A Framework for Historic Bridge Preservation

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Sponsored by TxDOT – Fort Worth District
TxDOT Personnel

TxDOT Fort Worth District
- Maribel Chavez – District Engineer (retired)
- Alfredo Valles – District Bridge Engineer (Project Manager), now retired
- Taylor Buckner – Bridge Inspection Engineer (Assist with Project Management), now retired
- Rocky Armendariz – Bridge Inspector
- Ricardo Gonzalez – North Tarrant Area Engineer
- Jaime Aparicio – Transportation Engineer
- Greg Cedillo – South Tarrant Area Engineer
- Elisa Garcia – Environmental Specialist
- Enedina Alexander – Administrative Technician

TxDOT ENV Division
- Renee Benn – Historian (ENV Historical Branch)

TxDOT BRG Division
- Jamie Griffin
- Brian Merrill
- Michelle Veale
Overview

Motivation and Objectives

Background

Research Tasks

• Historic Bridge Prioritization Framework
• Top 10 Bridges

Conclusions and Takeaways
Motivation and Objectives
West 7th Street Bridge

Bridge carrying West 7th Street over West Fork of the Trinity River in Fort Worth (built in 1913).

Designated for removal in 2011.

TxDOT Fort Worth District desired to develop a proactive approach to identifying and preserving historic bridges in Tarrant County.
Motivation and Objectives

**Benefits of historic bridges**
- Representation of history
- Aesthetic value
- Commercial value
- Functionality

**Concerns**
- Deterioration is inevitable
- Funding is limited

**Primary Goal**: Preserve the integrity of historic bridges for future generations through better planning and management strategies.
Background

• Important parameters
• Notable TxDOT studies
• Frameworks in other states
**NBI Historical Significance Rating**

Signifies eligibility for National Register of Historic Places (NRHP)

1. Listed on the NRHP
2. Eligible for listing on the NRHP
3. May be eligible or is on a state or local historic register
4. Eligibility is not determinable at the time
5. Not eligible

<table>
<thead>
<tr>
<th>Historical Significance</th>
<th>Number of Bridges in Tarrant County</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>3</td>
<td>14</td>
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<tr>
<td>4</td>
<td>151</td>
</tr>
<tr>
<td>5</td>
<td>1186</td>
</tr>
</tbody>
</table>
NRHP Eligibility Criteria

**Criterion A:** Associated with a significant historic event

**Criterion B:** Associated with a significant person in history

**Criterion C:** Embodies the distinctive characteristics of a type, period, or method of construction, or represents the work of a master

**Criterion D:** Has potential to yield information important in history or prehistory
FHWA Sufficiency Rating

- Ranges from 1 to 100, indicates the sufficiency of a bridge to remain in service
  - 80-100: Good condition
  - 50-79.9: Eligible for rehabilitation
  - < 50: Eligible for replacement
Previous TxDOT Studies

TxDOT Metal Truss Bridge Task Force (1996)
Research and evaluation of preservation options for 38 historic metal truss bridges

TxDOT Inventory Survey of Non-Truss Structures (1997-1999)
Evaluation of 40,000 bridges for NRHP eligibility

Evaluation of 14,799 bridges for NRHP eligibility

All of these previous TxDOT studies have been combined into and updated in the Multiple Property nomination entitled “Historic Road Infrastructure of Texas, 1866-1965”
State DOT Frameworks

Indiana DOT
Condition and Eligibility Scores

<table>
<thead>
<tr>
<th>Condition Score</th>
<th>High</th>
<th>Medium</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eligibility Score</td>
<td>High</td>
<td>Medium</td>
<td>Low</td>
</tr>
<tr>
<td>Max Points</td>
<td>1</td>
<td>4</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>5</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>6</td>
<td>9</td>
<td></td>
</tr>
</tbody>
</table>

Ohio DOT
Technological and General Significance

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Max Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>Technological Significance</td>
<td></td>
</tr>
<tr>
<td>Length of individual span</td>
<td>12</td>
</tr>
<tr>
<td>Special Features</td>
<td>12</td>
</tr>
<tr>
<td>General Significance</td>
<td></td>
</tr>
<tr>
<td>History</td>
<td>4</td>
</tr>
<tr>
<td>Integrity</td>
<td>4</td>
</tr>
<tr>
<td>Aesthetics</td>
<td>4</td>
</tr>
</tbody>
</table>
Research Tasks
Overview of Research Framework

**Primary Goal:** Preserve the integrity of historic bridges for future generations through better planning and management strategies

- **Task 1:** Develop and Implement Prioritization Methodology
- **Task 2:** Identify Potential Funding Sources
- **Task 3:** Performance-Based Bridge Preservation

  - **Task 3.1:** Provide Guidance for Individual Bridge Preservation
  - **Task 3.2:** Develop Resource Allocation Methodology

- **Condition Assessment and Structural Health Monitoring**
- **Mitigation Strategies**
- **Template for Individual Bridge Preservation Plans**
Task 1: Prioritization

Task 1: Develop and Implement Prioritization Methodology

Task 2: Identify Potential Funding Sources

Task 3: Performance-Based Bridge Preservation

Task 3.1: Provide Guidance for Individual Bridge Preservation

Task 3.2: Develop Resource Allocation Methodology

Condition Assessment and Structural Health Monitoring

Mitigation Strategies

Template for Individual Bridge Preservation Plans
Inventory Review and Prioritization

All Tarrant County Bridges (2860)

Initial Screening → Evaluation Matrix → Further Review → Quantitative Rating System

Final Inventory (37)
Initial Screening

All Tarrant County Bridges (2860)

Initial Screening → Evaluation Matrix → Further Review → Quantitative Rating System → Final Inventory (37)
Initial Screening

- Removed post-1972 bridges
- Removed culverts
- Removed railroad bridges
- Removed bridges with no listing for sufficiency or historical significance ratings

2427 bridges eliminated, 433 remaining
Evaluation Matrix

All Tarrant County Bridges (2860)

Initial Screening → Evaluation Matrix → Further Review → Quantitative Rating System

Final Inventory (37)
Evaluation Matrix

<table>
<thead>
<tr>
<th>Historical Significance</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sufficiency Rating</td>
<td>0-24.9</td>
<td>25-49.9</td>
<td>50-64.9</td>
<td>65-79.9</td>
<td>80-100</td>
</tr>
</tbody>
</table>

- **Priority 1**
- **Priority 2**
- **Priority 3**
# Evaluation Matrix Applied to 433 Bridges

- **404 bridges eliminated, 29 remaining**

## Historical Significance

<table>
<thead>
<tr>
<th>Historical Significance</th>
<th>0-24.9</th>
<th>25-49.9</th>
<th>50-64.9</th>
<th>65-79.9</th>
<th>80-100</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
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<tr>
<td>2</td>
<td>1</td>
<td>3</td>
<td>6</td>
<td>2</td>
<td>5</td>
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<td>0</td>
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<td>7</td>
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</tr>
<tr>
<td>4</td>
<td>0</td>
<td>10</td>
<td>23</td>
<td>51</td>
<td>26</td>
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<tr>
<td>5</td>
<td>1</td>
<td>3</td>
<td>15</td>
<td>62</td>
<td>208</td>
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</table>

_Sufficiency Rating_
Further Review

All Tarrant County Bridges (2860)

Initial Screening ➔ Evaluation Matrix ➔ Further Review ➔ Quantitative Rating System ➔ Final Inventory (37)
Further Review

- All pre-1940 bridges further reviewed
- Eight bridges from third priority region displayed characteristics worthy of preservation

8 bridges returned, 37 remaining
All Tarrant County Bridges (2860) → Initial Screening → Evaluation Matrix → Further Review → Quantitative Rating System → Final Inventory (37)
Quantitative Rating System

- Modeled after system used by TxDOT for pre-1950 bridges
- Measures historical and engineering significance

<table>
<thead>
<tr>
<th>Criterion</th>
<th>Max Possible Points</th>
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<tbody>
<tr>
<td>Year Built</td>
<td>40</td>
</tr>
<tr>
<td>Main Span Length</td>
<td>20</td>
</tr>
<tr>
<td>Overall Length</td>
<td>4</td>
</tr>
<tr>
<td>Rail Type</td>
<td>14</td>
</tr>
<tr>
<td>Special Design</td>
<td>10</td>
</tr>
<tr>
<td>Structural Integrity</td>
<td>8</td>
</tr>
<tr>
<td>Site Integrity</td>
<td>8</td>
</tr>
<tr>
<td>Sufficiency Rating</td>
<td>8</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td><strong>112</strong></td>
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TxDOT 1999
## Quantitative Rating System
### Year Built

<table>
<thead>
<tr>
<th>Year</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>1900-1909</td>
<td>40</td>
</tr>
<tr>
<td>1910-1919</td>
<td>35</td>
</tr>
<tr>
<td>1920-1929</td>
<td>30</td>
</tr>
<tr>
<td>1930-1939</td>
<td>25</td>
</tr>
<tr>
<td>1940-1949</td>
<td>20</td>
</tr>
<tr>
<td>1950-1959</td>
<td>15</td>
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<tr>
<td>Post-1959</td>
<td>10</td>
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</tbody>
</table>
**Quantitative Rating System**

**Main Span Length**

<table>
<thead>
<tr>
<th>Concrete Girders:</th>
<th>Concrete Slabs:</th>
<th>Steel I-beams:</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Concrete Girder Image]</td>
<td>![Concrete Slab Image]</td>
<td>![Steel I-beam Image]</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
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<tbody>
<tr>
<td>≥ 45</td>
<td>20</td>
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<tr>
<td>40-45</td>
<td>10</td>
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</table>

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
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<tbody>
<tr>
<td>≥ 30</td>
<td>20</td>
</tr>
<tr>
<td>25-30</td>
<td>10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td>≥ 65</td>
<td>20</td>
</tr>
<tr>
<td>60-65</td>
<td>10</td>
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</table>

20 points for structures in top 5% among its type in state, 10 for top 10%
## Quantitative Rating System
### Main Span Length

<table>
<thead>
<tr>
<th>Concrete Arches:</th>
<th>Length (ft)</th>
<th>Points</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 40</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>30-40</td>
<td>10</td>
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</table>

<table>
<thead>
<tr>
<th>Trusses:</th>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&gt; 100</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>80-100</td>
<td>10</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Plate Girders:</th>
<th>Length (ft)</th>
<th>Points</th>
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<tbody>
<tr>
<td></td>
<td>&gt; 80</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>50-80</td>
<td>10</td>
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</table>

<table>
<thead>
<tr>
<th>Rigid Frames:</th>
<th>Length (ft)</th>
<th>Points</th>
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<tbody>
<tr>
<td></td>
<td>&gt; 50</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>40-50</td>
<td>10</td>
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TxDOT 1999
Quantitative Rating System
Overall Length

Concrete Girders:

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
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<tbody>
<tr>
<td>≥ 420</td>
<td>4</td>
</tr>
<tr>
<td>100-420</td>
<td>2</td>
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</tbody>
</table>

Concrete Slabs:

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 300</td>
<td>4</td>
</tr>
<tr>
<td>200-300</td>
<td>2</td>
</tr>
</tbody>
</table>

Steel I-beams:

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 520</td>
<td>4</td>
</tr>
<tr>
<td>340-520</td>
<td>2</td>
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</tbody>
</table>

4 points for structures in top 5% among its type in state, 2 for top 10%
## Quantitative Rating System

### Overall Length

**Concrete Arches:**

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 200</td>
<td>4</td>
</tr>
<tr>
<td>80-200</td>
<td>2</td>
</tr>
</tbody>
</table>

**Plate Girders:**

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 500</td>
<td>4</td>
</tr>
<tr>
<td>200-500</td>
<td>2</td>
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</tbody>
</table>

**Trusses:**

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 1000</td>
<td>4</td>
</tr>
<tr>
<td>300-1000</td>
<td>2</td>
</tr>
</tbody>
</table>

**Rigid Frames:**

<table>
<thead>
<tr>
<th>Length (ft)</th>
<th>Points</th>
</tr>
</thead>
<tbody>
<tr>
<td>≥ 200</td>
<td>4</td>
</tr>
<tr>
<td>100-200</td>
<td>2</td>
</tr>
</tbody>
</table>

TxDOT 1999
## Quantitative Rating System

### Rail Type

<table>
<thead>
<tr>
<th>Rail Type</th>
<th>Points</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Types A-J</td>
<td>14</td>
<td>![Image of Types A-J rail]</td>
</tr>
<tr>
<td>Special Design</td>
<td>12</td>
<td>![Image of Special Design rail]</td>
</tr>
<tr>
<td>Types K &amp; L</td>
<td>10</td>
<td>![Image of Types K &amp; L rail]</td>
</tr>
<tr>
<td>Type M</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Types P &amp; Q</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>Types R-8 7 R-10</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>Other post-1940 standard rail</td>
<td>2</td>
<td></td>
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</table>
## Quantitative Rating System

### Special Design

<table>
<thead>
<tr>
<th>Special Design</th>
<th>Score</th>
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</thead>
<tbody>
<tr>
<td>Decorative Elements</td>
<td>10</td>
</tr>
<tr>
<td>Engineering Response</td>
<td>8</td>
</tr>
<tr>
<td>Super/Substructure</td>
<td>6</td>
</tr>
<tr>
<td>Superstructure</td>
<td>4</td>
</tr>
<tr>
<td>Substructure</td>
<td>2</td>
</tr>
</tbody>
</table>

![Image 1]![Image 2]![Image 3]![Image 4]

TxDOT 1999
Final Inventory

All Tarrant County Bridges (2860)

Initial Screening → Evaluation Matrix → Further Review → Quantitative Rating System

Final Inventory (37)
Final Inventory

- 37 bridges
- Scores range from 40 to 104
- Includes all non-railroad bridges from TxDOT recommended list
Top 10 Bridges
BU 287P (N. Main St.) over Trinity River

- Year Built: 1914
- Owner: TxDOT
- Historical Significance: 1
- Sufficiency Rating: 66 (upgraded from 33.5 after rehabilitation)
- Member Type: Open Spandrel Arch
- Rail Type: Special Design

Score: 106/112

Top 10 highest priority for maintenance and restoration: #1
Samuels Ave. over West Fork Trinity River

- Year Built: 1914
- Owner: City of Fort Worth
- Historical Significance: 2*
- Sufficiency Rating: 81.3
- Member Type: Concrete Girder
- Rail Type: H

Score: 101/112
W. Lancaster over Clear Fork Trinity River

- Year Built: 1938
- Owner: City of Fort Worth
- Historical Significance: 2
- Sufficiency Rating: 80.2
- Member Type: Steel Truss
- Rail Type: Special Design

Score: 95/112

Top 10 highest priority for maintenance and restoration: #2
SH 180 WB over Sycamore Creek

- **Year Built:** 1928
- **Owner:** TxDOT
- **Historical Significance:** 4
- **Sufficiency Rating:** 92.2
- **Member Type:** Concrete Girder
- **Rail Type:** H

**Score:** 94/112
E. Exchange Avenue over Marine Creek

Year Built: 1930
Owner: City of Fort Worth
Historical Significance: 2*
Sufficiency Rating: 81.3
Member Type: Closed Spandrel Arch
Rail Type: Special Design

Score: 93/112
Off-system
Owner: City of Fort Worth
Year Built: 1930
AADT: 4,350
Hist. Sig.: 3
Span Type: Arch
Roadway Type: Deck
Member Type: Concrete Arch
Rail Type: H
Sufficiency Rating: 90.4

Score: 93/112
SH 199 (Henderson St.) over Clear Fork Trinity River

On-system

Owner: TxDOT

Year Built: 1930

AADT: 28,000

Hist. Sig.: 2

Span Type: Arch

Roadway Type: Deck

Member Type: Concrete Arch, Open Spandrel

Rail Type: H

Sufficiency Rating: 57.5

Score: 93/112

Top 10 highest priority for maintenance and restoration: #4
SH 199 (Henderson St.) over W. Fork Trinity River
02-220-0171-05-017

On-system
Owner: TxDOT
Year Built: 1931
AADT: 28,000
Hist. Sig.: 2
Span Type: Continuous
Roadway Type: Deck
Member Type: Concrete Girder, Var. Depth – Tee Beam
Rail Type: Special Design
Sufficiency Rating: 55.0

Score: 91/112

Top 10 highest priority for maintenance and restoration: #7
On-system

Owner: TxDOT

Year Built: 1938

AADT: 6,650

Hist. Sig.: 3

Span Type: Simple Span

Roadway Type: Deck

Member Type: Concrete Girder - Tee Beam

Rail Type: H

Sufficiency Rating: 74.7

Score: 91/112
US 377 (E. Belknap) over Trinity River

02-220-0081-01-001

On-system
Owner: TxDOT
Year Built: 1932
AADT: 5,800
Hist. Sig.: 2
Span Type: Continuous
Roadway Type: Deck
Member Type: Concrete Girder, Var. Depth – Tee Beam
Rail Type: Special Design
Sufficiency Rating: 56.6

Score: 87/112

Top 10 highest priority for maintenance and restoration: #6
Conclusions and Takeaways
Conclusions and Takeaways

• Historical significance and sufficiency ratings provide initial guidance, but are not adequate parameters for an accurate prioritization of bridges.

• A quantitative rating system was applied to the bridge inventory to provide a more detailed assessment.

• Past preservation programs are useful as models but often require modification for a specific bridge inventory.

• The prioritization framework used in this project could also be applied to other bridge inventories, particularly in Texas.
**Primary Goal:** Preserve the integrity of historic bridges for future generations through better planning and management strategies

- **Task 1:** Develop and Implement Prioritization Methodology
- **Task 2:** Identify Potential Funding Sources
- **Task 3:** Performance-Based Bridge Preservation
  - **Task 3.1:** Provide Guidance for Individual Bridge Preservation
  - **Task 3.2:** Develop Resource Allocation Methodology

Additional Research Tasks...

- Condition Assessment and Structural Health Monitoring
- Mitigation Strategies
- Template for Individual Bridge Preservation Plans
Thank you!

QUESTIONS?

More information:
tti.tamu.edu/documents/409139-1.pdf