GEOTECHNICAL EXPLORATION PROGRAM

FOR
PROJECT I.D. 2014-72-03

CTH V
ROCKY RUN BRIDGE
TOWN OF ROCK & TOWN OF CARY

WOOD COUNTY

APRIL 2014
OMNNI PROJECT NO. E2097A13

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REPORT OF
GEOTECHNICAL EXPLORATION PROGRAM
BRIDGE ON CTH V OVER ROCKY RUN
WOOD COUNTY, WISCONSIN

OMNNI REPORT E2097A13

1.0 INTRODUCTION

1.1 Project Information

The project site is a proposed bridge located on CTH V about 3.8 miles south of CTH N in Wood County, Wisconsin. The project location is on the line between Section 32 of T24N, R2E, Town of Rock and Section 5 of T23N, R2E Town of Cary. The existing structure spans Rocky Run and consists of a single span concrete bridge with beam guard. The existing structure currently is not long enough to qualify as a bridge and has an approximate clear roadway width of 28 feet.

The replacement structure is anticipated to be a short, single span concrete slab bridge with sill abutments. The replacement bridge is anticipated to have a clear width of 30 feet with a new total length of approximately 35 feet from back of abutment to back of abutment with beam guard.

1.2 Scope of Services

The scope of our work for this project was as follows:

1. Perform two (2) standard penetration borings, one to approximately 40 feet in depth at the east abutment location and one to 30 feet in depth at the west abutment location.
2. Perform a core of bedrock at one abutment location, if encountered.
3. Abandon all boreholes in compliance with Wisconsin Department of Natural Resources (WDNR) requirements.
4. Return samples to OMNNI's laboratory for classification and testing.
5. Prepare a written report documenting our field and laboratory testing program and presenting our engineering review and recommendations for foundation types and depths as well as a discussion of construction considerations relative to the subsurface conditions. The report will also include boring logs with Unified Soil Classification of soils, test results, water level information, relative surface elevations at boring locations, and a site sketch showing boring locations.

1.3 Purpose of Report

The purpose of this report is to present the results of our field and laboratory testing program and provide our engineering recommendations.

This report is intended for geotechnical purposes only, and not to document or detect the presence or absence of any environmental contamination at the site.

2.0 EXPLORATION PROGRAM RESULTS

2.1 Scope of Exploration

On November 6, 2013, two (2) standard penetration test soil borings were performed with a CME, truck-mounted rotary drill rig. Boring B1 was located 8 feet north of the CTH V roadway reference line and approximately 22 feet east of existing east abutment. Boring B2 was located 8 feet south of the CTH V roadway reference line and approximately 22 feet west of the existing west abutment. Based on survey information, elevations at the boring locations were approximately el. 1090.4 ft and el. 1090.7 ft at borings B1 and B2 respectively.

Soil borings were planned to be extended to a depth of 40 and 30 feet in boring B1 and B2, respectively. Boring B1 encountered split-spoon sampling refusal (very dense material) at a depth of 25 feet below existing ground surface. At a depth of 25 feet, boring B1 was then advanced with a hollow stem auger to a depth of 30 feet then below a depth of 30 feet, mud rotary drilling was then performed with a tricone bit to 40 feet at which split-spoon sampling refusal was encountered again. Boring B1 was taken to practical refusal in over 15 feet of very dense material. In boring B2, the boring was extended to a depth of 30 feet where split spoon sampling encountered refusal. At a depth of 30 feet, boring B2 was then advanced with a hollow stem auger to a depth of 35 feet, where practical refusal was encountered. Boring B2 was taken to practical refusal in over 5 feet of very dense material.

2.2 Surface Conditions

The direction of the water flow at the site was from north to south. Surveyed elevations at the boring locations were el. 1090.4 ft at boring B1 and el. 1090.7 ft at boring B2. At the time of drilling, the Rocky Run was measured at an elevation el. 1087.4 ft.

The project site is a proposed bridge located on CTH V about 3.8 miles south of CTH N in Wood County, Wisconsin. The project location is on the line between Section 32 of T24N, R2E, Town of Rock and Section 5 of T23N, R2E Town of Cary. The bridge is located in a rural area. There are no homes or buildings within 500 ft of the project. The existing bridge approaches generally slope slightly downward from west to east through the bridge section. Existing approach pavement does indicate some distress such as horizontal and transverse tracking.

Vegetation immediately along the creek consisted of grasses and brush. Also, overhead utilities are located on the north sides of the structure and approaches.

2.3 Subsurface Conditions

The subsurface conditions encountered at the test boring locations are shown on the logs included in the appendix. We wish to point out that the subsurface conditions at other times and locations on this site may differ from those found at our test locations. The test boring logs also indicate the possible geologic origin of the materials encountered.

A review of the soil boring log for boring B1 indicated 6 inches of asphaltic pavement over 8 inches of base course material. Fill was encountered below the base course material to approximately 2½ feet in depth. The fill encountered consisted of silty sand with clay and gravel. In boring B1, natural soils were encountered below the fill to the termination depth of the boring. In our opinion, the natural soils encountered to a depth of 40 feet below ground surface are alluvial in origin.

The natural alluvium encountered in boring B1 consisted of silt with organics and a little sand overlying sand with silt and gravel and then a stratum of clay consisting of a thin layer of lean clay with sand and a little silt over fat clay with a little sand and silt. Below the clay stratum followed various combinations of clay, gravel, and sand overlying weathered bedrock which was encountered to termination depth of the boring. The relative density of the upper naturally occurring silts was very loose while the upper sand with silt and gravel ranged from firm to dense. The clays encountered had a consistency of stiff while the relative densities of the clay, gravel, and sand combinations encountered below the clays ranged from very firm to very dense. The weathered bedrock encountered consisted of a clayey gravel with sand that was very dense in relative density.

A review of the soil boring log for boring B2 indicated 5 inches of asphaltic pavement over 8 inches of base course material. Fill was encountered below the base course material to approximately 5 feet in depth. The fill encountered consisted of silt with sand over sand with a little silt. In boring B2, natural soils were encountered below the fill to the termination depth of the boring. In our opinion, the natural soils encountered to a depth of 36½ feet below ground surface are alluvial in origin.

The natural alluvium encountered in boring B2 consisted of silt with sand and a little organics overlying sand with silt then a stratum various combinations of sand and gravel. Below the sand and gravel stratum followed a stratum of lean clay with silt and gravel then silty gravel with sand all over weathered bedrock to termination depth of the boring. The relative density of the upper silt was very loose while the upper sand with silt was very firm. The sand and gravel combinations were generally firm to loose in relative density. The lean clays encountered had a consistency of firm while the relative density of the silty gravel encountered below the lean clay stratum was firm. The weathered bedrock encountered consisted of gravel with silt that was very dense in relative density.

2.4 Soil Profile – Literature Review

The project area extended across variations of one mapping unit, as indicated by the United States Department of Agriculture – Soil Conservation Service (USDA-SCS) soil survey for Wood County, Wisconsin. The mapping units were as follows:

(Ve) Veedum silt loam

According to the SCS soil survey, the soil series indicated above consisted of the following:

- Veedum: Poorly drained soils which are moderately deep to a paralithic contact with interbedded sandstone and shale. They formed in silty alluvium and in residuum from the underlying interbedded sandstone and shale on low hills and pediments

Review of the Wisconsin Department of Transportation (WDOT) soil parameter database for the above soils suggests the following general parameters:

WDOT SOIL PARAMETERS

Symbol	Pedological Name	Design Group Index B/C	Frost Index B/C	Estimated Modulus of Subgrade Reaction (psi/in.) B/C
(Ve)	Veedum	12/12	F-3/F-3	150/150

2.5 Water Level Observations

The water level in the soil borings were indicated to be approximately 4 to 5 feet below the existing ground surface (approximate elevation el. 1086.0 ft) upon boring completion. While drilling, water levels in the soil borings were noted at elevations of el. 1082.9 ft and el. 1089.7 ft in borings B1 and B2, respectively. The cave-in of boreholes B1 and B2 was encountered at a depth of 6 feet and 4 feet, respectively from ground surface after auger removal. Upon competition of the soil borings groundwater levels both dropped (B2) and rose (B1) to a depth of 4 to 5 feet below the existing ground surface.

This drop and rise in depth generally indicates that the initial groundwater water level is perched water within upper granular soils at the west abutment location, while groundwater at the east abutment location likely rose as a result of borehole cave in.

Groundwater levels can be expected to fluctuate, both seasonally and annually, and from place to place on the site.

2.6 Laboratory Tests

Laboratory tests, were performed to aid in determining the engineering properties and classification of the soil samples. The soil samples were classified in accordance with the Unified Soil Classification System (USCS) and the probable geologic origin was noted.

3.0 ENGINEERING REVIEW

3.1 Project Data

We understand that the single span concrete structure, spanning Rocky Run on CTH V in Wood County, is proposed to be replaced with an approximately 35 foot, single span concrete slab bridge. The new bridge is also planned to be widened from the existing clear width of 28 feet to a width of 30 feet with a corresponding widening of the pavement cross section and bridge approaches. The existing bridge approaches generally slope slightly downward from west to east through the bridge section and consist of asphaltic pavement. Planned abutment bearing elevation will be approximately el. 1082 ft.

A foundation review was completed for a deep pile foundation system. A shallow foundation system was not reviewed due to the soil present at abutment locations and it's susceptibility to scour. A deep pile foundation will be designed according to Load and Resistance Factor Design criteria. All deep foundation soil pressures for piles were based upon a 10¾-inch cast-in-place (CIP) pile. Ultimate bearing capacity was determined using the computer program *Driven* developed by the Federal Highway Administration. Information inputted into the *Driven* program was based on the soil characteristics gathered during the geotechnical exploration (i.e. Standard Penetration Test results, pocket penetrometer test results, etc.) and our geotechnical experience. Table 1 and Table 2 in section 3.3.1 present each soil strata and their engineering properties that were used in the review.

Pile driveability was evaluated using the computer program *GRLWEAP* developed by GRL Engineers, Inc.

3.2 Discussion

A review of the soil boring logs indicated similar profiles in boring B1 and B2 consisting of 5 to 6 inches of asphaltic pavement over 8 inches of base course material. Fill was encountered below the

base course to depths ranging from 2½ to 5 feet. The fill in both borings B1 and B2 consisted primarily of silt and sand combinations. The granular fill soils were generally loose in relative density.

The natural soils encountered below the fill consisted of alluvial soils consisting primarily of upper silts and sands overlying an approximate 5 foot stratum of clay all over predominantly gravels with various amounts of sand, silt and clay. In the borings performed, weathered bedrock was encountered below the natural alluvial soil. In boring B1 on the east side of the bridge, the upper silts were very loose while the upper sand with silt and gravel ranged from firm to dense. The clays encountered were of a stiff consistency while the relative densities of the deeper clay, gravel, and sand combinations encountered ranged from very firm to very dense. In boring B2 on the west side of the bridge, the upper silts were very loose while the upper sand with silt and gravel were very firm. The sand and gravel combinations were generally firm to loose in relative density. The clays encountered had a firm consistency while the relative density of the silty gravel encountered was firm. The weathered bedrock encountered below the natural soils in each boring was very dense in relative density.

While drilling, water levels in the soil borings were noted at elevations of el. 1082.9 ft and el. 1086.7 ft in borings B1 and B2 respectively.

Based on the soil and water conditions encountered at the test boring locations, it is our opinion that water control measures such as sheet piling, temporary soil berms, and/or sumps and pumps be considered as construction of the proposed abutments will likely occur below the static groundwater table and within loose silty soils. Based on the conditions encountered at proposed bottom of abutment elevation, it should also be noted that excavation below subgrade (EBS) and replacement may be required to provide a construction/working platform to aid in construction operations. EBS performed below proposed bottom of abutment elevation is recommended to be backfilled with 3-inch dense graded base conforming to the grading requirements of Section 305, "Dense Graded Base", of the WisDOT Standard Specifications for Highway and Structure Construction.

It is our opinion the bridge abutment and pier foundations can be supported on driven piles consisting of 10¾-inch CIP piles with 0.219-inch wall thickness. The piles will be friction and end bearing piles, and it is our opinion they will be seated on and in the deep clayey sand with gravel and/or weathered bedrock (B1) or silty gravel and/or weathered bedrock (B2). The clayey sand with gravel encountered in boring B1 was encountered approximately 25 feet below existing ground surface at an elevation of el. 1065.4 ft. The silty gravel encountered in boring B2 was encountered approximately 25 feet below existing ground surface at an elevation of el. 1065.7 ft. It is our opinion that the pile tip elevations will range from el. 1065.0 ft to el. 1055.0 ft. The driven pile lengths will depend upon the type of pile hammer used and subsurface conditions encountered at pile locations.

The drivability evaluation for the CIP piles used a Delmag D-16-32 diesel hammer to determine if the pile would be overstressed at any time during pile installation. The results of the evaluation indicated that a 10¾-inch CIP pile with a wall thickness of 0.219-inches driven to approximate tip elevations ranging from el. 1065.0 ft to el. 1055.0 ft at the proposed abutment locations would not be overstressed during the pile installation process based on the computer program *GRLWEAP* developed by GRL Engineers, Inc.

3.3 Pile Evaluation Results

3.3.1 Deep Foundation

Based on the computer program *Driven* and our estimated soil properties, the estimated nominal skin friction and end bearing values of a 10¾-inch CIP pile driven to minimum required ultimate capacity in deep clayey sand with gravel and/or weathered bedrock layer at the east abutment location are given

in Table 1 below: (East Abutment (B1) Pile Analysis and Driven Results can be found in Appendix C)

Table 1: East Abutment Soil Parameters and Foundation Capacities

Soil Description	Friction Angle (degrees)	Cohesion (psf)	Unit Weight (pcf)	Nominal Skin Friction[1] (psf)	Nominal End Bearing[2] (psf)
East Abutment (B1)					
Silt, with Organics and a little Sand (Elevation 1087.9 ft - 1082.4 ft)	29	0	115	N/A	N/A
Sand, with Silt and Gravel (Elevation 1082.4 ft - 1075.4 ft)	34	0	125	322	27,000
Lean/Fat Clay, with little Sand and Silt (Elevation 1075.4 ft - 1070.4 ft)	0	1700	120	1232	15,300
Clayey Gravel, with Sand (Elevation 1070.4 ft - 1065.4 ft)	35	0	130	593	70,300
Clayey Sand, with Gravel (Elevation 1065.4 ft - 1060.4 ft)	40	0	135	1230	237,400
Weathered Bedrock (Elevation 1060.4 ft - 1050.4 ft)	40	0	145	1604	308,800

1. Skin friction values are nominal values and have not been modified by a resistance factor.
2. End bearing values are nominal values and have not been modified by a resistance factor.
3. N/A - not applicable

The estimated nominal skin friction and end bearing values of a 10¾-inch CIP pile driven to minimum required ultimate capacity in silty gravel and/or weathered bedrock layer at the west abutment location are given in Table 2 below: (West Abutment (B2) Pile Analysis and *Driven* Results can be found in Appendix C)

Table 2: East Abutment Soil Parameters and Foundation Capacities

Soil Description	Friction Angle (degrees)	Cohesion (psf)	Unit Weight (pcf)	Nominal Skin Friction[1] (psf)	Nominal End Bearing[2] (psf)
West Abutment (B2)					
Silt, with Sand and Organics (Elevation 11085.7 ft - 1080.7 ft)	29	0	115	155	10,700
Sand, with Silt (Elevation 1080.7 ft - 1075.7 ft)	34	0	120	310	33,900
Gravelly Sand, little Silt (Elevation 1075.7 ft - 1069.7 ft)	31	0	125	321	20,700
Lean Clay, with Silt and Gravel (Elevation 1069.7 ft - 1065.7 ft)	0	900	120	814	8,100
Silty Gravel, with Sand (Elevation 1065.7 ft - 1060.2 ft)	32	0	130	524	33,000
Weathered Bedrock (Elevation 1060.2 ft - 1054.2 ft)	40	0	145	1404	270,700

1. Skin friction values are nominal values and have not been modified by a resistance factor.
2. End bearing values are nominal values and have not been modified by a resistance factor.
3. N/A - not applicable

3.3.2 Pile Drivability

The pile drivability evaluation estimated a Delmag D-16-32 diesel hammer to determine if the pile would be overstressed at any time during pile installation. The results of the evaluation indicated that a 10¾-inch CIP pile with a wall thickness of 0.219-inches driven to an approximate tip elevation ranging from el. 1065.0 ft to el. 1055.0 ft at the proposed abutment locations would not be overstressed during the pile installation process based on the computer program GRLWEAP developed by GRL Engineers, Inc. Pile Drivability Analysis as well as *GRLWEAP* Results for each abutment location can be found in Appendix D.

3.4 Foundation Recommendations

We recommend that a driven pile foundation be used for support on this bridge, with the pile consisting of a 10¾-inch CIP pile with a wall thickness of 0.219-inches driven to a maximum "Required Driving Resistance" of 110 tons using the modified Gates dynamic formula. These values use a "Factored Axial Compression Resistance" of 55 tons and a Resistance Factor of 0.5 for the modified Gates dynamic formula. Driven to the maximum required driving resistance, pile tip elevations are estimated to range from el. 1065.0 ft to el. 1055.0 ft at the proposed abutment locations. If bridge design loads indicate that a lower "Required Driving Resistance" as determined by the modified Gates dynamic formula is sufficient for bridge support, OMNNI is recommended to be contacted to review the pile capacity based on planned bridge loading. If a lower "Required Driving Resistance" is to be used in construction, we would estimate pile tip elevations to still be near those previously stated, but we should be consulted to provide estimated pile depths and capacities.

Drivability evaluation indicated that a 10¾-inch CIP pile with a wall thickness of 0.219-inches driven to an approximate tip elevation ranging from el. 1065.0 ft to el. 1055.0 ft at the proposed abutment locations will not be overstressed during pile installation using a Delmag D-16-32 diesel hammer. If a different pile driving hammer is to be used for driving the 10¾-inch CIP pile, OMNNI is recommended to be contacted to review the pile drivability. Foundations are recommended be protected from frost penetration. We recommend that pile caps be extended to a depth of at least 6 feet below final grades.

3.5 Site Preparation

The abutment areas are recommended to be prepared in accordance with Section 206.3, "Excavation for Structures – Construction", of the 2014 WisDOT Standard Specifications for Highway and Structure Construction. It is our opinion that excavation should extend below planned grades to allow for a minimum 6 inches of granular fill meeting the requirements of Section 209, Granular Backfill, of the WisDOT specifications.

Backfill of structures should be as indicated below in Section 3.6 of this report.

At the abutment locations, we recommend the approach embankments be constructed in accordance with Section 207, "Embankment", of the Wisconsin Department of Transportation Standard Specifications for Highway and Structure Construction. We also recommend that compaction of the embankment fill be in accordance with Section 207.3.6.3, Special Compaction, of the WisDOT standard specifications to minimize settlement of embankment fill. It is our opinion that all existing topsoil, vegetation, and organic soil is recommended to be removed prior to the placement of embankment fill as the existing fill soils and virgin soils are suitable for fill support. Although existing fill soils and virgin soils are suitable for fill support, we do recommend that surficial subgrade soils be compacted to at least the dry density specified in Section 207.3.6.3(3), Special Compaction to minimize settlement of existing fill and natural soils under embankment fill loading.

3.6 Backfill

We recommend that structural backfill conform to the grading requirements of Section 210, "Structure Backfill", of the WisDOT Standard Specifications for Highway and Structure construction. We recommend that compaction of the backfill conform to Section 207.3.6.2, "Standard Compaction", of the WisDOT standard specifications.

3.7 Lateral Earth Pressure

Assuming that backfill is in general accordance with Section 3.6 of this report, we recommend that an active earth pressure for unrestrained structural elements be calculated using an equivalent fluid pressure of 40 pounds per cubic foot. For restrained elements, we recommend a coefficient of "at rest" earth pressure of 0.5 be used.

3.8 Embankment Slopes

We recommend that the embankment at the bridge approaches and abutments have a maximum vertical to horizontal slope of 1:3.

3.9 Drainage

We recommend that drain tile be installed behind the base of the abutments, out-flowing to the roadway ditches. The purpose of the tile is to facilitate drainage of water from soils behind the abutments and to minimize increases in lateral earth pressures.

3.10 Pavement Indices

Based on Soil Conservation Service Classification (SCS) of soils and our soil borings, we recommend that the following parameters be used for the subgrade soils for the bridge approach pavement design:

Frost Index	F-3
Design Group Index	12
Modulus of Subgrade Reaction (psi/in)	150
Soil Support Value	4.3

4.0 FIELD EXPLORATION PROCEDURES

Soil sampling was performed in accordance with ASTM:D1586 and power auger borings were done in general accordance with ASTM:D1452.

5.0 STANDARD OF CARE

The recommendations contained in this report represent our professional opinions. These opinions were arrived at in accordance with currently accepted engineering practices at this time and location. Other than this, no warranty is implied or intended.

Prepared By:
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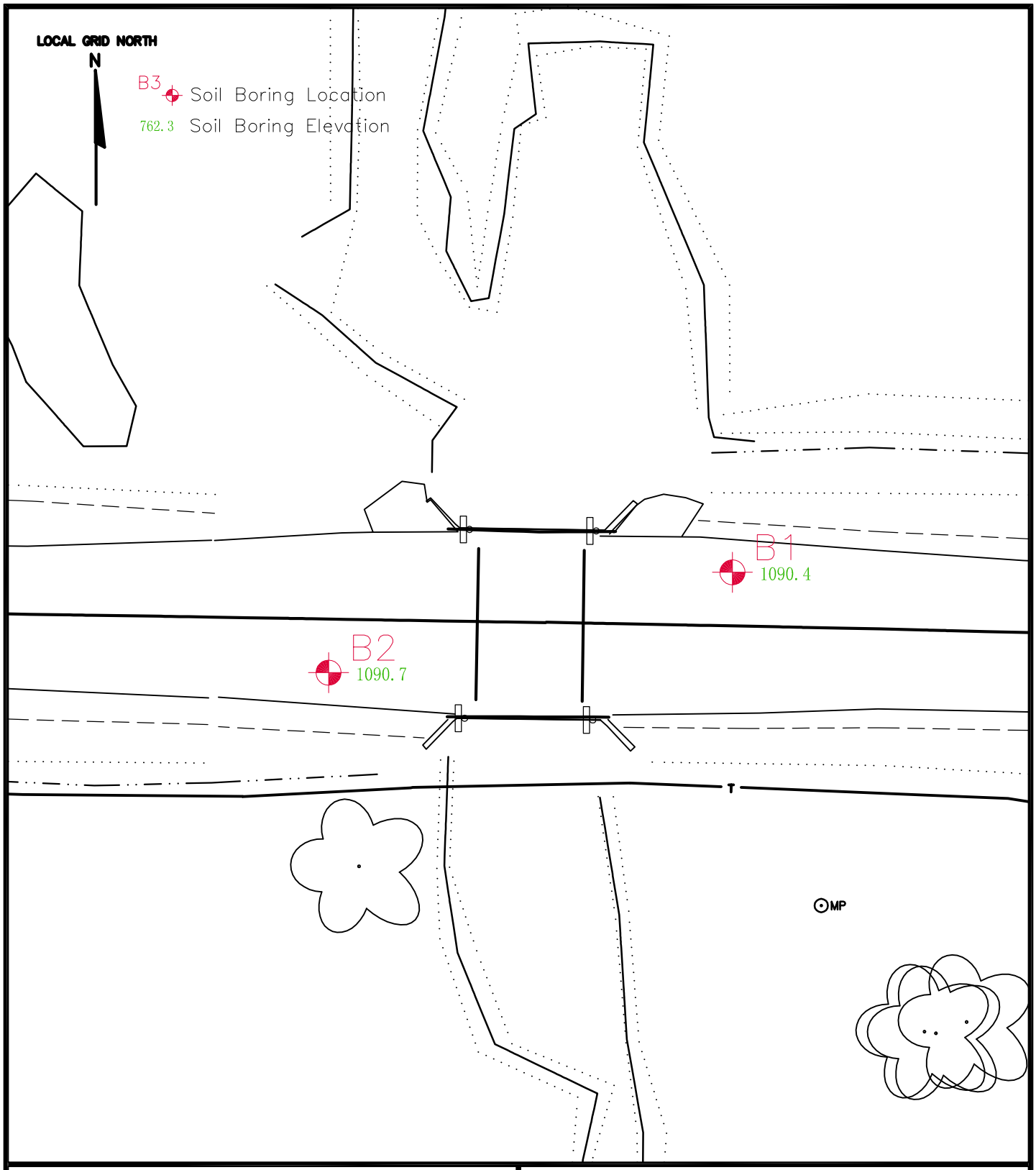
Appendix A

Soil Boring Plan



SOIL BORING LOCATION PLAN

PROJECT ID E2097A13
CTH V BRIDGE
ROCKY RUN CROSSING
WOOD COUNTY

OMNI ASSOCIATES
ONE SYSTEMS DRIVE
APPLETON, WI 54914
PHONE (920) 735-6900
FAX (920) 830-6100

PROJECT MANAGER:	TAB	PROJECT NO:	E2097A13
PROJECT ENGINEER:	BPA	CAD FILE NO:	E2097A13_BOR
DRAWN BY:	BPA	SCALE:	N.T.S.
REVIEWED BY:	TAB	DATE:	1/25/14

Appendix B

Soil Boring Log
Notes & Logs

OMNI ASSOCIATES
One Systems Drive
Appleton, WI 54914
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LOG NOTES & KEY TO SYMBOLS

CLIENT	PROJECT NAME
Wood County Highway Department	CTH V Bridge over Rocky Run
PROJECT NUMBER	**PROJECT LOCATION**
E2097A13	Wood County

LITHOLOGIC SYMBOLS (Unified Soil Classification System)

- ASPHALT: Asphalt
- CL: USCS Low Plasticity Clay
- GC: USCS Clayey Gravel
- GP-GM: USCS Poorly-graded Gravel with Silt
- SC: USCS Clayey Sand
- SP-SM: USCS Poorly-graded Sand with Silt
- CH: USCS High Plasticity Clay
- FILL: Fill (made ground)
- GM: USCS Silty Gravel
- ML: USCS Silt
- SP: USCS Poorly-graded Sand

SAMPLER SYMBOLS

- Auger Cuttings
- Standard Penetration Test

ABBREVIATIONS

LL - LIQUID LIMIT (%) - ASTM:D4318
PI - PLASTIC INDEX (%) - ASTM:D4318
W - MOISTURE CONTENT (%) - ASTM:D2216
DD - DRY DENSITY (PCF)
NP - NON PLASTIC
-200 - PERCENT PASSING NO. 200 SIEVE
PP - POCKET PENETROMETER (TSF)
Qu - UNCONFINED COMP. STRENGTH (TSF) - ASTM:D2166
Qc - TRIAXIAL COMP. STRENGTH (TSF)
RQD- ROCK QUALITY DESIGNATION (%)
OC - ORGANIC CONTENT - COMBUSTION METHOD
SPT - STANDARD PENETRATION TEST
SCP - STATIC CONE PENETROMETER TEST

WATER LEVELS

- Water Level at Time Drilling
- Water Level at End of Drilling
- Water Level After 24 Hours
- Cave-In Level at End of Drilling

Water levels shown on the boring logs are the levels measured in the borings at the time and under the conditions indicated. In sand, the indicated levels may be considered reliable groundwater levels. In clay soil, it may be possible to determine the groundwater level within the normal time required for test borings, except where lenses or layers of more pervious waterbearing soil are present. Even then, an extended period of time may be necessary to reach equilibrium. Therefore, the position of the water level symbol for cohesive or mixed texture soils may not indicate the true level of the ground water table. Perched water refers to water above an impervious layer, thus impeded in reaching the water table. The available water level information is given at the top of the log sheet.

DESCRIPTIVE TERMINOLOGY

RELATIVE DENSITY TERM	"N" VALUE	CONSISTENCY TERM	"N" VALUE
Very Loose	0-4	Very Soft	0-1
Loose	5-10	Soft	2-4
Firm	11-20	Firm	5-8
Very Firm	21-30	Stiff	9-15
Dense	31-50	Very Stiff	16-30
Very Dense	51+	Hard	31+

Standard "N" Penetration: Blows Per Foot of a 140 Pound Hammer Falling 30 inches on a 2 inch O.D. Split Spoon Sampler

Lamination	Up to ½" thick stratum
Layer	½" to 6" thick stratum
Lens	½" to 6" discontinuous stratum, pocket
Varved	Alternating laminations of clay, silt and/or fine grained sand, or colors thereof
Dry	Powdery, no noticeable water
Moist	Below saturation
Wet	Saturated, above liquid limit
Water-bearing	Pervious soil below water

RELATIVE GRAVEL PROPORTIONS

CONDITION	TERM	RANGE
Coarse Grained Soils	little gravel	2-14%
	with gravel	15-49%
Fine Grained Soils		
15-29% + No. 200	little gravel	2-7%
15-29% + No. 200	with gravel	8-29%
30% + No. 200	little gravel	2-14%
30% + No. 200	with gravel	15-24%
30%+No. 200	gravelly	16-49%

RELATIVE SIZES

Boulder	Over 12"
Cobble	3"-12"
Gravel	
Coarse	¾"-3"
Fine	#4-¾"
Sand	
Coarse	#4-#10
Medium	#10-#40
Fine	#40-#200
Silt & Clay	-#200, Based on Plasticity

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BORING NUMBER **B1**

CLIENT: Wood County Highway Department	PROJECT NAME: CTH V Bridge over Rocky Run
PROJECT NUMBER: E2097A13	PROJECT LOCATION: Wood County
DRILLING CONTRACTOR: Midwest Engineering Services, Inc.	ELEVATION & DATUM: 1090.4 ft NGVD; DATE STARTED: 11/6/2013; DATE FINISHED: 11/6/2013
DRILLING EQUIPMENT/METHOD: CME Mobile Drill Rig / Hollow Stem Auger	COMPLETION DEPTH: 40.0 ft / Elev. 1050.4 ft; CAVE-IN DEPTH: 6.0 ft / Elev. 1084.4 ft
SAMPLER: 2" O.D. Split Spoon Sampler	WATER LEVEL (ft): FIRST 7.5 ft / Elev. 1082.9 ft; COMPL. 5.0 ft / Elev. 1085.4 ft; 24 HR. ---
HAMMER TYPE: SPT; WEIGHT (lbs): 140; DROP (in): 30	LOGGED BY: Brendan P. Andrews

ELEV. (ft)	MATERIAL DESCRIPTION	SAMPLE NUMBER	TYPE	RECOV. (in)	PENETR. RESIST BL/6in	N-VALUE BLOWS PER FT	REMARKS (DRILLING FLUID, DEPTH OF CASING/HSA, MUD ROTTARY, DRILLING RESISTANCE, ETC.)
1089.9	**PAVEMENT** - 6" of Asphalt Pavement						
1089.2	**BASE COURSE** - 8" of GRAVELLY SAND, with Silt, fine to medium grained, very dark brown, moist, (SP-SM)	AU1					
1087.9	**FILL** SILTY SAND, with Clay, with Gravel, fine to medium grained, black to reddish brown, moist, (SM)	SPT2		12	2 2 1	3	
	ALLUVIUM SILT, with Organics, with Wood, little Sand, dark grayish brown, moist, very loose (ML)	SPT3		12	3 1 1	2	
1082.4	SAND WITH SILT, with Gravel, fine to coarse grained, dark gray to dark yellowish brown, moist, firm to dense (SP-SM)	SPT4		12	4 3 11	14	
		SPT5		12	9 17 16	33	
1075.4	LEAN CLAY, with Sand, little Silt, yellowish brown to dark grayish brown, moist, stiff (CL)	SPT6		15	7 4 7	11	
1074.4	FAT CLAY, little Sand, little Silt, dark reddish brown, moist, stiff (CH)						
1070.4	CLAYEY GRAVEL, with Sand, dark reddish brown, moist, very firm (GC)	SPT7		12	9 12 16	28	
1065.4	CLAYEY SAND, with Gravel, fine to medium grained, dark reddish brown to dark grayish brown, moist, very dense (SC)	SPT8		6	57	57/6"	
1060.4	**WEATHERED BEDROCK** CLAYEY GRAVEL, with Sand, dark reddish brown to dark yellowish brown, moist, very dense (GC)	SPT9		6	100	100/6"	Mud Rotary Drilling @ 30'

DEPTH SCALE: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34

OMNNI SOIL BORING LOG - OMNNI_BOR.GDT - 1/28/14 13:47 - F:\MATERIAL\GEOTECH\GINT\PROJECTS\E2097A13.GPJ

OMNI ASSOCIATES
One Systems Drive
Appleton, WI 54914
Telephone: 1-800-571-6677
Fax: 920-830-6100

BORING NUMBER **B1**

CLIENT	PROJECT NAME
Wood County Highway Department	CTH V Bridge over Rocky Run
PROJECT NUMBER	**PROJECT LOCATION**
E2097A13	Wood County

ELEV. (ft)	MATERIAL DESCRIPTION	SYMBOL LOG	DEPTH SCALE	SAMPLE DATA NUMBER	TYPE	RECOV. (in)	PENETR. RESIST BL/6in	N-VALUE BLOWS PER FT	REMARKS (DRILLING FLUID, DEPTH OF CASING/HSA, MUD ROTTARY, DRILLING RESISTANCE, ETC.)
	WEATHERED BEDROCK CLAYEY GRAVEL, with Sand, dark reddish brown to dark yellowish brown, moist, very dense (GC) *(continued)*		36	SPT10		0	50/1"	50/1"	
			38						
1050.4	Bottom of borehole at 40.0 feet.		40	SPT11		0	50/1"	50/1"	
			42						
			44						
			46						
			48						
			50						
			52						
			54						
			56						
			58						
			60						
			62						
			64						
			66						
			68						
			70						
			72						
			74						

OMNNI SOIL BORING LOG - OMNNI_BOR.GDT - 1/28/14 13:47 - F:\MATERIAL\GEOTECH\GINT\PROJECTS\E2097A13.GPJ

OMNI ASSOCIATES
One Systems Drive
Appleton, WI 54914
Telephone: 1-800-571-6677
Fax: 920-830-6100

BORING NUMBER **B2**

CLIENT: Wood County Highway Department	PROJECT NAME: CTH V Bridge over Rocky Run
PROJECT NUMBER: E2097A13	PROJECT LOCATION: Wood County
DRILLING CONTRACTOR: Midwest Engineering Services, Inc.	ELEVATION & DATUM: 1090.7 ft NGVD; DATE STARTED: 11/6/2013; DATE FINISHED: 11/6/2013
DRILLING EQUIPMENT/METHOD: CME Mobile Drill Rig / Hollow Stem Auger	COMPLETION DEPTH: 36.5 ft / Elev. 1054.2 ft; CAVE-IN DEPTH: 4.0 ft / Elev. 1086.7 ft
SAMPLER: 2" O.D. Split Spoon Sampler	WATER LEVEL (ft): FIRST 1.0 ft / Elev. 1089.7 ft; COMPL. 4.0 ft / Elev. 1086.7 ft; 24 HR. ---
HAMMER TYPE: SPT; WEIGHT (lbs): 140; DROP (in): 30	LOGGED BY: Brendan P. Andrews

ELEV. (ft)	MATERIAL DESCRIPTION	SAMPLE NUMBER	TYPE	RECOV. (in)	PENETR. RESIST BL/6in	N-VALUE BLOWS PER FT	REMARKS (DRILLING FLUID, DEPTH OF CASING/HSA, MUD ROTTARY, DRILLING RESISTANCE, ETC.)
1090.3	**PAVEMENT** - 5" of Asphalt Pavement						
1089.6	**BASE COURSE** - 8" of GRAVELLY SAND, with Silt, fine to medium grained, very dark brown, moist, (SP-SM)	AU1					
1088.2	**FILL** SILT, with Sand, little Gravel, black, moist, (ML)	SPT2		12	2 4 4	8	
	SAND, little Silt, fine to medium grained, yellowish brown, moist, loose (SP)						
1085.7	**ALLUVIUM** SILT, with Sand, with Wood, little Organics, very dark gray, moist, very loose (ML)	SPT3		15	2 2 2	4	
		SPT4		12	2 1 2	3	
1080.7	SAND, with Silt, fine to coarse grained, dark gray, moist, very firm (SP-SM)	SPT5		15	5 8 16	24	
1075.7	GRAVELLY SAND, little Silt, fine to coarse grained, dark yellowish brown, moist, firm (SP)	SPT6		6	4 5 9	14	
1070.7	SAND, with Gravel, fine to coarse grained, dark yellowish brown, moist, loose (SP)	SPT7		18	5 3 3	6	
1069.7	LEAN CLAY, with Silt, with Gravel, little Sand, greenish gray with dark brown, moist, firm (CL)						
1065.7	SILTY GRAVEL, with Sand, dark greenish gray, moist, firm (GM)	SPT8		12	3 6 8	14	
1060.2	**WEATHERED BEDROCK** GRAVEL, with Silt, dark greenish gray, moist, very dense (GP-GM)	SPT9			18 24 27	51	

SYMBOL LOG — DEPTH SCALE: 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34

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OMNI ASSOCIATES
One Systems Drive
Appleton, WI 54914
Telephone: 1-800-571-6677
Fax: 920-830-6100

BORING NUMBER **B2**

CLIENT	PROJECT NAME
Wood County Highway Department	CTH V Bridge over Rocky Run
PROJECT NUMBER	**PROJECT LOCATION**
E2097A13	Wood County

ELEV. (ft)	MATERIAL DESCRIPTION	SYMBOL LOG	DEPTH SCALE	SAMPLE DATA NUMBER	TYPE	RECOV. (in)	PENETR. RESIST BL/6in	N-VALUE BLOWS PER FT	REMARKS (DRILLING FLUID, DEPTH OF CASING/HSA, MUD ROTTARY, DRILLING RESISTANCE, ETC.)
			36	SPT10			50/5"	50/5"	
1054.2	Bottom of borehole at 36.5 feet.								
			38						
			40						
			42						
			44						
			46						
			48						
			50						
			52						
			54						
			56						
			58						
			60						
			62						
			64						
			66						
			68						
			70						
			72						
			74						

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Appendix C

Pile Analysis and Driven Results

Pile Analysis for Soils

Project ID: E2097A13
Structure: CTH V Bridge over Rocky Run
Boring #: B1
Station: N/A
Surface Elev. (ft): Approx. 1090.4
Foundation Elevation (ft): Approx. 1082.4

Pile Type: 10.75-inch CIP
Pile Dia: 0.896 feet
Perimeter: 2.814 feet
End Area: 0.630 sq. feet

Nordlund Resistance Factor = 1

Layer #	Depth to the top of the layer (ft)	Elevation at the top of the layer (ft)	Layer Thick. (ft)	Y	X	Y-X (Skin Friction)	End A	End B	Average End Bearing	Skin Friction (psf)	End Bearing - Displacement (psf)	End Bearing - Non Displacement (psf)
1	5.0	1082.4	7.0	6.34	0.00	6.34	27.18	6.80	16.99	322	26956	17970
2	12.0	1075.4	5.0	23.72	6.38	17.34	9.64	9.64	9.64	1232	15294	10196
3	17.0	1070.4	5.0	32.11	23.77	8.34	48.70	39.90	44.30	593	70284	46856
4	22.0	1065.4	5.0	49.47	32.16	17.31	163.32	135.97	149.65	1230	237420	158280
5	27.0	1060.4	10.0	94.68	49.55	45.13	225.78	163.43	194.61	1604	308752	205835
6						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
7						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
8						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
9						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
10						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
11						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
12						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: F:\TR\JOBS\E2097A13\REPORTS\GEOTECH\DRIVEN\B1.DVN
Project Name: CTH V Bridge (B1) Project Date: 01/23/2014
Project Client: Wood County
Computed By: BPA
Project Manager: TAB

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 8.00 ft
Diameter of Pile: 10.75 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	5.00 ft
	- Driving/Restrike	5.00 ft
	- Ultimate:	5.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	8.00 ft	33.00%	115.00 pcf	29.0/29.0	Nordlund
2	Cohesionless	7.00 ft	17.00%	125.00 pcf	34.0/34.0	Nordlund
3	Cohesive	5.00 ft	50.00%	120.00 pcf	1700.00 psf	T-79 Steel
4	Cohesionless	5.00 ft	33.00%	130.00 pcf	35.0/35.0	Nordlund
5	Cohesionless	5.00 ft	33.00%	135.00 pcf	40.0/40.0	Nordlund
6	Cohesionless	10.00 ft	33.00%	145.00 pcf	40.0/40.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
5.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.00 ft	Cohesionless	732.80 psf	15.34	N/A	0.00 Kips
8.01 ft	Cohesionless	733.11 psf	17.99	N/A	0.01 Kips
14.99 ft	Cohesionless	951.59 psf	17.99	N/A	6.34 Kips
15.01 ft	Cohesive	N/A	N/A	1184.18 psf	6.38 Kips
19.99 ft	Cohesive	N/A	N/A	1236.99 psf	23.72 Kips
20.01 ft	Cohesionless	1459.34 psf	18.52	N/A	23.77 Kips
24.99 ft	Cohesionless	1627.66 psf	18.52	N/A	32.11 Kips
25.01 ft	Cohesionless	1797.36 psf	21.16	N/A	32.16 Kips
29.99 ft	Cohesionless	1978.14 psf	21.16	N/A	49.47 Kips
30.01 ft	Cohesionless	2160.41 psf	21.16	N/A	49.55 Kips
39.01 ft	Cohesionless	2532.11 psf	21.16	N/A	89.61 Kips
39.99 ft	Cohesionless	2572.59 psf	21.16	N/A	94.68 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
5.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
8.00 ft	Cohesionless	732.80 psf	26.40	8.40 Kips	6.80 Kips
8.01 ft	Cohesionless	733.43 psf	55.60	46.34 Kips	17.04 Kips
14.99 ft	Cohesionless	1170.37 psf	55.60	46.34 Kips	27.18 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	9.64 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	9.64 Kips
20.01 ft	Cohesionless	1459.68 psf	64.00	67.82 Kips	39.90 Kips
24.99 ft	Cohesionless	1796.32 psf	64.00	67.82 Kips	48.70 Kips
25.01 ft	Cohesionless	1797.73 psf	160.00	263.21 Kips	135.97 Kips
29.99 ft	Cohesionless	2159.27 psf	160.00	263.21 Kips	163.32 Kips
30.01 ft	Cohesionless	2160.83 psf	160.00	263.21 Kips	163.43 Kips
39.01 ft	Cohesionless	2904.23 psf	160.00	263.21 Kips	219.66 Kips
39.99 ft	Cohesionless	2985.17 psf	160.00	263.21 Kips	225.78 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.00 ft	0.00 Kips	6.80 Kips	6.80 Kips
8.01 ft	0.01 Kips	17.04 Kips	17.04 Kips
14.99 ft	6.34 Kips	27.18 Kips	33.52 Kips
15.01 ft	6.38 Kips	9.64 Kips	16.02 Kips
19.99 ft	23.72 Kips	9.64 Kips	33.36 Kips
20.01 ft	23.77 Kips	39.90 Kips	63.67 Kips
24.99 ft	32.11 Kips	48.70 Kips	80.81 Kips
25.01 ft	32.16 Kips	135.97 Kips	168.13 Kips
29.99 ft	49.47 Kips	163.32 Kips	212.79 Kips
30.01 ft	49.55 Kips	163.43 Kips	212.98 Kips
39.01 ft	89.61 Kips	219.66 Kips	309.27 Kips
39.99 ft	94.68 Kips	225.78 Kips	320.46 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
5.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.00 ft	Cohesionless	732.80 psf	15.34	N/A	0.00 Kips
8.01 ft	Cohesionless	733.11 psf	17.99	N/A	0.01 Kips
14.99 ft	Cohesionless	951.59 psf	17.99	N/A	5.26 Kips
15.01 ft	Cohesive	N/A	N/A	1184.18 psf	5.28 Kips
19.99 ft	Cohesive	N/A	N/A	1236.99 psf	13.95 Kips
20.01 ft	Cohesionless	1459.34 psf	18.52	N/A	13.99 Kips
24.99 ft	Cohesionless	1627.66 psf	18.52	N/A	19.57 Kips
25.01 ft	Cohesionless	1797.36 psf	21.16	N/A	19.60 Kips
29.99 ft	Cohesionless	1978.14 psf	21.16	N/A	31.21 Kips
30.01 ft	Cohesionless	2160.41 psf	21.16	N/A	31.26 Kips
39.01 ft	Cohesionless	2532.11 psf	21.16	N/A	58.09 Kips
39.99 ft	Cohesionless	2572.59 psf	21.16	N/A	61.49 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
5.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
8.00 ft	Cohesionless	732.80 psf	26.40	8.40 Kips	6.80 Kips
8.01 ft	Cohesionless	733.43 psf	55.60	46.34 Kips	17.04 Kips
14.99 ft	Cohesionless	1170.37 psf	55.60	46.34 Kips	27.18 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	9.64 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	9.64 Kips
20.01 ft	Cohesionless	1459.68 psf	64.00	67.82 Kips	39.90 Kips
24.99 ft	Cohesionless	1796.32 psf	64.00	67.82 Kips	48.70 Kips
25.01 ft	Cohesionless	1797.73 psf	160.00	263.21 Kips	135.97 Kips
29.99 ft	Cohesionless	2159.27 psf	160.00	263.21 Kips	163.32 Kips
30.01 ft	Cohesionless	2160.83 psf	160.00	263.21 Kips	163.43 Kips
39.01 ft	Cohesionless	2904.23 psf	160.00	263.21 Kips	219.66 Kips
39.99 ft	Cohesionless	2985.17 psf	160.00	263.21 Kips	225.78 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.00 ft	0.00 Kips	6.80 Kips	6.80 Kips
8.01 ft	0.01 Kips	17.04 Kips	17.04 Kips
14.99 ft	5.26 Kips	27.18 Kips	32.44 Kips
15.01 ft	5.28 Kips	9.64 Kips	14.93 Kips
19.99 ft	13.95 Kips	9.64 Kips	23.59 Kips
20.01 ft	13.99 Kips	39.90 Kips	53.89 Kips
24.99 ft	19.57 Kips	48.70 Kips	68.27 Kips
25.01 ft	19.60 Kips	135.97 Kips	155.58 Kips
29.99 ft	31.21 Kips	163.32 Kips	194.52 Kips
30.01 ft	31.26 Kips	163.43 Kips	194.69 Kips
39.01 ft	58.09 Kips	219.66 Kips	277.76 Kips
39.99 ft	61.49 Kips	225.78 Kips	287.28 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
5.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.00 ft	Cohesionless	732.80 psf	15.34	N/A	0.00 Kips
8.01 ft	Cohesionless	733.11 psf	17.99	N/A	0.01 Kips
14.99 ft	Cohesionless	951.59 psf	17.99	N/A	6.34 Kips
15.01 ft	Cohesive	N/A	N/A	1184.18 psf	6.38 Kips
19.99 ft	Cohesive	N/A	N/A	1236.99 psf	23.72 Kips
20.01 ft	Cohesionless	1459.34 psf	18.52	N/A	23.77 Kips
24.99 ft	Cohesionless	1627.66 psf	18.52	N/A	32.11 Kips
25.01 ft	Cohesionless	1797.36 psf	21.16	N/A	32.16 Kips
29.99 ft	Cohesionless	1978.14 psf	21.16	N/A	49.47 Kips
30.01 ft	Cohesionless	2160.41 psf	21.16	N/A	49.55 Kips
39.01 ft	Cohesionless	2532.11 psf	21.16	N/A	89.61 Kips
39.99 ft	Cohesionless	2572.59 psf	21.16	N/A	94.68 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
4.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
5.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
8.00 ft	Cohesionless	732.80 psf	26.40	8.40 Kips	6.80 Kips
8.01 ft	Cohesionless	733.43 psf	55.60	46.34 Kips	17.04 Kips
14.99 ft	Cohesionless	1170.37 psf	55.60	46.34 Kips	27.18 Kips
15.01 ft	Cohesive	N/A	N/A	N/A	9.64 Kips
19.99 ft	Cohesive	N/A	N/A	N/A	9.64 Kips
20.01 ft	Cohesionless	1459.68 psf	64.00	67.82 Kips	39.90 Kips
24.99 ft	Cohesionless	1796.32 psf	64.00	67.82 Kips	48.70 Kips
25.01 ft	Cohesionless	1797.73 psf	160.00	263.21 Kips	135.97 Kips
29.99 ft	Cohesionless	2159.27 psf	160.00	263.21 Kips	163.32 Kips
30.01 ft	Cohesionless	2160.83 psf	160.00	263.21 Kips	163.43 Kips
39.01 ft	Cohesionless	2904.23 psf	160.00	263.21 Kips	219.66 Kips
39.99 ft	Cohesionless	2985.17 psf	160.00	263.21 Kips	225.78 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
5.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.00 ft	0.00 Kips	6.80 Kips	6.80 Kips
8.01 ft	0.01 Kips	17.04 Kips	17.04 Kips
14.99 ft	6.34 Kips	27.18 Kips	33.52 Kips
15.01 ft	6.38 Kips	9.64 Kips	16.02 Kips
19.99 ft	23.72 Kips	9.64 Kips	33.36 Kips
20.01 ft	23.77 Kips	39.90 Kips	63.67 Kips
24.99 ft	32.11 Kips	48.70 Kips	80.81 Kips
25.01 ft	32.16 Kips	135.97 Kips	168.13 Kips
29.99 ft	49.47 Kips	163.32 Kips	212.79 Kips
30.01 ft	49.55 Kips	163.43 Kips	212.98 Kips
39.01 ft	89.61 Kips	219.66 Kips	309.27 Kips
39.99 ft	94.68 Kips	225.78 Kips	320.46 Kips

Pile Analysis for Soils

Project ID: E2097A13
Structure: CTH V Bridge over Rocky Run
Boring #: B2
Station: N/A
Surface Elev. (ft): Approx. 1090.7
Foundation Elevation (ft): Approx. 1082.7

Pile Type: 10.75-inch CIP
Pile Dia: 0.896 feet
Perimeter: 2.814 feet
End Area: 0.630 sq. feet

Nordlund Resistance Factor = 1

Layer #	Depth to the top of the layer (ft)	Elevation at the top of the layer (ft)	Layer Thick. (ft)	Y	X	Y-X (Skin Friction)	End A	End B	Average End Bearing	Skin Friction (psf)	End Bearing - Displacement (psf)	End Bearing - Non Displacement (psf)
1	5.0	1082.7	2.0	0.87	0.00	0.87	7.20	6.22	6.71	155	10646	7097
2	7.0	1080.7	5.0	5.24	0.88	4.36	24.69	18.03	21.36	310	33889	22593
3	12.0	1075.7	6.0	10.68	5.26	5.42	13.02	13.02	13.02	321	20657	13771
4	18.0	1069.7	4.0	19.87	10.71	9.16	5.11	5.11	5.11	814	8107	5405
5	22.0	1065.7	5.0	27.28	19.91	7.37	20.80	20.80	20.80	524	33000	22000
6	27.0	1060.7	6.0	50.98	27.28	23.70	189.27	151.91	170.59	1404	270651	180434
7						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
8						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
9						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
10						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
11						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!
12						0.00			#DIV/0!	#DIV/0!	#DIV/0!	#DIV/0!

DRIVEN 1.2

GENERAL PROJECT INFORMATION

Filename: F:\TR\JOBS\E2097A13\REPORTS\GEOTECH\DRIVEN\B2.DVN
Project Name: CTH V Bridge (B2) Project Date: 01/23/2014
Project Client: Wood County
Computed By: BPA
Project Manager: TAB

PILE INFORMATION

Pile Type: Pipe Pile - Closed End
Top of Pile: 8.00 ft
Diameter of Pile: 10.75 in

ULTIMATE CONSIDERATIONS

Water Table Depth At Time Of:	- Drilling:	4.00 ft
	- Driving/Restrike	4.00 ft
	- Ultimate:	4.00 ft
Ultimate Considerations:	- Local Scour:	0.00 ft
	- Long Term Scour:	0.00 ft
	- Soft Soil:	0.00 ft

ULTIMATE PROFILE

Layer	Type	Thickness	Driving Loss	Unit Weight	Strength	Ultimate Curve
1	Cohesionless	10.00 ft	33.00%	115.00 pcf	29.0/29.0	Nordlund
2	Cohesionless	5.00 ft	17.00%	120.00 pcf	34.0/34.0	Nordlund
3	Cohesionless	6.00 ft	0.00%	125.00 pcf	31.0/31.0	Nordlund
4	Cohesive	4.00 ft	50.00%	120.00 pcf	900.00 psf	T-79 Steel
5	Cohesionless	5.00 ft	33.00%	130.00 pcf	32.0/32.0	Nordlund
6	Cohesionless	6.00 ft	17.00%	145.00 pcf	40.0/40.0	Nordlund

RESTRIKE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
3.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.00 ft	Cohesionless	670.40 psf	15.34	N/A	0.00 Kips
9.99 ft	Cohesionless	722.74 psf	15.34	N/A	0.87 Kips
10.01 ft	Cohesionless	775.89 psf	17.99	N/A	0.88 Kips
14.99 ft	Cohesionless	919.31 psf	17.99	N/A	5.24 Kips
15.01 ft	Cohesionless	1063.91 psf	16.40	N/A	5.26 Kips
20.99 ft	Cohesionless	1251.09 psf	16.40	N/A	10.68 Kips
21.01 ft	Cohesive	N/A	N/A	796.40 psf	10.71 Kips
24.99 ft	Cohesive	N/A	N/A	817.51 psf	19.87 Kips
25.01 ft	Cohesionless	1669.94 psf	16.93	N/A	19.91 Kips
29.99 ft	Cohesionless	1838.26 psf	16.93	N/A	27.23 Kips
30.01 ft	Cohesionless	2008.01 psf	21.16	N/A	27.28 Kips
35.99 ft	Cohesionless	2254.99 psf	21.16	N/A	50.98 Kips

RESTRIKE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
3.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
4.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
8.00 ft	Cohesionless	670.40 psf	26.40	8.40 Kips	6.22 Kips
9.99 ft	Cohesionless	775.07 psf	26.40	8.40 Kips	7.20 Kips
10.01 ft	Cohesionless	776.18 psf	55.60	46.34 Kips	18.03 Kips
14.99 ft	Cohesionless	1063.02 psf	55.60	46.34 Kips	24.69 Kips
15.01 ft	Cohesionless	1064.23 psf	35.20	13.02 Kips	13.02 Kips
20.99 ft	Cohesionless	1438.57 psf	35.20	13.02 Kips	13.02 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	5.11 Kips
24.99 ft	Cohesive	N/A	N/A	N/A	5.11 Kips
25.01 ft	Cohesionless	1670.28 psf	40.40	20.80 Kips	20.80 Kips
29.99 ft	Cohesionless	2006.92 psf	40.40	20.80 Kips	20.80 Kips
30.01 ft	Cohesionless	2008.43 psf	160.00	263.21 Kips	151.91 Kips
35.99 ft	Cohesionless	2502.37 psf	160.00	263.21 Kips	189.27 Kips

RESTRIKE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.00 ft	0.00 Kips	6.22 Kips	6.22 Kips
9.99 ft	0.87 Kips	7.20 Kips	8.07 Kips
10.01 ft	0.88 Kips	18.03 Kips	18.91 Kips
14.99 ft	5.24 Kips	24.69 Kips	29.93 Kips
15.01 ft	5.26 Kips	13.02 Kips	18.29 Kips
20.99 ft	10.68 Kips	13.02 Kips	23.70 Kips
21.01 ft	10.71 Kips	5.11 Kips	15.82 Kips
24.99 ft	19.87 Kips	5.11 Kips	24.97 Kips
25.01 ft	19.91 Kips	20.80 Kips	40.71 Kips
29.99 ft	27.23 Kips	20.80 Kips	48.03 Kips
30.01 ft	27.28 Kips	151.91 Kips	179.18 Kips
35.99 ft	50.98 Kips	189.27 Kips	240.25 Kips

DRIVING - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
3.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.00 ft	Cohesionless	670.40 psf	15.34	N/A	0.00 Kips
9.99 ft	Cohesionless	722.74 psf	15.34	N/A	0.58 Kips
10.01 ft	Cohesionless	775.89 psf	17.99	N/A	0.59 Kips
14.99 ft	Cohesionless	919.31 psf	17.99	N/A	4.21 Kips
15.01 ft	Cohesionless	1063.91 psf	16.40	N/A	4.23 Kips
20.99 ft	Cohesionless	1251.09 psf	16.40	N/A	9.65 Kips
21.01 ft	Cohesive	N/A	N/A	796.40 psf	9.66 Kips
24.99 ft	Cohesive	N/A	N/A	817.51 psf	14.24 Kips
25.01 ft	Cohesionless	1669.94 psf	16.93	N/A	14.27 Kips
29.99 ft	Cohesionless	1838.26 psf	16.93	N/A	19.17 Kips
30.01 ft	Cohesionless	2008.01 psf	21.16	N/A	19.21 Kips
35.99 ft	Cohesionless	2254.99 psf	21.16	N/A	38.89 Kips

DRIVING - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
3.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
4.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
8.00 ft	Cohesionless	670.40 psf	26.40	8.40 Kips	6.22 Kips
9.99 ft	Cohesionless	775.07 psf	26.40	8.40 Kips	7.20 Kips
10.01 ft	Cohesionless	776.18 psf	55.60	46.34 Kips	18.03 Kips
14.99 ft	Cohesionless	1063.02 psf	55.60	46.34 Kips	24.69 Kips
15.01 ft	Cohesionless	1064.23 psf	35.20	13.02 Kips	13.02 Kips
20.99 ft	Cohesionless	1438.57 psf	35.20	13.02 Kips	13.02 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	5.11 Kips
24.99 ft	Cohesive	N/A	N/A	N/A	5.11 Kips
25.01 ft	Cohesionless	1670.28 psf	40.40	20.80 Kips	20.80 Kips
29.99 ft	Cohesionless	2006.92 psf	40.40	20.80 Kips	20.80 Kips
30.01 ft	Cohesionless	2008.43 psf	160.00	263.21 Kips	151.91 Kips
35.99 ft	Cohesionless	2502.37 psf	160.00	263.21 Kips	189.27 Kips

DRIVING - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.00 ft	0.00 Kips	6.22 Kips	6.22 Kips
9.99 ft	0.58 Kips	7.20 Kips	7.78 Kips
10.01 ft	0.59 Kips	18.03 Kips	18.62 Kips
14.99 ft	4.21 Kips	24.69 Kips	28.90 Kips
15.01 ft	4.23 Kips	13.02 Kips	17.26 Kips
20.99 ft	9.65 Kips	13.02 Kips	22.67 Kips
21.01 ft	9.66 Kips	5.11 Kips	14.77 Kips
24.99 ft	14.24 Kips	5.11 Kips	19.35 Kips
25.01 ft	14.27 Kips	20.80 Kips	35.07 Kips
29.99 ft	19.17 Kips	20.80 Kips	39.97 Kips
30.01 ft	19.21 Kips	151.91 Kips	171.12 Kips
35.99 ft	38.89 Kips	189.27 Kips	228.16 Kips

ULTIMATE - SKIN FRICTION

Depth	Soil Type	Effective Stress At Midpoint	Sliding Friction Angle	Adhesion	Skin Friction
0.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
3.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
4.01 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	0.00	N/A	0.00 Kips
8.00 ft	Cohesionless	670.40 psf	15.34	N/A	0.00 Kips
9.99 ft	Cohesionless	722.74 psf	15.34	N/A	0.87 Kips
10.01 ft	Cohesionless	775.89 psf	17.99	N/A	0.88 Kips
14.99 ft	Cohesionless	919.31 psf	17.99	N/A	5.24 Kips
15.01 ft	Cohesionless	1063.91 psf	16.40	N/A	5.26 Kips
20.99 ft	Cohesionless	1251.09 psf	16.40	N/A	10.68 Kips
21.01 ft	Cohesive	N/A	N/A	796.40 psf	10.71 Kips
24.99 ft	Cohesive	N/A	N/A	817.51 psf	19.87 Kips
25.01 ft	Cohesionless	1669.94 psf	16.93	N/A	19.91 Kips
29.99 ft	Cohesionless	1838.26 psf	16.93	N/A	27.23 Kips
30.01 ft	Cohesionless	2008.01 psf	21.16	N/A	27.28 Kips
35.99 ft	Cohesionless	2254.99 psf	21.16	N/A	50.98 Kips

ULTIMATE - END BEARING

Depth	Soil Type	Effective Stress At Tip	Bearing Cap. Factor	Limiting End Bearing	End Bearing
0.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
3.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
4.01 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
7.99 ft	Cohesionless	0.00 psf	26.40	8.40 Kips	0.00 Kips
8.00 ft	Cohesionless	670.40 psf	26.40	8.40 Kips	6.22 Kips
9.99 ft	Cohesionless	775.07 psf	26.40	8.40 Kips	7.20 Kips
10.01 ft	Cohesionless	776.18 psf	55.60	46.34 Kips	18.03 Kips
14.99 ft	Cohesionless	1063.02 psf	55.60	46.34 Kips	24.69 Kips
15.01 ft	Cohesionless	1064.23 psf	35.20	13.02 Kips	13.02 Kips
20.99 ft	Cohesionless	1438.57 psf	35.20	13.02 Kips	13.02 Kips
21.01 ft	Cohesive	N/A	N/A	N/A	5.11 Kips
24.99 ft	Cohesive	N/A	N/A	N/A	5.11 Kips
25.01 ft	Cohesionless	1670.28 psf	40.40	20.80 Kips	20.80 Kips
29.99 ft	Cohesionless	2006.92 psf	40.40	20.80 Kips	20.80 Kips
30.01 ft	Cohesionless	2008.43 psf	160.00	263.21 Kips	151.91 Kips
35.99 ft	Cohesionless	2502.37 psf	160.00	263.21 Kips	189.27 Kips

ULTIMATE - SUMMARY OF CAPACITIES

Depth	Skin Friction	End Bearing	Total Capacity
0.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
3.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
4.01 ft	0.00 Kips	0.00 Kips	0.00 Kips
7.99 ft	0.00 Kips	0.00 Kips	0.00 Kips
8.00 ft	0.00 Kips	6.22 Kips	6.22 Kips
9.99 ft	0.87 Kips	7.20 Kips	8.07 Kips
10.01 ft	0.88 Kips	18.03 Kips	18.91 Kips
14.99 ft	5.24 Kips	24.69 Kips	29.93 Kips
15.01 ft	5.26 Kips	13.02 Kips	18.29 Kips
20.99 ft	10.68 Kips	13.02 Kips	23.70 Kips
21.01 ft	10.71 Kips	5.11 Kips	15.82 Kips
24.99 ft	19.87 Kips	5.11 Kips	24.97 Kips
25.01 ft	19.91 Kips	20.80 Kips	40.71 Kips
29.99 ft	27.23 Kips	20.80 Kips	48.03 Kips
30.01 ft	27.28 Kips	151.91 Kips	179.18 Kips
35.99 ft	50.98 Kips	189.27 Kips	240.25 Kips

Appendix D

Pile Drivability and GRLWEAP Results

Hammer:
Delmag D-16-32

Driveability Analysis

Location:
East Abutment (B1)

Weight of Hammer (lbs)
3520

REFUSAL

Pile:
10.75-inch CIP

Depth (ft)	Blow Count (blows/ft)	Stroke (ft)	Comp. Stress (ksi)	Ulti. Capacity (kips)	WisDOT (tons)	Modified Gates (tons)
8.0	0.0	11.47	0.000	0.0	#DIV/0!	#DIV/0!
8.0	1.7	3.87	12.515	17.1	1.9	-34.6
11.5	2.3	4.21	15.004	24.3	2.7	-19.9
15.0	3.1	4.47	16.861	32.2	3.9	-4.8
15.0	1.5	3.64	10.611	14.7	1.6	-40.4
17.5	1.7	3.87	12.670	18.0	1.9	-34.6
20.0	2.0	4.09	14.430	21.5	2.3	-26.7
20.0	5.7	5.15	21.355	51.8	7.9	29.7
22.5	6.5	5.36	22.181	58.5	9.2	38.2
25.0	7.3	5.51	23.005	65.6	10.5	45.6
25.0	19.5	6.99	42.970	153.0	30.2	116.2
27.5	22.2	7.30	45.876	171.5	34.7	127.7
30.0	25.6	7.55	48.202	190.6	39.7	139.6
30.0	25.7	7.55	48.237	190.9	39.8	139.8
35.0	35.5	8.22	52.909	234.2	53.8	168.9
40.0	53.0	8.84	56.624	280.3	73.0	203.9

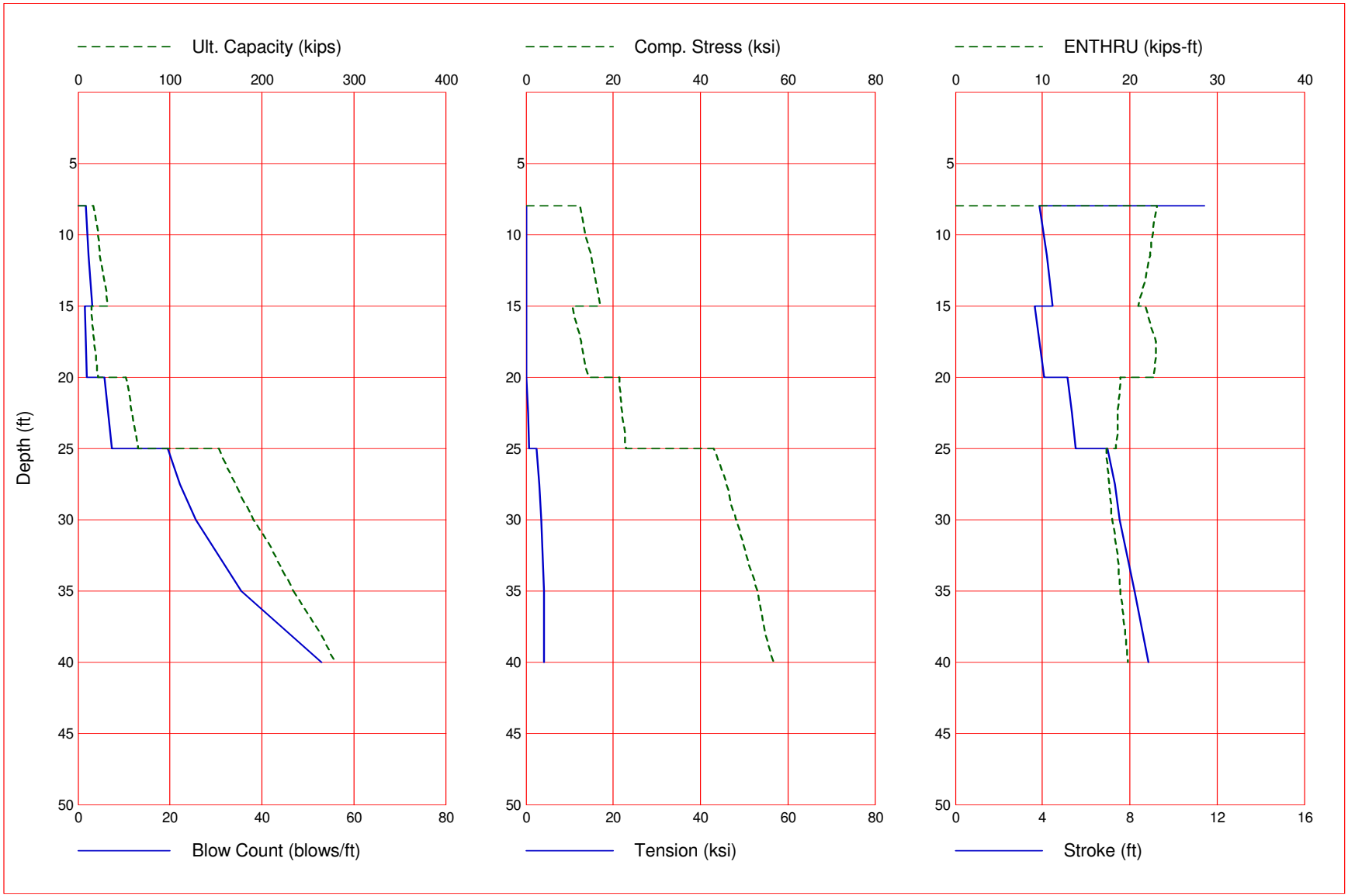
Omnni Associates Inc

Jan 23 2014

CTH V Bridge : 01/23/2014 : BPA

Gain/Loss 1 at Shaft and Toe 0.400 / 1.000

GRLWEAP(TM) Version 2005



Gain/Loss 1 at Shaft and Toe 0.400 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
8.0	0.0	0.0	0.0	0.0	0.000	0.000	11.42	0.0
8.0	17.1	0.0	17.1	1.7	12.515	0.000	3.87	23.1
11.5	24.3	2.2	22.1	2.3	15.004	0.000	4.21	22.3
15.0	32.2	5.0	27.2	3.1	16.861	0.000	4.47	21.0
15.0	14.7	5.1	9.6	1.5	10.611	0.000	3.64	21.8
17.5	18.0	8.4	9.6	1.7	12.670	0.000	3.87	23.0
20.0	21.5	11.8	9.6	2.0	14.430	0.000	4.09	22.8
20.0	51.8	11.9	39.9	5.7	21.355	0.000	5.15	18.9
22.5	58.5	14.2	44.3	6.5	22.181	-0.573	5.36	18.6
25.0	65.6	16.9	48.7	7.3	23.005	-0.735	5.51	18.4
25.0	153.0	16.9	136.0	19.5	42.970	-2.389	6.99	17.3
27.5	171.5	21.9	149.6	22.2	45.876	-3.069	7.30	17.7
30.0	190.6	27.3	163.3	25.6	48.202	-3.591	7.55	18.0
30.0	190.9	27.4	163.5	25.7	48.237	-3.598	7.55	18.0
35.0	234.2	39.8	194.4	35.5	52.909	-4.155	8.22	18.9
40.0	280.3	54.5	225.8	53.0	56.624	-4.121	8.84	19.8

Total Continuous Driving Time 13.00 minutes; Total Number of Blows 541

Hammer:
Delmag D-16-32

Driveability Analysis

Location:
West Abutment (B2)

Weight of Hammer (lbs)
3520

REFUSAL

Pile:
10.75-inch CIP

Depth (ft)	Blow Count (blows/ft)	Stroke (ft)	Comp. Stress (ksi)	Ulti. Capacity (kips)	WisDOT (tons)	Modified Gates (tons)
5.0	0.0	11.42	0.000	0.0	#DIV/0!	#DIV/0!
10.0	-1.0	0.00	0.000	7.7	0.0	#NUM!
10.0	1.8	3.93	12.737	18.6	2.0	-31.9
12.5	2.2	4.15	14.511	23.5	2.6	-22.2
15.0	2.7	4.37	15.605	28.7	3.3	-11.8
15.0	1.6	3.79	11.597	17.0	1.7	-37.4
18.0	1.7	3.87	12.448	19.5	1.9	-34.6
21.0	1.8	3.95	13.449	22.4	2.0	-31.8
21.0	1.4	3.53	9.218	14.6	1.4	-43.5
23.0	1.5	3.67	10.738	16.4	1.6	-40.4
25.0	1.6	3.81	11.953	18.2	1.7	-37.3
25.0	3.2	4.51	17.290	33.9	4.0	-3.0
27.5	3.4	4.55	17.806	36.0	4.3	0.1
30.0	3.6	4.62	18.300	38.3	4.6	3.2
30.0	22.1	7.26	46.055	169.5	34.4	127.0
33.0	26.8	7.62	49.515	196.9	41.4	143.3
36.0	32.8	8.02	52.423	225.5	49.9	161.2

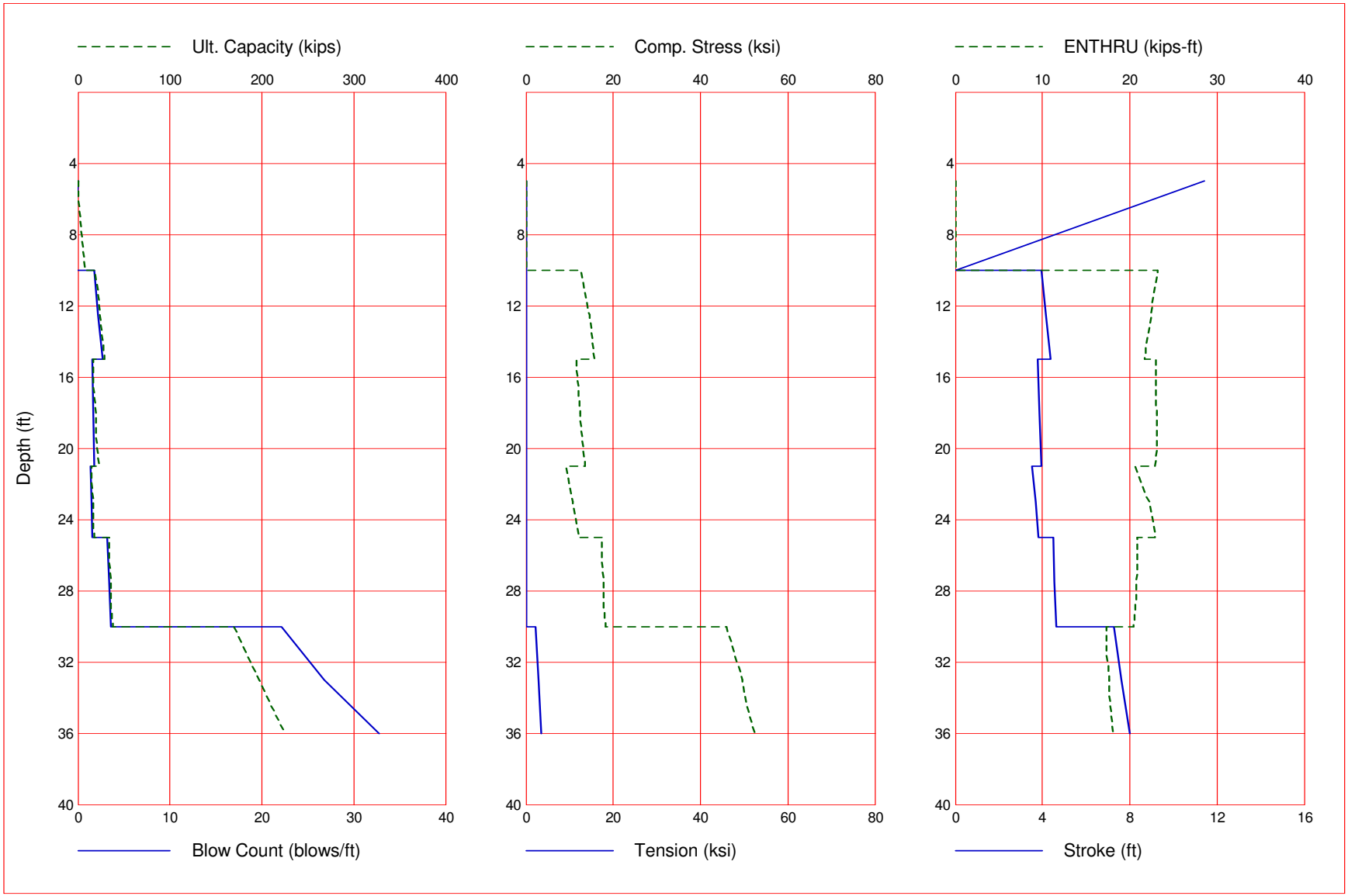
Omnni Associates Inc

Jan 23 2014

CTH V Bridge (B2) : 01/23/2014 : BPA

Gain/Loss 1 at Shaft and Toe 0.400 / 1.000

GRLWEAP(TM) Version 2005



Gain/Loss 1 at Shaft and Toe 0.400 / 1.000

Depth ft	Ultimate Capacity kips	Friction kips	End Bearing kips	Blow Count blows/ft	Comp. Stress ksi	Tension Stress ksi	Stroke ft	ENTHRU kips-ft
5.0	0.0	0.0	0.0	0.0	0.000	0.000	11.42	0.0
10.0	7.7	0.5	7.2	-1.0	0.000	0.000	0.00	0.0
10.0	18.6	0.5	18.0	1.8	12.737	0.000	3.93	23.2
12.5	23.5	2.1	21.4	2.2	14.511	0.000	4.15	22.5
15.0	28.7	4.0	24.7	2.7	15.605	0.000	4.37	21.7
15.0	17.0	4.0	13.0	1.6	11.597	0.000	3.79	23.0
18.0	19.5	6.5	13.0	1.7	12.448	0.000	3.87	23.1
21.0	22.4	9.4	13.0	1.8	13.449	0.000	3.95	22.9
21.0	14.6	9.5	5.1	1.4	9.218	0.000	3.53	20.6
23.0	16.4	11.2	5.1	1.5	10.738	0.000	3.67	22.2
25.0	18.2	13.1	5.1	1.6	11.953	0.000	3.81	22.9
25.0	33.9	13.1	20.8	3.2	17.290	0.000	4.51	20.8
27.5	36.0	15.2	20.8	3.4	17.806	0.000	4.55	20.7
30.0	38.3	17.5	20.8	3.6	18.300	0.000	4.62	20.4
30.0	169.5	17.6	152.0	22.1	46.055	-2.332	7.26	17.3
33.0	196.9	26.3	170.5	26.8	49.515	-2.932	7.62	17.6
36.0	225.5	36.2	189.3	32.8	52.423	-3.440	8.02	18.1

Total Continuous Driving Time 5.00 minutes; Total Number of Blows 206

Appendix E

Field Exploration Procedures

FIELD EXPLORATION PROCEDURES

Soil sampling was performed in accordance with ASTM:D1586. Using this procedure, a 2" O.D. split barrel sampler is driven into the soil by a 140 pound weight falling 30". After an initial set of 6", the number of blows required to drive the sampler an additional 12" is known as the penetration resistance or N value. The N value is an index of the relative density of cohesionless soils and the consistency of cohesive soils. Thin-wall tube samples were obtained according to ASTM:D1587 where indicated by appropriate symbol on the boring logs. Rock core samples, if taken, were obtained by rotary drilling in accordance with ASTM:D2113. Power auger borings, if performed, were done in general accordance with ASTM:D1452.

The samples were visually and manually classified by the crew chief in accordance with ASTM:D2488. Representative portions of the samples were then returned to the laboratory for further examination and for verification of the field classifications. Logs of the borings indicating the depth and identification of the various strata, the N value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are attached. Charts illustrating the soils classification procedure, the descriptive terminology and symbols used on the boring logs are also attached.

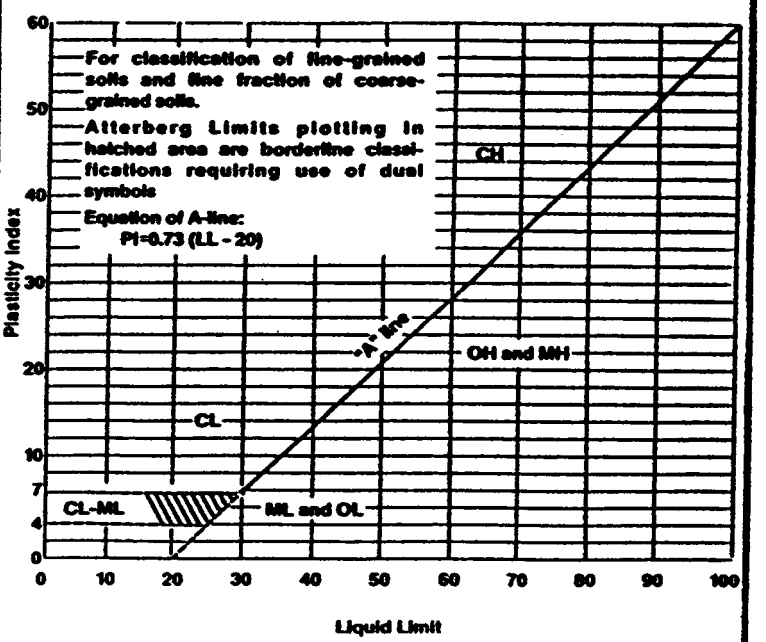
Appendix F

Classification of Soils

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

(ASTM: D 2487 and 2488)

Major divisions			Group symbols	Typical names	Laboratory classification criteria		
Coarse-grained soils (More than half of material is larger than No. 200 sieve size)	Gravels (More than half of coarse fraction larger than No. 4 sieve size)	Clean gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 per cent ..... GW, GP, SW, SP; More than 12 per cent ..... GM, GC, SM, SC; 5 to 12 per cent ..... *Borderline* cases requiring dual symbols	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	GM d / GM u	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Above "A" line with P.I. between 4 and 7 *are borderline* cases requiring use of dual symbols
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line or P.I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	Clean sands (Little or no fines)	SW	Well-graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 4; $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3	
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	SM d / SM u	Silty sands, sand-silt mixtures		Atterberg limits below "A" line or P.I. less than 4	Limits plotting in hatched zone with P.I. between 4 and 7 *are borderline* cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures		Atterberg limits below "A" line or P.I. greater than 7	
Fine-grained soils More than half of material is *smaller* than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands or clayey silts with slight plasticity			
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL	Organic silts and organic silty clays of low plasticity			
	Silts and clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts			
			CH	Inorganic clays of high plasticity, fat clays			
			OH	Organic clays of medium to high plasticity, organic silts			
	Highl organic soils		Pt	Peat and other highly organic soil			



Plasticity Chart