Structural Geotechnical Report

IDOT PTB 199-013
Work Order #5
Retaining Walls
IL Route 68 at Salt Creek
Cook County, Illinois

Prepared for:

Illinois Department of Transportation
Job No. D-94-079-21

Project Design Engineer:
Orion Engineers, PLLC

Prepared by:

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March 13, 2023

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IL Route 68 at Salt Creek
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Dear Mr. Janulis:

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 for two (2) retaining walls adjacent to the proposed IL Route 68 culvert. The site investigation for the proposed retaining walls included advancing four (4) soil borings to depths of 25 feet.

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

Sincerely,

Rachel Miller, P.E.
Project Engineer

Dawn Edgell, P.E.
Sr. Project Engineer

TABLE OF CONTENTS

Exhibits

Tables

Appendices

Structural Geotechnical Report
IDOT PTB 199-013 Work Order #5
Retaining Walls
IL Route 68 at Salt Creek
Cook County, IL
Job No. D-94-079-21

1.0 INTRODUCTION

GSG Consultants, Inc. (GSG) completed a geotechnical investigation for the proposed retaining walls as part of IDOT PTB 199-013, Work Order #5 along IL Route 68 in Palatine, 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 walls. **Exhibit 1** shows the general project location.

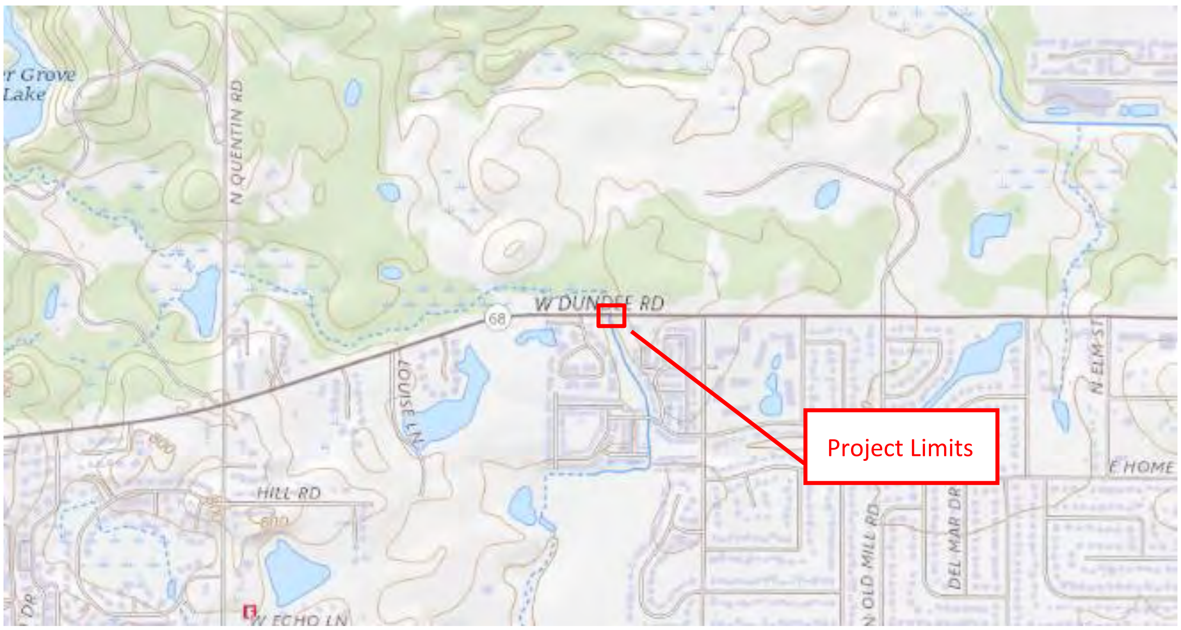


Exhibit 1 – Project Location Map

1.1 Proposed Retaining Wall Information

Based on the preliminary TSL drawings dated November 11, 2022, and a review of site topography, the proposed walls will be in a combined "fill" / "cut" section along the existing roadway alignment. The maximum exposed retaining wall height will be approximately 9 feet. The proposed retaining walls will be approximately 87.0 and 90.5 feet in length on either side of the new culvert. It is assumed that the proposed structures will consist of sheet pile, cast-in-place (CIP) concrete walls, or soldier pile walls. A new shared use path will be constructed along the top of the walls.

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 Orion Engineers. The borings were completed in the field based on field conditions and accessibility.

2.1 Subsurface Exploration Program

The subsurface exploration for the proposed retaining wall structures was conducted on July 28 and 29, 2022. The investigation included advancing four (4) borings to depths of 25 feet each. The locations of these soil borings were reviewed by Orion Engineers and 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 Boring Location Plan **(Appendix B)**. **Table 1** presents a summary of the borings used for the proposed retaining wall analysis.

Table 1 – Summary of Subsurface Exploration Borings

Boring ID	Station*	Offset (ft)*	Northing	Easting	Depth (ft)	Surface Elevation (ft)
RWB-01	24+50.39	2.69 LT	1993481.239	1060620.804	25.0	768.19
RWB-02	24+96.77	0.17 LT	1993478.841	1060667.191	25.0	768.20
RWB-03	25+79.49	0.59 LT	1993479.478	1060749.912	25.0	768.21
RWB-04	26+36.13	10.62 RT	1993468.409	1060806.577	25.0	769.05

* Based on existing IL Route 68 stationing

The soil borings were drilled using truck mounted Diedrich D-50 (hammer efficiency 97%) and CME-75 (hammer efficiency 91%) drill rigs, 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 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 where necessary 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. The laboratory testing consisted of moisture content tests (ASTM D2216 / AASHTO T-265) on representative samples.

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)**.

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. 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. 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 borings were completed along the shoulder of IL-68 and the surface elevations of the borings ranged between 768.2 and 769.1 feet. The four soil borings initially encountered 6 inches of asphalt pavement over 2 inches of sand subbase. Beneath the surficial pavement, brown, black, and gray silty clay fill materials were generally encountered to depths of 4 to 11 feet (764.2 to 757.2 feet).

Beneath the fill materials, the borings encountered stiff to hard, brown and gray silty clay grading to stiff to very stiff, gray silty clay at depths of 11.5 to 16 feet (El. 756.7 to 752.7 feet). A layer of medium stiff clay soils was observed at boring RWB-03 between depths of 13 and 15 feet below grade (El. 755.2 and 753.2 feet). The four borings were terminated within the gray silty clay at the boring termination depth of 25 feet (El. 744.1 to 743.2 feet).

The silty clay fill had unconfined compressive strengths between 0.8 and 3.5 tons per square foot (tsf) and moisture contents of 11 to 32 percent. The native brown and gray silty clay had unconfined compressive strengths between 1.5 tsf and 5.6 tsf. The layer of medium stiff clay in RWB-03 had an unconfined compressive strength value of 0.8 tsf. The native gray silty clay had unconfined compressive strengths between 1.0 tsf and 3.1 tsf, with most values 1.5 tsf or greater.

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 not encountered during or immediately after drilling in borings RWB-01 through RWB-04. None of the borings were left open after leaving the site due to safety concerns.

Based on the soil color change from brown to gray, it is anticipated that the long-term groundwater level may be between depths of 13 to 15.5 feet (El. 755.2 to 752.7 feet). Perched water may also be present within the fill soils. 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 nearby creek level, 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 walls 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 information about the structure loadings or elevations becomes available, we request that GSG be contacted so that we may re-evaluate our recommendations.

3.1 Settlement

It is anticipated that some of the existing fill soils in the area of the existing culvert and retaining walls will be removed and replaced during the culvert reconstruction. The new fill depths are assumed to approximately match the height of the existing roadway grade and will be less than 8 feet; accordingly, minimal settlement is anticipated below the new fill soils. If the roadway grade will be elevated, and the fill soil depth will be increased, please contact GSG so that we may re-evaluate the potential for settlement.

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 D. 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 2**. Given the site location and materials encountered, the potential for liquefaction is minimal.

Table 2 – Seismic Parameters

Building Code Reference	PGA	S_{DS}	S_{D1}
2020 AASHTO Guide for LRFD Seismic Bridge Design	0.041g	0.140g	0.081g

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

It is anticipated that the new retaining walls will be in an area with some cut into the existing roadway embankment and some fill to widen the crest of the embankment for support of the shared use path. There are various types of retaining walls that could be utilized within fill and cut areas. This section discusses several earth retaining structures that could be used for the proposed project.

4.1.1 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 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.

4.1.2 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.

4.1.3 Sheet Pile Walls

Sheet pile walls are typically used in cut areas when continuous support must be provided to maintain existing structures or other adjacent facilities. This type of wall can also be covered with CIP panels for aesthetics. The installation of sheet pile walls requires the use of specialty equipment to drive the piles into the ground. As the retaining walls are not anticipated be in excess of 15 feet in height, tie-backs will likely not be required for design.

4.1.4 Soldier Pile and Lagging Walls

Soldier pile and lagging walls are very similar to sheet pile walls and include most of the benefits and costs of that type of retention wall. Pile and lagging walls are also typically used in cut areas where the existing ground surface needed to be maintained during construction or when a near vertical excavation is needed. The major difference is that with the sheet pile wall, the entire wall section is installed vertically, one sheet pile at a time, with the use of heavy machinery. A soldier pile wall is normally installed using a series of H-piles into the ground, then excavating and installing the wooden lagging between the piles. Depending on the retaining wall height, the soldier pile wall design may require tie-backs to control wall deflection. As the retaining walls are not anticipated be in excess of 15 feet in height, tie-backs will likely not be required for design.

4.1.4 Recommended Wall Type

Based on the proposed grading plan and location of the wall within a combined fill / cut area, cast-in-place (CIP) concrete walls, sheet pile walls, or soldier pile walls may be considered for this project. GSG evaluated the global and external stability of each of these wall types 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 sliding and overturning failure.

Due to the presence of very stiff to hard clays, there is potential need for a heavier sheet pile section with a minimum thickness of 0.4 inches to alleviate any damage to the pile section during driving. Grade 50 steel should be used for the sheet pile. The interlocks could be partially clogged during driving and after installation due to fine soil particle migration. The steel sheet piles may be subject to potential corrosion. Corrosion rates are typically a function of temperature, soil pH, access to oxygen, and chemistry of the environment surrounding the pile. As the wall is intended to remain in place as a long-term wall, corrosion deterioration should be evaluated on the sheet pile wall design.

Soldier pile walls are typically used in areas when the existing soils will be excavated out, minimizing additional costs of over-excavation and backfill. The soldier pile wall can be covered with precast panels for aesthetics. The installation of soldier pile walls requires the use of specialty equipment to drive the piles into the ground or to be drilled and cast in place in the case where more lateral support is needed.

The soldier piles can either be driven or placed in drilled holes and backfilled with concrete (auger cast). For auger cast construction, construction of the borehole can be affected by the groundwater level and hard material. Due to the anticipated long-term groundwater elevation and clay soils, significant groundwater issues are not anticipated for construction. Perched water may be present in the upper fill soil layers. Granular layers were not encountered in the borings; temporary casing will not be required to keep the hole wall stable. As it can be expected that the shafts will penetrate through or into the hard clay soils, the contractor should be prepared for hard driving or drilling of the soldier piles.

It should be noted that construction related issues may occur during pile driving based on the proximity of the site to residential and commercial structures. These issues can include noise and vibration anticipated during installation. Vibration monitoring of nearby structures should be considered during pile driving operations as discussed in Section 5.7 of this report.

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 evaluated with respect to the collision load. **Table 3** 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 3 - LRFD Load Factors for Retaining Wall Analyses

	Type of Load	Sliding and Eccentricity Strength	Bearing Resistance Strength I	Sliding and Eccentricity Extreme II	Bearing Resistance Extreme II	Settlement Service I
Load Factors for Vertical Loads	Dead Load of Structural Components (DC)	0.90	1.25	1.00	1.00	1.00
	Vertical Earth Pressure Load (EV)	1.00	1.35	1.00	1.00	1.00
	Earth Surcharge Load (ES)		1.50			
	Live Load Surcharge (LS)		1.75		0.50	1.00
Load Factors for Horizontal Loads	Horizontal Earth Pressure Load (EH)	1.50		1.00	1.00	1.00
	Active		1.50			
	At-Rest		1.35			
	AEP for anchored walls		1.35			
	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. **Table 4** presents the soil design properties for the retaining wall for the anticipated soil types at the site, and 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. Additional soil parameters for use in design are included in **Table E-1** in **Appendix E**.

Table 4 – Lateral Soil Parameters

Depth, 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	Soil Strain (ε_{50})	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)
0-7 (768.5-761.5)	Fill Brown, Gray and Black Silty Clay	0.41	2.46	0.58	1,000	0.005	Stiff Clay w/o free water (Reese)
7-14.5 (761.5-754)	Brown and Gray Stiff to Hard Silty Clay	0.36	2.77	0.53	1,000	0.005	Stiff Clay w/o free water (Reese)
14.5-25 (754-743.5)	Gray Stiff to Very Stiff Silty Clay	0.36	2.77	0.53	1,000	0.005	Stiff Clay w/o free water (Reese)

Depth, 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	Soil Strain (ε_{50})	Soil Type
13-15 (755.5-753.5) **RWB-03 only**	Brown and Gray Medium Stiff Silty Clay	0.38	2.66	0.55	100	0.01	Soft Clay

*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 (Heq) 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. This could be accomplished by placing a Geocomposite Wall Drain 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.

4.2.2 Bearing Resistance

Bearing resistance for a CIP retaining wall founded on spread footings should be evaluated at the strength limit state using load factors (See **Table 3**), and factored bearing resistance. The bearing resistance factor, ϕ_b, for a gravity wall is 0.55 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 6 – Recommended Bearing Resistance for Retaining Wall

Stationing	Soil Boring Locations	Assumed Bearing Elevation (feet)	Nominal Resistance (ksf)	Factored Bearing Resistance (ksf)	Bearing Resistance for 1-inch Settlement Service Limit (ksf)	Anticipated Bearing Soil
24+30.0 to 25+10.5* **West Ret Wall**	RWB-01, RWB-02	754.5	8.3	4.6 (CIP)	4.6	Stiff to Very Stiff Silty Clay
25+42.5 to 26+25.0* **East Ret Wall**	RWB-03, RWB-04		10.9	6.0 (CIP)	5.5	Very Stiff to Hard Silty Clay or New Engineered Fill

* Based on existing IL 68 stationing

The minimum bearing depth of the wall 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 walls would be supported upon the soil types noted in **Table 6.**

4.2.3 Subgrade Undercut Areas

Based on the soil conditions along the wall alignment, undercuts may be necessary due to low strength, medium stiff clay in the area of boring RWB-03. Assuming a bearing elevation of El. 754.5 feet, about 1.5 feet of undercut is anticipated in the area of RWB-03 to remove the medium stiff clay and reach suitable, stiff to hard native clay at approximately El. 753 feet. Cohesive materials exhibiting moisture contents greater than 27% or unconfined compressive strengths less than 1.5 tsf, if encountered elsewhere, should also be removed during construction.

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 footing, then an additional 1 foot laterally for every 2 feet of structural fill depth as depicted in **Exhibit 2**. 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.

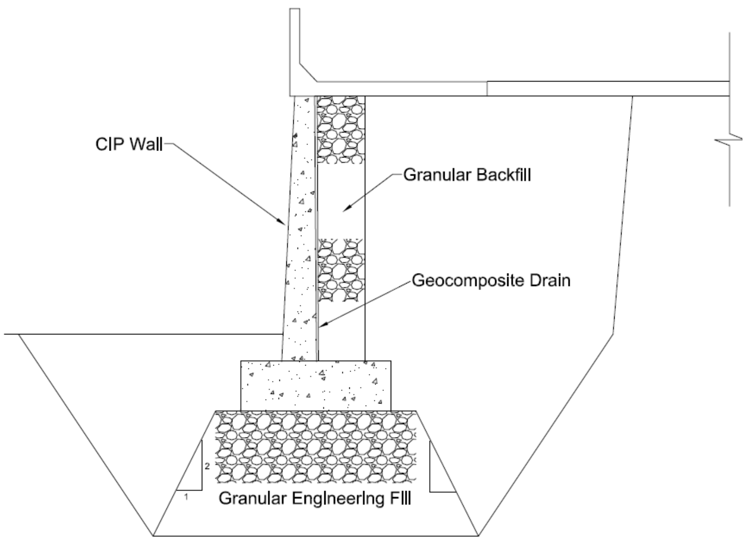


Exhibit 2 - Structural Fill Placement below CIP Wall Footing

4.3 Sliding and Overturning Stability

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

The factored resistance against sliding should be calculated using equation 10.6.3.4-2 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 beneath the wall footing. Assuming a layer of compacted granular material under the footing, the sliding resistance may be taken as one-half the normal stress on the interface between the footing and soil. The width of the footing 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 base width.

4.4 Wall and Embankment Settlement

Settlement of the CIP 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 as noted in **Table 6** are used, the settlement of the CIP wall will be on the order of 1 inch. Differential settlement between two points of 100 feet apart along the length of the wall will be ½ inch or less. If the existing roadway height is to be raised, i.e. fill added, additional settlement should be expected.

4.5 Global Slope Stability

The retaining walls should be designed for external stability of the wall systems. The wall design should be completed by a licensed structural engineer. The parameters in **Tables 7a and 7b** were used to evaluate the proposed sheet pile/soldier pile wall and CIP wall types, respectively.

Table 7a – Assumed Wall Dimensions Sheet Pile/Soldier Pile Wall

Description	Value
Maximum total exposed height of retaining wall	9 feet
Minimum embedment length - estimated	9 feet
Pile tip elevation - estimated	El. 750 feet
Unit weight of new granular backfill	125 pcf

*Additional embedment may be required for lateral pressures and structural design of the wall system

Table 7b – Assumed Wall Dimensions CIP Wall

Description	Value
Maximum total height of retaining wall	12.5 feet
Minimum CIP retaining wall footing width - estimated	6.5 feet
Unit weight of new granular backfill	125 pcf
Retaining wall bearing depth – minimum	3.5 feet

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.

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.

4.5.1 Global Slope Stability Results

Circular failure analyses were evaluated for both a short term (undrained) and long term (drained) condition based on the assumed geometry (**Tables 7a and 7b**) for the proposed retaining walls. A traffic load of 250 psf along IL Route 68 and groundwater level of El. 755 feet were assumed. The results of the analyses are shown in **Table 8**.

Table 8 – Retaining Wall Global Slope Stability Analyses Results

Cross Section	Wall Type	Analysis Type	Factor of Safety	Minimum Factor of Safety
RWB-01 through RWB-04	Sheet Pile/Soldier Pile Wall	Circular – Short Term	8.6	1.5
		Circular – Long Term	3.4	1.5
	CIP Wall	Circular – Short Term	7.5	1.5
		Circular – Long Term	2.5	1.5

Based on the analyses performed, the proposed retaining wall preliminary design meets the minimum factor of safety of 1.5. Copies of the slope stability analyses are included in **Appendix D**.

4.6 Drainage Recommendations

The wall design should include a drainage system to prevent the buildup of hydrostatic forces behind the wall. This could be accomplished with the installation of drainage blankets, geocomposite drainage panels, or gravel drains behind the facing of the wall with outlet pipes below the facing to collect and remove surface water away from the face of the CIP, sheet pile or soldier pile 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

Any pavement materials or topsoil encountered during construction should be stripped and stockpiled as per Section 211.03 of the IDOT Standard Specifications for Road and Bridge Construction (SSRBC). The topsoil should be separated from other materials being stockpiled onsite for reuse or haul off. Stripping of any trees, brush, vegetation, and topsoil may also be necessary at the proposed improvement location.

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, all 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. In accordance with OSHA Regulation 29 CFR 1926 Subpart P Appendix B, the maximum allowable slopes for excavations less than 20 feet should be completed per the OSHA Excavation Slopes shown in **Table 9**. Excavations made in layered soil systems shall use the maximum allowable slope for each layer as prescribed in the OSHA Regulation. Excavations greater than 20 feet deep should be designed by a registered professional engineer; any shoring or bracing systems should be designed by a licensed structural engineer.

Table 9 – OSHA Excavation Slopes

Soil or Rock Type	Maximum Allowable Slope (H:V) for less than 20 feet
Stable Rock	Vertical (90^{o})
Type A	¾:1 (53^{o})
Type B	1:1 (45^{o})
Type C	1 ½:1 (34^{o})

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. Surcharge loads from the excavated materials, construction equipment, and vehicles should be included in the design of the excavation system. Excavation near existing structures and underground utilities should be performed with extreme care to avoid undermining existing structures.

If water seepage occurs during excavation or where wet conditions are encountered such that the water cannot be removed with conventional sumping, GSG recommends 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 consisting of granular materials such as IDOT CA-6.

5.4 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 SSRBC (2022). The fill material should be free of organic matter and debris and should be placed and compacted in accordance with Section 205, Embankment, of the IDOT Construction Manual. Earth-moving operations should be avoided during excessively cold or wet weather to avoid freezing of softening subgrade soils. All backfill materials must be pre-approved by the site engineer. Backfill materials for undercut areas beneath the retaining walls should be placed in 8 inches loose lifts and should be compacted to 95% of the maximum dry density as determined by AASTHO T-180, Modified Proctor Method.

5.5 Groundwater Management

It is anticipated that the long-term groundwater level may be at approximate depths of 13 to 15.5 feet (El. 755.2 to 752.7 feet). GSG does not anticipate significant groundwater related issues during construction activities, 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.

5.6 Soldier Pile Construction

The following recommendations apply only to soldier pile wall construction using the auger cast soldier pile method. For auger cast construction, construction of the borehole can be affected by the groundwater level and hard material. Due to the anticipated long-term groundwater elevation and predominantly clay soils, significant groundwater issues are not anticipated for construction. Temporary casing or a permanent liner are not anticipated to be necessary to keep the hole wall stable.

During dry construction of a drilled hole, water should be removed from the base of the drilled shaft base prior to placing any concrete. The placement method of concrete for the drilled shaft should be based on the amount of water present at the base of the shaft just prior to placing the concrete. Concrete may be placed using the free fall method, provided less than 2 inches of water is present at the base of the shaft at the time the concrete is being placed. If more than 2 inches of water is present, a tremie should be used to displace the water to the surface for removal. GSG recommends that the shaft concrete be ready on site as the drilled excavation is completed, so that the concrete can be placed immediately after completing the drilled shaft excavation. This will reduce the potential of water accumulation in the bottom of the shaft. Bottom cleanliness of the drilled shaft excavation should be observed from the ground surface with the use of flood light or down-hole camera. Workers should not enter the shaft to manually clean the base of the shaft due to safety reasons.

5.6 Temporary Soil Retention

Temporary sheet piling is feasible because the existing soils strengths are generally less than 4.5 tsf. The Temporary Soil Retention System (TSRS) should be designed in accordance with the IDOT Bridge Design Manual, Section 3.13.1, Temporary Sheet Piling Design, Temporary Soil Retention Systems and Braced Excavations and the IDOT Design Guide. The design of the temporary earth retention system 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.

5.7 Existing Condition Survey and Construction Monitoring

Existing structures around the site could be impacted by construction activities such as ground vibration during foundation pile installation or ground vibration due to operation of heavy construction equipment. GSG recommends completing a pre-construction condition survey for all structures located around the site to document the existing conditions of the structures. The survey should include documentation of cracks, opening of joints, and other defects and deficiencies.

6.0 LIMITATIONS

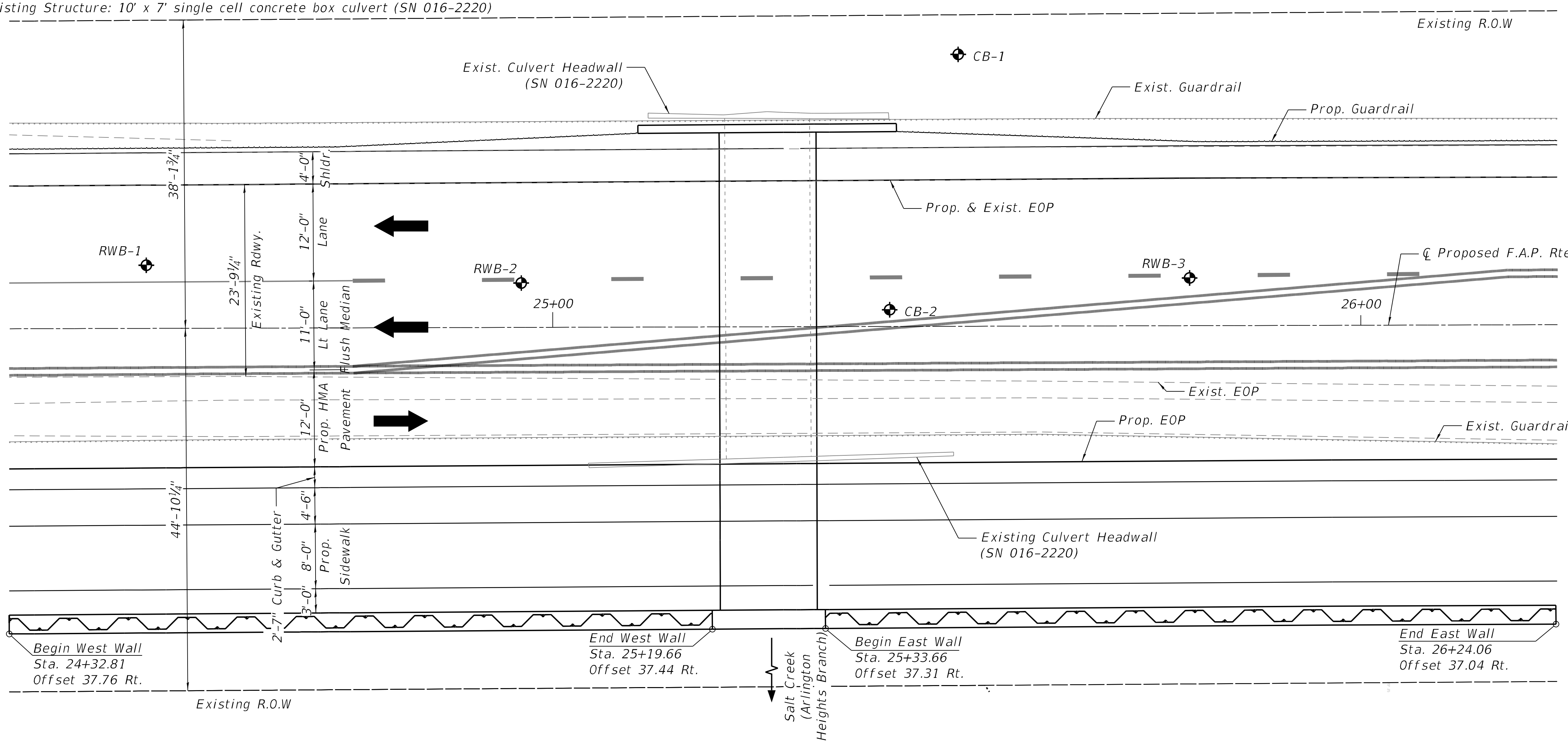
This report has been prepared for the exclusive use of the Illinois Department of Transportation and its consultant team. The recommendations provided in the report are specific to the project described herein and are based on the information obtained at the soil boring locations within the proposed 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

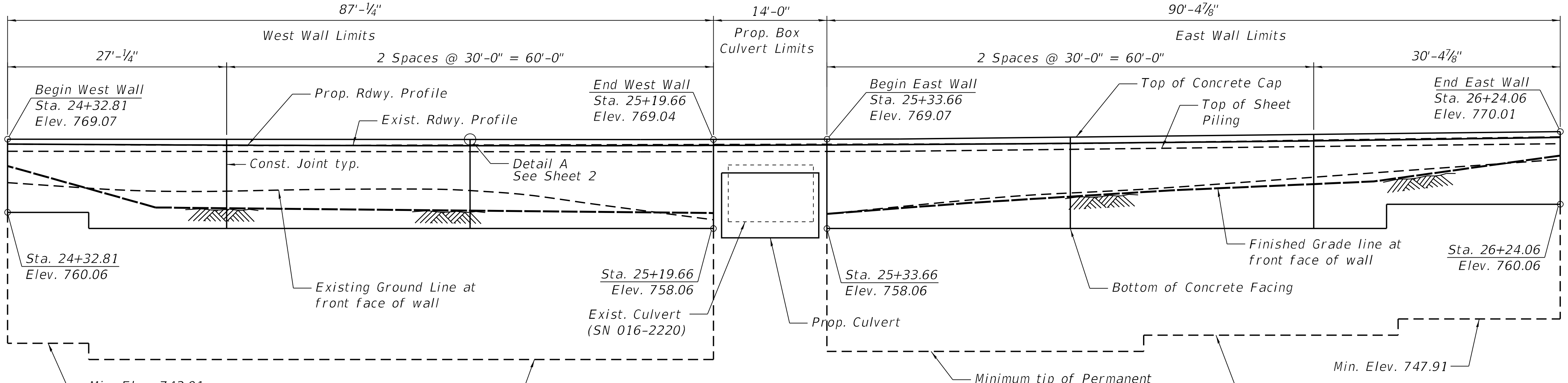
PRELIMINARY TSL

Bench Mark:

Existing Structure: 10' x 7' single cell concrete box culvert (SN 016-2220)



PLAN



ELEVATION

(Looking @ F.F. of wall)

DESIGN STRESSES

FIELD UNITS

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

DESIGN SPECIFICATIONS

2020 AASHTO LRFD Bridge Design Specifications 9th Edition

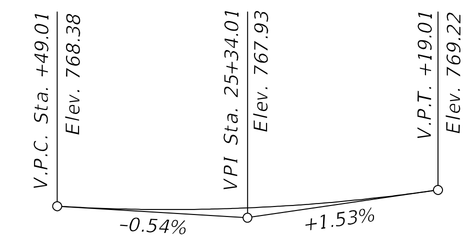
Illinois Department of Transportation Bridge Manual, January 2012

CURVE DATA

(F.A.P. Rte. 434)

P.I. Sta. = 16+48.76
Δ = 18°-32'-19" (RT)
D = 3°-34'-52"
R = 1,600.00'
T = 261.13'
L = 517.70'
E = 21.17'
e = 4.4%
P.C. Sta. = 13+87.63
P.T. Sta. = 19+05.33

RWB-4

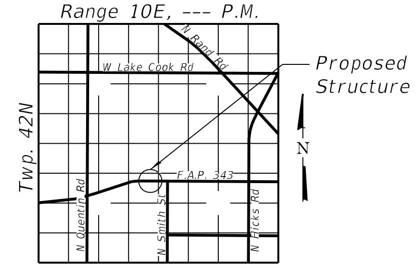


L.V.C. = 170.00' K=82

PROFILE GRADE

(along ℄ of roadway)

Range 10E, --- P.M.



LOCATION SKETCH

HIGHWAY CLASSIFICATION

F.A.P. Rte. 434 - Dundee Rd
Functional Class: Other Principal Arterial
ADT: 25,000 (2021); 22,000 (2040)
ADTT: 1,675 (2013); 1,760 (2040)
DHV: 2,060
Design Speed: 45 m.p.h.
Posted Speed: 45 m.p.h.
Two-Way Traffic
Directional Distribution:

GENERAL PLAN & ELEVATION
IL 68 (DUNDEE ROAD)
SEC. FAP 343 22 CULVERT
COOK COUNTY
STA 24+30 TO 25+10.5 & STA 25+42.5 TO 26+25
STRUCTURE NO. 000-0000

MODEL: Default
FILE NAME: C:\Users\mcucolotto\orionengineersllc.com\Charles Frangos - Orion\Projects\2021008 - IDOT PTB 199-013\Work Order #5\CADD\Sheet Files\D162R73-sht-TSL-01.dgn

ORION ENGINEERS

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	DRAWN - MBC	REVISED -
PLOT SCALE =	CHECKED - LJ	REVISED -
PLOT DATE = 11/11/2022 3:02:27 PM	DATE - 11/18/2022	REVISED -

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

GENERAL PLAN AND ELEVATION

SHEET 1 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
343	FAP 343 22 CULVERT	COOK	STOT	
		CONTRACT NO. 62R73		
		ILLINOIS	FED. AID PROJECT	

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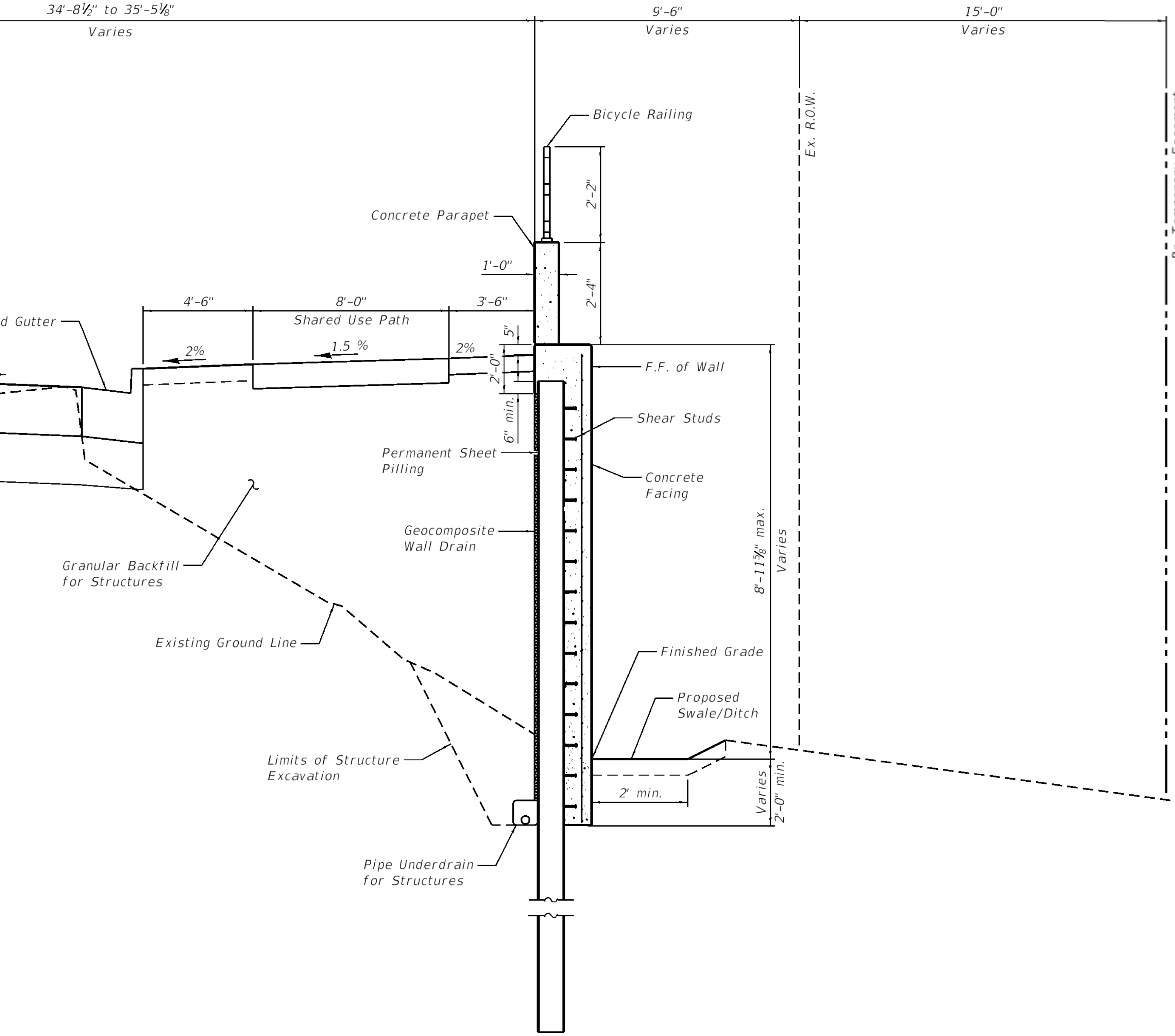
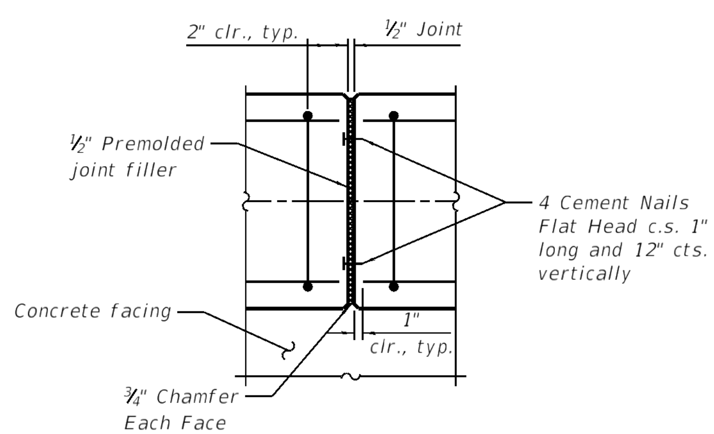


TYPICAL WALL SECTION

(Looking East)



DETAIL A

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ORION ENGINEERS

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STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

TYPICAL SECTION AND DETAILS

SHEET 2 OF 2 SHEETS

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
343	FAP 343 22 CULVERT	COOK	STOT	
		CONTRACT NO. 62R73		
		ILLINOIS FED. AID PROJECT		

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APPENDIX B

BORING LOCATION PLAN

LEGEND

BORING LOCATION

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TIME = 11:06:48 AM
SHEET SIZE = 17x11 (in.)
PLOT SCALE = 100.0000 sf / in.
USER NAME = ddimaggio

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

USER NAME	= ddimaggio	DESIGNED -	DD
SHEET SIZE	= 17x11 (in.)	DRAWN -	DD
PLOT SCALE	= 100.0000 sf / in.	CHECKED -	DE
PLOT DATE	= 8/17/2022	DATE -	08/17/2022

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

CONTRACT NO. 199-013

IL 68 AT SALT CREEK
BORING LOCATION PLAN

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

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

CONTRACT NO. 199-013

ILLINOIS | FED. AID PROJECT

APPENDIX C

SOIL BORING LOGS

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

SOIL BORING LOG

Date 7/28/22

ROUTE	Illinois Route 68	**DESCRIPTION**	Culvert and Retaining Walls	**LOGGED BY**	AA
SECTION		**LOCATION**	IL 68 at Salt Creek, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**		
COUNTY	Cook	**DRILLING RIG**	CME 75	**HAMMER TYPE**	Auto
		DRILLING METHOD	HSA	**HAMMER EFF (%)**	91

STRUCT. NO.	016-2302	**Surface Water Elev.**	N/A ft
Station		**Stream Bed Elev.**	N/A ft
BORING NO.	RWB-01	**Groundwater Elev.:**	
Station	24+50.39	**First Encounter**	None ft
Offset	2.69ft LT	**Upon Completion**	N/A ft
Ground Surface Elev.	768.19 ft	**After ___ Hrs.**	N/A ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6 inches of Asphalt	767.69				
2 inches of Sand subbase	767.53				
Black and Brown, Moist FILL: SILTY CLAY, trace gravel, little sand			6 4 6	3.3 B	11
	764.19		3		
Very Stiff to Hard Brown and Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML)		-5	3 6	2.9 B	20
			4 5 7	5.2 B	19
		-10	3 5 7	2.1 B	20
	755.19		4 5 10	4.6 B	20
Stiff Brown and Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML)	752.69	-15	3 5 8	1.9 B	19
Stiff Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML)			2 3 5	1.5 B	19
		-20	2 3 4	1.7 B	21
Stiff Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML) *(continued)*			2 4 7	1.9 B	18
	743.19	-25	5 6 7	1.5 B	16
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 7/28/22

ROUTE Illinois Route 68 **DESCRIPTION** Culvert and Retaining Walls **LOGGED BY** AA

SECTION ____ **LOCATION** IL 68 at Salt Creek, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**

COUNTY Cook **DRILLING RIG** CME 75 **HAMMER TYPE** Auto

DRILLING METHOD HSA **HAMMER EFF (%)** 91

STRUCT. NO. 016-2302
Station ____

BORING NO. RWB-02
Station 24+96.77
Offset 0.17ft LT
Ground Surface Elev. 768.20 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 ____ **Hrs.** N/A ft

Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6 inches of Asphalt	767.70				
2 inches of Sand subbase	767.54				
Black and Brown, Moist FILL: SILTY CLAY, little gravel, little sand			5, 5, 5	2.3 B	17
		-5	3, 4, 6	1.0 B	25
	762.20				
Stiff to Very Stiff Brown and Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML)			3, 5, 6	2.7 B	18
		-10	3, 4, 4	1.9 B	22
			5, 6, 9	3.1 B	18
	755.20				
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)		-15	3, 5, 7	2.9 B	18
			3, 3, 5	1.0 B	20
		-20	2, 4, 6	2.7 B	16
Stiff to Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*			2, 4, 6	2.9 B	18
	743.20	-25	3, 4, 6	2.7 B	17
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 7/28/22

ROUTE Illinois Route 68 **DESCRIPTION** Culvert and Retaining Walls **LOGGED BY** AA

SECTION ______ **LOCATION** IL 68 at Salt Creek, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**

COUNTY Cook **DRILLING RIG** CME 75 **HAMMER TYPE** Auto
DRILLING METHOD HSA **HAMMER EFF (%)** 91

STRUCT. NO. 016-2302
Station ______

BORING NO. RWB-03
Station 25+79.49
Offset 0.59ft LT
Ground Surface Elev. 768.21 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 ___ **Hrs.** N/A ft

Description	Elev. (ft)	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6 inches of Asphalt	767.71				
2 inches of Sand subbase	767.55				
Black, Brown and Dark Gray, Moist to Very Moist FILL: SILTY CLAY, trace gravel, trace sand			6, 4, 3	3.1 B	15
		-5	2, 2, 2	1.3 B	26
			2, 2, 2	0.8 B	32
		-10	2, 2, 3	2.1 B	26
	757.21				
Stiff Brown and Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML)			2, 2, 3	1.5 B	25
	755.21				
Medium Stiff Brown and Gray, Very Moist SILTY CLAY, trace gravel, trace sand (CL/ML)		-15	1, 2, 4	0.8 B	31
	753.21				
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)			2, 3, 5	2.3 B	21
		-20	2, 5, 5	2.5 B	20
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*			2, 5, 6	2.3 B	19
		-25	3, 5, 7	3.1 B	23
	743.21				
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 7/29/22

ROUTE Illinois Route 68 DESCRIPTION Culvert and Retaining Walls LOGGED BY AA

SECTION LOCATION IL 68 at Salt Creek, **SEC.** , **TWP.** , **RNG.** , **Latitude** , **Longitude**

COUNTY Cook DRILLING RIG D50 Blue HAMMER TYPE Auto
DRILLING METHOD HSA HAMMER EFF (%) 98

STRUCT. NO. 016-2302
Station

BORING NO. RWB-04
Station 26+36.13
Offset 10.62ft RT
Ground Surface Elev. 769.06 ft

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

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

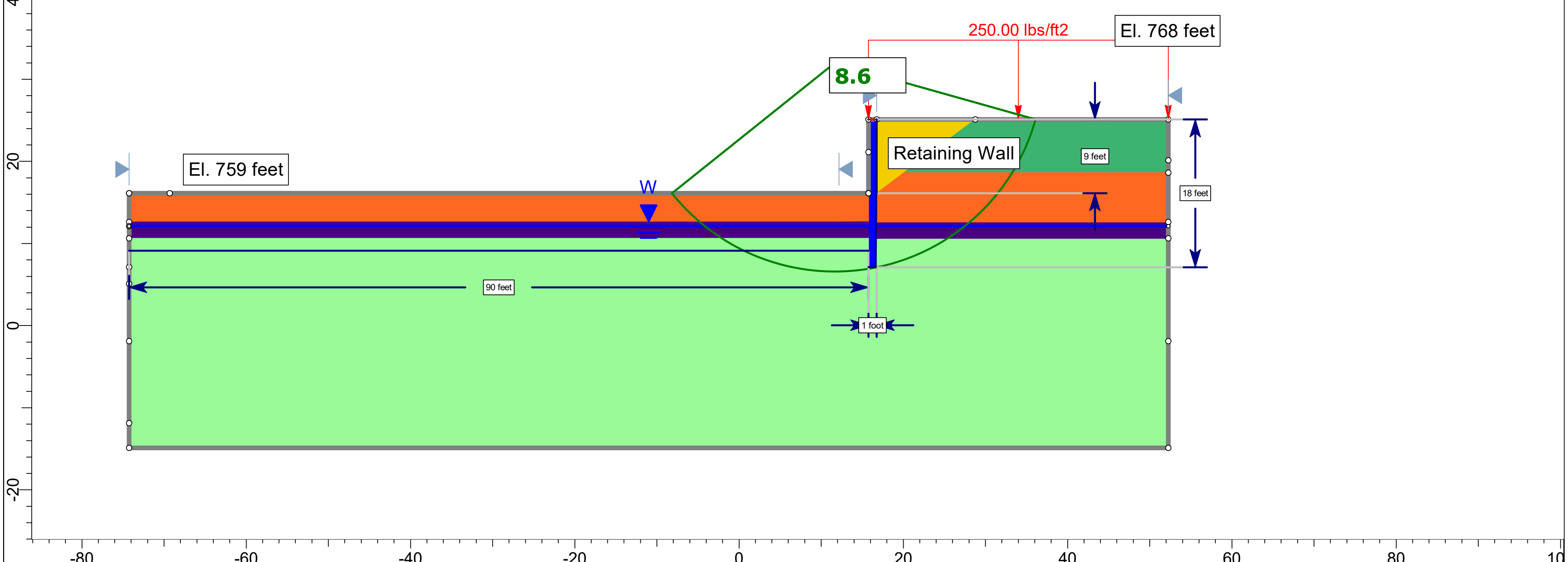
Description	Elev.	DEPTH (ft)	BLOWS (/6")	UCS Qu (tsf)	MOIST (%)
6 inches of Asphalt	768.56				
2 inches of Sand subbase	768.40				
Dark Gray, Brown and Black, Moist FILL: SILTY CLAY, trace gravel, little sand			10 5 5	3.5 B	15
		-5	2 4 5	2.7 B	21
	763.06				
Hard Brown and Gray, Moist SILTY CLAY, trace gravel, trace sand (CL/ML)			4 7 9	5.6 B	19
		-10	4 8 12	4.5 B	18
			3 6 9	4.2 B	22
	754.06	-15	3 6 8	4.5 B	20
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML)			2 4 5	2.9 B	20
		-20	2 4 6	2.3 B	19
Very Stiff Gray, Moist SILTY CLAY, trace gravel (CL/ML) *(continued)*			3 4 6	2.9 B	20
	744.06	-25	3 5 8	2.9 B	19
End of Boring		-30			
		-35			
		-40			

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

APPENDIX D

SLOPE STABILITY EXHIBITS

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Granular Engineered Fill Undrained		125	Mohr-Coulomb	0	30
Brown, Black, Gray Silty Clay Fill Undrained		131	Mohr-Coulomb	2200	0
Brown, Gray Stiff to Hard Silty Clay Undrained		136	Mohr-Coulomb	3300	0
Brown, Gray Medium Stiff Silty Clay Undrained		127	Mohr-Coulomb	800	0
Gray Stiff to Very Stiff Silty Clay Undrained		132	Mohr-Coulomb	2400	0
Sheet Pile Wall		490	Infinite strength		

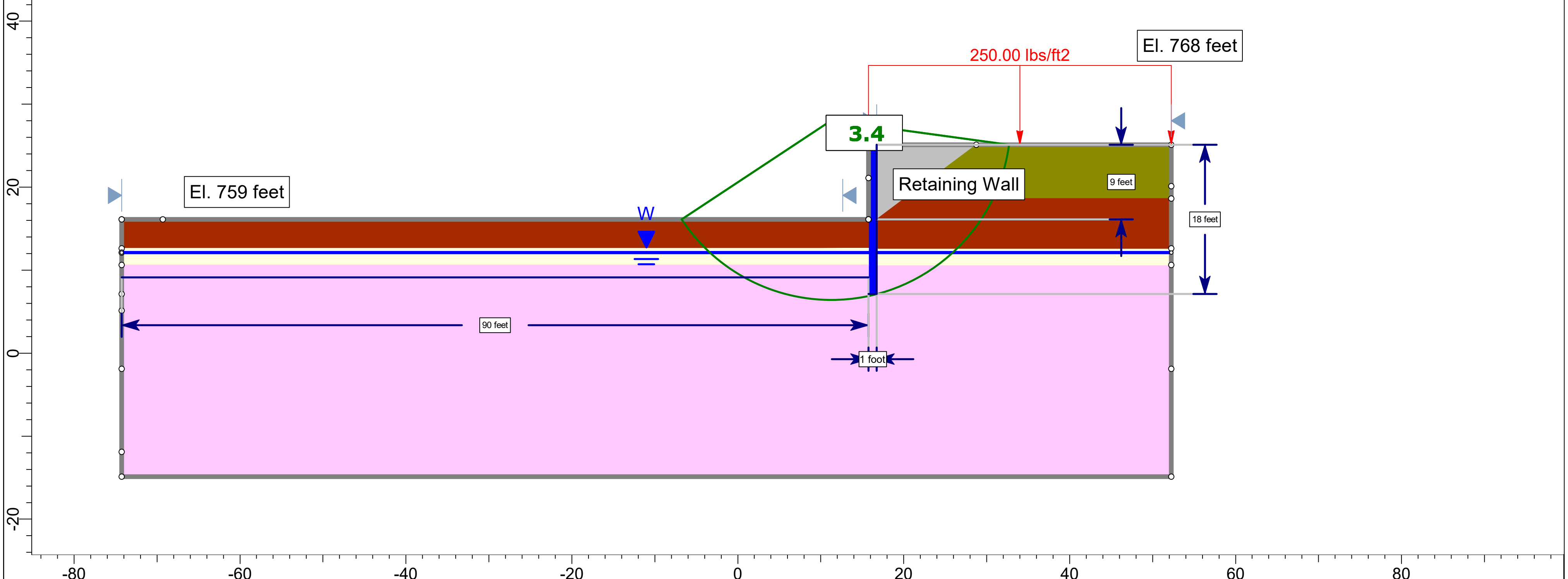


GSG CONSULTANTS, INC.
735 Remington Road, Schaumburg, IL 60173
Tel: 630.994.2600, www.gsg-consultants.com

Project	IL Route 68 at Salt Creek - Sheet Pile/Soldier Pile Retaining Walls		
Group	Group 1	*Scenario*	Short Term Stability - Water El. 755 feet
Drawn By	RM	*Company*	GSG Consultants, Inc.
Date	7/15/2021, 12:22:18 PM	*File Name*	Salt Creek Ret Wall - Sheet Pile.slmd

SLIDEINTERPRET 9.023

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Granular Engineered Fill Drained	(grey)	125	Mohr-Coulomb	0	30
Brown, Black, Gray Silty Clay Fill Drained	(olive)	131	Mohr-Coulomb	220	25
Brown, Gray Stiff to Hard Silty Clay Drained	(dark red)	136	Mohr-Coulomb	330	28
Brown, Gray Medium Stiff Silty Clay Drained	(cream)	132	Mohr-Coulomb	80	27
Gray Stiff to Very Stiff Silty Clay Drained	(pink)	132	Mohr-Coulomb	240	28
Sheet Pile Wall	(blue)	490	Infinite strength		



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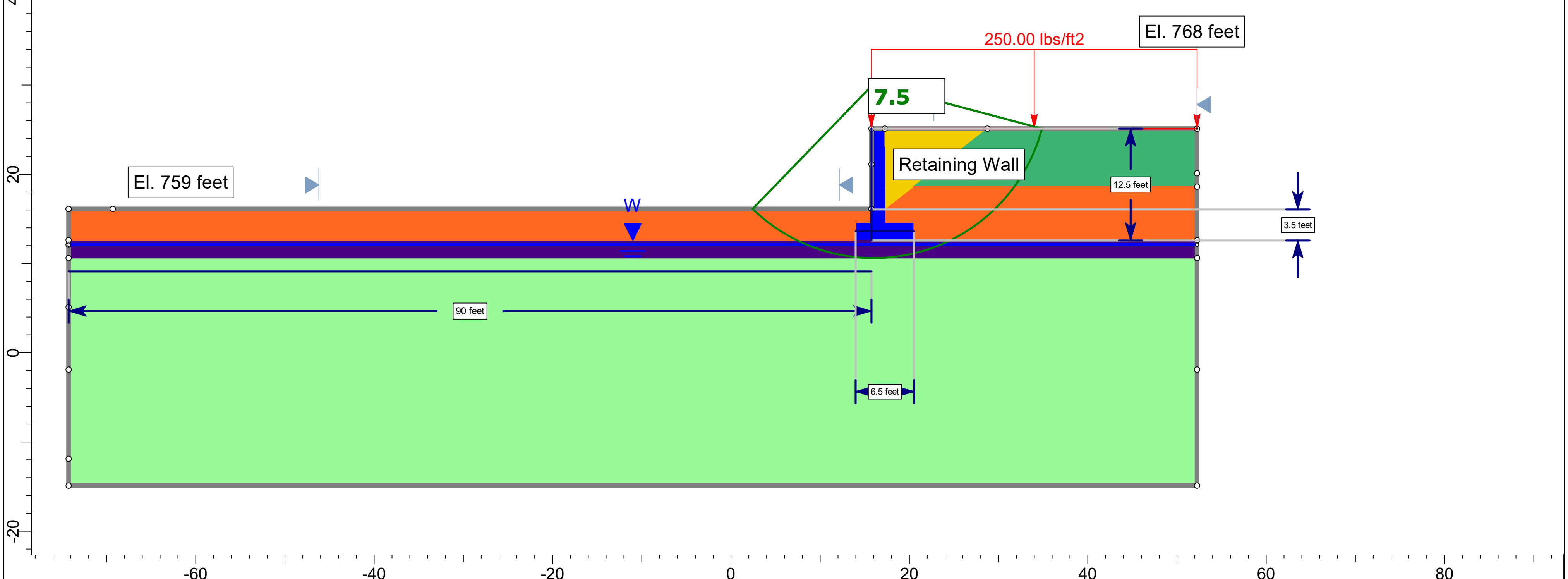
Tel: 630.994.2600, www.gsg-consultants.com

SLIDEINTERPRET 9.023

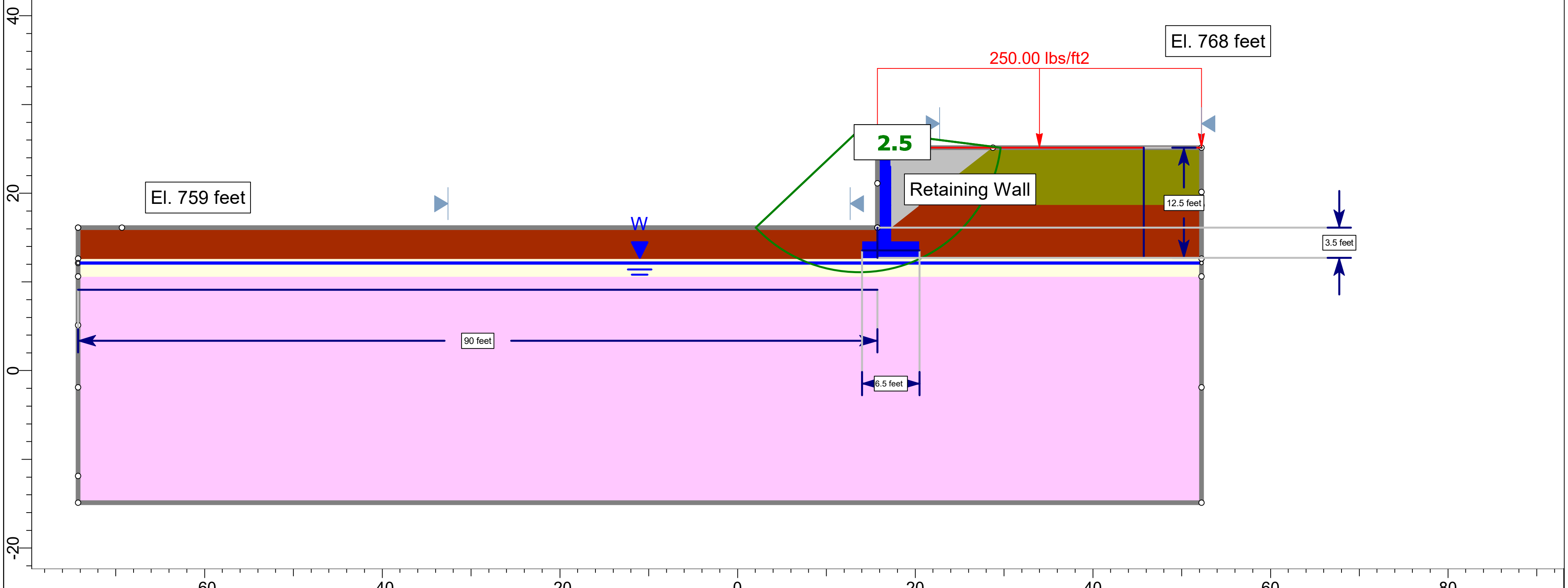
Project	IL Route 68 at Salt Creek - Sheet Pile/Soldier Pile Retaining Walls
Group	Group 1
Scenario	Long Term Stability - Water El. 755 feet
Drawn By	RM
Company	GSG Consultants, Inc.
Date	7/15/2021, 12:22:18 PM
File Name	Salt Creek Ret Wall - Sheet Pile.slmd

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Granular Engineered Fill Undrained	Yellow	125	Mohr-Coulomb	0	30
Brown, Black, Gray Silty Clay Fill Undrained	Green	131	Mohr-Coulomb	2200	0
Brown, Gray Stiff to Hard Silty Clay Undrained	Orange	136	Mohr-Coulomb	3300	0
Brown, Gray Medium Stiff Silty Clay Undrained	Purple	127	Mohr-Coulomb	800	0
Gray Stiff to Very Stiff Silty Clay Undrained	Light green	132	Mohr-Coulomb	2400	0
Concrete CIP Wall	Blue	140	Infinite strength		



GSG CONSULTANTS, INC. 735 Remington Road, Schaumburg, IL 60173 Tel: 630.994.2600, www.gsg-consultants.com	*Project* IL Route 68 at Salt Creek - CIP Retaining Walls		
	Group Group 1	*Scenario* Short Term Stability - Water El. 755 feet	
	Drawn By RM	*Company* GSG Consultants, Inc.	
SLIDEINTERPRET 9.023	*Date* 7/15/2021, 12:22:18 PM	*File Name* Salt Creek Ret Wall - CIP.slmd	

Material Name	Color	Unit Weight (lbs/ft3)	Strength Type	Cohesion (psf)	Phi (deg)
Granular Engineered Fill Drained		125	Mohr-Coulomb	0	30
Brown, Black, Gray Silty Clay Fill Drained		131	Mohr-Coulomb	220	25
Brown, Gray Stiff to Hard Silty Clay Drained		136	Mohr-Coulomb	330	28
Brown, Gray Medium Stiff Silty Clay Drained		132	Mohr-Coulomb	80	27
Gray Stiff to Very Stiff Silty Clay Drained		132	Mohr-Coulomb	240	28
Concrete CIP Wall		140	Infinite strength		



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APPENDIX E

SOIL PARAMETER TABLE

Table E-1 – Summary of Soil Parameters

Depth / Elevation Range (feet)	Soil Description	In situ Unit Weight γ (pcf)	Undrained		Drained	
			Cohesion c (psf)	Friction Angle ϕ (°)	Cohesion c (psf)	Friction Angle ϕ (°)
	New Engineered Clay Fill	125	1,000	0	50	25
	New Engineered Granular Fill	125	0	30	0	30
0-7 (768.5-761.5)	Fill Brown, Gray and Black Silty Clay	131	2,200	0	220	25
7-14.5 (761.5-754)	Brown and Gray Stiff to Hard Silty Clay	136	3,300	0	330	28
14.5-25 (754-743.5)	Gray Stiff to Very Stiff Silty Clay	132	2,400	0	240	28
13-15 (755.5-753.5) **RWB-03 only**	Brown and Gray Medium Stiff Silty Clay	127	800	0	80	27