STRUCTURE GEOTECHNICAL REPORT
KEAN AVENUE CULVERT AT STATION 77+13.55
EX SN 016-1255, PR SN 016-2298
COOK COUNTY, ILLINOIS

For
Collins Engineers, Inc.
123 North Wacker Drive, Suite 900
Chicago, IL 60606

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

Original Report: August 16, 2017
Revised Report: November 8, 2017

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, Kean Avenue Culvert at Station 77+13.55		**2. Original Date:** August 16, 2017 **Revised Date:** November 8, 2017 **3. Report Type** ☒ SGR ☐ RGR ☐ Draft ☒ Final ☒ Revised
4. Route / Section / County/ District/ Region FAU 2721/ 10-37-12 / Cook/ 1/ 1		**5. Contract** IDOT 62D40
6. PTB / Item No. 182/04	**7. Existing Structure Number(s)** SN 016-1255	**8. Proposed Structure Number(s)** SN 016-2298
9. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: M. Kothawala, P.E., D.GE QA/QC: Mickey Snider, P.E. PM: M. Kothawala, P.E., D.GE	**Contact** (630) 953-9928 ext. 1036 mkothawala@wangeng.com
10. Prepared for Collins Engineers, Inc. 123 N Wacker Drive Suite 900 Chicago, IL, 60606	**Design Engineer** HBM Engineering Group, LLC 4415 West Harrison Street Hillside, IL 60162	**Contact** (773) 236-0960 Mahmoud.issa@hbmengineering.com

11. Abstract

The existing single-cell box culvert carrying Kean Avenue over an Unnamed Ditch at Station 77+13.55 will be removed and replaced with a new double-cell concrete box culvert. The new culvert will have two interior openings of 7-foot wide by 3-foot high and a total width of 15.5 feet. The culvert length will measure 36.0 feet. Invert elevations will be at 660.56 feet at the upstream end and 660.32 feet at the downstream end. The culvert will have 6-foot horizontal wingwalls. This report provides geotechnical recommendation for the design and construction of the proposed culvert and wingwalls.

Beneath the pavement and up to 4 feet of fill material, the general lithologic profile includes up to 4 to 9 feet of soft to stiff silty clay to clay loam with organic matter and sand lenses followed by loose granular soils. Deeper foundation soils include stiff to very stiff silty clay to silty clay loam. The groundwater level was measured at elevations ranging from 653 to 654 feet, primarily within the sand and silt. As per TSL plan, the Estimated Water Surface Elevation is 662.52 feet. Temporary ditch diversion as well as temporary dewatering for the foundation excavations protected by steel sheet piling will be required.

The proposed culvert installation as well as recommended removal and replacement will require excavations up to 13 feet from existing grade. It will be feasible to construct the culvert on shallow foundations; however, as an alternative to the removal and replacement, the culvert could be supported on driven metal shell piles. With the recommended removal and replacement, our settlement analyses show the foundation soils along the culvert will undergo a maximum consolidation settlement of 0.5 inch or less with the differential settlement of 0.5 inch or less.

The proposed wingwall length of 6.0 feet complies with the requirements for horizontal cantilever walls as per IDOT *Culvert Manual* (2017).The horizontal cantilever walls should be founded a minimum of 3.0 feet below the invert elevation.

Any temporary slopes that cannot be sloped 1:1 (V:H) or flatter should be properly shored with temporary sheet piles. Our analyses indicate that temporary sheet pile design using IDOT *AGMU* 3.13.1 Charts will be feasible.

12. Path to archived file

S:\Netprojects\4862301\Reports\SN 016_2298_North\RPT_Wang_NSB_MAK_4862301_SN016_2298_v05_20171108.doc

TABLE OF CONTENTS

List of Tables

Wang Engineering

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

STRUCTURE GEOTECHNICAL REPORT
KEAN AVENUE CULVERT AT STATION 77+13.55
EX SN 016-1255, PR SN 016-2298
COOK COUNTY, ILLINOIS
FOR
COLLINS ENGINEERS, INC.

1.0 INTRODUCTION

This report presents the results of the Wang Engineering, Inc. (Wang) subsurface investigation, laboratory testing, and geotechnical evaluations to support the design and reconstruction of a culvert carrying Kean Avenue over an Unnamed Ditch at Station 77+13.55 in Palos Hills, Cook County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Based on the *TSL Plan* provided by HBM Engineering Group, Inc. on November 8, 2017, the proposed culvert will be a concrete double box with two interior openings of 7-foot wide by 3-foot high and a total width of 15.5 feet. The culvert length will measure 36.0 feet. The upstream invert elevation will be established at 661.56 feet, while the downstream invert elevation will be at 661.32 feet with the flow from east to west. The new structure will be constructed in the same location as the existing culvert; however, it will be longer and wider than existing one. The culvert end will have 6-foot long horizontal wingwalls at each corner. The proposed roadway grade elevation will be 665.76 feet. The TSL plan is included in Appendix C.

It is understood the proposed culvert design will be in accordance with 2014 AASHTO *LRFD Bridge Design Specifications* with 2015 and 2016 interims except as modified by 2017 IDOT *Culvert Manual*.

1.2 Existing Structure and Land Use

The existing culvert is a single cell cast-in-place concrete box culvert with an interior opening of 10-foot wide by 3-foot high and 32.2-foot long. The surrounding land is the Cook County Forest Preserve's open wetland area on the west side and developed area on the east side of Kean Avenue.

The purpose of this investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide recommendations for the design and construction of the proposed culvert and wingwalls.

2.0 METHODS OF INVESTIGATION

2.1 Field Investigation

The subsurface investigation consisted of two structure borings, designated as 1255-CUL-01 and 1255-CUL-02. The borings were drilled by Wang on July 18 and 19, 2017. The as-drilled northings, eastings, and elevations were acquired with a mapping-grade GPS unit. Stations and offsets were provided by HBM. Boring location data are presented in the *Boring Logs* (Appendix A). The as-drilled boring locations are shown in the *Boring Location Plan* (Exhibit 2).

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 T 206, "*Penetration Test and Split Barrel Sampling of Soils*." The soil was sampled at 2.5-foot intervals to 30 feet below ground surface (bgs) and at 5-foot intervals, thereafter. 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 classifications (IDH Textural), results of Rimac and pocket penetrometer unconfined compressive strength testing on cohesive soils, and results of Standard Penetration Tests (SPT) recorded as blows per 6 inches of penetration.

Groundwater observations were made during and at the end of drilling operations. Due to safety considerations, boreholes were backfilled immediately upon completion with soil cuttings and/or chips. The pavement surface was restored 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/T90) and particle size (AASHTO T88) analyses were performed on selected samples. Field visual descriptions of the soil samples were verified in the laboratory and index tested samples were classified according to the IDH Soil Classification System. 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 investigation 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

The borings advanced through pavement encountered 9 to 9.5 inch thick asphalt over 4.8 inch thick sandy gravel or 8 inch thick concrete. In descending order, the general lithologic succession encountered beneath the surface includes: 1) man-made ground (fill); 2) soft to stiff organic silty clay loam to clay loam; and 3) stiff to very stiff silty clay to silty clay loam.

1) Man-made Ground (Fill)

Beneath the pavement, the borings revealed 2 to 4 feet of fill materials. The fill is cohesive, consisting of medium stiff to very stiff silty clay to silty clay loam with organic matter. Boring 1255-CUL-01 encountered buried topsoil beneath cohesive fill. The unconfined compressive strength (Q_u) values range from 0.8 to 2.5 tsf with an average of 1.8 tsf and the moisture content values of 14 to 25%.

2) Soft to stiff silty clay to clay loam

Beneath the fill at elevations of 659 to 662 feet, the borings encountered 4 to 9 feet of soft to stiff, dark gray to gray silty clay to clay loam with organic matter. The cohesive soils have Q_u values of 0.4 to 1.1 tsf. The moisture content values through the full extent of this layer range from 33 to 67%. Laboratory index testing on samples from this unit showed liquid limit (L_L) values of 63 to 84% and plastic limits (P_L) values of 26 to 35%.

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

Beginning at elevations of 653 to 655 feet, the borings encountered gray, stiff to very stiff silty clay to silty clay loam with silt and sand lenses. The unit has Q_u values of 1.0 to 2.8 tsf and moisture content values of 11 to 28%. Loose, gray silt and sand lenses has N values of 5 to 8 blows per foot and moisture content values of 16 to 17%.

3.2 Groundwater Conditions

Groundwater was encountered while drilling at elevations of 653 and 654 (10 and 12 feet bgs). At the completion of drilling, the groundwater was observed at an elevation of 625 feet (39 and 40 feet bgs). As per the TSL plan, the Estimated Water Surface Elevation (EWSE) is 662.52 feet.

4.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the culvert are included in the following sections. Wang has performed bearing capacity, settlement, and global stability analyses for the culvert barrel and wingwalls. In addition, Wang has also evaluated the feasibility of cast-in-place and precast options based on foundation soils and new embankment loads.

4.1 Culvert Foundations

Based on our subsurface investigation, the foundation soils at the base of the culvert barrel are primarily soft to medium stiff, high moisture silty clay to clay loam with organic matter overlying by loose granular soils and stiff to hard cohesive soils. The soft to medium stiff soils or loose granular soils are up to 8 feet thick of the upstream end and up to 5 feet thick of the downstream end. We recommend removing these soils to an elevation of 652 feet at the upstream end and 655 feet at the downstream end and replacing it with Rockfill. The Rockfill should be capped with 6 inches of CA-7 and satisfy IDOT Standard Specifications. There is no removal and replacement information available for the existing culver construction. We recommend showing the removal and replacement on the plan for the full length of the proposed culvert. The actual depth of removal and replacement should be determined in the field during construction. The replacement material should extend a minimum of two feet beyond each side of the box (IDOT 2016).

Following the recommended removal and replacement, the recommended factored bearing resistance for culvert barrels is 3,000 psf with a bearing resistance factor of 0.45 (AASHTO, 2014). Culvert barrels should be designed based on lateral earth pressure diagram determined according to IDOT *Culvert Manual* (IDOT, 2017).

As an alternative to the removal and replacement, the proposed culvert could be supported on metal shell piles. The pile lengths were calculated with the spreadsheet, *IDOT Static Method of Estimating Pile Length vs Resistance*. The R_F, R_N, estimated pile tip elevations, and pile lengths for 12-inch diameter metal shell piles (MSP) are summarized in Table 1. The lengths shown in the table

assume a 1-foot pile penetration into the pile cap. We estimate the relative settlement between the pile and soil will be more than 0.4 inches; therefore, there will be downdrag load on piles.

Table 1: Estimated Pile Lengths and Tip Elevations for 12-inch Diameter w/0.25-inch Walls Metal Shell Piles

Limits (Reference Boring)	Culvert Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
Downstream 1255-CUL-01	659.5	89	6	12	30	19	641.5
		106	6	12	40	22	638.5
		124	6	12	50	23	637.5
		143	6	12	60	27	633.5
		161	6	12	70	28	632.5
		343(*)	6	12	171	32	628.5
Upstream 1255-CUL-02	659.7	99	8	16	30	20	640.7
		117	8	16	40	22	638.7
		135	8	16	50	27	633.7
		153	8	16	60	32	628.7
		160(*)	8	16	64	33	627.7

(*) Maximum Nominal Bearing at boring depth.

4.2 Settlement

Based on the plan and profile drawings, an approximately 0.7 feet of grade raise is proposed. The consolidation settlement of the foundation soils under the proposed culvert is estimated to be less than one inch across the existing embankment portion; however, without removal and replacement, the culvert in the widening portions of embankment will experience up to 2 inches of consolidation settlement.

Following the recommended removal and replacement, we estimate the foundation soils will

experience consolidation settlement of 0.5 inch in the widening portion of the culvert with the differential settlement of less than 0.5 inch.

4.3 Global Stability

Since the horizontal cantilever wingwalls will be utilized at the each corner, we do not anticipate any global instability concerns.

4.4 Cast-In-Place or Precast Culvert Considerations

The results of the settlement analyses indicate that the cast-in-place culvert is feasible if the unstable soil is removed and replaced with aggregate. Due to insuffient cover between the bottom of pavement to the top of the top slab (<6" per Culvert Manual 2.1.4), the precast alternate is not allowed. The differential settlement will be about 0.5 inch which will not cause excessive separation of the precast sections. A cast-in-place culvert will be required if the proposed culvert is supported on piles.

4.5 Stage Construction

The construction will be in one stage since the traffic will be fully detoured.

5.0 CONSTRUCTION CONSIDERATIONS

5.1 Site Preparation

Vegetation, surface topsoil, and debris should be cleared and stripped where the structure will be placed. If unstable or unsuitable materials are exposed during excavation, they should be removed and replaced with compacted fill as described in Section 6.3.

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. The proposed culvert installation, including the recommended removal and replacement, will require excavations up to 13 feet from the existing grade. We performed global slope stability analysis for a temporary excavation slope along the length of the culvert (across the roadway) considering undrained condition (short term).The minimum factor of safety (FOS) calculated was 4.2 for a temporary slope of 1:1 (V:H) with traffic load and 5.8 without traffic load. The IDOT accepts minimum FOS of 1.30 for a temporary cut slope. Any slopes that cannot be sloped 1:1 (V:H) or flatter should be properly shored with temporary sheet piling. Our analyses indicate that temporary sheet pile

design in accordance with the IDOT *AGMU 3.13.1 Charts* will be feasible.

During the subsurface investigation, the groundwater was encountered at elevations ranging from 653 to 654 feet and the Estimated Water Surface Elevation is 662.52 feet. At the culvert, the groundwater will be encountered at the founding level which is 7 to 10 feet above the anticipated excavation level. Temporary ditch diversion as well as temporary dewatering system for the foundation excavations will be required to construct the culvert.

Depending upon prevailing climatic conditions and the time of the year when construction take place, control of runoff and maintenance of existing flows will require temporary water diversion and control. The temporary water diversion could be achieved by routing the ditch channel to adjacent creek channel. Water that does accumulate in open excavations by seepage or runoff should be immediately removed by sump pump method.

5.3 Filling and Backfilling

Fill material required to attain the final design subgrade elevations should be in accordance with Section 205, Embankment (IDOT 2016). All fill and backfill materials should be pre-approved by the site engineer. The fill should be free of organic materials and debris.

Replacement material below the culvert barrel should be Rockfill capped with 6 inches of CA-7 and satisfy the IDOT Standard Specifications. Backfill materials for the wingwalls should be pre-approved by the Resident Engineer. We recommend porous granular material conforming to the requirements specified in the 2017 IDOT Supplemental Specification, *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 Exhibit 3. 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 Collins Engineers, 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.

Mohammed Kothawala, P.E., D.GE. 11-8-17
Sr. Project manager/Sr. Geotechnical Engineer

for Mickey L. Snider, P.E.
QA/QC Reviewer

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

MOHAMMED A KOTHAWALA
062-040483
LICENSED
PROFESSIONAL
ENGINEER
OF
ILLINOIS

License Expires: 11-30-17

REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (2014) "AASHTO LRFD Bridge Design Specifications." United States Depart of Transportation, Washington, D.C.

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

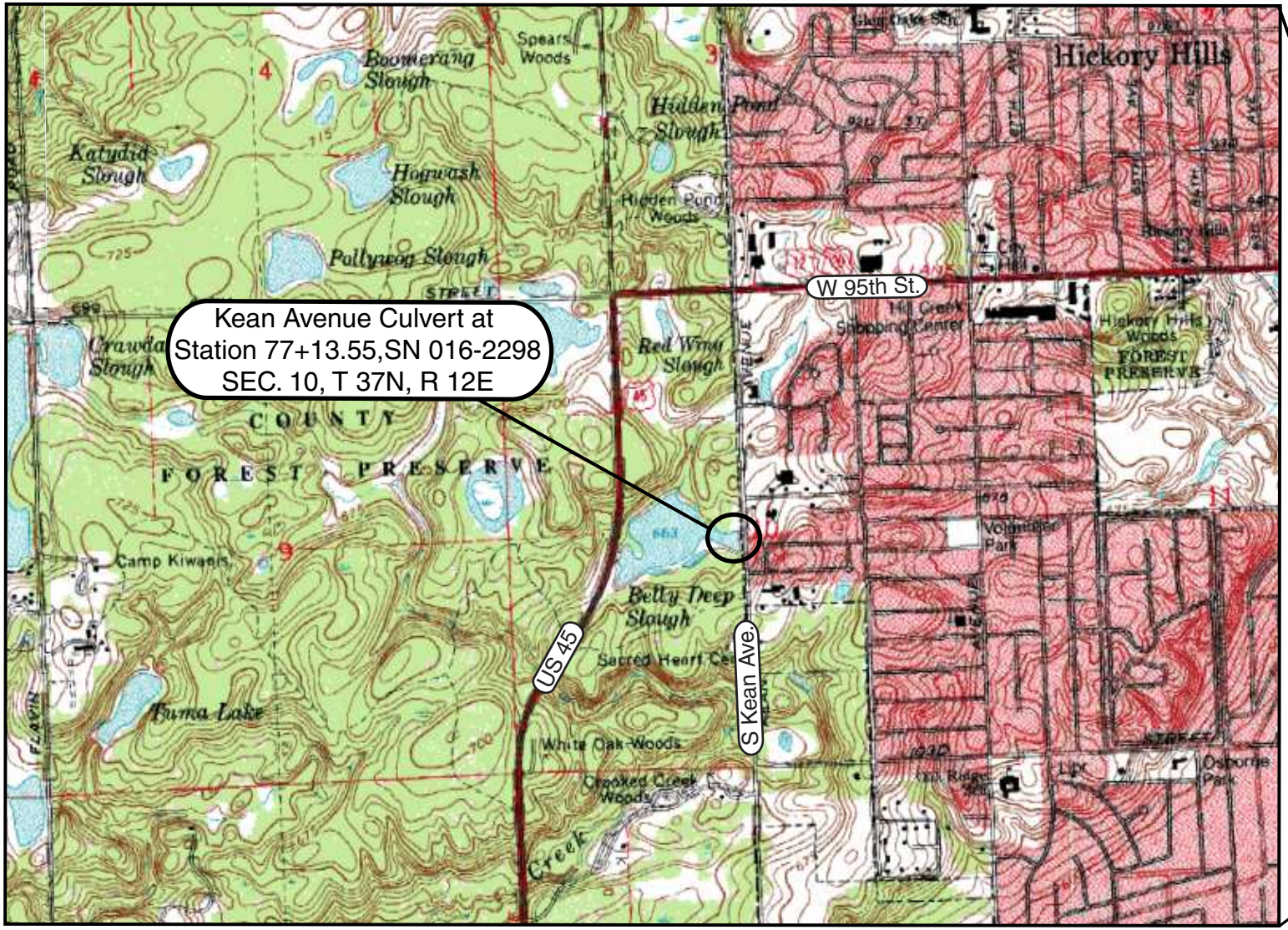
IDOT (2016) *Standard Specifications for Road and Bridge Construction.* Illinois Department of Transportation. 1098 pp.

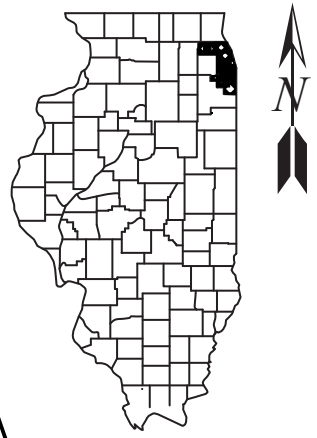
IDOT (2017) *Culvert Manaul.* Illinois Department of Transportation

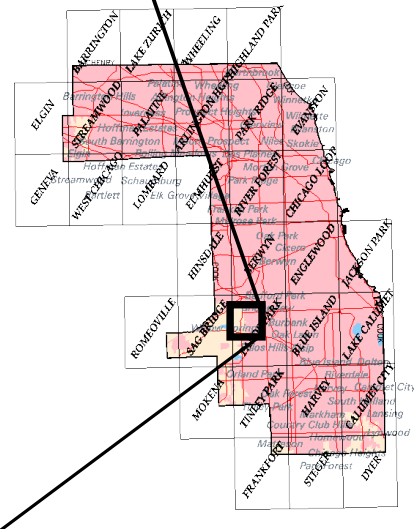
Wang Engineering

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

EXHIBITS







Cook County

Scale

0 0.5 1.0 Mile

SITE LOCATION MAP: KEAN AVENUE CULVERT AT STATION 77+13.55, SN 016-2298, COOK COUNTY, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: R. KC CHECKED BY: NSB

Wang Engineering
1145 N. Main Street
Lombard, IL 60148
www.wangeng.com

FOR COLLINS ENGINEERS, INC. 486-23-01

Bench Mark: Found Iron rod with cap on east side of roadway at approx. Sta. 76+29.00 Elevation 664.60

Existing Structure: SN 016-1255 originally constructed as a single cast-in-place box culvert 10' wide and 3' high and 32'-2" long. The date of construction is unknown. The existing structure is to be removed and replaced with a cast-in-place double box culvert 7' wide and 3' high and 39'-4" long. Traffic will be detoured during construction.

No Salvage.

Precast Alternative is not allowed

** Slope = 1:13 (V:H)
*** Slope = 1:7 (V:H)

HIGHWAY CLASSIFICATION

F.A.U. 2721- Kean Avenue
Functional Class: Major Collector
ADT: 2,400 (2014)/ 2,500 (2040)
DHV: 250 (2040)
ADTT: 2%
Design Speed: 45 mph
Posted Speed: 40 mph

WATERWAY INFORMATION

Drainage Area = 0.08 square miles

Existing Overtopping Elev. = 664.66 at Sta. 77+50
Proposed Overtopping Elev. = 665.36 at Sta. 77+95

Flood	Freq. Yr.	Discharge C.F.S	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	64.0	--	--	--	--	--	663.88	663.73
Design	50	120.0						664.74	664.20
Base	100	155.3						664.97	664.64
Overtop Existing		127.9						664.91	
Overtop Proposed		211.6							665.58
Max. Calc.	500	203.5						665.04	665.43

10-year velocity through the existing culvert = 3.2 fps.
10-year velocity through the proposed culvert = 2.3 fps.
2 Year Peak Flow (Q) = 6.9 cfs
Estimated Water Surface Elevation = 662.52 ft

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition. with 2015 and 2016 Interims

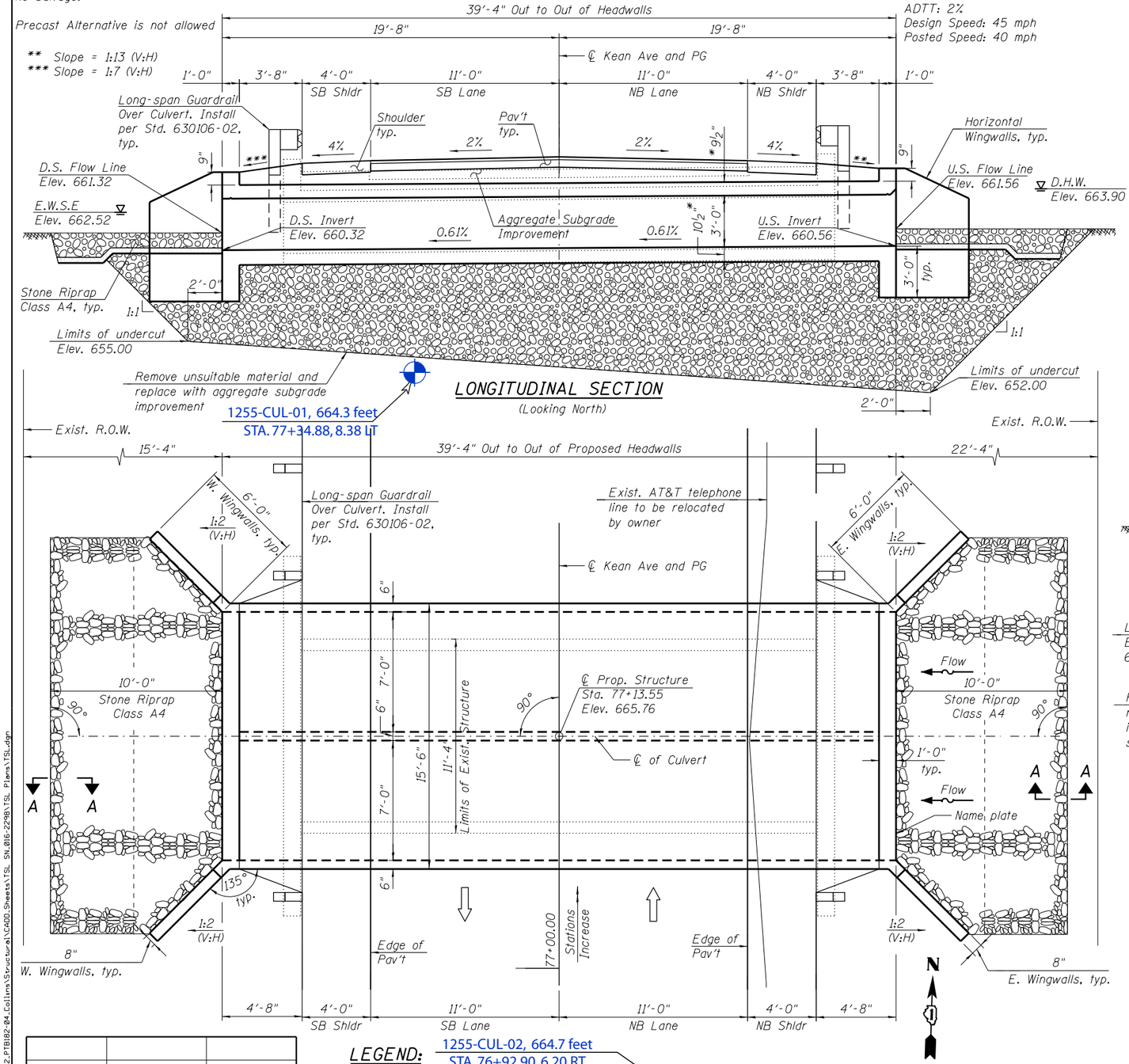
LOADING HL-93

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

DESIGN STRESSES

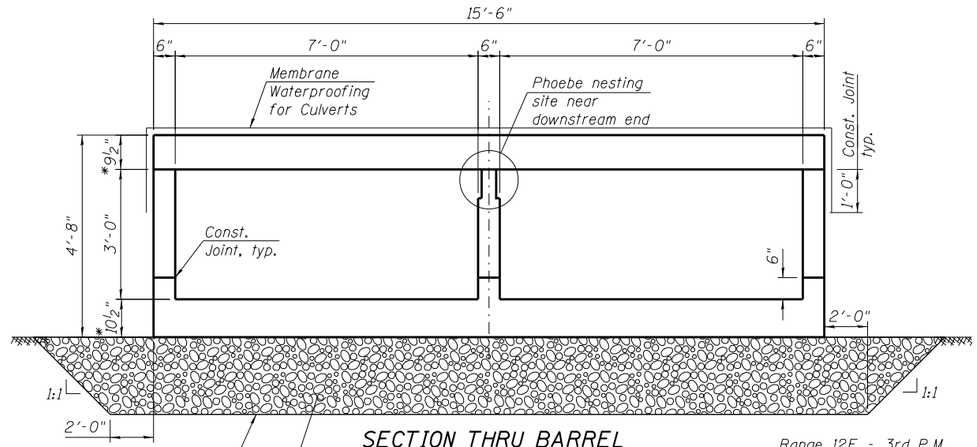
FIELD UNITS

f'_c = 3,500 psi (Concrete)
f_y = 60,000 psi (Reinforcement)



LONGITUDINAL SECTION

(Looking North)

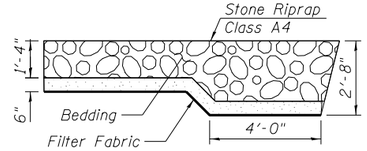


SECTION THRU BARREL

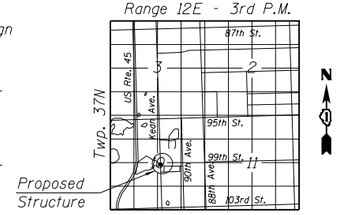
* Slab thickness may be refined in final design

Limits of undercut Elevation varies from 652.00 U.S. to 655.00 D.S.

Remove unsuitable material and replace with aggregate subgrade improvement (see longitudinal section for location)



SECTION A-A



LOCATION SKETCH

LEGEND:
PLAN Soil Boring
1255-CUL-02, 664.7 feet
STA. 76+92.90, 6.20 RT

BORING LOCATION PLAN: KEAN AVENUE CULVERT AT STATION 77+13.55, SN 016-2298, COOK COUNTY, ILLINOIS

SCALE: GRAPHICAL | EXHIBIT 2 | DRAWN BY: R. KC | CHECKED BY: NSB

Wang Engineering
1145 N. Main Street
Lombard, IL 60148
www.wangeng.com

FOR COLLINS ENGINEERS, INC. | 486-23-01

GENERAL PLAN
KEAN AVE
OVER UNNAMED DITCH
(0.5 MI SOUTH OF 95TH ST)
F.A.U. 2721 -SEC. 10-37-12
COOK COUNTY
STATION 77+13.55
STRUCTURE NO. 016-2298

HBM ENGINEERING GROUP, LLC

TSL.dgn	DESIGNED - SK, LAB	REVISED -
USER NAME = lisa.buntin	DRAWN - SK	REVISED -
PLOT SCALE = 7.0000 ' / in.	CHECKED - LAB, MI	REVISED -
PLOT DATE = 8/9/2017	DATE - 08/11/2017	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: | SHEET 1 OF 1 SHEETS | STA. | TO STA.

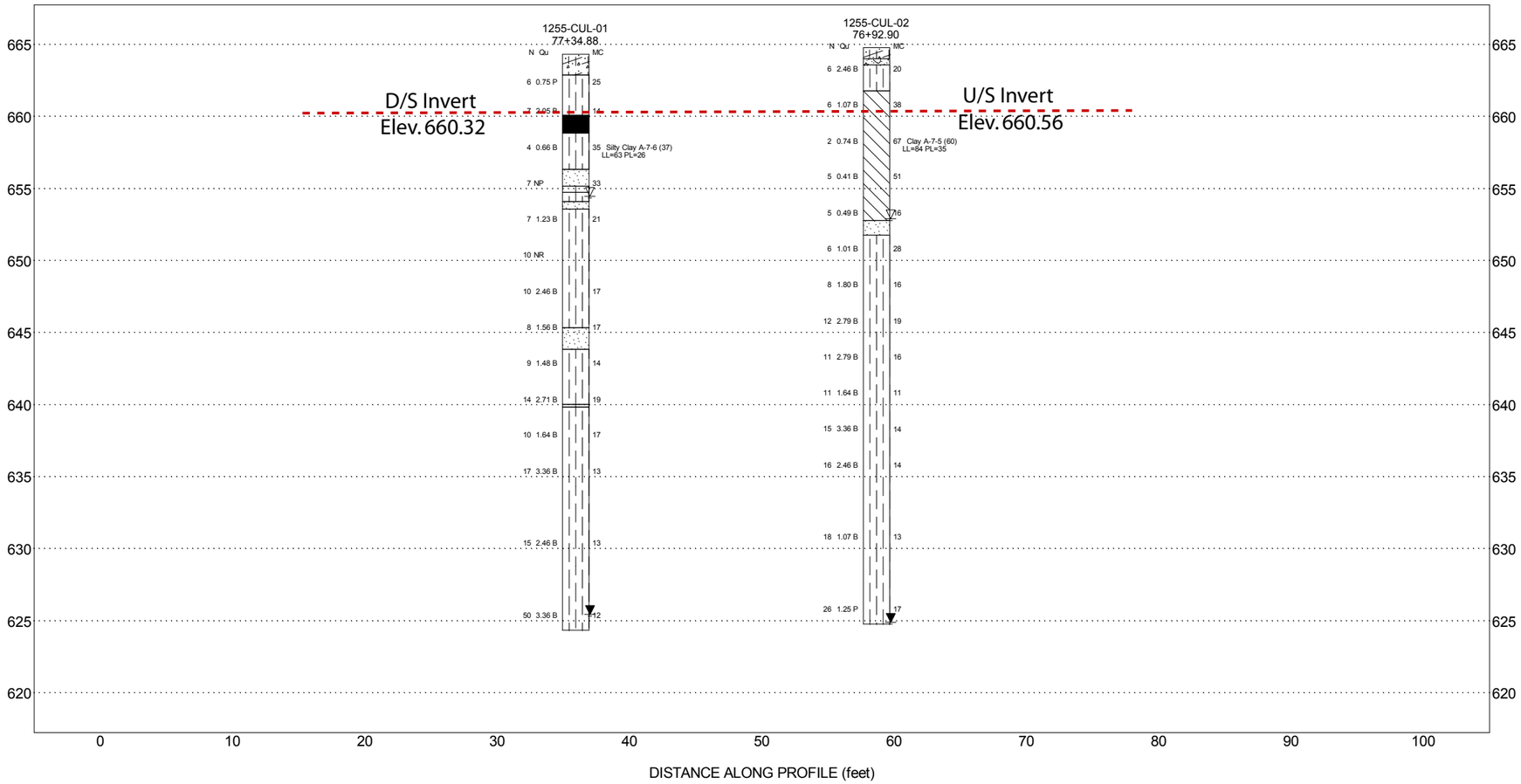
F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2721	10-37-12	COOK		
		CONTRACT NO. 62D40		
	ILLINOIS FED. AID PROJECT			

FILE PATH = P:\1702-692_PTB182-04_Collins\Structural\CADD_Sheets\TSL SN.016-2298\TSL Plans\TSL.dgn

◄ W

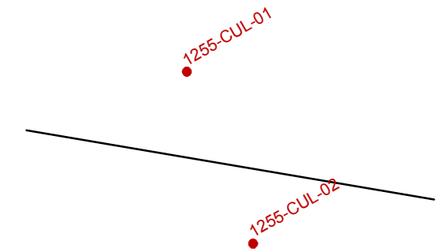
E ►

N



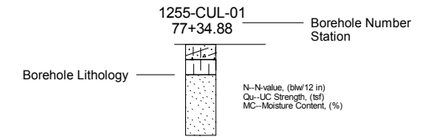
Lithology Graphics

- Pavement
- IDH Silty Clay, Silty Clay Loam
- Topsoil
- IDH Sand, Sandy Loam
- IDH Silt, Silty Loam
- Gravelly sand, sandy gravel
- IDH Clay



Site Map Scale 1 inch equals 35 feet

Explanation:



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

0 10

Horizontal Scale (feet)

Vertical Exaggeration: 1x

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

Subsurface Soil Data Profile
Kean Avenue Culvert at Staion 77+13.55
SN 016-2298

WEI SINCE 1982

Kean Avenue Culverts
Palos Hills, Cook County

JOB NUMBER	PLATE NUMBER
486-23-01	EXHIBIT 3

WEI 11X17 486230I.GPJ WANGENG.GDT 8/3/17

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

APPENDIX A

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG 1255-CUL-01

WEI Job No.: 486-23-01

Client: **Collins Engineers, Inc.**
Project: **Kean Avenue Culverts**
Location: **Palos Hills, Cook County**

Datum: NGVD
Elevation: 664.34 ft
North: 1837552.19 ft
East: 1117145.77 ft
Station: 77+34.88
Offset: 8.38 LT

Depth (ft)	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
0	662.9	9.5-inch ASPHALT over 8-inch thick CONCRETE --PAVEMENT--					
0		Medium stiff, brown SILTY CLAY LOAM, trace gravel; moist --FILL--		1	2 3 3	0.75 P	25
5	660.1	--Very stiff--		2	3 4 3	2.05 B	14
5	658.8	Medium stiff (0.75P), dark brown to black SILY CLAY LOAM, trace organic matter --BURIED TOPSOIL--					
5		Medium stiff, dark gray SILTY CLAY, trace organic matter --L_L(%)=63, P_L(%)=26-- --%Gravel=0.7-- --%Sand=10.7-- --%Silt=50.5-- --%Clay=38.1--		3	2 2 2	0.66 B	35
10	656.3						
10	655.2						
10	654.8	Loose, brown SANDY LOAM; damp		4	2 3 4	NP	33
10	654.1						
10	653.6	Loose, brown SILTY LOAM, trace organic matter; damp					
10		Very stiff (2.5P), brown SILTY CLAY, trace gravel		5	1 2 5	1.23 B	21
10		Sand; saturated					
10		Stiff to very stiff, gray SILTY CLAY to SILTY CLAY LOAM, trace gravel --NO RECOVERY--		6	3 3 7	NR	
15							
15				7	3 4 6	2.46 B	17
15	645.3	--Stiff--					
15		Loose, gray fine SANDY LOAM; damp		8	2 3 5	1.56 B	17
20							

Depth (ft)	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
20	643.8	Stiff to very stiff, gray SILTY CLAY LOAM; moist		9	3 4 5	1.48 B	14
25	640.0			10	4 6 8	2.71 B	19
25	639.8	Gray, SILT; wet					
25		Stiff to very stiff, gray SILTY CLAY LOAM, trace gravel; damp		11	3 4 6	1.64 B	17
30				12	7 7 10	3.36 B	13
30		--sand lens--		13	5 4 11	2.46 B	13
35							
35				14	10 29 21	3.36 B	12
40	624.3	Boring terminated at 40.00 ft					

GENERAL NOTES

Begin Drilling: **07-18-2017** Complete Drilling: **07-18-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **CME-55 TMR**
Driller: **JA + JG** Logger: **J. Rowells** Checked by: **NSB**
Drilling Method: **2.25 IDA HSA; Boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **10.00 ft**
At Completion of Drilling: **39.00 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.

WANGENGINC 4862301.GPJ WANGENG.GDT 8/7/17

Wang Engineering
wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG 1255-CUL-02

WEI Job No.: 486-23-01

Client: **Collins Engineers, Inc.**
Project: **Kean Avenue Culverts**
Location: **Palos Hills, Cook County**

Datum: NGVD
Elevation: 664.78 ft
North: 1837510.62 ft
East: 1117161.80 ft
Station: 76+92.90
Offset: 6.20 RT

Depth (ft)	Elevation (ft)	Soil and Rock Description	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	664.0	9-inch thick ASPHALT PAVEMENT					
	663.6	--PAVEMENT--					
		Brown SANDY GRAVEL --BASE COURSE--					
	661.8	Very stiff, dark brown to brown SILTY CLAY, trace organic matter --FILL--					
5		Soft to stiff, dark gray to gray, CLAY to CLAY LOAM, organic matter					
		--L_L(%)=84, P_L(%)=35-- --%Gravel=0.0-- --%Sand=0.8-- --%Silt=49.8-- --%Clay=49.4--					
10							
	652.8						
		Gray SILT, trace sand seams; saturated					
	651.8	Stiff to very stiff, gray SILTY CLAY to SILTY CLAY LOAM, trace gravel					
15							
20							
25							
30							
35							
40	624.8	Boring terminated at 40.00 ft					

Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		1	3 2 4	2.46 B	20
		2	2 3 3	1.07 B	38
		3	1 1 1	0.74 B	67
		4	0 3 2	0.41 B	51
		5	2 2 3	0.49 B	16
		6	1 2 4	1.01 B	28
		7	2 3 5	1.80 B	16
		8	3 5 7	2.79 B	19
		9	3 4 7	2.79 B	16
		10	3 5 6	1.64 B	11
		11	4 6 9	3.36 B	14
		12	10 7 9	2.46 B	14
		13	5 9 9	1.07 B	13
		14	11 14 12	1.25 P	17

GENERAL NOTES

Begin Drilling: **07-19-2017** Complete Drilling: **07-19-2017**
Drilling Contractor: **Wang Testing Services** Drill Rig: **CME-55 TMR**
Driller: **JA + JG** Logger: **J. Rowells** Checked by: **NSB**
Drilling Method: **2.25 IDA HSA; Boring backfilled upon completion**

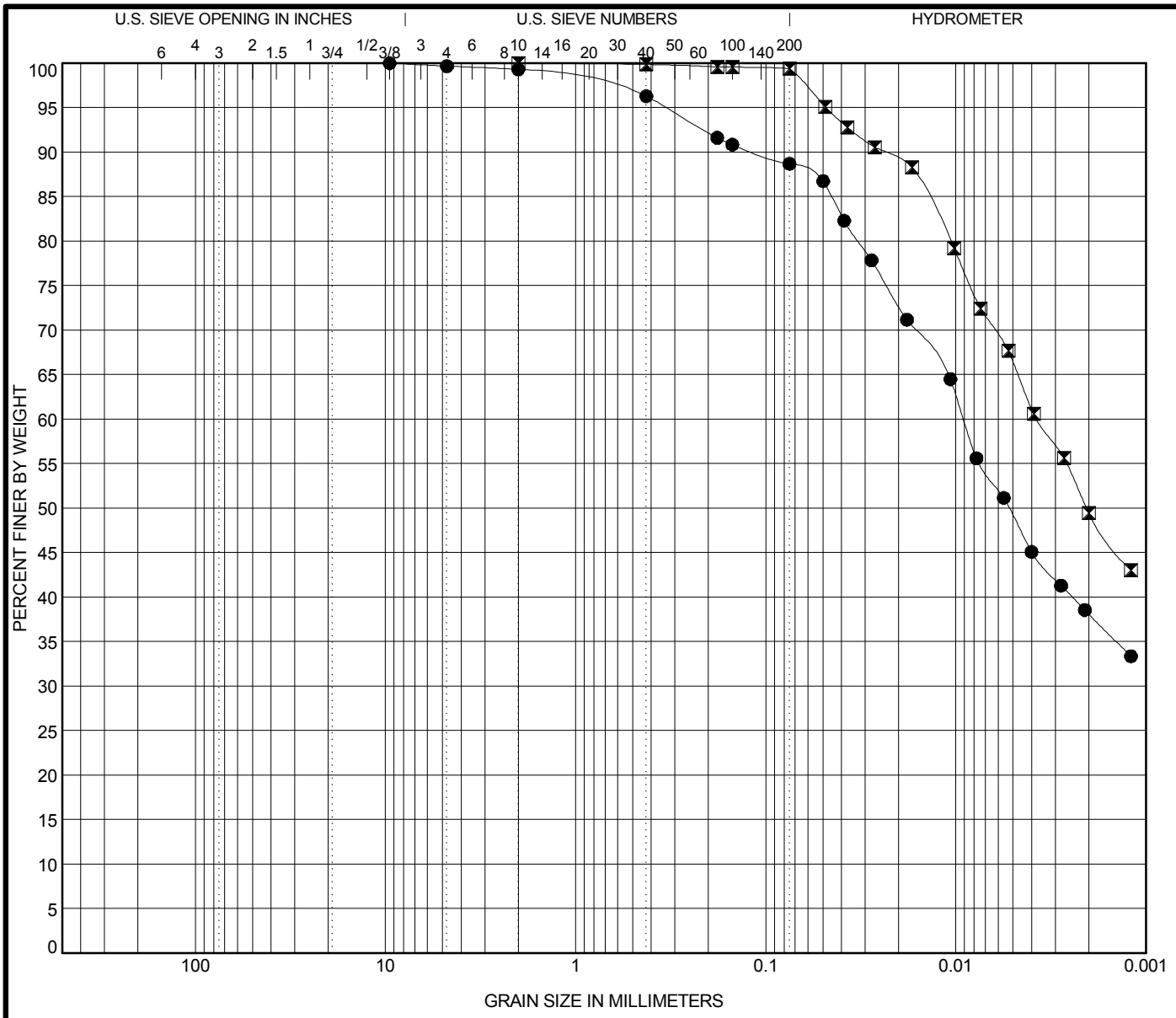
WATER LEVEL DATA

While Drilling: **12.00 ft**
At Completion of Drilling: **40.00 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
1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	1255-CUL-01#3	6.0 ft	**Silty Clay**	**63**	**26**	**37**		
⧓	1255-CUL-02#3	6.0 ft	**Clay**	**84**	**35**	**49**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	1255-CUL-01#3	6.0 ft	**9.5**	**0.009**			**0.7**	**10.7**	**50.5**	**38.1**
⧓	1255-CUL-02#3	6.0 ft	**2**	**0.004**			**0.0**	**0.8**	**49.8**	**49.4**

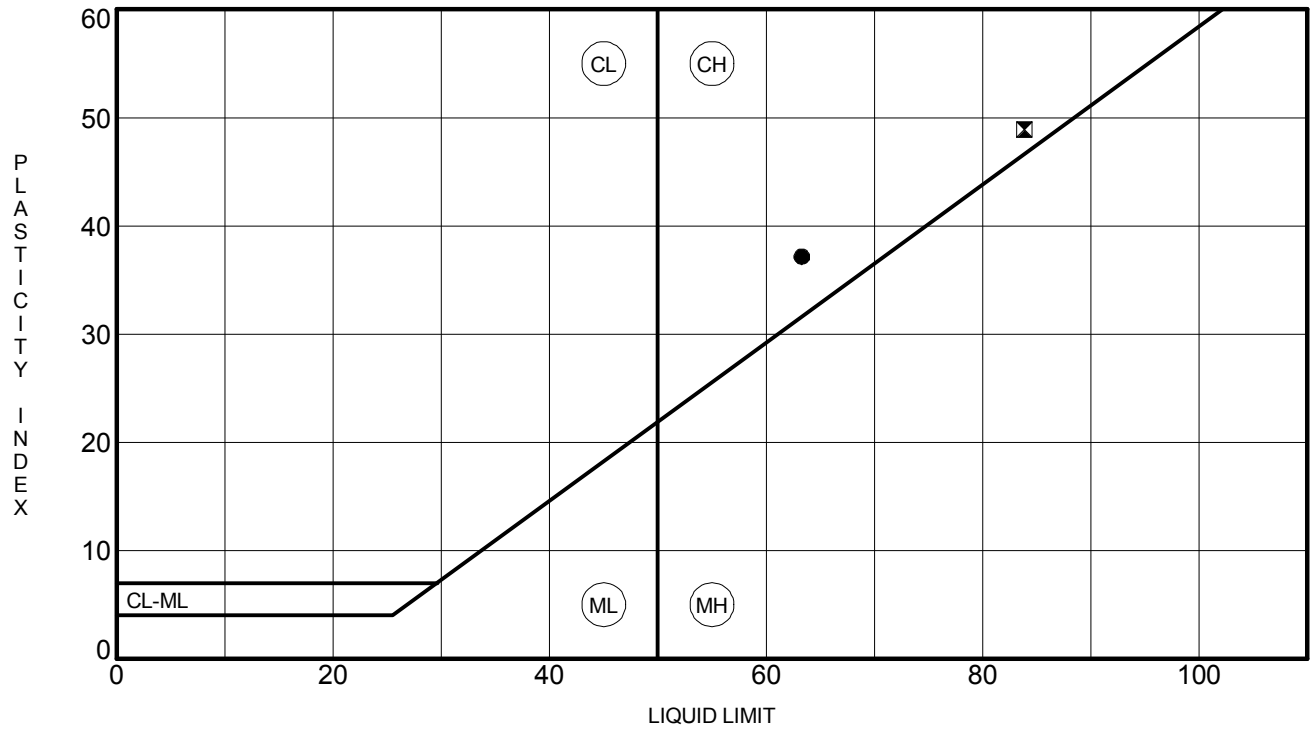
Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

GRAIN SIZE DISTRIBUTION

Project: Kean Avenue Culverts

Location: Palos Hills, Cook County

Number: 486-23-01



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	1255-CUL-01#3	6.0 ft	63	26	37	89	Silty Clay
⧓	1255-CUL-02#3	6.0 ft	84	35	49	99	Clay

Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

ATTERBERG LIMITS' RESULTS

Project: Kean Avenue Culverts

Location: Palos Hills, Cook County

Number: 486-23-01

Wang Engineering

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: Collins Engineers
Project: Kean Ave. Culverts
WEI Job: 486-23-01
Type/Condition: SS
Testing Furnace Temp °C.: 440

Analyst Name: A. Mohammed
Date Received: 7/20/2017
Date Tested: 7/24/2017
Soil Sample ID: 1255-CUL-02,No.3(6-7.5 ft.)
Sample Description: Brown Clay Loam

Moisture Content	Wet soil + tare (g)	Dry Soil + tare (g)	Tare mass (g)	w (%)
oven-dry method	53.96	46.62	36.47	72

Ash Content	Dry Soil + tare (g)	Ash + tare (g)	Tare mass (g)	Ash Content (%)
Loss On Ignition	46.62	45.62	36.47	90

Organic Content (%)= **9.9**

Prepared by: _____ Date: 8/7/17

Checked by: _____ Date: 8/7/17

AASHTO R18

Wang Engineering

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

APPENDIX C

Bench Mark: Found Iron rod with cap on east side of roadway at approx. Sta. 76+29.00 Elevation 664.60

Existing Structure: SN 016-1255 originally constructed as a single cast-in-place box culvert 10' wide and 3' high and 32'-2" long. The date of construction is unknown. The existing structure is to be removed and replaced with a cast-in-place double box culvert 7' wide and 3' high and 36'-0" long. Traffic will be detoured during construction.

No Salvage.

Precast Alternative is not allowed.

HIGHWAY CLASSIFICATION

F.A.U. 2721- Kean Avenue
Functional Class: Major Collector
ADT: 2,400 (2014)/ 2,500 (2040)
DHV: 250 (2040)
ADTT: 2% (2014)
Design Speed: 45 mph
Posted Speed: 40 mph
Two-Way Traffic
Directional Distribution: 50:50

WATERWAY INFORMATION

Drainage Area = 0.08 square miles

Existing Overtopping Elev. = 664.91 at Sta. 77+50
Proposed Overtopping Elev. = 665.58 at Sta. 77+95

Flood	Freq. Yr.	Discharge C.F.S	Opening Sq. Ft. Exist.	Opening Sq. Ft. Prop.	Nat. H.W.E.	Head - Ft. Exist.	Head - Ft. Prop.	Headwater El. Exist.	Headwater El. Prop.
	10	64.0	N/A	N/A	N/A	N/A	N/A	663.88	663.73
Design	50	120.0	N/A	N/A	N/A	N/A	N/A	664.74	664.20
Base	100	155.3	N/A	N/A	N/A	N/A	N/A	664.97	664.64
Overtop Existing		127.9	N/A	N/A	N/A	N/A	N/A	664.91	
Overtop Proposed		211.6	N/A	N/A	N/A	N/A	N/A		665.58
Max. Calc.	500	203.5	N/A	N/A	N/A	N/A	N/A	665.04	665.43

10-year velocity through the existing culvert = 3.2 fps.
10-year velocity through the proposed culvert = 2.3 fps.
2 Year Peak Flow (Q) = 6.9 cfs
Estimated Water Surface Elevation = 662.52 ft

DESIGN SPECIFICATIONS

2014 AASHTO LRFD Bridge Design Specifications, 7th Edition. with 2015 and 2016 Interims

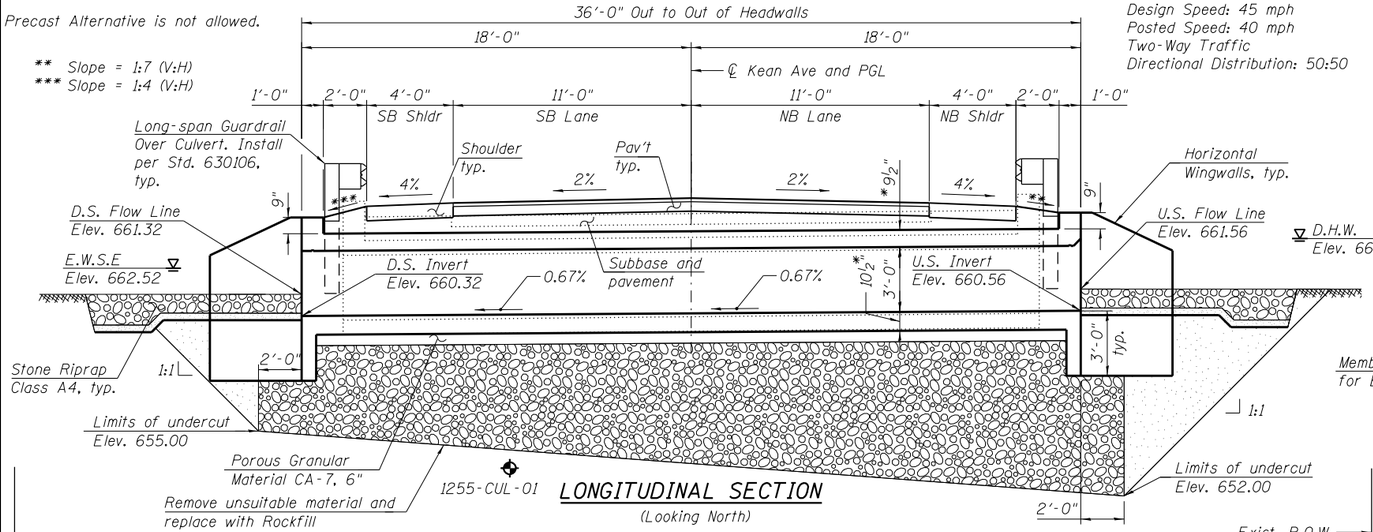
LOADING HL-93

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

DESIGN STRESSES

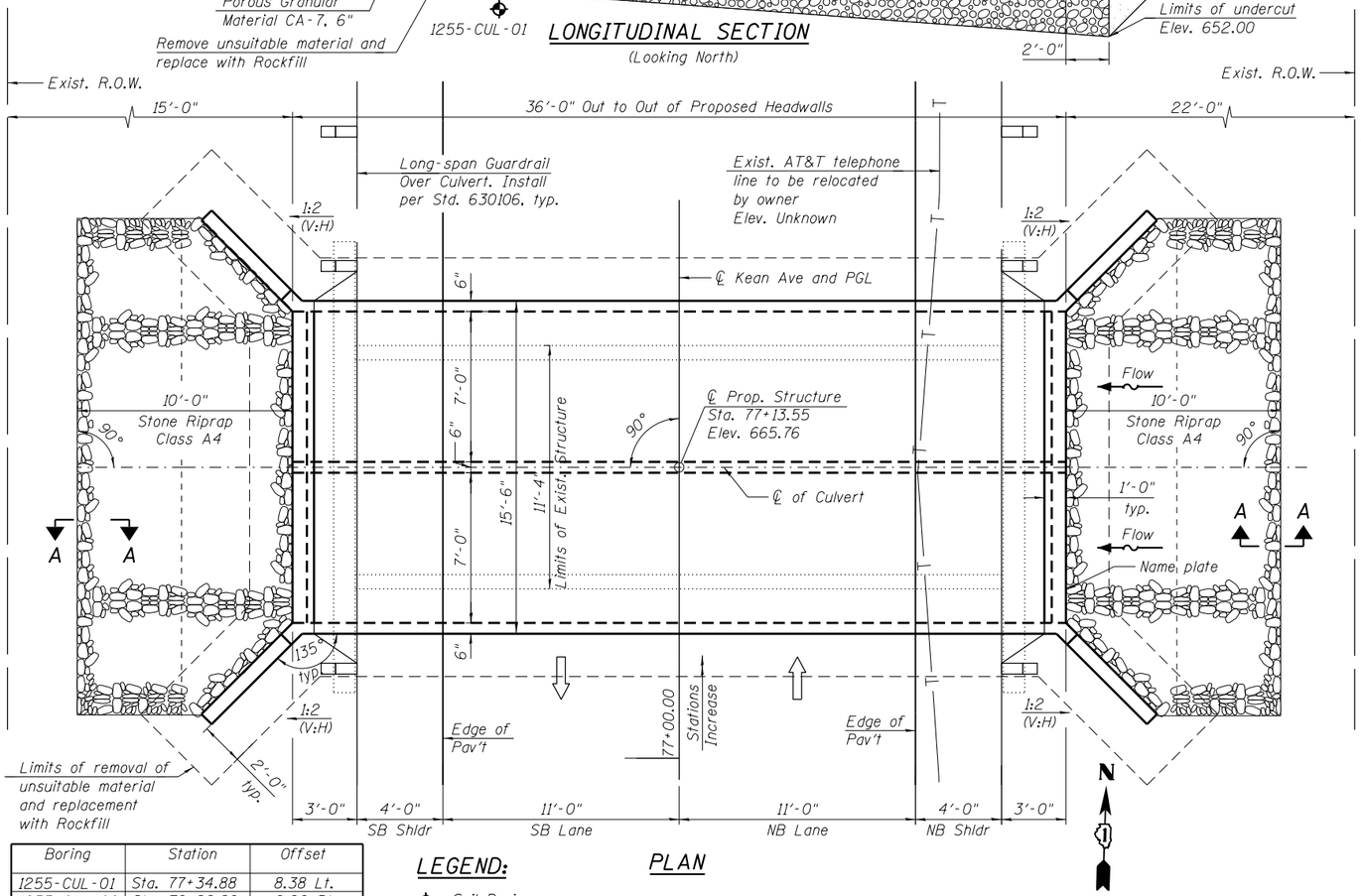
FIELD UNITS

f'_c = 3,500 psi (Concrete)
f_y = 60,000 psi (Reinforcement)



LONGITUDINAL SECTION

(Looking North)

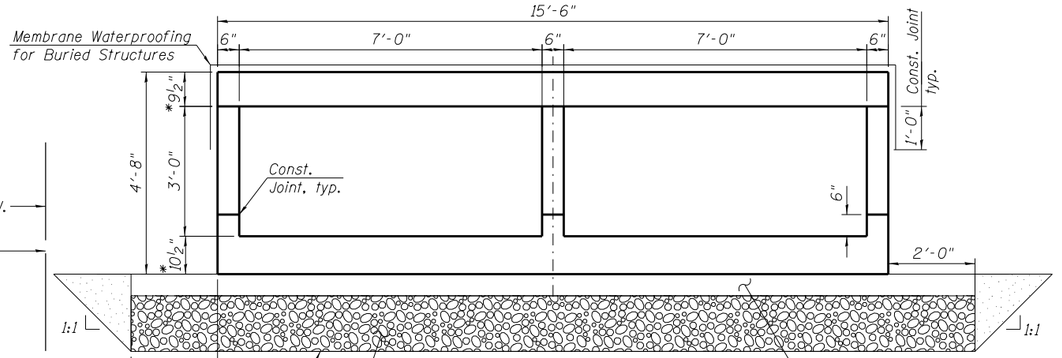


Boring	Station	Offset
1255-CUL-01	Sta. 77+34.88	8.38 Lt.
1255-CUL-02	Sta. 76+92.90	6.20 Rt.

LEGEND:
Soil Boring

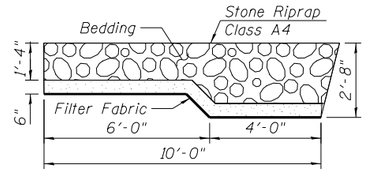
PLAN

1255-CUL-02

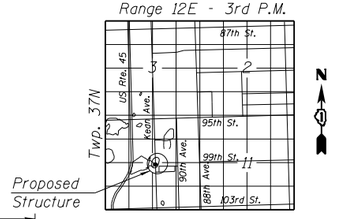


SECTION THRU BARREL

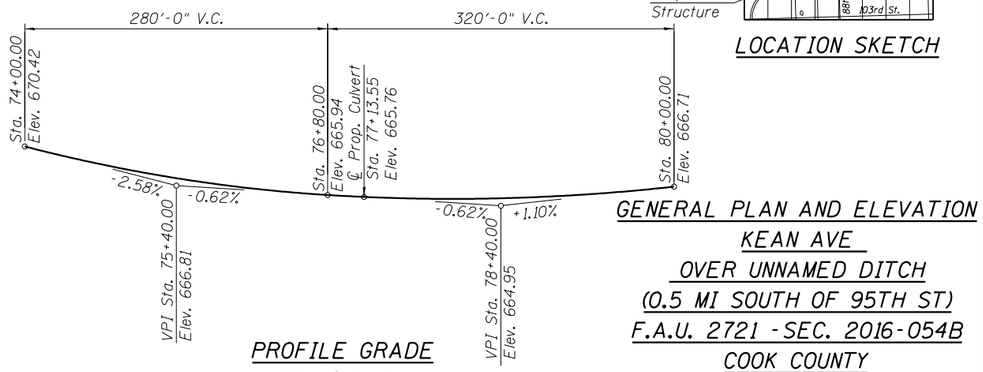
* Slab thickness may be refined in final design



SECTION A-A



LOCATION SKETCH



PROFILE GRADE

(Along ℄ Roadway)

GENERAL PLAN AND ELEVATION
KEAN AVE
OVER UNNAMED DITCH
(0.5 MI SOUTH OF 95TH ST)
F.A.U. 2721 -SEC. 2016-054B
COOK COUNTY
STATION 77+13.55
STRUCTURE NO. 016-2298

FILE PATH = P:\1702-692-PTB182-04_Collins\Structural\CADD_Sheets\TSL SN.016-2298\TSL Plans\TSL.dgn

HBM ENGINEERING GROUP, LLC

TSL.dgn	DESIGNED - SK, LAB	REVISED -	
USER NAME = lisa.buntin	DRAWN - SK	REVISED -	
PLOT SCALE = 7.0000 ' / in.	CHECKED - LAB, MI	REVISED -	
PLOT DATE = 11/8/2017	DATE - 11/06/2017	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SCALE: | SHEET 1 OF 1 SHEETS | STA. | TO STA.

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
2721	2016-054B	COOK		
		CONTRACT NO. 62D40		
		ILLINOIS FED. AID PROJECT		