SCOPE OF SERVICES
SCOPE OF SERVICES

- Bridge Inspection
  - In depth, hands on for all accessible members
  - Hands on for Fracture Critical members
  - Non-destructive testing of hanger cables
  - Sounding, sampling and GPR inspection of main piers

- Evaluation
  - Remaining service life of piers
  - Remaining fatigue life of steel members

- Rehabilitation Concepts & Alternatives
  - Short Term Repair – 10 years of additional service life
  - Long Term Rehabilitation – 35 years of additional service life

- Preliminary Plans
  - Bridge memo, cost estimate & preliminary plans of selected alternate
02 BRIDGE INSPECTION
DECK
- Wearing surface has numerous cracks both transverse and longitudinal
- Some bulging stay in place forms
- Deterioration near slab drains
- Deck saturation in north approach spans
RAILING

- Numerous locations of impact damage
  - Bent / broken rail tubes
  - Cracked / broken rail posts
- Spalling concrete on curb and parapet
- Pack rust on curb support brackets
EXPANSION JOINT SUPPORT

- Vertical deflections between sides of the joints
- Pack rust and deterioration of the supporting brackets
- Cracked clip angles supporting the joints
- Compression seals have failed
- Compression seal armor has failed
**STRINGER / FLOORBEAM**

- Pack rust between bottom flange of the stringers and bearing plates
- Deterioration of the stringer flanges and web near locations exposed to drainage
- Deterioration of stringer bearing stiffeners
- Cracking of stringer webs near ends
- Pitting in webs of floorbeams throughout
- Section loss in top and bottom floorbeam flanges
- Pack rust between floorbeam stiffening angles and webs
- Holes in floorbeam stiffening angles
LOWER HANGER CABLE RETAINERS

- Heavy pack rust at almost all locations
- Most locations have section loss and deflection
- Retainers have come off in several locations
**TIE GIRDER**

- Pack rust between top plate and connecting angles
- Cupping of top plate due to pack rust
- Localized areas of pitting
- Pack rust at old attachment points
LOWER OUTER GUSSET

- Pack rust between ends of floorbeams and gusset plate
- Pack rust between tie girder and gusset plate
- Section loss of gusset plate along areas of pack rust
PORTAL FRAME

- Pack rust between box member web plates and connecting angles
- Deterioration of the interior of the box members below the deck
MAIN PIERS

- Faces in generally poor condition
- Areas of delamination and spalls
- Elevated chloride content in the concrete
PIER SCOUR

- Large scour hole at Pier 2 in the river
- Hole is around all sides of the pier
- Pier 2 is embedded one foot into the shale

2015 USGS Bathymetric Survey

2013 Underwater Bridge Inspection
APPROACH PIERS

- Pack rust between flanges and connecting angles
- Deformation and section loss of flange and web plates
- Pack rust between end plates and connecting angles
- Localized concrete spalls
**BEARING SHELF PLATE**

- Load induced fatigue crack at the end of the web stiffening plate
- Supports the bearing shelf
- Critical location on non-redundant member
- Reinforced after inspection
- Remaining locations should be proactively reinforced
GIRDER CRACKING

- Systemic cracking of the girder webs at the ends of stiffeners
- Distortion induced fatigue cracking
- Most cracks stay in the stiffener weld
- Some cracks have propagated into the web
- Continuing crack growth and development
03 FATIGUE ANALYSIS
MINER’S LAW OF CUMULATIVE DAMAGE

- Nominal fatigue resistance is inverse to the applied stress range, up to a threshold

$$(\Delta f)_n = \left(\frac{A}{N}\right)^{\frac{1}{3}}$$

- If the applied stress is below the allowable for the threshold, fatigue damage will not occur
### Table 6.6.1.2.3.1 — Detail Categories for Load-Induced Fatigue

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Constant A</th>
<th>Threshold (lbf in)</th>
<th>Potential Crack Initiation Point</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.1. Floor metal, except miniaturized stiffening panel with rolled or channel sections, planar or curved with surface roughness value of 1.000 in or less, but without minor contours.</td>
<td>A</td>
<td>230 x 10^-16</td>
<td>8</td>
<td>Away from all welds or connections</td>
</tr>
<tr>
<td>1.2. Rolled plate steel, beam, or channel sections, planar or curved with surface roughness value of 1.000 in or less, but without minor contours.</td>
<td>B</td>
<td>120 x 10^-16</td>
<td>16</td>
<td>Away from all welds or connections</td>
</tr>
<tr>
<td>1.3. Machine with minimum member in a frame, corner, or fillet section</td>
<td>C</td>
<td>65 x 10^-10</td>
<td>10</td>
<td>Any external edge</td>
</tr>
<tr>
<td>1.4. Rolled cross sections with weld access holes made to the requirements of SANDIA-TR-1970, section weld access holes.</td>
<td>D</td>
<td>44 x 10^-10</td>
<td>10</td>
<td>In the base metal at the external cross of the weld access hole</td>
</tr>
<tr>
<td>1.5. Open holes to members (Brown et al., 2007).</td>
<td>E</td>
<td>20 x 10^-10</td>
<td>7</td>
<td>In the net section originating at the edge of the hole</td>
</tr>
<tr>
<td>2.1. Floor metal at the gross section of high-strength bolted joints designed as bearing type connections but fabricated and installed to all requirements for edge-out connections with pre-stressed high-strength bolts installed in holes drilled full size or in holes provided full size (Brown et al., 2007) and in the net section of other mechanically fastened joints, except for system and plate, e.g., plates in ASME Section VIII, Division 1 (see Section 2.2 for bolted angles or tee section member connections to gusset or connection plates).</td>
<td>B</td>
<td>120 x 10^-16</td>
<td>16</td>
<td>Through the gross section near the hole</td>
</tr>
</tbody>
</table>

### Table 6.6.1.2.3.1 (continued) — Detail Categories for Load-Induced Fatigue

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Constant A</th>
<th>Threshold (lbf in)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.2. Floor metal at the net section of high-strength bolted joints designed as bearing type connections but fabricated and installed to all requirements for edge-out connections with pre-stressed high-strength bolts installed in holes drilled full size or in holes provided full size (Brown et al., 2007) and in the net section of other mechanically fastened joints, except for system and plate, e.g., plates in ASME Section VIII, Division 1 (see Section 2.2 for bolted angles or tee section member connections to gusset or connection plates).</td>
<td>B</td>
<td>120 x 10^-16</td>
<td>16</td>
</tr>
<tr>
<td>2.3. Bolted joint in the gross section of high-strength bolted joints with pre-stressed bolts installed in holes provided full size (Brown et al., 2007) and in the net section of other mechanically fastened joints, except for system and plate, e.g., plates in ASME Section VIII, Division 1 (see Section 2.2 for bolted angles or tee section member connections to gusset or connection plates).</td>
<td>B</td>
<td>120 x 10^-16</td>
<td>16</td>
</tr>
<tr>
<td>2.4. Bolted joint in the net section of high-strength bolted joints with pre-stressed bolts installed in holes provided full size (Brown et al., 2007) and in the net section of other mechanically fastened joints, except for system and plate, e.g., plates in ASME Section VIII, Division 1 (see Section 2.2 for bolted angles or tee section member connections to gusset or connection plates).</td>
<td>B</td>
<td>120 x 10^-16</td>
<td>16</td>
</tr>
</tbody>
</table>

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continued on next page
### FATIGUE DETAIL CATEGORIES

#### Table 6.8.1.2.3-1 (continued) — Detail Categories for Load-Induced Fatigue

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Constant A ( \alpha )</th>
<th>Threshold ( \sigma /\sigma_{0} )</th>
<th>Potential Crack Initiation Form</th>
<th>Illustrative Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.9 (continued) The fatigue category shall be taken as that specified for Condition 2.1. For all other types of headed connections, replace ( A_{c} ) with the net area of the member, ( A_{n} ), comparing the effective area according to the preceding equation and use the appropriate fatigue category for that connection type specified for Condition 2.2 or 2.3, as applicable.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Section 5. Welded Joints Joining Components of Bulk Up Members (continued)

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Constant A ( \alpha )</th>
<th>Threshold ( \sigma /\sigma_{0} )</th>
<th>Potential Crack Initiation Form</th>
<th>Illustrative Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>5.1 Base metal at the termination of partial length welded cover plates, having square or rounded ends, with or without welds across the flange, or cover plates that are wider than the flange and without welds across the web.</td>
<td>E</td>
<td>( 11 \times 10^{6} )</td>
<td>4.3</td>
<td>In the flange at the point of the weld or at the end of the termination of the longitudinal weld, at the edge of the flange with weld over plate.</td>
<td></td>
</tr>
<tr>
<td>5.2 Base metal at the termination of partial length welded cover plates with lateral branch and connections satisfying the requirements of Article 6.8.1.2.3.3.</td>
<td>D</td>
<td>( 5 \times 10^{6} )</td>
<td>2.6</td>
<td>In the edge of the flange at the termination of the longitudinal weld.</td>
<td></td>
</tr>
</tbody>
</table>

#### Section 6. Welded Suddenly Connections

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Constant A ( \alpha )</th>
<th>Threshold ( \sigma /\sigma_{0} )</th>
<th>Potential Crack Initiation Form</th>
<th>Illustrative Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Base metal at the toe of transverse fillet to flange fillet welds and transverse fillet to web fillet welds. (Note: excludes similar welds on bearing surfaces and connection plates).</td>
<td>C</td>
<td>( 44 \times 10^{6} )</td>
<td>10</td>
<td>From the geometrical discontinuity at the toe of the fillet weld extending into the base metal.</td>
<td></td>
</tr>
<tr>
<td>6.2 Base metal and weld metal in partial length welded cover plates connected by continuous fillet welds parallel to the direction of applied stress.</td>
<td>B</td>
<td>( 120 \times 10^{6} )</td>
<td>16</td>
<td>From the surface or internal discontinuity in the weld away from the face of the weld.</td>
<td></td>
</tr>
</tbody>
</table>

continued on next page
FATIGUE DETAIL CATEGORIES

Table 6.4.1.2.3.1 (continued) — Detail Categories for Load-Induced Fatigue

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Constant $A$ (ksi$^2$)</th>
<th>Threshold $S/N$ (ksi)</th>
<th>Potential Crack Initiation Point</th>
<th>Eliminative Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Section 6 — Momentary Loadings ( \tau \leq 3 )</td>
<td>$n$</td>
<td>$41 \times 10^3$</td>
<td>30</td>
<td>From the point of tangency of the mating at the edge of the longitudinal load</td>
<td>[ \cdot ]</td>
</tr>
<tr>
<td>$n$</td>
<td>$41 \times 10^3$</td>
<td>30</td>
<td>From the point of tangency of the mating at the edge of the longitudinal load</td>
<td>[ \cdot ]</td>
<td></td>
</tr>
<tr>
<td>$n$</td>
<td>$41 \times 10^3$</td>
<td>30</td>
<td>From the point of tangency of the mating at the edge of the longitudinal load</td>
<td>[ \cdot ]</td>
<td></td>
</tr>
</tbody>
</table>
**Table 6.1.2.3-1 (continued) — Detail Categories for Load-Induced Fatigue**

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Contact A</th>
<th>Threshold Altitude</th>
<th>Potential Crack Initiation Point</th>
<th>Illustration Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.1 Base metal in a transversely loaded detail (e.g., a plate connection plate) attached to a longitudinally loaded component of another detail by a complete joint penetration groove weld parallel to the direction of primary stress and incorporating a transition radius, R, with weld reinforcement not removed.</td>
<td>A</td>
<td>120 x 10^-6</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 in. x 6 in.</td>
<td>B</td>
<td>44 x 10^-7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in. x 2 in.</td>
<td>D</td>
<td>22 x 10^-7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 in. x 1 in.</td>
<td>E</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With the weld reinforcement removed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.2 Base metal in a transversely loaded detail (e.g., a plate connection plate) attached to a longitudinally loaded component of another detail by a complete joint penetration groove weld parallel to the direction of primary stress and incorporating a transition radius, R, with weld reinforcement not removed.</td>
<td>A</td>
<td>120 x 10^-6</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 in. x 6 in.</td>
<td>B</td>
<td>44 x 10^-7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in. x 2 in.</td>
<td>D</td>
<td>22 x 10^-7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 in. x 1 in.</td>
<td>E</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With the weld reinforcement not removed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.3 Base metal in a transversely loaded detail (e.g., a plate connection plate) attached to a longitudinally loaded component of another detail by a complete joint penetration groove weld parallel to the direction of primary stress and incorporating a transition radius, R, with weld reinforcement not removed.</td>
<td>A</td>
<td>120 x 10^-6</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 in. x 6 in.</td>
<td>B</td>
<td>44 x 10^-7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in. x 2 in.</td>
<td>D</td>
<td>22 x 10^-7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 in. x 1 in.</td>
<td>E</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Table 6.1.2.3-1 (continued) — Detail Categories for Load-Induced Fatigue**

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Contact A</th>
<th>Threshold Altitude</th>
<th>Potential Crack Initiation Point</th>
<th>Illustration Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>6.4 Base metal in a transversely loaded detail (e.g., a plate connection plate) attached to a longitudinally loaded component by a fillet weld or a partial joint penetration groove weld, with the weld parallel to the direction of primary stress (Note: Condition 6.1 shall also be checked).</td>
<td>See Conditions 5.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6.5 Base metal in a transversely loaded detail (e.g., a plate connection plate) attached to a longitudinally loaded component by a fillet weld or a partial joint penetration groove weld, with the weld parallel to the direction of primary stress (Note: Condition 6.1 shall also be checked).</td>
<td>See Conditions 5.6</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.1 Base metal in a longitudinally loaded component at a transition radius (e.g., the transition radius between a plate connection and another detail) located parallel to the direction of primary stress.</td>
<td>A</td>
<td>120 x 10^-6</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 in. x 6 in.</td>
<td>B</td>
<td>44 x 10^-7</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in. x 2 in.</td>
<td>D</td>
<td>22 x 10^-7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2 in. x 1 in.</td>
<td>E</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(Note: see Condition 7.2 for welded angle or tee section members connected to plate or connection plates.)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7.2 Base metal in an angle or tee section member connected to a plate or connection plate by a partial joint penetration groove welds along both sides of the connected element of the member connected. The fatigue stress range shall be calculated on the effective net area of the member, A_e, where A_e = (π/4) x ((D/2) - (t/2))^2, and A is the gross area of the member.</td>
<td>C</td>
<td>44 x 10^-6</td>
<td>10</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 in. x 6 in.</td>
<td>B</td>
<td>22 x 10^-7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in. x 2 in.</td>
<td>D</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>With the weld reinforcement not removed.</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.2 Base metal in an angle or tee section member connected to a plate or connection plate by a partial joint penetration groove welds along both sides of the connected element of the member connected. The fatigue stress range shall be calculated on the effective net area of the member, A_e, where A_e = (π/4) x ((D/2) - (t/2))^2, and A is the gross area of the member.</td>
<td>E</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5 in. x 6 in.</td>
<td>B</td>
<td>22 x 10^-7</td>
<td>7</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6 in. x 2 in.</td>
<td>D</td>
<td>11 x 10^-7</td>
<td>4.5</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

continued on next page
### Table 6.9.1.2.3-1 (continued) — Detail Categories for Load-Induced Fatigue

<table>
<thead>
<tr>
<th>Description</th>
<th>Category</th>
<th>Fatigue Resistance Factor $k_f$ (%)</th>
<th>Fatigue Crack Initiation Point</th>
<th>Illustration Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Section 8 — Orthogonal Deck Details</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1 Rib to Deck Weld — Gusset plate weld with reinforcement to plate</td>
<td>C</td>
<td>$54 \times 10^2$</td>
<td>10</td>
<td>See Figure</td>
</tr>
<tr>
<td>Allowable Design Level 1, 2, or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Section 9 — Miscellaneous</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.1 Rib to Deck Weld — Gusset plate weld with reinforcement to plate</td>
<td>C</td>
<td>$54 \times 10^2$</td>
<td>10</td>
<td>See Figure</td>
</tr>
<tr>
<td>Allowable Design Level 1, 2, or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.2 Rib to Deck Weld — Gusset plate weld with reinforcement to plate</td>
<td>C</td>
<td>$54 \times 10^2$</td>
<td>10</td>
<td>See Figure</td>
</tr>
<tr>
<td>Allowable Design Level 1, 2, or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.3 Rib to Deck Weld — Gusset plate weld with reinforcement to plate</td>
<td>C</td>
<td>$54 \times 10^2$</td>
<td>10</td>
<td>See Figure</td>
</tr>
<tr>
<td>Allowable Design Level 1, 2, or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.4 Deck Plate Splice (In Plane) — Transverse or Longitudinal spring</td>
<td>D</td>
<td>$54 \times 10^2$</td>
<td>10</td>
<td>See Figure</td>
</tr>
<tr>
<td>Allowable Design Level 1, 2, or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8.5 Rib to Deck Weld — Gusset plate weld with reinforcement to plate</td>
<td>C</td>
<td>$54 \times 10^2$</td>
<td>10</td>
<td>See Figure</td>
</tr>
<tr>
<td>Allowable Design Level 1, 2, or 3</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Note 1: Stress values are determined by In-plane component at fillet or PJP welds, Eq. 6.9.1.2.3-4, shall be considered. In this case, $\sigma$ should be calculated at the thick section and the extrapolation procedure as per Article 8.3.3.C need not be applied.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

continued on next page
FATIGUE PRONE DETAILS

- Riveted girder / floorbeam flanges
- Longitudinal web welds
- Flange cover plate terminations
- Web stiffeners disconnected from flanges
- Weld termination access holes
FATIGUE PRONE DETAILS

- Bearing shelf supports with inadequate flange lengths
- Transverse welds at girder splices
- Open holes from past attachments
- Welded attachments
- Bolted attachments
- Shear connectors to top flange
REPAIR APPROACH

- Tension Flange in Approach Girders
  - Load induced fatigue
    - Rivets are counted as open holes
    - Replace rivets with bolts and make the structure composite while replacing the deck
  - Accept. Fatigue Range Exist. Rivets = 7 ksi
  - Accept. Fatigue Range Proposed Bolts = 16 ksi
  - Exist. Non-Composite Design = 11.87 ksi at extreme fiber
  - Proposed Composite Design = 10.90 ksi at extreme fiber
REPAIR APPROACH

- Cover Plate Terminations in Approach Girders
  - Load induced fatigue
    - Welds at plate ends are highly susceptible to cracking
    - Remove weld back from the end of the plate and added a bolted reinforcing plate, make the girder composite
  - Accept. Fatigue Range Exist. Welds = 2.6 ksi
  - Accept. Fatigue Range Proposed Bolts = 16 ksi
  - Exist. Non-Composite Design = 16.36 ksi at extreme fiber
  - Proposed Composite Design = 11.54 ksi at extreme fiber
REPAIR APPROACH

- **Disconnected Stiffeners**
  - Distortion induced fatigue
  - Web stiffeners not connected to flanges, stress occurs at stiffener to web weld
  - Stress caused by differential loading across the section
  - Add clip angles to stiffener and flanges to limit the distortion
REPAIR APPROACH

- Bearing Shelf Plate
  - Load induced fatigue crack at the end of the web stiffening plate
  - Supports the bearing shelf
  - Critical location
  - Remaining locations should be proactively reinforced
04 REHABILITATION CONCEPTS
SHORT TERM REPAIR

- A4649 Main Spans
  - Isolated Deck Repairs
  - Stringer End and Bearing Replacement
  - Expansion Joint Replacement
  - Cable Keeper Replacement
  - Floorbeam Repairs
  - Stringer Repairs
  - Railing Repairs
  - Lower Lateral Bracing Repairs
  - Tie Girder Repairs
  - Scour Remediation
  - Partial Repainting

- A4649 South Approach Spans
  - Isolated Deck Repairs
  - Drain Replacements
  - Girder Repairs
  - Approach Bent Bearings
  - Railing Repairs
  - Hinge Modifications
  - Partial Repainting
SHORT TERM REPAIR

- A4649 North Approach Spans
  - Isolated Deck Repairs
  - Railing Repairs
  - Cover Plate Retrofit
  - Bearing Support Shelf Modifications
  - Partial Repainting

- A4646 (Southbound North Approach)
  - Isolated Deck Repairs
  - Railing Repairs
  - Stiffener Retrofit
  - Cover Plate Retrofit
  - Hinge Modification
  - Partial Repainting
LONG TERM REHABILITATION

- **A4649 Main Spans**
  - Deck, Stringer and Rail Replacement
  - Expansion Joint Replacement
  - New Roadway Lighting
  - Deck Drainage System
  - Floorbeam Repairs
  - Cable Keeper Replacement
  - Tie Girder Rivet Replacement
  - Lower Outer Gusset Rivet Replacement
  - Lower Portal Frame Rivet Replacement
  - Tie Girder Repairs

- **A4649 Main Spans (Cont.)**
  - Lower Lateral Bracing Replacement
  - Main Pier Repairs
  - Scour Remediation
  - Complete Repainting
LONG TERM REHABILITATION

- A4649 South Approach Spans
  - Deck and Rail Replacement
  - Expansion Joint Replacement
  - Partial Bearing Replacement
  - New Roadway Lighting
  - Deck Drainage System
  - Girder Repairs
  - Girder Rivet Replacement
  - Shear Connector Addition
  - Hinge Modifications
  - Approach Bent Repairs
  - Complete Repainting

- A4649 North Approach Spans
  - Deck and Rail Replacement
  - Expansion Joint Replacement
  - Partial Bearing Replacement
  - New Roadway Lighting
  - Deck Drainage System
  - Cover Plate Retrofit
  - Shear Connector Addition
  - Bearing Support Shelf Modifications
  - Complete Repainting
LONG TERM REHABILITATION

- A4646 (Southbound North Approach)
  - Deck and Rail Replacement
  - Expansion Joint Replacement
  - New Roadway Lighting
  - Girder Replacement
  - Steel Framed Cap Beams
  - New Bearings
  - Column Rehabilitation
Replacement in Kind

- Same footprint as existing bridge
- Built on existing alignment
- Assumes significant structure above roadway, similar to existing bridge
- Provided for comparison purposes only, not meant to represent a true replacement structure
### SUMMARY

<table>
<thead>
<tr>
<th>Option</th>
<th>Estimated Cost</th>
<th>Assumed Life</th>
<th>Cost per Year</th>
<th>Road Closure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short Term Repair</td>
<td>$18,760,000</td>
<td>10 – 15 Years</td>
<td>$1,876,000 - $1,251,000</td>
<td>9 – 12 Months</td>
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<tr>
<td>Long Term Rehabilitation</td>
<td>$52,260,000</td>
<td>35 – 50 Years</td>
<td>$1,493,000 - $1,045,000</td>
<td>18 – 24 Months</td>
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<tr>
<td>Replacement in Kind¹</td>
<td>$94,310,000</td>
<td>75 – 100 Years</td>
<td>$1,258,000 - $943,000</td>
<td>24 – 30 Months</td>
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<tr>
<td>Short Term Repair – plus –</td>
<td>$113,070,000</td>
<td>85 – 110 Years</td>
<td>$1,330,000 - $1,028,000</td>
<td>9 – 12 Months – plus – 24 – 30 Months</td>
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<tr>
<td>Replacement in Kind¹</td>
<td></td>
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</tr>
</tbody>
</table>

¹ – Includes one assumed redecking with a current year cost of $11,810,000
RECOMMENDATION

Long Term Rehabilitation

- Can be implemented quickly to limit further deterioration
- Provides good annualized investment benefits to the public
- Fits the fiscal constraints
- Provides significant benefit to the public for the cost of the road closure
- Will prevent ongoing maintenance concerns that cause additional road closures
DISCUSSION
THE OPENING OF THE HANNIBAL BRIDGE IN 1869 was an occasion for celebration. Since the bridge was the first East-West railroad connection across the Missouri River west of St. Louis, it was a commercial triumph for Kansas City.