above public input and aesthetics
- Accommodate CSD within expedited timeline
- Creative hydraulic and geometric solutions
- Minimal/Limited aesthetic treatments


(Courtesy of Mead & Hunt/TxDOT)

Design/Safety-Driven

Route 206 Flood Channel Bridge Before Replacement (Image courtesy of Urban Engineers).

Route 206 Flood Channel Bridge After Replacement. (Image courtesy of Urban Engineers).

Design/Safety-Driven

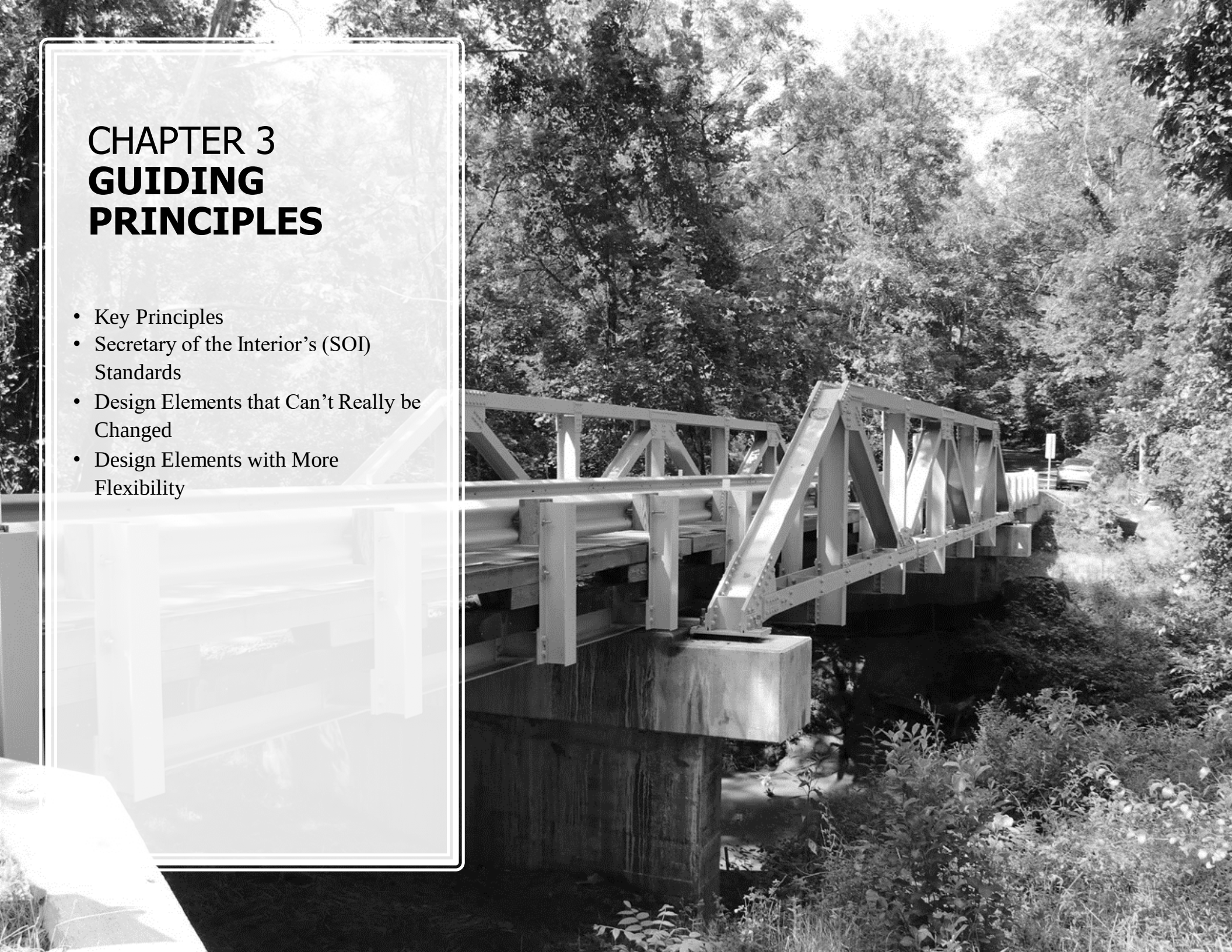
Morgan's Ford Bridge, Warren County, Virginia
Before (top) and After (bottom)

(VDOT)

(Courtesy of Trevor Wrayton, VDOT)

CHAPTER 3
GUIDING PRINCIPLES

- Key Principles
- Secretary of the Interior's (SOI) Standards
- Design Elements that Can't Really be Changed
- Design Elements with More Flexibility



KEY PRINCIPLES

- *Consideration of character-defining features of the historic bridge.*
- *Proper implementation of the principles of design aesthetics.*
- *Stakeholder engagement.*
- *Incorporate proper aesthetic design principles to achieve reference to past features of historic significance.*
- *Use desirable features of a historic bridge as basis for commonality between the old and the new.*
- *Avoid creating new visual elements.*

APPLICABLE SOI STANDARDS

Standard 3: "each property will be recognized as a physical record of its time, place and use. *Changes that create a false sense of historical development such as adding conjectural features or elements from other historic properties, will not be undertaken."*

Standard 9: "New additions, exterior alterations or related new construction will not destroy historic material features, and spatial relationships that characterize the property. *The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and the environment*."

DESIGN ELEMENTS THAT CAN'T REALLY BE CHANGED

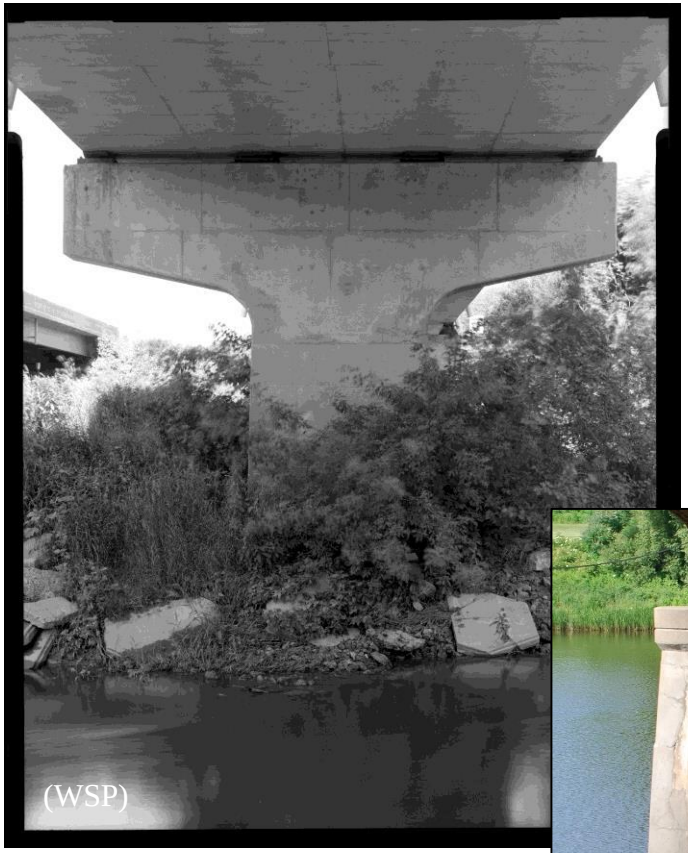
- *Vertical and Horizontal Geometry*
- *Superstructure Type*
- *Superstructure Shape*
- *Pier Placement*
- *Abutment Placement*


(Courtesy of Beam, Longest, and Neff)


(Courtesy of Elaine Deutsch, Historicbridges.org)

DESIGN ELEMENTS WITH MORE FLEXIBILITY

Pier Shape

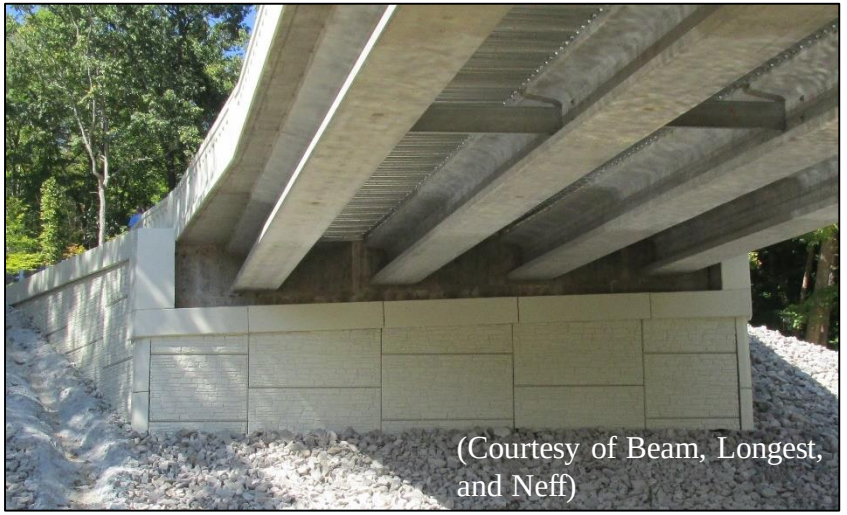


DESIGN ELEMENTS WITH MORE FLEXIBILITY

Abutment Shape

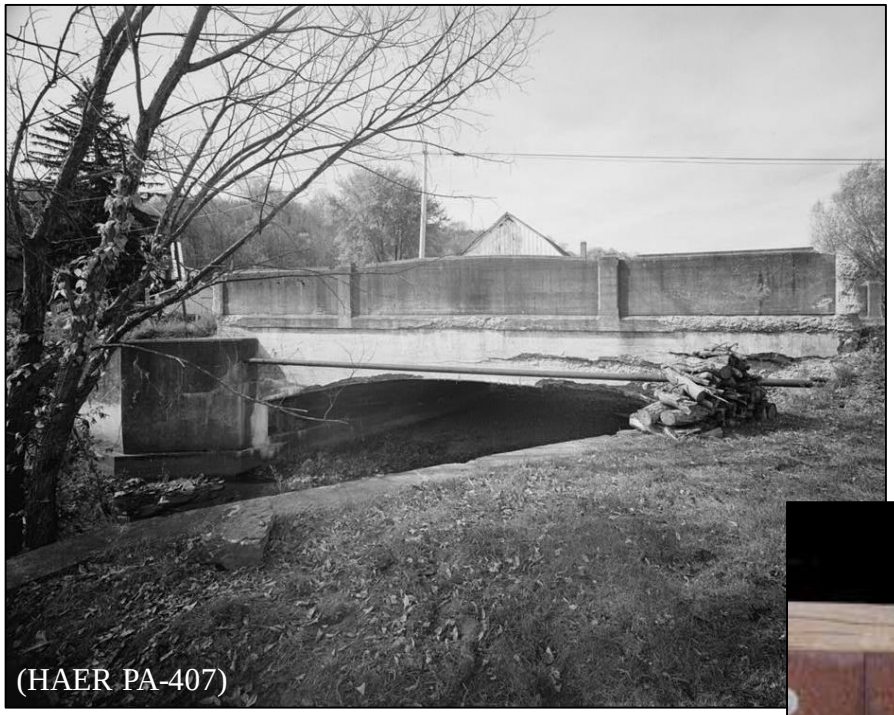

(WSP)


(WSP)


(Courtesy of Beam, Longest, and Neff)

DESIGN ELEMENTS WITH MORE FLEXIBILITY

Parapet and Railing Details


(HAER PA-407)


(Wikimedia Commons)


(Highway Safety Corps)

DESIGN ELEMENTS WITH MORE FLEXIBILITY

Colors and Texture

Plenary Group | Walsh Group | Granite | HDR

Plenary Group | Walsh Group | Granite | HDR

(WSP)

CHAPTER 4
DESIGN FEATURES

The most common design elements or features that contribute to successful workhorse bridge replacements in rural historic districts are:

- Bridge Type and Material
- Texture
- Color
- Scale
- Abutments and Wing Walls
- Rails

BRIDGE TYPE AND MATERIAL

- Decide bridge type as early as possible
- Replace with a similar structure type to existing or nearby structures
- Modern design standards
- Characteristically subdued in setting
- Structural design accuracy and suitability
- Materials appropriate to context
- Regionally available materials
- Reproduce elements of similar size, shape, and proportion

(WSP)

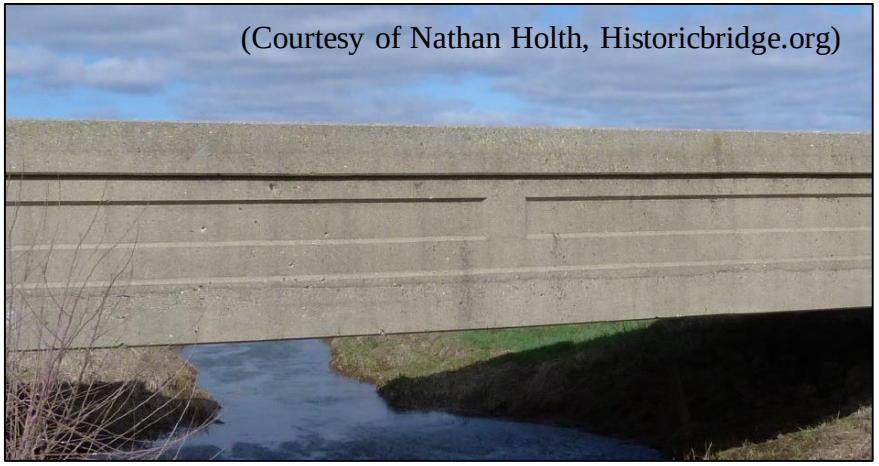
(Courtesy of VDOT)

BRIDGE TYPE AND MATERIAL

A three-span concrete-encased steel stringer bridge (left) was replaced with a single-span concrete slab beam bridge (right). (Images Courtesy of Urban Engineers).

TEXTURE

- Historically used, local stone
- Textures from surrounding area
- Reduce scale of large substructure elements with texture
- Repetitive features


(Courtesy of Nathan Holth, Historicbridge.org)


(Courtesy of Urban Engineers)


(Courtesy of Monica Harrower, PennDOT)

TEXTURE

As part of the Pennsylvania Rapid Bridge Replacement Program, the standard replacement design can be enhanced with the use of form liners (below) to achieve compatibility when the existing bridge (left) is set within a historic district.

(Images: Plenary Group | Walsh Group | Granite | HDR; parapidbridges.com)

COLOR

- Random, natural colors and patterns
- No more than three colors
- Highlight or disguise
- Background structure – subdued colors
- Statement structure – Contrasting colors
- Research historic colors used

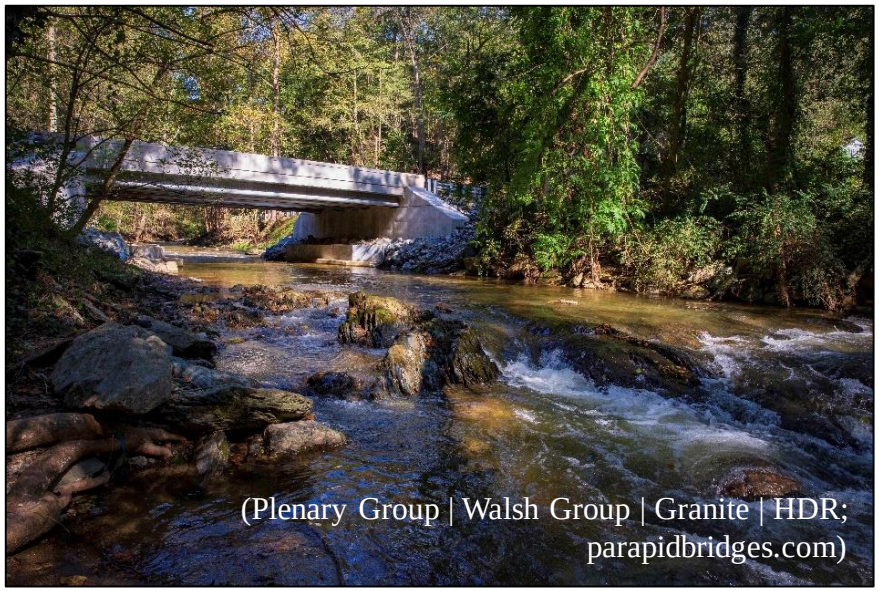
COLOR

Research into the historic paint colors of bridges prior to replacement will likely reveal compatible color choices for the replacement bridge. Metal truss bridges are likely candidates for color application. (Images: courtesy of VDOT).

SCALE

- Harmony with setting
- Maintain vertical profile
- Maintain masonry characteristics in stone size, and mortar width
- Addition of lanes will change scale
- Design to narrowest possible width

(Courtesy of Beam, Longest, and Neff



(Plenary Group | Walsh Group | Granite | HDR; parapidbridges.com)

SCALE

The Oyster River Bridge replacement exhibits a successful retention in scale. Before replacement (left) and after (bottom), Durham, NH. (Images: courtesy of NHDOT).

ABUTMENTS AND WING WALLS

- Commonly stone, integrated into landscape
- Texture and height
- Use similar material and form to existing
- Exposures good surface for texture and color
- Only use form liners when examples are nearby

(Plenary Group | Walsh Group | Granite | HDR; parapidbridges.com)

(Courtesy of Urban Engineers)

ABUTMENTS AND WING WALLS

A two-span, concrete channel beam bridge with rock masonry abutments and pier (left) replaced with a single-span concrete bridge, retaining the original stone abutments (right). A concrete sill was applied to the tops of the existing abutments to create a level surface for the new beams. (Images: courtesy of WSP).

RAILS

- Railing type should match bridge type
- Open railings often preferred in settings with scenic views
- True openings to replicate historic openings preferred over indentations when possible


(Mercer County, NJ)


(Courtesy of ODOT)

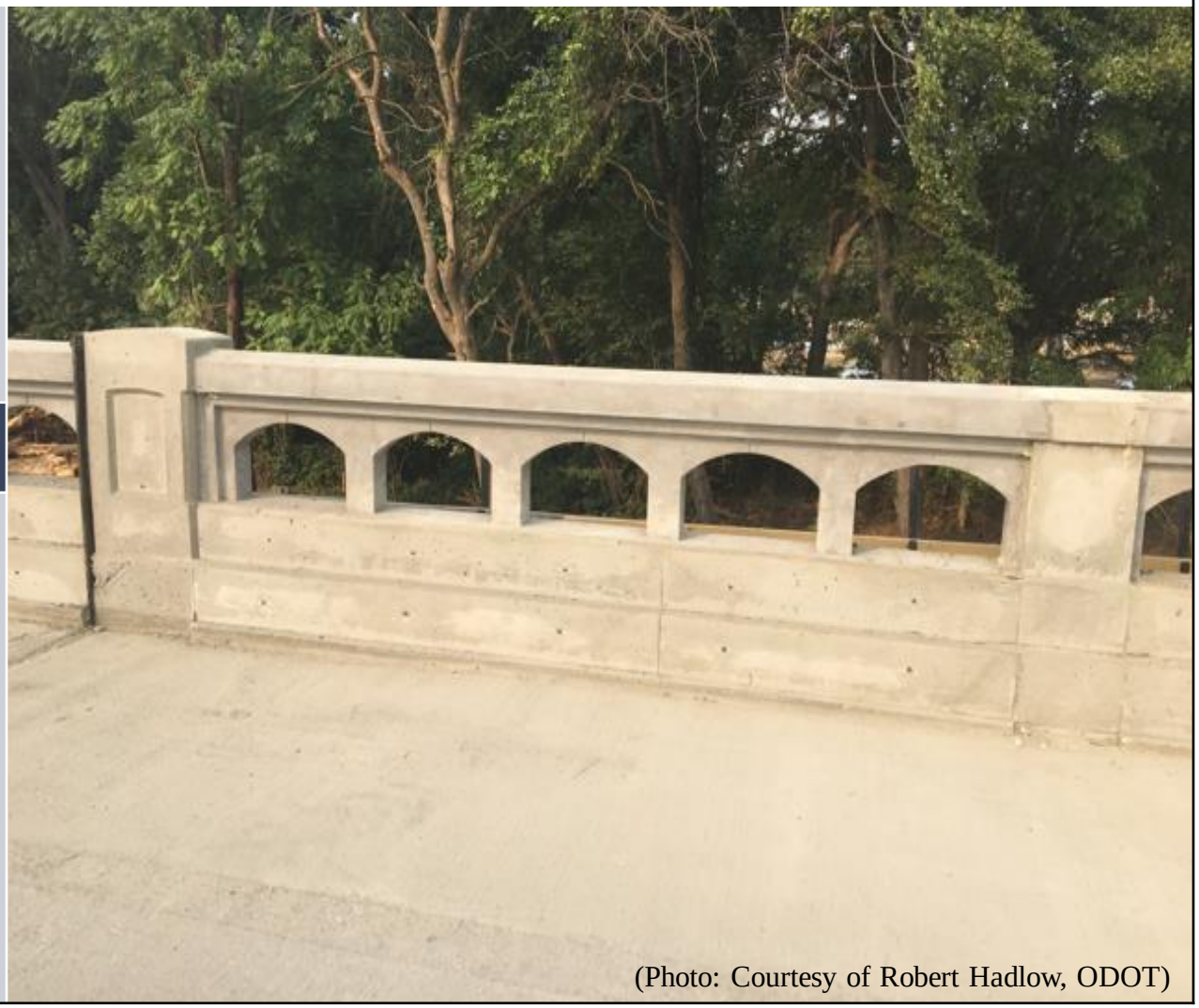

(Plenary Group | Walsh Group | Granite | HDR)

RAIL OPTIONS

- Oregon DOT Stealth Rail
- Nevada DOT Beaux Arts Bridge Rail
- Caltrans Concrete Barrier Type 80
- TxDOT T223
- Kansas Corral Rail 32” without curb
- Modified Kansas Corral Rail, 27”
- Timber Guardrail
- PennDOT Type 10M
- Texas Rail (Open Concrete Parapet)
- 2 Tube Metal
- NMDOT Type D

These railing designs have been used by state and county DOTs for workhorse bridge replacements.

Oregon DOT Stealth Rail

SUITABLE TO	IMAGE
• TL-4 rating (to ODOT Design Standards) • Rocky terrain • Reinforced concrete bridges	 (Photo: Courtesy of Robert Hadlow, ODOT)
COST	
• $1,000/LF (Oregon 2017) • 10x the cost of a standard rail	

Nevada DOT Beaux Arts Bridge Rail

SUITABLE TO	IMAGE
• TL-3 • Historic Beaux Arts style bridges in Nevada • Reinforced concrete bridges • Rural and urban settings	 (Photo: © Google 2016)
COST	
• Total bridge cost of example pictured: $622,000 (Nevada 2016)	

Caltrans Concrete Barrier Type 80

SUITABLE TO	IMAGE
• TL-4 • Coastal/Rural	 (Photographer: Trevor Wrayton, VDOT)
COST	
• $325/unit (To $1/10,000) – Caltrans 2018 Contract Cost Data – expected • $120/LF (Virginia 2018 bid) • $150/LF (Bridge Rail Guide, 2005)	

TxDOT T223

SUITABLE TO	IMAGE
• TL-3 • Rural • Agricultural context	 (Photo: Courtesy of Renee Benn, TxDOT)
COST	
• T223 is an improved version of the TxDOT T203 rail which costs $55/LF (TxDOT 2010)	

Kansas Corral Rail 32” without curb

SUITABLE TO	IMAGE
• TL-4 • Rural	 (Photo: FHWA)
COST	
• Approximately $250/LF (VDOT 2017)	

Modified Kansas Corral Rail, 27”

SUITABLE TO	IMAGE
• TL-2 • Rural	 (Photo: © Google 2016)
COST	
• $350/LF (VDOT 2019)	

Timber Guardrail

SUITABLE TO	IMAGE
• Rural • Village • Agricultural Context	 (Photo: Courtesy of Ron Campbell, RCOC)
COST	
• No cost information could be found for this rail. • Example pictured is located in Oakland County, MI, constructed in 2015	

PennDOT Type 10M

SUITABLE TO	IMAGE
• TL-4 • Rural • Village	 (Photographer: Monica Harrower, PennDOT)
COST	
• $250/LF, painted (PennDOT 2019) • $200/LF, unpainted (PennDOT 2019)	

Texas Rail (Open Concrete Parapet)

SUITABLE TO	IMAGE
• TL-2 • Village • Urban • Gateway	 (Photo: Courtesy of Beam, Longest and Neff)
COST	
• $94/LF (TxDOT 2010)	

2 Tube Metal

SUITABLE TO	IMAGE
• Village • Urban	 (Photo: Paul Graham, WSP)
COST	
• $85/LF (Michigan bid, 2010)	

NMDOT Type D

SUITABLE TO	IMAGE
• Urban • Low speeds, under 45mph	 (Photo: Courtesy of Richard Rotto, WSP)
COST	
• $295/LF (Santa Fe, NM bid)	

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