Final Geotechnical Evaluation Report

Willow Heights Subdivision
Knobloch Road
Town of Shelby, Wisconsin

Prepared for

ALT Investments, LLC

Brandon K. Wright, PE
Project Engineer
License Number: 40141
March 4, 2015

Project B1501263

Braun Intertec Corporation

BRAUN INTERTEC
The Science You Build On.

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March 4, 2015

Project B1501263

ALT Investments. LLC
c/o Mr. Daniel Cook, PE, CFM
Davy Engineering Company
115 6th Street South
La Crosse, Wisconsin 54601

Re: Final Geotechnical Evaluation
Proposed Willow Heights Subdivision
Knobloch Road
Town of Shelby, Wisconsin

Dear Mr. Cook:

We are pleased to present this Final Geotechnical Evaluation Report for the proposed pavements in the Willow Heights Subdivision. A summary of our results, and a summary of our recommendations in light of the geotechnical issues influencing design and construction, is presented below. More detailed information and recommendations follow.

Summary of Results

We drilled nine standard penetration test borings across the site. The borings indicate that the site consists of topsoil and undocumented fill over loess and residuum. The borings initially encountered approximately ½ foot of topsoil. The southernmost boring encountered 2 feet of undocumented fill beneath the topsoil. The topsoil and undocumented fill were underlain with loess and residual soils. Groundwater was not observed as our borings were advanced.

Based on penetration resistance testing, the loess is medium to rather stiff, the clayey residuum is medium to hard and the sandy residuum is medium dense.

Summary of Recommendations

The geotechnical issues influencing design and construction of the proposed pavements include (1) removing surficial vegetation from below areas that will be receiving new pavements and (2) backfilling the existing pond.

Following the removal of surficial vegetation, the excavation bottoms will be underlain with fine-grained soils that are soft, wet and susceptible to disturbance and strength loss. At the pavement subgrade elevation, we recommend lining the excavation bottoms with a woven geotextile fabric. Residential pavements include 3 inches of bituminous pavement over 8 inches of aggregate base material and 12 inches of subbase.

Remarks

Thank you for making Braun Intertec your geotechnical consultant for this project. If you have questions about this report, or if there are other services that we can provide in support of our work to date, please call Nicole Carlson or Brandon Wright at 608.781.7277.

Sincerely,

BRAUN INTERTEC CORPORATION

Nicole A. Carlson, EIT
Staff Engineer

Brandon K. Wright, PE
Project Engineer

Table of Contents

Table of Contents (continued)

A. Introduction

A.1. Project Description & Purpose

This Final Geotechnical Evaluation Report addresses a proposed residential road for a 25-lot residential subdivision. The residential development will be located south of Knobloch Road in the Town of Shelby, Wisconsin. The general location of the site with adjacent streets is shown on the Soil Boring Location Sketch in the Appendix.

A.2. Background Information and Reference Documents

To facilitate our evaluation, we reviewed (1) topographic maps of the area, (2) geologic atlas and (3) preliminary site plans provided by Davy Engineering Company, dated February 2, 2015.

A.3. Site Conditions

The site is an existing golf course consisting mostly of grass and mature trees. An existing pond and wood framed barn are also located on the property.

A.4. Scope of Services

Our scope of services for this project was originally submitted as a Proposal to Daniel Cook of Davy Engineering Company who provided us authorization to proceed. Our scope of services was performed under the terms of our September 1, 2009, General Conditions. Tasks performed in accordance with our authorized scope of services included:

- Staking exploration locations and clearing of underground utilities.
- Performing nine penetration test borings, extending them to a depth of 10 feet.
- Performing laboratory moisture content, dry density mechanical sieve analysis through a number 200-sieve test on selected penetration test samples.
- Preparing this report containing a CAD sketch, exploration logs, a summary of the geologic materials encountered, results of laboratory tests, and recommendations for pavement subgrade preparation and the design of pavement sections.

Our scope of work initially included borings for the proposed storm water infiltration areas. Since plans are preliminary at this time, and because the exact location of those infiltration areas are not known, we did not include provide discussion for storm water infiltration systems.

B. Results

B.1. Boring Logs

B.1.a. Log of Boring Sheets

Log of Boring sheets for our penetration test borings are included in the Appendix. The logs identify and describe the geologic materials that were penetrated, and present the results of penetration resistance and other in-situ tests performed within them, laboratory tests performed on penetration test samples retrieved from them, and groundwater measurements.

Strata boundaries were inferred from changes in the penetration test samples and the auger cuttings. Because sampling was not performed continuously, the strata boundary depths are only approximate. The boundary depths likely vary away from the boring locations, and the boundaries themselves may also occur as gradual rather than abrupt transitions.

B.1.b. Geologic Origins

Geologic origins assigned to the materials shown on the logs and referenced within this report were based on: (1) a review of the background information and reference documents cited above, (2) visual classification of the various geologic material samples retrieved during the course of our subsurface exploration, (3) penetration resistance and other in-situ testing performed for the project, (4) laboratory test results, and (5) available common knowledge of the geologic processes and environments that have impacted the site and surrounding area in the past.

B.2. Geologic Profile

The boring indicate that the site consists of topsoil and undocumented fill over loess and residuum.

B.2.a. Topsoil and Undocumented Fill

The borings initially encountered approximately ½ foot of topsoil. Beneath the topsoil, Boring ST-9 encountered undocumented fill that extends to a depth of 2 feet. The undocumented fill consists of poorly graded gravel (GP) that is brown and frozen.

B.2.b. Loess

Below the topsoil and undocumented fill, the borings encountered loess soils that extended to depths of 2 to 5 ½ feet or to the termination depths in Boring ST-1 and ST-7. The loess soil consists of lean clay (CL) that is brown and frozen to wet.

B.2.c. Residuum

In Borings ST-2 through ST-6 and Borings ST-8 and ST-9, the loess was underlain with residuum that extended to the termination depth of the borings. The residuum consisted of mostly of sandy lean clay (CL), lean clay with sand (CL), but also clayey sand (SC) and poorly graded sand with silt (SP-SM). The residual soils were brown to red and tan and damp to wet.

B.2.d. Penetration Resistance Testing

The results of our penetration resistance testing are summarized below in Table 1. Comments are provided to qualify the significance of the results.

Table 1. Penetration Resistance Data

Geologic Material	Classification	Range of Penetration Resistances	Comments
Loess	Lean Clay (CL)	6 to 17 BPF	Frozen to depths of 3 to 4 feet, medium to rather stiff below
Clayey Residuum	Sandy Clay (CL), Clay w/Sand (CL) & Clayey Sand (SC)	7 to 36 BPF	Medium to hard
Sandy Residuum	Sand w/ Silt (SP-SM)	22 BPF	Medium dense

B.2.e. Groundwater

Groundwater was not observed as our borings were advanced. Given the cohesive nature of the geologic materials encountered, however, it is likely that insufficient time was available for groundwater to seep into the borings and rise to its hydrostatic level. Piezometers or monitoring wells would be required to confirm if groundwater was present within the depths explored. Seasonal and annual fluctuations of groundwater should also be anticipated.

B.3. Laboratory Test Results

Results of our laboratory tests are presented below in Table 2.

Table 2. Laboratory Classification Test Results

Location	Sample Depth (ft)	Classification	Moisture Content (%)	Percent Passing a #200 Sieve	Dry Density (pcf)
ST-1	5	Lean Clay (CL)	32	--	92
ST-3	5	Lean Clay w/ Sand (CL)	43	77	--
ST-6	5	Lean Clay w/ Sand (CL)	20	--	103
ST-7	2 ½	Lean Clay (CL)	24	97	--
ST-8	2 ½	Clayey Sand (SC)	11	16	--

C. Basis for Recommendations

C.1. Design Details

C.1.a. Pavements and Traffic Loads

We have assumed that residential pavements for this development will have a bituminous section. We have also assumed, with the residential traffic loadings, pavements will be subjected to no more than 50,000 equivalent 18-kip single axle loads (ESALs) over an assumed design life of 20 years.

C.1.b. Precautions Regarding Changed Information

We have attempted to describe our understanding of the proposed construction to the extent it was reported to us by others. Depending on the extent of available information, assumptions may have been made based on our experience with similar projects. If we have not correctly recorded or interpreted the project details, we should be notified. New or changed information could require additional evaluation, analyses and/or recommendations.

C.2. Design & Construction Considerations

The geotechnical issues influencing design and construction of the proposed pavements include (1) removing surficial vegetation from below areas that will be receiving new pavements and (2) backfilling the existing pond. With the topsoil and undocumented fill removed and the pond backfilling, we believe the geologic materials present will be suitable for support of the proposed pavements.

Following the removal of surficial vegetation, the excavation bottoms will be underlain with fine-grained soils that are soft, wet and susceptible to disturbance and strength loss. At the pavement subgrade elevation, we recommend lining the excavation bottoms with a woven geotextile fabric. Residential pavements include 3 inches of bituminous pavement over 8 inches of aggregate base material and 12 inches of subbase.

D. Recommendations

D.1. Earthwork

D.1.a. Pond Backfilling

Prior to backfilling the existing pond, we recommend removing any organic materials or soft clayey soils, if encountered, from within the pond area. The on-site undocumented fill, loess soils and residuum can be considered for re-use as backfill in this area, provided debris (if encountered) is first removed. We recommend, however, that the plastic index of these materials not exceed 15.

We also recommend spreading backfill in loose lifts of approximately 8 inches. We recommend compacting backfill and fill be compacted to a minimum of 98 percent of their standard Proctor maximum dry densities (ASTM International Test Method D 698).

D.1.b. Pavement Subgrade Preparations

We recommend removing surficial vegetation from below the proposed residential roadway. We anticipate that the excavation bottoms will be underlain with fine-grained soils that are soft, wet and susceptible to disturbance and strength loss. At the pavement subgrade elevation, we recommend lining the excavation bottoms with a woven geotextile fabric meeting the Wisconsin Department of Transportation Standard Specification 645.2.8 for Type C fabric.

D.1.c. Pavement Subgrade Compaction

We recommend spreading backfill and fill in loose lifts of approximately 8 inches. We recommend compacting excavation backfill (including utility backfill) and additional required fill placed within 3 feet of pavement subgrade elevations to at least 98 percent of their maximum standard Proctor dry densities (ASTM International D 698). Backfill and fill placed more than 3 feet below pavement subgrade elevations should be compacted to at least 95 percent.

D.2. Pavement Recommendations

D.2.a. Subgrade Proof-Roll

Prior to placing aggregate base material, we recommend proof-rolling pavement subgrades to determine if the subgrade materials are loose, soft or weak, and in need of further stabilization, compaction or subexcavation and recompaction or replacement. A second proof-roll should be performed after the aggregate base material is in place, and prior to placing bituminous or concrete pavement.

D.2.b. Pavement Design Sections

Laboratory tests to determine a CBR value for pavement design were not included in the scope of this project. Based upon the aforementioned traffic loads and an estimated CBR value of 3, we recommend residential pavements include 3 inches of bituminous pavement over 8 inches of aggregate base material and 12 inches of subbase.

The above pavement designs are based upon a 20-year performance life. This is the amount of time before major reconstruction is anticipated. This performance life assumes maintenance, such as seal coating and crack sealing, is routinely performed. The actual pavement life will vary depending on variations in weather, traffic conditions and maintenance.

D.2.c. Pavement Materials and Compaction

We recommend specifying subbase material meeting Wisconsin Department of Transportation (WisDOT) Specification Section 350.2 and crushed aggregate base meeting the requirements of WisDOT Specification Section 305.2.2.1 for 1 ¼ inch Dense Graded Base. We recommend utilizing an E-1 mixture for the hot mix asphalt meeting the specifications of WisDOT Section 460. We recommend utilizing a nominal 12.5 mm gradation for the base courses and a nominal 9.5 mm gradation for the surface courses as defined in Table 460-1 in Section 460.2.2.3. We recommend the Performance Graded Asphalt cement be a PG 64-28.

We recommend that the subbase and aggregate base be compacted to a minimum of 98 percent of its maximum standard Proctor dry density. We recommend that the bituminous pavement be compacted to at least 92 percent of the maximum theoretical density.

D.2.d. Construction Traffic

We anticipate that significant construction traffic will utilize the road during construction of the various residences. Since the construction traffic will induce significant loading on the residential street, we recommend that paving be deferred until after most or all of the construction traffic has dissipated. A frequent practice is to defer placement of the final lift of asphalt until building construction is complete. We caution against the practice since the construction traffic can still cause significant, although not necessarily visual, damage to the asphalt pavement.

D.3. Storm Water Infiltration Systems

Plans for the development are preliminary at this time and, exact locations for storm water infiltration systems have not been determined. The Wisconsin Department of Natural Recourses (WDNR) requires that continuous sampled borings or test pits be located within these structures. However, based on the borings, we believe the site consists of lean soils as defined by the US Department of Agriculture. Considering the site is composed of clay soils, consideration could be given to classifying the site as under exempt status based on NR 151.124 (4) (c) 2.

D.4. Construction Quality Control

D.4.a. Excavation Observations

We recommend having a geotechnical engineer observe all excavations related to subgrade preparation and pavement construction. The purpose of the observations is to evaluate the competence of the geologic materials exposed in the excavations, and the adequacy of required excavation oversizing.

D.4.b. Materials Testing

We recommend density tests be taken in excavation backfill and additional required fill placed below pavements.

D.4.c. Pavement Subgrade Proof-Roll

We recommend that proof-rolling of the pavement subgrades be observed by a geotechnical engineer to determine if the results of the procedure meet project specifications, or delineate the extent of additional pavement subgrade preparation work.

D.4.d. Cold Weather Precautions

If site grading and construction is anticipated during cold weather, all snow and ice should be removed from cut and fill areas prior to additional grading. No fill should be placed on frozen subgrades. No frozen soils should be used as fill.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with a flotation-mounted core and auger drill equipped with hollow-stem auger. The borings were performed in accordance with ASTM D 1586. Penetration test samples were taken at 2 ½- or 5-foot intervals. Actual sample intervals and corresponding depths are shown on the boring logs.

E.2. Material Classification and Testing

E.2.a. Visual and Manual Classification

The geologic materials encountered were visually and manually classified in accordance with ASTM Standard Practice D 2488. A chart explaining the classification system is attached. Samples were placed in jars or bags and returned to our facility for review and storage.

E.2.b. Laboratory Testing

The results of the laboratory tests performed on geologic material samples are noted on or follow the appropriate attached exploration logs. The tests were performed in accordance with ASTM or AASHTO procedures.

E.3. Groundwater Measurements

The drillers checked for groundwater as the penetration test borings were advanced, and again after auger withdrawal. The boreholes were then backfilled or allowed to remain open for an extended period of observation as noted on the boring logs.

F. Qualifications

F.1. Variations in Subsurface Conditions

F.1.a. Material Strata

Our evaluation, analyses and recommendations were developed from a limited amount of site and subsurface information. It is not standard engineering practice to retrieve material samples from exploration locations continuously with depth, and therefore strata boundaries and thicknesses must be inferred to some extent. Strata boundaries may also be gradual transitions, and can be expected to vary in depth, elevation and thickness away from the exploration locations.

Variations in subsurface conditions present between exploration locations may not be revealed until additional exploration work is completed, or construction commences. If any such variations are revealed, our recommendations should be re-evaluated. Such variations could increase construction costs, and a contingency should be provided to accommodate them.

F.1.b. Groundwater Levels

Groundwater measurements were made under the conditions reported herein and shown on the exploration logs, and interpreted in the text of this report. It should be noted that the observation periods were relatively short, and groundwater can be expected to fluctuate in response to rainfall, flooding, irrigation, seasonal freezing and thawing, surface drainage modifications and other seasonal and annual factors.

F.2. Continuity of Professional Responsibility

F.2.a. Plan Review

This report is based on a limited amount of information, and a number of assumptions were necessary to help us develop our recommendations. It is recommended that our firm review the geotechnical aspects of the designs and specifications, and evaluate whether the design is as expected, if any design changes have affected the validity of our recommendations, and if our recommendations have been correctly interpreted and implemented in the designs and specifications.

F.2.b. Construction Observations and Testing

It is recommended that we be retained to perform observations and tests during construction. This will allow correlation of the subsurface conditions encountered during construction with those encountered by the borings, and provide continuity of professional responsibility.

F.3. Use of Report

This report is for the exclusive use of Davy Engineering Company, ALT Investments, LLC and their design and construction team. Without written approval, we assume no responsibility to other parties regarding this report. Our evaluation, analyses and recommendations may not be appropriate for other parties or projects.

F.4. Standard of Care

In performing its services, Braun Intertec used that degree of care and skill ordinarily exercised under similar circumstances by reputable members of its profession currently practicing in the same locality. No warranty, express or implied, is made.

Appendix

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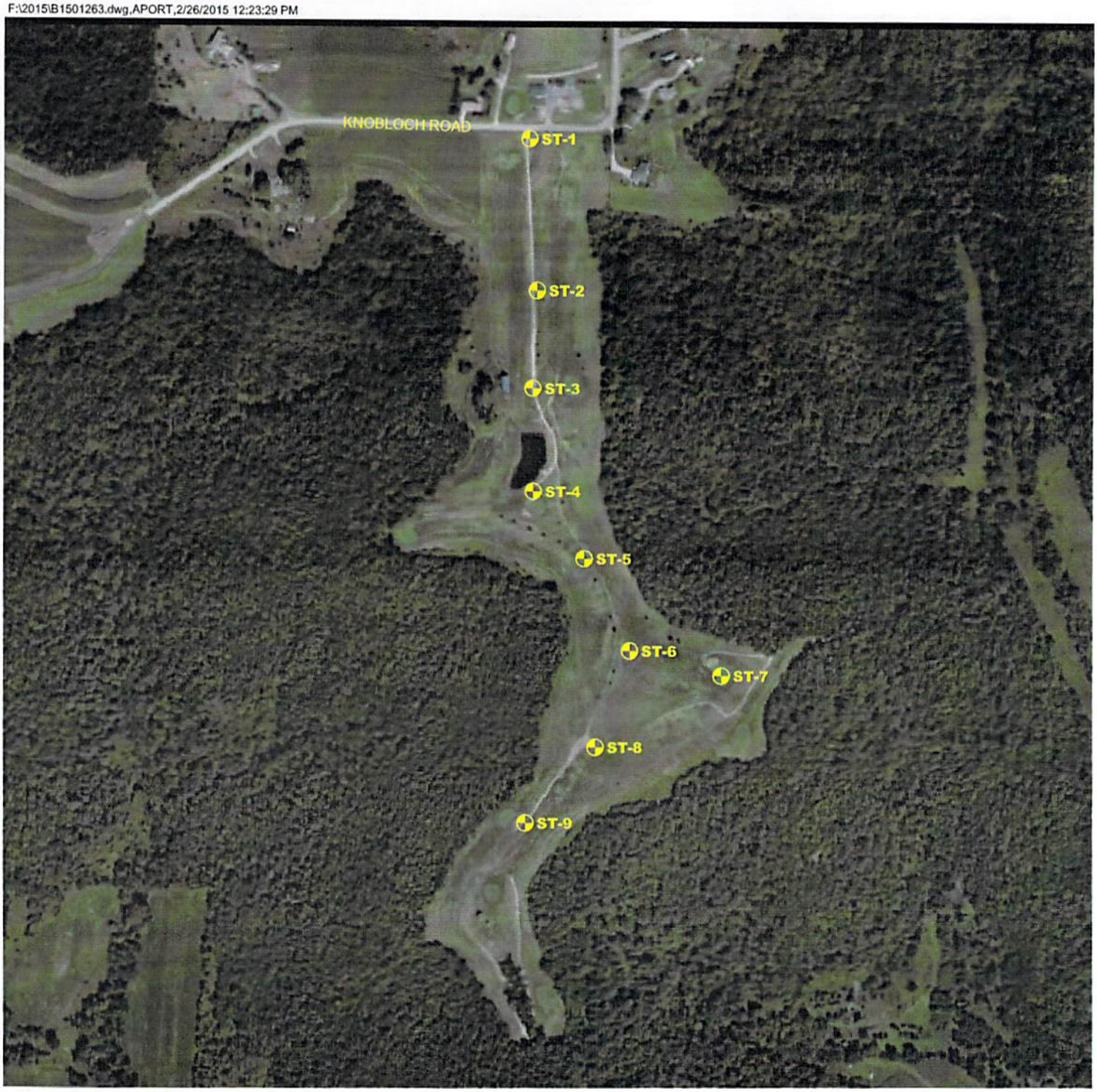

DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

N

300' 0 600'

SCALE: 1" = 600'

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Fig:	
Project No:	B1501263
Drawing No:	B1501263
Scale:	1" = 600'
Drawn By:	BJB
Date Drawn:	2/26/15
Checked By:	NC
Last Modified:	2/26/15

SOIL BORING LOCATION MAP
GEOTECHNICAL EVALUATION
PROPOSED WILLOW CREEK SUBDIVISION
KNOBLOCH ROAD
SHELBY, WISCONSIN

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Minneapolis, MN 55438
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FAX (952) 995-2020

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LOG OF BORING

Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-1**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.5	TS	6-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen to 3 feet then wet, medium. (Loess)	12		
			7		MC=32% DD=92 pcf
			6	▽	
			7		
11.0		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-2**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/24/15** | SCALE: **1" = 4'**

(See Descriptive Terminology sheet for explanation of abbreviations)

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.5	TS	6-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen to 3 feet then wet, medium. (Loess)	11		
5.5			14		
	CL	SANDY LEAN CLAY, with Gravel, red-brown, wet, stiff to hard. (Residuum)	16		
11.0			17		
		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

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GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-3**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.5	TS	6-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen. (Loess)	10		
4.0					
	CL	LEAN CLAY, with Sand, red-brown, wet, rather stiff. (Residuum)	9		MC=43% P200=77%
7.0					
	CL	SANDY LEAN CLAY, red, wet, medium. (Residuum)	7		
9.0					
	CL	SANDY LEAN CLAY, with Gravel, red-brown, wet, very stiff. (Residuum)	17		
11.0					
		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

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GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-4**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.7	TS	8-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen to 3 feet then wet, medium. (Loess)	10		
5.0					
	CL	SANDY LEAN CLAY, with Gravel, red-brown, wet, stiff. (Residuum)	15		
7.0					
	CL	LEAN CLAY, with Sand, with layers of Sand and trace of gravel, brown, wet, stiff. (Residuum)	19		
			17		
11.0					
		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-5**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: **2/24/15** | SCALE: **1" = 4'**

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.5	TS	6-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen. (Loess)			
2.0					
	CL	LEAN CLAY, with Sand, trace gravel, with layers of silty sand, red, frozen to 3 feet then wet, rather stiff. (Residuum)	9		
			11		
7.0					
	CL	LEAN CLAY, with Sand and Gravel, brown, wet, stiff to very stiff. (Residuum)	15		
			21		
11.0					
		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-6**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.7	TS	8-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen. (Loess)	12		
4.0					
	CL	LEAN CLAY, with Sand, with thin layers of Sand, red-brown, wet, stiff. (Residuum)	13		MC=20% DD=103 pcf
7.0					
	CL	SANDY LEAN CLAY, brown, wet, very stiff. (Residuum)	18		
11.0			22		
		END OF BORING. Water not observed while drilling. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-7**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.5	TS	6-inches of Topsoil.			
	CL	LEAN CLAY, brown, frozen to 3 feet then wet, medium to very stiff. (Loess)	17		MC=24% P200=97%
			7		
			17		
			13		
11.0		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-8**

LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

(See Descriptive Terminology sheet for explanation of abbreviations)

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.7	TS	8-inches of Topsoil.			
	CL	LEAN CLAY, trace of sand, brown, frozen. (Loess)			
2.0					
	SC	CLAYEY SAND, red-brown, frozen. (Residuum)	12		MC=11% P200=16%
4.0					
	CL	SANDY LEAN CLAY, with Gravel, red-brown, wet, rather stiff to very stiff. (Residuum)	27		
			12		
			11		
11.0		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

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Braun Project B15-01263
GEOTECHNICAL EVALUATION
Willow Creek Subdivision
La Crosse, Wisconsin

BORING: **ST-9**
LOCATION: See attached Boring Location Sketch.

DRILLER: GDC | METHOD: 3 1/4" HSA, Autohammer | DATE: 2/24/15 | SCALE: 1" = 4'

Depth feet	Symbol	Description of Materials (Soil-ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
0.0					
0.5	TS	6-inches of Topsoil.			
	FILL	FILL: Poorly Graded Gravel, trace of clay, brown, frozen.			
2.0					
	CL	LEAN CLAY, brown, frozen. (Loess)	12		
3.0					
	CL	SANDY LEAN CLAY, with Gravel, red-brown, wet, hard to very stiff. (Residuum)	36		
8.0			22		
	SP-SM	POORLY GRADED SAND with SILT, with Gravel, tan, damp, medium dense. (Residuum)	22		
11.0					
		END OF BORING.			
		Water not observed while drilling.			
		Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING N:\GINT\PROJECTS\LACROSSE\2015\B15-01263.GPJ BRAUN_V8_CURRENT.GDT 2/26/15 11:59

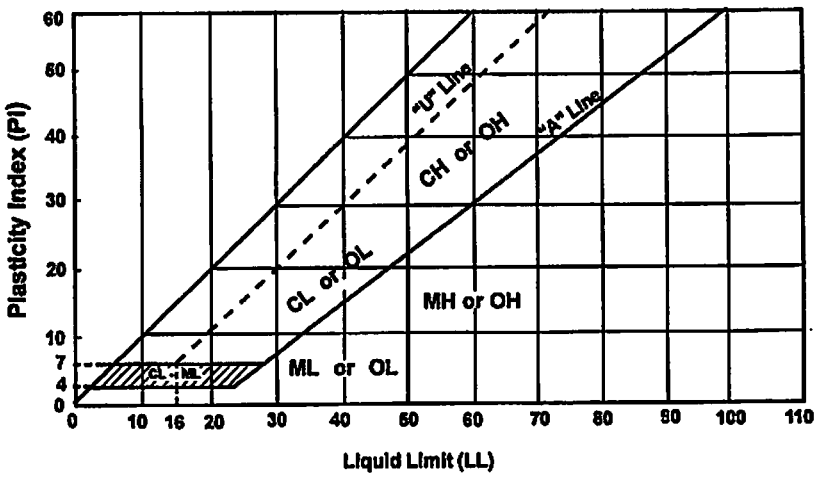
BRAUN
INTERTEC

Descriptive Terminology of Soil

Standard D 2487 - 00
Classification of Soils for Engineering Purposes
(Unified Soil Classification System)

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [a]				Soils Classification	
				Group Symbol	Group Name [b]
Coarse-grained Soils more than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels 5% or less fines [e]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [c]	GW	Well-graded gravel [d]
			$C_u < 4$ and/or $1 > C_c > 3$ [e]	GP	Poorly graded gravel [d]
		Gravels with Fines More than 12% fines [e]	Fines classify as ML or MH	GM	Silty gravel [d f g]
			Fines classify as CL or CH	GC	Clayey gravel [d f g]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands 5% or less fines [f]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [c]	SW	Well-graded sand [h]
			$C_u < 6$ and/or $1 > C_c > 3$ [c]	SP	Poorly graded sand [h]
		Sands with Fines More than 12% [f]	Fines classify as ML or MH	SM	Silty sand [f g h]
			Fines classify as CL or CH	SC	Clayey sand [f g h]
Fine-grained Soils 50% or more passed the No. 200 sieve	Silts and Clays Liquid limit less than 50	Inorganic	PI > 7 and plots on or above "A" line [j]	CL	Lean clay [k l m]
			PI < 4 or plots below "A" line [j]	ML	Silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic clay [k l m n]
				OL	Organic silt [k l m o]
	Silts and clays Liquid limit 50 or more	Inorganic	PI plots on or above "A" line	CH	Fat clay [k l m]
			PI plots below "A" line	MH	Elastic silt [k l m]
		Organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic clay [k l m p]
				OH	Organic silt [k l m q]
Highly Organic Soils		Primarily organic matter, dark in color and organic odor		PT	Peat

a. Based on the material passing the 3-in (75mm) sieve.
b. If field sample contained cobbles or boulders, or both, add "with cobbles or boulders or both" to group name.
c. $C_u = D_{60} / D_{10}$ $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$
d. If soil contains ≥15% sand, add "with sand" to group name.
e. Gravels with 5 to 12% fines require dual symbols:
GW-GM well-graded gravel with silt
GW-GC well-graded gravel with clay
GP-GM poorly graded gravel with silt
GP-GC poorly graded gravel with clay
f. If fines classify as CL-ML, use dual symbol GC-GM or SC-SM.
g. If fines are organic, add "with organic fines" to group name.
h. If soil contains ≥ 15% gravel, add "with gravel" to group name.
i. Sands with 5 to 12% fines require dual symbols:
SW-SM well-graded sand with silt
SW-SC well-graded sand with clay
SP-SM poorly graded sand with silt
SP-SC poorly graded sand with clay
j. If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay.
k. If soil contains 10 to 29% plus No. 200, add "with sand" or "with gravel" whichever is predominant.
l. If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.
m. If soil contains ≥ 30% plus No. 200 predominantly gravel, add "gravelly" to group name.
n. PI ≥ 4 and plots on or above "A" line.
o. PI < 4 or plots below "A" line.
p. PI plots on or above "A" line.
q. PI plots below "A" line.



Laboratory Tests

DD	Dry density, pcf	OC	Organic content, %
WD	Wet density, pcf	S	Percent of saturation, %
MC	Natural moisture content, %	SG	Specific gravity
LL	Liquid limit, %	C	Cohesion, psf
PL	Plastic limit, %	∅	Angle of internal friction
PI	Plasticity index, %	qu	Unconfined compressive strength, psf
P200	% passing 200 sieve	qp	Pocket penetrometer strength, tsf

Particle Size Identification

Boulders	over 12"
Cobbles	3" to 12"
Gravel	
Coarse	3/4" to 3"
Fine	No. 4 to 3/4"
Sand	
Coarse	No. 4 to No. 10
Medium	No. 10 to No. 40
Fine	No. 40 to No. 200
Silt	< No. 200, PI < 4 or below "A" line
Clay	< No. 200, PI ≥ 4 and on or above "A" line

Relative Density of Cohesionless Soils

Very loose	0 to 4 BPF
Loose	5 to 10 BPF
Medium dense	11 to 30 BPF
Dense	31 to 50 BPF
Very dense	over 50 BPF

Consistency of Cohesive Soils

Very soft	0 to 1 BPF
Soft	2 to 3 BPF
Rather soft	4 to 5 BPF
Medium	6 to 8 BPF
Rather stiff	9 to 12 BPF
Stiff	13 to 16 BPF
Very stiff	17 to 30 BPF
Hard	over 30 BPF

Drilling Notes

Standard penetration test borings were advanced by 3 1/4" or 6 1/4" ID hollow-stem augers unless noted otherwise, Jetting water was used to clean out auger prior to sampling only where indicated on logs. Standard penetration test borings are designated by the prefix "ST" (Split Tube). All samples were taken with the standard 2" OD split-tube sampler, except where noted.

Power auger borings were advanced by 4" or 6" diameter continuous-flight, solid-stem augers. Soil classifications and strata depths were inferred from disturbed samples augered to the surface and are, therefore, somewhat approximate. Power auger borings are designated by the prefix "B."

Hand auger borings were advanced manually with a 1 1/2" or 3 1/4" diameter auger and were limited to the depth from which the auger could be manually withdrawn. Hand auger borings are indicated by the prefix "H."

BPF: Numbers indicate blows per foot recorded in standard penetration test, also known as "N" value. The sampler was set 6" into undisturbed soil below the hollow-stem auger. Driving resistances were then counted for second and third 6" increments and added to get BPF. Where they differed significantly, they are reported in the following form: 2/12 for the second and third 6" increments, respectively.

WH: WH indicates the sampler penetrated soil under weight of hammer and rods alone; driving not required.

WR: WR indicates the sampler penetrated soil under weight of rods alone; hammer weight and driving not required.

TW indicates thin-walled (undisturbed) tube sample.

Note: All tests were run in general accordance with applicable ASTM standards.