Millennia Professional Services, Ltd

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Structural Geotechnical Report

IL 37 over Unnamed Stream
FAP 724, Section 1B-2
Jefferson County, Illinois
PTB190-035
Existing Structure 041-0031
Proposed Structure 041-2023

Prepared For:
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MPS Project Number MG19034.07
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FAP 724, Section 1B-2
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Existing Structure 041-0031
Proposed Structure 041-2023

1.0 Project Description and Proposed Structure Information

1.1 Introduction

This report summarizes the results of a geotechnical investigation performed for the design of the culvert replacement carrying Illinois Route 37 over the unnamed creek in Jefferson County, Illinois. The purpose of this study was to provide a geotechnical assessment of the planned replacement structure, based on subsurface conditions encountered at two borings performed by the Illinois Department of Transportation (IDOT) in September, 2018. This report describes the exploration procedures used, presents the field and laboratory data, includes an assessment of the subsurface conditions in the area, and provides geotechnical recommendations for the construction.

1.2 Project Description

The project consists of the removal and replacement of the existing bridge. The general site area is shown on the attached Vicinity Map, Figure 1 in Appendix A. A plan that shows the approximate locations of the borings performed for this study is presented as the TS&L Plan, Figure 2 in Appendix A. The unnamed creek is oriented east and west beneath the existing roadway and flows in a eastern direction. The existing structure consists of a short, three-span bridge supported by shallow foundations. It is our understanding that the existing structure will be replaced with new triple box culvert with a slight grade raise along the roadway. Based on the information provided, staged construction will be required to maintain traffic during construction. One lane of traffic will be maintained at all times.

1.3 Proposed Structure Information

The proposed structure will consist of a triple box culvert with each cell having dimensions of approximately 10 feet wide, about 43 feet long, and an opening of approximately 8 feet in height. The culvert will be a cast-in-place structure with horizontal cantilevered wingwalls with a maximum height of about 12 feet.

2.0 Subsurface Exploration and Laboratory Testing

2.1 Subsurface Exploration

On September 26 and 27, 2018, IDOT conducted a subsurface exploration at the site, consisting of two soil borings, designated as Borings 1-S and 2-S. The approximate locations of the borings are indicated on the TS&L Plan, Figure 2.

The borings were advanced using hollow-stem auger drilling methods. Samples were obtained at 2.5-foot intervals to boring termination. The borings were extended to depths of approximately 14.5 and 25 feet. Split-spoon samples were recovered using a 2-inch outside-diameter sampler, driven by a 140-pound hammer. The split-spoon samples were placed in containers for later testing at the District's laboratory. The sampling sequence for each boring is summarized on the boring logs in Appendix B.

Unconfined compression tests were performed on selected split-spoon samples using a Rimac field testing machine. The resulting unconfined compressive strengths are reported on the boring logs.

2.2 Laboratory Testing

A laboratory testing program consisting of natural moisture contents was conducted by IDOT to determine selected engineering properties of the obtained soil samples. The results of the individual tests are presented on the boring logs in Appendix B.

3.0 Subsurface Conditions

Details of the subsurface conditions encountered at the borings are shown on the boring logs. The general subsurface conditions encountered and their pertinent engineering characteristics are described in the following paragraphs. Conditions represented by the borings should be considered applicable only at the boring locations on the dates shown; the reported conditions may be different at other locations and at other times.

3.1 Generalized Subsurface Profile

The existing pavement section encountered at the borings consists of approximately 12.0 inches of asphalt and crushed limestone gravel.

Cohesive soils encountered at the site are predominantly made up of silty loam, clay loam, silty clay and silty clay loam. The upper approximately 12 feet of the soil profile at Boring 2-S is likely existing fill, since the boring encountered a concrete obstruction below that depth. Moisture contents vary from 20 to 29 percent. The standard penetration test (N) values range from weight-of-hammer (0) to 8 blows per foot (bpf), with one value of 15 bpf recorded on a sample containing weathered shale fragments. Rimac unconfined compression test values on samples range from 0.3 to 2.5 tons per square foot (tsf).

Natural granular soils were encountered below the cohesive layer at Boring 2-S and generally consist of clayey sand with a variable content of weathered sandstone. N-values in the granular soils of 10 bpf were observed, with a moisture content of 17 percent.

Sandy clay shale or sandstone bedrock was encountered below the natural soils at both boring locations. The southern Boring 1-S encountered bedrock noticeably shallower than the northern Boring 2-S. Bedrock was encountered at a depth of about 12 feet (elevation 425.8) at Boring 1-S and at a depth of about 24.5 feet (elevation 413.0) at Boring 2-S. The horizontal distance between the two borings is approximately 43 feet. MPS believes that the creek channel may have meandered and incised deeper in areas of the site over the course of its history. N-values in the bedrock vary from 100 blows for 4 inches of penetration to 100 blows for 2 inches of penetration.

3.2 Groundwater

Groundwater was observed at Boring 2-S during drilling, at a depth of 20 feet (Elevation 417.5). The presence or absence of groundwater at a particular location does not necessarily indicate that groundwater will be present or absent at that location at other times. Groundwater levels may vary significantly over time due to the effect of seasonal variations in precipitation, the water level in the unnamed creek tributary or other factors not evident at the time of exploration. The surface water level at the creek was measured to be at Elevation 427.2 during the field exploration.

4.0 Geotechnical Evaluations

4.1 Slope Stability

Grade changes will be minimal along the roadways. Therefore, slope stability is not a concern at this time.

4.2 Settlement

The proposed grade changes will be minimal for the new culvert profile. Therefore, issues related to significant settlement are not anticipated relating to the roadway grade changes.

Foundation soils consisting of very hard sandy clay shale near the southern portion of the site and soft, silty clay is anticipated to be encountered beneath the planned culvert at northern portion of the site. The thickness of the soft soil varies from about 7 to 8 feet. Millennia understands the existing bridge structure has been supported by spread footings for many years, without displaying signs of possible distress or significant settlement. The anticipated loading conditions for the planned culvert will be significantly less than the existing bridge foundation loads.

For the planned box culvert, MPS recommends that the soils be overexcavated about 3 feet to approximately Elevation 422.5 at the northern end. The soft soils should be replaced with compacted, crushed limestone such as RR-01 or CS-01, per the Special Provision for Aggregate Subgrade Improvement for subgrade thicknesses of more than 12 inches. An initial bridge lift of larger crushed stone such as CS-01 may be needed if the gradation of RR-01 is chosen. If areas of subgrade replacement of less than 12 inches are exposed during the excavation, then a smaller aggregate gradation, such as CA-6 would also be applicable. The compacted fill should be capped with 6 inches bedding consisting of CA-7. It is recommended that a non-woven geotechnical fabric be placed to separate the aggregate improvement and CA-7 aggregate cap material. We recommend showing the overexcavation underneath at least half of the planned culvert, due to the change in bedrock elevation between the two borings. MPS also recommends that the removal and replacement extend a minimum of 2 feet beyond each side of the culvert.

The southern portion of the culvert will likely bear on clayey shale. MPS recommends including a bid item for rock removal on the order of about 1 to 1.5 feet to achieve the bearing elevation for the culvert at this portion of the site. Wing walls are shown as approximately 3 feet below the flow elevation (Elevation 423.6 to 423.4). Additional rock removal may be needed to install the horizontal cantilever wing walls. A ripper tool on a trackhoe may be sufficient in removing the clayey shale bedrock at the site. A minimum of 6 inches of CA-7 bedding should be placed beneath the planned culvert.

The limits and quantities of removal and replacement may be modified by the District Geotechnical and Field Engineers for variable surface conditions encountered in the field. This is based on the understanding that the bearing elevation of the proposed box culvert will be approximately 425.5.

Any undercutting should be conducted in such a manner that limits or minimizes the potential for disturbance of the subgrade. To prevent unnecessary disturbance of the subgrade soils, trucks and other heavy construction vehicles should be restricted from traveling through the finished

subgrade area. If disturbed areas develop, they should be reworked and compacted as necessary. These remedial actions will likely improve the bearing capacity of the planned culvert.

Based on the conditions encountered at the boring locations, the understanding that the subgrade soils have been essentially preloaded by the existing bridge foundations, along with the understanding that the proposed undercutting recommendations will be implemented, the maximum anticipated settlement of the proposed box culvert should be no more than one inch, and the maximum differential settlement should be less than one half the total settlement. The majority of the settlement should take place during construction as the structural loads are applied to the foundation.

4.3 Scour

Per All Bridge Designers Memorandum 14.2, design scour elevations for box culverts are not required as part of design.

4.4 Seismic

Per page 3-2 of the 2017 Culvert Manual, buried structures such as culverts are not designed for seismic effects.

5.0 Construction Considerations

5.1 Groundwater Control

The estimated water surface stream elevation is approximately 431.8. The groundwater level may fluctuate due to seasonal variations and other considerations that may not have been evident at the time the measurements were made, which may require temporary water diversion and control. Groundwater seepage into the excavations should be anticipated and the contractor should be prepared to handle dewatering the excavations. We believe that dewatering measures consisting of stream diversion will be required.

If groundwater conditions encountered during construction differ than those observed during the course of this study, then MPS should be consulted for additional guidance on groundwater control options.

5.2 Excavations

The construction activities should be performed in accordance with the current IDOT Standard Specifications for Road and Bridge Construction. Trenching, excavating, and bracing should be performed in accordance with Occupational Safety and Health Administration (OSHA) regulations, and other applicable regulatory agencies. All soil materials present throughout the project, whether fill, alluvium, or other, and whether or not saturated, are considered Class C, which requires a side slope for excavations no steeper than 1.5H:1.0V. However, worker safety and classification of the excavation soil is the responsibility of the contractor. According to OSHA requirements, any excavation extending to a depth of more than 20 feet must be designed by a registered professional engineer. We are currently unaware of any excavations at a depth of 20 feet or more for this project. Where the excavation lies within the zone of influence of existing pavements, buildings, utilities, or other structures, the integrity of those elements should be maintained by a properly designed earth retention system, underpinning, or other suitable means.

Portions of the excavations may be constructed within a few feet horizontally of existing utilities. Some of these utilities are likely backfilled with granular material. The granular backfill may contain free water and could be unstable when excavating beneath or adjacent to it. The undermining of these utilities and the adjacent area could occur due to running and caving of the granular backfill and surrounding soils. Temporary support of any utilities, if present, that cross over or lie adjacent to the excavations will likely be required.

We understand the project is planned to be constructed via staged construction. Due to the shallow bedrock observed at the south end of the site, a temporary soil retention system may be needed in this general area instead of sheet piling. Temporary sheet piling may be possible at the north end of the project, depending on the overall height of retained soil and the depth necessary to achieve fixity for sheet piles. The contractor should be aware of the change in bedrock surface noted between the two boring locations when selecting a temporary shoring system.

6.0 Closing

This report has been prepared for the exclusive use of Oates Associates, Inc. and the Illinois Department of Transportation for use in the design and construction of the proposed culvert replacement project in Jefferson County, Illinois. This report has been prepared in accordance with generally accepted soil and foundation engineering practices. No other warranty, expressed or implied, is made to the professional advice and recommendations included herein. This report is not for use by parties other than those named or for purposes other than those stated herein. It may not contain sufficient information for the use of other parties or for other purposes.

If there is a substantial lapse of time between the submission of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, this report should be reviewed by MPS to determine the applicability of the analyses and recommendations considering the changed conditions and time lapse. The report should also be reviewed by MPS if changes occur in structure location, size, and type, or in the planned loads, elevations, grading plans, and project concepts.

These analyses and recommendations are based on data obtained from site reconnaissance, the borings performed for this study and other pertinent information presented herein. This report does not reflect any variations between, beyond, or below the borings. Should such variations become evident, it may be necessary to re-evaluate the recommendations of this report after performing on-site observation during the construction period and noting the characteristics of any such variation.

We appreciate this opportunity to be of service to you and would be pleased to discuss any aspect of this report with you at your convenience.

Sincerely,

Millennia Professional Services of Illinois, Ltd.

Jacob A. Schaeffer, P.E.
Project Manager

Appendix A:

Figure 1: Vicinity Map
Figure 2: TS&L Plan
Figure 3: Subsurface Profile

Millennia Professional Services

11 Executive Drive, Suite 12, Fairview Heights, IL 62208

Phone: (618) 624-8610

Fax: (618) 624-8611

Project No.: MG19034.07

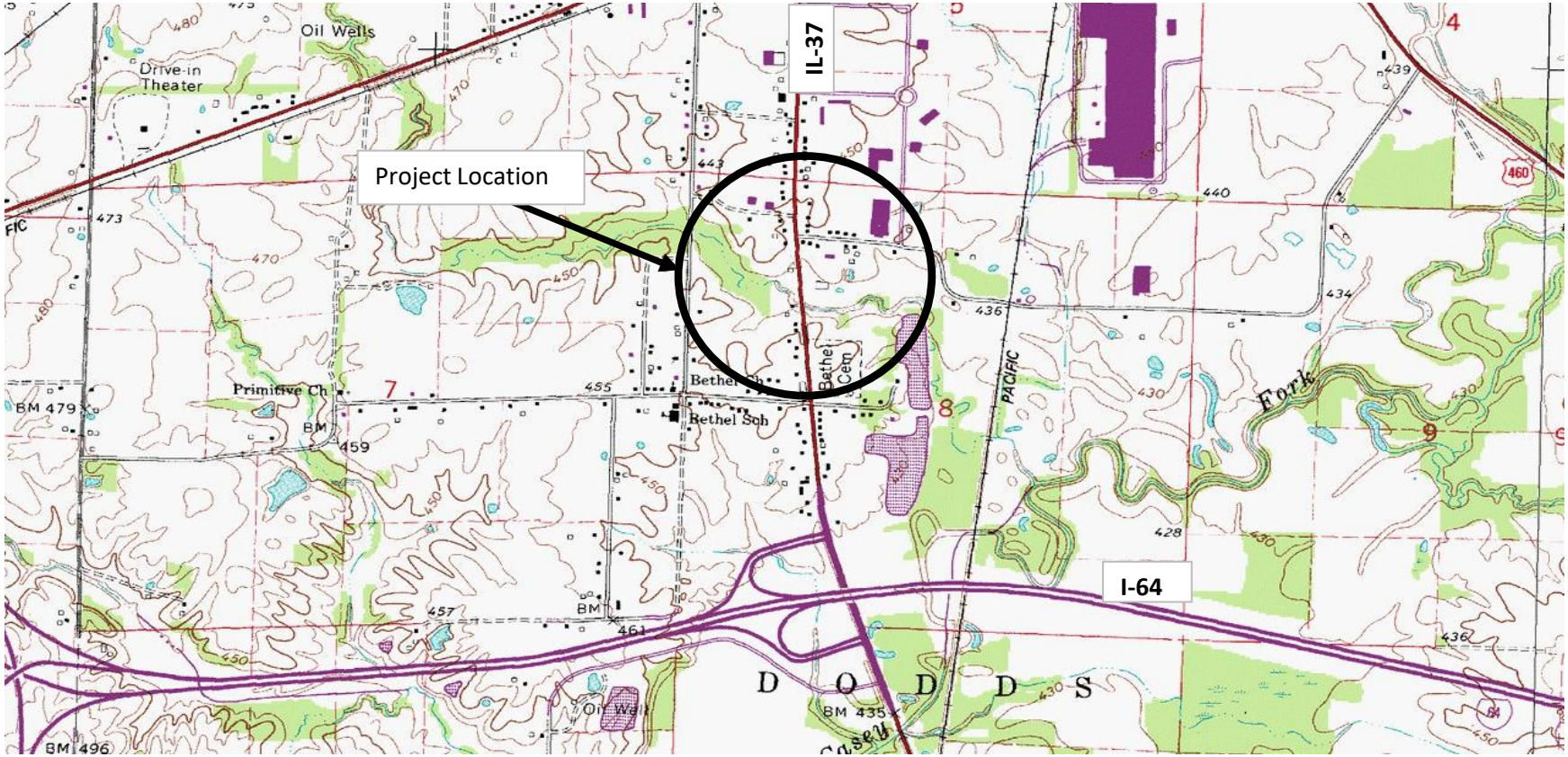


	FIGURE 1: VICINITY MAP			
N	IL-37 over Unnamed Stream Jefferson County, Illinois			
Project location designated by the black box at the center of the map	Drawn by:	B. Fisher	Checked by:	JAS
Image obtained from TopoQuest *Not to scale	Project No.:	MG19034.07	Date:	7/29/2020

Bench Mark: Chiseled "L" on NE corner of SW Wingwall of SN 041-0031, 18'± from ℄ IL 37 – Elev 437.16

Existing Structure: S.N. 041-0031 was originally built in 1921 as part of SBI Route 37, Section 1B. The original existing structure is a single span concrete through girder bridge on closed concrete abutments supported by spread footings. The structure was widened in 1952 by adding a 3 span reinforced concrete slab on each side of the bridge and is 28'-0" face to face of abutment backwalls with a clear width of 37'-4"±.

Traffic Control: One lane of traffic will be maintained by utilizing staged construction.

No Salvage.

Precast alternate not allowed.

WATERWAY INFORMATION

Drainage Area = 2.7 Sq Mi

Exist Overtopping Elev. 437.41 @ Sta. 87+00
Prop Overtopping Elev. 437.41 @ Sta. 87+00

Flood	Freq. Yr.	Q C.F.S.	Opening Ft² Exist.	Opening Ft² Prop.	Nat. H.W.E.	Head – Ft. Exist.	Head – Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	1,005	161	233	434.6	0.7	0.1	435.3	434.7
Design	50	1,500	169	233	435.3	1.1	0	436.4	435.3
Base	100	1,715	169	233	435.6	1.7	0.4	437.3	436.0
OVT (E)	100	1,715	169		435.6	1.7		437.3	
OVT (P)	500	2,325		233	436.2		1.4		437.6
Max. Calc.	500	2,325	169	233	436.2	2.2	1.4	438.4	437.6

10 Year Velocity through Existing Structure = 6.06 fps
10 Year Velocity through Proposed Structure = 4.32 fps

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

DESIGN STRESSES

FIELD UNITS

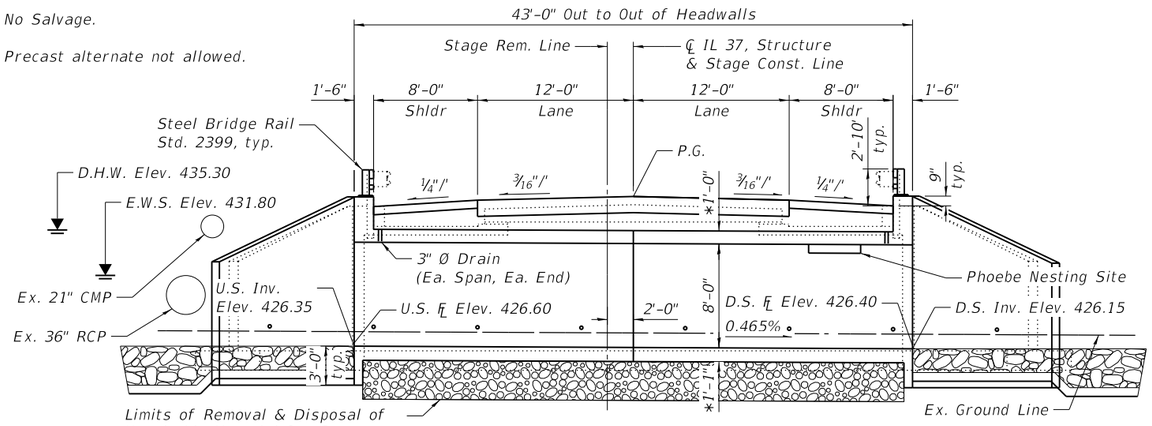
f'c = 3,500 psi
fy = 60,000 psi (Reinforcement)

HIGHWAY CLASSIFICATION

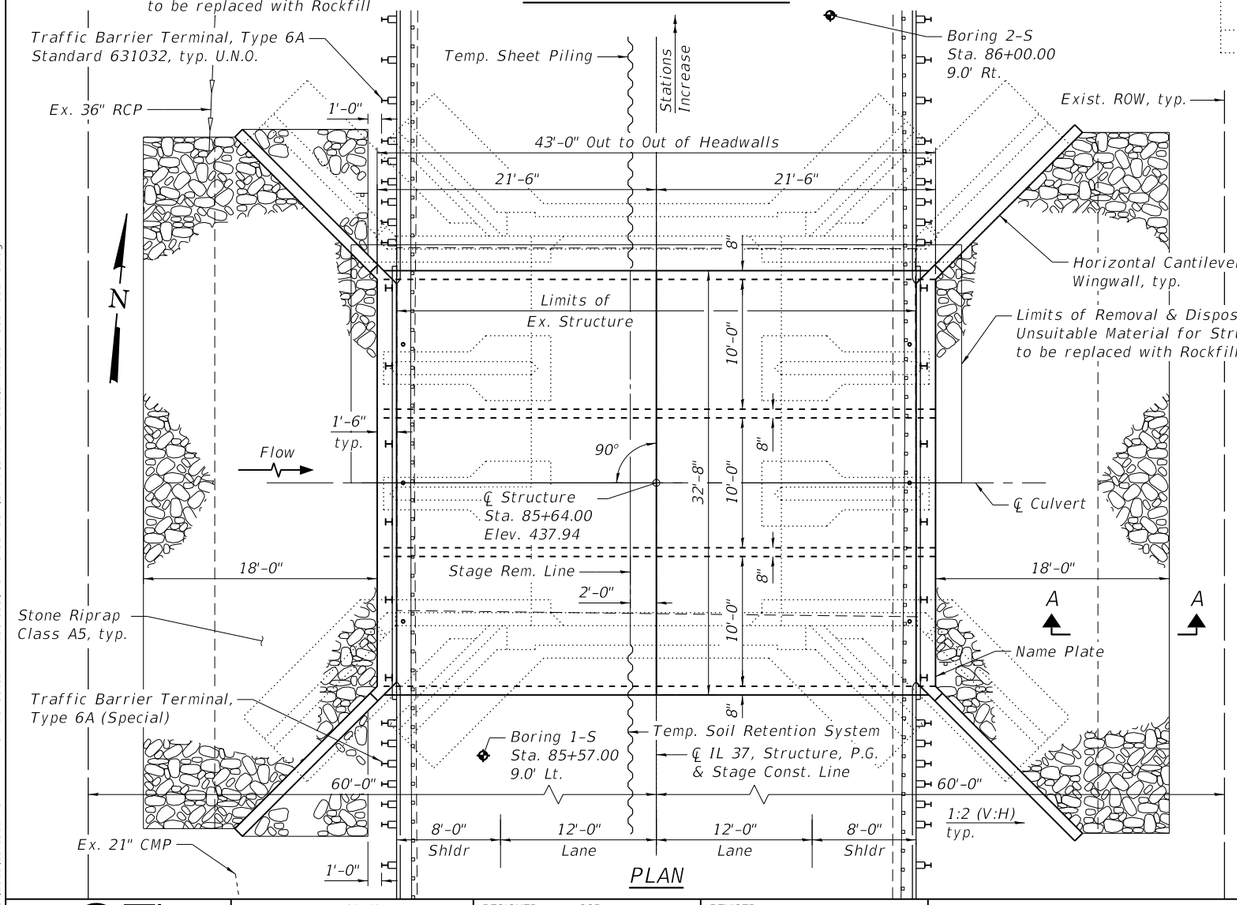
F.A.P Rte. 724 – IL 37
Functional Class: Other Principal Arterial
ADT: 6,000 (2017); 6,970 (2032)
ADTT: 550 (2017); 640 (2032)
DHV: 625 (2032)
Design Speed: 50 m.p.h.
Posted Speed: 45 m.p.h.
2-Way Traffic
Directional Distribution: 50/50

LOADING HL-93

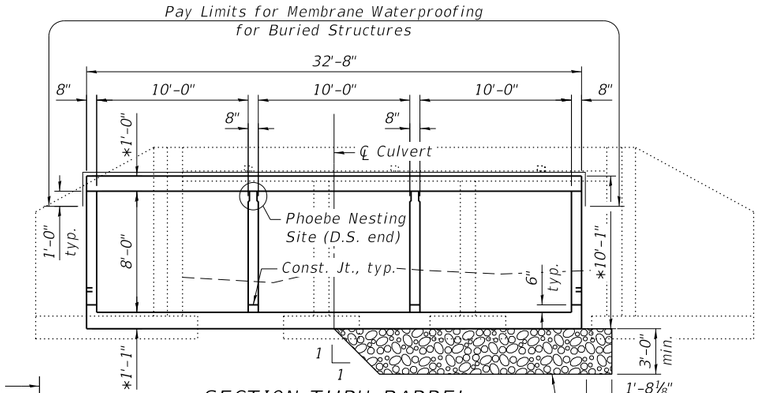
Allow 50#/sq. ft. for future wearing surface.



LONGITUDINAL SECTION



PLAN

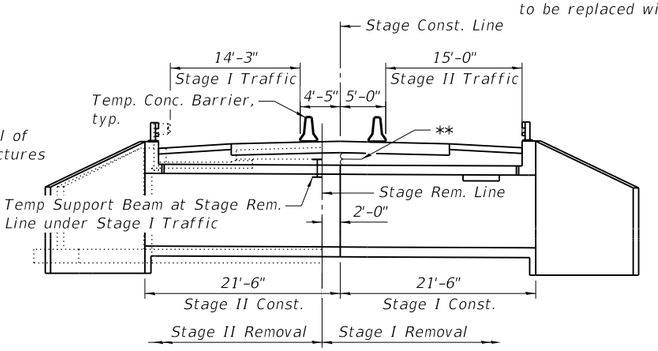


SECTION THRU BARREL

(Looking West)

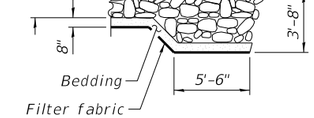
* Slab thickness to be refined in final design

Note:
Excavation behind existing abutment walls shall be performed to balance front and back soil pressure before removing the existing superstructure.



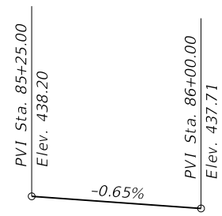
STAGE CONSTRUCTION SKETCH

(Looking North)



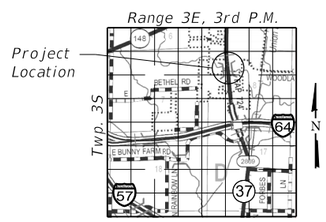
SECTION A-A

** Contractor shall retain the backfill material during the construction of the culvert. Cost included in Concrete Pavement



PROFILE GRADE

(Along ℄ IL 37)



LOCATION SKETCH

GENERAL PLAN & ELEVATION
IL 37 OVER UNNAMED STREAM
F.A.P. RTE. 724 – SEC. 1B-2
JEFFERSON COUNTY
STATION 85+64.00
STRUCTURE NO. 041-2023

QUIGG ENGINEERING INC

USER NAME = rwhiteside	DESIGNED - SCD	REVISED -	
0412023-78684-001-TSL.dgn	CHECKED - RPW	REVISED -	
PLOT SCALE = 0:2.0000 ':' / in.	DRAWN - SCD	REVISED -	
PLOT DATE =	CHECKED - MDC	REVISED -	

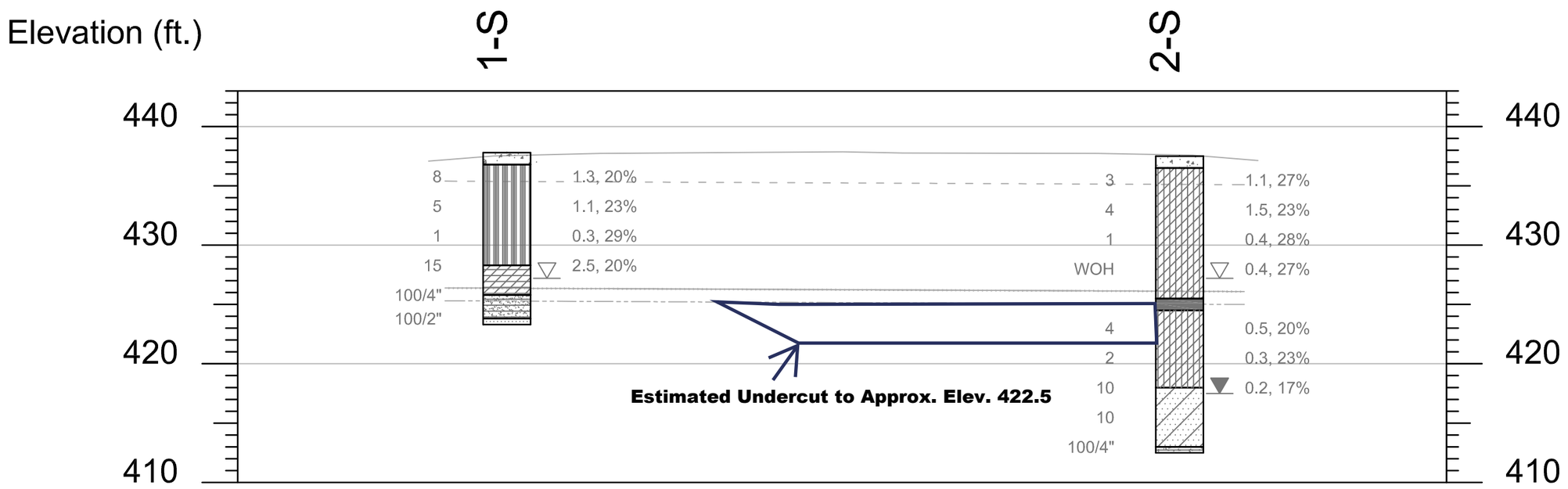
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET 1 OF 1 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
724	1B-2	JEFFERSON		
		CONTRACT NO. 78684		
	ILLINOIS	FED. AID PROJECT		

MODEL: Default
FILE NAME: S:\2019\19IL011 Var Ph III IDOT D9 Oates PTB 190-035\Work Order 3&7\CADD\CADD Sheets\0412023-78684-001-TSL.dgn
8/4/2020 9:05:27 AM

STRUCTURE NO. 041-0031



Note: Elevations are approximate. Actual conditions between borings are unknown, and are subject to change. Horizontal scale shown is only for reference.

LITHOLOGY KEY:

- CLAY LOAM W/ CLAY SHALE
- PAVEMENT AND GRAVEL
- SILTY CLAY
- CLAYEY SAND W/ SANDSTONE
- SANDSTONE
- SILTY LOAM
- OBSTRUCTION
- SANDY CLAY SHALE

TRENDLINE KEY:

- APPROXIMATE GROUND SURFACE ELEVATION
- APPROXIMATE FLOWLINE ELEVATION
- APPROXIMATE TOP OF CULVERT ELEVATION
- APPROXIMATE BOTTOM OF CULVERT ELEVATION

BORING DATA KEY:

Boring ID

N-Value (bpf) | Lithology

Rimac Value (tsf) , Moisture Content (%)

Surface water elevation

Groundwater level encountered while drilling

FIGURE 2

SUBSURFACE PROFILE

PROJECT NAME:	PROJECT No.:	DRAWN BY:	CHECKED BY:
Work Order No. 7 IL 37 over Unnamed Stream	MG19034.07	B. FISHER 07/27/2020	J. SCHAEFFER 07/27/2020

MILLENNIA PROFESSIONAL SERVICES

Appendix B:

Boring Logs

Illinois Department of Transportation

Memorandum

To:	Carrie Nelsen	Attn: David Piche
From:	Keith Roberts	By: Aaron Hayes RG AWH
Subject:	Structure Boring Logs	
Date:	December 18, 2018	

FAP 724 (IL 37)
Jefferson County
SN 041-0031 (Existing)

Attached are boring logs for the design of a replacement structure for Structure No. 041-0031 in Jefferson County.

AWH:ah
Attachments

cc: Soils File\Jefferson Co.\Structure Borings

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAP 724 (IL 37) Over Stream — Sheet 1 of 1

Route: IL 37 — Structure Number: 041-0031 — Date: 9/27/2018

Section 1B-2 — Bored By: L Estel

County: Jefferson — Location: 1.5 mi South of IL 148 — Checked By: A Hayes

Boring No 1-S
Station ~~86+57~~ 85+57
Offset 9' LT of CL
Ground Surface 437.8 Ft

Surf Wat Elev: 427.2
Ground Water Elevation
when Drilling
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%	DEPTH	BLOWS	Qu tsf	W%
Cored pavement, 12" HMA and GRAVEL 436.8				Bottom of hole at 14.5 feet			
				No free water observed			
	1						
Stiff Brown, Moist SILTY LOAM A-6	4	1.3S	20				
	4						
				Elevation referenced to BM on SW Wingwall of SN 041-0031			
5.0	1			Chiseled "L", Elev. = 437.16	30.0		
	3	1.1B	23				
	2			Borehole advanced with hollow stem auger (8" O.D., 3.25" I.D.)			
430.8							
	1			To convert "N" values to "N60" multiply by 1.5			
Soft Brown, Wet SILTY LOAM A-6	WH	0.3B	29				
	1						
428.3							
10.0	2				35.0		
V. Stiff Brown, Damp CLAY LOAM with weathered CLAY SHALE	7	2.5S	20				
	8						
425.8							
Hard Brown, Damp SANDY CLAY SHALE	15						
	100/4"						
423.8							
Hard Brown to Tan, Dry SANDSTONE	100/2"						
15.0					40.0		
20.0					45.0		
25.0					50.0		

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)

ILLINOIS DEPARTMENT OF TRANSPORTATION
District Nine Materials

Bridge Foundation Boring Log

FAP 724 (IL 37) Over Stream — Sheet 1 of 1

Route: IL 37 — Structure Number: 041-0031 — Date: 9/26/2018

Section 1B-2 — Bored By: L Estel

County: Jefferson — Location: 1.5 mi South of IL 148 — Checked By: A Hayes

Boring No 2-S
Station 86+00
Offset 9' RT of CL
Ground Surface 437.5 Ft

Surf Wat Elev: 427.2
Ground Water Elevation
when Drilling 417.5
At Completion
At: Hrs:

DEPTH	BLOWS	Qu tsf	W%		DEPTH	BLOWS	Qu tsf	W%
Cored Pavement, 12" HMA and GRAVEL 436.5					CLAY SHALE			
	1							
Stiff Brown, Moist SILTY CLAY A-6	1	1.1B	27					
	2							
5.0	1				30.0			
	2	1.5B	23	Bottom of hole at 25 feet				
	2							
430.5				Free water observed at 19.5 feet				
	1			Elevation referenced to BM on				
Soft Dark Grey, Moist SILTY CLAY LOAM A-6	WH	0.4B	28	SW Wingwall of SN 041-0031				
	1			Chiseled "L", Elev. = 437.16				
				Borehole advanced with hollow				
10.0	WH			stem auger (8" O.D, 3.25" I.D.)	35.0			
	WH	0.4B	27					
	WH			To convert "N" values to "N60"				
425.5				multiply by 1.5				
Concrete work pad or spillage (unknown obstruction) 424.5								
15.0	1				40.0			
Soft Brown and Mottled Grey, Moist SILTY CLAY A-6	2	0.5B	20					
	2							
	WH							
	1	0.3B	23					
	1							
418.0								
20.0	2				45.0			
Soft Brown and Grey, Moist CLAYEY SAND with Broken SANDSTONE	6	0.2B	17					
	4							
	2							
	5							
	5							
413.0	19							
Hard Grey, Dry SANDY 25.0	100/4"				50.0			

N-Std Pentr Test: 2" OD Sampler,140# Hammer, 30" Fall (Type Fail. B-Bulge S-Shear E-Estimated P-Penetrometer)