Structural Geotechnical Report

Bridge SN: 099-4666
I-55 at IL 59 Interchange from North of I-80 to US 52 Phase II
IDOT PTB 189-011
Will County, Illinois

Prepared for

Illinois Department of Transportation (IDOT)
Contract Number: D-91-368-18

Project Design Engineer Team
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Geotechnical Consultant:
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August 10, 2020

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August 10, 2020

Mr. Kurt Naus, P.E., S.E.
Alfred Benesch & Company
1230 East Diehl Rd. Suite 109
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Structural Geotechnical Report
Bridge SN: 099-4666
IDOT PTB 189-011

Dear Mr. Naus:

Attached is a copy of the Structural Geotechnical Report for the above referenced project. This report provides a brief description of the site investigation, site conditions, foundation and construction recommendations for the bridge and abutment MSE retaining walls for Bridge SN: 099-4666. The site investigation included advancing eight (8) soil borings to depths between 15 and 38 feet. Eleven (11) borings were performed by GSG Consultants as part of the Phase II investigation and three (3) boring were performed by others as part of the Phase I study for the project.

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

Sincerely,

Suhaib Ibrahim
Project Engineer

Ala E Sassila, Ph.D., P.E.
Principal

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1.0 INTRODUCTION

This report pertains to the proposed bridge (SN: 099-4666), which will carry IL-59 northbound over I-55, and the MSE walls at the east and west abutments of the bridge. GSG Consultants, Inc. (GSG) completed a geotechnical investigation for the Phase II design of the bridge and the east and west abutments MSE walls (Station 265+02.29 and 268+74.30 for the east wall, and Station 269+01.28 and 271+55.70 for the west wall) in the Village of Shorewood, Will County, Illinois. The purpose of this Phase II site investigation was to explore the subsurface conditions along the entire proposed structure locations, to determine engineering properties of the subsurface soil, and to develop final design and construction recommendations for the bridge and abutment MSE walls.

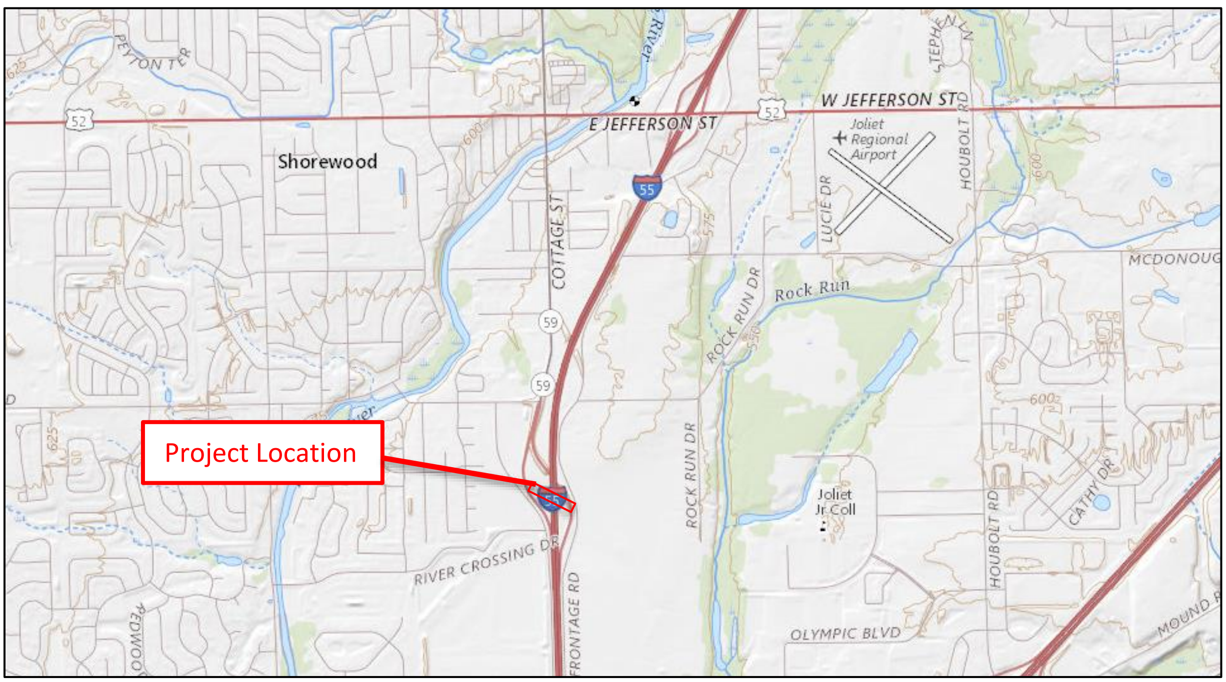


Exhibit 1 – Project Location Map
(Source: USGS Topographic Maps, usgs.gov)

The general scope of the overall project is the conversion of a partial access interchange to a full access interchange at I-55 and IL 59. This will include the construction of a Diverging Diamond Interchange (DDI) and associated auxiliary lanes at the intersection of I-55 and IL 59. Two new ramps are proposed to provide access and include a southbound exit and northbound entrance from/to I-55. An auxiliary lane between IL 59 and US 52, along I-55, is also proposed in each direction along the mainline. In proximity to the DDI, the existing I-55 East Frontage Road will be realigned further east.

1.1 Existing Site Conditions

The proposed bridge, and the east and west abutment MSE retaining walls will be located south of the existing bridge for IL 59 southbound over I-55. The area where the proposed improvements are to be built is on existing IDOT right-of-way (ROW) and consists of the unoccupied lands on the east and west sides of I-55. **Exhibit 2** shows the existing conditions where the proposed retaining walls will be constructed.

Exhibit 2a – Existing Site Conditions at Proposed East Wall Location, Looking North

Exhibit 2b – Existing Site Conditions at Proposed West Wall Location, Looking North

1.2 Proposed Bridge and Retaining Wall Information

As part of the Phase I design, Wang Engineering provided a preliminary structural geotechnical report for Bridge SN 099-4666 based on the preliminary plan and profiles and cross section, provided by IDOT in October 2018. Three (3) borings were completed to depths of 33.5 to 38 feet, including rock cores, at the proposed north abutment, south abutment and center pier locations. Geotechnical evaluation and preliminary recommendations were provided for the approach embankments and substructure foundations of the bridge. Recommendations for both driven pile and drilled shafts were provided.

Based on the final General Plan and Elevation (GP&E) for the bridge dated May 11, 2020 (**Appendix A**), the proposed bridge will be a two-span structure with a skew of 54°59'50", supported on drilled shafts socketed into rock. The bridge will have a total back-to-back of abutment length of 330'-3'' and out-to-out width of 58'-2". Both abutments will be wrapped with MSE walls, which will then extend beyond the proposed wingwalls. The proposed wingwalls will be constructed below the approach slabs and are anticipated to be concrete cantilever walls. The wingwalls are also anticipated to be supported on drilled shafts. The new MSE walls to be constructed north of each abutment will tie into the wingwalls of the existing bridge (SN 099-4642).

Based on the design information and drawings provided by Benesch (dated May 11, 2020), the proposed improvements will also include the construction of retaining walls under the bridge abutments and on the north and south sides of the bridge abutments. The proposed retaining walls will mainly have “fill” sections and MSE walls are considered. **Table 1** presents a summary of the proposed walls.

Table 1 –Retaining Wall Summary

Wall Name	Wall Stations*	Proposed Wall Type	Approximate Length (ft)	Maximum Anticipated Retained Wall Height (ft)
East Wall	265+02.29 and 268+74.30	MSE	321	22.6
West Wall	269+01.28 and 271+55.70	MSE	374	23.0

2.0 SITE SUBSURFACE EXPLORATION PROGRAM

This section describes the subsurface exploration program and laboratory testing program completed. GSG advanced four soil borings for the MSE walls as part of Phase II investigation, and utilized the subsurface soil data from three (3) soil borings completed by Wang for the bridge during the project Phase I study. The proposed locations and depths of the soil borings were selected in accordance with IDOT requirements and were coordinated with Benesch based on available design information at the time of the field activities. The boring locations were selected in the field based on field conditions and accessibility. as part of Phase II design of this project.

2.1 Subsurface Exploration Program

Borings for the east wall were completed between November 10 and November 20, 2019. The Phase II exploration program included advancing three (3) standard penetration test (SPT) borings at locations along the length of the proposed wall and the nearby subgrade locations.

Borings for the west wall were completed between November 22 and November 23, 2019. The Phase II exploration program included advancing three (3) standard penetration test (SPT) borings at locations along the length of the proposed wall and the nearby subgrade locations.

Borings for the bridge were completed by Wang (SB-01 through SB-03). The as-drilled locations of the soil borings are shown on the Soil Boring Location Map and Subsurface Profile (**Appendix B**). **Table 2** presents a list of the borings used for the proposed analysis.

Table 2 – Summary of Subsurface Exploration Borings

	Boring ID	Station	Offset (ft)/ Direction	Depth (ft)	Surface Elevation (ft)	Top of Bedrock Elevation (ft)
Bridge	SB-01*	NA	NA	36.5	593.6	572
	SB-02*	NA	NA	33.5	593.1	571
	SB-03*	NA	NA	38.0	594.8	572
East Wall	BSB-01	265+91.6	108.9 RT	21.0	591.5	571
	SGB-87	266+46.7	142.2 RT	15.0	590.3	NA
	SB-03*	267+41.4	55.5 RT	38.0	594.8	572
	BSB-02	267+93.1	97.3 RT	21.5	592.2	572
West Wall	BSB-03	269+16.2	130.2 LT	19.0	592.0	573
	SB-01*	269+89.7	51.7 LT	36.5	593.6	572
	SGB-90	270+59.0	149.0 LT	15.0	594.7	NA
	BSB-04	271+26.7	100.5 LT	22.0	595.0	573

* Boring drilled by Wang Engineering

GSG's soil borings were drilled using truck-mounted Diedrich D-50 drill rig 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 termination depth. 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.

Wang collected one (1) rock core sample from each boring, SB-01 and SB-03. Bedrock cores were obtained from the borings in either 5- or 10-foot runs with an NWD4-sized core barrel. Photographs of each bedrock core are attached in **Appendix C**.

2.2 Laboratory Testing Program

For the borings performed by GSG, 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 in the area of the proposed walls. 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
- Organic Content ASTM D7348 / AASHTO T-267
- Dry Unit Weight ASTM D7263

The laboratory tests on the borings drilled by GSG were performed in accordance with test procedures outlined in the IDOT Geotechnical Manual (2015), 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 Soil Conditions

This section provides a brief description of the soils encountered in the borings performed in the vicinity of the proposed retaining walls. Detailed descriptions of the subsurface soils are provided in the Soil Boring Logs (**Appendix C**). 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). Its assumed that 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. The subsurface soil condition for the bridge pier can be found in Wang's report (**Appendix H**).

East Wall

Borings SGB-87, BSB-01 and BSB02 were drilled in the grass area off the I-55 Northbound (NB) and boring SB-03 was drilled in the shoulder of I-55 NB. The surface elevations of the borings ranged between 590.3 and 594.8 feet.

Borings SGB-87, BSB-01, and BSB-02 noted topsoil depths ranging from 4 inches to 2 feet, while boring SB-03 noted 12 inches of asphalt. Under the pavement section or the topsoil, with the exception of BSB-01, the boring encountered silty clay fill to depths of 5 to 7 feet; followed by brown sand fill or sandy loam to depths of 9 to 16 feet; very stiff to hard gray silty clay to depths of 11 to 16 feet; and medium dense to extremely dense gray silty loam or silt to the termination depths. Borings BSB-01 and BSB-02 were terminated upon encountering auger refusal on apparent bedrock, while SGB-87 was terminated within the gray silty clay at a depth of 15 feet. Boring BSB-01 encountered a 1.5-foot sand and gravel fill layer between the topsoil and silty clay fill. The gray silty clay had unconfined compressive strength values ranging between 2.9 and 4.6 tsf. The silt or silty loam had SPT blow count (N) values ranging from 23 to 100 blows per foot. SB-03 initially encountered bedrock at a depth of 22 feet, and was extended to a depth of 38 feet. The rock consisted of gray dolostone that was observed to be slightly weathered. Two rock cores were collected between depths of 23 and 33 feet and between depths of 33 and 38 feet with RQD values of 58% and 32%.

West Wall

Borings SGB-90, BSB-03, BSB04 and SB-01 were drilled in the grass area adjacent to I-55 Southbound (SB). The surface elevations of the borings ranged between 592 and 595 feet.

The borings noted 4 to 12 inches of topsoil. Under the topsoil, most of the borings encountered brown, gray and black silty clay fill to depths of 3.5 to 7.0 feet; very stiff to hard brown and gray silty clay to depths of 9 to 11 feet; loose to dense brown and gray silt or sand to depths of 10 to 15 feet; very stiff to hard gray silty clay to depths of 11 to 22 feet; medium dense to dense gray silt to depths of 20 to 22 feet; and weathered limestone to the termination depths. The native brown and gray silty clay had unconfined compressive strength values ranging between 2.1 and 5.4. The gray silty clay had unconfined compressive strength values ranging between 2.5 and 6.3 tsf with most values between 2.1 and 4.5 tsf. The silt and sand had SPT blow count (N) values ranging from 11 to 29 blows per foot. Boring SB-01 was extended into bedrock to a depth of 36.5

feet. The rock consisted of gray dolostone that was observed to be slightly weathered. Two rock cores were collected between depths of 21.5 and 29.5 feet and between depths of 29.5 and 36.5 feet with RQD values of 55% and 64%.

2.4 Groundwater Conditions

Water levels were checked in each boring to determine the general groundwater conditions present at the site and were measured while drilling and after each boring was completed. Groundwater was encountered while drilling in borings BSB-02, BSB-03, SB-03, and SB-01 at elevations between 576 and 595 feet. Groundwater was encountered after drilling in boring SB-03 and SB-01 at elevations 578 and 574 feet. No delayed groundwater readings were obtained as the borings, which were backfilled immediately upon completion.

Based on the color change from brown and gray to gray, it is anticipated that the long-term groundwater level could range between elevations 576 and 580 feet at the east wall location and between elevations 581 and 584 feet at the west wall location. 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 herein.

3.0 GEOTECHNICAL ANALYSES

This section provides GSG's geotechnical analysis and recommendations for the design of the proposed retaining walls 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 structure locations, loadings, or elevations are changed, we request that GSG be contacted so that we may re-evaluate our recommendations. The soil parameters for the bridge can be found in Wang's report (**Appendix H**)

3.1 Derivation of Soil Parameters for Design

Based on the boring logs provided by Wang Engineering, generalized soil parameters for the soils in the project area for use in design are presented in **Table 3**.

Table 3a – Soil Parameters Table- East Wall

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	120	1,000	0	100	25
	New Engineered Granular Fill	125	0	30	0	30
592-585	FILL Brown and Gray Silty Clay	133	2,600	0	260	25
585-578	Gray Very Stiff to Hard Silty Clay	138	3,800	0	380	28
578-572	Gray Medium Dense to Extremely Dense Silt	138	0	38	0	38
585-576 (BSB-02)	FILL Brown Sand	129	0	30	0	30
589-584 (SB-03)	Brown Loose Sand	123	0	30	0	30

Table 3b – Soil Parameters Table- West Wall

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	120	1,000	0	100	25
	New Engineered Granular Fill	125	0	30	0	30
593-588	FILL Brown and Gray Silty Clay	130	2,000	0	200	25
588-582	Brown and Gray Very Stiff to Hard Silty Clay	138	3,800	0	380	28
582-574	Gray Ver Stiff to Hard Silty Clay	139	4,200	0	420	28
581-575 (BSB-03 & SB-01)	Gray Medium Dense Silt	136	0	36	0	36
585-583 (SB-01)	Brown Medium Dense Loam	136	0	36	0	36

3.2 Seismic Parameters

The seismic hazard for the site was analyzed per the IDOT Geotechnical Manual, IDOT Bridge Design Manual, and AASHTO LRFD Bridge Design Specifications.

The Seismic Soil Site Class was determined per the requirements of "All Geotechnical Manual Users" (AGMU) Memo 9.1, Design Guide for Seismic Site Class Determination, and the "Seismic Site Class Determination" Excel spreadsheet provided by IDOT. A global Site Class Definition was determined for this project, and was found to be Soil Site Class C. The Seismic Performance Zone (SPZ) was determined using Figure 2.3.10-2 in the IDOT Bridge Manual and was found to be Seismic Performance Zone 1.

The AASHTO Seismic Design Parameters program was used to determine the peak ground acceleration coefficient (PGA), and the short (S_{DS}) and long (S_{D1}) period design spectral acceleration coefficients for each of the proposed structures. For this section of the project, the

S_{DS} and the S_{D1} were determined using 2017 AASHTO Guide Specifications as shown in **Table 4**. Given the site location and materials encountered, the potential for liquefaction is minimal.

Table 4 – Seismic Parameters

Building Code Reference	PGA	S_{DS}	S_{D1}
2017 AASHTO Guide for LRFD Seismic Bridge Design	0.049g	0.127g	0.068g

4.0 APPROACH EMBANKMENT RECOMMENDATIONS

Based on the current design plans, it is anticipated that two approach embankments will be built with a combination of side slopes and retaining walls. GSG estimated the long-term consolidation settlement under the applied maximum height of 31-foot embankment at the west abutment, and 29-foot embankment at the east abutment, to be approximately 1.9 and 0.9-inches at the west and east approaches, respectively. The anticipated time required to complete the primary settlement with less than 0.4-inches of post-construction settlement is estimated to be 1 to 3 months.

Based on the current General Plan & Elevation drawing (dated 5/11/2020), an IDOT standard concrete cantilever wingwall will be built under each approach slab, parallel to the bridge to retain the new embankment. The wingwalls will be supported on drilled shafts. At the northwest wingwall, a T-wall will tie into the wingwall and extend beyond the approach slab. The T-wall will be sitting on the new embankment fill and will also be supported on drilled shafts. The drilled shafts recommendations can be found in Section 5.1

For the embankment beyond the approach slabs and wingwalls, the embankment is expected to be sloped. GSG utilized Slide 2018 to analyze the slope stability of the side slopes of the new embankments. Slide 2018 is a comprehensive slope stability analysis software used to evaluate the proposed slopes for the project based on the limit equilibrium method. A circular failure analysis was evaluated for both a short term (undrained) and long term (drained) using the simplified Bishop analyses methods. Based on the analysis, the side slope should be maintained at 2.25H:1V to meet the minimum factor of safety of 1.5 required by IDOT for fill conditions.

Table 5 – Slope Stability Analyses Results (Slope: 2.75H:1V)

Analysis Exhibit	Soil Profile Location	Analysis Type	Factor of Safety	Minimum Required Factor of Safety
Exhibit 1a	East Embankment Slope	Circular – Short Term	2.3	1.5
Exhibit 1b		Circular – Long Term	1.5	1.5
Exhibit 1c	West Embankment Slope	Circular – Short Term	2.6	1.5
Exhibit 1d		Circular – Long Term	1.5	1.5

Based on the analyses performed, the proposed abutment end slope meets the minimum factor of safety of 1.5. Copies of the analysis exhibits are included in the Slope Stability Analyses Exhibits (**Appendix E**).

5.0 GEOTECHNICAL BRIDGE FOUNDATION DESIGN RECOMMENDATIONs

5.1 Abutment Foundation Recommendations

5.1.1 Drilled Shafts Recommendations

Based on the current General Plan & Elevation drawing (dated 5/11/2020), it is anticipated that the bridge abutments, center pier, wingwalls and T-wall will be supported on drilled shafts extending to bedrock. Drilled shafts recommendations were provided in the report prepared by Wang Engineering (report date November 14, 2018, **Appendix H**). GSG concurs with the design recommendations provided in that report to support the bridge on drilled shafts extending to bedrock. However, Wang's report assumed shaft construction would be completed after embankment construction and downdrag effects were not considered.

As GSG understands, an advance contract is anticipated to construct the bridge first, including the MSE select fill and the embankment behind the MSE wall. The abutment drilled shafts are anticipated to be installed before the bridge and embankment construction. The wingwall and T-wall drilled shafts are anticipated to be installed immediately after the completion of embankment construction at the design elevations, 611.25 feet at the west abutment and 608.28 feet at the east abutment. Based on Section 3, the anticipated settlement will be larger than 0.4 inches for both abutments, wingwalls and T-walls. Therefore, downdrag allowance will be required for the drilled shafts.

According to AASHTO Section 3.11.8-Downdrag, the shaft should be designed to resist the downdrag if the ground settlement is anticipated to be 0.4 inches or greater. The nominal geotechnical resistance available to resist the structure load plus the downdrag load is estimated by considering only the positive side resistance and tip resistance below the lowest layer contributing to the downdrag. The soil layer below the depth where the settlement is less than 0.4 inches can be considered relatively incompressible, where no downdrag will occur.

There are several mitigation measures to resist the downdrag forces for drilled shafts. This includes soil surcharging and preloading, ground improvement, increasing the pile section, using larger pile diameter, and increasing the number of piles. We understand that soil preloading and surcharging may not be viable options based on the project schedule. Therefore, the downdrag load should be estimated and applied in the design.

Based on the settlement analysis of the native soil below the new embankment, settlement is estimated to be 0.4 inches or greater above elevation 579 feet for the west abutment, and 581 feet for the east abutment. The downdrag magnitude should be determined by computing the negative skin resistance using the procedures in AASHTO Section 10.8.3.4 for shaft length from bottom of abutment bent or the bottom of the wingwalls/T-wall to elevation 579 feet for the west abutment, and 581 feet for the east abutment. If the static analysis method in AASHTO Section 10.7.8.3.6 is used, the parameters provided in **Table 6a** and **6b** can be used to compute the negative skin resistance and downdrag load.

Table 6a –Drilled Shaft Downdrag Design Parameters for West Side (SB-01)

Elevation Range (ft)	Soil Description	Nominal Side Resistance (ksf)	Side Resistance Factor φ	Factored Side Resistance (ksf)
611-590 (Abutment)	MSE Wall Select Fill	1.60	0.55	0.88
610-590 (wingwall, T-wall)	New Embankment Fill (Clay)	1.10	0.45	0.50
590-587	Very Stiff to Hard Brown and Gray Silty Clay	2.15	0.45	0.97
587-585	Medium Dense Brown Gravel	3.00	0.55	1.65
585-580	Medium Dense Gray Silt	2.91	0.55	1.60
580-579	Very Stiff to Hard Gray Silty Clay	1.80	0.45	0.81

Table 6b –Drilled Shaft Downdrag Design Parameters for East Side (SB-03)

Elevation Range (ft)	Soil Description	Nominal Side Resistance (ksf)	Side Resistance Factor φ	Factored Side Resistance (ksf)
608-589 (Abutment)	MSE Wall Select Fill	1.48	0.55	0.81
608-589 (Wingwall)	New Embankment Fill (Clay)	1.10	0.45	0.50
589-584	Loose Brown Gravelly Sand	1.32	0.55	0.73
584-581	Very Stiff to Hard Gray Silty Clay	2.12	0.45	0.96

5.1.2 Driven Piles Recommendations

Alternatively, if driven piles are considered for support of the bridge substructure, the design information provided in Wang's report should be updated for the pile cut off elevations based on GP&E dated 05/11/2020 that include the new embankments to be constructed on either side of the bridge. Due to MSE wall construction at each abutment, the top of the pile foundations will extend through new embankment materials which will require pile sleeves to be installed within the wall select backfill. The pile sleeves may be filled full depth with clean sand. **Table 7** summarizes the difference in the pile cutoff elevations and anticipated increase to the pile lengths based on the current design drawings.

Table 7 - Driven Pile Cutoff Elevations and Length

Location	Estimated Pile Cut Off Elevation in Wang's Report (ft.)	Estimated Pile Cut Off Elevation in GP&E dated 04/01/2020 (ft.)	Increase in Pile Length (Ft.)
East Approach Slab	n/a	618.00	n/a
East Abutment (SB-03)	593.0	609.28	21.25
Pier (SB-02)	592.0	593.00	1.0
West Abutment (SB-01)	594.0	612.25	13.0
West Approach Slab	n/a	621.00	n/a

Based on the anticipated construction sequences, driven piles will also be subjected to downdrag influence and downdrag allowance will be required. If driven piles are selected for the abutment foundations, GSG should be consulted to include dowdrag effects in the pile resistance.

5.2 Approach Slab Foundation Recommendations

Design recommendations for the foundations for the approach slabs were not provided in Wang's report. As GSG understands, the bridge and the approach embankment will be constructed in an advance contract. If the approach embankments are allowed to settle for 1 to 3 months before the approach slabs are constructed, the settlement expected at the approach embankment will be less than 0.4 inches and at-grade sleeper slabs can be used to support the approach slabs. The sleeper slab should be designed following the IDOT Bridge Approach Slab Details.

If the approach slabs are constructed right after embankment construction, the settlement expected at the west approach embankment will be approximately 1.9 inches, and 0.9 inches at the east approach. Deep foundations, including driven piles and drilled shafts, may be considered for the approach slab to minimize the adverse effects from the settlement. Since the anticipated settlement will be larger than 0.4 inches, downdrag allowance will be required for the deep foundations.

For driven piles, GSG utilized the Modified IDOT static method-excel spreadsheet to estimate the pile lengths at various axial geotechnical resistances for driven piles to support the approach slabs per IDOT AGMU Memo 10.2. The factored resistance includes a reduction of 0.55 for the geotechnical resistance for the pile installation. Geotechnical losses due to downdrag were included in the axial pile capacity calculations. Based on the calculations, the available pile resistance will only consist of end bearing on bedrock due to the downdrag effects. To mitigate the downdrag effect, it is recommended to precore to an elevation of 580 feet, where the 0.4 inches of settlement was reached. Tables 8a and 8b summarize the estimated maximum pile lengths for representative pile sections along with the factored resistance available for H-piles that are feasible for the proposed substructures. The complete IDOT Pile Design Tables including factored resistance available (RF) and nominal required bearing (RN), are included in the **Appendix F**.

Table 8a Bridge West Approach Bent Pile Design (SB-01) with Precore to 580 feet

Pile Section	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (FT)*	Pile End Bearing Stratum
HP10x42 (Max. RN = 335 Kips)	335	184	43.0	2.5 ft into bedrock
HP12x53 (Max. RN = 418 Kips)	418	230	43.0	2.5 ft into bedrock
HP14x73 (Max. RN = 578 Kips)	578	318	43.0	2.5 ft into bedrock

* Estimated pile length is based on assuming the pile cut off elevation: 609.25 ft., and ground elevation at beginning of pile driving: 594.0 ft. Precore to 580 ft.

Table 8b Bridge East Approach Bent Pile Design (SB-03) with Precore to 580 feet

Pile Section	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (FT)*	Pile End Bearing Stratum
HP10x42 (Max. RN = 335 Kips)	335	184	40.0	2.5 ft into bedrock
HP12x53 (Max. RN = 418 Kips)	418	230	40.0	2.5 ft into bedrock
HP14x73 (Max. RN = 578 Kips)	578	318	40.0	2.5 ft into bedrock

*Estimated pile length is based on assuming the pile cut off elevation: 609.25 ft., and ground elevation at beginning of pile driving: 594.0 ft. Precore to 580 ft.

Alternatively, drilled shafts bearing on bedrock may also be considered. The design recommendations can refer to Wang's report and Section 5.1.1. If the static analysis method in AASHTO Section 10.8.3.5 is used, the parameters provided in **Tables 9a** and **9b** can be used to compute the negative skin resistance and downdrag load.

Table 9a –Drilled Shaft Downdrag Design Parameters for West Approach Slab (SB-01)

Elevation Range (ft)	Soil Description	Nominal Side Resistance (ksf)	Side Resistance Factor φ	Factored Side Resistance (ksf)
620-590	New Embankment Fill (Clay)	1.10	0.45	0.50
590-587	Very Stiff to Hard Brown and Gray Silty Clay	2.15	0.45	0.97
587-585	Medium Dense Brown Gravel	3.51	0.55	1.93
585-580	Medium Dense Gray Silt	3.32	0.55	1.83
580-579	Very Stiff to Hard Gray Silty Clay	1.80	0.45	0.81

Table 9b –Drilled Shaft Downdrag Design Parameters for East Approach Slab (SB-03)

Elevation Range (ft)	Soil Description	Nominal Side Resistance (ksf)	Side Resistance Factor φ	Factored Side Resistance (ksf)
617-589	New Embankment Fill (Clay)	1.10	0.45	0.50
589-584	Loose Brown Gravelly Sand	1.62	0.55	0.89
584-581	Very Stiff to Hard Gray Silty Clay	2.12	0.45	0.96

6.0 GEOTECHNICAL RECOMMENDATIONS

This section provides GSG's geotechnical recommendations for the design of the proposed retaining walls based on the results of the field exploration, laboratory testing, and geotechnical analyses, and information provided by the designer.

6.1 Retaining Wall Type Recommendations

There are several types of retaining walls that could be utilized for retaining earth embankments in fill areas or excavation slopes in cut areas. Based on the proposed grading, it appears that the proposed walls are located within fill areas. Possible wall types may include cast-in-place concrete cantilever, Mechanically Stabilized Earth (MSE), prefabricated modular gravity, steel sheet piles, soil nail wall, and soldier-pile and lagging.

The type of wall selected for design should be selected based on IDOT requirements, site condition, soil conditions, construction schedule, and cost. The following provides a brief description of each type of wall that could be considered at this location.

A. CIP Concrete Cantilever Walls

CIP concrete cantilever retaining walls are typically used in fill areas. They are constructed with a footing that extends laterally both in front of and behind the wall. They can be designed to resist horizontal loading with or without tie-backs by changing the geometry of the foundation. This type of wall typically requires that the area behind the wall be excavated to facilitate construction or are constructed where new fill embankments are necessary.

The advantages of a CIP wall include that it is a conventional system with well-established design procedures and performance characteristics; it is durable; and it has the ability to easily be formed, textured, or colored to meet aesthetic requirements. Disadvantages include a relatively long construction period due to undercutting, excavation, form work, steel placement, and curing of the concrete. This wall system is also sensitive to total and differential settlements.

B. Mechanically Stabilized Earth Walls

An MSE wall is typically associated with fill wall construction and consists of facing such as segmental precast units, dry block concrete or CIP concrete facing units connected to horizontal steel strips, bars or geosynthetic to create a reinforced soil mass. The reinforcement is typically placed in horizontal layers between successive layers of granular backfill. A free draining backfill is required to provide adequate performance of the wall. MSE walls can be used in cut situations as well. The additional cost of the excavations for an MSE wall is usually offset by the savings in construction costs and schedule as compared to a CIP wall on spread footings.

Advantages of the MSE wall include a relatively rapid construction schedule that does not require specialized labor or equipment, provided excavation for the reinforcement is not extensive. This type of retaining wall can accommodate relatively large total and differential settlements without distress, and the reinforcement materials are light and easy to handle. Facing panels can be designed for various architectural finishes.

The design of MSE walls for internal stability is normally the Contractor's responsibility and will need to be designed by a licensed Structural Engineer in the State of Illinois. The length of the reinforced soil mass from the outside face should be a minimum of 8 feet, but not less than 70% of the wall height. The length should be determined to satisfy eccentricity and sliding criteria and provide adequate length to prevent structural failure with respect to pullout and rupture of reinforcement. The MSE wall could be designed using a unit weight of 120 pcf and a minimum friction angle of 34 degrees for the reinforced backfill soil.

C. Prefabricated Modular Gravity Walls

This type of wall typically consists of interlocking soil or rock-filled concrete, steel, or wire modules or bins (such as gabions). The combined weight of the wall materials resists the lateral loads from the soil embankment being retained. This type of wall may be used where conventional reinforced concrete walls are also being considered but are typically selected when the overall wall height will be less than 25 feet.

The advantage of this type of wall is that less select fill is required for the backfill behind the wall and the construction is relatively more economical compared to other wall types; however, this type of wall may require additional soil excavation for placement of the modules. The additional cost of the excavations could be offset by the savings in construction costs and schedule as compared to other walls.

D. Soldier Pile and Lagging Walls

Soldier pile and lagging walls are typically used in cut areas where the existing ground surface needs to be maintained during construction or when a near vertical excavation is needed. The wall may be constructed with driven steel piles or steel piles placed in drilled holes and backfilled with concrete. The depth of the soldier pile is normally estimated to be two times the wall exposed height. Soldier piles are typically spaced at 8 to 10 foot on center and are faced with cast-in-place or precast concrete. Tie backs may be used to provide additional lateral resistance, if required. The installation of soldier pile walls requires the use of specialty equipment to drive the piles into the ground. To provide lateral resistance against the retained soil, the walls can be designed to act as a cantilever or can use tie backs behind the wall. The walls maintain the existing site conditions with minimal disturbance to existing structures and can be installed relatively quickly in most situations.

E. Recommended Wall Type

The proposed retaining walls are considered a “fill” wall. GSG concurs with Benesch’ design selection of MSE walls for this section of the project. GSG evaluated the global and external stability and settlement to determine the suitability of the retaining wall for this section of the project. The wall section should be analyzed to determine that adequate factors of safety relative to overturning failure. The contractor is responsible for providing detailed internal stability design for the wall. The wall should be designed, and constructed, in accordance with the proprietary contractor’s construction manual. The final wall design should be submitted to the structural design team for review prior to commencing construction of the wall.

6.2 Retaining Wall Design Recommendations

The engineering analyses performed for evaluation of the retaining wall options followed the current AASHTO Load and Resistance Factor Design (LRFD) Methodology as required by IDOT. LRFD methodology incorporates the use of load factors and resistance factors to account for uncertainty in applied loads and load resistance of structure elements separately. The AASHTO LRFD Bridge Design Specifications outline load factors and combinations for various strength, extreme event, service, and fatigue limit states. Section 11, which outlines geotechnical criteria for retaining walls, of the AASHTO specifications requires the evaluation of bearing resistance failure, lateral sliding, and overturning at the strength limit state and excessive vertical displacement, excessive lateral displacement, and overall stability at the service limit state. The selected wall should be also evaluated with respect to the collision load. **Table 10** outlines the load factors used in evaluation of the retaining wall in accordance with AASHTO Specification Tables 3.4.1-1 and 3.4.1-2.

Table 10 - LRFD Load Factors for Retaining Wall Analyses

	Type of Load	Sliding and Eccentricity Strength I	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
Load Factors for Horizontal Loads	Horizontal Earth Pressure Load (EH) Active At-Rest AEP for anchored walls	1.50	 1.50 1.35 1.35	1.00	1.00	1.00
	Earth Surcharge (ES)	1.50	1.50			
	Live Load Surcharge (LS)	1.75	1.75	0.50	0.50	1.00
Load Factor for Vehicular Collision				1.00	1.00	

6.2.1 Lateral Earth Pressures and Loading

The wall should be designed to withstand earth and live lateral earth pressures. The lateral earth pressures on MSE walls should be determined in accordance with AASHTO 3.11.5.8. Earth loads of retained soils behind the MSE wall may be calculated using an active earth pressure coefficient, K_a, calculated using the Rankine Theory. **Tables 11a and 11b** presents soil design properties for the retaining walls for the anticipated soil types at this site.

Table 11a – Lateral Soil Parameters – East Wall

Elevation Range (feet)	Soil Description	Long-term/Drained			Soil Parameters used in L-Pile		
		Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At-Rest Earth Pressure Coefficient (K_o)	Coefficient of Lateral Modulus of Subgrade Reaction (pci)	Soil Strain (ε_{50})	L-Pile Soil Type
	New Engineered Clay Fill	0.41	2.46	0.58	1,320	0.005	Stiff Clay w/o free water (Reese)
	New Engineered Granular Fill	0.36	2.77	0.53	1,900	0.005	Sand (Reese)
592-585	FILL Brown and Gray Silty Clay	0.24	4.2	0.38	125	N/A	Stiff Clay w/o free water (Reese)
585-578	Gray Very Stiff to Hard Silty Clay	0.33	3.00	0.5	90	N/A	Stiff Clay w/o free water (Reese)
578-572	Gray Medium Dense to Extremely Dense Silt	0.33	3.00	0.5	25	N/A	Silt
585-576 (BSB-02)	FILL Brown Sand	0.41	2.46	0.58	1,320	0.005	Sand (Reese)
589-584 (SB-03)	Brown Loose Sand	0.36	2.77	0.53	1,900	0.005	Sand (Reese)

*The initial p-y modulus, E_{py} , varies linearly with depth. To obtain E_{py} use the equation $E_{py} = k_{py} * z$, where k_{py} is the coefficient of lateral modulus of subgrade reaction given in the table and z is the distance from the surface to the center point of the layer in inches.

Table 11b – Lateral Soil Parameters – West Wall

Elevation Range (feet)	Soil Description	Long-term/Drained			Soil Parameters used in L-Pile		
		Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At-Rest Earth Pressure Coefficient (K_o)	Coefficient of Lateral Modulus of Subgrade Reaction (pci)	Soil Strain (ε_{50})	L-Pile Soil Type
	New Engineered Clay Fill	0.41	2.46	0.58	500	0.01	Stiff Clay w/o free water (Reese)
	New Engineered Granular Fill	0.33	3.00	0.50	90	N/A	Sand (Reese)
593-588	FILL Brown and Gray Silty Clay	0.41	2.46	0.58	1,000	0.005	Stiff Clay w/o free water (Reese)
588-582	Brown and Gray Very Stiff to Hard Silty Clay	0.36	2.77	0.53	1,910	0.005	Stiff Clay w/o free water (Reese)
582-574	Gray Ver Stiff to Hard Silty Clay	0.36	2.77	0.53	2,120	0.004	Stiff Clay w/o free water (Reese)
581-575 (BSB-03 & SB-01)	Gray Medium Dense Silt	0.26	3.85	0.41	125	N/A	Silt
585-583 (SB-01)	Brown Medium Dense Loam	0.26	3.85	0.41	125	N/A	Sand (Reese)

*The initial p-y modulus, E_{py} , varies linearly with depth. To obtain E_{py} use the equation $E_{py} = k_{py} * z$, where k_{py} is the coefficient of lateral modulus of subgrade reaction given in the table and z is the distance from the surface to the center point of the layer in inches.

Traffic and other surcharge loads should be included in the retaining wall design as applicable. A live load surcharge shall be applied where vehicular load is expected to act on the surface of the backfill within a distance equal to one-half the wall height behind the back face of the wall in accordance with AASHTO 3.11.6.4. The live load surcharge may be estimated as a uniform horizontal earth pressure due to an equivalent height (H_{eq}) of soil. An equivalent height (H_{eq}) of two (2) feet of soil should be used for vehicular loadings on retaining walls.

The retaining walls design should include a drainage system to allow movement of any water behind the wall, and not allowing hydrostatic (seepage) pressures to develop in the active soil wedge behind the wall. This could be accomplished by placing a Geocomposite Wall Drain or open grade stone over the entire length of the back face of the wall connected to 6-inch diameter perforated drain pipe and backfilling a minimum of 2 feet of free draining materials, Porous Granular Embankment, as measured laterally from the back of the wall. The backfill should be placed in accordance with the IDOT SSRBC. Heavy compaction equipment should not be allowed closer than five (5) feet to the retaining wall to prevent inducing high lateral earth pressures and causing wall yielding and/or other damage. The passive lateral earth pressure coefficient (Kp) from the upper 3.5 feet of level backfill at the toe of the wall should be neglected, unless the soil is confined or protected by a concrete slab or well drained pavement. The passive lateral earth pressure coefficient from the upper 3.5 feet of soil for a descending slope at the wall toe should also be neglected, regardless of any surface protection.

6.2.2 Bearing Resistance

It is anticipated that the MSE wall will bear on native clays or suitable existing fill materials. Bearing resistance for the retaining wall shall be evaluated at the strength limit state using load factors (See **Table 10**), and factored bearing resistance. The bearing resistance factor, ϕ_b, for an MSE wall is 0.65 per AASHTO Table 11.5.7-1. The bearing resistance shall be checked for the extreme limit state with a resistance factor of 1.0. **Table 12** presents the proposed bearing elevation and recommended bearing resistances of suitable materials to support the wall system.

Table 12 – Recommended Bearing Resistance

Location	Elevation (feet)*	Nominal Resistance (ksf)	Factored Bearing Resistance (ksf)	Bearing Resistance for 1-inch Settlement Service Limit (ksf)	Bearing Resistance for 2-inch Settlement Service Limit (ksf)	Bearing Resistance for 2.5-inch Settlement Service Limit (ksf)	Anticipated Bearing Soil
East Wall	590.3 to 586.5	8.2	5.3	3.0	5.3	n/a	Native Silty Clay/Existing Fill/Engineered Granular fill
West Wall	589.5 to 591.4	8.2	5.3	1.8	4.2	5.3	Native Silty Clay/Existing Fill//Engineered Granular fill

*Elevations estimated from GP&E dated 04/01/2020

The minimum depth of the wall leveling pad should be 3.5 feet below the final exterior grade to alleviate the effects of frost. The subgrade soils encountered at the bearing elevation should be cleared of any unsuitable material, such as topsoil. Based on the results of the subsurface exploration, we anticipate the wall would be supported upon the soil types noted in **Table 12.**

6.2.3 Subgrade Undercut Areas

Based on the soil conditions along the wall alignment, it is anticipated that silty clay fill with low unconfined compressive strength will be encountered near the bearing elevation between Station 266+25 and 266+75 at the east wall. When encountered, these soils are not generally considered suitable for foundation bearing and should be removed during construction. Cohesive materials exhibiting moisture contents greater than 27% and unconfined compressive strengths less than 1.5 tsf, if encountered should be removed during construction.

Table 13 – Potential Remedial Treatment Summary

	Station		Wall Height (feet)	Soil Description	Remedial Undercut		Reason for Undercut
	From	To			Top Elevation (feet)	Depth (feet)	
East Wall	266+25	266+75	20.0	Existing Silty Clay Fill	586.5	2.5	Qu < 1.5 tsf
West Wall	268+80	269+55	21.5	Existing Silty Clay Fill	591.3	3.0	Qu<1.5 tsf

Undercut areas should be replaced with granular structural fill in accordance with IDOT standard construction requirements. The lateral limit of the structural fill should extend a minimum of 1 foot beyond the edge of the MSE wall footing, then an additional 1 foot laterally for every 2 feet of structural fill depth as depicted in Exhibit 3. The granular structural fill should be placed and compacted to a minimum of 95% of the maximum dry density, as determined by AASHTO T-180: Standard Test Methods for Moisture-Density Relations of Soils and Soil-Aggregate Mixtures (ASTM D1557) in accordance with IDOT standard construction requirements.

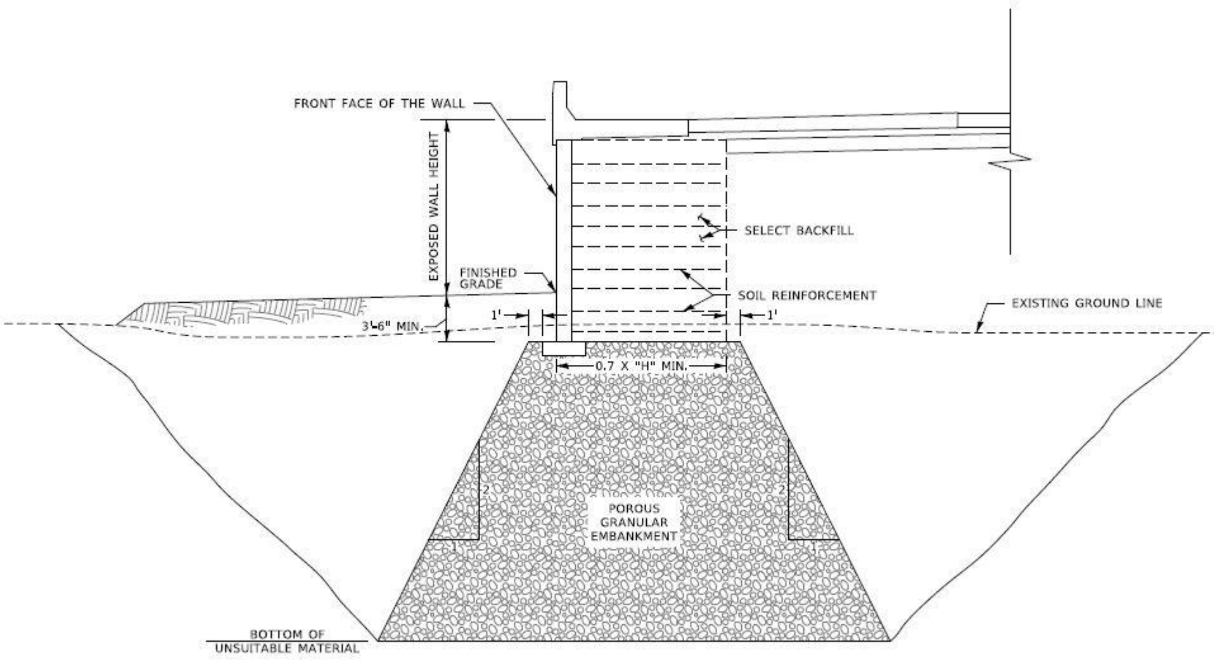


Exhibit 3 - Structural Fill Placement below MSE Wall

6.2.4 Sliding and Overturning Stability

The wall base width should be sufficient to resist sliding. The frictional resistance shall include the friction between granular backfill for the wall and supportive cohesive or granular soils, and the friction between the wall foundation and bearing soils.

The factored resistance against sliding should be calculated using equation 10.6.3.4-1 in the AASHTO LRFD manual. A sliding resistance factor, ϕ, of 1.0 (Table 11.5.7-1) shall be applied to the nominal sliding resistance of soil-on-soil beneath the MSE wall. A maximum frictional coefficient of 0.53 could be used for determining the sliding resistance for the soil to soil interfaces. The width of the MSE wall (length of the reinforcing) must be wide enough to resist overturning forces. The location of the resultant of the forces shall be within the middle two-thirds of the MSE base width.

6.2.5 Wall Embankment Settlement

Settlement of the MSE wall depends on the foundation size and bearing resistance, as well as the strength and compressibility characteristics of the underlying bearing soil. Assuming the foundation subgrade has been prepared as recommended above and the service bearing resistances for different station ranges as mentioned in **Table 12** are used, the settlement of the MSE walls will be between 1 and 2 inches for the east wall and between 2 to 3 inches for the west wall. Differential settlement between two points of 100 feet apart along the length of the walls will be 1 inch or less. AASHTO 11.10.4.1 provides guidelines regarding the maximum total and differential tolerable settlements for various facing of MSE walls. No settlement issues are anticipated.

6.2.6 Overall Stability

The MSE wall should be designed for external stability of the wall system as well as the internal stability of the reinforced soil mass behind the wall facing. The wall contractor should confirm stability requirements based on the final wall configurations. The following parameters were used to evaluate the wall.

Table 14 – Walls Description

*Based on GPE plan dated 04/01/2020

Maximum total retained height of the retaining wall (H) East/West Wall	22.6/23.0 feet
Minimum length of reinforcement (0.80 *H) for the East Wall and (0.85*H) for the West Wall to reach Factor of Safety of 1.5	18.1/20.0 feet
Unit weight of the retained soil (embankment)	120 pcf
Unit weight of the reinforced soil mass	120 pcf

The actual wall width, and total height of the wall should be based on structural analysis performed by a Licensed Structural Engineer in the State of Illinois.

Slide 2018 is a comprehensive slope stability analysis software used to evaluate the proposed wall for the project based on the limit equilibrium method. The proposed wall was analyzed based on the preliminary grading and the soils encountered while drilling. A circular failure analyses were evaluated using the simplified Bishops analyses methods for the proposed wall geometry. The analyses were performed using the soil parameters in **Tables 3a and 3b**. Based on the proposed geometry and the soil borings, global stability analyses were performed.

6.2.7 Slope Stability Results

A circular failure analyses was evaluated for both a short term (undrained) and long term (drained) conditions based on the proposed geometry for the proposed retaining walls and embankment. The analyses were performed at Stations 270+00 for the east wall and 267+00 for the west wall. The results of the analyses are shown in **Table 15**.

Table 15 – Retaining Wall Global Slope Stability Analyses Results

	Analysis Exhibit	Station	Analysis Type	Factor of Safety	Minimum Factor of Safety
East Wall	Exhibit 4a	267+00	Circular – Short Term	1.8	1.5
	Exhibit 4b		Circular – Long Term	1.5	1.5
	Exhibit 4c	266+50	Circular – Short Term	1.9	1.5
	Exhibit 4d		Circular – Long Term	1.5	1.5
West Wall	Exhibit 5a	270+00	Circular – Short Term	2.1	1.5
	Exhibit 5b		Circular – Long Term	1.5	1.5
	Exhibit 5c	269+25	Circular – Short Term	1.9	1.5
	Exhibit 5d		Circular – Long Term	1.5	1.5

Based on the analyses performed, the proposed retaining wall meets the minimum factor of safety of 1.5. Copies of the analysis exhibits are included in the Slope Stability Analyses Exhibits (**Appendix G**).

6.3 Drainage Recommendations

The walls should be designed to prevent the buildup of hydrostatic forces. 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 wall. Geocomposite Wall Drain or open graded stone with a geotextile fabric system should be placed over the entire length of the back face of the wall.

7.0 CONSTRUCTION CONSIDERATIONS

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Road and Bridge Construction (2016). Any deviation from the requirements in the manuals above should be approved by the design engineer.

7.1 Site Preparation

Based on the existing site conditions at the proposed wall location, all vegetation, landscaping, and surface topsoil should be cleared and removed from the vicinity of the proposed foundations. It is anticipated that topsoil stripping depths could be on the order of about 12 inches, with thicker areas possible in the lower lying areas. Subgrade stability should be verified in the field by the Engineer (or technician representative) with a Dynamic Cone Penetration (DCP) or Static Cone Penetration (SCP) test in accordance with IDOT Subgrade Stability Manual, section 3.0. Any unsuitable materials observed during the test should be undercut and replaced with compacted structural fill and/or stabilized in-place. The possible need for, and extent of, undercutting and/or in-place stabilization required can best be determined by the geotechnical engineer at the time of construction. Once the site has been properly prepared, at grade construction may proceed.

Foundation aggregate fill should not be placed upon wet or frozen subgrade soils. If the subgrade or structural fill becomes frozen, desiccated, wet, disturbed, softened, or loose, the affected materials should be scarified, dried and moisture conditioned, and compacted to the full depth of the affected area or the soils should be removed. Rainfall and runoff can soften soils and affect the load bearing capacity of the soils. All water entering foundation excavation should be removed prior to placement backfill materials above the footings.

7.2 Existing Utilities

The proposed west wall will be built on top an existing Kinder Morgan gas line. Before proceeding with construction, any existing utility lines that will interfere with construction should be completely relocated from beneath the proposed construction areas. Where possible, existing utility lines that are to be abandoned in place should be removed and/or plugged with a minimum of 2 feet of cement grout. All excavations resulting from underground utility removal activities should be cleaned of loose and disturbed materials, including all previously placed backfill, and backfilled with suitable fill materials in accordance with the requirements of this section. During the clearing and stripping operations, positive surface drainage should be maintained to prevent the accumulation of water.

7.3 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.

7.4 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 (2016).

7.5 Groundwater Management

It is anticipated that the long-term water table could range between elevations 576 and 580 feet at the east wall and between elevations 581 and 584 feet at the west wall. GSG does not anticipate groundwater related issues during construction activity; however, water may become perched in the fill material encountered near the surface. If rainwater run-off or perched water is accumulated at the base of excavation, 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 excavations 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 to 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.

7.6 Temporary Earth Structure Lateral Earth Pressures

For the construction of the proposed walls, a temporary soil retention system (TSRS) is required where the proposed walls will tie with the existing walls to support the excavations and should be designed to withstand earth and live lateral earth pressures. The lateral earth pressures on the TSRS depends on the type of wall (i.e. restrained or unrestrained), the type of backfill and the method of placement against the wall, and the magnitude of surcharge weight on the ground surface adjacent to the wall. The retention system should be designed for at-rest condition if the adjacent embankment cannot withstand the anticipated horizontal and vertical movements of the construction excavation.

Tables 6a and 6b presents the recommended lateral earth pressure soil parameters to be used for the proposed TSRS design based on the anticipated soil types at this site. This assumes on-site materials behind the wall and a level backslope. The at-rest earth pressure coefficient (K_o), active earth pressure coefficient (Ka), and the passive earth pressure coefficient (K_p) were determined using the Rankine theory. In general, the undrained friction angle should be used for granular soils and the drained friction angle should be used for cohesive soils in calculating the earth pressure coefficients for the long-term conditions. However, during short term or temporary conditions undrained parameters can be used for both granular and cohesive soils. The undrained and drained parameters are given in **Tables 3a and 3b**. The Temporary Soil Retention System should be designed in accordance with the *Temporary Sheet Piling Design, Temporary Soil Retention Systems and Braced Excavations* and the IDOT Design Guide, Section 3.13.1. *Temporary Sheet Piling Design and the* Temporary Soil Retention System should be designed by an Illinois licensed structural engineer. Temporary Sheet Piling Design. The design of the TSRS is the responsibility of the contractor. The contractor should submit the TSRS plans to the structural design team for review prior to commencing.

8.0 LIMITATIONS

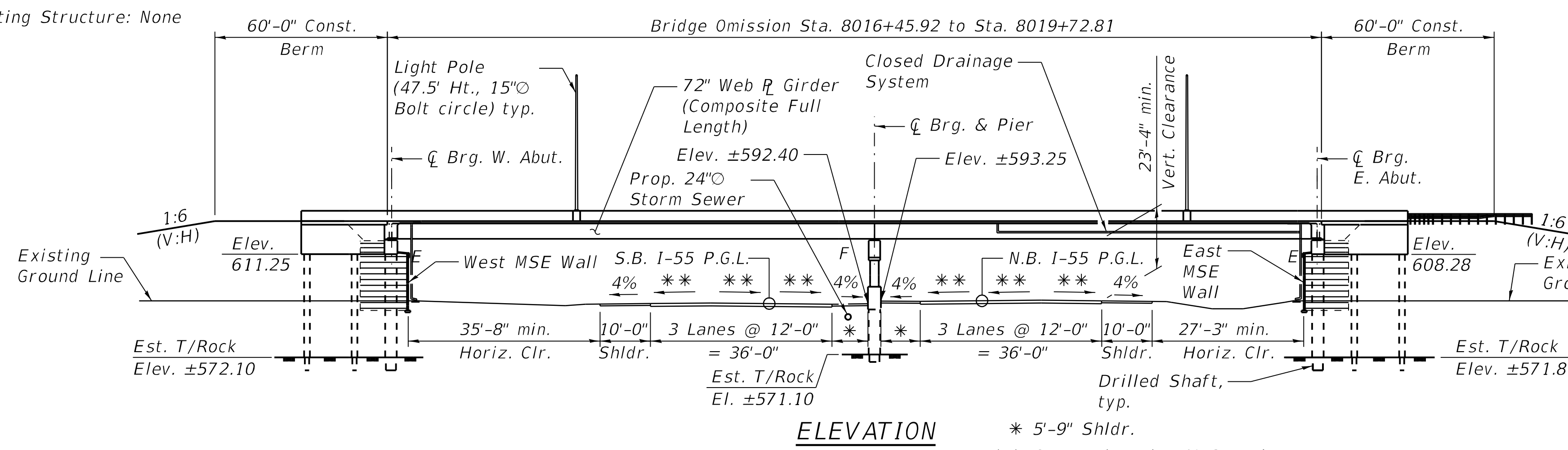
This report has been prepared for the exclusive use of the Illinois Department of Transportation (IDOT) and its Design Section Engineer consultant. The recommendations provided in the report are specific to the project described herein and are based on the information obtained at the soil boring locations within the proposed retaining wall areas. The analyses have been performed, and the recommendations have been provided 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: BM-302 Set 2" diameter Aluminum Disc in bridge wall at northwest corner of existing NB IL-59 Ramp Bridge over I-55, El. 625.23.

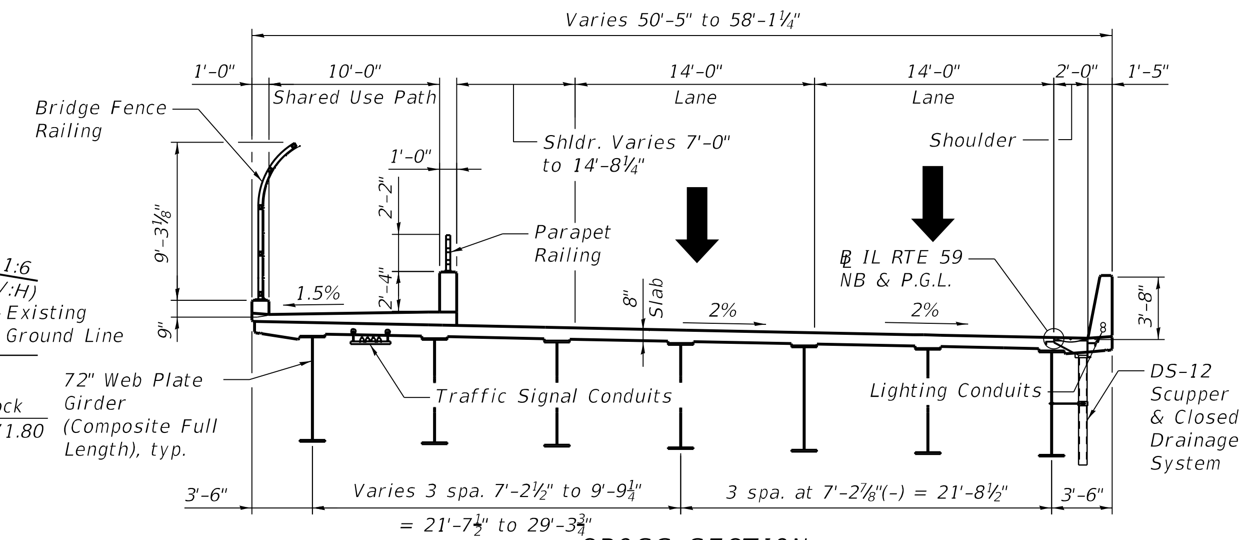
Existing Structure: None



ELEVATION

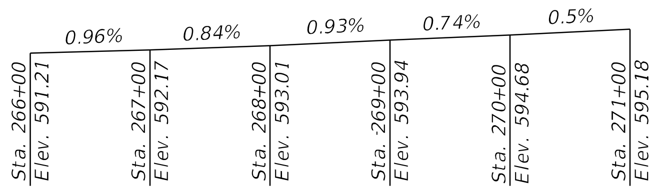
✳ 5'-9" Shldr.

✳✳ Cross slope is 1% & varies.



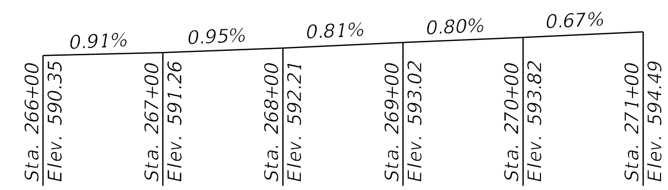
CROSS SECTION

(Looking East)



PROFILE GRADE

NB I-55



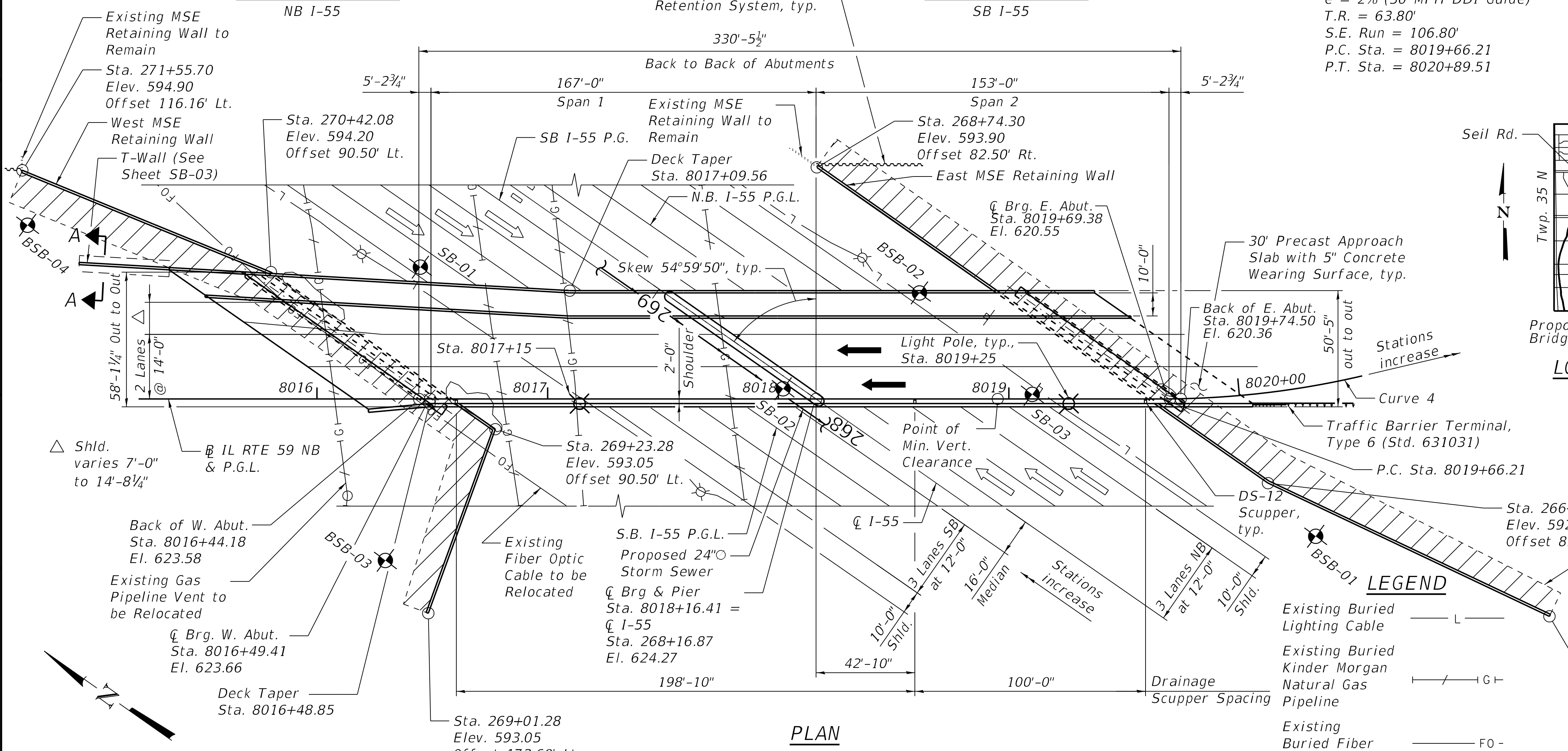
PROFILE GRADE

SB I-55

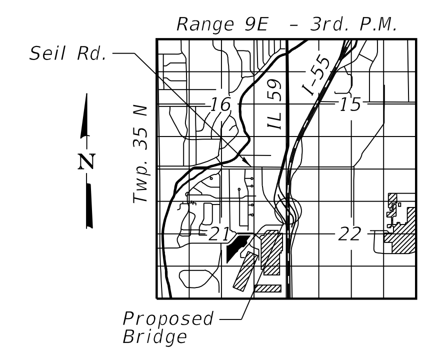
CURVE DATA - 4

(IL RTE 59 NB)

P.I. Sta. = 8020+28.40
Δ = 18° 26' 43" (LT)
D = 14° 57' 35"
R = 383.00'
T = 62.19'
L = 123.30'
E = 5.02'
e = 2% (30 MPH DDI Guide)
T.R. = 63.80'
S.E. Run = 106.80'
P.C. Sta. = 8019+66.21
P.T. Sta. = 8020+89.51



PLAN



LOCATION SKETCH

LEGEND

Existing Buried Lighting Cable — L —

Existing Buried Kinder Morgan Natural Gas Pipeline — G —

Existing Buried Fiber Optic Cable — FO —

HIGHWAY CLASSIFICATION

F.A.P. Rte. 338 - Illinois Rte. 59
Functional Class: Other Principal Arterial
ADT: 26,500 (Bridge) (2040); 40,200 (IL 59) (2040)
ADTT: 13% (including single and multiple unit trucks)
DHV: 2,760 (2040)
Design Speed: 30 m.p.h.
Posted Speed: 30 m.p.h.

F.A.I. Rte. 55 - I-55
Functional Class: Interstate
ADT: 62,300 (2016); 90,300 (2040)
ADTT: 23% (including single and multiple unit trucks)
DHV: 3,005 (2040)
Design Speed: 70 m.p.h.
Posted Speed: 65 m.p.h.

LOADING HL-93

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

DESIGN SPECIFICATIONS

2017 AASHTO LRFD Bridge Design Specifications, 8th Edition

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (M270 Grade 50)

PRECAST UNITS

f'c = 6,000 psi
f'ci = 5,000 psi

SEISMIC DATA

Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.068g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.127g
Soil Site Class = C

GENERAL PLAN & ELEVATION
IL RTE 59 NB OVER I-55
F.A.P. ROUTE 338
SECTION NO. 2018-075-R
WILL COUNTY
STATION 8018+16.41
STRUCTURE NO. 099-4666

$FILE$ 5:08:27 PM 5/11/2020

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benesch — Alfred Benesch & Company, 35 W Wacker Drive, Suite 3300, Chicago, Illinois 60601, 312-565-0450, Job No. 10740	USER NAME = dschriks	DESIGNED - EO	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
		CHECKED - DTS	REVISED -	
	PLOT SCALE =	DRAWN - RMG	REVISED -	
	PLOT DATE = 5/11/2020	CHECKED - DTS	REVISED -	

SHEET NO. SB-01 OF SB-03 SHEETS

F.A.I./P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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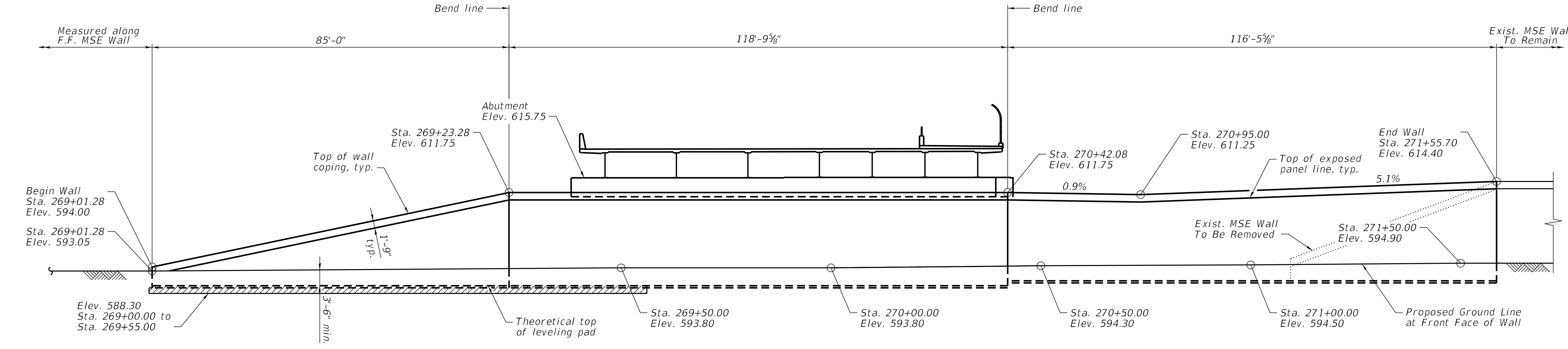
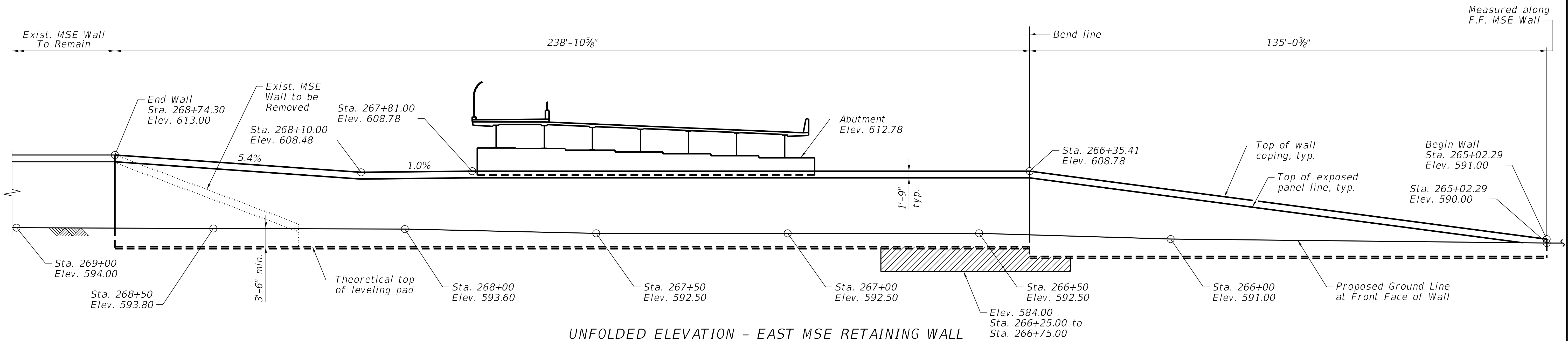
	CONTRACT NO. 62H15			
• FAI 55, FAP 338	ILLINOIS FED. AID PROJECT			



UNFOLDED ELEVATION - WEST MSE RETAINING WALL

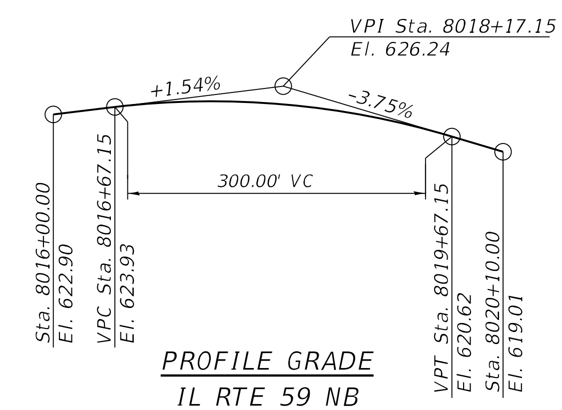
(Max. wall exposure = 19'-6")



UNFOLDED ELEVATION - EAST MSE RETAINING WALL

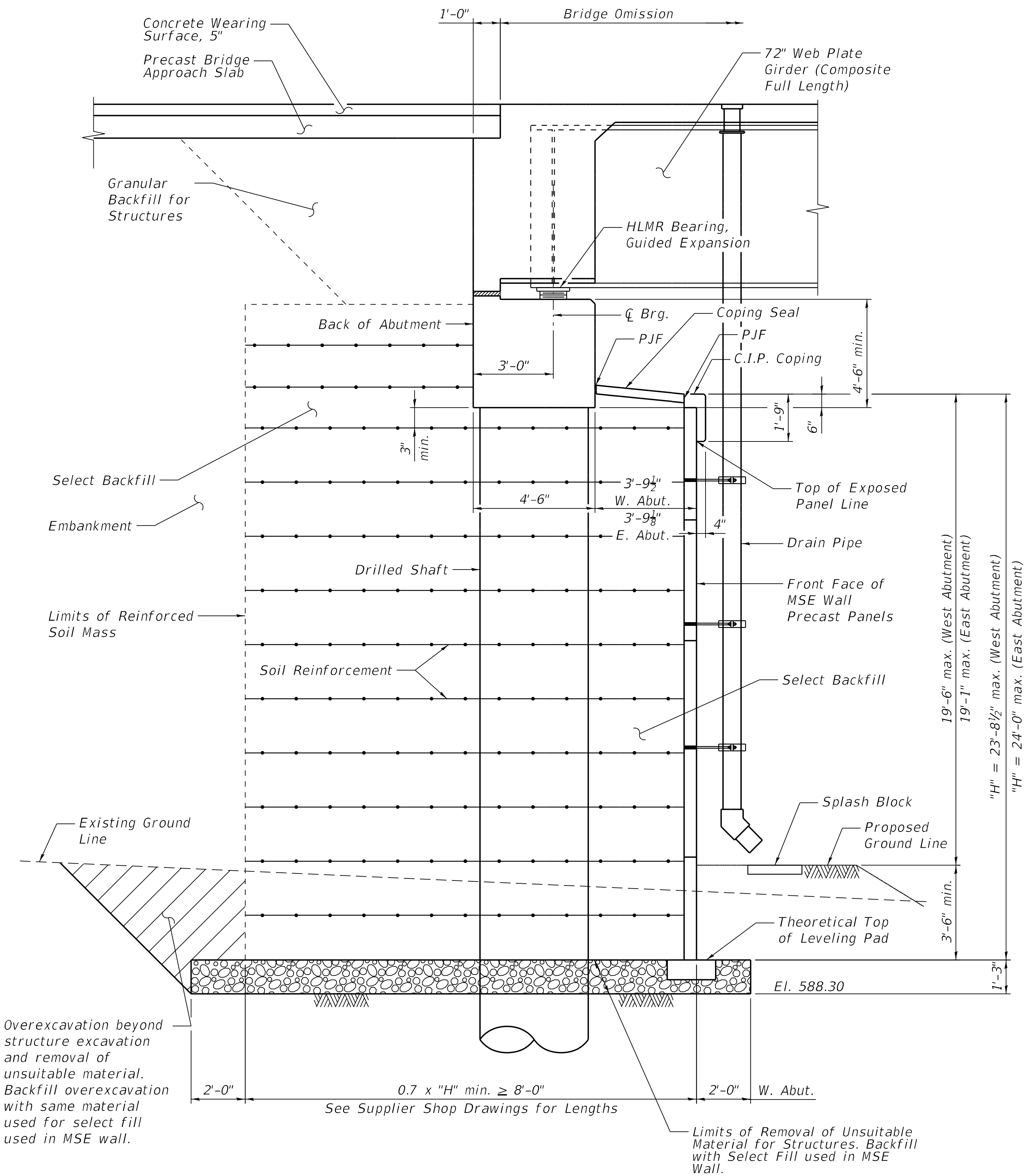
(Max. wall exposure = 19'-1")

Limits of Removal of Unsuitable Material for Structures. Backfill with Select Fill used in MSE Wall.



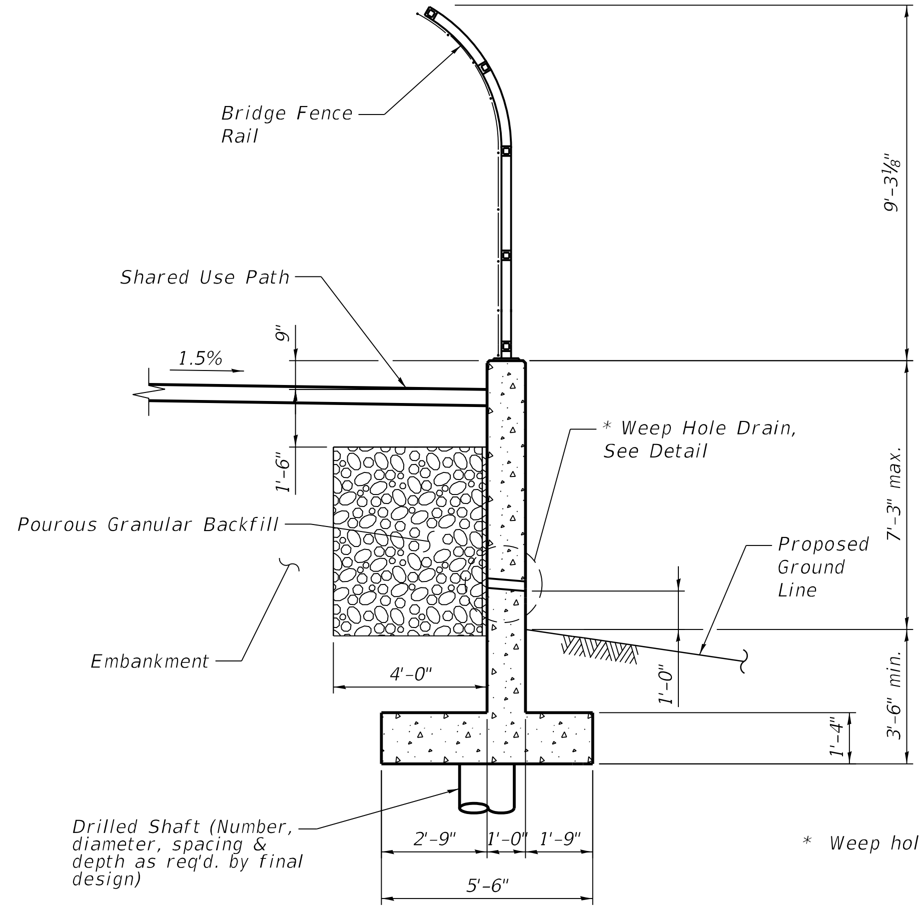
PROFILE GRADE
IL RTE 59 NB

MSE WALL ELEVATIONS
IL RTE 59 NB OVER I-55
F.A.P. ROUTE 338
SECTION NO. 2018-075-R
WILL COUNTY
STATION 8018+16.41
STRUCTURE NO. 099-4666



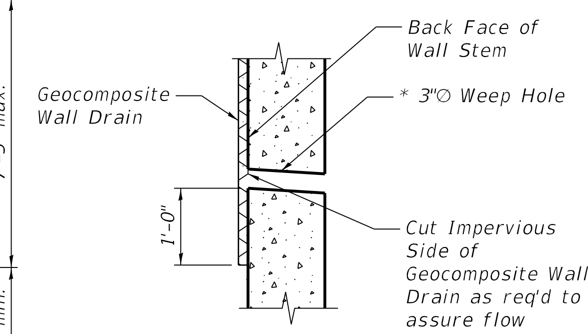
SECTION THRU ABUTMENT

All Horizontal Dimensions at Rt. Angles



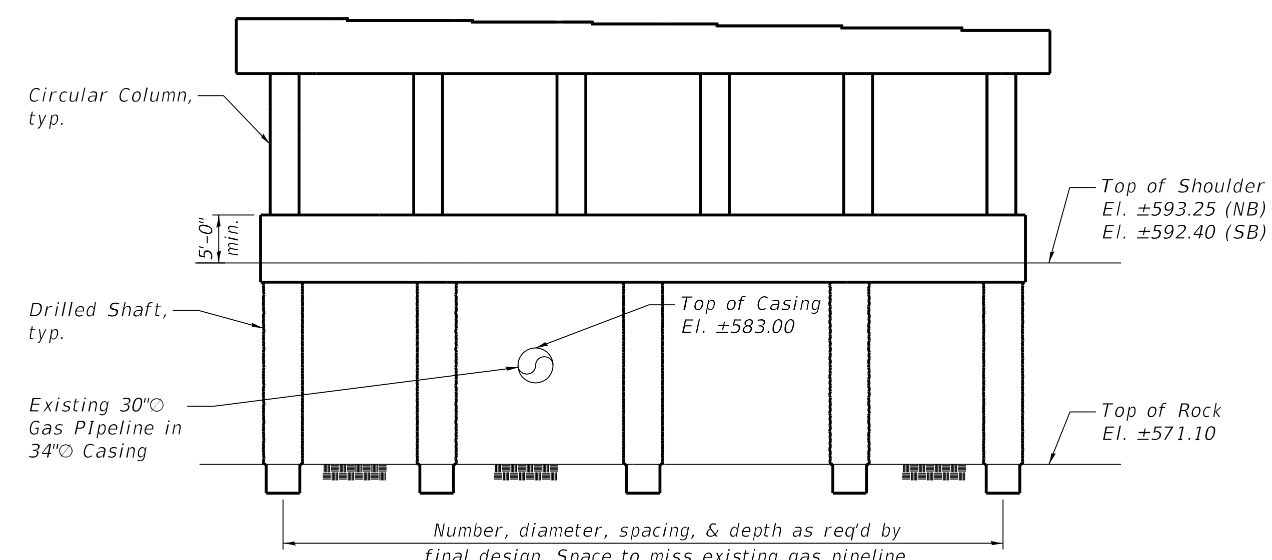
SECTION A-A

(T-Wall at Northwest Wingwall - Looking West)



WEEP HOLE DRAIN DETAIL

* Weep hole spacing shall be at ±8'-0" horizontally.



PIER SKETCH

(Looking East)

DETAILS
IL RTE 59 NB OVER I-55
F.A.P. ROUTE 338
SECTION NO. 2018-075-R
WILL COUNTY
STATION 8018+16.41
STRUCTURE NO. 099-4666

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benesch
Alfred Benesch & Company
35 W Wacker Drive, Suite 3300
Chicago, Illinois 60601
312-565-0450 Job No. 10740

USER NAME = dschriks	DESIGNED - EO	REVISED -
	CHECKED - DTS	REVISED -
PLOT SCALE =	DRAWN - RMG	REVISED -
PLOT DATE = 5/11/2020	CHECKED - DTS	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

SHEET NO. SB-03 OF SB-03 SHEETS

F.A.I./P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
•	2018-075-R	WILL		
		CONTRACT NO. 62H15		

• FAI 55, FAP 338 | ILLINOIS | FED. AID PROJECT

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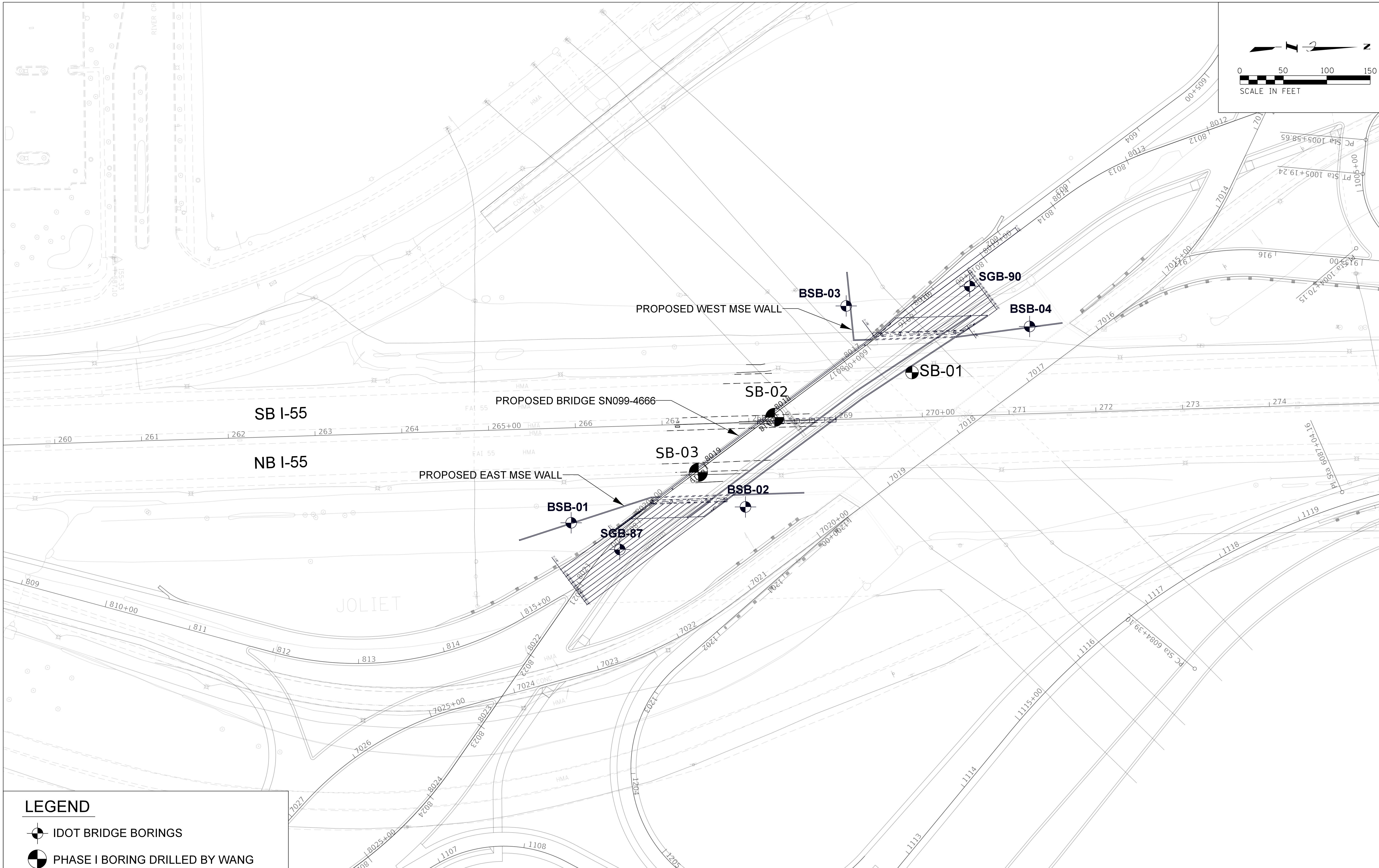
APPENDIX B

SOIL BORING LOCATION PLAN

AND SUBSURFACE PROFILE



GSG CONSULTANTS, INC.
Engineers, Scientists & Construction Managers
623 Cooper Court Schaumburg, IL 60173
Tel: 630.994.2600
"Integrity| Quality| Reliability"

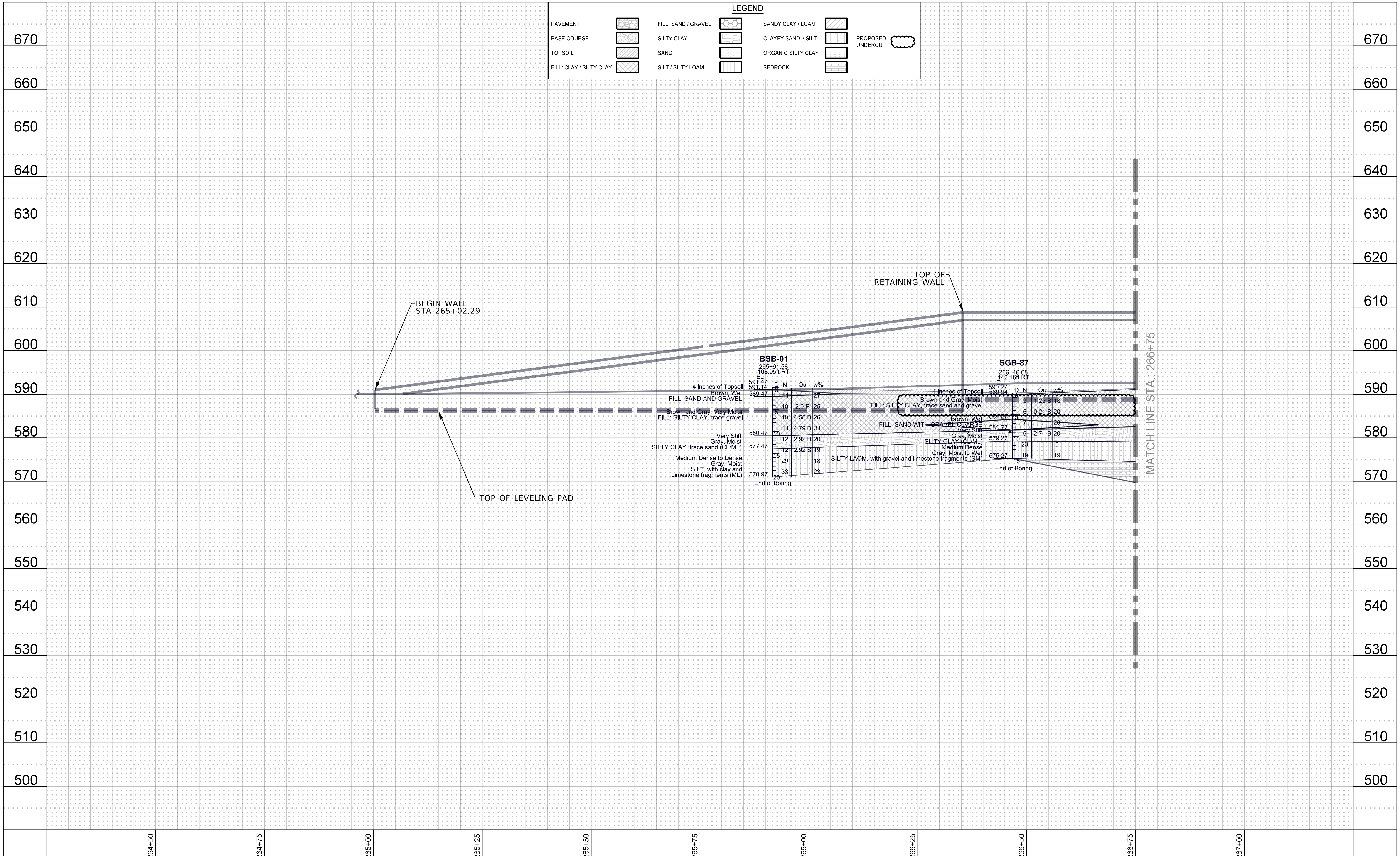
USER NAME = kkrahulik		DESIGNED -	SI
SHEET SIZE = 1.41667x0.916667 (ft.)		DRAWN -	NN
PLOT SCALE = 1200.0000 ' / ft.		CHECKED -	DE
PLOT DATE = 8/4/2020		DATE -	04/03/2020

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CONTRACT NO. 189-011
I-55/ROUTE 59 WILL COUNTY
BORING LOCATION PLAN SN:099-4666

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

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
I-55		WILL	1	1
		CONTRACT NO. 189-011		
		ILLINOIS	FED. AID PROJECT	



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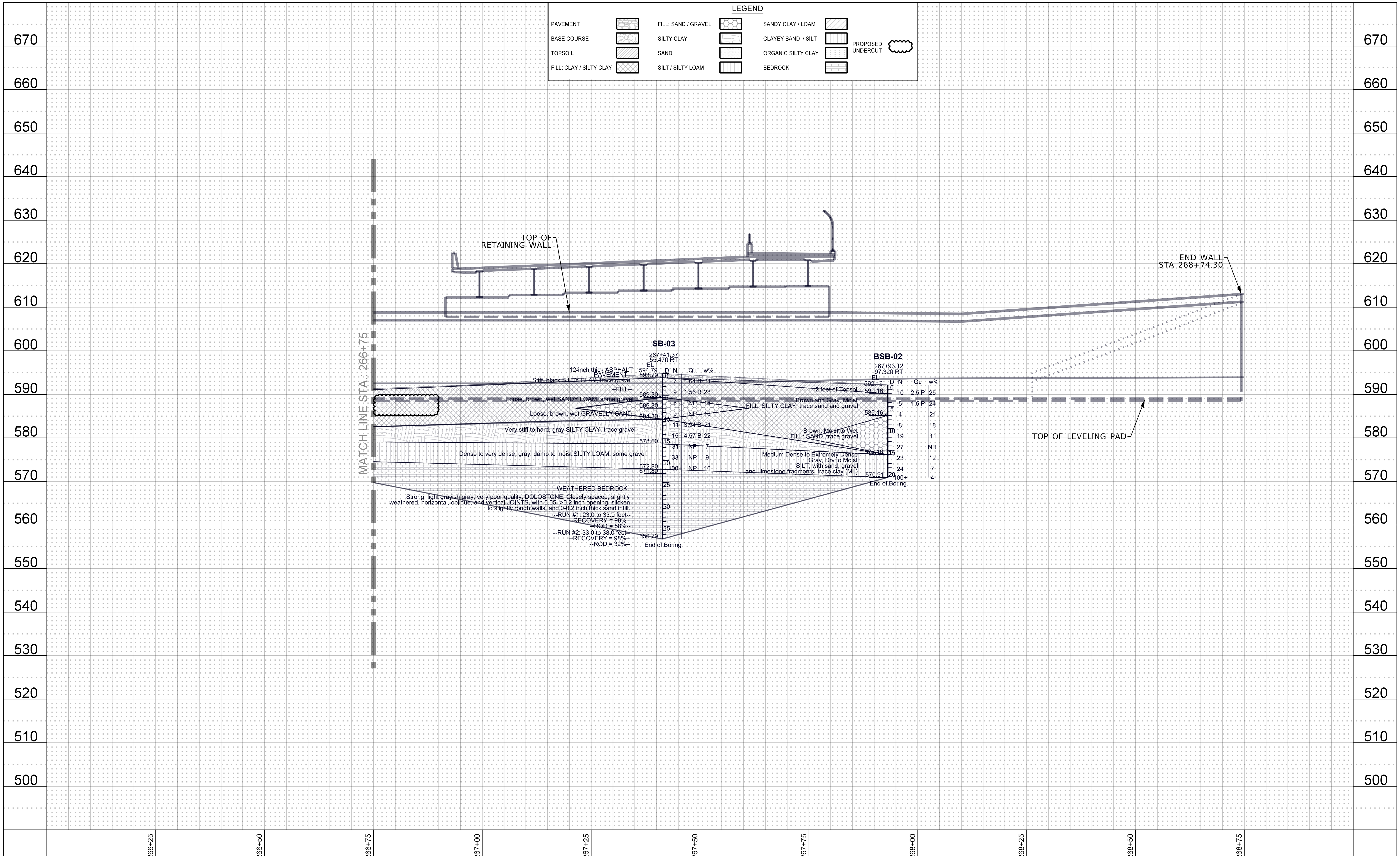
	PLOT SCALE = 240.0000 ' / ft.	CHECKED - DE		BORING LOCATION PLAN/PROFILE, SN:099-4666 EAST MSE WALL	COUNTY: WILL; TOTAL SHEETS: 3; SHEET NO.: 2
	PLOT DATE = 4/30/2020	DATE - 04/30/2020		SCALE: AS NOTED · SHEET 1 OF 2 SHEETS · STA. 264+75 TO STA. 266+75	CONTRACT NO. 2189-011; ILLINOIS FED. AID PROJECT



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TIME = 11:52:59 AM
SHEET SIZE = 1.41667x0.916667 (ft.)
PLOT SCALE = 240.0000 ' / ft.
USER NAME = nnano

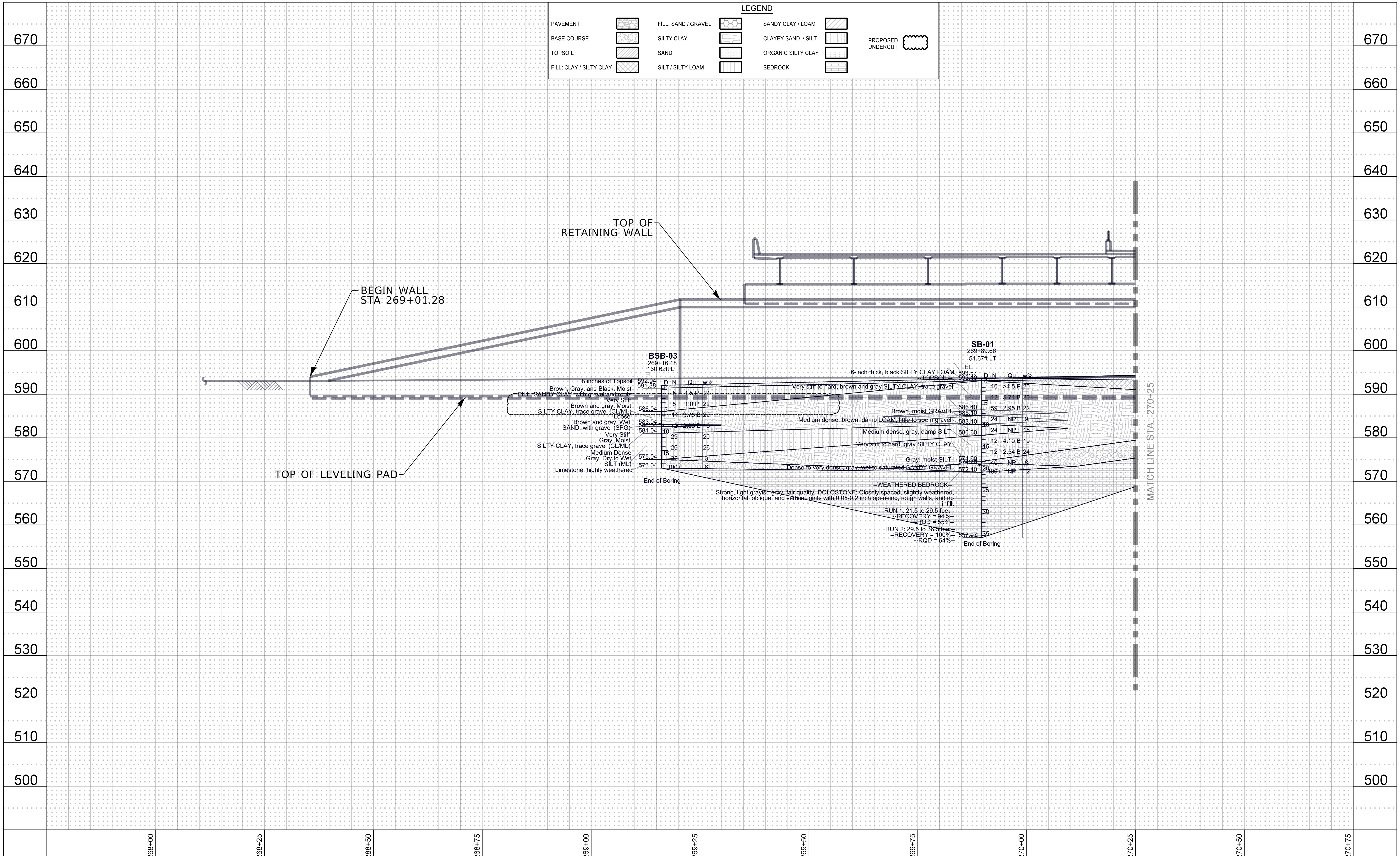
GSG CONSULTANTS, INC.
Engineers, Scientists & Construction Managers

USER NAME	= nnano	DESIGNED	-	SI
SHEET SIZE	= 1.41667x0.916667 (ft.)	DRAWN	-	NN
PLOT SCALE	= 240.0000 ' / ft.	CHECKED	-	DE
PLOT DATE	= 4/30/2020	DATE	-	04/30/2020

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CONTRACT NO. 189-011
I-55/ROUTE 59 WILL COUNTY
BORING LOCATION PLAN/PROFILE, SN:099-4666 EAST MSE WALL
SCALE: ____AS NOTED | SHEET 2 OF 2 SHEETS | STA. 266+75 TO STA. 268+75

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
I-55		WILL	3	3
		CONTRACT NO.	2189-011	
		ILLINOIS	FED. AID PROJECT	



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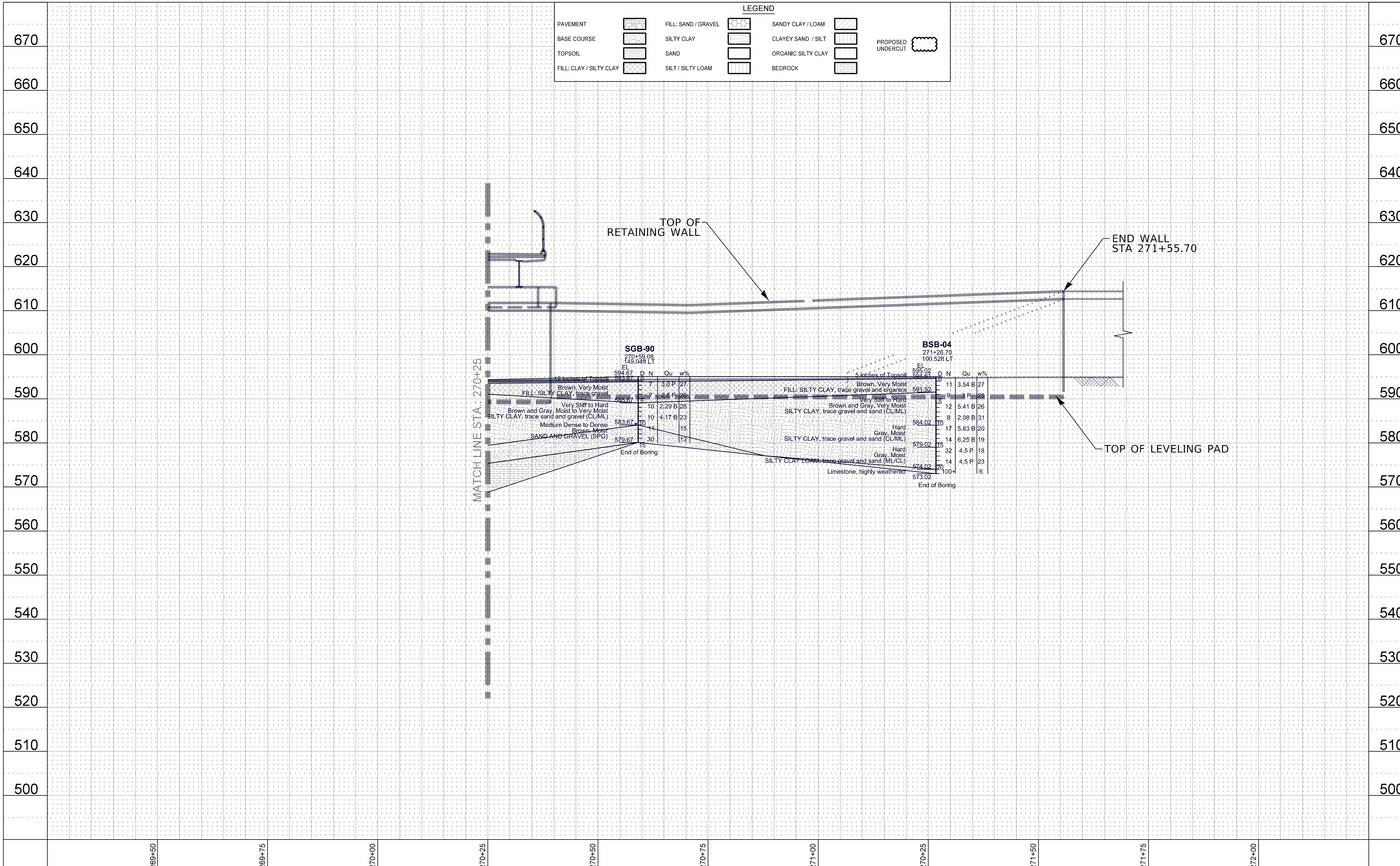
	SHEET SIZE = 1.41667x0.916667 (ft.)	DRAWN - NN		I-55/ROUTE 59 WILL COUNTY	
	PLOT SCALE = 240.0000 ' / ft.	CHECKED - DE		BORING LOCATION PLAN/PROFILE, SN:099-4666 WEST MSE WALL	
	PLOT DATE = 4/17/2020	DATE - 04/08/2020		SCALE: AS NOTED SHEET 1 OF 2 SHEETS STA. 268+00 TO STA. 270+25	

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
I-55		WILL	3	2
		CONTRACT NO. 2189-011		
	ILLINOIS	FED. AID PROJECT		



GSG CONSULTANTS, INC.

USER NAME	= nnano	DESIGNED	- SI
SHEET SIZE	= 1.41667x0.916667 (ft.)	DRAWN	- NN
PLOT SCALE	= 240.0000 ' / ft.	CHECKED	- DE
PLOT DATE	= 4/17/2020	DATE	- 04/08/2020

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CONTRACT NO. 189-011
I-55/ROUTE 59 WILL COUNTY
BORING LOCATION PLAN/PROFILE, SN:099-4666 WEST MSE WALL
SCALE: AS NOTED | SHEET 2 OF 2 SHEETS | STA. 270+25 TO STA. 271+75

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
I-55		WILL	3	3
		CONTRACT NO.	2189-011	
		ILLINOIS	FED. AID PROJECT	

APPENDIX C

SOIL BORING LOGS

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

BORING LOG SB-01

WEI Job No.: 555-16-04

Client: **IDOT**
Project: **I-55 at IL 59**
Location: **Will County, IL**

Datum: NAVD 88
Elevation: 593.57 ft
North: 1761463.96 ft
East: 1021245.35 ft
Station: NA
Offset: NA

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
593.1	6-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Very stiff to hard, brown and gray SILTY CLAY, trace gravel --RDR 2--		1	5 5 5	> 4.50 P	20
		5	2	4 5 7	5.74 B	20
586.4	--hard drilling to 8.5 feet-- --offset boring 7 feet east--		3	3 29 30	2.95 B	22
585.1	Brown, moist GRAVEL --strong oil odor--					
583.1	Medium dense, brown, damp LOAM, little to some gravel --RDR 2--	10	4	11 10 14	NP	9
580.6	Medium dense, gray, damp SILT --RDR 2--		5	5 11 13	NP	15
	Very stiff to hard, gray SILTY CLAY --RDR 2-- --<1-inch thick, damp silt laminations-- --L_L(%)=31, P_L(%)=18-- --%Gravel=0.0-- --%Sand=0.2-- --%Silt=67.0-- --%Clay=32.7-- --A-6 (13)--	15	6	3 5 7	4.10 B	19
574.6			7	6 6 6	2.54 B	24
574.2	Gray, moist SILT					
572.1	Dense to very dense, gray, wet to saturated SANDY GRAVEL --RDR 2 to 4--	20	8	6 20 20	NP	8
	--WEATHERED BEDROCK--		9	50/1"	NP	12
	Strong, light grayish gray, fair quality, DOLOSTONE; Closely spaced, slightly weathered, horizontal, oblique, and vertical joints, with 0.05 - 0.2 inch opening, rough walls, and no infill.	25	10	CORE		
	--RUN 1: 21.5 to 29.5 feet-- --RECOVERY = 94%-- --RQD = 55%--					
	--RUN 2: 29.5 to 36.5 feet-- --RECOVERY = 100%-- --RQD = 64%--	30	11	CORE		
		35				
557.1	Boring terminated at 36.50 ft					
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **10-01-2018** Complete Drilling **10-01-2018**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50T [81%]**
Driller **J&K** Logger **M. Ciapas** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; auto hammer; boring grouted backfilled**

WATER LEVEL DATA

While Drilling ▽ **20.00 ft**
At Completion of Drilling ▼ **17.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**
The stratification lines represent the approximate boundary between soil types: the actual transition may be gradual.

0 6 inches

Boring SB-01:
Run #1, 21.5' to 29.5'
RECOVERY=94%
RQD=55%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	APPENDIX C-1	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		555-16-04

0 6 inches

Boring SB-01:
Run #2, 29.5' to 36.5'
RECOVERY=100%
RQD=64%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	APPENDIX C-2	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		555-16-04

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

BORING LOG SB-02

WEI Job No.: 555-16-04

Client: **IDOT**
Project: **I-55 at IL 59**
Location: **Will County, IL**

Datum: NAVD 88
Elevation: 593.07 ft
North: 1761306.37 ft
East: 1021297.20 ft
Station: NA
Offset: NA

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	12-inch thick ASPHALT --PAVEMENT--					
592.1	Medium dense to dense, gray, moist SANDY GRAVEL --FILL-- --RDR 2--		1	5 20 18	NP	5
		5	2	5 7 5	NP	5
587.6	Stiff to very stiff, brown and gray CLAY to SILTY CLAY --RDR 2--		3	3 3 3	1.64 B	23
		10	4	2 4 6	2.30 B	22
	--damp silt lenses--		5	3 5 7	2.95 S	22
580.1	Very stiff, gray SILTY CLAY LOAM, trace gravel --RDR 2-- --L_L(%)=29, P_L(%)=18-- --%Gravel=0.0-- --%Sand=0.4-- --%Silt=70.3-- --%Clay=29.2-- --A-6 (10)--	15	6	3 9 12	3.50 N/6	17
			7	4 12 22	3.28 B	15
576.1	Medium dense to dense, gray, wet GRAVELLY LOAM --RDR 3--	20	8	7 11 18	NP	11
572.6	Very dense, gray, saturated SANDY GRAVEL		9	50/4"	NP	8
571.1	Strong, light grayish gray, fair quality, DOLOSTONE; Closely spaced, fresh, horizontal JOINTS, with 0.05 - 0.2 inch opening, slicken walls, and no infill. -- Run 1: 22.0 to 32.0 feet-- --Recovery = 98%-- --RQD = 56%--	25, 30	1	CORE		
	-- Run 2: 32.0 to 33.5 feet-- --Recovery = 0%-- --RQD = 0%-- --core barrel jammed--		2	CORE		
559.6	Boring terminated at 33.50 ft	35, 40, 45, 50				

GENERAL NOTES

Begin Drilling **10-07-2018** Complete Drilling **10-07-2018**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50T [81%]**
Driller **J&K** Logger **F. Bozga** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; auto hammer; boring grouted backfilled**

WATER LEVEL DATA

While Drilling ▽ **17.00 ft**
At Completion of Drilling ▼ **17.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

0 6 inches

Boring SB-02:
Run #1, 22.0' to 32.0'
RECOVERY=98%
RQD=56%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**APPENDIX C-3**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**

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

BORING LOG SB-03

WEI Job No.: 555-16-04

Client: **IDOT**
Project: **I-55 at IL 59**
Location: **Will County, IL**

Datum: NAVD 88
Elevation: 594.79 ft
North: 1761218.45 ft
East: 1021359.88 ft
Station: NA
Offset: NA

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
593.8	12-inch thick ASPHALT --PAVEMENT--					
	Stiff, black SILTY CLAY, trace gravel --FILL-- --RDR 2--		1	3 3 4	1.64 B	31
589.3	--L$_L$(%)=56, P$_L$(%)=21-- --%Gravel=0.1-- --%Sand=6.3-- --%Silt=61.8-- --%Clay=31.8-- --A-7-6 (36)--	5	2	4 4 5	1.56 B	28
586.8	Loose, brown, wet SANDY LOAM, some gravel --RDR 2--		3	2 3 3	NP	18
584.3	Loose, brown, wet GRAVELLY SAND --RDR 2--	10	4	4 4 5	NP	18
	Very stiff to hard, gray SILTY CLAY, trace gravel --RDR 2--		5	2 3 8	3.94 B	21
		15	6	3 7 8	4.57 B	22
578.6	--Qu= 1.5 tsf--					
	Dense to very dense, gray, damp to moist SILTY LOAM, some gravel --RDR 2 to 4-- --hard drilling; slow advancement--		7	25 15 16	NP	7
		20	8	10 15 18	NP	9
572.8			9	13 21 50/2"	NP	10
571.8	Brown DOLOSTONE fragments --very hard, steady drilling-- --WEATHERED BEDROCK--					
	Strong, light grayish gray, very poor quality, DOLOSTONE;	25		CORE		
	Closely spaced, slightly weathered, horizontal, oblique, and vertical JOINTS, with 0.05 -> 0.2 inch opening, slicken to slightly rough walls, and 0 - 0.2 inch thick sand infill. --RUN #1: 23.0 to 33.0 feet-- --RECOVERY = 98%-- --RQD = 58%--	30	10			
	--RUN #2: 33.0 to 38.0 feet-- --RECOVERY = 98%-- --RQD = 32%--	35	11	CORE		
556.8	Boring terminated at 38.00 ft	40				
		45				
		50				

GENERAL NOTES

Begin Drilling **10-02-2018** Complete Drilling **10-02-2018**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50T [81%]**
Driller **J&K** Logger **M. Ciapas** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; auto hammer; boring grouted backfilled**

WATER LEVEL DATA

While Drilling ▽ **5.50 ft**
At Completion of Drilling ▼ **17.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

0 6 inches

Boring SB-03:
Run #1, 23.0' to 33.0'
RECOVERY=98%
RQD=58%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**APPENDIX C-4**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**

0 6 inches

Boring SB-03:
Run #2, 33.0' to 38.0'
RECOVERY=98%
RQD=32%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**APPENDIX C-5**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**

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

SOIL BORING LOG

Date 11/20/19

ROUTE I-55 and IL 59 **DESCRIPTION** IL 59 NB DDI over I-55 **LOGGED BY** MH

SECTION 2018-075-R **LOCATION** I-55 NB off shoulder, **SEC.** , **TWP.** , **RNG.** ,
Latitude , **Longitude**

COUNTY WILL **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. SN 099-4666
Station 8018+16.41

BORING NO. BSB-01
Station 265+91.58
Offset 108.95ft RT
Ground Surface Elev. 591.47 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	591.14				
Brown, Wet FILL: SAND AND GRAVEL	589.47		3 4 7		27
Brown and Gray, Very Moist FILL: SILTY CLAY, trace gravel		-5	2 4 6	2.0 P	25
			2 4 6	4.6 B	26
	580.47	-10	3 4 7	4.8 B	31
Very Stiff Gray, Moist SILTY CLAY, trace sand (CL/ML)	577.47		2 5 7	2.9 B	20
		-15	2 5 7		19
Medium Dense to Dense Gray, Moist SILT, with clay and Limestone fragments (ML)			9 16 13		18
		-20	14 14 19		23
Augur refusal at 20.5 feet Apparent bedrock at 20.5 feet	570.97				
End of Boring		-25, -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 11/19/19

ROUTE I-55 and IL 59 **DESCRIPTION** Il 59 (DDI) NB **LOGGED BY** MH

SECTION 2018-075-R **LOCATION** I-55 NB off shoulder, **SEC.** , **TWP.** , **RNG.** ,
Latitude , **Longitude**

COUNTY WILL **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. SN 099-4666
Station 8018+16.41

BORING NO. SGB-87
Station 266+46.68
Offset 142.16ft RT
Ground Surface Elev. 590.27 ft

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

Groundwater Elev.:
First Encounter 581.3 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	589.94				
Brown and Gray, Moist FILL: SILTY CLAY, trace sand and gravel			4		
			4	1.3	18
			5	B	
			1		
			3	0.2	20
		-5	3	B	
	584.27				
Brown, Wet FILL: SAND WITH GRAVEL COARSE			2		
			3		20
			4		
	581.77				
Very Stiff Gray, Moist SILTY CLAY (CL/ML)		▼	2		
			2	2.7	20
		-10	4	B	
	579.27				
Medium Dense Gray, Moist to Wet SILTY SAND, with gravel and limestone fragments (SM)			10		
			11		8
			12		
			5		
			8		19
	575.27	-15	11		
End of Boring					
		-20			

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 11/20/19

ROUTE I-55 and IL 59 **DESCRIPTION** IL 59 NB DDI over I-55 **LOGGED BY** MH

SECTION 2018-075-R **LOCATION** I-55 NB off shoulder, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**

COUNTY WILL **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. SN 099-4666
Station 8018+16.41

BORING NO. BSB-02
Station 267+93.12
Offset 97.32ft RT
Ground Surface Elev. 592.16 ft

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

Groundwater Elev.:
First Encounter 585.2 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
12 inches of Topsoil	591.16				
Brown and Gray, Moist FILL: SILTY CLAY, trace sand and gravel			2 5 5	2.5 P	25
		-5	2 2 3	1.5 P	24
	585.16 ▼		2 2 2		21
Brown, Moist to Wet FILL: SAND, trace gravel		-10	2 3 5		18
			2 7 12		11
		-15	10 11 16		NR
	576.16				
Medium Dense to Extremely Dense Gray, Dry to Moist SILT, with sand, gravel and Limestone fragments, trace clay (ML)			8 11 12		12
		-20	12 11 13		7
Augur refusal at 21.25 feet Top of bedrock at 21.25 feet	570.91		50/3"		4
End of Boring		-25			
		-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)

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Division of Highways
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SOIL BORING LOG

Date 10/23/19

ROUTE I-55 and IL 59 **DESCRIPTION** IL 59 NB DDI over I-55 **LOGGED BY** TEK

SECTION 2018-075-R **LOCATION** I-55 SB off shoulder, **SEC.** , **TWP.** , **RNG.** ,
Latitude , **Longitude**

COUNTY WILL **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. SN 099-4666
Station 8018+16.41

BORING NO. BSB-03
Station 269+16.18
Offset 130.62ft LT
Ground Surface Elev. 592.04 ft

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

Groundwater Elev.:
First Encounter 583.0 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
8 inches of Topsoil	591.38				
Brown, Gray, and Black, Moist FILL: SANDY CLAY, with gravel and roots			2 2 3	1.5 P	21
		-5	1 2 3	1.0 P	22
	586.04				
Very Stiff Brown and gray, Moist SILTY CLAY, trace gravel (CL/ML)			3 4 7	3.8 B	22
	583.04 ▼				
Loose Brown and gray, Wet SAND, with gravel (SPG)	582.54	-10	4 6 6	2.1 B	18
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)	581.04				
Medium Dense Gray, Dry to Wet SILT (ML)			9 11 18		20
		-15	5 9 17		26
	575.04		5 8 14		3
LIMESTONE, highly weathered					
Auger refusal at 19.0 feet	573.04		50/4"		6
End of Boring		-20			

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
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SOIL BORING LOG

Date 10/22/19

ROUTE I-55 and IL 59 **DESCRIPTION** I-55 at IL 59 Interchange **LOGGED BY** NP

SECTION 2018-075-R **LOCATION** I-55 NB to IL-59 NB, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**

COUNTY WILL **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. SN 099-4666
Station 8018+16.41

BORING NO. SGB-90
Station 270+59.08
Offset 149.04ft LT
Ground Surface Elev. 594.67 ft

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

Groundwater Elev.:
First Encounter 583.7 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
12 inches of Topsoil	593.67				
Brown, Very Moist FILL: SILTY CLAY, trace gravel			3 4 3	3.0 P	27
		-5	2 3 4	2.5 P	26
	588.67				
Very Stiff to Hard Brown and Gray, Moist to Very Moist SILTY CLAY, trace sand and gravel (CL/ML)			3 4 6	2.3 B	28
		-10	2 4 6	4.2 B	23
	583.67 ▼				
Medium Dense to Dense Brown, Moist SAND AND GRAVEL (SPG)			3 5 6		15
	579.67	-15	9 12 18		13
End of Boring		-20			

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 10/22/19

ROUTE I-55 and IL 59 **DESCRIPTION** IL 59 NB DDI over I-55 **LOGGED BY** NP

SECTION 2018-075-R **LOCATION** I-55 SB off shoulder, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**

COUNTY WILL **DRILLING METHOD** HSA **HAMMER TYPE** AUTO

STRUCT. NO. SN 099-4666
Station 8018+16.41

BORING NO. BSB-04
Station 271+26.70
Offset 100.52ft LT
Ground Surface Elev. 595.02 ft

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

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

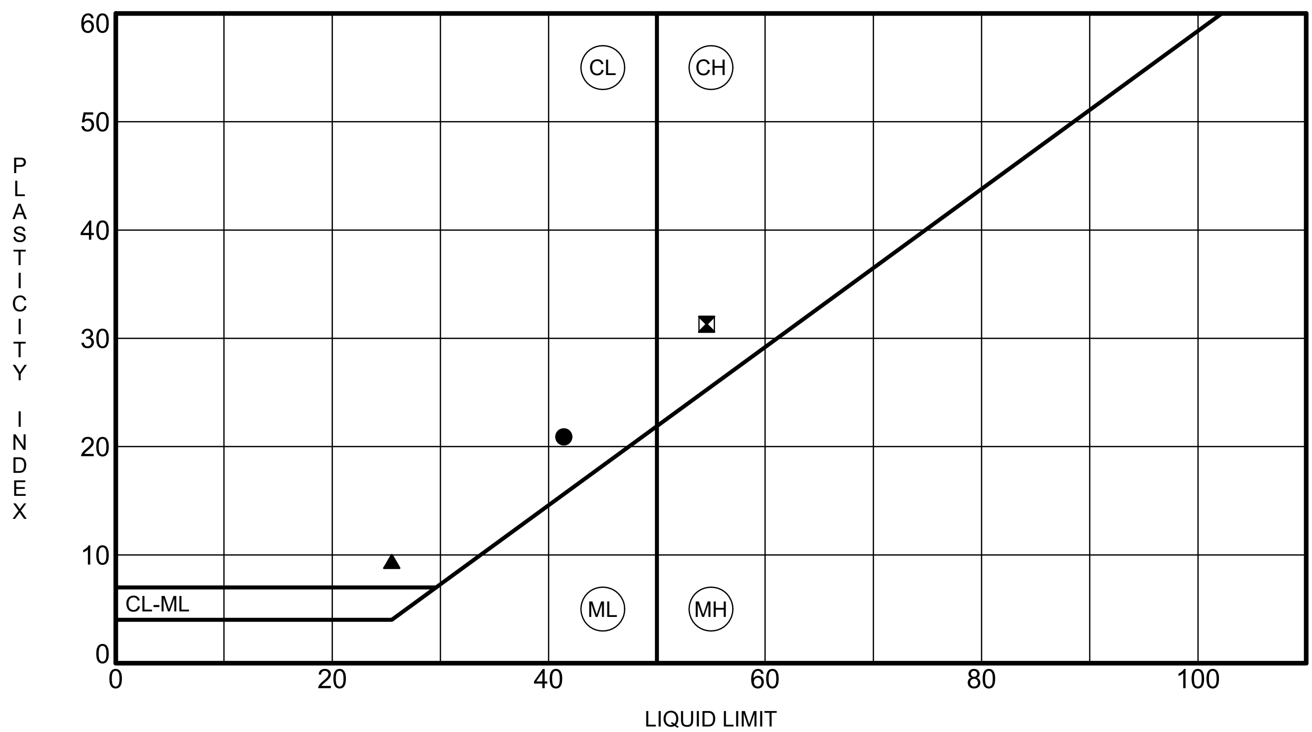
Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
5 inches of Topsoil	594.61				
Brown, Very Moist FILL: SILTY CLAY, trace gravel and organics			4 5 6	3.5 B	27
	591.52				
Very Stiff to Hard Brown and Gray, Very Moist SILTY CLAY, trace gravel and sand (CL/ML)		-5	2 4 5	3.0 P	25
			3 5 7	5.4 B	26
	586.52				
Very Stiff Brown and Gray, Very Moist CLAY, trace gravel and sand (CH)		-10	2 3 5	2.1 B	31
	584.02				
Hard Gray, Moist SILTY CLAY, trace gravel and sand (CL/ML)			4 7 10	5.8 B	20
		-15	3 6 8	6.3 B	19
	579.02				
Hard Gray, Moist SILTY CLAY LOAM, trace gravel and sand (ML/CL)			6 15 17	4.5 P	18
		-20	4 6 8	4.5 P	23

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
	574.02				
LIMESTONE, highly weathered			22		
Auger refusal at 22.0 feet	573.02		50/1"		6
End of Boring		-25			
		-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



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**BSB-01**	**8.50**	**41.4**	**20.5**	**20.9**		
⊠	**BSB-04**	**8.50**	**54.6**	**23.3**	**31.3**		
▲	**SGB-87**	**8.50**	**25.5**	**16.1**	**9.4**		

Illinois Department of Transportation

Division of Highways
GSG Consultants, Inc.

ATTERBERG LIMITS' RESULTS

Route: I-55 and IL 59, SN: 099-4666

Section: 2018-075-R

County: WILL

GSG CONSULTANTS, INC.
ENGINEERS • SCIENTISTS • CONSTRUCTION MANAGERS

623 Cooper Court • Schaumburg, IL 60173
Tel: 630.994.2600 • Fax: 312.733.5612

Table D1a–East and West Retaining Walls Test Results – Atterberg Limits

Boring ID	Sample Depth (ft)	Liquid Limit (%)	Plastic Limit (%)	Plasticity Index (%)	Soil Classification
BSB-01	8.5-10	41.4	20.5	20.9	Fill
BSB-04	8.5-10	54.6	23.3	31.3	CH
SGB-87	8.5-10	25.5	16.1	9.4	Fill

Table D1b– East and West Retaining Walls Test Results – Organic Content

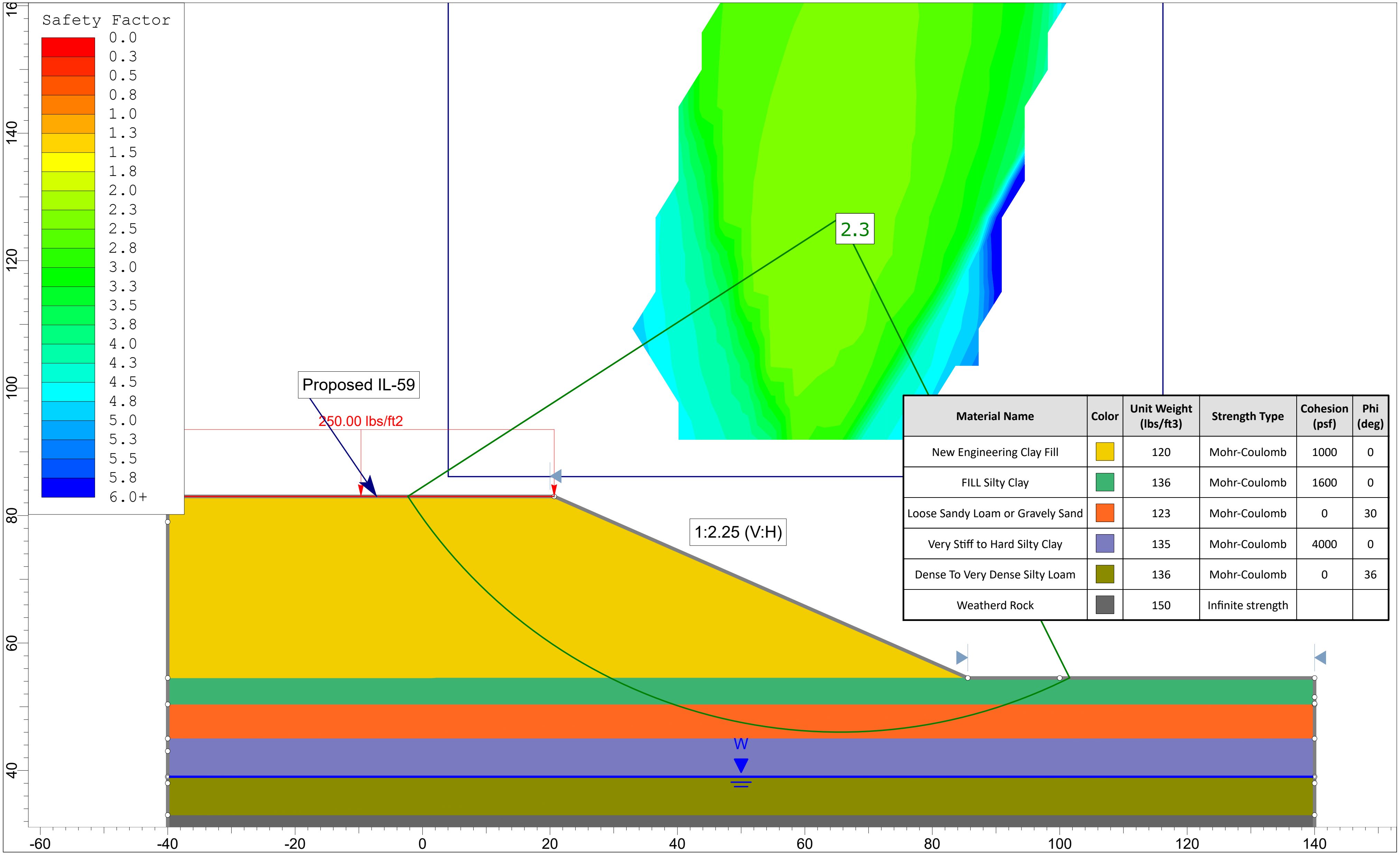
Boring ID	Sample Depth (ft)	Organic Content (%)	Soil Classification
BSB-01	8.5-10	3.7	Fill
BSB-04	8.5-10	3.9	CL

APPENDIX E

SLOPE STABILTY ANALYSIS

FOR APPROACH

EMBANKMENT



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineering Clay Fill		120	Mohr-Coulomb	1000	0
FILL Silty Clay		136	Mohr-Coulomb	1600	0
Loose Sandy Loam or Gravely Sand		123	Mohr-Coulomb	0	30
Very Stiff to Hard Silty Clay		135	Mohr-Coulomb	4000	0
Dense To Very Dense Silty Loam		136	Mohr-Coulomb	0	36
Weatherd Rock		150	Infinite strength		

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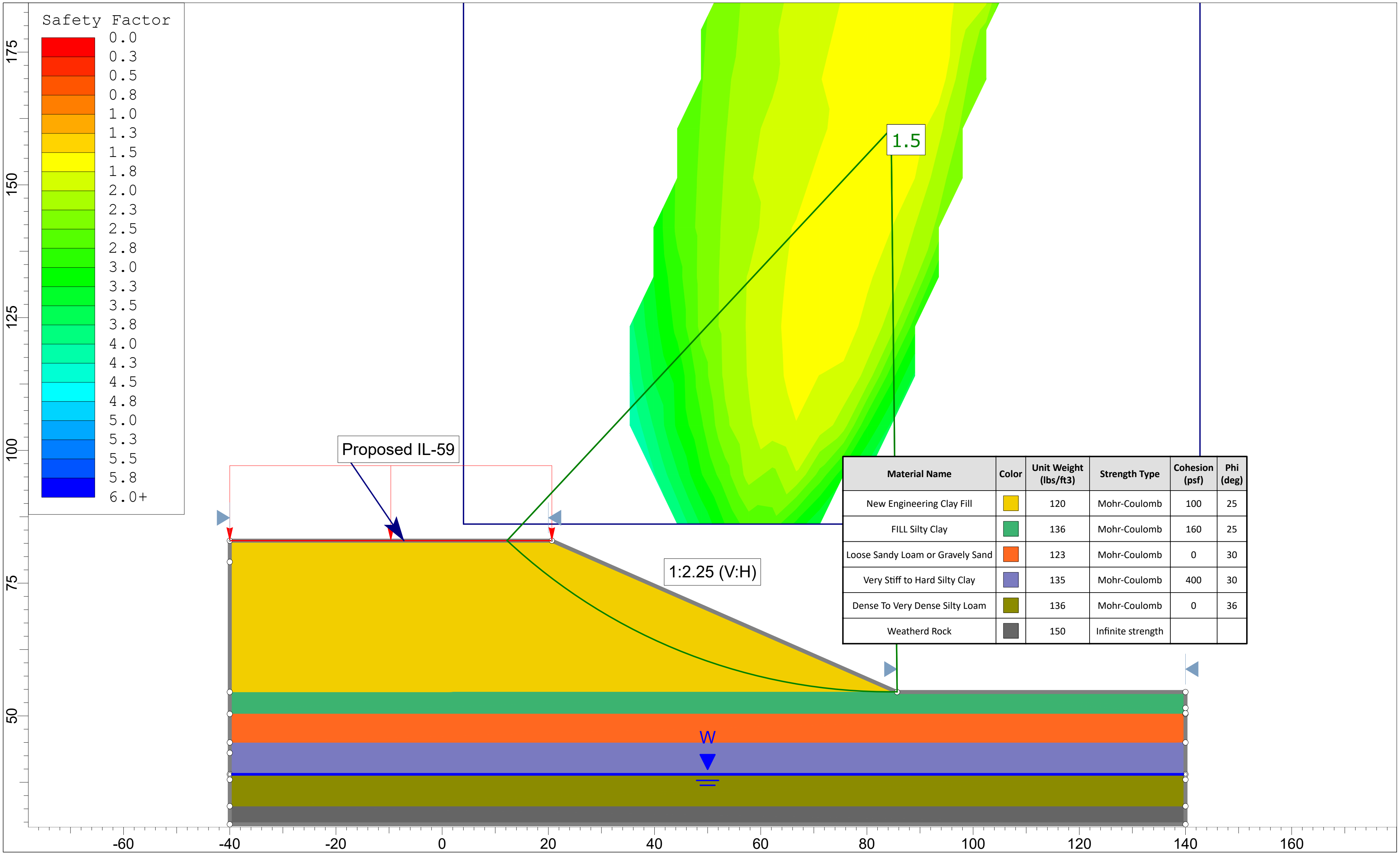
SLIDEINTERPRET 8.021

Project	Contract IDOT\189-011 East Approach Embankment (Boring SB-03)		
Analysis Description	Exhibit 1a: Circular Failure Short Term - Undrained		
Drawn By SI	*Scale* 1:250	*Company*	GSG Consultants, Inc.
Date	04/13/2020	*File Name*	Eastwall-short term



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineering Clay Fill		120	Mohr-Coulomb	100	25
FILL Silty Clay		136	Mohr-Coulomb	160	25
Loose Sandy Loam or Gravely Sand		123	Mohr-Coulomb	0	30
Very Stiff to Hard Silty Clay		135	Mohr-Coulomb	400	30
Dense To Very Dense Silty Loam		136	Mohr-Coulomb	0	36
Weatherd Rock		150	Infinite strength		

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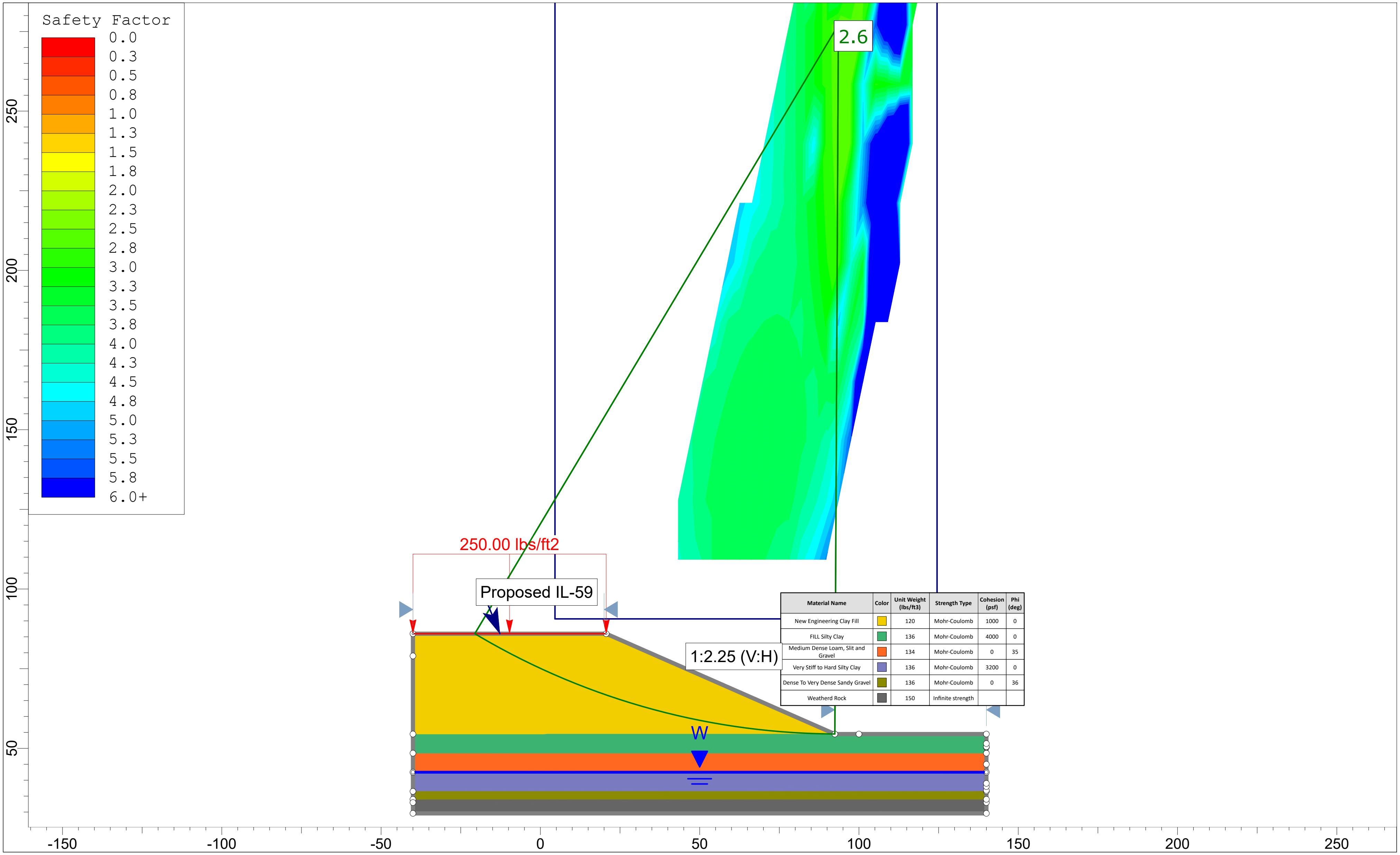
SLIDEINTERPRET 8.021

Project	Contract IDOT\189-011 East Approach Embankment (Boring SB-03)
Analysis Description	Exhibit 1b: Circular Failure Long Term - Drained
Drawn By	SI
Scale	1:300
Company	GSG Consultants, Inc.
Date	04/13/2020
File Name	Eastwall-long term



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineering Clay Fill		120	Mohr-Coulomb	1000	0
FILL Silty Clay		136	Mohr-Coulomb	4000	0
Medium Dense Loam, Slit and Gravel		134	Mohr-Coulomb	0	35
Very Stiff to Hard Silty Clay		136	Mohr-Coulomb	3200	0
Dense To Very Dense Sandy Gravel		136	Mohr-Coulomb	0	36
Weatherd Rock		150	Infinite strength		

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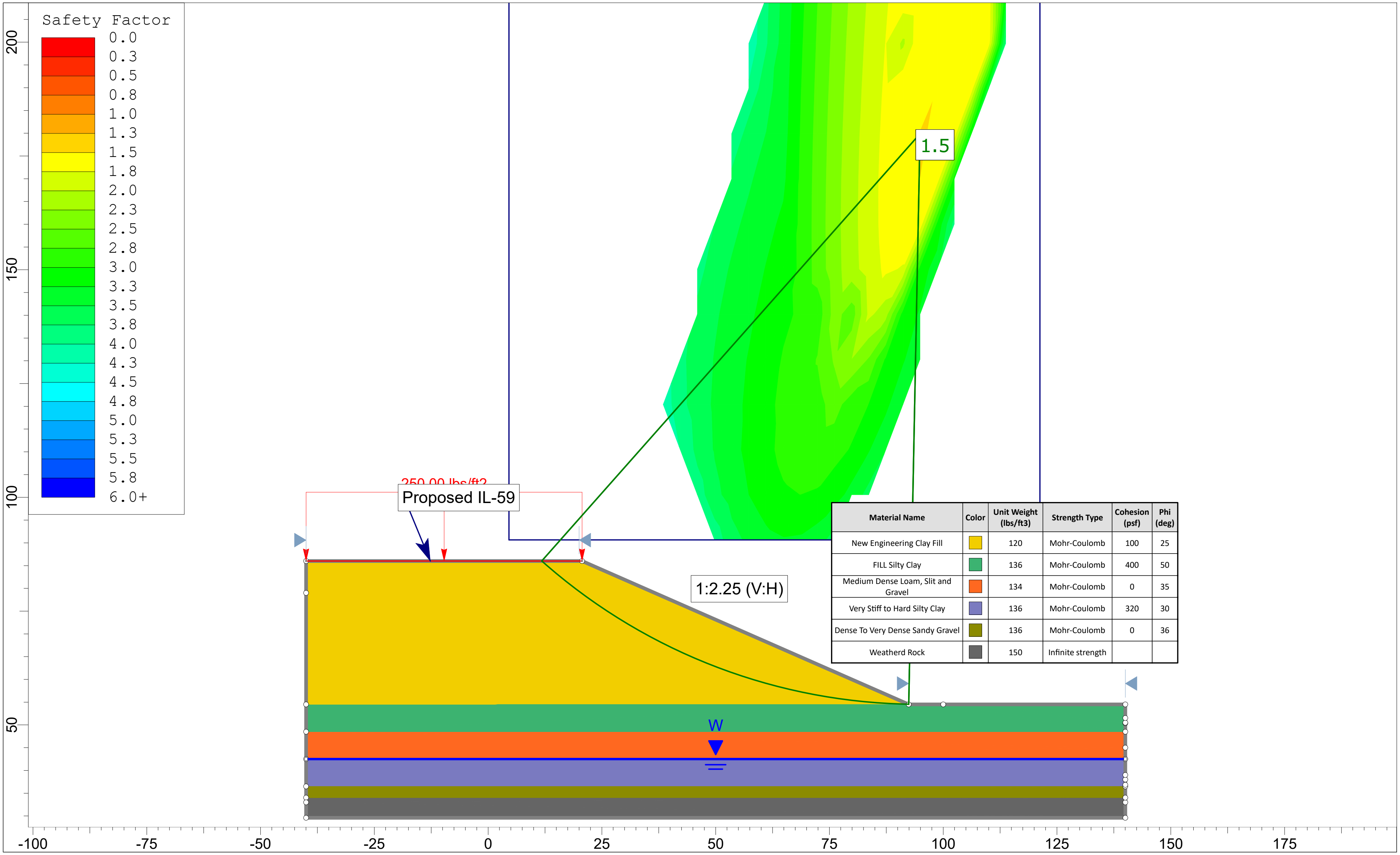
SLIDEINTERPRET 8.021

Project	Contract IDOT\189-011 West Approach Embankment (Boring SB-01)
Analysis Description	Exhibit 1c: Circular Failure Short Term - Undrained
Drawn By	SI
Scale	1:500
Company	GSG Consultants, Inc.
Date	04/13/2020
File Name	Westwall-short term



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineering Clay Fill		120	Mohr-Coulomb	100	25
FILL Silty Clay		136	Mohr-Coulomb	400	50
Medium Dense Loam, Slit and Gravel		134	Mohr-Coulomb	0	35
Very Stiff to Hard Silty Clay		136	Mohr-Coulomb	320	30
Dense To Very Dense Sandy Gravel		136	Mohr-Coulomb	0	36
Weathered Rock		150	Infinite strength		

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SLIDEINTERPRET 8.021

Project	Contract IDOT\189-011 West Approach Embankment (Boring SB-01)
Analysis Description	Exhibit 1d: Circular Failure Long Term - Drained
Drawn By SI	*Scale* 1:350
Company	GSG Consultants, Inc.
Date	04/13/2020
File Name	Westwall-long term

APPENDIX F

IDOT PILE TABLE WITH PRECORE FOR APPROACH BENT

Pile Design Table for SN 099-4666 west approah slab utilizing Boring #SB-01, precore to 580 ft

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls				**Steel HP 10 X 42**				**Steel HP 12 X 84**			
	35	19	32.3		5	3	32		10	5	32
	39	21	34.1		20	11	34.1		27	15	34
	238	131	38		49	27	38		66	36	37.6
Metal Shell 14"Φ w/.25" walls					72	40	40.1		105	58	40.1
	48	26	32.3		133	73	41		179	98	40.6
	50	27	34.1		194	106	41.1		253	139	41
	316	174	37.6		254	140	41.6		327	180	42
Metal Shell 14"Φ w/.312" walls					335	184	42.6		664	365	44.1
	48	26	32.3	**Steel HP 10 X 57**				**Steel HP 14 X 73**			
	50	27	34		7	4	32.3		9	5	32.3
	316	174	37.6		21	12	34.1		30	16	34.1
Metal Shell 16"Φ w/.312" walls					52	29	38		72	40	37.6
	62	34	34.1		80	44	40		110	61	40.1
	406	223	37.6		141	78	40.6		197	108	41
Metal Shell 16"Φ w/.375" walls					202	111	41.1		284	156	41.1
	62	34	34.1		263	145	41.6		371	204	41.6
	406	223	37.6		454	250	43.6		578	318	43.1
Steel HP 8 X 36				**Steel HP 12 X 53**				**Steel HP 14 X 89**			
	4	2	32		6	3	32.3		10	6	32
	16	9	34.1		24	13	34.1		31	17	34.1
	39	22	37.6		59	32	37.6		76	42	37.6
	59	33	40.1		88	48	40.1		119	65	40.1
	108	59	40.6		160	88	40.6		207	114	40.6
	156	86	41.1		232	128	41		294	162	41.1
	205	113	41.6		304	167	42		382	210	41.6
	286	157	42.6		418	230	43		705	388	43.6
				Steel HP 12 X 63				**Steel HP 14 X 102**			
					7	4	32		12	7	32.3
					25	14	34		32	18	34
					61	34	38		79	43	38
					94	52	40.1		126	69	40
					167	92	40.6		214	118	40.6
					240	132	41		302	166	41
					314	172	42		390	214	41.6
					497	273	43		810	445	44.1
				Steel HP 12 X 74				**Steel HP 14 X 117**			
					9	5	32.3		14	8	32.3
					26	14	34.1		33	18	34
					64	35	38		82	45	37.6
					100	55	40		134	74	40.1
					173	95	41		223	123	40.6
					247	136	41.1		312	171	41.1
					321	176	41.6		400	220	41.6
					589	324	44		929	511	45
								Precast 14"x 14"			
									61	34	32.3
									63	35	34

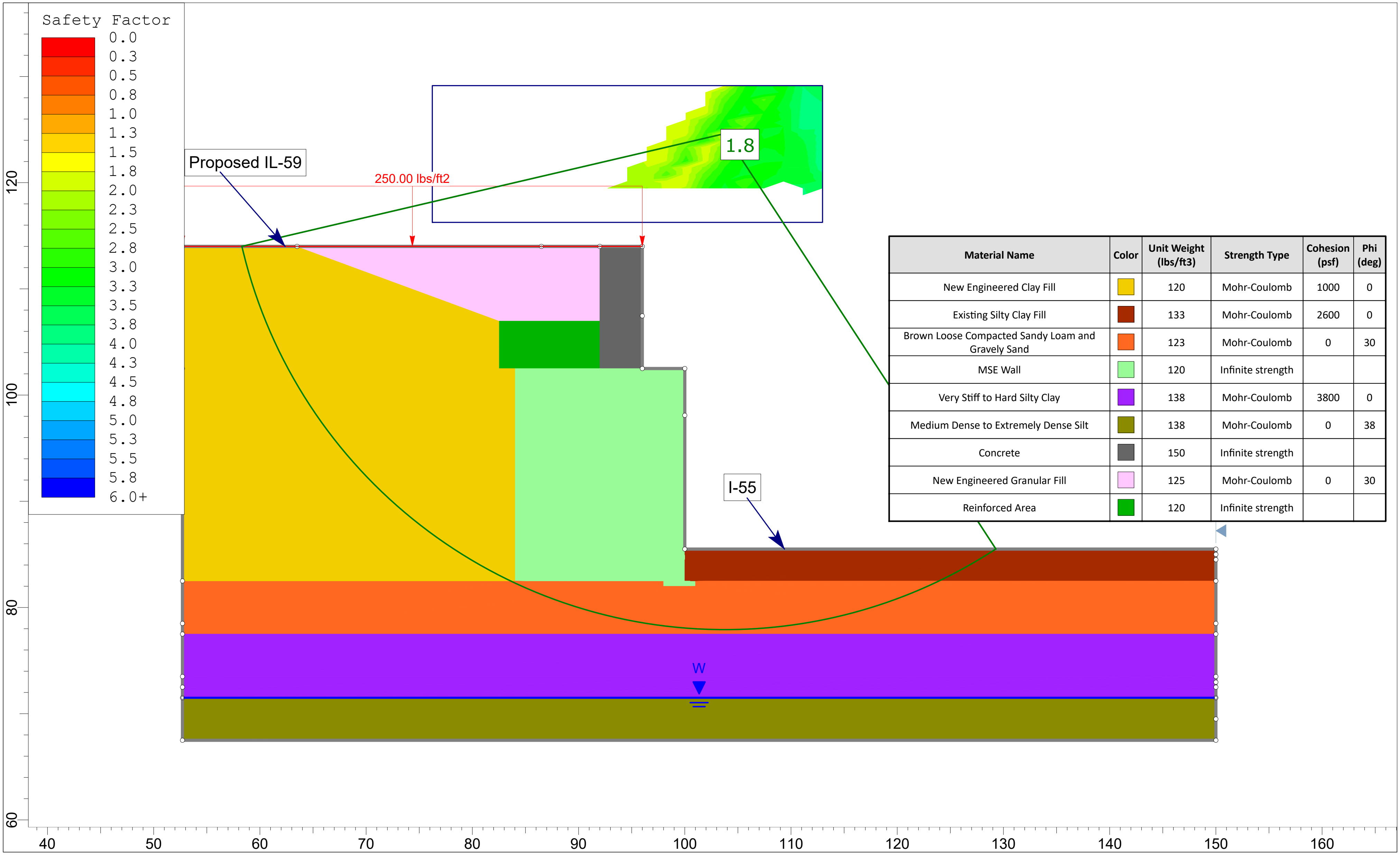
Pile Design Table for SN 099-4666 east approach slab utilizing Boring #SB-03, precore to 580 ft

	Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)		Nominal Required Bearing (Kips)	Factored Resistance Available (Kips)	Estimated Pile Length (Ft.)
Metal Shell 12"Φ w/.25" walls				**Steel HP 10 X 42**				**Steel HP 12 X 84**			
	39	22	29		14	8	30		11	6	29
	160	88	30		21	12	32		22	12	30
	194	107	32		33	18	35		32	17	32
	304	167	35		60	33	37		49	27	35
Metal Shell 14"Φ w/.25" walls					335	184	40		90	50	37
	54	29	29	**Steel HP 10 X 57**					664	365	41
	217	119	30		7	4	29	**Steel HP 14 X 73**			
	258	142	32		16	9	30		10	5	29
	403	222	35		24	13	32		22	12	30
Metal Shell 14"Φ w/.312" walls					37	20	35		33	18	32
	54	29	29		68	37	37		51	28	35
	217	119	30		454	250	41		93	51	37
	258	142	32	**Steel HP 12 X 53**					578	318	40
	403	222	35		7	4	29	**Steel HP 14 X 89**			
Metal Shell 16"Φ w/.312" walls					17	9	30		12	6	29
	70	38	29		26	14	32		24	13	30
	282	155	30		40	22	35		36	20	32
	331	182	32		73	40	37		55	30	35
	516	284	35		418	230	40		101	56	37
Metal Shell 16"Φ w/.375" walls				**Steel HP 12 X 63**					705	388	41
	70	38	29		8	5	29	**Steel HP 14 X 102**			
	282	155	30		18	10	30		13	7	29
	331	182	32		28	15	32		26	14	30
	516	284	35		43	24	35		38	21	32
Steel HP 8 X 36					79	43	37		58	32	35
	11	6	30		497	273	40		108	60	37
	18	10	32	**Steel HP 12 X 74**					810	445	41
	27	15	35		10	5	29	**Steel HP 14 X 117**			
	49	27	37		20	11	30		15	8	29
	286	157	40		30	16	32		29	16	30
					46	25	35		41	22	32
					85	47	37		63	34	35
					589	324	41		116	64	37
									929	511	41
								Precast 14"x 14"			
									68	38	29

APPENDIX G

SLOPE STABILTY ANALYSIS

FOR MSE WALLS



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	1000	0
Existing Silty Clay Fill		133	Mohr-Coulomb	2600	0
Brown Loose Compacted Sandy Loam and Gravely Sand		123	Mohr-Coulomb	0	30
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		138	Mohr-Coulomb	3800	0
Medium Dense to Extremely Dense Silt		138	Mohr-Coulomb	0	38
Concrete		150	Infinite strength		
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		

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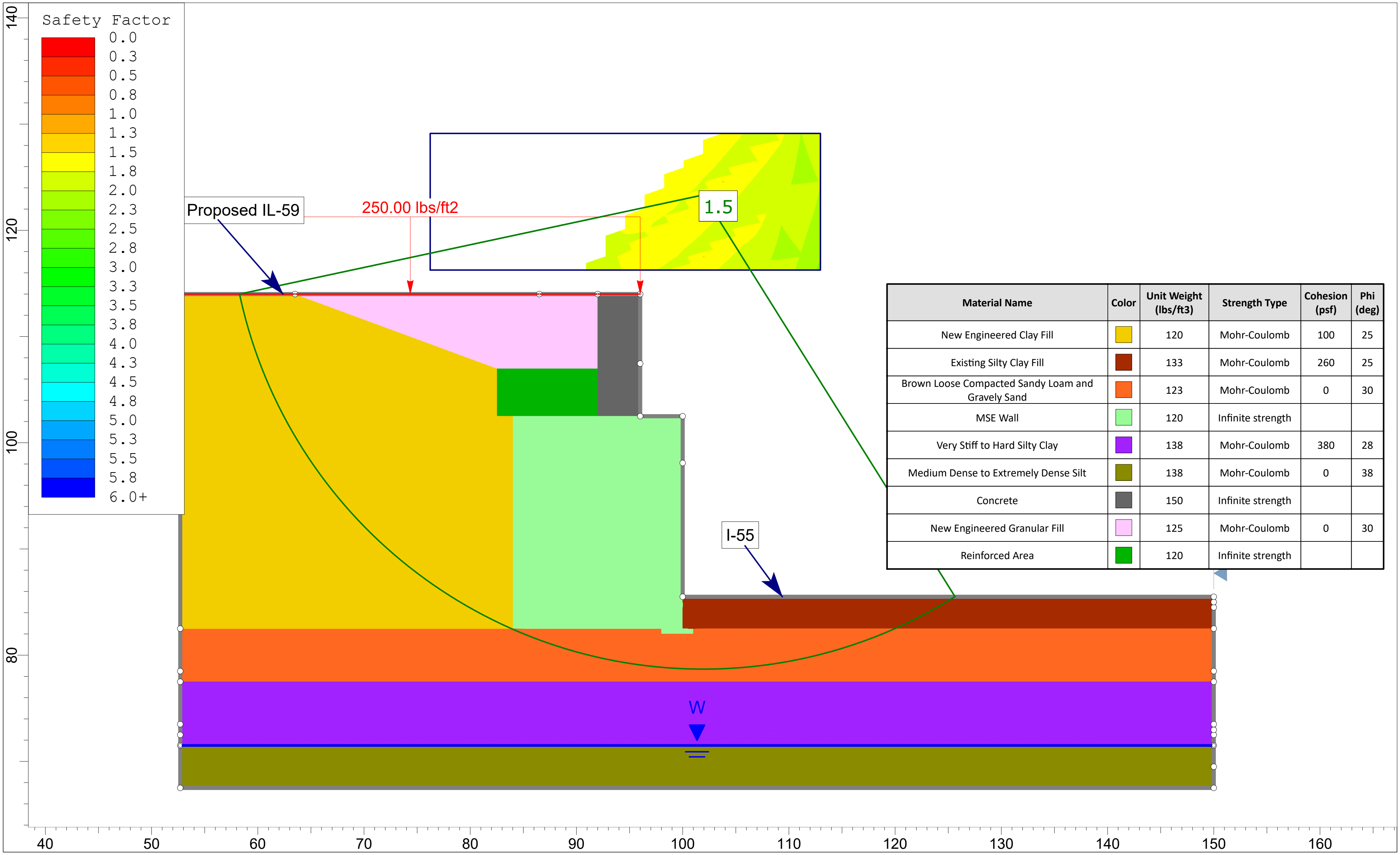
Project	Contract IDOT\189-011 East Abutment (Boring SB-03)		
Analysis Description	Exhibit 4a: Circular Failure Short Term - Undrained		
Drawn By SI	*Scale* 1:150	*Company*	GSG Consultants, Inc.
Date 04/21/2020		*File Name*	Eastwall-short term-Sta.267



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	100	25
Existing Silty Clay Fill		133	Mohr-Coulomb	260	25
Brown Loose Compacted Sandy Loam and Gravely Sand		123	Mohr-Coulomb	0	30
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		138	Mohr-Coulomb	380	28
Medium Dense to Extremely Dense Silt		138	Mohr-Coulomb	0	38
Concrete		150	Infinite strength		
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		

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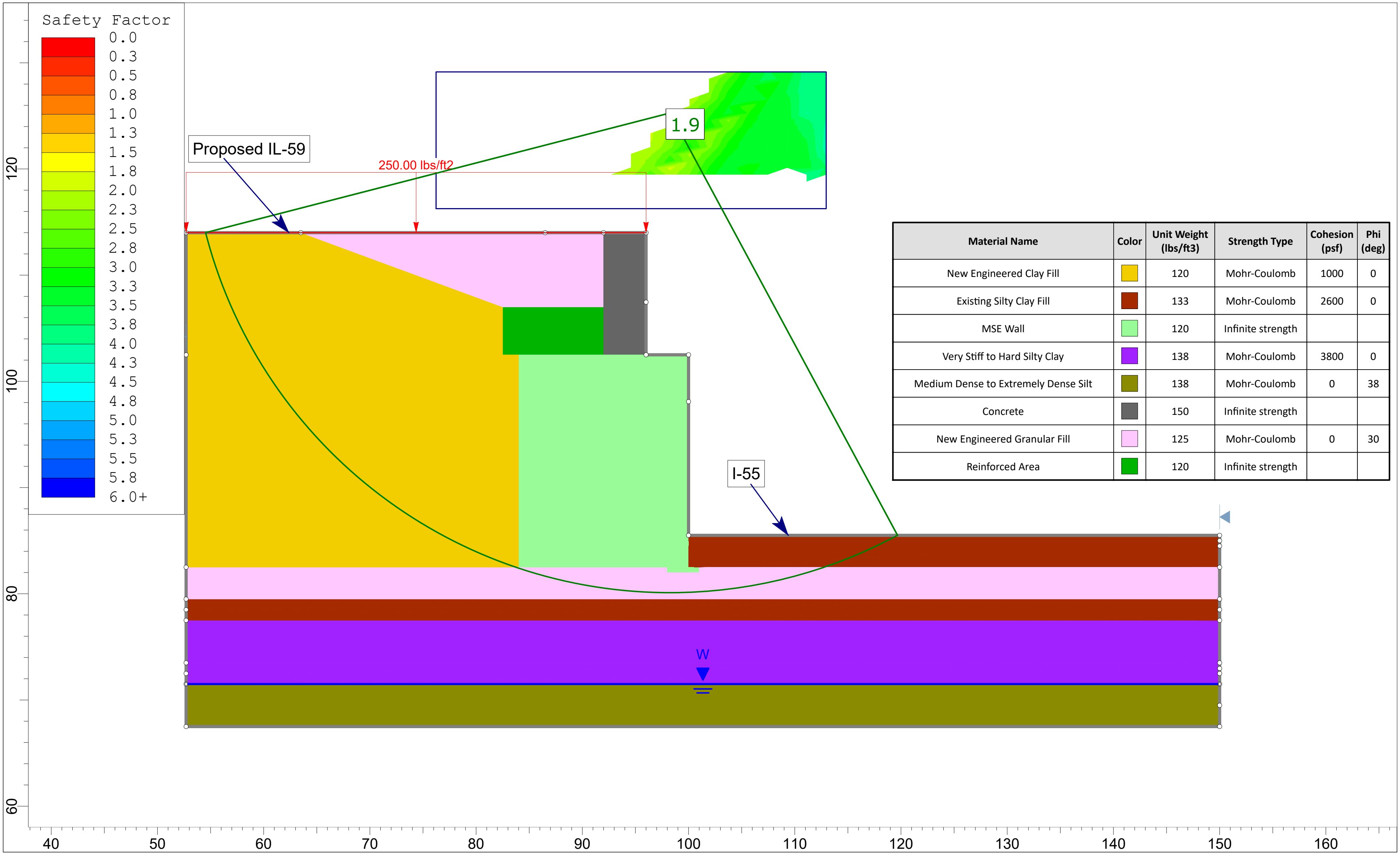
Project	Contract IDOT\189-011 East Abutment (Boring SB-03)
Analysis Description	Exhibit 4b: Circular Failure Long Term - Drained
Drawn By	SI
Scale	1:150
Company	GSG Consultants, Inc.
Date	04/21/2020
File Name	Eastwall-long term-Sta.267



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	1000	0
Existing Silty Clay Fill		133	Mohr-Coulomb	2600	0
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		138	Mohr-Coulomb	3800	0
Medium Dense to Extremely Dense Silt		138	Mohr-Coulomb	0	38
Concrete		150	Infinite strength		
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		

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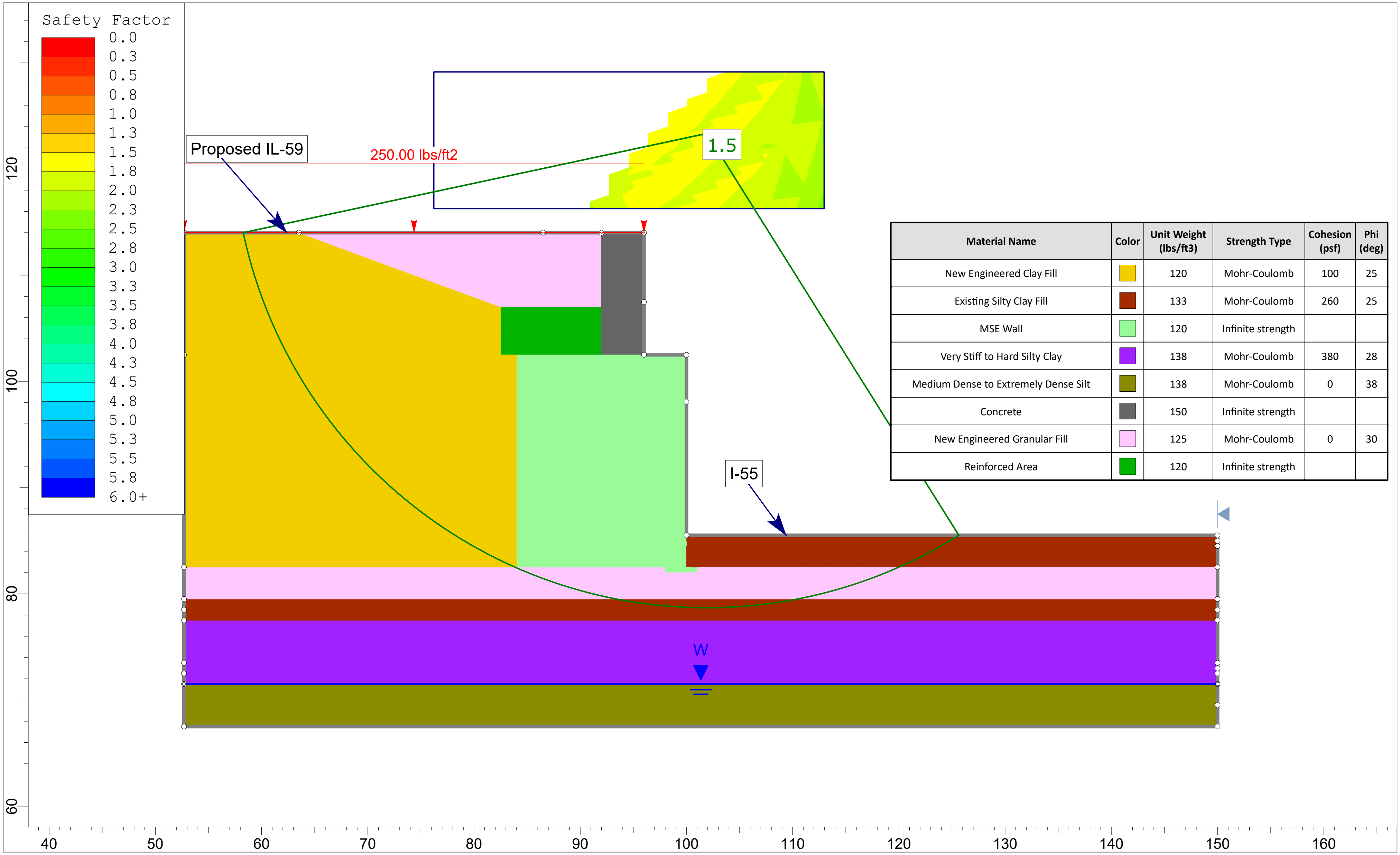
Project	Contract IDOT\189-011 East Abutment
Analysis Description	Exhibit 4c: Circular Failure Short Term - Undrained

Drawn By	SI	*Scale*	1:150	*Company*	GSG Consultants, Inc.
Date	04/30/2020			*File Name*	Eastwall-short term-Sta. 266+50



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	100	25
Existing Silty Clay Fill		133	Mohr-Coulomb	260	25
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		138	Mohr-Coulomb	380	28
Medium Dense to Extremely Dense Silt		138	Mohr-Coulomb	0	38
Concrete		150	Infinite strength		
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		

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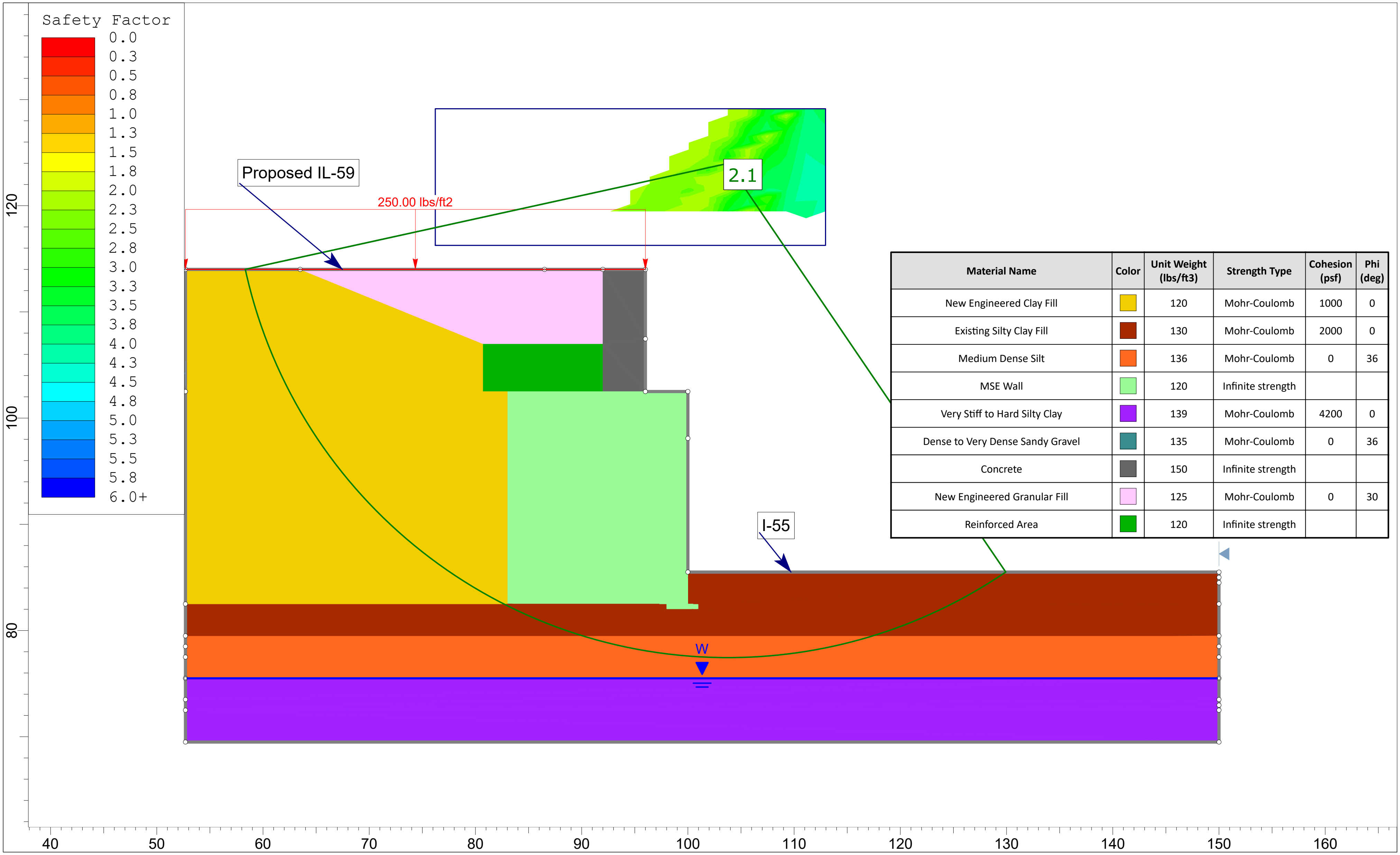
Project: Contract IDOT\189-011 East Abutment

Analysis Description: Exhibit 4d Circular Failure Long Term - Drained

Drawn By	*Scale*	*Company*
SI	1:150	GSG Consultants, Inc.

Date: 04/30/2020

File Name: Eastwall-long term-Sta.266+50



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	1000	0
Existing Silty Clay Fill		130	Mohr-Coulomb	2000	0
Medium Dense Silt		136	Mohr-Coulomb	0	36
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		139	Mohr-Coulomb	4200	0
Dense to Very Dense Sandy Gravel		135	Mohr-Coulomb	0	36
Concrete		150	Infinite strength		
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		

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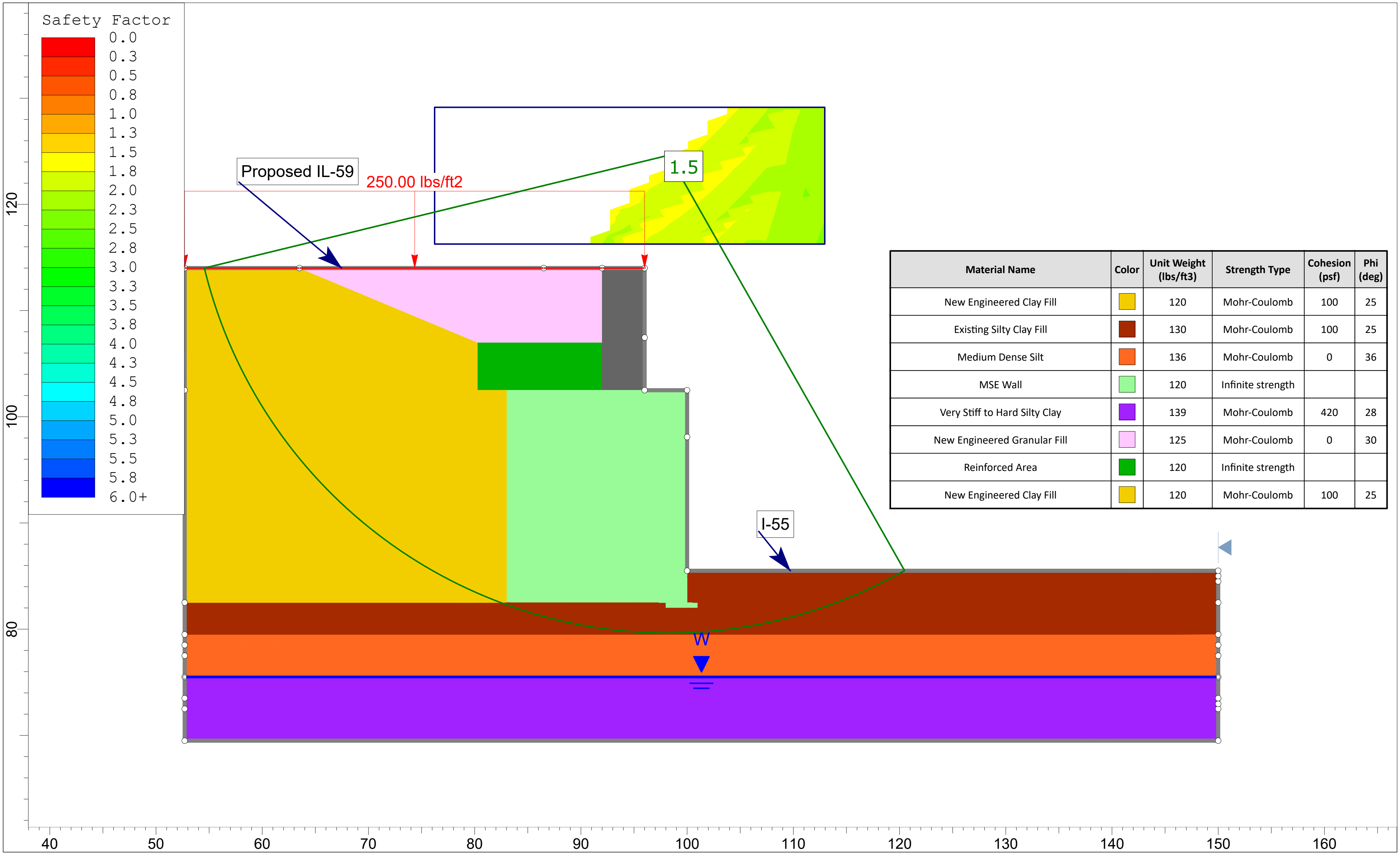
Project	Contract IDOT\189-011 West Abutment (Boring SB-01)
Analysis Description	Exhibit 5a: Circular Failure Short Term - Undrained
Drawn By	SI
Scale	1:150
Company	GSG Consultants, Inc.
Date	04/21/2020
File Name	Westwall-short term-Sta.270



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	100	25
Existing Silty Clay Fill		130	Mohr-Coulomb	100	25
Medium Dense Silt		136	Mohr-Coulomb	0	36
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		139	Mohr-Coulomb	420	28
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		
New Engineered Clay Fill		120	Mohr-Coulomb	100	25

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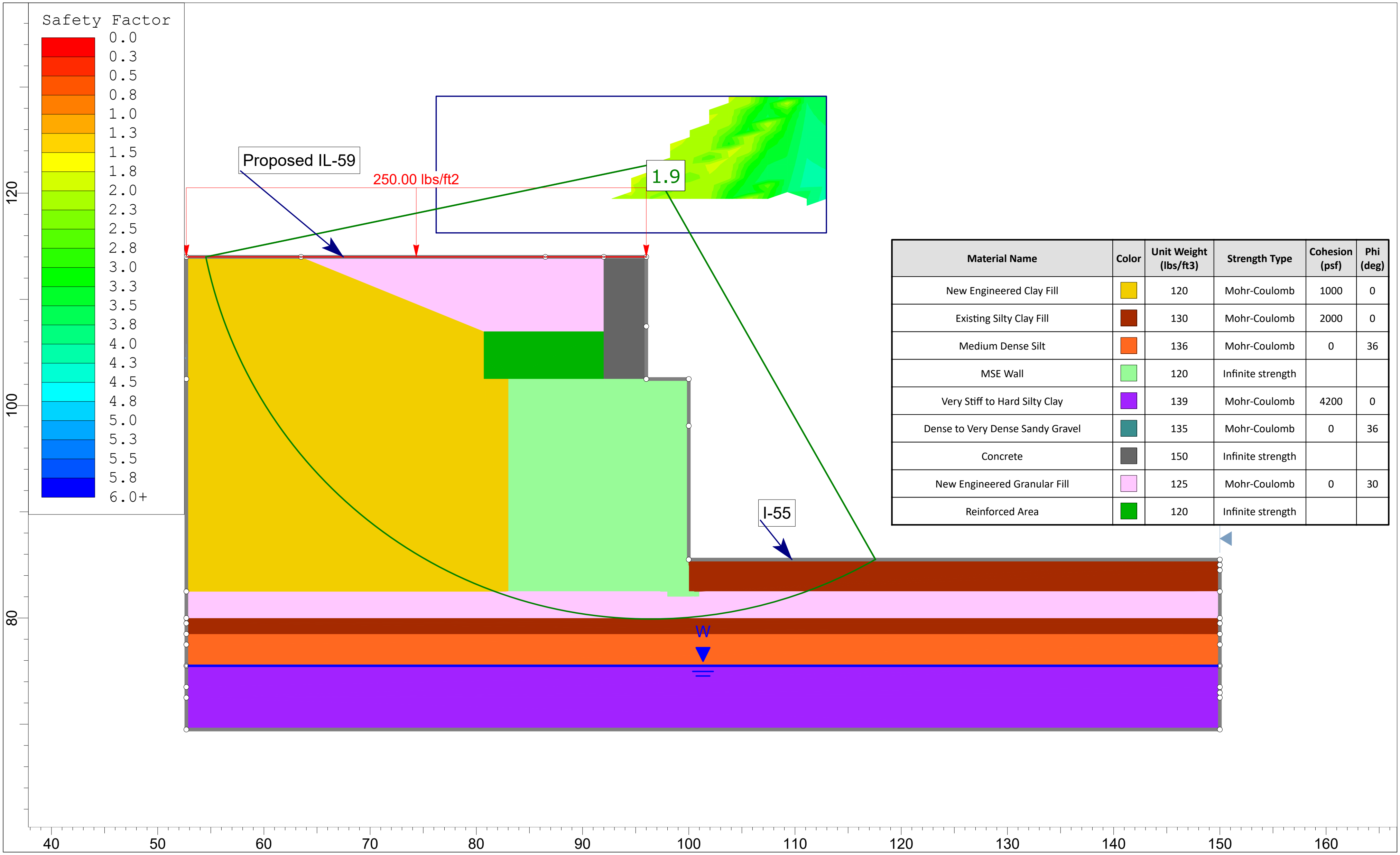
Project	Contract IDOT\189-011 West Abutment (Boring SB-01)		
Analysis Description	Exhibit 5b: Circular Failure Long Term - Drained		
Drawn By SI	*Scale* 1:150	*Company*	GSG Consultants, Inc.
Date	04/21/2020	*File Name*	Westwall-long term-Sta.270



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	1000	0
Existing Silty Clay Fill		130	Mohr-Coulomb	2000	0
Medium Dense Silt		136	Mohr-Coulomb	0	36
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		139	Mohr-Coulomb	4200	0
Dense to Very Dense Sandy Gravel		135	Mohr-Coulomb	0	36
Concrete		150	Infinite strength		
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		

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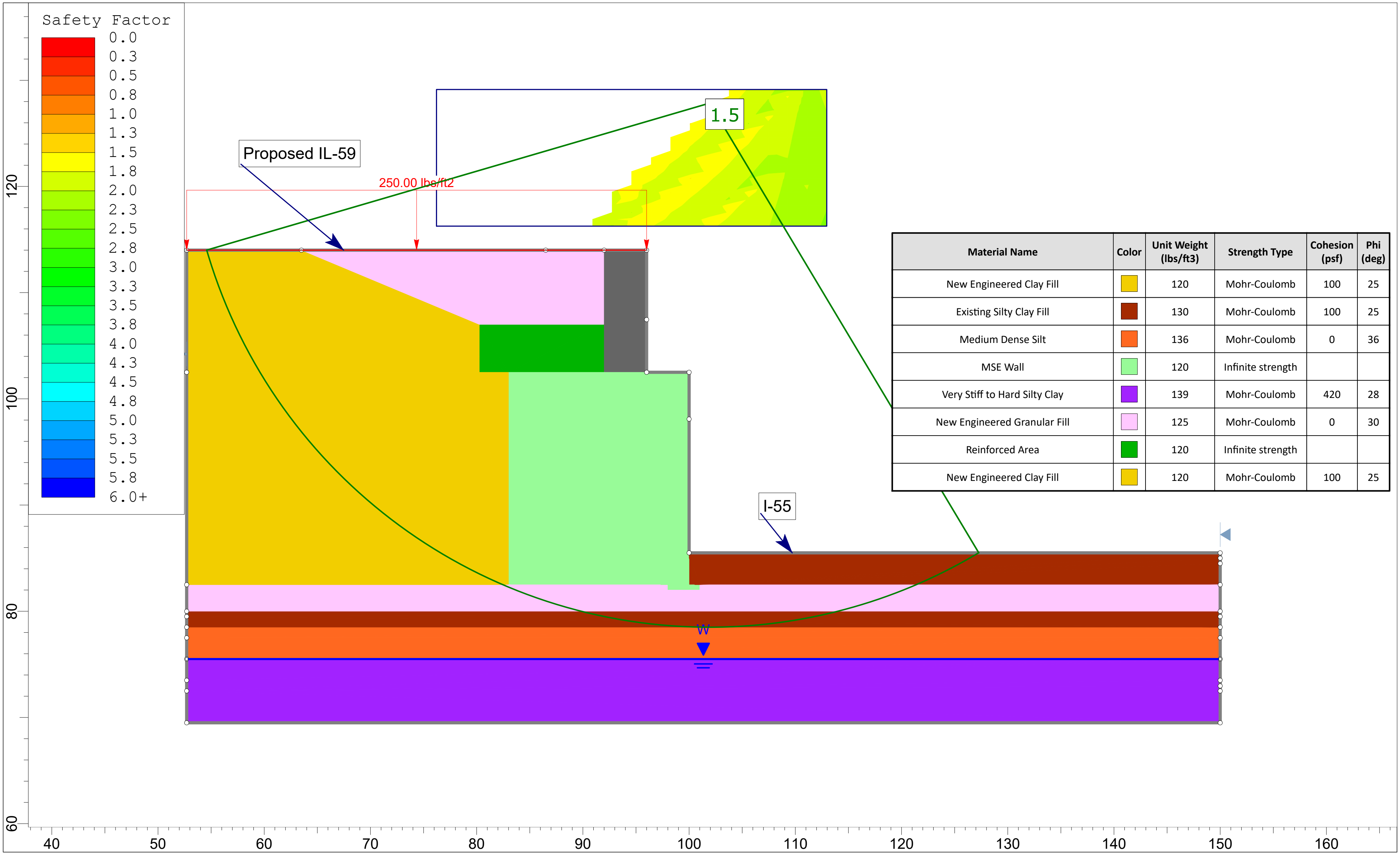
Project	Contract IDOT\189-011 West Abutment
Analysis Description	Exhibit 5c: Circular Failure Short Term - Undrained
Drawn By	SI
Scale	1:150
Company	GSG Consultants, Inc.
Date	04/30/2020
File Name	Westwall-short term-Sta.269+25



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
New Engineered Clay Fill		120	Mohr-Coulomb	100	25
Existing Silty Clay Fill		130	Mohr-Coulomb	100	25
Medium Dense Silt		136	Mohr-Coulomb	0	36
MSE Wall		120	Infinite strength		
Very Stiff to Hard Silty Clay		139	Mohr-Coulomb	420	28
New Engineered Granular Fill		125	Mohr-Coulomb	0	30
Reinforced Area		120	Infinite strength		
New Engineered Clay Fill		120	Mohr-Coulomb	100	25

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Project Contract IDOT\189-011 West Abutment

Analysis Description Exhibit 5d: Circular Failure Long Term - Drained

Drawn By SI | *Scale* 1:150 | *Company* GSG Consultants, Inc.

Date 04/30/2020 | *File Name* Westwall-long term-Sta.269+25

APPENDIX H

PHASE I GEOTECHNICAL REPORT

PRELIMINARY
STRUCTURE GEOTECHNICAL REPORT
ILLINOIS ROUTE 59 NORTHBOUND BRIDGE
OVER INTERSTATE 55
WILL COUNTY, ILLINOIS

For
Illinois Department of Transportation

District One

201 West Center Court

Schaumburg, IL 60196

Submitted by

Wang Engineering, Inc.

1145 North Main Street

Lombard, IL 60148

Original Report: October 23, 2018
Revised Report: November 14, 2018

Technical Report Documentation Page

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Illinois Route 59 Northbound Bridge
Over Interstate 55</td><td>2. Original Date: October 23, 2018
Revised Date: November 14, 2018
3. Report Type ☒ SGR ☐ RGR
☐ Draft ☒ Final ☒ Revised</td></tr>
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NA</td></tr>
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182 / 001</td><td>7. Existing Structure Number(s)
NA</td><td>8. Proposed Structure Number(s)
NA</td></tr>
<tr><td>9. Prepared by
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</table>

11. Abstract

A new, two-span structure will carry the proposed northbound Illinois Route 59 over Interstate 55 in Will County, Illinois. The proposed bridge will have an estimated length of 300.0 feet and an approximate out-to-out width of 45.0 feet. The approach embankments will be up to 30.0 feet high and will have a combination of side slopes graded at 1:2 to 1:3 (V:H) and retaining walls. This report provides geotechnical recommendations for the design and construction of the proposed bridge foundations. The associated embankments and wingwalls/retaining walls are not addressed in this report.

Beneath pavement or topsoil, and up to 4.5 feet of fill material, the general lithologic profile includes 5.0 to 12.0 feet of stiff to hard silty clay to silty clay loam over dense to very dense, saturated gravelly loam to silty loam followed by very dense sandy gravel. Strong, very poor to fair quality dolostone was encountered at about 21.5 to 23.0 feet below existing grade. The groundwater levels were measured at elevations ranging from 573.0 to 589.0 feet, primarily within the deeper silt and sand layers.

Long-term consolidation settlement of the foundation soils under the proposed 30.0-foot high east and west approach embankments is estimated to be 0.5 and 0.8 inches, respectively with less than 0.4 inches of total settlement remaining at the time of foundation installation, assuming the foundations are installed after embankment construction. Therefore, downdrag allowances are not required for the foundations. If the foundations will be installed prior to embankment construction, downdrag loads should be considered.

The bridge foundations could be supported on either driven metal-shell piles or H-piles or supported on drilled shafts installed one foot into the bedrock. Driven 12-inch MSP, 14-inch MSP, HP10x42, HP12x53 and HP14x73 steel H-piles will provide 195 to 318 kips of factored capacity. Drilled shafts established one foot into the bedrock will provide an estimated factored unit resistance of 200 ksf.

Temporary shoring of the excavation for the pier along the I-55 median may be needed if the excavation cannot be graded at a minimum slope of 1:2 (V: H). Temporary sheeting can designed in accordance with the guidelines provided by IDOT.

12. Path to archived file

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PRELIMINARY
STRUCTURE GEOTECHNICAL REPORT
ILLINOIS ROUTE 59 NORTHBOUND BRIDGE
OVER INTERSTATE 55
WILL COUNTY, ILLINOIS

FOR
ILLINOIS DEPARTMENT OF TRANSPORTATION
DISTRICT ONE

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and preliminary geotechnical evaluations and recommendations to support the Phase I design and construction of the proposed Diverging Diamond Interchange (DDI) northbound bridge carrying Illinois Route 59 (IL 59) over Interstate 55 (I-55). The new bridge structure is part of the proposed I-55 and IL 59 interchange improvement in Will County, Illinois. A *Site Location Map* is presented as Exhibit 1.

The purpose of this investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide preliminary recommendations for the design and construction of the proposed bridge foundations. Our scope of work only includes the bridge foundations and does not include the embankments and wingwalls/retaining walls associated with the proposed bridge. We understand that the Type Size Location (TSL) Plan will be prepared during the Phase 2 design. Recommendations for the embankment slope stability and their settlement; and for the walls will be needed as part of Phase 2 design.

1.1 Proposed Structure

Wang Engineering, Inc. (Wang) understands the project is still in Phase I and the proposed structure information is preliminary. Based on the preliminary *Plan and Profiles* (Appendix C) and *Cross Sections* (Appendix D), provided by the Illinois Department of Transportation, District One (IDOT) in October of 2018, Wang understands the proposed bridge will be a two-span bridge. Abutment and pier types were not available at the time this report was prepared. The bridge will have an estimated length of 300.0 feet approximately between Stations 8016+28.44 and 8019+66.21. The bridge width as measured from the cross-sections will be about 45.0 feet.

The profile grade along the proposed northbound IL 59 DDI will require the placement of up to 30.0 feet of new fill along the north and south approach embankments, based on the existing and proposed grade lines as shown on the provided drawings. The cross-sections at the north approach embankment shows the east side of the embankment will be graded at a side slope of 1:2 (V: H); whereas the west side of the north approach embankment will be supported by a retaining wall. At the south approach embankment, the west side will have side slopes graded at 1:3 (V: H); whereas the east side will be supported by a retaining wall. This report only addresses the proposed bridge substructures.

1.2 Existing Structure and Land Use

The northbound IL 59 DDI structure is new and there are is no existing bridge at the site. An existing bridge carrying southbound IL 59 over I-55 is located about 200.0 feet north of the proposed bridge. The existing southbound bridge is supported on drilled shafts socketed about 2.0 feet into the bedrock. The approach embankments at the existing bridge are supported by wrap around Mechanically Stabilized earth (MSE) walls.

2.0 GEOLOGICAL SETTING

The project area is located in northwest Will County, about ¾ of a mile north of the I-55/I-80 interchange. On the USGS *Plainfield Quadrangle 7.5 Minute Series* map, the bridge spans through NE ¼ of Section 21 and NW ¼ of Section 22, Tier 35 N, Range 9 E of the Third Principal Meridian. A *Site Location Map* is presented as Exhibit 1.

The following review of published geologic data, with emphasis on factors that might influence the design and construction of the proposed engineering works, is meant to place the project area within a geological framework and, thus, to confirm the dependability and consistency of the present subsurface investigation results. For the study of the regional geologic framework, Wang considered northeastern Illinois area in general and Will County in particular.

2.1 Physiography

The western Will County is part of the Kankakee Plain of the Till Plains section. Outflow from glacial Lake Chicago eroded to the bedrock glacial cover, and thick outwash deposits were accumulated within the Lake Chicago outlet valley (Leighton et al. 1948). The proposed structure is located on top of a plateau surrounded by outlet valleys.

At the proposed bridge location, surface elevation measures about 590 feet. The bridge is located about half a mile east of the Rock Run and about half a mile northwest of the DuPage River. Both rivers run southward and are Des Plaines River tributaries. The Des Plaines River runs about 5 miles south of the bridge.

2.2 Surficial Cover

Will County area was under the influence of an icesheet lobe ultimately responsible for the formation of a series of arcuate, end moraine ridges, separated by low relief till plains and lake plains. Thin deposits of silt, clay, and sand of the Equality Formation are present (Johnson and Hansel, 1999). The new structure, will be built on top of a plateau made up of glacial lake bottom and groundmoraine sediments. Quaternary glacigenic deposits unconformably overlie the bedrock. The *Site and Regional Geology* is illustrated in Exhibit 2.

2.3 Bedrock

Most of Will County bedrock consists of Silurian-age dolostone of the Joliet Formation. The dolostone reaches about 80 feet in thickness.

The bedrock topography of Will County is dominated by the presence of the northeast to southwest running Hadley Bedrock Valley, a buried feature whose axis is located immediately south of the site. In the project area, the top of the top of the bedrock is at about 570 feet elevation (McLean and Smith, 1995). The bedrock may be encountered at about 20 feet below ground surface (bgs); the bedrock crops out locally in the valleys of Des Plaines and Du Page rivers and on the bottom of the I&M Canal (Exhibit 2). No active faults or underground mines are known in the area. The new bridge is located about one mile north of the inactive Sandwich Fault.

Our subsurface investigation results fit into the local geologic context. The structure borings drilled on site encountered dolostone bedrock at elevations of 571.0 to 572.0 feet, or about 21.0 to 23.0 feet bgs.

3.0 METHODS OF INVESTIGATION

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

3.1 Field Investigation

The subsurface investigation consisted of three bridge borings, designated as SB-01 to SB-03, drilled by Wang in October of 2018. The borings were drilled from elevations of 593.1 to 594.8 feet and were advanced to depths of 33.5 to 38.0 feet bgs. The as-drilled northing and easting coordinates were acquired with a mapping-grade GPS unit; boring elevations were surveyed with a level. Boring location data are presented in the *Boring Logs* (Appendix A) and the as-drilled boring locations are shown in the *Boring Location Plan* (Exhibit 3).

A truck-mounted drilling rig, equipped with hollow stem augers, was used to advance and maintain open boreholes. Soil sampling was performed according to AASHTO T206, *"Penetration Test and Split Barrel Sampling of Soils."* The soil was sampled at 2.5-foot intervals to the top of sound bedrock. Bedrock cores were obtained from the borings in 5- to 10-foot runs with an NWD4-sized core barrel. 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. Each borehole was backfilled upon completion with soil cuttings and/or bentonite chips and, where necessary, the pavement surface was restored to its original condition.

3.2 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).

4.0 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 4). 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.

4.1 Lithological Profile

Boring SB-01, drilled outside the I-55 roadway, measured 6 inches of black silty clay loam topsoil at the surface. Borings SB-02 and SB-03, drilled within the I-55 shoulders, encountered 12 inches of asphalt pavement overlying fill. In descending order, the general lithologic succession encountered beneath the topsoil or pavement includes: 1) man-made ground (fill); 2) stiff to hard silty clay to silty clay loam; 3) dense to very dense gravelly loam and silty loam; and 4) strong, very poor to fair quality dolostone.

1) Man-made ground (fill)

Beneath the surface, Boring SB-03 encountered 4.5 feet cohesive fill. This fill consists of stiff, black silty clay with an average unconfined compressive strength (Q_u) value of 1.6 tsf and moisture content values of 28 to 31% averaging 30%. Laboratory index testing on a sample from the silty clay layer showed a liquid limit (L_L) value of 56% and a plastic limit (P_L) value of 21%. According to the AASHTO Soil Classification System, the soil belongs to the A-7-6 group.

Boring SB-02 revealed 4.5 feet of medium dense to dense, gray sandy gravel fill underneath the surface. This granular fill layer is characterized by SPT N values of 12 to 38 blows per foot and an average moisture content value of 5%.

2) Stiff to hard silty clay to silty clay loam

Beneath the fill, at elevations of 584.0 to 594.0 feet, the borings encountered 5.5 to 11.5 feet of stiff to hard, brown and gray silty clay to silty clay loam with Q_u values of 1.6 to 5.7 tsf with an average of 3.4 tsf and moisture content values of 15 to 24% with an average of 21%. Laboratory index testing on samples from this layer showed L_L values of 29 to 31% and P_L values of 18%. According to the AASHTO Soil Classification System, the soil belongs to the A-6 group.

At elevations of 583.0 to 590.0 feet, within the cohesive soil, a 2.5- to 5.0-foot thick layer of loose to medium dense, brown and gray loam to sandy loam, silt, and gravelly sand was encountered in the borings. This layer is characterized by N values of 6 to 24 blows per foot and moisture content values of 9 to 15%.

3) Dense to very dense gravelly loam and silty loam

At depths of 16.0 to 19.5 feet, or elevations of about 578 to 580 feet, the borings augured through 3.5 to 7.0 feet of medium dense to very dense, gray gravelly loam to silty loam to the top of the bedrock. This soil unit has N-values of 29 blows per foot to more than 50 blows per 2 inches of penetration and moisture content values of 7 to 11% with an average of 9%.

Borings SB-01 and SB-02 revealed dense to very dense, gray sandy gravel underlying the silty loam and continuing to the top of the bedrock elevations. This layer has N values of more than 50 blows per inch, with auger refusal indicated in Borings SB-02 and SB-03, and moisture contents of 8 to 12%. Hard drilling conditions were encountered at a depth of 17.0 to 24.0 feet bgs.

4) Strong, very poor to fair quality dolostone

The borings cored strong, very poor to fair quality dolostone bedrock beginning at 21.5 to 23.0 feet bgs, or at elevations of 571.1 to 572.1 feet. The rock is horizontally bedded and the joints are spaced at 0.05 to more than 0.2 inches and have slightly rough walls with some sand infill. The rock quality designation (RQD) ranges from 0 to 64%. Bedrock core photographs are attached in Appendix C.

4.2 Groundwater Conditions

Groundwater was encountered while drilling at elevations of 573.5 to 589.3 feet (5.5 to 20.0 feet bgs) within the loose to dense sandy loam and gravelly loam. At the completion of drilling, the groundwater was recorded at 576.0 to 577.8 feet (17.0 feet bgs). The design groundwater elevation is estimated to lie within the deeper granular soils at an average elevation of 578.0 feet. The granular layers beneath the fill, including those encountered deep are considered saturated and water bearing. Excavations and drilling into these soils will encounter caving and groundwater infiltration if advance provisions are not made for the control of groundwater.

It should be noted that groundwater levels might vary with seasonal rainfall patterns and long-term climate fluctuations or be influenced by local site conditions.

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and preliminary recommendations for the approach embankments and substructure foundations are included in the following sections. The north and south approach embankments will require new fill sections of up to 30.0 feet behind the abutments. The embankments will have a combination of side slopes graded at 1:2 to 1:3 (V: H) and retaining walls. This report does not address the proposed retaining walls.

Supporting the bridge substructure on shallow foundations will not be feasible due to the large loads estimated from the abutments and pier. We recommend supporting the substructures on deep foundations. Based on the soil conditions revealed by our investigation, steel metal shell piles (MSP) and/or H-piles or drilled shafts installed into the bedrock would be feasible to support the abutments and pier. The information provided shows the existing southbound IL 59 Bridge is supported on drilled shafts socketed into the bedrock.

Geotechnical evaluations and preliminary recommendations for the substructure foundations are included in the following sections.

5.1 Seismic Design Considerations

The seismic site class was determined in accordance with the IDOT Geotechnical Manual (IDOT 2015). The soils within the top 100 feet have a weighted average N value of 87 blows/foot (AASHTO 2015; Method C controlling), and the results classify the site in the Seismic Site Class C.

The project location belongs to the Seismic Performance Zone 1. The seismic spectral acceleration parameters recommended for design in accordance with the *AASHTO LRFD Bridge Design Specifications* (2018) are summarized in Table 1. According to the IDOT *Bridge Manual* (2012), liquefaction analysis is not required for a site located in Seismic Performance Zone 1.

Table 1: Seismic Design Parameters

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient[1)] (% g)	Site Factors	Design Spectrum for Site Class C[2)] (% g)
0.0	PGA= 4.9	F_{pga}= 1.2	**A_s= 5.9**
0.2	S_s= 10.6	F_a= 1.2	**S_{DS}= 12.7**
1.0	S_1= 4.0	F_v= 1.7	**S_{D1}= 6.8**

1) Spectral acceleration coefficients based on Site Class C

2) Site Class C Spectrum to be included on plans; $A_s = PGA*F_{pga}$; $S_{DS} = S_s*F_a$; $S_{D1} = S_1*F_v$

5.2 Approach Embankments

Wang has performed evaluations of the settlement for the northbound IL 59 bridge approach embankments. The profile grade along the proposed bridge will require up to 30.0 feet of fill at the east and west approach embankments. Settlement estimates have been made based on correlations to measured index properties (Appendix B). We estimate the clayey foundation soils will undergo approximately 0.5 and 0.8 inches inch of long-term consolidation settlement under the applied load of the full, 30-foot tall embankment, at the north and south approaches, respectively. We estimate the soil will achieve 50% of primary consolidation in approximately 50 days and 90% of primary consolidation in 208 days. Assuming the foundations are installed after construction of the embankment, we estimate that less than 0.4 inches of settlement will remain at the time of construction of the bridge foundations.

5.3 Structure Foundations

Wang recommends supporting the abutments and pier on either driven steel metal shell piles (MSP), H-piles, or drilled shafts. The soil conditions along the structure show stiff to hard clayey soils with loose to medium dense silty loam and sandy loam interbeds followed by dense to very dense granular soils overlying dolostone bedrock.

Loading information and proposed cap base elevations were not available at the time this report was prepared.

5.3.1 Driven Piles

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the factored resistance available (R_F) for steel H-piles and MSP should be based on a geotechnical resistance factor (Φ_G) of 0.55 (2012). Nominal tip and side resistance were estimated using the methods and empirical equations presented in the *Geotechnical Pile Design Guide* (IDOT 2009).

Based on IDOT standards, piles with greater than 0.4 inches of relative settlement along the sides require allowances for downdrag loads. The settlement of the embankments as discussed in Section 5.2.1 indicates that less than 0.4 inches of total foundation soil settlement will remain at the time of pile driving after embankment construction. Therefore, downdrag allowances will not be required for the piles. If the piles are to be installed prior to embankment construction, downdrag allowances will need to be considered.

For the purpose of analysis, the pile driving elevation was taken from the existing grade. To achieve maximum nominal pile capacity, the analysis shows that the steel H-piles would need to be driven to the top of the bedrock (TOR); in these instances, the piles should be considered end bearing and designed for the maximum nominal capacity of the pile.

The R_F, R_N, and estimated pile tip elevations for 12-inch diameter, 14-inch diameter MSP, HP10x42, HP12x53, and HP14x73 steel H-piles driven to maximum allowable nominal bearing at the abutments and piers are summarized in Tables 2, 3, and 4.

Table 2: Estimated Pile Capacities and Tip Elevations at North Abutment (Boring SB-01)

Pile Size	Pile Driving Elevation(1) (feet)	Nominal Required Bearing, R_N(2) (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Tip Elevation (feet)
12-inch MSP w/0.25-inch thick walls	593.0	355	0	0	195	576
14-inch MSP w/0.312-inch thick walls	593.0	516	0	0	284	578
HP 10X42	593.0	335	0	0	184	573
HP 12X53	593.0	419	0	0	230	573
HP 14X73	593.0	578	0	0	318	572

(1) Pile driving elevation assumed to start below the pavement or topsoil.

(2) Maximum allowable Nominal Required Bearing as per the IDOT Bridge Manual.

Table 3: Estimated Pile Capacities and Tip Elevations at Pier (Boring SB-02)

Pile Size	Pile Driving Elevation(1) (feet)	Nominal Required Bearing, R_N(2) (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Tip Elevation (feet)
12-inch MSP w/0.25-inch thick walls	592.0	355	0	0	195	580
14-inch MSP w/0.312-inch thick walls	592.0	516	0	0	284	580
HP 10X42	592.0	335	0	0	184	571
HP 12X53	592.0	419	0	0	230	571
HP 14X73	592.0	578	0	0	318	571

(1) Pile driving elevation assumed to start below the pavement or topsoil.

(2) Maximum allowable Nominal Required Bearing as per the IDOT Bridge Manual.

Table 4: Estimated Pile Capacities and Tip Elevations at South Abutment (Boring SB-03)

Pile Size	Pile Driving Elevation[1] (feet)	Nominal Required Bearing, R_N[2] (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Estimated Pile Tip Elevation (feet)
12-inch MSP w/0.25-inch thick walls	594.0	355	0	0	195	577
14-inch MSP w/0.312-inch thick walls	594.0	516	0	0	284	574
HP 10X42	594.0	335	0	0	184	571
HP 12X53	594.0	419	0	0	230	571
HP 14X73	594.0	578	0	0	318	570

(1) Pile driving elevation assumed to start below the pavement or topsoil.

(2) Maximum allowable Nominal Required Bearing as per the IDOT Bridge Manual.

5.3.2 Drilled Shafts

The abutments and pier could also be supported on drilled shafts established one foot into the bedrock.

The bedrock resistance was evaluated in accordance with the Geologic Strength Index (GSI) method provided by AASHTO (2017). The nominal and factored unit tip resistances along with estimated base elevations are summarized below in Table 5.

Table 5: Estimated Drilled Shaft Resistances and Base Elevations

Structure Unit (Boring)	Nominal Unit Tip Resistance (ksf)	Factored Unit Tip Resistance[1] (ksf)	Shaft Base Elevation (feet)
North Abutment (SB-01)	400	200	571
Pier (SB-02)	400	200	570
South Abutment (SB-03)	400	200	571

(1) The shafts should be designed for an end bearing resistance factor (ϕ_{stat}) of 0.50 at the top of bedrock (AASHTO 2017).

5.3.3 Lateral Loading

Lateral loads on the piles and drilled shafts should be analyzed for maximum moments and lateral deflections. Recommended lateral soil and rock parameters required for analysis via the p-y curve method are included in Tables 6 to 11. Once the lateral loads are determined, the pile groups should be checked for maximum moments and lateral deflections.

Table 6: Recommended Soil Parameters for Lateral Load Analysis at North Abutment (Boring SB-01)

Soil Type (Layer)	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} (%)
Very Stiff to Hard SILTY CLAY El 593.0 to 586.0 feet	120	4000	0	1500	0.45
Medium Dense LOAM and SILT EL 586.0 to 581.0 feet	115	0	33	130	--
Very Stiff to Hard SILTY CLAY EL 581.0 to 575.0 feet	120	3300	0	1150	0.5
Dense to V Dense SANDY GRAVEL EL 575.0 to 572.0 feet	58*	0	36	125	--

*Submerged unit weight

Table 7: Recommended Rock Parameters for Lateral Load Analysis at North Abutment (Boring SB-01)

Rock Type (Layer)	Total Unit Weight (pcf)	Modulus of Rock Mass (ksi)	Estimated Uniaxial Compressive Strength Q_u (psi)	RQD (%)	Strain Factor k_{rm}
Bedrock (Dolostone)	135	400	8,000	55	0.0005
Bedrock (Dolostone)	135	400	8,000	64	0.0005

Table 8: Recommended Soil Parameters for Lateral Load Analysis at Pier (Boring SB-02)

Soil Type (Layer)	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} (%)
Medium Dense to Dense SANDY GRAVEL FILL EL 592.0 to 588.0 feet	115	0	34	90	--
Stiff to V Stiff CLAY to SILTY CLAY and SILTY CLAY LOAM EL 588.0 to 576.0 feet	120	2700	0	900	0.55
Medium Dense to Dense GRAVELLY LOAM EL 576.0 to 573.0 feet	53*	0	33	90	--
Very Dense SANDY GRAVEL EL 573.0 to 571.0 feet	58*	0	36	150	--

*Submerged unit weight

Table 9: Recommended Rock Parameters for Lateral Load Analysis at Pier (Boring SB-02)

Rock Type (Layer)	Total Unit Weight (pcf)	Modulus of Rock Mass (ksi)	Estimated Uniaxial Compressive Strength Q_u (psi)	RQD (%)	Strain Factor k_{rm}
Bedrock (Dolostone)	135	400	8,000	56	0.0005

Table 10: Recommended Soil Parameters for Lateral Load Analysis at South Abutment (Boring SB-03)

Soil Type (Layer)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Stiff SILTY CLAY FILL EL 594.0 to 589.0 feet	120	1600	0	450	0.75
Loose SANDY LOAM to GRAVELLY SAND EL 589.0 to 584.0 feet	110	0	28	25	--
Very Stiff to Hard SILTY CLAY EL 584.0 to 579.0 feet	120	4300	0	1650	0.4
Dense to V Dense SILTY LOAM EL 579.0 to 573.0 feet	58*	0	36	100	--

*Submerged unit weight

Table 11: Recommended Rock Parameters for Lateral Load Analysis at South Abutment (Boring SB-03)

Rock Type (Layer)	Total Unit Weight (pcf)	Modulus of Rock Mass (ksi)	Estimated Uniaxial Compressive Strength Q_u (psi)	RQD (%)	Strain Factor k_{rm}
Bedrock (Dolostone)	135	400	8,000	58	0.0005
Bedrock (Dolostone)	135	400	8,000	32	0.0005

5.4 Stage Construction

There is no stage construction identified at this time.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

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

6.2 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. Excavations for the construction of the abutments will be made into the embankments to be placed. These excavations should be sloped at no steeper than 1:2 (V: H). The pier within the I-55 median will likely be constructed in sloped excavations that should also be limited to 1:2 (V: H). If the pier excavations cannot be sloped, they should be shored with temporary steel sheeting designed in accordance with the charts provided in IDOT *Design Guide 3.13.3*.

During the subsurface investigation, the groundwater was encountered at elevations ranging from 573.0 to 589.0 feet. The groundwater is about 17.0 feet bgs at the proposed Pier location and we do not anticipate the need for dewatering systems during its construction. Water that does accumulate in open excavations by seepage or runoff should be immediately removed.

6.3 Filling and Backfilling

Fill material used to attain final design elevations should be pre-approved, compacted; cohesive or granular soil conforming to Section 205, *Embankment*, of the IDOT Standard Specifications for Road and Bridge Construction (IDOT 2016). The fill material should be free of organic matter and debris and should be placed in lifts and compacted according to the standard.

Backfill materials for the abutments and piers must be pre-approved by the Resident Engineer. To backfill the abutments, we recommend porous granular material conforming to the requirements specified in Section 207, *Porous Granular Embankment* (IDOT 2016). Backfill material should be placed and compacted in accordance with the standard.

6.4 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.

6.5 Pile Installation

The driven piles shall be furnished and installed according to the requirements of IDOT Section 512, *Piling* (2016). Wang recommends performing a minimum of one test pile at each substructure location.

6.6 Drilled Shaft Construction

Drilled shafts should be constructed in accordance with the IDOT Special Provision. Control of the groundwater will be of high importance during excavation of the shafts and permanent steel casing will be required. The permanent steel casing will provide a good seal at the top of the bedrock and will be necessary for the installation of the shafts through the water bearing granular layers.

6.7 Embankment Construction

The bridge approach embankments should be constructed as early as possible in the project construction period in order to allow the embankments to settle under their own weights as much as possible prior to the installation of the foundations for the abutments. Embankment construction should be performed in accordance with Section 205, *Embankments* (IDOT 2016).

7.0 QUALIFICATIONS

The analysis and recommendations submitted in this report are based upon the data obtained from the borings drilled at the locations shown on the boring logs and in Exhibit 3. This report does not reflect any variations that may occur between the borings or elsewhere on the site, variations whose nature and extent may not become evident until the course of construction. In the event that any changes in the design and/or location of the structure are planned, we should be timely informed so that our recommendations can be adjusted accordingly.

It has been a pleasure to assist 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.

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Senior Project Manager

Azza Hamad, E.I.T
Project Geotechnical Engineer

Corina T. Farez, P.E., P.G.
QA/QC Reviewer

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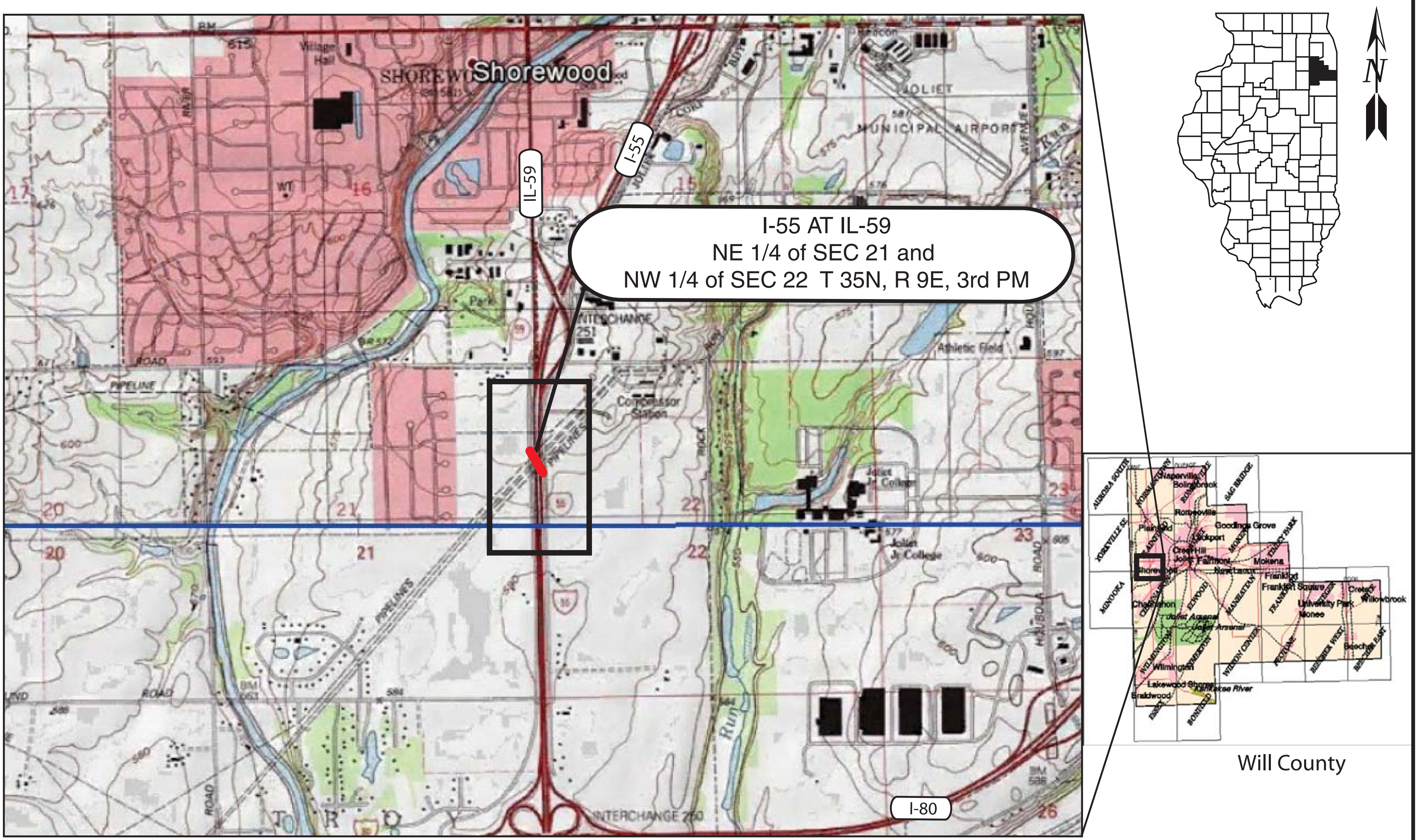
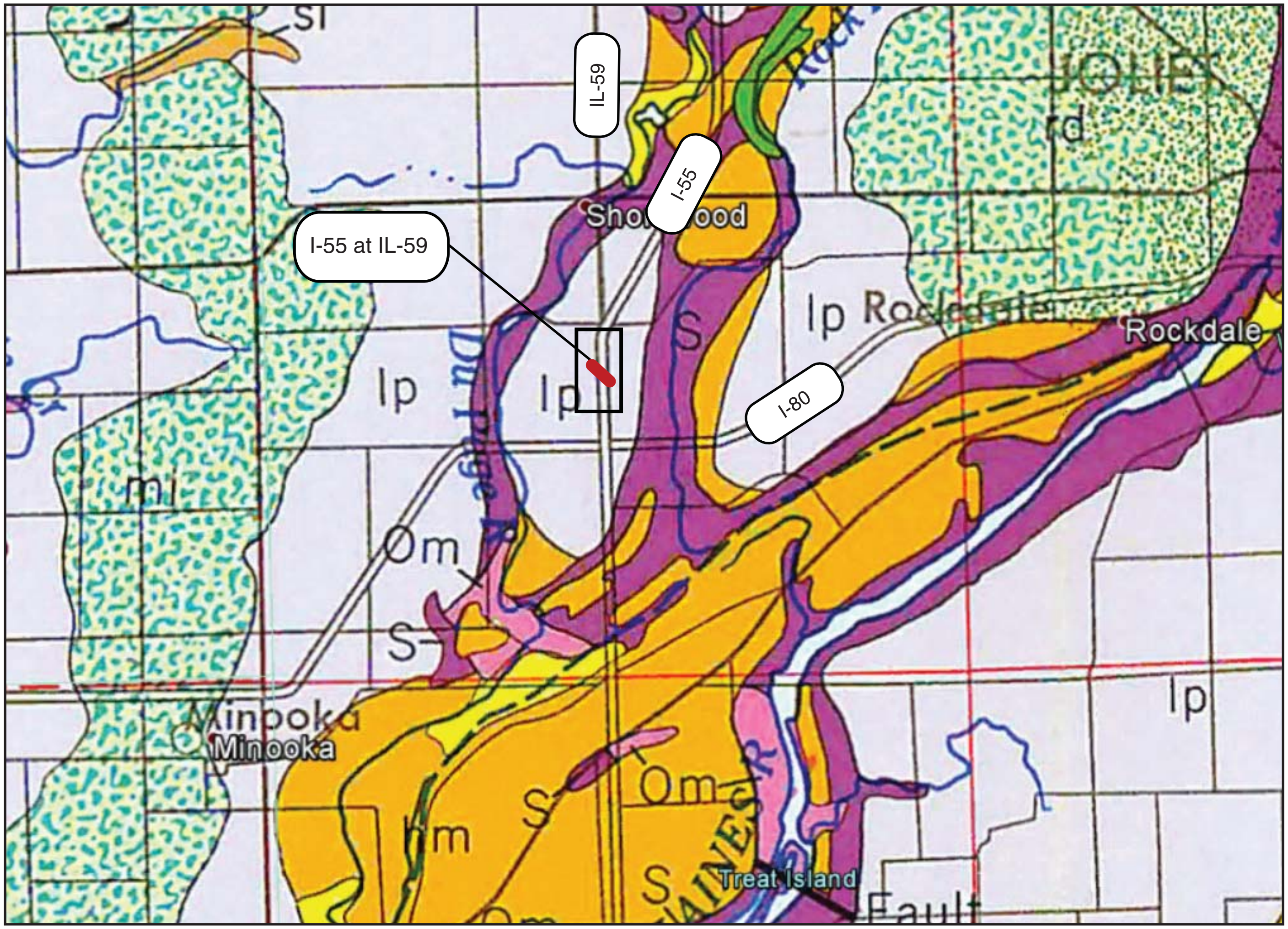
EXHIBITS



0 0.5 1.0 Mile

SITE LOCATION MAP: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**EXHIBIT 1**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**



0 0.5 1.0 1.5 2.0 Mile

Modified after Willman et al. (1970)

REGIONAL GEOLOGY

Wedron Group

- Wadsworth Formation
- Lemont Formation
- Tiskilwa Formation

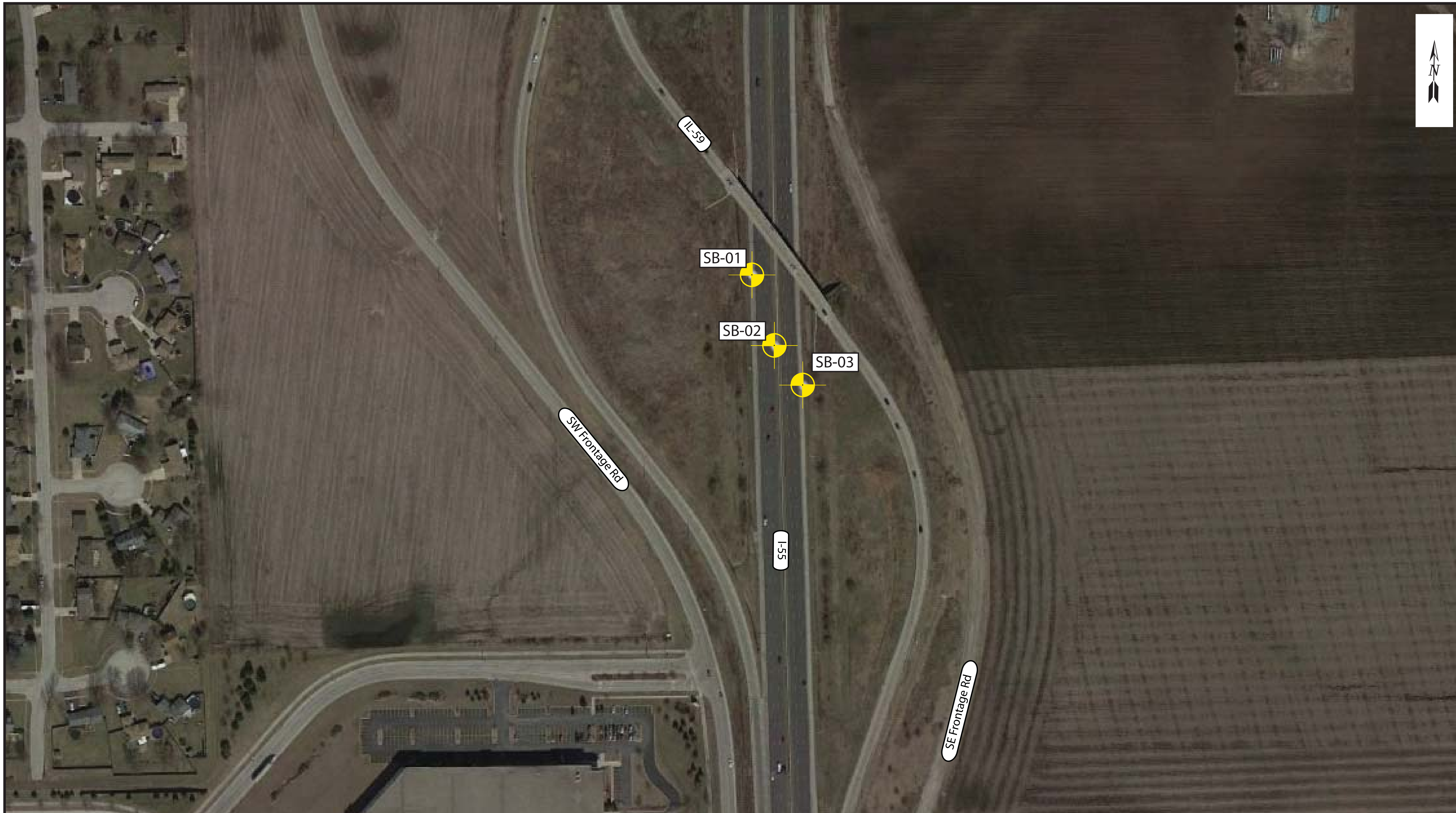
Modified after Hansel and Johnson (1996)

LEGEND

c	**Cahokia Alluvium** Deposits in floodplains and channels of modern rivers and streams; mostly poorly sorted silt and sand containing local deposits of sandy gravel
g	**Grayslake Peat** Peat, muck, and locally marl; dominantly organic deposits with interbedded silt and clay in places; mostly in glacial lake basins on floodplains of major rivers
lp	**Lake Plain** Floors of glacial lakes flattened by wave erosion and by minor deposition in low areas; largely underlain by glacial till; thin deposits of silt, clay, and sand of the Equality Formation.
hm	**Henry Formation** Sand and gravel with minor and local beds of silt; largely glacial outwash but locally includes deposits of outlet rivers of glacial lakes
ml	**Yorkville Member (Wedron Formation)** Mostly gray to dark gray clayey till, locally silty clayey till; contains abundant small pebbles, local lenses of silt, and less commonly lenses of sand and gravel
s	**Racine, Waukesha, Joliet, Kankakee, and Edgewood Formations** Largely dolomite, slightly to moderately argillaceous with scattered chert nodules; Racine Formation contains large reefs of massive to well bedded pure dolomite
Om	**Maquoketa Group** Red shale and oolite in local areas at the top; upper part largely greenish gray shale that in places grades laterally to silty argillaceous dolomite and dolomitic siltstone

Modified after Willman et al. (1970)

SITE AND REGIONAL GEOLOGY: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**EXHIBIT 2**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**



0 500 1000 Feet

Legend:

Soil Boring

BORING LOCATION PLAN: I-55 AT IL-59 WILL COUNTY, IL

SCALE: GRAPHICAL

EXHIBIT 3

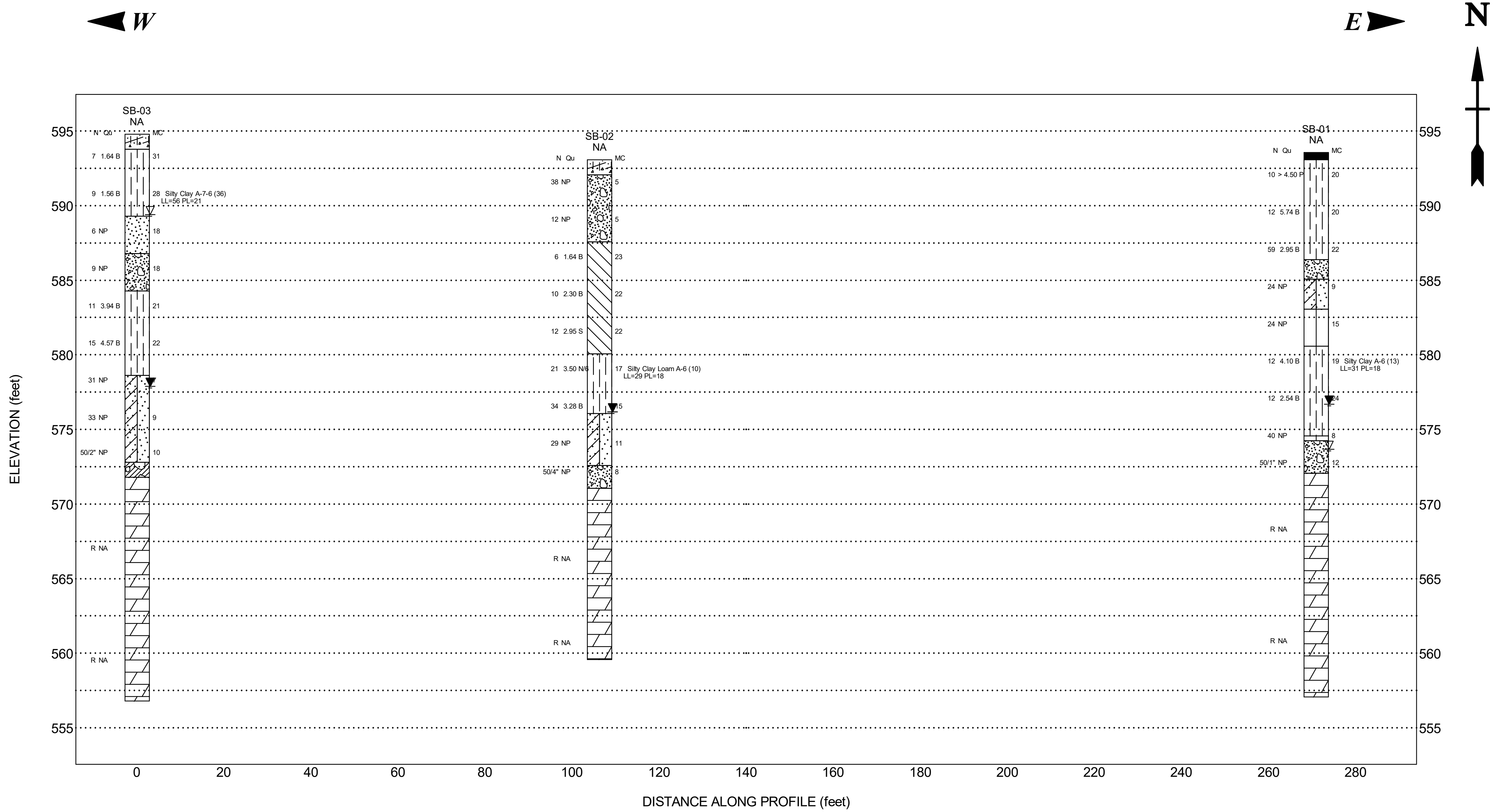
DRAWN BY: J. Rowells
CHECKED BY: M. Kothawala

Wang Engineering

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

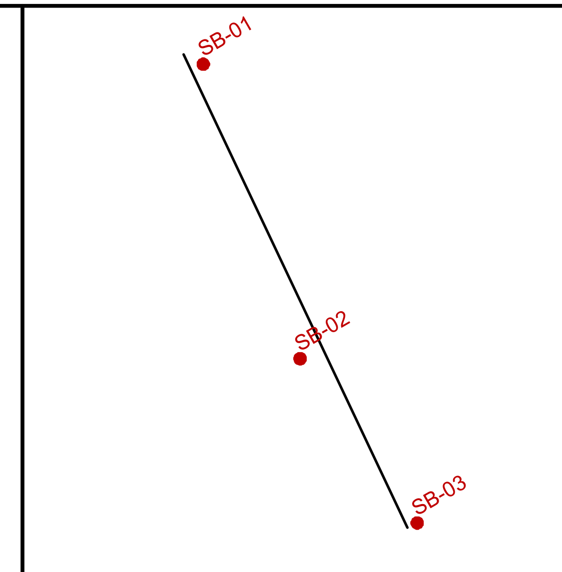
FOR IDOT, DISTRICT ONE

555-16-04



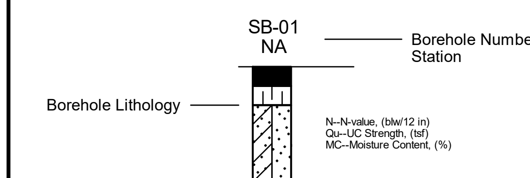
Lithology Graphics

- Topsoil
- IDH Silt, Silty Loam
- IDH Sand, Sandy Loam
- IDH Silty Clay, Silty Clay Loam
- Dolomite or Dolomitic Limestone
- Weathered bedrock
- Gravelly sand, sandy gravel
- Pavement
- IDH Loam
- IDH Clay



Site Map Scale 1 inch equals 105 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: 3.5x

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

IL 59 DDI Northbound Bridge over I-55
Subsurface Data Profile

WEI
SINCE 1982

I-55 at IL 59
Will County, IL

JOB NUMBER	PLATE NUMBER
555-16-04	EXHIBIT 4

WEI 11X17 5551604.GPJ WANGENG.GDT 10/22/18

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APPENDIX A

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BORING LOG SB-01

WEI Job No.: 555-16-04

Client: **IDOT**
Project: **I-55 at IL 59**
Location: **Will County, IL**

Datum: NAVD 88
Elevation: 593.57 ft
North: 1761463.96 ft
East: 1021245.35 ft
Station: NA
Offset: NA

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
593.1	6-inch thick, black SILTY CLAY LOAM --TOPSOIL--					
	Very stiff to hard, brown and gray SILTY CLAY, trace gravel --RDR 2--		1	5 5 5	> 4.50 P	20
		5	2	4 5 7	5.74 B	20
	--hard drilling to 8.5 feet-- --offset boring 7 feet east--		3	3 29 30	2.95 B	22
586.4	Brown, moist GRAVEL --strong oil odor--					
585.1	Medium dense, brown, damp LOAM, little to some gravel --RDR 2--	10	4	11 10 14	NP	9
583.1	Medium dense, gray, damp SILT --RDR 2--		5	5 11 13	NP	15
580.6	Very stiff to hard, gray SILTY CLAY --RDR 2-- --<1-inch thick, damp silt laminations--	15	6	3 5 7	4.10 B	19
	--L_L(%)=31, P_L(%)=18-- --%Gravel=0.0-- --%Sand=0.2-- --%Silt=67.0-- --%Clay=32.7-- --A-6 (13)--		7	6 6 6	2.54 B	24
574.6	Gray, moist SILT					
574.2	Dense to very dense, gray, wet to saturated SANDY GRAVEL --RDR 2 to 4--	20	8	6 20 20	NP	8
			9	50/1"	NP	12
572.1	--WEATHERED BEDROCK--					
	Strong, light grayish gray, fair quality, DOLOSTONE; Closely spaced, slightly weathered, horizontal, oblique, and vertical joints, with 0.05 - 0.2 inch opening, rough walls, and no infill.	25		CORE		
	--RUN 1: 21.5 to 29.5 feet-- --RECOVERY = 94%-- --RQD = 55%--		10			
	--RUN 2: 29.5 to 36.5 feet-- --RECOVERY = 100%-- --RQD = 64%--	30	11	CORE		
		35				
557.1	Boring terminated at 36.50 ft					
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **10-01-2018** Complete Drilling **10-01-2018**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50T [81%]**
Driller **J&K** Logger **M. Ciapas** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; auto hammer; boring grouted backfilled**

WATER LEVEL DATA

While Drilling ▽ **20.00 ft**
At Completion of Drilling ▼ **17.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG SB-02

WEI Job No.: 555-16-04

Client: **IDOT**
Project: **I-55 at IL 59**
Location: **Will County, IL**

Datum: NAVD 88
Elevation: 593.07 ft
North: 1761306.37 ft
East: 1021297.20 ft
Station: NA
Offset: NA

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
592.1	12-inch thick ASPHALT --PAVEMENT--					
587.6	Medium dense to dense, gray, moist SANDY GRAVEL --FILL-- --RDR 2--	5	1	5 20 18	NP	5
			2	5 7 5	NP	5
580.1	Stiff to very stiff, brown and gray CLAY to SILTY CLAY --RDR 2-- --damp silt lenses--	10	3	3 3 3	1.64 B	23
			4	2 4 6	2.30 B	22
			5	3 5 7	2.95 S	22
576.1	Very stiff, gray SILTY CLAY LOAM, trace gravel --RDR 2-- --L_L(%)=29, P_L(%)=18-- --%Gravel=0.0-- --%Sand=0.4-- --%Silt=70.3-- --%Clay=29.2-- --A-6 (10)--	15	6	3 9 12	3.50 N/6	17
			7	4 12 22	3.28 B	15
572.6	Medium dense to dense, gray, wet GRAVELLY LOAM --RDR 3--	20	8	7 11 18	NP	11
571.1	Very dense, gray, saturated SANDY GRAVEL		9	50/4"	NP	8
	Strong, light grayish gray, fair quality, DOLOSTONE; Closely spaced, fresh, horizontal JOINTS, with 0.05 - 0.2 inch opening, slicken walls, and no infill.	25		CORE		

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	-- Run 1: 22.0 to 32.0 feet-- --Recovery = 98%-- --RQD = 56%--	30	1			
559.6	-- Run 2: 32.0 to 33.5 feet-- --Recovery = 0%-- --RQD = 0%-- --core barrel jammed--		2	CORE		
	Boring terminated at 33.50 ft	35				
		40				
		45				
		50				

GENERAL NOTES

Begin Drilling **10-07-2018** Complete Drilling **10-07-2018**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50T [81%]**
Driller **J&K** Logger **F. Bozga** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; auto hammer; boring grouted backfilled**

WATER LEVEL DATA

While Drilling ▽ **17.00 ft**
At Completion of Drilling ▼ **17.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG SB-03

WEI Job No.: 555-16-04

Client: **IDOT**
Project: **I-55 at IL 59**
Location: **Will County, IL**

Datum: NAVD 88
Elevation: 594.79 ft
North: 1761218.45 ft
East: 1021359.88 ft
Station: NA
Offset: NA

Elevation (ft)	Soil and Rock Description	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
593.8	12-inch thick ASPHALT --PAVEMENT--					
	Stiff, black SILTY CLAY, trace gravel --FILL-- --RDR 2--		1	3 3 4	1.64 B	31
589.3	--L_L(%)=56, P_L(%)=21-- --%Gravel=0.1-- --%Sand=6.3-- --%Silt=61.8-- --%Clay=31.8-- --A-7-6 (36)--	5	2	4 4 5	1.56 B	28
586.8	Loose, brown, wet SANDY LOAM, some gravel --RDR 2--		3	2 3 3	NP	18
584.3	Loose, brown, wet GRAVELLY SAND --RDR 2--	10	4	4 4 5	NP	18
	Very stiff to hard, gray SILTY CLAY, trace gravel --RDR 2--		5	2 3 8	3.94 B	21
578.6	--Qu= 1.5 tsf--	15	6	3 7 8	4.57 B	22
	Dense to very dense, gray, damp to moist SILTY LOAM, some gravel --RDR 2 to 4-- --hard drilling; slow advancement--		7	25 15 16	NP	7
572.8		20	8	10 15 18	NP	9
			9	13 21 50/2"	NP	10
571.8	Brown DOLOSTONE fragments --very hard, steady drilling-- --WEATHERED BEDROCK--					
	Strong, light grayish gray, very poor quality, DOLOSTONE;	25		CORE		
	Closely spaced, slightly weathered, horizontal, oblique, and vertical JOINTS, with 0.05 - > 0.2 inch opening, slicken to slightly rough walls, and 0 - 0.2 inch thick sand infill. --RUN #1: 23.0 to 33.0 feet-- --RECOVERY = 98%-- --RQD = 58%--	30	10			
556.8	--RUN #2: 33.0 to 38.0 feet-- --RECOVERY = 98%-- --RQD = 32%--	35	11	CORE		
	Boring terminated at 38.00 ft	40, 45, 50				

GENERAL NOTES

Begin Drilling **10-02-2018** Complete Drilling **10-02-2018**
Drilling Contractor **Wang Testing Services** Drill Rig **17D50T [81%]**
Driller **J&K** Logger **M. Ciapas** Checked by **C. Marin**
Drilling Method **3.25" ID HSA; auto hammer; boring grouted backfilled**

WATER LEVEL DATA

While Drilling ∇ **5.50 ft**
At Completion of Drilling ▼ **17.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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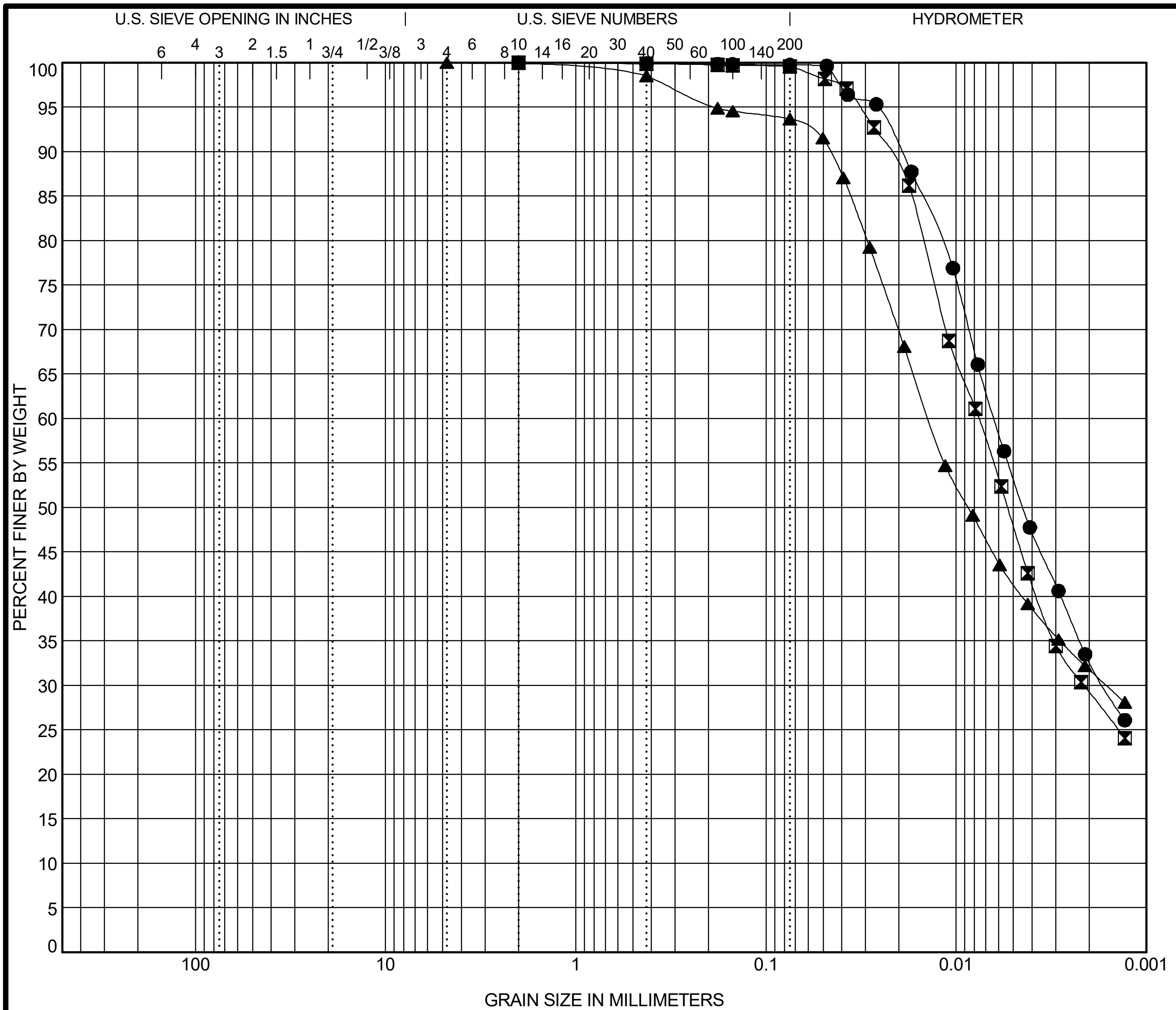
APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	**SB-01#6**	**13.5 ft**	**Silty Clay**	**31**	**18**	**13**		
⧗	**SB-02#6**	**13.5 ft**	**Silty Clay Loam**	**29**	**18**	**11**		
▲	**SB-03#2**	**3.5 ft**	**Silty Clay**	**56**	**21**	**35**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**SB-01#6**	**13.5 ft**	**2**	**0.006**	**0.002**		**0.0**	**0.2**	**67.0**	**32.7**
⧗	**SB-02#6**	**13.5 ft**	**2**	**0.008**	**0.002**		**0.0**	**0.4**	**70.3**	**29.2**
▲	**SB-03#2**	**3.5 ft**	**4.75**	**0.014**	**0.002**		**0.1**	**6.3**	**61.8**	**31.8**

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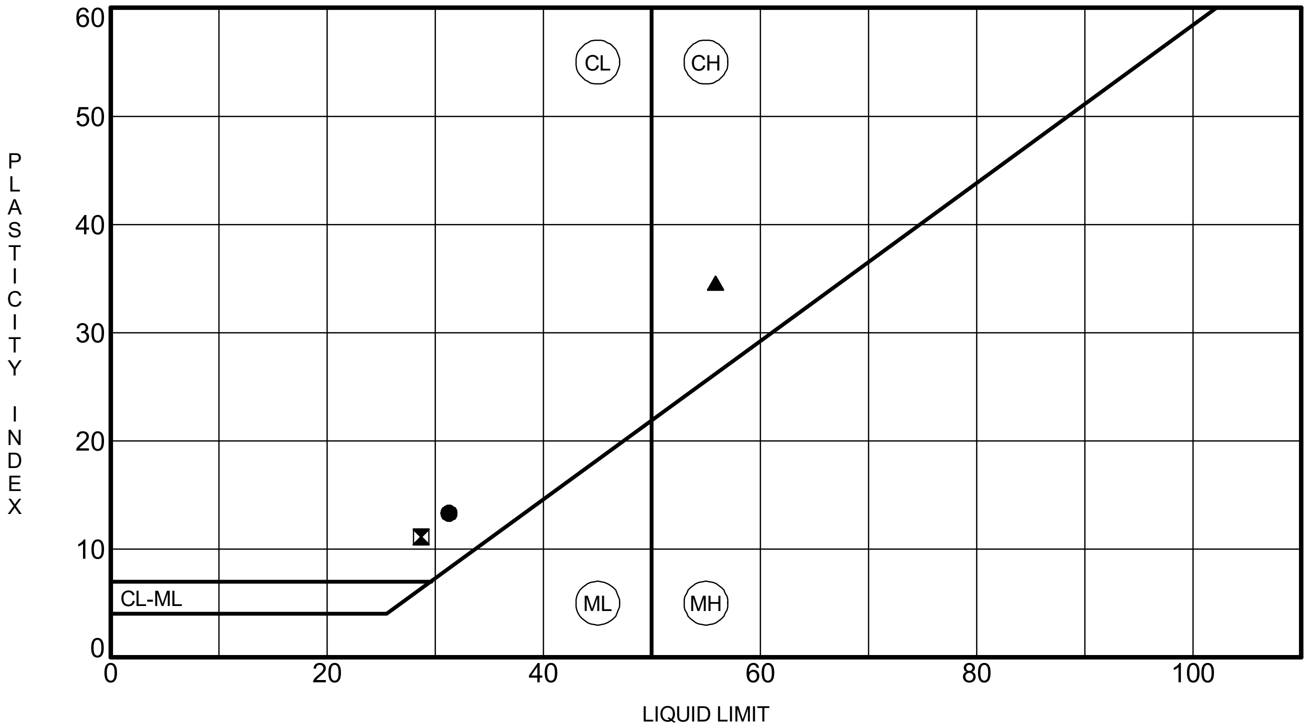
GRAIN SIZE DISTRIBUTION

Project: I-55 at IL 59

Location: Will County, IL

Number: 555-16-04



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**SB-01#6**	**13.5 ft**	**31**	**18**	**13**	**100**	**Silty Clay**
⊠	**SB-02#6**	**13.5 ft**	**29**	**18**	**11**	**100**	**Silty Clay Loam**
▲	**SB-03#2**	**3.5 ft**	**56**	**21**	**35**	**94**	**Silty Clay**

WEI SINCE 1982

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ATTERBERG LIMITS' RESULTS

Project: I-55 at IL 59

Location: Will County, IL

Number: 555-16-04

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APPENDIX C

0 6 inches

Boring SB-01:
Run #1, 21.5' to 29.5'
RECOVERY=94%
RQD=55%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**APPENDIX C-1**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**

0 6 inches

Boring SB-01:
Run #2, 29.5' to 36.5'
RECOVERY=100%
RQD=64%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL

SCALE: GRAPHICAL	**APPENDIX C-2**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala

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FOR IDOT, DISTRICT ONE

555-16-04

0 6 inches

Boring SB-02:
Run #1, 22.0' to 32.0'
RECOVERY=98%
RQD=56%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	APPENDIX C-3	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		555-16-04

0 6 inches

Boring SB-03:
Run #1, 23.0' to 33.0'
RECOVERY=98%
RQD=58%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	APPENDIX C-4	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		555-16-04

0 6 inches

Boring SB-03:
Run #2, 33.0' to 38.0'
RECOVERY=98%
RQD=32%

BEDROCK CORE: I-55 AT IL-59 WILL COUNTY, IL		
SCALE: GRAPHICAL	**APPENDIX C-5**	DRAWN BY: J. Rowells CHECKED BY: M. Kothawala
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
FOR IDOT, DISTRICT ONE		**555-16-04**

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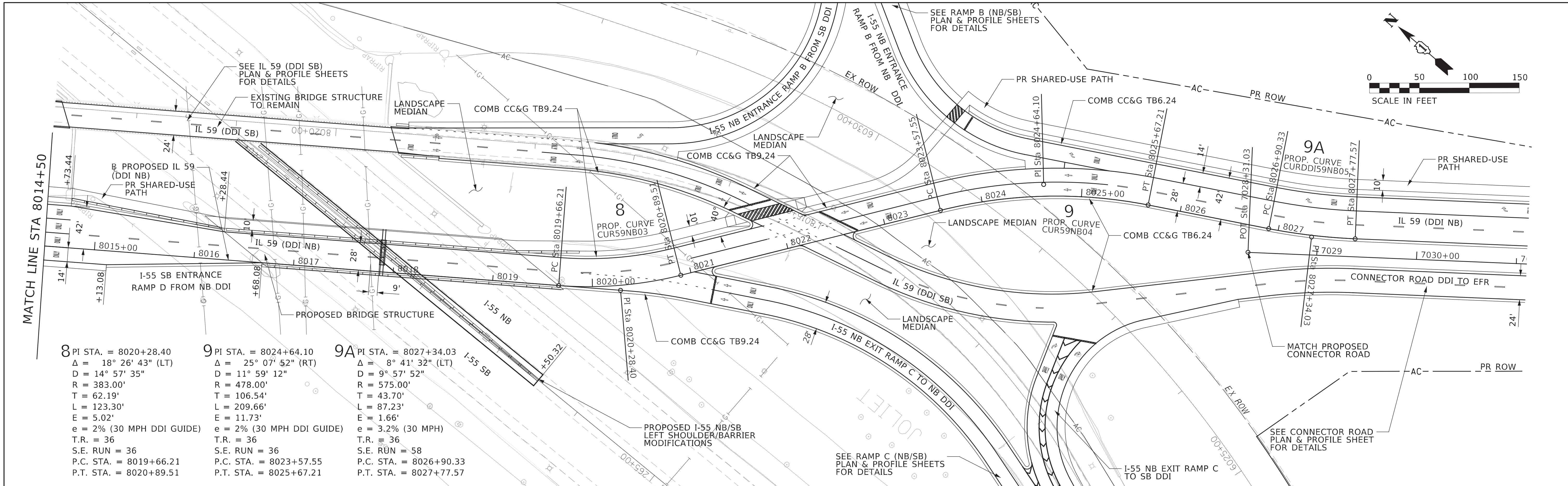
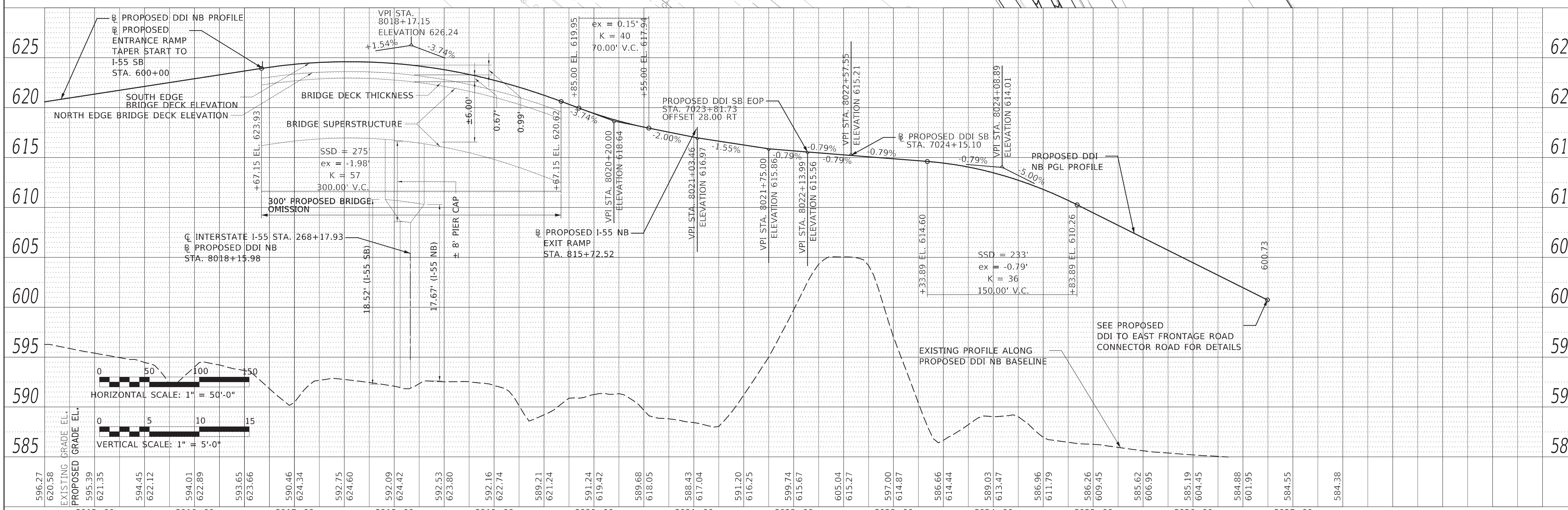
APPENDIX D





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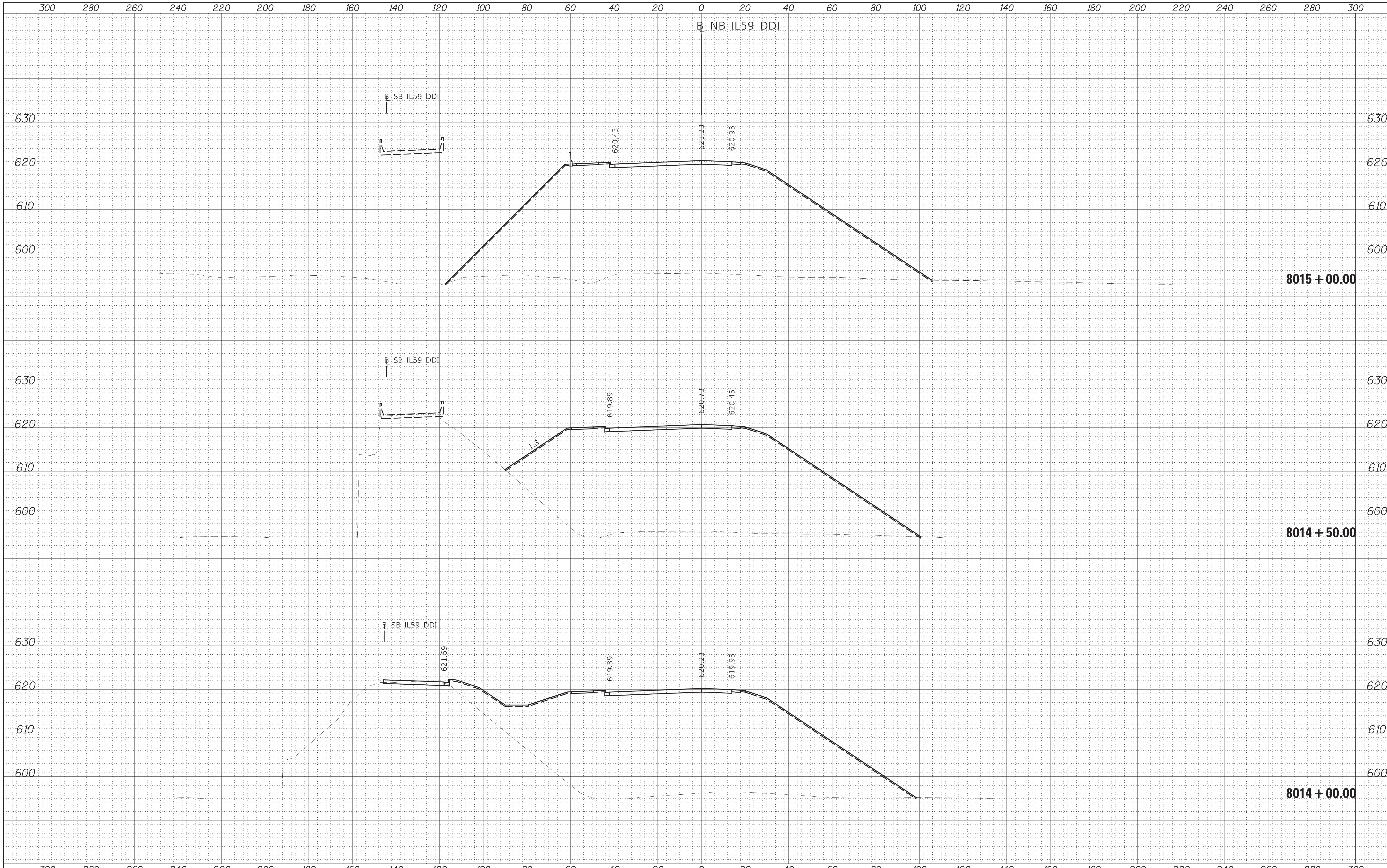
		DRAWN - GS, PAW, TPD	REVISED -							
	PLOT SCALE = 1:100	CHECKED - GS, CES	REVISED -		SCALE: SHEET OF SHEETS STA. TO STA.	CONTRACT NO.				
	PLOT DATE = 10/8/2018	DATE -	REVISED -			ILLINOIS FED. AID PROJECT P-91-015-19				



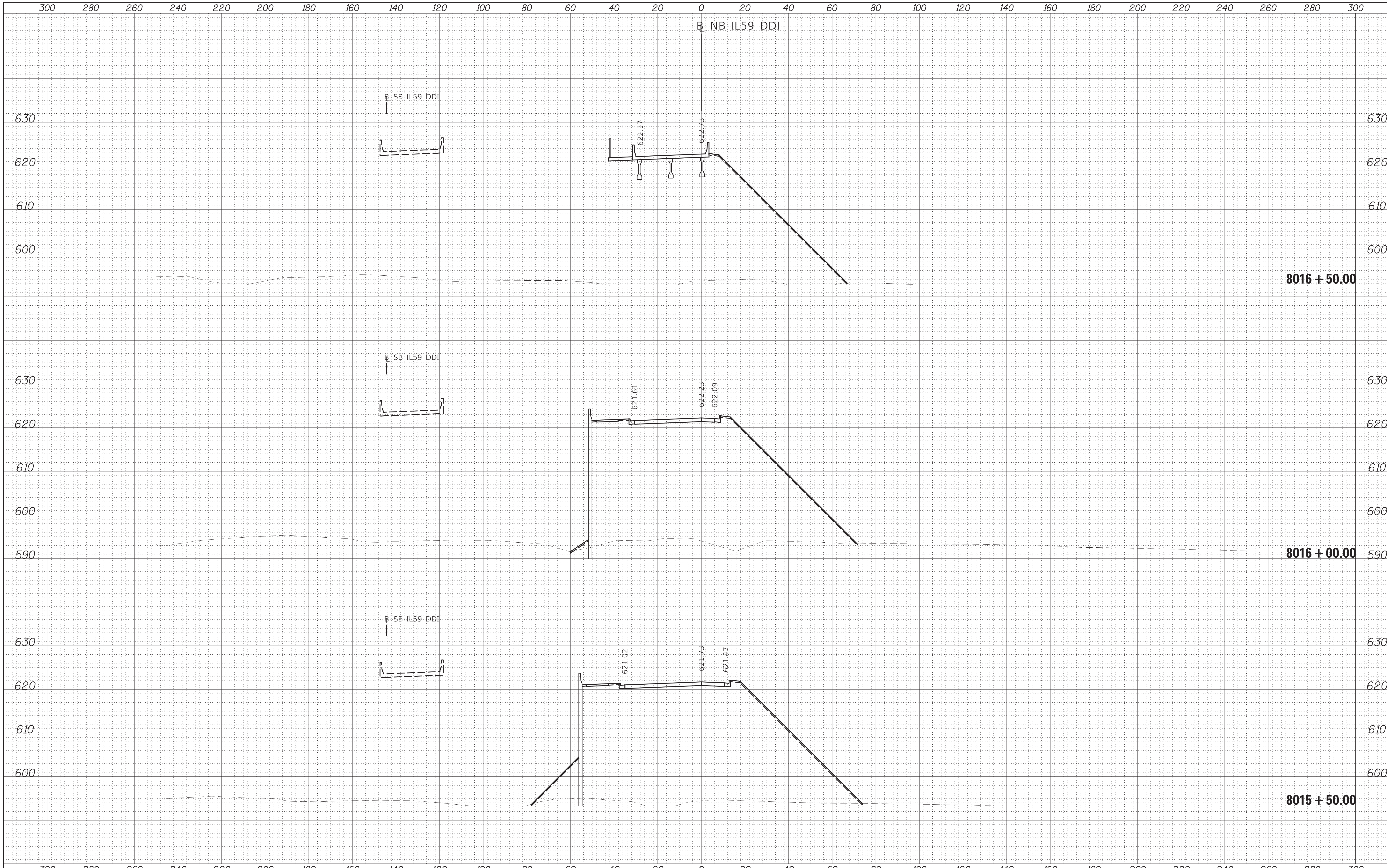
FINAL SURVEY | NOTE BOOK NO. | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

ORIGINAL SURVEY | NOTE BOOK NO. | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

FILE NAME = DI155ATIL59-sht-XS-02-DDI_Area-NorthAlign.dgn	USER NAME = mmaestra	DESIGNED -	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	CROSS SECTIONS I-55 AT IL59 DDI NB & SB	F.A. RTE. / SECTION S-10.20 / COUNTY / TOTAL SHEETS 184 / SHEET NO. 20
		DRAWN -	REVISED -			CONTRACT NO.
	PLOT SCALE = 1:40	CHECKED -	REVISED -		SCALE: SHEET 11 OF 23 SHEETS STA. 8014+00.00 TO STA. 8015+00.00	ILLINOIS FED. AID PROJECT P-91-015-19
	PLOT DATE = 10/8/2018	DATE -	REVISED -			

FINAL SURVEY	BY	DATE
NOTE BOOK NO.		
SURVEYED		
PLOTTED		
TEMPLATE		
AREAS		
AREAS CHECKED		

ORIGINAL SURVEY	BY	DATE
NOTE BOOK NO.		
SURVEYED		
PLOTTED		
TEMPLATE		
AREAS		
AREAS CHECKED		



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		DRAWN -	REVISED -
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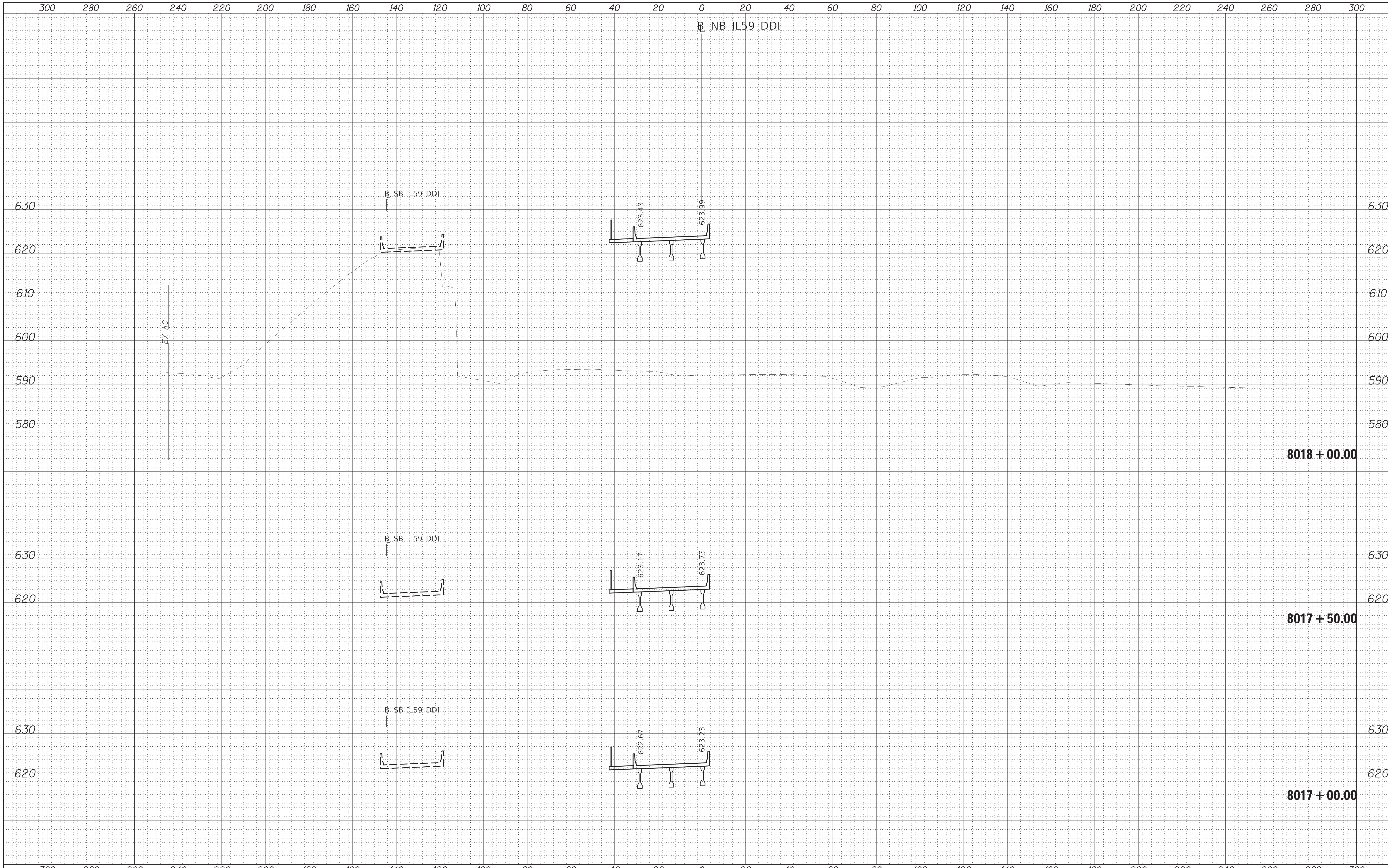
	PLOT DATE = 10/8/2018	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CROSS SECTIONS
I-55 AT IL59 DDI NB & SB

SCALE: | SHEET 12 OF 23 SHEETS | STA. 8015+50.00 TO STA. 8016+50.00

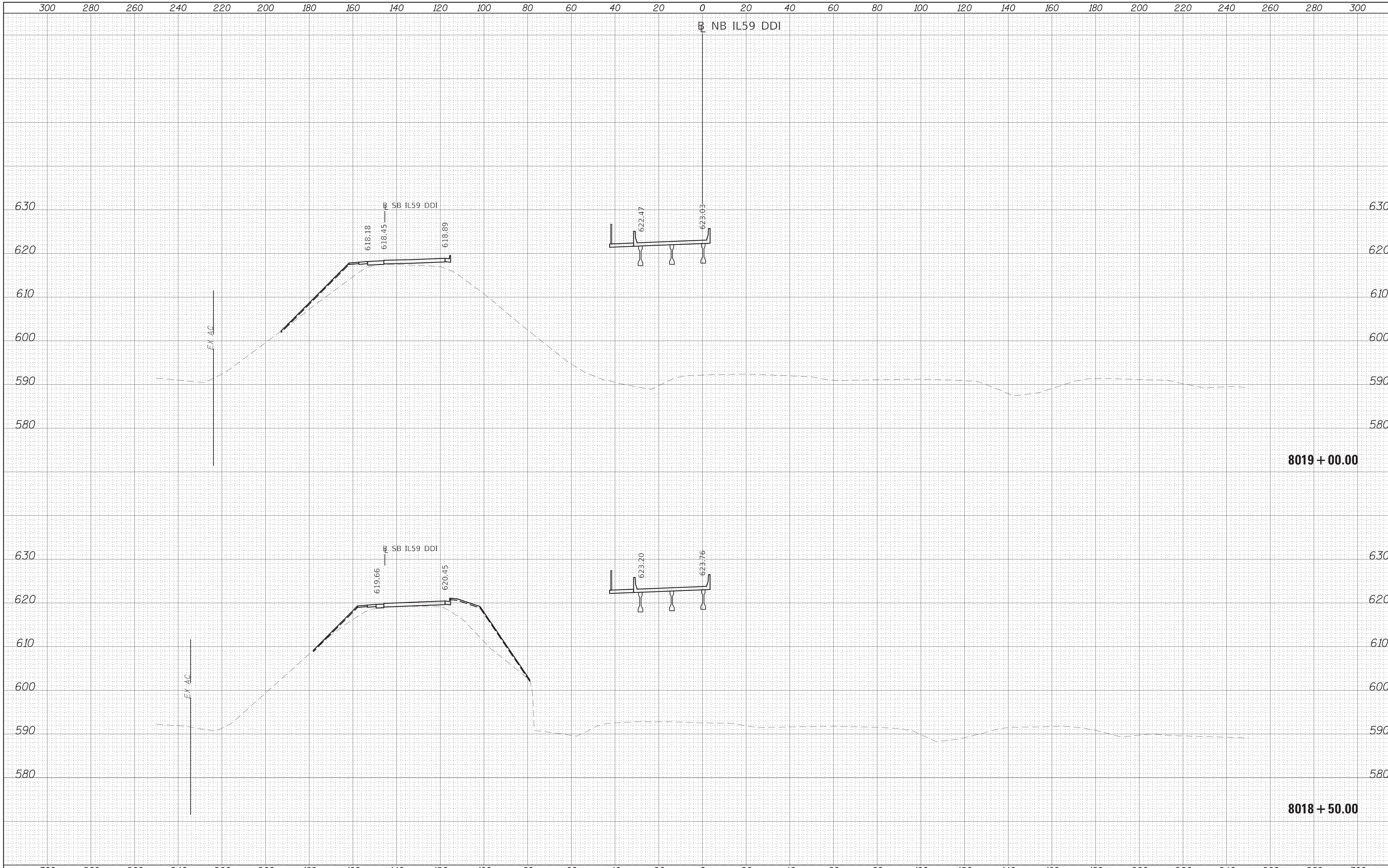
F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
			184	21
	S-10.21	CONTRACT NO.		
	ILLINOIS	FED. AID PROJECT	P-91-015-19	



FINAL SURVEY | NOTE BOOK | NO. | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

ORIGINAL SURVEY | NOTE BOOK | NO. | SURVEYED | PLOTTED | TEMPLATE | AREAS | AREAS CHECKED | BY | DATE

FILE NAME = DI155ATIL59-sht-XS-02-DDI_Area-NorthAlign.dgn	USER NAME = mmaestra	DESIGNED -	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION	CROSS SECTIONS I-55 AT IL59 DDI NB & SB	F.A. RTE. / SECTION: S-10.22 / COUNTY / TOTAL SHEETS: 184 / SHEET NO.: 22
		DRAWN -	REVISED -			CONTRACT NO.
	PLOT SCALE = 1:40	CHECKED -	REVISED -			
	PLOT DATE = 10/8/2018	DATE -	REVISED -		SCALE: / SHEET 13 OF 23 SHEETS / STA. 8017+00.00 TO STA. 8018+00.00	ILLINOIS FED. AID PROJECT P-91-015-19



FINAL SURVEY	NOTE BOOK NO.	SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED	BY	DATE

ORIGINAL SURVEY	NOTE BOOK NO.	SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED	BY	DATE

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		DRAWN -	REVISED -		
	PLOT SCALE = 1:40	CHECKED -	REVISED -		
	PLOT DATE = 10/8/2018	DATE -	REVISED -		SCALE: SHEET 14 OF 23 SHEETS STA. 8018+50.00 TO STA. 8019+00.00

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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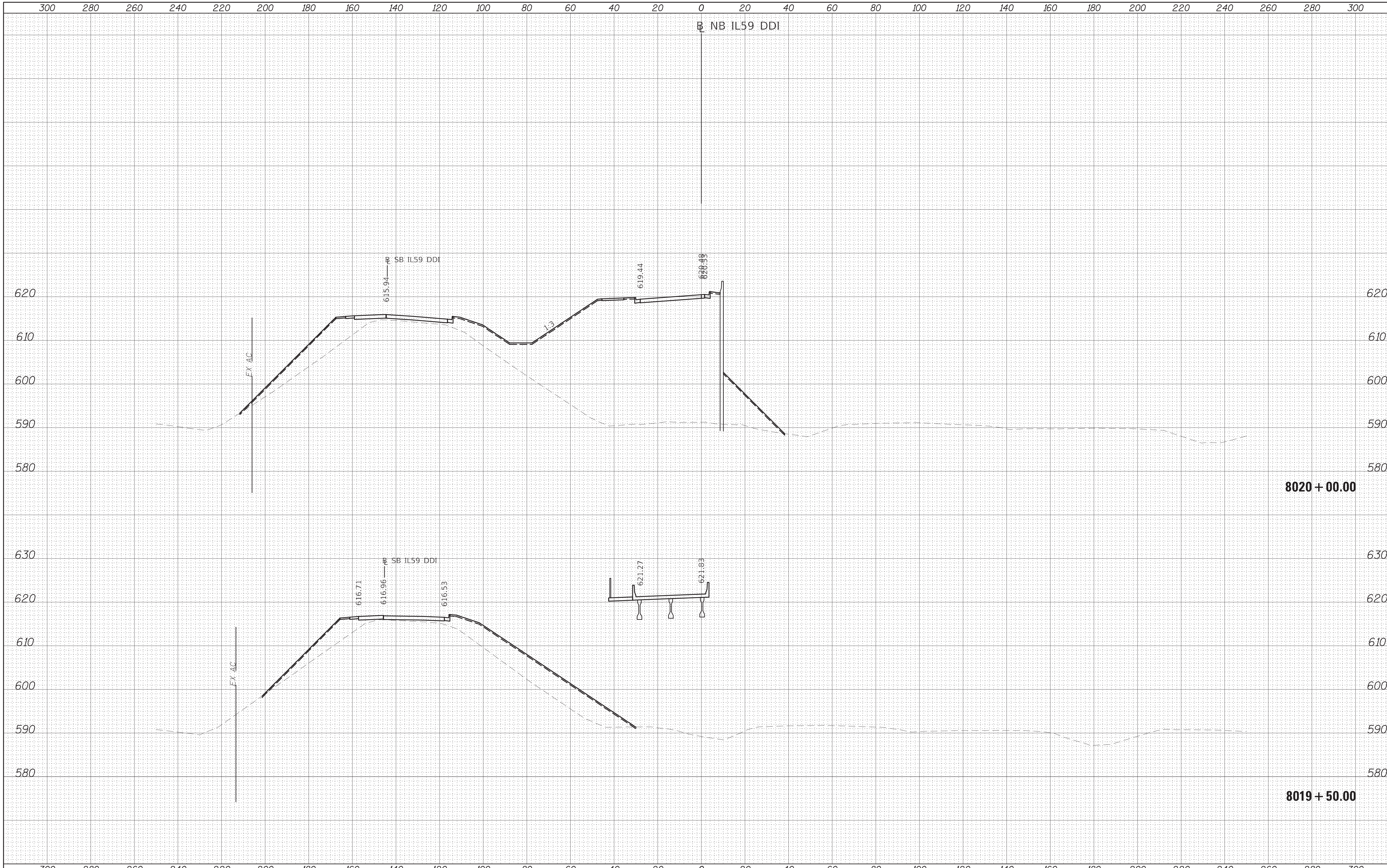
		CONTRACT NO.		
	ILLINOIS	FED. AID PROJECT	P-91-015-19	



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		DRAWN -	REVISED -
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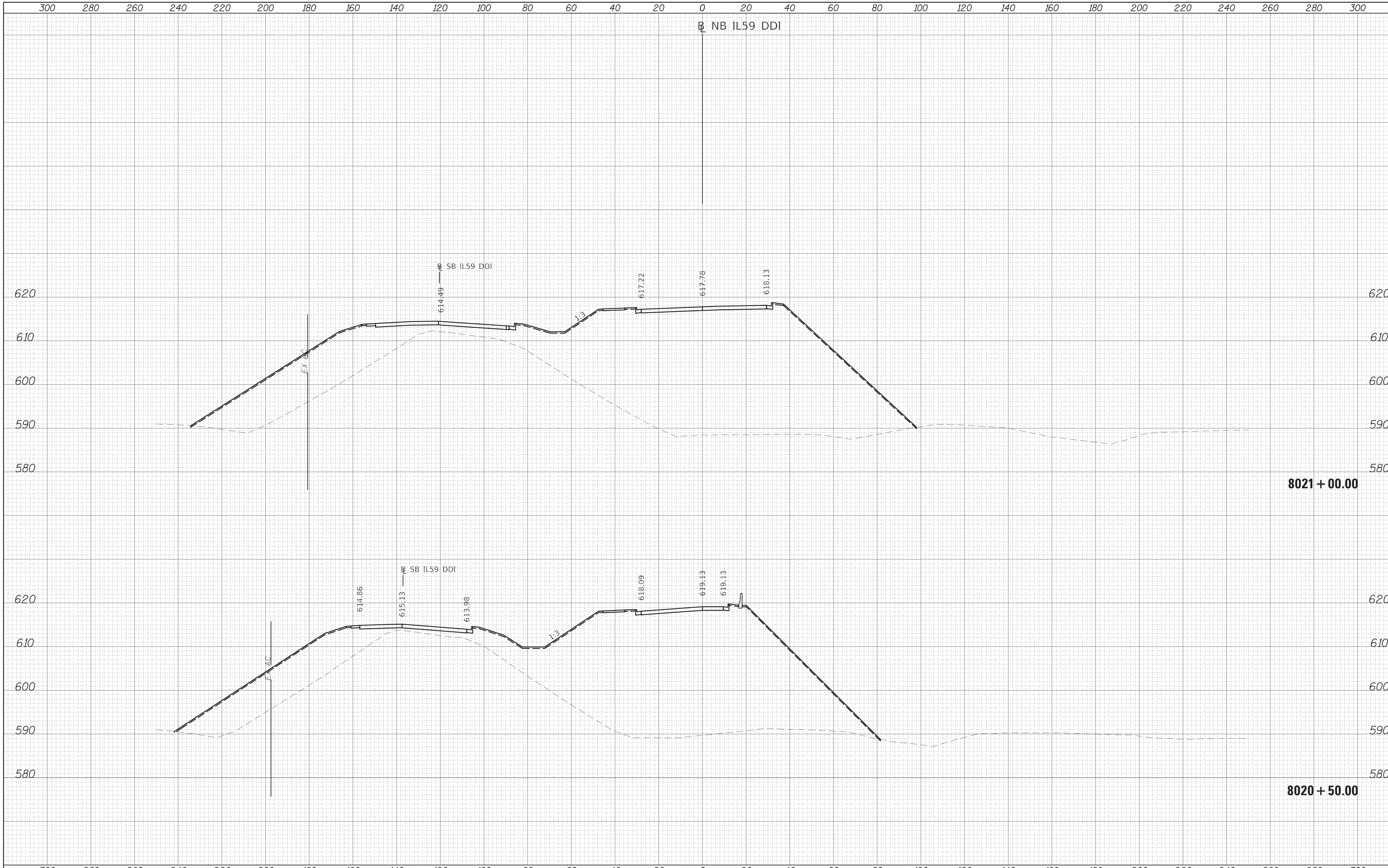
	PLOT DATE = 10/8/2018	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CROSS SECTIONS
I-55 AT IL59 DDI NB & SB

SCALE: SHEET 15 OF 23 SHEETS STA. 8019+50.00 TO STA. 8020+00.00

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
	S-10.24		184	24
		CONTRACT NO.		
		ILLINOIS FED. AID PROJECT	P-91-015-19	



FINAL SURVEY	NOTE BOOK NO.	SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED	BY / DATE
ORIGINAL SURVEY	NOTE BOOK NO.	SURVEYED / PLOTTED / TEMPLATE / AREAS / AREAS CHECKED	BY / DATE

FILE NAME = DI155ATIL59-sht-XS-02-DDI_Area-NorthAlign.dgn	USER NAME = mmaestra	DESIGNED -	REVISED -
		DRAWN -	REVISED -
	PLOT SCALE = 1:40	CHECKED -	REVISED -
	PLOT DATE = 10/8/2018	DATE -	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CROSS SECTIONS
I-55 AT IL59 DDI NB & SB

SCALE: | SHEET 16 OF 23 SHEETS | STA. 8020+50.00 TO STA. 8021+00.00

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
	S-10.25		184	25

CONTRACT NO.
ILLINOIS | FED. AID PROJECT | P-91-015-19