Speed Letter

Illinois Department of Transportation

Bureau of Bridges & Structures • 2300 S. Dirksen Parkway • Springfield, Illinois 62764

To: Wang Engineering, Inc.
1145 N. Main Street

Lombard, IL
60148-

Attention: Paul Wang

Date: June 15, 2010	**Job No.:** P-94-007-07
SN: 055-0082	**Contract No.:** 68689
Route: FAP 687	
Section: (122VB)BR-1	
County: McDonough	
Other: Il Route 95 over B.N.S.F. Railroad	

Subject: **Structure Geotechnical Report (SGR) Review**

We are Sending:

☐ Structure Geotechnical Report ☐ Foundation/Wall Design Details ☐ Settlement/Stability Analysis
☒ Approval ☐ Comments ☐ Special Provisions ☐

These Are:

☐ Approved As Submitted ☒ Approved Subject to Changes & Comments Below
☐ Returned for Revisions and Re-submittal ☐ For Your Use ☐ For Review and Comments
☐

Remarks:
Following our review of your SGR dated 03/05/2010, we request that Wang Engineering, Inc. revise and re-issue the SGR to address the issues below.

1. The SGR discusses slope stability issue and remedial measures for the roadway portion of the overall project, using Boring EB-01 200 ft from the structure, which we believe this should be presented in the roadway geotechnical report, not in the SGR.

2. Our independent analyses indicate that the MS piles listed in the pile tables reach their maximum NRB values at lengths much shorter than those shown in the tables and, therefore, we ask that these tables be revisited and revised accordingly.

3. The SGR indicates that temporary sheet piling will be required to facilitate stage construction. However, the TSL Plans show that the road will be closed and the traffic detoured during construction. Please obtain the latest TSL Plans from the TSL Consultant and revise the SGR accordingly.

4. The SGR should indicate the preliminary factored loadings, provided by the TSL Consultant for each substructure.

Please provide our office, the district, and structure designer with the revised dated SGR within 30 days, for use in final design and our review of the structure plans. If you have any questions or need further assistance, please contact Luis F. Camacho at (217)-785-1462 or Riyad M. Wahab at (217)-782-2704 of our Foundations and Geotechnical Unit.

By ____________________
For The Engineer of Bridges & Structures

Copies To: WHKS & Co.
Joseph E. Crowe - District 4 Attn:Eric S. Therkildsen

rmw/lfc SGR Speed Letter.doc 12/23/09

STRUCTURE GEOTECHNICAL REPORT
ILLINOIS ROUTE 95 (FAP 687) OVER
THE BNSF RAILROAD
SN 055-0082, SECTION (122VB)BR-1
IDOT JOB P-94-007-07, CONTRACT NO. 68689
McDONOUGH COUNTY, ILLINOIS

for

WHKS & Company Engineering

7018 Kingsmill Court

Springfield, IL 62711

(217) 483-9457

submitted by

Wang Engineering, Inc.

1145 North Main Street

Lombard, IL 60148

(630) 953-9928

March 5, 2010

Technical Report Documentation Page

1. Title and Subtitle Structure Geotechnical Report, Illinois Route 95 over the BNSF Railroad in McDonough County		**2. Report Date** March 5, 2010 **3. Report Type** ☒ SGR ☐ RGR ☒ Draft ☐ Final ☐ Revised
4. Route / Section / County FAP 687/ (122VB)BR-1/ McDonough		**5. IDOT Job / Contract No.** Job P-94-007-07 Contract 68689
6. PTB / Item No. 890/163	**5. Existing Structure Number(s)** S.N. 055-0017	**6. Proposed Structure Number(s)** S.N. 055-0082
7. Prepared by Wang Engineering, Inc. 1145 N Main Street Lombard, IL 60148	**Contributor(s)** Author: Mickey Snider, P.E. QC/QA: Jerry W.H. Wang, PhD, P.E. PM: Liviu Iordache, P.G.	**Contact Phone Number** (630) 953-9928 ext 27
9. Prepared for WHKS & Co. Engineering 7018 Kingsmill Court Springfield, IL 62711	**Design / Structural Engineer** Scott D. Sanford, P.E., S.E.	**Contact Phone Number** (217) 483-9457

10. Abstract

A new three-span structure with integral abutments will replace the existing Illinois Route 95 Bridge over the BNSF Railroad. This report provides geotechnical recommendations for the design of proposed approach embankments and bridge foundations and for stage construction using steel sheet piling.

The existing embankments consist of 17 to 22 feet of medium stiff to very stiff clay and clay loam fill. Beneath the embankments and near the surface at the pier locations, the foundation soils include 18 to 23 feet of soft to stiff silty clay loam and silt resting on top of competent outwash sand and clayey to silty till. The site classifies in the Seismic Class D.

The proposed abutments could be supported on steel H-piles or concrete-filled metal shell piles without downdrag losses. The piers could be supported on either pile type or spread footings. We provide geotechnical parameters for pile analysis under lateral load. We do not recommend the use of drilled shafts due to the presence of granular soils and relatively shallow groundwater.

Global stability analyses along the embankments show suitable FOS for toe and side slopes in undrained conditions, but inadequate FOS in drained conditions. An investigation was also performed along a shallow slope failure on the south side of the west embankment. We recommend benched slope stabilization to fix an existing shallow failure, prevent future failures, and provide adequate FOS against global instability in drained conditions.

Recommended geotechnical parameters are provided for the design of temporary sheet pile walls during stage construction.

11. Path to archived file

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Wang Engineering

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THE BNSF RAILROAD
SN 055-0082, SECTION (122VB)BR-1
IDOT JOB P-94-007-07, CONTRACT 68689
McDONOUGH COUNTY, ILLINOIS
FOR
WHKS & COMPANY ENGINEERING

1.0 INTRODUCTION

This report presents the results of our field investigation, laboratory testing, and geotechnical evaluations for the replacement of the Illinois Route 95 (IL 95) Bridge over the Burlington Northern and Santa Fe (BNSF) Railroad in McDonough County, Illinois. A *Site Location Map* is presented as Exhibit 1.

1.1 Proposed Structure

Wang Engineering, Inc. (Wang) understands WHKS & Co. envisions a new three-span structure with integral abutments and footing-supported piers. The back-to-back abutment length will measure 195.0 feet, with two 58.8-foot long end spans and one 75.0-foot long center span. The proposed out-to-out bridge width will amount to 35.2 feet with a 24.0-foot wide roadway, 4.0-foot wide shoulders, and 1.6-foot wide rails. Relative to the existing foundations, the proposed abutments will be moved back approximately 40 feet; the piers approximately 18 feet. The substructure relocations will require cuts into the existing embankments and removal of the existing abutments. Stage construction will be used to make the proposed cuts and temporary shoring with steel sheet piling will be required.

The existing IL 95 pavement is at an elevation of approximately 683.0 to 684.0 feet; the proposed top of pavement elevation will measure 686.5 to 687.3 feet resulting in a total profile grade and embankment height increase of approximately 3.5 feet. The approach embankments extend down to the railroad elevation at approximately 655.3 feet for total embankment heights of 32.0 feet. Side and toe slopes will be graded at 2:1 (H:V).

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 the bridge replacement, approach embankments, and stage construction.

1.2 Existing Structure

The original IL 95 Bridge was constructed in 1929 as a 117-foot long, 26.3-foot wide, three span structure. The bridge includes two piers supported on shallow foundations at base elevations of 652.8 feet. The existing abutments are gravity-type walls, also on spread footings with base elevations of 660.0 feet. The approach embankments measure approximately 1000 feet long on the west and 500 feet on the east; side slopes vary from 2:1 (H:V) near the abutments to 1.6:1 further down the embankments. The slopes are covered with vegetation and a scarp appears to be forming on the south side of the west embankment approximately 250 feet from the abutment (see Section 5.1.2).

2.0 SITE CONDITIONS AND GEOLOGICAL SETTING

The project area is located in northeast McDounough County, approximately 4.0 miles south of Bushnell, Illinois. On the USGS *Adair Quadrangle 7.5 Minute Series* map, the bridge site is located in the NE¼ of Section 22, Tier 6 N, Range 1 W of the Fourth Principal Meridian.

The following review of published geologic data, with emphasis on factors that might influence the design and construction of 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 northwestern Illinois in general and McDonough County in particular. Exhibit 2 illustrates the *Site and Regional Geology*.

2.1 Physiography

Northeastern McDonough County is part of the Galesburg Plain, a low-relief till plain, level to undulatory, with few morainic ridges. The site is underlain by groundmoraine. The general topography slopes gently west, toward the La Moine River (Leighton et al. 1948). At the bridge site, surface elevations at railroad level measure about 655 feet and at road level up to 684 feet. The surrounding area is rural and occupied by agricultural land.

2.2 Surficial Cover

The project area is underlain by up to 100-foot thick glacial deposits. The surficial deposits are comprised primarily of Illinoian-age glacial tills and include the Hulick Till Member of the Glasford Formation (Lineback 1975). The Hulick Till is made up of clayey glacial till intercalated with sand and gravel outwash (Willman et al. 1975).

2.3 Bedrock

The bedrock may be encountered at an approximate elevation of 540 feet, or at about 100 feet below ground surface (bgs). The bedrock consists of Pennsylvanian-age sandstone, limestone and coal. (Kolata 2005). The bedrock dips gently at 0.02º toward the southeast. Structurally, the site is located on the east flank of the Mississippi River Arch.

No underground mines are known or mapped at the bridge site. However, the closest mining area is approximately five miles east along IL 95, near Marietta in adjoining Fulton County (Louchios et al. 2008).

Our subsurface investigation results fit into the local geologic context. The borings drilled in the project area revealed the native sediments consists of clay to silty clay loam intercalated with sand (Hulick Till Member). None of the borings encountered bedrock.

3.0 METHODS OF INVESTIGATION

The following section outlines the subsurface and laboratory investigations performed by Wang.

3.1 Field Investigation

The subsurface investigation along IL 95 and the BNSF was performed by Wang in November 2008 and June 2009. The investigation included four structure borings, designated as Borings RR-01 through RR-04, drilled from elevations of 657.1 to 684.4 feet to depths of 60.0 to 78.9 feet bgs. Borings RR-01 and RR-02 were advanced along IL 95 to investigate the conditions at the abutments; Borings RR-03 and RR-04 were drilled along the BNSF to investigate the proposed pier locations. One embankment boring, designated as EB-01 was used to supplement the subsurface information beneath the west embankment. The embankment boring was drilled from an elevation of 673.7 feet to a depth of 30.0 feet bgs. The as-drilled boring locations are shown in the *Boring Logs* (Appendix A) and on the *Boring Location Plan* (Exhibit 3).

Truck- and ATV-mounted drilling rigs, equipped with hollow stem augers, were 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 a depth of 30 feet bgs and at 5.0-foot intervals thereafter. Soil samples from each interval were placed in sealed jars for laboratory testing. At Boring RR-02, two undisturbed Shelby tube samples were obtained between 23 and 27 feet bgs in accordance with AASHTO T 207, "*Thin-Walled Tube Sampling of Soils*."

Field boring logs prepared and maintained by Wang engineers, included lithological descriptions, visual-manual soil classifications (IDH textural classification), results of pocket penetrometer or Rimac unconfined compressive strength testing on cohesive soils, and Standard Penetration Test (SPT) results recorded as blows per 6 inches of penetration.

Groundwater observations were made during and at the completion of drilling operations. The borings were backfilled with soil cuttings and bentonite chips, and the surface was restored as close as possible to the original condition.

3.2 Laboratory Testing

All soil samples were tested in the laboratory for moisture content (AASHTO T-265). Atterberg limits (AASHTO T 89/T 90) and particle size (AASHTO T 88) analyses were also performed on selected samples. A laboratory unconfined compressive strength test (AASHTO T 208) was performed on one Shelby tube sample. Field visual descriptions of the soil samples were verified in the laboratory and classified according to the IDH Soil Classification System. Laboratory test 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 pavement structure along IL 95 consists of 1.5 inches of asphalt pavement over 5.5 to 10.5 inches of concrete pavement. At the surface condition along the BNSF, the borings found 24 to 36 inches of black silty loam topsoil with gravel and miscellaneous debris. In descending order, the general lithologic succession encountered includes: 1) medium stiff to very stiff silty clay and clay loam fill; 2) soft to stiff silty clay loam to silt; 3) stiff to very stiff silty and sandy clay; 4) medium dense to dense sand; and 5) interbedded medium dense silt and stiff to hard clay and silty clay.

1) Medium stiff to very stiff clay and clay loam fill

Beneath the surface, the borings drilled through the embankments encountered 17 to 22 feet of medium stiff to very stiff, black, brown and gray silty clay and clay loam fill. The fill has unconfined compressive strength (Q_u) values of 0.8 to 4.0 tsf with an average of 1.7 tsf. The moisture content of the clay varies from 23 to 32% and has an average of 27%. The Q_u values are generally lower behind the west abutment, where several medium stiff samples (Q_u < 1.0 tsf) were taken. Laboratory index testing of this material shows a liquid limit (L_L) of 48% and a plastic limit (P_L) of 21%. The strength of the fill behind the east abutment, as well as further behind the west abutment (Boring EB-01) is stiff to very stiff.

2) Soft to stiff silty clay loam to silt

Underneath the fill, at elevations of 665.9 to 661.4 feet (18 to 23 feet bgs) the borings advanced through 3.5 to 14.0 feet of soft to stiff, brown and gray silty clay loam to silt. The silty soil has Q_u values of 0.3 to 1.7 tsf and averages 0.9 tsf. Moisture contents were measured between 18 and 30% with an average of 25%. Soft samples (Q_u of 0.3 tsf by Rimac) were collected beneath the west embankment at approximately 658.4 feet and under the east embankment at approximately 655.1 feet. A laboratory unconfined compressive strength test performed on a Shelby tube sample recovered from this material in Boring RR-02 shows a higher Q_u value of 0.9 tsf than was measured in the field by Rimac. Laboratory index testing shows a L_L of 35% and a P_L of 22%. Moisture contents are generally closer to the L_L than the P_L and the liquidity index (L_I) is approximately 0.5 to 0.6; the data suggest this layer is lightly overconsolidated (Sabatini, 2005).

3) Stiff to very stiff silty and sandy clay

The soft to stiff silty clay loam and silt lies on top of a 2.5 to 5.0-foot thick layer of stiff to very stiff silty and sandy clay. This layer is identified by higher Q_u values between 1.6 to 3.9 tsf and lower moisture contents of 16 to 20%.

4) Medium dense to dense sand

At elevations of 649.1 to 646.9 feet (8.0 to 37.0 feet bgs) the borings encountered 20.0 to 25.0 feet of medium dense to very dense sand. This layer has SPT (N)-values from 5 to 68 blows/foot and averages 23 blows/foot. The loose (5 blows/foot) and very dense (68 blows/foot) samples represent statistical outliers; the majority of N-values are generally in the 20 to 30 blows/foot range.

5) Medium dense silt and stiff to hard clay

At elevations of 627.8 to 621.9 feet (29.5 to 62.0 feet bgs), the borings encountered medium dense silt with N-values of 11 to 22 blows/foot bedded with stiff to hard, gray clay with Q_u values of 1.2 to greater than 5.0 tsf. This layer continues to the termination depths of the borings.

4.2 Groundwater Conditions

Groundwater was encountered during drilling between 641.6 and 645.6 feet (15.5 to 39.0 feet bgs) within the sand (**Layer 4**, Section 4.1). At the completion of drilling operations the groundwater was measured at 639.1 to 648.6 feet (18.0 to 38.5 feet bgs). The groundwater elevation was taken at an elevation of 645 feet in our foundation and embankment analyses.

4.3 Scour Considerations

The IL 95 Bridge is not associated with a waterway and scour is not a concern.

4.4 Seismic Design Considerations

Wang estimates the minimum factor of safety (FOS) against liquefaction for the saturated sand (**Layer 4**) is greater than the AASHTO required FOS of 1.1. The soils within the top 100 feet have an weighted average SPT blow count of 27 blows per foot, classifying the site in Seismic Site Class D (AASHTO, 2008; Method C controlling); the project location belongs to Seismic Performance Zone 1. The seismic spectral acceleration parameters recommended for design in accordance with the 2008 *Interim Revisions* of the AASHTO *LRFD Design Specifications* are summarized in Table 1 (AASHTO, 2008).

Table 1: Seismic Design Parameters for IL 95 Bridge

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient[1)] (% g)	Site Factors for Class Conversion	Design Spectrum for Site Class D[2)] (% g)
0.0	PGA= 4.5	F_{pga}= 1.6	**A_s= 7.2**
0.2	S_S= 10.7	F_a= 1.6	**S_{DS}= 17.2**

Spectral Acceleration Period (sec)	Spectral Acceleration Coefficient[1)] (% g)	Site Factors for Class Conversion	Design Spectrum for Site Class D[2)] (% g)
1.0	S_1= 4.7	F_v= 2.4	**S_{D1}= 11.2**

1) Base spectral acceleration coefficients from AASHTO, 2008

2) Site Class D values to be presented on plans ($A_s = PGA*F_{pga}$; $S_{DS}= S_1*F_a$; $S_{D1}= S_2*F_v$)

5.0 FOUNDATION ANALYSIS AND RECOMMENDATIONS

Geotechnical evaluations and recommendations for the approach embankments, approach slabs, and structure foundations are included in the following sections. Wang concurs that the proposed pile-supported integral abutments and footing-supported pier shown in the TSL are the most appropriate foundation types.

The abutments should consist of single row of vertical concrete-filled metal shell piles (MSP) or steel H-piles (IDOT 2009). Due to the soil conditions within the embankments, shallow foundations are not economically appropriate for support of the abutments. The pier could be supported by shallow foundations, steel H-piles, or MSP. Drilled shafts were also investigated for support of both the piers and abutments. However, the combination of granular soils (**Layers 4 and 5**) and relatively high groundwater will result in soil caving and heaving that make shafts economically undesirable compared to driven pile foundations.

5.1 Approach Embankments and Slabs

Wang has performed global stability and settlement analyses for the approach embankments and slabs based on the preliminary TSL plan provided by WHKS & Co. Due to the relatively minor raise in profile grade we conclude that settlement allowances (waiting period or negative skin friction) will not be required. Global stability meets the IDOT-required FOS.

5.1.1 Settlement

Evaluations were performed to estimate settlements within the 30.0-foot high approach embankments for the 3.5-foot high profile change. Soil consolidation parameters for the silty clay fill (**Layer 1**) were obtained by correlation to measured index properties. Our evaluations show the foundation soils will undergo total long-term consolidation settlement of approximately 1.0 inch with 75% of the settlement (0.75-inch) within the initial 7 feet. Below 7 feet, the soils will undergo approximately 0.25-inch of settlement. For these estimated settlements Wang does not anticipate problems with the placement of the proposed approach slabs, and downdrag allowances will not be required for the foundation piles.

5.1.2 Global Stability

The global stability of side and toe slopes was analyzed based on the soil profile described in Section 4.1 and the information provided in the preliminary TSL. The slopes for the proposed approach embankments are anticipated at 2:1 and the slope heights are approximately 30.0 feet. The slopes are considered structure-supporting cuts; the worst soil condition parameters were obtained from Shelby tube samples. Therefore, the minimum required factor of safety (FOS) for both short-term and long-term conditions is 1.5 (IDOT, 200). Analyses were performed with Slide 5.0 and slope stability evaluation exhibits are shown in Appendix C. For the undrained (short-term) condition, Wang estimates the slopes have a FOS of 1.5 (Appendix C-1); for the drained (long-term) condition, Wang estimates the slopes have a FOS of 1.4 (Appendix C-2). The undrained condition meets the IDOT-required FOS; however the drained condition does not.

Wang investigated the slope failure along the existing west embankment at the location of Boring EB-01 (approximate Station 23+00). In this area of the approach, the slope is approximately 1.6:1 with a pavement elevation of 674 feet and a slope toe at approximately 655 feet. The field investigation of the slope included a survey of the suspected failure and dynamic compaction testing of the embankment materials. The survey showed a scarp near the top of the embankment, at an offset of approximately 25 feet from the roadway centerline and matching soil-flow debris at the toe of the embankment. These features suggest a shallow failure of the embankment materials. The survey data showing the scarp, failed mass, and estimated shallow failure surface are included in Exhibit 5. Slope stability evaluations with Slide show a FOS against slope failure of 1.7 in the undrained condition (Appendix C-3), but a FOS of 1.3 in the drained condition (Appendix C-4) with the failure surface also extending through the toe of the embankment; however, rotational moment-equilibrium analysis does not appropriately represent the mechanism of shallow slope failures.

Wang concludes the existing embankment is likely undergoing a surficial slope failure extending 4 feet or less into the embankment. Surficial slope failures occur due to desiccation and shrinking of shallow cohesive embankment soils in hot weather. During periods of heavy rain, the shallow soils saturate and swell, decreasing the shear strength and increasing the permeability. The increase in permeability results in seepage parallel to the slope face and excess pore pressure, which coupled with decreased shear strength results in failure of the saturated material. The existing embankment fill properties likely exacerbated the issue along IL 95, as the soils encountered during our investigation are of relatively high-plasticity, average Q_u, and high moisture content. An analysis with the surficial slope stability methods provided by Day (2000) show a FOS against failure of 0.87 for the 1.6:1 slope. If the slope is increased to 2:1 for the same estimated soil parameters, the FOS increases to approximately 1.0. Therefore, Wang estimates the surficial slope failure is a combination of relatively weak fill materials and a slope greater than 2:1 even though the slope may be stable in moment-equilibrium analysis. If the embankment conditions are not improved, a similar scenario could develop along the side slope closer to the abutments or at the proposed toe slope.

To remediate the existing embankment and improve the conditions along the proposed slope, we recommend benching both the side slopes as well as the toe slopes prior to pile installation. The benched excavations should be performed between Stations 21+00 and the proposed west abutment toe slope (approximately 500 feet) and Station 31+00 and the proposed east abutment toe slope (approximately 300 feet). After temporarily rerouting any existing utilities, we recommend the failed mass be excavated starting from the top. Benches with a maximum height of 2.0 feet and minimum width of 8.0 feet should be cut into the embankment based on the standard IDOT Benching Detail. An example of the benched excavation at Station 23+50 near Boring EB-01 is also included in Exhibit 5. A new cohesive fill material should be placed from bottom to top and graded to a minimum slope of 2:1. It should be placed in lifts of maximum 8.0-inch thick loose thickness and compacted to at least 95% of standard dry density (AASHTO T 99). The moisture content of the placed fill should be within 2% of optimum, should have maximum dry density greater than 98 pcf, L_L less than 40%, and plasticity index (P_I) between 12 and 25%. After benching, we estimate the drained FOS against global instability at the toe and along the side slopes will be adequate (Appendix C-5 and C-6). The FOS against surficial slope failure is approximately 1.3.

5.2 Structure Foundations

Wang recommends the abutments be supported on steel H-piles or 14-inch diameter MSP. The pier could be supported on the same driven pile foundations or shallow foundations. Due to relatively poor embankment soil conditions, we do not recommend shallow foundations at the abutments. The combination of granular soil and high groundwater conditions makes drilled shaft construction economically unfeasible.

5.2.1 Shallow Pier Foundations

Wang recommends shallow pier foundations be installed a minimum of 4.0 feet below the finished grade. Given the proposed pier locations shown on the preliminary TSL, the foundations would be installed within the very stiff silty clay (**Layer 3**), approximately 2.0 to 3.0 feet above the medium dense sand (**Layer 4**). The required geotechnical resistance factor for the shallow foundations (Φ_b) is 0.45 (AASHTO, 2007). and For an assumed 5.0-foot wide footing installed at elevations of 651.1 and 651.3 feet, we estimate the foundations should be designed for a maximum factored bearing capacity of 4,000 psf. A summary of the bearing capacity analysis is provided in Table 2. The maximum factored load produces an estimated pier settlement of 1.0-inch over 10 years.

Table 2: Summary of IL 95 Shallow Pier Foundation Recommendations

Structure Unit	Boring ID	Footing Base Elevation (feet)	Assumed Footing Width (feet)	Maximum Factored Bearing Capacity (psf)
West Pier #1	RR-04	651.3	5.0	4,000
East Pier #2	RR-03	651.1	5.0	4,000

The estimated friction angle between the base of a concrete abutment wall and the very stiff silty clay is 23°. The corresponding friction coefficient is 0.42 (NAVFAC, 1986). Abutments on shallow foundations should be designed with a geotechnical resistance factor against sliding (Φ_τ) of 0.80 (AASHTO, 2007). Our analysis shows the footings will be stable for a lateral load of 3 kips.

5.2.2 Driven Piles

IDOT specifies the maximum nominal required bearing ($R_{N\ MAX}$) 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 (AASHTO, 2007; IDOT, 2009). Nominal tip and side resistance were estimated using the methods and empirical equations presented in *AGMU Memorandum 10.2 – Geotechnical Pile Design* (IDOT, 2009). We have estimated pile lengths for a variety of nominal and factored loads. The R_F, R_N, estimated pile tip elevations, and lengths for driven piles are summarized in Table 3 (14-inch Diameter MSP with 0.25-inch walls), Table 4 (HP12x53), and Table 5 (HP14x73). Estimated pile lengths include a 2-foot embedment in the abutments and piers.

The R_F estimates are governed by the relationship $R_F = \phi_G R_N - \phi_G(DD+S_C+L_{iq}) - DD$ (IDOT, 2009). The total long-term consolidation settlement of the clay and clay loam fill (**Layer 1**) is estimated at 1.0-inch. However, due to the relatively small profile grade change, we estimate the settlement below the base of the abutment (679.4 feet) will be 0.25-inch; therefore we do not anticipate settlement concerns requiring downdrag (DD) allowances.

Table 3: Estimated Pile Lengths and Tip Elevations for 14-inch Diameter Metal Shell Piles

Structure Unit	Pile Encasement Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Nominal Downdrag Load, DD (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment	679.4	400	0.0	220	59	622.7
		364	0.0	200	34	647.7
		291	0.0	160	34	647.7
		218	0.0	120	34	647.7
Pier 1	651.3	400	0.0	220	52	600.5
		364	0.0	200	52	600.5
		291	0.0	160	19	633.6
		218	0.0	120	10	641.8
Pier 2	651.1	400	0.0	220	56	595.9
		364	0.0	200	52	600.7
		291	0.0	160	23	629.6
		218	0.0	120	11	641.1
East Abutment	679.2	400	0.0	220	43	637.9
		364	0.0	200	38	643.6
		291	0.0	160	34	647.0
		218	0.0	120	34	647.0

Table 4: Estimated Pile Lengths and Tip Elevations for HP12x53 Pile Size

Structure Unit	Pile Encasement Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Nominal Downdrag Load, DD (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment	679.4	400	0.0	220	79	602.3
		364	0.0	200	59	622.7
		291	0.0	160	33	648.7
		218	0.0	120	32	649.9
Pier 1	651.3	400	0.0	220	68	584.2
		364	0.0	200	61	590.9
		291	0.0	160	57	595.4
		218	0.0	120	54	597.9
Pier 2	651.1	400	0.0	220	56	596.4
		364	0.0	200	52	600.0
		291	0.0	160	46	606.1
		218	0.0	120	36	616.1
East Abutment	679.2	400	0.0	220	69	612.0
		364	0.0	200	69	612.0
		291	0.0	160	38	643.6
		218	0.0	120	32	649.1

Table 5: Estimated Pile Lengths and Tip Elevations for HP14x73 Pile Size

Structure Unit	Pile Encasement Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Nominal Downdrag Load, DD (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
West Abutment	679.4	578	0.0	318	97	583.9
		545	0.0	300	85	596.3
		455	0.0	250	65	616.8
		364	0.0	200	33	648.5

Structure Unit	Pile Encasement Base Elevation (feet)	Required Nominal Bearing, R_N (kips)	Nominal Downdrag Load, DD (kips)	Factored Resistance Available, R_F (kips)	Total Estimated Pile Length (feet)	Estimated Pile Tip Elevation (feet)
Pier 1	651.3	578	0.0	318	72	580.5
		545	0.0	300	70	582.5
		455	0.0	250	61	591.0
		364	0.0	200	57	595.5
Pier 2	651.1	578	0.0	318	61	591.6
		545	0.0	300	59	593.3
		455	0.0	250	54	598.3
		364	0.0	200	48	604.2
East Abutment	679.2	578	0.0	318	89	592.6
		545	0.0	300	81	600.0
		455	0.0	250	69	612.0
		364	0.0	200	40	641.0

5.2.3 Lateral Loading

Lateral loads on piles should be analyzed for maximum moments and lateral deflections. Recommended lateral soil modulus parameters and soil strain parameters required for analysis via the p-y curve method are included in Table 6. Due to high groundwater elevations, all granular soils should be considered under submerged (effective) conditions. A preliminary analysis of lateral capacity for 14-inch MSP driven to 19 feet bgs at Pier 1 under 3.0 kips of lateral load shows a lateral deflection of approximately 0.2 inches.

Table 6: Recommended Soil Parameters for Lateral Load Pile Analysis

Soil Type (Layer)	Effective Unit Weight, $\gamma'^{1)}$ (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 and Clay Loam Fill (1)	58	1000	0	1000	0.7

Soil Type (Layer)	Effective Unit Weight, γ'[1)] (pcf)	Undrained Shear Strength, c_u (psf)	Estimated Friction Angle, Φ (°)	Estimated Lateral Soil Modulus Parameter, k (pci)	Estimated Soil Strain Parameter, ε_{50} (%)
M Stiff to Stiff Silty Clay Loam (2)	58	800	0	500	1
Soft Silty Clay Loam (2)	53	500	0	200	2
V Stiff Silty Clay (3)	63	2000	0	1500	0.5
M Dense Sand (4)	58	0	32-34	60	--
M Dense Silt (5)	58	0	30-32	60	--
Hard Clay (5)	63	4000	0	2000	0.5

1) Effective unit weight for soils below the groundwater table at EL 645 feet. For layers above the water table, add 62.4 pcf to obtain total unit weight.

5.3 Stage Construction Considerations

Wang understands the replacement of the IL 95 Bridge will be performed in stages: stage one will include the removal and replacement of the northern 17.6 feet of the bridge; stage two replaces the southern 17.6 feet. The locations of the new abutments shown on the TSL suggest large cut sections and complete removal of the existing shallow foundations at the toe slope. To accommodate the stage construction, flexible cantilever steel sheet pile walls will be driven along the stage-line behind both existing abutments. The groundwater level will not require underwater structure excavation protection. Wang believes sheet piling is an economically feasible soil shoring method based on the design charts provided by IDOT (IDOT, 2009) and that temporary wire or geotextile-supported MSE walls are not a feasible alternative due to the required cuts; a more elaborate temporary soil retention system will not be required.

Wang assumes that required cut sections will be supported by temporary walls. Any temporary excavation slopes should be graded at no greater than 2.5:1 (H:V) and the geometry should be checked for stability prior to construction. Estimated geotechnical parameters for the design of the temporary sheet pile walls behind the abutments are included in Table 7.

Table 7: Geotechnical Parameters for Design of Temporary Stage Line Sheet Pile Walls

Soil Description	Effective Unit Weight[1)] (pcf)	Undrained Shear Strength Properties		Earth Pressure Coefficients	
		Cohesion (psf)	Friction Angle (°)	Active Pressure	Passive Pressure
Stiff Silty Clay and Clay Loam Fill (1)	58	1000	0	1.00	1.00
M Stiff to Stiff Silty Clay Loam (2)	58	800	0	1.00	1.00
Soft Silty Clay Loam (2)	53	500	0	1.00	1.00
V Stiff Silty Clay (3)	63	2000	0	1.00	1.00
M Dense Sand (4)	58	0	32	0.31	3.26
M Dense Silt (5)	58	0	31	0.32	3.12
Hard Clay (5)	63	4000	0	1.00	1.00

1) Effective unit weight for soils below the groundwater table at EL 645 feet. For layers above the water table, add 62.4 pcf to obtain total unit weight.

6.0 CONSTRUCTION CONSIDERATIONS

6.1 Site Preparation

All vegetation, surface topsoil, existing pavement, and debris should be cleared and stripped where approach embankment 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 Utilities

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

No utility conflicts were identified that would impact the foundation design. However, the Contractor should ensure there are no utility conflicts with the final design and construction program.

6.3 Filling and Backfilling

Fill material required to attain the final design elevations should be structural fill material. Coarse aggregate of IDOT gradation CA-7 or pre-approved, compacted, cohesive or granular soil conforming to IDOT Section 204 would be acceptable as structural fill (IDOT, 2007). The fill material should be free of organic matter and debris. The onsite clayey soils encountered near the surface have plasticities too high to be considered for structural fill unless improvement measures, such as lime additive, are taken to lower the plasticity. Structural fill should be placed in lifts and compacted according to Section 205, *Embankment* (IDOT, 2007).

All backfill materials must be pre-approved by the Resident Engineer. To backfill the abutments and pier we recommend porous granular material, such as crushed stone or crushed gravel that conforms to the gradation requirements specified in IDOT Articles 1004.01 or 1004.05 (IDOT, 2007). Backfill material should be placed and compacted in accordance with the Section 205, *Embankment* (IDOT, 2007) and the IDOT *Bridge Manual* (IDOT, 2009). Estimated design parameters for granular structural backfill materials are presented in Table 8.

Table 8: Estimated Granular Backfill Parameters

Soil Description	Porous Granular Material Backfill
Unit Weight	125 pcf
Angle of Effective Internal Friction	32°
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 Piling

Driven piles shall be furnished and installed according to the requirements of IDOT Section 512, *Piling* (IDOT, 2007) and steel H-piles shall be according to AASHTO M270, Grade 50. Wang recommends a minimum of one test pile be performed at each abutment and pier location. Test piles should be driven to 110 percent of the nominal required bearing indicated above in Tables 3, 4, and 5 of Section 5.2. Due to anticipated hard driving conditions within the sand, we recommend the piles be driven with a metal shoe.

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 WHKS & Company 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, PhD., P.E.
Senior Geotechnical Engineer	QA/QC Reviewer

REFERENCES

AMERICAN ASSOCIATION OF STATE HIGHWAY TRANSPORTATION OFFICIALS (2007) *LRFD Bridge Design Specifications*. United States Department of Transportation, Washington, D.C.

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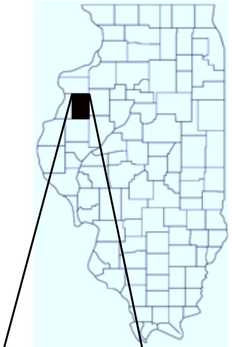
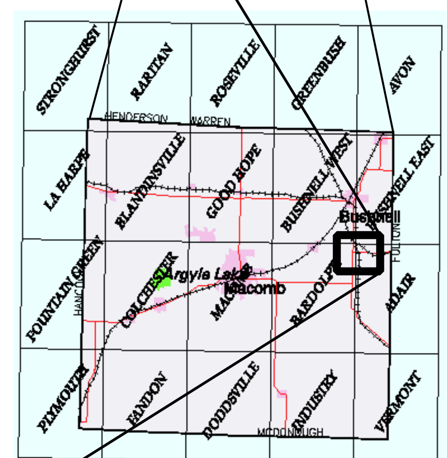
LOUCHIOS, A., ELRICK, S., KOROSE, C., and MORSE, D. (2008) *Coal Mines McDounough County Quad Maps*, ISGS Sep. 15, 2008.

WILLMAN, H.B. (1970) *Pleistocene Stratigraphy of Illinois: ISGS Bulletin 94.* Urbana, Illinois State Geological Survey, 204 p.

EXHIBITS

0 1/4 1/2 3/4 1.0 miles





McDonough County

SITE LOCATION MAP: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: GRAPHICAL	EXHIBIT 1	DRAWN BY: C. Marin CHECKED BY: L.Iordache

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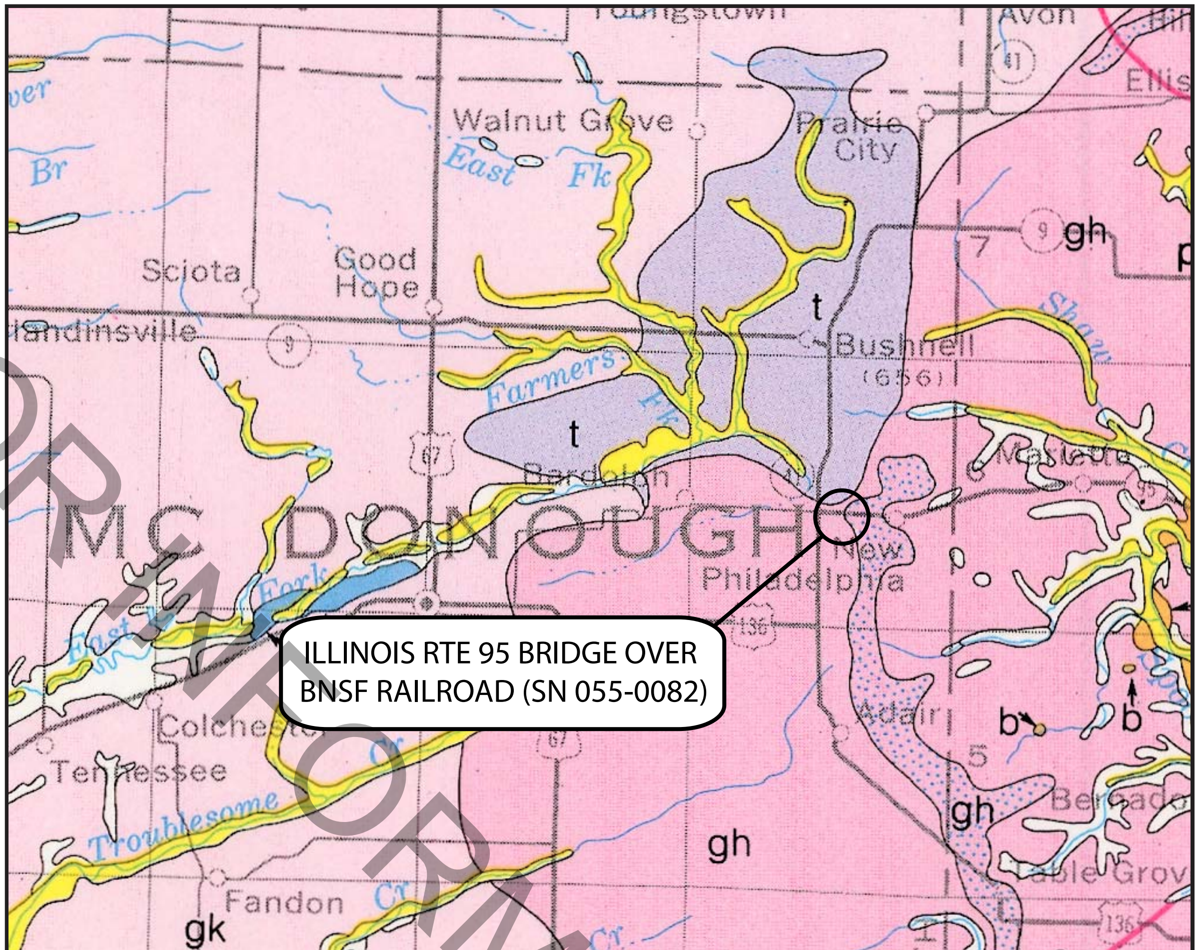
760-01-02



Modified after Lineback (1979)

0 1 2 3 4 miles

LEGEND

Post Glacial Deposits

c	**Cahokia Alluvium** Deposits in flood plains and channels of modern rivers and streams; poorly sorted sand, silt and clay;

Glacial Cover

Teneriffe Silt,

t	Mostly silt and clayey silt with beds of sand or clay deposited in large proglacial lakes associated with several Illinoian glaciers;

Pearl Formation,

pe	Sand, gravel and some silt in outwash plains and valley-train deposits of Illinoian glaciers;

Glasford Formation,

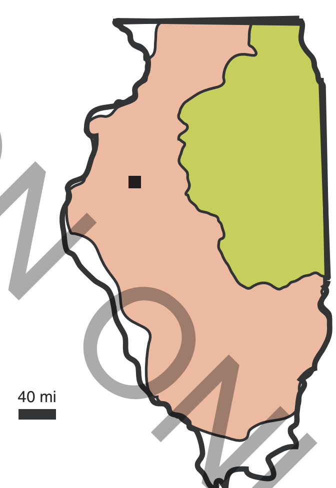
ml	**Moraine** The moraines consists of subdued, rounded ridges of till and some outwash sands and gravels;
gh	**Hulick Till Member,** Hard, compact sandy till, with sand and gravel
gk	**Kellerville Till Member,** Brown and gray silty till with discontinuous sand and gravel bed;

Banner Formation,

b	Mostly till, but includes small areas of outwash sands and gravels and lacustrine silt and clay;

Modified after Lineback, 1979.

REGIONAL GEOLOGY



Wedron Group

Glasford Formation

Modified after Hansel and Johnson (1996)

SITE AND REGIONAL GEOLOGY: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: GRAPHICAL	EXHIBIT 2	DRAWN BY: C. MARIN CHECKED BY: L.IORDACHE

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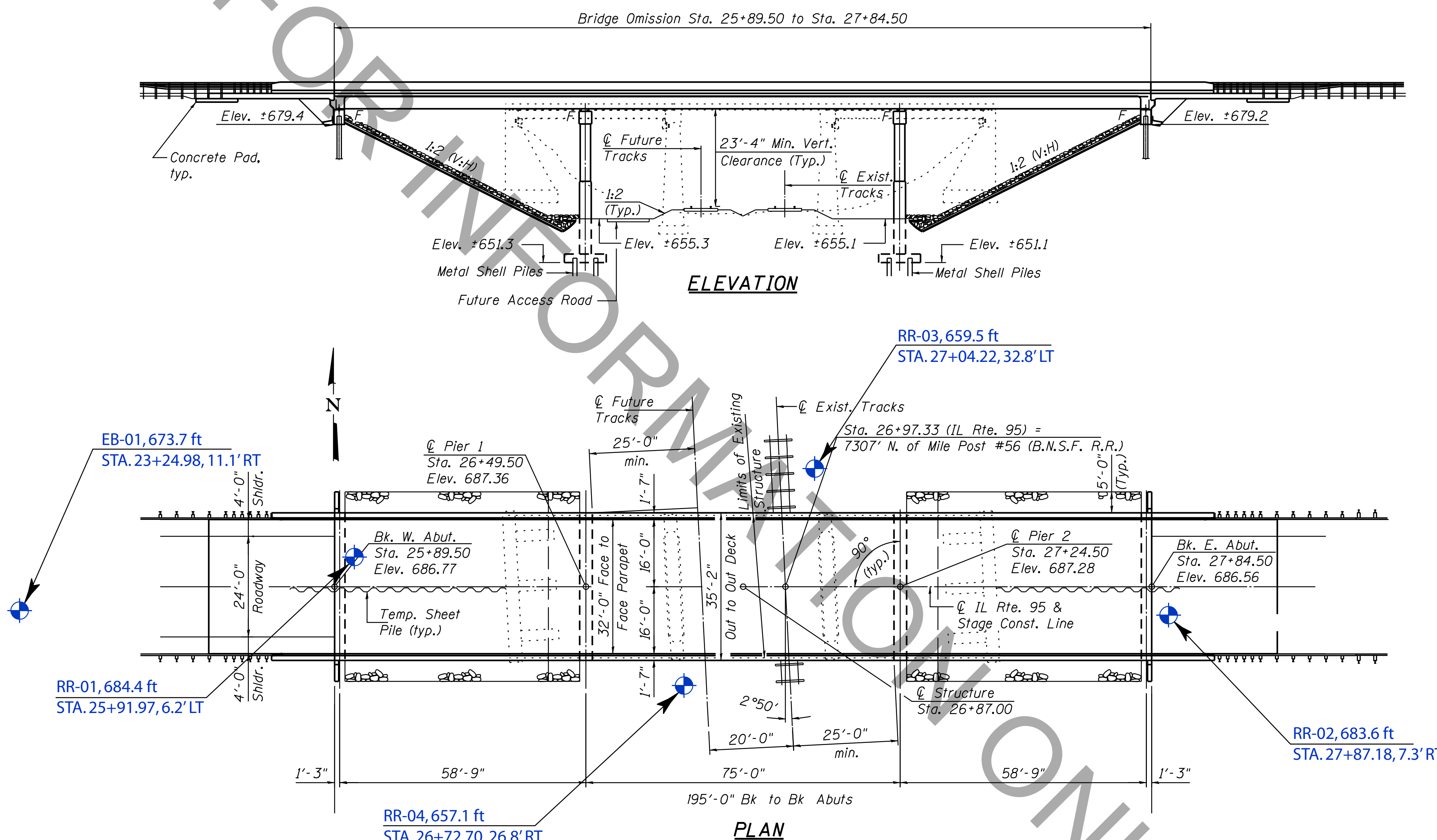
760-01-02



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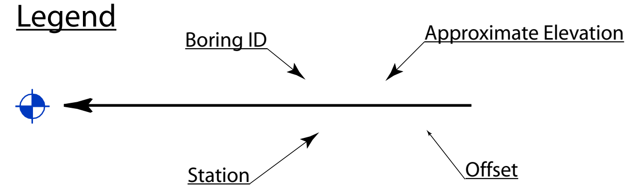

BORING LOCATION PLAN: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: AS SHOWN	EXHIBIT 3	DRAWN BY: MLS CHECKED BY: LMI

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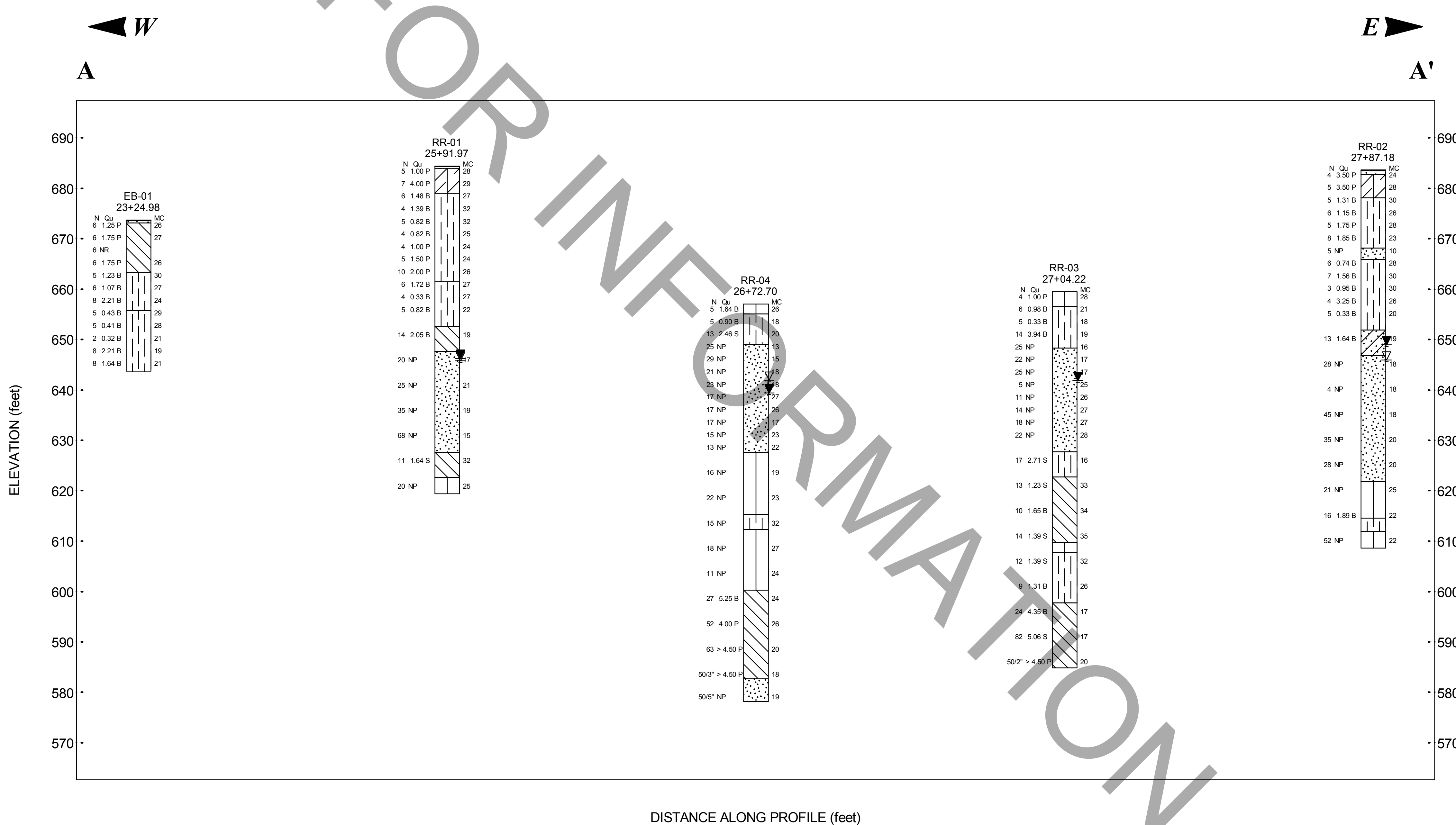
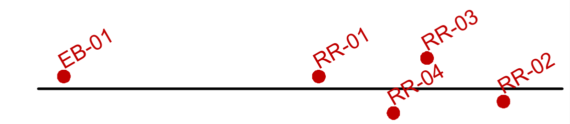


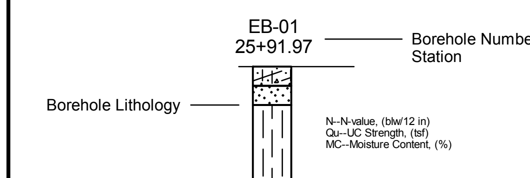
Lithology Graphics

- Pavement
- Concrete
- IDH Sand, Sandy Loam
- IDH Clay Loam
- IDH Clay
- IDH Silt, Silty Loam
- IDH Silty Clay, Silty Clay Loam
- IDH Sandy Clay, Sandy Clay Loam



Site Map Scale 1 inch equals 200 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: 2x

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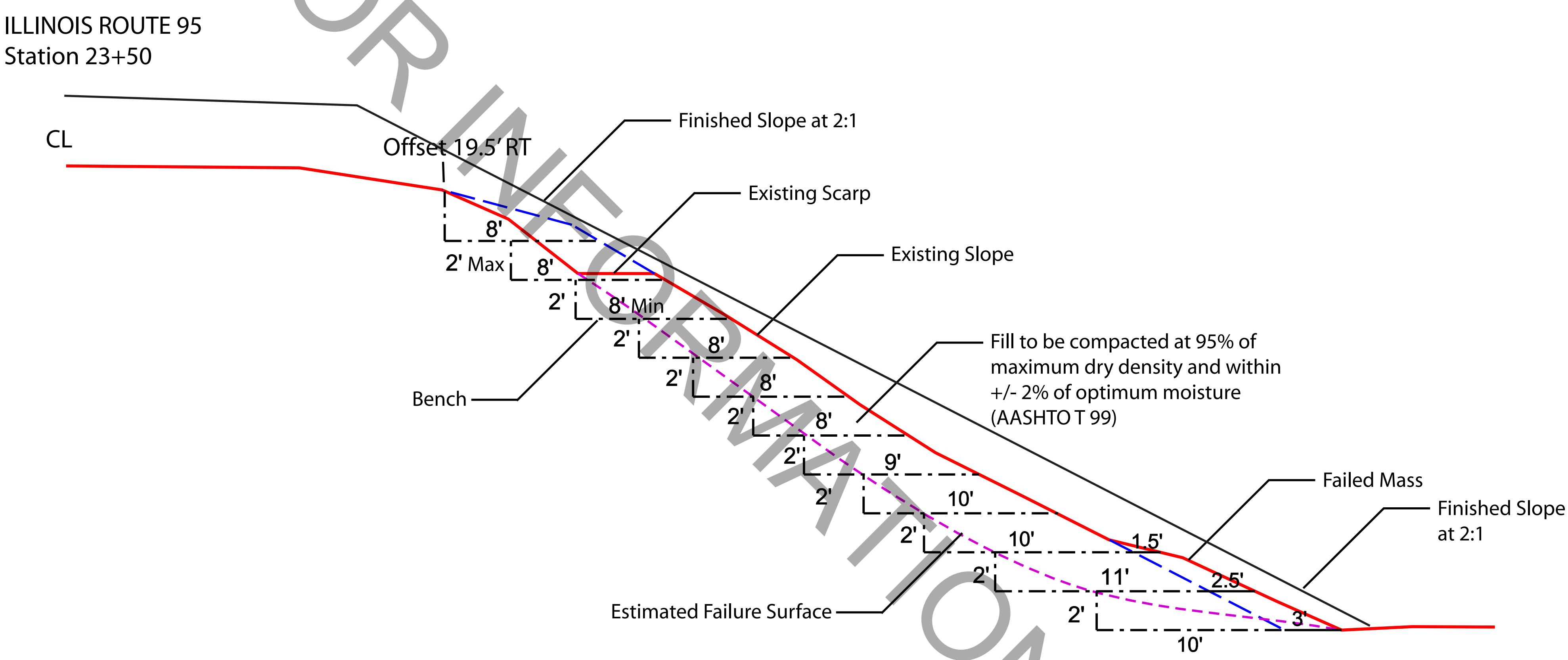
Soil Profile A-A'
SN 055-0082, Sec (122VB)BR-1

WEI SINCE 1982

IL Route 95 over the BNSF Railroad
McDonough County, IL

JOB NUMBER	PLATE NUMBER
760-01-02	EXHIBIT A-1

WEI 11X17 7600102.GPJ WANGENG.GDT 3/8/10



*To be used in conjunction with Illinois Department of Transportation Benching Detail for Embankment Widening (Sheet BD-51)

EXAMPLE BENCHING DETAIL: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: GRAPHICAL	EXHIBIT 5	DRAWN BY: END CHECKED BY: MLS

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FOR WHKS & COMPANY ENGINEERING | 760-01-02

APPENDIX A

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

BORING LOG EB-01

WEI Job No.: 760-01-02

Client: **WHKS & Company Engineering**
Project: **IL Route 95 over the BNSF Railroad**
Location: **McDonough County, IL**

Datum: NGVD
Elevation: 673.70 ft
North: 1392741.74 ft
East: 2205044.56 ft
Station: 23+24.98
Offset: 11.12' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
673.6	1.5-inch thick ASPHALT --PAVEMENT--					
673.1	Brown SANDY LOAM, some gravel --FILL--		1	4 3 3	1.25 P	26
	Stiff, brown CLAY and CLAY LOAM --FILL--		2	3 3 3	1.75 P	27
		5				
			3	2 3 3	NR	
			4	2 3 3	1.75 P	26
		10				
663.2	Stiff to very stiff, black and gray SILTY CLAY --FILL--		5	2 2 3	1.23 B	30
			6	1 3 3	1.07 B	27
		15				
			7	2 4 4	2.21 B	24
655.7	Stiff to very stiff, brown and gray SILTY CLAY LOAM to SILT		8	1 2 3	0.43 B	29
		20				
			9	1 2 3	0.41 B	28
			10	1 1 1	0.32 B	21
		25				
			11	2 3 5	2.21 B	19
			12	2 4 4	1.64 B	21
643.7	Boring terminated at 30.00 ft	30				
		35				
		40				

GENERAL NOTES

Begin Drilling **11-05-2008** Complete Drilling **11-05-2008**
Drilling Contractor **Wang Testing Service** Drill Rig **Mobile B-57 TMR**
Driller **K & J** Logger **F. Bozga** Checked by **E. Datz**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout 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.

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BORING LOG RR-01

WEI Job No.: 760-01-02

Client **WHKS & Company Engineering**
Project **IL Route 95 over the BNSF Railroad**
Location **McDonough County, IL**

Datum: NGVD
Elevation: 684.40 ft
North: 1392741.67 ft
East: 2205312.08 ft
Station: 25+91.97
Offset: 6.18' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
684.3	1.5-inch thick ASPHALT --PAVEMENT--					
683.9	5.5-inch thick CONCRETE --PAVEMENT--					
	Stiff to hard, brown and black CLAY LOAM --FILL--		1	3, 2, 3	1.00 P	28
		5	2	3, 3, 4	4.00 P	29
678.9	Medium stiff to very stiff, black, brown, and gray SILTY CLAY --FILL--		3	1, 3, 3	1.48 B	27
		10	4	1, 1, 3	1.39 B	32
			5	1, 2, 3	0.82 B	32
		15	6	1, 1, 3	0.82 B	25
			7	2, 1, 3	1.00 P	24
		20	8	1, 3, 2	1.50 P	24
			9	4, 4, 6	2.00 P	26
661.4	Soft to stiff, brown SILTY CLAY LOAM to SILT	25	10	2, 3, 3	1.72 B	27
			11	1, 2, 2	0.33 B	27
		30	12	1, 3, 2	0.82 B	22
652.7	Very stiff, brown and black CLAY	35	13	3, 5, 9	2.05 B	19
647.7	Medium dense to very dense, brown SAND	40	14	4, 10, 10	NP	17

GENERAL NOTES

Begin Drilling **11-05-2008** Complete Drilling **11-05-2008**
Drilling Contractor **Wang Testing Service** Drill Rig **Mobile B-57 TMR**
Driller **K & J** Logger **F. Bozga** Checked by **E. Datz**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling ▽ **39.00 ft**
At Completion of Drilling ▼ **38.50 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

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BORING LOG RR-01

WEI Job No.: 760-01-02

Client: **WHKS & Company Engineering**
Project: **IL Route 95 over the BNSF Railroad**
Location: **McDonough County, IL**

Datum: NGVD
Elevation: 684.40 ft
North: 1392741.67 ft
East: 2205312.08 ft
Station: 25+91.97
Offset: 6.18' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45	15	0 11 14	NP	21
		50	16	4 14 21	NP	19
		55	17	16 31 37	NP	15
627.7	Stiff, gray CLAY					
		60	18	4 4 7	1.64 S	32

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
622.7	Medium dense, gray SILT					
619.4		65	19	5 10 10	NP	25
	Boring terminated at 60.00 ft					
		70				
		75				
		80				

GENERAL NOTES

Begin Drilling: **11-05-2008** Complete Drilling: **11-05-2008**
Drilling Contractor: **Wang Testing Service** Drill Rig: **Mobile B-57 TMR**
Driller: **K & J** Logger: **F. Bozga** Checked by: **E. Datz**
Drilling Method: **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling: **39.00 ft**
At Completion of Drilling: **38.50 ft**
Time After Drilling: **NA**
Depth to Water: **NA**

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

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BORING LOG RR-02

WEI Job No.: 760-01-02

Client: **WHKS & Company Engineering**
Project: **IL Route 95 over the BNSF Railroad**
Location: **McDonough County, IL**

Datum: NGVD
Elevation: 683.60 ft
North: 1392715.57 ft
East: 2205506.03 ft
Station: 27+87.18
Offset: 7.26' RT

SOIL AND ROCK DESCRIPTION

Elevation (ft)	Soil and Rock Description	Depth (ft)
683.5	1.5-inch thick ASPHALT --PAVEMENT--	
682.7	10.5-inch thick CONCRETE --APPROACH SLAB--	
	Very stiff, black CLAY LOAM --FILL--	5
678.1	Stiff, brown, black and gray SILTY CLAY --FILL-- --L_L = 48%, P_L = 21%-- --% Gravel = 0.1%-- --% Sand = 1.1%-- --% Silt = 67.4%-- --% Clay = 31.4%--	10, 15
668.1	Loose, brown and black SAND --FILL--	
665.9	Soft to stiff, brown and gray SILTY CLAY LOAM to SILT	20
	Shebly tube (ST#1) 23' to 25'	25
	Shebly tube (ST#2) 25' to 27' --L_L = 35%, P_L = 22%-- --% Gravel = 0.0%-- --% Sand = 0.3%-- --% Silt = 80.5%-- --% Clay = 19.2%--	30
651.9	Stiff, brown SANDY CLAY	35
646.9	Loose to dense, brown SAND	40

Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
1	2 2 2	3.50 P	24
2	3 2 3	3.50 P	28
3	2 2 3	1.31 B	30
4	2 2 4	1.15 B	26
5	1 2 3	1.75 P	28
6	2 2 6	1.85 B	23
7	2 2 3	NP	10
8	1 2 4	0.74 B	28
9	2 3 4	1.56 B	30
10	1 1 2	0.95 B	30
11	1 2 2	3.25 B	26
12	2 2 3	0.33 B	20
13	2 5 8	1.64 B	19
14	8 12 16	NP	18

GENERAL NOTES

Begin Drilling **11-04-2008** Complete Drilling **11-04-2008**
Drilling Contractor **Wang Testing Service** Drill Rig **Mobile B-57 TMR**
Driller **K & J** Logger **F. Bozga** Checked by **E. Datz**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling **38.00 ft**
At Completion of Drilling **35.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

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BORING LOG RR-02

WEI Job No.: 760-01-02

Client **WHKS & Company Engineering**
Project **IL Route 95 over the BNSF Railroad**
Location **McDonough County, IL**

Datum: NGVD
Elevation: 683.60 ft
North: 1392715.57 ft
East: 2205506.03 ft
Station: 27+87.18
Offset: 7.26' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45	15	2 2 2	NP	18
		50	16	9 19 26	NP	18
		55	17	4 13 22	NP	20
		60	18	11 13 15	NP	20
621.9	Medium dense, gray SILT					
		65	19	6 9 12	NP	25
614.6	Stiff, gray SILTY CLAY					
		70	20	9 7 9	1.89 B	22
611.9	Very dense, gray SILT					
		75	21	10 23 29	NP	22
608.6	Boring terminated at 75.00 ft					

GENERAL NOTES

Begin Drilling **11-04-2008** Complete Drilling **11-04-2008**
Drilling Contractor **Wang Testing Service** Drill Rig **Mobile B-57 TMR**
Driller **K & J** Logger **F. Bozga** Checked by **E. Datz**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling **38.00 ft**
At Completion of Drilling **35.00 ft**
Time After Drilling **NA**
Depth to Water **NA**

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

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BORING LOG RR-03

WEI Job No.: 760-01-02

Client: **WHKS & Company Engineering**
Project: **IL Route 95 over the BNSF Railroad**
Location: **McDonough County, IL**

Datum: NGVD
Elevation: 659.50 ft
North: 1392760.91 ft
East: 2205425.77 ft
Station: 27+04.22
Offset: 32.77' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample Type recovery	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	36-inch thick, black, gravelly SILTY LOAM with clay interbeds --FILL--						
				1	2 1 3	1.00 P	28
656.5	Medium stiff to very stiff, brown SILTY CLAY LOAM to SILT						
		5		2	3 3 3	0.98 B	21
				3	2 2 3	0.33 B	18
		10		4	4 6 8	3.94 B	19
648.3	Loose to medium dense, light brown, medium SAND						
				5	4 10 15	NP	16
		15		6	7 10 12	NP	17
				7	9 12 13	NP	17
		20		8	1 2 3	NP	25
				9	3 4 7	NP	26
		25		10	3 6 8	NP	27
				11	4 7 11	NP	27
		30		12	6 9 13	NP	28
627.8	Very stiff, gray SILTY CLAY with sand						
		35		13	5 7 10	2.71 S	16
622.8	Stiff, gray CLAY						
		40		14	3 5 8	1.23 S	33

GENERAL NOTES

Begin Drilling **06-17-2009** Complete Drilling **06-17-2009**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 Turbo, ATV**
Driller **T & E** Logger **E. Datz** Checked by **M. Snider**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling ▽ **18.00 ft**
At Completion of Drilling ▼ **18.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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BORING LOG RR-03

WEI Job No.: 760-01-02

Client **WHKS & Company Engineering**
Project **IL Route 95 over the BNSF Railroad**
Location **McDonough County, IL**

Datum: NGVD
Elevation: 659.50 ft
North: 1392760.91 ft
East: 2205425.77 ft
Station: 27+04.22
Offset: 32.77' LT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
		45	15	3 4 6	1.65 B	34
			16	3 4 10	1.39 S	35
609.8	Gray SILT	50				
607.8	Stiff, gray SILTY CLAY					
		55	17	4 6 6	1.39 S	32
		60	18	2 4 5	1.31 B	26

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
597.8	Hard, brown and gray CLAY					
		65	19	10 11 13	4.35 B	17
		70	20	9 22 60	5.06 S	17
584.8	Boring terminated at 74.67 ft	75	21	11 27 50/2"	> 4.50 P	20
		80				

GENERAL NOTES

Begin Drilling **06-17-2009** Complete Drilling **06-17-2009**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 Turbo, ATV**
Driller **T & E** Logger **E. Datz** Checked by **M. Snider**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling ▽ **18.00 ft**
At Completion of Drilling ▼ **18.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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BORING LOG RR-04

WEI Job No.: 760-01-02

Client: **WHKS & Company Engineering**
Project: **IL Route 95 over the BNSF Railroad**
Location: **McDonough County, IL**

Datum: NGVD
Elevation: 657.06 ft
North: 1392703.55 ft
East: 2205390.56 ft
Station: 26+72.70
Offset: 26.76' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
	24-inch thick, black SILTY LOAM with gravel and cinders --FILL--		1	1, 2, 3	1.64 B	26
655.1	Medium stiff to very stiff, brown SILTY CLAY LOAM to SILT		2	1, 2, 3	0.90 B	18
		5	3	3, 5, 8	2.46 S	20
649.1	Medium dense, light brown, medium SAND		4	3, 10, 15	NP	13
		10	5	10, 13, 16	NP	15
			6	3, 10, 11	NP	18
		15	7	7, 10, 13	NP	18
			8	5, 6, 11	NP	27
		20	9	3, 6, 11	NP	26
			10	4, 6, 11	NP	17
		25	11	3, 6, 9	NP	23
627.6	Medium dense, gray SILT		12	5, 6, 7	NP	22
		30	13	8, 8, 8	NP	19
		35	14	5, 11, 11	NP	23
		40				

GENERAL NOTES

Begin Drilling **06-15-2009** Complete Drilling **06-15-2009**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 Turbo, ATV**
Driller **T & E** Logger **E. Datz** Checked by **M. Snider**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling ▽ **15.50 ft**
At Completion of Drilling ▼ **18.00 ft**
Time After Drilling **NA**
Depth to Water ▼ **NA**

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

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BORING LOG RR-04

WEI Job No.: 760-01-02

Client **WHKS & Company Engineering**
Project **IL Route 95 over the BNSF Railroad**
Location **McDonough County, IL**

Datum: NGVD
Elevation: 657.06 ft
North: 1392703.55 ft
East: 2205390.56 ft
Station: 26+72.70
Offset: 26.76' RT

Elevation (ft)	SOIL AND ROCK DESCRIPTION	Depth (ft)	Sample No.	SPT Values (blw/6 in)	Qu (tsf)	Moisture Content (%)
615.3	Very stiff, gray SILTY CLAY					
		45	15	4 6 9	NP	32
612.3	Medium dense, gray SILT					
		50	16	5 8 10	NP	27
		55	17	2 4 7	NP	24
600.3	Hard, brown and gray CLAY with gravel					
		60	18	5 9 18	5.25 B	24
		65	19	5 24 28	4.00 P	26
		70	20	9 28 35	> 4.50 P	20
582.8	Very dense, fine SANDY LOAM with gravel	75	21	15 50/3"	> 4.50 P	18
578.2	Boring terminated at 78.90 ft	80	22	50/5"	NP	19

GENERAL NOTES

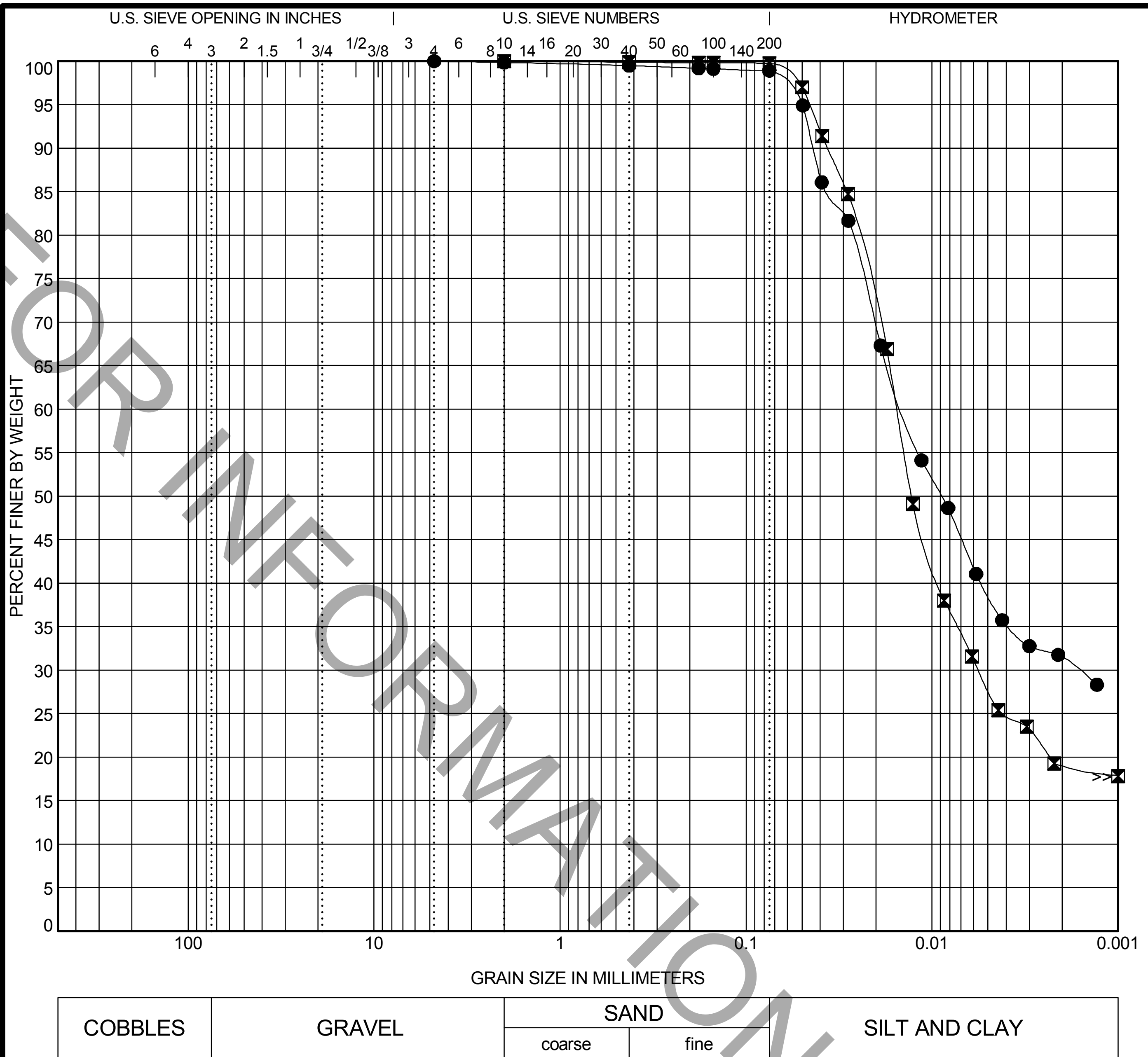
Begin Drilling **06-15-2009** Complete Drilling **06-15-2009**
Drilling Contractor **Wang Testing Service** Drill Rig **D-50 Turbo, ATV**
Driller **T & E** Logger **E. Datz** Checked by **M. Snider**
Drilling Method **3.25-IDA HSA, Boring backfilled with lean grout upon completion**

WATER LEVEL DATA

While Drilling ▽ **15.50 ft**
At Completion of Drilling ▼ **18.00 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



	Specimen Identification		IDH Classification	LL	PL	PI	Cc	Cu
●	**RR-02**	**6.0**	**Silty Clay**	**48**	**21**	**27**		
⧗	**RR-02ST**	**25.0**	**Silt**	**35**	**22**	**13**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**RR-02**	**6.0**	**4.75**	**0.014**	**0.002**		**0.1**	**1.1**	**67.4**	**31.4**
⧗	**RR-02ST**	**25.0**	**2**	**0.015**	**0.006**		**0.0**	**0.3**	**80.5**	**19.2**

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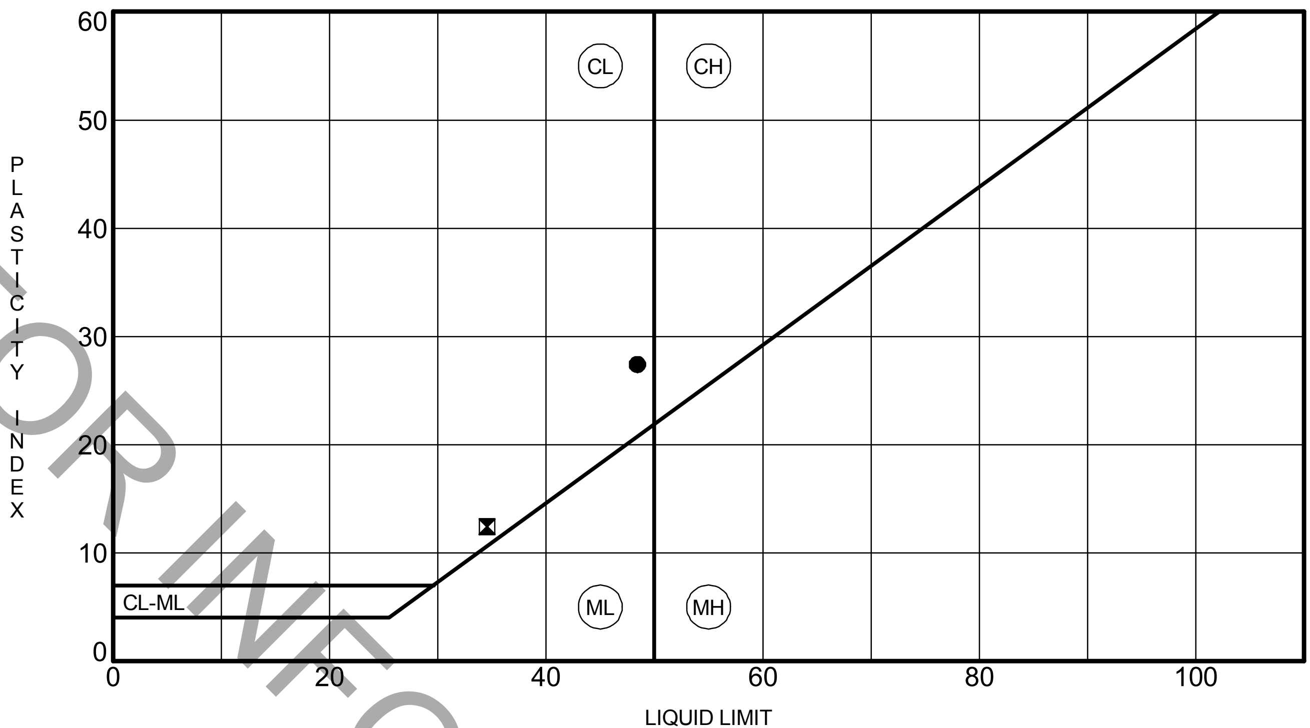
GRAIN SIZE DISTRIBUTION

Project: IL Route 95 over the BNSF Railroad

Location: McDonough County, IL

Number: 760-01-02



	Specimen Identification		LL	PL	PI	Fines	IDH Classification
●	**RR-02**	**6.0**	**48**	**21**	**27**	**99**	**Silty Clay**
⧗	**RR-02ST**	**25.0**	**35**	**22**	**13**	**100**	**Silt**

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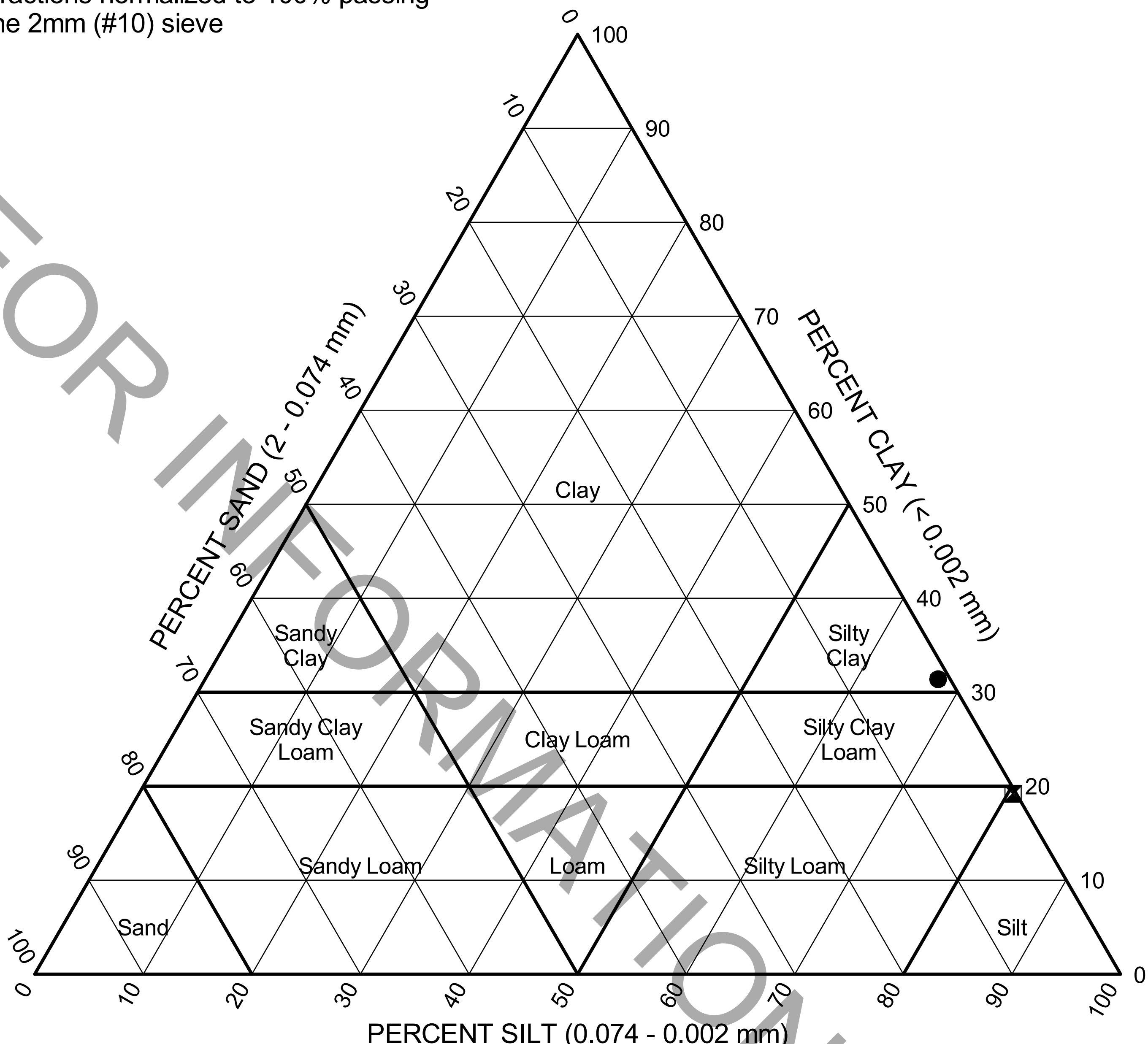
ATTERBERG LIMITS' RESULTS

Project: IL Route 95 over the BNSF Railroad

Location: McDonough County, IL

Number: 760-01-02

Fractions normalized to 100% passing the 2mm (#10) sieve



	Borehole	Depth	Sand (%)	Silt (%)	Clay (%)	Classification		
						IL DOT	AASHTO	ASTM
●	**RR-02**	**6.0**	**1.1**	**67.5**	**31.4**	**Silty Clay**	**A-7-6 (30)**	**CL**
⧗	**RR-02ST**	**25.0**	**0.3**	**80.5**	**19.2**	**Silt**	**A-6 (14)**	**CL**

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IDH Textural Classification Chart

Project: IL Route 95 over the BNSF Railroad

Location: McDonough County, IL

Number: 760-01-02

WEI_IDH 7600102.GPJ WANGENG.GDT 3/1/10

UNCONFINED COMPRESSIVE STRENGTH
(AASHTO T 208 / ASTM 2166)

Project: IL Rte 95 over the BNSF Railroad
Client: WHKS & Company Engineering
WEI Job No.: 760-01-02
Sample ID/Location: Boring RR-02, ST#2, 25' to 27'
Type/Condition: Shelby Tube/undisturbed

Analyst name: *R. Edelmann*
Date received: *4-Nov-08*
Test date: *5-Jan-09*
Sample description:

Brown and Gray
SILTY CLAY LOAM

Average initial height h_0 = *5.96* in
Average initial diameter d_0 = *2.83* in
Height to diameter ratio= *2.10*
Mass of wet sample and tare M_i = *1411.80* g
Mass of dry sample and tare M_d = *1147.40* g
Mass of tare M_t = *186.70* g
Mass of sample Ms= *1225.10* g
Estimated specific gravity G_s = *2.75*

Initial water content w = 27.52% (sample)
Initial unit weight g = 124.22 pcf
Initial dry unit weight g_d = 97.41 pcf
Initial void ratio e_0 = 0.76
Initial degree of saturation S_r = 99%
Young's modulus E = 25.14 tsf
Unconfined compressive strength q_u = 0.95 tsf
Shear Strength= 0.47 tsf

Displacement (in) Δh	Force (lbs) F	Strain (%) e	Stress (tsf) s
0.00	*0.00*	0.00	0.00
0.02	*6.22*	0.34	0.07
0.03	*10.37*	0.50	0.12
0.04	*14.52*	0.67	0.16
0.05	*16.59*	0.84	0.19
0.08	*30.07*	1.34	0.34
0.10	*39.41*	1.68	0.44
0.12	*47.70*	2.02	0.53
0.15	*60.15*	2.52	0.67
0.18	*66.37*	3.02	0.73
0.21	*70.52*	3.53	0.78
0.25	*78.81*	4.20	0.86
0.30	*82.96*	5.04	0.90
0.35	*87.11*	5.88	0.94
0.40	*89.18*	6.72	0.95
0.45	*89.18*	7.56	0.94
0.50	*90.22*	8.40	0.94
0.60	*89.18*	10.08	0.92
0.70	*76.74*	11.75	0.77
0.80	*49.78*	13.43	0.49
0.90	*45.63*	15.11	0.44

NOTES: ______

Prepared by: ______ Date: ______

Checked by: ______ Date: ______

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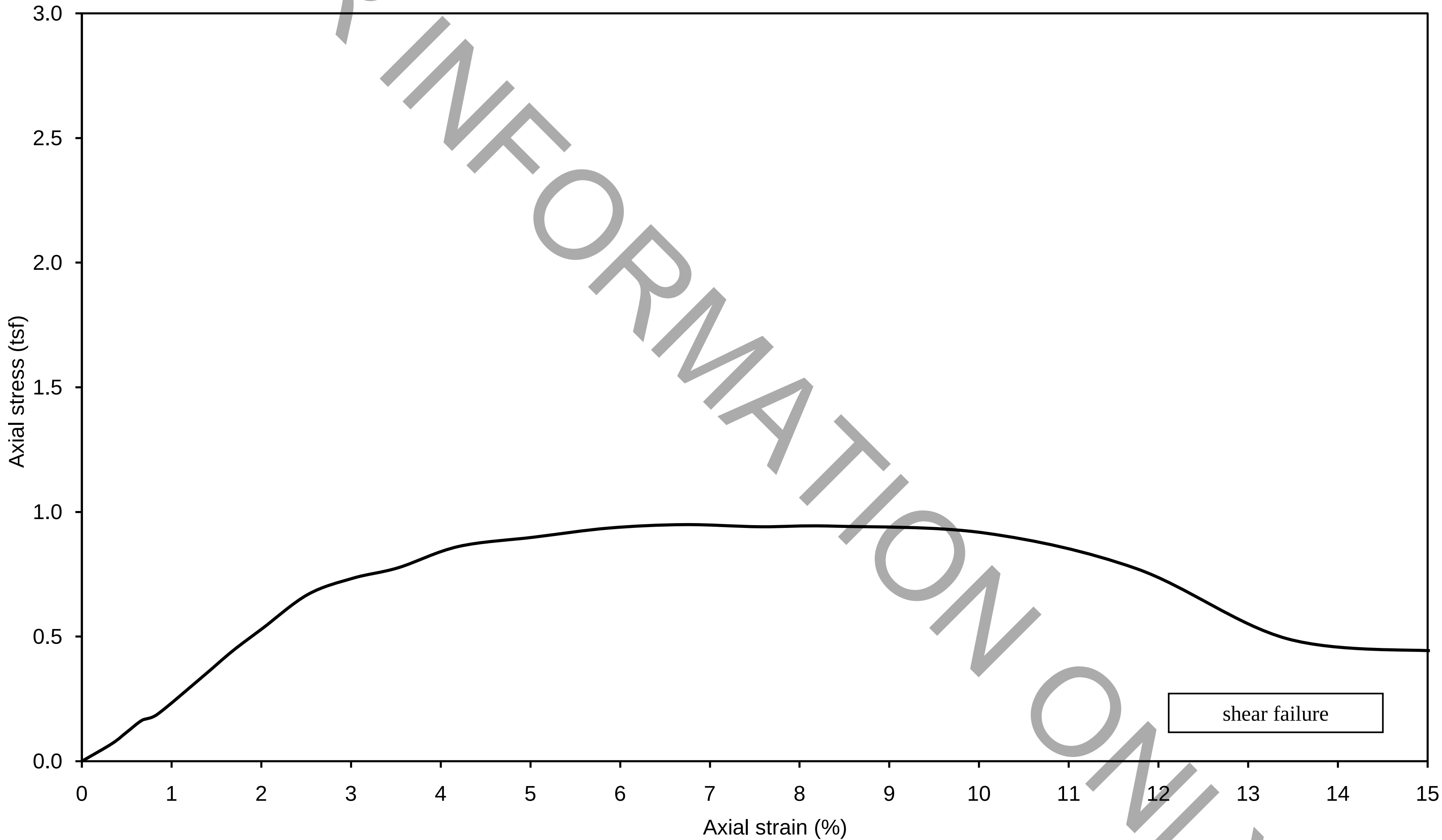
Axial Stress vs. Axial Strain
Unconfined Compressive Strength
Boring RR-02, ST#2, 25' to 27'



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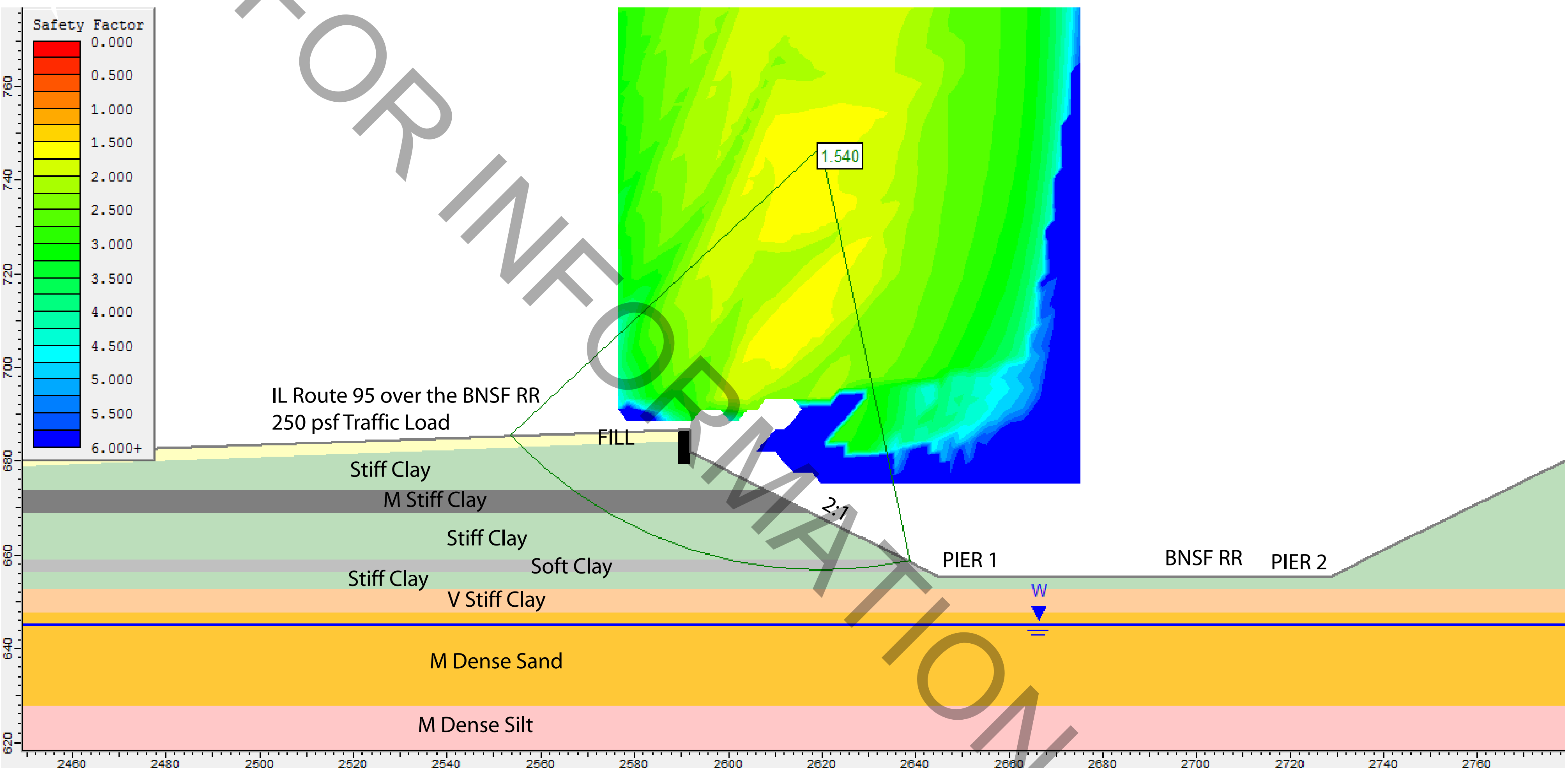
APPENDIX C



Undrained (Short Term) Analysis

Layer ID	Description	Unit Weight (lb/ft3)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
FILL	Cohesive FILL	125	1000	0
1	Stiff CLAY	120	1000	0
1	M Stiff CLAY	120	800	0
1	Soft CLAY	115	500	0
2	V Stiff CLAY	125	2000	0
3	M Dense SAND	120	0	32
4	M Dense SILT	120	0	31

GLOBAL STABILITY ANALYSIS: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

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

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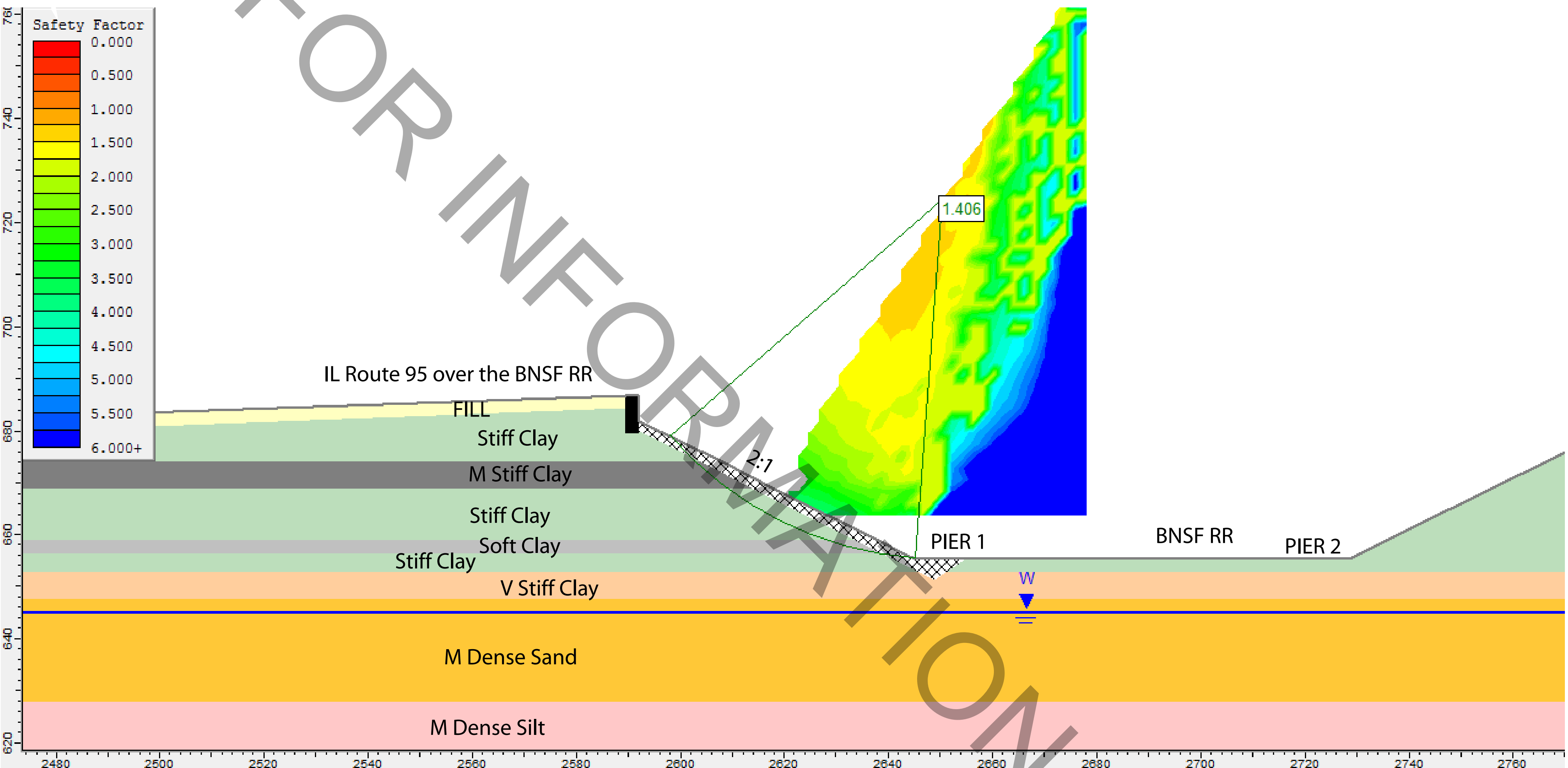
FOR WHKS & COMPANY ENGINEERING | 760-01-02



Drained (Long Term) Analysis

Layer ID	Description	Unit Weight (lb/ft3)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
FILL	Cohesive FILL	125	100	30
1	Stiff CLAY	120	75	28
1	M Stiff CLAY	120	25	28
2	Soft CLAY	115	0	28
3	V Stiff CLAY	125	100	28
4	M Dense SAND	120	0	32
5	M Dense SILT	120	0	31

GLOBAL STABILITY ANALYSIS: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: AS SHOWN

APPENDIX C-2

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CHECKED BY: LMI

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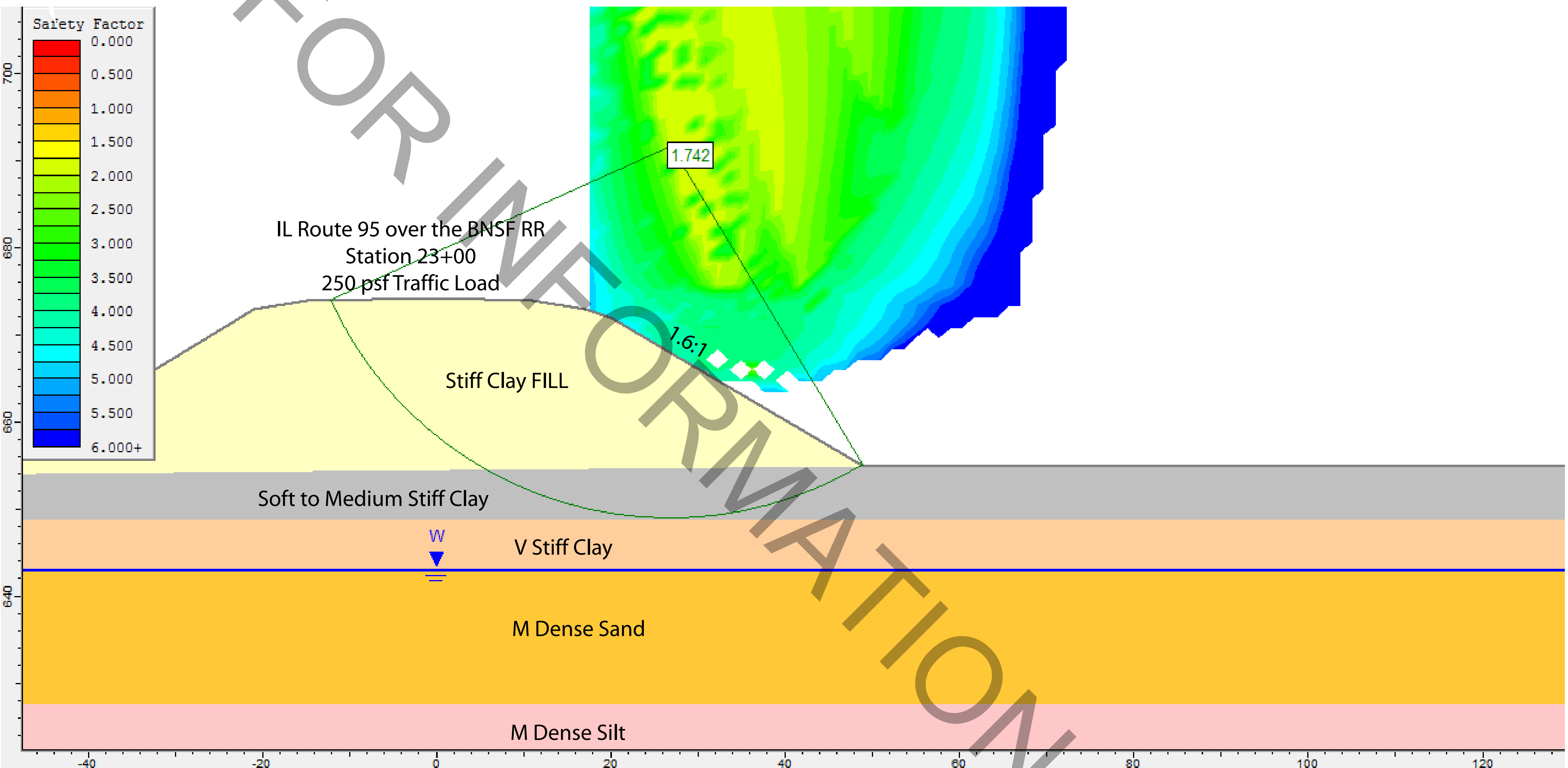
FOR WHKS & COMPANY ENGINEERING

760-01-02



Undrained (Short Term) Analysis

Layer ID	Description	Unit Weight (lb/ft3)	Undrained Cohesion (psf)	Undrained Friction Angle (degrees)
1	Stiff CLAY FILL	120	1200	0
2	Soft to M Stiff CLAY	115	400	0
3	V Stiff CLAY	125	2000	0
4	M Dense SAND	120	0	32
5	M Dense SILT	120	0	31

GLOBAL STABILITY ANALYSIS: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

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

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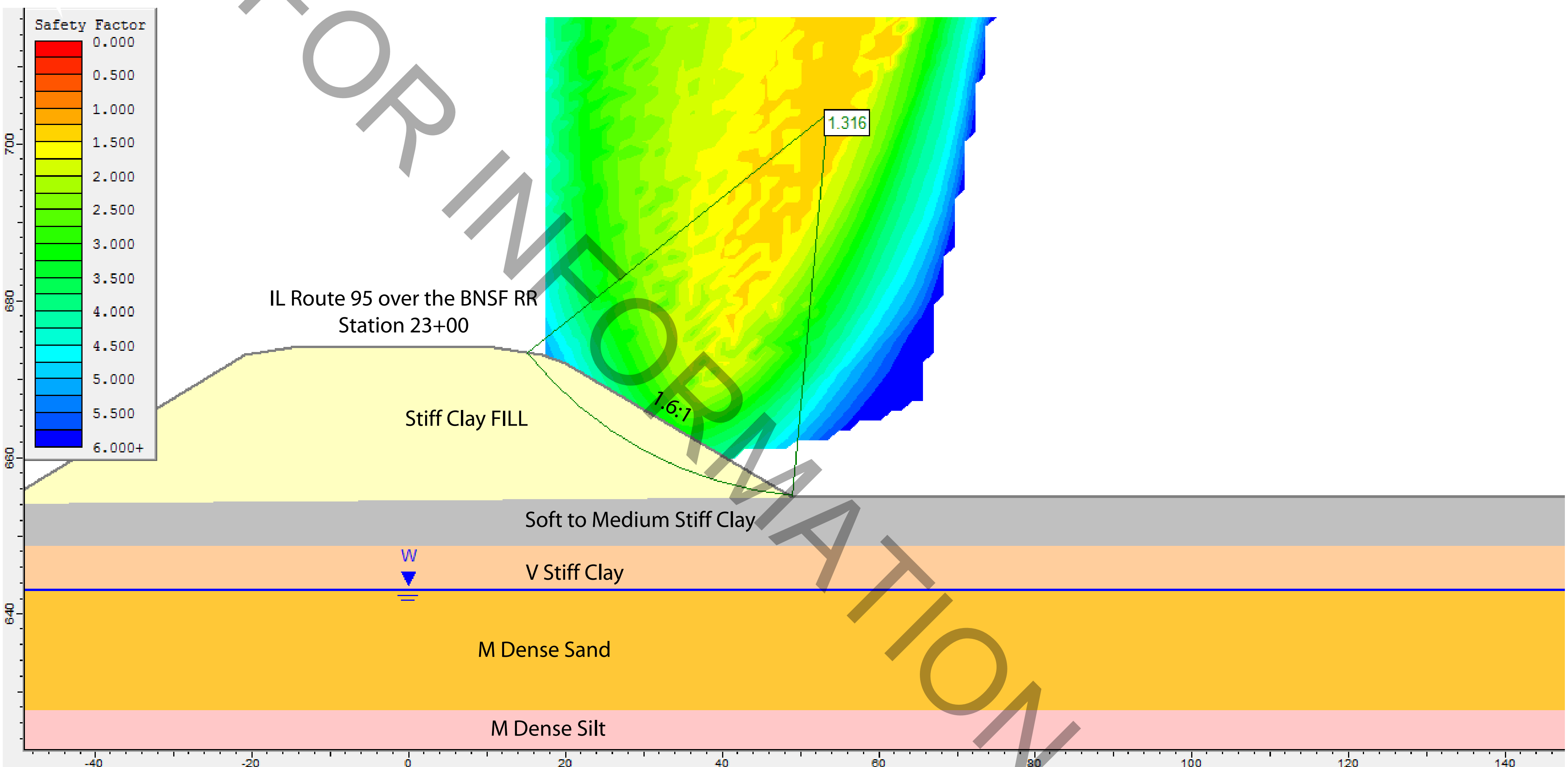

Drained (Long Term) Analysis

Layer ID	Description	Unit Weight (lb/ft3)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
1	Stiff CLAY FILL	120	75	28
2	Soft to M Stiff CLAY	115	25	28
3	V Stiff CLAY	125	100	28
4	M Dense SAND	120	0	32
5	M Dense SILT	120	0	31

GLOBAL STABILITY ANALYSIS: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

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

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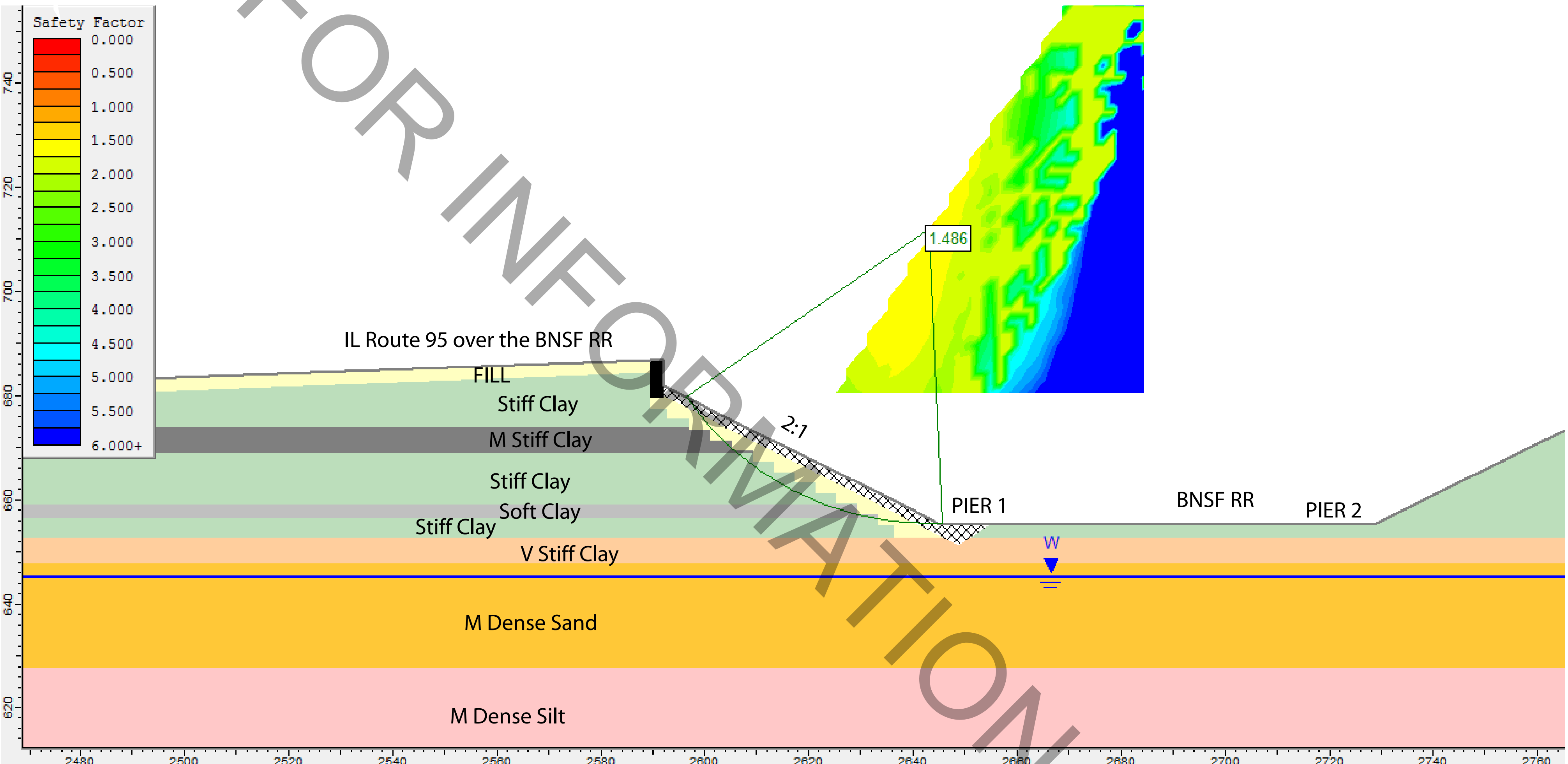

Drained (Long Term) Analysis

Layer ID	Description	Unit Weight (lb/ft3)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
FILL	Cohesive FILL	125	100	30
1	Stiff CLAY	120	75	28
1	M Stiff CLAY	120	25	28
2	Soft CLAY	115	0	28
3	V Stiff CLAY	125	100	28
4	M Dense SAND	120	0	32
5	M Dense SILT	120	0	31

GLOBAL STABILITY ANALYSIS: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: AS SHOWN

APPENDIX C-5

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CHECKED BY: LMI

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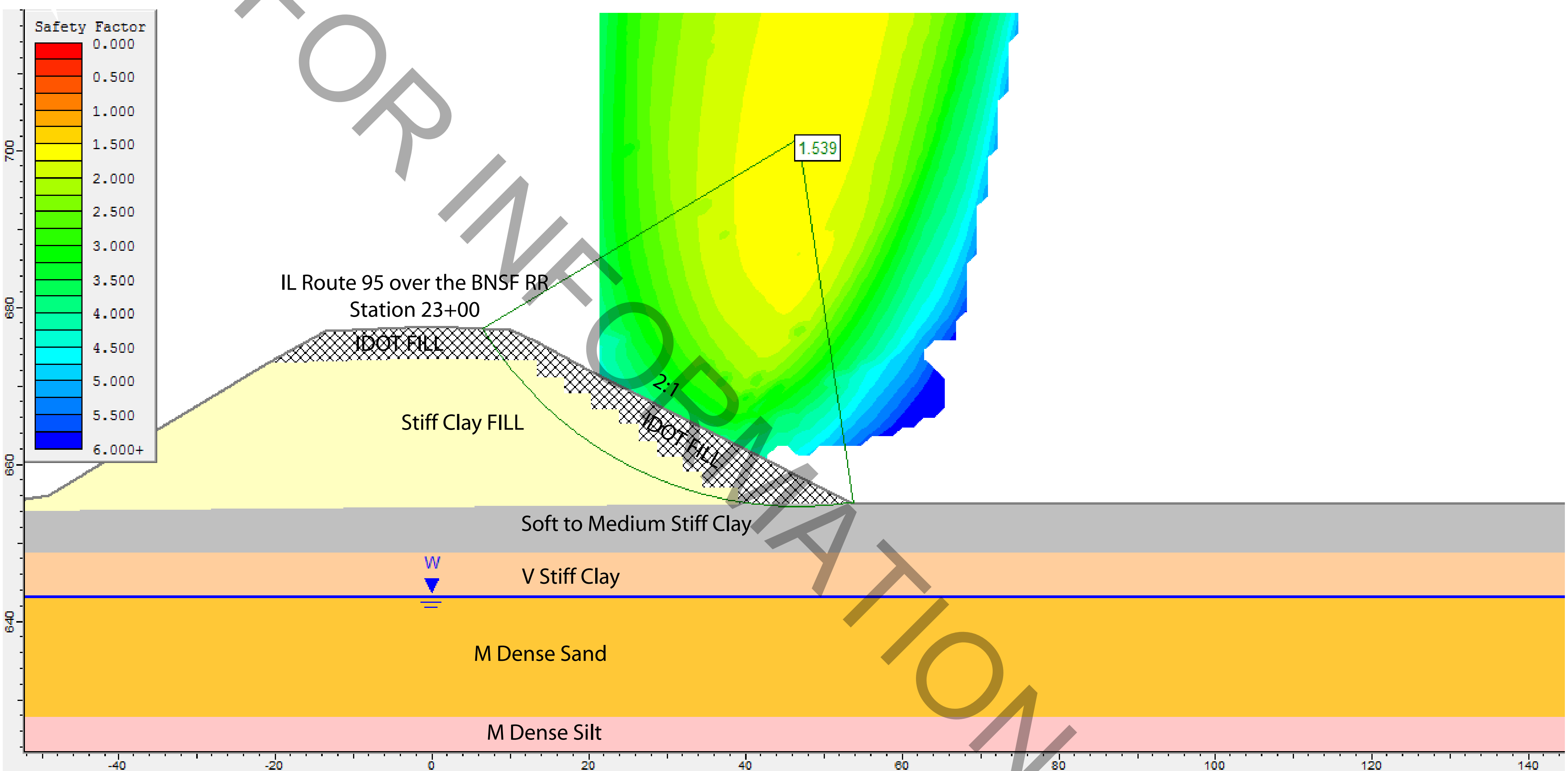
FOR WHKS & COMPANY ENGINEERING

760-01-02



Drained (Long Term) Analysis

Layer ID	Description	Unit Weight (lb/ft3)	Drained Cohesion (psf)	Drained Friction Angle (degrees)
FILL	Cohesive FILL	125	100	30
1	Stiff CLAY FILL	120	75	28
2	Soft to M Stiff CLAY	115	25	28
3	V Stiff CLAY	125	100	28
4	M Dense SAND	120	0	32
5	M Dense SILT	120	0	31

GLOBAL STABILITY ANALYSIS: ILLINOIS RTE 95 BRIDGE OVER THE BNSF RAILROAD, SN 055-0082, IDOT No. P-94-007-07, McDONOUGH COUNTY

SCALE: AS SHOWN | APPENDIX C-6 | DRAWN BY: MLS
CHECKED BY: LMI

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FOR WHKS & COMPANY ENGINEERING | 760-01-02