REVIEWED
By Mary Kennedy at 12:30 pm, Mar 01, 2022

Historic Bridge Alternatives Analysis

BRIDGE NUMBER: (933)31-71-03690 E

DESIGNATION NUMBER: 1900011

ROUTE IDENTIFICATION AND FEATURE CROSSED:
SR 933 over St. Joseph River

COUNTY: St. Joseph

NBI NUMBER: 011046

PROJECT LOCATION: 1.59 miles north of SR 23, in Section 1, T-37-N, R-2-E,
Portage Township, St. Joseph County, Indiana

REFERENCE POINT: 113+51

LATITUDE: 41° 41’ 17”
LONGITUDE: 86° 15’ 02”

PREPARED BY: Adam Steury, PE, SE
Lochmueller Group, Inc.

DATE: February 17, 2022

This bridge was evaluated by personnel from the Indiana Department of Transportation (INDOT) Bridge Design Unit, the District Office and the designer. The attached Draft Historic Bridge Alternatives Analysis has been reviewed by the INDOT Bridge Design Unit and Cultural Resources Office for thoroughness of the rehabilitation option and compliance with INDOT design policies. Concurrence by INDOT with the proposed Scope of Work does not constitute Final Approval of the Historic Bridge Alternatives Analysis. This draft HBAA may now be distributed to the historic consulting parties for review.

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I. EXISTING STRUCTURE DATA

A. Identification/History

Bridge No.: (933)31-71-3690 E
Project Location: SR 933 over St. Joseph River
South Bend, Indiana, St. Joseph County
Indiana Department of Transportation (INDOT) LaPorte District
See Appendix A for project location maps.
Designation No.: 1900011
Year Built: 1914
Years Repaired:

- 1945 Rehabilitation, Des. No. Unknown, Contract Unknown
    - Select limestone railing panels replaced in-kind with limestone panels, maintaining the same architectural railing details from the original construction
- 1977 Rehabilitation (Locally Funded)
    - Bituminous surface added to travelway.
    - Concrete barrier curb replaced between sidewalk and travelway.
    - Replaced select limestone railing panels with concrete panels. Architectural details did not match original construction.
- 1997 Rehabilitation, Des. No. 0067416, Contract M-25197
    - Revetment riprap placed at upstream face of both piers.
- 2001 Rehabilitation “A”, Des. No. 0017430, Contract RS-25199
    - Bituminous wearing surface milled and resurfaced.
- 2006 Rehabilitation “B”, Des. No. 9610500, Contract B-27194
    - Concrete filled cofferdams constructed around both piers.
    - Riprap placed around perimeter of cofferdams.
    - Select spandrel wall limestone blocks repaired or replaced.
    - New aluminum cast ornamental light standards installed on the pier and abutment pilasters.
    - All spandrel wall limestone joints repointed.
    - Arch ring repaired with pneumatically placed mortar patching, epoxy injection of cracks and installation of weep holes at the arch spring lines.

    - Existing concrete barrier curbs, sidewalks, and 6" of asphalt/concrete wearing surface removed and replaced with new concrete barrier curbs, a 6" thick concrete roadway pavement, and 6" thick concrete sidewalks.
- 2012 Rehabilitation "C", Des. No. 1173149, Contract B-34153
    - Select railing panels replaced with concrete panels. Architectural details did not match original construction.
    - Select spandrel wall limestone blocks repaired.
    - Transverse cracking in arches repaired with epoxy injection.
    - Arches strengthened with fiber reinforced polymer (FRP) strips.
    - Construction joints between arch segments patched.
- 2018 Rehabilitation "D", Des. No. 1500673, Contract B-36679
    - Polymeric concrete bridge deck overlay placed.

Most Recent Field Inspection Dates per Type of Inspection:

- 03/19/2021 – Routine Inspection
- 09/05/2019 – Special Inspection for Arch Settlement Monitoring
- 03/20/2018 – Critical Finding Inspection Due to Failing FRP
- 05/18/2016 – Underwater Inspection

Average Daily Traffic (Year of ADT):

- Construction: 16,110 vpd (2023)
- Design: 16,110 vpd (2043)

Percentage of Commercial Vehicles: 7%

Low volume road: No

Functional Classification: Other Principal Arterial

Detour Length: 3.7 miles

Load Rating:

- Load rating information provided from the Bridge Rating Application Database of Indiana (BRADIN), which is the governing system for all bridge load ratings in Indiana. Note that no legal or routine permit loads (Operating Loads) produce a rating factor (RF) less than 1.0, so load posting of the bridge is not required in accordance with INDOT Bridge Inspection Manual 3-6.0. However, there is a permanent restriction entered for this structure in the INDOT CARS Program, which prohibits issuance of any overweight vehicle permits to cross the bridge. Additionally, all design loads (Inventory Loads) produce a RF less than 1.0. A load rating factor less than 1.0 indicates that the design vehicle cannot safely utilize the bridge for an indefinite period of time.

- HS20-44
    - Operating: RF = 1.35; Load Capacity = 48 Tons
    - Inventory: RF = 0.81; Load Capacity = 29 Tons
- H20-44
    - Inventory: RF = 0.90; Load Capacity = 18 Tons

Sufficiency Rating: 49.1 (out of 100)

National Register of Historic Places Status:

- Listed as Contributing Resource within the Leeper Park Historic District
- National Register File Number & Date: NR-1393; 02/18/1999

Historic Bridge Prioritization Status: Select

Historic Character-Defining Features: Reinforced Concrete Arch Bridge with Limestone Facade

- This bridge represents a variation, evolution, or transition that is conveyed through important features or innovations related to bridge construction, design, or engineering, and it retains historic integrity necessary to convey its engineering significance.
- This bridge has a decorative limestone facade on both spandrel walls, ornate concrete and limestone railing, and limestone railing pilasters with ornamental lighting.

B. Structure/Dimensions

Surface Type: Polymeric Concrete Overlay
Out to Out of Copings: 72′-1″
Out to Out of Bridge Floor: 323′-3″
Clear Roadway Width: 55′-0″
Number of Lanes on Structure: 5: 2 – 11′-0″ Lanes, 2 – 10′-0″ Lanes, 1 – 11′-0″ Turn Lane, 1′-0″ Curb Offsets
Skew: 0°
Type of Superstructure: Filled Reinforced Concrete Arch
Spans: 3 Spans; Clear Span Lengths = 84′-0″, 120′-0″, 84′-0″
Type of Substructure/Foundation: Concrete Pedestals Supported by Timber Piles
Seismic Zone: 1

C. Appurtenances

Bridge Railing:
- Open concrete railing on both sides of bridge with ornamental limestone-clad pier and abutment pilasters and intermediate railing span pilasters.
  - Approximately 3′-6 7/8″ height above sidewalk surface.
  - Approximately 4′-4 1/2" & 4′-4 1/4" height above road surface on the west and east sides of the bridge, respectively.

Bridge Lighting:
- Ornamental aluminum cast light fixtures on top of pier and abutment pilasters.

Curbs:
- Barrier curb on both sides of roadway.
  - It is cast integrally with roadway pavement and sidewalk.
  - The barrier curb is 2′-6″ and 2′-0″ tall above roadway surface, on the west and east sides of the bridge respectively, based on current survey information. It is 1′-9″ tall above sidewalk surface on both sides of the bridge.
  - The barrier curb is 1′-2″ wide.

Sidewalks:
- West side of bridge: 5′-3/4″ minimum width, based on field measurements; 9″ above roadway surface
- East side of bridge: 3′-11 1/16″ minimum width, based on field measurements; 9″ above roadway surface

Utilities: There are no utilities attached to the outer surfaces of the bridge; however there are electric, communication, gas, and water lines beneath the sidewalk and pavement on the bridge. There are additional electric, communication, gas, water, and sanitary sewer lines near the end of the bridge at the intersection with North Shore Drive.

Railroad: None within project limits or anticipated to be affected by proposed maintenance of traffic.

D. Approaches

Roadway Width: 55′-0″
Surface Type: Asphalt
Guardrail: None
Guardrail End Treatment: None

II. EXISTING CONDITIONS

For the purposes of this report the bridge deck refers to the roadway pavement, barrier curbs, sidewalks, and railings; the superstructure refers to the reinforced concrete arches and spandrel walls. Condition ratings range from 0 to 9, with 0 indicating a failed structure and 9 indicating a new structure with no deficiencies. Photos of the existing conditions can be found in Appendix B.

A. Bridge Deck

- General: The overall condition of the bridge deck is "fair" (Condition Rating 5 out of 9). The bridge deck on this structure consists of a Polymeric Concrete Overlay on 6" of reinforced concrete pavement on approximately 8 ¼" to 12" of unreinforced concrete pavement on fill that consists of sand, gravel, and some sandy loam. The concrete pavement thickness and fill is based on cores taken through the existing bridge (See Appendix I).
- Overlay: There is a Polymeric Concrete Overlay on the bridge.
- Surface Condition: The condition of Polymeric Concrete Overlay wearing surface is "fair" (Condition Rating 5 out of 9). Widely spaced transverse cracks intersecting with a single longitudinal crack are present in the northbound lane of the south and main spans.
- Underside Condition: The underside of the concrete pavement is not visible due to the arch superstructure. Water is leaking through the deck based on the presence of minor leakage between select arch segments and out of drain outlets at the base of arches beneath the bridge. See below under "Superstructure" for additional arch conditions and explanation of arch segments.
- Joints: There are no expansion joints on the bridge. The type I-A joints at the ends of the bridge are in good condition with minor asphalt spalling along them.
- Drainage: Drainage on the bridge is conveyed along the barrier curb lines to both ends of the bridge where it is directed along curbed roadway gutters to storm sewer inlets.
- Bridge Railing: The concrete railing is in good condition with minor cracking and weathering. Two panels of original limestone railing are present at the southeast corner of the bridge; the northernmost panel has

moderate weathering while the southernmost panel has negligible deficiencies. Limestone pilasters are present between railing panels at approximately 15′-0″ spacing and are in fair condition with minor cracking, spalling, and weathering.

- Curbs: The barrier curb between the roadway and sidewalk is in good condition with vertical cracking at approximately 2′-0″ spacing. There is no visual indication of collision damage on the barrier curb.
- Sidewalks: The sidewalks are both in good condition with minor transverse cracking present.

B. Superstructure

- General: The overall condition of the superstructure is "fair" (Condition Rating 5 out of 9).
- Spandrel Walls: The reinforced concrete spandrel walls, covered by a limestone facade, are in poor condition. Cores were previously taken through the spandrel walls and found the reinforced concrete to be crumbling on both the inside and outside faces. The limestone facade on the east side of Span B has a noticeable sag. Select limestone blocks are cracked, spalled, or exhibit significant weathering. Numerous mortar joints between stone blocks are partially or completely missing mortar.
- Arches: The arches (underside of the bridge) are in fair condition. Each span consists of four (Spans A & C) or six (Span B) separate conventionally reinforced concrete, directly adjacent, arch ring segments which are tied together with minimal reinforcement. Fiber reinforced polymer strips on the underside of the arches in all spans exhibit air pockets and debonding between the strip and the concrete surface in many locations with some locations peeling off. Differential settlement between the exterior and first interior arch ring segments of Spans B and C is present on the east (upstream) side of the bridge. This differential settlement between arches is a maximum of approximately 3″ in the main span and 2″ in the north span. Settlement of the east end of Pier 3 (north pier) is believed to have caused this differential arch settlement; please see substructure conditions below for further explanation.

C. Substructures and Foundations

- General: The overall condition of the substructure is "fair" (Condition Rating 5 out of 9). Limestone weathering and concrete deterioration is present at all substructure units.
- Scour & Settlement: Settlement is present at the east end of Pier 3. This settlement is believed to have been due to previous scour and footing undermining that was initially stabilized with riprap and later with a concrete filled cofferdam around the piers.

D. Approaches

- General: The asphalt approach pavement overall is in good condition. Minor cracking and rutting is present in the approach pavement. Curb ramps meeting current standards are present near the north end of the bridge at the intersection of SR 933 and North Shore Drive.

E. Slopewalls

- General: There are no slopewalls present at this bridge.

III. PURPOSE AND NEED

The primary need for the Leeper Park Michigan Street Bridge project, named after the adjacent historic park and street carried by the bridge, is evidenced by the deteriorated condition and insufficient load carrying capacity of the bridge.

The condition of the existing bridge is reflected by the current condition rating of 5 out of 9 for the deck, superstructure, and substructure. Condition ratings range from 0 to 9, with 0 indicating a failed structure and 9 indicating a new structure with no deficiencies; a condition rating of 5 indicates "fair" condition. The "fair" condition rating is primarily due to the differential settlement of the arches on the east side of the bridge. The deck, superstructure, and substructure elements of the bridge have an estimated remaining life of 5-10 years with no repairs or work performed.

The current load rating factor for the required HS20-44 design vehicle (semi-truck and trailer) is 0.81 per the Bridge Rating Application Database of Indiana (BRADIN), which is the governing system for all bridge load ratings in Indiana. A load rating factor less than 1.0 indicates that the design vehicle cannot safely utilize the bridge for an indefinite period of time. The reduced load rating factor for this structure is based on the limiting load carrying capacity of the arch rings without consideration of the substructure. However, concrete filled cofferdams were installed at the piers during the 2006 rehabilitation, which applied additional unintended loads to the substructure foundations. This further reduced the safe live load carrying capacity of the structure.

The purpose of the project is to provide a crossing of the St. Joseph River that has a deck, superstructure, and substructure condition rating of at least 7 out of 9, which is considered "good" condition. In addition, the purpose of the project is to improve the load rating factor to at least 1.0 for the HS20-44 design vehicle. This project will extend the life of this crossing for a minimum of 25 years in accordance with INDOT *Historic Bridge Programmatic Agreement*.

IV. ALTERNATIVES

A virtual scoping field check was held on January 27, 2021 and a follow up virtual scoping meeting was held on February 25, 2021. (See Appendix G)

A virtual consulting parties meeting was held on May 20, 2021. (See Appendix K)

A. No Build/Do Nothing

This alternative proposes no work take place, leaving all elements in their current state. No federal funds would be expended. This alternative would result in no environmental impacts and is an avoidance alternative which would result in no impact to the historic bridge. This is a feasible alternative.

This alternative does not improve the condition of the superstructure or substructure, the load rating factor remains 0.81 for the HS20-44 design vehicle, the substructure foundations capacity are inadequate, and the current service life expectancy remains to be 5-10 years until repairs are required on the structure. This alternative is feasible, however it is not prudent since the purpose and need are not satisfied.

B1a. Rehabilitation for Continued Vehicular Use Meeting Secretary of Interior's Standards for Rehabilitation – Partial Replacement of Arches with Foundation Strengthening

This alternative would include rehabilitation of the structure for continued vehicular use for five lanes (two in each direction and a center turn lane at the north end of the bridge) across the bridge. The proposed bridge cross section will maintain the existing overall bridge width and 55′-0″ clear roadway width and utilize 10″ reinforced concrete vehicular/pedestrian traffic separation barrier railing on both sides of the clear roadway, which will provide sidewalk widths of 5′-10 ¾″ and 4′-9 1/16″ on the west and east side of the bridge, respectively.

The scope of the rehabilitation includes:

- Removal of the bridge deck, sidewalks, barrier curbs, railings, spandrel walls, arch fill, and displaced arch rings in Spans B and C on the east side of the bridge.
- Removal of approach pavement, sidewalks, barrier curb transitions, and curbs as necessary for removal of all arch fill.
- Removal of concrete within the pier cofferdams and cutting off of the cofferdam sheet piling within the limits of concrete removal.
- Installation of micropiles within the pier cofferdams followed by encasement in concrete to structurally connect the micropiles to the piers and strengthen their foundations.
- Placement of scour countermeasures around the piers and abutments.
- Reconstruction of arch ring segments removed in Spans B and C.
- Application of waterproofing membrane to all arch rings.
- Construction of new concrete spandrel walls, reinstalling the existing limestone fascia blocks after repair or replacement, in-kind, of deteriorated blocks.
- Placement of new arch fill.
- Placement of new concrete bridge deck and sidewalks. The sidewalks will be separated from traffic by a 34″ tall, 10″ wide, reinforced concrete barrier railing which will taper down to match the height of the approach curbs, similar to the existing barrier curbs.
- Placement of the two existing limestone railing panels back in their original location. Placement of new concrete railing replicating the architectural details from the 1945 Rehabilitation plans, which match the original limestone railing. Limestone blocks on railing pilasters will be reused, repaired, or replaced in-kind, depending on extent of deterioration. Ornamental lighting will be reinstalled on pier and abutment pilasters.

See Appendix C for graphical explanation of the proposed work described above.

Micropiles are proposed to strengthen the existing pier foundations, prevent further settlement, and offset the additional dead load of the concrete within the pier cofferdams which offers some scour protection and transfers the loads from the proposed micropiles to the existing piers. A preliminary analysis found that 20 – 7″ diameter micropiles driven around the perimeter of the existing pier, within the pier cofferdams, is anticipated to achieve the necessary strengthening. Micropile installation with access from beneath the existing arches to remain is feasible based on the minimum vertical and horizontal clearances required for installation.

The existing timber piles and pier cofferdam piling are not installed deep enough to resist Q100 or Q500 scour according to the scour elevations provided in the 2006 Rehabilitation "B" Plans. Therefore, Piers 2 and 3 remain vulnerable to scour and future undermining and differential settlement. According to the 2006 Rehabilitation Plans, the Q100 scour elevation is El. 640.77 and the Q500 scour elevation is El. 637.41. The cofferdam sheet piling was installed with a bottom of piling elevation of El. 650.00. The bottom tip elevation of the existing pier timber piles is approximately El. 640.00, according to the Foundation Condition Assessment of Pier No. 3, dated December 18, 2002, prepared by Earth Exploration. Earth Exploration measured the approximate bottom tip elevation of the existing timber piles at Pier 3 in October 2002 by conducting a parallel seismic test. The existing abutment foundation depths are unknown.

Based on the scour and substructure foundation elevations presented herein, the bridge is believed to be scour critical and scour countermeasures are anticipated to be required. Based on the stream velocity from the Rehabilitation "B" Plans Class 1 riprap is proposed to be placed in accordance with IDM Figure 203-3B.

Since some of the existing arch rings, on which the current structural capacity load rating is based, will be maintained in the rehabilitated bridge the load rating factor of 0.81 for the HS20-44 design vehicle will remain unchanged. Cores were taken through the existing arches during the non-destructive testing and geotechnical investigation conducted in November 2020 (See Appendix I) which found horizontal delaminations within the arch concrete, further raising concerns of existing capacity. In accordance with Indiana Design Manual (IDM) Figure 412-2A and Figure 55-3E, since the ADT is greater than 400 vehicles per day for the urban (built-up) principal arterial route a structural capacity rating factor of 1.0 is required for a HS20-44 design vehicle. A design exception is required for this Level One Design Loading Structural Capacity criteria.

The sidewalk on the east side of the bridge does not meet current Americans with Disabilities Act (ADA) standards. The current east sidewalk width is restricted at each bridge railing pilaster with clearance between the barrier curb and pilasters varying from 3′-11 1/16″ to 4′-3 7/8″. Between railing pilasters there is an additional approximately 6″ of width between the barrier curb and face of bridge railing. This provides a maximum sidewalk width from 4′-5 1/16″ to 4′-9 7/8″ in these areas. The bridge railing pilasters are located at an approximately 12′-0″ spacing along the bridge with an unobstructed length of approximately 9′-4″ between bridge railing pilasters. Current ADA guidelines, per the Proposed Public Rights-of-Way Accessibility

Guidelines (PROWAG), require the sidewalk to have a continuous minimum width of 5′-0″ or a continuous minimum width of 4′-0″ with a 5′-0″ wide by 5′-0″ long minimum passing space located at a 200′-0″ maximum interval. To satisfy ADA requirements, the east bridge sidewalk width must be widened to one of the two available ADA compliant options.

The proposed 34″ tall barrier railing will be a Hawaii Department of Transportation (HDOT) vertical faced barrier (See Appendix H) that meets Manual for Assessing Safety Hardware (MASH) Test Level 3 (TL-3) required by applicable design criteria for this bridge (See Appendix E). The proposed barrier railing will have a flat, non-aesthetic, face to more closely match the existing barrier curb in appearance. Pipes will be provided through the proposed barrier railing, similar to the existing barrier curb, for sidewalk drainage into the roadway gutter line. This barrier railing is 4″ narrower than the existing barrier curb which allows adequate room for 5′-0″ wide by 5′-0″ long minimum passing spaces on the east sidewalk of the bridge, thereby meeting ADA requirements.

During construction, vehicular and pedestrian traffic is proposed to be maintained by detour. The vehicular detour will utilize West Cleveland Road, North Bendix Drive, Lincoln Way West, and Doctor Martin Luther King Jr. Boulevard and has been approved by the City of South Bend as an acceptable detour for truck traffic. The pedestrian detour will utilize East North Shore Drive sidewalk, the East Bank Trail, East Lasalle Avenue sidewalk, and Doctor Martin Luther King Jr. Boulevard sidewalk and has been verified to be ADA compliant for its full extent.

Phased construction was assessed for this and the following alternative. Phased construction is feasible for this alternative but is not for the following alternative; consequently, a detour was used for both alternatives for cost comparison. The user costs associated with maintenance of traffic were evaluated based on INDOT and Texas Department of Transportation (TXDOT) available information and were found to be approximately $58,177,400 for a detour and $1,642,700 for phased construction. Although there is a considerably higher user cost associated with a detour, it is still recommended for both alternatives since phased construction is not feasible for the following alternative and adds considerable construction complexity and cost to this alternative. A detour will cause some delays to medical transport services accessing the Memorial Hospital of South Bend campus located approximately 0.20 miles south of the bridge. However, with the use of unofficial local detours, those delays can be minimized. See Appendix J for further explanation regarding the feasibility of phasing, detailed user costs, and figures showing the proposed detour routes.

No permanent right-of-way is anticipated for this alternative, however approximately 0.52 acres of temporary right-of-way is anticipated for construction access. Approximately 150 linear feet of temporary and permanent stream impacts are anticipated for construction access and riprap placement, respectively. No wetland impacts are expected.

The estimated construction cost of this alternative is $8,608,000 (See Appendix D). The expected service life of the rehabilitated bridge is 30 years with an anticipated deck, superstructure, and substructure condition rating of 7 out of 9, indicating a "good" condition. The substructure foundations will have adequate capacity for all design loads, however the load rating factor will remain 0.81 for the HS20-44 design vehicle. A single Level One design exception, for Design Loading Structural Capacity, is required for this alternative. The Level One design exception would be prepared in accordance with IDM Section 40-8.04(01) with review and approval by INDOT if this alternative is pursued. The Level One design exception is not expected to be approved, if pursued, because retention of the existing arches would prevent lifting the overweight vehicle permit restriction for this crossing. Also, advancement of the current arch deterioration and material degradation over time will further reduce load carrying capacity and result in load posting.

This alternative does not fully address the purpose and need of this project since the bridge will still have a load rating factor of less than 1.0 for the HS20-44 design vehicle. This alternative is feasible if the required design exceptions are approved by INDOT, however it is not prudent since the purpose and need are not satisfied.

See Appendix E for a summary table of the applicable Level One design criteria, the existing and proposed conditions, and if the proposed conditions satisfy Level One design criteria.

B1b. Rehabilitation for Continued Vehicular Use NOT Meeting Secretary of Interior's Standards for Rehabilitation – Complete Replacement of Arches with Foundation Replacement

Since the previous alternative did not satisfy the purpose and need, this alternative is a more extensive rehabilitation developed to address those items that were not sufficient in the previous alternative.

This alternative includes rehabilitation of the structure for continued vehicular use for five lanes (two in each direction and a center left turn lane at the north end of the bridge) across the bridge. Identical to the previous alternative, the proposed bridge cross section will maintain the existing overall bridge width and 55'-0" clear roadway width and utilize 10" reinforced concrete vehicular/pedestrian traffic separation barrier railing on both sides of the clear roadway, which will provide sidewalk widths of 5′-10 ¾″ and 4′-9 1/16″ on the west and east side of the bridge, respectively.

The scope of the rehabilitation includes:

- Removal of all bridge elements (i.e. bridge deck, sidewalks, barrier curbs, railings, spandrel walls, arch fill, arches, substructure pedestals, and concrete filled cofferdams) to the existing foundations.
- Installation of new deep pile foundations.
- Construction of new substructure pedestals reusing existing limestone blocks at the ends.
- Construction of new arch rings and application of a waterproofing membrane on the top of arch rings.
- Construction of new concrete spandrel walls, reinstalling the existing limestone fascia blocks after repair or replacement, in-kind, of deteriorated blocks.
- Placement of new arch fill.
- Placement of new concrete bridge deck and sidewalks. The sidewalks will be separated from traffic by a 34″ tall, 10″ wide, reinforced concrete barrier railing which will taper down to match the height of the approach curbs, similar to the existing barrier curbs.
- Placement of the two existing limestone railing panels back in their original location. Placement of new concrete railing replicating the architectural details from the 1945 Rehabilitation plans, which match the original limestone railing. Limestone blocks on railing pilasters will be reused, repaired, or replaced in-kind, depending on extent of deterioration. Ornamental lighting will be reinstalled on pier and abutment pilasters.

See Appendix C for graphical explanation of the proposed work described above.

Since full substructure and superstructure replacement is recommended with new deep pile foundations, new substructure pedestals, new arch rings, and new concrete spandrel walls a HL-93 design vehicle in accordance with AASHTO LRFD Bridge Design Specifications, 9th Edition is recommended per IDM Figure 412-3A. Bridges designed for a HL-93 design vehicle consistently also satisfy the capacity requirements of a HS-20 design vehicle due to the similarities between vehicle loadings.

Similar to Alternative B1a, the 34″ tall HDOT barrier railing will replace the existing barrier curb. See Alternative B1a above for additional information.

As mentioned above within Alternative B1a, both vehicular and pedestrian phased construction is not feasible for this alternative. A detour is required to maintain both vehicular and pedestrian traffic for this alternative.

No permanent right-of-way is anticipated for this alternative, however approximately 0.52 acres of temporary right-of-way is anticipated for construction access. Approximately 150 linear feet of temporary steam impacts are anticipated for construction access; no permanent stream impacts are anticipated. No wetland impacts are expected.

The estimated construction cost of this alternative is $12,201,400. The expected service life of the rehabilitated bridge is 75 years with an anticipated deck, superstructure, and substructure condition rating of 9 out of 9, indicating an "excellent" condition. The substructure foundations will have adequate capacity for all design loads and a load rating factor of 1.0 or greater will be obtained for the HS20-44 design vehicle. No Level One design exceptions are required for this alternative.

This alternative fully addresses the purpose and need of this project. This alternative is feasible since the minimum design standards in the Indiana Design Manual will be met and is prudent since the purpose and need are satisfied.

See Appendix E for a summary table of the applicable Level One design criteria, the existing and proposed conditions, and if the proposed conditions meet Level One design criteria.

V. MINIMIZATION AND MITIGATION

A. Minimization

For the preferred alternative, efforts to minimize impacts to the historic bridge will include maintaining the bridge's historic aesthetics by reusing the existing limestone spandrel wall and arch ring fascia blocks, railing pilaster blocks, and ornamental lighting, maintaining the two panels of original limestone railing remaining, and replacing the existing concrete railing panels with concrete, but replicating the architectural details from the 1945 Rehabilitation plans for stone railing repairs which are detailed to match the original limestone railing elements.

The Indiana State Historic Preservation Officer (SHPO) asked during the Consulting Parties Meeting about the feasibility and anticipated life of using limestone railing throughout the bridge instead of replacing existing concrete railing with new concrete railing (See Appendix K). Panels of the original limestone railing have been removed and replaced with either limestone or concrete beginning with the 1945 Rehabilitation. Ultimately, all but two panels have been replaced with concrete, which illustrates limestone's limited durability in this railing application adjacent to a roadway which receives deicing salts and other chemical treatments (See Appendix C). Based on rehabilitations performed on this bridge, limestone railing at this location would have an estimated service life of 40 years while concrete railing would have an estimated service life of 75 years. Also, limestone railing is more costly than concrete railing.

B. Bridge Marketing

Bridge marketing is not necessary for this Select bridge.

C. Mitigation

Consultation with the SHPO will take place to determine if photo documentation of the existing bridge is needed. Rehabilitation plans will be provided to the Indiana SHPO at 30%, 60%, and 90% completion for review and concurrence.

Although not required per the Historic Bridge Programmatic Agreement, as a result of consulting party input, INDOT will install interpretive signage at the project location to inform the public about the historic bridge and acknowledge its reconstruction with some original construction materials salvaged and reused.

VI. PRELIMINARY PREFERRED ALTERNATIVE

Alternative B1b, Rehabilitation for Continued Vehicular Use NOT Meeting Secretary of Interior's Standards for Rehabilitation, is recommended as both feasible and prudent and, therefore is the preliminary preferred alternative.

Although Alternative B1b does not meet the Secretary of Interior's Standards for Rehabilitation (SOI), the plans will be developed such that the rehabilitation will adhere "as close to the Standards as is practicable," as outlined in Attachment B of the Historic Bridge Programmatic Agreement. The existing reinforced concrete substructure units, founded on driven piling, will be replaced in-kind except with steel piles in place of timber piles. Each substructure unit will require custom design to receive the original limestone facade blocks, just as the original substructure units were designed. The conventionally reinforced concrete arches will be replaced with conventionally reinforced concrete arches matching the shape and width of the original arches. The original reinforced concrete spandrel walls, custom designed to receive the limestone facade, will be replaced with similarly custom designed spandrel walls made up of the same construction materials and built using similar cast-in-place reinforced concrete construction methods. The elements of the bridge will also be built following a similar construction sequence as the original construction.

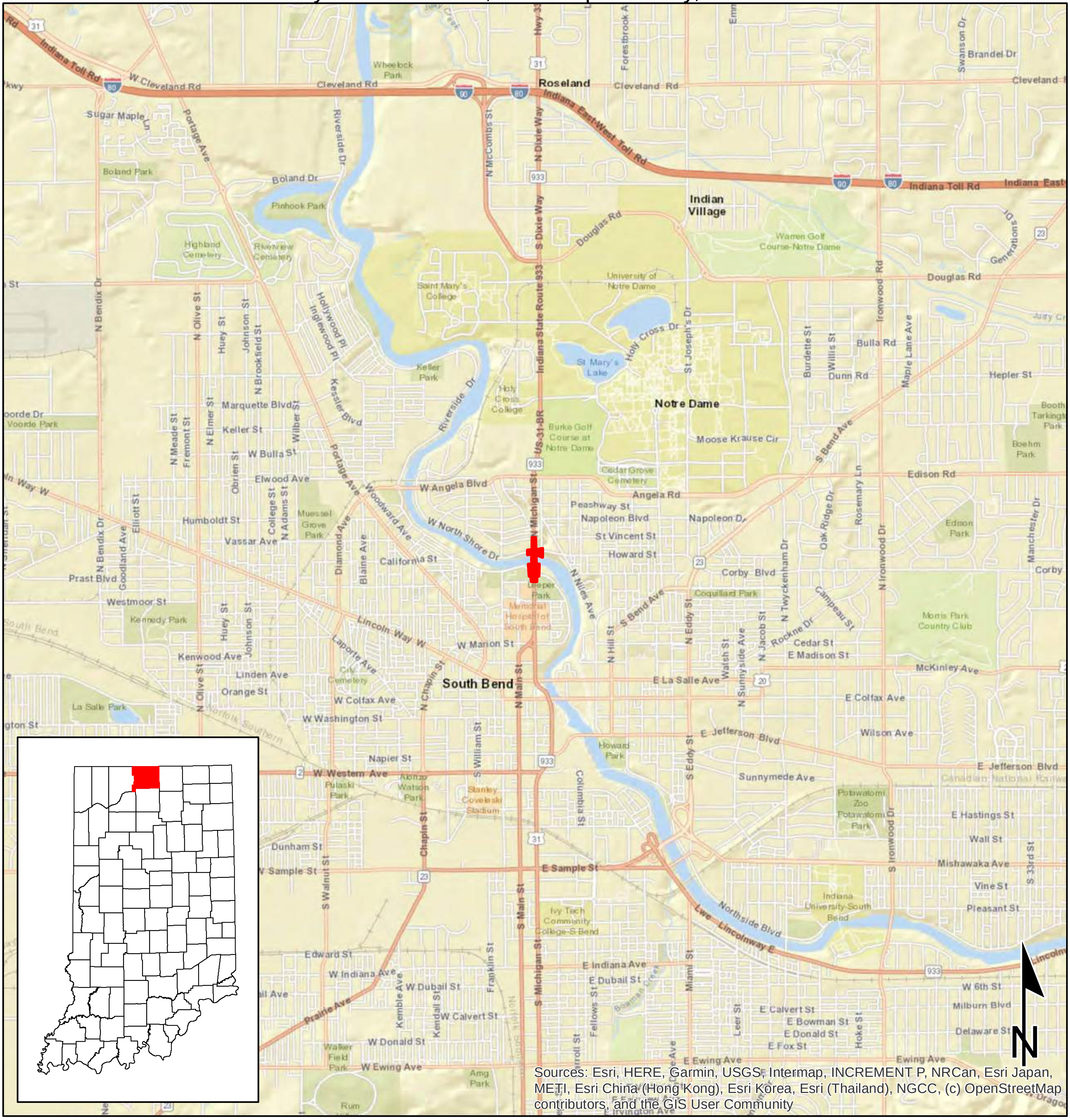
The original limestone arch ring, spandrel wall, pier, abutment, wingwall, and railing fascia will be reinstalled on the replaced reinforced concrete elements. Damaged limestone blocks will either be repaired or replaced in-kind. The replaced reinforced concrete element geometry will need to very closely match that of the original construction in order for the limestone fascia to fit properly and be reinstalled in its original shape and configuration.

See Appendix F for the Alternatives Analysis Table.

Appendix A:

Maps

Des. No. 1900011
SR 933 over St. Joseph River Bridge Project
SR 933 Bridge over St. Joseph River
City of South Bend, St. Joseph County, Indiana



Sources: Esri, HERE, Garmin, USGS, Intermap, INCREMENT P, NRCan, Esri Japan, METI, Esri China (Hong Kong), Esri Korea, Esri (Thailand), NGCC, (c) OpenStreetMap contributors, and the GIS User Community

0.5 0.25 0 0.5 Miles

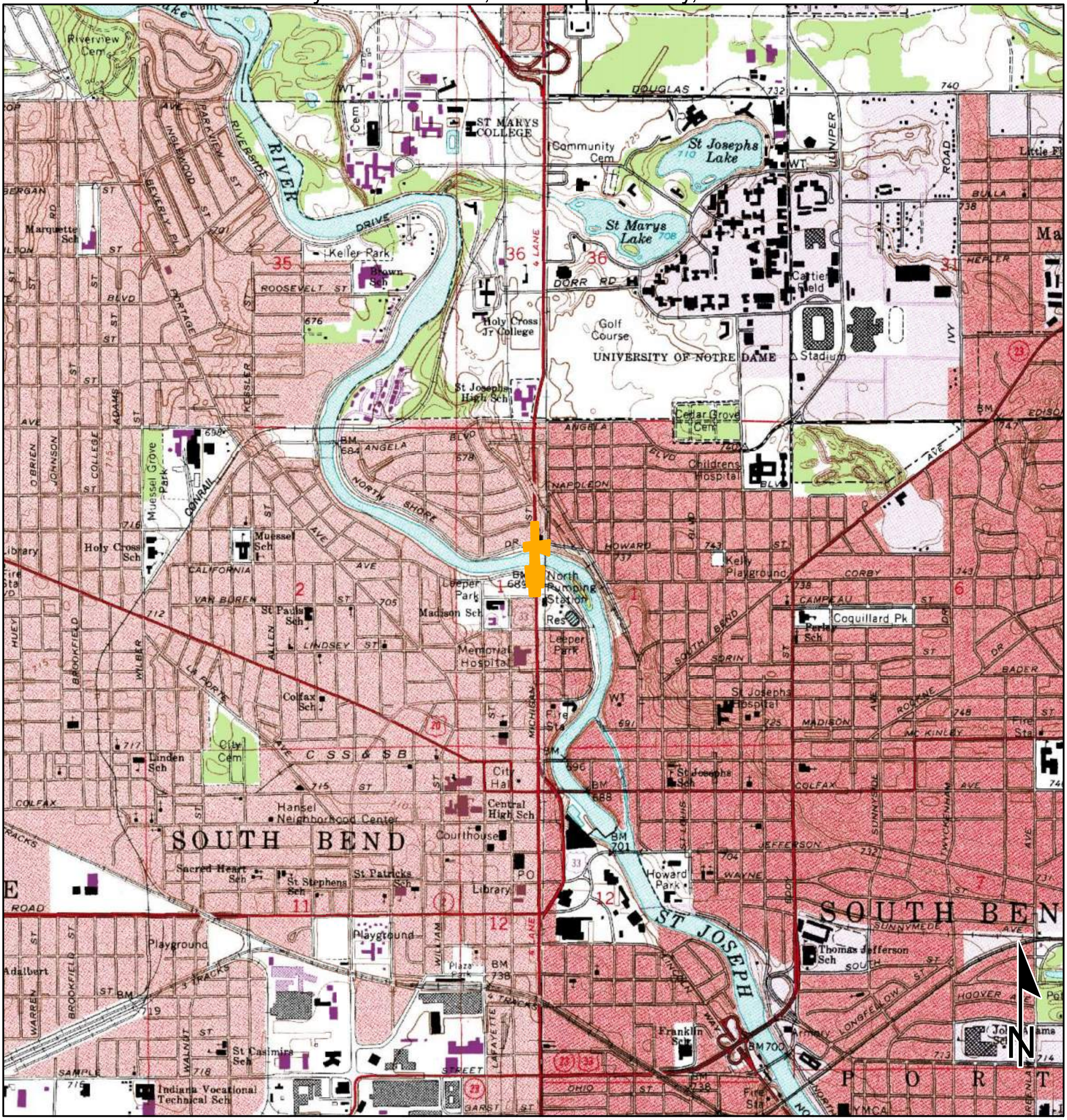
Sources:
Non Orthophotography Data - Obtained from the State of Indiana Geographical Information Office Library
Orthophotography - Obtained from Indiana Map Framework Data (www.indianamap.org)
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

General Location Map

🟥 Project Area

Des. No. 1900011
SR 933 over St. Joseph River Bridge Project
SR 933 Bridge over St. Joseph River
City of South Bend, St. Joseph County, Indiana



Sources:

Non Orthophotography

Data - Obtained from the State of Indiana Geographical Information Office Library

Orthophotography - Obtained from Indiana Map Framework Data (www.indianamap.org)

Map Projection: UTM Zone 16 N **Map Datum:** NAD83

0.25 0.125 0 0.25 Miles

This map is intended to serve as an aid in graphic representation only. This information is not warranted for accuracy or other purposes.

Portion of the USGS 7.5' series South Bend, Indiana topographic quadrangle showing the location of the project area.

🟧 Project Area

Des. No. 1900011
SR 933 over St. Joseph River Bridge Project
SR 933 Bridge over St. Joseph River
City of South Bend, St. Joseph County, Indiana

A 2016 aerial orthophotography showing the project location.

Aerial Source: IndianaMAP - St. Joseph County

Sources:
Non Orthophotography Data - Obtained from the State of Indiana Geographical Information Office Library
Orthophotography - Obtained from Indiana Map Framework Data (www.indianamap.org)
Map Projection: UTM Zone 16 N **Map Datum:** NAD83

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Appendix B:

Photographs

Photo 1
Vantage Point: South of Bridge
Direction: Looking North
Description: South Approach

Photo 2
Vantage Point: Northwest of Bridge
Direction: Looking Southeast
Description: North Approach

Photo 3

Vantage Point: Southeast of Bridge
Direction: Looking Northwest
Description: East Bridge Elevation View

Photo 4

Vantage Point: Southwest of Bridge
Direction: Looking Northeast
Description: West Bridge Elevation View

Photo 5

Vantage Point: Southeast Corner of Bridge
Direction: Looking Southeast
Description: Leeper Park (Land Use Surrounding South End of Bridge)

Photo 6

Vantage Point: Southeast Corner of Bridge
Direction: Looking North
Description: East Sidewalk, Barrier Curb, and Railing

Photo 7
Vantage Point: Southwest Corner of Bridge
Direction: Looking North
Description: West Sidewalk, Barrier Curb, and Railing

Photo 8
Vantage Point: West Side of Bridge
Direction: Looking North
Description: Typical Decorative Lighting Post

Photo 9
Vantage Point: East Side of Bridge
Direction: Looking Southwest
Description: Typical Existing Roadway Wearing Surface

Photo 10
Vantage Point: East Side of Bridge
Direction: Looking Northwest
Description: Typical Existing Roadway Wearing Surface

Photo 11
Vantage Point: Beneath Span A
Direction: Looking South
Description: Span A Arch and Abutment 1

Photo 12
Vantage Point: Beneath Span A
Direction: Looking North
Description: Span A Arch and Pier 2

Photo 13
Vantage Point: Beneath Span B
Direction: Looking South
Description: Span B Arch and Pier 2

Photo 14
Vantage Point: Beneath Span B
Direction: Looking North
Description: Span B Arch and Pier 3

Photo 15
Vantage Point: Beneath Span C
Direction: Looking South
Description: Span C Arch and Pier 3

Photo 16
Vantage Point: Beneath Span C
Direction: Looking North
Description: Span C Arch and Abutment 4

Photo 17
Vantage Point: East Side of Pier 2
Direction: Looking Southwest
Description: Ornate Limestone Details at Pier Pilasters (Typ. All Piers)

Photo 18
Vantage Point: Midspan at East Side of Span B
Direction: Looking West
Description: Ornate Limestone Keystone Block at Midspan (Typ. All Spans)

Photo 19
Vantage Point: Southeast Corner of Bridge
Direction: Looking Northeast
Description: Original Limestone Railing (Second Railing Panel from South)

Photo 20
Vantage Point: Southeast Corner of Bridge
Direction: Looking Northeast
Description: Original Limestone Railing (First Railing Panel from South)

Photo 21
Vantage Point: Northeast Corner of Bridge
Direction: Looking East
Description: Concrete Railing from Rehabilitation Prior to 2006 (Typ.)

Photo 22
Vantage Point: West Sidewalk over Span B
Direction: Looking West
Description: Concrete Railing from 2012 Rehabilitation (Typ.)

Photo 23
Vantage Point: Northeast Corner of Bridge
Direction: Looking Southwest
Description: Curb Ramp at Intersection with North Shore Drive

Photo 24
Vantage Point: Northwest Corner of Bridge
Direction: Looking South
Description: Curb Ramp at Intersection with North Shore Drive

Photo 25
Vantage Point: West Side of Pier 2
Direction: Looking North
Description: Sag in Limestone Coping Blocks at Middle of Span B

Photo 26
Vantage Point: East Side of Pier 3
Direction: Looking South
Description: Sag in Limestone Coping Blocks at Middle of Span B

Photo 27
Vantage Point: East Side of Middle of Span B
Direction: Looking Northwest
Description: Patched Gap in Railing Pilaster

Photo 28
Vantage Point: Pier 3 beneath Span B
Direction: Looking South
Description: Arch Separation

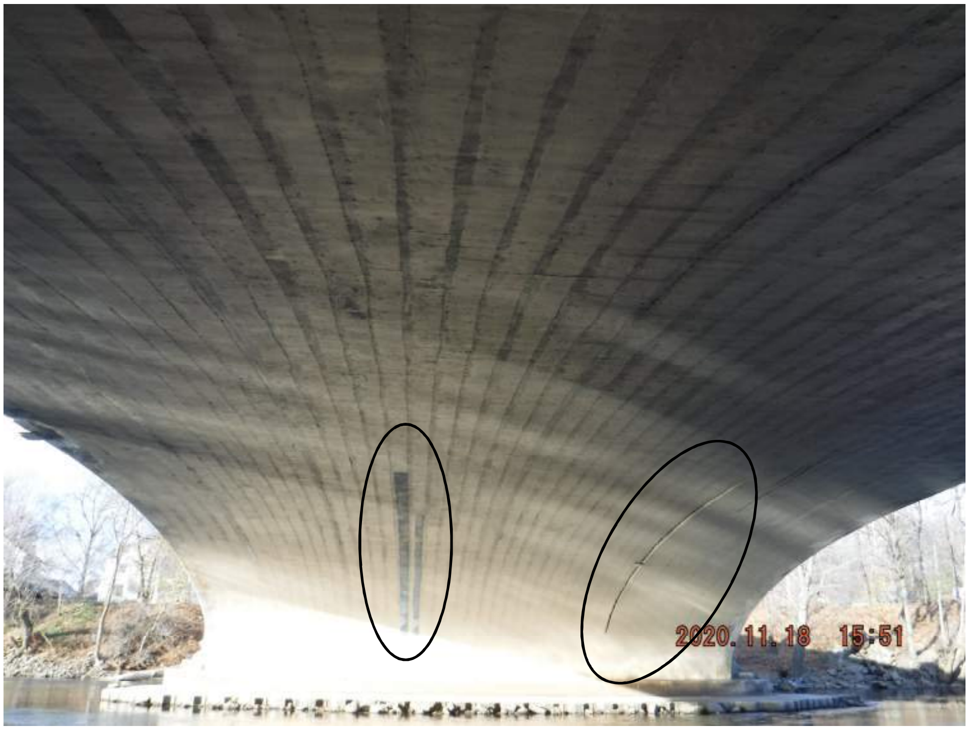


Photo 29
Vantage Point: Pier 2 beneath Span B
Direction: Looking North
Description: Fiber Reinforced Polymer Fallen Off and Arch Separation

Photo 30
Vantage Point: Pier 3 beneath Span C
Direction: Looking North
Description: Arch Separation

Photo 31
Vantage Point: East Side of Pier 2
Direction: Looking Southwest
Description: Spalling of Limestone Block (Typ.)

Photo 32
Vantage Point: East Side of Span A
Direction: Looking West
Description: Cracking of Limestone Block (Typ.)

Photo 33
Vantage Point: West Side of Span C
Direction: Looking East
Description: Failing Grout at Joints between Limestone Blocks (Typ.)

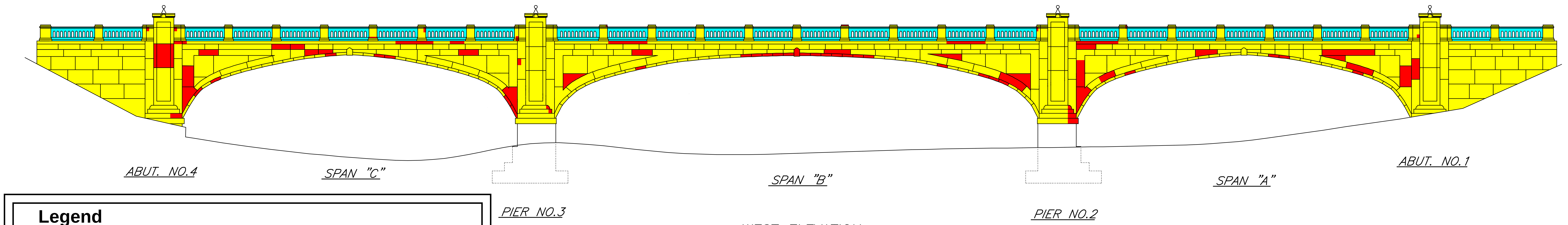
Photo 34
Vantage Point: East Side of South Abutment (Abutment 1)
Direction: Looking West
Description: Leakage Present Between Limestone Blocks, Cracking, Spalls

Appendix C:

Graphics/Drawings

Limestone Conditions and Recommendations

(Based on 11/18/2020 Inspection by Lochmueller Group, Inc.)



WEST ELEVATION

Not to Scale

Legend

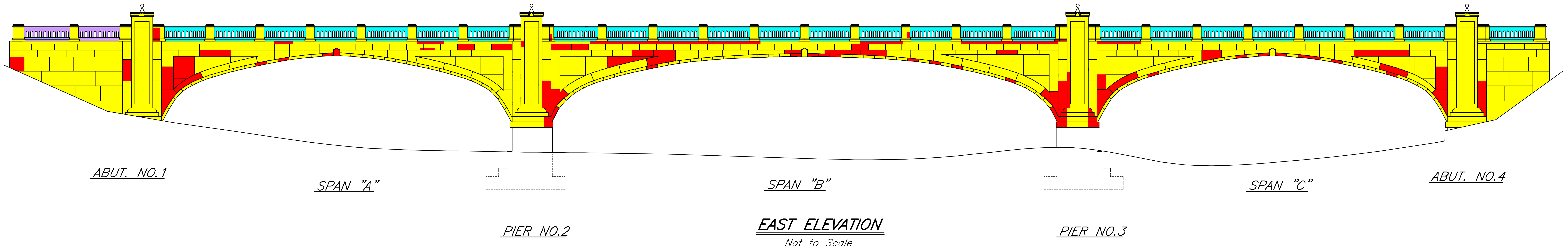
🟨 Estimated areas of limestone facade reused due to no deficiencies noted.

🟥 *Estimated areas of limestone facade repairs for reuse or replacement due to cracking, spalling, or other deterioration.

🟦 Existing concrete railing to be removed and replaced in-kind.

🟪 Existing limestone railing to be reused with any deteriorated portions repaired or replaced.

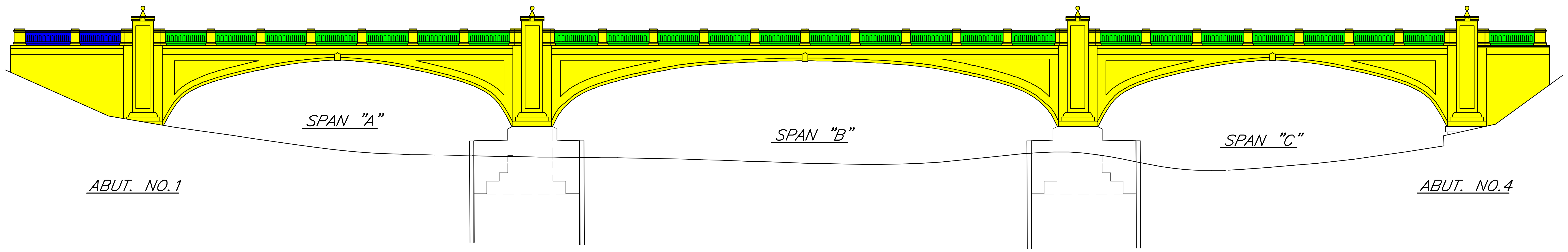
*Estimated area shown for all sides of railing pedestals, not just side shown.



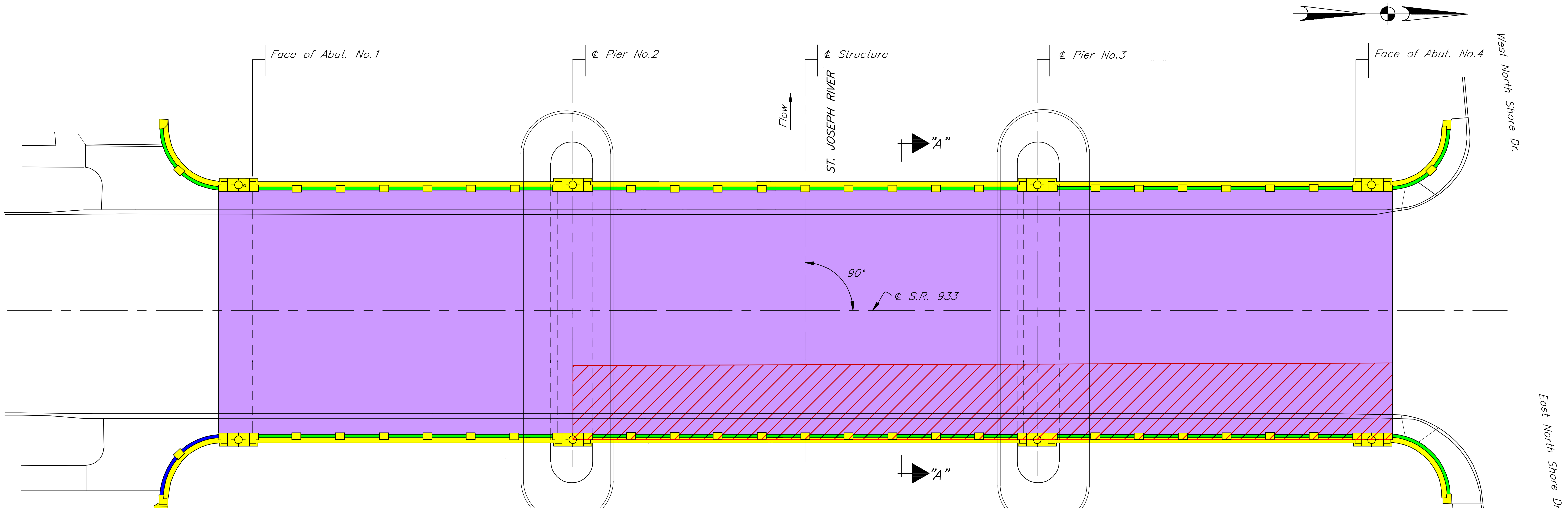
EAST ELEVATION

Not to Scale

Alternative B1a
Removal



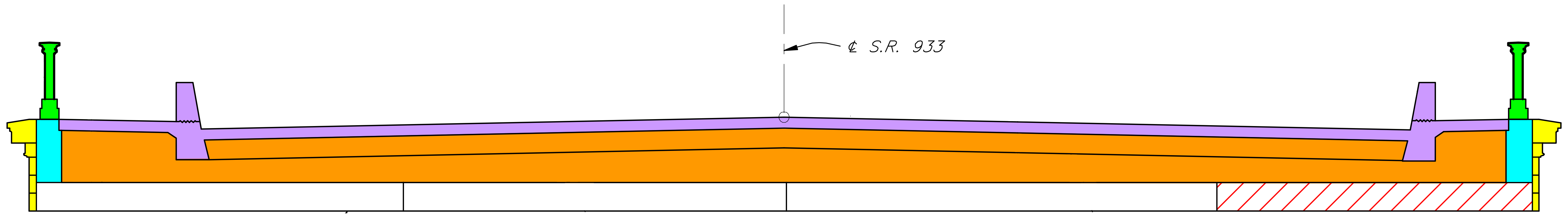
ELEVATION



PLAN

Legend

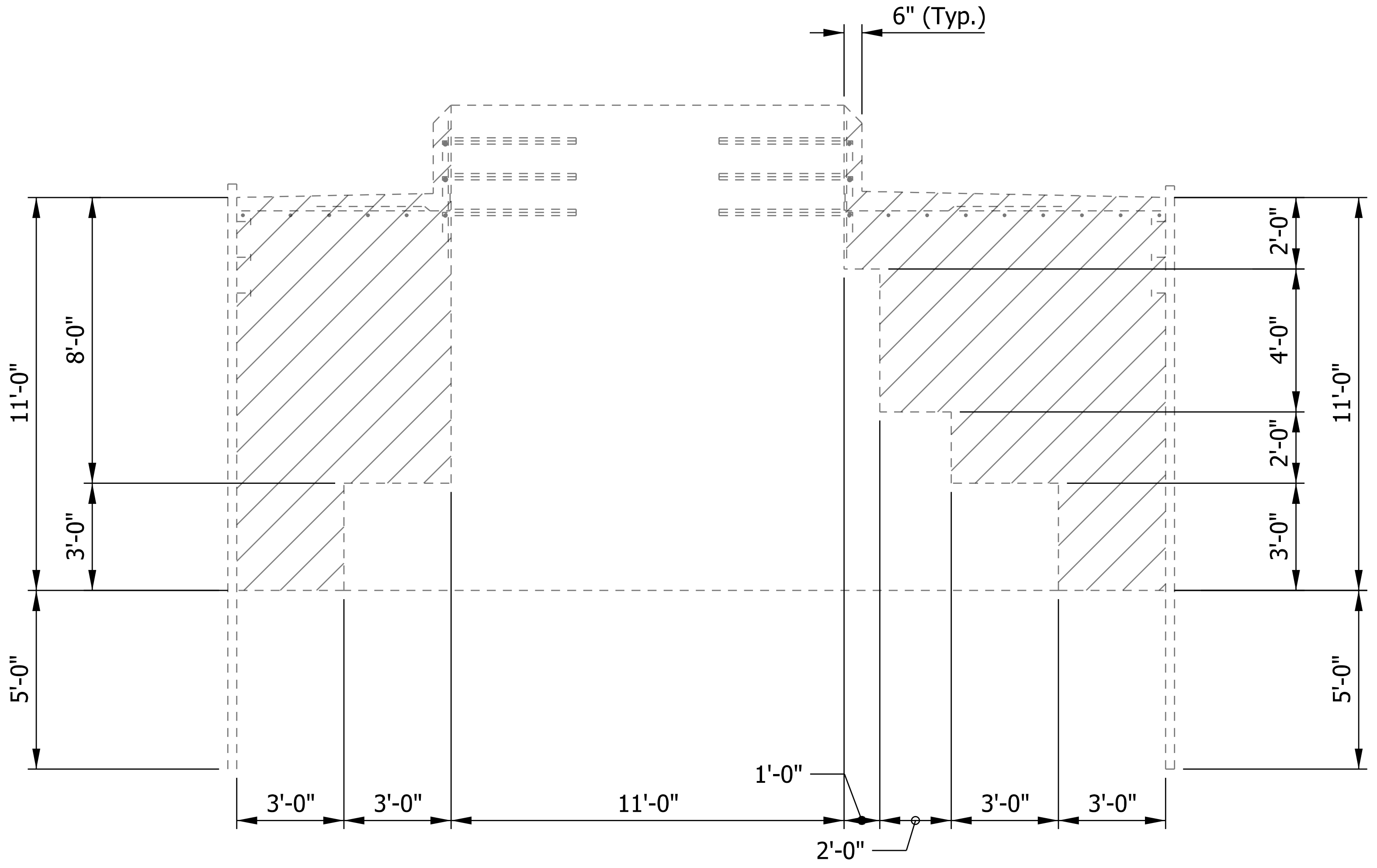
🟨	Limestone blocks and light posts will be removed and stored for reuse. Any damaged or deteriorated limestone blocks will be repaired or replaced with identical limestone blocks.
🟩	Concrete railing will be removed.
🟦	Limestone railing will be removed and stored for reuse. Any damaged or deteriorated limestone blocks will be repaired or replaced with identical limestone blocks.
🟪	Concrete sidewalk, barrier curb, and roadway pavement will be removed.
🟧	Fill materials within bridge will be removed.
■	Concrete (spandrel) walls will be removed.
▨	Concrete arch segments in Span "B" & "C" on the east side of the bridge, that have settled, will be removed.



SECTION "A–A"

Alternative B1a
Removal

ELEVATION
Scale: $\frac{3}{32}$" = 1'-0"



▨ Indicates limits of Removal

REMOVAL DETAIL
BENT NO. 3 SHOWN (BENT NO. 2 MIRRORED)
Scale: ½" = 1'-0"

gai consultants

RECOMMENDED
FOR APPROVAL ______ DESIGN ENGINEER DATE

DESIGNED: TDJ DRAWN: TMT
CHECKED: ______ CHECKED: ______

INDIANA
DEPARTMENT OF TRANSPORTATION

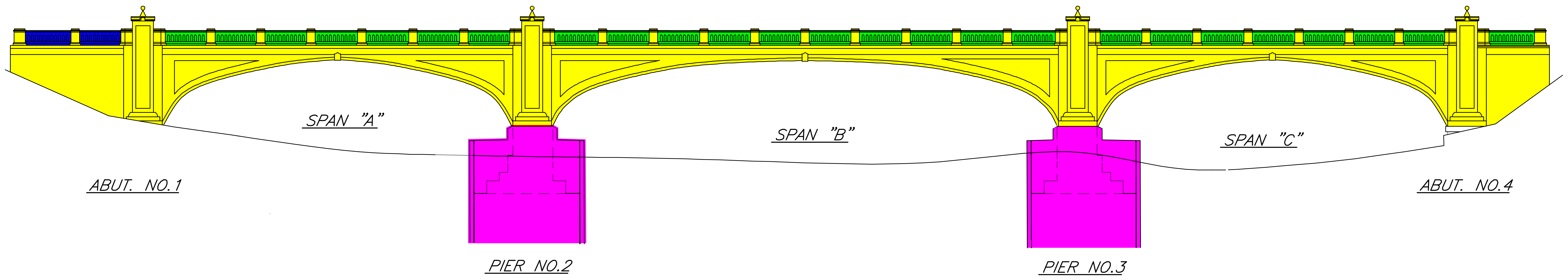
MICROPILE TRANSFER BLOCK
PIER DETAIL

SCALE	BRIDGE FILE
	XXXXX
	DESIGNATION
1" = XX'	XXXXX
SURVEY BOOK	SHEETS
XXXXX	1 of 1
CONTRACT	PROJECT
XXXXX	XXXXX

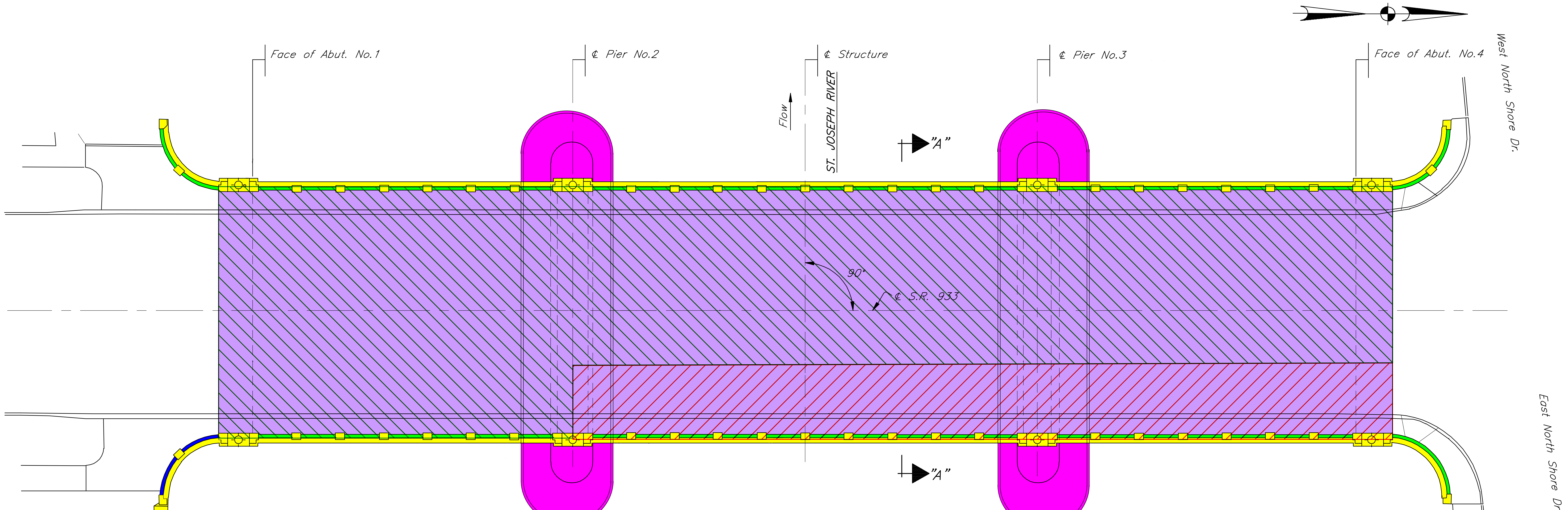
Plot:6/18/2021 8:51:44 PM By: ThomaTM Pen: Transportation.tbl Model:Elevation and Removal

Z:\2020\R200331.00 - Loch LP SR 23 HMA Overlay\CAD\Production Drawings\R200331.00 General Plan.01.dgn

Alternative B1a
Reconstruction



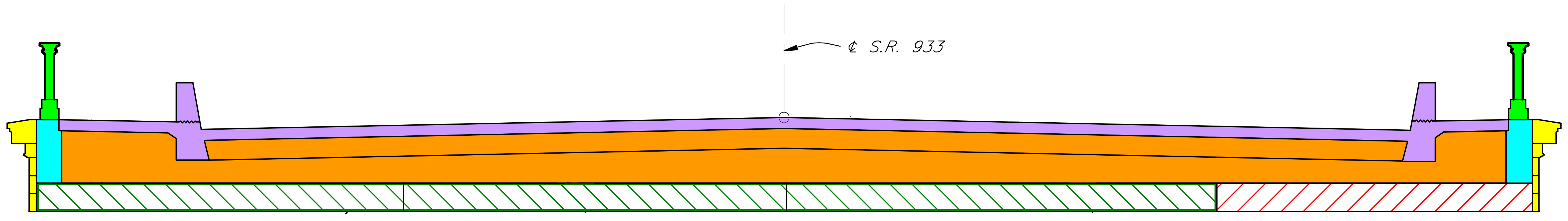
ELEVATION



PLAN

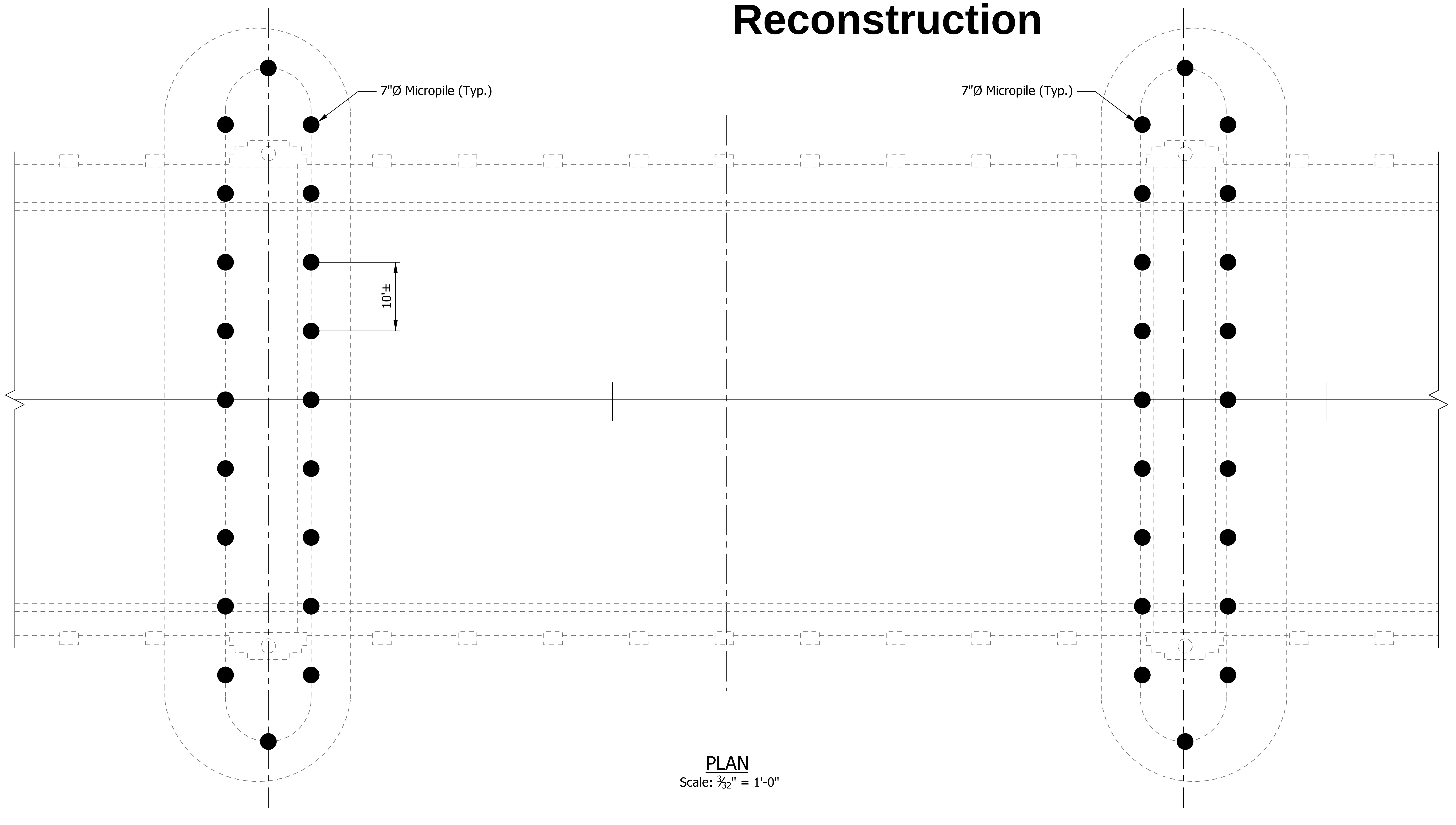
Legend

🟨	Limestone blocks and light posts will be reinstalled.
🟩	Concrete railing will be reconstructed, matching the appearance of the original limestone railing.
🟦	Limestone railing will be reinstalled.
🟪	Concrete sidewalk, barrier curb, and roadway pavement will be reconstructed matching the existing appearance.
🟧	Fill will be placed within bridge.
■	Concrete (spandrel) walls will be reconstructed.
▨	Concrete arch segments in Span "B" & "C" on the east side of the bridge, that were removed, will be reconstructed.
▨	Concrete arch segments not removed will receive a waterproofing membrane placed on the side against the fill.
🟪	Existing foundations will be strengthened with small pipe (micro) piles by being driven through or beside existing concrete filled cofferdams.

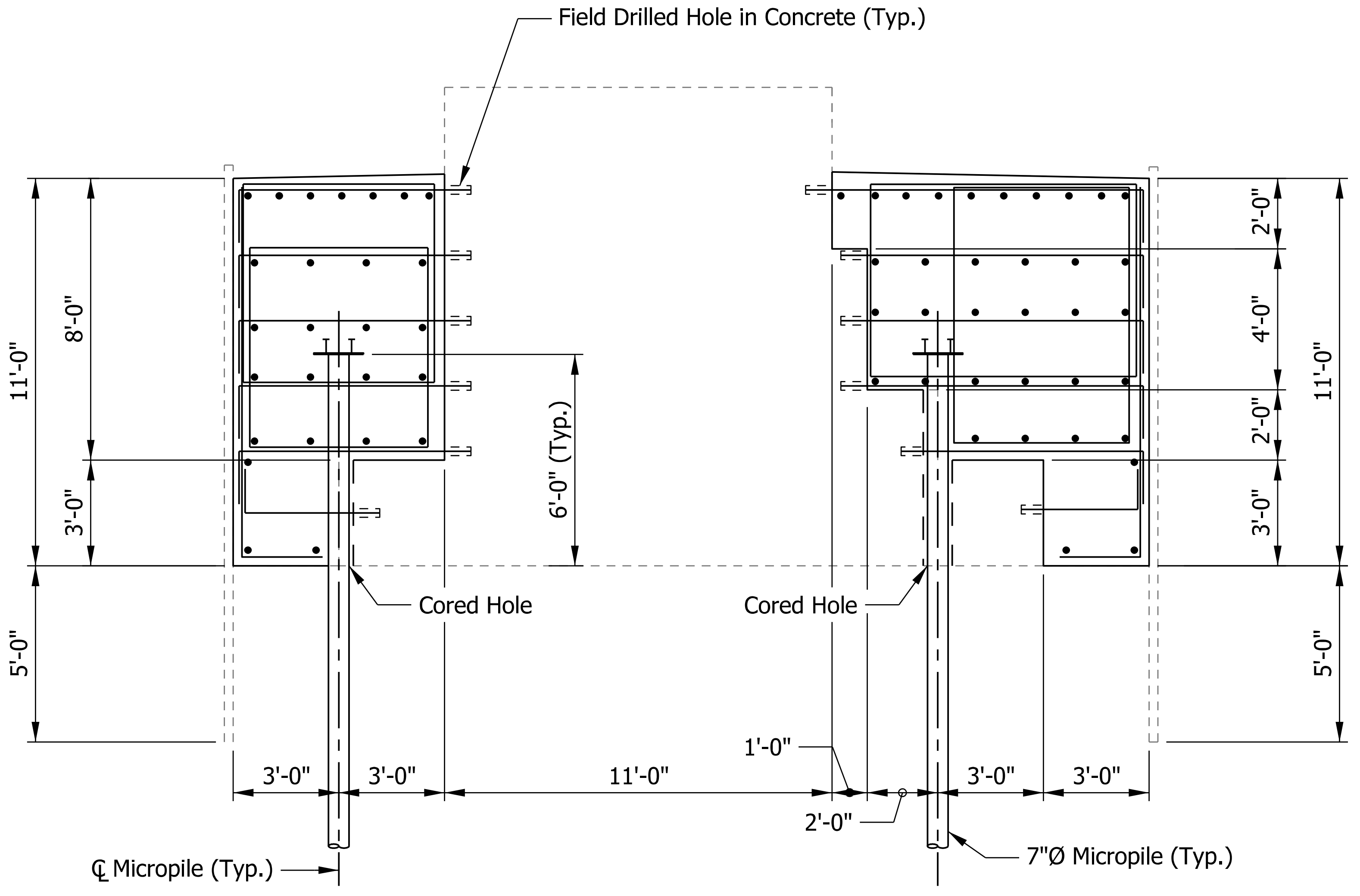


SECTION "A–A"

Alternative B1a
Reconstruction



PLAN
Scale: 3/32" = 1'-0"



MICROPILE TRANSFER BLOCK DETAIL
BENT NO. 3 SHOWN (BENT NO. 2 MIRRORED)
Scale: ½" = 1'-0"

NOTES:

1. For preliminary analysis, micro-piles assumed at 7"diameter and 150k allowable service design load per micro-pile.
2. Micro-pile depth assumed at 50' below existing footing.
3. Minimum clearance window for installation assumed at 2' laterally from existing vertical face and 9' vertically from top of micro-pile to overhead obstruction.
4. Desired overhead vertical clearance is 14' for more cost effective installation.
5. Minimum transfer block concrete strength assumed at 5,000 psi
6. Load transfer to existing foundation to be provided by field drilled holes with epoxy dowels or Dywidag Bars placed through cored holes in existing foundation or a combination of both.
7. Temporary cofferdam to be constructed approximately 2' minimum outside existing sheet piling location. Portion of existing sheet piling below bottom of foundation shall remain in place.

Plot:6/18/2021 9:13:50 PM By: ThomaTM Pen: Transportation.tbl Model:Elevation and Removal

gai consultants

RECOMMENDED FOR APPROVAL
DESIGN ENGINEER DATE

DESIGNED: TDJ
DRAWN: TMT
CHECKED:
CHECKED:

INDIANA
DEPARTMENT OF TRANSPORTATION

MICROPILE TRANSFER BLOCK
PIER DETAIL

SCALE	BRIDGE FILE
	XXXXX
	DESIGNATION
1" = XX'	XXXXX
SURVEY BOOK	SHEETS
XXXXX	1 of 1
CONTRACT	PROJECT
XXXXX	XXXXX

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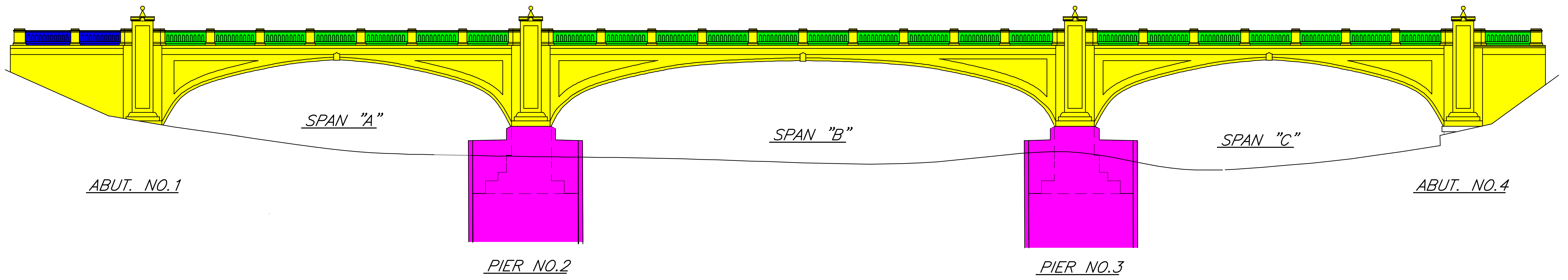
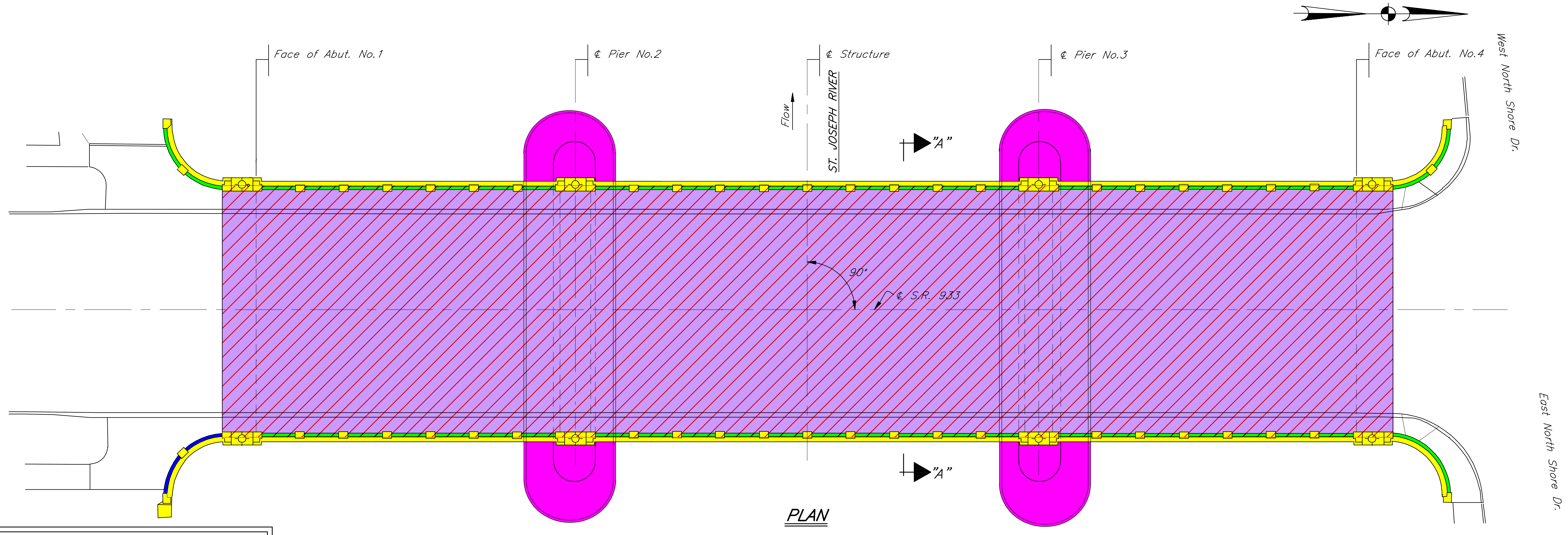
Alternative B1b
Removal



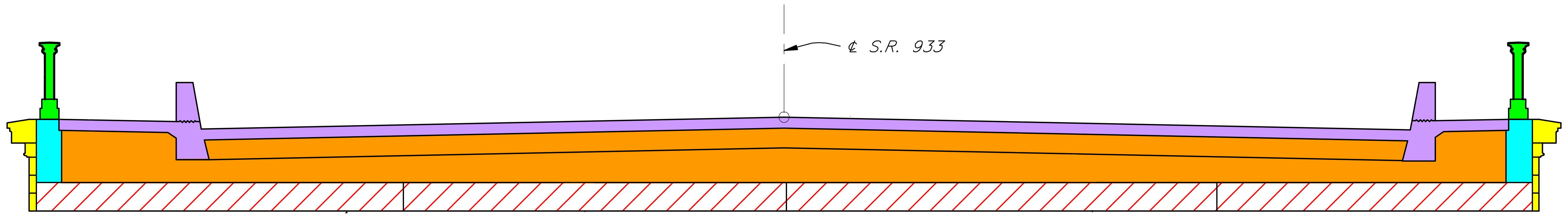
ELEVATION



PLAN

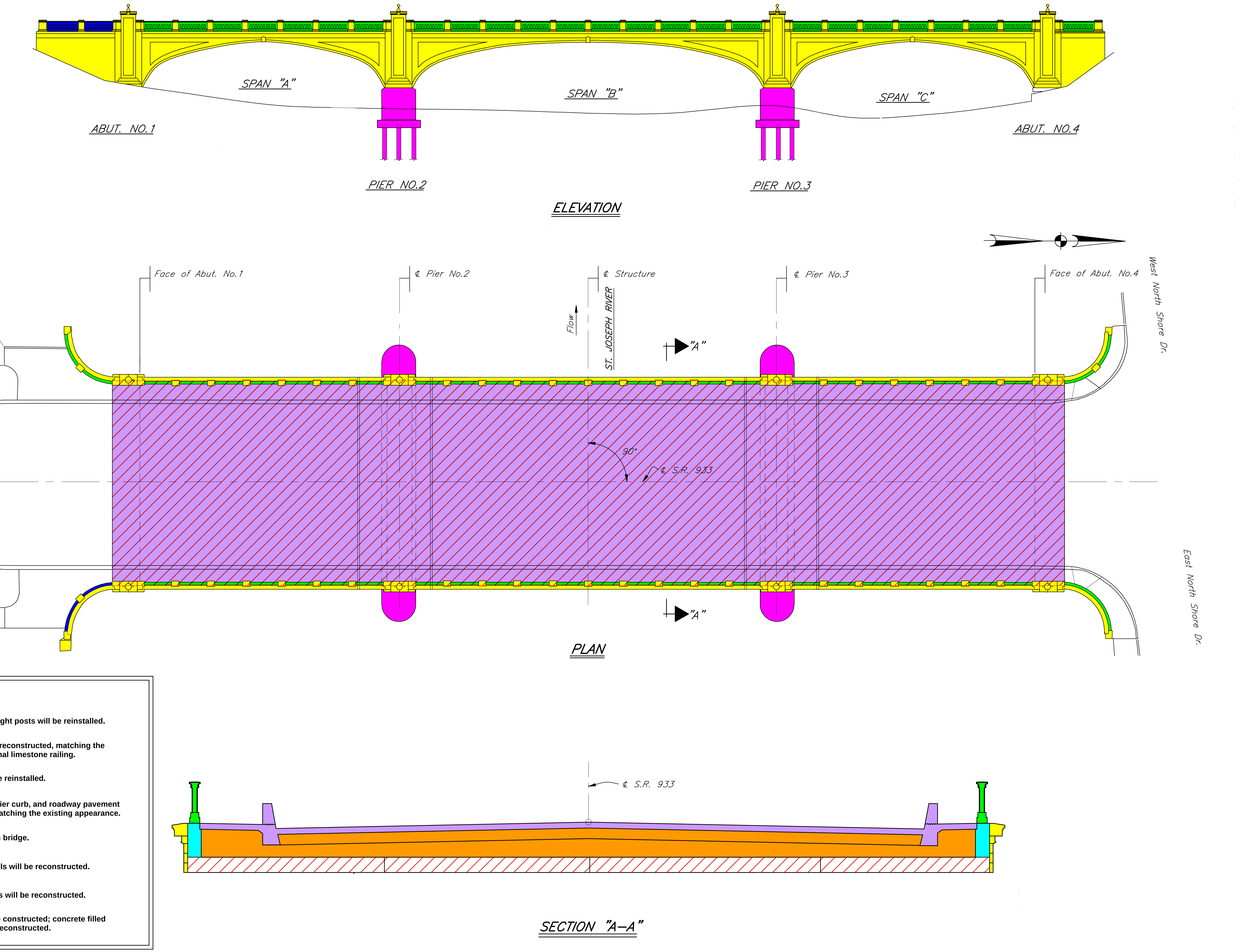
Legend

🟨	Limestone blocks and light posts will be removed and stored for reuse. Any damaged or deteriorated limestone blocks will be repaired or replaced with identical limestone blocks.
🟩	Concrete railing will be removed.
🟦	Limestone railing will be removed and stored for reuse. Any damaged or deteriorated limestone blocks will be repaired or replaced with identical limestone blocks.
🟪	Concrete sidewalk, barrier curb, and roadway pavement will be removed.
🟧	Fill materials within bridge will be removed.
■	Concrete (spandrel) walls will be removed.
▨	Concrete arch segments will be removed.
🟥	Concrete filled cofferdams and foundations will be removed.



SECTION "A–A"

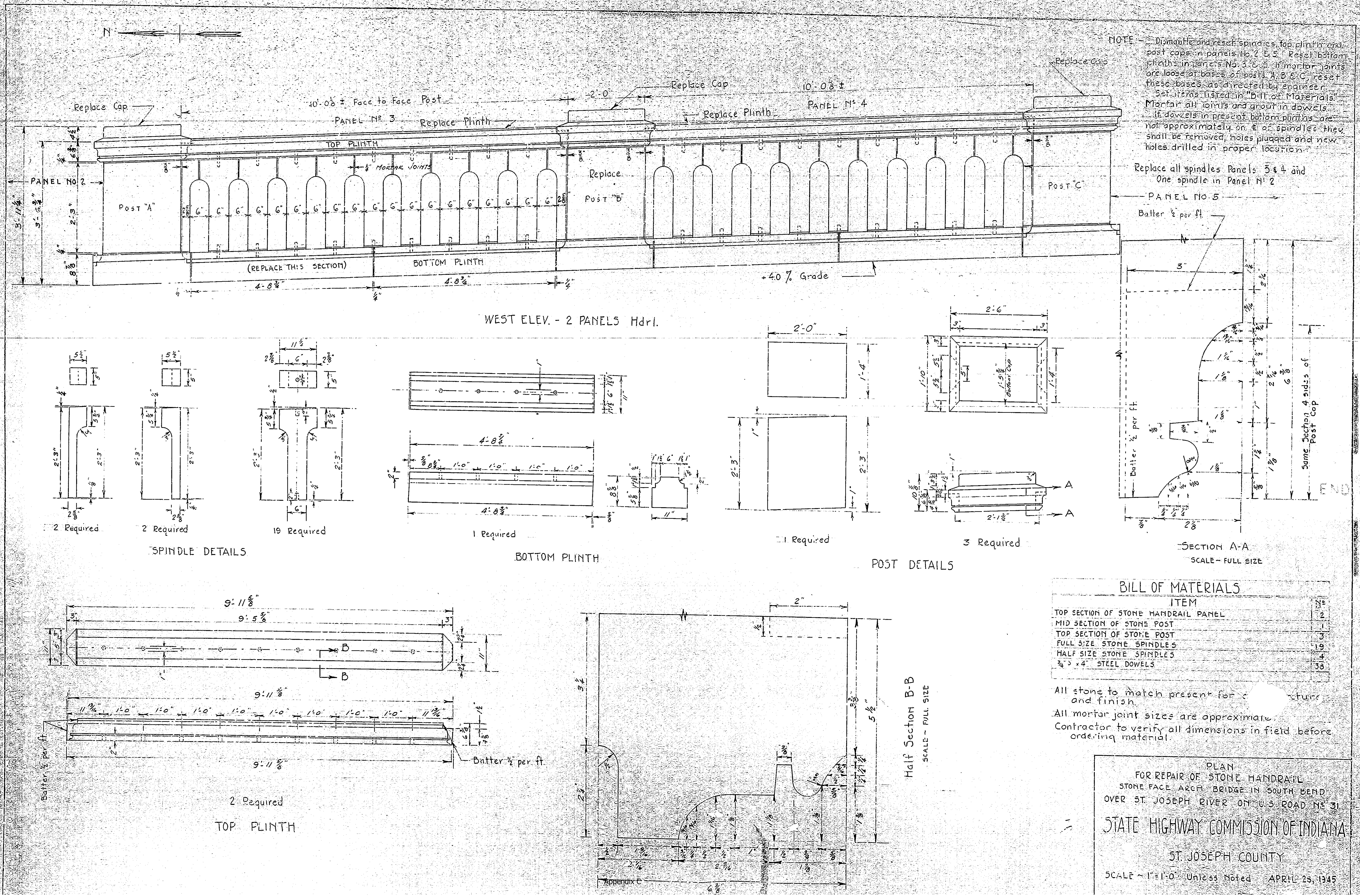
Alternative B1b
Reconstruction



Legend

- 🟨 Limestone blocks and light posts will be reinstalled.
- 🟩 Concrete railing will be reconstructed, matching the appearance of the original limestone railing.
- 🟦 Limestone railing will be reinstalled.
- 🟪 Concrete sidewalk, barrier curb, and roadway pavement will be reconstructed matching the existing appearance.
- 🟧 Fill will be placed within bridge.
- ■ Concrete (spandrel) walls will be reconstructed.
- ▨ Concrete arch segments will be reconstructed.
- 🟥 New foundations will be constructed; concrete filled cofferdams will not be reconstructed.

Stone Railing Details from 1945 Rehabilitation Plans



NOTE - Dismantle and reset spindles, top plinth and post caps in panels No. 2 & 5. Reset bottom plinths in panels No. 3 & 4. If mortar joints are loose at bases of posts A, B & C, reset these bases as directed by engineer.

Set items listed in "Bill of Materials". Mortar all joints and grout in dowels.

If dowels in present bottom plinths are not approximately on ℄ of spindles they shall be removed, holes plugged and new holes drilled in proper location.

Replace all spindles Panels 3 & 4 and One spindle in Panel Nº 2

BILL OF MATERIALS

ITEM	Nº
TOP SECTION OF STONE HANDRAIL PANEL	2
MID SECTION OF STONE POST	1
TOP SECTION OF STONE POST	3
FULL SIZE STONE SPINDLES	19
HALF SIZE STONE SPINDLES	4
3/4" ⌀ x 4" STEEL DOWELS	38

All stone to match present for c[illegible]ture and finish.

All mortar joint sizes are approximate.

Contractor to verify all dimensions in field before ordering material.

PLAN
FOR REPAIR OF STONE HANDRAIL
STONE FACE ARCH BRIDGE IN SOUTH BEND
OVER ST. JOSEPH RIVER ON U.S. ROAD Nº 31
STATE HIGHWAY COMMISSION OF INDIANA
ST. JOSEPH COUNTY
SCALE ~ 1" = 1'-0" Unless Noted APRIL 28, 1945

LOCHMUELLER GROUP

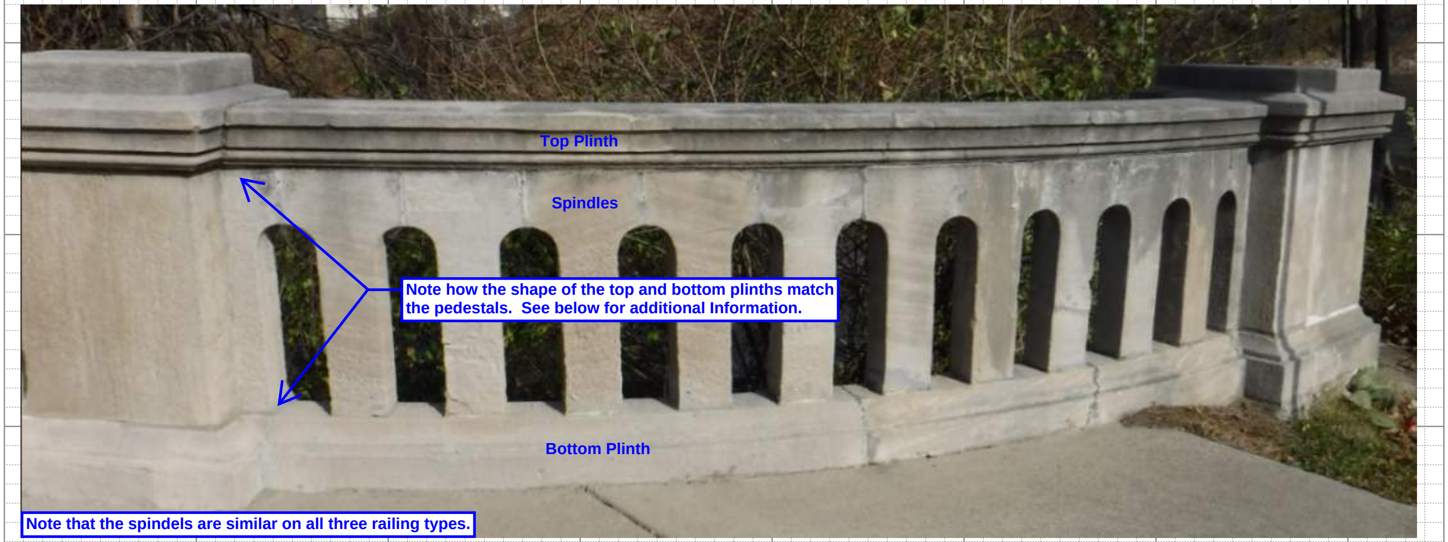
PROJECT NAME SR 933 (Michigan Road) over St. Joseph River
DES/PROJECT NUMBER 1900011
LOCH GROUP PROJECT NUMBER 120-3001-01B
MADE BY ACS DATE 07/01/2021
CHECKED BY MAR DATE 07/01/2021
SHEET 1 OF 2

Comparison of Railing Types Currently on the Bridge

There are 3 different types of railings, disregarding the barrier curb between the sidewalks and travel way, currently on the bridge carrying SR 933 (Michigan Road) over St. Joseph River. Below are photos, plan details (as available), and descriptions to explain their differences and what is preferred for replacement of railings as part of this proposed project.

Railing Type 1 - Original Stone Railing

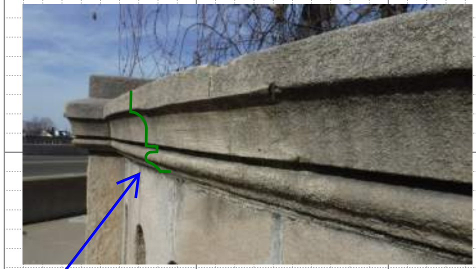
There are only two panels of the original stone railing remaining on the bridge, both at the southeast corner of the bridge at the end of the railing. Please see below for specific aesthetics of this railing for comparison to the following two railing types on the bridge.



Note how the shape of the top and bottom plinths match the pedestals. See below for additional Information.

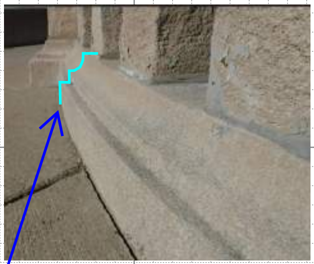
Note that the spindels are similar on all three railing types.

Elevation View



Profile View of Top Plinth

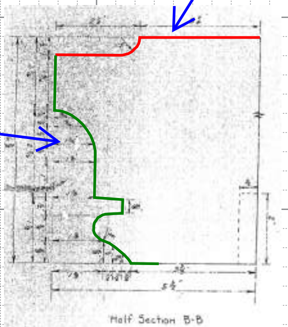
Top View of Top Plinth



Profile View of Bottom Plinth

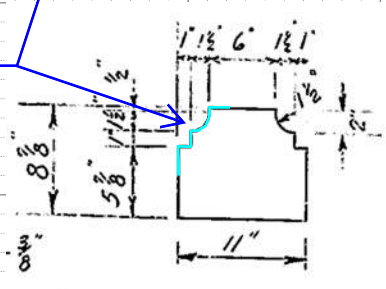
Note the raise portion with curved sides.

Note the various curves.



Top Plinth

Note the curve.



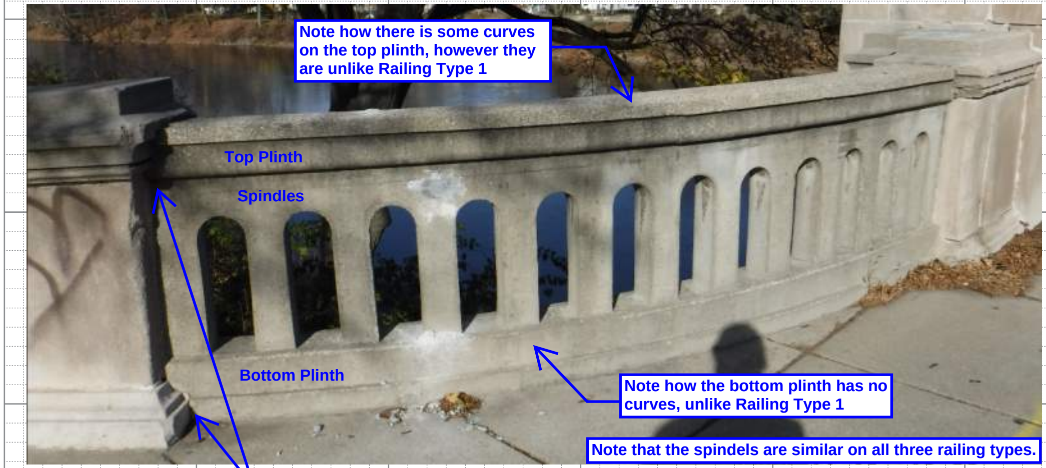
Bottom Plinth

Stone Railing Details from 1945 Rehabilitation Plans

PROJECT NAME SR 933 (Michigan Road) over St. Joseph River
DES/PROJECT NUMBER 1900011
LOCH GROUP PROJECT NUMBER 120-3001-01B
MADE BY ACS DATE 07/01/2021
CHECKED BY MAR DATE 07/01/2021
SHEET 2 OF 2

Railing Type 2 - Concrete Railing at Corners

There are six panels of this concrete railing remaining on the bridge, they are located at the southwest, northwest, and northeast corners of the bridge at the end of the railing. Please see below for specific aesthetics of this railing and its comparison to the Railing Type 1 (original).



Note how there is some curves on the top plinth, however they are unlike Railing Type 1

Note how the bottom plinth has no curves, unlike Railing Type 1

Note that the spindels are similar on all three railing types.

Elevation View

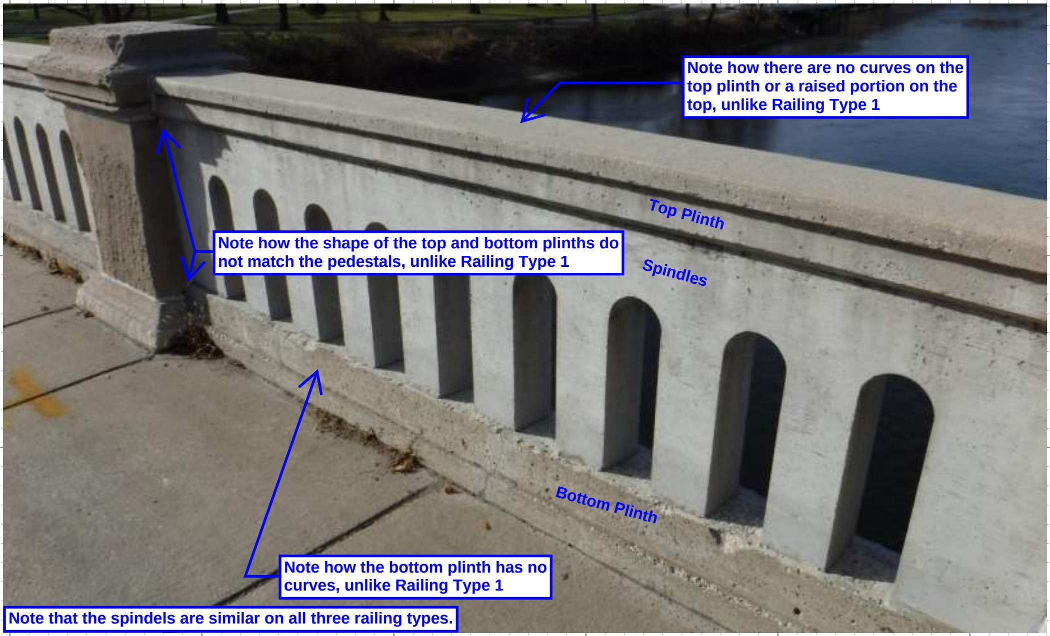
Note how the shape of the top and bottom plinths do not match the pedestals, unlike Railing Type 1

Top View of Top Plinth

Note there is a raised portion similar to the Railing Type 1, however the sides are squared instead of curved.

Railing Type 3 - Concrete Railing Elsewhere

All remaining railing panels which are not Type 1 or 2 are this Type 3 concrete railing. Please see below for specific aesthetics of this railing and its comparison to the Railing Type 1 (original).



Note how there are no curves on the top plinth or a raised portion on the top, unlike Railing Type 1

Note how the shape of the top and bottom plinths do not match the pedestals, unlike Railing Type 1

Note how the bottom plinth has no curves, unlike Railing Type 1

Note that the spindels are similar on all three railing types.

Elevation View

Note that it is recommended on this project that all railing replaced be concrete and match the details from the 1945 Rehabilitation Plans to match the shape of the original stone railing.

LOCHMUELLER GROUP

PROJECT NAME SR 933 (Michigan Road) over St. Joseph River
DES/PROJECT NUMBER 1900011
LOCH GROUP PROJECT NUMBER 120-3001-01B
MADE BY ACS DATE 07/01/2021
CHECKED BY MAR DATE 07/01/2021
SHEET 1 OF 2

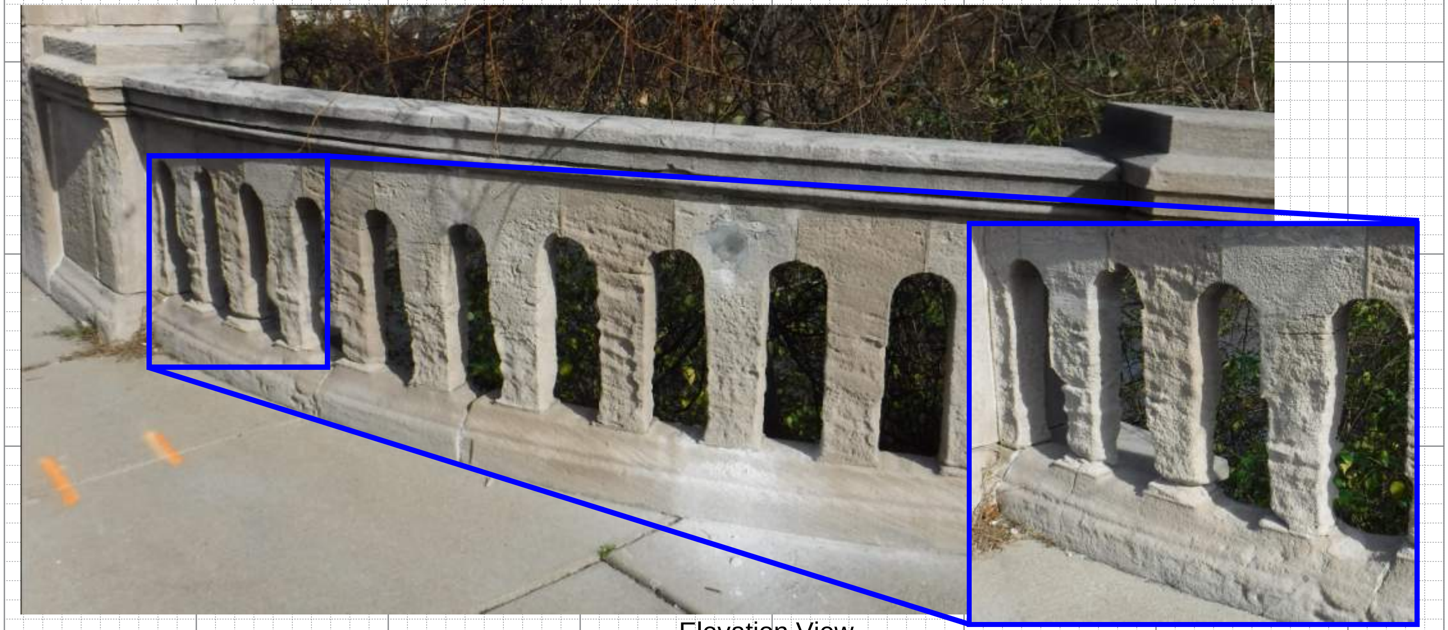
Comparison of Stone and Concrete Railing Durability

The stone railing, installed during the original construction in 1914, has deteriorated and required replacement starting with the 1945 Rehabilitation. All stone railing panels, except two in the southeast corner of the bridge, have been replaced with concrete railing.

Stone Railing

Elevation View

This remaining stone railing panel, at the south end of the east bridge railing, shows limited deterioration. This limited deterioration is believed to be due to it's location further from the roadway than nearly all other railing panels, limiting the amount of salt spray and other roadside chemicals.



Elevation View

This remaining stone railing panel, second panel from the south end of the east bridge railing, shows typical deterioration experienced by stone railing on this bridge. This deterioration is the reason only this and the above stone panel remain on the bridge.

Concrete Railing

Elevation View

This is a typical concrete railing panel which was replaced in 2006; however note that the replacement was due to cracking, as visible above, due to settlement at the east end of Pier 3 and not due to deterioration of the railing.

Elevation View

This is a typical concrete railing panel from the 1977 rehabilitation, which exhibit limited deterioration.

Due to the continued replacement of stone railing on this bridge due to deterioration it is recommended that concrete railing be used to replace all existing concrete railing with the two existing stone railing panels be removed and reinstalled.

Appendix D:

Cost Estimate and Quantity Calculations

					Alternatives			
					B1a		B1b	
Pay Item Number	Pay Item Description	Supplemental Description	Units	Unit Price	Quantity	Extended	Quantity	Extended
105-06845	CONSTRUCTION ENGINEERING		LS	-	1	$132,500.00	1	$188,500.00
110-01001	MOBILIZATION AND DEMOBILIZATION		LS	-	1	$341,600.00	1	$484,200.00
201-52370	CLEARING RIGHT OF WAY		LS	-	1	$75,000.00	1	$75,000.00
202-02240	PAVEMENT REMOVAL		SYS	$30.00	1976	$59,280.00	1976	$59,280.00
202-51328	PRESENT STRUCTURE, REMOVE PORTIONS		LS	-	1	$500,000.00	-	-
202-51330	PRESENT STRUCTURE, REMOVE		LS	-	-	-	1	$700,000.00
202-52710	SIDEWALK CONCRETE, REMOVE		SYS	$20.00	528	$10,560.00	528	$10,560.00
203-02000	EXCAVATION, COMMON		CYS	$24.00	7465	$179,160.00	7465	$179,160.00
205-12108	STORMWATER MANAGEMENT BUDGET		DOL	$1.00	10000	$10,000.00	10000	$10,000.00
205-12616	STORMWATER MANAGEMENT IMPLEMENTATION		LS	-	1	$62,700.00	1	$62,700.00
205-12618	SWQCP PREPARATION		LS	-	1	$20,000.00	1	$20,000.00
206-51220	EXCAVATION, WET		CYS	$75.00	-	-	856	$64,200.00
206-51235	COFFERDAM		LS	-	1	$200,000.00	1	$200,000.00
207-09935	SUBGRADE TREATMENT, TYPE IC		SYS	$35.00	2999	$104,965.00	2999	$104,965.00
211-09266	STRUCTURE BACKFILL, TYPE 3		CYS	$38.00	5165	$196,270.00	5165	$196,270.00
302-06464	SUBBASE FOR PCCP		CYS	$97.00	750	$72,750.00	750	$72,750.00
306-08043	MILLING, TRANSITION		SYS	$7.00	739	$5,173.00	739	$5,173.00
401-07328	QC/QA-HMA, 3, 70, SURFACE, 9.5 mm		TON	$216.00	61	$13,176.00	61	$13,176.00
401-10258	JOINT ADHESIVE, SURFACE		LFT	$2.50	450	$1,125.00	450	$1,125.00
401-11785	LIQUID ASPHALT SEALANT		LFT	$1.25	450	$562.50	450	$562.50
406-05521	ASPHALT FOR TACK COAT		SYS	$2.00	739	$1,478.00	739	$1,478.00
501-06323	QC/QA-PCCP, 12 IN.		SYS	$86.00	1802	$154,972.00	1802	$154,972.00
503-05240	D-1 CONTRACTION JOINT		LFT	$21.00	1485	$31,185.00	1485	$31,185.00
604-06070	SIDEWALK, CONCRETE		SYS	$63.00	539	$33,957.00	539	$33,957.00
604-08086	CURB RAMP, CONCRETE		SYS	$170.00	58	$9,860.00	58	$9,860.00
604-12083	DETECTABLE WARNING SURFACES		SYS	$135.00	8	$1,080.00	8	$1,080.00
605-02278	CURB, REMOVE		LFT	$25.00	787	$19,675.00	787	$19,675.00
605-06120	CURB, CONCRETE		LFT	$69.00	40	$2,760.00	40	$2,760.00
616-05688	RIPRAP, CLASS 1		TON	$75.00	2545	$190,875.00	-	-
616-12251	GEOTEXTILE FOR RIPRAP TYPE 3		SYS	$4.00	2265	$9,060.00	-	-
621-01004	MOBILIZATION AND DEMOBILIZATION FOR SEEDING		EACH	$452.00	1	$452.00	1	$452.00
621-06560	MULCHED SEEDING U		SYS	$6.00	89	$534.00	89	$534.00
701-XXXXX	MICROPILE, 7 IN		LFT	$165.00	2000	$330,000.00	-	-
701-XXXXX	MICROPILE, TESTING		LSUM	-	1	$60,000.00	-	-
701-06011	DYNAMIC PILE LOAD TEST		EACH	$4,000.00	-	-	4	$16,000.00
701-09557	TEST PILE, DYNAMIC, PRODUCTION		LFT	$70.00	-	-	240	$16,800.00
701-09559	TEST PILE, DYNAMIC, RESTRIKE		EACH	$3,000.00	-	-	4	$12,000.00
701-09683	PILE SHOE, HP 12 X 74		EACH	$110.00	-	-	162	$17,820.00
701-95780	PILE, STEEL H, HP 12 X 74		LFT	$60.00	-	-	8100	$486,000.00
702-02925	WATERPROOFING MEMBRANE SYSTEM		SFT	$6.00	22426	$134,556.00	21786	$130,716.00
702-03607	CORED HOLE IN CONCRETE		EACH	$450.00	40	$18,000.00	40	$18,000.00
702-04325	TEMPORARY SHORING		LS	-	1	$150,000.00	1	$150,000.00
702-51005	CONCRETE, A, SUBSTRUCTURE		CYS	$900.00	-	-	1252.6	$1,127,340.00
702-51015	CONCRETE, B, FOOTINGS		CYS	$360.00	-	-	889.6	$320,256.00
702-51046	CONCRETE, FOUNDATION SEAL		CYS	$220.00	-	-	263.5	$57,970.00
702-51863	FIELD DRILLED HOLE IN CONCRETE		EACH	$20.00	1200	$24,000.00	-	-
702-92857	CONCRETE, C, SUBSTRUCTURE	, MODIFIED	CYS	$750.00	470.2	$352,650.00	-	-
703-06028	REINFORCING BARS		LBS	$1.40	94040	$131,656.00	128532	$179,944.80
703-06029	REINFORCING BARS, EPOXY COATED		LBS	$1.50	85380	$128,070.00	190028	$285,042.00
704-51002	CONCRETE, C, SUPERSTRUCTURE		CYS	$950.00	756.1	$718,295.00	2064.2	$1,960,990.00
706-04683	RAILING	, ORNAMENTAL	LFT	$40.00	767	$30,680.00	767	$30,680.00
706-08496	REINFORCED CONCRETE MOMENT SLAB, 12 IN.		SYS	$136.00	916	$124,576.00	916	$124,576.00
706-51020	RAILING, CONCRETE C		CYS	$900.00	65.3	$58,770.00	65.3	$58,770.00
709-51821	SURFACE SEAL		LS	-	1	$60,000.00	1	$60,000.00
710-XXXXX	LIMESTONE		SFT	$450.00	4000	$1,800,000.00	4000	$1,800,000.00
713-04331	TEMPORARY CAUSEWAY		LS	-	1	$400,000.00	1	$400,000.00
715-05407	PIPE, END BENT DRAIN, 6 IN.		LFT	$19.00	1131	$21,489.00	1131	$21,489.00
715-09938	PIPE, BRIDGE DECK DRAIN SYSTEM		LS	-	1	$30,000.00	1	$30,000.00
715-91361	PIPE PVC 6 IN		LFT	$56.00	36	$2,016.00	36	$2,016.00
720-45145	INLET, J10 MODIFIED		EACH	$2,700.00	8	$21,600.00	8	$21,600.00
801-04308	ROAD CLOSURE SIGN ASSEMBLY		EACH	$187.00	6	$1,122.00	6	$1,122.00
801-06625	DETOUR ROUTE MARKER ASSEMBLY		EACH	$108.00	28	$3,024.00	28	$3,024.00
801-06640	CONSTRUCTION SIGN, A		EACH	$151.00	12	$1,812.00	12	$1,812.00
801-06775	MAINTAINING TRAFFIC	, ROADWAY	LS	-	1	$35,000.00	1	$35,000.00
801-06775	MAINTAINING TRAFFIC	, WATERWAY	LS	-	1	$25,000.00	1	$25,000.00
801-07118	BARRICADE, III-A		LFT	$11.00	96	$1,056.00	96	$1,056.00
801-07119	BARRICADE, III-B		LFT	$12.00	48	$576.00	48	$576.00
801-11642	PORTABLE CHANGEABLE MESSAGE SIGN		EACH	$3,300.00	8	$26,400.00	8	$26,400.00
802-04993	SIGN	, INTERPRETIVE	LS	$10,000.00	1	$10,000.00	1	$10,000.00
805-06595	CONDUIT, PVC, 2 IN.		LFT	$8.00	873	$6,984.00	873	$6,984.00
807-04744	LIGHTING	, ORNAMENTAL	LS	-	1	$15,000.00	1	$15,000.00
808-10031	LINE, MULTI-COMPONENT, BROKEN, WHITE, 4 IN.		LFT	$3.00	202	$606.00	202	$606.00
808-10033	LINE, MULTI-COMPONENT, SOLID, WHITE, 4 IN.		LFT	$2.50	50	$125.00	50	$125.00
808-10034	LINE, MULTI-COMPONENT, SOLID, YELLOW, 4 IN.		LFT	$1.75	1300	$2,275.00	1300	$2,275.00
808-10051	TRANSVERSE MARKING, MULTI-COMPONENT, STOP LINE, WHITE, 24 IN.		LFT	$20.00	110	$2,200.00	110	$2,200.00
808-10056	TRANSVERSE MARKING, MULTI-COMPONENT, CROSSWALK LINE, WHITE, 6 IN.		LFT	$4.00	450	$1,800.00	450	$1,800.00
808-10077	PAVEMENT MESSAGE MARKINGS MULTI-COMPONENT LANE INDICATION ARROW		EACH	$286.00	2	$572.00	2	$572.00
808-12032	GROOVING FOR PAVEMENT MARKINGS		LFT	$1.25	2112	$2,640.00	2112	$2,640.00
Contingency (20%)						$1,434,651.90		$2,033,555.26
Total (Rounded)						**8,608,000**		**12,201,400**

Quantity Calculations

Project Information

General Info:

Bridge Length: $L_s := 323.25\ ft$

Bridge Out-to-Out Width: $W_s := 72.08\ ft$

Bridge Width Btw Railing: $W_{btw.rail} := 68\ ft$ (Per Survey and Field Measurements)

Bridge Clear Rdwy Width: $W_{clr} := 55\ ft$

Barrier Curb Width: $W_{bar.curb} := 1.17\ ft$

Bridge Skew: $Skew := 0\ deg$

Length of Appr. Full Depth Replacement: $L_{appr.full.depth.N} := 20\ ft$ (Approximate from end of bridge to straight line continuation of curbs on south side of North Shore Drive)

$L_{appr.full.depth.S} := 50\ ft$ (Approximate to the end of barrier curb taper into approach curb)

Construction Info:

Construction Duration: $T_{construction} := 24$ Months (Estimated)

105-06845 Construction Engineering

Alternatives B1a & B1b:

Estimated at 2% of Total Contract Cost per IDM 20-2.03.

$Total_{105.06845} := 1$ LSUM $\qquad Total_{105.06845} = 1$ LSUM

110-01001 Mobilization and Demobilization

Alternatives B1a & B1b:

Estimated at 5% of Total Contract Cost per IDM 20-2.03.

$Total_{110.01001} := 1$ LSUM $\qquad Total_{110.01001} = 1$ LSUM

201-52370 Clearing Right of Way

Alternatives B1a & B1b:

Estimated at $75,000 based on project site.

$Total_{201.52370} := 1$ LSUM $\qquad Total_{201.52370} = 1$ LSUM

202-02240 Pavement Removal

Alternatives B1a & B1b:

$Total_{202.02240} := \text{ceil}\left(\left(W_{clr} \cdot L_s\right)\ \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2 \qquad Total_{202.02240} = 1976\ \boldsymbol{yd}^2$

202-51328 Present Structure, Remove Portions

Alternatives B1a:

$Total_{202.51328} := 1$ LSUM $\qquad Total_{202.51328} = 1$ LSUM

202-51330 Present Structure, Remove

Alternatives B1b:

$Total_{202.51330} := 1$ LSUM $\qquad Total_{202.51328} = 1$ LSUM

202-52710 Sidewalk Concrete, Remove

Alternatives B1a & B1b:

Total Combined Existing Sidewalks Width: $W_{existing.sidewalks} := W_{btw.rail} - W_{clr} - W_{bar.curb} \cdot 2 = 10.66\ \boldsymbol{ft}$

Additional Area at Ends of Bridge: $A_{N.sidewalk} := 300\ \boldsymbol{ft}^2 \qquad A_{S.sidewalk} := 1000\ \boldsymbol{ft}^2$

$Total_{202.52710} := \text{ceil}\left(\left(W_{existing.sidewalks} \cdot L_s + A_{N.sidewalk} + A_{S.sidewalk}\right)\ \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2 \qquad Total_{202.52710} = 528\ \boldsymbol{yd}^2$

203-02000 Excavation, Common

Alternatives B1a & B1b:

Approx. Elevation Area of Arch Backfill: $A_{arch.backfill} := 2900\ \boldsymbol{ft}^2$

Approx. Width of Spandrel Walls: $W_{spandrel.walls} := 2\ \boldsymbol{ft}$

Approach Pavement Removal Depth: $D_{appr.pvmt} := 12\ \boldsymbol{in}$ (Approximate)

Additional Area of Pavement Removal in North Intersection: $A_{add.intersection} := 250\ \boldsymbol{ft}^2$

Approach Pavement Removal Area: $A_{appr.pvmt} := W_{clr} \cdot \left(L_{appr.full.depth.N} + L_{appr.full.depth.S}\right) + A_{add.intersection} = 455.6\ \boldsymbol{yd}^2$

$Total_{203.02000} := \text{ceil}\left(\left(A_{arch.backfill} \cdot \left(W_s - W_{spandrel.walls} \cdot 2\right) + A_{appr.pvmt} \cdot D_{appr.pvmt}\right)\ \boldsymbol{yd}^{-3}\right)\ \boldsymbol{yd}^3 \qquad Total_{203.02000} = 7465\ \boldsymbol{yd}^3$

205-12108 Stormwater Management Budget

Alternatives B1a & B1b:

Estimated at $10,000 per cost on similar project.

$Total_{205.12108} := 10000$ DOL $\qquad$ $Total_{205.12108} = 10000$ DOL

205-12616 Stormwater Management Implementation

Alternatives B1a & B1b:

SWQM Level 2 expected since the following two Secondary Category items are met per INDOT Design Memo 20-05.
- Project is within St. Joseph Sole Source Aquifer
- Project duration expected to be two full construction seasons or more.

Stormwater Management Inspections: $Cost_{Inspect} := 425 \cdot \left(T_{construction} \cdot 4\right) = 40800$ DOL

SWQM Progress Meetings: $Cost_{Meeting} := 425 \cdot \left(T_{construction} \cdot 2\right) = 20400$ DOL

SWQM Level: $Cost_{Level} := 1500$ DOL

Total Cost: $Total_{SWQM.Impl.Cost} := Cost_{Inspect} + Cost_{Meeting} + Cost_{Level} = 62700$ DOL

$Total_{205.12616} := 1$ LSUM $\qquad$ $Total_{205.12616} = 1$ LSUM

205-12618 SWQCP Preparation

Alternatives B1a & B1b:

Estimated at $20,000 per INDOT Design Memo 20-05.

$Total_{205.12618} := 1$ LSUM $\qquad$ $Total_{205.12618} = 1$ LSUM

206-51220 Excavation, Wet

Alternative B1b:

Note: This is for the excavation for the casting of the new bent footings.

Width of Bent Footings: $W_{footing.bent} := 20\ \boldsymbol{ft}$ (Approximate)

Height of Bent Footings: $H_{footing.bent} := 3\ \boldsymbol{ft}$ (Approximate)

Length of Bent Footings: $L_{footing.bent} := W_s + 14\ \boldsymbol{ft} \cdot 2 = 100\ \boldsymbol{ft}$ (Approximate)

Dist. From Bott. Bent
Footings to Existing Ground: $D_{footing.bent.depth} := 12\ \boldsymbol{ft}$ (Approximate)

Depth of Foundation Seal: $D_{foundation.seal} := 3\ \boldsymbol{ft}$ (Estimated)

$$Total_{206.51220} := \operatorname{ceil}\left(\left(\left(\left(\left(W_{footing.bent} + 3\ \boldsymbol{ft}\right) \cdot \left(L_{footing.bent} + 3\ \boldsymbol{ft}\right)\right) - \left(W_{footing.bent} \cdot L_{footing.bent}\right)\right) \cdot \left(D_{footing.bent.depth} + D_{foundation.seal}\right) \cdot 2 + W_{footing.bent} \cdot L_{footing.bent} \cdot D_{foundation.seal} \cdot 2\right) \cdot \boldsymbol{yd}^{-3}\right) \boldsymbol{yd}^3$$

$Total_{206.51220} = 856\ \boldsymbol{yd}^3$

206-51235 Cofferdam

Alternatives B1a & B1b:

Estimated at $200,000 for Alt. B1a and $200,000 for Alt. B1b per cost on similar project.

$Total_{206.51235} := 1$ LSUM $\qquad$ $Total_{206.51235} = 1$ LSUM

207-09935 Subgrade Treatment, Type IC

Alternatives B1a & B1b:

Width of PCCP: $W_{PCCP} := W_{btw.rail} = 68\ ft$

Length of PCCP: $L_{PCCP} := L_s + L_{appr.full.depth.N} + L_{appr.full.depth.S} = 393\ ft$

$Total_{207.09935} := \text{ceil}\left(\left(W_{PCCP} \cdot L_{PCCP} + A_{add.intersection}\right) yd^{-2}\right) yd^2$

$Total_{207.09935} = 2999\ yd^2$

211-09266 Structure Backfill, Type 3

Alternatives B1a & B1b:

Volume of Pavement, Subbase, and Subgrade: $V_{pvmt} := (12\ in + 9\ in + 12\ in) \cdot (W_{clr} + 10\ in \cdot 2) \cdot L_s = 1865.7\ yd^3$

Volume of Sidewalk, Subbase, and Subgrade: $V_{sidewalk} := (4\ in + 9\ in + 12\ in) \cdot (W_{btw.rail} - W_{clr} - 10\ in \cdot 2) \cdot L_s = 282.7\ yd^3$

$Total_{211.09266} := \text{ceil}\left(\left(Total_{203.02000} - A_{appr.pvmt} \cdot D_{appr.pvmt} - V_{pvmt} - V_{sidewalk}\right) yd^{-3}\right) yd^3$

$Total_{211.09266} = 5165\ yd^3$

302-06464 Subbase for PCCP

Alternatives B1a & B1b:

Depth of Subbase: $D_{subbase} := 9\ in$ (Estimated)

$Total_{302.06464} := \text{ceil}\left(Total_{207.09935} \cdot D_{subbase} \cdot yd^{-3}\right) yd^3$

$Total_{302.06464} = 750\ yd^3$

306-08043 Milling, Transition

Alternatives B1a & B1b:

Areas of Milling: $A_{milling.N} := 5000\ ft^2$ (Approximate)

$A_{milling.S} := W_{clr} \cdot 30\ ft = 1650\ ft^2$

$Total_{306.08043} := \text{ceil}\left(\left(A_{milling.N} + A_{milling.S}\right) yd^{-2}\right) yd^2$

$Total_{306.08043} = 739\ yd^2$

401-07328 QC/QA-HMA, 3, 70, Surface, 9.5 mm

Alternatives B1a & B1b:

HMA Unit Weight: $\gamma_{HMA} := 0.055\ \dfrac{ton}{yd^2}$ (per 1"; IDM Fig. 17-4A)

HMA Depth: $D_{HMA} := 1.5\ in$

$Total_{401.07328} := \text{ceil}\left(Total_{306.08043} \cdot \gamma_{HMA} \cdot \left(\dfrac{D_{HMA}}{1\ in}\right) \cdot ton^{-1}\right) ton$

$Total_{401.07328} = 61\ ton$

401-10258 Joint Ashesive, Surface

Alternatives B1a & B1b:

Number of Joints: $N_{HMA.joints} := 5$

Joint Lengths: $L_{HMA.joints.N} := 60\ ft$ $L_{HMA.joints.S} := 30\ ft$

$Total_{401.10258} := \text{ceil}\left(N_{HMA.joints} \cdot \left(L_{HMA.joints.N} + L_{HMA.joints.S}\right) \cdot ft^{-1}\right) ft$

$Total_{401.10258} = 450\ ft$

401-11785 Liquid Asphalt Sealant

Alternatives B1a & B1b:

$Total_{401.11785} := Total_{401.10258}$

$Total_{401.11785} = 450\ ft$

406-05521 Asphalt for Tack Coat

Alternatives B1a & B1b:

$Total_{406.05521} := Total_{306.08043}$

$Total_{406.05521} = 739\ \boldsymbol{yd}^2$

501-06323 QC/QA-PCCP, 12 IN

Alternatives B1a & B1b:

$Total_{501.06323} := \text{ceil}\left(\left(Total_{207.09935} - \left(W_{btw.rail} - W_{clr} - 10\ \boldsymbol{in} \cdot 2 + 11\ \boldsymbol{ft} \cdot 2\right) \cdot L_s\right) \cdot \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2$

$Total_{501.06323} = 1802\ \boldsymbol{yd}^2$

503-05240 D-1 Contraction Joint

Alternatives B1a & B1b:

Joint Spacing: $S_{joints} := 15\ \boldsymbol{ft}$ (Conservatively used based on 18 ft max. spacing per Std. Spec. 503.03(a))

Number of Joints: $N_{joints} := \text{ceil}\left(\dfrac{L_{PCCP}}{S_{joints}}\right) = 27$

$Total_{503.05240} := \text{ceil}\left(W_{clr} \cdot N_{joints} \cdot \boldsymbol{ft}^{-1}\right)\ \boldsymbol{ft}$

$Total_{503.05240} = 1485\ \boldsymbol{ft}$

604-06070 Sidewalk, Concrete

Alternatives B1a & B1b:

Proposed Barrier/Curb Width on Bridge: $W_{prop.bar} := 10\ \boldsymbol{in}$

Total Combined Proposed Sidewalks Width: $W_{prop.sidewalks} := W_{btw.rail} - W_{clr} - W_{prop.bar} \cdot 2 = 11.33\ \boldsymbol{ft}$

Curb Ramps Area: $A_{curb.ramps.sw.se} := 120\ \boldsymbol{ft}^2$ (At southwest and southeast corners of intersection north of bridge)

$Total_{604.06070} := \text{ceil}\left(\left(W_{prop.sidewalks} \cdot L_s + A_{N.sidewalk} + A_{S.sidewalk} - A_{curb.ramps.sw.se}\right)\ \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2$

$Total_{604.06070} = 539\ \boldsymbol{yd}^2$

604-08086 Curb Ramp, Concrete

Alternatives B1a & B1b:

Curb Ramps Area: $A_{curb.ramps.nw.ne} := 400\ \boldsymbol{ft}^2$ (At northwest and northeast corners of intersection north of bridge)

$Total_{604.08086} := \text{ceil}\left(\left(A_{curb.ramps.sw.se} + A_{curb.ramps.nw.ne}\right) \cdot \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2$

$Total_{604.08086} = 58\ \boldsymbol{yd}^2$

604-12083 Detectable Warning Surfaces

Alternatives B1a & B1b:

Areas Estimated per Existing Detectable Warning Surfaces.

Area at Southwest Corner of Intersection: $A_{SW.warning.surface} := 8\ \boldsymbol{ft} \cdot 2\ \boldsymbol{ft} = 16\ \boldsymbol{ft}^2$ (Estimated)

Area at Southeast Corner of Intersection: $A_{SE.warning.surface} := 4\ \boldsymbol{ft} \cdot 2\ \boldsymbol{ft} = 8\ \boldsymbol{ft}^2$ (Estimated)

Area at Northwest Corner of Intersection: $A_{NW.warning.surface} := 12\ \boldsymbol{ft} \cdot 2\ \boldsymbol{ft} = 24\ \boldsymbol{ft}^2$ (Estimated)

Area at Northeast Corner of Intersection: $A_{NE.warning.surface} := 12\ \boldsymbol{ft} \cdot 2\ \boldsymbol{ft} = 24\ \boldsymbol{ft}^2$ (Estimated)

$$Total_{604.12083} := \text{ceil}\left(\begin{pmatrix}A_{SW.warning.surface} + A_{SE.warning.surface} \hookleftarrow \\ + A_{NW.warning.surface} + A_{NE.warning.surface}\end{pmatrix} \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2$$

$Total_{604.12083} = 8\ \boldsymbol{yd}^2$

605-02278 Curb, Remove

Alternatives B1a & B1b:

Note: This includes the removal of the existing barrier curb.

Additional Lengths at Ends of Bridge: $L_{N.curb} := 40\ \boldsymbol{ft}$ $L_{S.curb} := 100\ \boldsymbol{ft}$

$Total_{605.02278} := \mathrm{ceil}\left(\left(L_s \cdot 2 + L_{N.curb} + L_{S.curb}\right) \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$

$Total_{605.02278} = 787\ \boldsymbol{ft}$

605-06120 Curb, Concrete

Alternatives B1a & B1b:

$Total_{605.06120} := \mathrm{ceil}\left(L_{N.curb} \cdot \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$

$Total_{605.06120} = 40\ \boldsymbol{ft}$

616-05688 Riprap, Class 1

Alternatives B1a:

Note: For this alternative the piers and abutments require scour protection. Based on the hydrualic information in the 2006 rehabilitation plans Class 1 riprap is proposed. The riprap will be placed in accordance with IDM Fig. 203-3B still based on the pier width but placed around the cofferdam.

Depth of Riprap: $D_{riprap.pier} := 3\ \boldsymbol{ft}$ (IDM Fig. 203-3B)

$D_{riprap.abut} := 2\ \boldsymbol{ft}$ (IDM Fig. 203-3B)

Unit Weight of Riprap: $\gamma_{riprap} := 1.5\ \dfrac{\boldsymbol{ton}}{\boldsymbol{yd}^3}$ (IDM Fig. 17-4A)

Pier Width: $W_{pier} := 11\ \boldsymbol{ft}$

Water Depth: $D_{water} := 5\ \boldsymbol{ft}$ (Approximate)

Controlling Riprap Width: $W_{riprap.pier} := \max\left(6\ \boldsymbol{ft}, 2 \cdot W_{pier}\right) = 22\ \boldsymbol{ft}$ (IDM Fig. 203-3B)

$W_{riprap.abut} := \max\left(10\ \boldsymbol{ft}, 2 \cdot D_{water}\right) = 10\ \boldsymbol{ft}$ (IDM Fig. 203-3B)

Riprap Areas:
(Conservative Approx.)

$A_{riprap.areas.piers} := 14200\ \boldsymbol{ft}^2$

$$A_{riprap.areas.abuts} := \left(W_{riprap.abut} + W_{footing.bent}\right) \cdot \left(W_{riprap.abut} \cdot 2 + L_{footing.bent}\right) - \left(W_{footing.bent} \cdot L_{footing.bent}\right) = 1601\ \boldsymbol{ft}^2$$

Riprap Perimeter:
(Conservative Approx.)

$P_{riprap.perimeters.piers} := 1300\ \boldsymbol{ft}$

$$P_{riprap.perimeters.abuts} := \left(W_{riprap.abut} \cdot 6 + L_{footing.bent} \cdot 2 + W_{footing.bent} \cdot 4\right) = 340\ \boldsymbol{ft}$$

$$Total_{616.05688} := \mathrm{ceil}\left(\left(D_{riprap.pier} \cdot A_{riprap.areas.piers} + D_{riprap.abut} \cdot A_{riprap.areas.abuts}\right) \cdot \gamma_{riprap} \cdot \boldsymbol{ton}^{-1}\right) \boldsymbol{ton}$$

$Total_{616.05688} = 2545\ \boldsymbol{ton}$

616-12251 Geotextile For Riprap, Type 3

Alternatives B1a:

$$Total_{616.12251} := \mathrm{ceil}\left(\left(A_{riprap.areas.piers} + P_{riprap.perimeters.piers} \cdot D_{riprap.pier} + A_{riprap.areas.abuts} + P_{riprap.perimeters.abuts} \cdot D_{riprap.abut}\right) \cdot \boldsymbol{yd}^{-2}\right) \boldsymbol{yd}^2$$

$Total_{616.12251} = 2265\ \boldsymbol{yd}^2$

621-01004 Mobilization and Demobilization for Seeding

Alternatives B1a & B1b:

$Total_{621.01004} := 1$ EACH

$Total_{621.01004} = 1$ EACH

621-06560 Mulched Seeding, U

Alternatives B1a & B1b:

Area: $A_{seeding} := 200\ ft^2 \cdot 4 = 800\ ft^2$ (Estimated for all bridge quadrants)

$Total_{621.06560} := \text{ceil}\left(A_{seeding} \cdot yd^{-2}\right)\ yd^2$ $Total_{621.06560} = 89\ yd^2$

701-XXXXX Micropile, 7 IN

Alternatives B1a:

Number of Micropiles: $N_{micropiles} := 20$ (Per Pier)

Length of Micropiles: $L_{micropiles} := 50\ ft$ (Estimated)

$Total_{701.XXXXX} := \text{ceil}\left(N_{micropiles} \cdot L_{micropiles} \cdot 2 \cdot ft^{-1}\right)\ ft$ $Total_{701.XXXXX} = 2000\ ft$

701-XXXXX Micropile, Testing

Alternatives B1a:

Estimated at $60,000 .

$Total_{701.XXXXX.Testing} := 1$ LSUM $Total_{701.XXXXX.Testing} = 1$ LSUM

701-06011 Dynamic Pile Load Test

Alternatives B1b:

Note: It is estimated that one pile load test will be completed per bent receiving new piling.

Number of Pile Load Tests: $N_{pile.load.test.B1b} := 4$ EACH

$Total_{701.06011.B1b} := N_{pile.load.test.B1b}$ $Total_{701.06011.B1b} = 4$ EACH

701-09557 Test Pile, Dynamic, Production

Alternatives B1b:

Note: It is estimated that one test pile will be provided per bent receiving new piling.

Piling Length: $L_{piles} := 50\ ft$

$Total_{701.09557.B1b} := \text{ceil}\left(N_{pile.load.test.B1b} \cdot \left(L_{piles} + 10\ ft\right)\ ft^{-1}\right)\ ft$ $Total_{701.09557.B1b} = 240\ ft$

701-09559 Test Pile, Dynamic, Restrike

Alternatives B1b:

Note: It is estimated that one test pile will be provided per bent receiving new piling.

$Total_{701.09559.B1b} := N_{pile.load.test.B1b}$ $Total_{701.09559.B1b} = 4$ EACH

701-09683 Pile Shoe, HP 12x74

Alternative B1b:

Number of Piles: $N_{piles.abut} := 36$ EACH $N_{piles.pier} := 45$ EACH (Estimated per bent)

$Total_{701.09683} := \left(N_{piles.abut} + N_{piles.pier}\right) \cdot 2$ $Total_{701.09683} = 162$ EACH

701-95780 Pile, Steel H, HP 12x74

Alternative B1b:

$Total_{701.95780} := \text{ceil}\left(\left(N_{piles.abut} + N_{piles.pier}\right) \cdot 2 \cdot L_{piles} \cdot ft^{-1}\right)\ ft$ $Total_{701.95780} = 8100\ ft$

702-02925 Waterproofing Membrane System

Alternatives B1a & B1b:

Approx. Length Along Tops of Arches: $L_{top.arch.span.A} := 95\ ft$ $L_{top.arch.span.B} := 130\ ft$ $L_{top.arch.span.C} := 95\ ft$

$$Total_{702.02925} := \text{ceil}\left(\left(L_{top.arch.span.A} + L_{top.arch.span.B} + L_{top.arch.span.C}\right) \cdot \left(W_s - W_{spandrel.walls} \cdot 2\right) \cdot ft^{-2}\right)\ ft^2$$

$$Total_{702.02925} = 21786\ ft^2$$

702-03607 Cored Hole in Concrete

Alternative B1a:

$Total_{702.03607} := \text{ceil}\left(N_{micropiles} \cdot 2\right)$ $Total_{702.03607} = 40$ EACH

702-04325 Temporary Shoring

Alternatives B1a & B1b:

$Total_{702.04325} := 1$ LSUM $Total_{702.04325} = 1$ LSUM

702-51005 Concrete, A, Substructure

Alternative B1b:

Note: Concrete piers and abutments will be fully removed and replaced.

Height of Bent Caps: $H_{bent.caps} := 8\ ft$ (Approximate)

Width of Bent Caps: $W_{bent.caps} := 11\ ft$ (Approximate)

Length of Bent Caps: $L_{bent.caps} := W_s + 12\ ft \cdot 2 = 96\ ft$ (Approximate)

$$Total_{702.51005} := \text{Ceil}\left(H_{bent.caps} \cdot W_{bent.caps} \cdot L_{bent.caps} \cdot 4 \cdot yd^{-3}, 0.1\right)\ yd^3$$

$$Total_{702.51005} = 1252.6\ yd^3$$

702-51015 Concrete, B, Footings

Alternative B1b:

$$Total_{702.51015} := \text{Ceil}\left(W_{footing.bent} \cdot H_{footing.bent} \cdot L_{footing.bent} \cdot 4 \cdot yd^{-3}, 0.1\right)\ yd^3$$

$$Total_{702.51015} = 889.6\ yd^3$$

702-51046 Concrete, Foundation Seal

Alternative B1b:

$$Total_{702.51046} := \text{Ceil}\left(\left(W_{footing.bent} + 3\ ft\right) \cdot \left(L_{footing.bent} + 3\ ft\right) \cdot D_{foundation.seal} \cdot yd^{-3}, 0.1\right)\ yd^3$$

$$Total_{702.51046} = 263.5\ yd^3$$

702-51863 Field Drilled Hole in Concrete

Alternative B1a:

Number of Holes per Pier: $N_{holes} := 600$ (Approximate)

$Total_{702.51863} := \text{ceil}\left(N_{holes} \cdot 2\right)$ $Total_{702.51863} = 1200$ EACH

702-92857 Concrete C, Substructure, Modified

Alternative B1a:

Note: Existing concrete within the pier cofferdams will be removed to allow the instllation of micropiles, then once the micropiles have been installed the concrete will be repoured to tie the micropiles into the existing foundation. Minimum concrete strength shall be 5 ksi.

Cross-Sectional Area of Concrete: $A_{concrete.cofferdam.B1a} := 120.9\ ft^2$ (Approximate)

Length of Cofferdam: $L_{cofferdam} := 105\ ft$ (Approximate)

$$Total_{702.76240} := \text{Ceil}\left(A_{concrete.cofferdam.B1a} \cdot L_{cofferdam} \cdot yd^{-3}, 0.1\right)\ yd^3$$

$$Total_{702.76240} = 470.2\ yd^3$$

703-06028 Reinforcing Bars

Alternative B1a:

Reinforcement per Cu. Yd. of Concrete: $\gamma_{reinf.pier.repairs} := 200\ \frac{\boldsymbol{lb}}{\boldsymbol{yd}^3}$

$Total_{703.06028.B1a} := \text{ceil}\left(Total_{702.76240} \cdot \gamma_{reinf.pier.repairs} \cdot \boldsymbol{lb}^{-1}\right)\ \boldsymbol{lb}$ $\quad Total_{703.06028.B1a} = 94040\ \boldsymbol{lb}$

Alternative B1b:

Reinforcement per Cu. Yd. of Concrete: $\gamma_{reinf.sub.and.ftgs} := 60\ \frac{\boldsymbol{lb}}{\boldsymbol{yd}^3}$

$Total_{703.06028.B1b} := \text{ceil}\left(\left(Total_{702.51005} + Total_{702.51015}\right) \cdot \gamma_{reinf.sub.and.ftgs} \cdot \boldsymbol{lb}^{-1}\right)\ \boldsymbol{lb}$ $\quad Total_{703.06028.B1b} = 128532\ \boldsymbol{lb}$

703-06029 Reinforcing Bars, Epoxy Coated

Alternative B1a:

Thickness of Arches: $T_{arches} := 2\ \boldsymbol{ft}$ (Estimated)

Concrete Volume: $V_{conc.super.B1a.arches} := \text{Ceil}\left(\left(L_{top.arch.span.B} + L_{top.arch.span.C}\right) \cdot T_{arches} \cdot \left(\frac{W_s}{3}\right) \cdot \boldsymbol{yd}^{-3}, 0.1\right)\ \boldsymbol{yd}^3 = 400.5\ \boldsymbol{yd}^3$

$V_{conc.super.B1a.spandrel.walls} := \text{Ceil}\left(\left(3200\ \boldsymbol{ft}^2\right) \cdot 1.5\ \boldsymbol{ft} \cdot 2 \cdot \boldsymbol{yd}^{-3}, 0.1\right)\ \boldsymbol{yd}^3 = 355.6\ \boldsymbol{yd}^3$

Reinforcement per Cu. Yd. of Concrete: $\gamma_{reinf.arches} := 80\ \frac{\boldsymbol{lb}}{\boldsymbol{yd}^3}$ $\quad \gamma_{reinf.spandrel.walls} := 150\ \frac{\boldsymbol{lb}}{\boldsymbol{yd}^3}$

$$Total_{703.06029.B1a} := \text{ceil}\left(\begin{pmatrix} V_{conc.super.B1a.arches} \cdot \gamma_{reinf.arches} \hookleftarrow \\ + V_{conc.super.B1a.spandrel.walls} \cdot \gamma_{reinf.spandrel.walls} \end{pmatrix} \cdot \boldsymbol{lb}^{-1}\right)\ \boldsymbol{lb}$$

$Total_{703.06029.B1a} = 85380\ \boldsymbol{lb}$

Alternatives B1b:

Concrete Volume:

$$V_{conc.super.B1b.arches} := \text{Ceil}\left(\begin{pmatrix} L_{top.arch.span.A} \hookleftarrow \\ + L_{top.arch.span.B} \hookleftarrow \\ + L_{top.arch.span.C} \end{pmatrix} \cdot T_{arches} \cdot \left(W_s\right) \cdot \boldsymbol{yd}^{-3}, 0.1\right)\ \boldsymbol{yd}^3 = 1708.6\ \boldsymbol{yd}^3$$

$V_{conc.super.B1b.spandrel.walls} := V_{conc.super.B1a.spandrel.walls} = 355.6\ \boldsymbol{yd}^3$

$$Total_{703.06029.B1b} := \text{ceil}\left(\begin{pmatrix} V_{conc.super.B1b.arches} \cdot \gamma_{reinf.arches} \hookleftarrow \\ + V_{conc.super.B1b.spandrel.walls} \cdot \gamma_{reinf.spandrel.walls} \end{pmatrix} \cdot \boldsymbol{lb}^{-1}\right)\ \boldsymbol{lb}$$

$Total_{703.06029.B1b} = 190028\ \boldsymbol{lb}$

704-51002 Concrete, C, Superstructure

Alternative B1a:

$Total_{704.51002.B1a} := V_{conc.super.B1a.arches} + V_{conc.super.B1a.spandrel.walls}$ $\quad Total_{704.51002.B1a} = 756.1\ \boldsymbol{yd}^3$

Alternative B1b:

$Total_{704.51002.B1b} := V_{conc.super.B1b.arches} + V_{conc.super.B1b.spandrel.walls}$ $\quad Total_{704.51002.B1b} = 2064.2\ \boldsymbol{yd}^3$

706-04683 Railing, Ornamental

Alternatives B1a & B1b:

Note: This is pay item will cover the cost of of the removal, reuse and reinstallation where possible, and replacement where not possible to reuse the existing ornate railing along the copings of the bridge.

Additional Railing Length at Bridge Corners: $L_{railing.ornate.addl} := 30\ \boldsymbol{ft}$

$Total_{706.04683} := \text{ceil}\left(\left(L_s \cdot 2 + L_{railing.ornate.addl} \cdot 4\right) \cdot \boldsymbol{ft}^{-1}\right)\ \boldsymbol{ft}$ $\quad Total_{706.04683} = 767\ \boldsymbol{ft}$

706-08496 Reinforced Concrete Moment Slab, 12 IN

Alternatives B1a & B1b:

Note: It is estimated that the moment slab will reach from beneath the concrete barrier railing to the inside edge of the first lane instead of the standard 8'-0" specified in Std. Drwg. 706-MSRW-01 & 02 .

Width of Moment Slab: $W_{moment.slab} := 10\ \boldsymbol{in} + 1\ \boldsymbol{ft} + 10\ \boldsymbol{ft} = 11.83\ \boldsymbol{ft}$

$Total_{706.08496} := \text{ceil}\left(\left(L_s \cdot 2 + L_{appr.full.depth.S}\right) \cdot W_{moment.slab} \cdot \boldsymbol{yd}^{-2}\right)\ \boldsymbol{yd}^2$

$Total_{706.08496} = 916\ \boldsymbol{yd}^2$

706-51020 Railing, Concrete C

Alternatives B1a & B1b:

Note: This pay item will cover the concrete of the 34" tall HDOT aesthetic concrete bridge railing and the railing is anticipated to taper into the curbs at the ends of the bridge similar to the existing barrier curb, however the full railing dimensions will be conservatively used for this preliminary quantity.

Railing Area: $A_{railing} := 34\ \boldsymbol{in} \cdot 10\ \boldsymbol{in} = 2.36\ \boldsymbol{ft}^2$

$Total_{706.51020} := \text{Ceil}\left(A_{railing} \cdot \left(L_s \cdot 2 + L_{S.curb}\right) \cdot \boldsymbol{yd}^{-3}, 0.1\right)\ \boldsymbol{yd}^3$

$Total_{706.51020} = 65.3\ \boldsymbol{yd}^3$

709-51821 Surface Seal

Alternatives B1a & B1b:

Width of Surface Seal: $W_{surface.seal} := W_{clr} + \left(34\ \boldsymbol{in} + 10\ \boldsymbol{in} + \left(34\ \boldsymbol{in} - 9\ \boldsymbol{in}\right) + \left(W_s - W_{clr} - 10\ \boldsymbol{in} \cdot 2\right)\right) = 76.2\ \boldsymbol{ft}$

$Total_{709.51821} := \text{ceil}\left(W_{surface.seal} \cdot L_s \cdot \boldsymbol{ft}^{-2}\right)\ \boldsymbol{ft}^2$

$Total_{709.51821} = 24620\ \boldsymbol{ft}^2$

710-XXXXX Limestone

Alternatives B1a & B1b:

Note: This pay item will need to be a unique pay item and will cover all costs assoicated with the removal, storage, replacement as necessary, and reinstallation of the limestone facade on the spandrel walls, bents, and railing.

Area of Limestone: $A_{limestone} := 4000\ \boldsymbol{ft}^2$ (Approximate)

713-04331 Temporary Causeway

Alternatives B1a & B1b:

Estimated at $400,000.

$Total_{715.09938} := 1$ LSUM

$Total_{715.09938} = 1$ LSUM

715-05407 Pipe, End Bent Drain, 6 IN

Alternatives B1a & B1b:

Note: End bent drain pipe is proposed to run along both spandrel walls, on both span faces of pier bents, and at abutment bents.

$$Total_{715.05407} := \text{ceil}\left(\begin{pmatrix}\left(L_{top.arch.span.B} + L_{top.arch.span.B} + L_{top.arch.span.C}\right) \cdot 2 \hookleftarrow \\ + \left(W_s - W_{spandrel.walls}\right) \cdot 6\end{pmatrix} \cdot \boldsymbol{ft}^{-1}\right)\ \boldsymbol{ft}$$

$Total_{715.05407} = 1131\ \boldsymbol{ft}$

715-09938 Pipe, Bridge Deck Drain System

Alternatives B1a & B1b:

Estimated at $10,000 per cost on similar project.

$Total_{715.09938} := 1$ LSUM

$Total_{715.09938} = 1$ LSUM

715-91361 Pipe PVC 6 IN

Alternatives B1a & B1b:

Note: Drainage from end bent pipe will outlet through the spandrel walls at each corner of each span.

Number of Outlets: $N_{outlets} := 12$ EACH

$Total_{715.91362} := \text{ceil}\left(N_{outlets} \cdot \left(T_{arches} + 1\ \boldsymbol{ft}\right) \cdot \boldsymbol{ft}^{-1}\right)\ \boldsymbol{ft}$ $Total_{715.91362} = 36\ \boldsymbol{ft}$

720-45145 Inlet, J10 Modified

Alternatives B1a & B1b:

Number of Inlets: $N_{inlets} := 8$ EACH

$Total_{720.45145} := N_{inlets}$ $Total_{720.45145} = 8$ EACH

801-04308 Road Closure Sign Assembly

Alternatives B1a & B1b:

Estimated per preliminary MOT evaluation.

$Total_{801.04308} := 6$ EACH $Total_{801.04308} = 6$ EACH

801-06625 Detour Route Marker Assembly

Alternatives B1a & B1b:

Estimated per preliminary MOT evaluation.

$Total_{801.06625} := 28$ EACH $Total_{801.06625} = 28$ EACH

801-06640 Construction Sign, A

Alternatives B1a & B1b:

Estimated per preliminary MOT evaluation.

$Total_{801.06640} := 12$ EACH $Total_{801.06640} = 12$ EACH

801-06775 Maintaining Traffic, Roadway

Alternatives B1a & B1b:

Estimated at $35,000 per cost on similar project.

$Total_{801.06775.Roadway} := 1$ LSUM $Total_{801.06775.Roadway} = 1$ LSUM

801-06775 Maintaining Traffic, Waterway

Alternatives B1a & B1b:

Estimated at $25,000 per cost on similar project.

$Total_{801.06775.Waterway} := 1$ LSUM $Total_{801.06775.Waterway} = 1$ LSUM

801-07118 Barricade, III-A

Alternatives B1a & B1b:

Estimated per preliminary MOT evaluation.

$Total_{801.07118} := 96\ \boldsymbol{ft}$ $Total_{801.07118} = 96\ \boldsymbol{ft}$

801-07119 Barricade, III-B

Alternatives B1a & B1b:

Estimated per preliminary MOT evaluation.

$Total_{801.07119} := 48\ \boldsymbol{ft}$ $Total_{801.07119} = 48\ \boldsymbol{ft}$

801-11642 Portable Changeable Message Sign

Alternatives B1a & B1b:

Estimated per preliminary MOT evaluation.

$Total_{801.11642} := 8$ EACH

$Total_{801.11642} = 8$ EACH

802-04993 Sign, Interpretive

Alternatives B1a & B1b:

Estimated at $10,000.

$Total_{802.04993} := 1$ LSUM

$Total_{802.04993} = 1$ LSUM

805-06595 Conduit, PVC, 2 IN

Alternatives B1a & B1b:

Note: Conduit for ornamental lighting.

Height of Light Pedestals: $H_{pedestal} := 7\ \boldsymbol{ft}$

Number of Light Pedestals: $N_{pedestal} := 4$ (Per side)

Additional Length Percentage: $P_{inc.length} := 15\%$ (Add'l percentage of length for that which may not be directly accounted for)

$$Total_{805.06595} := \text{ceil}\left(\left(\left(L_s + H_{pedestal} \cdot 2 \cdot N_{pedestal}\right) \cdot 2\right) \cdot \left(1 + P_{inc.length}\right) \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$$

$Total_{805.06595} = 873\ \boldsymbol{ft}$

807-04744 Lighting, Ornamental

Alternatives B1a & B1b:

Note: This pay item will cover the cost of the removal and reinstallation of the existing ornate lighting on the bridge.

Estimated at $15,000 per cost on similar project.

$Total_{807.04744} := 1$ LSUM

$Total_{807.04744} = 1$ LSUM

808-10031 Line, Multi-Component, Broken, White, 4 IN

Alternatives B1a & B1b:

Length of Broken White Line: $L_{line.broken.white} := \left(L_s + L_{appr.full.depth.S} + 30\ \boldsymbol{ft}\right) \cdot 2 \cdot 0.25 = 201.6\ \boldsymbol{ft}$

$Total_{808.10031} := \text{ceil}\left(L_{line.broken.white} \cdot \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$

$Total_{808.10031} = 202\ \boldsymbol{ft}$

808-10033 Line, Multi-Component, Solid, White, 4 IN

Alternatives B1a & B1b:

Length of Solid White Line: $L_{line.solid.white} := 50\ \boldsymbol{ft}$ (Approximate)

$Total_{808.10033} := \text{ceil}\left(L_{line.solid.white} \cdot \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$

$Total_{808.10033} = 50\ \boldsymbol{ft}$

808-10034 Line, Multi-Component, Solid, Yellow, 4 IN

Alternatives B1a & B1b:

Length of Solid Yellow Line: $L_{line.solid.yellow} := 1300\ \boldsymbol{ft}$ (Approximate)

$Total_{808.10034} := \text{ceil}\left(L_{line.solid.yellow} \cdot \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$

$Total_{808.10034} = 1300\ \boldsymbol{ft}$

808-10051 Transverse Marking, Multi-Component, Stop Line, White, 24 IN

Alternatives B1a & B1b:

Length of Stop Line: $L_{stop.line} := 110\ \boldsymbol{ft}$ (Approximate)

$Total_{808.10051} := \text{ceil}\left(L_{stop.line} \cdot \boldsymbol{ft}^{-1}\right) \boldsymbol{ft}$

$Total_{808.10051} = 110\ \boldsymbol{ft}$

808-10056 Transverse Marking, Multi-Componenet, Crosswalk Line, White, 6 IN

Alternatives B1a & B1b:

Length of Crosswalk Line: $L_{crosswalk.line} := 450\ \boldsymbol{ft}$ (Approximate)

$Total_{808.10056} := \text{ceil}\left(L_{crosswalk.line} \cdot \boldsymbol{ft}^{-1}\right)\ \boldsymbol{ft}$

$Total_{808.10056} = 450\ \boldsymbol{ft}$

808-10077 Pavement Message Markings, Multi-Component, Lane Indication Arrow

Alternatives B1a & B1b:

Number of Turn Arrows: $N_{arrows} := 2$ EACH

$Total_{808.10077} := N_{arrows}$

$Total_{808.10077} = 2$ EACH

808-12032 Grooving for Pavement Markings

Alternatives B1a & B1b:

$Total_{808.12032} := \text{ceil}\left(\left(L_{line.broken.white} + L_{line.solid.white} + L_{line.solid.yellow} + L_{stop.line} + L_{crosswalk.line}\right) \cdot \boldsymbol{ft}^{-1}\right)\ \boldsymbol{ft}$

$Total_{808.12032} = 2112\ \boldsymbol{ft}$

Appendix E:

Bridge Existing Condition and Applicable Design Criteria Table

LEVEL ONE CONTROLLING CRITERIA CHECKLIST

Date: 07/02/2021
Submittal: Historic Bridge Alternatives Analysis
Des. No. 1900011
Is route on the National Truck Network? ☐ Yes ☒ No

Route: SR 933 over St. Joseph River
Design Year AADT: 16,110 vpd (2043)
Functional Classification: Urban (Built-Up) Principal Arterial
Terrain: Level

Project Scope of Work: 3R (Non-Freeway)	Design Criteria Reference	Existing Condition	**Alternative B1a** Does the proposed design satisfy the criteria?			**Alternative B1b** Does the proposed design satisfy the criteria?		
*Enter the minimum criteria below.			Yes	No (1) (2)	N/A	Yes	No (1) (2)	N/A
1. Design Speed: 35 mph	IDM Fig. 55-3E	35 mph	35 mph			35 mph		
2. Lane Width, Mainline: 10 ft Auxiliary Lanes: 10 ft	IDM Fig. 55-3E	10 ft (Min.) 11 ft	10 ft (Min.) 11 ft			10 ft (Min.) 11 ft		
4. Bridge Clear Roadway Width: 55 ft (3)	IDM Fig. 412-2A & IDM Fig. 55-3E	55 ft	55 ft			55 ft		
5. Design Loading Structural Capacity: HS20-44 (Alt. B1a) HL-93 (Alt. B1b)	IDM Fig. 412-2A & IDM Fig. 55-3E	H20-44		H20-44		HL-93		
8b. Stopping Sight Distance, Vertical Curve (Crest Only): 250 ft	IDM Fig. 55-3E	> 250 ft	> 250 ft			> 250 ft		
9. Maximum Grades 9 %	IDM Fig. 55-3E	4.40 %	4.40 %			4.40 %		
10. Travel Lane Cross Slope: 2 %	IDM Fig. 55-3E	2 %	2 %			2 %		
13. Americans with Disabilities Act (ADA)	PROWAG	Does Not Meet	Meets			Meets		
14. Bridge Railing Test Level (3) (circle one of the following) TL-2 [✓ TL-3] TL-5	IDM 404-4.0	Unknown	TL-3			TL-3		

(1) *For high speed facilities **and Freeways**, items 1-3, 5-6 & 8-12 require a Level One design exception when minimum criteria are not satisfied.*

(2) *For low speed facilities, items 1, 2(NTN only), 5 & 12 require a Level One design exception when minimum criteria are not satisfied.*

(3) *A Level Two design exception is required for items not referenced in note 1 or 2 when minimum criteria are not satisfied. Include a brief explanation with the design computations.*

*The following design criteria have been removed from the checklist above since not applicable to either alternative: Usable Shoulder Width (uncurbed sections); Paved Shoulder Width (uncurbed sections); Horizontal Curve, Minimum Radius; Superelevation Transition Length and Distribution (on tangent/on curve); Stopping Sight Distance, Horizontal Curve; Superelevation Rate; Minimum Vertical Clearance.

Are there plan revisions from the previous submittal that affect Level One criteria? ☒ Yes ☐ No Date 6/30/2021

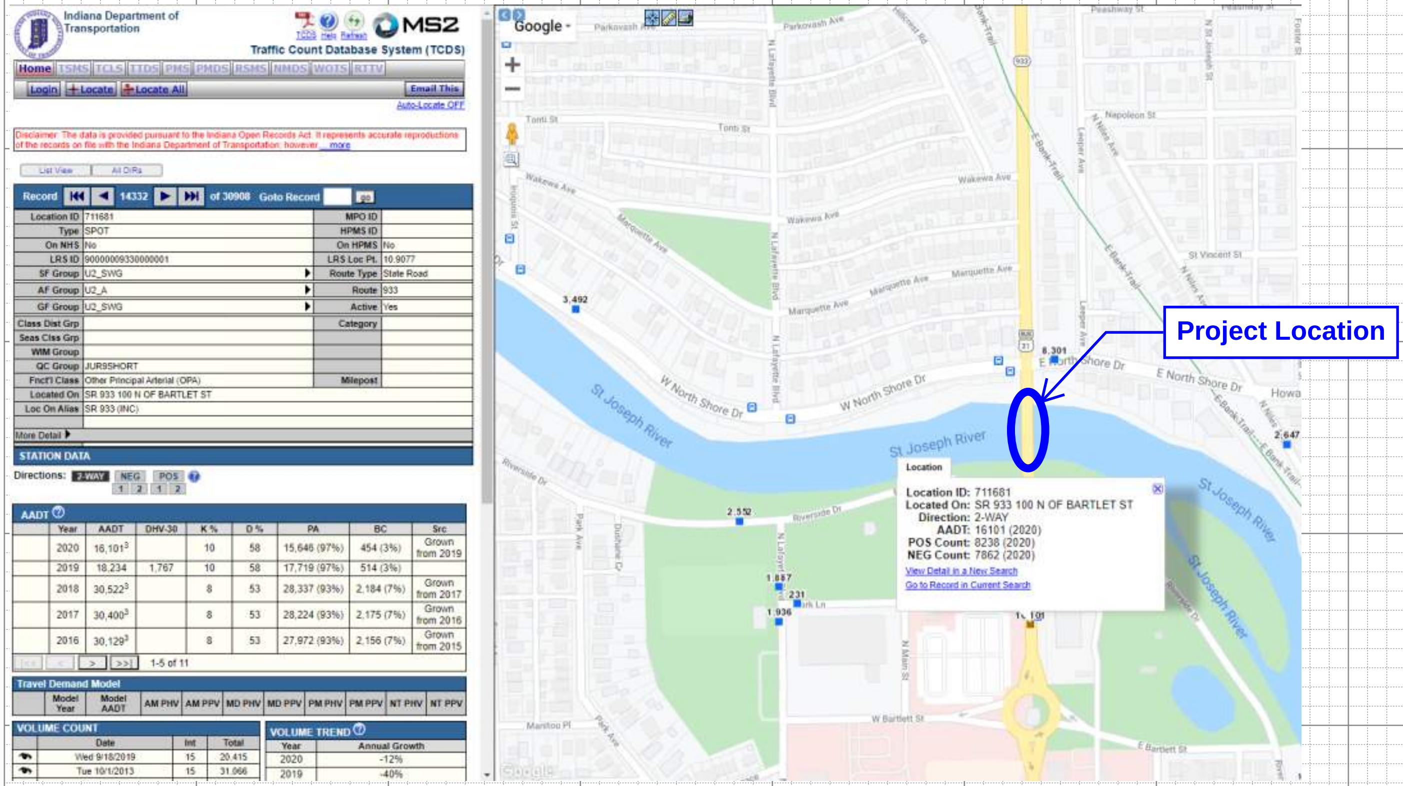
Submitted By ACS Date 5/4/2021 INDOT location or Consultant: Lochmueller Group, Inc.

Checked By MV Date 7/1/2021

INDOT reviewer Click or tap here to enter text. Date Click or tap to enter a date.

PROJECT NAME SR 933 over St. Joseph River
DES/PROJECT NUMBER 1900011
LOCH GROUP PROJECT NUMBER 120-3001-01B
MADE BY ACS DATE 03/30/2021
CHECKED BY BKA DATE 07/01/2021
SHEET 1 OF 1

Traffic Information per INDOT Traffic Count Database System for SR 933 over St. Joseph River



Disclaimer: The data is provided pursuant to the Indiana Open Records Act. It represents accurate reproductions of the records on file with the Indiana Department of Transportation; however ... more

Location ID	711681	MPO ID	
Type	SPOT	HPMS ID	
On NHS	No	On HPMS	No
LRS ID	900000009330000001	LRS Loc Pt.	10.9077
SF Group	U2_SWG	Route Type	State Road
AF Group	U2_A	Route	933
GF Group	U2_SWG	Active	Yes
Class Dist Grp		Category	
Seas Clss Grp			
WIM Group			
QC Group	JUR9SHORT		
Fnct'l Class	Other Principal Arterial (OPA)	Milepost	
Located On	SR 933 100 N OF BARTLET ST		
Loc On Alias	SR 933 (INC)		

AADT

	Year	AADT	DHV-30	K %	D %	PA	BC	Src
	2020	16,101[3]		10	58	15,646 (97%)	454 (3%)	Grown from 2019
	2019	18,234	1,767	10	58	17,719 (97%)	514 (3%)	
	2018	30,522[3]		8	53	28,337 (93%)	2,184 (7%)	Grown from 2017
	2017	30,400[3]		8	53	28,224 (93%)	2,175 (7%)	Grown from 2016
	2016	30,129[3]		8	53	27,972 (93%)	2,156 (7%)	Grown from 2015

1-5 of 11

Travel Demand Model

	Model Year	Model AADT	AM PHV	AM PPV	MD PHV	MD PPV	PM PHV	PM PPV	NT PHV	NT PPV

VOLUME COUNT

	Date	Int	Total
	Wed 9/18/2019	15	20,415
	Tue 10/1/2013	15	31,066

VOLUME TREND

Year	Annual Growth
2020	-12%
2019	-40%

Location

Location ID: 711681
Located On: SR 933 100 N OF BARTLET ST
Direction: 2-WAY
AADT: 16101 (2020)
POS Count: 8238 (2020)
NEG Count: 7862 (2020)
View Detail in a New Search
Go to Record in Current Search

A growth rate of 0% has been used for traffic forecasting based on an INDOT provided traffic forecast further north on SR 933 than this project site.

Traffic Data Forecast

Traffic Information Provided

Year: $Year_{prov} := 2020$ AADT: $AADT_{prov} := 16101$ Growth Rate: $i := 0\%$

Projected Traffic (Design Year)

Design Year: $Year_{design} := 2043$ $n_{design} := Year_{design} - Year_{prov} = 23$

Guess Values

$AADT_{design} := 1000$

Constraints

$$i = \left(\frac{AADT_{design}}{AADT_{prov}}\right)^{\frac{1}{n_{design}}} - 1$$

Solver

$AADT_{design} := \mathrm{Ceil}\left(\mathbf{find}\left(AADT_{design}\right), 10\right) = 16110$

$AADT_{design} = 16110$

Projected Traffic (Construction Year)

Design Year: $Year_{const} := 2023$ $n_{const} := Year_{const} - Year_{prov} = 3$

Guess Values

$AADT_{const} := 1000$

Constraints

$$i = \left(\frac{AADT_{const}}{AADT_{prov}}\right)^{\frac{1}{n_{const}}} - 1$$

Solver

$AADT_{const} := \mathrm{Ceil}\left(\mathbf{find}\left(AADT_{const}\right), 10\right) = 16110$

$AADT_{const} = 16110$

DESIGN SPEED (mph)	ROUNDED SSD FOR DESIGN [1] (ft)		CALCULATED *K* VALUE [2]		*K* VALUE ROUNDED FOR DESIGN	
	Des.	Min.	Des.	Min.	Des.	Min.
15	115	80	6.1	3.0	7	3
20	155	115	11.1	6.1	12	7
25	200	155	18.5	11.1	19	12
30	250	200	29.0	18.5	29	19
35	305	250	43.1	29.0	44	29
40	360	305	60.1	43.1	61	44
45	425	360	83.7	60.1	84	61
50	495	425	113.5	83.7	114	84
55	570	495	150.6	113.5	151	114
60	645	570	192.8	150.6	193	151
65	730	645	246.9	192.8	247	193
70	820	730	312.6	246.9	312	247

Notes:

[1] *Stopping sight distance (SSD) is from Figure 42-1A*.

[2] *The K value is calculated using the rounded value for design stopping sight distance, eye height of 3.5 ft, and object height of 2 ft.*

3. *If curbs are present, and K > 167, proper pavement drainage should be ensured near the high point of the curve.*

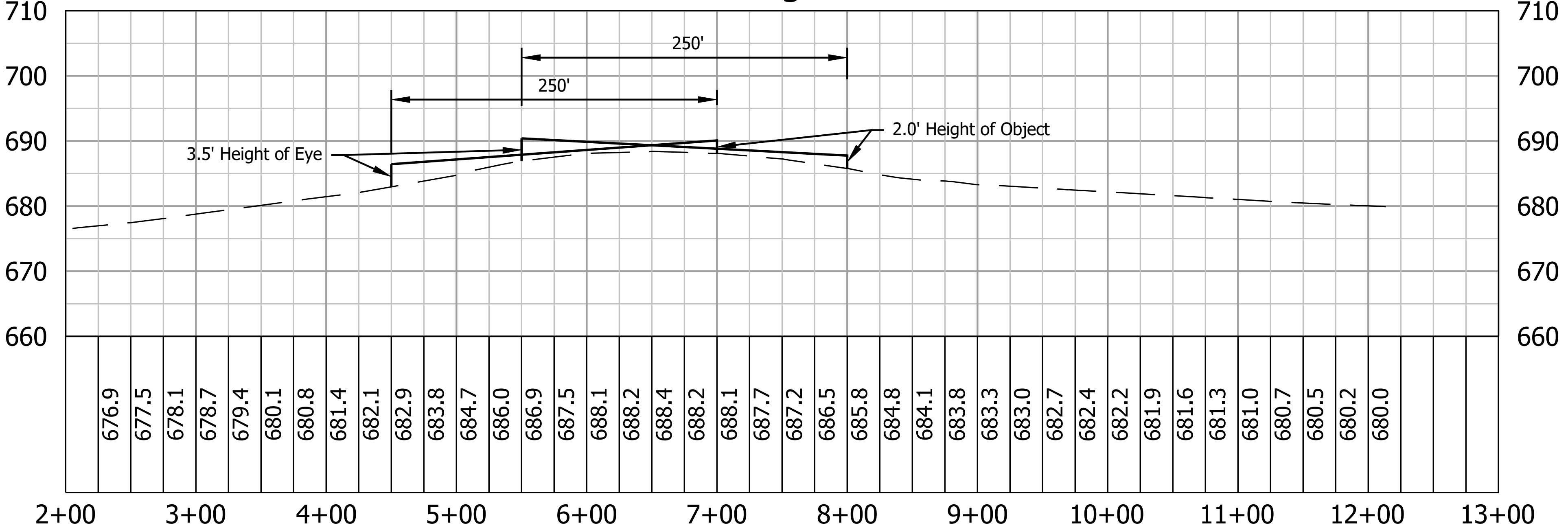
_K_ VALUE FOR CREST VERTICAL CURVE
(Stopping Sight Distance – Passenger Car)

Figure 44-3A

Back

Calc By: BKA 6/29/2021
Chk By: BSS 6/29/2021

NB - Line of Sight @ 35 MPH



Scale:
H: 1" = 120'
V: 1" = 24'

LOCHMUELLER GROUP
112 West Jefferson Blvd, Suite 500
South Bend, Indiana 46601
574.334.5460

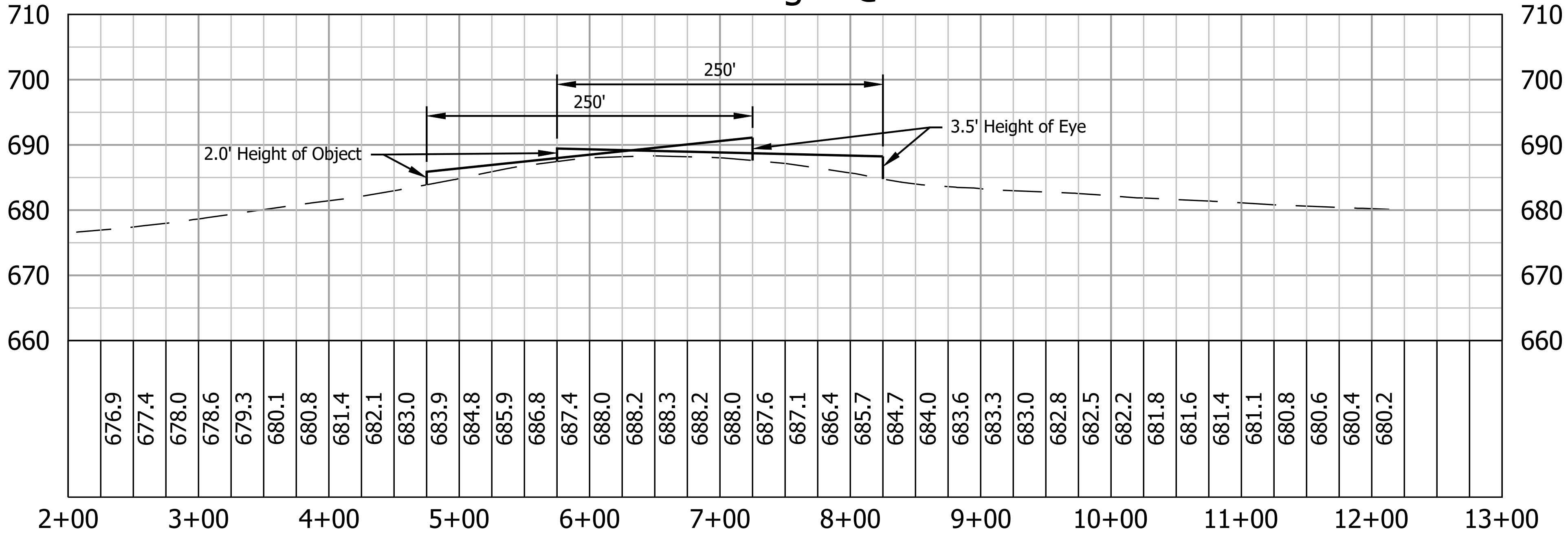
VERTICAL SIGHT DISTANCE - NB SR 933

Recommended for Approval:

Date:

Calc By: BKA 6/29/2021
Chk By: BSS 6/29/2021

SB - Line of Sight @ 35 MPH



Scale:
H: 1" = 120'
V: 1" = 24'

LOCHMUELLER GROUP
112 West Jefferson Blvd, Suite 500
South Bend, Indiana 46601
574.334.5460

VERTICAL SIGHT DISTANCE - SB SR 933

Recommended for Approval:

Date:

Bridge Barrier Warrants

Determine appropriate Test Level TL-2, TL-3 or TL-5 Barrier requirement

*The analysis is done according to Section 404-4.0 in the **Indiana Design Manual** by comparing the Adjusted AADT values to the test level ranges shown in the appropriate Barrier Test Level Selection Table for the project design speed.*

Roadway Traffic Data and Geometric Design Requirements:

Design Year:	$y_c := 2043$	Design Year AADT:	$AADT_c := 16110$
Percentage Trucks:	$P_{trucks} := 7.0\%$	Design Speed:	$DS := 35\ \boldsymbol{mph}$
Barrier Offset, Right:	$Offset_R := 1\ \boldsymbol{ft}$	Barrier Offset, Left:	$Offset_L := 1\ \boldsymbol{ft}$

Right Side Adjustment Factors:

$K_{g\_R} := 1.6$ Grade Traffic Adjustment Factor, See Figure 49-6B (4.40% Grade)

$K_{c\_R} := 1.0$ Curvature Traffic Adjustment Factor, See Figure 49-6B (Tangent)

$K_{s\_R} := 1.3$ Traffic Adjustment Factor, See Figure 49-6C (Approx. 30 ft from top of deck to flowline; High Occupancy Land Use)

Left Side Adjustment Factors:

$K_{g\_L} := 1.6$ Grade Traffic Adjustment Factor, See Figure 49-6B (4.40% Grade)

$K_{c\_L} := 1.0$ Curvature Traffic Adjustment Factor, See Figure 49-6B (Tangent)

$K_{s\_L} := 1.3$ Traffic Adjustment Factor, See Figure 49-6C (Approx. 30 ft from top of deck to flowline; High Occupancy Land Use)

Adjusted Average Daily Truck Traffic, T (1,000's) for Traffic Barrier Test Levels:

$$T_R := \frac{AADT_c \cdot K_{g\_R} \cdot K_{c\_R} \cdot K_{s\_R}}{1000} = 33.51 \qquad T_L := \frac{AADT_c \cdot K_{g\_L} \cdot K_{c\_L} \cdot K_{s\_L}}{1000} = 33.51$$

[IDM 49-6.02(03)]

Select the Appropriate Design Figure for the Railing Test Level Section:

Recall the Design Speed: $DS = 35\ mph$

Use **IDM FIGURE 49-6D(40)** for **Undivided With 4 Lanes or Fewer.**

Note: An IDM Figure 49-6D is not available for 35 mph, so the 40 mph IDM Figure 49-6D is conservatively used.

Right Side Barrier Warrant Test Level Selection:

Recall: Truck Percent: $P_{trucks} = 7\%$

Edge of Travel Lane to barrier front face: $Offset_R = 1.00\ ft$

Test Level Limits: $Low_R := 7.1$

$High_R := 55.6$

$$TL_R := \left\| \begin{array}{l} \text{if } T_R < Low_R \\ \quad \| \ 2 \\ \text{if } Low_R \le T_R < High_R \\ \quad \| \ 3 \\ \text{if } T_R \ge High_R \\ \quad \| \ 5 \end{array} \right.$$

Required Min. Test Level: $TL_R = 3$

(TL-2 minimum allowed per IDM 404-4.02 since Design Speed < or = 45 mph and route not on NHS, however TL-3 is required by this barrier warrant analysis.)

Left Side Barrier Warrant Test Level Selection:

Recall: Truck Percent: $P_{trucks} = 7\%$

Edge of Travel Lane to barrier front face: $Offset_L = 1.00\ ft$

Test Level Limits: $Low_L := 7.1$

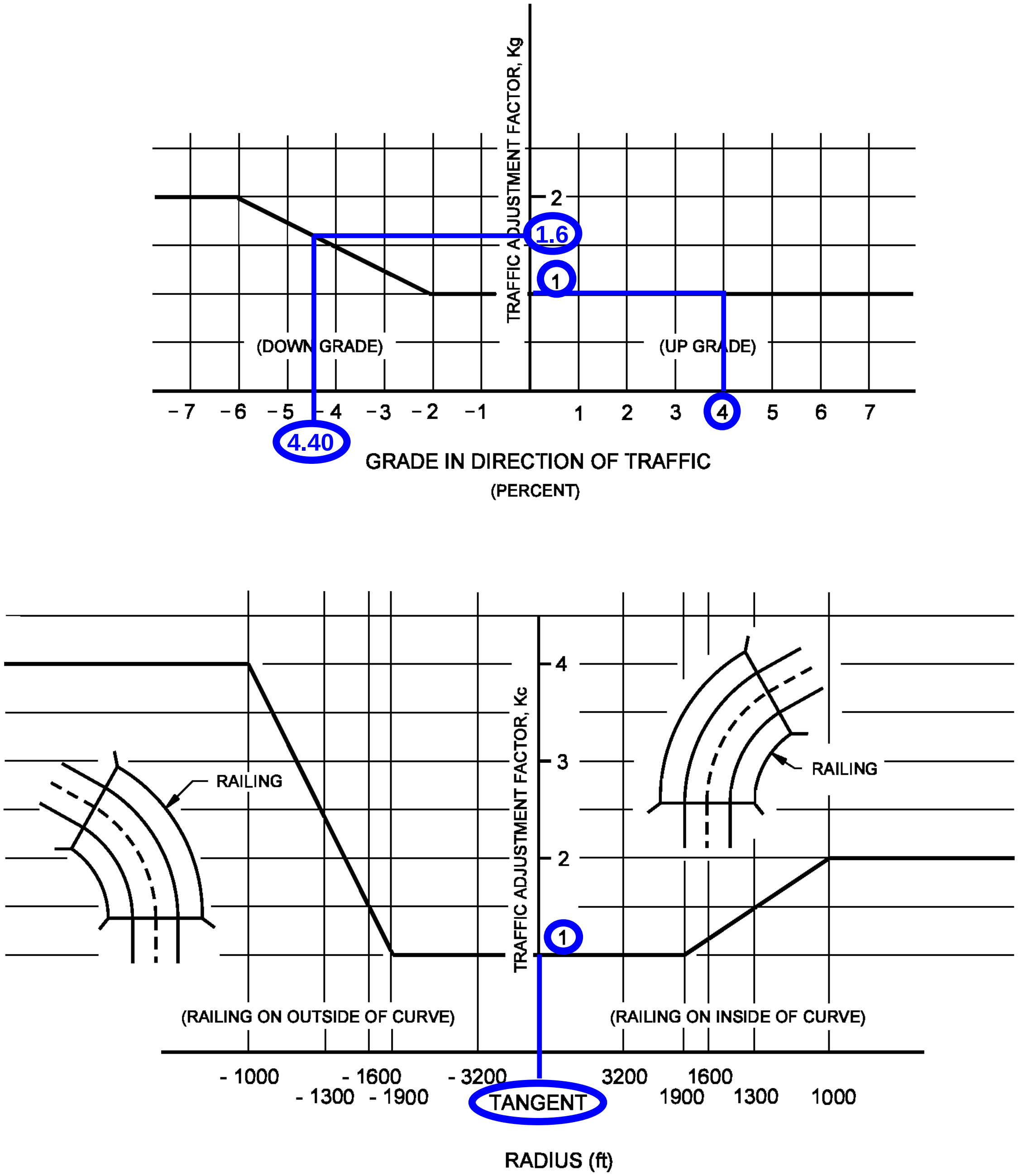
$High_L := 55.6$

$$TL_L := \left\| \begin{array}{l} \text{if } T_L < Low_L \\ \quad \| \ 2 \\ \text{if } Low_L \le T_L < High_L \\ \quad \| \ 3 \\ \text{if } T_L \ge High_L \\ \quad \| \ 5 \end{array} \right.$$

Required Min. Test Level: $TL_L = 3$

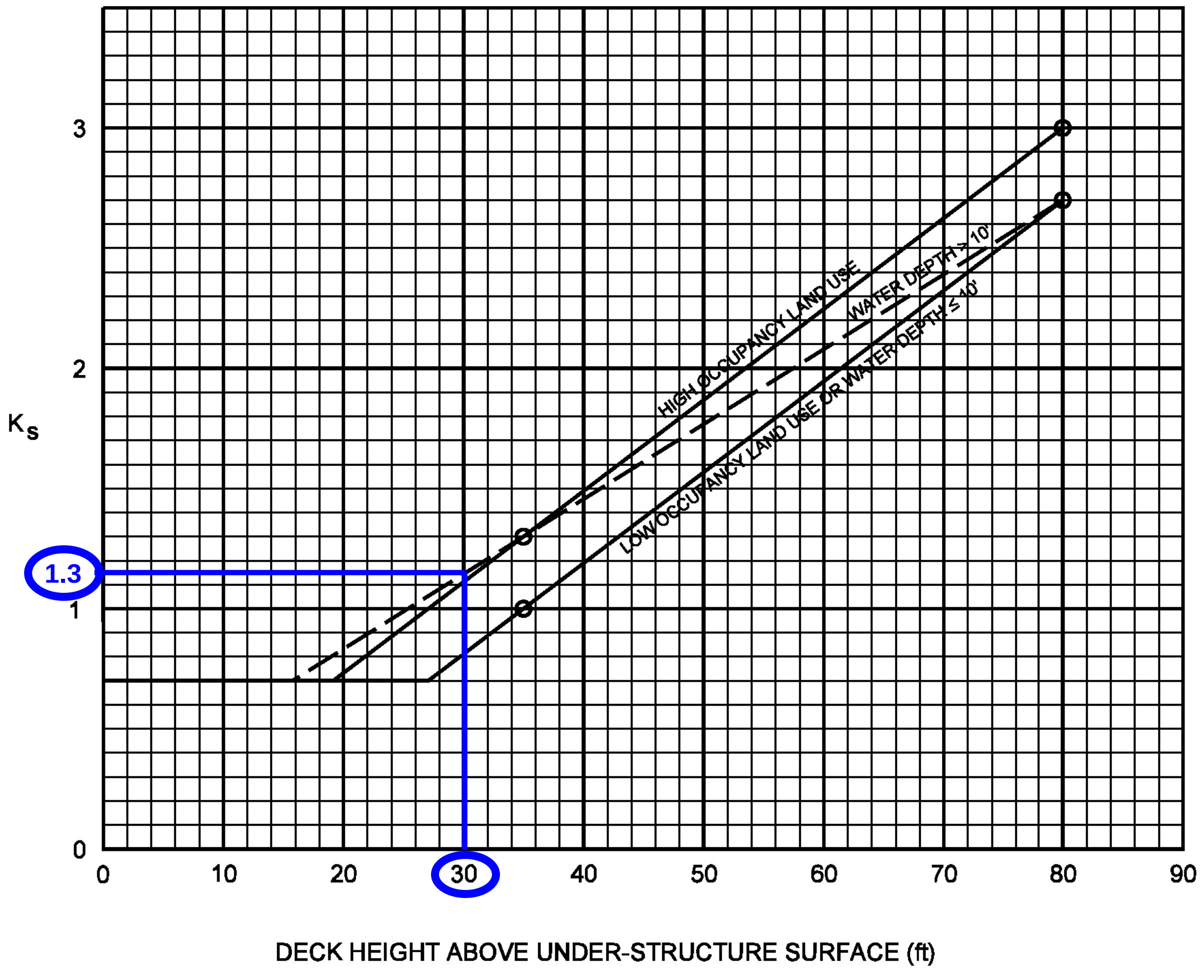
(TL-2 minimum allowed per IDM 404-4.02 since Design Speed < or = 45 mph and route not on NHS, however TL-3 is required by this barrier warrant analysis.)

FIGURE 49-6D(50): Minimum Test Level TL-2 is allowed per IDM 404-4.02, however Test Level TL-3 is the min. required. Therefore, **TL-3 Railing required for bridge.**



GRADE TRAFFIC-ADJUSTMENT FACTOR, K_g AND
CURVATURE TRAFFIC-ADJUSTMENT FACTOR, K_c

Figure 49-6B



TRAFFIC-ADJUSTMENT FACTOR K_S,

Deck Height and Under-Structure Shoulder Height Conditions

Figure 49-6C

Create By: ACS 03/30/2021
Checked By: MAR 06/30/2021

Site Characteristics		Adjusted Construction-Year Average Annual Daily Traffic, T, (1000s) for Traffic-Barrier Test Levels								
		Highway Type								
% Trk	Edge of Travel Lane to Front Face Barrier, L_2 (ft)	Divided, or Undivided With 5 or More Lanes			Undivided With 4 Lanes or Fewer			One-Way		
		Test Level			Test Level			Test Level		
		TL-2	TL-4	TL-5	TL-2	TL-4	TL-5	TL-2	TL-4	TL-5
0≤ % <5	≤ 3	< 14.0	14.0 ≤ T < 280.7	≥ 280.7	< 10.4	10.4 ≤ T < 202.4	≥ 202.4	< 7.0	7.0 ≤ T < 140.4	≥ 140.4
	$3 < L_2 \le 7$	< 18.0	18.0 ≤ T < 335.1	≥ 335.1	< 13.4	13.4 ≤ T < 253.8	≥ 253.8	< 9.0	9.0 ≤ T 167.6	≥ 167.6
	$7 < L_2 \le 12$	< 24.4	24.4 ≤ T < 452.0	≥ 452.0	< 19.2	19.2 ≤ T < 366.7	≥ 366.7	< 12.2	12.2 < 226.0	≥ 226.0
	> 12	< 39.5	> 39.5	n/a	< 32.1	> 32.1	n/a	< 19.8	19.8 ≤ T < 362.7	≥ 362.7
5≤ % <10	≤ 3	< 9.8	9.8 ≤ T < 79.7	≥ 79.7	< 7.1	7.1 ≤ T < 55.6	≥ 55.6	< 4.9	4.9 ≤ T < 39.9	≥ 39.9
	$3 < L_2 \le 7$	< 12.7	12.7 ≤ T < 89.8	≥ 89.8	< 9.2	9.2 ≤ T < 68.6	≥ 68.6	< 6.4	6.4 ≤ T < 44.9	≥ 44.9
	$7 < L_2 \le 12$	< 16.9	16.9 ≤ T < 132.4	≥ 132.4	< 12.8	12.8 ≤ T < 102.3	≥ 102.3	< 8.5	8.5 ≤ T < 66.2	≥ 66.2
	> 12	< 25.8	25.8 ≤ T < 183.6	≥ 183.6	< 20.1	20.1 ≤ T < 157.2	≥ 157.2	< 12.9	12.9 ≤ T < 91.8	≥ 91.8
10≤ % <15	≤ 3	< 7.5	7.5 ≤ T < 46.4	≥ 46.4	< 5.4	5.4 ≤ T < 32.2	≥ 32.2	< 3.8	3.8 ≤ T < 23.2	≥ 23.2
	$3 < L_2 \le 7$	< 9.8	9.8 ≤ T < 51.9	≥ 51.9	< 7.0	7.0 ≤ T < 39.6	≥ 39.6	< 4.9	4.9 ≤ T < 26.0	≥ 26.0
	$7 < L_2 \le 12$	< 12.9	12.9 ≤ T < 77.6	≥ 77.6	< 9.6	9.6 ≤ T < 59.4	≥ 59.4	< 6.5	6.5 ≤ T < 38.8	≥ 38.8
	> 12	< 19.1	19.1 ≤ T < 105.1	≥ 105.1	< 14.6	14.6 ≤ T < 89.6	≥ 89.6	< 9.6	9.6 ≤ T < 52.6	≥ 52.6
15≤ % <20	≤ 3	< 6.1	6.1 ≤ T < 32.8	≥ 32.8	< 4.4	4.4 ≤ T < 22.7	≥ 22.7	< 3.1	3.1 ≤ T < 16.4	≥ 16.4
	$3 < L_2 \le 7$	< 8.0	8.0 ≤ T < 36.5	≥ 36.5	< 5.6	5.6 ≤ T < 27.9	≥ 27.9	< 4.0	4.0 ≤ T < 18.3	≥ 18.3
	$7 < L_2 \le 12$	< 10.4	10.4 ≤ T < 54.9	≥ 54.9	< 7.7	7.7 ≤ T < 41.9	≥ 41.9	< 5.2	5.2 ≤ T < 27.5	≥ 27.5
	> 12	< 15.2	15.2 ≤ T < 73.6	≥ 73.6	< 11.5	11.5 ≤ T < 62.7	≥ 62.7	< 7.6	7.6 ≤ T < 36.8	≥ 36.8
20≤ % <25	≤ 3	< 5.1	5.1 ≤ T < 25.3	≥ 25.3	< 3.6	3.6 ≤ T < 17.5	≥ 17.5	< 2.6	2.6 ≤ T < 12.7	≥ 12.7
	$3 < L_2 \le 7$	< 6.7	6.7 ≤ T < 28.1	≥ 28.1	< 4.7	4.7 ≤ T < 21.5	≥ 21.5	< 3.4	3.4 ≤ T < 14.1	≥ 14.1
	$7 < L_2 \le 12$	< 8.8	8.8 ≤ T < 42.4	≥ 42.4	< 6.4	6.4 ≤ T < 32.3	≥ 32.3	< 4.4	4.4 ≤ T < 21.2	≥ 21.2
	> 12	< 12.6	12.6 ≤ T < 56.7	≥ 56.7	< 9.5	9.5 ≤ T < 48.2	≥ 48.2	< 6.3	6.3 ≤ T < 28.4	≥ 28.4

**MEDIAN-BARRIER OR BRIDGE-RAILING TEST-LEVEL SELECTION,
DESIGN SPEED 40 mph**

Figure 49-6D(40)

Appendix F:

Alternatives Analysis Table

Alt.	Alt. Description	Meets Project Purpose & Need?	Construction Cost	R/W Amount & Cost	Total Cost	Other Factors	Feasible & Prudent?
A	No Build/Do Nothing	No	N/A	N/A	N/A	Deterioration	This alternative is feasible; however not prudent since it does not meet the project purpose and need.
B1a	Rehabilitation for Continued Vehicular Use Meeting Secretary of Interior's Standards for Rehabilitation (SISR) – Partial Replacement of Arches with Foundation Strengthening	No	$8,608,000	0.52 acres (Temp. R/W) ($20,000)	$8,628,000	Historic bridge elements will be reused or recreated. One Level One design exception would be required. Approximately 150 linear feet of temporary and permanent stream impacts anticipated. No wetland impacts are expected.	This alternative is feasible with design exceptions; however not prudent since it does not meet the project purpose and need.
B1b	Rehabilitation for Continued Vehicular Use NOT Meeting Secretary of Interior's Standards for Rehabilitation (SISR) – Complete Replacement of Arches with Foundation Replacement	Yes	$12,201,400	0.52 acres (Temp. R/W) ($20,000)	$12,221,400	Historic bridge elements will be reused or recreated. No Level One design exceptions would be required. Approximately 150 linear feet of temporary, and no permanent, stream impacts anticipated. No wetland impacts are expected.	This alternative is feasible and prudent.

Appendix G:

Historic Bridge Field Check Meeting Minutes

LOCHMUELLER GROUP

MEETING MINUTES

Meeting: Virtual Scoping Field Check

Prepared By: Katlyn Shergalis, PE
Structural Team Leader

Date: Wednesday, January 27, 2021 - 1:00 – 3:00PM CST

Project: Contract B-42441
DES #1900011 – Leeper Park Michigan St. Bridge

Location: Virtual – Microsoft Teams

Attendees:

John Krueckeberg, PMP	INDOT LaPorte District – jkrueckeberg@indot.in.gov
Mark Pittman, PE, MBA	INDOT LaPorte District – mapittman@indot.in.gov
Steven Hauersperger	INDOT LaPorte District – shauersperger@indot.in.gov
Ashley Sharkey	INDOT LaPorte District – assharkey@indot.in.gov
Stewart Michels	INDOT LaPorte District – smichels@indot.in.gov
Steven Travis	INDOT LaPorte District – stravis2@indot.in.gov
Martha Chernet, PE	INDOT Central Office – mchernet@indot.in.gov
Mahmoud Hailat, PE	INDOT Central Office – mhailat@indot.in.gov
Gregory Klevitsky, PE	INDOT Central Office – gklevitsky@indot.in.gov
Mary Kennedy	INDOT Central Office – mkennedy@indot.in.gov
Troy Jessop, PE	GAI Consultants – t.jessop@gaiconsultants.com
Scott Zajac, PE	Terracon Consultants, Inc. – scott.zajac@terracon.com
Ruth Hook, CPESC, CESSWI	Lochmueller Group – rhook@lochgroup.com
Gary Quigg, MA, RPA	Lochmueller Group – gquigg@lochgroup.com
Susan Al Abbas, PE	Lochmueller Group – salabbas@lochgroup.com
Daniel Cooper, EIT	Lochmueller Group – dcooper@lochgroup.com
Michael Vereb, PE	Lochmueller Group – mvereb@lochgroup.com
Katlyn Shergalis, PE	Lochmueller Group – kshergalis@lochgroup.com

Purpose: The purpose of this meeting was to discuss the existing conditions of the bridge and goals for the project.

Discussion and/or Comments:

1. Review of Existing Information – Timeline

- The bridge has been rehabilitated several times since its original construction in 1914. Original plans of the bridge are not available. Below is a brief summary of the rehabilitations that have been performed:

1945 Rehab A: Replacement of some of the stone railing panels.

1977 Rehab: No A, B, C designation because it was a City of South Bend Contract. New bituminous surface and added a 2 ft. tall curb between sidewalk and travelway.

1997 Rehab: No A, B, C designation, revetment riprap was placed on upstream face of both piers.

2006 Rehab B: Added cofferdams around piers for scour protection, stone repair, and replacement of asphalt wearing surface with a concrete deck.

2012 Rehab C: Railing panel replacement (stone replaced with concrete), stone repair, epoxy injection of the transverse cracking, added a fiber reinforced polymer (FRP) to underside of arch for crack repair, patched construction joints between arch segments.

2018 Rehab D: Polymeric overlay placed on wearing surface.

- One of the primary concerns regarding the existing bridge is the deflection that is visually detectable at the upstream/east side of the center span. This deflection corresponds to a drop of two of the arch segments at the center span (Span B). The superstructure was constructed in six longitudinal arch segments, with a construction joint separating the segments. The two outer most east segments have vertically dropped on the north side of the Span B and the south side of Span C (northern most span). The maximum vertical drop occurs in Span B and is measured at approximately 3 inches.

- Lochmueller explained the theory and corresponding timeline as to why it is believed the deflection and arch segment drops have occurred. The below timeline is based on information that was available on INDOT's AssetWise database, and represents Lochmueller's educated estimation on the timeline of deterioration:

1994: INDOT performed the 1st Underwater Inspection on the bridge and scour was discovered on the upstream face of Pier No. 3.

1997: Riprap revetment was placed on the upstream faces of both piers for scour protection.

1998: 3-inch arch segment drop was documented in the 1998 Routine Inspection Report.

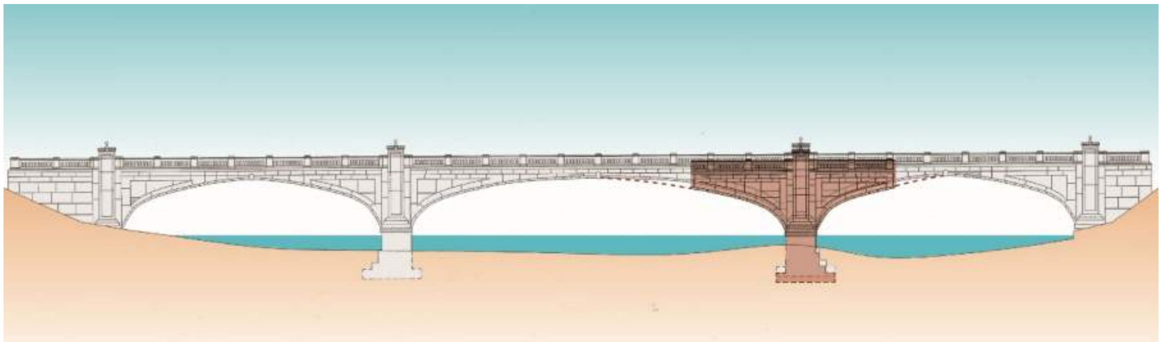
2003: 1-inch vertical crack in Pier No. 3 was documented in the 2003 Underwater Inspection Report. The vertical crack aligned with the same location as the arch segment drop. Scour and undermining at Pier No. 3 also progressed inward and was near the location of the vertical crack.

2006: A cofferdam was added around the piers which consisted of sheet piling encased in concrete. There is concern that addition of the cofferdam resulted in additional settlement of the piers and overstress of the foundation. The cofferdam was doweled into the existing foundation and adds about 2000 kips of dead load to the foundation.

2012: Epoxy injection and the addition of a fiber reinforced polymer (FRP) was performed to repair the extensive transverse cracking on each span of the arches. It is unclear when the cracks first started to propagate but it is believed the cracks worsened following the placement of the cofferdam at the piers.

2013: INDOT began doing an annual special inspection of the bridge to measure the differential in the arch segment drop.

- As illustrated by the figure below, it is believed that the undermining and scour at the upstream side of Pier No. 3, caused the pier to settle. This settlement corresponds to the drop in the arch segments in the pier. There has been little change in the differential of the arch segment drops since beginning the annual special inspections in 2013.



Arch Drop and Deflection Theory

2. Findings from Non-Destructive Testing (NDT)

- Terracon provided an overview of the non-destructive testing (NDT) that was performed on the bridge, as part of this project. Terracon performed infrared thermography (IR), ground penetrating radar (GPR), and an impact echo (IE) to assess the condition of the concrete arch. Cores were also taken at the arch, pier foundations, spandrel walls, and bridge railings.
- The NDT primarily noted deterioration on the downstream side of the Span B arch. The other spans noted minimal deterioration from honeycombing or delamination, especially compared to the NDT that was performed by Earth Exploration in 2011. The cores from the arch were generally in good condition, and the fracture in one of the arch cores is believed to be from the coring process. The core from the foundation at Pier No. 3 did not indicate any scour at the location that it was obtained.

3. Findings from In-Depth Field Inspection

- Lochmueller performed an In-Depth Field Inspection on November 18th and 19th, 2020 in order to visually inspect the underside of the arches, cofferdams, stone spandrel wall, bridge railing, and the wearing surface. The purpose of the inspection was to assess the condition of the bridge, to review the known existing deterioration, and to confirm if any of the deterioration had worsened.
- Cracking in the cofferdam was noted, most predominantly on the upstream faces of the piers. Lochmueller talked with Bill Dittrich at INDOT, who had performed several of the routine and special inspections on the structure. Bill indicated that he noted several occasions where he observed water shooting up from the cracks (3-5 inches) at the upstream face of Pier No. 3 and he believes this could indicate some pressure build-up beneath the cofferdam. Lochmueller also pointed out that the sheet piling for the cofferdam was installed 10-12 feet below the flowline of the channel (due to the low clearance with the existing arches) and the scour depth for a Q100 storm is approximately 18.5 feet below the flowline according to the 2003 INDOT Hydraulic Scour

Memo. The Foundation Assessment and NDT that was performed by Earth Explorations in 2002, indicate that the foundation is supported on timber piles (estimated 15 feet length).

- The fiber reinforced polymer (FRP), that was added to the underside of the arch in the 2012 rehabilitation, is in generally good condition. There are few locations where the strips have peeled off or air bubbles have developed, indicating a lack of adhesion. Lochmueller did not detect any of the existing transverse cracks at the locations between the FRP strips. Overall, the arches appeared to be in good condition, with the exception of the downstream/west side of Span B. This was consistent with the findings of the NDT, that noted deterioration primarily at this area. At this location, there was rust staining, efflorescence, and several patch areas along the arch ring blocks.
- The bridge inspection reports had indicated that the arch had a “melan” type reinforcing system. A melan arch design employs parallel beams or small steel trusses embedded in the concrete to provide the tensile strength that concrete inherently is lacking. The GPR test from the NDT only found evidence of standard rebar in the arch. Lochmueller also talked to Bill Dittrich, who performed many of the inspections, regarding the melan arch designation. He said that it was originally believed to be a melan arch but throughout the years of inspection and rehabilitation, no evidence was found to support this. The group also did not have any historical documentation or evidence to support the theory that the structure was a melan arch. Lochmueller will proceed with the assumption that the arch was constructed with traditional rebar reinforcing.
- Lochmueller performed a visual inspection of each stone on the spandrel wall. From the geological classification performed by Terracon, the stone in the spandrel wall is limestone. Deficiencies including cracks, spalls, and erosion were identified in the field notes. A preliminary assessment of which stones could be re-used, replaced, and repaired was performed and designated in the notes. Overall, the limestone was in fair condition and it is believed less than 20 percent of the stones would need to be replaced. It is also recommended that the stones be cleaned, and mortar joints re-pointed.
- Cores of the spandrel wall were taken in 2011. From these cores, the spandrel wall consists of an outside stone façade (approximately 0.5 feet thick) and a concrete wall (approximately 1.5 feet thick). The two spandrel wall cores revealed concrete crumbling at those locations.
- The wearing surface consists of a 6-inch concrete deck with a polymeric overlay placed in 2018. The wearing surface is in fair condition, and widely spaced transverse cracks were noted.
- The historic railing consists of concrete railing panels (originally stone and replaced with concrete in 2012), and limestone pilasters. There is an exception to this in the southeast quadrant, where there are two panels of stone railing. It is believed that the limestone pilasters are mostly original, though some have been replaced. The pilasters show evidence of erosion, likely due to their age.
- There is a concrete barrier curb separating the sidewalk and travelway on both sides of the bridge. This was originally placed by the City of South Bend in 1977 and replaced in the 2006 rehabilitation. No impacts to the barrier curb were noted; however, there was vertical cracking noted throughout.

- With no original plans available for the construction of the bridge, the load rating was based on "engineering judgement" based on field observation of the deterioration and performance under routine traffic. The HS-20 Inventory Rating Factor was reduced to 0.809 due to the observed deterioration and segment drop of the arch. Based on the load rating, the bridge is sufficient to carry routine legal loads, but overweight permits are restricted.

4. Project Purpose and Need

- In accordance with INDOT's project development process for historic bridges, Lochmueller stressed the importance of determining the purpose and need for the project before developing the proposed alternatives. Mary pointed out that part of the purpose for historic bridges is maintaining a safe crossing for a minimum of 25 years. Mark also emphasized that INDOT has performed several repairs and inspections, and the goal of this project would be to develop a long-term solution. A secondary goal of the project would be to explore the option of relinquishing the bridge to the County, and INDOT understood in order to do this the bridge would need to be in good condition.

- Mary suggested developing the purpose and need and sending to INDOT for review/input. Lochmueller will prepare the purpose and need statement for INDOT to review. With the purpose and need, Lochmueller will also develop preliminary alternatives that describe generally what the proposed scope will be. This will be followed up with an additional scoping meeting to discuss the alternatives.

- Mary noted that the Historic Preservation Commission of South Bend would also be a Consulting Party for this project. The project would also require a Certificate of Appropriateness with approval from the Historic Preservation Commission of South Bend.

5. General Scope Discussion Items

- As part of the rehabilitation, the group agreed that the presumed overloading of the foundation due to the placement of the cofferdam will need to be addressed as part of this project. Troy suggested the potential to strengthen the foundation with micropiles. The other alternative would be to replace both pier foundations, which would require an extensive rehabilitation.

- The group was in concurrence that the condition of the concrete spandrel wall will need to be addressed, as the cores indicated the wall was crumbling. Replacement of the concrete spandrel wall would require removal and replacement/re-construction of arch fill, bridge deck, historic railing, barrier curb, and stone spandrel wall.

- Bridge lighting, sitting on some of the pilasters, was added to the bridge in 2006 and was a replication of the original lighting that no longer existed. It was confirmed following the meeting, the bridge lighting is in working order. Regardless of the scope of work, the lights will be returned to a functioning condition.

- It was discussed if a crashworthy railing should be placed in between the sidewalk and barrier rail as part of this project. Lochmueller noted that no evidence of impact was found on the existing barrier curb and they were awaiting crash information at the location. If the crash data does not reveal any issues, then the barrier curb will likely be replaced in-kind.

- Maintenance of traffic for the project was discussed. Steve had mentioned that when the 2012 rehab was performed, Notre Dame was adamant that four lanes of traffic be open at this crossing during football season. The route and bridge are heavily trafficked and there are few options in the way of an alternative crossing/route. INDOT believed it would be difficult to get the support to close the structure during construction. Katlyn did caution the group, that depending on the scope of work, it could become very challenging and expensive to phase the construction of the project. Temporary retaining walls would need to be constructed to retain the arch fill. On a similar project, Katlyn stated the maintenance of traffic cost to phase construction of an arch bridge was about $1 million. In the HBAA Report, for each alternative, Lochmueller will provide estimates for a full closure as well as phased construction for INDOT to make a decision. INDOT also suggested aligning the letting in fall/early winter so that the Contractor could start as soon as the weather allows and stop work in time for Notre Dame football season. The maintenance of traffic scheme will require coordination with Alen Holderread and Adam Parkhouse at the District.

6. Project Name

- Lochmueller has developed a public involvement plan for the project that includes website development, social media posts, stakeholder meetings, a public information meeting, public hearing, and consulting party meetings. Being that this will be a high-profile project due to its proximity to downtown South Bend and Notre Dame, and the historical significance of the bridge, the design team highlighted the importance of utilizing a consistent name for the project. The "project name" will be utilized in communications with the public and internally with the design team to establish a consistent branded project. Lochmueller had two suggestions for the project name: "Leeper Historic Bridge Project" and "Michigan St. Historic Bridge Project". Steve, who is a local resident to the South Bend area, said the bridge is typically referred to as the "Leeper Park Michigan St. Bridge". INDOT suggested to utilize this name because it resonates with the local residents. Katlyn to coordinate with Adam Parkhouse at the District regarding the name, for official concurrence.

7. Next Steps

- Week of 2/1 - Lochmueller to develop the Purpose and Need Statement for the project and send to INDOT for review. Lochmueller to also provide concise descriptions of the proposed alternatives that align with the purpose and need.
- February 2021 - Lochmueller to schedule a meeting with the same attendees to discuss the purpose and need, and the proposed scope of work for the project.
- February 2021 – Lochmueller to schedule and host an Initial Stakeholder Meeting to provide an introduction to the project.
- March 2021 – Lochmueller to schedule and host an Initial Consulting Party Meeting to discuss the proposed alternatives and to solicit feedback.
- May 2021 – Lochmueller to submit the DRAFT HBAA Report to INDOT.

LOCHMUELLER GROUP

MEETING MINUTES

Meeting: Virtual Scoping Meeting

Prepared By: Katlyn Shergalis, PE
Structural Team Leader

Date: Thursday, February 25, 2021 - 1:00 – 2:30PM CST

Project: Contract B-42441
DES #1900011 – Leeper Park Michigan St. Bridge

Location: Virtual – Microsoft Teams

Attendees:

John Krueckeberg, PMP	INDOT LaPorte District – jkrueckeberg@indot.in.gov
Mark Pittman, PE, MBA	INDOT LaPorte District – mapittman@indot.in.gov
Steven Hauersperger	INDOT LaPorte District – shauersperger@indot.in.gov
Ashley Sharkey	INDOT LaPorte District – assharkey@indot.in.gov
Stewart Michels	INDOT LaPorte District – smichels@indot.in.gov
Steven Travis	INDOT LaPorte District – stravis2@indot.in.gov
Martha Chernet, PE	INDOT Central Office – mchernet@indot.in.gov
Mahmoud Hailat, PE	INDOT Central Office – mhailat@indot.in.gov
Gregory Klevitsky, PE	INDOT Central Office – gklevitsky@indot.in.gov
Mary Kennedy	INDOT Central Office – mkennedy@indot.in.gov
Troy Jessop, PE	GAI Consultants – t.jessop@gaiconsultants.com
Scott Zajac, PE	Terracon Consultants, Inc. – scott.zajac@terracon.com
Ruth Hook, CPESC, CESSWI	Lochmueller Group – rhook@lochgroup.com
Jessica Clark, PE	Lochmueller Group – jclark@lochgroup.com
Brian Arterbery, PE	Lochmueller Group – barterbery@lochgroup.com
Gary Quigg, MA, RPA	Lochmueller Group – gquigg@lochgroup.com
Susan Al Abbas, PE	Lochmueller Group – salabbas@lochgroup.com
Daniel Cooper, EIT	Lochmueller Group – dcooper@lochgroup.com
Michael Vereb, PE	Lochmueller Group – mvereb@lochgroup.com
Katlyn Shergalis, PE	Lochmueller Group – kshergalis@lochgroup.com

Purpose: The purpose of this meeting was to discuss the proposed scope of work for the project and to develop consensus on the HBAA Report alternatives.

Discussion and/or Comments:

1. Update from Last Meeting

- The first scoping meeting for the project was held on January 27, 2021. The meeting focused on discussing the existing condition of the bridge, results of the Non-Destructive Testing (NDT), findings from the In-Depth Field Inspection, areas of and the history of deterioration, and a general discussion of the project scope. Following that meeting, Lochmueller developed the purpose and need statement for the project, as well as a draft version of the project alternatives.

- The draft version of the purpose and need statement, and draft alternatives were sent to the meeting participants as well as the Central Office NEPA staff for review and comment. The document is attached to these meeting minutes. The Central Office NEPA staff had no comments on the purpose and need. Various comments were received from INDOT staff related to the scope of work, these comments were incorporated into the agenda and discussion for this meeting and are described below.
- The purpose statement was made more concise from the direction of Paul South, the Scoping Manager in LaPorte District. Mary suggested that the information related to improving the condition rating should remain in the purpose statement, as it is an important benchmark, and since NEPA staff had no comments on the previous version. The purpose statement has been revised to reflect this comment.

2. Scoping Discussion

- Katlyn reviewed the draft alternatives with the group. The draft alternatives are attached to the meeting minutes. In terms of general concept, the two alternatives are a minor and major rehabilitation. Mary pointed out that if the major rehabilitation was the preferred alternative then justification would be required for the more intrusive alternative. A clarification was provided regarding the replacement of damaged stones in the spandrel wall. These stones would be replaced with limestone intended to replicate the existing.
- Greg suggested removing the thickness of the concrete slab from the alternatives since it has not been designed yet.
- The minor rehabilitation would include strengthening the foundations to add additional capacity equivalent to the dead load of the cofferdam that was added to the structure in 2006. The major rehabilitation would include a complete foundation replacement, including the abutments. Troy discussed two methods that would be explored regarding strengthening the foundations with micropiles. Option 1 would entail driving the micropiles from the top of the bridge deck and through the cofferdam. Option 2 would entail driving micropiles below the arch and outside of the existing cofferdam footprint. Concrete would be placed around the cofferdam and tied into the existing cofferdam. A question was asked regarding the environmental impacts of strengthening the foundation. Troy explained that it would be no different than a traditional foundation replacement in terms of environmental impacts.
- The idea of constructing a beam superstructure within the arch fill to carry most of the bridge's live load was discussed. Lochmueller reviewed the cores that Terracon performed at the crown of the arch. Based on these cores, there is approximately 28 inches of cover from the top of the arch to the top of the bridge deck. The team discussed that the only feasible superstructure type that could span the arch and have a depth of 28 inches or less was a post-tensioned beam system. The team decided this was not feasible from a constructability or cost perspective.
- Lochmueller suggested the idea of utilizing lightweight arch fill in lieu of typical stone that would be used. The intent of this method would be to reduce the dead load to the foundation and in turn reducing the amount that the foundation would need to be strengthened. Lochmueller proposed the idea of utilizing geofoam, which is a material that has been used to construct roadway embankments. For a roadway application, the geofoam is used in order to reduce the dead load acting on the subgrade which reduces settlement. This approach will be further investigated and discussed throughout the project development process.

- Mark had heard concerns from the City of South Bend that it was difficult to find replacement parts and light bulbs for the decorative lighting on the bridge. The City of South Bend is a stakeholder for the project, and Lochmueller will engage with the City to understand these challenges and to potentially mitigate them as part of this project. The intent of the project would be to retain the replicated decorative lighting, but they would potentially be modernized or re-wired.
- The idea of converting a portion of the structure to a pedestrian bridge by removing the eastern half of the existing bridge and re-building the east spandrel wall was proposed in another firm's proposal. A new bridge would be constructed adjacent to the reduced width pedestrian bridge. This idea was discarded due to not meeting the purpose and need of the project, and it would likely cause right of way impacts to the 6(f) property of Leeper Park to the south and the historic neighborhood to the north.
- The existing sidewalk on the east side of the bridge is approximately 3'-4" wide and does not meet ADA criteria. A Level One Design exception cannot be obtained for the width of the sidewalk due to the requirement of meeting ADA criteria. Lochmueller will investigate an appropriate method for meeting ADA criteria, and will coordinate with the City regarding the sidewalk. Additionally, consideration will be made for making this a secondary "need" for the project.
- Lochmueller re-emphasized the approach for maintenance of traffic. In the HBAA Report, Lochmueller to develop costs for each alternative for phased construction and a full closure with detour route. Considerations for pedestrian maintenance of traffic will also be discussed in the Report.

3. <u>Next Steps</u>

- Ruth provided an update on the public involvement for the project. The logo and website for the project are under development. Coordination will also begin related to scheduling the first stakeholders meeting.
- Lochmueller had asked for concurrence from INDOT in regards to the proposed draft alternatives to confirm that the project was headed in the intended direction. INDOT concurred with the proposed draft alternatives and Lochmueller will work towards submitting the Draft HBAA Report by May 15, 2021.

PURPOSE AND NEED

The need for the Leeper Park Michigan St. Bridge project derives from the condition of the existing bridge. According to the 2019 INDOT Bridge Inspection Report, the current ratings for the superstructure and the substructure are fair (5 out of 9). Condition ratings range from 0 to 9, with 0 indicated a failed structure and 9 indicating a new structure with no deficiencies. The scour that was discovered in the 2003 Underwater Inspection Report performed by Collins Engineers, has caused the upstream portion of the Pier 3 foundation (the northern most pier) to settle. This settlement has caused the arches supporting the middle and north spans of the bridge to sag or deflect. Earth Exploration obtained cores of the existing spandrel wall in 2011, that noted crumbling of the concrete portion of the spandrel wall.

The need also derives from the load carrying capacity of the existing foundations. In 2006, as a method to mitigate future scour at both pier foundations, cofferdams were constructed and were designed and built to be integral with the existing foundations. While the cofferdams helped to prevent further scour, they increased the loading of the piles beneath Pier 2 and 3's foundation by approximately an additional 2000 kips (1 kip is equivalent to 1000 lbs.). The original structure was not designed to carry the additional 2000 kips of deadload; and there is concern the foundations are now overloaded. The overloading of the foundations causes concern related to additional settlement of the piers, which would correlate to additional stress in the arches and subsequent transverse cracking that was repaired in 2012. With no repairs or work performed on the structure, it is believed the estimated remaining life of the bridge is approximately 10 years.

The purpose of the project is to maintain a vehicular and pedestrian crossing of the St. Joseph River for the City of South Bend. This project will extend the life of this crossing for a minimum of 25 years. The project should address the condition of the bridge's superstructure and substructure and raise both the superstructure and substructure's rating to at least good (7 out of 9.). The project should also improve the load carrying capacity of the foundation by at least 2000 kips to secure the future safety and preservation of the structure.

A. No Build/Do Nothing

B1a. Rehabilitation for Continued Vehicular Use (two-lane or one-lane option) Meeting Secretary of Interior's Standards for Rehabilitation

- Remove existing bridge deck, historic railing, spandrel wall, barrier curb, arch fill, outer east two segments of arch in Span B and C.
- Strengthen foundations, look at using micro-piles.
- Re-construct the outer east two arch segments in Span B and C.
- Apply waterproofing membrane to the top of the arch.
- Construct a new concrete spandrel wall.
- Re-set existing limestone stone in spandrel wall that is in good condition. Repair or replace limestone that is in poor condition.
- Place new arch fill, No. 8 stone.
- Place a new concrete bridge deck.
- Construct new historic railing panels utilizing concrete.
- Re-use limestone pilasters that are in good condition. Replace limestone that is in poor condition.
- Re-construct concrete barrier curb and sidewalk, in-kind.

B1b. Rehabilitation for Continued Vehicular Use (two-lane or one-lane option) Meeting Secretary of Interior's Standards for Rehabilitation

- Remove existing bridge deck, historic railing, spandrel wall, barrier curb, arch fill, arches, and foundations.
- Replace foundations. Concrete pedestals on deep pile foundations.
- Re-construct the concrete arches.
- Apply waterproofing membrane to the top of the arch.
- Construct a new concrete spandrel wall.
- Re-set existing limestone stone in spandrel wall that is in good condition. Repair or replace limestone that is in poor condition.
- Place new arch fill, No. 8 stone.
- Place a new concrete bridge deck.
- Construct new historic railing panels utilizing concrete.
- Re-use limestone pilasters that are in good condition. Replace limestone that is in poor condition.
- Re-construct concrete barrier curb and sidewalk, in-kind.

Appendix H:

HDOT 34" Tall Aesthetic Concrete Bridge Rail

August 14, 2020

U.S. Department
of Transportation
Federal Highway
Administration

1200 New Jersey Ave., SE
Washington, D.C. 20590

In Reply Refer To:
HSST-1/B-345

Mr. James Fu
State of Hawaii, Department of Transportation
601 Kamokila Boulevard, Room 611
Kapolei, HI 96707
USA

Dear Mr. Fu:

This letter is in response to your March 31, 2020 request for the Federal Highway Administration (FHWA) to review a roadside safety device, hardware, or system for eligibility for reimbursement under the Federal-aid highway program. This FHWA letter of eligibility is assigned FHWA control number B-345 and is valid until a subsequent letter is issued by FHWA that expressly references this device.

Decision

The following device is eligible within the length-of-need, with details provided in the form which is attached as an integral part of this letter:

- HDOT 34” Tall Aesthetic Concrete Bridge Rail

Scope of this Letter

To be found eligible for Federal-aid funding, new roadside safety devices should meet the crash test and evaluation criteria contained in the American Association of State Highway and Transportation Officials’(AASHTO) Manual for Assessing Safety Hardware (MASH). However, the FHWA, the Department of Transportation, and the United States Government do not regulate the manufacture of roadside safety devices. Eligibility for reimbursement under the Federal-aid highway program does not establish approval, certification or endorsement of the device for any particular purpose or use.

This letter is not a determination by the FHWA, the Department of Transportation, or the United States Government that a vehicle crash involving the device will result in any particular outcome, nor is it a guarantee of the in-service performance of this device. Proper manufacturing, installation, and maintenance are required in order for this device to function as tested.

This finding of eligibility is limited to the crashworthiness of the system and does not cover other structural features, nor conformity with the Manual on Uniform Traffic Control Devices.

Eligibility for Reimbursement

Based solely on a review of crash test results and certifications submitted by the manufacturer, and the crash test laboratory, FHWA agrees that the device described herein meets the crash test and evaluation criteria of the AASHTO's MASH. Therefore, the device is eligible for reimbursement under the Federal-aid highway program if installed under the range of tested conditions.

Name of system: HDOT 34" Tall Aesthetic Concrete Bridge Rail
Type of system: Longitudinal Barrier
Test Level: MASH Test Level 3 (TL 3)
Testing conducted by: Midwest Roadside Safety Facility
Date of request: March 31, 2020

FHWA concurs with the recommendation of the accredited crash testing laboratory on the attached form

Full Description of the Eligible Device

The device and supporting documentation, including reports of the crash tests or other testing done, videos of any crash testing, and/or drawings of the device, are described in the attached form.

Notice

This eligibility letter is issued for the subject device as tested. Modifications made to the device are not covered by this letter. Any modifications to this device should be submitted to the user (i.e., state DOT) as per their requirements.

You are expected to supply potential users with sufficient information on design, installation and maintenance requirements to ensure proper performance.

You are expected to certify to potential users that the hardware furnished has the same chemistry, mechanical properties, and geometry as that submitted for review, and that it will meet the test and evaluation criteria of AASHTO's MASH.

Issuance of this letter does not convey property rights of any sort or any exclusive privilege. This letter is based on the premise that information and reports submitted by you are accurate and correct. We reserve the right to modify or revoke this letter if: (1) there are any inaccuracies in the information submitted in support of your request for this letter, (2) the qualification testing was flawed, (3) in-service performance or other information reveals safety problems, (4) the system is significantly different from the version that was crash tested, or (5) any other information indicates that the letter was issued in error or otherwise does not reflect full and complete information about the crashworthiness of the system.

Standard Provisions

- To prevent misunderstanding by others, this letter of eligibility designated as FHWA control number B-345 shall not be reproduced except in full. This letter and the test documentation upon which it is based are public information. All such letters and documentation may be reviewed upon request.

- This letter shall not be construed as authorization or consent by the FHWA to use, manufacture, or sell any patented system for which the applicant is not the patent holder.

- This FHWA eligibility letter is not an expression of any Agency view, position, or determination of validity, scope, or ownership of any intellectual property rights to a specific device or design. Further, this letter does not impute any distribution or licensing rights to the requester. This FHWA eligibility letter determination is made based solely on the crash-testing information submitted by the requester. The FHWA reserves the right to review and revoke an earlier eligibility determination after receipt of subsequent information related to crash testing.

- If the subject device is a patented product it may be considered to be proprietary. If proprietary systems are specified by a highway agency for use on Federal-aid projects: (a) they must be supplied through competitive bidding with equally suitable unpatented items; (b) the highway agency must certify that they are essential for synchronization with the existing highway facilities or that no equally suitable alternative exists; or (c) they must be used for research or for a distinctive type of construction on relatively short sections of road for experimental purposes. Our regulations concerning proprietary products are contained in Title 23, Code of Federal Regulations, Section 635.411.

Sincerely,

Michael S. Griffith

Michael S. Griffith
Director, Office of Safety Technologies
Office of Safety

Enclosures

Request for Federal Aid Reimbursement Eligibility of Highway Safety Hardware

Submitter	Date of Request:	March 31, 2020	● New ○ Resubmission
	Name:	James Fu, S.E.	
	Company:	State of Hawaii, Department of Transportation	
	Address:	601 Kamokila Boulevard, Room 611, Kapolei, HI 96707	
	Country:	USA	
	To:	Michael S. Griffith, Director FHWA, Office of Safety Technologies	

I request the following devices be considered eligible for reimbursement under the Federal-aid highway program.

Device & Testing Criterion - Enter from right to left starting with Test Level

System Type	Submission Type	Device Name / Variant	Testing Criterion	Test Level
'B': Rigid/Semi-Rigid Barriers (Roadside, Median, Bridge Railings)	● Physical Crash Testing ○ Engineering Analysis	HDOT 34'' Tall Aesthetic Concrete Bridge Rail	AASHTO MASH	TL3

By submitting this request for review and evaluation by the Federal Highway Administration, I certify that the product(s) was (were) tested in conformity with the AASHTO Manual for Assessing Safety Hardware and that the evaluation results meet the appropriate evaluation criteria in the MASH.

Individual or Organization responsible for the product:

Contact Name:	James Fu, S.E.	Same as Submitter ☒
Company Name:	State of Hawaii, Department of Transportation	Same as Submitter ☒
Address:	601 Kamokila Boulevard, Room 611, Kapolei, HI 96707	Same as Submitter ☒
Country:	USA	Same as Submitter ☒

Enter below all disclosures of financial interests as required by the FHWA `Federal-Aid Reimbursement Eligibility Process for Safety Hardware Devices' document.

The Midwest Roadside Safety Facility (MwRSF) and its employees were asked to perform crash testing and evaluate the device named herein for the Hawaii Department of Transportation.

MwRSF’s financial interests are as follows:
(i) No compensation, including wages, salaries, commissions, professional fees, or fees for business referrals;
(ii) Consulting relationships consist of answering design and implementation questions;
(iii) Research funding or other forms of research support include continued funding for roadside safety research projects with MwRSF;
(iv) No patents, copyrights, or other intellectual property interests for this system;
(v) No licenses or contractual relationships for this system; and
(vi) No business ownership and investment interests for this system.

PRODUCT DESCRIPTION

● New Hardware or Significant Modification ○ Modification to Existing Hardware

The Hawaii Department of Transportation (HDOT) 34-in. tall aesthetic concrete bridge rail contained five concrete barrier segments consisting of two 11-ft long end segments and three 22-ft long interior barrier segments. The bridge rail was 34 in. tall relative to the traffic-side tarmac and 10 in. wide at the top and the bottom. The top surface had ¾-in. chamfered edges. Recessed aesthetic lines, ½-in. deep, were located 7 in. below the top surface and 9 in. above the bottom surface on the traffic- and back-side faces. The main aesthetic feature on this concrete bridge rail was 60-in. wide x 15-in. tall x ½-in. deep recessed panels on both the traffic-side and back-side faces. The edges of the panels transitioned to the face of the rail using 2H:1V slope. The concrete mix for the bridge rail sections required a minimum 28-day compressive strength of 4,000 psi.

Steel reinforcement in the barrier consisted of ASTM A615 Grade 60 rebar. Each concrete bridge rail segment consisted of eight no. 5 longitudinal bars (four per face) that were vertically spaced 10 in. apart. Vertical stirrups were also provided using no. 5 rebar, which were spaced on 12-in. centers on the back-side face and on 6-in. centers on the traffic-side face. Vertical reinforcement bars were anchored to an existing concrete tarmac on both the traffic-side and back-side faces to a depth of 8 in. and epoxied with Hilti HIT RE-500 V3 in order to develop the full tensile strength of the bar. The minimum bond strength of the epoxy adhesive was 1,560 psi after a two-day cure.

The existing concrete tarmac surface was milled to a depth of 2 in. and filled with low-strength concrete after removal of the formwork to replicate the wearing surface of a bridge deck. Each barrier segment was separated by an expansion joint consisting of a ½-in. open gap that was filled with expansion joint sealant. The expansion joint assembly consisted of three 24-in. long no. 8 horizontal smooth rebar placed within PVC tubes and caps that were cast into the parapet.

Note, HDOT's 34-in. tall, Aesthetic Concrete Bridge Rail was fabricated for evaluation of the length of need (LON) of the interior barrier segments of the bridge rail. Therefore, the crashworthiness of the end segments and the transition buttresses were not evaluated in this testing program. It is recommended that end sections and buttresses be designed with similar or greater capacity to the bridge rail. Further, reducing the spacing of the vertical reinforcement near the end sections of the barrier could potentially mitigate some of the cracking and damage that was observed in the full-scale crash tests and reduce the need for repair of the bridge rail.

CRASH TESTING

By signature below, the Engineer affiliated with the testing laboratory, agrees in support of this submission that all of the critical and relevant crash tests for this device listed above were conducted to meet the MASH test criteria. The Engineer has determined that no other crash tests are necessary to determine the device meets the MASH criteria.

Engineer Name:	Ronald Faller	
Engineer Signature:	Ronald K. Faller Digitally signed by Ronald K. Faller DN: cn=Ronald K. Faller, o=University of Nebraska-Lincoln, ou=Midwest Roadside Safety Facility, email=rfaller1@unl.edu, c=US Date: 2020.04.17 08:52:20 -05'00'	
Address:	130 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853	Same as Submitter ☐
Country:	USA	Same as Submitter ☐

A brief description of each crash test and its result:

Required Test Number	Narrative Description	Evaluation Results
3-10 (1100C)	Lab test no.: H34BR-1 Date of test: April 17, 2019 Crash test report no.: TRP-03-420-19 A 2,430-lb small car with a simulated occupant seated in the front passenger seat, impacted the concrete bridge rail 42 9/16-in. upstream from the expansion joint between barrier nos. 3 and 4 at a speed of 62.4 mph and at an angle of 25.7 degrees, resulting in a lateral impact force of 58.8 kips and an impact severity of 59.2 kip-ft. At 0.160 sec after impact, the vehicle became parallel to the system with a speed of 50.9 mph. At 0.290 sec, the vehicle exited the system at a speed of 43.0 mph and angle of 6.9 degrees. The vehicle was successfully redirected. Exterior vehicle damage was moderate and the interior occupant compartment deformations were minor with a maximum deformation of 1.9 in., consequently not violating the limits established in MASH 2016. Damage to the concrete bridge rail was minor, consisting of minor cracks and spalling of the concrete in several locations. The maximum lateral permanent set of the barrier system was 0.2 in. The maximum lateral dynamic barrier deflection, including tipping of the barrier along the top of the surface, was 0.3 in. at the upstream end of barrier no. 3. The working width of the system was 10.3 inches. There was no potential for the barrier to intrude into the occupant compartment. All vehicle decelerations, occupant compartment deformations, the maximum angular displacements, occupant ridedown accelerations (ORAs), and occupant impact velocities (OIVs) fell within the recommended safety limits established in MASH 2016. The test vehicle showed no tendency for rollover and did not penetrate or ride over the barrier.	PASS

Required Test Number	Narrative Description	Evaluation Results
3-11 (2270P)	Lab test no. H34BR-2 Date of test April 29, 2019 Crash test report no. TRP-03-420-19 A 5,001-lb pickup truck with a simulated occupant seated in the front passenger seat, impacted the concrete bridge rail 51 15/16 in. upstream from the expansion joint between barrier nos. 2 and 3 at a speed of 64.0 mph at an angle of 25.4 degrees, resulting in a lateral impact force of 88.6 kips and an impact severity of 126.4 kip-ft. At 0.192 sec after impact, the vehicle became parallel to the system with a speed of 50.9 mph. At 0.408 sec, the vehicle exited the system at a speed of 44.0 mph and an angle of 8.9 degrees. The vehicle was successfully redirected. Exterior vehicle damage was moderate and the interior occupant compartment deformations were moderate, with a maximum deformation of 5.4 in., consequently not violating the limits established in MASH 2016. Damage to the barrier was minimal, consisting of tire and scuff marks and concrete spalling and cracking. The maximum lateral permanent set of the barrier system was 0.1 in., including barrier and deck panel shift. The maximum lateral dynamic barrier deflection, including tipping of the barrier along the top surface was 0.2 in. at the upstream end of barrier no. 3. The working width of the system was 17.2 inches. There was no potential for the barrier to intrude into the occupant compartment. All vehicle decelerations, occupant compartment deformations, the maximum angular displacements, occupant ridedown accelerations (ORAs), and occupant impact velocities (OIVs) fell within the recommended safety limits established in MASH 2016. The test vehicle showed no tendency for rollover and did not penetrate or ride over the barrier.	PASS
3-20 (1100C)	Test no. 3-20 is not applicable for this type of system.	Non-Relevant Test, not conducted
3-21 (2270P)	Test no. 3-21 is not applicable for this type of system.	Non-Relevant Test, not conducted

Full Scale Crash Testing was done in compliance with MASH by the following accredited crash test laboratory (cite the laboratory's accreditation status as noted in the crash test reports.):

Laboratory Name:	Midwest Roadside Safety Facility	
Laboratory Signature:	Karla Lechtenberg DN: cn=Karla Lechtenberg, o=MwRSF, ou, email=kpolivka2@unl.edu, c=US Digitally signed by Karla Lechtenberg Date: 2020.04.17 09:59:46 -05'00'	
Address:	30 Whittier Research Center, 2200 Vine Street, Lincoln, NE 68583-0853	Same as Submitter ☐
Country:	USA	Same as Submitter ☐
Accreditation Certificate Number and Dates of current Accreditation period :	A2LA Certificate Number: 2937.01, Valid to November 30, 2019 (Currently, valid to November 30, 2021)	

Submitter Signature*:

Submit Form

ATTACHMENTS

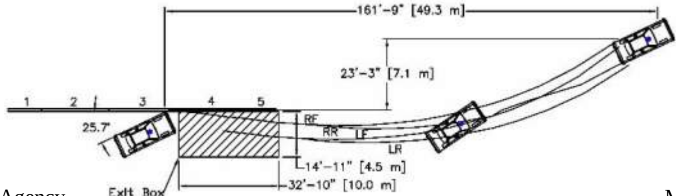
Attach to this form:

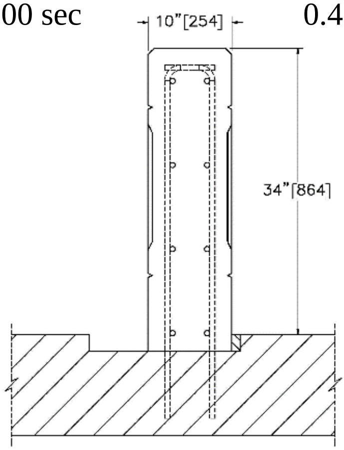
1) Additional disclosures of related financial interest as indicated above.
2) A copy of the full test report, video, and a Test Data Summary Sheet for each test conducted in support of this request.
3) A drawing or drawings of the device(s) that conform to the Task Force-13 Drawing Specifications [Hardware Guide Drawing Standards]. For proprietary products, a single isometric line drawing is usually acceptable to illustrate the product, with detailed specifications, intended use, and contact information provided on the reverse. Additional drawings (not in TF-13 format) showing details that are relevant to understanding the dimensions and performance of the device should also be submitted to facilitate our review.

FHWA Official Business Only:

Eligibility Letter		
Number	Date	Key Words

0.000 sec 0.100 sec 0.200 sec 0.300 sec 0.400 sec





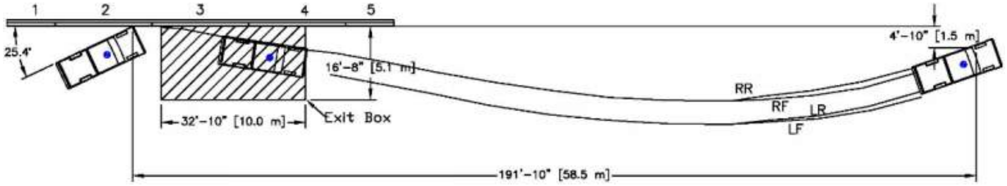
- Test Agency .... MwRSF
- Test Number H34BR-1
- Date 4/17/2019
- MASH 2016 Test Designation No. 3-10
- Test Article .... HDOT 34-in. Tall, Aesthetic Concrete Bridge Rail
- Total Length .... 88 ft
- Key Component – Barrier Segment
  - Length .... 22 ft
  - Depth .... 10 in.
  - Height .... 34 in.
- Key Component – Barrier Segment
  - Length .... 11 ft
  - Depth .... 10 in.
  - Height .... 34 in.
- Type of Support Surface .... Concrete Tarmac
  - Anchor .... Vertical rebar anchored to concrete tarmac and epoxied
- Vehicle Make /Model .... 2009 Hyundai Accent
  - Curb .... 2,511 lb
  - Test Inertial .... 2,430 lb
  - Gross Static .... 2,589 lb
- Impact Conditions
  - Speed .... 62.4 mph
  - Angle .... 25.7 deg.
  - Impact Location .... $42^{9}/_{16}$ in. upstream from the expansion joint, barrier nos. 3 and 4
- Impact Severity .... 59.2 kip-ft > 51 kip-ft limit from MASH 2016
- Exit Conditions
  - Speed .... 43.0 mph
  - Angle .... 6.9 deg.
- Exit Box Criterion .... Pass
- Vehicle Stability .... Satisfactory
- Vehicle Stopping Distance .... 161 ft – 9 in. downstream, 23 ft - 3 in. laterally behind
- Vehicle Damage .... Moderate
  - VDS [11] 1-RFQ-4
  - CDC [12] 01-RRER-5
  - Maximum Interior Deformation .... 3.1 in.
- Test Article Damage .... Minimal
- Maximum Test Article Deflections
  - Permanent Set .... 0.2 in.
  - Dynamic .... 0.3 in.
  - Working Width .... 10.3 in.
- Transducer Data

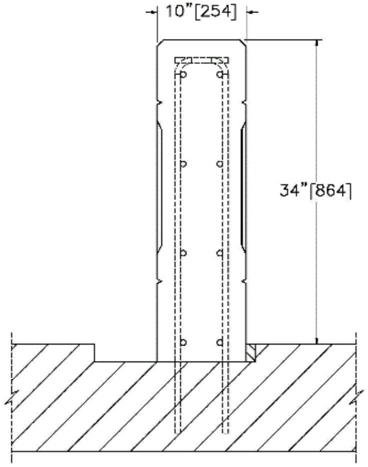
Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-2 (primary)	DTS	
OIV ft/s (m/s)	Longitudinal	−23.41	−25.16	±40
	Lateral	−32.76	−29.78	±40
ORA g's	Longitudinal	−4.11	−3.76	±20.49
	Lateral	−10.63	−12.92	±20.49
MAX ANGULAR DISP. deg.	Roll	5.7	N/A	±75
	Pitch	−2.5	N/A	±75
	Yaw	−39.0	N/A	not required
THIV – ft/s		39.68	N/A	not required
PHD – g's		10.90	N/A	not required
ASI		2.54	2.39	not required

N/A – Data not available due to equipment malfunction

Figure 47. Summary of Test Results and Sequential Photographs, Test No. H34BR-1

0.000 sec 0.100 sec 0.200 sec 0.300 sec 0.400 sec

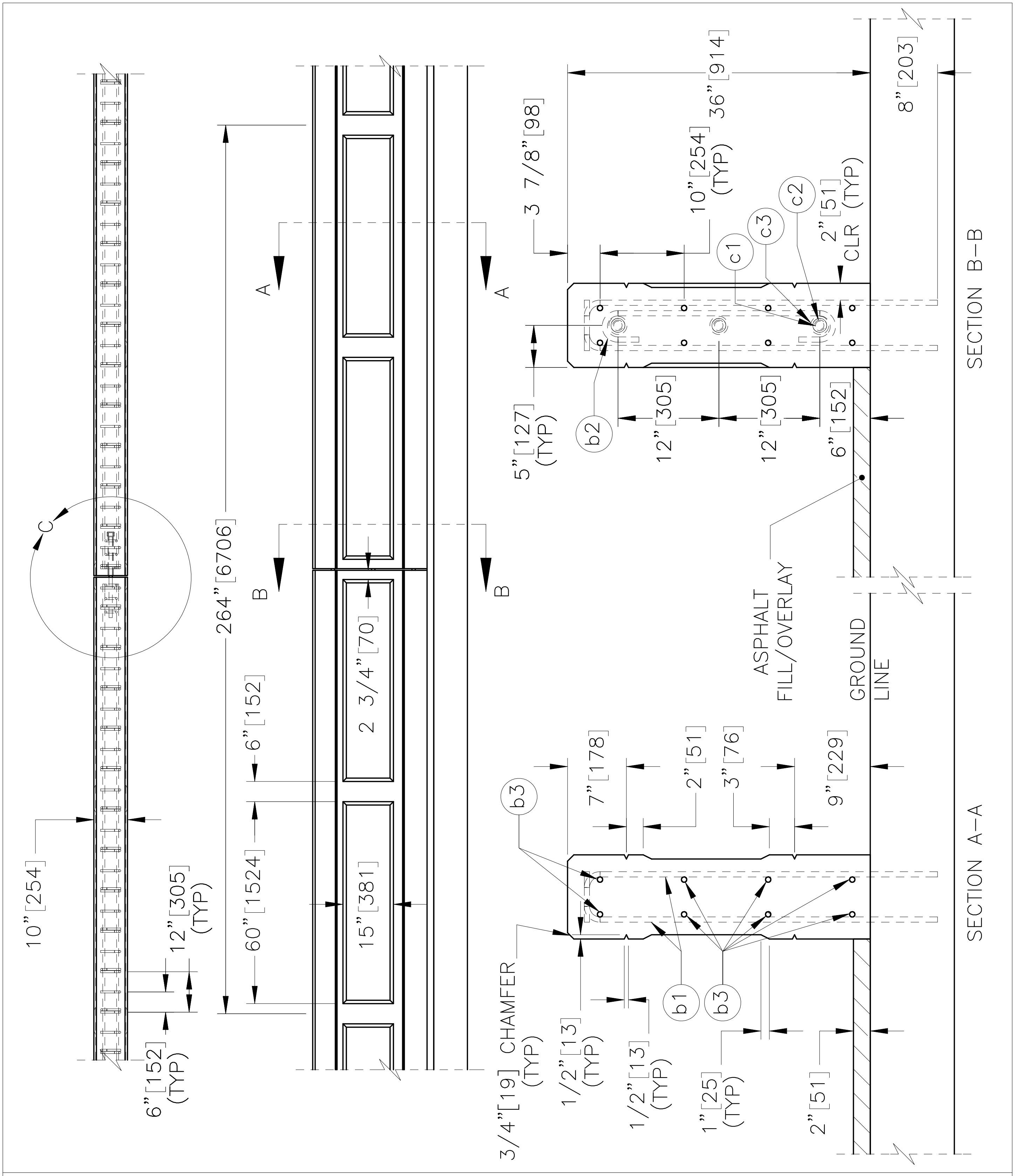




- Test Agency ... MwRSF
- Test Number ... H34BR-2
- Date ... 4/29/2019
- MASH 2016 Test Designation No. ... 3-11
- Test Article ... HDOT 34-in. Tall Aesthetic Concrete Bridge Rail
- Total Length ... 88 ft
- Key Component – Barrier Segment
  - Length ... 22 ft
  - Width ... 10 in.
  - Depth ... 34 in.
- Key Component – Barrier Segment
  - Length ... 11 ft
  - Width ... 10 in.
  - Depth ... 34 in.
- Type of Support Surface ... Concrete Tarmac
  - Anchor ... Vertical rebar anchored to concrete tarmac and epoxied
- Vehicle Make /Model ... 2013 Dodge Ram 1500 quad cab pickup truck
  - Curb ... 5,068 lb
  - Test Inertial ... 5,001 lb
  - Gross Static ... 5,167 lb
- Impact Conditions
  - Speed ... 64.0 mph
  - Angle ... 25.4 deg.
  - Impact Location ... $51\frac{15}{16}$ in. upstream from the expansion joint, barrier nos. 2 and 3
- Impact Severity ... 126.4 kip-ft > 106 kip-ft limit from MASH 2016
- Exit Conditions
  - Speed ... 44.0 mph
  - Angle ... 8.9 deg.
- Exit Box Criterion ... Pass
- Vehicle Stability ... Satisfactory
- Vehicle Stopping Distance ... 191 ft – 10 in. downstream, 4 ft – 10 in. laterally in front
- Vehicle Damage ... Moderate
  - VDS [11] ... 1-RFQ-4
  - CDC [12] ... 01-RRER-5
  - Maximum Interior Deformation ... 5.4 in.
- Test Article Damage ... Minimal
- Maximum Test Article Deflections
  - Permanent Set ... 0.1 in.
  - Dynamic ... 0.2 in.
  - Working Width ... 17.2 in.
- Transducer Data

Evaluation Criteria		Transducer		MASH 2016 Limit
		SLICE-1	SLICE-2 (primary)	
OIV ft/s	Longitudinal	−21.94	−21.83	±40
	Lateral	−24.65	−27.53	±40
ORA g's	Longitudinal	−4.00	−4.06	±20.49
	Lateral	−9.83	−7.17	±20.49
MAX ANGULAR DISP. deg.	Roll	17.0	1.37	±75
	Pitch	2.4	−2.8	±75
	Yaw	−44.6	−44.9	not required
THIV – ft/s		31.26	34.80	not required
PHD – g's		10.29	7.76	not required
ASI		1.71	1.88	not required

Figure 66. Summary of Test Results and Sequential Photographs, Test No. H34BR-2



HAWAII 34" AESTHETIC CONCRETE BRIDGE RAIL

XXX##

SHEET NO. 1 of 5

DATE: 4/20/2020

INTENDED USE

The Hawaii 34” [864] Aesthetic Concrete Bridge Rail is non-proprietary concrete bridge rail that is anchored to a concrete bridge deck with a 2-in. [51] thick concrete or asphalt finishing surface applied on the traffic-side face of the bridge rail. This bridge rail has aesthetic recessed rectangular panels on the traffic-side and back-side surfaces. These aesthetic recessed panels measure 60 in. [1524] wide, 15 in. [381] tall, and ½ [13] in. deep with an inclination angle of 45 degrees. Expansion joints using smooth dowels are typically located at 22-ft [6706] intervals in the bridge rail. End sections measuring 3 ft – 6 in. [1067] long are placed at the end of the bridge rail adjacent to an end buttress structure and should have similar or greater capacity as the bridge rail. The concrete used for the Hawaii 34” [864] Bridge rail should have a minimum nominal compressive strength of 4,000 psi [27.6 MPa]. The Hawaii 34” [864] Aesthetic Concrete Bridge Rail should be used in location where a maximum dynamic deflection of 0.3 in. [8] at the top of the barrier or less is acceptable and where a working width of 17.2 in. [438 mm] is provided. The Hawaii 34” [864] Aesthetic Concrete Bridge Rail should be used with the Modified Hawaii Thrie Beam Approach Guardrail Transition when transitioning to 31” [787] tall strong-post, W-beam guardrail such as Midwest Guardrail System (SGR20). The Hawaii 34” [864] Aesthetic Concrete Bridge Rail has been crash tested under Test Level 3 (TL-3) conditions and deemed crashworthy according to the Manual for Assessing Safety Hardware, Second Edition (MASH 2016) performance criteria.

COMPONENTS

Unit Length = 264” [6706]

DESIGNATOR	COMPONENT	NUMBER
c1	1” [25] Dia. Smooth 24” [610] Long Rebar	3
c2	1 1/4" [32] Dia. PVC Pipe	3
c3	1 1/4” [32] PVC Cap	3
---	Concrete, Minimum 4,000 psi f’c	-
---	See Bill of Bars	-

ELIGIBILITY

Eligibility will be pursued.

REFERENCES

Bielenberg, R. W., Yoo, S., Faller, R. K., and Urbank, E. L., *Crash Testing and Evaluation of the HDOT 34-in. Tall Aesthetic Concrete Bridge Rail: MASH Test Designation Nos. 3-10 and 3-11*, Report to Hawaii Department of Transportation, Transportation Report No. TRP-03-420-19, Midwest Roadside Safety Facility, University of Nebraska-Lincoln, October 2019.

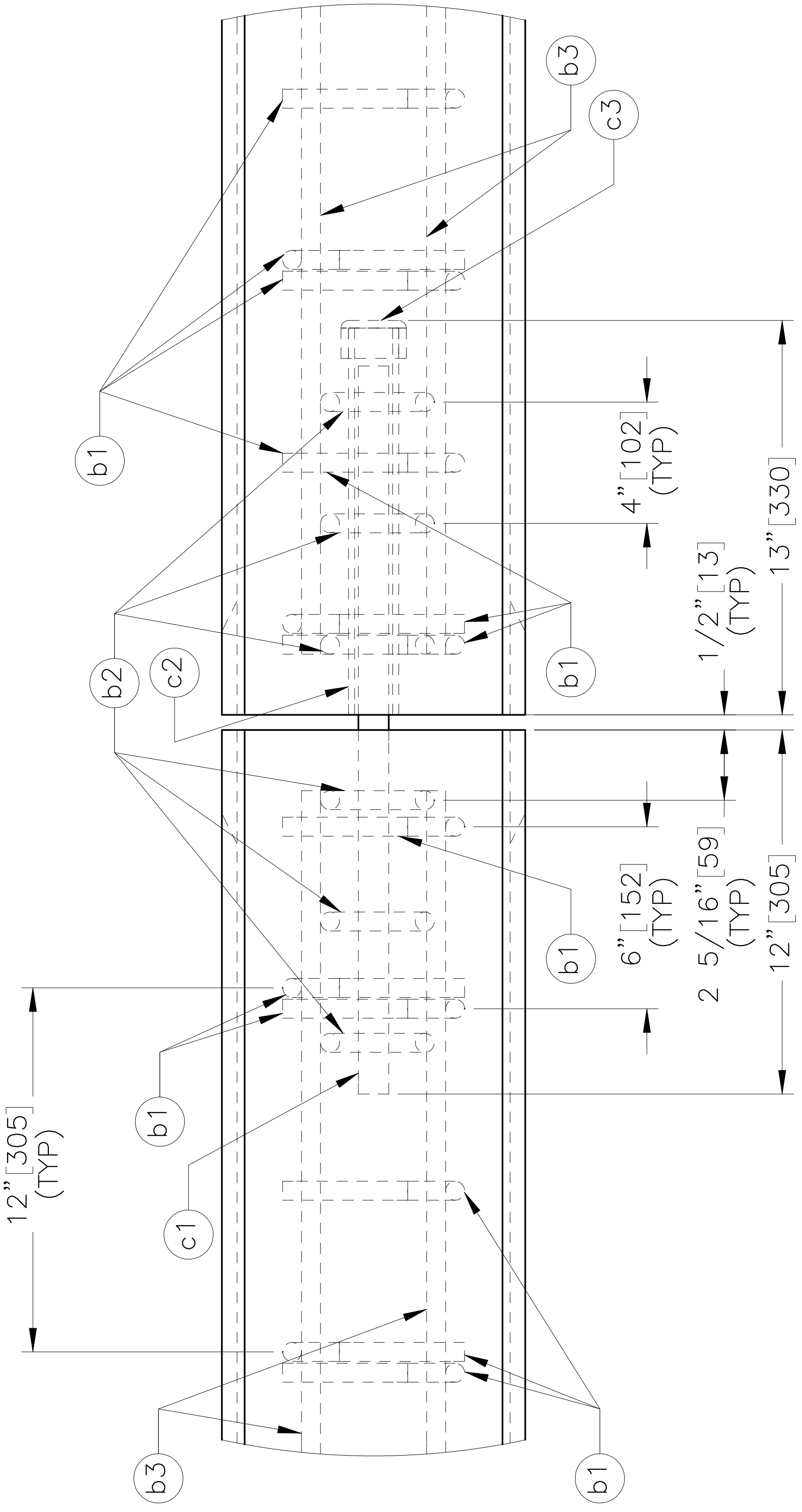
CONTACT INFORMATION

Hawaii Department of Transportation
Aliiaimoku Building
869 Punchbowl St.
Honolulu, HI 96813

HAWAII 34" AESTHETIC CONCRETE BRIDGE RAIL

XXX##

SHEET NO.	DATE:
2 of 5	4/20/2020



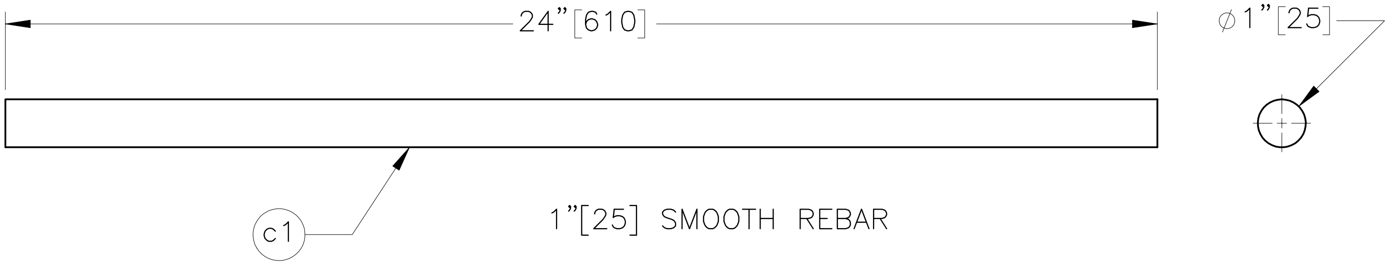
DETAIL C

NOTE: SMOOTH DOWELS ARE CAST IN PLACE ON ONE SIDE OF THE EXPANSION JOINT, AND INSERTED INTO PLASTIC SLEEVES, WHICH ARE CAST INTO THE BARRIER ON THE OTHER SIDE OF THE EXPANSION JOINT.

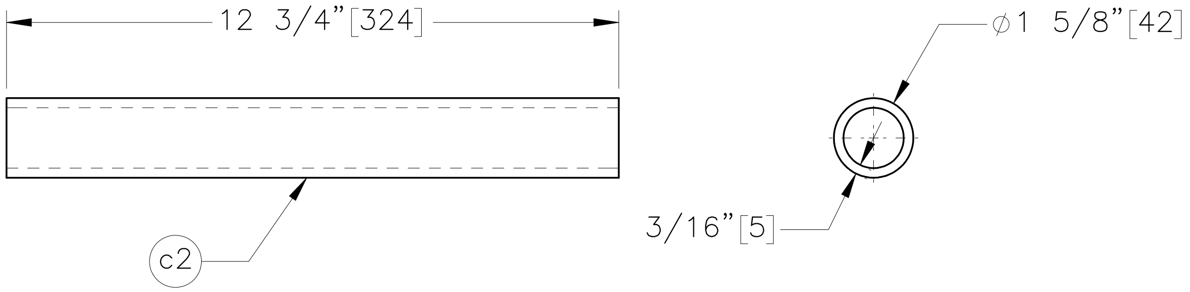
HAWAII 34" AESTHETIC CONCRETE BRIDGE RAIL

XXX##

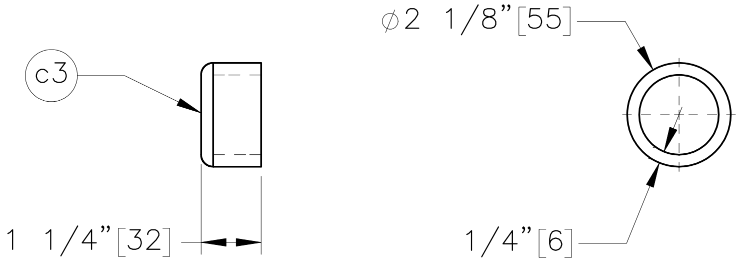
SHEET NO.	DATE:
3 of 5	4/20/2020



1"[25] SMOOTH REBAR



1 1/4"[32] DIA. PVC PIPE



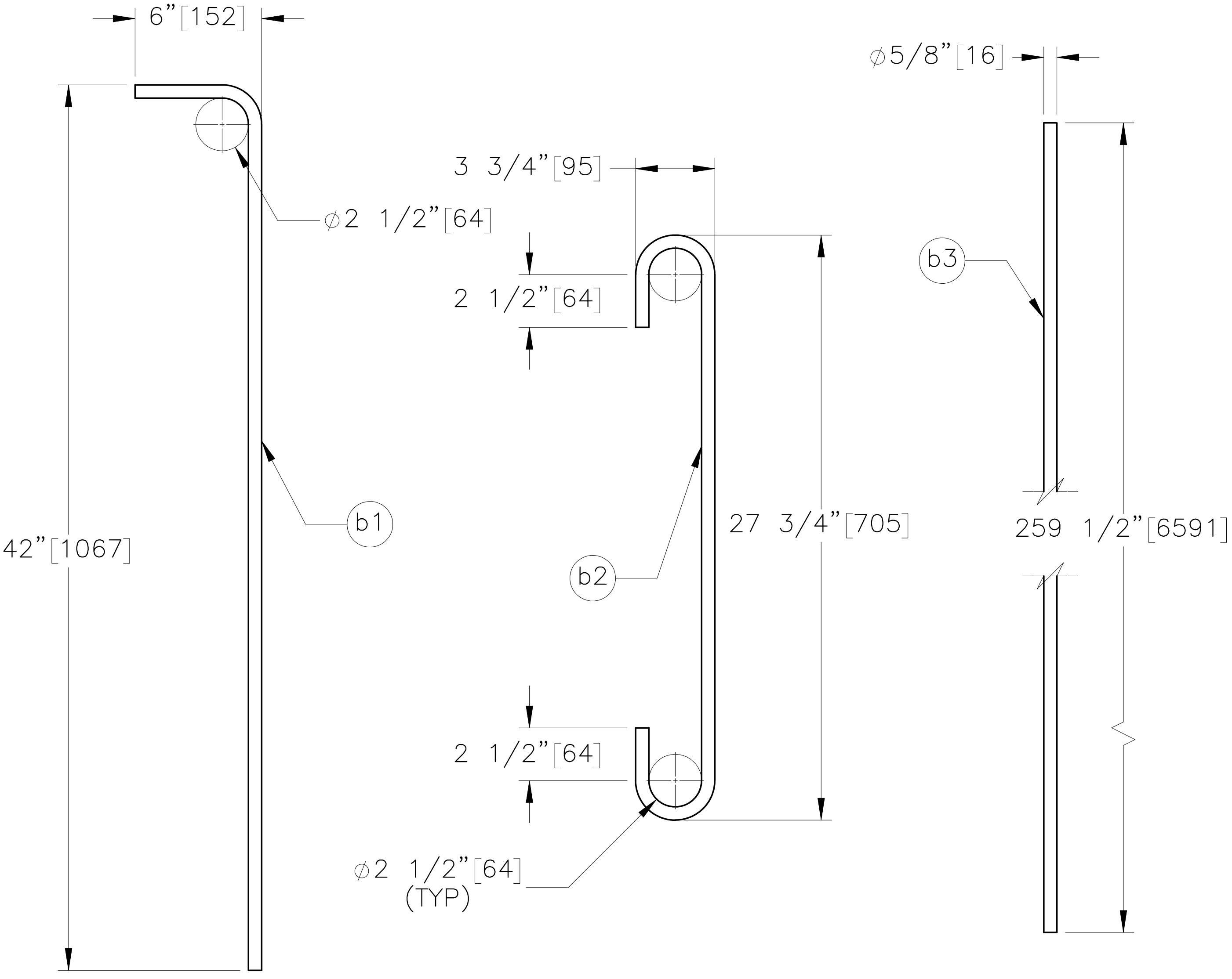
1 1/4"[32] PVC CAP

HAWAII 34" AESTHETIC CONCRETE BRIDGE RAIL

XXX##

SHEET NO.	DATE:
4 of 5	4/20/2020

BILL OF BARS				
Part No.	Bar No.	No.	Unbent Length	Material
b1	#5	68	46 3/4" [1187]	ASTM A615 Gr. 60
b2	#5	6	38 7/8" [987]	ASTM A615 Gr. 60
b3	#5	8	259 1/2" [6591]	ASTM A615 Gr. 60



HAWAII 34" AESTHETIC CONCRETE BRIDGE RAIL

XXX##

SHEET NO.	DATE:
5 of 5	4/20/2020

Appendix I:

Non-Destructive Testing & Geotechnical Investigation Report

Terracon

December 21, 2020

Ms. Katlyn Shergalis, P.E.
Lochmueller Group
3502 Woodview Trace, Suite 150
Indianapolis, IN 46268

RE: **Memorandum No.1**
Preliminary Observations
Non-Destructive Testing, Bridge Cores and Geotechnical Boring
SR 933 over St. Joseph River
Saint Joseph Co., Indiana
EEI Project No. CJ205128

Dear Katlyn:

Terracon performed non-destructive testing (NDT), bridge cores, and a soil boring during the period of November 2 and November 17, 2020 on the SR 933 bridge over the St. Joseph River. This memorandum provides preliminary observations from these field activities.

Non-Destructive Testing Observations

To provide information regarding the condition of the concrete arches, we performed multiple non-destructive surveys of each of the three spans. The non-destructive methods included:

1. Preliminary site visit and Infrared Thermography (IR): The purpose of the IR survey was to provide a broad inspection of the underside of the concrete arches and identify any surficial signs that may be reflecting subsurface issues.
2. Ground Penetrating Radar (GPR) scan: The purpose of the GPR survey was to assist in identifying areas of subsurface deterioration and other anomalous zones.
3. Impact Echo (IE). The IE survey utilized information from the GPR survey to further investigate areas of subsurface deterioration and provide additional information on the overall thickness and identify deeper areas of potential deterioration that were undetectable with the GPR.
4. Rebar locator: The rebar locator provided information on cover thickness and rebar orientation in areas where GPR signal was limited due to reinforcing strips.

In general, the effectiveness of the IR survey was limited, likely due to interference from surficial coatings and the reinforcing strips. The areas of potential deterioration that were revealed by the IR survey corresponded to locations with surficial staining, seeps and mineral deposits and were limited to the downstream side of Span B. Other observations from the IR survey corresponded to visible construction joints and areas of the arch where the reinforcing strips were either separated from the arch or completely removed.

Due to the impacts of the reinforcing strips on the GPR signal, we completed a rebar scan using a Proceq Profoscope rebar locator to provide additional information on reinforcement presence. Three east-west scans (transects) were completed on each arch at the ¼, ½, and ¾ marks on each span from south to north. The reinforcing strips did not appear to influence the effectiveness of the rebar locator. The findings of the rebar scan are summarized in Table 1 below. The range of values corresponds to the minimum and maximum distance between longitudinal reinforcement observed among the three transects for each arch. Note that the rebar locator was unable to distinguish transverse reinforcement, likely due to interference from the longitudinal reinforcement. Furthermore, the estimated bar diameter could not be determined with the rebar locator. Transverse bars were observed in the GPR dataset and will be summarized in the final report.

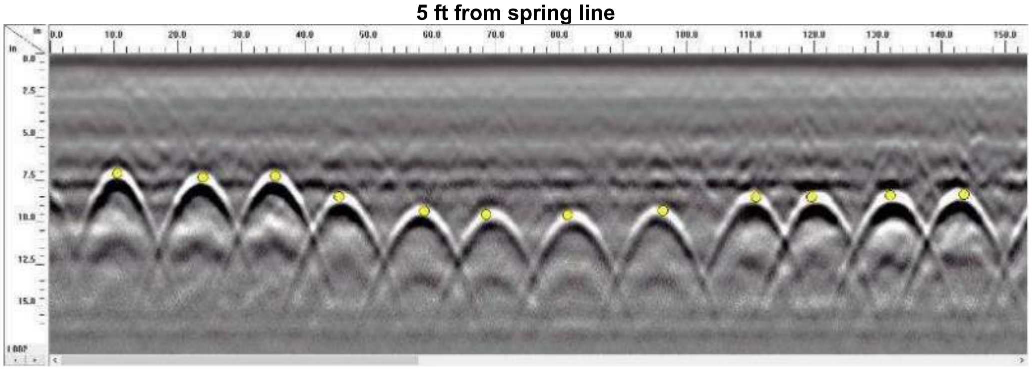
Table 1: Summary of Longitudinal Reinforcement Observations

Span	Spacing between Longitudinal Reinforcement (in.)	Concrete Cover thickness (in.)
A	10 - 15	2¼ - 3½
B	10 - 14	1 – 3½
C	10 - 14	1¼ - 3

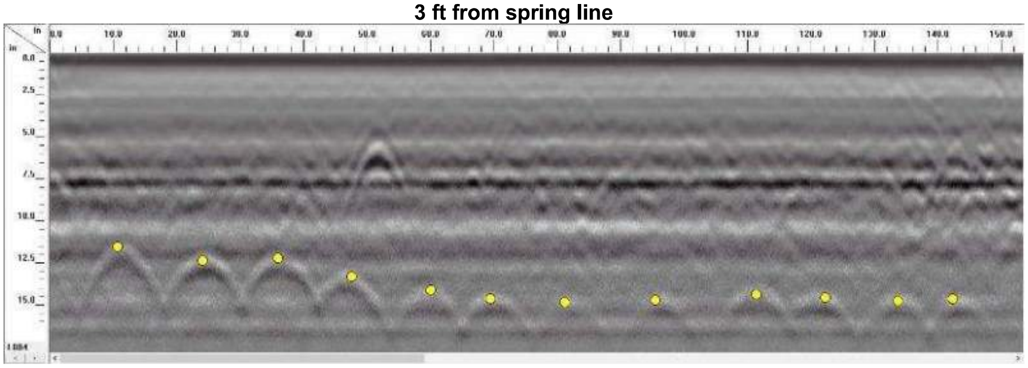
GPR lines were collected from the center (longitudinal) construction joint of each span to the east and west facades between the reinforcing strips, from about 7 ft above the spring line to the spring line. Longitudinal reinforcement bar spacing observed in these GPR transects was consistent with the rebar locator observations. The concrete cover thickness was consistently observed to increase as the longitudinal reinforcement approached the spring line. The longitudinal reinforcement became out of range approximately 1 to 2 ft above the spring line, as illustrated by the series of images below from Span A. The images below are from parallel lines collected from the center joint of Span A towards the west façade. The yellow markers represent reinforcement bars.

GPR Images – Span A

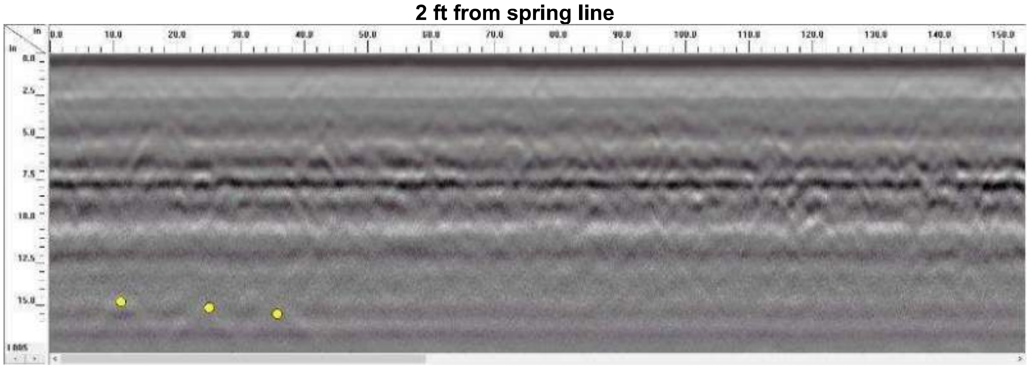
5 ft from spring line



3 ft from spring line



2 ft from spring line



Based on initial NDT observations, areas of delamination were limited to the downstream, central area of Span B, generally within about 8 ft from the west façade (i.e., to the first construction joint). This zone also contains several surficial expressions (e.g. rust staining, active seeps, mineral crystallization) that may be the result of potential internal deterioration. These observations are consistent with historical information. Examples of surficial expressions observed in the downstream, central area of Span B are shown in the photographs below.

Surficial Expressions on Arch – Span B

Rust staining and active seep, downstream center of Span B

Mineral crystallization, downstream center of Span B

Test Cores and Geotechnical Boring Observations

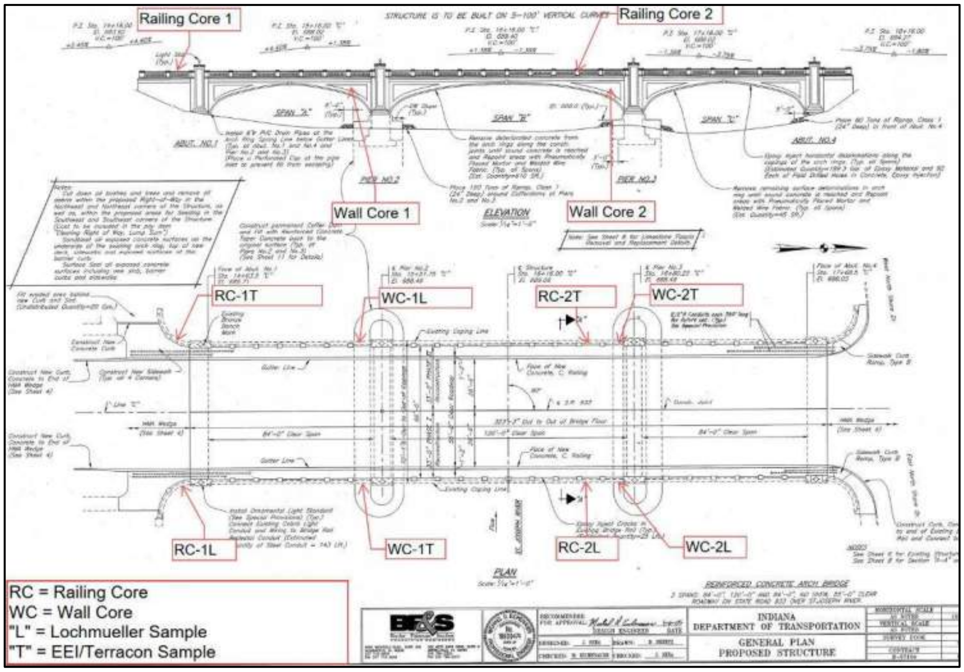
A total of 14 test cores were performed as part of the assessment at the following locaitons:

- Three from the bridge deck (TC-2, TC-3, and TC-4);
- Three from the underside of the arch (AC-1A, AC-1B, and AC-1C); and
- Eight on the spandrel walls and railings (WC-1, WC-2 and RC-1, RC-2).
    - Four cores were recovered for Lochmueller (designated with an “L”)
    - Four cores were recovered for Terracon (designated with a “T”)

A geotechnical soil boring was performed near the south bridge abutment. Approximate locations for each core/boring are shown on the Exploration Site Plan and Spandrel Wall and Railing core Locations figure below.

Exploration Site Plan

Spandrel Wall and Railing Core Locations



Preliminary logs for test cores TC-2, TC-3, and TC-4 and Boring TB-1 are attached. Visual classifications of the arch, spandrel wall, and railing cores are presented in Table 2 below. Photos of the cores recovered are attached to this memo.

Table 2 – Summary of Arch, Spandrel Wall, and Railing Cores

Test Core No.	Core Thickness (in)	**Description** - All Classifications are visual
AC-1A	17.2	Portland Cement Concrete, 1-in. max. aggregate size, fractures near 7.3 in. and 11.5 in.
AC-1B	13.5 *	Portland Cement Concrete, 1-in. max. aggregate size, fractures near 8.2 in. and 10.0 in.
AC-1C	16.8	Portland Cement Concrete, 1-in. max. aggregate size, fractures near 5.0 and 12.0 in.
RC-1T	---	Portland Cement Concrete, ½-in. maximum aggregate size
RC-2T	---	Limestone (possible fossiliferous limestone)
WC-1T	---	Limestone (possible fossiliferous limestone)
WC-2T	---	Limestone (possible fossiliferous limestone)

* Several inches of the core were lost during coring operations. See core photo for more information.

Preliminary observations include:

- The distance from the top of pavement to the bottom of the pier footing was about 35 ft at both piers.
- There was no discernable indication of a void below either pier footings.
- Each pier footing is supported on a granular (sand) layer about 1 ft in thickness over cohesive (clay) soils that appears to vary in consistency of soft to medium stiff.
- The arch fill consists of sand, gravel, and sandy loam with brick and possible asphalt/concrete fragments.

Laboratory tests are currently being performed on the soil samples collected in Bboring TB-1 and Test Cores TC-2 and TC-4. Strength and chloride/sulfate ion tests have been assigned based on your sample selections. Sample preparation is underway.

Thank you for the opportunity to provide our professional services. If you have any questions regarding the enclosed information, please contact us.

Sincerely,
Terracon Consultants, Inc.

Stephen Brellenthin
Stephen Brellenthin, L.P.G.
Senior Staff Geophysicist

Scott Zajac
Scott Zajac, P.E.
Project Engineer

Attachments:
Log of Test Boring (TC-2, TC-3, TC-4, TB-1)
Core Photos

LOG OF TEST BORING

BORING NO.: **TC-2**
SHEET 1 OF 2
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68792
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25051
PROJECT TYPE: Bridge Assessment
DATUM : WGS84
LOCATION : SR 933 over St. Joseph River
DATE STARTED : 11-04-20
COUNTY : St. Joseph PROJECT NO.: CJ205128
DATE COMPLETED : 11-05-20

ELEVATION : 684.0
STATION :
OFFSET : 25.0 ft Right
LINE :
DEPTH : 38.0 ft

BORING METHOD : Hollow Stem Auger
RIG TYPE : D-50
CASING DIA. : ---
CORE SIZE : NQ2

HAMMER : Auto
DRILLER/INSP : JS
TEMPERATURE : 70 °F
WEATHER : Fair

GROUNDWATER: ∇ Encountered at Dry ▼ At completion Dry

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION		SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete	0.3											
		Portland Cement Concrete	1.2											
	2.5			SS 1	28-16-26-22									
680.0				SS 2	41-27-20-17									
	5.0	**Sand and Gravel,** (fill)		SS 3	50/2"									
	7.5			SS 4	50/3"									
			8.5											
675.0														
	10.0			RC 1 RQD= 97%		100								
	12.5	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 8.6', 9.5', 12.6', 13.8', 14.3', 14.9', 15.4', 15.8', 16.2', 17.1', 17.6', 18.8'												
670.0														
	15.0			RC 2 RQD= 97%		100								
	17.5													
665.0			19.3											
	20.0	**Limestone,** fractured near 19.3', 19.5', 19.8', 20'	20.8	RC 3 RQD= 78%		98								
	22.5	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 21.8', 22.8', 23.9'												
660.0														
	25.0		25.4											
		Limestone, fractured near 25.7'	26.2	RC 4 RQD= 90%		98								
	27.5	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 26.6', 27.4', 27.8', 29', 29.5', 30'												
655.0														
	30.0		30.0											

Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 12/15/20

LOG OF TEST BORING

EARTH EXPLORATION

BORING NO.: **TC-2**
SHEET 2 OF 2
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68792
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25051
PROJECT TYPE: Bridge Assessment
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
	32.5	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 31.1', 31.8', 32.1', 32.8', 33.3', and 33.9'; fractured in pieces near 28.4'-28.8', 30'-30.4', 32.1'-32.4', and 34.3'-34.6'; voided with possible weathering near 30'-31.1' and 32.4'-32.8' 35.0	RC 5 RQD= 61%		92								
650.0	35.0		RC 6 RQD= 81%		100								
		Sand 36.0											35.0, Sand description based on driller's experience and presence of sand in core barrel bit.
	37.5	**Clay,** medium stiff, moist, gray 38.0	SS 5	2-3-4-5	75								
645.0	40.0	Bottom of Boring at 38.0 ft											
	42.5												
640.0	45.0												
	47.5												
635.0	50.0												
	52.5												
630.0	55.0												
	57.5												
625.0	60.0												
	62.5												
620.0	65.0												

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 12/15/20

LOG OF TEST BORING

EARTH EXPLORATION A Terracon COMPANY

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment
LOCATION : SR 933 over St. Joseph River
COUNTY : St. Joseph PROJECT NO.: CJ205128

BORING NO.: **TC-3**
SHEET 1 OF 1
LATITUDE : 41.68810
LONGITUDE : -86.25051
DATUM : WGS84
DATE STARTED : 11-05-20
DATE COMPLETED : 11-05-20

ELEVATION : 684.0
STATION :
OFFSET : 25.0 ft Right
LINE :
DEPTH : 4.7 ft

BORING METHOD : Hollow Stem Auger
RIG TYPE : D-50
CASING DIA. : ---
CORE SIZE : NQ2

HAMMER : Auto
DRILLER/INSP : JS
TEMPERATURE : 70 °F
WEATHER : Fair

GROUNDWATER: ∇ Encountered at Dry ▼ At completion Dry

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete 0.3											
		Portland Cement Concrete Pavement, fractured near 0.5" and 1.5", reinforcement near 0.6" 1.5											0.6, Steel reinforcement near 0.6 ft
		Sand, (fill) 2.3											
680.0	2.5	**Portland Cement Concrete** 4.7	RC 1 RQD= 100%		100								
	5.0	Bottom of Boring at 4.7 ft											
	7.5												
675.0													
	10.0												

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 12/15/20

LOG OF TEST BORING

BORING NO.: **TC-4**
SHEET 1 OF 2
LATITUDE : 41.68827
LONGITUDE : -86.25052
DATUM : WGS84
DATE STARTED : 11-09-20
DATE COMPLETED : 11-09-20

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment
LOCATION : SR 933 over St. Joseph River
COUNTY : St. Joseph PROJECT NO.: CJ205128

ELEVATION : 684.0
STATION :
OFFSET : 25.0 ft Right
LINE :
DEPTH : 38.0 ft

BORING METHOD : Hollow Stem Auger
RIG TYPE : D-50
CASING DIA. : ---
CORE SIZE : NQ2

HAMMER : Auto
DRILLER/INSP : JS
TEMPERATURE : 75 °F
WEATHER : Cloudy

GROUNDWATER: ∇ Encountered at Dry ▼ At completion Dry

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete 0.3											
		Portland Cement Concrete 1.5											
	2.5		SS 1	50/3	100								
680.0	5.0	**Sandy Loam,** moist, brown, with gravel, (fill)	B 1										3.5, Bucket sample of cuttings 3.5 to 10 ft
675.0	7.5 10.0	10.0											
	12.5		RC 1 RQD= 100%		100								
670.0	15.0	**Portland Cement Concrete,** max aggregate size 1.0", fractures near 10.6', 12.9', 14.5', 16.6', 17.6', 18.2', 18.7'											
	17.5	19.2	RC 2 RQD= 100%		100								
665.0	20.0	**Limestone with Interbedded Shale,** fractures near 19.2', 19.7', 20.3' 20.3											
	22.5		RC 3 RQD= 96%		100								
660.0	25.0	**Portland Cement Concrete,** max aggregate size 1.0", fractures near 21.5', 21.7', 22.8', 23.6', 24.6', and 28.5'											
	27.5		RC 4 RQD= 100%		100								
655.0	30.0												

Continued on next page

EARTH EXPLORATION
a Terracon company

LOG OF TEST BORING

BORING NO.: **TC-4**
SHEET 2 OF 2
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68827
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25052
PROJECT TYPE: Bridge Assessment
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
	32.5	**Portland Cement Concrete,** max aggregate size 1.0", fractures near 21.5', 21.7', 22.8', 23.6', 24.6', and 28.5' 35.0	RC 5 RQD= 96%		100								
650.0													
	35.0	**Sand** 36.0											35.0, Sand description based on driller's experience and presence of sand in core barrel bit.
	37.5	**Clay,** very soft to soft, grey 38.0	SS 2		0								36.0, Cohesive soil/clay present on core barrel and split spoon shoe. Two attempts were made to recover a sample. SPT values not recorded but approx. one-half of those recorded at TC-2 based on driller's notes.
645.0		Bottom of Boring at 38.0 ft											
	40.0												
	42.5												
640.0													
	45.0												
	47.5												
635.0													
	50.0												
	52.5												
630.0													
	55.0												
	57.5												
625.0													
	60.0												
	62.5												
620.0													
	65.0												

EARTH EXPLORATION a Terracon company

LOG OF TEST BORING

BORING NO.: **TB-1**
SHEET 1 OF 3
CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment
LOCATION : SR 933 over St. Joseph River
COUNTY : St. Joseph PROJECT NO.: CJ205128
LATITUDE : 41.68765
LONGITUDE : -86.25051
DATUM : WGS84
DATE STARTED : 11-12-20
DATE COMPLETED : 11-12-20

ELEVATION : 684.0
STATION : 37 S of Bridge Joint
OFFSET : 25.0 ft Right
LINE :
DEPTH : 90.0 ft
BORING METHOD : Hollow Stem Auger
RIG TYPE : CME 550 X
CASING DIA. : ---
CORE SIZE : ---
HAMMER : Auto
DRILLER/INSP : JP
TEMPERATURE : 45 °F
WEATHER : Fair

GROUNDWATER: ∇ Encountered at 19.0 ft ▼ At completion 10.0 ft ⊠ Caved in at 37.2 ft

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete 1.0											
		Portland Cement Concrete 1.6											
	2.5	**Sandy Loam,** very loose to loose, moist, dark brown to brown below 11 ft, cohesive near 6 and 10 ft, with sand seam near 14 ft	SS 1	5-3-4	0								
680.0	5.0		SS 2	2-1-2	67								
	7.5		SS 3	2-3-3	33			0.75 0.50					
675.0	▼10.0		SS 4	2-3-7	0			0.75					
	12.5		SS 5	1-2-3	100								
670.0	15.0		SS 6	1-2-2	100								
	17.5	17.0	SS 7	1-2-4	100								
665.0∇	20.0	**Gravelly Sand,** very loose to medium dense, moist to wet below 19 ft, brown, with sand seams near 18 and 29 ft	SS 8	3-3-5	83								
	22.5		SS 9	2-2-3	100								
660.0	25.0		SS 10	0-1-2	100								
	27.5		SS 11	2-2-3	100								
655.0	30.0		SS 12	3-7-13	100								

Continued on next page

LOG OF TEST BORING

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment

BORING NO.: **TB-1**
SHEET 2 OF 3
LATITUDE : 41.68765
LONGITUDE : -86.25051
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Gravelly Sand, very loose to medium dense, moist to wet below 19 ft, brown, with sand seams near 18 and 29 ft 32.0											
	32.5												
650.0	35.0		SS 13	3-5-8	100			3.5 3.75					
	37.5												
645.0	40.0		SS 14	4-5-8	100			0.75					
	42.5												
640.0	45.0		SS 15	2-4-5	100			2.75 2.5					
	47.5												
635.0	50.0	**Silty Clay,** medium stiff to hard, moist to wet, gray, with sand seams near 29, 60 and 69 ft	SS 16	2-4-5	100			>4.5 3.0					
	52.5												
630.0	55.0		SS 17	2-3-4	100			2.5 2.0					
	57.5												
625.0	60.0		SS 18	2-5-25	100			1.75 1.25					
	62.5												
620.0	65.0		SS 19	5-8-16	100			2.0 1.25					

Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 12/10/20

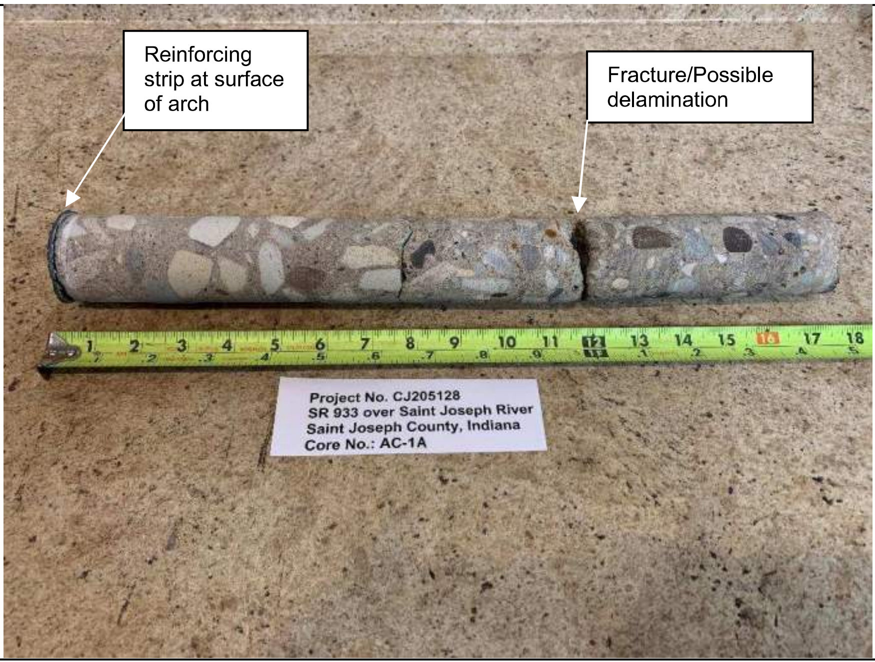
LOG OF TEST BORING

EARTH EXPLORATION A Terracon COMPANY

BORING NO.: **TB-1**
SHEET 3 OF 3
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68765
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25051
PROJECT TYPE: Bridge Assessment
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
	67.5	**Silty Clay,** medium stiff to hard, moist to wet, gray, with sand seams near 29, 60 and 69 ft 76.0											
615.0			SS 20	13-16-15	100			1.0					
	70.0												
	72.5												
610.0			SS 21	17-24-24	100			0.75 1.0					
	75.0												
	77.5	**Sand,** dense, wet, gray 88.0											
605.0			SS 22	26-15-18	100								
	80.0												
	82.5												
600.0			SS 23	15-19-23	100								
	85.0												
	87.5												
595.0		**Sandy Gravel,** dense, wet, gray 90.0	SS 24	18-16-19	100								
	90.0	Bottom of Boring at 90.0 ft											
	92.5												
590.0													
	95.0												
	97.5												
585.0													
	100.0												
	102.5												

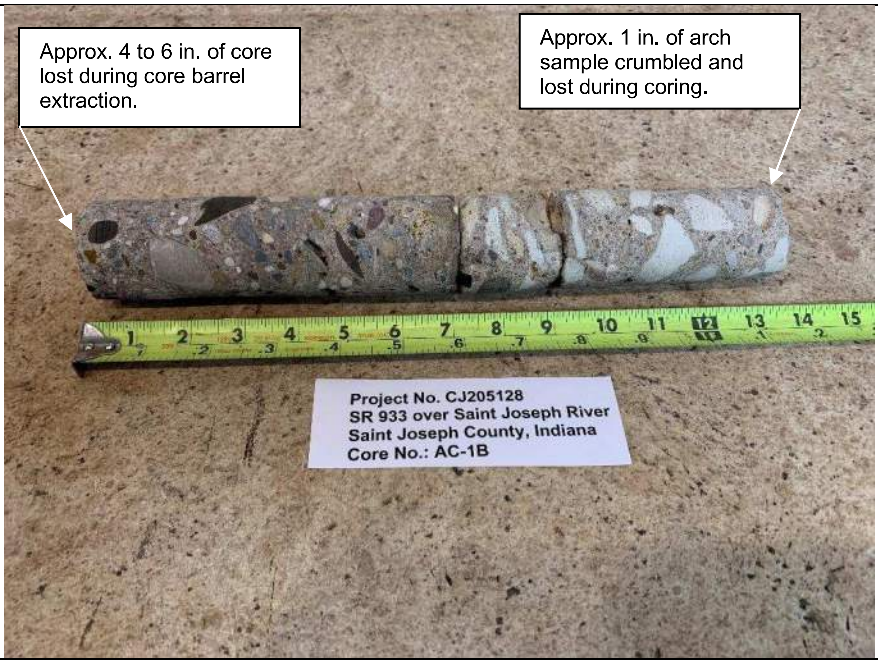
EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 12/10/20



Reinforcing strip at surface of arch

Fracture/Possible delamination

Project No. CJ205128, Boring No. AC-1A



Approx. 4 to 6 in. of core lost during core barrel extraction.

Approx. 1 in. of arch sample crumbled and lost during coring.

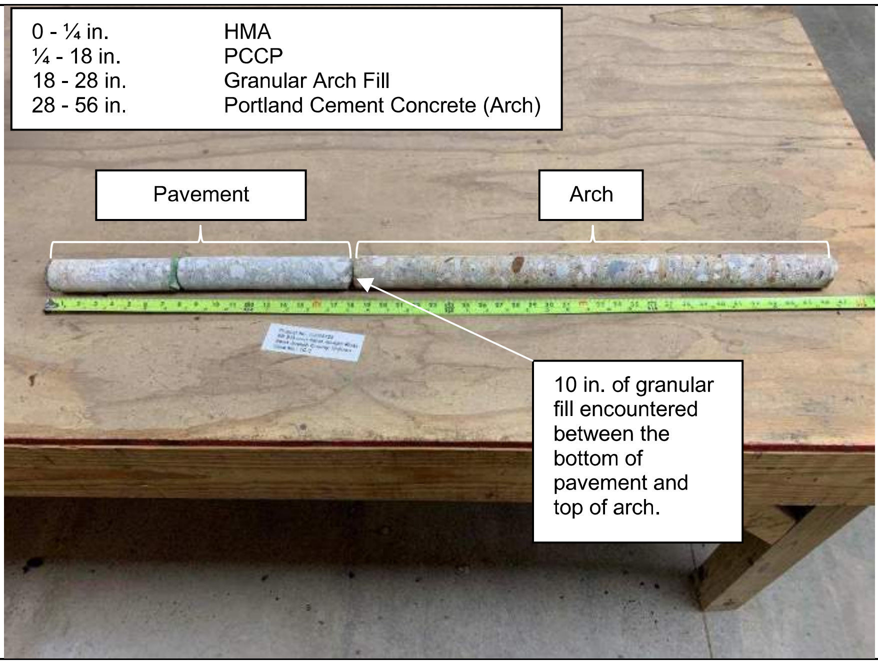
Project No. CJ205128, Boring No. AC-1B

Project No. CJ205128, Boring No. AC-1C

Project No. CJ205128, Boring No. TC-2 8.5'-18.5'

Project No. CJ205128, Boring No. TC-2 18.5'-28.5'

Project No. CJ205128, Boring No. TC-2 28.5'-33.5'



0 - ¼ in.	HMA
¼ - 18 in.	PCCP
18 - 28 in.	Granular Arch Fill
28 - 56 in.	Portland Cement Concrete (Arch)

Pavement

Arch

10 in. of granular fill encountered between the bottom of pavement and top of arch.

Project No. CJ205128, Boring No. TC-3

Project No. CJ205128, Boring No. TC-4 10’-20’

Project No. CJ205128, Boring No. TC-4 20'-30'

Project No. CJ205128, Boring No. TC-4 30'-35'

Project No. CJ205128, Boring No. WC-1T

Project No. CJ205128, Boring No. WC-2T

Project No. CJ205128, Boring No. RC-1T

Project No. CJ205128, Boring No. RC-2T

January 25, 2021

Ms. Katlyn Shergalis, P.E.
Lochmueller Group
3502 Woodview Trace, Suite 150
Indianapolis, IN 46268

RE: **Memorandum No.2**
Observations
Non-Destructive Testing, Bridge Cores, and Geotechnical Boring
SR 933 over St. Joseph River
Saint Joseph Co., Indiana
EEI Project No. CJ205128

Dear Katlyn:

Terracon performed non-destructive testing (NDT), bridge cores, and a soil boring during the period of November 2 through November 17, 2020 on the SR 933 bridge over the St. Joseph River. Memorandum No. 1, dated December 21, 2020, provided preliminary NDT and coring observations. This memorandum incorporates additional data review and laboratory test results and supersedes the observations from Memorandum No. 1.

Previous NDT and Bridge Core Observations

2002: Earth Exploration Inc. (EEI) performed a foundation condition assessment of Pier No. 3. The 2002 assessment was prompted by a 2000 Bridge Condition Report by Collins Engineers, Inc. that indicated a portion of the foundation supporting Pier No. 3 had been undermined. The purpose of the foundation condition assessment was to assess the substructure conditions associated with the foundation of Pier No. 3, including an evaluation of the presence, length, and type of piling and depths of historical scouring. Exploratory test borings, a parallel seismic survey, and a Ground Penetrating Radar (GPR) survey were performed as part of the assessment at Pier 3. Among other things, the foundation condition assessment concluded that:

- Pier No. 3 includes timber piles that extending approximately 15 to 16 ft below the bottom of the pier cap; and
- The pier foundation had experienced a temporary loss in foundation support due to scour resulting in a redistribution of load resistance from the subgrade soils directly below the foundation to the piles.

Sheeting surrounding and structurally-tied to the pier foundation was recommended to reduce potential scour effects.

2006: EEI performed an NDT survey on each span of the bridge to evaluate the occurrence of delamination of the concrete surface of the outer arch rings within a few feet of the limestone fascia. The Impact Echo (IE) method was performed. Delamination was present in each of the arch rings. Indications of honeycombing and/or delamination were observed elsewhere, though conclusive determinations could not be made.

2011: EEI performed an Integrity Assessment of the bridge to evaluate the occurrence of horizontal delamination of the concrete surface on the underside of the arches; depths of transverse cracking; extent of epoxy injection from a previous repair; and thicknesses of the arches and spandrel walls. The NDT methods performed included IE and an electromagnetic rebar locator. Concrete coring was performed as well. The assessment indicated the following:

- Delamination was present in Span B but was not observed in Spans A and C at the locations tested;
- Transverse cracking depths ranged from 8 to 17 in. deep into the arch;
- Honeycombing was present within about 3 in. from the underside of the arch surface.
- IE observations suggested the concrete thickness ranged from 20 to 33 in. over the flatter portions of the arches, with a majority of thicknesses between 22 and 24 in;
- Steel reinforcement observations suggested a cover of about 3 in. and bar spacing of approximately 12 in.; and,
- Cores performed from the underside of the arches indicated that the arch thickness ranged from 22 to 24 in. Compressive strengths of the arch concrete ranged from about 5,000 to 9,200 psi.

Non-Destructive Testing Observations

To provide information regarding the current (2020) condition of the concrete arches, we performed multiple NDT surveys on the underside of the arches on each span. The NDT survey extents are presented in Exhibit 1. The non-destructive methods included:

- Infrared Thermography (IR): The purpose of the IR survey was to provide a broad inspection of the underside of the concrete arches to identify any surficial signs that may be indicative of issues originating within the arches;
- Rebar Locator: The rebar locator provided information on concrete cover thickness and rebar orientation in areas where the GPR signal was limited;
- Ground Penetrating Radar: The purpose of the GPR survey was to assist in identifying areas of deterioration within the arch and other anomalous zones; and
- Impact Echo: The IE survey utilized information from the GPR survey to further investigate areas of subsurface deterioration, provide additional information on the overall arch thickness, and identify deeper areas of potential deterioration that were undetectable with the GPR.

Infrared Thermography

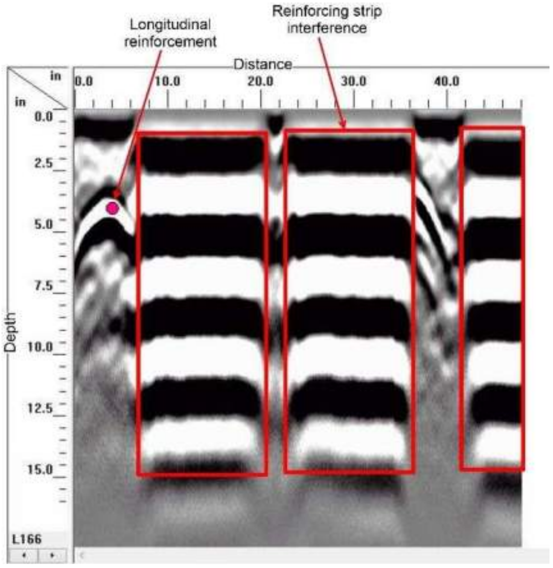
At the time of the IR survey, the surface of the underside of each arch was covered with paint and fiber-reinforced polymer (FRP) strips. The FRP strips were approximately 12-in. wide and spanned across the underside of each arch from approximately 5 ft above each springline. The IR survey was limited due to these surface conditions of the arch (i.e., the presence of the FRP strips). In general, areas of potential deterioration identified by the IR corresponded to locations of surficial staining, seeps, and efflorescence. These surficial features were generally located on the downstream portion of Span B.

Rebar Locator

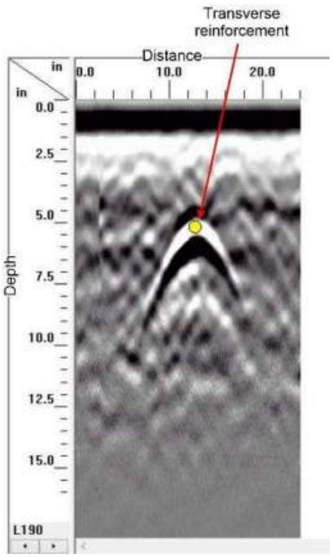
The rebar locator indicated longitudinal bar spacing between 10 and 15 in., and a cover thickness from about 1 to 3½ in. on all spans. The rebar locator was unable to determine location and cover thickness of transverse reinforcing bars.

GPR Survey

The GPR survey was performed using a GSSI Structure Scan Mini XT with a 2.6 GHz antenna. GPR transects were performed near the springlines and in a series of 2 ft by 4 ft GPR grids collected every 5 ft on the underside of the arch on each span. See Exhibit 1 for survey extents and Exhibit 2 for an illustration of the GPR grid layout. Two east-west GPR lines were collected in each grid and oriented perpendicular to the FRP strips. Due to interference from the FRP strips, north-south lines (parallel to the FRP strips) were limited to the areas between the FRP strips. These space constraints typically allowed for one to three lines per grid. Additionally, the inability to collect adjacent (side-by-side) GPR lines within a grid further limited interpretation. See the images below for data examples. On average, the maximum penetration depth of the GPR signal was approximately 10 in.



Data example from east-west line



Data example from north-south line

Zones of potential deterioration within the arch and reinforcement locations are presented on Exhibits 2, 3, and 4. Areas of delamination/potential deterioration within the effective range of the GPR appear to be concentrated on the downstream portion near mid-span of Span B. Zones of deterioration were not observed in the GPR data collected on Spans A and C. These observations are generally consistent with previously-made observations.

GPR transects near the springlines indicated longitudinal spacing consistent with the rebar locator observations. Additionally, cover thickness increased as the longitudinal reinforcement approached the springlines, as observed in the GPR transects. Transverse reinforcement was observed on the underside of each span. Additional longitudinal reinforcement was observed with the rebar locator transects. Due to the spacing of the grids, GPR observations did not capture all reinforcement present. The reinforcement response observed on the GPR survey is consistent with round steel bars. Reinforcement other than rebar (e.g., steel trusses, falsework) was not observed in the GPR survey or rebar locator transects.

Impact Echo Survey

Impact echo testing was performed utilizing equipment manufactured by Impact Echo Instruments Company of Ithaca, New York. The instrument was calibrated to a depth of 28-in. based on a core length obtained near the midspan of Span B (Test Core TC-3). Wave speed was calculated to be 6,500 meters-per-second with a frequency of 4.6 Kilohertz. Impact Echo testing was performed at 83 locations on the bridge (25 locations on Span A, 36 on Span B and 22 on Span C). Results indicated three locations that exhibited delaminations on the downstream side of Span B at approximately 5 in. from the surface of the arch at the center of the span to 16 in. in the northwest corner of the arch. Evidence of delamination was not observed in the IE measurements collected on Spans A and C. The locations exhibiting delaminations are noted on Exhibit 4. Note that these locations do not encompass all the testing locations, only those exhibiting delamination. Results of all IE tests performed for this assessment are tabulated in the attached Summary of Impact Echo Results. Impact echo observations indicate that the arch thicknesses range from about 23 to 28 in.

Drawings prepared by Butler Fairman and Seufert (BF&S) from 2012 displayed mapped cracks and patches present at that time. Such historical information was digitized and combined with the present NDT observations and are shown on Exhibits 3, 4, and 5. Observations from EEI's 2011 NDT surveys are also included on Exhibits 3, 4 and 5.

Test Cores and Geotechnical Boring Observations

A total of fourteen test cores were performed as part of the assessment for the following purposes:

- Three from the bridge deck using truck-mounted equipment (TC-2, TC-3, and TC-4);
  - Test Cores TC-2 and TC-4 were performed over/through Pier Nos. 2 and 3, respectively, to obtain a vertical profile of the pavement, arch fill, pier concrete, and foundation concrete. Test Core TC-3 was performed near the midpoint of Span B with the intention of obtaining a continuous core of the arch concrete to calibrate the IE survey.
- Three from the bridge deck using hand-operated equipment (AC-1A, AC-1B, and AC-1C);
  - Test Cores AC-1A and AC-1C were performed in areas where cracks were previously mapped on the underside of Spans A and C. Test Core AC-1B was performed near an area of Span B where the IE indicated delamination.

- Eight on the spandrel walls and railings using hand-operated equipment (WC-1, WC-2 and RC-1, RC-2).
  - Four cores were recovered for Lochmueller (designated with an "L")
  - Four cores were recovered for Terracon (designated with a "T") for visual classification purposes.

A geotechnical soil boring (Boring TB-1) was performed near the south bridge abutment. A geotechnical soil boring (Boring TB-2) will be performed near the north bridge abutment at a later date. Approximate locations for each test core/boring performed from the bridge deck/pavement surface are shown on Exhibit 1. The approximate test core locations performed on the spandrel walls and railings are shown on Exhibit 6.

The exploratory locations were marked in the field by Terracon personnel referencing physical features on the bridge and marked utilities. Ground surface elevations noted on the core/boring logs were estimated based on topographic information depicted on historic plans. Details of the drilling and sampling procedures are attached. Portions of the core holes within the concrete arches/piers were backfilled with cement grout. A combination of grout, sand, and gravel was used to backfill the portion of the core holes located within the arch fill. All core holes were capped with a concrete patch.

While performing Test Core TC-2 (through Pier 2), circulating water used in the coring process was observed exiting the eastern (upstream) drains on both sides of the pier, from several arch joints, and from joints on the upstream facade near the base of the pier as shown in the photographs below. The same phenomena was not readily apparent while performing Test Core TC-4 through Pier 3.

The south side of Pier 2 while performing Test Core TC-2.

The north side of Pier 2 while performing Test Core TC-2. Water exiting the drain, arch joints and façade.

Test Cores TC-2 and TC-4 both extended through the bottom of the concrete footings. A granular (sand) layer about 1 ft in thickness over cohesive (clay) soil varying in consistency from soft to medium stiff was exposed below the bottom of the footings. No discernable indication of a void was observed below either footing during coring/sampling.

Logs for Test Cores TC-2 through TC-4 and Boring TB-1 are attached. A summary of the visual classifications for the remaining test cores is presented in the table below. Core photos annotated with descriptive information and laboratory test results are also attached.

Summary of Visual Classifications
Arch, Spandrel Wall, and Railing Cores

Test Core No.	Core Length (in)	Visual Classification
AC-1A	17.2 *	Portland Cement Concrete, 1-in. max. aggregate size
AC-1B	13.5 *	Portland Cement Concrete, 1-in. max. aggregate size
AC-1C	16.8 *	Portland Cement Concrete, 1-in. max. aggregate size
RC-1T **	4	Portland Cement Concrete, ½-in. maximum aggregate size
RC-2T **	4	Limestone (fossiliferous)
WC-1T **	4	Limestone (fossiliferous)
WC-2T **	4	Limestone (fossiliferous)

* Recovered core length. The core lengths do not necessarily equal the arch thickness at these test core locations. See memo text below for additional information.

** Spandrel wall and railing cores were obtained for visual classification purposes only.

The arch core lengths recovered from Test Cores AC-1A through AC-1C are shorter compared to the arch core length recovered at Test Core TC-3. Due to safety constraints that arose during coring operations, Test Cores AC-1A through AC-1C could not be obtained in one continuous core run as was possible for Test Core TC-3 (i.e., multiple runs of approximately 4 in. in length were required to recover the cores). This process results in greater potential for core loss (e.g., see annotated core photo for Test Core AC-1B attached). As such, the recovered core lengths for Test Cores AC-1A through AC-1C do not necessarily reflect the arch thickness at these test core locations. In our opinion, the fractures observed in Test Cores AC-1A through AC-1C are due to mechanical effects of the coring process itself and do not reflect *in situ* conditions.

Test Core TC-3 is considered to have provided the highest quality core recovery among the four cores performed through the arch. As indicated earlier, the IE was calibrated using the arch core length from Test Core TC-3. The IE results from the current assessment indicate that the arch is no less than about 23 in. in thickness at the locations tested. All locations where IE tests were performed are shown on Exhibits 3 through 5.

Laboratory Testing

Laboratory tests were performed on soil samples and on the concrete cores. Soil tests included classification and strength testing. Sulfate ion and chloride ion concentration tests were performed on the arch fill soil collected from the auger cuttings in Test Core TC-4. Concrete testing consisting of compressive strength, density, and chloride ion concentration were performed on sample selections provided by you. As additional input, phenolphthalein stain testing was performed on four core samples to provide an indication of the degree of carbonation.

Results of the laboratory tests are provided on the attached logs, core photos, and/or respective laboratory reports in the attachments. In summary:

- The arch fill soil recovered from Test Core TC-4:
  - Soluble Sulfate = 260 ppm
  - Chloride = 8,000 ppm
- Compressive strength of the arch concrete ranges from about 5,260 psi to 9,660 psi.
- Compressive strength of the pier footing concrete:
  - Pier No. 2 – 2,010 psi
  - Pier No. 3 – 6,400 psi
- Chloride content in concrete ranged from 0.007 to 0.032 lb/ft^3
- No carbonation was apparent in the samples tested.

Action Items

Information from Boring TB-2 that will be performed near the north abutment will be presented on a boring log and submitted to you once drilling and laboratory testing is completed at a future date. We will proceed with attempting to recover additional arch core samples near Test Cores AC-1A through AC-1C if warranted based on discussions with you and the project team.

Closing

Thank you for the opportunity to provide our professional services. If you have any questions, please contact us.

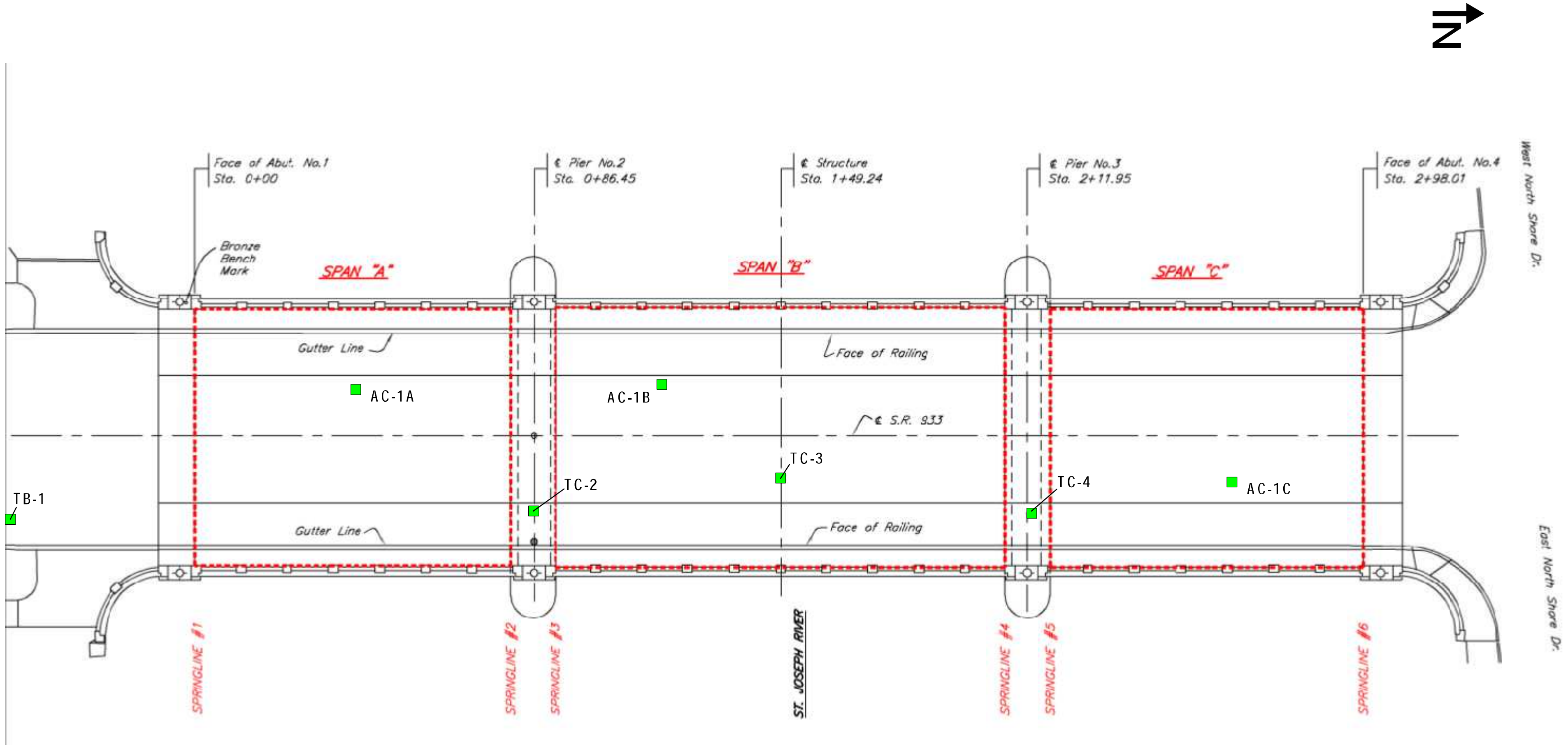
Sincerely,
Terracon Consultants, Inc.

Stephen Brellenthin
Stephen Brellenthin, L.P.G.
Senior Staff Geophysicist

Scott Zajac, P.E.
Project Engineer

Attachments:

- Exhibit 1 – NDT Survey Extents and Exploratory Locations
- Exhibit 2 – NDT Grid Layout
- Exhibit 3 – Observation of NDT – Span A
- Exhibit 4 – Observation of NDT – Span B
- Exhibit 5 – Observation of NDT – Span C
- Exhibit 6 – Spandrel Wall and Railing Test Core Locations
- Summary of Impact Echo Results
- Field Methods for Exploring and Sampling Soils and Rock
- Log of Test Boring (4)
- Core Photographs
- Grain Size Distribution Test Report
- Unconfined Compression Test (3)
- Concrete Core Test Report
- Laboratory Services Report
    - Determining Water Soluble Chloride Ion Content in Soils
    - Degree of Carbonation Using Phenolphthalein Staining



Legend

🟥 🟥	NDT survey extents
TC-2 🟩	Exploratory location and designation

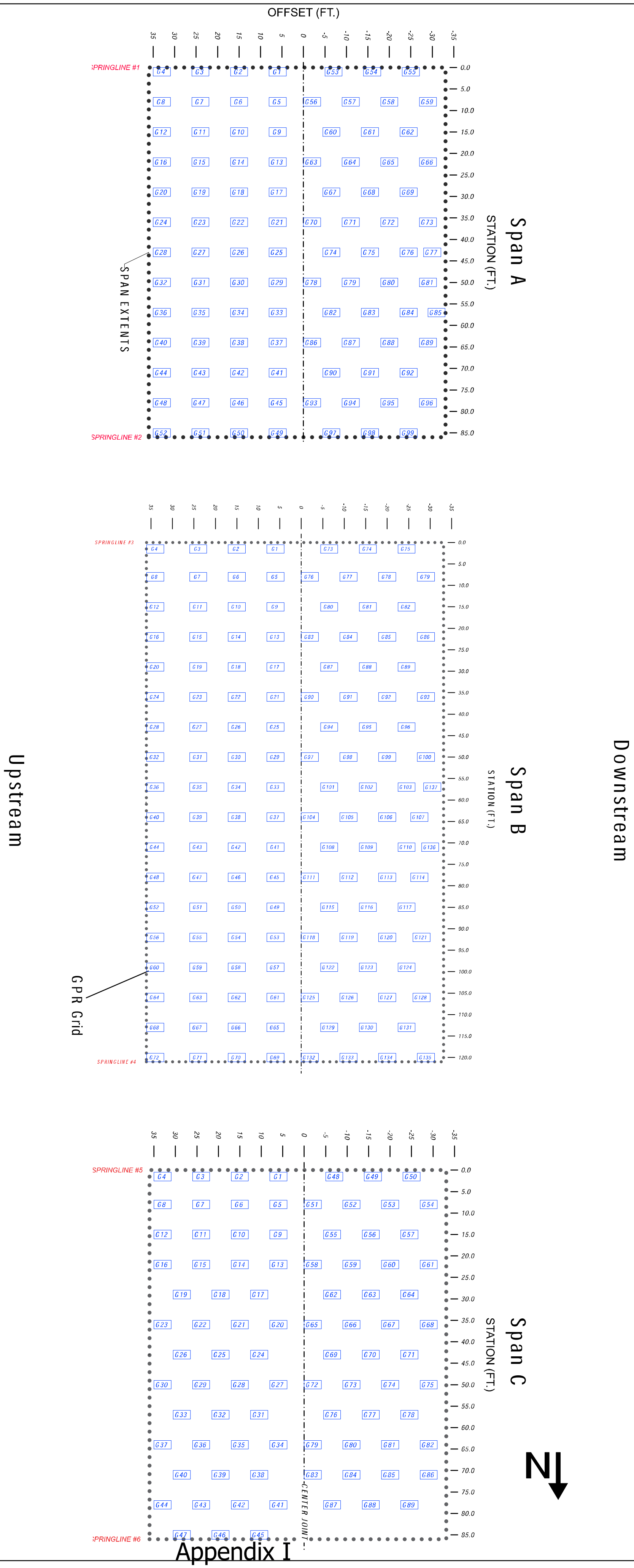
Notes

1. Plans digitized from 2012 BF&S drawings.
2. Drawing not to scale.

Exhibit 1 - NDT Survey Extents and Exploratory Locations

Project: SR 933 over St. Joseph River
Client: Lochmueller Group
Location: St. Joseph Co., IN
Project No.: CJ205128
Date: January 14, 2021

Terracon



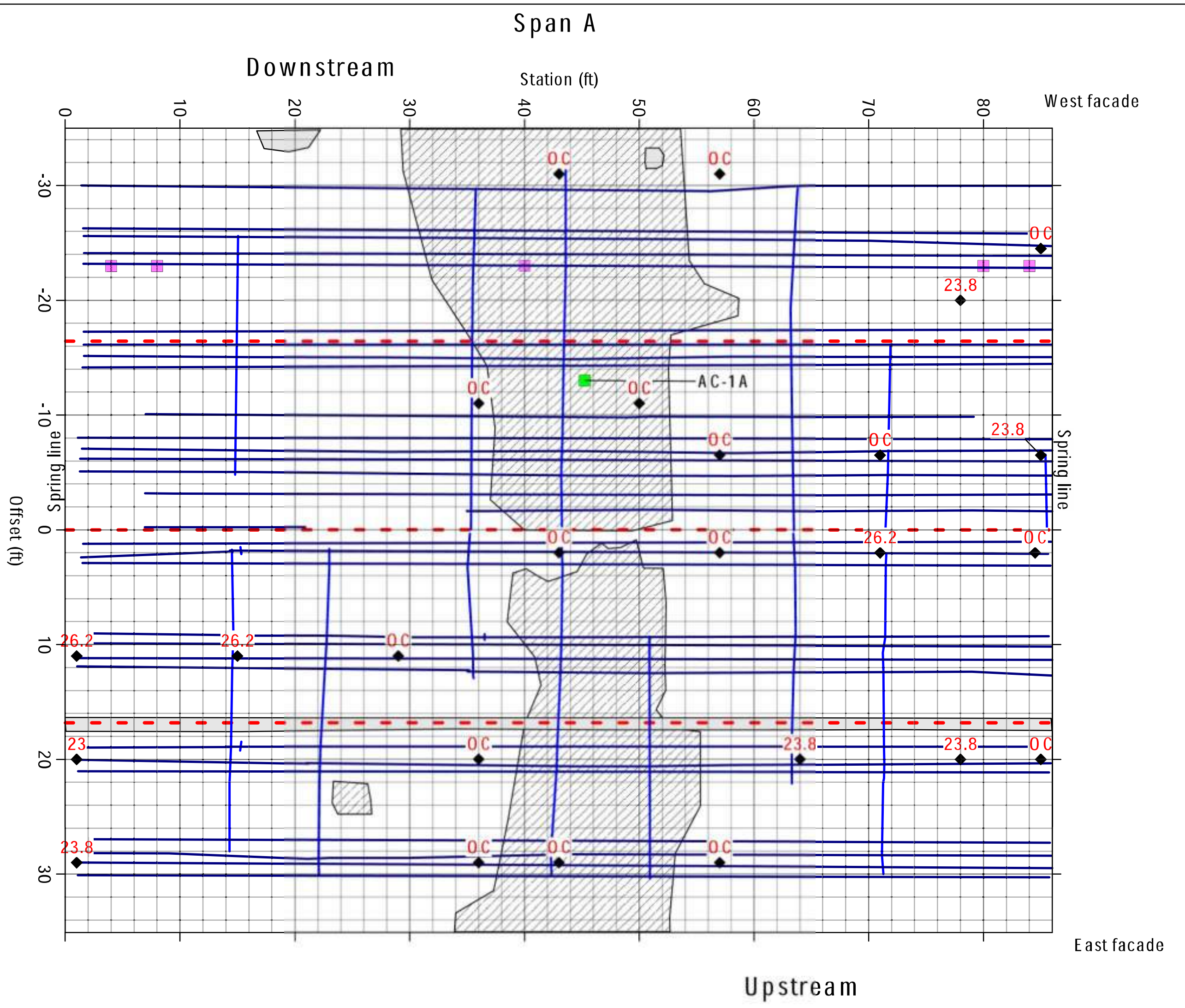
Legend

Notes

1. Drawing not to scale.

Exhibit 2 - NDT Grid Layout

Project: SR 933 over St. Joseph River
Client: Lochmueller Group
Location: St. Joseph Co., IN
Project No.: CJ205128
Date: January 12, 2021



Additional Notes:
The reinforcement illustrated on this drawing represents observations from the GPR survey only. Please refer to *Non-Destructive Testing Observations* section in the memo for additional information.

IE observations were made over the entire span. The IE points illustrated on the drawing represent areas were honeycombing or delamination was identified. Please refer to the *Impact Echo Survey* in the memo for additional information.

Legend

—	Observed longitudinal reinforcement
—	Observed transverse reinforcement
- -	Construction Joint
◆	Anomlous zone from GPR
✚	Delamination from IE
🟪	2011 IE testing location where honeycombing or delamination was detected
AC-1A 🟩	Arch core location and designation
23.6 ◆	2020 IE testing location ("0C" = outside calibrated depth)

Previously noted by others

▱	2011 Existing Patch
▨	2011 Mapped crack extents
▨	2011 Concrete overspray

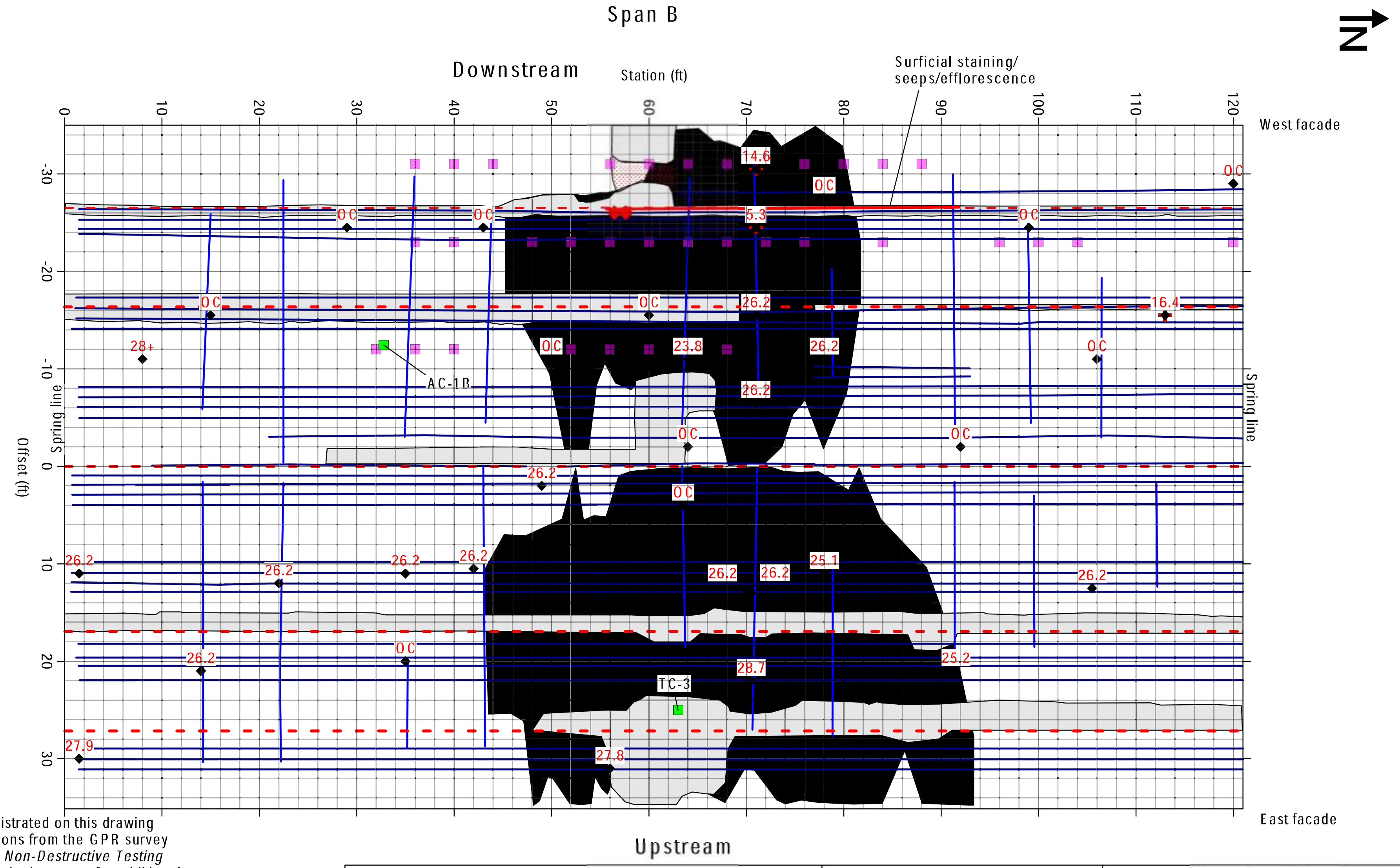
Notes

1. Drawing Scale: 1" = 10'
2. The reinforcement lines are based on GPR data only
3. Reinforcement locations interpolated between GPR grids and should not be considered complete due to the grid spacing and interference.
4. 2011 information digitized from 2012 BF&S drawings.

Exhibit 3 - Observation of NDT - Span A

Project: SR 933 over St. Joseph River
Client: Lochmueller Group
Location: St. Joseph Co., IN
Project No.: CJ205128
Date: January 25, 2021

Terracon



Additional Notes:
The reinforcement illustrated on this drawing represents observations from the GPR survey only. Please refer to *Non-Destructive Testing Observations* section in the memo for additional information.

IE observations were made over the entire span. The IE points illustrated on the drawing represent areas were honeycombing or delamination was identified. Please refer to the *Impact Echo Survey* in the memo for additional information.

Legend

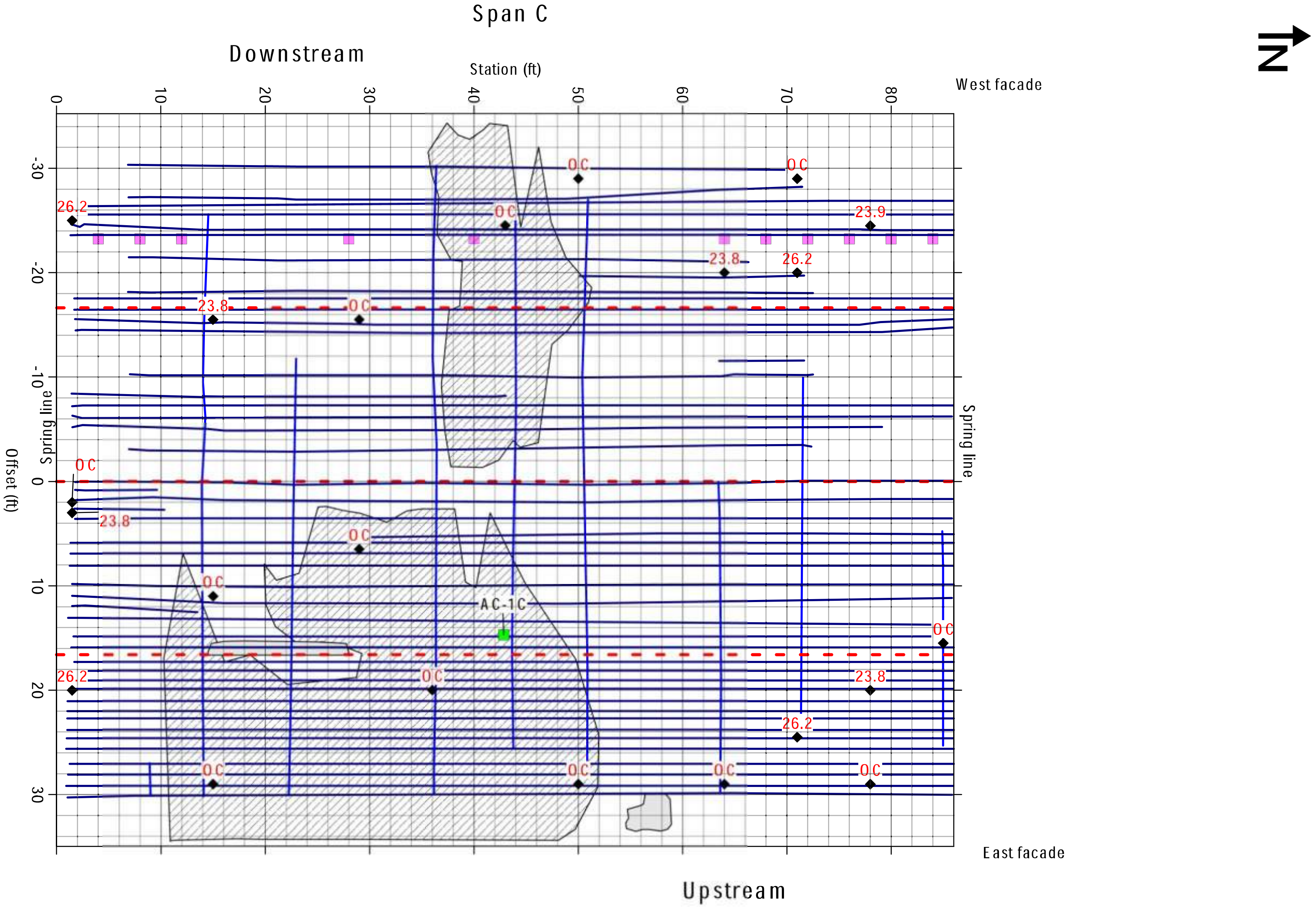
—	Observed longitudinal reinforcement	🟪	2011 IE testing location where honeycombing or delamination was detected		**Previously noted by others**
—	Observed transverse reinforcement	AC-1B 🟩	Arch core location and designation	◇	2011 Existing Patch
- -	Construction Joint	23.6 ◆	2020 IE testing location ("OC" = outside calibrated depth)	▨	2011 Mapped crack extents
◆	Anomlous zone from GPR			▨	2011 Concrete overspray
✚	Delamination from IE				

Notes

1. Drawing Scale: 1" = 10'
2. The reinforcement lines are based on GPR data only
3. Reinforcement locations interpolated between GPR grids and should not be considered complete due to the grid spacing and interference.
4. 2011 information digitized from 2012 BF&S drawings.

Exhibit 4 - Observation of NDT - Span B

Project: SR 933 over St. Joseph River
Client: Lochmueller Group
Location: St. Joseph Co., IN
Project No.: CJ205128
Date: January 25, 2021



Additional Notes:
The reinforcement illustrated on this drawing represents observations from the GPR survey only. Please refer to *Non-Destructive Testing Observations* section in the memo for additional information.

IE observations were made over the entire span. The IE points illistrated on the drawing represent areas were honeycombing or delamination was identified. Please refer to the *Impact Echo Survey* in the memo for additional information.

Legend

- Observed longitudinal reinforcement
- Observed transverse reinforcement
- Construction Joint
- ◆ Anomlous zone from GPR
- ✚ Delamination from IE
- 🟪 2011 IE testing location where honeycombing or delamination was detected
- A C-1C 🟩 Arch core location and designation
- 23.6 ◆ 2020 IE testing location ("O C" = outside calibrated depth)

Previously noted by others

- 2011 Existing Patch
- 2011 Mapped crack extents
- 2011 Concrete overspray

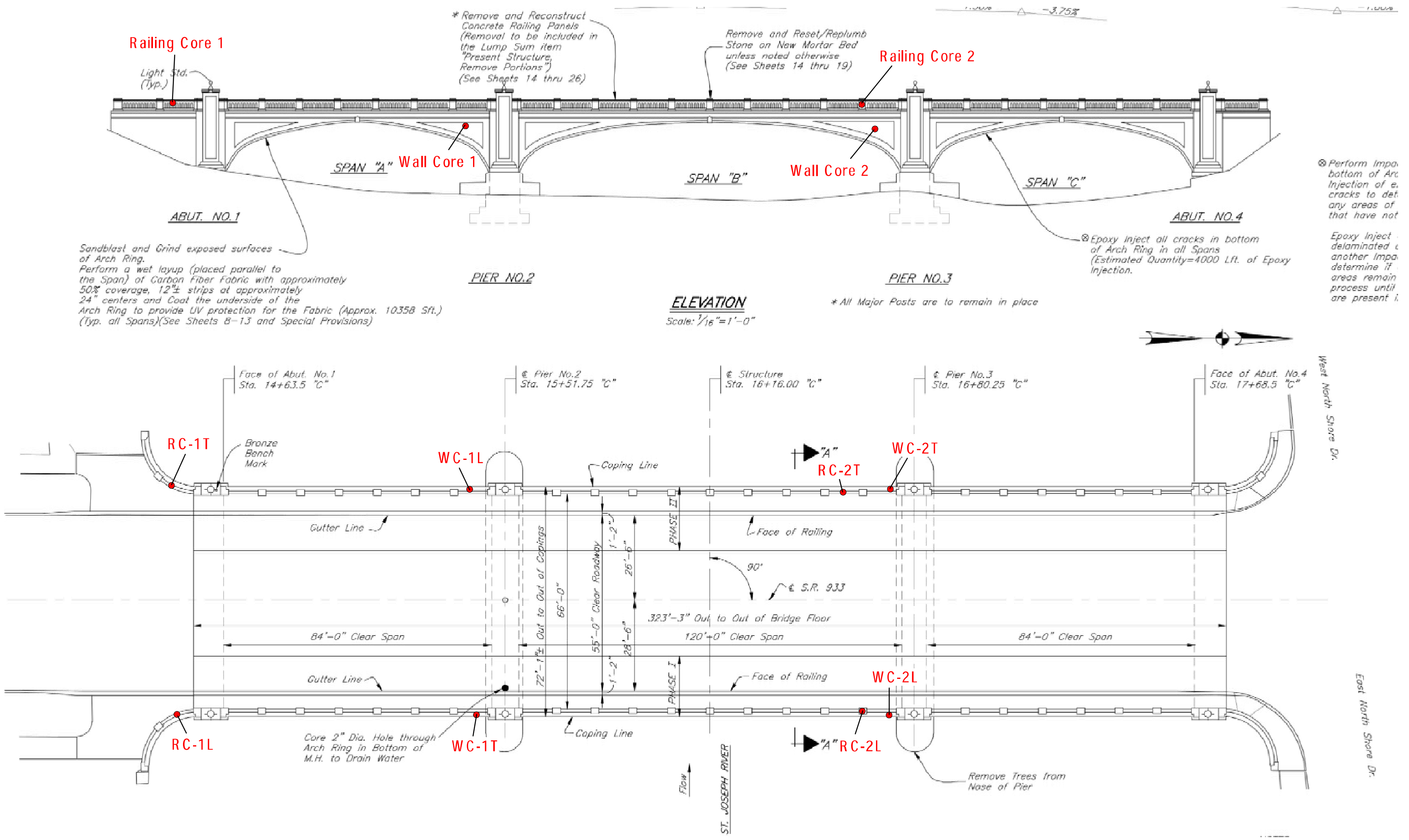
Notes

1. Drawing Scale: 1" = 10'
2. The reinforcement lines are based on GPR data only
3. Reinforcement locations interpolated between GPR grids and should not be considered complete due to the grid spacing and interference.
4. 2011 information digitized from 2012 BF&S drawings.

Exhibit 5 - Observation of NDT - Span C

Project: SR 933 over St. Joseph River
Client: Lochmueller Group
Location: St. Joseph Co., IN
Project No.: CJ205128
Date: January 25, 2021

Terracon



Legend

WC-1L ●	RC - Railing Core Location and designation WC - Wall Core Location and designation "L" denotes Lochmueller sample "T" denotes Terracon sample

Notes

1. Plans digitized from 2012 BF&S drawings.
2. Drawing not to scale.

Exhibit 6 - Spandrel Wall and Railing Test Core Locations

Project: SR 933 over St. Joseph River
Client: Lochmueller Group
Location: St. Joseph Co., IN
Project No.: CJ205128
Date: January 14, 2021

Terracon

Summary of Impact Echo Results

SR 933 over St. Joseph River
St. Joseph County, Indiana

Span	Station* (ft)	Offset** (ft)	Direction**	Measured Concrete Thickness	Comments
Span A	1	11	Upstream	26.2 inches	Thicker than calibrated depth
Span A	1	20	Upstream	23.0 inches	
Span A	1	29	Upstream	23.8 inches	
Span A	15	11	Upstream	26.2 inches	
Span A	29	11	Upstream	Outside of calibration depth	Thicker than calibrated depth
Span A	36	20	Upstream	Outside of calibraiton depth	Thicker than calibration depth
Span A	36	29	Upstream	Outside of calibration depth	Thicker thsn calibration depth
Span A	43	2	Upstream	Outside of calibration depth	Thicker than calibrated depth
Span A	43	29	Upstream	Outside of calibration depth	Thicker than calibration depth
Span A	57	2	Upstream	Outside of calibration depth	Thicker than calibrated depth
Span A	57	29	Upstream	Outside of calibration depth	Thicker than calibration depth
Span A	64	20	Upstream	23.8 inches	
Span A	71	2	Upstream	26.2 inches	
Span A	78	20	Upstream	23.8 inches	
Span A	84.5	2	Upstream	Outside of calibaration depth	Thicker than calibration depth
Span A	85	20	Upstream	Outside of calibration depth	Thicker than calibration depth
Span A	36	11	Downstream	Outside of calibration depth	Thicker than calibration depth
Span A	43	31	Downstream	Outside of calibration depth	Thicker than calibration depth
Span A	50	11	Downstream	Outside of calibration depth	Thicker than calibration depth
Span A	57	6.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span A	57	31	Downstream	Outside of calibration depth	Thicker than calibration depth
Span A	71	6.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span A	78	20	Downstream	23.8 inches	
Span A	85	6.5	Downstream	23.8 inches	
Span A	85	24.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	1.5	11	Upstream	26.2 inches	
Span B	1.5	30	Upstream	27.9 inches	
Span B	14	21	Upstream	26.2 inches	
Span B	22	12	Upstream	26.2 inches	
Span B	35	11	Upstream	26.2 inches	
Span B	35	20	Upstream	Outside calibration depth	Thicker than calibraiton depth
Span B	42	10.5	Upstream	26.2 inches	
Span B	49	2	Upstream	26.2 inches	
Span B	56	31	Upstream	27.8 inches	
Span B	63.5	4	Upstream	Outside of calibration depth	Thicker than calibration depth
Span B	70.5	13	Upstream	26.2 inches	
Span B	70	13	Upstream	26.2 inches	
Span B	70.5	22	Upstream	28.7 inches	
Span B	78	11	Upstream	25.1 inches	
Span B	91.5	21	Upstream	25.2 inches	
Span B	105.5	12.5	Upstream	26.2 inches	
Span B	8	11	Downstream	28 inches plus	
Span B	15	15.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	29	24.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	43	24.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	50	11	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	60	15.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	64	2	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	64	11	Downstream	23.8 inches	
Span B	71	6.5	Downstream	26.2 inches	
Span B	71	15.5	Downstream	26.2 inches	
Span B	**71**	**24.5**	**Downstream**	**5.3 inches**	**Delamination detected**
Span B	78	11	Downstream	26.2 inches	
Span B	78	27.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	92	2	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	99	24.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	106	11	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	**113**	**15.5**	**Downstream**	**16.4 inches**	**Delamination detected**
Span B	120	29	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	120	29	Downstream	Outside of calibration depth	Thicker than calibration depth
Span B	**71**	**30.5**	**Downstream**	**14.6 inches**	**Delamination detected**
Span C	1.5	2	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	1.5	20	Upstream	26.2 inches	
Span C	15	11	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	15	29	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	29	6.5	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	36	20	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	50	29	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	64	29	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	71	24.5	Upstream	26.2 inches	
Span C	78	20	Upstream	23.8 inches	
Span C	78	29	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	85	15.5	Upstream	Outside of calibration depth	Thicker than calibration depth
Span C	1.5	3	Upstream	23.8 inches	
Span C	1.5	25	Downstream	26.2 inches	
Span C	15	15.5	Downstream	23.8 inches	
Span C	29	15.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span C	43	24.5	Downstream	Outside of calibration depth	Thicker than calibration depth
Span C	50	29	Downstream	Outside of calibration depth	Thicker than calibration depth
Span C	64	20	Downstream	23.8 inches	
Span C	71	20	Downstream	26.2 inches	
Span C	71	29	Downstream	Outside of calibration depth	Thicker than calibration depth
Span C	78	24.5	Downstream	23.9 inches	

*** From south spring line on each span**
**** Relative to center construction joint**

FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK

A. Boring Procedures Between Samples

The boring is extended downward, between samples, by a hollow stem auger (AASHTO* Designation T251), continuous flight auger, driven and washed-out casing, or rotary boring with drilling mud or water.

B. Standard Penetration Test and Split-Barrel Sampling of Soils

(AASHTO* Designation: T206)

This method consists of driving a 2-in. outside diameter split-barrel sampler using a 140-lb weight falling freely through a distance of 30 in. The sampler is first seated 6 in. into the material to be sampled and then driven 12 in. The number of blows required to drive the sampler the final 12 in. is recorded on the Log of Test Boring and known as the Standard Penetration Resistance or N-value. Recovered samples are first classified as to texture by the field personnel. Later in the laboratory, the field classification is reviewed by a geotechnical engineer who observes each sample.

C. Thin-walled Tube Sampling of Soils

(AASHTO* Designation: T207)

This method consists of hydraulically pushing a 2-in. or 3-in. outside diameter thin wall tube into the soil, usually cohesive types. Relatively undisturbed samples are recovered.

D. Soil Investigation and Sampling by Auger Borings

(AASHTO* Designation: T203)

This method consists of augering a hole and removing representative soil samples from the auger flight or bucket at 5-ft intervals or with each change in the substrata. Relatively disturbed samples are obtained and its use is therefore limited to situations where it is satisfactory to determine approximate subsurface profile.

E. Diamond Core Drilling for Site Investigation

(AASHTO* Designation: T225)

This method consists of advancing a hole in rock or other hard strata by rotating downward a single tube or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings. Normally, a 3-in. outside diameter by 2-in. inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and laboratory. Cores are stored in partitioned boxes and the length of recovered material is expressed as a percentage of the actual distance penetrated.

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* American Association of State Highway and Transportation Officials, Washington D.C.

LOG OF TEST BORING

EARTH EXPLORATION

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment
LOCATION : SR 933 over St. Joseph River
COUNTY : St. Joseph PROJECT NO.: CJ205128

BORING NO.: **TB-1**
SHEET 1 OF 3
LATITUDE : 41.68765
LONGITUDE : -86.25051
DATUM : WGS84
DATE STARTED : 11-12-20
DATE COMPLETED : 11-12-20

ELEVATION : 684.0
STATION : 0+37
OFFSET : 25.0 ft Right
LINE : 'C'
DEPTH : 90.0 ft

BORING METHOD : Hollow Stem Auger*
RIG TYPE : CME 550 X
CASING DIA. : ---
CORE SIZE : ---

HAMMER : Auto
DRILLER/INSP : JP
TEMPERATURE : 45 °F
WEATHER : Fair

GROUNDWATER: ▽ Encountered at 19.0 ft ▼ At completion 10.0 ft ☒ Caved in at 37.2 ft

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete 1.0											
		Portland Cement Concrete 1.6											
	2.5		SS 1	5-3-4	0								
680.0	5.0		SS 2	2-1-2	67								
	7.5		SS 3	2-3-3	33	12.3		0.75 0.50					
675.0	▼10.0	**Sand,** very loose to loose, moist, dark brown to brown below 11 ft, cohesive near 6 and 10 ft, with sand seam near 14 ft, A-2-4 (0), Lab No. 29532	SS 4	2-3-7	0	11.4		0.75					
	12.5		SS 5	1-2-3	100					NP	NP	NP	11.0, pH = 8.6, SG = 2.65
670.0	15.0		SS 6	1-2-2	100								
	17.5	17.0	SS 7	1-2-4	100								
665.0 ▽	20.0		SS 8	3-3-5	83								
	22.5		SS 9	2-2-3	100					NP	NP	NP	
660.0	25.0	**Gravelly Sand,** very loose to medium dense, moist to wet below 19 ft, brown, with sand seams near 18 and 29 ft, A-1-b (0), Lab No. 29533	SS 10	0-1-2	100								
	27.5		SS 11	2-2-3	100								
655.0	30.0		SS 12	3-7-13	100								

Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 1/13/21

LOG OF TEST BORING

EARTH EXPLORATION A Terracon COMPANY

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment

BORING NO.: **TB-1**
SHEET 2 OF 3
LATITUDE : 41.68765
LONGITUDE : -86.25051
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		32.0											
	32.5												
650.0	35.0		SS 13	3-5-8	100	24.7	102.5	3.5 3.75	1.93				
	37.5												
645.0	40.0		SS 14	4-5-8	100			0.75		18	17	1	38.0, pH = 8.1, SG = 2.77
	42.5												
640.0	45.0		SS 15	2-4-5	100	22.6	106.4	2.75 2.5	1.11				
	47.5												
635.0	50.0	**Silty Loam,** medium stiff to hard, moist, gray, with sand seams near 29, 60 and, 69 ft, A-4 (0), Lab No. 29534	SS 16	2-4-5	100		104.6	>4.5 3.0					
	52.5												
630.0	55.0		SS 17	2-3-4	100	22.7	106.4	2.5 2.0	0.66	27	17	10	* 55.0, Begin rotary drilling
	57.5												
625.0	60.0		SS 18	2-5-25	100			1.75 1.25					
	62.5												
620.0	65.0		SS 19	5-8-16	100	16.1		2.0 1.25					

Continued on next page

LOG OF TEST BORING

EARTH EXPLORATION
A Terracon COMPANY

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment

BORING NO.: **TB-1**
SHEET 3 OF 3
LATITUDE : 41.68765
LONGITUDE : -86.25051
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
	67.5												
615.0			SS 20	13-16-15	100			1.0					
	70.0												
		Silty Loam, medium stiff to hard, moist, gray, with sand seams near 29, 60 and, 69 ft, A-4 (0), Lab No. 29534											
	72.5												
610.0			SS 21	17-24-24	100	18.8		0.75 1.0		22	11	11	
	75.0												
		76.0											
	77.5												
605.0			SS 22	26-15-18	100								
	80.0												
		Sand, dense, wet, gray, A-2-4, Lab No. 29532											
	82.5												
600.0			SS 23	15-19-23	100								
	85.0												
	87.5	88.0											
595.0		**Sandy Gravel,** dense, wet, gray, (visual)	SS 24	18-16-19	100								
	90.0	90.0											
		Bottom of Boring at 90.0 ft											
	92.5												
590.0													
	95.0												
	97.5												
585.0													
	100.0												
	102.5												

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 1/13/21

LOG OF TEST BORING

BORING NO.: **TC-2**
SHEET 1 OF 2
CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment
LOCATION : SR 933 over St. Joseph River
COUNTY : St. Joseph PROJECT NO.: CJ205128
LATITUDE : 41.68792
LONGITUDE : -86.25051
DATUM : WGS84
DATE STARTED : 11-04-20
DATE COMPLETED : 11-05-20

ELEVATION : 684.0
STATION :
OFFSET : 25.0 ft Right
LINE : 'C'
DEPTH : 38.0 ft
BORING METHOD : Hollow Stem Auger
RIG TYPE : D-50
CASING DIA. : ---
CORE SIZE : NQ2
HAMMER : Auto
DRILLER/INSP : JS
TEMPERATURE : 70 °F
WEATHER : Fair

GROUNDWATER: ∇ Encountered at Dry ▼ At completion Dry

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete 0.3											
		Portland Cement Concrete 1.2											
	2.5		SS 1	28-16-26-22	13								
680.0			SS 2	41-27-20-17	17								
	5.0	**Sand and Gravel,** (fill), (visual)	SS 3	50/2"	0								
	7.5	8.5	SS 4	50/3"	100								
675.0	10.0		RC 1 RQD= 97%		100								9.0, f_c = 5,280 psi, density = 141.4 pcf, chloride = 0.013 pcf
670.0	12.5 15.0 17.5	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 8.6', 9.5', 12.6', 13.8', 14.3', 14.9', 15.4', 15.8', 16.2', 17.1', 17.6', 18.8' 19.3	RC 2 RQD= 97%		100								
665.0	20.0	**Limestone**, fractured near 19.3', 19.5', 19.8', 20' 20.8	RC 3 RQD= 78%		98								
660.0	22.5	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 21.8', 22.8', 23.9' 25.4											
	25.0	**Limestone,** fractured near 25.7' 26.2	RC 4 RQD= 90%		98								
655.0	27.5 30.0	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 26.6', 27.4', 27.8', 29', 29.5', 30' 30.0											

Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 1/13/21

EARTH EXPLORATION
A Terracon COMPANY

LOG OF TEST BORING

BORING NO.: **TC-2**
SHEET 2 OF 2
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68792
DES NO. : 1900011
STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25051
PROJECT TYPE: Bridge Assessment
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
650.0	32.5 35.0	**Portland Cement Concrete,** max aggregate size 1.0", fractured near 31.1', 31.8', 32.1', 32.8', 33.3', and 33.9'; fractured in pieces near 28.4'-28.8', 30'-30.4', 32.1'-32.4', and 34.3'-34.6'; voided with possible weathering near 30'-31.1' and 32.4'-32.8' 35.0	RC 5 RQD= 61% RC 6 RQD= 81%		92 100								34.0, f_c = 2,010 psi, density = 142.1 pcf, chloride = 0.007 pcf
		Sand, (visual) 36.0											
	37.5	**Clay,** medium stiff, moist, gray, A-7-6 (25), Lab No. 29535 38.0	SS 5	2-3-4-5	75	30.9 27.9				44	20	24	35.0, Sand description based on driller's experience and presence in core barrel. No discernible indication of a void.
645.0	40.0	Bottom of Boring at 38.0 ft											
	42.5												36.0, pH = 7.9, SG = 2.77, soluble sulfate = 240 ppm, LOI = 1.1%
640.0	45.0												
	47.5												
635.0	50.0												
	52.5												
630.0	55.0												
	57.5												
625.0	60.0												
	62.5												
620.0	65.0												

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 1/13/21

EARTH EXPLORATION
A Terracon COMPANY

LOG OF TEST BORING

BORING NO.: TC-3
SHEET 1 OF 1
LATITUDE : 41.68810
LONGITUDE : -86.25051
DATUM : WGS84
DATE STARTED : 11-05-20
DATE COMPLETED : 11-05-20

CLIENT : Lochmueller Group, Inc.
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
PROJECT TYPE: Bridge Assessment
LOCATION : SR 933 over St. Joseph River
COUNTY : St. Joseph PROJECT NO.: CJ205128

ELEVATION : 684.0
STATION :
OFFSET : 25.0 ft Right
LINE : 'C'
DEPTH : 4.7 ft

BORING METHOD : --
RIG TYPE : D-50
CASING DIA. : ---
CORE SIZE : NQ2

HAMMER : Auto
DRILLER/INSP : JS
TEMPERATURE : 70 °F
WEATHER : Fair

GROUNDWATER: ▽ Encountered at Dry ▼ At completion Dry

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION		SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete	0.3											
		Portland Cement Concrete, fractured near 0.5" and 1.5"	1.5											0.6, Steel reinforcement near 0.6 ft
		Sand, (fill, visual)	2.3	RC 1 RQD= 100%		100								
680.0	2.5	**Portland Cement Concrete**	4.7											2.5, f_c = 7,540 psi, density = 144.8 pcf, chloride = 0.013 pcf 4.5, f_c = 7,910 psi, density = 144.4 pcf, chloride = 0.013 pcf
	5.0	Bottom of Boring at 4.7 ft												
	7.5													
675.0	10.0													

LOG OF TEST BORING

EARTH EXPLORATION a Terracon company

BORING NO.: **TC-4**
SHEET 1 OF 2
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68827
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25052
PROJECT TYPE: Bridge Assessment
DATUM : WGS84
LOCATION : SR 933 over St. Joseph River
DATE STARTED : 11-09-20
COUNTY : St. Joseph PROJECT NO.: CJ205128
DATE COMPLETED : 11-09-20

ELEVATION : 684.0
STATION :
OFFSET : 25.0 ft Right
LINE : 'C'
DEPTH : 38.0 ft
BORING METHOD : Hollow Stem Auger
RIG TYPE : D-50
CASING DIA. : ---
CORE SIZE : NQ2
HAMMER : Auto
DRILLER/INSP : JS
TEMPERATURE : 75 °F
WEATHER : Cloudy

GROUNDWATER: ∇ Encountered at Dry ▼ At completion Dry

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Asphaltic Concrete 0.3											
		Portland Cement Concrete 1.5											
			SS 1	50/3	100								Hit obstruction at 2.5 ft. Offset 1 ft north
	2.5												
										17	15	2	Bucket sample of auger cuttings 1.5 to 10 ft, soluble sulfate = 260 ppm, pH = 8.1, SG = 2.74. chloride = 8,000 ppm
680.0													
	5.0												
		Sandy Loam, moist, brown, A-2-4(0), Lab No. 29531 (fill)											
			B 1										
	7.5												
675.0													
	10.0	10.0											
													11.0, f_c = 7,890 psi, density = 145.5 pcf
	12.5		RC 1 RQD= 100%		100								
670.0		**Portland Cement Concrete,** max aggregate size 1.0", fractures near 10.6', 12.9', 14.5', 16.6', 17.6', 18.2', 18.7'											
	15.0												
	17.5		RC 2 RQD= 100%		100								
665.0		19.2											
	20.0	**Limestone,** fractures near 19.2', 19.7', 20.3' 20.3											
	22.5		RC 3 RQD= 96%		100								
660.0													
	25.0	**Portland Cement Concrete,** max aggregate size 1.0", fractures near 21.5', 21.7', 22.8', 23.6', 24.6', and 28.5'											
													25.5, f_c = 5,260 psi, density = 143.8 pcf, chloride = 0.013 pcf
	27.5		RC 4 RQD= 100%		100								
655.0													
	30.0												

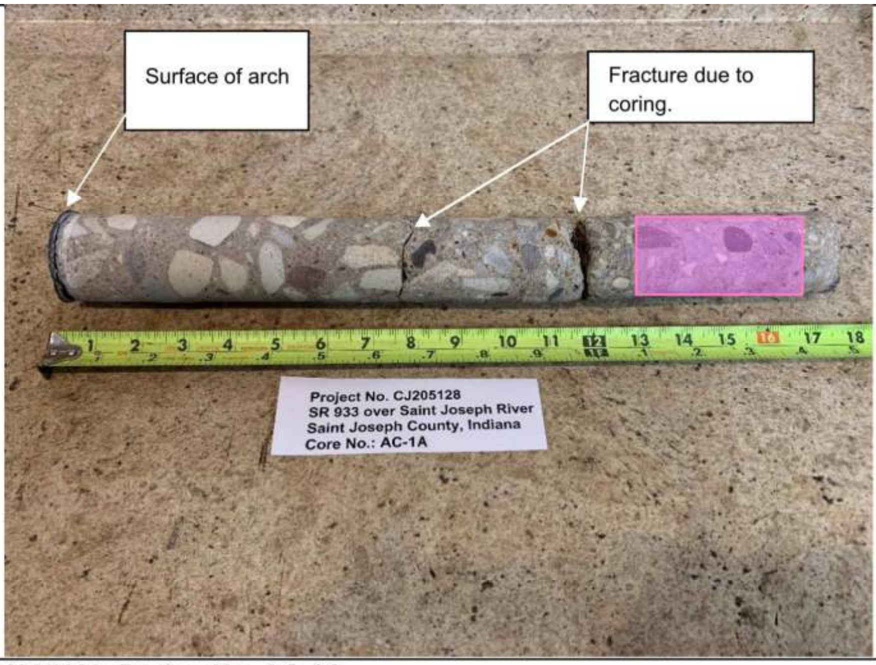
Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 1/13/21

LOG OF TEST BORING

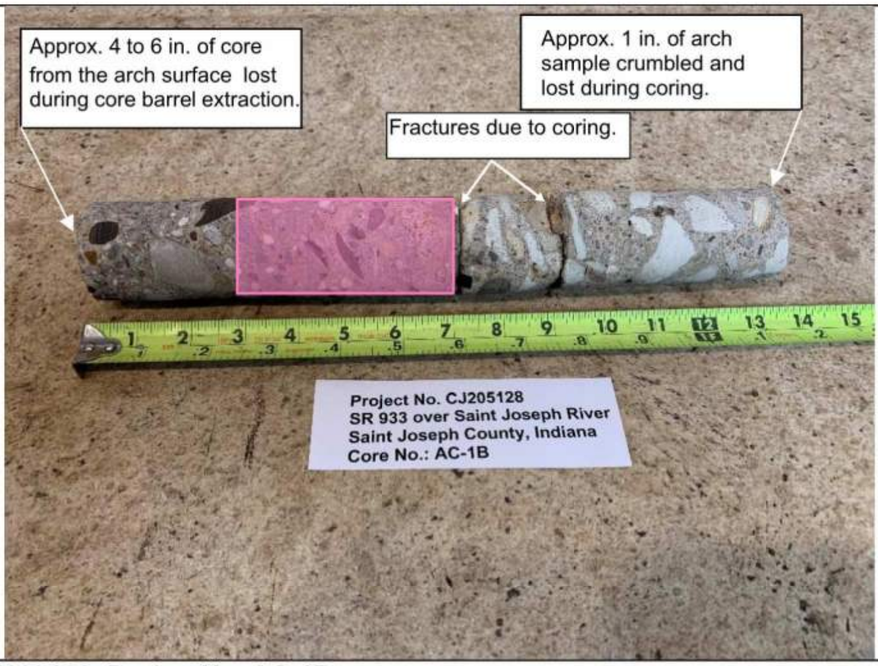
BORING NO.: **TC-4**
SHEET 2 OF 2
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68827
DES NO. : 1900011 STRUCTURE #: (933) 31-71-3690C
LONGITUDE : -86.25052
PROJECT TYPE: Bridge Assessment
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
	32.5	**Portland Cement Concrete,** max aggregate size 1.0", fractures near 21.5', 21.7', 22.8', 23.6', 24.6', and 28.5' 35.0	RC 5 RQD= 96%		100								33.0, f_c = 6,430 psi, density = 146.8 pcf, chloride = 0.007 pcf
650.0	35.0	**Sand,** (visual) 36.0											35.0, Sand description based on driller's experience and presence in core barrel. No discernible indication of a void.
	37.5	**Clay,** soft, grey (visual) 38.0	SS 2		0								36.0, Cohesive soil present on core barrel and shoe of split spoon. Two attempts made to recover sample. SPT values not recorded but approximately one-half of those recorded at TC-2 based on driller's notes.
645.0	40.0	Bottom of Boring at 38.0 ft											
	42.5												
640.0	45.0												
	47.5												
635.0	50.0												
	52.5												
630.0	55.0												
	57.5												
625.0	60.0												
	62.5												
620.0	65.0												



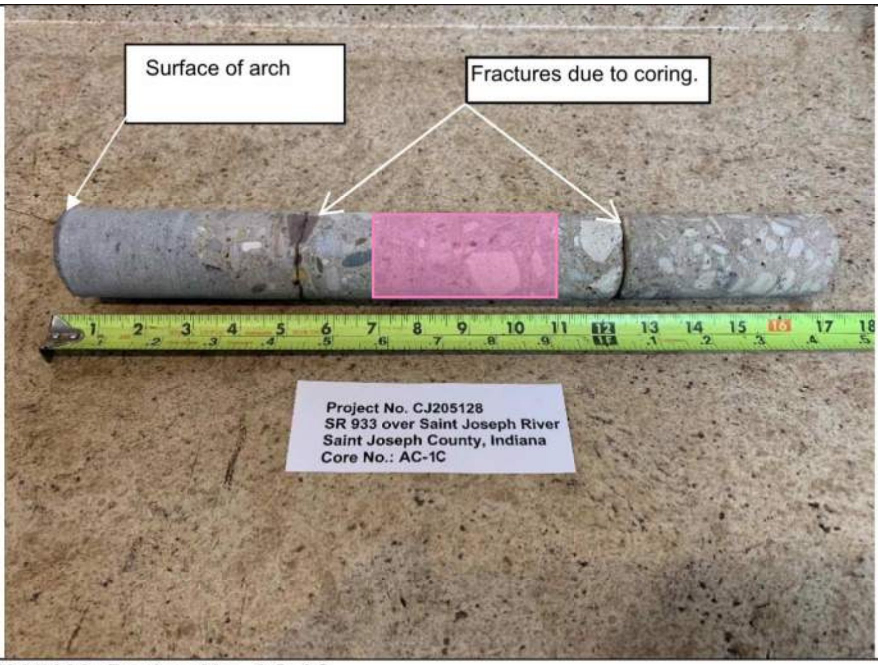
AC-1A (1.1-1.4')
f_c = 6,770 psi
Density = 140.7 lb/ft^3
Chloride = 0.007 lb/ft^3

Project No. CJ205128, Boring No. AC-1A



AC-1B(0.3-0.6')
f_c = 5,950 psi
Density = 139.3 lb/ft^3
Chloride = 0.007 lb/ft^3

Project No. CJ205128, Boring No. AC-1B



AC-1C (0.6-0.9')
f_c = 9,640 psi
Density = 145.5 lb/ft^3
Chloride = 0.032 lb/ft^3

Project No. CJ205128, Boring No. AC-1C

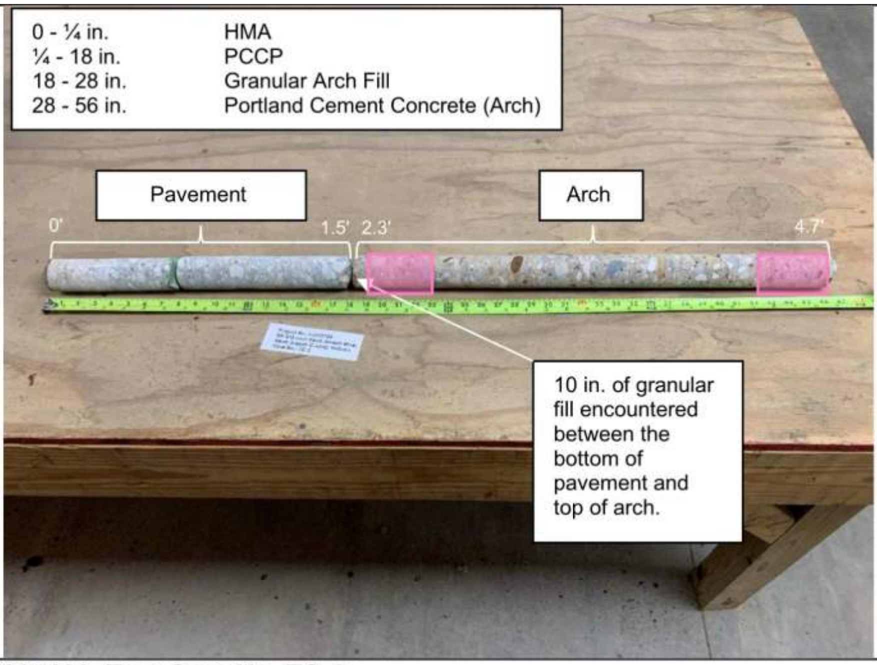
TC-2 (near 9')
f_c = 5,280 psi
Density = 141.1 lb/ft^3
Chloride = 0.013 lb/ft^3

Project No. CJ205128, Boring No. TC-2 8.5'-18.5'

Project No. CJ205128, Test Core No. TC-2 18.5'-28.5'

TC-2 (near 34')
f'_c = 2,010 psi
Density = 142.1 lb/ft^3,
Chloride = 0.007 lb/ft^3

Project No. CJ205128, Test Core No. TC-2 28.5'-35'



TC-3 (near 2.5')
f_c = 7,540 psi
Density = 144.8 lb/ft^3
Chloride = 0.007 lb/ft^3

TC-3 (near 4.5')
f_c = 7,910 psi
Density = 144.4 lb/ft^3
Chloride = 0.013 lb/ft^3

Project No. CJ205128, Test Core No. TC-3

TC-4 (near 11')
f_c = 7,890 psi
Density = 145.5 lb/ft^3

Project No. CJ205128, Test Core No. TC-4 10'-20'

TC-4 (near 25.5')
f_c = 5,260 psi
Density = 143.8 lb/ft^3
Chloride = 0.013 lb/ft^3

Project No. CJ205128, Test Core No. TC-4 20'-30'

TC- 4 (near 33')
f_c = 6,430 psi
Density = 146.8 lb/ft^3
Chloride = 0.007 lb/ft^3

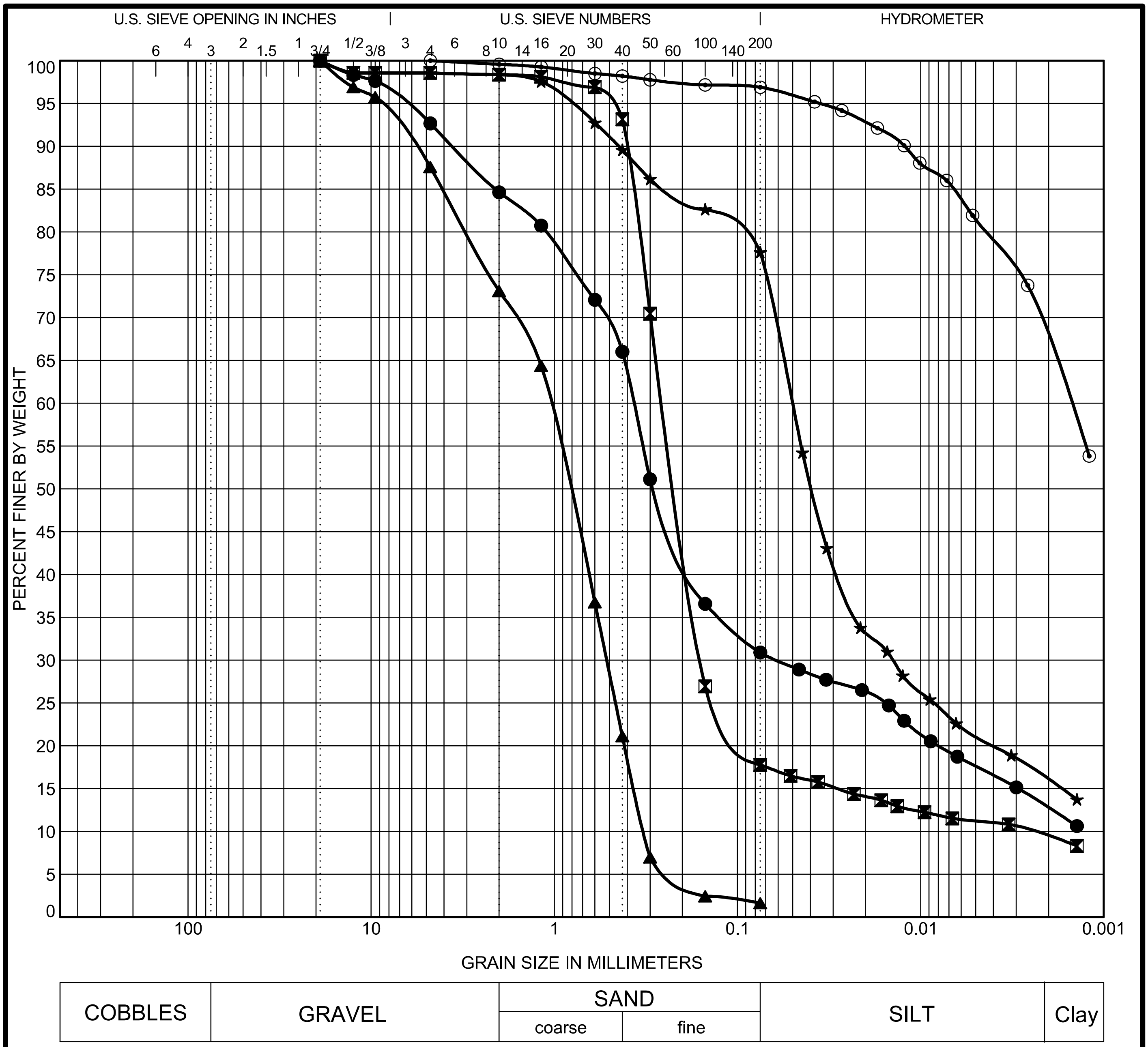
Project No. CJ205128, Test Core No. TC-4 30'-35'

Project No. CJ205128, Test Core No. WC-1T

Project No. CJ205128, Test Core No. WC-2T

Project No. CJ205128,Test Core No. RC-1T

Project No. CJ205128, Test Core No. RC-2T



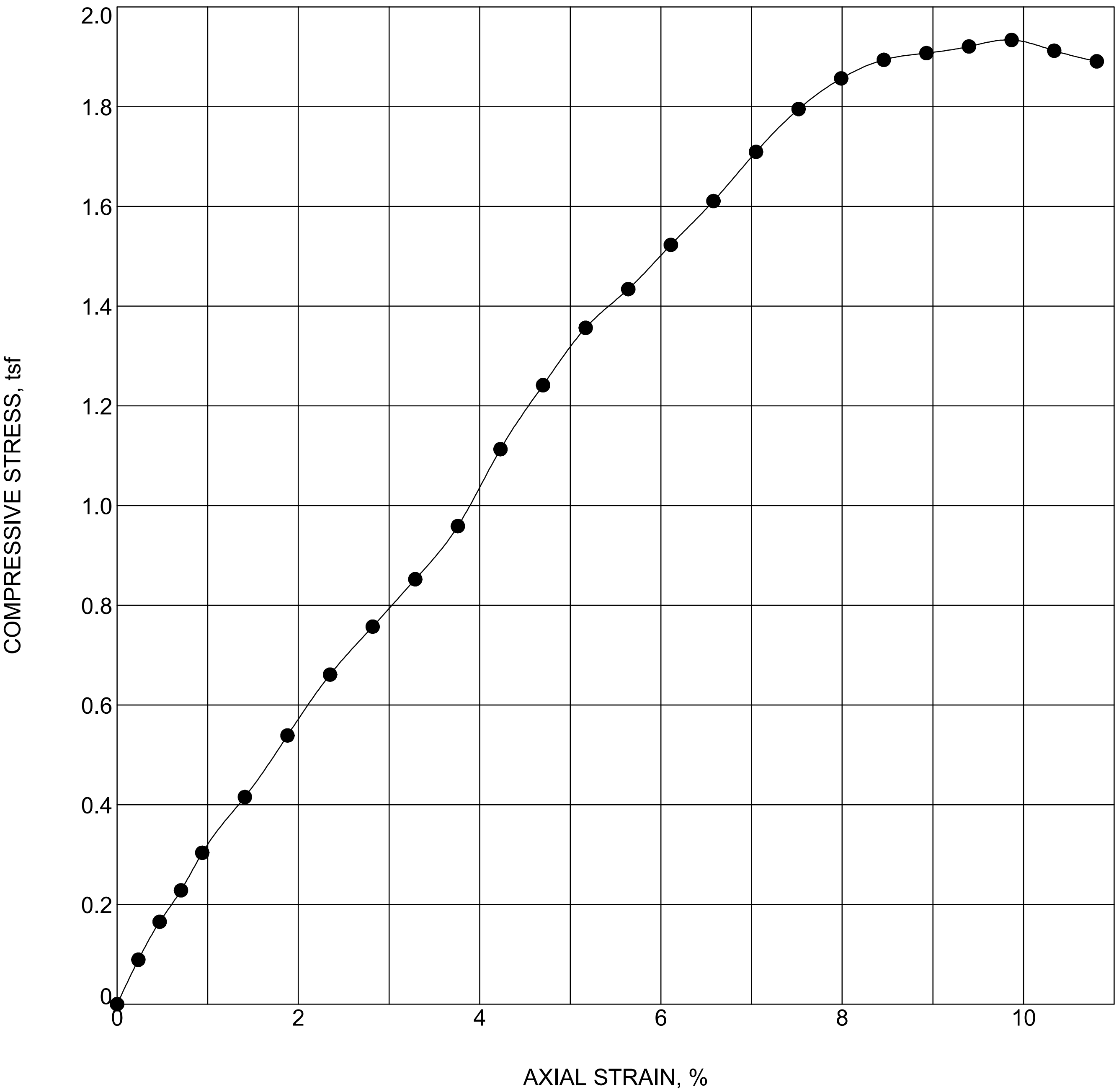
Specimen Identification				Lab #	Textural Classification	LL	PL	PI	Cc	Cu
●	**TC-4**	**B-1**	**1.5**	**29531**	**A-2-4 (0) SANDY LOAM**	**17.0**	**15.0**	**2.0**		
⧗	**TB-1**	**SS-5**	**11.0**	**29532**	**A-2-4 (0) SAND**	**NP**	**NP**	**NP**	**39.19**	**101.91**
▲	**TB-1**	**SS-9**	**21.0**	**29533**	**A-1-b (0) SAND , GRAVELLY**	**NP**	**NP**	**NP**	**0.78**	**3.28**
★	**TB-1**	**SS-14**	**38.5**	**29534**	**A-4 (0) SILTY LOAM**	**18.0**	**17.0**	**1.0**		
☉	**TC-2**	**SS-5**	**36.0**	**29535**	**A-7-6 (25) CLAY**	**44.0**	**20.0**	**24.0**		

Specimen Identification				D60	D30	D10	LOI	pH	%Gravel	%Sand	%Silt	%Clay	SG
●	**TC-4**	**B-1**	**1.5**	**0.369**	**0.06**			**8.1**	**15.4**	**53.7**	**18.2**	**12.7**	**2.74**
⧗	**TB-1**	**SS-5**	**11.0**	**0.254**	**0.157**	**0.002**		**8.6**	**1.6**	**80.6**	**8.4**	**9.4**	**2.65**
▲	**TB-1**	**SS-9**	**21.0**	**1.06**	**0.517**	**0.323**			**26.9**	**71.5**			
★	**TB-1**	**SS-14**	**38.5**	**0.05**	**0.014**			**8.1**	**1.6**	**20.7**	**61.7**	**16.0**	**2.77**
☉	**TC-2**	**SS-5**	**36.0**	**0.002**				**7.9**	**0.4**	**2.7**	**29.9**	**67.0**	**2.77**

Earth Exploration Inc.
7770 W New York St.
Indianapolis, IN 46214
Telephone: (317) 273-1690
Fax:

GRAIN SIZE DISTRIBUTION TEST REPORT

DES #: 1900011 Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River



Boring	Sample	Depth	Classification
TB-1	SS-13B	33.5 - 35	SILTY LOAM

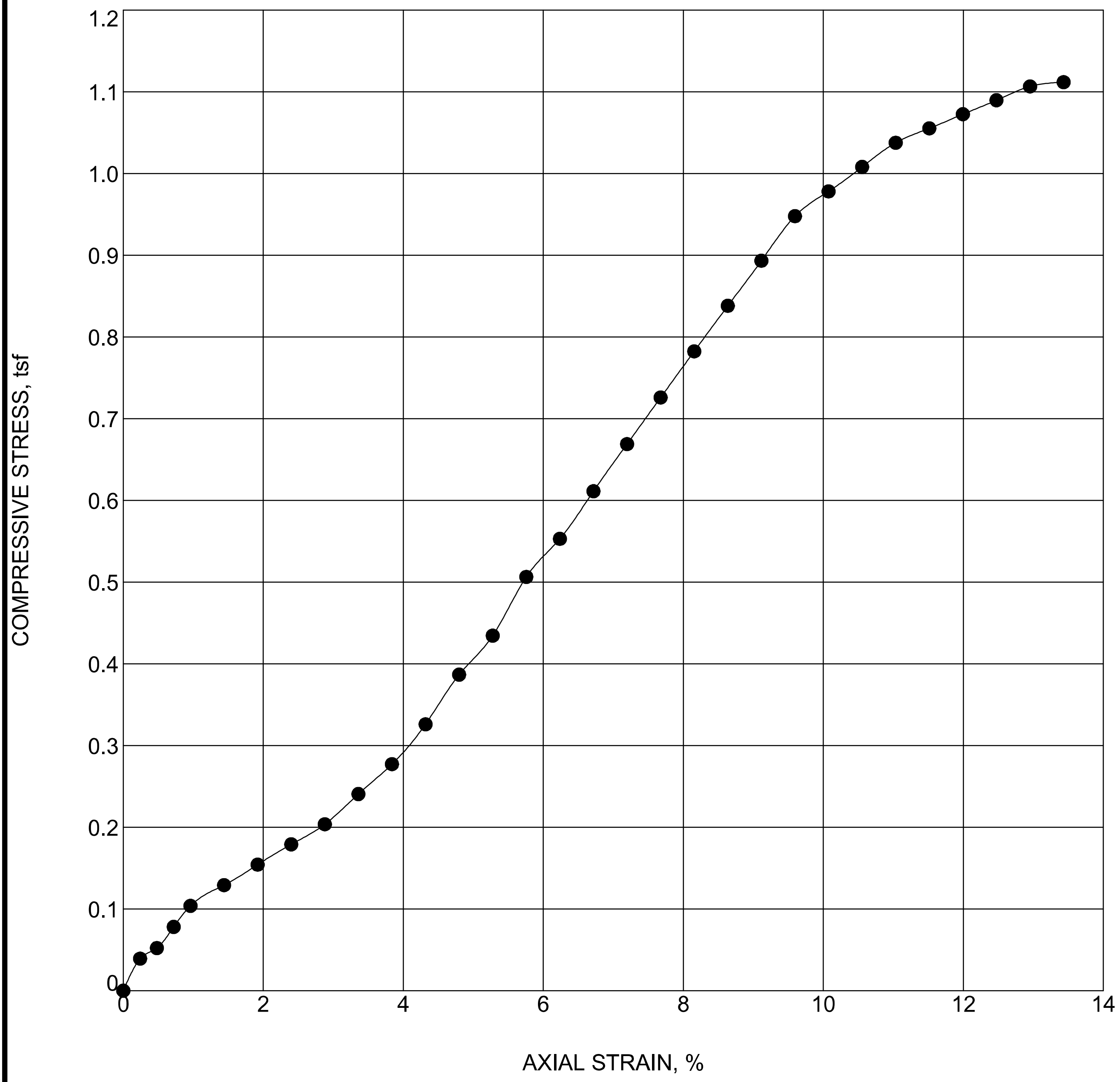
Moisture Content (%)	Moist Density (pcf)	Dry Density (pcf)	Unconfined Strength (tsf)	Strain Rate (%)	Failure Strain (%)
24.7	127.8	102.5	1.93	1.0	9.9
Shear Strength (tsf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
0.97	100	0.686	38.17	75.67	2.0

INDOT UNCONFINED TEST (EEI LOGO) CJ205128.GPJ IN DOT1.GDT 1/6/21

Earth Exploration Inc.
7770 W New York St.
Indianapolis, IN 46214
Telephone: (317) 273-1690
Fax:

UNCONFINED COMPRESSION TEST

DES #: 1900011 Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River



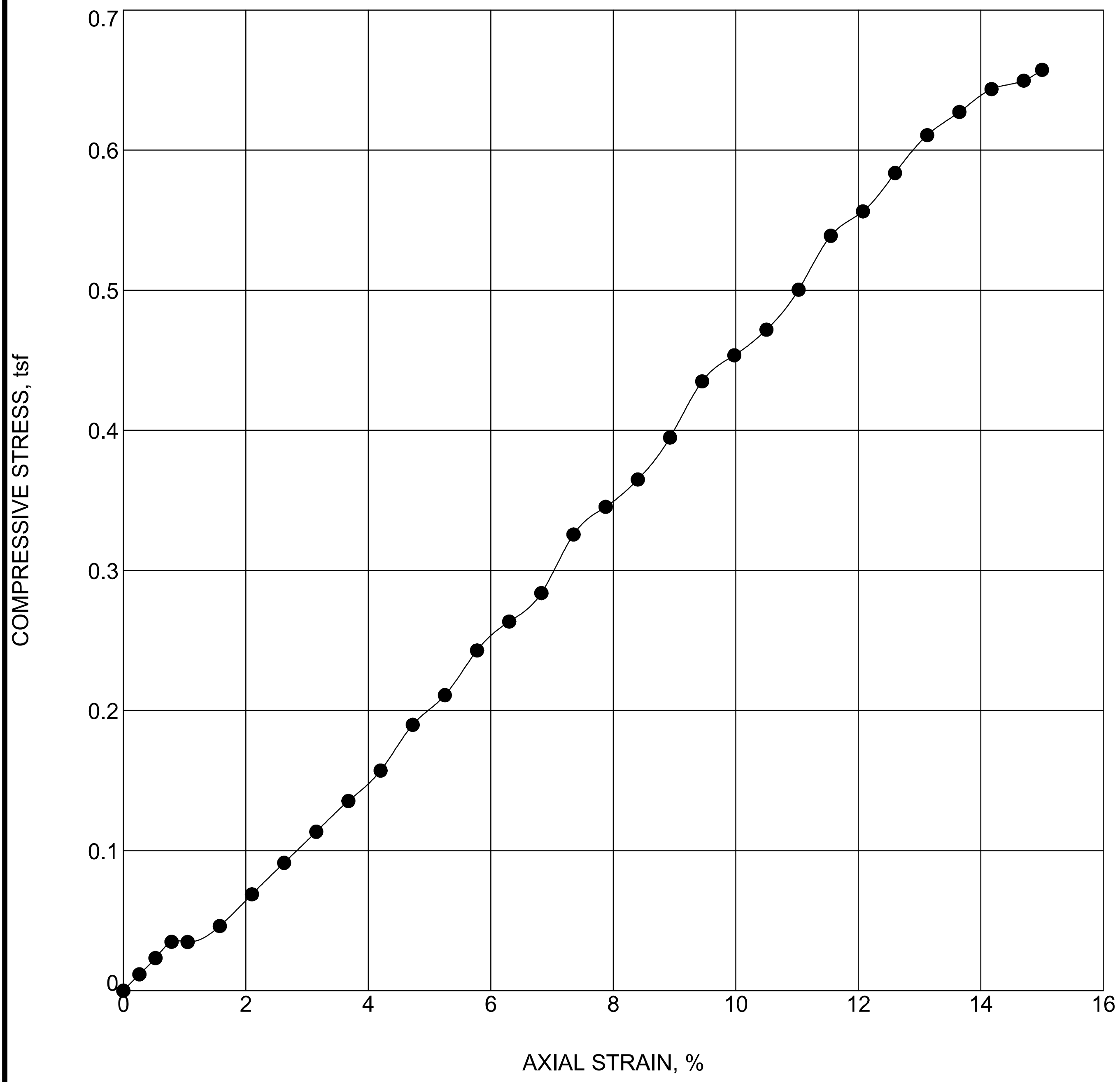
Boring	Sample	Depth	Classification
TB-1	SS-15B	43.5 - 45	SILTY LOAM

Moisture Content (%)	Moist Density (pcf)	Dry Density (pcf)	Unconfined Strength (tsf)	Strain Rate (%)	Failure Strain (%)
22.6	130.4	106.4	1.11	1.0	13.4
Shear Strength (tsf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
0.56	100	0.625	37.68	74.12	2.0

Earth Exploration Inc.
7770 W New York St.
Indianapolis, IN 46214
Telephone: (317) 273-1690
Fax:

UNCONFINED COMPRESSION TEST

DES #: 1900011 Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River



Boring	Sample	Depth	Classification
TB-1	SS-17B	53.5 - 55	SILTY CLAY

Moisture Content (%)	Moist Density (pcf)	Dry Density (pcf)	Unconfined Strength (tsf)	Strain Rate (%)	Failure Strain (%)
22.7	130.5	106.4	0.66	1.0	15.0
Shear Strength (tsf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
0.33	99	0.630	39.85	67.73	1.7

Earth Exploration Inc.
7770 W New York St.
Indianapolis, IN 46214
Telephone: (317) 273-1690
Fax:

UNCONFINED COMPRESSION TEST

DES #: 1900011 Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River

Concrete Core Test Report

Report Number: CJ205128.0002
Service Date: 01/14/21
Report Date: 01/14/21
Task: Laboratory Services

EARTH EXPLORATION A Terracon COMPANY
7770 W New York St
Indianapolis, IN 46214-2988
317-273-1690

Client

Lochmueller Group Inc
Attn: Michael Vereb
112 West Jefferson Blvd.
Suite 500
South Bend, IN 46601

Project

SR 933 Bridge Rehab
Des No. 1900011
St. Joseph Co., IN

Project Number: CJ205128

Material Information

Specified Strength:

Specified Length:
Mix ID: NA
Nominal Maximum Size Aggregate:

Sample Information

Placement Date: Early1900's
Date Tested: 12/21/20 **Time:** 0000
Sampled By: Scott, Zajac
Drill Directions: Other - See Comments
Date Core Obtained: 10/01/20 **Time:** 0000
Date Ends Trimmed: 12/16/20 **Time:** 0000
Moisture Conditioning History: According to ASTM C-42

Laboratory Test Data

Core ID	Location	Cored Length (in)	Trim Length (in)	Capped Length (in)	Diam. (in)	Area (sq in)	Length / Diam. Ratio	Max Load (lbs)	Corr. Factor	Comp. Strength (psi)	Fracture Type	Density (pcf)	Tested By
1	AC-1A 1.1-1.4'		3.69	3.86	1.96	3.02	1.97	20440	1.000	6770	3	140.7	CCB
2	AC-1B 0.3-0.6'		3.71	3.91	1.95	2.99	2.01	17810	1.000	5960	2	139.3	CCB
3	AC-1C 0.6-0.9'		3.70	3.91	1.96	3.02	1.99	29160	1.000	9660	2	145.5	CCB
4	TC-2 Near 9'		3.71	3.91	1.98	3.08	1.97	16190	1.000	5260	3	141.4	CCB
5	TC-2 Near 34'		3.76	3.94	1.97	3.05	2.00	6130	1.000	2010	3	142.1	CCB
6	TC-3 Near 2.5'		3.69	3.83	1.98	3.08	1.93	23170	1.000	7520	3	144.8	CCB
7	TC-3 Near 4.5'		3.68	3.93	1.98	3.08	1.98	24270	1.000	7880	2	144.4	CCB
8	TC-4 Near 11'		3.68	3.91	1.98	3.08	1.97	24230	1.000	7870	2	145.5	CCB
9	TC-4 Near 25.5'		3.72	3.87	1.98	3.08	1.95	16170	1.000	5250	3	143.8	CCB
10	TC-4 Near 33'		3.60	3.76	1.98	3.08	1.90	19720	1.000	6400	2	146.8	CCB

Comments:

- Cores were tested dry.
- Cores were smooth cut at both ends and capped.
- Test location is referenced from underside surface of the arch for Test Cores AC-1A through AC-1C and the top of pavement for Test Cores TC-2 through TC-4.

Fracture Type:
Type 1 - Reasonably well-formed cones on both ends
Type 2 - Well-formed cone on one end, vertical cracks running through caps
Type 3 - Columnar vertical cracking through both ends
Type 4 - Diagonal fracture

Concrete Core Test Report

Report Number: CJ205128.0002
Service Date: 01/14/21
Report Date: 01/14/21
Task: Laboratory Services

EARTH EXPLORATION A Terracon COMPANY
7770 W New York St
Indianapolis, IN 46214-2988
317-273-1690

Client

Lochmueller Group Inc
Attn: Michael Vereb
112 West Jefferson Blvd.
Suite 500
South Bend, IN 46601

Project

SR 933 Bridge Rehab
Des No. 1900011
St. Joseph Co., IN

Project Number: CJ205128

Services:
Earth Exploration, Inc. Rep.: Curtis Bradburn Curtis C. Bradburn
Reported To:
Contractor:
Report Distribution:
(1) Lochmueller Group Inc, Michael Vereb

Reviewed By: ______________________
Scott, Zajac

Test Methods: ASTM C39, ASTM C42, ASTM C174

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

LABORATORY SERVICES REPORT

Report Number: N120MLAB.0174
Service Date: 01/05/21
Report Date: 01/13/21 Revision 1 - Addition Data Added
Task: CJ205128

Terracon
611 Lunken Park Dr
Cincinnati, OH 45226-1813
513-321-5816

Client

Lochmuller Group Inc.
112 West Jefferson Blvd.
Suite 500
South Bend, IN 46601

Project

SR 933 Bridge Rehab
Des No. 1900011
St. Joseph Co., IN

Project No. N120MLAB Task No. CJ205128

Laboratory Test Data

Sample ID	Lab No.	Sample Depth, In.	Percent Chloride by Weight of Concrete	Saturated Surface Dry Density, lb/ft³	Chloride, lb/ft³ by Weight of Concrete
AC-1A	4	1.1'-1.4'	0.005	140.7	0.007
AC-1B	5	0.3'-0.6'	0.005	139.3	0.007
AC-1C	6	0.6'-0.9'	0.022	145.5	0.032
TC-2	7	9'	0.009	141.4	0.013
TC-2	8	34'	0.005	142.1	0.007
TC-3	9	2.5'	0.005	144.8	0.007
TC-3	10	4.5'	0.009	144.4	0.013
TC-4	12	25.5'	0.009	143.8	0.013
TC-4	13	33'	0.005	146.8	0.007

Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

Reviewed By: ______________________
Stewart Abrams
Staff Geologist

The tests were performed in general accordance with applicable ASTM, AASHTO, or DOT test methods. This report is exclusively for the use of the client indicated above and shall not be reproduced except in full without the written consent of our company. Test results transmitted herein are only applicable to the actual samples tested at the location(s) referenced and are not necessarily indicative of the properties of other apparently similar or identical materials.

LABORATORY SERVICES REPORT

Report Number: N120MLAB.0174
Service Date: 01/05/21
Report Date: 01/11/21
Task: CJ205128

Terracon
611 Lunken Park Dr
Cincinnati, OH 45226-1813
513-321-5816

Client

Lochmuller Group Inc.
112 West Jefferson Blvd.
Suite 500
South Bend, IN 46601

Project

SR 933 Bridge Rehab
Des No. 1900011
St. Joseph Co., IN

Project No. N120MLAB Task No. CJ205128

Determining Water-Soluble Chloride Ion Content in Soils-AASHTO T 291-94

SAMPLE INFORMATION

Sample Type: Bag
Sample Location: ---

Lab Number	Hole Numer	Sample Number	Sample Depth	Chloride Concentration, ppm
14	TC-4	---	---	8000

Services:
Terracon Rep:
Reported To:
Contractor:

Report Distribution

Reviewed By: ______________________________
Stewart Abrams
Staff Geologist

METHODOLOGY

Phenolphthalein stain was applied to broken surfaces of each core. Phenolphthalein is a pH indicator which turns from colorless to magenta at about a pH of 9-10. When the stain remains colorless after application, the concrete is usually carbonated and maintains a pH below 9.

Photographs of the cores after stain application are included in below.

Photo 1: Broken surfaces of Core AC-1A (1.1'-1.4') after application of phenolphthalein stain. Areas not stained magenta are carbonated. No Carbonation apparent.

Photo 2: Broken surfaces of Core TC-2 (32') after application of phenolphthalein stain. Areas not stained magenta are carbonated. No Carbonation apparent.

Photo 3: Broken surfaces of Core TC-3 (2.5') after application of phenolphthalein stain. Areas not stained magenta are carbonated. No Carbonation apparent.

Photo 4: Broken surfaces of Core TC-4 (33') after application of phenolphthalein stain. Areas not stained magenta are carbonated. No Carbonation apparent.

February 24, 2021

Ms. Katlyn Shergalis, P.E.
Lochmueller Group
3502 Woodview Trace, Suite 150
Indianapolis, IN 46268

RE: **Memorandum No.3**
Geotechnical Boring near North Abutment
SR 933 over St. Joseph River
Saint Joseph Co., Indiana
EEI Project No. CJ205128

Dear Katlyn:

Terracon performed a soil boring (Boring TB-2) near the north abutment of the SR 933 bridge over the St. Joseph River. Boring TB-2 was performed on January 21, 2021 near the centerline of SR 933. The approximate location of Boring TB-2 is shown on Exhibit 1. The soil boring location was determined in the field by Terracon personnel referencing physical features on the bridge and marked utilities. Constraints associated with traffic control, buried utilities, and pedestrian access limited where the boring could be safely performed. Details of the drilling and sampling procedures are attached. The borehole was backfilled with auger cuttings and capped with a concrete patch. The log for Boring TB-2 is attached. The ground surface elevation noted on the boring log was estimated based on topographic information depicted on historic plans.

Laboratory Testing

Laboratory testing including classification and strength tests were performed. Results of the laboratory tests are provided on the attached logs and respective laboratory reports in the attachments.

Observations

Boring TB-2 exposed approximately 13 ft of fill visually classified as loose sand and hard cohesive sandy loam overlying the abutment. The boring augered through the Portland cement concrete abutment (approximately 12 ft in thickness). Medium stiff to stiff cohesive silty loam approximately 15 ft in thickness was encountered below the concrete abutment. Alternating layers of granular and cohesive soils were exposed below the cohesive silty loam to the maximum depth of the boring (90 ft). Additional information is provided on the attached boring log.

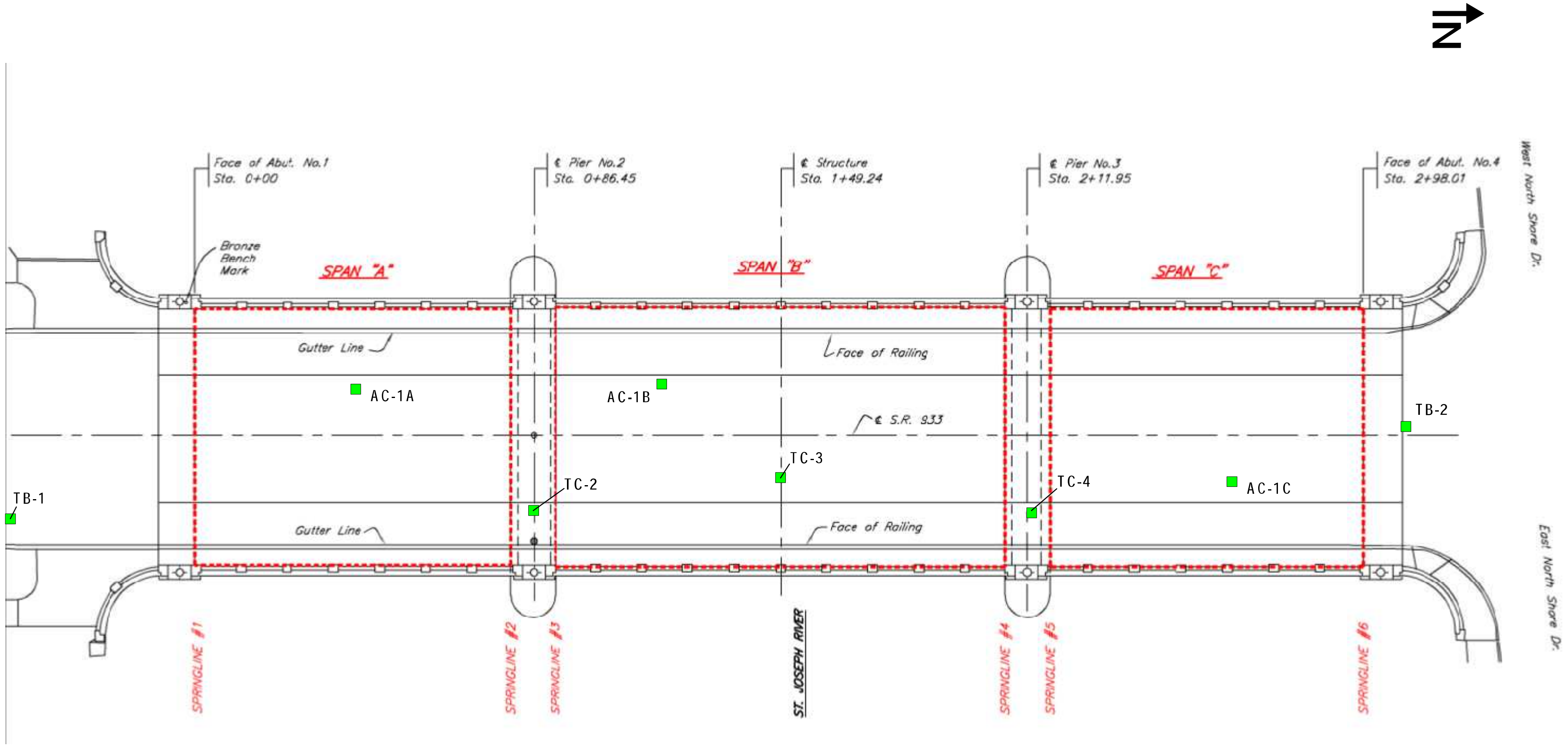
Thank you for the opportunity to provide our professional services. If you have any questions, please contact us.

Sincerely,
Terracon Consultants, Inc.

Scott H. Zajac

Scott Zajac, P.E.
Project Engineer

Attachments:
- Exhibit 1 – NDT Survey Extents and Exploratory Locations
- Field Methods for Exploring and Sampling Soils and Rock
- Log of Test Boring
- Grain Size Distribution Test Report
- Unconfined Compression Test (2)



Legend	Notes	Exhibit 1 - NDT Survey Extents and Exploratory Locations
🟥 🟥 NDT survey extents TC-2 🟩 Exploratory location and designation	1. Plans digitized from 2012 BF&S drawings. 2. Drawing not to scale.	Project: SR 933 over St. Joseph River Client: Lochmueller Group Location: St. Joseph Co., IN Project No.: CJ205128 Date: February 24, 2021 Terracon

FIELD METHODS FOR EXPLORING AND SAMPLING SOILS AND ROCK

A. Boring Procedures Between Samples

The boring is extended downward, between samples, by a hollow stem auger (AASHTO* Designation T251), continuous flight auger, driven and washed-out casing, or rotary boring with drilling mud or water.

B. Standard Penetration Test and Split-Barrel Sampling of Soils

(AASHTO* Designation: T206)

This method consists of driving a 2-in. outside diameter split-barrel sampler using a 140-lb weight falling freely through a distance of 30 in. The sampler is first seated 6 in. into the material to be sampled and then driven 12 in. The number of blows required to drive the sampler the final 12 in. is recorded on the Log of Test Boring and known as the Standard Penetration Resistance or N-value. Recovered samples are first classified as to texture by the field personnel. Later in the laboratory, the field classification is reviewed by a geotechnical engineer who observes each sample.

C. Thin-walled Tube Sampling of Soils

(AASHTO* Designation: T207)

This method consists of hydraulically pushing a 2-in. or 3-in. outside diameter thin wall tube into the soil, usually cohesive types. Relatively undisturbed samples are recovered.

D. Soil Investigation and Sampling by Auger Borings

(AASHTO* Designation: T203)

This method consists of augering a hole and removing representative soil samples from the auger flight or bucket at 5-ft intervals or with each change in the substrata. Relatively disturbed samples are obtained and its use is therefore limited to situations where it is satisfactory to determine approximate subsurface profile.

E. Diamond Core Drilling for Site Investigation

(AASHTO* Designation: T225)

This method consists of advancing a hole in rock or other hard strata by rotating downward a single tube or double tube core barrel equipped with a cutting bit. Diamond, tungsten carbide, or other cutting agents may be used for the bit. Wash water is used to remove the cuttings. Normally, a 3-in. outside diameter by 2-in. inside diameter coring bit is used unless otherwise noted. The rock or hard material recovered within the core barrel is examined in the field and laboratory. Cores are stored in partitioned boxes and the length of recovered material is expressed as a percentage of the actual distance penetrated.

* American Association of State Highway and Transportation Officials, Washington D.C.

LOG OF TEST BORING – GENERAL NOTES

DESCRIPTIVE CLASSIFICATION

GRAIN SIZE TERMINOLOGY

Soil Fraction		Particle Size	US Standard Sieve Size
Boulders		Larger than 75 mm	Larger than 3”
Gravel		4.76 mm to 75 mm	#10 to 75 mm
Sand:	Coarse	2.00 to 4.76 mm	#40 to #10
	Fine	0.075 to 0.42 mm	#200 to #40
Silt		0.002 to 0.075 mm	Smaller than #200
Clay		Smaller than 0.002 mm	Smaller than #200

GENERAL TERMINOLOGY

Physical Characteristics
- Color, moisture, grain shape fineness, etc.

Major Constituents
- Clay silt, sand, gravel

Structure
- Laminated, varved, fibrous, stratified, cemented, fissured, etc.

Geologic Origin
- Glacial, alluvial, eolian, residual, etc.

RELATIVE PROPORTIONS OF COHESIONLESS SOILS

Term	Defining Range by % of Weight
Trace	1 – 10%
Little	11 – 20%
Some	21 – 35%
And	36 – 50%

ORGANIC CONTENT BY COMBUSTION METHOD

Soil Description	LOI
w/ organic matter	4 – 15 %
Organic Soil (A-8)	16 – 30%
Peat (A-8)	More than 30%

RELATIVE DENSITY

Term	“N” Value
Very loose	0 – 5
Loose	6 – 10
Medium dense	11 – 30
Dense	31 – 50
Very Dense	51+

CONSISTENCY

Term	“N Value”
Very soft	0 - 3
Soft	4 - 5
Medium	6 - 10
Stiff	11 - 15
Very Stiff	16 - 30
Hard	31+

PLASTICITY

Term	Plastic Index
None to slight	0 – 4
Slight	5 – 7
Medium	8 – 22
High/Very High	Over 22

The penetration resistance, N, is the summation of the number of blows required to effect two successive 6-in. penetrations of the 2-in. split-barrel sampler. The sampler is driven with a 140-lb weight falling 30 in. and is seated to a depth of 6 in. before commencing the standard penetration test.

SYMBOLS

DRILLING AND SAMPLING

AS – Auger Sample
BS – Bag Sample
C – Casing Size 2½”, NW, 4”, HW
COA – Clean-Out Auger
CS – Continuous Sampling
CW – Clear Water
DC – Driven Casing
DM – Drilling Mud
FA – Flight Auger
FT – Fish Tail
HA – Hand Auger
HSA – Hollow Stem Auger
NR – No Recovery
PMT – Borehole Pressuremeter Test
PT – 3” O.D. Piston Tube Sample
PTS – Peat Sample
RB – Rock Bit
RC – Rock Coring
REC – Recovery
RQD – Rock Quality Designation
RS – Rock Sounding
S – Soil Sounding
SS – 2” O.D. Split-Barrel Sample
2ST – 2” O.D. Thin-Walled Tube Sample
3ST – 3” O.D. Thin-Walled Tube Sample
VS – Vane Shear Test
WPT – Water Pressure Test

LABORATORY TESTS

q_p – Penetrometer Reading, tsf
q_u – Unconfined Strength, tsf
W – Moisture Content, %
LL – Liquid Limit, %
PL – Plastic Limit, %
PI – Plasticity Index
SL – Shrinkage Limit, %
LOI – Loss on Ignition, %
γ_d – Dry Unit Weight, pcf
pH – Measure of Soil Alkalinity/Acidity

WATER LEVEL MEASUREMENT

BF – Backfilled upon Completion
NW – No Water Encountered

Note: Water level measurements shown on the boring logs represent conditions at the time indicated and may not reflect static levels, especially in cohesive soils.

LOG OF TEST BORING

Terracon

BORING NO.: **TB-2**
SHEET 1 OF 3
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68856
DES NO. : 1900011
STRUCTURE # : (933) 31-71-3690C
LONGITUDE : -86.25062
PROJECT TYPE : Bridge Assessment
DATUM : WGS84
LOCATION : SR 933 over St. Joseph River
DATE STARTED : 01-21-21
COUNTY : St. Joseph
PROJECT NO.: CJ205128
DATE COMPLETED : 01-21-21

ELEVATION : 685.0
STATION :
OFFSET : 0.0 ft
LINE : 'C'
DEPTH : 90.0 ft

BORING METHOD : Hollow Stem Auger*
RIG TYPE : CME 550 X
CASING DIA. : ---
CORE SIZE : ---

HAMMER : Auto
DRILLER/INSP : JP
TEMPERATURE : 39 °F
WEATHER : Cloudy

GROUNDWATER: ▽ Encountered at 43.5 ft ▼ At completion 12.8 ft ☒ Caved in at 14.8 ft

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
		Portland Cement Concrete 1.5											
	2.5	**Sand**, loose, moist, brown, with silty loam seams, (fill; visual)	SS 1	6-7-3	56								
680.0	5.0		SS 2	5-6-4	67			0.5					
	7.5		SS 3	8-4-5	72			1.25					
675.0	10.0	11.0	SS 4	6-4-4	100			0.75					
	12.5 ▼	**Sandy Loam**, hard, moist, brown, with brick fragments, (fill; visual) 13.0	SS 5	3-3-50/2	42	15.1							
		Portland Cement Concrete	SS 6	50/2	83								
670.0 ☒	15.0												
			SS 7	50/3	100								
	17.5												
			SS 8	50/2	83								
665.0	20.0												
			SS 9	50/2	83								
	22.5												
		25.0	SS 10	50/3	100								
660.0	25.0	**Silty Loam**, medium stiff to stiff, moist, gray, A-4, Lab No. 29534											
	27.5		SS 11	4-3-5	100	17.1		4.5					
655.0	30.0		SS 12	3-3-4	100	19.3		4.25					

Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 2/24/21

LOG OF TEST BORING

Terracon

BORING NO.:	**TB-2**
SHEET	2 OF 3
CLIENT :	Lochmueller Group, Inc.
LATITUDE :	41.68856
DES NO. :	1900011
STRUCTURE # :	(933) 31-71-3690C
LONGITUDE :	-86.25062
PROJECT TYPE :	Bridge Assessment
DATUM :	WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
			ST 1		92	18.4	112.2	>4.5 3.75	4.67				
	32.5												
650.0	35.0	**Silty Loam**, medium stiff to stiff, moist, gray, A-4, Lab No. 29534	SS 13	3-5-9	100	21.9		4.5					
	37.5												
645.0	40.0	40.0	SS 14	3-5-7	100	23.1	103.9	3.25	2.10				
	42.5												
640.0	45.0	**Silty Loam**, loose, wet, gray, A-4(0), Lab No. 29981	SS 15	2-4-6	100	26.3				NP	NP	NP	43.5, SS-15 : SG = 2.60, pH = 8.6
	47.5												
635.0	50.0	50.0	SS 16	2-4-6	100	22.6							
	52.5	**Silty Clay Loam**, stiff, moist, gray, (visual)											
630.0	55.0	55.0	SS 17	3-5-9	100	24.5 25.3		2.75					
	57.5												
625.0	60.0	**Sand**, medium dense to very dense below 60 ft, wet, gray, A-2-4, Lab No. 29532	SS 18	4-6-10	100								* 60.0, Begin rotary drilling
	62.5												
			SS 19	50/5	100								
620.0	65.0												

Continued on next page

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 2/24/21

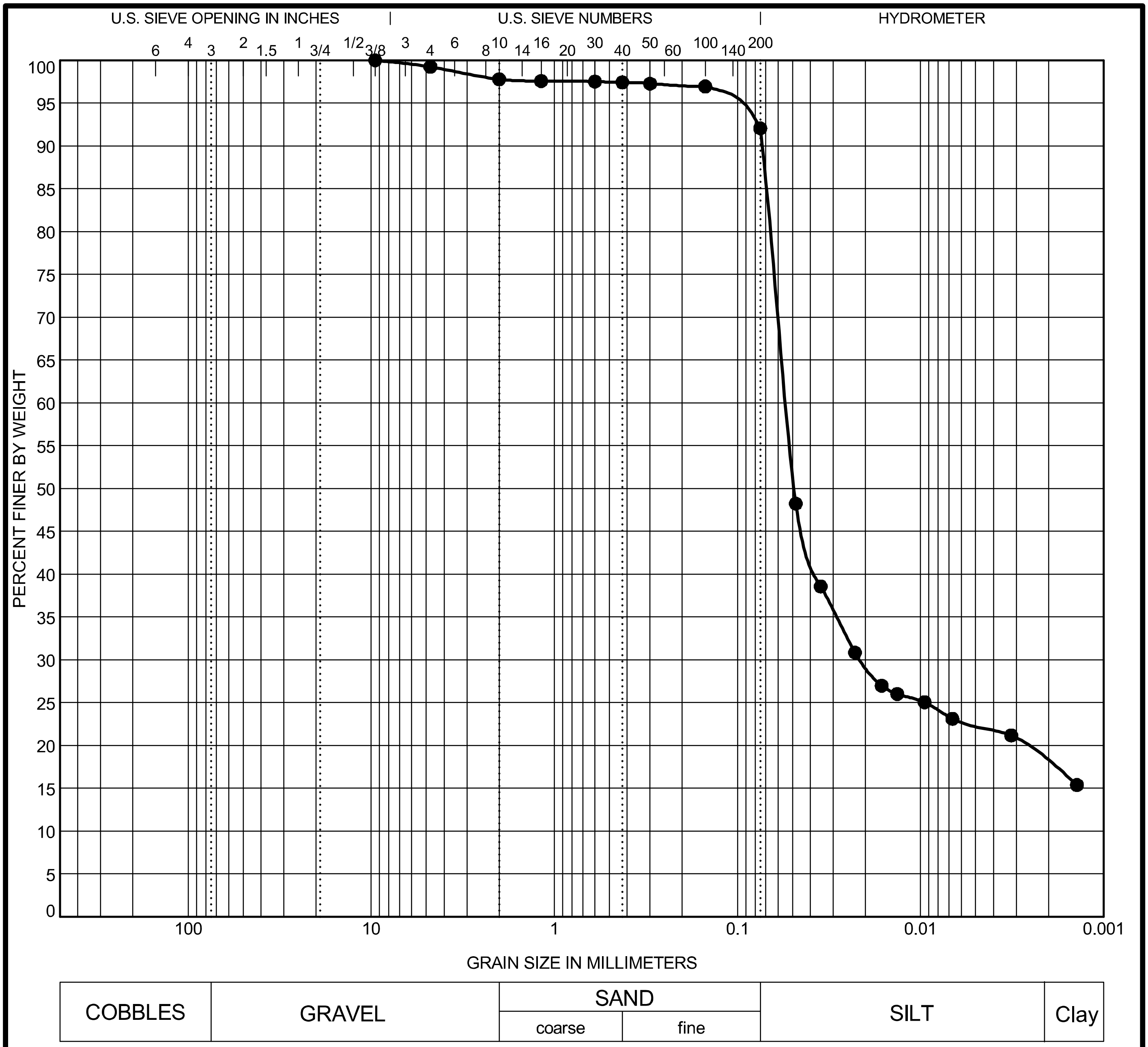
LOG OF TEST BORING

Terracon

BORING NO.: **TB-2**
SHEET 3 OF 3
CLIENT : Lochmueller Group, Inc.
LATITUDE : 41.68856
DES NO. : 1900011
STRUCTURE # : (933) 31-71-3690C
LONGITUDE : -86.25062
PROJECT TYPE : Bridge Assessment
DATUM : WGS84

ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	SAMPLE NUMBER	SPT per 6"	% RECOVERY	MOISTURE CONTENT	DRY DENSITY, pcf	POCKET PEN., tsf	UNCONF. COMP., tsf	ATTERBERG LIMITS LL	PL	PI	REMARKS
	67.5												
			SS 20	24-32-42	100								
615.0	70.0												
	72.5												
			SS 21	50/5	100								
610.0	75.0												
	77.5												
		Sand, medium dense to very dense below 60 ft, wet, gray, A-2-4, Lab No. 29532	SS 22	42-44-50/4	100								
605.0	80.0												
	82.5												
			SS 23	30-32-50/4	100								
600.0	85.0												
	87.5												
			SS 24	32-50/1	83								
595.0	90.0	90.0											
		Bottom of Boring at 90.0 ft											
	92.5												
590.0	95.0												
	97.5												
585.0	100.0												
	102.5												

EEI BORING LOG (INDOT FORMAT) LAT./LONG. CJ205128.GPJ IN_DOT1.GDT 2/24/21



	Specimen Identification	Lab #	Textural Classification	LL	PL	PI	Cc	Cu
●	**TB-2 SS-15 43.5**	**29981**	**A-4 (0) SILTY LOAM**	**NP**	**NP**	**NP**		

	Specimen Identification	D60	D30	D10	LOI	pH	%Gravel	%Sand	%Silt	%Clay	SG
●	**TB-2 SS-15 43.5**	**0.054**	**0.021**				**2.2**	**5.7**	**74.2**	**17.9**	**2.6**

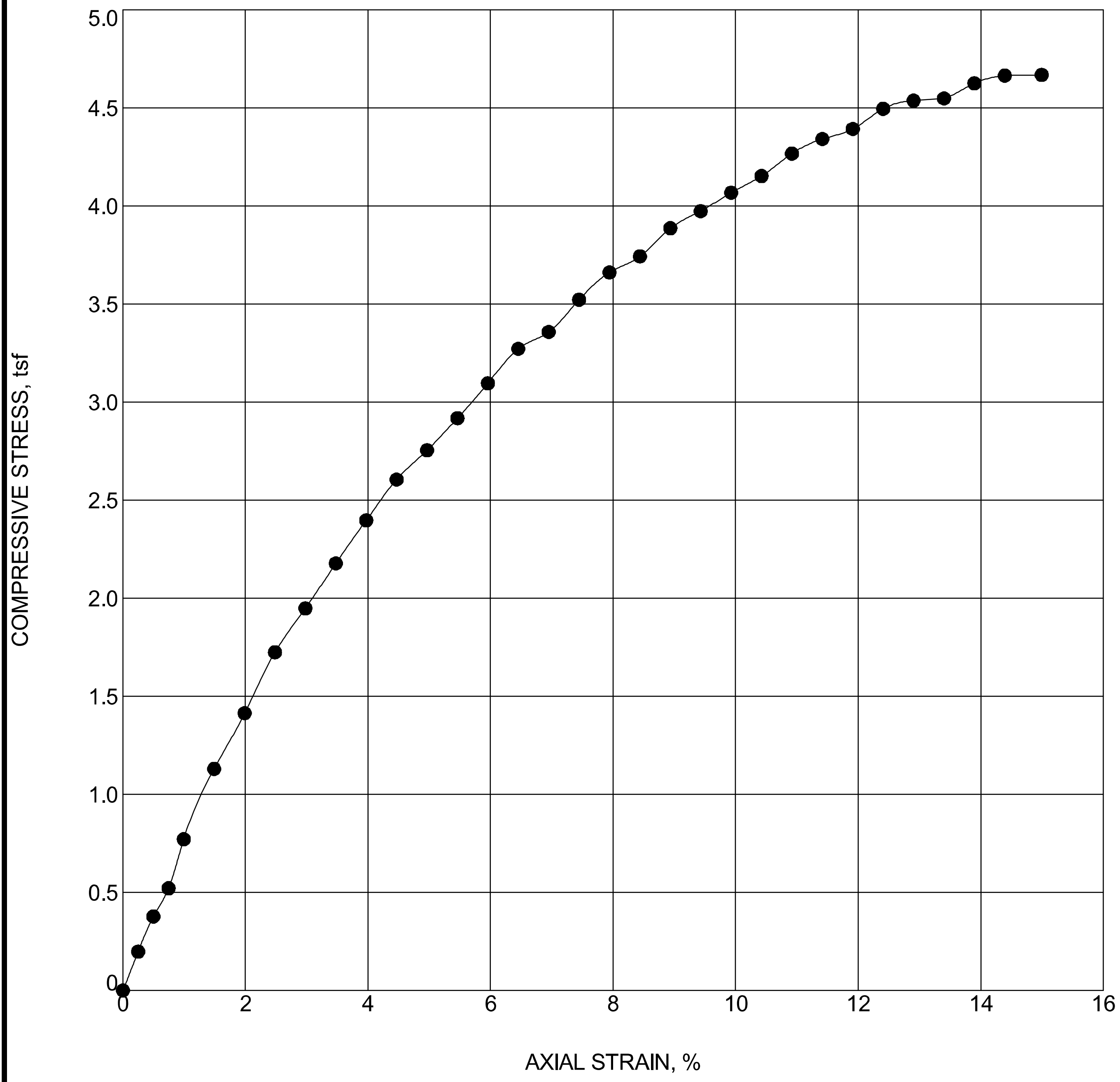
Terracon

Terracon Consultants, Inc.
7770 West New York Street
Indianapolis IN 46214
Telephone: (317) 273-1690
Fax: (317) 273-2250

GRAIN SIZE DISTRIBUTION TEST REPORT

DES #: 1900011
Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River

INDOT GRAIN SIZE (EEI LOGO) CJ205128.GPJ IN DOT1.GDT 2/24/21



Boring	Sample	Depth	Classification
TB-2	ST-1	30 - 32	SILTY LOAM

Moisture Content (%)	Moist Density (pcf)	Dry Density (pcf)	Unconfined Strength (tsf)	Strain Rate (%)	Failure Strain (%)
18.4	132.8	112.2	4.67	1.0	15.0
Shear Strength (tsf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
2.33	97	0.513	73.17	143.3	2.0

Terracon

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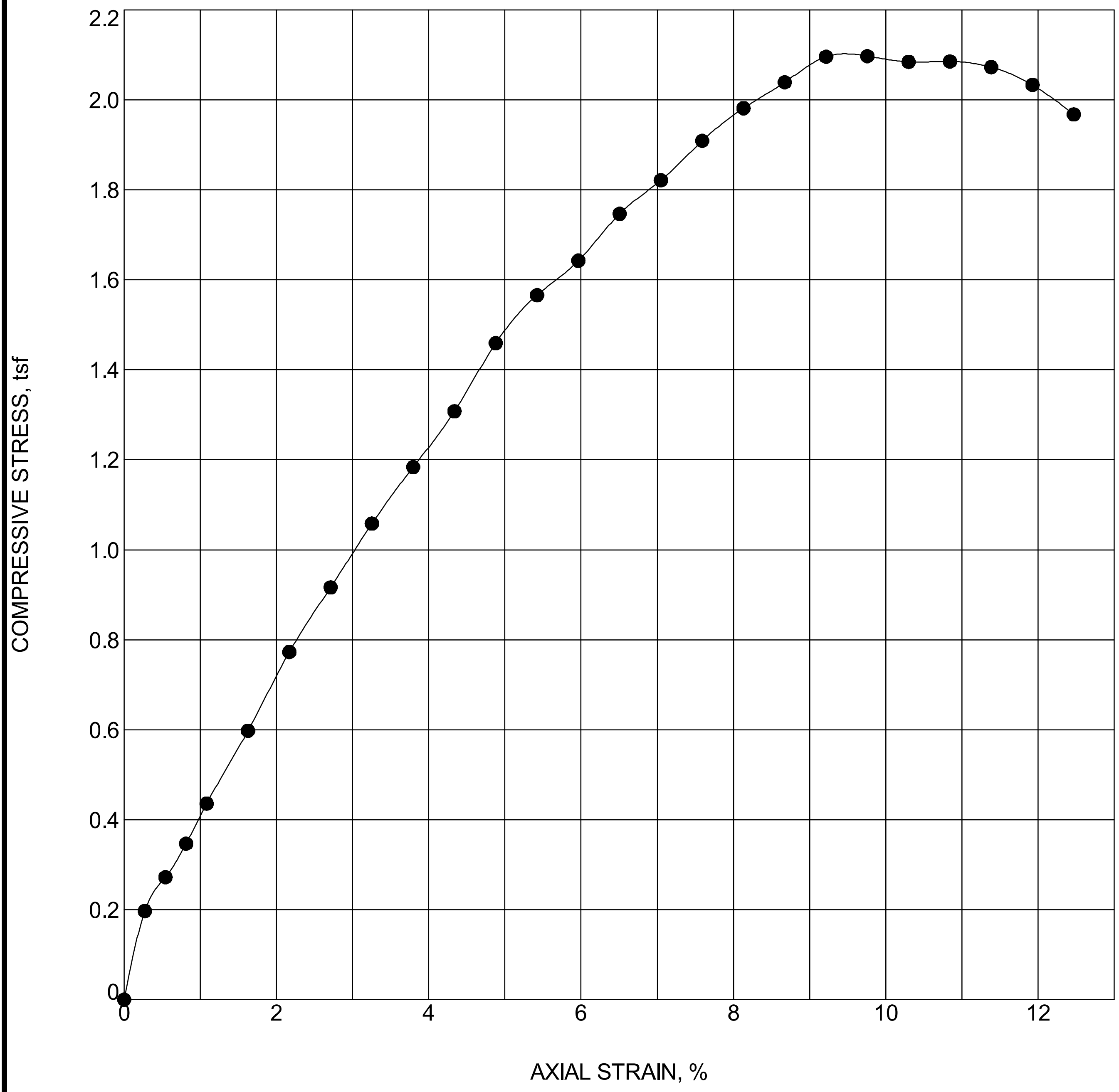
Fax: (317) 273-2250

UNCONFINED COMPRESSION TEST

DES #: 1900011 Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River

INDOT UNCONFINED TEST (EEI LOGO) CJ205128.GPJ IN DOT1.GDT 2/24/21



Boring	Sample	Depth	Classification
TB-2	SS-14T	38.5 - 40	SILTY LOAM

Moisture Content (%)	Moist Density (pcf)	Dry Density (pcf)	Unconfined Strength (tsf)	Strain Rate (%)	Failure Strain (%)
23.1	127.9	103.9	2.10	1.0	9.8
Shear Strength (tsf)	**Saturation (%)**	**Void Ratio**	**Specimen Diameter (mm)**	**Specimen Height (mm)**	**Height/Diameter Ratio**
1.05	99	0.634	35	65.59	1.9

INDOT UNCONFINED TEST (EEI LOGO) CJ205128.GPJ IN DOT1.GDT 2/24/21

Terracon Consultants, Inc.
7770 West New York Street
Indianapolis IN 46214
Telephone: (317) 273-1690
Fax: (317) 273-2250

UNCONFINED COMPRESSION TEST

DES #: 1900011 Structure #: (933) 31-71-3690C
Project #: CJ205128
County: St. Joseph
Location: SR 933 over St. Joseph River

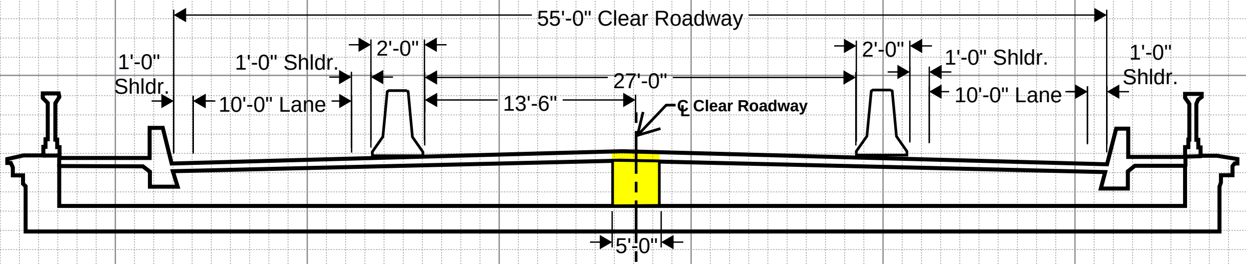
Appendix J:

Maintenance of Traffic Conceptual Plan

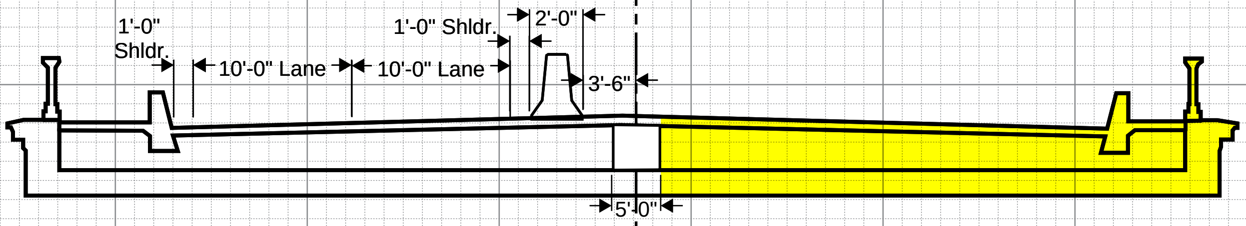
PROJECT NAME SR 933 (Michigan Road) over St. Joseph River
DES/PROJECT NUMBER 1900011
LOCH GROUP PROJECT NUMBER 120-3001-01B
MADE BY ACS DATE 06/27/2021
CHECKED BY MAR DATE 06/30/2021
SHEET 1 OF 1

Proposed Phasing

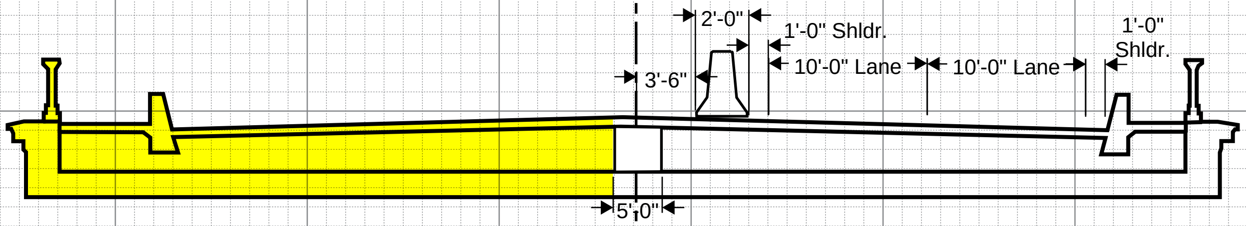
(Alternative B1a Only)



Pre-Phase



Phase 1



Phase 2

Legend

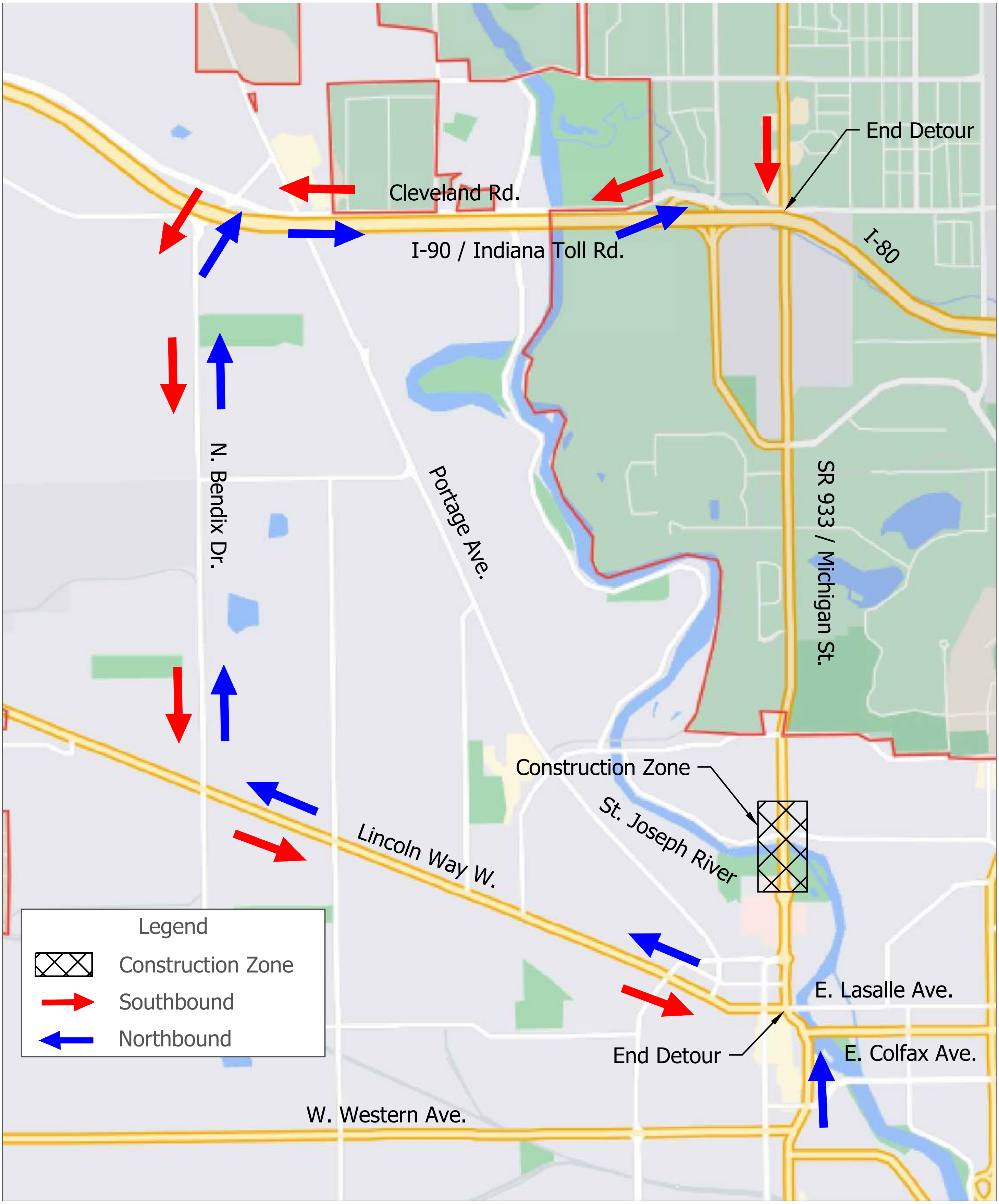
🟨 **Removal and Replacement**

Phasing Work Expectations

Pre-Phase: **One lane of traffic will be maintained on each side of the bridge with the middle of the bridge open for construction. A phasing wall will be constructed on top of the existing arches (conservatively assumed to be 5' wide) for the full length of the bridge, at the center of the clear roadway width.**

Phase 1 & 2: **Each side of the existing bridge will be completely removed and reconstructed.**

Note that phasing is only feasible for Alternative B1a in which the existing arches are being maintained along the center of the bridge clear roadway width. Due to full substructure and foundation replacement phasing is not feasible for Alternative B1b.



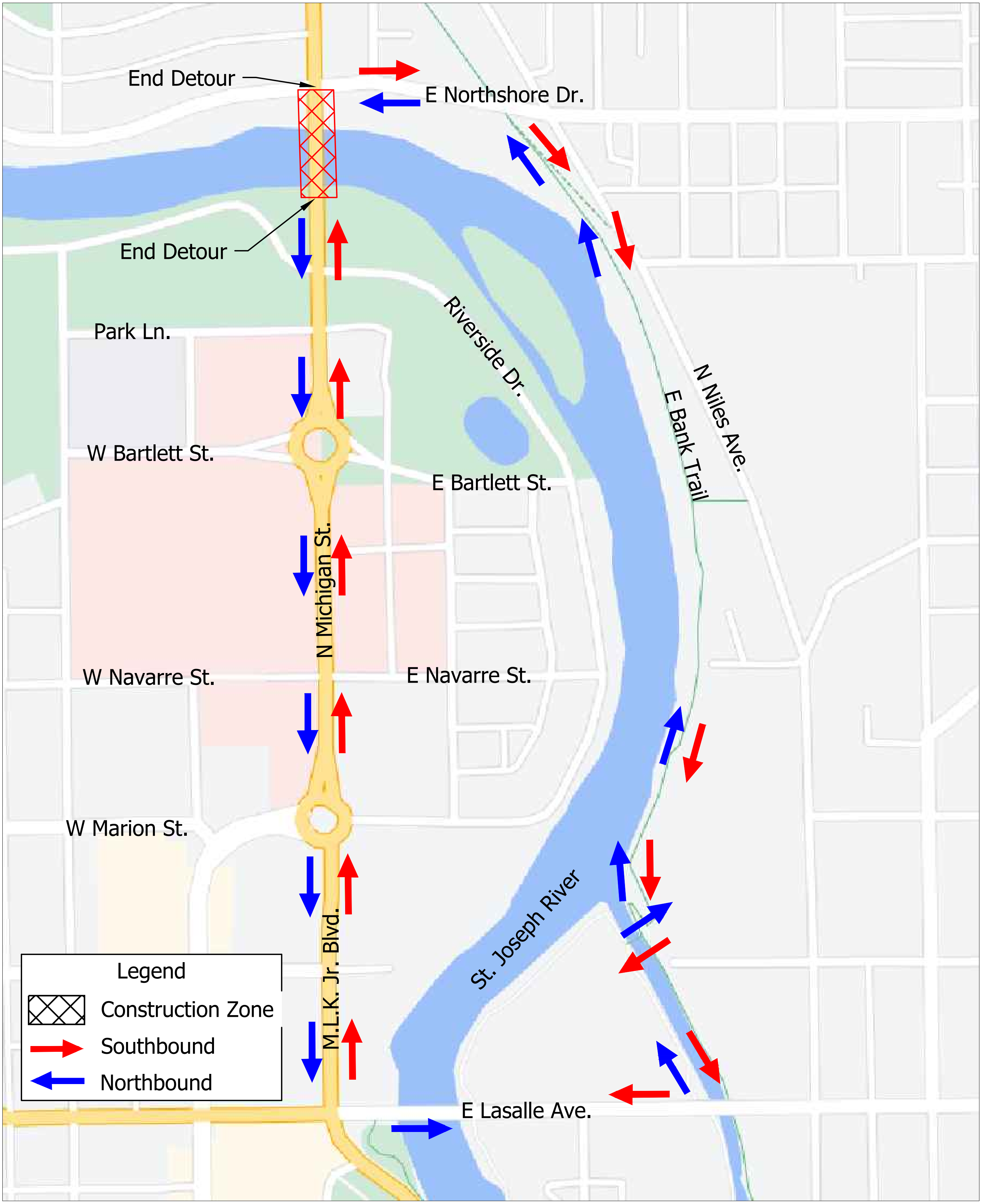
Scale
1" = 4000'

Exhibit - Vehicular Traffic Detour for SR 933 / Michigan St.

Recommended for Approval:

Date: 06/28/2021

Designation No: 1900011 Bridge File No: 933(31-71-3690 D)



Scale 1" = 500'	**Exhibit - Pedestrian Traffic Detour for SR 933 / Michigan St.**	Recommended for Approval:
		Date: 06/28/2021

Designation No: 1900011
Bridge File No: 933(31-71-3690 D)

Lochmueller Group, Inc.	Calc By:	BKA	5/25/2021
	Chck By:	BSS	5/25/2021

Work Zone Road Users Costs

Detour resulting in Additional Travel Time using Increased Travel Time

Project Information

Des:	1900011
Highway / Roadway:	SR 933 - Michigan Street Bridge
County:	St. Joseph
District:	LaPorte
Project Letting Year:	2023

Inputs

	Car	Truck
AADT of Detoured Section:	17,805	480
Time to Drive the Roadway Section (Mins):	7	7
Time to drive the detour or work zone (Mins):	15.5	15.5
Duration of Work Zone (Days):	700	

Calculations

Hourly Value of Time:	$31.77	$43.60
Delay (Mins):	8.50	8.50
Delay (Hours):	0.14	0.14
Delay Cost per Vehicle ($):	$4.50	$6.18
Delay Cost per Day ($):	$80,145	$2,965
Delay Cost for Work Zone Duration:	$56,101,835	$2,075,511
Total Delay Cost for Work Zone Duration:	$58,177,346	

Results

Average Delay Cost per Day:	**$83,110**

Estimated User Cost - Phased Construction

Lochmueller Group, Inc.	Calc By:	BKA	5/25/2021
	Chck By:	BSS	5/25/2021

Work Zone Road Users Costs

Reduced Speed Scenario

Project Information

Des:	1900011
Highway / Roadway:	SR 933 - Michigan Street Bridge
County:	St. Joseph
District:	LaPorte
Project Letting Year:	2023

Inputs

	Car	Truck
AADT of Section:	17,805	480
Length of the Work Zone (Miles):	0.35	
Original Posted Speed (MPH):	35	35
Work Zone Speed (MPH):	25	25
Duration of Work Zone (Days):	700	

Calculations

Hourly Value of Time:	$31.77	$43.60
Travel Time Posted Speed (Secs):	36.00	36.00
Travel Time Work Zone Speed (Secs):	50.40	50.40
Additional Travel Time (Secs):	14.40	14.40
Additional Travel Time (Hours):	0.004	0.004
Delay Cost per Vehicle:	$0.13	$0.17
Delay Cost per Day:	$2,263	$84
Delay Cost for Work Zone Duration:	$1,584,052	$58,603
Total Delay Cost for Work Zone Duration:	$1,642,654	

Results

Average Delay Cost per Day:	**$2,347**

Appendix K:

Consulting Parties Meeting Summary & Response Comments

Subject of email: FHWA Project: Des. No. 1900011; Consulting Party Meeting Summary, SR 933 Bridge Project, St. Joseph County, Indiana

Des. No.: 1900011
Project Description: Scope undetermined
Location: SR 933 (Michigan Street) over St. Joseph River, 1.59 miles north of SR 23, City of South Bend, Portage Township, St. Joseph County, Indiana

The Indiana Department of Transportation (INDOT), with funding from the Federal Highway Administration (FHWA), proposes to proceed with a bridge project (Des. No. 1900011). The Section 106 Early Coordination Letter for this project was originally distributed on November 2, 2020. The Historic Property Short Report was distributed on January 28, 2021.

As part of Section 106 of the National Historic Preservation Act, a Meeting Summary for the May 20, 2021, consulting party meeting has been prepared and is ready for review and comment by consulting parties.

Please review this documentation, which is attached to this email and also located in IN SCOPE at http://erms.indot.in.gov/Section106Documents/ (the Des. No. is the most efficient search term, once in IN SCOPE), and respond with any comments that you may have. If a hard copy of the materials is needed, please respond to this email with your request as soon as you can.

Consulting parties have thirty (30) calendar days to review and provide comment. Tribal consulting parties may enter the process at any time and are encouraged to respond to this notification with any comments or concerns at their earliest convenience. Tribal contacts may contact Shaun Miller at smiller@indot.in.gov or 317-416-0876 or Kari Carmany-George at FHWA at K.CarmanyGeorge@dot.gov or 317-226-5629.

Thank you in advance for your input,

LOCHMUELLER GROUP

MEETING SUMMARY

Date of Meeting:	May 20, 2021	**Re:**	Des. No. 1900011 (DHPA No. 26693), SR 933 Bridge Project – Scope Undetermined, Bridge No. (933)31-71-03690 E (NBI No. 011046), SR 933 (Michigan Street) over St. Joseph River
Location:	Virtual	**Issue Date:**	May 26, 2021

Submitted By: Hannah Blad

In Attendance:

Mary Kennedy, INDOT CRO	Chad Costa, Lochmueller Group
Kelyn Alexander, INDOT CRO	Gary Quigg, Lochmueller Group
John Krueckeberg, INDOT PM	Hannah Blad, Lochmueller Group
Danielle Kauffmann, SHPO	Ruth Hook, Lochmueller Group
Rachel Sharkey, SHPO	Michael Vereb, Lochmueller Group
Kari Carmany-George, FHWA	
Adam Toering, Historic Preservation Commission of South Bend & St. Joseph County	

This summary is an overview of the meeting discussion and is not presented as detailed minutes, wherein each individual speaker's questions or comments are quoted as a matter of record. Although, in several areas for clarity, more precise wording from the recording of the meeting has been used for optimal representation.

ITEMS DISCUSSED:

I. **Welcome & Introductions:**
   a. The attendees listed above were introduced and their affiliations were provided.

II. **Section 106 & Indiana's Historic Bridges Programmatic Agreement Background**
   a. Hannah Blad (HB) of Lochmueller Group opened up the meeting by explaining the background of Section 106 and the National Historic Preservation Act (NHPA). HB explained Section 106 is part of the National Historic Preservation Act, a federal law requiring federal government agencies to take into account the effects of their undertakings (i.e. construction projects) on historic properties (resources either eligible for, or

listed in, the National Register of Historic Places [NRHP]). Kari Carmany-George (KCG) of the Federal Highway Administration (FHWA) was asked to provide any additional information and she noted that Section 106 applies when certain criteria are met and that usually it is federal funding that engages the Section 106 process. KCG stressed that FHWA wants to hear from the Consulting Parties regarding their concerns and that the project team is “here to listen” today as well as present information.

b. HB then went on to explain the steps of the Section 106 process and provided an outline. HB then moved on to explain the history of Indiana’s Historic Bridges Programmatic Agreement, including when the agreement was initiated, the goals of the agreement, and the management tools that came out the agreement. HB also explained the 2010 Indiana Historic Bridges Inventory, the resulting list of eligible bridges, and how they are divided into “Select” and “Non-Select” bridges and what these terms mean. The SR 933/Michigan Street Bridge is a “Select” bridge.

c. HB gave a quick review of the Section 106 process to show where the SR 933 bridge project stands now. HB noted that Step 1 has been completed and Early Coordination Letters were sent to potential consulting parties on November 2, 2020. As a result, the State Historic Preservation Officer (SHPO), Indiana Landmarks – Northern Regional Office, the Historic Preservation Commission of South Bend & St. Joseph County, and the Miami Tribe of Oklahoma have accepted consulting party status.

d. HB then talked about Step 2, the identification of historic properties, noting that a Historic Property Short Report (HPSR) was sent to consulting parties on January 28, 2021. HB also noted that an Archaeology Report will be completed, if necessary, after the final project scope has been determined. It was also brought up that a mistake was made in the consulting party invitation email. This email incorrectly noted that an Archaeology Report was available for review, but such a report has yet to be produced and will only be produced if deemed necessary after the scope of the project has been determined. Finally, HB talked about Step 3 which is the Historic Bridge Alternatives Analysis (HBAA). This step was noted as ongoing.

e. HB then moved on to reviewing the above-ground resources within the APE for the project. HB first explained what a historic property is and what criteria a property must meet to be listed in the NRHP.

f. HB then provided an overview, explaining each resource already listed in the NRHP and deemed eligible for the NRHP within the APE for the project. Each resource was shown along with a short summary of each resource.

g. HB then progressed further into defining Step 3 of the Section 106 process, the development of the HBAA, and introduced Michael Vereb (MV).

III. Step 3: Development of the HBAA

a. MV started his part of the presentation reintroducing the participants to the Michigan Street Bridge. He discussed the physical characteristics of the bridge including its type, style, construction materials, and length, width, and bridge typical section features.

b. MV then moved on to discuss the history of the rehabilitation work done to the bridge using a series of historic photos of the bridge. MV pointed out the original bridge typical section features were modified through the years including changes to the sidewalks, the addition of raised curb barriers, the removal of the historic light standards, and the replacement of the light standards. MV then brought up a timeline of the rehabilitations, noting that since its original construction in 1914, the bridge has undergone five significant rehabilitation projects.
c. MV then proceeded to talk about the structural condition of the bridge. MV first noted that railing cracking and coping deflections are an indication of underlying structural deficiencies. Next, MV pointed out the arch and pier segment displacement that has occurred. MV noted that a portion of Pier 3 settled due to undermining and that this led to the displacement of arch segments in Spans B and C. Photos were then shown of the arch segment displacement, noting that in 2013 INDOT began taking measurements at marked locations along the separation to monitor the arch segment displacement. The measurements have not appreciably changed since 2013, which means the movement appears to be stabilized.
d. MV then moved on to discuss the repairs that have been made to address the structure deficiencies. MV noted that in 2006 a cofferdam was added around each of the piers consisting of a sheet piling perimeter filled with concrete. While the addition of the concrete filled cofferdam helped to stabilize the foundations, it also added load to the existing foundations. MV noted that in 2012 deterioration of the arch rings was addressed by epoxy injection of transverse cracks, patching, and installation of Carbon Fiber Reinforced Polymer (FRP) strips. This rehabilitation did not address the differential settlement of the arch segments in Spans B and C and that condition remains today. MV further detailed the FRP strips, noting that a coating was applied to the underside of arches for UV protection of FRP and that there are some locations where the FRP strips are becoming unbonded and have peeled off the bottom of the arch, especially in Span B.
e. Finally, MV discussed the overall limestone condition of the bridge. MV noted, and showed with images, that the limestone shows different types of deterioration including spalling, weathering, and mortar joint deterioration. MV also showed images of cracking and spalling of the limestone blocks in the spandrel wall fascia.

IV. Review of Anticipated Alternatives:

a. Prior to discussing the alternatives, MV first talked about the purpose and need for the project. MV noted that the purpose and need on the slide were abbreviated versions. The purpose and need statements are below:

1. The primary need for the Michigan Street Bridge project is evidenced by the deteriorated condition and insufficient load capacity of the bridge. In addition, the sidewalk on the east side of the bridge does not meet current Americans with Disabilities Act (ADA) standards.
2. The purpose of the project is to provide a crossing of the St. Joseph River that has a condition rating of at least 7 out of 9, which is considered to be in "good" condition, as well as provide ADA-compliant pedestrian facilities. In addition, the purpose of the project is to improve the load rating factor. This project will extend the life of this crossing for a minimum of 25 years.

b. MV then described the three alternatives, first discussing the No Build Alternative. MV stated that the No Build alternative would not result in any work being done to the structure and leaving it as is. MV also noted that this alternative is not feasible because the current structure has an estimated remaining service life of 5 to 10 years until rehabilitation or reconstruction is needed.

c. The second alternative MV discussed was Alternative B1a which is the Rehabilitation for Continued Vehicular Use Meeting Secretary of the Interior's Standards for Rehabilitation, including arch and foundation rehabilitation. Plan sheets were shown with colors indicating what would be removed and replaced and what would be removed, repaired, and reinstalled on the bridge. This alternative includes the removal and storage of light standards and limestone for repair and replacement. The pier foundations will be strengthened, a portion of the arch where the displacement has occurred will be reconstructed, all the arches will be patched and waterproofed, the spandrel walls will be reconstructed, the arch fill will be replaced, and the pavement/curb barrier/sidewalks will be reconstructed.

d. The third alternative MV discussed was Alternative B1b which is the Rehabilitation for Continued Vehicular Use Meeting Secretary of the Interior's Standards for Rehabilitation, including arch and foundation replacement. Similar to the second alternative the limestone and light standards will be removed and stored before they are repaired and replaced on the rehabilitated structure. This alternative includes the construction of a new abutment and pier foundations on new piling. The arches will be reconstructed and waterproofed. The spandrel walls will be reconstructed, the arch fill replaced, and the concrete pavement/curb barrier/sidewalks will also be reconstructed.

e. Following the alternatives, MV showed an image of both elevations of the bridge where the current limestone and concrete conditions are color coded. The yellow-colored limestone fascia and railing post and pilaster elements (as shown on the image) would be removed and replaced on the rehabilitated structure to match the existing appearance. The red colored limestone (as shown on the image) indicated damaged limestone that will either be repaired or replaced in-kind. MV noted that the light blue rail panels (as shown on the image) are the existing concrete panels and they will be replaced in-kind. MV pointed out two purple colored rail panels (as shown on the image) on the east elevation on the south end of the bridge. These are the only two remaining rail panels constructed of limestone. MV noted the intent of the project is to preserve the limestone railing panels and place them back in their location with the rehabilitation. The next slide showed images of the two remaining limestone railing panels and their current condition.

V. **Summary Remarks/Next Steps:**

a. Following the discussion of the alternatives, HB talked about the next steps for the project which includes the distribution of the meeting summary, the acceptance of consulting party comments regarding the consulting party meeting, and the eventual distribution of the HBAA.

b. Danielle Kauffmann (DK) asked for clarification regarding the replacement of the concrete rails, asking if they will be replaced in-kind and if the only two existing limestone panels will be the only limestone railing panels on the bridge following the reconstruction. MV concurred with DK's statement, noting that concrete rails will be replaced in-kind with concrete rails and that only the two existing limestone railing panels will continue to be constructed of limestone following the rehabilitation alternatives as currently planned. MV noted that as early as 1945, limestone panels were replaced on the bridge which indicates that the material was and is not ideal to use in the railing area of the bridge. MV also noted that some of the historic aesthetic details of the original railing panels might be restored in the reconstructed concrete railing panels, as over time the previous rail replacements were not sympathetic to the original design of the bridge.

c. Mary Kennedy (MK) asked if replacing the concrete rails in-kind was a cost issue, deadweight issue, a combination of the two, or another issue entirely. MV indicated that it was not a structural issue, but that it would be a cost issue that would prevent putting limestone railings throughout the structure. MK asked if there were durability issues with the limestone railings. MV concurred with this statement, noting that starting in 1945 the panels began to be replaced. He noted that weathering and maintenance issues likely resulted in the replacement of the limestone railing panels. John Krueckeberg (JK) asked MV if the concrete railings could be stamped to look like limestone or somehow given the appearance of limestone. MV concurred with that statement. JK then asked HB if the material or the aesthetic would be more important to the historic nature of the bridge. HB noted that both the material and aesthetic are important but that if the material used in the original construction has long term maintenance issues, a comparable material would be acceptable. HB noted that if the concrete can be made to look more like limestone, the bridge would retain a higher level of historic aesthetic. MV and JK continued to talk about the use of concrete. MV noted that aggregate can be seen in the concrete panels and that it could be possible to stamp them or texturize the replacement panels to look similar to limestone. HB asked if the salt use (for ice melt on the pavement) on the bridge can be attributed as the main cause of the deterioration of the limestone railing panels. MV agreed that the use of the salt could be a cause of the deterioration and noted that the remaining two panels do seem to indicate that, since the one closer to the road has significantly more deterioration than the other panel. MV also noted that in general the varied degree of limestone deterioration in the individual blocks could be the nature of the material, depending on where they were extracted from as evidenced by similar weathering of fascia blocks on the spandrel walls which are not directly exposed to road salt. Adam Toering (AT) asked if the remaining limestone panels were located at the end of the bridge where the railing flares. MV confirmed that the remaining limestone panels are located at the southeast corner of the bridge.

d. AT then asked about the lifespan option associated with the alternatives, noting that the bridge currently has a lifespan of 5-10 years, but wondered if the other two options had an anticipated lifespan of 25 years or a longer outcome. MV noted that the full replacement of the foundations and arches would result in an anticipated lifespan of about 75 years, while the rehabilitation of the foundations and arches would be less, the exact lifespan amount is unknown at this time. MV brought up the fact that the bridge has load restrictions and that the foundation fixes in the past have added additional weight. These problems will persist even after the rehabilitation.

e. MK noted that the bridge is a local historic landmark and due to local preservation ordinances, a Certificate of Appropriateness (COA) will be needed for the work on the bridge. MK asked AT if any of the proposed alternatives would cause problems with getting an approved COA, and that INDOT should be looking out for any problems the work will cause with regard to getting an approved COA. AT noted that he thinks the alternatives will be able to be approved administratively because of how the bridge will be reconstructed. AT noted that if the footprint changed or if the light standards were removed, that's when such an issue would come up and the COA would need to go in front of the board. AT reiterated that tentatively he thinks either alternative could be approved but noted that a lot of review needs to happen before the application can be approved.

f. No other questions were asked, and HB concluded the meeting.

VI. Next Steps

a. Consulting Parties have 30 days to provide comments on the preliminary alternatives. Comments are expected by June 25, 2021.

The meeting concluded at approximately 10:57 am.

Meeting Summary prepared by Hannah Blad and Gary Quigg

The above constitutes our understanding of the meeting. If you believe there are omissions, additions, or corrections, please send your written comments within seven working days to Lochmueller Group.

DNR Indiana Department of Natural Resources

Eric Holcomb, Governor
Daniel W. Bortner, Director

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June 1, 2021

Hannah Blad
Section 106/Historian
Lochmueller Group
112 W. Jefferson Boulevard, Suite 500
South Bend, Indiana 46601

State Agency: Indiana Department of Transportation ("INDOT")
Federal Agency: Federal Highway Administration, Indiana Division ("FHWA")

Re: DUAL REVIEW: Consulting party meeting summary for the SR 933 Bridge Project over the St. Joseph River (Scope Undetermined), South Bend, St. Joseph County, Indiana (Des. No. 1900011; DHPA No. 26693)

Dear Ms. Blad:

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended (54 U.S.C. § 306108); implementing regulations at 36 C.F.R. Part 800; the "Programmatic Agreement Among the Federal Highway Administration, the Indiana Department of Transportation, the Indiana Historic Preservation Officer, and the Advisory Council on Historic Preservation Regarding Management and Preservation of Indiana's Historic Bridges" ("Indiana Historic Bridges PA"); and the "Programmatic Agreement (PA) Among the Federal Highway Administration, the Indiana Department of Transportation, the Advisory Council on Historic Preservation and the Indiana State Historic Preservation Officer Regarding that Implementation of the Federal Aid Highway Program In the State of Indiana" ("Indiana Minor Projects PA"); and also pursuant to Indiana Code 14-21-1-18 and 312 Indiana Administrative Code ("IAC") 20-4, the staff of the Indiana State Historic Preservation Officer ("Indiana SHPO") has reviewed your April 26, 2021 submission which enclosed the invitation to the May 20, 2021 consulting parties meeting. We received the subsequent meeting summary May 26, 2021.

Danielle Kauffmann and Rachel Sharkey of my office virtually attended the May 20, 2021 consulting parties meeting. Regarding the meeting summary, we have no corrections to suggest. While the exact scope of work for the project is not yet determined, we note that the project's purpose and need is to improve the condition of the bridge, extend the overall life of the structure, and provide ADA accessible sidewalks across the bridge.

As we asked at the meeting, we are curious about the differences in cost, project life, and feasibility between replacing the concrete railings in-kind or instead with limestone as it was originally constructed. We note that the meeting mentioned stamping the concrete to mimic the appearance of limestone, however, we caution creating a false sense of history by some of the design ideas mentioned.

We look forward to reviewing the Historic Bridges Alternatives Analysis that will go into greater detail the specifics of the two proposed rehabilitation alternatives discussed at the meeting.

SHPO Comments to Consulting Parties Meeting Summary
Page 2 of 3

As indicated in INDOT’s April 26 distribution letter and again in the meeting summary, information on archaeological investigations, if needed, will be provided after the scope of work for this project is finalized.

If you have questions regarding our dual review of the aforementioned project, please contact DHPA. Questions about archaeological issues should be directed to Rachel Sharkey at (317) 234-5254 or rsharkey@dnr.IN.gov. Questions about historic buildings or structures pertaining to this review should be directed to Danielle Kauffmann at (317) 232-0582 or dkauffmann@dnr.IN.gov.

For the benefit of those recipients of a copy of this letter who are not Section 106 consulting parties, please be aware that the documents discussed here can be found online in IN SCOPE at http://erms.indot.in.gov/Section 106Documents/. From there, search by this project’s designation number: 1900011. Anyone receiving an e-mailed copy of this letter who does *not* wish to receive future copies of our correspondence about this bridge project is asked to reply to dkauffmann@dnr.IN.gov and so advise us.

In all future correspondence regarding the dual review of this bridge project on SR 933 over the St. Joseph River in South Bend, St. Joseph County (Des. No. 1900011), please continue to refer to DHPA No. 26693.

Very truly yours,

Chad W. Slider

Beth K. McCord
Deputy State Historic Preservation Officer

BKM:DMK:dmk

EMC to federal and state agency or consultant staff members
Kari Carmany-George, FHWA
Anuradha Kumar, INDOT
Mary Kennedy, INDOT
Shaun Miller, INDOT
Susan Branigin, INDOT
Hannah Blad, Lochmueller Group
Chad Costa, Lochmueller Group
Danielle Kauffmann, DNR-DHPA
Rachel Sharkey, DNR-DHPA

EMC to Indiana Historic Preservation Review Board Members:
J. Scott Keller, Review Board
Daniel Kloc, Review Board
Jason Larrison, Review Board
Chandler Lighty, Review Board
Beth McCord, DNR-DHPA, Review Board
Ryan Mueller, Deputy Director DNR, Chairman, Review Board
Anne Shaw, Review Board
April Sievert, Review Board

EMC to potentially interested persons:
Eastern Shawnee Tribe of Oklahoma
Forest County Potawatomi Community
Miami Tribe of Oklahoma
Peoria Tribe of Indians of Oklahoma
Pokagon Band of Potawatomi Indians
Shawnee Tribe

Michiana Area Council of Governments

St. Joseph County Commissioners
St. Joseph County Historian
The History Museum
Historic Preservation Commission of South Bend/St. Joseph County
Indiana Landmarks, Northern Regional Office
St. Joseph County Highway Department
City of South Bend Venues Parks & Arts
Honorable James Mueller, Mayor of South Bend
City of South Bend, City Engineer
Dr. James L. Cooper, DePauw University, Professor Emeritus of History
Paul Brandenburg, Indiana Historic Spans Task Force
Tony Dillon, Historic Hoosier Bridges
Nathan Holth, Historicbridges.org
Kitty Henderson, Historic Bridge Foundation
South Bend Common Council