PROGRAMMATIC SECTION 4(f) EVALUATION: HISTORIC BRIDGE EXAMPLES

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Programmatic Section 4(f) (Example1) Evaluation

For the Replacement of the Spur 347 Bridge at the OKT & UP Railroads

I. INTRODUCTION

Project BR 98(443) will replace and widen the Spur 347 (Belknap Street) bridge over the OKT & UP Railroads. This bridge is structurally and geometrically deficient. The existing data indicates that 20,000 vehicles a day cross this structure with approximately 3.1% being truck traffic. The roadway is classified as a principal arterial and is part of the National Highway System. The project location is shown on Figure A.

The bridge was constructed circa 1933 by Butcher and Sweeny, in a joint venture between Tarrant County and the City of Fort Worth. The designer of the structure was F.D. Hughes. The structure was designed for an H20 load rating and currently carries a H19 load rating. The bridge was determined eligible for inclusion in the National Register of Historic Places (NRHP) as a good example of a Depression-Era concrete bridge with Art Deco detailing. Since the bridge was determined eligible for NRHP an alternative analysis has been performed.

TxDOT maintains that the geometric deficiencies at the Union Pacific Railroad (UPRR) are not safe and could cause a catastrophic event should there be a derailment at this location. In the late 1980's, approximately 0.25 mile north of this location a derailment did occur. The train hit a conventional structure with 48 inch columns. One column was severely damaged due to the incident and the structure was closed until repairs could be performed. Therefore, there is a probability of a similar accident occurring at this location.

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II. NEED FOR PROJECT

The purpose of the project is to replace the Belknap Street bridge. The replacement of the structure is needed to address the structural and geometric deficiencies. The roadway carries approximately 20,000 vehicles per day. The posted speed for the roadway in this area is 35 mph. The 85th percentile speed, which is the average speed that 85% of the traffic travels at or below, is 52 mph. The 85th percentile speed is the method set by legislation in the state of Texas for helping to determine posted speeds. The usual lane width for a principal arterial street is 12 feet with curb offsets. Belknap has 10 feet lanes with no curb offsets. Additionally, the geometric deficiency at the UPRR cannot be remedied without using extraordinary measures such as realignment of the rail switching yard. The deck and girders are in poor shape with deterioration evident.

<u>Structure Condition</u>

The structure has 16 cast-in-place slab and girder spans, 6 tower spans, 1-162 feet 3 span continuous steel unit and 1-205.33 feet 4 span continuous steel unit for a total of 29 spans. There are 2-30.75 feet spans, 8-46.06 feet spans and 6-46.9 feet spans that are slab and girder or tee beams. The slab and girder spans have variable depth beams. The tower spans are 16 feet long.

The foundations are concrete footings cast-in-place on top of precast concrete piles with columns cast-in-place extending above the footings (see Figure B). There is no indication of any repair needed to the foundations.

There is spalling and minor cracking in the abutments indicating that chlorides (from salt) have been carried into the concrete and have caused the reinforcing steel to rust. There are water stains on the abutments indicating leakage through the joints. This implies that chlorides have contaminated the concrete. Chloride contamination reduces the strength of the concrete and promotes rusting of the reinforcing steel.

There are water stains on the interior caps, indicating that the interior caps are also being contaminated with chlorides. This is further confirmed by cracking of the caps. Five of the 6 tower bents have had major maintenance in the past. Steel platforms for bearings to support beams (girders for the spans) have been added to the structure due to the cracking in the beam bearing areas. The columns associated with the modified tower bents have a steel beam clamped to them to provide a platform for bearings to support beams in areas that have failed. The added bearing (steel platform) is on a portion of the beam that has not cracked/failed. The steel on these added supports has also begun to rust.

The 205.33 feet 4 span unit has three interior supports consisting of four steel columns that have bearings at ground level. These steel columns also have rust. The columns are adjacent to the tracks for the UPRR and have no crash protection. American Railroad Engineering Association (AREA) specifications require crash protection for columns within 25 feet of railroad tracks. The existing columns on this steel unit are 8 feet 7 inches from the nearest track. Based on practices in the state of Texas, there is not enough room to provide protection (usually consisting of fitting a 2 feet 6 inch concrete wall between and including the interior supports) for these bents and provide the minimum clearance required under the specifications, which is 8 feet 6 inches. This is a serious deficiency. The steel columns in the 205.33 feet unit are inadequate to sustain an impact from a load shift on the railroad. Should an impact occur, the result would be catastrophic. The entire steel unit could fail causing the roadway to collapse onto the railroad tracks.

Some of the concrete girders have cracking and spalling indicating that there is chloride contamination of the concrete in the girders. Some reinforcing steel is exposed and rusted indicating the concrete covering has spalled most likely due to chloride contamination. Water stains are on a portion of the girders with leaching evident. A white deposit around cracks indicates leaching. The white deposit is calcium dissolved from the cement in the concrete. This reduces the strength of the concrete. The steel units have the beams coated with concrete that is approximately 2 inches thick. The cover shows rust stains that indicates that there is rusting of the steel girders. There is rust on the expansion bearings.

There is severe cracking and leaching with water stains on the deck in the steel units. The concrete units have some cracking and minor leaching. The deck joints are in poor shape with areas where the joints are broken. This has caused some joints to be offset. Some of the joints have missing sections. The joints are not sealed which allows water that is contaminated with salt to drain onto the substructure (caps). All of the joints require some

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repair. The repairs would generally consist of sealing the joints, replacing broken steel on the finger joints, removing a portion of the slab so a splice to the reinforcing steel could be made and new materials used to reform the edges of the slab. The curbs have some cracking and spalling with exposed reinforcing steel. The deck drains are clogged due to previous hot-mix asphaltic concrete (HMAC) overlays done as preventive maintenance measure by the Texas Highway Department (former name of the Texas Department of Transportation (TxDOT)). The first known HMAC overlay applied to the bridge was in 1947; probably to improve the ride of the facility but possibly to seal the deck from salt contamination in inclement weather events. There have been additional overlays through the years. This was a common practice in early days; however, the overlay has caused water to become trapped on the deck resulting in contamination of the deck with chlorides. This has caused the water to drain along the curb until it drains through an open joint/crack or off the end of the bridge.

In 1947, repairs consisting of the addition of steel rocker assemblies to tower bents #2 and #3 were installed and new finger joint plates were added. Plates were added to the finger joints to level them. The plates were added by drilling holes through the deck and bolting on the new steel. Rocker assemblies are a combination of steel columns (bolster) strapped to the concrete columns on the tower bents with a rocker and pin connection at the top to allow for movement. The rocker assemblies were added to the structure because the concrete girders had cracked ends and were in jeopardy of shearing off. The assemblies provided a new bearing seat for the beams. Also, the existing sidewalk and curb expansion joints were cleaned and repaired. This repair to open the expansion joints was required so there is allowance for expansion of the concrete as it cycles through the hot and cold seasons. In 1957, additional rocker assemblies were added to tower bents #3, #4, and #5. Around 1977, the finger joints were replaced and the spalled areas on the columns repaired.

The rails have some cracks with evidence of some rusting of the reinforcing steel. This style of rail is not crash tested and will not calculate to be safe at impact. There is no way to crash test the rail without destroying it. The roadway is now 40 feet wide from curb to curb with 4 lanes for traffic. The bridge has a sight distance of 177.5 feet, which is suitable for a speed of 25 to 30 mph. The facility is posted at 35 mph. The less than desirable sight distance is a geometric deficiency involving when a driver perceives that he will be needing to stop and the distance that is left to safely come to a stop. Although speed checks indicate that the 85th percentile is in excess of 50 mph; Belknap Street is posted at 35 mph. This posting is based on the transition zone from the eastern freeway speeds to the western city street speeds and the need for traffic to slow.

III. EVALUATION OF THE PROPOSED ACTION

Since the bridge was determined eligible for NRHP, an alternative analysis has been performed and is as follows:

<u>Alternatives Considered</u>

- <u>No build</u>
  The structural deficiencies on this bridge are serious enough that it is unsafe for

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traffic. This option does not address the structural and geometric deficiencies currently existing, namely the lane width, horizontal clearance at the railroads, sight distance and the concrete deterioration. This option has been eliminated because it does not meet the purpose and need for the project.

- Repair the structure without widening
  Eight partial spans on the northeastern end of the structure have been demolished. This area would need to be reconstructed using new materials.

The abutments should be repaired with cleaning, epoxy injecting and patching of the spalled areas and joints sealed to protect them from chloride contamination.

The deck on the 162 feet 3 span continuous steel unit (over the BNSF RR and UPRR) should be removed and replaced. However, the steel unit (girders and columns) could be left in place; the concrete coating on the steel unit would need to be removed and the steel would need to be cleaned and painted. The interior bents would need to be retrofitted with a concrete crash wall for protection of the structure adjacent to the railroad. In this steel unit, the clearances between the railroad tracks and interior bents is sufficient for retrofitting of a concrete crash wall. This wall would encase the steel columns from the ground to the required height (approximately 12 feet). To accomplish removal of the deck in this section, the railing would need to be cut away from the deck and shoring used to support the structure. Once free from the deck and girders, the railing would be picked up and moved for storing while the new deck was being installed. Many cuts would need to be made to the railing in order to pick it up and whether or not this could actually be accomplished without the railing crumbling during construction is unknown.

All of the expansion joints should be removed and replaced with sealed expansion joints. The repair of the deck near the expansion joints should be a full depth repair (removal of all existing concrete and replacing with new material). The concrete beams should be repaired to correct any spalled areas and epoxy injected to restore the integrity of the beams. The spalls on the bents should be repaired by a similar means.

The steel unit (205.33 feet 4 span continuous steel unit) over the UPRR tracks is an element that represents a danger to the public and to UPRR. Based on common practices using the AREA specifications in the state of Texas, there is not enough room to retrofit crash walls and it would not be prudent to rehabilitate this bridge without fixing this deficiency. The distance from the face of the interior steel bent to the railroad is 8 feet 7 inches. The minimum acceptable distance allowed by Texas state law is 8 feet 6 inches. To retrofit a crash wall, the minimum thickness of the wall is 2 feet 6 inches. The proximity in these spans does not allow for retrofitting with a crash wall. The other option for obtaining the minimum acceptable distance would be relocation of the tracks. At this particular location, the tracks are part of a switching yard. Any relocation of the tracks would require the relocation of much of the switching yard which would be cost prohibitive and disruptive; therefore, it is not prudent to keep this unit and it should be replaced.

In this option, the deck in the tower spans and the slab and girder units would have to be

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evaluated for chloride contamination. Repairs such as patching and epoxy injecting would be made as necessary to the deck and girders.

Once the deck, girders and interior bents are repaired, the railing could be reattached to the structure; however, since the railing is not a crash tested rail, a new barrier rail would need to be installed in front of the decorative rail (see Figure C). Installation of the barrier rail would have to be on the pedestrian sidewalk which is currently 5 feet in width. The barrier rail requires 2 feet for installation. This option would reduce the sidewalk width to 3 feet which does not meet current American With Disabilities Act (ADA) requirements. The railing would then need to be patched at saw cuts and other areas that may have deteriorated during handling procedures. Installation of the barrier rail would also obscure the existing rail from those traveling across the structure.

For a principal arterial street, the usual lane widths are 12 feet with curb offsets. This option does not address the lane width deficiency; however, a design exception could be requested and possibly granted considering the historic nature of the structure.

This option would require relocating the railroad tracks to adequately address public safety and meet AREA specifications. Relocating the railroad tracks is cost prohibitive and not prudent. In addition, removing and reinstalling the historic rail may not be possible due to the unknown nature of the condition of the railing. In this option, the 4 span steel unit would be replaced and in essence, would lose the historic integrity of this unique feature. Additionally, this option does not address the limited sight distance with the high speed of vehicles existing the freeway. This option does not meet the purpose and need of the project.

- <u>Repair with widening</u>
  The construction for this option would be much the same as that for 'Repair without widening,' except the deck geometry could be attained including the sidewalk width requirement for ADA.

  The exterior overhangs would be removed and additional supports added to offset the load for the additional width for installation of the barrier rail and the lane width. Most likely, an additional column would be added to each bent. Again, the severe horizontal deficiency at the UPRR would not be corrected and the existing rail would still be obscured from those traveling across the structure due to the barrier rail installation (see Figure C).

  This option would be cost prohibitive due to moving the railroad tracks and may not be possible due to the unknown condition of the railing. The unique 4 span steel unit feature at the UPRR railroad would be replaced. This would be a loss of integrity for this feature. The desired feature of seeing the existing rail while crossing the structure would also be lost due to the need for a crash tested barrier rail installation and the limited locations for the barrier. This option would meet the purpose and need of the project by using extraordinary measures that would be cost prohibitive and not prudent.

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- New Location
  The existing structure would be left in place and an alternate alignment would be sought for through traffic flow. This option would require that the 8 partial spans that have been demolished be recreated with new materials. The existing structure would be closed to vehicular traffic and a maintenance agreement with the local entity would be required establishing future maintenance of the structure.

  Due to the close proximity to the Fort Worth downtown area and the urban nature of the area, an alternate route is not available. Existing city streets are already overburdened in the area and any additional flow redirected to them would exacerbate the congestion during peak hours.

  If the structural and geometric deficiencies of the historic bridge are not addressed, then this option would not be cost prohibitive. However, it is likely the City of Fort Worth would consider the option detrimental to its' city street system and the general public would not benefit from a more circuitous route. By not addressing the lack of horizontal clearance at the UPRR which is a safety concern for all who use the structure it's usefulness for an alternative use is limited or non-existent. This option would not meet the purpose and need of the project because it does not correct the horizontal deficiency associated with the railroad.

- Parallel Alignment
  The existing roadway is already part of a parallel route into and out of Fort Worth. The twin structure is Weatherford Street. Belknap Street serves as the one-way direction headed westbound and Weatherford Street is the one-way direction headed eastbound. With the current traffic volumes (20,000 vehicles per day), the possibility of using one structure for both movements of traffic is not reasonable or prudent for safety reasons.

  Possibly, another parallel structure could be constructed in the area between Belknap and Weatherford Street (see Figure D). This alternative would require additional right of way purchase including the purchase of at least one business. The western end of the structure would tie-in to the existing Belknap Street alignment leading into downtown Fort Worth. While this alternative would not demolish the historic structure, it would only be seen from a distance instead of as it is being crossed over. The existing connection ramps from IH 35W and SH 121 would need to be revised. The SH 121 connection structure would need to be replaced due to the increase in the horizontal curve to "fit" the parallel alignment. The southbound exit ramp from IH 35W to westbound Belknap would be relocated to accommodate the new structure location. This scenario would also create an undesirable increase in the horizontal curvature for the SH 121 connection.

  This option would be cost prohibitive (cost of two new bridges; one for Belknap Street and one for the SH 121 connection over IH 35W) and disruptive to the existing

Example

interchange at IH 35W. This option would meet the purpose and need of the project; however, at an unreasonable cost. Also, this option does not address the horizontal deficiencies associated with the railroad which would make the historic bridge limited for adaptive use or eliminate if from reuse due to public safety concerns.

Replace On Same Location

As previously discussed, planning measures for alternatives to the taking of the resource have been considered. Based on our evaluation of the structural and geometric deficiencies and the safety concerns of the bridge, it would not be feasible to maintain the existing bridge; it should be replaced. The existing facility carries approximately 20,000 vehicles per day and this number is estimated to increase to 28,000 vehicles per day in the next 20 years.

Replacing the structure on the same location will minimize the amount of new right of way required since the existing right of way can be utilized and only small amounts of additional right of way would be required. The sight distance deficiency can be corrected by decreasing the vertical curve of the structure. The clearances at the railroad tracks can be corrected with new span spacings. Utilization of crash tested railing eliminates the safety concerns to the traveling public. Maintenance of the structure will be minimal for many years. The deck and new substructure will eliminate the structural deficiency of these features and the joints will be sealed preventing chlorides from coming into contact with the substructure. The riding surface of the structure will be more pleasing to the users of the facility.

This option addresses all structural, geometric and safety concerns associated with this location. The historical aspects are addressed by mitigation measures.

III. MEASURES TO MINIMIZE HARM

Mitigation

A major character defining feature of the bridge is the architecturally significant Art Deco influenced detailing. These details are primarily seen by those crossing the structure. TxDOT maintains that these feature cannot be salvaged from the existing structure without using extraordinary measures that are cost prohibitive and possibly unable to accomplish. TxDOT also maintains that the substructure consisting of the concrete girder spans is not unique and has been modified for structural reasons in the past in a way that compromises the original design. The steel substructure spans at the UPRR are a unique design with the rocker assemblies at the foundation level as opposed to the typical cap elevation; however, TxDOT maintains that this feature is not safe and could cause a catastrophic event should there be a derailment at this location.

A mitigation plan for the bridge has been developed by TxDOT and the Texas State Historic Preservation Officer (SHPO). The mitigation plan consists of:

1. Full documentation of the existing bridge with the Historic American Engineering Record Level II standards prior to demolition of the bridge. This has occurred.

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2. Replication of the large concrete posts at either end of the existing structure, including the “TC” and “FW” inscriptions and the sloped top rails adjoining the large posts.
3. The use of the C-411(M) Texas Classic Combination Railing with type D (pointed arch) window openings.
4. Installation of an interpretive plaque at a publicly accessible location on the new structure.

Example

MINUTE-MEMORANDUM

FROM:	**Donald E. Harley, Structural Engineer**	**DATE: December 7, 1999**
TO:	**Walter Waidelich, District Engineer**	
SUBJECT:	**Belknap Street Historic Bridge - Fort Worth**	

On November 29 & 30, 1999 I visited the bridge site and worked with the Fort Worth District of TxDOT to reconfirm and document estimates that led to the HBRRP replacement project.

For your consideration, I've attached tables that outline four alternatives TxDOT considered along with cost estimates prepared by TxDOT for three of the alternatives, the "DO NOTHING ALTERNATIVE" has no associated improvement cost. At your request, I've added Alternative 2B which discusses some of the implications of a suggestion from Mr. Abba Lichtenstein to widen the bridge on the existing superstructure.

For ease of identification and to emphasis the engineering and safety challenges for each alternative, information in the tables is color coded. Red indicates a seriously deficient engineering or safety item that is not addressed by the alternative. Blue indicates a less than desirable engineering or safety item that is not addressed.

Summary comments on each alternative are included at the bottom of each table along with cost information.

Enclosed as Attachment A is a series of photographs of the bridge and a short descriptive narrative to identify the features thereon.

At your request, the Fort Worth District of TxDOT provide the following additional background information. Their detailed response is included as Attachment B.
The 85 percentile speed is 52 mph. One way AADT in 1999 was 19,500. Truck traffic is estimated at 3%.
Pedestrian traffic on the structure is minimal.
There appears to have been 121 accidents between 1990 and 1998 in the vicinity of the bridge. Causal information is not specific.
TxDOT's estimate for repainting included costs for handling the removal of lead based paint.

COMMENTS

1. The "Do Nothing Alternative" does not address any of the deficiencies.
2. Rehabilitation alternative 2A addresses so few of the deficiencies of the structure that it would be a questionable HBRRP eligible project. Selected portions of this alternative would be a good heavy maintenance project for the owner. Cost is estimated at $1.8 million.
3. Rehabilitation alternative 2B appears to require a very rigorous engineering analysis and constructability evaluation before I would consider it practical or even feasible within any reasonable funding limit.
4. Rehabilitation alternative 3 addresses , not all, but a number of the existing deficiencies but severely impacts most of the historical features. Cost approximates the replacement option. Cost is estimated at $2.9 million.
5. The forth alternative would replace the bridge. Cost for this work was bid at $ 3.0 million.

CONCLUSIONS AND OPINIONS

The cost estimates provided by TxDOT appear reasonable. In my opinion, the decision to replace the bridge rather than implement any of the three rehabilitation alternatives is reasonable and prudent from an engineering, economic, and safety perspective. Others will need to weigh in on whether the historical significance should take precedence over these factors.

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Example

Belknap Street Bridge - Fort Worth

Alternative #1 - Do Nothing

Historical Considerations	
Feature	Impact/Mitigation
Rail/Decorative Concrete	None
Variable Depth Beams and Corbels	None
Substructure	None
Engineer/Architect	None

Geometric Considerations	
Feature	Description [Bridge Inspection Database Rating]
Approach Roadway Width 48'	
Sidewalk Width: 2 @ 5.0'	Meets AASHTO minimum
Lane Width: 4 @ 10 feet, no offset - no shoulder	Less than minimum to remain - AASHTO manual pg. 497
Deck Geometry: 40' clear roadway	Intolerable condition - less than approach Item 68 [2]
Min. Vertical Clearance over RR: 21' 1"	Somewhat better than minimum to remain Item 69 [5]
Min. Lateral Clearance at RR: 8' 7"	Meets minimum tolerable condition Item 69 [4]
Min. Lateral Clearance at Roadway: 3.0'	Intolerable condition Item 69 [2]
Vertical Curvature - Crest K = 24. 25 mph	Less than minimum for posted speed [35mph]

Structural Considerations	
Feature	Description [Bridge Inspection Database Rating]
Rail Type - Decorative concrete - unknown strength	Untested - seriously deficient Item 36 [0,0,0,0]
Rail Condition	Fair condition – limited local deterioration
Deck Condition	Poor condition – strength loss - steel unit Item 58 [4]
Superstructure Condition	Minor deterioration Item 59 [6]
Substructure Condition	Minor deterioration Item 60 [6]
Design Load: H20	Less than current standard
Inventory Rating: HS 14	Somewhat better than minimum to remain Item 67 [5]

Costs & General Comments
1. Annual costs will continue to increase as condition continues to deteriorate. 2. Existing deficiencies will not be addressed. 3. Historic significance will not be impacted.

Example

Belknap Street Bridge - Fort Worth

Alternative #2 A - Rehabilitation *[Replace Deck on steel units, retain rail, add crash walls]*

Historical Considerations	
Feature	Impact/Mitigation
Rail/Decorative Concrete	None
Variable Depth Beams and Corbels	None
Substructure	Crash walls may obscure steel bents and bearings/photograph and document
Engineer/Architect	None

Geometric Considerations	
Feature	Description [Bridge Inspection Database Rating]
Approach Roadway Width: 48'	
Sidewalk Width: 2 @ 5.0'	Meets AASHTO minimum
Lane Width: 4 @ 10 feet, no offset, no shoulder	Less than minimum to remain - AASHTO manual pg. 497
Deck Geometry: 40' clear roadway	Intolerable condition - less than approach Item 68 [2]
Min. Vertical Clearance over RR: 21' 1"	Somewhat better than minimum to remain Item 69 [5]
Min. Lateral Clearance at RR: 8.6'	Meets minimum tolerable condition Item 69 [4]
Min. Lateral Clearance at Roadway: 3.0'	Intolerable condition Item 69 [2]
Vertical Curvature - Crest K = 24. 25mph	Less than minimum for posted speed [35mph]

Structural Considerations	
Feature	Description [Bridge Inspection Database Rating]
Rail Type - Decorative concrete - unknown strength	Untested - seriously deficient *Item 36 [0,0,0,0]
Rail Condition	Fair condition – limited local deterioration
Deck Condition	Minor deterioration *Item 58 [6]
Superstructure Condition	Good condition *Item 59 [7]
Substructure Condition	Good condition *Item 60 [7]
Design Load: H20	Less than current standard
Inventory Rating: HS 14	Somewhat better than minimum to remain Item 67 [5]

Costs & General Comments
1. Estimated cost for rehabilitation in alternate 2A is $ 1,845,000. 2. Condition of the bridge would be improved. 3. Other deficiencies would not be addressed. 4. Crash walls may obscured historic features of some columns and pinned connections.

Key: * Estimated

Example

Belknap Street Bridge - Fort Worth

Alternative #2 B - Rehabilitation *[Replace Deck on steel units, retain old rail, add crash walls & widen roadway to 44' add traffic rail]*

Historical Considerations	
Feature	Impact/Mitigation
Rail/Decorative Concrete	New traffic rail may obscure the historic rail
Variable Depth Beams and Corbels	None
Substructure	Crash walls may obscure steel bents and bearings/photograph and document
Engineer/Architect	None

Geometric Considerations		
Feature	Description [Bridge Inspection Database Rating]	
Approach Roadway Width: 48'		
Sidewalk Width: 2 @ 2.0'	Less than AASHTO minimum	
Lane Width: 4 @ 11 feet	Meets than minimum to remain - AASHTO manual pg. 497	
Deck Geometry: 44' clear roadway	Intolerable condition - less than approach	Item 68 [2]
Min. Vertical Clearance over RR: 21' 1"	Somewhat better than minimum to remain	Item 69 [5]
Min. Lateral Clearance at RR: 8.6'	Meets minimum tolerable condition	Item 69 [4]
Min. Lateral Clearance at Roadway: 3.0'	Intolerable condition	Item 69 [2]
Vertical Curvature - Crest K = 24. 25mph	Less than minimum for Posted Speed [35mph]	

Structural Considerations		
Feature	Description [Bridge Inspection Database Rating]	
Pedestrian Rail -Decorative Concrete		
Traffic Rail, Retrofit tested traffic rail at curb line	Tested	*Item 36 [1,1,1,1]
Rail Condition – Existing	Fair condition – limited local deterioration	
Deck Condition	Minor deterioration	*Item 58 [6]
Superstructure Condition	Good condition	*Item 59 [7]
Substructure Condition	Good condition	*Item 60 [7]
Design Load: H20	Less than current standard	
Inventory Rating: HS 14	Somewhat better than minimum to remain	Item 67 [5]

Costs & General Comments

1. Estimated cost for rehabilitation in alternate 2B is $ 1,845,000 plus cost for removal and reconstruction of curb and widening the deck on concrete units as well as adding a traffic rail at the curb line. While TxDOT has not estimated this alternative, it could be as much as an additional $ 1,000,000.
2. This alternative may be impractical or impossible due to engineering and construction difficulties associated with the original design of the corbels.
3. Condition of the bridge would be improved.
4. Deficiencies relating to roadway width and untested traffic rail would be improved.
5. Sidewalks would be reduced to 2' width would be seriously deficient by AASHTO standards.
6. Other Deficiencies would remain.
7. Crash wall may obscured historic features of some columns and pinned connections.
8. New traffic rail at curb line may obscure historic rail.

Key: * Estimated

Example

Belknap Street Bridge - Fort Worth

Alternative # 3- Rehabilitation *[Replace Deck and Rail, Widen, add Crash walls]*

Historical Considerations	
Feature	Impact/Mitigation
Rail/Decorative Concrete	Document old. Replace rail with C-411. Replace Decorative concrete
Variable Depth Beams and Corbels	Widen with similar construction, document loss of corbels.
Substructure	Crash walls may obscure steel bents and bearings/photograph & document
Engineer/Architect	None

Geometric Considerations		
Feature	Description [Bridge Inspection Database Rating]	
Approach Roadway Width: 48'		
Sidewalk Width: 1 @ 7' & 1 @ 6'	Exceeds AASHTO minimums	
Lane Width: 4 @ 12 + 2' offset to curbs	Meets or exceeds desirable - AASHTO manual page 497	
Deck Geometry: 52' Clear Roadway	Matches approaches	Item 68 [4]
Min. Vertical Clearance over RR: 21' 1"	Somewhat better than minimum to remain	Item 69 [5]
Min. Lateral Clearance at RR: 8' 6"	Meets minimum tolerable condition	Item 69 [4]
Min. Lateral Clearance at Roadway: 3.0'	Intolerable condition	Item 69 [2]
Vertical Curvature Crest K = 24 25mph	Less than minimum for posted speed [35mph]	

Structural Considerations		
Feature	Description [Bridge Inspection Database Rating]	
Rail Type	Meets current standards	*Item 36 [1,1,1,1]
Rail Condition	Near new	
Deck Condition	Near new	*Item 58 [8]
Superstructure Condition	Good condition	*Item 59 [7]
Substructure Condition	Good condition	*Item 60 [7]
Design Load: H20	Less than current standard	
Inventory Rating: HS 14	Somewhat better than min. to remain	Item 67 [5]

Costs & General Comments
1. Estimated cost for this alternative is $2,942,000. 2. All historical features would be impacted to some degree. 3. Condition of the structure would be improved. 4. Deficiencies relating to roadway width and traffic rail would be addressed and improved. 5. Other deficiencies would not be addressed. 6. Cost approximates the replacement alternative.

Key: * Estimated

Example

Belknap Street Bridge - Fort Worth

Alternative # 4 - Replacement

Historical Considerations	
Feature	Impact/Mitigation
Rail/Decorative Concrete	Document old. Replace rail with C-411. Replace Decorative concrete
Variable Depth Beams & corbels	Document
Substructure	Document
Engineer/Architect	Document

Geometric Considerations		
Feature	Description [Bridge Inspection Database Rating]	
Approach Roadway Width: 48'		
Sidewalk Width: 1 @ 7' & 1 @ 6'	Exceeds AASHTO minimums	
Lane Width: 4 @ 12 plus 2' offset to curb	Meets or exceeds desirable - AASHTO manual page 497	
Deck Geometry: 52' Clear width	Matches approaches	Item 68 [4]
Min. Vertical Clearance over RR: 23"	Equal to present desirable	Item 69 [8]
Min. Lateral Clearance at RR: 12.5'	Better than minimum	Item 69 [5]
Min. Lateral Clearance at Roadway: 13'	Equal to present desirable	Item 69 [8]
Vertical Curvature Crest K = 53 35mph	Meets or exceeds minimum for posted speed [35mph]	

Structural Considerations		
Feature	Description [Bridge Inspection Database Rating]	
Rail Type	Meets current standard	Item 36 [1,1,1,1]
Rail Condition	Near new	
Deck Condition	Near new	Item 58 [8]
Superstructure Condition	Near new	Item 59 [8]
Substructure Condition	Near new	Item 60 [8]
Design Load: HS20	Meets current standard	
Inventory Rating: HS 20	Meets or exceeds current standard	Item 67 [9]

Costs & General Comments
1. Estimated Costs for this alternative is $ 3,033,000. 2. All deficiencies would be eliminated or improved. 3. All historical features would be removed. 4. New rail and decorative concrete features would be similar to the existing historical features.

120399dh.369

Example

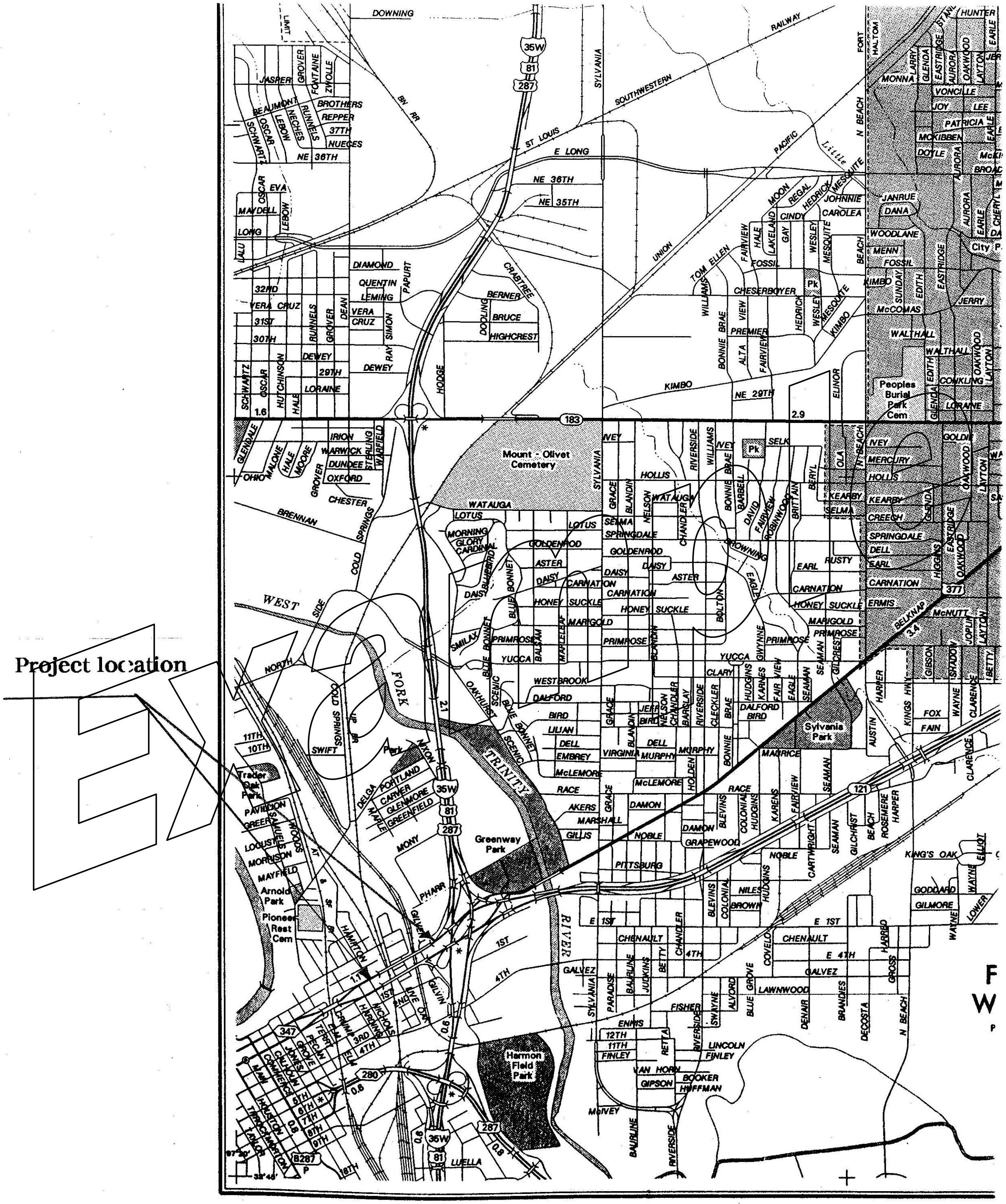
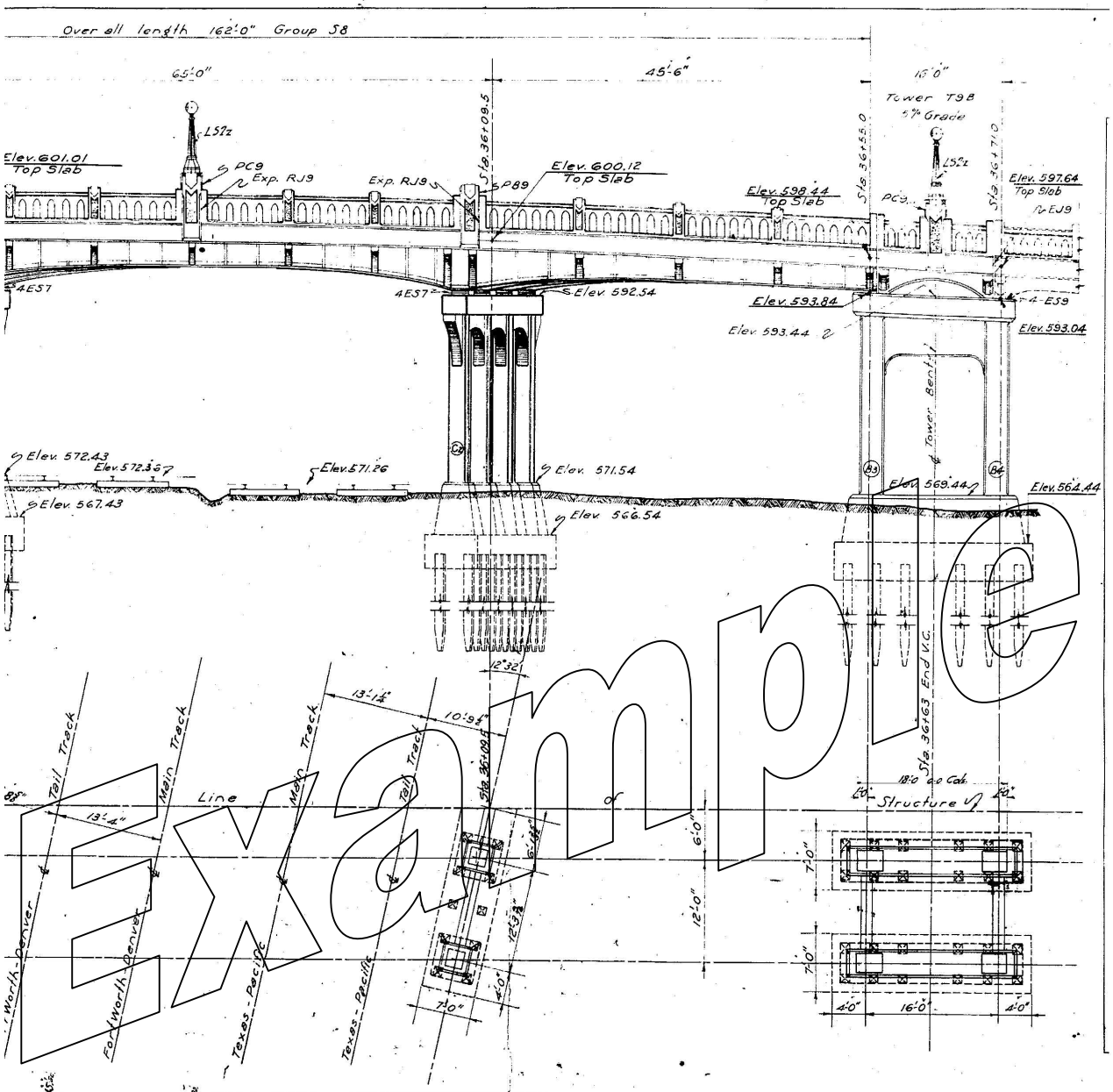
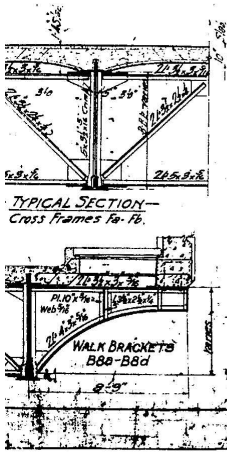

Project location
DOWNING
LIMIT
JASPER
GROVER
FONTAINE
ZWOLLE
BEAUMONT
BROTHERS
REPPER
37TH
NUECES
NE 36TH
SCHWARTZ
OSCAR
LEBOW
NECHES
RUNNELS
EVA
MAYDELL
LONG
LALU
BN RR
35W
81
287
SYLVANIA
SOUTHWESTERN
RAILWAY
ST LOUIS
E LONG
NE 36TH
NE 35TH
PACIFIC
UNION
Little
FORT
HALTOM
N BEACH
MONNA
LARRY
GLENDA
EASTRIDGE
AURORA
OAKWOOD
LAYTON
EARLE
HUNTER
VONCILLE
JOY
LEE
PATRICIA
MCKIBBEN
DOYLE
BROAD
JANRUE
DANA
WOODLANE
MENN
FOSSIL
KIMBO
SUNDAY
EDITH
JERRY
McCOMAS
WALTHALL
CONKLING
Peoples Burial Park Cem
LORAINE
MOON
REGAL
HEDRICK
MESQUITE
JOHNNIE
CAROLEA
CINDY
GAY
LAKELAND
HALE
FAIRVIEW
WESLEY
BEACH
TOM ELLEN
WILLIAMS
CHESERBOYER
Pk
BONNIE BRAE
ALTA
VIEW
PREMIER
KIMBO
NE 29TH
ELINOR
2.9
DIAMOND
QUENTIN
LEMING
PAPURT
32ND
VERA CRUZ
31ST
30TH
RUNNELS
GROVER
DEAN
SIMON
RAY
DEWEY
29TH
LORAINE
HUTCHINSON
HALE
HODGE
1.6
CRABTREE
BERNER
DOOLING
BRUCE
HIGHCREST
183
GLENDALE
IRION
WARWICK
DUNDEE
OXFORD
STERLING
WARFIELD
OHIO
MALONE
MOORE
CHESTER
BRENNAN
COLD SPRINGS
Mount - Olivet Cemetery
WATAUGA
LOTUS
MORNING GLORY
CARDINAL
IVEY
SELK
RIVERSIDE
HOLLIS
GRACE
BLANDIN
NELSON
CHANDLER
BARBELL
DAVID
ROBINWOOD
BRITTAIN
BERYL
OLA
KEARBY
SELMA
CREECH
SPRINGDALE
DELL
EARL
CARNATION
ERMIS
GOLDIE
MERCURY
HIGGINS
GOLDENROD
ASTER
DAISY
BROWNING
BOLTON
EAGLE
RUSTY
HONEY SUCKLE
MARIGOLD
PRIMROSE
YUCCA
GWYNNE
BLUEBIRD
BLUE BONNET
SMILAX
BALSAM
MAPLELEAF
WESTBROOK
DALFORD
CLARY
HUDGINS
KARNES
FAIR VIEW
SEAMAN
GILCREST
BELKNAP
3.4
377
McNUTT
JOPLIN
GIBSON
SHADOW
BETTY
WEST SIDE
NORTH
FORK
TRINITY
RIVER
OAKHURST
SCENIC
2.1
JERRY
BIRD
LILIAN
EMBREY
McLEMORE
VIRGINIA
MURPHY
BARCLAY
CLECKLER
Sylvania Park
MAURICE
AUSTIN
HARPER
KINGS HWY
FOX
FAIN
WAYNE
CLARENCE
121
RACE
AKERS
MARSHALL
GILLIS
DAMON
NOBLE
GRAPEWOOD
BLEVINS
COLONIAL
KARENS
CARTWRIGHT
GILCHRIST
ROSEMERE
KING'S OAK
ELLIOT
PITTSBURG
NILES
BROWN
GODDARD
GILMORE
LOWER
E 1ST
CHENAULT
E 4TH
GALVEZ
HARRED
GROSS
PARADISE
BAURLINE
JUDKINS
COVELO
LAWNWOOD
ALVORD
BLUE GROVE
SWAYNE
FISHER
DENAIR
BRANDIES
DECOSTA
ENNIS
12TH
11TH
FINLEY
RETTA
LINCOLN
VAN HORN
GIPSON
BOOKER
HUFFMAN
McIVEY
Harmon Field Park
Greenway Park
11TH
10TH
Trader Oak Park
PAVILLION
GREER
SAMUELS
LOCUST
MORRISON
WOODS
MAYFIELD
Arnold Park
Pioneer Rest Cem
SWIFT
UP RR
Park
NIXON
DELGA
PORTLAND
CARVER
GLENMORE
GREENFIELD
MAPLE
MONY
PHARR
HAMILTON
GILVIN
1.1
1ST
2ND
LIVE OAK
NICHOLS
HARDING
CRUMP
ELM
TERRY
PECAN
3RD
4TH
347
GROVE
JONES
CALHOUN
COMMERCE
MAIN
HOUSTON
THROCKMORTON
TAYLOR
5TH
6TH
7TH
8TH
9TH
280
0.6
0.8
B287
18TH
LUELLA
97°20'
32°45'
F
W
P

FIGURE A





ESTIMATE OF QUANTITIES			
CLASSIFICATION	SUBSTRUCTURE	SUPERSTRUCTURE	TOTAL
Class "A" Excavation	590 Cu. Yds.		590 Cu. Yds.
Concrete Piling	2112 Lin. Ft.		2112 Lin. Ft.
Class "A" Concrete	176.6 Cu. Yds.	368.5 Cu. Yds.	545.1 Cu. Yds.
Class "B" Concrete	303.1 Cu. Yds.		303.1 Cu. Yds.
Reinforcing Steel	58795 Lbs.	50562 Lbs.	109357 Lbs.
Structural Steel		213380 Lbs.	213380 Lbs.
Side Walks		1602 Sq. Ft.	1602 Sq. Ft.
Concrete Railing		340 Lin. Ft.	340 Lin. Ft.
Hot Mix Paving		752 Sq. Yds.	752 Sq. Yds.
Cement Gun Encasing		4428 Sq. Ft.	6758 Sq. Ft.

DATA ON DESIGN

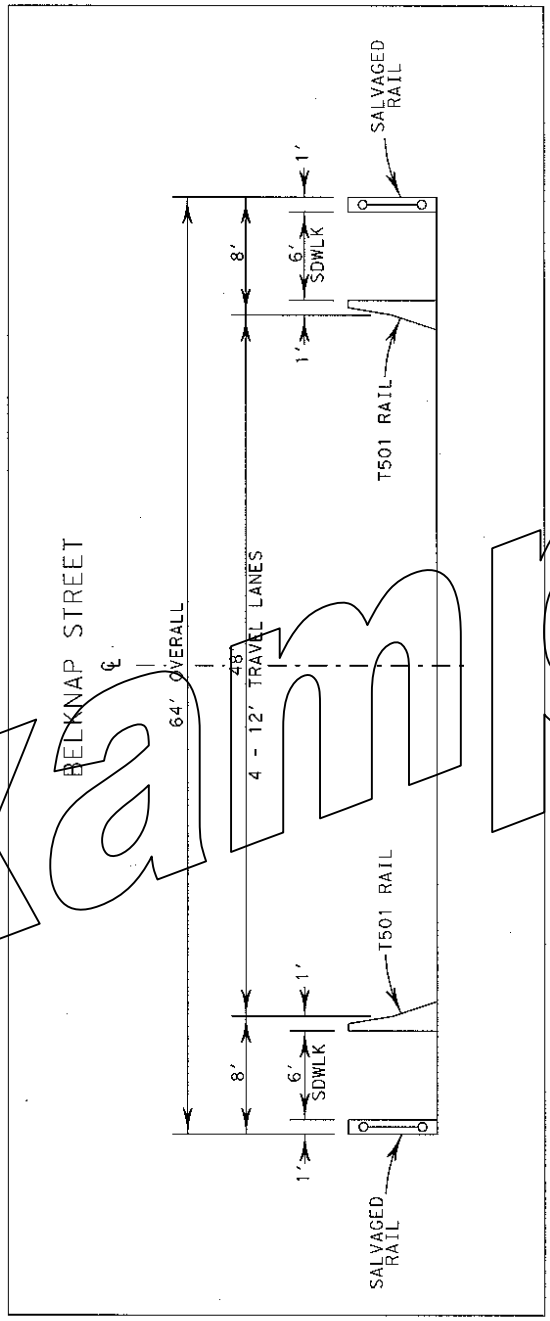
Concentrated Live Load @ ℄ Girders 24000#
Uniform Live Load per lineal foot Girders 640#
Dead Load per lineal foot Girders 2400#
Impact on Live Load 25%. Moments include impact

MAXIMUM MOMENTS

Loading	@ ℄ End Grds	@ Pier	@ ℄ Center Grd.
Con. L.L.	280000'#	320000'#	300000'#
Unfr. L.L.	172000'#	316000'#	225000'#
Dead Load	300000'#	948000'#	350000'#
Total Mom.	752000'#	1584000'#	875000'#
Flange Area =	14.12 □"	14.35 □"	13.31 □"
Use Top Flg = 2 Ls 8X6X½ =	12.50	12.50	12.50
⅜ Web =	1.92	3.20	1.92
Total	14.42	15.70	14.42
Bottom Flng. 2 Ls 6X6X½ =	9.50	9.50	9.50
⅜ Web =	1.92	3.20	1.92
14 X ⅜ Cov. pl. =	4.50	4.50	4.50
Total	15.92 □"	15.92 □"	15.92 □"

Stiffner Ls Ends and Brackets 2 Ls 5X3X½ Inter 2 Ls 3½X3½X½
Laterals La 2 Ls 3½X
Brackets and Frame

FIGURE B



Typical Section

Example

FIGURE C

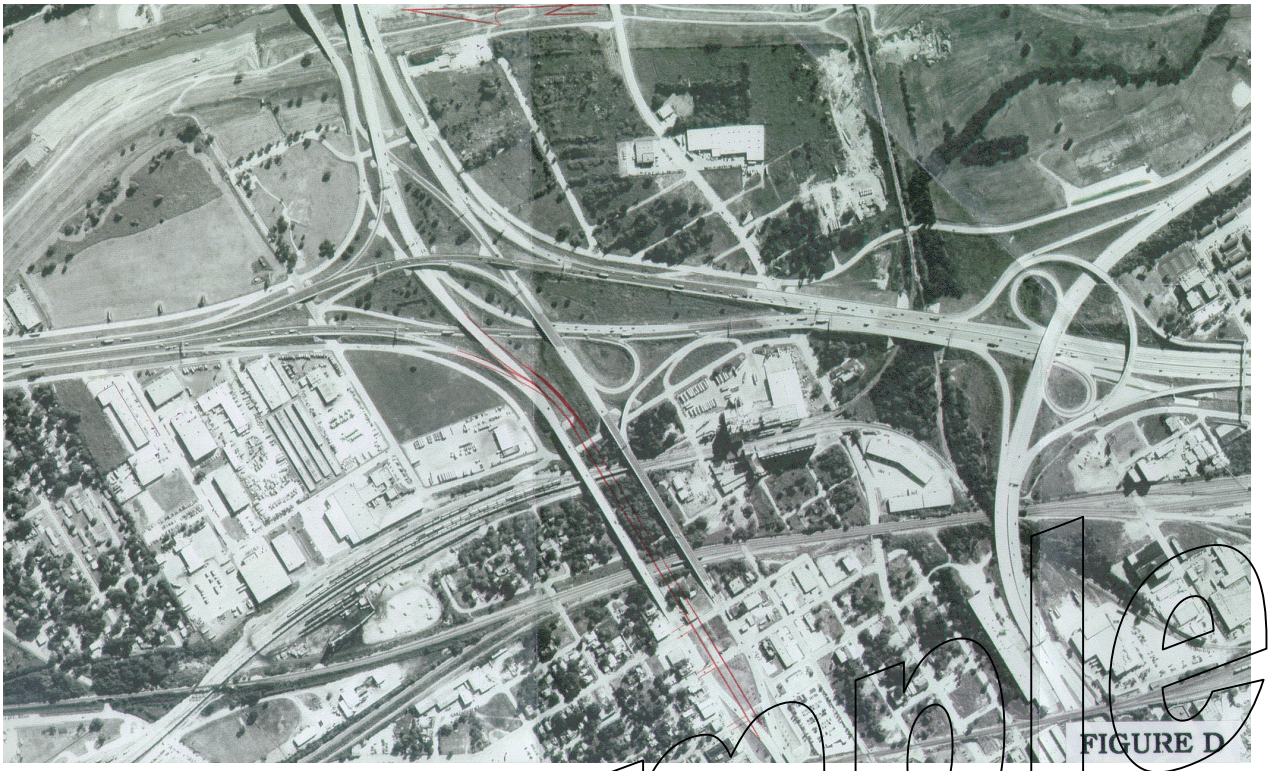


FIGURE D

Example

PROGRAMMATIC SECTION 4(f) (Example 2) EVALUATION: HISTORIC BRIDGE

PROGRAMMATIC 4(f) EVALUATION

Decatur Road Bridge

CSJ: 0902-20-042
Chico, Texas
Wise County

Example

INTRODUCTION

The project covered under this report is on Decatur Road, a city street within the city limits of Chico, Wise County, Texas. It consists of the removal and replacement of a bridge, which is functionally inadequate and structurally deficient. It is located approximately 65 feet west of SH 101 and approximately 250 feet north of FM 1810. Decatur Road is the main access to Chico's town square. The existing right of way is currently 40 feet wide. No additional right of way will be required.

According to the department's bridge records, the bridge was built in 1930. However, local history indicates a bridge of masonry construction may have occurred in this location in the1880s. The SHPO, State Historic Preservation Officer, has concurred with TxDOT regarding eligibility of the bridge. The bridge is eligible under Criterion C, Engineering, at the local level of significance for its importance as one of a small number of true masonry arch bridges existing in Texas.

PURPOSE AND NEED

The existing bridge is structurally deficient and has been determined inadequate to convey traffic. Decatur Road is a two-lane facility with an asphalt surface approximately 23.6 feet, with no shoulders. The bridge is one-lane with a width of 14.4 feet. Due to the narrow width of the bridge and the traffic volume there have been several traffic accidents resulting in damage to the sides and curbing. The existing facility was not designed to meet the current traffic flow/volume (550 vehicles daily) and will not accommodate or sustain such traffic. Currently the majority of traffic across this bridge meets or exceeds the advised load weight limit of 3000 lbs.

Safety problems are also present due to the age of the structure. Stress fractures, mortar/rock crumbling, water scouring, erosion at all corners and undermining of the foundation of the arches has greatly reduced the bridge's sufficiency rating. The bridge received a sufficiency rate of 22 points out of a possible 100. Automobile impacts to the bridge railing have destroyed two 3-5 foot sections of the curbing. The bridge currently has no railing to prevent vehicles from going over the edges.

The ADT for this project is approximately 550 vehicles. Due to safety reasons the existing bridge was closed to through traffic. However, the barricade has disappeared and

vehicles continue to utilize this bridge due to easy access to businesses. Such disregard for the bridge closure would most likely continue.

The proposed bridge will be a four (4) span, three (3) column structure, approximately 41.4 feet long, with no change in the alignment from the existing bridge. The bridge will have a clear roadway width of 23.6 feet to match the width of current approaches, thus providing two 11.8 feet lanes, with no shoulders.

ALTERNATIVES CONSIDERED

Several alternatives were examined: no build/do nothing, construction on new location, parallel construction, rehabilitation, and removal and replacement of the bridge.

1. No Build /Do Nothing

The No Build/Do Nothing Alternative was evaluated and for safety and functional reasons, does not meet the purpose and need for this project. The existing facility was not designed to meet the current traffic flow/volume (550 vehicles daily) and will not accommodate or sustain such traffic. Currently the majority of traffic across this bridge meets or exceeds the advised load weight limit of 3000 lbs. Safety problems are also present due to the age of the structure. Stress fractures, mortar/rock crumbling, concrete spalling, collision damage, scouring, erosion at all four corners and undermining of the foundation at various locations have greatly reduced the bridges sufficiency rating. Due to the narrow width of the bridge and the traffic volume there have been several traffic accidents resulting in damage to the sides of the bridge and the railing. Automobile impacts to the bridge railing have destroyed two 3-5 foot sections of the railing.

This alternative was considered undesirable. A no build action would not address the structural deficiencies, the deterioration problems, or functional inadequacies.

2. Construction on New Location

As an alternative design, the current road could be turned into a one-way facility with a new one-way road built parallel to either the south or the north.

Acquisition of right-of-way from the north side of the bridge would result in additional environmental effects to several large trees (8-16 inches), the channel bank and various species of undergrowth vegetation. This alternative would also impact an underground petroleum storage tank located about three feet from the right-of-way. Also, the north side would involve the relocation of a 25- inch main water line and a gas line, both resulting in financial burdens to the City of Chico. This alternative was determined to be undesirable.

Acquisition of right-of-way from the south side would involve a substantial change in grade. Currently the City of Chico maintains a gravity flow sewage line with a 2% slope to the south. Modification to the existing terrain due to the construction of a bridge on this side would significantly alter the terrain and thus affect the slope. Any affect to the

Example

slope would necessitate the construction of a lift station, causing an additional financial burden to the city. The south side would also involve impacting the flow grade to a recently installed box culvert along the intersection of the adjacent Highway 101. This alternative was determined to be undesirable

3. Parallel Construction (utilizing an existing road)

The closest parallel roads are Sherman Street approximately ¼ mile to the north and Maginnis Street about 1/10 of mile to the south. If Decatur Road were closed and both roads utilized as alternate routes the results would deny direct access to several small businesses on Decatur Road, and significantly increase automobile traffic through residential areas. This would mean that the existing bridge and road would have to be closed to automobile traffic and the bridge would continue to deteriorate. This would ultimately result in the dilapidation of the structure and a likely collapse. Decatur Road is the main access to the town square of Chico leading from Highway 101. This alternative was determined to be undesirable.

4. Rehabilitation

TxDOT district bridge design personnel examined the existing bridge to determine if rehabilitation might be a viable option. The deficiencies due to the spalled rock and mortar could be patched in kind due to lost materials. The collision damage to the stone rails/curbing has displaced the materials and these cannot be recovered. Due to the missing rock and mortar at the top of one of the arches, the structural integrity of the arch has been compromised. The only feasible repair for this deficiency is the rebuilding/replacement of the arch.

Rehabilitation of the existing bridge would not address the problems of erosion and undermining at the bridge's foundation. These problems consist of water eroding the soils below the arch bases and the concrete below the arches. Repairs to correct the undermining would require substantial construction to the bridge's substructure and would have the potential to cause further damage to the bridge and alter its appearance. Repair would substantially impact the physical integrity of the structure and would still not address the narrowness of the bridge.

The only way to repair the footing within the structure would be to replace a portion and rebuild it. As with any arch structure, the integrity of the structure is lost when any part of the structure is removed. The erosion problem will continue to exacerbate the existing situation. The only feasible option is complete replacement. The potential damage due to removing and replacing any part of the damaged arch would potentially cause the rest of the structure to fail. If that were to occur, the entire structure would need replacing. Since this is a stone structure, the original rocks would not be able to be replaced in the exact same configuration as it was previous to the original rehabilitation. Rehabilitation is not a feasible option in terms of monetary measures or structural integrity. Some of the original structure (rocks) has already been lost due to previous crashes. Reclaiming the original rocks for use in the proposed replacement bridge is not considered feasible as they would likely be crushed or broken during removal of the bridge.

Example

Rehabilitation of the existing bridge would require substantial alterations to the bridge in order to meet required safety standards. Alterations to repair stress fractures, replace the crumbling mortar/rock, channel scouring, and erosion undermining of the foundation would be substantial enough to change the historic integrity of the bridge. This measure was determined undesirable.

Safety standards can not be met on this particular structure. It is only one lane wide. Crash proof railing is not available due to the lack of previous crash testing on retrofit rail of this type. Not only is there a lack of crash tested rail there is not an existing rail/curbing in some areas in which to retrofit. Some of the existing rail/has been knocked off in previous crashes. Two crashes have occurred since the last Bridge Inspection Database report dated February 1998. This fact should be taken into consideration when discussing this structure. It is unsafe in its present condition. The historic integrity of this structure has been taken into consideration during the design of this structure. It will be replaced with a similar structure (structural plate arch with a stone façade) that incorporates the necessary safety features as well.

5. Remove and replace the existing bridge

Removal and replacement of the existing bridge is the only option that addresses all of the functional and structural deficiencies while minimizing impacts to the channel, vegetation, utilities, underground storage tanks, businesses, cost and increases safety. For these reasons, removal and replacement is the preferred option.

MEASURES TO MINIMIZE HARM

1. Planning

Traffic management would not alleviate the deterioration and need for replacement of the bridge. Although due to safety reasons the existing bridge is technically closed to through traffic, vehicles continue to utilize this bridge due to easy access to businesses. Such disregard would most likely continue to occur using traffic management procedures such as detouring vehicles or posting a stricter weight limit on the bridge. This measure was determined undesirable.

If the bridge were to remain open to traffic, the traffic problems that currently exist would not have been addressed. If the street were closed, the bridge would serve no purpose and direct access to several businesses and the town square of Chico would be lost.

No reasonable or prudent measures to minimize harm to the structure were conceivable. Pedestrian and vehicle safety will remain a concern if the existing bridge is not replaced. Repair and or rehabilitation are not considered viable options.

Avoidance of the Section 4(f) Historic Bridge by altering the roadway design, bridge rehabilitation, traffic management or avoidance was determined for reasons of terrain, social, economic, environmental and engineering to be not feasible or prudent.

Example

2. Mitigation

TxDOT proposes to complete HAER Level III documentation consisting of photographs and a written narrative that describes the history and significance of the bridge. Copies of this package will be provided to the SHPO, a local archive of their choice, and a copy will be retained at TxDOT. SHPO will be afforded 30 days to review and comment on the documentation package.

Example