STRUCTURE GEOTECHNICAL REPORT
IL ROUTE 137 OVER BULL CREEK
CULVERT REPLACEMENT
EX SN 049-0214; PR SN 049-0700
LAKE COUNTY, ILLINOIS

For
WBK Engineering, LLC
116 W Main Street, Suite 201
St. Charles, IL 60174

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

Original Report: May 15, 2020
Revised Report: August 26, 2020

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, IL Route 137 over Bull Creek, Culvert Replacement		**2. Original Date:** May 15, 2020 **Revised Date:** August 26, 2020 **3. Report Type** ☒ SGR ☐ RGR ☐ Draft ☒ Final ☐ Revised
4. Route / Section / County FAP 352/ NA / Lake		**5. IDOT Project No. / Contract No.** P-91-239-14 / NA
6. PTB / Item No. 193/08	**7. Existing Structure Number(s)** 049-0214	**8. Proposed Structure Number(s)** 049-0700
9. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: Nesam S. Balakumaran, P.Eng. QA/QC: Corina T. Farez, P.G., P.E. PM: Andri Kurnia, P.E.	**Contact** (630) 953-9928 ext. 1025 akurnia@wangeng.com
10. Prepared for WBK Engineering, LLC 116 W Main Street Suite 201 St. Charles, IL, 60174	**Contact(s)** Ryan Sikes, PE, PTOE	**Contact Information** (630) 443-7755 rsikes@wbkengineering.com

11. Abstract

The existing double cell 8-foot wide by 10-foot tall concrete box culvert carrying IL 137 over Bull Creek will be removed and replaced with three cell culvert with an interior opening of 12-foot by 12-foot cast-in-place box culvert. The proposed culvert will be 167.4-foot long out-to-out of headwalls. The proposed culvert will have upstream invert elevation of 591.42 feet and downstream invert elevation of 590.68 feet.

Beneath the pavement and up to 25.5 feet of granular fill, the soils consist of up to 9.0 feet of very loose to loose sand followed by up to 5.0 feet of loose silty loam to organic silty loam. Deeper foundation soils includes dense to very dense silty loam to silt and hard silty clay to silty clay loam. The groundwater level during drilling was observed at elevation of 609 feet (18.0 bgs). Perched water should be anticipated within the granular fill. We estimate the groundwater elevation of 601.5 feet.

At the culvert base elevations, the borings show suitable soil conditions to construct the culvert. However, the Contractor may need to create a working platform to properly construct the culvert bottom slab. The Field Engineer should make the determination that a working platform is required during excavation based on the field conditions. Total long-term settlements are estimated to be 0.5 inches with a differential settlement of about 0.5 inches or less.

Since the proposed culvert will be a cast-in-place culvert, horizontal cantilever and L-type walls typically are considered. However, the proposed wingwalls will be 18 feet long; therefore, horizontal cantilever walls are not suitable. T-type wall and flexible walls such as sheet pile wall and soldier pile and lagging walls could also be considered. Since installation of sheet pile walls will be difficult due the presence of dense to very dense granular soils and hard silty clay loam at the embedment depths, we do not recommend the use of sheet pile wall. For same reason, drilled soldier pile should be considered in lieu of driven piles. We have provided geotechnical parameters for potential wall types.

For the replacement of the culvert, temporary soil retention will be required. No stage construction is envisioned as traffic detour during the construction is planned.

12. Path to archived file

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Wang Engineering

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IL ROUTE 137 OVER BULL CREEK
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LAKE COUNTY, ILLINOIS
FOR
WBK ENGINEERING, LLC.

1.0 INTRODUCTION

This report presents the results of the subsurface investigation, laboratory testing, geotechnical evaluations, and recommendations to support the removal and replacement of the culvert at IL Route 137 (IL 137) over Bull Creek. The site is located about 850 feet south of West Wandsworth Road and IL 137 intersection in Lake County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Based on the General Plan and Elevation (GPE) drawing (Appendix D) provided by WBK Engineering, LLC (WBK), Wang Engineering, Inc. (Wang) understands the existing double cell box culvert will be removed and replaced with a cast-in-place three cell box culvert with an interior opening of 12-foot wide by 12-foot tall. The proposed culvert will be 167.4-foot long out-to-out headwalls with a total width of 41.3 feet. The proposed culvert will have upstream invert elevation of 591.42 feet and downstream invert elevation of 590.68 feet. The proposed wingwalls will be 18-foot long and wingwall type is yet to be determined. The proposed culvert will have about 22 feet of fill with a side slope of 1:2 (V:H) on the top to match the existing roadway grade elevation. The roadway at the culvert location is to be closed during construction and traffic will be detoured.

1.2 Existing Structure

The existing culvert (SN 049-0214) was built in 1930s as a double cell 8-foot by 10-foot cast-in-place culvert and extended in 1960 and 1970. The existing culvert measures 154-foot out-to-out headwalls, 19-foot wide, and placed on a 6 degrees skew.

2.0 METHODS OF INVESTIGATION

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

2.1 Field Investigation

The subsurface investigation includes two structure borings, designated as 0214-CUL-01 and 0214-CUL-02, performed by Wang on October 2015. The borings were drilled from elevations of 626.95 and 626.96 feet and were advanced to a depth of 60.0 feet bgs. The as-drilled northings, eastings, and elevations were acquired with a mapping-grade GPS unit. Stations and offsets were provided by WBK. 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 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 T206, *"Penetration Test and Split Barrel Sampling of Soils."* The soil was sampled at 2.5-foot intervals to 30 feet and 5-foot intervals to boring termination depths of 60 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. 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 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

In descending order, the general lithologic succession encountered beneath the pavement includes: 1) man-made ground (fill); 2) very loose to loose sand; 3) loose silty loam with organic matter; 4) dense to very dense silt to silty loam; and 5) hard silty clay to silty clay loam.

1) Man-made ground (fill)

Beneath the surface, the borings encountered up to 25.5 feet of fill. The fill primarily consists of very loose to very dense, brown sand, sandy loam, and sandy gravel. The granular fill has SPT N-values of 2 to over 50 blows per foot with moisture content values of 6 to 14%. Boring 0214-CUL-02 encountered about 2.2 feet of medium stiff clay loam fill with an unconfined compressive strength (Q_u) value of 0.75 tsf and a moisture content value of 20%.

2) Very loose to loose sand

Beneath the fill, at an elevation of 604 feet, Boring 0214-CUL-02 encountered about 9 feet of very loose to loose, wet to saturated, brown and gray sand. The layer has SPT-N values of 2 to 6 blows per foot and moisture content values of 8 to 22%.

3) Loose silty loam with organic matter

At elevations of 595.2 and 601.5 feet, the borings revealed up to 5 feet of loose, dark brown and gray, silty loam with organic matter. The layer has SPT-N values of 4 to 7 blows per foot and moisture content values of 31 and 80%.

4) Dense to very dense silt to silty loam

At elevations of 590.2 and 599.0 feet, the borings encountered 5 to 15 feet of dense to very dense, gray silt to silty loam. This unit has SPT-N values of 34 to 70 blows per foot and moisture content values of 14 to 20%.

5) Hard silty clay to silty clay loam

At an elevation of 585.2 feet, the borings advanced through hard, gray silty clay to silty clay loam interbedded with very dense silt extending to boring termination depths of 60 feet bgs. The unit is characterized by Q_u values of 5.4 to greater than 10.3 tsf and moisture content values of 9 to 14%. Laboratory index testing on this unit shows a liquid limit (L_L) value of 20% and a plastic limit (P_L) value of 12%. The interbedded silt in Boring 0214-CUL-02 has SPT-N values greater than 88 blows per foot.

3.2 Groundwater Conditions

Groundwater was encountered while drilling at an elevation of 609 feet (18.0 bgs) in Boring 0214-CUL-02. Boring 0214-CUL-01 was found dry to elevation of 601 feet (25.0 bgs). Since mud rotary techniques were used to advance the boreholes from 18 to 25 feet bgs, the groundwater measurement at completion of drilling was not possible. Perched water should be anticipated within the granular fill. We estimate the groundwater will be about elevation of 601.5 feet. Based on the information provided by WBK, the Bull Creek calculated Estimated Water Surface Elevation (EWSE) is 596.05 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 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

Based on our subsurface investigation, the soils at the base of the culvert barrel are expected to be dense to very dense silty loam to silt. Since the silty soils are expected at the base of culvert, a working platform of coarse aggregate up to 2 feet may be considered in order to provide a level and stable surface to construct the bottom slab (IDOT 2015). The Field Engineer or District Geotechnical

Engineer should make the determination that a working platform is required during excavation based on the field conditions (IDOT 2017).

4.3 Settlement

We estimate the foundation soils will experience settlement up to 0.5 inches with the differential settlement of 0.5 inches or less. The settlement estimates are acceptable for the culvert structure.

4.4 Wingwalls

Based on the GPE plan and information provided by WBK, the wingwalls will be 18-foot long and wingwalls type is 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.

The horizontal cantilever walls cannot be considered as they need to be less than 16 feet (IDOT 2017). L-type wingwall could be considered. L-type walls should be designed based on the structural guidelines provided in Section 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 586.68 and 587.42 feet at the downstream and upstream ends, respectively. Based on subsurface investigation, dense to very dense silty loam to silt is expected to be encountered at the footing elevation. These T-type walls should be designed based on a maximum factored resistance of 5,400 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).

Installation of sheet pile walls will be difficult due the presence of dense to very dense granular soils and hard silty clay loam at the embedment depths. We do not recommend sheet pile walls.

For the soldier pile and lagging walls, the piles will have to be drilled soldier piles not driven piles due the presence of dense to very dense granular soil and hard silty clay loam at the embedment depth. In addition, the installation of drilled soldier piles will produce minimal noise and vibration during construction. We recommend drilled soldier piles 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 2017) using long-term (drained) soil parameters in Tables 1 and 2 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 and construction of wall should consider the perched groundwater elevation as high as 610 feet.

Table 1: Geotechnical Parameters for Design of Upstream Soldier Pile Walls

Reference Boring: 0214-CUL-02

Soil Description Elevation	Unit Weight, γ (pcf)	Drained Shear Strength Properties		Earth Pressure Coefficients [1]	
		Cohesion (psf)	Friction Angle (°)	Active Pressure	Passive Pressure
M Dense to Dense SAND to GRAVELLY SAND FILL Surface to EL 615.5 feet	120	0	33	0.44	3.39
Loose SAND to SANDY GRAVEL FILL EL 615.5 to 604.0 feet	115	0	30	0.54	3.00
V Loose to Loose SAND EL 604.0 to 601.5 feet	115	0	29	0.58	2.88
V Loose to Loose SAND EL 601.5[2] to 595.2 feet	53[3]	0	29	0.58	2.88
Loose SILTY LOAM EL 595.2 to 590.2 feet	53[3]	0	28	0.63	2.77
Dense SILTY LOAM to SILT EL 590.2 to 585.2 feet	58[3]	0	35	0.39	3.69
Hard SILTY CLAY LOAM EL 585.2 to EL 575.2 feet	58[3]	100	31	0.50	3.12

Soil Description Elevation	Unit Weight, γ (pcf)	Drained Shear Strength Properties		Earth Pressure Coefficients [1]	
		Cohesion (psf)	Friction Angle (°)	Active Pressure	Passive Pressure
V Dense SILT EL 575.2 to 570.2 feet	58[3]	0	35	0.39	3.69
Hard SILTY CLAY LOAM EL 570.2 to EL 567.0[4] feet	58[3]	100	31	0.50	3.12

[1]Active pressure for 1:2 (V:H) ; [2]Groundwater elevation; [3]Submerged unit weight; [4]Boring termination depth.

Table 2: Geotechnical Parameters for Design of Downstream Soldier Pile Walls

Reference Boring: 0214-CUL-01

Soil Description Elevation	Unit Weight, γ (pcf)	Drained Shear Strength Properties		Earth Pressure Coefficients [1]	
		Cohesion (psf)	Friction Angle (°)	Active Pressure	Passive Pressure
M Dense to V Dense SAND to SANDY LOAM FILL Surface to EL 614 feet	120	0	33	0.44	3.39
V Loose to Loose SAND FILL EL 614 to 601.5 feet	115	0	29	0.58	2.88
Loose ORGANIC SILTY LOAM EL 601.5[2] to 599.0 feet	53[3]	0	28	0.63	2.77
Dense to V Dense SILT EL 599.0 to 585.2 feet	58[3]	0	35	0.39	3.69
Hard SILTY CLAY to SILTY CLAY LOAM EL 585.2 to 567[4] feet	58[3]	100	31	0.50	3.12

[1]Active pressure for 1:2 (V:H) ; [2]Groundwater elevation; [3]Submerged unit weight; [4]Boring termination depth.

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 3 and 4.

Table 3: Recommended Parameters for Lateral Load Analysis of Upstream Soldier Pile Walls

Reference Boring: 0214-CUL-02

Soil Description Elevation Range	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} (%)
M Dense to Dense SAND to GRAVELLY SAND FILL Surface to EL 615.5 feet	120	0	33	90	--
Loose SAND to SANDY GRAVEL FILL EL 615.5 to 604.0 feet	115	0	30	40	--
V Loose to Loose SAND EL 604.0 to 601.5 feet	115	0	29	30	--
V Loose to Loose SAND EL 601.5[(1)] to 595.2 feet	53[(2)]	0	29	30	--
Loose SILTY LOAM EL 595.2 to 590.2 feet	53[(2)]	0	28	30	--
Dense SILTY LOAM to SILT EL 590.2 to 585.2 feet	58[(2)]	0	35	110	--
Hard SILTY CLAY LOAM EL 585.2 to EL 575.2 feet	58[(2)]	7000	0	2000	0.4
V Dense SILT EL 575.2 to 570.2 feet	58[(2)]	0	35	110	--
Hard SILTY CLAY LOAM EL 570.2 to EL 567.0[(3)] feet	58[(2)]	9000	0	2000	0.4

[(1)]Groundwater elevation; [(2)]Submerged unit weight; [(3)]Boring termination depth

Table 4: Recommended Parameters for Lateral Load Analysis of Downstream Soldier Pile Walls

Reference Boring: 0214-CUL-01

Soil Description Elevation Range	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} (%)
M Dense to V Dense SAND to SANDY LOAM FILL Surface to EL 614.0 feet	120	0	33	90	--
V Loose to Loose SAND FILL EL 614.0 to 601.5 feet	115	0	29	40	--
Loose ORGANIC SILTY LOAM EL 601.5[(2)] to 599.0 feet	53[(2)]	0	28	30	--
Dense to V Dense SILT EL 599.0 to 585.2 feet	58[(2)]	0	35	110	--
Hard SILTY CLAY to SILTY CLAY LOAM EL 585.2 to 567[(3)] feet	58[(2)]	6000	0	2000	0.4

[(1)]Groundwater elevation; [(2)]Submerged unit weight; [(3)]Boring termination depth

4.5 Global Stability

We have analyzed the global stability of embankment behind the T-type wingwalls at the most critical location at the upstream end where weaker soil layers were encountered. The maximum design total height of T-type wall will be about 19 feet. The global stability was analyzed using Slide2 V9.0 and the results of the analyses are shown in Appendix C. We estimate the T-type wingwalls have an undrained (short-term) FOS of 1.85 (Appendix C-1) and a drained (long-term) FOS of 1.51 (Appendix C-2). FOSs meet the minimum FOS requirement of 1.5 (IDOT 2015).

For the soldier pile and lagging walls, the soldier pile will be required to extend a minimum tip elevation of at least 575 feet to provide adequate FOSs. We estimate undrained (short-term) FOS of 4.65 (Appendix C-3) and a drained (long-term) FOS of 1.83 (Appendix C-4). The designer should perform other analyses including lateral earth pressure and lateral deflection to determine minimum required embedment depth.

4.6 Cast-In-Place or Precast Culvert Considerations

The results of the settlement, bearing resistance, and global stability analyses indicate that both cast-in-place and precast culvert options are feasible at the site. However, the encountered stream bed soils consisting silt to silty loam raise concern for scour and potential erosion. As per Section 2.1.4 of Culvert Manual (IDOT 2017), the use of precast culvert is not recommended.

4.7 Stage Construction

Based on the GPE drawing, the existing roadway at culvert location is to be closed during construction and traffic will be detoured.

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. We recommend slopes that cannot be graded at 1:2.5(V: H) should be properly shored with temporary sheet piling or soil retention system. We have also evaluated the feasibility of temporary sheet piling design using IDOT *Design Guide 3.13.1* (IDOT 2012). Our evaluations with a retained wall height of 37 feet show the temporary sheet piling is not feasible due the dense to very dense (N>45 blows per foot) silty loam to silt at the embedment depth. A Temporary Soil Retention System (TSRS) should be considered. The design and construction of TSRS should consider the perched water within the granular fill.

The estimated groundwater elevation is at 601.5 feet, which is about 12 feet above the base elevation of the culvert. In addition, the EWSE is 596.05 feet, which is about 5.4 feet above the culvert base elevation. Therefore, we recommend Type I Cofferdam for the 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 WBK Engineering, LLC 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.

Andri A. Kurnia, 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.

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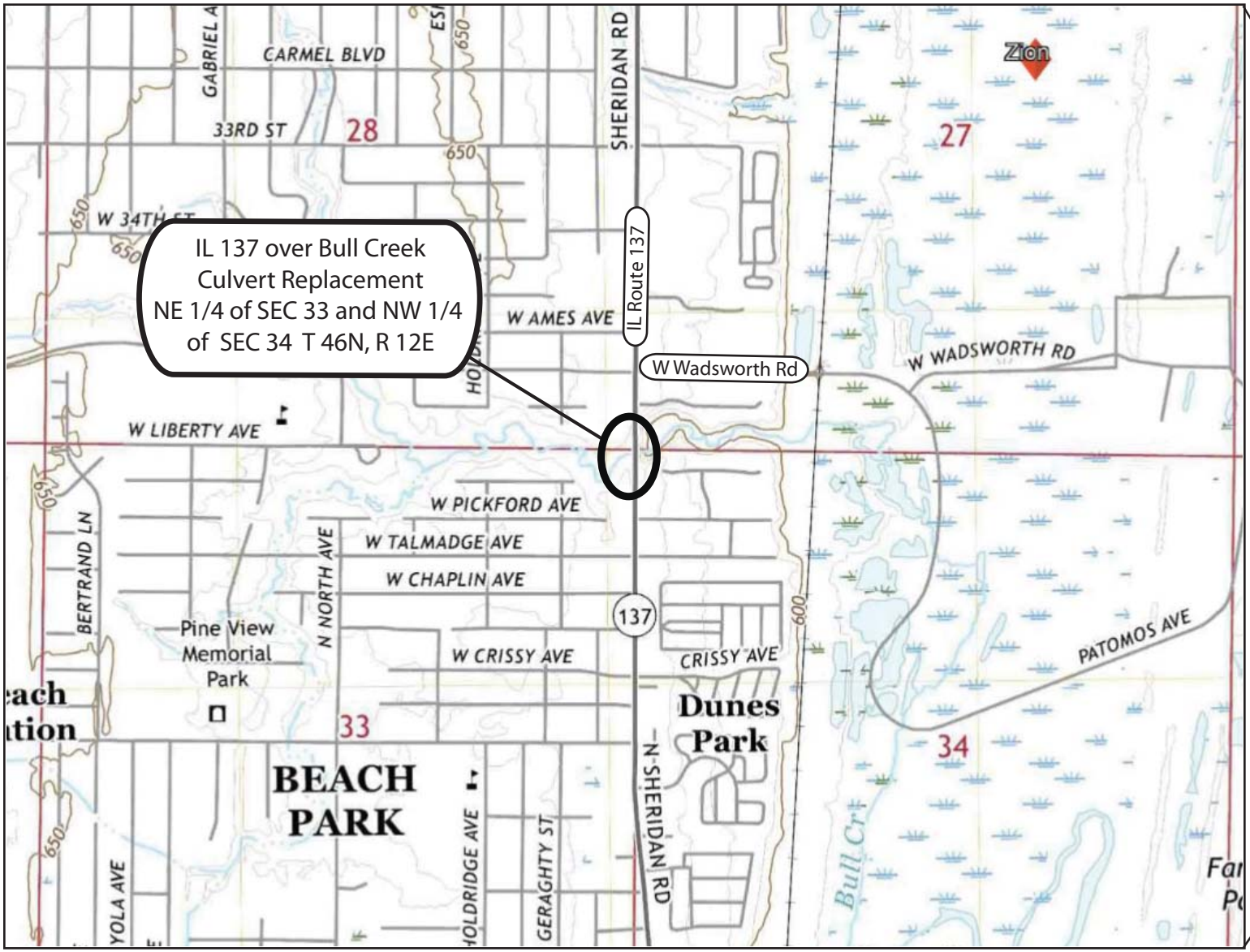
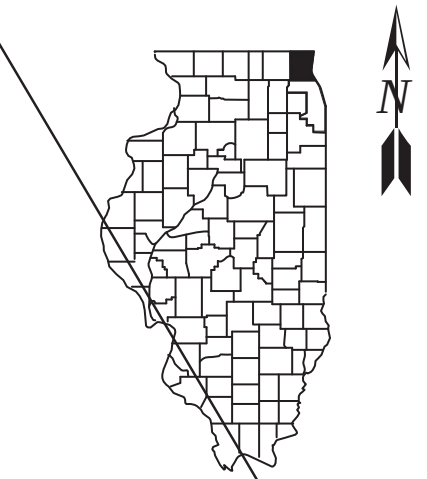
EXHIBITS





Lake County

0 0.5 1.0 Mile

SITE LOCATION MAP: IL ROUTE 137 OVER BULL CREEK, CULVERT REPLACEMENT, SN 049-0700, LAKE COUNTY, IL

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: N. Balakumaran CHECKED BY: A. Kurina

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FOR WBK ENGINEERING, LLC	412-13-01

Legend

Boring Location

0 250 500 feet

BORING LOCATION PLAN: IL ROUTE 137 OVER BULL CREEK, CULVERT REPLACEMENT, SN 049-0700, LAKE COUNTY, IL

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: N. Balakumaran CHECKED BY: A. Kurnia

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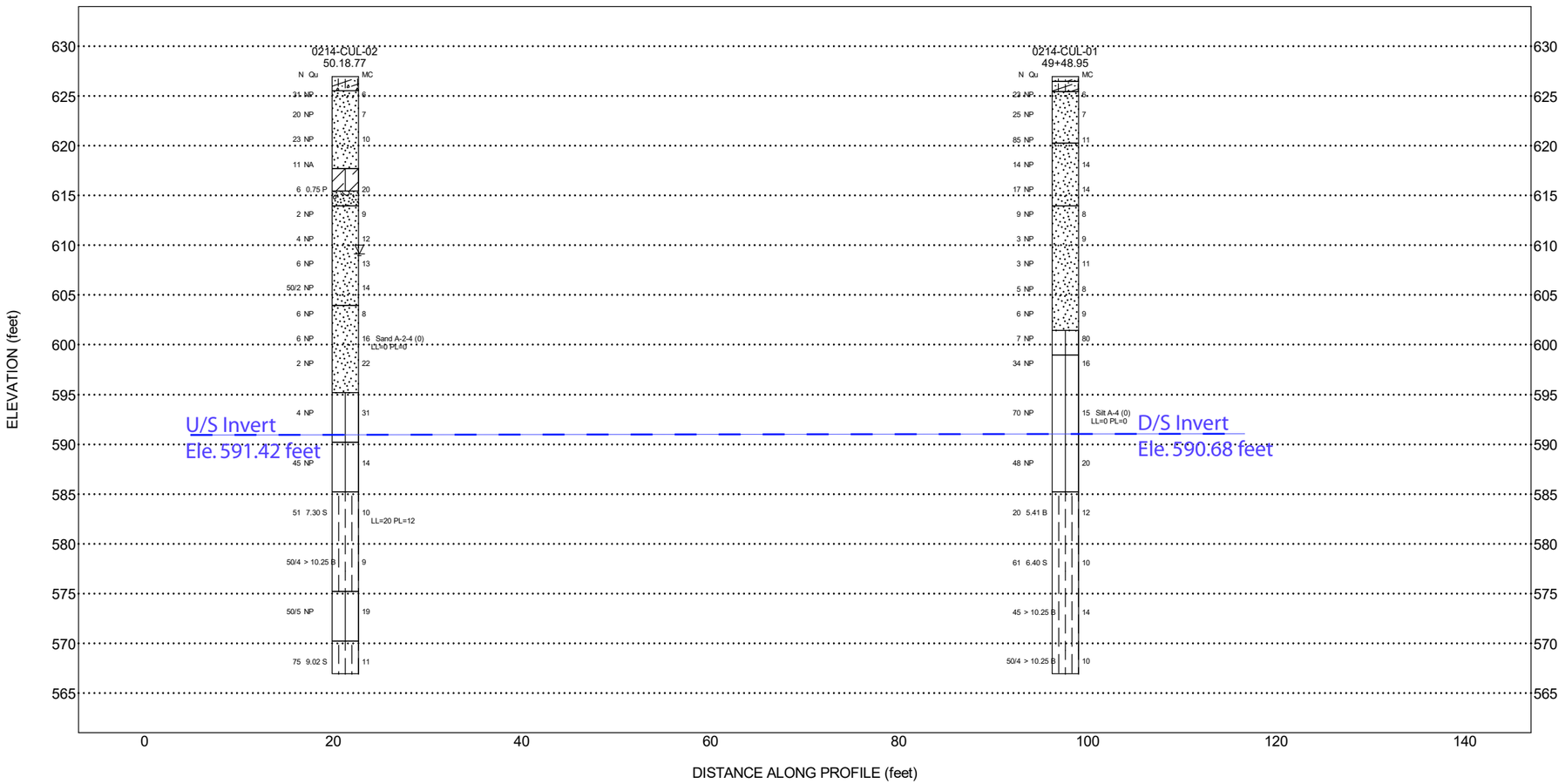
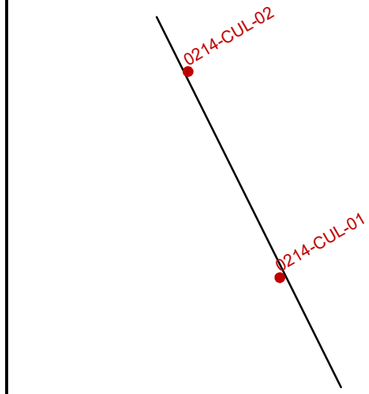
FOR WBK ENGINEERING, LLC | 412-13-01



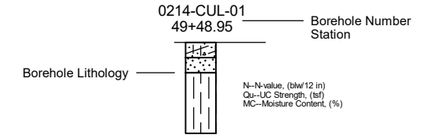
Lithology Graphics

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

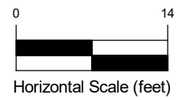


Site Map Scale 1 inch equals 50 feet

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: 1x

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

Soil Profile
IL Route 137 over Bull Creek, SN 049-0700

IL Route 137 (Sheridan Road) over Bull Creek
Beach Park, Lake County, IL

JOB NUMBER	PLATE NUMBER
555-15-05	EXHIBIT 3

WEI 11X17 5551505.GPJ BEARING-TRIAL.GDT 4/30/20

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APPENDIX A

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1145 N. Main Street
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Telephone: 6309539928
Fax: 6309539938

BORING LOG 0214-CUL-01

WEI Job No.: 555-15-05

Client: **Illinois Department of Transportation**
Project: **IL Route 137 (Sheridan Road) over Bull Creek**
Location: **Beach Park, Lake County, IL**

Datum: NGVD
Elevation: 626.95 ft
North: 2098886.12 ft
East: 1121314.28 ft
Station: 49+48.95
Offset: 7.3 RT

Elevation (ft)	Depth (ft)	SOIL AND ROCK DESCRIPTION	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
626.5		6-inch thick ASPHALT --PAVEMENT--					
625.5		12-inch thick, CONCRETE --PAVEMENT--					
		Medium dense to very dense, brown, medium SAND --FILL--		1	8 11 12	NP	6
	5			2	12 14 11	NP	7
620.3		Medium dense, brown SANDY LOAM, trace gravel --FILL--		3	13 45 40	NP	11
	10			4	8 8 6	NP	14
				5	5 9 8	NP	14
614.0		Very loose to loose, brown, medium SAND, trace gravel --FILL--		6	4 4 5	NP	8
	15			7	2 1 2	NP	9
	20			8	2 1 2	NP	11
		--Moist--		9	1 2 3	NP	8
	25			10	2 3 3	NP	9
601.5		Loose, dark brown ORGANIC SILTY LOAM and wood fibers		11	2 3 4	NP	80
599.0		Dense to very dense, gray SILT		12	4 13 21	NP	16
		--%Gravel=0.3-- --%Sand=8.6-- --%Silt=82.1-- --%Clay=9.0-- --A-4-(0)--		13	19 32 38	NP	15
	35						
		--Moist--		14	14 19 29	NP	20
	40						

GENERAL NOTES

Begin Drilling: **10-29-2015** Complete Drilling: **10-29-2015**
Drilling Contractor: **WTS** Drill Rig:
Driller: **R&R** Logger: **FB** Checked by: **ND**
Drilling Method: **2.25" HSA to 25', mud rotary thereafter, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **10' MUD**
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 5551505.GPJ WANGENG.GDT 5/4/20

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BORING LOG 0214-CUL-01

WEI Job No.: 555-15-05

Client: **Illinois Department of Transportation**
Project: **IL Route 137 (Sheridan Road) over Bull Creek**
Location: **Beach Park, Lake County, IL**

Datum: NGVD
Elevation: 626.95 ft
North: 2098886.12 ft
East: 1121314.28 ft
Station: 49+48.95
Offset: 7.3 RT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	585.2	Hard, gray SILTY CLAY to SILTY CLAY LOAM, trace gravel						
			45		15	10 9 11	5.41 B	12
			50		16	17 29 32	6.40 S	10
			55		17	14 17 28	> 10.25 B	14
	567.0		60		18	17 28 50/4	> 10.25 B	10
		Boring terminated at 60.00 ft						

GENERAL NOTES

Begin Drilling: **10-29-2015** Complete Drilling: **10-29-2015**
Drilling Contractor: **WTS** Drill Rig:
Driller: **R&R** Logger: **FB** Checked by: **ND**
Drilling Method: **2.25" HSA to 25', mud rotary thereafter, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **DRY**
At Completion of Drilling: **10' MUD**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG 0214-CUL-02

WEI Job No.: 555-15-05

Client: **Illinois Department of Transportation**
Project: **IL Route 137 (Sheridan Road) over Bull Creek**
Location: **Beach Park, Lake County, IL**

Datum: NGVD
Elevation: 626.96 ft
North: 2098955.93 ft
East: 1121283.15 ft
Station: 50.18.77
Offset: 23.6 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		17-inch thick ASPHALT --PAVEMENT--						
	625.5							
		Medium dense to dense, brown medium SAND to GRAVELLY SAND --FILL--			1	8 9 22	NP	6
			5		2	5 10 10	NP	7
					3	7 7 16	NP	10
	617.7				4	5 6 5	NA	
		Medium stiff, brown CLAY LOAM --FILL--	10					
	615.5				5	3 3 3	0.75 P	20
		Loose, brown SANDY GRAVEL --FILL--						
	614.0							
		Loose, brown, fine to medium SAND, trace gravel --FILL--			6	2 1 1	NP	9
			15					
		--Moist--			7	2 2 2	NP	12
		--Wet--			8	4 3 3	NP	13
			20					

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
					9	4 6 50/2	NP	14
		--Concrete obstruction at 22', offset 10' north--						
	604.0							
		Very loose to loose, brown and gray, medium SAND, trace gravel --Wet--			10	4 3 3	NP	8
			25					
		--%Gravel=3.6-- --%Sand=77.4-- --%Silt=14.2-- --%Clay=4.8-- --A-2-4-(0)--			11	2 3 3	NP	16
		--Saturated--			12	2 1 1	NP	22
			30					
	595.2							
		Loose, gray SILTY LOAM, trace organic matter and wood fragments			13	5 2 2	NP	31
			35					
	590.2							
		Dense, gray SILTY LOAM to SILT, trace gravel			14	11 20 25	NP	14
			40					

GENERAL NOTES

Begin Drilling: **10-28-2015** Complete Drilling: **10-28-2015**
Drilling Contractor: **WTS** Drill Rig:
Driller: **R&R** Logger: **FB** Checked by: **ND**
Drilling Method: **2.25" HSA to 18', mud rotary thereafter, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **18.00 ft**
At Completion of Drilling: **10' MUD**
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 5551505.GPJ WANGENG.GDT 5/4/20

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BORING LOG 0214-CUL-02

WEI Job No.: 555-15-05

Client: **Illinois Department of Transportation**
Project: **IL Route 137 (Sheridan Road) over Bull Creek**
Location: **Beach Park, Lake County, IL**

Datum: NGVD
Elevation: 626.96 ft
North: 2098955.93 ft
East: 1121283.15 ft
Station: 50.18.77
Offset: 23.6 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type / recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	585.2							
		Hard, gray SILTY CLAY LOAM, trace gravel						
		--L_L(%)=20, P_L(%)=12--	45		15	13 20 31	7.30 S	10
			50		16	29 38 50/4	> 10.25 B	9
	575.2							
		Very dense, gray SILT						
		--Wet--	55		17	30 38 50/5	NP	19
	570.2							
		Hard, gray SILTY CLAY LOAM, trace gravel						
	567.0		60		18	25 35 40	9.02 S	11
		Boring terminated at 60.00 ft						

GENERAL NOTES

Begin Drilling: **10-28-2015** Complete Drilling: **10-28-2015**
Drilling Contractor: **WTS** Drill Rig:
Driller: **R&R** Logger: **FB** Checked by: **ND**
Drilling Method: **2.25" HSA to 18', mud rotary thereafter, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **18.00 ft**
At Completion of Drilling: **10' MUD**
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 5551505.GPJ WANGENG.GDT 5/4/20

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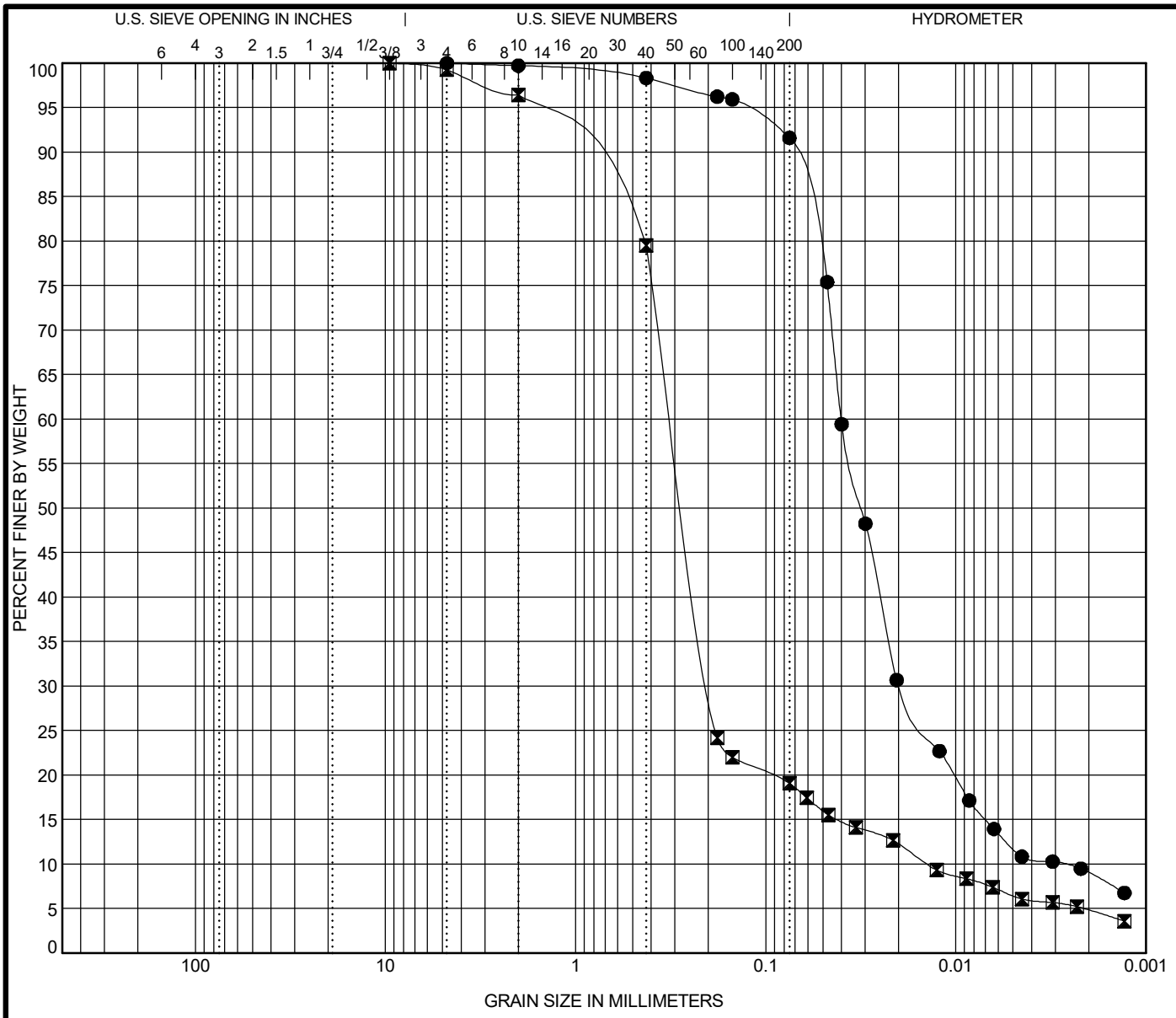
APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	0214-CUL-01#13	33.5 ft	**Silt**	**NP**	**NP**	**NP**	**3.49**	**14.60**
⊠	0214-CUL-02#11	26.0 ft	**Sand**	**NP**	**NP**	**NP**	**8.81**	**22.37**

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	0214-CUL-01#13	33.5 ft	**4.75**	**0.04**	**0.02**	**0.003**	**0.3**	**8.6**	**82.1**	**9.0**
⊠	0214-CUL-02#11	26.0 ft	**9.5**	**0.314**	**0.197**	**0.014**	**3.6**	**77.4**	**14.2**	**4.8**

WEI SINCE 1982
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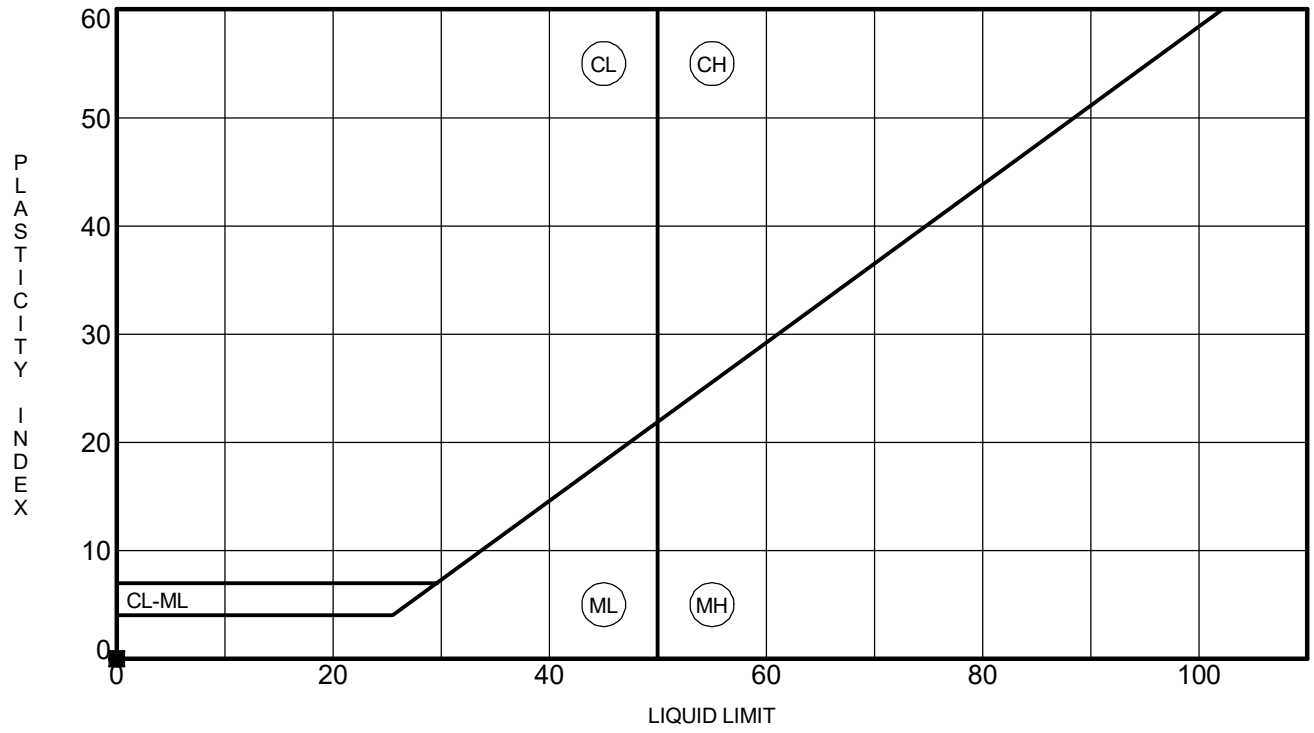
GRAIN SIZE DISTRIBUTION

Project: IL Route 137 (Sheridan Road) over Bull Creek

Location: Beach Park, Lake County, IL

Number: 555-15-05



Specimen Identification		LL	PL	PI	Fines	IDH Classification
● 0214-CUL-01#13	33.5 ft	NP	NP	NP	92	Silt
⧓ 0214-CUL-02#11	26.0 ft	NP	NP	NP	19	Sand

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ATTERBERG LIMITS' RESULTS

Project: IL Route 137 (Sheridan Road) over Bull Creek

Location: Beach Park, Lake County, IL

Number: 555-15-05

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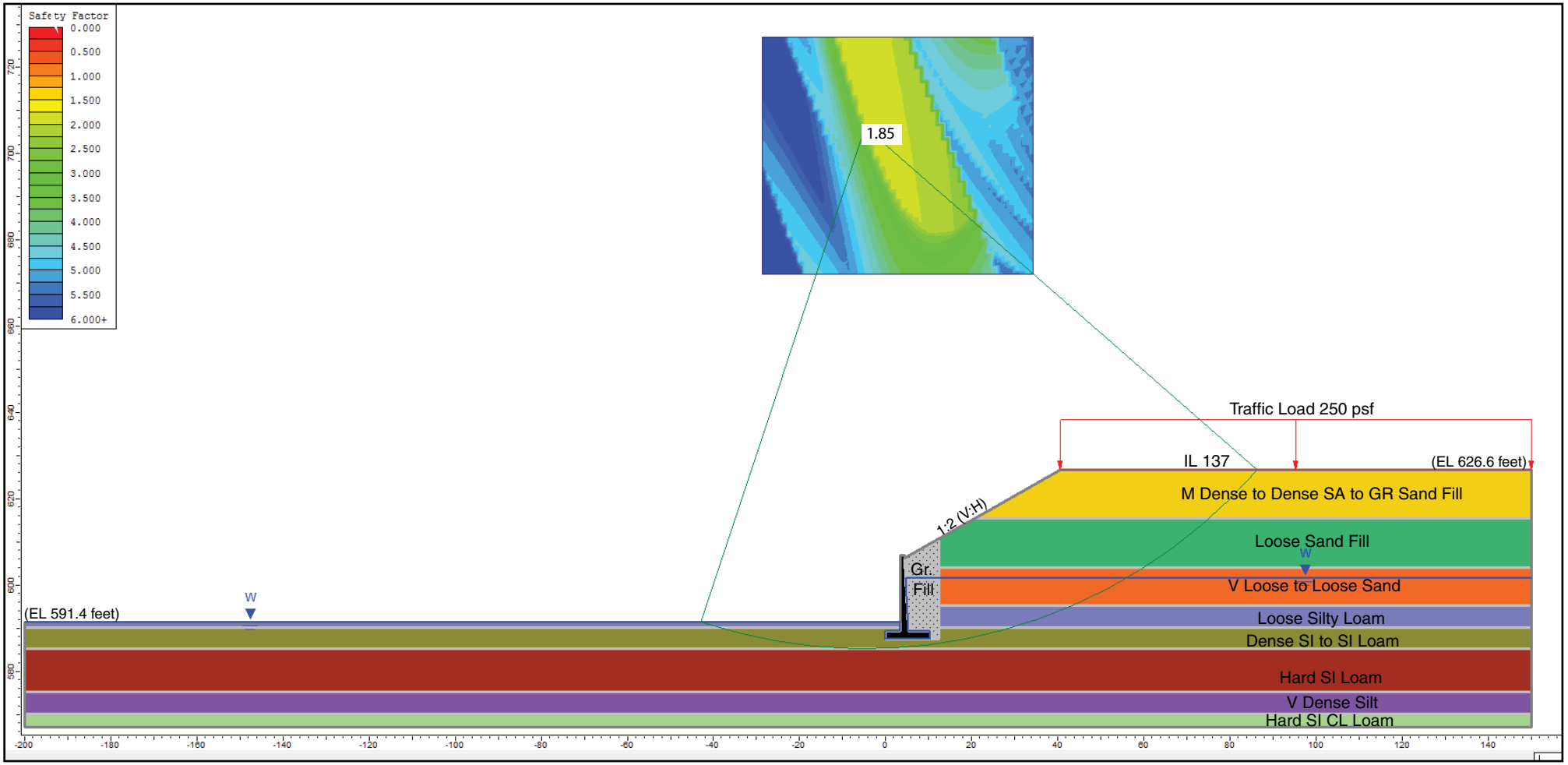
APPENDIX C



Undrained Analysis, Upstream Wingwall, Ref Boring: 0214-CUL-02

Layer ID	Description	Total Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	M Dense to Dense SA to GR Sand Fill	120	0	33
2	Loose Sand Fill	115	0	30
3	V Loose to Loose Sand	115	0	29
4	Loose Silty Loam	115	0	28
5	Dense SI to SI Loam	125	0	35
6	Hard SI CL Loam	125	7000	0
7	V Dense Silt	125	0	35
8	Hard SI CL Loam	125	9000	0
9	Granular Fill	125	0	30

GLOBAL STABILITY: IL ROUTE 137 OVER BULL CREEK CULVERT REPLACEMENT, SN 049-0700, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-1 | DRAWN BY: RKC CHECKED BY: NSB

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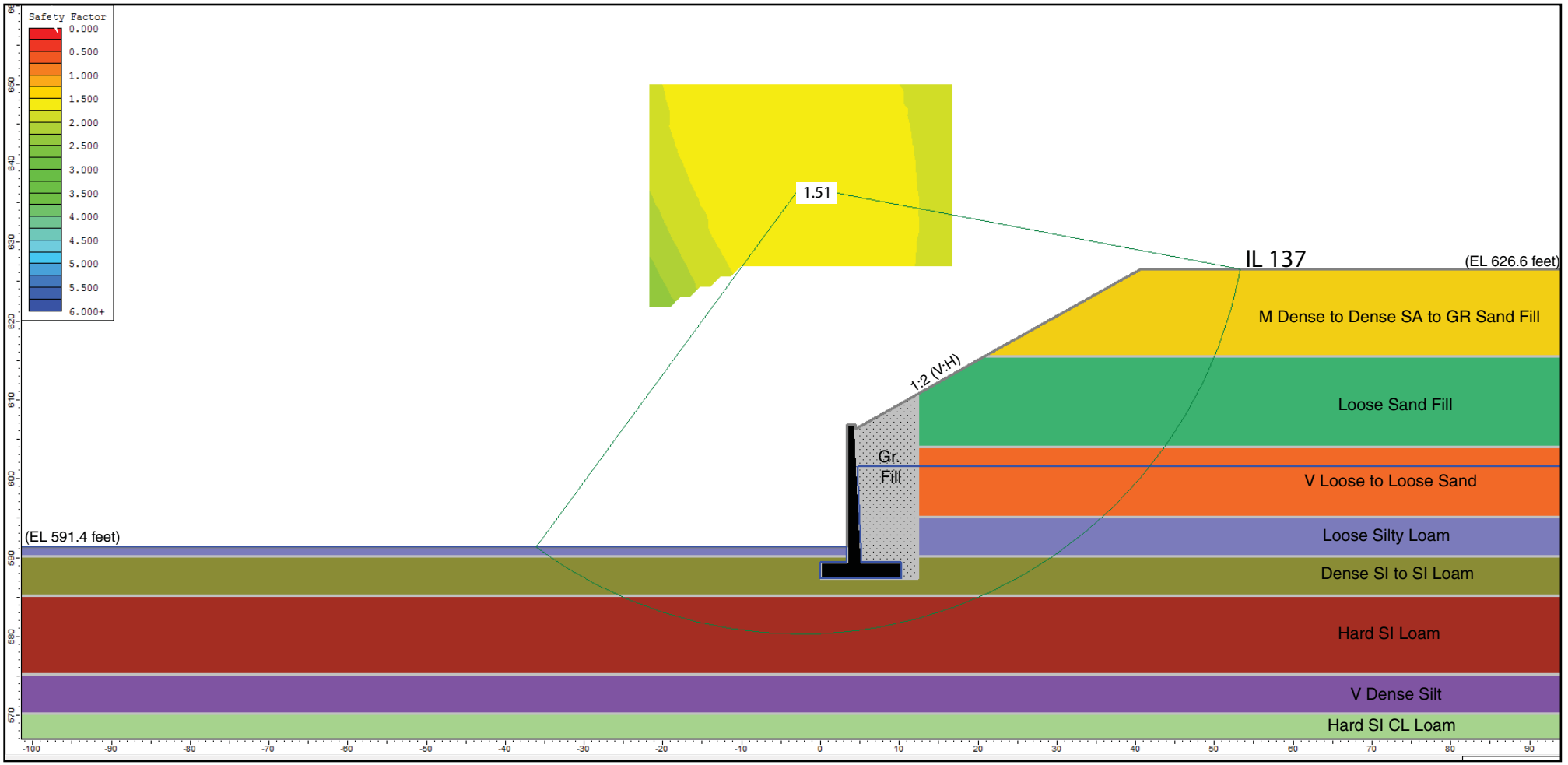
FOR WBK ENGINEERING, LLC | 412-13-01



Drained Analysis, Culvert SN. 049-0700, Ref Boring: 0214-CUL-02

Layer ID	Description	Total Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	M Dense to Dense SA to GR Sand Fill	120	0	33
2	Loose Sand Fill	115	0	30
3	V Loose to Loose Sand	115	0	29
4	Loose Silty Loam	115	0	28
5	Dense SI to SI Loam	125	0	35
6	Hard SI Loam	125	100	31
7	V Dense Silt	125	0	35
8	Hard SI CL Loam	125	100	30
9	Granular Fill	125	0	30

GLOBAL STABILITY: IL ROUTE 137 OVER BULL CREEK CULVERT REPLACEMENT, SN 049-0700, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-2 | DRAWN BY: RKC CHECKED BY: NSB

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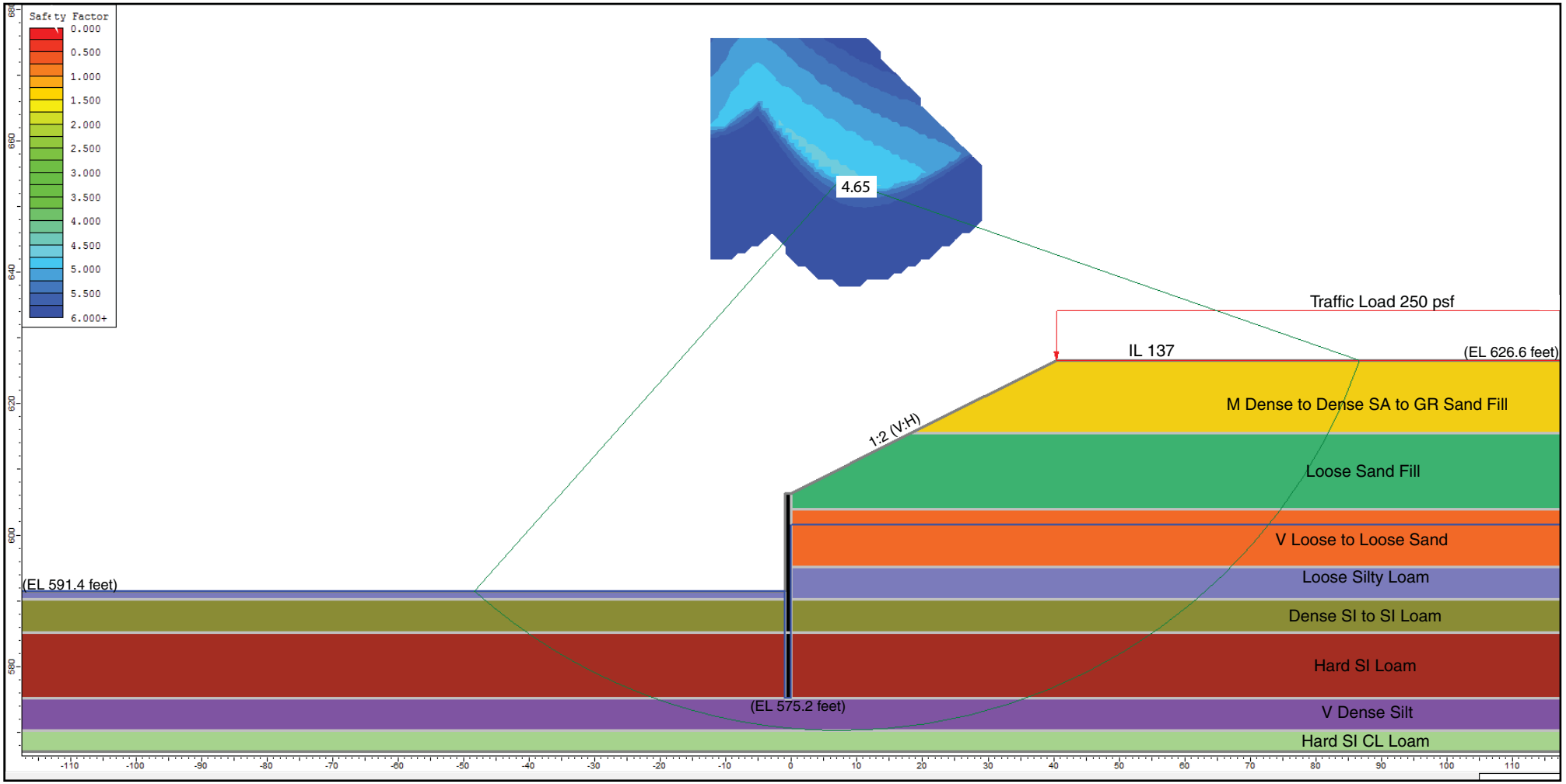

Undrained Analysis, Upstream Wingwall, Ref Boring: 0214-CUL-02

Layer ID	Description	Total Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	M Dense to Dense SA to GR Sand Fill	120	0	33
2	Loose Sand Fill	115	0	30
3	V Loose to Loose Sand	115	0	29
4	Loose Silty Loam	115	0	28
5	Dense SI to SI Loam	125	0	35
6	Hard SI Loam	125	7000	0
7	V Dense Silt	125	0	35
8	Hard SI CL Loam	125	9000	0

GLOBAL STABILITY: IL ROUTE 137 OVER BULL CREEK CULVERT REPLACEMENT, SN 049-0700, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-3 | DRAWN BY: RKC CHECKED BY: NSB

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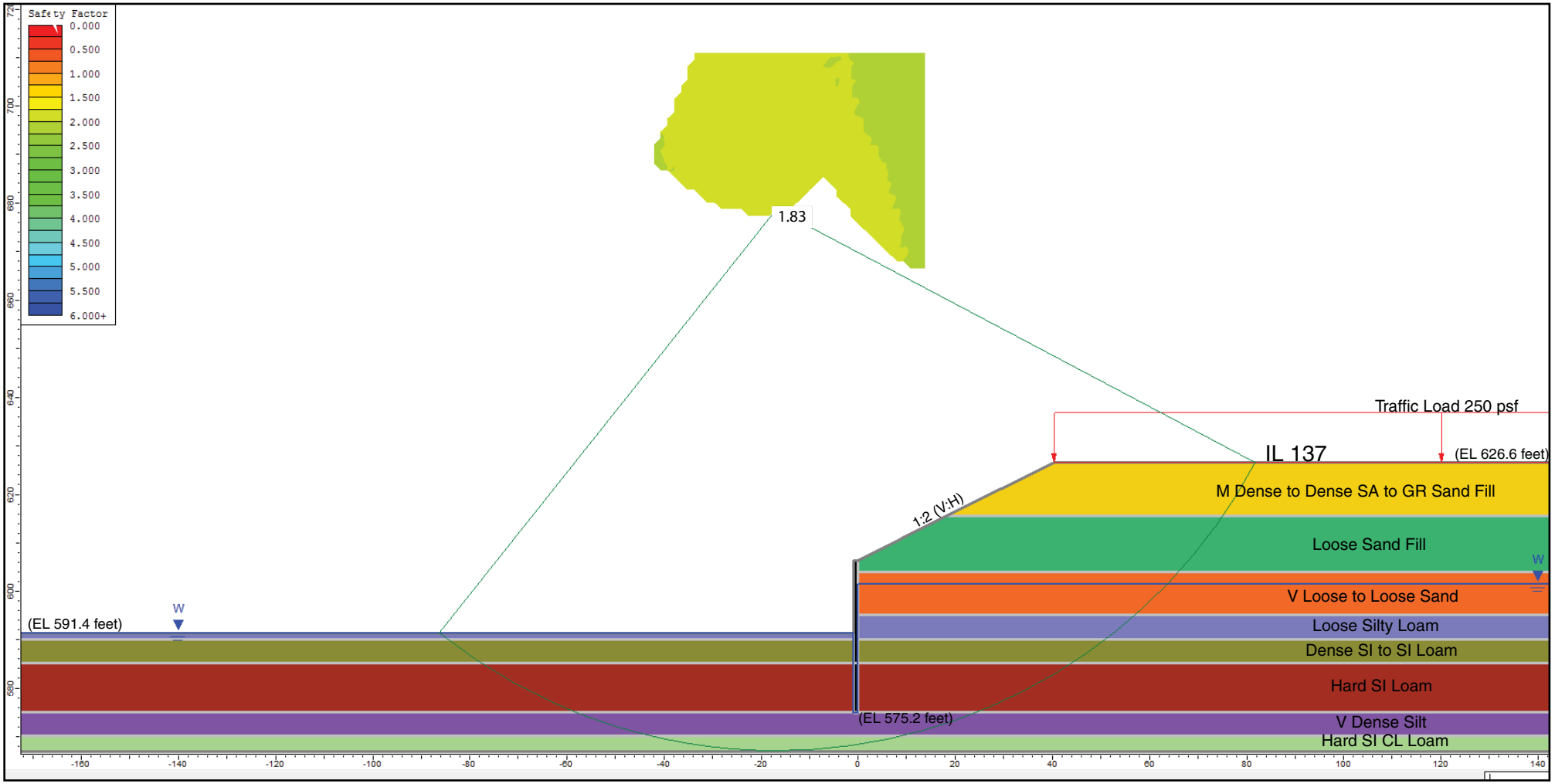

Drained Analysis, Upstream Winwall, Ref Boring: 0214-CUL-02

Layer ID	Description	Total Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	M Dense to Dense SA to GR Sand Fill	120	0	33
2	Loose Sand Fill	115	0	30
3	V Loose to Loose Sand	115	0	29
4	Loose Silty Loam	115	0	28
5	Dense SI to SI Loam	125	0	35
6	Hard SI CL Loam	125	100	31
7	V Dense Silt	125	0	35
8	Hard SI CL Loam	125	100	30

GLOBAL STABILITY: IL ROUTE 137 OVER BULL CREEK CULVERT REPLACEMENT, SN 049-0700, LAKE COUNTY, ILLINOIS

SCALE: GRAPHICAL | APPENDIX C-4 | DRAWN BY: RKC CHECKED BY: NSB

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FOR WBK ENGINEERING, LLC | 412-13-01

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APPENDIX D

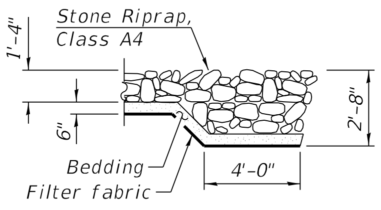
Benchmark: Brass disk in SE quadrant of Wadsworth Road and Union Pacific – North Railroad Tracks at chain link fence corner. Elev. 593.51.

Existing Structure: S.N. 049-0214 was built in the 1930s as a double cell 8'x10' cast-in-place box culvert and extended in 1960 and 1970. The existing culvert measures 154 ft out-to-out headwalls, 19 ft wide and placed on a 0° skew.

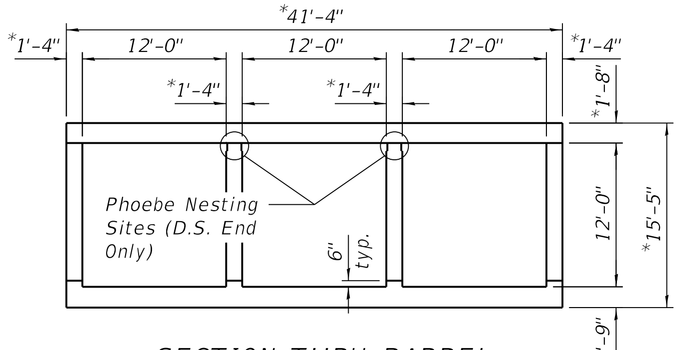
The existing roadway to be closed during construction and traffic detoured.

Precast option is not allowed.

No Salvage.



SECTION A-A



SECTION THRU BARREL

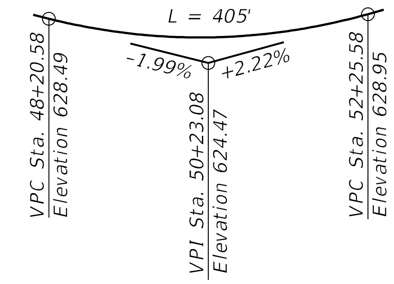
*Slab and wall thickness may be refined in final design.

WATERWAY INFORMATION

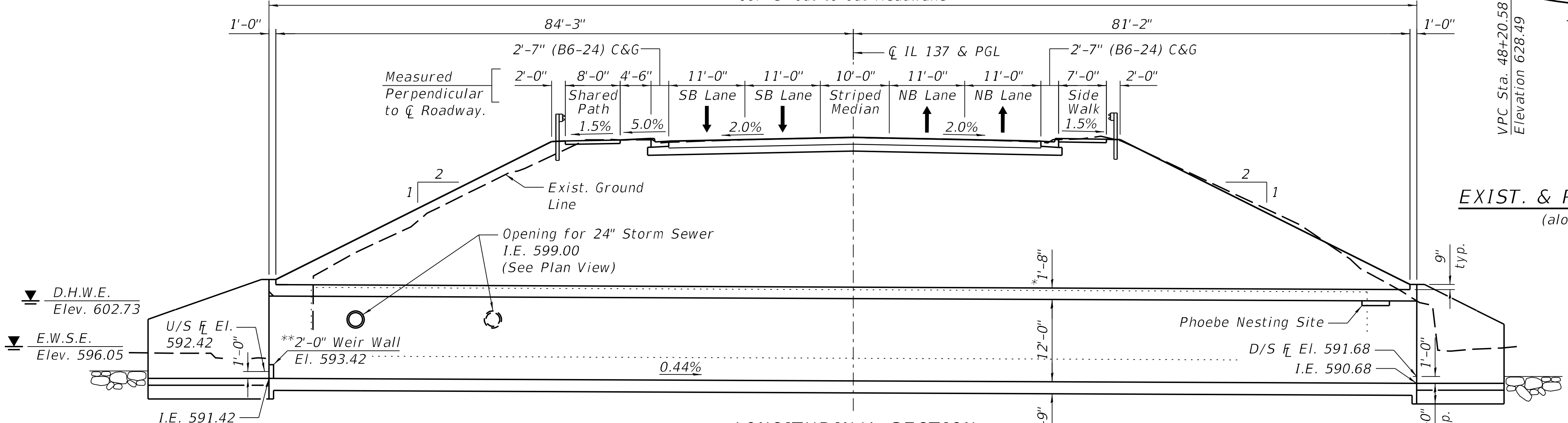
Drainage Area = 5.94 square miles
Existing Overtopping Elev. = 626.55 at Sta. 50+00
Proposed Overtopping Elev. = 626.55 at Sta. 50+00

Flood Event	Freq. Yr.	Discharge (cfs)	Opening (Sq. Ft.)		Nat. H.W.E. (ft.)	Head (ft.)		Headwater El.	
			Exist.	Prop.		Exist.	Prop.	Exist.	Prop.
	10	1854	110	303	601.51	5.70	0	607.21	601.51
Design	50	2988	129	347	602.73	10.26	0.67	612.99	603.40
Base	100	3619	139	370	603.35	13.91	1.35	617.26	604.70
Overtopping (E)	±250	4800	156		604.41	22.58		626.99	
Overtopping (P)									
Max. Calc.	500	6395	160	372	605.66	23.07	7.28	628.73	612.94

10-Year Velocity Through Existing Culvert = 15 fps
10-Year Velocity Through Proposed Culvert = 6.04 fps



EXIST. & PROP. PROFILE GRADE
(along ℄ IL 137 & PGL)



LONGITUDINAL SECTION

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

DESIGN STRESSES

FIELD UNITS

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

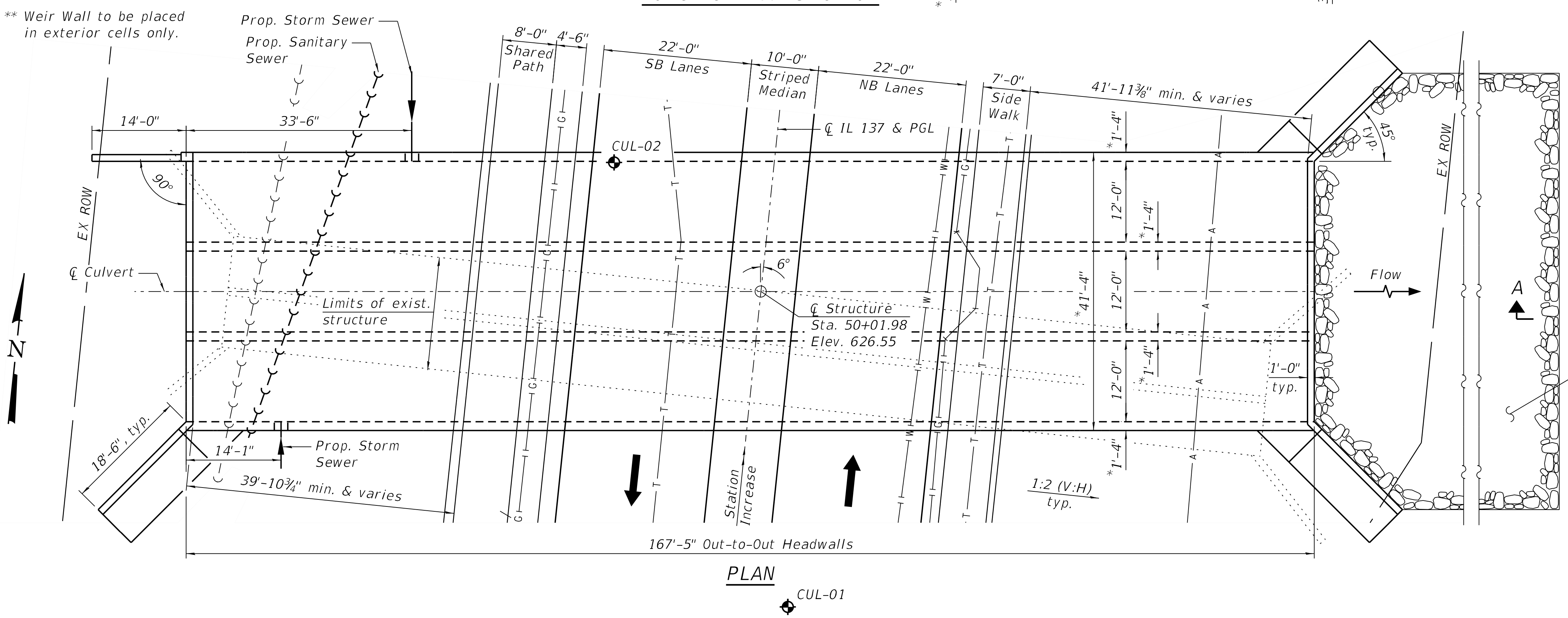
LOADING HL-93

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

HIGHWAY CLASSIFICATION

FAP Route 352 (IL 137)
Functional Class: Other Principle Arterial
ADT: 18,300 (2015); 23,000 (2040)
ADTT: 1,950 (2015); 2,540 (2040)
DHV: 1,830
Design Speed: 40 m.p.h.
Posted Speed: 40 m.p.h.
2-Way Traffic
Directional Distribution: 50/50

** Weir Wall to be placed in exterior cells only.

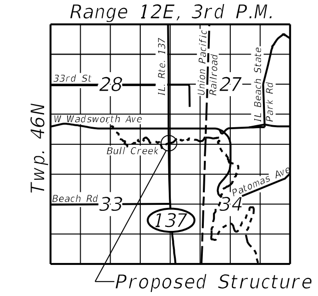


PLAN

LEGEND

— A — Exist. Aerial
—)—)— Exist. Sanitary
— T — Exist. Telephone
— W — Exist. Water
— G — Exist. Gas
Prop. Storm
Prop. Sanitary
Boring Location

Note:
All existing utilities shown are to be relocated by Others.



LOCATION SKETCH

GENERAL PLAN AND ELEVATION
IL 137 OVER BULL CREEK
FAP ROUTE 352
SECTION 2019-074-SW&I
LAKE COUNTY
STATION 50+01.98
S.N. 049-0700

FILE NAME = W:\Projects\2019\190221 IDOTPTB193\cadd\Structural\Dgn\TSL\0490700-62J41.dgn

WBK engineering — WBKENGINEERING LLC, 116 WEST MAIN STREET, SUITE 201, ST. CHARLES, ILLINOIS 60174, (630) 443-7755	USER NAME = ctacey	DESIGNED - JMM	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
		CHECKED - JZ	REVISED -	
	PLOT SCALE = 1:20	DRAWN - CPT	REVISED -	
	PLOT DATE = 6/30/2020	CHECKED - JZ	REVISED -	SHEET NO. 1 OF 1 SHEETS

F.A.P RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
352	2019-074-SW&I	LAKE	1	1

CONTRACT NO.62J41
ILLINOIS FED. AID PROJECT