STRUCTURE GEOTECHNICAL REPORT
131ST STREET OVER MILL CREEK
CULVERT REPLACEMENT
PR SN 016-0933
COOK COUNTY, ILLINOIS

For
James J. Benes & Associates, Inc.
1011 Warrenville Road, Suite 420
Lisle, IL 60532

Submitted by
Wang Engineering, Inc.
1145 North Main Street
Lombard, IL 60148

Original: August 11, 2021
Revised Report: N/A

Technical Report Documentation Page

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<tr><td>9. Prepared by
Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148</td><td>Contributor(s)
Author: Metin W. Seyhun, P.E.
QA/QC: Corina T. Farez, P.G., P.E.
PM: Metin W. Seyhun, P.E.</td><td>Contact
(630) 953-9928 ext. 1018
mseyhun@wangeng.com</td></tr>
<tr><td>10. Prepared for
James J. Benes & Associates Inc.
1011 Warrenville Road
Suite 420,
Lisle, IL, 60532</td><td>Contact(s)
Bradley Hargett, PE, PLS</td><td>Contact Information
(630) 719-7578 (Direct)
bhargett@jjbenes.com</td></tr>
</table>

11. Abstract

The existing two side by side 6-foot wide by 5.7-foot tall and a 12-foot by 6-foot concrete box culvert carrying 131st Street over Mill Creek will be removed and replaced with a three-cell box culvert with an interior cell opening of 8-foot by 7-foot. The proposed culvert will be skewed to the 131st Street alignment and will have an out-to-out headwall length of 103.3 feet. The new culvert will have upstream invert elevation of 660.60 feet and downstream invert elevation of 660.30 feet.

Beneath the pavement and up to 5 feet of cohesive fill, the soils consist of up to 20 feet of very soft to medium stiff organic clay to silty clay interbedded with peat layers. Deeper foundation soils includes stiff to very stiff silty clay to silty clay loam. The groundwater level during drilling was observed at elevation of 652 to 663 feet (8.0 and 21.0 bgs). We estimate a design groundwater elevation of 655 feet.

At culvert base elevations, the borings encountered very soft to medium stiff organic clay and silty clay with peat layers. Therefore, foundation improvements such as removal and replacement (**Option 1)** or supporting the culvert on a load transfer platform and timber piles **(Option 2)** could be considered. The removal and replacement includes removal of soft soils (up to 7 feet deep below culvert base), camber, and settlement collar at the upstream portion. The replacement material should consist of rockfill capped with CA-7. Cast-in-place culvert design will be required for Option 1 whereas precast culvert is feasible for Option 2.

The wingwalls type and length are yet to be determined. In general, wingwalls types suitable for a cast-in-place culvert include horizontal cantilever and L-type walls. T-type wall and flexible walls such as sheet pile wall and soldier pile and lagging walls could also be considered. Precast or cast-in-place apron wingwalls are typically used with precast culverts.

For the replacement of the culvert, temporary soil retention system will be required. We note that temporary soil retention system for removal and replacement will be larger than for supporting the culvert on timber piles with a load transfer platform.

12. Path to archived file S:\Netprojects\4110502\Reports\131StCulvert\RPT_Wang_NSB_MWS_4110502_131StCulvertReplacementV02_20210811.doc

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Wang Engineering

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

STRUCTURE GEOTECHNICAL REPORT
131ST STREET OVER MILL CREEK
CULVERT REPLACEMENT
PR SN 016-0933
COOK COUNTY, ILLINOIS
FOR
JAMES J. BENES & ASSOCIATES, INC.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, geotechnical evaluations, and recommendations to support the removal and replacement of the culvert at 131St Street over Mill Creek. The site is located about 200 feet east of 131st Street and IL Route 7 (SW Highway) intersection in Cook County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Based on the General Plan and Elevation drawing dated August 4, 2021 provided by James J. Benes & Associates, Inc. (Benes), Wang Engineering, Inc. (Wang) understands the existing side by side box culverts will be removed and replaced with a three-cell box culvert with an interior cell opening of 8-foot wide by 7-foot tall. The proposed culverts will be about 103.3-foot long and will have upstream invert elevation of 660.60 feet and downstream invert elevation of 660.30 feet. The proposed culvert will have 3-foot high weir wall above invert on the upstream to channel the flow in the center cell during low flow conditions. The proposed culvert overlaps with the existing culvert for the north half of the structure and will have 3.2 to 3.9 feet of fill with a side slope of 1:2.5 to 1:4(V:H) on the top to match the existing roadway grade elevation.

1.2 Existing Structure

The existing structure is a 5.7-foot by 6-foot and a 12-foot by 6-foot side by side box culverts with a length of 62.5 feet.

2.0 METHODS OF INVESTIGATION

The following sections outline the subsurface and laboratory investigations performed by Wang.

2.1 Field Investigation

The initial subsurface investigation included three structure borings, designated as CB-13 through CB-15, performed by Wang from September 19 to September 26, 2020. The supplemental investigation included two additional structure borings designated as B-04 and B-05 drilled on February 23, 2021. The borings were drilled from elevations of 670.35 to 673.36 feet and were advanced to depths of 25.0 and 45.0 feet bgs. The as-drilled northings and eastings were acquired with a mapping-grade GPS unit. Stations, offsets, elevations were provided by JJBenes. Boring location data are presented in the Boring Logs (Appendix A) and the as-drilled boring locations are shown in the Boring Location Plan (Exhibit 3).

A truck-mounted drilling rig, equipped with hollow stem augers, was used to advance and maintain open boreholes. Soil sampling was performed according to AASHTO T206, *"Penetration Test and Split Barrel Sampling of Soils."* The soil was sampled at 2.5-foot intervals to boring termination depths of 25 feet bgs. Soil samples collected from each sampling interval were placed in sealed jars and transported to the laboratory for further examination and laboratory testing.

Field boring logs, prepared and maintained by Wang geologists, include lithological descriptions, visual-manual soil (IDH Textural) classifications, results of Rimac and pocket penetrometer unconfined compressive strength tests, and results of Standard Penetration Tests (SPT) recorded as blows per 6 inches of penetration.

Groundwater levels were measured while drilling and at completion of each boring. For safety considerations each borehole was backfilled upon completion with soil cuttings and/or bentonite chips and the pavement restored as close as possible to its original condition.

2.2 Laboratory Testing

The soil samples were tested in the laboratory for moisture content (AASHTO T265). Atterberg limits (AASHTO T89 and T90) and particle size (AASHTO T88) analyses were performed on selected samples. A Shelby tube sample from Boring B-04 was tested for one-dimensional consolidation (AASHTO T 216). Field visual descriptions of the soil samples were verified in the laboratory. Laboratory test results are shown in the *Boring Logs* (Appendix A) and in the *Laboratory Test Results* (Appendix B).

3.0 INVESTIGATION RESULTS

Detailed descriptions of the soil conditions encountered during the subsurface investigations are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profile* (Exhibit 3). Please note that strata contact lines represent approximate boundaries between soil types. The actual transition between soil types in the field may be gradual in horizontal and vertical directions.

3.1 Lithological Profile

At the surface, borings drilled on 131st Street pavement encountered either 13-inch thick asphalt over 7-inch thick concrete or 14- to 20-inch thick asphalt over stiff silty clay fill. Boring CB-13 encountered 15-inch thick sandy gravel. In descending order, the general lithologic succession encountered beneath the surface cover includes: 1) man-made ground (fill); 2) soft to medium stiff organic clay to silty clay and peat; and 3) medium stiff to very stiff silty clay to silty clay loam.

1) Man-made ground (fill)

Beneath the pavement, the borings encountered up to 5.5 feet of fill. The fill consists of stiff to very stiff, brown and black to gray silty clay with unconfined compressive strength (Q_u) values of 1.5 to 4.5 tsf and moisture content values of 15 to 21%.

2) Very soft to soft organic clay to silty clay and peat

Beneath the fill, at elevations of 665.1 to 666.7 feet, the borings encountered up to 20 feet of very soft to medium stiff organic clay to silty clay interbedded with peat layers. The unit has Q_u values of 0.16 to 1.0 tsf with moisture content values of 21 to 91%. The interbedded peat has moisture content values of 98 to 161%. Laboratory index testing on this unit shows liquid limit (L_L) values of 36 to 55% and plastic limit (P_L) values of 19 and 24%. The long-term consolidation properties of the organic silty clay from Boring B-04 were obtained from one-dimensional oedometer testing. The resulting soil parameters are summarized in Table 1 and the laboratory sheets are attached in Appendix B.

Table 1: Summary of Consolidation Testing

Boring ID	Test Depth (feet)	Test Elevation (feet)	C_C	C_S	e_O	OCR	Moisture Content (%)	L_L/P_L
B-04	21 to 23	648.6	0.365	0.072	1.157	1.02	41	42/19

3) Medium stiff to very stiff silty clay to silty clay loam

At elevations of 645.1 to 651.7 feet (20 to 25.5 feet bgs), the borings advanced through medium stiff to very stiff, gray silty clay to silty clay loam interbedded with sand and silt extending to boring termination depths of 45 feet bgs. The unit is characterized by Q_u values of 0.7 to 3.4 tsf and moisture content values of 13 to 20%.

3.3 Groundwater Conditions

Groundwater was encountered while drilling at elevations of 652 to 663 feet (8.0 and 21.0 bgs). At completion of drilling, the groundwater was measured at elevations 638 and 655 feet (18.0 and 33.0 feet bgs) in Borings B-04 and CB-13. We estimate the groundwater table at elevation 655 feet. As per GPE drawing, the Mill Creek Estimated Water Surface Elevation (EWSE) will be 665.5 feet.

4.0 ANALYSIS AND RECOMMENDATIONS

In the following sections, we present the results of our analyses and recommendations for the proposed culvert replacement.

4.1 Scour Considerations

The design scour elevation should be taken at the bottom of the cutoff wall (IDOT 2012). At the horizontal and L-type wingwalls, the cutoff walls are established 3.0 feet below the culvert invert elevations. To prevent local erosion, we recommend placing stone riprap or a concrete apron at the ends of the culvert. This will also prevent sediments from entering and accumulating in the culvert, minimize long term maintenance, and provide protection to the stream bed at the interface.

4.2 Culvert Foundation Treatment and Settlement

Based on our subsurface investigation, the soils at the base of the culvert barrel are expected to be very soft to medium stiff peat or organic clay to silty clay extending to 6.6 to 13.3 feet below culvert base resulting in unacceptable settlements of the new structure. Wang has evaluated various thicknesses of removal and replacement of the unsuitable soils below the base of the newly proposed culvert and reached a reasonable amount of settlement at 7-foot replacement. The following options should be considered to mitigate the settlements:

- **<u>Option 1 - Removal and Replacement up to 7 feet:</u>** This option includes 7 feet removal of very soft to medium stiff soils from the upstream half section below the culvert base to an elevation of 651.3 feet and 6.6 feet removal from the downstream half to an elevation 651.7 feet. The replacement material could be rockfill capped with 6-inches of CA-7 bedding in accordance with 2017 *IDOT Culvert Manual*. The removal and replacement should extend 2 feet beyond the edge of the precast sections both sides of the culvert. A temporary soil retention system will be required for removal and replacement. Following removal and replacement, the estimated settlements at the upstream portion is about 1.0 inches; middle section about 0.1 inches; and downstream end about 0.2 inches. Differential settlement will be about 0.9 inches between the upstream and middle section. Therefore, we recommend 1 inch camber on the upstream portion of culvert with the inclusion of settlement collars at this location as shown in Exhibit 4. Differential settlement for the remaining portion of culvert will be minimal. It should be noted that water can be a significant issue during deep replacement and large shoring systems can be costly.

- **<u>Option 2 – Timber Piles with a Load Transfer Platform</u>**: This option includes supporting the new culvert on timber piles with a load transfer platform system. It should be noted that loading information will be required to estimate spacing of the timber piles. For the preliminary estimating purposes, the system may include timber piles driven in a 6.5 feet by 6.5 feet rectangular pattern for entire length of the culvert. The maximum nominal load for a timber pile with a 14-inch diameter butt section and 8-inch diameter tip is 153 kips and the corresponding factored resistance available is 84 kips based on the IDOT resistance factor of 0.55 (IDOT 2012). We estimate pile length of 32 feet will be required to reach the maximum pile capacity based on Boring B-04. The piles should be capped with 3-foot by 3-foot square caps and a 24-inch thick load transfer platform should be placed on the top of caps. The load transfer platform should consist of coarse aggregate with IDOT gradation CA-18 and two layers of Tensar BX1200 geogrid or equivalent, placed 6 inches apart above the top of pile caps. We estimate the top of pile cap elevation will be approximately 656.3 feet and the load transfer platform would extend from that elevation to the culvert base at elevation of 658.3 feet. After the culvert is placed on this system, we estimate the total, long-term settlement will be less than 1 inch with differential settlement with 0.5 inch or less. This option can be favorable due to minimal excavation and smaller shoring system.

In our opinion, both options are technically feasible; however, we recommend preforming a cost and constructability analysis to choose a preferred option.

4.3 Wingwalls

In general, wingwalls types suitable for a cast-in-place culvert include horizontal cantilever and L-type walls. T-type wall and flexible walls such as sheet pile wall and soldier pile and lagging walls could also be considered. Precast or cast-in-place apron wingwalls are typically used with precast culverts.

The horizontal cantilever walls can be considered as they need to be less than 16 feet long (IDOT 2017). L-type wingwall can be used for lengths of up to 30 feet. Horizontal and L-type walls should be designed based on the structural guidelines provided in Sections 4.2 and 4.3 of the IDOT *Culvert Manual* (IDOT 2017). These wingwalls should be founded at a minimum depth of 3.0 feet below the culvert elevations.

For the cast-in-place T-type walls, the footings should be established at a depth such that they would be at least 4 feet below culvert barrel invert elevation. Footings will be established at elevations 656.60 and 656.30 feet at the downstream and upstream ends, respectively. Based on subsurface investigation, very soft to soft organic silt to organic silty clay is expected to be encountered at the footing elevation. We recommend removing these soils to elevation 651.3 at upstream end and at elevation 651.7 at downstream end and replacing with IDOT District One *Aggregate Subgrade Improvement* material. Following the recommended foundation improvements, the T-type walls could be designed based on a maximum factored resistance of 3,000 psf, determined with a bearing resistance factor of 0.45 (AASHTO 2017). The wingwalls should be sized and designed based on the information and typical sections shown in IDOT Section 4.4 (IDOT 2017).

If the apron walls are utilized, the apron wingwalls should be designed based on IDOT Base sheet dated 2/17/2017 *"MCB-AES, Multi-Cell Precast Box Culvert Apron End Section Details."*

For flexible walls, we recommend sheet pile or soldier pile walls and should be designed for both lateral earth pressure and lateral deformation. The embedment depth in moment equilibrium for the walls should be designed in accordance with LRFD guidelines (AASHTO 2020) using long-term (drained) soil parameters in Tables 2 and 3 for upstream and downstream walls, respectively. The design of the wall should ignore 3 feet of soil in front of the wall measured from finished ground surface elevation in providing passive pressure due to the frost-heave condition. Drainage behind the wall and underdrain should be as per IDOT Bridge Manual (IDOT 2012). The water pressure should be added to the earth pressure if drainage is not provided. The design of wall should consider the groundwater elevation at 655 feet.

Table 2: Geotechnical Parameters for Design of Upstream Flexible Walls
Reference Borings: CB-14 and B-04

Soil Description Elevation	Unit Weight, γ (pcf)	Drained Shear Strength Properties		Earth Pressure Coefficients [1]	
		Cohesion (psf)	Friction Angle (°)	Active Pressure (Straight)	Passive Pressure (Straight)
V Stiff SILTY CLAY FILL Surface to EL 667.4 feet	120	0	30	0.33	3.00
Soft to M Stiff CLAY to SILTY CLAY EL 667.4 to 657.9 feet	115	0	28	0.36	2.77
V Soft to Soft CLAY to SILTY CLAY, Organic SILT EL 657.9 to 651.9 feet	43 (submerged)	0	24	0.42	2.37
Loose SILT and SAND EL 651.9 to 649.4 feet	53 (submerged)	0	29	0.35	2.88
Stiff to V Stiff SILTY CLAY to SILTY CLAY LOAM EL 649.4 to 625.6 feet (EOB)	58 (submerged)	100	30	0.33	3.00

Table 3: Geotechnical Parameters for Design of Downstream Flexible Walls

Reference Boring: CB-15

Soil Description Elevation	Unit Weight, γ (pcf)	Drained Shear Strength Properties: Cohesion (psf)	Drained Shear Strength Properties: Friction Angle (°)	Earth Pressure Coefficients (1): Active Pressure (Straight)	Earth Pressure Coefficients (1): Passive Pressure (Straight)
Stiff SILTY CLAY Surface to EL 666.1 feet	120	0	30	0.33	3.00
M Stiff SILTY CLAY and PEAT EL 666.1 to 658.0 feet	100	0	24	0.42	2.37
V Soft to CLAY to SILTY CLAY EL 658.0 to 653.7 feet	43 (submerged)	0	28	0.36	2.99
M Stiff to V Stiff SILTY CLAY to SILTY CLAY LOAM EL 653.7 to 646.7 feet (EOB)	58 (submerged)	100	30	0.33	3.00

Design considerations should also establish deflection control at the top of flexible wall. The estimated soil parameters that may be used to analyze deflection of the wall using COMP 624P, LPILE or any other programs are presented in Tables 4 and 5.

Table 4: Recommended Parameters for Lateral Load Analysis of Upstream Flexible Walls

Reference Borings: CB-14 and B-04

Soil Description Elevation Range (feet)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
V Stiff SILTY CLAY FILL Surface to EL 664.5	120	2500	0	1000	0.4
Soft to M Stiff CLAY to SILTY CLAY EL 664.5 to 660.1	115	500	0	50	1.0
V Soft to Soft CLAY to SILTY CLAY, PEAT, Organic SILT EL 660.1 to 645.1	43 (submerged)	400	0	30	1.2

Soil Description Elevation Range (feet)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Loose SILT and SAND EL 645.1 to 644.3 feet	53 (submerged)	0	29	30	--
Stiff to V Stiff SILTY CLAY to SILTY CLAY LOAM EL 644.3 to 625.6 (EOB)	58 (submerged)	2400	0	1000	0.4

Table 5: Recommended Parameters for Lateral Load Analysis of Downstream Flexible Walls

Reference Boring: CB-15

Soil Description Elevation Range (feet)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Stiff SILTY CLAY Surface to EL 666.1	120	1500	0	500	0.7
M Stiff SILTY CLAY and PEAT EL 666.1 to 658.0	100	750	0	100	1.0
V Soft to CLAY to SILTY CLAY EL 658.0 to 653.7	43 (submerged)	200	0	30	1.2
M Stiff to V Stiff SILTY CLAY to SILTY CLAY LOAM EL 653.7 to 646.7 (EOB)	58 (submerged)	2000	0	1000	0.4

4.4 Global Stability

Global stability analysis will be performed when wingwall type becomes available.

4.5 Cast-In-Place or Precast Culvert Considerations

The results of the settlement analysis indicate that both cast-in-place and precast culvert options are feasible at the site. However, a cast-in-place culvert will be required for the Option 1.

4.6 Stage Construction

We understand staged construction will be required to maintain the traffic along 131st Street. Temporary Soil Retention System will be required for stage construction. We do not recommend temporary sheet piling design using IDOT *Design Guide 3.13.1* (IDOT 2012).

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Site Preparation

All vegetation, surface topsoil, pavement, and debris should be cleared and stripped where the culvert and culvert wingwalls will be placed.

5.2 Excavation, Dewatering, and Utilities

Excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction. Since the very soft to soft soils and peat encountered in the borings, we recommend considering Temporary Soil Retention System (TSRS). The TSRS can be included as *Pay Item*. We do not recommend temporary sheet piling design using IDOT *Design Guide 3.13.1* (IDOT 2012).

The estimated groundwater elevation is at 655 feet, which is about 3 feet above the base elevation of the culvert. However, for the unsuitable/unstable soils excavations, the groundwater control will be required. The EWSE in Mill Creek is 665.5 feet. Although the existing creek flows through the existing culvert and extension during the proposed culvert construction, the groundwater control protected by sheetpile may be required for construction.

Depending upon prevailing climate conditions and the time of the year when culvert and wingwalls construction take place, control runoff and maintenance of existing flows may require temporary water diversion and control. Any water that accumulates in open excavations by seepage or runoff should be immediately removed.

5.3 Filling and Backfilling

Fill used as embankment material and for replacement of any unstable or unsuitable soils encountered during construction should be pre-approved by the Engineer. The materials used to backfill around, and to a level at least 1 foot over the top of the culvert box, should be porous granular material conforming to the requirements specified in the IDOT 2020 Supplemental Specifications and Recurring Special Provisions, *Granular Backfill for Structures*.

5.4 Earthwork Operations

The required earthwork can be accomplished with conventional construction equipment. Moisture and traffic will cause deterioration of exposed subgrade soils. Precautions should be taken by the Contractor to prevent water erosion of the exposed subgrade. A compacted subgrade will minimize water runoff erosion.

Earth moving operations should be scheduled to not coincide with excessive cold or wet weather (early spring, late fall or winter). Any soil allowed to freeze or soften due to the standing water should be removed. Wet weather can cause problems with subgrade compaction.It is recommended that an experienced geotechnical engineer be retained to inspect the exposed subgrade, monitor earthwork operations, and provide material inspection services during the construction phase of this project.

6.0 QUALIFICATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on the boring logs and in Exhibits 2. This report does not reflect any variations that may occur between the borings or elsewhere on the site, variations whose nature and extent may not become evident until the course of construction. In the event that any changes in the design and/or location of the structure are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

It has been a pleasure to assist James J. Benes & Associates, Inc. and the Illinois Department of Transportation on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Metin W. Seyhun, P.E.
Senior Geotechnical Engineer

Corina T. Farez, P.E., P.G.
Vice President

Nesam S. Balakumaran, P.Eng.
Project Geotechnical Engineer

REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (2017) "AASHTO LRFD Bridge Design Specifications." United States Depart of Transportation, Washington, D.C.

IDOT (2012) *Bridge Manual.* Illinois Department of Transportation.

IDOT (2015) *Geotechnical Manual.* Illinois Department of Transportation.

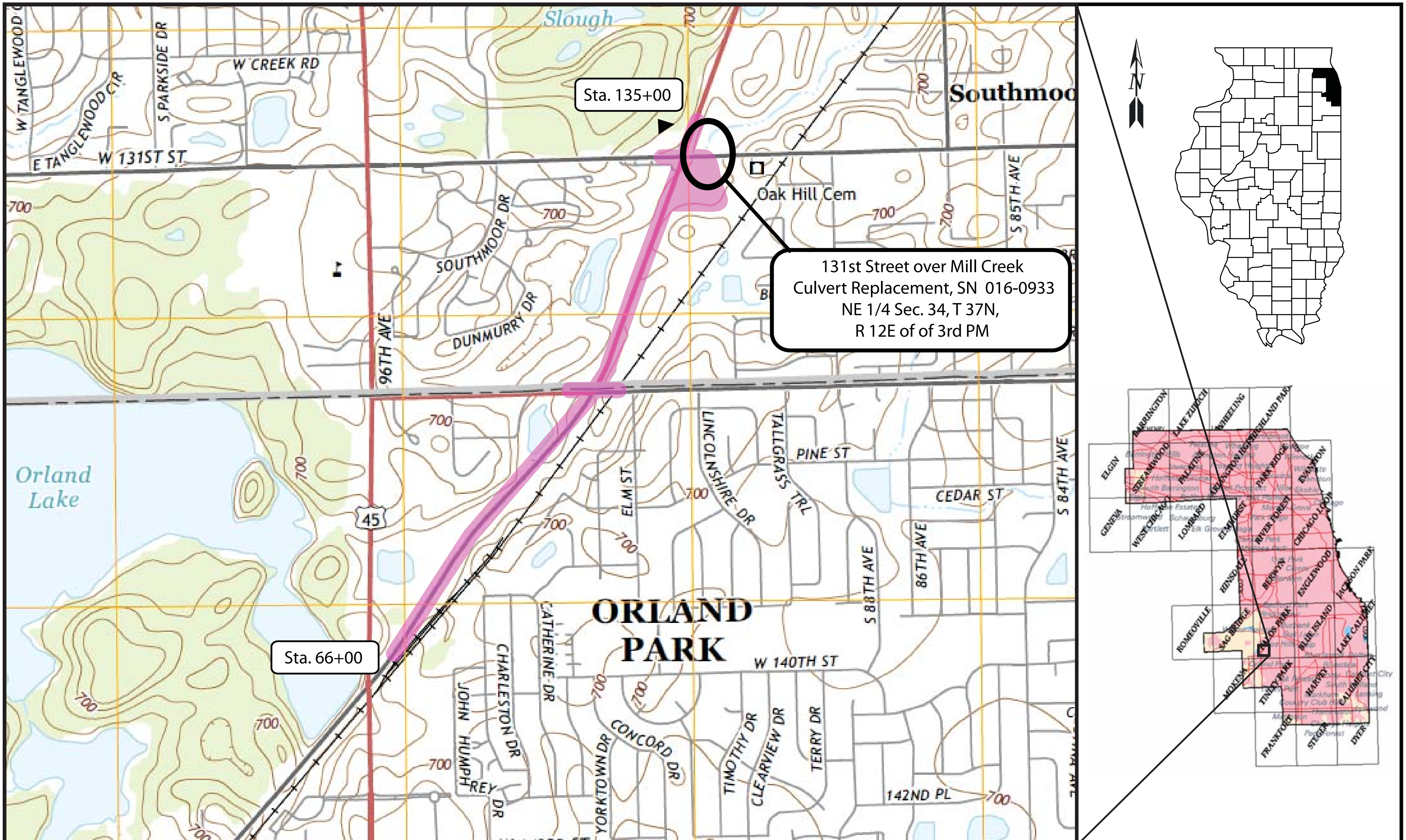
IDOT (2016) *Standard Specifications for Road and Bridge Construction.* Illinois Department of Transportation. 1098 pp.

IDOT (2017) *Culvert Manual.* Illinois Department of Transportation.

IDOT (2020) *Supplimental Specifications and Recurring for Recurring Special Provisions.* Illinois Department of Transportation.

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

EXHIBITS

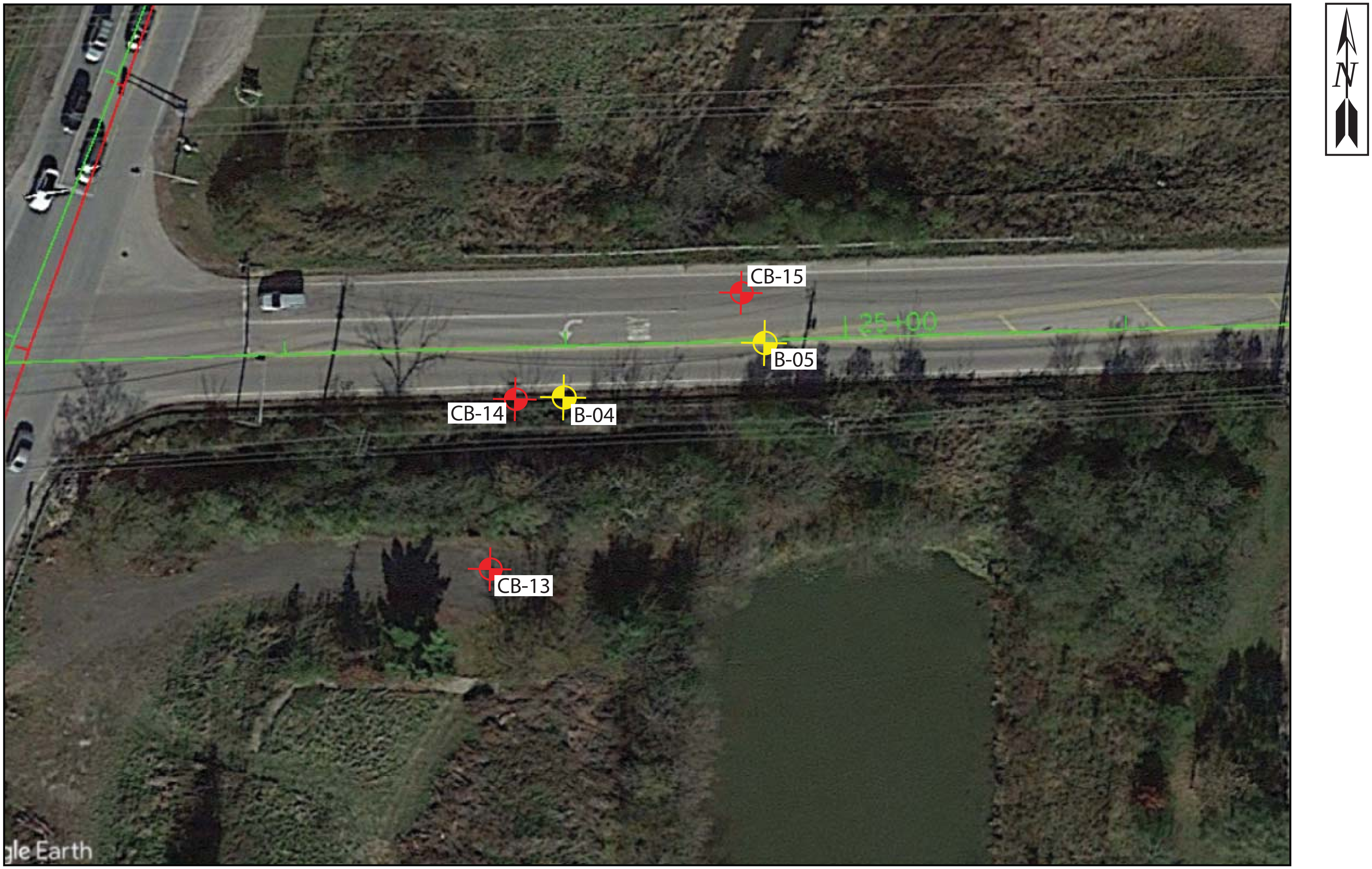


0 0.25 0.5 1.0 Mile

Contours are 10 feet intervals

Modified after USGS (2015)

SITE LOCATION MAP: 131ST OVER MILL CREEK CULVERT REPLACMENT, SN 016-0933, , COOK COUNTY, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: E. Yim CHECKED BY: NSB
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR JAMES J. BENES & ASSOCIATES, INC.		411-05-01



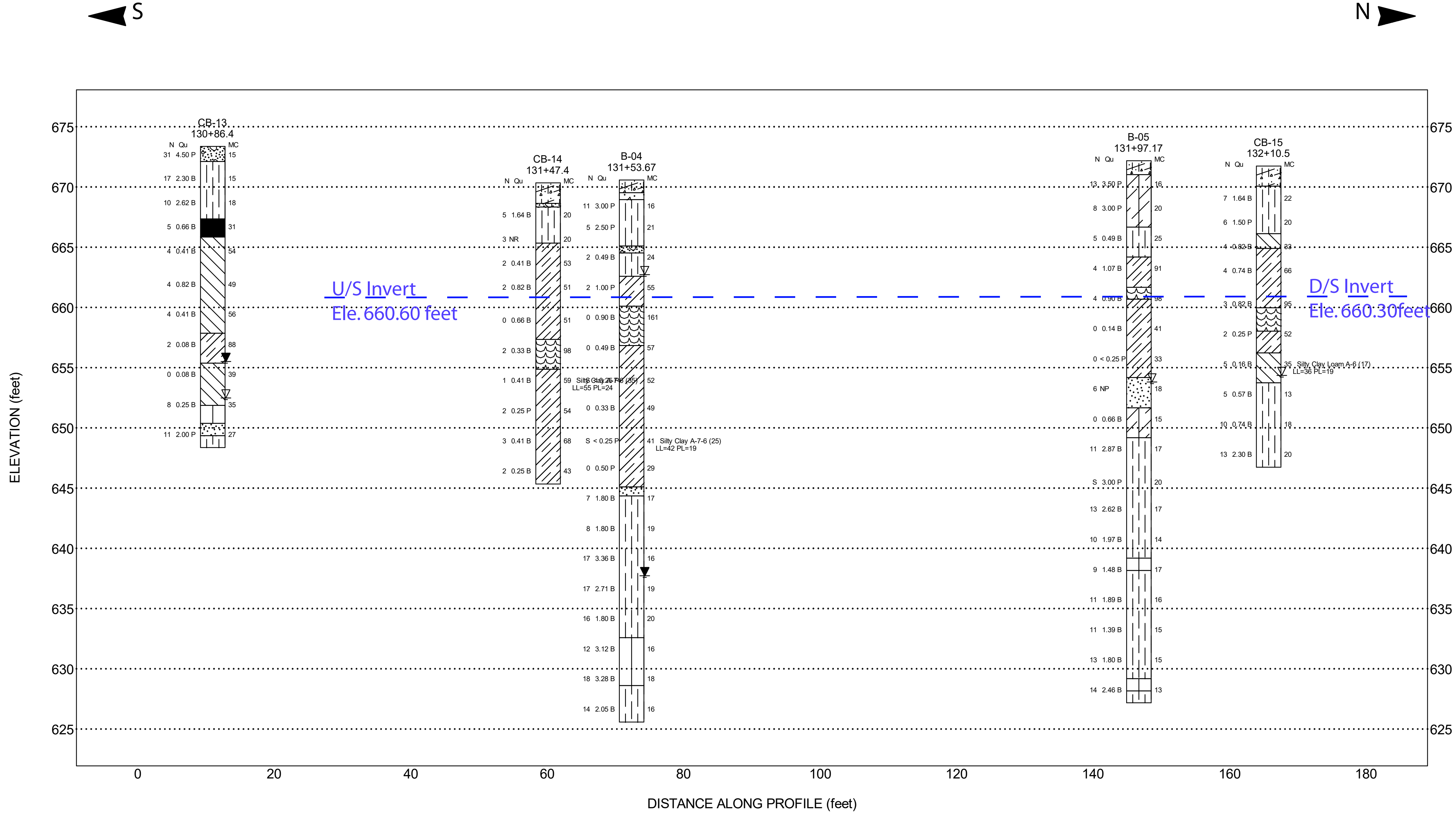
0 100 200 Feet

Legend

Culvert Boring

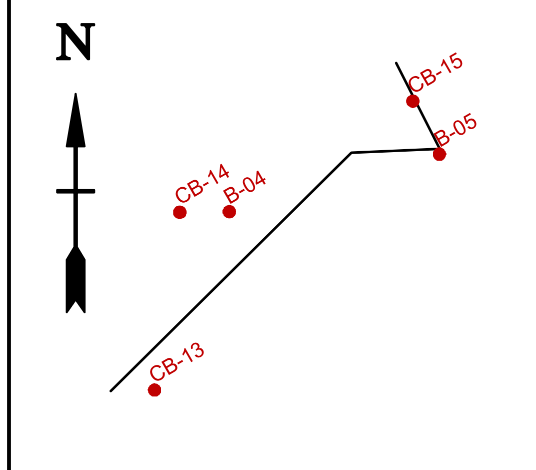
Supplement Boring

BORING LOCATION PLAN: 131ST OVER MILL CREEK CULVERT REPLACMENT, SN 016-0933, , COOK COUNTY, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: J. Bensen CHECKED BY: NSB
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR JAMES J. BENES & ASSOCIATES, INC.		411-05-02



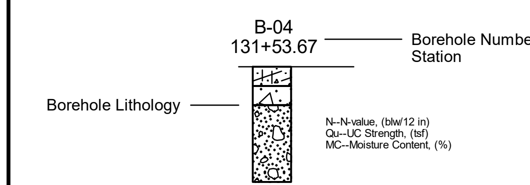
Lithology Graphics

Pavement	Concrete	IDH Silty Clay, Silty Clay Loam	Gravelly sand, sandy gravel
Organic Soil	USCS Peat	IDH Sand, Sandy Loam	IDH Silt, Silty Loam
IDH Clay Loam	Topsoil	IDH Clay	USCS High Plasticity Organic silt or clay



Site Map Scale 1 inch equals 65 feet

Explanation:



∇ Water Level Reading at time of drilling.

▼ Water Level Reading 24-hr after drilling or at end of drilling

Horizontal Scale (feet)

Vertical Exaggeration: 2x

Wang Engineering, Inc.
1145 N. Main Street
Lombard/IL/60148

Soil Profile
131St Street Culvert Replacement

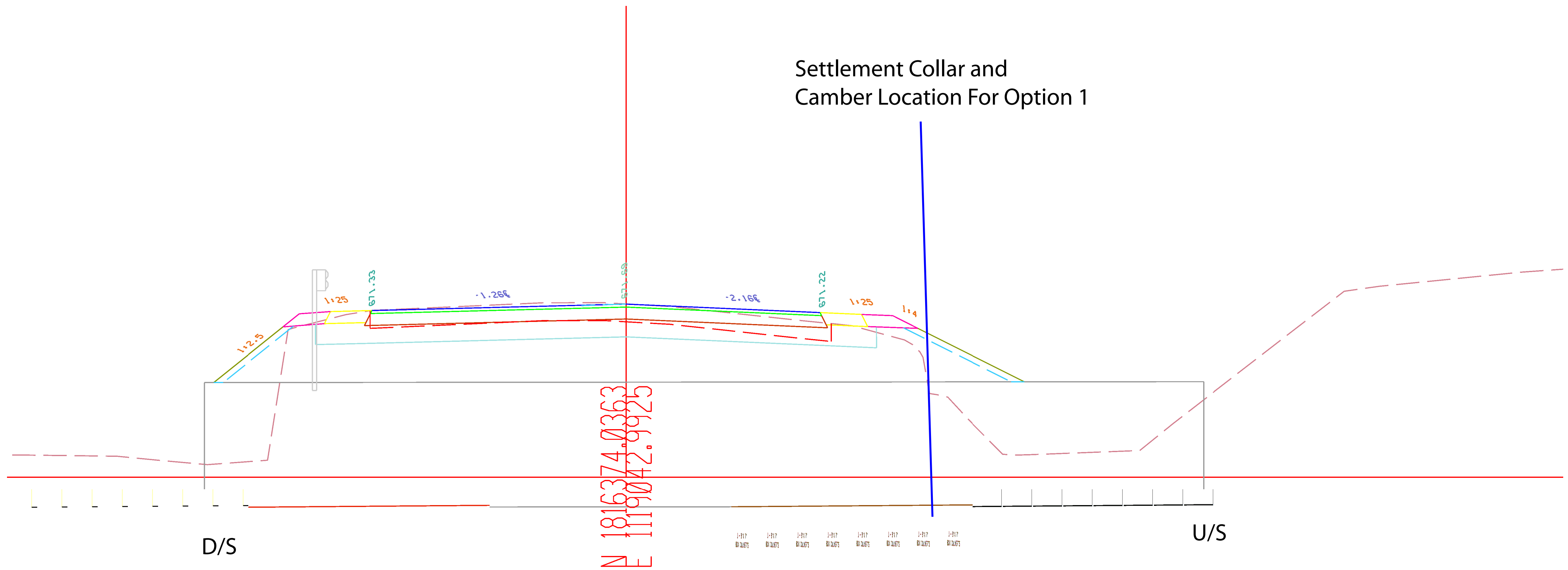
WEI SINCE 1982

IL Route 7 from 131st Street to 135th Street
Cook County, Illinois

JOB NUMBER	PLATE NUMBER
411-05-02	EXHIBIT 3

WEI 11X17 4110502.GPJ WANGENG.GDT 5/17/21

EXHIBIT 4



Settlement Collar and
Camber Location For Option 1
N 1816374.0363
E 1119042.9925
D/S
U/S

APPENDIX A

Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG B-04

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 670.59 ft
North: 1816356.32 ft
East: 1119018.40 ft
Station: 131+53.67
Offset: 189.17 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	13-inch thick ASPHALT --PAVEMENT--					
669.5	7-inch thick CONCRETE --PAVEMENT--					
668.9	Very stiff, brown, black and gray SILTY CLAY to SILTY CLAY LOAM, trace gravel; damp --FILL-- --RDR 2--		1	5 5 6	3.00 P	16
		5	2	4 2 3	2.50 P	21
665.1	Gray SANDY GRAVEL; damp					
664.5	Soft, gray SILTY CLAY LOAM; wet --RDR 2--		3	2 1 1	0.49 B	24
662.6	Stiff, black Organic SILTY CLAY LOAM; wet		4	1 1 1	1.00 P	55
		10				
660.1	Medium stiff, brown PEAT, few organic silt lenses; moist --RDR 2--		5	0 0 0	0.90 B	161
656.8	Very soft to medium stiff, black and gray Organic SILTY CLAY; wet --RDR 2--		6	0 0 0	0.49 B	57
		15				
			7	PUSH	< 0.25 P	52
		20	8	0 0 0	0.33 B	49
	--L$_L$(%)=42, P$_L$(%)=19-- --%Gravel=0.0-- --%Sand=0.2-- --%Silt=58.7-- --%Clay=41.0-- --%Organics=3.8--		9	PUSH	< 0.25 P	41
		25	10	0 0 0	0.50 P	29
645.1	Brown SANDY LOAM, trace gravel; saturated					
644.3	Stiff to very stiff, brown to gray SILTY CLAY to SILTY CLAY LOAM, trace gravel; damp to moist --RDR 2--		11	4 3 4	1.80 B	17
		30	12	2 3 5	1.80 B	19
			13	5 7 10	3.36 B	16
		35	14	5 7 10	2.71 B	19
			15	5 7 9	1.80 B	20
632.6	Very stiff, brown SILTY LOAM to SILTY CLAY LOAM, trace gravel; moist	40	16	4 5 7	3.12 B	16

GENERAL NOTES

Begin Drilling **02-23-2021** Complete Drilling **02-23-2021**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **KS&MG** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **8.00 ft**
At Completion of Drilling **33.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

The stratification lines represent the approximate boundary between soil types; the actual transition may be gradual.

Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG B-04

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 670.59 ft
North: 1816356.32 ft
East: 1119018.40 ft
Station: 131+53.67
Offset: 189.17 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			17	7 8 10	3.28 B	18
628.6	Very stiff, brown SILTY CLAY LOAM, trace gravel; damp --RDR 2--					
			18	3 6 8	2.05 B	16
625.6	Boring terminated at 45.00 ft	45				
		50				
		55				
		60				

GENERAL NOTES

Begin Drilling **02-23-2021** Complete Drilling **02-23-2021**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **KS&MG** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ∇ **8.00 ft**
At Completion of Drilling ▼ **33.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG B-05

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 672.17 ft
North: 1816376.05 ft
East: 1119090.62 ft
Station: 131+97.17
Offset: 249.41 RT

Elevation (ft)	Soil and Rock Description	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	14-inch thick ASPHALT					
671.0	Very stiff, brown and gray CLAY LOAM, trace gravel; damp --FILL-- --RDR 2--		1	7 7 6	3.50 P	16
		5	2	3 3 5	3.00 P	20
666.7	Soft to stiff (1.0P), gray SILTY CLAY; moist to wet		3	3 2 3	0.49 B	25
664.2	Stiff, black SILTY CLAY LOAM, some organic matter; moist --RDR 2--	10	4	1 2 2	1.07 B	91
661.7	Medium stiff, brown PEAT, some clay					
660.7	Very soft to medium stiff, black and gray Organic SILTY CLAY; wet --RDR 2--		5	1 2 2	0.90 B	98
		15	6	0 0 0	0.14 B	41
			7	0 0 0	< 0.25 P	33
654.2	Loose, gray SANDY LOAM, trace gravel; saturated --RDR 2--	20	8	0 4 2	NP	18
651.7	Medium stiff, pinkish gray CLAY LOAM, trace gravel; moist --RDR 2--		9	0 0 0	0.66 B	15
649.2	Stiff to very stiff, gray SILTY CLAY LOAM, trace gravel; damp --RDR 2--	25	10	3 5 6	2.87 B	17
			11	P U S H	3.00 P	20
		30	12	3 5 8	2.62 B	17
			13	3 4 6	1.97 B	14
639.2	Gray SILT; saturated					
638.2	Stiff to very stiff, gray SILTY CLAY LOAM, trace gravel; damp to moist --RDR 2--	35	14	2 4 5	1.48 B	17
			15	3 5 6	1.89 B	16
		40	16	4 5 6	1.39 B	15

GENERAL NOTES

Begin Drilling: **02-23-2021** Complete Drilling: **02-23-2021**
Drilling Contractor: **Wang Testing Services** Drill Rig: **17D50A [87%]**
Driller: **KS&MG** Logger: **E. Yim** Checked by: **C. Marin**
Drilling Method: **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **18.50 ft**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

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Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG B-05

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 672.17 ft
North: 1816376.05 ft
East: 1119090.62 ft
Station: 131+97.17
Offset: 249.41 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			17	4 5 8	1.80 B	15
629.2	Brownish gray SILTY LOAM, few silt and clay laminations; damp					
628.2	Very stiff, gray SILTY CLAY LOAM to SILTY LOAM, trace gravel; damp		18	7 6 8	2.46 B	13
627.2	Boring terminated at 45.00 ft	45				
		50				
		55				
		60				

GENERAL NOTES

Begin Drilling **02-23-2021** Complete Drilling **02-23-2021**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50A [87%]**
Driller **KS&MG** Logger **E. Yim** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **18.50 ft**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

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Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG CB-13

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 673.36 ft
North: 1816295.07 ft
East: 1118992.69 ft
Station: 130+86.4
Offset: 186.4' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	15-inch thick dense, brown SANDY GRAVEL; damp --RDR 2--		1	12, 17, 14, 8	4.50 P	15
672.1	Very stiff, brown and black SILTY CLAY, some gravel, fragments of asphalt and brick-- --FILL-- --RDR 2--		2	7, 7, 10, 10	2.30 B	15
		5	3	3, 5, 5, 7	2.62 B	18
667.4	Medium stiff, black SILTY CLAY LOAM, some gravel; moist --BURIED TOPSOIL-- --RDR 2--		4	2, 2, 3, 3	0.66 B	31
665.9	Soft to medium stiff, black and brown CLAY to SILTY CLAY, trace to little organic matter; moist --RDR 2--		5	2, 2, 2, 4	0.41 B	54
		10	6	2, 2, 2	0.82 B	49
			7	3, 2, 2	0.41 B	56
657.9	Very soft, gray and black organic SILT; wet --RDR 1--	15	8	2, 1, 1	0.08 B	88
655.4	Very soft to soft, gray CLAY to SILTY CLAY, trace organic matter; moist --RDR 1--		9	0, 0, 0	0.08 B	39
		20				
651.9	Loose, gray SILT, few sand and clay lamination; wet --RDR 2--		10	0, 4, 4	0.25 B	35
650.4	Gray SAND; saturated --RDR 2--					
649.4	Very stiff, brown SILTY CLAY, trace gravel; damp --RDR 2--		11	7, 5, 6	2.00 P	27
648.4	Boring terminated at 25.00 ft	25				
		30				
		35				
		40				

GENERAL NOTES

Begin Drilling **09-19-2019** Complete Drilling **09-19-2019**
Drilling Contractor **Wang Testing Services** Drill Rig
Driller **KS** Logger **I. Nenn** Checked by **C. Marin**
Drilling Method **2.25" HSA, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **21.00 ft**
At Completion of Drilling **18.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG CB-14

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 670.35 ft
North: 1816356.10 ft
East: 1119001.35 ft
Station: 131+47.4
Offset: 173.8' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	13-inch thick, ASPHALT over 7-inch thick, CONCRETE --PAVEMENT--					
668.7						
668.4	Brown SANDY GRAVEL --BASE COURSE--					
	Stiff, brown and gray SILTY CLAY; damp --RDR 2--		1	2 2 3 2	1.64 B	20
665.4		5	2	3 2 1 2	NR	20
	Soft to medium stiff, brown, gray and black SILTY CLAY, trace to some organic matter; damp to wet --RDR 1--		3	0 0 2 3	0.41 B	53
		10	4	0 0 2 2	0.82 B	51
			5	0 0 0	0.66 B	51
657.4	Soft, blak and gray Organic CLAY and PEAT; wet --RDR 1--	15	6	0 0 2	0.33 B	98
654.9	Soft, black and dark gray SILTY CLAY, some organic matter; moist --RDR 1-- --L_L(%)=55, P_L(%)=24-- --%Gravel=0.2-- --%Sand=0.8-- --%Silt=66.4-- --%Clay=32.6-- --Organic Content = 6.9%--		7	0 0 1	0.41 B	59
		20	8	0 0 2	0.25 P	54
			9	0 2 1	0.41 B	68
645.4		25	10	1 1 1	0.25 B	43
	Boring terminated at 25.00 ft	30				
		35				
		40				

GENERAL NOTES

Begin Drilling: **09-26-2019** Complete Drilling: **09-26-2019**
Drilling Contractor: **Wang Testing Services** Drill Rig:
Driller: **R&J** Logger: **I. Nenn** Checked by: **C. Marin**
Drilling Method: **2.25" HSA, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

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Wang Engineering
wangeng@wangeng.com
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

BORING LOG CB-15

WEI Job No.: 411-05-02

Client: **James J. Benes & Associates**
Project: **IL Route 7 from 131st Street to 135th Street**
Location: **Cook County, Illinois**

Datum: NAVD 88
Elevation: 671.73 ft
North: 1816394.26 ft
East: 1119081.48 ft
Station: 132+10.5
Offset: 234.3' RT

SOIL AND ROCK DESCRIPTION

Elevation (ft)	Depth (ft)	Soil and Rock Description
671.73 – 670.1		20-inch thick, ASPHALT --PAVEMENT--
670.1 – 666.1		Stiff, brown and gray SILTY CLAY; damp --FILL-- --RDR 2--
666.1 – 664.9		Medium stiff, brown and gray CLAY to SILTY CLAY; damp --RDR 2--
664.9 – 660.0		Medium stiff, black SILTY CLAY, trace to some organic matter; moist --RDR 1--
660.0 – 658.0		Medium stiff, dark brown Organic SILTY CLAY to PEAT; moist --RDR 1--
658.0 – 656.2		Soft, gray and black SILTY CLAY, some organic matter; moist to saturated --RDR 1--
656.2 – 653.7		Very soft, gray CLAY to SILTY CLAY; wet --RDR 1-- --L_L(%)=36, P_L(%)=19-- --%Gravel=6.5-- --%Sand=15.2-- --%Silt=46.0-- --%Clay=32.3--
653.7 – 646.7	25	Medium stiff to very stiff, brown SILTY CLAY to SILTY CLAY LOAM, trace to little gravel; damp --RDR 2--
646.7	25	Boring terminated at 25.00 ft

Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
1	3, 3, 4, 3	1.64 B	22
2	5, 3, 3, 2	1.50 P	20
3	3, 2, 2, 2	0.82 B	33
4	0, 2, 2, 1	0.74 B	66
5	1, 2, 1	0.82 B	95
6	0, 0, 2	0.25 P	52
7	2, 2, 3	0.16 B	35
8	2, 2, 3	0.57 B	13
9	3, 4, 6	0.74 B	18
10	4, 5, 8	2.30 B	20

GENERAL NOTES

Begin Drilling: **09-26-2019** Complete Drilling: **09-26-2019**
Drilling Contractor: **Wang Testing Services** Drill Rig:
Driller: **R&J** Logger: **I. Nenn** Checked by: **C. Marin**
Drilling Method: **2.25" HSA, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **17.50 ft**
At Completion of Drilling: **DRY**
Time After Drilling: **NA**
Depth to Water: **NA**

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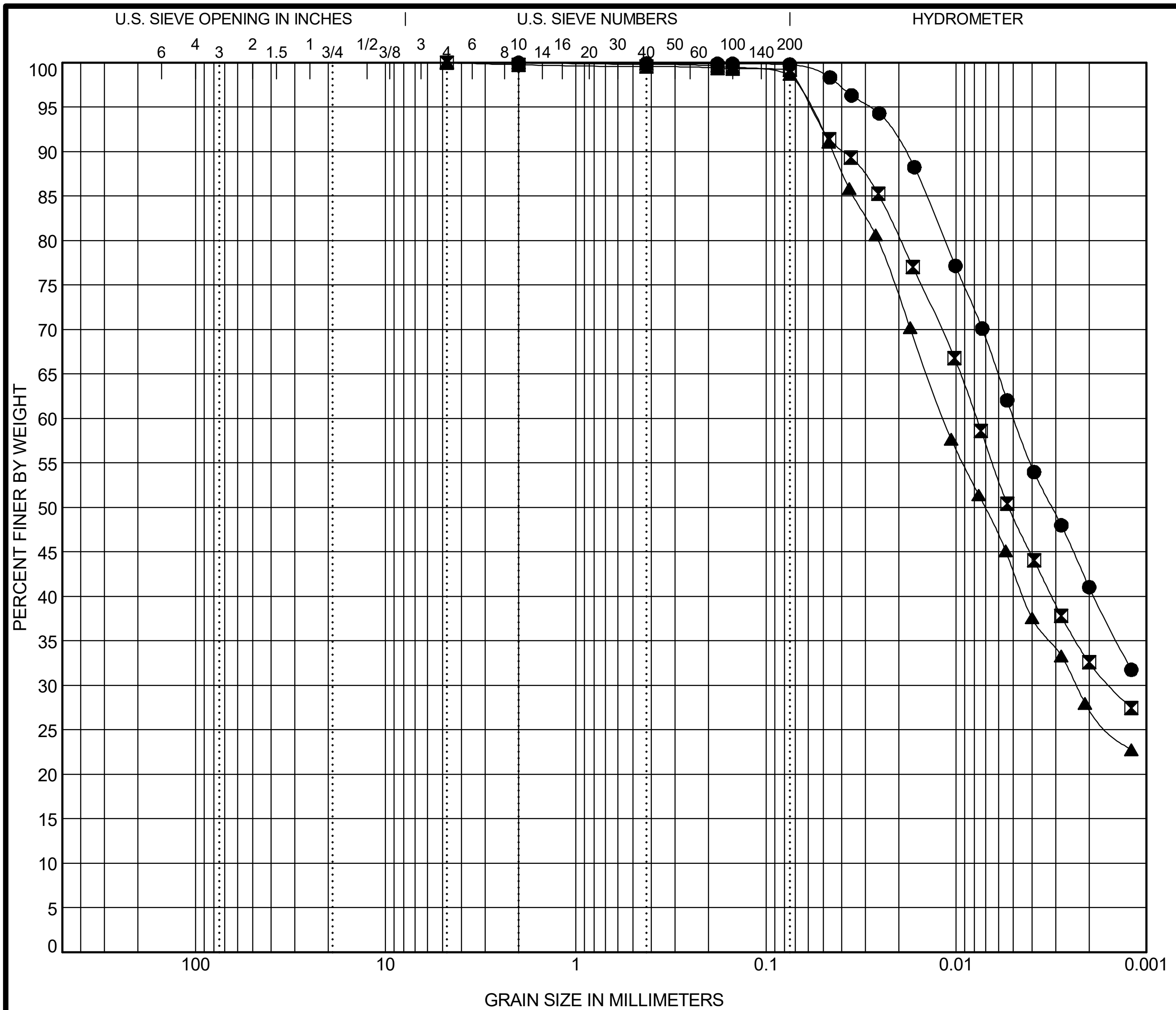
1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

APPENDIX B



COBBLES	GRAVEL	SAND coarse	SAND fine	SILT AND CLAY

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	B-04#9	21.0 ft	Silty Clay	42	19	23		
⊠	CB-14#7	16.0 ft	Silty Clay	55	24	31		
▲	CB-15#7	16.0 ft	Silty Clay Loam	36	19	17		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-04#9	21.0 ft	2	0.005			0.0	0.2	58.7	41.0
⊠	CB-14#7	16.0 ft	4.75	0.008	0.002		0.2	0.8	66.4	32.6
▲	CB-15#7	16.0 ft	4.75	0.012	0.002		0.0	1.5	70.9	27.5

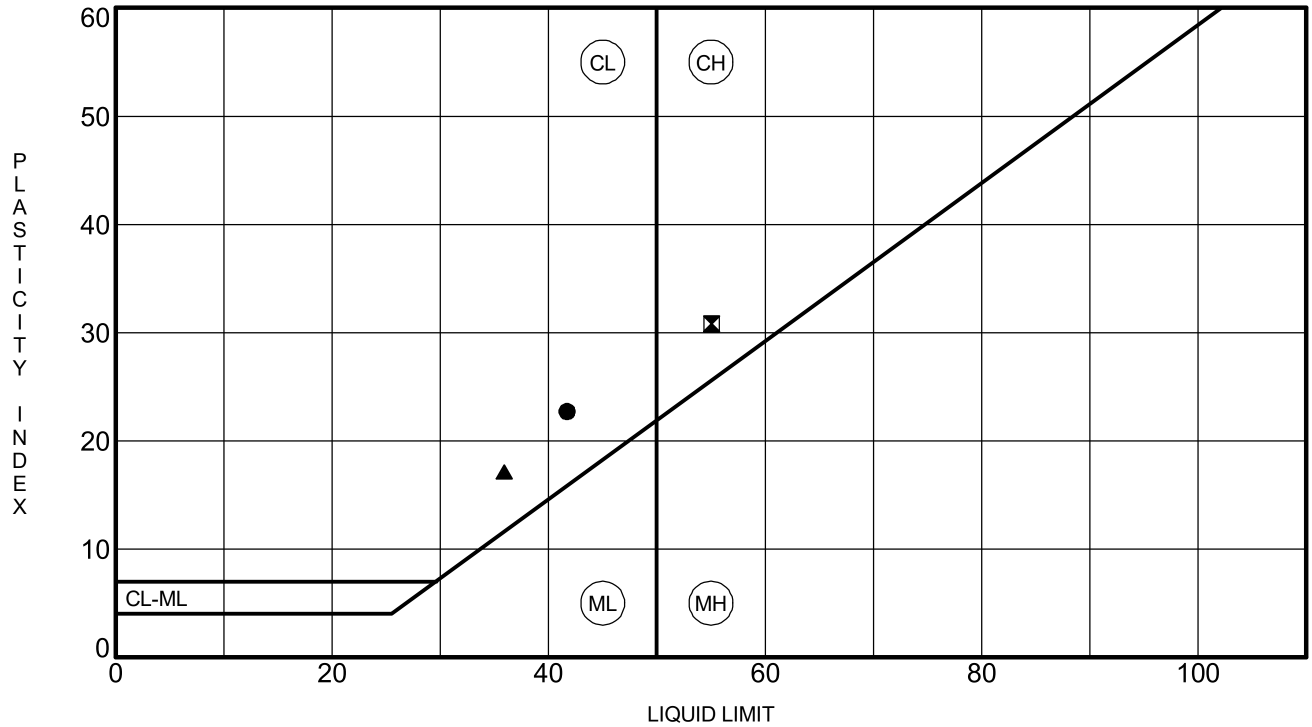
WEI SINCE 1982
Wang Engineering, Inc.
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

GRAIN SIZE DISTRIBUTION

Project: IL Route 7 from 131st Street to 135th Street

Location: Cook County, Illinois

Number: 411-05-02



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**B-04#9**	**21.0 ft**	**42**	**19**	**23**	**100**	**Silty Clay**
⧗	**CB-14#7**	**16.0 ft**	**55**	**24**	**31**	**99**	**Silty Clay**
▲	**CB-15#7**	**16.0 ft**	**36**	**19**	**17**	**99**	**Silty Clay Loam**

WEI SINCE 1982

Wang Engineering, Inc.
1145 N. Main Street
Lombard/IL/60148
Telephone: 6309539928
Fax: 6309539938

ATTERBERG LIMITS' RESULTS

Project: IL Route 7 from 131st Street to 135th Street

Location: Cook County, Illinois

Number: 411-05-02

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

ORGANIC CONTENT in SOILS by LOSS on IGNITION

ASTM D 2974, Method C

Client: JJ Benes & Associates
Project: IL 7
WEI Job: 411-05-02
Type/Condition: SS/ST
Testing Furnace Temp °C.: 440

Analyst Name: L. Varzaru
Date Received: Various
Date Tested: 4/1/2021

Sample No./ Depth	B-02 ST#3 (20-22ft.)	B-03 SS#6 (16-17.5ft.)	B-04 ST#2 (21-23ft.)	B-07 SS#8 (18.5-20ft.)	
wet soil + tare	107.25	67.67	120.61	74.24	
Dry Soil + Tare	79.76	57.81	97.26	63.01	
Tare Mass	43.26	43.24	41.37	42.44	
w (%)	75	68	42	55	
Dry Soil + Tare	79.76	57.81	97.26	63.01	
Ash+ Tare	76.13	56.71	95.11	62.03	
Tare Mass	43.26	43.24	41.37	42.44	
Ash Content (%)	90	92	96	95	
Organic Content (%)	9.9	7.5	3.8	4.8	

Prepeared By:____

Reviwed By:____

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

ONE-DIMENSIONAL CONSOLIDATION TEST
AASHTO T 216 / ASTM D 2435

Project: Illinois Route 7
Client: JJ Benes & Associates
Soil Sample ID: Boring B-04, ST#2, 21 to 23 feet
Sample Description: Dark Brown SI CLAY

Tested by: M. Snider
Prepared by: M. Snider
Test date: 3/24/2021
WEI: 411-05-02

Initial sample height =	1.001 in	Ring diameter =	2.499 in
Initial sample mass =	144.54 g	Ring mass =	109.44 g
Initial water content =	41.51%	Initial sample and ring mass =	253.98 g
Initial dry unit weight =	79.27 pcf	Tare mass =	163.14 g
Initial void ratio =	1.157	Final ring and sample mass =	240.16 g
Initial degree of saturation =	98.31%	Mass of wet sample and tare =	293.58 g
		Mass of dry sample and tare =	265.28 g
Final sample mass =	130.44 g	Initial dial reading =	0.01000 in
Final dry sample mass =	102.14 g	Final dial reading =	0.19930 in
Final water content =	27.71%	LL =	42 %
Final dry unit weight =	97.75 pcf	PL =	19 %
Final void ratio =	0.749	% Sand =	0.2 %
Final degree of saturation =	100.00%	% Silt =	58.7 %
Estimated specific gravity =	2.74	% Clay =	41.0 %

In-Situ Vertical Effective Stress = 1400 psf

Compression and Swelling Indices

Compression index C_c = 0.344
Field corrected C_c = 0.365
Swelling index C_s = 0.072

Preconsolidation pressure,s_C
Casagrande Method = 1427 psf
Over-Consolidation Ratio (OCR) = 1.02

Load number	Vertical stress psf	Dial reading in	System deflection in	Vertical strain %	Void ratio	C_v ft^2/day	Cae %	Elapsed time min
1	100.0	0.01158	0.00010	0.17	1.153	N/A	N/A	720
2	200.0	0.01391	0.00023	0.41	1.148	0.1479	0.07	720
3	500.0	0.02231	0.00058	1.29	1.129	0.1381	0.16	720
4	1000.0	0.03606	0.00090	2.69	1.099	0.1369	0.27	720
5	2000.0	0.06065	0.00135	5.20	1.045	0.1280	0.51	720
6	4000.0	0.09987	0.00193	9.17	0.959	0.1107	0.74	720
7	8000.0	0.14751	0.00253	13.99	0.855	0.1328	0.82	1440
8	16000.0	0.19470	0.00324	18.77	0.752	0.1436	0.70	720
9	32000.0	0.23934	0.00413	23.32	0.654	0.1520	0.65	720
10	8000.0	0.24183	0.00295	23.45	0.651	N/A	N/A	720
11	2000.0	0.22473	0.00198	21.65	0.690	N/A	N/A	720
12	500.0	0.20309	0.00123	19.41	0.738	N/A	N/A	720

Prepared by: ______________________ Date: ______________

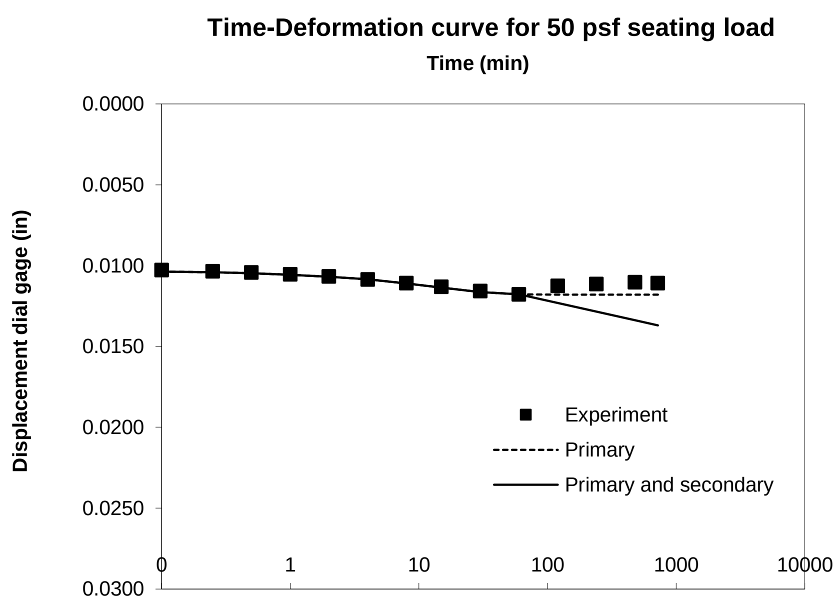
Checked by: ______________________ Date: ______________

Wang Engineering

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

Applied stress	Elapsed time	Dial	Fitted Primary	Fitted Primary and Secondary
psf	min	in	in	in
50.0	*0.00*	0.01000	0.01027	0.01027
	0.10	0.01027	0.01036	0.01036
	0.25	0.01034	0.01041	0.01041
	0.50	0.01042	0.01048	0.01048
	1.00	0.01053	0.01056	0.01056
	2.00	0.01068	0.01068	0.01068
	4.00	0.01086	0.01085	0.01085
	8.00	0.01109	0.01109	0.01109
	15.00	0.01131	0.01137	0.01137
	30.00	0.01157	0.01164	0.01164
	60.00	0.01178	0.01177	0.01177
	120.00	0.01125	0.01179	0.01232
	240.00	0.01115	0.01179	0.01285
	480.00	0.01103	0.01179	0.01338
	720.00	0.01109	0.01179	0.01369

h_0 = 1.00100 in
U_s = 99%
t_s = 61.28 min
d_s = 0.01177 in
d_0 = 0.01027 in
d_{100} = 0.01179 in
d = 0.49999 in
C_v = 0.0073 in^2/min
r_i = 24.7%
r_p = 139.2%
r_s = -63.9%
Slope = -0.0018
Intercept = 0.0149
h_c = 0.9992 in
t_c = 59.87 min
C_{ae} = 0.176%



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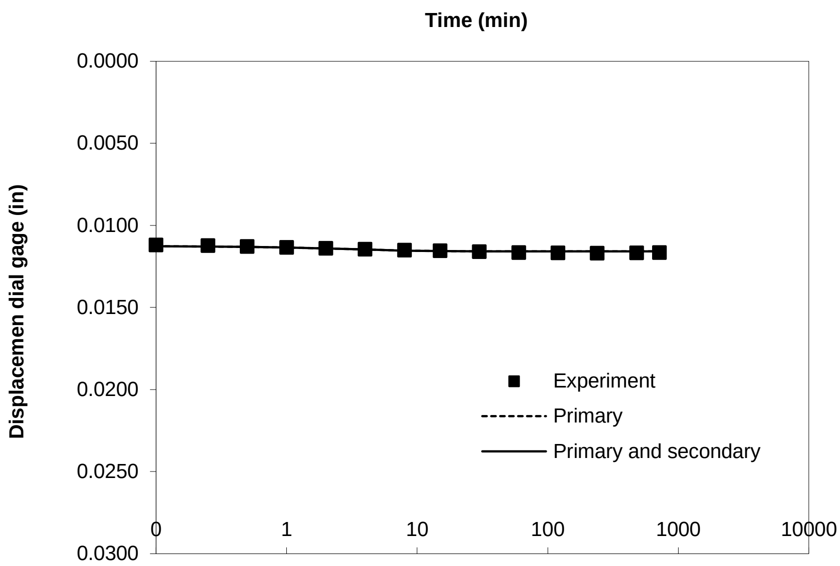
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
100.0	*0.00*	0.01108	0.01123	0.01123
	0.10	0.01120	0.01127	0.01127
	0.25	0.01125	0.01129	0.01129
	0.50	0.01129	0.01132	0.01132
	1.00	0.01135	0.01135	0.01135
	2.00	0.01141	0.01140	0.01140
	4.00	0.01147	0.01147	0.01147
	8.00	0.01151	0.01154	0.01154
	15.00	0.01156	0.01157	0.01157
	30.00	0.01162	0.01158	0.01158
	60.00	0.01166	0.01158	0.01158
	120.00	0.01169	0.01158	0.01158
	240.00	0.01171	0.01158	0.01158
	480.00	0.01169	0.01158	0.01158
	720.00	0.01168	0.01158	0.01158

h_0 =	0.99992	in
U_s =	99%	
t_s =	17.76	min
d_s =	0.01157	in
d_0 =	0.01123	in
d_{100} =	0.01158	in
d =	0.49980	in
C_v =	0.0250	in^2/min
r_i =	25.2%	
r_p =	58.3%	
r_s =	16.5%	
Slope =	-0.0001	
Intercept =	0.0119	
h_c =	0.9994	in
t_c =	28357.55	min
C_{ae} =	0.006%	

Time-Deformation curve for 100 psf load



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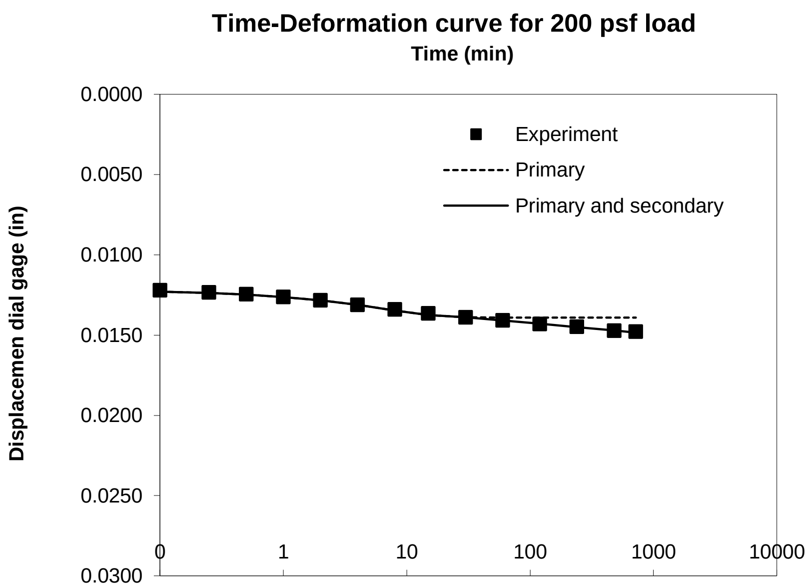
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
200.0	*0.00*	0.01181	0.01214	0.01214
	0.10	0.01220	0.01229	0.01229
	0.25	0.01234	0.01238	0.01238
	0.50	0.01245	0.01248	0.01248
	1.00	0.01262	0.01262	0.01262
	2.00	0.01283	0.01283	0.01283
	4.00	0.01311	0.01311	0.01311
	8.00	0.01339	0.01346	0.01346
	15.00	0.01365	0.01375	0.01375
	30.00	0.01389	0.01389	0.01389
	60.00	0.01408	0.01391	0.01408
	120.00	0.01430	0.01391	0.01429
	240.00	0.01448	0.01391	0.01450
	480.00	0.01473	0.01391	0.01471
	720.00	0.01479	0.01391	0.01484

h_0 =	0.99919	in
U_s =	99%	
t_s =	29.99	min
d_s =	0.01389	in
d_0 =	0.01214	in
d_{100} =	0.01391	in
d =	0.49899	in
C_v =	0.0148	in^2/min
r_i =	10.9%	
r_p =	59.4%	
r_s =	29.7%	
Slope =	0.0007	
Intercept =	0.0128	
h_c =	0.9971	in
t_c =	33.74	min
C_{ae} =	0.070%	



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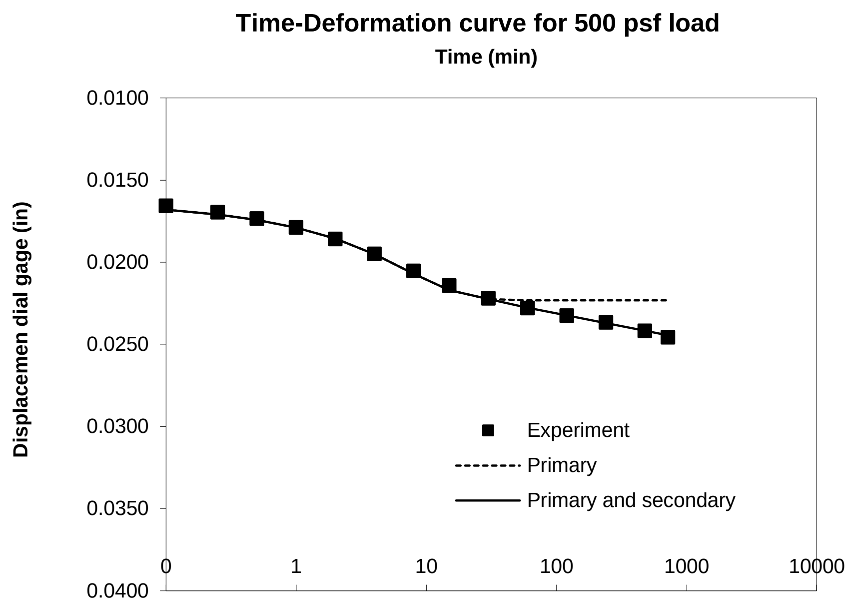
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
500.0	*0.00*	0.01545	0.01629	0.01629
	0.10	0.01659	0.01680	0.01680
	0.25	0.01697	0.01709	0.01709
	0.50	0.01736	0.01743	0.01743
	1.00	0.01788	0.01790	0.01790
	2.00	0.01859	0.01857	0.01857
	4.00	0.01950	0.01951	0.01951
	8.00	0.02054	0.02070	0.02070
	15.00	0.02144	0.02170	0.02170
	30.00	0.02221	0.02224	0.02224
	60.00	0.02279	0.02231	0.02277
	120.00	0.02326	0.02231	0.02324
	240.00	0.02367	0.02231	0.02370
	480.00	0.02419	0.02231	0.02417
	720.00	0.02458	0.02231	0.02444

h_0 =	0.99555	in
U_s =	99%	
t_s =	31.70	min
d_s =	0.02225	in
d_0 =	0.01629	in
d_{100} =	0.02231	in
d =	0.49585	in
C_v =	0.0138	in^2/min
r_i =	9.1%	
r_p =	66.0%	
r_s =	24.9%	
Slope =	0.0015	
Intercept =	0.0200	
h_c =	0.9887	in
t_c =	30.30	min
C_{ae} =	0.157%	



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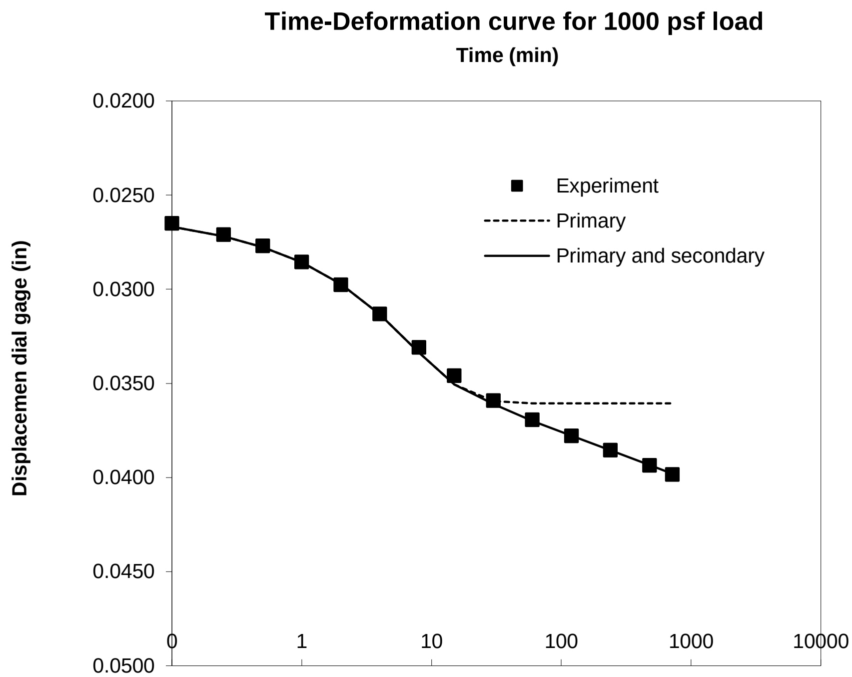
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
1000.0	*0.00*	0.02506	0.02580	0.02580
	0.10	0.02650	0.02668	0.02668
	0.25	0.02709	0.02719	0.02719
	0.50	0.02770	0.02776	0.02776
	1.00	0.02854	0.02857	0.02857
	2.00	0.02976	0.02971	0.02971
	4.00	0.03131	0.03133	0.03133
	8.00	0.03309	0.03336	0.03336
	15.00	0.03460	0.03505	0.03505
	30.00	0.03591	0.03594	0.03610
	60.00	0.03693	0.03606	0.03700
	120.00	0.03779	0.03606	0.03778
	240.00	0.03855	0.03606	0.03857
	480.00	0.03935	0.03606	0.03935
	720.00	0.03984	0.03606	0.03980

h_0 =	0.98594	in
U_s =	99%	
t_s =	31.23	min
d_s =	0.03596	in
d_0 =	0.02580	in
d_{100} =	0.03606	in
d =	0.49003	in
C_v =	0.0137	in^2/min
r_i =	5.0%	
r_p =	69.4%	
r_s =	25.6%	
Slope =	0.0026	
Intercept =	0.0324	
h_c =	0.9749	in
t_c =	25.99	min
C_{ae} =	0.266%	



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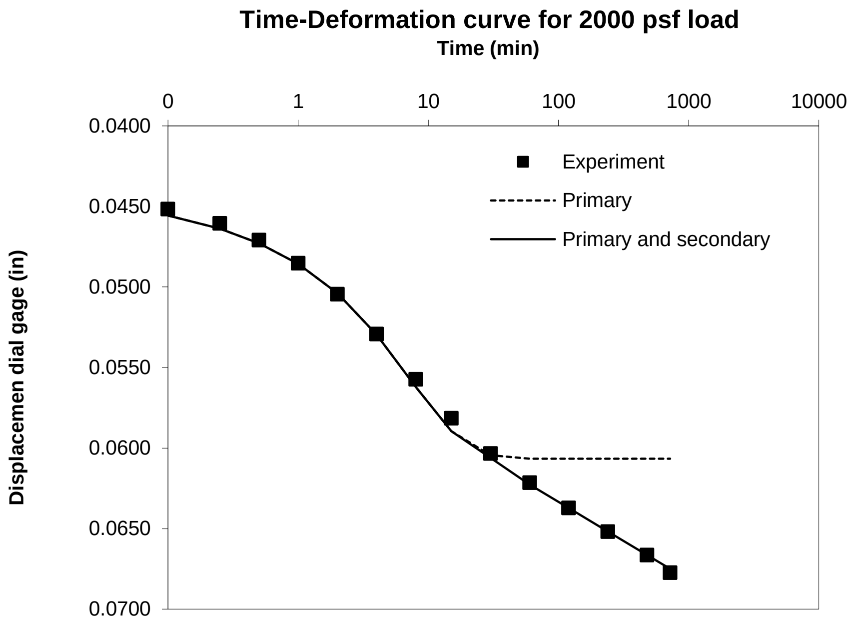
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
2000.0	*0.00*	0.04298	0.04419	0.04419
	0.10	0.04517	0.04557	0.04557
	0.25	0.04607	0.04638	0.04638
	0.50	0.04709	0.04729	0.04729
	1.00	0.04853	0.04857	0.04857
	2.00	0.05046	0.05039	0.05039
	4.00	0.05293	0.05296	0.05296
	8.00	0.05574	0.05621	0.05621
	15.00	0.05815	0.05896	0.05896
	30.00	0.06035	0.06044	0.06059
	60.00	0.06215	0.06065	0.06226
	120.00	0.06372	0.06065	0.06373
	240.00	0.06519	0.06065	0.06519
	480.00	0.06664	0.06065	0.06665
	720.00	0.06774	0.06065	0.06750

h_0 =	0.96802	in
U_s =	99%	
t_s =	31.95	min
d_s =	0.06049	in
d_0 =	0.04419	in
d_{100} =	0.06065	in
d =	0.47929	in
C_v =	0.0128	in^2/min
r_i =	4.9%	
r_p =	66.5%	
r_s =	28.6%	
Slope =	0.0048	
Intercept =	0.0536	
h_c =	0.9503	in
t_c =	27.91	min
C_{ae} =	0.510%	



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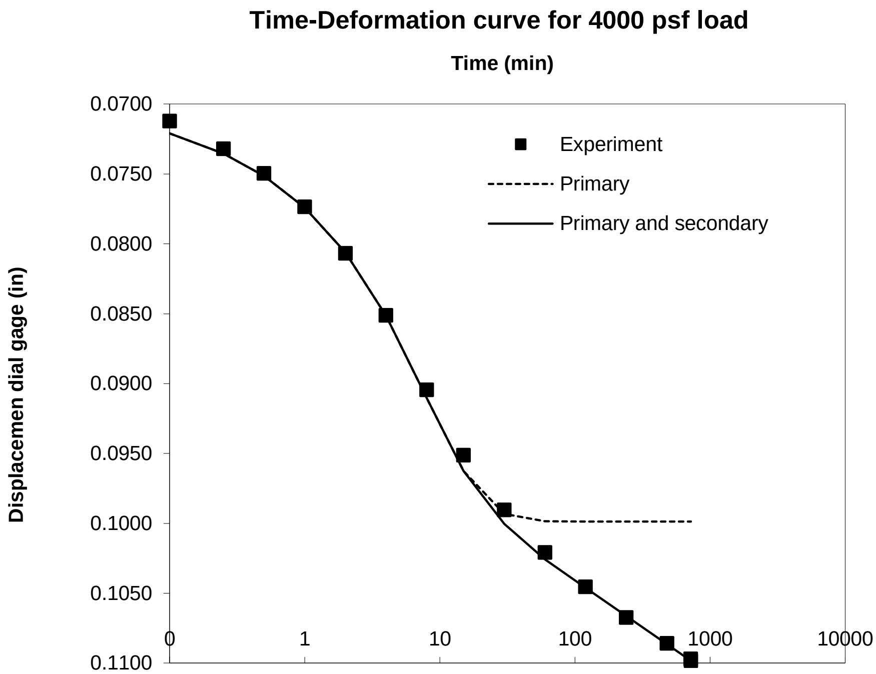
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
4000.0	0.00	0.06935	0.06966	0.06966
	0.10	0.07122	0.07211	0.07211
	0.25	0.07319	0.07353	0.07353
	0.50	0.07497	0.07513	0.07513
	1.00	0.07736	0.07740	0.07740
	2.00	0.08068	0.08061	0.08061
	4.00	0.08512	0.08515	0.08515
	8.00	0.09044	0.09103	0.09103
	15.00	0.09513	0.09625	0.09625
	30.00	0.09903	0.09933	0.10002
	60.00	0.10209	0.09986	0.10257
	120.00	0.10455	0.09987	0.10460
	240.00	0.10674	0.09987	0.10663
	480.00	0.10859	0.09987	0.10865
	720.00	0.10971	0.09987	0.10983

h_0 =	0.94165	in
U_s =	99%	
t_s =	34.49	min
d_s =	0.09957	in
d_0 =	0.06966	in
d_{100} =	0.09987	in
d =	0.46312	in
C_v =	0.0111	in^2/min
r_i =	0.8%	
r_p =	74.9%	
r_s =	24.4%	
Slope =	0.0067	
Intercept =	0.0906	
h_c =	0.9111	in
t_c =	23.68	min
C_{ae} =	0.737%	



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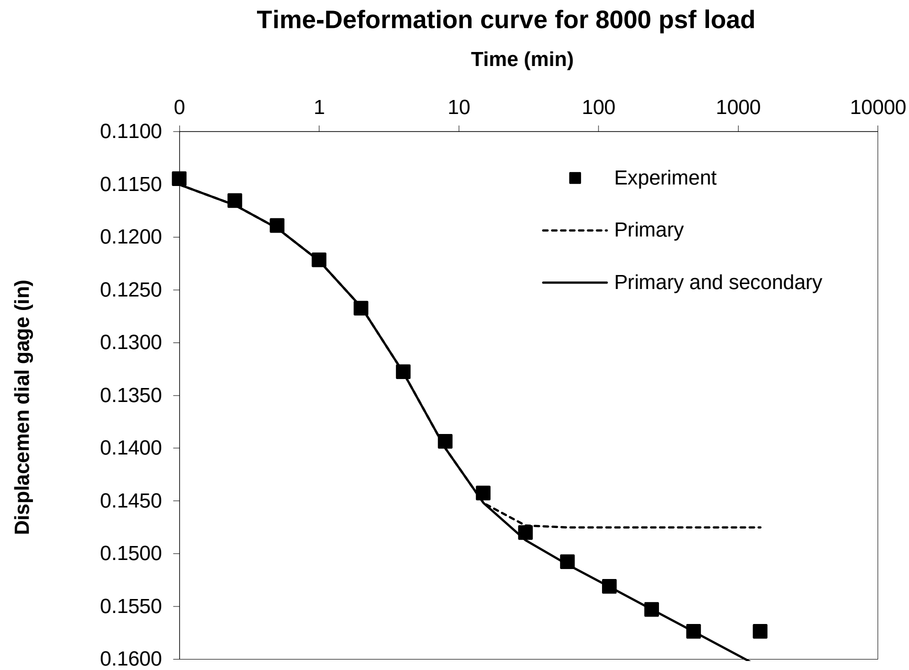
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
8000.0	0.00	0.11075	0.11169	0.11169
	0.10	0.11447	0.11503	0.11503
	0.25	0.11657	0.11697	0.11697
	0.50	0.11892	0.11916	0.11916
	1.00	0.12218	0.12226	0.12226
	2.00	0.12677	0.12664	0.12664
	4.00	0.13277	0.13283	0.13283
	8.00	0.13937	0.13998	0.13998
	15.00	0.14426	0.14520	0.14520
	30.00	0.14803	0.14733	0.14873
	60.00	0.15079	0.14751	0.15103
	120.00	0.15313	0.14751	0.15315
	240.00	0.15532	0.14751	0.15527
	480.00	0.15737	0.14751	0.15739
	1440.00	0.15737	0.14751	0.16076

h_0 =	0.90025	in
U_s =	99%	
t_s =	26.06	min
d_s =	0.14716	in
d_0 =	0.11169	in
d_{100} =	0.14751	in
d =	0.44070	in
C_v =	0.0133	in^2/min
r_i =	2.0%	
r_p =	76.8%	
r_s =	21.1%	
Slope =	0.0070	
Intercept =	0.1385	
h_c =	0.8635	in
t_c =	19.00	min
C_{ae} =	0.816%	



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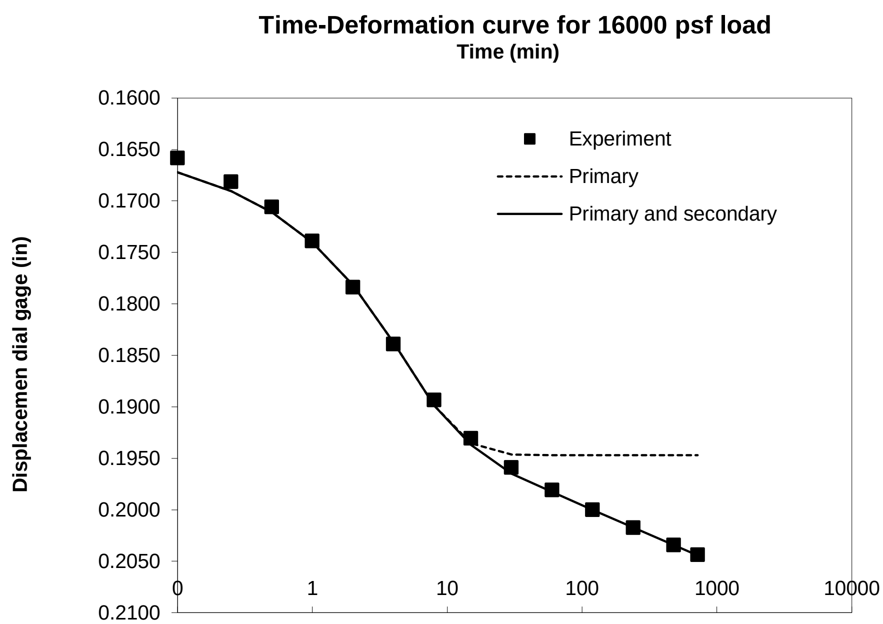
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
16000.0	*0.00*	0.16244	0.16407	0.16407
	0.10	0.16583	0.16722	0.16722
	0.25	0.16814	0.16905	0.16905
	0.50	0.17058	0.17112	0.17112
	1.00	0.17391	0.17403	0.17403
	2.00	0.17838	0.17816	0.17816
	4.00	0.18390	0.18376	0.18376
	8.00	0.18935	0.18988	0.18988
	15.00	0.19305	0.19355	0.19369
	30.00	0.19589	0.19464	0.19651
	60.00	0.19807	0.19470	0.19828
	120.00	0.19998	0.19470	0.20000
	240.00	0.20174	0.19470	0.20172
	480.00	0.20342	0.19470	0.20344
	720.00	0.20436	0.19470	0.20444

h_0 =	0.84856	in
U_s =	99%	
t_s =	21.44	min
d_s =	0.19439	in
d_0 =	0.16407	in
d_{100} =	0.19470	in
d =	0.41581	in
C_v =	0.0144	in^2/min
r_i =	3.9%	
r_p =	73.1%	
r_s =	23.0%	
Slope =	0.0057	
Intercept =	0.1881	
h_c =	0.8163	in
t_c =	14.16	min
C_{ae} =	0.699%	



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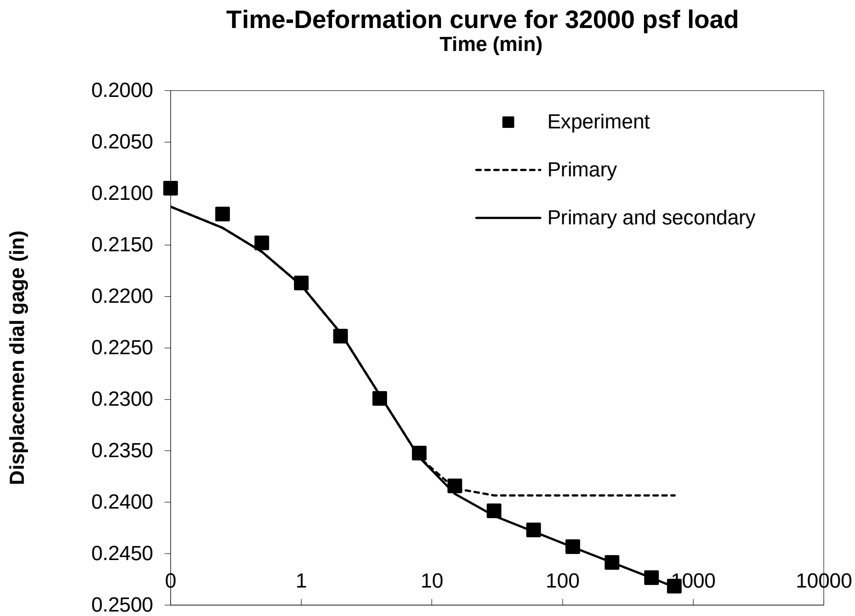
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
32000.0	*0.00*	0.20530	0.20775	0.20775
	0.10	0.20950	0.21128	0.21128
	0.25	0.21201	0.21333	0.21333
	0.50	0.21481	0.21565	0.21565
	1.00	0.21871	0.21892	0.21892
	2.00	0.22388	0.22354	0.22354
	4.00	0.22994	0.22962	0.22962
	8.00	0.23526	0.23565	0.23565
	15.00	0.23844	0.23866	0.23918
	30.00	0.24085	0.23932	0.24134
	60.00	0.24271	0.23934	0.24286
	120.00	0.24435	0.23934	0.24436
	240.00	0.24589	0.23934	0.24587
	480.00	0.24736	0.23934	0.24737
	720.00	0.24820	0.23934	0.24825

h_0 =	0.80570	in
U_s =	99%	
t_s =	18.16	min
d_s =	0.23903	in
d_0 =	0.20775	in
d_{100} =	0.23934	in
d =	0.39373	in
C_v =	0.0152	in^2/min
r_i =	5.7%	
r_p =	73.6%	
r_s =	20.6%	
Slope =	0.0050	
Intercept =	0.2340	
h_c =	0.7717	in
t_c =	11.83	min
C_{ae} =	0.647%	



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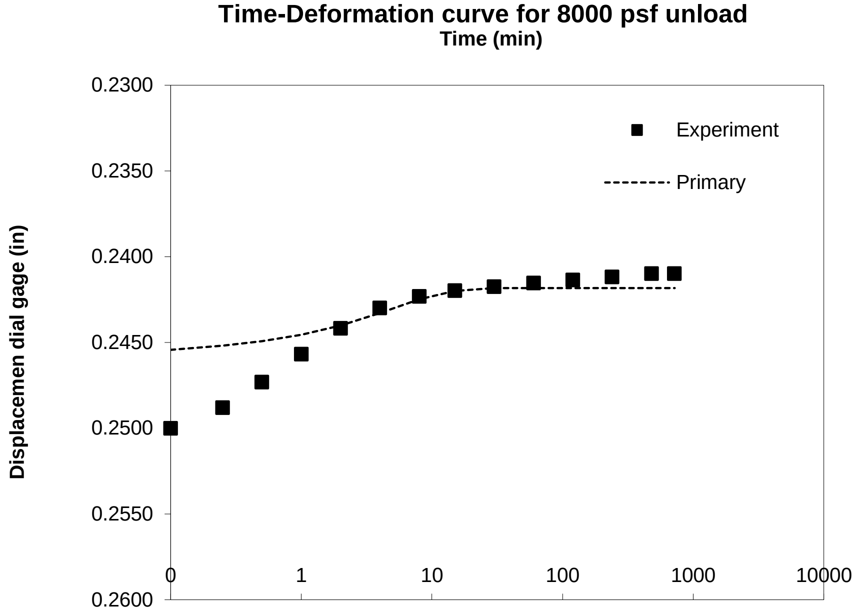
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
8000.0	*0.00*	0.25211	0.24583	0.24583
	0.10	0.25002	0.24543	0.24543
	0.25	0.24881	0.24519	0.24519
	0.50	0.24732	0.24492	0.24492
	1.00	0.24568	0.24455	0.24455
	2.00	0.24418	0.24402	0.24402
	4.00	0.24299	0.24329	0.24329
	8.00	0.24232	0.24249	0.24249
	15.00	0.24199	0.24199	0.24199
	30.00	0.24176	0.24184	0.24191
	60.00	0.24155	0.24183	0.24209
	120.00	0.24138	0.24183	0.24229
	240.00	0.24118	0.24183	0.24248
	480.00	0.24099	0.24183	0.24267
	720.00	0.24099	0.24183	0.24279

h_0 =	0.75889	in
U_s =	99%	
t_s =	22.04	min
d_s =	0.24187	in
d_0 =	0.24583	in
d_{100} =	0.24183	in
d =	0.38358	in
C_v =	0.0119	in^2/min
r_i =	56.5%	
r_p =	36.0%	
r_s =	7.6%	
Slope =	-0.0006	
Intercept =	0.2427	
h_c =	0.7692	in
t_c =	23.50	min
C_{ae} =	0.084%	

Time-Deformation curve for 8000 psf unload



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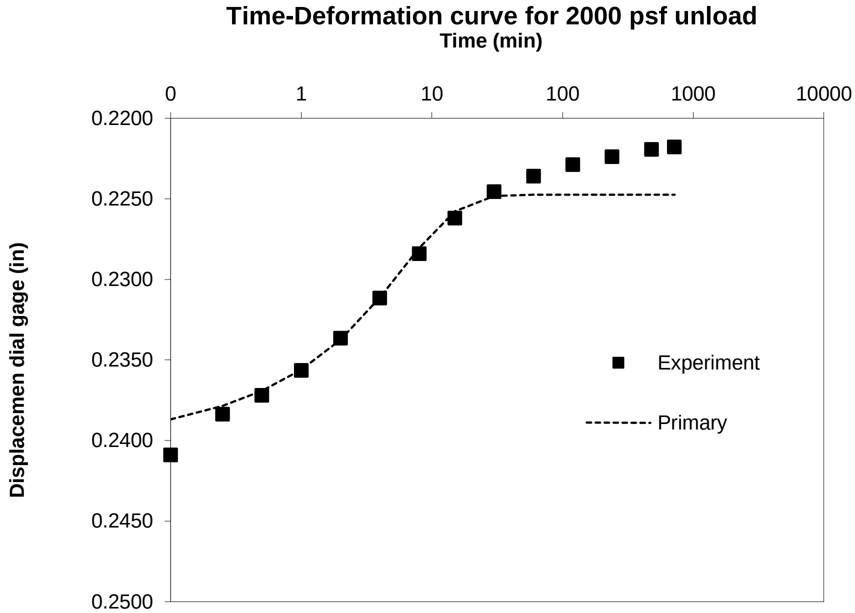
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
2000.0	*0.00*	0.24090	0.24010	0.24010
	0.10	0.24090	0.23868	0.23868
	0.25	0.23836	0.23785	0.23785
	0.50	0.23719	0.23692	0.23692
	1.00	0.23566	0.23561	0.23561
	2.00	0.23366	0.23375	0.23375
	4.00	0.23115	0.23112	0.23112
	8.00	0.22840	0.22805	0.22805
	15.00	0.22620	0.22577	0.22620
	30.00	0.22455	0.22482	0.22573
	60.00	0.22360	0.22473	0.22611
	120.00	0.22288	0.22473	0.22659
	240.00	0.22239	0.22473	0.22706
	480.00	0.22193	0.22473	0.22754
	720.00	0.22179	0.22473	0.22782

h_0 =	0.77010	in
U_s =	99%	
t_s =	26.55	min
d_s =	0.22489	in
d_0 =	0.24010	in
d_{100} =	0.22473	in
d =	0.38929	in
C_v =	0.0102	in^2/min
r_i =	4.2%	
r_p =	80.4%	
r_s =	15.4%	
Slope =	-0.0016	
Intercept =	0.2262	
h_c =	0.7863	in
t_c =	7.99	min
C_{ae} =	0.201%	



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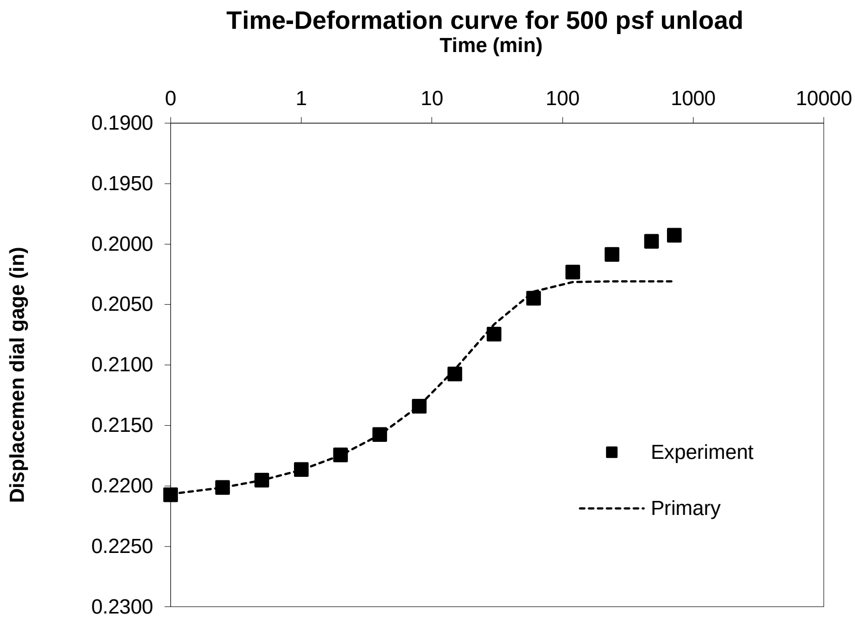
Applied stress psf	Elapsed time min	Dial in	Fitted Primary in	Fitted Primary and Secondary in
500.0	*0.00*	0.22166	0.22159	0.22159
	0.10	0.22074	0.22067	0.22067
	0.25	0.22015	0.22013	0.22013
	0.50	0.21954	0.21953	0.21953
	1.00	0.21868	0.21867	0.21867
	2.00	0.21746	0.21747	0.21747
	4.00	0.21576	0.21576	0.21576
	8.00	0.21344	0.21335	0.21335
	15.00	0.21077	0.21038	0.21038
	30.00	0.20748	0.20663	0.20663
	60.00	0.20449	0.20393	0.20393
	120.00	0.20234	0.20313	0.20313
	240.00	0.20087	0.20309	0.20379
	480.00	0.19979	0.20309	0.20507
	720.00	0.19930	0.20309	0.20581

h_0 =	0.78934	in
U_s =	99%	
t_s =	91.43	min
d_s =	0.20327	in
d_0 =	0.22159	in
d_{100} =	0.20309	in
d =	0.39933	in
C_v =	0.0031	in^2/min
r_i =	0.3%	
r_p =	82.8%	
r_s =	16.9%	
Slope =	-0.0042	
Intercept =	0.2125	
h_c =	0.8079	in
t_c =	163.46	min
C_{ae} =	0.524%	



Wang Engineering

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
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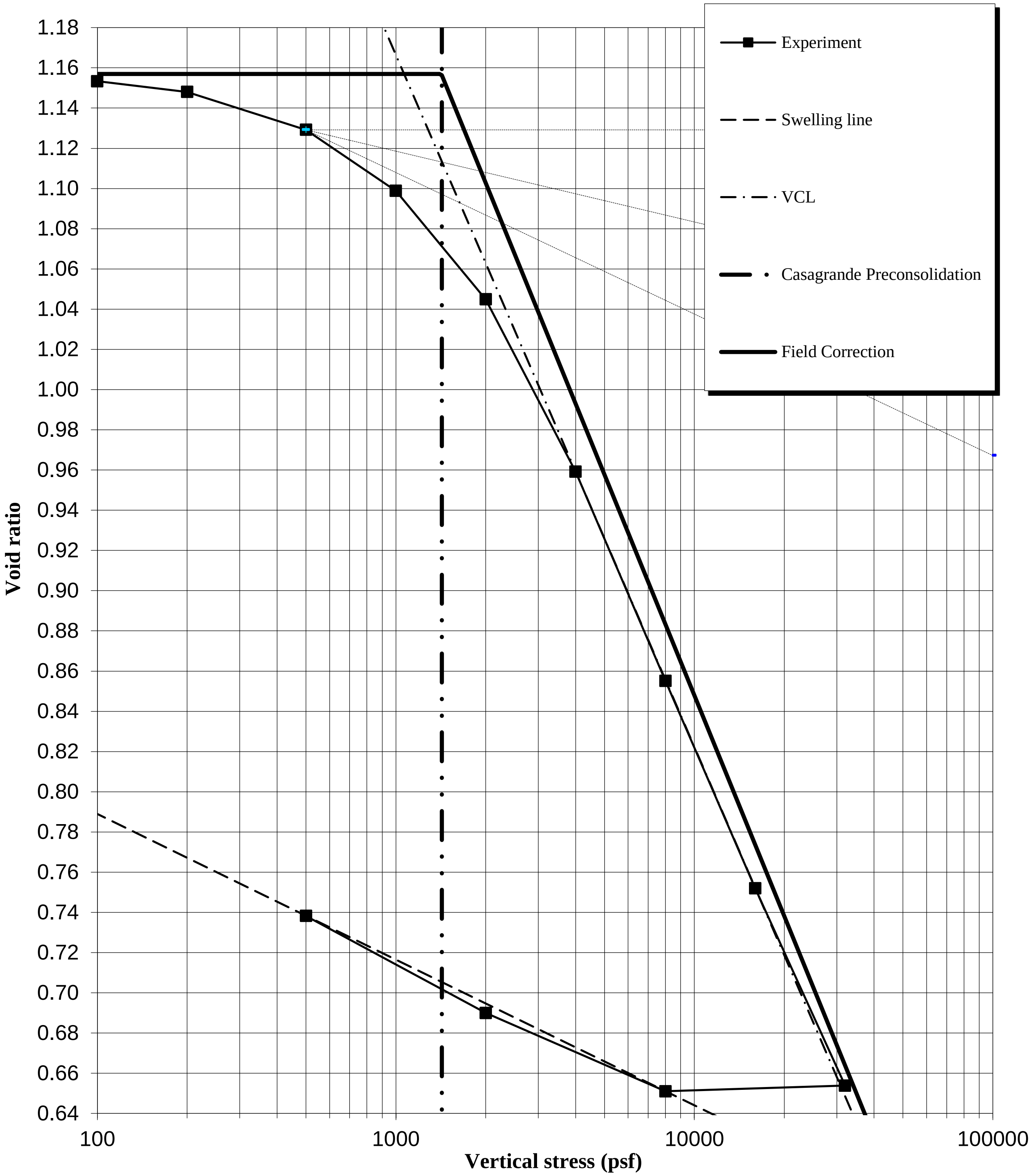
CONSOLIDATION CURVE

Sample B-04, ST#2, 21 to 23 feet



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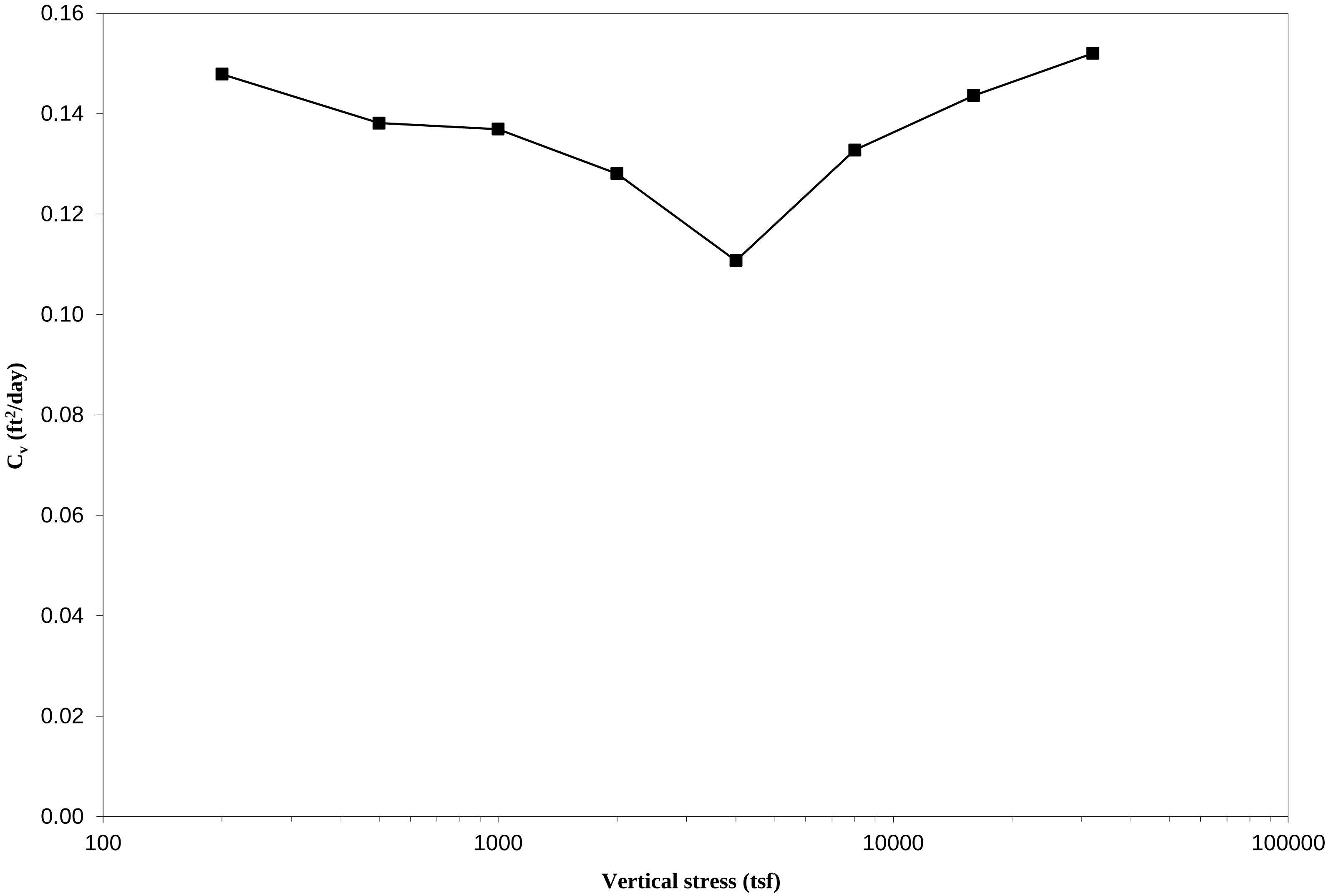
CONSOLIDATION COEFFICIENT (C_v) vs. VERTICAL STRESS

Sample B-04, ST#2, 21 to 23 feet



AASHTO R18

APPENDIX C

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Phone (630) 953-9928
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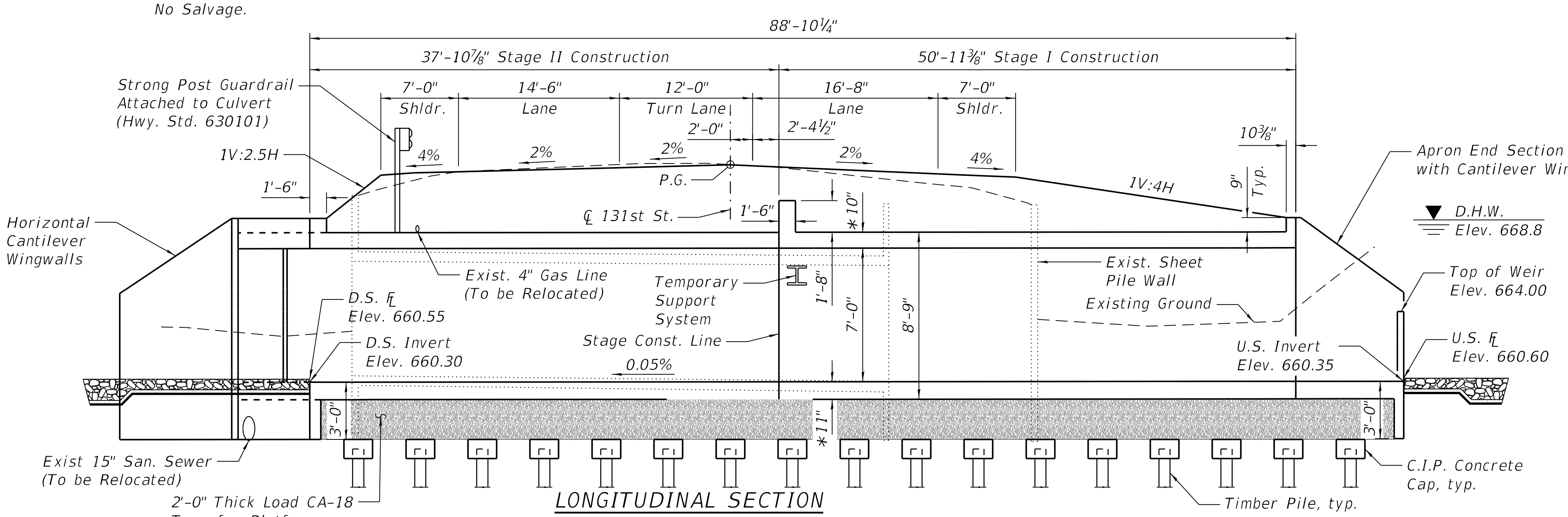
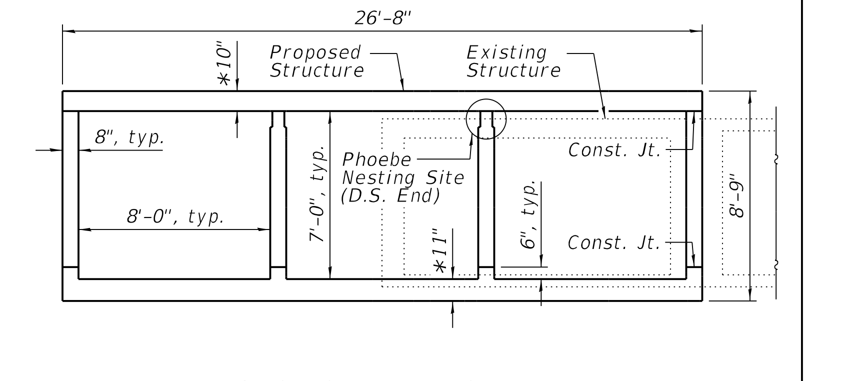
APPENDIX D

Bench Mark: BM #8: Cut "□" in top northeast corner of concrete traffic signal post foundation located at the southwest corner of IL Rte. 7 and 131st St., near Sta. 130+40 Lt. Elevation = 672.36 (NAVD88).

Existing Structure: Existing S.N. 016-0898 is a C.I.P. concrete box culvert built in 1930, and extended in 1958 under Section 3113-15D-I. Existing structure is a 62'-10" long, 6'x5.7' & 12'x6' double box culvert. The existing structure will be partially removed, or abandoned in place and filled, and replaced with a C.I.P. triple box culvert. Stage construction will be utilized to maintain one lane of traffic in each direction and a left turn lane during construction.
Precast alternate is not allowed.
No Salvage.



LONGITUDINAL SECTION
(All Dimensions at Rt. ∠'s to ℄ Roadway, U.N.O.)



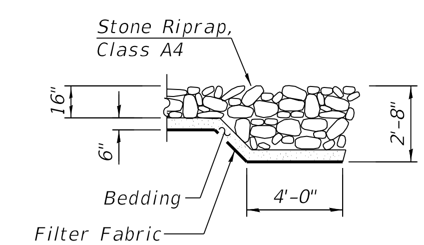
SECTION THRU CULVERT

*Subject to refinement during final design.

**2'-0" width of P.G.E. to be installed full length of proposed culvert, to 3'-0" from the end of the proposed wingwalls. Adjacent to culvert, vertical limits are from bottom of bottom slab to top of top slab. Along wingwalls, vertical limits are from bottom of culvert bottom slab to 1'-0" below top of wingwall. P.G.E. shall be capped with a 12" thick layer of impervious material. Cost of impervious material shall be included in the cost of Porous Granular Embankment.

HIGHWAY CLASSIFICATION

F.A.U. Route 1593 (131st St.)
Functional Class: Minor Arterial
ADT: 10,500 (2018), 15,000 (2040)
DHV: 1,650 (2040)
ADTT: 929 (2040)
Design Speed: 45 mph
Posted Speed: 40 mph
Directional Distribution: 50:50



SECTION A-A

DESIGN SPECIFICATIONS

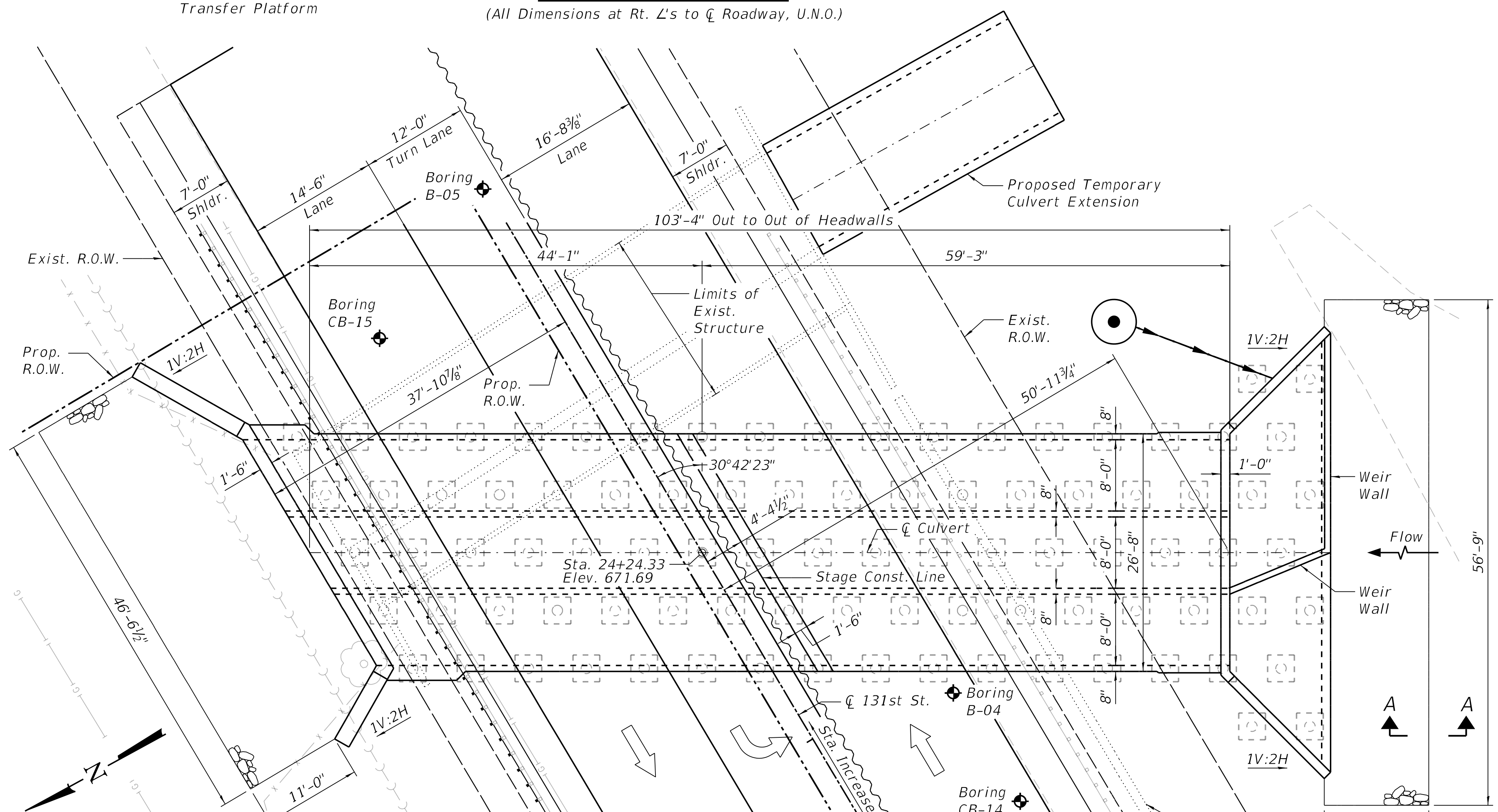
2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

LOADING HL-93

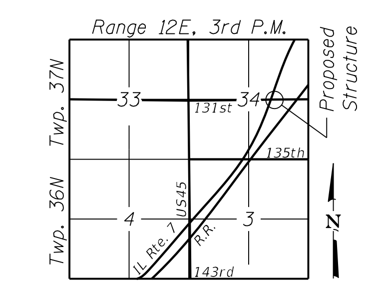
Allow 50#/sq. ft. for future wearing surface.

DESIGN STRESSES

FIELD UNITS (New Construction)
f'c = 3,500 psi
fy = 60,000 psi (Reinforcement)



PLAN



LOCATION SKETCH

GENERAL PLAN AND ELEVATION
131st ST. OVER MILL CREEK
F.A.U. RTE. 3578 SEC. 2019-001-R
COOK COUNTY
STATION 24+24.33
S.N. 016-0933

LIN ENGINEERING, LTD. Consulting Engineers Springfield, Illinois	USER NAME = LIN06-PC	DESIGNED - AGJ	REVISED -
		CHECKED - VPT	REVISED -
	PLOT TIME = 11:43:10 AM	DRAWN - AGJ	REVISED -
	PLOT DATE = 8/4/2021	CHECKED - VPT	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN AND ELEVATION
STRUCTURE NO. 016-0933
SHEET 1 OF 2 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3578	2019-001-R	COOK	2	1
		CONTRACT NO. 62H82		
		ILLINOIS FED. AID PROJECT		

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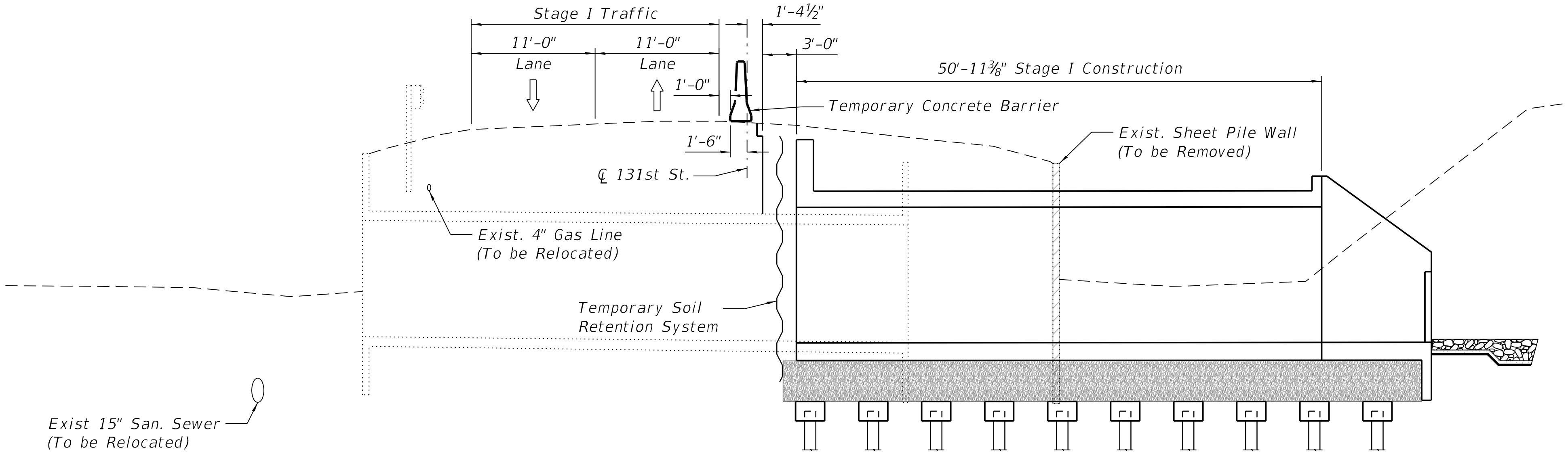
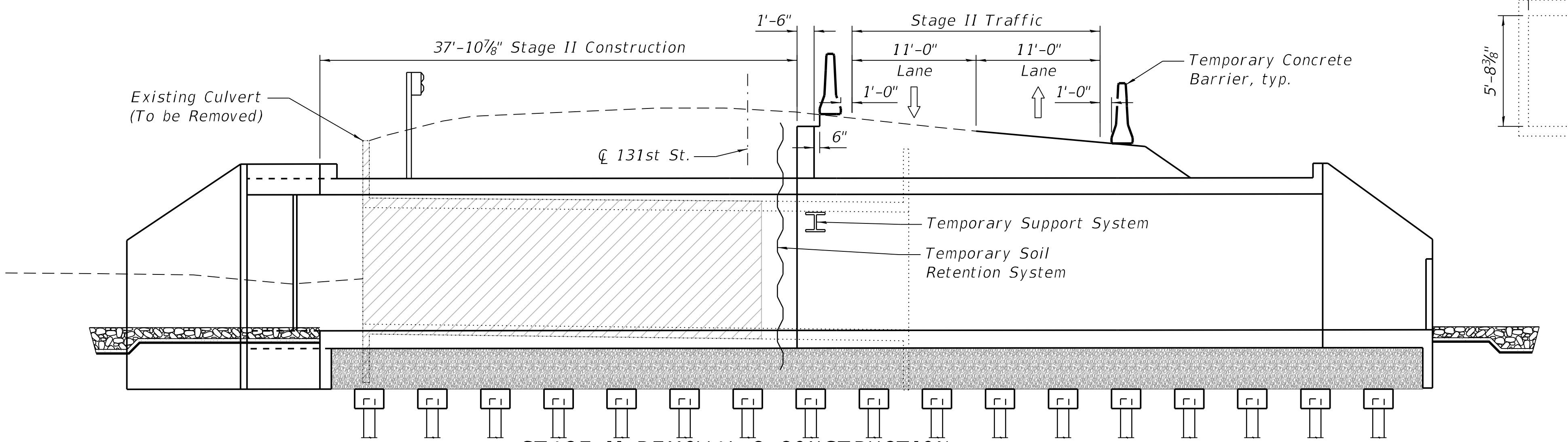


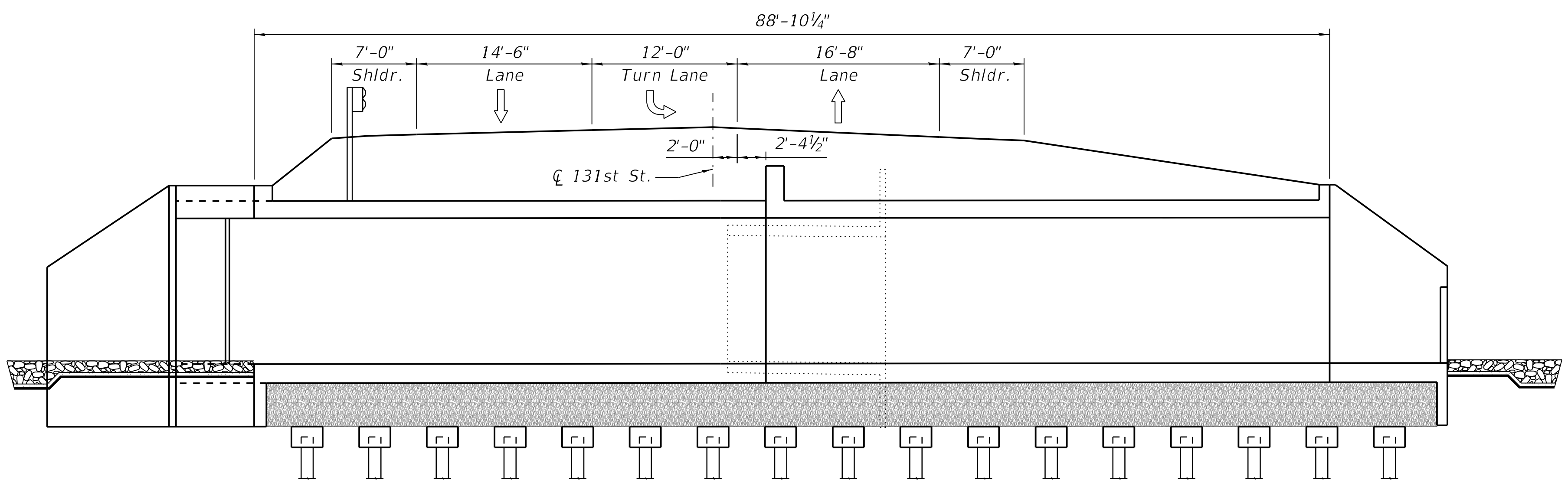
STAGE I REMOVAL & CONSTRUCTION

(Dimensioned at Rt. ∠'s to ℄ Roadway)



STAGE II REMOVAL & CONSTRUCTION

(Dimensioned at Rt. ∠'s to ℄ Roadway)

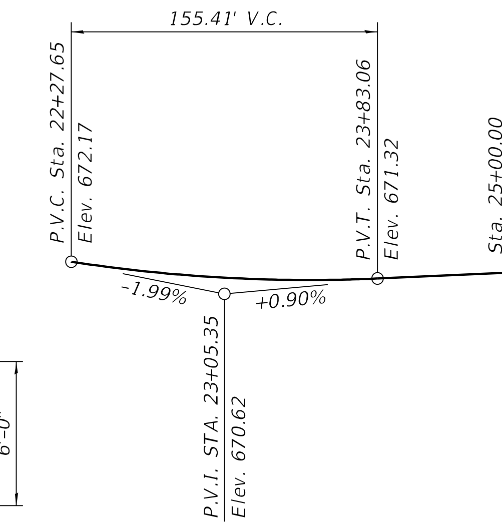


FINAL CONDITION

(Dimensioned at Rt. ∠'s to ℄ Roadway)

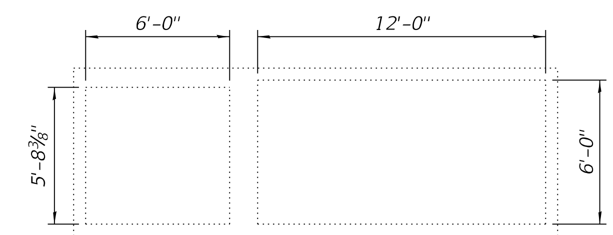
WATERWAY INFORMATION

Drainage Area = 5.92 sq. mi. Low Grade Elev. = 672.7 @ Sta. 131+00									
Flood	Freq. Yr.	Q C.F.S.	Opening Sq. Ft.		Nat. H.W.E.	Head - Ft.		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
	10	228	106.2	136	667.9	0	0	667.7	667.6
Design	50	461	106.2	136	668.8	0.4	0	669.2	668.7
Base	100	498	106.2	136	669.4	0.4	0	669.8	669.1
Overtopping									
Max. Calc.	100	498	106.2	136	669.4	0.4	0	669.8	669.1



PROFILE GRADE

Along ℄ Proposed 131st St.



SECTION THRU EXISTING CULVERT EXTENSION

CULVERT CONSTRUCTION SEQUENCE

1. Grade around upstream end of existing culverts to existing invert elevation.
2. Clean existing culverts and install temporary culvert extension.
3. Shift traffic to the north side of roadway.
4. Install Temporary Soil Retention System.
5. Divert water from construction area to the eastern most existing culvert barrel.
6. Fill southern portion of existing western culvert barrel.
7. Construct south portion of load transfer platform and proposed culvert.
8. Reconstruct pavement to match previously existing condition, and widen embankment to support temporary pavement and shoulder (See Roadway Plans for details).
9. Adjust temporary soil retention system at stage line as necessary.
10. Shift traffic to south side of roadway.
11. Perform removal of existing structure as necessary for construction.
12. Construct north portion of load transfer platform and proposed culvert.
13. Remove water diversion measures.
14. Fill any portions of the existing culvert barrels that have not been removed.
15. Reconstruct pavement to match previously existing condition, and widen embankment to the north culvert limits (See Roadway Plans for details).
16. Open roadway to traffic.
17. Roadway will be removed and replaced to Final configuration in a later stage.

GENERAL DATA
131st ST. OVER MILL CREEK
F.A.U. RTE. 3578 SEC. 2019-001-R
COOK COUNTY
STATION 24+24.33
S.N. 016-0933

MODEL: Default
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		CHECKED - VPT	REVISED -		
	PLOT TIME = 11:43:12 AM	DRAWN - AGJ	REVISED -		
	PLOT DATE = 8/4/2021	CHECKED - VPT	REVISED -		SHEET 2 OF 2 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3578	2019-001-R	COOK	2	2
		CONTRACT NO. 62H82		
	ILLINOIS	FED. AID PROJECT		

8/4/2021 11:43:12 AM