Needs and Deficiencies Report

US 51 Ohio River Bridge Study between Wickliffe, KY, and Cairo, IL
Kentucky Transportation Cabinet
Item No. 1-100.00 and 1-1140.00

June 4, 2013

REVISION HISTORY

The following table summarizes changes which have been made to this White Paper.

Version	Date	Name	Description of Changes

CDM Smith
Document Code

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Needs and Deficiencies Report

The US 51 Bridge Replacement Project (KYTC Item Nos. 1-100.00 and 1-1140.00) proposes replacement or rehabilitation of the existing US 51 Bridge - also known as the Cairo Bridge - that connects Ballard County, Kentucky with Cairo, Illinois. The purpose of the project is to improve or replace the functionally obsolete and structurally deficient bridge, to improve or maintain cross river connectivity, and to improve safety.

The Cairo Bridge carries US 51, US 60, and US 62 traffic across the Ohio River. The bridge carries approximately 5,400 vehicles across the Ohio River each day between Wickliffe and Ballard County, KY and Cairo, IL with approximately 35% of that being truck traffic. It also provides a connection to the US 60/US 62 Mississippi River Bridge to Missouri, approximately ½ mile to the south.

This Needs & Deficiencies Report provides a planning level overview of the existing roadway and traffic conditions within the Study Area, shown in **Figure 1**. The following sections examine existing conditions of the US 51 Bridge, existing conditions on other roadways in the Study Area, traffic operations, and traffic safety.

1. Existing Bridge Conditions

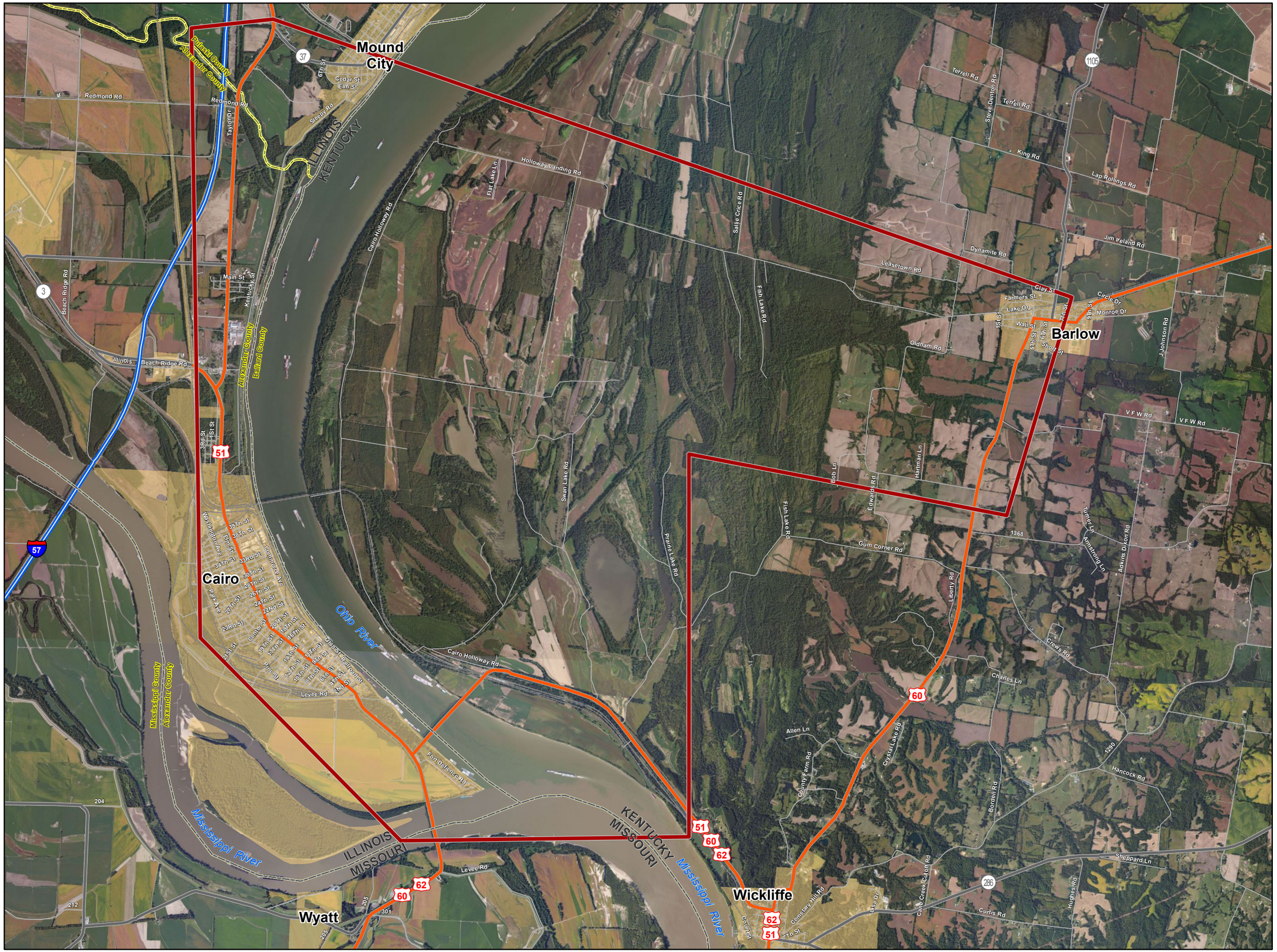
The purpose of this chapter is to describe key structural and geometric deficiencies of the existing US 51 Bridge. This chapter is intended to provide an overview of the condition of the bridge through the review of existing documentation and coordination with state bridge maintenance teams. **Appendix A** contains the Existing Bridge Deficiencies White Paper; **Appendix B** contains the Geotechnical Study White Paper.

1.1. Structure Location & Type

The US 51 Bridge was constructed between 1936 and 1938 and was last rehabilitated in 1999. The US 51 Bridge consists of 32 spans with 4 distinct bridge types. The bridge crosses nearly perpendicular to the Ohio River near the confluence of the Ohio and Mississippi Rivers.

- Illinois Approach: Spans 1-5 consist of simply supported two-girder spans measuring 60-90 feet in length.
- Span 6 is a simple span deck truss measuring 181 feet in length.
- Main Truss: Spans 7-11 are a variable depth cantilever truss with cantilever spans at spans 9 and 10 and a drop-in span at span 8. The span lengths for the main river crossing are as follows: 365 feet, 800 feet (main navigation channel), 650 feet, 650 feet, and 365 feet.
- Kentucky Approach: Spans 12-20 consist of simply supported deck truss spans measuring 181-182 feet in length. Spans 21, 23 and 25 are simply supported two-girder spans measuring 48-90 feet with cantilevered ends to support the shallow multi-girder drop-in Spans 22 and 24 which measure 90 feet each. Spans 26-32 are simply supported two-girder spans measuring approximately 60 feet in length each.

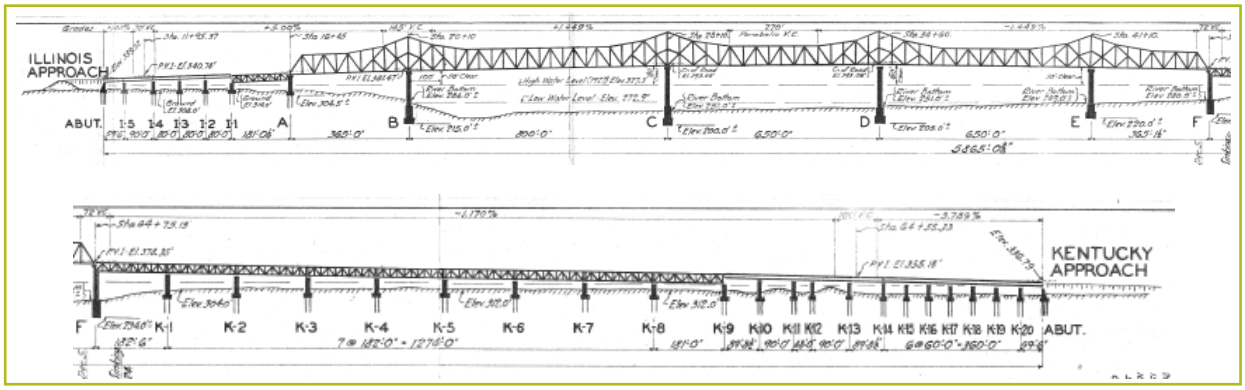
Figure 2 shows a drawing of the bridge profile taken from the 1936 plans. The figure is split between the main span and KY approach to better fit the page.



US 51
Ohio River Bridge

Figure 1: Study Area

Figure 2: Drawing of Bridge Profile, 1936



1.2. Bridge Geometry

The existing US 51 Bridge contains two 10-foot wide lanes with two 1.25-foot wide shoulders for an overall 22.5-foot roadway width. These widths do not meet AASHTO's *Policy on Geometric Design of Highways and Streets*, 2011. Current state design standards in KY and IL also require wider roadway and shoulder widths.

The bridge contains a series of grade segments and vertical curves. According to the 1936 plans, grades range from 0.00-5.00% along the bridge. Vertical curves range from 70-100 feet in length between these graded segments. While the grades meet statewide standards, one of the vertical curves on the bridge does not meet current AASHTO policy for headlight sight distance (i.e., how far ahead drivers can see at night).

The horizontal curve on the Kentucky approach is signed with a 20 mph speed limit; this curve does not meet AASHTO or state design policies.

The bridge passes over the Ohio River and a railroad line. Horizontal and vertical clearances over both passages meet current agency standards for geometric and navigational needs.

Because of its substandard geometric features, mainly the narrow bridge width, the US 51 Bridge is rated Functionally Obsolete. This designation does not mean that the bridge is unsafe.

1.3. Bridge Condition

The US 51 Bridge is inspected every two years, in accordance with FHWA requirements. Based on the October 2012 fracture critical inspection, the bridge deck, superstructure, and substructure were each rated Satisfactory. A Satisfactory rating means that structural elements are sound but may have experienced minor deterioration. Last painted in 2007, the paint was rated in Good condition. The 2012 inspection recommended a number of minor repairs: fixes for light cracking, rust, steel corrosion, and debris accumulation. Specific recommendations are presented in **Appendix A**.

The bridge was analyzed by KYTC in April 2013 to determine the load rating. The bridge can carry all legal loads (i.e., vehicles within the size and weight limitations for US highways) at this time, but permit loads (i.e., special permits issued by KYTC for oversize or overweight vehicles) are not allowed.

Because the original design load for the bridge is less than today's current design standards, the US 51 Bridge is rated Structurally Deficient. This designation does not mean that the bridge is unsafe.

Following the 2012 inspection and 2013 analysis, KYTC assigned a sufficiency rating of 39.8. The sufficiency rating is a score out of 100 possible points, based on a number of factors: safety, structural condition, geometry, traffic volumes, detour length, and more. Bridges considered structurally deficient or functionally obsolete with a sufficiency rating less than 50.0 are eligible for replacement with federal funds under the Federal-Aid Highway Bridge Replacement or Rehabilitation Program.

1.4. Pier Assessment

A preliminary engineering assessment was conducted on the river piers to compare the bridge condition to current design criteria for scour, seismic loading, and barge impact:

- Scour, or erosion around piers and foundations, is normal based on changes in the river bed during 2001-2009. Sour does not pose a concern for the foundation of the bridge. Additional analysis is recommended before final conclusions can be drawn.
- The existing bridge was designed before seismic design was required. Applying today's seismic design criteria, preliminary estimates indicate that severe damage or collapse is probable in the event of a major earthquake. Additional evaluation will be completed as alternatives are developed.
- Preliminary assessments on vessel collisions suggest the piers may resist an impact; however, additional analysis will be completed as alternatives are developed.

2. Other Study Area Roadways

State and local roadways in the Study Area affect how traffic accesses the US 51 Bridge. This chapter presents the identified deficiencies on key approach roadways to the bridge, specifically focusing on US 51 from Wickliffe to I-57 and on US 60 between Barlow and Wickliffe.

A number of data sources were used to identify elements on key approach roadways which do not meet current design guidance. This effort included observations during field visits, a comparison of available construction plans against design manuals, and input from KYTC and IDOT. For Kentucky Roadways, a comparison was made of the common practices identified in the *KYTC 2006 Highway Design Manual* for Rural Arterials with As-Built Plans and the KYTC Highway Information System. The *2010 IDOT Bureau of Design & Environment Manual* was used to determine roadway deficiencies for Illinois roads. However, no As-Built plans were provided for Illinois roads; therefore, Illinois deficiencies are based on field inspection of area roadways.

2.1. US 60, Barlow to Wickliffe

In the Study Area, US 60 is a two lane highway that travels generally north-south between Barlow and Wickliffe, KY. This section of highway has two 11-12 foot wide driving lanes and varying width shoulders. The posted speed limit is 55 mph, dropping to 25-35 mph within Barlow and Wickliffe city limits. The highway is classified as a rural principal arterial. It is part of the National Highway System, is classified as a Primary (Other) route within the State System, and is a state designated truck route with an AAA (80,000 lbs gross vehicle weight) weight limit.

Recommendations for lane and shoulder widths are decided based on the roadway type, design speed, and estimated ADT. The *KYTC 2006 Highway Design Manual* recommends two 12-foot travel lanes plus 8-foot graded shoulders for rural arterials with ADT volumes over 2,000 vehicles per day (vpd). Based on this guidance a majority of the shoulder widths along US 60 are deficient along this section of road.

There are five structures along this portion of the route. Based on the *2006 KYTC State Bridge Inventory*, none of the structures are considered Structurally Deficient or Functionally Obsolete.

- Bridge 004B00059: 90-foot concrete girder bridge over Shawnee Creek, US 60 milepoint 5.74
- Bridge 004B00005: 45-foot culvert, milepoint 5.56
- Bridge 00400062: 55-foot concrete girder bridge over Little Shawnee Creek, milepoint 5.31
- Bridge 00400061: 99-foot concrete girder bridge over Big Cane Creek, milepoint 2.49
- Bridge 00400056: 118-foot concrete girder bridge over South Fork Cane Creek, milepoint 1.94

Recommendations for minimum radii on horizontal curves are decided based on the roadway type, design speed, and maximum superelevation rate. The *KYTC 2006 Highway Design Manual* recommends a minimum radius of 300 feet for rural arterials with a 25 mph design speed and a maximum superelevation rate of 4%. With a maximum superelvation rate of 6%, KYTC recommends a minimum radius of 380 feet for 35 mph horizontal curves and 1,065 feet for 55 mph horizontal curves. Based on As-Built construction plans, there are four deficient horizontal curves on this section of roadway. Three of these curves are in Wickliffe: at Lee Street (milepoint 0.20), 6th Street (milepoint 0.32), and Mayolo Avenue (milepoint 0.55). The fourth deficient horizontal curve is at milepoint 2.96, just south of Borden Road.

In addition to deficient horizontal curves, the US 60/US 62/US 51 intersection in Wickliffe has turning radii that appear to be too small for large trucks. Intersections with small radii force large trucks to travel outside of the designated lane and use multiple lanes when turning. Trucks must often wait until the adjacent lane is clear of other traffic before completing turns. Alternately, trucks may also resort to driving on the outside curb and/or sidewalk to complete turns if there is not a clear space in adjacent lanes; this causes damage to roadside facilities.

2.2. US 51 in Kentucky, Wickliffe to Ohio River Bridge

US 51/US 60/US 62 heads northwest from Wickliffe, generally following the river. This section of highway has two 11-12 foot wide driving lanes and varying width shoulders. The posted speed limit is 55 mph, dropping to 40 mph on the US 51 Bridge itself and to 35 mph in Wickliffe. The highway is classified as a rural principal arterial. It is part of the National Highway System, is classified as a Primary (Other) route within the State System, and is a state designated truck route with an AAA (80,000 lbs gross vehicle weight) weight limit.

The KYTC 2006 Highway Design Manual recommends two 12-foot travel lanes plus 8-foot graded shoulders for rural arterials with ADT volumes over 2,000 vpd. Based on this guidance most of the shoulder widths along US 51 are deficient after the Willow Slough bridge crossing (milepoint 5.2).

Due to the flat terrain, the majority of this segment is elevated on embankment to avoid flood water. The roadway shows signs of subsidence in places where the embankment has been undercut by water. Reportedly portions of the road were overtopped by floodwater in 2011.

There are two structures prior to the Ohio River Bridge on this portion of US 51. Based on the *2006 KYTC State Bridge Inventory*, neither structure is considered Structurally Deficient or Functionally Obsolete.

- Bridge 004B00066: 3,306-foot concrete girder bridge over Willow Slough, US 51 milepoint 4.25
- Bridge 004B00063: 371-foot concrete girder bridge over Minor Slough, milepoint 6.66

KYTC guidance for rural arterials with a maximum superelvation rate of 6% establishes a minimum radius of 380 feet for 35 mph horizontal curves, 510 feet for 40 mph horizontal curves and 1,065 feet for 55 mp horizontal curves. Based on As-Built construction plans, there is one deficient horizontal curve on US 51 at the Cairo Bridge approach (milepoint 2.9).

2.3. US 51 in Illinois, Ohio River Bridge to I-57

In Illinois, the US 51 Bridge approach terminates at the stop-controlled T-intersection with US 60/US 62. From this intersection, US 51 is a principal arterial highway that travels north as a four lane, undivided highway. It forms the main thoroughfare through Cairo, locally designated as Washington Avenue and Sycamore Street. US 51 progresses through a two mile series of closely spaced stop-controlled intersections in town. Lanes are 11-12 feet in width with curb/gutter; some sections provide on-street parking. Generally, paved sidewalks run alongside either side of the highway through Cairo.

North of Cairo, US 51 crosses a series of railroad lines. Moving south to north, this includes 1) a steel railroad trestle supported by steel piers and concrete abutments, posted with a 14-foot 4-inch clearance; 2) an at-grade crossing with warning lights, 3) a concrete arch bridge, constructed in 1903; and 4) a single span steel girder bridge with concrete abutments. A movable section of floodwall crosses US 51, located between railroad overpasses 3 & 4 above.

North of the railroad lines, the highway transitions to a four-lane divided cross-section. The intersection with IL 37 is signalized. There is one additional railroad overpass before US 51 reaches the I-57 partial cloverleaf interchange.

Although information about roadway alignment elements (e.g. horizontal and vertical curve data) is not readily available, most of this section of road appears adequate based on field observations.

2.4. Special Designations

The entirety of US 51 in the Study Area is part of the National Highway System, which includes interstates and other principal arterials important to the nation's economy, defense, and mobility.

Portions of several routes in the Study Area are designated as National Scenic Byways:

- The Great River Road follows the Mississippi River through 10 states, stretching over 2,000 miles. In the Study Area, it follows SR 3/US 51 into Cairo, crosses the US 51 bridge into KY, then continues south through Wickliffe.

- The Ohio River Byway meanders along the northern bank of the Ohio River over 900 miles. It begins in the Study Area at Fort Defiance Park then follows US 51 north through Cairo to SR 37 northbound along the Ohio River.

Two designated bicycle routes use the US 51 corridor through Kentucky: the Mississippi River Trail and the Ramblin' River Tour. In Illinois, the majority of US 51 in the Study Area is "not recommended for bicycling" by IDOT.

3. Traffic Operations

As part of the analysis to document needs and deficiencies, a set of traffic volumes were developed based on historic traffic data and recent traffic counts. To forecast future volumes, a comprehensive review of traffic and demographic data was analyzed and a growth rate was evaluated. Base year (2020) and a design year (2040) traffic forecasts were established. The Traffic Operations Analysis White Paper in **Appendix C** contains additional information about the analyses completed.

3.1. Existing & Future Traffic Volumes

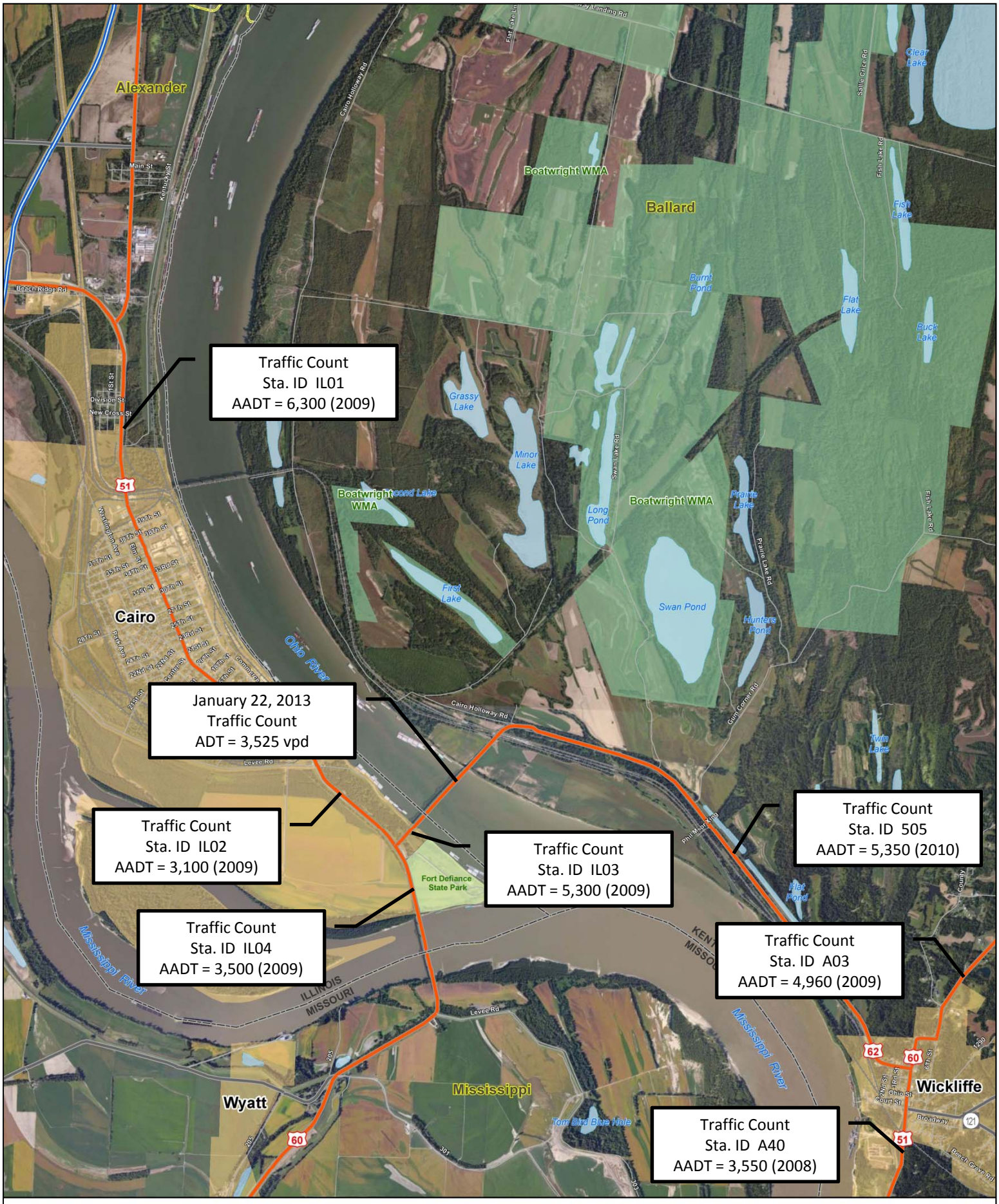
During January 2013, traffic counts at the US 51 approach in Kentucky and at the US 51/US 60/US 62 intersection in Illinois were conducted. Historic traffic volumes on key highway segments were collected from KYTC and IDOT records. **Figure 3** shows traffic count locations, the most recent Annual Average Daily Traffic (AADT) volumes, and the daily traffic volume from the 2013 traffic count of the bridge.

As part of the traffic analysis, projected growth rates were compared from a variety of sources: historic traffic trends within the Study Area, historic population growth and projections, and employment forecasts. Each of the growth rates examined was relatively low, with some showing negative growth. Based on these figures, an exponential annual growth rate of 0.50% was applied to existing traffic volumes to forecast future volumes. **Table 1** presents daily traffic volumes for the US 51 Bridge, applying the 0.50% growth rate. The 2013 AADT volume on the US 51 Bridge is 5,400 vehicles per day (vpd). Based on the January 2013 count and the KYTC's 2010 count, approximately 35% of the bridge traffic is trucks.

Table 1: Bridge AADT volumes

Scenario	Daily Traffic
2010 AADT (KYTC Sta. ID #505)	5,350
2013 Current Year	5,400
2020 Base Year (start construction)	5,600
2040 Design Year	6,200

To transition between a daily and hourly forecast volume, analysts must apply two specific conversion factors: K-factor and D-factor. The K-factor describes what percentage of the weekday traffic volume is accounted for during the 30th highest hour during the year. The D-factor describes what percentage of the total traffic on a link is traveling in the peak direction. The average K-factor listed in *KYTC's 2008 Traffic Forecasting Report* is 12.2% for Rural Minor Arterials. The January 2013 traffic count had an average directional distribution (D-Factor) of 56.0%. These values were applied to the volumes in **Table 1** to estimate peak hour traffic volumes.



US 51 Ohio River Bridge

Figure 3: Traffic Counts

3.2. Traffic Operations Analysis

Two methodologies were applied to describe traffic operations: Level of Service (LOS) and volume-to-capacity ratio (V/C):

- V/C represents the number of vehicles using the bridge in a specific time period compared to the number of vehicles the bridge was designed to be able to handle during that period. The target V/C ratio is 0.9 for rural areas and 1.0 for urban areas. A V/C greater than this indicates the facility is congested, i.e. it is operating above its design capacity.

- LOS is a qualitative measure of highway traffic conditions, as identified in the *2010 Highway Capacity Manual* (HCM). Individual levels of service characterize these conditions in terms of speed, travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Six levels of service are defined and given letter designations from A to F, with LOS A as the best condition, representing free flow conditions, and ranging to LOS F, representing severe congestion and/or time delays. Typically, a minimum LOS D is considered acceptable in urban areas and LOS C is considered acceptable in rural areas.

US 51 Bridge

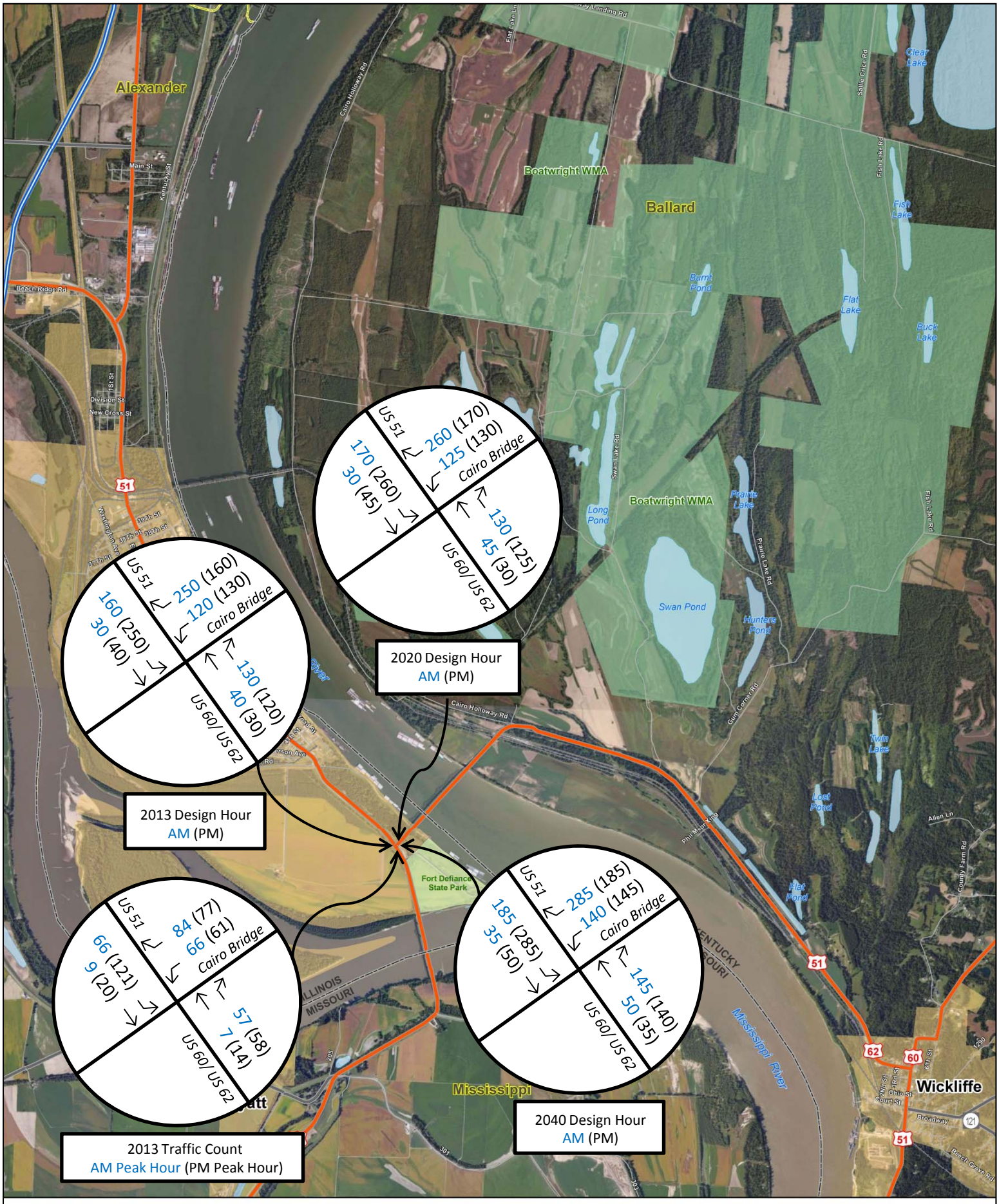
Based on the 2013 forecast, K-factor, and D- factor, there are an estimated 370 vehicles per hour traveling along the bridge in the peak direction. The theoretical capacity of the bridge is estimated at 1,020 vehicles per hour per direction based on the terrain, geometry, and percentage of truck traffic. Comparing these values, the US 51 Bridge is operating with a V/C of 0.36; this indicates the bridge has adequate capacity to handle the existing traffic volumes.

Running the same calculations for the 2040 Design Year, the future V/C of the bridge is projected to be 0.42; this indicates the bridge has adequate capacity to handle the projected future traffic volumes.

Based on the analysis, a two lane bridge between Wickliffe and Cairo provides adequate capacity to accommodate existing and future traffic volumes.

US 51/US 60/US 62 Intersection in Illinois

Traffic operations at the three-leg intersection between US 51/US 60/US 62 just west of the bridge were also analyzed. There is a stop sign at the end of the bridge but traffic moving north/south along US 60/US 62 does not have to stop. **Figure 4** shows the traffic volumes for each scenario at this intersection. Movements coming off the Bridge function at LOS D during the 2040 PM design hour; all other time periods and movements operated at LOS C or better. Measures to improve operations at this intersection should be considered as alternatives are developed.



US 51 Ohio River Bridge

Figure 4: Traffic Volumes at US 51/US 60/US 62 Intersection

4. Traffic Safety

Crash records were collected from KYTC and IDOT for major routes in the project area over a four-year period (October 2008- September 2012). Crashes were geospatially referenced and compared to statewide data to identify locations exhibiting above average crash rates. The methodology employed and results of the analysis are presented in the following sections.

4.1. KYTC Crash Analysis Methodology

KYTC's crash analysis methodology, as outlined in the Kentucky Transportation Center (KTC) report *Analysis of Crash Data in Kentucky*[1], identifies two types of analysis areas: "spots" and "segments." Spots are 1/10 mile in length and are identified based on the location of crash concentrations. Segments vary in length, divided based on traffic volumes and geometric characteristics.

Each spot or segment is assigned a Critical Rate Factor (CRF) based on formulas published by the KTC. The CRF is one measure of the safety of a roadway, expressed as a ratio of the crash rate at the study location to the average crash rate for roadways of the same functional classification throughout Kentucky. CRF also takes into account traffic volume, area type (rural or urban), and the number of lanes. If the CRF is 1.00 or greater, it is assumed that crashes are happening due to circumstances that cannot be attributed to random occurrence.

For consistency, the KYTC crash analysis methodology was applied to both Kentucky and Illinois reported crashes.

4.2. Crashes on Bridge

On the bridge and its approaches, defined as the area between the 20 mph curve in Kentucky (milepoint 7.300) and the US 60-US 62 intersection in Illinois (milepoint 0.20), there were 18 crashes in the four year analysis period. Of these, there were no fatalities and one injury crash. As shown in **Figure 5**, crashes are concentrated at either end of the analysis segment. Based on an estimated ADT of 5,400 vehicles per day, the 1.2 mile long segment that includes the bridge and its approaches exhibits a CRF of 0.58.

Figure 5: Reported Crash Locations on US 51 Bridge & Approaches

[1] Green, Agent, & Pigman (2012). *Analysis of Traffic Crash Data in Kentucky (2007-2011).* Lexington, KY: Kentucky Transportation Center.

Analysts also considered the type of crashes to determine causation trends. Three types of crashes occurred on the bridge:

- 3 Rear End: one vehicle impacts the rear end of another, which may be stopped or moving;
- 8 Sideswipe: two vehicles traveling in opposite directions collide, the side of one vehicle impacting the other; and
- 7 Single Vehicle Collisions: one vehicle impacts a fixed object, such as the guardrail.

Figure 6 depicts the distribution of crash types graphically. In addition to reported crashes, there is anecdotal evidence that minor crashes – such as trucks hitting mirrors in passing – caused by the narrowness of the bridge occur but go unreported.

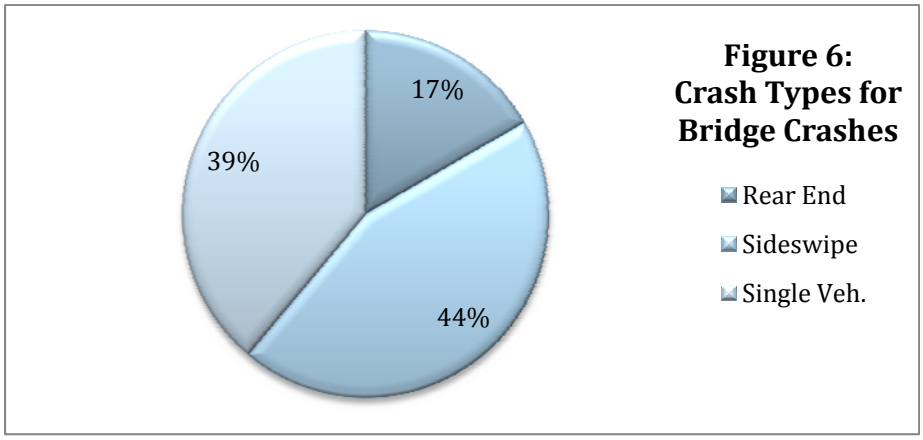


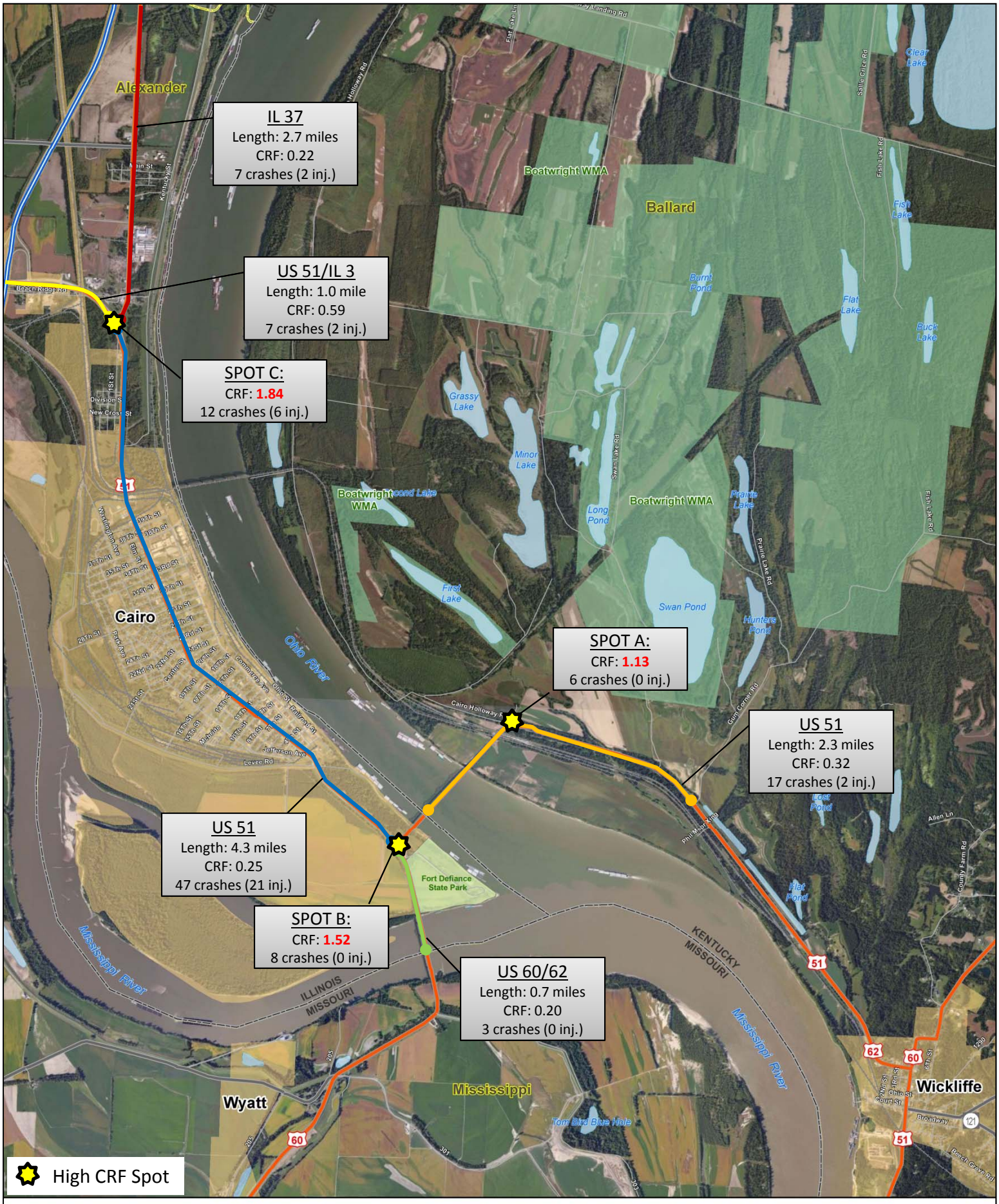
Figure 6: Crash Types for Bridge Crashes

4.3. Crash Segments

Applying the KYTC analysis methodology to highway segments in both states, no high crash segments were identified. **Figure 7** presents the analysis segments and CRF based on 2009-2010 ADT volumes.

4.4. Crash Spots

Applying the KYTC analysis methodology to concentrated crash location in both states, three high crash spots (CRF > 1.0) were identified, as shown in **Figure 7**.



Interstate
US Highway
State Highway
Local Road
Railroad
State Boundary
County Boundary
Park
City
Lake/Pond
Wildlife Management Area

0 2,000 4,000 Feet

0 0.5 1 Miles

US 51 Ohio River Bridge

Figure 7: Crash Spots & Segments

5. Conclusions

This report is intended to present an overview of the existing transportation needs and deficiencies observed in the study area.

5.1. Role of the Bridge

The Cairo Bridge carries US 51, US 60, and US 62 traffic across the Ohio River. It also provides a connection to the US 60/US 62 Mississippi River Bridge to Missouri, approximately ½ mile to the south. Maintaining this cross-river connectivity is important to the local communities, residents, farms, and other businesses in the region. During the traffic counts completed in January 2013, over 150 farm, grain, and logging trucks were observed using the bridge over an 8-hour period.

There are alternative river crossings in the project region, but the travel distances do not make these crossings viable choices for local traffic. If the US 51 Bridge were not available for local traffic, the detour trip between Wickliffe and Cairo increases from 7 miles to 80+ miles per direction.

The 2013 AADT volume on the US 51 Bridge is 5,400 vehicles per day (vpd) with approximately 35% of the bridge traffic being trucks. The traffic analysis showed a two lane bridge between Wickliffe and Cairo provides adequate capacity to accommodate existing and future traffic volumes.

5.2. Existing Bridge Needs

Based on current geometric design standards, there are several deficiencies with the bridge and its approaches:

- Narrow lane and shoulder widths of the existing structure
- One vertical curve on the bridge that does not meet guidance for headlight sight distance
- The horizontal curve on the Kentucky approach

The US 51 Bridge has a sufficiency rating of 39.8, rated out of 100 possible points. Because of its substandard geometric features, mainly the narrow bridge width, the US 51 Bridge is rated Functionally Obsolete. The original design load for the US 51 bridge is less than today's current design standards, which results in the bridge being designated Structurally Deficient even though it allows legal loads. It is anticipated that bridge repairs and/or improvements will be required to maintain the bridge at the existing load rating over the next 25 years.

Two high crash spots (CRF > 1.0) were identified on the bridge: one at the horizontal curve on the Kentucky approach and the other at the three-leg US 51/US 60/US 62 intersection just west of the bridge in Illinois.

5.3. Needs of Adjacent Bridge Approaches

Deficiencies were also identified on roads connecting to the existing bridge. On the Kentucky side, roadway subsidence, sharp horizontal curves, shoulder widths, and small radii at the US 51/US60/US62 intersection in Wickliffe create safety issues and impede traffic flow. On the Illinois side, most of US 51 appears adequate based on field observations.

Appendix A

Existing Bridge Conditions White Paper

US 51 Ohio River Bridge Engineering and Environmental Study

ITEM NOS. 1-100.00 & 1-1140.00

Existing Bridge Deficiencies White Paper

Prepared by:

Michael Baker Jr., Inc.
9750 Ormsby Station Rd
Louisville, KY 40223

Final Report May 17, 2013

Baker

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EXECUTIVE SUMMARY

As part of the overall US 51 Ohio River Bridge Engineering and Environmental Study, this white paper examines the existing bridge with respect to the current and historic physical condition of the bridge. An engineering assessment was also performed to provide a first look at how the existing piers perform against the current AASHTO LRFD design criteria for bridge scour, seismic loading, and barge impact.

PHYSICAL CONDITION – The US 51 Cairo Bridge was constructed between 1936 and 1938 and was last rehabilitated in 1999. The bridge received a National Bridge Inventory (NBI) Condition Rating value of 6, which refers to a "Satisfactory" condition, in the October 2012 inspection findings. This is defined by NBI as "structural elements are sound, but may have minor deterioration".

From the inspection data gathered, the project team concludes that the existing bridge has several issues affecting its physical condition. They include:

- Bridge Deck – The original bridge deck was replaced with an overlay and new bridge deck in 1980. The overlay is beginning to show signs of failure through cracks and spalling. This could be representative of larger issues underneath the overlay. The existing bridge deck is over 50% of its estimated service life.
- Structural Steel – The primary concern for the structural steel is continued deterioration and formation of pack rust between the members. Surface corrosion is largely due to localized failure of the overcoat paint system, particularly in the splash-zone region. The bridge was last painted in 2007.
- Piers – The piers were noted with minor cracking, spalling and delaminations. These deficiencies were typically observed at or near the pier caps.

The bridge was load rated by KYTC in April of 2013. This analysis determines the vehicles that the bridge can safely carry under its current condition. The controlling load rating elements are the main truss members from U24 to L25. All bridge members were adequate for the KYTC legal load vehicles.

A bridge considered structurally deficient or functionally obsolete and with a sufficiency rating of less than 50 (NBI-SR) will be eligible for federal bridge replacement and rehabilitation funds in accordance with the Highway Bridge Replacement and Rehabilitation Program. The NBI Sufficiency Rating (SR) was computed at 39.8 by KYTC. The SR is used to indicate a bridge's sufficiency to remain in service. SR takes into account a number of factors including condition of the bridge and geometrics.

The bridge is classified as Structurally Deficient (SD). Being listed as SD does not mean the bridge is unsafe. The SD designation takes into account the current physical condition of the bridge and the load carrying capacity of the superstructure and substructure. The US 51 Cairo Bridge falls into the SD category for the reason that the

original design load and the controlling inventory load rating are less than today's current design standards. The US 51 Bridge is considered as Functionally Obsolete (FO). The term FO refers to a bridge with sub-standard geometric features. Geometric features of the bridge are discussed in section 4.

ENGINEERING ASSESSMENT – A preliminary assessment was performed on the existing piers. This assessment provided a first look at the existing piers against the current AASHTO LRFD design criteria for bridge scour, seismic loading, barge impact and river pier foundations. The following findings are highlighted:

Bridge Scour –

- The changes in the river bed between 2001 and 2009 are considered normal and do not pose a concern for the foundations of the bridge.
- At River Piers B-F, the predicted local scour was in the range of 24ft-31ft. Further refinement is needed on scour depth and velocities before a final conclusion can be drawn.

Seismic Loading –

- The existing bridge was designed before seismic design was required by codes. The current AASHTO LRFD code recommends design of new bridges for a 1000 year return period.
- Using the 1000 year event, a preliminary structural assessment and similar project experience indicates that severe damage or even collapse is probable for the existing piers.
- Seismic analysis is outside the scope of this paper. Further analysis is needed to assess the hazard level and potential damage to the bridge.

Barge Impact –

- Preliminary vessel collision forces were estimated from previous projects that utilized AASHTO LRFD design criteria and from anticipated vessel characteristics and velocities.
- Preliminary structural assessment indicates that the piers may have the capacity needed to resist these loads; however additional refinement of the loads and demands is needed.

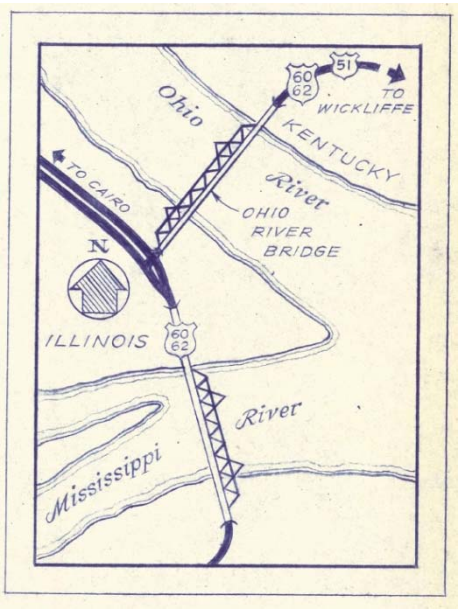
River Piers Foundation –

- Any additional load applied to the foundation will induce settlements of the pier foundation. This will need to be considered during any potential remediation design.
- The existing foundations are inadequate to support seismic loads associated with the 1000 year return period.

The information summarized in this white paper identifies concerns affecting the physical condition and structural capacity of the existing piers. Looking forward, this information will be utilized during development of a "no-build" alternative, a rehabilitation concept and superstructure replacement concept.

1. INTRODUCTION

The purpose of this report is to understand the key structural deficiencies of the existing bridge so that appropriate actions can be developed to support the environmental document and evaluation of the alternatives to “Do Nothing”, Repair or Replace the bridge. This report summarizes the available documentation of inspections, repairs and load ratings since the 1999 rehabilitation performed on the US 51 Cairo Bridge over the Ohio River between Alexander County, Illinois and Ballard County, Kentucky. This report is intended to give an overview of the existing physical condition and noted deficiencies for the approach spans and main truss spans. This was accomplished through the review of existing documentation with the purpose of developing an approved environmental document that addresses these deficiencies



2. STRUCTURE LOCATION AND TYPE

The US 51 Cairo Bridge carries two lanes of traffic between Alexander County, Illinois and Ballard County, Kentucky connecting the two communities of Wickliffe, KY and Cairo, IL.

As documented in the Cultural Historic Overview Report:

The bridge is a continuous span cantilever Warren truss bridge with anchor arm spans at each end. It was constructed in 1938; the engineering company responsible for bridge design and construction was Modjeski, Masters and Case. The Missouri Valley Bridge and Iron Company constructed the substructure. The Mount Vernon Bridge Company was responsible for construction of the superstructure.

The main spans are four steel Cantilever Warren trusses that total 2,830 feet in length. The Cairo Bridge is the longest cantilever truss in Kentucky. The main spans are flanked by Warren deck truss approaches at each end; the approach spans on the Illinois side are 570 feet in length, while the Kentucky approach spans are 2,684 feet in length.

The bridge consists of 32 spans with 4 distinct bridge types utilizing various rolled steel shapes and built-up steel members. The bridge crosses the Ohio River at a nearly 0-degree skew near the confluence of the Ohio and Mississippi Rivers. The layout of the bridge is oriented from southwest in Illinois to the northeast as can be seen in Photo 1.

Illinois Approach: Spans 1-5 consist of simply supported two-girder spans measuring 59-6", 90', and 3 @ 80'. Span 6 is a simple span deck truss measuring 181'-0$^{1}/_{4}$".

Main Truss: Spans 7-11 are a variable depth cantilever truss with cantilever spans at spans 9 and 10 and a drop-in span at span 8. The spans for the main river crossing are as follows: 365', 800' (main navigation channel), 650', 650', and 365'-1 ½".

Kentucky Approach: Spans 12-20 consist of simply supported deck truss spans measuring 182'-6", 7 @ 182', and 181'. Spans 21, 23 and 25 are simply supported two-girder spans measuring 89'-8 ½", 48', and 90' with cantilevered ends to support the shallow multi-girder drop-in Spans 22 and 24 measuring 90' each. Spans 26-32 are simply supported two-girder spans measuring 6 at 60', and 60'-6".

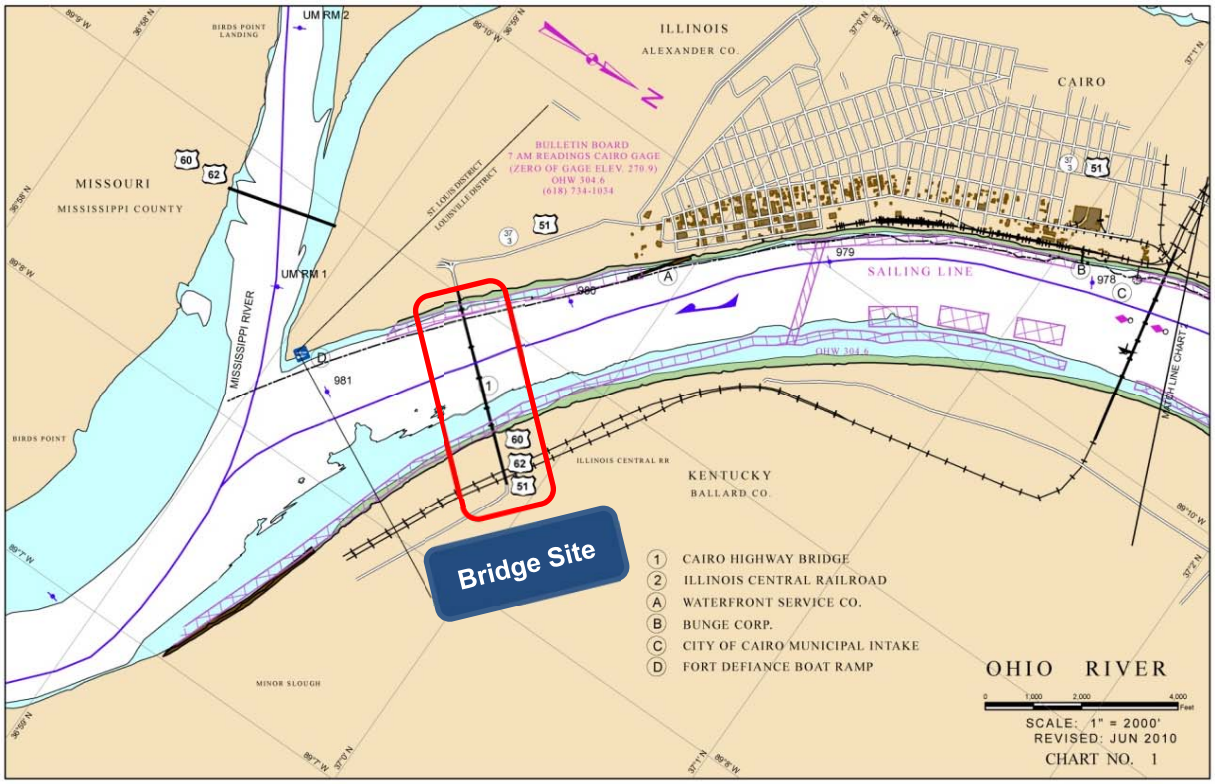


Photo 1 – 2010 Ohio River Navigation Chart (U.S. Army Corps of Engineers)

Photo 2 – Typical view of main truss spans and deck truss approach span

Photo 3 – Typical view of 2-girder approach spans

3. METHODOLOGY

Project team bridge engineers gathered available documents on the bridge. These documents include original construction plans, rehabilitation plans and available inspection reports. Information was also obtained by meeting with key individuals from the Kentucky Transportation Cabinet (KYTC).

In accordance with the scope of work, the project team bridge engineers reviewed the available documentation in order to come up with a general appraisal of the condition of the bridge. This information will be utilized during development of a "no-build" alternative, a rehabilitation concept and superstructure replacement concept.

4. GEOMETRIC AND FUNCTIONAL ASSESSMENT

4.1. DESIGN CONTROLS

The existing US 51 Bridge is located between Wickliffe, Kentucky and Cairo, Illinois. The roadway is classified as rural principal arterial by the Kentucky Transportation Cabinet and Illinois Department of Transportation (IDOT). Based on this classification, AASHTO's A Policy on Geometric Design of Highways and Streets, 2011, specifies that the roadway should be designed for speeds of 40 to 75 mph depending on terrain, driver expectancy, and alignment of the existing facility. The Kentucky and Illinois sections of US 51 have an existing speed limit of 55 mph prior to the bridge approach. A design speed of 45 mph will be used in determining the geometric design criteria for new alignment alternatives. For alternatives where a 45 mph design speed cannot be obtained due to existing constraints, the option for design exceptions will be evaluated. In accordance with AASHTO's A Policy on Geometric Design of Highways and Streets, 2011, the minimum stopping site distance is 360 feet for a 45 mph design speed on a rural arterial. A maximum superelevation of 6.0% will be used for all new alignment alternatives. Access control on US 51 is by permit only. The existing posted speed for the bridge is 40 mph, which will be used to assess the existing bridge deficiencies. The horizontal curve on the Kentucky approach bridge has an existing posted speed of 20 mph.

4.2. CROSS SECTION ELEMENTS

In accordance with AASHTO's Policy on Geometric Design of Highways and Streets, 2011, the minimum width of travel way for a 40 to 70 mph design speed is 24 feet for traffic volumes over 2000 vehicles per day. The corresponding usable shoulder width for rural arterials is denoted as 8 feet. Per AASHTO's A Policy on Geometric Design of Highways and Streets, 2011, long bridges, defined as bridges having an overall length in excess of 200 feet, should provide an offset to parapet, rail or barrier of at least 4 feet measured from the traveled way on both sides of the roadway for a rural arterial.

Per KYTC Bridge Design Manual, the required bridge roadway cross slope is 2.0%. The 2012 IDOT Bridge Manual states that typically the minimum cross slope should be 1.56% (3/16-inch per foot) for all new bridge superstructures. KYTC's Highway Design Manual requires a minimum 12-foot wide lane, 8-foot wide paved shoulder, and 2-foot wide earth or aggregate shoulder for rural arterial roadway. The 2012 IDOT Bureau of

Design and Environmental Manual requires a minimum 24-foot wide travel width and 10-foot paved shoulders. Per KYTC's design manual, the minimum bridge width on a two lane bidirectional roadway is 22 feet. KYTC's Bridge Design Manual states that, in general, the bridge width between gutters should be matched to the approach roadway width between faces of guardrail. IDOT's Bridge Manual requires that bridge widths match the paved roadway width, including the paved shoulder and any exceptions to the bridge width policies require the District to submit proper justification and documentation for consideration.

US 51 is identified as a part of the National Highway Network in Kentucky and Illinois. The existing US 51 Bridge contains two 10' wide lanes with two 1'-3" shoulders at a 2.0% cross slope for an overall 22'-6" roadway width. The dimension from back-of-curb to back-of-curb is approximately 24'-0". The existing curb is directly adjacent to the truss superstructure as shown in Photo 4.

Photo 4 - View Looking North (towards KY) on Bridge

Based on design criteria, the existing US 51 Bridge width does not meet state or federal standards for lane or shoulder width.

The US 51 roadway approach in Kentucky was designed in 1937 as two 8' wide lanes, with 8' unpaved shoulders on both sides. The roadway has been repaved various times since the original construction and no field survey was completed for this report. Visual inspection indicates that the typical section varies, but there are approximately two 11' lanes with approximately 3'-4' shoulders on both sides. The existing US 51 roadway approach in Kentucky does not meet KYTC standards.

No design plans or field survey information was available for the US 51 roadway approach in Illinois. Visual inspection indicates that the typical section varies, but there are approximately four 11' lanes with a 4' median and 2' paved shoulders to the north traveling towards Cairo. To the south on US 62/US60 to Missouri, visual inspection indicates approximately two 12' lanes and 2' paved shoulders. The existing roadway approach in Illinois does not meet IDOT standards.

There is not a sidewalk or accommodations for pedestrians and bicyclists on the existing US 51 Bridge or on either of the approaches. IDOT's Bureau of Design and Environmental Manual and KYTC's Guidelines for Pedestrians & Bicycle Accommodations require that the addition of a pedestrian and/or bicycle facility be considered on a case-by-case basis.

4.3. Alignment Elements

According to the 1936 original design plans, the existing bridge profile grade, from the south abutment, begins with a +1.00% grade into Span 2. It then goes through a 70' vertical curve into Span 3 which transitions to a +5.00% grade into Span 7 at panel point 8. A 145' vertical curve between panel points 8 and 12 transitions to a +1.449% grade into Span 9 at panel point 37. A 270' vertical curve transitions to a -1.449% grade into Span 11 at panel point 75. A 72' vertical curve transitions to a -1.170% grade which goes for nearly 1,909 feet into Span 24. It is then followed by a 100' vertical curve which transitions into a -3.789% grade which extends to the north abutment. The 1937 US 51 roadway plans show a 300 foot vertical curve transitioning from the -3.789% grade to a 0.0% grade after the abutment.

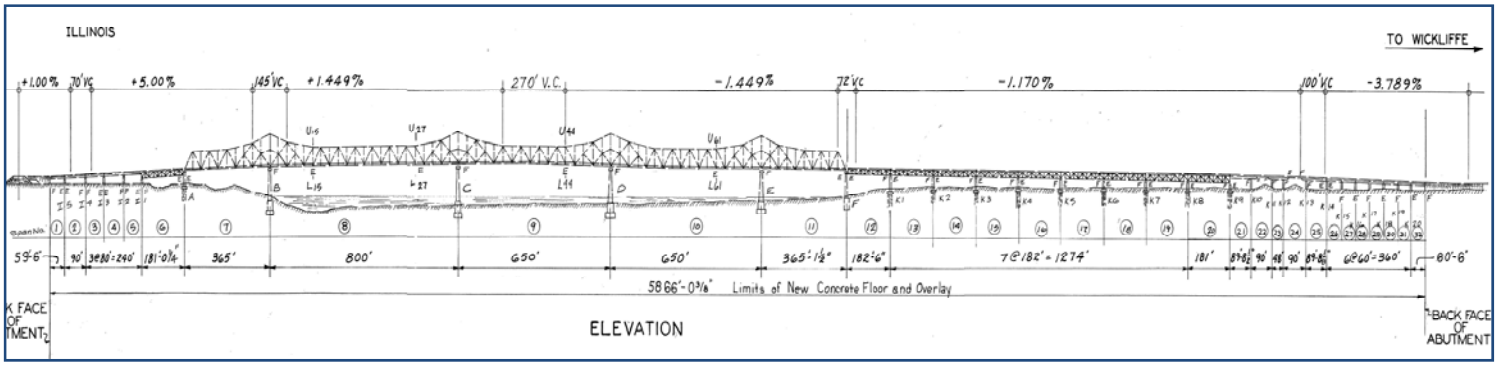


Figure 1 - Layout sheet from 1980 deck replacement project.

The maximum allowable grade for rolling terrain is 6% and the maximum allowable grade for level terrain is 5% for KYTC. Based on the existing signed speed limit of 40 mph, AASHTO's Policy on Geometric Design of Highways and Streets, 2011, a minimum stopping site distance of 305 feet is required. The existing stopping sight distances and headlight sight distances were calculated for the vertical geometry described above for a 40 mph design speed. The crest curves also exceed the criteria according to the criteria outline in AASHTO's A Policy on Geometric Design of Highways and Streets, 2011. One of the sag vertical curves, the 70' curve in Span 2 and 3, does not meet the criteria in AASHTO's A Policy on Geometric Design of

Highways and Streets, 2011, for headlight sight distance. This curve is substandard and would have to be lengthened to 243' to meet the minimum requirements for headlight sight distance.

For a proposed roadway typical section with curb, KYTC recommends a 0.5% minimum grade but will allow a 0.3% grade with a satisfactorily crowned pavement in order to provide adequate drainage. KYTC recommends that cross slope should range from 1.5% to 2.0%. IDOT states that it is desirable to provide a minimum grade 0.5%, but longitudinal gradients of approaching 0% may be acceptable on some pavements that have adequate cross slopes. IDOT recommends a minimum cross slope of 1.56% (or 3/16-inch per foot). IDOT requires that new bridges provide a minimum longitudinal gradient of 0.5% across the bridge. The existing bridge grade meets requirements in Kentucky and Illinois. However, the grade of US 51 on the roadway approach is listed at 0.0% on the 1937 original roadway design plans. The roadway approach in this area does not meet current KYTC standards for longitudinal slope. The cross slope on the Kentucky roadway approach is identified as 2.0% on the design plans.

As previously noted, the horizontal curve on the Kentucky approach is currently signed with a speed limit of 20 mph. The KYTC 1937 US 51 construction plans show this curve to have a radius of 465.0 feet, but the superelevation is not known. Based on a maximum 6.0% superelevation and a design speed of 45 mph, the minimum radius would be 643 feet according to AASHTO's A Policy on Geometric Design of Highways and Streets, 2011, and would be 660 feet according to KYTC's Highway Design Guide. The existing Kentucky approach radius of 465 feet is substandard for the design conditions. The remaining horizontal alignment across the bridge is in a tangent and does not have any curves or deflection angles.

4.4. Cross Section and Alignment Deficiencies Summary

In summary, the US 51 Bridge is sub-standard in the following areas:

- Typical Section – narrow bridge and approach roadway and shoulder width
- Vertical Alignment – sag curve beginning in Span 2 does not meet headlight sight distance
- Horizontal Alignment – 465 foot vertical curve on the Kentucky approach does not meet 45 mph design criteria
- Longitudinal Grade – US 51 roadway at the Kentucky approach has a grade of 0.0%; the bridge grade meets the Kentucky and Illinois requirements.

The bridge is considered "Functionally Obsolete" (FO). The term FO refers to a bridge with sub-standard geometric features. The designation does not mean the bridge is unsafe.

4.5. Bridge Clearances

The existing US 51 Cairo Bridge crosses the Ohio River and railroad lines under Spans 22 and 24. For the Ohio River, the existing navigable horizontal and vertical clearances are 630 feet and 105.3 feet, respectively. The vertical clearance over the railroad

bridge per the Structure Inventory and Appraisal (SIA) Item 53 is 19.0 feet. For the railroad lines, the controlling vertical underclearance is 40.0 feet per SIA Item 54B. The lateral underclearance per SIA Item 55 is 33.1 feet.

All clearances satisfy current agency clearance requirements for railroad geometrics and navigational needs.

5. CONDITION OVERVIEW OF EXISTING SUPERSTRUCTURE

As required by the Federal Highway Administration (FHWA), in accordance with the National Bridge Inspection Standards (NBIS), the US 51 Cairo Bridge approach spans and the main river spans are inspected every 2 years. The condition of the bridge members is determined by this inspection. By understanding the current condition of the bridge, the Kentucky Transportation Cabinet (KYTC) and Illinois Department of Transportation (IDOT) can maintain the structural integrity of the bridge for the travelling public.

Recent bridge inspection reports consisted of NBIS fracture critical biennial inspections (2012/2010/2008), underwater inspections (2009/2004/2001) as well as Joint Annual Inspections with KYTC and IDOT. The last NBIS in-depth inspection occurred in 1997.

5.1. CURRENT BRIDGE CONDITION

The current NBIS biennial fracture critical (FC) inspection was completed in October, 2012. The FC bridge inspection primarily included: (1) the fracture critical members of the deck truss approach spans and main truss spans, (2) the floorbeam connections to the trusses, (3) the 2-girder approach spans, (4) Category E and E' details in the truss members, girders and floorbeams, and (5) previously noted deficiencies. A routine inspection was accomplished on the remaining bridge components. The bridge received the following condition ratings in 2012:

Item	Condition Rating
58 - Deck	6 - Satisfactory
59 - Superstructure	6 – Satisfactory
59A - Paint	7 – Good
60 - Substructure	6 - Satisfactory

Key Findings from the 2012 FC Inspection:

Item 58 – Deck:

- The deck is in overall satisfactory condition with areas of spalling, typically adjacent to the joints. Light cracking is common in the overlay.
- The joint armor and/or seal are damaged, cracked, or with missing sections at 9 joint locations.

- The steel railing is corroding from the inside – out, and there are several corrosion holes in the railing and posts. The concrete blisters are cracked and spalled at several locations, exposing the anchor bolts and reinforcing steel.

Item 59 – Superstructure:

- Stringer end cracks and section loss at main truss panel points L15, L44, and L61.
- Pack rust is common between components of built-up truss members, including between gusset plates and truss members. As a result of pack rust accumulation, some of the gussets plates are bowed approximately 1/8" to 1/2" along the plate edges.
- Pitting and section loss located primarily at joint locations is typically inactive since 2007 painting.
- Downstream main truss bearing at panel point L0 has cracks in the bearing collar.
- Deck truss bearings in the approach spans are showing signs of pack rust, section loss, and debris accumulation.

Item 60 – Substructure:

- The piers were observed with minor cracking, delaminations and spalling.

Following the inspection, the NBI Sufficiency Rating (SR) was computed at 39.8 by KYTC. The SR is used to indicate a bridge's sufficiency to remain in service. The result is a percentage in which 100 percent represents an entirely sufficient bridge and zero percent represents an entirely insufficient or deficient bridge. SR takes into account a number of factors including condition of the bridge as well as geometrics.

The bridge is classified as "Structurally Deficient" (SD). Being listed as SD does not mean the bridge is unsafe. The SD designation takes into account the current physical condition of the bridge and the load carrying capacity of the superstructure and substructure. The US 51 Cairo Bridge falls into the SD category for the reason that the original design load and the controlling inventory load rating are less than today's current design standards.

A bridge considered structurally deficient or functionally obsolete and with a sufficiency rating of less than 50 will be eligible for federal bridge replacement and rehabilitation funds in accordance with the Highway Bridge Replacement and Rehabilitation Program.

A bridge considered structurally deficient or functionally obsolete and with a sufficiency rating of less than 50 will be eligible for federal bridge replacement and rehabilitation funds in accordance with the Highway Bridge Replacement and Rehabilitation Program.

Based on the inspection findings, repair plans have been developed at the time of writing this report to address the deficient deck joints, stringer end cracks and miscellaneous deck patching.

From FHWA Recording and Coding Guide –

Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition. Evaluation is for the materials related, physical condition of the deck, superstructure, and substructure components of a bridge. Condition codes are properly used when they provide an overall characterization of the general condition of the entire component being rated. Correct assignment of a condition code must, therefore, consider both the severity of the deterioration or disrepair and the extent to which it is widespread throughout the component being rated.

Item 58 - Concrete decks should be inspected for cracking, scaling, spalling, leaching, chloride contamination, potholing, delamination, and full or partial depth failures. The condition of the wearing surface/protective system, joints, expansion devices, curbs, sidewalks, parapets, fascias, bridge rail, and scuppers shall not be considered in the overall deck evaluation. However, their condition should be noted on the inspection form.

Item 59 - The structural members should be inspected for signs of distress which may include cracking, deterioration, section loss, and malfunction and misalignment of bearings. The condition of bearings, joints, paint system, etc. shall not be included in this rating, except in extreme situations, but should be noted on the inspection form.

Item 60 - All substructure elements should be inspected for visible signs of distress including evidence of cracking, section loss, settlement, misalignment, scour, collision damage, and corrosion.

Typical condition rating descriptions in evaluating Items 58, 59, and 60:

***8** - VERY GOOD CONDITION - no problems noted.*

***7** - GOOD CONDITION - some minor problems.*

***6** - SATISFACTORY CONDITION - structural elements show some minor deterioration.*

***5** - FAIR CONDITION - all primary structural elements are sound but may have minor section loss, cracking, spalling or scour.*

***4** - POOR CONDITION - advanced section loss, deterioration, spalling or scour.*

***3** - SERIOUS CONDITION - loss of section, deterioration, spalling or scour have seriously affected primary structural components. Local failures are possible. Fatigue cracks in steel or shear cracks in concrete may be present.*

***2** - CRITICAL CONDITION - advanced deterioration of primary structural elements. Fatigue cracks in steel or shear cracks in concrete may be present or scour may have removed substructure support. Unless closely monitored it may be necessary to close the bridge until corrective action is taken.*

5.2. Historical Bridge Condition

Condition ratings are used to describe the existing, in-place bridge as compared to the as-built condition. Repairs are typically required to maintain the safe operation of the bridge which is reflected through its historical condition ratings. The following list summarizes the major repairs/maintenance that has occurred over the life of the US 51 Cairo Bridge.

Year	Recent Repair/Maintenance Summary
1980	- Install new 6 ¾" concrete deck with 1 ½" concrete overlay - Install new steel barrier railing - Install new deck joints. Existing finger joints, to remain. - Install new drain scuppers - Install new electrical conduit and navigation lights
1986	- Apply overcoat to all steel members using a zinc-vinyl paint system
1999	- Replace 3' wide strip of concrete overlay (full length bridge) - Repair concrete at Pier F - Replace truss windlock assembly - Replace expansion bearings in 2-girder spans - Epoxy inject cracks in Piers B, E, and F - Misc. steel repairs in truss members - Repair miscellaneous stringer web cracks in truss spans
2007	- Apply overcoat to all steel members using a calcium-sulfonate paint system
2012 *(planned)*	- Install new deck joints at Piers I2, I4, and K15 thru K20 - Repair stringer web cracks in truss spans at L15, L27, L44 and L61

The Project Team Bridge Engineers obtained previous inspection reports from KYTC which covers a 15 year period from 2012 to 1997. The accepted NBI deviation between the "correct" condition rating and the stated condition ratings is +/- 1. Applying this deviation to the condition ratings shows a relatively constant physical condition for the overall NBI condition ratings during this 15 year period.

BRIDGE DECK

The Bridge Deck (Item 58) condition has been steady with an NBI rating value of 6 (satisfactory). The existing concrete bridge deck was constructed in 1980 using phase construction. Some spans used stay-in-place (SIP) forms for full width of the deck and other spans used SIP forms for half of the deck width. This permanent formwork makes it difficult for the bridge inspector to perform a visual inspection on the underside of the deck. Typically, deficiencies are noted once the SIP forms show signs of corrosion. Corrosion of the SIP form often indicates moisture and chlorides have penetrated through full depth cracks in the deck (see Photo 5).

Photo 5 - Typical corrosion at edge of SIP form

The condition of the existing concrete overlay is not included in the overall NBI condition rating for the deck. Typically, when an overlay is observed in good condition then there are no visual indications to note on the bridge deck. However, as the concrete overlay deteriorates through cracking and spalling (see Photo 6 and Photo 7), this deterioration will begin to enter into the concrete deck and begin to exhibit cracking, efflorescence and spalling.

The current reinforced concrete bridge deck is comprised of bare reinforcing steel with a concrete overlay. At 33 years old, the bridge deck has used over 50% of its estimated service life of 50 to 60 years. The concrete overlay is at the end of its estimated service life of 20 to 30 years. Given the deficiencies noted in the overlay, it is anticipated that the condition rating of the deck will begin to decrease without an effective waterproofing protection system in place.

Field investigations are outside the scope of this project; however, coring to determine concrete deterioration and current material properties could be used to provide data into the actual amount of deterioration in the concrete deck. This information could then be used to predict the remaining service life of the concrete deck and/or identify maintenance needs to achieve the required service life.

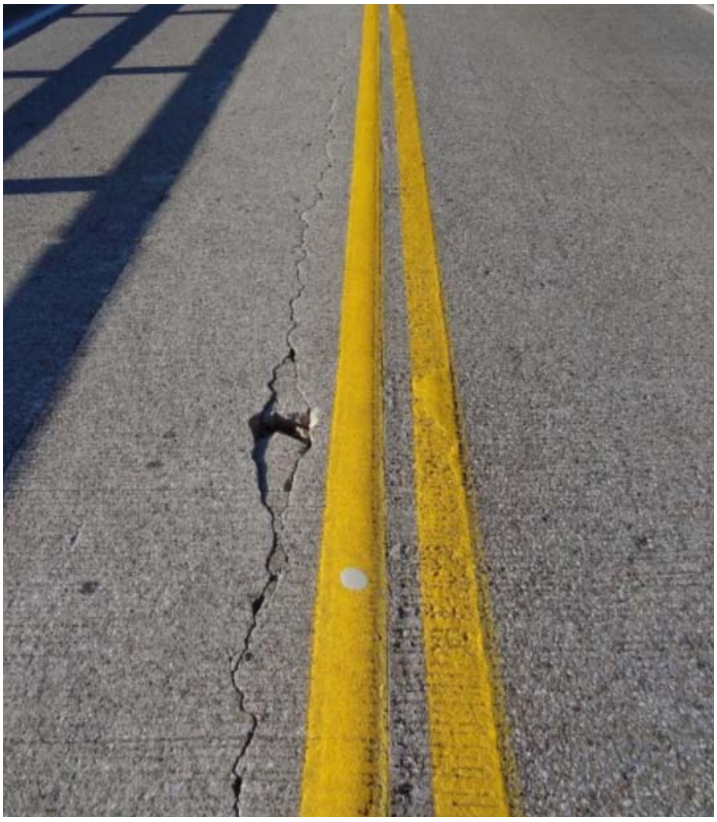


Photo 6 - Typical longitudinal crack in overlay running nearly full length of bridge from 2012.

Photo 7 - Typical random area of spalling in overlay from 2012.

SUPERSTRUCTURE

The condition of the Superstructure (Item 59) has been steady with an NBI condition rating value of 6 (satisfactory). The primary factor affecting the deterioration of the steel superstructure is corrosion. To protect against steel deterioration, an effective paint system is necessary. The Paint (Item 59A) condition degraded to an NBI condition rating value of 4 (poor) prior to the 2007 paint overcoat project. After painting, the NBI condition rating was raised to a current value of 7 (good).

The steels used in the US 51 Cairo Bridge are a non-weathering steel comprising of medium carbon steel and silicon structural steel. Although the silicon steel is more corrosion resistant than the carbon steel, both steels require an effective paint overcoat system to protect against deterioration.

The 2012 Inspection Report states, the US 51 Cairo Bridge has localized areas of section loss and random areas of pack rust located primarily in the splash zone of the main truss spans and under the deck joints.

Photo 8 - Example of packrust between built-up members in main truss spans

Photo 9 - Example of packrust between built-up members in deck truss spans

Deterioration of the structural steel due to corrosion is one of the primary deficiencies typically noted for bridge types and age similar to that of the US 51 Cairo Bridge. Deterioration in the form of uniform section loss and pitting is common in the “splash zones” of the bridge and under deck joints which typically leak over time.

Splash zones typically encompass the following areas: (1) floorbeam ends, (2) fascia stringer ends at deck joints, (3) lower chord gussets, (4) lower lateral bracing at panel point, (5) various horizontal plate at lower panel points, and (6) ends of vertical and diagonal truss members at lower chord panel points. Steel within the splash zone is typically exposed to wet conditions, which is made worse by exposure to deicing salts.

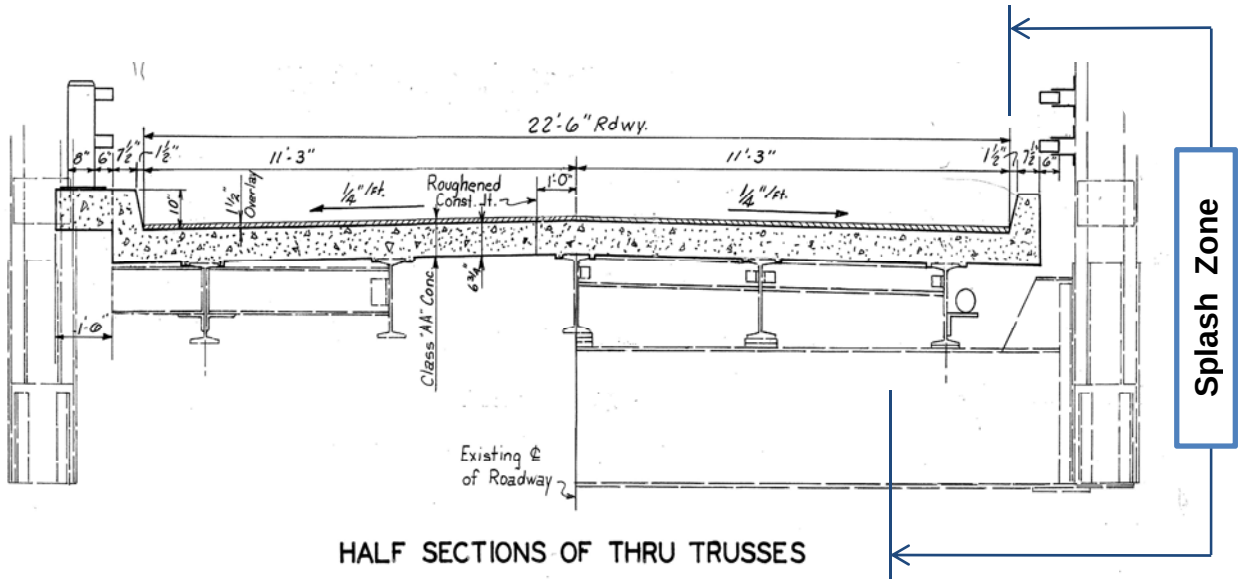


Figure 2 – Limits of Splash Zone. Limits apply to each side of truss.

Minor to moderate pack rust was noted throughout the bridge. Pack rust typically forms between multiple plates connected together by rivets or bolts to create a built-up member. Pack rust has the ability to expand creating such high expansive forces that the plate material will deform or bend. Pack rust has the capability to fracture rivets or bolts in extreme situations.

Although the current paint overcoat system has a good condition rating, the paint system is showing the beginning signs of distress. In discussions with KYTC Bridge Maintenance, they have seen a reduced service life on several bridges throughout the state that are currently using this type of calcium-sulfonate paint overcoat system. Possible factors include existing rust not being fully removed during surface preparation and/or chlorides remaining on surface. The primary concern is the paint system (see Photo 10) would fall short of its estimated 10 to 15 year service life.

Photo 10 – Typical paint condition after 5 years in-service.

5.3. LOAD RATING

The US 51 Cairo Bridge was load rated by KYTC Bridge Maintenance for the main truss spans and both approach spans utilizing LARS Complex Truss by Bentley. The rating was provided for the Inventory and Operating loading (HS20), as well as the KYTC legal load vehicles Type 1 to 4.

The Inventory rating provides the largest vehicle that can safely utilize the bridge for an indefinite period. The Operating rating is the maximum permissible load level to which the structure may be subjected for the vehicle type used in the rating.

Load Rating	Controlling Location	Rating (tons)
Inventory	Main Truss at U24-L25	15.8
Operating	Main Truss at U24-L25	26.3
Type 1	Cantilevered girders KY app	30.0
Type 2	Cantilevered girders KY app	32.0
Type 3	Cantilevered girders KY app	37.0
Type 4	L2-L3 (and L2'-L3') upstream and downstream of the deck trusses	44.0

The controlling load rating elements are the main truss members from U24 to L25 for the Inventory and Operating ratings. All bridge members were considered adequate for the KYTC legal load vehicles Type 1 to 4. The Inventory and Operating rating below the HS20 truck baseline weight of 36 tons does not indicate the bridge is in imminent danger of failure.

5.4. Fatigue and Riveted Trusses

Based on research findings by Fisher and others, it was found that for riveted bridges:

- AASHTO fatigue strength category D is a reasonable lower bound for the initial fatigue crack development.
- Primary members in riveted bridges are seldom subjected to stress ranges that exceed the category D fatigue limit, and thus are not likely to develop fatigue cracks.
- The riveted details most likely to develop cracks are those subjected to distortion or displacement-induced stresses at connections.
- Corrosion can reduce the fatigue resistance.

Facts for US 51 Cairo Bridge:

- Per the US 51 Cairo Bridge Inspection Manual, there are no existing Category E or E' details.
- No suspected fatigue cracks were noted on the primary truss members and floorbeams per the 2012 Bridge Inspection Report.
- Two types of steel were used in the construction of this bridge. They are designated on the shop drawings as medium carbon steel (truss members), and silicon steel (floorbeams, stringers, and truss members).
- The unit stresses per the original plans provided allowable tensile values of 18.0 ksi, and 24.0 ksi for the medium steel and silicon steel respectively, which was supported by Table 6B.6.2.1 from the AASHTO Manual for Bridge Evaluation.

6-86 THE MANUAL FOR BRIDGE EVALUATION

Table 6B.6.2.1-1—Inventory Rating Allowable Stresses, psi

			DATE BUILT-STEEL UNKNOWN								
			Prior to 1905	1905 to 1936	1936 to 1963	After 1963	Carbon Steel	Silicon Steel Over 2 in. to 4 in. incl.	Nickel Steel	$1^1/_8$ in. and under	Over $1^1/_8$ in. to 2 in. incl.
AASHTO Designation[a]							M 94 (1961)	M 95 (1961)	M 96 (1961)		
ASTM Designation[a]							A 7 (1967)	A 94 (1966)	A 8 (1961)	A 94	A 94
Minimum Tensile Strength		F_H	52,000	60,000			60,000	70,000	90,000	75,000	72,000
Minimum Yield Point		F_Y	26,000	30,000	33,000	36,000	33,000	45,000	55,000	50,000	47,000
Axial tension in members with no holes for high-strength bolts or rivets. Use net section when member has any open holes larger than $1^1/_4$-in. diameter, such as perforations.		$0.55F_y$	14,000	16,000	18,000	20,000	18,000	24,000	30,000	27,000	25,000
		$0.46F_y$	NOT APPLICABLE								
Axial tension in members with holes for high-strength bolts or rivets and tension in extreme fiber of rolled shapes, girders, and built-up sections subject to bending.	use whichever is smaller	Gross* Section $0.55F_y$	14,000	16,000	18,000	20,000	18,000	24,000	30,000	27,000	25,000
• When the area of holes deducted for high-strength bolts or rivets is more than 15 percent of the gross area, that area in excess of 15 percent shall be deducted from the gross area in determining stress on the gross section. In determining gross section, any open holes larger than $1^1/_4$-in. diameter, such as perforations, shall be deducted.		Net Section $0.50F_H$	26,000	30,000	30,000	30,000	30,000	35,000	45,000	37,000	36,000
		Net Section $0.46F_H$	NOT APPLICABLE								

Figure 3 - AASHTO Manual for Bridge Evaluation, Steel Properties Table

Corrosion and Fatigue Resistance

A study was done of the fatigue strength of trolley bridge stringers made of ASTM A7 Steel, which is similar to medium carbon steel, by Albrecht and Lenwari (2008). In that report, it indicated that highway and railway bridges fabricated from ASTM A7 and A36 carbon steels will corrode if the paint system is allowed to fail because of a lack of maintenance. Corroding members lose strength as a result of pitting and uniform corrosion. The pits act as stress risers and cause cracks to initiate. The uniform loss of cross-sectional area increases the nominal stress range. Hence, corrosion reduces fatigue strength. The strength continues to decrease as long as the steel members continue to corrode.

Figure 4 taken from the Albrecht and Lenwari (2008) report shows that decades of corrosion reduced the fatigue strength of the trolley bridge stringers from Category A to Category D, depending on the degree of corrosion and pitting.

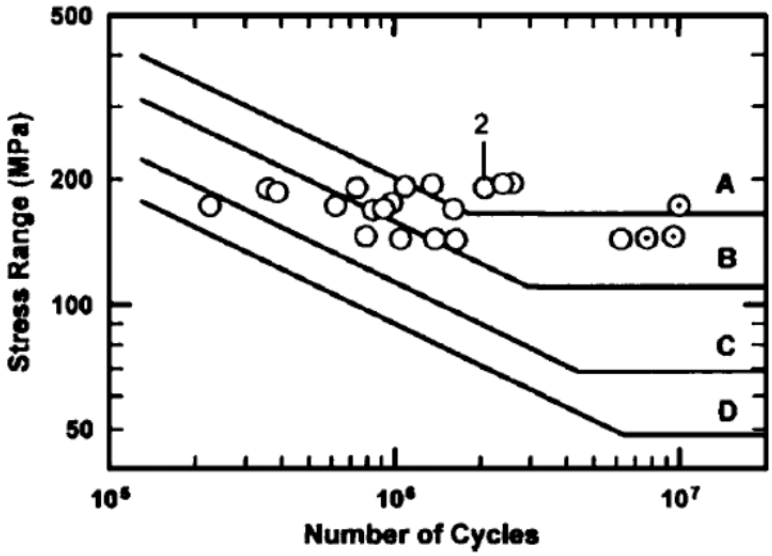


Figure 4 – S-N Data for all A-7 Stringers
(Albrecht et al, 2008)

KYTC has numerous riveted trusses, similar to the US 51 Cairo Bridge, across the Ohio River. All of these riveted bridges have a good performance record with respect to a minimal number of noted fatigue issues. Fatigue cracks have been rare with these bridges, and the fatigue cracks noted were typically associated with out-of-plane distortion and were randomly located.

Thus, research for this paper indicates there are no significant fatigue issues that would negatively affect the remaining service life of the US 51 Cairo Bridge.

6. CONDITION OVERVIEW OF EXISTING SUBSTRUCTURE

The project team reviewed the available existing bridge inspection reports in order to establish a general condition appraisal for the existing piers supporting the US 51 Cairo Bridge. The condition of the piers above the waterline was documented in fracture critical bridge inspection reports. These inspections did not conduct an arms-length inspection of the piers (with exception of the pier cap/bearings). Inspection of these pier elements were conducted, without requiring climbing or specialized equipment. The team also reviewed the condition of the piers as documented in three underwater inspection reports from 2001, 2004, and 2009.

Detailed information on the condition of the individual piers above the waterline was not available, so it is assumed that all piers are included in the overall substructure condition rating. The condition of the Substructure (Item 60) has been steady with an NBI condition rating value of 6 (satisfactory).

The following conditions were noted in the 2012 fracture critical inspection report: "*Minor cracking with efflorescence and minor delaminations are present on some piers. Approach piers have minor cracking, delaminations and spalls".* It was also noted that some of the patches are beginning to fail at the interface to the existing concrete. The general condition can be seen in the following two photographs taken from the 2009 underwater inspection report.

Photo 8 - Pier E looking towards KY

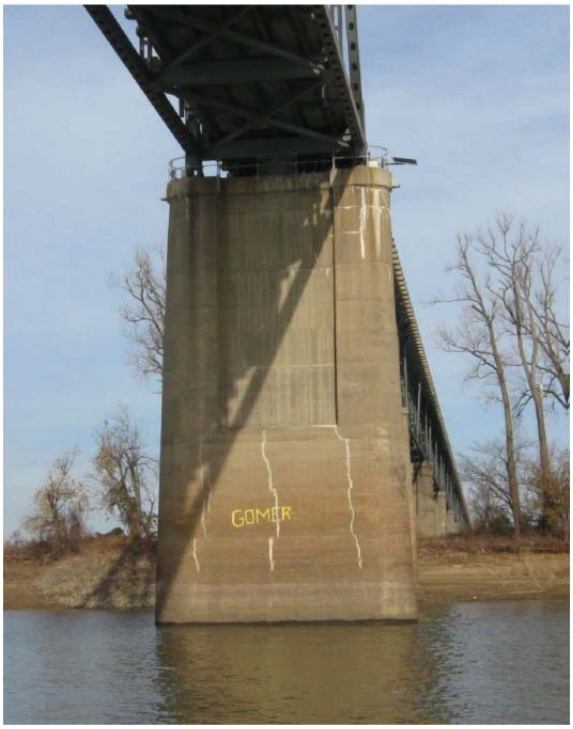


Photo 9 - Pier F looking towards KY

Piers B thru F were inspected below the waterline during a “hands-on” inspection by divers. Light to moderate scaling was found on the faces of the piers below the water surface. Hairline vertical cracks were noted in the inspection to extend from above the water surface below water and in some cases down to the ledge between the bottom of the pier shaft and the permanent cofferdam. Cracks found ranged in size from hairline to ¾” wide. Timber formwork on the permanent cofferdam section was noted as partially remaining and attached to Piers C, D, and F. Light biological growth of zebra mussels was also observed. Spalling was noted on the North Face of Pier C and at the cold joints on Pier D. Overall condition rating of the bearings was listed as satisfactory (6).

Concrete patching was performed on Illinois Approach Piers I-1 thru I-5, River Piers B, C, E & F, Kentucky Approach Pier K2 and the KY Abutment as part of the 1999 repair contract. Epoxy injection of cracks was performed on Illinois Approach Piers I-2, River Piers B, C, E & F and the KY Abutment as part of that same repair contract.

7. ENGINEERING ASSESSMENT OF EXISTING RIVER PIERS

A preliminary engineering assessment was conducted on the existing piers for current AASHTO LRFD design criteria loadings for Bridge Scour, Seismic Loading, Barge Impact and Foundation Evaluation. The approach span piers were not included in this assessment.

7.1. BRIDGE SCOUR

The 2009 underwater inspection report indicates that the riverbed material around the piers consists mainly of sand and gravel with some silt, and miscellaneous debris. Rip-rap and boulders were observed at Piers B, C, D, and E.

Cross sections of the river were taken as part of the each of the underwater inspections. The existing foundations are pneumatic caissons. They were excavated through recent alluvial deposits and into the underlying Tertiary aged varved clay layer. The changes in the river bed between 2001 and 2009 are considered normal and do not pose a concern for the foundations of the bridge.

During the late 1990’s KYTC conducted a scour risk assessment for their bridges. A summary of the report indicated that this bridge is not scour critical; however, the detailed report has not been located by KYTC. New 2012 estimates of the preliminary scour were made for inclusion in this paper based on guidance from HEC-18 and 100year flow velocity estimates obtained from the USACE.

At river Piers B-F, the predicted local scour was in the range of 24ft-31ft. Estimates from other Ohio River Bridge projects have indicated that scour can exceed 40ft depending upon local conditions in the river. It is recommended that further refinement of the scour estimate is needed before full conclusions can be drawn.

The preliminary scour estimates have been shown on the channel profile from the underwater bridge inspection report below. The figure below shows Pier F to be the most susceptible to scour because of the relatively shallow depth of foundation, however the velocity may be lower than was assumed at this location. Refined velocity estimates are needed to further evaluate the scour for Pier F.

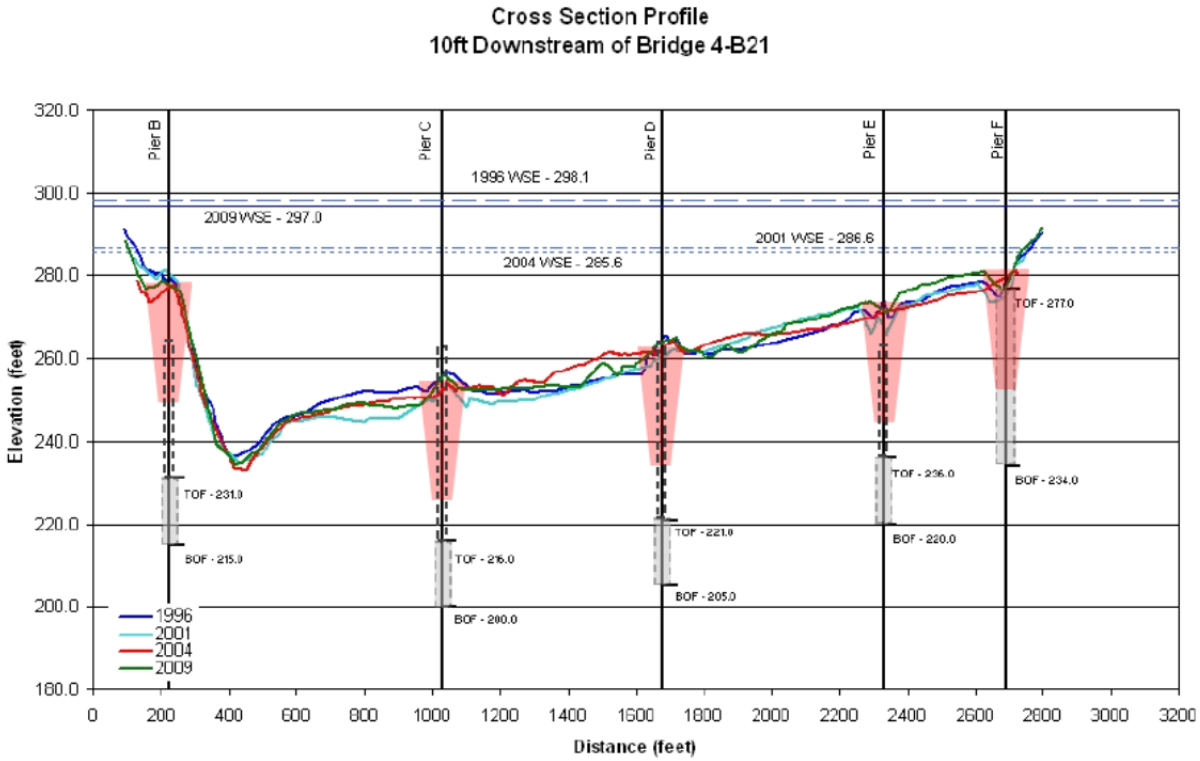


Figure 5 - Preliminary Scour Depths (Looking Upstream)

7.2. Seismic Loading

The 1998 KTC Report 98-20 evaluated the susceptibility of the US 51 Cairo Bridge to a 50year return earthquake. This study found that the main bridge could resist this quake without yielding or buckling any truss members, or without failing the bearings. The study also recommended that the approach span bearings be retrofitted to resist this magnitude of seismic event. The bridge piers were not evaluated in the KTC study.

The AASHTO Seismic Retrofitting manual indicates that the level of seismic event and retrofit should be a function of the remaining service life of the bridge. For the purpose of the existing assessment, it was decided to evaluate the piers for a 1,000 year seismic event as the baseline for comparison.

The design of the existing piers pre-dates the code requirements for seismic design. The preliminary assessment of the piers, along with similar project experience indicates that severe damage or even collapse is probable for the existing piers for the 1,000 year return period. There is also concern that even under a lower level seismic event the

existing piers would be damaged to the point where it would be unsafe to permit vehicles to cross.

Based on these preliminary findings, additional study and further discussion is needed to determine how much damage is acceptable to KYTC and assist in defining the rehabilitation necessary to meet those requirements.

7.3. Barge Impact

The main river piers of the existing US 51 Bridge over the Ohio River were assessed for the following vessel collision event:

A barge flotilla or ship striking the bridge while navigating the waterway under typical conditions combined with the effects of one-half of the predicted Contraction Scour and no Local Scour. The barge flotillas in the design fleet include both fully-loaded barges and fully-unloaded barges. The unloaded barges are lighter and therefore have reduced loads, but they draft higher in the water and impact elevation on the pier components is higher.

The Importance Classification of the existing US 51 bridge over the Ohio River was assumed to be a Typical Bridge.

A preliminary study investigated the potential vessel collision with the piers per AASHTO LRFD 3.14 Information for the study was gathered from previous projects on similar waterways. Vessel traffic data was assumed from a recent study on the Milton-Madison Bridge over the Ohio River.

Table 1: Comparison of Ohio River Bridge Main Span Vessel Impact Load

Bridge Name/Location	Main Span (ft)	Maximum Vessel Load (kips)
Owensboro	1100	4137
New Louisville Downtown	750	6000
Milton-Madison	727	4700
Maysville	1050	5000
Ironton-Russell	900	6161
Pomeroy Mason	675	4500
US 51 (Estimated)	**650**	**5000**

A comparison of other Ohio River Bridge barge impact loads is provided in Table . The maximum estimated vessel load calculated for the US 51 Cairo Bridge is 5000 kips. This load was utilized in the preliminary foundation assessment.

7.4. FOUNDATION EVALUATION

The existing main span foundations were constructed as pneumatic caissons. The approximate base dimensions of these caissons are 30 feet x 61.5 feet. They were excavated through about 40 feet of recent alluvial deposits and about 5 feet into the underlying Tertiary aged varved clay layer. This makes sense as the clay layer would have provided a good seal for the pneumatic caisson and the older more consolidated sediments would allow proper preparation of the foundation base to receive concrete. The varved clay layer extends about 25 to 40 feet below the tip of the caissons where it overlies a sand layer of indeterminate depth. Bedrock is at least 450 feet below the bottom of the river.

Based on the available descriptions of the bearing material, the design of the original foundations and engineering experience, the nominal bearing resistance of the varved clay at the bottom of the main pier caissons is estimated as 45 ksf. Since the caissons are founded on a significant layer of clay overlying deep sand deposits, any additional load applied to the foundation will induce some immediate and long term settlements of the pier foundation. This will need to be considered during any potential remediation design.

The estimated net vertical load on the main span piers (unfactored) is about 22,000 kips. This gives a net bearing pressure of about 12 ksf which is pretty close to the assumed allowable bearing capacity of 15 ksf (based on the estimated nominal resistance of 45 ksf and a safety factor of 3). This was likely the basis for the design of the original foundation.

Design of the original bridge likely ignored the effect of horizontal loads on bearing pressures. Current design practice treats the caisson foundation as a spread footing subject to overturning moments from wind, seismic and vessel impact. The soil surrounding the caisson shaft is not assumed to resist overturning moments due to its potential to be removed by scour and the difference in horizontal and vertical response in the soil.

Based on preliminary calculations of the overturning moments and the assumed bearing pressure, it is concluded that the existing foundations are inadequate to support seismic loads and may be capable of resisting the assumed barge impact forces when evaluated using current design standards. Plausible seismic retrofit scenarios will be discussed in the Bridge Rehabilitation White Paper.

8. NEXT STEPS

The information summarized in this white paper identifies concerns affecting the physical condition and structural capacity of the existing piers. Looking forward, this information will be utilized during development of a “no-build” alternative, a rehabilitation concept and superstructure replacement concept.

As part of the overall US 51 Cairo Bridge project study, a “no-build” alternative will be examined. Under this option, only ongoing maintenance and low cost improvements would be made. Members with significant deterioration and with substandard load ratings will be considered for repair. This minor rehabilitation would focus on immediate repairs that are necessary for the bridge to continue to maintain traffic safely until such time as the bridge becomes structurally deficient. The assumption of low cost improvements for the maintenance does not include having the entire bridge cleaned and re-painted. This means that any deterioration that has been documented in the form of rust packing, pitting and uniform section loss will continue to progress. In addition, no corrective measures for sub-standard highway conditions would be planned under the “no-build” alternative.

Rehabilitation alternatives will also be considered to maintain the existing bridge for an additional 25 year period, including the bridge deck, structural steel, and paint system. The potential rehabilitation will also consider needs to address bridge scour, seismic loading and barge impact. Detail information on the “no-build” alternative as well as the rehabilitation alternatives will be included in the Rehabilitation Concepts White Paper.

APPENDIX A

US 51 SIA Form

April 2013

Structure Inventory and Appraisal Sheet (English Units)

Bridge Key: 296 | Agency ID: 004B00021N | SR: 39.8 | SD/FO: FO

IDENTIFICATION

State 1: 21 Kentucky
Struc Num 8: 004B00021N
Facility Carried 7: US-51
Location 9: 4.0 MI WEST OF JCT US51&6
Rte.(On/Under)5A: Route On Structure
Rte. Signing Prefix 5B: 2 U.S. Numbered Hwy
Level of Service 5C: 1 Mainline
Rte. Number 5D: 00051
Directional Suffix 5E: 0 N/A (NBI)
% Responsibility : 50
SHD District 2: District 1
County Code 3: Ballard (004)
Place Code 4: FIPS 0000
Mile Post 11: 7.949 mi
Feature Intersected 6: OHIO RIVER -IC (SOU) RR
Latitude 16: 36d 59' 40"
Longitude 17: 089d 08' 40"
Border Bridge Code 98: 17 Illinois
Border Bridge Number 99: 002-0006

INSPECTION

Frequency 91: 12 months
Inspection Date 90: 10/29/2012
Next Inspection: 10/29/2013
FC Frequency 92A: 24 months
FC Inspection Date 93A: 10/29/2012
Next FC Inspection: 10/29/2014
UW Frequency 92B: 60 months
UW Inspection Date 93B: 12/1/2009
Next UW Inspection: 12/1/2014
SI Frequency 92C: NA
SI Date 93C: NA
Next SI: NA
Element Frequency: 12 months
Element Inspection Date: 10/29/2012
Next Elem. Insp. Due: 10/29/2013

CLASSIFICATION

Defense Highway 100: 0 Not a STRAHNET hwy
Parallel Structure 101: No || bridge exists
Direction of Traffic 102: 2 2-way traffic
Temporary Structure 103: Not Applicable (P)
Highway System 104: 1 On the NHS
NBIS Length 112: Long Enough
Toll Facility 20: 3 On free road
Functional Class 26: 02 Rural Other Princ
Defense Hwy 110: 0 Not a STRAHNET
Historical Significance 37: 3 Possibly eligible for
Owner 22: 01 State Highway Agency
Custodian 21: 01 State Highway Agency

STRUCTURE TYPE AND MATERIALS

Number of Approach Spans 46: 27
Number of Spans Main Unit 45: 5
Main Span Material/Design 43A/B:
3 Steel
10 Truss-Thru
Approach Span Material/Design 44A/B:
3 Steel
02 Stringer/Girder
Deck Type 107: 1 Concrete-Cast-in-Place
Wearing Surface 108A: 3 Latex Concrete/Similar
Membrane 108B: 0 None
Deck Protection 108C: None

CONDITION

Deck 58: 6 Satisfactory
Super 59: 6 Satisfactory
Sub 60: 6 Satisfactory
Culvert 62: N N/A (NBI)
Channel/Channel Protection 61: 7 Minor Damage

LOAD RATING AND POSTING

Inventory Rating Method 65: 1 LF Load Factor
Operating Rating Method 63: 1 LF Load Factor
Inventory Rating 66: HS9.9
Operating Rating 64: HS17.5
Design Load 31: 4 M 18 (H 20)
Posting 70: 2 20.0-29.9%below
Posting status 41: A Open, no restriction

AGE AND SERVICE

Year Built 27: 1937
Year Reconstructed 106: Unknown
Type of Service on 42A: 1 Highway
Type of Service under 42B: 7 Railroad-waterway
Lanes on 28A: 2
Lanes Under 28B: 0
Detour Length 19: 98.0 mi
ADT 29: 5,040
Truck ADT 109: 35 %
Year of ADT 30: 2012

APPRAISAL

Bridge Rail 36A: 0 Substandard
Approach Rail 36C: 1 Meets Standards
Transition 36B: 1 Meets Standards
Approach Rail Ends 36D: 1 Meets Standards
Str. Evaluation 67: 4
Deck Geometry 68: 2 Intolerable - Replace
Underclearance, Vertical and Horizontal 69: 9 Above Desirable
Waterway Adequacy 71: 5 Above Tolerable
Approach Alignment 72: 4 Minimum Tolerable
Scour Critical 113: 5 Stable w/in footing

GEOMETRIC DATA

Length Max Span 48: 799.9 ft
Structure Length 49: 5,865.2 ft
Curb/Sdwlk Width L 50A: 2.0 ft
Curb/Sidewalk Width R 50B: 2.0 ft
Width Curb to Curb 51: 20.0 ft
Width Out to Out 52: 24.0 ft
Approach Roadway Width 32: (w/ shoulders) 24.0 ft
Median 33: 0 No median
Deck Area: 140,763.8 sq. ft
Skew 34: 0.00 °
Structure Flared 35: 0 No flare
Vertical Clearance 10: 19.00 ft
Horiz. Clearance 47: 20.00 ft
Minimum Vertical Clearance Over Bridge 53: 19.0 ft
Minimum Vertical Underclearance Reference 54A: R Railroad beneath struc
Minimum Vertical Underclearance 54B: 40.0 ft
Minimum Lateral Underclearance Reference R 55A: R Railroad beneath struc
Minimum Lateral Underclearance R 55: 33.1 ft
Minimum Lateral Underclearance L 56: 0.0 ft

PROPOSED IMPROVEMENTS

Bridge Cost 94: $ 20,938,000
Type of Work 75: 31 Repl-Load Capacity
Roadway Cost 95: $ 0
Length of Improvement 76: 586.6 ft
Total Cost 96: $ 20,938,000
Future ADT 114: 7,660
Year of Cost Estimate 97: 2004
Year of Future ADT 115: 2032

NAVIGATION DATA

Navigation Control 38: 1 Permit Required
Vertical Clearance 39: 105.3 ft
Horizontal Clearance 40: 630.0 ft
Pier Protection 111: Not Applicable (P)
Lift Bridge Vertical Clearance 116: 0.0 ft

ELEMENT CONDITION STATE DATA

Str Unit	Elm/Env	Description	Units	Total Qty	% in 1	Qty. St. 1	% in 2	Qty. St. 2	% in 3	Qty. St. 3	% in 4	Qty. St. 4	% in 5	Qty. St. 5
1	22/1	P Conc Deck/Rigid Ov	(SF)	132,827	0 %	0	100 %	132,827	0 %	0	0 %	0	0 %	0
1	107/1	Paint Stl Opn Girder	(LF)	2,673	0 %	0	100 %	2,673	0 %	0	0 %	0	0 %	0
1	113/1	Paint Stl Stringer	(LF)	14,151	60 %	8,491	35 %	4,953	4 %	566	0 %	0	1 %	142
1	121/1	P/Stl Thru Truss/Bot	(LF)	5,660	0 %	0	25 %	1,415	20 %	1,132	5 %	3,113	0 %	0
1	126/1	P/Stl Thru Truss/Top	(LF)	5,660	0 %	0	94 %	5,320	6 %	340	0 %	0	0 %	0
1	131/1	Paint Stl Deck Truss	(LF)	3,637	0 %	0	20 %	727	5 %	2,910	0 %	0	0 %	0

Structure Inventory and Appraisal Sheet (English Units)

Str Unit	Elm/Env	Description	Units	Total Qty	% in 1	Qty. St. 1	% in 2	Qty. St. 2	% in 3	Qty. St. 3	% in 4	Qty. St. 4	% in 5	Qty. St. 5
1	152/1	Paint Stl Floor Beam	(LF)	2,079	53 %	1,102	45 %	936	2 %	42	0 %	0	0 %	0
1	210/1	R/Conc Pier Wall	(LF)	819	65 %	532	30 %	246	5 %	41	0 %	0	0 %	0
1	215/1	R/Conc Abutment	(LF)	280	87 %	244	13 %	36	0 %	0	0 %	0	0 %	0
1	300/1	Strip Seal Exp Joint	(LF)	384	100 %	384	0 %	0	0 %	0	0 %	0	0 %	0
1	301/1	Pourable Joint Seal	(LF)	672	64 %	430	28 %	188	8 %	54	0 %	0	0 %	0
1	304/1	Open Expansion Joint	(LF)	120	0 %	0	99 %	119	1 %	1	0 %	0	0 %	0
1	310/1	Elastomeric Bearing	(EA)	20	90 %	18	10 %	2	0 %	0	0 %	0	0 %	0
1	311/1	Moveable Bearing	(EA)	32	53 %	17	44 %	14	3 %	1	0 %	0	0 %	0
1	313/1	Fixed Bearing	(EA)	60	85 %	51	15 %	9	0 %	0	0 %	0	0 %	0
1	331/1	Conc Bridge Railing	(LF)	465	90 %	418	10 %	47	0 %	0	0 %	0	0 %	0
1	334/1	Metal Rail Coated	(LF)	11,267	0 %	0	50 %	5,633	20 %	2,253	20 %	2,253	0 %	1,127
1	357/1	Pack Rust Smart Flag	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0
1	358/1	Deck Cracking SmFlag	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0
1	362/1	Traf Impact SmFlag	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0
1	363/1	Section Loss SmFlag	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0
1	503/1	Curbs	(LF)	11,267	35 %	3,943	40 %	4,507	20 %	2,253	5 %	563	0 %	0
1	606/1	Drains	(EA)	1	0 %	0	100 %	1	0 %	0	0 %	0	0 %	0
1	607/1	Utilities	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0
1	609/1	Debris on Superstruc	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0
1	613/1	Vegetation	(EA)	1	100 %	1	0 %	0	0 %	0	0 %	0	0 %	0

APPENDIX B

FRACTURE CRITICAL INSPECTION

2012

Transportation Cabinet
Division of Operations

TC 71-118
Rev. 1/96

BRIDGE INSPECTION REPORT

Reviewed By:
Review Date:

Two Yr	X	Substd		UnderWater		In-Depth		Fracture Critical	X

Project No: 004B00021N **NBI-Location:** 1.4 MI WEST OF JCT US 51

Local-ID: BRIDGE OVER THE OHIO RIVER AT CAIRO, IL

Structure Description: THRU STEEL TRUSS AND WELDED STL PLATE GIRDER APP SPANS

Milepoint: 007.327 **Inspectors Initials:** STR **Inspection Date:** 10 28 12

Inspector's Signature Scott Rill
Burgess & Niple, Inc.

58	Deck	6
1	Structural Condition	6
2	Wearing Surface	6
3	Joints	5
4	Drains	6
5	Expansion Devices	6
6	Curbs, Sidewalks, Medians	6
7	Railings	4
8	Lighting or Utilities	7

59	Superstructure	6
1	Stringers, Girders, Beams	6
2	Floor Beams	6
3	Trusses – Main Members	6
3a	Trusses – Bracing, Portals	7
3b	Trusses – Inspection Walk	N
4	Bearing Devices	6
5	Alignment/ Structural Members	7
6	Deflection/ Vibration under Load	7
7	Debris on Members	8

59a Paint Condition				7
Color	GRAY	Date Painted	11	07

60	Substructure	6
1	Abutments, Wingwalls	6
2	Piers/ or Bents	6
3	Alignment/ or Settling	7
4	Scour, Erosions	7
5	Debris on Seats, Caps	7
6	Protection Systems	N
7	Abutments, Wingwalls (S.Z.D.)	N
8	Piers/ or Bents (S.Z.D.)	N
9	Alignment or Settling Due to Scour	N

61	Channel/Channel Protection	7
1	Channel Scour	7
2	Embankment Erosion	7
3	Drift	7
4	Channel Alignment	8
5	Vegetation	7
6	Erosion Control System	N
7	Rip-Rap	N

62	Culvert-Retaining Walls	N
1	Barrel	N
2	Wingwalls, Headwall	N
3	Debris	N
4	Scour Under Footings (Underwater)	N
5	Erosion at Wingwalls (Underwater)	N
6	Drainage Adequacy (Underwater)	N

10 Inventory Route Vertical Clearances

Over: 19 FT 00 IN
Under: 21 FT 09 IN

36 Traffic Safety

0	0	0	0

71	Waterway Adequacy	5
72	Approach Roadway Alignment	6

113	Scour Critical Bridge Rating	6

108 Wearing Surface/Protective System

Type:	3	Membrane:	0	Protection:	0

OVERLAY	No:			
	Yes:	X	Date:	1980
TYPE	Latex:		PCC: x	Asphalt:
				Depth:

RECOMMENDED LOAD CAPACITIES (tons) I: ____ II: ____ III: ____ IV: ____ Gross:____

FIELD POSTINGS N/E Yes S/W Yes I: ____ II: 27 III: 34 IV: 40 Gross:____

Underwater Data:

ITEM NO.	ADDITIONAL COMMENTS
58.1	**Structural Condition** – There are patches and spalling that extend into the deck.
58.2	**Wearing Surface** – There is light cracking in the overlay over the length of the bridge and a 1/8" wide longitudinal crack most of the length of the deck trusses in the Kentucky Approach. There are patches and spalls, some of which extend into the deck.
58.3	**Deck Joints** – Joint armor is damaged, cracked, or has missing sections at Pier I-4, Pier I-2, L57, L72, Pier K-15, Pier K-16, Pier K-18, Pier K-19, and Pier K-20, and the pourable seals are typically damaged or missing at those locations. The strip seal joint are collecting debris.
58.4	**Drains** – Most of the drains were open at the time of the inspection. Debris was present in a few of the drains as well as along the curbs.
58.5	**Expansion Devices** – There are vertical misalignments up to 3/4" across the fingers, and there is one cracked finger on the south side of the L61 joint near the upstream curb.
58.6	**Deck Curbs, Sidewalks, Medians** – Vertical cracking is present in the curbs, and there are isolated areas of more significant deterioration, most commonly adjacent to joints.
58.7	**Deck Railings** – The steel railing is corroding from the inside out, and there are several corrosion holes in the railing and railing posts. The railing supports commonly have cracks, and there are a number of spalls that are exposing anchor bolts and reinforcing steel.
59.1	**Stringers, Girders, Beams** – There are cracks on stringer ends on the fixed side of expansion joint locations at L15 (Stringers 2, 3, and 4), L44 (Stringer 3), and L61 (Stringers 2 and 3). The remaining stringers at those locations typically have substantial section loss. The upstream girder for Span 21 is at its expansion limit and is in contact with the batten plates for the deck truss end vertical.
59.2	**Floor Beams** – Pack rust is present between floorbeams and horizontal gusset plates. Section loss on floorbeams under joints is mostly inactive following the 2007 painting. The end floorbeam for Span 28 at Pier K-16 is rotated several degrees from vertical.
59.3	**Trusses – Main Members** – Pack rust is present at between the components of built up truss members and between truss members and gusset plates. The majority of the section loss that occurred prior to the 2007 painting is not active. The sliding pin assemblies appear to be able to freely move.
59.4	**Bearing Devices** – The bearings typically have minor surface corrosion and/or pack rust and are functioning as intended. The downstream bearing at L0 has multiple cracks on the bearing collar and both upper ends of the block assembly are broken on the inboard side.
60.1	**Abutments, Wingwalls** – There is minor vertical cracking on the abutments.
60.2	**Piers/ or Bents** – The piers typically have minor cracking, delaminations, spalling, and/or vegetation growth. Debris is present on a few piers due to open joints or failed joint seals.

BURGESS & NIPLE
Engineers ■ Architects ■ Planners

December 10, 2012

Mr. Josh Rogers, PE, LSIT
Division of Maintenance
Kentucky Transportation Cabinet
200 Mero Street, 3rd Floor
Frankfort, Kentucky 40622

Re: Statewide
Inspection Year 2012 Bridge Inspection Services
Contract Package 2
Cairo Bridge Inspection Report
004B00021N

Dear Mr. Rogers:

Between October 22 and 28, 2012, Burgess & Niple (B&N) completed the Fracture Critical Inspection of the Cairo Bridge over the Ohio River in Ballard County, Bridge No. 004B00021N. The extents of the inspection were from abutment to abutment, and the total inspected bridge length was 5885 feet.

The truss spans and the girder spans in the Illinois approach were accessed by climbing techniques developed by B&N, which eliminated traffic disruption. Team members used webbing, ropes, and harnesses to position themselves on the structure. A girder spans in the Kentucky Approach were inspected with a 125 foot manlift. No lanes were closed during the course of the inspection

The work included arm's length inspection of –

- All fracture critical members of the trusses,
- Both faces of each girder,
- All floorbeam connections,
- Floorbeams located directly under expansion joints where deficiencies were previously noted or observed from the connections,
- Pier caps and bearings,
- Category E and E' details in truss members, girders, and floorbeams, and
- Areas where significant problems were found during previous inspections.

Non-fracture critical truss members were observed from each panel point during the course of the arm's length inspection of the fracture critical components. Additional inspection was performed in sufficient detail to complete KYTC Form TC71-118, and element level information was gathered to complete the Pontis report.

400 Blankenbaker Parkway, Suite 300, Louisville, Kentucky 40243 ■ phone: 502.254.2344 ■ fax: 502.254.3008

SUMMARY OF FINDINGS

The following is a summary of the significant findings resulting from the fracture critical inspection:

Element 22 – Concrete Deck – Protected w/ Rigid Overlay

- The deck in satisfactory condition.
- There are areas of spalling and patching, most commonly in the vicinity of the joints.
- Light cracking is common in the overlay. There is a longitudinal crack up to 1/8" wide that is a few inches to the downstream side of the centerline. It extends much of the length of the deck trusses in the Kentucky Approach. (See Photograph 1)

Element 107 – Painted Steel Open Girder/Beam

- The girders in the approaches are in satisfactory condition.
- The paint on the exterior faces is fading, peeling, and chalking. This is typical for all painted bridge components not sheltered from the elements.
- Small areas of 1/16" to 1/8" deep pitting are present, typically near joints. The majority of this section loss is painted over and is not active.
- The upstream girder for Span 21 is at its expansion limit and is in contact with the batten plates for the deck truss end vertical. (See Photograph 2)

Element 113 – Painted Steel Stringer

- The roadway stringers are generally in satisfactory condition.
- Pitting that occurred prior to the 2007 painting is present on stringers below several of the joints. At some of these locations, pack rust has formed above and/or below the stringer bearing plate. (See Photograph 3) The corrosion is reactivating in some locations.
- Stringer 1 at Floorbeam 40 is missing an anchor rivet on the north side. (See Photograph 3)
- Cracks have been observed on stringer ends on the fixed side of expansion joint locations at L15 (Stringers 2, 3, and 4), L44 (Stringer 3), and L61 (Stringers 2 and 3). The cracks are either longitudinal in the web near the fillet to the bottom flange (See Photograph 4) or are intersecting longitudinal and transverse in the bottom flange. (See Photograph 5) Stringers that were not cracked commonly had substantial section loss. Similar detailing is present at L27 below a deck joint. No cracks were observed at this location, but section loss due to corrosion was present.

Element 121 – Painted Steel Bottom Chord Thru Truss

- The truss lower chord is in satisfactory condition.
- Pack rust has developed between the components of the lower chord, commonly 1/8" to 1/4" thick with local occurrences as great as 3/4" inch. Pack rust was observed at a few locations between the lower chord and primary gusset plates and more commonly between the lower chord and horizontal gusset plates. Thicknesses were commonly 1/8" to 1/4" with up to 1 1/2" locally.
- The chord sliding pins appeared to be moving freely, and the position of the pins appeared to be appropriate for the ambient temperature at the time of the inspection.

Element 126 – Painted Steel Thru Truss (excl. bottom chord)

- The components of the truss above the lower chord are in satisfactory condition.

- Pack rust is developed between the components of some of the built up truss members, most commonly between vertical flanges and batten plates. Thicknesses of 1/8" to 1/4" were observed with some frequency with isolated instances of up to 1/2". (See Photograph 6) Similarly, pack rust is present between primary truss members and primary gusset plates, commonly 1/8" to 1/4" thick with some locations as thick as 1/2".
- There are two missing rivets between the inboard gusset plate and vertical at L30, downstream truss. (See Photograph 7)
- The hanger verticals, particularly on the upstream truss, were generally shifted fully to one side such that the verticals were in contact with the hanger plates on one side and a gap was present on the other. (See Photograph 8)
- Minor impact and rigging damage were observed, but none of the affected members appeared to be substantially distressed.

Element 131 – Painted Steel Deck Truss

- The deck trusses are in satisfactory condition.
- Pack rust up to 3/4" exists between the flanges and flange cover plates of many of the end diagonals. (See Photograph 9)
- There is up to 5/16" pack rust between the lower chords and lower chord splice plates.

Element 152 – Painted Steel Floor Beam

- The floorbeams are generally in satisfactory condition.
- On the through truss spans, pack rust has developed between floorbeam bottom flanges and horizontal gusset plates, typically 1/8" to 1/4". This corrosion is reactivating at some locations.
- The end floorbeam for Span 28 at Pier K-16 has rotated several degrees out of plane. (See Photograph 10)

Element 163 – Truss Connections – Gusset Plate(s) Assembly Painted

- The gusset plates are in satisfactory condition.
- Pack rust has developed between a number of the truss members and primary gusset plates. Thicknesses of 1/8" to 1/4" were most common with isolated instances of up to 1/2".
- As a result of the pack rust accumulation, some of the gusset plates are bowed with 1/8" to 1/2" commonly observed at locations where bowing is present. There are isolated instances of up to 1". (See Photograph 11)

Element 210 – Reinforced Concrete Pier Wall

- The piers are in satisfactory condition.
- The through truss piers commonly have minor cracking with efflorescence present at some locations. Minor delaminations are also present on some of the piers. (See Photograph 12)
- The approach piers have minor cracking and delaminations as well as a few spalls. There is a spall on the downstream end of Pier K-14 that is approaching the masonry plate. (See Photograph 13)
- The bond between a few of the existing patches and pier concrete is failing.
- Debris is present on the pier caps at Pier A and F at the level of the deck truss bearings and on Piers K-16, K-19, and I-2.

Element 215 – Reinforced Concrete Abutment

- The abutments are in good condition.
- There is minor vertical cracking on the abutments.

Element 300 – Strip Seal Expansion Joint

- The strip seal joints are in satisfactory condition.
- The joint seals and armor typically have little to no deficiencies. Light to moderate debris is collecting in the joints.

Element 301 – Pourable Joint Seal

- The pourable joints are in poor condition.
- Joint armor is damaged, cracked, or has missing sections at Pier I-4, Pier I-2, L57, L72, Pier K-15, Pier K-16, Pier K-18, Pier K-19, and Pier K-20. The joint seals are damaged or missing at those locations. (See Photograph 14)
- There are typically minor to significant spalls adjacent to the joint armor. (See Photograph 14)
- The joint armor typically has minor deformations, particularly in the northbound lane.

Element 304 – Open Expansion Joint

- The finger joints are in satisfactory condition.
- There are vertical misalignments of up to 3/4" across the fingers, which is at least in part due to the deterioration of stringers below the joints.
- The joint at L61 has one cracked finger on the south side near the upstream curb. (See Photograph 15)
- The quality of the welds of the support channels for the joints is often poor outside of the fascia stringers. The joints were lengthened when the deck was widened from 20'-0" to 22'-6". Short lengths of channels were added to support the wider joints.

Element 310 – Elastomeric Bearing

- The elastomeric bearings are in satisfactory condition.
- In the curve on the Kentucky Approach, the bearings have significant lateral movement under heavy load, allowing the sole plates to make contact with the keeper plates.
- The upstream bearing on the south end of the suspended portion of Span 22 has walked approximately 1/2" off of the steel. (See Photograph 16)

Element 311 – Moveable Bearing

- The moveable bearings typically in satisfactory condition.
- The bearings typically have light surface corrosion and are functioning as intended. Some of the bearings for the deck trusses have pack rust above and below the rockers and between the sole plate and rocker assemblies. (See Photograph 17)
- The downstream bearing at L0 has multiple cracks on the bearing collar and both upper ends of the block assembly are broken on the inboard side. (See Photograph 18) The bearing audibly pops under moderate to heavy loads.

Element 313 – Fixed Bearing

- The fixed bearings are in satisfactory condition.
- The bearings typically have light surface corrosion and are functioning as intended. Some of the approach bearings have pack rust up to 3/4" thick between the masonry and sole plates, and the corrosion is reactivating in some locations. (See Photograph 19)

Element 331 – Concrete Bridge Railing

- The concrete railing is in satisfactory condition.
- There are minor vertical cracks and evidence of vehicular impacts.

Element 334 – Metal Bridge Railing – Coated

- The metal bridge railings are in poor condition.
- The railing and railing posts are corroding from the inside out, and deterioration is not often visible until a corrosion hole has formed. (See Photograph 20)
- A considerable length of railing has been replaced, and some of the replacement sections have not been painted.
- The blisters that support the railing commonly have full height cracks at the outboard anchor bolts. In many locations, spalls have formed, exposing anchor bolts and occasionally reinforcing steel. (See Photograph 21)

Element 357 – Pack Rust Smart Flag

- Pack rust has developed between the components of built up truss members and between truss members and gusset plates. Much of the pack rust is contained by the 2007 painting, but it is reactivating at some locations.

Element 358 – Deck Cracking Smart Flag

- Light cracking is common in the overlay, and there is a longitudinal crack that runs that majority of the length of the deck trusses in the Kentucky Approach.

Element 362 – Traffic Impact Smart Flag

- There is minor impact damage to a few lower sway struts. A vertical stiffener on the upstream girder in Span 24 is bent, reportedly from a railroad accident.

Element 363 – Section Loss Smart Flag

- Section loss is typically minor and generally occurs from the splash zone down and under joints. Most of the section loss is inactive following the 2007 painting.

Element 503 – Reinforced Concrete Curb

- The concrete curb is generally in satisfactory condition.
- Vertical cracking is present in the curbs, and there are isolated areas of more significant deterioration, most commonly adjacent to joints. (See Photograph 22)

Element 606 – Drains

- Most of the drains were open at the time of the inspection. Debris was present in a few of the drains as well as along the curbs.

Element 607 – Utilities

- The wiring for the navigation lights was replaced since the previous inspection. The new conduit along the back of the downstream curb produces a mild shock when touched at some locations.
- Remnants of the previous conduits, wiring, and junction boxes are present over the length of the through truss. Utility curb boxes are often open and filled with debris, which is trapping moisture within the curb.

Element 609 – Debris on Superstructure

- There is a negligible amount of debris on the truss.

Element 613 – Vegetation

- Vegetation is growing on many of the approach piers, though the amount of growth is typically minor. The upstream nose of Pier K-20 has vegetation the full height. (See Photograph 23)

Other Bridge Components

- The tower ladders have buckled and have some damaged rungs. (See Photograph 24)

RECOMMENDATIONS

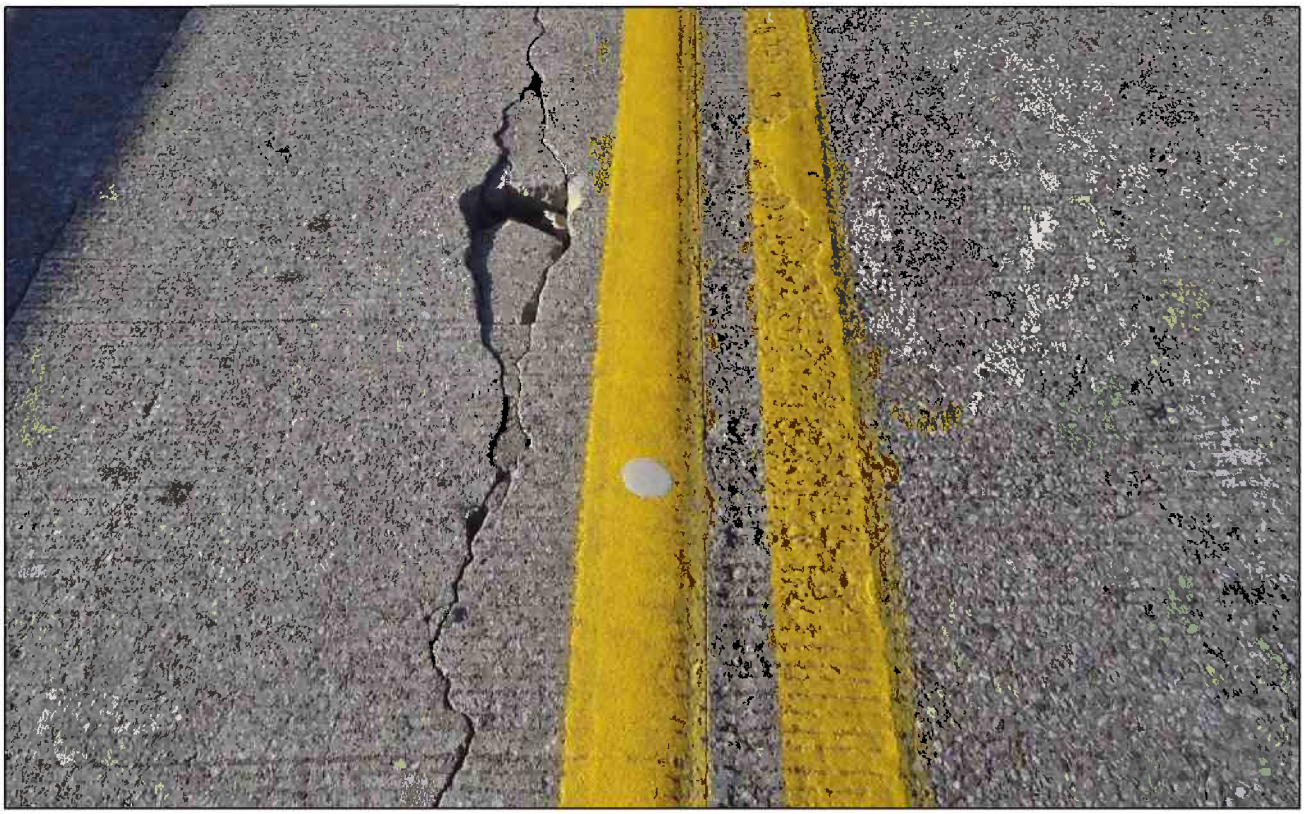
A rehabilitation project is currently in development to address the stringer cracks, damaged joints, and some of the other conditions described above. The recommendations below are provided with the understanding that the rehabilitation will proceed as scheduled in 2013.

- Repair the cracked stringer ends under finger joints and consider performing the same retrofits to the other stringers at those locations.
- Monitor or repair the downstream through truss bearing at L0.
- Patch the spalls in the deck and repair the damaged sections of curb.
- Replace deteriorated joints.
- Repair the cracked finger at the L61 joint.
- Repair the damaged railing supports and replace deteriorated sections of railing.
- Replace the two missing rivets with bolts on the inboard gusset plate at L30, downstream truss.
- Consider replacing the tower ladders.
- Remove the vegetation from the piers.
- Clean out the utility curb boxes and replace missing or damaged covers.
- Clear the drains that have debris and remove debris from the deck.
- Monitor the elastomeric bearing on the upstream side of Span 22 for further movement off the end of the steel.
- Monitor the girder ends and deck truss end verticals at Pier K-9 for distress caused by thermal movements in the girders.

Sincerely,

Scott Ribble, PE
Project Manager

Enclosures
Copy: Mr. Mark E. Bernhardt, PE, Director of Facility Inspection
File



Photograph 1: Looking south at the deck in Span 18 along the centerline. Note longitudinal crack with a spall in the northbound lane near the centerline.

Photograph 2: Looking northeast at the south end of the upstream girder in Span 21. Note that the girder is at its expansion limit and is making contact with the batten plates for the deck truss end vertical.

Photograph 3: Looking northeast at Stringer 1 at Floorbeam 40. Note missing anchor rivet, painted over pitting, and pack rust above and below the stringer bearing plate.

Photograph 4: Looking northeast at Stringer 2 at Floorbeam 61. Note 6 1/8" long crack in stringer web near the fillet to the bottom flange.

Photograph 5: Looking southeast at Stringer 4 at Floorbeam 15. Note intersecting longitudinal and transverse cracks on upstream bottom flange.

Photograph 6: Looking downstream and down at L26-U26, downstream truss. Note 1/4" pack rust between the outboard T section and batten plate.

Photograph 7: Looking northeast at the inboard gusset plate at L30, downstream truss. Note two missing rivets between the vertical and gusset plate.

Photograph 8: Looking south at L27-U27, upstream truss. Note the hanger vertical is shifted fully upstream with gaps between the vertical and downstream hanger plates and between the pin and upstream hanger plates.

Photograph 9: Looking south at U9-L10, upstream truss, in Span 18. Note 5/8" pack rust between outboard flange and cover plate.

Photograph 10: Looking downstream at the floorbeams at Pier K-16. Note the end floorbeam for Span 28 (left) is rotated several degrees from vertical.

Photograph 11: Looking northwest at the outboard gusset plate at L21, downstream truss. Note 1/2" bow in gusset plate due to pack rust development.

Photograph 12: Looking south at Pier 5 at the level of the deck truss bearings. Note cracking, delamination, and efflorescence.

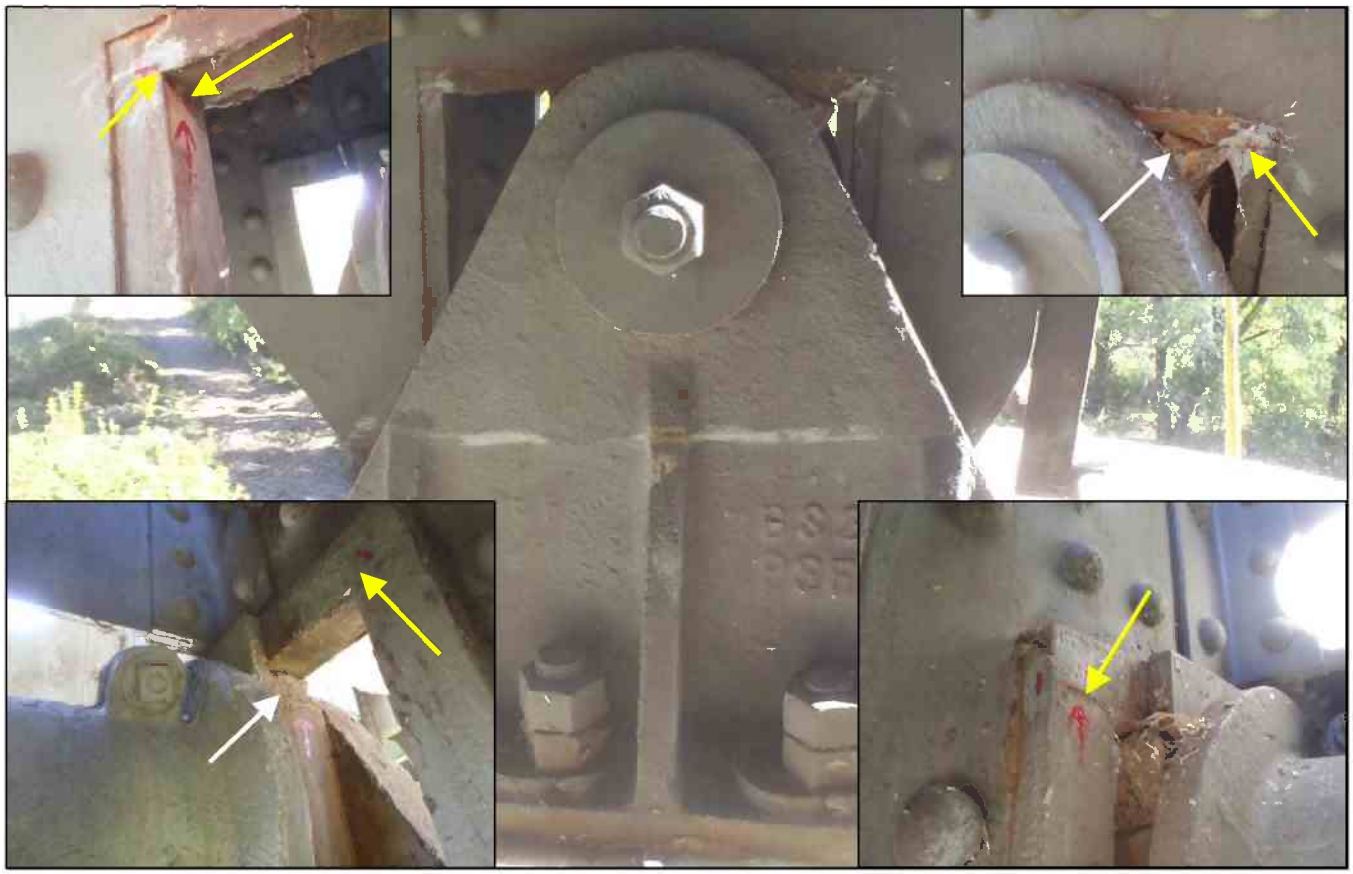
Photograph 13: Looking southwest at the downstream end of Pier K-14. Note delamination and spalling is beginning to encroach on the masonry plate.

Photograph 14: Looking downstream at the joint at Pier K-18. Note missing joint armor, failed joint seal, and patching and spalling adjacent to the joint.

Photograph 15: Looking downstream at the joint at L61. Note cracked finger on the south side near the upstream curb.

Photograph 16: Looking upstream at the elastomeric bearing at the south end of the suspended span over the railroad, upstream side. Note the bearing has walked off the end of the steel.

Photograph 17: Looking downstream at the downstream deck truss bearing on Pier A. Note pack rust above and below the rockers and between the sole plate and rocker assembly.

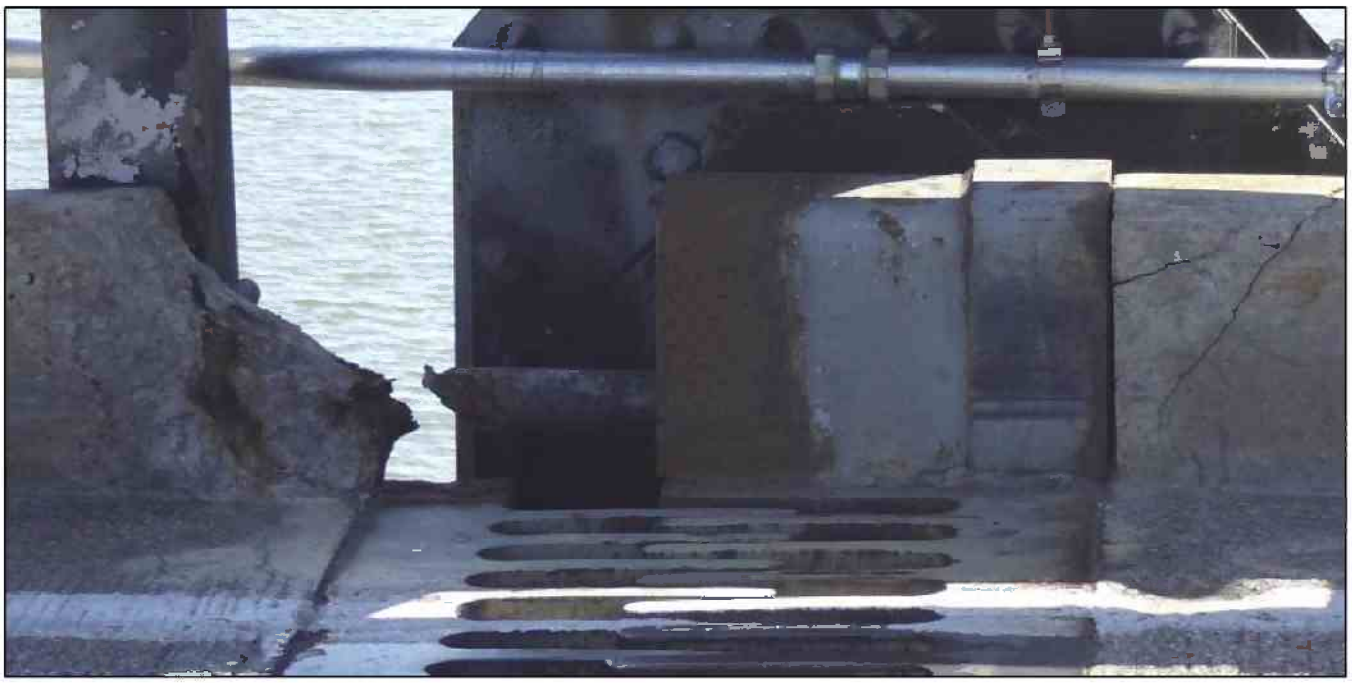


Photograph 18: Looking downstream at the downstream bearing on Pier A (the lower insets are looking upstream). Note cracks in the collar (yellow arrows) and breaks in the block assembly (white arrows).

Photograph 19: Looking southwest at the upstream bearings on Pier K-17. Note 3/4" pack rust between the sole and masonry plates on the north bearing.

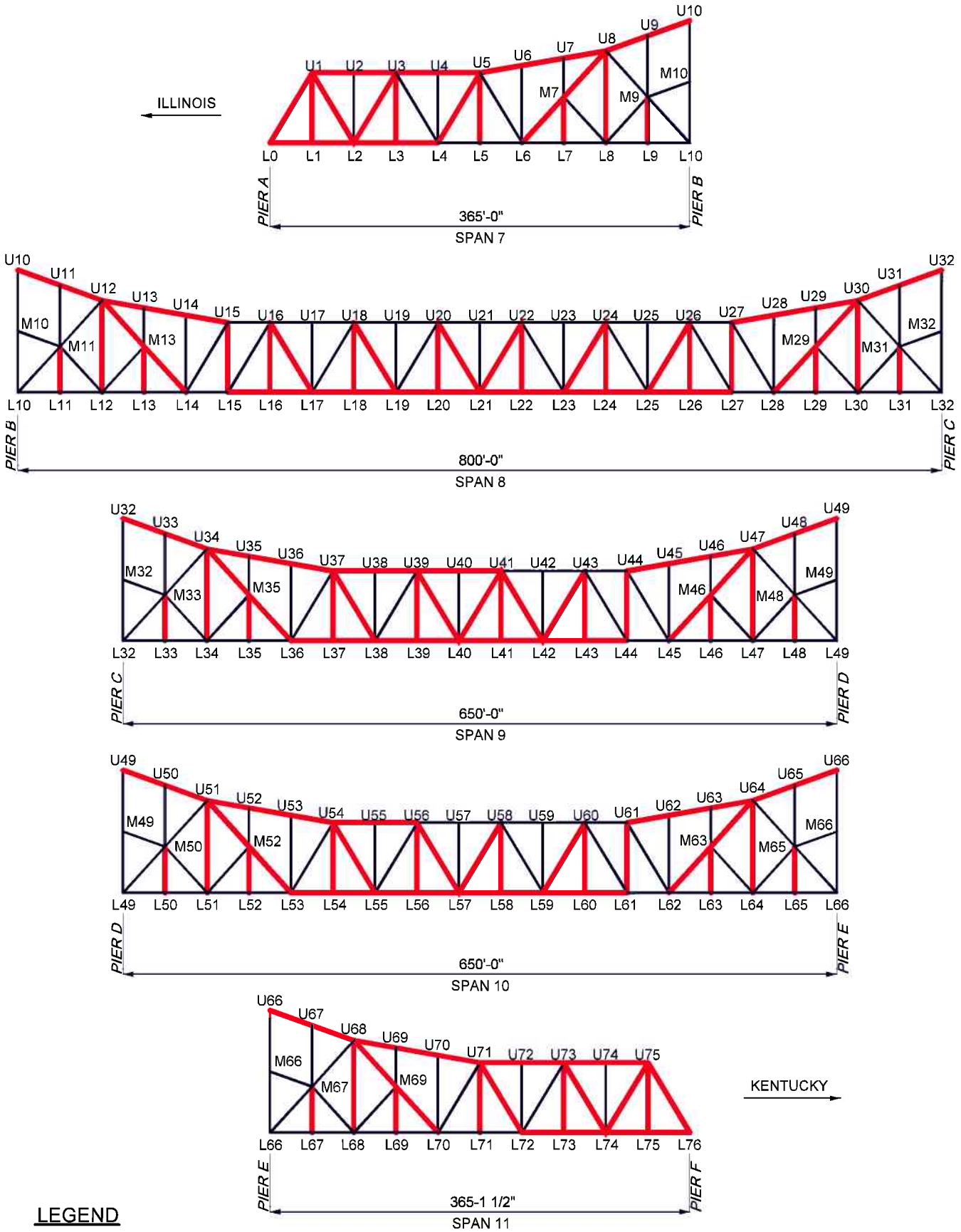
Photograph 20: Looking northeast at the lower railing near L41, upstream truss. Note 8"x3" corrosion hole.

Photograph 21: Looking northeast at the first railing support blister south of L5, upstream truss. Note spalled concrete has exposed two anchor bolts and reinforcing steel.



Photograph 22: Looking downstream at the downstream curb at L44. Note cracked and spalled concrete and missing curb plate on the north side of the joint.

Photograph 23 (left): Looking downstream at the upstream end of Pier K-20. Note full height vegetation.
Photograph 24 (right): Looking downstream and up at the ladder at L32-U32. Note the ladder has buckled over its length.



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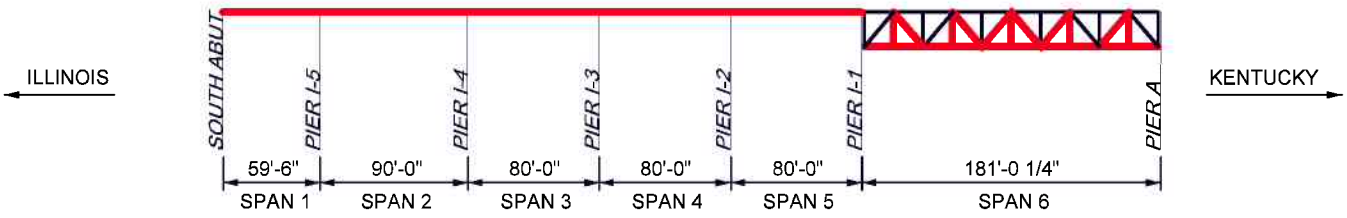
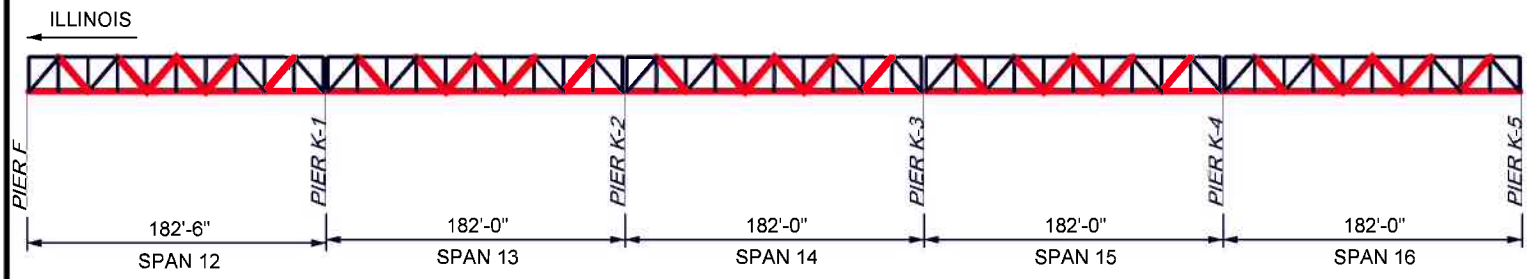
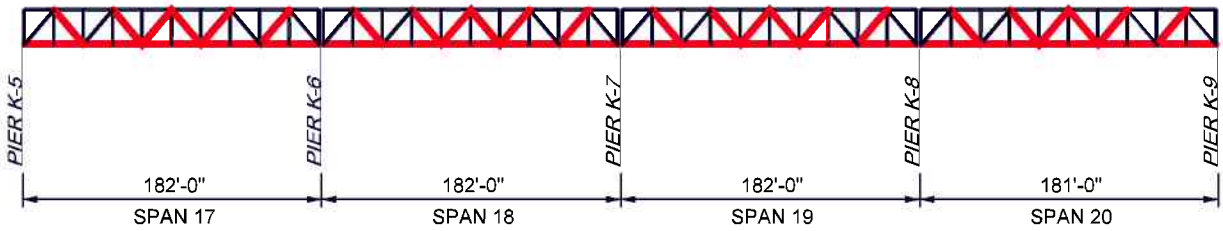
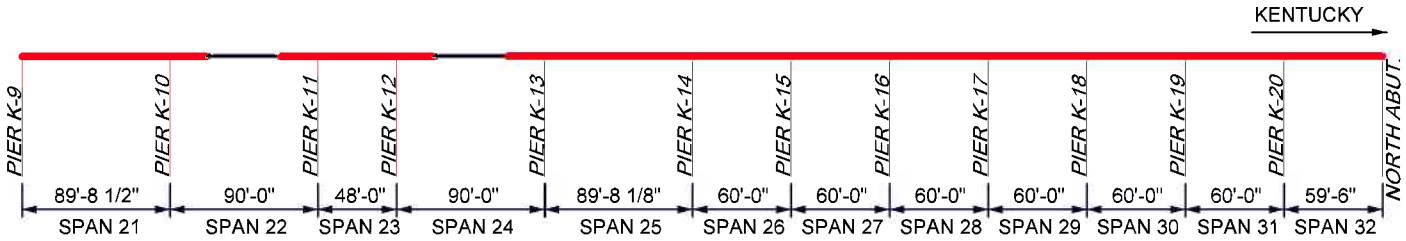
CAIRO BRIDGE OVER THE OHIO RIVER
AT CAIRO, ILLINOIS



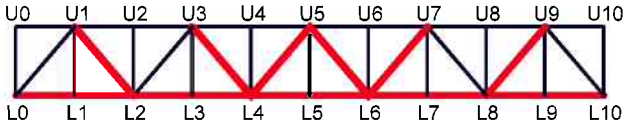
SOUTH APPROACH - ILLINOIS







NORTH APPROACH - KENTUCKY



TYPICAL DECK TRUSS SPANS

SPAN 6 & SPAN 12 THRU SPAN 20

LEGEND

FRACTURE CRITICAL

NON-FRACTURE CRITICAL

BURGESS & NIPLE

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CAIRO BRIDGE OVER THE OHIO RIVER

AT CAIRO, ILLINOIS

APPENDIX C

UNDERWATER INSPECTION

2009

Fuller Mossbarger Scott & May FMSM ENGINEERS

FMSM UNDERWATER BRIDGE INSPECTION FORM

1. Bridge Number: 4-0051-B00021

County: Ballard

Description: 51 Bridge over the Ohio River at Wickliff, KY

Water Body: Ohio River

2. Date Tuesday, December 01, 2009

3. FMSM Project No: 175569090

4. Weather **Temperature:** 40

☐ Sunny ☐ Partly Cloudy ☐ Other

☑ Cloudy ☐ Windy

5. Supervisor: AAC **Crew:** TCB, JAG, FJB

Visitors: **Arrive:** **Depart:**

Visitors **Arrive:** **Depart:**

6. Bridge Type:

☐ Continuous Plate Girder ☐ Suspension ☐ Reinforced Concrete Beam

☑ Steel Truss ☐ Wood Truss ☐ Other

7. Element Type:

☑ Reinforced Concrete ☐ Closed Web ☐ Open Web ☐ Steel Piles

☐ Masonry ☐ Timber Piles ☐ Other

8. Foundation Type

☐ Pile with pile cap ☐ Pile without pile cap Pier founded on rock ☐ or soil ☐

☐ Caisson ☑ Spread footing ☑ Other

9. Previous Report Available ☑ **Dates of Report:** 1991,1996,2001,2004

Originator: FMSM

10. Construction or As-Built Plans and/or Reports Available ☑ **Dates:** 1936

11. Water surface reference point on Pier or Bridge

Pier C, Bottom of middle web

Reference Point Elevation: 327 **Distance to Water** 30 **Water Elevation:** 297

12. Pictures Taken

1. Pier B Looking East
2. Pier C Looking East
3. Pier D Looking East
4. Pier E Looking East
5. Pier F Looking East
6. Planview Looking Downstream
7. Planview Looking Upstream

Fuller Mossbarger Scott & May FMSM ENGINEERS

FMSM UNDERWATER BRIDGE INSPECTION FORM

Bridge Number: 4-0051-B00021

Date: Tuesday, December 01, 2009

GPS Data 12/1/2009

13. Cross Sections:

	5'	10'	25'	50'	100'
☑ Upstream	☐	☑	☐	☑	☐
☑ Downstream	☐	☑	☐	☑	☐

View Point L to R Looking: ☑ Upstream ☐ Downstream

Benchmark Location: _____

Benchmark Coordinates Northing _____ Easting _____ Elevation _____

14. Scour:

a. Scour pockets or troughs ☑ No ☐ Yes _____

b. Footing or Foundation Element Exposed ☐ No ☑ Yes Pier F

c. Scour increased since last inspection ☑ No ☐ Yes ☐ No Previous Report Available

d. Comments: _____

15. Pier/Element Conditions: (see field notes for detailed description)

☑ Biological Growth Light to Moderate ☐ Zebra Mussel Growth _____

☑ Spalling See Notes ☐ Honeycombing _____

☑ Scaling Light to Moderate ☐ Reinforcing Steel Exposed _____

☑ Vertical Cracks ☑ Hairline ☑ Measurable 1/8" - 1/4"

☐ Horizontal Cracks ☐ Hairline ☐ Measurable _____

☑ Impact Damage ☑ Minor ☐ Major _____

☐ Pier Faces not Inspected List Piers _____

Reason for not inspecting _____

☐ Other: _____

16. Heavy debris located around element ☑ No ☐ Yes, elements _____

17. Bottom Conditions:

☑ Silt ☐ Gravel ☑ Boulders ☐ Clay ☑ Debris

☑ Sand ☐ Cobbles ☐ Bedrock, type _____

Debris:

☑ Sticks ☑ Tree Limbs ☑ Trees ☑ Timbers ☐ Steel Beam

☑ Construction Debris ☑ Waste Concrete ☐ Other: _____

Fuller Massbarger Scott & May FMSM ENGINEERS

FMSM UNDERWATER BRIDGE INSPECTION FORM

Bridge Number: 4-0051-B00021

Date: Tuesday, December 01, 2009

18. Inspection Method

☑ Surface Supplied Air ☐ Scuba ☐ Wading ☐ Other

19. Bridge Access

a. Boat: ☐ Skiff ☐ Whaler ☐ Jonboat ☐ Monark ☑ Other: Lobell

Ramp: ☑ Concrete ☐ Gravel ☐ Dirt ☐ None ☐ Ramp fee

Locked Through ☑ No ☐ Yes

Distance from ramp to bridge: 2 miles **Travel time:** 15 minutes

Comments / Directions: Boat ramp located on the KY side at the Ohio / Mississippi confluence.

b. Bank/Shore: ☑ Grass ☐ Rock ☐ Gravel ☐ Dirt/Mud ☐ Other

20. Boat Traffic

a. Recreational: ☐ Heavy ☐ Moderate ☑ Light ☐ N/A

b. Fishing: ☐ Heavy ☐ Moderate ☑ Light ☐ N/A

c. Barge: ☑ Heavy ☐ Moderate ☐ Light ☐ N/A

Comments:

21. Water Conditions:

Temperature: 55 Degrees F **Visibility:** 1.0

Current: ☑ Heavy ☐ Moderate ☐ Light ☐ None

22. General Comments (Include any unusual conditions encountered):

Structure 4-0051-B00021 County Ballard Date 12/1/2009

Description Pier B Looking East Crew AAC, TCB, JAG, FJB

Photos

Fuller Mossbarger Scott & May ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Description Pier C Looking East **Crew** AAC, TCB, JAG, FJB

Photos

Fuller Mossbarger Scott & May ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Description Pier D Looking East **Crew** AAC, TCB, JAG, FJB

Photos

Fuller Mossbarger Scott & May ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Description Pier E Looking East **Crew** AAC, TCB, JAG, FJB

Photos

Structure 4-0051-B00021 County Ballard Date 12/1/2009

Description Pier F Looking East Crew AAC, TCB, JAG, FJB

Photos

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Description Planview Looking Downstream **Crew** AAC, TCB, JAG, FJB

Photos

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

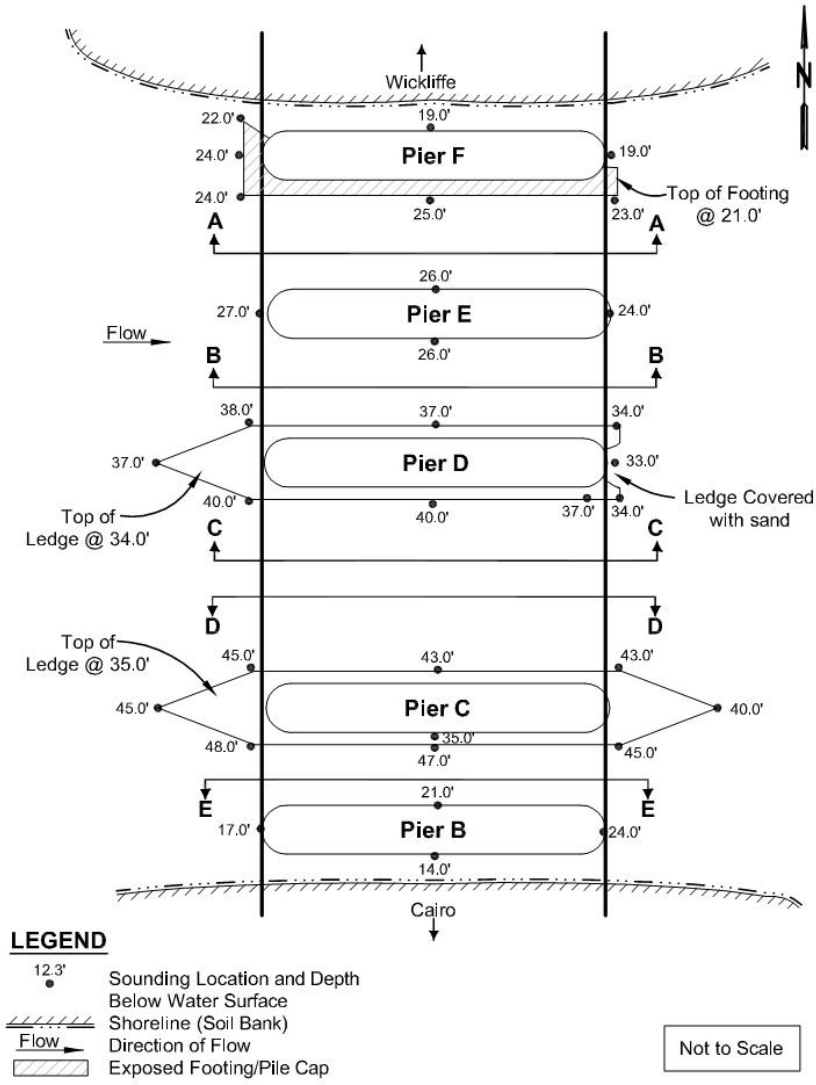
Description Planview Looking Upstream **Crew** AAC, TCB, JAG, FJB

Photos

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure	4-0051-B00021	**County**	Ballard	**Date**	12/1/2009
Description	Planview	**Crew**	AAC, TCB, JAG, FJB		

NOTE: All depths refer to depth below water surface at time of inspection



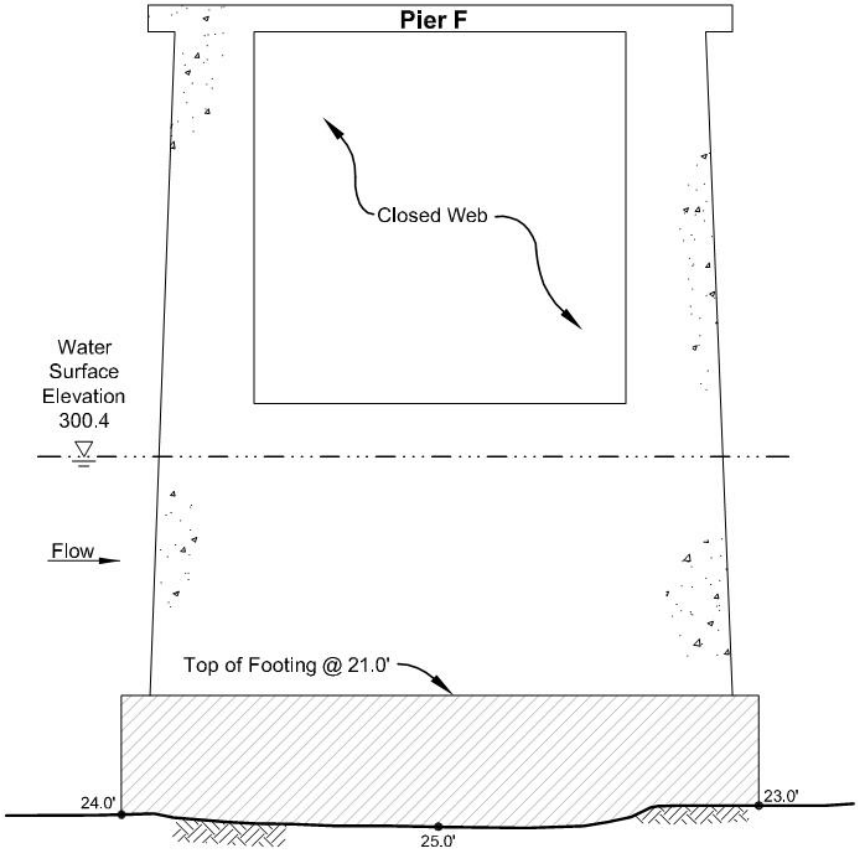
Plan View

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **Element** Pier F **Date** 12/1/2009

NOTE: All depths refer to depth below water surface at time of inspection

Individual Pier Rating



LEGEND

12.3' Sounding Location and Depth Below Water Surface
Water Surface
Direction of Flow
Concrete
Soil Channel Bottom
Exposed Footing/Pile Cap

Not to Scale

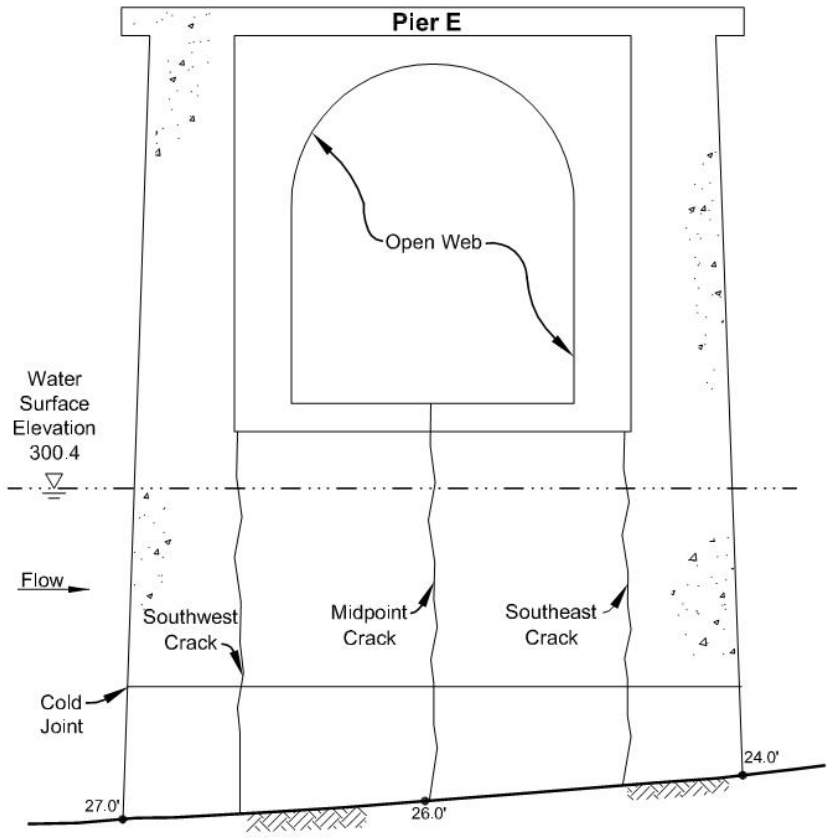
Section A-A

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **Element** Pier E **Date** 12/1/2009

NOTE: All depths refer to depth below water surface at time of inspection

Individual Pier Rating _____



LEGEND

12.3' Sounding Location and Depth Below Water Surface
Water Surface
Direction of Flow
Concrete
Soil Channel Bottom

Not to Scale

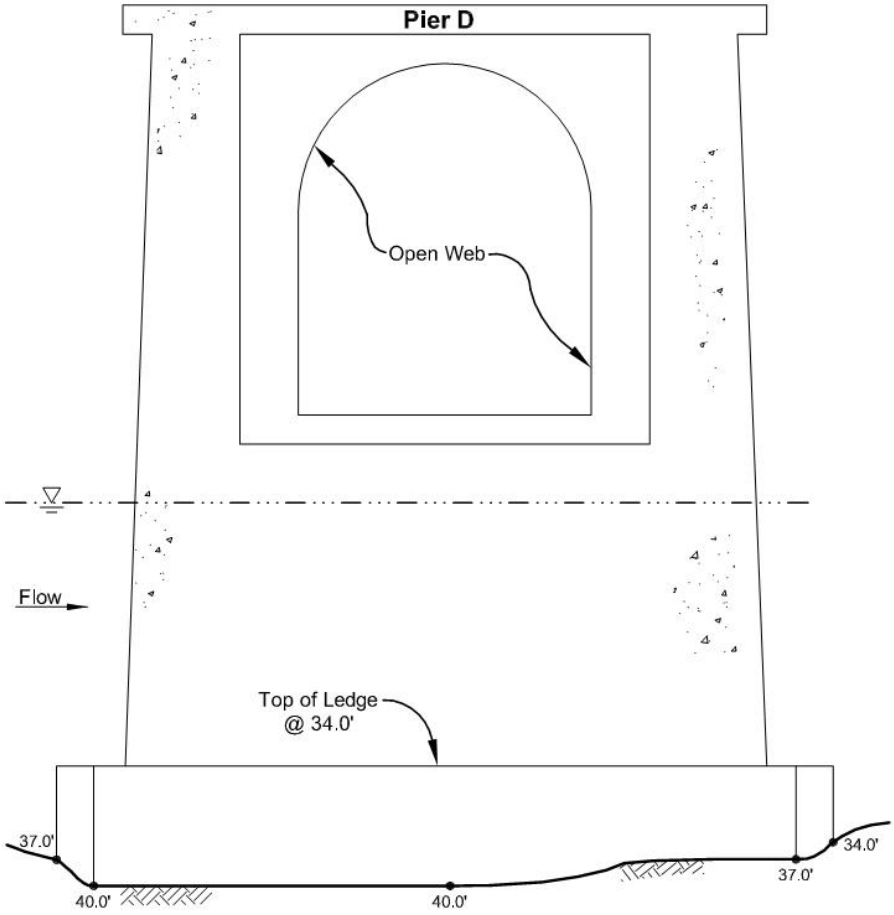
Section **B-B**

Fuller Mossbarger Scott & May ENGINEERS

Structure 4-0051-B00021 **Element** Pier D **Date** 12/1/2009

NOTE: All depths refer to depth below water surface at time of inspection

Individual Pier Rating



LEGEND

12.3' Sounding Location and Depth Below Water Surface

Water Surface

Direction of Flow

Concrete

Soil Channel Bottom

Not to Scale

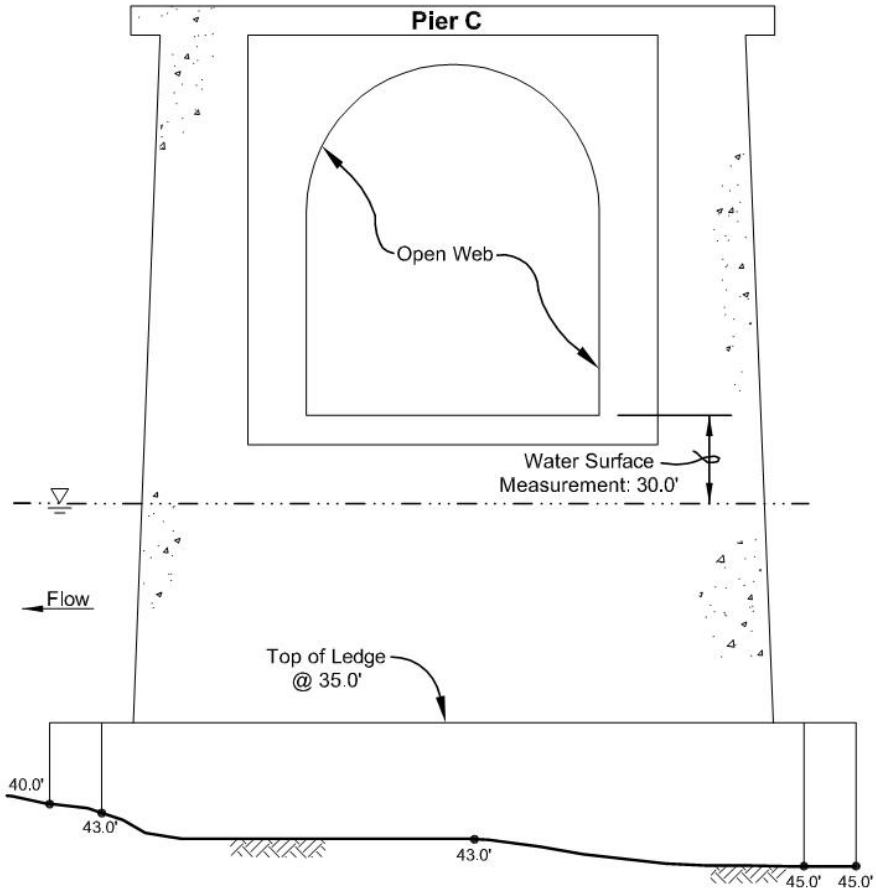
Section C-C

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **Element** Pier C **Date** 12/1/2009

NOTE: All depths refer to depth below water surface at time of inspection

Individual Pier Rating _____



LEGEND

12.3' Sounding Location and Depth Below Water Surface
Water Surface
Direction of Flow
Concrete
Soil Channel Bottom

Not to Scale

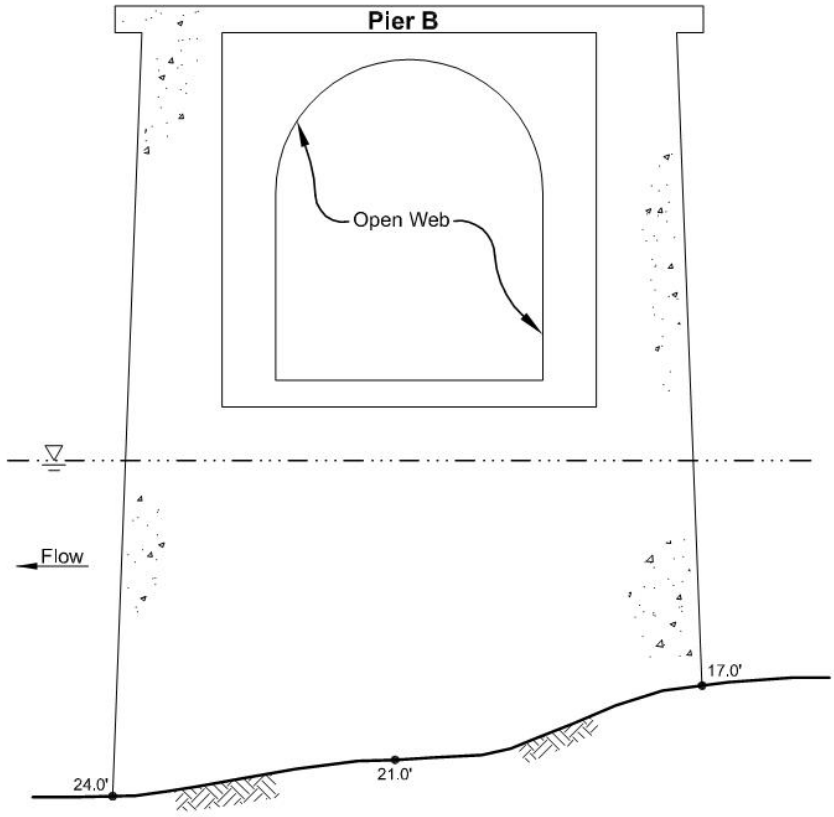
Section D-D

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **Element** Pier B **Date** 12/1/2009

NOTE: All depths refer to depth below water surface at time of inspection

Individual Pier Rating _____



LEGEND

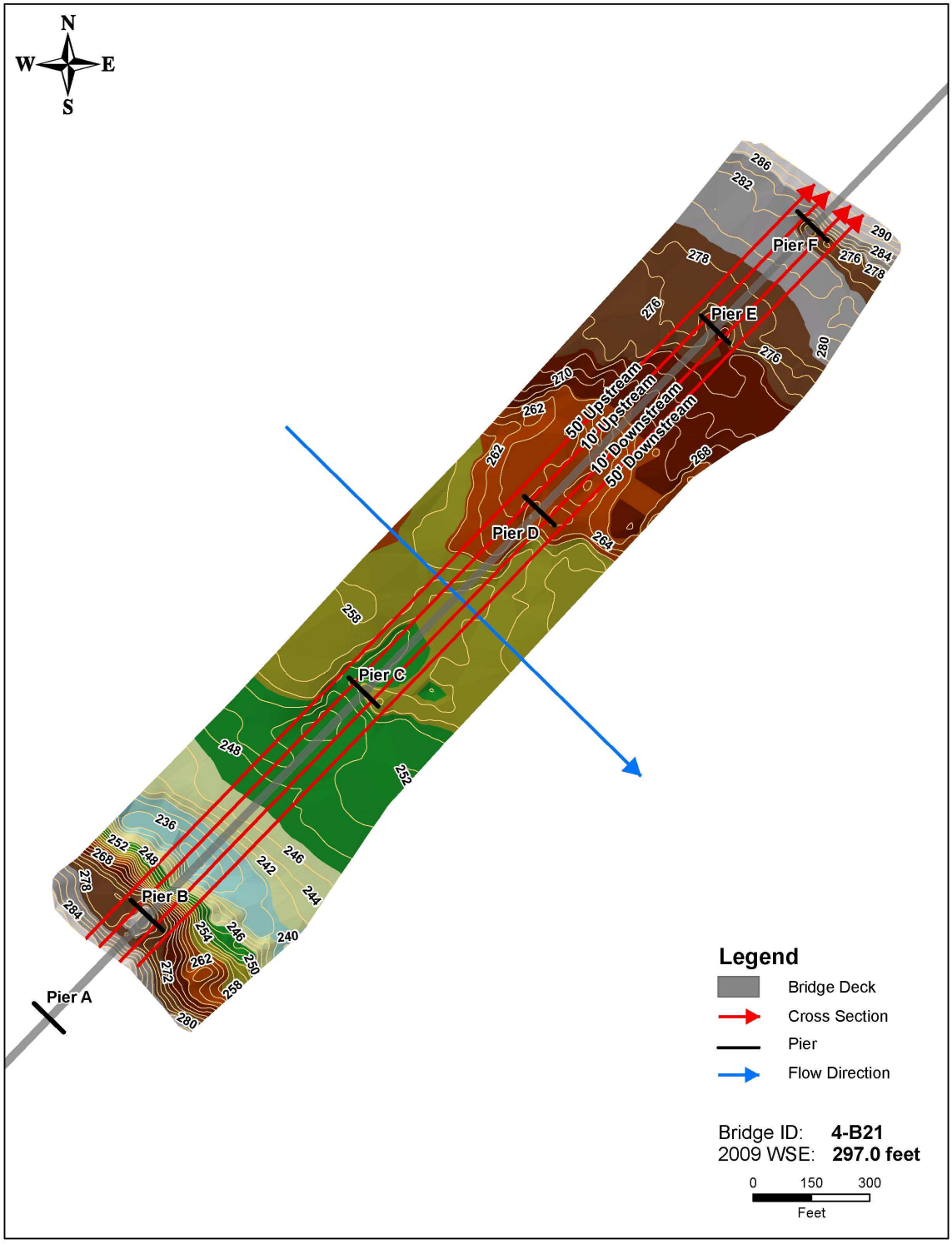
12.3' Sounding Location and Depth Below Water Surface
Water Surface
Direction of Flow
Concrete
Soil Channel Bottom

Not to Scale

Section **E-E**

Fuller Massbarger Scott & May FMSM ENGINEERS

Structure	4-0051-B00021	**County**	Ballard	**Date**	12/1/2009
Description	Hydrographic Survey Overview			**Crew**	AAC, TCB, JAG, FJB

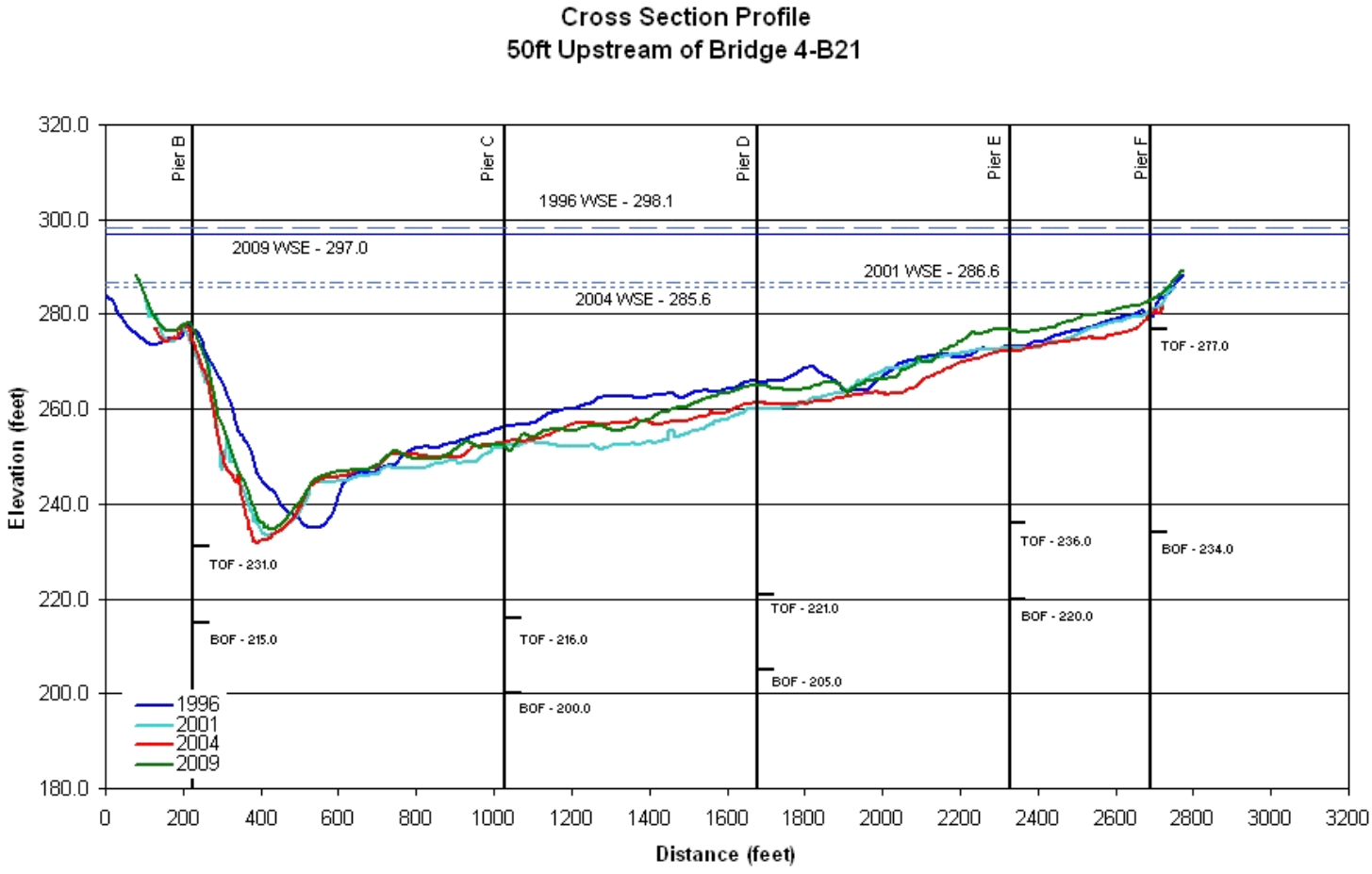


Cross Sections

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Description 50 Ft. Upstream **Crew** AAC, TCB, JAG, FJB

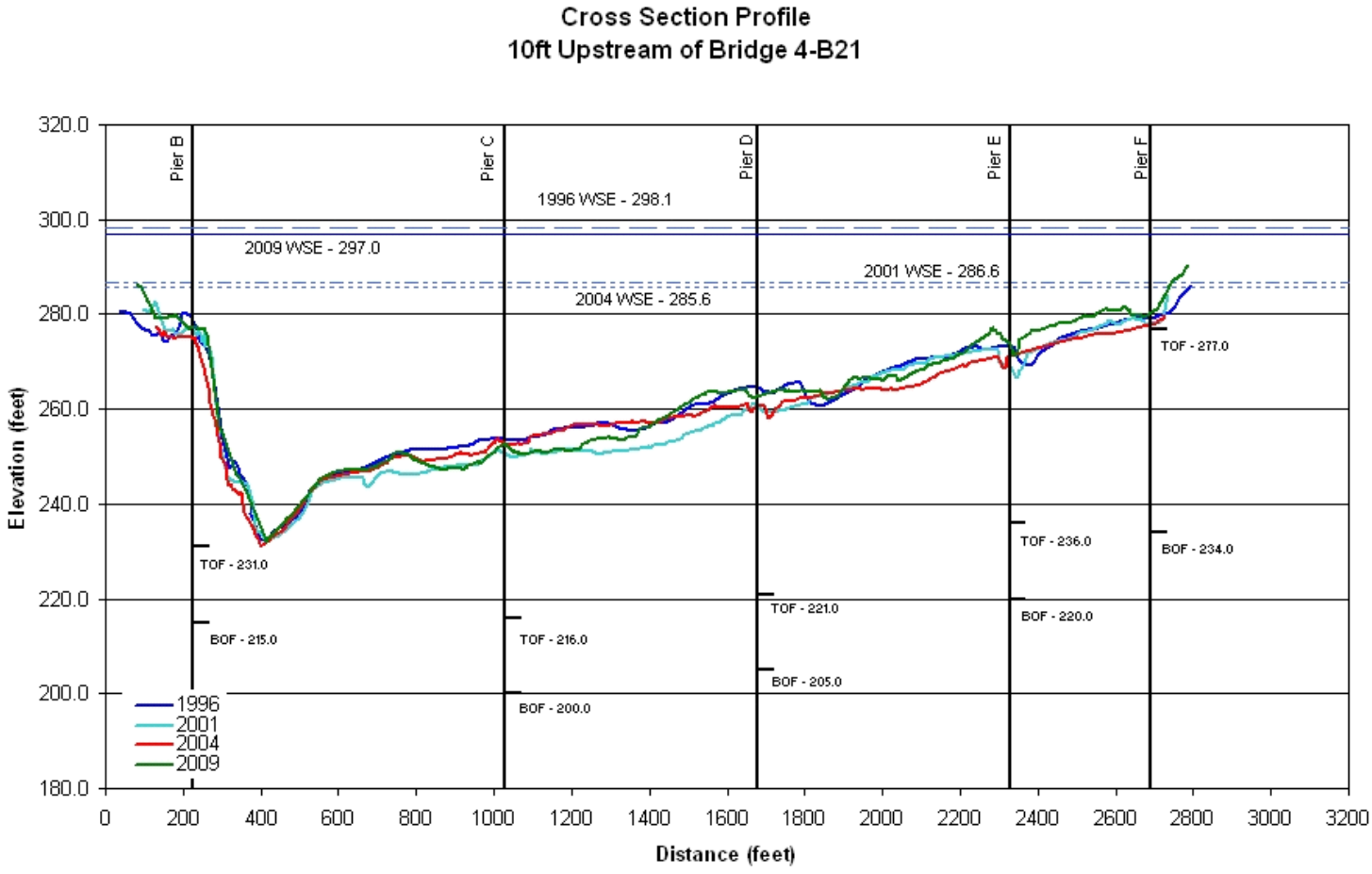


View Aspect: Facing Upstream

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

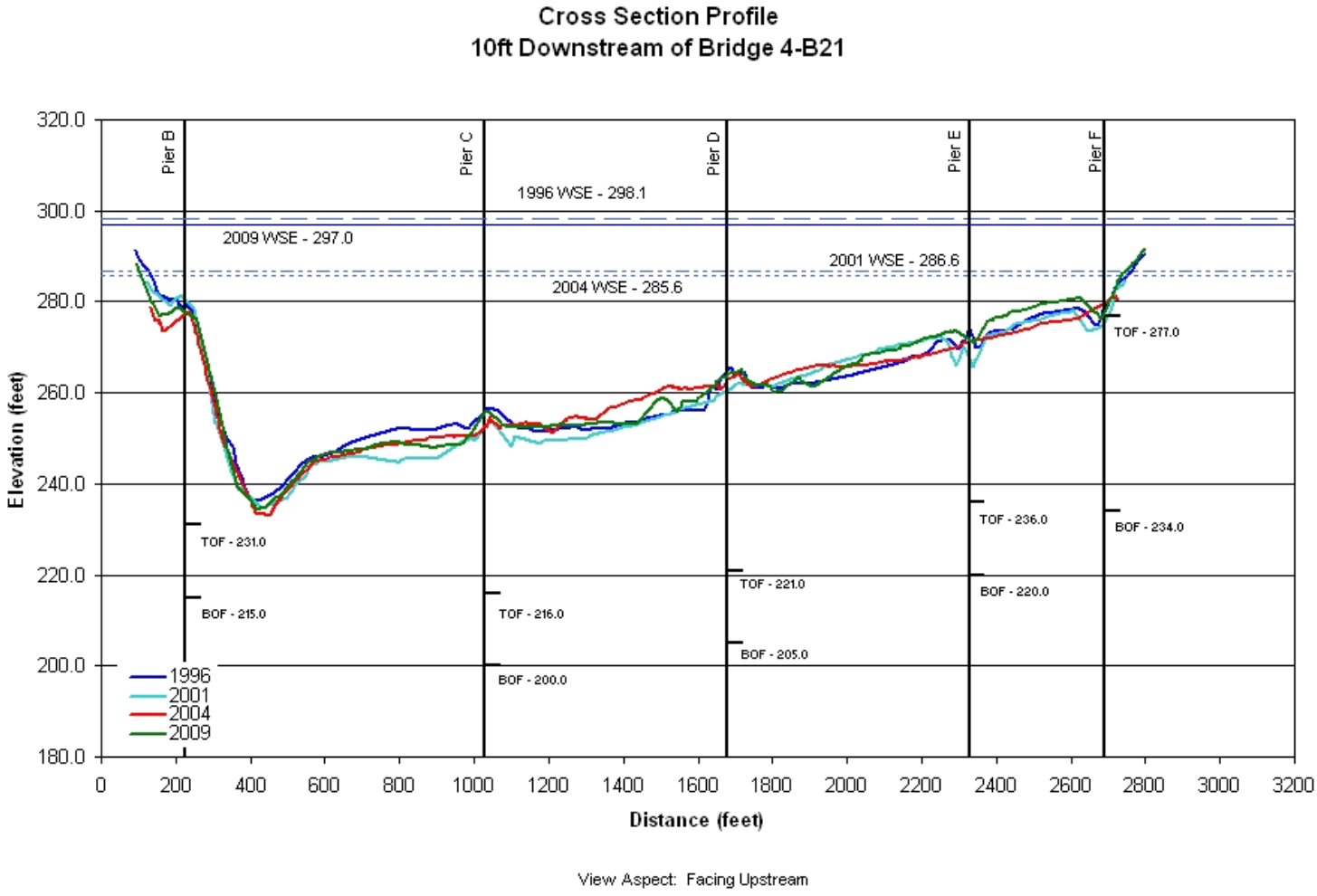
Description 10 Ft. Upstream **Crew** AAC, TCB, JAG, FJB



View Aspect: Facing Upstream

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure	4-0051-B00021	**County**	Ballard	**Date**	12/1/2009
Description	10 Ft. Downstream			**Crew**	AAC. TCB. JAG. FJB

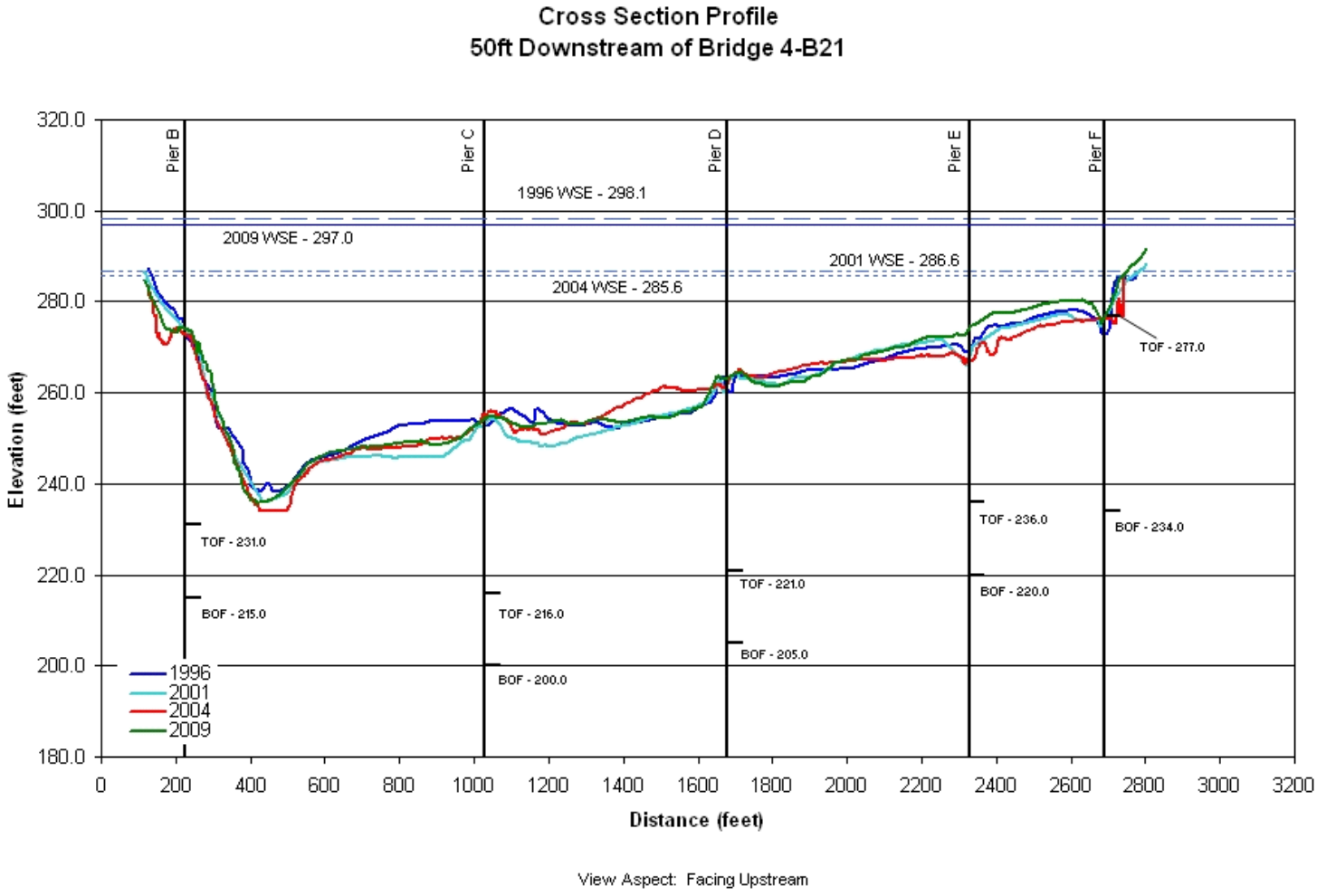


View Aspect: Facing Upstream

Fuller Mossbarger Scott & May FMSM ENGINEERS

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Description 50 Ft. Downstream **Crew** AAC. TCB. JAG. FJB



View Aspect: Facing Upstream

Structure 4-0051-B00021 County Ballard Date 12/1/2009

Crew AAC. TCB. JAG. FJB

Route 51 over the Ohio River at Wickliff, KY

Pontis Underwater Only

Item - 205 Qty - 10 EA
Condition State - 2 = 10 EA

Item - 220 Qty - 1 EA
Condition State - 2 = 1 EA

General

1. There is light to moderate scaling on the pier below the water surface.
2. There is light to moderate biological growth on the pier. Zebra mussel coverage is very light.

Pier B

1. The bottom material consists of sand, gravel and rip rap.
2. There is a hairline vertical crack located at the midpoint of the West face that begins above water surface and extends to the river bottom.
3. There is a hailine to 1/8" wide vertical crack located on the North face at the Northeast corner extending from above the water surface to the river bottom.
4. There is a hairline to 1/8" vertical crack located on the East face at the Southeast corner extending from above the water surface to the river bottom.
5. There is a hairline vertical crack located on the South face at the Southwest corner extending 1.0' above the water surface to the river bottom.

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Crew AAC. TCB. JAG. FJB

Route 51 over the Ohio River at Wickliff, KY

Pier C

1. The bottom material consists of medium to coarse sand with boulders and construction debris.
2. The top of the ledge is located 35' bws.
3. There is approximately 40% of the original timber formwork still attached around the ledge.
4. There is a vertical hairline crack located on the East face in the center extending 6' bws to 15' bws.
5. There is a 3" T x 12" L x 1" D impact mark located on the Southeast corner.
6. There are several tie holes and pieces of rebar at 33' and 35' bws on the North face.
7. There is a 4" diameter hole located in the center of the web at 36' bws on the North face.
8. There is a vertical hairline crack on the North face located 2.0' East of West corner of open web, extending from the opening in the web to 17' bws.
9. There is a vertical crack at Northeast corner of pier beginning 6' bws and extending 16.5' bws.
10. There is a piece of rebar protruding 6" out from the pier located 31' bws in the midpoint of the pier on the North face.
11. There is a section of spalling 6" diameter at located at 30.5' on the North face.
12. There are several pieces of rebar protruding 6" out from pier 1/4 way from each end of the South face located at 31' and 34' bws.
13. There is a vertical hairline crack on the South face located 2.0' East of West corner of the open web and extends from open web to 18.5' bws.
14. There is a vertical hairline crack on the South face located in center of face extending 7.5' bws to 21' bws.
15. There is a vertical hairline crack on the South face located 2.0' West of East corner of the open web, extending 15' bws.
16. There is a vertical hairline crack located on the West face at the Southwest corner of pier extending 7' bws to 15.5' bws.
17. There is a piece of rebar protruding 6" out from the pier located 31' bws in the Northwest corner of the pier on the West face.

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Crew AAC. TCB. JAG. FJB

Route 51 over the Ohio River at Wickliff, KY

Pier D

1. The bottom material consists of sand, gravel, and riprap.
2. There is a ledge located at 34' bws.
3. There is approximately 10% to 20% of the timber formwork still attached to the ledge.
4. There is a hairline to 1/8" wide vertical crack located at the midpint of the Northeast face and begins at the water surface and extends 10' bws.
5. There is a hairline to 1/8" wide crack located at the midpoint of the West face, above the water surface and extends to the ledge.
6. There is a piece of rebar protruding 1' out from the pier located 31.5' bws on the Northeast corner.
7. There is a large amount of 1" to 1.5" diameter wire rope located on the Northeast corner on the river bottom.
8. There is a piece of rebar protruding 1.0' out from the pier located 14' bws at the midpoint of the pier.
9. There is a 1/8" to 1/4" wide crack located on the North face 10.0' West of the Southwest corner and is located 6.0' above the water surface and extends 5' bws on the Northeast corner. There is spalling around the crack of 1/2" to 1".
10. There is a hairline to 1/8" wide crack located on the North face 12.0' East of Northwest corner. The crack begins above the water suface and extends to the ledge.
11. There is a hairline to 1/8" crack located on the North face at the midpoint of the web. The crack begins above the water surface and extends 13' bws. There are areas around the crack with a maximum spall of 1".
12. There is light spalling located in various locations of the face near cold joints.
13. There is a piece of rebar protruding 6" out from the pier located 28.0' on the Southeast corner.

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Crew AAC. TCB. JAG. FJB

Route 51 over the Ohio River at Wickliff, KY

Pier E

1. The bottom material consists of sand, boulders and riprap.
2. There is a hairline crack at the midpoint on the East face located 15' bws and extends to the mudline.
3. There is a hairline to 1/8" crack that starts at mudline and ends at 22' bws. The crack is located on the North face 10.0' downstream of the Northwest corner.
4. There is a hairline vertical crack on the North face located at the midpoint of the pier beginning above the water surface and extends 18.5' bws.
5. There is a 1/8" to 1/4" wide vertical crack on the North face located 3.0' East of Northwest corner beginning above the water surface and extending 20.5' bws.
6. There is a piece of rebar extending 1" out of pier, located at the midpoint of the North face 3.0' above the river bottom.
7. There is a hairline crack on the North face located on the Northeast corner extending from the river bottom to 3.0' above the bottom to a hole 1" deep.
8. There is a 3/4" wide vertical crack located 1.0' north of West point. The crack begins 2' bws and extends 22' bws.
9. There is a 1/2" wide vertical crack with spalling around the crack up to 2" located at the midpoint of the South face of the pier, extending from river bottom to above the water surface.
10. There is a 1/2" wide vertical crack on the South face located on the Southeast corner, extending from above the surface to the river bottom.

Structure 4-0051-B00021 **County** Ballard **Date** 12/1/2009

Crew AAC. TCB. JAG. FJB

Route 51 Bridge over the Ohio River at Wickliff, KY

Pier F

1. The bottom material consists of silt and sand.
2. The top of the footing is exposed from the Northwest corner arund the South face unitl it reaches the midpoint of the East face. The top of the footing is located 21' bws.
3. There is a hairling to 1/8" crack located on the West face at midpoint of the pier that starts at the footing and extends above the water surface.
4. There is a hairline to 1/8" crack at the midpoint of the face that starts at the footing and goes to 2' bws.
5. There is approximately 20% of the timber formwork remaining around the exposed portions of the footing.
6. There is a hairline crack on the south face of the pier extending above the water surface to the mudline.

Transportation Cabinet
Division of Operations

TC 71-118
Rev. 1/96

BRIDGE INSPECTION REPORT

Reviewed By:
Review Date:

Two Yr ☐ Substd ☐ Underwater ☑ In-Depth ☐ Fracture Critical ☐

Project No: 4-0051-B00021 NBI-Location: 51 over Ohio River at Wickliff, KY

Structure Description Steel Truss

Milepoint: 7.35 Inspectors Initials AAC

Inspector's Signature Date: 12/1/2009

58	DECK	
1	Structural Condition	
2	Wearing Surface	
3	Joints	
4	Drains	
5	Expansion Devices	
6	Curbs, Sidewalks, Medians	
7	Railings	
8	Lighting and/or Utilities	

59	SUPERSTRUCTURE	
1	Stringers, Girders, Beams	
2	Floor Beams	
3	Trusses - Main Members	
3a	Trusses - Bracing, Portals	
4	Bearing Devices	
5	Alignment/Structural Members	
6	Deflection/Vibration under load	
7	Debris on Members	

59A	PAINT CONDITION		
Color:		Date Painted:	

60	SUBSTRUCTURE	
1	Abutments, Wingwalls	
2	Piers and/or Bents:	
3	Alignment and/or Settling	
4	Scour, Erosions	
5	Debris on Seats, Caps	
6	Protection Systems	
7	Abutments, Wingwalls (S.Z.D.)	N
8	Piers /or Bents (S.Z.D.)	5
9	Alignment or Settling Due to Scour	

61	CHANNEL/CHANNEL PROTECTION	
1	Channel Scour	
2	Embankment Erosion	
3	Drift	
4	Channel Alignment	
5	Vegetation	
6	Erosion	
7	Rip-Rap	

62	CULVERT _RETAINING WALLS	
1	Barriers	
2	Wingwalls, Headwalls	
3	Debris	
4	Scour Under Footings (Underwater)	
5	Erosion At Wingwalls (Underwater)	
6	Drainage Adequacy (Underwater)	

10 INVENTORY ROUTE VERTICAL CLEARANCES

Over ft in.
Under ft in.

36. TRAFFIC SAFETY

71	WATER ADEQUACY	
72.	APPROACH ROADWAY ALIGNMENT	

113	SCOUR CRITICAL BRIDGE RATING	5

108 WEARING SURFACE/PROTECTIVE SYSTEM

Type Membrane Protection

OVERLAY ☐ Yes ☐ No Date:

TYPE: LATEX ☐ P.C.C. ☐ ASPHALT ☐

DEPTH OF ASPHALT

RECOMMENDED LOAD CAPACITIES (tons) I II III IV GROSS

FIELD POSTINGS NE SW I II III IV GROSS

Additional Comments

There are multiple significant cracks located at various locations on the piers. Cracks have been sealed above the water surface. Recommend that significant cracks be sealed below the water surface.

APPENDIX D

NBIS CONDITION RATING

SUMMARY

2012 TO 1997

US 51 Cairo Bridge over the Ohio River
Summary of Condition Ratings from 2012 to 1997

		2012	2010	2008	2005	2004	2003	2002	2001	2000	1999	1998	1997
58	**Deck**	**6**	**7**	**7**	**6**	**6**	**6**	**6**	**6**	**5**	**5**	**5**	**6**
1	Structural Condition	6	7	7	6	6	6	6	6	7	5	6	7
2	Wearing Surface	6	7	7	6	6	6	6	6	7	4	4	4
3	Joints	5	6	6	6	6	6	6	6	6	6	6	4
4	Drains	6	6	7	5	5	5	5	6	6	5	6	7
5	Expansion Devices	6	6	6	6	6	4	6	6	4	4	5	4
6	Curbs, Sidewalks	6	6	6	6	6	6	6	6	6	6	6	6
7	Railings	4	4	4	7	6	6	6	6	5	5	5	6
8	Lighting or Utilities	7	6	5	8	8	8	8	8	8	8	8	8

59	**Superstructure**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**5**	**5**	**5**	**6**
1	Stringers, Girders, Beams	6	6	5	6	6	6	6	6	5	5	5	5
2	Floor Beams	6	7	7	6	6	6	6	6	6	6	6	6
3	Trusses – Main Members	6	6	6	6	6	6	6	6	6	6	6	7
3a	Trusses – Bracing, Portals	7	7	7	6	6	6	6	6	6	6	6	5
4	Bearing Devices	6	6	6	5	5	5	6	6	6	6	6	5
5	Alignment/ Structural Members	7	7	7	7	7	7	7	7	7	7	7	6
6	Deflection/ Vibration under Load	7	7	7	7	7	7	7	7	7	7	7	7
7	Debris on Members	8	8	8	8	8	8	8	8	8	8	8	6

			2012	2010	2008	2005	2004	2003	2002	2001	2000	1999	1998	1997
59A	**Paint Condition**		**7**	**8**	**8**	**4**	**4**	**5**	**6**	**6**	**6**	**6**	**6**	**5**
Color	Gray	**Date Painted**	Nov-07	Nov-07	Nov-07	Oct-86	Oct-86	Oct-86	Oct-86	Oct-86	Oct-86	Oct-86	Oct-86	Oct-86

60	**Substructure**	**6**	**7**	**7**	**6**	**6**	**6**	**6**	**6**	**5**	**5**	**5**	**6**
1	Abutments, Wingwalls	6	7	7	6	6	6	6	6	6	6	6	5
2	Piers/ or Bents	6	6	6	6	6	6	6	6	5	4	4	4
3	Alignment/ or Settling	7	7	7	7	7	7	7	7	7	7	7	6
4	Scour, Erosions	7	7	7	7	7	7	7	7	7	7	7	7
5	Debris on Seats, Caps	7	7	7	5	5	5	5	5	6	6	7	6
6	Protection Systems	N	N	N	N	N	N	N	N	N	N	N	7
7	Abutments, Wingwalls (S.Z.D.)	N	N	-	N	-	N	-	N	-	N	-	-
8	Piers/ or Bents (S.Z.D.)	N	N	-	N	-	N	-	N	-	N	-	-
9	Alignment or Settling Due to Scour	N	N	-	N	-	N	-	N	-	N	-	-

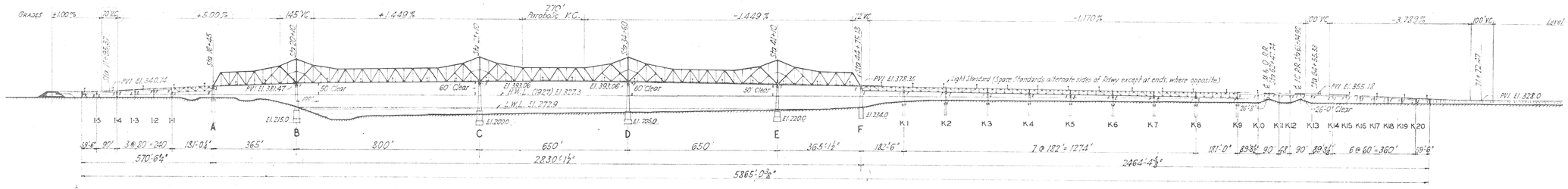
61	**Channel/Channel Protection**	**7**	**7**	**7**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**6**	**7**
1	Channel Scour	7	7	7	7	7	7	7	7	7	7	7	7
2	Embankment Erosion	7	7	7	6	6	6	6	6	6	6	6	7
3	Drift	7	7	7	6	6	6	6	6	6	6	6	7
4	Channel Alignment	8	8	8	8	8	8	8	8	8	8	8	7
5	Vegetation	7	7	7	5	6	7	7	7	7	7	7	7
6	Erosion Control System	N	N	N	N	N	N	N	N	N	N	N	N
7	Rip-Rap	N	N	N	N	N	N	N	N	N	N	N	N

APPENDIX E

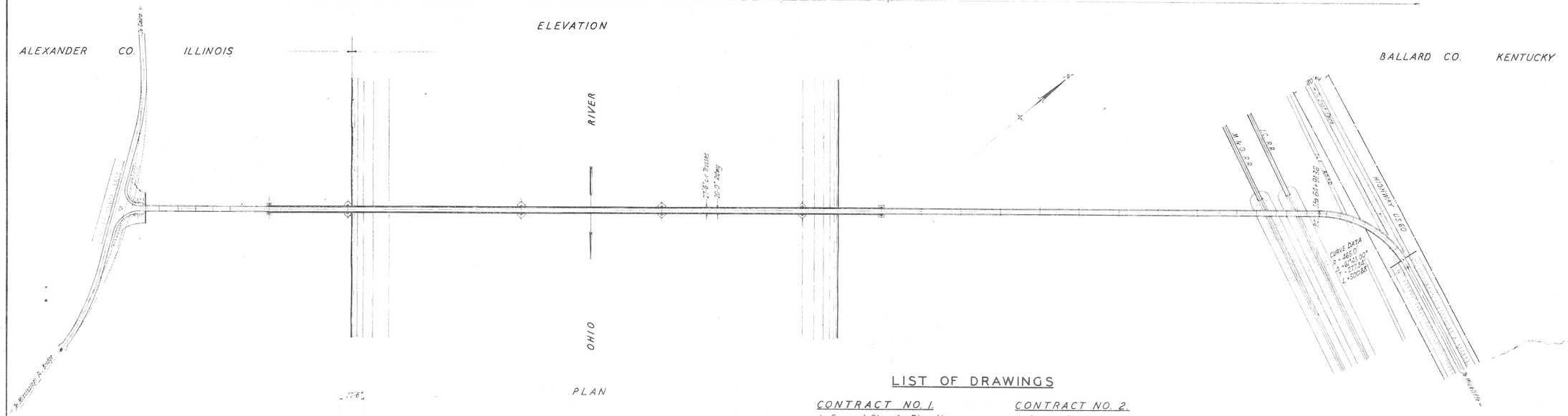
ORIGINAL CONSTRUCTION

PLANS

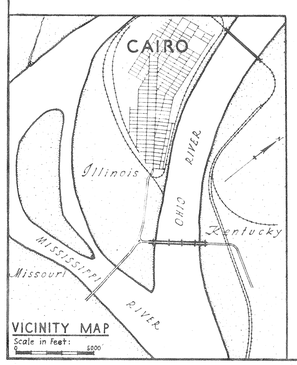
1936

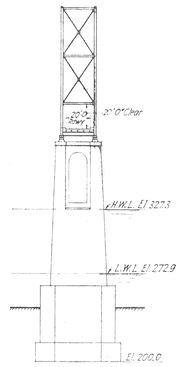


ELEVATION

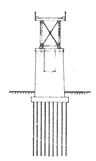


PLAN

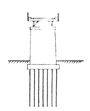




SECTION AT PIER C



SECTION AT PIER K2



SECTION AT PIER K15

Scale in feet
0 20 40 60 80 100

LIST OF DRAWINGS

CONTRACT NO. 1.

1. General Plan & Elevation
2. Main River Piers
3. Pier A and Approach Piers
4. Approach Piers & Abutments

Suppl. Drwg. No. 1. Survey & Boring Data
" " " 2. Hydrograph of Ohio River

CONTRACT NO. 2.

1. General Plan & Elevation
2. Stress Sheet - Anchor Arm AB & Cantilever Arm "D"
3. " " Cantilever Arms B & C, and Suspended Span
4. " " Anchor Arm "C"
5. " " Anchor Arm "D"
6. " " Cantilever E; Anchor Arm "E-F"
7. " " Approach Spans
8. Typical Details - Anchor Arm A-B
9. " " " " " Cont'd.
10. " " Cantilever Arms B & C
11. " " Suspended Span
12. Typical Details & Sections - Main Bridge
13. Details of Deck Truss Spans
14. Details of Girder Spans
15. Roadway & Miscellaneous Details

Supplementary Drwg. No. 1. Survey & Boring Data.
" " " 2. Hydrograph of Ohio River.

Approved:
Ralph Modjeski Eng. Lic. Illinois Cert. No. 11, Annual #434
F. M. Masters
M. B. Case.
Modjeski, Masters & Case.

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

GENERAL PLAN & ELEVATION

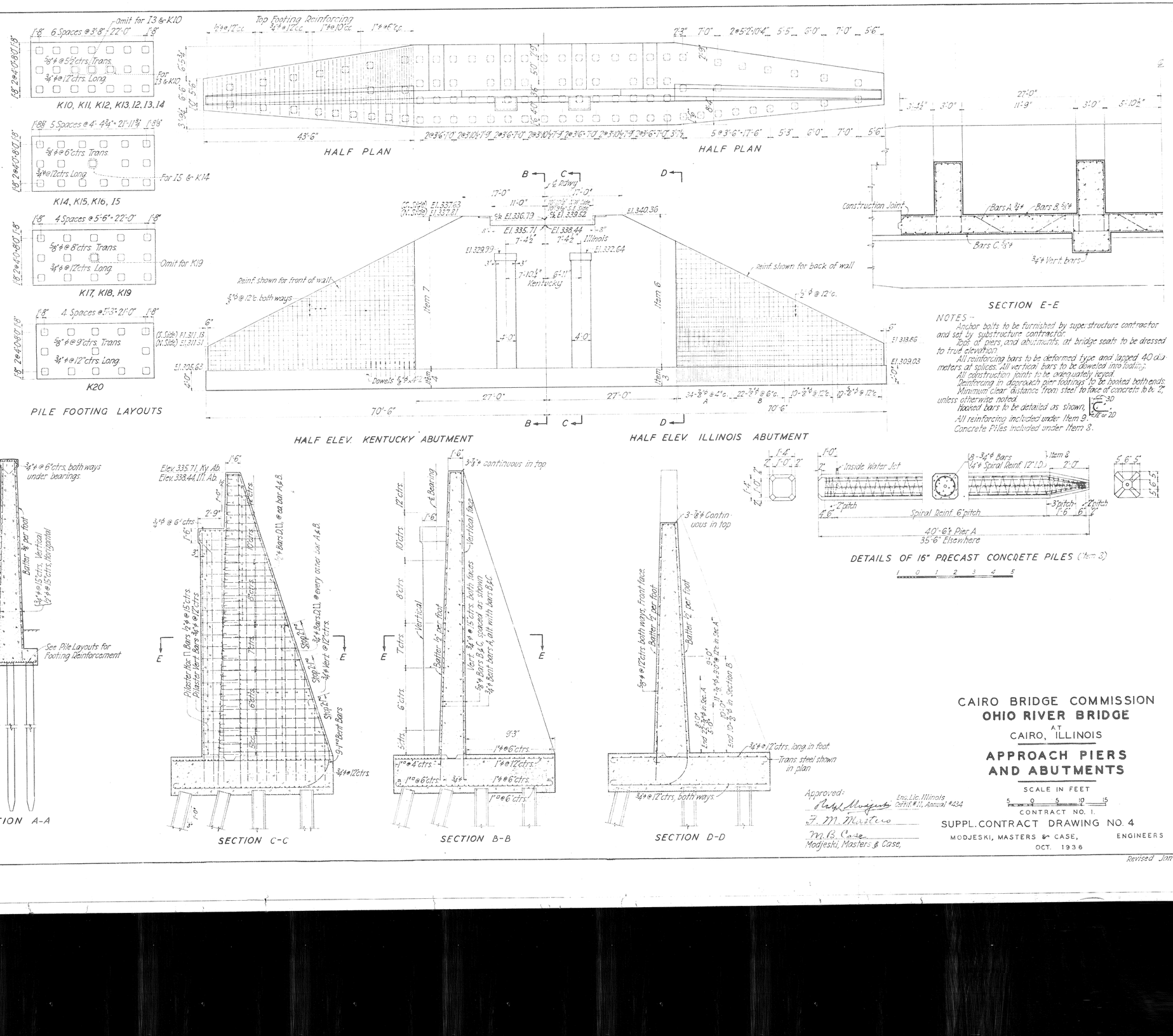
SCALE IN FEET
100 0 100 200 300 400 500

CONTRACTS NO. 1 & 2
SUPPL. CONTRACT DRAWING NO. 1
MODJESKI, MASTERS & CASE, ENGINEERS
OCT. 1936

Revised Jan. 6, 1937

TABLE OF PIER DIMENSIONS

Piers	Elev. Top of Pier	A	B	C	D	D+16'-3"	Elev. Top of Footing	Elev. of Groundline
K10	342.73	11'-4"	25'-4"	39'-3 3/8"	5'-11 7/16"	22'-2 7/16"	308.0	312.0±
11	347.73	"	"	38'-2 3/8"	5'-10 11/16"	22'-1 7/16"	308.0	311.0±
12	347.16	"	"	38'-1 7/16"	5'-11	22'-2	307.0	310.0±
13	345.73	"	"	37'-2 3/8"	5'-9 15/16"	22'-0 15/16"	307.0	310.3±
14	343.46	"	"	36'-11 7/16"	5'-9 3/8"	22'-0 3/8"	305.0	308.0±
15	343.59	"	"	35'-11 5/8"	5'-8 7/16"	21'-11 5/16"	307.0	310.5±
16	341.27	"	"	33'-9 3/4"	5'-7 7/16"	21'-10 9/16"	306.0	309.7±
17	339.04	"	"	31'-6 1/2"	5'-5 9/16"	21'-8 5/8"	306.0	309.5±
18	336.73	"	"	33'-2 3/8"	5'-6 15/16"	21'-9 15/16"	302.0	305.0±
19	334.49	"	"	26'-11 3/8"	5'-2 4"	21'-5 4"	306.0	309.5±
20	332.18	"	24'-4"	21'-8 5/16"	4'-10 4"	21'-1 1/4"	309.0	314.5±
I 2	341.71	11'-4"	25'-4"	29'-2 3/8"	5'-3 15/16"	21'-6 15/16"	311.0	314.4±
3	337.75	"	"	33'-3"	5'-6 15/16"	21'-9 15/16"	303.0	306.4±
4	332.48	"	"	24'-11 3/8"	5'-0 3/4"	21'-3 3/4"	306.0	310.0±
5	330.36	"	"	22'-10 5/8"	4'-11 1/8"	21'-2 5/8"	306.0	309.5±



NOTES –

Anchor bolts to be furnished by superstructure contractor and set by substructure contractor.

Tops of piers, and abutments, at bridge seats to be dressed to true elevation.

All reinforcing bars to be deformed type and lapped 40 diameters at splices. All vertical bars to be doweled into footing.

All construction joints to be adequately keyed.

Reinforcing in approach pier footings to be hooked both ends.

Minimum clear distance from steel to face of concrete to be 2" unless otherwise noted.

Hooked bars to be detailed as shown.

All reinforcing included under Item 9.

Concrete Piles included under Item 8.

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

APPROACH PIERS AND ABUTMENTS

SCALE IN FEET

CONTRACT NO. 1.

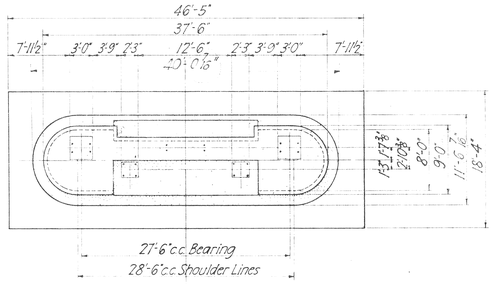
SUPPL. CONTRACT DRAWING NO. 4

MODJESKI, MASTERS & CASE, ENGINEERS

OCT. 1938

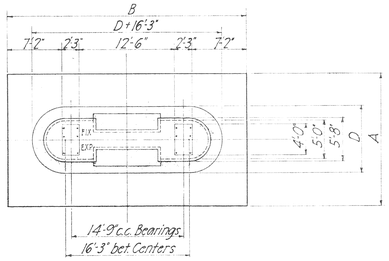
Approved:
Ralph Modjeski Eng. Lic. Illinois Certif. #11, Annual #434
F. M. Masters
M. B. Case
Modjeski, Masters & Case,

Revised Jan 6, 1937

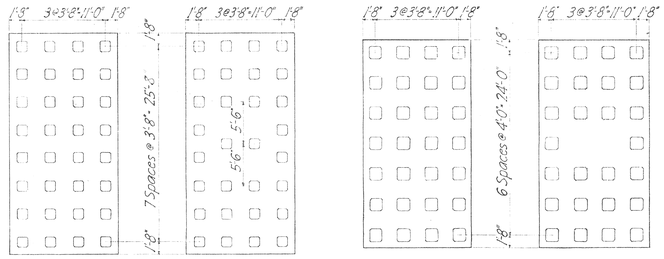


PLAN

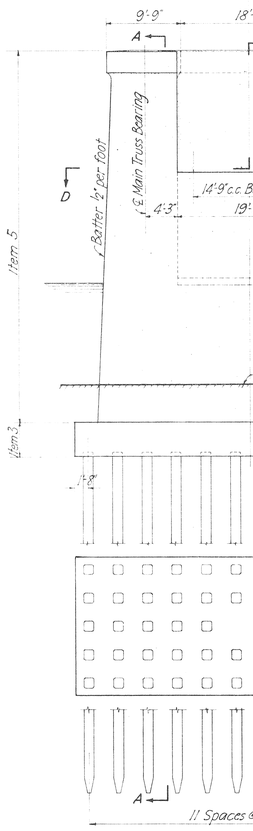
Note: For Section D-D, see Contract Drwg. No. 2



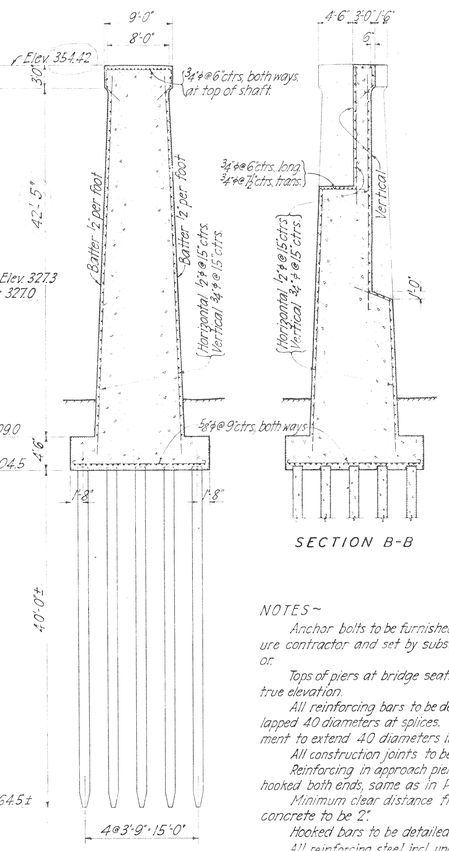
PLAN



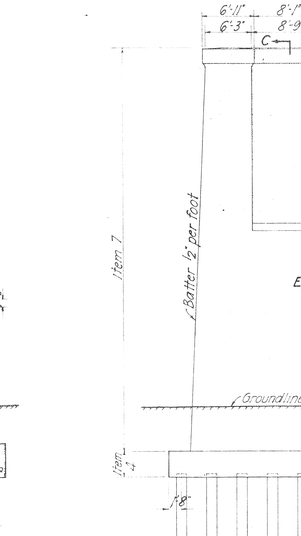
PILE LAYOUT - FOOTINGS



PIER A



SECTION A-A



SECTION B-B

NOTES~

Anchor bolts to be furnished by superstructure contractor and set by substructure contractor.

Tops of piers at bridge seats to be dressed to true elevation.

All reinforcing bars to be deformed type and lapped 40 diameters at splices. Crosswall reinforcement to extend 40 diameters into shafts.

All construction joints to be adequately keyed.

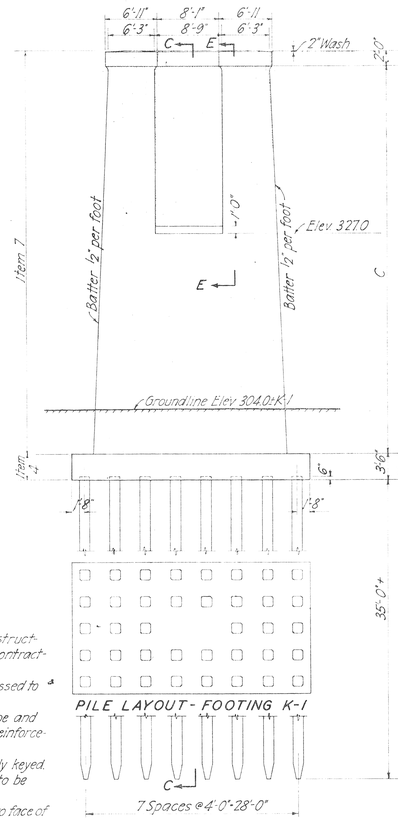
Reinforcing in approach pier footings to be hooked both ends, same as in Pier A.

Minimum clear distance from steel to face of concrete to be 2".

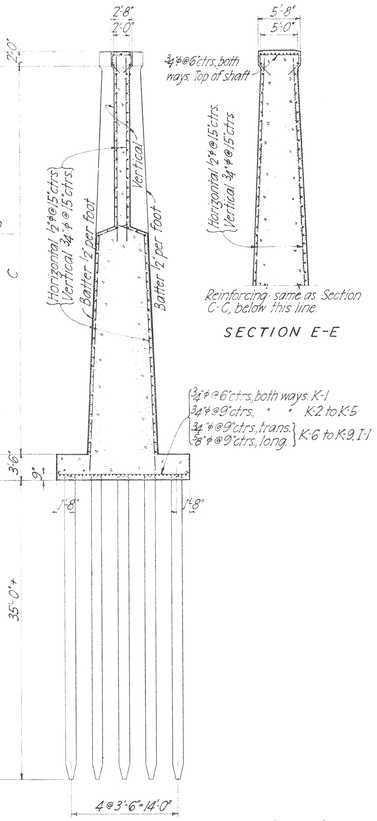
Hooked bars to be detailed as shown.

All reinforcing steel incl. under Item 9.

Concrete Piles included under Item 8.



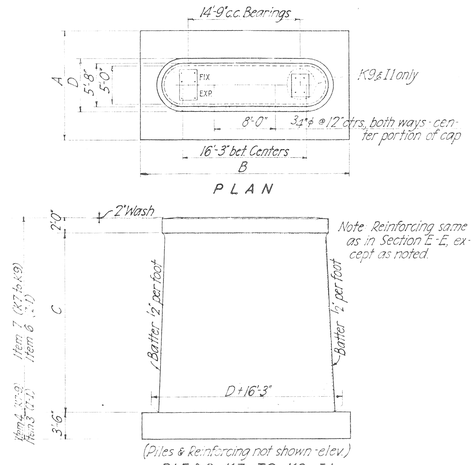
PILE LAYOUT - FOOTING K-1



SECTION C-C

SECTION E-E

3/4"φ @ 6" ctrs. both ways K-1
3/4"φ @ 9" ctrs. " K2 to K5
3/4"φ @ 9" ctrs. trans. } K6 to K9, I-1
5/8"φ @ 9" ctrs. long.



PLAN

PIERS K7 TO K9, I1.

TABLE OF PIER DIMENSIONS

Pier	Elev. Top of Footing	A	B	C	D	D+16'-3"	Elev. Top of Pier
K-1	298.0	17-4	31-4	51-4 9/16	9-3 3/8	25-6 3/8	351.33
2	307.0	14-4	29-0	40-3	8-4 1/4	24-7 1/4	343.25
3	"	"	"	38-1 7/16	8-2 1/8	24-5 1/8	341.12
4	"	"	"	36-0	8-0	24-3	344.99
5	"	"	"	33-10 5/16	7-9 3/8	24-0 7/8	342.8
6	"	"	27-4	31-8 3/4	7-7 1/4	23-10 1/4	340.73
7	"	"	"	29-7 1/16	7-5 3/8	23-8 3/8	338.60
8	"	"	"	27-5 5/8	7-3 1/2	23-6 1/2	336.47
9	298.0	"	"	34-4 1/16	7-10 3/8	24-1 3/8	334.34
I-1	309.0	"	"	18-3 3/4	6-6 5/16	22-9 5/16	329.31

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

PIER A & APPROACH PIERS

SCALE IN FEET
5 0 5 10 20 25

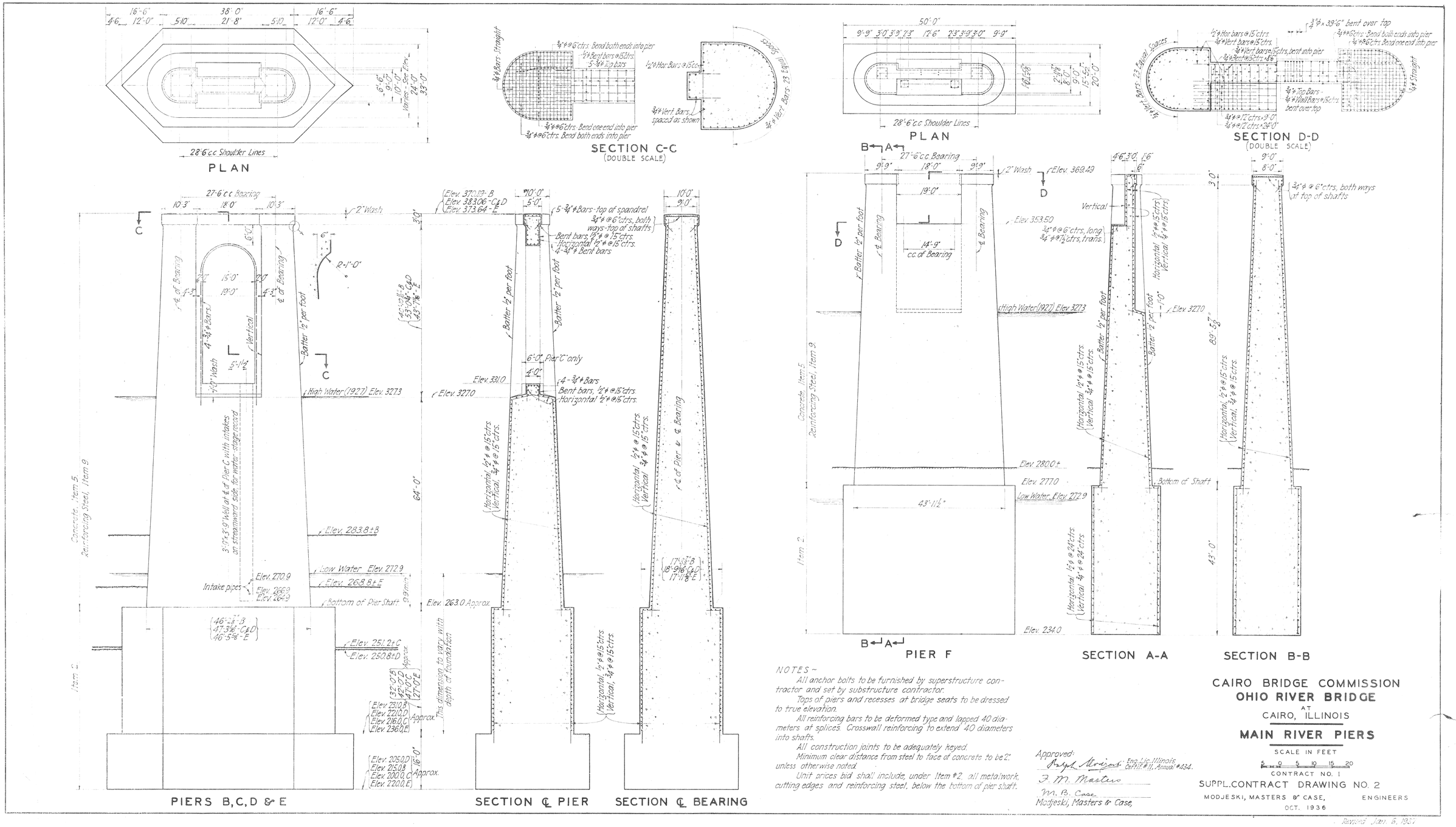
CONTRACT NO. I.

SUPPL. CONTRACT DRAWING NO. 3.

MODJESKI, MASTERS & CASE ENGINEERS
OCT. 1936

Approved:
Roy J. Mudgett Eng. Lic. Illinois Certif. # 11, Annual # 43.
F. M. Master
M. B. Case
Modjeski, Masters & Case,

Revised Jan. 6, 1937



NOTES ~

All anchor bolts to be furnished by superstructure contractor and set by substructure contractor.

Tops of piers and recesses at bridge seats to be dressed to true elevation.

All reinforcing bars to be deformed type and lapped 40 diameters at splices. Crosswall reinforcing to extend 40 diameters into shafts.

All construction joints to be adequately keyed.

Minimum clear distance from steel to face of concrete to be 2" unless otherwise noted.

Unit prices bid shall include, under Item #2, all metalwork, cutting edges and reinforcing steel, below the bottom of pier shaft.

Approved:
Ralph Modjeski Eng. Lic. Illinois Cert. #11, Annual #434.
F. M. Masters
M. B. Case
Modjeski, Masters & Case,

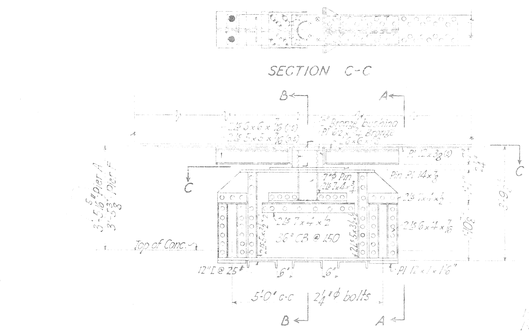
CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

MAIN RIVER PIERS

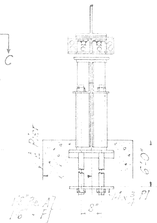
SCALE IN FEET
5 0 5 10 15 20

CONTRACT NO. 1
SUPPL. CONTRACT DRAWING NO. 2
MODJESKI, MASTERS & CASE, ENGINEERS
OCT. 1936

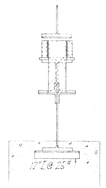
Revised Jan. 6, 1937



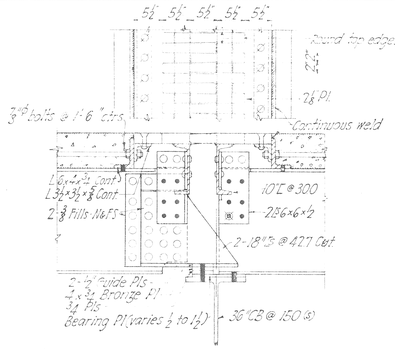
DETAILS OF WIND ANCHORAGE AT PIERS A & F



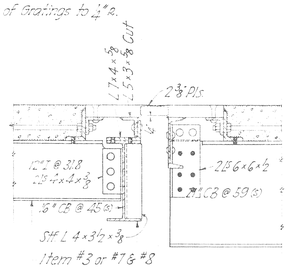
SECTION A-A



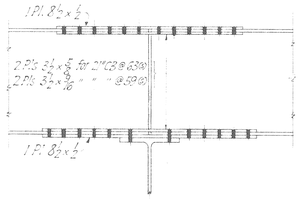
SECTION B-B



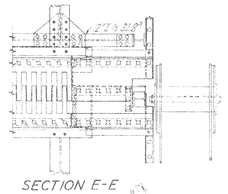
EXPANSION BEARINGS AT LS0 & LA12



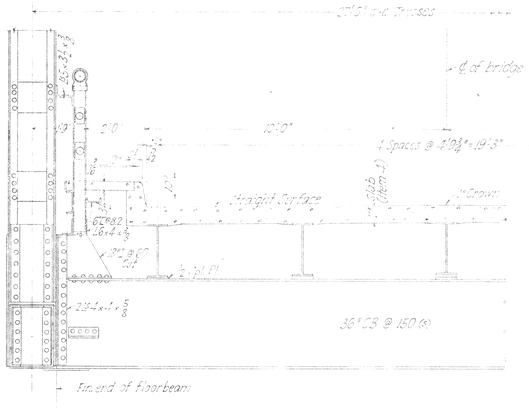
EXPANSION BEARINGS AT PIERS A & F



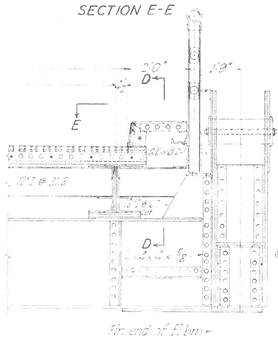
All Splice Pls. - Silicon Steel
STRINGER SPLICE



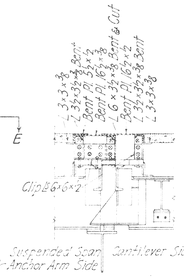
SECTION E-E



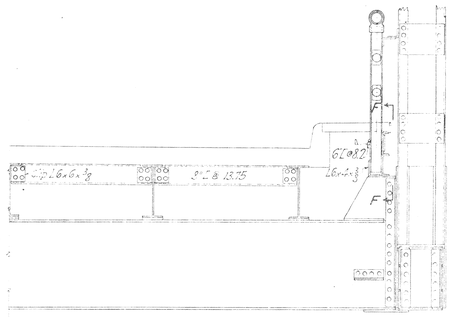
HALF SECTION AT LS6



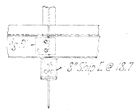
SECTION THRU EXP. DAM AT LS0 & LA12



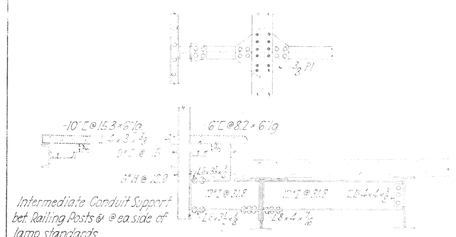
SECTION D-D



HALF SECTION AT STRINGER EXP. JOINTS



SECTION F-F



INTERMEDIATE RAILING SUPPORT

NOTES

Material: Medium carbon steel except where marked (s) which is silicon steel.

Rivets: 1" ⌀ - Main truss members
7/8" ⌀ - Floor System

For design loadings, unit stresses and general notes see Contract Drwg. No. 2.

All material shown on this drwg. furnished & erected under Item #1 except as noted.

Approved:
Capt. Morgan Eng. Lt. Illinois Capt. of Annual #434
F. M. Masters
M. B. Case
Modjeski, Masters & Case.

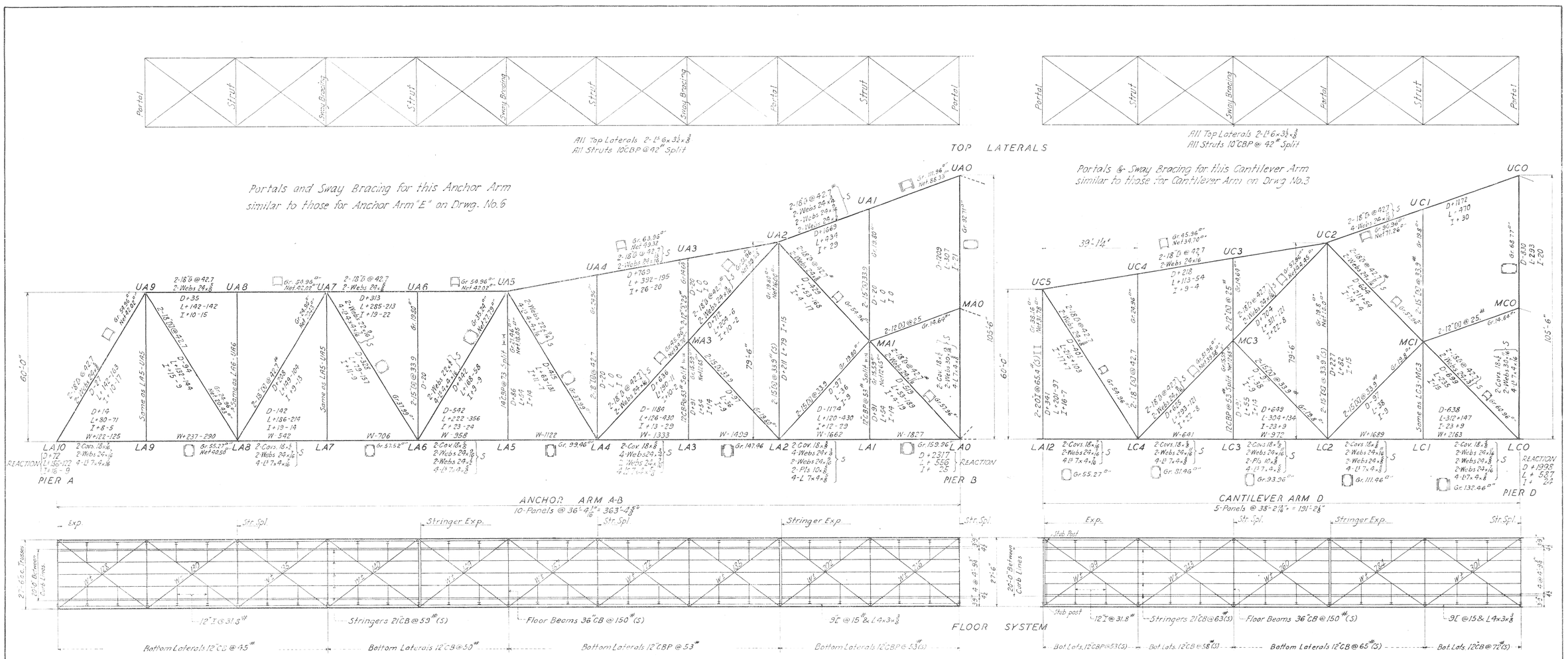
CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

TYPICAL SECTIONS & DETAILS MAIN BRIDGE

SCALE IN FEET
0 1 2 3 4 5
0 1 2

CONTRACT NO. 2.
SUPPL. CONTRACT DRAWING NO. 12
MODJESKI, MASTERS & CASE ENGINEERS
OCT. 1936.

Revised Jan. 6. 1937



GENERAL NOTES

DESIGN LOADINGS

D - Dead Load

Future Paving	300
Concrete Floor	2190
Conduits	200
Total	2690# per lin. ft

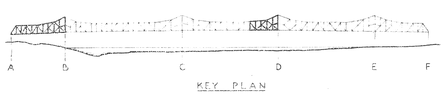
To this shall be added the weight of the steel construction.

L - Live Load

H20 Loading as contained in the Standard Specifications for Highway Bridges, 1935 edition of the American Asso. of State Highway Officials.

Lateral Forces

Moving load of 30# per sq. ft on 1½ times area of structure as seen in elevation plus 200# per lin. ft. of loaded structure or 50# per sq. ft applied as a force on unloaded structure.



UNIT STRESSES

	Med Carbon Steel	Silicon
Axial Tension, Net Section	18000	24000
Axial Compression	$15000 - \frac{1}{4}\left(\frac{L}{r}\right)^2$	$20000 - .46\left(\frac{L}{r}\right)^2$
Shear, Girder webs, gr. section	11000	14000
Pins & power driven rivets	12000	
Bearing, Pins & steel parts in contact	27000	32000
Power driven rivets	24000	

Bearing on Concrete - 600# per □"

Trusses shall be cambered for dead load plus a uniform live load of 640# per lin. ft. of bridge for the full length of spans.

Where CB Sections are shown, the contractor may substitute, subject to engineers' approval, sections of equal weight or strength.

Stresses, shears and reactions given in thousands of pounds.

Moments given in thousands of foot pounds.

Material: All material is medium carbon steel except as marked (s) indicating silicon steel. All anchor bolts to be furnished by superstructure contractor and set by substructure contractor.

All material shown on this drwg. furnished & erected under Item #1

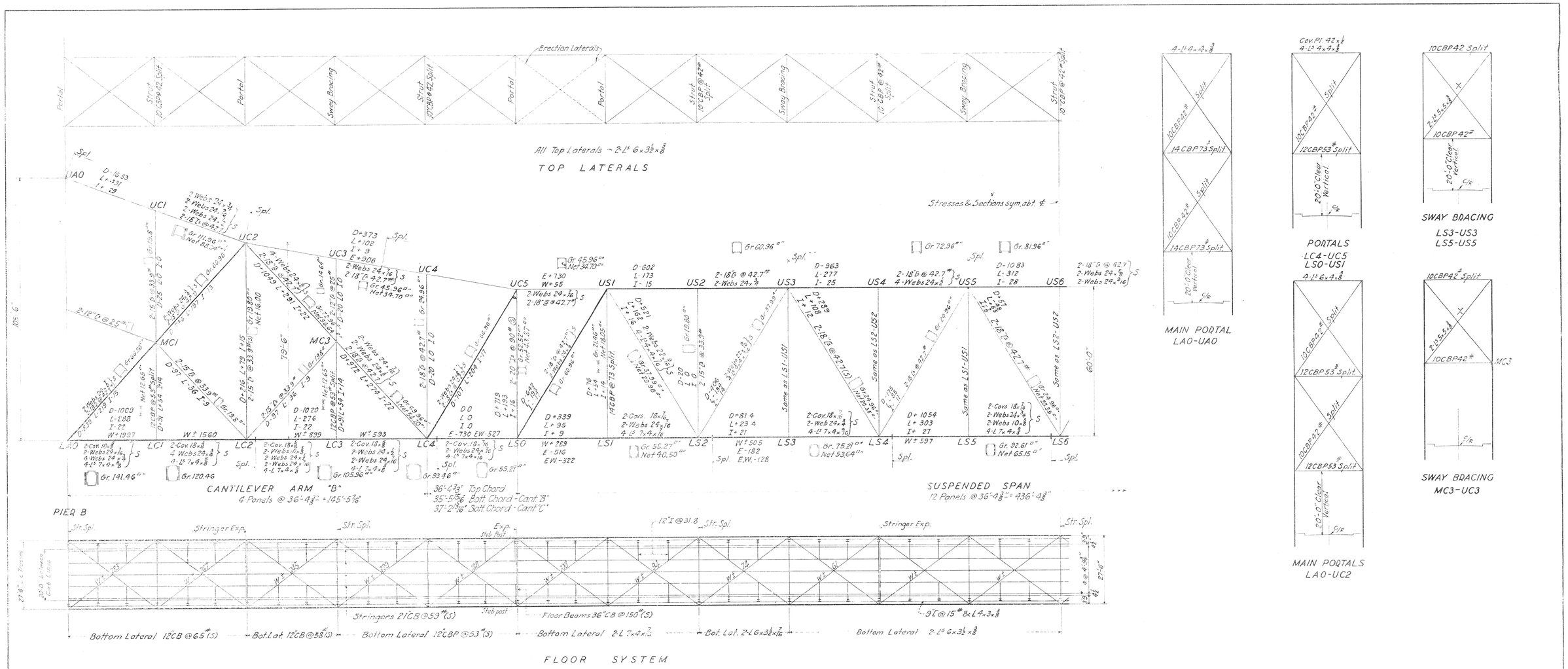
Approved
Engl Modjeski Eng. Lic. Illinois Certificate #11, Annual #434
J. M. Masters
M. B. Case.
Modjeski, Masters & Case

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

STRESS SHEET
ANCHOR ARM "A-B" & CANTILEVER ARM "D"

SCALE IN FEET
10 0 10 20 30

CONTRACT NO. 2
SUPPL. CONTRACT DRAWING NO. 2
MODJESKI, MASTERS & CASE, - ENGINEERS
OCT. 1936



KEY PLAN

STRINGERS

	Shear	Moment
D	12.0	58
L	20.0	134
I	6.2	42
	38.2 K	234 'K

S.M. req'd · 117.0 Silicon
Use 21 CB @ 59.0, Sil.

FLOORBEAMS

	Shear	Moment
D	53.0	405
L	41.2	361
I	10.5	92
	104.7 K	858 'K

S.M. req'd · 430 Silicon
Use 36 CB @ 150, Sil.

NOTES

For unit stresses, design loading and general notes, see Contract Drawing No. 2.
All material shown on this drwg. furnished & erected under Item #1.

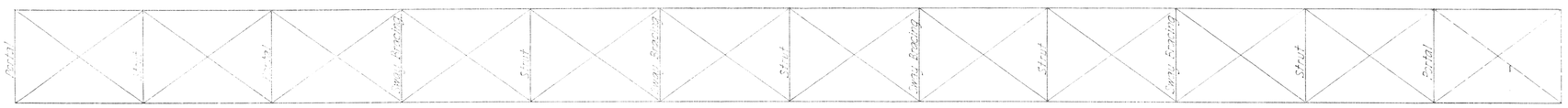
CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

STRESS SHEET
CANTILEVER ARMS "B" & "C" AND SUSPENDED SPAN

Approved:
Rudolph Modjeski Eng. Life Illinois Certificate No. Annual #4234
F. M. Masters
M. B. Case
Modjeski, Masters & Case,

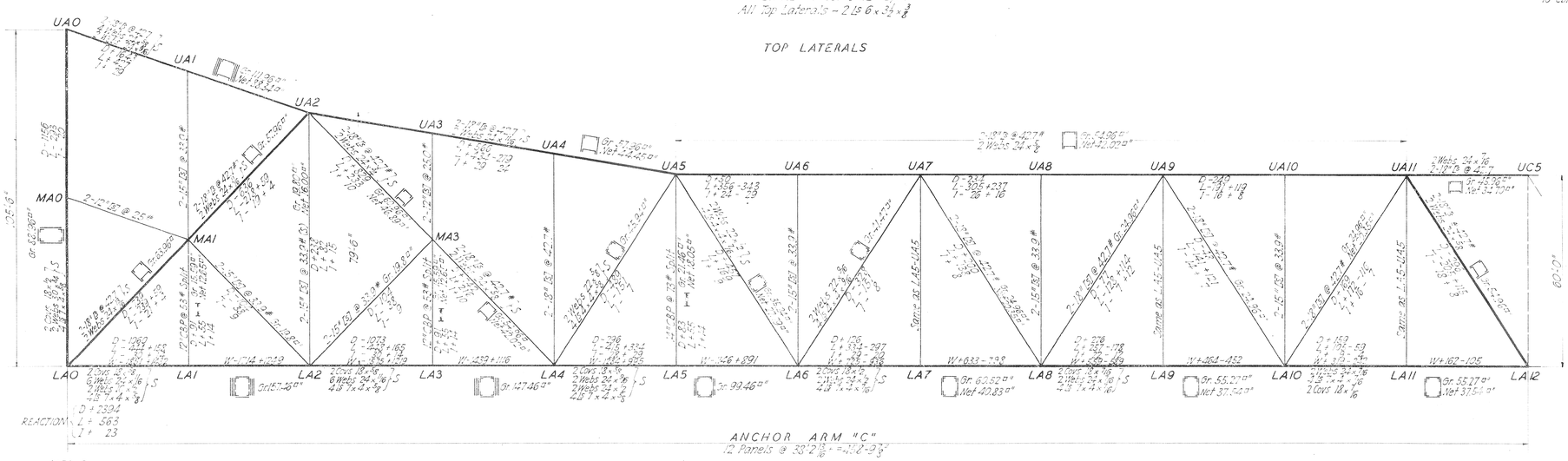
SCALE IN FEET
10 0 10 20 30

CONTRACT NO. 2.
SUPPL. CONTRACT DRAWING NO. 3.
MODJESKI, MASTERS & CASE, ENGINEERS.
OCT. 1936

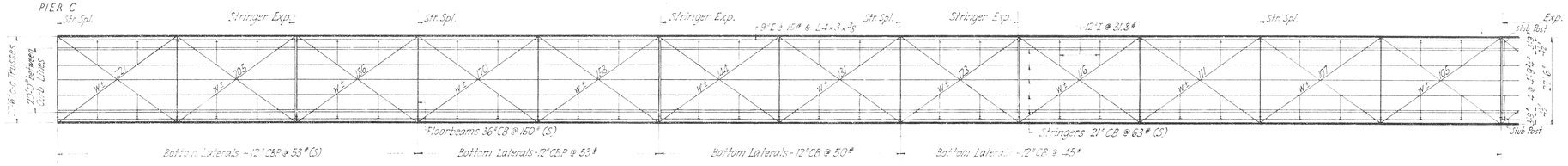


All Struts – 10" CBP @ 42# Split
All Top Laterals – 2 Ls 6 x 3½ x ⅜

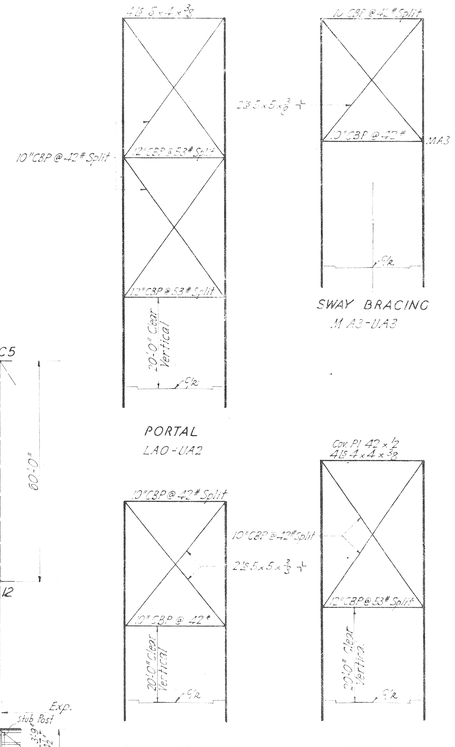
TOP LATERALS



ANCHOR ARM "C"
12 Panels @ 38'-2 13/16" = 458'-9 3/4"



FLOOR SYSTEM



Portal LA0-UA0 same as shown on Drwg. No. 3

STRINGERS	Shear	Mom
D	16.6	65
L	20.2	123
I	1.7	7.7
	38.8 K	251 'K

S.M. Req'd 126.5 (S)
Use 21" CB @ 63# (S)

FLOORBEAMS	Shear	Mom
D	56.0	227
L	41.7	354
I	10.4	51
	108.1 K	633 'K

S.M. Req'd 442 (S)
Use 36" CB @ 150# (S)

KEY PLAN

NOTES
For design loadings, unit stresses and general notes see Contract Drwg. No. 2
All material shown on this drwg. furnished & erected under Item # 1.

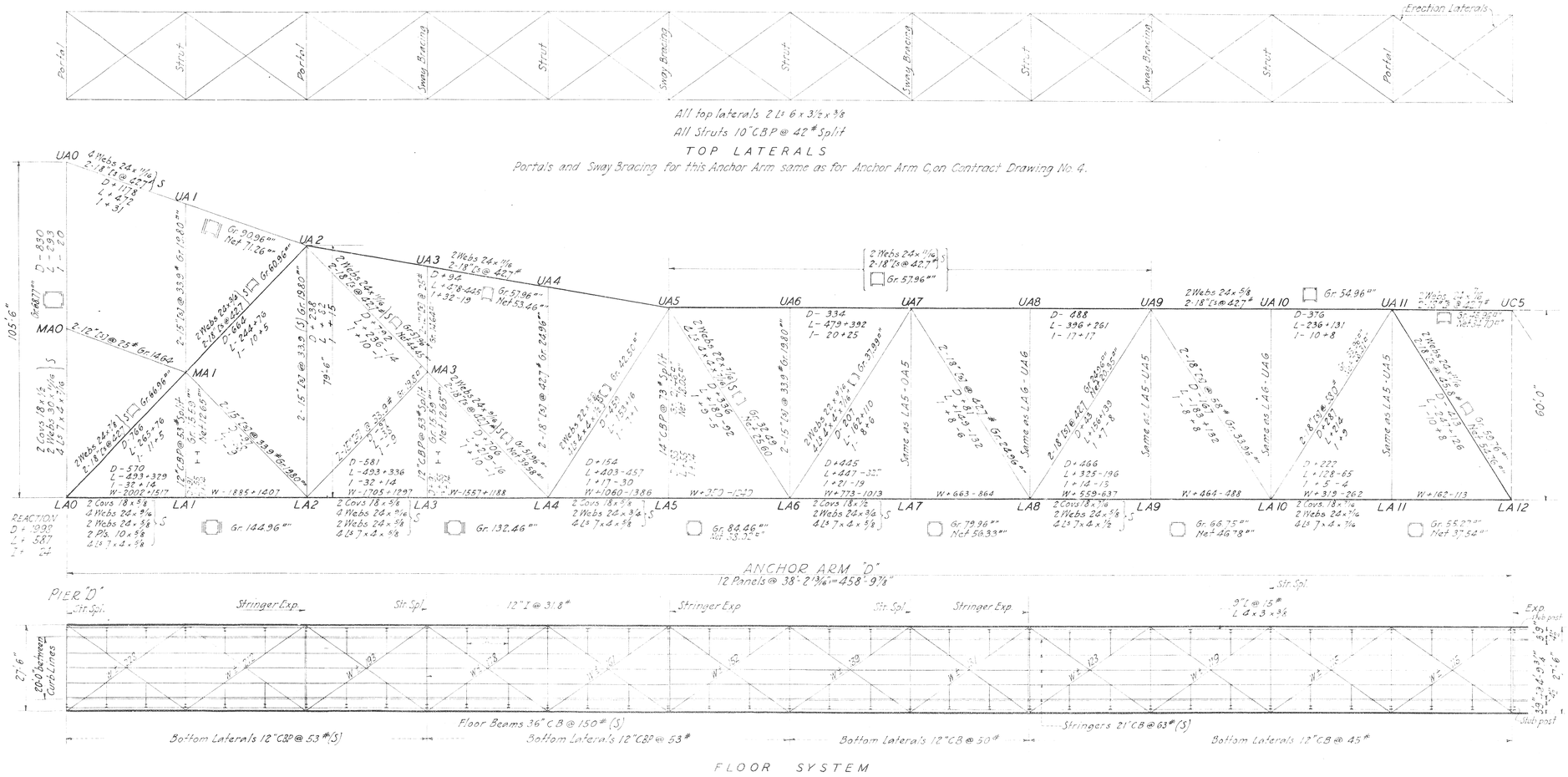
Approved:
Engr. Div. Illinois Coll. F.H. Annual #134
F. M. Masters
M.R. Case
Modjeski, Masters & Case,

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

STRESS SHEET
ANCHOR ARM "C"

SCALE IN FEET
10 0 10 20 30

CONTRACT NO. 2
SUPPL. CONTRACT DRAWING NO. 4
MODJESKI, MASTERS & CASE, ENGINEERS
OCT. 1936



NOTES

For design loadings, unit stresses and general notes, see Contract Drawing No. 2.
All material shown on this drwg. furnished & erected under Item #1

KEY PLAN

Approved
Ralph Modjeski
F. M. Masters
M. B. Case
Modjeski Masters & Case

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO ILLINOIS

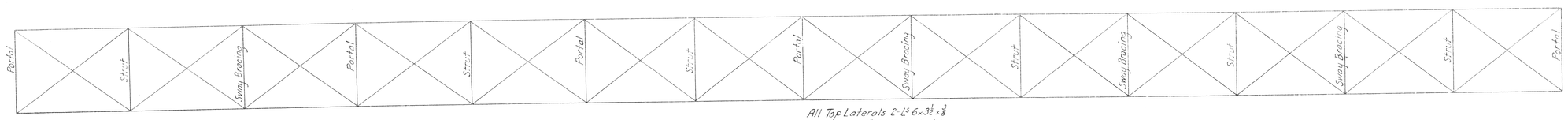
STRESS SHEET
ANCHOR ARM "D"

SCALE IN FEET
10 0 10 20 30

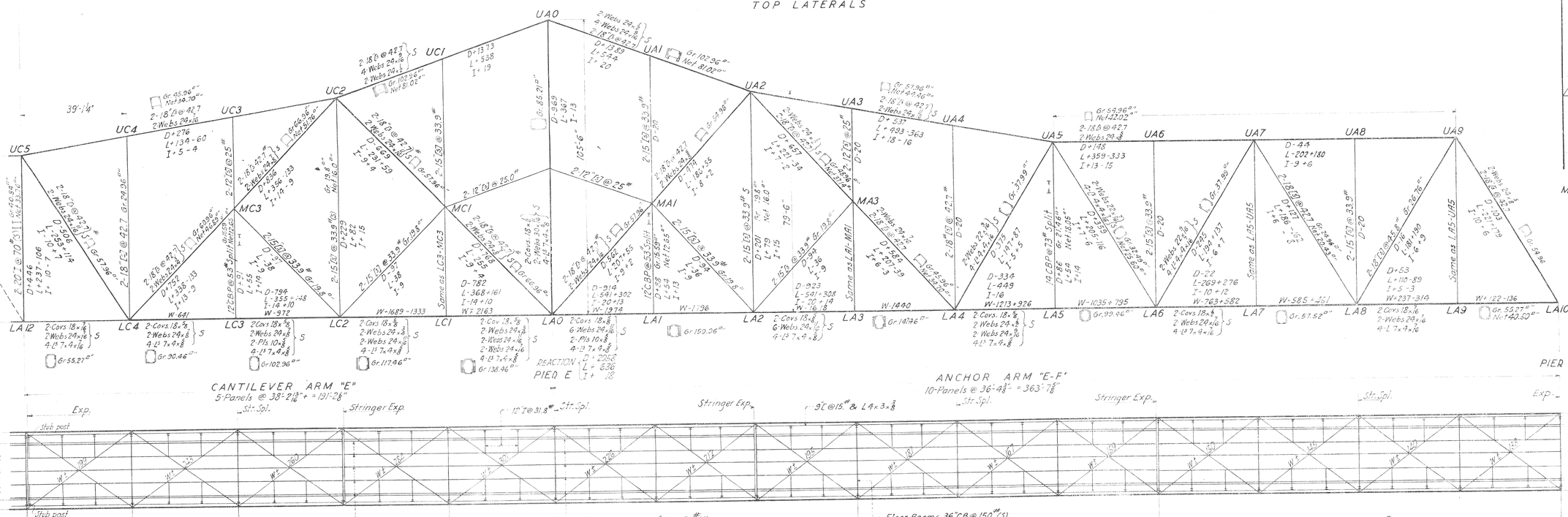
CONTRACT NO. 2

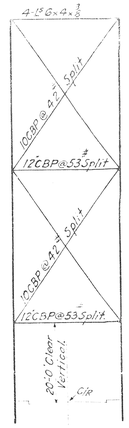
SUPPL. CONTRACT DRAWING NO. 5.

MODJESKI, MASTERS & CASE ENGINEERS
OCT. 1936

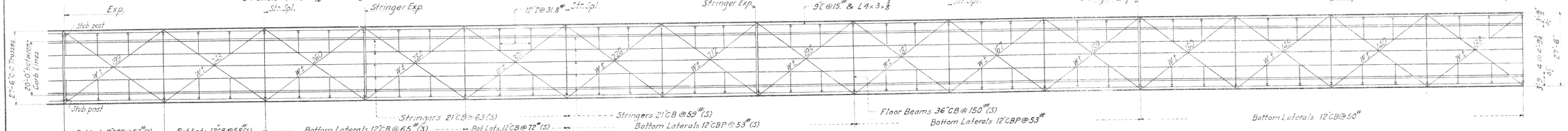


TOP LATERALS

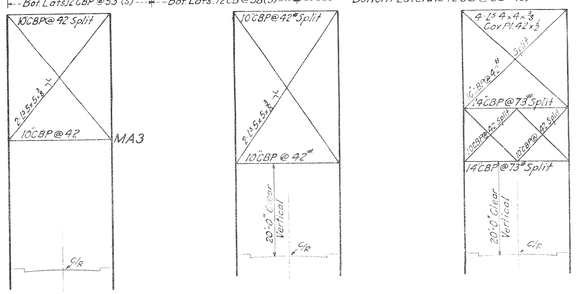




MAIN PORTALS
LA0-UA2
LA0-UC2



FLOOR SYSTEM



SWAY BRACING
LC3-MC3
LA3-MA3

SWAY BRACING
LA7-UA7
LA5-UA5

PORTAL
LA10-UA9

MAIN PORTAL LA0-UA0 Same as shown on Dwg. No. 3
PORTAL LC4-UC5 " " " " " " 3

NOTES

For unit stresses, design loadings and general notes, see Contract Drawing No. 2.
All material shown on this drwg. furnished and erected under Item #1

KEY PLAN

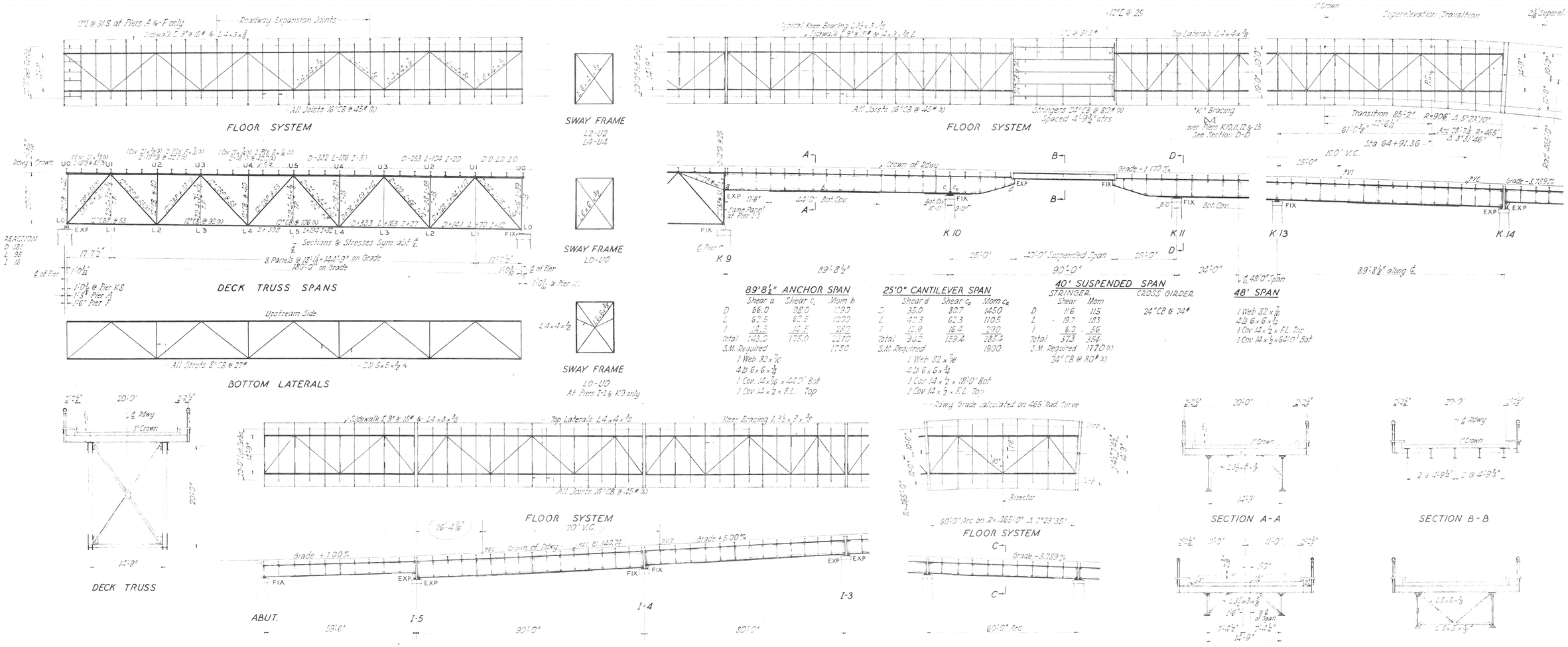
Approved:
Ralph Modjeski Eng. Lic. Illinois
Sr. Mem. #11, Consul. #434
L. W. Masters
M. B. Case
Modjeski, Masters & Case,

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

STRESS SHEET
CANTILEVER "E"-ANCHOR ARM "E-F"

SCALE IN FEET
10 0 10 20 30

CONTRACT NO. 2
SUPPL. CONTRACT DRAWING NO. 6.
MODJESKI, MASTERS & CASE, ENGINEERS.
OCT. 1936



NOTES

For design loadings, unit stresses and general notes, see Contract Drwg. No. 2.

Girders shall be cambered for dead load only.

Deck Truss Spans furnished under Item #3 or #7, erected under Item #3 or #8.

Girder Spans furnished under Item #2 or #6, erected under Item #2 or #8.

APPENDIX F

BRIDGE REHABILITATION

PLANS

1977

COUNTY OF	FISCAL YEAR	SHEET NO.	TOTAL SHEETS

COMMONWEALTH OF KENTUCKY
DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

PLANS OF PROPOSED PROJECT

BALLARD COUNTY

BRIDGE REPAIRS

GR 60-1(3)

INDEX OF SHEETS

SHEET NO.	DESCRIPTION
1	LOCATION
2	GENERAL SUMMARY AND ESTIMATE OF QUANTITIES
3	LAYOUT
4,5	GENERAL NOTES
6-13	ILLINOIS APPROACH SPANS 1-6
14-30	MAIN SPANS 7-11
31-42	KENTUCKY APPROACH SPANS 12-32
43	GUARDRAIL DETAILS
44,45	STRUCTURAL STEEL
46,47	MISCELLANEOUS DETAILS
48-51	LIGHTING DETAILS
52,53	GUARDRAIL STANDARDS

STANDARD DRAWINGS

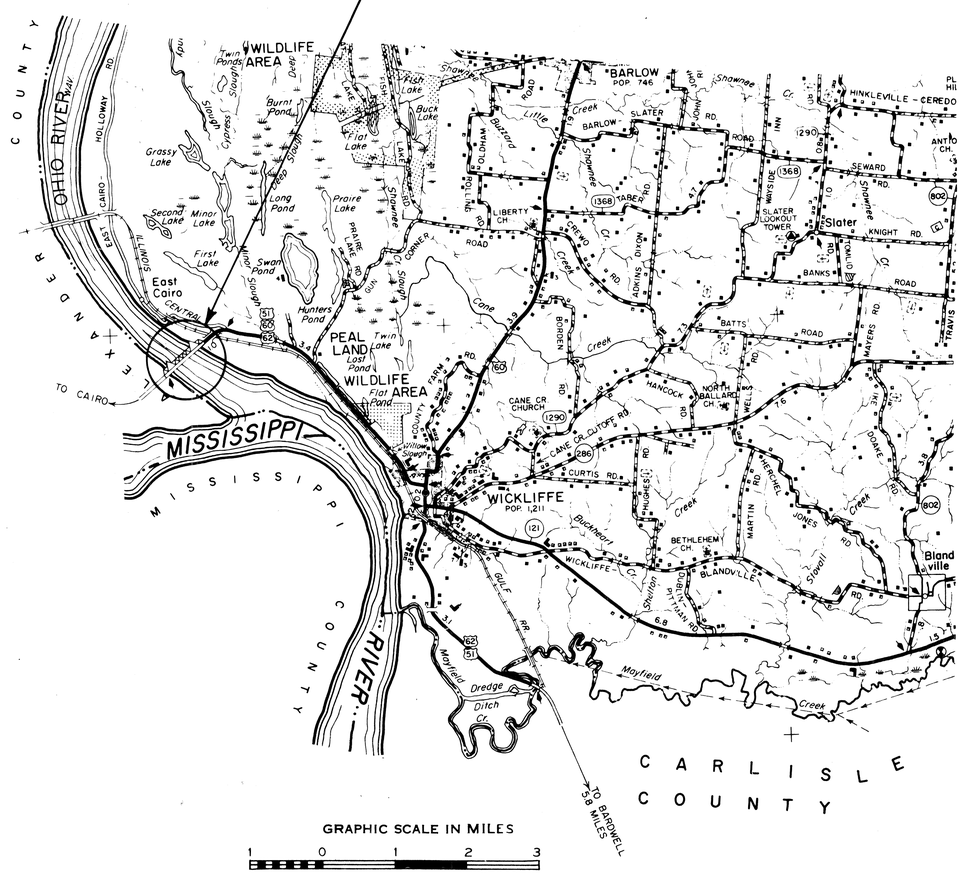
RBC-001-02	GUARDRAIL CONNECTOR TO BRIDGE END TYPE A
RBI-003	TYPICAL INSTALLATION FOR END TREATMENTS TYPE 2A AND 4
RBR-010-01	GUARDRAIL TERMINAL SECTIONS
RBR-015	GUARDRAIL POSTS
RBR-035	END TREATMENT TYPE 4
BJE-001-03	ARMORED EDGE
BJE-002-03	ARMORED EDGE
BJJ-003-02	PREFORMED JOINT SEAL
BJJ-004-02	PREFORMED CORK EXPANSION
RGS-001-02	CURVE WIDENING AND SUPERELEVATION

SPECIAL PROVISIONS

5A(76)	CONCRETE BRIDGE DECK OVERLAYS
6(76)	BRIDGE DECK REPAIRS

SPECIAL NOTES

FOR FINISH COAT
FOR FLAGGING AND OTHER PROTECTION OF RAILROAD PROPERTY DURING CONSTRUCTION



GRAPHIC SCALE IN MILES

1 0 1 2 3

LAYOUT MAP

N

DRAWING NO. 19382

SHEET 1 OF 53 19382

REPAIRS TO OHIO RIVER BRIDGE AT CAIRO ILL.

KENTUCKY
BUREAU OF HIGHWAYS
BALLARD
COUNTY
WICKLIFFE-CAIRO ILL.
ROAD

PROJECT NO. GR 60-1(3)

PLAN APPROVED April 29 1977 BY Charles E. Cook
DIRECTOR OF BRIDGES

PLAN APPROVED 4/29 1977 BY [illegible]
STATE HIGHWAY ENGINEER

U. S. DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION
BUREAU OF PUBLIC ROADS

APPROVED _____ 19__

DIVISION ENGINEER

DESIGN CRITERIA

CLASS OF HIGHWAY
TYPE OF TERRAIN
DESIGN SPEED
REQUIRED NPSD
REQUIRED PSD
LEVEL OF SERVICE
ADT PRESENT ( )
ADT FUTURE ( )
DHV
D %
T %

DESIGNED

% RESTRICTED SD
LEVEL OF SERVICE
MAX. DISTANCE W/O PASSING

GROSS LENGTH ___ LIN. FT. ___ MILES	GROSS LENGTH ___ LIN. FT. ___ MILES	GROSS LENGTH ___ LIN. FT. ___ MILES	GROSS LENGTH ___ LIN. FT. ___ MILES
ADDED DEDUCTED FOR EQUALITIES ___ LIN. FT.	ADDED DEDUCTED FOR EQUALITIES ___ LIN. FT.	ADDED DEDUCTED FOR EQUALITIES ___ LIN. FT.	ADDED DEDUCTED FOR EQUALITIES ___ LIN. FT.
NET LENGTH ___ LIN. FT. ___ MILES	NET LENGTH ___ LIN. FT. ___ MILES	NET LENGTH ___ LIN. FT. ___ MILES	NET LENGTH ___ LIN. FT. ___ MILES
NOT INCLUDED	NOT INCLUDED	NOT INCLUDED	NOT INCLUDED
RAILROAD CROSSINGS NO. ___ LIN. FT.	RAILROAD CROSSINGS NO. ___ LIN. FT.	RAILROAD CROSSINGS NO. ___ LIN. FT.	RAILROAD CROSSINGS NO. ___ LIN. FT.
BRIDGES ___ LIN. FT.	BRIDGES ___ LIN. FT.	BRIDGES ___ LIN. FT.	BRIDGES ___ LIN. FT.

MICROFILMED-77
Letting Date 5/19/77
SENT FOR FEDERAL APPROVAL | NO. SETS | DATE
RECORD PLANS
CONSTRUCTION PLANS
REVIEWED BY DIVISION OF CONSTRUCTION
PLANS CHECKED BY
FINAL CHECK BY
DETZEN 137 FORM NO.

UPDATE DATE

LETTING DATE

DEPARTMENT OF TRANSPORTATION
BUREAU OF HIGHWAYS

BALLARD COUNTY
WICKLIFFE-CAIRO, ILL.
BRIDGE OVER OHIO RIVER

GENERAL SUMMARY & ESTIMATE OF QUANTITIES

DESCRIPTION	SPANS	CONCRETE CLASS "A A" CU. YDS	REINFORCEMENT LBS.	REMOVE EXISTING REIN-FORCED CONCRETE L. S.	STRUCTURAL STEEL (1) LBS.	STRUCTURE EXCAVATION COMMON CU. YDS.	8" DRAIN PIPE LIN. FT.	MAINTAIN & CONTROL TRAFFIC L. S.	EXPANSION DAM 2" NEOPREME LIN. FT	EXPANSION DAM 2½" NEOPREME LIN. FT.	CONCRETE OVERLAY PORTLAND CEMENT CU. YDS.	CONCRETE OVERLAY LATEX CU. YDS.	DEMOBILIZATION L.S.	STEEL "W" BEAM GUARDRAIL SINGLE FACE L.F.	GUARDRAIL CONNECTOR TO BRIDGE END, TYPE A EACH	GUARDRAIL END TREATMENT TYPE 4 EACH	BITUMINOUS CONCRETE BASE CRUSHED LIMESTONE COARSE AGGREGATE TONS	BITUMINOUS CONCRETE BASE CRUSHED GRAVEL COARSE AGGREGATE TONS	BITUMINOUS CONCRETE SURFACE TYPE B CRUSHED LIMESTONE COARSE AGGREGATE TONS	BITUMINOUS CONCRETE SURFACE TYPE B CRUSHED GRAVEL COARSE AGGREGATE TONS	BITUMINOUS TACK COAT TONS	DENSE GRADED AGGREGATE TONS	MOBILIZATION L.S.	BLAST CLEANING SQ. YDS.	EPOXY SAND SLURRY BATCH
ILLINOIS APPROACH	1-6	350.3	117136				171		73		79.0	59.5												1576	16
MAIN SPANS	7-11	1671.8	494286				435				393.3	295.4												7823	78
KENTUCKY APPROACH	12-32	1674.5	512713				1163		99	193	346.8	261.1												6907	68
SUBSTRUCTURE			927			10																		720	72
ROADWAY APPROACHES														288	2	2	190	190	33	33	.2	40			
TOTALS		3696.6	1,125,002	1	1	10	1769	1	172	193	819.1	616.0	1	288	2	2	190	190	33	33	.2	40	1	17,026	234

(1) Estimated Weight of Structural Steel = 467,310

DESCRIPTION	SPANS	2" CONDUIT RIGID STEEL L.F	¾" CONDUIT RIGID STEEL L.F.	JUNCTION BOX 16"x 6"x 6" EACH	WOOD POLL 35 FT. CLASS 4 EACH	NAVIGATION LIGHT 180° RED EACH	NAVIGATION LIGHT 360° GREEN EACH	NAVIGATION LIGHT 180° WHITE EACH	WIRE NO.2 THW OR THWN L.F.	WIRE NO. 4 THW OR THWN L.F.	WIRE NO.12 THW OR THWN L.F	CONTROL CENTER EACH	REMOVAL EQUIPMENT ELECTRICAL EACH	¾ IN. FLEXIBLE CONDUIT, LIQUID TIGHT L.F	RELOCATE UTILITY LINES L.S.	
ILLINOIS APPROACH	1-6															
MAIN SPANS	7-11															
KENTUCKY APPROACH	12-32															
SUBSTRUCTURE																
ROADWAY APPROACHES																
TOTALS		6,000	550	40	1	10	6	6	24,750	2,900	1,600	1	1	350	1	

BILL OF INCIDENTAL MATERIALS

ITEM	NO.	DESCRIPTION
Pref. Jt. Seal	21	24'-6" long - for 1⅝" Joint
" " "	7	28'-0 long " " "
" Cork	21	1⅝" x 7" x 24'-0"
" "	7	1⅝" x 22" x 27'-0

SHEET 2

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE - CAIRO, ILL.
ROAD

STATION | **P. E. PROJECT NO.**

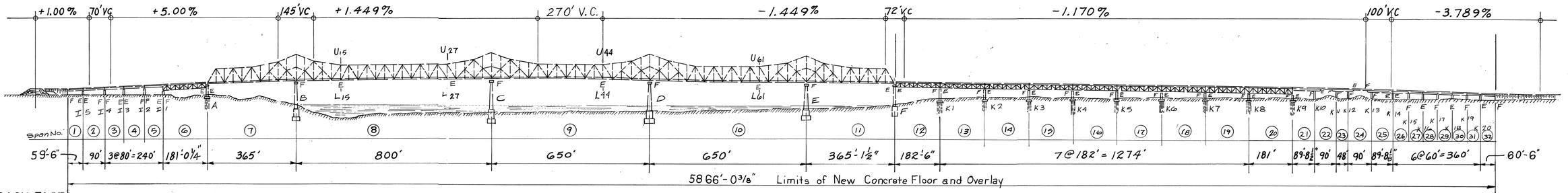
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

DESIGNED BY ____ DATE ____ REVISED ____
DETAILED BY ____ DATE ____ REVISED ____
TRACED BY ____ DATE ____ REVISED ____
CHECKED BY ____ DATE ____
CHECKED BY ____ DATE ____
CHECKED BY ____ DATE ____

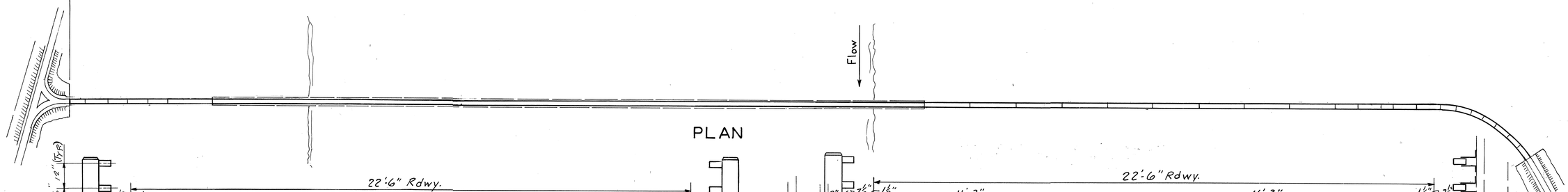
BRUNING 44-132 27786

ILLINOIS

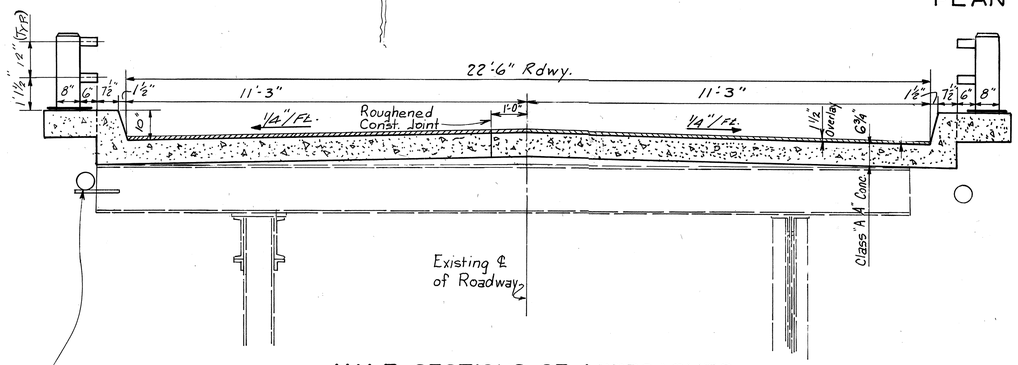
TO WICKLIFFE



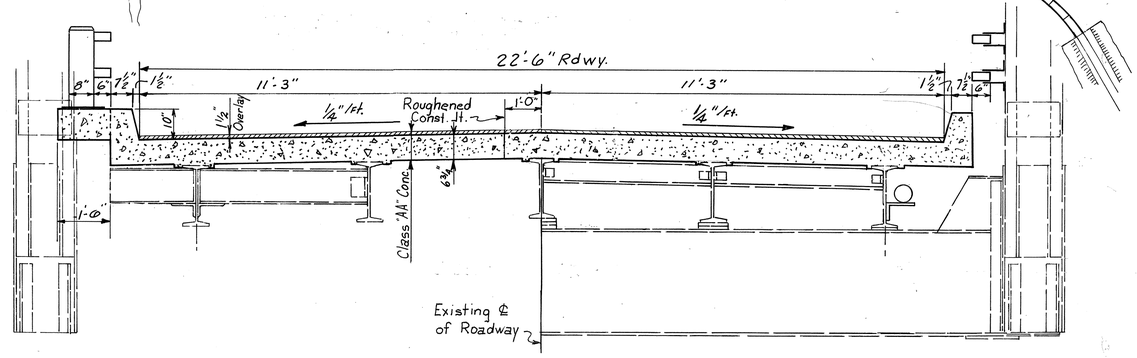
ELEVATION



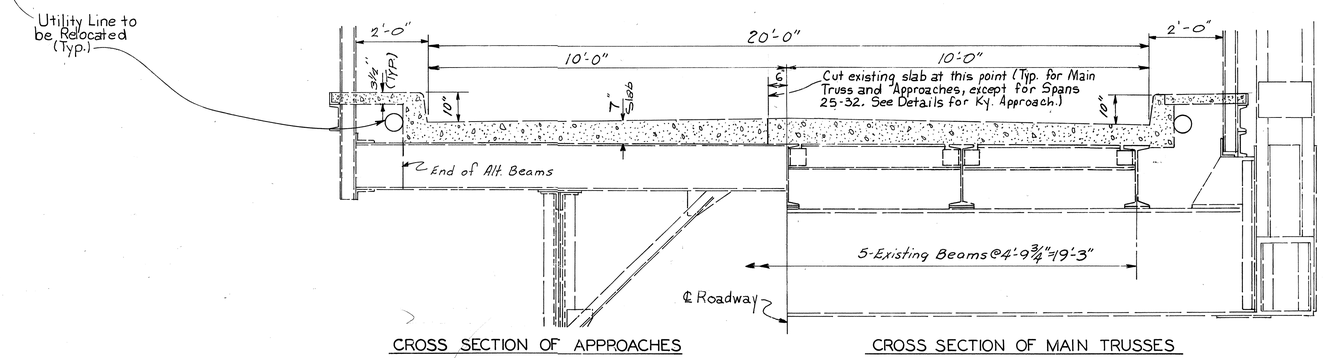
PLAN



HALF SECTIONS OF APPROACHES
(SEE SHEET 41 FOR SUPER ELEVATION SPANS 25-32)
(KENTUCKY APPROACH)



HALF SECTIONS OF THRU TRUSSES



CROSS SECTION OF APPROACHES

CROSS SECTION OF MAIN TRUSSES

EXISTING HALF SECTIONS OF BRIDGE

SHEET 3

LAYOUT

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE-CAIRO, ILL.
ROAD

STATION	P. E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

LETTING DATE

DATE REVISED
DATE REVISED
DATE REVISED
DATE REVISED

DESIGNED BY
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY

GENERAL NOTE

SPECIFICATIONS

THE KENTUCKY BUREAU OF HIGHWAYS STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, CURRENT EDITION SHALL APPLY TO THIS PROJECT.

DESIGN LOAD

THIS BRIDGE SLAB IS DESIGNED FOR H 20 LIVE LOAD AS SPECIFIED IN THE 1973 AASHO SPECIFICATIONS.

DESIGN STRESSES

FOR REINFORCED CONCRETE, CLASS AA

FS = 20,000 PSI	F'C = 4,000 PSI
FC = 1,600 PSI FOR OTHER THAN SLABS	U = 200 PSI FOR EMBEDMENT
FC = 1,200 PSI FOR DECK SLABS	N = 8

CONCRETE

CLASS AA CONCRETE IS TO BE USED THROUGHOUT.

REINFORCEMENT

DIMENSIONS SHOWN FROM THE FACE OF CONCRETE TO BARS ARE CLEAR DISTANCES UNLESS OTHERWISE SHOWN. SPACING OF BARS IS FROM CENTER TO CENTER OF BARS. ALL BARS WHICH REQUIRE FIELD BENDING SHALL BE GRADE 40. OTHER BARS MAY BE GRADE 40 OR GRADE 60. THE CONTRACTOR SHALL BE RESPONSIBLE FOR PROVIDING A METHOD FOR STRAIGHTENING THE SLAB BARS IN THE FIELD (WITHOUT HEAT) THAT WILL NOT KINK OR OTHERWISE DAMAGE THE BARS.

BEVELED EDGES

ALL EXPOSED EDGES SHALL BE BEVELED 7/8" UNLESS OTHERWISE SHOWN.

BILL OF INCIDENTAL MATERIAL

THE QUANTITIES SHOWN IN THE BILL OF INCIDENTAL MATERIALS ARE APPROXIMATE ONLY AND THE CONTRACTOR IS RESPONSIBLE FOR FURNISHING ENOUGH MATERIAL TO COMPLETE THE WORK IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS. THE COST OF THESE ITEMS IS TO BE INCLUDED IN THE UNIT PRICE BID FOR CLASS "AA" CONCRETE.

PAYMENT FOR STRUCTURAL STEEL

THE LUMP SUM BID FOR STRUCTURAL STEEL SHALL BE FULL PAYMENT FOR ALL STRUCTURAL STEEL, BOLTS, WASHERS, CAST IRON, WELDING AND WELDING MATERIALS, PAINT AND ALL LABOR AND MATERIALS NECESSARY TO ERECT THE STEEL IN ACCORDANCE WITH THE PLANS AND SPECIFICATIONS. THE APPROXIMATE WEIGHT OF STRUCTURAL STEEL SHOWN IN THE ESTIMATE OF QUANTITIES DOES NOT INCLUDE OVERRUN OR WELD MATERIAL. THE LUMP SUM BID FOR STRUCTURAL STEEL SHALL ALSO INCLUDE THE REMOVAL OF EXISTING HANDRAILS AND INCIDENTAL METAL CALLED FOR ON THE PLANS.

SHOP DRAWINGS

THE CONTRACTOR SHALL SUBMIT FULL SETS OF PRINTS OF THE DETAILED SHOP DRAWINGS FOR ALL STRUCTURAL STEEL TO THE BUREAU FOR REVIEW IN ACCORDANCE WITH SECTION 607.04 OF THE SPECIFICATIONS.

PAINTING NEW STRUCTURAL STEEL

ALL NEW STRUCTURAL STEEL SHALL BE CLEANED AND PAINTED IN ACCORDANCE WITH SECTION 607.25 OF THE SPECIFICATIONS EXCEPT THE LAST TWO COATS OF PAINT SHALL BE GRAY INSTEAD OF ALUMINUM. THIS GRAY PAINT IS TO BE IN ACCORDANCE WITH THE SPECIAL NOTES FOR FINISH COAT. THE FIRST GRAY COAT IS TO BE TINTED WITH LAMP BLACK AS DIRECTED BY THE ENGINEER TO PROVIDE A CONTRAST IN THE TWO COATS. THE COST OF THIS CLEANING AND PAINTING SHALL BE INCLUDED IN THE LUMP SUM BID FOR STRUCTURAL STEEL.

CONSTRUCTION NOTE

THE CONTRACTOR SHALL ARRANGE TO DO THE WORK IN ACCORDANCE WITH THE SPECIAL NOTES RELATIVE TO FLAGGING AND OTHER PROTECTION TO THE RAILROAD COMPANY DURING CONSTRUCTION OF THIS PROJECT.

MILL TEST REPORTS

NOTARIZED TEST REPORTS SHALL BE FURNISHED IN TRIPLICATE TO THE BUREAU SHOWING THAT ALL MATERIALS USED IN THE STRUCTURAL STEEL CONFORM TO THE REQUIREMENTS OF THE SPECIFICATIONS.

WELDING

ALL WELDING AND WELDING MATERIALS SHALL CONFORM TO THE SPECIFICATIONS FOR WELDED HIGHWAY AND RAILWAY BRIDGES OF THE AMERICAN WELDING SOCIETY, CURRENT EDITION. THE COST OF WELDING AND WELDING MATERIALS IS TO BE INCIDENTAL TO THE LUMP SUM BID FOR STRUCTURAL STEEL.

PROHIBITED FIELD WELDING

EXCEPT AS SHOWN ON THE PLANS, NO WELDING OF ANY NATURE SHALL BE PERFORMED ON THE LOAD CARRYING MEMBERS OF THE BRIDGE WITHOUT THE WRITTEN CONSENT OF THE DIRECTOR, DIVISION OF BRIDGES, OR HIS AUTHORIZED REPRESENTATIVE, AND THEN ONLY IN THE MANNER AND AT THE LOCATIONS DESIGNATED IN THE AUTHORIZATION.

CONNECTIONS

UNLESS OTHERWISE PROVIDED ON THE PLANS, ALL FIELD CONNECTIONS SHALL BE 7/8" DIAMETER HIGH STRENGTH BOLTS. OPEN HOLES SHALL BE 15/16" DIAMETER. ALL JOINTS ARE DESIGNED AS FRICTION TYPE CONNECTIONS. TIGHTENING SHALL BE DONE WITH PROPERLY CALIBRATED WRENCHES.

STRAIGHTENING BENT MATERIAL

IN LIEU OF STATEMENTS MADE TO THE CONTRARY IN SECTION 607.20 OF THE 1976 STANDARD SPECIFICATIONS, MATERIAL SHALL NOT BE STRAIGHTENED BY DIRECT HAMMERING.

MATERIALS

ASTM SPECIFICATIONS, CURRENT EDITION, AS DESIGNATED BELOW, SHALL GOVERN THE MATERIALS FURNISHED.

ASTM	MATERIAL
A36-75	STRUCTURAL STEEL
A48-74	GRAY IRON CASTINGS, CLASS 30A
A325-74	HIGH STRENGTH CARBON STEEL BOLTS, NUTS AND WASHERS

PAINTING DAMAGED AREAS

ALL AREAS OF NEW OR EXISTING STRUCTURAL STEEL ON WHICH THE PAINT HAS BEEN DAMAGED BY THE CONTRACTOR WITH WELD BURNS OR BY OTHER MEANS SHALL BE CLEANED AND SPOT PAINTED IN ACCORDANCE WITH SECTION 607.25 OF THE SPECIFICATIONS USING THE SAME FOUR COATS OF PAINT SPECIFIED FOR NEW STEEL. THE COST OF THIS CLEANING AND PAINTING IS TO BE INCIDENTAL TO THE LUMP SUM BID FOR STRUCTURAL STEEL.

CLEANING EXISTING STEEL

ALL AREAS OF EXISTING STEEL THAT ARE TO BE IN CONTACT WITH NEW STEEL, INCLUDING AREAS UNDER BOLT HEADS, SHALL BE CLEANED OF ALL DIRT, RUST, PAINT AND OTHER FOREIGN MATTER, BEFORE INSTALLING THE NEW STEEL. THE COST OF THIS CLEANING IS TO BE INCIDENTAL TO THE LUMP SUM BID FOR STRUCTURAL STEEL.

CLEANING TOPS OF BEAMS

THE TOPS OF ALL EXISTING STEEL STRINGERS, AND OTHER STEEL TO BE IN CONTACT WITH NEW CONCRETE, ARE TO BE CLEANED OF ALL RUST AND OTHER FOREIGN MATTER BEFORE POURING THE CONCRETE FLOOR. THE COST OF MATERIAL AND LABOR IS TO BE INCIDENTAL TO THE LUMP SUM BID FOR STRUCTURAL STEEL.

DRAIN DETAILS

FOUNDRY NOTE - ALL DRAINS SHALL BE GRAY IRON CASTINGS, ASTM A48, CURRENT EDITION, CLASS 30A. REPORT OF FIELD INSPECTION OF CASTINGS, CURRENT FORM, SHALL BE SUBMITTED TO THE DIVISION OF MATERIALS.

THE DRAIN PIPE SHALL BE 8" Ø STANDARD WEIGHT IN ACCORDANCE WITH SUB-SECTION 810.02.13 OF THE SPECIFICATIONS.
PIPE, FITTINGS, AND CONNECTIONS SHALL BE INCLUDED IN THE UNIT PRICE PER LINEAR FOOT OF 8" DRAIN PIPE COMPLETE IN PLACE. PIPE AND ALL FITTINGS SHALL BE PAINTED IN ACCORDANCE WITH SECTION 607.25 OF THE KBH SPECIFICATIONS.

DAMAGE TO THE STRUCTURE

THE CONTRACTOR IS RESPONSIBLE FOR ANY AND ALL DAMAGE TO THE STRUCTURE DURING RECONSTRUCTION, EVEN TO THE REPLACEMENT OF ENTIRE SPANS AND REMOVAL OF THE FALLEN SPANS AT HIS EXPENSE, SHOULD THEY BE ALLOWED TO FALL FOR ANY CAUSE WHATSOEVER.

CONSTRUCTION IDENTIFICATION

THE NAMES OF THE PRIME CONTRACTOR AND THE SUB-CONTRACTOR SHALL BE IMPRINTED IN THE CONCRETE WITH ONE INCH LETTERS AT A LOCATION DESIGNATED BY THE ENGINEER. THE CONTRACTOR SHALL FURNISH ALL PLANS, EQUIPMENT AND LABOR NECESSARY TO DO THE WORK FOR WHICH NO DIRECT PAYMENT WILL BE MADE.

SURFACE FINISH OF CLASS "AA" CONCRETE IN THE BRIDGE DECK

THE DECK OF THIS STRUCTURE IS TO RECEIVE AN OVERLAY, THEREFORE, THE BURLAP DRAG FINISH SPECIFIED BY SECTION 609.12 OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 1976 EDITION, IS ELIMINATED, NOR WILL ANY SURFACE TEXTURING BEYOND 10 FT. STRAIGHTEDGE SECTION 609.11 BE PERMITTED. THE CONTRACTOR IS CAUTIONED THAT THE PROPOSED DECK OVERLAYS ARE VERY SENSITIVE TO OILS, PAINTS, GREASE, WAXES AND SIMILAR SUBSTANCES AND IF THESE SUBSTANCES ARE DEPOSITED IN THE DECK, HE WILL BE RESPONSIBLE FOR THEIR COMPLETE REMOVAL WHICH MAY INCLUDE REMOVAL AND REPACEMENT OF THE AFFECTED CONCRETE TO THE DEPTH THE SUBSTANCES HAVE PENETRATED. ANY EXPENSE OF THIS REMOVAL WILL BE BORNE BY THE CONTRACTOR.

CURING OF CLASS "AA" CONCRETE IN THE BRIDGE DECK

THE DECK OF THIS STRUCTURE IS TO RECEIVE AN OVERLAY, THEREFORE, MEMBRANE CURING AS SPECIFIED IN SECTION 609.15 IS NOT TO BE APPLIED TO THE BRIDGE DECK. THE CONCRETE DECK, INCLUDING PORTIONS OF THE CURBS, AND/OR BARRIER WALLS DESIGNATED, MUST BE WET CURED IN CONFORMITY WITH SUB-SECTION 601.25A OF THE STANDARD SPECIFICATIONS FOR ROAD AND BRIDGE CONSTRUCTION, 1976 EDITION, WITH THE FOLLOWING REQUIREMENTS:

1. NO CURING COMPOUND, STYRENE BUTADIENE, LINSEED OIL, MASONRY COATING, FORM OIL OR SIMILAR SUBSTANCES WILL BE PERMITTED ON THE CLASS "AA" CONCRETE DECK SURFACE NOR FOR 6" VERTICALLY ABOVE THE CLASS "AA" CONCRETE GUTTER LINE OF THE INTERIOR FACES OF BARRIER CURBS.
2. AS SOON AFTER FINAL FINISH OF THE CONCRETE AS POSSIBLE, ONE THICKNESS OF PRE-WETTED BURLAP MUST BE APPLIED AND KEPT MOIST BY A FOG SPRAY APPLICATION OF WATER. THIS ONE THICKNESS OF BURLAP MUST BE FOLLOWED, AS SOON AS POSSIBLE, WITHOUT DAMAGING THE SURFACE OF THE CONCRETE, WITH AN ADDITIONAL LAYER OF WET BURLAP, COTTON MATS, ETC.
3. THE REQUIRED INITIAL LAYER OF BURLAP SHALL BE PRE-WETTED BY COMPLETE SATURATION WITH WATER EXCEPT THAT IT SHALL BE SQUEEZED FREE OF EXCESS WATER THAT WILL DAMAGE THE CONCRETE SURFACE BY DRIPPING. THE PRE-WETTED BURLAP MUST BE APPLIED FROM WORK BRIDGES AND WALKWAYS IN A MANNER THAT WILL PRECLUDE WORKMEN OR TOOLS DAMAGING THE FRESH CONCRETE SURFACE. THE PRE-WETTED BURLAP MUST BE APPLIED IN A MANNER THAT WILL PREVENT IT FROM BEING DRAGGED, UNTANGLED, OR UNROLLED ON THE FRESH CONCRETE SURFACE AND DAMAGING IT.

ALTERNATE TYPES OF CONCRETE OVERLAY

THE CONTRACTOR SHALL USE AT HIS OPTION, ONE OF THE FOLLOWING ALTERNATES THROUGHOUT THE PROJECT.

ALTERNATE A - CONCRETE OVERLAY, LATEX IN ACCORDANCE WITH SPECIAL PROVISION 5(76), CURRENT EDITION.

ALTERNATE B - CONCRETE OVERLAY, PORTLAND CEMENT IN ACCORDANCE WITH SPECIAL PROVISION 5(76), CURRENT EDITION.

THE OVERLAYS SHALL BE POURED BEFORE ANY TRAFFIC IS ALLOWED ON A NEW SLAB. THE DOWNSTREAM PORTION OF OVERLAY SHALL BE PLACED FROM THE NEW DOWNSTREAM GUTTER LINE TO THE FACE OF THE TEMPORARY GUARDRAIL. THE REMAINING PORTION OF THE DOWNSTREAM SIDE OF PAVEMENT SHALL BE OVERLAYED AT THE SAME TIME AS THE UPSTREAM SIDE OF PAVEMENT.

GENERAL NOTE

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER — SHEET 4

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE-CAIRO, ILL.
ROAD

STATION — P.E. PROJECT NO. MP004-0051-B0021

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
		19382

LETTING DATE

DESIGNED BY / DETAILED BY / TRACED BY

CHECKED BY (signature) DATE / CHECKED BY DATE / CHECKED BY DATE

REVISED Added to "Alt. types of Conc. Overlay" note DATE 5/6/77 / REVISED DATE / REVISED DATE

GENERAL NOTE

REMOVAL OF EXISTING REINFORCED CONCRETE

THIS WORK SHALL INCLUDE REMOVING THE REINFORCED CONCRETE DECK SLABS,SIDEWALKS,CURBS,OVERLAYS,PATCHES ETC.FOR THE ENTIRE LENGTH OF THE BRIDGE PLUS OTHER CONCRETE NOTED ON THE PLANS AND DISPOSING OF THIS MATERIAL AWAY FROM THE BRIDGE SITE. PROPER CARE SHALL BE TAKEN TO PROTECT THE STRUCTURAL STEEL FROM DAMAGE DURING THIS OPERATION. THE FLOOR SHALL BE REMOVED WITHOUT ALLOWING THE BROKEN CONCRETE TO DROP INTO THE RIVER,OR ON THE RAILROAD UNDERNEATH. THE CONTRACTOR SHALL BE RESPONSIBLE FOR ANY DAMAGE CAUSED BY FALLING PARTICLES. THE COST OF THIS WORK SHALL BE INCLUDED IN THE LUMP SUM BID FOR REMOVE EXISTING REINFORCED CONCRETE.

NEOPRENE EXPANSION DAM

THE CONTRACTOR SHALL USE ONE OF THE FOLLOWING OPTIONS:

	2"JOINT	21/2"JOINT
A. TRANSFLEX	200A	250
B. FEL SPAN	T20	T30
C. WABO ELASTODAM	200	300

THE EXPANSION JOINT SHALL BE FABRICATED TO FOLLOW THE CONTOUR OF THE ROADWAY AND UP THE CURBS AS SHOWN ON THE PLANS. THE EXPANSION JOINT SHALL BE INSTALLED PRIOR TO PLACING THE CONCRETE OVERLAY. THE TRANSFLEX EXPANSION DEVICE AS DESIGNED AND DETAILED BY GENERAL TIRE AND RUBBER CO.,WABASH,INDIANA,HAS BEEN DETAILED IN THE PLANS. IF FEL SPAN BY FEL-PRO INC.,SKOKIE,ILLINOIS,OR WABO ELASTODAM BY WATSON BOWMAN ASSOC.,BUFFALO,NEW YORK IS CHOSEN,THE CONTRACTOR SHALL SUBMIT A MODIFICATION TO THE CONTRACT PLANS DETAILING A BLOCKOUT TO ACCOMMODATE THAT EXPANSION DEVICE. ANY ADDITIONAL LABOR OR MATERIAL REQUIRED SHALL BE INCIDENTAL TO THE COST OF THE EXPANSION DEVICE. THE NEOPRENE EXPANSION DAM SHALL BE PAID FOR AT THE UNIT BID PER LIN.FT.AND SHALL INCLUDE ALL MATERIALS,TOOLS,LABOR AND INCIDENTALS NECESSARY FOR THE COMPLETE INSTALLATION. THE MANUFACTURER OF THE EXPANSION DAM SHALL SUBMIT THREE SETS OF SHOP DRAWINGS AND THREE SETS OF MODIFICATIONS TO THE CONTRACT PLANS TO THE BUREAU FOR REVIEW PRIOR TO INSTALLATION. THE EXPANSION DEVICE SHALL BE INSTALLED AS RECOMMENDED BY THE MANUFACTURER AND UNDER THE MANUFACTURER'S SUPERVISION.

POURING SEQUENCE

THE SLABS OF SPANS 7 THRU 11 SHALL BE REMOVED AND REPOURED AS SHOWN ON THE PLANS. THIS SEQUENCE MUST BE ADHERED TO IN ORDER TO PREVEN EXCESSIVE UPLIFTS AT VARIOUS POINTS IN THE MAIN SPANS.

BRIDGE LIGHTING

THE NAVIGATION LIGHTING SYSTEM ON THIS BRIDGE IS TO BE REPLACED OR REMODELED AS SHOWN ON THE PLANS. THE COST OF THIS ITEM SHALL BE INCLUDED IN THE VARIOUS ITEMS SHOWN ON THE PLANS.

GUARDRAIL

THE EXISTING GUARDRAIL ON THE KENTUCKY APPROACH TO THE BRIDGE SHALL BE REMOVED IN AN ACCEPTABLE MANNER TO THE ENGINEER AND SHALL BE STOCKPILED ON THE RIGHT-OF-WAY AT SITES APPROVED BY THE ENGINEER. ALL THE ITEMS IN THE SYSTEM SHALL REMAIN THE PROPERTY OF THE BUREAU. DRY SAND SHALL BE USED TO FILL ALL VOIDS LEFT AS THE RESULT OF PULLING EXISTING POSTS. THE FILL SHALL NOT BE LEFT UNGUARDED OVERNIGHT WITHOUT THE USE OF PROPER WARNING DEVICES. THE COST OF REMOVING THIS GUARDRAIL SYSTEM,STOCKPILING AND FILLING THE HOLES SHALL BE INCIDENTAL TO THE UNIT PRICE BID FOR STEEL W BEAM GUARD RAIL(SINGLE FACE). THE NEW STEEL W BEAM GUARD RAIL SYSTEM SHALL MEET ALL REQUIREMENTS OF THE PLANS AND STANDARD DRAWINGS.

CUTTING EXISTING BITUMINOUS SURFACING

THE EXISTING BITUMINOUS ROADWAY SURFACING SHALL BE CUT AND REMOVED AS REQUIRED TO YIELD A MINIMUM OF 1-1/2"THICK WEEK BITUMINOUS SURFACE COURSE. NO SEPARATE PAYMENT FOR THIS WORK AS THE COST OF THIS WORK IS TO BE INCLUDED IN THE UNIT PRICE BID FOR BITUMINOUS CONCRETE SURFACE.

BITUMINOUS CONCRETE

THE BITUMINOUS MATERIAL FOR BASE AND SURFACE,TYPE B BITUMINOUS CONCRETE SHALL BE AC-10. THE BITUMINOUS TACK COAT MAY BE LIQUID ASPHALT RC-250 OR EMULSIFIED ASPHALT SS-1H. THE QUANTITY OF TACK COAT HAS BEEN COMPUTED USING A RATE OF APPLICATION OF 0.1 GALLONS PER SQ.YD. IF THE CONTRACTOR ELECTS TO USE EMULSIFIED ASPHALT SS-1H FOR TACK COAT,THE QUANTITY WILL BE REDUCED 50% AND THE MATERIAL DILUTED WITH AN EQUAL QUANTITY OF WATER AND APPLIED AT THE RATE OF 0.1 GALLONS PER SQ.YD.. PAYMENT WILL BE MADE AT THE CONTRACT UNIT PRICE BID FOR BITUMINOUS TACK COAT AND FOR THE QUANTITY OF EMULSIFIED ASPHALT SS-1H BEFORE DILUTION. THE COST OF THE WATER AND APPLICATION WILL BE INCIDENTAL TO THE COST OF THE BITUMINOUS TACK COAT. OTHER BITUMINOUS MATERIAL MAY BE USED IF APPROVAL IN WRITING BY THE DIRECTOR,DIVISION OF BRIDGES.

SHIFT MAIN TRUSS SPANS

THE MAIN TRUSS SPANS SHALL BE SHIFTED AS SHOWN ON THE PLANS. THE LOWER CHORD EXPANSION JOINTS AND WIND EXPANSION DEVICES SHALL BE CLEANED,PAINTED AND GREASED AS SHOWN ON THE PLANS. THE COST OF THESE ITEMS SHALL BE INCLUDED IN THE LUMP SUM BID FOR STRUCTURAL STEEL.

EXISTING STEEL

ALL EXISTING STEEL THAT IS TO BE REMOVED AND NOT REUSED IN THE BRIDGE SHALL BECOME THE PROPERTY OF THE CONTRACTOR AND SHALL BE REMOVED FROM THE BRIDGE SITE WITH THE FOLLOWING EXCEPTION: 500 LIN.FT.OF EXISTING HANDRAIL,TAKEN FROM SPANS 12 THRU 20,INCLUDING THE 3 RAILS,POSTS AND RAIL CONNECTIONS,AND CROSS OVER PLATES USED BY THE DEPARTMENT TO COVER DECK POT HOLES. THESE HANDRAILS AND CROSS OVER PLATES SHALL BE CAREFULLY DISMANTLED AND STACKED NEAR THE SITE AS DIRECTED BY THE ENGINEER. THE COST OF THIS WORK IS TO BE INCLUDED IN THE LUMP SUM BID FOR STRUCTURAL STEEL.

UTILITY LINES

THE UTILITY LINES SHALL BE RELOCATED AS SHOWN ON THE PLANS OR AS DIRECTED BY THE ENGINEER. THE CONTRACTOR SHALL COOPERATE WITH THE UTILITY OWNERS DURING CONSTRUCTION AND SHALL BE RESPONSIBLE FOR DAMAGE TO THESE LINES CAUSED BY HIS NEGLEGENCE. ALL COST INVOLVED WITH THIS RELOCATION INCLUDING BRACKETS AND BOLTS SHALL BE INCLUDED IN THE LUMP SUM BID FOR RELOCATE UTILITY LINES.

EXISTING CONCRETE FLOORING

THE CONTRACTOR SHALL BE RESPONSIBLE FOR MAINTAINING THE EXISTING CONCRETE DECK FROM THE TIME THAT A WORK ORDER IS RECEIVED FROM THE DEPARTMENT,UNTIL IT'S COMPLETE REPLACEMENT. THIS ITEM INCLUDES PATCHING ALL POTHOLES OR EVEN REPLACING FULL DEPTH SLABS WHERE NECESSARY TO PROVIDE A SMOOTH AND SAFE SURFACE FOR VEHICULAR TRAVEL. THE COST OF CROSS OVER PLATES,CONCRETE,FORMS,LABOR,TOOLS AND OTHER NECESSARY MATERIALS REQUIRED FOR THIS ITEM SHALL BE INCLUDED IN THE LUMP SUM BID FOR MAINTAIN AND CONTROL TRAFFIC.

MAINTAIN TRAFFIC

AT LEAST ONE LANE OF VEHICULAR TRAFFIC SHALL BE MAINTAINED AND PROTECTED ON A 24 HOUR BASIS DURING CONSTRUCTION. SIGNS AND SIGNALS SHALL BE MAINTAINED IN ACCORDANCE WITH THE MANUAL OF UNIFORM TRAFFIC CONTROL DEVICES. THE BRIDGE SHALL NOT BE CLOSED TO ANY TRAFFIC UNTIL A REASONABLE AMOUNT OF MATERIAL FOR ITS RECONSTRUCTION IS AVAILABLE AT THE BRIDGE SITE AS JUDGED BY THE ENGINEER. THE CONTRACTOR MUST PROVIDE FLAGMEN FOR THE MAINTENANCE OF TRAFFIC WHENEVER TRAFFIC IS REDUCED TO ONE LANE. DURING TIMES OF TRAFFIC DELAYS,NO STACKING OF TRAFFIC WILL BE PERMITTED ON THE MAIN SPANS (SPANS 7 THRU 11). ON OTHER SPANS,TRUCKS MUST BE INSTRUCTED TO MAINTAIN A MINIMUM SPACE OF 50'BETWEEN TRUCKS WHETHER MOVING OR STOPPED. VEHICLES WEIGHING OVER 5000 LBS.MUST BE ELIMINATED FROM THE BRIDGE FOR A 24 HOUR PERIOD DURING THE POURING AND SETTING OF NEW DECK CONCRETE. THIS 24 HOUR PERIOD SHALL BEGIN WHEN POURING OF CONCRETE BEGINS. ONLY ONE POURING PERIOD PER WEEK WILL BE PERMITTED AND THE ENGINEER MUST BE NOTIFIED ONE WEEK IN ADVANCE OF ANY POURING SCHEDULE. WHEN ONE LANE OF CONCRETE SLAB IS REMOVED OR BEING REMOVED,THE OTHER LANE MUST BE PROTECTED WITH A BARRIER AS SHOWN ON THE PLANS. THE CONTRACTOR SHALL FURNISH ALL SIGNS,BARRACADES,CROSS OVER PLATES,FLAGMEN AND INCIDENTALS NECESSARY FOR THE MAINTENANCE AND PROTECTION OF TRAFFIC. THE COST OF FURNISHING,PLACING AND MAINTAINING THESE ITEMS AND PERFORMING OTHER NECESSARY WORK CALLED FOR IN THE PLANS OR AS DIRECTED BY THE ENGINEER FOR THE MAINTENANCE AND PROTECTION OF TRAFFIC SHALL BE INCLUDED IN THE LUMP SUM BID FOR MAINTAIN AND CONTROL TRAFFIC. TRAFFIC SIGNS WILL BE REQUIRED IN TWO DIRECTIONS ON THE ILLINOIS END OF THE BRIDGE SINCE THE ROAD DIVIDES THERE. THE ELIMINATION OF VEHICLES OVER 5000LBS. FOR A 24-HOUR PERIOD DURING THE POURING OF CONCRETE SHALL NOT APPLY TO THE POURING OF CONCRETE OVERLAYS. TRAFFIC SHALL NOT BE PERMITTED ON ANY NEW CONCRETE SLABS UNTIL THE NEW CURBS,NEW GUARDRAILS, AND CONCRETE OVERLAYS HAVE BEEN PLACED ON THOSE SLABS. FLAGMEN MUST BE USED FOR THE MAINTENANCE OF TRAFFIC WHENEVER A TEMPORARY BARRIER IS REQUIRED NEAR THE CENTERLINE OF ROADWAY EVEN THOUGH 2 LANES OF TRAFFIC MAY BE USED.

SEAL SUBSTRUCTURE CAPS

THE EXISTING PIER AND ABUTMENT CAPS SHALL BE BLAST CLEANED AND SEALED WITH AN EPOXY SAND SLURRY. THE ENTIRE AREA AS SHOWN ON THE PLANS SHALL BE BLAST CLEANED AND SEALED. ANY MASTIC OR OTHER SEALERS WHICH MAY BE ON THESE CAPS MUST BE COMPLETELY REMOVED. THE BLAST CLEANING AND EPOXY SAND SLURRY SHALL BE AS SPECIFIED IN THE SPECIAL PROVISION NO.6(76)-BRIDGE DECK REPAIRS. THE COST OF REMOVING EXISTING SEALERS OR OTHER FOREIGN MATERIALS SHALL BE INCIDENTAL TO THE UNIT PRICE BID FOR BLAST CLEANING.

GENERAL NOTE

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER SHEET 5

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE-CAIRO,ILL.
ROAD

STATION P.E. PROJECT NO. MP004-0051-B0021

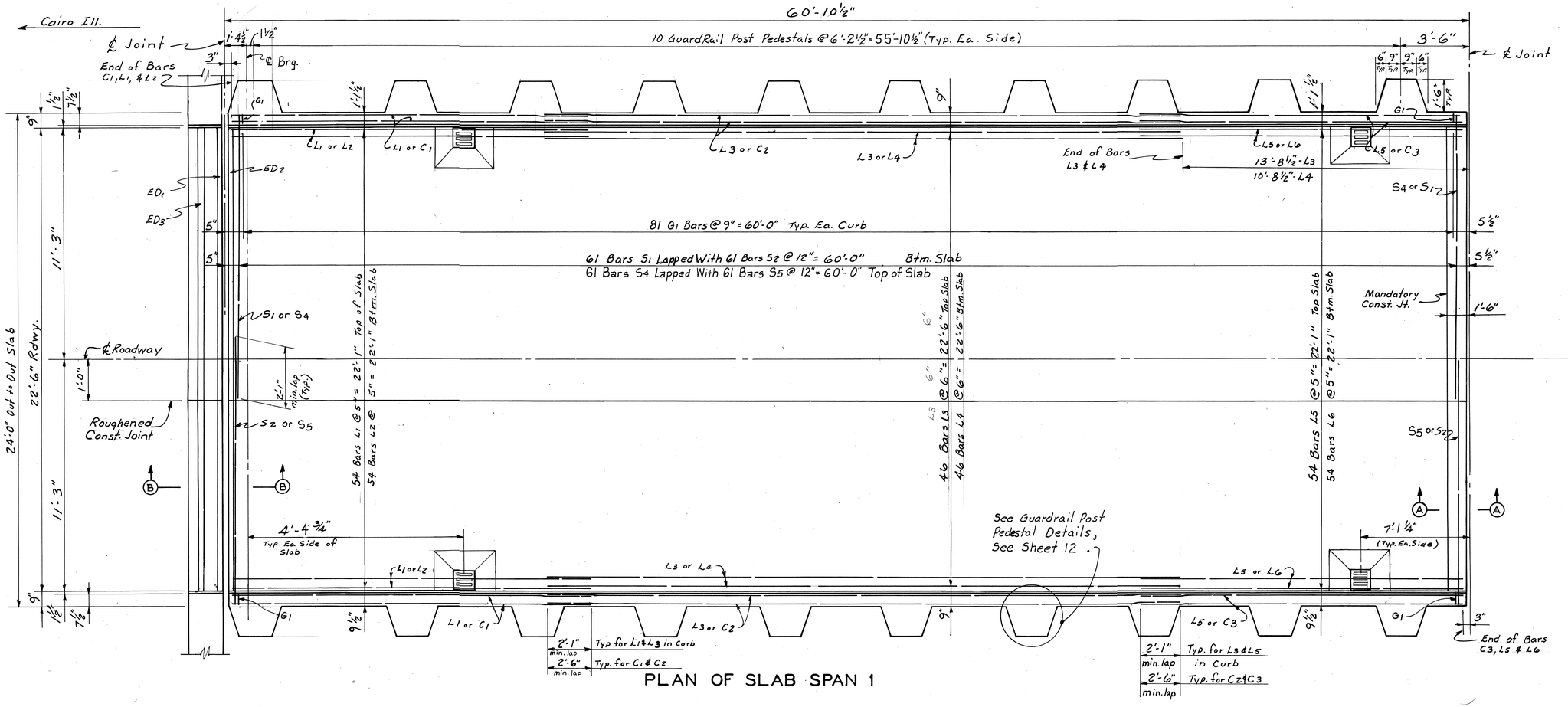
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
		19382

LETTING DATE

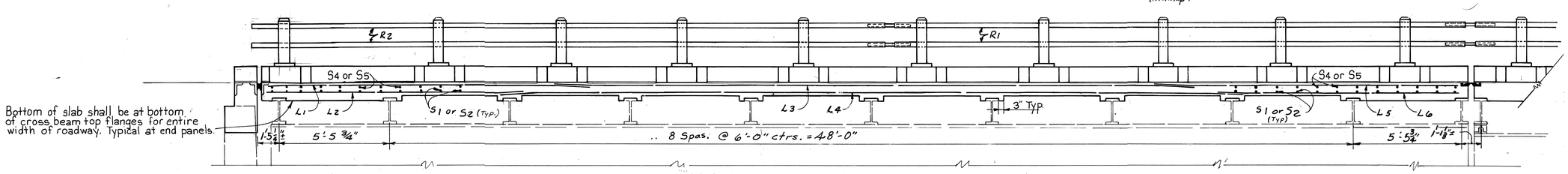
DESIGNED BY / DETAILED BY / TRACED BY

CHECKED BY DATE / CHECKED BY DATE / CHECKED BY DATE

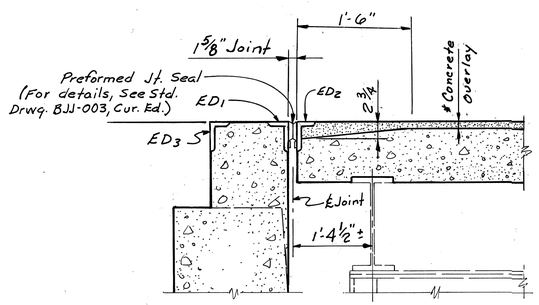
REVISED Added to "Maintain Traffic" note DATE 5/4/77
REVISED DATE
REVISED DATE



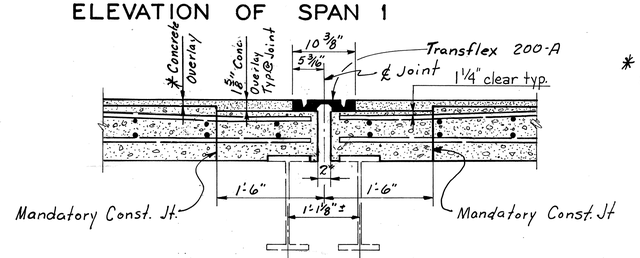
PLAN OF SLAB SPAN 1



ELEVATION OF SPAN 1



SECTION B-B



SECTION A-A

* 1½" Concrete Overlay, Latex
2" Concrete Overlay, Portland Cement

DETAILS SPAN 1

SHEET 6

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE-CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-80021	19382

UPDATE DATE
LETTING DATE

DATE 5/31/77 — Bars S4 & S5 clarified locations

DESIGNED BY
DETAILED BY Carpenter
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
REVISED
REVISED
REVISED
DATE
DATE
DATE

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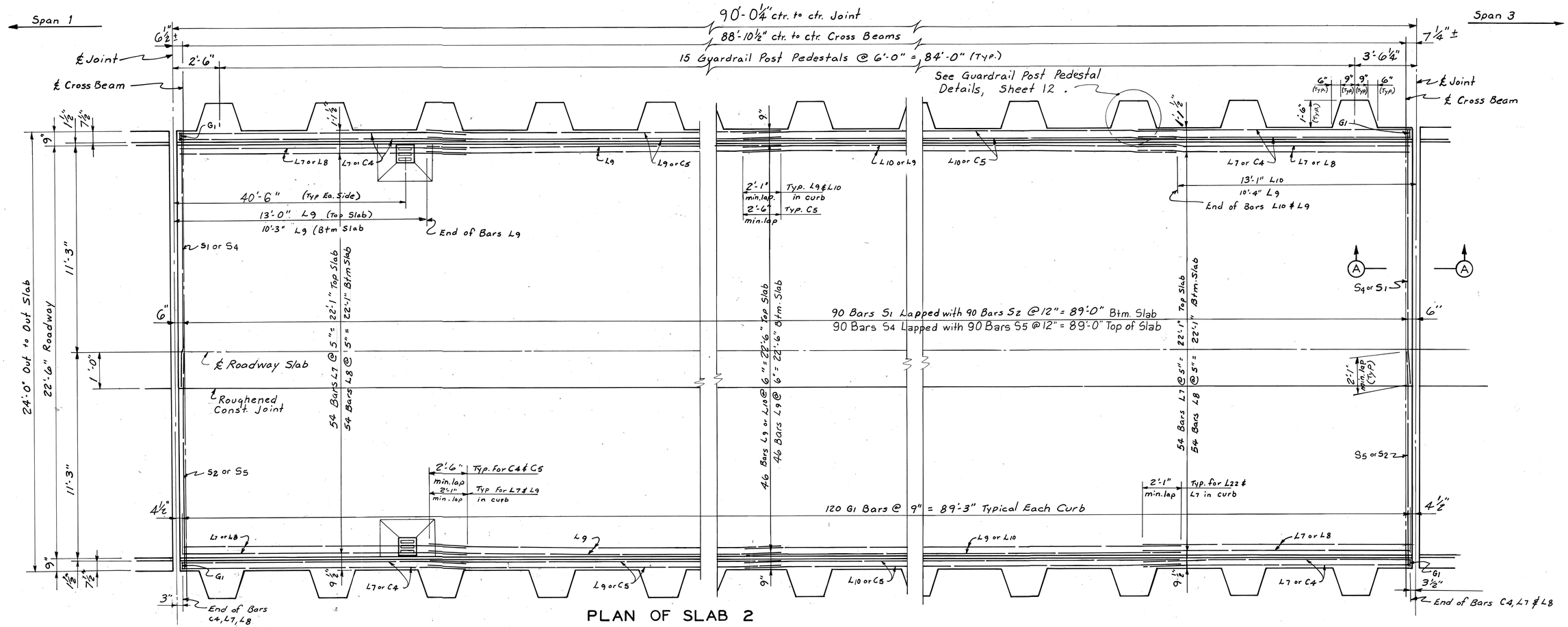
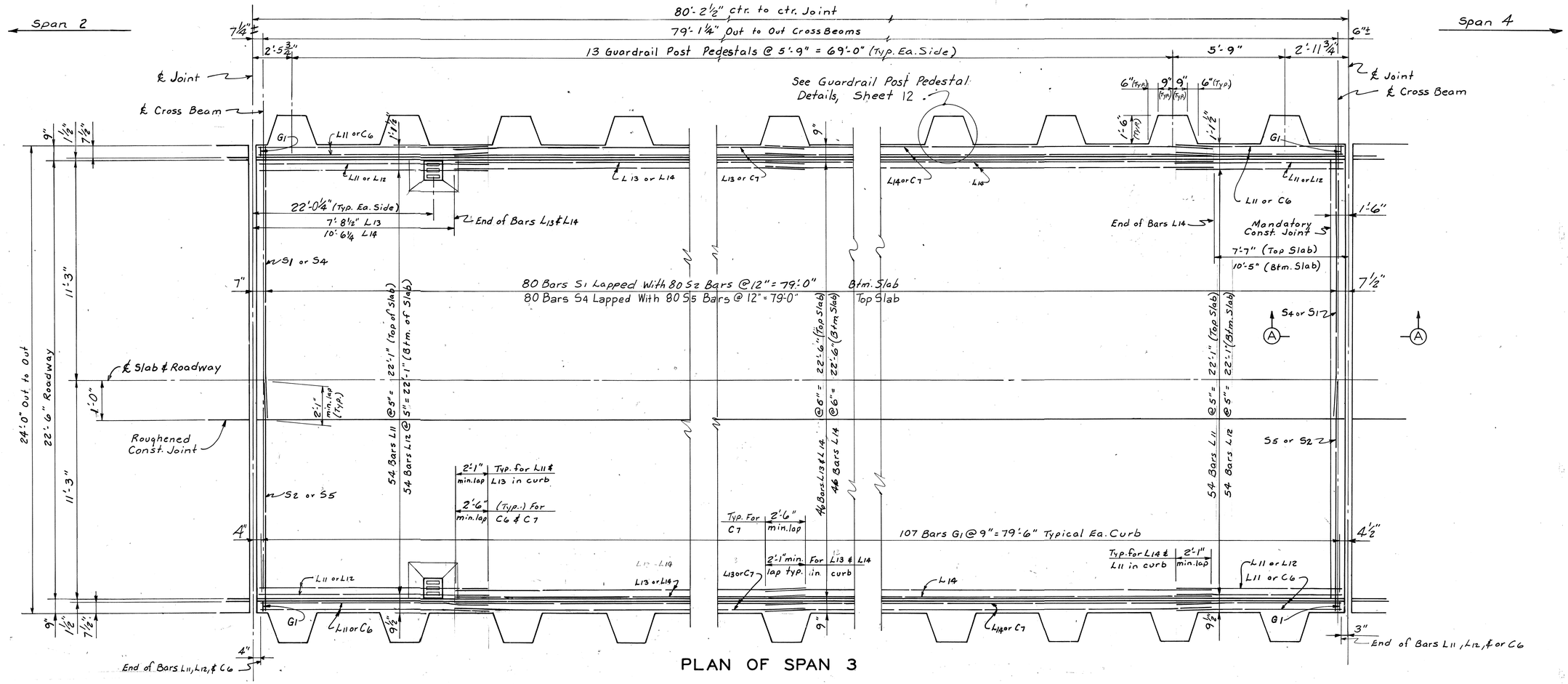
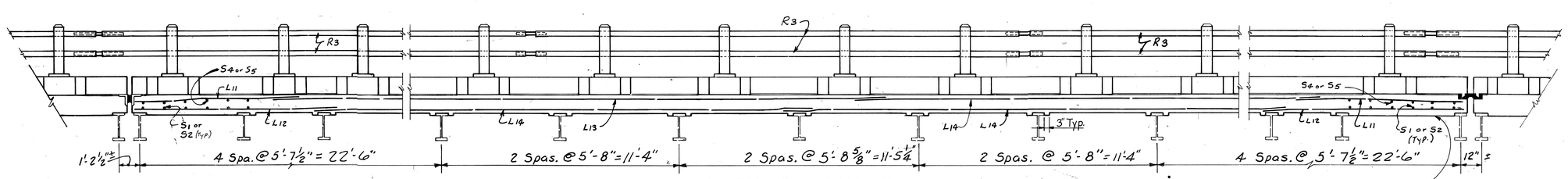

Span 1
Span 3
90'-0¼" ctr. to ctr. Joint
88'-10½" ctr. to ctr. Cross Beams
15 Guardrail Post Pedestals @ 6'-0" = 84'-0" (Typ.)
See Guardrail Post Pedestal Details, Sheet 12.
℄ Joint
℄ Cross Beam
40'-6" (Typ Ea. Side)
13'-0" L9 (Top Slab)
10'-3" L9 (Btm Slab
End of Bars L9
13'-1" L10
10'-4" L9
End of Bars L10 & L9
Typ. L9 & L10 in curb
Typ. C5
S1 or S4
S2 or S5
S4 or S1
S5 or S2
℄ Roadway Slab
Roughened Const. Joint
24'-0" Out to Out Slab
22'-6" Roadway
54 Bars L7 @ 5" = 22'-1" Top Slab
54 Bars L8 @ 5" = 22'-1" Btm Slab
46 Bars L9 or L10 @ 6" = 22'-6" Top Slab
46 Bars L9 @ 6" = 22'-6" Btm. Slab
90 Bars S1 Lapped with 90 Bars S2 @ 12" = 89'-0" Btm. Slab
90 Bars S4 Lapped with 90 Bars S5 @ 12" = 89'-0" Top of Slab
Typ. for C4 & C5
Typ. for L7 & L9 in curb
Typ. for L22 & L7 in curb
120 G1 Bars @ 9" = 89'-3" Typical Each Curb
End of Bars C4, L7, L8
PLAN OF SLAB 2
R1
S4 or S5
S1 or S2 (Typ.)
3" Typ
12 Spa. @ 5'-6¾" = 66'-9"
Bottom of slab shall be at bottom of cross beam top flanges for entire width of roadway. Typical for end panels.
ELEVATION OF SPAN 2
* Concrete Overlay
⅝" Joint
Pre formed Joint Seal
ED1
ED2
See Detail "X"
* 1½" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement
SECTION A-A
DETAIL "X"
DETAILS SPAN 2
SHEET 7
REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER
COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE - CAIRO, ILL.
ROAD
STATION
P.E. PROJECT NO.
CONSTRUCTION PROJECT NO.
MAINTENANCE PROJECT NO.
MP 004-0051-80021
DRAWING NO.
19382
UPDATE DATE
LETTING DATE
REVISED Bars S4 & S5 clarified locations
DATE 5/4/73
DESIGNED BY
DETAILED BY
TRACED BY
CHECKED BY
N9947



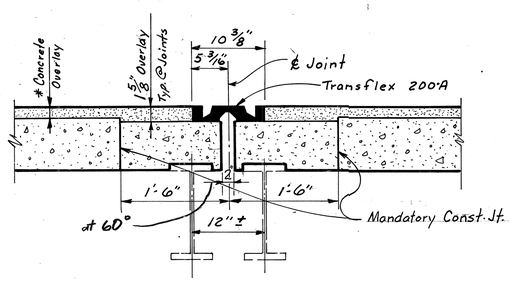
PLAN OF SPAN 3



ELEVATION OF SPAN 3

Bottom of slab shall be at bottom of cross beam top flanges for entire width of roadway. Typical at end panels.

* 1½" Concrete Overlay, Latex
2" Concrete Overlay, Portland Cement



SECTION A–A

DETAILS SPAN 3

SHEET 8

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

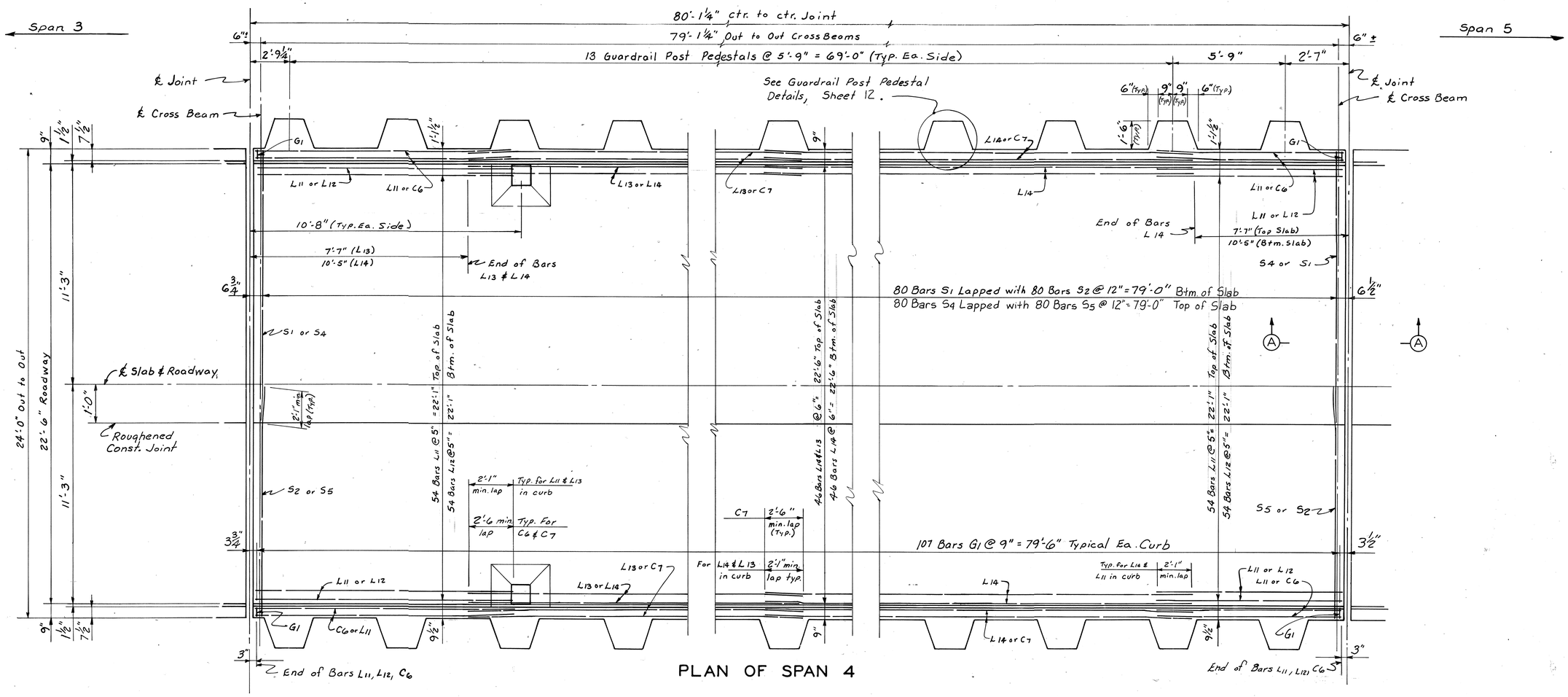
COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD
STATION P. E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

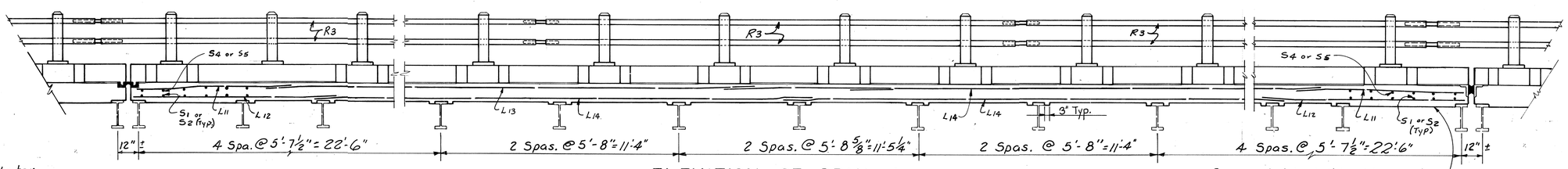
LETTING DATE

DESIGNED BY: CHECKED BY: DATE
DETAILED BY: CARPENTER CHECKED BY: DATE
TRACED BY: CHECKED BY: DATE

REVISED: Bars S4 & S5 clarified locations DATE 5/4/77
REVISED DATE
REVISED DATE



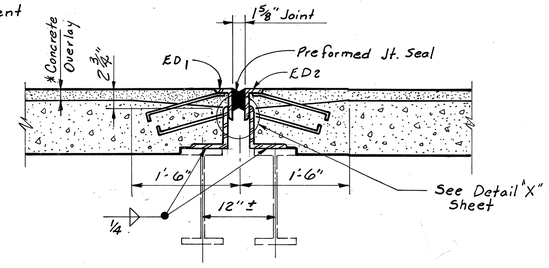
PLAN OF SPAN 4



ELEVATION OF SPAN 4

Bottom of slab shall be at bottom of cross beam top flanges for entire width of roadway. Typical at end panels.

* 1½" Concrete Overlay, Latex
2" Concrete Overlay, Portland Cement



SECTION A–A

DETAILS SPAN 4

SHEET 9

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD
STATION **P. E. PROJECT NO.**

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-80021	19382

LETTING DATE

DATE 5/4/77 REVISED Bars S4 & S5 clarified location

DESIGNED BY CHECKED BY DATE
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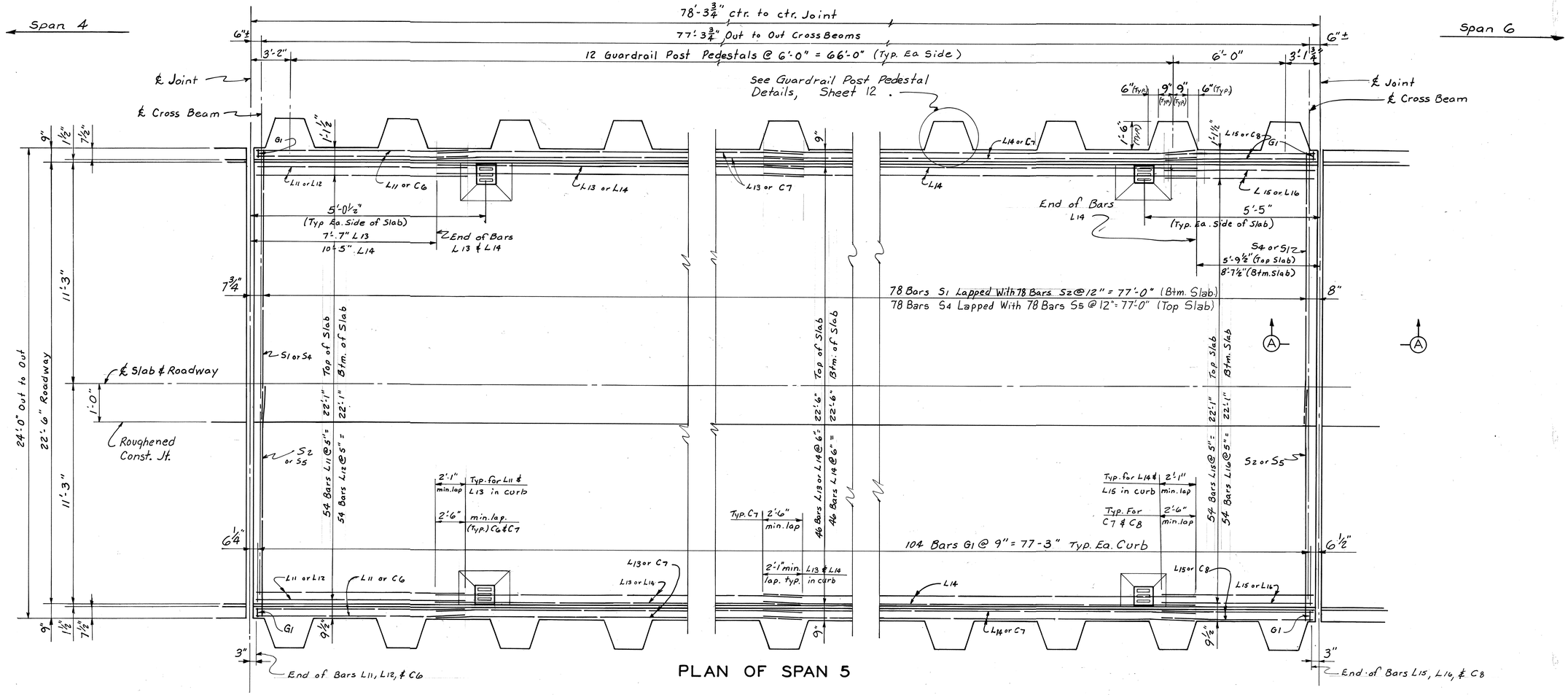
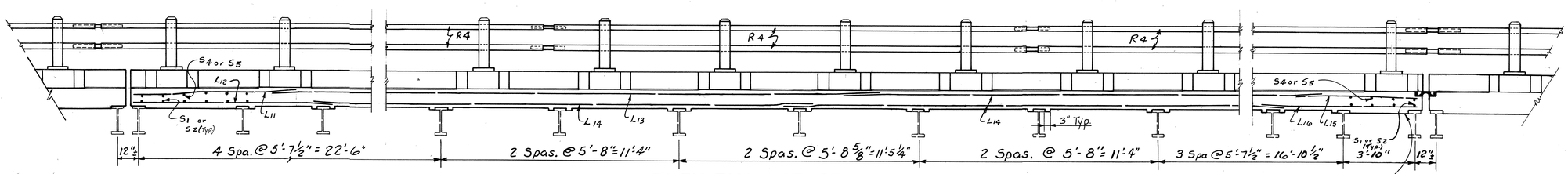
TRACED BY CHECKED BY DATE



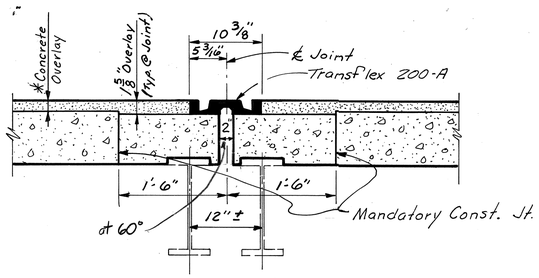
PLAN OF SPAN 5



ELEVATION OF SPAN 5

Bottom of slab shall be at bottom of cross beam top flanges for entire width of roadway. Typical at end panels.

* 1½" Concrete Overlay, Latex
2" Concrete Overlay, Portland Cement



SECTION A-A

DETAILS SPAN 5

SHEET 10

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

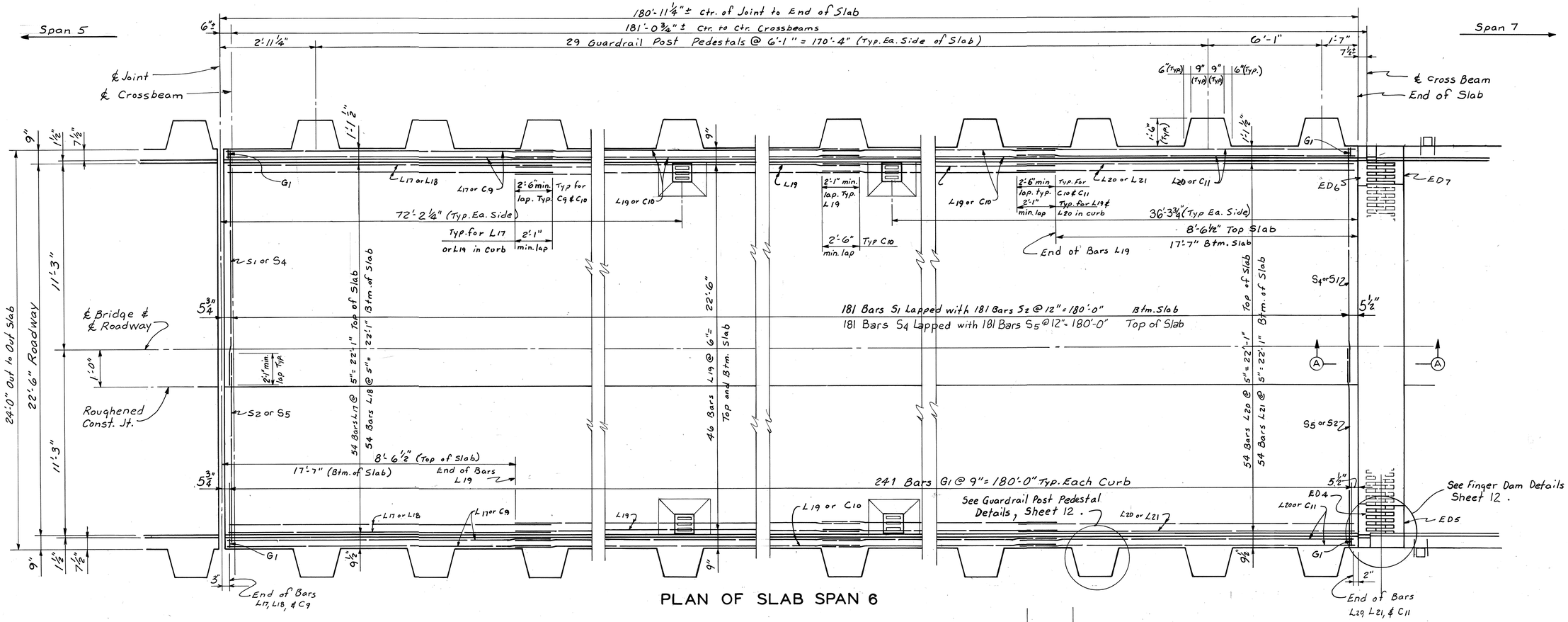
COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P. E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO. MP004-0051-B0021	DRAWING NO. 19382

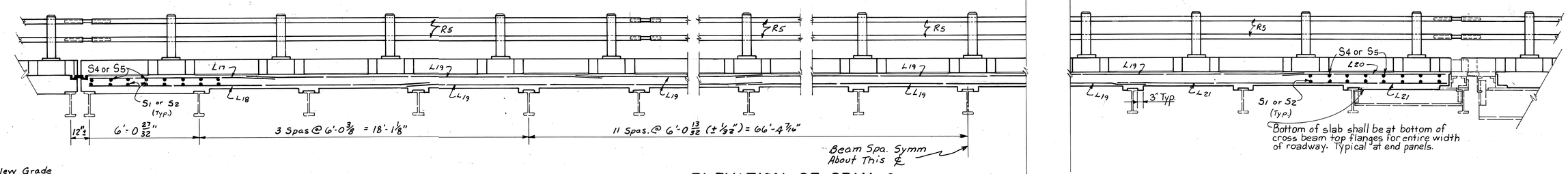
LETTING DATE

DESIGNED BY ___ CHECKED BY ___ DATE ___ REVISED ___
DETAILED BY ___ CHECKED BY ___ DATE ___ REVISED ___
TRACED BY ___ CHECKED BY ___ DATE ___ REVISED ___

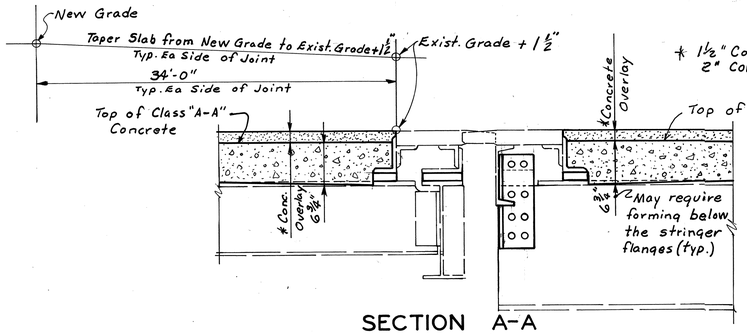
DATE 5/4/77 — Bars S4 & S5 Clarified locations



PLAN OF SLAB SPAN 6



ELEVATION OF SPAN 6



* 1½" Concrete Overlay, Latex
2" Concrete Overlay, Portland Cement

Note: See Sheet 13 for details for Raising Existing Finger Dam.

SECTION A-A
Showing Existing Finger Dam

DETAILS SPAN 6

SHEET 11

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

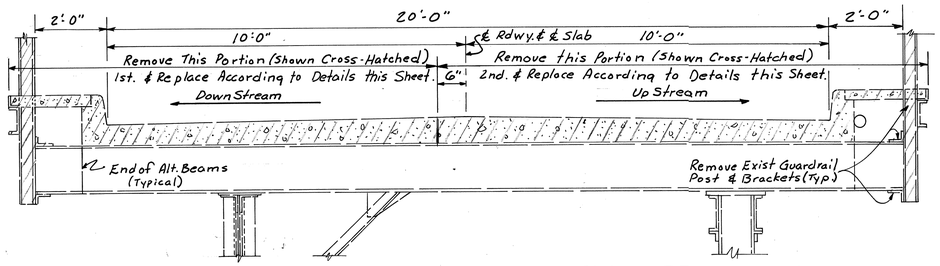
UPDATE DATE
LETTING DATE

DESIGNED BY ___ CHECKED BY ___ DATE ___ REVISED ___
DETAILED BY ___ CHECKED BY ___ DATE ___ REVISED ___
TRACED BY ___ CHECKED BY ___ DATE ___ REVISED ___

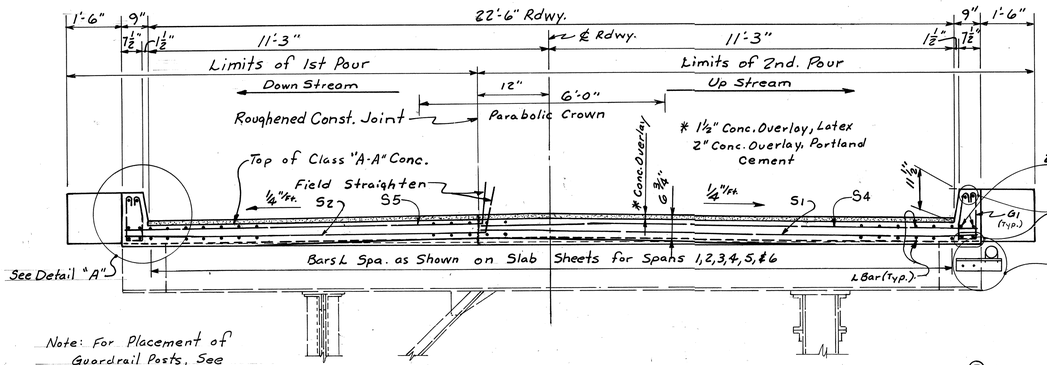
Bars S4 & S5 clarified locations

N9947

UPDATE DATE
LETTING DATE

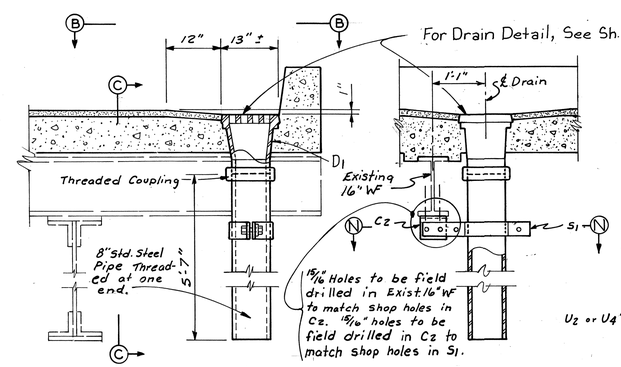


TYPICAL EXISTING SECTION OF ILL. APPROACHES
SPANS 1,2,3,4,5,6

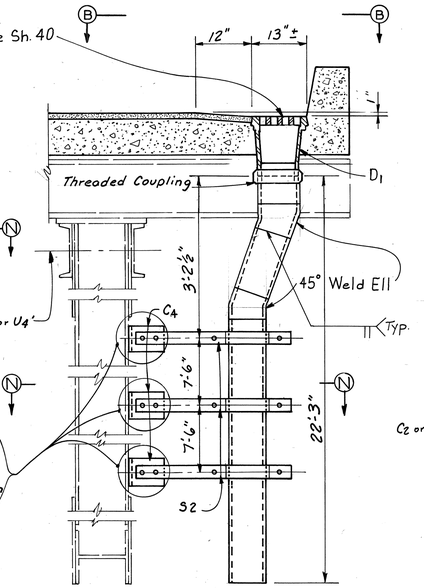


Note: For Placement of Guardrail Posts, See Details Sheet 43.

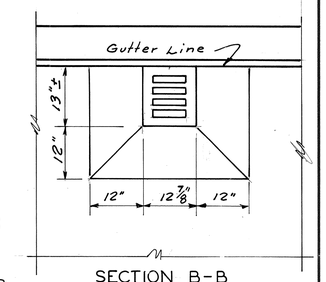
TYPICAL NEW SECTION OF ILL. APPROACHES
SPANS 1,2,3,4,5,6



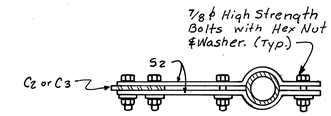
TYPICAL SECTION OF DRAINS-SPANS 1,2,3, 4 & 5 — 14 REQUIRED



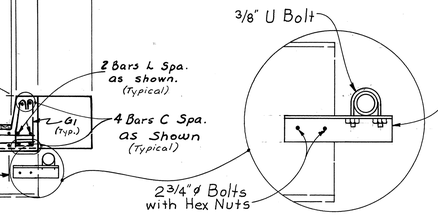
TYPICAL SECTION OF DRAINS
SPAN 6 — 4 REQUIRED



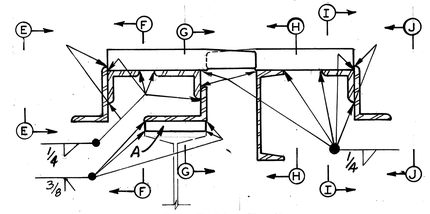
SECTION B-B



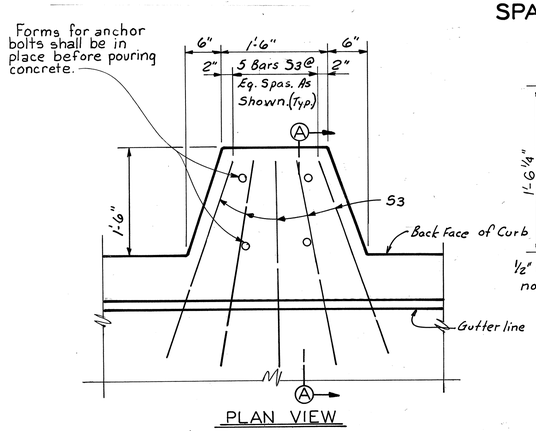
SECTION N-N



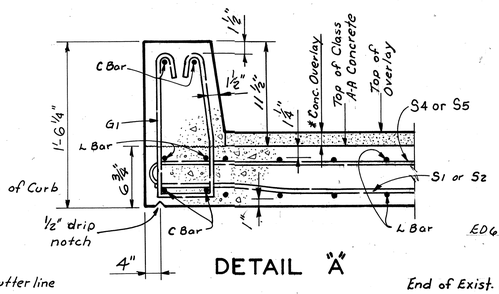
DRAIN DETAILS ILL. APPROACH SPANS 1,2,3,4,5 & 6

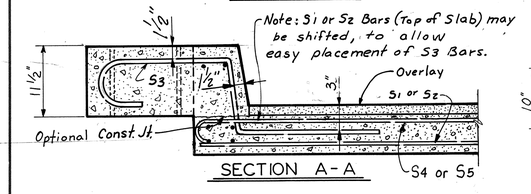


SECTION D-D



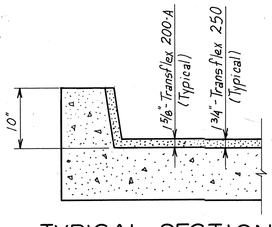
PLAN VIEW



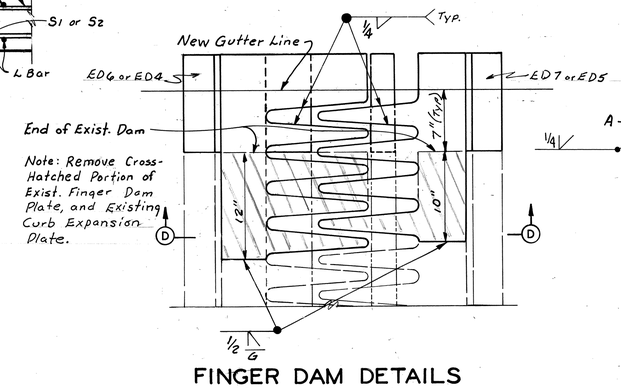


SECTION A-A

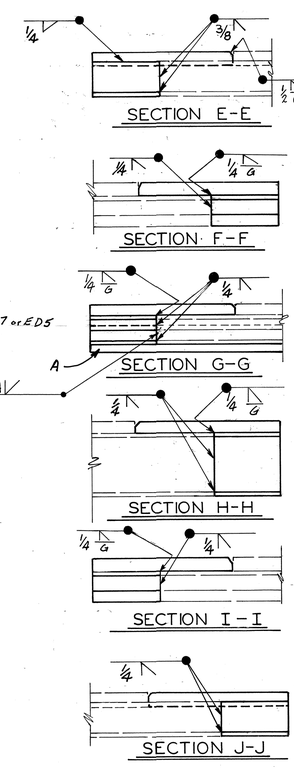
DETAILS OF GUARDRAIL POST PEDESTAL

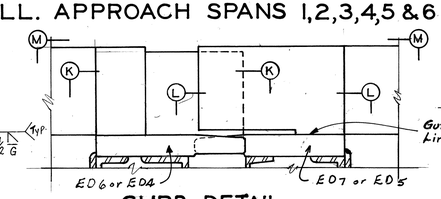


TYPICAL SECTION OF TRANSFLEX EXP. DAMS

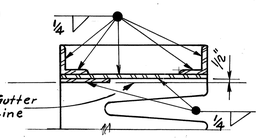


FINGER DAM DETAILS
ED 6 and ED 7 Shown
ED 4 and ED 5 OPP. Hand

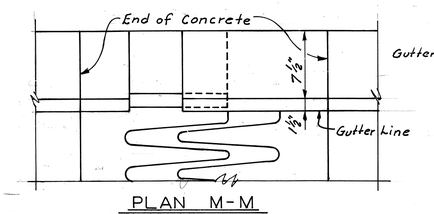




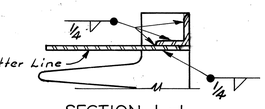
CURB DETAIL
ED 6 and ED 7 Shown
ED 4 and ED 5 Opp. Hand



SECTION K-K



PLAN M-M



SECTION L-L

Note: Raise finger dams complete (gutter to gutter). without construction joint in dam. This will require cross over plates, bituminous wedges etc. for the maintenance of traffic.

SHEET 12

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

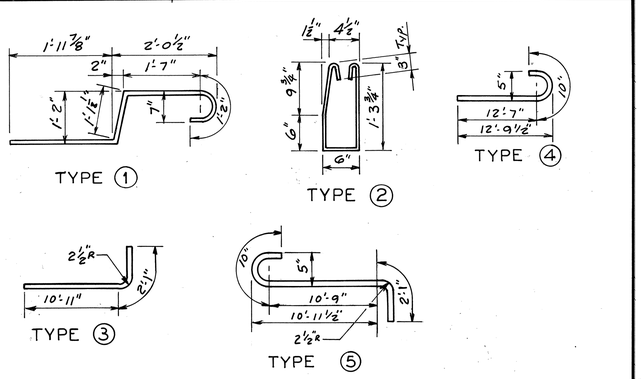
WICKLIFFE – CAIRO, ILL.
ROAD

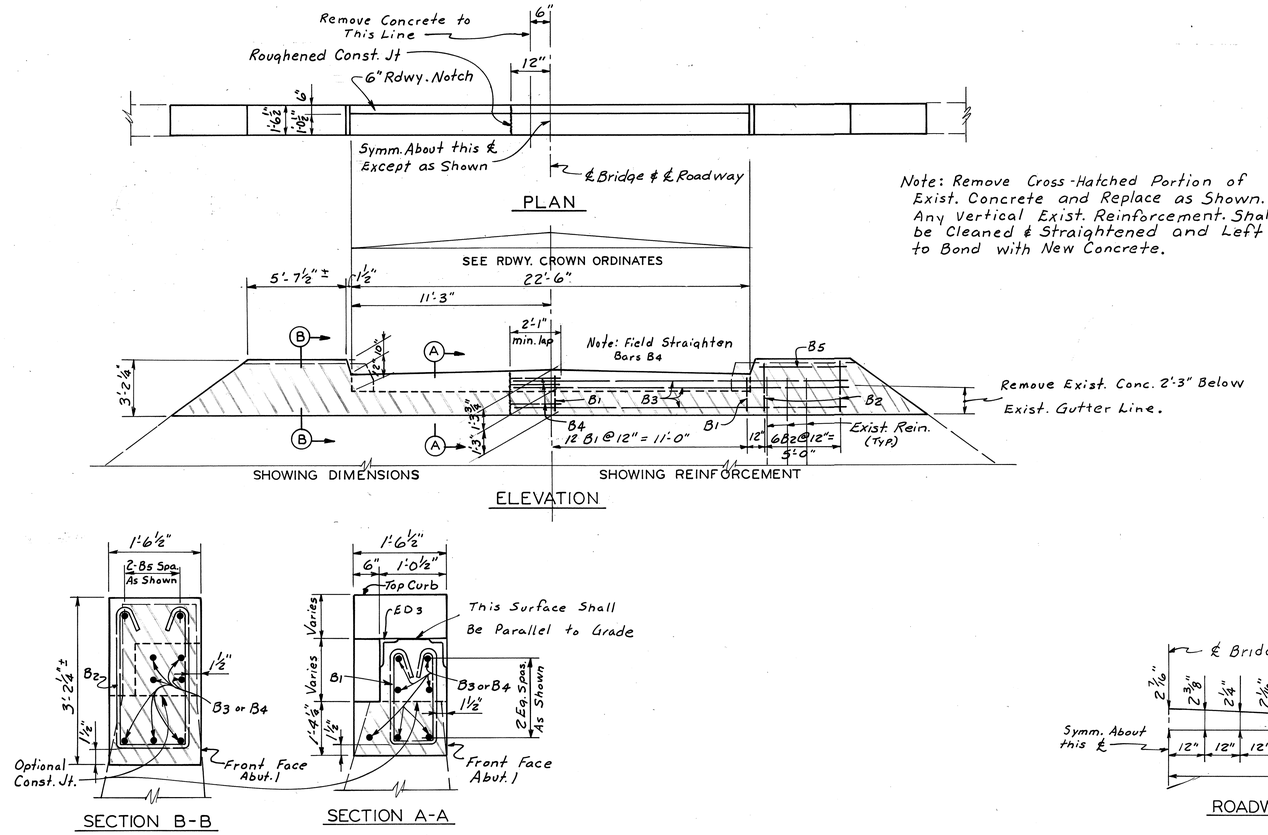
STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

DESIGNED BY: GARDENIER
DETAILED BY:
TRACED BY:
CHECKED BY:
CHECKED BY:
CHECKED BY:
DATE 5/4/77
REVISED Bars S4 & S5 clarified locations
REVISED
REVISED
N9947

BILL OF REINFORCEMENT
FOR SLABS, SPANS 1,2,3,4,5 & 6

MARK	TYPE	NO	SIZE	LENGTH FT.	LENGTH IN.	LOCATION	A FT.	A IN.	B FT.	B IN.	C FT.	C IN.	D FT.	D IN.
C1	Str.	8	#6	17	0	Curb, Span 1								
C2	↑	8	↑	32	4	do								
C3		8		16	1	do								
C4		16		15	6	Curb, Span 2								
C5		16		33	0	do								
C6		40		10	2	Curb, Span 3,4,5								
C7		48		33	6	do								
C8		8		8	2	Curb, Span 5								
C9		8		13	9	Curb, Span 6								
C10	↓	40	↓	32	8	do								
C11	Str.	8	#6	18	9	do								
G1	②	1520	#4	3	5	Curb, Spans 1 thru 6								
L1	Str.	54	#5	17	0	Slab, Span 1								
L2	↑	54	↑	14	0	do								
L3		46		32	9	do								
L4		46		38	9	do								
L5		54		16	3	do								
L6		54		13	3	do								
L7		108		15	6	Slab, Span 2								
L8		108		12	9	do								
L9		138		35	10	do								
L10		46		30	3	do								
L11		270		10	1	Slab, Span 3,4,5								
L12		270		12	10	do								
L13		276		36	5	do								
L14		276		30	9	do								
L15		54		8	3	Slab, Span 5								
L16		54		11	1	do								
L17		54		10	8	Slab, Span 6								
L18		54		19	9	do								
L19		782		20	3	do								
L20	↓	54	↓	9	7	do								
L21	Str.	54	#5	18	9	do								
S1	Str.	570	#5	12	10	Slab, Spans 1-6								
S2	③	570	#5	13	0	do								
S3	①	960	#7	5	10	Slab & Pedestals, Spans 1-6								
S4	④	570	#5	13	5	Slab Spans 1-6 (Top)								
S5	⑤	570	#5	13	8	do								

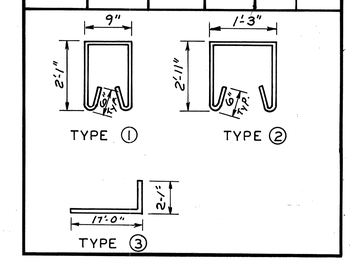


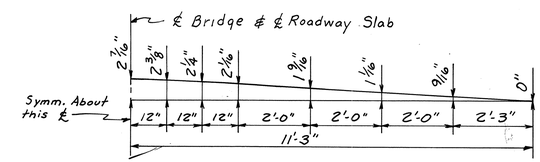


Note: Remove Cross-Hatched Portion of Exist. Concrete and Replace as Shown. Any Vertical Exist. Reinforcement Shall be Cleaned & Straightened and Left to Bond with New Concrete.

BILL OF REINFORCEMENT ABUTMENT 1

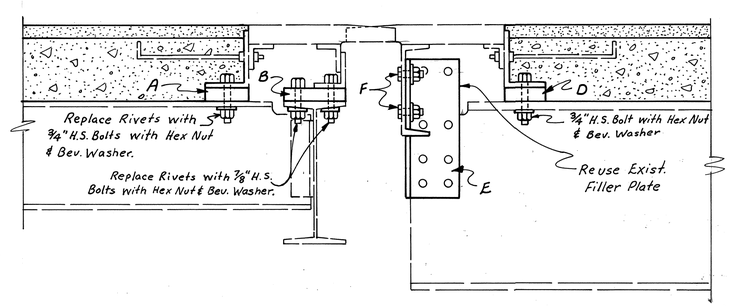
MARK	TYPE	NO	SIZE	LENGTH FT.	LENGTH IN.
B1	①	23	#4	5	9
B2	②	12	#4	7	11
B3	Str.	7	#5	18	0
B4	③	7	#5	18	3
B5	Str.	4	#5	5	4





ROADWAY CROWN ORDINATES

DETAILS ABUTMENT 1



DETAIL FOR RAISING FINGER DAM AT L_0, L_{79}

SHEET 13

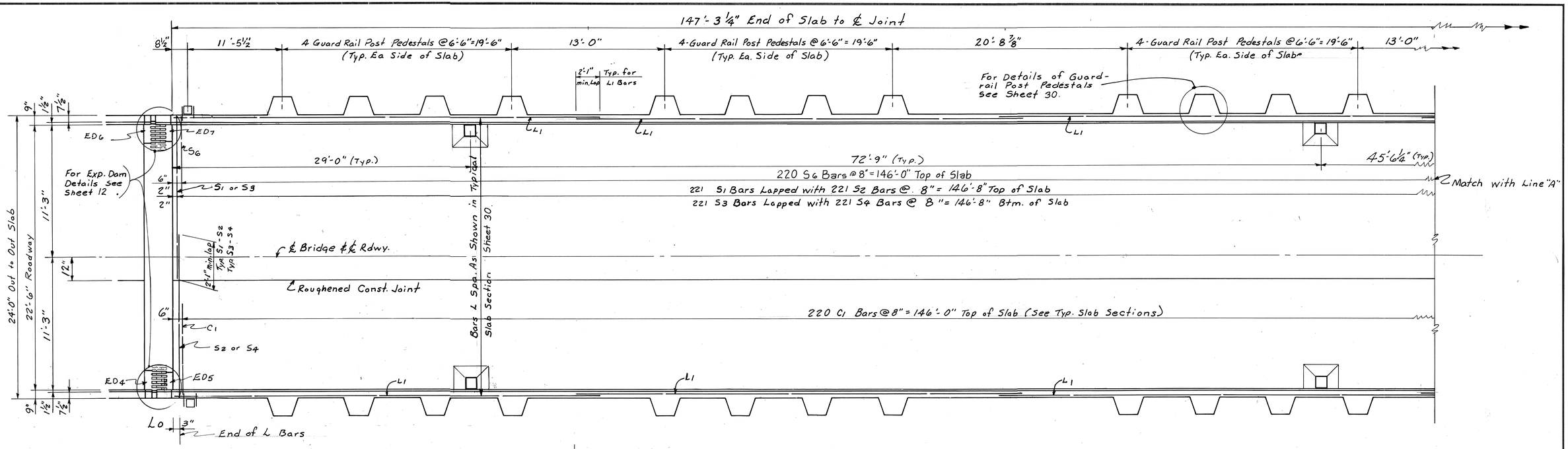
REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE - CAIRO, ILL.

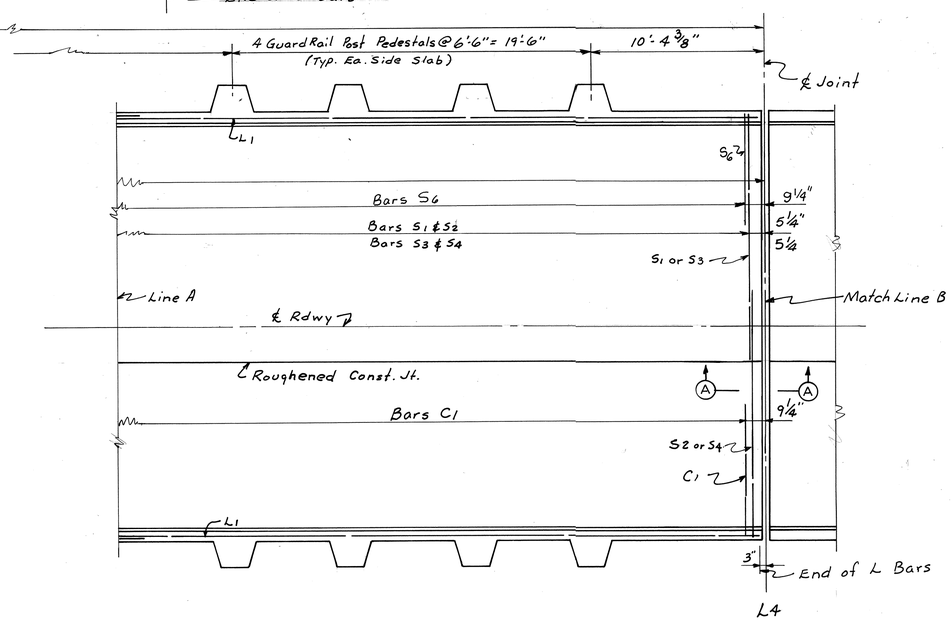
STATION | ROAD P.E. PROJECT NO.

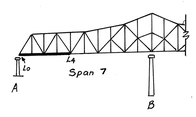
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

UPDATE DATE
LETTING DATE
DATE DATE DATE
REVISED REVISED REVISED
DATE DATE DATE
CHECKED BY CHECKED BY CHECKED BY
DESIGNED BY DETAILED BY TRACED BY
N9947

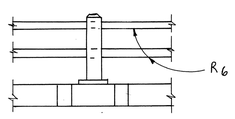


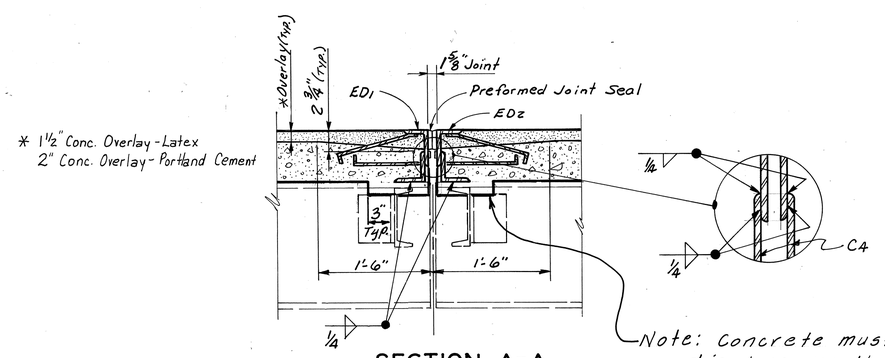
PLAN





LOCATION DIAGRAM





* 1 1/2" Conc. Overlay - Latex
2" Conc. Overlay - Portland Cement

SECTION A-A

Note: Concrete must bear on all diaphragms throughout spans 7 thru 11 as shown here.

SHEET 14

SLAB DETAILS SPAN 7

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

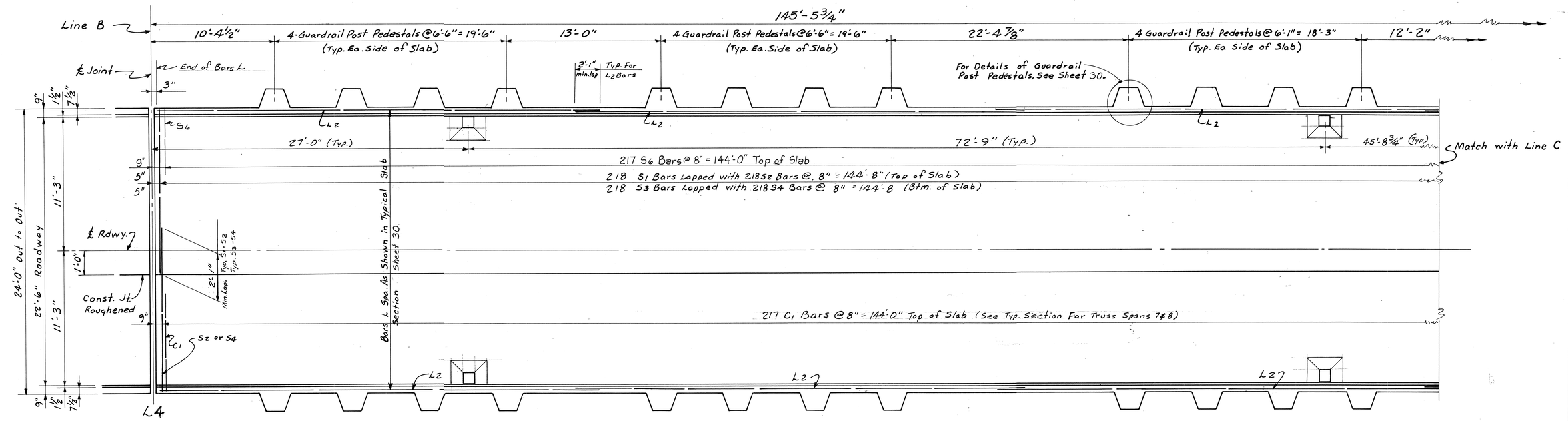
UPDATE DATE
LETTING DATE

added note that concrete bears on diaphragms 5/10/77

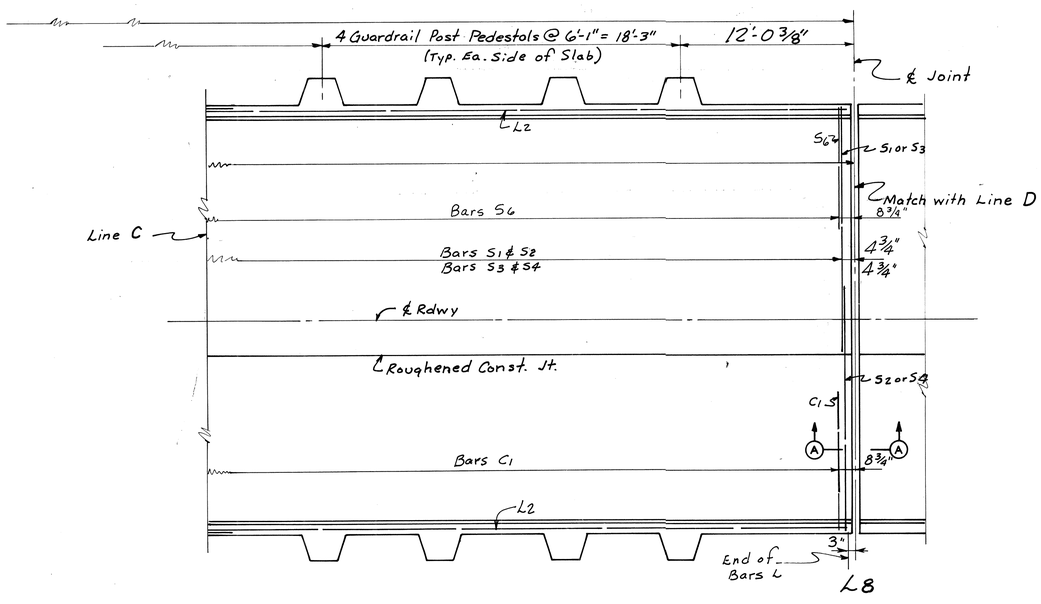
DESIGNED BY		CHECKED BY	DATE
DETAILED BY	C.A. Carpenter	CHECKED BY	DATE 4/77
TRACED BY		CHECKED BY	DATE

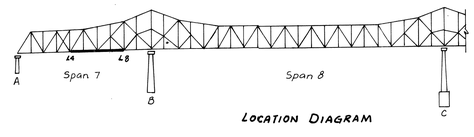
REVISED DATE
REVISED DATE
REVISED DATE

N9947

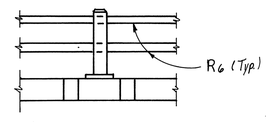


PLAN

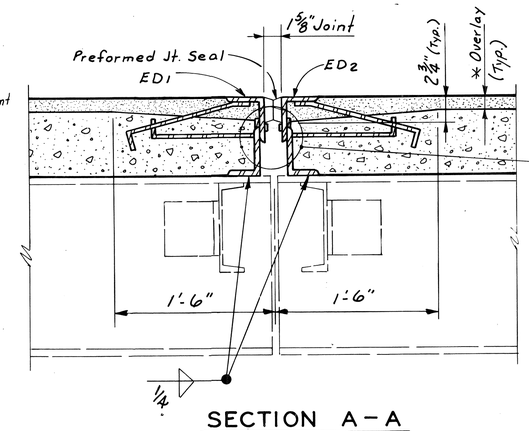




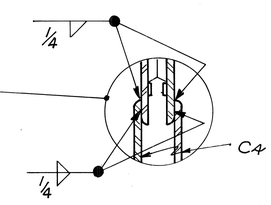
LOCATION DIAGRAM



* 1 1/2" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement



SECTION A-A



SLAB DETAILS SPAN 7

SHEET 15

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

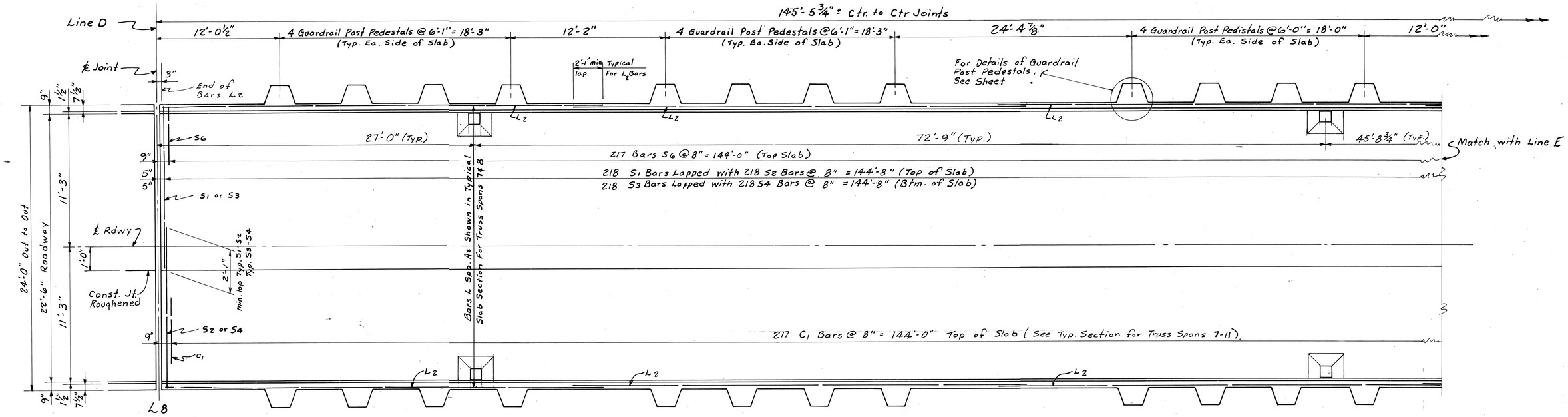
WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

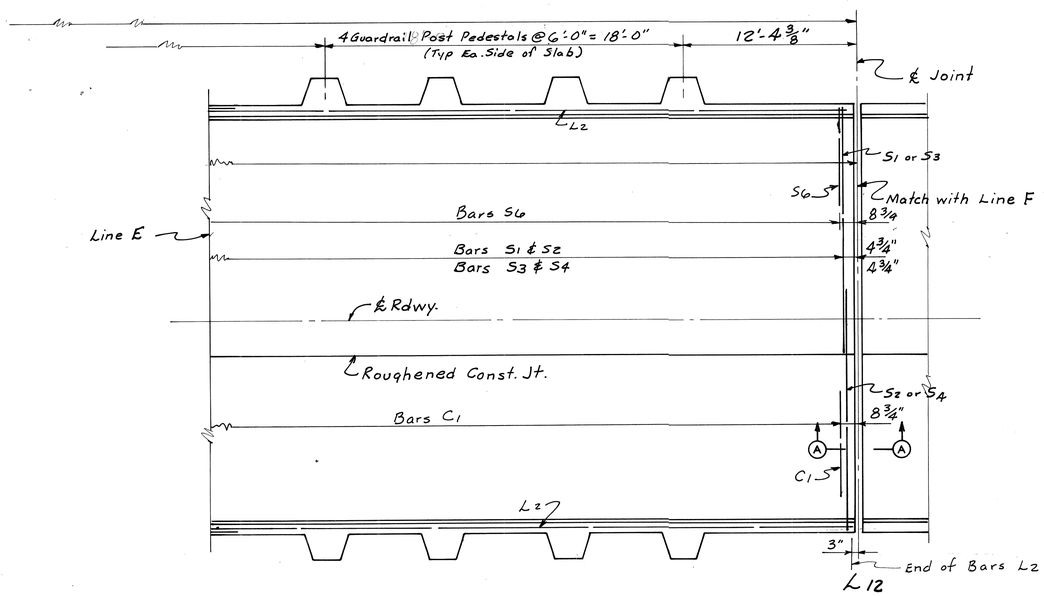
UPDATE DATE
LETTING DATE

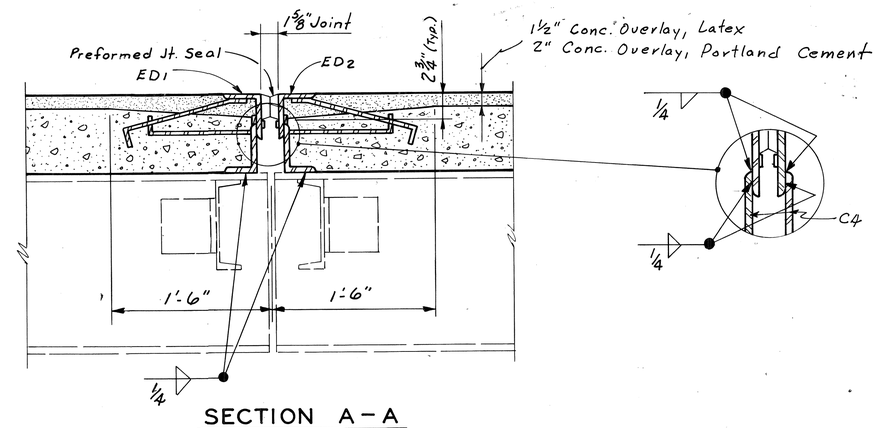
DESIGNED BY CARPENTER
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
REVISED
REVISED
REVISED
DATE
DATE
DATE

N99947

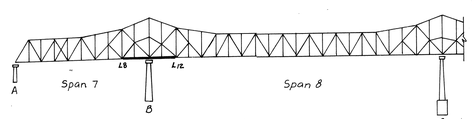


PLAN





SECTION A-A



LOCATION DIAGRAM

SHEET 16

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

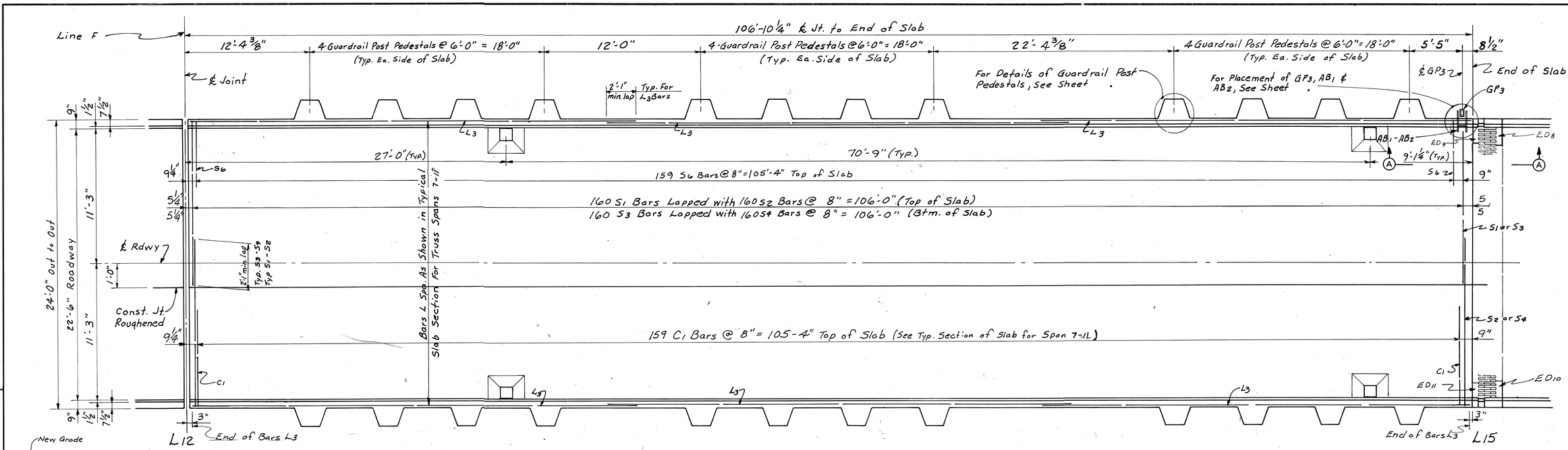
SLAB DETAILS SPAN 7 & 8 OVER PIER B

UPDATE DATE
LETTING DATE

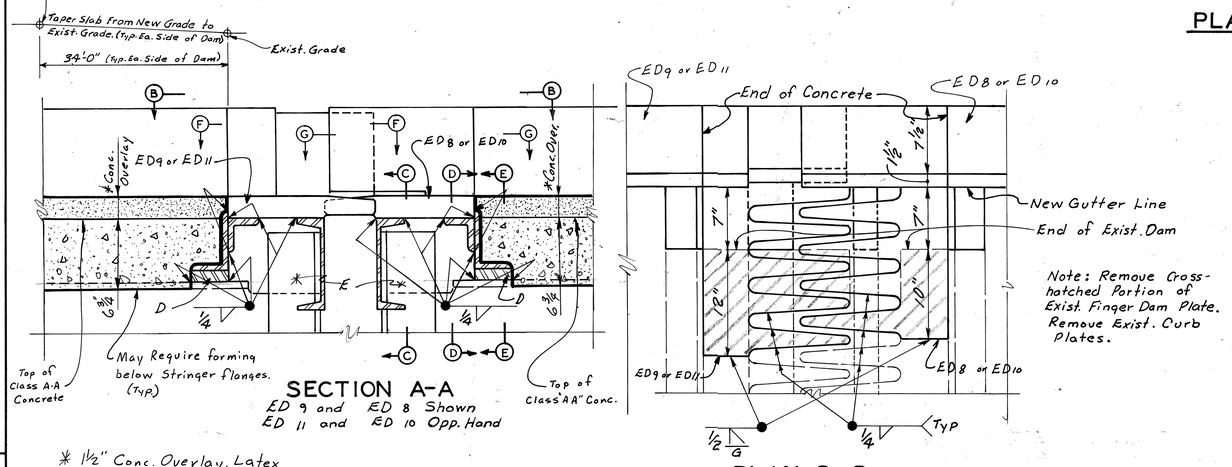
DATE REVISED
DATE REVISED
DATE REVISED

DESIGNED BY CARPENTER CHECKED BY
DETAILED BY CHECKED BY
TRACED BY CHECKED BY

N9947



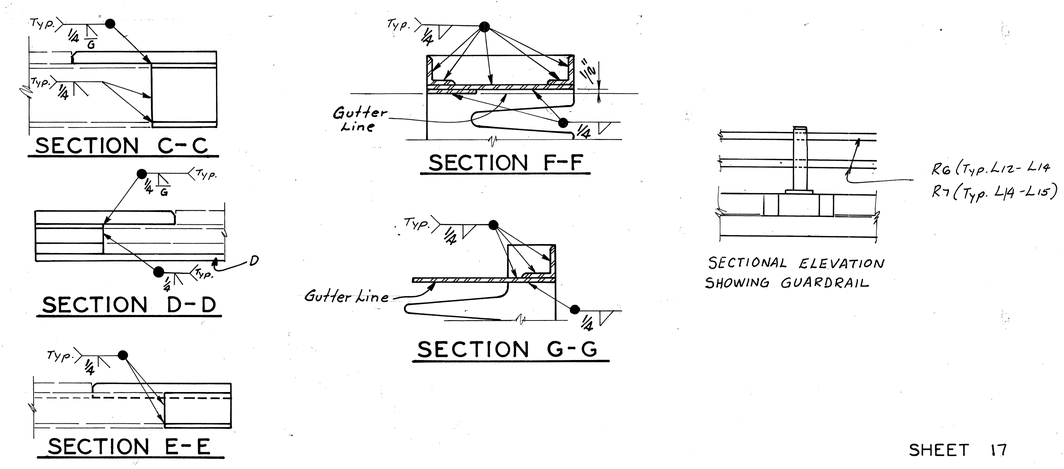
PLAN

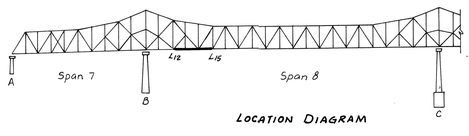


SECTION A-A
ED 9 and ED 8 Shown
ED 11 and ED 10 Opp. Hand

PLAN B-B
ED 9 and ED 8 Shown
ED 11 and ED 10 Opp. Hand

* 1½" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement





LOCATION DIAGRAM

SLAB DETAILS SPAN 8

SHEET 17

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

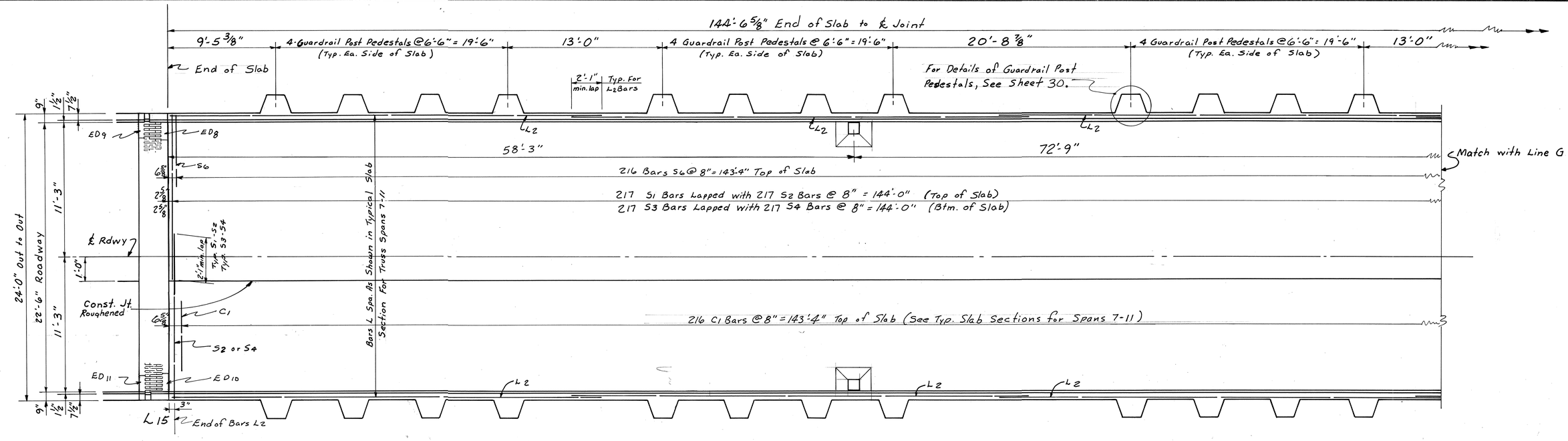
WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

UPDATE DATE
LETTING DATE

DESIGNED BY Carpenter
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
REVISED
REVISED
REVISED
DATE
DATE
DATE

N9947



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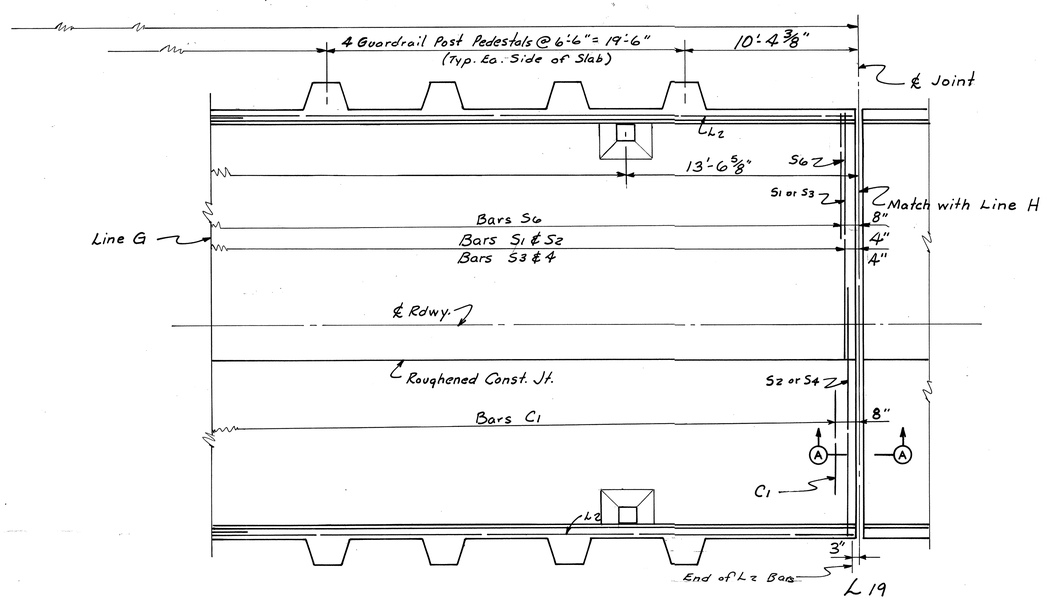
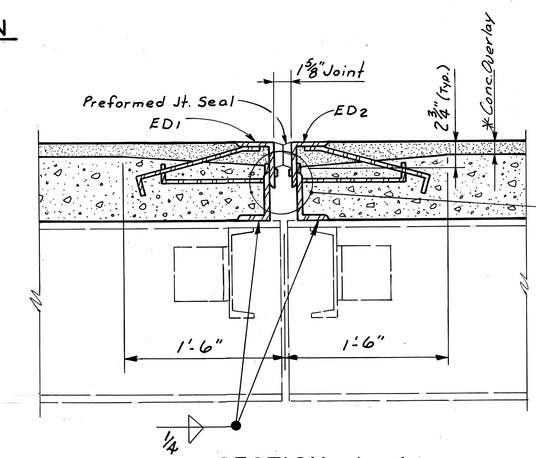
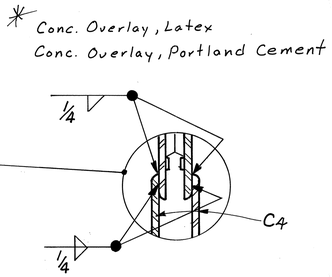
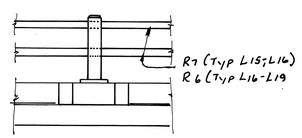


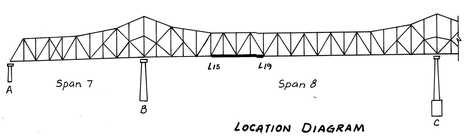


SECTION A-A





SECTIONAL ELEVATION SHOWING GUARDRAIL



LOCATION DIAGRAM

SLAB DETAILS SPAN 8

SHEET 18

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

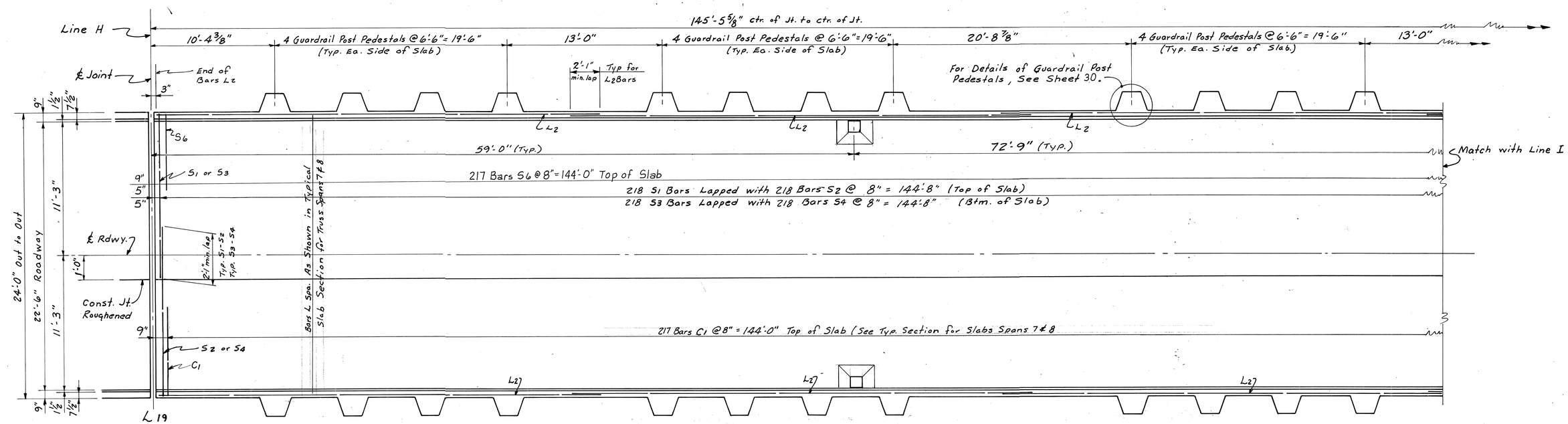
WICKLIFFE – CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

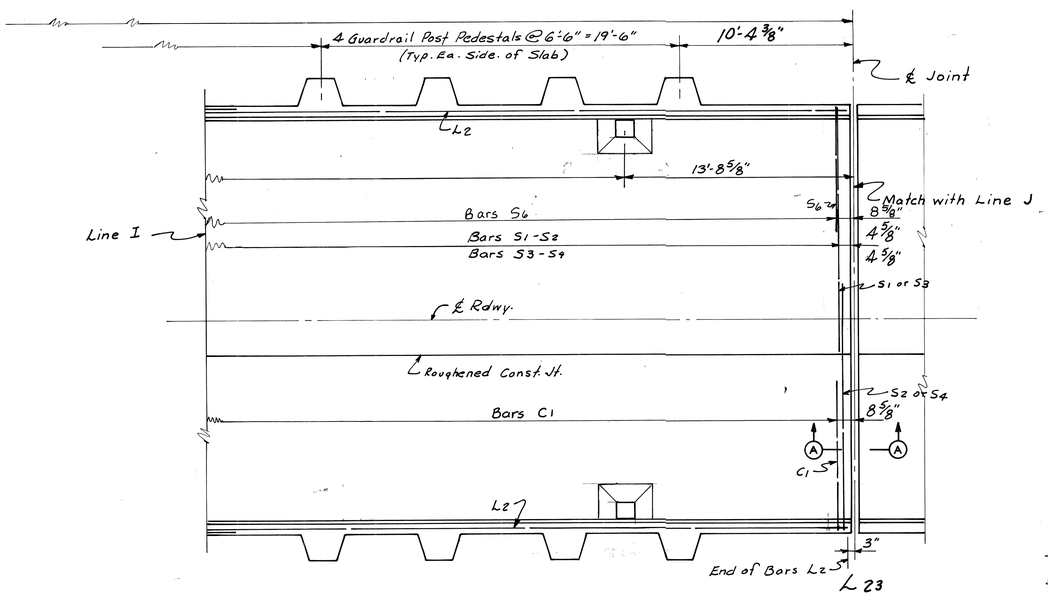
UPDATE DATE
LETTING DATE

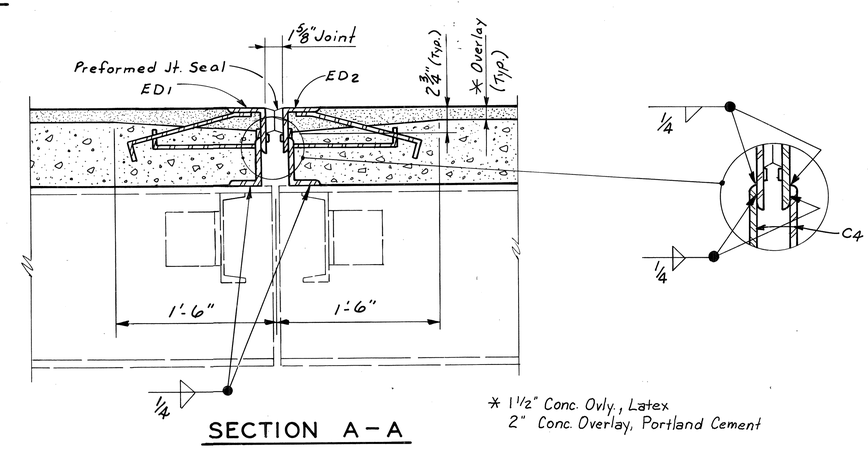
DESIGNED BY CARPENTER
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
REVISED
REVISED
REVISED
DATE
DATE
DATE

N9947



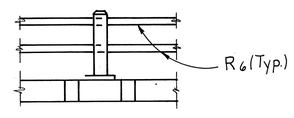
PLAN

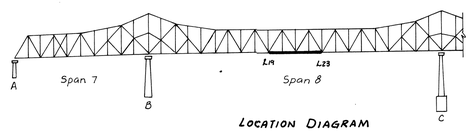




SECTION A – A

* 1 1/2" Conc. Ovly., Latex
2" Conc. Overlay, Portland Cement





LOCATION DIAGRAM

SLAB DETAILS SPAN 8

SHEET 19

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

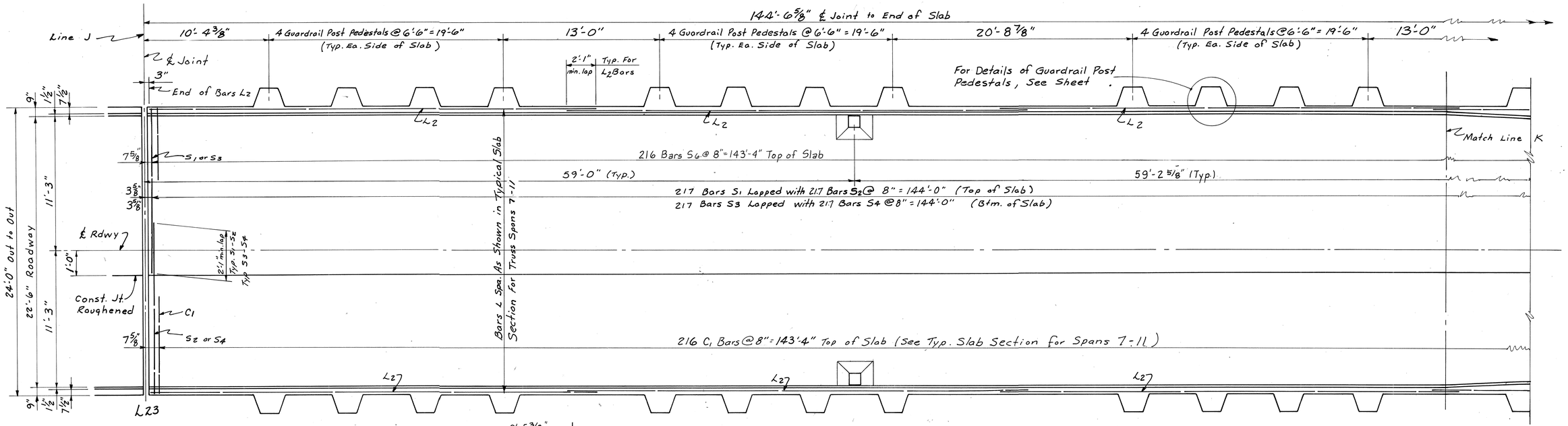
COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE – CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

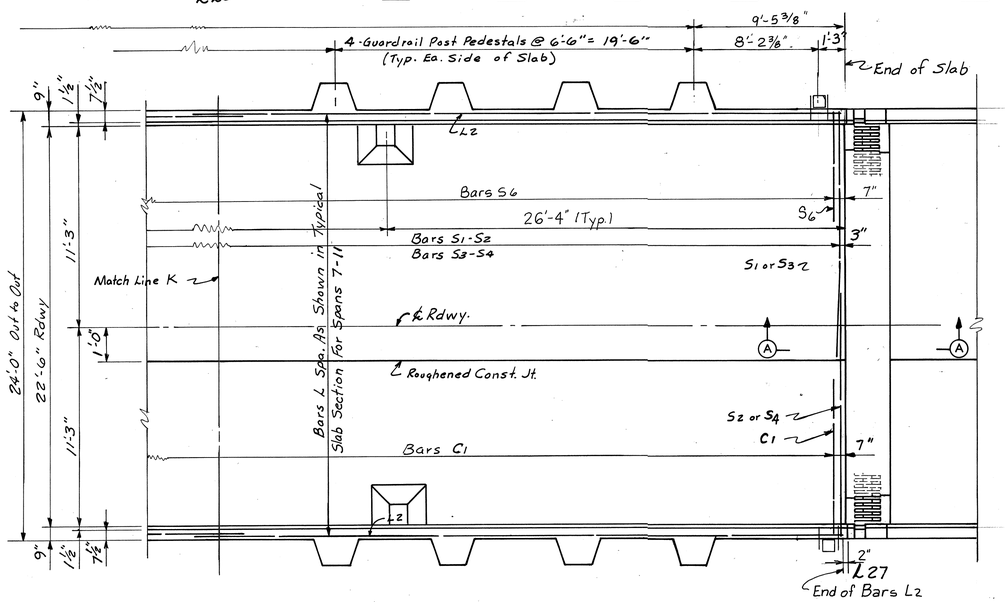
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

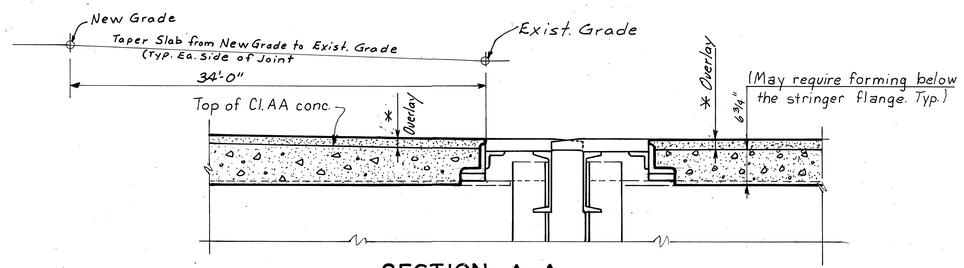
UPDATE DATE
LETTING DATE

DESIGNED BY CARPENTER
DETAILED BY
TRACED BY
CHECKED BY
REVISED
DATE



PLAN

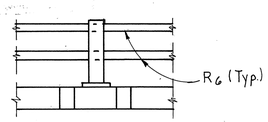


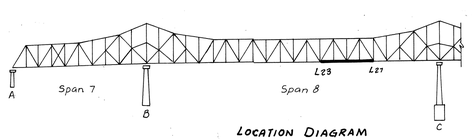


SECTION A-A

ED 10 & ED 11 As Shown
ED 8 & ED 9 Opp. Hand
(See Sheet For Details)

* 1 1/2" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement





LOCATION DIAGRAM

SLAB DETAILS SPAN 8

SHEET 20

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

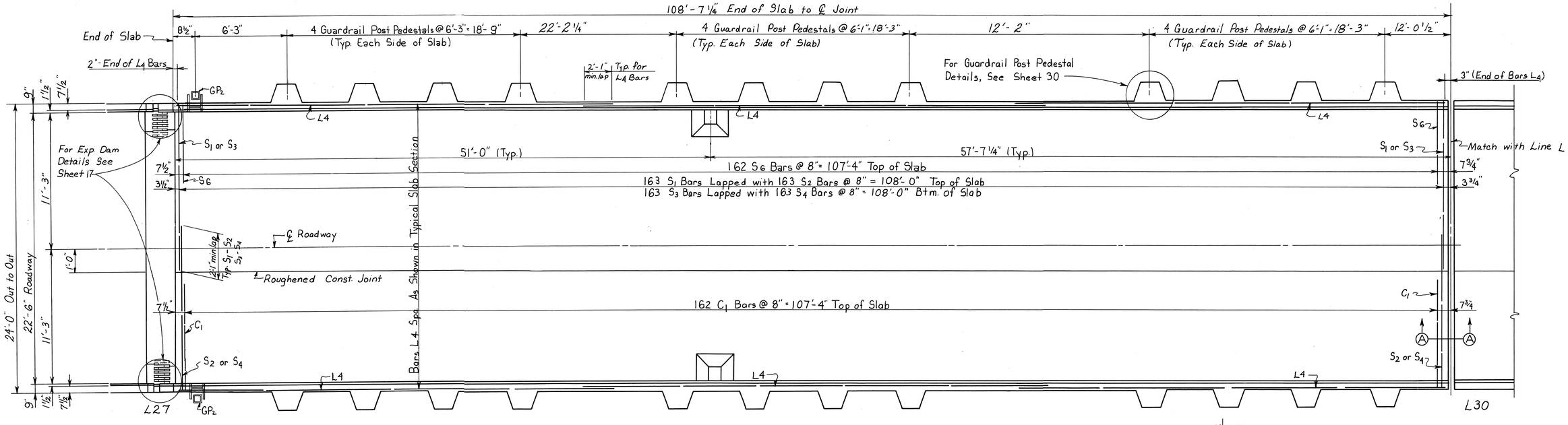
WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO. MP004-0051-B0021	DRAWING NO. 19382

UPDATE DATE
LETTING DATE

DESIGNED BY
DETAILED BY
TRACED BY
CHECKED BY
REVISED
DATE

N9947



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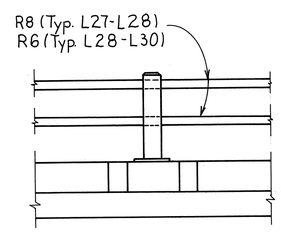
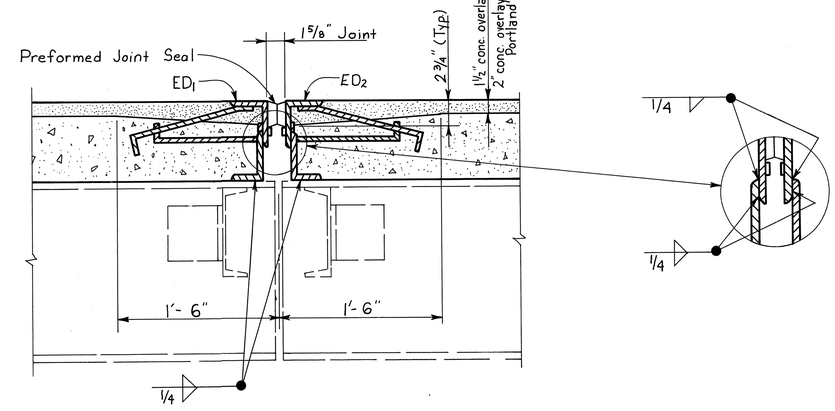
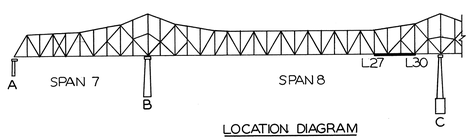


SECTIONAL ELEVATION SHOWING GUARDRAIL



SECTION A–A



LOCATION DIAGRAM

SLAB DETAILS SPAN 8

SHEET 21

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE – CAIRO, ILL.
ROAD

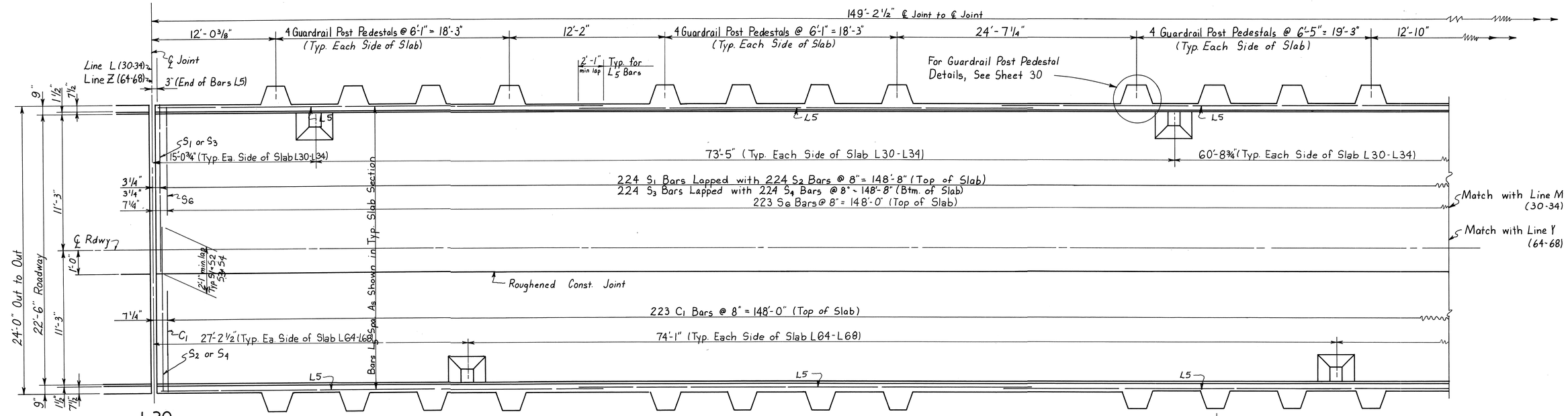
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

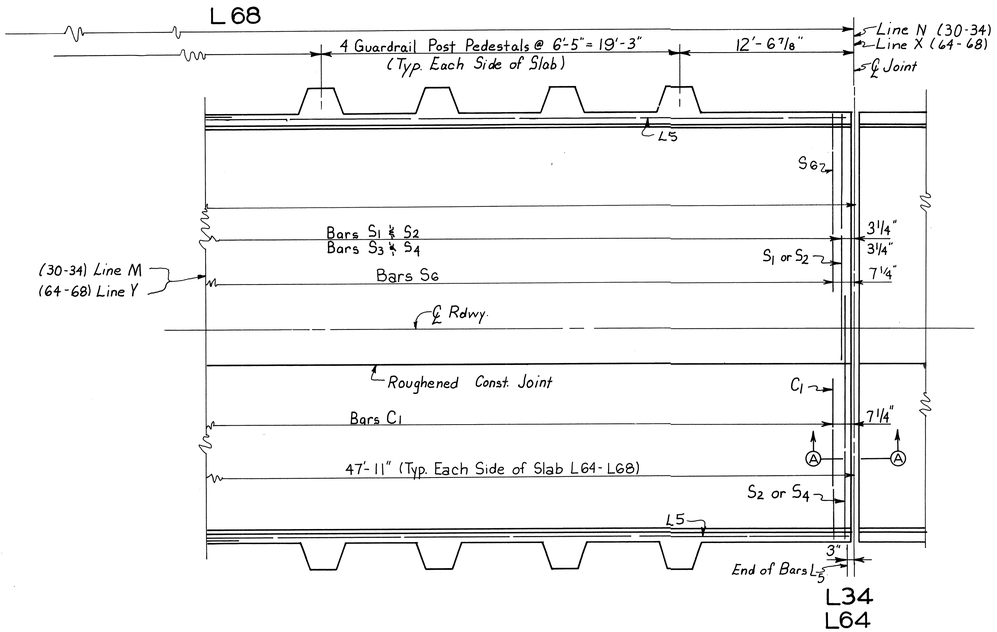
UPDATE DATE
LETTING DATE

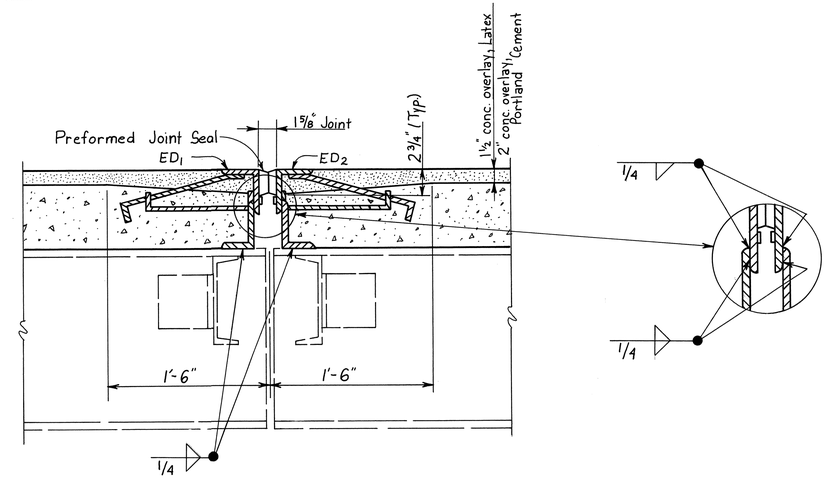
DESIGNED BY L.T. Graves
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
DATE 4/17
REVISED

N9947

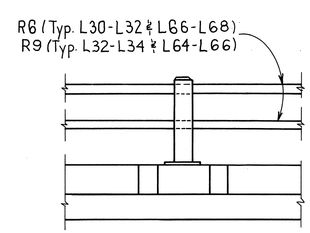


PLAN

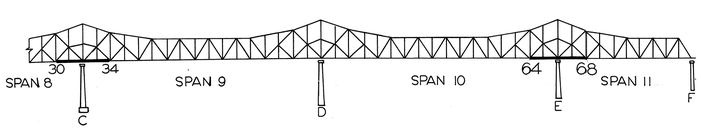




SECTION A-A



SECTIONAL ELEVATION SHOWING GUARDRAIL



LOCATION DIAGRAM

SHEET 22

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE - CAIRO, ILL.
ROAD

STATION | P.E. PROJECT NO.

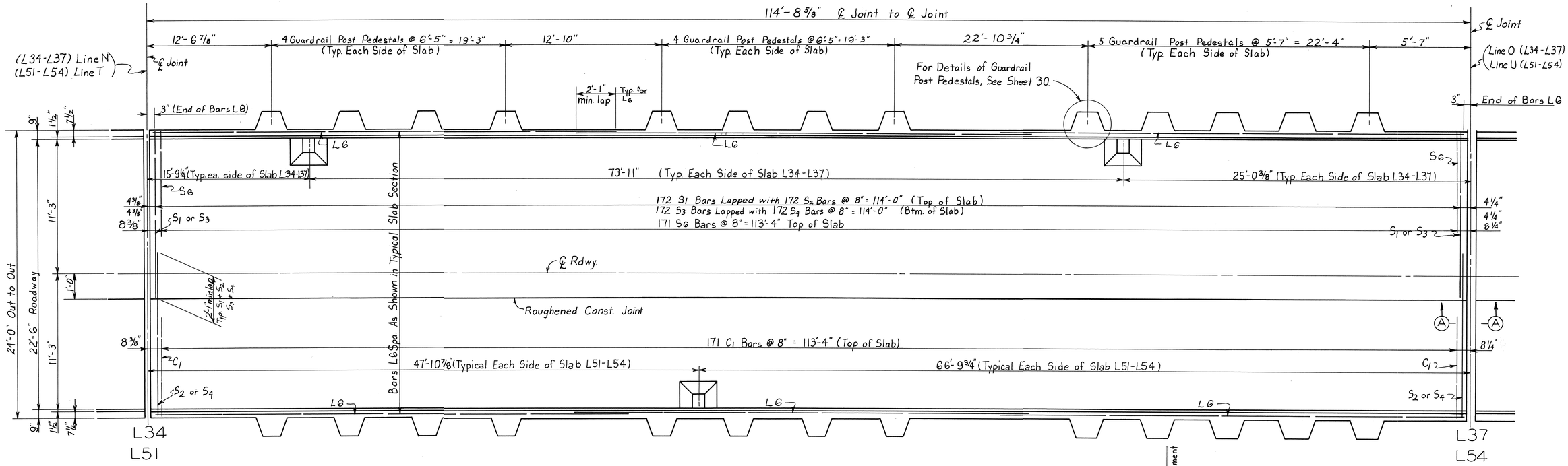
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

SLAB DETAILS SPANS (8-9) & (10-11)

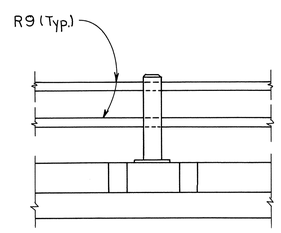
UPDATE DATE
LETTING DATE

DESIGNED BY L.T. Graves | DATE | REVISED
DETAILED BY | DATE | REVISED
TRACED BY | DATE | REVISED
CHECKED BY | DATE | REVISED
CHECKED BY | DATE
CHECKED BY | DATE

N9947



PLAN



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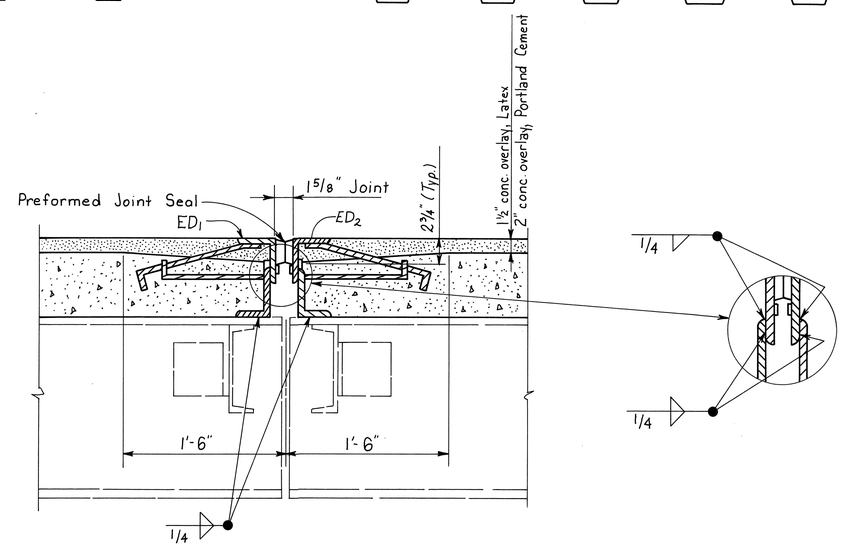

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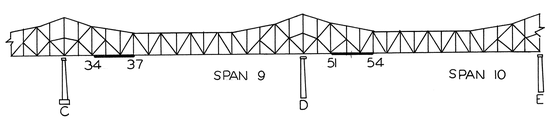


LOCATION DIAGRAM

SLAB DETAILS SPANS 9 & 10

SHEET 23

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE - CAIRO, ILL.
ROAD

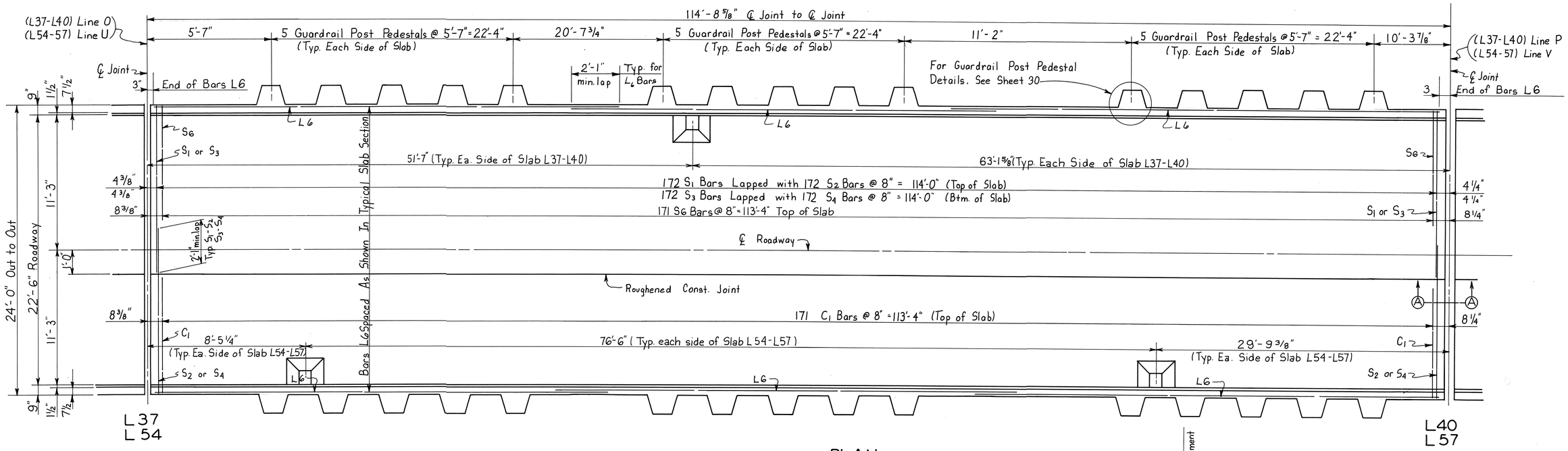
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

UPDATE DATE
LETTING DATE

DESIGNED BY L.T. Groves
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
DATE 4/77
DATE
DATE
REVISED
REVISED
REVISED

N9947



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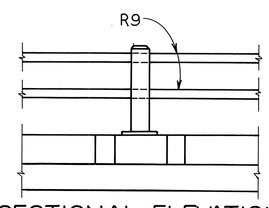
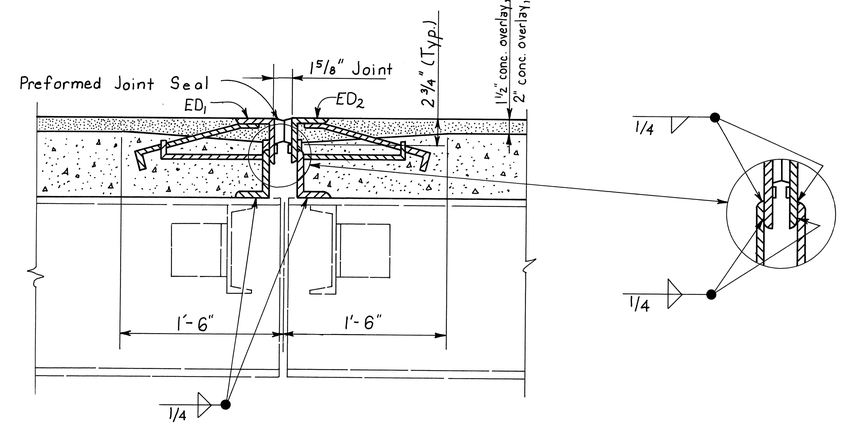
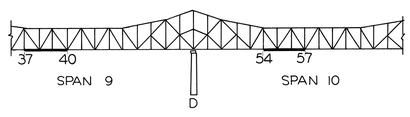


SECTIONAL ELEVATION SHOWING GUARDRAIL



SECTION A-A



LOCATION DIAGRAM

SLAB DETAILS SPANS 9-10

SHEET 24

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE - CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

UPDATE DATE
LETTING DATE

DESIGNED BY L. T. Graves DATE
DETAILED BY DATE
TRACED BY DATE
CHECKED BY DATE
CHECKED BY DATE
CHECKED BY DATE
REVISED
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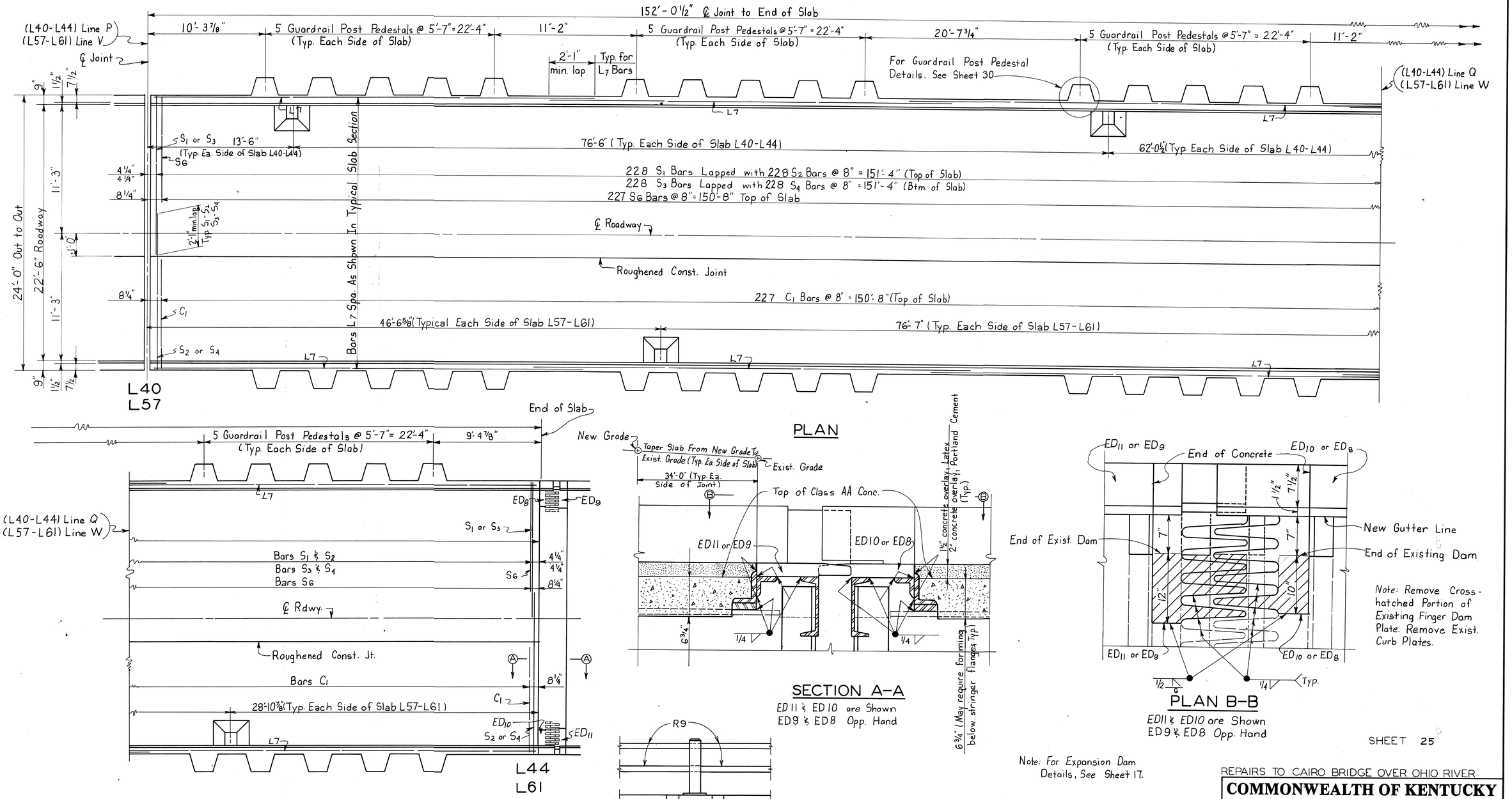
N9947



PLAN

SECTION A-A

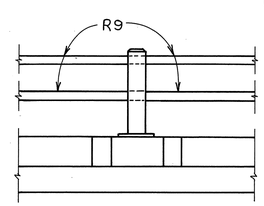
ED11 & ED10 are Shown
ED9 & ED8 Opp. Hand

PLAN B-B

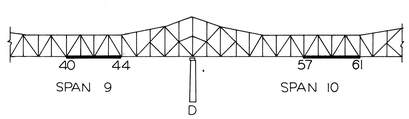
ED11 & ED10 are Shown
ED9 & ED8 Opp. Hand

Note: Remove Cross-hatched Portion of Existing Finger Dam Plate. Remove Exist. Curb Plates.

Note: For Expansion Dam Details, See Sheet 17.



SECTIONAL ELEVATION SHOWING GUARDRAIL



LOCATION DIAGRAM

SLAB DETAILS SPANS 9-10

SHEET 25

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF

BALLARD

WICKLIFFE - CAIRO, ILL.

ROAD

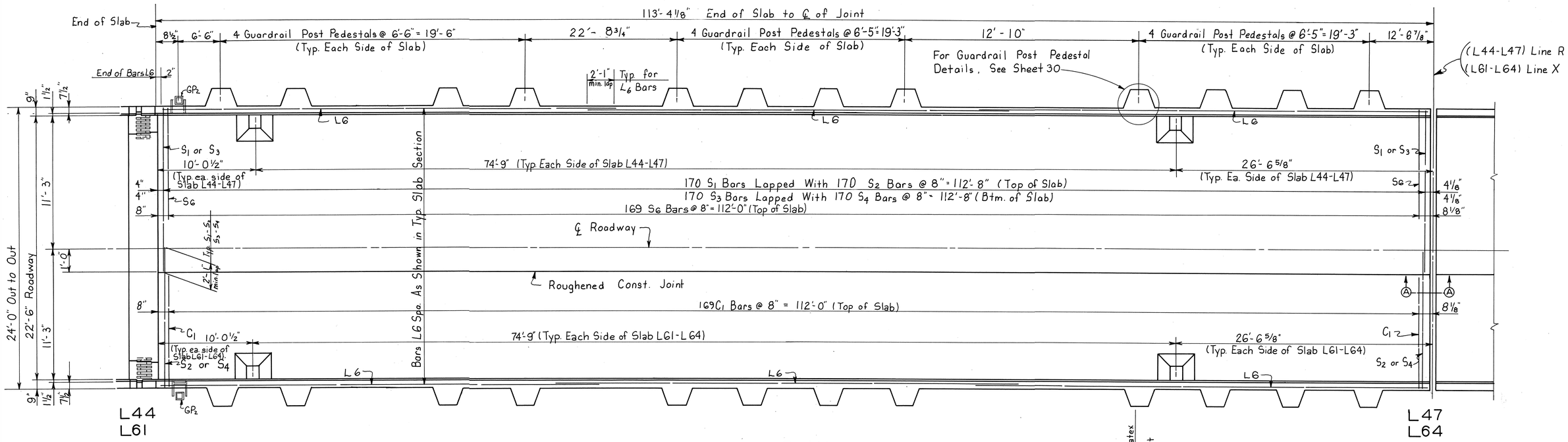
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

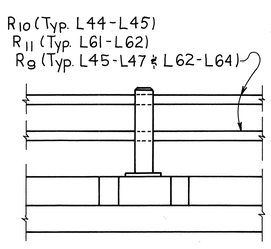
UPDATE DATE
LETTING DATE

DESIGNED BY L.T. Groves | CHECKED BY | DATE
DETAILED BY | CHECKED BY | DATE
TRACED BY | CHECKED BY | DATE
REVISED | REVISED | REVISED

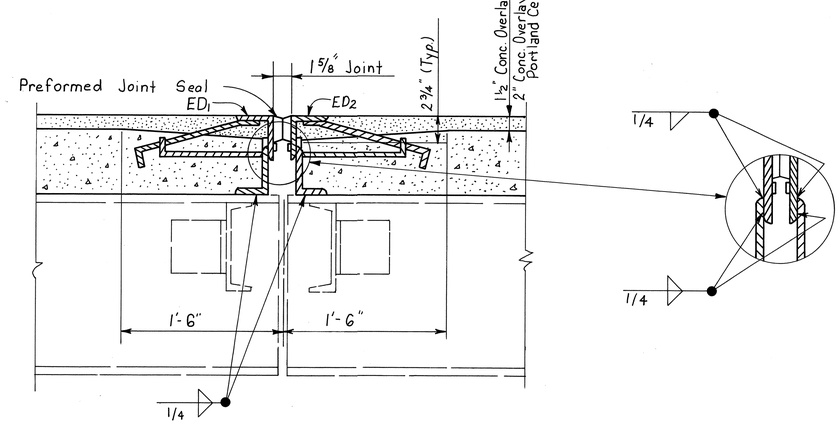
N9947



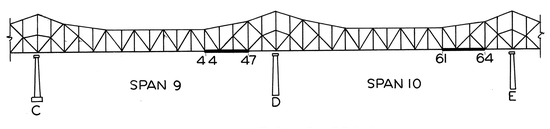
PLAN



SECTIONAL ELEVATION SHOWING GUARDRAILS



SECTION A-A



LOCATION DIAGRAM

SLAB DETAILS SPANS 9-10

SHEET 26

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

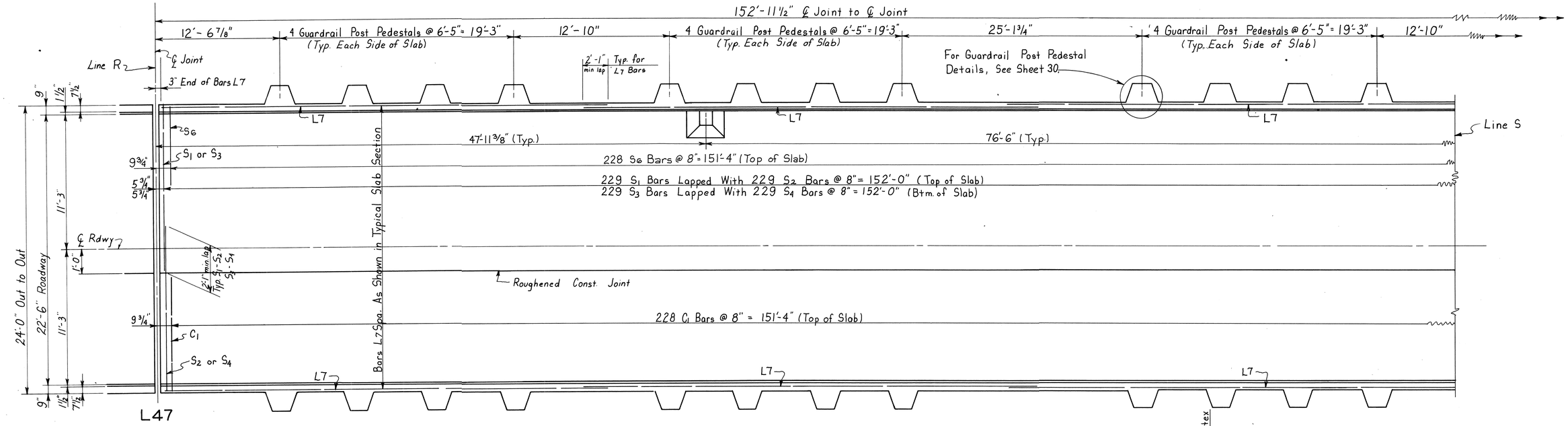
WICKLIFFE — CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

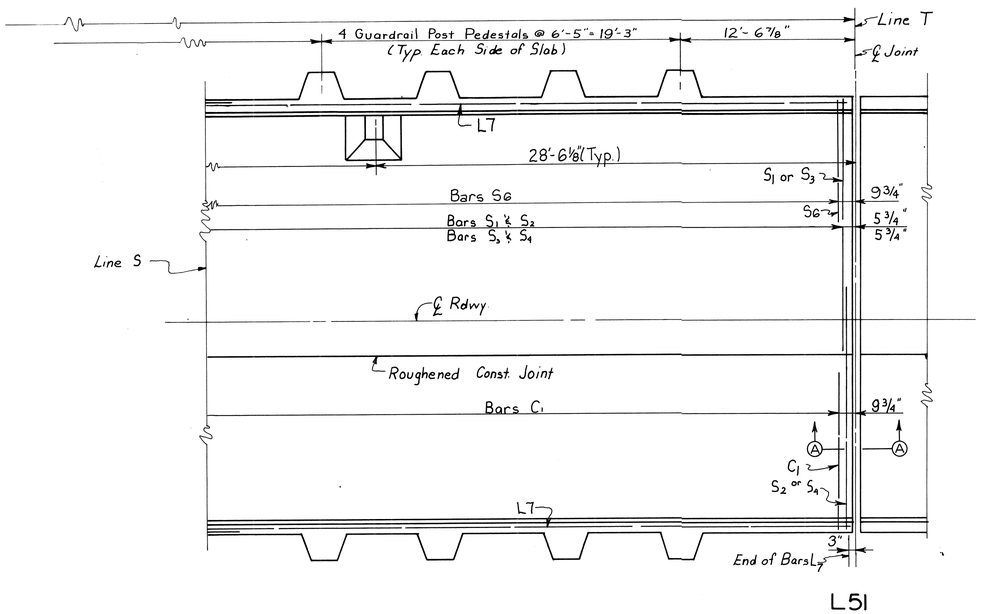
UPDATE DATE
LETTING DATE

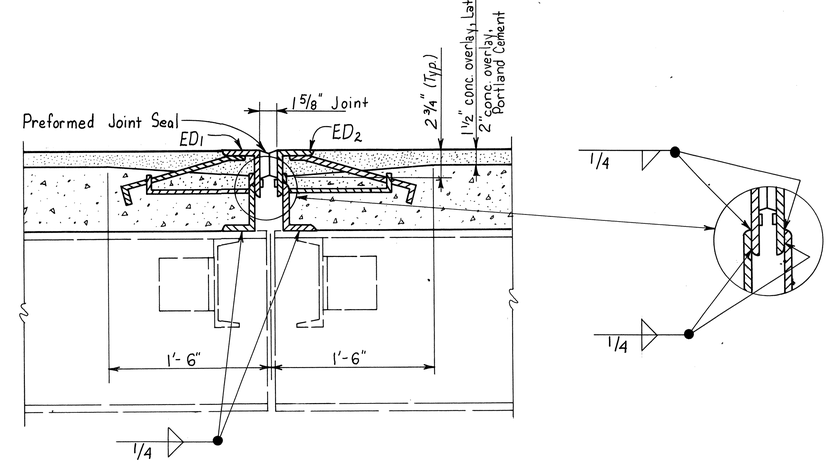
DESIGNED BY L.T. Groves
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
REVISED
REVISED
REVISED
DATE
DATE
DATE
DATE
DATE
DATE

N9947

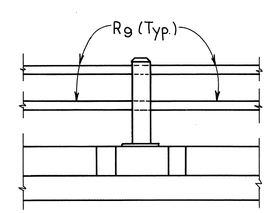


PLAN

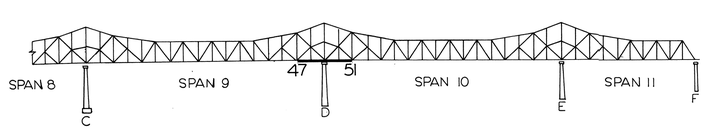




SECTION A-A



SECTIONAL ELEVATION SHOWING GUARDRAIL



LOCATION DIAGRAM

SHEET 27

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE - CAIRO, ILL.
ROAD

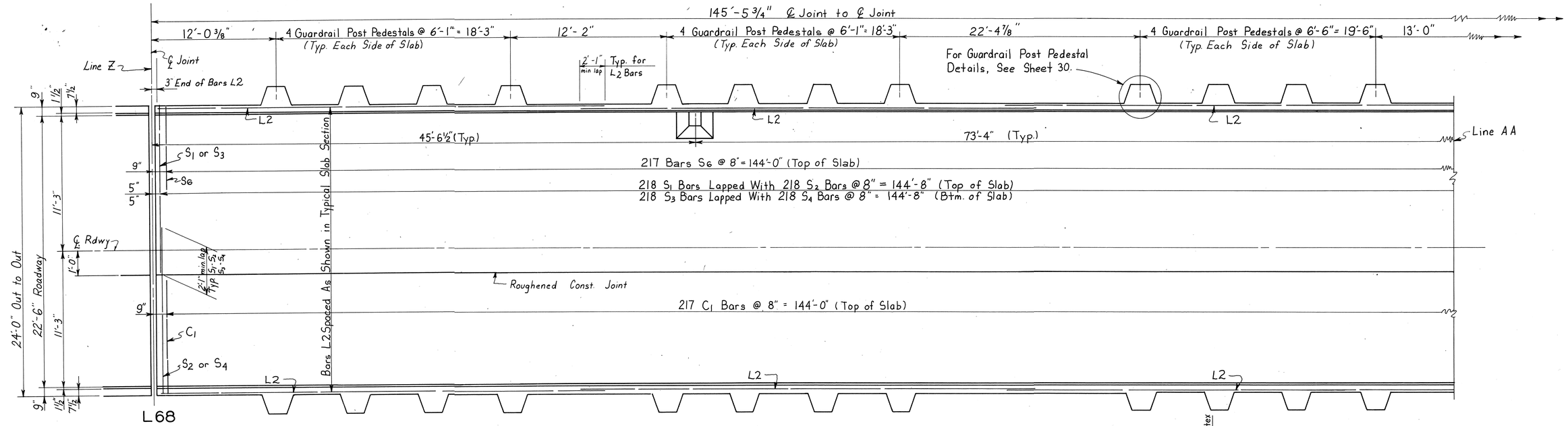
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

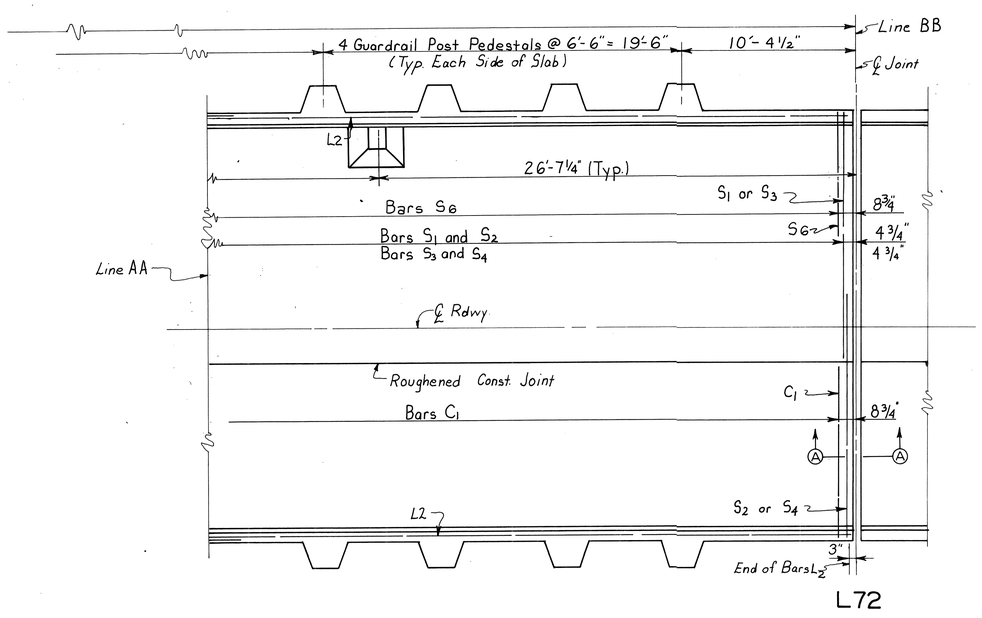
SLAB DETAILS SPAN 9-10

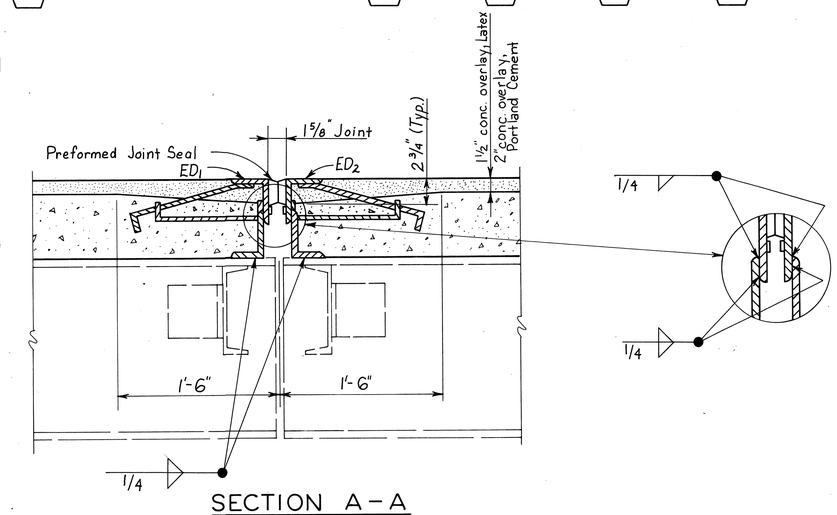
UPDATE DATE
LETTING DATE

DESIGNED BY L.T. Graves
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
DATE 4/77
DATE
DATE
REVISED
REVISED
REVISED
N9947

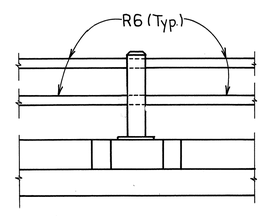


PLAN

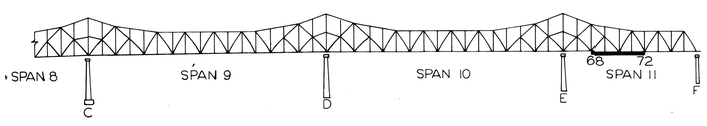




SECTION A-A



SECTIONAL ELEVATION SHOWING GUARDRAIL



LOCATION DIAGRAM

SHEET 28

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE – CAIRO, ILL.
ROAD

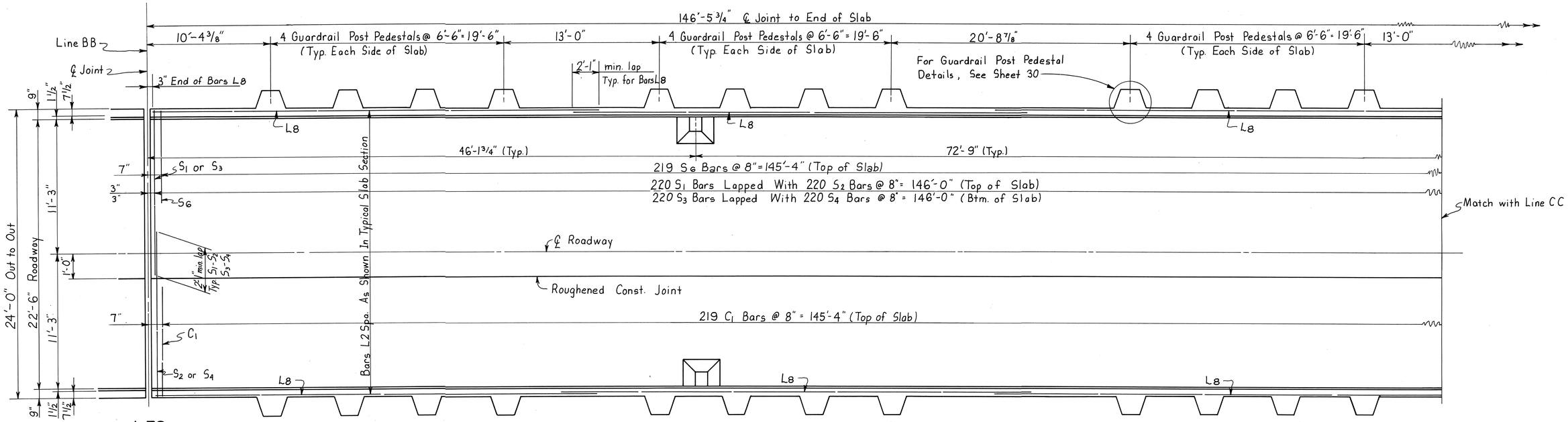
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

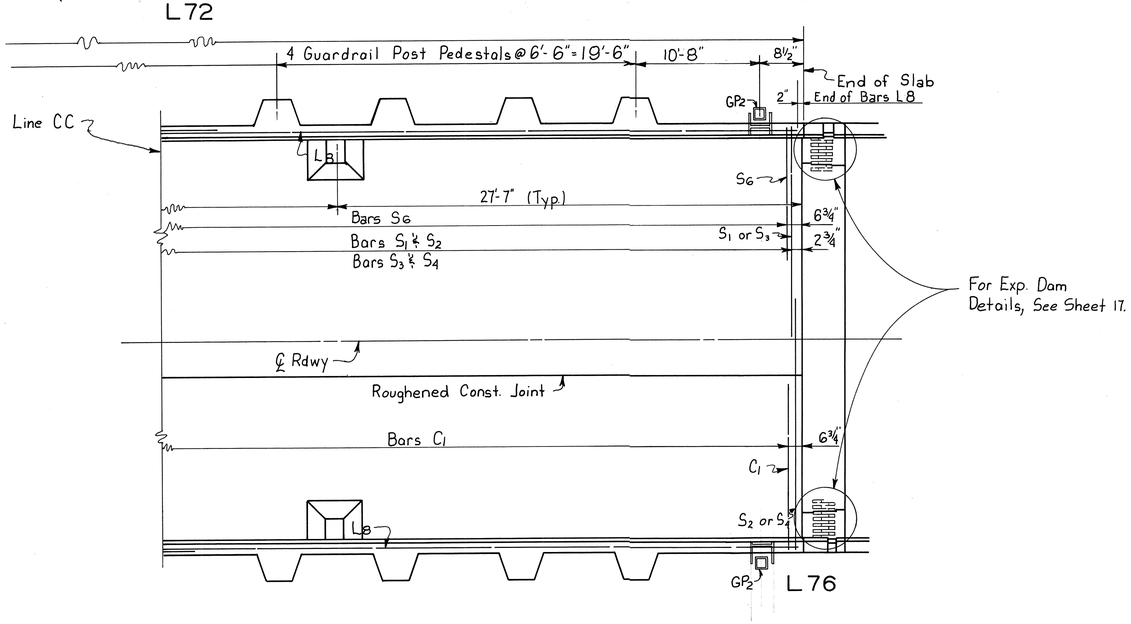
SLAB DETAILS SPAN 11

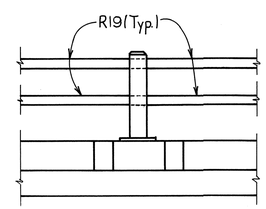
UPDATE DATE
LETTING DATE

DESIGNED BY L.T. Groves
DETAILED BY
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
DATE 4/77
REVISED
N9947

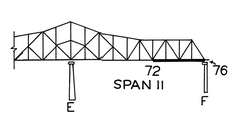


PLAN





SECTIONAL ELEVATION
SHOWING GUARDRAIL



LOCATION DIAGRAM

SLAB DETAILS SPAN 11

SHEET 29

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

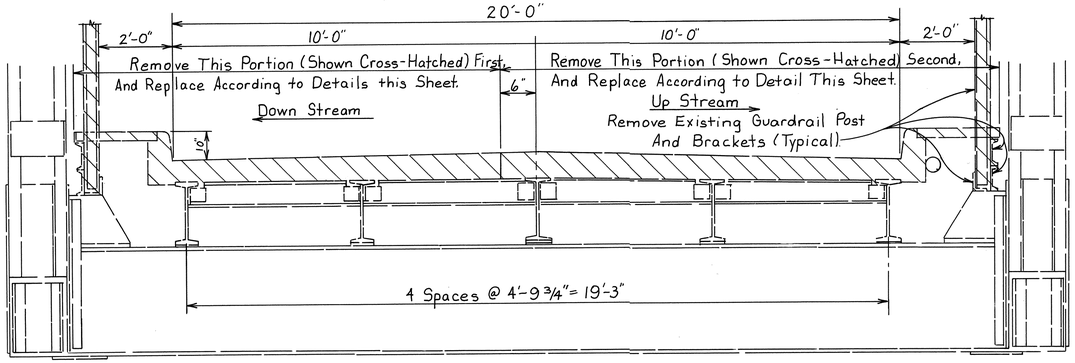
COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE – CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

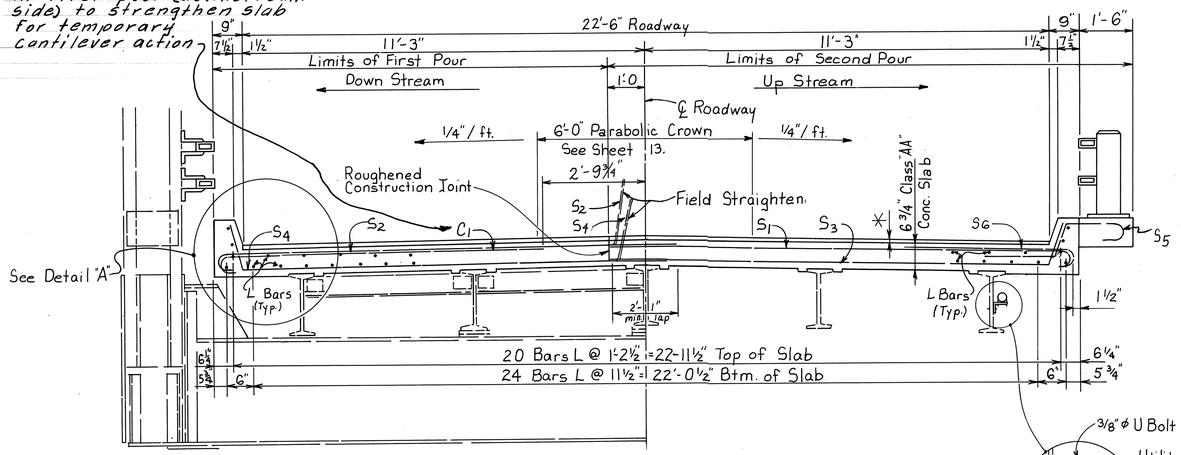
UPDATE DATE
LETTING DATE

DESIGNED BY
DETAILED BY L.T. Graves
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
DATE 4-77
REVISED
N9947

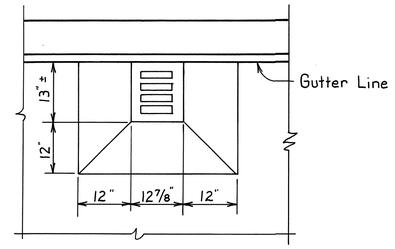


TYPICAL EXISTING SECTION SPANS 7-11

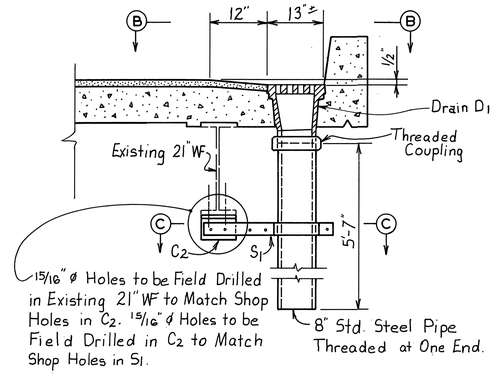
C1 Bars must be placed in first pour (downstream side) to strengthen slab for temporary cantilever action



TYPICAL NEW SECTION SPANS 7-11



SECTION B-B

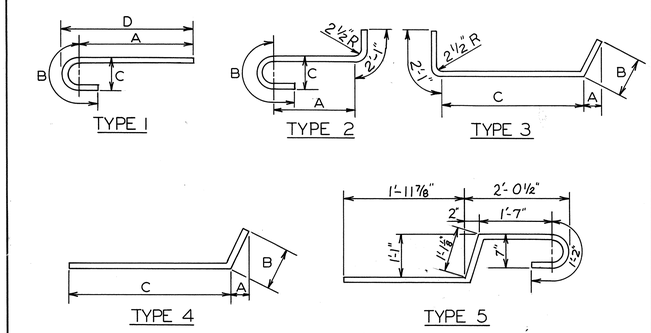


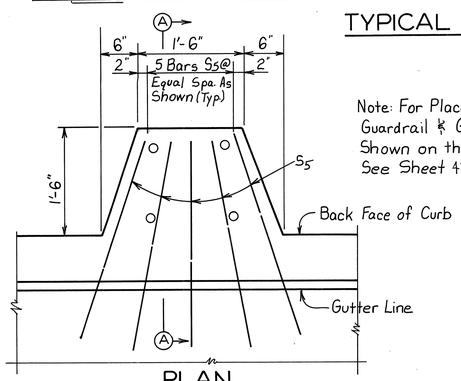
TYPICAL SECTION OF DRAINS SPANS 7-11

78 REQUIRED

BILL OF REINFORCEMENT
FOR ROADWAY SLAB SPANS 7-11

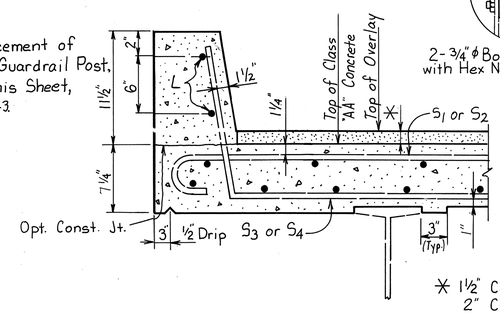
MARK	TYPE	NO	SIZE	LENGTH FT.	LENGTH IN.		A FT.	A IN.	B FT.	B IN.	C FT.	C IN.	D FT.	D IN.
L1	Str.	200	#5	38	4	Slab L0-L4								
L2	Str.	1200	5	37	10	Slabs L4-L12, L15-L27, L68-L72								
L3	Str.	150	5	36	11	Slab L12-L15								
L4	Str.	150	5	37	6	Slab L27-L30								
L5	Str.	400	5	38	9	Slabs L30-L34, L64-L68								
L6	Str.	900	5	39	6	Slabs L34-L40, L44-L47, L51-L57, L61-L64								
L7	Str.	600	5	39	9	Slabs L40-L44, L47-L51, L57-L61								
L8	Str.	200	5	38	1	Slab L72-L76								
S1	1	4231	5	13	6	Slabs L0-L76	12	8	0	10	0	5	12	10 1/2
S2	2	4231	5	13	8	do	10	9	0	10	0	5		
S3	4	4231	5	13	6	do	0	2 1/4	1	3	12	3		
S4	3	4231	5	13	9	do	0	2 1/4	1	3	10	5		
S5	5	3200	7	5	10	do								
S6	1	4210	5	4	8	do	3	10	0	10	0	5	4	0 1/2
C1	1	4210	5	9	8	Slabs L0-L76	8	10	0	10	0	5	9	0 1/2





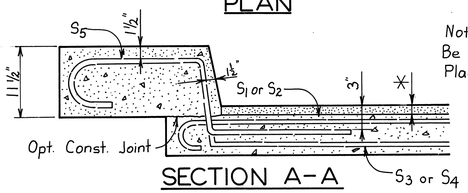
PLAN

Note: For Placement of Guardrail & Guardrail Post, Shown on this Sheet, See Sheet 43.



DETAIL "A"

✳ 1 1/2" Concrete Overlay, Latex
2" Concrete Overlay, Portland Cement

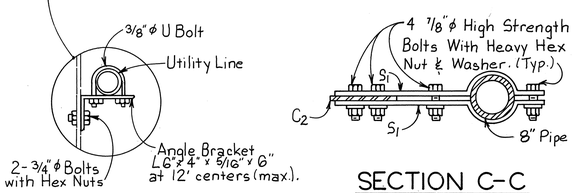


SECTION A-A

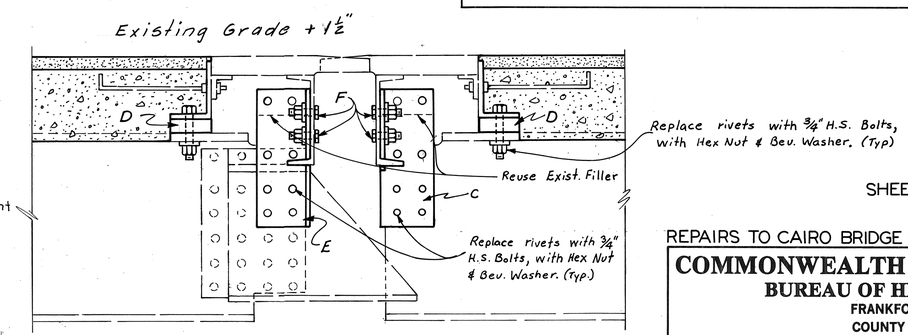
Note: S1 and S2 Bars May Be Shifted to allow easy Placement of S3, S4, and S5.

DETAILS OF GUARDRAIL POST PEDESTALS SPANS 7-11

Note: Where navigation light access ladders are attached to existing guardrail, disconnect and attach to new rail as directed by the Engineer. Cost to be incidental to lump sum bid for structural steel.



SECTION C-C



DETAIL FOR RAISING FINGER DAM AT L15, L27, L44, L66

TYPICAL DETAILS FOR SPANS 7-11

SHEET 30

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE - CAIRO, ILL.
ROAD

STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

UPDATE DATE
LETTING DATE

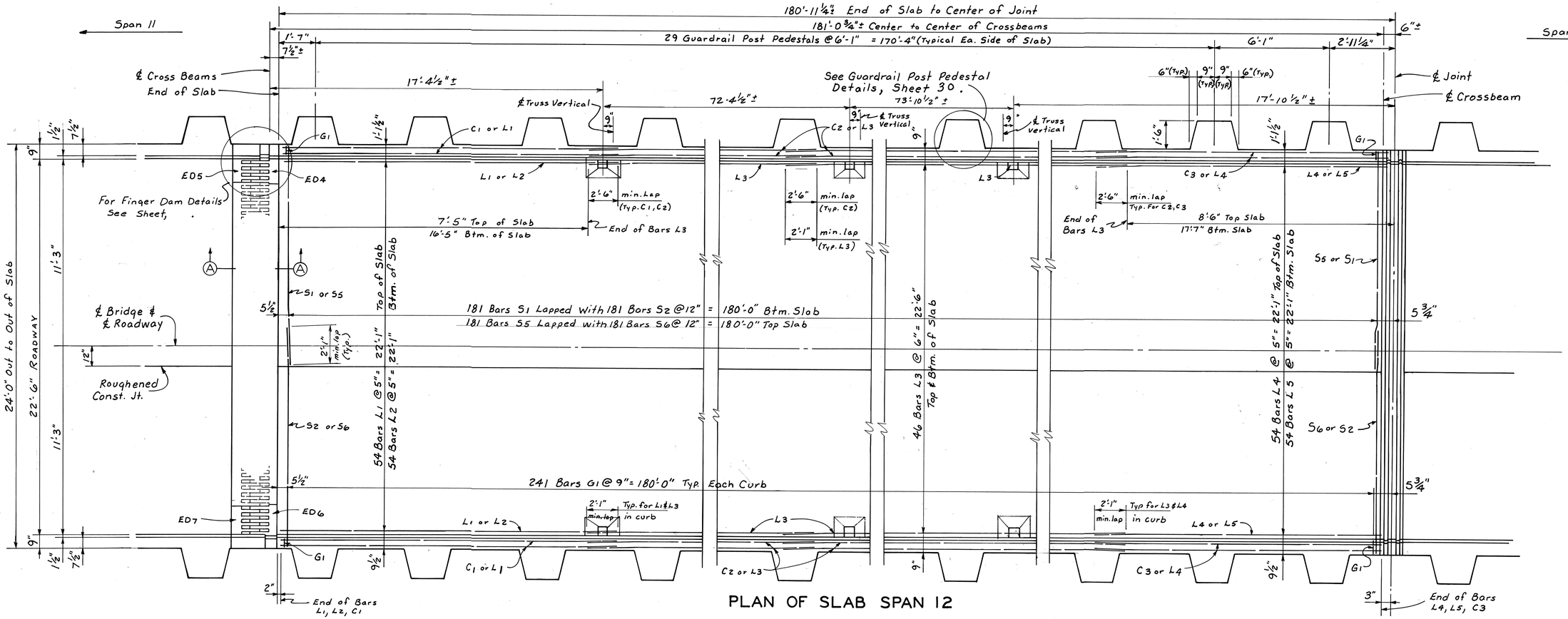
REVISED Added C1 Bar Note
REVISED
REVISED

DATE 5/18/77
DATE 4/17/77
DATE

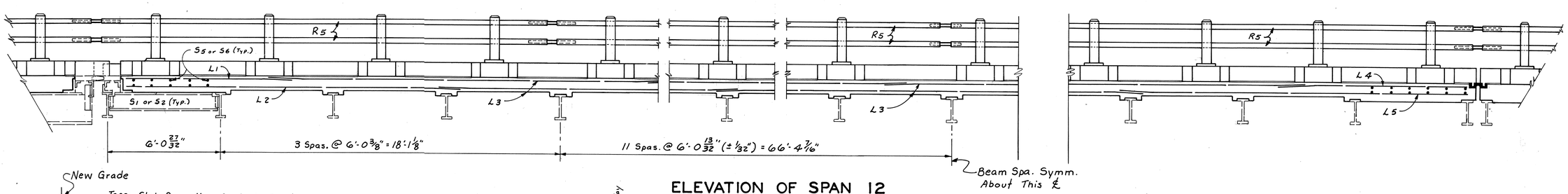
CHECKED BY
CHECKED BY
CHECKED BY

DESIGNED BY L.T. Groves
DETAILED BY
TRACED BY

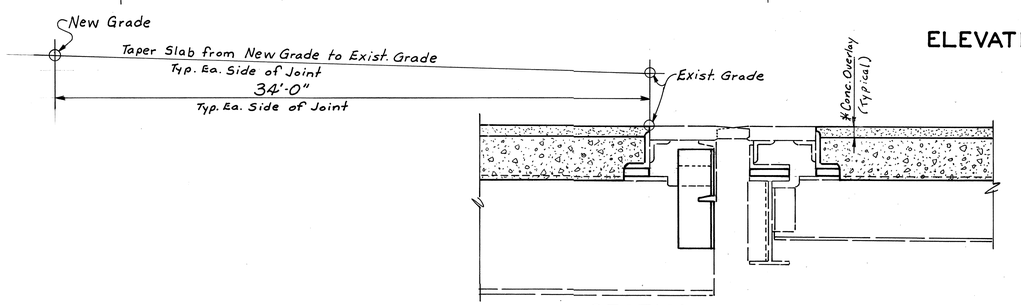
N9947



PLAN OF SLAB SPAN 12



ELEVATION OF SPAN 12



SECTION A-A
Showing Existing Finger Dam

* 1½" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement

SHEET 31

DETAILS SPAN 12

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

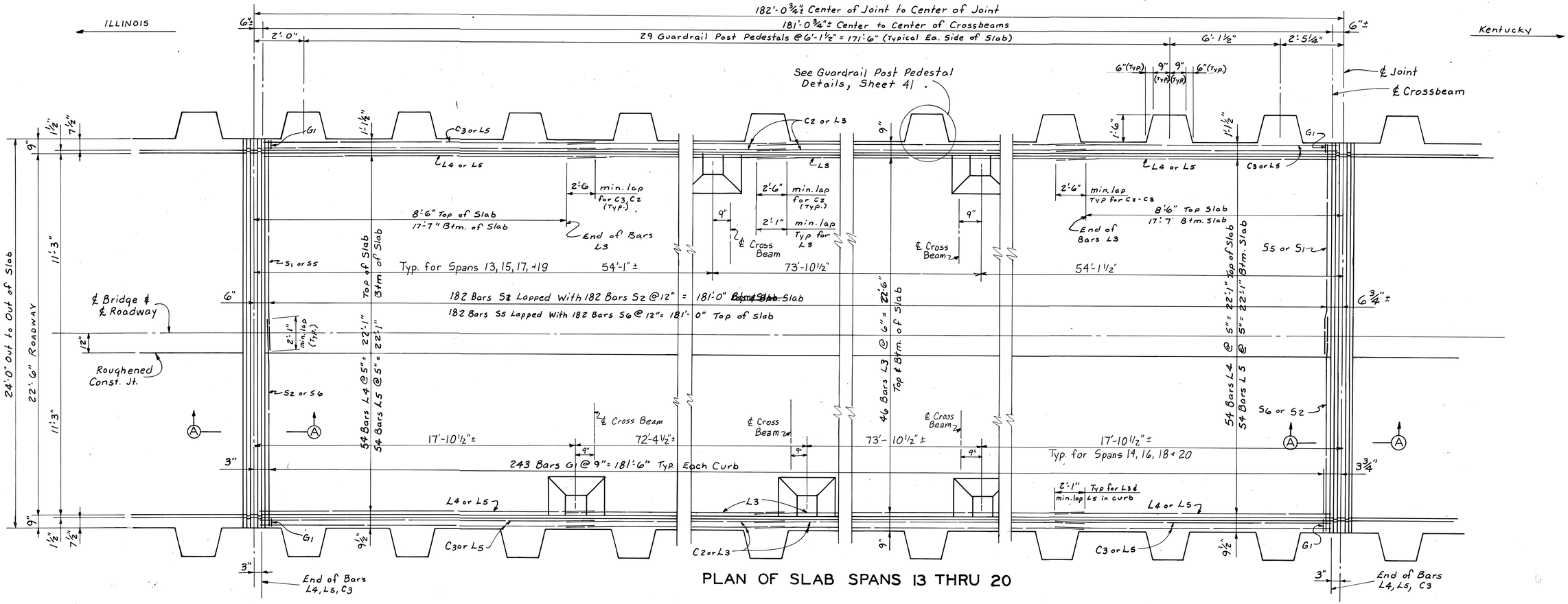
COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

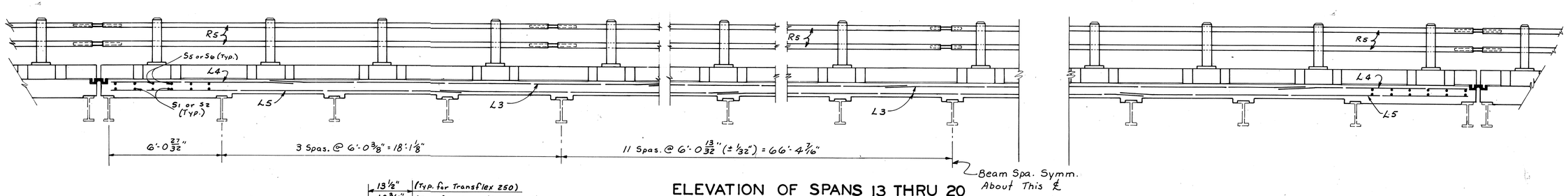
UPDATE DATE
LETTING DATE

DESIGNED BY ___ CHECKED BY ___ REVISED ___ DATE ___
DETAILED BY ___ CHECKED BY ___ REVISED ___ DATE ___
TRACED BY ___ CHECKED BY ___ REVISED ___ DATE ___

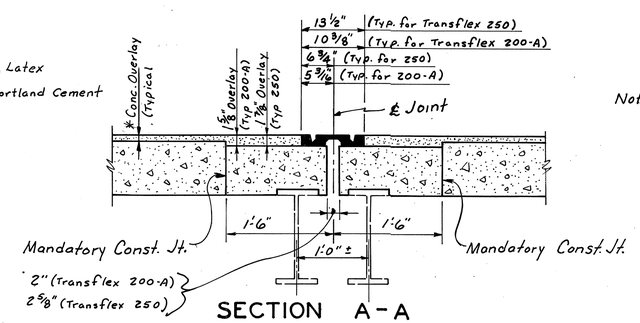
N9947



PLAN OF SLAB SPANS 13 THRU 20



ELEVATION OF SPANS 13 THRU 20



SECTION A-A

* 1 1/2" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement

Note Transflex 200-A is to be used only at Junction of Span 20 and Span 21.
Junction of Spans 12 & 13 Thru Junction of Spans 19 & 20 Shall Use Transflex 250.

SHEET 32

DETAILS SPANS 13 THRU 20

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE - CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

UPDATE DATE
LETTING DATE

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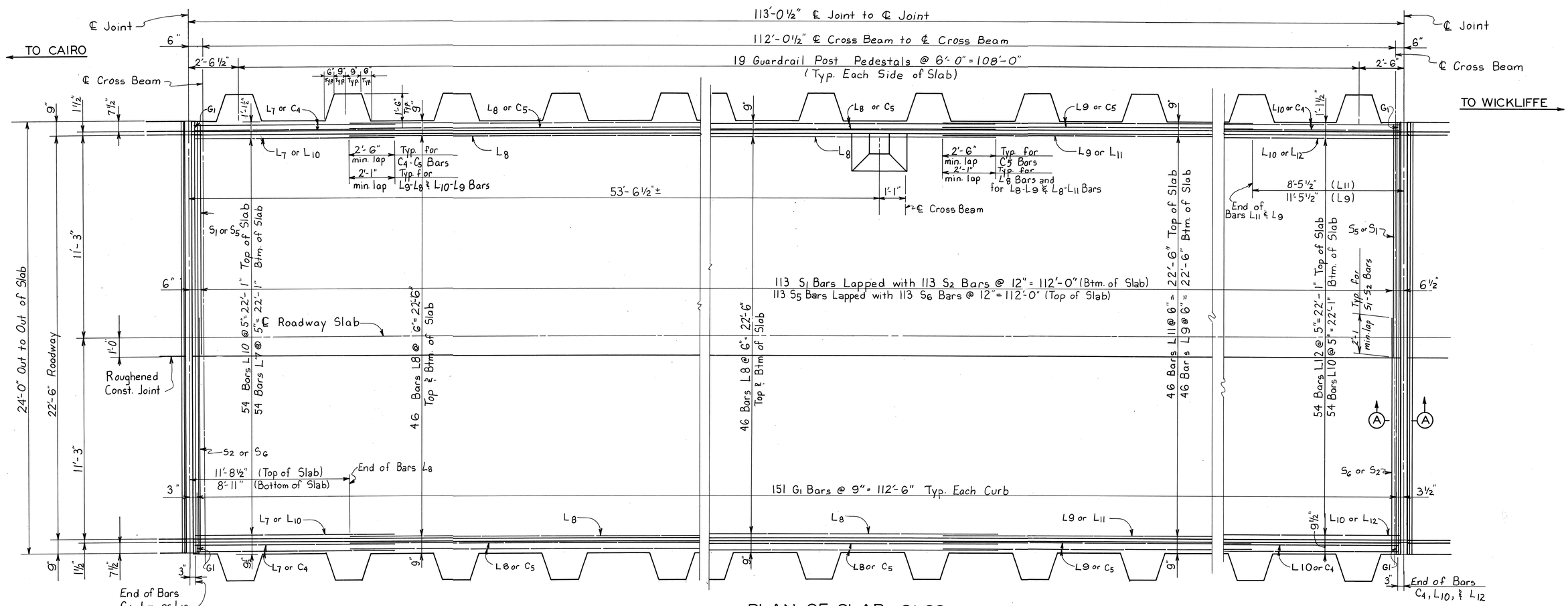
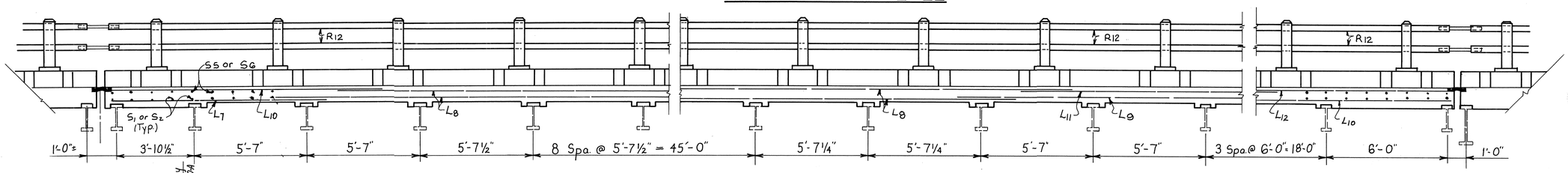
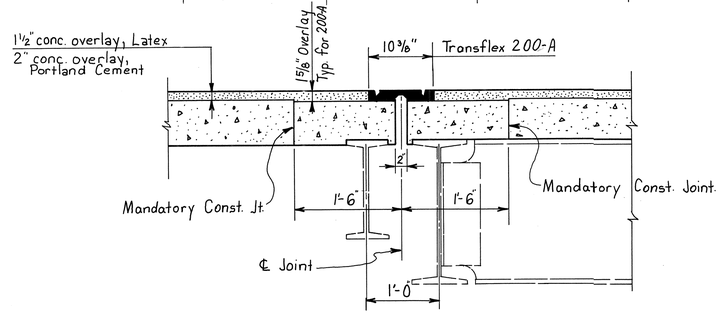


PLAN OF SLAB 21-22



ELEVATION OF SPANS 21-22



SECTION A-A

SHEET 33

SLAB DETAILS SPAN 21-22

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE-CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

UPDATE DATE
LETTING DATE

DESIGNED BY L.T. Grouges
DETAILED BY
TRACED BY
CHECKED BY
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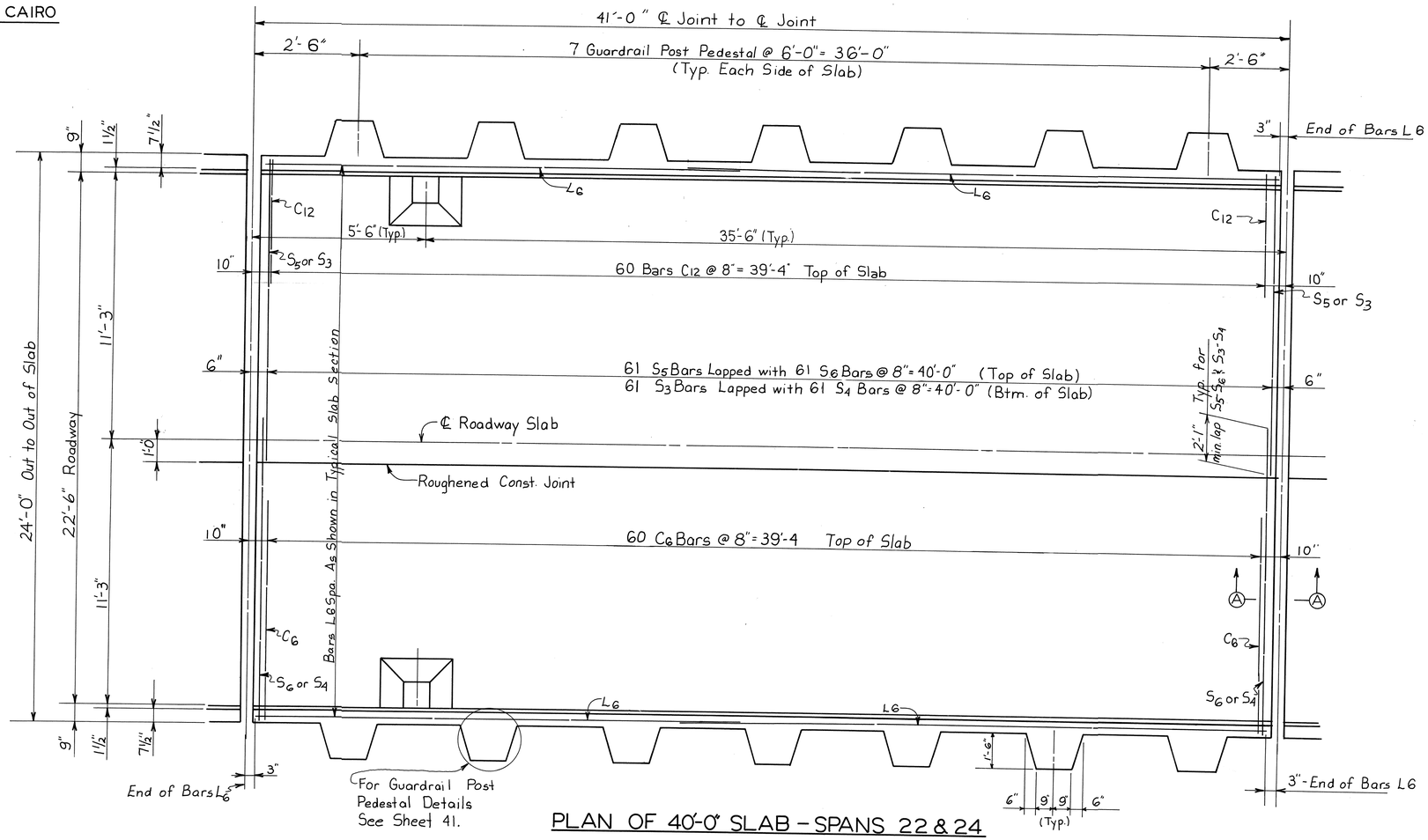
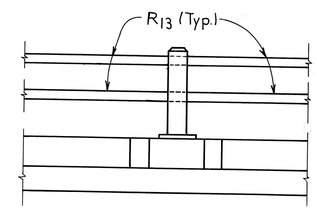
REVISED
REVISED
REVISED
DATE
DATE
DATE

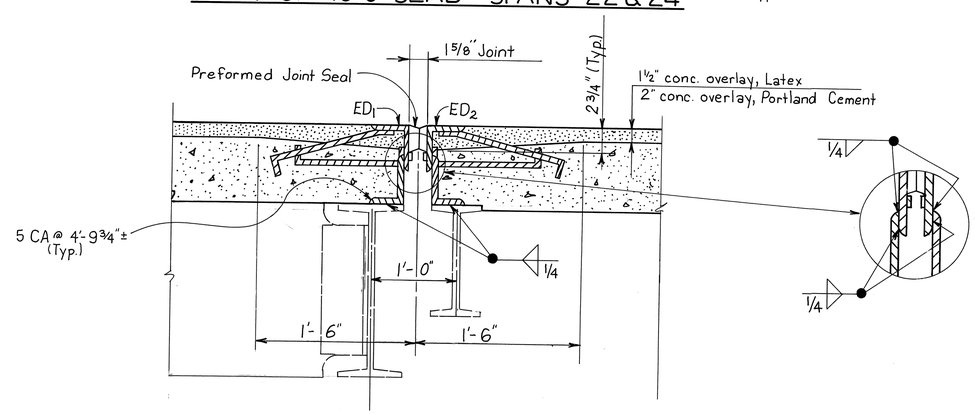
N9947



PLAN OF 40'-0" SLAB - SPANS 22 & 24



SECTIONAL ELEVATION SHOWING GUARDRAIL



SECTION A-A

40'-0" SLAB DETAILS SPANS 22&24

SHEET 34

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF

BALLARD

WICKLIFFE-CAIRO, ILL.

ROAD

STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
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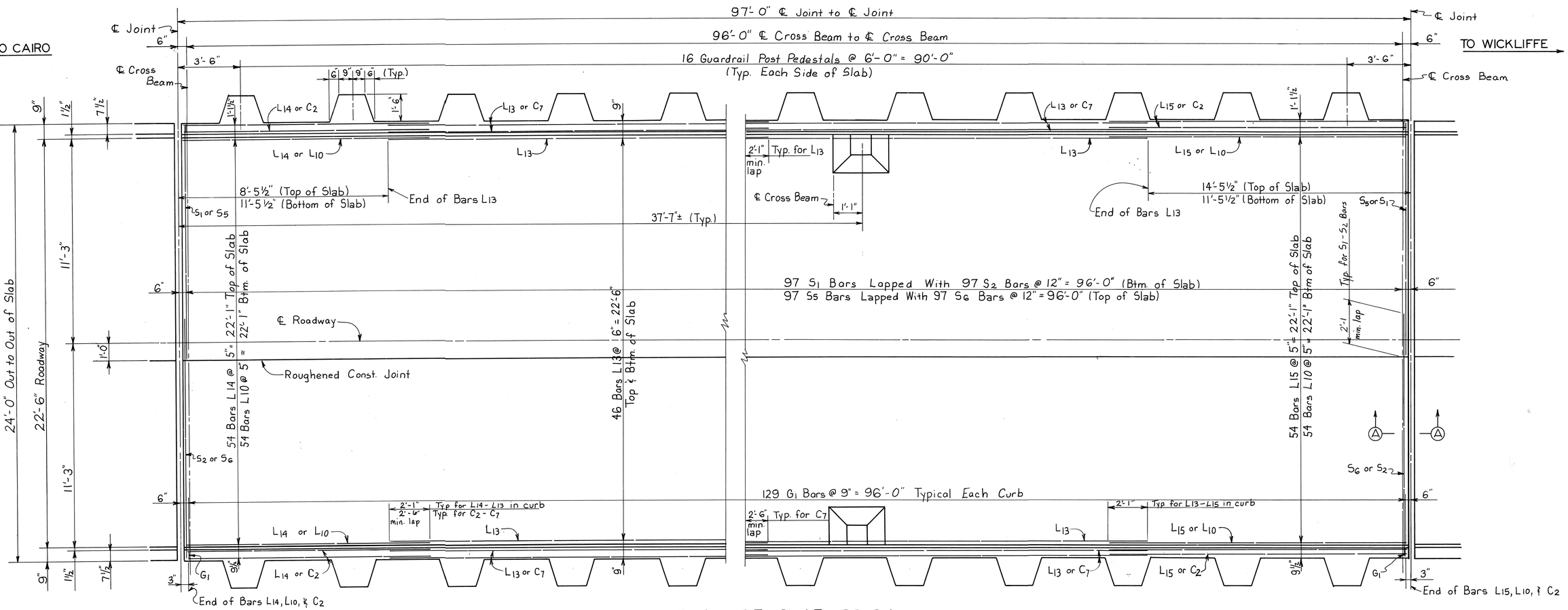
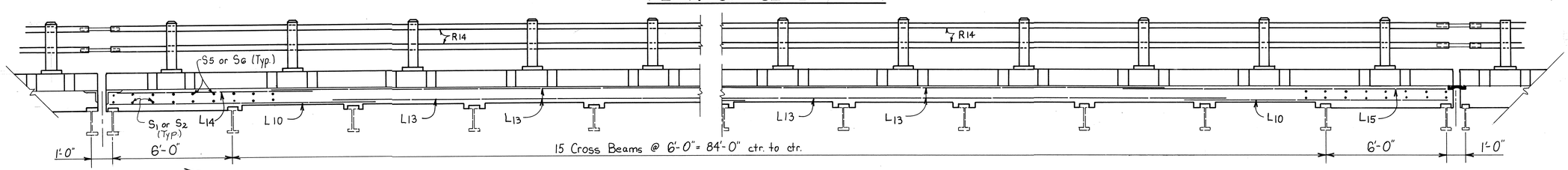
DESIGNED BY L.T. GROVES DATE 4/77
DETAILED BY DATE
TRACED BY DATE
CHECKED BY DATE
CHECKED BY DATE
CHECKED BY DATE

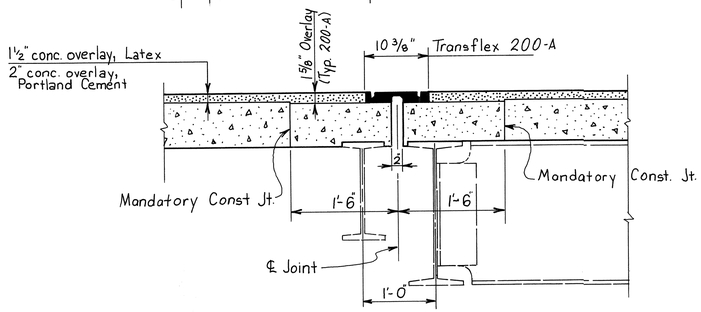
N9947



PLAN OF SLAB 22-24



ELEVATION OF SPANS 22-24



SECTION A-A

SHEET 35

SLAB DETAILS SPANS 22-24

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE-CAIRO, ILL.
ROAD

STATION	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

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DESIGNED BY L.T. GRAVES	DETAILED BY	TRACED BY

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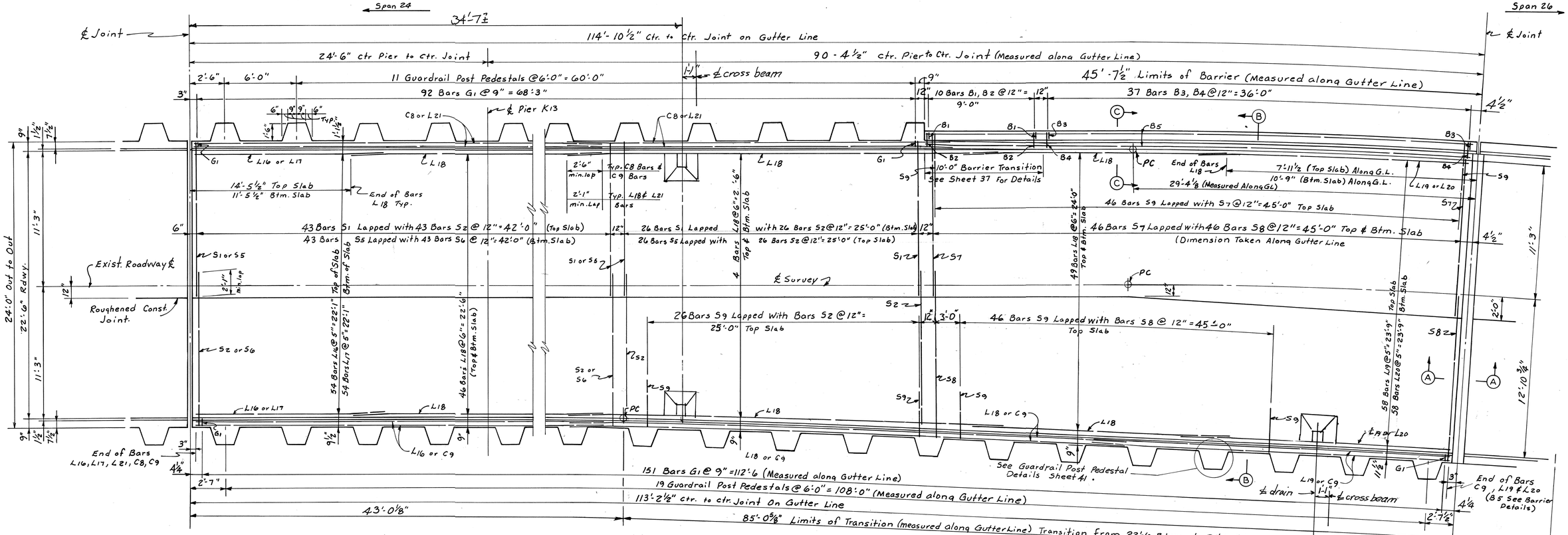
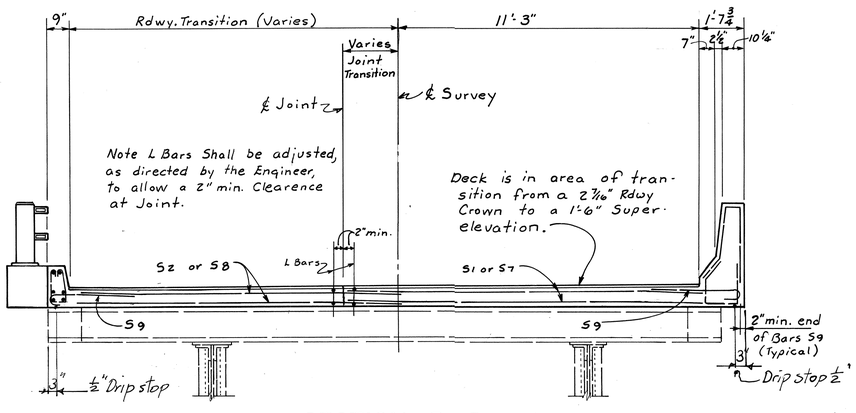
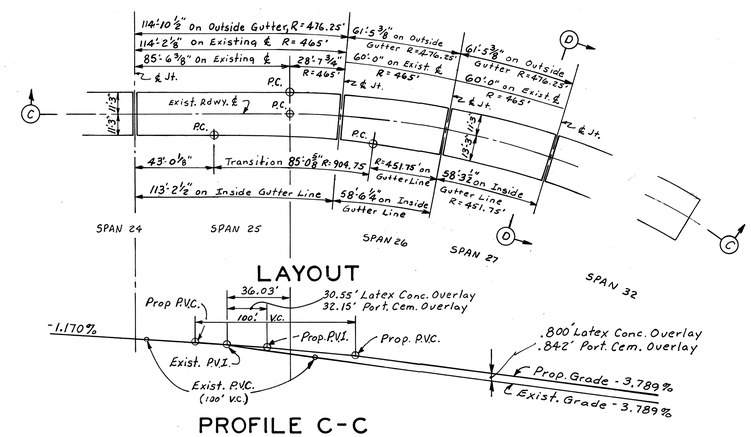


PART PLAN SPAN 24

PLAN SPAN 25



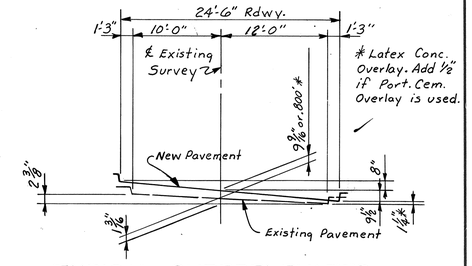
SECTION B-B



LAYOUT

PROFILE C-C

Note: Curve Superelevation is to be .06. Superelevation transition shall be as shown on Standard Drawing RGS-001-02 with L = 120 ft.



TYPICAL SUPERELEVATED SECTION D-D

DETAILS SPAN 24 - SPAN 25

SHEET 36

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE-CAIRO, ILL.

ROAD
STATION
P.E. PROJECT NO.

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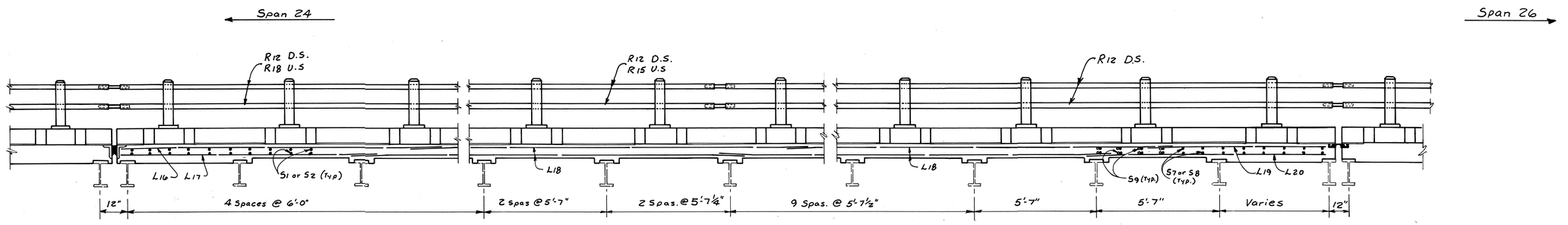
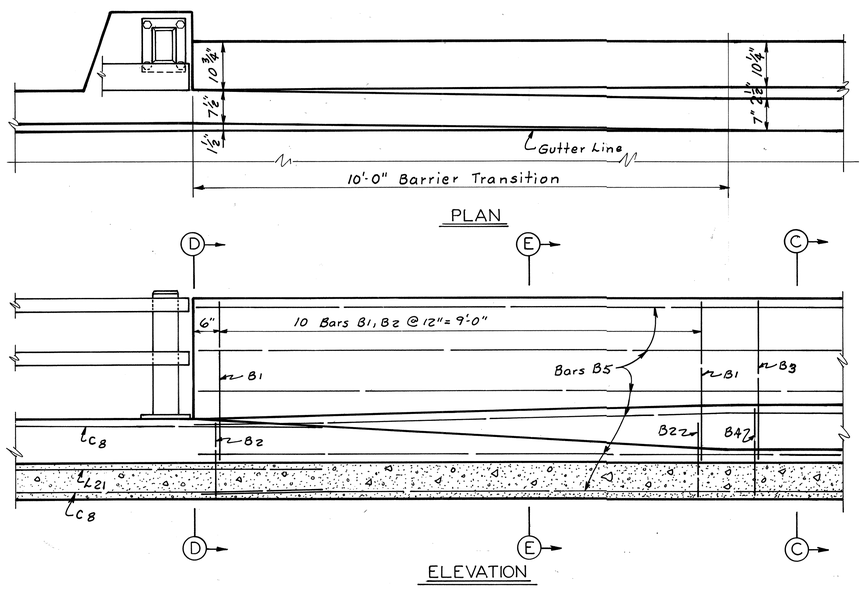
DATE CHECKED BY

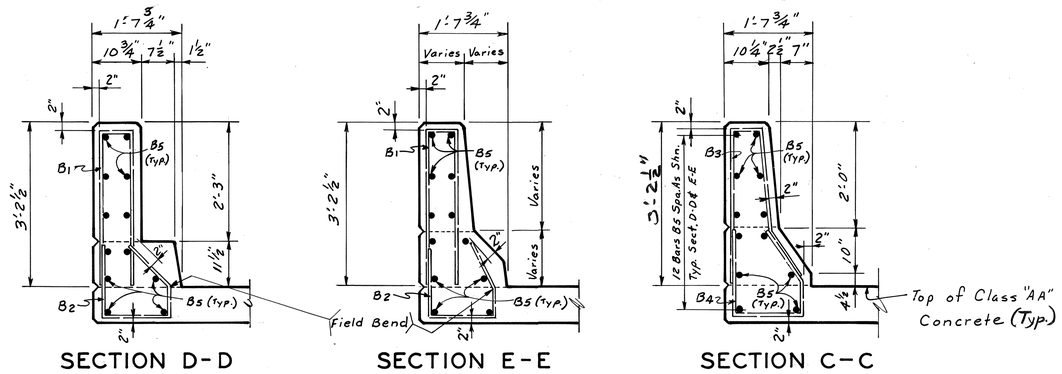
DIETZGEN 11-76
DRAWN BY
TRACED BY

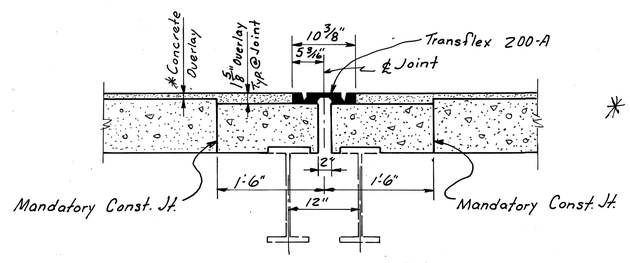


ELEVATION OF SPAN 24 & SPAN 25



BARRIER TRANSITION DETAILS





SECTION A-A

* 1½" Conc. Overlay, Latex
2" Conc. Overlay, Portland Cement

SHEET 37

DETAILS SPAN 24 & SPAN 25

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
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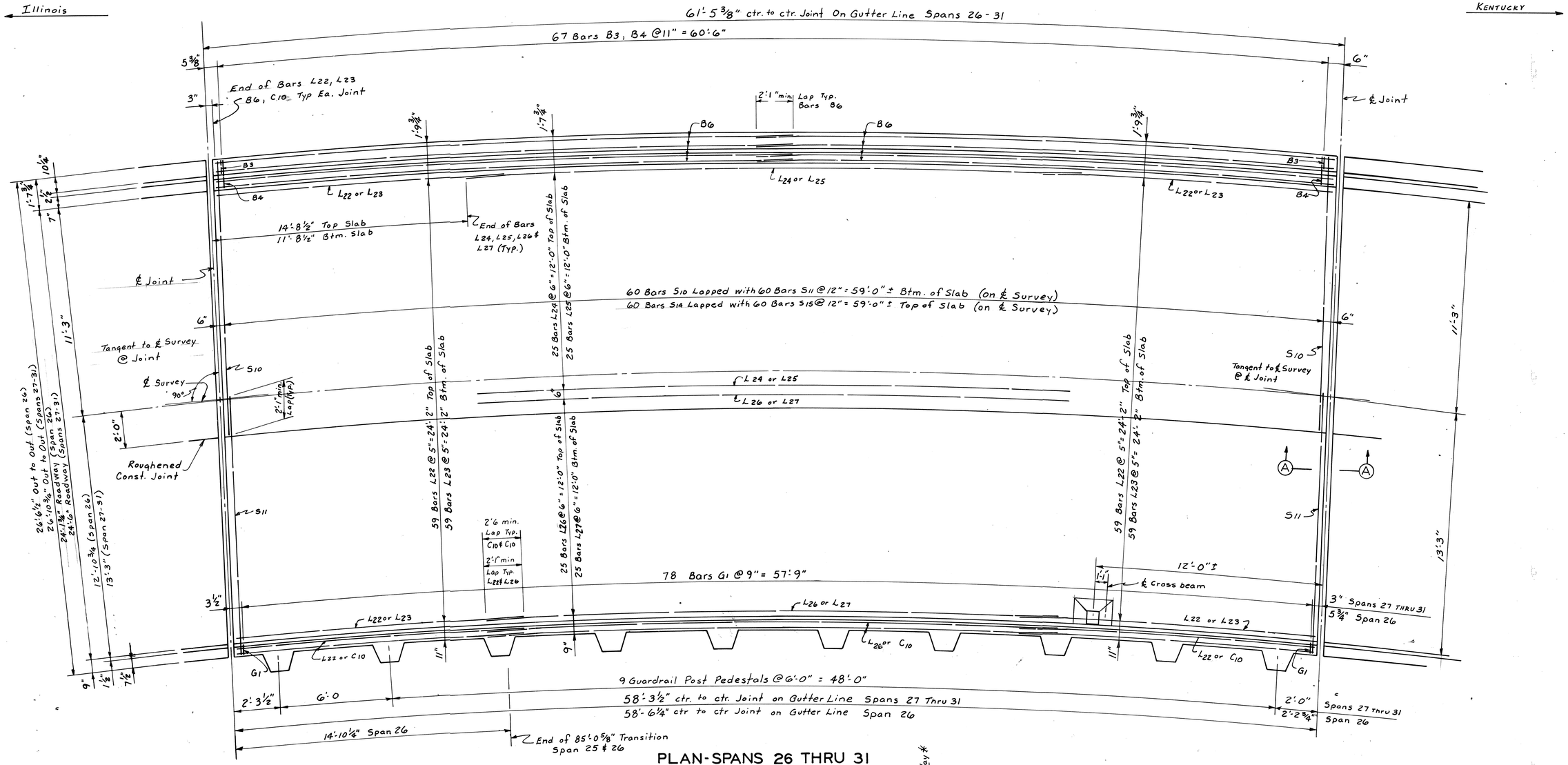
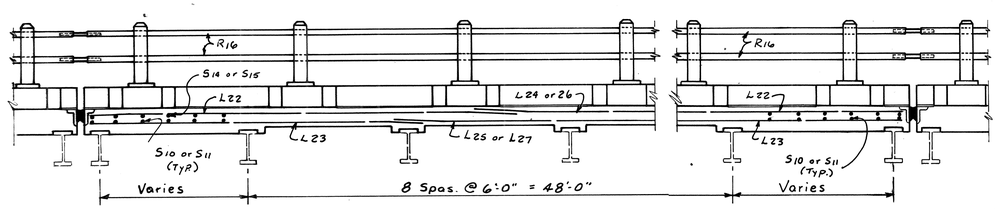
DIETZGEN 11-76

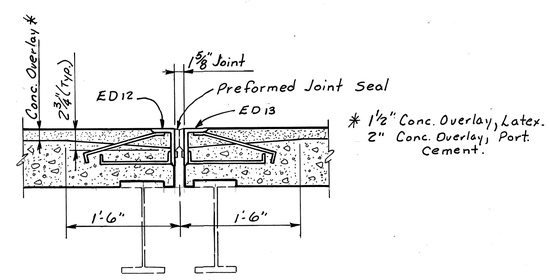
UPDATE DATE
LETTING DATE



PLAN-SPANS 26 THRU 31



ELEVATION SPANS 26 THRU 31



SECTION A-A

DETAILS SPANS 26 THRU 31

SHEET 38

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
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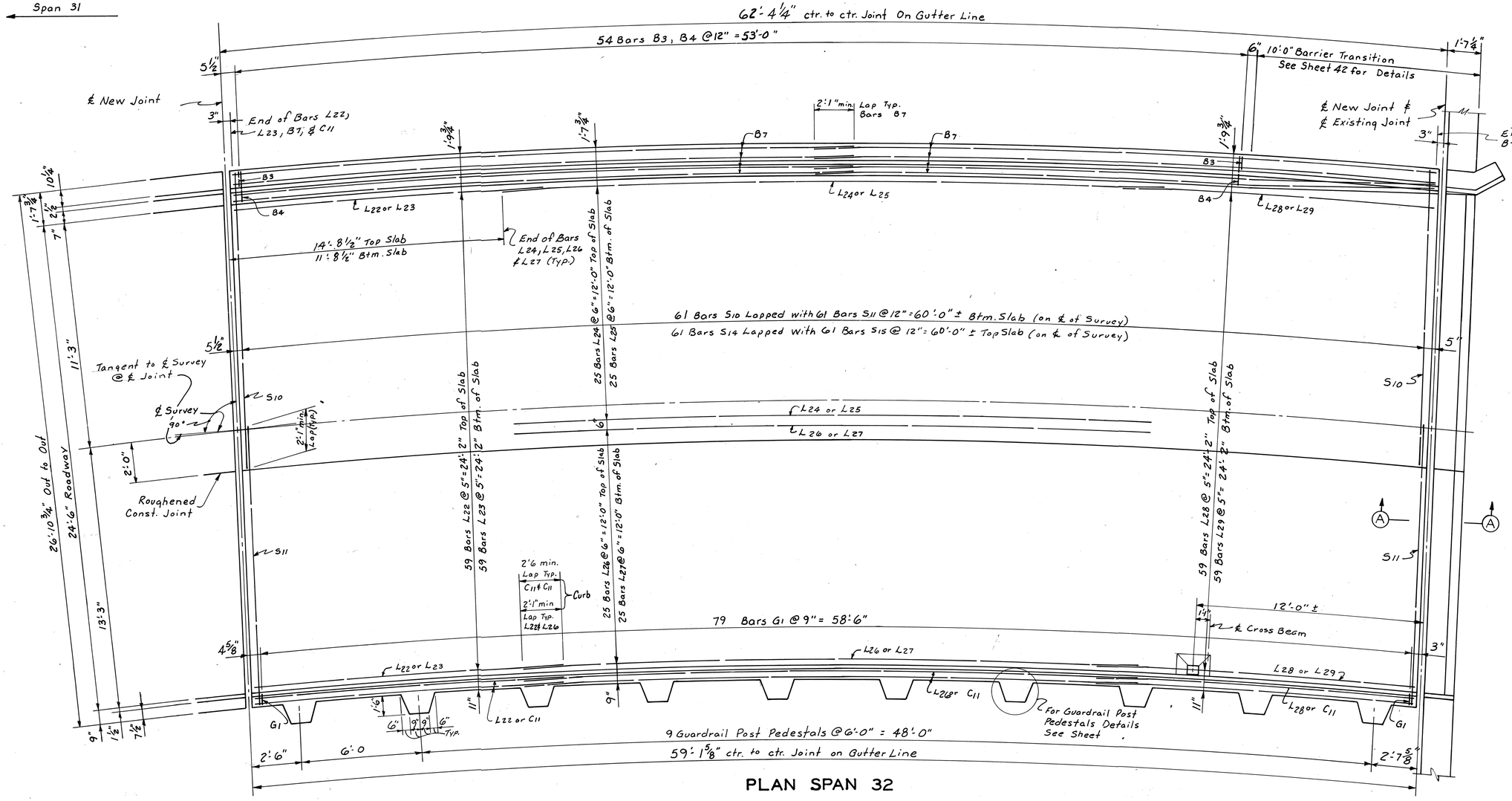
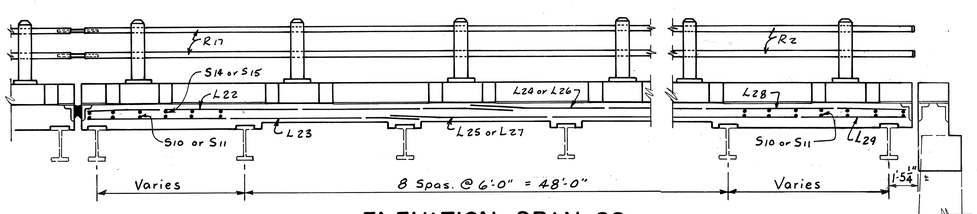
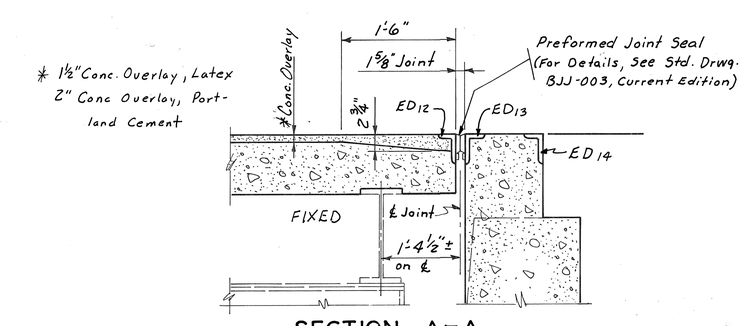
DIETZGEN 11-78







DETAILS SPAN 32

SHEET 39

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
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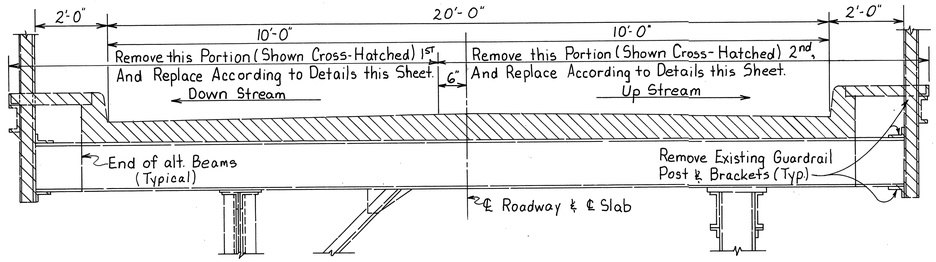
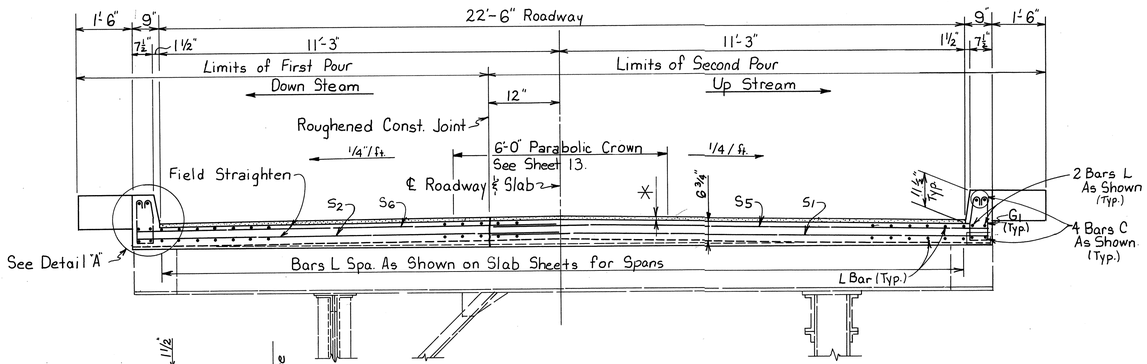
DETAILED BY
TRACED BY

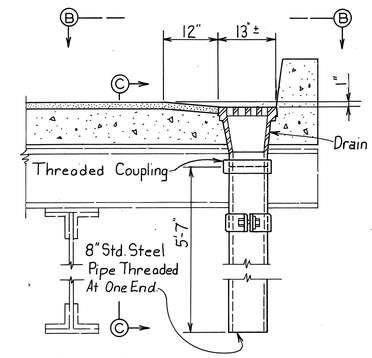
DIETZGEN 11-76



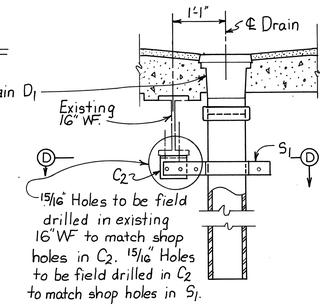
TYPICAL EXISTING SECTION OF KY. APPROACHES
SPANS 12-24



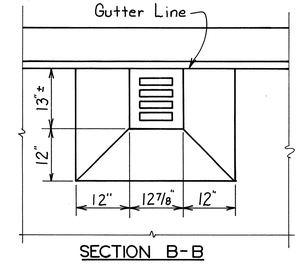
TYPICAL NEW SECTION OF KY. APPROACHES
SPANS 12-24



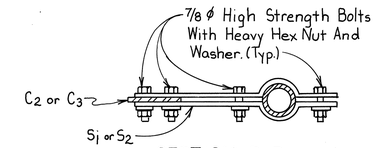
TYPICAL SECTION OF DRAINS
SPANS 20-32
18 REQUIRED



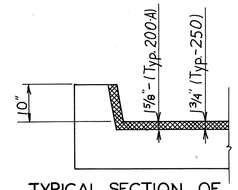
SECTION C-C



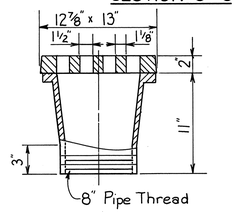
SECTION B-B



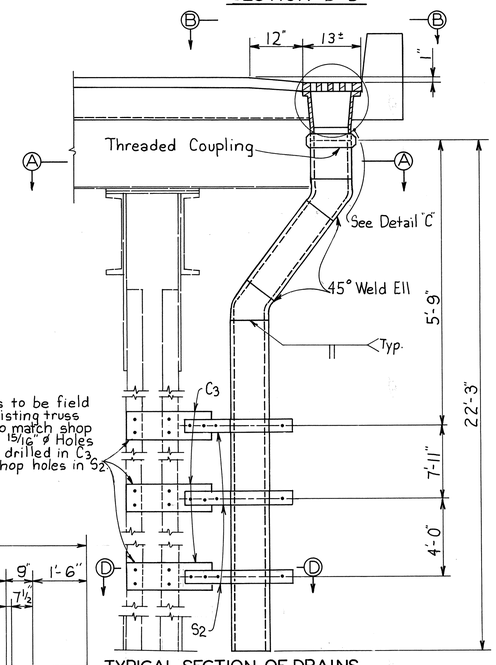
SECTION D-D



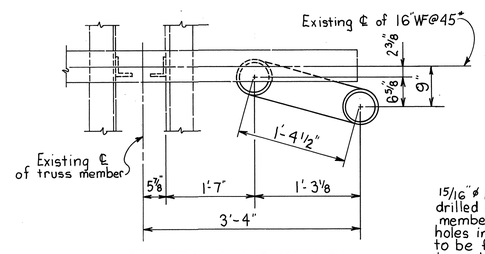
TYPICAL SECTION OF
TRANSFLEX EXPANSION DAMS



DETAIL "C"
BRIDGE DRAIN

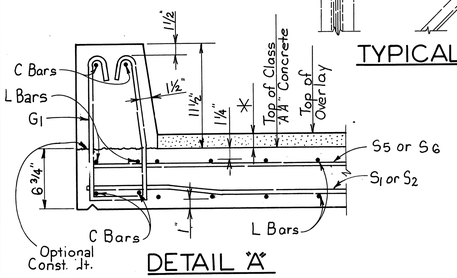


TYPICAL SECTION OF DRAINS
SPANS 12-20 - 46 REQUIRED

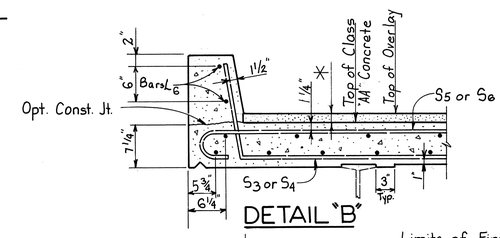


SECTION A-A SHOWING
LOCATION OF NEW DRAINS
SPANS 12-20

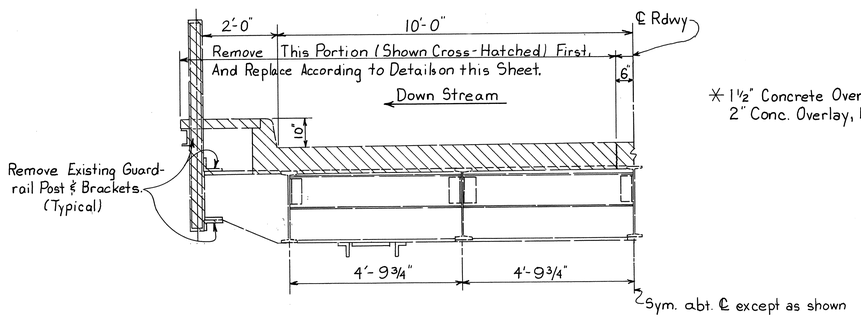
15/16" ϕ Holes to be field drilled in existing truss members to match shop holes in C3. 15/16" ϕ Holes to be field drilled in C3 to match shop holes in S2



DETAIL "A"

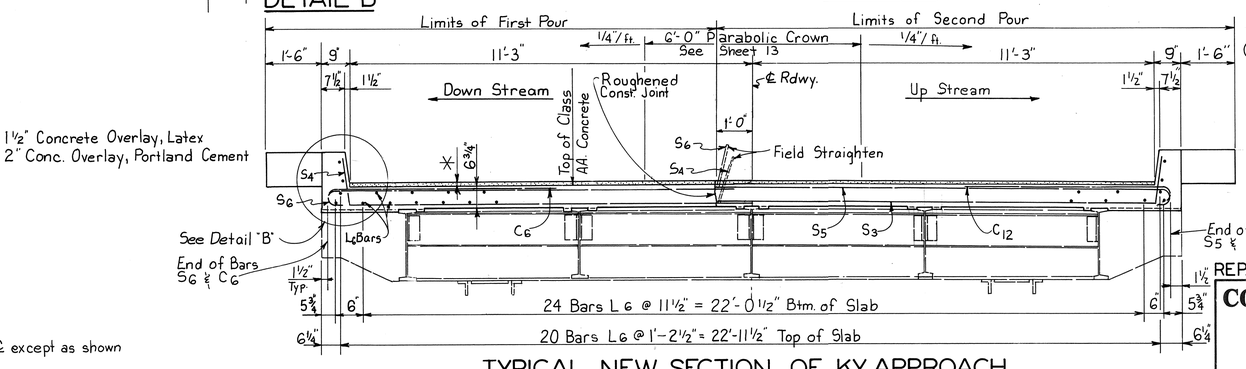


DETAIL "B"



✳ 1½" Concrete Overlay, Latex
2" Conc. Overlay, Portland Cement

TYPICAL EXISTING SECTION OF KY. APPROACH
40'-0" SLAB - SPANS 22 & 24



TYPICAL NEW SECTION OF KY. APPROACH
40'-0" SLAB - SPANS 22 & 24

TYPICAL DETAILS FOR KY. APPROACH

SHEET 40

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE - CAIRO, ILL.
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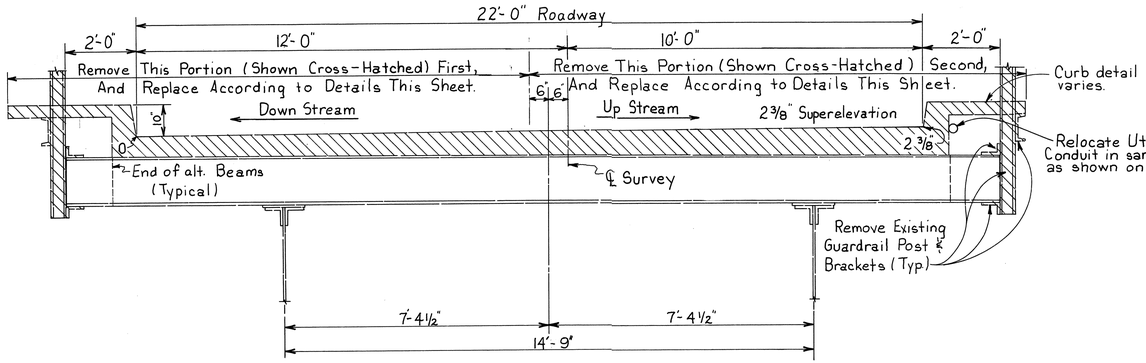
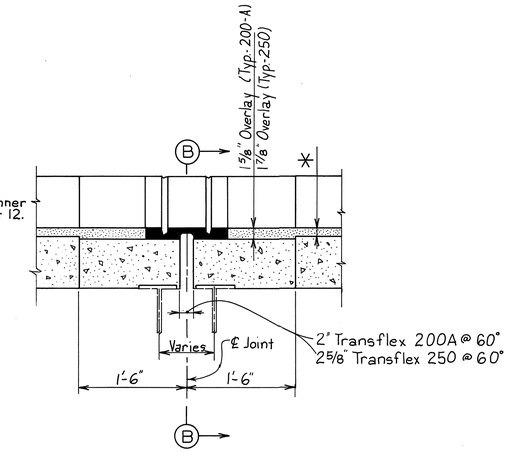
CHECKED BY
CHECKED BY

DESIGNED BY
DETAILED BY L.T. GROVES
TRACED BY

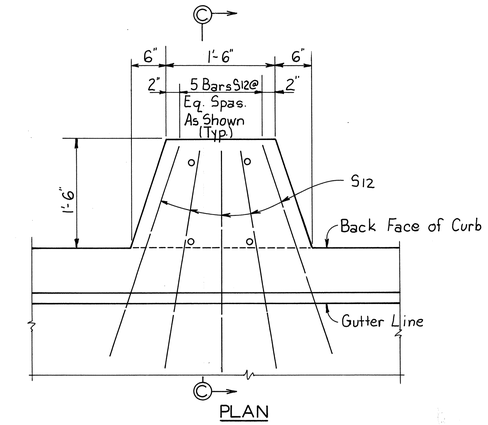
N9947

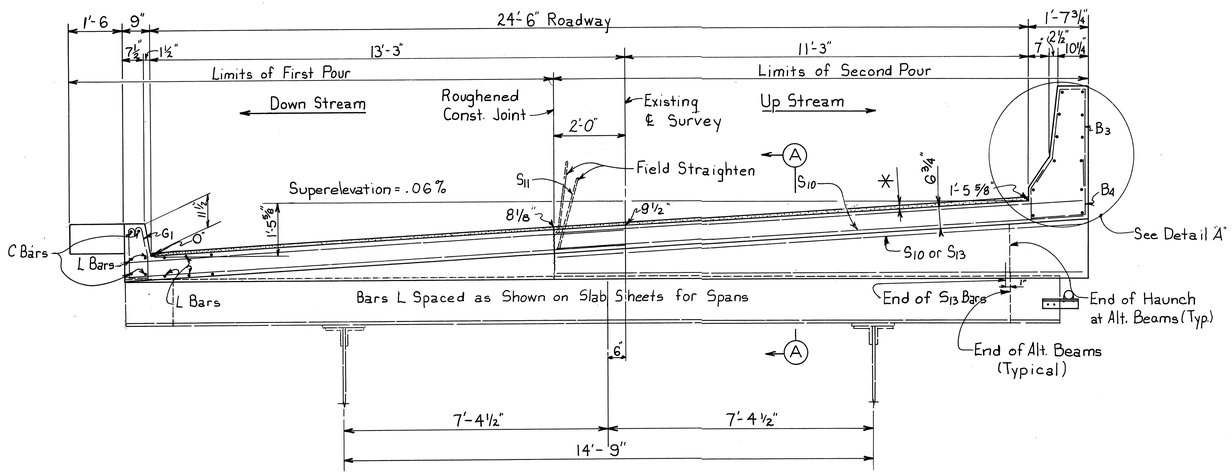


TYPICAL EXISTING SECTION SPANS 25-32

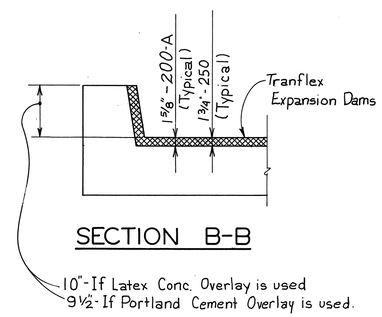


TYPICAL SECTION OF TRANSFLEX EXPANSION DAMS

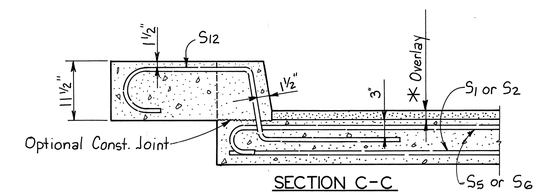




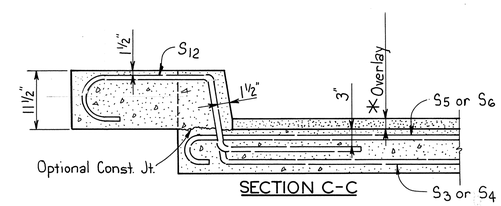
TYPICAL NEW SECTION SPANS 25-32



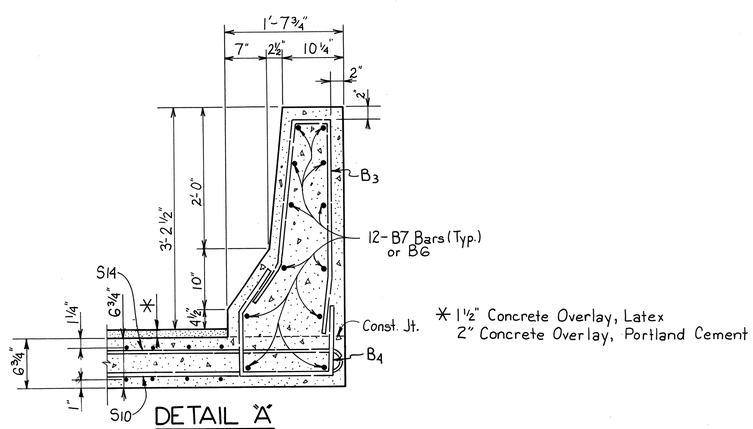
SECTION B-B

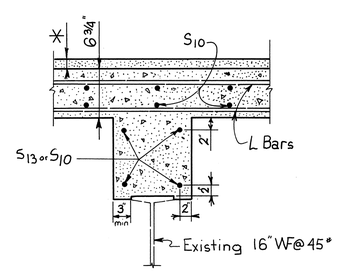


DETAILS OF GUARDRAIL POST PEDESTAL SPANS 12-32



DETAILS OF GUARDRAIL POST PEDESTALS 40-0 SLAB-SPANS 22&24





SECTION A-A

KY. APPROACH DETAILS SPANS 12-32

SHEET 41

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE - CAIRO, ILL.

STATION	ROAD	P.E. PROJECT NO.	
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.		DRAWING NO.
	MP004-0051-B0021		19382

UPDATE DATE
LETTING DATE

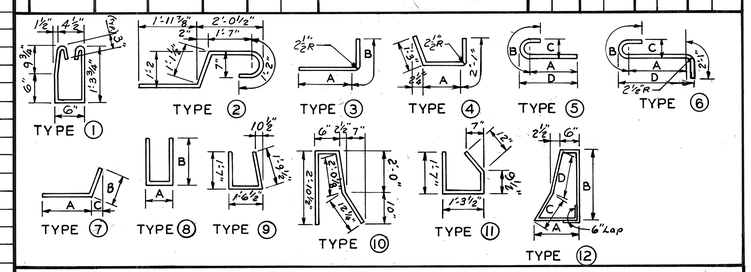
DESIGNED BY
DETAILED BY L. T. Graves
TRACED BY
CHECKED BY
CHECKED BY
CHECKED BY
DATE
REVISED

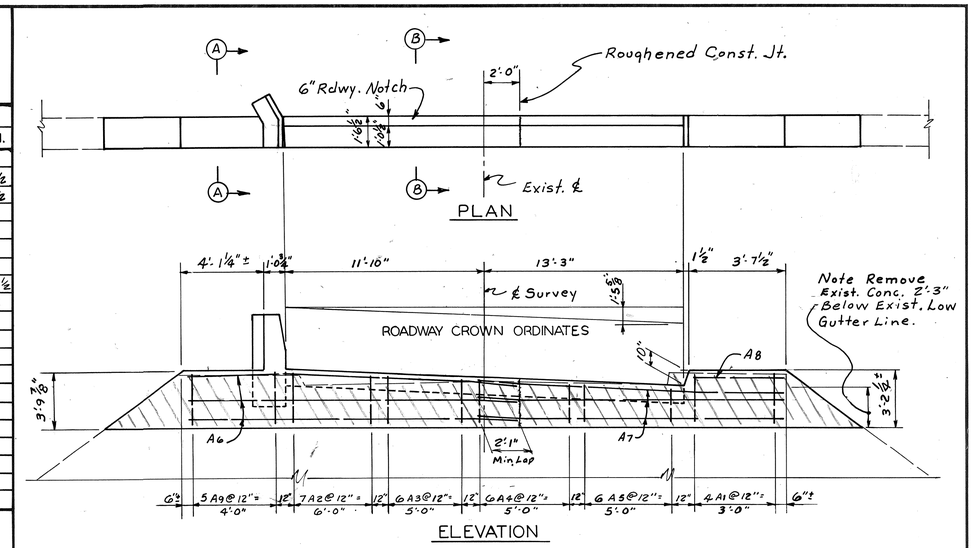
N9947

BILL OF REINFORCEMENT

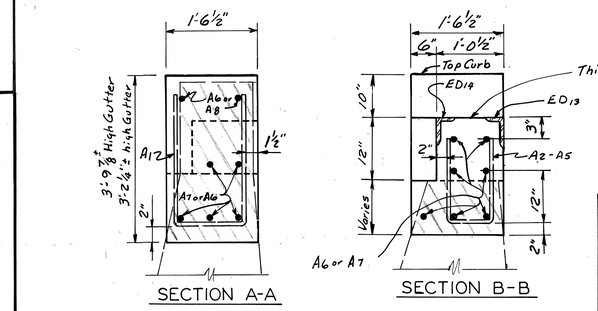
KENTUCKY APPROACH SPANS 12 THRU 32 & KY. ABUT.

MARK	TYPE	NO	SIZE	LENGTH FT.	LENGTH IN.	LOCATION	A FT.	A IN.	B FT.	B IN.	C FT.	C IN.	D FT.	D IN.
S1	Str	1916	#5	12	10	Spans 12-25								
S2	3	1916		13	0	do	10	11	2	1				
S3	7	122		13	6	Spans 22 & 24	12	3	1	3	0	2½		
S4	4	122		13	9	do	10	5	2	1				
S5	5	2038		13	6	do	12	8	0	10	0	5	12	10½
S6	6	2012		13	8	do	10	9	0	10	0	5	11	2
S7	Str	92		13	8	Span 25								
S8	3	92		13	5	do	11	4	2	1				
S9	5	118		4	8	do	3	10	0	10	0	5	4	0½
S10	Str.	617		14	8	Spans 26-32								
S11	3	617	#5	14	0	do	11	11	2	1				
S12	2	3695	#7	5	10	Spans 12-32								
S13	Str.	164	#5	12	5	Spans 25-32								
						#5 13,597.5393								
L1	Str.	58	#5	9	7	Span 12								
L2		54		18	9	do								
L3		7330		20	3	Span 12-20								
L4		922		10	9	do								
L5		982		19	9	do								
L6		200		21	4	40' Slab Spans 22-24								
L7		58		11	1	Span 21 & 22								
L8		288		24	7	do								
L9		50		25	3	do								
L10		220		13	7	Span 21-22 & 22-24								
L11		46		25	6	Span 21-22								
L12		54		10	7	do								
L13		288		26	1	Span 22-24								
L14		58		10	7	do								
L15		58		16	7	do								
L16		54		16	7	Span 24								
L17		54		13	7	do								
L18		396		24	11	Spans 24,25								
L19		60		10	1	Span 25								
L20		58		12	11	do								
L21		4		36	7	Span 25								
L22		793		16	7	Spans 26 THRU 32								
L23		767		13	7	do								
L24		175		32	1	do								
L25		175		38	1	do								
L26		189		30	7	do								
L27		175		36	7	Spans 26 THRU 32								
L28		61		17	6	Span 32								
L29	Str.	59	#5	14	6	Span 32								
						#5 269,329.2242								
G1	1	5820	#4	3	5	Spans 12-32								
C1	Str.	8	#6	19	0	Span 12								
C2		592		20	7	Spans 12-20, 22-24								
C3		128		19	9	Spans 12-20								
C4		16		20	10	Spans 21-22								
C5		32	#6	20	11	do								
C6		120	#4	5	0	40' Span 22-24								
C7		24	#6	21	10	Span 22-24								
C8		8		36	10	Span 25								
C9		16		30	5	Span 25								
C10		48		30	3	Spans 26-31								
C11	Str	8	#6	30	7	Span 31								
C12	5	120	#5	4	8	40' Spans 22-24	3	10	0	10	0	5	4	0½
B1	8	10	#5	6	3	Span 25	0	6	2	11				
B2	9	10		4	10	do								
B3	10	493		6	3	Span 25-32								
B4	11	493		4	6	do								
B5	Str.	24		24	2	Span 25								
B6	Str.	144		31	6	Spans 26-31								
B7	Str	24		31	11	Span 32								
B8	12	1		9	4	do	1	3½	3	4	1	7¾	1	9½
B9	12	1		9	1	do	1	2½	3	3	1	7½	1	8⅝
B10	12	1		8	11	do	1	2	3	2½	1	7½	1	7¾
B11	12	1		8	8	do	1	1	3	1½	1	7¼	1	6⅞
B12	12	1		8	4	do	1	0	3	0½	1	7	1	6
B13	12	1	#5	8	1	Span 32	0	11	2	11½	1	7⅜	1	5⅛
B14	12	1	#5	8	1	Span 32	0	11	2	11	1	8	1	4
B15	12	3		7	4	do	0	8½	2	8	1	7	1	1½
B16	12	2		10	0	do	0	8½	4	0	2	11	1	1½
B17	7	5		2	3	do	1	2	1	1	0	7		
B18	7	5	#5	2	7	Span 32	1	3½	1	3½	0	8		
S14	5	421	5	15	3	Span 26-32	14	5	0	10	0	5	14	7½
S15	6	421	5	14	8	do	11	9	0	10	0	5	12	2
						#5 24,574.2664								

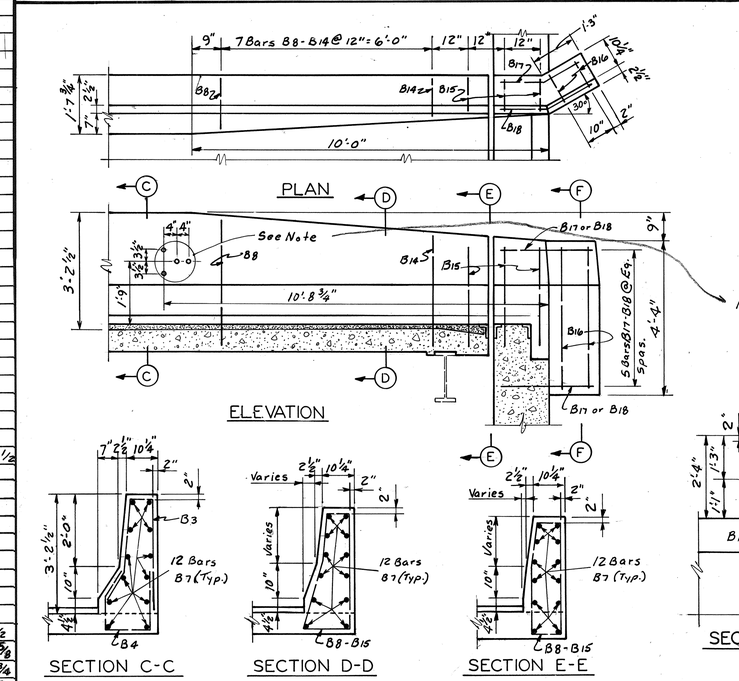




Note: Remove Cross-Hatched Portion of Exist. Concrete and Replace as Shown. Any Vertical Exist. Reinforcement Shall be Cleaned & Straightened and Left to Bond with New Concrete.



DETAILS KENTUCKY ABUTMENT

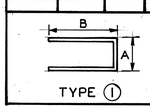


DETAILS BARRIER TRANSITION KENTUCKY ABUTMENT

BILL OF REINFORCEMENT

KENTUCKY ABUT.

MARK	TYPE	NO	SIZE	A LENGTH FT	A LENGTH IN	A FT	A IN	B FT	B IN
A1	1	4	#5	6	9	1	2	2	10
A2	1	7	#5	6	8	0	9	3	0
A3	1	6	#5	6	0	0	9	2	8
A4	1	6	#5	5	4	0	9	2	4
A5	1	6	#5	4	8	0	9	2	0
A6	Str.	7	#5	19	1				
A7	Str.	7	#5	17	0				
A8	Str.	2	#5	3	6				
A9	1	5	#5	7	11	1	2	3	5



SHEET 42

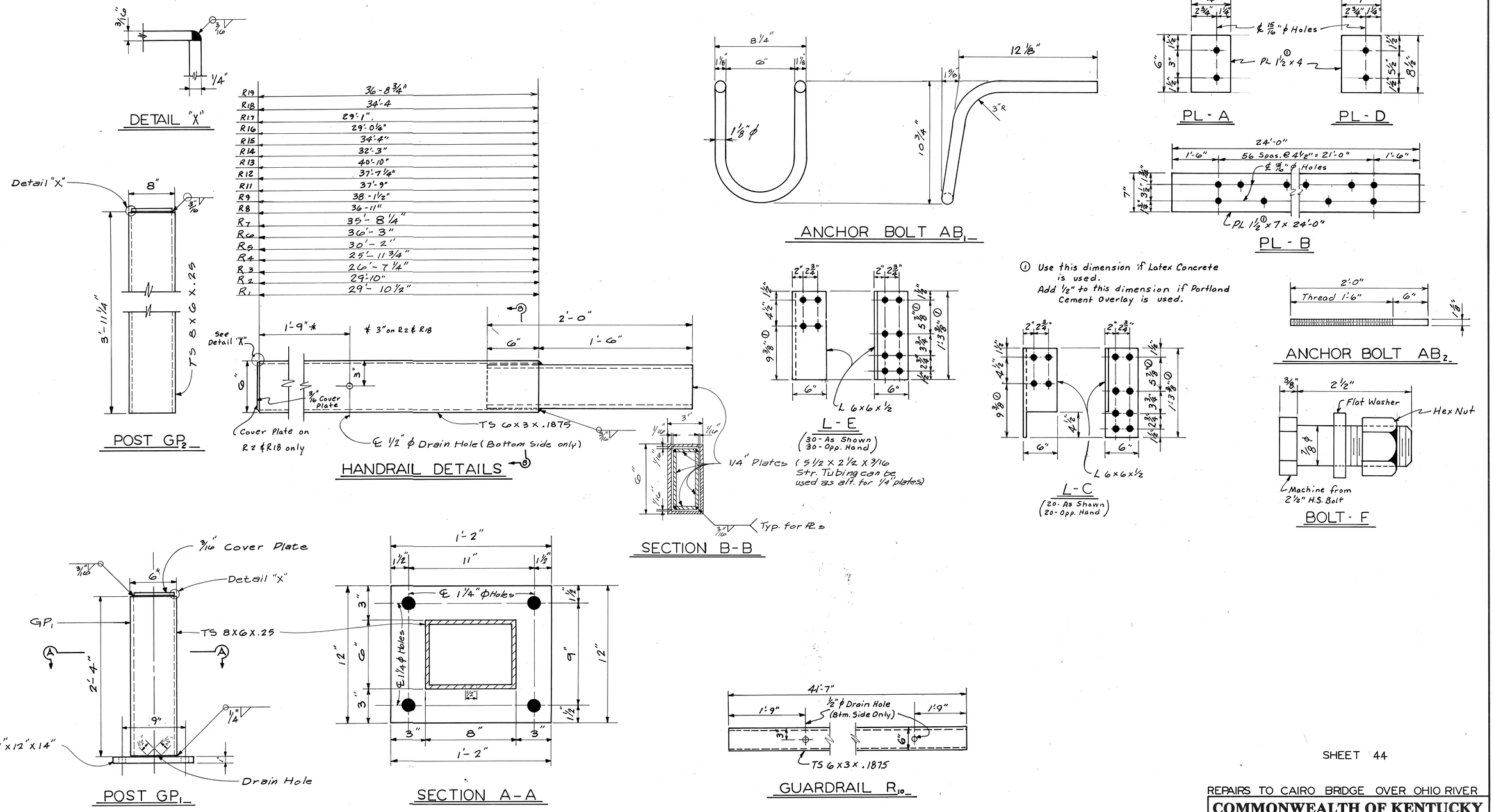
REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE - CAIRO, ILL.

ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004-0051-B0021	19382

UPDATE DATE
LETTING DATE
DESIGNED BY / DETAILED BY / TRACED BY / CHECKED BY / CHECKED BY / CHECKED BY
REVISED / REVISED / REVISED
DATE / DATE / DATE / DATE / DATE / DATE
N9947



SHEET 44

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE-CAIRO, ILL.
ROAD

STATION | P.E. PROJECT NO.

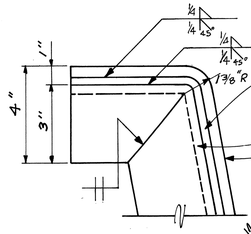
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP004-0051-B0021	19382

STRUCTURAL STEEL

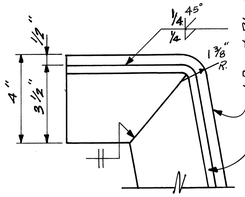
UPDATE DATE
LETTING DATE

DESIGNED BY ____ DATE ____ REVISED
DETAILED BY ____ DATE ____ REVISED
TRACED BY ____ DATE ____ REVISED
CHECKED BY ____ DATE ____
CHECKED BY ____ DATE ____
CHECKED BY ____ DATE ____

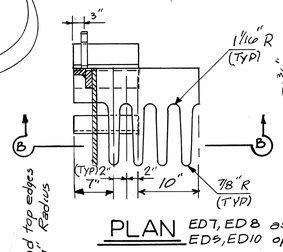
N9947



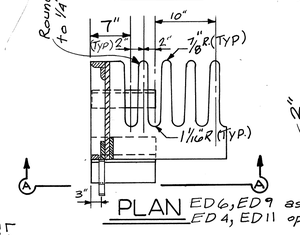
DETAIL "B"



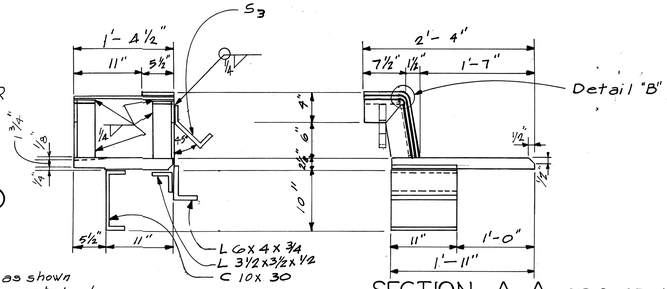
DETAIL "A"



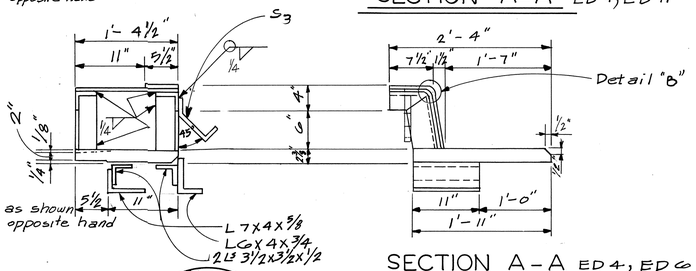
PLAN ED7, ED8 as shown
ED9, ED10 opposite hand



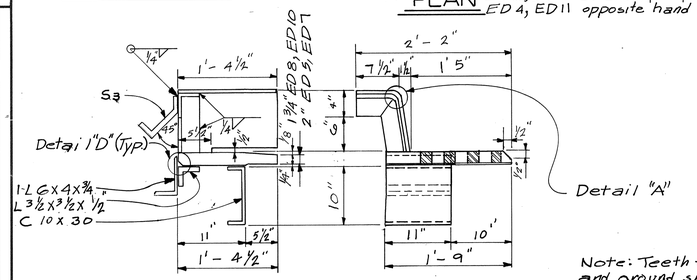
PLAN ED6, ED9 as shown
ED4, ED11 opposite hand



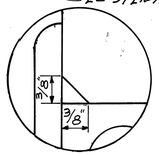
SECTION A-A ED 9, ED 11



SECTION A-A ED 4, ED 6

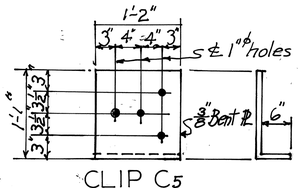


SECTION B-B

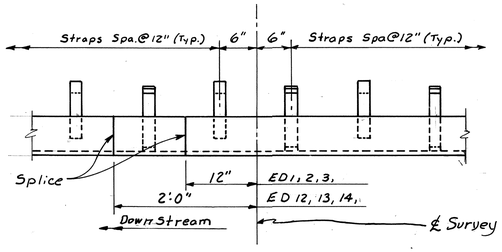


DETAIL "D"

Note: Teeth to be radiograph burned and ground smooth if necessary.



CLIP C5
2 Reqd. as shown
1 " opp. hand



EXPANSION DAM SPLICE DETAIL

ED 1, 12, 14, Spliced as Shown
ED 2, 3, 13, Spliced Opp. Hand

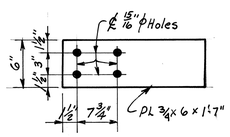
STRUCTURAL STEEL CONT.

MARK	NO.	DESCRIPTION
A	10	Plate - See Sheet 44 For Details
B	2	do
C	40	L - do
D	50	Plate - do
E	60	L - do
F	400	Bolt - do
JB	2	Jacking Block - See Sheet 47 For Details
SE	5	Stringer Extension - do

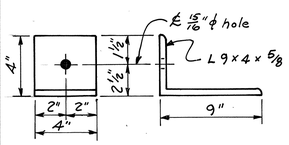
STRUCTURAL STEEL

MARK	NO.	DESCRIPTION
ED1	21	See Detail & Std. Drwg. BJE-002 Cur. Ed.
ED2	21	do do do
ED3	1	do do BJE 001 Cur. Ed.
ED4	2	Finger Dam See Detail
ED5	2	do
ED6	2	do
ED7	2	do
ED8	4	do
ED9	4	do
ED10	4	do
ED11	4	do
ED12	7	See Detail & Std. Drwg. BJE-002 Cur. Ed.
ED13	7	do do do
ED14	1	do do BJE-001 Cur. Ed.
CA	210	Clip Angle L 7x4 x ⅜ x 0'-6"
S1	220	Drain Strap See Detail
S2	300	do
		do
C1	1208	Guardrail to Truss Clip See Detail
C2	110	Drain Clip do
C3	138	do do
C4	12	do do
D1	160	Drains See Details Sheet 40
		do
C5	3	Guardrail Connector at ends of bridge
AB1	12	Anchor Bolt See Details
AB2	24	do
AB3	6292	Gdrl Post Anchor Bolt, 1"ϕ x 1'-3" Hex Hd Bolt w. Hex Nut and
		Flat Washer. (3 in. min thread on bolt)
GP1	1573	Guard Rail Post
GP2	12	do
R1	16	Guard Rail See Details
R2	6	do
R3	24	do
R4	12	do
R5	240	do
R6	140	do
R7	8	do
R8	4	do
R9	112	do
R10	4	do
R11	4	do
R12	18	do
R13	8	do
R14	12	do
R15	2	do
R16	24	do
R17	2	do
R18	2	do
R19	16	do

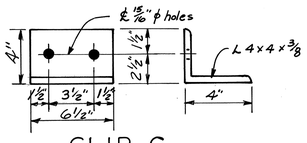
SHEET 45



CLIP C3



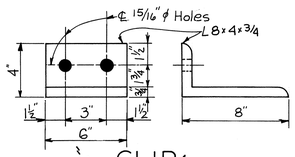
CLIP C1



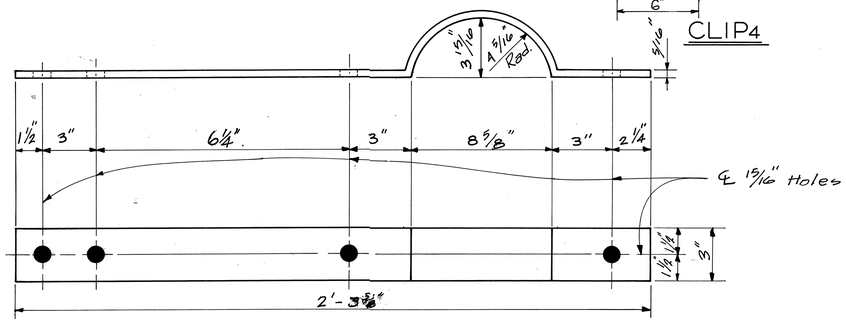
CLIP C2

EXPANSION DAMS

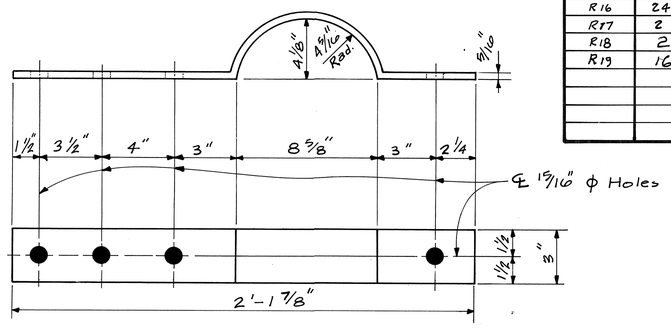
(ED 4, 5, 6, 7, 8, 9, 10, 11)



CLIP4



STRAP S2



STRAP S1

STRUCTURAL STEEL

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD

WICKLIFFE-CAIRO, ILL.
ROAD

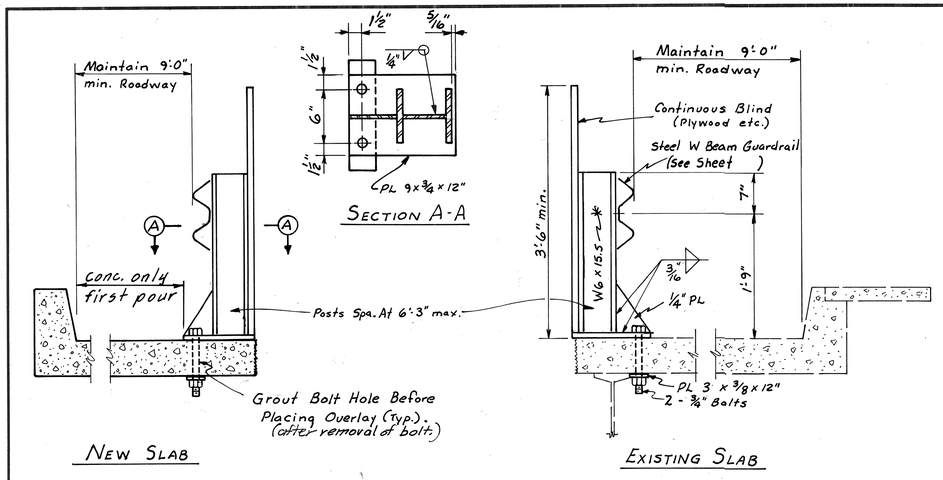
STATION | P.E. PROJECT NO.

CONSTRUCTION PROJECT NO. | MAINTENANCE PROJECT NO. MP004-0051-B0021 | DRAWING NO. 19382

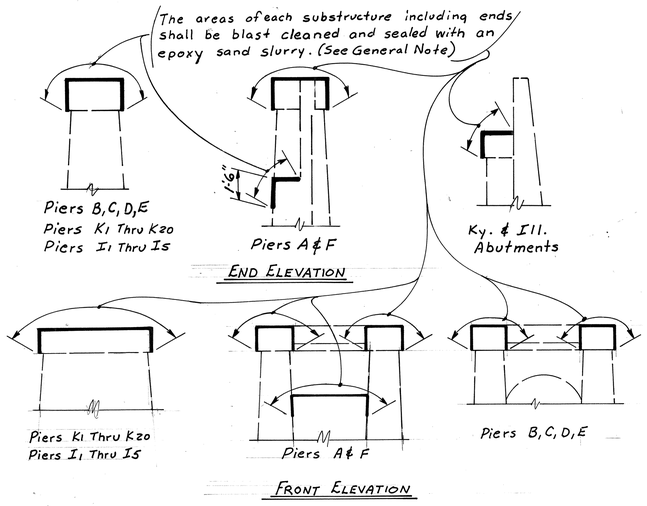
UPDATE DATE
LETTING DATE

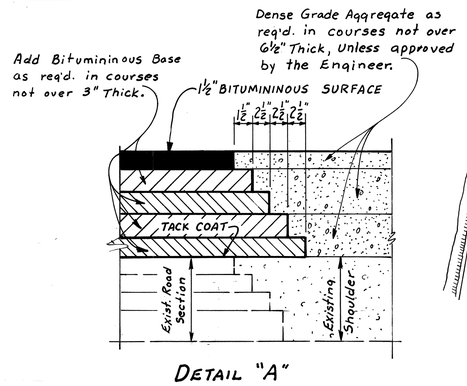
DATE | REVISED | DATE | REVISED
DATE | REVISED | DATE | REVISED
DATE | CHECKED BY | DATE | CHECKED BY
DESIGNED BY | DETAILED BY | TRACED BY

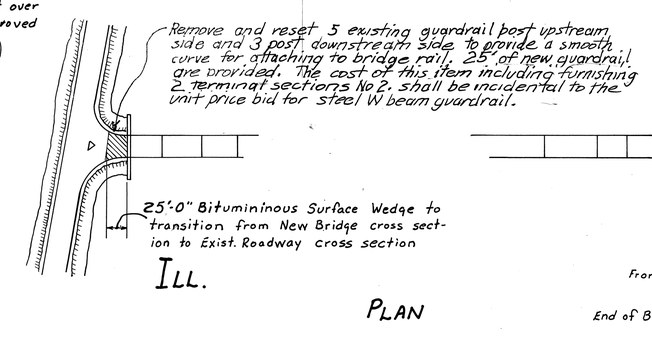
N9947

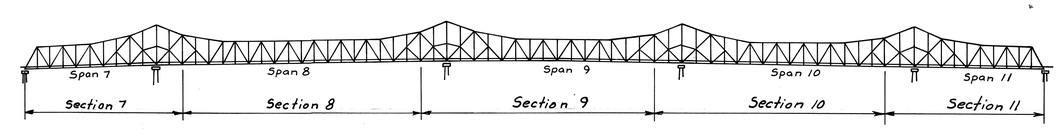


TEMPORARY BARRIER DETAILS









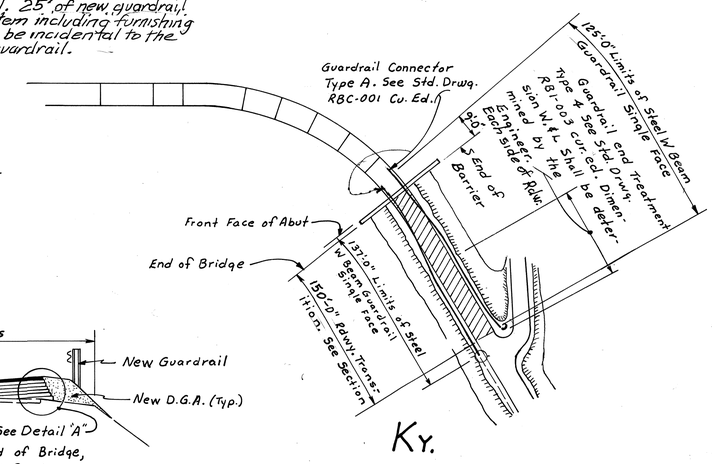
In order to prevent excessive uplift at various points throughout the main span trusses, the concrete slab must be removed and replaced in the following sequence, one lane at a time.

Remove concrete in section 8 first, then sections 9, 10, 11 and 7. However, section 7 may be removed at any time after the removal of section 8.

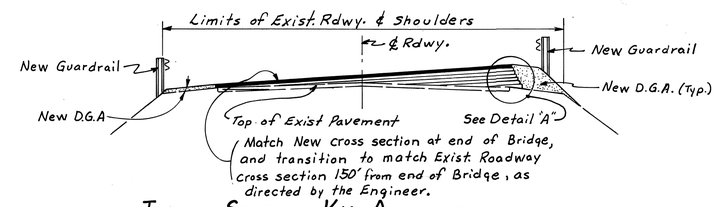
Replace concrete in section 11 first, then sections 10, 9, 7 and 8. However, section 7 may be replaced at any time before replacing section 8.

Section 7 may be poured at any time after the removal of section 8 but must be poured before the pouring of section 8.

POURING SEQUENCE

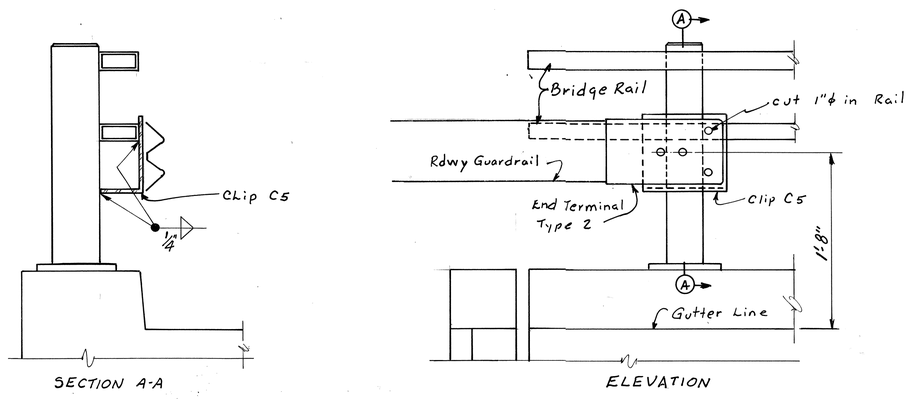


PLAN



TYPICAL SECTION KY. APPROACH

APPROACH DETAILS



RDWY. GUARDRAIL CONNECTOR TO END OF BRIDGE
(3 Required)

MISCELLANEOUS DETAILS

SHEET 46

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD
STATION | P.E. PROJECT NO.

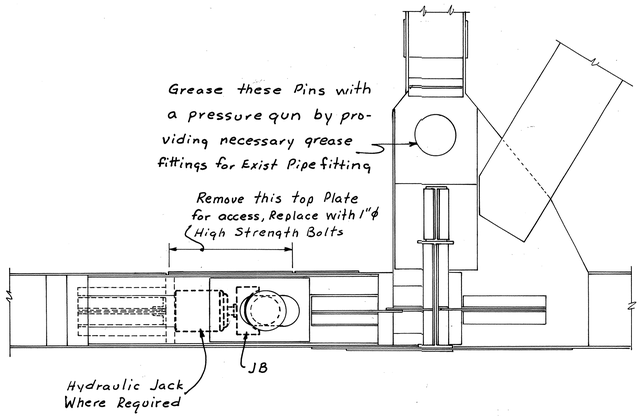
CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.
	MP 004 - 0051 - B0021	19382

UPDATE DATE
LETTING DATE

REVISED	DATE
Added note to Pouring Sequence	5/6/77
REVISED	DATE
REVISED	DATE

DESIGNED BY / CHECKED BY / DATE
DETAILED BY / CHECKED BY / DATE
TRACED BY / CHECKED BY / DATE

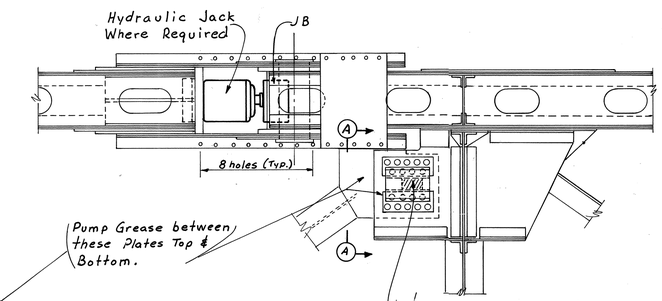
DIETZGEN 11-76



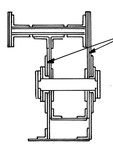
ELEVATION

Note: Thoroghly clean all areas within chord Which are accessable after removal of top plate. This cleaning must be done with a "Water Blaster". No Sand or Grit will be permitted. All areas shall then be painted with same paint coats specified for new Structural Steel.

Note "Waterblaster" where required shall be a high preasure water Jet of 5000 PSI min.



PLAN
(Top Plate Removed)



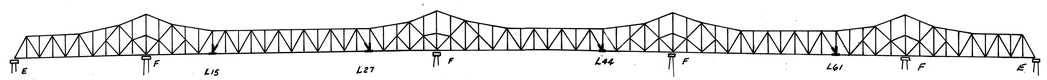
SECTION A-A

Pump Grease between these Plates Top & Bottom.

Thouroughly clean all areas which are accessible in and around this assembly with a "Water Blaster". No Sand or Grit will be permitted.

Coat all sliding surfaces with a heavy, non water soluable, grease as approved by the Engineer.

LOWER CHORD EXPANSION JOINTS

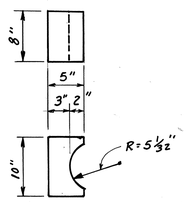


Install 2-50 Ton Jacks, one in each lower chord, at L15 and force the Suspended Span (L15-L27) towards L27 untill the Expansion Dams at L15 and L27 have Equal gaps. Remove Jacks.

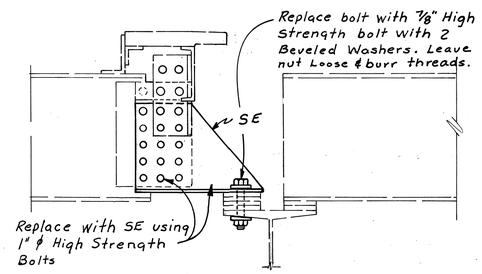
Remove Cover Plates of Lower Chord Clean, Paint and Grease Lower Chord and Lower Lateral Expansion Joints, each side of Roadway at Panel Points L15, L27, L44, and L61.

Remove Guide Blocks, Clean, Paint and Grease Wind Anchors at Panel Points L0 & L27.

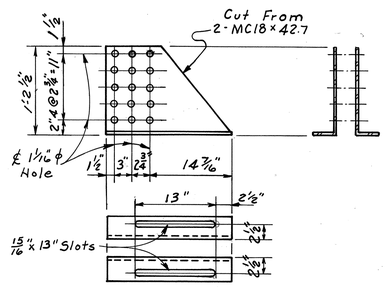
Remove & Replace Stringer Extensions at Panel Point L44 to Provide for additional movement.



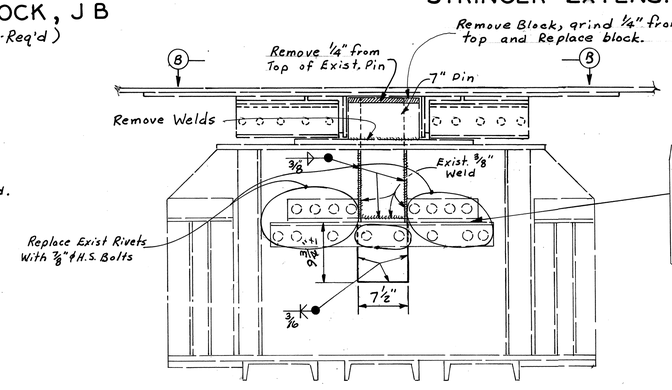
JACKING BLOCK, J B
(2 Req'd)



STRINGER EXTENSIONS



STRINGER EXTENSION-SE
(5 pair Req'd)



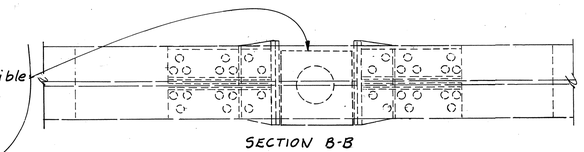
ELEVATION

Remove Exist 3/8" welds from around 7" Pin. Remove Angles At Base of Pin. Cut out section of Exist. Web plate (as shown) to allow removal of Pin. Grind 1/4" from top of pin and replace. Replace Exist. Piece of Web Plate (as Shown). Bolt Exist Angles with 7/8" ϕ H.S. Bolts, and reweld Pin as shown.

Note: Pin and Block must not be left out of position for more than 24 hrs.

SHEET 47

Remove guide block, and thoroughly clean all areas which are accessible in and around this assembly with a "Water-Blaster", (No Sand or Grit). Coat all sliding surfaces with a heavy, non-Water soluable grease as approved by the Engineer.



SECTION B-B

WIND ANCHOR @ L_0 & L_{76}

REPAIRS TO CAIRO BRIDGE OVER OHIO RIVER

COMMONWEALTH OF KENTUCKY
BUREAU OF HIGHWAYS
FRANKFORT
COUNTY OF
BALLARD
WICKLIFFE – CAIRO, ILL.
ROAD
STATION P.E. PROJECT NO.

CONSTRUCTION PROJECT NO.	MAINTENANCE PROJECT NO.	DRAWING NO.

UPDATE DATE
LETTING DATE

REVISED DATE
REVISED DATE
REVISED DATE

CHECKED BY DATE
CHECKED BY DATE
CHECKED BY DATE

DESIGNED BY
DETAILED BY
TRACED BY

DIETZGEN 11-76

COUNTY OF	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
BALLARD		48	

SPECIFICATIONS

STANDARDS

THE FOLLOWING SPECIFICATIONS AND STANDARDS FORM A PART OF THESE SPECIFICATIONS UNLESS OTHERWISE DIRECTED IN THESE PLANS:

KENTUCKY DEPARTMENT OF HIGHWAYS 1976 STANDARDS AND AMENDMENTS

NATIONAL ELECTRICAL CODE, LATEST ISSUE

STANDARDS OF THE UTILITY COMPANY SERVING THE INSTALLATION

MANUAL ON UNIFORM TRAFFIC CONTROL DEVICES FOR HIGHWAY CONSTRUCTION AND MAINTENCE PROJECTS

U S COAST GUARD AIDS TO NAVIGATION REGULATIONS, LATEST EDITION

ROADWAY LIGHTING SYSTEMS - SPECIAL PROVISION NO. 82-A

SCOPE OF WORK

THE WORK SHALL INCLUDE THE FURNISHING, INSTALLING, CONNECTING AND PLACING IN SATISFACTORY OPERATING CONDITION NAVIGATION LIGHTING SYSTEMS IN ACCORDANCE WITH THESE SPECIFICATIONS AND THE APPLICABLE DRAWINGS.

MEASUREMENT AND PAYMENT

MESUREMENT OF THE COMPLETED WORK WILL BE MADE IN THE UNITS SHOWN ON THE PLANS AND IN THE PROPOSAL. PAYMENT FOR THE COMPLETED WORK WILL BE MADE AT THE CONTRACT UNIT PRICES. SUCH PAYMENT SHALL BE FULL COMPENSATION FOR INSTALLING AND PLACING COMPLETE INSTALLATION IN SATISFACTORY OPERATION

RESPONSIBILITY

THE CONTRACTOR WILL BE HELD RESPONSIBLE FOR DEFECTIVE MATERIALS AND / OR WORKMANSHIP FOR A PERIOD OF ONE YEAR FROM DATE OF ACCEPTANCE. UPON NOTICE OF FAILURE FROM THE ENGINEER DURING THIS ONE YEAR PERIOD, THE AFFECTED PART(S) SHALL BE REPLACED BY AND AT THE EXPENSE OF THE CONTRACTOR. FIVE PERCENT (5 %) OF THE LUMP SUM BID WILL BE WITHHELD UNTIL EXPIRATION OF THIS ONE YEAR PERIOD.

MATERIAL

THE CONTRACTOR SHALL PROVIDE, IN TRIPLICATE, DESCRIPTIVE LITERATURE AND / OR DRAWINGS (FURNISHED BY THE MANUFACTURERS) OF ALL MATERIALS USED FOR APPROVAL PRIOR TO COMMENCEMENT OF WORK. EXCEPTIONS TO MATERIALS SPECIFIED MAY BE TAKEN ONLY WITH THE PRIOR WRITTEN APPROVAL OF THE ENGINEER.

CONDUIT

ALL CONDUCTORS SHALL BE RUN INSIDE RIGID STEEL CONDUIT EXCEPT WHERE OTHERWISE DIRECTED, AND WHERE CONDUCTORS ARE RUN INSIDE POLES. ALL RIGID STEEL CONDUIT SHALL BE GALVANIZED INSIDE AND OUT, AND SHALL CONFORM TO THE UNDERWRITER'S LABORATORIES' REQUIREMENTS FOR RIGID METALLIC CONDUIT. ALL CONDUIT INSTALLATIONS SHALL CONFORM TO THE PROVISIONS OF THE NATIONAL ELECTRICAL CODE, UNLESS OTHERWISE DIRECTED IN THESE PLANS. THE ENDS OF ALL CONDUITS SHALL BE REAMED TO REMOVE BURRS AND ROUGH EDGES. DAMAGED PORTIONS OF THE GALVANIZED COATING AND UNTREATED THREADS RESULTING FROM FIELD CUTS SHALL BE PAINTED WITH AN APPROVED RUST INHIBITIVE PAINT. SLIP JOINTS WILL BE PERMITTED FOR COUPLING RIGID CONDUIT TO JUNCTION BOXES. WHEN A STANDARD COUPLING CANNOT BE USED FOR COUPLING RIGID CONDUIT, AN APPROVED THREADED UNION SHALL BE USED. ALL CONDUIT THREADS SHALL BE PAINTED WITH SUITABLE PIPE DOPE WHEN FITTED UP. CONDUIT BENDS SHALL HAVE A RADIUS OF NOT LESS THAN TWELVE (12) TIMES THE NOMINAL DIAMETER OF THE CONDUIT. THE TOTAL BENDING IN ANY RUN OF CONDUIT SHALL NOT EXCEED 360°.

SPLICES

SPLICES WILL BE PERMITTED ONLY IN JUNCTION BOXES, POLE BASES, OR IN COUNDLETS OF SUFFICIENT SIZE TO PERMIT EASY REMOVAL AND REINSERTION OF SPLICE FOR INSPECTION PURPOSES. SPLICES SHALL BE MADE WITH MECHANICAL CONNECTORS OF AN APPROVED TYPE BY THE ENGINEER OR TWISTED AND SOLDERED. SPLICES MUST BE PROTECTED AS FOLLOWS: DOUBLE SPIRAL WRAP OF RUBBER TAPE, DOUBLE SPIRAL WRAP OF FRICTION TAPE AND THOROUGH PAINTING OF THE COMPLETED SPLICE WITH AN INSULATING ELECTRICAL PAINT, OR SEALED WITH SUITABLE SELF-SEALING, MOISTURE RESISTANT VINYL MASTIC TAPE WITH A MINIMUM DIELECTRIC RATING OF 600 VOLTS AND COVERED WITH DOUBLE SPIRAL WRAP OF PLASTIC OR FRICTION TAPE.

PAINTING

EXPOSED JUNCTION BOXES, PULL BOXES, CONTROL PANELS, PLATES, MOUNTING FLANGES, NEW STEEL, IRON, AND ABRAZED PLACES SHALL BE GIVEN ONE SHOP COAT OF RED LEAD AND ONE COAT OF PREVAILING COLOR OF THE BRIDGE

TESTING

AFTER THE INSTALLATION IS COMPLETED AND AT SUCH TIME AS THE ENGINEER SHALL DIRECT, THE CONTRACTOR SHALL CONDUCT AN OPERATING TEST FOR APPROVAL. THE SYSTEMS SHALL BE DEMONSTRATED TO OPERATE IN ACCORDANCE WITH SPECIFICATIONS. THE TESTS SHALL BE PERFORMED IN THE PRESENCE OF THE ENGINEER. THE CONTRACTOR SHALL FURNISH ALL INSTRUMENTS AND PERSONNEL NECESSARY FOR THE TEST, AND THE DEPARTMENT OF HIGHWAYS WILL FURNISH THE POWER. CIRCUITS SHALL TEST FREE OF GROUNDS AND SHORTS AND SHALL HAVE AN INSULATING RESISTANCE NOT LESS THAN TEN (10) MEGOHMS WHEN TESTED WITH A 500 VOLT DIRECT CURRENT POTENTIAL IN A REASONABLY DRY ATMOSPHERE BETWEEN CONDUCTORS AND GROUND.

NAVIGATION INDICATIONS

THE CONTRACTOR WILL BE HELD RESPONSIBLE FOR MAINTAINING ACCEPTABLE NAVIGATION INDICATIONS ON THE BRIDGE FROM TIME WORK IS BEGUN UNTIL FINAL ACCEPTANCE IS MADE.

NOTE: AT THE TIME THAT THIS BRIDGE IS HAVING THE LIGHTING SYSTEM INSTALLED ANOTHER CONTRACTOR MAY BE WORKING IN THE AREA. THE LIGHTING CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION WITH THE OTHER CONTRACTOR FOR ANY AGREEMENTS NECESSARY TO ELIMINATE INTERFERENCE OF WORK.

NOTES: ANY UTILITIES DISTURBED OR DAMAGED BY THE CONTRACTOR THROUGH CARELESSNESS DURING HIS CONSTRUCTION OPERATIONS SHALL REPLACED BY THE CONTRACTOR AT NO EXTRA COST TO THE DEPARTMENT.

THE CONTRACTOR SHALL RESTORE ANY DISTURBED AREA DUE TO HIS OPERATION TO THE SATISFACTION OF THE ENGINEER ON CONSTRUCTION.

WIRE

ALL WIRE SHALL BE SINGLE-CONDUCTOR, TYPE THW OR THWN, WITH SIZES LARGER THAN NO. 12 BEING STRANDED.

NAVIGATION FIXTURES

NAVIGATION FIXTURES SHALL CONFORM TO THE FOLLOWING SPECIFICATIONS FOR FIXTURES DESCRIBED IN SUMMARY OF QUANTITIES:

RED INDICATION - NAVIGATION LIGHTING FIXTURE, DUPLEX PER LIGHT WITH 180° FRENEL LENSES, 8 INCH RED WITH LAMP BURN-OUT RELAY TO AUTOMATICALLY CHANGE LAMPS IN CASE OF LAMP BURN-OUT AND ARRANGED FOR USE WITH A-21 TRAFFIC SIGNAL LAMP, 116 WATTS. FIXTURE SHALL CONSIST OF ALUMINUM BODY CASTINGS, CADMIUM PLATED STEEL ASSEMBLY BOLTS AND SCREWS. FIXTURE SHALL BE* ADEQUATELY VENTILATED TO PREVENT SWEATING WITH VENTILATORS DESIGNED TO PREVENT ENTRANCE OF RAIN WATER WHEN MOUNTED ON PEDESTAL OR SUSPENDED FROM CONDUIT.

GREEN INDICATION - NAVIGATION LIGHTING FIXTURE, DUPLEX CENTER CHANNEL LIGHT WITH 360° FRENEL LENSES, 8 INCH GREEN, WITH LAMP BURN-OUT RELAY TO AUTOMATICALLY CHANGE LAMPS IN CASE OF LAMP BURN-OUT, AND ARRANGED FOR USE WITH A-21 TRAFFIC SIGNAL LAMP, 116 WATTS. FIXTURE SHALL CONSISTS OF ALUMINUM BODY CASTINGS, CADMIUM PLATED STEEL ASSEMBLY BOLTS AND SCREWS. FIXTURE SHALL BE* ADEQUATELY VENTILATED TO PREVENT SWEATING WITH VENTILATORS DESIGNED TO PREVENT ENTRANCE OF RAIN WATER WHEN FIXTURE IS MOUNTED ON PEDESTAL OR SUSPENDED FROM CONDUIT.

WHITE INDICATION - SAME AS ABOVE NOTE FOR RED INDICATION WITH THE EXCEPTION OF BEING 8 INCH WHITE.

QUANITIES

QUANITITY	UNIT	ITEM
1	EACH	CONTROL CENTER
1	EACH	35' CLASS 4 WOOD POLE
6,000	LIN. FT.	2" RIGID STEEL CONDUIT
550	LIN. FT.	3/4" RIGID STEEL CONDUIT
49	EACH	2" EXPANSION FITTINGS - OZ TYPE "EX" OR APPROVED EQUAL
24,750	LIN. FT.	WIRE #2 STRANDED AWG, THW OR THWN
2,900	LIN. FT	WIRE #4 STRANDED AWG, THW OR THWN
1600	LIN FT	WIRE #12 SOLID AWG, THW OR THWN
350	LIN FT	3/4" LIQUID TIGHT FLEXIBLE CONDUIT
1	EACH	PHOTOELECTRIC CONTROL
1	EACH	100 AMP MAGNETIC CIRCUIT BREAKER, 2 POLE, 600 VOLT AC - TO BE WESTINGHOUSE TYPE F OR APPROVED EQUAL
1	EACH	MAGNETIC CONTACTOR, 480V. MIN., 100 A. FULL-LOAD (INCANDESCENT) RATING, 3-POLE, WITH 120V. COIL. ELECTRICALLY HELD. TO BE G.E. 16015T02AA OR APPROVED EQUAL.
1	EACH	DPDT ENCLOSED SWITCH
1	EACH	WEATHER-PROOF ENCLOSURE
10	EACH	180° RED NAVIGATION LIGHTS - ADAMS & WESTLAKE NO. 1331 OR APPROVED EQUAL
6	EACH	360° GREEN NAVIGATION LIGHTS - ADAMS & WESTLAKE NO. 1331 OR APPROVED EQUAL
6	EACH	180° WHITE NAVIGATION LIGHTS - ADAMS & WESTLAKE NO. 1331 OR APPROVED EQUAL
1	EACH	3/8" x 8' COPPERWELD GROUND ROD WITH CLAMPS & GROUND WIRE AS REQUIRED
1	EACH	120/240 VOLT SECONDARY LIGHTNING ARRESTER - TO BE JOSLYN J9200-1 OR APPROVED EQUAL
1	EACH	REMOVAL OF EQUIPMENT
40	EACH	JUNCTION BOX (16"x6"x6")
5	EACH	20 AMP MAGNATIC CIRCUIT BREAKER, G.E. TYPE TED 113020 WL OR APPROVE EQUAL.

ALL THE ABOVE ITEMS SHALL BE FURNISHED AND INSTALLED BY THE CONTRACTOR.

BID ITEM NOTES

CONTROL CENTER, FURNISHED AND INSTALLED SHALL INCLUDE INSTALLATION OF WEATHER-PROOF ENCLOSURE INCLUDING 100 AMP. AND 20 AMP MAGNETIC CIRCUIT BREAKERS, PHOTOELECTRIC CONTROL MAGNETIC CONTACTOR, DPDT ENCLOSED SWITCH, CONDUITS, AND NECESSARY WIRING. TO PROVIDE ELECTRIC SERVICE AND THE WIRING OF THE NEW NAVIGATION LIGHTS.
THIS ITEM SHALL ALSO INCLUDE FURNISHING AND INSTALLING A GROUND ROD. PROVIDING ELECTRIC SERVICE SHALL INCLUDE FURNISHING AND INSTALLING METERING EQUIPMENT AND NECESSARY CONDUITS. ALSO TO INCLUDE FURNISHING AND INSTALLING SECONDARY LIGHTNING ARRESTER, AND BRANCH CIRCUIT BREAKERS.

* EACH FIXTURE SHALL BE PROVIDED VENTILATION FROM BOTH ENDS OF FIXTURE, AND ALL OPENINGS SHALL BE SCREENED.

35' CLASS 4 WOOD POLE FURNISHED AND INSTALLED, SHALL INCLUDE FURNISHING AND INSTALLING POLE INCLUDING NECESSARY EXCAVATION, BACKFILLING, AND RESTORATION OF DISTURBED AREAS.

CONDUIT, FURNISHED AND INSTALLED, SHALL INCLUDE FURNISHING AND INSTALLING CONDUIT, LIQUID TIGHT FLEXIBLE CONDUIT, FITTINGS, AND EXPANSION JOINTS WITH BONDING STRAP. THIS DOES NOT INCLUDE CONDUITS ASSOCIATED WITH CONTROL CENTER

WIRE, FURNISHED AND INSTALLED, SHALL INCLUDE FURNISHING AND INSTALLING SPECIFIED CONDUCTORS WITHIN CONDUIT AS INDICATED ON DRAWINGS.

NAVIGATION LIGHTS, FURNISHED AND INSTALLED, SHALL INCLUDE FURNISHING SPECIFIED NAVIGATION LIGHTS, FABRICATION, INSTALLATION AND CONNECTION TO CONTROL CENTER. THIS ITEM SHALL INCLUDE FURNISHING AND INSTALLING PROPER LAMPS, MOUNTING BRACKETS, CONDUIT FITTINGS, PIPE NIPPLES, AND ALL NECESSARY HARDWARE

REMOVAL OF EQUIPMENT SHALL INCLUDE THE REMOVAL OF ALL EXISTING EQUIPMENT NOT TO BE RE-USED. REMOVED NAVIGATION LIGHTS SHALL BE RETURNED TO THE BUREAU OF HIGHWAYS. ALL OTHER EQUIPMENT SHALL BE DISPOSED OF BY THE CONTRACTOR OFF THE PROJECT.

JUNCTION BOX (16"x6"x6") FURNISHED AND INSTALLED, SHALL INCLUDE FURNISHING AND INSTALLING SPECIFIED JUNCTION BOX.

Sheet 48

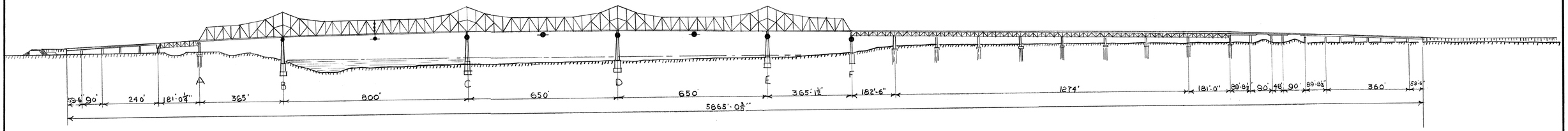
BALLARD CO.
WICKLIFFE - CAIRO ILL.

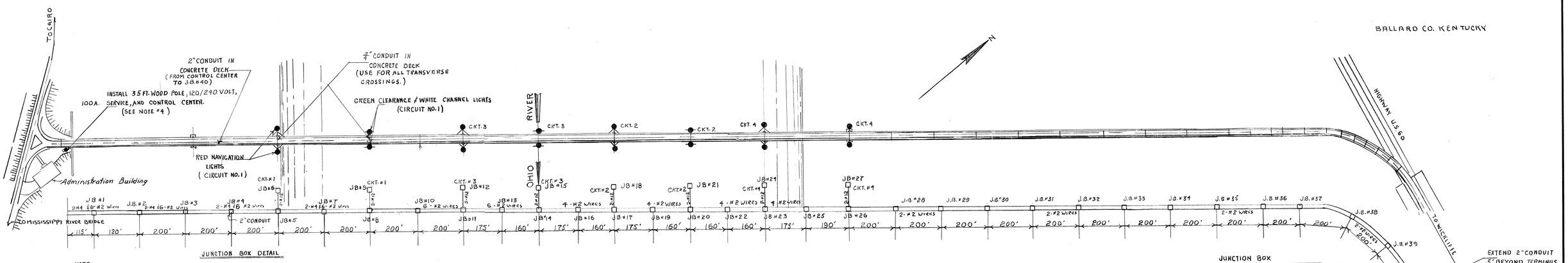
Repairs to Bridge over Ohio River

Drawing No. 19382

DIETZGEN 7-13-73 FORM NO. 2

COUNTY OF	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
BALLARD		49	





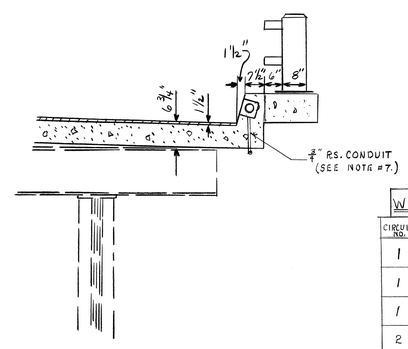
NOTE:
DISTANCES ARE APPROXIMATE - NONE TO EXCEED 220 FEET.

ADDED NOTES:

1. JUNCTION BOXES TO BE CAST IRON, HOT-DIPPED GALVANIZED FINISH, INSIDE FLANGE, WITH RECESS COVER FURNISHED WITH GASKET AND BRASS SCREWS. (O.Z. TYPE "YU" OR APPROVED EQUAL)
2. EXPANSION FITTING TO PERMIT A 12" CONDUIT MOVEMENT TO BE INSTALLED AT EACH EXPANSION JOINT. EXPANSION FITTING TO BE EQUIPPED WITH BONDING JUMPER. (O.Z. TYPE "EX" OR APPROVED EQUAL)
3. THE LIGHTING CONTRACTOR SHALL BE RESPONSIBLE FOR COORDINATION WITH GENERAL CONTRACTOR FOR THE PLACEMENT OF CONDUIT, JUNCTION BOXES, AND EXPANSION FITTINGS IN CONCRETE DECK.
4. POLE SITE TO BE LOCATED FOR LIGHTING CONTRACTOR BY RESIDENT ENGINEER.
5. LIGHTING CONTRACTOR SHALL ASSUME RESPONSIBILITY FOR MAINTENANCE, AND DISPLAY OF THE NECESSARY NAVIGATION LIGHTS UPON AWARD OF CONTRACT, AND SHALL REMAIN SO UNTIL FINAL ACCEPTANCE BY THE KENTUCKY DEPARTMENT OF TRANSPORTATION.
6. CONTRACTOR SHALL REMOVE ALL EQUIPMENT (FIXTURES, MOUNTING BRACKETS, WIRING, STRAPS, ETC.) NOT TO BE RE-USED FROM BRIDGE STRUCTURE AND PIERS.
7. EACH JUNCTION BOX SHALL BE PROVIDED WITH A ¾" CONDUIT EXTENDING THROUGH BOTTOM OF BRIDGE DECK A MINIMUM OF 3", AND A MAXIMUM OF 5". EXPOSED END OF EACH CONDUIT SHALL BE THREADED WITH STANDARD CONDUIT THREAD.

LEGEND

- 180° WHITE CHANNEL MARKER NAVIGATION LIGHT
- 180° RED NAVIGATION LIGHT
- 360° GREEN NAVIGATION LIGHT
- 16"X6"X6" JUNCTION BOX



WIRE SCHEDULE

CIRCUIT NO.	FROM	TO J.B. NO.	WIRE SIZE (AWG)
1	CC	5 & 8	#4
1	J.B.#5	6	#12
1	J.B.#8	9	#12
2	CC	17 & 20	#2
2	J.B.#17	18	#12
2	J.B.#20	21	#12
3	CC	11 & 14	#2
3	J.B.#11	12	#12
3	J.B.#14	15	#12
4	CC	23 & 26	#2
4	J.B.#23	24	#12
4	J.B.#26	27	#12
5	CC	40 (TAPE)	#2

Sheet 49

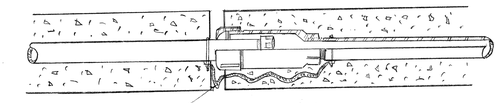
BALLARD CO.
OHIO RIVER BRIDGE
WICKLIFFE KY. — CAIRO ILL.

NO SCALE JRC

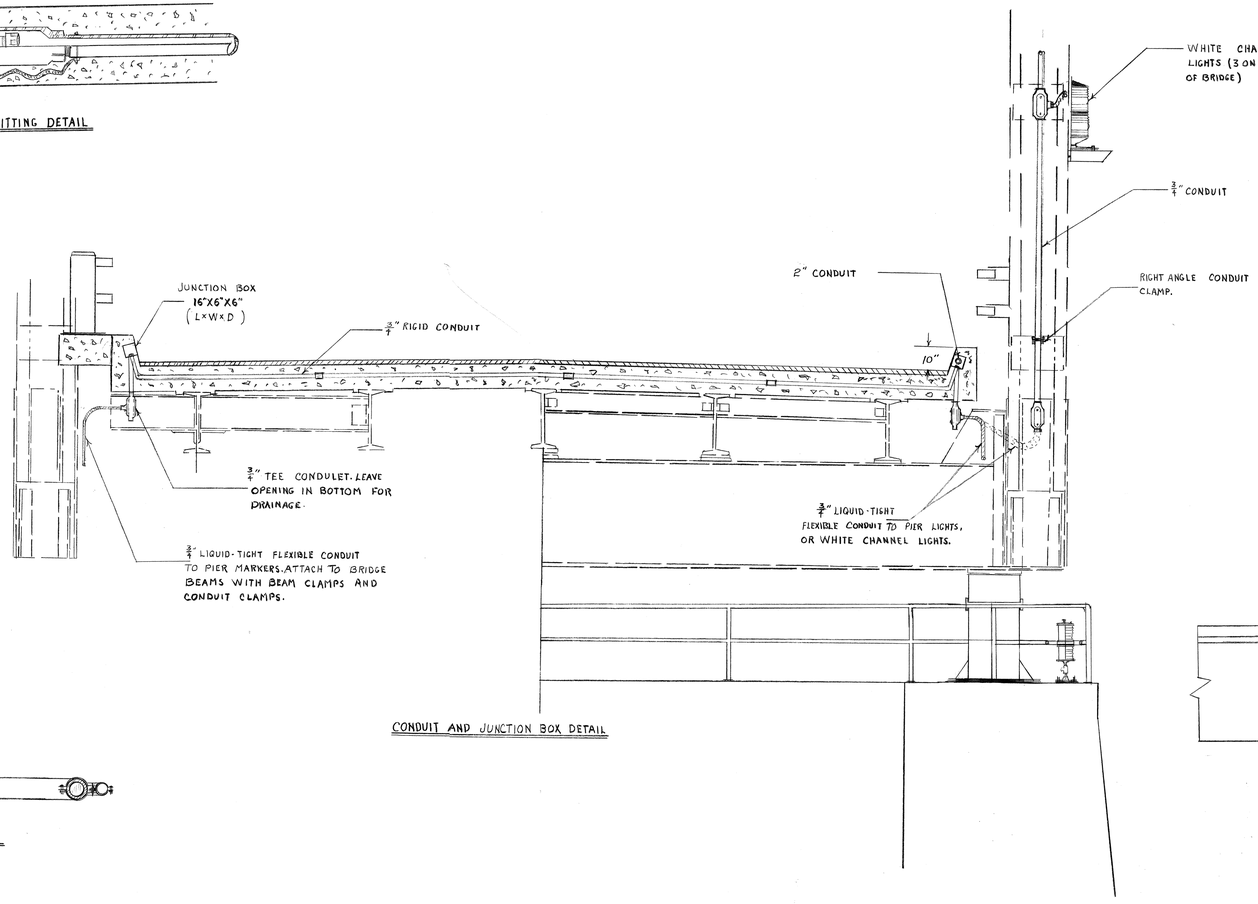
Drawing No. 19382

DIETZGEN 7-13-73 FORM NO. 2

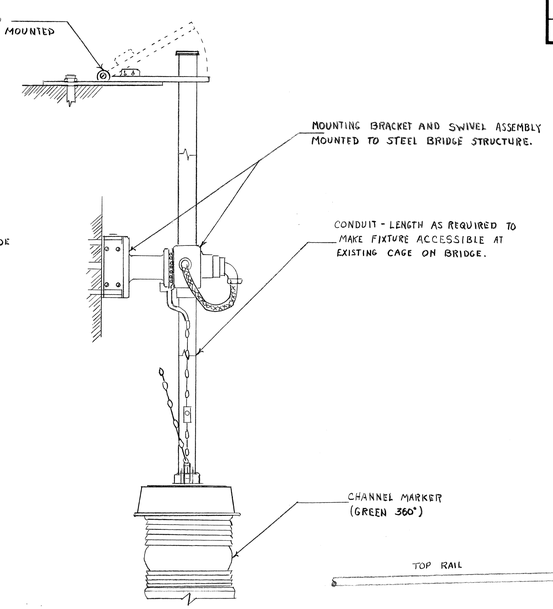
COUNTY OF	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
BALLARD		50	



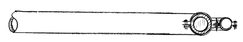
EXPANSION FITTING DETAIL



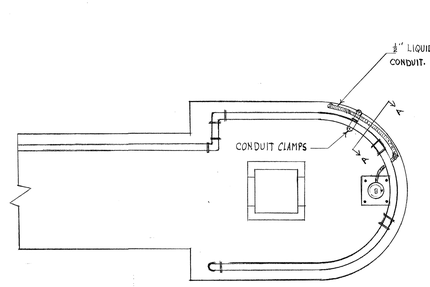
CONDUIT AND JUNCTION BOX DETAIL

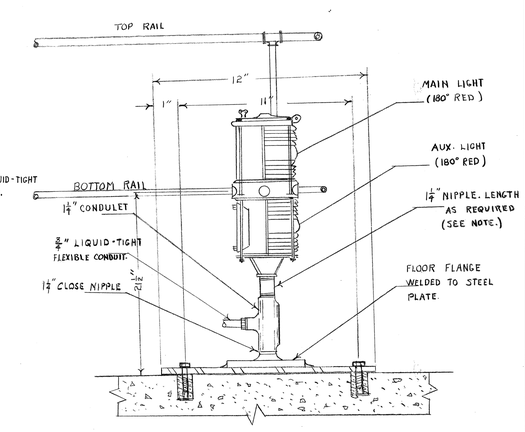


TYPICAL CHANNEL MARKER INSTALLATION



SECTION A-A

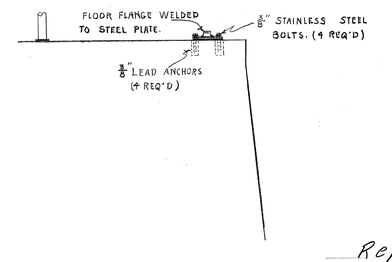




NOTE:
POSITION FIXTURE SO THAT BREAK BETWEEN LENS IS ON LEVEL WITH BOTTOM HORIZONTAL RAIL.

TYPICAL PIER MARKER INSTALLATION

BEAM AND CONDUIT CLAMP DETAIL



PIER MARKER DETAIL

NOTE:
ALL WELDS TO BE 1/4" CONTINUOUS FIELD FILLET WELDS.

Sheet 50

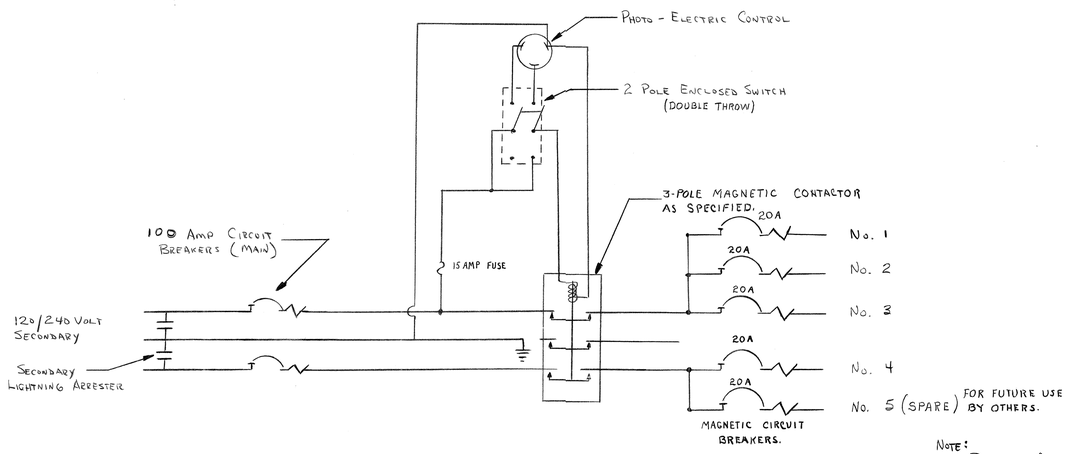
BALLARD CO.
WICKLIFFE - CAIRO ILL.

Repairs to Bridge over Ohio River

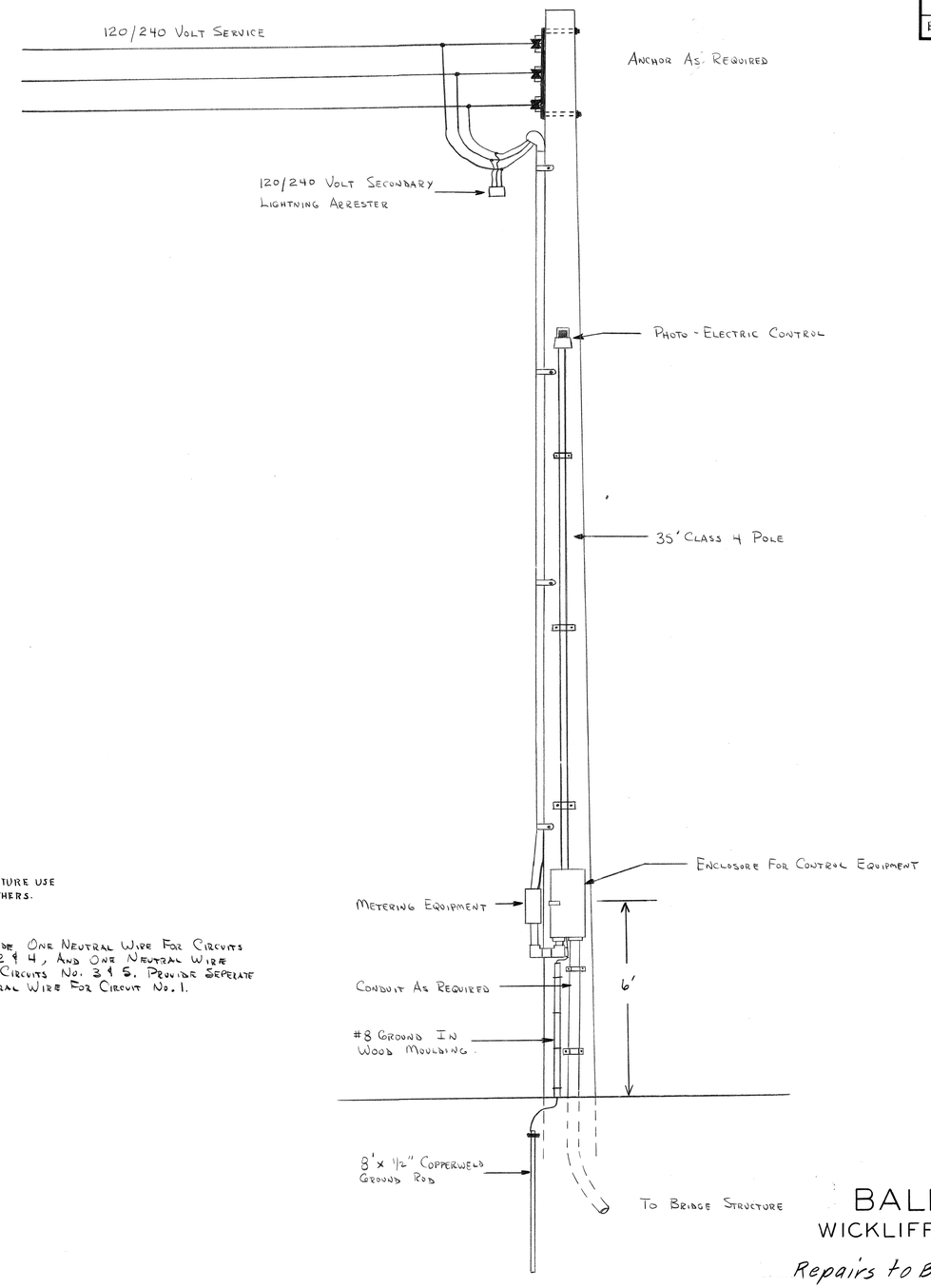
Drawing No. 19382

DIETZGEN 7-13-73 FORM NO. 2

COUNTY OF	FISCAL YEAR	SHEET NO.	TOTAL SHEETS
BALLARD		51	



Note:
Provide One Neutral Wire For Circuits No. 2 & 4, And One Neutral Wire For Circuits No. 3 & 5. Provide Seperate Neutral Wire For Circuit No. 1.



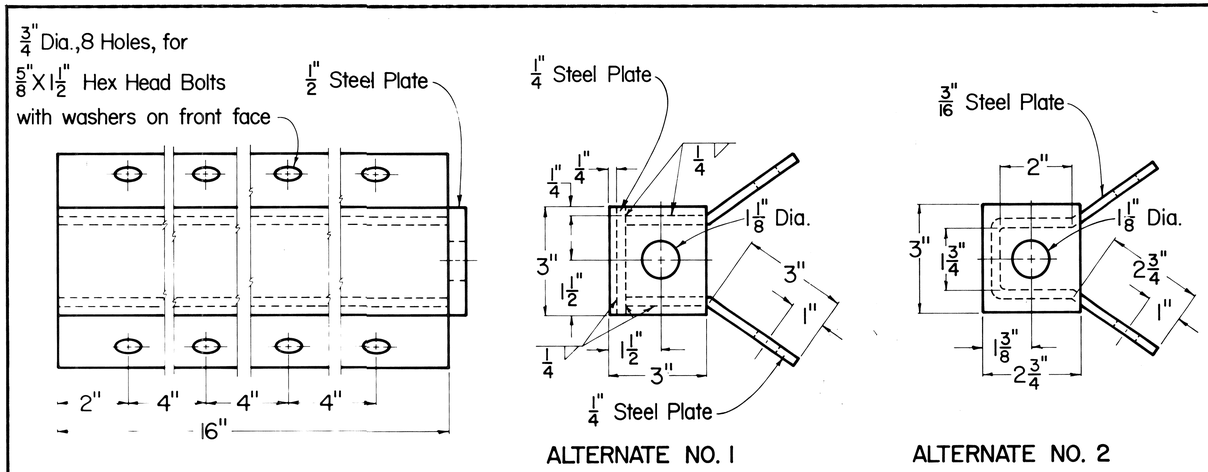
Sheet 51

BALLARD CO
WICKLIFFE - CAIRO ILL.

Repairs to Bridge over Ohio River

Drawing No. 19382

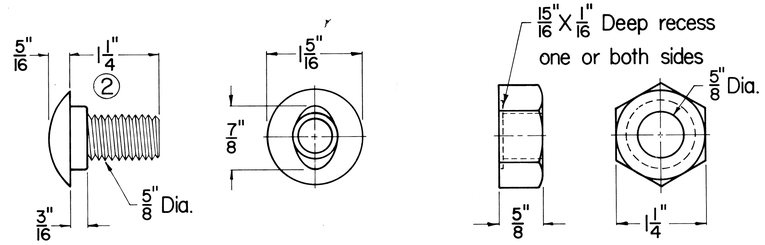
DIETZGEN 7-13-73 FORM NO. 2



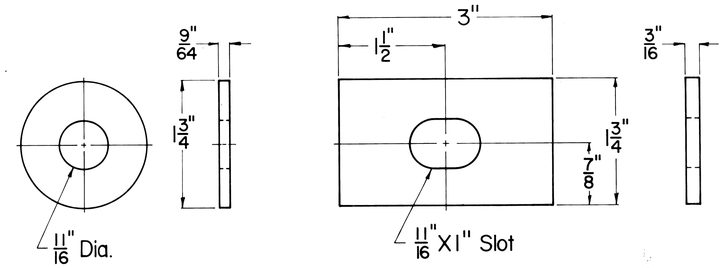
ALTERNATE NO. 1

ALTERNATE NO. 2

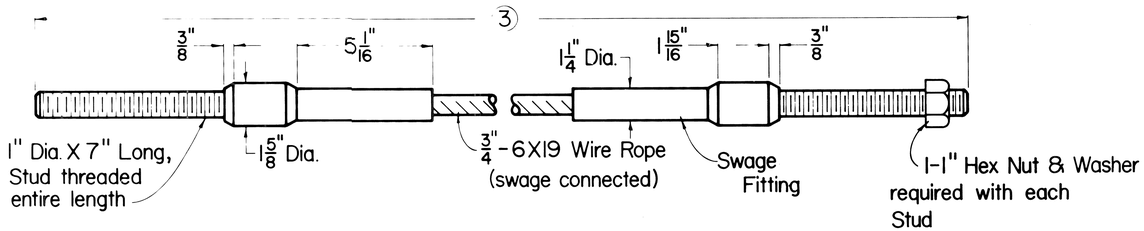
· RAIL ANCHOR ASSEMBLY ·



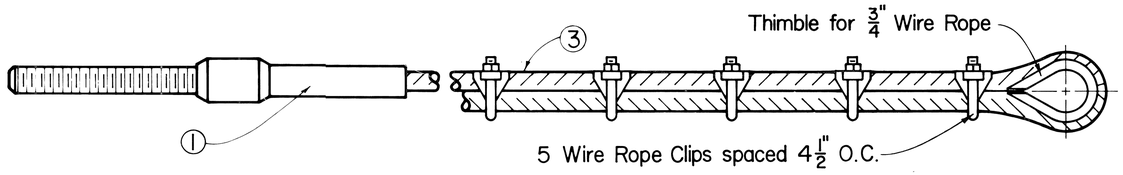
· BUTTON HEAD BOLT AND RECESS NUT ·



· ROUND WASHER AND RECTANGULAR PLATE WASHER ·



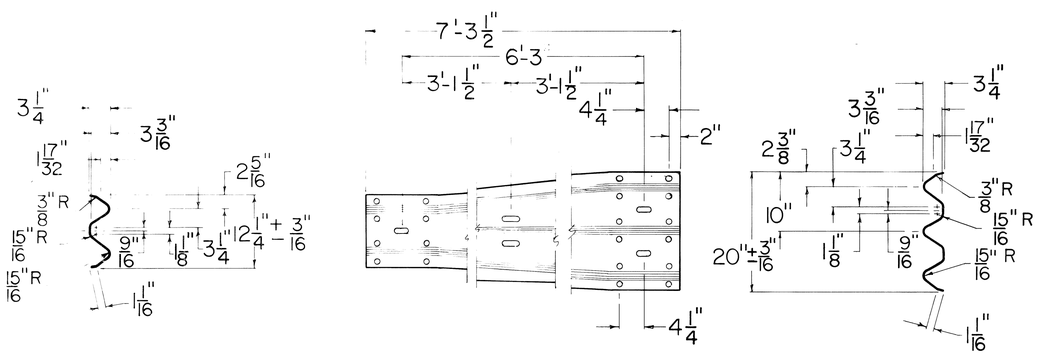
· CABLE ASSEMBLY TYPE 1 ·



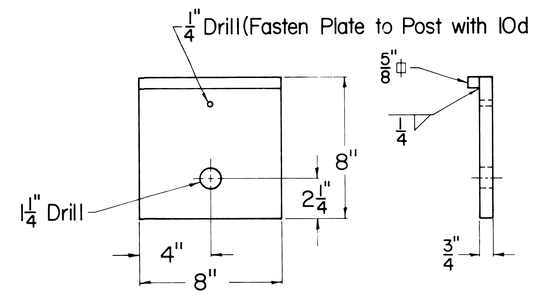
· CABLE ASSEMBLY TYPE 3 ·

· NOTES ·

1. Dimensions for Stud, Swage Fitting, and Wire Rope are the same as shown for Cable Assembly Type 1.
2. Rail Bolt similar except length
3. Approx. Overall Lengths:
   a. Cable Assembly Type 1
      1. End Treatment Type 4 - 6'-6"
      2. End Treatment Type 6 - 10'-6"
   b. Cable Assembly Type 3
      1. End Treatment Type 2A
4. The Thrie Beam to "W" Beam Connector shall comply with AASHTO M-180 Class A, Type 2 except where in conflict with this detail.



· THRIE BEAM TO "W" BEAM CONNECTOR · 4



· STEEL BEARING PLATE ·

SHEET 52

Drawing No. 19382

Repairs to Cairo Bridge Over Ohio River

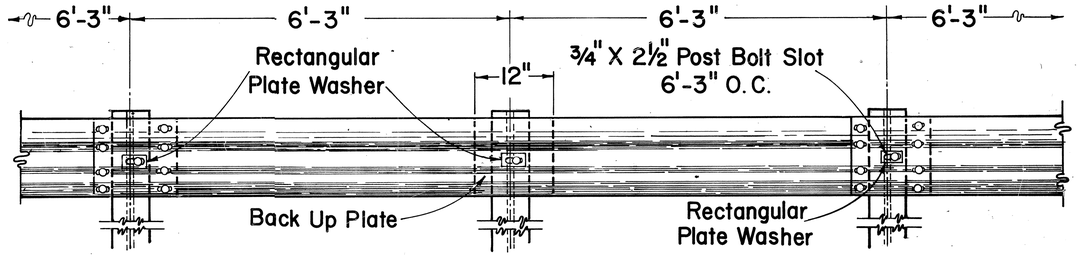
KENTUCKY
BUREAU OF HIGHWAYS

GUARDRAIL
COMPONENTS

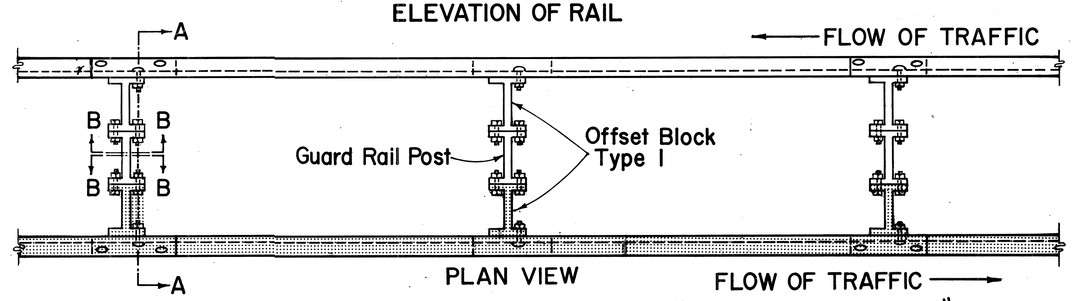
STANDARD DRAWING No.

SUBMITTED Asst. E. B. Drake DIRECTOR DIVISION OF DESIGN 12-2-76 DATE

APPROVED STATE HIGHWAY ENGINEER DATE

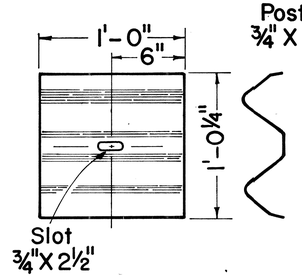


ELEVATION OF RAIL

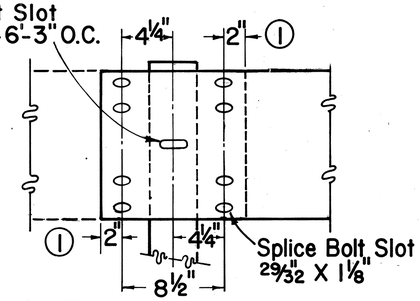


PLAN VIEW

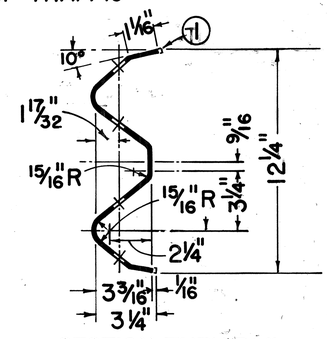
· DOUBLE FACE RAIL OR SINGLE FACE RAIL ·



BACK UP PLATE



② RAIL SPLICE



SECTION THRU RAIL CORRUGATED SHEET STEEL BEAM

NOTES

STEEL BEAM GUARD RAIL

The contract unit price bid shall be :

Steel "W" Beam Guard Rail (Single Face)

Or

Steel "W" Beam Guard Rail (Double Face)

Dimensional tolerances not shown or implied are intended to be those consistent with the proper functioning of the part, including its appearance and accepted manufacturing practices.

The rail element shall comply with AASHTO M-180-Class A, Type 2.

Connect Offset Block Type I to Steel and Concrete Post with two diagonally located bolts.

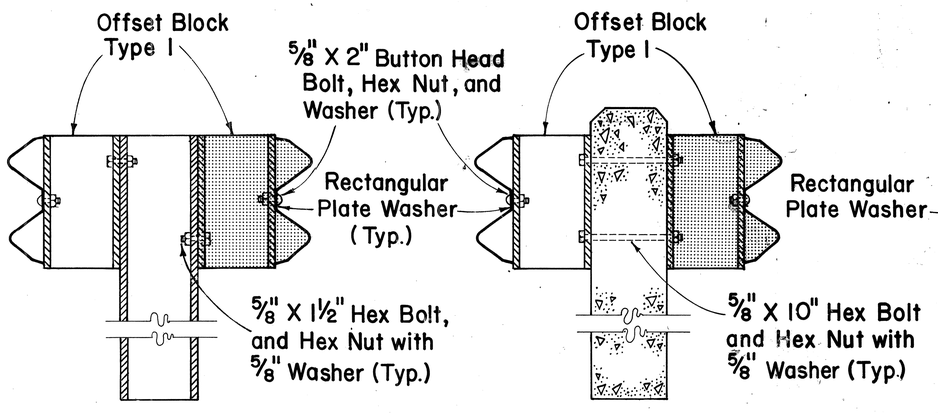
All laps shall be in the direction of traffic flow.

① Tolerance $+ 1\frac{1}{4}" - \frac{1}{4}"$

② $8\text{-}\frac{5}{8}" \times 1\frac{1}{4}"$ Button Head Bolts and Nuts

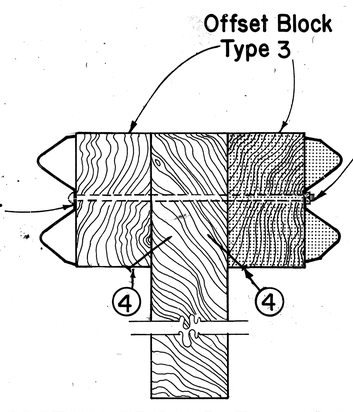
③ Length equals Post and Block width plus :
$2\frac{1}{4}"$ for Threaded Rod.
2" for Bolt.

④ Galvanized Steel 10d Common Coated Nail (Drive nail at center of Block and Post after Post Bolt is installed.)



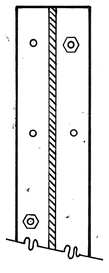
SECTION A-A DOUBLE FACE RAIL WITH STEEL POST (W 6 X 8.5)

SECTION OF DOUBLE FACE RAIL WITH CONCRETE POST



SECTION OF DOUBLE FACE RAIL WITH TIMBER POST

$\frac{5}{8}" \times$ ③ Steel Threaded Rod, Nuts and Washers or
$\frac{5}{8}" \times$ ③ Button or Hex Head Bolt Nut and Washer



SECTION B-B

Required for Double Rail

SHEET 53

Drawing No. 19382

Repairs To Cairo Bridge Over Ohio River

KENTUCKY
BUREAU OF HIGHWAYS

STEEL BEAM GUARD RAIL ("W" BEAM)

STANDARD DRAWING No.

SUBMITTED E.B. Drake DIRECTOR DIVISION OF DESIGN — DATE 2/14/77

APPROVED STATE HIGHWAY ENGINEER — DATE

DRAWN R.W.R. CHECKED S.C.M. E.B.D. RECOMMENDED APPROVED FHWA

DATE 11-1-75

REVISED 2-10-77

Appendix B

Geotechnical White Paper

White Paper Geotechnical Study

US 51 Ohio River Bridge Scoping Study
Wickliffe, Ballard County, KY

March 18, 2013

Terracon Project Number: N1135002

Prepared for:

CDM Smith
Lexington, KY

Prepared by:

Terracon Consultants
Cincinnati, Ohio

Offices Nationwide
Employee-Owned
Established in 1965
terracon.com

Terracon

Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

March 18, 2013

CDM Smith
1648 McGrathiana Parkway Suite 340
Lexington, KY 40511

Attn: Samantha Jones Wright, PE
Project Manager
P: [859] 254-5759 ext. 109
C: [859] 333-0138
F: [859] 254-576
E: wrightsj@cdmsmith.com

Re: White Paper Geotechnical Study
US 51 Ohio River Bridge Scoping Study
Wickliffe, Ballard County, KY
Terracon Project Number: N1135002

Dear Ms. Wright:

Terracon Consultants, Inc (Terracon) has completed the white paper geotechnical study for the US 51 Ohio River Bridge Scoping Study. This study was performed in general accordance with the agreement dated December 18, 2012. This report presents the findings from screening existing archive boring logs, geological survey maps and geological survey publications. Recommendations for a geotechnical subsurface investigation are also provided.

Sincerely,
Terracon Consultants, Inc.

Nancy Dendramis, E.I.T
Staff Geotechnical Engineer

RadhaKrishna M. Daita, P.E.
Project Geotechnical Engineer

Ronald J. Ebelhar, P.E.
Senior Principal

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APPENDIX A - SITE MAPS, GEOLOGY QUDRANGLES, CONSTRUCTION PLANS

Exhibit A-1 Site Location Map
Exhibit A-2 Site Topographic Map (West)
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Exhibit A-4 Geologic Quadrangles
Exhibit A-5 1936 Bridge Plan Drawings

APPENDIX B - BORING LOCATION MAP, ARCHIVE BORINGS, SUMMARY TABLE

Exhibit B-1 Historical Subsurface Study & Well Vicinity Map
Exhibit B-2 Handwritten Logs from 1997 Inspection Report
Exhibit B-3 Cairo Bridge Commission Survey and Boring Data
Exhibit B-4 to B-7 IDOT Logs interactive ISGS Database
Exhibit B-8 USACE Boring Summary Table

APPENDIX C – GEOLOGIC FAULT MAP, SEISMIC STUDY RESULTS

Exhibit C-1 Geologic Fault Map
Exhibit C-2 Seismic Study Results

APPENDIX D – LEVEE WALL, WETLAND AND KARST POTENTIAL MAPS

Exhibit D-1	USACE Levee Wall Location Map
Exhibit D-2	KGS Generalized Land Use Map with Wetland Location
Exhibit D-3	KGS Known Karst Risk Potential

EXECUTIVE SUMMARY

A white paper geotechnical study has been performed as part of a comprehensive US 51 Bridge Scoping Study. The existing bridge is under consideration for remediation and/or reconstruction. Preliminary geotechnical data has been assembled for the bridge study; findings and considerations are as follows:

- The US 51 Bridge conveys traffic over the Ohio River between Wickliffe, Ballard County, Kentucky and Cairo, Alexander County, Illinois. The topography both east and west of the River is generally level with ground elevations ranging between 310 and 315 feet.
- The site is located within the Mississippi (Gulf) Embayment physiographic region with typically thick layers of granular and cohesive deposits with deep bedrock. The study site subsurface stratigraphy has been extrapolated from surficial and bedrock geologic quadrangle maps and other documentation published by USGS, KGS and ISGS.
- Archive records from subsurface investigations near the project site were found from a variety of sources including an old bridge inspection report, quadrangle maps (USGS and ISGS), and ISGS and KGS archive databases for borings performed in Alexander County, IL and Ballard County, KY respectively. Approximate locations for borings with available records are shown in the Historical Subsurface Study and Well Vicinity Map.
- Based on the original 1936 bridge construction drawings of the bridge provided by Modjeski and Masters and by Baker, the bridge has 31 interior piers and two abutments. With the exception of the piers in the channel, the interior piers and both abutments are supported by pile caps on driven reinforced concrete piles. The construction drawing dimensions and soil stratigraphic profiles interpolated from archive records indicate that the piles extend into inter-layered granular and cohesive overburden. The interior piers within the channel are supported on caisson foundations embedded and bearing in alluvial soils.
- Data to adequately represent existing soil and bedrock conditions and to furnish information for engineering recommendations were not found for the subject site during this white paper geotechnical study. It is recommended that new soil test borings (SPT and CPT soundings) be performed per the KYTC Geotechnical Manual specifications.
- Based on Missouri Department of Natural Resources maps and USGS publications, the project footprint is not located above any known geologic faults; however the site is within the potentially active New Madrid seismic zone. A preliminary seismic analysis has been performed for the scoping study.
- Based on USACE records, the average Ohio River pool stage elevation is at 297 feet and the 50-year flood stage is 329 feet. Surrounding ground surface elevations are between 310 and 315 feet. Historically, the site has experienced local and regional flooding. With the exception of the 4 interior piers in the channel, the interior piers of the existing bridge are within flood plains east and west of the Ohio River.

- Other local geotechnical hazards including karst, landslide potential and mining activity were evaluated. Based on topographical maps and other published data for KGS, ISGS, and USGS, the project site does not contain any known karst hazard. Due to the generally level ground surface topography, landslide risk is expected to be low. Geomorphic evidence of surficial movement could be obtained by on-site field inspection. Mining history investigations for Alexander County, IL and Ballard County, KY have produced no evidence of current mining activity or evidence of abandoned mines at or near the project site.

File and archive data are the primary focus of this report and are for screening purposes only. Present and historical observations at the site may not reflect long-term conditions. This summary should be used in conjunction with the entire report. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the items contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report limitations.

US 51 OHIO RIVER BRIDGE SCOPING STUDY
WICKLIFFE, BALLARD COUNTY, KENTUCKY

Terracon Project No. N1135002

March 18, 2013

1.0 INTRODUCTION

The purpose of this project (KYTC 6YP Numbers 1-100.00 and 1-1140.0) is to study the salient aspects for the replacement or rehabilitation of the US 51 Bridge between Cairo, Alexander County, Illinois and Wickliffe, Ballard County, Kentucky.

A project team under CDM Smith, Inc. has been assembled to provide a scoping study report for the existing 75-year old Composite Span Bridge (004B00021N) with provision for a safe, reliable roadway giving due consideration to future transportation needs and appropriate corridor alternatives. The project team with their respective disciplines includes the following:

CDM Smith, Inc.	Planning/Environmental
Michael Baker Jr, Inc.	Bridges
Palmer Engineers	Roadway
Third Rock	Environmental Overview
EHI Consultants	Environmental Justice and DBE Coordinator
Terracon Consultants	Geotechnical Engineering
Daryl Armstrong	Media Relations and Public Involvement
Tim Hagerty	NEPA Legal Sufficiency

2.0 PROJECT DESCRIPTION

2.1 Project Location

The project site consists of the US 51 Bridge over the Ohio River just upstream from the confluence between the Ohio River and the Mississippi River in Ballard County, Kentucky and Alexander County, Illinois (see Exhibit A-1, Appendix A).

2.2 Purpose

The purpose of the geotechnical white paper study for the US 51 bridge replacement/rehabilitation was to review available geologic information and archive data to conceptually characterize the subsurface conditions and summarize the geotechnical considerations within the proposed study area. This report summarizes our findings and provides an overview of the general geotechnical findings relevant to the bridge replacement/rehabilitation.

2.3 Bridge Historical Background and Recent Inspection

The existing US 51 Bridge consists of a two-lane, composite span, cantilevered Warren-type through-truss bridge completed in 1936 to span the Ohio River and connect Ballard County, Kentucky with Alexander County, Illinois (see bridge plans Exhibit A-4, Appendix A). The existing steel truss bridge on 31 reinforced concrete interior piers and abutments was designed by Modjeski, Masters, & Case Engineers and constructed by the Mt. Vernon Bridge Company with oversight from the Cairo Bridge Commission in conjunction with the Federal Emergency Administration of Public Works and the respective highway departments of Illinois and Kentucky. The bridge was opened to vehicle traffic on November 11, 1936.

The bridge was rehabilitated in 1979 and has undergone regular safety inspections. The most recent inspection revealed that the existing bridge is rated functionally obsolete with a sufficiency rating of 35.4. The structure width is narrow at 22.6 feet curb to curb with an approaching roadway width of 24 feet including shoulders. The deck geometry and approach alignment are “intolerable.” Presently the bridge carries more than 5,000 vehicles daily from US 51, US 60, and US 62 connecting the US 60/US 62 Mississippi River Bridge to Bird’s Point, Missouri at the southern tip of Illinois.

3.0 GEOTECHNICAL DATA SUMMARY

Given the findings from the recent inspection concluding that the US 51 bridge is in need of replacement or rehabilitation, a white paper geotechnical study was begun in order to conceptually characterize the subsurface conditions and summarize the geotechnical considerations within the proposed study area. The geotechnical study summary included in this report is based on available United States Geological Society (USGS), Kentucky Geological Society (KGS), and Illinois State Geological Society (ISGS) topographic maps, surficial geologic maps, bedrock geologic maps, archive boring logs, boring log summaries, and other published data.

The study site (Exhibit A-1 in Appendix A) for this report is focused on the area along US 51 at the roadway, abutments and interior spans of the US 51 Bridge. The existing topography east and west of the existing bridge is mostly level flood plain with ground surface elevations between 310 feet and 315 feet. The surficial soils within the study area consist of Holocene alluvial silt and sand (see Exhibits A-2, A-3, and A-4 in Appendix A). Based on US Army Corp of Engineers (USACE) records, the pool stage of the Ohio River at the US 51 bridge is 295 feet elevation and the 50-year flood stage is at Elevation 329.0 feet.

3.1 Geologic History

The existing US 51 bridge is near the northern end of the Mississippian (Gulf) Embayment, a physiographic feature of the South Central United States. Sedimentation from the Cretaceous to present has filled the continental rift generating significant water-bearing layers in between occluding layers within the Mississippi Valley (USGS publications). A broad, generalized cross section diagram of the Mississippi Embayment Aquifer illustrating the sedimentary deposits at the southern end of the present day Embayment stratigraphy is shown below.

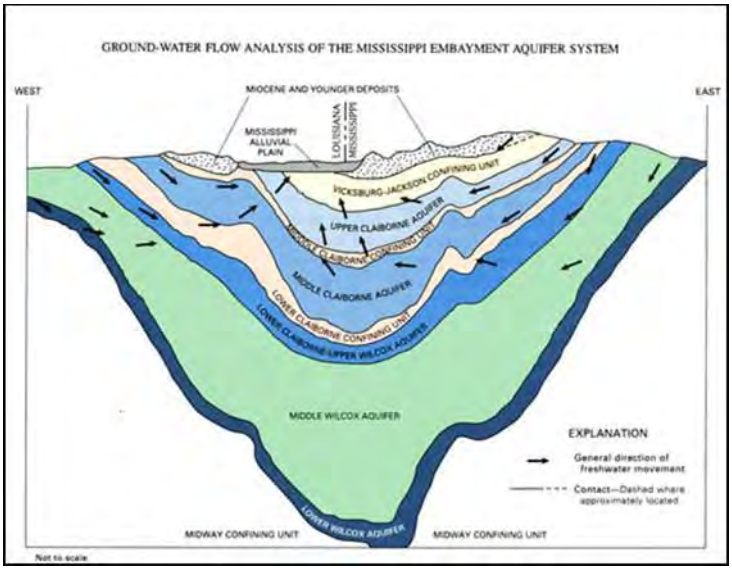


Figure 1. Mississippi Embayment Stratigraphy

3.2 Regional Geologic Formation Descriptions

Generalized stratigraphic layers expected at the subject site are listed in the table at the end of this section and summarized in the text below. These layers are based primarily on the subsurface data provided on the ISGS Cairo/Wyatt geology quadrangle map.

The west bank of the Ohio River upstream of the bridge location (see ISGS Cairo Quadrangle Map, Appendix A) contains surface layers of unconsolidated Holocene layers defined as the *Cahokia Formation ($Qc_{(C)}$)*. Historic meandering of the Mississippi and Ohio Rivers has generated these layers and sand bars which are overlain by a flood veneer of silt and silty clay. The thickness of these layers varies widely due to erosion and flooding. (See figure below). Varying thicknesses of quaternary deposits (Q_{al}) are present in some locations underlying the Cahokia formation (not shown in the diagram, see table below). These deposits generally include silt (derived mainly from loess) underlain by Metropolis Formation (Q_m) silty sand and sandy silt with chert gravel followed by a layer of angular to rounded chert pebbles up to several inches in diameter.

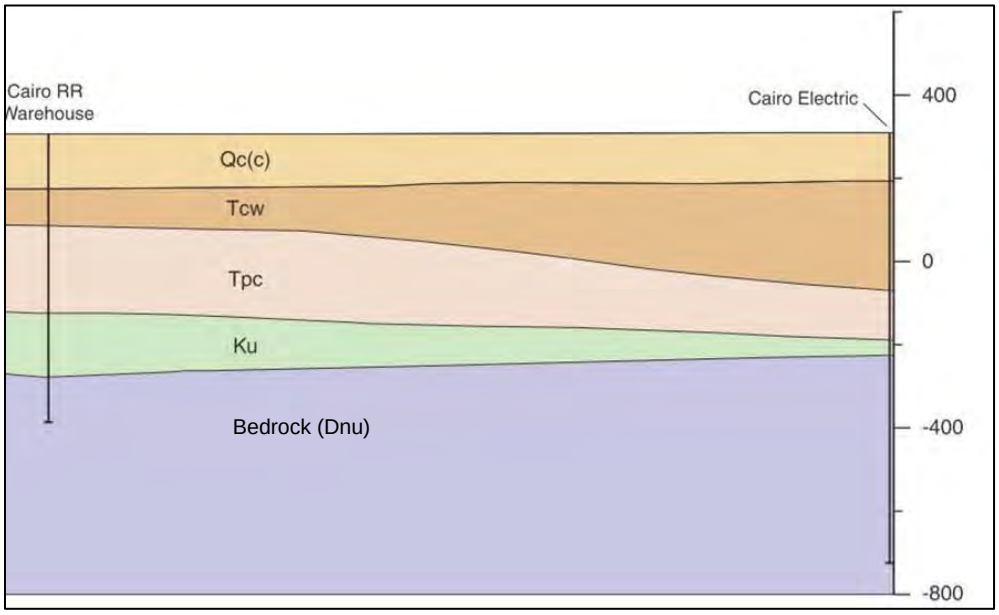


Figure 2. General Stratigraphy North of the Subject Site (Reproduced from ISGS Cairo Geologic Quadrangle)

Below the quaternary surface layers is a geographically-widespread, well-defined thick layer in the Mississippian Embayment, *Claiborne-Wilcox Formation* (T_{cw}), with sand, silt and clay deposits containing well-rounded and polished sand-sized chert particles, mica, and clay balls up to 2" in diameter. The Claiborne-Wilcox is underlain by a stiff, massive clay bed, *Porters Creek Clay Formation* (T_{pc}). The clay mineral is dominantly *montmorillonite*. Four additional unconsolidated layers (K_U) underlie the clay above the bedrock. Top of rock, the *New Harmony Group* (D_{nu}), consists mainly of chert 350 to 650 feet thick above cherty limestone and argillaceous limestone.

Table 1, Regional Geologic Formation Stratigraphy

Stratum	Formation	Approximate thickness[1] (feet)	Material Encountered[2]	
			Illinois (Alexander county)	Kentucky (Ballard county)
Stratum 1	Lower Cahokia Formation ($Qc_{(c)}$)	0-50	clay overlain by a veneer of silt and silty clay flood deposition	Not present
Stratum 2	Quaternary Alluvium (Q_{al})	0-175	Sand, silt and gravel	Sand, silt and gravel
Stratum 3	Peoria Silt, Roxana Silt and Loveland Silt	Thin to not present	Silt derived from loess	

Stratum	Formation	Approximate thickness[1] (feet)	Material Encountered[2]	
			Illinois (Alexander county)	Kentucky (Ballard county)
Stratum 4	Metropolis Formation (Q_m) underlain by Mounds Gravel	Thin to not present	Silty sand and sandy silt with chert pebbles underlain by sub-angular to rounded fine to coarse chert gravel	
Stratum 5	Claiborne-Wilcox Formations (T_{cw})	90-150	Sand, silt and clay with well rounded sand sized chert particles, mica, and clay balls up to 2" in diameter	
Stratum 6	Porters Creek Clay Formation (T_{pc}),	0-50	Clay, dark gray to dark olive gray, predominantly montmorillonite	
Stratum 7a	Clayton Formation & Owl Creek Formation (K_u)	Unknown	Sand and clay	
Stratum 7b	McNairy Formation and Post Creek Formation (K_u)	Unknown	Sand silt and clay underlain by cherty gravel with pyritic sand and clay filling depressions in the bedrock	
Bedrock[3,4]	New Harmony Group (D_{nu})	350-650	Chert grading to cherty limestone and argillaceous limestone.	

[1]Thickness varies with location
[2]Interpolated from Cairo, Barlow, Wyatt, and Wickliffe geologic quadrangles (USGS, ISGS)
[3]Depth to bedrock expected at >200 feet below ground surface at the project site
[4]Lower Devonian to upper Silurian

3.3 Archive Boring Records

Archive records for subsurface investigations performed near the project site were found from multiple sources including archive records provided by Modjeski and Masters Engineering, an old bridge inspection report, quadrangle maps (USGS and ISGS), and ISGS and KGS archive databases. Soil depths and soil descriptions (rock descriptions where encountered in Ballard County wells) are provided below:

1. The 1997 US 51 Bridge Inspection Report contained four handwritten boring logs (Exhibit B-2, Appendix B) included on the original plan and profile page of the 1931 Bridge proposal submitted by Modjeski, Masters & Case Engineers. The borings were noted as "typical" and were performed 3000 feet upstream from the project during the proposal period prior to construction of the original bridge. Soil type and thicknesses were recorded but blow count, density or consistency remarks were not noted. The borings with depths varying between 90 feet and 200 feet deep encountered inter-layered granular and cohesive overburden soils.

2. The archive records provided by Modjeski and Masters Engineering contained 15 logs of borings performed along the US 51 Bridge alignment included on the Cairo Bridge

Commission Ohio River Bridge Survey and Boring Data 1936 Supplemental Drawing No. 1; Modjeski, Masters & Case Engineers (Exhibit B-3, Appendix B). Soil type and thicknesses were recorded but blow count, density or consistency remarks were not noted. The borings encountered inter-layered granular and cohesive overburden soils.

Fourteen of these logs are represented on the USGS Wickliffe Quadrangle map as Cross-Section A-A' (see quadrangle map, Appendix A). The diagram shown below illustrates the soil stratigraphic profile interpolated from borings along the existing bridge alignment. These borings are between 100 feet to 150 feet deep and extend through alluvial deposits (Q_{al}) and all but two terminate in the Caliborne (T_c) Formation. Bedrock was not encountered in these borings.

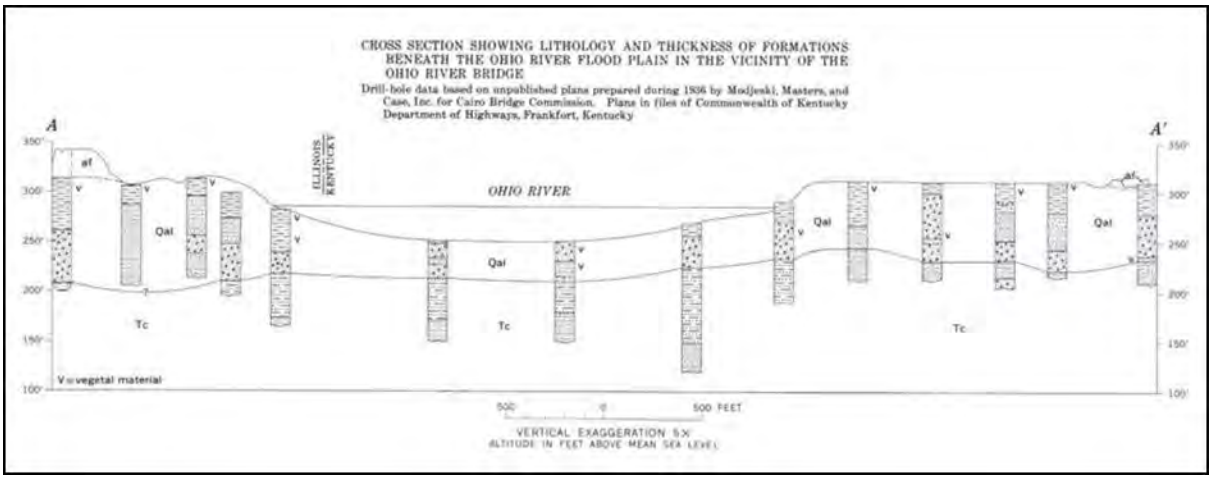


Figure 3. Stratigraphy Profile at US 51 Bridge
(Reproduced from USGS Wickliffe Quadrangle Map)

3. Four archive boring logs contained in the ISGS archive boring log database are from the test borings performed along Interstate 57 in Alexander County, IL between 1965-1969 and in 2000. The site is shown on the Boring Location Plan Map (Exhibit B-1) and the boring logs identified as Exhibits B-4 to B-7 are attached in Appendix B. These borings with depths varying between approximately 65 feet to 152 feet encountered soft to stiff cohesive soil and very loose to very dense granular deposits. Blow count data was not recorded.

4. The KGS Well Sample Database contained six Ballard County, KY archive (1921-1988) boring logs for wells drilled to depths between 1020 feet to 3415 feet. Please refer to the Boring Location Plan (Exhibit B-1) in Appendix B for the general location of these wells. The well logs describe the encountered overburden as inter-layered cohesive and granular. No blow count, density, or consistency data was noted. In five of the borings located north and east of the project site, bedrock was encountered between depths of

340 and 450 feet. The sixth boring located south of the project site encountered bedrock at 1000 feet deep.

5. Fifty-five USACE borings were performed upstream from the study site at the Cairo railroad bridge and at Mound City, IL. The Boring Location Plan Map (Exhibit B-1) in Appendix B shows the general location of these test borings. Boring logs were not available; however, elevation data for the top of Claiborne, Wilcox, and Porters Creek Clay Formations are tabulated on the USGS East Cairo and Barlow Quadrangle map. The tables have been reproduced and are attached in Exhibit B-14 in Appendix B.

3.4 Groundwater

Groundwater is expected to be within the granular layers overlying the Porters Creek Formation and confined to the water-bearing granular layers between well-defined occluding cohesive layers. Groundwater levels are also dependent on seasonal variations and the pool elevation of Ohio River. The region is dotted with wells penetrating the Mississippian Embayment Aquifer for public, domestic, industrial, irrigation, observation, and livestock use.

3.5 Bridge History and Foundations

Based on the original 1936 construction drawings of the bridge provided by Modjeski and Masters and by Baker, there are 31 interior piers and two abutments (Bridge Plans - Exhibit A-4, Appendix A). Interior piers I-5 to I-1 and A, listed from west to east, are on the Illinois side of the river channel. Interior piers B, C, D, and E (west to east) are within the river channel. Interior piers F and K-1 to K-20 are on the Kentucky side of the river channel. With the exception of the piers in the channel, the interior piers and both abutments are supported by pile caps on driven reinforced concrete piles. The interior piers within the channel are supported by caisson foundations bearing in inter-layered granular and cohesive alluvial soils. At some locations, the piles may be tipped into the mostly-granular Claiborne Formation. Relevant dimensions and elevations are contained in the following table.

Table 2. Summary of Existing Bridge Foundation Support Details

Pier ID[1]	Ground Surface Elevation (feet) (Mud Line at B-F)	Elevation at Top of Pile Cap (feet)	Bottom of Caisson Footing Elevation[3]	Embedment Depth (feet)	Pile Length (feet)	Number of Piles[2]	Dimensions
I-5	309.5	306.0		3.5	35.5	17	16” x 16” driven, jetted piles grouped under pile cap
I-4	310.0	306.0		4.0	35.5	21	
I-3	306.4	303.0		3.4	35.5	21	
I-2	314.4	311.0		3.4	35.5	21	
I-1	329.3	309.0			35.5	26	
A	314.0	309.0		5.0	40.5	58	
B	283.8		215.0	68.8			71’ x 33‘ (caisson base)
C	251.2		200.0	51.2			
D	250.8		205.0	45.8			
E	268.8		220.0	48.8			
F	280.0		234.0	46.0			50’ x 20’ (caisson base)
K-1	304.0	298.0		6.0	35.5	38	16” x 16” driven, jetted piles grouped under pile cap
K-2		307.0			35.5	32	
K-3		307.0			35.5	32	
K-4		307.0			35.5	30	
K-5	312.0	307.0			35.5	30	
K-6	312.0	307.0			35.5	28	
K-7	312.0	307.0			35.5	28	
K-8	312.0	307.0			35.5	28	
K-9		298.0			35.5	26	
K-10	312.0	308.0		4.0	35.5	21	
K-11	311.0	308.0		3.0	35.5	21	
K-12	310.0	307.0		3.0	35.5	21	
K-13	310.3	307.0		3.3	35.5	21	

Pier ID[1]	Ground Surface Elevation (feet) (Mud Line at B-F)	Elevation at Top of Pile Cap (feet)	Bottom of Caisson Footing Elevation[3]	Embedment Depth (feet)	Pile Length (feet)	Number of Piles[2]	Dimensions
K-14	308.0	305.0		3.0	35.5	17	
K-15	310.5	307.0		3.5	35.5	17	
K-16	309.7	306.0		3.7	35.5	17	16” x 16” driven, jetted piles grouped under pile cap
K-17	309.5	306.0		3.5	35.5	15	
K-18	305.0	302.0		3.0	35.5	15	
K-19	309.5	306.0		3.5	35.5	14	
K-20	314.5	309.0		5.5	35.5	13	

[1]Piers are listed in order from west to east (Illinois to Kentucky)
[2]See Construction Drawings for Pile Group Layout for Piers I-5 to I-1, Pier A, and Piers K-1 to K-20 (Exhibit A-4, Appendix A)
[3]Bridge Piers B-F are supported on embedded caisson foundations

4.0 POTENTIAL GEOLOGICAL HAZARDS

Various geological conditions were investigated for potential risk to the existing structure and for potential impact on future improvements. These include:

- Seismic risk and known geologic faults
- Flooding, levees and wetlands
- Karst
- Landslide history
- Mining history
- Scour

4.1 Seismic Risk

Based on Missouri Department of Natural Resources maps and USGS publications, the project footprint is not located above any known geologic faults (Exhibit C-1 - KGS Faults Map, Appendix C); however, the existing bridge is at risk for seismic activity due to its location within the New Madrid Seismic Zone.

The following paragraphs summarize relevant information related to the seismic hazard. The selection of the design seismic event will have a significant impact on the seismic loads used for evaluation and design of a renovated or a replacement bridge.

The New Madrid Seismic Zone is a major seismic zone and a prolific source of intraplate earthquakes (earthquakes within a tectonic plate) in the southern and midwestern United States, located near New Madrid, Missouri. The New Madrid fault system was responsible for the 1811–1812 New Madrid earthquakes and may have the potential to produce large earthquakes in the future. Since 1812, frequent smaller earthquakes have been recorded in the area.

Earthquakes that occur in the New Madrid Seismic Zone potentially threaten parts of seven American states: Illinois, Indiana, Missouri, Arkansas, Kentucky, Tennessee and Mississippi.

The 150-mile (240 km) long fault system, which extends into five states, stretches southward from Cairo, Illinois; through Hayti, Caruthersville and New Madrid in Missouri; through Blytheville into Marked Tree in Arkansas. It also covers a part of West Tennessee, near Reelfoot Lake, extending southeast into Dyersburg. Most of the seismicity is located between 3 and 15 miles (4.8 and 24 km) beneath the Earth's surface.

The zone had four of the largest North American earthquakes in recorded history, with moment magnitudes estimated to be as large as 8.0, all occurring within a three-month period between December 1811 and February 1812. Many of the published accounts describe the cumulative effects of all the earthquakes (known as the New Madrid Sequence); thus finding the individual effects of each quake can be difficult. Magnitude estimates and epicenters are based on interpretations of historical accounts and may vary.

The biggest quake since 1811–1812 was a 6.6-magnitude quake on October 31, 1895, with an epicenter at Charleston, Missouri. The quake damaged virtually all buildings in Charleston, creating sand volcanoes by the city, cracked a pier on the Cairo Rail Bridge and toppled chimneys in St. Louis, Missouri, Memphis, Tennessee, Gadsden, Alabama and Evansville, Indiana.

The next biggest quake was a 5.4-magnitude quake (although it was reported as a 5.5 at the time) on November 9, 1968, near Dale, Illinois. The quake damaged the civic building at Henderson, Kentucky and was felt in 23 states. It is the biggest recorded quake with an epicenter in Illinois in that state's recorded history.

Instruments were installed in and around the area in 1974 to closely monitor seismic activity. Since then, more than 4,000 earthquakes have been recorded, most of which were too small to be felt. On average, one earthquake per year is large enough to be felt in the area. A preliminary seismic analysis is included in Appendix C.

The map below shows earthquakes (circles) of the New Madrid and Wabash Valley seismic zones (orange patches). Red circles indicate earthquakes that occurred from 1974 to 2002 with magnitudes larger than 2.5 located using modern instruments (University of Memphis). Green circles denote earthquakes that occurred prior to 1974 (USGS Professional Paper 1527). Larger earthquakes are represented by larger circles.

KTC Research Report KTC-00-1 describes a general assessment of the seismic stability of highway embankments in Kentucky. This included an evaluation of the approach embankments for the subject US 51 Ohio River Bridge. There were no soil borings or engineering data obtained for this study and the same borings identified earlier in our report for the existing bridge were used for this general assessment. This report also describes the alluvial nature of the soil profile, consisting of the interlayered gravel, sand, silt and clay mentioned previously. The report concluded that liquefaction is highly likely in the alluvial soils near the bridge for a 500-year recurrence interval seismic event, resulting in loss of embankment stability and potential loss of abutments and bridge spans. Site-specific geotechnical exploration and testing is required to obtain parameters to further define the expected seismic performance of the soil profiles and their impact on existing or proposed bridges at this location.

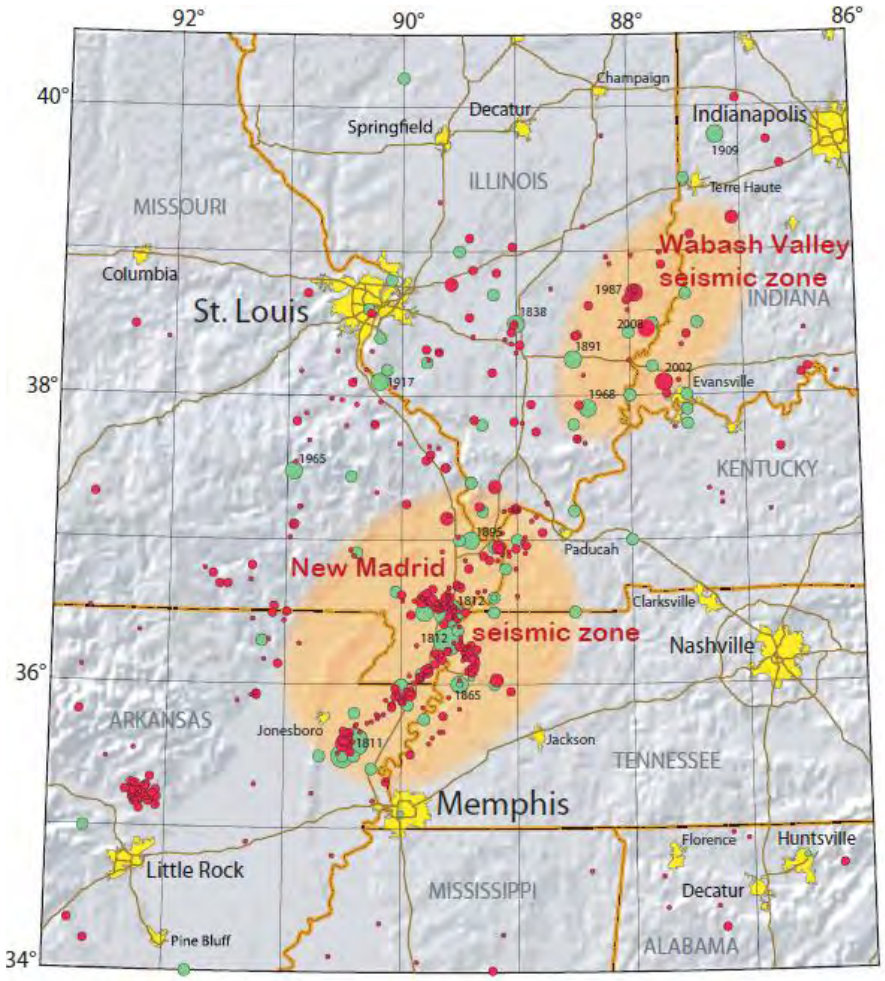


Figure 3. Recent Seismicity on New Madrid Seismic Zone (USGS)

The following tables summarize the findings of our preliminary seismic analysis.

Table 3. Seismic Site Classification

Code or Standard Used	Site Classification
2009 AASHTO [1]	E [2]

1. In general accordance with the 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (seismic design event is 7% probability of exceedance in 75 years (recurrence interval of 1000 years).
2. The 2009 AASHTO Guide requires a site soil profile determination extending a depth of 100 feet for seismic site classification. Borings with engineering data adequate to determine the Site Class have not been performed. Since the possibility exists that soft or loose soils subject to cyclic softening or liquefaction due to seismic loading are present, site specific response analyses are required to fully characterize the ground response and Site Class and to obtain accurate ground motion parameters for design.

Table 4. Preliminary Ground Motion Parameters (USGS Website)

Ground Motion Parameter	Value (g)1,2
A_s	0.956
S_{DS}	1.701
S_{D1}	1.280

1. Latitude 36.993 and Longitude -87.472 degrees, for the assumed Site Class.
2. These parameters are preliminary and should be confirmed by site-specific response analyses

4.2 Other Geological Hazards

Historically, the tri-state region at the confluence of the Ohio River and the Mississippi River has experienced regular local and regional flooding; risk at the existing bridge for both severe and seasonal flooding is high. The channel normal pool stage elevation at Cairo is at 297 feet and natural surrounding ground surface elevations are at 310 to 315 feet. The project site has a tornado risk higher than the national average.

Flood risk has been mitigated locally in Alexander County, IL by the construction of levees to protect the residents of Cairo, IL (see Exhibit D-1, USACE map of levee wall locations, Appendix D). However, the bridge west abutment and interior piers on the Illinois side are outside the area protected by the levee wall.

Natural wetlands at major water ways have been used to allow for relief during seasonal pressure from flooding and are protected against development. In Ballard County along the Ohio River, the Kentucky Department of Fish and Wildlife (KDFW) Service manages over 8,000 acres of natural wetlands which provide both flood protection and wildlife protection (see Exhibit D-2, Wetland Location Map, Appendix D). The bridge east abutment and interior piers on the Kentucky side are within a flood plain and near the KDFW wetland preservation area.

Karst features are the result of limestone bedrock dissolution and are common in central western Kentucky. Based on topographical maps and other published data for KGS, ISGS and USGS, the project site does not contain any known karst hazards (see Exhibit D-3, Karst Risk Potential). A field survey should be performed to confirm absence of karst terrain.

Due to the generally level ground surface topography, landslide risk is expected to be low. Geomorphic evidence of surficial movement should be confirmed by on-site field inspection.

Mining history investigations for Alexander County, IL and Ballard County, KY have produced no evidence of current mine activity or evidence of abandoned mines at or near the project site. Interactive data-based maps show that Ballard County is located outside of the mined areas in Kentucky. Similar results were found for Alexander County. It is recommended that prior to any

subsurface investigation that recent applications for mining permits be investigated for potential activity near the project site.

Scour analysis is outside the scope of our investigation and scour studies for the existing bridge have not been reviewed. We recommend scour analysis as part of a comprehensive program to improve the US 51 bridge foundation performance at interior piers within the channel.

5.0 RECOMMMENDATIONS FOR GEOTECHNICAL STUDY

Data to adequately represent existing soil and bedrock conditions and to furnish information for engineering recommendations were not found for the subject site during this white paper geotechnical study. It is recommended that a subsurface geotechnical investigation be performed per KYTC and IDOT specifications.

5.1 Subsurface Investigation

The overburden investigation should include CPT soundings and SPT borings with split-spoon and Shelby tube sampling at abutments and interior pier locations. A barge-mounted drill rig may be used to access interior pier locations within the channel. Shear wave velocity measurements using applicable downhole tools (downhole seismic or P-S suspension logging) are recommended at representative locations.

Based on our study of the subject site, bedrock is expected to be deep (> 200 feet). We recommend extending at least two test borings into bedrock to determine top-of-rock depths to better define the site geology. Considering the site being within an existing flood zone, challenges in scheduling field exploration and subsequent construction may include planning around seasonal weather changes.

5.2 Laboratory Investigation

Upon completion of the field exploration, the recovered soil samples be visually examined by a geotechnical engineer. In addition, select recovered samples should be tested for index properties including grain-size distribution and Atterberg Limits. Specialized tests such as unconfined strength, triaxial, and consolidation should be performed on Shelby tube samples. Grain-size distribution results will enable future scour analyses and seismic analyses. Resonant column and cyclic simple shear tests on representative samples will be required to obtain accurate site-specific parameters for input into seismic analyses. Per KYTC subsurface investigation specifications, soil testing and Standard Proctor Tests should be performed on bag samples taken from potential borrow pits.

5.3 Engineering Analyses

The data obtained from the recommended subsurface exploration supplemented with the data gathered during this white paper study can be used to develop geotechnical engineering recommendations for proposed bridge rehabilitation/replacement. Engineering analyses to develop bridge foundation recommendations should also include evaluation of axial and lateral capacity of the support members, slope stability at the bridge abutments, abutment retaining wall analyses, settlement and downdrag on support members at bridge abutments, settlement of approach embankment, and seismic studies including site response analyses, liquefaction, seismic settlement and lateral displacement analyses.

6.0 EXISTING BRIDGE INVESTIGATION

The existing bridge, constructed more than 75 years ago, has aging members including the interior piers and their foundations. An investigation should be performed at select interior piers to confirm the structural integrity, composition and state of deterioration in order to predict longevity and to determine factors affecting future performance under expected loads.

6.1 Destructive and Non-destructive Field Testing

It is recommended that coring into pier concrete be performed at select interior pier locations. Multiple holes drilled into the pier concrete at specified depths will allow access for cross-hole sonic testing to better define the structural integrity and composition of the pier. A barge-supported drill rig mobilized to the site for soil test borings will facilitate access to the piers for concrete coring above and below the waterline.

Consideration should be given to certified diving inspectors to perform pier coring and a thorough visual inspection above and below the waterline. Due to the local availability of chert gravel, we expect aggregate composition in the concrete to include a significant portion of chert. The bridge inspection team should be equipped with the experience and proper drilling tools to core through tough chert aggregate.

6.2 Laboratory Testing

The obtained concrete core samples at the interior piers should be examined by petrographic analysis for characterization of the cementation and aggregate composition. Core samples should be examined visually and microscopically per ASTM 856 to determine the present condition of the concrete including the air void ratio, presence of fractures and evidence of decomposition due to chemical reactions. Air voids present in the concrete increase material durability and resistance to degradation due to freeze-thaw cycles.

7.0 GENERAL COMMENTS

The conclusions, analyses and recommendations presented in this report are based upon the available file data obtained from archive boring logs and from other information discussed in this report. File and archive data are the primary focus of this report and are for screening purposes only. Present and historical observations at the site may not reflect long-term conditions.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

8.0 REFERENCES

Geologic Quadrangle Maps

Wilson, W.J., 2008, Geology of Cairo Quadrangle, Alexander and Pulaski Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Cairo-G, 2 sheets, 1:24,000.

Olive, Wilds W., 1974, Geologic Map of the Wickliffe Quadrangle, Kentucky-Missouri, and the part of the Wyatt Quadrangle in Kentucky, GQ 1161, 1:24,000.

Olive, Wilds W., 1971, Geologic Map of parts of the Cairo and Barlow Quadrangles, Ballard County, Kentucky, GQ 885, 1:24,000.

Internet Interactive Sites

Kentucky Geologic Survey (KGS) interactive data base:
http://minemaps.ky.gov/
http://www.uky.edu/KGS/
http://kgs.uky.edu/kgsweb/DataSearching/OilGas/

USGS

http://waterdata.usgs.gov/nwis/gw
http://pubs.er.usgs.gov/

Illinois State Geologic Society (ISGS) interactive data base
http://www.isgs.uiuc.edu/maps-data-pub/wwdb/wwdb.shtml

USACE Nashville District
http://www.lrn.usace.army.mil/

Google Earth with USDA Soil Survey overlays:
Ballard County, Kentucky and Alexander County, Illinois

Google and Google Maps
https://www.google.com/

Sutterer, K.G., Harik, I.E., Allen, D.L., and Street, R., (2000), "Ranking and Assessment of Seismic Stability of Highway Embankments in Kentucky (KYSPR 96-173)", KTC-00-1 Research Report, Kentucky Transportation Research Center, College of Engineering, University of Kentucky, July 2000

APPENDIX A

APPENDIX A - TABLE OF CONTENTS

Exhibit A-1	**Site Location Map**
Exhibit A-2	**Site Topographic Map (West)**
Exhibit A-3	**Site Topographic Map (East)**
Exhibit A-4	**Geologic Quadrangles (4)**
Exhibit A-5	**1936 Bridge Plan Drawing**

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SOURCE: GOOGLE MAPS

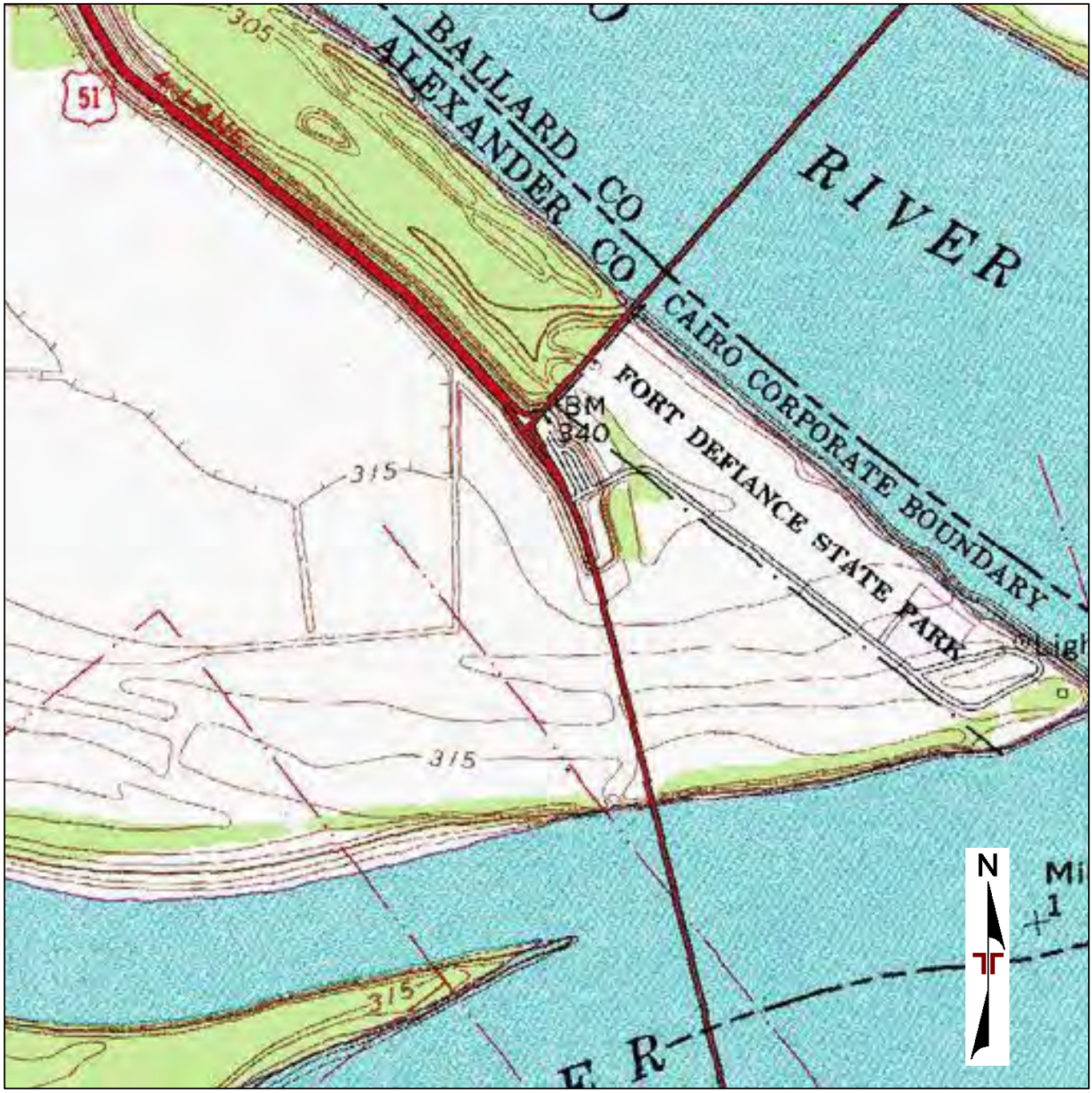
Project Manager:	NCD
Drawn by:	NCD
Checked by:	DRK
Approved by:	DRK
Project No.	N1135002
Scale:	As Shown
File Name:	A1
Date:	03-01-2013

Terracon
Consulting Engineers & Scientists
611 Lunken Park Drive Cincinnati, Ohio 45226
PH. (513) 321-5816 FAX. (513) 321-0294

SITE LOCATION MAP

US51 OHIO RIVER BRIDGE SCOPING STUDY
CDM SMITH
WICKLIFFE BALLARD COUNTY KENTUCKY

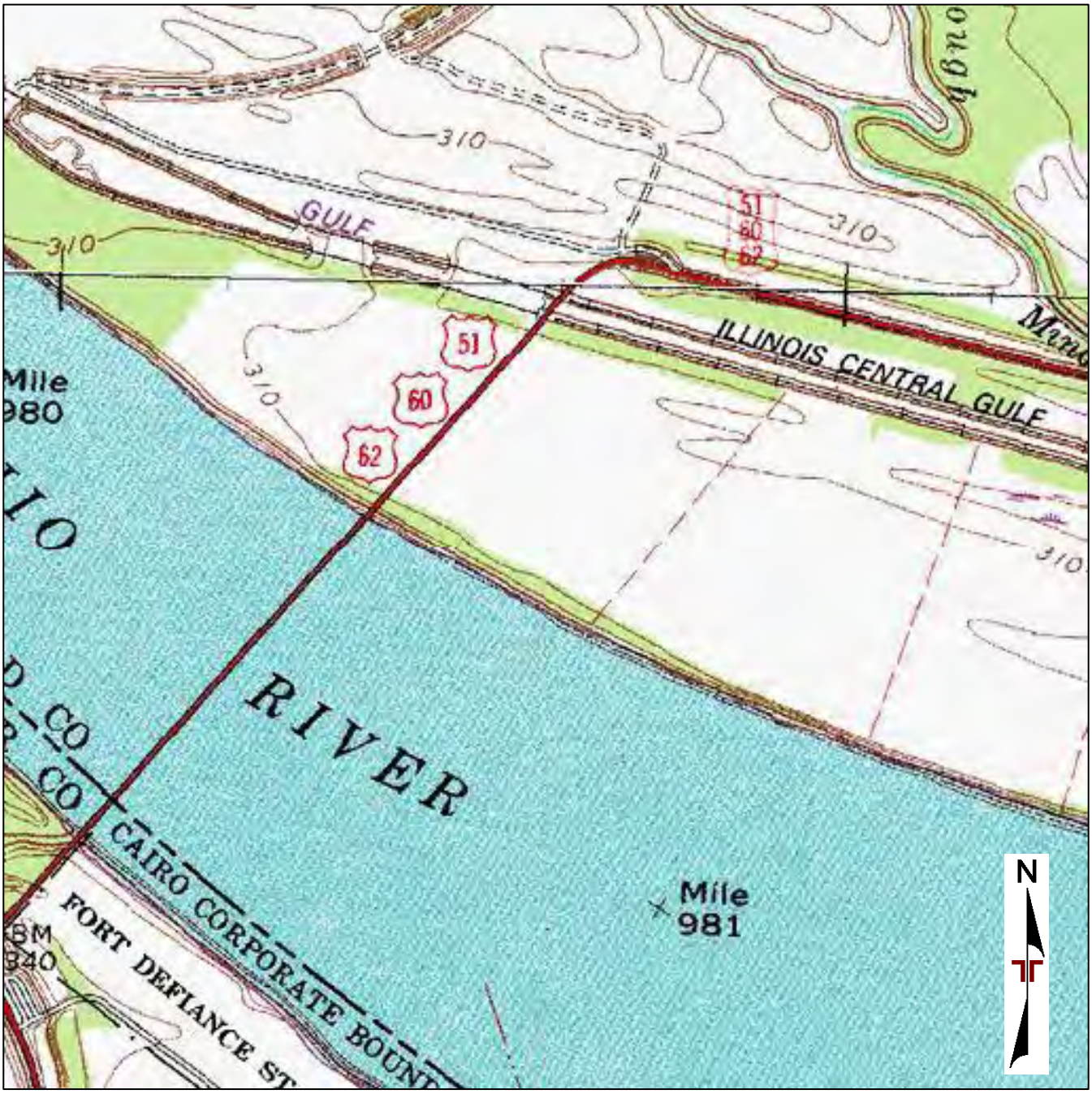
Exhibit
A-1



Source: Topoquest

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: NCD	Project No. N1135002	Terracon Consulting Engineers & Scientists	SITE TOPOGRAPHIC MAP (WEST)	Exhibit
Drawn by: NCD	Scale: N.T.S	611 Lunken Park Drive Cincinnati, Ohio 45226	US51 OHIO RIVER BRIDGE SCOPING STUDY	A-2
Checked by: DRK	File Name: A-2	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH	
Approved by: DRK	Date: 03-01-2013		CAIRO ALEXANDER COUNTY ILLINOIS	



Source: TopoQuest

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

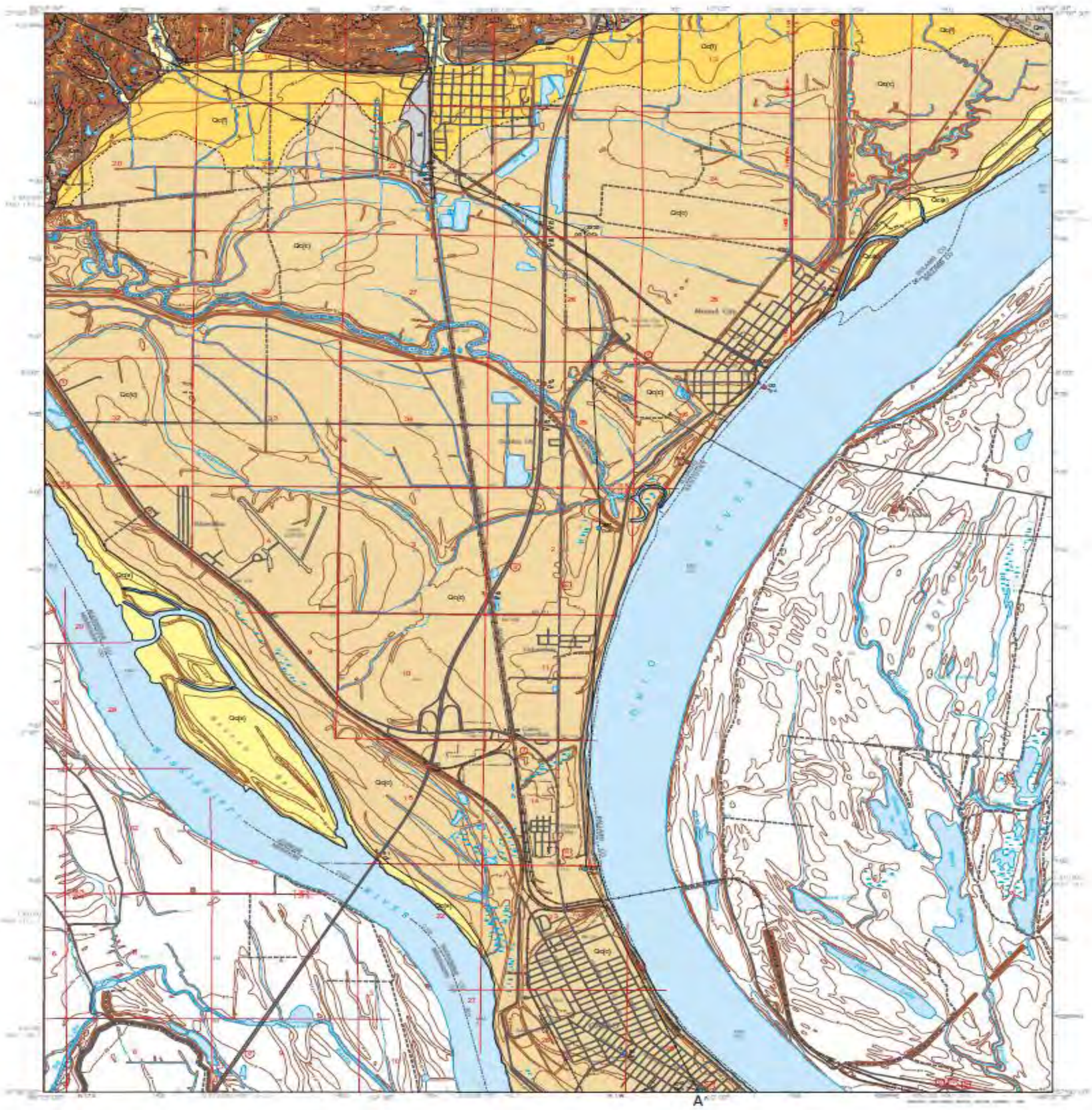
Project Manager: NCD	Project No. nN1135002	Terracon Consulting Engineers & Scientists	SITE TOPOGRAPHIC MAP (EAST)	Exhibit
Drawn by: NCD	Scale: N.T.S	611 Lunken Park Drive Cincinnati, Ohio 45226	US51 OHIO RIVER BRIDGE SCOPING STUDY	A-3
Checked by: DRK	File Name: S A-3	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH	
Approved by: DRK	Date: 03-01-2013		WICKLIFFE BALLARD COUNTY KENTUCKY	

Illinois Department of Natural Resources
ILLINOIS STATE GEOLOGICAL SURVEY
William W. Shilts, Chief

GEOLOGY OF CAIRO QUADRANGLE
ALEXANDER AND PULASKI COUNTIES, ILLINOIS

W. John Nelson
2008

Illinois Geologic Quadrangle Map
IGQ Cairo-G



EXPLANATION

	af	Artificial fill	
Quaternary	Qc(s)	Cahokia Formation (sandy deposits)	Holocene
	Qc(f)	(alluvial fans)	
	Qc(c)	(clayey deposits)	
	Unconformity		
	Qm	Metropolis Formation (loess cover not shown)	Pleistocene
	Unconformity		
Tertiary	Tmm	Mounds Gravel (loess cover not shown)	Pliocene
	Unconformity		
	Tw	Wilcox Formation (loess cover not shown)	Eocene

Note: Loess deposits, comprising the Peoria, Roxana, and Loveland silts, cover uplands near the northern edge of the map. Loess is not shown on this map.

Drill Holes
from which subsurface data were obtained

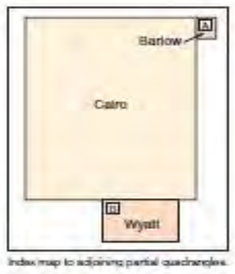
- Stratigraphic boring (ISGS)
- Water well
- Engineering boring
- Dry oil test hole

Numeric label indicates total depth of boring in feet. Borings with samples (s), geophysical log (G), or core (c). Unit label denotes formation at bottom (Tcw, Claiborne/Wilcox; Tpc, Porters Creek Clay/Clayton; Ock, Knox Group; Koc, Owl Creek; Km, McNairy; Dhh, New Harmony; br, bedrock). Dot indicates location accurate within 100 feet.

Line Symbols
Dashed where inferred; dotted where concealed

- Contact
- A—A' Line of cross section

Note: Well and boring records are on file at the ISGS Geological Records Unit and are available online from the ISGS Web site.



Index map to adjoining partial quadrangles

Partial Barlow Quadrangle

Scale 1:24,000

Partial Wyatt Quadrangle

Scale 1:24,000

Base map compiled by Illinois State Geological Survey from digital data provided by the United States Geological Survey. Planimetry of Illinois compiled by photogrammetric methods from imagery dated 1985. Topography partly by planetable surveys 1967. Revised from imagery dated 1993. PLSS and survey control current as of 1997. Map edited 1998. Contours not revised. Contours that conflict with revised planimetry are dashed.

North American Datum of 1983 (NAD 83)
Projection: Transverse Mercator
10,000-foot ticks: Illinois Illinois State Plane Coordinate system, east zone (Transverse Mercator)
1,000-meter ticks: Universal Transverse Mercator grid system, zone 16

Recommended citation:
Nelson, W.J., 2008, Geology of Cairo Quadrangle, Alexander and Pulaski Counties, Illinois: Illinois State Geological Survey, Illinois Geologic Quadrangle Map, IGQ Cairo-G, 2 sheets, 1:24,000

SCALE 1:24,000

BASE MAP CONTOUR INTERVAL 5 FEET
NATIONAL GEODETIC VERTICAL DATUM OF 1929

Released by the authority of the State of Illinois: 2008

Geology based on field work and well-log analysis by W. John Nelson, 1999–2002.

Digital cartography by J. Domier, M. Widener, and J. Palmer, Illinois State Geological Survey.

The Illinois State Geological Survey, the Illinois Department of Natural Resources, and the State of Illinois make no guarantee, expressed or implied, regarding the correctness of the interpretations presented in this document and accept no liability for the consequences of decisions made by others on the basis of the information presented here. The geologic interpretations are based on data that may vary with respect to accuracy of geographic location, the type and quantity of data available at each location, and the scientific and technical qualifications of the data sources. Maps or cross sections in this document are not meant to be enlarged.

For more information contact:
Illinois State Geological Survey
615 East Peabody Drive
Champaign, Illinois 61820-6964
(217) 244-2414
http://www.isgs.uiuc.edu

ADJOINING QUADRANGLES
1 Tamms
2 Pulaski
3 Olmsted
4 Cache
5 Belknap
6 Charleston
7 Wyatt
8 Wickliffe

APPROXIMATE MEAN DECLINATION, 2008

ROAD CLASSIFICATION
Primary highway, hard surface
Secondary highway, hard surface
Light-duty road, hard or improved surface
Unimproved road
Interstate Route
U.S. Route
State Route

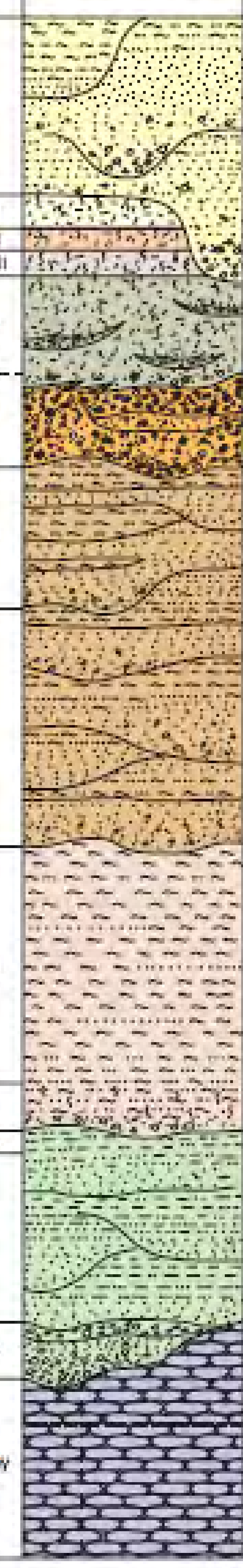
N

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: RJE	Project No. N1135002	Terracon Consulting Engineers & Scientists	ISGS CAIRO QUADRANGLE MAP
Drawn by: DRK	Scale: N.T.S	3601 Mojave Court, Suite A Columbia, Missouri 65202	US 51 OHIO RIVER BRIDGE SCOPING STUDY
Checked by: RJE	File Name: EXHIBIT A-4A	PH. (573) 214-2677 FAX. (573) 214-2714	CDM SMITH
Approved by: RJE	Date: 2/22/2013		CAIRO ALEXANDER COUNTY ILLINOIS

FIG No. A-4A

SYSTEM	SERIES AND STAGE		FORMATION	THICKNESS (FEET)	UNIT
QUATERNARY	Holocene		Cahokia	20–130	A
QUATERNARY	Pleistocene	Wisconsinan	Peoria Silt	0–20	B
QUATERNARY	Pleistocene	Wisconsinan	Roxana Silt	0–12	C
QUATERNARY	Pleistocene	Illinoian	Loveland Silt	0–7	D
QUATERNARY	Pleistocene	Pre-Illinoian	Metropolis	0–70	E
TERTIARY	Pliocene / Miocene		Mounds Gravel	10–60	F
TERTIARY	Eocene		Claiborne	0–280	G
TERTIARY	Eocene		Wilcox		
TERTIARY	Paleocene		Porters Creek Clay	60–190	H
TERTIARY	Paleocene		Clayton	14–30	I
CRETACEOUS	Upper or Gulfian	Maastrichtian	Owl Creek	0–15	J
CRETACEOUS	Upper or Gulfian	Maastrichtian	McNairy	5–180	K
CRETACEOUS	Upper or Gulfian	Campanian	Post Creek	0–25?	L
DEVONIAN AND OLDER			New Harmony Group and older		M



A Cahokia Formation Sand, gravel, silt, and clay. Four surficial facies have been mapped.

1. Sand bars (map unit Qc(s)) occur along the banks of the Ohio and Mississippi Rivers and as islands in the rivers. These landforms likely developed within historic time and are dynamically changing. In places, the sand is overlain by a veneer of silt and silty clay derived from overbank flooding. This unit interfingers with Qc(c) and overlies coarse sand and gravel.

2. Clayey deposits (map unit Qc(c)) encompass most of the map area. Surficial sediments are 13 feet to more than 25 feet thick and consist of mottled medium to dark gray and brownish gray clay, silty clay, and silt containing lenses of sand, mica flakes, iron-manganese and calcite nodules, and plentiful organic matter. These deposits grade downward to sand and gravel, which is not exposed at the surface. The sand is very fine to very coarse, composed of quartz and chert along with diverse sedimentary, igneous, and metamorphic rock fragments derived from glacial outwash. Gravel composition is similar to that of sand.

A small area of surficial sand was mapped by Parks and Fehrenbacher within this facies adjacent to the Cache River in Secs. 20 and 29, T16S, R1W (Parks and Fehrenbacher 1968). This area could represent one or more "sand blows" resulting from earthquake-induced liquefaction; given the location, however, a more likely explanation is washover of sand during a flood of the Mississippi River.

Arcuate ridge-and-swale topography that reflects buried meanders can be discerned on the topographic map and is clearly evident on aerial photographs. Prior to construction of natural levees, the area was regularly inundated during spring floods. Typical soils are the Darwin and Jacob clays and the Cape, Karnak, and [illegible]

[illegible]

Introduction

[illegible]

Paleozoic Bedrock Stratigraphy

[illegible]

Structure

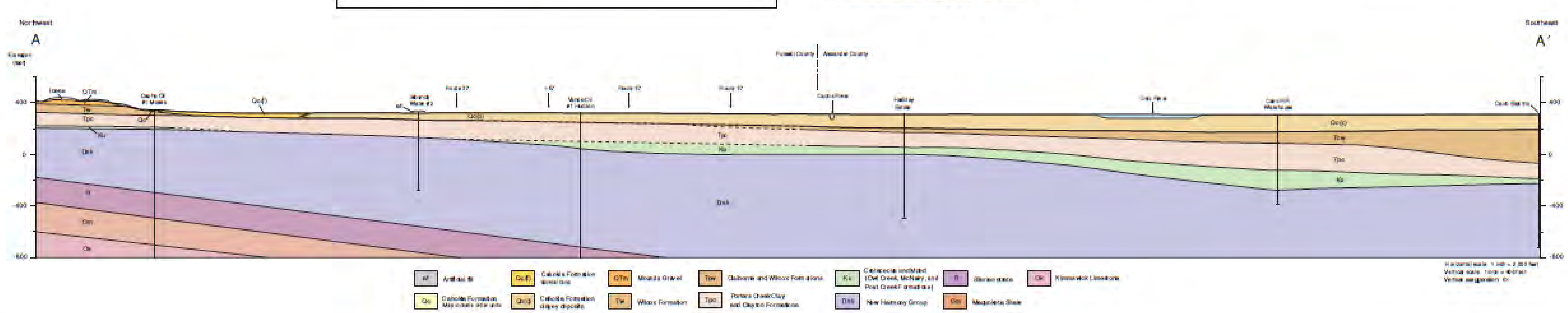
[illegible]

Economic Geology

[illegible]

References

[illegible]



Project Manager: RJE	Project No. N1135002
Drawn by: DRK	Scale: N.T.S.
Checked by: RJE	File Name: EXHIBIT A-4A
Approved by: RJE	Date: 2/22/2013

Terracon
Consulting Engineers & Scientists
3601 Mojave Court, Suite A · Columbia, Missouri 65202
PH. (573) 214-2677 · FAX. (573) 214-2714

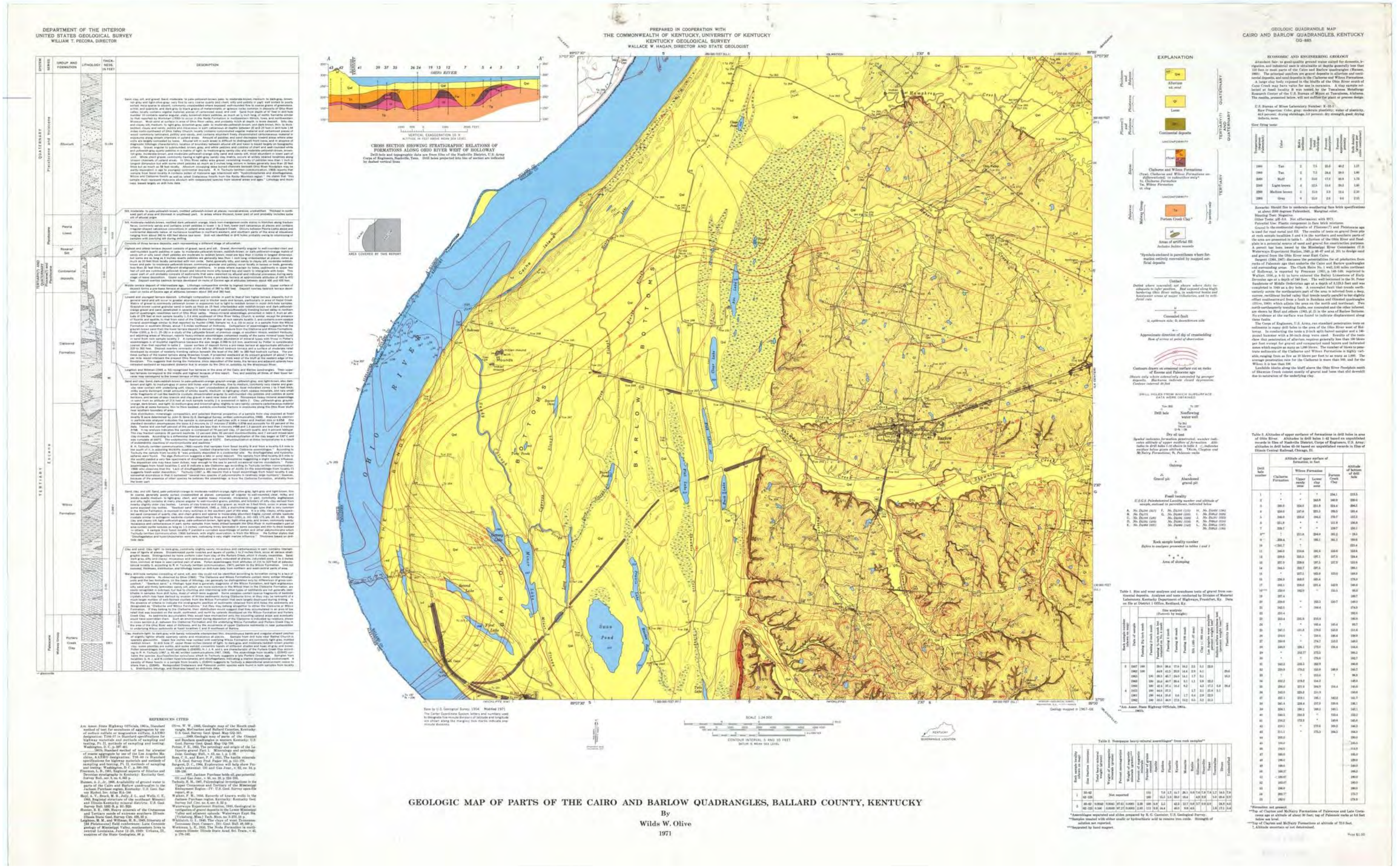
ISGS CAIRO QUADRANGLE MAP

US 51 OHIO RIVER BRIDGE SCOPING STUDY

CDM SMITH

CAIRO · ALEXANDER COUNTY · ILLINOIS

FIG No. A-4A



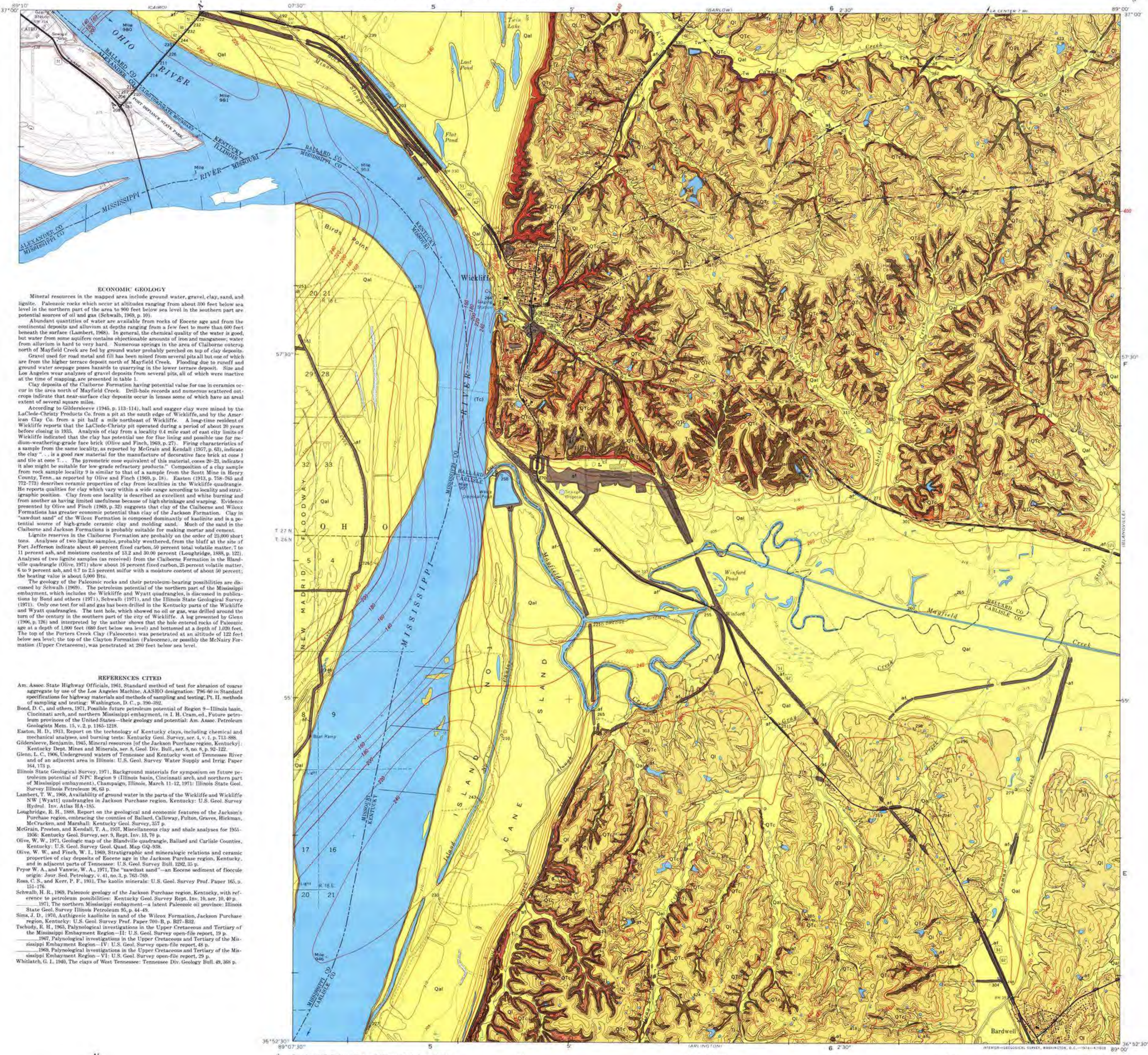
Project Manager: RJE	Project No. N1135002	Terracon Consulting Engineers & Scientists	USGS CAIRO QUADRANGLE MAP	Exhibit
Drawn by: DRK	Scale: NTS	611 Lunken Park Drive Cincinnati, Ohio 45226	US 51 OHIO RIVER BRIDGE SCOPING STUDY	A-4B
Checked by: RJE	File Name: A4B	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH	
Approved by: RJE	Date: 2/22/2013		CAIRO, ALEXANDER COUNTY, ILLINOIS	

DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY
V. E. McKELVEY, DIRECTOR

PREPARED IN COOPERATION WITH
THE COMMONWEALTH OF KENTUCKY, UNIVERSITY OF KENTUCKY
KENTUCKY GEOLOGICAL SURVEY
WALLACE W. HAGAN, DIRECTOR AND STATE GEOLOGIST

GEOLOGIC QUADRANGLE MAP
WICKLIFFE AND WYATT QUADRANGLES
KENTUCKY–MISSOURI
GQ-1181

SYSTEM	SERIES	FORMATION	LITHOLOGY	THICKNESS, IN FEET	DESCRIPTION
QUATERNARY	Pleistocene and Holocene	Alluvium		0-102	[illegible]
QUATERNARY	Pleistocene	Peoria Loess		0-30	[illegible]
QUATERNARY	Pleistocene	Roxana Silt		0-7	[illegible]
TERTIARY(?) AND QUATERNARY	Pliocene(?) and Pleistocene	Continental deposits		0-55	[illegible]
				0-34	[illegible]
TERTIARY	Eocene	Jackson Formation		150±	[illegible]
TERTIARY	Eocene	Claiborne Formation		500+	[illegible]
TERTIARY	Eocene	Wilcox Formation		174+	[illegible]



ECONOMIC GEOLOGY

Mineral resources in the mapped area include ground water, gravel, clay, sand, and lignite. Paleozoic rocks which occur at altitudes ranging from about 300 feet below sea level in the northern part of the area to 900 feet below sea level in the southern part are potential sources of oil and gas (Schwalb, 1969, p. 10).

Abundant quantities of water are available from rocks of Eocene age and from the continental deposits and alluvium at depths ranging from a few feet to more than 600 feet beneath the surface (Lambert, 1968). In general, the chemical quality of the water is good, but water from some aquifers contains objectionable amounts of iron and manganese; water from alluvium is hard to very hard. Numerous springs in the area of Claiborne outcrop north of Mayfield Creek are fed by ground water probably perched on top of clay deposits.

Gravel used for road metal and fill has been mined from several pits all but one of which are from the higher terrace deposit north of Mayfield Creek. Flooding due to runoff and ground water seepage poses hazards to quarrying in the lower terrace deposit. Size and Los Angeles wear analyses of gravel deposits from several pits, all of which were inactive at the time of mapping, are presented in table 1.

Clay deposits of the Claiborne Formation having potential value for use in ceramics occur in the area north of Mayfield Creek. Drill-hole records and numerous scattered outcrops indicate that near-surface clay deposits occur in lenses some of which have an areal extent of several square miles.

According to Gildersleeve (1945, p. 113-114), ball and sagger clay were mined by the LaClede-Christy Products Co. from a pit at the south edge of Wickliffe, and by the American Clay Co. from a pit half a mile northeast of Wickliffe. A long-time resident of Wickliffe reports that the LaClede-Christy pit operated during a period of about 20 years before closing in 1935. Analysis of clay from a locality 0.4 mile east of east city limits of Wickliffe indicated that the clay has potential use for flue lining and possible use for medium-weathering-grade face brick (Olive and Finch, 1969, p. 27). Firing characteristics of a sample from the same locality, as reported by McGrain and Kendall (1957, p. 63), indicate the clay ". . . is a good raw material for the manufacture of decorative face brick at cone 1 and tile at cone 7. . . The pyrometric cone equivalent of this material, cones 20-23, indicates it also might be suitable for low-grade refractory products." Composition of a clay sample from rock sample locality 9 is similar to that of a sample from the Scott Mine in Henry County, Tenn., as reported by Olive and Finch (1969, p. 18). Easton (1913, p. 758-765 and 772-773) describes ceramic properties of clay from localities in the Wickliffe quadrangle. He reports qualities for clay which vary within a wide range according to locality and stratigraphic position. Clay from one locality is described as excellent and white burning and from another as having limited usefulness because of high shrinkage and warping. Evidence presented by Olive and Finch (1969, p. 32) suggests that clay of the Claiborne and Wilcox Formations has greater economic potential than clay of the Jackson Formation. Clay in "sawdust sand" of the Wilcox Formation is composed dominantly of kaolinite and is a potential source of high-grade ceramic clay and molding sand. Much of the sand in the Claiborne and Jackson Formations is probably suitable for making mortar and cement.

Lignite reserves in the Claiborne Formation are probably on the order of 25,000 short tons. Analyses of two lignite samples, probably weathered, from the bluff at the site of Fort Jefferson indicate about 40 percent fixed carbon, 50 percent total volatile matter, 7 to 11 percent ash, and moisture contents of 13.2 and 30.00 percent (Loughridge, 1888, p. 122). Analyses of two lignite samples (as received) from the Claiborne Formation in the Blandville quadrangle (Olive, 1971) show about 16 percent fixed carbon, 25 percent volatile matter, 6 to 9 percent ash, and 0.7 to 2.5 percent sulfur with a moisture content of about 50 percent; the heating value is about 5,000 Btu.

The geology of the Paleozoic rocks and their petroleum-bearing possibilities are discussed by Schwalb (1969). The petroleum potential of the northern part of the Mississippi embayment, which includes the Wickliffe and Wyatt quadrangles, is discussed in publications by Bond and others (1971), Schwalb (1971), and the Illinois State Geological Survey (1971). Only one test for oil and gas has been drilled in the Kentucky parts of the Wickliffe and Wyatt quadrangles. The test hole, which showed no oil or gas, was drilled around the turn of the century in the southern part of the city of Wickliffe. A log presented by Glenn (1906, p. 126) and interpreted by the author shows that the hole entered rocks of Paleozoic age at a depth of 1,000 feet (680 feet below sea level) and bottomed at a depth of 1,020 feet. The top of the Porters Creek Clay (Paleocene) was penetrated at an altitude of 122 feet below sea level; the top of the Clayton Formation (Paleocene), or possibly the McNairy Formation (Upper Cretaceous), was penetrated at 280 feet below sea level.

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E, D1667A, upper Claiborne (Tschudy, 1965, p. 7)
F, D4341, lower or middle Claiborne (Tschudy, 1969, p. 2)
G, D4195, Claiborne (Tschudy, 1969, p. 29)

2
Rock sample locality number
Refers to analyses presented in tables 1 and 2 and in description of columnar section

Table 1. Size and wear analyses of gravel from continental deposits. Analyses and tests conducted by Division of Material Laboratory, Kentucky Department of Highways, Frankfort, Ky. Data on file at District 1 Office, Reidland, Ky.

Rock sample locality number	Size analysis (Percent by weight): Passing 2½-inch mesh	Passing 2-inch mesh	Passing ¾-inch mesh	Passing 4 mesh	Passing 40 mesh	Passing 100 mesh	Passing 200 mesh	Silt (.005-.07 mm)	Clay (<.005 mm)	Los Angeles wear analysis percent weight loss*
1		100	95.0	36.4	3.8	0.1				23.3
2	100			63.4	27.6		4.5			22.6
		100		43.2	12.1		1.4			22.4
3	100			31.2	5.4		0.7			25.6
4	100		83.4	56.1	24.4	4.9		1.0	3.7	
5		100		49.6	9.7		0.9			23.6
	100		75.7	30.1	11.8	9.6		1.0	5.9	

*Am. Assoc. State Highway Officials, 1961

Table 2. Non-opaque heavy-mineral assemblages from rock samples*

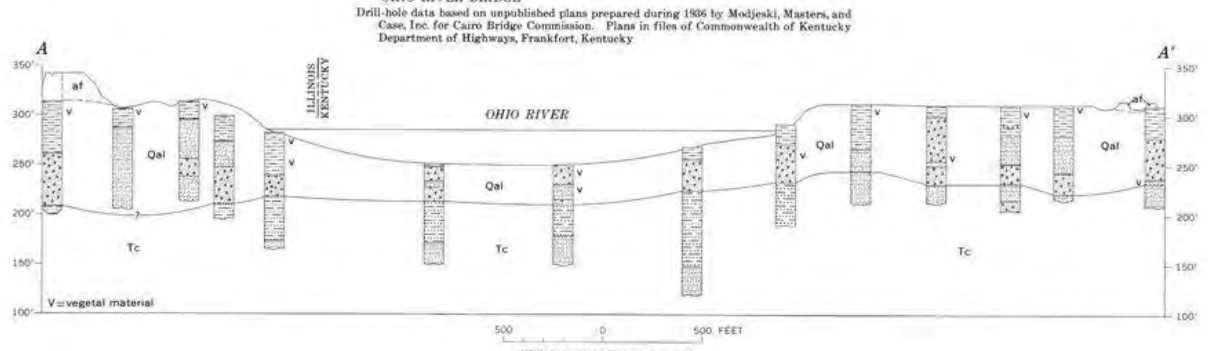
Rock sample locality no.	Lithology of sample	Size fractions (microns)	Number of grains counted	Biotite	Epidote	Fluorite	Garnet	Hornblende	Kyanite	Rutile	Staurolite	Sphene	Topaz	Tourmaline	Zircon
6	Very coarse pebbly sand	44-62	100	5		1	1	1	6	4	30	1	4	28	19
		62-125	100						2	6	7			3	82
7	Fine to medium sand	44-62	100							5	1			5	89
		62-125	100		1				2	8	11			10	68
8	Very coarse pebbly sand	44-62	100	1	2	1			5	10	8			6	67
		62-125	100						4	2	14			10	70

*Assemblages separated in bromoform; magnetic minerals removed by hand magnet.

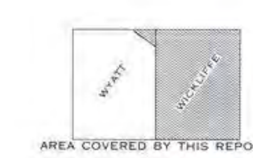
Price $1.00

CROSS SECTION SHOWING LITHOLOGY AND THICKNESS OF FORMATIONS BENEATH THE OHIO RIVER FLOOD PLAIN IN THE VICINITY OF THE OHIO RIVER BRIDGE

Drill-hole data based on unpublished plans prepared during 1936 by Modjeski, Masters, and Case, Inc. for Cairo Bridge Commission. Plans in files of Commonwealth of Kentucky Department of Highways, Frankfort, Kentucky



VERTICAL EXAGGERATION X 6
ALTITUDE IN FEET ABOVE MEAN SEA LEVEL



AREA COVERED BY THIS REPORT

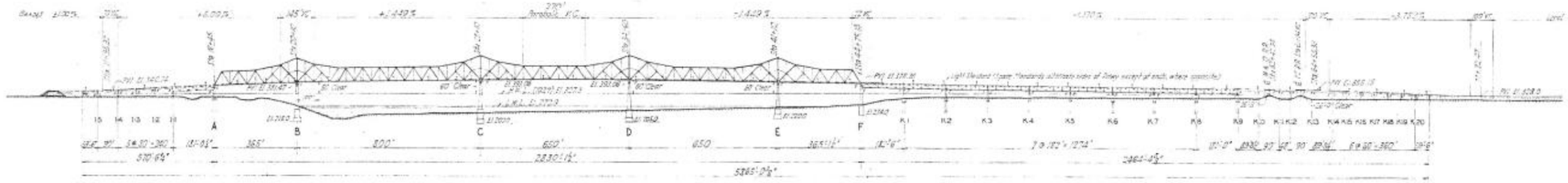
CONTOUR INTERVAL 5 AND 10 FEET
DOTTED LINES REPRESENT 5-FOOT CONTOURS
DATUM IS MEAN SEA LEVEL

QUADRANGLE LOCATION

GEOLOGIC MAP OF THE WICKLIFFE QUADRANGLE, KENTUCKY–MISSOURI, AND THE PART OF THE WYATT QUADRANGLE IN KENTUCKY

By
Wilds W. Olive
1974

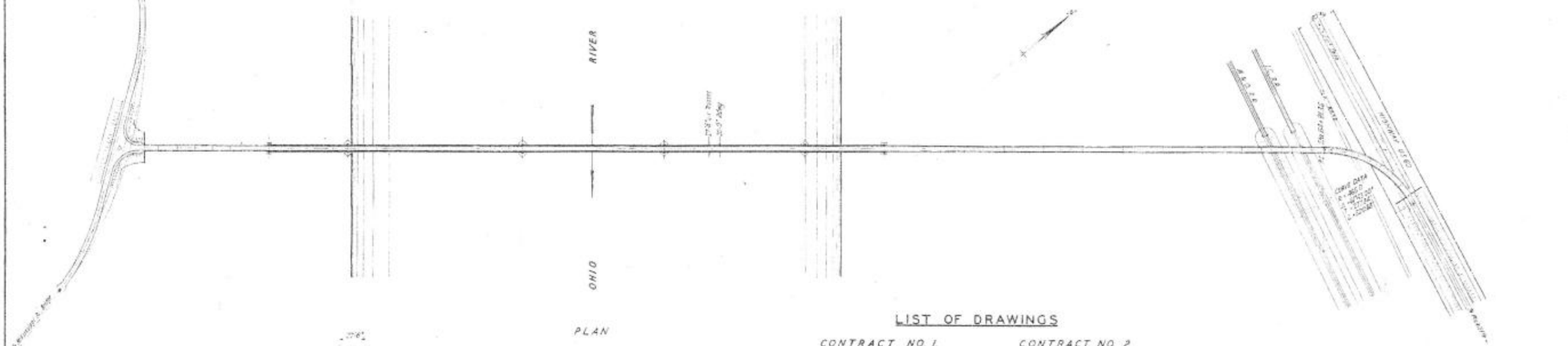
Project Manager: RJE	Project No. N1135002	Terracon Consulting Engineers & Scientists	USGS WICKLIFFE-WYATT QUADRANGLE MAP	Exhibit
Drawn by: DRK	Scale: NTS	611 Lunken Park Drive, Cincinnati, Ohio 45226	US 51 OHIO RIVER BRIDGE SCOPING STUDY CDM SMITH	A-4C
Checked by: RJE	File Name: A4B	PH. (513) 321-5816 FAX. (513) 321-0294	CAIRO, ALEXANDER COUNTY, ILLINOIS	
Approved by: RJE	Date: 2/22/2013			



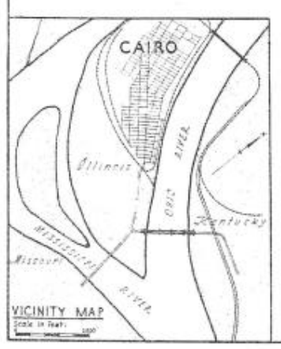
ELEVATION

ALEXANDER CO. ILLINOIS

BALLARD CO. KENTUCKY

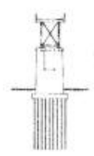


PLAN



VICINITY MAP

SECTION AT PIER C



SECTION AT PIER K2

SECTION AT PIER K15

LIST OF DRAWINGS

CONTRACT NO. 1

1. General Plan & Elevation
2. Main River Piers
3. Pier A and Approach Piers
4. Approach Piers & Abutments

Suppl. Drwg No. 1. Survey & Boring Data
" " " 2. Hydrograph of Ohio River

CONTRACT NO. 2.

1. General Plan & Elevation
2. Stress Sheet - Anchor Arm "A" & Cantilever Arm "D"
3. " " Cantilever Arms B & C and Suspended Span
4. " " Anchor Arm "C"
5. " " Anchor Arm "D"
6. " " Cantilever E & Anchor Arm "E"
7. " " Approach Spans
8. Typical Details - Anchor Arm A-B
9. " " " " Cont'd.
10. " " Cantilever Arms B & C
11. " " Suspended Span
12. Typical Details & Sections - Main Bridge
13. Details of Deck Truss Spans
14. Details of Girder Spans
15. Roadway & Miscellaneous Details

Supplementary Drwg No. 1. Survey & Boring Data
" " " 2. Hydrograph of Ohio River

CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS

GENERAL PLAN & ELEVATION

Approved:
Ralph Modjeski
F. M. Masters
M. R. Case,
Modjeski, Masters & Case.

CONTRACTS NO. 1 & 2
SUPPL. CONTRACT DRAWING NO. 1
MODJESKI, MASTERS & CASE, ENGINEERS
OCT. 1936

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager: NCD	Project No. N1135002	Terracon Consulting Engineers & Scientists	CAIRO BRIDGE PLAN 1936
Drawn by: NCD	Scale: As Shown	611 Lunken Park Drive Cincinnati, Ohio 45226	US51 OHIO RIVER BRIDGE SCOPING STUDY
Checked by: DRK	File Name: A-5	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH
Approved by: DRK	Date: 03-01-013		WICKLIFFE BALLARD COUNTY KENTUCKY

Exhibit A-5

APPENDIX B

APPENDIX B - TABLE OF CONTENTS

Exhibit B-1	**Historical Subsurface Study and Well Vicinity Map**
Exhibit B-2	**Handwritten Logs from 1997 Inspection Report**
Exhibit B-3	**Cairo Bridge Commission Survey and Boring Data**
Exhibit B-3 to B-6	**IDOT Logs from Interactive Database**
Exhibit B-7	**USACE Boring Summary Table (Reproduced from USGS Cairo-Barlow Quadrangle Geologic Map)**

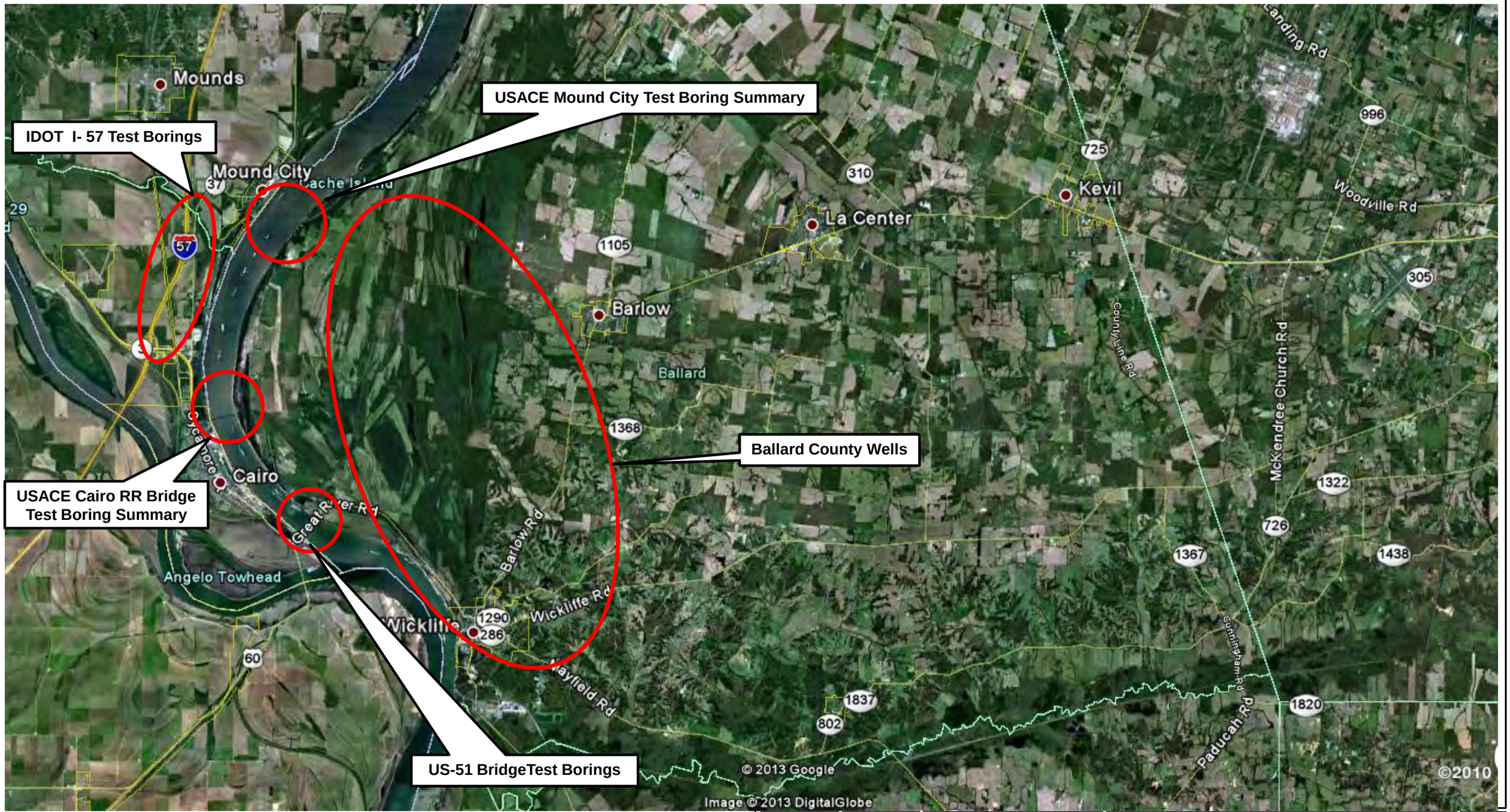


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SOURCE: GOOGLE EARTH 2013

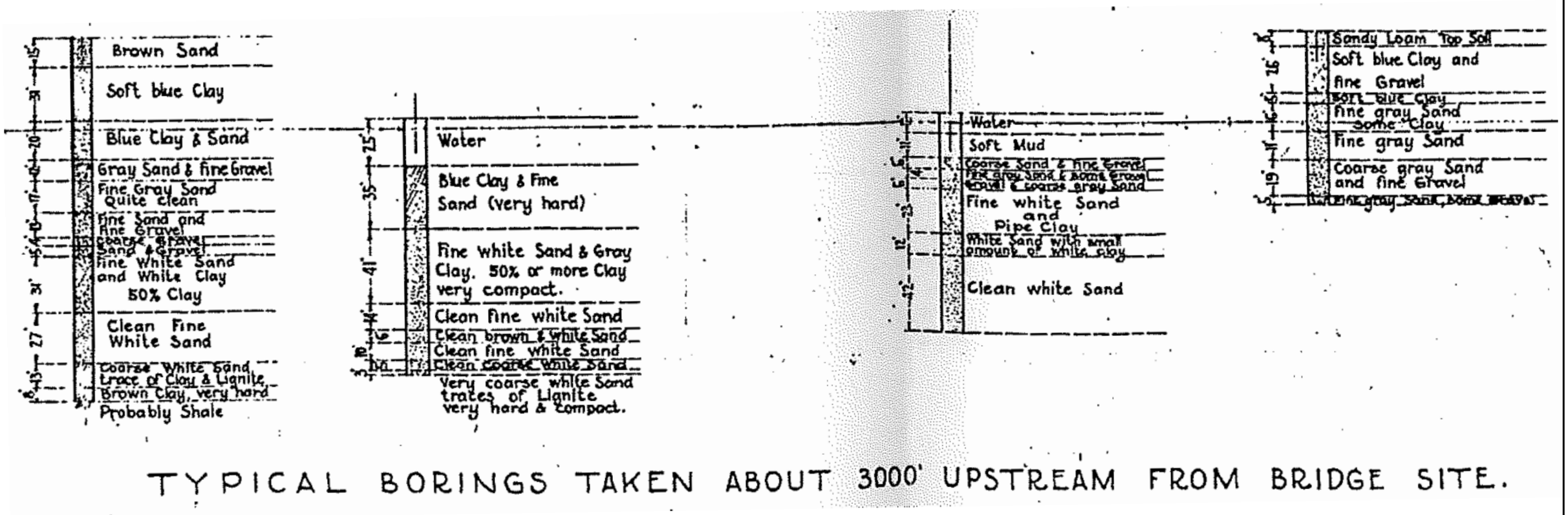
Project Manager: NCD	Project No. N1135002
Drawn by: NCD	Scale: As Shown
Checked by: DRK	File Name: B-1
Approved by: DRK	Date: 03-01-2013

Terracon
Consulting Engineers & Scientists
611 Lunken Park Drive Cincinnati, Ohio 45226
PH. (513) 321-5816 FAX. (513) 321-0294

HISTORICAL SUBSURFACE STUDY & WELL VICINITY MAP

US51 OHIO RIVER BRIDGE SCOPING STUDY
CDM SMITH
ALEXANDER COUNTY, IL BALLARD COUNTY ,KY

Exhibit B-1



TYPICAL BORINGS TAKEN ABOUT 3000' UPSTREAM FROM BRIDGE SITE.

Project Manager: NCD	Project No. N1135002	Terracon Consulting Engineers & Scientists	HANDWRITTEN LOGS 1997 INSPECTION REPORT
Drawn by: NCD	Scale: As Shown	611 Lunken Park Drive Cincinnati, Ohio 45226	US51 OHIO RIVER BRIDGE SCOPING STUDY
Checked by: DRK	File Name: B-2	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH
Approved by: DRK	Date: 03-01-2013		WICKLIFFE BALLARD COUNTY KENTUCKY

Exhibit B-2

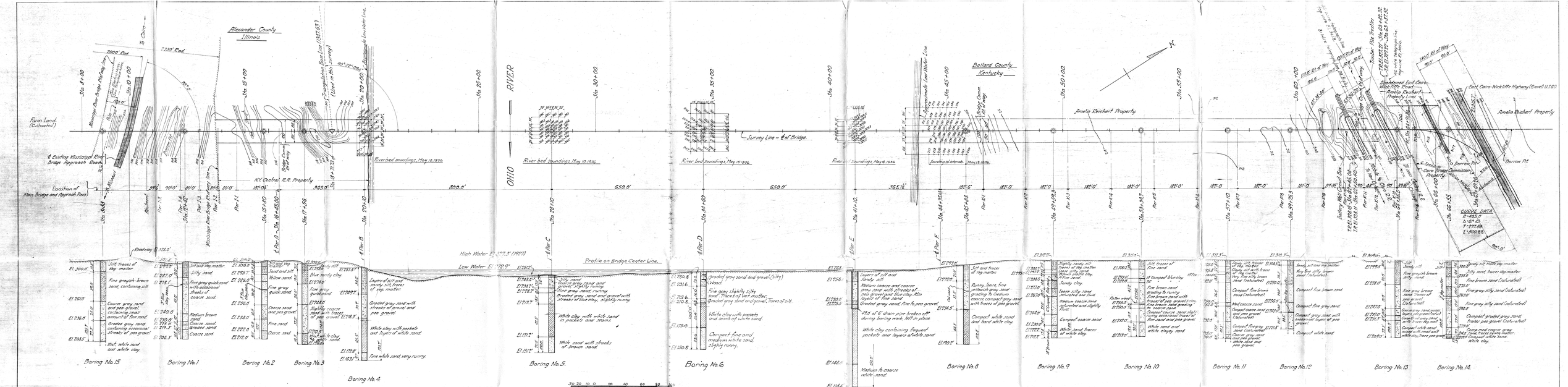
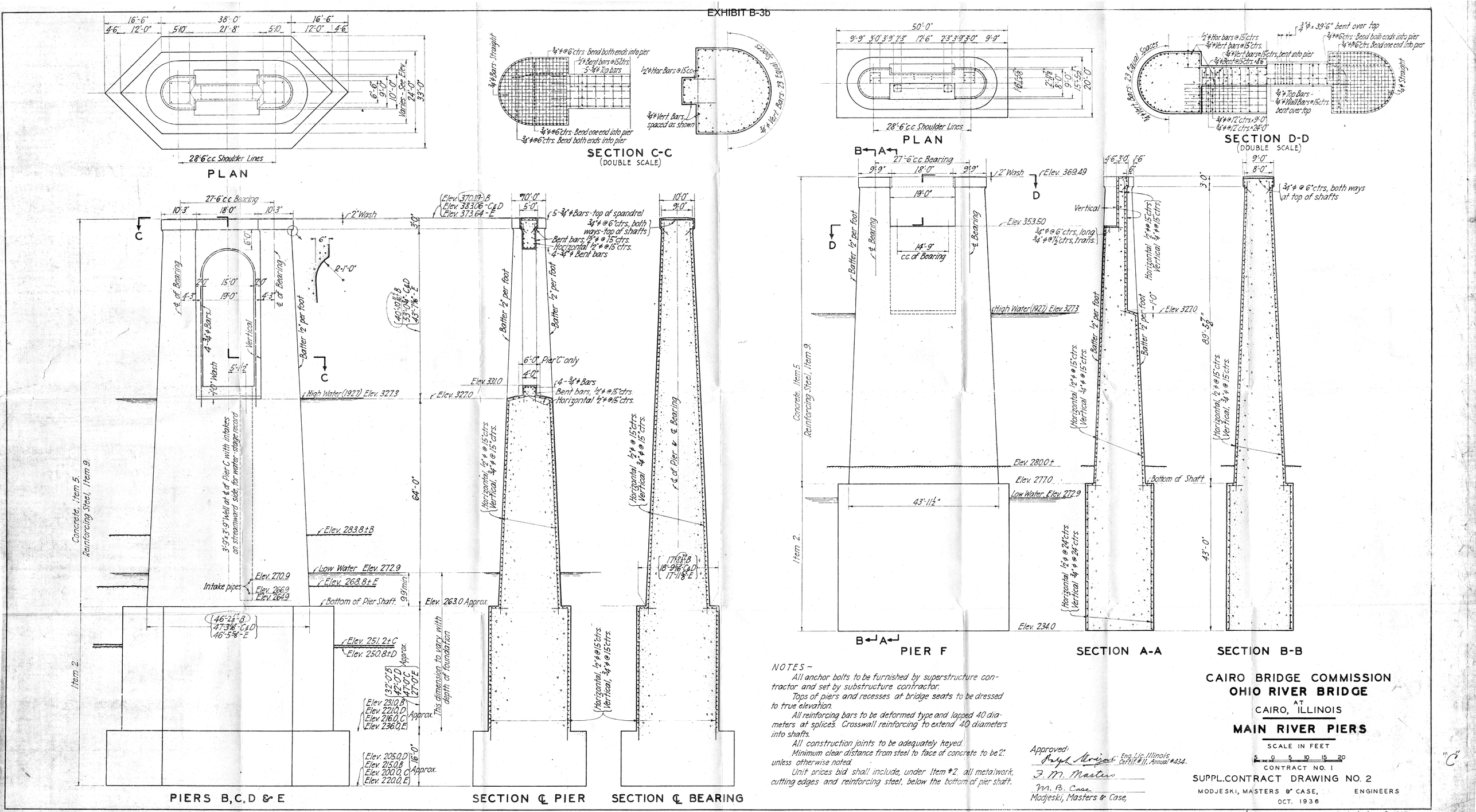

Alexander County
Illinois
Ballard County
Kentucky
OHIO RIVER
Farm Land (Cultivated)
Location of Main Bridge and Approach Piers
Survey Line - ℄ of Bridge
Amelia Reichert Property
NY Central R.R. Property
River bed soundings May 18 1936
Profile on Bridge Center Line
High Water El. 377.3' (1927)
Low Water El. 322.9'
Vertical Scale All Borings
Boring No.15
Boring No.1
Boring No.2
Boring No.3
Boring No.4
Boring No.5
Boring No.6
Boring No.7
Boring No.8
Boring No.9
Boring No.10
Boring No.11
Boring No.12
Boring No.13
Boring No.14
GUIDE DATA
Approved
U.S. Government precise Bench Mark "B2" - Elev. 372.93 referred to Sandy Hook Datum
Elevations given referred to Sandy Hook Datum
CAIRO BRIDGE COMMISSION
OHIO RIVER BRIDGE
AT
CAIRO, ILLINOIS
SURVEY AND BORING DATA
SCALE IN FEET
SUPPLEMENTARY DRAWING NO.1
MODJESKI, MASTERS & CASE, INC. - ENGINEERS
MAY 1936

EXHIBIT B-3a

EXHIBIT B-3b



NOTES ~

All anchor bolts to be furnished by superstructure contractor and set by substructure contractor.

Tops of piers and recesses at bridge seats to be dressed to true elevation.

All reinforcing bars to be deformed type and lapped 40 diameters at splices. Crosswall reinforcing to extend 40 diameters into shafts.

All construction joints to be adequately keyed.

Minimum clear distance from steel to face of concrete to be 2" unless otherwise noted.

Unit prices bid shall include, under Item #2, all metalwork, cutting edges and reinforcing steel, below the bottom of pier shaft.

Approved: Ralph Modjeski, Eng. Lic. Illinois, Certif. #11, Annual #434.

F. M. Masters

M. B. Case

Modjeski, Masters & Case,

CAIRO BRIDGE COMMISSION

OHIO RIVER BRIDGE

AT

CAIRO, ILLINOIS

MAIN RIVER PIERS

SCALE IN FEET

5 0 5 10 15 20

CONTRACT NO. 1

SUPPL. CONTRACT DRAWING NO. 2

MODJESKI, MASTERS & CASE, ENGINEERS

OCT. 1936

"C"

Revised Jan. 6, 1937

(2840—50M—12-64) 2

ILLINOIS GEOLOGICAL SURVEY, URBANA

	Thickness	Top	Bottom
Bridge Boring # 1 S Section 137-1SB Station 83+10 Offset 50' left			
Soft to medium very moist to moist brown caly A-7-6 (15)			8.0
Medium moist brown silty clay A-6 (11-12)			11.5
Very soft wet brown clay loam A-4(5-7)			13.0
Medium to stiff moist brown mottled gray clay A-7-6(15+)			23.0
Dense Wet Gray fine grained sand			30.5
Very dense wet gray coarse grained sand			53.0
Very dense wet gray fine grained sand			55.8
			TD
U.S. 51 crosses railroad 150'SL, 1000' WL.			
Copy of Highway Division log filed in Groundwater Section			
NO ENVELOPE			

COMPANY Illinois Division of Highways

FARM SBI-150 ICRR over SBI Rt. 150

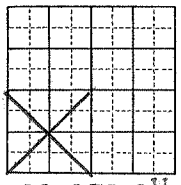
DATE DRILLED September 1965 **COUNTY NO.** 66

AUTHORITY Log by Division of Highways

ELEVATION 310' G. L.

LOCATION SW

COUNTY ALEXANDER



11-17S-1W

SAMPLE STUDY Co# 20633

Division of Highways (now IDOT), Highway Structure Test #4
NE¼ NE¼ NW¼, Sec.15, T17S, R1W
Alexander County, Cairo Quadrangle
Sample Set #C-4755
Examined by John Nelson, February 2, 2000

Samples are in small cloth sack and paper packets and were collected at intervals that vary from 2 to 10 feet (in most cases).

Thickness	Top	Bottom	
			Cahokia Formation
8.0	2.5	11.5	Silty clay, medium brownish gray, massive, finely micaceous, contains fragments of coal and modern plant debris.
5.0	11.5	16.5	Silt, medium brownish-gray, massive, coarse, has a clay matrix and contains scattered fine sand grains, slightly micaceous.
25.0	16.5	41.5	Silt, medium-light gray with yellowish-brown mottling, finer than above. Fine silt at the top becomes coarser and sandier downward, then back to fine silt with little sand. Modern-looking plant fragments are common throughout the interval.
18.5	41.5	60.0	Silt, medium to medium-light gray, generally uniform color and coarse silt, without sand. Abundant mica, massive, no plant material.

Henry Formation

26.5	60.0	86.5	Sand, light brownish-gray, fine to very coarse, subrounded to well-rounded, larger grains are more rounded. About 90% clear and smoky quartz and 10% chert and lithic grains. Scattered pebbles less than 1 cm across. Mostly loose, a little weakly lithified.
7.5	86.5	94.0	Sand and gravel, sand as above, mixed with ⅓ to ½ gravel, mostly rounded, 2 cm maximum diameter. Pebbles include quartz, many varieties of chert, siltstone, sandstone, diabase or basalt, coarse-grained granitic to intermediate igneous rocks.
2.5	94.0	96.5	Sand, light brownish gray, very fine to medium-grained, 80-90% quartz and 10-20% lithic grains. Loose to weakly lithified, silt matrix.
7.5	96.5	104.0	Sand and wood, sand medium brownish gray, very fine, borderline to coarse silt, weakly lithified, "salt and pepper" appearance from abundant lithic grains. Wood light brown, dry and brittle, fine fibrous texture (not peat or lignite). Sampled for radiocarbon dating.
5.0	106.5	111.5	Sand, brownish yellow, coarse to very coarse with small granules, mostly quartz, weakly lithified with a silt-clay matrix.

Eocene strata ?

10.0	111.5	121.5	Sand, white, well sorted, fine to medium grained, virtually 100% quartz, all loose sand.
30.0	121.5	151.5	Sand, clear to pale yellow, medium to very coarse, with small granules, subrounded to well rounded. Again it is almost 100% quartz. Only two samples for the interval.

T.D. 151.5 feet

E:\BLR\W.J.N\ss C-4755 Alexander Cty GRU.wpd

EXHIBIT B-6

(2840—50M—12-64) 2

ILLINOIS GEOLOGICAL SURVEY, URBANA

	Thickness	Top	Bottom
Bridge Boring # 2 Section 02-1B-1 Station 1138+50 Offset Centerline			
Medium to soft moist brown mottled gray silty clay to clay A-6 (12)			7.5
Medium moist dark gray mottled brown clay A7-6(13-15)			15.0
Soft very moist gray clay A-6(11-12)			20.
Medium to very loose moist to wet fine grained gray sand			25
Very loose wet gray sandy loam to sand			27.6
Loose to medium wet fine grained gray sand			32.6
Medium wet fine grained gray sand with rotten vegetation			37.6
Medium to dense wet fine grained gray sand			47.6
Medium wet medium to coarse grained gray sand			52.6
Dense wet coarse grained gray sand with some gravel			60.1
Medium to dense wet coarse gray sand and gravel			75.1
Dense to very dense wet medium to fine grained gray sand			82.1
Dense to very dense wet medium to coarse grained sand and gravel			90.6 TD
Copy of Highway Division log filed in Groundwater Section NO ENVELOPE			

COMPANY Illinois Division of Highways
FARM FAI 57 over Mississippi River **NO.**
DATE DRILLED August 18, 1964 **COUNTY NO.** 64
AUTHORITY Log by Division of Highways
ELEVATION 308' G.L.
LOCATION SW corner
COUNTY ALEXANDER

15-17S-1W

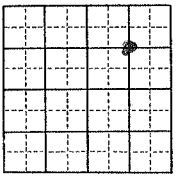
EXHIBIT B-7

(2840—50M—12-64) 2

ILLINOIS GEOLOGICAL SURVEY, URBANA

	Thickness	Top	Bottom
Bridge Boring # 9 S Section 02-1VB-1 Station 1106+34 Offset 48' Right Centerline Median			
Medium moist black silty clay loam to clay loam A-4 (8)			2.5
Medium to stiff moist brown clay A-7-6(15)			11.5
Soft very moist light brown clay A-7-6(14-15)			16.5
Stiff very moist light brown clay A-7-6(17)			19.9
Medium very moist light brown clay loam A-4(8)			21.3
Medium very moist light brown clay A-7-6(15+)			25.8
Soft to medium very moist gray clay loam A-4 (7-8)			28.8
Medium moist dark gray clay A-7-6(15+)			31.3
Stiff moist to very moist brown to mottled dark brown clay A-7-6(20+)			41.3
Medium very moist dark gray silty clay A-6(9)			44.8
No record			52.3
Medium very moist dark gray silty clay A-6(9)			54.8
Soft to medium very moist dark gray silt loam A-4 (8)			57.3
Medium moist dark gray silty clay A-7-6(13)			59.8
Medium to stiff moist dark gray silt loam A-4 (8)			68.3
Stiff moist dark gray silty clay A-6(12)			70.8
Dense to very dense wet brown fine to coarse grained sand			87.3
Very dense wet brown coarse grained sand with fine gravel			94.8
Very dense moist gray fine grained sand (continued)			97.3

COMPANY Illinois Division of Highways
FARM FAI 57 over MO Pac & GM & O RR **No.**
DATE DRILLED April 30, 1965 **COUNTY NO.** 65
AUTHORITY Log by Division of Highways
ELEVATION 337' G.L. 1000' NL, 1900' EL
LOCATION Center NE
COUNTY ALEXANDER



15-17S-1W

EXHIBIT B-7

(65600—40M—10-57) 2

ILLINOIS GEOLOGICAL SURVEY, URBANA

Strata	Thickness	Top	Bottom
Medium moist gray silt loam to loam A-4	(5-7)		102.3
Very dense moist gray gravel			104.8
Very dense wet gray coarse grained sand			107.3
Very dense wet brown coarse grained sand			112.3
Very dense wet white very fine grained sand			122.3
Very dense wet light gray mottled brown coarse grained sand			127.3
Very dense wet light gray mottled brown to light brown fine to coarse grained sand			152.3 TD
Copy of Highway Division log filed in Groundwater Section			
NO ENVELOPE			

Illinois Division of Highways FAI-57

COUNTY ALEXANDER 15-17S-1W

Summary Table of Subsurface Data from Borings Performed at Mound City, IL[a]

Source	Boring ID	Elevation at Top of Layer (feet)				End of Boring
		Claiborne	Wilcox Formation		Porters Creek Clay	
			Upper Sandy Zone	Lower Clay Zone		
Elevation data based on unpublished records in files of Nashville District USACE, boring drilled within Ohio River channel and along west bank at Mound City	1	*	*	*	234.1	213.5
	2	*	*	243.8	240.9	220.0
	3	250.8	245.0	251.8	224.4	206.5
	4	250.0	247.0	231.5	198.5	185.4
	5	246.0	225.6	194.5	170.7	157.5
	6	251.8	*	*	151.8	150.8
	7	239.7	*	*	159.7	150.1
	8[b]		211.8	204.0	161.2	-19.5
	9	238.4	*	195.1	161.1	160.6
	10	241.7				221.4
	11	246.0	210.6	191.6	158.6	153.6
	12	239.6	225.5	197.1	157.5	124.4
	13	237.0	229.8	197.5	157.3	155.0
	14	244.5	222.7	197.5		183.1
	15	*	237.5	165.0	153.0	148.0
	16	236.0	208.9	185.6		178.3
	17	243.1	236.0	231.4	142.0	140.4
	18[c]	250.0	182.0	*	155.5	66.0
	19	237.4				189.7
	20	230.8	*	162.3	150.7	149.0
	21	242.3	*	184.4		174.9
	22	253.4				182.6
	23	253.4	233.8	216.9		180.8
	24		*	163.4	145.4	93.7
	25	247.1	181.8	178.6	153.8	151.6
	26	234.0	*	158.6	146.4	138.9
	27	230.8	*	174.7	153.3	149.5
	28	248.9	226.1	172.0	156.4	144.6
	29	*	232.0	172.8		160.5
	30	*		178.6		102.7
	31	242.2	233.3	163.9		160.6
	32	239.9	170.2	163.8	148.0	143.7
	33			153.0		98.9
	34	232.2	219.2	154.3		149.8
	35	236.0	231.0	184.9	154.4	145.0
	36	242.8	225.3	151.8		150.8
	37	235.1	219.1	193.1	142.2	141.7
	38	245.4	228.4	157.0	139.6	136.1
	39	234.1	190.1	168.5	149.1	143.1
	40	240.5	230.3	*	153.4	152.2
	41	216.2	172.3	*	149.6	145.6
	42	210.1	*	179.6	169.2	146.3
	43	211.1	*	175.5	164.5	134.5

Summary Table of Subsurface Data from Borings Performed at Cairo, IL[a]

Source	Boring ID	Elevation at Top of Layer (feet)				End of Boring
		Claiborne	Wilcox Formation		Porters Creek Clay	
			Upper Sandy Zone	Lower Clay Zone		
Elevation data at Cairo RR bridge based on unpublished records in files of Illinois Central Railroad, Chicago, IL	44	208.6				130.0
	45	184.0				105.5
	46	194.0				114.9
	47	168.0				105.0
	48	196.0				129.9
	49	198.0				140.0
	50	168.3				168.3
	51	180.0				180.0
	52	183.0				180.0
	53	186.0				180.0
	54	202.7				175.7

* formation not present

[a]Reproduced from USGS Cairo and Barlow Geologic Quadrangles

[b]Top of Clayton and McNairy Formation of Paleocene and Late Cretaceous at elevation of approx. 30 feet

[c]Top of Clayton and McNairy formations at elevation of 72.0 feet

Project Manager: RJE	Project No. N1135002	Terracon Consulting Engineers & Scientists	USACE BORING SUMMARY TABLE
Drawn by: DRK	Scale: N.T.S	3601 Mojave Court, Suite A Columbia, Missouri 65202	US 51 OHIO RIVER BRIDGE SCOPING STUDY
Checked by: RJE	File Name: B-8	PH. (573) 214-2677 FAX. (573) 214-2714	CDM SMITH
Approved by: RJE	Date: 2/22/2013		CAIRO & MOUND CITY, ALEXANDER COUNTY, ILLINOIS

FIG No. B-8

APPENDIX C

APPENDIX C – TABLE OF CONTENTS

Exhibit C-1	**Geologic Fault Map**
Exhibit C-2	**Seismic Study Results**

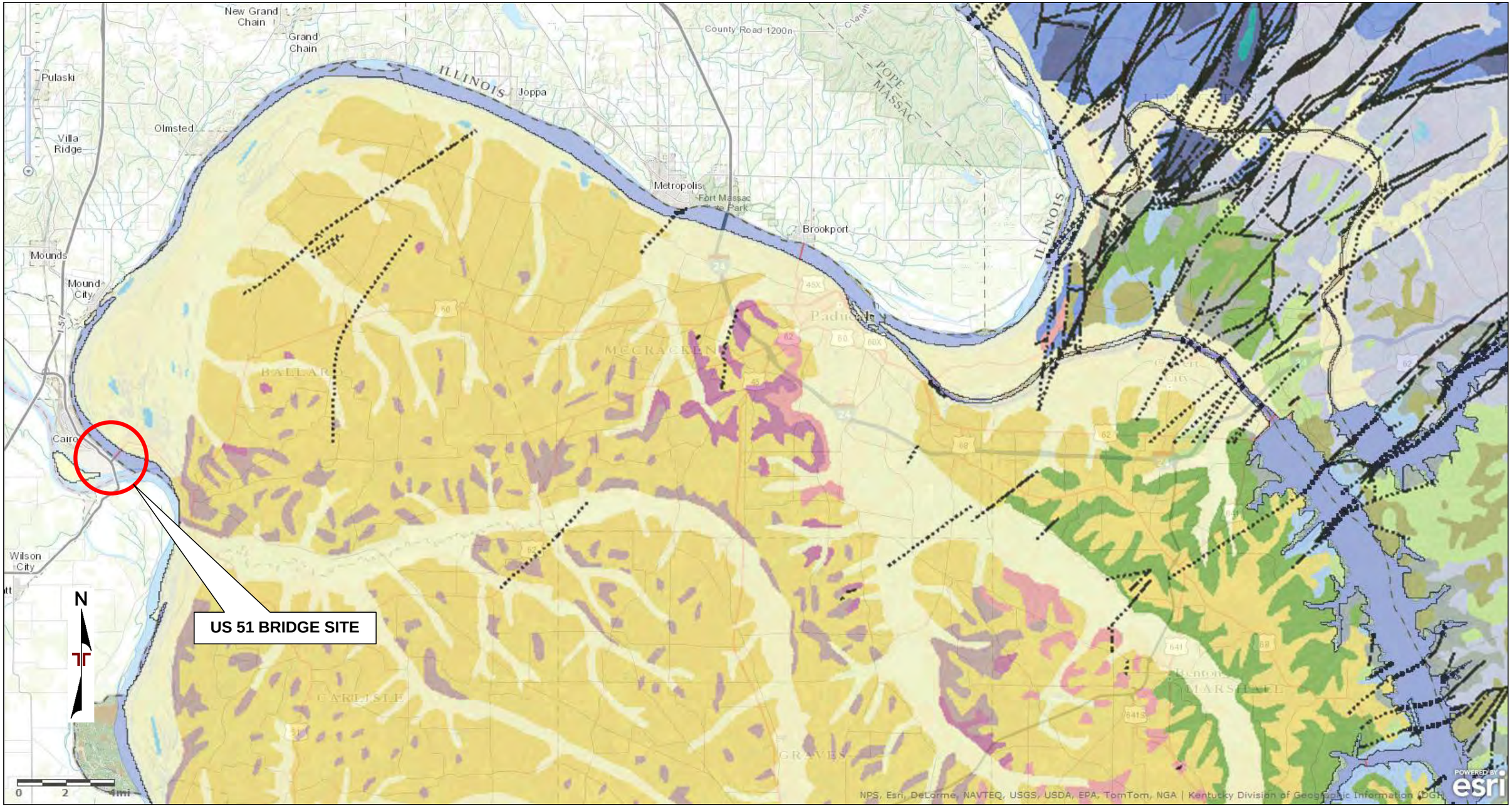


DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SOURCE: ArcGIS Kentucky Geology & Faults

Project Manager: NCD	Project No. N1135002
Drawn by: NCD	Scale: As Shown
Checked by: DRK	File Name: A1
Approved by: DRK	Date: 03-01-2013

Terracon
Consulting Engineers & Scientists
611 Lunken Park Drive Cincinnati, Ohio 45226
PH. (513) 321-5816 FAX. (513) 321-0294

GEOLOGIC FAULT MAP

US51 OHIO RIVER BRIDGE SCOPING STUDY
CDM SMITH
WICKLIFFE BALLARD COUNTY KENTUCKY

Exhibit
C-1

Design Maps Summary Report

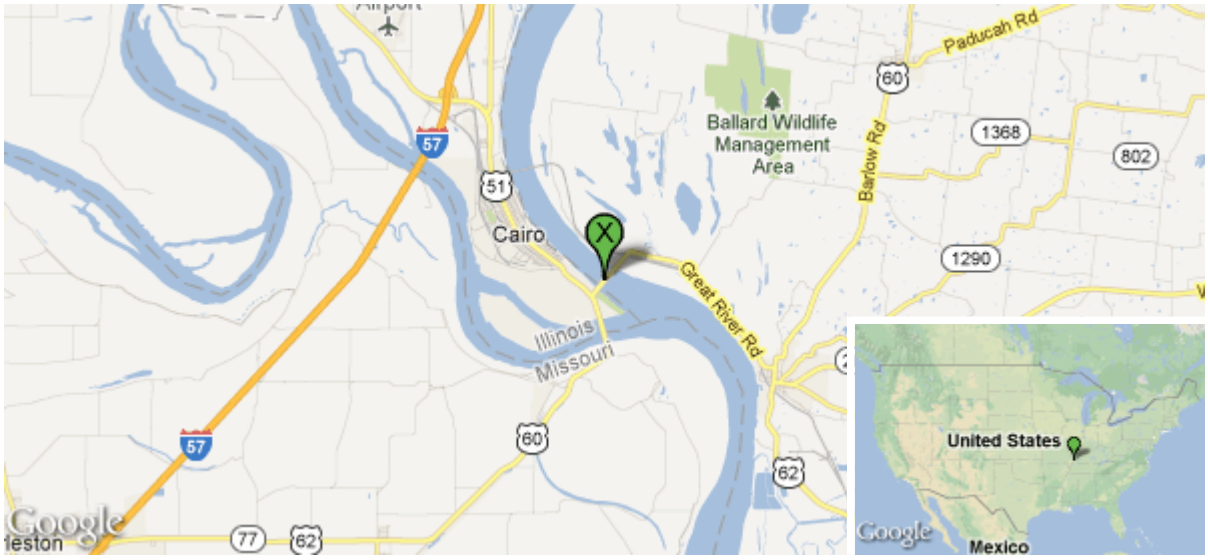
User–Specified Input

Report Title US51 Bridge@Cairo IL/Wickliffe KY
Wed January 9, 2013 15:28:35 UTC

Building Code Reference Document 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design
(which makes use of 2002 USGS hazard data)

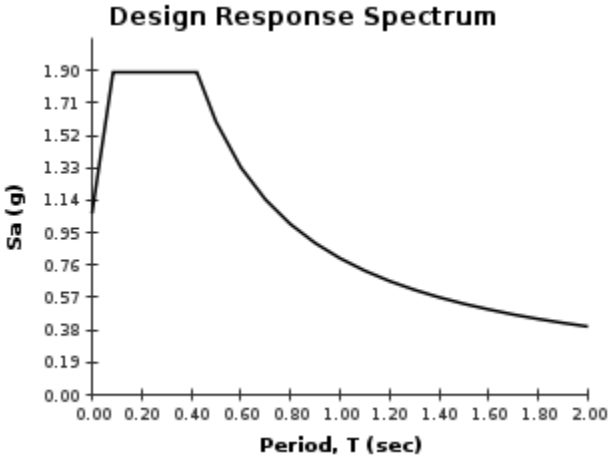
Site Coordinates 36.993°N, 89.147°W

Site Soil Classification Site Class D – "Stiff Soil"



USGS–Provided Output

PGA =	1.062 g	**A_s =**	1.062 g
S_S =	1.890 g	**S_{DS} =**	1.890 g
S_1 =	0.533 g	**S_{D1} =**	0.800 g



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

EXHIBIT C-2

Design Maps Detailed Report

2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (36.993°N, 89.147°W)

Article 3.4.1 — Design Spectra Based on General Procedure

Note: Maps in the 2009 AASHTO Specifications are provided by AASHTO for Site Class B. Adjustments for other Site Classes are made, as needed, in Article 3.4.2.3.

From Figure 3.4.1-2[1]	PGA = 1.062 g
From Figure 3.4.1-3[2]	S_S = 1.890 g
From Figure 3.4.1-4[3]	S_1 = 0.533 g

EXHIBIT C-2

Article 3.4.2.1 — Site Class Definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class D, based on the site soil properties in accordance with Article 3.4.2.

Table 3.4.2.1–1 Site Class Definitions

SITE CLASS	SOIL PROFILE NAME	Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \bar{v}_s \leq 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_s \leq 2{,}500$	$\bar{N} > 50$	>2,000 psf
D	Stiff soil profile	$600 \leq \bar{v}_s < 1{,}200$	$15 \leq \bar{N} \leq 50$	1,000 to 2,000 psf
E	Stiff soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	<1,000 psf
E	—	Any profile with more than 10 ft of soil having the characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \geq 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$) 4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

EXHIBIT C-2

Article 3.4.2.3 — Site Coefficients

Table 3.4.2.3-1 (for F_{pga})—Values of F_{pga} as a Function of Site Class and Mapped Peak Ground Acceleration Coefficient

Site Class	Mapped Peak Ground Acceleration				
	PGA ≤ 0.1	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA ≥ 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = D and PGA = 1.062 g, F_{PGA} = 1.000

Table 3.4.2.3-1 (for F_a)—Values of F_a as a Function of Site Class and Mapped Short-Period Spectral Acceleration Coefficient

Site Class	Spectral Response Acceleration Parameter at Short Periods				
	S_S ≤ 0.25	S_S = 0.5	S_S = 0.75	S_S = 1	S_S ≥ 1.25
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = D and S_S = 1.890 g, F_a = 1.000

EXHIBIT C-2

Table 3.4.2.3-2—Values of F_v as a Function of Site Class and Mapped 1-sec Period Spectral Acceleration Coefficient

Site Class	Mapped Spectral Response Acceleration Coefficient at 1-sec Periods				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = D and S_1 = 0.533 g, F_v = 1.500

Equation (3.4.1-1): $A_S = F_{PGA}\ PGA = 1.000 \times 1.062 = 1.062$ g

Equation (3.4.1-2): $S_{DS} = F_a\ S_S = 1.000 \times 1.890 = 1.890$ g

Equation (3.4.1-3): $S_{D1} = F_v\ S_1 = 1.500 \times 0.533 = 0.800$ g

Figure 3.4.1-1: Design Response Spectrum

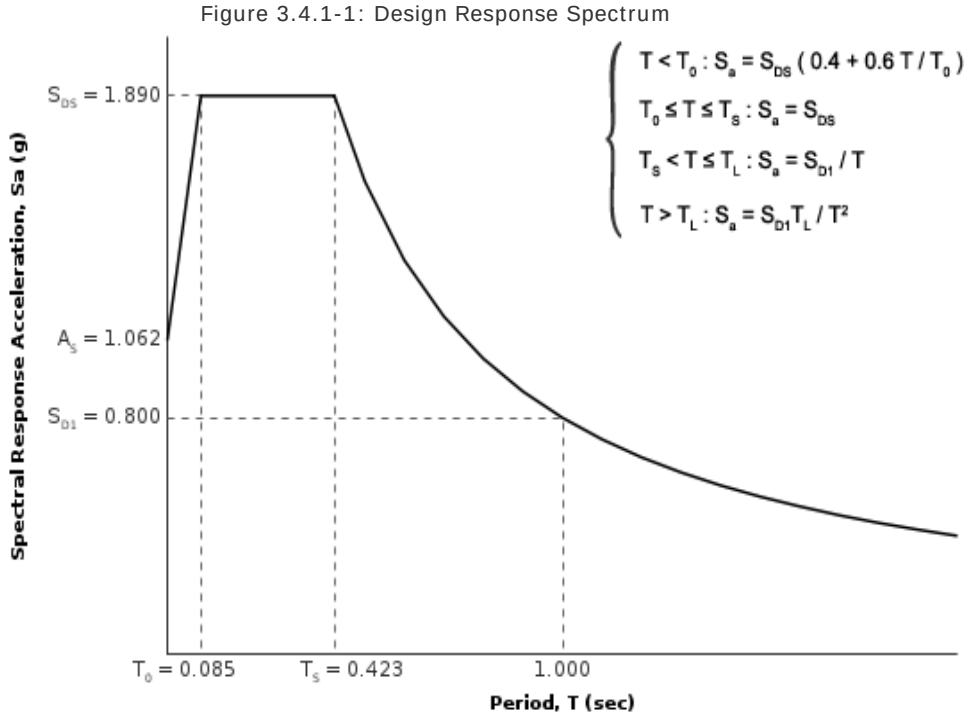


EXHIBIT C-2

Article 3.5 - Selection of Seismic Design Category (SDC)

Table 3.5-1—Partitions for Seismic Design Categories A, B, C, and D

VALUE OF S_{D1}	SDC
$S_{D1} < 0.15g$	A
$0.15g \leq S_{D1} < 0.30g$	B
$0.30g \leq S_{D1} < 0.50g$	C
$0.50g \leq S_{D1}$	D

For S_{D1} = 0.800 g, Seismic Design Category = D

Seismic Design Category ≡ “the design category in accordance with Table 3.5-1” = D

EXHIBIT C-2

References

1. *Figure 3.4.1-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-2.pdf
2. *Figure 3.4.1-3*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-3.pdf
3. *Figure 3.4.1-4*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-4.pdf

EXHIBIT C-2

Design Maps Summary Report

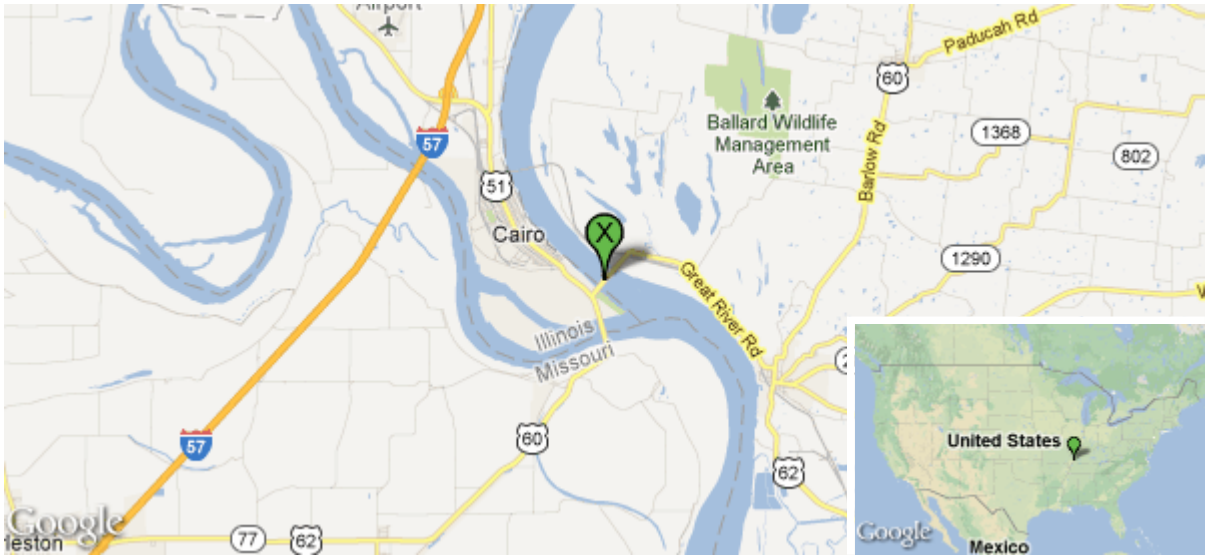
User–Specified Input

Report Title US51 Bridge@Cairo IL/Wickliffe KY
Wed January 9, 2013 15:29:09 UTC

Building Code Reference Document 2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design
(which makes use of 2002 USGS hazard data)

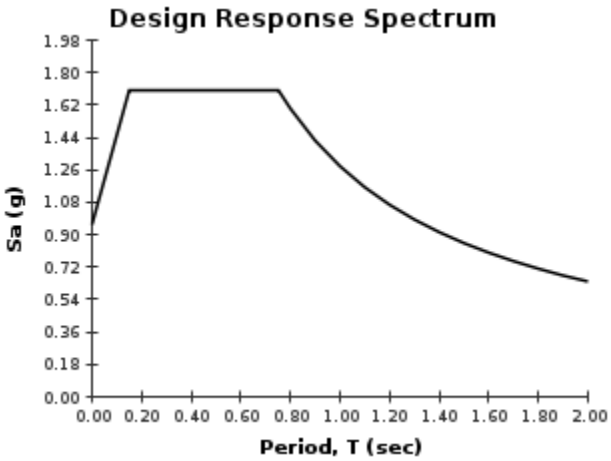
Site Coordinates 36.993°N, 89.147°W

Site Soil Classification Site Class E – "Soft Clay Soil"



USGS–Provided Output

PGA =	1.062 g	**A_s =**	0.956 g
S_S =	1.890 g	**S_{DS} =**	1.701 g
S_1 =	0.533 g	**S_{D1} =**	1.280 g



Although this information is a product of the U.S. Geological Survey, we provide no warranty, expressed or implied, as to the accuracy of the data contained therein. This tool is not a substitute for technical subject-matter knowledge.

EXHIBIT C-2

Design Maps Detailed Report

2009 AASHTO Guide Specifications for LRFD Seismic Bridge Design (36.993°N, 89.147°W)

Article 3.4.1 — Design Spectra Based on General Procedure

Note: Maps in the 2009 AASHTO Specifications are provided by AASHTO for Site Class B. Adjustments for other Site Classes are made, as needed, in Article 3.4.2.3.

From Figure 3.4.1-2[1]	PGA = 1.062 g
From Figure 3.4.1-3[2]	S_S = 1.890 g
From Figure 3.4.1-4[3]	S_1 = 0.533 g

EXHIBIT C-2

Article 3.4.2.1 — Site Class Definitions

The authority having jurisdiction (not the USGS), site-specific geotechnical data, and/or the default has classified the site as Site Class E, based on the site soil properties in accordance with Article 3.4.2.

Table 3.4.2.1–1 Site Class Definitions

SITE CLASS	SOIL PROFILE NAME	Soil shear wave velocity, $\bar{v}_s$, (ft/s)	Standard penetration resistance, $\bar{N}$	Soil undrained shear strength, $\bar{s}_u$, (psf)
A	Hard rock	$\bar{v}_s > 5{,}000$	N/A	N/A
B	Rock	$2{,}500 < \bar{v}_s \leq 5{,}000$	N/A	N/A
C	Very dense soil and soft rock	$1{,}200 < \bar{v}_s \leq 2{,}500$	$\bar{N} > 50$	>2,000 psf
D	Stiff soil profile	$600 \leq \bar{v}_s < 1{,}200$	$15 \leq \bar{N} \leq 50$	1,000 to 2,000 psf
E	Stiff soil profile	$\bar{v}_s < 600$	$\bar{N} < 15$	<1,000 psf
E	—	Any profile with more than 10 ft of soil having the characteristics: 1. Plasticity index $PI > 20$, 2. Moisture content $w \geq 40\%$, and 3. Undrained shear strength $\bar{s}_u < 500$ psf		
F	—	Any profile containing soils having one or more of the following characteristics: 1. Soils vulnerable to potential failure or collapse under seismic loading such as liquefiable soils, quick and highly sensitive clays, collapsible weakly cemented soils. 2. Peats and/or highly organic clays ($H > 10$ feet of peat and/or highly organic clay where H = thickness of soil) 3. Very high plasticity clays ($H > 25$ feet with plasticity index $PI > 75$) 4. Very thick soft/medium stiff clays ($H > 120$ feet)		

For SI: 1ft/s = 0.3048 m/s 1lb/ft² = 0.0479 kN/m²

EXHIBIT C-2

Article 3.4.2.3 — Site Coefficients

Table 3.4.2.3-1 (for F_{pga})—Values of F_{pga} as a Function of Site Class and Mapped Peak Ground Acceleration Coefficient

Site Class	Mapped Peak Ground Acceleration				
	PGA ≤ 0.1	PGA = 0.2	PGA = 0.3	PGA = 0.4	PGA ≥ 0.5
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of PGA

For Site Class = E and PGA = 1.062 g, F_{PGA} = 0.900

Table 3.4.2.3-1 (for F_a)—Values of F_a as a Function of Site Class and Mapped Short-Period Spectral Acceleration Coefficient

Site Class	Spectral Response Acceleration Parameter at Short Periods				
	S_S ≤ 0.25	S_S = 0.5	S_S = 0.75	S_S = 1	S_S ≥ 1.25
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.2	1.2	1.1	1.0	1.0
D	1.6	1.4	1.2	1.1	1.0
E	2.5	1.7	1.2	0.9	0.9
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_S

For Site Class = E and S_s = 1.890 g, F_a = 0.900

EXHIBIT C-2

Table 3.4.2.3-2—Values of F_v as a Function of Site Class and Mapped 1-sec Period Spectral Acceleration Coefficient

Site Class	Mapped Spectral Response Acceleration Coefficient at 1-sec Periods				
	$S_1 \leq 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \geq 0.5$
A	0.8	0.8	0.8	0.8	0.8
B	1.0	1.0	1.0	1.0	1.0
C	1.7	1.6	1.5	1.4	1.3
D	2.4	2.0	1.8	1.6	1.5
E	3.5	3.2	2.8	2.4	2.4
F	See AASHTO Article 3.4.3				

Note: Use straight–line interpolation for intermediate values of S_1

For Site Class = E and S_1 = 0.533 g, F_v = 2.400

Equation (3.4.1-1): $A_S = F_{PGA}\ PGA = 0.900 \times 1.062 = 0.956$ g

Equation (3.4.1-2): $S_{DS} = F_a\ S_S = 0.900 \times 1.890 = 1.701$ g

Equation (3.4.1-3): $S_{D1} = F_v\ S_1 = 2.400 \times 0.533 = 1.280$ g

Figure 3.4.1-1: Design Response Spectrum

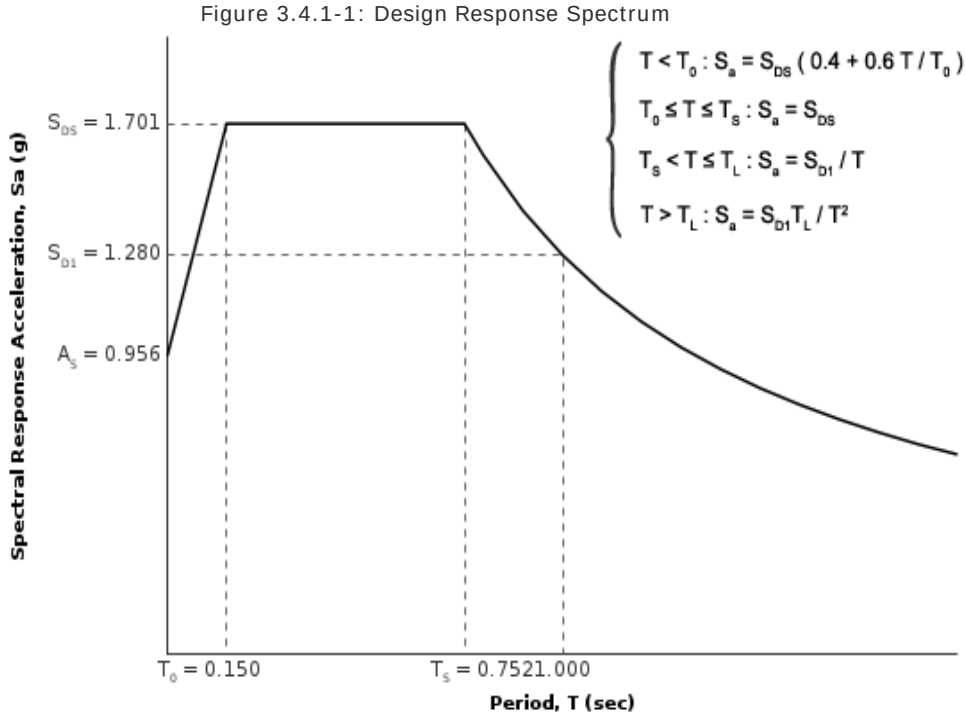


EXHIBIT C-2

Article 3.5 - Selection of Seismic Design Category (SDC)

Table 3.5-1—Partitions for Seismic Design Categories A, B, C, and D

VALUE OF S_{D1}	SDC
$S_{D1} < 0.15g$	A
$0.15g \leq S_{D1} < 0.30g$	B
$0.30g \leq S_{D1} < 0.50g$	C
$0.50g \leq S_{D1}$	D

For S_{D1} = 1.280 g, Seismic Design Category = D

Seismic Design Category ≡ “the design category in accordance with Table 3.5-1” = D

EXHIBIT C-2

References

1. *Figure 3.4.1-2*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-2.pdf
2. *Figure 3.4.1-3*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-3.pdf
3. *Figure 3.4.1-4*: http://earthquake.usgs.gov/hazards/designmaps/downloads/pdfs/AASHTO-2009-Figure-3.4.1-4.pdf

EXHIBIT C-2

APPENDIX D

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Exhibit D-2	**KGS Generalized Land Use Map with Wetland Location**
Exhibit D-3	**KGS Known Karst Risk Potential**

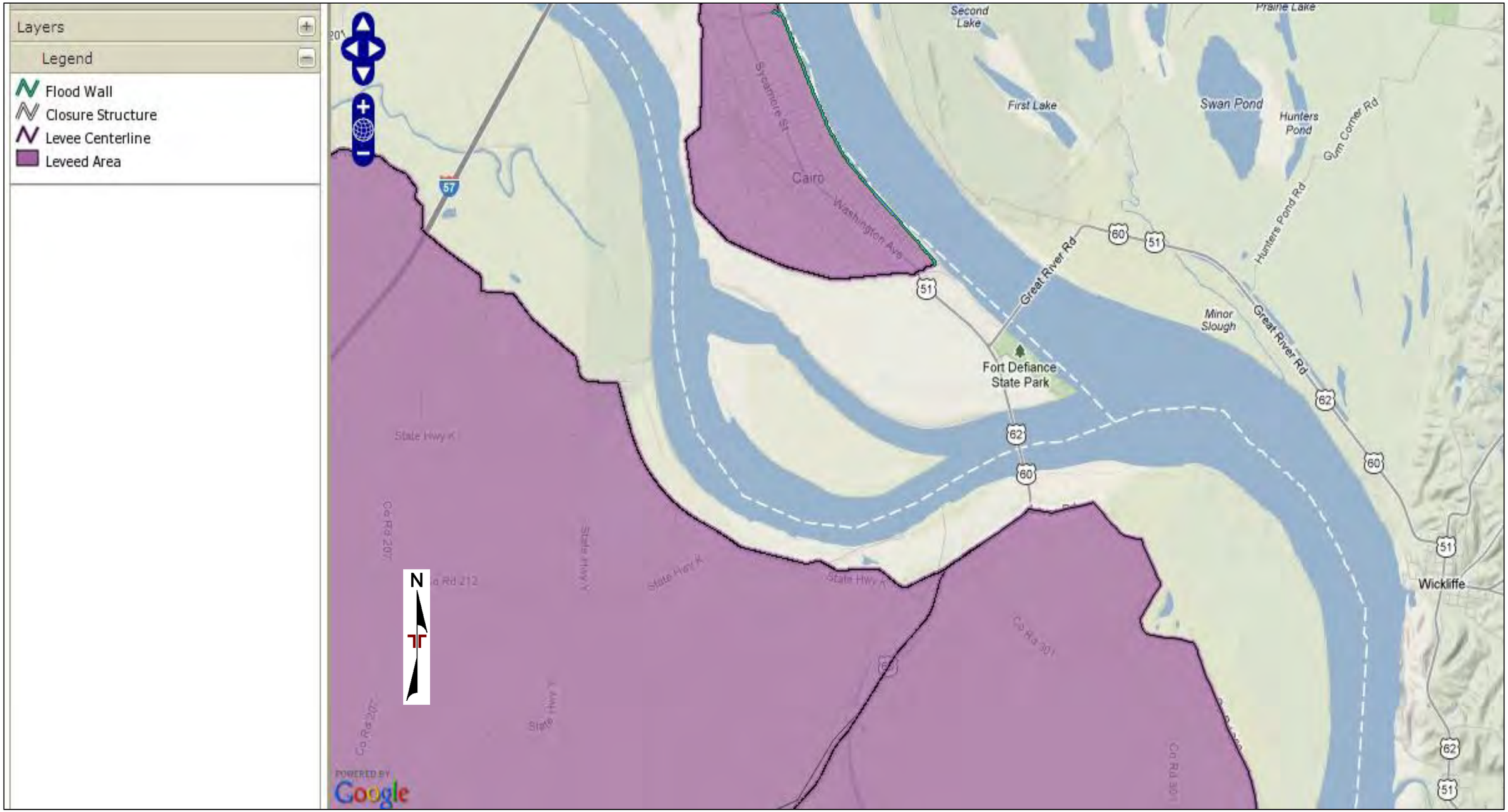

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SOURCE: USACE NATIONAL LEVEE DATABASE

Project Manager: NCD	Project No. N1135002	Terracon Consulting Engineers & Scientists	USACE LEVEE WALL LOCATION MAP
Drawn by: NCD	Scale: NTS	611 Lunken Park Drive Cincinnati, Ohio 45226	**US51 OHIO RIVER BRIDGE SCOPING STUDY**
Checked by: DRK	File Name: D-1	PH. (513) 321-5816 FAX. (513) 321-0294	**CDM SMITH**
Approved by: DRK	Date: 03-01-2013		**CAIRO ALEXANDER COUNTY ILLINOIS**

Exhibit

D-1

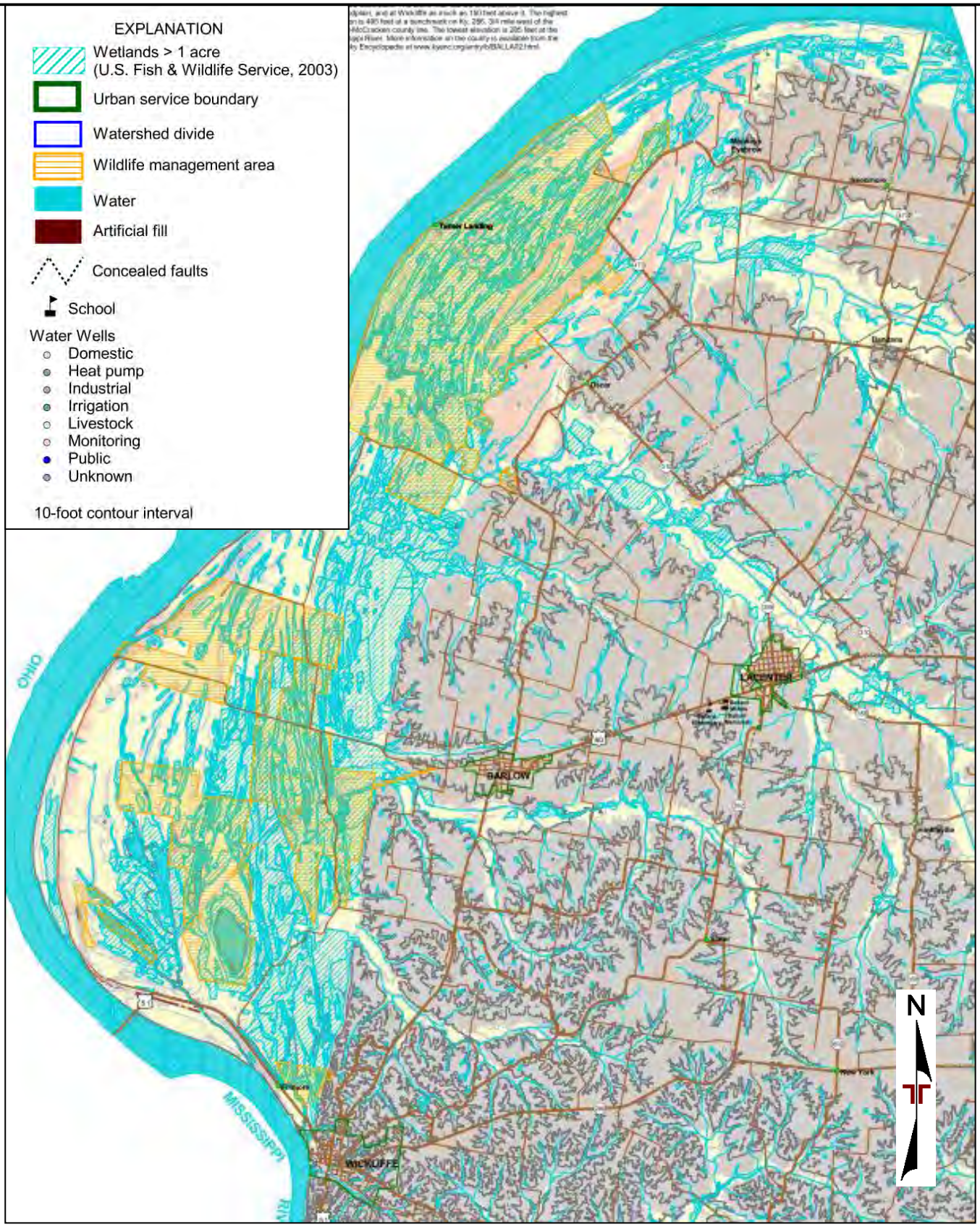

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Source: KGS: GENERALIZED LAND USE MAP

Project Manager: NCD	Project No. N1135002	Terracon Consulting Engineers & Scientists	WETLAND MAP	Exhibit
Drawn by: NCD	Scale: N.T.S	611 Lunken Park Drive Cincinnati, Ohio 45226	US51 OHIO RIVER BRIDGE SCOPING STUDY	D-2
Checked by: DRK	File Name: D-2	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH	
Approved by: DRK	Date: 03-01-2013		WICKLIFFE BALLARD COUNTY KENTUCKY	

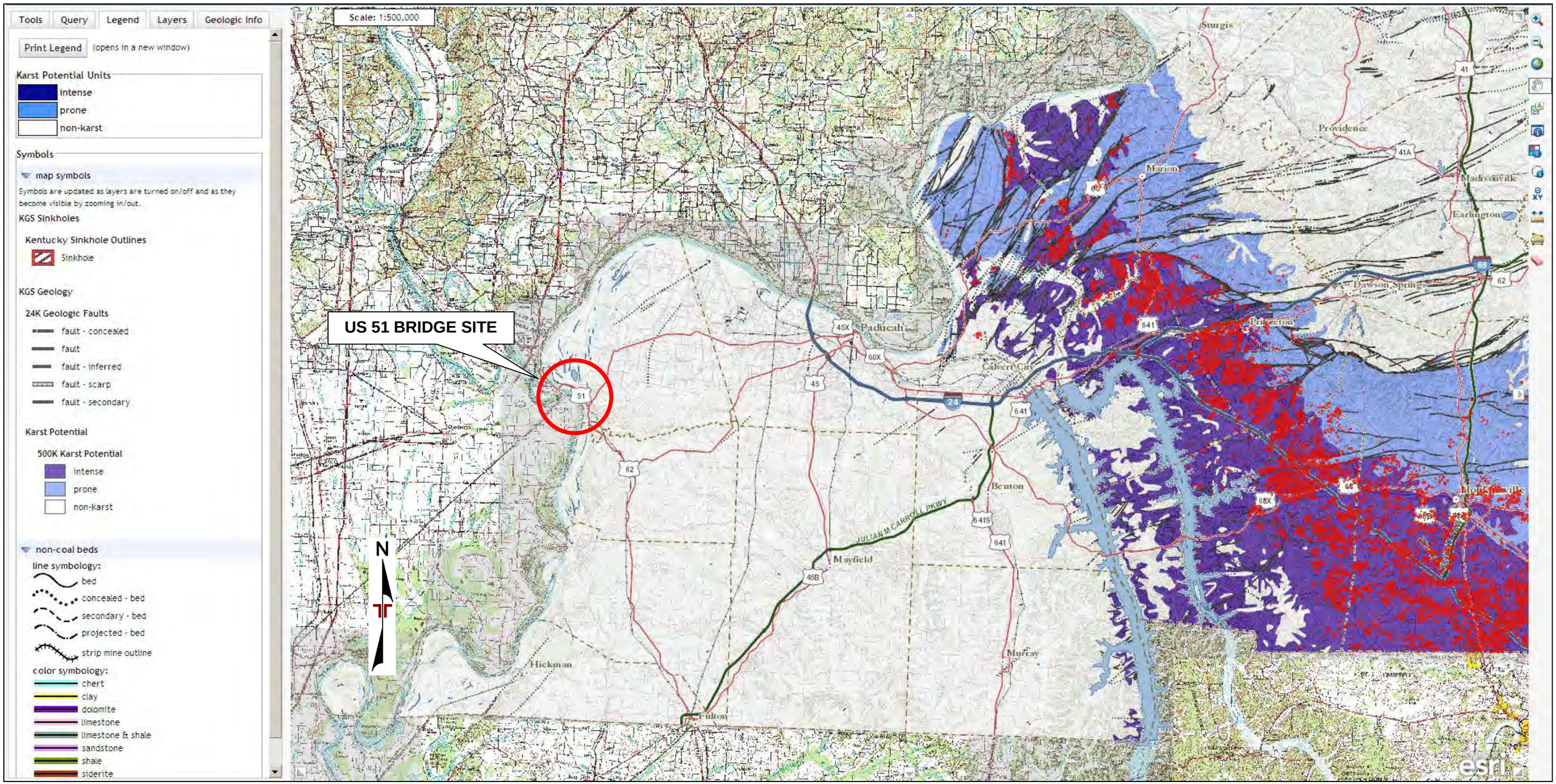

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

SOURCE: KENTUCKY GEOLOGIC MAP INFORMATION SERVICE

Project Manager: NCD	Project No. N1135002	Terracon Consulting Engineers & Scientists	GEOLOGIC KNOWN KARST MAP
Drawn by: NCD	Scale: As Shown	611 Lunken Park Drive Cincinnati, Ohio 45226	US51 OHIO RIVER BRIDGE SCOPING STUDY
Checked by: DRK	File Name: D-3	PH. (513) 321-5816 FAX. (513) 321-0294	CDM SMITH
Approved by: DRK	Date: 03-01-2013		WICKLIFFE BALLARD COUNTY KENTUCKY

Exhibit D-3

Appendix C

Traffic Operations White Paper

Traffic Operations Analysis White Paper

US 51 Ohio River Bridge Study between Wickliffe, KY, and Cairo, IL
Kentucky Transportation Cabinet
Item No. 1-100.00 and 1-1140.00

April 2, 2013

REVISION HISTORY

The following table summarizes changes which have been made to this White Paper.

Version	Date	Name	Description of Changes

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2.2 Population and Employment Forecasts 5
2.3 Traffic and Demographic Data Summary 6
2.4 Truck Percentage 6

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Figure 4.4 US 51/US 60/US 62 Intersection Analysis: 2040 Design Hour 14

Traffic Operations Analysis White Paper

The Cairo Bridge carries US 51, US 60, and US 62 traffic across the Ohio River at US 51 Kentucky milepoint 7.372. The bridge carries approximately 5,400 vehicles across the Ohio River each day between Wickliffe, KY, and Cairo, IL with approximately 35% of that being truck traffic. It also provides a connection to the US 60/US 62 Mississippi River Bridge, which is located at the southern tip of Illinois and continues to Wyatt, Sikeston and Charleston, MO.

The US 51 Ohio River Bridge was constructed by the Cairo Bridge Commission as a toll facility and opened to traffic on November 11, 1938. Tolls were removed from the crossing on November 11, 1948, when the highway departments of Kentucky and Illinois took over maintenance of the structure. The Cairo Bridge is at Ohio River navigation mile point 980.4.

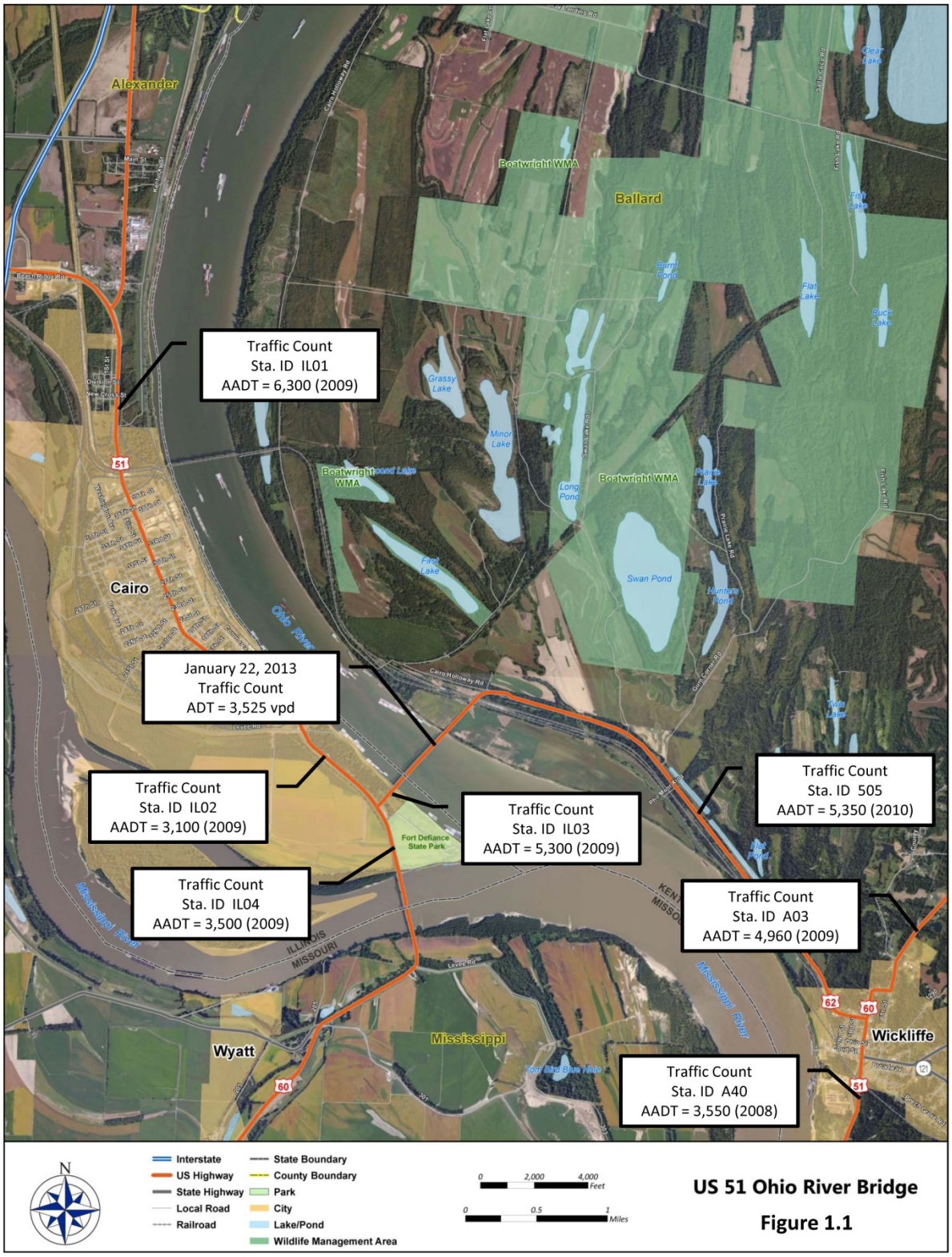
The existing two-lane bridge on US 51 over the Ohio River has a sufficiency rating of 22.4. The structure width is 22.6 feet curb to curb with an approaching roadway width of 24 feet including shoulders. The 76-year-old structure is officially designated as "functionally obsolete" because it does not meet current geometric standards.

The nearest alternate river crossings are the I-24 Ohio River Bridge (39 miles upstream) at Paducah, KY, the Dorena-Hickman Ferry (32 miles downstream), and the I-155 Mississippi River Bridge (122 miles downstream) near Caruthersville, Mo.

CDM Smith is leading a team of three primary consulting firms to undertake a planning study of the US 51 Bridge for the Kentucky Transportation Cabinet (KYTC). The purpose of this phase of the project is to study options for improving the US 51 crossing of the Ohio River between Wickliffe, Kentucky and Cairo, Illinois. This planning study will consider several improvement scenarios, including: 1) rehabilitation of the existing bridge, 2) replacement of the bridge in its current location, 3) the feasibility of a new bridge in a new location, and 4) a no-build or do-nothing alternative. This study will include a location study, an environmental overview, and recommendations for a preferred alternative to be considered further under NEPA in the next phase of work.

1. Methodology

As part of the analysis to document needs and deficiencies, a set of traffic volumes were developed based on historic traffic data and recent traffic counts. In order to establish a new forecast, a comprehensive review of traffic and demographic data was analyzed, a growth rate was evaluated, and a base year (2020) and a design year (2040) traffic forecasts were established. The findings are presented in the following sections. **Figure 1.1** shows the study area, traffic count locations, most recent Annual Average Daily Traffic (AADT), and the Daily Traffic Volume from a January 22, 2013 traffic count of Cairo Bridge.



US 51 Ohio River Bridge

Figure 1.1

2. Traffic and Demographic Data

2.1. Historical Traffic Volumes

Looking at 20 years of historical traffic data on the Cairo Bridge, Station ID 505 in Ballard County, Kentucky, and Station ID IL03 in Alexander County, Illinois, an annual growth rate was developed. See **Figure 1.1** for traffic count locations. Two methods were used to calculate the annual growth rates. The average annual linear growth rate between the two count locations was calculated to be 0.295 percent (0.295%). In addition, KYTC has established a methodology that utilizes exponential growth. Using this method, the annual growth rate increases slightly to 0.30 percent (0.30%).

For comparison purposes, five other nearby locations in Kentucky and Illinois were also examined. In Kentucky; US 60 just north of Wickliffe (Station ID A03) and US 51 just south of Wickliffe (Station ID A40) were examined. US 60 had an average annual growth rate of 1.1% and US 51 had a negative growth rate at this location. In Illinois; US 51 just north of Cairo (Station ID IL01), US 51 just south of Cairo (Station ID IL02), and US 60/US 62 just south of the existing Cairo Bridge (Station ID IL04) were examined. All three locations in Illinois had a negative growth rate. The average annual growth rate of all five locations in Illinois and Kentucky, assuming 0.0% growth where there is negative growth, is 0.24 percent (0.24%) over the past 20 years.

2.2. Population and Employment Forecasts

For further comparison, population projections prepared by the Kentucky State Data Center at the University of Louisville were reviewed. Comparing 2010 population to the 2040 population forecast, growth rates were calculated to be a negative 0.2 percent (-0.2%) for Ballard County. In Illinois population projections prepared by the Illinois Department of Commerce and Economic Opportunity were reviewed. Comparing 2010 population to the 2030 population forecast, growth rates were calculated to be a 0.5 percent (0.5%) for Alexander County. According to Woods and Poole's 2013 Complete Economic and Demographic Data Source (CEDDS), growth rates were calculated to be 0.5 percent (0.5%) and negative 0.1 percent (-.01%) for Ballard County, KY and Alexander County, IL, respectively. Comparing each source, population is projected to grow between -0.2 and 0.5 percent (-0.2% and 0.5%) for Ballard County and between -0.1 and 0.5 percent (-0.1% and 0.5%) for Alexander County.

The 2013 CEDDS also forecasts employment through 2040. Comparing 2010 employment to the 2040 employment forecast, growth for Ballard County is 1.6 percent (1.6%), while growth for Alexander County is negative 0.2 percent (-0.2%).

2.3. Traffic and Demographic Data Summary

A summary of the growth rates discussed in the previous section is presented below.

Traffic/Demographic Data:	Annual Growth Rates
Traffic Volume Growth (linear)	0.295%
Traffic Volume Growth (exponential)	0.30%
source: KYTC, based on 20 yrs of data	
Population Forecast (Ballard County)	-0.2%
source: Kentucky State Data Center	
Population Forecast (Alexander County)	
source: Illinois Department of Commerce and Economic Opportunity	0.5%
Population Forecast (Ballard County)	0.5%
Population Forecast (Alexander County)	-0.1%
source: Woods & Poole 2012 CEDDS	
Employment Forecast (Ballard County)	1.6%
Employment Forecast (Alexander County)	-0.2%
source: Woods & Poole 2012 CEDDS	

After review and discussion with the project team, an annual growth rate of 0.50 percent (0.50%) was applied exponentially. This approach is consistent with KYTC methodologies on similar projects. All of the growth rates listed above are relatively low, with some showing negative growth. The average growth rate of the summary rates listed above was 0.34 percent (0.34%). With such low projected growth, assuming 0.50 percent (0.50%) annual growth will give a reasonably conservative estimate.

2.4. Truck Percentage

A traffic count was conducted on January 22, 2013 for the bridge. On this day the total truck percentage was 32.3% of the total volume. The latest US 51 tube count in Kentucky (Station ID 505) had a truck percentage of 35.2% in 2010. This project assumes a truck percentage of 35% for Cairo Bridge.

3. Traffic Forecast

3.1. Forecast Volumes

Considering all of the analysis presented in the previous sections, a traffic forecast was conducted for Cairo Bridge. Volumes for the Current Year (2013), Base Year (2020), which represents the estimated start of construction, and a Design Year (2040) were established. The volumes were calculated using the 2010 annual average daily traffic (AADT) from KYTC Station ID 505 and applying the 0.5% exponential annual growth rate presented in **Section 2.3**. The resulting daily traffic forecast for Cairo Bridge is presented below.

2010 Traffic Count (KYTC Station ID 505)	Daily Traffic
Annual Average Daily Traffic	5,350

2013 Current Year	Daily Traffic
0.5% Annual Growth	5,400

2020 Base Year (Start Construction)	Daily Traffic
0.5% Annual Growth	5,600

2040 Design Year	Daily Traffic
0.5% Annual Growth	6,200

3.2. Build vs. No-Build Bridge Volumes

Traffic operations are being assessed for alternatives near the existing Cairo Bridge which connect to the existing US 51 approach in Kentucky. Under this scenario there are two differences between a build and no-build alternative;

1. No-Build Alternative: Over time as the bridge condition deteriorates the load rating would be reduced and eventually the bridge would be closed to traffic. This would decrease the traffic projections.
2. Build Alternatives: If a new bridge were constructed or the existing bridge rehabbed with wider lanes and wider shoulders, permit loads could be allowed on the bridge. The increase in traffic would be negligible.

As shown in the volume-to-capacity analysis in **Section 4.1** below, a significant increase in traffic would be needed before the Cairo Bridge would require more than two-lanes (one-lane in each direction). Because the change in traffic is negligible between the build and no-build alternatives, separate analysis was not conducted.

Although none of the build alternatives are expected to generate enough traffic to require additional lanes on the proposed bridge, a more detailed traffic analysis will be conducted if a northern alternative is selected that provides a new direct connection between US 60 in Kentucky and US 51 in Illinois, bypassing the cities of Wickliffe and Cairo.

4. Traffic Operations Analysis

4.1. Cairo Bridge

Level of Service (LOS) is a qualitative measure of highway traffic conditions, as identified in the *2010 Highway Capacity Manual* (HCM). Individual levels of service characterize these conditions in terms of speed, travel time, freedom to maneuver, traffic interruptions, and comfort and convenience. Six levels of service are defined and given letter designations from A to F, with LOS A as the best condition, representing free flow conditions, and ranging to LOS F, representing severe congestion and/or time delays. Typically, a minimum LOS D is considered acceptable in urban areas and LOS C is considered acceptable in rural areas.

For two lane highways, LOS is controlled by operating speed and passing opportunities. Because the existing bridge has a 40 mph speed limit and no passing zones, standard HCM calculation procedures results in a LOS D for the 2013, 2020, and 2040 design peak hour volumes. However, this measure is not representative of the actual operations on the bridge. Because the LOS description is governed by speed

and passing, poor sensitivity of the two-lane highway LOS module indicates LOS is not the most accurate methodology to analyze operations on the bridge.

As an alternative to LOS Methodology, design volumes were compared to the bridge's theoretical capacity. A volume-to-capacity ratio (V/C) represents the number of vehicles using the bridge in a specific time period compared to the number of vehicles the bridge was designed to be able to handle during that period. The target V/C ratio is 0.9 for rural areas and 1.0 for urban areas. A V/C greater than this indicates the bridge is congested, i.e. operating above its design capacity.

As part of this analysis, the 2013, 2020, and 2040 design bridge volumes discussed in **Section 3** were evaluated. This analysis helps determine the number of lanes needed on the bridge based on existing and future traffic demand. To transition between a daily and hourly forecast volume, analysts must apply two specific conversion factors. The K-factor describes what percentage of the weekday traffic volume is accounted for during the 30th highest hour during a typical year. The D-factor describes what percentage of the total traffic on a link is traveling in the peak direction.

The average K-factor and D-factor listed in *KYTC's 2008 Traffic Forecasting Report* are 12.2% and 58.8%, respectively for Rural Minor Arterials. A traffic count was conducted on January 22, 2013. On this day the peak hour percent volume was 9.0% and the average directional distribution was 56.0% for AM Peak Hour, PM Peak Hour and ADT. This project will assume a K-factor of 12.2% and a D-Factor of 56.0%.

Based on the forecast, an estimated 5,400 vehicles per day (vpd) are expected to cross the bridge in 2013. Using the K-factor and D-factor described above, this represents a peak hour volume of 660 vehicles and a directional peak hour volume of 370 vehicles. The theoretical capacity for a two lane bridge is calculated using an ideal capacity of 3,200 passenger cars per hour (1,700 passenger cars per hour per lane) factored by the peak hour factor (0.9), grade factor (0.9 for rolling terrain), and heavy vehicle factor (0.74 based on thirty five percent trucks). The resulting theoretical capacity of 1,920 passenger cars per hour was then compared to the 2013 peak hour volume of 660 vehicles resulting in a V/C of 0.34 for the existing Cairo Bridge. The theoretical capacity of 1,020 passenger cars per hour per lane was also compared to the 2013 directional peak hour volume of 370 vehicles which results in a V/C of 0.36. Because the V/C is less than 0.9, the bridge is operating below its design capacity.

An estimated 5,600 vpd are expected to cross the bridge in 2020. Using the K-factor and D-factor described above, this represents a peak hour volume of 685 vehicles and a directional peak hour volume of 385 vehicles. This results in a V/C of 0.36 and 0.38 for the 2020 peak hour volume and the 2020 directional peak hour volume, respectively. Because both are less than 0.9, the bridge would operate below the design capacity of a two-lane highway bridge.

An estimated 6,200 vpd are expected to cross the bridge in 2040. Using the K-factor and D-factor described above, this represents a peak hour volume of 755 vehicles and a directional peak hour volume of 425 vehicles. This results in a V/C of 0.39 and 0.42 for the 2040 peak hour volume and the 2040 directional peak hour volume, respectively. Because both are less than 0.9, the bridge would operate below the design capacity of a two-lane highway bridge.

Following the steps described above, V/C calculations were completed for the remaining future scenarios. The resulting V/C analysis is presented below in **Table 4.1**. Based on this analysis there is adequate capacity with a two-lane bridge between Wickliffe and Cairo to accommodate the existing and future traffic volumes.

Table 4.1: Cairo Bridge Volume-to-Capacity (V/C) Summary

Design Volumes	V/C Ratio
2013 Peak Hour Volume	0.34
2013 Directional Peak Hour Volume	0.36
2020 Peak Hour Volume	0.36
2020 Directional Peak Hour Volume	0.38
2040 Peak Hour Volume	0.39
2040 Directional Peak Hour Volume	0.42

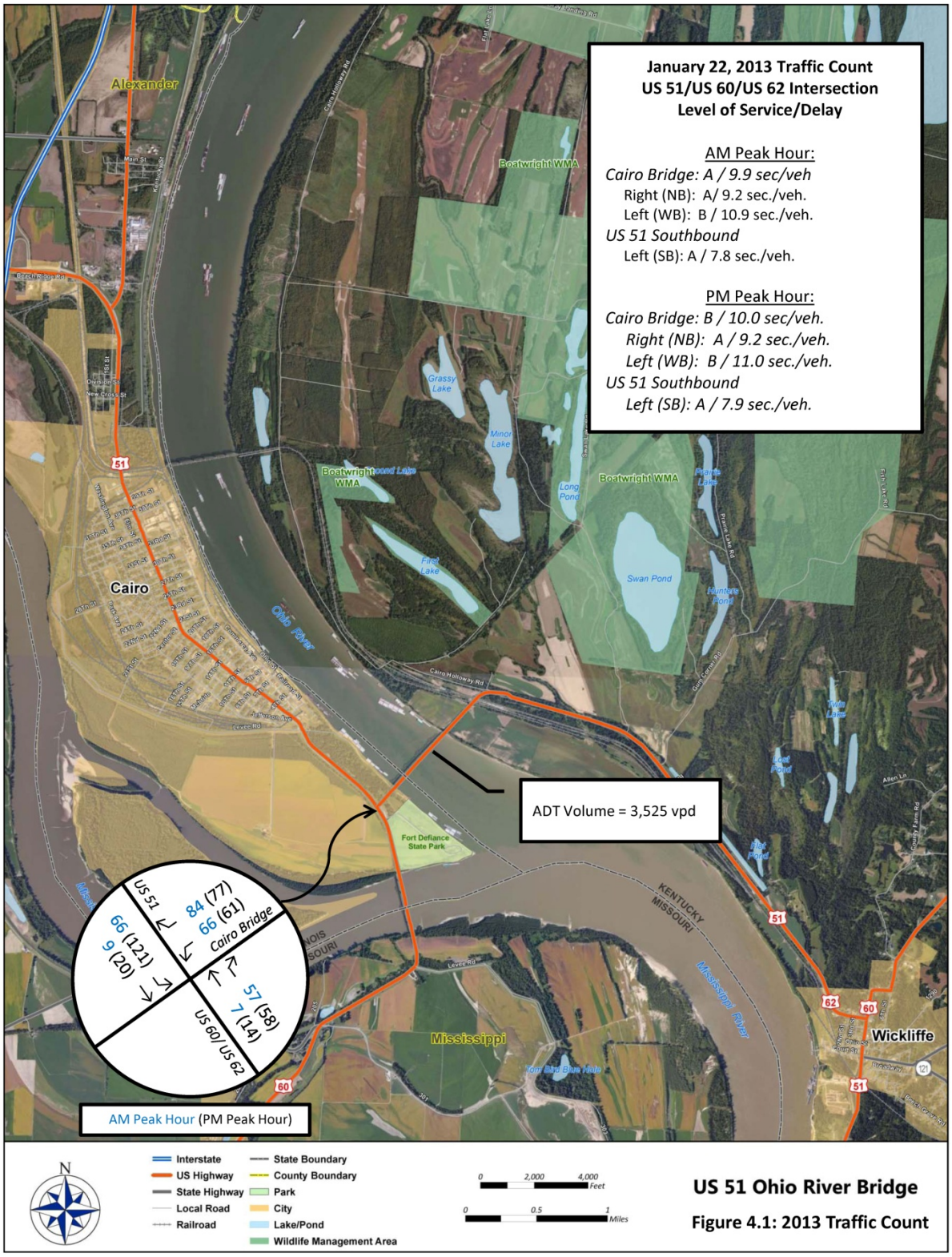
4.2. US 51/US 60/US 62 Intersection

The Cairo Bridge approach has a three leg intersection in Illinois. Vehicles traveling northbound on US 51 coming off the Cairo Bridge have a stop sign at the US 51/US 60/US 62 intersection in Illinois. The other two approaches, US 51 southbound and US 60/US 62 westbound, are not stop controlled. Turning movement volumes were derived from the January 22, 2013 traffic count. The traffic count volumes were increased and balanced to match the 2013, 2020 and 2040 design hour volumes discussed in **Section 3**. The turning movement volumes are shown in **Figures 4.1 – 4.4**. **Table 4.2** presents the LOS and Delay for this intersection based on standard calculations from the HCM. As shown the northbound US 51 bridge approach functions at a LOS D during the 2040 PM design hour. At all other time periods the intersection functions adequately at a LOS C or better.

To improve the delay at the northbound approach a couple of improvement options could be considered: the intersection could be signalized or the intersection could be converted to a three-way stop. Based on the January 22, 2013 traffic count, the intersection does not meet HCS Signal Warrants for Eight-Hour Vehicular Volume, Four-Hour Vehicular Volume or Peak Hour. While the intersection does not meet signal warrants, a three-way stop will be looked at during the alternative development process.

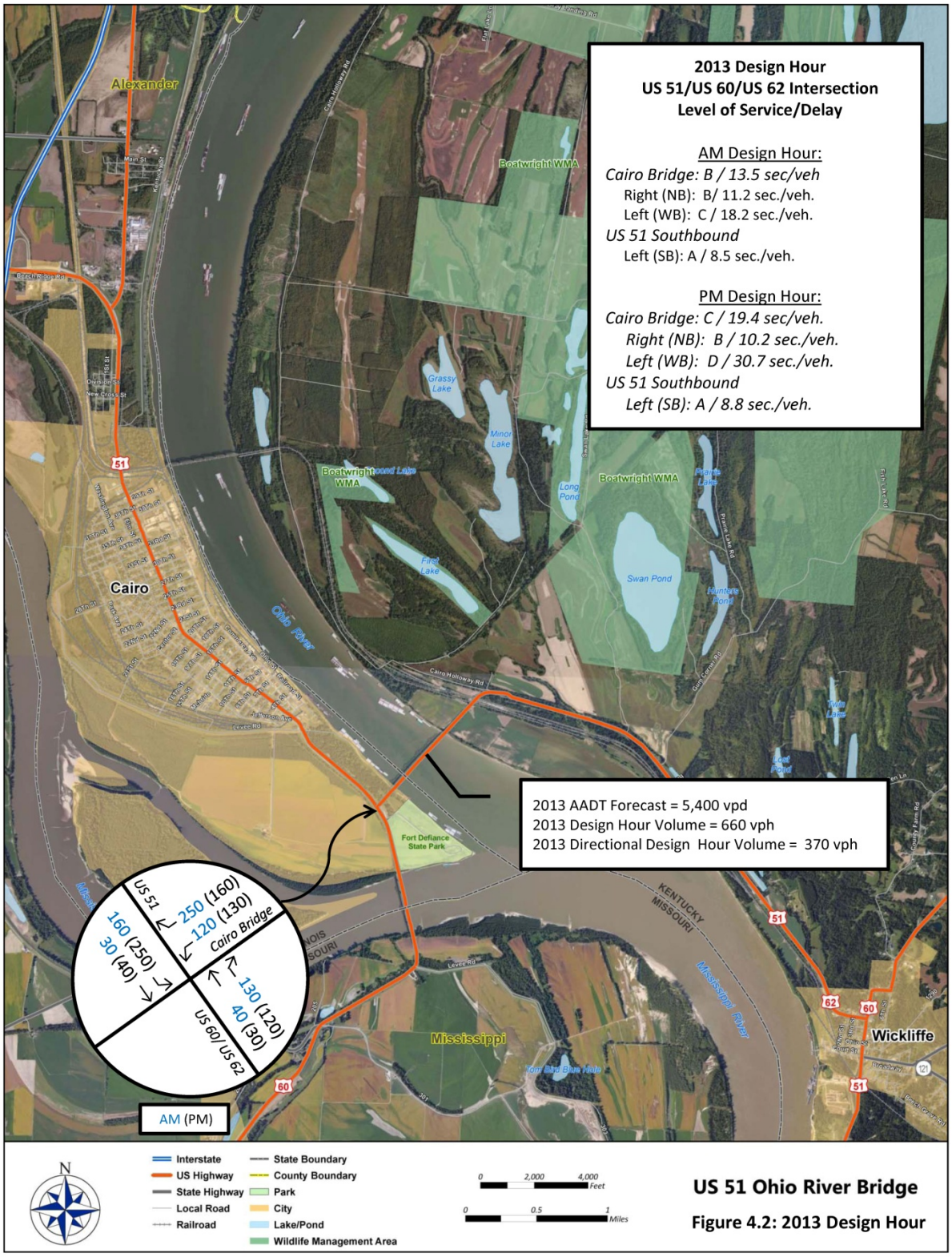
Table 4.2: US 51/US 60/US 62 Intersection LOS Summary

Approach	LOS	Delay (sec/veh)
2013 AM Design Hour Volume		
NB US 51 (Bridge)	B	13.5
SB US 51	A	8.5
WB US 60/US 62	Free Movement	
2013 PM Design Hour Volume		
NB US 51 (Bridge)	C	19.4
SB US 51	A	8.8
WB US 60/US 62	Free Movement	
2020 AM Design Hour Volume		
NB US 51 (Bridge)	B	14.0
SB US 51	A	8.5
WB US 60/US 62	Free Movement	
2020 PM Design Hour Volume		
NB US 51 (Bridge)	C	20.4
SB US 51	A	8.8
WB US 60/US 62	Free Movement	
2040 AM Design Hour Volume		
NB US 51 (Bridge)	C	15.7
SB US 51	A	8.7
WB US 60/US 62	Free Movement	
2040 PM Design Hour Volume		
NB US 51 (Bridge)	D	28.4
SB US 51	A	9.0
WB US 60/US 62	Free Movement	



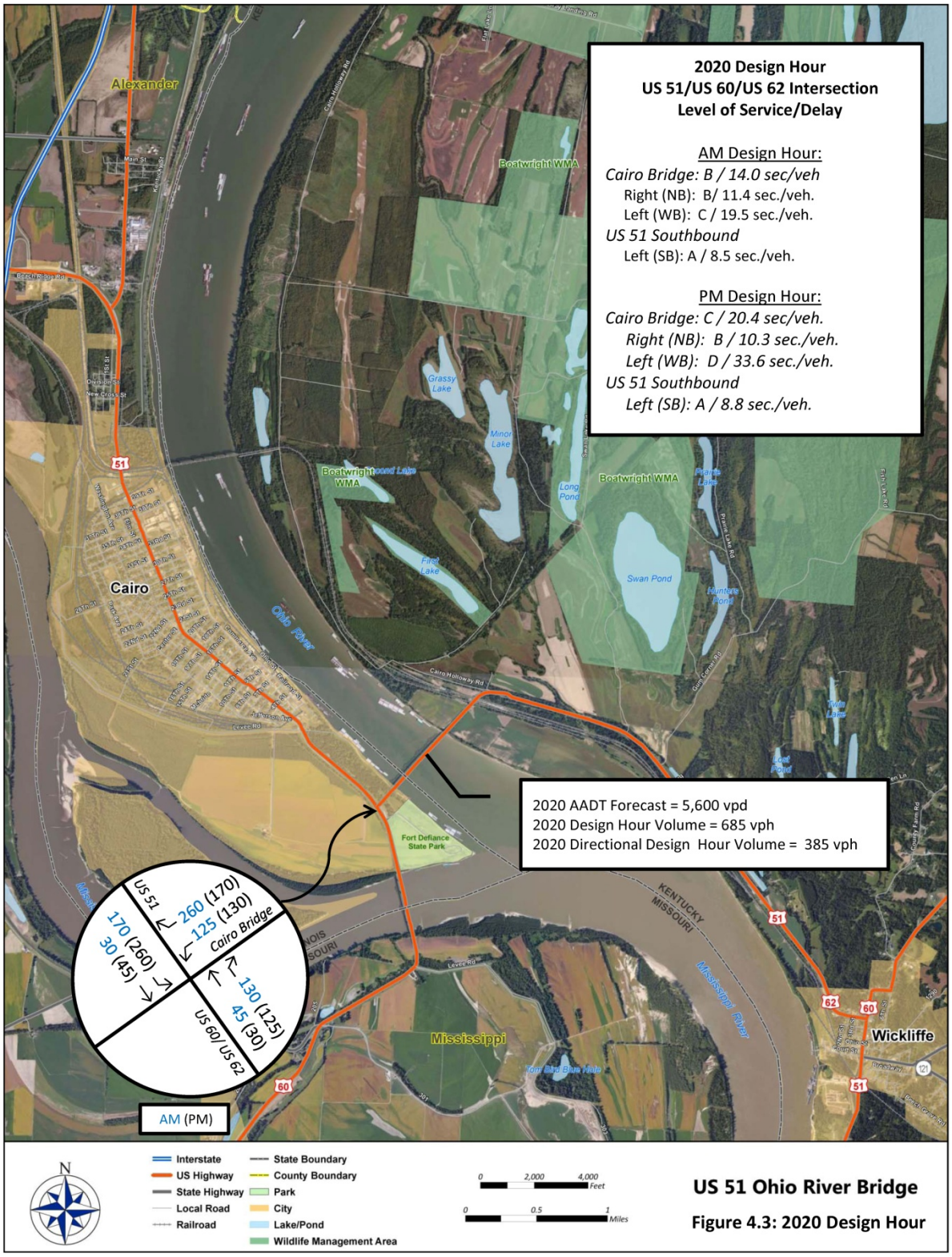
US 51 Ohio River Bridge

Figure 4.1: 2013 Traffic Count



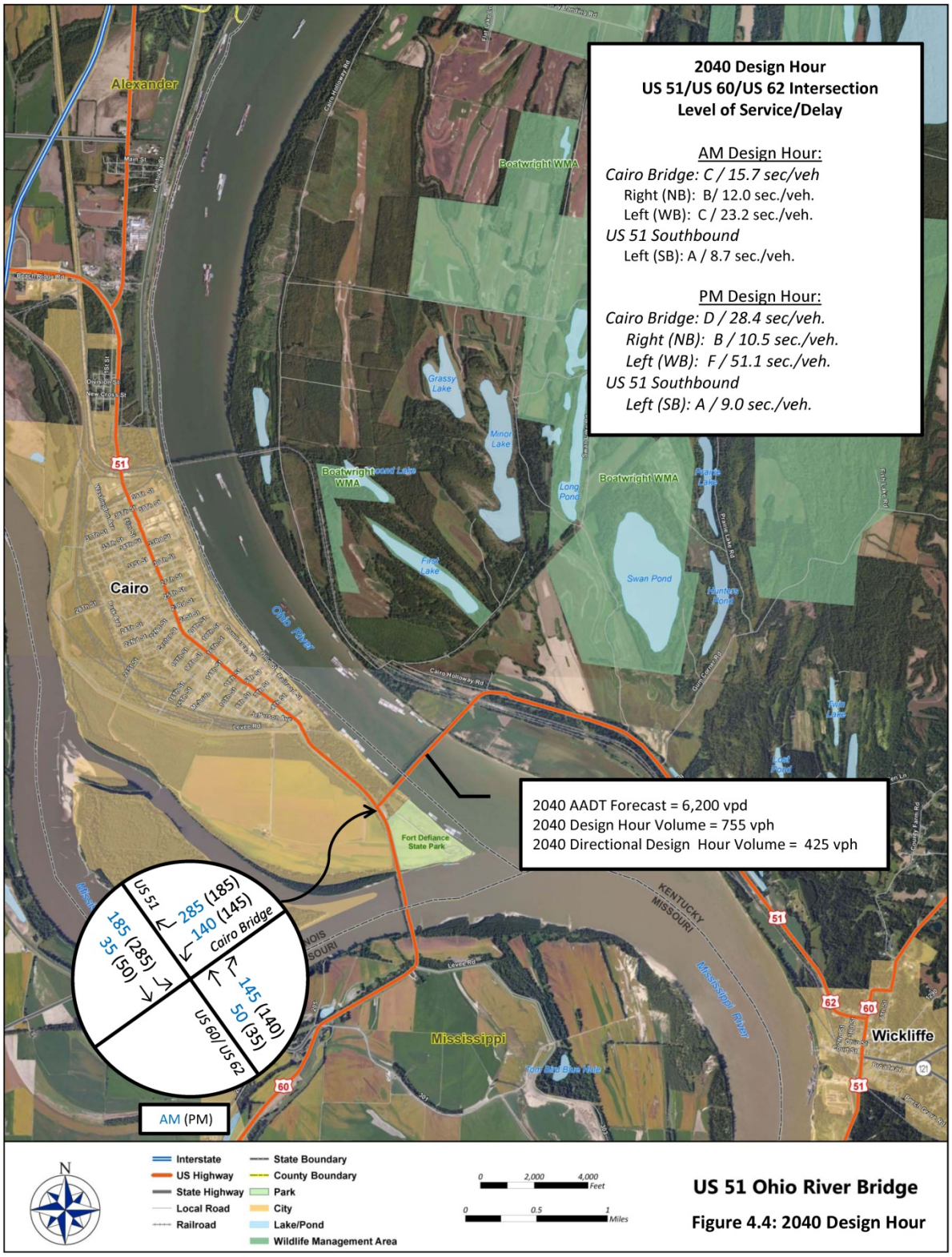
US 51 Ohio River Bridge

Figure 4.2: 2013 Design Hour



US 51 Ohio River Bridge

Figure 4.3: 2020 Design Hour



US 51 Ohio River Bridge

Figure 4.4: 2040 Design Hour

5. Summary

The traffic analysis presented in this report determined:

- The daily traffic forecast volumes for Cairo Bridge are:

2013 Current Year	Daily Traffic
0.5% Annual Growth	5,400

2020 Base Year (Start Construction)	Daily Traffic
0.5% Annual Growth	5,600

2040 Design Year	Daily Traffic
0.5% Annual Growth	6,200

- There is adequate capacity with a two-lane bridge between Wickliffe and Cairo to accommodate existing and future traffic volumes.
- The northbound US 51 approach in Illinois functions at a LOS D during the 2040 PM design hour. Otherwise the intersection functions adequately at a LOS C or better for the existing and future traffic volumes. Converting the intersection to a three-way stop will be looked at during the alternative development process.
- Although none of the build alternatives are expected to generate enough traffic to require additional lanes on the proposed bridge, a more detailed traffic analysis will be needed if a northern alternative is selected that provides a new direct connection between US 60 in Kentucky and US 51 in Illinois, bypassing the cities of Wickliffe and Cairo.