Structural Geotechnical Report

IDOT PTB 200-004
Work Order #6
I-57 at Pauling Road
Proposed Retaining Wall SN 099-W1000
Will County, Illinois

Prepared for

Illinois Department of Transportation
Job No. P-91-028-18

Project Design Engineer Team
Atlas Engineering Group, LTD.

Prepared by:

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May 4, 2023

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Proposed Retaining Wall, SN 099-W1000
Will County, IL
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Dear Mr. Amini:

Attached is a copy of the Structural Geotechnical Report for the above referenced project. The report provides a description of the site investigation, site conditions, and foundation and construction recommendations. The site investigation for the proposed retaining wall included advancing seven (7) soil borings to depths between 25 and 45 feet.

Should you have any questions or require additional information, please call us at 630-994-2600, or mheron@gsg-consultants.com.

Sincerely,

Matthew J Heron, P.E.
Project Engineer

Dawn Edgell, P.E.
Sr. Project Engineer

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1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed a geotechnical investigation for the proposed retaining wall along the south embankment of Pauling Road in Will County, Illinois. The purpose of the investigation was to explore the subsurface conditions, to determine engineering properties of the subsurface soil, and develop design and construction recommendations for the proposed retaining wall. **Exhibit 1** shows the general project location.

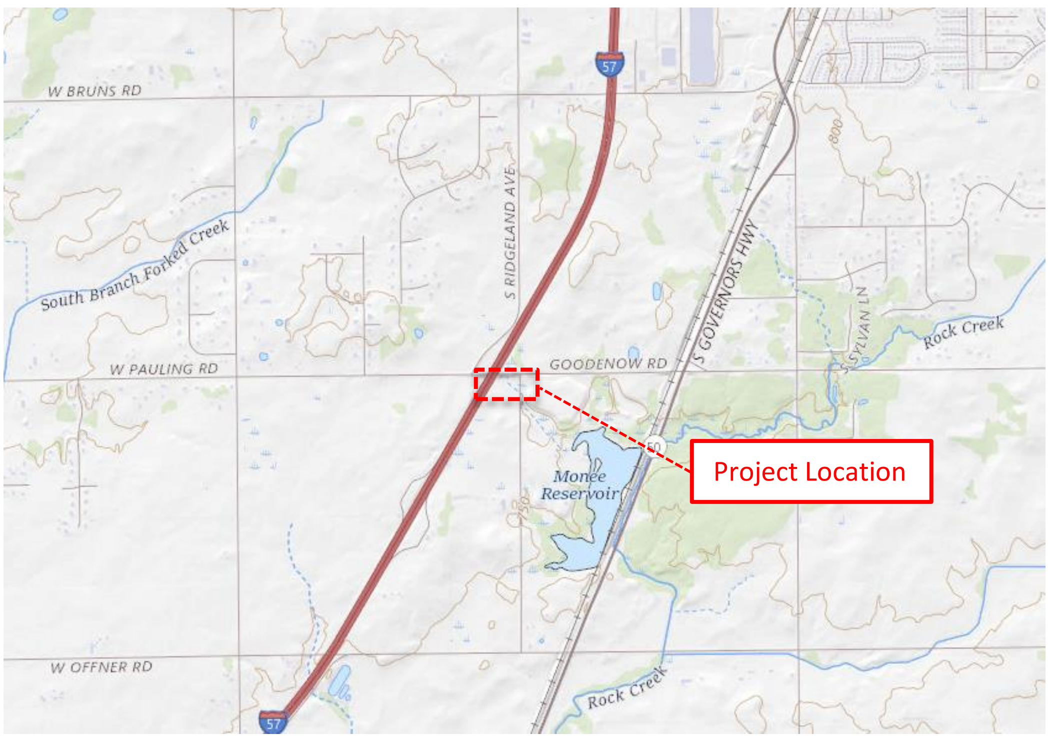


Exhibit 1 – Project Location Map
(Source: USGS Topographic Maps, usgs.gov)

1.1 Existing Conditions

The proposed improvements to Pauling Road will involve the widening of the approach embankment for the bridge over I-57. A retaining wall is required to limit the expansion of the embankment into the Monee Reservoir Forest Preserve. According to the Pauling Road General Plan and Elevation (**Appendix A**) provided by Atlas, the proposed retaining wall will be constructed approximately 6 feet south of the existing guardrail and approximately 22 feet south of the centerline of Pauling Road within the existing embankment on the IDOT Right-of-Way. There will be both mainly fill sections to construct the wall within the existing embankment and widen the crest of the roadway. There is an existing box culvert near the middle of the embankment that will remain in place. **Exhibits 2a thru2c** show the existing conditions where the proposed retaining wall will be constructed.

Exhibit 2a – Existing Pauling Road, Looking West

Exhibit 2b – Existing Pauling Road, Looking East

Exhibit 2c – Proposed Project Area, Aerial

1.2 Proposed Retaining Wall Information

The proposed wall type is anticipated to be a Drilled Soldier Pile Wall. Based on preliminary design information provided and a review of site topography, the proposed wall will have mainly fill sections, approximately 22 feet south of the Pauling Road centerline near the top of the existing embankment. The proposed retaining wall will be approximately 344.5 feet in length, with a maximum exposed wall height of up to approximately 7.5 feet. The crest of the existing embankment will be widened by approximately 10 feet on each side, at the roadway level.

A retaining wall is proposed for this location as shown on the Preliminary Cross Sections (**Appendix A**). **Table 1** presents a summary of the proposed structure.

Table 1 – Preliminary Retaining Wall Summary

Structure Name	Wall Stations*	Approximate Length (ft)	Maximum Anticipated Exposed Wall Height (ft)
SN 099-W1000	Sta. 111+28.15 RT to Sta. 114+65.59 RT	344.5	7.5

* Based on Pauling Road Stationing

2.0 SITE SUBSURFACE CONDITIONS

This section describes the subsurface exploration program and laboratory testing program completed as part of this project. The proposed locations and depths of the soil borings were selected in accordance with IDOT requirements and reviewed with Atlas Engineering Group, LTD (Atlas). The borings were completed in the field based on field conditions and accessibility.

2.1 Subsurface Exploration

The site subsurface exploration for the proposed retaining wall structure was conducted on January 24, 2023. Boring SGB-05 was previously drilled as part of the roadway improvement investigation on October 4, 2022. The investigation included advancing seven (7) borings to depths between 25 and 45 feet. The locations of these soil borings were approximately 10 to 15 feet north of the proposed alignment and were adjusted in the field as necessary based on utilities and access. Elevations and as-drilled locations for the borings were gathered by GSG's field crew using GPS surveying equipment. The approximate as-drilled locations of the soil borings are shown on the Soil Boring Location Plan & Subsurface Profiles **(Appendix B)**. **Table 2** presents a summary of the borings used for the proposed retaining wall analysis. Copies of the Soil Boring Logs are provided in **Appendix C**.

Table 2 – Summary of Subsurface Exploration Borings

Boring ID	Station *	Offset (ft) *	Northing	Easting	Depth (ft)	Surface Elevation (ft)
RWB-08	111+34.44	10.88 RT	1723634.100	1139334.602	45.0	778.60
RWB-09	111+70.24	10.29 RT	1723635.261	1139370.390	45.0	777.43
RWB-10	112+60.60	11.05 RT	1723635.958	1139460.742	45.0	775.34
RWB-11	113+24.92	10.98 RT	1723637.059	1139525.054	35.0	772.81
SGB-05	113+86.92	7.85 RT	1723641.190	1139586.994	40.0	770.28
RWB-13	114+35.03	10.99 RT	1723638.830	1139635.153	25.0	768.12
RWB-14	114+82.43	10.83 RT	1723639.754	1139682.543	25.0	765.83

* Based on Pauling Road Stationing

The soil borings were drilled using truck mounted Diedrich D-50 (hammer efficiency 99.5%), CME -75 (hammer efficiency 79.8%) drill rigs and a Diedrich D-50 ATV drill rig (hammer efficiency 91.5%), each equipped with 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 a depth of 30 feet or the boring termination depths, followed by 5-foot intervals to the boring termination depths. 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 and surface patching with asphalt to match the existing pavement.

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 were collected from each sample interval and were placed in jars and returned to the laboratory for further testing and evaluation.

2.2 Laboratory Testing Program

All samples were inspected in the laboratory to verify the field classifications. A laboratory testing program was undertaken to characterize and determine engineering properties of the subsurface soils encountered in the area. 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
- Particle Size Analysis ASTM D422 / AASHTO T-88
- Loss on Ignition/Organic Content – AASHTO T267

The laboratory tests were performed in accordance with test procedures outlined in the most current IDOT Geotechnical Manual, 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 shown along with the field test results in the Soil Boring Logs **(Appendix C)** and in the Laboratory Results (**Appendix D)**.

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 wall. Variations in the general subsurface soil profile were noted during the drilling activities. Detailed descriptions of the subsurface soils are provided in the soil boring logs and are shown graphically in the Boring Location Plan & Subsurface Profiles. The soil boring logs provide specific conditions encountered at each boring location and include soil descriptions, stratifications, penetration resistance, elevations, location of the samples, and laboratory test data. Unless otherwise noted, soil descriptions indicated on boring logs are visual identifications. The stratifications shown on the boring logs represent the conditions only at the actual boring locations and represent the approximate boundary between subsurface materials; however, the actual transition may be gradual.

The surface elevations of the borings ranged between 765.8 and 778.6 feet along the south shoulder of Pauling Road. The borings initially encountered 5 to 9.5 inches of asphalt. Borings RWB-10, RWB-11, RWB-13 and SGB-05 then noted 3 to 8 inches of aggregate base. Beneath the pavement layers brown and gray silty clay fill materials were encountered to depths of 8.5 to 23.5 feet (elevations 753.9 to 757.3 feet). Wooden fragments were encountered in boring RWB-08 at a depth of 22 feet, while a gravel seam was noted in boring RWB-09 at a depth of 22 feet. The silty clay fill materials had unconfined compressive strengths between 1.0 and 6.5 tsf.

Beneath the fill materials, the borings generally encountered brown, dark brown and gray medium stiff to hard silty clay and silty clay loam to depths of 16 to 37 feet (elevations 741.6 to 749.8 feet), followed by gray stiff to very stiff silty clay and silty clay loam to the boring termination depths. Layers of medium dense to dense sandy loam, with thicknesses from 2.5 to 4.5 feet, were encountered in borings RWB-08, RWB-10 and SGB-05 at various depths between elevations 735.0 and 749.5 feet. Layers of loose to medium dense silty loam and loam materials, with thicknesses from 2.5 to 6 feet, were encountered in borings RWB-11 and RWB-13 between elevations 743.5 and 752.0 feet. Cobbles were encountered in borings RWB-08, RWB-09, and SGB-05 at various depths.

The native brown and gray silty clay had unconfined compressive strengths between 0.6 tsf and 5.2 tsf, with an average strength of 2.25 tsf. The gray silty clay had unconfined compressive strengths between 1.3 tsf and 3.8 tsf, with an average strength of 2.2 tsf. The sandy loam had SPT blow count (N) values ranging from 12 to 31 blows per foot (bpf) with an average value of 14 bpf. The silty loam and loam had SPT blow count (N) values ranging from 8 bpf to 12 bpf, with an average value of 10 bpf.

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. Water was observed between elevations of 735.5 and 747.0 feet in four borings (RWB-08 thru RWB-11), typically within the confined granular layers. Groundwater was not encountered during or immediately after drilling in borings RWB-13, RWB-14 and SGB-05. None of the borings were left open after leaving the site due to safety concerns.

Based on the observed water levels and soil color change from brown to gray, it is anticipated that the long-term groundwater level may be between elevations 741.5 and 750.0 feet. Perched water may also be present within the fill materials and confined granular layers. Water level readings were made in the boreholes at times and under conditions shown on the boring logs and stated in the text of this report. However, it should be noted that fluctuations in groundwater level may occur due to variations in the 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 for the design of the proposed retaining wall and embankment based on the results of the field exploration, laboratory testing, and geotechnical analysis. Subsurface conditions between borings 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.

3.1 Derivation of Soil Parameters for Design

Soil parameters for the design of the wall were developed based on the most recent design information and the soil borings information available. Soil parameter tables developed for the proposed wall are presented in **Appendix F**.

3.2 Embankment

Based on the provided plans, the existing embankment will be widened at the roadway level by approximately 10 feet. New engineered fill will be placed on top of the existing embankment slope and retained by the proposed retaining wall. Based on the cross-section drawings, the height of the existing embankment is between 15 and 20 feet. The height of new fill behind the proposed retaining wall ranges between 3 and 4 feet.

Existing slopes steeper than 3H:1V or higher than 15 feet should be stepped and benched to provide a level surface for the placement and compaction of the new fill materials. Benching will provide level surfaces for compaction and reduce the development of inclined planes of potential weakness between the existing soil and the fill material. The embankment should be constructed as early as possible in the project construction period in order to allow the embankments to adjust or settle under its own weight as much as possible prior to pavement construction.

3.3 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 2020 AASHTO Guide Specifications as shown in **Table 3**. Given the site location and materials encountered, the potential for liquefaction is minimal.

Table 3 – Seismic Parameters

Building Code Reference	PGA	S_{DS}	S_{D1}
2020 AASHTO Guide for LRFD Seismic Bridge Design	0.046g	0.121g	0.068g

4.0 GEOTECHNICAL WALL DESIGN RECOMMENDATIONS

This section provides retaining wall design parameters including recommendations on foundation type, bearing capacity, settlement, and lateral earth pressures. The foundations for the proposed retaining walls must provide sufficient support to resist the dead and live loads, as well as seismic loading.

4.1 Retaining Wall Type Recommendations

The proposed retaining wall will be partially constructed within an area of new fill for the proposed widened embankment. However, construction of the wall will impact and cut into the existing embankment. There are various types of retaining walls that could be utilized for this type of construction. Up to 10 feet of new fill may be required to widen the embankment behind the new wall. This section discusses several earth retaining structures that could be used for the proposed project.

4.1.1 CIP Concrete Cantilever Walls

Cast-In-Place (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 can easily be formed, textured, or colored to meet aesthetic requirements. Disadvantages include a relatively long construction period due to undercutting, excavation, formwork, steel placement, and curing of the concrete. This wall system is also sensitive to total and differential settlements.

4.1.2 Mechanically Stabilized Earth Walls

A Mechanically Stabilized Earth (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 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 friction angle of 34 degrees for the reinforced backfill soil.

4.1.3 Precast Modular "T" Type Walls

This type of wall typically consists of modular precast concrete units and select backfill. The combined weight of the wall materials and backfill 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.

4.1.4 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.

4.1.5 Recommended Wall Type

GSG understands that a Drilled Soldier Pile Wall is being considered for the design of the retaining wall the project. Non-drivable W-sections are anticipated to accommodate the loading from the atypically wide spacing required to clear the existing culvert and utilities. Also, the drilled shafts will provide better control to help avoid conflicts with the buried elements.

GSG evaluated the global and external stability and settlement to determine the suitability of the retaining wall type for this project. The wall section should be analyzed to determine adequate factors of safety relative to overturning failure. The contractor is responsible for providing a 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.

4.2 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 4** outlines the load factors used in the evaluation of the retaining wall in accordance with AASHTO Specification Tables 3.4.1-1 and 3.4.1-2.

Table 4 - LRFD Load Factors for Retaining Wall Analyses

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

4.2.1 Lateral Earth Pressures and Loading

The wall should be designed to withstand earth and live lateral earth pressures. The lateral earth pressures on retaining walls depend 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 active earth pressure coefficient (Ka), and the passive earth pressure coefficient (Kp) were determined in accordance with AASHTO Section 3.11.5.3 and 3.11.5.4. The soil design properties for the retaining wall for the anticipated soil types at the site are included in **Appendix F**, including recommended lateral soil modulus and soil strain parameters that can be used for laterally loaded pile analysis via the p-y curve method based on the encountered subsurface conditions.

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. **Table 5** provides the equivalent heights of soils for vehicular loadings on retaining walls.

Table 5 - Equivalent Height of Soil for Vehicular Loading on Retaining Walls Parallel to Traffic

Retaining Wall Height (ft)	H_{eq} Distance from Wall Back face to Edge of Traffic	
	0 feet	1.0 feet or Further
5	5.0 feet	2.0 feet
10	3.5 feet	2.0 feet
≥20	2.0 feet	2.0 feet

Reference: AASHTO LRFD Table 3.11.6.4-2

The retaining wall 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.

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.

4.3 Soldier Pile and Lagging

Soldier pile walls are generally constructed at 8 to 10-foot centers along the retaining wall alignment into the bearing stratum. The soldier piles could either be driven or drilled. Driving piles is normally less expensive but the designs are limited to H-pile and small W-sections. Drilled soldier piles can utilize larger W-sections, built up plate sections or multiple W-sections. For drilled piles, the pile will be placed into the hole and centered, and the annular space around each pile section will be filled with flowable grout. The lagging and piles should be designed based on structural analysis.

Resistance to lateral movement or overturning of the soldier pile is furnished by passive resistance of the soil below the depth of excavation. The design should include a structural evaluation of the pile section to meet applied shear and moment, and an evaluation of overturning to determine embedment depth and other design requirements. The walls shall be designed to withstand earth and live lateral earth pressures. The lateral earth pressures on retaining walls depend 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. Soldier pile walls are considered flexible and such the earth loads may be calculated using active earth pressure for the load above the design grade, and both active and passive earth pressures below the design grade. The active earth pressure coefficient (Ka), and the passive earth pressure coefficient (Kp) are shown in **Appendix F**.

The simplified earth pressure distributions shown in the AASHTO Standard Specifications for Highway Bridges could be used for the wall design. **Appendix F** also provides recommended lateral soil modulus and soil strain parameters that can be used for laterally loaded pile analysis via the p-y curve method based on the encountered subsurface conditions. The passive resistance in front of the wall should be ignored for the upper 3.5 feet due to excavation activities and frost-heave conditions. Construction equipment surcharge loads should be added to the lateral earth pressure.

In order to limit wall deflections and provide additional resistance, the soldier pile and lagging retention system could be restrained with tie-back anchors. The soldier pile and lagging retention system restrained with tie-backs will be subjected to “trapezoidal” lateral soil pressures. For tall retaining walls, the “trapezoidal” pressure will result in greater lateral forces and moments compared to the cantilever design.

Soldier pile and lagging and sheet pile walls over 15 feet in height typically require additional lateral resistance to maintain stability and/or limit wall movements. This lateral resistance can be provided using ground anchors, buried deadmen or soil nails. For highway applications, anchored sheet pile walls are typically less than 33 feet in height due to excessive top of wall deflections, excessive sheet pile bending stresses, and high stresses at the wall-anchor connection. Anchor terminology, minimum anchor length and embedment guidelines are shown in AASHTO Figure 11.9.1-1. Anchor spacing is controlled by many factors including anchor (or deadmen) capacity, temporary (unsupported) cut slope stability, subsurface obstructions in the anchorage zone, and the structural capacity of lagging or facing elements. Performance or proof testing shall be performed on every production anchor in accordance with the requirements in AASHTO Section 11.9.8.1. Excavation shall not proceed more than 3.0 feet below the level of ground anchors until the ground anchors have been accepted by the Engineer. Where backfill is placed behind an anchored wall, either above or around the unbonded length, special designs and construction specifications shall be provided to prevent anchor damage.

4.4 Global Slope Stability

Based on the preliminary information provided by Atlas, the retaining wall should be designed for external stability of the wall system. The geometry in **Table 7** was used to evaluate the soldier pile wall. Once the final wall type has been determined, a final global stability analysis should be completed for the final wall configuration.

Table 7 – Wall Description at Station 111+92.09

Description	Value
Maximum exposed height of the retaining wall (H)*	7.5 feet
Depth below finished grade to bottom of concrete facing	2.0 feet
Unit weight of the existing retained soil (embankment)	138 pcf
Estimated embedment length below bottom of concrete facing for soldier pile	9.5 feet
Estimated Maximum Pile tip elevation – soldier pile wall	758.5

* Based on GPE dated 12/13/2023
**Additional embedment may be required for lateral pressures and structural design of the wall system

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

Slide2 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. Circular failure analyses were evaluated using the simplified Bishops analyses methods for the proposed wall geometries. Based on the proposed geometry and the soil borings, global stability analyses were performed.

4.4.1 Global Slope Stability Results

Circular failure analyses were evaluated for both a short term (undrained) and long term (drained) condition based on the proposed geometries (**Table 7**) for the proposed soldier pile wall. The analyses were performed at Station 111+92.09. The results of the analyses are shown in **Table 8**.

Table 8 – Retaining Wall Global Slope Stability Analyses Results

Analysis Exhibit	Location	Wall Type	Analysis Type	Factor of Safety	Minimum Factor of Safety
Exhibit 1	Station 111+92.09	Soldier Pile	Circular – Short Term	4.0	1.7
Exhibit 2			Circular – Long Term	1.9	1.7

Based on the analyses performed, the proposed retaining wall design meets the minimum factor of safety of 1.5 for walls with fill embankments per IDOT. Copies of the slope stability analyses are included in the Slope Stability Analyses Exhibits (**Appendix E**).

4.5 Drainage Recommendations

The wall design should include a drainage system to prevent the buildup of hydrostatic forces behind the wall. If weep holes are to be used, it is recommended that a geocomposite wall drain be placed over the interlocks and area of the weep holes. If drainage is not provided, hydrostatic pressure should be included in the wall design and the horizontal earth pressure should be determined in accordance with AASHTO Article 3.11.3.

5.0 CONSTRUCTION CONSIDERATIONS

All work performed for the proposed project should conform to the requirements in the IDOT Standard Specifications for Road and Bridge Construction (SSRBC) (2022). Any deviation from the requirements in the manuals above should be approved by the design engineer.

5.1 Site Preparation

All trees, pavements, vegetation, landscaping, and surface topsoil should be cleared and removed from the vicinity of the proposed foundations. Where possible, the engineer may require proof-rolling of the subgrade with a 35-ton loaded truck or other pneumatic-tired vehicle of similar size and weight. The purpose of the proof-rolling is to locate soft, weak, or excessively wet soils present at the time of construction. Proof-rolling should be performed during a time of good weather and not while the site is wet, frozen, or severely desiccated. Any unsuitable materials observed during the evaluation and proof-rolling operations 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 wall bottom.

5.2 Existing Utilities and Structures

Before proceeding with construction, any existing underground utility lines or structures that will interfere with construction should be completely relocated from 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 utilities or structure 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.

5.3 Site Excavation

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

5.4 Embankment Construction

Embankment should be constructed in accordance with Section 205 Embankment of IDOT SSRBC. The new fill should be benched into the side slopes of the existing embankment to provide interlocking between the old and new fill. GSG recommends benching the slopes according to Article 205.03 and placement according to Article 205.04 of IDOT SSRBC. Failure of the widened embankment may occur due to inadequate benching into the existing embankment and no proper drainage control during construction. GSG recommends including typical benching detail developed by IDOT District One or similar detail in the contract plan.

GSG recommends removing existing vegetation from the existing embankment without destabilizing the slopes before placement of new fill. Maintenance of the slope during the construction will be required for localized areas of cut slopes where erosion-prone soils (silt and sand) are encountered. These soils will develop minor sloughing; however, major sloughing may occur if these soils are saturated with perched groundwater. These conditions should be observed during construction and corrective measures should be taken. Heavy construction equipment and material should not be placed near the top of the existing slope.

5.5 Borrow Material and Compaction Requirements

If borrow material is to be used for onsite construction, it should conform to Section 204 "Borrow and Furnish Excavations" of the IDOT Construction Manual (2021) and the District One Embankment I Special Provision. Imported or on-site fill materials should be evaluated using Table 8.4-1 of the IDOT Geotechnical Manual, Requirements of Borrow Soils for the top 24 inch, and Section 204, "Borrow and Furnish Excavations" of the IDOT SSRBC.

The fill material should be free of organic matter and debris and should be placed and compacted in accordance with Section 205, Embankment, of the IDOT SSRBC (2021) and the District One Embankment I Special Provision. Earth-moving operations should be avoided during excessively cold or wet weather to avoid freezing of softening subgrade soils. Fill should be placed in lifts and compacted according to Section 205, Embankment (IDOT, 2016) and the District One Embankment I Special Provision.

5.6 Groundwater Management

Long term groundwater may be at elevations between 741.5 and 750.0 feet. GSG does not anticipate that groundwater related issues occur during construction activity, however, perched water may be encountered within the existing fill materials. If rainwater run-off or groundwater is accumulated at the base of excavations, the contractor should remove accumulated water using conventional sump pit and pump procedures and maintain a dry and stable excavation. The location of the sump should be determined by the contractor based on field conditions. During earthmoving activities at the site, grading should be performed to ensure that drainage is maintained throughout the construction period. Water should not be allowed to accumulate in the foundation area either during or after construction. Undercut and excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater or surface run-off. Grades should be sloped away from the excavations to minimize runoff from entering.

If water seepage occurs during 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. The remaining portion of the excavation beneath the footings should be backfilled using approved structural fill.

5.7 Temporary Earth Retention Systems

Temporary soil retention systems (TSRS) will likely be required for portions of the construction. Based on the soil profile, a cantilevered sheet pile system could be used. The sheet pile retaining system should be designed in accordance with the IDOT Bridge Design Manual, Section 3.13.1, Temporary Sheet Piling Design, Temporary Soil Retention Systems. The design of the TSRS is the responsibility of the contractor.

The IDOT Temporary Sheet Piling Design procedures include limitations if the required embedment depths fall below soil layers with a Qu value larger than 4.5 tsf or N-values larger than 45 blows or rock, because the sheet piling may not penetrate these layers. Refer to the soil boring logs for the elevations to the hard stratum. If adequate retained heights cannot be obtained using the IDOT Temporary Sheet Piling Design Guide, then a Temporary Soil Retention System shall be designed by the Contractor. The Temporary Soil Retention Systems should include surcharge loads from the excavated materials, construction equipment and truck traffic as necessary. The retention system should extend to a sufficient depth below excavation bottom to provide the required lateral passive resistance if the active case is used for the design. Embedment depths should be determined based on the principles of force and moment equilibrium. The retention system should be designed for at-rest condition if the adjacent railroad embankment cannot withstand the anticipated horizontal and vertical movements of the construction excavation.

The retention system shall be designed by an Illinois licensed structural engineer in accordance with the IDOT Bridge Design Manual. The design of the temporary soil retention system (TSRS) is the responsibility of the contractor. The contractor should submit the TSRS plans to the structural design team for review prior to commencing construction of the TSRS.

6.0 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 area. The analyses have been performed and the recommendations provided in this report are based on subsurface conditions determined at the location of the borings. This report may not reflect all variations that may occur between boring locations or at some other time, the nature and extent of which may not become evident until during the time of construction. If variations in subsurface conditions become evident after submission of this report, it will be necessary to evaluate their nature and review the recommendations presented herein.

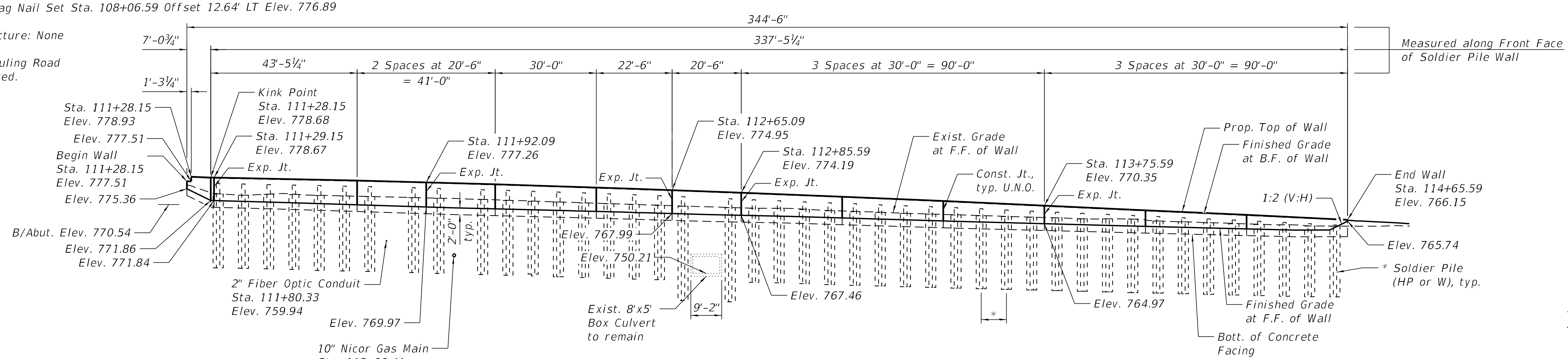
APPENDIX A

General Plan and Elevation

Benchmark: Mag Nail Set Sta. 108+06.59 Offset 12.64' LT Elev. 776.89

Existing Structure: None

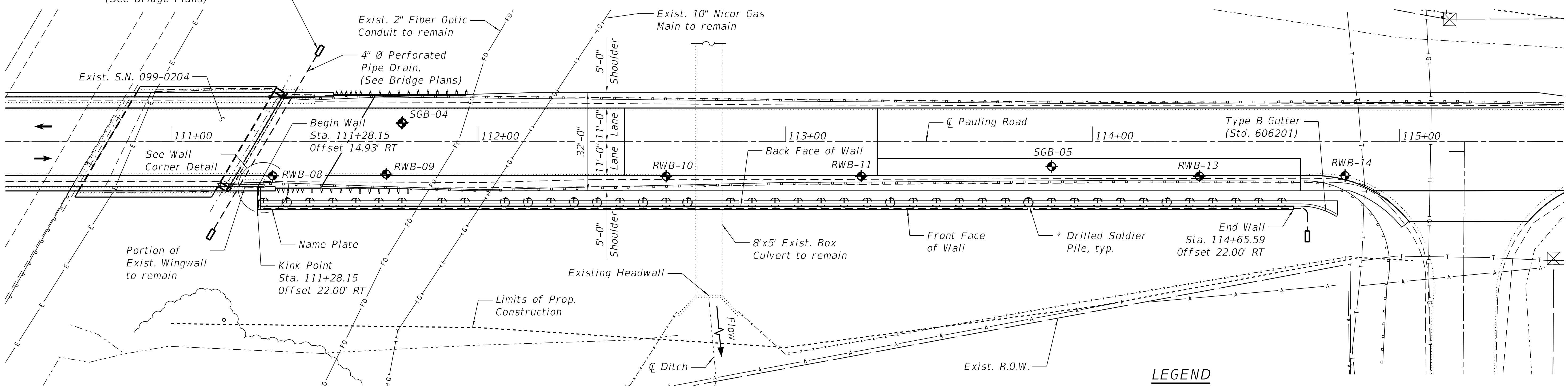
Traffic on Pauling Road will be detoured.



UNFOLDED ELEVATION

(Bridge Abutment and Wingwall not shown for clarity)

* Pile section, spacing, tip elevation, and shaft diameter to be determined during final design.



PLAN

LEGEND

- FO — Existing Underground Fiber Optic
- G — Existing Underground Gasline
- A — Existing Aerial Line
- T — Existing Telephone
- E — Existing Buried Electric
- Existing Fence
- Soil Boring
- U.N.O. Unless Noted Otherwise
- F.F. Front Face
- Prop. Guardrail
- Exist. Guardrail

Notes:

1. Stations and offsets are measured from CL Pauling Road to the front face of the cast-in-place concrete facing.
2. The Contractor shall exercise caution during wall construction to make certain that construction activities will not have detrimental effects on the existing utilities and other facilities.
3. The utility depth as shown is based on electronic depth determined during survey. Contractor to verify in field. Space soldier piles to miss existing fiber optic conduit and Nicor gas main.

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications, 9th Edition

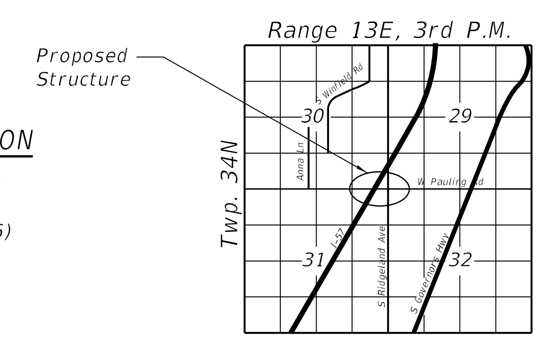
DESIGN STRESSES

FIELD UNITS

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

HIGHWAY CLASSIFICATION

Pauling Road (F.A.U. Rte. 5700)
Functional Class: Local Road
ADT: 1,800 (2019) / 2,592 (2046)
ADTT: 216 (2019) / 311 (2046)
DHV: 180 (2019)
Design Speed: 45 m.p.h.
Posted Speed: 45 m.p.h.
Two Way Traffic
Directional Distribution: 50:50



LOCATION SKETCH

GENERAL PLAN AND ELEVATION
F.A.U. 5700 (PAULING ROAD)
SECTION 99-1 HB-2-BR
WILL COUNTY
STATION 111+28.15 TO 114+65.59
STRUCTURE NO. 099-W1000

HDR 9450 W. BRYN MAWR AVE. ROSEMONT, IL 60018	USER NAME = untitled	DESIGNED - PS	REVISED -	STATE OF ILLINOIS DEPARTMENT OF TRANSPORTATION
		CHECKED - BHS	REVISED -	
	PLOT SCALE = 100.0000 ' / in.	DRAWN - AMN	REVISED -	
	PLOT DATE = 12/13/2023	CHECKED - BHS	REVISED -	SHEET 1 OF 3 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
57	99-1HB-2-BR	WILL		
		CONTRACT NO. 60R76		
		ILLINOIS FED. AID PROJECT		

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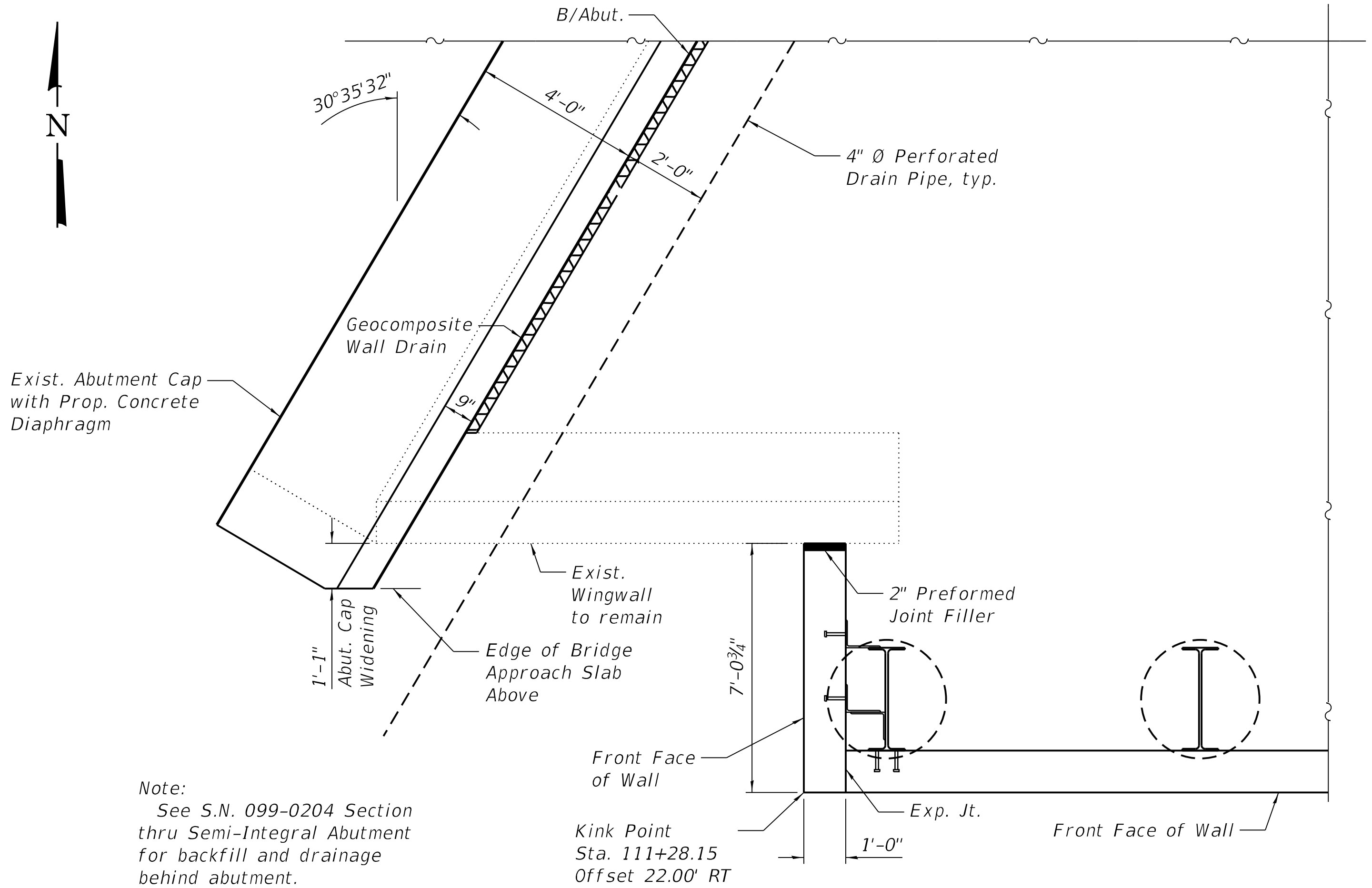
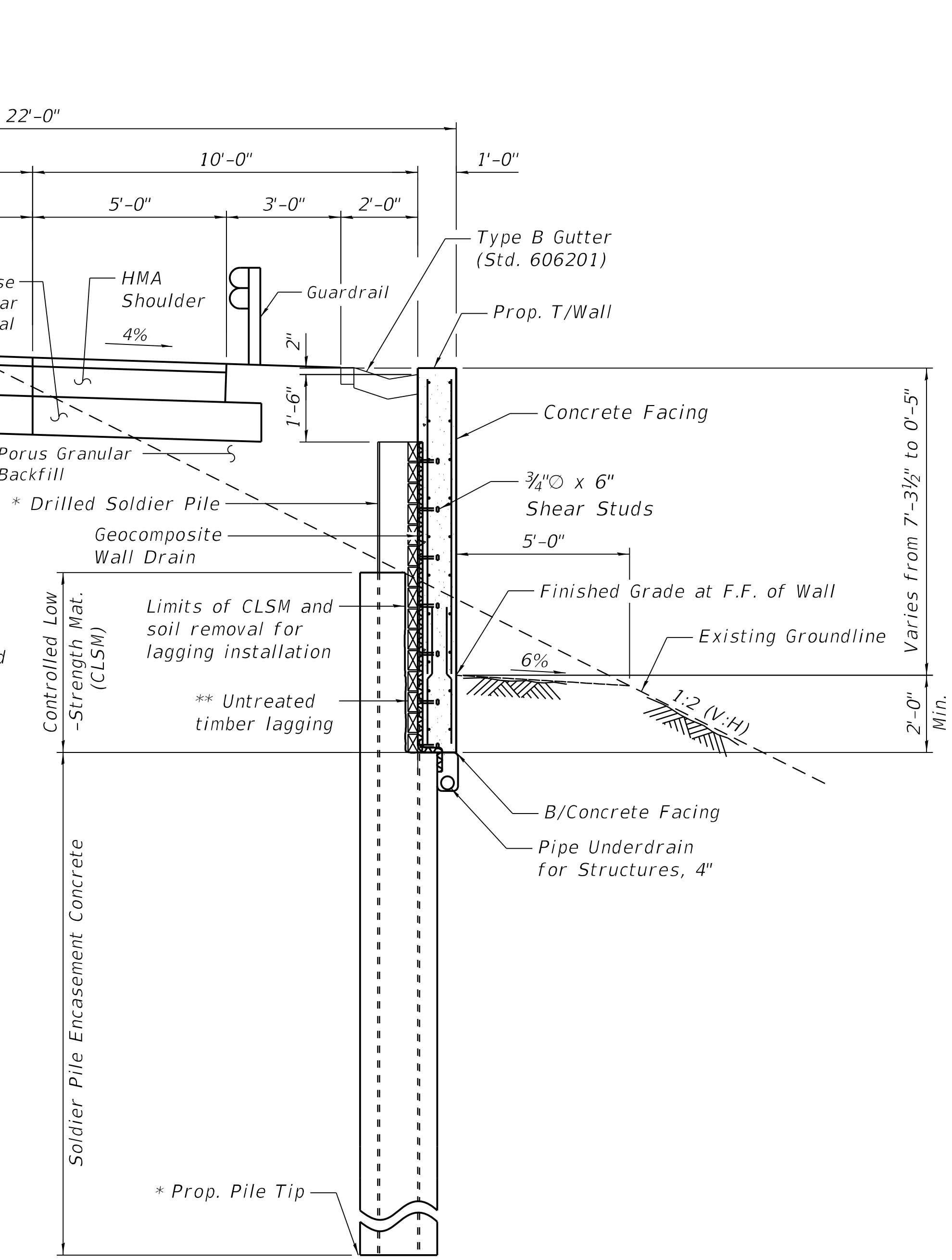
12/13/2023 3:22:18 PM



Note:
See S.N. 099-0204 Section thru Semi-Integral Abutment for backfill and drainage behind abutment.

WALL CORNER DETAIL



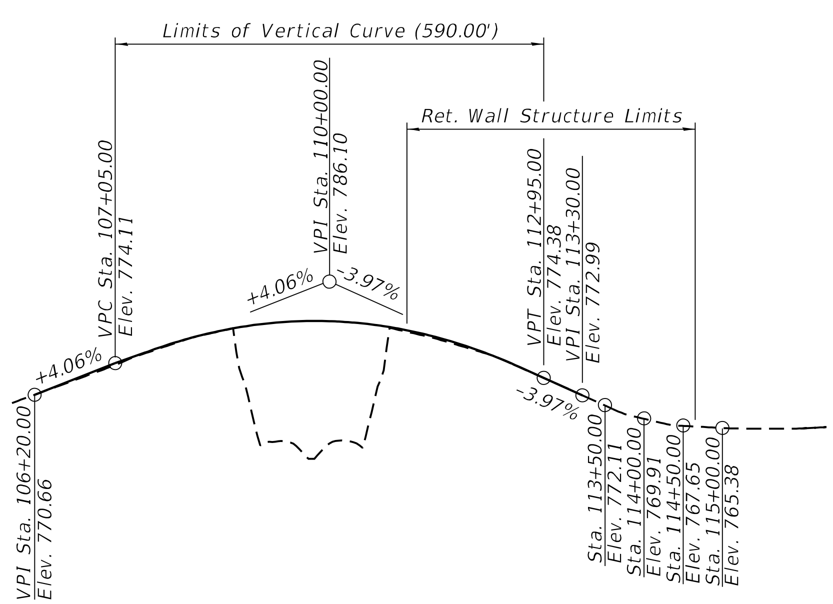
* Pile section, spacing, tip elevation and shaft diameter to be determined during final design.

** Alternative lagging materials may be used for the pile spaces over culvert, fiber optic line, and gas main.

(1) 0'-0" to Sta. 113+30.00
5'-6" Sta. 113+30.00 to Sta. 114+65.59

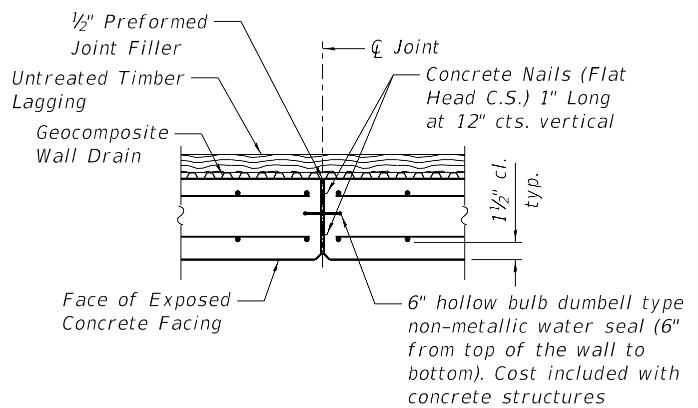
(2) 11'-0" to Sta. 113+30.00
5'-6" Sta. 113+30.00 to Sta. 114+65.59

TYPICAL WALL SECTION
(Looking East)

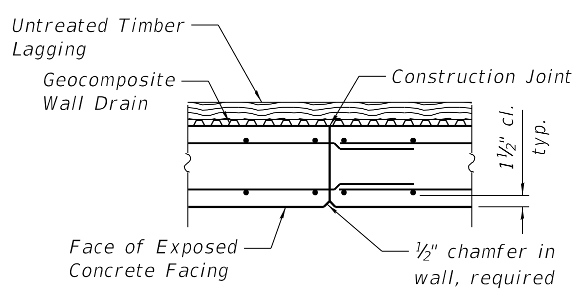


PROPOSED PROFILE GRADE
(Along ℄ Pauling Road)

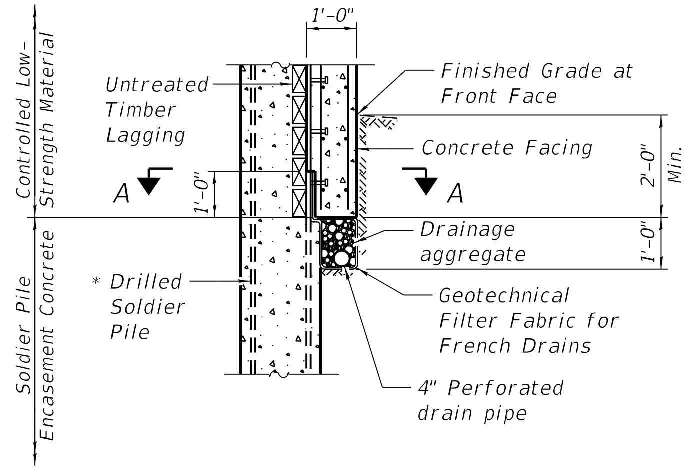
DETAILS
F.A.U. 5700 (PAULING ROAD)
SECTION 99-1 HB-2-BR
WILL COUNTY
STATION 111+28.15 TO 114+65.59
STRUCTURE NO. 099-W1000



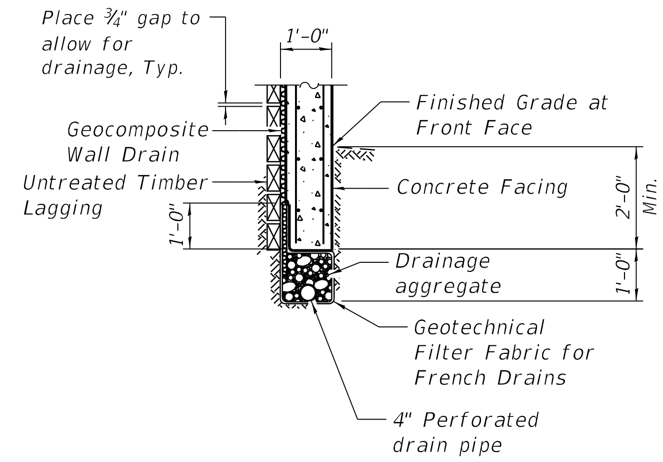
EXPANSION JOINT DETAIL



CONSTRUCTION JOINT DETAIL

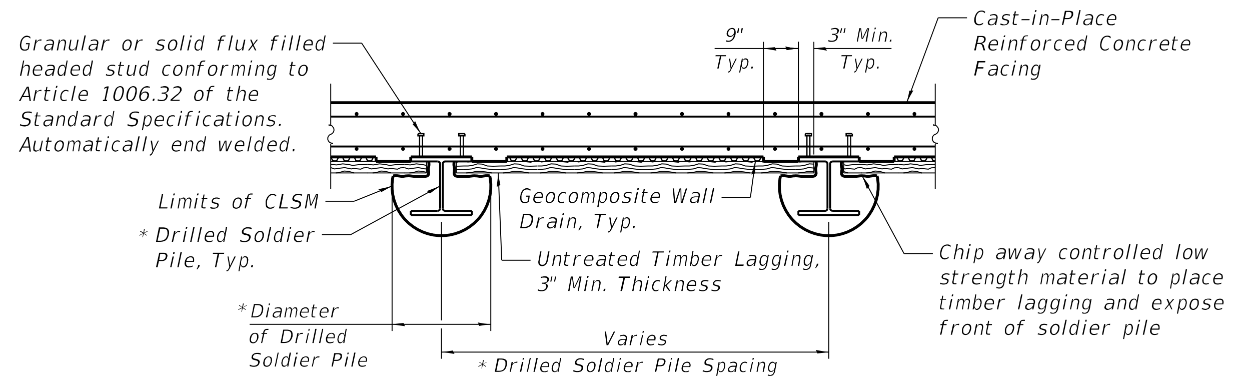


AT SOLDIER PILES



BETWEEN SOLDIER PILES

PIPE UNDERDRAIN DETAIL



SECTION A-A

* Pile section, spacing, tip elevation and shaft diameter to be determined during final design.

DETAILS
F.A.U. 5700 (PAULING ROAD)
SECTION 99-1 HB-2-BR
WILL COUNTY
STATION 111+28.15 TO 114+65.59
STRUCTURE NO. 099-W1000

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		CHECKED - BHS	REVISED -
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	PLOT DATE = 12/13/2023	CHECKED - BHS	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

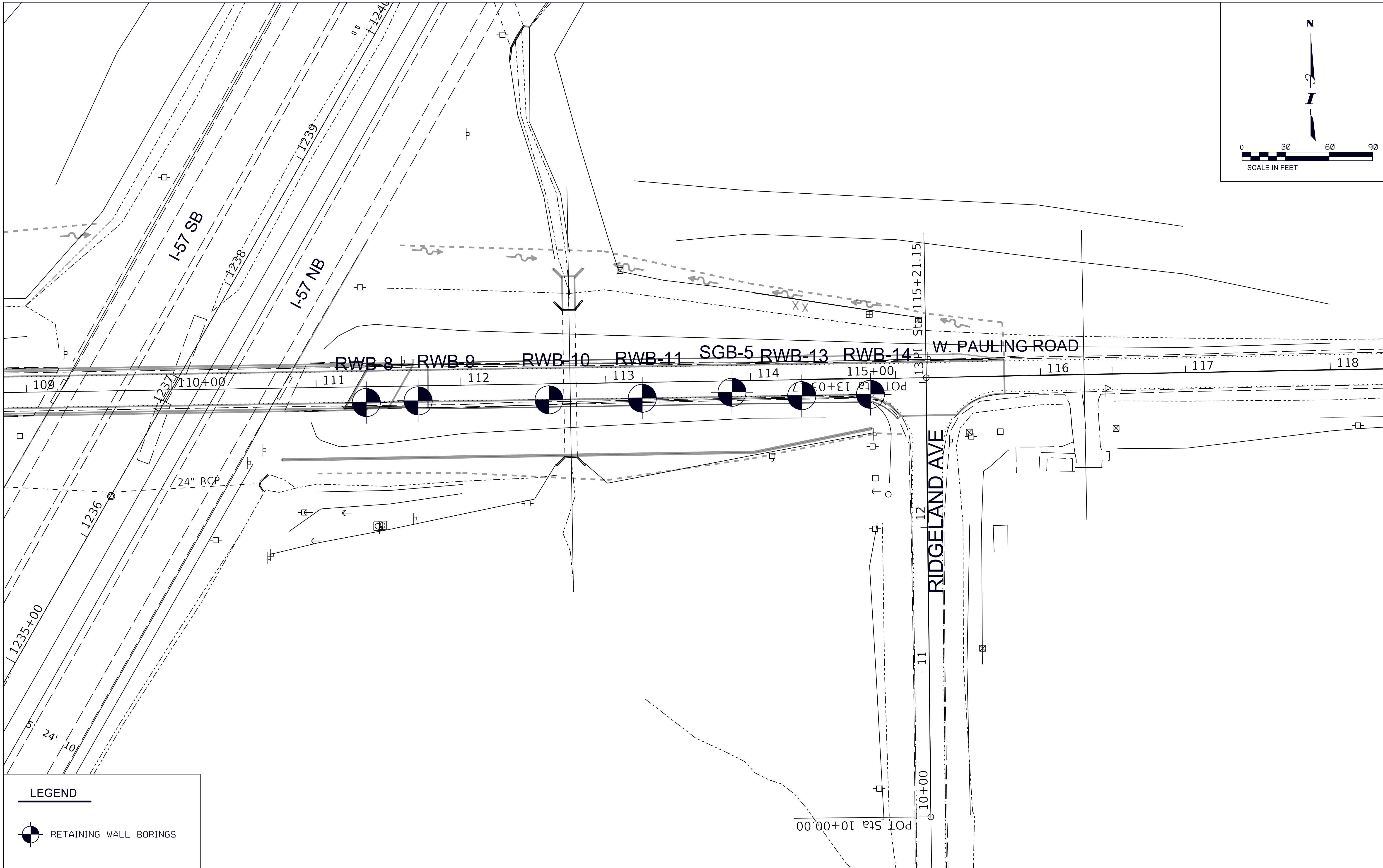
SHEET 3 OF 3 SHEETS

F.A.I. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
57	99-1HB-2-BR	WILL		
CONTRACT NO. 60R76				
ILLINOIS	FED. AID PROJECT			

APPENDIX B

SOIL BORING LOCATION PLAN

AND SUBSURFACE PROFILES



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PLOT SCALE	= 720.0000 ' / ft.	CHECKED	- DE
PLOT DATE	= 2/6/2023	DATE	- 02/06/2023

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

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CONTRACT NO. PTB-200-004

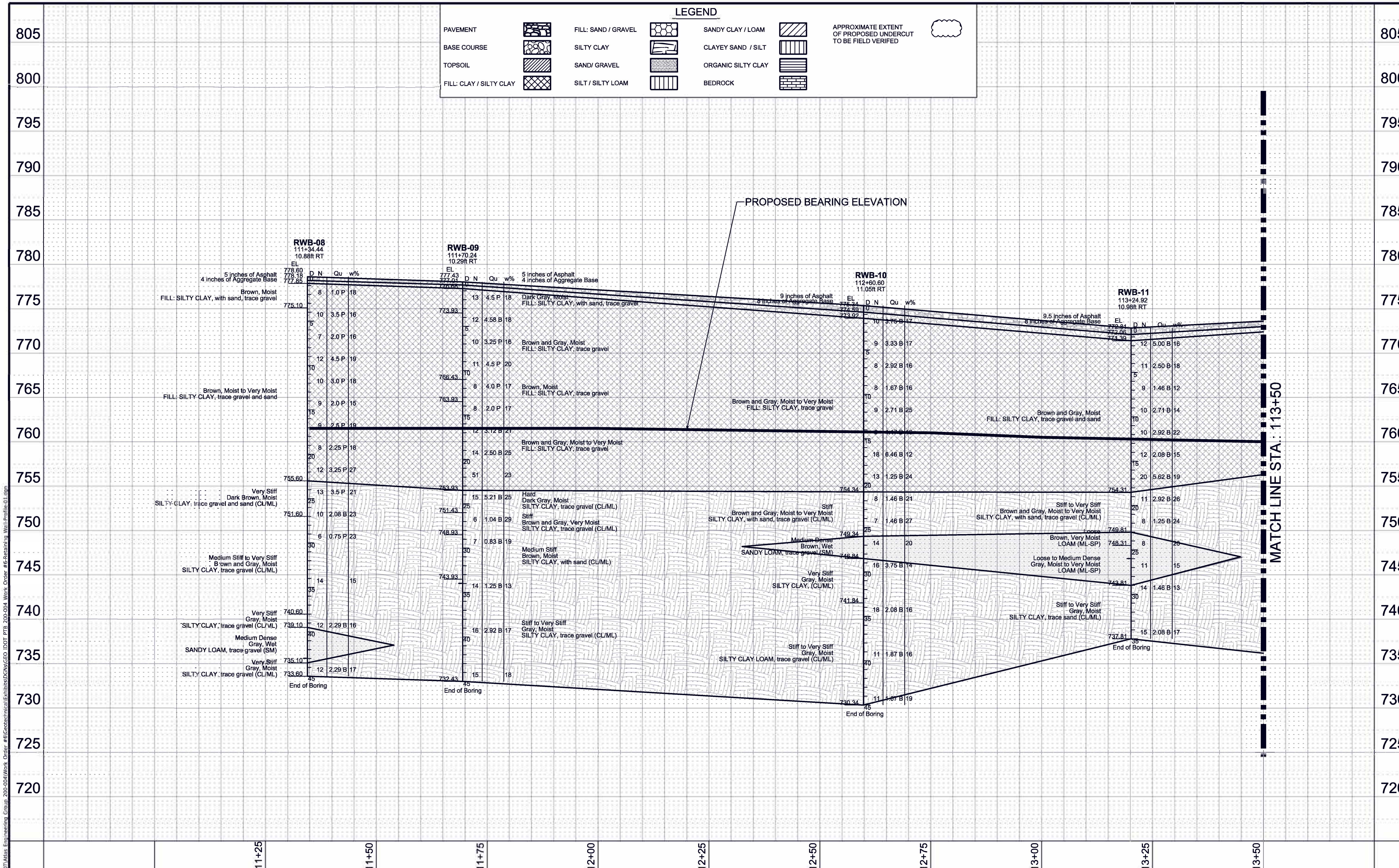
RETAINING WALL SOIL BORING LOCATION PLAN
I-57 AND PAULING ROUD, MONEE, ILLINOIS

SCALE: 1:30 | SHEET 1 OF 1 SHEETS | STA. | TO STA.

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
		COOK	3	1

CONTRACT NO. PTB-200-004

ILLINOIS | FED. AID PROJECT



GSG CONSULTANTS, INC. 735 E. Remington Rd, Schaumburg, IL 60173 TEL: +1630.994.2600 | WWW.GSG-CONSULTANTS.COM	USER NAME = nnano	DESIGNED - MH	REVISED -	
		DRAWN - NN	REVISED -	STATE OF ILLINOIS
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	PLOT DATE = 2/9/2023	DATE - 02/06/2023	REVISED -	

IDOT PTB 200–004 RETAINING WALL
I–57 AND PAULING ROAD, MONEE, ILLINOIS
BORING PROFILE

SCALE: AS NOTED | SHEET 1 OF 2 SHEETS | STA. 111+25 TO STA. 113+50

F.A. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
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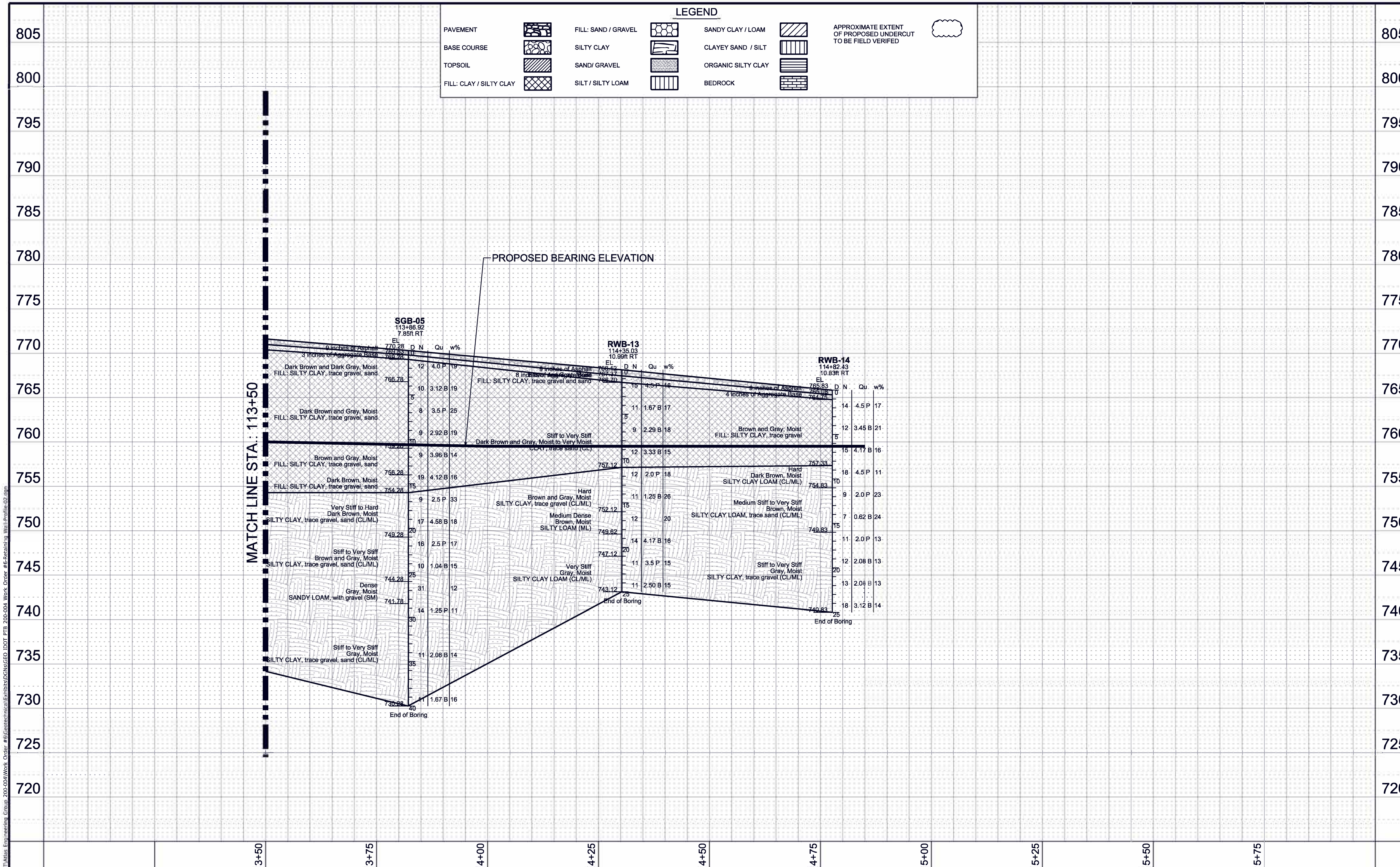
		CONTRACT NO. PTB-200-004		
	ILLINOIS FED. AID PROJECT			



GSG CONSULTANTS, INC.	USER NAME = nnano	DESIGNED - MH	REVISED -
		DRAWN - NN	REVISED -
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	PLOT DATE = 2/9/2023	DATE - 02/06/2023	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

IDOT PTB 200-004 RETAINING WALL
I-57 AND PAULING ROAD, MONEE, ILLINOIS
BORING PROFILE

SCALE: AS NOTED | SHEET 2 OF 2 SHEETS | STA. 113+50 TO STA. 115+75

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

CONTRACT NO. PTB-200-004

ILLINOIS | FED. AID PROJECT

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APPENDIX C

SOIL BORING LOGS

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

SOIL BORING LOG

Date 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** AA

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E,
Latitude 41.39771951, **Longitude** -87.76807648

COUNTY WILL **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO.
Station

BORING NO. RWB-08
Station 111+34.44
Offset 10.88ft RT
Ground Surface Elev. 778.60 ft

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

Groundwater Elev.:
First Encounter 735.6 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 Asphalt	778.18				
4 inches of Aggregate Base	777.85				
Brown, Moist FILL: SILTY CLAY, with sand, trace gravel			2 3 5	1.0 P	18
	775.10				
Brown, Moist to Very Moist FILL: SILTY CLAY, trace gravel and sand		-5	4 4 6	3.5 P	16
			3 3 4	2.0 P	16
		-10	4 5 7	4.5 P	19
			3 4 6	3.0 P	18
		-15	2 4 5	2.0 P	15
			3 4 5	2.5 P	19
		-20	2 3 5	2.3 P	18

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Brown, Moist to Very Moist FILL: SILTY CLAY, trace gravel and sand *(continued)* Wooden fragments at 22 feet			2 5 7	3.3 P	27
	755.60				
Very Stiff Dark Brown, Moist SILTY CLAY, trace gravel and sand (CL/ML)		-25	3 7 6	3.5 P	21
			4 4 6	2.1 B	23
	751.60				
Medium Stiff to Very Stiff Brown and Gray, Moist SILTY CLAY, trace gravel (CL/ML)		-30	2 3 3	0.8 P	23
Cobbles at 33.5 feet		-35	4 6 8		15
	740.60				
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)		-40	3 5 7	2.3 B	16
	739.10				

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 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** AA

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E, **Latitude** 41.39771951, **Longitude** -87.76807648

COUNTY WILL **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO.
Station

BORING NO. RWB-08
Station 111+34.44
Offset 10.88ft RT
Ground Surface Elev. 778.60 ft

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

Groundwater Elev.:
First Encounter 735.6 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Medium Dense Gray, Wet SANDY LOAM, trace gravel (SM) *(continued)* ▼ 735.10				
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML) 733.60	-45	5 4 8	2.3 B	17
End of Boring	-50 -55 -60			

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 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** AA

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E,
Latitude 41.39772206, **Longitude** -87.76794602

COUNTY WILL **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO.
Station

BORING NO. RWB-09
Station 111+70.24
Offset 10.29ft RT
Ground Surface Elev. 777.43 ft

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

Groundwater Elev.:
First Encounter 743.4 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 Asphalt	777.01				
4 inches of Aggregate Base	776.68				
Dark Gray, Moist FILL: SILTY CLAY, with sand, trace gravel			3 6 7	4.5 P	18
	773.93				
Brown and Gray, Moist FILL: SILTY CLAY, trace gravel		-5	6 5 7	4.6 B	18
			3 4 6	3.3 P	16
		-10	4 5 6	4.5 P	20
	766.43				
Brown, Moist FILL: SILTY CLAY, trace gravel			3 3 5	4.0 P	17
	763.93				
Brown and Gray, Moist to Very Moist FILL: SILTY CLAY, trace gravel		-15	2 3 5	2.0 P	17
			3 5 7	3.1 B	21
		-20	4 6 8	2.5 B	25
Brown and Gray, Moist to Very Moist FILL: SILTY CLAY, trace gravel *(continued)* Gravel seam at 22 feet			4 37 14		23
	753.93				
Hard Dark Gray, Moist SILTY CLAY, trace gravel (CL/ML)		-25	5 8 7	5.2 B	25
	751.43				
Stiff Brown and Gray, Very Moist SILTY CLAY, trace gravel (CL/ML)			3 3 3	1.0 B	29
	748.93				
Medium Stiff Brown, Moist SILTY CLAY, with sand (CL/ML)		-30	2 3 4	0.8 B	19
	743.93				
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)	▼	-35	4 7 7	1.3 B	13
		-40	4 8 8	2.9 B	17

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 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** AA

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E,
Latitude 41.39772206, **Longitude** -87.76794602

COUNTY WILL **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO. ____
Station ____

BORING NO. RWB-09
Station 111+70.24
Offset 10.29ft RT
Ground Surface Elev. 777.43 ft

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

Groundwater Elev.:
First Encounter 743.4 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*					
Cobbles at 43.5 feet			6		
			7		18
	732.43	-45	8		
End of Boring					
		-50			
		-55			
		-60			

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 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** DD

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E,
Latitude 41.39772235, **Longitude** -87.7676167

COUNTY WILL **DRILLING RIG** Diedrich D50 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 99.5

STRUCT. NO. ____
Station ____

BORING NO. RWB-10
Station 112+60.60
Offset 11.05ft RT
Ground Surface Elev. 775.34 ft

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

Groundwater Elev.:
First Encounter 746.8 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
9 inches of Asphalt 8 inches of Aggregate Base	774.59				
	773.92				
Brown and Gray, Moist to Very Moist FILL: SILTY CLAY, trace gravel			4 5 5	3.8 B	17
		-5	4 5 4	3.3 B	17
			3 4 4	2.9 B	16
		-10	3 5 3	1.7 B	16
			4 3 6	2.7 B	25
		-15	3 3 6	4.2 B	16
			4 7 11	6.5 B	12
		-20	4 5 8	1.3 B	24
	754.34				
Stiff Brown and Gray, Moist to Very Moist SILTY CLAY, with sand, trace gravel (CL/ML)			2 4 4	1.5 B	21
		-25	3 3 4	1.5 B	27
	749.34				
Medium Dense Brown, Wet SANDY LOAM, trace gravel (SM)			5 7 7		20
	746.84 ▼				
Very Stiff Gray, Moist SILTY CLAY, (CL/ML)		-30	4 7 9	3.8 B	14
	741.84				
Stiff to Very Stiff Gray, Moist SILTY CLAY LOAM, trace gravel (CL/ML)		-35	5 7 11	2.1 B	16
		-40	4 5 6	1.9 B	16

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 1/24/23

ROUTE Pauling Road DESCRIPTION Retaining Wall Boring LOGGED BY DD

SECTION I-57 at Pauling Road LOCATION , SEC. 31, TWP. 34N, RNG. 13E, Latitude 41.39772235, Longitude -87.7676167

COUNTY WILL DRILLING RIG Diedrich D50 HAMMER TYPE AUTO
DRILLING METHOD HSA HAMMER EFF (%) 99.5

STRUCT. NO.
Station

BORING NO. RWB-10
Station 112+60.60
Offset 11.05ft RT
Ground Surface Elev. 775.34 ft

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

Groundwater Elev.:
First Encounter 746.8 ft ▼
Upon Completion N/A ft
After N/A Hrs. N/A ft

Description	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Very Stiff Gray, Moist SILTY CLAY LOAM, trace gravel (CL/ML) *(continued)*		4 4 7	1.7 B	19
730.34	-45			
End of Boring	-50			
	-55			
	-60			

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 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** DD

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E, **Latitude** 41.39772422, **Longitude** -87.76738228

COUNTY WILL **DRILLING RIG** Diedrich D50 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 99.5

STRUCT. NO.
Station

BORING NO. RWB-11
Station 113+24.92
Offset 10.98ft RT
Ground Surface Elev. 772.81 ft

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

Groundwater Elev.:
First Encounter 746.8 ft ▼
Upon Completion N/A ft
After N/A **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
9.5 inches of Asphalt 8 inches of Aggregate Base	772.06 771.39		6		
Brown and Gray, Moist FILL: SILTY CLAY, trace gravel and sand			5 7	5.0 B	16
			4 4 7	2.5 B	18
		-5			
			3 3 6	1.5 B	12
			3 4 6	2.7 B	14
		-10			
			3 5 5	2.9 B	22
			4 4 8	2.1 B	15
		-15			
			9 11 9	5.6 B	19
	754.31		3 5 6	2.9 B	26
		-20			

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
Stiff to Very Stiff Brown and Gray, Moist to Very Moist SILTY CLAY, with sand, trace gravel (CL/ML) *(continued)*	749.81		4 3 5	1.3 B	24
Loose Brown, Very Moist LOAM (ML-SP)	748.31		1 3 5		20
Loose to Medium Dense Gray, Moist to Very Moist LOAM (ML-SP)		-25			
▼			11 7 4		15
	743.81		4		
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace sand (CL/ML)			6 8	1.5 B	13
		-30			
	737.81		4 6 9	2.1 B	17
		-35			
End of Boring					
		-40			

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

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

SOIL BORING LOG

Date 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** DD

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E, **Latitude** 41.3977271, **Longitude** -87.76698096

COUNTY WILL **DRILLING RIG** Diedrich D50 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 99.5

STRUCT. NO. ____
Station ____

BORING NO. RWB-13
Station 114+35.03
Offset 10.99ft RT
Ground Surface Elev. 768.12 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 (%)
9 inches of Asphalt					
8 inches of Aggregate Base	767.37				
	766.70		5		
Brown and Gray, Moist FILL: SILTY CLAY, trace gravel and sand			7 8	4.5 P	16
			3 5 6	1.7 B	17
		-5			
			3 4 5	2.3 B	18
			3 6 6	3.3 B	15
		-10			
	757.12				
Stiff to Very Stiff Dark Brown and Gray, Moist to Very Moist CLAY, trace sand (CL)			5 5 7	2.0 P	18
			2 5 6	1.3 B	26
		-15			
	752.12				
Medium Dense Brown, Moist SILTY LOAM (ML)			3 6 6		20
	749.62				
			4 7 7	4.2 B	16
		-20			
Hard Brown and Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*	747.12		5 5 6	3.5 P	15
Very Stiff Gray, Moist SILTY CLAY LOAM (CL/ML)			4 4 7	2.5 B	15
	743.12	-25			
End of Boring					
		-30			
		-35			
		-40			

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

Illinois Department of Transportation

Division of Highways
GSG Consultants, Inc.

SOIL BORING LOG

Date 1/24/23

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** AA

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E, **Latitude** 41.39772879, **Longitude** -87.76680822

COUNTY WILL **DRILLING RIG** CME 75 **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 79.8

STRUCT. NO. ______
Station ______

BORING NO. RWB-14
Station 114+82.43
Offset 10.83ft RT
Ground Surface Elev. 765.83 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 (%)
9 inches of Asphalt	765.08				
4 inches of Aggregate Base	764.75				
Brown and Gray, Moist FILL: SILTY CLAY, trace gravel			5 6 8	4.5 P	17
		-5	4 5 7	3.5 B	21
	757.33		3 6 9	4.2 B	16
Hard Dark Brown, Moist SILTY CLAY LOAM (CL/ML)	754.83	-10	9 10 8	4.5 P	11
Medium Stiff to Very Stiff Brown, Moist SILTY CLAY LOAM, trace sand (CL/ML)			4 4 5	2.0 P	23
	749.83	-15	3 3 4	0.6 B	24
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)			3 5 6	2.0 P	13
		-20	4 5 7	2.1 B	13
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*			4 6 7	2.1 B	13
	740.83	-25	4 7 11	3.1 B	14
End of Boring					
		-30			
		-35			
		-40			

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

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

SOIL BORING LOG

Date 10/4/22

ROUTE Pauling Road **DESCRIPTION** Retaining Wall Boring **LOGGED BY** AA

SECTION I-57 at Pauling Road **LOCATION** , **SEC.** 31, **TWP.** 34N, **RNG.** 13E,
Latitude 41.39773445, **Longitude** -87.76715643

COUNTY WILL **DRILLING RIG** D50 ATV **HAMMER TYPE** AUTO
DRILLING METHOD HSA **HAMMER EFF (%)** 91.5

STRUCT. NO.
Station

BORING NO. SGB-05
Station 113+86.92
Offset 7.85ft RT
Ground Surface Elev. 770.28 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

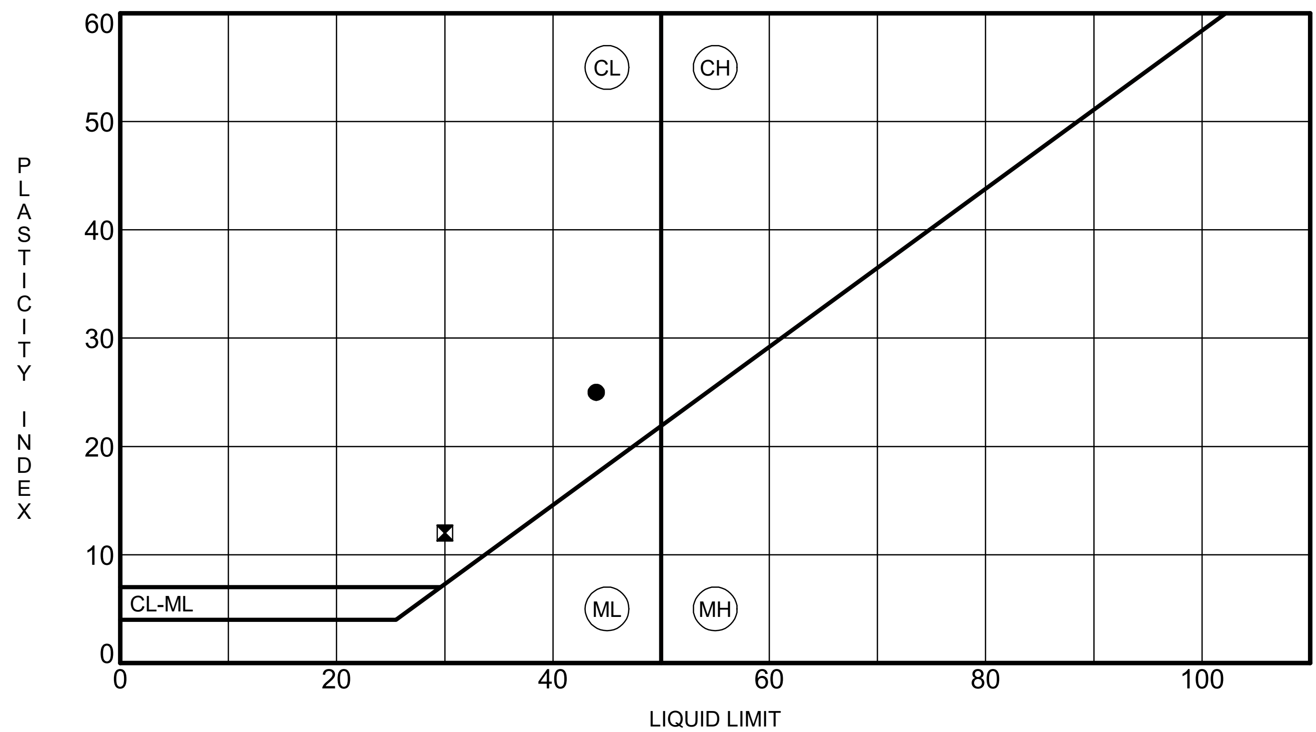
Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
9 inches of Asphalt 3 inches of Aggregate Base	769.53 769.28				
Dark Brown and Dark Gray, Moist FILL: SILTY CLAY, trace gravel, sand			4 5 7	4.0 P	19
	766.78				
Dark Brown and Gray, Moist FILL: SILTY CLAY, trace gravel, sand		-5	3 5 5	3.1 B	19
			3 3 5	3.5 P	25
		-10	2 4 5	2.9 B	19
	759.28				
Brown and Gray, Moist FILL: SILTY CLAY, trace gravel, sand			3 4 5	4.0 B	14
	756.28		3		
Dark Brown, Moist FILL: SILTY CLAY, trace gravel, sand		-15	9 10	4.1 B	16
	754.28				
Very Stiff to Hard Dark Brown, Moist SILTY CLAY, trace gravel, sand (CL/ML)			2 4 5	2.5 P	33
		-20	3 7 10	4.6 B	18
	749.28				
Stiff to Very Stiff Brown and Gray, Moist SILTY CLAY, trace gravel, sand (CL/ML) Cobbles at 21.5 feet			5 7 9	2.5 P	17
		-25	3 4 6	1.0 B	15
	744.28				
Dense Gray, Moist SANDY LOAM, with gravel (SM)			5 21 10		12
	741.78				
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel, sand (CL/ML) Cobbles at 28.5 feet		-30	5 6 8	1.3 P	11
		-35	4 5 6	2.1 B	14
	730.28	-40	4 5 6	1.7 B	16

End of Boring

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
●	**RWB-09**	**16.00**	**44.0**	**19.0**	**25.0**		
⧗	**RWB-13**	**11.00**	**30.0**	**18.0**	**12.0**		

Illinois Department of Transportation

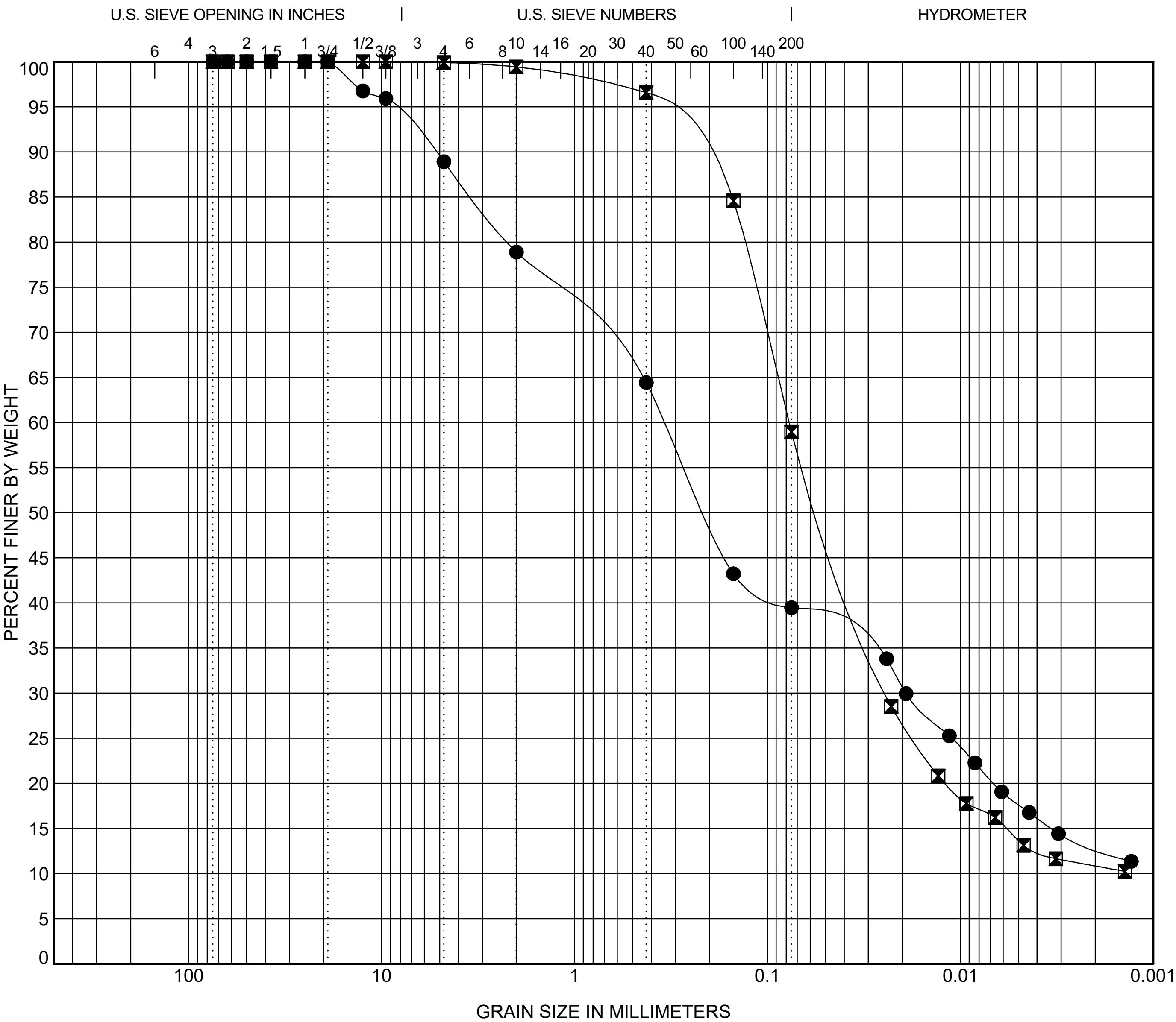
Division of Highways
GSG Consultants, Inc.

ATTERBERG LIMITS' RESULTS

Route: Pauling Road

Section: I-57 at Pauling Road

County: WILL



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Specimen Identification			Classification	LL	PL	PI	Cc	Cu
●	**RWB-10**	**26.00**	**SANDY LOAM**					
⊠	**RWB-11**	**23.50**	**LOAM**					

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RWB-10**	**26.00**		**0.342**	**0.019**					**12.9**
⊠	**RWB-11**	**23.50**		**0.077**	**0.024**					**10.9**

Illinois Department of Transportation

Division of Highways
GSG Consultants, Inc.

GRAIN SIZE DISTRIBUTION

Route: Pauling Road

Section: I-57 at Pauling Road

County: WILL

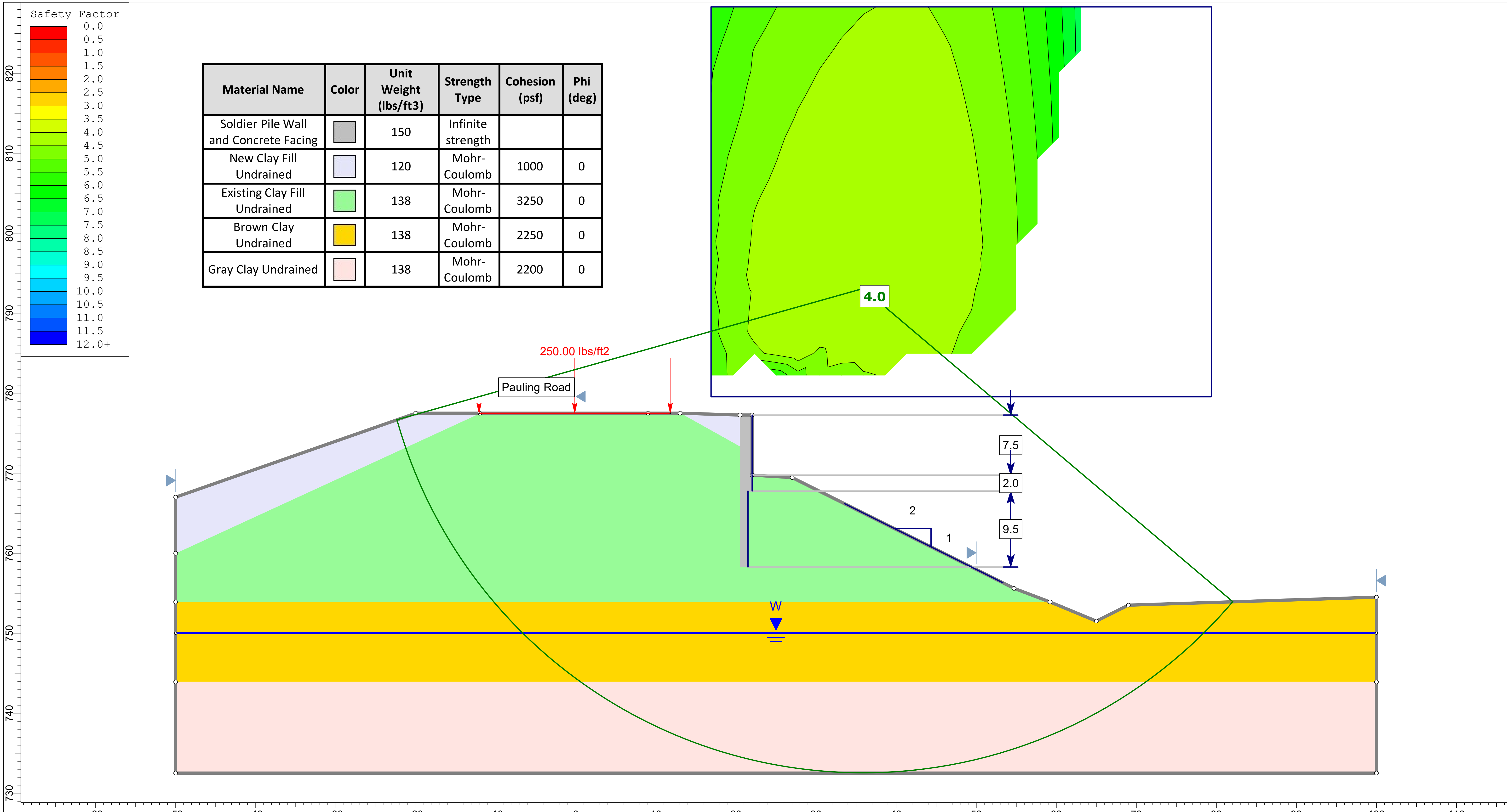
GRAIN SIZE PTB 200-004 WO6, 57 AT PAULING.GPJ IL DOT.GDT 2/6/23

Table D1 – Summery of Organic Test Data

Boring ID	Depth (feet)	Soil Description	Organic Content
RWB-9	23.5 – 25.0	Black Silty Clay	3.9%
RWB-14	8.5 – 10	Dark Brown Silty Clay	3.5%

APPENDIX E

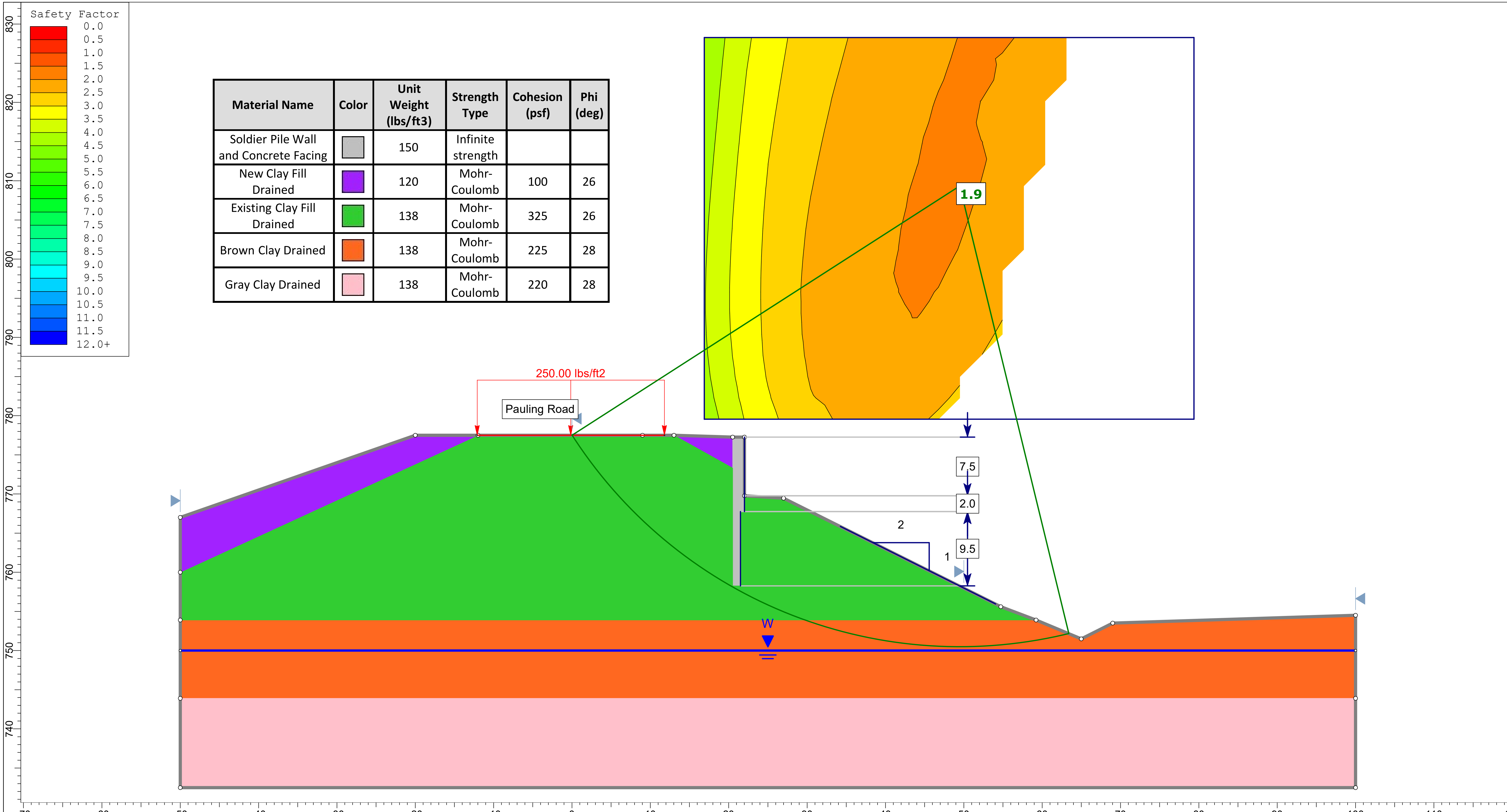
SLOPE STABILTY ANALYSES EXHIBITS



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soldier Pile Wall and Concrete Facing		150	Infinite strength		
New Clay Fill Undrained		120	Mohr-Coulomb	1000	0
Existing Clay Fill Undrained		138	Mohr-Coulomb	3250	0
Brown Clay Undrained		138	Mohr-Coulomb	2250	0
Gray Clay Undrained		138	Mohr-Coulomb	2200	0

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

Project	PTB 200-004 W.O.6 - Soldier Pile Wall - Station 111+92.09
Analysis Description	Exhibit 1 - Circular Failure Short Term
Drawn By	MH
Company	GSG Consultants, Inc.
Date	12/14/2023
File Name	wo6 slope stability 111+90 - soldier pile_12142023.slmd



Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Soldier Pile Wall and Concrete Facing		150	Infinite strength		
New Clay Fill Drained		120	Mohr-Coulomb	100	26
Existing Clay Fill Drained		138	Mohr-Coulomb	325	26
Brown Clay Drained		138	Mohr-Coulomb	225	28
Gray Clay Drained		138	Mohr-Coulomb	220	28

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

Project	PTB 200-004 W.O.6 - Soldier Pile Wall - Station 111+92.09
Analysis Description	Exhibit 2 - Circular Failure Long Term
Drawn By	MH
Company	GSG Consultants, Inc.
Date	12/14/2023
File Name	wo6 slope stability 111+90 - soldier pile_12142023.slmd

APPENDIX F

SOIL DESIGN PARAMETERS

Table F1 – Retaining Wall Soil Parameters

Approximate Elevation Range (feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained					L-Pile Parameters		
			Cohesion c (psf)	Friction Angle ϕ (Degrees)	Cohesion c (psf)	Friction Angle ϕ (Degrees)	Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	At-Rest Earth Pressure Coefficient (K_o)	Horizontal Strain Factor E_{50}	Constant for Lateral Modulus of Subgrade Reaction* k_{py} (pci)	L Pile Soil Type
	New Engineered Granular Fill	120	0	34	0	34	0.28	3.54	0.44	N/A	25	Sand (Reese)
	New Engineered Clay Fill	120	1,000	0	100	26	0.39	2.56	0.56	0.007	500	Stiff Clay w/o free water (Reese)
778.0 to 755.0	Brown and Gray Silty Clay Fill	138	3,250	0	325	26	0.39	2.56	0.56	0.005	1,000	Stiff Clay w/o free water (Reese)
755.0 to 746.0	Stiff to Very Stiff Brown and Gray Silty Clay	138	2,250	0	225	28	0.36	2.77	0.53	0.005	1,000	Stiff Clay w/o free water (Reese)
746.0 to 730.0	Stiff to Very Stiff Gray Silty Clay	138	2,200	0	220	28	0.36	2.77	0.53	0.005	1,000	Stiff Clay w/o free water (Reese)
Various Elevations (RWB-08, RWB-10 and SGB-05 only)	Medium Dense to Dense Brown and Gray Sandy Loam	126	0	33	0	33	0.29	3.39	0.46	N/A	90	Sand (Reese)
Various Elevations (RWB-11 through RWB-13 only)	Loose to Medium Dense Brown and Gray Loam and Silty Loam	123	0	33	0	33	0.29	3.39	0.46	N/A	90	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 subgrade modulus given in the table and z is the distance from the surface to the center point of the layer in inches.