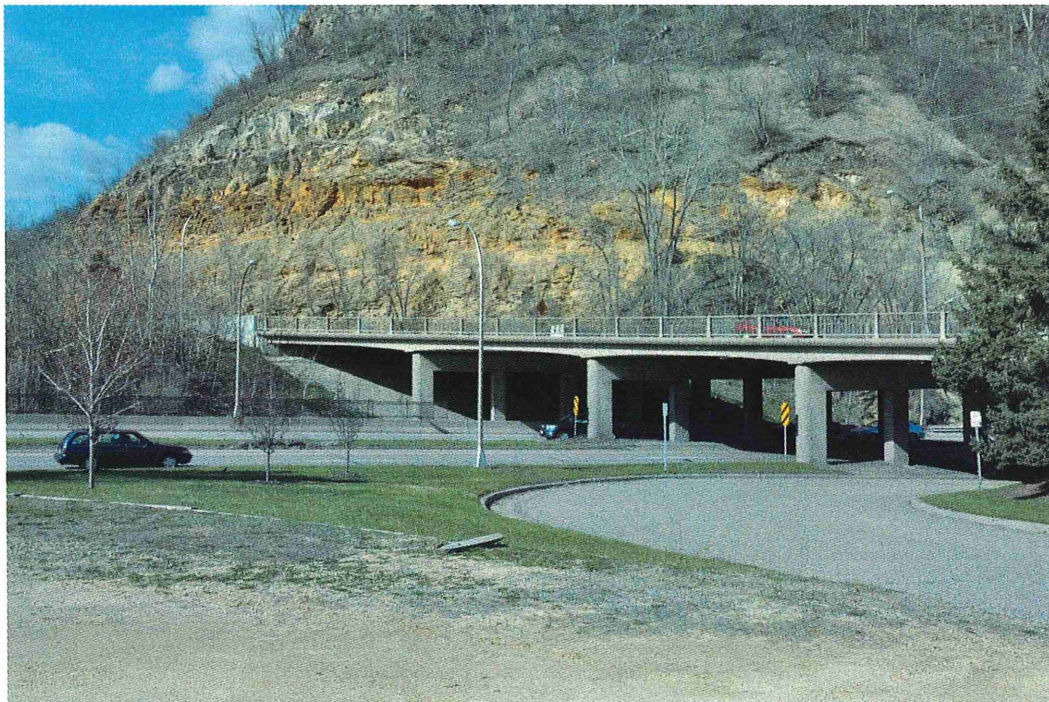


# **Bridge 9103 Rehabilitation Study Final Report Red Wing, Minnesota**

**August 2013**



**Submitted to  
Minnesota Department of Transportation**

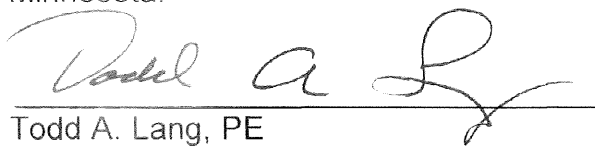
**Prepared by  
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Consultant's Report**

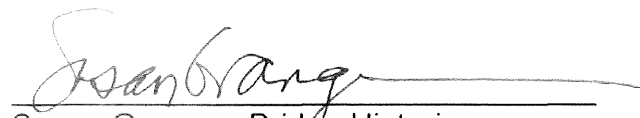
I hereby certify that this report was prepared by me or under my direct supervision and that I am a duly Licensed Professional Engineer under the laws of the state of Minnesota.



Todd A. Lang, PE  
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Date: 8/2/2013 License Number: 42962

I hereby certify that I meet the Secretary of the Interior's Professional Qualifications for History and Architectural History (36 CFR part 81).



Susan Granger, Bridge Historian  
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## EXECUTIVE SUMMARY

The Bridge 9103 Rehabilitation Study is being conducted to explore alternatives for the rehabilitation of Bridge 9103 at the junction of TH 63 and TH 61 in Red Wing, Minnesota. The bridge is eligible for the National Register of Historic Places. A principal goal of the study is to identify alternatives that rehabilitate the bridge for continued use on-site in a manner consistent with the Secretary of the Interior's Standards for the Treatment for Historic Properties.

The bridge was completed in 1960 to serve as the southern approach to the Eisenhower Bridge (Bridge 9040) over the Mississippi River, as well as to carry TH 63 over TH 61 and over an access road that serves the parking area of the Red Wing Shoe Company's Main and Potter Street facility. Both TH 63 and TH 61 are on the National Highway System and classified as principal arterial routes.

Bridge 9103 is a 211'-long, continuous concrete slab span with an adjacent 220' southern approach roadway. The bridge and southern approach were designed and built together, and the boundaries of the National Register-eligible property include both. The property is eligible for the National Register under Criterion C for engineering significance and exceptional aesthetic qualities.

Bridge 9103's overall condition is fair. However, on the bottom surface of the concrete slab there are substantial areas of delaminated and deteriorating concrete concentrated near the longitudinal construction joint along the centerline of the bridge. There are numerous spalls in Spans 2, 3, 4, and 5. Areas where spalls are 2" deep or greater comprise more than 5% of the underside. In some areas, spalling and delamination are so deep that the bottom longitudinal reinforcing steel is no longer bonded to the concrete. This is evident at 8 to 10 longitudinal bars in each of Spans 2, 3, 4, and 5 along most of their length. Although 8 to 10 bars comprise only 5% to 6% of the total longitudinal bars, the affected bars are concentrated within a design strip width. Testing indicates a high level of chloride content throughout the slab, which suggests additional reinforcing steel has begun to corrode or will begin to do so in the foreseeable future.

The bridge is not currently posted and is safely carrying normal traffic. However, deterioration of the concrete superstructure threatens the ability to maintain adequate load capacity. Posting the bridge to prohibit heavy loads would hinder the increasing number of heavy commercial haulers who use the Mississippi River crossing at Red Wing for the transport of agricultural and industrial materials and other freight.

Bridge 9103 meets some modern design criteria. Vertical profile and horizontal curve geometrics are more than adequate for the 30 mph posted speed limit (35 mph design speed), and the bridge meets lane and shoulder width requirements. However, the historic railing's strength (crashworthiness) falls below MnDOT BPIR and MnDOT Bridge Design Manual standards, and the bridge is not universally accessible. On TH 61 beneath the bridge, horizontal clearance is significantly more narrow than MnDOT standards, which is a potential safety concern, and vertical clearance is several inches lower than MnDOT standards, which causes the diversion of some oversize loads onto other routes.

Four alternatives for the rehabilitation of Bridge 9103 were identified and opportunities to create hybrid alternatives were explored. The four alternatives were assessed against a set of



evaluation criteria, most of which were derived from the Red Wing Bridge Project's Purpose and Need. Detailed cost estimates were developed.

All four alternatives would increase load capacity. Alternatives 1 and 2, which differ only in the use of an inner TL-2 rail, would meet the Secretary of the Interior's Rehabilitation Standards. Alternatives 3 and 4, which propose to replace the bridge's concrete slab superstructure, would not meet the Standards and would diminish the property's historic integrity to the point that it is no longer eligible for the National Register. Alternatives 2, 3, and 4 would improve traffic safety, a secondary need, with railings that meet TL-2 crash test requirements, while Alternative 1's rail would remain below standards. (Alternative 4 would also meet criteria for rail height and opening size.) All four alternatives would meet ADA requirements. Alternative 4 would increase traffic capacity, a secondary need, by accommodating a four-lane rather than two-lane roadway. None of the alternatives would improve horizontal clearance on TH 61. Alternatives 1, 2, and 3 could improve vertical clearance if an optional lowering of the TH 61 roadway is included. No improvement of vertical clearance is possible with Alternative 4. Horizontal and vertical clearance are other considerations in the Purpose and Need statement.

Alternatives 1 and 2 each have a service life of 10 to 15 years, which could be increased to about 20 years if optional cathodic protection is included. Alternatives 3 and 4 each have a service life of about 60 years. Service life is defined as the number of years before significant rehabilitation would be required; significant rehabilitation is defined as work that requires hiring a contractor but excludes mill and overlay which is considered expected maintenance within a bridge's service life.

There is a risk under Alternatives 1 and 2 that unforeseen deterioration of the slab may be identified during construction, complicating construction staging and threatening maintenance of traffic on TH 63, which is a secondary need. Alternative 3 is the most complicated of the four to construct. Alternative 4 is the only alternative that would require additional right-of-way; it would require acquisition of approximately four parcels with two likely relocations.

The rehabilitation study committee recommends that Alternatives 1 and 2 are viable alternatives for the rehabilitation of Bridge 9103. Each has two optional work items: passive cathodic protection of the concrete slab, and lowering TH 61 by about 10" to improve vertical clearance. The committee recommends that Alternatives 3 and 4 are not viable because they would not meet the Secretary of the Interior's Standards for the Treatment for Historic Properties and would diminish Bridge 9103's historic integrity to the point that it is no longer eligible for the National Register. These two alternatives would create an adverse effect under Section 106 of the National Historic Preservation Act and likely constitute "use" of historic properties under Section 4(f) of the Transportation Act of 1966.

## 1.0 INTRODUCTION

The Minnesota Department of Transportation (MnDOT), in partnership with the Wisconsin Department of Transportation, is studying options to rehabilitate or replace two bridges in Red Wing, Minnesota: the Eisenhower Bridge (Bridge 9040), which carries TH 63 over the Mississippi River between Red Wing and Pierce County, Wisconsin, and Bridge 9103, which serves as the southern approach to the Eisenhower Bridge and carries TH 63 over TH 61 and over an access road that serves the parking area of the Red Wing Shoe Company's Main and Potter Street facility. Both bridges were opened for traffic in 1960.

One of the two bridges, Bridge 9103, is eligible for the National Register of Historic Places. The boundaries of the National Register-eligible property (Figure 3) include both Bridge 9103 and an adjacent southern approach roadway with which it was comprehensively designed and built (see historic plans in Appendix B). Per National Register guidelines, the boundaries include the entire resource and its grounds (or the surrounding land historically associated with the resource - in this case the area within MnDOT right-of-way).

This rehabilitation study is being conducted to explore alternatives for the rehabilitation of Bridge 9103, and in particular to investigate whether the bridge can be rehabilitated in a manner consistent with the Secretary of the Interior's Standards for the Treatment for Historic Properties. According to MnDOT's Management Plan for Historic Bridges (2006), the preferred option for the treatment of a historic bridge is rehabilitation for continued vehicular use on-site, with the rehabilitation following the Secretary of the Interior's Standards.

This study is being conducted within the framework of two laws that offer a measure of protection to historic properties, Section 106 of the National Historic Preservation Act of 1966 and Section 4(f) of the Transportation Act of 1966. Section 106 requires that federally-funded projects take historic properties into consideration during planning and implementation. Under Section 4(f) of the Transportation Act of 1966, a federally-funded transportation project cannot "use" a historic property unless there is no prudent and feasible alternative to the use and the undertaking includes all possible planning to minimize harm to the property resulting from the use. Both laws define historic properties as those listed on, or eligible for, the National Register of Historic Places.

The study is also being conducted within the context of a Section 106 Programmatic Agreement (PA) on Pre-1956 Historic Bridges in Minnesota signed by MnDOT, the Federal Highway Administration (FHWA), and other signatories in 2008. The PA encourages historic bridge rehabilitation projects to explore context-sensitive solutions during project planning, including the use of tools such as design exceptions, when practical, to help preserve a bridge's historic integrity. The PA does not currently apply to bridges such as Bridge 9103 that were built after 1955, but it is being amended to do so. In the meantime, MnDOT is proceeding with the treatment of post-1955 bridges as if the PA amendment has been completed.

The rehabilitation study committee is comprised of staff from FHWA; MnDOT (including District 6, the Bridge Office, and the Office of Environmental Stewardship); SEH, Inc. (prime consultant for the Red Wing Bridge Project); HDR Engineering, Inc. (bridge engineering subconsultant); and Gemini Research (bridge historian consultant). The committee met in 2012 and 2013.

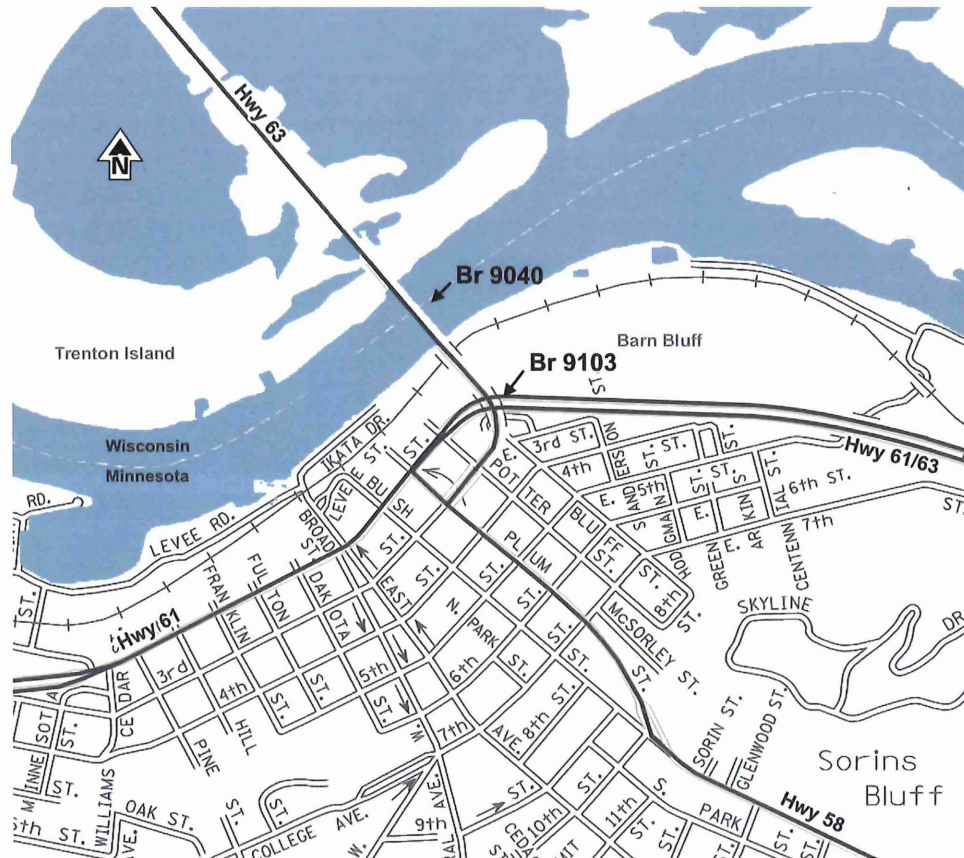


Figure 1. Location of Bridge 9103 in Red Wing, Minnesota.

## 2.0 PROJECT PURPOSE AND NEED

The Red Wing Bridge Project includes two bridges, the Eisenhower Bridge over the Mississippi River (Bridge 9040) and its approach bridge, Bridge 9103. The Eisenhower Bridge provides the only regional crossing of the river for approximately 30 miles upstream or downstream. Completed in 1960, the Eisenhower Bridge is a two-lane, continuous steel through-truss bridge. Bridge 9103, also completed in 1960, is 350' south of Bridge 9040 with no roadway accesses between them (Figure 1). TH 63 and TH 61 are both on the National Highway System and classified as principal urban arterial routes. The 2012 AADT (annual average daily traffic) for both bridges is 12,000.

The Red Wing Bridge Project's Purpose and Need Statement is included in Appendix A. The document's summary Purpose Statement reads as follows:

The primary purpose of the project is to provide a structurally sound bridge crossing of the Mississippi River Main Channel at Red Wing, Minnesota and a structurally sound crossing of US 61. In addition, the project needs to maintain the connection between



the Red Wing, Minnesota and Wisconsin highway systems located on Trenton Island, and provide adequate capacity to safely accommodate future transportation needs within the design life of the bridges, while maintaining traffic to the maximum extent possible during construction.

Primary purposes of the Project are to provide structurally sound crossings of the Mississippi River and TH 61.

Secondary needs are the need to maintain the continuity of TH 63; the need to maintain TH 63's connections to TH 61 and TH 58; the need for adequate capacity, acceptable traffic operations, and safe design; the need for maximum maintenance of traffic; the need for access to Trenton Island (Wisconsin); and the need to maintain or improve pedestrian/bicycle facilities.

Other considerations include structural redundancy (Bridge 9040), geometrics, economic development, parking, and regulatory requirements. The regulatory requirements include directives such as Section 106 of the National Historic Preservation Act, Section 4(f) of the Transportation Act, the US Coast Guard's maintenance of the Mississippi River navigational channel, and Section 404 of the Clean Water Act.

See Appendix A for the full Purpose and Need statement.

### **3.0 BRIDGE BACKGROUND AND SIGNIFICANCE**

#### **3.1 Bridge 9103**

Bridge 9103 was completed in 1960 to serve as the approach bridge for the Eisenhower Bridge (Bridge 9040), which crosses the Mississippi River. The same designers and builders worked on both bridges.

Bridge 9103 is a 211'-long continuous concrete slab span with an adjacent 220' southern approach roadway. Together the bridge and southern approach curve nearly 90-degrees from Red Wing's Third Street to the river crossing, lift traffic up to the elevation of the river bridge, and separate TH 63 and TH 61 at a new junction that was created by the 1960 project (Figures 1, 2, and 19).

Bridge 9103 and its southern approach are significant from both an engineering and aesthetic standpoint. The bridge's unusually long curved form and the combined property's Modernist design and ornamental railing achieved the project's engineering goals and at the same provided a handsome approach to a major Mississippi River crossing and a gateway to downtown Red Wing.

The river bridge (Bridge 9040) was built to replace a deteriorating 1895 truss bridge that state and local officials had been planning to replace since before World War II. The new bridge was dedicated by sitting President Dwight D. Eisenhower in October 1960. It was originally called the Hiawatha Bridge but renamed the Eisenhower Bridge soon after the President's visit.

West of downtown Red Wing, TH 61 had been realigned and widened in 1951-1953. Two years later, in 1955, the legislature approved Minnesota's share of funding of the \$3.4 million Eisenhower Bridge project. The contract for designing the new river crossing was awarded to Alfred Benesch and Associates of Chicago in the spring of 1956. On the marshy Wisconsin side of the river, the 2-mile-long project would require 1½ miles of fill and several minor spans.

Initial grading for the two bridges and associated realignments began in April 1958. The river bridge was under construction by that fall. The state highway department's project engineer was William C. Merritt. Industrial Construction of Minneapolis was the contractor for the entire project. The improvements were controversial – 85 houses in East Red Wing had to be razed or moved, and the project required alteration of Barn Bluff, the 325'-tall island mesa that was Red Wing's best-known landmark and a place of cultural significance for centuries. On Barn Bluff's west flank, massive amounts of earth were removed (and hauled to Trenton Island for fill). A monumental public stairway up the side of the bluff was demolished. In May of 1959 a huge piece of Barn Bluff's towering "Indian head" formation tumbled to the ground, damaging boxcars and a nearby industrial facility and ending hopes that the formation could remain in place above the south end of the new river bridge.



Figure 2. This aerial view from October 1960 shows newly-completed Bridges 9103 and 9040, as well as construction scars on the west flank of Barn Bluff. TH 61 under the bridge is not yet complete (Minnesota Historical Society photo by the St. Paul Dispatch).

Both Bridge 9103 and Bridge 9040 were designed by Alfred Benesch and Associates of Chicago. (H. B. Schultz was the designing engineer.) Benesch and Associates was founded in 1946 by World War II veteran Alfred Benesch. The company initially worked in the Midwest and Northeast providing engineering services for factories, office towers, and public buildings. In the

early 1950s Benesch began to design highway and railroad bridges. The Benesch firm designed several notable bridges that still stand in Chicago including a 4,000'-long 42-span plate-girder built in the mid-1950s as part of Chicago's Skyway Toll Bridge system, and seven truss bridges completed in 1964-1970. In the 1960s-1980s, Benesch and Associates was engineer for several well-known residential skyscrapers on Lake Michigan in downtown Chicago (Randall 1999). Alfred Benesch retired in 1971. The company is still based in Chicago.

Bridge 9103 and Bridge 9040 and associated highway improvements were built as part of an overarching, postwar initiative to widen and improve TH 61 between La Crescent and St. Paul. TH 61 was a major artery between Chicago and the Twin Cities that carried heavy commercial traffic. It was also a popular tourist route with stunning views of the Mississippi River and its bluffs. In addition to the two 1960 bridges and associated realignments, other TH 61 improvements of the period included reconstructing TH 61 in West Red Wing (1951-1953), a new bridge at Hastings (1951), survey for a four-lane from Red Wing to La Crosse (1952), a major bypass of downtown Winona (let in 1952), and completion of the last four-lane segments between St. Paul and Hastings (1958). In the 1950s Congress also approved planning funds for the Great River Road, a proposed scenic route along the Mississippi River from New Orleans on the Gulf Coast to the river's headwaters in northern Minnesota. The Great River Road had been in the planning stages since the 1930s and was predicted to increase recreational traffic on TH 61 in Minnesota.

### **National Register Eligibility**

Bridge 9103 is eligible for the National Register under Criterion C (design and construction) in the area of Engineering. The bridge was determined eligible for the National Register as part of a statewide evaluation of post-1955 highway bridges conducted in 2010 by Mead and Hunt for MnDOT. Both Bridge 9103 and its southern approach roadway are included within the boundary of the eligible property (Figure 3).

Bridge 9103's National Register eligibility is based on two principal factors:

*Engineering Significance.* Bridge 9103 is the only horizontally-curved, continuous concrete slab bridge from the period 1955-1970 standing in Minnesota. In addition, the horizontal curve of 14 degrees is the greatest curvature for any extant bridge in Minnesota from the period. At 211' long, Bridge 9103 is also exceptionally long for its type. According to Mead and Hunt, the bridge's unusual curvature and length demonstrate "the complex design issues the engineers faced to meet the site challenges and road requirements for a bridge at this location."

*Exceptional Aesthetic Qualities.* Bridge 9103 is one of only four bridges identified in the post-1955 statewide bridge study that are eligible for the National Register for "high artistic value." The bridge and its southern approach were given special aesthetic consideration because of proximity to the new Eisenhower Bridge and to downtown Red Wing.

Bridge 9103 and its southern approach are essentially unaltered. The property retains strong historic integrity in all seven categories cited in National Register eligibility criteria: location, design, setting, materials, workmanship, feeling, and association. The level of significance is State and the period of significance is the year of construction, 1960.



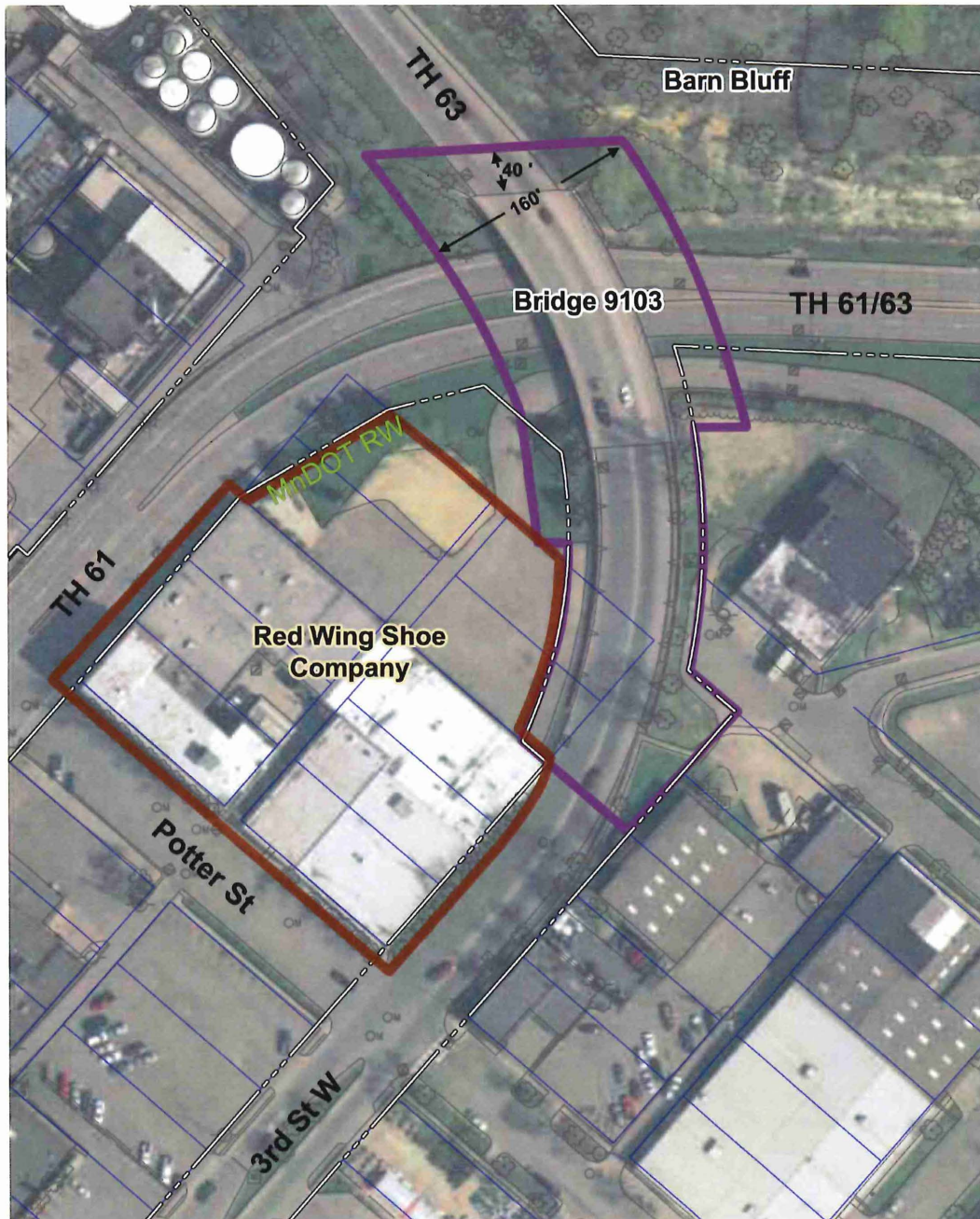


Figure 3. The purple line indicates the boundary of the National Register-eligible property. Bridge 9103 is also part of the Highway 61 (Great River Road) Historic District. Barn Bluff and the Red Wing Shoe Company are historic properties immediately adjacent to Bridge 9103 (Gemini Research drawing).

### 3.2 Other Historic Properties

Bridge 9103 is a Contributing element in a linear historic district – called Highway 61 (Great River Road) – and immediately adjacent to two other historic properties, Barn Bluff and the Red Wing Shoe Company (see map in Appendix N).

Highway 61 (Great River Road) Historic District. TH 61 between St. Paul and La Crosse was recommended eligible for the National Register in 2009. The road is eligible under Criterion A (broad patterns of history) in the area of Transportation. Historic roads are treated as linear historic districts by the National Register program. The portion within the Red Wing city limits is known as the Red Wing Segment (GD-RWC-1448). Bridge 9103 (GD-RWC-1387) is a Contributing element within the linear historic district.

Barn Bluff (GD-RWC-280), now a 73-acre city park, was listed on the National Register in 1990 (Figures 4 and 19). It is one of the best-known natural features on the Mississippi River between La Crescent and St. Paul and is significant to both Euro-American and native cultures. The National Register boundary follows the bluff's 740' contour line. In 2011 Gemini Research recommended that the National Register boundary was too small and should be expanded to follow the current city park limits. This line is the MnDOT right-of-way line near the northeastern end of Bridge 9103.

Red Wing Shoe Company (GD-RWC-019), built in five stages in 1905-1954, is eligible for the National Register under Criterion A (broad patterns of history) in the area of Industry. The company has been a leading Red Wing employer since its establishment in 1905. The recommended period of significance of 1905-1965 begins when the first phase of the factory was built, and ends in 1965 when the company built a second plant in the Burnside neighborhood of Red Wing, ending this facility's role as the company's sole factory. The boundary of the National Register-eligible property includes the factory and its east parking area (Figure 3).

There are two other historic properties located within 1½ blocks of Bridge 9103: the CMSTPP Railroad Historic District (GD-RWC-1371) at the river's edge, and the Red Wing Commercial Historic District (GD-RWC-1451), which begins one lot west of the intersection of TH 61 (Main Street) and Potter Street. The Eisenhower Bridge (Bridge 9040) over the Mississippi is not eligible for the National Register.

There are no archaeological concerns within Bridge 9103's existing footprint. Any ground-disturbing work outside of the existing footprint could have potential impacts to archaeology, but they are unknown at this time. The Phase I archaeological survey for the Red Wing Bridge Project started in fall 2012 and will resume in spring 2013.



## 4.0 BRIDGE DESCRIPTION & CHARACTER-DEFINING FEATURES

### 4.1 Geometrics and Bridge Configuration

Bridge 9103, completed in 1960, is located at the junction of TH 63 and TH 61, about 350' south of Bridge 9040 (the Eisenhower Bridge) which crosses the Mississippi River at the base of Red Wing's highest summit, Barn Bluff.

Bridge 9103 is a curving, five-span, continuous concrete slab on a 14-degree curve. The slab serves as both superstructure and deck. (See Appendix B for original plans and Appendix L for photos taken soon after completion.) The bridge has an overall structural length of 211', measured along the centerline of the roadway. The longest span is 47'6". Connected to the south end is a 220'-long curving approach roadway that is supported on retained fill with cast-in-place concrete retaining walls. Outlines and other imprints from the construction forms are visible on the walls' surface (Figure 6). The bridge and approach were designed as a single project. The bridge deck slab and piers create a strong Modernist form, while the railings represent a transition away from the Art Deco-influences of the 1930s and 1940s and into modern design.

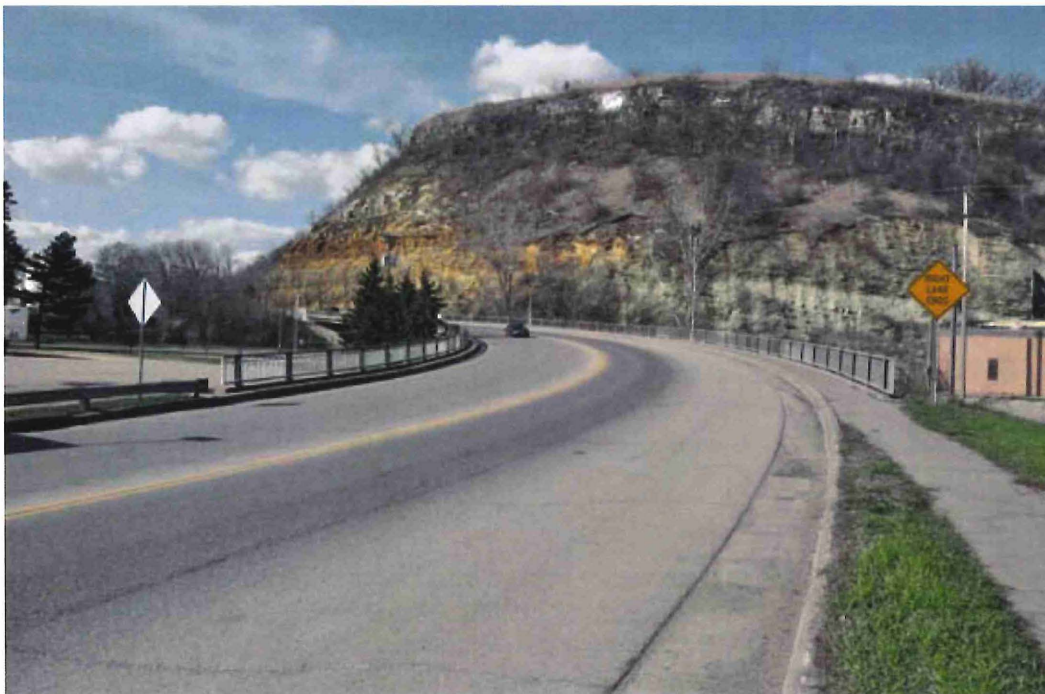


Figure 4. Bridge 9103 and its southern approach with Barn Bluff to the north. The first 220' of railing mark the southern approach; the car in the center of the photo is just leaving the bridge.

The out-to-out slab width of Bridge 9103, and of the corresponding approach roadway, is 62'6". On both structures this distance includes a superelevated 52'-wide roadway, a 2'6" raised sidewalk on the west side, and a 5' raised sidewalk on the east side. The 52'-wide roadway consists of two 12'-wide lanes and two 14'-wide shoulders. On the bridge and southern



approach, TH 63 functions as a two-lane roadway, while south of the approach, southbound TH 63 widens from one to two lanes.

Beneath the bridge, TH 61 consists of two 12' lanes in each direction with an adjacent a 24'-wide service drive under Span 2. This drive provides sole access to the parking area of the Red Wing Shoe Company's Main and Potter Street facility. There are no pedestrian facilities on TH 61 beneath the bridge. On southbound TH 61, the inside shoulder is 0' wide and the outside shoulder is about 2' wide (basically the gutter pan). On northbound TH 61, the inside shoulder is 0' wide and the outside shoulder is about 4' wide. (The northbound outside shoulder varies; it is less than 4' wide south of the bridge and more than 4' wide north of the bridge.) Bridge 9103's horizontal clearance does not meet design criteria in the MnDOT Bridge Preservation, Improvement and Replacement Guidelines (BPIR) and the MnDOT Bridge Design Manual (see Section 6.0).

Both TH 63 and TH 61 are on the National Highway System and classified as principal urban arterial routes. Therefore, the appropriate design speed for these highways is 35 mph. The posted speed limit is 30 mph on both TH 63 over the bridge and TH 61 under the bridge.

Bridge 9103 is located on a constant 4% vertical grade and a 14-degree horizontal curve. The bridge contains a variable superelevation with a maximum slope of 4%. Both the vertical and horizontal curve geometrics on top of the bridge are adequate for a 35-mph design speed.

Segments of steel w-beam guardrail extend north from the west bridge railing, and south (after a pedestrian opening of 4') from the southern approach's west railing. Beneath the bridge, a concrete traffic barrier topped with a black metal railing has been added to the north edge of TH 61 northbound. The barrier and rail extend west to Potter Street.

The bridge superstructure consists of a five-span parabolically-haunched continuous concrete slab that varies in thickness from 18½" at midspan to 27" over the piers. The slab has a longitudinal construction joint along the centerline that is visible on the underside. The main reinforcing in the slab runs longitudinally along the curve. It is made up of #8 bars (in the bottom of the slab) and #8 or #10 bars (in the top of the slab over the piers). The transverse reinforcing is made up of #4 bars in the top of the slab and #5 bars in the bottom of the slab (see original bridge plans in Appendix B). The bars are uncoated (i.e., do not have a protective coating against corrosion). The span lengths are 34', 42', 42', 45'6", and 47'6", measured along the centerline of the roadway. The bottom surface of the slab retains outlines and other imprints from the original construction forms (Figure 5; see also inspection photos in Appendix E). Along the bridge fascia is a distinctive curved coping that continues along the approach roadway retaining walls (Figure 7).

The latest MnDOT inspection report notes that Bridge 9103 has a minimum vertical clearance of 15.5' over TH 61 southbound, 16.4' over TH 61 northbound, and 14.7' over the service drive to the Red Wing Shoe Company parking area. The vertical clearance over TH 61 does not meet design criteria in the MnDOT BPIR and the MnDOT Bridge Design Manual for clearance over a principal arterial. The clearance over the service drive meets the standards in those documents (see Section 6.0).

Bridge 9103's substructure includes four piers, each comprised of five rectangular columns on square spread footings (Figure 5). The outer ends of the exterior columns are rounded beneath the bridge fascia. The exterior columns have overall dimensions of 2'6" by 4'. The interior columns are 2' by 3' in rectangular cross section. The pier caps are 3'6" tall with rounded ends that are flush with the rounded ends of the exterior columns. The piers retain outlines and other imprints from the original construction forms (Figure 5).

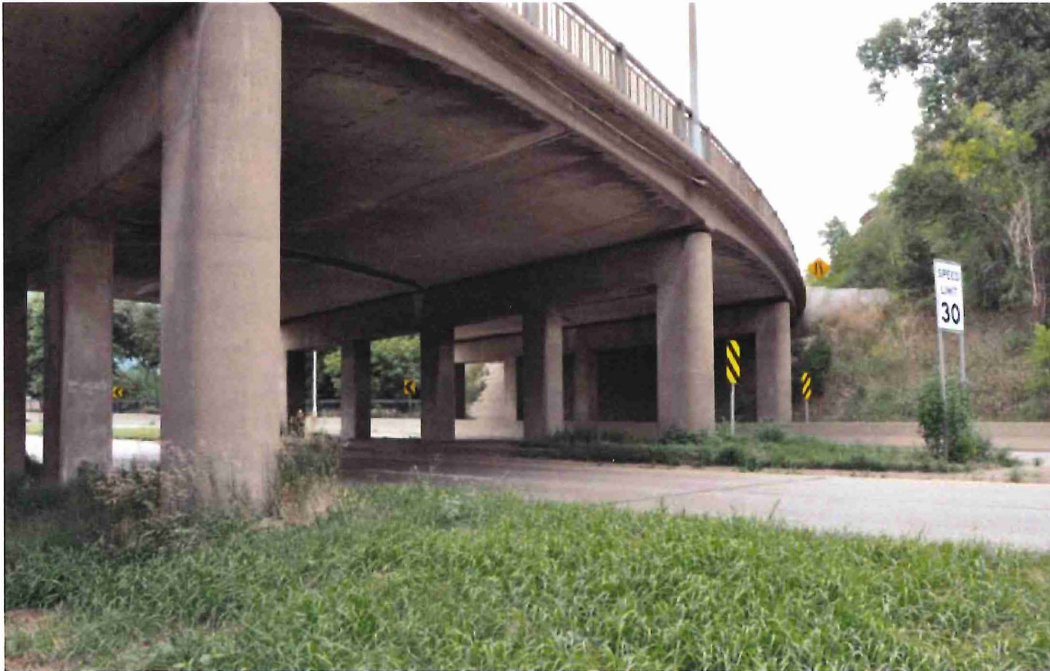


Figure 5. The continuous concrete slab and distinctive piers, facing north.

The south abutment consists of a high parapet abutment supported on a spread footing keyed into rock, while the north abutment consists of a low parapet abutment with the stem bearing directly on rock. The south abutment has retaining walls that are part of the southern approach roadway, while the north abutment has flared wings on either side. The abutment slopes are protected by square precast concrete blocks (Figure 7).

The bridge has expansion bearings at both abutments and at Piers 1 and 4, and fixed bearings at Piers 2 and 3. A total of 12 equally-spaced bearing devices are present at each substructure unit.

The bridge was originally built with open joints at each end of the deck slab covered with 3/4" steel plates in the roadway sections and 3/8" steel plates in the raised sidewalk sections. In 1978 the open joints were replaced with the strip seal joints that are in place today. At the same time, a 2½" low-slump concrete overlay was added to the top of the slab. The slab had been originally covered with a bituminous overlay that served the same purpose.

The southern approach roadway is supported on earth fill that is retained by a pair of smooth cast-in-place concrete retaining walls along which the bridge coping and railing extend (Figure

6). The retaining walls have approximately 1' of exposed height near the south end, about 8' in the middle, and about 6' of exposed height near the bridge's south abutment. For a majority of the length the exposed height of the retaining walls varies between 5' and 8' to follow the existing terrain. The driving surface of the approach is bituminous.

The ornamental railing is continuous on both the bridge and southern approach. Made of galvanized steel, the railing has 39"-tall posts with Art Deco-inspired fluting that arches to form a shallow point at the top of each post. The railing panels are about 8'2" long with rectangular handrails and an alternating pattern of slender vertical members. The bridge railing is a version of a standard Minnesota Highway Department design used elsewhere in Red Wing on portions of TH 61 that were rebuilt in the 1950s. Bridge 9103's railing differs slightly from other versions. For example, remnants of railing west of downtown (1951-1953) have round rather than rectangular handrails, and rail panels that are attached to the outsides of the posts rather than being inset. TH 61's Hastings Bridge (completed in 1951, now being replaced) has a railing similar to that of Bridge 9103 but with posts that have flat rather than pointed tops. The bridge railing does not meet modern design criteria for crashworthiness and rail height, and does not meet some standards for rail opening size (see Section 6.0). The historic rail has a transverse load capacity of 5.4 kip (ASD) or 9.8 kip (LRFD). (For comparison, a Test Level 1 or TL-1 rail has a 13.5 kip transverse load capacity (LRFD) and a TL-2 rail has a 27.0 kip transverse load capacity (LRFD); see Section 6.0.)



Figure 6. West retaining wall on the southern approach, facing northeast. The edge of the Red Wing Shoe Company parking area is in the foreground.

Seven lights are within the National Register-eligible property boundary. (There are a few similar lights just outside of the boundary.) The lamp standards have a fairly typical, slender, design, with cobra-head fixtures. Two of the seven lights are located directly on the bridge and southern approach; both are integrated into the east railing (see Photo 15 in Appendix D). Five of the seven lights are adjacent to the bridge and approach. (The five are on southbound TH 63 off the north end of the bridge; northbound TH 63 off the southern approach; northbound TH 61 both west and east of the bridge; and southbound TH 61 west of the bridge.) All seven lights are believed to be in their original positions, per historic photos (Appendix L). The two standards on the bridge are original and the other five are replacements that resemble the originals. All seven cobra-head fixtures are replacements that resemble the originals.

The most visually substantive landscaping within the historic property is a group of mature spruce trees on the grassy slope west of the bridge's south abutment (Figure 7). Historic photos suggest they were planted in the 1970s or later. Also within the boundary of the National Register-eligible property is a line of recently-planted deciduous and evergreen shrubs that curves along the southern approach's east retaining wall.

Bridge 9103 and its southern approach retain historic integrity. Changes have been minor and include: replacement of the bridge deck joints, a low-slump concrete overlay on the bridge (the overlay was originally bituminous), replacement of bituminous on the southern approach roadway, replacement of five streetlights close to the bridge, and the addition of a concrete barrier topped by a black railing on the north edge of TH 61 northbound (from the bridge west to Potter Street).

## **4.2 Character-Defining Features**

Character-defining features are prominent or distinctive qualities or elements of a historic property that contribute significantly to its physical character and historic integrity and significance. Bridge 9103's character-defining features include, but are not limited to:

- the 211'-long, 14-degree-curved, continuous concrete slab
- the 220'-long southern approach roadway, comprehensively designed and built with the bridge
- the elements that contribute to the property's Mid-Century Modern design and other aspects of its aesthetics. These elements include:
  - a long, continuous curved form created by the bridge superstructure and southern approach
  - smooth concrete surfaces that emphasize the lean, sculptural design
  - a slim deck slab formed with shallow haunched arches over each bay which maximize vertical clearance while making the slab appear slender and light
  - the approach roadway's smooth vertical retaining walls
  - elegant curved coping along the bridge fascia and approach walls which emphasizes the long horizontal curve and visually slims the deck slab
  - distinctive piers, comprised of five evenly-spaced columns, that resemble flat panels with rectilinear cut-outs; the pier ends are rounded to match the curved coping and to smoothly meet the shallow arches of the haunched slab



- o a continuous ornamental railing on both bridge and southern approach that emphasizes the length and shape of the horizontal curve; the railing's gray unpainted surface and slender members create a light, open, almost translucent effect when viewed from some angles
- the bridge's dramatic setting at the base of Barn Bluff and adjacent to the Eisenhower Bridge and downtown Red Wing



Figure 7. Bridge 9103's west railing, curved coping, and haunched deck slab over rounded piers, facing southeast.

## 5.0 CONDITION ANALYSIS

### 5.1 Overall Condition

The most recent routine NBIS (National Bridge Inspection Standards) inspection of Bridge 9103 was performed by MnDOT on September 15, 2011. The Structure Inventory Report and Bridge Inspection Report from that inspection can be found in Appendix C. HDR engineers performed additional inspection work at the bridge site on April 12<sup>th</sup>, May 16<sup>th</sup>, and June 26<sup>th</sup>, and November 7<sup>th</sup>, 2012. HDR's site visits have been led by Nick Sovell, PE, who has 23 years of bridge design and inspection experience, and is a MnDOT-Certified Bridge Inspection Team Leader. Photographs from HDR's site visits can be found in Appendix E and a map of inspection findings is in Appendix G. In addition, MnDOT took concrete cores at several locations throughout the bridge in 2011 to measure chloride content, performed infrared

thermography on the bridge on July 12, 2012, and performed destructive testing on August 13, 2012 (see the findings in Appendices F, H, and I).

The overall condition of the bridge is fair. The underside of the continuous concrete slab has areas of spalling and exposed reinforcing bars. Several of the exposed bars have section losses between 24% and 44%. One of the longitudinal bars in Span 3 and one of the longitudinal bars in Span 4 have completely corroded through and several feet of the bars are completely gone. Several of the transverse bars have sections from approximately 1' to 3' in length that are completely missing. Chloride testing indicates a high level of chloride content in the slab. Detailed results of the inspection and testing work are discussed in the following sections.

## **5.2 Deck Overlay, Joints, Bearings, Sidewalks, Lights, and Railing**

### **Deck Overlay**

When the bridge was originally constructed, the concrete slab had a 2" bituminous wearing surface on it. The bituminous surface would have done very little to prevent chlorides from salt applications from reaching the top of the concrete deck. The 2½" low-slump concrete overlay currently on the bridge structure was installed in 1978 to replace the 2" bituminous wearing surface. The purpose of the low-slump overlay is to provide a layer of protection over the structural concrete slab to slow the ingress of chlorides. Map cracking of the overlay surface is present throughout the bridge and there are structural cracks with delamination in the northbound lane of Spans 2 and 5. MnDOT records show that approximately 4400 linear feet of cracks were sealed in 2008.

See the condition of the concrete slab under 5.3 Superstructure Condition below.

### **Joints**

The strip seal joints on both ends of the bridge appear to be in satisfactory condition. The seals are full of dirt and debris, but there are no signs of leakage. The paving block at the north abutment has several longitudinal cracks across its length and there is settled and cracked bituminous approach pavement at both ends of the bridge.

### **Bearings**

From the most recent MnDOT inspection report, the fixed bearings at Piers 2 and 3 are in satisfactory condition with little or no deterioration.

All 12 expansion bearings at each abutment have masonry plates with active corrosion and minor section loss. Two of the 12 expansion bearing masonry plates at Pier 1 have active corrosion with minor section loss, while all 12 expansion bearings at Pier 4 are in satisfactory condition.

### **Sidewalks**

There is map cracking and small pop-outs throughout the curbs and sidewalks on both the bridge and the southern approach roadway. There is settlement of the approach curb and sidewalk at the south end of the bridge. With no accessible ramps or tactile paving and a west sidewalk that is only 2'6" wide, the sidewalks along TH 63 do not meet ADA standards (see Section 6.0). There are no sidewalks below the bridge.



### Lights

The bridge and its southern approach each have one light integrated into the east railing. The lamp standards are original and the cobra fixtures closely resemble the original fixtures. The lights are in fair condition.

### Railing

The galvanizing on the ornamental rail on both the bridge and the southern approach is breaking down on all steel surfaces with light areas of corrosion showing. The rails have been struck by vehicles in several locations. Damage to rails or spindles was noted at nearly 20 different locations. One or more spindles have been damaged at least 5 places on the east rail and at least 13 places on the west rail where the adjacent sidewalk is only 2'6" wide. The bridge railing does not meet modern design criteria for crashworthiness and rail height, and does not meet some standards for rail opening size (see Section 6.0).

## 5.3 Superstructure Condition

According to the most recent MnDOT inspection report for Bridge 9103, the deck and superstructure both have NBIS condition ratings of 5, which designate fair condition. The top of the deck contains a 2½" low-slump concrete overlay that was installed in 1978. Map cracking of the overlay surface is present throughout the bridge. Also, there are structural cracks with delamination in the northbound lane of Spans 2, 4 and 5. Based on field observations, these cracks appear to go completely through the depth of the slab.

There are two spalls and a scrape on the western side of the slab over southbound TH 61 that appear to have been caused by impacts from high-load vehicles traveling on southbound TH 61 under the bridge.

On the bottom of the slab there are areas of delaminated and deteriorating concrete at the longitudinal construction joint along the centerline of the bridge. The entire length of longitudinal construction joint on the underside of the slab is leaching. There are numerous spalls in Spans 2, 3, 4, and 5. Areas where the spalls are 2" deep or greater amount to more than 5% of the underside of the deck. None of the exposed reinforcing bars have any corrosion protection. All of the existing reinforcing in the slab is comprised of uncoated steel bars, rather than the epoxy-coated bars that would be used under current construction practices. Exposed rebar on the bottom of the slab has been repaired with epoxy in the past, but this epoxy has worn off and the rebar continues to deteriorate. In addition to the leaching at the centerline joint, the outside edges of the slab also have numerous cracks with leaching and efflorescence.

In some areas, the spalling and delamination of the concrete on the underside of the slab are so deep that the bottom reinforcing steel running parallel to TH 63 (longitudinal) is no longer bonded to the concrete. This is evident at 8 to 10 longitudinal bars in each of Spans 2, 3, 4, and 5 along most of their length. This steel is the main reinforcing steel in the middle of the spans. It is corroded and section loss has occurred all the way around many of the bars (Figure 8). Although 8 to 10 bars comprise only 5% to 6% of the total longitudinal bars, the affected bars are concentrated within a design strip width. Two exposed reinforcing bars that were completely debonded from the concrete were measured and found to have a remaining

diameter of approximately  $\frac{3}{4}$ ". These bars were originally 1" in diameter, which equates to a 44% loss in cross sectional area. (See Section 7.0; see also Page 4 of Appendix G.)

All of the areas of cracks, spalling and delamination have been mapped on a plan view of the bridge on Sheet 1 and 3 in Appendix G. All of the exposed reinforcing steel and the remaining diameter of several exposed bars have been recorded on Sheet 2 in Appendix G. The mapping of the areas of spalling and delamination was accomplished by visual inspection and by sounding the entire underside of the slab with a hammer from a bucket truck. When areas of sound concrete are hit with a hammer they make a solid "ping" sound while delaminated concrete makes a hollow "clunk" sound.



Figure 8. Exposed and debonded reinforcing in Span 3.

In addition to the sounding performed by HDR, MnDOT verified the areas of delamination by performing infrared thermography on the underside of the concrete slab on July 12, 2012. The results from this work can be found in Appendix H. In general, the infrared thermography verified the areas of delamination identified by the sounding and did not find any additional areas of deterioration.

MnDOT also obtained four concrete cores from the slab of Bridge 9103 which were processed at MnDOT's Office of Materials Laboratory. The results of this testing are summarized in the BR #9103 Slab Span Chloride Content Test Results Report, dated November 7, 2011, which is included in Appendix F. The purpose of the cores was to measure the presence of chlorides within the concrete slab as an indicator of possible corrosion of the reinforcing steel and the general condition of the slab. All four cores showed high chloride content throughout the depth of the cores. The chloride content threshold at which corrosion is likely to begin in the reinforcing steel is dependant on several factors including chemical composition of the concrete, the water-to-cement ratio used in the concrete, and the environment to which the concrete has been exposed. Commonly-used values for the threshold chloride content at which corrosion of reinforcement begins are as low as 350 ppmCl and are estimated at 700 ppmCl as the high end. Every chloride content value in the four cores, with the exception of eight values in the middle of Core 1 and one value in Core 2, exceeds 700 ppmCl. The content in the upper two inches of

the bridge deck (the area of the low-slump overlay) ranged from 1500 to 5500 ppm. Readings at depths of 2" to 24" were frequently in the 1500 to 3900 ppm range, far in excess of accepted thresholds for corrosion.

The November 2011 chloride content testing report did not assign a specific value to section loss, which is reasonable given the information available. The amount and rate of corrosion of reinforcing steel is dependent on the ratio of the corroded area to the uncorroded area, which cannot be determined without physically inspecting the steel. However, the report does include a general statement indicating, "it is reasonable to suspect advanced degradation of the reinforcing steel throughout the slab," which is supported by the results of the chloride content test. Once degradation of the reinforcing steel has begun, it cannot be reversed but can only be arrested. While the actual section loss in the reinforcing bars that were not exposed cannot be quantified, the conclusion of the MnDOT chloride content tests are valid regarding possible degradation throughout the slab. In addition, based on measured chloride content, it is reasonable to assume that, in the future, new corrosion will initiate and existing corrosion will propagate.

Lastly, on August 13, 2012, destructive testing was performed by MnDOT at six locations on the underside of the bridge. The six locations for testing were selected because they were near the areas of cracking and spalling but slightly outside of them. These locations represent areas that were suspected as possible areas of corrosion and deterioration initiation. The testing involved chipping out an area of concrete that was approximately 1' x 1', and exposing one or two reinforcing bars. In all six locations the concrete was found to be sound, and little or no corrosion was found on the exposed reinforcing bars. Photographs and field notes from this testing can be found in Appendix I.

In addition to the testing and inspection work that has already been done, several additional testing methods were considered to gain additional information about the condition of the bridge. The use of Ground Penetrating Radar (GPR) was discussed and considered, but based on MnDOT's past experience with the technology and the capability of GPR, the results would be limited to identification of possible voids or delaminations. The chloride testing results, infrared thermography, and reinforcing bar section losses already measured provide quality information for the assessment of this bridge and GPR data would not add to that information.

Drilling concrete cores through reinforcing bars at several locations was considered so that section losses could be measured in additional reinforcing bars that were not exposed due to spalling. Taking further cores would be invasive and it was decided by MnDOT that the limited additional information gained from taking these cores would not justify the damage that would be done.

### **Summary of Superstructure Condition**

While the condition of the concrete superstructure is rated as fair, deterioration of the slab threatens the ability to maintain adequate load capacity. The load capacity of the bridge is discussed in detail in Section 7.0. The underside of the slab has large areas of spalling and exposed reinforcing steel, concentrated near the longitudinal construction joint along the centerline of the bridge. These areas range from less than 2% in Span 1 to about 9% in Span 4. There are structural cracks with delamination in the northbound lane of Spans 2, 4 and 5. Based on field observations, these cracks appear to go completely through the depth of the

slab. Section losses in the main reinforcing steel were measured between 24% and 44% in many locations along the structure. One of the longitudinal bars in Span 3 and one of the longitudinal bars in Span 4 have completely corroded through and several feet of the bars are completely gone. Several of the transverse bars have sections from approximately 1' to 3' in length that are completely missing.

Nearly all of the chloride content measurements taken in the four concrete cores were higher than the anticipated threshold for corrosion initiation. The cores were taken at locations throughout the slab, not just near the centerline joint, so it can be concluded that corrosion of the reinforcing steel may be initiated in areas that have not yet spalled off. In six locations on the underside of the slab, near existing spalled areas, destructive testing found sound concrete and the reinforcing bars that were exposed were found to have little or no corrosion.

## 5.4 Substructure Condition

Based on visual inspections, the substructure of Bridge 9103 has an NBIS condition rating of 5, which designates fair condition. The pier columns generally exhibit superficial to minor map cracking. The pier caps generally have minor random cracks at both ends, with superficial cracking on both sides, and scattered rust on the bottom of the caps due to exposed rebar chairs.

The abutments have vertical cracks with some leaching in the front face. Both abutments also have areas of delaminated concrete on the front face, which measure approximately 8 square feet and 70 square feet for the south and north abutments, respectively. The south abutment has spalled areas that measure approximately 12 square feet, and the north abutment has random and horizontal cracking that measures approximately 35' in length. Typical examples of the deterioration found on both abutments are shown in Figure 9. The slope paving in front of the North Abutment has several areas of severe settlement, up to 12" in depth. According to inspection records, the settlement and erosion at the north abutment began at least five years ago but it is unclear if it has stabilized or getting worse.



Figure 9. Spalled and delaminated concrete on the north abutment.



## 5.5 Southern Approach Roadway

The cast-in-place retaining walls that support the southern approach roadway on retained fill are supported on spread footings. They are in generally good condition with some hairline vertical cracks. The hairline vertical cracks are typically spaced at 10' or more with the exception of the first 40' of the west wall where the crack spacing varies from 2' to 5'. There are minor corner spalls at three of the vertical joints but they are all 3" x 4" or less in size and less than 3' long. See Figure 10 for typical cracks and spalls.

The galvanizing on the ornamental rail is breaking down on all steel surfaces with light areas of corrosion showing. Like the railing on the bridge itself, the current rail does not meet most modern design criteria (see Section 6.0).



Figure 10. Typical spalls and cracks in the approach retaining walls.

The sidewalks along the southern approach roadway are also cast-in-place concrete. Like those on the bridge, they do not meet ADA standards (see Section 6.0). The sidewalks contain map cracking and small pop-outs. There is settlement of the sidewalk and curb where the approach roadway meets the south end of the bridge.

The driving surface of the southern approach is bituminous pavement. The pavement contains map cracking and is settling where it meets the south end of the bridge.

## 6.0 REHABILITATION ALTERNATIVES EVALUATION CRITERIA

Most of the criteria used to compare and evaluate alternatives for the rehabilitation of Bridge 9103 are based on the Red Wing Bridge Project's Purpose and Need statement (see Appendix A). Some are based on design criteria specified by the MnDOT Bridge Preservation, Improvement and Replacement Guidelines (BPIR), the MnDOT Bridge Design Manual, and AASHTO LRFD Bridge Design Specifications. Construction costs and the estimated service life for each alternative are also considered.



The evaluation criteria are listed below. The alternatives' ability to meet the criteria is described in Section 8.0 and summarized in the matrix in Section 9.0.

### Primary Needs

Provide structurally sound crossing of the Mississippi River. The rehabilitation alternatives are judged on their ability to maintain connectivity to Bridge 9040. (Certain changes to Bridge 9103 such as modifying its vertical profile would impact the function of Bridge 9040.)

Provide structurally sound crossing of TH 61. Per guidance from the MnDOT Bridge Office, an inventory rating factor of 0.9, based on LRFR, is the lower limit used to identify "structurally sound" members that do not require any strengthening or replacement. The 0.9 limit is based on the MnDOT BPIR. In Table G-1 of the BPIR under Column 4 (Minimum Criteria for Bridge Improvements), an HS-18 inventory load rating is required. Accepting an HS-18 inventory rating for the standard HS-20 truck represents a 10% reduction from full capacity. This equates to a 0.9 rating factor based on LRFR.

### Secondary Needs

Maintain continuity of TH 63. Ability to maintain the continuity of TH 63, part of the National Highway System and an important regional route serving increasing numbers of heavy commercial haulers and other traffic.

Maintain TH 63's connections to TH 61 and TH 58. Ability to maintain connections with TH 61, also part of the National Highway System, and TH 58.

Provide adequate capacity, acceptable traffic operations, and safe design. Ability to provide adequate capacity for the design year 2042 estimated AADT of 15,600. (The estimated ADT for 2018, the proposed year of construction, is 12,700.) Both TH 63 and TH 61 are principal arterial routes.

**Rail strength.** Safe design includes the crashworthiness of the bridge railing. Bridge 9103's historic rail has a transverse load capacity of 5.4 kip (ASD) or 9.8 kip (LRFD) and meets no modern design standards. For comparison, a Test Level 1 or TL-1 rail has a 13.5 kip transverse load capacity (LRFD) and a TL-2 rail has a 27.0 kip transverse load capacity (LRFD). A TL-2 railing is crash-tested for vehicles traveling 45 mph (formerly expressed as 70 km/h or 43.5 mph), and a TL-1 railing is tested for vehicles traveling 30 mph (formerly expressed as 50 km/h or 31.1 mph).

Bridge 9103's historic railing must contain both vehicles and pedestrians, and is therefore considered a combination rail. According to the MnDOT Bridge Design Manual, for a combination rail mounted on a raised sidewalk where the design speed is 40 mph or less, the railing is required to meet TL-2 standards in accordance with the AASHTO LRFD Bridge Design Specifications (Section 13.7.2) and NCHRP 350. The MnDOT BPIR contain some guidance for rail criteria to be used on rehabilitation projects. The BPIR specifies a 10-kip (ASD) transverse load capacity if the design speed is less than 30 mph. The design speed on TH 63 is 35 mph so the neither the lower capacity referenced in the BPIR or the TL-1

standard could be used without a design exception. (As explained above, the existing historic rail does not meet either of these standards.)

It is likely that Bridge 9103 will carry increasing amounts of heavy commercial truck traffic in the future. Silica (frac) sand mining is increasing in the region, for example, and sand mined in Wisconsin may be hauled to potential processing plants and shipping locations in Red Wing. In addition, rising fuel prices have resulted in more heavy commercial traffic using the Mississippi River crossing at Red Wing, including Bridge 9103, as the trucks travel from the I-94 area in Wisconsin to Rochester, Minnesota, and vicinity.

*Maximum maintenance of traffic.* Each alternative is judged on its ability to maintain traffic during construction. Full closure of TH 63 would require a maximum detour of approximately 65 miles (about 1½ hours). Since traffic using the crossing is generated from various locations around the region, the average detoured trip length is assumed to be approximately 2/3 of that. This is based on data from the 2005 and 2010 Red Wing Bridge Origin-Destination and Traffic Circulation Studies. Both full closure of TH 61 and reduction in vertical clearance due to construction falsework would require a local detour using CSAH 21 (Flower Valley Road) and TH 58. (Trucks unable to meet the vertical clearance height restriction would experience a CSAH 21 detour which, while not lengthy, has serious operational difficulties including additional four-way stops and traffic lights, tight downtown turns which require semi-trucks to encroach into opposing lanes, and heavy traffic on Plum (TH 58) and adjacent streets.)

*Maintain access to Trenton Island.* Maintaining connectivity to Bridge 9040 would maintain access to Trenton Island.

*Maintain or improve pedestrian/bicycle facilities.* **Pedestrian facilities** on public rights-of-way are required to be universally accessible per Section 504 of the Rehabilitation Act of 1973 and Title II of the Americans with Disabilities Act of 1990 (ADA). MnDOT's Strategic Plan and the Statewide Transportation Plan recognize accessibility as an integral part of the State's transportation networks. ADA-compliant sidewalks must be 5' wide, a distance that can be reduced to 3' if 5' x 5' passing areas are provided every 200'. The ADA standard for maximum profile grade is 5% and the maximum allowed cross slope is 2.08%. Under MnDOT guidelines (PROWAG 2005), projects must provide ADA-compliant curb ramps with detectable warnings and proper cross slope, running slope, and landings.

On top of Bridge 9103 and the southern approach there are two raised sidewalks, 2'6" wide on the west and 5' wide on the east. The west sidewalk does not meet ADA width requirements. Neither sidewalk has accessible ramps or tactile paving. The profile grades and cross slopes meet ADA standards.

Bridge 9103's sidewalks are aligned with two 2'6" raised sidewalks on Bridge 9040. If changes to Bridge 9040 include improved pedestrian facilities, which is likely, then Bridge 9103's facilities would need to accommodate more users.

On TH 63 beneath Bridge 9103 there are no pedestrian accommodations.

**Bicycle facilities.** By state law, MnDOT has substantial authority and responsibility for accommodating and encouraging safe bicycling. Minnesota Statute Chapter 174.01, Subd. 2 (14), which creates the Department of Transportation, specifically refers to bicycle transportation as part of the state's transportation system's goals "to promote and increase bicycling as an energy-efficient, nonpolluting, and healthful transportation alternative." MnDOT policies and design guidance for bike facilities are contained in the Minnesota Bikeway Facility Design Manual. In Table 4-1 of the manual for the Bridge 9103's traffic speed and ADT the suggested bikeway design is a 6' bike lane or 8' paved shoulder.

On top of the bridge, bicycles travel on TH 63's outside paved shoulders which are 12' wide. Below the bridge, bicycles use TH 61's outside shoulders which are about 2' wide (basically the gutter pan) on southbound TH 61 and about 4' wide on northbound TH 61. (The northbound outside shoulder varies; it is less than 4' wide south of the bridge and more than 4' wide north of the bridge.)

Bicycle use in the vicinity of Bridge 9103 is expected to increase. Red Wing is a popular bike destination and part of three interconnected trail systems in the region, described below. The three trails are linked to an expanding local trail system within the City of Red Wing.

The Mississippi River Trail (MRT) follows the Mississippi from its source in northern Minnesota to the Gulf of Mexico. It is the only US Bicycle Route in Minnesota. On the Minnesota side of the river, the MRT uses TH 61 except in central Red Wing where local streets are used, thereby avoiding the TH 63/TH 61 junction and Bridge 9103. (The city's long-range plans include a riverfront trail that would eventually carry the MRT under the south end of Bridge 9040 and on the north side of Barn Bluff.) On the Wisconsin side of the river, a unit of the MRT uses Wisconsin Highway 35, which is about 2½ miles north of Bridge 9040. Cyclists on the Wisconsin side often cross Bridges 9040 and 9103 to visit Red Wing, as do participants in the popular Tour de Pepin that circles Lake Pepin on parts of the MRT. While Bridges 9040 and 9103 are not officially part of the MRT, they provide the primary link between the MRT in each state.

The Cannon Valley Regional Trail meets the MRT west of downtown Red Wing near County Road 1 (west of Hay Creek). The popular trail follows the Cannon River for 19 miles between its endpoints: Red Wing on the east and Cannon Falls on the west.

The Goodhue Pioneer State Trail meets the MRT and the Cannon Valley Trail west of downtown Red Wing (near Hay Creek). Still under development, the Goodhue Pioneer Trail will eventually link Red Wing with communities to the southwest such as Zumbrota, as well as connecting with the Douglas State Trail which leads to Rochester.

## Other Considerations

Structural redundancy. Not applicable; Bridge 9103 has no fracture critical members.

Geometrics. The set of rules that governs **vertical clearance** is the MnDOT Bridge Design Manual. In addition, the MnDOT BPIR contains some guidance for vertical clearance criteria in rehabilitation projects. Table G-1 of the BPIR states that if a project is using federal funds then the vertical clearance requirements should meet Column 5 of the table

(see footnote "\*\*"). The required vertical clearance for principal arterials is 16.33' (16'4") for new construction and 16.0' for rehabilitation projects. Specified vertical clearance over local roads in an urban setting is 14.5' (14'6").

Bridge 9103 currently provides 15.5' (15'6") over TH 61 southbound, 16.4' (16'5") over TH 61 northbound, and 14.7' (about 14'8") over the service drive in Span 2 that leads to the Red Wing Shoe Company's parking lot.

According to the MnDOT Freight Office, approximately two to three new oversize load permits per week are denied between mid-May and mid-November. Statistics are not available on the number of oversize haulers who avoid TH 61 through Red Wing because of the restriction and therefore detour to I-90, for example. The denied loads are in the 15'6" range, with 6 additional inches needed for tolerance. There are fewer applicants during the winter months. The loads are primarily construction equipment and large boats. Bridge 9103 is the only bridge on TH 61 between I-90 on the south and I-94 and TH 52 on the north that has these vertical clearance restrictions. All other bridges between these points can accommodate oversize permit loads.

**Horizontal clearance.** The source for design criteria governing horizontal clearance on TH 61 is the MnDOT Bridge Design Manual. The MnDOT BPIR also contains some guidance for horizontal clearance criteria for rehabilitation projects. According to Section 2.1.3 of the MnDOT Bridge Design Manual, the horizontal clearance should be 5'-6" on the left and 10' on the right. Table G-1 of the BPIR states that the horizontal clearance for a one-way principal arterial should be 4' on the left and 10' on the right.

Horizontal clearance on TH 61 below the bridge does not meet the above guidelines. On southbound TH 61, the inside shoulder is 0' wide and the outside shoulder is about 2' wide (basically the gutter pan). On northbound TH 61 the inside shoulder is 0' wide and the outside shoulder is about 4' wide. (The northbound outside shoulder varies; it is less than 4' wide south of the bridge and more than 4' wide north of the bridge.) One result of the existing horizontal clearance is that large vehicles traveling under the bridge tend to shy away from the closest pier and track into the adjacent travel lane.

**Rail height and opening size.** Railing height and the size of railing openings are considered as part of the geometrics criterion. Applicable rules for the height and opening size of pedestrian rails come from the MnDOT Bridge Design Manual (Section 13.2.2) and AASHTO LRFD Bridge Design Specifications (Section 13.8). The specifications make no distinction between new rails and existing rails.

The existing rail is 39" tall. (The height is measured from the top of the walkway to the top of the highest horizontal rail component.) The standard in both the MnDOT Bridge Design Manual and AASHTO LRFD Bridge Design Specifications is 42". The existing railing has openings that are 4½" to 5½" wide. The MnDOT Bridge Design Manual specifies that openings below 27" block a 4" sphere and openings above 27" block a 6" sphere. The AASHTO LRFD Bridge Design Specifications state that openings below 27" should block a 6" sphere and openings above 27" should block an 8" sphere.

If changes to the river crossing (Bridge 9040) include improved pedestrian facilities, which is likely, then Bridge 9103's facilities, if not improved, would be inadequate and need to accommodate more users.

*Economic development.* Each alternative is judged on its ability to maintain or improve economic development – particularly in downtown Red Wing – by maintaining or improving traffic operations (e.g., downtown congestion).

*Parking.* Each alternative is judged on ability to maintain or improve downtown parking.

*Regulatory requirements: Section 106.* Alternatives are evaluated on their ability to avoid an adverse effect to historic properties under Section 106 of the National Historic Preservation Act of 1966. The Act defines historic properties as properties listed on, or eligible for, the National Register of Historic Places.

Under Section 106, a project is deemed to have an adverse effect if it proposes to “alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for inclusion in the National Register, in a manner that would diminish the integrity of the property’s location, design, setting, materials, workmanship, feeling, or association.” The Act also states that, to avoid an adverse effect, the “alteration of a [historic] property, including restoration, rehabilitation, repair, maintenance, stabilization” must be “consistent with the Secretary of the Interior’s Standards for the Treatment of Historic Properties (36 CFR part 68) and applicable guidelines.” In addition, a project must avoid diminishing the integrity of other historic properties (e.g., other historic properties in the vicinity).

*Regulatory requirements: Section 4(f).* Alternatives are judged on their ability to avoid Section 4(f) “use” of certain properties. Under Section 4(f) of the Transportation Act of 1966, a federally-funded project cannot use a park or recreation land, wildlife or waterfowl refuge, or historic site unless there is no prudent and feasible alternative to the use, and the undertaking includes all possible planning to minimize harm to the property resulting from the use. Section 4(f) implementation generally references Section 106 (see above) for identifying historic properties and assessing potential effect.

FHWA’s Section 4(f) policy on historic bridges indicates that a proposed project will use a historic bridge if it impairs the historic integrity of the bridge either through demolition or through rehabilitation that adversely affects the bridge’s historic integrity. Rehabilitation of a historic bridge should preserve its historic integrity “to the greatest extent possible, consistent with unavoidable transportation needs, safety, and load requirements.” To avoid adversely affecting historic integrity, the rehabilitation should be consistent with the Secretary of the Interior’s Standards. Project planning must include identification of feasible and prudent alternatives that meet Purpose and Need, avoid using Section 4(f) properties, and explore all possible ways to minimize harm resulting from use.

*Regulatory requirements: navigational channel.* Certain changes to Bridge 9103 (e.g., alteration of vertical profile) could have implications for Bridge 9040 and its relationship with the Mississippi River navigational channel.



Regulatory requirements: stormwater management. Alternatives are judged on ability to meet stormwater management practices required by Section 404 of the Clean Water Act.

### Social, Economic, and Environmental Issues

Right-of-way impacts. Alternatives are evaluated on right-of-way acquisition (i.e., the number of parcels and structures acquired), on the number of relocations, on temporary easements during construction, and on other potential right-of-way impacts.

Property access. Alternatives are judged on ability to maintain access to nearby properties during construction, and ability to maintain permanent access after the rehabilitation. The service drive in Span 2 provides sole access to the parking area of the Red Wing Shoe Company's Main and Potter Street facility.

Other environmental impacts (contaminated properties, Threatened and Endangered Species, etc.). The potential for additional environmental impacts is considered.

### Cost

Construction cost estimate. Initial construction costs are provided for each rehabilitation alternative in 2018 dollars.

Cost estimates were generated using today's prices and adding 15% for miscellaneous minor items that have not been quantified yet and 33% for inflation. When a range is shown, the lower limit of the range does not contain any contingencies and the upper limit includes a contingency based on the given alternative.

Life cycle costs include the cost of the 2018 rehabilitation project plus anticipated future maintenance and repair costs. They do not contain any increases for contingencies. The costs for future work are discounted back to construction year 2018 by using the MnDOT prescribed Real Discount Rate of 2.5%. Costs for minor maintenance and bi-annual inspections are not included.

Service life. Service life is estimated for each alternative. Service life is defined as the number of years before significant rehabilitation would be required. Significant rehabilitation is defined as work that is more invasive (and usually requires hiring a contractor) such as full-depth repairs and deck replacement; it excludes mill and overlay which is considered expected maintenance within a bridge's service life.

## 7.0 REHABILITATION LOAD RATING ANALYSIS

The inventory load rating factor (RFinv) is the ratio of the structural capacity of a bridge divided by the forces that are applied from traffic loads on a regular basis. Load ratings for the existing bridge were performed using the Virtis Bridge Load Rating software from AASHTOWare. Following MnDOT's current policies, the Load and Resistance Factor Rating (LRFR) methodology was used to compute the inventory rating factors (RFinv). An RFinv of 1.0 or greater is desired. The Load Factor Rating (LFR) methodology was used to check if any postings or permit restrictions were required.

The methodology was applied using three different levels of condition deterioration and section loss to produce a sensitivity analysis of the bridge's load rating based on its existing condition. The three condition level assumptions are described in the following paragraphs and the results from all three of them are summarized in the two tables below. (See details in Appendix J.) One table contains LFR results and the other contains LRFR results. The methodology that Virtis uses to load rate a continuous concrete slab such as this bridge, analyzes a strip width along the length of the bridge. Applying the equations from Section 4.6.2.3 of the AASHTO LRFD Bridge Design Specifications, it was calculated that the design strip width for this bridge is 6.25' wide per wheel load. For each condition level that was analyzed, it was assumed that condition applied uniformly across the width of the design strip.

*Condition Code 5, No Losses.* This condition represents the upper bound of the bridge's load rating and only applies to those areas of the bridge where it is certain no section loss of the reinforcing steel has taken place. In the most recent MnDOT inspection report for this bridge, the deck and superstructure were given NBIS condition ratings of 5 ("Fair" condition). According to Section 6A.4.2.3 of the AASHTO Manual for Bridge Evaluation (MBE), a Fair condition requires that a Condition Factor of 0.95 be used when rating the bridge using LRFR. In a similar manner, Section 15.4 of the MnDOT LRFD Bridge Design Manual states that members that have condition rating of 5 require a capacity reduction factor of 0.95 to be used when rating the bridge using LFR. Because the bridge is a concrete slab, a LRFR System Factor of 1.00 was used for all of the condition levels.

*Loss of 1/8" of Diameter on Longitudinal Reinforcing Bars.* The main reinforcing in the middle of each span of this bridge is made up of #8 (originally 1"-diameter) reinforcing bars that run parallel to the roadway in the bottom of the slab. Based on field inspections performed by HDR, there are at least 12 locations where the existing #8 bars are completely exposed because the existing concrete has spalled off, and the remaining section of the reinforcing bar is 7/8" in diameter or less. This condition level analyzes the load rating based on the remaining reinforcing steel at these locations.

*Loss of 1/4" of Diameter on Longitudinal Reinforcing Bars.* Based on field inspections performed by HDR, there are at least 3 locations where the existing #8 bars are completely exposed because the existing concrete has spalled off, and the remaining section of the reinforcing bar is 3/4" in diameter or less. This condition level analyzes the load rating as the bars continue to deteriorate and the section losses reach a level where the average losses in all of the bars within a 6.25'-wide design strip are equal to 1/4" in diameter.

**Table 1. LFR Load Rating Results**

	LRFR Condition Factor, $\phi_c$	LRFR System Factor, $\phi_s$	Section Losses in Analysis	LRFR RF <sub>inv</sub>	LRFR RF for Legal Loads
NBIS Condition Code = 5 (Fair)	0.95	1.00	None	1.04	1.42
7/8" Dia. remains on #8 bars (24% Section Loss)	0.95	1.00	1/16" all around	0.92	1.36
3/4" Dia. remains on #8 bars (44% Section Loss)	0.95	1.00	1/8" all around	0.59	0.88

**Table 2. LRFR Load Rating Results**

	Section Losses in Analysis	LFR Capacity Reduction	LFR RF <sub>inv</sub>	LFR RF for Legal Loads	LFR Analysis - Posting Req'd.?	LFR Analysis - Permit Restriction?
NBIS Condition Code = 5 (Fair)	None	0.95	1.00	1.49	No	No
7/8" Dia. remains on #8 bars (24% Section Loss)	1/16" all around	0.95	0.88	1.30	No	No
3/4" Dia. remains on #8 bars (44% Section Loss)	1/8" all around	0.95	0.55	0.82	Yes	Yes

From the tables above it can be seen that the RF<sub>inv</sub> is greater than or equal to 1.0 only in the areas of the bridge where no section loss of the reinforcing steel has taken place. Once the main reinforcing bars have deteriorated down to an average of 7/8" diameter remaining in a 6.25'-wide design strip, the RF<sub>inv</sub> is computed to be about 0.9 (0.88 using LFR and 0.92 using LRFR). An RF<sub>inv</sub> of 0.9 is MnDOT's typical threshold for requiring strengthening or repairing members. When the deterioration of the reinforcing bars exceeds 24%, the RF<sub>inv</sub> will fall below 0.9.

The bridge slab area along the centerline of the bridge has delaminated concrete, deep spalls, and exposed and corroded reinforcing bars. Many of bars in this area and some outside of the center section of the bridge have 24% section loss or greater. When load ratings were calculated assuming this amount of section loss in a 6.25' design strip width, the LRFR inventory load rating factor computed was 0.92.

There are also areas along the centerline that have up to 44% section loss in some of the reinforcing bars. When load ratings were calculated assuming this amount of section loss in a 6.25' design strip width, the LRFR inventory load rating factor computed was 0.59.

When the actual section losses measured in June 2012 are used, the remaining reinforcing section area in a 6.25'-wide design strip at the midspan of Span 4 is calculated to be 86.7%, or 13.3% section loss (see Page 4 in Appendix G). This level of section loss equates to an inventory load rating factor (RFinv) for Bridge 9103 of approximately 0.95. As previously noted, it is desirable for the RFinv to be greater than 1.0.

Although the RFinv is less than 1.0, Bridge 9103 does not currently require load posting and is safely carrying normal traffic. However, as the section losses in the bottom reinforcing steel continue to increase, this will need to be re-evaluated annually. If the average section losses in the longitudinal bottom bars exceed 24% (1/8" of deterioration) in a 6.25'-wide design strip, the inventory rating factor would become less than the MnDOT threshold of 0.9 minimum. Repairs such as replacing deteriorated or missing bars would then be required to restore the load rating and avoid posting. (Posting the bridge would interfere with the transport of heavy freight critical to the region's agricultural, industrial, and commercial sectors; see Section 6.0.)

## **8.0 REHABILITATION ALTERNATIVES**

### **Scenarios Not Discussed Herein**

The rehabilitation study team considered several scenarios for Bridge 9103 that are not discussed in this report. They include:

- preserving Bridge 9103 on-site but bypassing it. The option was considered infeasible because there is not sufficient distance to bypass Bridge 9103 and keep the river crossing at the approximately location of Bridge 9040.
- relocating Bridge 9103 and rehabilitating it for less-demanding use on a new site. This was considered infeasible because of the bridge's length and continuous concrete slab construction.
- not rehabilitating Bridge 9103, but simply maintaining it (in its continued role as the approach to the river crossing). Although the bridge is not currently posted, further corrosion of the reinforcing steel will lead to the need for posting in the near future if repairs are not made. (Posting has important implications because the bridge is part of an important regional route serving increasing numbers of heavy commercial haulers.) Rehabilitation Alternative 1, described below, represents the minimal amount of repair needed to address Bridge 9103's deterioration including chloride content, spalling, and section loss in the reinforcing steel.
- rehabilitating Bridge 9103 to serve as the approach for one of a pair of two-lane river crossing bridges. The option was considered infeasible because there is not sufficient room to build a second approach bridge to the other bridge in a potential pair. Bridge 9103 could not be used to carry TH 63's two northbound lanes because there is not adequate distance between the river bridge and the Red Wing Shoe Company building to build a southbound bridge to the west of Bridge 9103 and get the horizontal alignment tied back into Third Street. Bridge 9103 could not be used to carry TH 63's two southbound lanes because



there is not adequate distance between Bridge 9103 and Barn Bluff to build the northbound lanes to the east of Bridge 9103.

### **Scenarios Considered But Not Fully Developed**

As the team developed the details of the four rehabilitation alternatives documented in this report, additional concepts were considered but set aside or not fully developed, usually because they were determined infeasible from an engineering standpoint, or did not meet the Secretary of the Interior's Standards for Rehabilitation, or both. These ideas are briefly described in Section 8.6 below.

### **Four Rehabilitation Alternatives**

Four alternatives for the rehabilitation of Bridge 9103 were developed and are described below. The work tasks associated with each alternative are summarized in Table 3.

**Table 3. Summary of Rehabilitation Alternatives Work Tasks**

COMPONENT	WORK TASKS	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
		Replace Approx. 10'-15' Strip	Replace Approx. 10'-15' Strip and Add Inner Rail	Full Deck Replacement	Widen to Four Lanes
SLAB	Replace approx 10'-15' strip in-kind	X	X		
	Replace slab in-kind			X	
	Replace with wider slab				X
	Patch spalls	X	X		
	Repair cracks	X	X		
	Replace joints	X	X	X	X
	Replace deck overlay	X	X	X	X
RAIL	Restore historic rail	X	X	X	
	Add inner TL-2 rail		X	X	
	Replace historic rail with new TL-2 rail				X
	Install guardrail end terminals	X	X	X	X
LIGHTS	Restore two lights at railing	X	X	X	
	Replace two lights at railing				X
SIDEWALKS	Widen west to 5' (east is already 5')	X			
	Widen both to 6' (5' clear)		X	X	
	Extend west sidewalk to 3rd and Potter	X	X	X	
	Replace sidewalks with one 10' trail (west side only; goes to 3rd and Potter)				X
	Add ADA ramps and tactile paving	X	X	X	X
ABUTMENTS AND PIERS	Patch spalls	X	X	X	X
	Repair slope paving	X	X	X	X
	Widen abutments, piers, slope paving				X
APPROACH ROADWAY	Seal retaining wall cracks	X	X	X	
	Replace approach panel	X	X	X	X
	Widen approach				X
SERVICE DRIVE	Lower elevation				X
CATHODIC PROTECTION		OPTION	OPTION		
LOWER TH 61		OPTION	OPTION	OPTION	X

Where "Cathodic Protection" and "Lower TH 61" are shown as an OPTION on the table, these work tasks could be added to the alternative but would not have to be. In Alternative 4, where "Lower TH 61" is shown with an "X," it is not optional and must be included in the alternative.

## 8.1 Rehabilitation Alternative 1 – Replace Approximately 10' to 15' Strip

### 8.1.1 Description

Alternative 1 involves the least amount of work that can be done to the bridge while addressing the project's primary needs. The alternative would replace in-kind a longitudinal center strip of the concrete slab to mitigate the most serious deterioration and spalling of the deck slab and section loss in the bottom reinforcing. The alternative would restore the historic pedestrian railing, in addition to other repair work. It would maintain the load rating and provide some extension of the service life of the bridge, but would not provide any geometric improvements.

As shown in Table 3, Alternative 1's major work items include replacing an approximately 10'- to 15'-wide strip of the concrete slab and restoring the historic railing and two lights. The alternative also includes minor work items such as patching spalls in the slab, epoxy injecting minor cracks in the slab, replacing deck expansion joints, replacing the concrete deck overlay, patching spalls on the piers and abutments, repairing the slope paving, repairing the approach retaining walls and approach panel, and adding crashworthy end terminals to the guardrail. The west sidewalk would be widened to 5' and a new sidewalk would be built from the southern approach's west sidewalk to the corner of Third and Potter Streets.

There are two optional work items under Alternative 1: passive cathodic protection of the concrete slab and lowering the elevation of TH 61 by about 10" to improve vertical clearance.

#### Deck Slab

For a girder bridge with a reinforced concrete deck (deck and girder bridge), the dead load of the deck and traffic loads are carried by the deck over a span of 4' to 6' to the nearest girder, and the girder system is the primary load-carrying member of the bridge. Unsound or deteriorated sections of the deck of a girder bridge, such as a 4' by 4' section, can be removed and replaced with new concrete and reinforcing. Removal and replacement of the deck can be readily done by supporting forms from the girders. Such a repair generally does not adversely impact the other bridge components such as girders and adjacent sound deck.

A reinforced concrete slab bridge such as Bridge 9103, however, performs quite a bit differently than a deck and girder bridge. The slab itself carries all of the dead load plus traffic loads longitudinally along the bridge to the supports (piers and abutments), making the slab the primary structural member. When Bridge 9103 was originally constructed, falsework was built across TH 61 to support the forms, reinforcing steel, and concrete slab pour while the concrete hardened. The falsework was then released and pulled down from the underside of the slab and the slab supported itself. The reinforcing steel and concrete were placed under stress as they began holding up the self-weight of the bridge without the aid of the shoring. While the slab spans from pier to pier, any narrow section of the slab that is loaded by a truck tire is aided by the adjacent sections of the slab in carrying load. The slab acts as a monolithic member.

In contrast to the deck on a deck and girder bridge, a 4' by 4' deteriorated portion of a concrete slab span bridge cannot simply be cut out and replaced. Such an action would adversely impact the adjacent sections of slab. The continuity of the slab span from pier to pier would be broken, forcing the adjacent spans to pick up load as it is redistributed. This would cause the positive moments in the midspans of the spans adjacent to the removal to increase because the

dead load from the span that was removed would no longer be counteracting their dead load. The adjacent remaining sections of the slab on either side of the removal would also pick up additional load. This additional dead load would reduce the reserve capacity of those sections to carry live loads, resulting in a diminished live load rating capacity for the bridge.

To properly replace a deteriorated section of a reinforced concrete slab bridge, the span and adjacent spans must once again have falsework shoring installed below the slab. The slab would then need to be jacked up to transfer the dead weight of the slab to the falsework. Once the slab is unloaded, the deteriorated section could be removed and recast. When the falsework is lowered, this new section of the slab would then share the load of the bridge as intended in the original design. During construction operations, the falsework would reduce the bridge's existing vertical clearance by 1' to 2' while the new section of slab is being constructed.

Alternative 1 would replace in-kind the portion of the concrete slab that is most deteriorated, an approximately 10'-15' constant-width strip along the entire length of the bridge (Figures 11 and 12). The final required width would be determined in Final Design. (Final Design could include more nondestructive testing to refine the strip dimensions.) The strip to be replaced would be located along the existing longitudinal construction joint. The upper bound width of approximately 15' was determined by using the maximum distance that the spall along the centerline joint extends away from the joint based on the field inspections, which is approximately 5'. The lap length of a #5 reinforcing bar (the size of the transverse bars) was then added to the 5' to allow for the new transverse bars to be lapped onto sound existing reinforcement that would be cleaned, straightened, and left in place to extend from the existing concrete into the new concrete, and then the distance was rounded up to the nearest 6". The lap length of the transverse reinforcing was calculated using AASHTO equations and found to be approximately 25". The transverse reinforcing also needs to be lapped in accordance with AASHTO to distribute load between the existing and new concrete slab as the design strip width methodology assumes. This resulted in removal limits that extend 7'6" on each side of the joint, or about 15' total. It has been determined that two-way traffic can be maintained on TH 63 if the width of removal is limited to about 15' (Figure 12). However, lanes would be reduced to 11' and the shoulders to 2', which is less than typical standards, and the contractor's workers would be required to operate in a narrow work zone that has live traffic on both sides. The lower bound width of approximately 10' was determined by assuming that the widest area of deterioration in Span 3 is small enough that it could be repaired outside of the constant width strip and that the repair would not be symmetrical about the centerline joint (Figure 11).

As part of this study, several possible strip widths were considered. The recommendation of approximately 10' to 15' was based on the desire to minimize the loss of historic fabric, as well as factors such as those described above. Various strip widths were evaluated for consistency with the Secretary of the Interior's Standards, and it was determined that removal and replacement in-kind of slightly more or less than a strip 10' to 15' wide would not significantly affect the property's historic integrity. Removing a strip wider than 15' would not be well-supported by engineering evidence because the current limits of observed deterioration do not extend outside of this limit. Because of the structural behavior of continuous concrete slabs, it was determined that the use of falsework, which would reduce the vertical clearance on TH 61 during construction, would be required even for a replacement strip narrower than the recommended 10' to 15'.

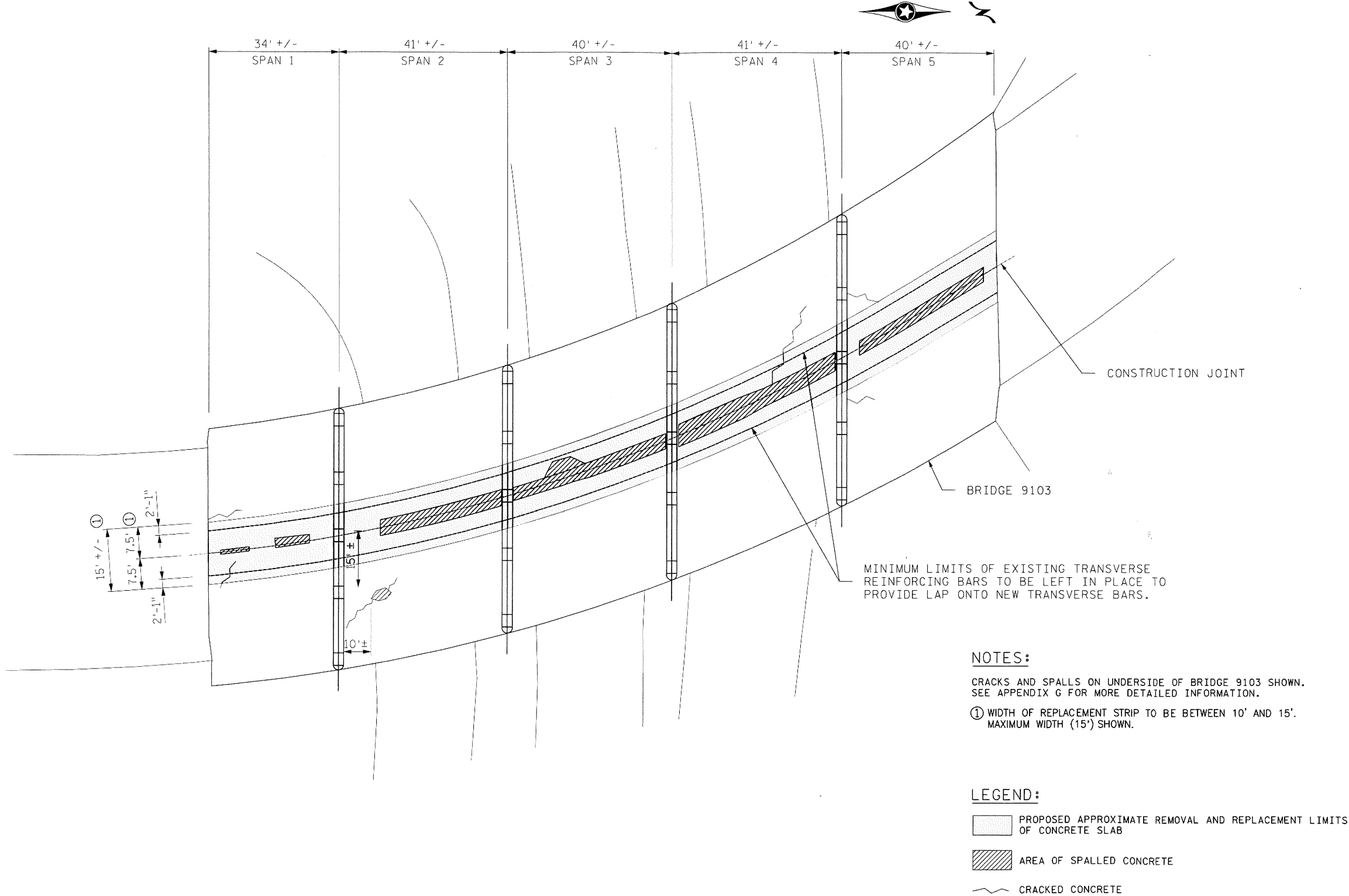


Figure 11. Plan view showing existing cracking and spalling of concrete slab on underside of Bridge 9103 and the approximate limits of removal and replacement for Alternatives 1 and 2 (HDR drawing).



It is recommended that the replaced strip be a constant width for several reasons. The first is based on how the continuous concrete slab functions, as described above. If the removed strip is wider in one span than in an adjacent span, the redistribution of loads would cause the dead load being carried by the adjacent span to be greater than was originally intended. Secondly, a constant-width strip helps maintain the continuity of the reinforcing bars. Varying the width would cause the cut line for the removal to cross the longitudinal reinforcing steel, potentially at sharp angles. This would make it very difficult or not possible to lap onto existing longitudinal bars. Construction would be complicated and time consuming for the contractor, requiring field-cutting of numerous reinforcement bars to fit varying widths and lengths of deck replacement. Although using a variable-width strip would remove slightly less material, all of the construction operations (i.e., concrete removals, erecting falsework, forming, reinforcement placement, and finishing the concrete) would still be required regardless of the removal width at any particular location. There would not be any time savings, and, in fact, constantly varying the width would delay the construction crew as they would have to continually stop and assess the limits of removal. The inefficiencies would offset any savings from decreased quantities of concrete and reinforcing.

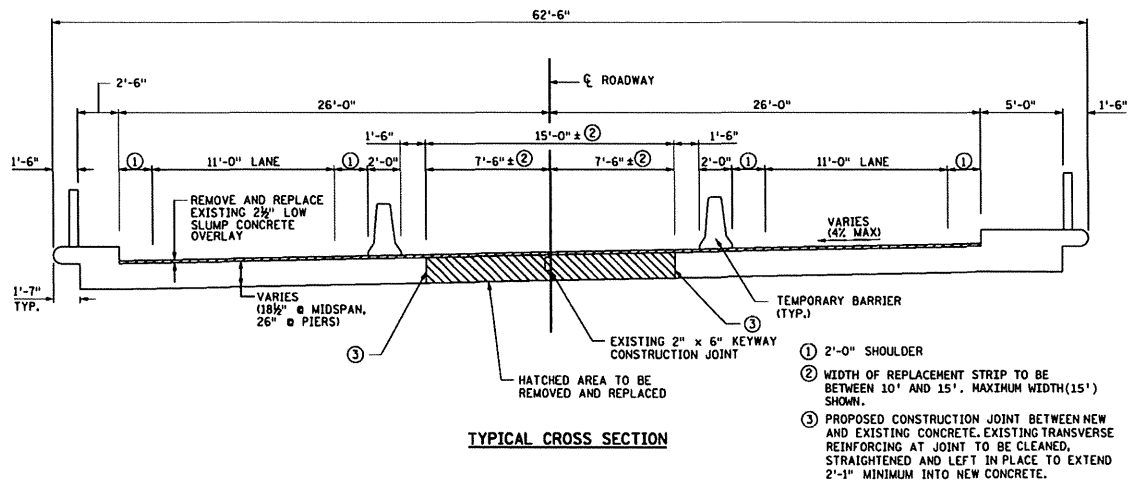


Figure 12. Approximate concrete slab removal and replacement limits for Alternatives 1 and 2 with possible lane configuration for maintaining traffic (HDR drawing).

In addition to replacement of the center 10'- to 15'-wide strip, Alternative 1 would patch spalled areas of the slab outside of the removal limits and epoxy inject all cracks. Expansion joints at the ends of the deck would be replaced with new strip seal joints. The map cracking and chloride content in the slab's overlay (noted in Sections 5.2 and 5.3) has reduced the overlay's effectiveness in protecting the structural concrete slab from the ingress of chlorides, therefore the deck's 2½" low-slump concrete overlay would be replaced on the entire width of the bridge. A MnDOT-approved crashworthy end terminal would be added to the bridge approach guardrail.

#### Adding Cathodic Protection (Optional)

Adding passive Cathodic Protection (CP) to the concrete slab is an option under Alternative 1. As noted above, a new overlay will improve the protection of the structural slab from the ingress of additional chlorides. A CP system will

electrochemically protect the reinforcing steel from the chlorides that already exist in the structural slab. CP would be installed after the low-slump concrete overlay has been removed and after the central 10'- to 15'-wide strip of the slab has been replaced and additional areas of deteriorated concrete have been patched and sealed. The recommended type of CP is a galvanic system, a type that does not require an external power source to provide an impressed current. On the bottom of the slab, threaded rods would be embedded into the slab where they would connect with the bottom reinforcing bars. The rods would be spaced about 15' apart in a grid pattern and their ends would project slightly. The bottom surface of the slab would be lightly sandblasted and cleaned of sand and dust with pressurized air. A zinc mesh plate, about 4" x 4" square, would be bolted to the end of each threaded rod. The lower slab surface would then be arc-sprayed with an activated zinc coating (Figure 13). The coating would be between 0.01" and 0.02" thick and grayish-white in color. It would have a glint or metallic sheen from the zinc. The coating and mesh plates would be visible on the lower surface of the slab.

On the top of the slab, the process to mill away the overlay would also remove an approximately 1"-thick layer of the existing concrete slab to expose the reinforcing steel. Sacrificial zinc anodes up to 7.5' long would be embedded longitudinally about 1' to 2' apart where they would make contact with the reinforcing steel (Figure 13). The final required spacing would be determined in detailed design. A new concrete overlay would then be placed over the anodes.



Figure 13. Cathodic protection: arc-spraying a zinc coating (left) and embedding sacrificial anodes in the top of a slab (right).

It is important to note that CP would not reduce the chloride content in the concrete slab or reverse corrosion or section loss, but would instead create a measure of electro-chemical protection for the reinforcing steel because the sacrificial zinc anodes would corrode instead. The sacrificial zinc anodes will need to be replaced in the future as their effectiveness is reduced. Thermally sprayed on zinc anodes have been used to effectively mitigate chloride-induced corrosion of reinforcing steel by the Oregon Department of

Transportation since 1992 for several historic reinforced concrete bridges in marine coastal areas. Based on Oregon's experience and manufacturer's recommendations, it would be necessary to renew the sprayed-on cathodic protection at about 15- to 20-year intervals by lightly sandblasting to remove the zinc coating and arc-spraying to apply a new coat. Likewise, the zinc anodes embedded in the top of the slab below the low-slump concrete overlay will need to be replaced every 30 years when the overlay is replaced. (For more information about Cathodic Protection see Appendix K.)

### **Railing and Sidewalks**

Alternative 1 would restore the historic pedestrian railing on both the bridge and the southern approach. Vehicle damage to the railing would be repaired, requiring that some of the railing's bent elements be replaced in-kind. After repairs have been made, the railing would be sandblasted and re-galvanized before being reinstalled in its original position.

This alternative would require obtaining a design exception for railing strength or crashworthiness (see Table 4). The historic rail has a transverse load capacity of 5.4 kip (ASD) or 9.8 kip (LRFD) and meets no design standard including TL-1, which must have a minimum transverse load capacity of 13.5 kip (LRFD). According to the AASHTO LRFD Bridge Design Specifications (Section 13.7.2), TL-1 railings are acceptable for "very low volume, low speed local streets" and have a test speed of 30 mph. TL-1 would not be appropriate for a trunk highway with 12,000 AADT and a design speed of 35 mph. According to the MnDOT Bridge Design Manual, for a combination rail mounted on a raised sidewalk where the design speed is 40 mph or less, the railing is required to meet TL-2 crash test standards in accordance with the AASHTO Specifications and NCHRP Report 350. A railing meeting TL-2 is crash-tested for vehicles traveling 45 mph (formerly expressed as 70 km/h or 43.5 mph), and has a transverse load capacity of 27.0 kip (LRFD). Despite a low accident history, the MnDOT Bridge Office does not consider a design exception to be an acceptable remedy to the historic railing's insufficient crash load capacity because the potential would remain for a vehicle to crash through the railing and fall to the roadway below.

Alternative 1 would require obtaining a design exception for railing height and opening size (see Table 4). The existing rail is 39" tall, whereas the standard in both the MnDOT Bridge Design Manual and AASHTO LRFD Bridge Design Specifications is 42". While there is a potential safety concern for pedestrians walking adjacent to a railing that doesn't meet MnDOT specifications for height, given the National Register eligibility of the bridge, the fact that the sidewalks are not heavily traveled, and the fact that the historic rail is only slightly below the criteria, a design exception may be appropriate.

The existing railing has openings that are 4½" to 5½" wide, which do not meet MnDOT standards but do meet AASHTO standards (see Section 6.0). Given the National Register eligibility of the bridge, the fact that the sidewalks are not heavily traveled, and the fact that the openings meet AASHTO standards, a design exception may be appropriate.

See Sections 8.6.4 through 8.6.7 for the unsuccessful exploration of concepts to improve the historic rail's strength, height, and opening size in ways that would meet the Secretary of the Interior's Rehabilitation Standards.

Alternative 1 would widen the west sidewalk on both the bridge and southern approach from 2'6" to 5' wide to better accommodate pedestrians and meet ADA requirements. The east sidewalk is already 5' wide. The west sidewalk currently ends at the south end of the southern approach. An ADA-compliant ramp would likely be built to tie this sidewalk to the Red Wing Shoe Company parking area. (The grass in Photo 13 in Appendix D marks the approximate location of the ramp; the parking area is in the left half of the photo.) In addition, a new 5' sidewalk would be built from the south end of the southern approach on the west side of TH 63 down to the corner of Third and Potter Streets (Figure 3). The new sidewalk would curve around the east corner of the Red Wing Shoe Company building and continue inside (immediately west of) the street trees near the building (Photo 18 in Appendix D). The curb ramp at Third and Potter Streets (near the woman in Photo 18) would be replaced with a ramp that meets current ADA standards. The east sidewalk on the bridge and southern approach (Figure 4) already extends southward to the corner of Third and Potter Streets (Photo 17 in Appendix D). Tactile paving would be added where needed.

### **Abutments, Piers, and Horizontal Clearance**

Alternative 1 would patch areas of spalled concrete on the abutments and piers. The slope paving would be repaired by removing broken or settled concrete blocks, filling in eroded areas under the slope paving, and replacing the concrete blocks. Paving blocks that are broken or missing would be replaced in-kind. Horizontal clearance on TH 61 could not be improved without moving the bridge piers, which would threaten the bridge's historic integrity and result in significant cost; a design exception would be required (see Table 4).

### **Vertical Clearance**

Alternative 1 would not change existing vertical clearance over TH 61 and would require a design exception (see Table 4) unless the option of lowering TH 61 were included. (See Lowering TH 61 (Optional) below.) Clearance is currently 15.5' (15'6") over TH 61 southbound and 16.4' (16'5") over TH 61 northbound. The applicable MnDOT BPIR standard is 16.0' for rehabilitation and 16.33' (16'4") for new construction. See Section 6.0 for the standards and implications of the existing condition.

#### Lowering TH 61 (Optional)

Lowering the elevation of TH 61 about 10" to improve vertical clearance is an option under Alternative 1. Although TH 61 would only need to be lowered by 4" to meet the 16.0' clearance standard in the MnDOT BPIR that is applicable to Alternatives 1 and 2, it is recommended that TH 61 be lowered to obtain 16.33' (16'4") clearance, which is the MnDOT BPIR standard for new construction, so Bridge 9103 is no longer a choke point along the TH 61 corridor (see Section 6.0).

When lowering the TH 61 roadway, care will be required so the bridge footings are not damaged. The elevations of the existing pier footings have been reviewed and they currently have enough cover to maintain a minimum of 4'6" above the bottom of footing even after TH 61 is lowered 10". Lowering the roadway would have to be accomplished one lane at a time to maintain traffic on TH 61. The required change in grade is less than 1' so it is not anticipated that any shoring would be required. However, the contractor's workers would have to operate in a narrow work zone next to live traffic.

### **Southern Approach Roadway**

On the southern approach roadway, Alternative 1 would restore the pedestrian railing. Minor repairs to the southern approach would include sealing vertical cracks in the concrete retaining walls. To correct roadway settlement at the end of the bridge, the roadway approach panel would be reconstructed and the pavement replaced. For sidewalks, see Railings and Sidewalks above.

### **Lights**

There are two lights on the bridge and southern approach, both integrated into the east railing. These lights would be removed, restored, and reinstalled in their original positions.

Preliminary planning for the Red Wing Bridge Project has not yet identified lighting needs. It is likely that a bridge rehabilitation project could alter the existing lighting scheme without compromising the property's historic integrity if the proposed lighting is simple and unobtrusive in design and the MnDOT Cultural Resources Unit is consulted during planning.

### **8.1.2 Risks**

The condition of the concrete and reinforcing steel at the removal limits of the approximately 10'- to 15'-wide strip cannot be fully known until the removal has taken place. Additional nondestructive testing could be undertaken during Final Design, especially if testing technology continues to advance and become more accurate. (A regular inspection schedule will also be maintained by MnDOT in the interim.) Given the high chloride content found throughout the depth of four different cores taken from the concrete slab and the use of uncoated reinforcing bars in the original construction, it can be expected that additional corrosion initiation and propagation will continue between the time of the 2012 inspections and a proposed 2018 construction date. If consistently good concrete and reinforcing are not found along the removal limits, it may be necessary to remove material in an area wider than the center 10' to 15' strip. Additional removals could eliminate the ability to maintain TH 63 traffic in both directions as well as increase the duration of construction.

While the approximately 10'- to 15'-wide strip is being removed and replaced, the contractor would be working with live traffic on both sides of the work zone, which would make the construction more hazardous than typical construction operations. If unanticipated additional removals are required, the already-minimal work area for construction would be reduced and the duration of construction would likely be increased.

There is also the likelihood that new, additional spalling will take place outside of the central strip replaced under Alternative 1. As stated, it is likely that the reinforcing steel in areas outside of the 10' to 15' removal limits has begun or will begin to corrode, which may lead to additional spalling. If the cathodic protection option is included with this alternate, corrosion of the steel could be delayed. While the CP system would inhibit the corrosion process, its effectiveness will vary dependent on the ability to establish and maintain electrical connectivity between the reinforcement and anode, and moisture and chloride content at the rebar location. Additional spalling would be a maintenance and safety concern and would require additional repairs to the



slab. Spalling of concrete from the bottom of bridge decks can be a problem; there have been several documented cases of concrete falling on vehicles and causing damage and injury.

Finally, it is likely that full-depth repairs to additional portions of the slab will be required within 10 to 15 years of this rehabilitation project (see Service Life below). As described above, it is anticipated that corrosion of the reinforcing steel will begin or is taking place outside of the approximately 10' to 15' center strip, given the uncoated rebar and the slab's high chloride content (measured throughout the depth of cores from four locations). While the cathodic protection option would slow the process, there are limits to the method as described above. It is possible that further full-depth strip removals such as the 10' to 15' strip proposed under Alternative 1 will be needed in 10 to 15 years. There is a risk that replacement of additional portions of the slab may not meet the Secretary of the Interior's Rehabilitation Standards due to the cumulative effect of changes to the property and loss of an unacceptable amount of historic fabric.

### **8.1.3 Service Life**

Alternative 1 would replace the area of the concrete slab that appears to be in the worst condition and raise the load rating of the bridge. However, given high chloride content in the slab and the use of uncoated reinforcing bars in the original construction, it is likely that additional corrosion of the reinforcing steel in the slab outside of the 10' to 15' center strip has begun or will begin in the foreseeable future. As described in Section 8.1.2, it is anticipated that additional full-depth patching and repairs to the slab will be required within 10 to 15 years of this rehabilitation project, based on MnDOT's previous experience with bridges built in this era. For example, the TH 52 Lafayette Bridge and the TH 61 Hastings Bridge are both undergoing replacement, but the decks on these bridges have had measured delamination over time even though they have undergone deck repairs in their history. The I-694 bridges in Oakdale were in need of and underwent deck replacement in 2010, even though deck repairs were made in the early 1990s. The I-394 Bridge in Minneapolis (Bridge 27831) near Dunwoody Institute was in need of and underwent deck replacement in 2007, even though deck repairs were made in the late 1980s. The Wisconsin Department of Transportation (WisDOT) has indicated that they have had similar experience with several repair projects on concrete slab span bridges. Three examples are discussed in detail in an email from WisDOT that appears in Appendix P.

Although rehabilitation projects such as the work that comprises Alternative 1 can gain additional bridge life and assist in keeping historic bridges in service, service life as defined in the rehabilitation alternatives evaluation criteria (see Section 6.0) refers to the number of years before significant rehabilitation would be required. Important in estimating service life for this alternative is the fact that Bridge 9103 has historically been heavily salted during bad weather. The practice will likely continue because of the bridge's curved, downhill geometry as TH 63 comes into the city of Red Wing. Although Alternative 1 will include a new overlay, years of heavy salting will continue to increase the chloride content in the concrete slab which will lead to additional deterioration.

An additional factor that was considered when estimating the service life of 10 to 15 years for Alternative 1 was the potential for the "halo effect" or "ring corrosion" after recommended repairs are constructed. Deterioration typically occurs because of chlorides present in a concrete slab. The casting of new concrete against existing concrete that contains chlorides can trigger a "halo

effect” whereby the old concrete and steel reinforcement on the periphery of the repaired area experience accelerated corrosion and damage due to the abrupt difference in corrosion potential between the new and existing concrete. This often occurs within a few years of the repair (Clemena and Jackson 2000). In discussions with MnDOT bridge inspection and construction staff, it was noted that they have seen this occur on Minnesota bridges after repairs have been completed. (MnDOT bridge staff also noted that, for a nonhistoric slab bridge in Bridge 9103’s condition, MnDOT would typically replace the entire slab because substantial additional repairs would continue to be needed.)

If the option of using cathodic protection is included with this alternate, the time until additional full-depth repairs are required could be increased and the extent of the repairs reduced. However, the zinc coating on the bottom of slab would require replacement in about 20 years, and the concrete overlay on top of the slab and the anodes beneath the overlay would require replacement in about 30 years.

#### 8.1.4 Cost Estimates

The estimated initial construction costs for Alternative 1 and its options are as follows:

Alternative 1	\$ 935,000 - \$ 1,170,000
Cathodic Protection (CP) Option	\$ 1,090,000 - \$ 1,360,000
Alternative 1 with CP Option	\$ 2,025,000 - \$ 2,530,000
Lowering TH 61 Option	\$ 665,000
Alternative 1 with Lowering TH 61 Option	\$ 1,600,000 - \$ 1,835,000
Alternative 1 with both options	\$ 2,690,000 - \$ 3,195,000

The lower limit of the range shown does not include any contingencies. The upper limit includes 25% for contingencies. This percentage was estimated assuming 15% for material cost volatility and the possibility of increased deterioration between now and construction in 2018, and is based on the level of detailed design completed to date. The additional 10% was added to account for the risk associated with the unknowns that may be uncovered during the partial removal of the slab.

Costs are in construction year 2018 dollars and do not include engineering or construction administration. Costs for new bridge approach panels, retaining wall repairs, and sidewalk improvements off the bridge are included, but costs for any other approach roadway work are not. See Appendix O for cost estimate details.

Life cycle costs for keeping the bridge structurally sound for the next 100 years were also estimated. The following assumptions about required future major maintenance activities were used:

Alternative 1	Slab patching and repairs every 10 years
	Deck mill and overlay every 30 years
Alternative 1 with CP	Reapply zinc coating to slab bottom every 20 years
	Replace zinc anodes in top of slab every 30 years
	Deck mill and overlay every 30 years

Estimated life cycle costs for Alternative 1 and its options are as follows:

Alternative 1	\$ 1,145,000
Alternative 1 with Cathodic Protection Option	\$ 2,785,000
Alternative 1 with Lowering TH 61 Option	\$ 1,810,000
Alternative 1 with both options	\$ 3,450,000

Life cycle costs include the cost of the 2018 rehabilitation project plus anticipated future maintenance and repair costs. Life cycle costs do not include any contingencies. The costs for future work are discounted back to construction year 2018 by using the MnDOT prescribed Real Discount Rate of 2.5%. Costs for minor maintenance and bi-annual inspections are not included. See Appendix O for cost estimate details.

### **8.1.5 Compatibility With the Secretary of the Interior's Standards for Rehabilitation**

See Appendix M for the Secretary of the Interior's (SOI) Standards for Rehabilitation.

The in-kind replacement of an approximately 10'- to 15'-wide section of the bridge slab (the final width to be determined in Final Design) would alter one of the bridge's most important character-defining features, but it is anticipated that the change would meet the Rehabilitation Standards. While Standard 6 directs that historic elements be repaired rather than replaced, the SOI Rehabilitation Guidelines allow "limited replacement in-kind" of "extensively deteriorated or missing parts of features" in some circumstances. Although Alternative 1 would replace up to about 24% of the slab width (approximately 15' of a 62.5'-wide slab), the width of the 10' to 15' strip is as conservative as possible per SOI Rehabilitation Guidelines. The replacement concrete would not be visible on top of the bridge where the driving surface would be covered by a concrete overlay. It would be visible on the bottom of the superelevated slab (Figure 5), although portions of the bottom of the slab are somewhat shadowed, reducing the visual impact. The replacement material would closely resemble the original construction material. (The principal differences are that modern steel rebar is epoxy-coated against corrosion, and modern concrete is less permeable than the concrete used in 1960.) The surface of the new concrete would be textured and colored to match the original as closely as possible. Replacement of a central strip would mean a change from the slab's original, single, centerline construction joint to a pair of construction joints symmetrically placed 7.5' out from the centerline. While this would constitute an alteration, the change would be primarily visual. The original joint is not a particularly significant component of the slab (e.g., not distinctive or innovative from an engineering or design standpoint), but instead is the result of standard construction practice and is typical for bridges of this type.

The use of low-slump concrete for the deck overlay, rather than the original bituminous, is a fairly minor change that would meet the Standards. Similarly, the sidewalk and guardrail changes proposed under Alternative 1 would increase safety and accessibility while being visually unobtrusive.

The rest of Alternative 1's work items would repair or restore deteriorated historic elements and extend the life of the historic property. They would preserve historic character and distinctive features (Standards 2 and 5) and would generally repair, rather than replace, deteriorated

elements (Standard 6). The proposed methods would not damage historic materials in accordance with Standard 7, which states that repair methods “will be undertaken using the gentlest means possible” and that “treatments that cause damage to historic materials will not be used.”

Cathodic protection of the slab is an option under Alternative 1. On the upper slab surface beneath the overlay, an approximately 1"-thick layer of the concrete slab would be milled off so anodes could be embedded to make contact with the rebar (Figure 13). The surface would then be covered with a new concrete overlay. A different style of anode – short threaded rods – would be embedded perpendicularly into the bottom surface of the slab in a 15' grid and 4"-square zinc mesh plates would be attached to the ends of the rods. The bottom surface of the slab would then be lightly sandblasted. The entire bottom surface would next be covered with a gray-white, paintlike coating that has a metallic glint.

Bridge 9103's lower surface is visually prominent from some angles because of the structure's superelevation (Figure 5). Views of the surface are somewhat obscured, however, by shadows and by the structure's tilt. Adding zinc plates and short rods to the bottom of the slab would introduce a gridwork of studs to the relatively smooth surface. Sandblasting the surface would change the texture of the raw concrete, which was meant to be exposed and has characteristic patterns left by the original formwork. Sandblasting would also remove the patina of aging including surface irregularities and discoloration. The arch-sprayed zinc would give the surface a smooth, uniform, paintlike coating that is several shades lighter than the existing concrete and has a metallic glint. While the glint would fade with time and the surface would get grayer and dirtier, the cathodic protection would need to be renewed every 15 to 20 years with additional sandblasting and recoating, just as the treatment was getting less obvious. While some sources suggest that cathodic protection is “reversible,” in reality the original texture and patina of the bridge's historic concrete could not be recovered. It is recommended that the cathodic protection proposed under Alternative 1 would diminish the historic integrity of the property but stop short of an adverse effect. If applied to more parts of Bridge 9103 than the bottom of the slab, the change would likely not meet the Standards.

Lowering TH 61 beneath the bridge is also an option under Alternative 1. The roadway would be lowered about 10". It is anticipated that the change would not cause a substantial visual effect given the large scale of the bridge, southern approach, and associated highways. The alteration would not diminish the property's historic integrity in any other significant way, and would meet the Rehabilitation Standards.

### **Other Historic Properties**

Bridge 9103 is a Contributing element within the Red Wing Segment of a linear historic district – the Highway 61 (Great River Road) Historic District – which is eligible for the National Register. Alternative 1 would not adversely affect the historic integrity of the district because the proposed changes to the bridge would meet the Secretary the Interior's Standards. Further, Bridge 9103 represents a small component of the district, which is many miles long.

Alternative 1 would have no adverse effect on the historic integrity of Barn Bluff, which is listed on the National Register.

Alternative 1 would have no adverse effect on the historic integrity of the Red Wing Shoe Company, which is eligible for the National Register. The recommended boundary of the National Register-eligible property extends to the existing Third Street curblin (Figure 3). Within this boundary, a new sidewalk would be built around the eastern corner of the building and inside the street trees against the eastern facade. Historically (i.e., within the Shoe Company's period of significance), there was a sidewalk in the same location that was evidently removed circa 1960. The sidewalk change would be fairly minor and visually unobtrusive. The street trees would remain in place.

Alternative 1's proposed changes to Bridge 9103 would not affect the setting or viewshed of any other historic properties in Red Wing.

### **Summary**

In summary, it is anticipated that Alternative 1, with its options, would meet the Secretary of the Interior's Standards for Rehabilitation. The proposed work would result in some change to Bridge 9103's integrity of design, materials, workmanship, feeling, and association, and no change to its integrity of location and setting. The property's historic character would generally be preserved per Section 106. No other historic properties would be adversely affected. It is anticipated that Alternative 1 is not likely to constitute "use" of historic properties under Section 4(f).

### **8.1.6 Alternative 1's Ability to Meet Purpose and Need**

Alternative 1's ability to meet the project Purpose and Need is summarized below. See also the Evaluation Matrix in Section 9.0.

#### **Primary Needs**

Alternative 1 would meet the primary needs of maintaining connectivity to the Mississippi River crossing and providing a structurally sound crossing of TH 61. The inventory load rating factor of the bridge would be improved to 1.04 which is greater than the minimum desired rating factor of 1.00 (see details in Appendix J). The alternative would improve the service life of the bridge by replacing the most deteriorated portions of the concrete slab and replacing the concrete overlay to improve protection against future chloride intrusion. In 10 to 15 years the bridge would require additional rehabilitation, which would include more full-depth repairs of the slab. If cathodic protection is added, the service life would be improved but the zinc coating would need replacement in 15 to 20 years and the anodes in the top of the slab would need replacement in 30 years. As noted in Section 8.1.3 above, the extent of these rehabilitations on a cycle of 10 to 15 years can be expected to be significant as reinforcement deterioration continues.

#### **Secondary Needs**

Alternative 1 would meet the secondary needs of maintaining the continuity of TH 63, maintaining TH 63's connections with TH 61 and TH 58, and maintaining access to Trenton Island.

The alternative would not improve the bridge's capacity in terms of traffic volume, or its role in traffic operations, but would maintain the status quo. Traffic safety would be maintained but not improved, although crashworthy end terminals would be added to the guardrail. The bridge



railing would not meet strength standards (including the lowest level of crashworthiness, TL-1). Despite a low accident history, the MnDOT Bridge Office does not consider a design exception to be an acceptable remedy to the railing's insufficient crash load capacity because the potential would remain for a vehicle to crash through the railing and fall to the roadway below.

The alternative maintains traffic to the maximum extent possible. By limiting deck slab replacement to an approximately 10'- to 15'-wide strip (the final width to be determined in Final Design), the alternative allows two-way traffic on TH 63 to remain open during construction. The work could be accomplished in one construction stage and is expected to last about 8 to 10 weeks. However, as noted in Section 8.1.2 above, there is a risk that additional removal beyond the 10' to 15' strip may be needed, thereby disrupting the ability to maintain TH 63 traffic in both directions, reducing the already-minimal construction work area, and increasing the duration of construction.

On TH 61, occasional short-term closures may be required for falsework construction but they would not be expected to last long. Vertical clearance on TH 61, however, would be reduced by 1' to 2' for approximately 4 to 6 weeks while falsework was in place. Trucks unable to meet the height restriction would be required to detour on TH 58 and CSAH 21 (Flower Valley Road). While the detour would only add about three miles to the trip, it is expected that detouring trucks (both northbound and southbound) would experience additional delays because of operational challenges. The detour would include two additional four-way-stop intersections and two additional traffic signals, as well as requiring the trucks to turn at a third downtown signal (Main and Plum Streets) where the current alignment is straight. Turning at Main and Plum Street is difficult for semi-trucks because of the tight radius, and they generally encroach into opposing traffic lanes which increases congestion and potentially affects traffic and pedestrian safety. The detour would increase the number of large trucks on Plum Street, which already experiences heavy traffic, thereby exacerbating congestion on Plum and adjacent streets downtown. (See Section 6.0 for additional information on trucks denied access to TH 61 under Bridge 9103 because of vertical clearance.)

Adding the cathodic protection option to Alternative 1 should not affect the construction schedule because the work could be done while other operations are taking place. However, cathodic protection would introduce the need for some additional temporary lane closures on TH 61 while the bottom of the slab is being worked on.

Adding the Lowering TH 61 Option to this alternative would not affect the overall construction schedule because it could be done during bridge repair operations. However it would require that southbound TH 61 be reduced from two lanes to one lane for approximately 2 to 4 weeks.

Alternative 1 would improve pedestrian facilities by widening the 2'6"-wide west sidewalk to an ADA-compliant 5' (the east sidewalk is already 5'), adding a sidewalk southward to Third and Potter Streets, and adding ADA-compliant ramps and tactile paving. Pedestrian accommodations would not be added to TH 61. Bicyclists would continue to use the TH 63 and TH 61 shoulders.

### **Other Considerations**

Unless the option of lowering TH 61 beneath the bridge is included, a design exception would be required for vertical clearance. No improvement in horizontal clearance for TH 61 is

proposed under Alternative 1 and a design exception would be required. Design exceptions would also be required for the pedestrian railing's height and the size of the rail openings (see Table 4).

The alternative would have no effect on the bridge's ability to maintain or improve economic development or maintain or improve downtown parking.

Alternative 1 would meet the Secretary of the Interior's Standards for Rehabilitation and would not diminish the historic integrity of adjacent historic properties (including archaeological resources). There would be no adverse effect under Section 106. There would be no use of protected resources under Section 4(f).

The alternative would have no effect on the navigational channel. Section 404 water quality requirements would be met.

### **Social, Economic, and Environmental Issues**

No parcels of property would be acquired. Two temporary easements during construction are anticipated. They are not expected to require any relocations.

Access to the parking lot of the Red Wing Shoe Company's Main and Potter Street facility would be affected during construction. The only entrance to the parking lot is via the service drive in Span 2, and the complex's only loading dock is on the northeast facade (Figure 3). The service drive would be occasionally closed for short periods of time while the falsework shoring for slab repairs was being erected. Vertical clearance for the service drive would be reduced by 1' to 2' for about 4 to 6 weeks while the falsework was in place. Vertical clearance over the drive is currently 14.7' (about 14'8"). The loading dock needs to be accessed each day by UPS trucks, which require 13'10" clearance, and about once per month by semi-trucks, which require 14' clearance, for essential deliveries and product shipment.

There are expected to be no other environmental impacts under this alternative.

## **8.2 Rehabilitation Alternative 2 – Replace Approximately 10' to 15' Strip and Add Inner Rail**

### **8.2.1 Description**

Alternative 2 is the similar to Alternative 1 except that an inner TL-2 railing would be added. Alternative 2 would replace in-kind a longitudinal center strip of the slab and restore the pedestrian railing and two lights, in addition to other repair work. It would maintain the load rating and provide some extension of the service life of the bridge, as well as traffic safety, but would not provide any geometric improvements.

As shown in Table 3, Alternative 2's major work items include replacing an approximately 10'- to 15'-wide strip of the slab, restoring the historic railing and two lights, and adding an inner TL-2 railing. Alternative 2's minor work items are similar to those under Alternative 1: patching spalls in the slab, epoxy injecting minor cracks in the slab, replacing deck expansion joints, replacing the low-slump concrete overlay, patching spalls on the piers and abutments, repairing the slope paving, repairing the approach retaining walls and approach panel, and adding crashworthy end

terminals to the guardrail. In addition, both sidewalks would be widened to 6' to accommodate the new inner railing and provide 5' of clear walkway. A new sidewalk would be built from the southern approach's west sidewalk to the corner of Third and Potter Streets.

There are two optional work items under Alternative 2: passive cathodic protection of the concrete slab and lowering the elevation of TH 61 by about 10" to improve vertical clearance.

### **Deck Slab**

Alternative 2 would replace in-kind the portion of the concrete slab that is most deteriorated, an approximately 10' to 15' constant-width strip along the slab's longitudinal construction joint for the entire length of the bridge (Figures 11 and 12). The final required width will be determined in Final Design. See Deck Slab under Alternative 1 (Section 8.1.1) for details.

Like Alternative 1, this alternative would also patch spalled areas of the slab outside of the approximately 10'- to 15'-wide center strip, epoxy inject all cracks, replace expansion joints at the ends of the concrete deck, and replace the low-slump concrete wearing surface.

#### Adding Cathodic Protection (Optional)

Adding passive Cathodic Protection to the concrete slab is an option under Alternative 2. See Deck Slab under Alternative 1 (Section 8.1.1) for details.

### **Railing and Sidewalks**

Alternative 2 would restore the historic pedestrian railing on both the bridge and southern approach. It would require design exceptions for railing height and opening size (Table 4). See Railing and Sidewalks under Alternative 1 (Section 8.1.1) for details.

See also Sections 8.6.4 through 8.6.7 for the unsuccessful exploration of concepts to improve the historic rail's strength, height, and opening size in ways that would meet the Secretary of the Interior's Rehabilitation Standards.

Alternative 2 would add an inner TL-2 railing on the inside edge of the raised sidewalk on both the bridge and the southern roadway approach. (See Section 6.0, as well as Railing and Sidewalks under Alternative 1 (Section 8.1.1), for information on rail strength.) The proposed inner rail has been used on the National Register-listed Taft Bridge in Washington, DC, and on other historic bridges. It consists of two horizontal steel members attached to curb-mounted steel posts. The inner rail would be about 17" tall measured from the top of the sidewalk (Figures 14 through 17).

## Bridge Rail Guide 2005 - Steel Tube Bridge Rails Attached to Top of Deck

### Washington, DC Historic Bridge Rail Retrofit (Curb Mount)

Height:  
27"

Cost per linear foot:  
\$—

Test level:  
TL-2

Utilized in:  
Washington, DC

Contact:  
Robert McNeely  
District Dept of Transportation  
1403 W Street, NW  
Washington, DC 20009  
(202) 438-7770



Figure 14. Inner TL-2 rail used in Washington, DC. This information, included in FHWA's 2005 Bridge Rail Guide, shows the rail mounted on the Taft Bridge on Connecticut Avenue in Washington, which is listed on the National Register.

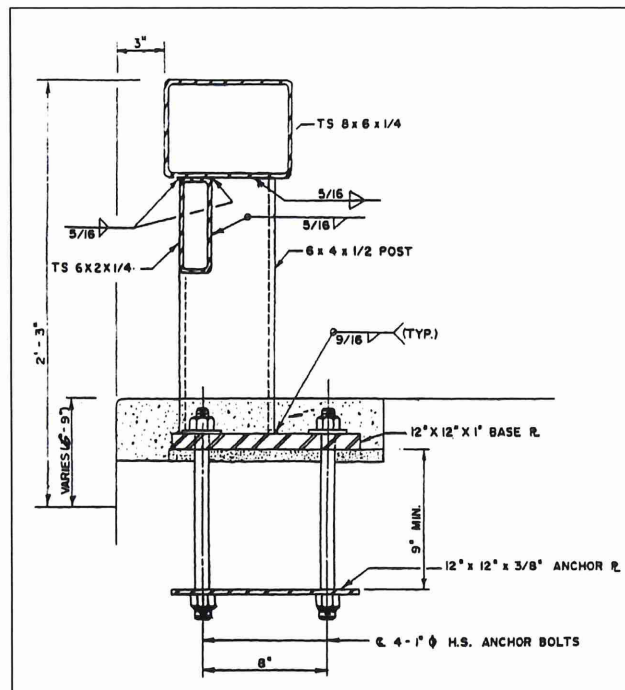


Figure 15. Construction details for the Washington, DC, inner TL-2 rail from FHWA's 2005 Bridge Rail Guide.



Figure 16. Bridge 9103 “before” the addition of the proposed inner TL-2 railing.

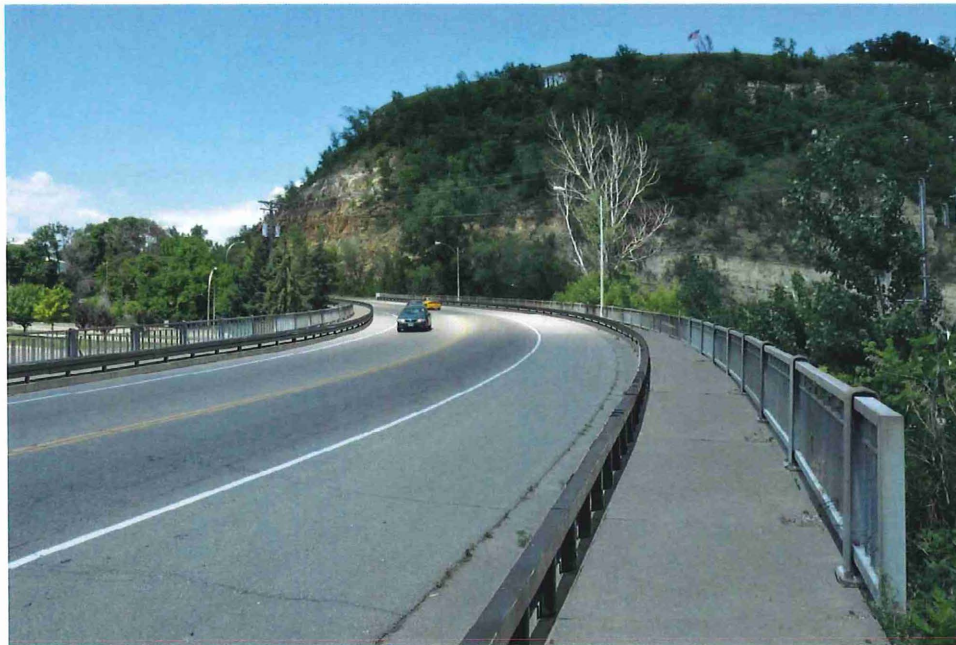


Figure 17. Photo mock-up of Bridge 9103 “after” the proposed inner rail (Gemini Research).



On both bridge and southern approach, Alternative 2 would also widen the west sidewalk from 2'6" to 6' and the east sidewalk from 5' to 6'. The widening would be needed to accommodate the inner rail, provide an ADA-compliant 5' walkway, and visually separate the new inner railing from the historic railing to help mitigate the visual effect of the change (Figures 16 and 17).

Alternative 2 would likely add an ADA-compliant ramp at the south end of the southern approach (on the west side of TH 63) to connect the west sidewalk with the Red Wing Shoes parking area. It would also add a new 5' sidewalk from the south end of the southern approach down to the corner of Third and Potter Streets (where there would be another ADA-compliant ramp). Tactile paving would be added. See Railing and Sidewalks under Alternative 1 (Section 8.1.1) for details.

### **Abutments, Piers, and Horizontal Clearance**

Alternative 2 would repair the abutments and piers by patching spalled concrete and repairing slope paving. See Abutments and Piers under Alternative 1 (Section 8.1.1) for details. Horizontal clearance on TH 61 could not be improved without moving the bridge piers, which would threaten the bridge's historic integrity and result in significant cost; a design exception would be required (see Table 4).

### **Vertical Clearance**

Alternative 2 would not change existing vertical clearance over TH 61 and would require a design exception (see Table 4) unless the option of lowering TH 61 were included. (See Lowering TH 61 (Optional) below.) Clearance is currently 15.5' (15'6") over TH 61 southbound and 16.4' (16'5") over TH 61 northbound. The applicable MnDOT BPIR standard is 16.0' for rehabilitation and 16.33' (16'4") for new construction. See Section 6.0 for the standards and implications of the existing condition.

#### *Lowering TH 61 (Optional)*

Lowering the elevation of TH 61 about 10" to improve vertical clearance is an option under Alternative 2. See Vertical Clearance under Alternative 1 (Section 8.1.1) for details.

### **Southern Approach Roadway**

On the southern approach roadway, Alternative 2 would restore the pedestrian railing and add the same inner TL-2 railing used on the bridge itself. The west sidewalk would be widened from 2'6" to 6' and the east sidewalk from 5' to 6' to accommodate the inner rail, provide a 5' clear walkway, and visually separate the new inner railing from the historic railing. For more on sidewalk changes, see Railings and Sidewalks above.

Minor repairs to the southern approach would include sealing the vertical cracks in the concrete retaining walls. To correct roadway settlement at the end of the bridge, the roadway approach panel would be reconstructed and the pavement replaced.

## Lights

The two lights on the bridge and southern approach would be restored. See Lights under Alternative 1 (Section 8.1.1) for details, as well as for a recommendation on future lighting changes.

### 8.2.2 Risks

The condition of the concrete and reinforcing steel at the removal limits of the approximately 10'- to 15'-wide strip cannot be fully known until the removal has taken place. Additional nondestructive testing could be undertaken during Final Design, especially if testing technology continues to advance and become more accurate. (A regular inspection schedule will also be maintained by MnDOT in the interim.) Given the high chloride content found throughout the depth of four different cores taken from the concrete slab and the use of uncoated reinforcing bars in the original construction, it can be expected that additional corrosion initiation and propagation will continue between the time of the 2012 inspections and a proposed 2018 construction date. If consistently good concrete and reinforcing are not found along the removal limits, it may be necessary to remove material in an area wider than the center 10' to 15' strip. Additional removals could eliminate the ability to maintain TH 63 traffic in both directions as well as increase the duration of construction.

While the approximately 10'- to 15'-wide strip is being removed and replaced, the contractor would be working with live traffic on both sides of the work zone, which would make the construction more hazardous than typical construction operations. If unanticipated additional removals are required, the already-minimal work area for construction would be reduced and the duration of construction would likely be increased.

There is also the likelihood that new, additional spalling will take place outside of the central strip replaced under Alternative 2. As stated, it is likely that the reinforcing steel in areas outside of the 10' to 15' removal limits has begun or will begin to corrode, which may lead to additional spalling. If the cathodic protection option is included with this alternate, corrosion of the steel could be delayed. While the CP system would inhibit the corrosion process, its effectiveness will vary dependent on the ability to establish and maintain electrical connectivity between the reinforcement and anode, and moisture and chloride content at the rebar location. Additional spalling would be a maintenance and safety concern and would require additional repairs to the slab. Spalling of concrete from the bottom of bridge decks can be a problem; there have been several documented cases of concrete falling on vehicles and causing damage and injury.

Finally, it is likely that full-depth repairs to additional portions of the slab will be required within 10 to 15 years of this rehabilitation project (see Service Life below). As described above, it is anticipated that corrosion of the reinforcing steel will begin or is taking place outside of the approximately 10' to 15' strip given the uncoated rebar and the slab's high chloride content (measured throughout the depth of cores from four locations). While the cathodic protection option would slow the process, there are limits to the method as described above. It is possible that further full-depth strip removals such as the 10' to 15' strip proposed under Alternative 2 will be needed in 10 to 15 years. There is a risk that replacement of additional portions of the slab may not meet the Secretary of the Interior's Rehabilitation Standards due to the cumulative effect of changes to the property and loss of an unacceptable amount of historic fabric.

### 8.2.3 Service Life

Alternative 2 would replace the area of the concrete slab that appears to be in the worst condition and raise the load rating of the bridge. However, given high chloride content in the slab and the use of uncoated reinforcing bars in the original construction, it is likely that additional corrosion of the reinforcing steel in the slab outside of the central 10' to 15' has begun or will begin in the foreseeable future. As described in Section 8.1.2, it is anticipated that additional full-depth patching and repairs to the slab will be required within 10 to 15 years of this rehabilitation project, based on MnDOT's previous experience with bridges built in this era. For example, the TH 52 Lafayette Bridge and the TH 61 Hastings Bridge are both undergoing replacement, but the decks on these bridges have had measured delamination over time even though they have undergone deck repairs in their history. The I-694 bridges in Oakdale were in need of and underwent deck replacement in 2010, even though deck repairs were made in the early 1990s. The I-394 Bridge in Minneapolis (Bridge 27831) near Dunwoody Institute was in need of and underwent deck replacement in 2007, even though deck repairs were made in the late 1980s. The Wisconsin Department of Transportation (WisDOT) has indicated that they have had similar experience with several repair projects on concrete slab span bridges. Three examples are discussed in detail in an email from WisDOT that appears in Appendix P.

Although rehabilitation projects such as the work that comprises Alternative 2 can gain additional bridge life and assist in keeping historic bridges in service, service life as defined in the rehabilitation alternatives evaluation criteria (see Section 6.0) refers to the number of years before significant rehabilitation would be required. Important in estimating service life for this alternative is the fact that Bridge 9103 has historically been heavily salted during bad weather. The practice will likely continue because of the bridge's curved, downhill geometry as TH 63 comes into the city of Red Wing. Although Alternative 2 will include a new overlay, years of heavy salting will continue to increase the chloride content in the concrete slab which will lead to additional deterioration.

An additional factor that was considered when estimating the service life of 10 to 15 years for Alternative 2 was the potential for the "halo effect" or "ring corrosion" after recommended repairs are constructed. Deterioration typically occurs because of chlorides present in a concrete slab. The casting of new concrete against existing concrete that contains chlorides can trigger a "halo effect" whereby the old concrete and steel reinforcement on the periphery of the repaired area experience accelerated corrosion and damage due to the abrupt difference in corrosion potential between the new and existing concrete. This often occurs within a few years of the repair (Clemena and Jackson 2000). In discussions with MnDOT bridge inspection and construction staff, it was noted that they have seen this occur on Minnesota bridges after repairs have been completed. (MnDOT bridge staff also noted that, for a nonhistoric slab bridge in Bridge 9103's condition, MnDOT would typically replace the entire slab because substantial additional repairs would continue to be needed.)

If the option of using cathodic protection is included with this alternate, the time until additional full-depth repairs are required could be increased and the extent of the repairs reduced. However, the zinc coating on the bottom of slab would require replacement in about 20 years, and the concrete overlay on top of the slab and the anodes beneath the overlay would require replacement in about 30 years.

## 8.2.4 Cost Estimates

The estimated initial construction costs for Alternative 2 and its options are as follows:

Alternative 2	\$ 1,075,000 - \$ 1,345,000
Cathodic Protection (CP) Option	\$ 1,090,000 - \$ 1,360,000
Alternative 2 with CP Option	\$ 2,165,000 - \$ 2,705,000
Lowering TH 61 Option	\$ 665,000
Alternative 2 with Lowering TH 61 Option	\$ 1,740,000 - \$ 2,010,000
Alternative 2 with both options	\$ 2,830,000 - \$ 3,370,000

The lower limit of the range shown does not include any contingencies. The upper limit includes 25% for contingencies. This percentage was estimated assuming 15% for material cost volatility and the possibility of increased deterioration between now and construction in 2018, and is based on the level of detailed design completed to date. The additional 10% was added to account for the risk associated with the unknowns that may be uncovered during the partial removal of the slab.

Costs are in construction year 2018 dollars and do not include engineering or construction administration. Costs for new bridge approach panels, retaining wall repairs, and sidewalk improvements off the bridge are included, but costs for any other approach roadway work are not. See Appendix O for cost estimate details.

Life cycle costs for keeping the bridge structurally sound for the next 100 years were also estimated. The following assumptions about required future major maintenance activities were used:

Alternative 2	Slab patching and repairs every 10 years
	Deck mill and overlay every 30 years
Alternative 2 with CP	Reapply zinc coating to slab bottom every 20 years
	Replace zinc anodes in top of slab every 30 years
	Deck mill and overlay every 30 years

Estimated life cycle costs for Alternative 2 and its options are as follows:

Alternative 2	\$ 1,285,000
Alternative 2 with Cathodic Protection Option	\$ 2,925,000
Alternative 2 with Lowering TH 61 Option	\$ 1,950,000
Alternative 2 with both options	\$ 3,590,000

Life cycle costs include the cost of the 2018 rehabilitation project plus anticipated future maintenance and repair costs. Life cycle costs do not include any contingencies. The costs for future work are discounted back to construction year 2018 by using the MnDOT prescribed Real Discount Rate of 2.5%. Costs for minor maintenance and bi-annual inspections are not included. See Appendix O for cost estimate details.

### 8.2.5 Compatibility With the Secretary of the Interior's Standards for Rehabilitation

See Appendix M for the Secretary of the Interior's (SOI) Standards for Rehabilitation.

The in-kind replacement of an approximately 10'- to 15'-wide section of the bridge slab (the final width to be determined in Final Design) would alter one of the bridge's most important character-defining features, but it is anticipated that the change would meet the Rehabilitation Standards. While Standard 6 directs that historic elements be repaired rather than replaced, the SOI Rehabilitation Guidelines allow "limited replacement in-kind" of "extensively deteriorated or missing parts of features" in some circumstances. Although Alternative 2 would replace up to about 24% of the slab width (approximately 15' of a 62.5'-wide slab), the size of the strip is as conservative as possible per SOI Rehabilitation Guidelines. The replacement concrete would not be visible on top of the bridge where the driving surface would be covered by a concrete overlay. It would be visible on the bottom of the superelevated slab (Figure 5), although portions of the bottom of the slab are somewhat shadowed, reducing the visual impact. The replacement material would closely resemble the original construction material. (The principal differences are that modern steel rebar is epoxy-coated against corrosion, and modern concrete is less permeable than the concrete used in 1960.) The surface of the new concrete would be textured and colored to match the original as closely as possible. Replacement of a central strip would mean a change from the slab's original, single, centerline construction joint to a pair of construction joints symmetrically placed 7.5' out from the centerline. While this would constitute an alteration, the change would be primarily visual. The original joint is not a particularly significant component of the slab (e.g., not distinctive or innovative from an engineering or design standpoint), but instead is the result of standard construction practice and is typical for bridges of this type.

Alternative 2 proposes to add an inner TL-2 railing to both the bridge and southern approach, an action considered a health and safety upgrade in terms of the SOI Standards and Guidelines. The sidewalks would be widened so they met ADA standards with 5' of clear walkway between the historic and new railing (Figures 14 and 17). The new railing, which has been used on historic bridges in Washington, DC, is compatible in size, scale, and proportion to the historic railing and does not visually overwhelm it. It would be physically separated and clearly differentiated from the historic railing so that an observer would be able to understand and experience the historic design while at the same time readily perceiving (and able to visually isolate) the alteration. Adding the inner railing would meet Standard 9, which states that new additions should "not destroy historic materials, features, and spatial relationships that characterize the property" and that the new work should be visually compatible with the historic materials or features and yet differentiated from them. Under the topic "Health and Safety Considerations," the SOI Rehabilitation Guidelines advise that "particular care must be taken not to obscure, radically change, damage, or destroy character-defining features in the process" of meeting health and safety requirements. The proposed inner rail is consistent with this recommendation.

The use of low-slump concrete for the deck overlay, rather than the original bituminous, is a fairly minor change that would meet the Standards. The guardrail changes proposed under Alternative 2 would increase safety while being visually unobtrusive.



The rest of Alternative 2's work items would repair or restore deteriorated historic elements and extend the life of the historic property. They would preserve historic character and distinctive features (Standards 2 and 5) and would generally repair, rather than replace, deteriorated elements (Standard 6). The proposed methods would not damage historic materials in accordance with Standard 7, which states that repair methods "will be undertaken using the gentlest means possible" and that "treatments that cause damage to historic materials will not be used."

Cathodic protection of the slab is an option under Alternative 2. On the upper slab surface beneath the overlay, an approximately 1"-thick layer of the concrete slab would be milled off so anodes could be embedded to make contact with the rebar (Figure 13). The surface would then be covered with a new concrete overlay. A different style of anode – short threaded rods – would be embedded perpendicularly into the bottom surface of the slab in a 15' grid and 4"-square zinc mesh plates would be attached to the ends of the rods. The bottom surface of the slab would then be lightly sandblasted. The entire bottom surface would next be covered with a gray-white, paintlike coating that has a metallic glint.

Bridge 9103's lower surface is visually prominent from some angles because of the structure's superelevation (Figure 5). Views of the surface are somewhat obscured, however, by shadows and by the structure's tilt. Adding zinc plates and short rods to the bottom of the slab would introduce a gridwork of studs to the relatively smooth surface. Sandblasting the surface would change the texture of the raw concrete, which was meant to be exposed and has characteristic patterns left by the original formwork. Sandblasting would also remove the patina of aging including surface irregularities and discoloration. The arch-sprayed zinc would give the surface a smooth, uniform, paintlike coating that is several shades lighter than the existing concrete and has a metallic glint. While the glint would fade with time and the surface would get grayer and dirtier, the cathodic protection would need to be renewed every 15 to 20 years with additional sandblasting and recoating, just as the treatment was getting less obvious. While some sources suggest that cathodic protection is "reversible," in reality the original texture and patina of the bridge's historic concrete could not be recovered. It is recommended that the cathodic protection proposed under Alternative 2 would diminish the historic integrity of the property but stop short of an adverse effect. If applied to more parts of Bridge 9103, the change would likely not meet the Standards.

Lowering TH 61 beneath the bridge is also an option under Alternative 2. The roadway would be lowered about 10". It is anticipated that the change would not cause a substantial visual effect given the large scale of the bridge, southern approach, and associated highways. The alteration would not diminish the property's historic integrity in any other significant way, and would meet the Rehabilitation Standards.

### **Other Historic Properties**

Bridge 9103 is a Contributing element within the Red Wing Segment of a linear historic district – the Highway 61 (Great River Road) Historic District – which is eligible for the National Register. Alternative 2 would not adversely affect the historic integrity of the district because the proposed changes to the bridge would meet the Secretary the Interior's Standards. Further, Bridge 9103 represents a small component of the district, which is many miles long.

Alternative 2 would have no adverse effect on the historic integrity of Barn Bluff, which is listed on the National Register.

Alternative 2 would have no adverse effect on the historic integrity of the Red Wing Shoe Company, which is eligible for the National Register. The recommended boundary of the National Register-eligible property extends to the existing Third Street curbline (Figure 3). Within this boundary, a new sidewalk would be built around the eastern corner of the building and inside the street trees against the eastern facade. Historically (i.e., within the Shoe Company's period of significance), there was a sidewalk in the same location that was evidently removed circa 1960. The sidewalk change would be fairly minor and visually unobtrusive. The street trees would remain in place.

Alternative 2's proposed changes to Bridge 9103 would not affect the setting or viewshed of any other historic properties in Red Wing.

### **Summary**

In summary, it is anticipated that Alternative 2, with its options, would meet the Secretary of the Interior's Standards for Rehabilitation. The proposed work would result in some change to Bridge 9103's integrity of design, materials, workmanship, feeling, and association, and no change to its integrity of location and setting. The property's historic character would generally be preserved per Section 106. No other historic properties would be adversely affected. It is anticipated that Alternative 2 is not likely to constitute "use" of historic properties under Section 4(f).

### **8.2.6 Alternative 2's Ability to Meet Purpose and Need**

Alternative 2's ability to meet the project Purpose and Need is summarized below. See also the Evaluation Matrix in Section 9.0.

#### **Primary Needs**

Alternative 2 would meet the primary needs of maintaining connectivity to the Mississippi River crossing and providing a structurally sound crossing of TH 61. The inventory load rating factor of the bridge would be improved to 1.04 which is greater than the minimum desired rating factor of 1.00 (see details in Appendix J). This alternative would improve the service life of the bridge by replacing the most deteriorated portions of the concrete slab and replacing the concrete overlay to improve protection against future chloride intrusion. In 10 to 15 years the bridge would require additional rehabilitation, which would include more full-depth repairs of the slab. If cathodic protection is added, the service life would be improved but the zinc coating would need replacement in 15 to 20 years and the anodes in the top of the slab would need replacement in 30 years. As noted in Section 8.2.3 above, the extent of these rehabilitations on a cycle of 10 to 15 years can be expected to be significant as reinforcement deterioration continues.

#### **Secondary Needs**

Alternative 2 would meet the secondary needs of maintaining the continuity of TH 63, maintaining TH 63's connections with TH 61 and TH 58, and maintaining access to Trenton Island.

The alternative would not improve the bridge's capacity in terms of traffic volume, or its role in traffic operations, but would maintain the status quo. Alternative 2 would improve traffic safety by adding an inner TL-2 railing. New guardrail would have crashworthy end terminals.

The alternative maintains traffic to the maximum extent possible. By limiting deck slab replacement to an approximately 10' to 15' strip (the final width to be determined in Final Design), the alternative allows two-way traffic on TH 63 to remain open during construction. The work could be accomplished in one construction stage and is expected to last about 8 to 10 weeks. However, as noted in Section 8.2.2 above, there is a risk that additional removal beyond the approximately 10'- to 15'-wide strip may be needed, thereby disrupting the ability to maintain TH 63 traffic in both directions, reducing the already-minimal construction work area, and increasing the duration of construction.

On TH 61, occasional short-term closures may be required for falsework construction but they would not be expected to last long. Vertical clearance on TH 61, however, would be reduced by 1' to 2' for approximately 4 to 6 weeks while the falsework was in place. Tall trucks would be required to detour on TH 58 and CSAH 21 (Flower Valley Road). The detour's challenges are described under Secondary Needs in Section 8.1.6 (Alternative 1) above.

Adding the cathodic protection option to this alternative should not affect the construction schedule because this work could be done while other operations are taking place. However, cathodic protection would introduce the need for some additional temporary lane closures on TH 61 while the bottom of the slab is being worked on.

Adding the Lowering TH 61 Option to this alternative would not affect the overall construction schedule because it could be done during bridge repair operations. However it would require that southbound TH 61 be reduced from two lanes to one lane for approximately 2 to 4 weeks.

Alternative 2 would improve pedestrian facilities by widening the sidewalks, adding a sidewalk southward to Third and Potter Streets, and adding ADA ramps and tactile paving. After construction, both west and east sidewalks on the bridge and southern approach would provide a 5' walkway between the historic and new TL-2 railings. Pedestrian accommodations would not be added to TH 61. Bicyclists would continue to use the TH 63 and TH 61 shoulders.

### **Other Considerations**

Unless the option of lowering TH 61 beneath the bridge is included, a design exception would be required for vertical clearance. No improvement in horizontal clearance for TH 61 is proposed under Alternative 2 and a design exception would be required. Design exceptions would also be required for the pedestrian railing's height and the size of the rail openings (see Table 4).

The alternative would have no effect on the bridge's ability to maintain or improve economic development or maintain or improve downtown parking.

Under Alternative 2, the bridge rehabilitation would meet the Secretary of the Interior's Standards for Rehabilitation and would not diminish the historic integrity of adjacent historic

properties (including archaeological resources). There would be no adverse effect under Section 106. There would be no use of protected resources under Section 4(f).

The alternative would have no effect on the navigational channel. Section 404 water quality requirements would be met.

### **Social, Economic, and Environmental Issues**

No parcels of property would be acquired. Two temporary easements during construction are anticipated. They are not expected to require any relocations.

Access to the parking lot of the Red Wing Shoe Company's Main and Potter Street facility would be affected during construction. The only entrance to the parking lot is via the service drive in Span 2, and the complex's only loading dock is on the northeast facade (Figure 3). The service drive would be occasionally closed for short periods of time while the falsework shoring for slab repairs was being erected. Vertical clearance for the service drive would be reduced by 1' to 2' for about 4 to 6 weeks while the falsework was in place. Vertical clearance over the drive is currently 14.7' (about 14'8"). The loading dock needs to be accessed each day by UPS trucks, which require 13'10" clearance, and about once per month by semi-trucks, which require 14' clearance, for essential deliveries and product shipment.

There are expected to be no other environmental impacts under this alternative.

## **8.3 Rehabilitation Alternative 3 – Full Slab Replacement**

### **8.3.1 Description**

Alternative 3 would fully replace the bridge slab in-kind to mitigate its deteriorating condition, rather than replacing a central strip as proposed under Alternatives 1 and 2. Like Alternative 2, this alternative would add an inner TL-2 railing. It would restore the historic pedestrian railing and two lights, in addition to other repair work. The alternative would improve the load rating and service life of the bridge, as well as traffic safety, but would not provide any geometric improvements.

As shown in Table 3, Alternative 3's major work items include replacing the concrete slab in-kind, restoring the historic railing and two lights, and adding an inner TL-2 railing. Minor work items would include replacing deck joints, patching spalls on the piers and abutments, repairing the slope paving, repairing the approach retaining walls and approach panel, and adding crashworthy end terminals to the guardrail. In addition, both sidewalks would be widened to 6' to accommodate the new inner railing and provide ADA-compliant 5' of clear walkway. A new sidewalk would be built from the southern approach's west sidewalk to the corner of Third and Potter Streets.

There is one optional work item under Alternative 3: lowering the elevation of TH 61 about 10" to improve vertical clearance.

## Deck Slab

Alternative 3 involves replacing the entire continuous concrete slab superstructure in-kind. The replacement superstructure – including its curved coping detail and shallow span arches – would be designed, detailed, and constructed to match the existing slab as closely as possible in design, color, texture, and, materials. It would be designed to visually blend with the southern approach (including its concrete coping and retaining walls), which would be retained.

In contrast to replacing an approximately 10'- to 15'-wide center strip of the slab, a full slab replacement would completely eliminate the issue of chloride concentration and reinforcing steel deterioration. Rather than simply slowing the continued deterioration, a full slab replacement would restore the concrete slab to new condition.

The construction of a full slab replacement would need to be accomplished in three stages to keep enough deck width in service to maintain two-way traffic on TH 63 during construction operations. Being constructed in three stages makes this alternative the most complicated of the four to construct. Bridge falsework shoring would be required below the slab along its entire length during slab removal and replacement. The falsework would likely reduce the bridge's vertical clearance by 2' to 3' while the new slab was being constructed.

## Railing and Sidewalks

Alternative 3 would restore the existing pedestrian railing on both the bridge and southern approach. A design exception would be required for the height and opening size of the pedestrian railing (Table 4). See Railing and Sidewalks under Alternative 1 for details.

See also Sections 8.6.4 through 8.6.7 for the unsuccessful exploration of concepts to improve the historic rail's strength, height, and opening size in ways that would meet the Secretary of the Interior's Rehabilitation Standards.

Alternative 3 would add an inner TL-2 railing to both the bridge and southern approach (Figures 14 and 15). See Railing under Alternative 2 for details.

When the bridge slab is replaced, the west sidewalk would be widened from 2'6" to 6' and the east sidewalk from 5' to 6' to accommodate the inner rail, provide a 5' clear walkway per ADA standards, and visually separate the new inner railing from the historic railing to help mitigate the visual change.

Alternative 3 would likely add an ADA-compliant ramp at the south end of the southern approach (on the west side of TH 63) to connect the west sidewalk with the Red Wing Shoes parking area. It would also add a new 5' sidewalk from the south end of the southern approach down to the corner of Third and Potter Streets (where there would be another ADA-compliant ramp). Tactile paving would be added where needed. See Railing and Sidewalks under Alternative 1 for details.

## Abutments, Piers, and Horizontal Clearance

Alternative 3 would repair the abutments and piers by patching spalled concrete and repairing slope paving. See "Abutments, Piers, and Horizontal Clearance" under Alternative 1 for details. Horizontal clearance on TH 61 could not be improved without moving the bridge piers, which



would threaten the bridge's historic integrity and result in significant cost; a design exception would be required (see Table 4).

### **Vertical Clearance**

Alternative 3 would not change existing vertical clearance over TH 61 and would require a design exception (see Table 4) unless the option of lowering TH 61 were included. (See Lowering TH 61 (Optional) below.) Clearance is currently 15.5' (15'6") over TH 61 southbound and 16.4' (16'5") over TH 61 northbound. The applicable MnDOT BPIR standard is 16.0' for rehabilitation and 16.33' (16'4") for new construction. See Section 6.0 for the standards and implications of the existing condition.

#### Lowering TH 61 (Optional)

Lowering the elevation of TH 61 about 10" to improve vertical clearance is an option under Alternative 3. See Vertical Clearance under Alternative 1 for details.

### **Southern Approach Roadway**

On the southern approach roadway, Alternative 3 would restore the pedestrian railing and add the same inner TL-2 railing used on the bridge itself. The west sidewalk would be widened from 2'6" to 6' and the east sidewalk from 5' to 6' to accommodate the inner rail, provide a 5' clear walkway, and visually separate the new inner railing from the historic railing. For more on sidewalk changes, see Railings and Sidewalks above.

Minor repairs to the southern approach would include sealing the vertical cracks and patching the spalls in the concrete retaining walls. To correct roadway settlement at the end of the bridge, the roadway approach panel would be reconstructed and the pavement replaced.

### **Lights**

The two lights on the bridge and southern approach would be restored. See Lights under Alternative 1 for details, as well as for a recommendation on future lighting changes.

### **8.3.2 Risks**

Alternative 3 is the most complicated of the four alternatives to construct because three construction stages would be needed. Construction work would occur next to live traffic for an estimated 6 to 8 months, with one of the stages requiring the contractor to work with live traffic on both sides of the work zone. Alternative 3 has relatively low risk that unforeseen factors will be identified during construction.

### **8.3.3 Service Life**

Alternative 3 would replace the concrete slab and raise the load rating of the bridge. With regular routine maintenance and a new concrete overlay after about 30 years, the bridge could be expected to remain in service for at least 60 years before any major rehabilitation work is required. The 60-year service life estimate is based on the substructures, which are original construction that would be repaired in 2018. The superstructure slab is expected to provide 75-100 years of service, consistent with other new decks that utilize coated reinforcing bars, less permeable concretes, and overlays.

### 8.3.4 Cost Estimates

The estimated initial construction costs for Alternative 3 and its option are as follows:

Alternative 3	\$ 1,780,000 - \$2,045,000
Lowering TH 61 Option	\$ 665,000
Alternative 3 with Lowering TH 61 Option	\$ 2,445,000 - \$2,710,000

The lower limit of the range shown does not include any contingencies. The upper limit includes 15% for contingencies such as material cost volatility and the possibility of increased deterioration between now and construction in 2018, and is based on the level of detailed design completed to date.

Costs are in construction year 2018 dollars and do not include engineering or construction administration. Costs for new bridge approach panels, retaining wall repairs, and sidewalk improvements off of the bridge are included, but costs for any other approach roadway work are not. See Appendix O for cost estimate details.

Life cycle costs for keeping the bridge structurally sound for the next 100 years were also estimated. The following assumptions about required future major maintenance activities were used:

Alternative 3	Deck mill and overlay every 30 years
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Estimated life cycle costs for Alternative 3 and its option are as follows:

Alternative 3	\$ 1,830,000
Alternative 3 with Lowering TH 61 Option	\$ 2,495,000

Life cycle costs include the cost of the 2018 rehabilitation project plus anticipated future maintenance and repair costs. Life cycle costs do not include any contingencies. The costs for future work are discounted back to construction year 2018 by using the MnDOT prescribed Real Discount Rate of 2.5%. Costs for minor maintenance and bi-annual inspections are not included. See Appendix O for cost estimate details.

### 8.3.5 Compatibility With the Secretary of the Interior's Standards for Rehabilitation

See Appendix M for the Secretary of the Interior's (SOI) Standards for Rehabilitation.

Alternative 3 proposes to fully replace Bridge 9103's superstructure slab to mitigate deterioration. The slab would be replaced in-kind and, with the exception of slightly-widened sidewalks, the new superstructure would match the historic slab as closely as possible. The historic railing and two adjacent lights would be restored and reinstalled in original positions on the new slab.

Bridge 9103's continuous concrete slab is one of its most distinctive elements and an essential part of its National Register eligibility. At first glance, replacing the slab in-kind might be

considered consistent with the Rehabilitation Standards. Standard 6, for example, states that “Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will [i.e., must] be substantiated by documentary and physical evidence.”

The SOI Rehabilitation Guidelines state that repairs should be as conservative as possible, but that the “limited replacement in-kind” of “extensively deteriorated or missing parts of features when there are surviving prototypes” can be considered. The Guidelines explain:

Following repair in the hierarchy, Rehabilitation guidance is provided for replacing an entire character-defining feature with new material because the level of deterioration or damage of materials precludes repair (e.g., an exterior cornice; an interior staircase; or a complete porch or storefront). If the essential form and detailing are still evident so that the physical evidence can be used to re-establish the feature as an integral part of the rehabilitation, then its replacement is appropriate. Like the guidance for repair, the preferred option is always replacement of the entire feature in-kind, that is, with the same material. . . . It should be noted that, while the National Park Service guidelines recommend the replacement of an entire character-defining feature that is extensively deteriorated, they never recommend removal and replacement with new material of a feature that – although damaged or deteriorated – could reasonably be repaired and thus preserved.

The Guidelines include recommendations and examples to help interpret the Standards. Under the category “Masonry” (which includes reinforced concrete), the Guidelines provide 51 recommendations. Under “Recommended,” they include, for example:

Recommended: “Cutting damaged concrete back to remove the source of deterioration (often corrosion on metal reinforcement bars).”

Recommended : “Repairing masonry features by patching, piecing-in, or consolidating the masonry using recognized preservation methods. Repair may also include the limited replacement in-kind – or with compatible substitute material – of those extensively deteriorated or missing parts of masonry features when there are surviving prototypes such as terra-cotta brackets or stone balusters.”

Recommended: “Replacing in-kind an entire masonry feature that is too deteriorated to repair – if the overall form and detailing are still evident – using the physical evidence as a model to reproduce the feature. Examples can include large sections of a wall, a cornice, balustrade, column, or stairway.”

Under “Not Recommended,” they include, for example:

Not Recommended: “Replacing an entire masonry feature such as a cornice or balustrade when repair of the masonry and limited replacement of deteriorated or missing parts are appropriate.”

Not Recommended: "Replacing or rebuilding a major portion of exterior masonry walls that could be repaired so that, as a result, the building is no longer historic and is essentially new construction."

Full replacement of Bridge 9103's slab would be inconsistent with the above guidance. The action would require replacement of 54% of the property's historic concrete (calculated by adding up slab, piers, abutments, footings, and southern approach retaining walls). The SOI Rehabilitation Guidelines' use of the word "limited" in phrases such as "limited replacement in-kind" and "limited replacement of deteriorated or missing parts" suggests that replacement of historic fabric on the scale proposed under Alternative 3 is not intended and would not meet the Standards.

The elements that the Guidelines use to illustrate replacement recommendations are all small or limited in scale: cornice, staircase, porch, storefront, brackets, balusters, column, wall section. Replacement of an entire masonry feature of substantial size is never mentioned.

Replacement of Bridge 9103's entire slab would result in a property that has entered the realm of reconstruction, rather than being an authentic historic property that retains integrity. The slab replacement would be inconsistent with Standards 2 and 5, which emphasize retention and preservation of distinctive materials and features. While Standard 6 allows the in-kind replacement of a distinctive feature if it is too deteriorated to repair, replacement on a scale proposed under Alternative 3 is not supported.

Considered separately from the slab replacement, Alternative 3's other work tasks (e.g., adding the inner TL-2 railing and various repair and maintenance items) would likely meet the Rehabilitation Standards, as described in Sections 8.1.5 and 8.2.5. Lowering TH 61, an option under Alternative 3, would meet the Rehabilitation Standards if considered separately from slab replacement (see Sections 8.1.5 and 8.2.5).

### **Other Historic Properties**

Bridge 9103 is a Contributing element within the Red Wing Segment of a linear historic district – the Highway 61 (Great River Road) Historic District – which is eligible for the National Register. The proposed changes to Bridge 9103 would not meet the Secretary the Interior's Standards and would alter one of the district's Contributing elements. However, because Bridge 9103 represents a small component of the many-mile-long historic district, the district's overall historic integrity would not be significantly diminished.

Alternative 3 would have no adverse effect on the historic integrity of Barn Bluff, which is listed on the National Register.

Alternative 3 would have no adverse effect on the historic integrity of the Red Wing Shoe Company, which is eligible for the National Register. The recommended boundary of the National Register-eligible property extends to the existing Third Street curblin (Figure 3). Within this boundary, a new sidewalk would be built around the eastern corner of the building and inside the street trees against the eastern facade. Historically (i.e., within the Shoe Company's period of significance), there was a sidewalk in the same location that was evidently removed circa 1960. The sidewalk change would be fairly minor and visually unobtrusive. The street trees would remain in place.

Alternative 3's proposed changes to Bridge 9103 would not affect the setting or viewshed of any other historic properties in Red Wing.

### **Summary**

In summary, it is anticipated that Alternative 3 would not meet the Secretary of the Interior's Standards for Rehabilitation. The proposed work would result in substantial change to Bridge 9103's integrity of materials, workmanship, feeling, and association; some change to integrity of design; and no change to its integrity of location and setting. The alterations would adversely effect the property's historic character per Section 106. (No other historic properties would be adversely affected.) It is recommended that Bridge 9103 would be no longer be eligible for the National Register after the change. Alternative 3 would likely constitute "use" of the historic property under Section 4(f).

### **8.3.6 Alternative 3's Ability to Meet Purpose and Need**

Alternative 3's ability to meet the project Purpose and Need is summarized below. See also the Evaluation Matrix in Section 9.0.

#### **Primary Needs**

Alternative 3 would meet the primary needs of maintaining connectivity to the Mississippi River crossing and providing a structurally sound crossing of TH 61. The inventory load rating factor of the bridge would be improved to greater than the minimum desired rating factor of 1.00 (see details in Appendix J), and the service life of the bridge would be increased to at least 60 years.

#### **Secondary Needs**

The alternative would meet the secondary needs of maintaining the continuity of TH 63, maintaining TH 63's connections with TH 61 and TH 58, and maintaining access to Trenton Island.

The alternative would not improve the bridge's capacity in terms of traffic volume, or its role in traffic operations, but would maintain the status quo. Alternative 3 would improve traffic safety by adding an inner TL-2 railing. New guardrail would have crashworthy end terminals.

The alternative maintains traffic to the greatest extent possible. By constructing Alternative 3 in three stages, two-way traffic could be maintained on TH 63. Construction work would occur next to live traffic for an estimated to 6 to 8 months. The contractor would be required to work with live traffic on both sides of the work zone during one of the construction stages.

On TH 61, occasional short-term closures may be required for falsework construction but they would not be expected to last long. Vertical clearance on TH 61, however, would be reduced by 2' to 3' for approximately 10 to 14 weeks while the falsework was in place. Tall trucks would be required to detour on TH 58 and CSAH 21 (Flower Valley Road). The detour's challenges are described under Secondary Needs in Section 8.1.6 (Alternative 1) above.



Adding the Lowering TH 61 Option to this alternative would not affect the overall construction schedule because it could be done during bridge repair operations. However it would require that southbound TH 61 be reduced from two lanes to one lane for approximately 2 to 4 weeks.

Alternative 3 would improve pedestrian facilities by widening the sidewalks, adding a sidewalk southward to Third and Potter Streets, and adding two ADA ramps. After construction, both west and east sidewalks on the bridge and southern approach would provide a 5' walkway between the historic and new TL-2 railings. Pedestrian accommodations would not be added to TH 61. Bicyclists would continue to use the TH 63 and TH 61 shoulders.

### **Other Considerations**

Unless the option of lowering TH 61 beneath the bridge is included, a design exception would be required for vertical clearance. No improvement in horizontal clearance for TH 61 is proposed under Alternative 3 and a design exception would be required. Design exceptions would also be required for the pedestrian railing's height and the size of the rail openings (see Table 4).

The alternative would have no effect on the bridge's ability to maintain or improve economic development or maintain or improve downtown parking.

Alternative 3 would constitute an adverse effect under Section 106 and would likely constitute use of a historic property under Section 4(f). The bridge rehabilitation would not meet the Secretary of the Interior's Standards for Rehabilitation, primarily because of the large amount of historic fabric that would be removed, including the character-defining superstructure slab. It is recommended that the bridge would no longer be eligible for the National Register. The alternative would not diminish the historic integrity of adjacent historic properties (including archaeological resources).

Alternative 3 would have no effect on the navigational channel. Section 404 water quality requirements would be met.

### **Social, Economic, and Environmental Issues**

No parcels of property would be acquired. Two temporary easements during construction are anticipated. They are not expected to require any relocations.

Access to the parking lot of the Red Wing Shoe Company's Main and Potter Street facility would be affected during construction. The only entrance to the parking lot is via the service drive in Span 2, and the complex's only loading dock is on the northeast facade (Figure 3). The service drive would be occasionally closed for short periods of time while the falsework shoring for slab repairs was being erected. Vertical clearance for the service drive would be reduced by 2' to 3' for about 10 to 14 weeks while the falsework was in place. Vertical clearance over the drive is currently 14.7' (about 14'8"). The loading dock needs to be accessed each day by UPS trucks, which require 13'10" clearance, and about once per month by semi-trucks, which require 14' clearance, for essential deliveries and product shipment.

There are expected to be no other environmental impacts under this alternative.

## 8.4 Rehabilitation Alternative 4 – Widen to Four Lanes

### 8.4.1 Description

The study team explored the option of rehabilitating Bridge 9103 to accommodate a four-lane river crossing since alternatives for Bridge 9040 (which Bridge 9103 approaches) include both two- and four-lane scenarios. Carrying four lanes on TH 63 addresses the secondary need of providing adequate traffic capacity now and in the foreseeable future. A wider Bridge 9103, which Alternative 4 proposes, could serve as the approach for either a new four-lane river bridge or for a pair of two-lane river bridges. Rehabilitating Bridge 9103 to serve as the approach for *one* of a pair of two-lane river bridges, with a second approach bridge needed for the second bridge in the pair, was determined infeasible (see the top of Section 8.0).

Alternative 4 would replace Bridge 9103's slab with a wider slab to mitigate deterioration and accommodate four lanes of traffic. (Widening, rather than replacing, the slab was determined impractical; see Section 8.6.9.) The replacement slab would be designed to accommodate a 78'-wide roadway that would consist of 4-12' lanes, 2' inside shoulders, 6' outside shoulders, a 4' raised center median, and a 10' raised trail on the west side only (Figure 18). Alternative 4 would replace the historic railing with a new TL-2 railing mounted near the outside edge of the slab. The alternative would improve the bridge's capacity, load rating, and service life, as well as improving traffic safety and providing geometric improvements.

As shown in Table 3, Alternative 4's major work items would include replacing the concrete superstructure with a new slab that extends approximately 18.5' farther to the west than the current slab, and correspondingly widening the piers, abutments, and slope paving. The southern approach roadway would be reconstructed so it was wider, had a new horizontal alignment, and had two new retaining walls. The historic rail on both bridge and southern approach would be replaced with a new TL-2 rail, and the two lights integrated into the historic railing would be replaced. The elevation of both TH 61 and the service drive (in Span 2) would be lowered to maintain vertical clearance beneath the superelevated superstructure. Minor work items would include patching spalls on the piers and abutments, repairing slope paving, and adding crashworthy end terminals to the guardrail. Instead of two sidewalks, the new slab would have a raised 10'-wide pedestrian/bicycle trail on the west side only; the trail would extend southward to Third and Potter Streets.

#### Deck Slab

Alternative 4 involves replacing the entire continuous concrete superstructure with a wider slab to accommodate a four-lane roadway. The existing superstructure is 62'6" wide, while the new slab would be approximately 81' wide (measured outside to outside). To line up with a potential four-lane river bridge, the new slab would extend about 18.5' farther west than the current slab, but be positioned the same as the current slab on the east side. Although wider, the replacement slab would be designed and detailed to match the existing slab in appearance as closely as possible.

The construction of this full slab replacement would need to be accomplished in two stages to keep enough deck width in service to maintain two-way traffic on TH 63 during construction. Because of the additional width, the slab could be constructed one-half at a time using relatively common two-staged construction. Bridge falsework shoring would be required below the slab



would threaten the bridge's historic integrity and result in significant cost; a design exception would be required (see Table 4).

### **Vertical Clearance**

Because Bridge 9103's superstructure is superelevated, the elevation of TH 61 would need to be lowered about 1' under Alternative 4 to maintain existing vertical clearance beneath a wider slab. A design exception would still be required for vertical clearance because it would not meet current MnDOT standards (see Table 4). Clearance is currently 15.5' (15'6") over TH 61 southbound and 16.4' (16'5") over TH 61 northbound. The applicable MnDOT BPIR standard is 16.0' for rehabilitation and 16.33' (16'4") for new construction. See Section 6.0 for the standards and implications of the existing condition.

The elevation of the service drive to the Red Wing Shoe Company's parking area would also need to be lowered – about 6" – to continue to meet the MnDOT vertical clearance standard of 14'6" over a local street in an urban setting (see Section 6.0).

### **Southern Approach Roadway**

Alternative 4 would reconstruct the southern approach roadway to align with the widened bridge. The new approach would be wider and have a different horizontal alignment than the original. The approach's retaining walls would be removed and new walls constructed that would resemble the original walls.

A widened southern approach would require reducing the size of the Red Wing Shoe Company parking area (Figure 18). The eastern edge of the lot, which is within MnDOT right-of-way, would be removed to accommodate the approach. Additional right-of-way would not be required at this location.

The southern approach's historic railing would be replaced by a new TL-2 railing. The approach's raised sidewalks would be removed. On the western side there would be a new 10'-wide, raised pedestrian/bike trail. The trail would extend southward from the end of the approach to the corner of Third and Potter Streets. ADA-compliant ramps and tactile paving would be added.

### **Lights**

The two lights on the bridge and southern approach would be replaced with new lights (style to be determined; preliminary planning for the Red Wing Bridge Project has not yet identified lighting needs).

### **8.4.2 Risks**

Alternative 4 has relatively low risk that unforeseen factors will be identified during construction. The alternative would require standard two-stage construction. The contractor would be working with live traffic on one side of the work zone.

### 8.4.3 Service Life

Alternative 4 would replace the concrete slab and raise the load rating of the bridge. With regular routine maintenance and a new concrete overlay after about 30 years, the bridge could be expected to remain in service for at least 60 years before any major rehabilitation work is required. The 60-year service life estimate is based on the substructures, which are original construction that would be repaired in 2018. The superstructure slab is expected to provide 75-100 years of service, consistent with other new decks that utilize coated reinforcing bars, less permeable concretes, and overlays.

### 8.4.4 Cost Estimates

The estimated initial construction cost for Alternative 4 is:

Alternative 4	\$ 3,015,000 - \$ 3,345,000
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The lower limit of the range shown does not include any contingencies. The upper limit includes 15% for contingencies such as material cost volatility and the possibility of increased deterioration between now and construction in 2018, and is based on the level of detailed design completed to date.

Costs are in construction year 2018 dollars and do not include engineering, construction administration, or right-of-way acquisition. Costs include new bridge approach panels and retaining walls, but no other bridge approach roadway improvements because the limits of these improvements are beyond the scope of this study. See Appendix O for cost estimate details.

Life cycle costs for keeping the bridge structurally sound for the next 100 years were also estimated. The following assumptions about required future major maintenance activities were used:

Alternative 4	Deck mill and overlay every 30 years
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Estimated life cycle costs for Alternative 4 are as follows:

Alternative 4	\$ 3,065,000
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Life cycle costs include the cost of the 2018 rehabilitation project plus anticipated future maintenance and repair costs. Life cycle costs do not include any contingencies. The costs for future work are discounted back to construction year 2018 by using the MnDOT prescribed Real Discount Rate of 2.5%. Costs for minor maintenance and bi-annual inspections are not included. See Appendix O for cost estimate details.

### 8.4.5 Compatibility With the Secretary of the Interior's Standards for Rehabilitation

See Appendix M for the Secretary of the Interior's (SOI) Standards for Rehabilitation.



Alternative 4 proposes to replace Bridge 9103's slab with a new superstructure that is about one-third wider than the original slab. The historic piers, abutments, and slope paving would be enlarged to the west to accommodate the new slab. TH 61 would be lowered about 1' beneath the bridge.

The southern approach roadway would also be altered. The approach would be widened and its horizontal alignment modified so a widened TH 63 would avoid impacting the eastern corner of the National Register-eligible Red Wing Shoe Company building (Figures 3 and 18). The southern approach's historic retaining walls would be removed and replaced with new walls.

The historic railing on both the bridge and southern approach would be replaced with a new TL-2 railing of undetermined design. The two historic lights on the bridge and approach would be replaced with new lights of undetermined design. Mature spruce trees immediately west of the spot where the southern approach meets the bridge would be removed.

Alternative 4's proposed work items would not meet the Secretary of the Interior's Standards. A substantial part of the bridge's historic fabric would be lost and numerous character-defining features would be altered.

### **Other Historic Properties**

Bridge 9103 is a Contributing element within the Red Wing Segment of a linear historic district – the Highway 61 (Great River Road) Historic District – which is eligible for the National Register. The proposed changes to the bridge would not meet the Secretary of the Interior's Standards and would alter one of the district's Contributing elements. However, because Bridge 9103 represents a small component of the many-mile-long historic district, the district's overall historic integrity would not be significantly diminished.

Alternative 4 would change the setting of Barn Bluff, which is listed on the National Register. Under this alternative Bridge 9103 and its approach – located south of the western flank of the bluff (Figures 4 and 19) – would be widened by about one-third and would carry four rather than two lanes of traffic as well as a 10'-wide trail. Because the change would occur to an element that is already a modern intrusion in Barn Bluff's setting, and because the bridge would be widened away from the bluff rather than moving closer toward it, it is recommended that the widening of Bridge 9103 proposed under Alternative 4 would not be a change substantial enough to significantly diminish the property's historic integrity. (The assessment of other effects to Barn Bluff from the Red Wing Bridge Project are beyond the scope of this bridge rehabilitation study.)

Alternative 4 would also change the setting of the Red Wing Shoe Company, which is eligible for the National Register. The recommended boundary of the National Register-eligible property extends to the existing Third Street curblin (Figure 3). Under this alternative, Bridge 9103 and its approach north and northeast of the property would be widened by about one-third and would carry four, rather than two, lanes of traffic as well as a 10' trail. A narrow slice of the eastern side of the Shoe Company's parking area would be removed. The slice to be removed is on MnDOT right-of-way (Figure 6) and outside the boundary of the National Register-eligible property. The right-of-way would not expand at this location. In another setting change, Third Street immediately east of the Shoe Company would be widened by about 50% and would carry more lanes of traffic and a 10' trail. The trail would be east of the existing Third Street curblin,

whose alignment would not change, and the mature street trees immediately west of the curb would remain in place. Finally, both buildings across the street to the east of the Shoe Company would likely be demolished.



Figure 19. Barn Bluff in 1960 with new and old alignments of TH 63 (Minnesota Historical Society photo by the St. Paul Pioneer Press).

It is anticipated that the described setting changes would not be substantial enough to significantly diminish the Red Wing Shoe Company's historic integrity. The factory was built within, and would remain within, a downtown setting with an urban street grid predominant to the south and west. The factory would remain adjacent to a modern bridge and highway (Bridge 9103 and TH 63) that became part of the Shoe Company's setting within the property's National Register period of significance of 1905-1965. The changes in setting proposed under Alternative 4 would not substantially alter the property's ability to convey its historic character and significance. Integrity of location, design, materials, workmanship, feeling, and association would be retained. Stewardship of the property would not likely be affected.

Alternative 4's proposed changes to Bridge 9103 would not affect the setting or viewshed of any other historic properties in Red Wing. However, assessing changes in traffic volume and pattern resulting from the change from two to four lanes on the bridge and on Third Street are beyond the scope of this rehabilitation study and will be addressed in the NEPA process.

### Summary

In summary, it is anticipated that Alternative 4 would not meet the Secretary of the Interior's Standards for Rehabilitation. The proposed work would result in substantial change to Bridge

9103's integrity of design, materials, workmanship, feeling, and association; but no change to its integrity of location and setting. The alterations would adversely effect Bridge 9103's historic character per Section 106. (No other historic properties would be adversely affected.) It is recommended that Bridge 9103 would no longer be eligible for the National Register after the change. Alternative 4 would likely constitute "use" of the historic property under Section 4(f).

#### **8.4.6 Alternative 4's Ability to Meet Purpose and Need**

Alternative 4's ability to meet the project Purpose and Need is summarized below. See also the Evaluation Matrix in Section 9.0.

##### **Primary Needs**

Alternative 4 would meet the primary needs of maintaining connectivity to the Mississippi River crossing and providing a structurally sound crossing of TH 61. The inventory load rating factor of the bridge would be improved to greater than the minimum desired rating factor of 1.00 (see details in Appendix J), and the service life of the bridge would be increased to at least 60 years.

##### **Secondary Needs**

The alternative would meet the secondary needs of maintaining the continuity of TH 63, maintaining TH 63's connections with TH 61 and TH 58, and maintaining access to Trenton Island.

The alternative would improve the bridge's capacity in terms of traffic volume by widening it from a two-lane to a four-lane bridge.

Alternative 4 would improve traffic safety by replacing the historic railing (which does not meet current standards for strength) with a new TL-2 railing. In addition, new guardrail would have crashworthy end terminals.

The alternative maintains traffic to the greatest extent possible. By constructing Alternative 4 in two stages, two-way traffic could be maintained on TH 63. Because of the additional slab width in this alternative, the slab could be constructed one-half at a time using relatively common two-stage construction. This alternative would require the contractor to work with live traffic on one side of the work zone. Slab construction would be expected to last up to 4 to 5 months.

On TH 61, occasional short-term closures may be required for falsework construction but they would not be expected to last long. Vertical clearance on TH 61, however, would be reduced by 2' to 3' for approximately 6 to 10 weeks while the falsework was in place. Tall trucks would be required to detour on TH 58 and CSAH 21 (Flower Valley Road). The detour's challenges are described under Secondary Needs in Section 8.1.6 (Alternative 1) above.

The process of lowering TH 61 would also require that both directions of TH 61 be reduced from two lanes to one lane for approximately 2 to 4 weeks.

Alternative 4 would improve pedestrian/bicycle facilities by replacing the existing raised sidewalks on the bridge and southern approach with a raised 10'-wide trail on the west side

only. The trail would extend to Third and Potter Streets. ADA-compliant ramps and tactile paving would be added where needed.

### **Other Considerations**

Bridge geometrics would be somewhat improved because of replacement of the historic railing with a new railing that meets MnDOT standards for height and opening size. No improvement in horizontal clearance for TH 61 is proposed under Alternative 4 and a design exception would be required. A design exception would also be required for vertical clearance (see Table 4).

Because Bridge 9103 and Third Street would carry four rather than two lanes of traffic, the alternative has the potential to increase downtown congestion, which may hinder economic development. The increase from two to four lanes may also result in a reduction in downtown parking.

Alternative 4 would constitute an adverse effect under Section 106 and would likely constitute use of a historic property under Section 4(f). The bridge rehabilitation would not meet the Secretary of the Interior's Standards for Rehabilitation, primarily because of the extensive removal and alteration of character-defining features. It is recommended that the bridge would no longer be eligible for the National Register. The historic integrity of other historic properties (see 8.4.5 above) would not be significantly diminished. However, construction would occur outside of the existing footprint of the bridge and its southern approach; potential archaeological impacts are unknown pending an archaeological survey.

Alternative 4 would have no effect on the navigational channel. Section 404 water quality requirements would be met.

### **Social, Economic, and Environmental Issues**

Alternative 4 would require the acquisition of approximately four parcels, including two warehouses, on the east side of Third Street (shaded in pink on Figure 18). (Increasing the right-of-way on the east side of Third Street, rather than on the west side, avoids impacts to the Red Wing Shoe Company, which is eligible for the National Register.) Acquisition of the two warehouses would likely result in two relocations. The parking lot between the two warehouses (see Figure 18) is owned by the same owner as the southwestern warehouse. The northeastern warehouse is the western part of a complex that includes the parking lot and buildings east of the northeastern warehouse.

Access to the parking lot of the Red Wing Shoe Company's Main and Potter Street facility would be affected during construction. The only entrance to the parking lot is via the service drive in Span 2, and the complex's only loading dock is on the northeast facade (Figure 3). The service drive would be occasionally closed for short periods of time while the falsework shoring for slab repairs was being erected. Vertical clearance for the service drive would be reduced by 2' to 3' for about 6 to 10 weeks while the falsework was in place. Vertical clearance over the drive is currently 14.7' (about 14'8"). The loading dock needs to be accessed each day by UPS trucks, which require 13'10" clearance, and about once per month by semi-trucks, which require 14' clearance, for essential deliveries and product shipment.

Access to the Red Wing Shoes parking area would also be affected by the process of lowering the elevation of the service drive to continue to meet MnDOT's vertical clearance standard (see Table 4). This is necessary because vertical clearance would be permanently reduced by widening the superelevated slab. The service drive could be lowered one lane at a time so access to the parking area is maintained.

The Red Wing Shoe Company parking area would also be slightly but permanently reduced in size because of the widened bridge and southern approach. The part of the parking area to be removed is at its eastern edge and is within MnDOT right-of-way. The right-of-way would not need to expand at the parking area.

Alternative 4 is expected to require four temporary easements during construction.

There are expected to be no other environmental impacts under this alternative.

## **8.5 Relationship to Design Standards**

**Table 4. Relationship to Design Standards**

See Section 6.0 for information on the standards referenced.

	EXISTING CONDITION		ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
DESIGN EXCEPTIONS						
RAILING STRENGTH	5.4 kip transverse load capacity (ASD); 9.8 kip tranverse load capacity (LRFD)	Standards MnDOT BPIR: 10 kip transverse load (ASD) MnDOT Br Design Manual and AASHTO LRFD Br Design Specs: TL-2 which is 27.0 kip transverse load (LRFD)	MnDOT BPIR or MnDOT Design Manual	MnDOT BPIR or MnDOT Design Manual	TL-2	TL-2
		Alternative proposes	No change	Historic rail plus new inner TL-2	Historic rail plus new inner TL-2	New TL-2 rail
		Exception needed?	Yes	No	No	No
RAILING HEIGHT	39"	Standards MnDOT Br Design Manual: 42" AASHTO LRFD Br Design Specs: 42"				
		Alternative proposes	No change	No change	No change	New TL-2 rail (at least 4'6" tall for bikes)
		Exception needed?	Yes	Yes	Yes	No
RAILING OPENING SIZE	4½" to 5½"	Standards MnDOT Br Design Manual: 4" below 27" and 6" above 27"; AASHTO Br Design Specs: 6" below 27" and 8" above 27"				
		Alternative proposes	No change	No change	No change	New TL-2 rail (meeting standards)
		Exception needed?	Yes	Yes	Yes	No
VERTICAL CLEARANCE	15.5' over TH 61 SB 16.4' over TH 61 NB 14.7' over service drive	Standards MnDOT BPIR: varies over principal arterial; 14.5' over local street	16.0' needed	16.0' needed	16.33' needed	16.33' needed
		Alternative proposes	No change unless Lower TH 61 Option included, then 16.4'	No change unless Lower TH 61 Option included, then 16.4'	No change unless Lower TH 61 Option included, then 16.4'	No change
		Exception needed?	Yes, unless Lower TH 61 Option included	Yes, unless Lower TH 61 Option included	Yes, unless Lower TH 61 Option included	Yes
HORIZONTAL CLEARANCE	TH 61 SB 0' left, 2' right TH 61 NB 0' left, ~4' right	Standards MnDOT Br Design Manual: 5.5' left, 10' right MnDOT BPIR: 4' left, 10' right				
		Alternative proposes	No change	No change	No change	No change
		Exception needed?	Yes	Yes	Yes	Yes
OTHER DESIGN ELEMENTS						
PEDESTRIAN FACILITIES AND ACCESSIBILITY STANDARDS	TH 63: west sidewalk 2'-6", east 5', grade and cross slope okay, no ramps or tactile paving TH 61: no ped facilities	Standards ADA: 5' sidewalk, 5% grade, 2.08% cross slope; ramps, tactile paving				
		Alternative proposes	TH 63: 5' walks with ramps and tactile paving; meets ADA TH 61: no change	TH 63: 5' walks with ramps and tactile paving; meets ADA TH 61: no change	TH 63: 5' walks with ramps and tactile paving; meets ADA TH 61: no change	TH 63: raised 10' ped/bike trail west side only, ramps, tactile paving; meets ADA TH 61: no change
BICYCLE FACILITIES	TH 63: bikes on 12' paved shoulders TH 61: bikes on 2' and ~4' paved shoulders	Standards MnDOT: 6' bike lane or 8' paved shoulder				
		Alternative proposes	TH 63: no change TH 61: no change	TH 63: no change TH 61: no change	TH 63: no change TH 61: no change	TH 63: raised 10' ped/bike trail west side only TH 61: no change



## 8.6 Rehabilitation Options Considered But Not Fully Developed

Described below are rehabilitation options that were considered during the development of the alternatives but not fully developed, generally because they were infeasible from an engineering standpoint or did not meet the Secretary of the Interior's (SOI) Standards for Rehabilitation, or both.

### 8.6.1 Cathodic Protection Alone

Using Cathodic Protection alone to mitigate chloride saturation of the deck slab was explored but determined not to be a viable alternative given the slab's advanced state of deterioration. Cathodic protection is described in some detail in Appendix K.

Bridge 9103 exhibits a significant amount of corrosion on the underside of the slab. The deterioration is particularly significant along the longitudinal slab joint, but is also present to varying degrees elsewhere on the slab.

Chloride concentrations were found to be high throughout the slab area and elevated from the surface to the bottom of the 9"- to 24"-deep core samples. Typically, high chloride concentrations are contained in the upper 1"-2" of a deck slab near the top reinforcing mat.

Given the state of the bridge slab, cathodic protection does not provide a long-term solution for the bridge. Cathodic protection cannot reverse the corrosion and loss of reinforcing steel section that has occurred, nor can it restore the lost live load capacity of the bridge. Cathodic protection would not remove the capacity reduction factors from the rating analysis, so the structural capacity of the bridge would not be significantly improved using this method alone.

A cathodic protection system has a finite life and would need replacement in 15 to 20 years. The effectiveness of cathodic protection for Bridge 9103 may also be negatively impacted by the fact that corrosion in the steel reinforcing grid has deteriorated contact between the bars and there may be insufficient contact to maintain electrical continuity in places.

### 8.6.2 Electrochemical Chloride Extraction

Using Electrochemical Chloride Extraction (ECE) to mitigate chloride saturation in the slab was also explored. Electrochemical chloride extraction is described in some detail in Appendix K.

ECE was determined to not be a viable alternative for Bridge 9103 given the issues outlined below:

- ECE systems can remove chlorides in the top several inches of a typical 8" bridge slab. Bridge 9103, however, is a continuous slab of 18½" thickness at midspan, haunched to 26" at the piers. The chlorides present lower in the 18½" to 26" depth will not be extracted. The lower reinforcing must carry the bridge slab self-weight and live loads in the midspan regions, and is thus a critical component. The midspan region is one of the most highly-stressed areas of a concrete slab bridge and ECE will not benefit this steel.

- Similar to cathodic protection, ECE does not restore section loss that has already occurred in the reinforcing steel
- Bridge 9103 would need to be closed for up to 8 weeks for the ECE installation and operation (at odds with one of the Red Wing Bridge Project's Secondary Needs). Similar to cathodic protection, the ECE process has a limited life and must be repeated every 10 to 15 years, which would result in several multiple-week detours during the remaining service life of the bridge.
- A level surface is the most desirable for installation of an ECE system. The ECE system requires the anode be kept wet in an electrolyte bath over the entire upper slab surface. In the case of Bridge 9103 the grade is significant at 4%, and is additionally complicated by a superelevation of up to 0.04 ft/ft. With the significant elevation differences in the deck slab, it would be difficult to install a system and end dams to maintain the electrolyte over the entire area without extraordinary construction, such as numerous terraced dams and separate ECE systems.

### 8.6.3 Deck Slab Patching

Deck slab patching is done to remove and replace deteriorated concrete in a deck slab to extend service life, but is generally not a permanent repair. Deterioration typically occurs due to chlorides present in a concrete slab. The casting of new concrete against existing concrete that contains chlorides can trigger "ring corrosion" where the old concrete and reinforcement on the periphery of the patched area will experience accelerated corrosion and damage, often within a few years of the repair (Clemena and Jackson 2000). There may be some smaller areas where patching is a possible solution for Bridge 9103, but the large areas of concrete spalls and corroded reinforcing along the existing centerline longitudinal joint are too great for patching to be a viable solution. In addition, most of the visible areas of deterioration are on the underside of the slab. Performing removal and patching operations overhead could prove to be more labor-intensive and time-consuming than removal of a full-depth strip. Overhead patches have a history of eventual failure, causing the concrete to fall to the roadway below. These are a safety issue for the owner.

### 8.6.4 Adding Members to the Existing Railing to Improve Strength and Geometrics

The rehabilitation study team explored adding steel members to the existing railing on both the bridge and southern approach to increase rail strength and height, and reduce opening size.

The option was eventually eliminated after no design could be identified that would not significantly alter the historic railing – a key component of the property's significant aesthetics. The proposed alterations would be in a highly-visible location and would not meet SOI Rehabilitation Standard 9 (changes should "not destroy historic materials, features, and spatial relationships that characterize the property"). The work would also be inconsistent with the SOI Rehabilitation Guidelines, which do not recommend "Altering, damaging, or destroying character-defining spaces, features, and finishes while making modifications to a building or site to comply with safety codes," or "Making changes to historic [properties] without first exploring

equivalent health and safety systems, methods, or devices that may be less damaging to historic spaces, features, and finishes.”

#### **8.6.5 Mounting the Existing Railing on a 6" Concrete Parapet to Improve Height**

The study team explored placing the existing railing, on both the bridge and southern approach, on a 6"-tall concrete parapet so the railing system would meet MnDOT and AASHTO height standards for pedestrian railings. After the alteration, the railing posts, which are 10' apart, would meet TL-2 strength standards. However, the horizontal rails and vertical pickets would not meet strength standards and a design exception would still be required. The size of the railing openings would not be altered; they would continue to meet AASHTO standards but not MnDOT standards (see Section 6).

The proposed parapet would be a continuous concrete structure 6" tall by 12" wide. Two possible locations were explored. The first placed the parapet so the railing would remain at its current location: the centerline of the railing currently rises from a point 12" inside the outermost edge of the curved concrete coping (Figure 7). The second option was to place the parapet so the centerline of the railing would rise 12" farther to the inside. It was hoped that shifting the parapet to the inside might help maintain the distinctive, sculptural line of the coping.

It was ultimately determined that a 6" parapet in either location would significantly alter critical aspects of the bridge design including the slim Modernist deck slab (which would be visually thickened by the parapet); the shape and line of the curved coping (including its important planar upper surface); and the coping's spatial relationship with the bridge railing. The proposed change would affect a distinctive and highly-visible part of the bridge and would not be consistent with SOI Rehabilitation Standard 9 (i.e., alterations should "not destroy historic materials, features, and spatial relationships that characterize the property"). The alteration would also be inconsistent with the SOI Rehabilitation Guidelines which do not recommend "Altering, damaging, or destroying character-defining spaces, features, and finishes while making modifications to a building or site to comply with safety codes," or "Making changes to historic [properties] without first exploring equivalent health and safety systems, methods, or devices that may be less damaging to historic spaces, features, and finishes."

#### **8.6.6 Mounting the Railing on a 28" Concrete Parapet to Meet Strength and Geometric Standards**

The team briefly explored the option of placing the existing railing, on both the bridge and southern approach, on a 28"-tall poured concrete parapet so the railing system would meet TL-2 strength standards. After the alteration, the railing would also meet MnDOT and AASHTO standards for height and opening size (see Section 6.0). The parapet would be a continuous concrete structure 28" tall and 12" wide. Two locations were considered. Because the 28" parapet would be a more radical change than the 6" parapet (see above), it was dropped from consideration for the same reasons the 6" parapet was eliminated.

### 8.6.7 Replacing the Existing Railing with a Custom Railing That Meets Design Standards

The team explored the option of replacing the existing railing, on both the bridge and southern approach, with a custom-designed railing that meets MnDOT standards for strength, height, and opening size (see Section 6.0) and replicates the existing railing as closely as possible. No design could be identified that did not differ significantly from the existing railing (see, for example, Figure 20).

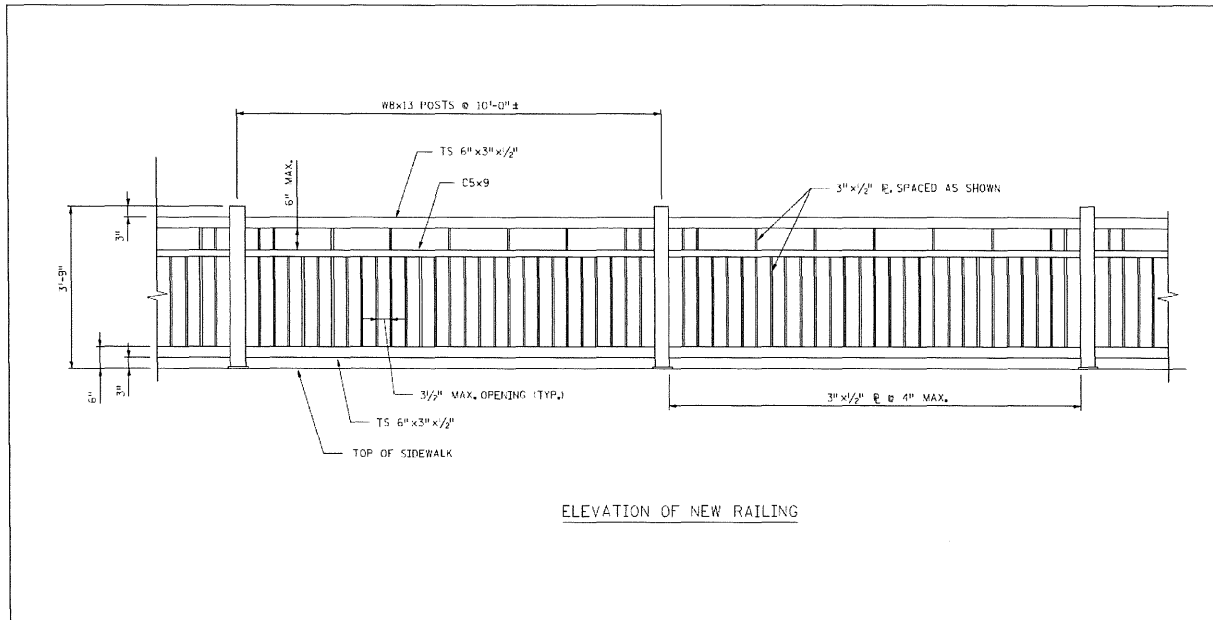


Figure 20. Potential custom-designed railing that meets MnDOT standards for strength, height, and opening size and replicates the existing railing as closely as possible. Its use on Bridge 9103 would not meet the Secretary of the Interior's Standards for Rehabilitation (HDR drawing).

The proposed change would be in a highly-visible location and seriously diminish the historic integrity of the bridge. The loss of the original railing would not meet SOI Rehabilitation Standards 2 and 5, which emphasize retaining and preserving important, distinctive elements. The change would not be reversible, which is inconsistent with Standard 10. Like other railing changes described above, the work would be inconsistent with the SOI Rehabilitation Guidelines which do not recommend "Altering, damaging, or destroying character-defining spaces, features, and finishes while making modifications to a building or site to comply with safety codes," or "Making changes to historic [properties] without first exploring equivalent health and safety systems, methods, or devices that may be less damaging to historic spaces, features, and finishes."

### **8.6.8 Raising the Bridge Slab to Increase Vertical Clearance**

The study team explored the possibility of raising the bridge slab or superstructure by approximately 10" to improve vertical clearance in Alternative 3, which proposes to fully replace the slab (see Section 8.3.1). Under this scenario, the height of the pier caps (the upper part of each pier) would be increased from the existing 3'6" to about 4'4". The abutments would be correspondingly altered, as would the southern approach, whose roadway, sidewalk, coping, and concrete retaining walls align with those of the bridge.

The option was dropped from consideration because the alterations would substantially diminish the historic property's integrity of design. The changes would alter shapes and proportions essential to the bridge's aesthetics including the design of the slim Modernist slab and the visual relationship between slab and piers (Figure 7). The change would not meet the Secretary of the Interior's Rehabilitation Standards 2, 5, 9, and 10.

### **8.6.9 Widening Rather Than Replacing Existing Slab to Accommodate Four Lanes**

To accommodate a 78'-wide roadway with four lanes of traffic, the possibility of widening the existing slab, rather than replacing it as proposed in Alternative 4, was considered. The deteriorated approximately 10'- to 15'-wide strip down the center of the slab would still need to be replaced. The option was dropped from consideration because the cost of widening the existing slab and replacing the central 10' to 15' would be similar to the cost of replacement, yet issues of chloride concentration and deteriorating reinforcing steel would remain in the portions of the historic slab that were retained. The service life would be shorter than if the slab were replaced, and additional patching and repairs to areas of the slab outside the approximately 10' to 15' center strip would still be required within 10 to 15 years. It was also determined the change would not meet the Secretary of the Interior's Rehabilitation Standards, including Standards 2, 5, 9, and 10.

### **8.6.10 Rehabilitating Bridge 9103 to Accommodate One of a Pair of River Crossing Bridges**

Creating a pair of bridges at the river crossing is one of the proposed alternatives for Bridge 9040. Rehabilitating Bridge 9103 to serve as the approach for one of a pair of two-lane river bridges was considered by the rehabilitation study team. The option was determined infeasible because of Bridge 9103's horizontal alignment and close proximity to the river crossing.

Bridge 9103 could not be used to carry TH 63's two northbound lanes because there is not adequate distance between the river bridge and the Red Wing Shoe Company building to build a southbound bridge west of Bridge 9103 and tie the horizontal alignment back into Third Street.

Bridge 9103 could not be used to carry TH 63's two southbound lanes because there is not adequate distance between Bridge 9103 and Barn Bluff to build the northbound lanes to the east of Bridge 9103.

## **9.0 REHABILITATION ALTERNATIVES EVALUATION MATRIX**

Bridge 9103 Rehabilitation Alternatives Evaluation Matrix - August 2013

EVALUATION CRITERIA	See this report's Table 4 for information on the standards referenced below	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3	ALTERNATIVE 4
		Replace Approx. 10'-15' Strip	Replace Approx. 10'-15' Strip and Add Inner Rail	Full Slab Replacement	Widen to Four Lanes
PRIMARY NEEDS					
Structurally sound crossing of the Mississippi River	Ability to maintain connectivity to Bridge 9040	No effect	No effect	No effect	No effect
Structurally sound crossing of US 61	Ability to meet structural requirements	Repaired concrete slab, Inv Rating Factor > 1.00	Repaired concrete slab, Inv Rating Factor > 1.00	Replaced concrete slab, Inv Rating Factor > 1.00	Replaced concrete slab, Inv Rating Factor > 1.00
SECONDARY NEEDS					
Continuity of US 63	Ability to maintain continuity	Yes	Yes	Yes	Yes
US 63 connection to US 61 and TH 58	Ability to maintain connections	Yes	Yes	Yes	Yes
Adequate capacity, acceptable traffic operations, safe design	Ability to provide adequate capacity for design year 2042 estimated AADT of 15,600	No improvement	No improvement	No improvement	Capacity improved from 2 to 4 Lanes
	Ability to maintain acceptable operations	Yes	Yes	Yes	Yes
	Ability to maintain or improve traffic safety	Maintained	Improved - inner TL-2 rail added	Improved - inner TL-2 rail added	Improved - rail replaced with TL-2 rail
	Ability to meet current standards for bridge rail crashworthiness	Does not meet TL-2 standards 9.8 kip transverse load capacity (LRFD); see Table 4	Meets TL-2 standards 27.0 kip transverse load capacity (LRFD); see Table 4	Meets TL-2 standards 27.0 kip transverse load capacity (LRFD); see Table 4	Meets TL-2 standards 27.0 kip transverse load capacity (LRFD); see Table 4
Maximum maintenance of traffic	Duration of full closure of US 63	Negligible	Negligible	Negligible	Negligible
	Duration of full closure of US 61	Negligible	Negligible	Negligible	Negligible
	Duration US 61's vertical clearance is reduced	4 to 6 weeks	4 to 6 weeks	10 to 14 weeks	6 to 10 weeks
	Complexity of construction staging	One stage but work zone between 2-way live traffic	One stage but work zone between 2-way live traffic	Three stages required, all next to live traffic	Conventional two-stage construction
	Risk of unforeseen factors affecting traffic maintenance	Risk that removal limits increase during construction	Risk that removal limits increase during construction	Low Risk	Low Risk
Access to Trenton Island	Ability to maintain connectivity to Bridge 9040	No effect	No effect	No effect	No effect
Maintain or improve pedestrian/bicycle facilities	Ability to maintain or improve pedestrian/bicycle facilities (see also Geometrics)	Improved for TH 63 peds - sidewalks widened, extended to 3rd and Potter, ADA ramps added; no improvement on TH 61	Improved for TH 63 peds - sidewalks widened, extended to 3rd and Potter, ADA ramps added; no improvement on TH 61	Improved for TH 63 peds - sidewalks widened, extended to 3rd and Potter, ADA ramps added; no improvement on TH 61	Improved for TH 63 peds and bikes - sidewalks replaced with one 10' trail to 3rd and Potter with ADA ramps; no improvement on TH 61
OTHER CONSIDERATIONS					
Structural redundancy	Not applicable to Bridge 9103	n/a	n/a	n/a	n/a
Geometrics	Meet current design standards - vertical clearance	Only with Lowering TH 61 Option; see Table 4	Only with Lowering TH 61 Option; see Table 4	Only with Lowering TH 61 Option; see Table 4	No - see Table 4
	Meet current design standards - horizontal clearance	No - see Table 4	No - see Table 4	No - see Table 4	No - see Table 4
	Meet current design standards -pedestrian rail height	No - 3" low see Table 4	No - 3" low see Table 4	No - 3" low see Table 4	Yes see Table 4
	Meet current design standards - pedestrian rail opening size	Meets AASHTO, not MnDOT; see Table 4	Meets AASHTO, not MnDOT; see Table 4	Meets AASHTO, not MnDOT; see Table 4	Meets both; see Table 4
Economic development	Ability to maintain or improve economic development	No effect	No effect	No effect	Potential congestion increase due to 4-lane traffic
Parking	Ability to maintain or improve downtown parking	No effect	No effect	No effect	Potential parking loss due to 4-lane traffic
Regulatory Requirements:					
Section 106 compliance - Bridge 9103	Ability to meet the SOI's Standards for Rehabilitation	No adverse effect - meets SOI Rehab Standards	No adverse effect - meets SOI Rehab Standards	Adverse effect - does not meet SOI Standards, property would be ineligible for NRHP	Adverse effect - does not meet SOI Standards, property would be ineligible for NRHP
Section 106 compliance - Other historic properties	Effect on Highway 61 (Great Riv Rd) Historic District	No adverse effect	No adverse effect	No adverse effect	No adverse effect
	Effect on Barn Bluff	No adverse effect	No adverse effect	No adverse effect	No adverse effect
	Effect on Red Wing Shoe Company	No adverse effect	No adverse effect	No adverse effect	No adverse effect
Section 4(f) compliance	Section 4(f) impacts	No Section 4(f) use	No Section 4(f) use	Section 4(f) use TBD	Section 4(f) use TBD
Navigational channel	Effect on maintenance of channel	No effect	No effect	No effect	No effect
Section 404 water quality requirements	Ability to meet required stormwater management practices	Yes	Yes	Yes	Yes
SOCIAL, ECONOMIC AND ENVIRONMENTAL ISSUES					
Right-of-way impacts	Number of parcels acquired	None	None	None	4
	Number of structures acquired	None	None	None	2
	Number of relocations	None	None	None	2
	Number of temporary easements	2	2	2	4
Property access	Ability to maintain access to nearby properties during construction	Vertical clearance for RW Shoes access road reduced for 4 to 6 weeks	Vertical clearance for RW Shoes access road reduced for 4 to 6 weeks	Vertical clearance for RW Shoes access road reduced for 10 to 14 weeks	Vertical clearance for RW Shoes access road reduced for 6 to 10 weeks
	Ability to maintain permanent access to nearby properties	Access maintained	Access maintained	Access maintained	Access maintained
Other environmental impacts	Ability to minimize other environmental impacts	No impacts	No impacts	No impacts	No impacts
COST					
Construction Cost Estimate	Base alternative	\$ 935,000 - \$ 1,170,000	\$ 1,075,000 - \$ 1,345,000	\$ 1,780,000 - \$ 2,045,000	\$ 3,015,000 - \$ 3,345,000
	Alternative with Cathodic Protection (CP) Option	\$ 2,025,000 - \$ 2,530,000	\$ 2,165,000 - \$ 2,705,000	n/a	n/a
	Alternative with Lowering TH 61 Option	\$ 1,600,000 - \$ 1,835,000	\$ 1,740,000 - \$ 2,010,000	\$ 2,445,000 - \$ 2,710,000	n/a
	Alternative with both options	\$ 2,690,000 - \$ 3,195,000	\$ 2,830,000 - \$ 3,370,000	n/a	n/a
Service Life	Number of years until significant rehabilitation required	10 to 15 years, increased to 20 with CP Option	10 to 15 years, increased to 20 with CP Option	60 years	60 years



## 10.0 RECOMMENDATIONS/CONCLUSION

Bridge 9103, completed in 1960 and eligible for the National Register of Historic Places, serves as the approach for Bridge 9040 over the Mississippi River and carries TH 63 over TH 61. Both roads are on the National Highway System.

Bridge 9103's inventory load rating factor (RF<sub>inv</sub>) is approximately 0.95, below the desired factor of 1.0. The bridge does not currently require load posting and is safely carrying normal traffic. However, while the bridge's overall condition is listed as fair, the concrete superstructure is deteriorating and threatens the ability to maintain adequate load capacity. Posting the bridge to prohibit heavy loads would hinder the increasing number of large commercial haulers who use the Mississippi River crossing at Red Wing for the transport of agricultural and industrial materials and other freight.

Bridge 9103 meets some modern design criteria including vertical profile, horizontal curve geometrics, and lane and shoulder width. However, the historic railing's crashworthiness falls below MnDOT BPIR and MnDOT Bridge Design Manual standards, and the bridge is not universally accessible. Horizontal clearance for TH 61 is significantly more narrow than MnDOT standards, a potential safety concern, and vertical clearance is several inches lower than MnDOT standards, causing the diversion of some oversize loads onto other routes.

A rehabilitation study committee comprised of staff from FHWA, MnDOT, SEH, HDR Engineering, and Gemini Research met in 2012 and 2013 to develop alternatives for the rehabilitation of the bridge, particularly seeking alternatives that would meet the Secretary of the Interior's Standards for the Treatment of Historic Properties and comply with Section 106 of the National Historic Preservation Act and Section 4(f) of the Transportation Act of 1966.

Four alternatives were identified and opportunities to create hybrid alternatives were explored. The four alternatives were assessed against a set of evaluation criteria, most of which were derived from the Red Wing Bridge Project's Purpose and Need.

All four alternatives would increase load capacity. Alternatives 1 and 2, which differ only in the use of an inner TL-2 rail, would meet the Secretary of the Interior's Rehabilitation Standards. Alternatives 3 and 4, which propose to replace the bridge's concrete slab superstructure, would not meet the Standards and would diminish the property's historic integrity to the point that it is no longer eligible for the National Register. Alternatives 2, 3, and 4 would improve traffic safety, a secondary need, with railings that meet TL-2 crash test requirements, while Alternative 1's rail would remain below standards. (Alternative 4 would also meet criteria for rail height and opening size.) All four alternatives would meet ADA requirements. Alternative 4 would increase traffic capacity, a secondary need, by accommodating a four-lane rather than two-lane roadway. None of the alternatives would improve horizontal clearance on TH 61. Alternatives 1, 2, and 3 could improve vertical clearance if an optional lowering of the TH 61 roadway is included. No improvement of vertical clearance is possible with Alternative 4. Horizontal and vertical clearance are other considerations in the Purpose and Need statement.

Alternatives 1 and 2 each have a service life of 10 to 15 years, which could be increased to about 20 years if optional cathodic protection is included. Alternatives 3 and 4 each have a service life of about 60 years. Service life is defined as the number of years before significant

rehabilitation would be required; significant rehabilitation is defined as work that requires hiring a contractor but excludes mill and overlay which is expected maintenance within a bridge's service life.

Alternatives 1 and 2 have the risk that unforeseen deterioration of the slab may be identified during construction, complicating construction staging and threatening maintenance of traffic on TH 63, which is a secondary need. Alternative 3 is the most complicated of the four to construct. Alternative 4 is the only alternative that would require additional right-of-way; it would require acquisition of about four parcels with two likely relocations.

The rehabilitation study committee recommends that Alternatives 1 and 2 are viable alternatives for the rehabilitation of Bridge 9103. Each has two optional work items: passive cathodic protection of the concrete slab, and lowering TH 61 by about 10" to improve vertical clearance. The committee recommends that Alternatives 3 and 4 are not viable because they would not meet the Secretary of the Interior's Standards for the Treatment for Historic Properties and would diminish Bridge 9103's historic integrity to the point that it is no longer eligible for the National Register. These two alternatives would create an adverse effect under Section 106 of the National Historic Preservation Act and likely constitute "use" of historic properties under Section 4(f) of the Transportation Act of 1966.

## 11.0 REFERENCES

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# APPENDIX A PROJECT PURPOSE AND NEED

# **RED WING TH 63 BRIDGE PROJECT**

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## **PURPOSE AND NEED: WORKING DRAFT**

*August 15, 2012*

The two primary purposes of this project are to provide a structurally sound bridge crossing of the Mississippi River Main Channel at Red Wing (i.e., the Red Wing Bridge ) and to provide a structurally sound crossing of US TH 61. Due to the condition of the existing bridges and maintenance requirements (detailed below), the existing bridges will not adequately meet this need without extensive investment.

Due to the role of TH 63 in the project area transportation system and due to the physical and cultural setting of the project, there are other needs that must be met by this project. The project must provide for continuity of US TH 63 between Minnesota and Wisconsin. The crossings, connecting roadways, and intersection(s) must maintain the connection of US TH 63 in Trenton Island, Wisconsin to US TH 61 and MN TH 58 in Red Wing. The crossings, connecting roadways, and intersection(s) at the Red Wing touchdown point(s) must be safe, have adequate capacity to serve existing and future traffic volumes, and be studied in conjunction with the bridge crossings. Maintenance of traffic -- both across the river and on the river -- must be maximized (i.e. as short an amount of time with total closure as possible). Access must continue to be provided from US TH 63 to Trenton Island and pedestrian and bicyclist facilities must be at least maintained and potentially improved.

Finally, it is desirable, though not essential, for the project to meet other transportation needs, which are described under Other Considerations below.

### **PRIMARY NEEDS:**

#### **A. NEED FOR STRUCTURALLY SOUND BRIDGE CROSSING OF THE MISSISSIPPI RIVER MAIN CHANNEL AT RED WING**

##### **Rehabilitation, maintenance, and inspection history**

The existing Red Wing Bridge (MN Bridge 9040/WI Bridge B470024) was completed in 1960, has maintenance needs that will require extensive ongoing investment, and is nearing the end of its design life. The bridge still has its original deck, which is approximately 50 years old. In 1978 a 2 inch low slump overlay was added to the bridge deck. The expansion joints were also reconstructed at that time. The bridge received a complete painting (zinc/epoxy/urethane paint system) in 2002. The final coat of paint that was applied in 2002 was poor quality, which will likely negatively impact the life of the paint system.

The north abutment and pier 8 began to experience substantial movement/settlement problems shortly after the bridge was constructed. In 1972 the bearing areas on the abutment and pier were reconstructed. The bridge seat for the north abutment was raised approximately 26-29 inches to

restore the bridge to the original grade. The concrete bridge seat was also raised approximately 16 inches on pier 8 to raise the bridge to the original grade on account of the movement and settlement issues. The raised portion of the beam seats is experiencing concrete deterioration and all of the blocks under the five girders are experiencing cracking, spalling, and delamination. Steel supports have also been added to pier 8 in order to raise the bridge to provide support during future maintenance activities. Settlement has slowed in recent years, however the abutment and pier 8 continue to settle. Pier 7 is also experiencing some settling issues. The total settlement of the north abutment is nearly 3.5 feet and the total settlement of pier 8 is approximately 2.5 feet.

Several inspection reports, including the May 2010 bridge inspection report, have noted that many of the tack welds in the superstructure have cracked, however none have been noted to have propagated into the main members thus far. Monitoring of the cracked tack welds will continue during future inspections to verify that cracking has not propagated into the base metal.

Several inspection reports have also noted that the superstructure has been continually moving longitudinally toward the south, likely due to the bearings not working properly. The July 2010 fracture critical inspection confirmed that the bearings on pier 8 have expanded to their limits and are no longer functioning. Several other bearings in other locations of the structure are also nearing their limit. Several of the bearings were re-seated in 1972, however movement has continued and many are in need of re-seating again. This cannot be done without further modification or replacement of the piers and north abutment, since the plates and bearings are reaching the limit of where they can be moved toward the edge of the seat on the top of the piers and abutment.

### **Condition Summary**

Overall the bridge is still functional. However, it is nearing the end of its useful life, and although activities over the last few decades have assisted in extending the life of the bridge, it is time for a higher level of investment in the structure as the bridge has reached an age at which substantial maintenance needs are anticipated. Maintenance needs and costs have been relatively low for the bridge up to this point, however, the scope of maintenance work and the costs of that work will be substantially higher in the near future.

The bridge currently has a sufficiency rating of 43.8. The deck has a large amount of cracking and widespread spalling throughout, especially the concrete stools adjacent to the floor beams and stringers. Deck replacement will be needed in the near future to address the problems. The July 2010 fracture critical inspection found that the deck condition is getting worse, likely due to the substantial amount of salt brine that is applied during winter conditions. Concrete delamination and spalling was found under the deck in numerous areas. As a result, many of these areas of delaminated and spalled concrete were knocked down by maintenance crews to prevent safety issues from falling concrete.

The existing finger joints allow a substantial amount of chloride to drain onto the bridge beams and cause corrosion. The finger joints are in need of replacement to help reduce future



corrosion. The paint system is functioning adequately at this time, with 5% being unsound, but due to the paint that was used in 2002 it is unlikely that it will have a life longer than 15 years.

Pier 2 has vertical cracking, spalling, and large areas of delaminated concrete, due to two separate barge impacts that occurred in 1992 and 1995 and because of the age of the structure. Several other piers also have cracking and spalling concrete noted in the inspection reports. Numerous areas of the superstructure and bearings have been noted as having failed paint and active corrosion. Several of the bearings have pack rust and are not functioning properly, as noted above. Several of the hinges on the stringers have heavy corrosion and large amounts of debris, which is likely restricting movement.

The truss spans appear to be in relatively good condition, especially when compared to other similar structures built during the same time period. They also have adequate load capacity. The north approach spans are in worse condition and do not have the required load capacity. Inspection reports for the bridge do not note any serious deficiencies in the fracture critical members. There are no economical means of correcting the lack of redundancy for the truss spans. Geometrically, the bridge cannot be expanded to provide more travel lanes.

Substantial maintenance activities that have been completed on the existing bridge thus far include pier and abutment repairs due to settlement (1972); the addition of a low-slump concrete wearing course (1978); and truss repainting (1974, 1987, & 2002).

Without a higher level of investment in the river crossing there are extensive maintenance activities that are expected on the existing structure in the near future to keep the bridge functional in the short term. Some of these activities include complete deck replacement; replacement of expansion joint devices; replacement of several bearings; replacement of several approach span girders (to meet load rating requirements); replacement of the north abutment, Pier 8, and potentially Pier 7 to address settlement/movement issues; repainting; concrete surface repairs; channel stabilization at Pier 2; concrete surface repairs to piers; possible stringer and floorbeam replacement (where joint leakage has led to corrosion); and possibly the addition of a containment system for deck run-off.

## **B. NEED FOR STRUCTURALLY SOUND CROSSING OF US TH 61**

The existing US TH 63 bridge over US TH 61 (MN Bridge 9103) on the Minnesota approach to the Red Wing Bridge was completed in 1960. US TH 63 functions as a modified facility on the bridge, since NB US TH 63 functions as a single lane and SB US TH 63 widens from one to two lanes on the bridge. It is a concrete slab span, curved structure, has maintenance needs that will require extensive ongoing investment, and is nearing the end of its design life. It currently has a sufficiency rating of 50.4. In 1978 a low slump overlay was added to the bridge deck. Both of the abutments and most of the piers have map cracking, delaminated areas, and spalling concrete. The concrete deck on several of the spans has numerous spalls that have been knocked off. Many of the rebars are exposed and are rusting. Many of the masonry plates and bearings have active corrosion with some loss of section.

This bridge is located on the Minnesota approach to the Red Wing Bridge. MN Bridge 9103 and MN Bridge 9040/WI Bridge B470024 are separated by approximately 350 feet, there are no roadway accesses between the two bridges, and the length of a potential detour for the bridges is identical. The traffic capacities of the two bridges are interrelated, so limiting the capacity of one bridge also limits the capacity of the other. The vertical profiles of the bridges are also interrelated, so modifying the profile of one bridge directly impacts the other bridge profile. As a result, the needs of this bridge are being studied in conjunction with studying the needs of MN Bridge 9040/WI Bridge B470024 over the river.

## **SECONDARY NEEDS:**

### **C. NEED FOR CONTINUITY OF US TH 63**

US TH 63 is an important regional and interstate route that extends from I-20 (Ruston, LA) to US TH 2 (Ashland, WI). The Red Wing Bridge and the US TH 61 crossing provide a critical connection to maintain the continuity of US TH 63. Both Wisconsin and Iowa classify US TH 63 as a Principal Arterial. It is designated as a State of Wisconsin Backbone 2030 Connector Route as well as an Official Designated Long Truck Route. Minnesota classifies US TH 63 from a Medium-Priority Interregional Corridor to a Minor Arterial, depending on the specific location within the state. The Red Wing Bridge and the US TH 61 crossings serve to connect this important highway.

US TH 63 is an important freight route between Wisconsin, Red Wing, and southeast Minnesota. A large number of trucks use this interstate route daily. It is a critical hauling route for bringing grain and other loads from Wisconsin to both the CP Rail terminal and the port in Red Wing. It is also an important freight route that is used for hauling between Wisconsin and the Rochester, Minnesota area, with trucks using the US TH 63 to MN TH 58 to US TH 52 route. Truck counts taken in August 2010 from 7:00-10:00 AM and 2:00-6:00 PM indicated approximately 170 trucks crossing from Wisconsin into Red Wing with 27% traveling south on MN TH 58 and 35% with destinations to the north on US TH 61, including the port and the rail terminal. The Red Wing Bridge and the US TH 61 crossings serve to provide a critical link in this important freight route.

The continuity of US TH 63 is critical for hauling oversize loads. The existing shoulders on the Red Wing Bridge are only 3 feet wide, which requires closure of the opposing lane when certain loads go across. Depending on the time of day, this causes various backups for the opposing traffic on US TH 63. From 2007 to 2009 a total of 1,549 trucks in excess of the legal width of eight feet six inches were issued permits for crossing, with 877 from 10 to 12 feet and 546 of them in excess of 12 feet. The continuity of US TH 63 between Wisconsin and Minnesota is important for maintaining this route for oversize loads.

### **D. NEED FOR CONNECTION TO US TH 61 AND MN TH 58**

The US TH 63 in Wisconsin to US TH 61 and MN TH 58 connections are important regional and interstate routes. US TH 61 is a part of the National Highway System and connects New Orleans, Louisiana to Minneapolis/St. Paul. It is a portion of the Great River Road and is

designated as a National Scenic Byway. It is a High-Priority Regional Corridor in the Red Wing area and is an important route for people commuting from Wisconsin for work, shopping, and personal trips, as well as being an important route for commerce, recreation, and tourism. Therefore, the direct connection of US TH 63 in Wisconsin to US TH 61 needs to be maintained.

The US TH 63 in Wisconsin to MN TH 58 connection is an important commuter and commerce route. MN TH 58 connects US TH 63 to US TH 52, which is a High-Priority Interregional Corridor. Commuters utilize US TH 63 in Wisconsin and MN TH 58 to travel from communities in Wisconsin to Rochester, home of IBM and the Mayo Clinic, and to other communities in southern Minnesota. A substantial amount of freight is hauled from western Wisconsin to southern Minnesota utilizing US TH 63 and MN TH 58. Therefore, the connection of US TH 63 in Wisconsin to MN TH 58 needs to be maintained.

## **E. NEED FOR ADEQUATE CAPACITY, ACCEPTABLE TRAFFIC OPERATIONS AND SAFE DESIGN**

### **1. Bridge Capacity**

Under future No-Build conditions, forecast traffic volumes exceed the capacity of the existing bridges, based on planning-level thresholds. The two-lane Red Wing Bridge carried an average daily traffic (ADT) of 13,300 vehicles per day in 2012, which is within the theoretical design capacity of a two-lane undivided urban road. The capacity of a two-lane facility at LOS D is 14,100, according to the Highway Capacity Manual.

A traffic study was completed for downtown Red Wing in 2005 and updated in 2012. Forecasts for the river crossing were developed for year 2042 and 2072. The year 2042 was selected to represent 20 years following a potential project completion date. The 50-year horizon represented by the year 2072 was analyzed in consideration of the long-term investment represented by a major bridge project. The forecast daily traffic volume on the Red Wing Bridge for year 2042 is 18,700 vehicles, which is over the theoretical capacity of a two-lane facility. An operational analysis was conducted to better understand the ability of the existing bridge and approach roadways to carry the forecast level of traffic. As detailed in the following section, operational issues are expected under future No-Build conditions. The 50-year forecast anticipates a traffic volume on the Red Wing Bridge of 24,100 vehicles per day, substantially over the capacity of a two-lane roadway. If additional capacity is not provided, substantial delays and potential safety issues are anticipated.

Wisconsin DOT has also completed traffic forecasts as a part of an Environmental Assessment (EA) process to study upgrading US TH 63 in Wisconsin. The 2040 traffic forecast for the Red Wing Bridge, which is similar to the 20 year forecast for this study, was 19,400 vehicles per day. The Wisconsin EA also stated that public input has confirmed that traffic congestion on US TH 63 is currently a problem, especially during AM and PM peak hour periods. It was determined that the existing two-lane facility in Wisconsin would not be able to handle the projected traffic increases. The outcome of the WisDOT EA process was that US TH 63 in Wisconsin is planned to be upgraded to a four-lane divided facility in future years. Therefore, there is a need to

address future continuity of the four-lane section from Wisconsin, across the river, into Minnesota.

## **2. Operational Deficiencies (Connecting Roadways & Intersections)**

Several operational deficiencies have been identified on TH 63 and connecting roadways in downtown Red Wing in proximity to the TH 63 bridge over TH 61 (Bridge 9103). US TH 63 intersects MN TH 58 and the two highways run concurrent for one block on Plum Street. MN TH 58 ends at the US TH 61 (Main Street) intersection. At that point US TH 63 turns to the south and runs concurrent with US TH 61 to Lake City. This overlapping of highways leads to congestion, queuing, and substantial delays during certain periods of the day.

The existing corner radius in the northeast quadrant of the US TH 63/MN TH 58 intersection is very tight for large trucks. It is not possible for semi trucks on SB TH 63 coming from Wisconsin to make the right turn on Plum Street to continue on US TH 63 towards US TH 61 without complete encroachment into the opposing lane. This maneuver is very difficult for trucks due to the volume of opposing traffic, which contributes to congestion and operational deficiencies at the intersection.

Under existing and future No-Build conditions, these intersections and roadways cannot achieve operational performance goals of:

- A stable (predictable) level of service D (LOS D) or better
- Queue lengths that do not impact adjacent intersections

Under existing conditions three intersections in the study area have notable operational deficiencies. The US TH 63 intersections with Potter Street, MN TH 58, and US TH 61 all currently experience LOS F and/or substantial queuing during peak periods. For existing conditions, the analysis also indicated that the major traffic bottleneck was the segment of Plum Street between 3rd Street and Main Street, the block where MN TH 58 and US TH 63 run concurrent. In the AM peak hour NB traffic queues frequently extend from the Main Street/Plum Street intersection back through the Plum Street/3rd Street intersection and back towards the Red Wing Bridge. In the PM peak hour SB traffic queues frequently extend from the Plum Street/3rd Street intersection back through the Main Street/Plum Street intersection and onto SB US TH 61.

With no improvements, year 2042 traffic forecasts show that several intersections in the study area will experience major operational deficiencies. The US TH 63 intersections with Potter Street, MN TH 58 (Plum Street), and US TH 61 (Main Street) and the US TH 61/US TH 63 intersection with Potter Street will all experience LOS F and/or substantial queuing during several hours of the day. Without improvements to the highway facilities the existing deficiencies will continue to become worse in the future as traffic increases.

### **3. Safety**

Geometric design deficiencies are discussed under Section I. Some deficiencies result in safety problems. In particular, the US TH 63/Potter Street intersection sight distance is inadequate. The building in the northeast quadrant of the intersection obstructs visibility for SB traffic on Potter Street, making it very difficult for drivers on Potter Street to see vehicles SB on US TH 63 coming into Red Wing from the Red Wing Bridge. The intersection has a crash rate of 0.6, which is double the statewide average crash rate of 0.3 for similar intersections. The inadequate right shoulder widths on US TH 61 under the US TH 63 bridge have a detrimental effect on traffic safety and capacity. The shoulder widths also affect safety for bicyclists, who are forced to travel in the through lanes on US TH 61 due to the lack of adequate shoulders.

The US TH 61/US TH 63 intersection with Potter Street has a crash rate of 0.4, which is also above the statewide average rate of 0.3 for similar intersections. As noted in the previous section, the US TH 63/MN TH 58 intersection has geometric deficiencies that cause trucks to encroach considerably into the opposing lanes, which is also a safety issue. The intersection has had 24 crashes in the five years analyzed, but the crash rate is only 0.7 and is below the statewide average crash rate of 0.9. The substantial amount of congestion and slow speeds that occur at the intersection likely contributes to the lower number of crashes than would be expected with these conditions.

### **4. Bridge, Roadway, and Intersection Interrelationship**

The needs at the US TH 63, US TH 61, and MN TH 58 intersections and roadways described above need to be studied in conjunction with studying the needs of the two bridges. Addressing the needs of MN Bridge 9040/WI Bridge B470024 and MN Bridge 9103 will likely affect both the vertical and horizontal alignment of US TH 63 entering Red Wing, as well as the roadway width. This will likely have a direct impact on the ability to address the safety, capacity, and operational deficiencies of the intersections and roadways, as described in the previous sections. Affecting bridge and approach roadway geometrics without addressing the intersection and roadway needs could severely limit the opportunity to address these needs in the future.

The existing two-lane Red Wing Bridge limits the volume of traffic that can enter the downtown Red Wing area throughout the day. If additional capacity were to be provided on the Red Wing Bridge to address the capacity needs identified in Section E.1, then the Red Wing Bridge would allow a greater volume of traffic to flow through these deficient intersections and into the downtown area. This increase in traffic would exacerbate the operational deficiencies in the area. As a result of this interrelationship between the horizontal and vertical alignment, roadway width, and roadway/intersection capacities, as described above, it is important that the needs of these intersections and connecting roadways are studied in conjunction with studying the needs of the two bridges.

## **F. NEED FOR MAXIMUM MAINTENANCE OF TRAFFIC**

Sections C and D above describe the role of the TH 63 crossing and connecting roadways in regional and interstate traffic transportation. The Red Wing Bridge provides the only access across the Mississippi River between Hastings (approximately 25 miles northwest) and Wabasha (approximately 30 miles southeast). Closure of the Red Wing Bridge necessitates a detour of approximately 58 miles (over one hour) for travelers between Red Wing and Pierce and Pepin Counties in Wisconsin.

Stakeholders have stated the bridge crossing plays an important role for the community on both sides of the river with a large number of people using the bridge to commute between home and work, as well as for shopping and other personal trips. The Red Wing Regional Airport is located in Bay City, WI on Highway 35 across the river from Red Wing. The airport, which averages 38 flights per day and has 57 aircraft based on the field, is an important facility for Red Wing business travelers. Thus it is necessary for travelers from Red Wing to utilize the Red Wing Bridge in order to access the city airport. The bridge also serves as a regional crossing to move goods and provide roadway access to the river ports in Red Wing. Continuous access is necessary to meet community and economic needs. Both Wisconsin and Red Wing area stakeholders have requested the existing bridge remain open during any construction to the maximum extent possible.

The communities on both sides of the river rely on the Red Wing Bridge to provide access for emergency response, including fire, law enforcement, and emergency medical vehicles. Without the bridge in place, emergency response times would be substantially slower, which would negatively impact quality of life. In addition, service providers would face personnel complications, as some staff for providers in Red Wing live in Wisconsin.

The Red Wing Bridge is a critical link in one of the officially designated Prairie Island Nuclear Plant evacuation routes in the event of a nuclear emergency. US TH 63 is one of only three designated evacuation routes for people in the Red Wing area. It also is the link for people to get to Elmwood, Wisconsin which is one of the two officially designated nuclear evacuation Reception Centers. Maintaining traffic across the Red Wing Bridge during construction is critical for public safety in the event of a nuclear emergency.

The Mississippi River provides access for barges and other river traffic. According to the Army Corps of Engineers, an average of 5800 barges a year passed through Lock and Dam 3 (located just upstream from Red Wing) from 2007-2009. An average of 6500 barges a year passed through Lock and Dam 4 (located south of Wabasha) from 2007-2009. Since Red Wing has the only river ports between these two Lock and Dams, approximately 5800-6500 barges a year travel under the Red Wing Bridge. Several thousand recreational vessels pass under the bridge as well on an annual basis. It is economically important to ensure the river remains open to navigation to the maximum extent possible during construction. The U.S Coast Guard, which has jurisdiction over structures spanning the navigational channel, will also require this.

## **G. NEED FOR ACCESS TO TRENTON ISLAND**

The connection to Trenton Island located in the Town of Trenton in Pierce County, Wisconsin is necessary to provide access to the Island Campground and Marina. The connection provides access to 108 campsites, 54 boat slips, and boat access to the Mississippi River. The only access



to the campsites east of US TH 63 is provided under the existing river bridge. No other roadway connection to Trenton Island exists, other than what is provided off of US TH 63. Emergency fire, ambulance, and law enforcement services need to access Island Campground and Marina via/under the Red Wing Bridge.

## **H. NEED TO MAINTAIN OR IMPROVE PEDESTRIAN/BICYCLE FACILITIES**

US TH 61 through Red Wing and Wisconsin Highway 35 are both a part of the Mississippi River Trail, which courses along from Itasca, Minnesota to the Gulf of Mexico, offering approximately 3000 miles of on-road bicycle trails and pedestrian pathways. The Mississippi River Trail is the only US Bicycle Route in Minnesota. Red Wing is also a popular bicycle destination, with access to the Cannon Valley Trail and the city is looking long-term to connect all of the major city parks with bike trails. The Wisconsin DOT promotes bicycling on the state bike maps for several nearby roadways. Wisconsin Highway 35, which is part of the Great River Road, and several nearby county roads are listed on the state bike map as having the "Best Conditions for Bicycling." US TH 63 and the Red Wing Bridge provide a link between these Minnesota and Wisconsin bicycle routes.

The existing bridges provide 2.5-foot wide sidewalks on both sides of the bridges, which does not meet the current MnDOT standard of a minimum 6-foot width for pedestrian use, or minimum 10-foot width for a combined bike/pedestrian facility. The existing right shoulders on US TH 61 under the US TH 63 bridge are the width of the gutter, which does not meet current MnDOT standards.

Pedestrian safety is also an issue of concern in downtown Red Wing. Several of the pedestrian facilities and roadway crossings are difficult for pedestrians to navigate due to the volume of traffic, narrow sidewalks in certain areas, and complete lack of sidewalks in others. Alternatives being considered for the Red Wing project should incorporate current pedestrian facility design standards, as appropriate.

## **OTHER CONSIDERATIONS:**

The following describes needs that would be desirable to address:

### **a. Structural Redundancy**

The Red Wing Bridge is a fracture critical bridge with non-redundant design. Current designs in compliance with MnDOT design standards do not contain fracture critical design components. Chapter 152 of the Minnesota Legislature 2008 Session Laws directs MnDOT to establish a bridge improvement program with an emphasis on structurally deficient and fracture critical bridges. The Red Wing Bridge is classified as a Tier 1 bridge in Chapter 152, which means that if it is repaired but not replaced, justification for the repair instead of replacement is required.

### **b. Geometrics**

The geometric design of the bridge does not meet current MnDOT design standards. The roadway width is 30 feet, which includes two 3-foot shoulders. Table 9-2.03A in the MnDOT Road Design Manual specifies a minimum shoulder width of four feet to barrier rail for low speed, two-lane urban highways. [The existing posted speed on the bridge is 30 mph, which falls in the low speed range.] The inadequate shoulder width does not allow for snow storage and also results in effectively closing a lane of traffic during vehicle breakdowns, emergency stops, or law enforcement stops. Additionally, for occasional over-width loads, the bridge must be restricted to a one-way crossing until the permitted load passes due to overhang and encroachment into the opposing lane. From 2007 to 2009 there were a total of 1549 (516 annually) oversize trucks requiring permits that crossed the Red Wing Bridge. Of those, 546 exceeded 12 feet in width.

The right shoulder widths on US TH 61 under the US TH 63 bridge do not meet current MnDOT design standards. The right shoulder width in each direction on US TH 61 is the width of the gutter. Table 4-4.01A in the MnDOT Road Design Manual specifies a right shoulder width of six feet for low-speed, divided urban arterial highways. The location of the bridge piers for the US TH 63 bridge over US TH 61 prohibits the widening of US TH 63 under the bridge, so it is not possible to meet current MnDOT design standards for right shoulder width. This has detrimental effects on traffic capacity and safety. US TH 61 is an important bicycle route, since it is part of the Mississippi River Trail. The inadequate shoulder widths under the bridge also affect safety for bicyclists, since they are forced to ride in the through lanes on US TH 61.

As noted in Section E., the design of the US TH 63/MN TH 58 intersection is inadequate and is very tight for trucks turning right from 3rd Street onto Plum Street. Several other intersections are also moderately difficult for certain vehicles to navigate on account of the roadway design. Many of the turn lanes do not meet design standards and are shorter and/or narrower than recommended.

#### **c. Economic development**

The amount of congestion in downtown Red Wing makes it undesirable for shoppers and tourists to visit the businesses during certain hours of the day. A portion of the downtown area is comprised of buildings that are vacant and/or in need of maintenance, which is unattractive for businesses. The city has been promoting redevelopment of the area to restore existing or construct new facilities to fit in with the downtown historic district and also to make it more attractive for businesses to locate there. There is a need to improve traffic flow, increase opportunities for redevelopment, and foster economic development in the downtown area.

#### **d. Parking**

Access to nearby parking for businesses in the downtown, for tourists and local people, is critical to maintaining the economic viability of the downtown. Stakeholders in Red Wing have voiced concerns about the lack of parking near to businesses in the downtown area and the negative impact that the lack of parking has on businesses. Congestion along several of the streets makes it difficult to utilize on-street parking and the number of nearby parking lots is minimal. Any proposed project alternatives that affect roadways in downtown Red Wing need to consider the availability of on-street parking and/or parking facilities for downtown businesses.

### **e. Regulatory Requirements**

The project must consider numerous regulatory requirements; due to the context of the project, requirements related to historic resources, parklands, navigation, and stormwater management are particularly critical. While these requirements alone do not establish the need for a project to occur, any project (rehabilitation, reconstruction, or both) needs to meet these regulatory requirements to gain regulatory agency approval.

#### *Historic Resources*

The existing 50-year old US TH 63 bridges over the Mississippi River and over US TH 61 have been reviewed to determine their eligibility for listing on the National Register of Historic Places. It has been determined that Bridge 9103 over US TH 61 is eligible for listing, while Bridge 9040 over the Mississippi River is not eligible. Bridge 9103 was determined eligible for listing in the area of engineering at the state level of significance due to its high artistic value and unique design. In addition, Red Wing currently has a total of 25 properties listed on the National Register of Historic Places. Its downtown is comprised of four historic districts and the majority of the commercial buildings that were constructed during the city's early boom period of 1860-1910 have been retained. Barn Bluff, which is immediately adjacent to US TH 63 on the Minnesota approach to the bridge, is also listed on the National Register of Historic Places.

Existing truck traffic and traffic congestion have a detrimental effect on the historic nature of the downtown historic districts and properties. Access to parking, along with pedestrian and bicycle mobility, is critical to maintain the historic and economic viability of the downtown districts. Noise and pollution from trucks and other friction from traffic congestion all degrade the historic districts. As a magnet for tourism, the downtown historic districts need to maintain their historic nature, which has been recognized nationally and internationally numerous times.

The project needs to comply with Section 4(f) of the Department of Transportation Act of 1966 which requires avoidance of impacts (e.g. property acquisition and/or demolition) to an historic resource unless no prudent and feasible alternative exists. The project also needs to comply with Section 106 of the National Historic Preservation Act which also provides protection against both direct and indirect (e.g. noise, visual) adverse effects for historic properties, and emphasizes first avoiding impacts. If impacts cannot be avoided, efforts must be made to minimize, and then mitigate for the impacts.

#### *Parkland*

In addition to protecting historic resources as described above, Section 4(f) provides protections for publicly owned parks, trails, recreational areas, and wildlife and waterfowl refuges. As noted above, Section 4(f) requires avoidance unless there is no prudent and feasible alternative to the use. If avoidance is not possible, then Section 4(f) requires all possible planning to minimize harm to the park property. Section 4(f) protected park or refuge properties in close proximity to the Red Wing Bridge include Levee Park, Barn Bluff, and Colvill Park. The city is also in the planning phase for developing a riverfront trail that would connect the Cannon Valley Trail with these three parks.

#### *Navigational Channel*

The U.S. Army Corps of Engineers (USACE) maintains a navigational channel on the Mississippi River beneath the Red Wing Bridge. As noted in Section F above, the U.S. Coast Guard (USCG) has jurisdiction over structures spanning the navigation channel. The USCG has determined that the project will need to maintain adequate horizontal and vertical clearances. The existing vertical clearance is 64 feet over the normal pool. The existing horizontal clearance is approximately 418 feet, which is the clear distance between the inside faces of the existing piers flanking the navigation channel.

#### *Stormwater*

Under current conditions, stormwater on the Red Wing Bridge drains directly to the Mississippi River, to land adjacent to the Mississippi River, or to municipal storm sewer without treatment. Further, since most bridge stormwater empties directly into the Mississippi River, any roadway contaminants (gasoline, oil, salt, etc.) or accidental spills of hazardous materials also directly enter the Mississippi River. The existing infrastructure does not meet current stormwater management practices. Construction of bridge and/or roadway improvements would require incorporation of stormwater management practices consistent with current regulations.

#### **f. Property Impacts**

There are numerous residential properties, some of which are currently being investigated for their eligibility on the National Register of Historic Places, near Bridge 9103 that experience noise and traffic impacts related to the nearby highways. Several of these properties are presumed to be lower income housing. Several of the downtown businesses also are affected by the noise and traffic of the highways, as detailed in Section (f) of the Other Considerations. The project needs to consider the noise, property, and traffic impacts to these neighborhoods and properties.

#### **PURPOSE STATEMENT:**

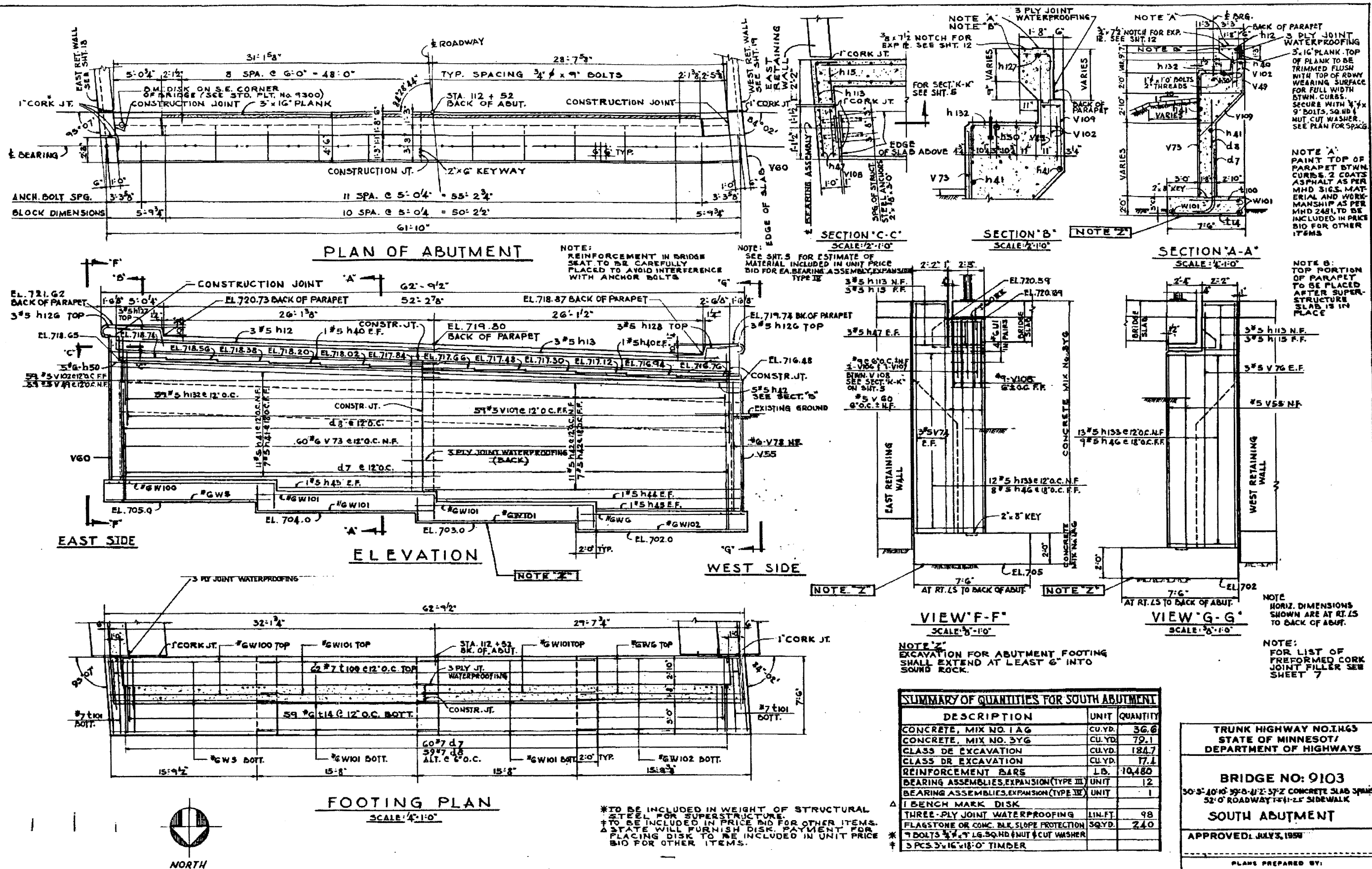
The primary purpose of the project is to provide a structurally sound bridge crossing of the Mississippi River Main Channel at Red Wing, Minnesota and a structurally sound crossing of US 61. In addition, the project needs to maintain the connection between the Red Wing, Minnesota and Wisconsin highway systems located on Trenton Island, and provide adequate capacity to safely accommodate future transportation needs within the design life of the bridges, while maintaining traffic to the maximum extent possible during construction.

## **APPENDIX B HISTORIC BRIDGE PLANS**

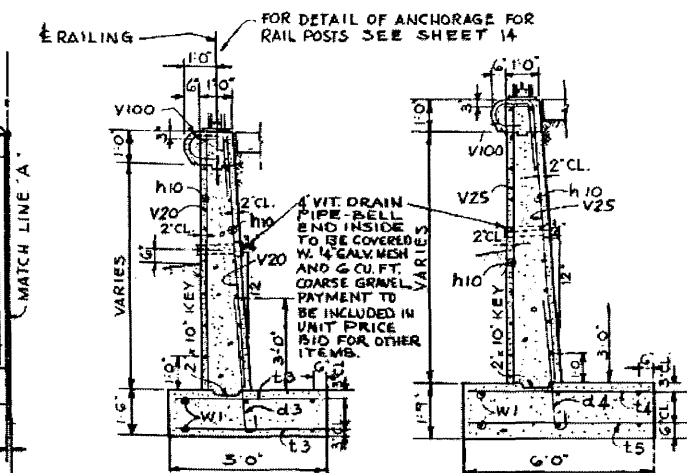
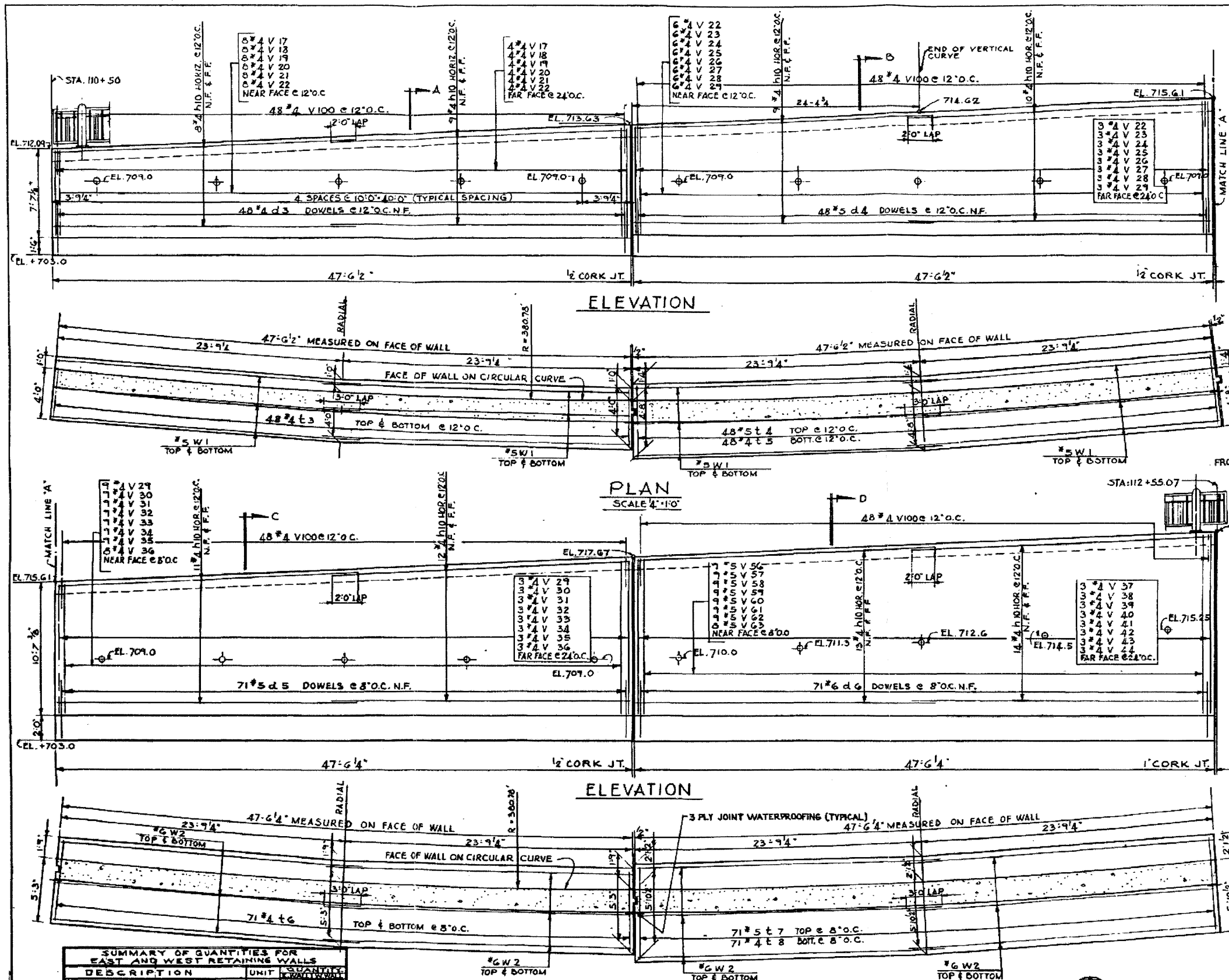




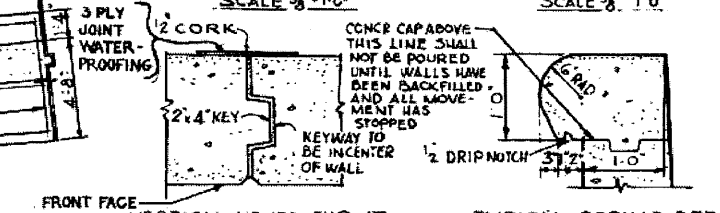




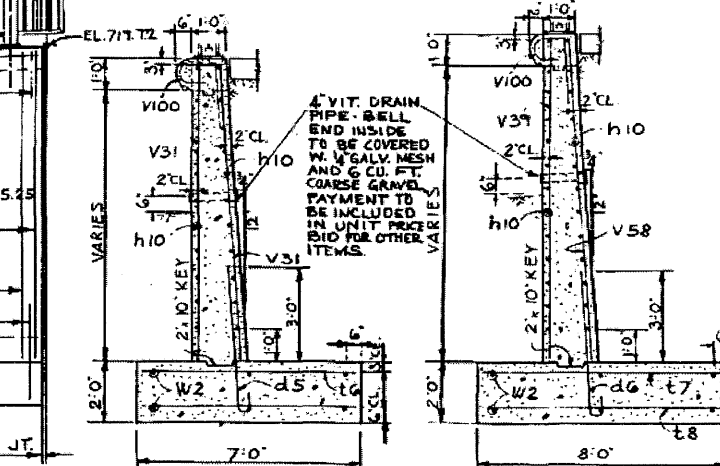




SECTION A' SCALE 3/8" = 1'-0"  
SECTION B' SCALE 3/8" = 1'-0"



SECTION C' SCALE 3/8" = 1'-0"  
SECTION D' SCALE 3/8" = 1'-0"



TYPICAL COPING DETAIL SCALE 1" = 1'-0"

SUMMARY OF QUANTITIES FOR EAST AND WEST RETAINING WALLS			
DESCRIPTION	UNIT	QUANTITY	REMARKS
CONCRETE, MIX #1A	CUYD	81.3	84.6
CONCRETE, MIX #5YG	CUYD	108.2	106.6
CLASS DE EXCAVATION	CUYD	275.6	411.3
REINFORCEMENT BARS	LBS.	8560.9	91300
3 PLY JOINT WATERPROOFING	LIN. FT.	40	33

WEST RETAINING WALL STA. 110+50 TO STA. 112+55.07

NOTE: FOR LIST OF PREFORMED CORK JOINT FILLER SEE SHEET 7.

TRUNK HIGHWAY NO. 163  
STATE OF MINNESOTA  
DEPARTMENT OF HIGHWAYS

BRIDGE NO: 9103  
30'-5" 40'-10" 39'-8" 41'-2" 37'-2" CONCRETE SLAB SPANS  
32'-0" ROADWAY 1'-5" 1'-2" SIDEWALK

WEST RETAINING WALL

APPROVED: JULY 3, 1958

PLANS PREPARED BY:  
ALFRED BENESCH & ASSOCIATES  
CONSULTING ENGINEERS CHICAGO ILL.

NOTE: REINFORCEMENT IN BRIDGE SEAT TO BE CAREFULLY PLACED TO AVOID INTERFERENCE WITH ANCHOR BOLTS (3" CC. MIN).

NOTE: SEE ELECTRICAL PLANS IN GRADING PORTION OF CONTRACT.

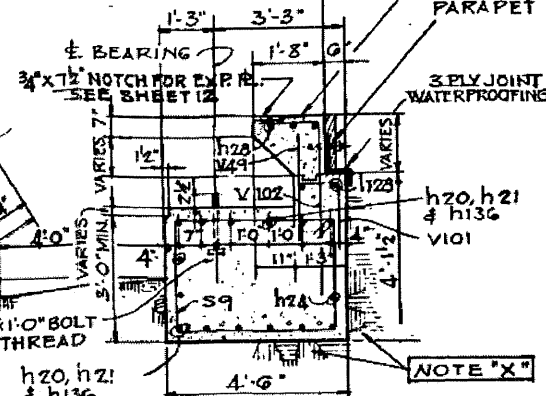
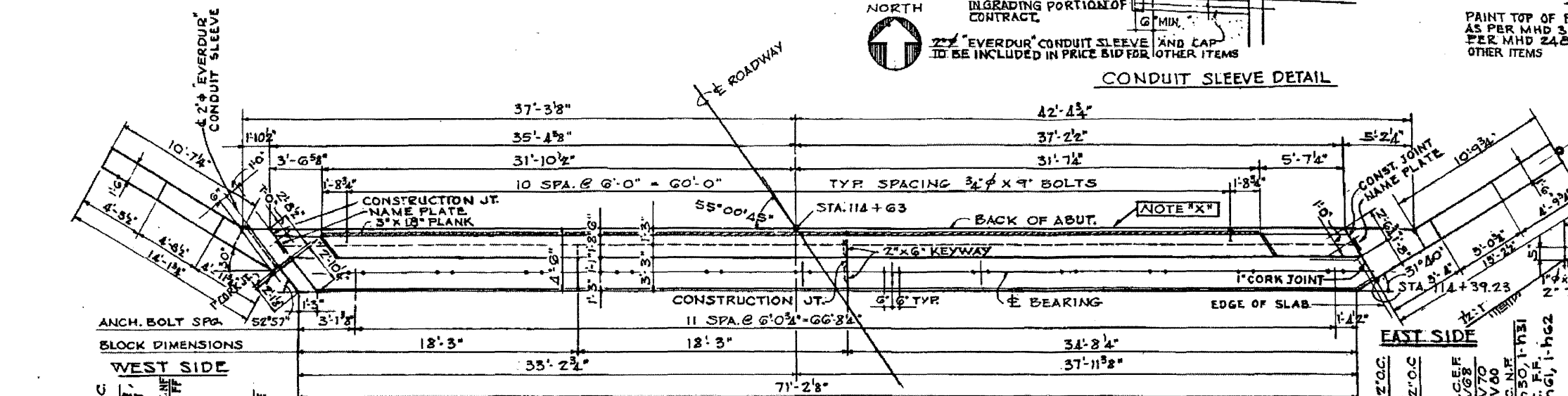


NOTE: "EVERDUR" CONDUIT SLEEVE AND CAP TO BE INCLUDED IN PRICE BID FOR OTHER ITEMS.

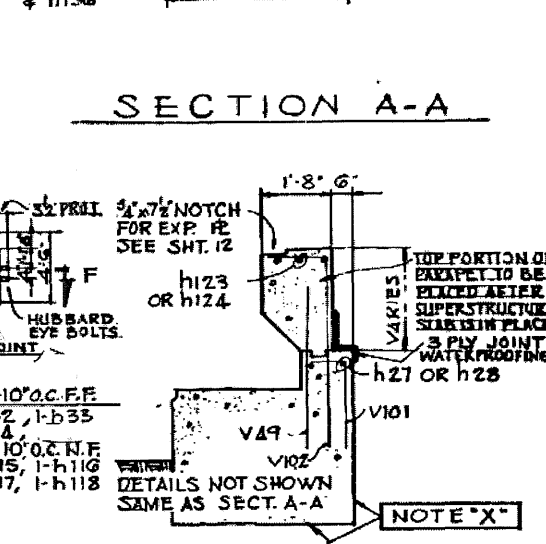
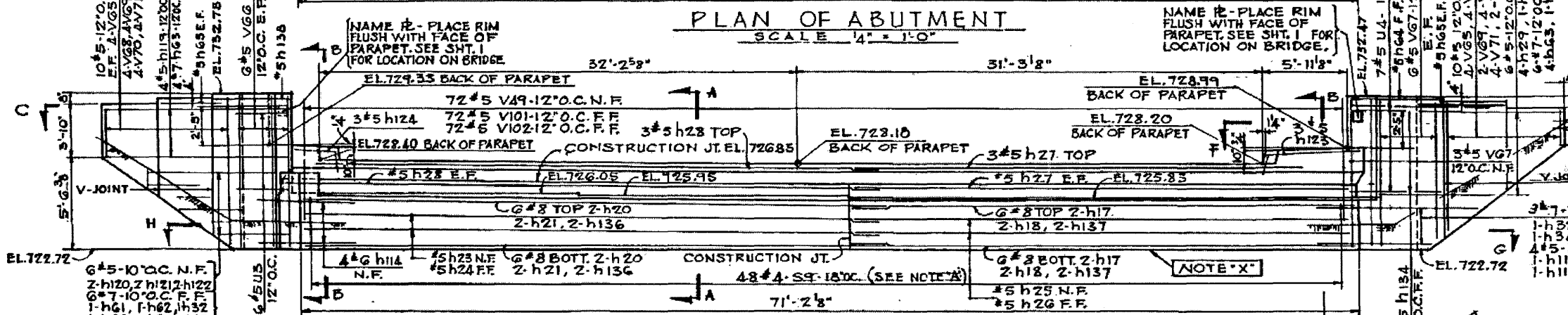
### CONDUIT SLEEVE DETAIL

3"x18" PLANK TOP OF PLANK TO BE TRIMMED FLUSH WITH TOP OF RDWY. WEARING SURFACE FOR FULL WIDTH BETWEEN CURBS. SECURE WITH 3"x6"x1/2" BOLTS SQ. HD. & NUT, CUT WASHER. SEE PLAN FOR SPACING.

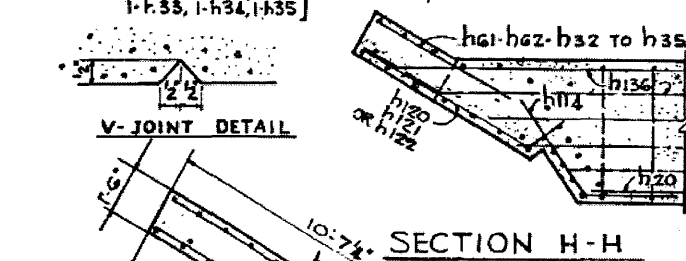
PAINT TOP OF PARAPET BETWEEN CURBS 2 COATS ASPHALT AS PER MHD 315 MATERIAL AND WORKMANSHIP AS PER MHD 2481 TO BE INCLUDED IN PRICE BID FOR OTHER ITEMS.



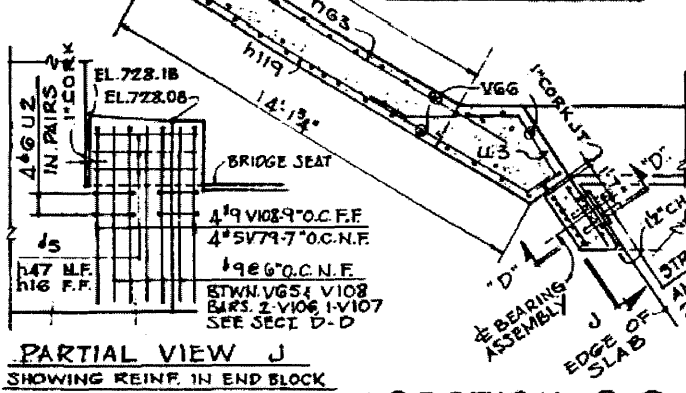
### SECTION A-A



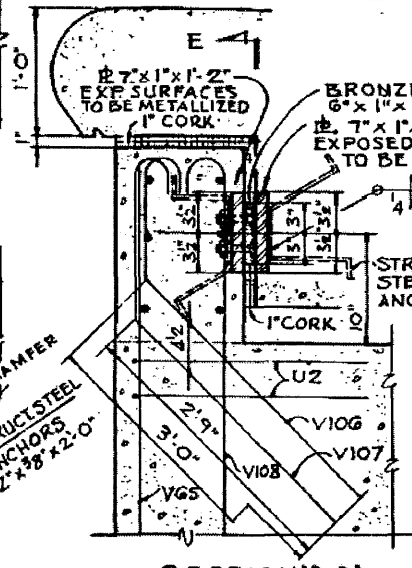
### SECTION B-B



### SECTION H-H



### SECTION C-C



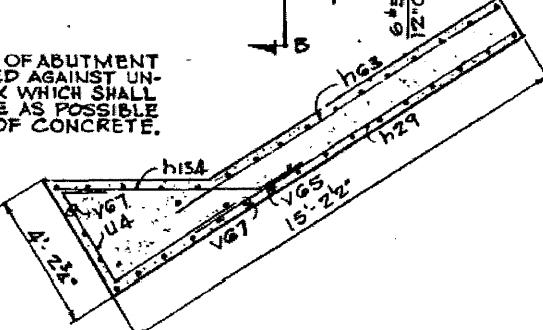
### SECTION D-D

### VIEW E

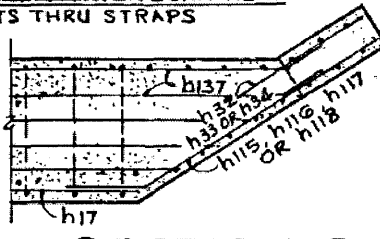
### BEARING ASSEMBLY, EXPANSION TYPE IV

MATERIAL TO BE INCLUDED IN UNIT PRICE BID FOR EACH BEARING ASSEMBLY EXPANSION, TYPE IV

- 1 SOLE PLATE 32 LB.
- 1 BRONZE PLATE 25 LB.
- 1 BASE PLATE 32 LB.
- 4 STRUCT. STL. ANCHS. 21 LB.
- 4 BRONZE BOLTS



### SECTION F-F



### SECTION G-G

SUMMARY OF QUANTITIES FOR NORTH ABUTMENT		
DESCRIPTION	UNIT	QUANTITY
CONCRETE, MIX NO. 3YG	CY	63.1
CLASS DR. EXCAVATION	CY	65.7
REINFORCEMENT BARS	LB	6220
STATE NAME PLATE STD. PLT. #8220 FOR BR. 9103 DATED 1958	UNIT	1
FEDERAL NAME PLATE STD. PL. #8223 (BRONZE)	UNIT	1
BEARING ASSEMBLY EXPANSION (TYPE III)	UNIT	12
BEARING ASSEMBLY EXPANSION (TYPE IV)	UNIT	1
"EVERDUR" CONDUIT (2" x 1/2")	LF	73
11 BOLTS 3/4" x 9" LB. SQ. HD. & NUT & CUT WASHER		
4 PCS. 3" x 12" x 16" O.D. TIMBER		
2 HUBBARD EYE BOLTS #39932 (GALV.)		
3 PLY JOINT WATERPROOFING	SQ. FT.	73

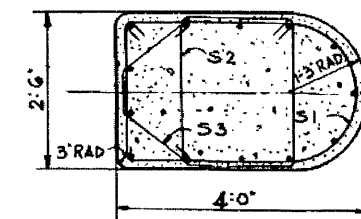
TRUNK HIGHWAY NO. 163  
STATE OF MINNESOTA  
DEPARTMENT OF HIGHWAYS

BRIDGE NO. 9103  
30'-5" x 40'-0" x 30'-0" 11'-2" x 2" CONCRETE SLAB SPANS  
52'-0" ROADWAY 1'-5" x 2'-5" SIDEWALK  
NORTH ABUTMENT

APPROVED: JULY 3, 1958

PLANS PREPARED BY:  
ALFRED BENESCH & ASSOCIATES  
CONSULTING ENGINEERS CHICAGO ILL.

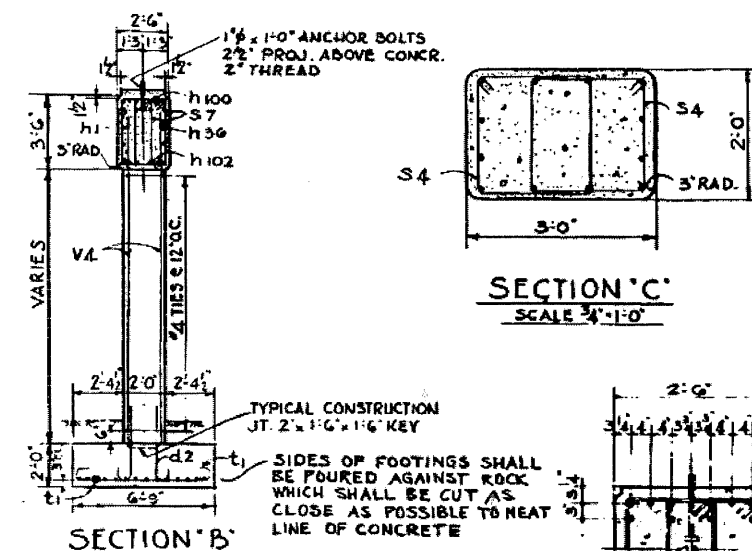




SECTION "A"  
SCALE 3/4"=1'-0"

[illegible]

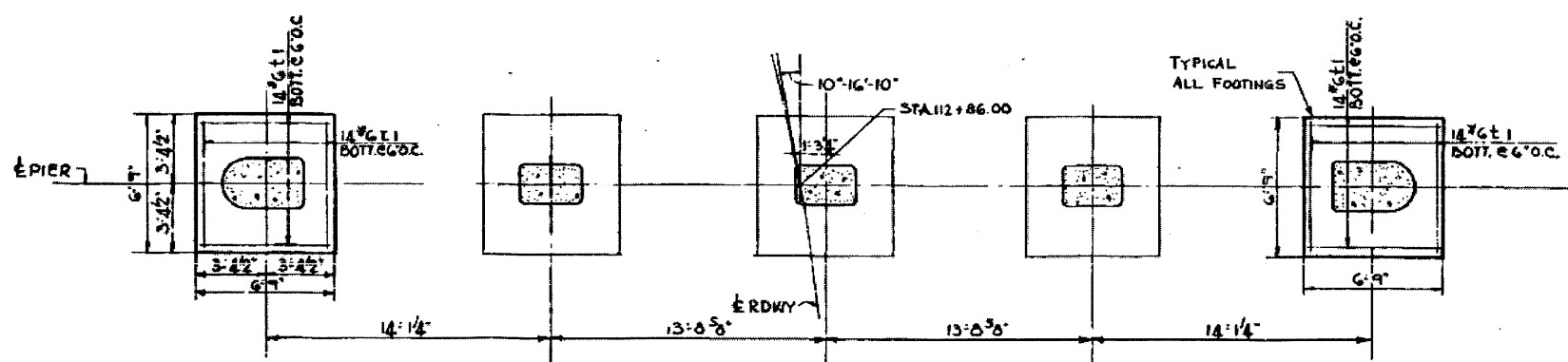
ELEVATION  
SCALE: 1"=10'



SECTION 'C'  
SCALE 3/4" = 1'-0"

SIDES OF FOOTINGS SHALL  
BE POURED AGAINST ROCK  
WHICH SHALL BE CUT AS  
CLOSE AS POSSIBLE TO NEAR  
LINE OF CONCRETE

DETAIL OF TOP BAR SPACING  
IN BRIDGE SEAT  
SCALE  $\frac{3}{4}":1'-0"$



**FOOTING PLAN**  
**SCALE: 1/4" = 1'-0"**

SUMMARY OF QUANTITIES FOR PIER No.1			
DESCRIPTION	UNIT	QUANTITY	FINAL QUANTITY
CONCRETE, MIX NO. 1A G	CU. YD.	14.8	17.0
CONCRETE, MIX NO. 3YG	CU. YD.	35.8	37.4
CLASS DR EXCAVATION	CU. YD.	29.1	29.1
REINFORCEMENT BARS	LBS.	11 540.0	12136
BEARING ASSEMBLIES, EXPANSION (TYPE X)	UNIT	12	12

TRUNK HIGHWAY NO. 1463  
STATE OF MINNESOTA  
DEPARTMENT OF HIGHWAYS

BRIDGE NO: 9103

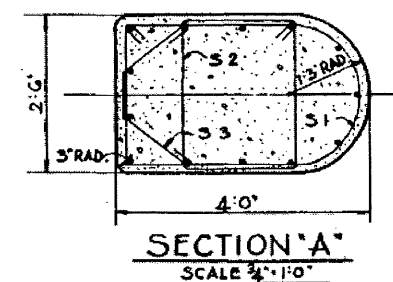
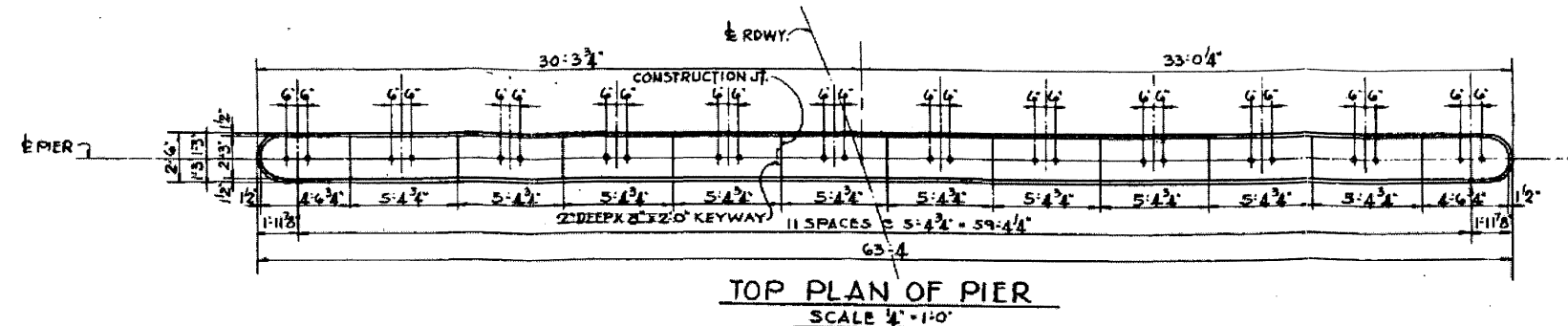
30'-5" 40'-10" 50'-5" 41'-2" 37'-2" CONCRETE SLAB SPANS  
52'-0" ROADWAY 15'-11-25" SIDEWALK

PIER No 1

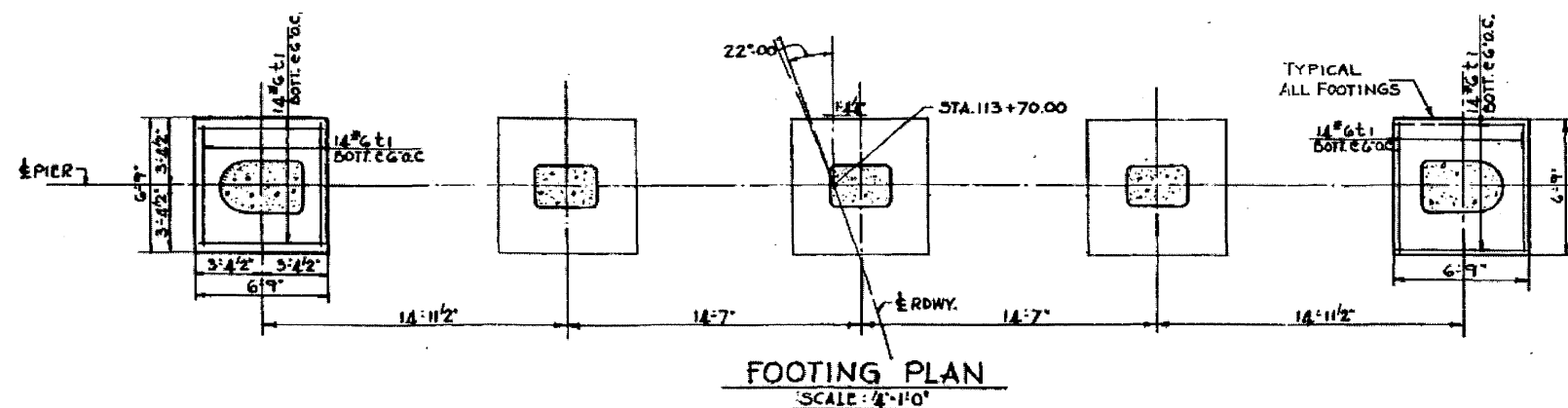
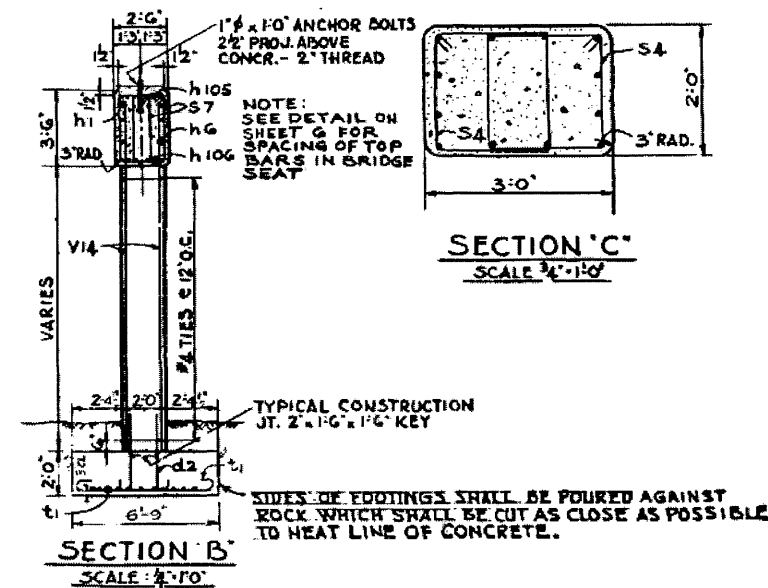
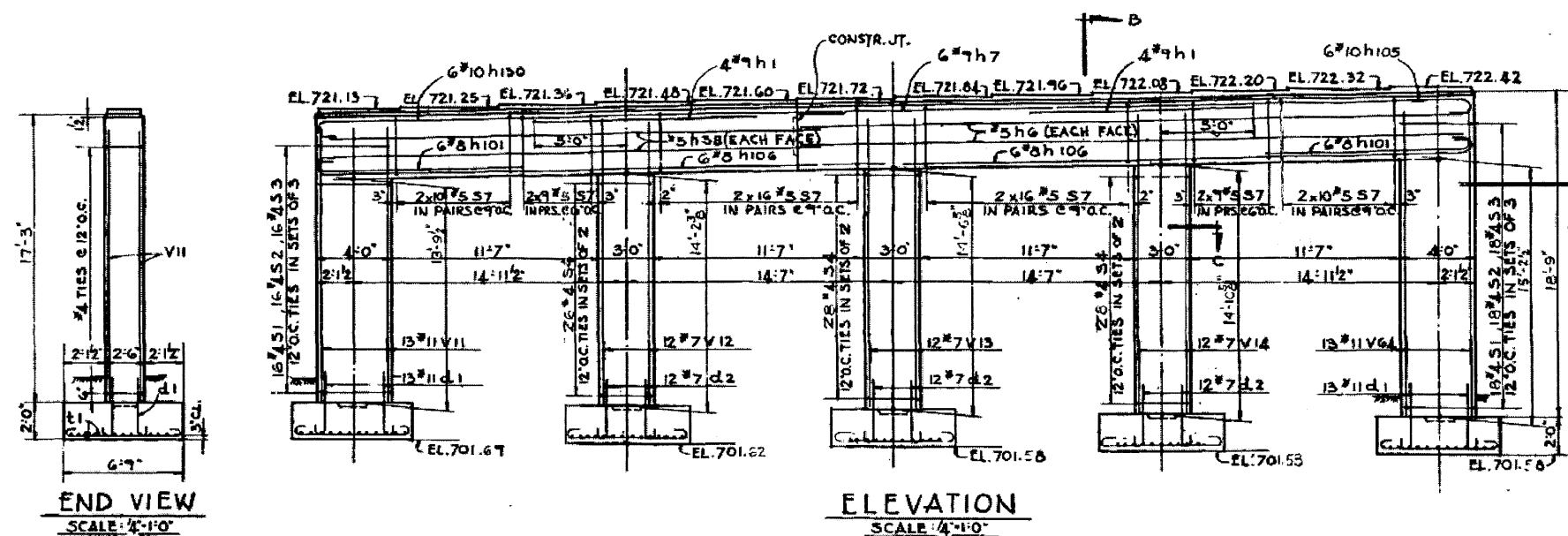
APPROVED: JULY 3, 1958

PLANS PREPARED BY:  
**ALFRED BENESCH & ASSOCIATES**  
CONSULTING ENGINEERS CHICAGO ILL.





NOTE:  
REINFORCEMENT IN BRIDGE SEAT  
TO BE CAREFULLY PLACED TO AVOID  
INTERFERENCE WITH ANCHOR BOLTS



SUMMARY OF QUANTITIES FOR PIER No.3			
DESCRIPTION	UNIT	QUANTITY	FINAL QUANTITY
CONCRETE, MIX N° 1 A G	CUYD	14.8	17.
CONCRETE, MIX N° 3 Y G	CUYD	38.3	40.
CLASS DR EXCAVATION	CUYD	26.2	26.
REINFORCEMENT BARS	LBS.	12,150.0	128.
BEARING ASSEMBLIES, FIXED (TYPE 1)	UNIT	12	12

TRUNK HIGHWAY NO. 143  
STATE OF MINNESOTA  
DEPARTMENT OF HIGHWAYS

BRIDGE NO:9103

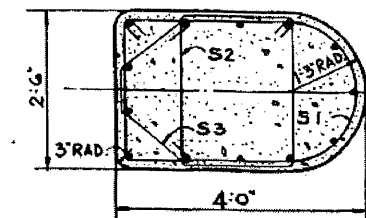
30'-5" - 40'-10" - 39'-6" - 41'-2" - 37'-2" CONCRETE SLAB SPANS  
52'-0" ROADWAY 1'-5" - 1'-2 1/2" SIDEWALK

PIER № 3

APPROVED: JULY 3, 1958

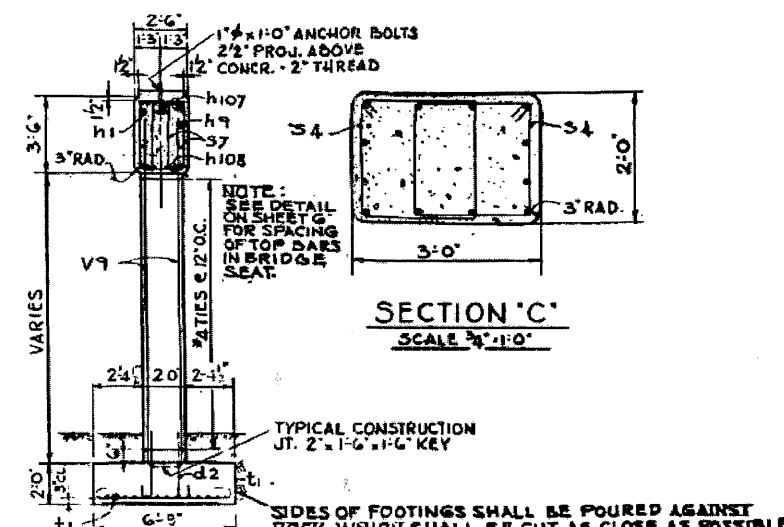
PLANS PREPARED BY:  
**ALFRED BENESCH & ASSOCIATES**  
CONSULTING ENGINEERS CHICAGO ILL.



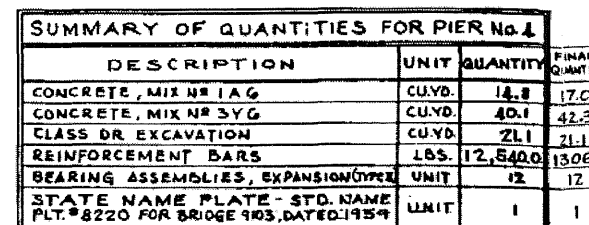


SECTION 'A'  
SCALE 3/4"=1'-0"

SCALE 3/4"=1'-0"



SECTION "B"  
SCALE: 4"=10'

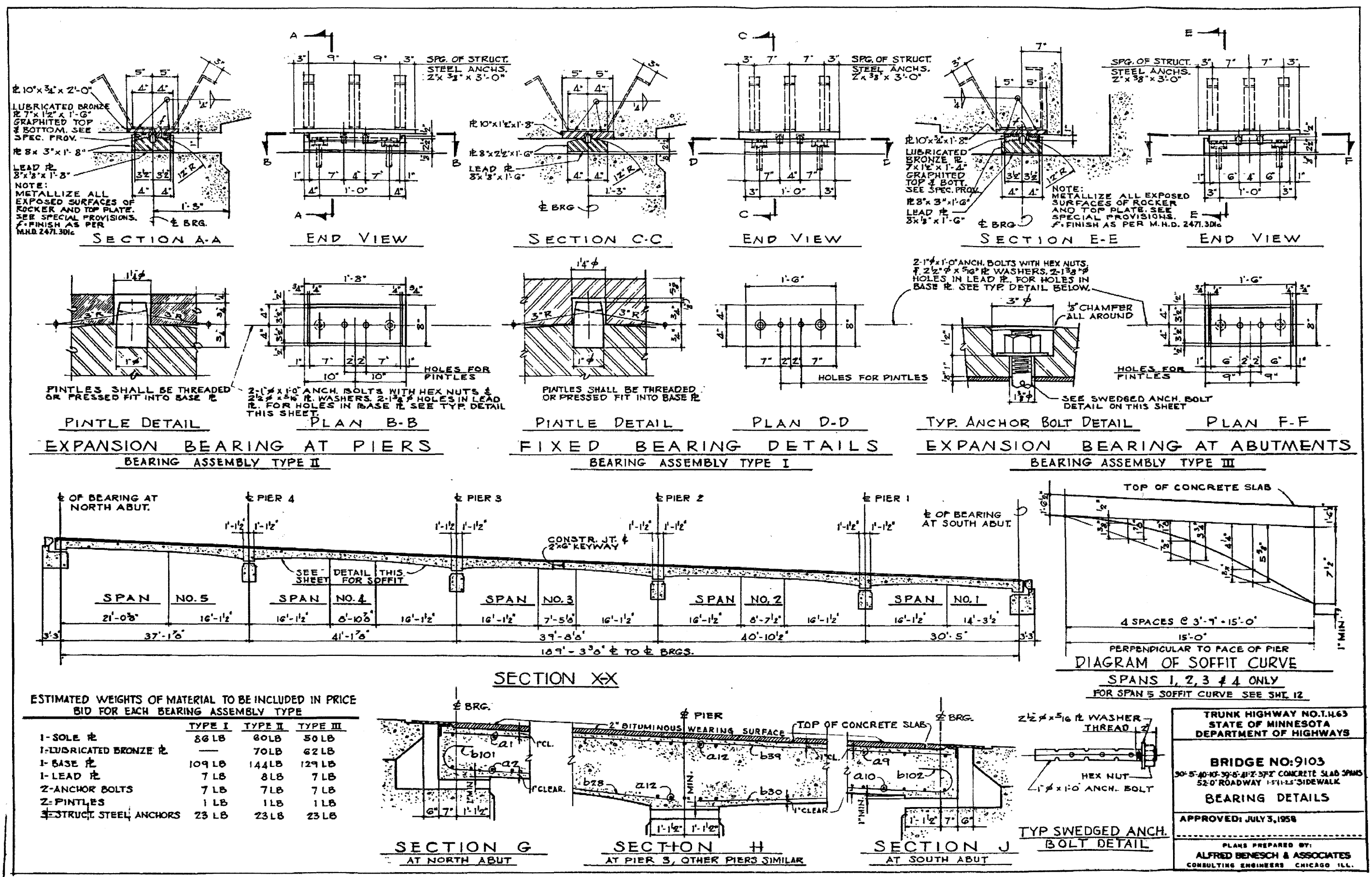


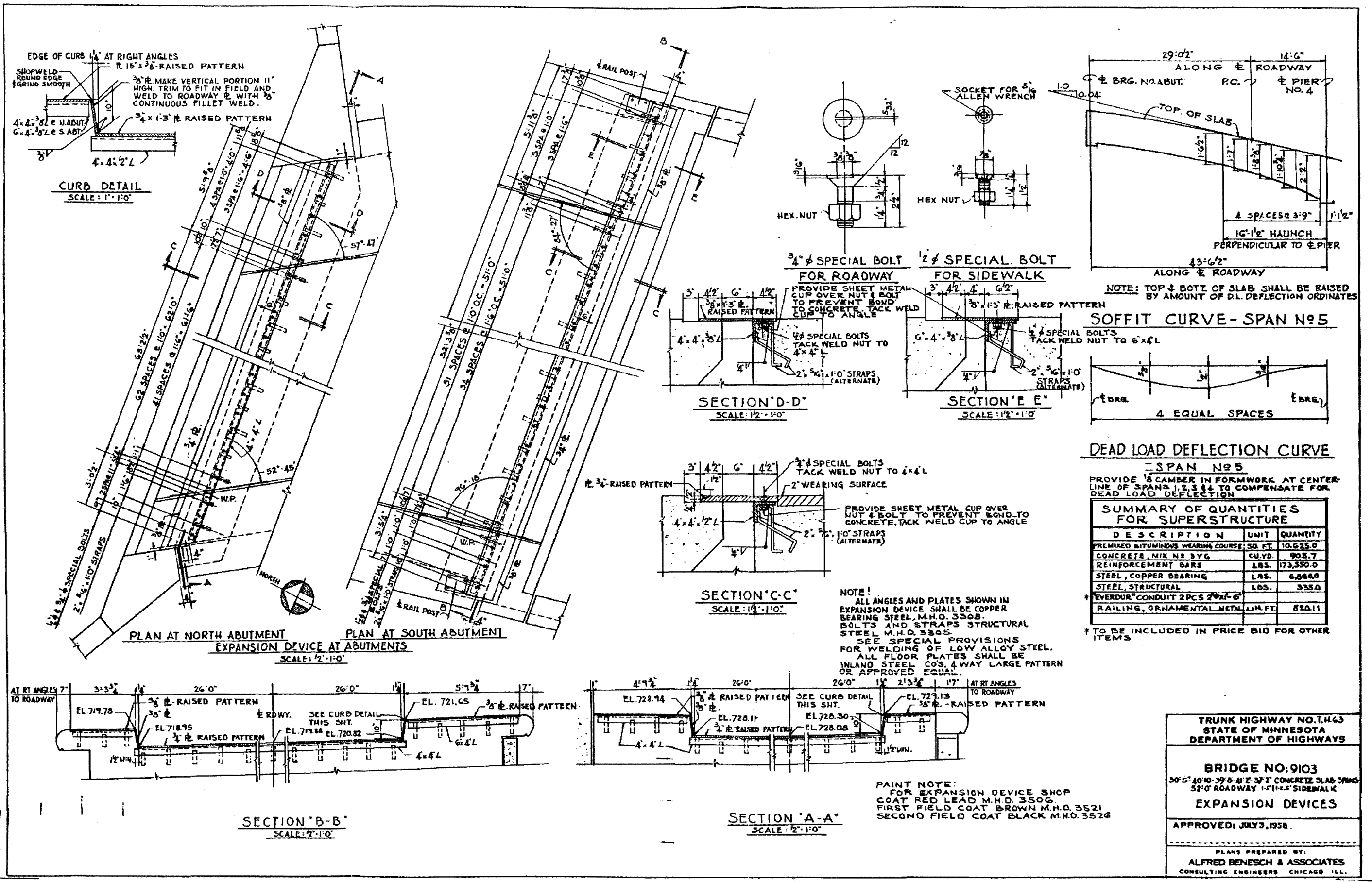
### SUMMARY OF QUANTITIES FOR PIER No.4

DESCRIPTION	UNIT	QUANTITY	FINAL QUANTITY
CONCRETE, MIX N° 1A6	CU.YD.	12.8	17.0
CONCRETE, MIX N° 3YG	CU.YD.	40.1	42.3
CLASS DR EXCAVATION	CU.YD.	21.1	21.1
REINFORCEMENT BARS	LBS.	12,540.0	1306.0
BEARING ASSEMBLIES, EXPANSION TYPE	UNIT	12	12
STATE NAME PLATE- STD. NAME PLT. # 8220 FOR BRIDGE #103, DATED 1954	UNIT	1	1

PLANS PREPARED BY:  
**ALFRED BENESCH & ASSOCIATES**  
CONSULTING ENGINEERS CHICAGO ILL.

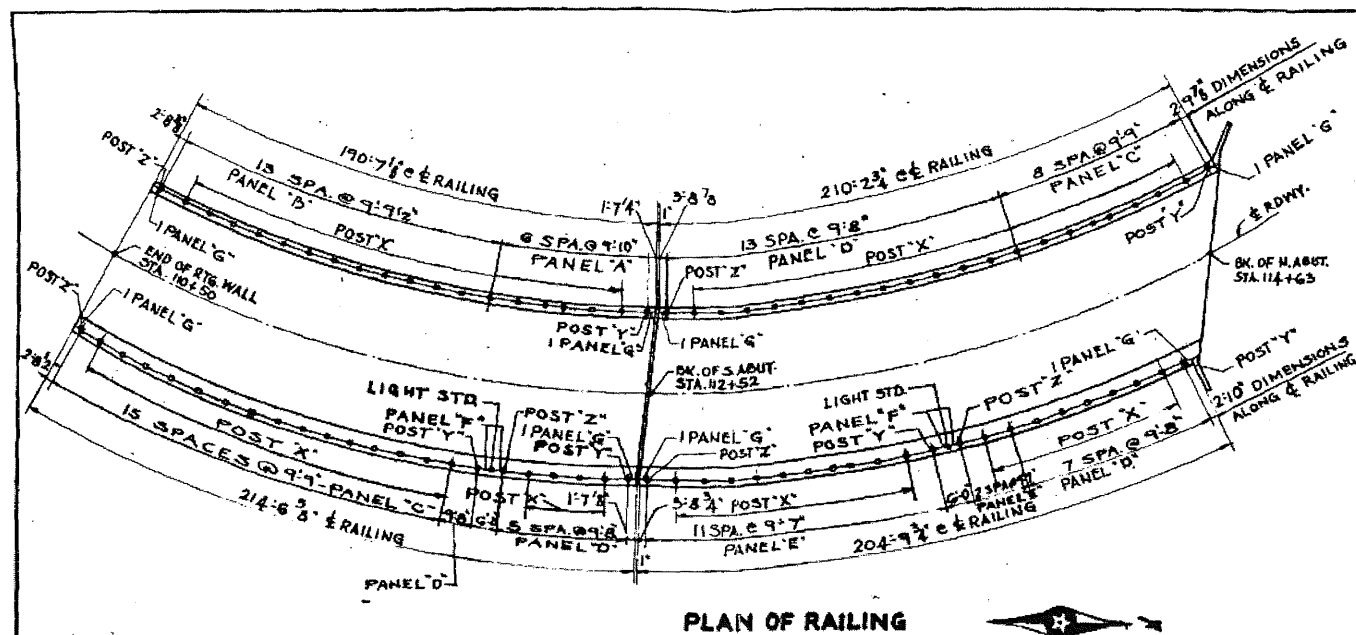




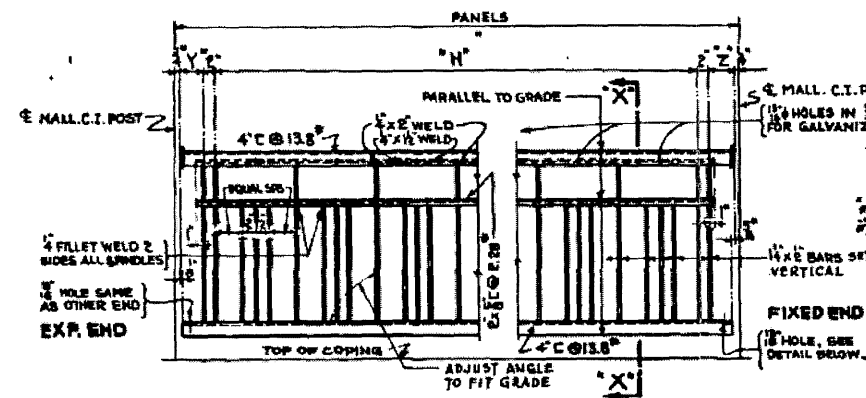




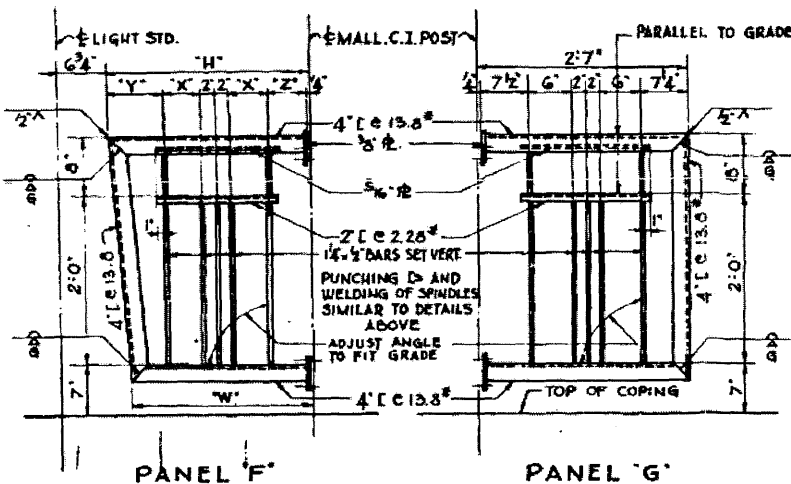




PLAN OF RAILING

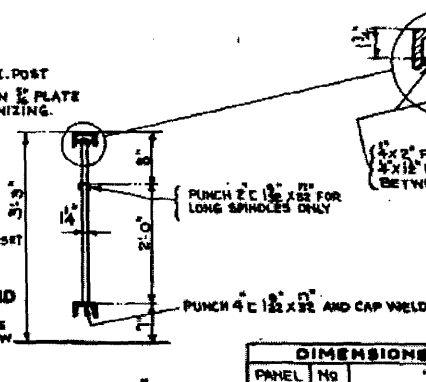


ELEVATION OF PANELS



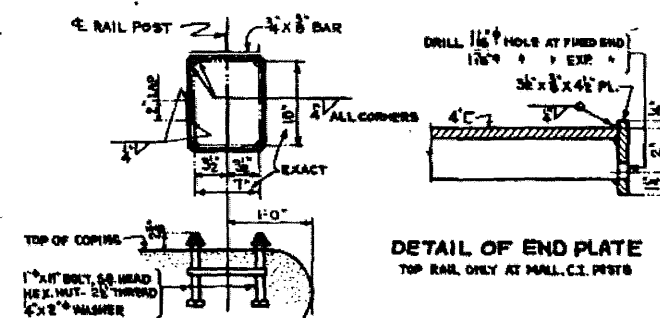
PANEL F'

PANEL G'

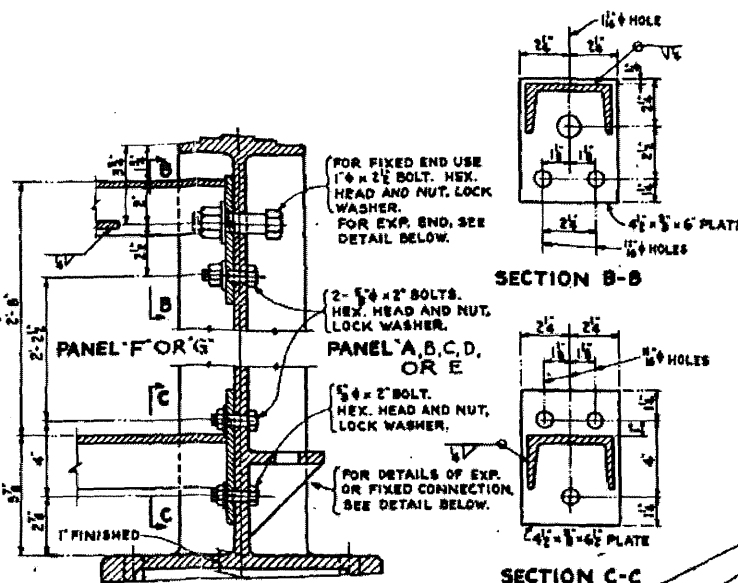


SECTION X-X'

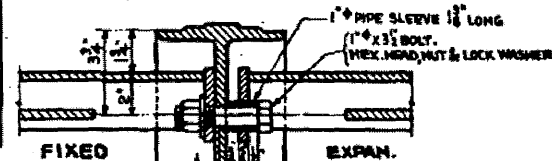
DIMENSIONS FOR RAIL PANELS									
PANEL	NO.	"H"	"Y"	"Z"	"W"	"X"			
A	6	7' 0" 1/2	8' 2"	7' 4"	7' 4"				
B	13	7' 0" 1/2	8' 2"	7' 4"	7' 4"				
C	28	7' 0" 1/2	8' 2"	6' 4"	7' 4"				
D	28	7' 0" 1/2	8' 2"	6' 4"	6' 4"				
E	13	7' 0" 1/2	8' 2"	5' 4"	6' 4"				
F	4	2' 5' 1/4"	8' 2"	8' 2"	6' 4"	22' 5' 1/4"			
G	8	SEE DETAIL							



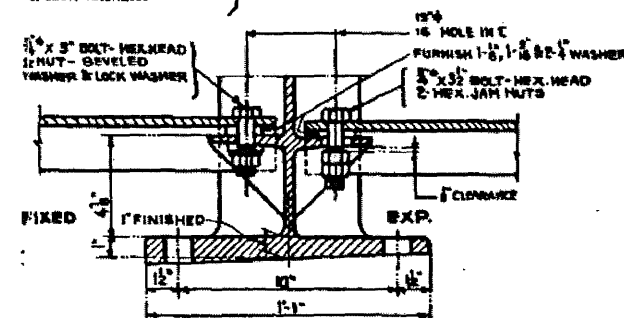
ANCHOR BOLT ASSEMBLY  
87 REQ'D THUS (GALV.)



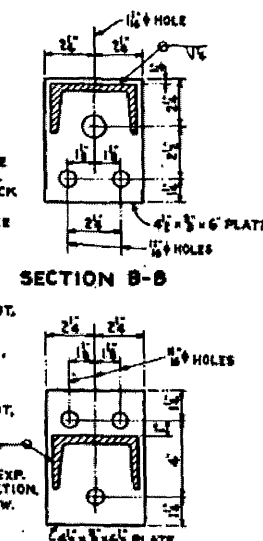
SECTION THRU END POST



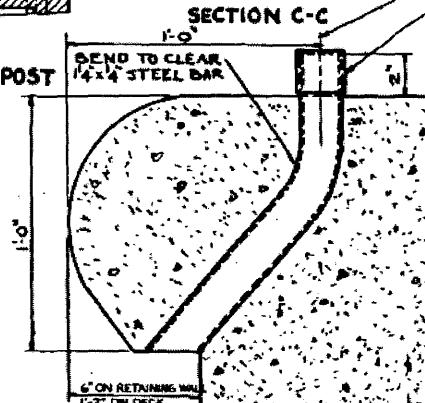
FOR POSTS WITH FIXED CONNECTIONS BOTH SIDES ONLY PIPE SLEEVE AND USE 1/2" X 3/4" BOLT, HEX. HEAD, NUT & LOCK WASHER.



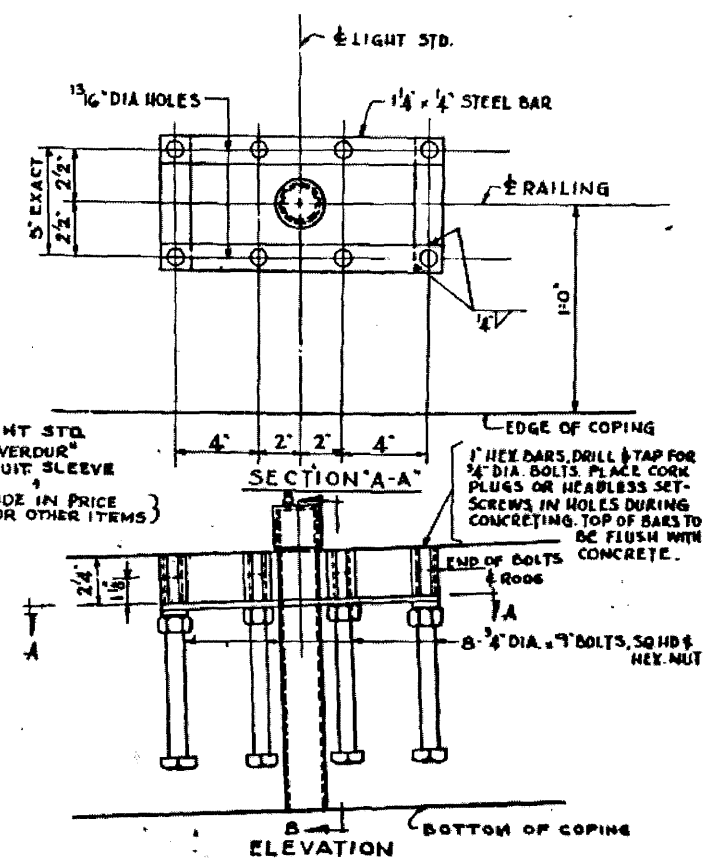
SECTION THRU POSTS



SECTION B-B



SECTION C-C



SECTION A-A

ANCHOR ASSEMBLY FOR LIGHT STANDARD  
2 REQUIRED

NOTES:  
ALL RAIL PANELS TO BE SAND BLASTED AFTER FABRICATION AND BEFORE GALVANIZING.  
ALL RAIL PANELS, CONNECTIONS AND FITTINGS TO BE GALVANIZED AFTER FABRICATION AS PER M.M.D. 3394. NO PAINT REQUIRED.  
ALL RAIL PANELS, MALLEABLE CAST IRON POSTS, ANCHOR BOLT ASSEMBLIES, RAIL SOCKETS, U-BOLTS, CONNECTION BOLTS, WASHERS, PIPE SLEEVES AND SHEET LEAD TO BE INCLUDED IN PRICE BID FOR "MINIMUM METAL RAILING".  
CASTINGS FITTED BECAUSE OF IMPROPER PICKLING WILL BE REJECTED.  
ANCHOR ASSEMBLIES FOR LIGHT STANDARDS WILL BE PAID FOR UNDER ITEM 2402.521 "STEEL, STRUCTURAL". ALL LIGHT STANDARDS SHALL BE FURNISHED AND INSTALLED UNDER GRADING PORTION OF CONTRACT.  
LENGTH OF RAILING FOR PAYMENT TO BE MEASURED FROM FACE OF CONCRETE WINGWALLS AT NORTH ABUTMENT TO OUTSIDE END OF PANELS AT SOUTH END OF RETAINING WALLS.

TRUNK HIGHWAY NO. 1463 STATE OF MINNESOTA DEPARTMENT OF HIGHWAYS
<b>BRIDGE NO. 9103</b> 30'-5" (30'-0" + 5'-0") CONCRETE SLAB SPANS 32'-0" ROADWAY + 1'-0" SIDEWALK
<b>RAILING DETAILS</b>
APPROVED: JULY 3, 1958
PLANS PREPARED BY: ALFRED BENESCH & ASSOCIATES CONSULTING ENGINEERS, CHICAGO, ILL.



# REINFORCEMENT BAR LISTS

NO. REQUIRED	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	K	PN
RETAINING WALLS														
STRAIGHT														
EAST	WEST													
24	24	6	25'-0"	W 2										
43	48	5	5'-6"	t 4										
51	71	5	7'-6"	t 7										
43	71	5	6'-0"	t 10										
9		5	11'-9"	V 53										
8		5	12'-0"	V 54										
9		5	12'-3"	V 55										
8		5	12'-6"	V 56										
9		5	12'-9"	V 57										
8		5	13'-0"	V 58										
9		5	13'-3"	V 59										
9		5	13'-6"	V 60										
9		5	13'-9"	V 61										
9		5	14'-0"	V 62										
8		5	14'-3"	V 63										
24	24	5	25'-0"	W 1										
36		5	22'-9"	W 3										
172		4	24'-9"	h 10										

NO. REQUIRED	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	K	PN
RETAINING WALLS (CONT.)														
138		4	22'-3"	h 11										
86	96	4	4'-6"	t 3										
43	48	4	5'-6"	t 5										
142		4	6'-6"	t 6										
71		4	7'-6"	t 8										
86		4	4'-0"	t 9										
43		4	6'-0"	t 11										
51		4	7'-0"	t 13										
11	12	4	7'-6"	V 17										
11	12	4	7'-9"	V 18										
11	12	4	8'-0"	V 19										
10	12	4	8'-3"	V 20										
11	12	4	8'-6"	V 21										
10	21	4	8'-9"	V 22										
23	9	4	9'-0"	V 23										
11	9	4	9'-3"	V 24										
10	9	4	9'-6"	V 25										
11	9	4	9'-9"	V 26										
10	9	4	10'-0"	V 27										
12	9	4	10'-3"	V 28										
14	21	4	10'-6"	V 29										
13	12	4	10'-9"	V 30										
13	12	4	11'-0"	V 31										
13	12	4	11'-3"	V 32										
13	12	4	11'-6"	V 33										
17	12	4	11'-9"	V 34										
4	12	4	12'-0"	V 35										
3	11	4	12'-3"	V 36										
4	3	4	12'-6"	V 37										
3	3	4	12'-9"	V 38										
4	3	4	13'-0"	V 39										
3	4	4	13'-3"	V 40										
3	4	4	13'-6"	V 41										
3	4	4	13'-9"	V 42										
3	4	4	14'-0"	V 43										
3	4	4	14'-3"	V 44										
13		4	6'-6"	V 45										
14		4	6'-9"	V 46										
13		4	7'-0"	V 47										
14		4	7'-3"	V 48										
BENT														
51	71	6	5'-6"	d 6	1	1'-1"	4'-5"							6'
100	48	5	5'-3"	d 4	1	11"	4'-4"							5'
71		5	5'-6"	d 5	1	11"	4'-7"							5'
86	48	4	5'-0"	d 3	1	8"	4'-4"							4'
215	192	4	3'-9"	V 100	3	8'	1'-2"	1'-11"						1'-11"
NORTH ABUTMENT														
STRAIGHT														
4		8	34'-6"	h 17										
4		8	37'-0"	h 18										
4		8	40'-9"	h 20										
4		8	43'-9"	h 21										
2		7	7'-6"	h 32										
2		7	6'-0"	h 33										
2		7	4'-6"	h 34										
1		7	3'-6"	h 35										

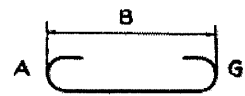
NO. REQUIRED	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	K	PN
NORTH ABUTMENT (CONT.)														
2		7	11'-0"	h 61										
2		7	4'-6"	h 62										
8		7	12'-6"	h 63										
1		5	5'-9"	h 64										
2		5	6'-6"	h 65										
3		5	2'-6"	h 16										
2		5	38'-0"	h 23										
2		5	44'-0"	h 24										
2		5	34'-6"	h 25										
2		5	40'-9"	h 26										
5		5	33'-9"	h 27										
5		5	40'-0"	h 28										
4		5	12'-0"	h 29										
1		5	10'-6"	h 30										
1		5	9'-0"	h 31										
3		5	1'-9"	h 47										
72		5	2'-6"	V 49										
8		5	3'-8"	V 65										
12		5	9'-8"	V 66										
15		5	9'-5"	V 67										
8		5	4'-8"	V 68										
6		5	6'-6"	V 69										
8		5	7'-0"	V 70										
8		5	8'-0"	V 71										
4		5	5'-0"	V 79										
4		5	5'-8"	V 80										
BENT														
2		9	5'-6"	V 106	3	1'-1"	1'-5"	3'-0"						2'-11"
1		9	5'-6"	V 107	3	1'-1"	1'-8"	2'-9"						1'-11"
4		9	5'-6"	V 108	1	1'-3"	4'-3"							8'
4		8	47'-6"	h 36	3		1'-3"	4'-3"						7'-2"
4		8	40'-6"	h 37	3		1'-3"	3'-3"						8'-10"
4		6	5'-6"	h 114	3		2'-0"	3'-6"						1'-7"
4		6	6'-9"	U 2	2	3'-0"	9'							3'-0"
1		5	14'-8"	h 138	53									9'-2"
1		5	7'-3"	h 115	3		1'-6"	5'-9"						9'-2"
1		5	8'-9"	h 116	3		1'-6"	7'-3"						9'-2"
1		5	10'-3"	h 117	3		1'-6"	8'-9"						9'-2"
1		5	12'-0"	h 118	3		1'-6"	10'-6"						9'-2"
5		5	14'-9"	h 119	3		1'-0"	13'-9"						11'
2		5	11'-9"	h 120	3		1'-0"	10'-9"						11'
2		5	8'-6"	h 121	3		1'-0"	7'-6"						11'
2		5	5'-3"	h 122	3		1'-0"	4'-3"						11'
3		5	7'-0"	h 123	2	1'-6"	5'-6"							
3		5	4'-3"	h 124	2	1'-6"	2'-9"							
6		5	8'-0"	h 134	3		1'-3"	6'-9"						8'-11"
6		5	8'-0"	U 3	52		1'-3"	3'-6"	2'-3"	1'-0"	7'-2"	1'-1"		3'-0"
7		5	10'-1"	U 4	30		1'-6"	3'-9"	4'-0"					1'-5"
72		5	3'-3"	V 101	2	9'	2'-6"							
72		5	5'-3"	V 102	2	1'-3"	4'-0"							
48		4	14'-2"	39	T 1	5	4'-0"	2'-8"	4'-0"	2'-6"				5'

NO. REQUIRED	SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	K	PN	
SOUTH ABUTMENT															
STRAIGHT															
5	6	32'-3"	h50												
59	6	7'-0"	t14												
60	6	11'-0"	V73												
1	6	12'-3"	V78												
3	6	18'-0"	W5												
2	6	14'-9"	W6												
6	5	2'-0"	h15												
6	5	1'-9"	h47												
4	5	32'-0"	h40												
18	5	32'-3"	h41												
23	5	30'-6"	h42												
2	5	15'-3"	h43												
2	5	28'-3"	h44												
2	5	12'-6"	h45												
17	5	4'-0"	h46												
59	5	2'-6"	V49												
2	5	12'-3"	V55												
4	5	13'-6"	V60												
6	5	14'-3"	V74												
6	5	15'-6"	V76												
3	5	28'-0"	h12												
3	5	30'-0"	h13												
BENT															
2	9	5'-6"	V106	3	1'-1"	1'-5"	3'-0"						2'-11"	2'-11"	6"
1	9	5'-6"	V107	3	1'-1"	1'-8"	2'-4"						1'-11 1/2"	1'-11 1/2"	6"
4	9	5'-6"	V108	1	1'-3"	4'-3"									8"
60	7	11'-3"	d7	4	1'-2"	3'-2"	1'-7"	5'-4"		1'-0"					7"
59	7	14'-1"	d8	4		1'-3"	1'-7"	11'-3"		1'-0"					
2	7	6'-3"	t100	1	1'-2"	5'-1"									7"
4	7	9'-4"	t101	1	1'-2"	7'-0"						1'-2"			7"
4	6	7'-3"	U1	2	3'-3"	8"						3'-3"			
2	6	20'-3"	W100	2	2'-6"	17'-9"									
10	6	20'-0"	W101	2	2'-6"	17'-6"									
3	6	17'-6"	W102	2	2'-6"	15'-0"									
6	5	3'-7"	h126	1	11"	2'-2"									5"
3	5	5'-10"	h127	2	1'-0"	4'-10"									
3	5	3'-4"	h128	2	1'-0"	2'-4"									
59	5	9'-0"	h132	3						4'-1"	4'-0"	11"			5"
25	5	5'-9"	h133	2	1'-7"	4'-2"									
53	5	5'-3"	h102	2	1'-3"	4'-0"									
59	5	8'-10"	h109	3			5'-5"	2'-7"	10"				3'-10 1/2"	3'-10 1/2"	
6	5	3'-0"	h113	2	1'-0"	2'-0"									

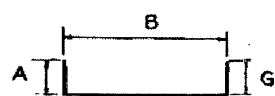
# REINFORCEMENT BAR LISTS

[illegible]

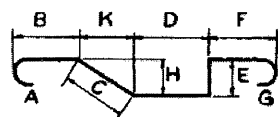
NO. REQUIRED				SIZE	LENGTH	MARK	TYPE	A	B	C	D	E	F	G	H	K	PIN
1	2	3	4														
	P		I		E		R		S								
			B		E		N		T								
26	26	26	26	11	6'-5"	d1	1	1'-8"	4'-9"								10
6				10	22'-3"	h100	1	1'-6"	20'-9"								9
	6			10	22'-9"	h103	1	1'-6"	21'-3"								9
		6		10	23'-0"	h105	1	1'-6"	21'-6"								9
			6	10	24'-0"	h107	1	1'-6"	22'-6"								9
6				10	28'-9"	h125	1	1'-6"	27'-3"								9
	6			10	29'-3"	h129	1	1'-6"	27'-9"								9
		6		10	30'-0"	h130	1	1'-6"	28'-6"								9
			6	10	31'-3"	h131	1	1'-6"	29'-9"								9
12	12	12	12	8	12'-6"	h101	1	1'-3"	11'-3"								8
12				8	30'-3"	h102	1	1'-3"	29'-0"								8
	12			8	31'-0"	h104	1	1'-3"	29'-9"								8
		12		8	32'-0"	h106	1	1'-3"	30'-9"								8
			12	8	33'-6"	h108	1	1'-3"	32'-3"								8
36	36	36	36	7	4'-8"	d2	1	1'-2"	3'-6"								7
140	140	140	140	6	8'-5"	t1	1	1'-1"	6'-3"					1'-1"			6
128	132	140	148	5	10'-2"	S7	T1	5"	3'-2"	1'-6"	3'-2"	1'-6"					5"
31	31	34	34	4	11'-7"	S1	50	5"	2'-2"	2'-7"	3'-5"	2'-7"	1'-1"				5"
31	34	34	34	4	8'-11"	S2	T1	5"	1'-10"	2'-2"	1'-10"	2'-2"					5"
31	34	34	34	4	4'-1"	S3	51	5"	SEE	DETAIL	BELOW						5"
78	84	82	86	4	8'-2"	S4	T1	5"	2'-0"	1'-8"	2'-0"	1'-8"					5"

[illegible][illegible]

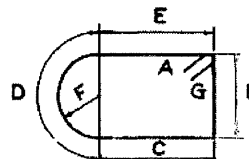
1 TYPE II



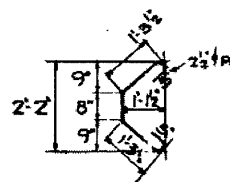
TYPE 2



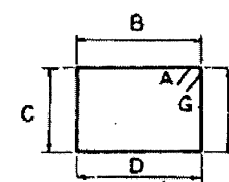
TYPE 3



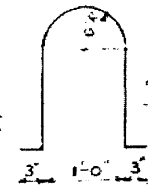
TYPE 50



TYPE 51



TYPE T1



BAR JI

TRUNK HIGHWAY NO. T.H. 63  
STATE OF MINNESOTA  
DEPARTMENT OF HIGHWAYS

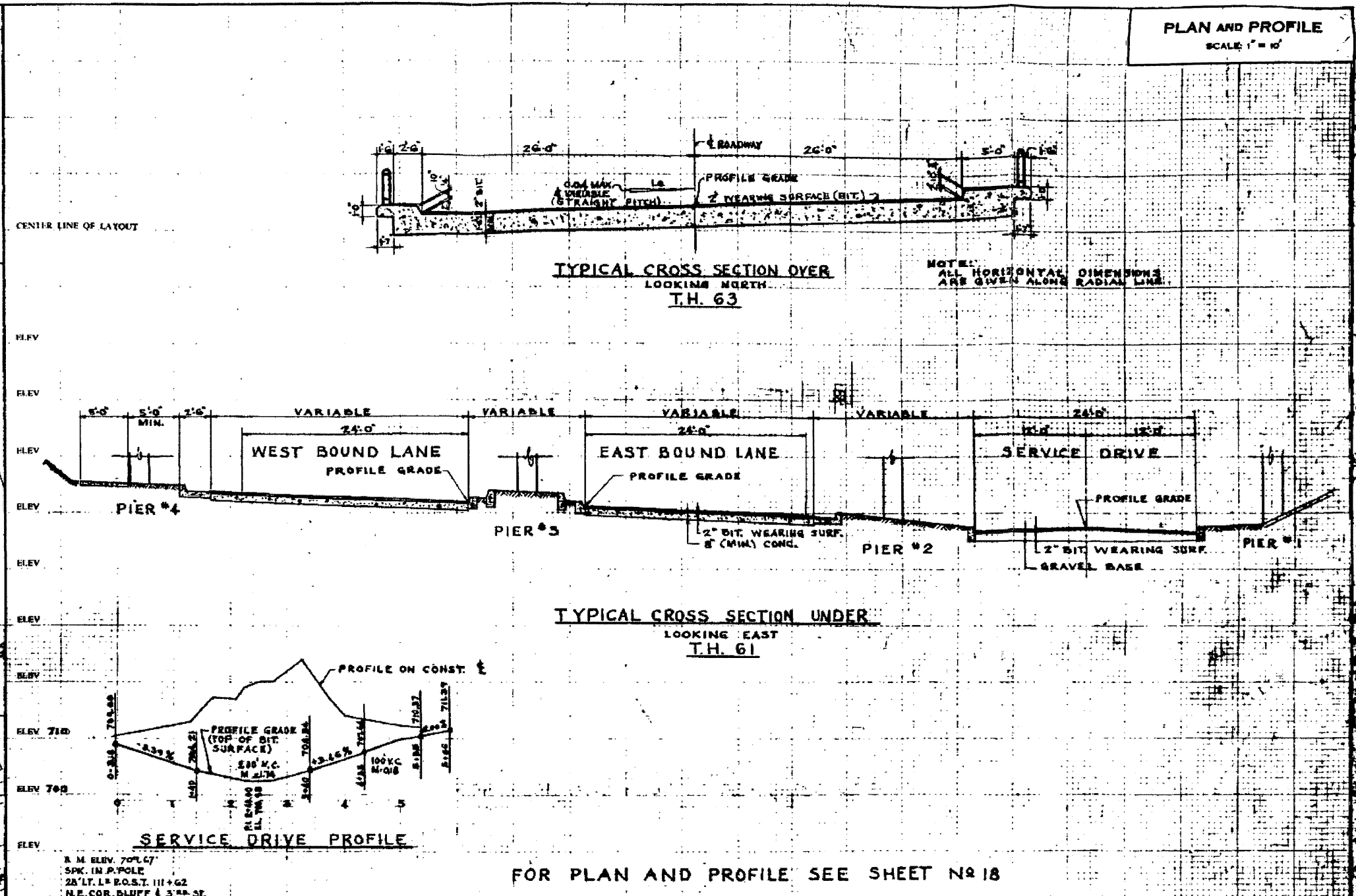
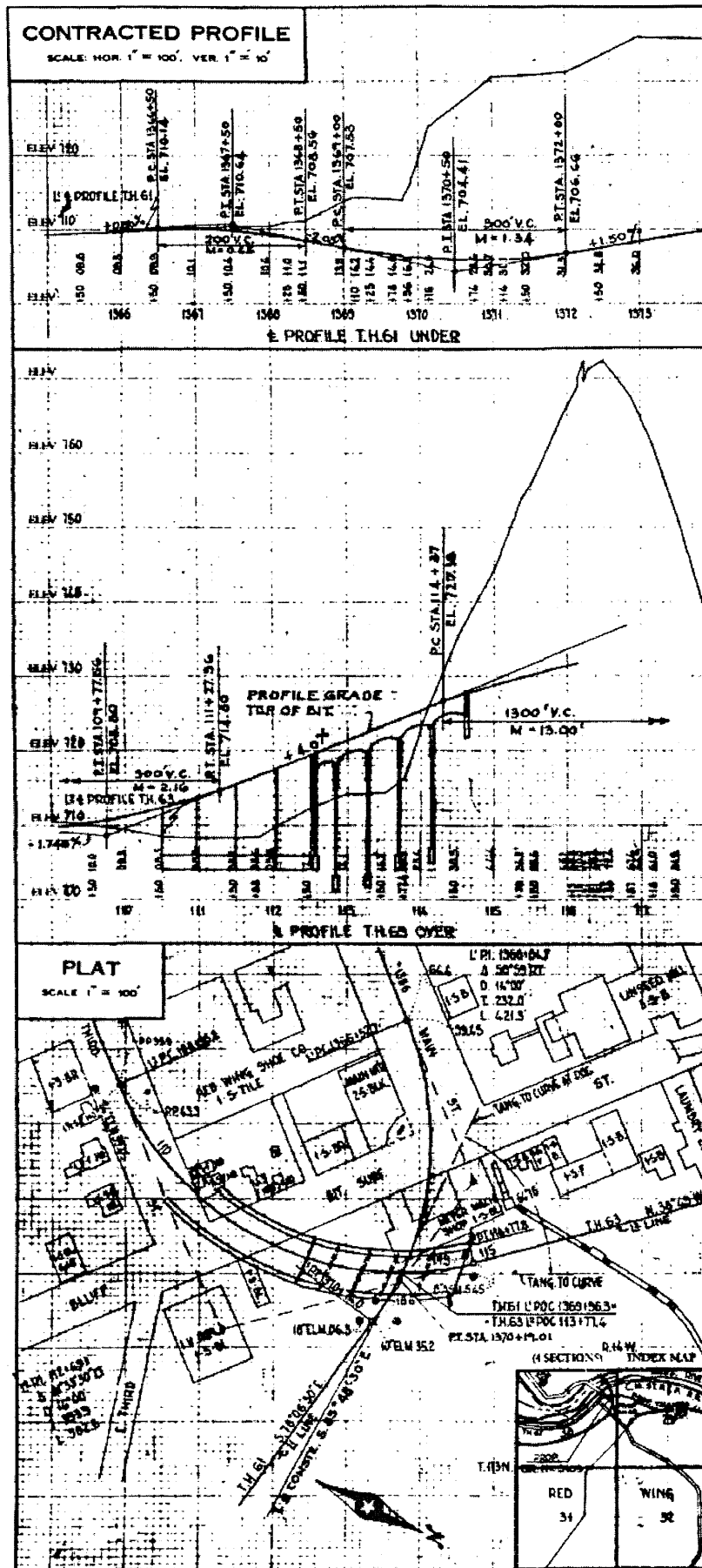
BRIDGE NO: 9103

30'-5" 40'-10" 39'-8" 41'-2" 37'-2" CONCRETE SLAB SPANS  
52'-0" ROADWAY 1'-5" 1'-2" SIDEWALK  
REINFORCEMENT BAR LISTS

APPROVED: JULY 3, 1958

PLANS PREPARED BY:  
**ALFRED BENESCH & ASSOCIATES**  
CONSULTING ENGINEERS CHICAGO ILL.

SHEET NO. 16 OF 18 SHEETS 9103



**FOLLOW SEPARATE "INSTRUCTIONS FOR PREPARATION OF BRIDGE SURVEYS" WHEN MAKING BRIDGE SURVEYS.**

**DATA**

- Preliminary recommendations of Engineer in charge of Bridge Survey:
  - Net span length and type of bridge.
  - Width of roadway on bridge.
  - Number and width of sidewalks, if any.
  - Locate center of bridge at station. U.S. 113+11.4 T.H. 63
  - If a draw bridge is recommended, the angle of draw should be.
  - Is piling required?
- Special features: Windfalls, dams, exceptional floods, ice, driftwood, shifting banks, logging, etc.
- Changes in height or length from that of old bridge, and reasons why.

**DATA (Contd.)**

- Other bridges in vicinity:
  - Over same stream (particularly structures which carry high water without overflow of roadway); give location, length, height above water, net cross-sectional area at high water stage and estimated age.
  - Over or under same highway or railroad; give location, length, bedrock and vertical clearance and estimated age.
  - Reasons why these bridges are, or are not, fair indications of what length the proposed bridge should be.
- If structure is over a drainage ditch, is ditch gradient liable to be altered?
- Navigation clearance required, if any.
- Information and evidence in regard to high water stages was obtained as follows.
- Must contractors provide for traffic during construction of proposed bridge? If so, by what means?

**HIGH AND LOW WATER ELEVATIONS**

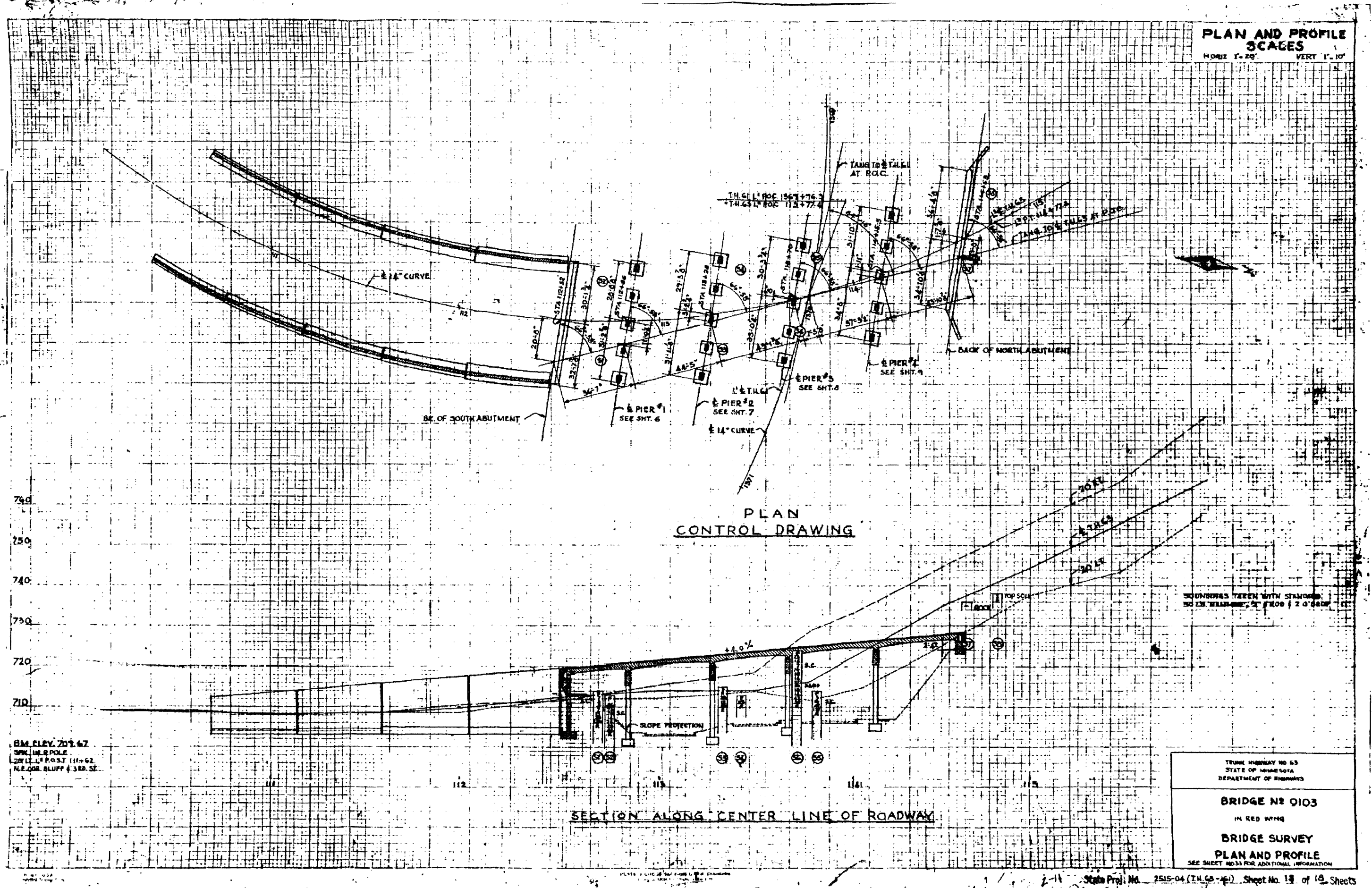
Data obtained from \_\_\_\_\_ reflects highest water elevations in the area of this construction to be \_\_\_\_\_ and the lowest water elevation to be \_\_\_\_\_. The above figures are for informational purposes only. The same highest water elevations are represented that these figures for high water and low water are in any way indicative of the high water or low water to be expected or encountered during this construction.

**SHIPPING POINT**

Proposed Bridge is \_\_\_\_\_ miles \_\_\_\_\_ of \_\_\_\_\_ IN CITY OF RED WING \_\_\_\_\_ which is the nearest Railroad shipping point. (Give name of town, station or siding)

**STATE OF MINNESOTA**  
**DEPARTMENT OF HIGHWAYS**  
**BRIDGE SURVEY**  
FOR  
PROPOSED BRIDGE LOCATED \_\_\_\_\_ MILES \_\_\_\_\_ OF  
IN RED WING \_\_\_\_\_ ON T.H. 63  
(TOWN OR CITY) (T.H., S.A.R. OR C.A.R. NUMBER)  
SEC. 30 TWP. 113 N. R. 16 W.  
TOWNSHIP: MACOUTA COUNTY: GOODHUE  
SURVEY MADE DURING MONTH OF FEB. 1956  
SURVEY MADE BY: L.F. LUHRSEN  
BRIDGE No. 9103  
SURVEY BY: D.L.C.





## **APPENDIX C**

# **INVENTORY REPORT AND INSPECTION REPORT**

# Mn/DOT Structure Inventory Report

Bridge ID: 9103 US 63 over US 61, US 63, & SRVC DR

Date: 02/15/2013

+ GENERAL +	+ ROADWAY +	+ INSPECTION +
Agency Br. No.	Bridge Match ID (TIS) 2	Deficient Status ADEQ
District 6 Maint. Area 6B	Roadway O/U Key 1-ON	Sufficiency Rating 50.4
County 25 - GOODHUE	Route Sys/Nbr USTH 63	Last Inspection Date 09-15-2011
City RED WING	Roadway Name or Description	Inspection Frequency 24
Township	US 63	Inspector Name DISTRICT6
Desc. Loc. AT JCT TH 63	Roadway Function MAINLINE	Structure A-OPEN
Sect., Twp., Range 30 - 113NN - 14W	Roadway Type 2 WAY TRAF	<b>+ NBI CONDITION RATINGS +</b>
Latitude 44d 34m 05.68s	Control Section (TH Only) 15	Deck 5
Longitude 92d 31m 53.90s	Ref. Point (TH Only) 091+00.391	Superstructure 5
Custodian STATE HWY	Date Opened to Traffic 01-01-1961	Substructure 5
Owner STATE HWY	Detour Length 58 mi.	Channel N
Inspection By DISTRICT 6	Lanes 4 Lanes ON Bridge	Culvert N
BMU Agreement	ADT (YEAR) 11,500 (2004)	<b>+ NBI APPRAISAL RATINGS +</b>
Year Built 1960	HCADT 920	Structure Evaluation 5
Year Fed Rehab	Functional Class. URB/OTH PR ART	Deck Geometry 4
Year Remodeled	<b>+ RDWY DIMENSIONS +</b>	Underclearances 4
Temp	If Divided NB-EB SB-WB	Waterway Adequacy N
Plan Avail. CENTRAL	Roadway Width 52.0 ft	Approach Alignment 5
<b>+ STRUCTURE +</b>	Vertical Clearance	<b>+ SAFETY FEATURES +</b>
Service On HWY;PED	Max. Vert. Clear.	Bridge Railing 0-SUBSTANDARD
Service Under HIGHWAY	Horizontal Clear. 51.9 ft	GR Transition 0-SUBSTANDARD
Main Span Type CCONC SLAB SPAN	Lateral Clr. - Lt/Rt	Appr. Guardrail 0-SUBSTANDARD
Main Span Detail	Appr. Surface Width 52.0 ft	GR Termini N-NOT REQUIRED
Appr. Span Type	Roadway Width 52.0 ft	<b>+ IN DEPTH INSP. +</b>
Appr. Span Detail	Median Width	Frac. Critical
Skew 20R	<b>+ MISC. BRIDGE DATA +</b>	Underwater
Culvert Type	Structure Flared NO	Pinned Asbly.
Barrel Length	Parallel Structure NONE	Spec. Feat.
Number of Spans	Field Conn. ID	<b>+ WATERWAY +</b>
MAIN: 5 APPR: 0 TOTAL: 5	Cantilever ID	Drainage Area
Main Span Length 47.5 ft	Foundations	Waterway Opening
Structure Length 211.0 ft	Abut. CONC - SPRD ROCK	Navigation Control NOT APPL
Deck Width 62.5 ft	Pier CONC - SPRD ROCK	Pier Protection
Deck Material C-I-P CONCRETE	Historic Status ELIGIBLE	Nav. Vert./Horz. Clr.
Wear Surf Type LOW SLUMP CONC	On - Off System ON	Nav. Vert. Lift Bridge Clear.
Wear Surf Install Year 1978	<b>+ PAINT +</b>	MN Scour Code A-NON WATERWAY
Wear Course/Fill Depth 0.21 ft	Year Painted Pct. Unsound	Scour Evaluation Year
Deck Membrane NONE	Painted Area	<b>+ CAPACITY RATINGS +</b>
Deck Protect. N/A	Primer Type	Design Load HS20
Deck Install Year	Finish Type	Operating Rating HS 46.00
Structure Area 13,188 sq ft	<b>+ BRIDGE SIGNS +</b>	Inventory Rating HS 27.80
Roadway Area 10,968 sq ft	Posted Load NOT REQUIRED	Posting
Sidewalk Width - L/R 2.5 ft 5.0 ft	Traffic NOT REQUIRED	Rating Date 12-01-1977
Curb Height - L/R 0.83 ft 0.83 ft	Horizontal NOT REQUIRED	Mn/DOT Permit Codes
Rail Codes - L/R 40 40	Vertical ROADWAY RESTRICTION	A: 1 B: 1 C: 1



# Mn/DOT Structure Inventory Report

Bridge ID: 9103 US 63 over US 61, US 63, & SRVC DR

Date: 02/15/2013

+ GENERAL +	+ ROADWAY +	+ INSPECTION +
Agency Br. No.	Bridge Match ID (TIS) 1	Deficient Status ADEQ
District 6 Maint. Area 6B	Roadway O/U Key A-UNDER (1ST)	Sufficiency Rating 50.4
County 25 - GOODHUE	Route Sys/Nbr USTH 61	Last Inspection Date 09-15-2011
City RED WING	Roadway Name or Description	Inspection Frequency 24
Township	US 61	Inspector Name DISTRICT6
Desc. Loc. AT JCT TH 63	Roadway Function MAINLINE	Structure A-OPEN
Sect., Twp., Range 30 - 113NN - 14W	Roadway Type 2 WAY TRAF	<b>+ NBI CONDITION RATINGS +</b>
Latitude 44d 34m 05.68s	Control Section (TH Only) 13	Deck 5
Longitude 92d 31m 53.90s	Ref. Point (TH Only) 090+00.858	Superstructure 5
Custodian STATE HWY	Date Opened to Traffic	Substructure 5
Owner STATE HWY	Detour Length 9 mi.	Channel N
Inspection By DISTRICT 6	Lanes 4 Lanes UNDER Bridge	Culvert N
BMU Agreement	ADT (YEAR) 8,000 (2004)	<b>+ NBI APPRAISAL RATINGS +</b>
Year Built 1960	HCADT 640	Structure Evaluation 5
Year Fed Rehab	Functional Class. URB/OTH PR ART	Deck Geometry 4
Year Remodeled	<b>+ RDWY DIMENSIONS +</b>	Underclearances 4
Temp	If Divided NB-EB SB-WB	Waterway Adequacy N
Plan Avail. CENTRAL	Roadway Width 26.0 ft 28.0 ft	Approach Alignment 5
<b>+ STRUCTURE +</b>	Vertical Clearance 16.3 ft 15.4 ft	<b>+ SAFETY FEATURES +</b>
Service On HWY;PED	Max. Vert. Clear. 16.3 ft 15.4 ft	Bridge Railing 0-SUBSTANDARD
Service Under HIGHWAY	Horizontal Clear. 35.0 ft 37.0 ft	GR Transition 0-SUBSTANDARD
Main Span Type CCONC SLAB SPAN	Lateral Clr. - Lt/Rt 5.4 ft 6.0 ft	Appr. Guardrail 0-SUBSTANDARD
Main Span Detail	Appr. Surface Width 64.0 ft	GR Termini N-NOT REQUIRED
Appr. Span Type	Roadway Width 54.0 ft	<b>+ IN DEPTH INSP. +</b>
Appr. Span Detail	Median Width 12.0 ft	Frac. Critical
Skew 20R	<b>+ MISC. BRIDGE DATA +</b>	Underwater
Culvert Type	Structure Flared NO	Pinned Asbly.
Barrel Length	Parallel Structure NONE	Spec. Feat.
Number of Spans	Field Conn. ID	<b>+ WATERWAY +</b>
MAIN: 5 APPR: 0 TOTAL: 5	Cantilever ID	Drainage Area
Main Span Length 47.5 ft	Foundations	Waterway Opening
Structure Length 211.0 ft	Abut. CONC - SPRD ROCK	Navigation Control NOT APPL
Deck Width 62.5 ft	Pier CONC - SPRD ROCK	Pier Protection
Deck Material C-I-P CONCRETE	Historic Status ELIGIBLE	Nav. Vert./Horz. Clr.
Wear Surf Type LOW SLUMP CONC	On - Off System ON	Nav. Vert. Lift Bridge Clear.
Wear Surf Install Year 1978	<b>+ PAINT +</b>	MN Scour Code A-NON WATERWAY
Wear Course/Fill Depth 0.21 ft	Year Painted Pct. Unsound	Scour Evaluation Year
Deck Membrane NONE	Painted Area	<b>+ CAPACITY RATINGS +</b>
Deck Protect. N/A	Primer Type	Design Load HS20
Deck Install Year	Finish Type	Operating Rating HS 46.00
Structure Area 13,188 sq ft	<b>+ BRIDGE SIGNS +</b>	Inventory Rating HS 27.80
Roadway Area 10,968 sq ft	Posted Load NOT REQUIRED	Posting
Sidewalk Width - L/R 2.5 ft 5.0 ft	Traffic NOT REQUIRED	Rating Date 12-01-1977
Curb Height - L/R 0.83 ft 0.83 ft	Horizontal NOT REQUIRED	Mn/DOT Permit Codes
Rail Codes - L/R 40 40	Vertical ROADWAY RESTRICTION	A: 1 B: 1 C: 1

# Mn/DOT Structure Inventory Report

Bridge ID: 9103 US 63 over US 61, US 63, & SRVC DR

Date: 02/15/2013

+ GENERAL +	+ ROADWAY +	+ INSPECTION +
Agency Br. No.	Bridge Match ID (TIS) 3	Deficient Status ADEQ
District 6 Maint. Area 6B	Roadway O/U Key B-UNDER (2ND)	Sufficiency Rating 50.4
County 25 - GOODHUE	Route Sys/Nbr MUN 106	Last Inspection Date 09-15-2011
City RED WING	Roadway Name or Description	Inspection Frequency 24
Township	MUN 106 (SERVICE DR)	Inspector Name DISTRICT6
Desc. Loc. AT JCT TH 63	Roadway Function MAINLINE	Structure A-OPEN
Sect., Twp., Range 30 - 113NN - 14W	Roadway Type 2 WAY TRAF	<b>+ NBI CONDITION RATINGS +</b>
Latitude 44d 34m 05.68s	Control Section (TH Only)	Deck 5
Longitude 92d 31m 53.90s	Ref. Point (TH Only)	Superstructure 5
Custodian STATE HWY	Date Opened to Traffic	Substructure 5
Owner STATE HWY	Detour Length 9 mi.	Channel N
Inspection By DISTRICT 6	Lanes 2 Lanes UNDER Bridge	Culvert N
BMU Agreement	ADT (YEAR) 100 (1960)	<b>+ NBI APPRAISAL RATINGS +</b>
Year Built 1960	HCADT	Structure Evaluation 5
Year Fed Rehab	Functional Class. URBAN LOCAL	Deck Geometry 4
Year Remodeled	<b>+ RDWY DIMENSIONS +</b>	Underclearances 4
Temp	If Divided NB-EB SB-WB	Waterway Adequacy N
Plan Avail. CENTRAL	Roadway Width 24.0 ft	Approach Alignment 5
<b>+ STRUCTURE +</b>	Vertical Clearance 14.6 ft	<b>+ SAFETY FEATURES +</b>
Service On HWY;PED	Max. Vert. Clear. 14.6 ft	Bridge Railing 0-SUBSTANDARD
Service Under HIGHWAY	Horizontal Clear. 38.6 ft	GR Transition 0-SUBSTANDARD
Main Span Type CCONC SLAB SPAN	Lateral Clr. - Lt/Rt 5.5 ft	Appr. Guardrail 0-SUBSTANDARD
Main Span Detail	Appr. Surface Width 24.0 ft	GR Termini N-NOT REQUIRED
Appr. Span Type	Roadway Width 24.0 ft	<b>+ IN DEPTH INSP. +</b>
Appr. Span Detail	Median Width	Frac. Critical
Skew 20R	<b>+ MISC. BRIDGE DATA +</b>	Underwater
Culvert Type	Structure Flared NO	Pinned Asbly.
Barrel Length	Parallel Structure NONE	Spec. Feat.
Number of Spans	Field Conn. ID	<b>+ WATERWAY +</b>
MAIN: 5 APPR: 0 TOTAL: 5	Cantilever ID	Drainage Area
Main Span Length 47.5 ft	Foundations	Waterway Opening
Structure Length 211.0 ft	Abut. CONC - SPRD ROCK	Navigation Control NOT APPL
Deck Width 62.5 ft	Pier CONC - SPRD ROCK	Pier Protection
Deck Material C-I-P CONCRETE	Historic Status ELIGIBLE	Nav. Vert./Horz. Clr.
Wear Surf Type LOW SLUMP CONC	On - Off System ON	Nav. Vert. Lift Bridge Clear.
Wear Surf Install Year 1978	<b>+ PAINT +</b>	MN Scour Code A-NON WATERWAY
Wear Course/Fill Depth 0.21 ft	Year Painted Pct. Unsound	Scour Evaluation Year
Deck Membrane NONE	Painted Area	<b>+ CAPACITY RATINGS +</b>
Deck Protect. N/A	Primer Type	Design Load HS20
Deck Install Year	Finish Type	Operating Rating HS 46.00
Structure Area 13,188 sq ft	<b>+ BRIDGE SIGNS +</b>	Inventory Rating HS 27.80
Roadway Area 10,968 sq ft	Posted Load NOT REQUIRED	Posting
Sidewalk Width - L/R 2.5 ft 5.0 ft	Traffic NOT REQUIRED	Rating Date 12-01-1977
Curb Height - L/R 0.83 ft 0.83 ft	Horizontal NOT REQUIRED	Mn/DOT Permit Codes
Rail Codes - L/R 40 40	Vertical ROADWAY RESTRICTION	A: 1 B: 1 C: 1

# Mn/DOT BRIDGE INSPECTION REPORT

05/15/2012

Inspector: District 6

BRIDGE 9103 US 63 OVER US 61, US 63, & SRVC DR

ROUTINE INSP. DATE: 09/15/2011

County: Goodhue Location: AT JCT TH 63 Length: 211.0 ft.  
 City: Red Wing Route: 02 - USTH 63 Ref. Pt.: 091+00.391 Deck Width: 62.5 ft.  
 Township: Control Section: 2515 Rdwy. Area/ Pct. Unsnd: 10968 sq. ft. / %  
 Section: 30 Township: 113N Range: 14W Maint. Area: 6B Paint Area/ Pct. Unsnd: sq. ft. / %  
 Span Type: 2 - Concrete Continuous 01 - Slab Local Agency Bridge Nbr.: Culvert: N/A  
 List: Postings:

NBI Deck: 5 Super: 5 Sub: 5 Chan: N Culv: N  
 Open, Posted, Closed: A - Open  
 MN Scour Code: A - NON WATERWAY

Appraisal Ratings - Approach: 5 Waterway: N Unofficial Structurally Deficient N  
 Required Bridge Signs - Load Posting: 0 - Not Required Traffic: 0 - Not Required Unofficial Functionally Obsolete N  
 Horizontal: 0 - Not Required Vertical: 1 - Rdwy. Clr. Restriction Unofficial Sufficiency Rating 50.4

## Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
988	Miscellaneous Items	1	Routine	09/15/2011	1 EA	1	0	0	N/A	N/A
			Routine	10/07/2009	1 EA	1	0	0	N/A	N/A
Notes: No swallow nests.										
048	Low Slump O/L (Concrete Slab with Uncoated Rebar)	2	Routine	09/15/2011	13188 SF	0	13188	0	0	0
			Routine	10/07/2009	13188 SF	0	13188	0	0	0
Notes: A concrete overlay was placed in 1978. There is light concrete scaling in the south bound lane. There are no spalls or delaminations were noted along the deck surface at this time.										
Span # 3 - the north fascia side over the right hand lane has 2 small high load impact spalls along the bottom edge and 1 scrape mark.										
205	Reinforced Concrete Column	2	Routine	09/15/2011	20 EA	16	4	0	0	N/A
			Routine	10/07/2009	20 EA	16	4	0	0	N/A
Notes: Pier # 1 Columns - columns 1 and 5 have superficial random cracking.										
Pier # 2 Columns - all of the columns have minor map cracking.										
Pier # 3 Columns - all of the columns have map cracking. Column 1 has a 1' X 1' rebar spall near the bottom along the north side. Column 4 has a 1' X 4' cracked and delaminated area along the east side. Column 5 has a vertical cracks along the southwest and southeast corners with delaminated areas.										
Pier # 4 Columns - columns 1 and 3 have superficial random cracking. Column 5 has a cracked and delaminated area along the southwest corner.										
215	Reinforced Concrete Abutment	2	Routine	09/15/2011	125 LF	61	64	0	0	N/A
			Routine	10/07/2009	125 LF	61	64	0	0	N/A
Notes: West Abutment - has 12 vertical cracks scattered across the front face with some with leaching. There are 3 areas of cracked and delaminated concrete scattered across the front face approximately 8 square feet. There are 5 spalled areas scattered across the front face approximately 12 square feet. There is a 1' X 2' cracked, delaminated and spalled area along the south end. There is graffiti painted on the face of the abutment.										
East Abutment - has 11 vertical cracks scattered across the front face with some with leaching. There are 2 areas of random or horizontal cracking along the front face located between bearings 3 thru 6 and 8 thru 10 approximately 35 linear feet. There are approximately 70 square feet of delaminated concrete.										

## Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
234	Reinforced Concrete Pier Cap	2	Routine	09/15/2011	250 LF	236	14	0	0	N/A
			Routine	10/07/2009	250 LF	236	14	0	0	N/A
Notes: Pier # 1 - there are minor random cracks at both ends of the cap with superficial cracking on both sides of the cap. There are rust scattered along the bottom due to exposed rebar chairs.										
Pier # 2 - there are minor random cracks at both ends of the cap with superficial cracking on both sides of the cap. There are rust scattered along the bottom due to exposed rebar chairs.										
Pier # 3 - there are minor random cracks at both ends of the cap with superficial cracking on both sides of the cap. There are rust scattered along the bottom due to exposed rebar chairs.										
Pier # 4 - there are minor random cracks at both ends of the cap with superficial cracking on both sides of the cap. There are rust scattered along the bottom due to exposed rebar chairs.										
300	Strip Seal Deck Joint	2	Routine	09/15/2011	110 LF	109	1	0	N/A	N/A
			Routine	10/07/2009	110 LF	109	1	0	N/A	N/A
Notes: East End - OK, the strip seals are full of dirt and debris. There is a 1 foot long patched area in the east bound lane near the center line.										
West End - OK, the strip seals are full of dirt and debris; however there are no signs of leakage at the bridge seat. There is a small patched area near the center line and there are no bolts holding down the cover plate at the southeast corner.										
301	Poured Deck Joint	2	Routine	09/15/2011	63 LF	63	0	0	N/A	N/A
			Routine	10/07/2009	63 LF	63	0	0	N/A	N/A
Notes: All joints were sealed at the time of this inspection.										
311	Expansion Bearing	2	Routine	09/15/2011	48 EA	22	26	0	N/A	N/A
			Routine	10/07/2009	48 EA	22	26	0	N/A	N/A
Notes: The expansion bearings are located along both abutments and along piers 1 & 4.										
West Abutment Bearings - all 12 masonry plates have active corrosion with minor loss of section.										
Pier # 1 Bearings - bearings 6 & 7 the masonry plates have active corrosion with minor loss of section.										
Pier # 4 Bearings - OK, the expansion bearings show little or no deterioration.										
East Abutment Bearings - all 12 masonry plates have active corrosion with minor loss of section.										
313	Fixed Bearing	2	Routine	09/15/2011	24 EA	24	0	0	N/A	N/A
			Routine	10/07/2009	24 EA	24	0	0	N/A	N/A
Notes: The fixed bearings are located along pier 2 & 3.										
Pier # 2 Bearings - OK, the fixed bearings show little or no deterioration.										
Pier # 3 Bearings - OK, the fixed bearings show little or no deterioration.										
320	Concrete Approach Slab-Bituminous Wearing Surface	2	Routine	09/15/2011	2 EA	0	2	0	0	N/A
			Routine	10/07/2009	2 EA	0	2	0	0	N/A
Notes: West Approach Slab - has numerous unsealed random cracks along the end block with small potholes forming.										
East Approach Slab - has numerous unsealed random cracks along the end block with small potholes forming.										

## Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
334	Metal Bridge Railing (Coated or Painted)	2	Routine	09/15/2011	422 LF	0	422	0	0	0
			Routine	10/07/2009	422 LF	0	422	0	0	0
	Notes: The galvanizing is breaking down on all steel surfaces with light areas of surface corrosion showing.									
	North Side Railing - has 3 small areas of minor impact damage located in spans 1 & 5.									
358	Concrete Deck Cracking Smart Flag	2	Routine	09/15/2011	1 EA	1	0	0	0	N/A
			Routine	10/07/2009	1 EA	1	0	0	0	N/A
	Notes: Approximately 4400 linear feet of deck cracks were sealed in 2008.									
359	Underside of Concrete Deck Smart Flag	2	Routine	09/15/2011	1 EA	0	0	1	0	0
			Routine	10/07/2009	1 EA	0	0	1	0	0
	Notes: There are areas of saturated and deteriorating concrete along the centerline construction joint beneath the deck. The outside edges of the slab have numerous leaching cracks with efflorescence. Spans 2, 3 and 4 have numerous spalls knocked off in vicinity of the centerline beneath the deck. Spalls should be knocked down from span # 5 also. The centerline beneath the deck is leeching for the entire length of bridge. Exposed rebar's have been epoxyed in the past, the epoxy is worn off and the rebar's are rusting again. There are small concrete patches in the north side overhang near pier 2. There are 3 small 6" X 6" high load impact chips along the north side located in span 3.									
387	Reinforced Concrete Wingwall	2	Routine	09/15/2011	2 EA	2	0	0	0	N/A
			Routine	10/07/2009	2 EA	2	0	0	0	N/A
	Notes:									
964	Critical Finding Smart Flag	2	Routine	09/15/2011	1 EA	1	0	N/A	N/A	N/A
			Routine	10/07/2009	1 EA	1	0	N/A	N/A	N/A
	Notes: No critical finding were observed at the time of this inspection.									
981	Signing	2	Routine	09/15/2011	1 EA	1	0	0	0	0
			Routine	10/07/2009	1 EA	1	0	0	0	0
	Notes: Signs Required: Vertical Clearance Delineator signs are not required on top of the bridge (TH-63). All delineator signs below the bridge are in place.									
982	Approach Guardrail	2	Routine	09/15/2011	1 EA	1	0	0	N/A	N/A
			Routine	10/07/2009	1 EA	1	0	0	N/A	N/A
	Notes: All guard railing sections were intact at the time of this inspection.									
983	Plowstraps	2	Routine	09/15/2011	1 EA	0	1	0	N/A	N/A
			Routine	10/07/2009	1 EA	0	1	0	N/A	N/A
	Notes: East End - 5 missing plow straps.									
984	Deck & Approach Drainage	2	Routine	09/15/2011	1 EA	0	1	0	N/A	N/A
			Routine	10/07/2009	1 EA	0	1	0	N/A	N/A
	Notes: The catch basin is located along the north side of the west approach slab. There are areas of deterioration along the concrete spacer rings under the steel casting.									
985	Slopes & Slope Protection	2	Routine	09/15/2011	1 EA	0	1	0	N/A	N/A
			Routine	10/07/2009	1 EA	0	1	0	N/A	N/A
	Notes: West Slope - there is minor heaving of the slope with small trees growing through the blocks on the south side of the slope.									
East Slope - some of the blocks near the center are heaving or settling with some undermining.										

## Structure Unit:

ELEM NBR	ELEMENT NAME	ENV	REPORT TYPE	INSP. DATE	QUANTITY	QTY CS 1	QTY CS 2	QTY CS 3	QTY CS 4	QTY CS 5
986	Curb & Sidewalk	2	Routine	09/15/2011	1 EA	0	1	0	N/A	N/A
			Routine	10/07/2009	1 EA	0	1	0	N/A	N/A

Notes: There are scattered cracks and small stone pop-outs in the face of both curbs. There is a small spall that extends down into the abutment in the south walk next to the expansion joint. The curbs and walks are settling slightly off the west end of the bridge. The sidewalk and curb cracks were sealed in 2008. The joint cover plate is loose and all the bolts are broken off the south east corner. This is a large plate that covers the joint over the sidewalk and curb.

## General Notes:

NOTE: All columns and bearings are numbered from the south and all spans and piers are numbered from the west.

NOTE: Bridge was inspected in 2009 by Brian Haugen.

NOTE: Bridge was inspected in 2011 by Gary Waletzki.

58. Deck NBI:

36A. Brdg Railings NBI:

36B. Transitions NBI:

36C. Appr Guardrail NBI:

36D. Appr Guardrail

Terminal NBI:

59. Superstructure NBI:

60. Substructure NBI:

61. Channel NBI:

62. Culvert NBI:

71. Waterway Adeq NBI:

72. Appr Roadway

Alignment NBI:

Inventory Notes:

Gary Waletzki

Inspector's Signature

Craig Lenz

Reviewer's Signature



## **APPENDIX D GENERAL PHOTOS**



Photo 1. West side of Bridge 9103 with service drive to Red Wing Shoe Company parking area in foreground (facing northeast)



Photo 2. East side of bridge with service drive at left (facing west)

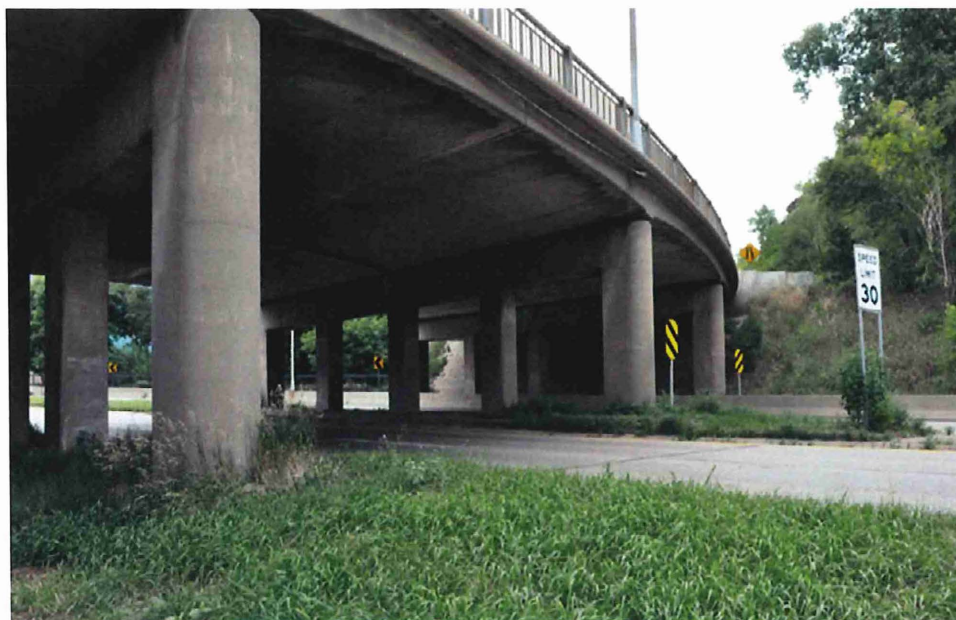


Photo 3. Bridge deck and piers (facing northwest)



Photo 4. Pier 1, slope paving, and south abutment (facing southeast)





Photo 5. East side of the bridge with service drive in foreground (facing northwest)



Photo 6. Span 3 and TH 61 southbound lanes; note vehicle damage on slab fascia (facing east)



Photo 7. Southern approach roadway structure (facing north)

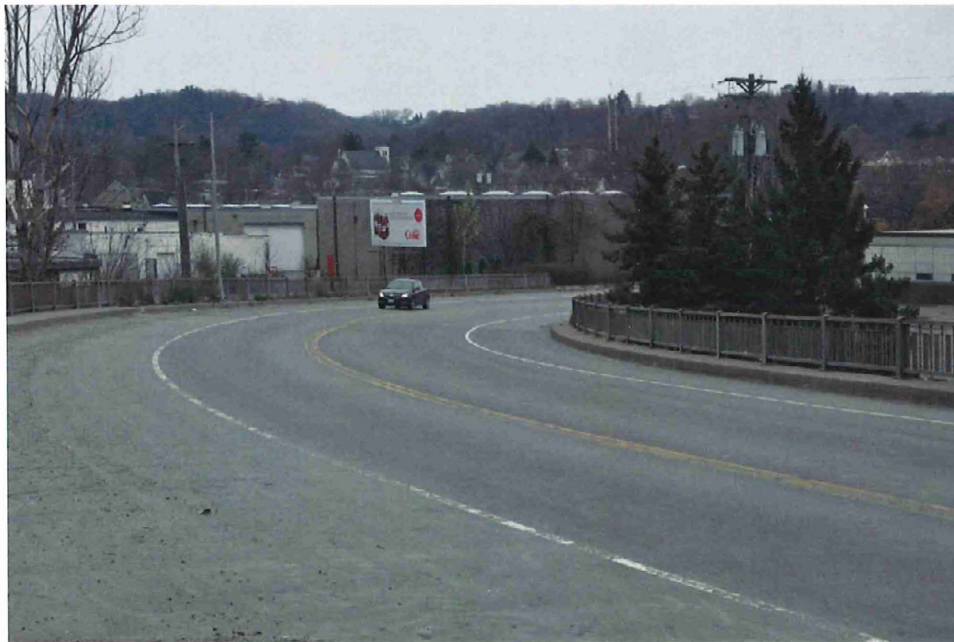


Photo 8. Bridge 9103 and its southern approach roadway (facing south)

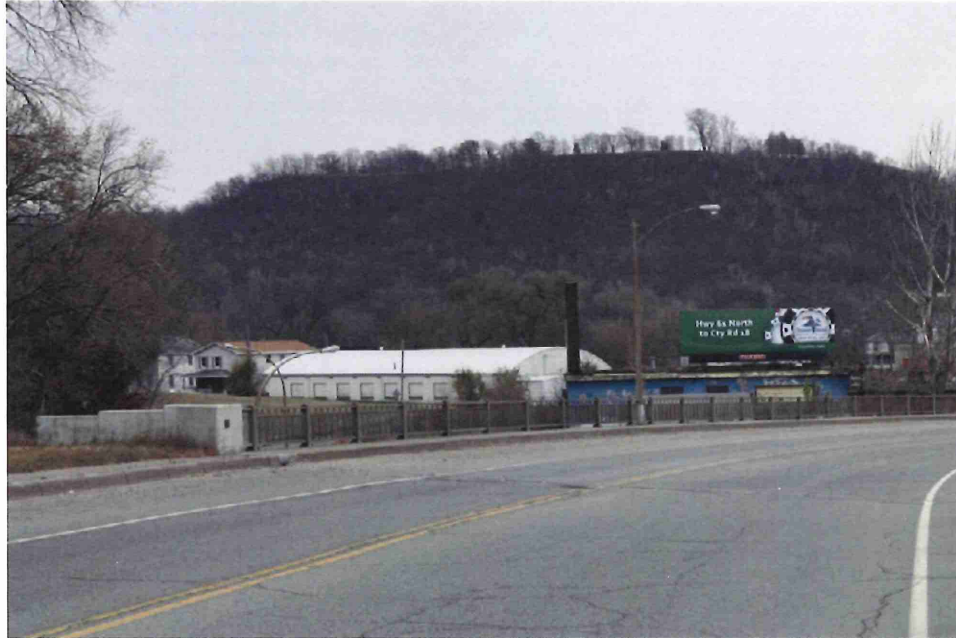


Photo 9. North end of bridge (facing southeast)



Photo 10. Curved bridge, railing, coping, and piers on west side of bridge (facing south)





Photo 11. East side of the bridge (facing south)



Photo 12. Southern approach structure's west retaining wall; Red Wing Shoe Company parking area in foreground (facing northeast)



Photo 13. South end of southern approach's west retaining wall; note curved coping (facing northeast)



Photo 14. East railing (facing northeast)



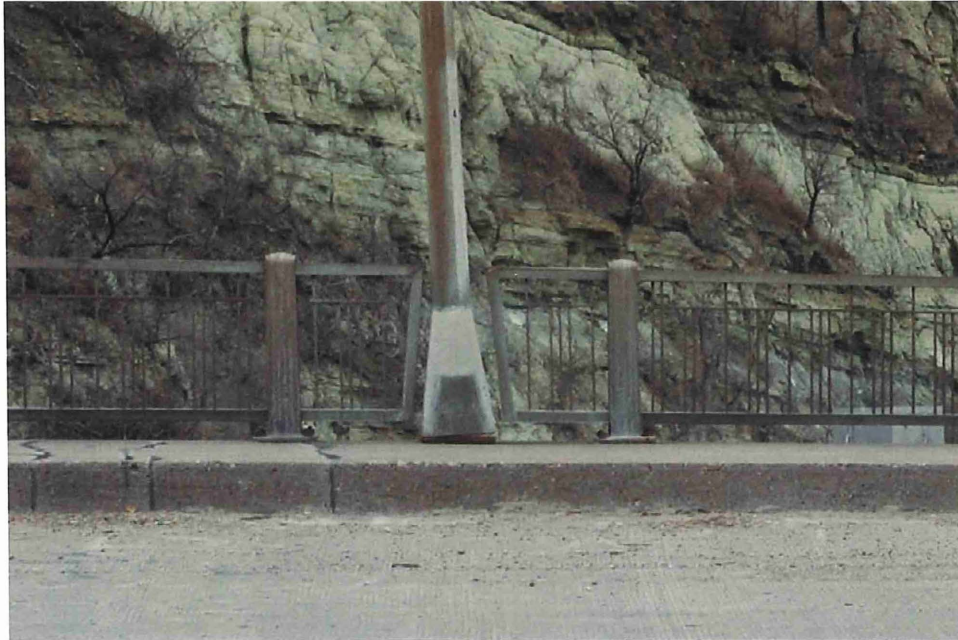


Photo 15. Detail of light integrated into east railing (facing east)



Photo 16. West railing; Red Wing Shoe Company parking area at rear (facing northwest)

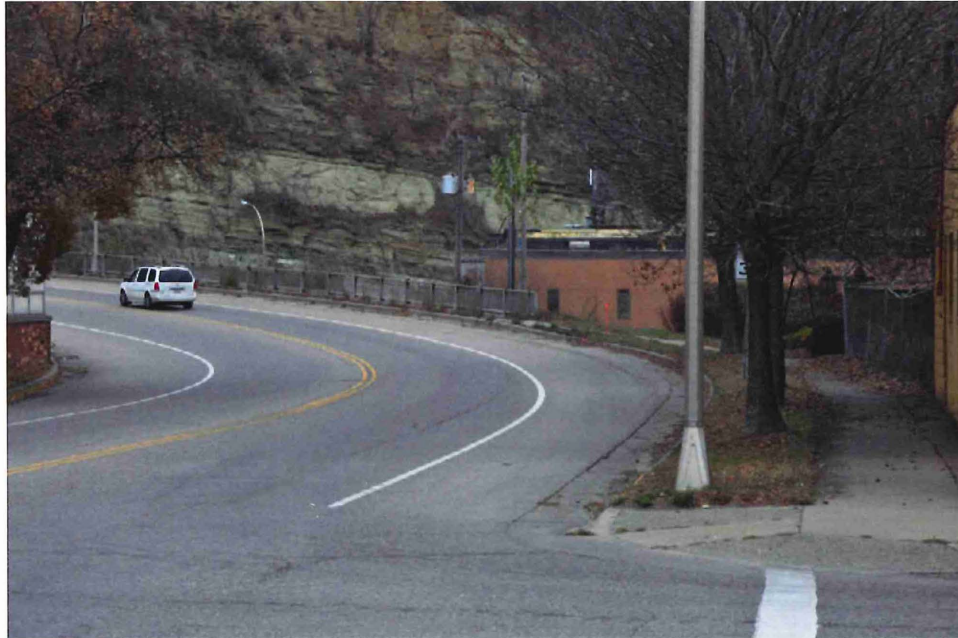


Photo 17. TH 63 from the intersection of Third and Potter; car is on the southern approach (facing northeast)

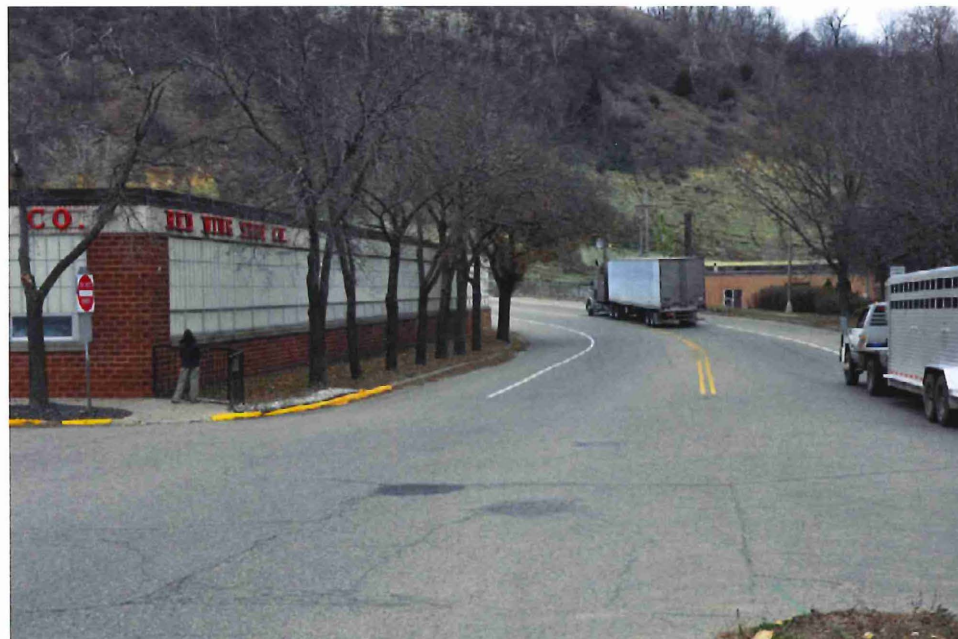


Photo 18. TH 63 from the intersection of Third and Potter; Red Wing Shoe Company at left (facing northeast)



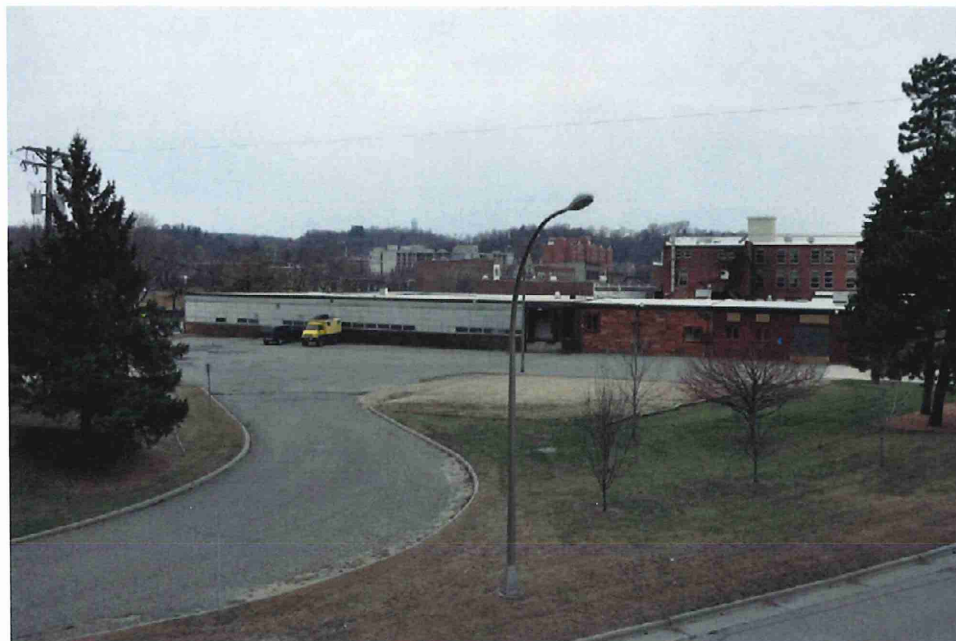


Photo 19. Service drive to Red Wing Shoe Company parking area; TH 61 southbound



Photo 20. TH 61 west of the bridge (facing southwest)

## APPENDIX E INSPECTION PHOTOS





West elevation view - Elevation view looking NE.

Photo 1



Span 2 - Underside of deck.

Photo 2

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 3 - Underside of deck.

Photo 3



Span 4 - Underside of deck.

Photo 4

Bridge No: 9103  
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US HWY 63 over US HWY 61/63 & SRVC DR  
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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 5 - Underside of deck.

Photo 5



East elevation view - Elevation view looking NW.

Photo 6

Bridge No: 9103  
DISTRICT 6, Goodhue County

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 1 - Underside of deck.

Photo 7



Span 1 - Close-up view of spalled areas. Approximately 2' either side of centerline joint is either spalled or delaminated full length of span. The exposed reinforcement bars have corrosion with some initial section loss and the spall depth extends up to 3" deep.

Photo 8

Bridge No: 9103  
DISTRICT 6, Goodhue County

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 2 - Close-up view of spalled areas. Approximately 2'-6" either side of centerline joint is either spalled or delaminated full length of span. The exposed bars have corrosion with some initial section loss and the spall depth extends up to 3" deep. Some loss of bond is occurring on some longitudinal reinforcement bars.

Photo 9



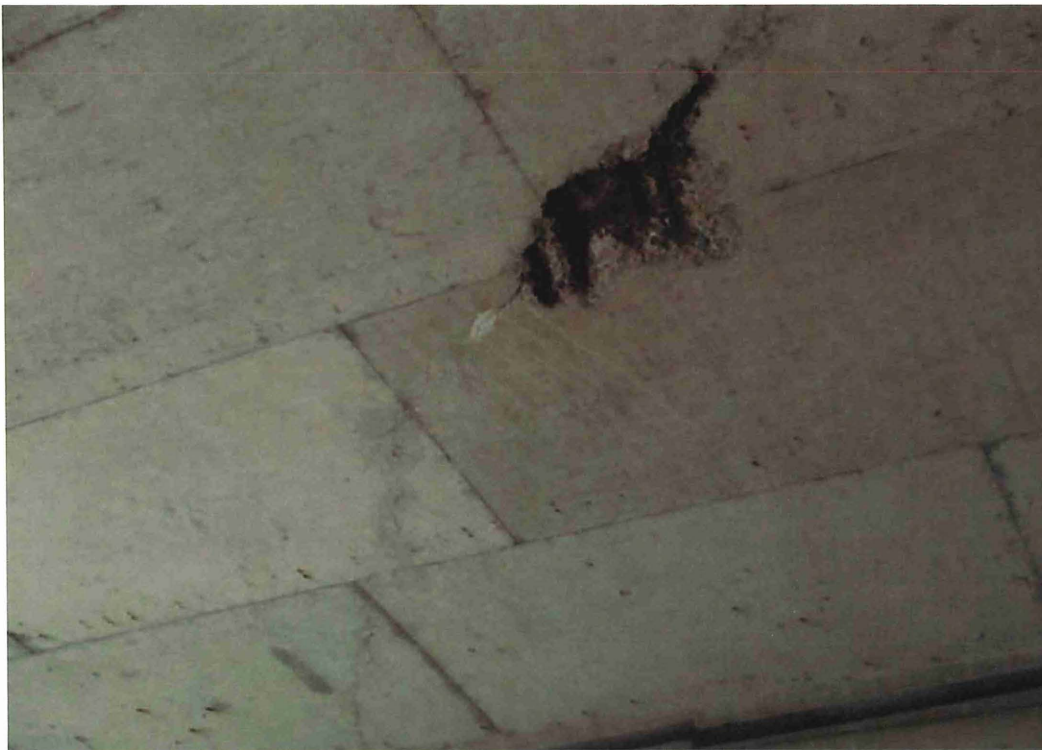
Span 2 - Additional close-up view of spalled areas.

Photo 10

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 2 - 2'-0" diameter spall approximately 2" deep located 10' north of Pier 1, and 20' from east edge of deck. Noteable circular structural crack with efflorescence starting 16' from the east edge of the deck at Pier 1, and extending to the CL bridge joint at 14' from Pier 1.

Photo 11



Span 3 - Close-up view of spalled areas. Approximately 2' to 3' either side of centerline joint is either spalled or delaminated full length of span. The exposed reinforcement bars have advanced corrosion with some initial section loss and the spall depth extends up to 3" to 4" deep.

Photo 12

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

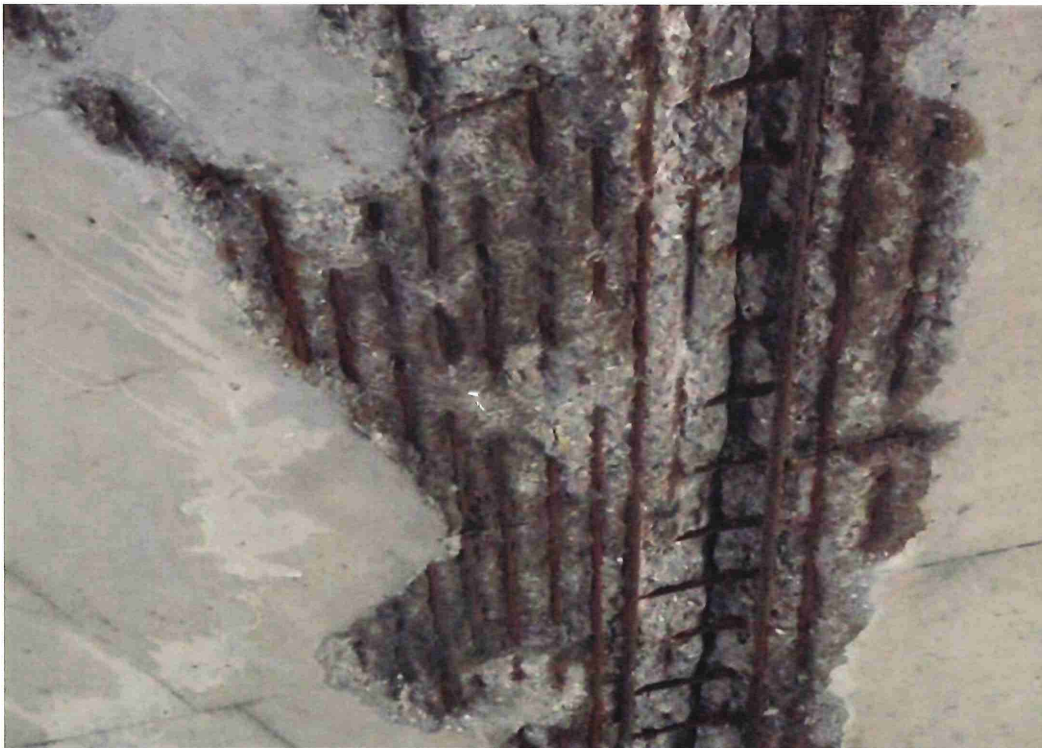
INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 3 - Close-up view of spalled areas. Some loss of bond is occurring on four longitudinal reinforcement bars. One longitudinal bar with 3/4" remaining section.

Photo 13



Span 4 - Close-up view of spalled areas. Approximately 2' on the east side of the CL joint and up to 4' on the west side is either spalled or delaminated the full length of span. The exposed reinforcement bars have advanced corrosion with some initial section loss and the spall depth extends up to 3" and 4" deep.

Photo 14

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 4 - Circular structural crack with efflorescence starting 20' from the west edge of the deck at Pier 4, and extending to the CL bridge joint at approximately the midspan of Span 3.

Photo 15



Span 4 - Additional photo of structural crack

Photo 16

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

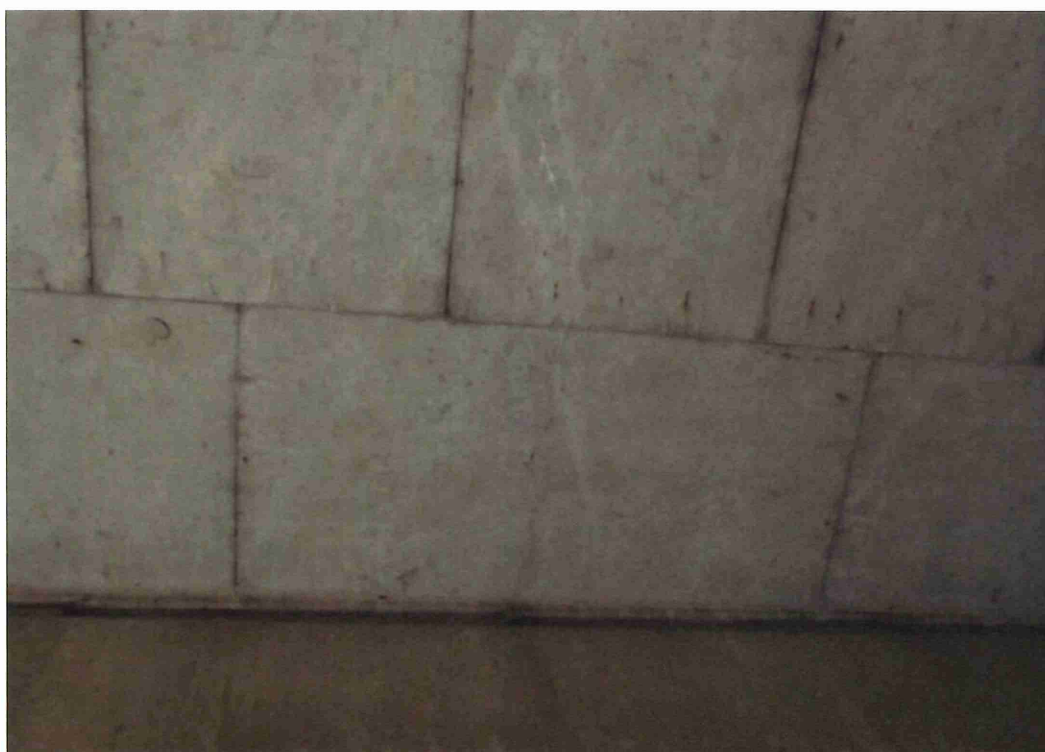
INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 4 - Diagonal structural crack with efflorescence starting 24' from the east edge of deck at Pier 4, and extending to the CL bridge joint 12' from Pier 4.

Photo 17



Span 4 - Several areas of map cracking most prevalent in the south half of the span.

Photo 18

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Span 4 - Additional photo of areas of map cracking.

Photo 19



Span 5 - Close-up view of spalled areas. Approximately 2' either side of centerline joint is either spalled or delaminated full length of span. The exposed reinforcement bars have corrosion with some initial section loss and the spall depth extends up to 3" deep.

Photo 20

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 5 - Additional photo of spalled areas.

Photo 21



North Abutment slope paving - Slope paving has several areas of severe settlement up to 12".

Photo 22

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





North Abutment slope paving - Additional photo of severe settlement.

Photo 23



North Abutment - Corner spall/delamination starting at Bearing #3 (from west) and extending to Bearing #5. Spall measures up to 4" deep on abutment face x 16" vertical by 12' long, and delamination on top of cap in same location extends to 8" deep.

Photo 24

Bridge No: 9103  
DISTRICT 6, Goodhue County

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



North Abutment - Additional corner spall/delamination photo.

Photo 25



North Abutment - Corner spall/delamination between Bearing #8 (from west) and Bearing #9. Spall measures up to 3" deep on abutment face x 12" vertical by 6' long, and delamination on top of cap in same location extends to 4" deep.

Photo 26

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US HWY 63 over US HWY 61/63 & SRVC DR  
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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Name plate

Photo 27



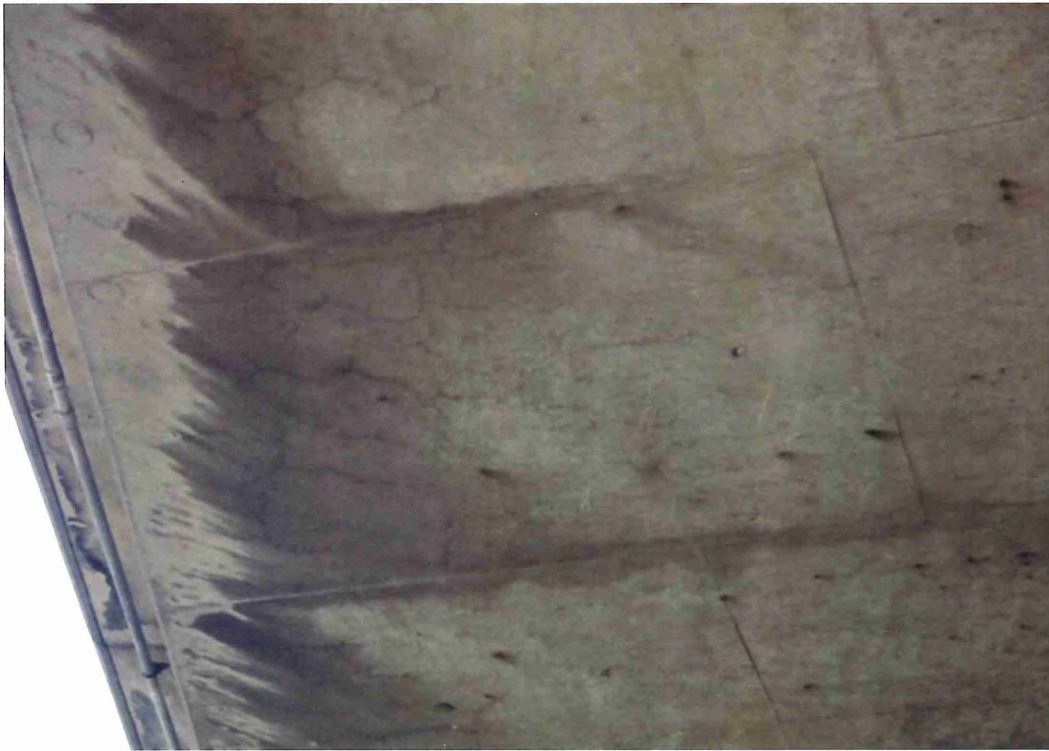
Column (typical) - Typical minor spalling on some of the pier columns.

Photo 28

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Deck underside (typical) - Map cracking along east edge of deck extending in approximately 4'-0" with signs of chloride contamination and staining.

Photo 29



South Abutment - Several areas of spalling extending to 2" deep with some exposed reinforcement bars.

Photo 30

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DISTRICT 6, Goodhue County

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Deck underside (typical) - Map cracking along west edge of deck extending in approximately 4'-0" with signs of chloride contamination and staining.

Photo 31



Deck underside (typical) - Additional photo of map cracking along west edge of deck with signs of chloride contamination and staining.

Photo 32

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





West fascia - Minor impact damage on west fascia above the SB 61 lanes.

Photo 33



West fascia (typical) - Vertical hairline cracks at approximate 12" centers (typical).

Photo 34

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Deck surface - Map cracking on deck surface (NB lane shown, typical throughout).

Photo 35



Deck surface, Span 2, NB lane - Structural crack with delamination along length.

Photo 36

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

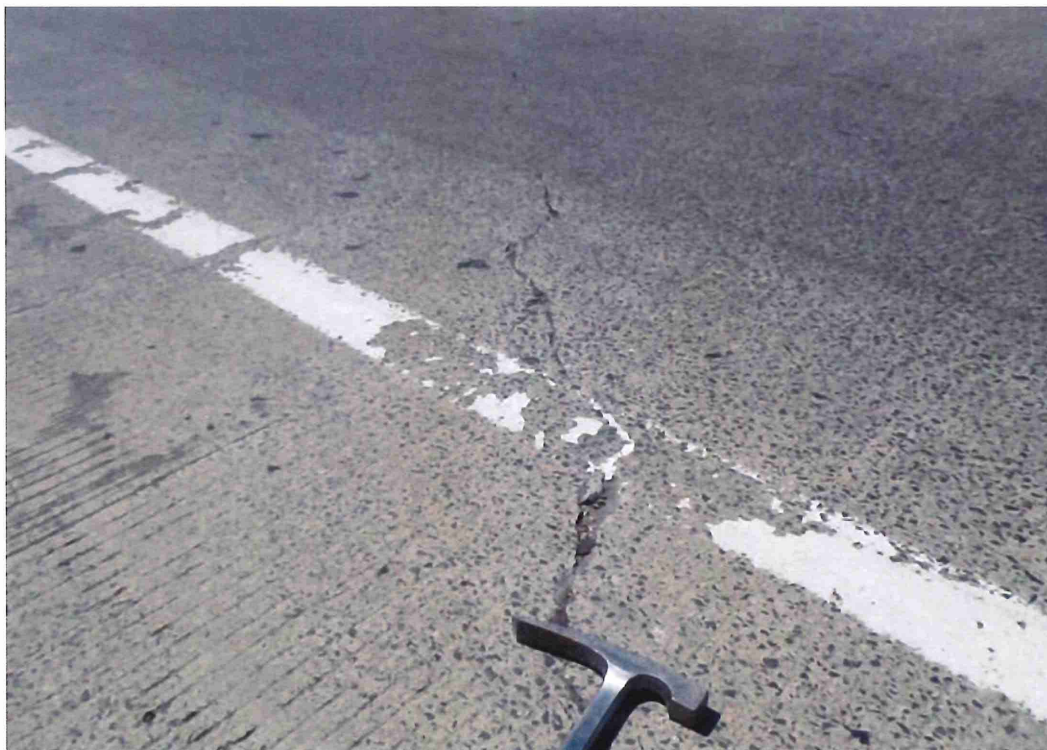
INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Deck surface, Span 5, NB lane - Structural crack with delamination along length.

Photo 37



Deck surface, Span 5, NB lane - Additional photo of a structural crack with delamination along length.

Photo 38

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INSPECTION DATE May 16, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



North approach pavement - Evidence of settlement full width of approach.

Photo 39



Approach roadway - Looking south from North Abutment.

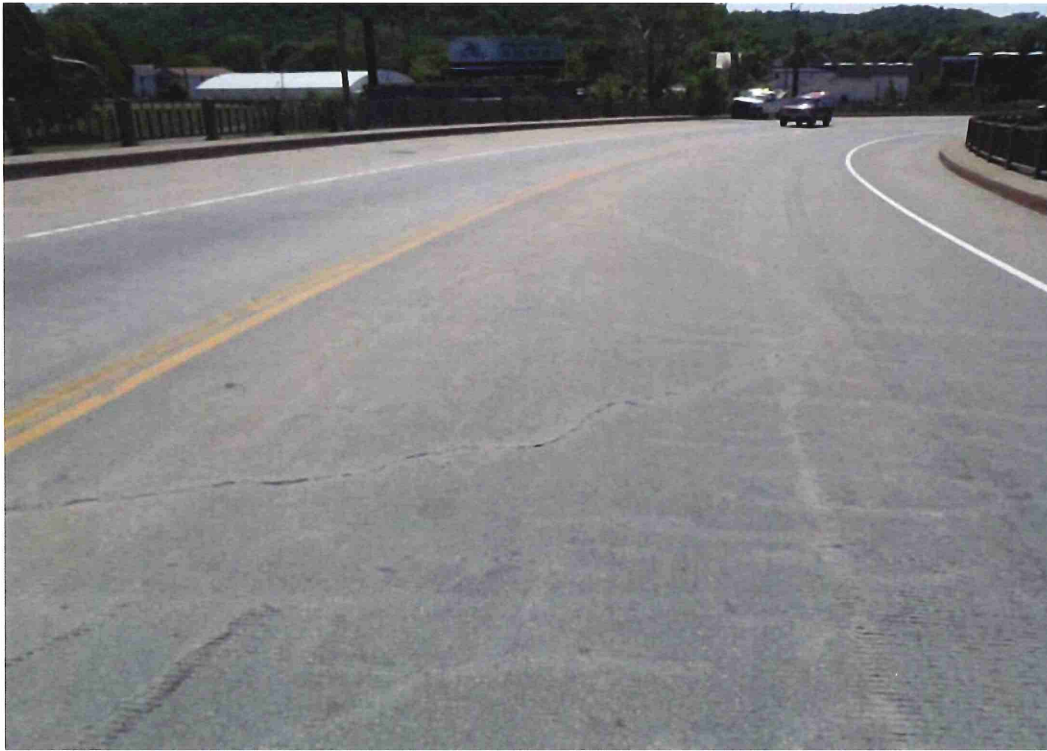
Photo 40

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE May 16, 2012

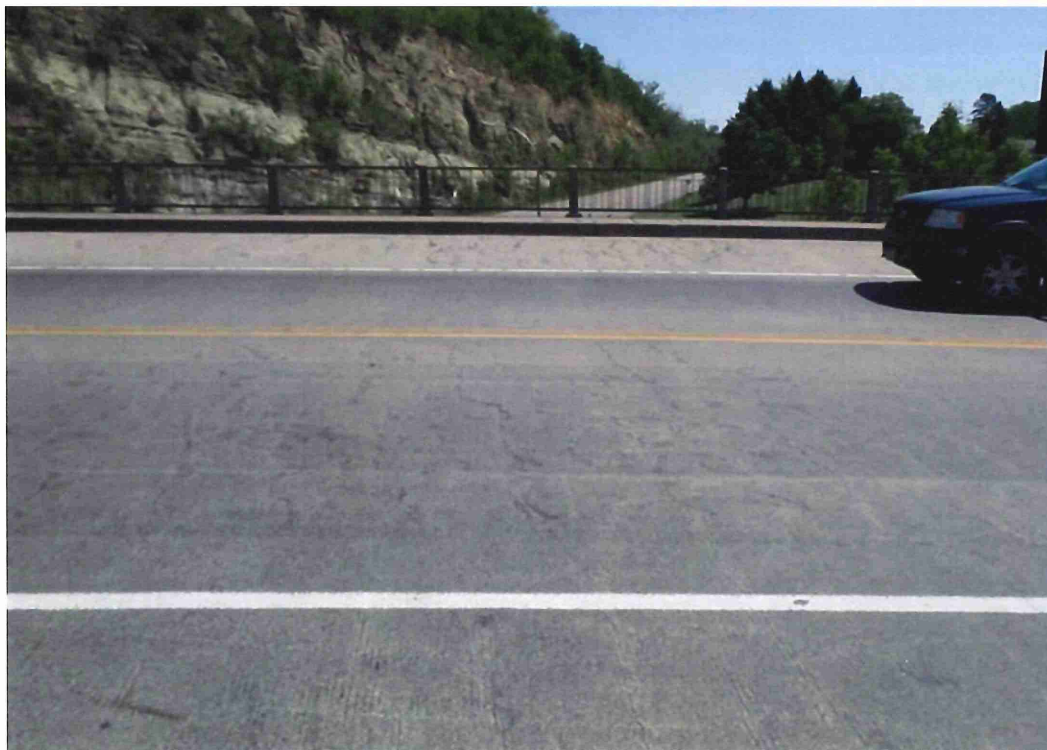
INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Deck surface, Span 4/5, SB lane - Structural cracks with delamination along length.

Photo 41



Deck surface - Map cracking on deck surface (NB/SB Lane above Span 2 shown, typical throughout).

Photo 42

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





South approach pavement - Minor settlement and poor condition of bituminous pavement noted.

Photo 43

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Bridge Name Plate

Photo 1



West Elevation

Photo 2

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East Elevation

Photo 3



Span 3 - Section loss in two bars, 7/8" remain, starts 12' from Pier 3 and continues to midspan.

Photo 4

Bridge No: 9103  
DISTRICT 6, Goodhue County

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 3 - Section loss in two bars, 7/8" remain. Loss starts 12' from Pier 3 and continues to midspan

Photo 5



Span 3 - Broken / 100% Section loss in transverse bars.

Photo 6

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Span 3 - Close up of Broken / 100% section loss in transverse bars.

Photo 7



Span 3 - General view along the centerline joint.

Photo 8

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 3 - General view perpendicular to the street looking at the North half of the span.

Photo 9



Span 4 - Missing rebar along 2/3 of span.

Photo 10

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 4 - Close up of section loss at midspan, West side of the street.

Photo 11



Span 4 - Section loss at midspan of the first rebar, East side of the street.

Photo 12

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INSPECTION DATE June 26, 2012

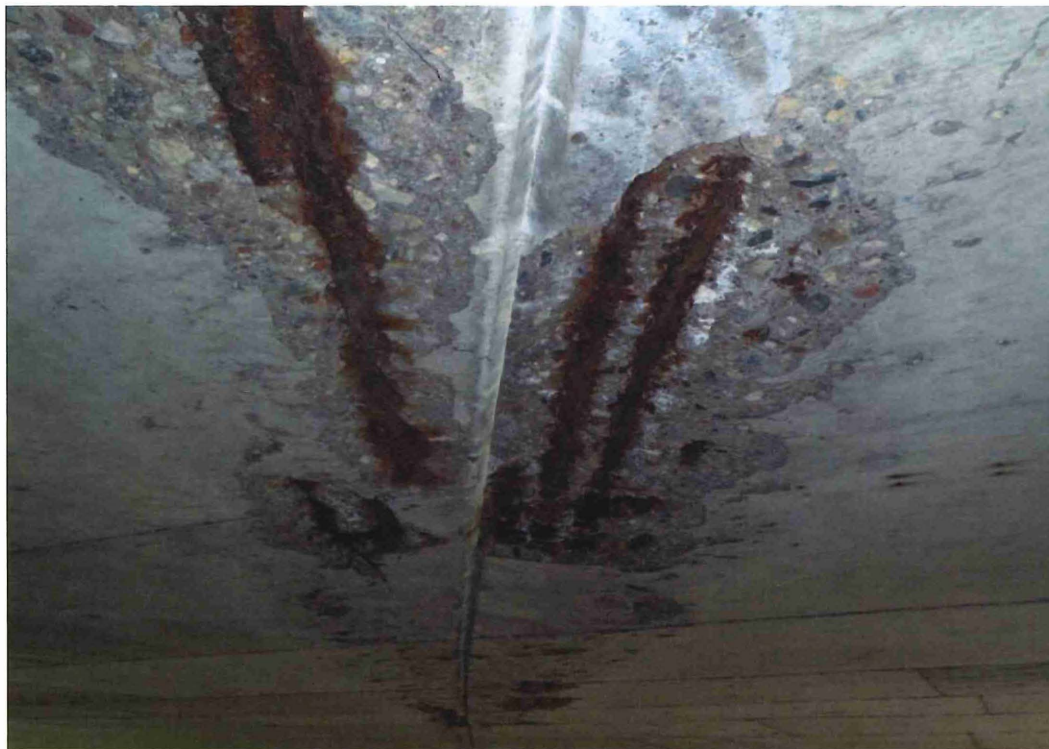
INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 4 - General view along the centerline.

Photo 13



Span 5 - General view along the centerline joint showing areas of spalling and delamination.

Photo 14

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Photo 15

Span 3 - General view along centerline.



Photo 16

Span 3 - Section loss at the South end of the span.

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DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE June 26, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 3 - Close up of spalled areas occurring in half of span 3

Photo 17



Span 3 - Additional close up of spalled areas occurring in half of span 3

Photo 18

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DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 4 - Spalled deck area with 6 exposed rebar measuring 1" in diameter.

Photo 19



Span 4 - Hairline crack with efflorescence. The concrete is sound around the crack.

Photo 20

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 4 - Close up view of hairline crack.

Photo 21



Span 5 - Hairline crack with efflorescence, concrete is sound.

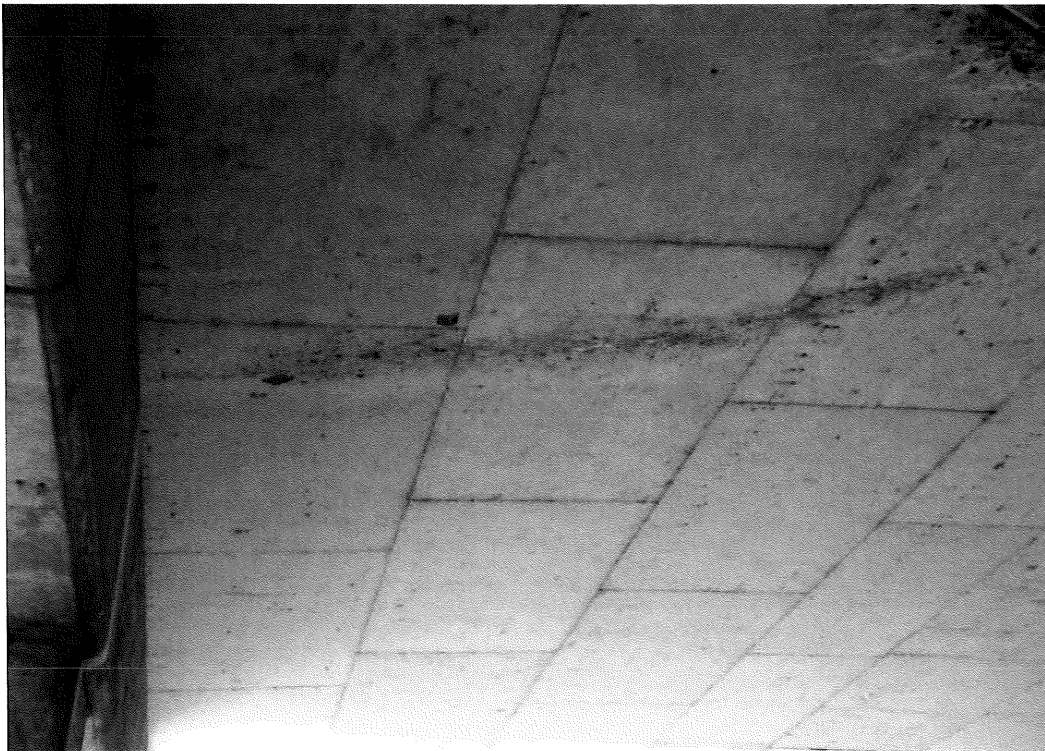
Photo 22

Bridge No: 9103  
DISTRICT 6, Goodhue County

US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE June 26, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 5 - Additional view of the hairline crack.

Photo 23



Span 2 - Section loss and spalling in areas of Span 2.

Photo 24

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 2 - Close up view of spalling in areas of Span 2.

Photo 25



Span 2 - Spalled concrete near Pier 1.

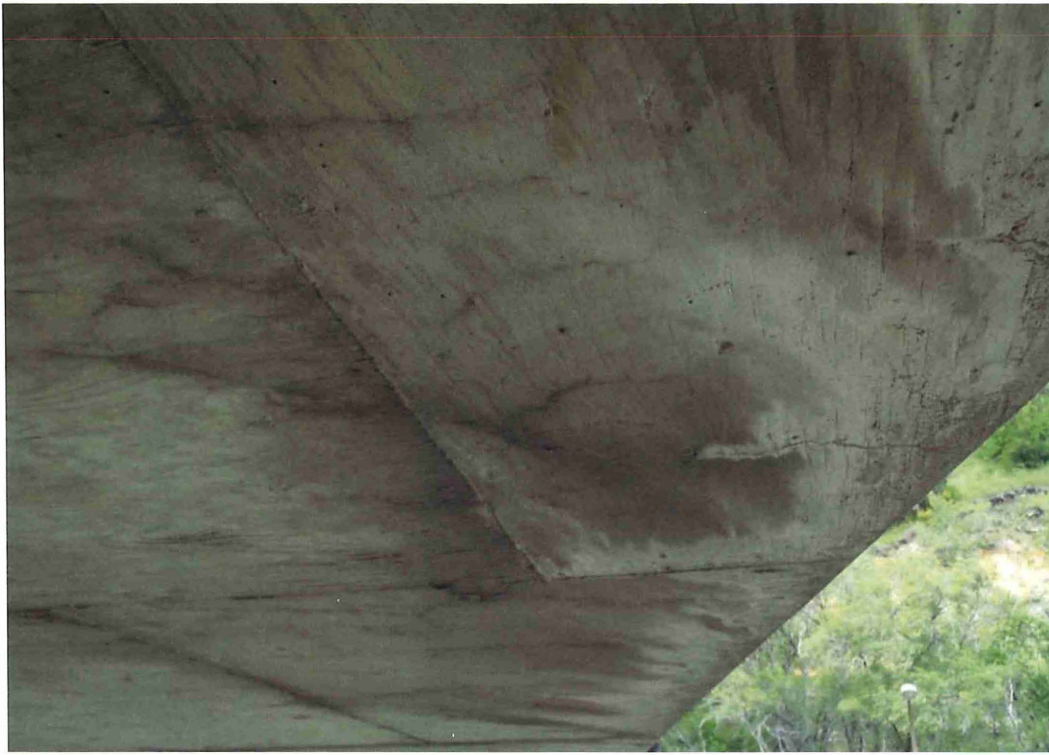
Photo 26

Bridge No: 9103  
DISTRICT 6, Goodhue County

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INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT





Span 1 - Cracking on the outside East face of the bridge, the concrete is sound.

Photo 27



Span 1 - Spalling in the interior of Span 1.

Photo 28

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DISTRICT 6, Goodhue County

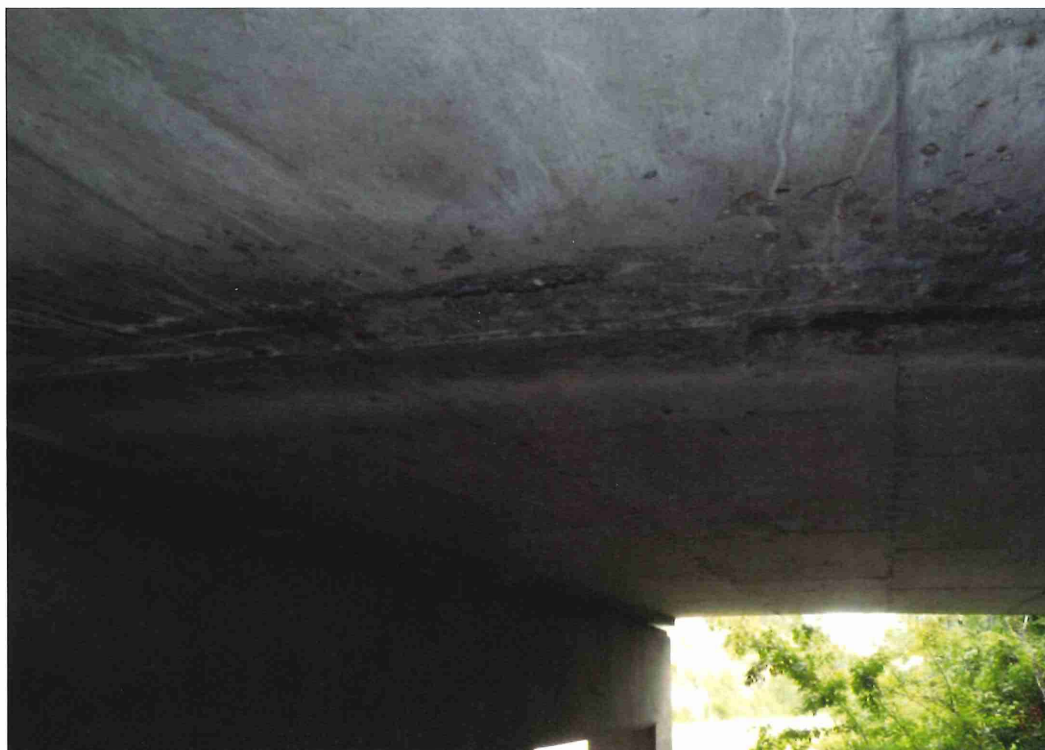
US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE June 26, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT



Span 1 - Additional photo of spalling in the interior of Span 1.

Photo 29



Span 1 - Additional photo of spalling in the interior of Span 1.

Photo 30

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US HWY 63 over US HWY 61/63 & SRVC DR  
INSPECTION DATE June 26, 2012

INSPECTION PHOTOS FOR RED WING BRIDGE PROJECT

## **APPENDIX F CHLORIDE CONTENT TEST RESULTS**





## Minnesota Department of Transportation

### District 6

Mail Stop 060  
2900 48<sup>th</sup> Street N.W.  
Rochester, MN 55901-5848

Office: 507-286-7690

Fax: 507-285-7355

E-mail: [ramon.riba@state.mn.us](mailto:ramon.riba@state.mn.us)

---

Date: November 7, 2011

To: Craig Lenz, P.E.  
District Structures Engineer

From: Ramón Riba, P.E.  
Asst. District Structures Engineer

Subject: **BR #9103 SLAB SPAN CHLORIDE CONTENT TEST RESULTS**

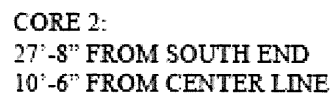
Craig – I have processed the data from the chloride content test performed by the Office of Materials, for easier visualization. I have also converted the units from parts per million (ppmCl) to percent of sample by weight, and pounds per cubic yard, to aid in comparison against references, if needed.

Four cores were obtained from the slab at the locations shown in Figure 1 and processed at MnDOT's Office of Materials laboratory. The test's objective was to ascertain the presence of chlorides within the concrete mass as an indicator of possible corrosion of the reinforcing steel and generalized distress overall. Laboratory testing and experience have long established the limit around 150 ppmCl to be the threshold at which corrosion of the first uncoated layer of steel is likely to start (Broomfield 2007, Darwin et.al. 2009). Of course, departures can be expected around this mark due to variability in the material, condition, environment, etc., but it has proven over time to be a reliable estimate (See Table 2). It is important to note that this threshold applies to *uncarbonated* concrete. Concrete in use over time becomes carbonated by the environment, especially in places where it is exposed to prolonged alternate dry and wet periods (Bertolini, L., et al. (2004). This can substantially accelerate chloride attack in the concrete's mass, even at a level of chlorides lower than the threshold.

It seems that – with the exception of Core 1 (where chloride contents are high only for the first two inches and the bottom 22 to 24 inches) all others show heavy chloride intrusion profiles (see Table 1). In particular, chloride contents in these three are high throughout the depth explored (see Figure 2), which likely means chlorides were brought there directly via deep cracks (even within close vicinity), rather than solely by diffusion, as in Core 1, where chloride content is high only through the first two inches, then drops rapidly. Given these profiles and the bridge's under-deck spalls repair history, it is reasonable to suspect advanced degradation of the reinforcing steel throughout the slab.

RMR





### Figure 1 Sample core locations

**Table 1: Sample chloride content per AASHTO T260 Ttest Standard**

Field ID	Location	Sample ID	Depth	ppmCl	%	#/CY
Core #1	Br Deck, 36'3" E of W end strip seal, 18" S of CL	CO-DD11-0114	0-1"	5562	0.56	21.14
		CO-DD11-0115	1-2"	1571	0.16	5.97
		CO-DD11-0116	2-3"	204	0.02	0.78
		CO-DD11-0117	3-4"	71	0.01	0.27
		CO-DD11-0118	6-7"	251	0.03	0.95
		CO-DD11-0119	9-10"	79	0.01	0.30
		CO-DD11-0120	12-13"	56	0.01	0.21
		CO-DD11-0121	15-16"	176	0.02	0.67
		CO-DD11-0122	18-19"	183	0.02	0.70
		CO-DD11-0123	21-22"	317	0.03	1.20
		CO-DD11-0124	23-24"	815	0.08	3.10
Core # 2	Br, Decl<, 39'-8" E of W end strip seal 10'-6" S of CL	CO-DD11-0125	0-1"	5342	0.53	20.30
		CO-DD11-0126	1-2"	2667	0.27	10.13
		CO-DD11-0127	2-3"	2871	0.29	10.91
		CO-DD11-0128	3-4"	1721	0.17	6.54
		CO-DD11-0129	4-5"	2098	0.21	7.97
		CO-DD11-0130	5-6"	1671	0.17	6.35
		CO-DD11-0131	6-7"	732	0.07	2.78
		CO-DD11-0132	7-8"	678	0.07	2.58
		CO-DD11-0133	8-9"	857	0.09	3.26
		CO-DD11-0134	9-10"	695	0.07	2.64
Core # 3	Br. Deck 70'- 10" W of end strip seal 10'- 0" N of CL	CO-DD11-0135	0-1"	4944	0.49	18.79
		CO-DD11-0136	1-2"	2776	0.28	10.55
		CO-DD11-0137	2-3"	1958	0.20	7.44
		CO-DD11-0138	3-4"	1816	0.18	6.90
		CO-DD11-0139	4-5"	3923	0.39	14.91
		CO-DD11-0140	5-6"	1964	0.20	7.46
		CO-DD11-0141	6-7"	1558	0.16	5.92
		CO-DD11-0142	7-8"	1507	0.15	5.73
		CO-DD11-0143	8-9"	1410	0.14	5.36
		CO-DD11-0144	9-10"	1347	0.13	5.12
Core # 4	Br. Deck, 41'-5" W of E ;end strip seal, 12'-9" N of CL	CO-DD11-0145	0-1"	4994	0.50	18.98
		CO-DD11-0146	1-2"	3036	0.30	11.54
		CO-DD11-0147	2-3"	2631	0.26	10.00
		CO-DD11-0148	3-4"	3083	0.31	11.72
		CO-DD11-0149	4-5"	3154	0.32	11.99
		CO-DD11-0150	5-6"	2753	0.28	10.46
		CO-DD11-0151	6-7"	1694	0.17	6.44
		CO-DD11-0152	7-8"	1153	0.12	4.38
		CO-DD11-0153	8-9"	961	0.10	3.65

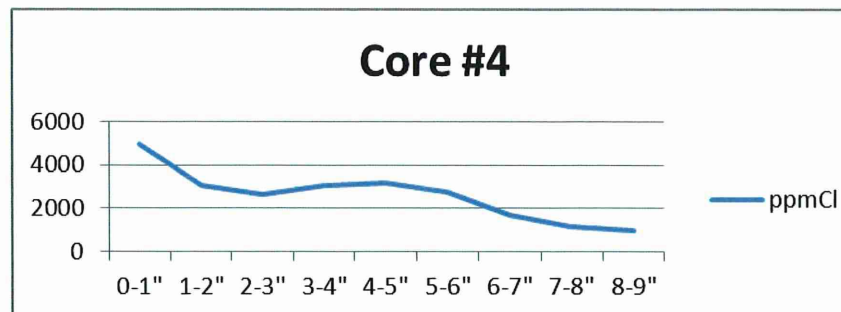
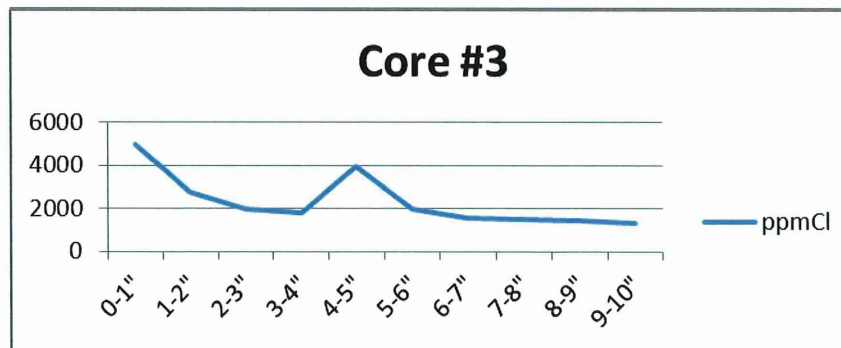
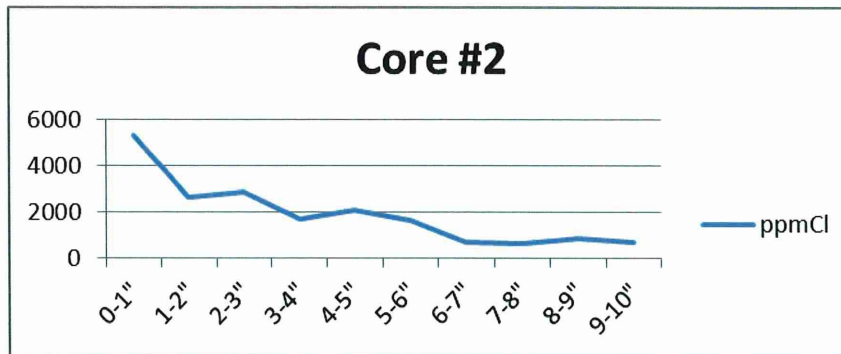
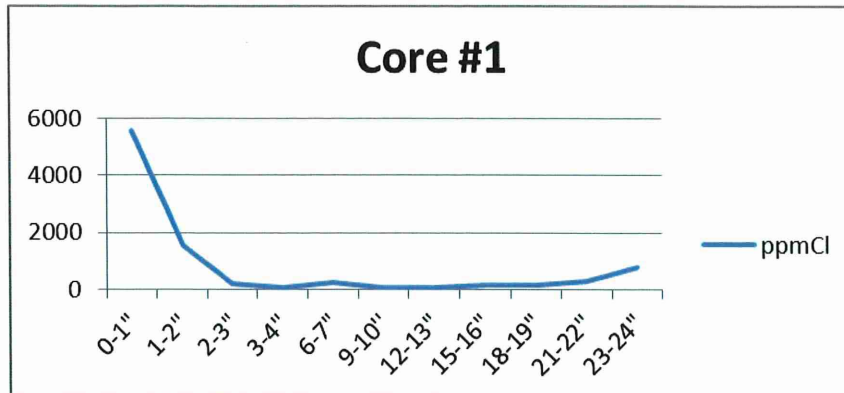


Figure 2 Chloride content profiles along core depths

**Table 2 Uncoated steel critical chloride threshold (Darwin et al. (2009))**

Specimens <sup>a</sup>	Bar	Age, weeks	Rate, $\mu\text{m}/\text{year}$	Potential, V	Water soluble $\text{Cl}^-$ , $\text{lb}/\text{yd}^3$										Average, $\text{lb}/\text{yd}^3$	Standard deviation	Coefficient of variation
					1	2	3	4	5	6	7	8	9	10			
C-MSE-1	1 <sup>†</sup>	—	—	—	—	—	—	—	—	—	—	—	—	—	1.56	0.74	0.48
	2	8	0.84	-0.273	0.69	1.51	1.68	2.71	1.20	—	—	—	—	—			
C-MSE-2	1 <sup>†</sup>	—	—	—	—	—	—	—	—	—	—	—	—	—	1.56	0.62	0.40
	2	12	2.89	-0.396	0.94	2.39	1.28	4.78 <sup>‡</sup>	1.64	—	—	—	—	—			
C-MSE-3	1	15	1.96	-0.404	0.69	0.82	0.63	0.82	0.94	1.83	1.26	2.58	—	—	1.32	0.64	0.48
	2	14	1.79	-0.380	3.65 <sup>‡</sup>	1.70	1.01	1.32	2.27	—	—	—	—	—			
C-MSE-4	1	9	1.76	-0.379	0.77	1.03	0.85	0.86	0.77	0.77	0.58	1.29	0.77	1.37	0.98	0.32	0.33
	2	9	3.51	-0.421	0.80	1.04	1.67	0.60	0.77	1.02	0.84	1.38	0.77	1.63			
C-MSE-5	1	14	0.82	-0.332	1.70	2.33	2.39	1.64	1.83	1.13	1.51	0.92	0.73	1.20	1.22	0.54	0.44
	2	9	0.35	-0.280	0.87	0.84	0.65	1.03	0.69	0.87	0.73	0.73	1.60	0.94			
C-MSE-6	1	20	1.52	-0.361	1.51	1.38	1.83	2.64	3.21	1.33	3.02	1.45	2.27	2.08	2.02	0.68	0.34
	2	17	1.84	-0.379	2.71	1.83	1.83	3.02	2.83	1.13	1.16	1.32	2.20	1.70			
	Side <sup>§</sup>																
C-B-1	1	21	1.17	-0.358	1.51	2.46	1.26	2.27	1.38	3.08	1.89	1.64	1.95	1.57	1.88	0.59	0.32
	2				4.36 <sup>‡</sup>	2.29	1.95	2.31	1.45	3.02	0.95	1.40	2.20	1.21			
C-B-2	1	23	1.17	-0.392	2.27	0.85	1.82	1.67	1.30	1.36	1.48	1.54	1.36	1.54	1.94	0.67	0.35
	2				1.13	2.71	2.71	2.77	2.58	2.84	2.33	1.55	2.96	4.81 <sup>‡</sup>			
C-B-3	1	14	1.02	-0.344	2.27	1.04	1.89	2.77	3.97 <sup>‡</sup>	2.51	1.13	1.89	2.52	1.51	1.97	0.66	0.34
	2				2.14	3.08	1.57	2.90	2.20	0.82	1.20	2.58	1.89	1.57			
Average															1.63		

<sup>a</sup>C = conventional steel; B = beam specimens; MSE = modified southern exposure.

<sup>†</sup>Sample not available.

<sup>‡</sup>Outlier sample.

<sup>§</sup>Ten chloride samples taken from each side of bar per specimen.

Note: 1  $\text{lb}/\text{yd}^3 = 0.5933 \text{ kg}/\text{m}^3$ .



## REFERENCES

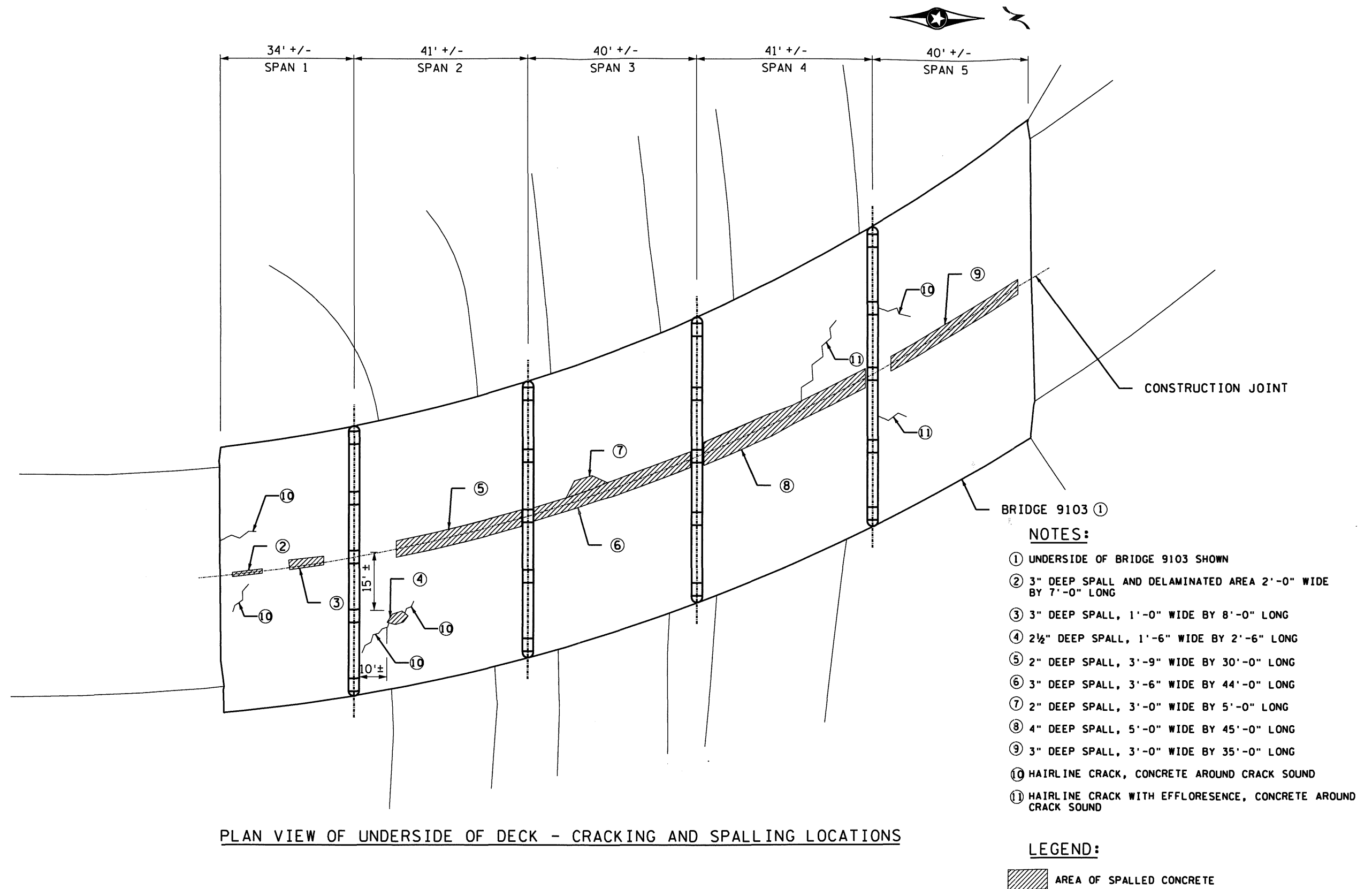
AASHTO (1997) "Standard Method of Test for Sampling and Testing for Chloride Ion in Concrete and Concrete Raw Materials". American Association of State Highway and Transportation Officials. Washington, DC U.S.A.

Darwin, D., J. Browning, M. O'Reilly, L. Xing, and J. Ji. (2009). "Critical Chloride Corrosion Threshold of Galvanized Reinforcing Bars". ACI Materials Journal, V. 106, No. 2, March-April 2009.

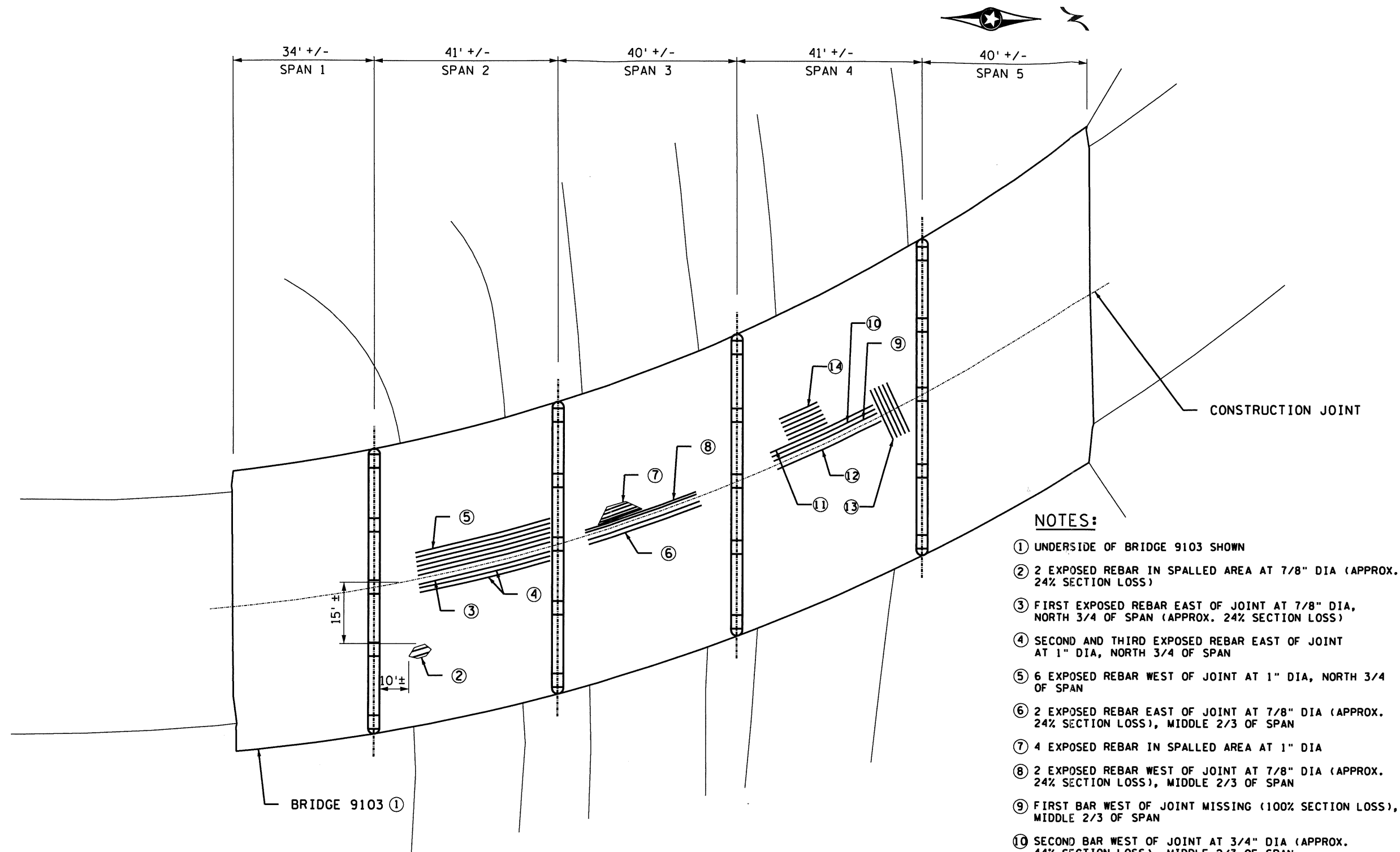
Broomfield, J. (2007) Corrosion of Steel in Concrete. Understanding, Investigation and Repair. Taylor and Francis. New York, U.S.A.

Bertolini, L., Elsener, B., Pedersen, P., Polder, R. (2004). Corrosion of Steel in Concrete. Prevention, Diagnosis and Repair. Wiley-VCH Weinheim, FDR.

**APPENDIX G**  
**MAPPED AREAS OF CRACKING, SPALLING,**  
**AND DELAMINATION**



user: 1/15/12 1:01 PM  
\\naspe-srv1\EGG\CADStandards\WDDOT\_BR\_V8\1\PILOTDRY\WDDOT\_PLT  
ct:\work\Ing\oma\dd819416\inspection Notes\_062612.dgn

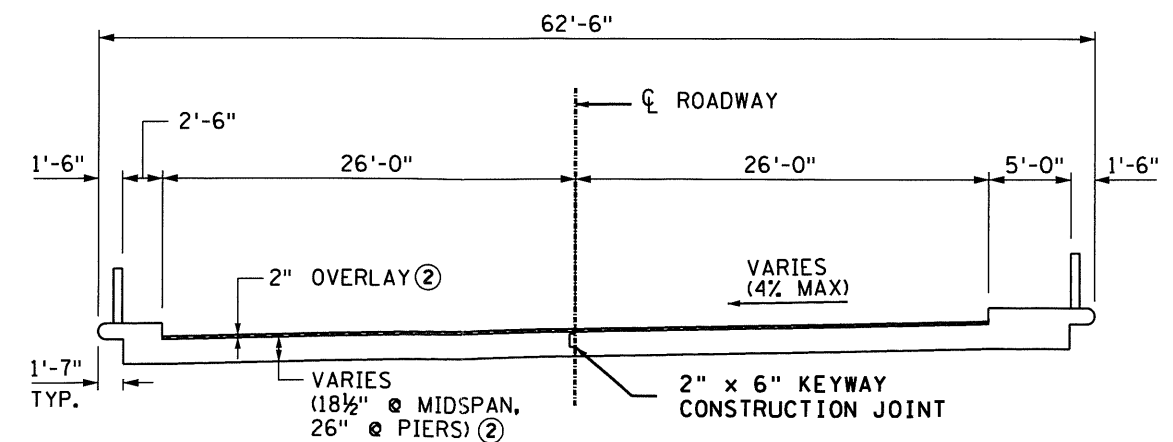
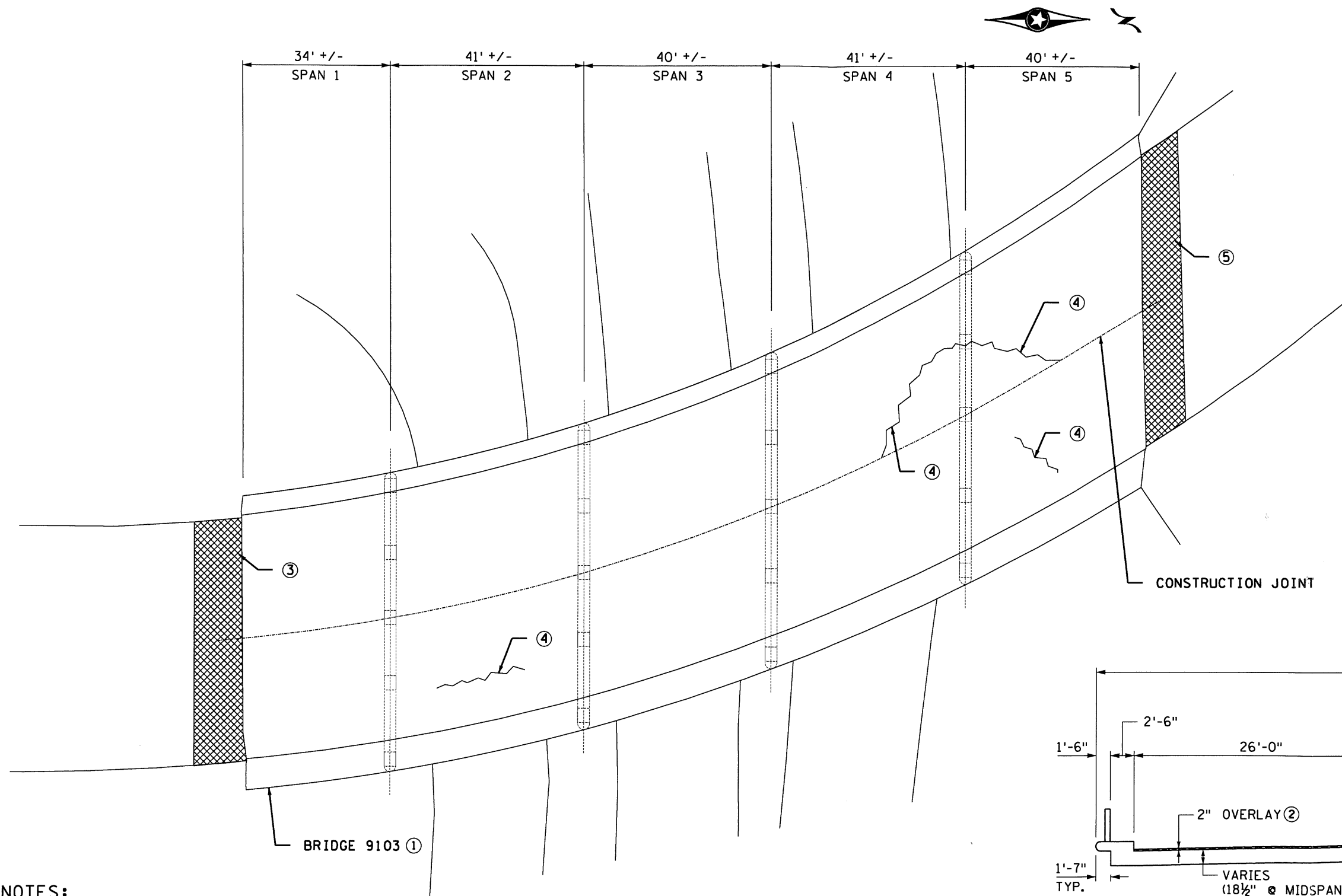


PLAN VIEW OF UNDERSIDE OF DECK - EXPOSED REINFORCING AND REMAINING SECTIONS

NOTES:

- ① UNDERSIDE OF BRIDGE 9103 SHOWN
- ② 2 EXPOSED REBAR IN SPALLED AREA AT 7/8" DIA (APPROX. 24% SECTION LOSS)
- ③ FIRST EXPOSED REBAR EAST OF JOINT AT 7/8" DIA, NORTH 3/4 OF SPAN (APPROX. 24% SECTION LOSS)
- ④ SECOND AND THIRD EXPOSED REBAR EAST OF JOINT AT 1" DIA, NORTH 3/4 OF SPAN
- ⑤ 6 EXPOSED REBAR WEST OF JOINT AT 1" DIA, NORTH 3/4 OF SPAN
- ⑥ 2 EXPOSED REBAR EAST OF JOINT AT 7/8" DIA (APPROX. 24% SECTION LOSS), MIDDLE 2/3 OF SPAN
- ⑦ 4 EXPOSED REBAR IN SPALLED AREA AT 1" DIA
- ⑧ 2 EXPOSED REBAR WEST OF JOINT AT 7/8" DIA (APPROX. 24% SECTION LOSS), MIDDLE 2/3 OF SPAN
- ⑨ FIRST BAR WEST OF JOINT MISSING (100% SECTION LOSS), MIDDLE 2/3 OF SPAN
- ⑩ SECOND BAR WEST OF JOINT AT 3/4" DIA (APPROX. 44% SECTION LOSS), MIDDLE 2/3 OF SPAN
- ⑪ THIRD BAR WEST OF JOINT AT 3/4" DIA (APPROX. 44% SECTION LOSS), MIDDLE 2/3 OF SPAN
- ⑫ FIRST BAR EAST OF JOINT AT 7/8" DIA (APPROX. 24% SECTION LOSS), MIDDLE 2/3 OF SPAN
- ⑬ BOTTOM TRANSVERSE BARS EXPOSED IN SPALLED AREAS NEAR JOINT SHOW SEVERE CORROSION UP TO 100% SECTION LOSS, TYPICAL THROUGHOUT SPANS 2, 3, AND 4
- ⑭ 6 EXPOSED REBAR AT 1" DIA





#### NOTES:

- ① TOP OF DECK SHOWN. IN ADDITION TO SETTLEMENT AND STRUCTURAL CRACKS SHOWN, MAP CRACKING IS TYPICAL THROUGHOUT DECK SURFACE.
- ② THICKNESS SHOWN FROM EXISTING PLANS
- ③ MINOR SETTLEMENT AND POOR CONDITION OF BITUMINOUS PAVEMENT
- ④ STRUCTURAL CRACK WITH DELAMINATION ALONG LENGTH
- ⑤ EVIDENCE OF SETTLEMENT FULL WIDTH OF APPROACH PANEL

#### LEGEND

AREAS SHOWING EVIDENCE OF SETTLEMENT



RED WING BRIDGE NO. 9103 - JUNE 26, 2012 INSPECTION FINDINGS

DES: DR: CHK: CHK:

BRIDGE NO. 9103

SHEET NO. 3 OF 3 SHEETS

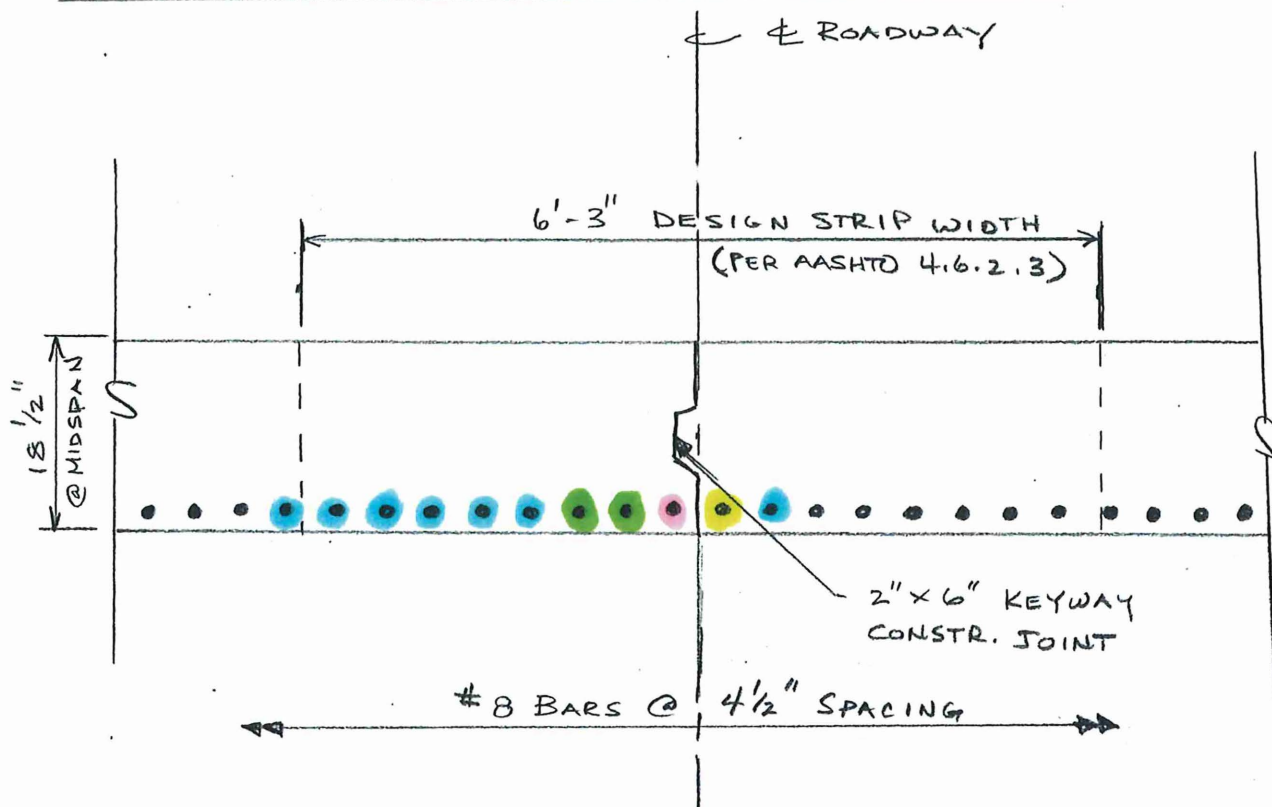
user: 04 PM  
7/2/2012  
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\\naspe-srv1\EGGCADStandards\MDOT\_BR\_V8\IN\OTDRV\MNDOT\_PLT  
ct:\work\Ing\oma\0819416\inspection Notes\_062612.dgn



ONE COMPANY  
Many Solutions®

Project: RED WING BRIDGE Computed: TAL Date: 3/29/13  
Subject: BRIDGE 9103 REHAB Checked: Date:  
Task: SPAN 4 DETERIORATION Page: of:  
Job #: 177092 No: APPENDIX G-PAGE 4

### MEASURED CORROSION IN SPAN 4 - MIDSPAN



#### LEGEND (BASED ON 6/26/12 INSPECTION)

- = BAR IS CORRODED COMPLETELY THROUGH
- = BAR IS CORRODED TO  $\frac{3}{4}$ "  $\phi$  REMAINING
- = BAR IS CORRODED TO  $\frac{7}{8}$ "  $\phi$  REMAINING
- = BAR IS EXPOSED AND CORRODED BUT 1"  $\phi$  REMAINING

#### REMAINING SECTION IN DESIGN STRIP WIDTH :

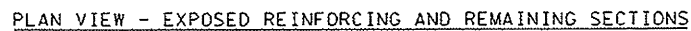
$$\frac{5(0.79) + 2(0.44) + 1(\phi) + 1(0.60) + 7(0.79)}{16(0.79)} = 86.7\%$$



## **APPENDIX H INFRARED THERMOGRAPHY RESULTS**







**HDR**  
HDR Engineering, Inc.

BRIDGE NO.	9103
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# Measurements

Sp1 83.8

# Parameters

Emissivity 0.95

Ref. temp. 68 °F

°F 7/12/2012 8:08:08 AM



IR\_0413.jpg

7/12/2012 8:08:08 AM



DC\_0414.jpg



# Measurements

7/12/2012 8:08:24 AM

Sp1 83.5

# Parameters

Emissivity 0.95  
Refl. temp. 68 °F



IR\_0416.jpg

7/12/2012 8:08:24 AM



DC\_0417.jpg



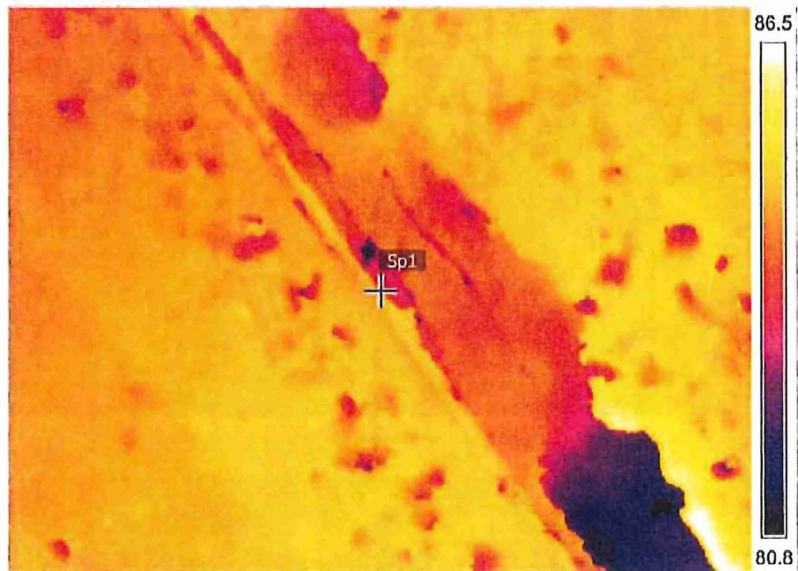
## Measurements

Sp1 84.7

## Parameters

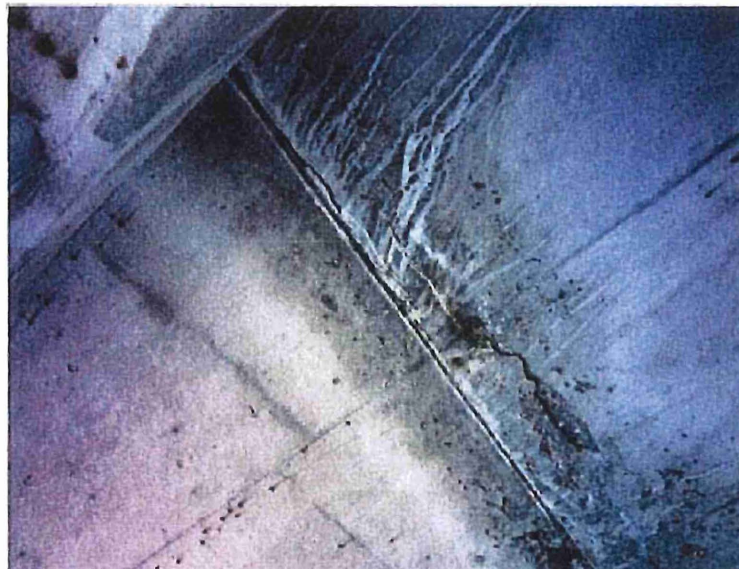
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°F 7/12/2012 8:08:51 AM



IR\_0419.jpg

7/12/2012 8:08:51 AM



DC\_0420.jpg





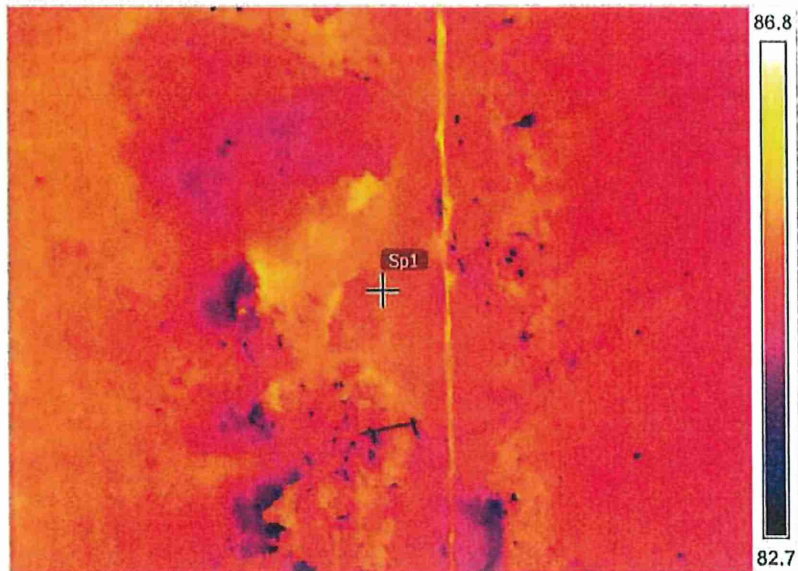
# Measurements

Sp1 85.0

# Parameters

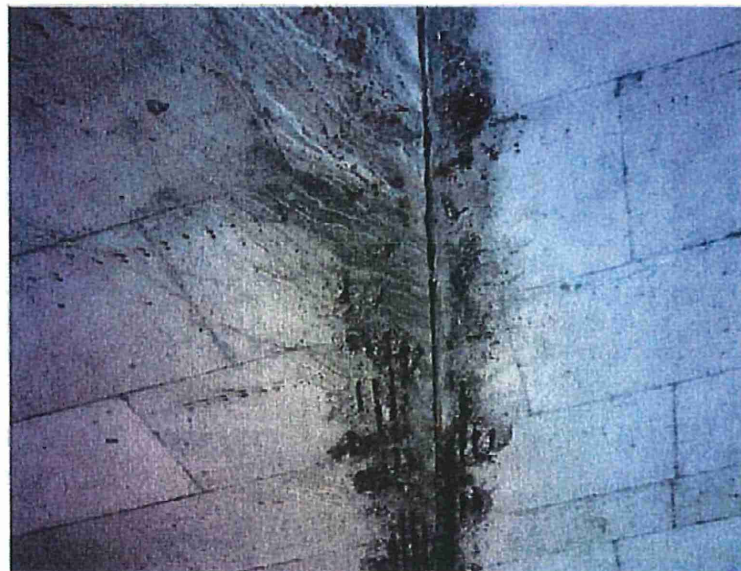
Emissivity 0.95  
Ref. temp. 68 °F

°F 7/12/2012 8:12:19 AM



IR\_0422.jpg

7/12/2012 8:12:19 AM



DC\_0423.jpg



## Measurements

Sp1 84.7

## Parameters

Emissivity 0.95  
Refl. temp. 68 °F

°F 7/12/2012 8:12:42 AM



IR\_0425.jpg

7/12/2012 8:12:42 AM



DC\_0426.jpg





## Measurements

°F 7/12/2012 8:13:02 AM

Sp1 84.7

## Parameters

Emissivity 0.95

Ref. temp. 68 °F



IR\_0428.jpg

7/12/2012 8:13:02 AM



DC\_0429.jpg



### Measurements

Sp1 84.5

### Parameters

Emissivity 0.95

Refl. temp. 68 °F

°F 7/12/2012 8:13:28 AM



IR\_0431.jpg

7/12/2012 8:13:28 AM



DC\_0432.jpg





### Measurements

Sp1 83.8

### Parameters

Emissivity 0.95

Refl. temp. 68 °F

°F 7/12/2012 8:14:03 AM



IR\_0434.jpg

7/12/2012 8:14:03 AM



DC\_0435.jpg



## Measurements

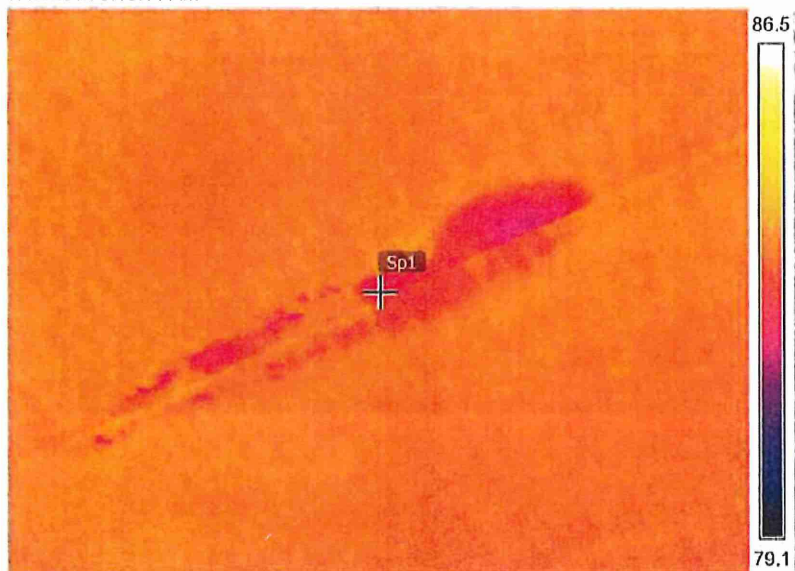
Sp1 82.4

## Parameters

Emissivity 0.95

Refl. temp. 68 °F

°F 7/12/2012 8:15:11 AM



IR\_0437.jpg

7/12/2012 8:15:11 AM



DC\_0438.jpg



## Measurements

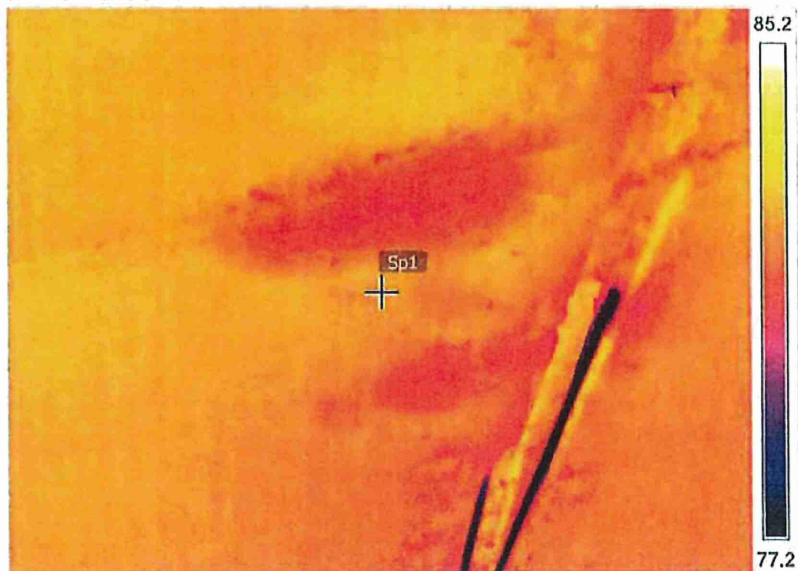
Sp1 82.6

## Parameters

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Refl. temp. 68 °F

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IR\_0440.jpg

7/12/2012 8:15:52 AM



DC\_0441.jpg





## Measurements

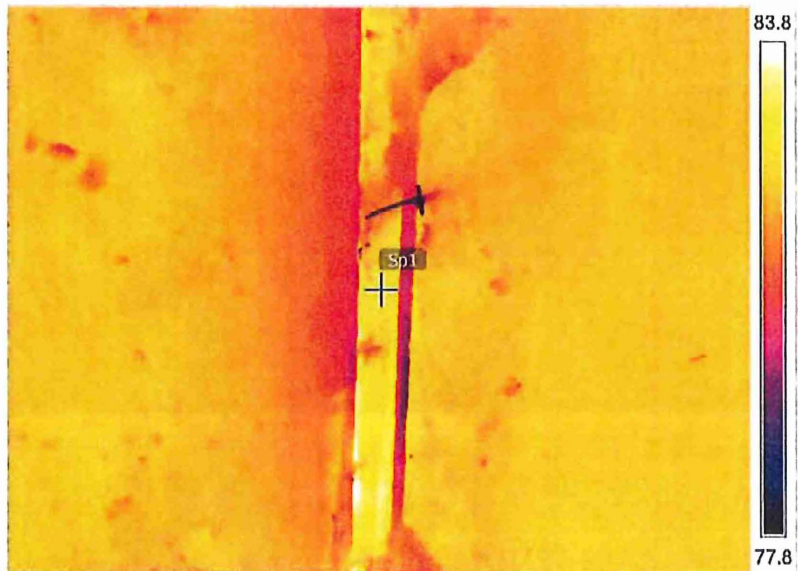
Sp1 82.5

## Parameters

Emissivity 0.95

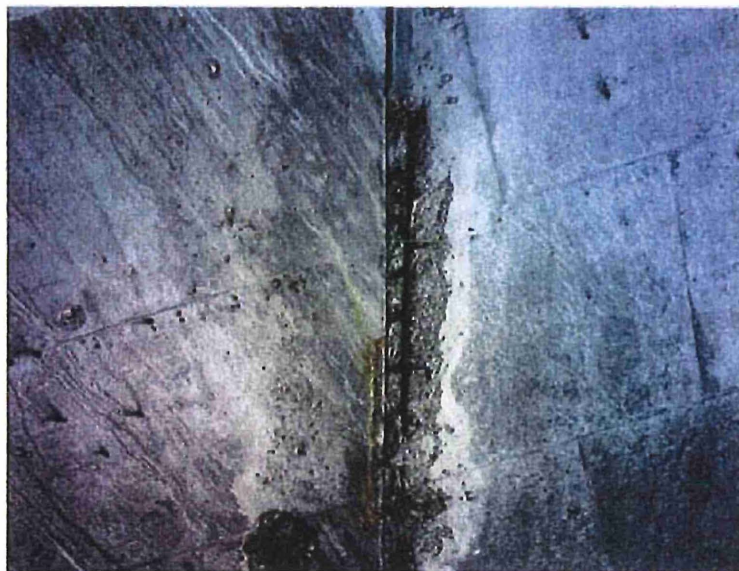
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°F 7/12/2012 8:16:22 AM



IR\_0443.jpg

7/12/2012 8:16:22 AM



DC\_0444.jpg





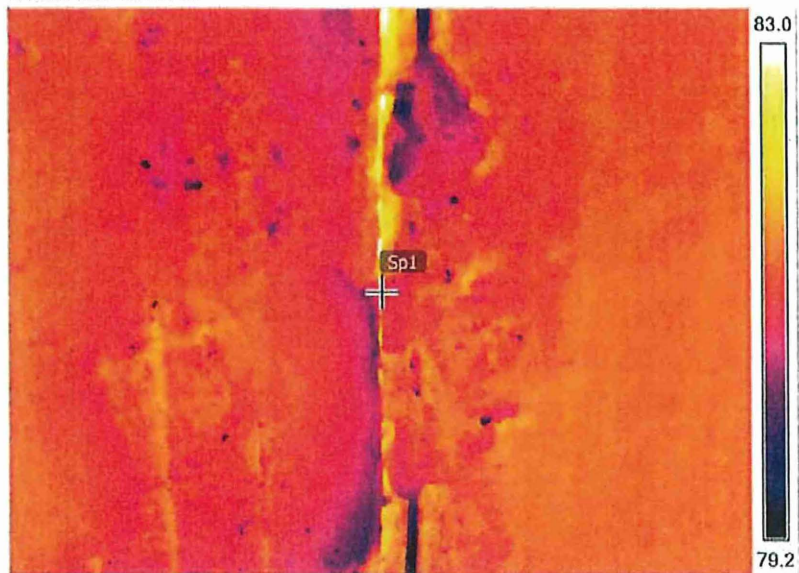
# Measurements

Sp1 81.2

# Parameters

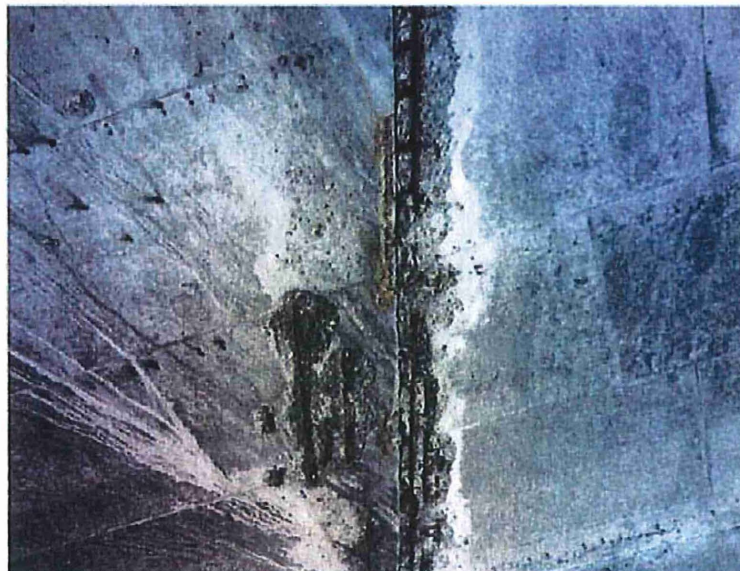
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Refl. temp. 68 °F

°F 7/12/2012 8:16:39 AM



IR\_0446.jpg

7/12/2012 8:16:39 AM



DC\_0447.jpg



## Measurements

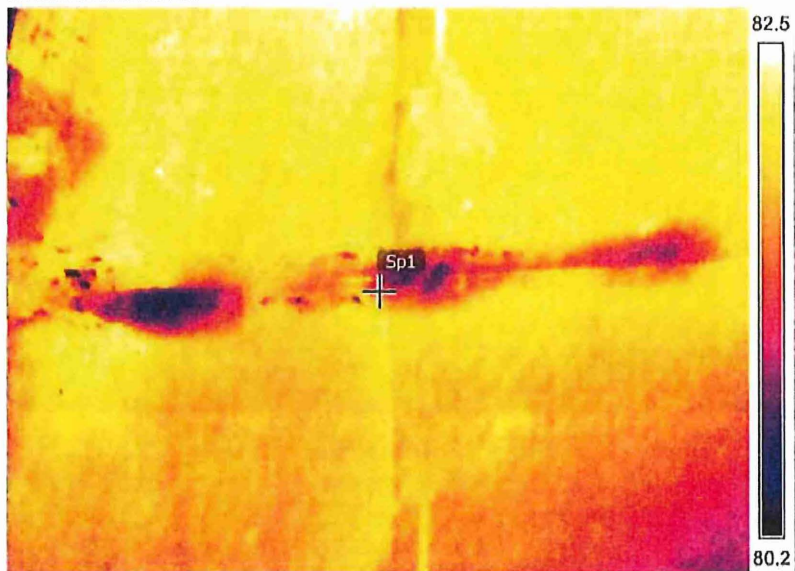
Sp1 81.4

## Parameters

Emissivity 0.95

Refl. temp. 68 °F

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IR\_0449.jpg

7/12/2012 8:17:00 AM



DC\_0450.jpg





## Measurements

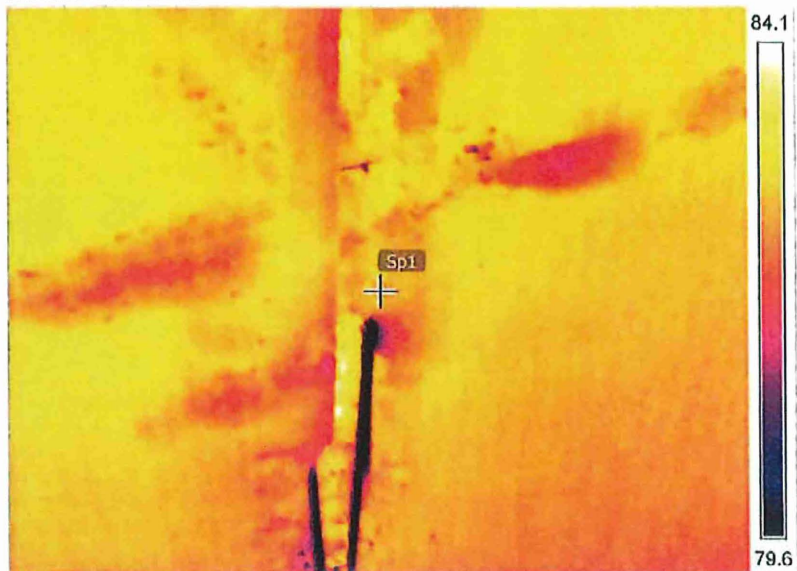
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Sp1 82.6

## Parameters

Emissivity 0.95

Refl. temp. 68 °F



IR\_0452.jpg

7/12/2012 8:17:22 AM



DC\_0453.jpg



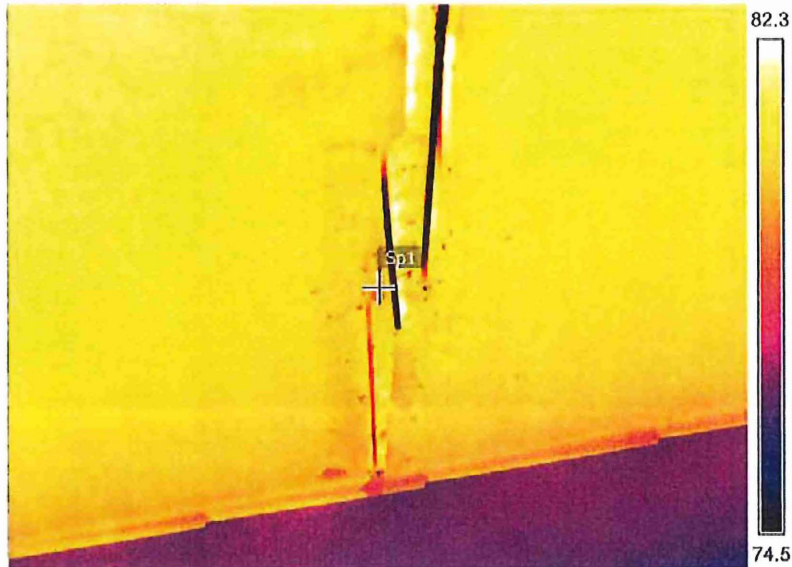
Measurements °F 7/12/2012 8:17:53 AM

Sp1 80.0

Parameters

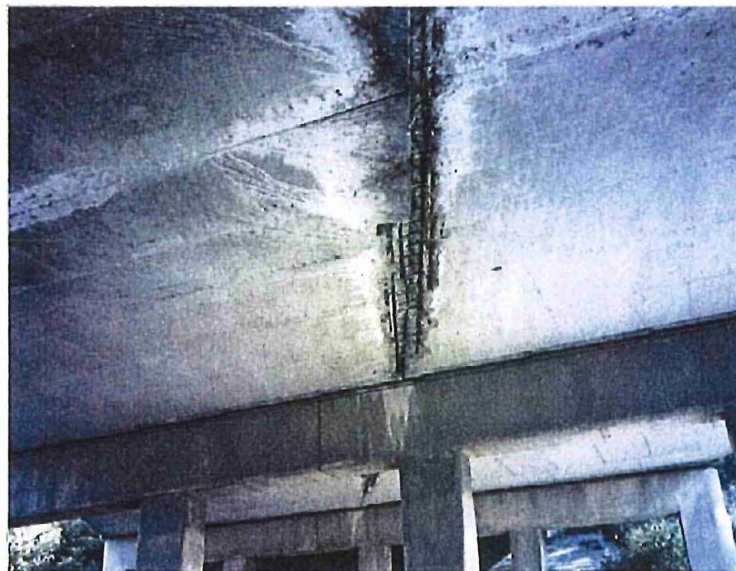
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Refl. temp. 68 °F



IR\_0455.jpg

7/12/2012 8:17:53 AM



DC\_0456.jpg





# Measurements

Sp1 80.4

# Parameters

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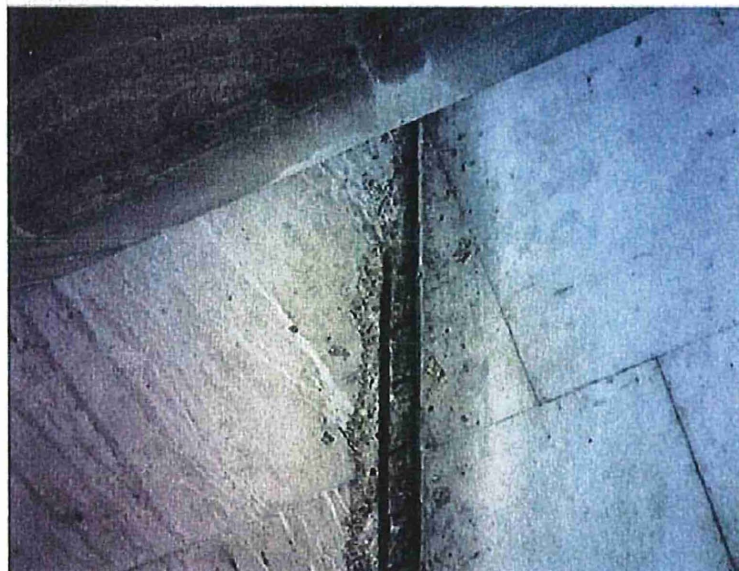
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IR\_0458.jpg

7/12/2012 8:18:32 AM



DC\_0459.jpg



# Measurements

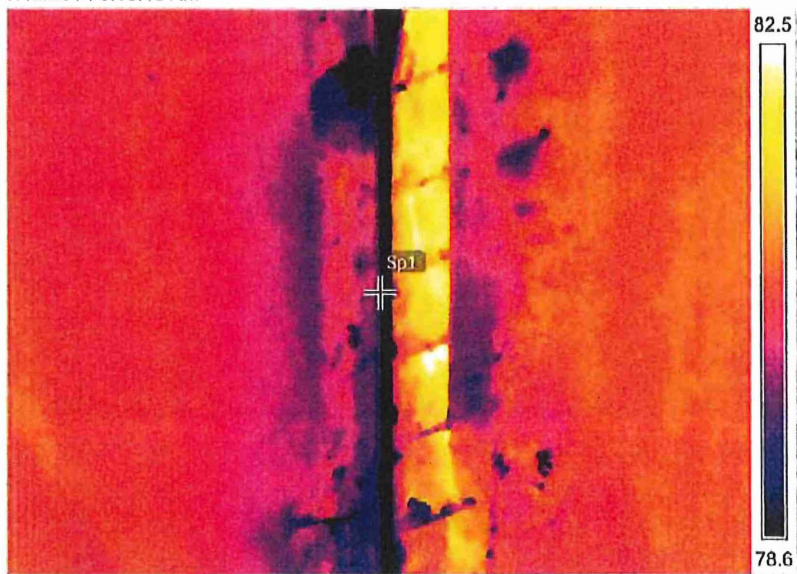
Sp1 78.1

# Parameters

Emissivity 0.95

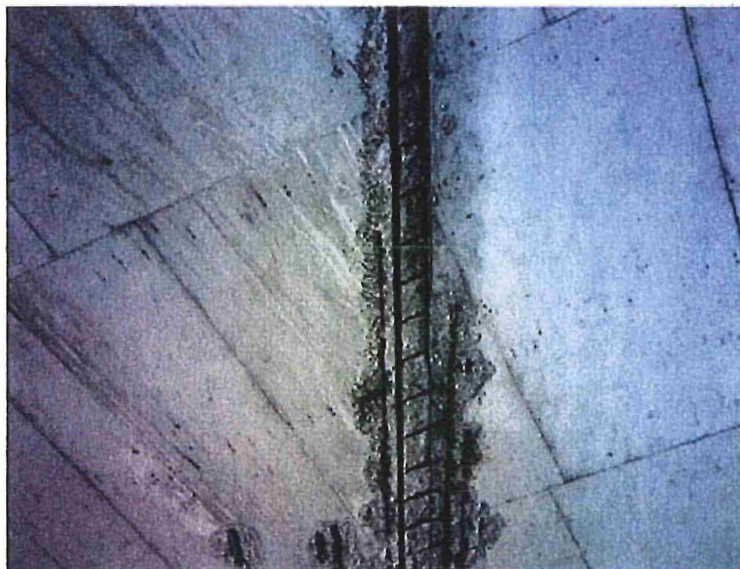
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IR\_0461.jpg

7/12/2012 8:18:48 AM



DC\_0462.jpg





### Measurements

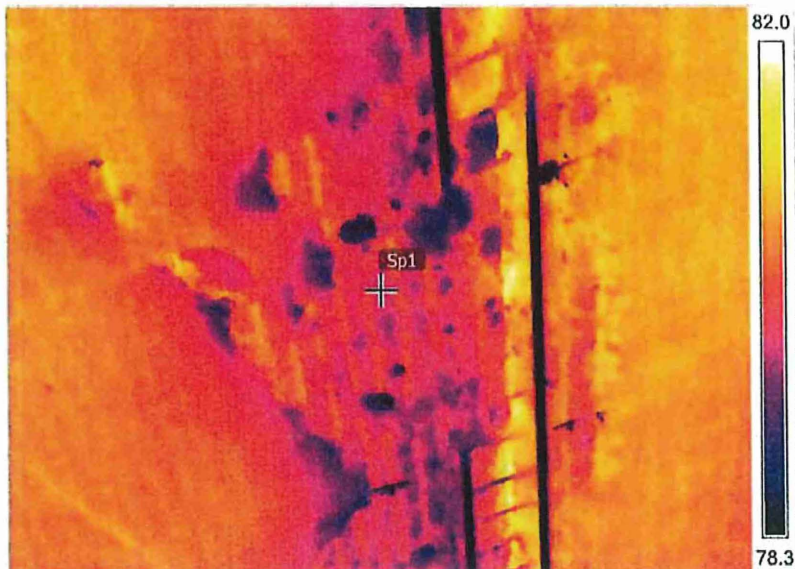
Sp1 79.5

### Parameters

Emissivity 0.95

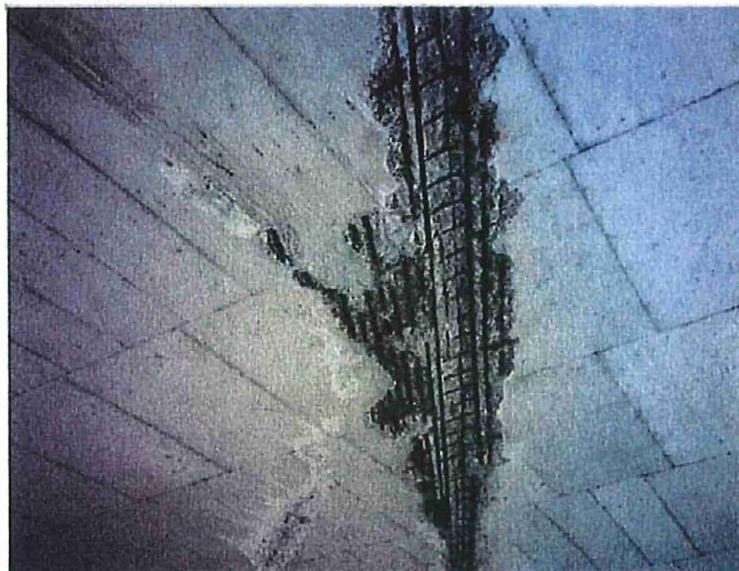
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IR\_0464.jpg

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DC\_0465.jpg



## Measurements

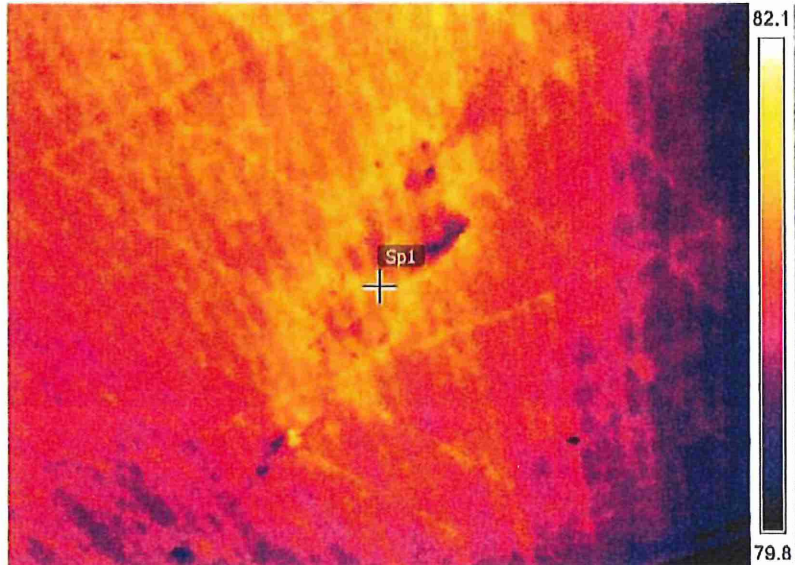
Sp1 81.4

## Parameters

Emissivity 0.95

Refl. temp. 68 °F

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IR\_0467.jpg

7/12/2012 8:19:45 AM



DC\_0468.jpg





## Measurements

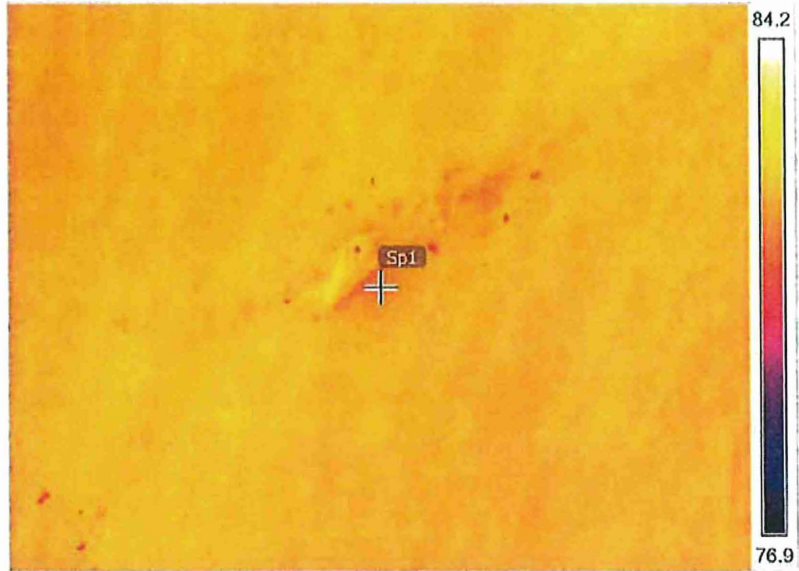
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Sp1 81.4

## Parameters

Emissivity 0.95

Refl. temp. 68 °F



IR\_0470.jpg

7/12/2012 8:20:58 AM



DC\_0471.jpg



## Measurements

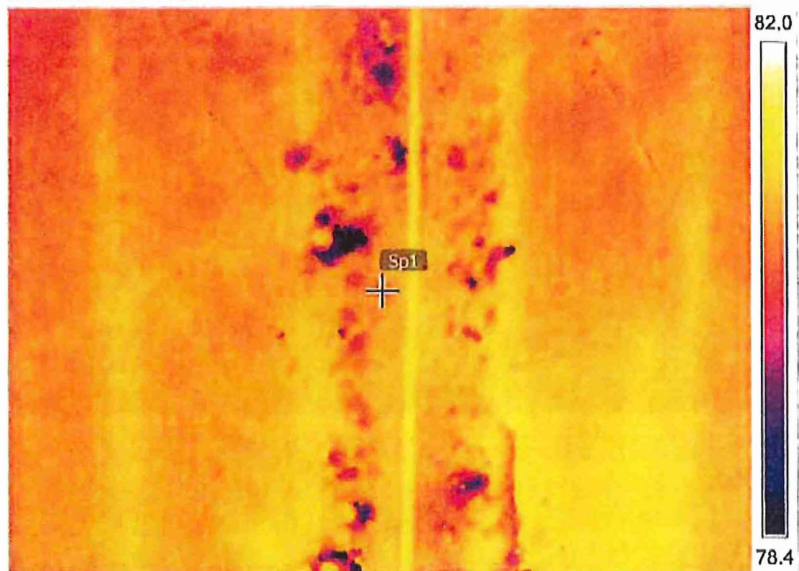
Sp1 80.6

## Parameters

Emissivity 0.95

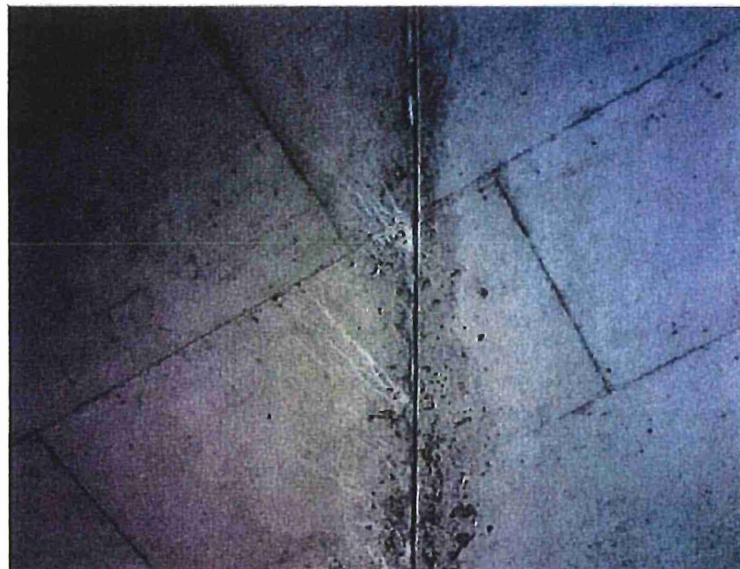
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°F 7/12/2012 8:21:21 AM



IR\_0473.jpg

7/12/2012 8:21:21 AM



DC\_0474.jpg



## Measurements

Sp1 80.6

## Parameters

Emissivity 0.95

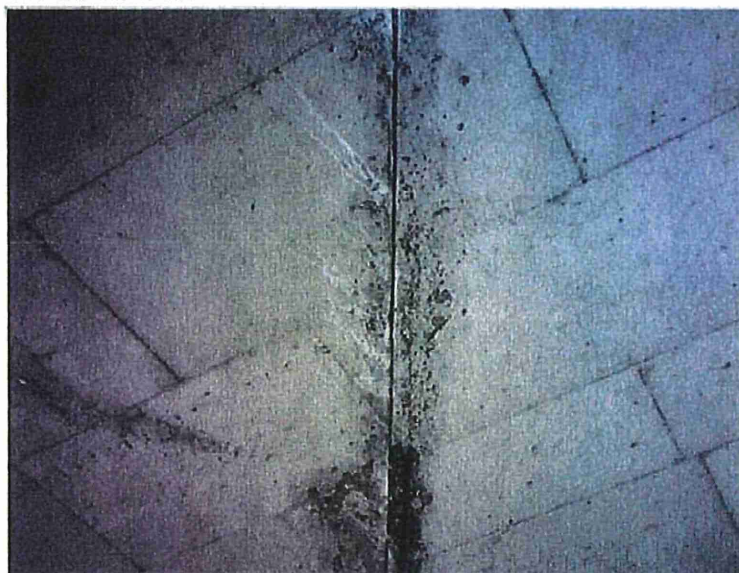
Refl. temp. 68 °F

°F 7/12/2012 8:21:36 AM



IR\_0476.jpg

7/12/2012 8:21:36 AM



DC\_0477.jpg





## Measurements

Sp1 81.2

## Parameters

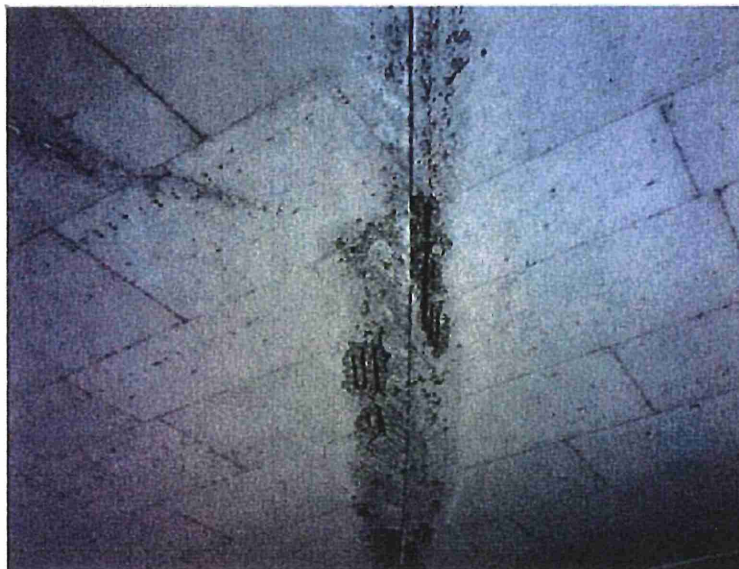
Emissivity 0.95  
Ref. temp. 68 °F

°F 7/12/2012 8:21:53 AM



IR\_0479.jpg

7/12/2012 8:21:53 AM



DC\_0480.jpg





### Measurements

°F 7/12/2012 8:22:16 AM

Sp1 80.0

### Parameters

Emissivity 0.95

Refl. temp. 68 °F



IR\_0482.jpg

7/12/2012 8:22:16 AM



DC\_0483.jpg



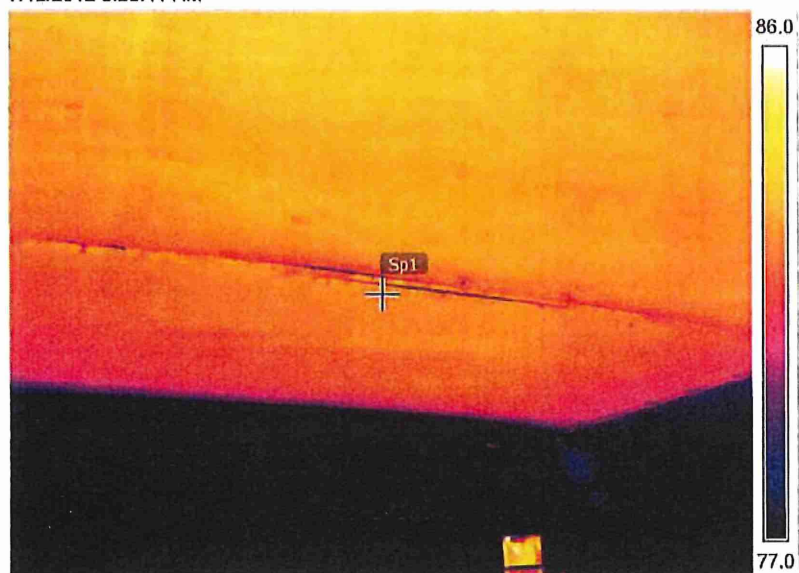
## Measurements

Sp1 82.7

## Parameters

Emissivity 0.95  
Refl. temp. 68 °F

°F 7/12/2012 8:23:41 AM



IR\_0485.jpg

7/12/2012 8:23:41 AM



DC\_0486.jpg



# Measurements

7/12/2012 8:24:28 AM

Sp1 84.3

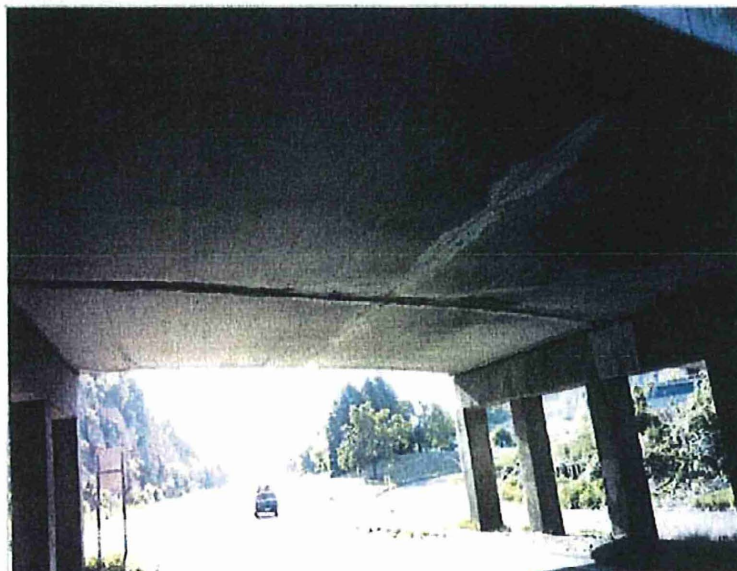
# Parameters

Emissivity 0.95  
Refl. temp. 68 °F



IR\_0488.jpg

7/12/2012 8:24:28 AM



DC\_0489.jpg





## Measurements

°F 7/12/2012 8:25:04 AM

Sp1 82.9

## Parameters

Emissivity 0.95  
Refl. temp. 68 °F



IR\_0491.jpg

7/12/2012 8:25:04 AM



DC\_0492.jpg





### Measurements

Sp1 82.8

### Parameters

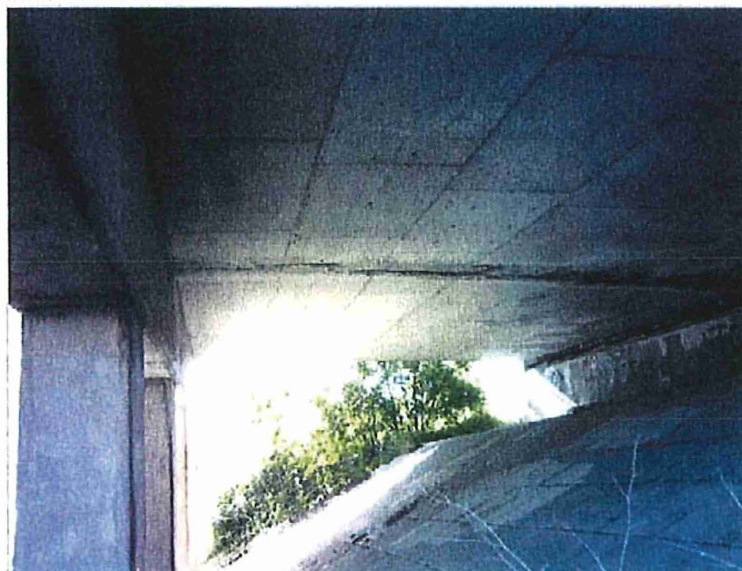
Emissivity 0.95  
Refl. temp. 68 °F

°F 7/12/2012 8:25:38 AM



IR\_0494.jpg

7/12/2012 8:25:38 AM



DC\_0495.jpg

# **APPENDIX I DESTRUCTIVE TESTING RESULTS**

# Bridge 9103

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## Destructive Testing

Gary Waletzki E.S Structures

8/13/2012

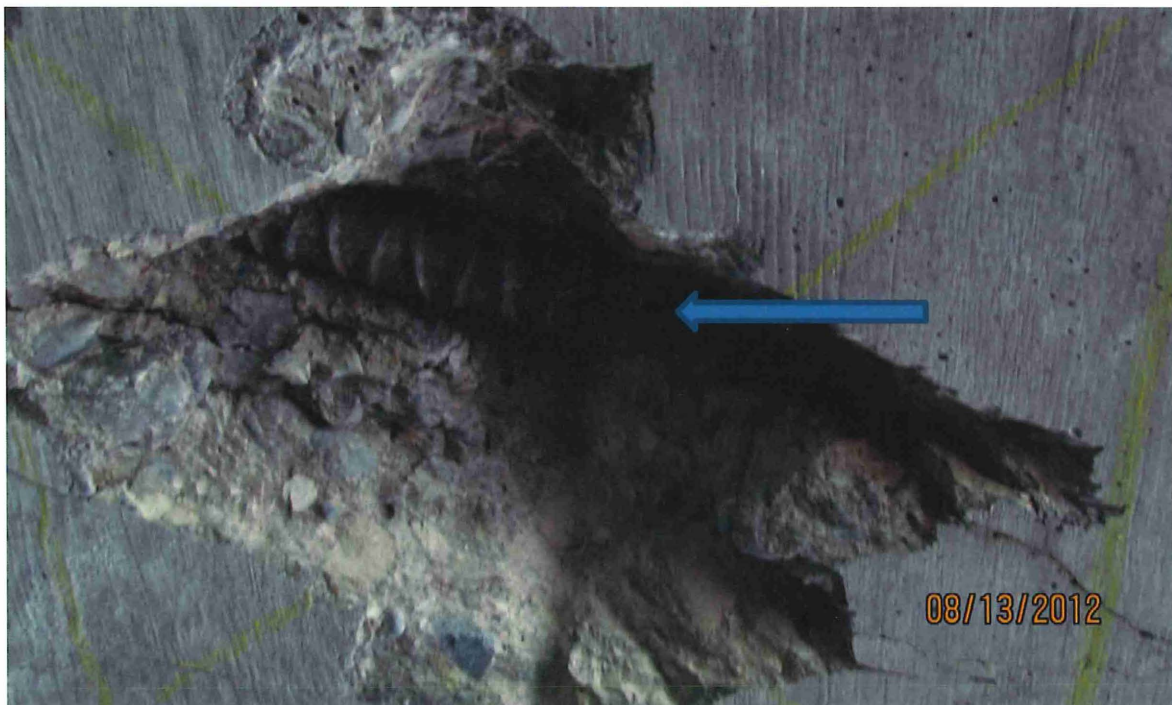
Bridge No. 9103 is located in the City of Red Wing, North Hwy 63, District 6. The District Structures Section agree to perform destructive testing on the underside of the bridge deck to assess the extent of the concrete delamination and the condition of the reinforcing steel in the lower portion of the deck. We selected six sample locations which were agreed upon during an earlier meeting. The sample locations were selected near cracking that seemed to represent suspect areas of the under deck, and away from the center line joint where deterioration could be easily observed.

The Owatonna Bridge Crew did the sampling for us. The predetermined sample locations were marked out and labeled on a Bridge map of 9103 produced in an earlier inspections. The sample areas are approximately 1'x 1' in area exposing one or two rebar in most samples. We found that in most cases there was little or no rust on the reinforcing steel. The sample areas were then sealed with paint to slow down future rusting from exposure. I have attached photos below illustrating the results of our assessment. If we can assist you in any other manner concerning Bridge 9103 please let us know. Thanks!

Bridge 9103 Destructive Testing 8/13/2012

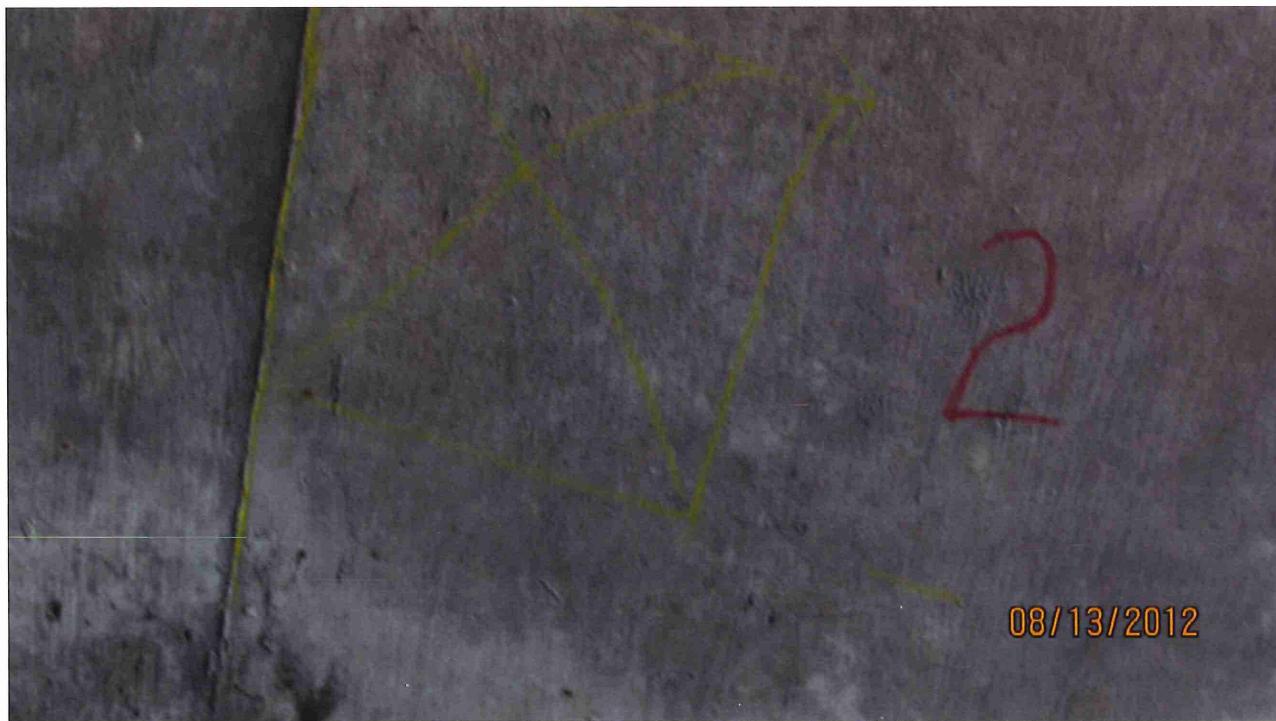


Sample # 1 Location 2' North of South abutment centered over a crack east of center line.



The rebar in Sample # 1 after the concrete has been removed. There is light brown rust staining of the rebar.





Sample # 2 was taken 4' North of South Abutment 2' West of center line



Sample #2 after removal of concrete. There is a light brown staining to the rebar no pack rust or scaling.



Sample # 3 is 4' North of Pier #1 and 3' west of center line. This is next to an existing patch. This was a full depth core sample that showed high chloride concentration levels,



Sample # 3 after removal of concrete no rust or rust staining. This was in the area of highest chloride concentrations near the full depth core.





Sample # 4 is 8' North of Pier #1 and 7'6" East of center line



Sample # 4 after concrete has been removed. Rebar shows no sign of rust.





Sample # 5 is 10' North of Pier #2 and 3' west of center line near an area of delamination and spalls.

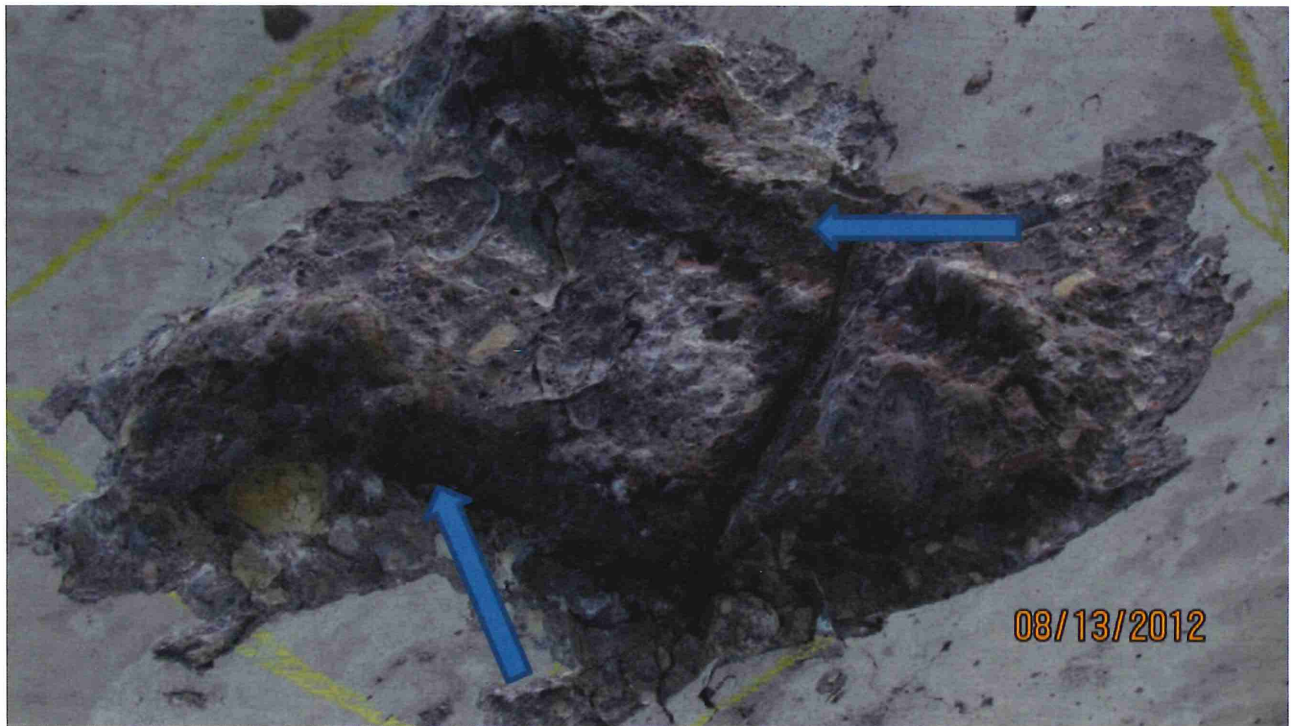


Sample # 5 after removal of concrete. Rebar shows no sign of rust.





Sample # 6 is 16' 5" South of Pier #4 and West 5' of center line. This location show signs of cracking and pour consolidation of concrete.



Sample #6 after concrete has been removed. This sample shows some rusting of the rebar. There is minors scaling of the rebar but no pack rust or loss of section noted.

## APPENDIX J LOAD RATINGS

Project: Reowing Bridge

 Computed: CBS Date: 1/25/12

 Subject: Br. 9/03

 Checked: CEN Date: 2/10/12

 Task: VERTS INPUT

 Page: 1 of:

 Job #: 177092

No:

 BAR MARKS b102,  
b33-b36, b28-b31

NOTE: RATING BASED ON REPRESENTATIVE 1'-0" STRIP OF CONCRETE SLAB; SEE PLANS F. SLAB THICKNES  
REINFORCEMENT Summary

MAT	LOCATION	SIZE	A	No. (for 12" SLAB)	SUPPORT	DIR.	START
* BOT.	SPANS 1-4	8	167.5	$12/4.5" = 2.6$	1	L	0.0
(b101, b25-27) * BOT.	SPAN 5	10	47.5	2.6	5	L	0.0
TOP (b42)	PIER 1	8	21.85	$12/18" = 0.67$	2	L	15.0
TOP (b42)	PIER 1	8	21.85	0.67	2	L	12.5
TOP (b42)	PIER 1	8	21.85	0.67	2	L	10.0
TOP (b42)	PIER 1	8	21.85	0.67	2	L	8.0
TOP (b39)	PIER 2/3	8	23.68/24.54	$12/16" = 0.75$	3/4	L	16.25
TOP (b39)	PIER 2/3	8	23.68/24.54	0.75	3/4	L	13.5
TOP (b39)	PIER 2/3	8	23.68/24.54	0.75	3/4	L	10.5
TOP (b39)	PIER 2/3	8	23.68/24.54	0.75	3/4	L	7.75
TOP (b37)	PIER 4	10	27.84	0.67	5	L	17.0
TOP (b37)	PIER 4	10	27.84	0.67	5	L	13.5
TOP (b37)	PIER 4	10	27.84	0.67	5	L	11.0
TOP (b37)	PIER 4	10	27.84	0.67	5	L	7.5
TOP (b43)	SPAN 1	6	17.75	$12/18" = 0.67$	1	L	0
TOP (b41)	SPAN 2	6	14.75	0.67	2	R	13.63
TOP (b40)	SPAN 3	6	12.5	0.67	3	R	14.75
TOP (b38)	SPAN 4	6	13.0	0.67	4	R	16.25
TOP (b36)	SPAN 5	6	22.5	0.67	6	L	23.5

\* LENGTH (A) SIMPLIFIED FOR VERTS INPUT

\*\* BY RUNNING BARS CONTINUOUSLY THROUGH ALL SPANS, INSTEAD OF CUTTING THEM OFF IN NEG. MOMENT REGIONS, TOP REINF. OVER PIERS USES PLAN LENGTH NORMAL TO PIER  
MEMBER LOADS ADJUSTED FOR SKEW.

WEARING SURFACE (2 1/2" L.S. OVERLAY PLACED IN 1978 PER S.I.N.)  
(2.5") (1/12) (.150 KCF) (1') = 0.031 K/FT/FT (DL2)

SIDEWALK

$$(4') (1.06') (0.150 \text{ KCF}) + (6.5') (1.06') (0.150 \text{ KCF}) = 1.67 \text{ K/FT}$$

$$(1.67) / 59.5' = \underline{0.029 \text{ K/FT/FT}} \text{ (DL2)}$$

↑  
SLAB  
WIDTH



Project: REDWING BRIDGE

Computed: CRS Date: 1/26/12

Subject: Be. 9103

Checked: CEN Date: 2/10/12

Task: VIRTIS WPT

Page: 2 of:

Job #: 177092

No:

MEMBER LOADS (CONTINUED)

RAIL

USE 90 PLF FOR DESIGN CRITERIA

$$(2)(90) / 59.5' = 3.03 \text{ 16/ft}, \text{ SM } 0.003 \text{ K/ft/ft (DC2)}$$

PEDESTRIAN LIVE LOAD

NOTE: NOT LOADED SIMULTANEOUSLY WITH OTHER LL

$$(175 \text{ psf})(5 + 2.5) = 902.5 \text{ 16/ft}$$

$$(902.5) / 59.5 = 0.009 \text{ K/ft/ft, RAIL AS SEPARATE LOAD CASE}$$

DISTRIBUTION FACTOR

SPAN LENGTH = 30.75, CONSERVATIVELY USE SHORTEST SPAN

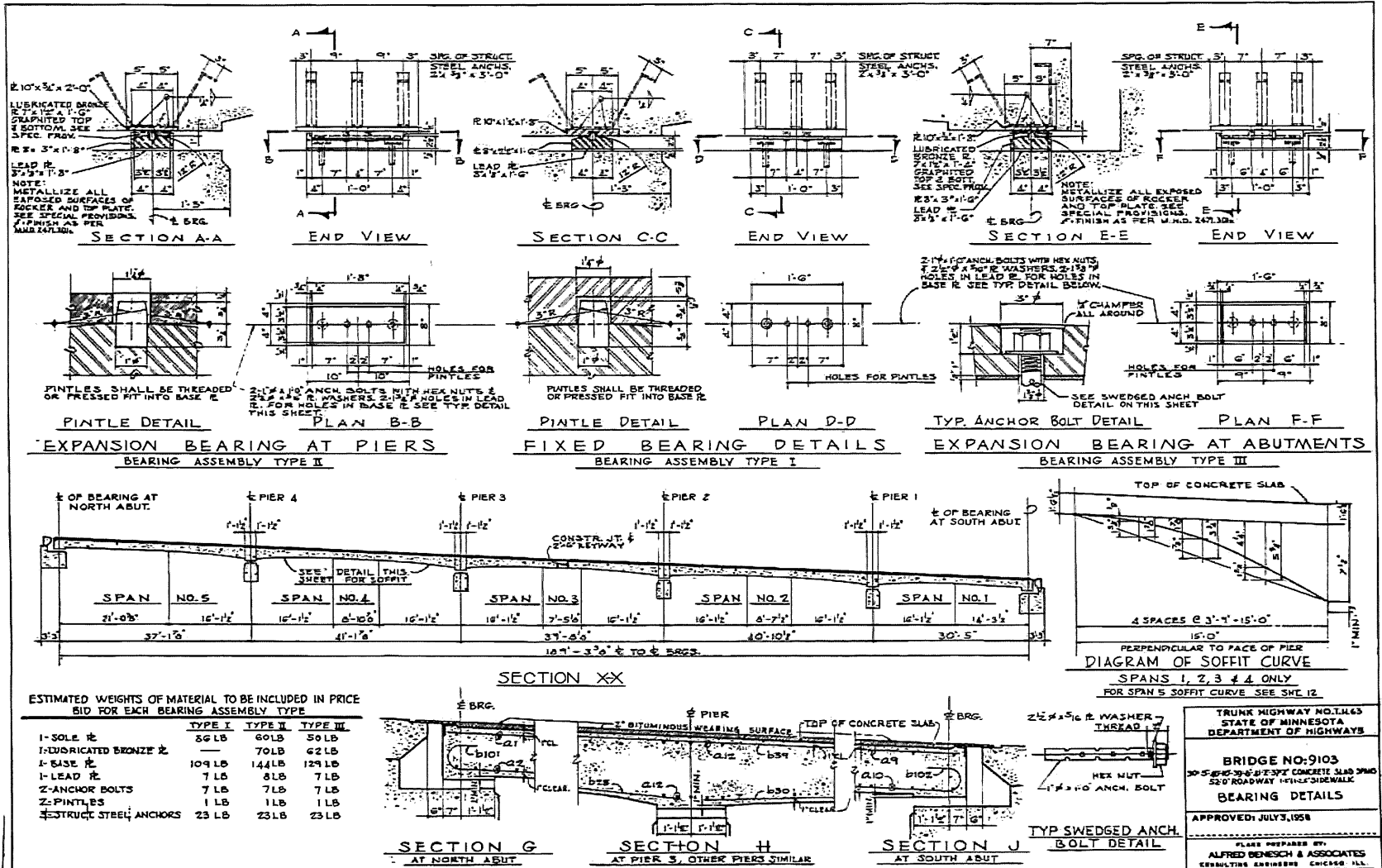
$$\text{WIDTH} = [4 + 0.06(5)] = 4 + 0.06(30.75) = 5.85'$$

$$\text{DF} = 1/5.85 = 0.172$$





# SLAB THICKNESS





ONE COMPANY  
Many Solutions

Project: RED WING BRIDGE

Computed: CRS Date: 7/11/12

Subject: BR. 9103

Checked: TAL Date: 7/15/12

Task: VIRTIS INPUT

Page: 4 of:

Job #: 177092

No:

### ACCOUNTING FOR SECTION LOSS

BASED ON A FIELD INSPECTION OF BRIDGE 9103, TWO VIRTIS MODELS WERE CREATED TO ACCOUNT FOR SECTION LOSS IN THE BRIDGE BY REDUCING THE BAR SIZE IN THE BOTTOM LONGITUDINAL SLAB REINFORCEMENT:

- 1) MODEL WITH  $1/16"$  S.L. AROUND ENTIRE PERIMETER ( $7/8"$   $\phi$  REMAINS)
- 2) MODEL WITH  $1/8"$  S.L. AROUND ENTIRE PERIMETER ( $3/4"$   $\phi$  REMAINS)

$$\text{AREA OF \#8 BAR} = (\pi)(0.5")^2 = 0.79 \text{ IN}^2$$

$$\text{W/1/16" S.L.} = (\pi)(0.5" - 1/16")^2 = 0.60 \text{ IN}^2 \text{ (\#7 BARS USED)}$$

$$\text{W/1/8" S.L.} = (\pi)(0.5" - 1/8")^2 = 0.44 \text{ IN}^2 \text{ (\#6 BARS USED)}$$



LFR ☐NBIS CONDITION CODE = 5 RATING RESULTS WITH 0.95 CAPACITY REDUCTION

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
HS 20-44	Axle Load	LFD	36.12	60.32	1.003	1.676	42.68	2 - ( 30.0 )	42.68	2 - ( 30.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
HS 20-44	Lane	LFD	45.42	75.85	1.003	2.107	87.17	3 - ( 40.0 )	87.17	3 - ( 40.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
Post S4 - 27	Axle Load	LFD		50.40		1.867			42.68	2 - ( 30.0 )		ULTIMATE MOMENT	As Requested	As Requested
Post S4S - 31	Axle Load	LFD		54.60		1.761			42.68	2 - ( 30.0 )		ULTIMATE MOMENT	As Requested	As Requested
Post S6 - 35	Axle Load	LFD		55.04		1.582			42.68	2 - ( 30.0 )		ULTIMATE MOMENT	As Requested	As Requested
Post S7 - 39	Axle Load	LFD		57.54		1.485			42.68	2 - ( 30.0 )		ULTIMATE MOMENT	As Requested	As Requested
Post T3M	Axle Load	LFD		50.60		2.001			42.68	2 - ( 30.0 )		ULTIMATE MOMENT	As Requested	As Requested
Post T3S2-40	Axle Load	LFD		85.25		2.001			30.42	2 - ( 0.0 )		ULTIMATE MOMENT	As Requested	As Requested
Post T3S3M - 40	Axle Load	LFD		81.99		2.050			30.42	2 - ( 0.0 )		ULTIMATE MOMENT	As Requested	As Requested

LFR RFinv LFR RF for Legal Load

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Close

For Help, press F1 NUM

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
C152b	Axle Load	LFD	51.82	66.54	0.681	1.137	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
C174b	Axle Load	LFD	62.40	104.21	0.717	1.198	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
C214b	Axle Load	LFD	87.67	146.40	0.819	1.368	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
C237b	Axle Load	LFD	96.79	161.65	0.817	1.364	87.17	3 - ( 40.0 )	87.17	3 - ( 40.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
C256b	Axle Load	LFD	96.93	161.88	0.757	1.265	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
P 411	Axle Load	LFD	76.12	127.12	0.735	1.228	87.17	3 - ( 40.0 )	87.17	3 - ( 40.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
P 413	Axle Load	LFD	92.68	154.78	0.727	1.214	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
Standard A	Axle Load	LFD	49.50	82.67	0.952	1.590	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
Standard B	Axle Load	LFD	49.66	82.93	0.730	1.220	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
Standard C	Axle Load	LFD	53.52	89.38	0.673	1.124	30.42	2 - ( 0.0 )	30.42	2 - ( 0.0 )	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested

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Close

For Help, press F1 NUM

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
CPM200	Axle Load	LFD		143.14		1.431			30.42	2 - ( 0.0 )		ULTIMATE MOMENT	As Requested	As Requested

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Close

For Help, press F1 NUM



LFR RATING RESULTS FOR 7/8 DIA. REMAINING ON #8 BARS WITH 0.95 CAPACITY REDUCTION

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
HS 20-44	Axle Load	LFD	31.56	52.70	0.877	1.464	50.86	2 - (50.0)	50.86	2 - (50.0)	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
HS 20-44	Lane	LFD	42.34	70.70	1.60	1.964	50.86	2 - (50.0)	50.86	2 - (50.0)	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
Post SU4 - 27	Axle Load	LFD		42.55		1.576			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post SU5 - 31	Axle Load	LFD		46.08		1.487			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post SU6 - 35	Axle Load	LFD		47.23		1.359			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post SU7 - 39	Axle Load	LFD		50.20		1.296			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post T3M	Axle Load	LFD		42.76		1.571			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post T3S2-40	Axle Load	LFD		81.46		2.036			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested
Post T3S3M - 40	Axle Load	LFD		78.38		1.950			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested

LFR RFinv

LFR RF for Legal Load

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Close

For Help, press F1

NUM

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
C152b	Axle Load	LFD		86.33		1.134			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested
C174b	Axle Load	LFD		104.15		1.197			30.42	2 - (0.0)		ULTIMATE MOMENT	As Requested	As Requested
C214b	Axle Load	LFD		145.77		1.362			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested
C237b	Axle Load	LFD		146.83		1.239			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
C256b	Axle Load	LFD		161.79		1.264			30.42	2 - (0.0)		ULTIMATE MOMENT	As Requested	As Requested
P 411	Axle Load	LFD		110.00		1.063			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested
P 413	Axle Load	LFD		154.41		1.211			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested
Standard A	Axle Load	LFD		82.15		1.580			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested
Standard B	Axle Load	LFD		82.08		1.207			12.17	1 - (40.0)		ULTIMATE MOMENT	As Requested	As Requested
Standard C	Axle Load	LFD		89.33		1.124			30.42	2 - (0.0)		ULTIMATE MOMENT	As Requested	As Requested

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Close

For Help, press F1

NUM

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
CPM200j	Axle Load	LFD		134.10		1.341			50.86	2 - (50.0)		ULTIMATE MOMENT	As Requested	As Requested



LFR RATING RESULTS FOR 3/4 DIA. REMAINING ON #8 BARS WITH 0.95 CAPACITY REDUCTION

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
HS 20-44	Axle Load	LFD	19.96	33.33	0.554	0.936	50.86	2 - ( 50.0)	50.86	2 - ( 50.0)	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
HS 20-44	Lane	LFD	26.77	44.71	0.771	1.242	50.86	2 - ( 50.0)	50.86	2 - ( 50.0)	ULTIMATE MOMENT CA	ULTIMATE MOMENT	As Requested	As Requested
Post SU4 - 27	Axle Load	LFD		26.91		0.997			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post SU5 - 31	Axle Load	LFD		29.14		0.940			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post SU6 - 35	Axle Load	LFD		29.87		0.860			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post SU7 - 39	Axle Load	LFD		31.75		0.819			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post T3M	Axle Load	LFD		27.04		1.27			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
Post T3S2-40	Axle Load	LFD		52.08		1.302			50.86	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
Post T3S3M - 40	Axle Load	LFD		50.12		1.253			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested

LFR RFinv

LFR RF for Legal Load

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Close

For Help, press F1

NUM

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
C152b	Axle Load	LFD		55.20		0.725			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
C174b	Axle Load	LFD		71.87		0.826			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
C214b	Axle Load	LFD		93.20		0.871			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
C237b	Axle Load	LFD		92.86		0.783			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
C256b	Axle Load	LFD		102.61		0.802			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
P 411	Axle Load	LFD		69.57		0.672			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested
P 413	Axle Load	LFD		98.73		0.774			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
Standard A	Axle Load	LFD		52.53		1.010			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
Standard B	Axle Load	LFD		52.48		0.772			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested
Standard C	Axle Load	LFD		59.92		0.754			12.17	1 - ( 40.0)		ULTIMATE MOMENT	As Requested	As Requested

BRASS-GIRDER - Version 6.00.03 - Apr. 14, 2010 \*\* BRASS Export Version 6.2.0.3001

Close

For Help, press F1

NUM

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Inventory Limit State	Operating Limit State	Impact	Lane
CPH200j	Axle Load	LFD		84.81		0.848			50.86	2 - ( 50.0)		ULTIMATE MOMENT	As Requested	As Requested

LRFR ☐ NBIS CONDITION CODE = 5 RATING RESULTS WITH 0.95 CONDITION FACTOR

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Legal Load Rating (Ton)	Permit Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Legal Rating Factor	Permit Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Legal Location (ft)	Legal Location Span-(%)	Permit Location (ft)	Permit Location Span-(%)	Inventory Limit State	Operating Limit State
HL-93 (US)	Axle Load	LRFR	38.01	49.27			1.038	1.369			42.68	2 - ( 30.0)	42.68	2 - ( 30.0)					STRENGTH I - Flexure	STRENGTH II - Flexure
HL-93 (US)	Tandem	LRFR	25.95	33.64			1.038	1.345			42.68	2 - ( 30.0)	42.68	2 - ( 30.0)					STRENGTH I - Flexure	STRENGTH II - Flexure
HL-93 (US)	Truck Pair	LRFR	51.16	66.32			1.038	1.642			30.42	2 - ( 0.0)	30.42	2 - ( 0.0)					STRENGTH I - Flexure	STRENGTH II - Flexure
Post SU4 - 27	Axle Load	LRFR			48.47				1.795						42.68	2 - ( 30.0)				
Post SU5 - 31	Axle Load	LRFR			52.65				1.699						42.68	2 - ( 30.0)				
Post SU6 - 35	Axle Load	LRFR			52.72				1.547						42.68	2 - ( 30.0)				
Post SU7 - 39	Axle Load	LRFR			55.05				1.421						42.68	2 - ( 30.0)				
Post T3M	Axle Load	LRFR			48.42				2.016						42.68	2 - ( 30.0)				
Post T3S2-40	Axle Load	LRFR			85.81				2.145						30.42	2 - ( 0.0)				
Post T3S3M - 40	Axle Load	LRFR			82.52				2.063						30.42	2 - ( 0.0)				

LRFR RFinv

LRFR RF for Legal Load

BRASS GIRDER(LRFD) - Version 2.0.3 - May, 12, 2010 \*\* BRASS Export Version 6.2.0.3001

Close

For Help, press F1

NUM



# LRFR RATING RESULTS FOR 7/8" DIA. REMAINING ON #8 BARS WITH 0.95 CONDITION FACTOR

Virtis - [Analysis Results - G1]																					
File Edit View Bridge Tools Window Help																					
Report Type Lane/Impact Loading Type Display Format																					
Rating Results Summary As Requested Detailed Multiple rating levels per row																					
Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Legal Load Rating (Ton)	Permit Load Rating (Ton)	Inventory Rating Factor	Operating Rating Factor	Legal Rating Factor	Permit Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Legal Location (ft)	Legal Location Span-(%)	Permit Location (ft)	Permit Location Span-(%)	Inventory Limit State	Operating Limit State	Legal Limit State
HL-93 (US)	Axle Load	LRFR	36.32	47.09			1.000	1.308			131.56	4 - ( 50.0)	131.56	4 - ( 50.0)					STRENGTH I - Flexure	STRENGTH II - Flexure	
HL-93 (US)	Tandem	LRFR	22.92	29.72			0.917	1.189			12.17	1 - ( 40.0)	12.17	1 - ( 40.0)					STRENGTH I - Flexure	STRENGTH II - Flexure	
HL-93 (US)	Truck Pair	LRFR	51.13	66.28			1.000	1.841			30.42	2 - ( 0.0)	30.42	2 - ( 0.0)					STRENGTH I - Flexure	STRENGTH II - Flexure	
Post SU4 - 27	Axle Load	LRFR			43.76				1.621						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post SU5 - 31	Axle Load	LRFR			47.87				1.544						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post SU6 - 35	Axle Load	LRFR			49.65										12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post SU7 - 39	Axle Load	LRFR			52.74				1.361						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post T3M	Axle Load	LRFR			44.06										12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post T3S2-40	Axle Load	LRFR			78.61				1.765						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post T3S3M - 40	Axle Load	LRFR			75.61				1.490						12.17	1 - ( 40.0)					STRENGTH I - Flexure

LRFR RFinv

LRFR RF for Legal Load

BRASS-GIRDER(LRFD) - Version 2.0.3 - May, 12, 2010 \*\* BRASS Export Version 6.2.0.3001

Close

NUM

For Help, press F1

# LRFR RATING RESULTS FOR 3/4" DIA. REMAINING ON #8 BARS WITH 0.95 CONDITION FACTOR

Virtis - [Analysis Results - G1]

File Edit View Bridge Tools Window Help

Report Type: Rating Results Summary Lane/Impact Loading Type: As Requested Display Format: Multiple rating levels per row

Live Load	Live Load Type	Rating Method	Inventory Load Rating (Ton)	Operating Load Rating (Ton)	Legal Load Rating (Ton)	Permit Load Rating	Inventory Rating Factor	Operating Rating Factor	Legal Rating Factor	Permit Rating Factor	Inventory Location (ft)	Inventory Location Span-(%)	Operating Location (ft)	Operating Location Span-(%)	Legal Location (ft)	Legal Location Span-(%)	Permit Location (ft)	Permit Location Span-(%)	Inventory Limit State	Operating Limit State	Legal Limit State
HL-93 (US)	Axle Load	LRFR	23.66	30.67			0.592	0.852			50.86	2 - ( 50.0)	50.86	2 - ( 50.0)					STRENGTH I - Flexure	STRENGTH II - Flexure	
HL-93 (US)	Tandem	LRFR	14.79	19.17			0.767				12.17	1 - ( 40.0)	12.17	1 - ( 40.0)					STRENGTH I - Flexure	STRENGTH II - Flexure	
HL-93 (US)	Truck Pair	LRFR	51.07	66.21			1.839				30.42	2 - ( 0.0)	30.42	2 - ( 0.0)					STRENGTH I - Flexure	STRENGTH II - Flexure	
Post SU4 - 27	Axle Load	LRFR			28.24				1.046						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post SU5 - 31	Axle Load	LRFR			30.89				0.996						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post SU6 - 35	Axle Load	LRFR			32.03				0.996						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post SU7 - 39	Axle Load	LRFR			34.03				0.878						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post T3M	Axle Load	LRFR			28.43				1.258						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post T3S2-40	Axle Load	LRFR			50.72				1.220						12.17	1 - ( 40.0)					STRENGTH I - Flexure
Post T3S3M - 40	Axle Load	LRFR			48.79				1.220						12.17	1 - ( 40.0)					STRENGTH I - Flexure

LRFR RFinv

LRFR RF for Legal Load

BRASS GIRDER(LRFD) - Version 2.0.3 - May, 12, 2010 \*\* BRASS Export Version 6.2.0.3001

For Help, press F1

Close

NUM



# **APPENDIX K CATHODIC PROTECTION AND ELECTROCHEMICAL CHLORIDE EXTRACTION**

## CATHODIC PROTECTION AND ELECTROCHEMICAL CHLORIDE EXTRACTION

### Cathodic Protection

Cathodic protection (CP) systems control the corrosion of a metal by creating an electrochemical cell where the metal to be protected becomes the cathode of the cell. A second metal, which is more easily corroded (more negative electrochemical potential), is connected to the cathode metal to serve as the “sacrificial metal” and becomes the anode of the electrochemical cell. For bridges the reinforcing steel would be the metal to protect or “cathode” in the electrical system. Cathodic protection for reinforcing steel in concrete can either be an impressed current system or galvanic system.

**Impressed Current Systems.** For large structural systems, such as a bridge deck, an electrical current must be introduced to provide protection throughout the slab and supplement the natural current that exists when the anode metal is connected to the cathode metal. Effective installations can arrest or slow the corrosion of the existing steel reinforcing in the bridge deck. The drawing below from the FHWA Research website depicts a typical system.

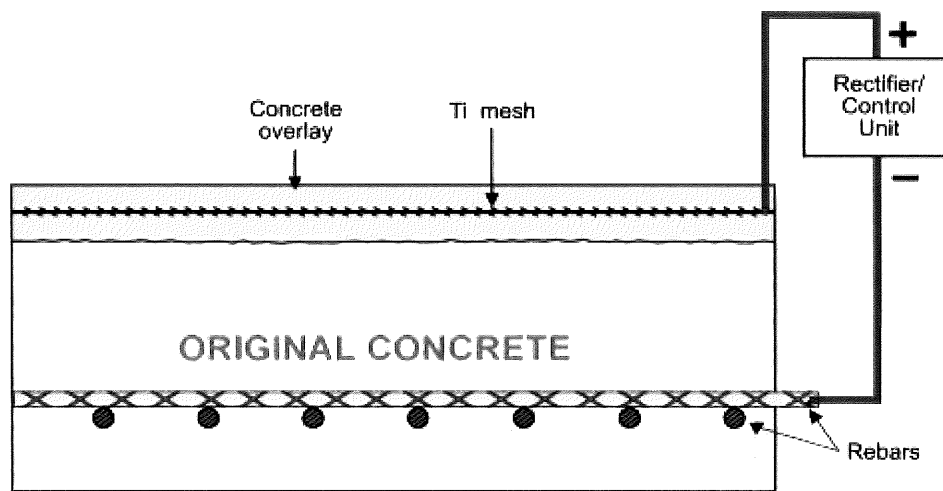


Figure 1. Cathodic protection system for reinforced concrete (Drawing from publication FHWA-RD-02-107) (1)

The rectifier control unit regulates and provides the current to polarize the reinforcing steel to reduce the rate of corrosion. The titanium (Ti) mesh shown in the drawing is the sacrificial anode that completes the electrical system and serves to protect the reinforcing steel by deteriorating or corroding in place of the steel.

MnDOT has experience with impressed current cathodic protection, installing a system on the 42nd Street Bridge over I-35W in Minneapolis. The system was installed in 1983 and monitored for 15 years. After 15 years of operation the conclusion noted in an FHWA report regarding this

installation was; “The reference cells were drying up as indicated by the increase in resistance with time. The results of the depolarization testing suggested that the system was not providing adequate protection at the low current densities at which they were being operated.” (2) MnDOT had difficulty keeping the electrical system functioning properly and eventually shut the system down.

Cathodic protection systems installed in bridge decks naturally have a finite life with a buried anode. The anode is sacrificial by design, and will eventually be consumed as it corrodes to protect the steel reinforcement cathode. Additionally, the electrical components of the system and connections deteriorate with time in service.

**Galvanic Systems.** In contrast to an impressed current system, a galvanic CP system does not require a rectifier because the source of the current is the anode. When two different metals (steel and the galvanic anode) are electrically connected to each other, a galvanic cell is established. As a result, electrical current flows naturally from the galvanic anode to the steel through the concrete electrolyte. Since reinforcing in concrete tends to be close to the surface and densely packed, the anode usually covers the entire surface of the concrete or separate anodes are closely spaced.

All galvanic CP systems require a metallic connection to the reinforcing steel. The type of connection depends on the construction. Where high strength steel is used, such as in pre-stressed or post-tensioned construction, the attachment is generally done mechanically. In other situations brazing or other thermal methods may be used.

Thermally sprayed zinc can be used as a sacrificial anode for atmospherically exposed reinforced concrete structures. Pure zinc is applied to the concrete surface using standard metallizing equipment (e.g., flame spray, electric arc). As with all galvanic anode systems, the presence of embedded metal near the surface that would short out and render ineffective an impressed current anode system has no detrimental effect on a galvanic anode system. Metallized zinc is typically applied at thicknesses of 10 to 20 mils.

The following are items to consider regarding cathodic protection systems:

- CP systems imbedded in a structure have a finite life, 5-25 years, due to deterioration of the system electronics and the sacrificial anode being consumed.
- While an effective CP system added to an existing structure or pipeline can arrest or retard further corrosion, it does not rehabilitate or restore the steel that has corroded to date.
- Continuity of the electrical connection is necessary to provide protection throughout a structure. For new reinforced concrete structures that will include a cathodic protection system, care needs to be taken in installing the reinforcing to ensure the steel mat is well tied. This provides a positive continuous electrical connection with the bars directly in contact with each other. It is difficult to verify these connections in existing concrete.

- For impressed current systems, the amount of current introduced by the rectifier must be carefully controlled to avoid the creation of hydrogen ions that can cause hydrogen embrittlement of the steel, reducing its strength.

Bridge 9103 exhibits a significant amount of corrosion on the underside of the deck. The deterioration is particularly significant along the longitudinal deck joint, but is also present to varying degrees elsewhere on the slab. Chloride concentrations are high throughout the deck area and also elevated from the surface to the bottom of the cores which were 9" to 24" deep. Often high chloride concentrations are contained in the upper 1"-2" of a deck in the area of the top reinforcing mat. However, that is not the case for Bridge 9103, with chloride penetrations being very advanced. Concentrations are extremely high with many samples ranging from 1000 to 5500 parts per million (ppm), which is well in excess of the threshold level for corrosion of 700 ppm. With the visible deterioration and high chloride concentration, it is reasonable to conclude the corrosion of the reinforcing steel has or will be initiated soon, and may be widespread.

Given the state of the bridge deck, cathodic protection alone does not provide a long term solution for the deteriorating deck condition of Bridge 9103. Cathodic protection cannot reverse the corrosion and loss of reinforcing steel section that has occurred, nor can it restore the lost live load capacity of the bridge. A CP system also has a finite life, and would need replacement in 15-20 years. The effectiveness of a CP system may also be negatively impacted by the fact that corrosion in the steel reinforcing grid has deteriorated contact between the bars and may be insufficient to maintain electrical continuity in places. In summary, cathodic protection alone is not a viable alternative given the advanced state of deterioration.

### **Electrochemical Chloride Extraction (ECE)**

Electrochemical Chloride Extraction is a more recent tool for bridge rehabilitation, with research beginning in the late 1970's and experimental installations occurring in several states since that time.

Electrochemical Chloride Extraction systems operate based on the known principal that opposite electrical charges attract and like charges repel. Similar to cathodic protection systems, a metal with a higher potential for corrosion (the anode) is attached to the surface of the concrete structure. Current is passed through the anode metal and the existing steel reinforcement, creating an electrical field with the reinforcing bars becoming negatively charged and the anode metal becoming positively charged. The negatively charged chloride ions (Cl) in the concrete are drawn away from the steel bars and toward the anode metal on the surface of the concrete. To be effective and allow extraction over the entire surface, the anode is kept wet in an electrolyte bath and is typically sandwiched between the concrete deck and a plastic sheeting. The drawing below from the FHWA Research website referenced earlier depicts such a system:



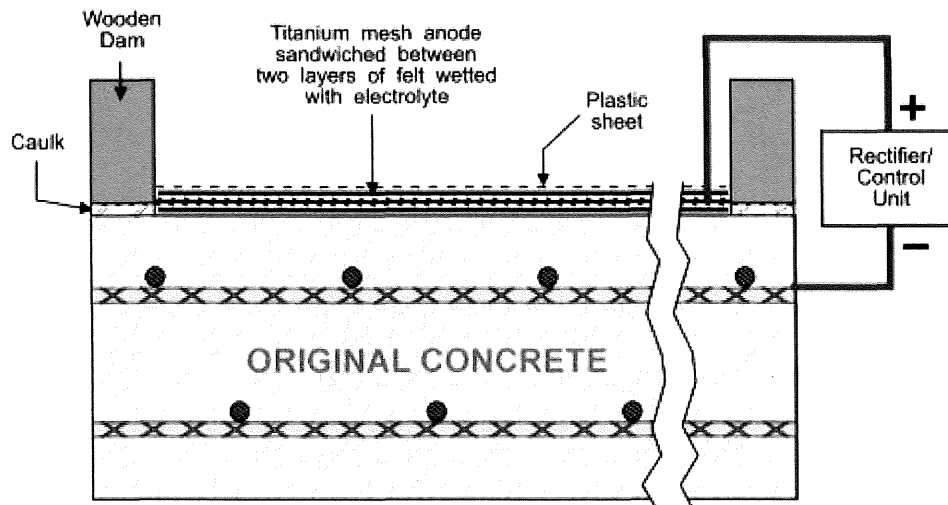


Figure 2. Illustration of ECE setup on the 34th Street Bridge in Arlington, Virginia (Drawing from publication FHWA-RD-02-107) (1)

MnDOT installed an ECE system on selected pier columns of Bridge 27831, the I-394 Bridge over Dunwoody Boulevard in 1997-98. The columns had corrosion damage from deicing salt and high chloride concentration levels. The ECE system was installed and operated for 60 days in the spring of 1998. The results of the process were somewhat mixed as described in the following excerpt from page 3 of the Executive Summary of MnDOT Research Report 2000-24 Evaluation of Electrochemical Chloride Extraction (ECE) and Fiber Reinforced Polymer (FRP) Wrap Technology (3):

Following ECE, the percentage of powder samples with a chloride concentration in excess of 2000 PPM was reduced from 66% to 23% on Pier 34 North and from 25% to 5% on Pier 37 North. This is in contrast to the structures not treated with ECE which showed a reduction from 29% to 27%. It can be assumed that this reduction is within the uncertainty of the chloride sampling process. However, the effectiveness of the treatment process varied greatly by location, sample depth, and original chloride content. In general, ECE reduced the average chloride concentrations the most near the concrete surface, and the effectiveness decreased slightly with depth into the structure. Certain locations also experienced greater chloride reductions than others, but this disparity might be associated with the proximity of each location to reinforcing steel. Chloride ions closer to reinforcing steel would be expected to be subject to a larger driving force, from the negatively charged rebar, towards the external anode and out of the structure, than chloride ions further from the rebar.

The following are items to consider regarding ECE systems:

- Application of an ECE system to a bridge deck requires the installation of a temporary treatment system on the deck surface as depicted in the drawing.
- The required treatment duration is 4-8 weeks for bridge decks of typical depth such as 8".
- Traffic must be detoured during the treatment process since the anode and electrolyte bath system cannot withstand vehicle weights.
- The protection provided by ECE treatments is estimated to be 10-15 years. The polarizing effect that ECE imparts on the steel bars in a treated bridge fades with time, and the chloride content will again rise. Treatment can be repeated at regular intervals to maintain the benefit of the chloride reduction.
- ECE systems have shown the ability to reduce chloride concentrations from the surface to several inches of slab depth. For bridge decks this removes chlorides in the vicinity of the top reinforcing bar mat. This is typically the area of the highest chloride concentration and in most need of treatment.

There are several barriers to successful implementation of an ECE system for Bridge 9103. These include:

- As noted ECE systems can remove chlorides in the top several inches of a typical 8" bridge deck. Bridge 9103 however, is considerably different since it is a continuous slab of 18 1/2" thickness at midspan, haunched to 26" at the piers. The anode and electrolyte solution applied to the deck surface will attract chlorides that reside in the vicinity of the top reinforcing. The top steel in turn will drive chlorides away as the steel is negatively charged by the rectifier. The chlorides present lower in the 18 1/2" to 26" depth will not be extracted. The bridge slab for Bridge 9103 has deep chloride penetration which is already causing section loss and deterioration in the lower reinforcing. The lower reinforcing must carry the bridge slab self weight and live loads in the midspan regions, and is thus a critical component. The midspan region is one of the most highly stressed areas of a concrete slab bridge and ECE will not benefit this steel.
- Bridge 9103 would need to be closed for up to 8 weeks for the ECE installation and operation. Similar to cathodic protection, the ECE process has a limited life and must be repeated every 10-15 years, which would result in several multiple-week detours during the remaining service life of the bridge.
- A level surface is the most desirable for installation of an ECE system. The ECE system requires the anode be kept wet in an electrolyte bath over the entire deck area. Bridges however typically have some grade and cross slope that must be accounted for in the installation. In the case of Bridge 9103 the grade is significant at 4 %, and is additionally complicated by a superelevation of up to 0.04 ft/ft. With the significant elevation differences in the deck, it would be difficult to install a system and end dams to maintain the electrolyte

over the entire area without extraordinary construction, such as numerous terraced dams and separate ECE systems.

- Similar to cathodic protection, chloride extraction does not restore the section loss to date in the steel.

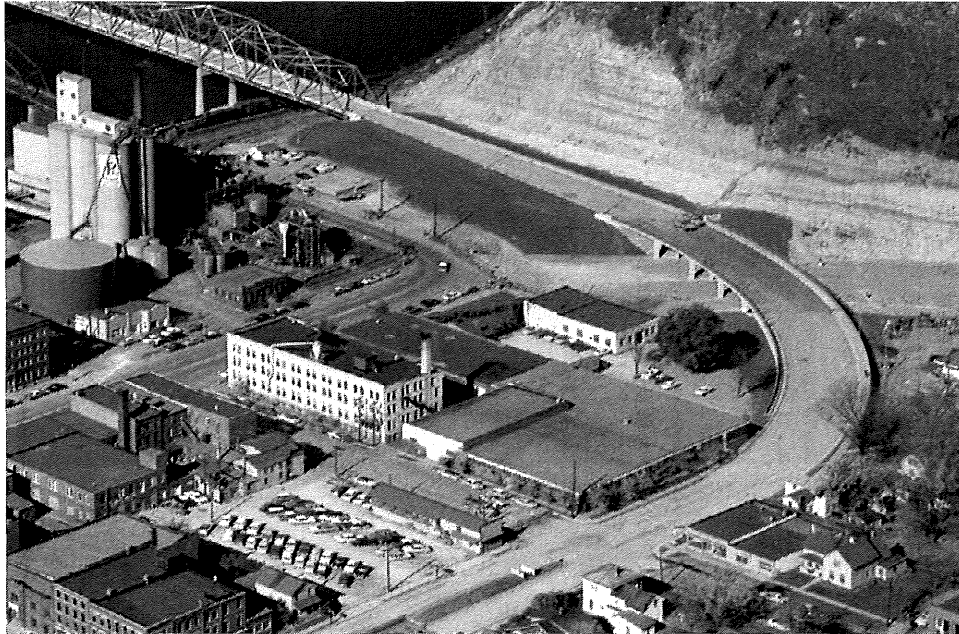
Given the above issues with Bridge 9103, ECE is not a viable alternative for Bridge 9103.

### Endnotes

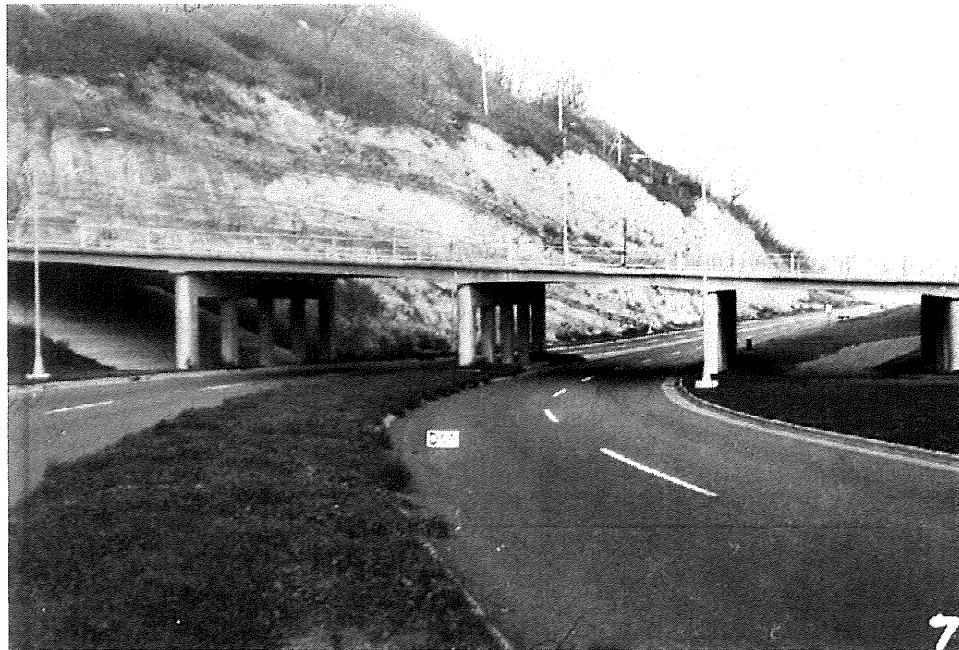
- (1) S. R. Sharp et al., *Electrochemical Chloride Extraction: Influence of Concrete Surface on Treatment*, FHWA-RD-02-107 (McLean, VA: Federal Highway Administration, 2002).
- (2) *Long-term Effectiveness of Cathodic Protection Systems on Highway Structures*, FHWA-RD-01-096 (McLean, VA: Federal Highway Administration, 2001).
- (3) M. Chauvin et al., *Evaluation of Electrochemical Chloride Extraction (ECE) and Fiber Reinforced Polymer (FRP) Wrap Technology*, MnDOT Final Report 2000-24 (St. Paul: MnDOT, June 2000).
- (4) G. T. Clemena and D. R. Jackson, *Trial Application of Electrochemical Chloride Extraction on Concrete Bridge Components in Virginia*, VTRC 00-R18 (Charlottesville, VA: Virginia Transportation Research Council, 2000).

## **APPENDIX L HISTORIC PHOTOS**

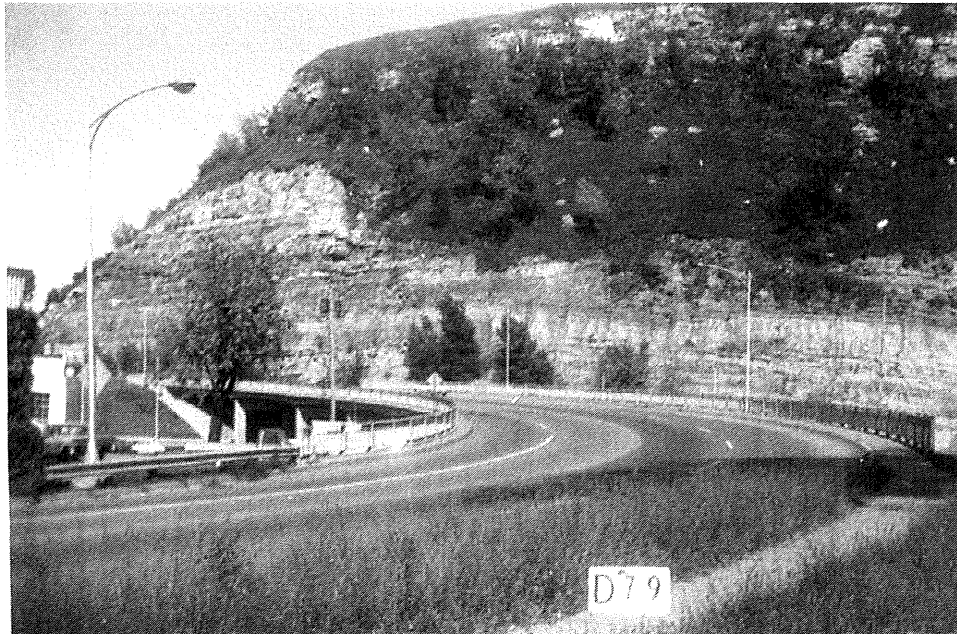




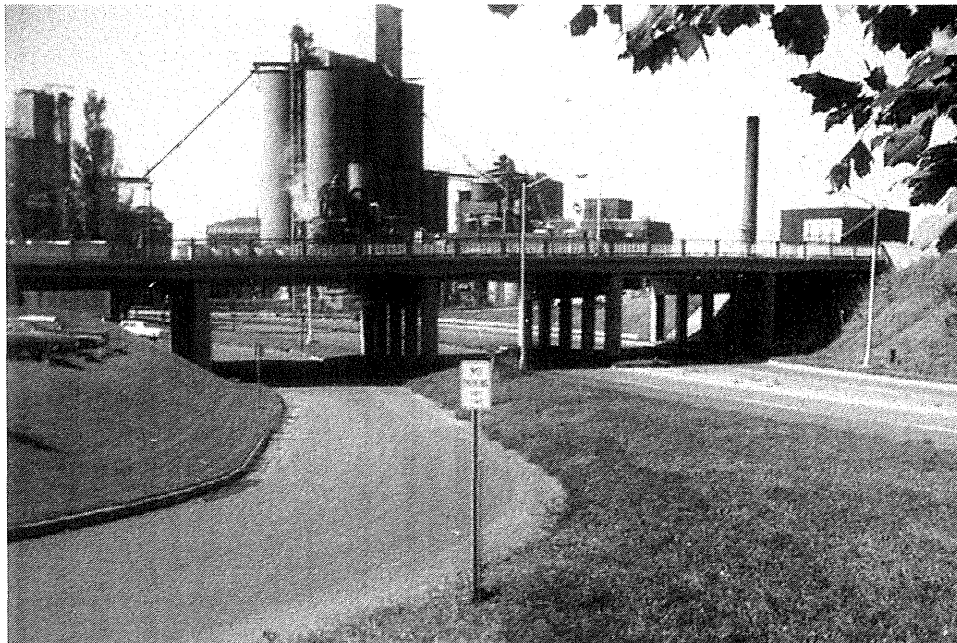
Aerial photo taken by St. Paul Dispatch in October 1960 (Minnesota Historical Society)



Bridge 9103 in 1964 (facing east, MnDOT photo).



Bridge 9103 in 1972 (facing northeast, MnDOT photo).



Bridge 9103 in 1972 (facing west, MnDOT photo).

**APPENDIX M**  
**SECRETARY OF INTERIOR'S STANDARDS**

## SECRETARY OF THE INTERIOR'S STANDARDS

### Secretary of the Interior's Standards for the Treatment of Historic Properties

The Secretary of the Interior's Standards for the Treatment of Historic Properties were authorized by the National Historic Preservation Act of 1966. The Standards were revised in 1992 and the revisions codified in 1995 (36 CFR 68). The Standards are designed to be applied to all types of historic properties including buildings, sites, structures, districts, and objects. They are accompanied by a set of advisory guidelines.

The Standards and Guidelines outline a hierarchy of four treatment approaches: Preservation, Rehabilitation, Restoration, and Reconstruction.

The first treatment, Preservation, places a high premium on the retention of all historic fabric through conservation, maintenance and repair. Rehabilitation, the second treatment, emphasizes the retention and repair of historic materials, but more latitude is provided for replacement because it is assumed the property is more deteriorated prior to work. Restoration, the third treatment, focuses on the retention of materials from the most significant time in a property's history, while permitting the removal of materials from other periods. Reconstruction, the fourth treatment, establishes limited opportunities to recreate a building, structure, object, or landscape that has disappeared.

Rehabilitation is the treatment approach most applicable to the current bridge project.

The Standards and Guidelines for all four treatments, including Rehabilitation, emphasize that the most conservative treatments – retaining, preserving, and repairing historic materials and features – are the preferred approach for preserving the historic integrity of a property. The Standards and Guidelines begin with the recommendation that features important in defining the historic character of the property be identified, retained, preserved, protected, and maintained. If repair is necessary, it should begin with the least intervention possible. If parts of an element are extensively damaged or deteriorated, limited replacement of those parts in-kind is acceptable. Next in the hierarchy, if the entire feature or element has deteriorated beyond repair, the preferred option is replacement in-kind, with the same material. Removal and replacement of a historic feature that could reasonably be repaired (and thus preserved) is never recommended.

The Standards and Guidelines direct that when alterations are needed to assure continued use of a historic property – for example, improving a bridge's load capacity and geometry – the alterations should not radically change, obscure, or destroy important materials, features, or finishes.



The Guidelines also advise that the effect of proposed changes be assessed within the overall context of the entire property, stating that "loss of [historic] character is just as often caused by the cumulative effect of a series of actions that would seem to be minor interventions" as by a single action.

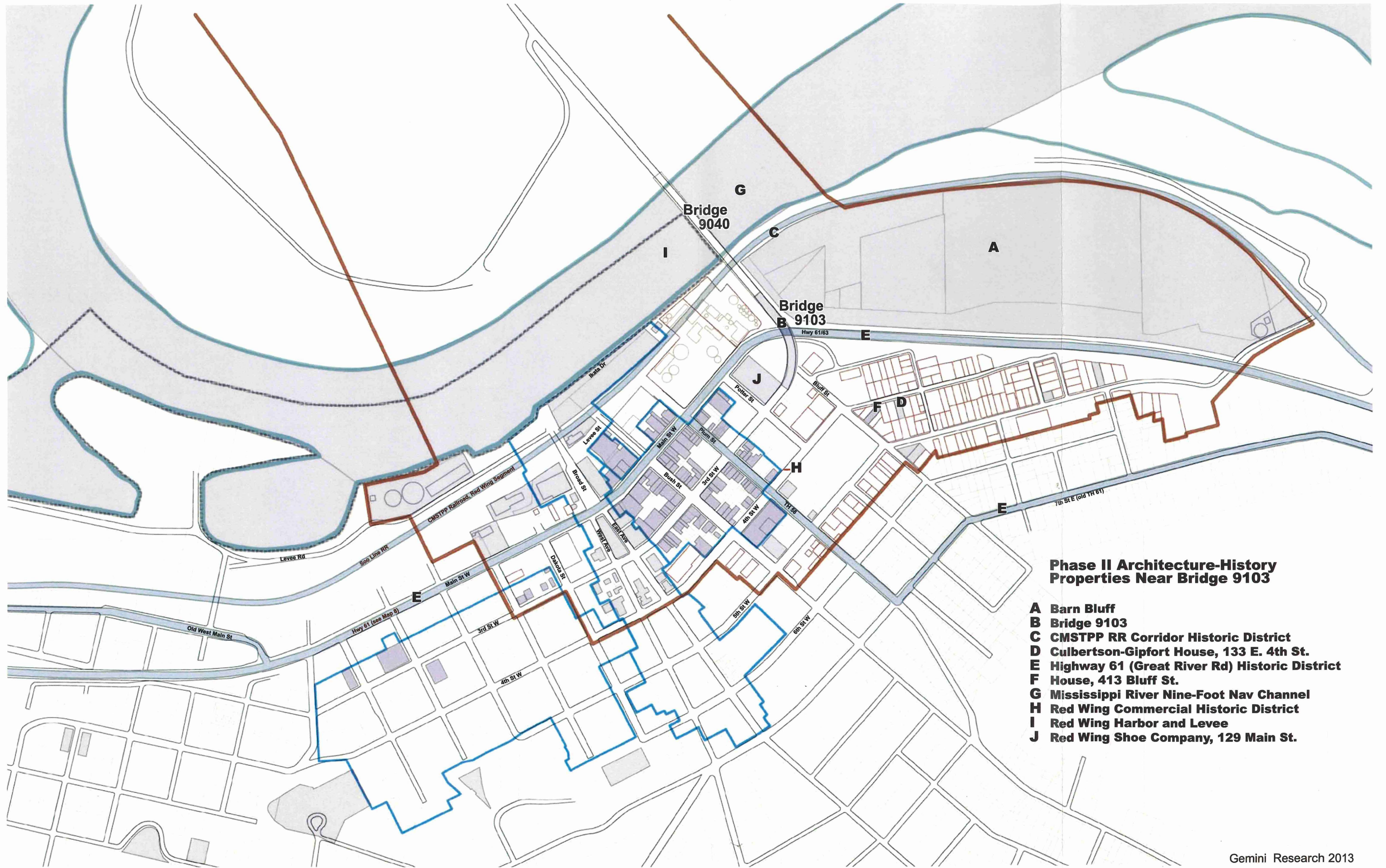
### **Standards for Rehabilitation**

1. A property will be used as it was historically or be given a new use that requires minimal change to its distinctive materials, features, spaces, and spatial relationships.
2. The historic character of a property will be retained and preserved. The removal of distinctive materials or alteration of features, spaces, and spatial relationships that characterize a property will be avoided.
3. Each property will be recognized as a physical record of its time, place, and use. Changes that create a false sense of historical development, such as adding conjectural features or elements from other historic properties, will not be undertaken.
4. Changes to a property that have acquired historic significance in their own right will be retained and preserved.
5. Distinctive materials, features, finishes, and construction techniques or examples of craftsmanship that characterize a property will be preserved.
6. Deteriorated historic features will be repaired rather than replaced. Where the severity of deterioration requires replacement of a distinctive feature, the new feature will match the old in design, color, texture, and, where possible, materials. Replacement of missing features will be substantiated by documentary and physical evidence.
7. Chemical or physical treatments, if appropriate, will be undertaken using the gentlest means possible. Treatments that cause damage to historic materials will not be used.
8. Archeological resources will be protected and preserved in place. If such resources must be disturbed, mitigation measures will be undertaken.
9. New additions, exterior alterations, or related new construction will not destroy historic materials, features, and spatial relationships that characterize the property. The new work will be differentiated from the old and will be compatible with the historic materials, features, size, scale and proportion, and massing to protect the integrity of the property and its environment.

10. New additions and adjacent or related new construction will be undertaken in such a manner that, if removed in the future, the essential form and integrity of the historic property and its environment would be unimpaired.

**APPENDIX N**  
**MAP OF PHASE II ARCHITECTURE-HISTORY PROPERTIES**  
**CLOSE TO BRIDGE 9103**





**Phase II Architecture-History  
Properties Near Bridge 9103**

- A** Barn Bluff
- B** Bridge 9103
- C** CMSTPP RR Corridor Historic District
- D** Culbertson-Gipfort House, 133 E. 4th St.
- E** Highway 61 (Great River Rd) Historic District
- F** House, 413 Bluff St.
- G** Mississippi River Nine-Foot Nav Channel
- H** Red Wing Commercial Historic District
- I** Red Wing Harbor and Levee
- J** Red Wing Shoe Company, 129 Main St.



## APPENDIX O COST ESTIMATES



ONE COMPANY  
Many Solutions

Project: <b>Red Wing Bridge Project</b>	Computed: <b>CEW</b>	Date: <b>10/7/2012</b>
Subject: <b>Bridge No. 9103</b>	Checked: <b>CRS</b>	Date: <b>10/22/2012</b>
Task: <b>Preliminary Cost Estimate - Alt. 1</b>	Page: _____	of: _____
Job #: <b>177092</b>	No: _____	

Preliminary Cost Estimate - Alternative 1: Replace 15' Strip - Alone and with Lowering TH 61 Option

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2104.503	Remove Concrete Approach Panel	SF	3,440	\$3.00	\$10,320.00
2301.553	Bridge Approach Panel	SF	3,440	\$17.00	\$58,480.00
2401.501	Structural Concrete (3Y43)	CY	2	\$550.84	\$877.26
2401.501	Structural Concrete (3Y36A)	CY	220	\$500.00	\$110,000.00
2401.541	Reinforcement Bars (Epoxy Coated)	LB	44,320	\$1.14	\$50,524.80
2402.591	Expansion Joint Devices Type 4	LF	138	\$135.73	\$18,730.74
2402.603	Salvage and Install Metal Railing	LF	800	\$250.00	\$200,000.00
2404.501	Concrete Wearing Course (3U17A)	SF	10,663	\$3.55	\$37,854.08
2404.505	Remove Bridge Deck Overlay	SF	10,663	\$2.00	\$21,326.24
2404.505	Remove Slab Type 1	SF	100	\$19.00	\$1,900.00
2411.618	Architectural Surface Finish (Single Color)	SF	30	\$3.70	\$111.00
2433.506	Remove Concrete Slab	LS	1	\$30,000.00	\$30,000.00
2433.618	Concrete Surface Repair - Type 1	SF	172	\$90.00	\$15,480.00
2433.618	Seal Structural Crack	LF	290	\$70.00	\$20,300.00
2433.618	Reconstruct Concrete Slope Paving	SF	400	\$15.00	\$6,000.00
2554.523	Guardrail End Terminal	EA	2	\$1,000.00	\$2,000.00
Item Subtotal:					\$583,905
15% for Miscellaneous Items:					\$87,586
Bridge Subtotal:					\$671,491
5% for Mobilization:					\$33,575
33% for inflation to 2018:					\$232,672
Total:					<b>\$937,737</b>
Rounded Total:					<b>\$935,000</b>
Bridge SF					<b>13,188</b>
Total per SF:					<b>\$72</b>
Adding Lowering of TH 61 Total					<b>\$1,600,000</b>

Assume 30' removed on each end of bridge  $30' * (52' + 62.5') = 3440$  sf

Assume CSR depth = 3"

Bridge length =  $211.00' - (3.25' - 0.58') / \sin 84.48 - (3.25' - 0.58') / \sin 55.01 = 205.06'$

Assume 200 lb/cy of 3Y43 and 3Y36A

Curb-to-curb =  $(2) * (26.00') = 52.00'$

Curb-to-curb =  $(2) * (26.00') = 52.00'$

Assume all deck repairs are Type 1

Paint over graffiti with paint color to match existing concrete, actual paint areas to be determined by engineer in field.

Repair of existing concrete surface where existing reinforcing remains in place, maximum depth 2" past reinforcing.

Seal structural cracks

Assume 10' wide area for entire length of north abutment slope paving (approximately 400 SF)

Includes lights, sidewalk improvements off the bridge, etc.

+25% Contingency

**\$1,170,000**

**\$1,835,000**



ONE COMPANY  
Many Solutions

Project: <b>Red Wing Bridge Project</b>	Computed: <b>CEW</b>	Date: <b>10/7/2012</b>
Subject: <b>Bridge No. 9103</b>	Checked: <b>CRS</b>	Date: <b>10/22/2012</b>
Task: <b>Preliminary Cost Estimate - Alt. 1</b>	Page: _____	of: _____
Job #: <b>177092</b>	No: _____	

Preliminary Cost Estimate - Alternative 1: Replace 15' Strip with Cathodic Protection Option; with and without Lowering TH 61 Option

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2104.503	Remove Concrete Approach Panel	SF	3,440	\$3.00	\$10,320.00
2301.553	Bridge Approach Panel	SF	3,440	\$17.00	\$58,480.00
2401.501	Structural Concrete (3Y43)	CY	1	\$550.84	\$775.26
2401.501	Structural Concrete (3Y36A)	CY	220	\$500.00	\$110,000.00
2401.541	Reinforcement Bars (Epoxy Coated)	LB	44,290	\$1.14	\$50,490.60
2402.591	Expansion Joint Devices Type 4	LF	138	\$135.73	\$18,730.74
2402.603	Salvage and Install Metal Railing	LF	800	\$250.00	\$200,000.00
2404.501	Concrete Wearing Course (3U17A)	SF	10,663	\$3.55	\$37,854.08
2404.505	Remove Bridge Deck Overlay	SF	10,663	\$2.00	\$21,326.24
2404.505	Remove Slab Type 1	SF	100	\$19.00	\$1,900.00
2433.506	Remove Concrete Slab	LS	1	\$30,000.00	\$30,000.00
2411.618	Architectural Surface Finish (Single Color)	SF	30	\$3.70	\$111.00
2433.618	Concrete Surface Repair - Type 1	SF	172	\$90.00	\$15,480.00
2433.618	Seal Structural Crack	LF	290	\$70.00	\$20,300.00
2433.618	Reconstruct Concrete Slope Paving	SF	400	\$15.00	\$6,000.00
2554.523	Guardrail End Terminal	EA	2	\$1,000.00	\$2,000.00
	Zinc Metalizing	SF	12,166	\$25.00	\$304,155.25
	Distributed Anode System	SF	10,663	\$35.00	\$373,209.20
	Item Subtotal:				\$1,261,133
	15% for Miscellaneous Items:				\$189,170
	Bridge Subtotal:				\$1,450,303
	5% for Mobilization:				\$72,515
	33% for inflation to 2018:				\$502,530
	Total:				<b>\$2,025,348</b>
	Rounded Total:				<b>\$2,025,000</b>
	Bridge SF				<b>13,188</b>
	Total per SF:				<b>\$154</b>
	Adding Lowering of TH 61 Total				<b>\$2,690,000</b>

Assume 30' removed on each end of bridge  $30' * (52' + 62.5') = 3440$  sf

Assume CSR depth = 3"

Bridge length =  $211.00' - (3.25' - 0.58') / \sin 84.48 - (3.25' - 0.58') / \sin 55.01 = 205.06'$

Assume 200 lb/cy of 3Y43 and 3Y36A

Curb-to-curb =  $(2) * (26.00') = 52.00'$

Curb-to-curb =  $(2) * (26.00') = 52.00'$

Assume all deck repairs are Type 1

Paint over graffiti with paint color to match existing concrete, actual paint areas to be determined by engineer in field.

Repair of existing concrete surface where existing reinforcing remains in place, maximum depth 2" past reinforcing.

Seal structural cracks

Assume 10' wide area for entire length of north abutment slope paving (approximately 400 SF)

Applied to bottom of slab; total width = 59.33'

Applied to top of slab between curbs, proposed width = 52.00'

Includes lights, sidewalk improvements off the bridge, etc.

+25% Contingency

**\$2,530,000**

**\$3,195,000**



ONE COMPANY  
Many Solutions

Project: <b>Red Wing Bridge Project</b>	Computed: <b>CEW</b>	Date: <b>10/7/2012</b>
Subject: <b>Bridge No. 9103</b>	Checked: <b>CRS</b>	Date: <b>10/22/2012</b>
Task: <b>Preliminary Cost Estimate - Alt. 2</b>	Page: _____	of: _____
Job #: <b>177092</b>	No: _____	

Preliminary Cost Estimate - Alternative 2: Replace 15' Strip and Add Inner Rail - Alone and with Lowering TH 61 Option

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2104.503	Remove Concrete Approach Panel	SF	3,440	\$3.00	\$10,320.00
2301.553	Bridge Approach Panel	SF	3,440	\$17.00	\$58,480.00
2401.501	Structural Concrete (3Y43)	CY	1	\$550.84	\$775.26
2401.501	Structural Concrete (3Y36A)	CY	270	\$500.00	\$135,000.00
2401.541	Reinforcement Bars (Epoxy Coated)	LB	54,290	\$1.14	\$61,890.60
2402.584	Structural Tube Railing Design Special	LF	415	\$125.00	\$51,875.00
2402.591	Expansion Joint Devices Type 4	LF	138	\$135.73	\$18,730.74
2402.603	Salvage and Install Metal Railing	LF	800	\$250.00	\$200,000.00
2404.501	Concrete Wearing Course (3U17A)	SF	9,740	\$3.55	\$34,578.24
2404.505	Remove Bridge Deck Overlay	SF	10,663	\$2.00	\$21,326.24
2404.505	Remove Slab Type 1	SF	100	\$19.00	\$1,900.00
2433.506	Remove Concrete Slab	LS	1	\$30,000.00	\$30,000.00
2411.618	Architectural Surface Finish (Single Color)	SF	30	\$3.70	\$111.00
2433.618	Concrete Surface Repair - Type 1	SF	172	\$90.00	\$15,480.00
2433.618	Seal Structural Crack	LF	290	\$70.00	\$20,300.00
2433.618	Reconstruct Concrete Slope Paving	SF	400	\$15.00	\$6,000.00
2554.523	Guardrail End Terminal	EA	2	\$1,000.00	\$2,000.00
Item Subtotal:					\$668,768
15% for Miscellaneous Items:					\$100,316
Bridge Subtotal:					\$769,084
5% for Mobilization:					\$38,454
33% for inflation to 2018:					\$266,488
Total:					<b>\$1,074,026</b>
Rounded Total:					<b>\$1,075,000</b>
Bridge SF					<b>13,188</b>
Total per SF:					<b>\$82</b>
Adding Lowering of TH 61 Total				<b>\$1,740,000</b>	<b>\$2,010,000</b>

Assume 30' removed on each end of bridge  $30' \times (52' + 62.5') = 3440 \text{ sf}$

Assume CSR depth = 3"

Bridge length =  $211.00' - (3.25' - 0.58') / \sin 84.48 - (3.25' - 0.58') / \sin 55.01 = 205.06'$

Assume 200 lb/cy of 3Y43 and 3Y36A

WashDOT railing; assume same length as outside metal railing

Proposed Curb-to-curb =  $(2') \times (26.00') - 3.50' - 1.00' = 47.50'$

Existing Curb-to-curb =  $(2') \times (26.00') = 52.00'$

Assume all deck repairs are Type 1

Paint over graffiti with paint color to match existing concrete, actual paint areas to be determined by engineer in field.

Repair of existing concrete surface where existing reinforcing remains in place, maximum depth 2" past reinforcing.

Seal structural cracks

Assume 10' wide area for entire length of north abutment slope paving (approximately 400 SF)

Includes lights, sidewalk improvements off the bridge, etc.

+25% Contingency

**\$1,345,000**





ONE COMPANY  
Many Solutions

Project: <b>Red Wing Bridge Project</b>	Computed: <b>CEW</b>	Date: <b>10/7/2012</b>
Subject: <b>Bridge No. 9103</b>	Checked: <b>CRS</b>	Date: <b>10/22/2012</b>
Task: <b>Preliminary Cost Estimate - Alt. 2</b>	Page:	of:
Job #: <b>177092</b>	No:	

Preliminary Cost Estimate - Alternative 2: Replace 15' Strip and Add Inner Rail with Cathodic Protection Option; with and without Lowering TH 61 Option

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2104.503	Remove Concrete Approach Panel	SF	3,440	\$3.00	\$10,320.00
2301.553	Bridge Approach Panel	SF	3,440	\$17.00	\$58,480.00
2401.501	Structural Concrete (3Y43)	CY	2	\$550.84	\$877.26
2401.501	Structural Concrete (3Y36A)	CY	270	\$500.00	\$135,000.00
2401.541	Reinforcement Bars (Epoxy Coated)	LB	54,320	\$1.14	\$61,924.80
2402.584	Structural Tube Railing Design Special	LF	415	\$125.00	\$51,875.00
2402.591	Expansion Joint Devices Type 4	LF	138	\$135.73	\$18,730.74
2402.603	Salvage and Install Metal Railing	LF	800	\$250.00	\$200,000.00
2404.501	Concrete Wearing Course (3U17A)	SF	9,740	\$3.55	\$34,578.24
2404.505	Remove Bridge Deck Overlay	SF	10,663	\$2.00	\$21,326.24
2404.505	Remove Slab Type 1	SF	100	\$19.00	\$1,900.00
2433.506	Remove Concrete Slab	LS	1	\$30,000.00	\$30,000.00
2411.618	Architectural Surface Finish (Single Color)	SF	30	\$3.70	\$111.00
2433.618	Concrete Surface Repair - Type 1	SF	172	\$90.00	\$15,480.00
2433.618	Seal Structural Crack	LF	290	\$70.00	\$20,300.00
2433.618	Reconstruct Concrete Slope Paving	SF	400	\$15.00	\$6,000.00
2554.523	Guardrail End Terminal	EA	2	\$1,000.00	\$2,000.00
	Zinc Metalizing	SF	12,166	\$25.00	\$304,155.25
	Distributed Anode System	SF	10,663	\$35.00	\$373,209.20
	Item Subtotal:				\$1,346,268
	15% for Miscellaneous Items:				\$201,941
	Bridge Subtotal:				\$1,548,209
	5% for Mobilization:				\$77,410
	33% for inflation to 2018:				\$536,454
	Total:				<b>\$2,162,074</b>
	Rounded Total:				<b>\$2,165,000</b>
	Bridge SF				<b>13,188</b>
	Total per SF:				<b>\$164</b>
	Adding Lowering of TH 61 Total				<b>\$2,830,000</b>

Assume 30' removed on each end of bridge  $30' * (52' + 62.5') = 3440$  sf

Assume CSR depth = 3"

Bridge length =  $211.00' - (3.25' - 0.58') / \sin 84.48 - (3.25' - 0.58') / \sin 55.01 = 205.06'$

Assume 200 lb/cy of 3Y43 and 3Y36A

WashDOT railing; assume same length as outside metal railing

Proposed Curb-to-curb =  $(2) * (26.00') - 3.50' - 1.00' = 47.50'$

Existing Curb-to-curb =  $(2) * (26.00') = 52.00'$

Assume all deck repairs are Type 1

Paint over graffiti with paint color to match existing concrete, actual paint areas to be determined by engineer in field.

Repair of existing concrete surface where existing reinforcing remains in place, maximum depth 2" past reinforcing.

Seal structural cracks

Assume 10' wide area for entire length of north abutment slope paving (approximately 400 SF)

Applied to bottom of slab; total width = 59.33'

Applied to top of slab between curbs, proposed width = 47.50'

Includes lights, sidewalk improvements off the bridge, etc.

+25% Contingency

**\$2,705,000**

**\$3,370,000**



ONE COMPANY  
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Project: <b>Red Wing Bridge Project</b>	Computed: <b>CEW</b>	Date: <b>10/7/2012</b>
Subject: <b>Bridge No. 9103</b>	Checked: <b>CRS</b>	Date: <b>10/22/2012</b>
Task: <b>Preliminary Cost Estimate - Alt. 3</b>	Page:	of:
Job #: <b>177092</b>	No:	

Preliminary Cost Estimate - Alternative 3: Full Deck Replacement - Alone and with Lowering TH 61 Option

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2104.503	Remove Concrete Approach Panel	SF	3,440	\$3.00	\$10,320.00
2301.553	Bridge Approach Panel	SF	3,440	\$17.00	\$58,480.00
2401.501	Structural Concrete (3Y43)	CY	31	\$550.84	\$17,244.38
2401.501	Structural Concrete (3Y36A)	CY	980	\$400.00	\$392,000.00
2401.541	Reinforcement Bars (Epoxy Coated)	LB	202,270	\$1.14	\$230,587.80
2402.584	Structural Tube Railing Design Special	LF	415	\$125.00	\$51,875.00
2402.591	Expansion Joint Devices Type 4	LF	138	\$135.73	\$18,730.74
2402.603	Salvage and Install Metal Railing	LF	800	\$250.00	\$200,000.00
2404.501	Concrete Wearing Course (3U17A)	SF	9,740	\$3.55	\$34,578.24
2433.506	Remove Concrete Slab	LS	1	\$50,000.00	\$50,000.00
2411.618	Architectural Surface Finish (Single Color)	SF	30	\$3.70	\$111.00
2433.618	Concrete Surface Repair - Type 1	SF	172	\$90.00	\$15,480.00
2433.618	Seal Structural Crack	LF	290	\$70.00	\$20,300.00
2433.618	Reconstruct Concrete Slope Paving	SF	400	\$15.00	\$6,000.00
2554.523	Guardrail End Terminal	EA	2	\$1,000.00	\$2,000.00
Item Subtotal:					\$1,107,708
15% for Miscellaneous Items:					\$166,157
Bridge Subtotal:					\$1,273,865
5% for Mobilization:					\$63,693
33% for inflation to 2018:					\$441,394
Total:					\$1,778,952
Rounded Total:					\$1,780,000
Bridge SF					13,188
Total per SF:					\$135
Adding Lowering of TH 61 Total					\$2,445,000

Assume 30' removed on each end of bridge  $30' * (52' + 62.5') = 3440$  sf

9" pedestal over entire substructure length and width + assumed 3" CSR depth  
Bridge length =  $211.00' - (3.25' - 0.58') / \sin 84.48 - (3.25' - 0.58') / \sin 55.01 = 205.06'$   
Assume 200 lb/cy of 3Y43 and 3Y36A  
WashDOT railing; assume same length as outside metal railing

Proposed Curb-to-curb =  $(2) * (26.00') - 3.50' - 1.00' = 47.50'$

Paint over graffiti with paint color to match existing concrete, actual paint areas to be determined by engineer in field.  
Repair of existing concrete surface where existing reinforcing remains in place, maximum depth 2" past reinforcing.  
Seal structural cracks  
Assume 10' wide area for entire length of north abutment slope paving (approximately 400 SF)

Includes lights, sidewalk improvements off the bridge, etc.

+15% Contingency  
**\$2,045,000**

**\$2,710,000**



ONE COMPANY  
Many Solutions

Project: <b>Red Wing Bridge Project</b>	Computed: <b>CEW</b>	Date: <b>10/7/2012</b>
Subject: <b>Bridge No. 9103</b>	Checked: <b>CRS</b>	Date: <b>10/22/2012</b>
Task: <b>Preliminary Cost Estimate - Alt. 4</b>	Page:	of:
Job #: <b>177092</b>	No:	

Preliminary Cost Estimate - Alternative 4: Four Lanes

ITEM NO	DESCRIPTION	UNIT	QUANTITY	UNIT PRICE	AMOUNT
2104.503	Remove Concrete Approach Panel	SF	3,440	\$3.00	\$10,320.00
2301.553	Bridge Approach Panel	SF	4,520	\$17.00	\$76,840.00
2401.501	Structural Concrete (3Y43)	CY	100	\$550.84	\$55,252.34
2401.501	Structural Concrete (3Y36A)	CY	1,320	\$400.00	\$528,000.00
2401.541	Reinforcement Bars (Epoxy Coated)	LB	284,070	\$1.14	\$323,839.80
2402.513	Type P-1 (TL-2) Railing Conc (3Y46)	LF	415	\$100.00	\$41,500.00
2402.591	Expansion Joint Devices Type 4	LF	174	\$135.73	\$23,617.02
2404.501	Concrete Wearing Course (3U17A)	SF	13,431	\$3.55	\$47,680.05
2433.506	Remove Concrete Slab	LS	1	\$50,000.00	\$50,000.00
2411.618	Architectural Surface Finish (Single Color)	SF	30	\$3.70	\$111.00
2433.618	Concrete Surface Repair - Type 1	SF	172	\$90.00	\$15,480.00
2433.618	Seal Structural Crack	LF	290	\$70.00	\$20,300.00
2433.618	Reconstruct Concrete Slope Paving	SF	1,480	\$15.00	\$22,200.00
2554.523	Guardrail End Terminal	EA	2	\$1,000.00	\$2,000.00
	Retaining Walls	SF	2,400	\$60.00	\$144,000.00
Item Subtotal:					\$1,361,141
15% for Miscellaneous Items:					\$204,172
Bridge Subtotal:					\$1,565,313
5% for Mobilization:					\$78,266
33% for inflation to 2018:					\$542,381
Lowering of TH 61 and Service Drive Total					<b>\$830,000</b>
Total:					<b>\$3,015,960</b>
Rounded Total:					<b>\$3,015,000</b>

Assume 30' removed on each end of bridge  $30' * (52' + 62.5') = 3440$  sf

9" pedestal over entire substructure length and width + assumed 3" CSR depth  
 Bridge length =  $211.00' - (3.25' - 0.58') / \sin 84.48 - (3.25' - 0.58') / \sin 55.01 = 205.06'$   
 Assume 200 lb/cy of 3Y43 and 3Y36A

Proposed Curb-to-curb =  $(2) * (26.00') - 3.50' - 1.00' = 47.50'$

Paint over graffiti with paint color to match existing concrete, actual paint areas to be determined by engineer in field.  
 Repair of existing concrete surface where existing reinforcing remains in place, maximum depth 2" past reinforcing.  
 Seal structural cracks  
 Assume 10' wide area for entire length of north abutment slope paving (approximately 400 SF)

Assuming 400' of retaining walls that are an average of 6' high

Includes lights, sidewalk improvements off the bridge, etc.

\$665,000 for TH 61 plus additional 25% for service drive  
 +15% Contingency (Not applied to \$830,000 of Roadwork)

**\$3,345,000**

# HDR Engineering, Inc.

Job No. 177092

Project	Red Wing Bridge 9103	Computed	CRS	Date	1/14/2013
Subject	Rehabilitation Study	Checked	TAL	Date	1/15/2013
Task	Life Cycle Cost Analysis	Sheet		Of	

## Deck Patching and Repairs Every 10 Years

Event: Deck patching and repairs every 10 years  
Event Interval: 10 Years  
Present Year: 2018  
Design Life Year: 2108  
Future Cost (F): \$50,000  
Real Discount Rate: 2.5% Annual

Year	n	Present Value (PV)
2028	10	\$39,060
2038	20	\$30,514
2048	30	\$23,837
2058	40	\$18,622
2068	50	\$14,547
2078	60	\$11,364
2088	70	\$8,878
2098	80	\$6,935
2108	90	\$5,418

TOTAL:	\$159,174
ROUNDED TOTAL:	\$160,000

## Deck Mill and Overlay Every 30 Years

Event: Deck mill and overlay every 30 years  
Event Interval: 30 Years  
Present Year: 2018  
Design Life Year: 2108  
Future Cost (F): \$60,000  
Real Discount Rate: 2.5% Annual

Year	n	Present Value (PV)
2048	30	\$28,605
2078	60	\$13,637
2108	90	\$6,501

TOTAL:	\$48,743
ROUNDED TOTAL:	\$50,000

## Reapply Zinc Coating to Bottom of Slab Every 20 Years

Event: Reapply zinc coating to bottom of slab every 20 years  
Event Interval: 20 Years  
Present Year: 2018  
Design Life Year: 2108  
Future Cost (F): \$300,000  
Real Discount Rate: 2.5% Annual

Year	n	Present Value (PV)
2038	20	\$183,081
2058	40	\$111,729
2078	60	\$68,185
2098	80	\$41,611

TOTAL:	\$404,607
ROUNDED TOTAL:	\$405,000



# HDR Engineering, Inc.

Job No. 177092

Project	Red Wing Bridge 9103	Computed	CRS	Date	1/14/2013
Subject	Rehabilitation Study	Checked	TAL	Date	1/15/2013
Task	Life Cycle Cost Analysis	Sheet		Of	

## Replace Zinc Anodes in Top of Slab Every 30 Years

Event: Reapply zinc anodes in top of slab every 30 years  
Event Interval: 30 Years  
Present Year: 2018  
Design Life Year: 2108  
Future Cost (F): \$375,000  
Real Discount Rate: 2.5% Annual

Year	n	Present Value (PV)
2048	30	\$178,779
2078	60	\$85,231
2108	90	\$40,633
TOTAL:		\$304,643
TOTAL:		\$305,000

## Alternative 1 Cost Summary

\$935,000 Alternative 1 Construction Costs  
\$2,025,000 Alternative 1 Construction Costs with Cathodic Protection  
\$665,000 Lowering TH 61 Costs

<b>COST</b>	<b>CASE</b>
\$1,145,000	Alternative 1
\$2,785,000	Alternative 1 with Cathodic Protection
\$1,810,000	Alternative 1 with Lowering of TH 61
\$3,450,000	Alternative 1 with Cathodic Protection and Lowering TH 61

## Alternative 2 Cost Summary

\$1,075,000 Alternative 2 Construction Costs  
\$2,165,000 Alternative 2 Construction Costs with Cathodic Protection  
\$665,000 Lowering TH 61 Cost

<b>COST</b>	<b>CASE</b>
\$1,285,000	Alternative 2
\$2,925,000	Alternative 2 with Cathodic Protection
\$1,950,000	Alternative 2 with Lowering of TH 61
\$3,590,000	Alternative 2 with Cathodic Protection and Lowering TH 61

## Alternative 3 Cost Summary

\$1,780,000 Alternative 3 Construction Costs  
\$665,000 Lowering TH 61 Cost

<b>COST</b>	<b>CASE</b>
\$1,830,000	Alternative 3
\$2,495,000	Alternative 3 with Lowering of TH 61

## Alternative 4 Cost Summary

\$3,015,000 Alternative 4 Construction Costs

<b>COST</b>	<b>CASE</b>
\$3,065,000	Alternative 4

**APPENDIX P**  
**WisDOT EXPERIENCE WITH THE REPAIR**  
**OF CONCRETE SLAB SPAN BRIDGES**

**Subject:** FW: Full Depth Slab Repair on Concrete Slab Spans

**From:** "Hanson, Chad (DOT)" <chad.hanson@state.mn.us>

**Date:** 7/9/2013 1:19 PM

**To:** "Daubenberger, Nancy (DOT)" <nancy.daubenberger@state.mn.us>, "Stevens, Todd (DOT)" <Todd.Stevens@state.mn.us>, "Lang, Todd A." <Todd.Lang@hdrinc.com>, "Hiniker, Chris" <chiniker@sehinc.com>, "Wagner, Anthony L (DOT)" <Anthony.Wagner@state.mn.us>

Here is some information from WisDOT on their experience with full depth repairs on slab span bridges.

---

**From:** Haig, Gregory - DOT [mailto:gregory.haig@dot.wi.gov]

**Sent:** Friday, June 14, 2013 9:51 AM

**To:** Hanson, Chad (DOT)

**Cc:** Koenig, James - DOT; Hayek, Mohamad - DOT

**Subject:** Full Depth Slab Repair on Concrete Slab Spans

Chad,

Here are a few examples on what we have for experience with full depth removals and replacement on our slab structures:

Bridge B-17-0054 (I-94 westbound over USH 12 in Menomonie Wisconsin):

- Originally built in 1959
- Deck repair/replacement in 1984
  - Consisted of removal and replacement of 3 feet wide section along longitudinal construction joints
  - Overlaid after full depth repair was made
- Deck repair/replacement in 2003
  - Full depth repair from 1984 was redone due to failure
  - Structure was re-overlaid after full depth repair was made
- Pictures of current condition attached, 2013
  - Full depth patch is failing
  - Appear that the deterioration is spreading into the original concrete









- Consisted of removal and replacement of 3 feet wide section along longitudinal construction joints
  - Overlaid after full depth repair was made
- Deck repair/replacement in 2003
  - Full depth repair from 1984 was redone due to failure
  - Structure was re-overlaid after full depth repair was made
- Pictures of current condition attached, 2013
  - Full depth patch is failing
  - Appear that the deterioration is spreading into the original concrete













- Consisted of removal and replacement of 3 feet wide section along centerline construction joint
- Overlaid after full depth was repair made
- Deck repair/replacement in 2001
  - Full depth repair from 1981 was redone due to failure
  - Structure was re-overlaid after full depth repair was made
- Pictures of current condition attached, 2013
  - Failure of the full depth patch area is imminent
  - Leaching through the patch has caused corrosion and section loss in the pier











We do have several other examples, but they are pretty much the same. The full depth repair usually begins to show signs of failure between 10-15 years after construction. After which another repair is performed (around 20 years after the first). The second repair usually begins to show signs of failure between 5-10 years and we are replacing them after about 15 years. All of the full depth repairs are protected with a concrete overlay. Here's a quick break down of the average life expectancy that we've been experiencing/expecting on our Interstate slab bridges:

- Original Deck is built (black steel reinforcing)
- After Approximately 25 years of life
  - Full depth patch along centerline
  - Concrete Overlay
- Between 40-45 years of life
  - Replacement/repair of full depth patch
  - Concrete Re-Overlay
- Between 55-65 years of life
  - Full Replacement

Please be aware that all of the full depth patches were protected with a concrete overlay. Although the overlays appear to be sound, there is inevitably moisture leaching through the top of the deck to soffit on all of the bridges. In addition, special attention should be paid to chloride concentrations in the deck. Regardless of what treatment is done to the deck, there will always be active corrosion if there is a high concentration of chlorides in the deck.

I hope this information is useful and if you have any questions please feel free to contact me.

Thanks,

**Gregory Haig, P.E.**  
Bridge Maintenance Engineer  
Northwest Region, Eau Claire  
[gregory.haig@dot.wi.gov](mailto:gregory.haig@dot.wi.gov)  
cell. (715) 577-0646