Geotechnical Evaluation Report

Proposed North Industrial Park Expansion
Bowen Circle, West Robb Road and Cemetery Road
Richland Center, Wisconsin

Prepared for

City of Richland Center

WISCONSIN PROFESSIONAL ENGINEER
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March 16, 2010

Project LC-10-00592

Braun Intertec Corporation

BRAUN
INTERTEC

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March 16, 2010

Project LC-10-00592

Mr. Andy Zimmer
MSA Professional Services, Inc.
c/o City of Richland Center
450 South Main Street
Richland Center, Wisconsin 53581

Re: Geotechnical Evaluation
Proposed North Industrial Park Expansion
Bowen Circle, West Robb Road and Cemetery Road
Richland Center, Wisconsin

Dear Mr. Zimmer:

We are pleased to present this Geotechnical Evaluation Report for the proposed North Industrial Park Expansion of Bowen Circle, West Robb Road and Cemetery Road in Richland Center, Wisconsin. A summary of our results and a summary of our recommendations in light of the geotechnical issues influencing design and construction are presented below. More detailed information and recommendations follow.

Summary of Results

Our borings indicate that the general material profile is composed of topsoil over alluvial soils and residual soils. The topsoil extended to depths of 1 to 1 1/2 feet and was composed of silty sand. Two borings (Borings ST-14 and ST-15), however, initially encountered 1 to 2 1/2 inches of bituminous over 5 to 5 1/2 inches of aggregate base. Below the topsoil and existing pavement, the borings encountered alluvial soils. The alluvial soils were composed of poorly graded sand (SP), poorly graded sand with silt (SP-SM), poorly graded sand with clay (SP-SC), clayey sand (SC), and lean clay (CL). The borings on Bowen Circle encountered residual soils beneath the alluvial soils. The residual soils were composed of poorly graded sand with clay, silty sand and clayey sand.

Groundwater was observed at the depths of 2 to 24 feet below the ground surface while drilling. These depths correspond to elevations 737 1/2 to 744. The groundwater surface appears to slope downward Bowen Circle.

Summary of Construction Recommendations

In designing and constructing this project, the team members should be aware that:

- Excavations could penetrate the groundwater surface at depths of approximately 2 to 24 feet (corresponding to elevations 373 1/2 to 744). Dewatering will be required to facilitate an evaluation of the geologic materials exposed in the excavation sides and bottoms, and the placement and compaction of backfill.

- The clays were found to be in a wet condition at the time of our investigation and will need to be dried to facilitate compaction if re-used as backfill.

- Pavement subgrades need to be prepared by stripping topsoil and existing pavement from below pavement areas. We anticipate that the excavation bottoms could be underlain with fine-grained soils that are soft, wet and susceptible to disturbance and strength loss. For this reason, when clayey soils are present at pavement subgrades; we recommend either (1) removing the clayey soils and exposing the underlying alluvial sand soils, or (2) lining the excavation bottoms with a woven geotextile fabric.

- On-site soils free of organic material can be considered for reuse as backfill and fill. The alluvial clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces. We recommend that imported material needed to replace excavation spoils or balance cut and fill quantities, consist of sand having less than 20 percent of the particles by weight passing a #200 sieve.

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 Brandon Wright at 608.781.7277 or by email bwright@braunintertec.com.

Sincerely,

BRAUN INTERTEC CORPORATION

Brandon K. Wright, PE
Project Engineer

FOR:

Daniel B. Mahrt, PE
Senior Engineer

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Appendix

A. Introduction

A.1. Project Description

This Geotechnical Evaluation Report addresses the expansion of the North Industrial Park in Richland Center, Wisconsin. The project will include installation of sanitary sewer, storm sewer, and water main. Additionally, installation of approximately 2,100 lineal feet of urban street including, asphaltic concrete pavement, curb & gutter, and sidewalks are planned. The development will also include construction of three drainage swales for storm water management.

A.2. Purpose

The purpose of a geotechnical evaluation is to characterize subsurface geologic conditions at selected exploration locations and evaluate their impact on the design and construction of pavement and installation of underground utilities.

A.3. Scope of Services

Our scope of services for this project was originally submitted as a Proposal to Mr. Andy Zimmer of MSA Professional Services, Inc. We received authorization to proceed from City of Richland Center on February 19, 2010. Our scope of services was performed under the terms of our June 15, 2006, General Conditions.

A.3.a. Staking and Surveying

Exploration locations and surface elevations were staked and surveyed by MSA Professional Services, Inc.

A.3.b. Subsurface Exploration

We performed nine penetration test borings at the locations shown on Soil Boring Location Sketch in the Appendix. The borings were extended to depths of 10 to 30 feet.

Prior to commencing with our subsurface exploration activities, we cleared the exploration locations of underground utilities through Digger's Hotline.

A.3.c. Geotechnical Evaluation, Analysis and Reporting

Information obtained from the borings was used to identify the geotechnical issues influencing design and construction, qualify the nature of their impact, and outline alternatives for their mitigation. Upon reviewing our results, we developed baseline recommendations for:

- Subgrade preparation, including excavations and ground improvement.
- Excavation dewatering.
- Selecting, placing and compacting on-site or imported earth materials.
- Designing pavements and recommendations for utility installation.

B. Results

B.1. Exploration 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 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 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

As revealed by the borings, the site is underlain with topsoil, existing pavement, alluvial soils and residual soils.

B.2.a. Topsoil

Borings ST-9 to ST-13 and Borings ST-16 and ST-17 initially encountered topsoil. The topsoil extended to depths of 1 to 1 1/2 feet and was composed of silty sand that was dark brown to black and frozen.

B.2.b. Existing Pavement

Borings ST-14 and ST-15 initially encountered 1 to 2 1/2 inches of bituminous over 5 to 5 1/2 inches of aggregate base.

B.2.c. Alluvial Soils

Below the topsoil and existing pavement, the borings encountered alluvial soils. The alluvial soils were composed of poorly graded sand (SP), poorly graded sand with silt (SP-SM), poorly graded sand with clay (SP-SC), clayey sand (SC), and lean clay (CL). The alluvial soils were shades of brown and gray, and were moist to wet and waterbearing.

B.2.d. Residual Soils

Borings ST-13 and ST-14 encountered residual soils beneath the alluvial soils. The residual soils were composed of poorly graded sand with clay, silty sand and clayey sand that was reddish-brown and moist.

B.2.e. Inferred Geologic Material Properties

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
Cohesive (clayey) Alluvial Soils	CL and SC	6 to 12 BPF	Medium to rather stiff
Cohesionless (sandy) Alluvial Soils	SP, SP-SM, and SM	3 to 22 BPF	Very loose to medium dense, loose overall
Residual Soils	SM, SP-SC, and SC	12 to 34 BPF	Medium dense to dense

B.2.f. Groundwater

Groundwater was observed at the depths shown below in Table 2. Corresponding groundwater elevations were determined from comparisons of the measured/estimated depths to groundwater and surface elevations, and were rounded to the highest 1/2-foot.

Table 2. Groundwater Summary

Location	Surface Elevation	Measured or Estimated Depth to Groundwater (ft)	Corresponding Groundwater Elevation (ft)
ST-9	756.7	Greater than 11 feet	Below Elevation 745 1/2
ST-10	750.9	7	744
ST-11	756.3	12	744
ST-12	746.3	Greater than 11 feet	Below Elevation 735 1/2
ST-13	753.6	16	737 1/2
ST-14	761.2	23	738
ST-15	768.0	24	744
ST-16	742.3	2	740
ST-17	740.7	3	737 1/2

As indicated, groundwater was consistently in the range of elevations 737 1/2 to 744. The groundwater surface appears to slope downward Bowen Circle. Given the cohesive nature, stratification and arrangement of the alluvial soils encountered, however, it is likely that insufficient time was available for groundwater to seep into the bore hole 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 3.

Table 3. Laboratory Classification Test Results

Location	Sample Depth (ft)	Classification	Moisture Content (%)	Percent Passing a #200 Sieve
ST-10	7 1/2	Poorly Graded Sand with Silt (SP-SM)	8	11
ST-11	20	Lean Clay with Sand (CL)	27	85
ST-12	15	Sandy Lean Clay (CL)	16	57
ST-14	2 1/2	Clayey Sand (SC)	22	40
ST-17	7 1/2	Lean Clay with Sand (CL)	20	81

C. Basis for Recommendations

C.1. Design Details

C.1.a. Pavements and Traffic Loads

According to Mr. Andy Zimmer of MSA Professional Services, the pavement areas will have a bituminous section. Mr. Zimmer also informed us that pavements will be subjected to 1.8 Million equivalent 18-kip single axle loads (ESALs) over a desired design life of 20 years.

C.1.b. Anticipated Grade Changes

Grading around the development is expected to balance cuts and fills and should result in finished grades within approximately 2 to 3 feet of the existing ground surface.

C.1.c. Utility Installation

Utility installation will require excavations for water mains and sanitary sewer lines. These utilities will range in depth from 7 to 27 feet below existing site grades.

C.1.d. 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 and Construction Considerations

The designing and construction this project, the team members should be aware that:

- Excavations could penetrate the groundwater surface at a depth of approximately 2 to 24 feet. Dewatering will be required to facilitate an evaluation of the geologic materials exposed in the excavation sides and bottoms, and the placement and compaction of backfill.
- The clays were found to be in a wet condition at the time of our investigation and will need to be dried to facilitate compaction if re-used as backfill.

- Pavement subgrades need to be prepared by stripping topsoil and existing pavement from below pavement areas. We anticipate that the excavation bottoms could be underlain with fine-grained soils that are soft, wet and susceptible to disturbance and strength loss. For this reason, when clayey soils are present at pavement subgrades; we recommend either (1) removing the clayey soils and exposing the underlying alluvial sand soils, or (2) lining the excavation bottoms with a woven geotextile fabric.

D. Recommendations

D.1. Earthwork

D.1.a. Excavation Support

The clayey alluvial soils are Type B Soil under OSHA guidelines and unsupported excavations in these soils should therefore be maintained at a gradient no steeper than 1:1 (horizontal: vertical). The sandy alluvial soils are Type C Soil under OSHA guidelines and unsupported excavations in these soils should therefore be maintained at a gradient no steeper than 1 1/2:1, or be shored.

D.1.b. Excavation Dewatering

We recommend removing groundwater from the excavations. Sumps and pumps can be considered for excavations in low-permeability silt- and clay-rich soils, or where groundwater can be drawn down 2 feet below the bottoms of excavations in more permeable sands. In large excavations, or where groundwater must be drawn down more than 2 feet, a well contractor should review our logs to determine if wells are required, how many will be required, and to what depths they will need to be installed.

In sands, we do not recommend attempting to dewater from within an excavation. Upward seepage will loosen and disturb the excavation bottom. Rather, groundwater should be drawn down at least 2 feet below the anticipated excavation bottom in advance of excavation.

D.2. Utilities

D.2.a. Subgrade Stabilization

We anticipate that utilities can be installed per manufacturer bedding requirements. Due to areas of very loose to loose sands, we recommend the sand subgrade in utility trenches be thoroughly compacted prior to placing utilities. If areas of soft clays are encountered, they may be stabilized with aggregate.

D.2.b. Selection, Placement and Compaction of Backfill

We recommend compacting excavation backfill and additional required fill placed within 3 feet of pavement subgrade elevations to at least 100 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.3. Pavements

D.3.a. Pavement Subgrade Preparation

We recommend stripping topsoil and existing pavement from below pavement areas. The present information indicates that the topsoil is, on average, approximately 1 to 1 1/2 feet thick.

We anticipate that the excavation bottoms could be underlain with fine-grained soils that are soft, wet and susceptible to disturbance and strength loss. When clayey subgrades are encountered, we recommend either (1) removing the clayey soils and exposing alluvial sand soils, or (2) lining the excavation bottoms with a woven geotextile having a grab tensile strength of at least 200 pounds both along the machine and cross directions, or a biaxial geogrid having an ultimate tensile strength of at least 1,000 pounds per foot.

D.3.b. Selecting Excavation Backfill and Additional Required Fill

On-site soils free of organic material can be considered for reuse as backfill and fill. The alluvial clays, however, being fine-grained, will be more difficult to compact if wet or allowed to become wet, or if spread and compacted over wet surfaces.

We recommend that imported material needed to replace excavation spoils or balance cut and fill quantities, consist of sand having less than 20 percent of the particles by weight passing a #200 sieve.

D.3.c. Compaction Requirements

We recommend compacting excavation backfill (including utility backfill) and additional required fill placed within 3 feet of pavement subgrade elevations to at least 100 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.3.d. 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.3.e. 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 a CBR value of 10, we recommend a pavement section that includes 5 1/2 inches of bituminous pavement over 8 inches of aggregate base. Where clayey subgrades are present, 12 inches of subbase will be needed to be incorporated below the aggregate base in order to support the design traffic count.

Alternatively concrete pavements could be utilized. For this option, we recommend that at least 6 inches of aggregate base be placed over the subgrade to provide more uniform support for the concrete, and to provide a more stable working platform for construction. We recommend a minimum 8-inch thick concrete slab. These designs are based on a modulus of subgrade reaction (k) of 200 pci.

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.3.f. Materials and Compaction

We recommend specifying crushed aggregate base meeting the requirements of Wisconsin Department of Transportation (WisDOT) Specification Section 305.2.2.1 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 aggregate base be compacted to a minimum of 100 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 Rice density.

D.3.g. Subgrade Drainage

We recommend installing perforated drainpipes throughout pavement areas at low points and about catch basins. The drainpipes should be placed in small trenches extended at least 8 inches below the granular subbase layer, or below the aggregate base material where no subbase is present.

D.4. Infiltration Basins/Drainage Swales

Most of the soils encountered in the borings are well suited for infiltration basins or drainage swales. The soils encountered in the proposed infiltration basin or drainage swales areas are summarized below in Table 4.

Table 4. Summary of Soils Encountered in Proposed Drainage Swale/Infiltration Basin Areas

Boring	Depth (Ft)	Geologic Origin	USCS Soil Classification	USDA Soil Classification	Design Infiltration Rates[1] (inches/hour)
ST-9	0 – 1	Topsoil	Silty Sand (SM)	Sandy Loam	0.50
	1 – 4	Alluvium	Silty Sand (SM)	Sandy Loam	0.50
	4 – 9	Alluvium	Poorly Graded Sand w/Silt (SP-SM)	Loamy Sand	1.63
	4 – 11	Alluvium	Poorly Graded Sand (SP)	Sand	3.60

1. Values provided in Table 2 of the Site Evaluation for Stormwater Infiltration design guide provided by the Wisconsin Department of Natural Resources.

Infiltration rates in natural soils are variable based on soil type, moisture content, void space between soil particles and discontinuities in the soil structure. Discontinuities generally are not present in disturbed or compacted soils, such as existing fills, because void space between soil particles is reduced form compaction efforts. Therefore, infiltration rates in disturbed soils could be less than the values shown in the table above.

In general, most of the soils we encountered in the borings, with the exception of the silty sands, should probably be considered "limiting layers" rather than layers capable of accommodating infiltration.

D.5. Construction Quality Control

D.5.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.5.b. Materials Testing

We recommend density tests be taken in excavation backfill and additional required fill placed below pavements. We also recommend Marshall tests on bituminous mixes to evaluate strength and air voids, and density tests to evaluate compaction.

D.5.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.5.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.

Concrete delivered to the site should meet the temperature requirements of ASTM C 94. Concrete should not be placed on frozen subgrades. Concrete should be protected from freezing until the necessary strength is attained.

E. Procedures

E.1. Penetration Test Borings

The penetration test borings were drilled with a truck-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 1/2- 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.

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 the parties to which it has been addressed. 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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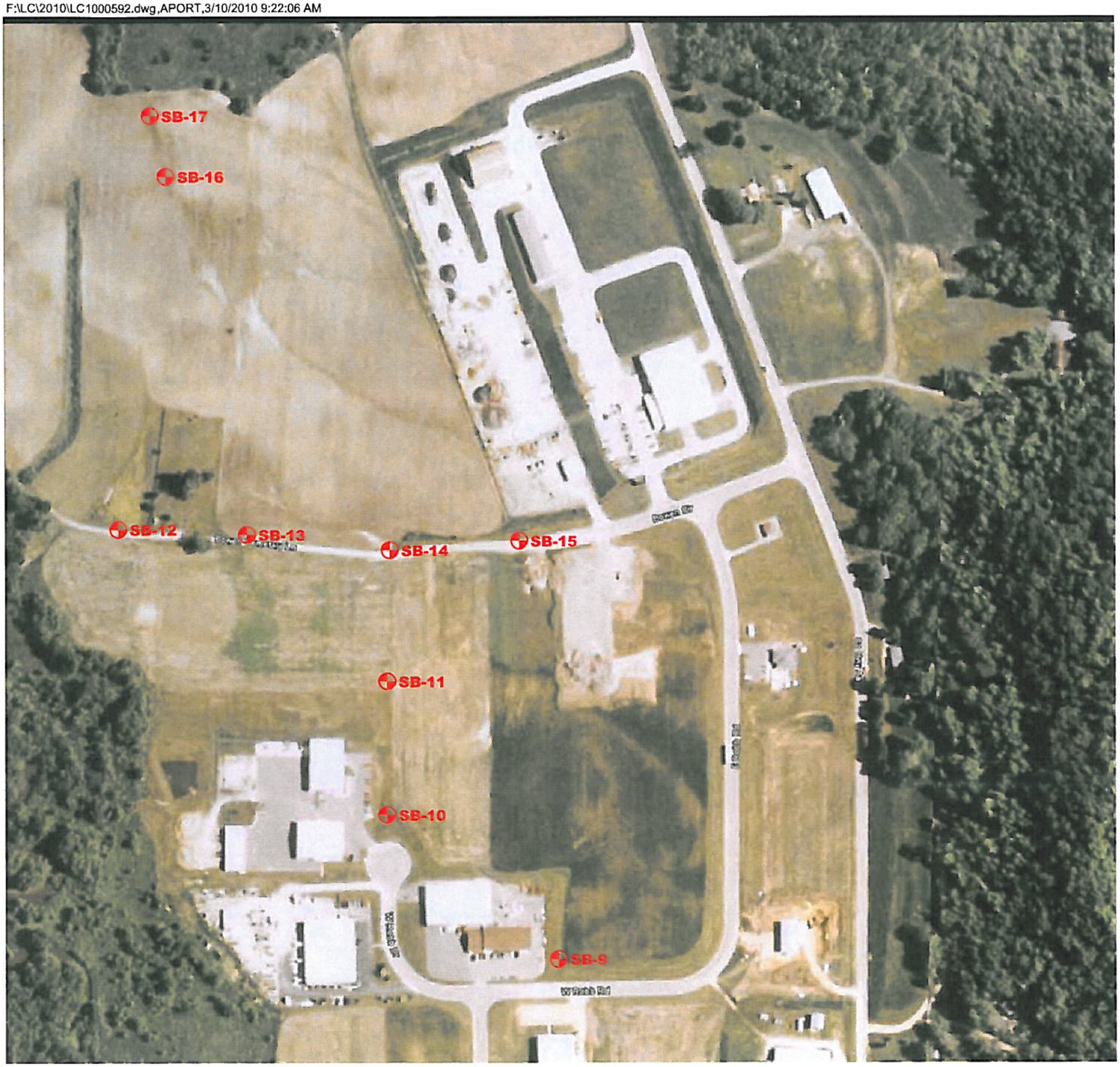

200'± 0 400'±

SCALE: 1" = 400'±

DENOTES APPROXIMATE LOCATION OF STANDARD PENETRATION TEST BORING

Sheet: of	Project No: LC1000592
	Drawing No: LC1000592
Fig:	Scale: 1" = 400'±
	Drawn By: BJB
	Date Drawn: 3/10/10
	Checked By: BW
	Last Modified: 3/10/10

SOIL BORING LOCATION SKETCH
GEOTECHNICAL EVALUATION
PROPOSED NORTH INDUSTRIAL PARK EXPANSION
BOWEN CIRCLE, WEST ROBB ROAD, AND CEMETERY LANE
RICHLAND CENTER, WISCONSIN

BRAUN INTERTEC
11001 Hampshire Avenue So.
Minneapolis, MN 55438
PH. (952) 995-2000
FAX (952) 995-2020

BRAUN INTERTEC

LOG OF BORING

Braun Project LC-10-00592	BORING: ST- 9
GEOTECHNICAL INVESTIGATION Industrial Park Expansion Bowen Circle Richland Center, Wisconsin	LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: 3/1/10	SCALE: 1" = 5'

Elev. feet 756.7	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
755.6	1.1	SM	SILTY SAND, fine-grained, dark brown, frozen. (Topsoil)			
752.7	4.0	SM	SILTY SAND, fine-grained, brown, frozen. (Alluvium)	11		
747.7	9.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown to light brown, moist, loose. (Alluvium)	6 6		
745.7	11.0	SP	POORLY GRADED SAND, fine-grained, light brown, moist, loose. (Alluvium)	8		
			END OF BORING. Water not observed while drilling. Boring then backfilled.			Benchmark (BM): Elevations were provided on boring location stakes. Borings were staked by MSA Professional Services, Inc.

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project LC-10-00592
GEOTECHNICAL INVESTIGATION
Industrial Park Expansion
Bowen Circle
Richland Center, Wisconsin

BORING: **ST-10**

LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: **3/1/10**	SCALE: **1" = 5'**

Elev. feet 750.9	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
749.7	1.2	SM	SILTY SAND, fine-grained, with Roots, dark brown, frozen. (Topsoil)			
		SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown to light brown, frozen to 3 feet then moist to 7 feet then waterbearing, loose to medium dense. (Alluvium)	7		
				11		
				8	▽	MC=8% P200=11%
738.9	12.0			7		
		SM	SILTY SAND, fine-grained, brown, waterbearing, loose to medium dense. (Alluvium)	5		
733.9	17.0			15		
729.9	21.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, waterbearing, medium dense. (Alluvium)	20		

END OF BORING.

Water observed at 7 feet while drilling.

Cave-in depth of 7 feet immediately after withdrawal of auger.

Boring then grouted.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING LC-10-00592.GPJ BRAUN.GDT 3/16/10 12:46

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LOG OF BORING

Braun Project LC-10-00592 **GEOTECHNICAL INVESTIGATION** **Industrial Park Expansion** **Bowen Circle** **Richland Center, Wisconsin**	BORING: **ST-11** LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: **3/1/10**	SCALE: **1" = 5'**

Elev. feet 756.3	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
755.1	1.2	SM	SILTY SAND, fine-grained, dark brown, frozen. (Topsoil)			
		SP	POORLY GRADED SAND, fine-grained, light brown, frozen to 3 feet then moist, loose to medium dense. (Alluvium)	7		
			Thin layer of dark brown silty sand at 5 feet.	5		
				12		
				12		
744.3	12.0				∇	
		SM	SILTY SAND, fine-grained, brown, waterbearing, loose. (Alluvium)	5		
742.3	14.0					
		SP-SM	POORLY GRADED SAND with SILT, fine-grained, trace of gravel, brown, moist, medium dense. (Alluvium)	22		
739.3	17.0					
		CL	LEAN CLAY with SAND, brown, wet, rather stiff. (Alluvium)			
				9		MC=27% P200=85%
				10		
730.3	26.0		END OF BORING. Water observed at 12 feet while drilling. Cave-in depth of 11 feet immediately after withdrawal of auger. Boring then grouted.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING LC-10-00592.GPJ BRAUN.GDT 3/16/10 12:46

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LOG OF BORING

Braun Project LC-10-00592 GEOTECHNICAL INVESTIGATION Industrial Park Expansion Bowen Circle Richland Center, Wisconsin	BORING: ST-12 LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: 3/2/10	SCALE: 1" = 5'

Elev. feet 746.3	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
745.1	1.2	SM	SILTY SAND, fine-grained, dark brown, frozen. (Topsoil)			
743.3	3.0	SC	CLAYEY SAND, brown, frozen. (Alluvium)	6		
739.3	7.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, moist, loose. (Alluvium)	7		
735.3	11.0	CL	LEAN CLAY with SAND, brown, wet, rather stiff. (Alluvium)	11 10		MC=20% P200=81%
			END OF BORING. Water not observed while drilling. Boring then backfilled.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING LC-10-00592.GPJ BRAUN.GDT 3/16/10 12:46

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INTERTEC

LOG OF BORING

Braun Project LC-10-00592 GEOTECHNICAL INVESTIGATION Industrial Park Expansion Bowen Circle Richland Center, Wisconsin	BORING: ST-13 LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: 3/2/10	SCALE: 1" = 5'

Elev. feet 753.6	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
751.9	1.7	SM	SILTY SAND, fine-grained, with Roots, dark brown, frozen. (Topsoil)			
750.6	3.0	SM	SILTY SAND, fine-grained, brown, frozen. (Alluvium)	4		
745.6	8.0	SP	POORLY GRADED SAND, fine-grained, light brown, moist, loose. (Alluvium)	6 8		
741.6	12.0	SC	CLAYEY SAND, fine-grained, brown, wet, medium to rather stiff. (Alluvium)	12		
735.6	18.0	SP-SC	POORLY GRADED SAND with CLAY, fine- to medium-grained, red-brown, wet, medium dense. (Residuum)	14 14	▽	
732.6	21.0	SM	SILTY SAND, fine-grained, red-brown, waterbearing, medium dense. (Residuum)	24		
			END OF BORING. Water observed at 16 feet while drilling. Cave-in depth of 19 feet immediately after withdrawal of auger. Boring then grouted.			

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING LC-10-00592.GPJ BRAUN.GDT 3/16/10 12:47

BRAUN INTERTEC

LOG OF BORING

Braun Project LC-10-00592
GEOTECHNICAL INVESTIGATION
Industrial Park Expansion
Bowen Circle
Richland Center, Wisconsin

BORING: **ST-14**

LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg | METHOD: 3 1/4" HSA, Autohammer | DATE: **3/2/10** | SCALE: **1" = 5'**

Elev. feet 761.2	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
760.7	0.5	PAV	1 inch bituminous over 5 inches of aggregate base.			
759.7	1.5	SM	SILTY SAND, fine- to medium-grained, dark brown, frozen.			
759.2	2.0	SP	POORLY GRADED SAND, fine-grained, brown, frozen.	9		
754.2	7.0	SP	POORLY GRADED SAND, fine-grained, light brown, moist, loose. (Alluvium)	6		
752.2	9.0	SP-SC	POORLY GRADED SAND with CLAY, fine-grained, light brown, moist, loose. (Alluvium)	8		
749.2	12.0	SP	POORLY GRADED SAND, fine-grained, light brown, moist, medium dense. (Alluvium)	12		
748.2	13.0	SC	CLAYEY SAND, gray-brown, wet, medium. (Alluvium)	7		
747.2	14.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, moist, loose. (Alluvium)			
743.2	18.0	CL	SANDY LEAN CLAY, brown, wet, loose. (Alluvium)	6		MC=16% P200=57%
738.2	23.0	CL	SANDY LEAN CLAY, brown, wet, medium. (Alluvium)	6	▽	
733.2	28.0	SC	CLAYEY SAND, trace of gravel, red-brown, wet, dense. (Residuum)	34		
730.2	31.0	SM	SILTY SAND, fine-grained, red-brown, waterbearing, medium dense. (Residuum)	12		

END OF BORING.

Water observed at 23 feet while drilling.

Cave-in depth of 22 feet immediately after withdrawal of auger.

Boring then grouted.

(See Descriptive Terminology sheet for explanation of abbreviations)

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LOG OF BORING

Braun Project LC-10-00592
GEOTECHNICAL INVESTIGATION
Industrial Park Expansion
Bowen Circle
Richland Center, Wisconsin

BORING: **ST-15**

LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg | METHOD: 3 1/4" HSA, Autohammer | DATE: **3/2/10** | SCALE: **1" = 5'**

Elev. feet 768.0	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
767.3	0.7	PAV	2 1/2 inches of bituminous over 5 1/2 inches of aggregate base.			
765.0	3.0	SM	SILTY SAND, fine-grained, dark brown, frozen. (Alluvium)	16		
764.0	4.0	SP-SC	POORLY GRADED SAND with CLAY, fine-grained, brown, wet, medium dense. (Alluvium)			
754.0	14.0	SP	POORLY GRADED SAND, fine-grained, brown, wet, medium dense. (Alluvium)	13 13 13 11		
752.5	15.5	CL	SANDY LEAN CLAY, gray, wet, rather stiff. (Alluvium)	9		
750.0	18.0	SP-SM	POORLY GRADED SAND with SILT, fine-grained, brown, moist, loose. (Alluvium)			
745.0	23.0	SP	POORLY GRADED SAND, fine-grained, brown to let brown, moist, medium dense. (Alluvium)	18		
742.0	26.0	SM	SILTY SAND, fine-grained, brown, waterbearing, very loose. (Alluvium)	3	▽	

END OF BORING.

Water observed at 24 feet while drilling.

Cave-in depth of 20 feet immediately after withdrawal of auger.

Boring then grouted.

(See Descriptive Terminology sheet for explanation of abbreviations)

LOG OF BORING LC-10-00592.GPJ BRAUN.GDT 3/16/10 12:47

BRAUN[SM] INTERTEC

LOG OF BORING

Braun Project LC-10-00592 **GEOTECHNICAL INVESTIGATION** **Industrial Park Expansion** **Bowen Circle** **Richland Center, Wisconsin**	BORING: **ST-16** LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: **3/2/10**	SCALE: **1" = 5'**

Elev. feet 742.3	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
741.1	1.2	SM	SILTY SAND, fine-grained, dark brown, frozen. (Topsoil)			
739.3	3.0	SC	CLAYEY SAND, light gray, frozen. (Alluvium)		▽	
735.3	7.0	SP	POORLY GRADED SAND, fine-grained, light gray, waterbearing, loose. (Alluvium)	7 9		
731.3	11.0	SP	POORLY GRADED SAND, fine-grained, brown, waterbearing, very loose. (Alluvium)	3 4		
			END OF BORING. Water observed at 2 feet while drilling. Cave-in depth of 3 feet immediately after withdrawal of auger. Boring then grouted.			

(See Descriptive Terminology sheet for explanation of abbreviations)

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BRAUN INTERTEC

LOG OF BORING

Braun Project LC-10-00592
GEOTECHNICAL INVESTIGATION
Industrial Park Expansion
Bowen Circle
Richland Center, Wisconsin

BORING: **ST-17**

LOCATION: See Boring Location Sketch.

DRILLER: B. Oldenberg	METHOD: 3 1/4" HSA, Autohammer	DATE: **3/2/10**	SCALE: **1" = 5'**

Elev. feet 740.7	Depth feet 0.0	Symbol	Description of Materials (Soil- ASTM D2488 or D2487, Rock-USACE EM1110-1-2908)	BPF	WL	Tests or Notes
739.9	0.8	SM	SILTY SAND, fine-grained, dark brown, frozen. (Topsoil)			
737.7	3.0	SC	CLAYEY SAND, gray, frozen.			MC=22% P200=40%
731.7	9.0	SP	POORLY GRADED SAND, fine-grained, gray, moist to 4 1/2 feet then waterbearing. (Alluvium)	8 6 7	▽	
729.7	11.0	SP	POORLY GRADED SAND, fine-grained, brown, waterbearing, loose. (Alluvium)	5		
			END OF BORING.			

Water observed at 3 feet while drilling.

Cave-in depth of 4 1/2 feet immediately after withdrawal of auger.

Boring then grouted.

(See Descriptive Terminology sheet for explanation of abbreviations)

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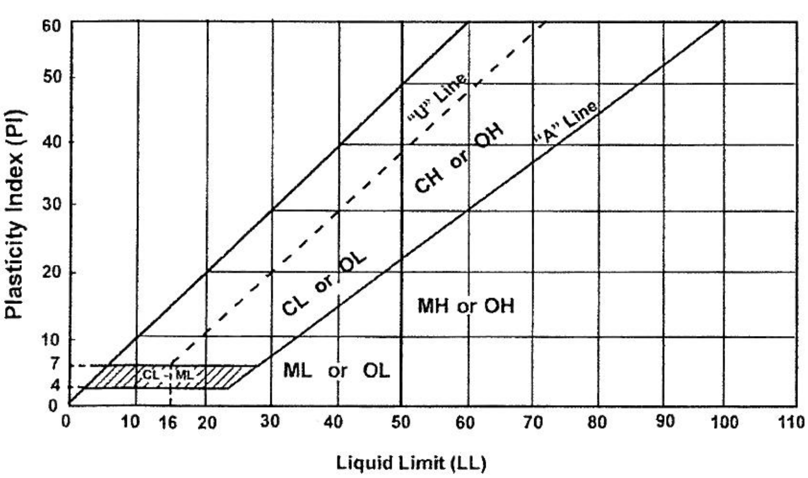
Descriptive Terminology of Soil

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	Soils Classification: 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 $1 > C_c > 3$ [c]	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 [i]	$C_u \geq 6$ 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% [i]	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.