STRUCTURE GEOTECHNICAL REPORT
NORTHBOUND ILLINOIS ROUTE 43 (FAP 348)
OVER THE MWRDGC RAILROAD
PR SN 016-1330, EX SN 016-0314
SECTION 0708.3A-BR(11), PTB 163/ITEM 013
IDOT D-91-281-12, CONTRACT 60T07
COOK COUNTY, ILLINOIS

for

ESI Consultants, Ltd.

1979 North Mill Street, Suite 100

Naperville, IL 60563

(217) 348-1900

submitted by

Wang Engineering, Inc.

1145 North Main Street

Lombard, IL 60148

(630) 953-9928

Original Report: May 13, 2014

Revised Report: September 17, 2015

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, Northbound Illinois Route 43 (Harlem Avenue) Bridge over the MWRDGC RailRoad		**2. Report Date** September 17, 2015 **3. Report Type** ☒ SGR ☐ RGR ☐ Draft ☐ Final ☒ Revised
4. Route / Section / County FAP 348 / 0708.3A-BR(11) /Cook		**5. IDOT Project Number(s)** Job D-91-281-12
6. PTB / Item No. 163/013	**7. Existing Structure Number(s)** SN 016-0314	**8. Proposed Structure Number(s)** SN 016-1330
9. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: Mickey L. Snider, P.E. Project Manager: Liviu Iordache, P.G. QA/QC: Jerry W.H. Wang, PhD, P.E.	**Contact Phone Number** (630) 953-9928 x 1027 MSnider@wangeng.com
10. Prepared for ESI Consultants, Ltd. 1979 N Mill Street, Ste 100 Naperville, IL 60563	**Project Manager(s)/Design Eng(s)** Mark Reznicek, P.E. Max Watkins, P.E., S.E.	**Contact Phone Number** (217) 348-1900

11. Abstract

The existing, five-span structure carrying northbound Illinois Route 43 over the MWRDGC Railroad will be removed and replaced with a new, two-span structure. The bridge will have integral abutments constructed above and behind retaining walls and a multi-column pier. A proposed shift in the alignment of the roadway will necessitate an MSE retaining wall around the north abutment to retain the 22 feet of fill. The north embankment widening will require a soldier pile and lagging wall north of Station 25+00. This report provides geotechnical recommendations for the design of proposed bridge foundations, retaining walls, and embankments.

The existing embankment material behind the abutments consists of generally stiff silty clay fill. Beneath the embankments, the borings encountered about 5 to 7 feet of soft and compressible silty loam with organic material. Deeper foundation soils include very stiff to hard silty clay and dense sand and gravelly sand overlying strong, fair quality dolostone bedrock at 62 feet below the railroad elevation. The site classifies in the Seismic Class C.

The fill areas along the proposed retaining walls will include up to 22 feet of additional fill. We estimate the new fill could cause approximately 6 inches of total long-term settlement The external stability of approach embankment and retaining wall is adequate; however, we estimate the factored bearing resistance of 3,500 psf is inadequate for the construction of the MSE wall without ground improvement. We recommend installing Aggregate Column Ground Improvement, in accordance with IDOT GBSP No. 71 with estimated diameters of 30 inches at 7-foot on-center spacing.

The proposed abutments and piers could be supported on driven piles (size HP12x53, HP14x73, or 14-inch diameter MSP). We estimate 20 to 70 foot long MSP to achieve 75 to 250 kips of factored capacity and 40 to 70 foot long steel piles to achieve similar capacity; the north abutment piles should include allowances for negative skin friction due to the anticipated settlement. The pier foundations could also be supported on 3.0- to 6.0-foot diameter drilled shafts established within the hard silty clay or socketed into the bedrock. Rock sockets would be 2 feet long and designed for end bearing. Permanent casing will be required for socket coring due to the presence of groundwater.

Stage construction for the abutments and MSE wall should be supported by *Temporary Soil Retention Systems*, designed by the Contractor and approved by IDOT prior to construction. If the pier excavation cannot be sloped at 1:2 (V:H) it should be supported by *Temporary Soil Retention System.*

12. Path to archived file

S:\Netprojects\8850202\Reports\RPT_Wang_MLS_8850201HarlemMWRD_20150420.pdf

TABLE OF CONTENTS

1.0 INTRODUCTION ... 1

1.1 PROPOSED STRUCTURE ... 1

1.2 EXISTING STRUCTURE ... 2

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING ... 2

2.1 PHYSIOGRAPHY ... 2

2.2 SURFICIAL COVER ... 3

2.3 BEDROCK ... 3

3.0 METHODS OF INVESTIGATION ... 3

3.1 SUBSURFACE INVESTIGATION ... 3

3.2 LABORATORY TESTING ... 4

4.0 RESULTS OF FIELD AND LABORATORY INVESTIGATIONS ... 4

4.1 SOIL CONDITIONS ... 5

4.2 GROUNDWATER CONDITIONS ... 6

4.3 SEISMIC DESIGN CONSIDERATIONS ... 6

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS ... 7

5.1 APPROACH EMBANKMENTS, SLABS, AND RETAINING WALLS ... 8

5.1.1 Bearing Capacity and Sliding ... 9

5.1.2 Settlement ... 9

5.1.3 Global Stability ... 10

5.1.4 Ground Improvement Recommendations ... 10

5.1.5 Soldier Pile and Lagging Walls ... 11

5.2 STRUCTURE FOUNDATIONS ... 12

5.2.1 Driven Piles ... 13

5.2.2 Drilled Shafts ... 16

5.2.3 Lateral Loading ... 18

5.3 STAGE CONSTRUCTION DESIGN RECOMMENDATIONS ... 19

6.0 CONSTRUCTION CONSIDERATIONS ... 19

6.1 SITE PREPARATION ... 19

6.2 EXCAVATION AND DEWATERING 20
6.3 FILLING AND BACKFILLING 20
6.4 EARTHWORK OPERATIONS 21
6.5 PILE INSTALLATION 21
6.6 DRILLED SHAFTS 21

7.0 QUALIFICATIONS 22

REFERENCES 23

EXHIBITS

1. Site Location Map

2. Site and Regional Geology

3. Boring Location Plan

4. Soil Profile

APPENDIX A

Boring Logs

APPENDIX B

Laboratory Testing Results

APPENDIX C

Global Stability Analysis

LIST OF TABLES

Table 1: Seismic Design Parameters 7
Table 2: Geotechnical Parameters for Design of Soldier Pile Walls 12
Table 3: Recommended Parameters for Lateral Load Analysis of Soldier Pile Walls 12
Table 4: Estimated Pile Lengths and Tip Elevations for 14-inch Diameter MSP with 0.312-inch Walls 14
Table 5: Estimated Pile Lengths and Tip Elevations for HP12x53 Steel Piles 14
Table 6: Estimated Pile Lengths and Tip Elevations for HP14x73 Steel Piles 15
Table 7: Estimated Resistances and Base Elevations for Pier Shafts 17
Table 8: Estimated Rock Socket Thicknesses and Tip Elevations for Rock Socket Pier Shafts 18
Table 9: Recommended Soil Parameters for Lateral Load Pile Analysis 18
Table 10: Recommended Bedrock Parameters for Lateral Load Pile Analysis 19
Table 11: Estimated Granular Backfill Parameters 20

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

STRUCTURE GEOTECHNICAL REPORT
NORTHBOUND ILLINOIS ROUTE 43 (FAP 348)
OVER THE MWRDGC RAILROAD
PR SN 016-1330, EX SN 016-0314
SECTION 0708.3A-BR(11), PTB 163/ITEM 013
IDOT D-91-281-12, CONTRACT 60T07
COOK COUNTY, ILLINOIS
FOR
ESI CONSULTANTS, LTD.

1.0 INTRODUCTION

This report presents the results of our subsurface investigation, laboratory testing, and geotechnical evaluations for the reconstruction of the northbound Illinois Route 43 (Harlem Avenue) Bridge over the Metropolitan Water Reclamation District of Greater Chicago (MWRDGC) Railroad in Forest View, Cook County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Wang Engineering, Inc. (Wang) understands ESI Consultants, Ltd. (ESI) envisions a new, two-span structure with deep foundations replacing the existing five-span northbound bridge. The General Plan and Elevation (GPE) drawing provided by ESI shows a bridge with a back-to-back of abutments length of 130.0 feet and two span lengths of 65.0 feet. The out-to-out width will measure 46.8 feet to accommodate a 28-foot wide roadway, a 5-foot wide sidewalk on the west side, and a 10-foot wide sidewalk on the south side. The bridge will be 33.5 feet shorter and 10 feet narrower than the existing structure, with the north abutment constructed approximately 30 to 35 feet in front of the existing and the south abutment constructed immediately behind the existing. To support the abutments each approach will include abutment walls. The south abutment wall will run parallel to the axis of the abutment and will have a maximum exposed height of 9.3 feet. The north abutment wall will include a 61-foot long wingwall along the west side, a 90-foot long abutment wall, and a 415-foot long wall on the east side. The west and abutment walls will have exposed heights of about 9.5 to 10.5 feet, whereas the east wall exposed height will range from about 4 to 15 feet. Between Stations 26+45 and 27+20, the east wall will be constructed over the existing box culvert running beneath Harlem Avenue. The embankments will grade down from the roadway level to the MSE walls at 1:2.5 to 1:3 (V:H).

The purpose of our investigation was to characterize the site soil and groundwater conditions, perform geotechnical analyses, and provide recommendations for the design and construction of bridge foundations and retaining walls.

1.2 Existing Structure

According to the Bridge Condition Report provided by ESI, the original northbound bridge was built in 1931 as a three-span slab bridge over the railroad. The superstructure was replaced with prestressed, precast concrete deck beams in 1970, and two additional spans were added to create the existing five-span structure. The bridge has a back-to-back length of 163.5 feet and an out-to-out width is 56.5 feet. The substructures consist of a large, counterfort south abutment and a pile-bent north abutment with multi-column piers supported on deep foundations of unknown type and size.

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING

The site is located in the Village of Forest View, Cook County, Illinois. On the USGS *Berwyn 7.5-minute series* map the project is located in the NE ¼ of Section 12, Tier 38 N, Range 12 E and the NW ¼ of Section 7, T 38N, R13E of the 3rd Principal Meridian.

The following review of the published geologic data, with emphasis on factors that might influence the design and construction of the proposed engineering works, is meant to place the project area within a geological framework and confirm the dependability and consistency of the subsurface investigation results. For the study of the regional geologic framework, Wang considered the northeastern Illinois area in general and Cook County in particular. Exhibit 2 illustrates the *Site and Regional Geology*.

2.1 Physiography

The project is located near the beginning of the north arm of the Y-shaped Chicago outlet valley where the Des Plaines River meets the Chicago Sanitary and Ship Canal (Johnson and Hansel, 1999; Willman, 1971). The Des Plaines River is about 2500 feet to the west and the Cal-Sag Channel is about 500 feet to the south of the bridge. The area is primarily used by MWRDGC, and the surrounding land has been graded and altered significantly by many years of urban activity. A bog area of Portage Woods lies immediately to the northwest of the bridge and endures significant flooding from the Des Plaines River during periods of heavy precipitation.

2.2 Surficial Cover

The surficial cover is the result of Wisconsinan-age glacial activity. Up to 63-foot thick drift rests over the bedrock (Leetaru et al. 2004). The glacigenic deposits were emplaced during pulsating advances and retreats of an icesheet lobe responsible for the formation of end moraines and associated low-relief till and lake plains (Hansel and Johnson 1996). The Cahokia Alluvium deposits, stratified sand, silt, and clay with gravel and occasionally organic matter, overlie the glacial deposits along the canal. The glacial cover belongs mainly to the Glacial Lake Bottom deposits and is made up predominantly of clayey diamictons of the Wadsworth Formation (Bretz 1932, Hansel and Johnson 1996, Leetaru et al 2004). The Wadsworth Formation contains relatively homogenous, massive, gray till with clay to silty clay matrix, with dolomite and shale clasts and occasional lenses of sorted and stratified silt (Hansel and Johnson 1996). Mostly sand and gravel the outwash/sluiceway deposits of Henry Formation are present along the bottom of the outlet valley. From geotechnical viewpoint the Wadsworth diamicton is characterized by low plasticity, medium to low moisture content, medium to very stiff consistency, poor permeability, and low compressibility (Bauer et al. 1991).

2.3 Bedrock

In the project area, the glacigenic deposits rest unconformably over a thick Silurian-age dolostone (Leetaru et al. 2004) at approximate depth of 60 feet below ground surface (bgs). Structurally, no active faults are known in the area (Nelson 2010). No underground mines have been mapped in the area (ISGS 2013).

Our subsurface investigation results fit into the local geologic context. The borings drilled in the project area revealed the native sediments consist of stratified alluvium deposits made of silt and silty clay with traces of organic matter and sand interbeds, over silty clay till, and sand and gravel outwash deposits that overlie the bedrock. Dolostone bedrock was encountered at 60 to 63 feet bgs.

3.0 METHODS OF INVESTIGATION

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

3.1 Subsurface Investigation

The subsurface investigation performed by Wang consisted of seven structure borings, designated as BSB-01 through BSB-04 and RW-01 through RW-03, and two approach embankment borings designated as RB-01 and RB-02. The investigation was performed in April and May 2013. The borings were drilled from elevations of 590.2 to 614.0 feet to depths of 10 to 83 feet bgs. Northings and eastings were surveyed by Wang with a mapping-grade GPS; elevations, stations, and offsets were taken from design drawings provided by ESI. The boring location data are shown in the *Boring Logs* (Appendix A), and the as-drilled locations are shown in the *Boring Location Plan* (Exhibit 3).

A truck-mounted drill rig, equipped with hollow stem augers, was used to advance and maintain an open borehole. Soil sampling was performed according to AASHTO T 206, "*Penetration Test and Split Barrel Sampling of Soils*." The soil was sampled at 2.5-foot intervals to 30 feet bgs and at 5.0-foot intervals to the top of bedrock. Soil samples from each interval were placed in sealed jars for further laboratory testing. The bedrock was cored in Boring BSB-02 in a single, 10-foot run with a NWD4-sized core barrel. An undisturbed Shelby tube sample was obtained adjacent to Boring RW-01 at a depth of 12 feet bgs for advanced laboratory testing.

Field boring logs, prepared and maintained by a Wang geologist include lithological descriptions, visual-manual soil classifications, results of Rimac and pocket penetrometer unconfined compressive strength tests, and results of Standard Penetration Tests (SPT), recorded as blows per 6 inches of penetration.

Groundwater observations were made during and after drilling operations. The borings were backfilled with soil cuttings after completion and the ground surface along the boring locations was restored as close as possible to the original condition.

3.2 Laboratory Testing

The soil samples were tested in the laboratory for moisture content (AASHTO T 265). Selected samples were also testing for Atterberg limits (AASHTO T 89/90) and particle size (AASHTO T 88) analyses. The Shelby tube sample was tested for one-dimensional consolidation (AASHTO T 216). The soils were classified according to the IDH Textural Classification system and field visual-manual descriptions were verified in the laboratory. The laboratory results are shown in the *Boring Logs* (Appendix A) and in the *Laboratory Test Results* (Appendix B).

4.0 RESULTS OF FIELD AND LABORATORY INVESTIGATIONS

Detailed descriptions of the soil conditions encountered during the subsurface investigation are presented in the attached *Boring Logs* (Appendix A) and in the *Soil Profile* (Exhibit 4). Please note that strata contact lines represent approximate boundaries between soil types. The actual transition between soil types in the field may be gradual in horizontal and vertical directions.

4.1 Soil Conditions

The inside shoulder pavement along IL 43 consists of 4 inches of asphalt over 8 to 10 inches of concrete. An additional 2 to 4 inches of crushed stone base was encountered beneath the pavement. At the railroad elevation, the surface consists of either 3 to 7 inches of asphalt pavement over 4 to 8 inches crushed stone base or 36 inches of crushed stone rail ballast. In descending order, the general lithologic succession encountered along the bridge includes: 1) man-made ground (fill); 2) soft to stiff silty clay and clay loam; 3) very stiff to hard silty clay and silty loam; 4) very dense sandy loam and gravelly sand; and 5) strong, fair quality dolostone.

(1) Man-made ground (Fill)

Immediately beneath the shoulder pavement the borings encountered about 20 to 25 feet of stiff to hard, brown and gray silty clay and silty clay loam fill. The fill has unconfined compressive strength values of 1.0 to 4.0 tsf with an average of about 1.7 tsf. The moisture content values of the fill measure between 13 and 45% with an average of about 30%. Several samples revealed traces of organic matter and shell fragments, identifying the likely source of the elevated moisture content within the fill.

(2) Soft to stiff silty clay loam and silty loam

At elevations of 591 to 581 feet, the borings encountered about 5 to 10 feet of soft to stiff, gray silty clay loam and silty loam alluvial deposits with organic matter. The silty soil has Q_u values of 0.4 to 1.3 tsf with an average of 0.9 tsf and moisture content values of 26 to 59% with an average of 35%. Laboratory index testing of this material shows liquid limit (L_L) values of 47, 53, and 64% and plastic limit (P_L) values of 21, 28, and 37%. The soil recovered in the Shelby tube tested as non-plastic silty loam. The Shelby tube material tested for consolidation had a relatively low moisture content (29%) when compared to the highest moisture content measured within the layer (59%).

(3) Very stiff to hard silty clay loam and silty loam

Underlying the alluvial soils the deeper foundation materials consist of very stiff to hard, gray silty clay loam and silty loam. This competent foundation soil has Q_u values of 2.1 to greater than 6.0 tsf with an average of 3.0 tsf and moisture contents of 12 to 30% with an average of 16%. This layer has a thickness of 35 to 40 feet.

(4) Very dense sandy loam to gravelly sand

At elevations of 542 to 537 feet, the borings encountered very dense, gray sandy loam to gravelly sand resting on top of the underlying bedrock. SPT testing within the 5- to 10-foot thick sandy soil recorded almost exclusively spoon refusal and found a relatively dry soil with moisture contents of about 10 to 13%. Auger refusal was recorded at 536 to 531 feet along the bridge borings.

(5) Strong, fair quality dolostone

At elevation 532 feet, or 62 feet below the railroad elevation, Boring BSB-02 encountered strong, fair rock quality dolostone. The initial 18 inches of bedrock is fractured with weathered joints; the remaining core was intact and unweathered. The core has a rock quality designation (RQD) value of 65%, and a uniaxial compressive strength test performed on the intact portion shows a compressive strength value of 13,700 psi.

4.2 Groundwater Conditions

Groundwater was encountered while drilling between elevations of 573.5 and 579.7 feet (15 to 21 feet bgs along Broadway and Canal Streets) generally associated with the sand and silty loam. The normal water elevation in the Cal-Sag Channel, noted in the bridge condition report, is about 577.5 feet, which correlates appropriately with the water levels encountered during the investigation.

4.3 Seismic Design Considerations

The seismic site class was determined in accordance with the IDOT *All Geotechnical Manual Users (AGMU) 9.1* (2010) method of analysis. The soils within the top 100 feet have a weighted average S_u-value of 2.95 tsf (AASHTO 2012; Method C controlling). These results classify the site in Seismic Site Class C in accordance with the IDOT method; the project location belongs to Seismic Performance Zone 1. The seismic spectral acceleration parameters recommended for design in accordance with the 2012 AASHTO *LRFD Design Specifications* are summarized in Table 1 (AASHTO 2012). The factor of safety (FOS) against liquifacton along the bridge site is greater than the AASHTO-required value of 1.1 (AASHTO 2012).

Table 1: Seismic Design Parameters

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient[1)] (% g)	Site Factors	Design Spectrum for Site Class C[2)] (% g)
0.0	PGA= 4.5	F_{pga}= 1.2	**A_s= 5.4**
0.2	S_S= 9.6	F_a= 1.2	**S_{DS}= 11.5**
1.0	S_1= 3.7	F_v= 1.7	**S_{D1}= 6.2**

1) Base spectral acceleration coefficients from AASHTO (2012)

2) Site Class C values to be presented on plans (A_s = PGA*F_{pga}; S_{DS}= S_S*F_a; S_{D1}= S_1*F_v)

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the approach embankment, approach slab, retaining walls, and structure foundations are included in the following sections. The eastern half of the approach embankments will require additional fill along the existing slopes. We estimate the additional fill and wall placement will result in bearing capacity and long-term settlement that will require remediation and will influence the pile designs. Wang recommends supporting the proposed abutments and pier on driven piles or drilled shafts. Shallow foundations would undergo excessive deformations due to the presence of high moisture soils and are not recommended above an elevation of about 577 feet. We estimate the global stability of the south approach embankments is adequate. The overall stability of the large, wall-supported fill section at the north abutment is adequate, but the bearing capacity is insufficient and the fill will under large long-term consolidation settlement. We propose the north remediating the north embankment foundation soils from the face of the abutment wall to Station 25+00 prior to constructing this section as an MSE wall; at approximately Station 25+00, the wall should be transitioned to soldier pile and lagging for the remaining run along the east side parallel to Harlem Avenue. The piles at the north abutment will require allowances for down drag losses.

The GPE shows the proposed south integral abutment constructed immediately behind the existing with the north abutment constructed approximately 30 to 35 feet in front of the existing. We assume the existing south abutment will remain in place, as much as practical, and the slope wall will be removed in front of the new soldier pile wall, as shown in the GPE, down to an elevation of about

592.5 feet. At the north abutment, we assume the existing will also be removed only as necessary to place fill material and compact. The existing piles can remain in place.

The pier is positioned such that the new foundations will not interfere with the existing caps; therefore, the existing piers can be cut off below the ground surface and left in place. Both the existing abutments and piers could have battered piles included in their foundations. The proposed pile or shaft layouts will need to be positioned to miss the existing piles and caps.

5.1 Approach Embankments, Slabs, and Retaining Walls

Wang has performed evaluations of the settlement and global stability for the widening and shifting of the approach embankments based on the soil conditions encountered in Borings BSB-03, BSB-04 and RW-01 through RW-03 on the north side and Borings BSB-01 and BSB-02 on the south side. The proposed shift in the bridge alignment will result in additional fill material being placed along the existing embankments and will require a 415-foot long retaining wall at the east right-of-way line of the north approach with an exposed height of about 4 to 15 feet. The abutment locations will be moved and retaining walls will be required to accommodate this shift.

Poor soil conditions were encountered at the north abutment down an elevation of about 576 feet. The north retaining wall system begins on the west side of the abutment at Station 24+13.72 with an exposed height of 9 feet. The wall runs south, parallel to Harlem Avenue, for 61.4 feet and turns east in front of the proposed abutment. The abutment wall is 90 feet long and retains an 8-foot tall exposed fill section at the front face. At Station 23+86.80 and offset 46 feet right of the centerline, the wall turns back north to contain a larger exposed fill section up to 14 feet to the east of the proposed abutment. These fill sections will be best constructed as mechanically-stabilized earth (MSE) walls. At Station 25+00, the wall face meets the toe of the existing embankment, and construction of MSE walls north of this station would require a cut into the existing embankment and temporary shoring until the wall meets the portage culvert at Station 26+71.00; therefore, to avoid these issues, we recommend constructing a soldier pile and lagging wall from Station 25+00 to Station 28+25.00.

The estimated FOS against global stability is suitable at both wall locations. The bearing capacity and settlement performance at the south wall is adequate, due primarily to the support provided by the existing abutment to remain in place. Due to insufficient bearing capacity and as much as 6 inches of anticipated settlement, we recommend improving the soil beneath the north abutment fill section contained by the proposed MSE wall by installing Aggregate Column Ground Improvement (stone columns).

5.1.1 Bearing Capacity and Sliding

The top of leveling pad elevation for the MSE wall should be placed at least 3.5 feet below the final grade in front of the wall. We estimate the north MSE wall, with a maximum height of 15 feet, will apply an equivalent uniform bearing pressure of 2,600 psf and a factored uniform bearing pressure of 5,100 psf. The nominal bearing resistance of the foundation soils is calculated as 5,500 psf and the factored bearing resistance is 3,500 psf, calculated with a bearing resistance factor of 0.65 (AASHTO, 2012). We estimate the wall foundation soils do not provide sufficient bearing resistance and should be remediated as discussed below in Section 5.1.4.

The base of the MSE wall will be constructed on very stiff silty clay loam and silty loam fill. The estimated friction angle between the select backfill base of an MSE wall and the stiff fill is 30° and the corresponding friction coefficient is 0.58 (AASHTO, 2012). MSE retaining walls are designed based on a geotechnical sliding resistance factor (ϕ_τ) of 1.0 for soil-on-soil contact (AASHTO, 2012). Our analysis shows MSE walls with widths of 0.7 times the maximum height will be stable in sliding. The eccentricities lie within the middle third of the walls, and we estimate the resistance against overturning is also sufficient.

5.1.2 Settlement

The profile grade along the IL 43 centerline will be raised by about 2 to 3 feet and the embankment will be widened to the east by about 4 feet at the top; however, the north abutment will be constructed in front of the existing slope wall and will require approximately 22 feet of additional fill. We estimate the amount of fill to be placed behind the abutment will result in large long-term settlement at the approach slab and through the north MSE wall.

We estimate the soft alluvial soils between elevations of about 586 to 576 feet revealed in Borings BSB-01, BSB-04, BSB-03, and RW-01 will undergo approximately 6 inches of long-term consolidation settlement under the MSE wall uniform equivalent bearing pressure. The settlement estimates are based on the consolidation oedometer testing (Appendix B), as well as correlations to measured index properties. We estimate the soil will achieve 50% of primary consolidation (1.5 inches) in approximately 45 days and 90% of primary consolidation is 210 days. The estimated movement will cause issues with the approach pavement and produce downdrag on the proposed pile foundations. We recommend a ground improvement along the north approach embankment and MSE wall to reduce the long-term settlement and improve the performance of the pavement. Application of the downdrag losses to the piles will still be necessary and the losses are discussed in Section 5.2.1.

At the north embankment soldier pile wall, the maximum fill section will be approximately 11 feet, and will be placed along the side of the existing embankment. Borings RW-02 and RW-03 show poor soil conditions between elevations of about 587 to 581 feet. We estimate these soft, silty soils will undergo approximately 2.0 inches of long-term consolidation settlement.

The widening along the south abutment will not result in a significant fill section. The area east of the existing abutment is relatively flat and only a minor, 1-foot profile grade increase is proposed. We estimate the total long-term settlement will be less than 0.4 inches.

5.1.3 Global Stability

The global stability of the proposed MSE walls at the north abutment were analyzed based on the soil profile described in Section 4.1 and the information provided in the GPE. The walls are structure-supporting fill walls, and the minimum required FOS for both short and long-term conditions is 1.5 (IDOT, 2012a). *Slide v5.0* evaluation exhibits are shown in Appendix C. Wang estimates the northeast embankment wall at Station 24+00 has an FOS of 1.7 (Appendix C-1 and C-2) in both undrained (short-term) and drained (long-term) loading. The north abutment end slope wall has a FOS of 1.5 (Appendix C-3) in undrained loading and an FOS of 1.6 (Appendix C-4) in drained loading. The FOS at each location meets the minimum requirement.

5.1.4 Ground Improvement Recommendations

Due to the insufficient bearing capacity and large, long-term consolidation settlement at the north MSE wall and approach embankment, we recommend performing a ground improvement by one of the following methods:

- Aggregate Column Ground Improvement in accordance with IDOT Guide Bridge Special Provision #71. Along the north abutment wall, the aggregate columns should extend from the front face of the wall to the front of the existing abutment at Station 24+34. The ground improvement should extend along the east side of the embankment back to Station 25+00, or the full length of the proposed MSE wall. The columns should begin at the existing ground surface and extend to a minimum elevation of 580 feet. We estimate the columns at each location should be assumed 30 inches in diameter and spaced 7 feet on-center in a triangular pattern. The final design, performed by the Contractor, should be approved by IDOT prior to construction. We recommend requiring an aggregate column method that produces minimal spoil material due to the likely contaminated nature of the foundation soils. This method of ground improvement may still result in up to 4 inches of embankment settlement; therefore, the downdrag losses on the piles will still apply.

- Removal of the poor soil and replacement with IDOT gradation CA-1 or equivalent, capped with a minimum 6 inches of IDOT gradation CA-6 or equivalent. The removal along the north abutment wall should extend from a minimum 2 feet in front of the wall to a minimum 2 feet beyond the toe of the existing end slope from the ground surface to an elevation of 580 feet. While we estimate this method of improvement is feasible, we recommend the aggregate column improvement as a more economic option due to the temporary earth retention that will be required for the removal and replacement, as well as the large quantities of contaminated soils that will require disposal.

5.1.5 Soldier Pile and Lagging Walls

We recommend placing the soldier piles at both the north embankment wall and the south abutment wall within prebored holes and the combination of soldier piles and shafts should be designed for both lateral earth pressure and lateral deformation. The soldier piles should be prebored to accurately maintain alignment though the weak material, to provide corrosion protection, and to allow for the potential use of wide flange sections. The design embedment depth for the wall sections should include a minimum FOS of 1.5 against earth pressure failure for walls in the long-term (drained) condition using the soil parameters shown in Table 2.

The lateral deformation of the wall should be designed for movement and moment fixity at the base of the prebore and a limiting lateral movement of 1.0% of the exposed wall height using the parameters shown in Table 3 via p-y curve (COM624) method. In the final design, we estimate the soldier piles at the tallest wall sections may need to be wide-flange sections. The wall will be a fill section, and we recommend backfilling with granular material that does not require compaction next to the wall.

Table 2: Geotechnical Parameters for Design of Soldier Pile Walls

Soil Description	Unit Weight, γ (pcf)	Drained Shear Strength Properties: Cohesion (psf)	Drained Shear Strength Properties: Friction Angle (°)	Earth Pressure Coefficients[1)]: Active Pressure	Earth Pressure Coefficients[1)]: Passive Pressure
Granular BACKFILL	120	0	32	0.47	3.25
Stiff to V Stiff SILTY CLAY	120	100	30	0.54	3.00
V Soft to Soft SILTY CLAY/LOAM	105	0	26	0.90	2.56
V Stiff to Hard SILTY CLAY LOAM	125	100	32	0.47	3.25

1) Earth Pressure Coefficients for 1:2 (V:H) backfill slope behind wall, as per sections

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

Soil Type (Layer)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Granular BACKFILL	120	0	32	60	--
Stiff to V Stiff SILTY CLAY	120	2000	0	750	0.6
V Soft to Soft SILTY CLAY/LOAM	105	400	0	100	1.0
V Stiff to Hard SILTY CLAY LOAM	125	4000	0	2000	0.4

5.2 Structure Foundations

Wang recommends supporting the abutments and piers on steel H-piles or MSP; alternatively, the pier could be supported on drilled shafts. The soil conditions along the structure show soft and deformable soils with high moisture content overlying hard till and dense granular soils. The approximate loading for the substructures is assumed to be about 1300 kips of factored load per abutment and 2600 kips of factored load at the pier. These loads are estimates for general sizing of foundations only and are subject to change.

5.2.1 Driven Piles

IDOT specifies the maximum nominal required bearing (R_{NMAX}) for each pile and states the factored resistance available (R_F) for steel H-piles and MSP should be based on a geotechnical resistance factor (Φ_G) of 0.55 (IDOT, 2012a). Nominal tip and side resistance were estimated using the methods and empirical equations presented in *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2011). Based on the estimated abutment and pier loads and the length of the foundations, the load per pile at the abutments will range between about 80 and 225 kips for a single row of piles spaced at 3- to 8-feet. The approximate loading at the pier will have the same range, but will require two rows of piles. The R_F, R_N, estimated pile tip elevations, and pile lengths for 14-inch diameter MSP with 0.312-inch diameter walls, HP12x53, and HP14x73 steel H-piles are summarized in Tables 4, 5, and 6. The evaluations have been performed assuming the abutment piles will be driven from the base elevations of the walls shown in the GPE. The lengths shown in the tables assume a 2-foot pile embedment into the abutment and pier caps and include the length of pile within the MSE walls. The annular space between the driving sleeves and the piles would be backfilled with loose sand.

The R_F estimates are governed by the relationship $R_F = \phi_G R_N - \phi_G(DD_R+S_C+L_{iq})I_G - (\gamma_p)(\lambda_{IS})DD_L$ (IDOT, 2012a). Due to the increase to the proposed profile grade, as well as the widening and shifting of the roadway section we estimate the settlement of the soft silty soils around the north abutment piles will be greater than 0.4-inch, even with the proposed ground improvement, and downdrag allowances will be required. Several options have been investigated with regards to the downdrag around the piles: 1) apply the downdrag reduction and loading to the piles by adjusting the nominal required bearing; 2) precore the pile locations to the base of the soft soil, drive the piles through the precored holes, and backfill the annular space with loose sand; or 3) install metal sleeves through the MSE walls, construct the walls around the sleeves, wait an approximate amount of time for the settlement to reach an acceptable level and drive the abutment piles through the sleeves. After investigating each option, we recommend driving the piles deeper to an increased R_{NMAX} and applying the downdrag losses to the piles. This solution adds about 15 to 20 feet to the total length of each pile. The precore option will require additional equipment mobilization.

The south abutment will be constructed immediately behind the existing. The consolidation resulting from the modest raise in profile grade on the south side will not exceed 0.4 inches of post-construction settlement. Therefore, downdrag allowances on the south abutment piles will not be necessary.

Table 4: Estimated Pile Lengths and Tip Elevations for 14-inch Diameter MSP with 0.312-inch Walls

Structure Unit (Reference Boring)	Pile Cap Base Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (BSB-01)	608.0	513	0.0	0.0	282	44	566
		455	0.0	0.0	250	43	567
		364	0.0	0.0	200	42	568
		273	0.0	0.0	150	36	574
		182	0.0	0.0	100	33	577
Pier (BSB-02/03)	589.0	455	0.0	0.0	250	47	544
		364	0.0	0.0	200	34	557
		273	0.0	0.0	150	30	561
		182	0.0	0.0	100	27	564
		136	0.0	0.0	75	21	570
North Abutment (BSB-04)	607.4	513	18	35	229	66	543
		460	18	35	200	55	554
		369	18	35	150	52	557
		278	18	35	100	50	559
		233	18	35	75	41	568

Table 5: Estimated Pile Lengths and Tip Elevations for HP12x53 Steel Piles

Structure Unit (Reference Boring)	Pile Cap Base Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (BSB-01)	608.0	418	0.0	0.0	230	72	538
		364	0.0	0.0	200	71	539

Structure Unit (Reference Boring)	Pile Cap Base Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
		273	0.0	0.0	150	43	567
		182	0.0	0.0	100	33	577
		136	0.0	0.0	75	31	579
Pier (BSB-02/03)	589.0	418	0.0	0.0	230	60	531
		364	0.0	0.0	200	58	533
		273	0.0	0.0	150	56	535
		182	0.0	0.0	100	44	547
		136	0.0	0.0	75	38	553
North Abutment (BSB-04)	607.4	418	12	25	193	68	541
		385	12	25	175	68	541
		340	12	25	150	68	541
		249	12	25	100	57	552
		204	12	25	75	51	558

Table 6: Estimated Pile Lengths and Tip Elevations for HP14x73 Steel Piles

Structure Unit (Reference Boring)	Pile Cap Base Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
South Abutment (BSB-01)	608.0	578	0.0	0.0	318	72	538
		364	0.0	0.0	200	58	552
		273	0.0	0.0	150	33	572
		182	0.0	0.0	100	31	579

Structure Unit (Reference Boring)	Pile Cap Base Elevations (feet)	Required Nominal Bearing, R_N (kips)	Factored Geotechnical Loss (kips)	Factored Geotechnical Load Loss (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
		136	0.0	0.0	75	26	584
Pier (BSB-02/03)	589.0	578	0.0	0.0	318	59	532
		364	0.0	0.0	200	54	537
		273	0.0	0.0	150	48	543
		182	0.0	0.0	100	40	551
		136	0.0	0.0	75	29	562
North Abutment (BSB-04)	607.4	578	14	29	275	72	537
		442	14	29	200	69	540
		351	14	29	150	66	543
		260	14	29	100	62	547
		215	14	29	75	47	562

5.2.2 Drilled Shafts

The foundation for the pier could be supported on drilled shafts. The borings encountered very stiff to hard silty clay and silty loam below an elevation of about 577 feet, continuing to 550 to 545 feet. We estimate shafts could be belled within this material. Alternatively, the shafts could be socketed into the underlying bedrock, which was identified with auger refusal in each of the bridge borings between elevations of 536 to 531 feet and cored in Boring BSB-02.

The AASHTO *LRFD Bridge Design Specifications* (2012) indicate shafts designed in clayey soil should be designed for an end bearing resistance factor (ϕ_{stat}) of 0.40 and a side resistance ϕ_{stat} of 0.45. We estimate the shafts will have a nominal unit base resistance in the silty clay and silty loam (**Layer 3**) of 32 ksf and a factored unit base resistance of 13 ksf. The estimated base elevation of the shafts within this material is about 555 feet. The nominal unit side resistance within the same layer is estimated at about 1.7 ksf and a factored unit side resistance of 0.8 ksf. Due to the soft and higher moisture condition within the upper soil layers, we do not account for side friction above an elevation of 577 feet. The R_F, R_N, and estimated base elevations for the shafts are summarized below in Table 7 for 3-, 3.5, and 4-foot diameter straight shafts. We estimate the settlement of the shafts will be less than 0.5-inch. While some perched groundwater was encountered above the bearing elevation, we estimate this water could be removed by pumping and will not necessitate temporary casing or drilling fluid.

Table 7: Estimated Resistances and Base Elevations for Pier Shafts

Structure Unit	Shaft Cap Base Elevation (feet)	Nominal Unit Base/Side Resistance (ksf)	Shaft Base Diameter (feet)	Nominal Shaft Resistance, R_N (kips)	Factored Resistance Available, R_F (kips)	Total Shaft Length (feet)	Estimated Shaft Base Elevation (feet)
Pier (BSB-02/03)	589.0	32 / 1.7	3.0	333	138	34	555
			3.5	433	179	34	555
			4.0	545	225	34	555

If the bearing resistances of the shafts established in the silty clay/silty loam do not meet the loading criteria, the shafts could be socketed into the underlying bedrock. The bedrock core obtained in Boring BSB-02 shows uniform, good bedrock conditions, with sound, unfractured bedrock beginning about 18 inches below the top of rock elevation. We estimate the rock sockets will have diameters of about 4.0 to 6.0 feet; the shaft above the bedrock should have diameters 6 inches larger than the sockets.

The R_F, R_N, and estimated rock socket thickness required for 4, 5, and 6 foot diameter sockets are summarized in Table 8. We recommend establishing the base of the sockets a minimum of 2 feet into the bedrock and designing for a FAIR to GOOD quality nominal unit end resistance of 400 ksf (AASHTO 2012, 10.4.6.4/10.8.3.5.4c and Brown 2008). The resistance factor for side friction in rock is 0.50 (AASHTO 2014). We do not anticipate the shafts will require casing to protect against groundwater infiltration; however, the shaft may still require casing above the bedrock to prevent caving during socket coring.

Table 8: Estimated Rock Socket Thicknesses and Tip Elevations for Rock Socket Pier Shafts

Structure Unit	Top of Rock Elevation (feet)	Nominal Unit End Resistance (ksf)	Nominal Shaft Resistance, R_N (kips)	Factored Resistance Available, R_F (kips)	Total Socket Depth (feet)	Estimated Shaft Tip Elevation (feet)	Shaft Diameter (feet)
Pier 1 (BSB-02)	532	400	5027	2500	2.0	530	4
			7850	3900	2.0	530	5
			11310	5655	2.0	530	6

5.2.3 Lateral Loading

Lateral loads on piles and shafts should be analyzed for maximum moments and lateral deflections. Recommended lateral soil modulus and strain parameters required for analysis via the p-y curve method are included in Tables 9 (soil parameters) and 10 (bedrock parameters).

Table 9: Recommended Soil Parameters for Lateral Load Pile Analysis

Soil Type (Layer)	Unit Weight, γ (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
Stiff SILTY CLAY FILL (1)	120	2000	0	750	0.6
V Soft to soft SILTY CLAY (2)	105	400	0	100	1.0
V Stiff to Hard SILTY CLAY/SILTY LOAM (3)	125	4000	0	2000	0.4
V Dense SANDY LOAM to GRAVELLY SAND (4)	125	0	38	120	--

Table 10: Recommended Bedrock Parameters for Lateral Load Pile Analysis

Rock Type (Layer)	Total Unit Weight, γ (pcf)	Young's Modulus (ksi)	Uniaxial Comp. Strength (ksi)	RQD (%)	Lateral Rock Modulus Parameter
Fair Quality Dolostone (5)	135	1,500	13.7	65	0.0005

5.3 Stage Construction Design Recommendations

The GPE shows the structure constructed in two stages. Stage one will include the construction of the eastern 30.3 feet, which will include the initial fill section behind the north MSE wall and the construction of the soldier pile wall north of Station 25+00. The stage line at the north abutment will require a *Temporary Soil Retention System*; we estimate the system could be designed as a temporary wire-faced MSE wall tied into the proposed MSE wall system and constructed on the aggregate column ground improvement. The system should be designed by the Contractor and approved by IDOT prior to construction. At the south abutment, we estimate the minor level of shoring along the stage line behind the existing abutment can be accomplished with temporary steel sheet piling designed in accordance with IDOT *Design Guide 3.13.1* (2012a).

We do not anticipate the need for temporary shoring to cut off the pier foundations below the ground surface. These excavations should be sloped at 1:2 (V:H) for a maximum of 5 feet. If these excavations cannot be sloped they should also be supported with a *Temporary Soil Retention System*, as the soft foundation soils are not appropriate for steel sheet piling designed based on IDOT *Design Guide 3.13.1* (2012a).

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

Vegetation, topsoil, existing pavement, and debris should be cleared and stripped where foundations and structural fills will be placed. The exposed subgrade should be proofrolled. To aid in locating unstable and unsuitable materials, the proofrolling should be observed by a qualified engineer. Any unstable or unsuitable materials should be removed and replaced with compacted structural fill as described in Section 6.3.

6.2 Excavation and Dewatering

Foundation excavations should be performed in accordance with local, state, and federal regulations. The potential effect of ground movements upon nearby utilities should be considered during construction.

The shallow excavations required to remove the piers will not encounter groundwater. Any precipitation allowed to enter excavations should be immediately removed via sump pump. Any soil allowed to soften under standing water should be removed and replaced with structural fill as described below in Section 6.3.

6.3 Filling and Backfilling

Fill material required to attain the final design elevations should be structural fill material and should be pre-approved prior to placement. Compacted cohesive or granular soil conforming to IDOT Section 204 would be acceptable as structural fill (2012b). The fill material should be free of organic matter and debris. Structural fill should be placed in lifts and compacted according to IDOT Section 205, *Embankment* (2012b). The onsite fill materials (**Layer 1**) could be considered as new fill material assuming they have an organic content less than 10%; materials within 24-inches of the organic soil (**Layer 2**) should not be reused.

Backfill materials must be pre-approved by the Resident Engineer. To backfill the abutment and piers we recommend the material conforming to the requirements specified in the IDOT Special Provision, *Granular Backfill for Structures* (2013). Backfill material should be placed and compacted in accordance with the Special Provision. Estimated design parameters for granular structural backfill materials are presented in Table 11.

Table 11: Estimated Granular Backfill Parameters

Soil Description	Porous Granular Material Backfill
Unit Weight	125 lbs/ft^3
Angle of Effective Internal Friction	32 degrees
Active Earth Pressure Coefficient	0.31
Passive Earth Pressure Coefficient	3.26

At-Rest Earth Pressure Coefficient	0.5

6.4 Earthwork Operations

The required earthwork can be accomplished with conventional construction equipment. Moisture and traffic will cause deterioration of exposed subgrade soils. Precautions should be taken by the Contractor to prevent water erosion of the exposed subgrade. A compacted subgrade will minimize water runoff erosion.

Earth moving operations should be scheduled to not coincide with excessive cold or wet weather (early spring, late fall or winter). Any soil allowed to freeze or soften due to the standing water should be removed. Wet weather can cause problems with subgrade compaction.

It is recommended that an experienced geotechnical engineer be retained to inspect the exposed subgrade, monitor earthwork operations, and provide material inspection services during the construction phase of this project.

6.5 Pile Installation

The driven piles shall be furnished and installed according to the requirements of IDOT Section 512, *Piling* (IDOT 2010). Wang recommends performing one test pile at each substructure location prior to ordering production piles. The test piles shall be driven to 110 percent of the nominal required bearing indicated in Section 5.2.1, Tables 4, 5, and 6. We do not anticipate the piles will require a metal shoe. The steel H-piles shall be according to AASHTO M270M, Grade 50.

6.6 Drilled Shafts

The drilled shaft excavations could encounter some perched groundwater infiltration, and the Contractor should be prepared to either immediately remove the water by pumping or install temporary casings at each shaft location in order to facilitate the rock coring. Failure to anticipate the challenges posed by the groundwater could result in caving or heaving sand and significant weakening of the foundation soils. The shafts should be designed 6 inches larger in diameter than the proposed sockets. The shafts should be constructed in accordance with FHWA Publication NHI-10-016, *Drilled Shafts: Construction Procedures and LRFD Design Methods* (FHWA, 2010).

7.0 QUALIFICATIONS

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

It has been a pleasure to assist ESI Consultants, Ltd. and the Illinois Department of Transportation on this project. Please call if there are any questions, or if we can be of further service.

Respectfully Submitted,

WANG ENGINEERING, INC.

Mickey L. Snider, P.E.	Jerry W.H. Wang, Ph.D., P.E.
Senior Geotechnical Engineer	QA/QC Reviewer

REFERENCES

AASHTO (2012) *LRFD Bridge Design Specifications*. American Association of State Highway and Transportation Officials, Washington, D.C.

BAUER, R.A., CURRY, B.B., GRAESE, A.M., VAIDEN, R.C., SU, W.J., and HASEK, M.J. (1991) Geotechnical Properties of Selected Pleistocene, Silurian, and Ordovician Deposits of Northeastern Illinois: Environmental Geology 139, Illinois State Geological Survey, 69 p.

BRETZ, J.H. (1953) Geology of the Chicago Region: Part I--General: ISGS Bulletin 65: Urbana, Illinois State Geological Survey, 118 p.

BROWN, DAN (2008) *Load Testing of Drilled Shaft Foundations in Limestone, Nashville Tennessee.*

HANSEL, A.K. AND JOHNSON, W.H. (1996) *Wedron and Mason Groups: Lithostratigraphic Reclassification of the Wisconsin Episode, Lake Michigan Lobe Area*. ISGS Bulletin 104. Illinois State Geological Survey, Champaign, 116 pp.

IDOT (1999) *Geotechnical Manual*. Illinois Department of Transportation.

IDOT (2011) *AGMU Memorandum 10.2 - Static Method of Estimating Pile Length*

IDOT (2012a) *Bridge Manual*. Illinois Department of Transportation.

IDOT (2012b) *Standard Specifications for Road and Bridge Construction*. Illinois Department of Transportation, 1098 pp.

IDOT (2013) *Guide Bridge Special Provisions*

LEETARU, H.E., SARGENT, M.L., and KOLATA, D.R. (2004) Geologic Atlas of Cook County for Planning Purposes, Open File Series 2004-12, Illinois State Geological Survey, p. 30.

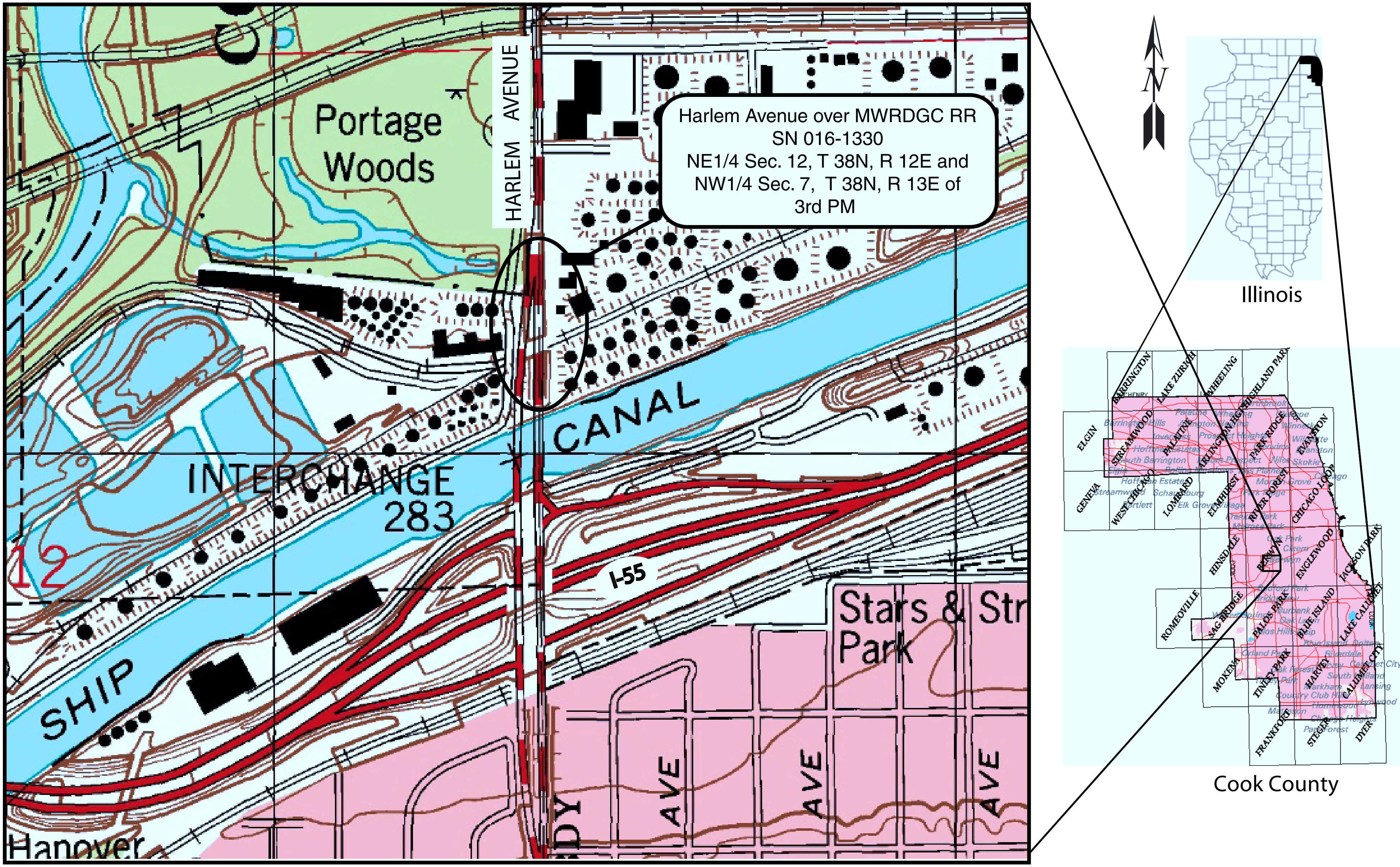
LEIGHTON, M.M., EKBLAW, G.E., and HORBERG, L. (1948) *Physiographic Divisions of Illinois.* The Journal of Geology, v. 56, p. 16-33.

NELSON, W.J. (2010) *"Structural Features"*, *Geology of Illinois*. Champaign, IL: University of Illinois at Urbana-Champaign, Institute of Natural Resource Sustainability, Illinois State Geological Survey, Cp. 4, p. 90-104.

WILLMAN, H.B. (1971) *Summary of the Geology of the Chicago Area*. ISGS Circular C460. Illinois State Geological Survey, Urbana, 77 pp.

WILLMAN, H.B., FRYE, J.C., SIMON, J.A., CLEGG, K.E., SWANN, D.H., ATHERTON, E., COLLINSON, C., LINEBACK, J.A. AND BUSCHBACH, T.C. (1975) *Handbook of Illinois Stratigraphy*. Illinois State Geological Survey, Bulletin 95, Urbana, IL.

EXHIBITS



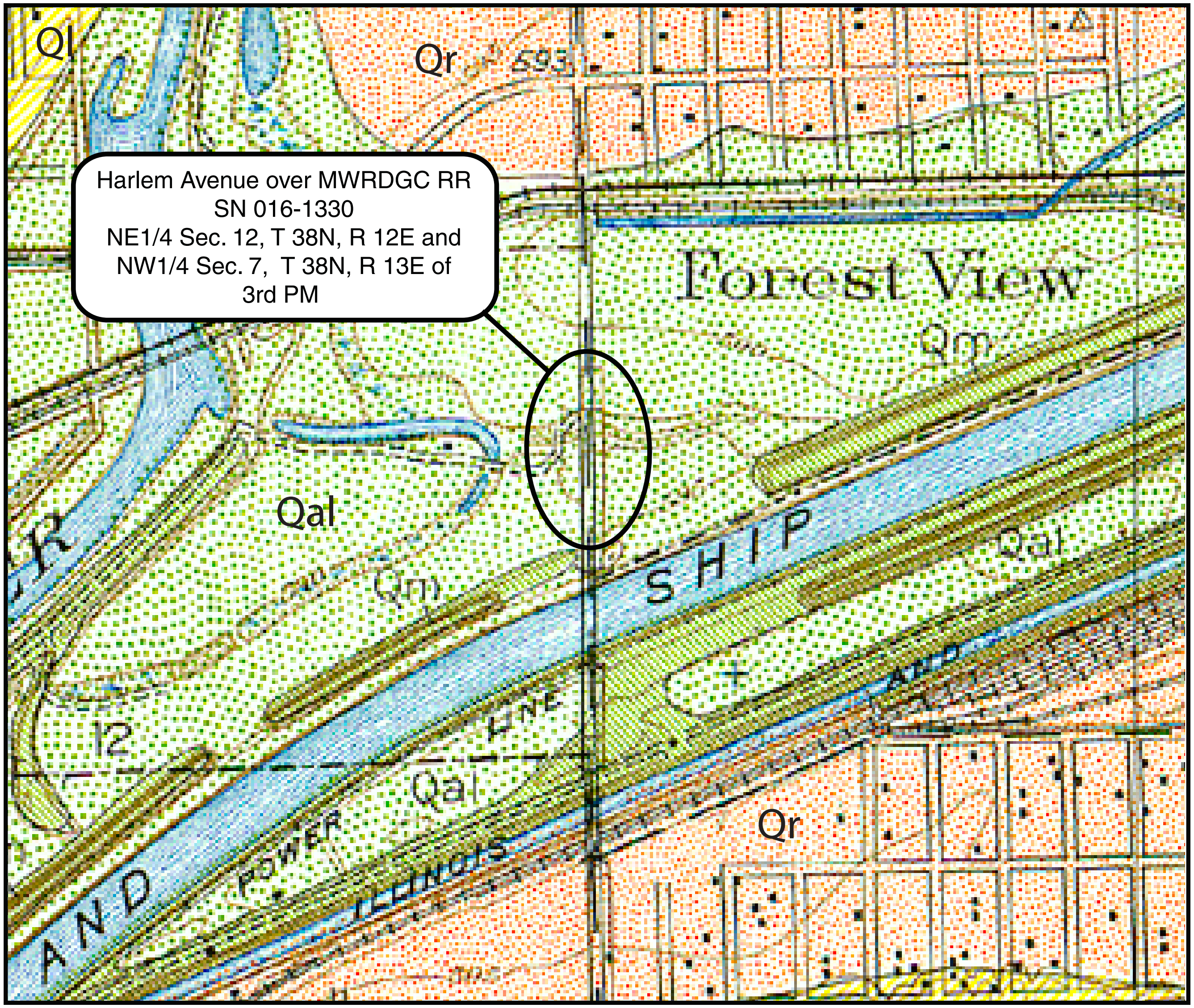
SITE LOCATION MAP: HARLEM AVENUE (ILLINOIS ROUTE 43)
BRIDGE OVER MWRDGC RAILROAD, FOREST VIEW, ILLINOIS

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: C. Marin CHECKED BY: M. Snider

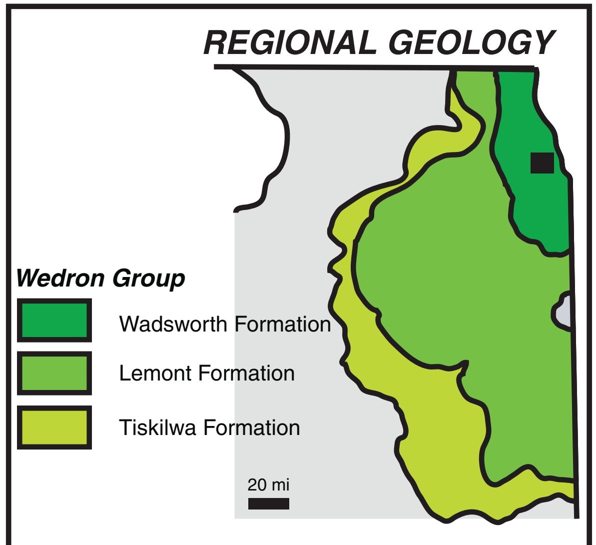
Wang Engineering

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

For ESI Consultants, Ltd — 885-02-01



Modified after Bretz (1955)



Modified after Hansel and Johnson (1996)

Legend

Qm	Man-made ground (fill)
Qal	Cahokia Alluvium Silt, sand, and gravel deposited by present streams
Ql	Glacial Lake Bottom Silty clay to silty clay loam till, commonly without lacustrine deposits
Qr	Glacial River Bottom (sluiceway) Erosional channels, outlets cut into till; contains mostly sand and gravel outwash deposits

SITE AND REGIONAL GEOLOGY: HARLEM AVENUE (ILLINOIS ROUTE 43) BRIDGE OVER MWRDGC RAILROAD, FOREST VIEW, ILLINOIS		
SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. Marin CHECKED BY : M. Snider
Wang Engineering		1145 N. Main Street Lombard, IL 60148 www.wangeng.com
For ESI Consultants, Ltd.		885-02-01

Bench Mark: Chiseled square on N.E. wingwall Sta. 20+35.58, 27.83' RT. Elev. 618.46

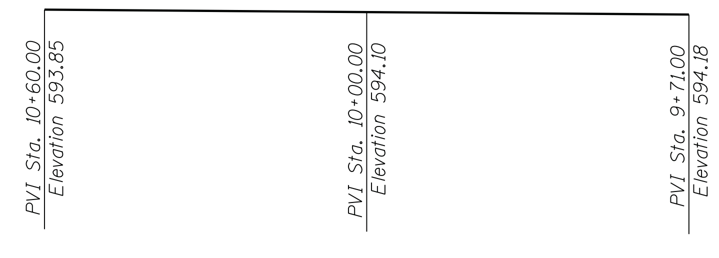
Existing Structure: SN. 016-0314 built in 1931 as FA 42, section 039-2323.3-15-D. Reconstructed, including superstructure replacement and lengthening of the bridge with construction of two additional spans, in 1970 as FA 42, section 207-0708.08-C.F. Structure consists of 5 total spans; 3 PPC Deck Beam spans (1 to 3) and 2 continuous spans (4 to 5) of reinforced concrete T-Beams. The superstructure is supported on 1 closed counterfort (spread footing) abut, 1 pile bent abutment and multi-column piers (Shaft - pier 10; Piles - pier 11; Spread Footing - piers 8 & 9). The structure is 163'-6" back-to-back of abutments, 56'-6" out-to-out deck. Structure is to be removed and replaced.

Traffic Control: Staged construction will be utilized by maintaining two NB lanes of traffic in stage I and one NB lane of traffic during stage II construction.

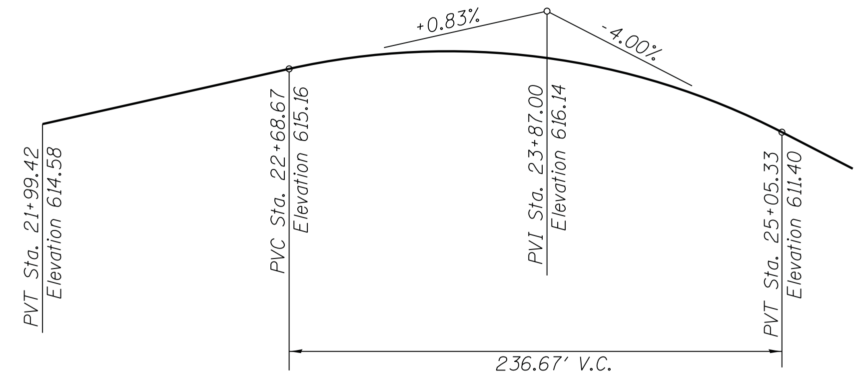
Salvage: Bridge handrail, posts, and temporary support beams.

Pier Removal: Piers may be left inplace during Stage I removal and removed during Stage II construction.

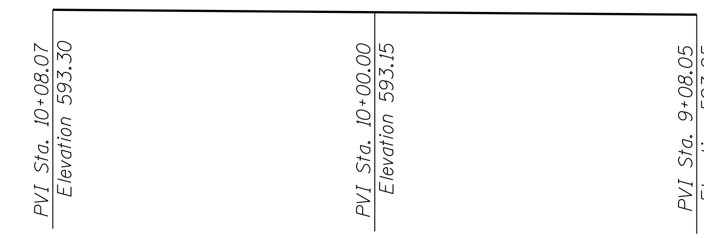
STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION



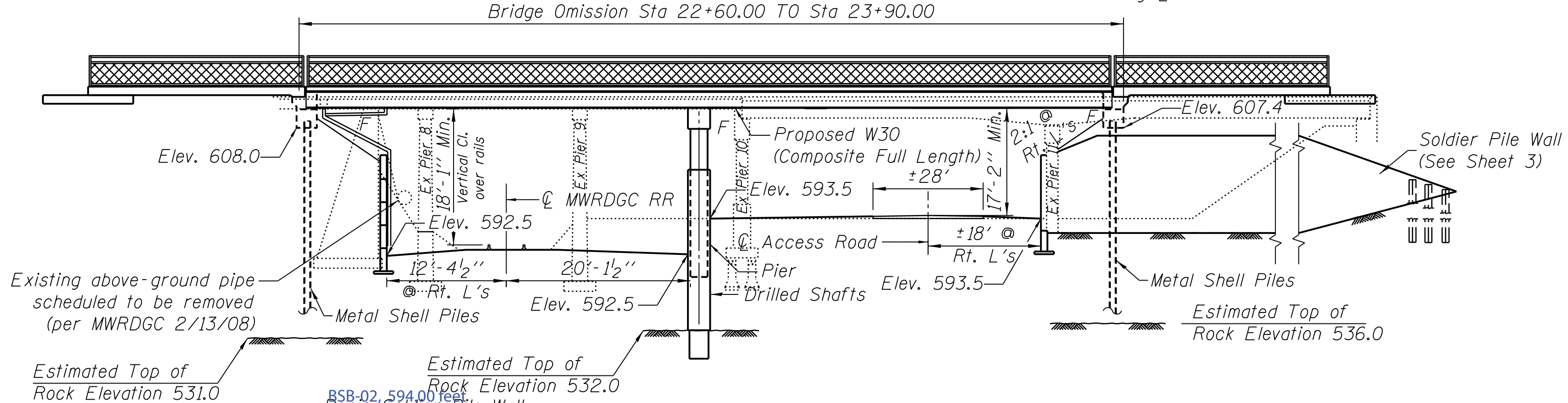
PROFILE GRADE
(Along ℄ Access Road)



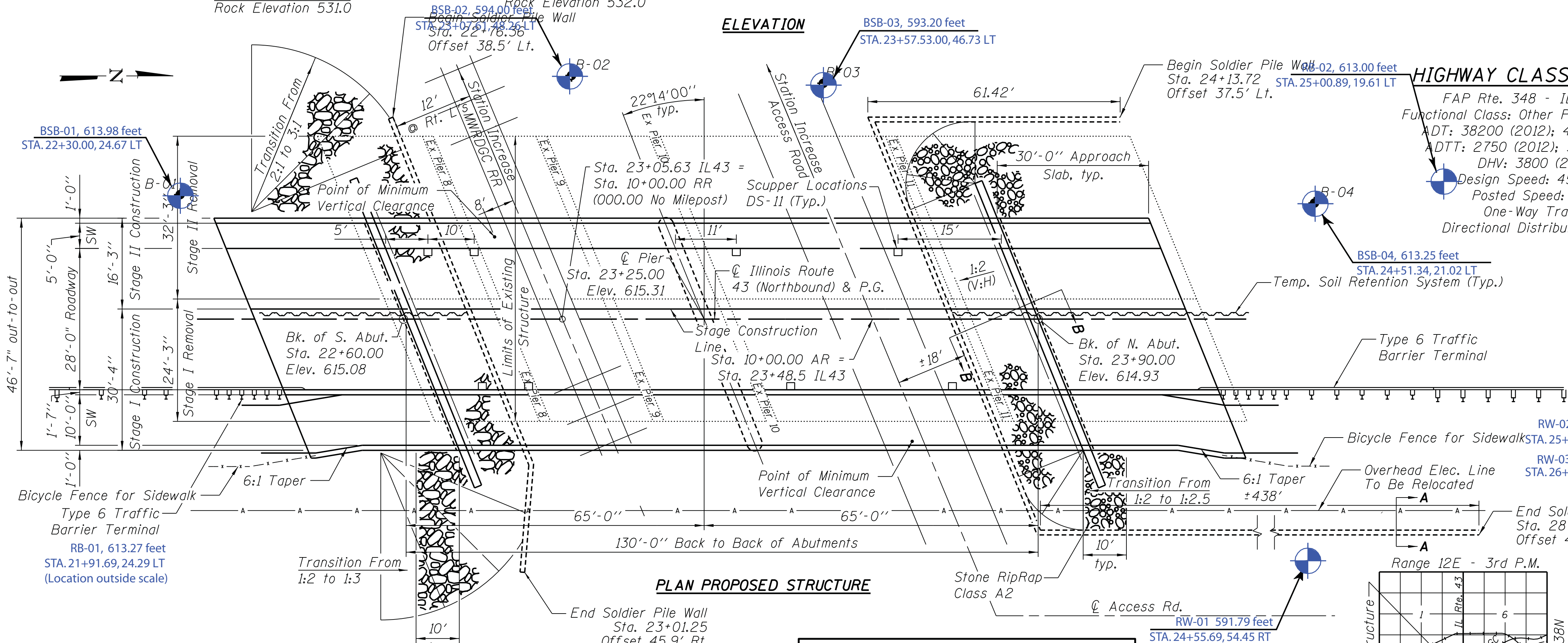
PROFILE GRADE
(Along ℄ Roadway)



PROFILE GRADE
(Along ℄ Railroad)



ELEVATION



PLAN PROPOSED STRUCTURE

HIGHWAY CLASSIFICATION

FAP Rte. 348 - IL Rte. 43
Functional Class: Other Principal Arterial
ADT: 38200 (2012); 45000 (2030)
ADTT: 2750 (2012); 3240 (2030)
DHV: 3800 (2030)
Design Speed: 45 m.p.h.
Posted Speed: 40 m.p.h.
One-Way Traffic
Directional Distribution: 100%

LOADING HL-93

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

DESIGN SPECIFICATIONS

2012 AASHTO LRFD Bridge Design Specifications
6th Edition with 2012 & 2013 Interims

DESIGN STRESSES

FIELD UNITS

f'c = 3,500 psi
fy = 60,000 psi (Reinforcement)
fy = 50,000 psi (AASHTO M 270 Grade 50)

PRECAST UNITS

f'c = 4,500 psi (Precast Panels)

SEISMIC DATA

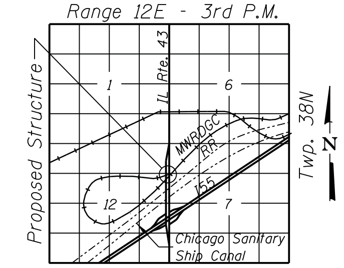
Seismic Performance Zone (SPZ) = 1
Design Spectral Acceleration at 1.0 sec. (S_{D1}) = 0.062g
Design Spectral Acceleration at 0.2 sec. (S_{DS}) = 0.115g
Soil Site Class = C

Notes:
No freefall deck drains will be permitted in the span over the tracks or within 10ft. of the crossarms of a railroad pole line.

See Sheet 2 for Section A-A

BORING LOCATION PLAN: HARLEM AVENUE (ILLINOIS ROUTE 43) BRIDGE OVER MWRD RAILROAD, FOREST VIEW, ILLINOIS
SCALE: GRAPHICAL | EXHIBIT 3 | DRAWN BY: C. Marin | CHECKED BY: M. Snider
Wang Engineering
1145 N. Main Street
Lombard, IL 60148
www.wangeng.com
FOR ESI Consultants, Ltd | 885-02-02

Range 12E - 3rd P.M.



LOCATION SKETCH

GENERAL PLAN & ELEVATION
IL ROUTE 43 OVER MWRDGC RAILROAD
FAP ROUTE 348
SECTION 0708.08B-R(1)
COOK COUNTY
STATION 23+25.00
STRUCTURE NO. 016-1330

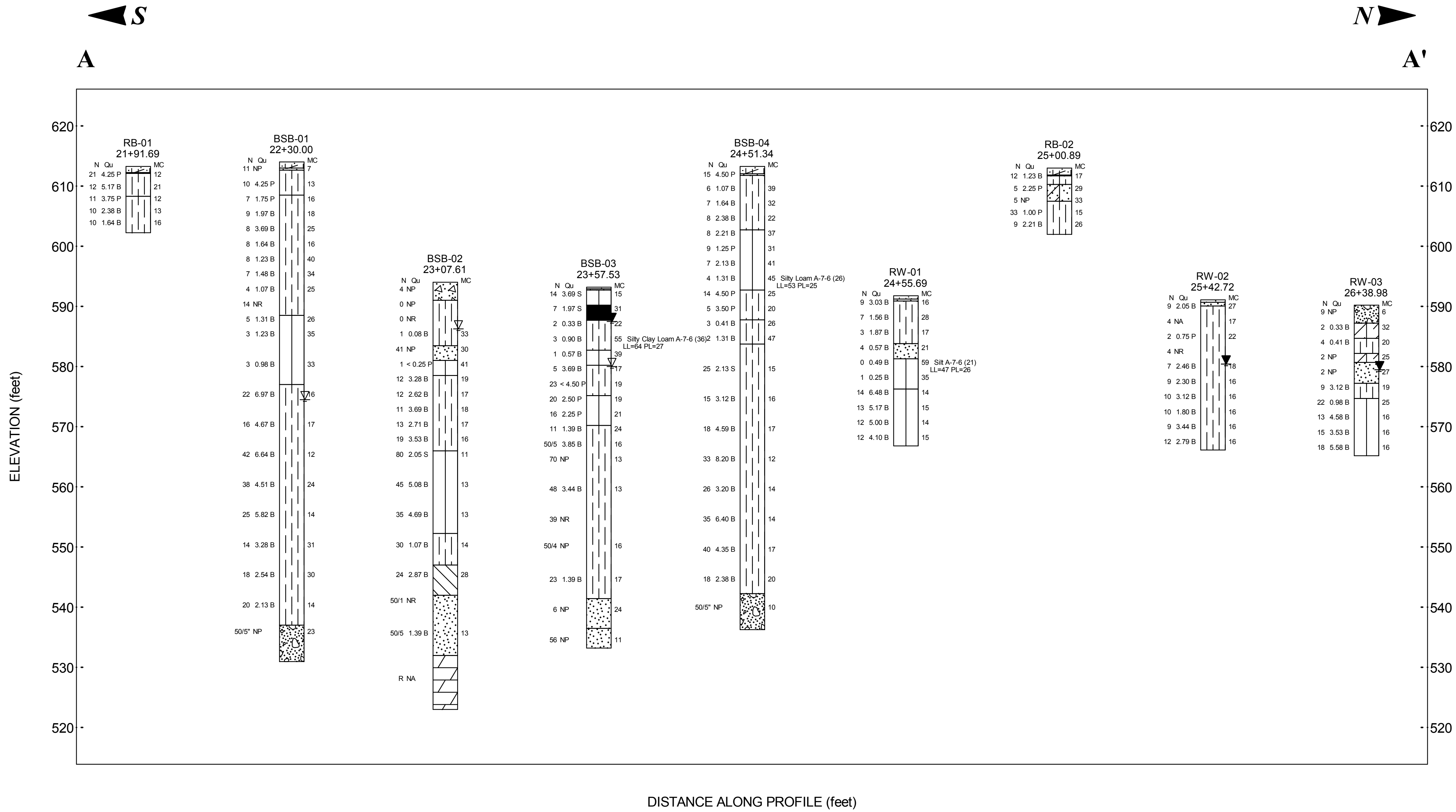
USER NAME = Jhickox	DESIGNED - JEH	REVISED -	
	CHECKED - DF/CMW	REVISED -	
PLOT SCALE = 0:1.0000 ':' / in.	DRAWN - JEH	REVISED -	
PLOT DATE = 4/20/2015	CHECKED - CMW	REVISED -	

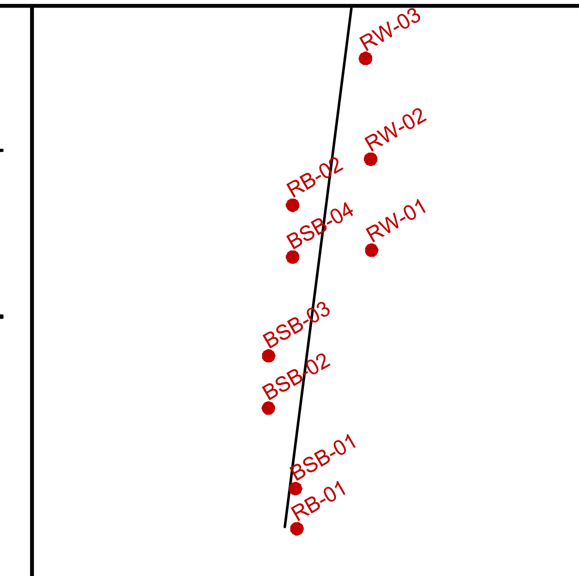
ESI CONSULTANTS, LTD
Excellence. Service. Integrity

STATE OF ILLINOIS
DEPARTMENT OF TRANSPORTATION

F.A.P. RTE.	SECTION	COUNTY	TOTAL SHEETS	SHEET NO.
348	0708.08B-R(1)	COOK	5	1
		CONTRACT NO. 60T06		
		ILLINOIS FED. AID PROJECT		

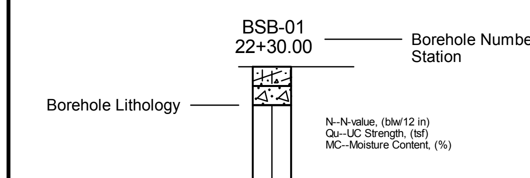
PRINTED DATE: 4/20/2015
FILE NAME: N:\Projects\IDOT\12-485 IDOT D1 IL43 (Harlem Ave)\CADD\Drawings\Exhibits\Harlem_TS&L_NB_1.dgn





Site Map Scale 1 inch equals 185 feet

Explanation:



Water Level Reading at time of drilling.

Water Level Reading 24-hr after drilling or at end of drilling

Horizontal Scale (feet)

Vertical Exaggeration: 2.5x

Lithology Graphics

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

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

Soil Profile A-A'
SN 016-1330, Sec 0708.08B-R(11)

WEI SINCE 1982

IL 43 (Harlem Ave) over MWRDGC RR
Forest View, Cook County, Illinois

JOB NUMBER	PLATE NUMBER
885-02-01	EXHIBIT 4

WEI 11X17 8850201.GPJ WANGENG.GDT 4/20/15

APPENDIX A

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

BORING LOG BSB-01

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.98 ft
North: 1870991.08 ft
East: 1129148.82 ft
Station: 22+30.00
Offset: 24.67 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
613.0	4-inch thick ASPHALT over 8-inch thick CONCRETE --PAVEMENT--					
612.7	4-inch thick CRUSHED STONE --AGGREGATE BASE--					
	Hard, brown SILTY CLAY LOAM, trace gravel --FILL--		1	8, 6, 5	NP	7
		5	2	3, 5, 5	4.25 P	13
608.5	Stiff to very stiff, gray SILTY CLAY LOAM, trace gravel and sand seams --FILL--		3	3, 3, 4	1.75 P	16
		10	4	2, 4, 5	1.97 B	18
			5	3, 4, 4	3.69 B	25
		15	6	2, 3, 5	1.64 B	16
			7	3, 2, 6	1.23 B	40
		20	8	2, 3, 4	1.48 B	34
			9	2, 2, 2	1.07 B	25
		25	10	5, 7, 7	NR	
588.5	Stiff, gray SILT to SILTY LOAM, trace gravel		11	3, 2, 3	1.31 B	26
	6-inches brown SILTY LOAM	30	12	2, 1, 2	1.23 B	35
		35	13	2, 1, 2	0.98 B	33
577.0	Very stiff to hard, gray SILTY CLAY to CLAY, trace gravel					
	2-inches gray SANDY GRAVEL,	40	14	7, 9, 13	6.97 B	16

GENERAL NOTES

Begin Drilling **04-25-2013** Complete Drilling **04-25-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 TMR**
Driller **R&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **2.25-inch SSA to 10', Mud rotary 10' to 77', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **39.75 ft**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG BSB-01

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.98 ft
North: 1870991.08 ft
East: 1129148.82 ft
Station: 22+30.00
Offset: 24.67 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		wet						
			45		15	6 6 10	4.67 B	17
			50		16	12 20 22	6.64 B	12
			55		17	7 11 27	4.51 B	24
			60		18	12 11 14	5.82 B	14

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
			65		19	3 6 8	3.28 B	31
			70		20	6 7 11	2.54 B	30
			75		21	5 8 12	2.13 B	14
	537.0	Very dense, gray SANDY GRAVEL, with pieces of clay --Hard Drilling, 77'--			22	50/5"	NP	23
			80					

GENERAL NOTES

Begin Drilling **04-25-2013** Complete Drilling **04-25-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 TMR**
Driller **R&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **2.25-inch SSA to 10', Mud rotary 10' to 77', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **39.75 ft**
At Completion of Drilling **MUD**
Time After Drilling **NA**
Depth to Water **NA**

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

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

BORING LOG BSB-01

WEI Job No.: 885-02-01

Client **ESI Consultants, Ltd.**
Project **IL 43 (Harlem Ave) over MWRDGC RR**
Location **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.98 ft
North: 1870991.08 ft
East: 1129148.82 ft
Station: 22+30.00
Offset: 24.67 LT

Profile	Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type *recovery*	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		--Hard Drilling, 81'--						
	531.0	--AUGER REFUSAL, 83'--						
		Boring terminated at 83.00 ft						
			85					
			90					
			95					
			100					

GENERAL NOTES

Begin Drilling **04-25-2013** Complete Drilling **04-25-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 TMR**
Driller **R&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **2.25-inch SSA to 10', Mud rotary 10' to 77', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **39.75 ft**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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

BORING LOG BSB-02

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 594.00 ft
North: 1871068.03 ft
East: 1129123.03 ft
Station: 23+07.61
Offset: 48.26 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	Loose, gray CRUSHED STONE --RAIL BALLAST--		1	2 2 2	NP	
591.0	Very soft, gray SILTY CLAY LOAM, trace gravel and organic matter		2	1 0 0	NP	
		5	3	0 0 0	NR	
			4	0 0 1	0.08 B	33
583.5	Dense, black and brown SANDY LOAM, little gravel and organic matter	10	5	5 13 28	NP	30
581.0	Very soft, brown SILT, trace gravel		6	2 1 0	< 0.25 P	41
578.5	Very stiff, gray SILTY CLAY, trace gravel	15	7	3 3 9	3.28 B	19
			8	4 4 8	2.62 B	17
		20	9	3 3 8	3.69 B	18
			10	3 5 8	2.71 B	17
		25	11	4 7 12	3.53 B	16
566.0	Very stiff to hard, gray SILTY LOAM, trace to some gravel		12	19 35 45	2.05 S	11
		30	13	9 17 28	5.08 B	13
		35	14	9 14 21	4.69 B	13
		40				

GENERAL NOTES

Begin Drilling **04-30-2013** Complete Drilling **04-30-2013**
Drilling Contractor **K&S** Drill Rig **CME-75 TMR**
Driller **E,R&C** Logger **D. Wind** Checked by **N. Boddy**
Drilling Method **4.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **8.00 ft**
At Completion of Drilling **MUD**
Time After Drilling **NA**
Depth to Water **NA**

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

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

BORING LOG BSB-02

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 594.00 ft
North: 1871068.03 ft
East: 1129123.03 ft
Station: 23+07.61
Offset: 48.26 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type (recovery)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
552.3	Stiff, gray SILTY CLAY, trace gravel						
		45	SS	15	11 15 15	1.07 B	14
547.0	Very stiff, gray CLAY						
		50	SS	16	9 11 13	2.87 B	28
542.0	Stiff, gray GRAVELLY SANDY LOAM						
			SS	17	50/1	NR	
		55					
			SS	18	25 50/5	1.39 B	13
		60					

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type (recovery)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
532.0	Strong, light gray to white, fair quality DOLOSTONE Run #1, 62.0' to 71.0' 62.0' to 63.5' fractured, highly weathered 63.5' to 71' intact, unweathered --Recovery = 97%-- --RQD = 65%--	65		1	CORE		
		70					
523.0	Boring terminated at 71.00 ft						
		75					
		80					

GENERAL NOTES

Begin Drilling **04-30-2013** Complete Drilling **04-30-2013**
Drilling Contractor **K&S** Drill Rig **CME-75 TMR**
Driller **E,R&C** Logger **D. Wind** Checked by **N. Boddy**
Drilling Method **4.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling ▽ **8.00 ft**
At Completion of Drilling ▼ **MUD**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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

BORING LOG BSB-03

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 593.20 ft
North: 1871117.93 ft
East: 1129123.16 ft
Station: 23+57.53
Offset: 46.73 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
593.0	3-inch thick ASPHALT --PAVEMENT--					
592.7	2.5-inch thick CRUSHED STONE --AGGREGATE BASE--					
	Very stiff, gray SILTY LOAM, trace gravel --FILL--		1	3 7 7	3.69 S	15
590.2	Stiff, black SILTY LOAM --BURIED TOPSOIL--	5	2	2 3 4	1.97 S	31
587.7	Soft to medium stiff, black to dark gray SILTY LOAM to SILTY CLAY LOAM, with sand seams and organic matter		3	0 1 1	0.33 B	22
	--L_L = 64%, P_L = 27%-- --% Gravel = 1.2%-- --% Sand = 12.5%-- --% Silt = 57.0%-- --% Clay = 29.3%--	10	4	1 2 1	0.90 B	55
582.7	Medium stiff, black and dark brown SILT, trace gravel		5	1 0 1	0.57 B	39
580.2	Very stiff to hard, gray SILTY CLAY, trace gravel	15	6	0 1 4	3.69 B	17
			7	7 10 13	< 4.50 P	19
575.2	Very stiff, gray SILTY LOAM, trace gravel	20	8	5 8 12	2.50 P	19
			9	3 8 8	2.25 P	21
570.2	Stiff to very stiff, gray SILTY CLAY, trace gravel	25	10	2 4 7	1.39 B	24
			11	6 11 50/5	3.85 B	16
	--shale fragments at 28.5'--	30	12	17 34 36	NP	13
		35	13	25 21 27	3.44 B	13
		40	14	13 14 25	NR	

GENERAL NOTES

Begin Drilling **04-30-2013** Complete Drilling **04-30-2013**
Drilling Contractor **K&S** Drill Rig **CME-75 TMR**
Driller **E,R&C** Logger **D. Wind** Checked by **C. Marin**
Drilling Method **4.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **13.50 ft**
At Completion of Drilling **6.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG BSB-03

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 593.20 ft
North: 1871117.93 ft
East: 1129123.16 ft
Station: 23+57.53
Offset: 46.73 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	--shale fragments at 43.5'--		15	50/4	NP	16
		45				
		50	16	6 9 14	1.39 B	17
541.5	Loose, gray, fine SAND					
		55	17	1 4 2	NP	24
536.5	Very dense, gray GRAVELLY SANDY LOAM					
533.2		60	18	25 18 38	NP	11
	Boring terminated at 60.00 ft					

GENERAL NOTES

Begin Drilling **04-30-2013** Complete Drilling **04-30-2013**
Drilling Contractor **K&S** Drill Rig **CME-75 TMR**
Driller **E,R&C** Logger **D. Wind** Checked by **C. Marin**
Drilling Method **4.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **13.50 ft**
At Completion of Drilling **6.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG BSB-04

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.25 ft
North: 1871212.43 ft
East: 1129146.20 ft
Station: 24+51.34
Offset: 21.02 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
612.1	4-inch thick ASPHALT over 10-inch thick CONCRETE --PAVEMENT--					
611.8	3-inch thick CRUSHED STONE --AGGREGATE BASE--					
	Stiff to hard, brown and gray SILTY CLAY LOAM, trace to little gravel and bioclasts/shells --FILL--		1	3 6 9	4.50 P	
		5	2	2 2 4	1.07 B	39
			3	2 3 4	1.64 B	32
		10	4	2 3 5	2.38 B	22
602.8	Stiff to very stiff, brown and gray SILTY LOAM, trace gravel and organic matter, sand seams --FILL--		5	4 4 4	2.21 B	37
		15	6	2 4 5	1.25 P	31
			7	2 4 3	2.13 B	41
	--L_L = 53%, P_L = 25%-- --% Gravel = 0.6%-- --% Sand = 13.3%--	20	8	2 2 2	1.31 B	45
	--% Silt = 67.5%-- --% Clay = 18.7%--					
592.8	Very stiff to hard, brown SILTY CLAY LOAM, trace gravel --FILL--		9	5 8 6	4.50 P	25
		25	10	2 2 3	3.50 P	20
587.8	Soft, gray SILTY CLAY LOAM, trace gravel		11	1 1 2	0.41 B	26
		30	12	1 1 1	1.31 B	47
583.8	Very stiff to hard, gray SILTY CLAY to SILTY CLAY LOAM, trace to some gravel	35	13	7 15 10	2.13 S	15
		40	14	4 6 9	3.12 B	16

GENERAL NOTES

Begin Drilling **04-29-2013** Complete Drilling **04-29-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-55 TMR**
Driller **P&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **2.25-inch SSA to 10', Mud rotary 10' to 77', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **NA**
At Completion of Drilling **MUD**
Time After Drilling **NA**
Depth to Water **NA**

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

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

BORING LOG BSB-04

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.25 ft
North: 1871212.43 ft
East: 1129146.20 ft
Station: 24+51.34
Offset: 21.02 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45	15	4 7 11	4.59 B	17
		50	16	11 14 19	8.20 B	12
		55	17	8 14 12	3.20 B	14
		60	18	7 16 19	6.40 B	14
		65	19	12 16 24	4.35 B	17
		70	20	4 6 12	2.38 B	20
542.3	Very dense, gray SILTY LOAM, with gravel --Hard Drilling--					
		75	21	22 50/5"	NP	10
536.3	--AUGER REFUSAL, 77'-- Boring terminated at 77.00 ft					
		80				

GENERAL NOTES

Begin Drilling **04-29-2013** Complete Drilling **04-29-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-55 TMR**
Driller **P&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **2.25-inch SSA to 10', Mud rotary 10' to 77', auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **NA**
At Completion of Drilling **MUD**
Time After Drilling **NA**
Depth to Water **NA**

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

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

BORING LOG RB-01

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.27 ft
North: 1870952.81 ft
East: 1129150.23 ft
Station: 21+91.69
Offset: 24.29 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
612.3	4-inch thick, ASPHALT over 8-inch thick CONCRETE --PAVEMENT--					
612.1	2-inch thick, CRUSHED STONE --AGGREGATE BASE--					
	Hard, brown and gray SILTY CLAY LOAM, trace gravel --FILL--		1	16 9 12 12	4.25 P	12
608.3		5	2	9 7 5 9	5.17 B	21
	Very stiff, gray SILTY CLAY LOAM, trace gravel --FILL--		3	4 5 6 6	3.75 P	12
			4	3 6 4 5	2.38 B	13
602.3		10	5	3 4 6 6	1.64 B	16
	Boring terminated at 11.00 ft	15				
		20				

GENERAL NOTES

Begin Drilling **04-25-2013** Complete Drilling **04-25-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **D-50 TMR**
Driller **R&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **2.25-inch SSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **DRY**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

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

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

BORING LOG RB-02

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 613.00 ft
North: 1871262.00 ft
East: 1129146.20 ft
Station: 25+00.89
Offset: 19.61 LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
611.8	4-inch thick, ASPHALT over 10-inch thick CONCRETE --PAVEMENT--					
611.7	2-inch thick CRUSHED STONE --AGGREGATE BASE--		1	2 5 7 7	1.23 B	17
610.3	Stiff, brown and gray SILTY CLAY LOAM to SILTY LOAM, seams of fine sand and silt, trace gravel --FILL--		2	3 2 3 2	2.25 P	29
607.5	Loose, brown and gray LOAM, some gravel --FILL--	5				
	Stiff to very stiff, brown and g ray SILTY CLAY LOAM, trace gravel and organics (shells) --FILL--		3	2 2 3 5	NP	33
			4	15 28 5 6	1.00 P	15
602.0		10	5	2 5 4 6	2.21 B	26
	Boring terminated at 11.00 ft	15				
		20				

GENERAL NOTES

Begin Drilling **04-29-2013** Complete Drilling **04-29-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-55 TMR**
Driller **P&N** Logger **A. Happel** Checked by **M. Snider**
Drilling Method **3.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **DRY**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

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

Wang Engineering

wangeng@wangeng.com
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

BORING LOG RW-01

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 591.79 ft
North: 1871218.91 ft
East: 1129221.53 ft
Station: 24+55.69
Offset: 54.45 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	7-inch thick ASPHALT --PAVEMENT--					
591.2	4-inch thick CRUSHED STONE --AGGREGATE BASE--					
590.9	Stiff to very stiff, black to gray SILTY CLAY, trace gravel		1	4, 4, 5	3.03 B	16
		5	2	1, 3, 4	1.56 B	28
			3	1, 1, 2	1.87 B	17
583.8	Medium stiff, gray SANDY LOAM		4	1, 2, 2	0.57 B	21
581.3	Soft, gray SILT --L_L = 47%, P_L = 26%-- --% Gravel = 0.0%-- --% Sand = 10.1%-- --% Silt = 84.4%-- --% Clay = 5.5%--	10	5	1, 0, 0	0.49 B	59
		15	6	0, 0, 1	0.25 B	35
576.3	Hard, gray SILTY LOAM to SILTY LOAM CLAY, trace gravel		7	3, 6, 8	6.48 B	14
		20	8	3, 6, 7	5.17 B	15
			9	3, 5, 7	5.00 B	14
566.8		25	10	2, 5, 7	4.10 B	15
	Boring terminated at 25.00 ft					

GENERAL NOTES

Begin Drilling **05-02-2013** Complete Drilling **05-02-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-75 TMR**
Driller **C&R** Logger **D. Wind** Checked by **N. Boddy**
Drilling Method **3.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **DRY**
At Completion of Drilling **DRY**
Time After Drilling **NA**
Depth to Water **NA**

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

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

BORING LOG RW-02

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 591.12 ft
North: 1871305.99 ft
East: 1129220.68 ft
Station: 25+42.72
Offset: 56.11 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
590.7	5-inch thick ASPHALT --PAVEMENT--					
590.0	8-inch thick CRUSHED STONE --AGGREGATE BASE--					
	Medium stiff to very stiff, black to gray SILTY CLAY, trace gravel and sand seams		1	3 4 5	2.05 B	27
		5	2	2 1 3	NA	17
			3	2 1 1	0.75 P	22
		10	4	2 2 2	NR	
			5	1 3 4	2.46 B	18
		15	6	2 3 6	2.30 B	16
			7	3 4 6	3.12 B	16
		20	8	3 4 6	1.80 B	16
			9	3 4 5	3.44 B	16
566.1		25	10	2 5 7	2.79 B	16
	Boring terminated at 25.00 ft					

GENERAL NOTES

Begin Drilling: **05-02-2013** Complete Drilling: **05-02-2013**
Drilling Contractor: **Wang Testing Services** Drill Rig: **CME-75 TMR**
Driller: **C&R** Logger: **D. Wind** Checked by: **N. Boddy**
Drilling Method: **3.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling: **11.00 ft**
At Completion of Drilling: **11.00 ft**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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

BORING LOG RW-03

WEI Job No.: 885-02-01

Client: **ESI Consultants, Ltd.**
Project: **IL 43 (Harlem Ave) over MWRDGC RR**
Location: **Forest View, Cook County, Illinois**

Datum: NGVD
Elevation: 590.19 ft
North: 1871402.16 ft
East: 1129215.77 ft
Station: 26+38.98
Offset: 53.98 RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	Loose, brown SANDY GRAVEL --SURFACE AGGREGATE--		1	4, 4, 5	NP	6
587.2	Soft, black CLAY LOAM	5	2	2, 0, 2	0.33 B	32
584.7	Soft, gray SILTY CLAY		3	1, 2, 2	0.41 B	20
582.2	Soft, gray CLAY LOAM		4	1, 1, 1	NP	25
580.7	Very loose, black to gray, fine SAND	10	5	0, 1, 1	NP	27
577.2	Very stiff, gray SILTY CLAY, trace gravel	15	6	2, 3, 6	3.12 B	19
574.7	Medium stiff to hard, gray SILTY LOAM to SILTY LOAM CLAY, trace gravel and sand seams		7	6, 11, 11	0.98 B	25
		20	8	4, 5, 8	4.58 B	16
			9	4, 6, 9	3.53 B	16
565.2		25	10	4, 7, 11	5.58 B	16
	Boring terminated at 25.00 ft	30				
		35				
		40				

GENERAL NOTES

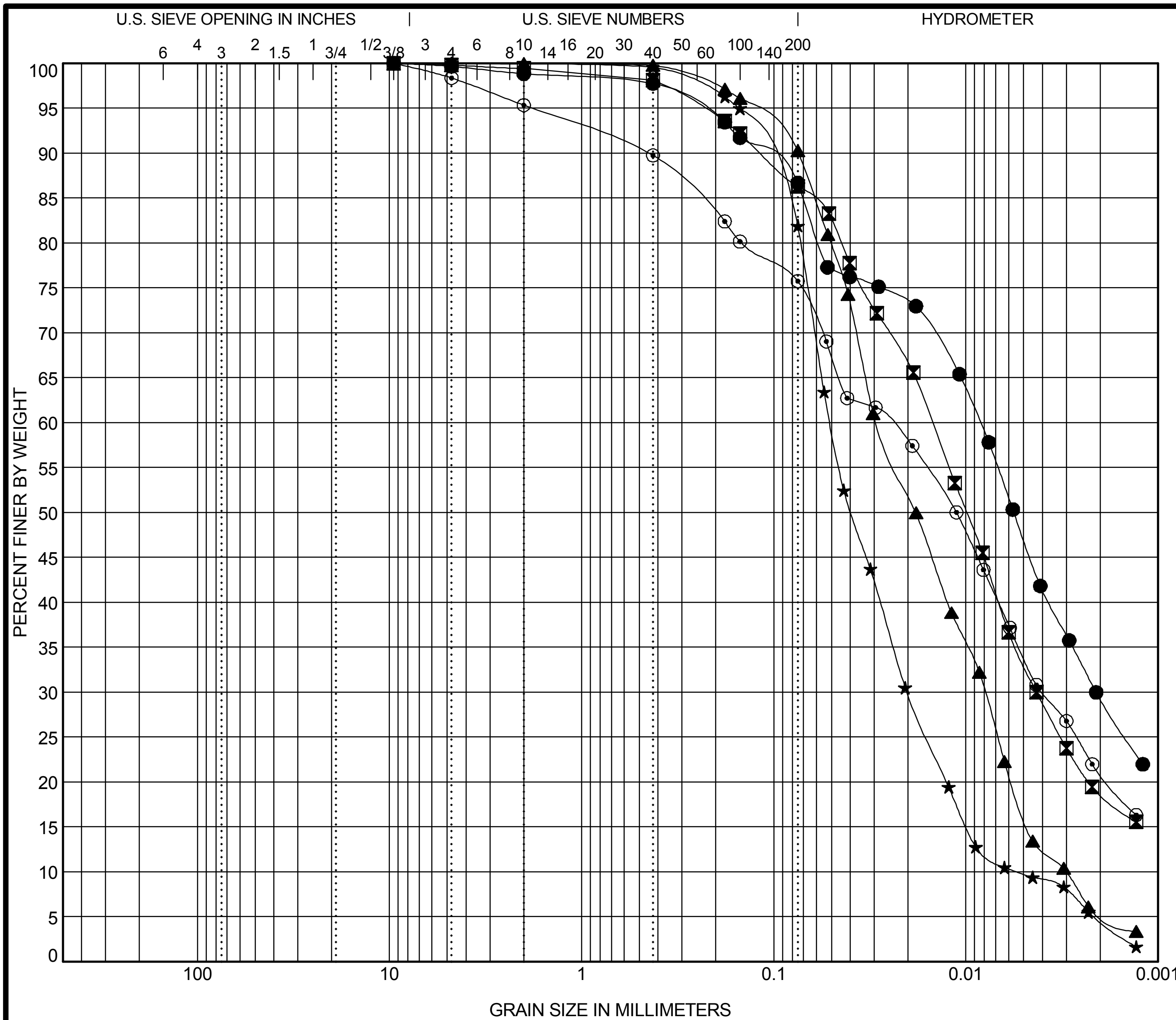
Begin Drilling **05-02-2013** Complete Drilling **05-02-2013**
Drilling Contractor **Wang Testing Services** Drill Rig **CME-75 TMR**
Driller **C&R** Logger **D. Wind** Checked by **N. Boddy**
Drilling Method **3.25-inch IDA HSA, auto hammer, boring backfilled upon completion**

WATER LEVEL DATA

While Drilling **11.00 ft**
At Completion of Drilling **11.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

APPENDIX B



COBBLES	GRAVEL	SAND		SILT AND CLAY
		coarse	fine	

	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	BSB-03#4	8.5 ft	**Silty Clay Loam**	64	27	37		
⧗	BSB-04#8	18.5 ft	**Silty Loam**	53	25	28		
▲	RW-01#5	11.0 ft	**Silt**	47	26	21	0.72	9.61
★	RW-01#	12.0 ft	**Silty Loam**	NP	NP	NP	1.48	9.36
⊙	RW-01#	14.0 ft	**Silty Clay Loam**	27	14	13		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	BSB-03#4	8.5 ft	9.5	0.008	0.002		1.2	12.5	57.0	29.3
⧗	BSB-04#8	18.5 ft	9.5	0.015	0.004		0.6	13.3	67.5	18.7
▲	RW-01#5	11.0 ft	2	0.029	0.008	0.003	0.0	10.1	84.5	5.4
★	RW-01#	12.0 ft	4.75	0.051	0.02	0.005	0.0	18.8	76.6	4.6
⊙	RW-01#	14.0 ft	9.5	0.025	0.004		4.7	19.8	54.6	21.0

WEI SINCE 1982

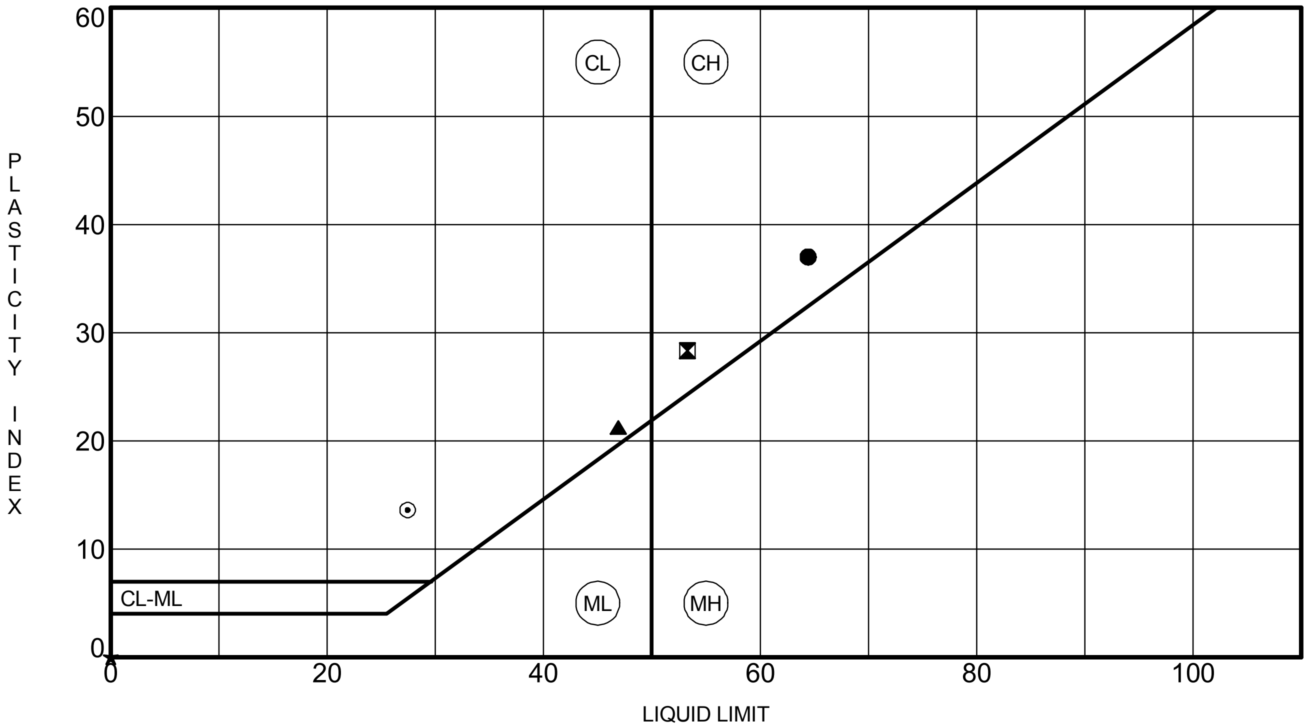
Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

GRAIN SIZE DISTRIBUTION

Project: IL 43 (Harlem Ave) over MWRDGC RR

Location: Forest View, Cook County, Illinois

Number: 885-02-01



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**BSB-03#4**	**8.5 ft**	**64**	**27**	**37**	**87**	**Silty Clay Loam**
⧗	**BSB-04#8**	**18.5 ft**	**53**	**25**	**28**	**86**	**Silty Loam**
▲	**RW-01#5**	**11.0 ft**	**47**	**26**	**21**	**90**	**Silt**
★	**RW-01#**	**12.0 ft**	**NP**	**NP**	**NP**	**82**	**Silty Loam**
⊙	**RW-01#**	**14.0 ft**	**27**	**14**	**13**	**76**	**Silty Clay Loam**

WEI SINCE 1982
Wang Engineering, Inc.
1145 N Main Street
Lombard, IL 60148
Telephone: 630 953-9928
Fax: 630 953-9938

ATTERBERG LIMITS' RESULTS

Project: IL 43 (Harlem Ave) over MWRDGC RR

Location: Forest View, Cook County, Illinois

Number: 885-02-01

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

ONE-DIMENSIONAL CONSOLIDATION TEST

AASHTO T 216 / ASTM D 2435

Project: **NB Harlem Avenue over MWRD Railroad**
Client: **ESI Consultants, Ltd.**
Soil Sample ID: **Boring RW-01, ST#1, 12' to 14'**
Sample Description: **Brown SILTY LOAM**

Tested by: **M. Snider**
Prepared by: **M. Snider**
Test date: **5/17/2013**
WEI: **885-02-01**

Initial sample height =	0.989	in
Initial sample mass =	158.65	g
Initial water content =	28.05%	
Initial dry unit weight =	97.24	pcf
Initial void ratio =	0.784	
Initial degree of saturation =	99.47%	
Final sample mass =	152.36	g
Final dry sample mass =	123.90	g
Final water content =	22.97%	
Final dry unit weight =	106.82	pcf
Final void ratio =	0.624	
Final degree of saturation =	100.00%	
Estimated specific gravity =	2.78	

Ring diameter =	2.500	in
Ring mass =	109.56	g
Initial sample and ring mass =	268.21	g
Tare mass =	72.44	g
Final ring and sample mass =	262.01	g
Mass of wet sample and tare =	224.80	g
Mass of dry sample and tare =	196.34	g
Initial dial reading =	0.01000	in
Final dial reading =	0.09870	in
LL=	NP	
PL=	NP	
% Sand=	18.8	
% Silt=	76.6	
% Clay=	4.6	
In-Situ Vertical Effective Stress =	1500	psf

Compression and Swelling Indices

Compression index C_c =	0.147	
Field corrected C_c =	0.172	
Swelling index C_s =	0.019	

Preconsolidation pressure,s_C

Casagrande Method =	5496	psf
Over-Consolidation Ratio (OCR) =	3.66	

Load number	Vertical stress psf	Dial reading in	System deflection in	Vertical strain %	Void ratio	C_v ft^2/day	Cae %	Elapsed time min
1	100.0	0.01364	0.00010	0.38	0.777	N/A	N/A	660
2	200.0	0.01511	0.00023	0.54	0.774	0.1613	0.05	2400
3	500.0	0.02338	0.00058	1.41	0.759	0.1962	0.12	1320
4	1000.0	0.03009	0.00090	2.12	0.746	0.1322	0.14	2715
5	2000.0	0.04045	0.00135	3.22	0.727	0.1362	0.15	1860
6	4000.0	0.05609	0.00193	4.85	0.697	0.1985	0.19	1200
7	8000.0	0.07138	0.00253	6.46	0.669	0.1543	0.22	855
8	16000.0	0.08633	0.00324	8.05	0.640	0.1583	0.22	1785
9	32000.0	0.11004	0.00413	10.53	0.596	0.1555	0.26	1116
10	8000.0	0.11073	0.00295	10.48	0.597	N/A	N/A	480
11	2000.0	0.10586	0.00198	9.89	0.607	N/A	N/A	480
11	500.0	0.10008	0.00123	9.23	0.619	N/A	N/A	1320

Prepared by: ______________________ Date: ______________

Checked by: ______________________ Date: ______________

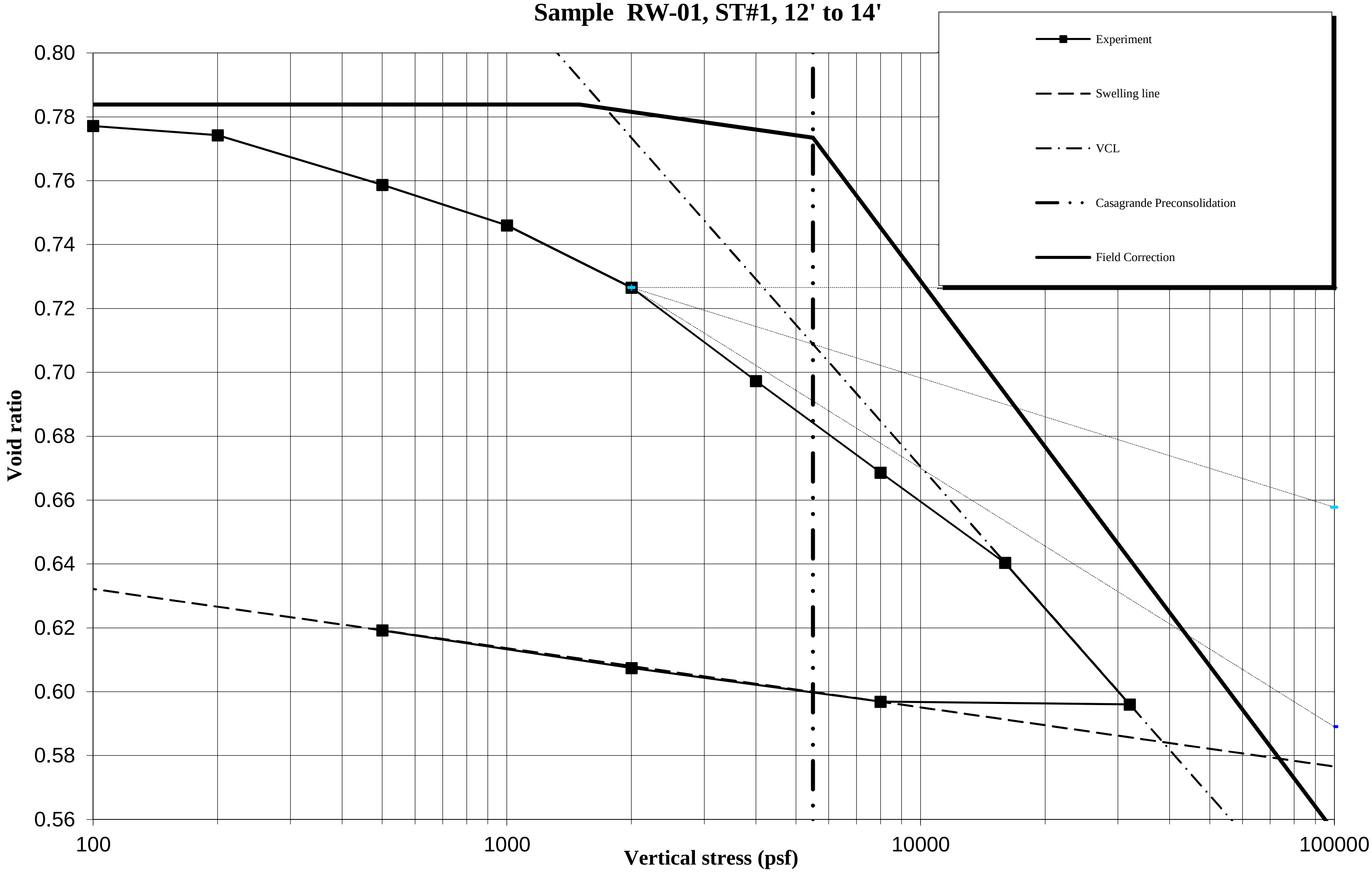
AASHTO R18

Wang Engineering

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

CONSOLIDATION CURVE

Sample RW-01, ST#1, 12' to 14'



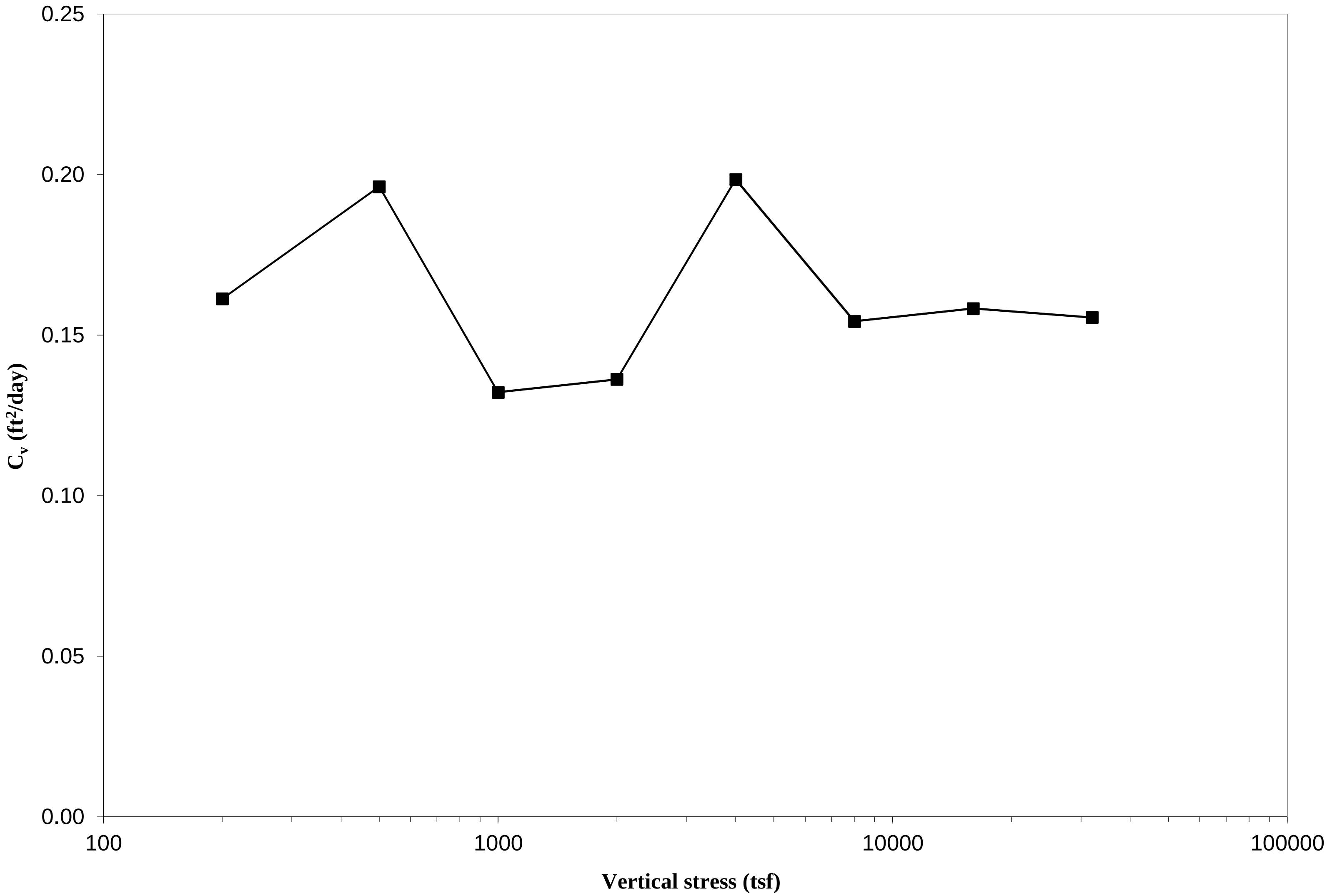
s:\netprojects\8850201\lab data\consolidation\ch12\lws_wang_mls_8850201_12to14feet_20130603.xls

AASHTO R18

1145 North Main Street
Lombard, Illinois 60148
Phone (630) 953-9928
www.wangeng.com

CONSOLIDATION COEFFICIENT (C_v) vs. VERTICAL STRESS

Sample RW-01, ST#1, 12' to 14'



AASHTO R18

Standard Test Method for Compressive Strength of Cohesive Soil
ASTM D 2166

Project: Harlem Avenue over MWRDGC RR

Client: ESI Consultants, Ltd

WEI Job No.: 885-02-01

Field Sample ID	Lab Specimen ID	Break Date	Location	Length (in)^{X} Total Core	Length (in)^{X} Before Capping	Length (in)^{X} After Capping	Diameter (in)	Total Load (lbs)	Total Pressure (psi)	Fracture Type*	Tested By	Area (in^2)
BSB-02,RUN-1	5591	5/7/2013			3.76	3.93	2.04	44800	13730	3	AM	3.26

*** Fracture Types:**

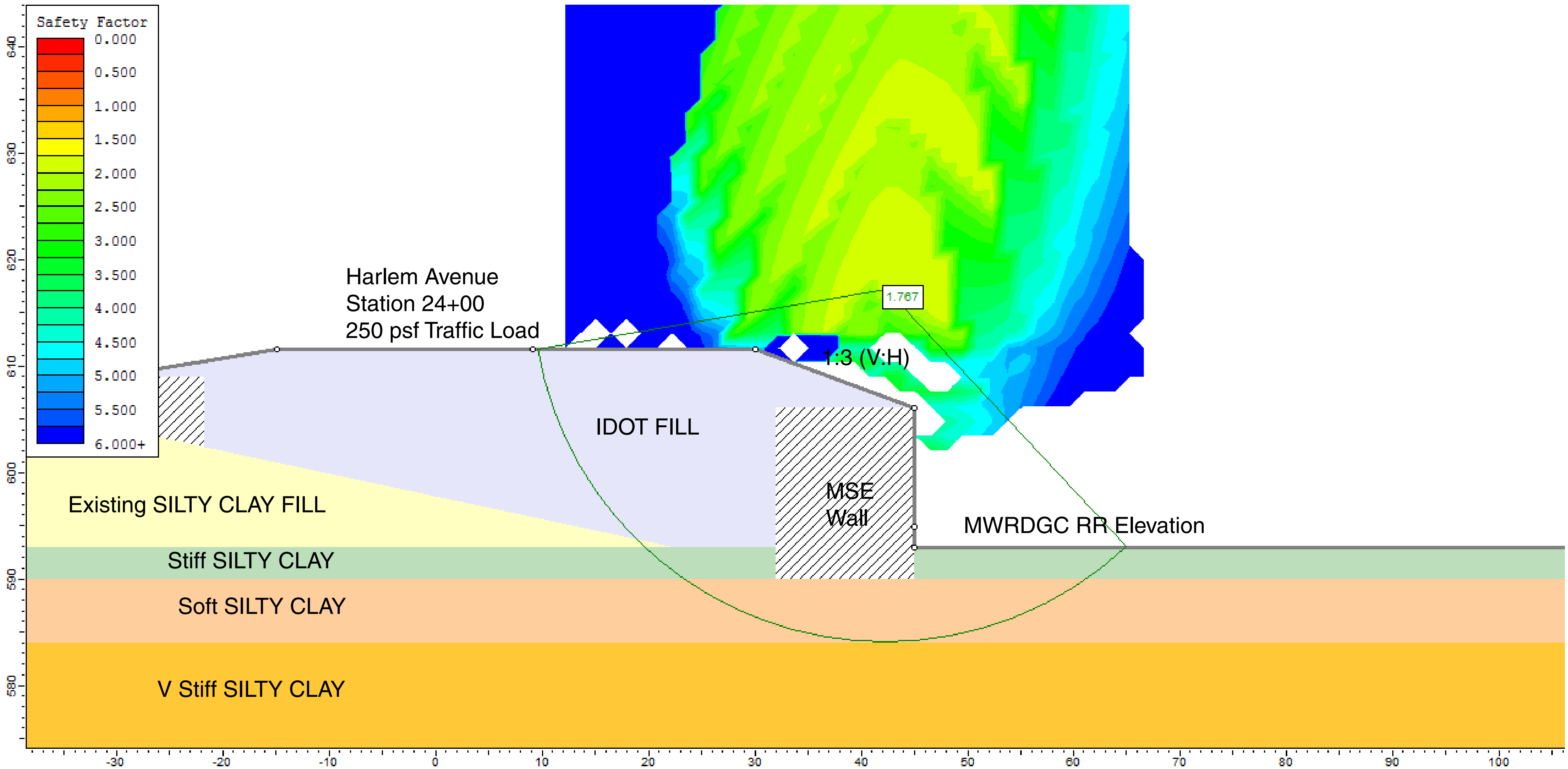
Type 1 - Reasonably well-formed cones on both ends, less than 1 in. [25 mm] of cracking through caps;
Type 2 - Well-formed cone on one end, vertical cracks running through caps, no well defined cone on other end;
Type 3 - Columnar vertical cracking through both ends, no well-formed cones;
Type 4 - Diagonal fracture with no cracking through ends; tap with hammer to distinguish from Type 1;
Type 5 - Side fractures at top or bottom (occur commonly with unbonded caps);
Type 6 - Similar to Type 5 but end of cylinder is pointed.

Prepared by:______________________________

Checked by: ______________________________

WANG ENGINEERING, INC.
1145 N. Main Street, Lombard. IL 60148

APPENDIX C



Undrained Analysis for Embankment Slope and Retaining Wall, Ref Boring BSB-04 and RW-01

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	IDOT FILL	125	1000	0
2	SILTY CLAY FILL	120	1800	0
3	Stiff SILTY CLAY	120	1800	0
4	Soft SILTY CLAY	105	400	0
5	V Stiff SILTY CLAY	120	2500	0

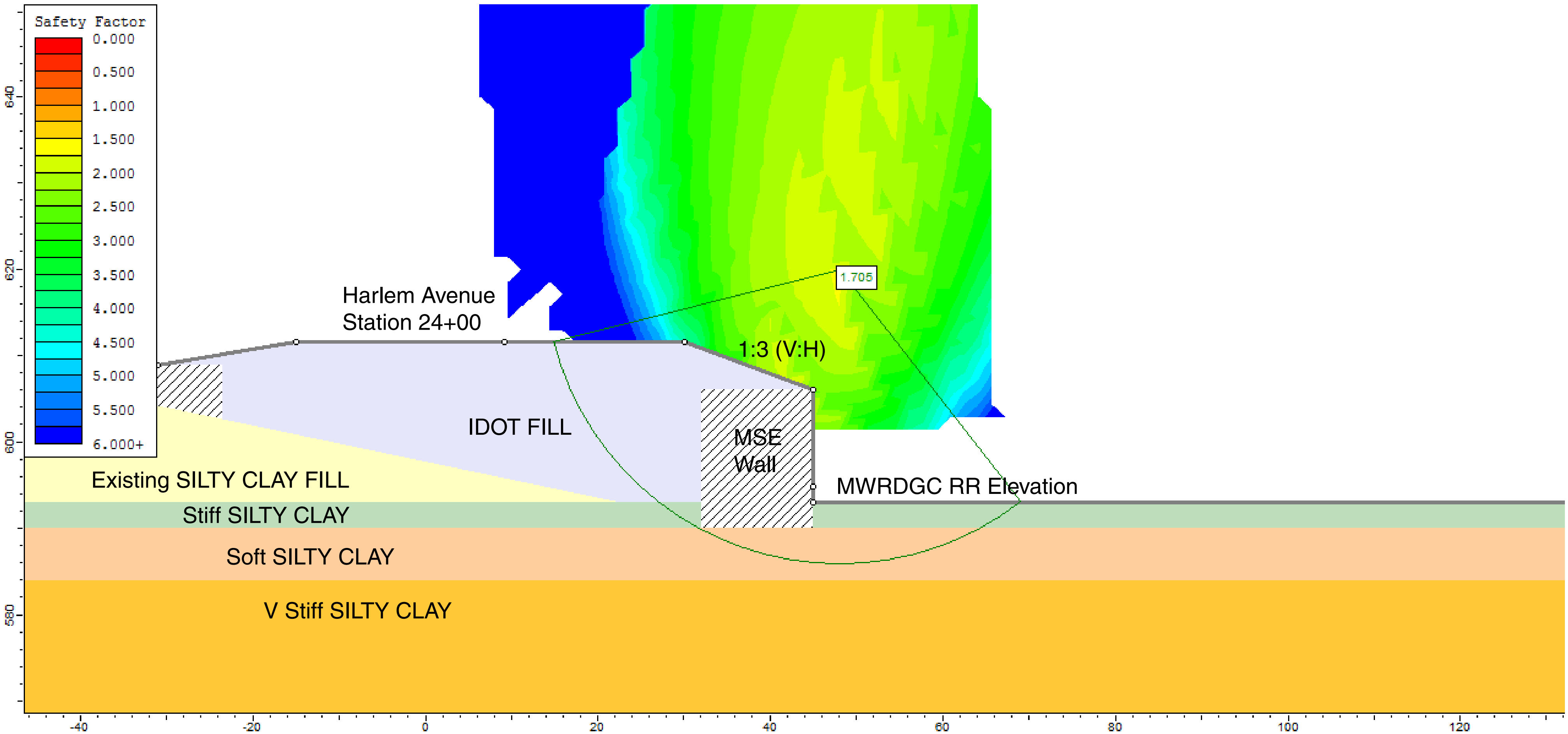
GLOBAL STABILITY: HARLEM AVENUE (ILLINOIS ROUTE 43)
BRIDGE OVER MWRD RAILROAD, FOREST VIEW, ILLINOIS

SCALE: AS SHOWN | APPENDIX C-1 | DRAWN BY: MLS | CHECKED BY: LMI

Wang Engineering

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

FOR ESI Consultants, Ltd | 885-02-02



Drained Analysis for Embankment Slope and Retaining Wall, Ref Boring BSB-04 and RW-01

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	IDOT FILL	125	100	30
2	SILTY CLAY FILL	120	100	30
3	Stiff SILTY CLAY	120	100	30
4	Soft SILTY CLAY	105	0	28
5	V Stiff SILTY CLAY	120	100	30

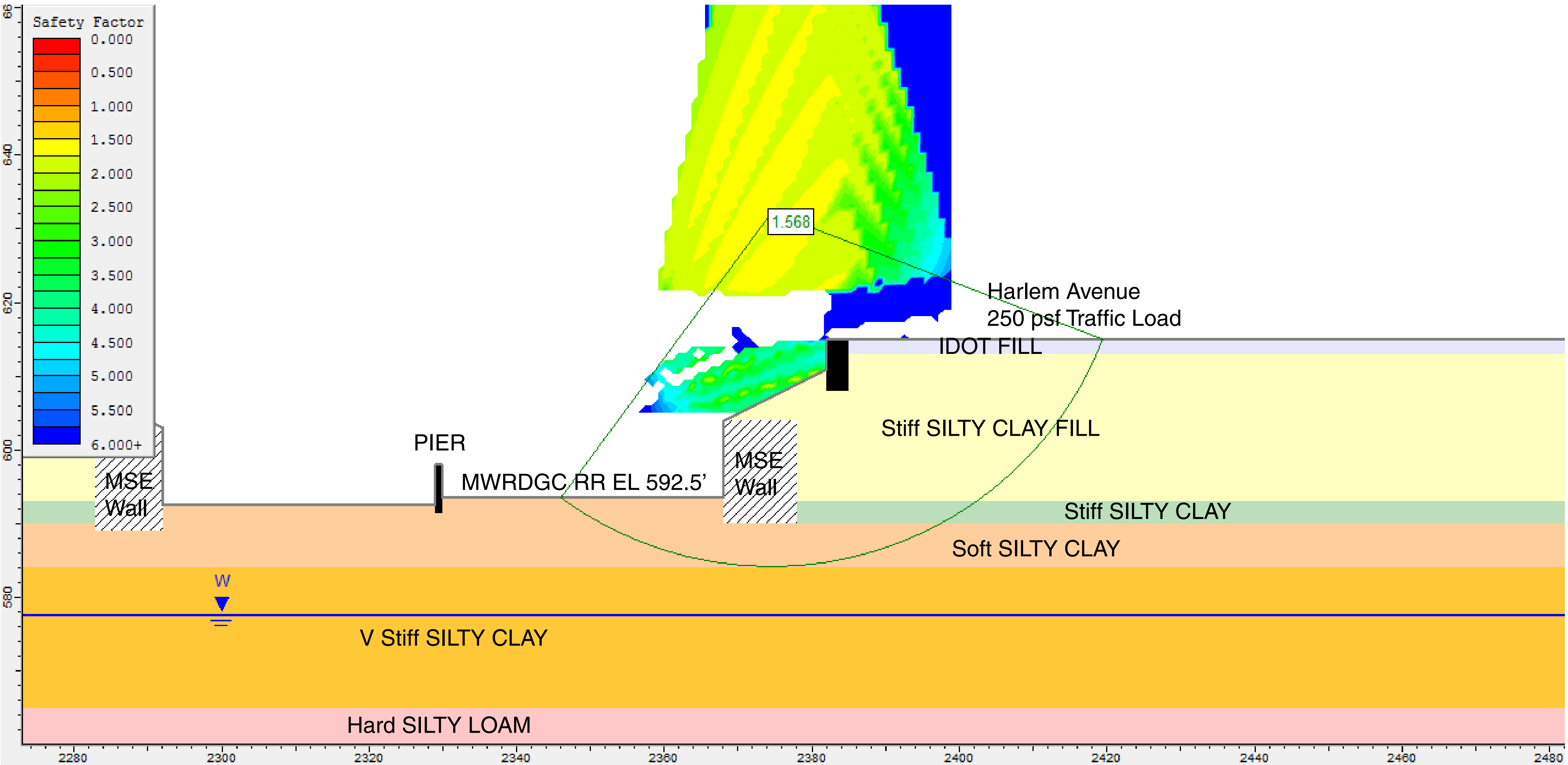
GLOBAL STABILITY: HARLEM AVENUE (ILLINOIS ROUTE 43) BRIDGE OVER MWRD RAILROAD, FOREST VIEW, ILLINOIS

SCALE: AS SHOWN | APPENDIX C-2 | DRAWN BY: MLS | CHECKED BY: LMI

Wang Engineering

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

FOR ESI Consultants, Ltd | 885-02-02



Undrained Analysis for North End Slope and Retaining Wall, Ref Boring BSB-04 and RW-01

Layer ID	Description	Unit Weight (pcf)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	IDOT FILL	125	1000	0
2	Stiff SILTY CLAY FILL	120	1300	0
3	Stiff SILTY CLAY	120	1800	0
4	Soft SILTY CLAY	105	400	0
5	V Stiff SILTY CLAY	120	2500	0
6	Hard SILTY LOAM	125	4500	0

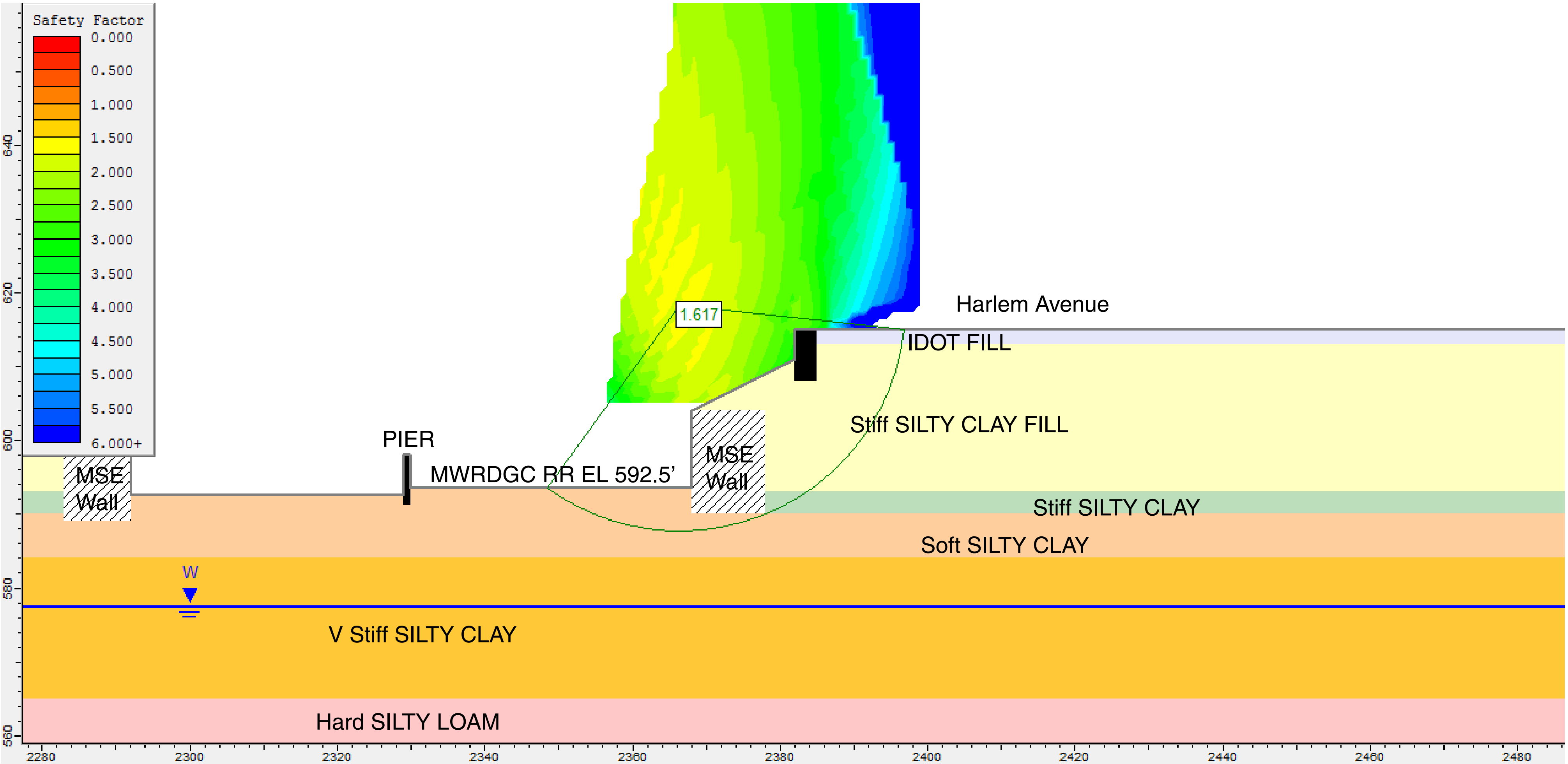
GLOBAL STABILITY: HARLEM AVENUE (ILLINOIS ROUTE 43)
BRIDGE OVER MWRD RAILROAD, FOREST VIEW, ILLINOIS

SCALE: AS SHOWN | APPENDIX C-3 | DRAWN BY: MLS | CHECKED BY: LMI

Wang Engineering

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

FOR ESI Consultants, Ltd | 885-02-02



Drained Analysis for North Embankment Slope and Retaining Wall, Ref Boring BSB-04 and RW-01

Layer ID	Description	Unit Weight (pcf)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	IDOT FILL	125	100	30
2	Stiff SILTY CLAY FILL	120	100	30
3	Stiff SILTY CLAY	120	100	30
4	Soft SILTY CLAY	105	0	28
5	V Stiff SILTY CLAY	120	100	32
6	Hard SILTY LOAM	125	100	32

GLOBAL STABILITY: HARLEM AVENUE (ILLINOIS ROUTE 43) BRIDGE OVER MWRD RAILROAD, FOREST VIEW, ILLINOIS

SCALE: AS SHOWN | APPENDIX C-4 | DRAWN BY: MLS CHECKED BY: LMI

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

FOR ESI Consultants, Ltd | 885-02-02