Structural Geotechnical Report

Proposed Reinforced Concrete Box (RCB) Culverts
6' x 6' RCB Culvert (SN 016-8370)
4' x 3' RCB Culvert

IDOT PTB 163-017
IL Route 171
Willow Springs, Illinois

Prepared for:

Illinois Department of Transportation
Contract Number: 60R94

Project Design Engineer:
Ames Engineering, Inc.

Prepared by:

GSG CONSULTANTS, INC.
Engineers. Scientists. Construction Managers
735 Remington Road, Schaumburg IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

May 14, 2024

GSG CONSULTANTS, INC.

735 Remington Road
Schaumburg, IL 60173
Tel: 630.994.2600
www.gsg-consultants.com

May 14, 2024

Mr. Joseph Regis, PE, PTOE, CFM
Senior Project Manager
Ames Engineering, Inc.
6330 Belmont Road, Suite 4B
Downers Grove, IL 60516

Structural Geotechnical Report
Proposed Reinforced Concrete Box Culverts
IL Route 171, Willow Springs, IL
IDOT PTB 163-017

Dear Mr. Regis:

Attached is a copy of the Structural Geotechnical Report for the above referenced project. The report provides a brief description of the site investigation, site conditions, and geotechnical recommendations for the proposed improvements. The site investigation included advancing four (4) borings to depths of 25 feet.

Should you have any questions or require additional information, please call us at 630-994-2600.

Sincerely,

Thomas E. Kasang, P.E.
Project Engineer

Dawn Edgell, P.E.
Senior Project Engineer

TABLE OF CONTENTS

Exhibits

Tables

Appendices

1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed a geotechnical investigation for the design of two concrete box culverts proposed to cross IL Route 171 in Willow Springs, Illinois. The purpose of this site investigation was to explore the subsurface conditions at each proposed structure location, to determine engineering properties of the subsurface soil, and to develop design and construction recommendations for the proposed culverts. **Exhibit 1** shows the general project location.

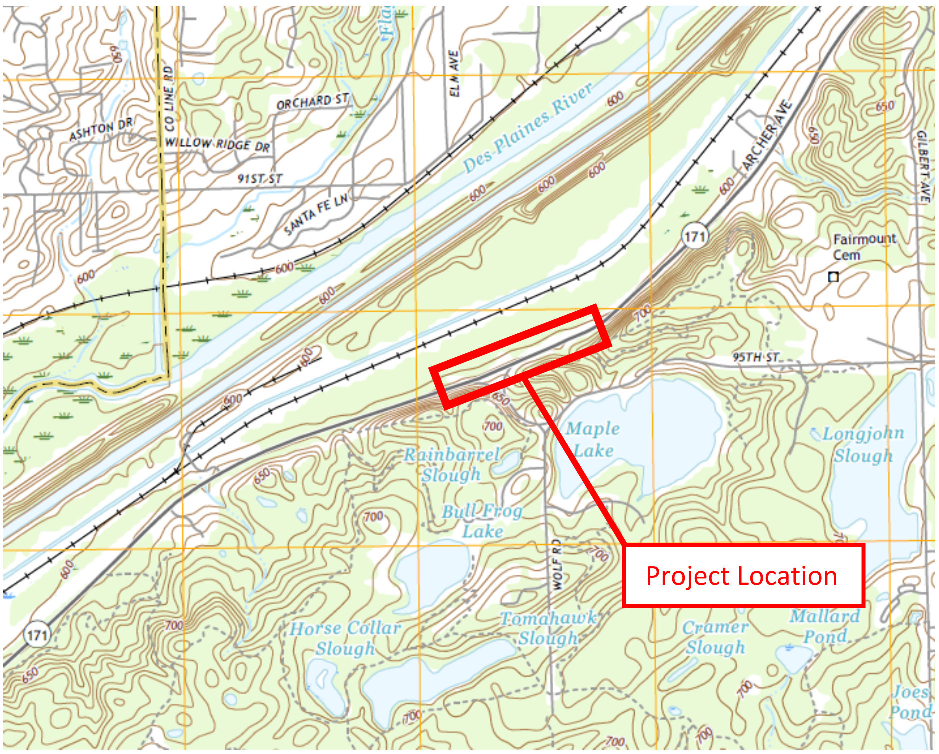


Exhibit 1 – Project Location Map
(Source: USGS Topographic Maps, usgs.gov)

The general scope of the overall project is to raise the grade of IL 171 for a new intersection with 95th Street. A retaining wall (SN 016-2310) will be required along the northern right-of-way of IL 171 due to limited right-of-way available for slope reconfiguration. The project will also include constructing two (2) new culverts, traffic signals, and roadway improvements including new embankment construction and realigning the IL 171 and 95th Street intersection. The proposed culverts will be discussed in this report.

1.1 Proposed Project Information

Based on the drawings (dated July 1, 2022) and design information (dated March 27, 2024) (**Appendix A**) provided by Collins Engineers, Inc. (Collins), two new precast concrete box culverts are proposed to cross IL Route 171. The first culvert will be a 6’ X 6’ reinforced concrete box culvert (RCBC) (SN 016-8370) and will be approximately 230 feet in out-to-out headwall length. The second culvert will be a 4’ X 3’ RCBC culvert and will be approximately 74 feet in length. The proposed invert elevations for each structure are shown in **Table 1**. The base of the proposed culverts will be cut into the existing ground surface; however, the culverts will be located in a “fill” section within the newly constructed roadway embankment, with new fill heights of approximately 3 and 17 feet at the proposed 4’ x 3’ and 6’ x 6’ RCB culverts, respectively.

Table 1 – Summary of Proposed Culverts

Proposed Structure	Station	Upstream Invert Elevation (ft.)	Downstream Invert Elevation (ft.)	Total Length (feet)
6’ x 6’ RCB Culvert (SN 016-8370)	326+89.13	601.6	597.0	230
4’ x 3’ RCB Culvert	STA 334+88	604.0	603.0	74

1.2 Project and Scope of Services

The site investigation included completing the following:

1. Advancing a total of four (4) soil borings to evaluate the general condition and physical characteristics of the subsurface soil.
2. Perform geotechnical laboratory testing on representative soil samples to evaluate relevant engineering parameters of the subsurface soils.
3. Perform engineering analysis and evaluation of the data collected during the field investigation and laboratory testing to develop geotechnical engineering design recommendations for the proposed improvements.

2.0 SITE SUBSURFACE EXPLORATION PROGRAM

This section describes the subsurface exploration program and laboratory testing program completed as part of this project. The proposed locations and depths of the soil borings were selected in accordance with IDOT requirements and reviewed with Ames Engineering, Inc. (Ames) for available design information at the time of the field activities. The borings were completed in the field based on field conditions and accessibility.

2.1 Subsurface Exploration Program

Soil borings were completed between June 11 and June 21, 2021. The exploration program included advancing four (4) standard penetration test (SPT) borings at locations along the length of the proposed culverts. Two borings (CB-04 and CB-06) were proposed at either end of the second culvert, however, could not be completed due to the site access and heavy vegetation at the proposed locations. The as-drilled locations of the soil borings are shown on the Soil Boring Location Plan and Subsurface Profile (**Appendix B**). **Table 2** presents a list of the borings used for the proposed culverts analysis.

Table 2 – Summary of Subsurface Exploration Borings

Boring	Northing	Easting	Existing Ground Elevation (ft)	Depth (ft)	Proposed Culvert
CB-01	1839808.833	1103313.778	611.7	25.0	6' x 6' RCB Culvert (SN 016-8370)
CB-02	1839777.253	1103331.364	612.1	25.0	
CB-03	1839748.581	1103344.509	616.6	25.0	
CB-04*	1840120.448	1103992.955	610.0	25.0*	4' x 3' RCB Culvert
CB-05	1840073.741	1104000.158	609.0	25.0	
CB-06*	1840053.729	1104009.980	608.4	25.0*	

*Borings not completed due to site access restrictions

The soil borings were drilled using truck-mounted Diedrich D-50 (hammer efficiency 92%) and CME-75 (hammer efficiency 91%) drill rigs using 3¼-inch I.D. hollow stem augers and an automatic hammer. Soil sampling was performed according to AASHTO T 206, "Penetration Test and Split Barrel Sampling of Soils." Soil samples were obtained at 2.5-foot intervals to the boring termination depths of 25 feet below grade. Water level measurements were made in each boring when evidence of free groundwater was detected on the drill rods or in the samples. The boreholes were also checked for free water immediately after auger removal, and before filling the open boreholes with soil cuttings.

GSG's field representative inspected, visually classified and logged the soil samples during the subsurface exploration activities and performed unconfined compressive strength tests on cohesive soil samples using a calibrated Rimac compression tester and a calibrated hand penetrometer in accordance with IDOT procedures and requirements. Representative soil samples collected from each sample interval, were placed in jars and were returned to the laboratory for further testing and evaluation.

2.2 Laboratory Testing Program

All samples were inspected in the laboratory to verify the field classifications. A laboratory testing program was undertaken to characterize and determine engineering properties of the subsurface soils encountered. The following laboratory tests were performed on representative soil samples:

- Moisture content ASTM D2216 / AASHTO T-265
- Atterberg Limits ASTM D4318 / AASHTO T-89 / AASHTO T-90
- Dry Unit Weight ASTM D7263

The laboratory tests were performed in accordance with test procedures outlined in the IDOT Geotechnical Manual (2020), and per ASTM and AASHTO requirements. Based on the laboratory test results, the soils encountered were classified according to the AASHTO and the Illinois Division of Highways (IDH) classification systems. The results of the laboratory testing program are included in the **Appendix D Laboratory Test Results** and are also shown along with the field test results in **Appendix C Soil Boring Logs**.

2.3 Subsurface Conditions

This section provides a brief description of the soils encountered in the borings performed in the vicinity of the proposed RCB culverts. Variations in the general subsurface soil profile were noted during the drilling activities. Detailed descriptions of the subsurface soils are provided in the Soil Boring Logs (**Appendix B**). The soil boring logs provide specific conditions encountered at each boring location, including soil descriptions, stratifications, penetration resistance, elevations, location of the samples, water levels (when encountered), and laboratory test data.

Variations in the general subsurface soil profile were noted during the drilling activities. The stratifications shown on the boring logs represent the conditions only at the actual boring locations and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

6' x 6' RCB Culvert (SN 016-8370) (CB-01, CB-02 & CB-03)

Borings CB-01, CB-02 and CB-03 were drilled in the vicinity of the proposed culvert along Illinois 171 and 95^{th} Street. The surface elevations of these borings were 611.7, 612.1 and 616.6 feet respectively.

The borings initially noted 2 and 6 inches of topsoil. Beneath the topsoil, boring CB-01 encountered stiff brown and black clay loam to an elevation of 606.2 feet and boring CB-03 encountered stiff to very stiff silty clay loam to an elevation of 610.6 feet. The borings then encountered medium stiff to hard brown and dark brown silty clay to elevations between 601.0 and 586.7 feet. Boring CB-03 then noted very stiff to hard gray silty clay to the boring termination depth at an elevation of 591.6 feet. Boring CB-02 then noted loose to medium dense brown gravel to an elevation of 596.0 feet followed by medium dense brown sandy clay loam to elevation 593.6 and brown soft clay loam to the boring termination depth at an elevation of 587.0 feet. The unconfined compressive strength values of the silty clay ranged between 0.5 tsf and 5.0 tsf. The SPT blow count 'N' values of the granular soils ranged between 8 and 16 bpf.

4' x 3' RCB Culvert (CB-05)

The boring was drilled in the vicinity of the proposed culvert along IL Route 171. The surface elevation of this boring was 609.0 feet.

The boring initially noted 3 inches of topsoil. Beneath the topsoil, the boring encountered medium stiff to stiff brown and dark brown silty clay to a depth of 6 feet below grade. The boring then encountered soft brown clay loam to a depth 18.5 feet followed by medium dense to extremely dense brown sandy clay loam to the boring termination depth of 25 feet below grade. Gravel and cobbles were noted below a depth of 20 feet. The unconfined compressive strength values of the brown and dark brown silty clay ranged between 0.62 tsf and 1.25 tsf. The unconfined compressive strength values of the brown clay loam ranged between 0.42 tsf and 0.62 tsf. The SPT blow count 'N' values of the granular soils ranged between 21 to 50 blows per 1 inch of recovery.

2.4 Groundwater Conditions

Water level measurements were made at the boring locations when evidence of free groundwater was detected on the drill rods or in the samples. The boreholes were also checked for free water immediately after auger removal and before filling the open boreholes with soil cuttings. Groundwater was encountered in boring CB-05 at depths of 11 feet below grade (elevation of 598.0 feet) during drilling. Water was not encountered during drilling at any of the other soil boring locations. Perched water may also be present within the confined granular materials.

Based on the observed water and color change from brown to gray, the long-term groundwater level may be at an elevation between 595.5 feet to below the depth of the borings. Water level readings were made in the boreholes at times and under conditions shown on the boring logs and stated in the text of this report. However, it should be noted that fluctuations in groundwater level may occur due to variations in rainfall, other climatic conditions, or other factors not evident at the time measurements were made and reported heroin.

3.0 GEOTECHNICAL ANALYSIS

This section provides GSG's geotechnical analysis and recommendations for the design of the proposed culverts based on the results of the field exploration, laboratory testing, and geotechnical analysis. Subsurface conditions in unexplored locations may vary from those encountered at the boring locations. If the structure location, loadings, or elevations are changed, we request that GSG be contacted so that we may re-evaluate our recommendations.

3.1 Soil Parameters for Design

GSG determined the geotechnical parameters to be used for the project design based on the results of the field and laboratory test data on individual boring logs as well as our experience. Unit weights, friction angles and shear strength parameters were estimated using standard penetration test (SPT) results for the fill and cohesionless soils and in-situ and laboratory test results for cohesive soils. Based on the field investigation data collected, generalized soil parameters for the soils for use in design are presented in **Appendix E.**

3.2 Seismic Considerations

The seismic hazard for the site was analyzed per the IDOT Geotechnical Manual, IDOT Bridge Design Manual, and AASHTO LRFD Bridge Design Specifications. As per the Bridge Manual, seismic data is not typically needed for buried structures. Therefore, no additional analysis is warranted.

3.3 Scour Analysis

Scour analysis is not warranted for closed bottom box culvert per All Bridge Designers memo 14.2, dated November 7, 2014. Therefore, no additional scour analysis is warranted.

4.0 GEOTECHNICAL DESIGN RECOMMENDATIONS

This section provides the results of GSG's geotechnical evaluation of the existing foundation system and design recommendations in accordance with the most current AASHTO LRFD 9th Edition (2020) and IDOT Geotechnical Manual (2020). The foundations for the proposed culverts must provide sufficient support to resist the dead and live loads.

4.1 Culvert Foundation Bearing Resistance

GSG evaluated the soils at the assumed bearing grade elevations of 1-foot below the invert for the proposed culverts. The recommendations in this report are based on the preliminary plan drawings provided by Collins and Ames. For the design of the foundations for the culverts, the total live load, impact loads, and dead loads, including the load of the overburden soils, should be considered. Design should be completed in accordance with the design hydraulics report and the IDOT Culvert Manual (2017).

A foundation system consisting of shallow spread footings could be used to support the proposed culvert and wing walls. The footing for the wing walls should be placed at a minimum depth of 3 feet below grade for Type L walls or 4 feet below finished grade for Type T Walls (in accordance with IDOT Culvert manual), for frost protection. The wingwalls are anticipated to be constructed as horizontal cantilever walls attached to the culvert walls. Wingwalls should be designed based on the information and typical sections shown in Section 4.2 of the IDOT Culvert Manual (IDOT 2017). Headwalls should be designed based on the information provided in Section 4.1.5 of the IDOT Culvert Manual (IDOT 2017).

It is anticipated that the RCB culverts will bear on native clay and new engineered fill. The bearing resistance factor, ϕ_b, for shallow foundations in clay is 0.50, per AASHTO Table 10.5.5.2.2.1. The bearing resistance shall be checked for the extreme limit state with a resistance factor of 1.0. **Table 3** presents the recommended bearing resistance of suitable materials to support the proposed culverts.

Table 3 – Recommended Culvert Bearing Resistances

Proposed Structure	Elevation (feet)*	Location	Nominal Bearing Resistance (ksf)	Factored Bearing Resistance (ksf)	Anticipated Bearing Soil
6' x 6' RCB Culvert (SN 016-8370)	596.0 to 600.6	Inlet	13.7	6.8	Very Stiff Brown Silty Clay
		Outlet	11.1	5.5	New Engineered Fill**
4' x 3' RCB Culvert	602.0 to 603.0	Entire Culvert	10.9	5.4	New Engineered Fill**

* Estimated based on drawings provided by Collins (dated 07/01/2022)

** Assumed properties of new engineered clay fill: cohesion = 2,000 psf, unit weight = 125 pcf

Based on the anticipated loading of the new embankment height of 17 feet at the proposed 6' x 6' RCB (SN 016-8370) culvert, the soils at this location may be subject to large settlements. Additional ground improvement measures should be considered at this location and are discussed further in Section 4.6.

The subgrade soils at bearing grade should be evaluated per the guidelines provided in Section 8.9 of IDOT Geotechnical Manual (2020) for suitability/workability prior to placing any portion of the proposed culvert structures. Due to the presence of unsuitable low strength and high moisture content materials at the invert elevations of the proposed culverts, undercuts to reach suitable soil will be required at each proposed culvert location to provide stable support, reduce anticipated settlements, and increase bearing resistances. Following undercutting to suitable native soils, the over-excavations should be backfilled to the design bearing grade with structural fill. The structural fill should be placed in accordance with the Construction Considerations section of this report. **Table 4** provides the approximate suitable bearing depths and the anticipated undercut based on the Table 8.9-1 of the IDOT Geotechnical Manual (2020). The undercut values shall be field verified during construction.

Table 4 – Anticipated Undercut Depths

Proposed Structure	Boring ID	Anticipated Bearing Elevation*	Recommended Undercut Elevation	Maximum Undercut Depth (ft)	Comment/Reason for Remediation
6' x 6' RCB Culvert (SN 016-8370)	CB-01	596.0	593.0	3.0	Medium Stiff Silty Clay Qu between 0.5 – 0.7 tsf
4' x 3' RCB Culvert	CB-05	602.0 to 603.0	598.0 to 599.0	4.0	Medium Stiff Silty Clay Qu between 0.6 – 1.0 tsf & High Moisture (>27%)

*Estimated as 1-foot below proposed culvert invert elevations

4.2 Culvert and Embankment Settlement

Settlement for the proposed culvert and embankment system depends on the culvert type selected, foundation widths and bearing pressures, as well as the strength and compressibility characteristics of the underlying bearing soils. It is recommended to provide vertical collars if large differential settlements over short horizontal distances are anticipated.

Based on information provided by Collins and Ames, the proposed culverts will be installed in fill areas with up to 17 feet of new fill at the 6' x 6' RCB culvert (SN 016-8370) location, and 3 feet at the 4' x 3' RCB culvert location. Settlement analysis was performed at boring locations CB-01, CB-02, CB-03 for the 6' x 6' RCB culvert, and at CB-05 for the 4' x 3' RCB culvert based on the drawings (dated 07/01/2022) and wall design information (dated 03/27/2024) provided by Collins. The total primary settlement beneath the culverts were calculated based on anticipated loading conditions from the proposed embankment. Based on the variable soil conditions across the length of the embankment at the maximum fill height, the analysis was broken into several sections to evaluate the anticipated amount of primary settlement. The low strength, high plasticity and moisture content clays encountered in boring CB-02 may be subject to high settlements. The maximum estimated total settlements were calculated as shown in **Table 5.**

Table 5 – Anticipated Culvert Settlement

Proposed Structure	Boring ID	Embankment Height*	Settlement Location	Anticipated Total Primary Settlement (inches)
6' x 6' RCB Culvert (SN 016-8370)	CB-01	17.0	North side of proposed IL 171 roadway	< 1.0
	CB-02	17.0	South side of proposed IL 171 roadway	4.0
	CB-03	17.0		< 1.0
4' x 3' RCB Culvert	CB-05	3.0	Middle of Culvert	< 1.0

*Based on drawings (dated 07/01/2022) and wall design information (dated 03/27/2024) provided by Collins

Based on experience with similar soils, 90% of the primary consolidation will occur within approximately 9 to 12 months from the date of loading. If the estimated settlements are considered to be too large to accommodate in design for a precast RCB culvert, then the subgrade will require improvements such as the remediation methods discussed in Section 4.6.

4.3 Lateral Load Resistance

The culvert headwall and wingwalls will be subject to uneven loading and should be evaluated for anticipated lateral loads. Lateral earth pressures for permanent underground structures will be dependent on the type of backfill used, whether it is in a drained or undrained state, as well as loading conditions. The proposed culverts should be designed using the at-rest earth pressure coefficients provided in **Tables 6a and 6b.**

The lateral earth pressures for the culvert should be designed per the guidance provided in Section 4 of the IDOT Culvert Manual (2017). Wall sections that are independent of the culvert should be designed using the Rankine active earth pressure coefficient, K_a. Headwalls that are fixed to the culvert to resist movement should be designed using an at-rest earth pressure coefficient. Lateral design parameters for use in design are provided in **Tables 6a and 6b** and **Appendix E**.

Table 6a – Lateral Load Resistance Soil Parameters for CB-1, CB-2, and CB-3

Elevation Range (feet)	Soil Description	Unit Weight γ (pcf)	Friction Angle Φ (degrees)	Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At-Rest Earth Pressure Coefficient (K_o)
	New Engineered Clay Fill	125	25	0.41	2.46	0.58
	New Engineered Granular Fill	125	30	0.33	3.00	0.50
0.5 to 12.0 (612.5 to 601.0)	Medium Stiff to Stiff Brown, Black, and Gray Silty Clay / Clay Loam	122	26	0.39	2.56	0.56
12.0 to 25.0 (601.0 to 588.0)	Medium Stiff to Stiff Brown Silty Clay	126	26	0.39	2.56	0.56
12.0 to 17.0 (601.0 to 596.0) *CB-2 only*	Loose Brown Gravel	121	31	0.32	3.12	0.48
17.0 to 19.5 (596.0 to 593.5) *CB-2 only*	Medium Dense Brown Sandy Clay Loam	127	39	0.22	4.39	0.37
12.0 to 17.0 (601.0 to 596.0) *CB-3 only*	Very Stiff to Hard Brown Silty Clay	140	28	0.36	2.77	0.53
17.0 to 25.0 (596.0 to 588.0) *CB-3 only)*	Very Stiff to Hard Gray Silty Clay	140	28	0.36	2.77	0.53

Table 6b – Lateral Load Resistance Soil Parameters for CB-5

Elevation Range (feet)	Soil Description	Unit Weight γ (pcf)	Friction Angle Φ (degrees)	Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At-Rest Earth Pressure Coefficient (K_o)
	New Engineered Clay Fill	125	25	0.41	2.46	0.58
	New Engineered Granular Fill	125	30	0.33	3.00	0.50
0.5 to 3.5 (608.5 to 605.5)	Medium Stiff Brown and Dark Brown Silty Clay	123	26	0.39	2.56	0.56
3.5 to 6.0 (605.5 to 603.0)	Stiff Brown Silty Clay	132	26	0.39	2.56	0.56
6.0 to 18.5 (603.0 to 590.5)	Soft to Medium Stiff Brown Clay Loam	123	26	0.39	2.56	0.56
18.5 to 25.0 (590.5 to 584.0)	Medium Dense to Extremely Dense Brown Sandy Clay Loam	128	42	0.19	5.04	0.33

4.4 Slope Stability

IDOT requires that slope stability analysis be performed in areas where the cut or fill heights will exceed 15 feet in height. Based on the design information provided by Collins on 03/27/2024, the roadway grade change will be approximately 17 feet higher at the 6’ x 6’ RCB culvert (SN 016-8370) location, and the grade change will be approximately 3 feet higher at the 4’ x 3’ RCB culvert location. The culverts will be installed below the new embankment and proposed retaining wall along IL 171. The slope stability analyses for the new embankment and retaining wall are included in the Roadway Geotechnical Report and Retaining Wall Structural Geotechnical Report.

4.5 Drainage Recommendation

The wingwalls of the culvert should be designed to prevent the buildup of hydrostatic forces behind the wall. This can be done with the construction of a base drain and back drain to collect and remove surface water away from the face of the retaining wall. Geocomposite Wall Drain or open grade stone with a geotextile fabric system should be placed over the entire length of the back face of the wall. If a drain cannot be installed behind the wall, hydrostatic pressures should be accounted for with the lateral design of the wingwall.

4.6 Ground Improvement Recommendation

It is anticipated that the proposed embankment height of 17 feet at the 6' x 6' RCB culvert (SN 016-8370) will lead to total settlement greater than 1 inch. Based on the anticipated settlements noted in **Table 5,** additional ground modification should also be considered. The installation of rammed aggregate piers, stone columns or rigid inclusions below the culvert bottom could be considered to stabilize the site, minimize long term settlement and provide a higher allowable bearing capacity for support of the proposed culvert structure. Additional ground improvement would be necessary for only a portion of the culvert where additional bearing resistance is necessary and excessive settlement is anticipated. Based on the engineering analysis, the ground improvements are recommended at the 6' x 6' RCB culvert (SN 016-8370) from the north edge of the proposed embankment widening and extending past boring CB-03.

Aggregate columns can also act as wick drains in accelerating drainage at the site and decrease the time frame for consolidation settlement. Typical column diameters range from 18 to 36 inches and, in general, are most economical for sites requiring column lengths less than 35 feet deep and preferably about 20 feet deep below the surface, such as this site.

Rigid inclusions (RIs) are columns of grout used to reinforce the ground to increase bearing resistance and reduce settlement of a structure or embankment. Rigid Inclusions are constructed with an auger displacement tool or vibrated pipe tool that displaces soil laterally, producing very little spoils. Grout mixes for rigid inclusions shall consist of Portland cement, sand, and water, and may also contain coarse aggregate, a mineral admixture and/or approved fluidifier. Geogrid or geotextile and reinforcing steel can also be used to increase the strength of the inclusions. Typical inclusion diameters range from 12 to 18 inches. The rigid inclusions reinforce the soil rather than function as distinct structural elements or piles. The improved ground has increased stiffness and therefore improved settlement and bearing characteristics.

In addition to the stone columns or rigid inclusions, a load transfer layer consisting of compacted material with geogrid reinforcement would be necessary to transfer the embankment load to the columns. The embankment construction and fill placement could then be completed after the installation of the columns and the load transfer layer.

This site improvement technique would provide a stable platform for construction of the embankment by transferring the embankment loads to the lower medium dense to extremely dense granular materials and limit the influence on the compressible materials. Based on the subsurface conditions the stone columns should be designed to bear within the medium dense to extremely dense granular soils approximately 26 feet below the existing native grade as noted in the retaining wall SGR report, in accordance with *GBSP 71-Aggregate Column Ground Improvement* provided within the IDOT guidelines.

The installation of this ground improvement method could have significant initial costs for the project; however, there would be limited impact on the construction schedule, and little to no long-term maintenance costs.

5.0 CONSTRUCTION CONSIDERATIONS

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Construction (2016), the IDOT Culvert Manual (2017) and the IDOT Subgrade Stability Manual (2005). Any deviation from the requirements in the manuals above should be approved by the design engineer.

5.1 Site Preparation

Any topsoil encountered during construction should be stripped and stockpiled as per Section 211.03 of the IDOT Standard Specifications for Construction. The topsoil should be separated from other materials being stockpiled onsite for reuse or haul off. Base coarse aggregate encountered at the site should be evaluated to determine suitability for reuse as general fill. The contractor should not mix the existing base course materials, if any, with existing subgrade soils during the stripping and stockpiling activities. The subgrade below the base course should be evaluated in accordance with the Pavement Subgrade Preparation section of this report.

5.2 Foundation Preperation for Box Culverts

The foundation soil requirements for a culvert barrel vary depending on the size of the culvert, the fill height above the culvert, the current foundation soil loading, and whether the culvert is pre-cast or cast-in-place. Foundation soils supporting culvert wing walls on spread footings have specific strength requirements based on the applied loadings. Since the conditions encountered upon excavation can differ, the District Geotechnical Engineer and Field Construction Engineer may need to extend or reduce the limits to address the "as encountered conditions". Unless otherwise noted, the limits and depth of removal and replacement should not be significantly altered by the inspector.

5.3 Site Excavation

Site excavations are expected to encounter various types of soils as described in the Subsurface Exploration section of this report. The contractor will be responsible to provide a safe excavation during the construction activities of the project. All excavations should be conducted in accordance with applicable federal, state, and local safety regulations, including, but not limited to the Occupational Safety and Health Administration (OSHA) excavation safety standards. Excavation stability and soil pressures on temporary shoring are dependent on soil conditions, depth of excavations, installation procedures, and the magnitude of any surcharge loads on the ground surface adjacent to the excavation. Excavation near existing structures and underground utilities should be performed with extreme care to avoid undermining existing structures. Excavations should not extend below the level of adjacent existing foundations or utilities unless underpinning or other support is installed. It is the responsibility of the contractor for field determinations of applicable conditions and providing adequate shoring (if needed) for all excavation activities.

5.4 Scour Considerations

The design scour elevation should be taken at the bottom of the cutoff walls. To help prevent local erosion, it is recommended to place stone riprap at the end of the culverts. This will help prevent sediments from entering and accumulating in the culvert, reduce long term maintenance, and provide protection to the streambed at the interface.

Unsuitable materials are generally replaced with aggregate when soil strength and groundwater conditions dictate. A special provision for Aggregate Subgrade Improvement or Rockfill should be included in the plans to indicate the replacement material properties and capping requirements.

5.5 Borrow Material and Compaction Requirements

If borrow material is to be used for onsite construction, it should conform to Section 204 "Borrow and Furnish Excavations" of the IDOT Construction Manual (2021). The fill material should be free of organic matter and debris and should be placed and compacted in accordance with Section 205, Embankment, of the IDOT Construction Manual. Earth-moving operations should be avoided during excessively cold or wet weather to avoid freezing or softening of subgrade soils. All backfill materials around the culvert must be pre-approved by the site engineer. Backfill materials for undercut areas beneath the culvert should be placed in 8 inches loose lifts and should be compacted to 95% of the maximum dry density as determined by AASTHO T-180, Modified Proctor Method.

5.6 Groundwater Management

It is anticipated that the long-term groundwater level may be at an elevation between 595.5 feet to below the depth of the borings. Water may be perched in the confined granular layers. GSG anticipates that groundwater related issues may occur during construction activity due to the extent of the proposed improvements for the culverts and the anticipated time frame for the excavation construction. If rainwater run-off or groundwater is accumulated at the base of excavations, the contractor should remove accumulated water using conventional sump pit and pump procedures and maintain a dry and stable excavation. The location of the sump should be determined by the contractor based on field conditions. During earthmoving activities at the site, grading should be performed to ensure that drainage is maintained throughout the construction period. Water should not be allowed to accumulate in the foundation area either during or after construction. Undercut and excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater or surface run-off. Grades should be sloped away from the excavations to minimize runoff from entering.

If water seepage occurs during the excavations on the shorelines or where wet conditions are encountered such that the water cannot be removed with conventional sumping, we recommend placing open grade stone similar to IDOT CA-7 to stabilize the bottom of the excavation below the water table. The CA-7 stone should be placed 12 inches above the water table, in 12-inch lifts, and should be compacted with the use of a heavy smooth drum roller or heavy vibratory plate compactor until stable. The remaining portion of the excavation beneath the footings should be backfilled using approved structural fill.

5.7 Temporary Soil Retention

If stage construction is used for the proposed improvement, temporary sheet piling is feasible because the existing soils strengths are less than 4.5 tsf. The Temporary Soil Retention System (TSRS) should be designed in accordance with the IDOT Bridge Design Manual, Section 3.13.1, Temporary Sheet Piling Design, Temporary Soil Retention Systems and Braced Excavations and the IDOT Design Guide.

6.0 LIMITATIONS

This report has been prepared for the exclusive use of the Illinois Department of Transportation and its consultant team. The recommendations provided in the report are specific to the project described herein and are based on the information obtained from the soil boring locations within the proposed project limits. The analyses performed and the recommendations provided in this report are based on subsurface conditions determined at the location of the borings. This report may not reflect all variations that may occur between boring locations or at some other time, the nature and extent of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations presented herein.

APPENDIX A

GENERAL PLANS, ELEVATIONS, AND DETAILS

Bench Mark: A 2" metal disk in concrete located in grass median at 95th Street and IL Route 171 lying 36' south of south pavement edge along IL Route 171 and 29' northwest of west pavement edge along east leg for 95th Street. Elev. 608.57.

Existing Structure: The existing culvert (SN 016-1406) is a 157' long 6'x6' box culvert. The culvert was extended by an 85' long double 48" reinforced concrete pipes. Under Contract 62B61, a 60" reinforced concrete pipe was installed to prevent collapse.

No Salvage.

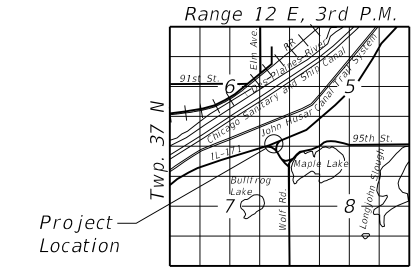
Traffic to be detoured during construction.

Note:
For section A-A, see sheet 3.

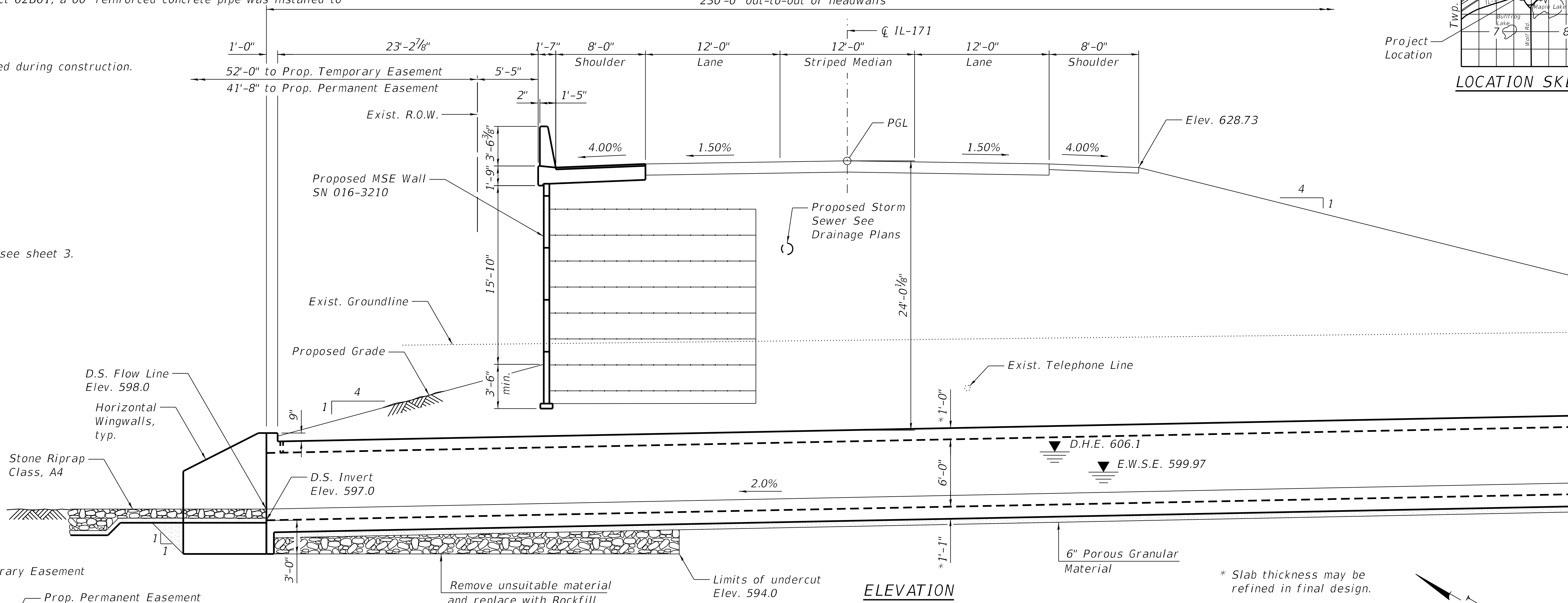
LOADING HL-93
Allow 50 Lb/Sq. Ft. for Future Wearing Surface

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

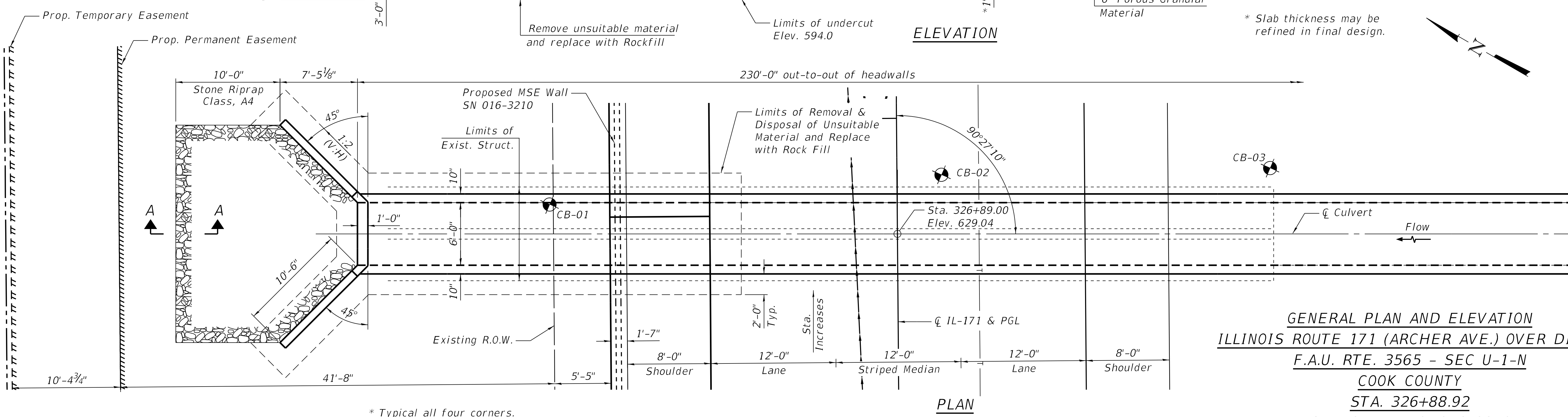
DESIGN SPECIFICATIONS
2020 AASHTO LRFD Bridge Design Specifications, 9th Edition



LOCATION SKETCH



ELEVATION



PLAN

* Typical all four corners.

GENERAL PLAN AND ELEVATION
ILLINOIS ROUTE 171 (ARCHER AVE.) OVER DITCH
F.A.U. RTE. 3565 - SEC U-1-N
COOK COUNTY
STA. 326+88.92
STRUCTURE NO. 016-8370

MODEL: Default
FILE NAME: \\nasuni-ill\IL\data-il\Poseidon\DOCS\13117 - Ames-IDOT IL171 at 95th Street\CADD\CADD_Sheets\D160R94-008-Culvert1.dgn

7/1/2022 3:06:48 PM

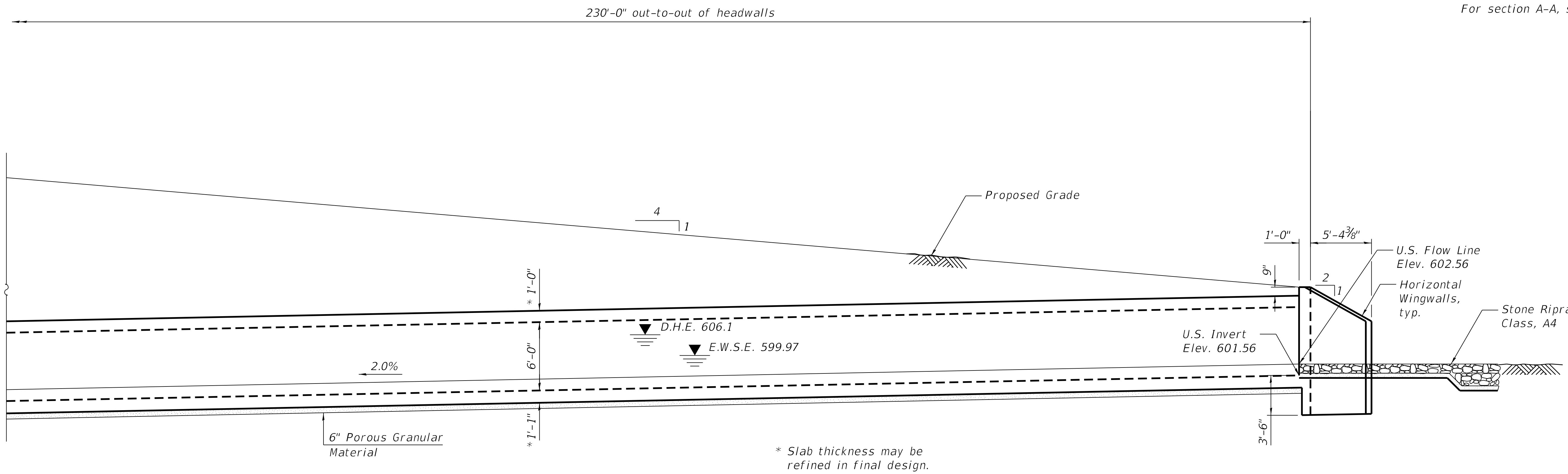
COLLINS ENGINEERS INC.

USER NAME =	DESIGNED - AMS	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
	CHECKED - AMS	REVISED -	
PLOT SCALE =	DRAWN - DR	REVISED -	
PLOT DATE =	CHECKED - AMS	REVISED -	

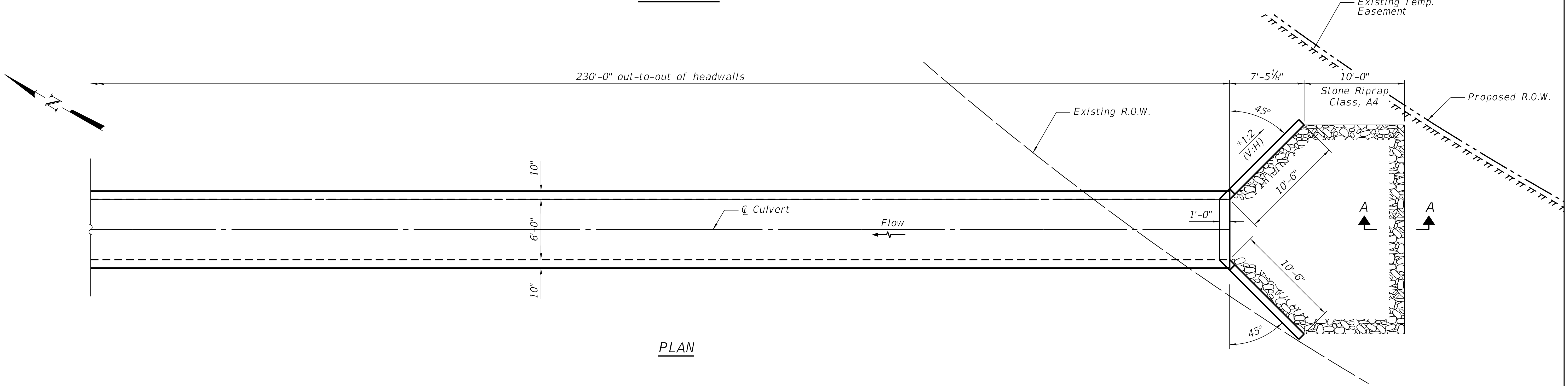
CULVERT PLAN AND ELEVATION I
STRUCTURE NO. 016-8370
SHEET 1 OF 3 SHEETS

F.A.U. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
3565	U-1-N	COOK		6
		CONTRACT NO. 60R94		
	ILLINOIS	FED. AID PROJECT		

Note:
For section A-A, see sheet 3.



ELEVATION



PLAN

GENERAL PLAN AND ELEVATION
ILLINOIS ROUTE 171 (ARCHER AVE.) OVER DITCH
F.A.U. RTE. 3565 - SEC U-1-N
COOK COUNTY
STA. 326+88.92
STRUCTURE NO. 016-8370

COLLINS ENGINEERS INC.	USER NAME =	DESIGNED - AMS	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	CULVERT PLAN AND ELEVATION II STRUCTURE NO. 016-8370	F.A.U. RTE. 3565 · SECTION U-1-N · COUNTY COOK · TOTAL SHEETS · SHEET NO.
		CHECKED - AMS	REVISED -			CONTRACT NO. 60R94
	PLOT SCALE =	DRAWN - DR	REVISED -			
	PLOT DATE =	CHECKED - AMS	REVISED -		SHEET 2 OF 3 SHEETS	ILLINOIS FED. AID PROJECT

MODEL: Default
FILE NAME: \\nasuni-ill\L\data-il\Poseidon\DOCS\13117 - Ames-IDOT IL171 at 95th Street\CADD\CADD_Sheets\D160R94-009-Culvert2.dgn
7/1/2022 2:19:38 PM

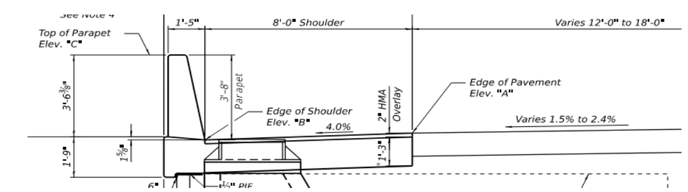
at top of leveling pad

	Station	OFFSET	Top of Mom Slab	FINISHED GRADE	Top of Leveling Pad	Wall Height	Wall Strap length	DC	EV	LS = 240	Service brg pressure	Factored brg pressure
			ELEV.	ELEV.	ELEV.	Ft	ft	psf	psf	psf	psf	psf
	317+80.13	21.08	614.63	614.26	610.76	3.87	8.00	344.0	306.5	240.0	890.5	1,263.7
	318+70.13	21.08	617.27	615.39	611.89	5.37	8.00	344.0	494.7	240.0	1,078.7	1,517.9
	319+08.98	21.08	618.41	615.81	612.31	6.10	8.00	344.0	585.5	240.0	1,169.5	1,640.4
	319+68.88	22.28	619.92	615.81	612.31	7.61	8.00	344.0	774.5	240.0	1,358.5	1,895.6
kink	320+58.87	24.08	622.20	615.67	612.17	10.03	8.00	344.0	1076.2	240.0	1,660.2	2,302.9
	321+49.11	25.91	625.23	615.79	612.29	12.94	9.06	303.9	1440.3	240.0	1,984.1	2,744.2
	322+39.57	27.08	627.33	615.66	612.16	15.17	10.62	259.2	1718.9	240.0	2,218.1	3,064.5
	323+29.86	27.08	628.81	615.05	611.55	17.26	12.08	227.8	1980.3	240.0	2,448.1	3,378.1
	324+20.15	27.08	629.64	614.95	611.45	18.20	12.74	216.1	2097.3	240.0	2,553.4	3,521.5
	324+32.66	27.08	629.71	614.98	611.48	18.22	12.76	215.7	2101.0	240.0	2,556.7	3,526.0
	324+42.69	37.08	629.75	615.01	611.51	18.24	12.77	215.6	2102.8	240.0	2,558.3	3,528.2
kink	324+52.65	37.08	629.78	615.04	611.54	18.25	12.77	215.5	2103.6	240.0	2,559.1	3,529.2
kink	324+62.70	27.08	629.81	615.07	611.57	18.24	12.77	215.5	2103.4	240.0	2,558.9	3,528.9
kink	325+10.44	27.08	629.83	615.09	611.59	18.23	12.76	215.6	2102.0	240.0	2,557.6	3,527.2
kink	325+27.43	27.08	629.79	614.97	611.47	18.32	12.82	214.6	2112.8	240.0	2,567.4	3,540.5
	325+38.04	37.31	629.75	614.89	611.39	18.36	12.85	214.1	2118.1	240.0	2,572.2	3,547.0
kink	325+48.00	37.14	629.71	614.82	611.32	18.39	12.88	213.7	2122.0	240.0	2,575.8	3,551.9
kink	325+57.77	27.08	629.66	614.75	611.25	18.42	12.89	213.5	2124.9	240.0	2,578.4	3,555.5
kink	326+00.73	27.08	629.51	614.44	610.94	18.57	13.00	211.7	2143.9	240.0	2,595.6	3,578.9
kink	326+89.13	27.08	628.45	614.67	611.17	17.27	12.09	227.6	1982.2	240.0	2,449.8	3,380.5
	326+90.73	27.08	628.42	614.68	611.18	17.25	12.07	228.0	1978.5	240.0	2,446.5	3,376.0
culvert	327+80.73	27.08	626.67	614.56	611.06	15.61	10.93	251.8	1774.2	240.0	2,266.1	3,130.0
	328+70.73	27.08	624.28	613.88	610.38	13.90	9.73	282.8	1560.8	240.0	2,083.6	2,880.6
	329+60.73	27.08	621.51	613.03	609.53	11.97	8.38	328.3	1319.8	240.0	1,888.1	2,612.1
	330+28.12	27.08	619.43	612.68	609.18	10.25	8.00	344.0	1103.6	240.0	1,687.6	2,339.8
	330+58.12	26.81	618.51	612.71	609.21	9.31	8.00	344.0	986.2	240.0	1,570.2	2,181.4
kink	331+48.10	24.68	616.11	612.54	609.04	7.07	8.00	344.0	706.1	240.0	1,290.1	1,803.2
	332+38.08	22.88	614.36	612.41	608.91	5.44	8.00	344.0	503.5	240.0	1,087.5	1,529.8
	333+27.91	21.08	613.22	612.55	609.05	4.17	8.00	344.0	344.4	240.0	928.4	1,314.9

Table 3 - LRFD Load Factors for Retaining Wall Analyses

	Type of Load	Sliding and Eccentricity Strength	Bearing Resistance Strength I	Sliding and Eccentricity Extreme II	Bearing Resistance Extreme II	Settlement Service I
Load Factors for Vertical Loads	Dead Load of Structural Components (DC)	0.90	1.25	1.00	1.00	1.00
	Vertical Earth Pressure Load (EV)	1.00	1.35	1.00	1.00	1.00
	Earth Surcharge Load (ES)		1.50			
	Live Load Surcharge (LS)		1.75		0.50	1.00

DC	1.25
EV	1.35
LS	1.75



unit weight of concrete = 150 pcf
unit weight of soil = 125 pcf

	Thickness	Width	per 1 ft		
Moment slab weight =	1.4167	9.583	1	2036.39	lbs / ft
Weight of parapet=	1.416667	3.666667	1	779.17	lbs / ft
0.5 x	-0.70833	3.666667	1	-194.79	lbs / ft
coping	0.5	1.75	1	131.25	lbs / ft
			total weight =	2752.01	lbs / ft

/ wall strap length

EV = (wall height-slab thickness) x unit weight of soil (lb/sf)

0.22439

APPENDIX B

SOIL BORING LOCATION PLAN

AND SUBSURFACE PROFILES

MODEL: Default
FILE NAME: T:\Illinois DOT\Ames Engineering_163-17\Geotechnical\Exhibits\DGNs\IDOT AMES PTB 163-017 IL 171 & 95th Street-PL-01.dgn

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

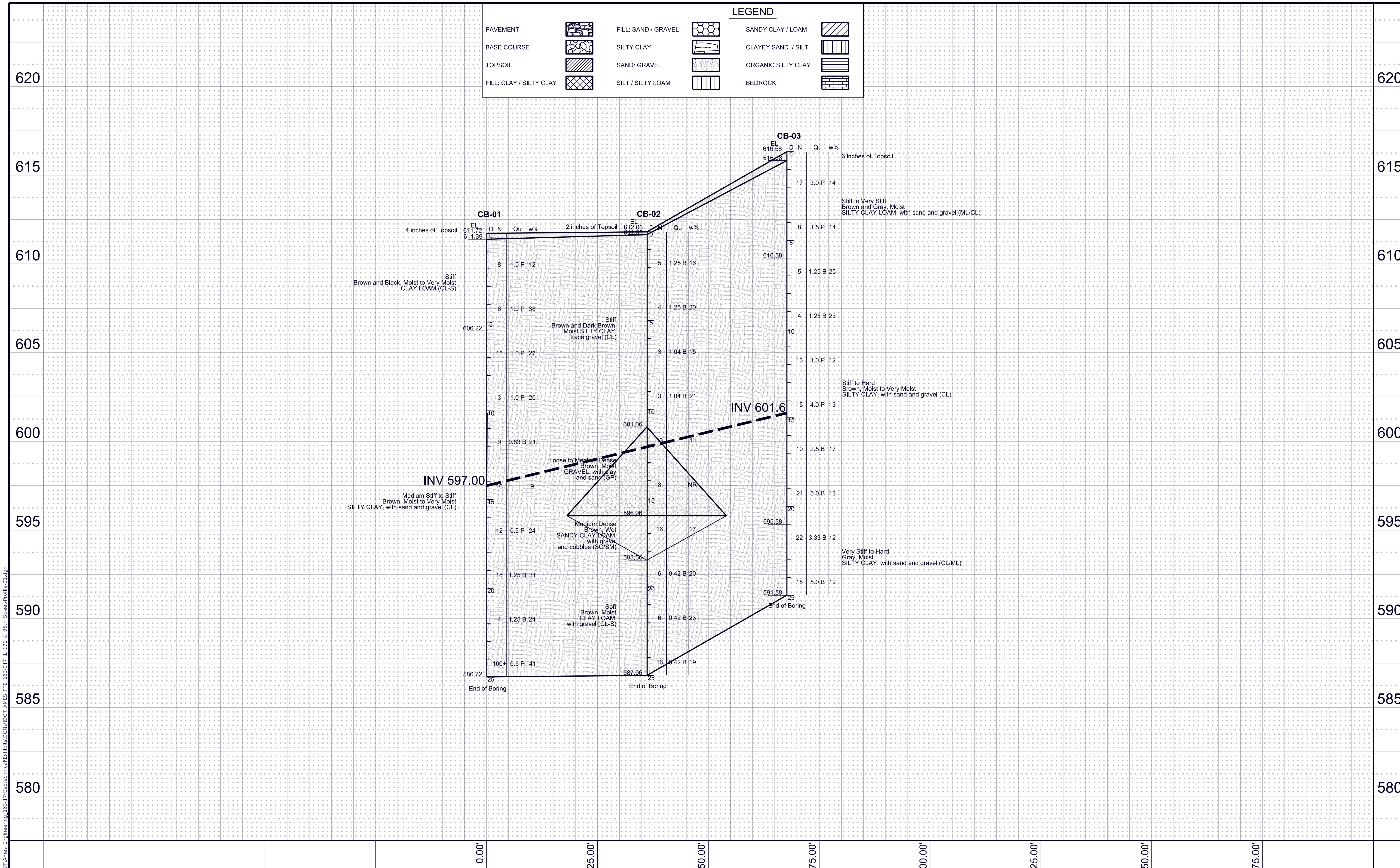
USER NAME = nnano	DESIGNED - ES	REVISED -	
	DRAWN - NN	REVISED -	
PLOT SCALE = 1200.0000 ' / ft.	CHECKED - DE	REVISED -	
PLOT DATE = 8/13/2021	DATE - 08/13/2021	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

IDOT AMES PTB 163–017
IL 171 & 95TH STREET –
REINFORCED CONCRETE BOX CULVERTS BORING LOCATION PLAN

SCALE: 1:50 | SHEET 1 OF 1 SHEETS | STA. | TO STA.

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
		COOK	1	1
		CONTRACT NO. 163-017		
	ILLINOIS	FED. AID PROJECT		



MODEL: Default
FILE NAME: T:\Illinois DOT\Ames Engineering 163-17\Geotechnical\Exhibits\DGN\IDOT AMES PTB 163-017 IL 171 & 95th Street-Profile-01.dgn

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

USER NAME = nnano	DESIGNED - ES	REVISED -	
	DRAWN - NN	REVISED -	
PLOT SCALE = 240.0000 ' / ft.	CHECKED - DE	REVISED -	
PLOT DATE = 9/14/2021	DATE - 09/14/2021	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

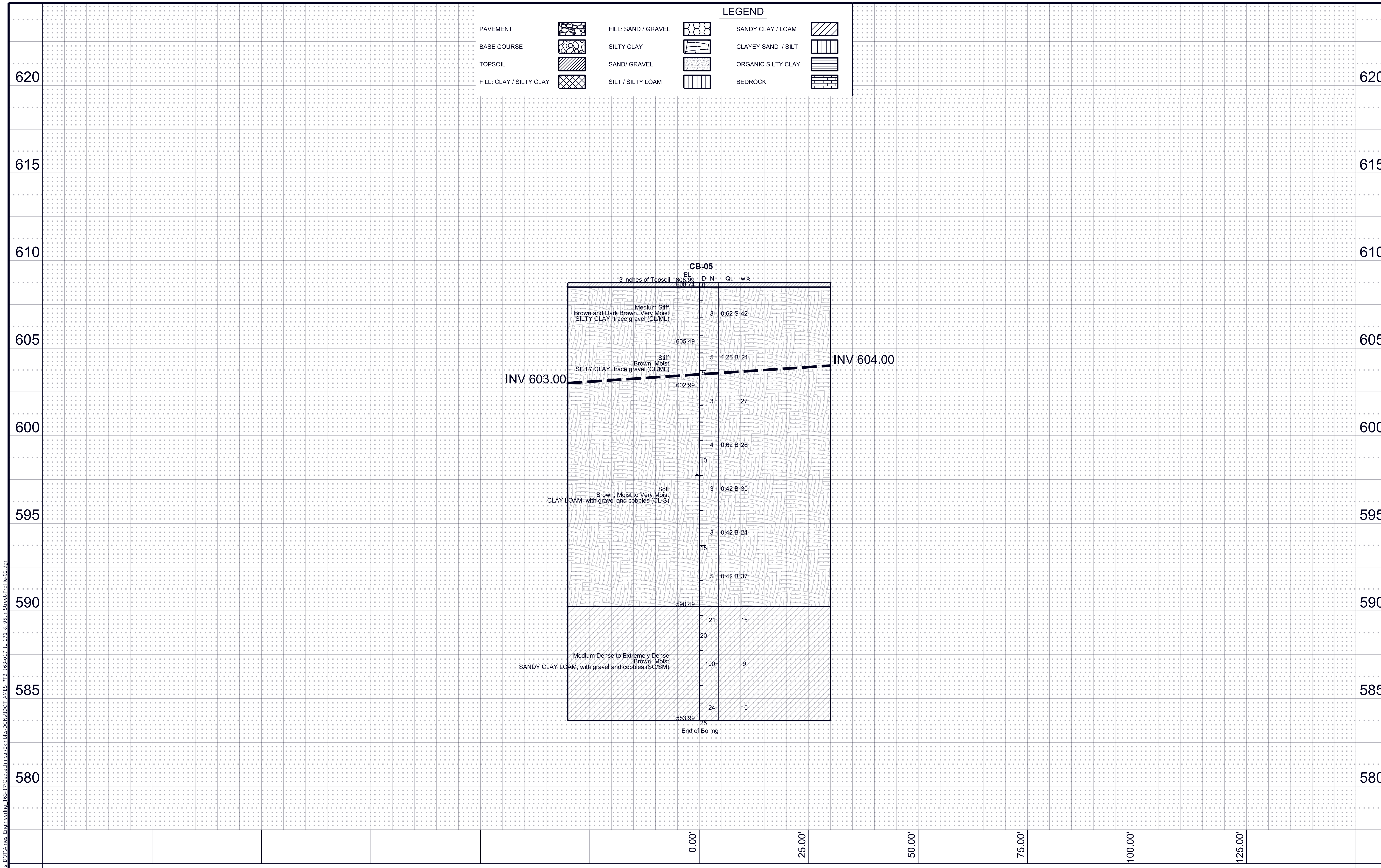
IDOT AMES PTB 163–017
IL 171 & 95TH STREET
6'x6' RCB CULVERT BORING PROFILE

SCALE: AS NOTED | SHEET 1 OF 2 SHEETS | STA. TO STA.

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
		COOK	3	2

CONTRACT NO. 163-017

ILLINOIS | FED. AID PROJECT



MODEL: Default
FILE NAME: T:\Illinois DOT\Ames Engineering 163-17\Geotechnical\Exhibits\DGN\IDOT AMES PTB 163-017 IL 171 & 95th Street-Profile-02.dgn

GSG CONSULTANTS, INC.
735 E. REMINGTON RD, SCHAUMBURG, IL 60173
TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM

USER NAME = nnano	DESIGNED - ES	REVISED -	
	DRAWN - NN	REVISED -	
PLOT SCALE = 240.0000 ' / ft.	CHECKED - DE	REVISED -	
PLOT DATE = 9/14/2021	DATE - 09/14/2021	REVISED -	

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

IDOT AMES PTB 163–017
IL 171 & 95TH STREET
4'x3' RCB CULVERT BORING PROFILE

SCALE: AS NOTED | SHEET 2 OF 2 SHEETS | STA. | TO STA.

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
		COOK	3	3

CONTRACT NO. 163-017

ILLINOIS | FED. AID PROJECT

APPENDIX C

SOIL BORING LOGS

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 6/11/21

ROUTE 95th Street **DESCRIPTION** Culvert Boring **LOGGED BY** EH

SECTION IL 171 & 95th Street **LOCATION** IL 171, **SEC.** 22, **TWP.** 37N, **RNG.** 12E, **Latitude** 41.7171126, **Longitude** -87.897224

COUNTY COOK **DRILLING RIG** CME-75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 91

STRUCT. NO. SN 016-8370
Station 326+89.13

BORING NO. CB-01
Station 326+36.85
Offset 31.99ft RT
Ground Surface Elev. 611.72 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
4 inches of Topsoil	611.39				
Stiff Brown and Black, Moist to Very Moist CLAY LOAM (CL-S)			6 2 6	1.0 P	12
			3 2 4	1.0 P	38
	606.22	-5			
Medium Stiff to Stiff Brown, Moist to Very Moist SILTY CLAY, with sand and gravel (CL)			6 6 9	1.0 P	27
		-10	1 2 1	1.0 P	20
			7 5 4	0.8 B	21
Cobbles at 13.5-15 feet		-15	11 9 7		9
			4 4 8	0.5 P	24
		-20	9 9 9	1.3 B	31

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium Stiff to Stiff Brown, Moist to Very Moist SILTY CLAY, with sand and gravel (CL) *(continued)*			2 2 2	1.3 B	24
Cobbles at 23.5-25 feet	586.72	-25	50/6"	0.5 P	41
End of Boring					
		-30			
		-35			
		-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation

Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 6/21/21

ROUTE 95th Street **DESCRIPTION** Culvert Boring **LOGGED BY** JB

SECTION IL 171 & 95th Street **LOCATION** IL 171, **SEC.** 22, **TWP.** 37N, **RNG.** 12E,
Latitude 41.7170257, **Longitude** -87.8971602

COUNTY COOK **DRILLING RIG** Diedrich D-50 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 92

STRUCT. NO. SN 016-8370
Station 326+89.13

BORING NO. CB-02
Station 326+40.13
Offset 67.99ft RT
Ground Surface Elev. 612.06 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
2 inches of Topsoil	611.90				
Stiff Brown and Dark Brown, Moist SILTY CLAY, trace gravel (CL)			2 2 3	1.3 B	16
		-5	2 2 2	1.3 B	20
			1 1 2	1.0 B	15
	601.06	-10	1 1 2	1.0 B	21
Loose to Medium Dense Brown, Moist GRAVEL, with clay and sand (GP)			3 5 8		11
No recovery at 13.5-15 feet	596.06	-15	3 3 5		NR
Medium Dense Brown, Wet SANDY CLAY LOAM, with gravel and cobbles (SC/SM)	593.56		6 11 5		17
Soft Brown, Moist CLAY LOAM, with gravel (CL-S)		-20	2 3 3	0.4 B	20
Soft Brown, Moist CLAY LOAM, with gravel (CL-S) *(continued)*			2 2 4	0.4 B	23
	587.06	-25	4 7 9	0.4 B	19
End of Boring		-30			
		-35			
		-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 6/17/21

ROUTE 95th Street **DESCRIPTION** Culvert Boring **LOGGED BY** EH

SECTION IL 171 & 95th Street **LOCATION** IL 171, **SEC.** 22, **TWP.** 37N, **RNG.** 12E, **Latitude** 41.7169469, **Longitude** -87.8971126

COUNTY COOK **DRILLING RIG** Diedrich D-50 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 92

STRUCT. NO. SN 016-8370
Station 326+89.13

BORING NO. CB-03
Station 326+40.52
Offset 99.53ft RT
Ground Surface Elev. 616.58 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter None ft
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6 inches of Topsoil	616.08				
Stiff to Very Stiff Brown and Gray, Moist SILTY CLAY LOAM, with sand and gravel (ML/CL)			5 / 8 / 9	3.0 P	14
		-5	4 / 4 / 4	1.5 P	14
	610.58				
Stiff to Hard Brown, Moist to Very Moist SILTY CLAY, with sand and gravel (CL)			2 / 2 / 3	1.3 B	25
		-10	2 / 2 / 2	1.3 B	23
			4 / 7 / 6	1.0 P	12
		-15	6 / 7 / 8	4.0 P	13
			4 / 5 / 5	2.5 B	17
		-20	6 / 9 / 12	5.0 B	13

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	595.58				
Very Stiff to Hard Gray, Moist SILTY CLAY, with sand and gravel (CL/ML)			7 / 11 / 11	3.3 B	12
	591.58	-25	6 / 8 / 10	5.0 B	12
End of Boring					
		-30			
		-35			
		-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

BBS, form 137 (Rev. 8-99)

Illinois Department of Transportation
Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 6/21/21

ROUTE 95th Street **DESCRIPTION** Culvert Boring **LOGGED BY** JB

SECTION IL 171 & 95th Street **LOCATION** IL 171, **SEC.** 22, **TWP.** 37N, **RNG.** 12E, **Latitude** 41.7178301, **Longitude** -87.894705

COUNTY COOK **DRILLING RIG** Diedrich D-50 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 92

STRUCT. NO. N/A
Station N/A

BORING NO. CB-05
Station 333+71.69
Offset 68.07ft RT
Ground Surface Elev. 608.99 ft

Surface Water Elev. N/A ft
Stream Bed Elev. N/A ft

Groundwater Elev.:
First Encounter 598.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
3 inches of Topsoil	608.74				
Medium Stiff Brown and Dark Brown, Very Moist SILTY CLAY, trace gravel (CL/ML)			1 1 2	0.6 S	42
	605.49				
Stiff Brown, Moist SILTY CLAY, trace gravel (CL/ML)		-5	2 2 3	1.3 B	21
	602.99				
Soft Brown, Moist to Very Moist CLAY LOAM, with gravel and cobbles (CL-S) Little recovery at 6-7.5 feet			5 1 2		27
		-10	1 2 2	0.6 B	28
▼ Silt seam at 12 feet			1 1 2	0.4 B	30
Silt and sand seam at 14.5 feet		-15	1 1 2	0.4 B	24
			2 2 3	0.4 B	37
	590.49				
		-20	6 7 14		15
Medium Dense to Extremely Dense Brown, Moist SANDY CLAY LOAM, with gravel and cobbles (SC/SM) *(continued)*			21 28 50/1"		9
	583.99	-25	12 10 14		10
End of Boring					
		-30			
		-35			
		-40			

The Unconfined Compressive Strength (UCS) Failure Mode is indicated by (B-Bulge, S-Shear, P-Penetrometer)
The SPT (N value) is the sum of the last two blow values in each sampling zone (AASHTO T206)

APPENDIX D

LABORATORY TEST RESULTS

GSG CONSULTANTS, INC.

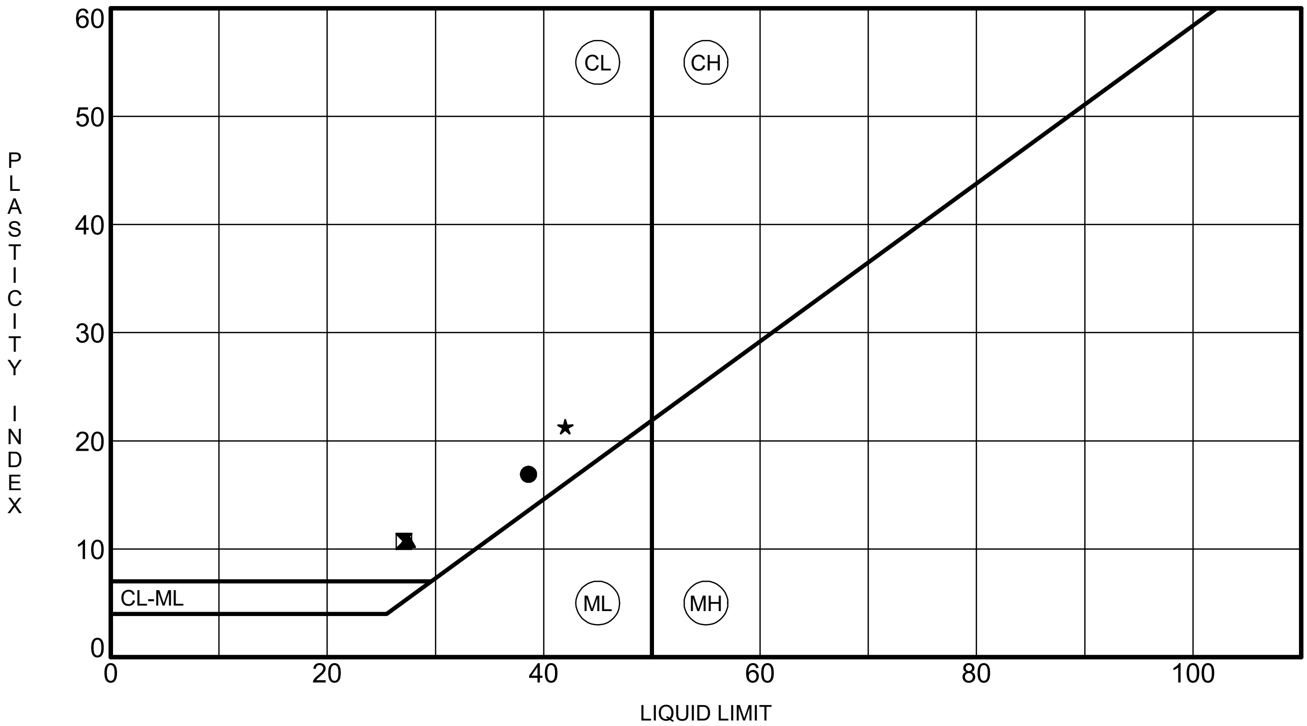
735 Remington Road
Schaumburg, IL 60173
Tel: 630.994.2600
www.gsg-consultants.com

Table D1 – Atterberg Limits Test Results

Boring ID	Sample Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Soil Classification
CB-01	11-12.5	39.0	22.0	17.0	CL
CB-02	6-7.5	27.0	16.0	11.0	CL
CB-03	16-17.5	27.0	17.0	10.0	CL
CB-05	11-12.5	42.0	21.0	21.0	CL

Table D2 – PTB 163-17 Test Results – Dry Unit Weight

Boring ID	Sample Depth (ft)	Dry Unit Weight (pcf)	Wet Unit Weight (pcf)	Soil Classification
CB-01	6-7.5	96.0	122.0	CL
CB-03	16-17.5	119.8	140.2	CL
CB-05	11-12.5	95.1	123.6	CL-S



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**CB-01**	**11.00**	**38.6**	**21.7**	**16.9**		
⧗	**CB-02**	**6.00**	**27.1**	**16.4**	**10.7**		
▲	**CB-03**	**16.00**	**27.4**	**16.6**	**10.8**		
★	**CB-05**	**11.00**	**42.0**	**20.7**	**21.3**		

GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

ATTERBERG LIMITS' RESULTS

Route: IL 171

Section: IL 171 & 95th Street

County: COOK

APPENDIX E

SOIL PARAMETER TABLES

Table E1 –Soil Parameters Table

(CB-1, CB-2, and CB-3)

Elevation Range (feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained	
			Cohesion c (psf)	Friction Angle ϕ (°)	Cohesion c (psf)	Friction Angle ϕ (°)
	New Engineered Clay Fill	125	1,000	0	50	25
	New Engineered Granular Fill	125	0	30	0	30
0.5 to 12.0 (612.5 to 601.0)	Medium Stiff to Stiff Brown, Black, and Gray Silty Clay / Clay Loam	122	1,000	0	100	26
12.0 to 25.0 (601.0 to 588.0)	Medium Stiff to Stiff Brown Silty Clay	126	750	0	75	26
12.0 to 17.0 (601.0 to 596.0) *CB-2 only*	Loose Brown Gravel	121	0	31	0	31
17.0 to 19.5 (596.0 to 593.5) *CB-2 only*	Medium Dense Brown Sandy Clay Loam	127	0	39	0	39
12.0 to 17.0 (601.0 to 596.0) *CB-3 only*	Very Stiff to Hard Brown Silty Clay	140	3,900	0	390	28
17.0 to 25.0 (596.0 to 588.0) *CB-3 only)*	Very Stiff to Hard Gray Silty Clay	140	4,000	0	400	28

Table E2 –Soil Parameters Table

(CB-5)

Elevation Range (feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained	
			Cohesion c (psf)	Friction Angle ϕ (°)	Cohesion c (psf)	Friction Angle ϕ (°)
	New Engineered Clay Fill	125	1,000	0	50	25
	New Engineered Granular Fill	125	0	30	0	30
0.5 to 3.5 (608.5 to 605.5)	Medium Stiff Brown and Dark Brown Silty Clay	123	600	0	60	26
3.5 to 6.0 (605.5 to 603.0)	Stiff Brown Silty Clay	132	1,250	0	125	26
6.0 to 18.5 (603.0 to 590.5)	Soft to Medium Stiff Brown Clay Loam	123	400	0	40	26
18.5 to 25.0 (590.5 to 584.0)	Medium Dense to Extremely Dense Brown Sandy Clay Loam	128	0	42	0	42