Soils & Structures Inc.

Structural Engineering

Geotechnical Engineering

Construction Material Testing

Geotechnical Drilling

REPORT OF GEOTECHNICAL INVESTIGATION FOR DENTIST OFFICE NORTON SHORES, MICHIGAN

JULY 18, 2005

Oppenhuizen Architects
333 Jackson Street
Grand Haven, Michigan, 49417

Project No. 2005.0564

6480 Grand Haven Road
Muskegon, MI 49441

(231) 798 4127
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July 18, 2005

Oppenhuizen Architects
333 Jackson Street
Grand Haven, Michigan 49417

Attention: Mr. Mark Oppenhuizen

Regarding: Dentist Office
Norton Shores, Michigan

Dear Mr. Oppenhuizen:

Soils & Structures is pleased to present the report of the geotechnical investigation for the above referenced project.

The investigation included five (5) test borings drilled to depths of 10.0 and 20.0 feet in accordance with ASTM D 1586 procedures.

The report, test boring location plan and test boring logs are enclosed. The report provides recommendations for site preparation, spread foundations, fill, floors and pavement.

We appreciate the opportunity to be of service to you. If you have a question concerning the report please contact our office.

Sincerely,
Soils & Structures, Inc.

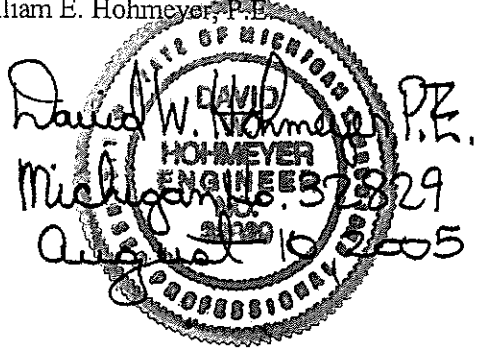
David W. Hohmeyer

David W. Hohmeyer, P.E.
DWH/dh

Reviewed By:

William E. Hohmeyer /DWH

William E. Hohmeyer, P.E.



David W. Hohmeyer P.E.
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Soils & Structures Inc.

Table of Contents

Location of Soil Investigation

The soil investigation was located at 739 and 755 Seminole Road in Norton Shores, Michigan.

Purpose of Investigation

The purpose of the investigation is to provide soil related recommendations for a new building.

Design Information

The proposed building is assumed to be a one story masonry and wood frame structure with a slab on grade floor. The overall dimensions will be 75.0 by 129.5 feet.

The maximum column load is anticipated to be approximately 150,000 pounds. The maximum of wall loads is anticipated to be approximately 5000 pounds per linear foot. Average floor loads are anticipated to be less than approximately 100 pounds per square foot. Allowable settlements of 0.6 inches for total settlement and 0.4 inches for differential settlement are assumed.

The maximum depth of fill under the building is anticipated to be approximately 2.0 feet. Soil will be excavated from the most of the building area to obtain the anticipated floor elevation.

The maximum excavation depth is assumed to be less than 10.0 feet.

The recommendations for the pavement subgrade are based on automobile traffic. An Equivalent Axle Load (EAL) of 1,900 and a service life of twenty years were used for the recommendations. The recommendations are also based on a subgrade that has been prepared in accordance with the recommendations in this report.

Tests Performed

Five test borings were drilled to depths of 10.0 and 20.0 feet in accordance with ASTM D 1586 procedures at the locations recommended by Soils & Structures. The ASTM D 1586 standard describes the procedure for testing the soil and is included in the appendix.

Soil samples were classified according to the Unified Soil Classification System. This method is a standardized system for classifying soil according to its engineering properties. Please refer to the appendix of this report for the Unified Classification System Chart. The classification is shown in the right hand column of the test boring logs.

The soil strength and the allowable soil bearing value were evaluated using the "N" value. The "N" value is the number of blows required to drive a soil sampler one foot with a standard 140 pound drop hammer. The sampler is driven a distance of 18.0 inches. The number of blows for each 6.0 inch increment is recorded. The sum of the second and third intervals is the "N" value. The number of blows for each 6.0 inch interval is shown on the test boring logs under the column labeled "Penetration." The "N" value for each sample is shown in the adjacent column.

In building to the field and laboratory tests the U.S. Geological Survey map and the Quaternary Geology map of Southern Michigan were reviewed.

Surface elevations were obtained from the site plan by Milanowski & Englert dated April 20, 2005. The elevations are based on an assigned elevation of 100.0 feet for the top of the flange bolt under the letter "E" in the word "EJIW" on the hydrant 72 east and 35 north of the northeast property corner.

Description of Soil

The general soil profile consists of sand to a depth of at 6.5 to 13.5 feet over clay. Topsoil and asphalt pavement are present over this profile at the surface.

The topsoil consists of a dark brown sandy topsoil with a low to moderate organic content. The thickness ranges from 5.0 to 12.0 inches with an average of approximately 10.0 inches.

The pavement consists of 2.0 inches of asphalt over 3.0 inches of gravel. The pavement is confined to the driveways of the existing houses.

The sand layer consists of light brown to brown fine to medium sand. The sand is a glacial lake deposit which is characterized by relatively uniform gradation throughout the deposit. In the middle portion of the site in the area of the houses the upper up to 4.0 feet of the sand is fill. Most of the sand is in a compact state which is indicated by the "N" value which ranges from 6 to 14. In the middle portion of the site the upper up to 4.0 feet of the sand is loose. In the compact state the sand has an internal angle of friction of 34 to 38 degrees. The sand layer will support foundations.

The clay layer consists of a brown and gray silty clay with occasional sand lenses and is a glacial till deposit. The shear strength ranges from 2000 to 5000 pounds per square foot which classifies the clay as stiff to very stiff. The clay layer will support foundations.

Description of Groundwater Conditions

Groundwater is present in a relatively thin zone 0.5 to 1.0 feet thick in the lower portion of the sand layer. The groundwater is flowing over the clay layer. The elevation of the groundwater ranged from 88.0 to 92.0 feet. These elevations correspond to a depth of 6.0 to 13.0 feet below the existing surface elevation and 8.0 to 12.0 feet below the anticipated floor elevation.

Description of Site

The area of the building is lawn and pavement. The area is relatively flat and level with a surface elevation of 99.0 to 100.0 feet.

Settlement

The maximum building settlement will be approximately 0.1 to 0.3 inches with spread foundations provided the recommendations in this report are observed. Differential settlement will be approximately one half to three quarters of the maximum value.

Recommendations

Building Pad & Site Preparation

The topsoil and asphalt should be removed from the building, pavement and fill areas. The gravel layer under the asphalt may be left in place.

The building, pavement and fill areas should be compacted with a vibratory roller prior to placing fill. A minimum of five passes are recommended. The vibratory roller should have a weight of 10 tons or greater.

Fill should be placed in accordance with the "Fill" section of this report. The fill should be compacted to a density of 95.0 percent of its maximum density. The soil which will be used for fill should be kept free of topsoil and other organic materials. Compaction tests are recommended to check the compaction of the fill.

The existing sand may be reused for fill. The portion of the sand that contains topsoil should be discarded.

Foundations

Spread foundations are recommended for the proposed building. The foundations should bear on the new fill or natural sand.

The sand should be compacted to a density of 95.0 percent of its maximum density to a depth of 1.5 feet below the foundation. Fill under foundations should possess a density of 95.0 percent of its maximum density to its full depth. Compaction tests should be performed in the foundation subgrade to verify this level of compaction. Soil that possesses lower densities should be recompacted.

The recommended cover over exterior foundations is 42 inches for protection against frost heave.

Foundations should not be constructed on frozen soil.

The site classification for seismic design is "D" based on the Michigan Building Code. The long period acceleration for the site is 4.0 percent and the short period acceleration is 8.2 percent. The design spectral response acceleration parameters (S_D) are 0.064g for the one second response and 0.088g for the short term response.

Foundations may be designed using an allowable soil bearing value of 4000 pounds per square foot for column foundations and 3000 pounds per square foot for wall foundations provided the recommendations in this report are observed. A minimum foundation width of 16.0 inches is recommended.

Floors

A base of 12.0 inches of clean sand is recommended under the floor. The sand should meet MDOT Class II specifications. The existing sand meets these specifications and may be left in place and used for the sand base. Fill under floors should be compacted to a density of 95.0 percent of its maximum density for its full depth.

A modulus of subgrade reaction of 150 pounds per inches cubed is recommended for the design of slabs on grade.

Lateral Earth Pressures

Sand should be used as backfill behind retaining and foundation walls. The walls should be designed using a soil density of 130 pounds per cubic foot and a coefficient of active earth pressure of 0.35 for level sand backfill. The equivalent fluid pressure is 46 pounds per cubic foot for level backfill. The effects of any surcharge or sloping backfill should also be included in the design. The passive resistance of the existing sand should be calculated using an earth pressure coefficient of 4.0.

Excavations

The existing sand is an OSHA type "C" soil. Excavations should be based on OSHA requirements for a type "C" soil. Based on OSHA requirements a maximum allowable side slope of 34 degrees (1.5H:1V) is recommended for trench excavations 4.0 to 10.0 feet deep. For nontrench type excavations a side slope of 45 degrees (1H:1V) is recommended provided the excavation is less than 10.0 feet deep. For excavations adjacent to existing foundations and retaining walls or over 10.0 feet deep retaining systems are recommended. Excavations less than 4.0 feet deep may have vertical side slopes. Trench excavations are defined as excavations in which the depth exceeds the width.

Fill

Fill including the aggregate layers under pavement should be compacted to a density of 95.0 percent of its maximum density as determined by ASTM D 1557. A maximum thickness per layer of 6.0 inches is recommended. The lift thickness may be increased to 12.0 inches if a vibratory roller is used for compaction.

General structural fill should be sand meeting MDOT Class II requirements or ASTM requirements for a SP or SW which are the designations for clean sand. The existing sand meets these requirements and is suitable for use as fill.

Compaction tests are recommended to confirm that the fill is compacted to the required density.

Groundwater Management

Dewatering should not be required to construct the foundations and utilities. Groundwater is at or below an elevation of 92.0 feet which is anticipated to be below the foundations and utilities.

Asphalt Pavement

A bituminous thickness of 2.5 inches with an MDOT 22A gravel base of 6.0 inches and an MDOT Class II sand subbase of 12.0 inches is the recommended. In the entry a bituminous thickness of 3.0 inches and a gravel thickness of 8.0 inches are recommended. The bituminous mixture should be placed in two lifts. The existing sand may be left in placed and used for the sand base. The paving contractor should submit the proposed mix designs for review. The bituminous paving mixture should meet and be installed to the following criteria:

Table One: Bituminous Mixture Requirements

Criteria	Base Course		Wearing Course	
	minimum	maximum	minimum	maximum
MDOT Mix Type	3B		36A	
Marshall Stability	1100		1100	
Flow (0.01 inches)	8.0	16.0	8.0	16.0
Asphalt Content (%)	4.5	6.0	5.0	7.0
Void Content (%)	3.0	5.0	3.0	7.0
VMA (%)	15.0		15.0	
Max. Aggregate Size (inches)	0.50	0.75	0.50	0.50
Crushed Aggregate (%)	50		50	
Lift Thickness (inches) Parking Areas Entry	 1.5 2.0		 1.0 1.0	

The existing soil will provide an adequate subgrade for the pavement provided it is prepared in accordance with the "Site Preparation" and "Fill" section of this report.

The base course should have an asphalt content of 0.4 to 0.8 percent less than the wearing course. The asphalt grade should be AC-10. The base course should be compacted to 93.0 percent of the 50 blow Marshall Densities and the wearing course should be compacted to 94.0 percent.

Concrete Pavement

The subgrade should be prepared in accordance with the "Site Preparation" and "Fill" sections of this report.

A base of 12.0 inches of clean sand is recommended under the pavement. The existing sand may be left in place and used for the sand base.

A modulus of subgrade reaction of 150 pounds per inches cubed is recommended for the design of pavement. A minimum slab thickness 5.5 inches is recommended. The reinforcing should be designed by a structural engineer.

Quality Control Testing

Compaction tests (ASTM D 2922) are recommended to confirm that fill and natural soil in the building area are compacted to the specified density. While the building area is being filled compaction tests should be performed throughout the depth of the fill with a minimum of three tests performed each day fill is placed. Compaction tests should be performed under foundations at the rate of one test per 50 linear feet for wall foundations and one test per column foundation. The recommended testing frequency in the floor subgrade is one test per 2500 square feet and in the pavement subgrade one test per 2500 square feet. Tests should also be performed in the backfill over foundations and utilities.

A smooth 0.5 to 0.75 inch diameter rod should be used in conjunction with compaction tests to probe for loose areas under foundations, in fill and under floors.

The maximum density should be determined in accordance with ASTM D 1557 or ASTM D 4253 procedures.

Testing should be performed by technicians supervised by a registered geotechnical engineer.

General Conditions & Reliance

The report was prepared in accordance with generally accepted practices of the geotechnical engineering profession. The scope of work consisted of performing five test borings and providing soil related recommendations for the design and construction of a new building. The scope of work did not include an environmental study or wetland determination.

The report and the associated test boring were prepared specifically for the previously described project and site. Soils & Structures should be consulted if a significant change in the scope of the project is made.

The test borings represent point information and may not have encountered all of the soil types and materials present on this site. This report does not constitute a guarantee of the soil or groundwater conditions or that the test boring is an exact representation of the soil or groundwater conditions at all points on this site.

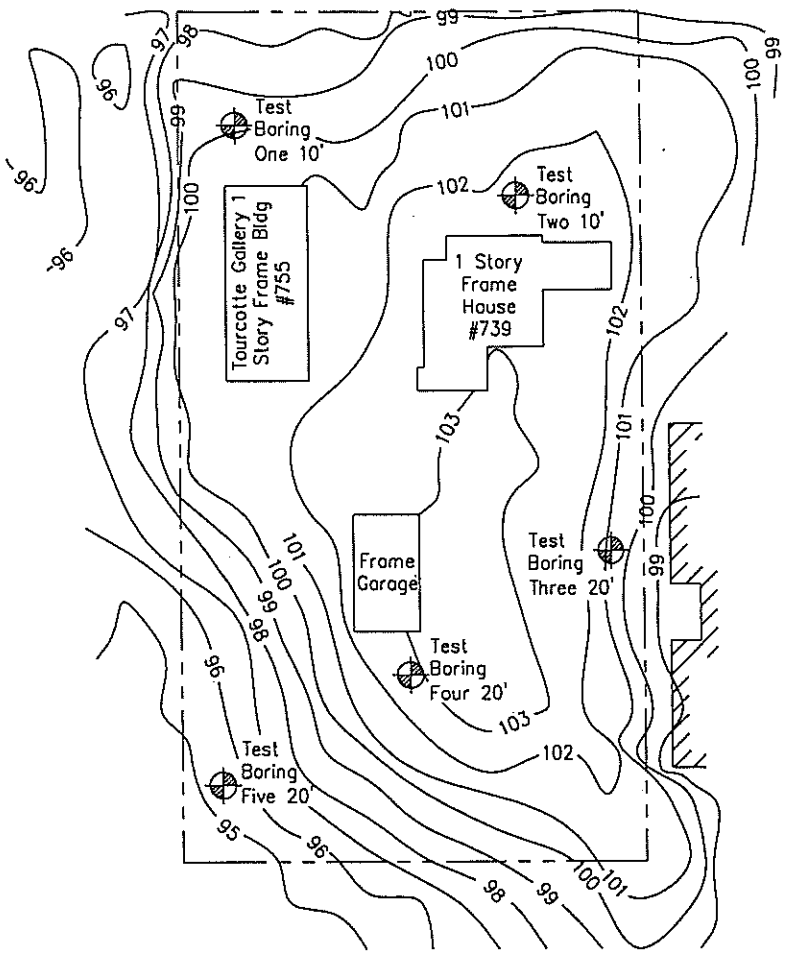
The descriptions and recommendations contained in this report are based on an interpretation of the test borings and laboratory tests. The test borings should not be used independently of the report. If soil conditions are encountered which are significantly different from the test borings Soils & Structures should be consulted for additional recommendations.

The report and test borings may be relied upon by Oppenhuizen Architects for the design, construction, permitting and financing associated with the construction of a building at 739 and 755 Seminole Road in Norton Shores, Michigan. The use of the report and test borings by third parties or for other sites has not been agreed upon by Soils & Structures. Soils & Structures does not recommend or consent to third party use or reliance of the report or test borings unless allowed to review the proposed use of these materials. Unless obtained in writing no consent to third party use should be assumed. Third parties using the report or test boring logs do so at their own risk and are offered no guarantee or promise of indemnity.

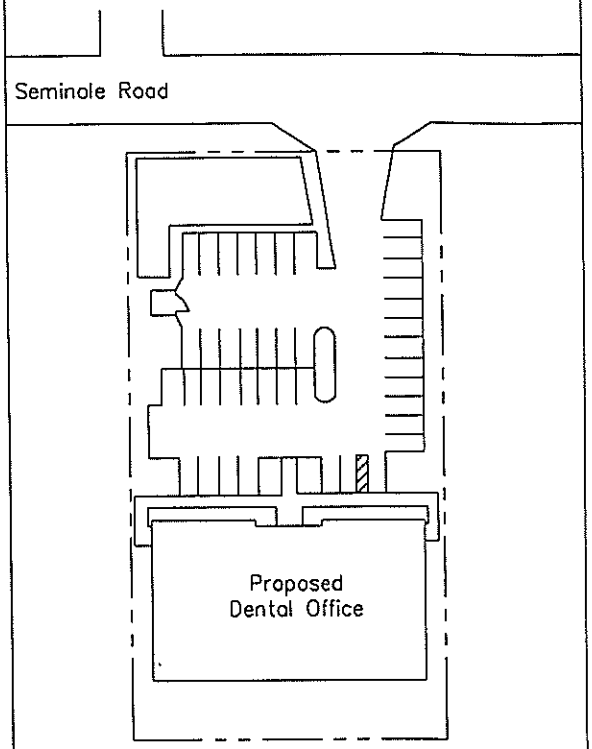
Appendix

Test Boring Location Plan, General Soil Profile, Test Boring Logs,
Laboratory Tests & General Soil Information

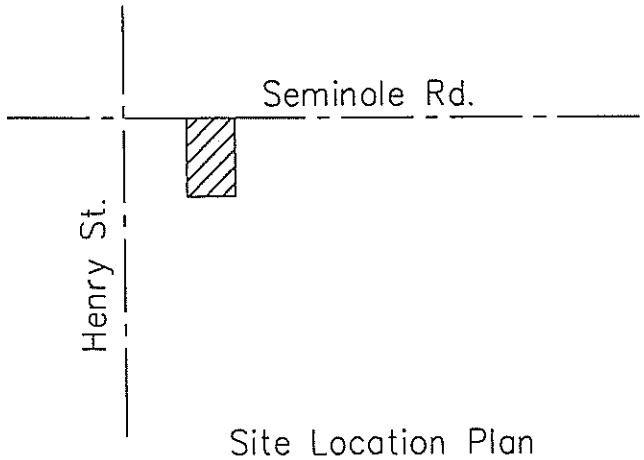
Seminole Road



Existing Site Conditions



Proposed Site Layout



Site Location Plan

TEST BORING LOCATION PLAN
NTS

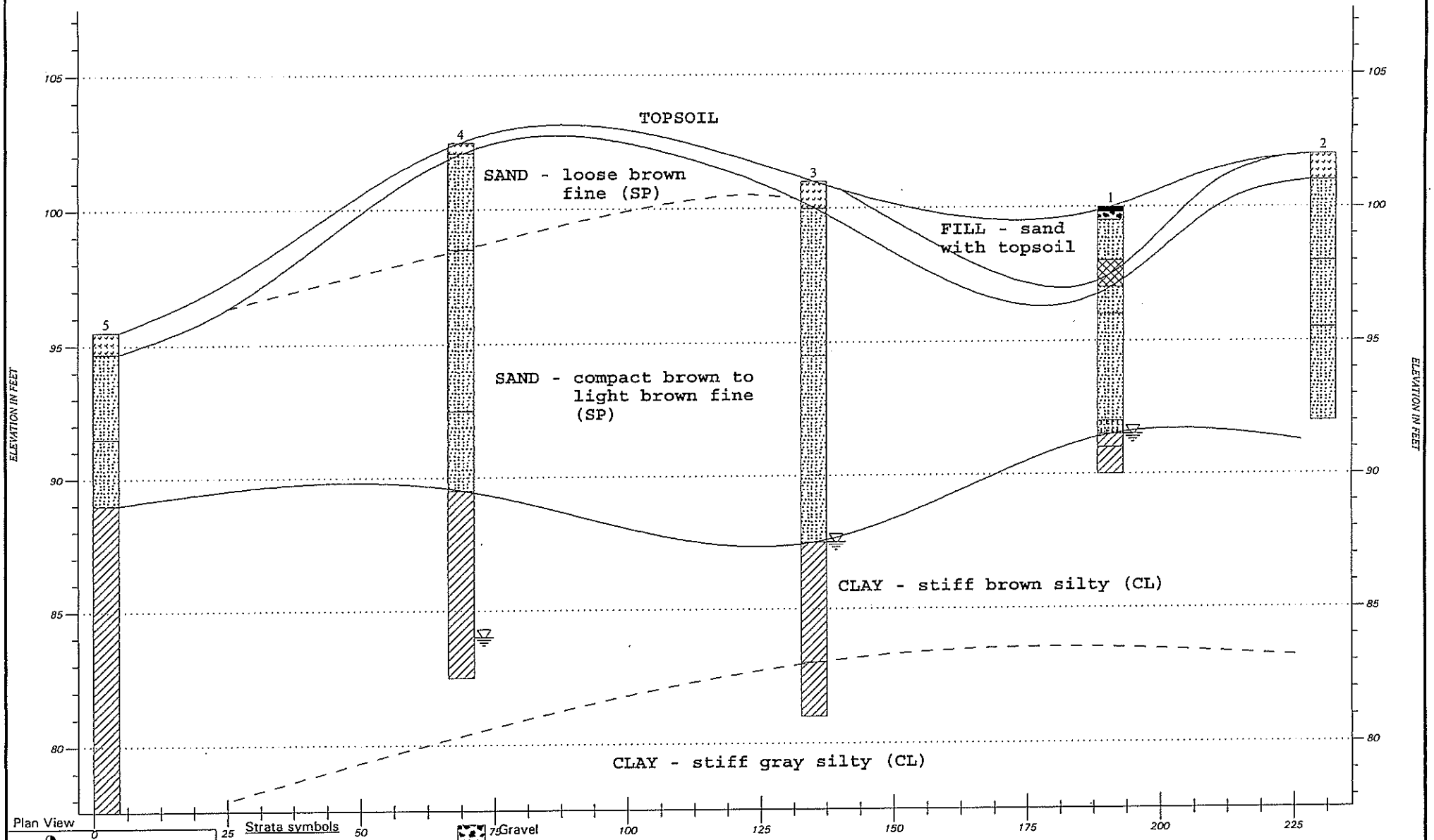
N

Proposed Dental Office

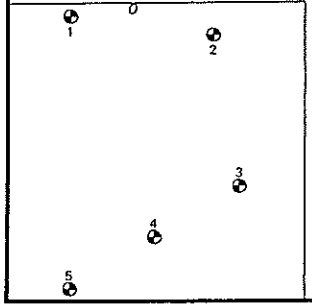
Norton Shores, Michigan

Soils & Structures, Inc.
6480 Grand Haven Road
Muskegon, Michigan 49441

JOB NO. 2005.0564 DATE 7.19.2005



Plan View



Strata symbols

- Topsoil
- Poorly graded sand
- Low plasticity clay
- Paving
- Gravel
- Fill
- Poorly graded sand with silt

NOTE: Groundwater is at a depth of 8.5 to 19.0 feet.

SOILS & STRUCTURES, INC.
GENERALIZED SOIL PROFILE

HORIZONTAL SCALE: 1"=(proportional)' VERTICAL SCALE: 1"=5'	DRAWN BY/APPROVED BY	DATE DRAWN
	D. Hohmeyer	8/11/2005

Dentist Office
Norton Shores, Michigan

PROJECT NO. 2005.0564

FIGURE NUMBER 1

Log of Test Boring

Soils & Structures, Inc.

6480 Grand Haven Road
Muskegon, Michigan 49441

231-798-4127 / 1-800-933-3959
fax 231-798-1383

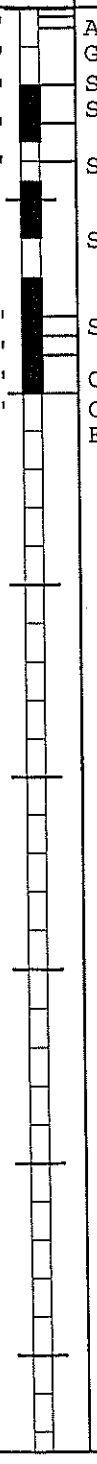
Project: Dentist Office

Location: Norton Shores, Michigan

Project Number: 2005.0564

Boring Number 1	Crew Chief J. Spangler	Ground Water Encountered 8.5 ft.	Plugging Record: Boring Sealed with: excavated soil
Depth Drilled 10 ft.	Helper B. Fritz	After Completion ____ ft.	soil between 0.0 ft. & 10.0 ft.
Surface Elev. 100.0 ft.	Drill Rig D-50 ATV	After ____ hrs. ____ ft.	____ between ____ ft. & ____ ft.
Date Started 7-11-05	Boring Method ____	Volume ____	Test Boring Location: ____
Date Completed 7-11-05	hollow stem auger	Seepage at ____ ft.	

Depth in Feet	Soil Description	Penetration ASTM D 1586	"N" (BPF)	Laboratory Data: Water Content (%)	Dry Density (pcf)	Unconfined Strength (psf)	Unified Soil Classif.
0.2'	ASPHALT						
0.5'	GRAVEL -						
2.0'	SAND - brown fine						
3.0'	SAND - compact brown fine with seams of topsoil	3-3-4	7				Fill
4.0'	SAND - compact red fine						
		3-2-4	6				SP
	SAND - compact brown fine						
		3-3-3	6				SP&SC
8.0'	SAND - compact brown fine to medium with a trace of clay						
8.5'		7-14-19	33				CL
9.0'	CLAY - very stiff brown silty						
10.0'	CLAY - very stiff gray silty End of Boring						



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Location: Norton Shores, Michigan

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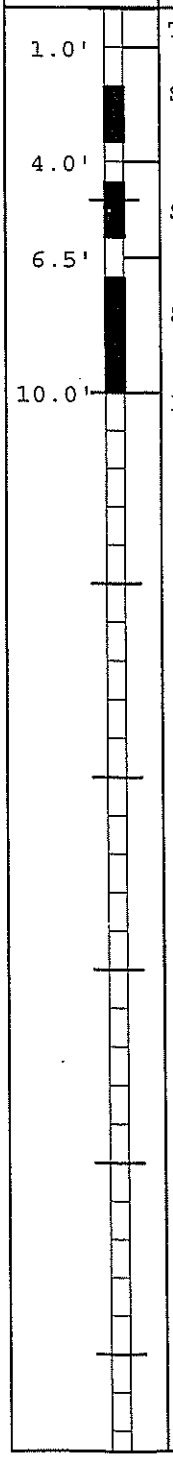
Boring Number 2	Crew Chief J. Spangler	Ground Water Encountered none ft.	Plugging Record Boring Sealed with: excavated soil		
Depth Drilled 10 ft.	Helper B. Fritz	After Completion none ft.	soil between 0.0 ft. & 10.0 ft.		
Surface Elev. 102.0 ft.	Drill Rig D-50 ATV	After ____ hrs. none ft.	____ between ____ ft. & ____ ft.		
Date Started 7-11-05	Boring Method	Volume	Test Boring Location:		
Date Completed 7-11-05	hollow stem auger	Seepage at none ft.			

Depth in Feet	Soil Description	Penetration ASTM D 1586	"N" (BPF)	Laboratory Data: Water Content (%)	Dry Density (pcf)	Unconfined Strength (psf)	Unified Soil Classif.
	TOPSOIL - dark brown sandy						
1.0'	SAND - slightly compact light brown fine	2-2-2	4				SP
4.0'	SAND - compact light brown fine	3-3-4	7				SP
6.5'	SAND - compact light brown fine to medium	3-4-3	7				SP
		3-2-3	5				SP
10.0'	End of Boring						



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Boring Number 3	Crew Chief J. Spangler	Ground Water Encountered 13.5 ft.	Plugging Record Boring Sealed with: excavated soil
Depth Drilled 20 ft.	Helper B. Fritz	After Completion ____ ft.	soil between 0.0 ft. & 20.0 ft.
Surface Elev. 101.0 ft.	Drill Rig D-50 ATV	After ____ hrs. ____ ft.	____ between ____ ft. & ____ ft.
Date Started 7-11-05	Boring Method ____	Volume ____	Test Boring Location: ____
Date Completed 7-11-05	hollow stem auger	Seepage at ____ ft.	

Depth in Feet	Soil Description	Penetration ASTM D 1586	"N" (BPF)	Laboratory Data: Water Content (%)	Dry Density (pcf)	Unconfined Strength (psf)	Unified Soil Classif.
1.0'	TOPSOIL - dark brown sandy						
		3-5-6	11				SP
	SAND - compact light brown fine						
		4-5-5	10				SP
6.5'							
		4-6-5	11				SP
	SAND - compact light brown fine to medium	3-5-6	11				SP
13.5'							
	CLAY - very stiff brown with occasional seams of fine to medium sand	7-11-15	26				CL
18.0'							
	CLAY- very stiff gray silty	5-7-11	18				CL
20.0'	End of Boring						

Log of Test Boring

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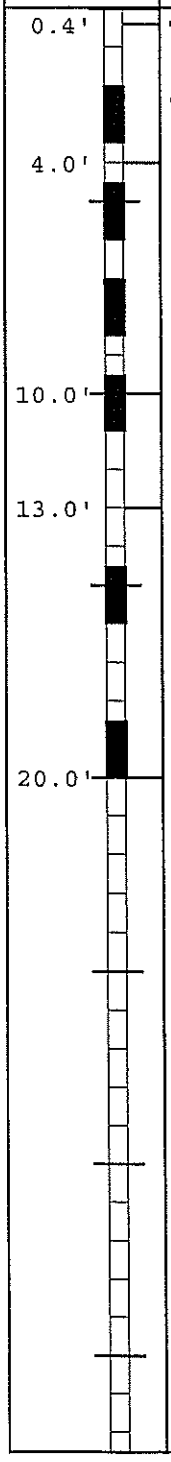
Project: Dentist Office

Location: Norton Shores, Michigan

Project Number: 2005.0564

Boring Number 4	Crew Chief J. Spangler	Ground Water Encountered 18.5 ft.	Plugging Record Boring Sealed with: excavated soil
Depth Drilled 20 ft.	Helper B. Fritz	After Completion ____ ft.	soil between 0.0 ft. & 20.0 ft.
Surface Elev. 102.5 ft.	Drill Rig D-50 ATV	After ____ hrs. ____ ft.	____ between ____ ft. & ____ ft.
Date Started 7-11-05	Boring Method	Volume	Test Boring Location:
Date Completed 7-11-05	hollow stem auger	Seepage at ____ ft.	

Depth in Feet	Soil Description	Penetration ASTM D 1586	"N" (BPF)	Laboratory Data: Water Content (%)	Dry Density (pcf)	Unconfined Strength (psf)	Unified Soil Classif.
0.4'	TOPSOIL - dark brown sandy						
	SAND - loose light brown fine	1-2-1	3				SP
4.0'		1-2-4	6				SP
	SAND - compact light brown fine	4-5-6	11				SP
10.0'		4-4-5	9				SP
	SAND - compact light brown fine to medium						
13.0'							
	CLAY - very stiff brown with seams of fine to medium sand belwo 18.5 feet	7-8-11	19				CL
		8-8-11	19				CL
20.0'	End of Boring						



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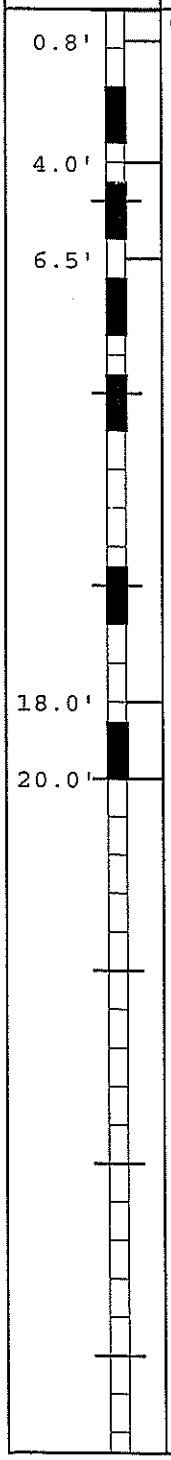
Boring Number 5	Crew Chief J. Spangler	Ground Water Encountered 19.0 ft.	Plugging Record Boring Sealed with: excavated soil
Depth Drilled 20 ft.	Helper B. Fritz	After Completion ____ ft.	soil between 0.0 ft. & 20.0 ft.
Surface Elev. 95.5 ft.	Drill Rig D-50 ATV	After ____ hrs. ____ ft.	____ between ____ ft. & ____ ft.
Date Started 7-11-05	Boring Method ____	Volume ____	Test Boring Location: ____
Date Completed 7-11-05	hollow stem auger	Seepage at ____ ft.	

Depth in Feet	Soil Description	Penetration ASTM D 1586	"N" (BPF)	Laboratory Data: Water Content (%)	Dry Density (pcf)	Unconfined Strength (psf)	Unified Soil Classif.
0.8'	TOPSOIL - dark brown sandy						
	SAND - compact light brown fine	4-4-6	10				SP
4.0'	SAND - compact light brown fine to medium	4-6-8	14				SP
6.5'		11-16-20	36				CL
		11-9-15	24				CL
	CLAY - very stiff brown with occasional seams of fine to medium sand						
		7-11-18	29				CL
18.0'	CLAY - very stiff gray with occasional seams of fine to medium sand	5-7-11	18				CL
20.0'	End of Boring						



General Information

Method of Field Investigation

This soil investigation was performed in accordance with the American Society of Testing and Materials method ASTM D 1586, which describes the method of "Standard Penetration and split-Barrel Sampling of Soils". Samples of compressible clays or organic soils are obtained with a thin walled steel tube in accordance with ASTM D 1587 procedures when consolidation is a consideration. Rock may be cored in conjunction with the above methods as specified in ASTM D 2113 "Diamond Core Drilling for Site Investigation".

Field Testing

Standard Penetration Tests in accordance with ASTM D 1586 were performed at depths of 2.5',. 5.0', 7.5', 10.0', and 5.0' intervals.

Laboratory Testing

Samples obtained from the Standard Penetration Test (ASTM D 1586) or thin walled tube method (ASTM D 1587) were tested in the laboratory for moisture content and density. When a soil sample possessed sufficient cohesive properties, it was tested for its compressive strength in the unconfined state.

Natural Percent Moisture content (N.P.M.) of the soil is the percentage by weight of water contained in the soil compared to the dry weight of the solids of which the soil is composed.

Natural Density (N.D.) of soil as reported on the appended boring logs is the natural wet density of the soil expressed in pounds per cubic foot.

The unconfined compressive strength of cohesive soils, ASTM D 2166, is determined in the laboratory on "undisturbed" samples. This test determined the maximum load required at a specified rate to deform the length of the cohesive soil specimen twenty (20%) percent. The primary purpose of the unconfined compression test is to obtain approximate quantitative values of the compressive strength of soil possessing sufficient coherence to permit testing in the unconfined state.

Color:

When the color of the soil is uniform throughout, the color recorded will be such as brown, gray, black and may be modified by adjectives such as light and dark. If the soils predominant color is shaded by secondary color, the secondary color precedes the primary color, such as: gray-brown, yellow-brown. If two major and distinct colors are swirled throughout the soil, the colors will be modified by the term mottled; such as; mottled brown and gray.

Water Observations:

Depth of water recorded in the test boring is measured from the ground surface to the water surface. Initial depth indicates water level during boring, completion depth indicates water level immediately after boring, and depth after "X" number of hours indicates water level after letting water rise or fall over a period of time. Water observations in pervious soils are considered reliable groundwater levels for accurate groundwater measurements for that date unless records are made over several days' time. Factors such as weather, soil porosity, etc., will cause the groundwater level to fluctuate for both pervious and impervious soils.

Sample Type:

If not otherwise indicated, the sample is a split-barrel liner sample, ASTM D 1586.

"S.T." - shelby tube sample, ASTM D 1587

"A" - disturbed augered sample

"C" - rock core sample, ASTM D 2113

N.P.M. - Natural Percent Moisture of insitu soil sample

N.D. - Natural Density of insitu soil sample in p.c.f.

S.S. - Shear Strength of cohesive soil samples as determined by the Unconfined Compression Tests in k.s.f.

Classification Data - Laboratory data to assist in classification of soils and classification of soil characteristics. i.e., Plastic Limit, Liquid Limit.

Test Boring Logs

Particle Size		Visual
Boulders		Larger than 8"
Cobbles		8" to 3"
Gravel	- Coarse	3" to 3/4"
	- Fine	2mm. to 3/4"
Sand	- Coarse	2mm. - 0.6mm.
	- Medium	0.6mm. - 0.2mm.
	- Fine	0.2mm. - 0.6mm.
Silt		0.06mm. - 0.002mm.
Clay		0.002 and smaller

Soil Components

Major Component	Minor Component	
Gravel	Trace	1-10%
Sand	Some	11-35%
Clay	and	36-50%

Condition of Soil Relative to Compactness

Granular Material	"N" Value
Very Loose	0-1
Loose	1-1 ½
Slightly Compact	2-4 ½
Compact	5-16
Very Compact	17-25
Extremely Compact	26 and above

"N" values in clay soils are not to be used as a measure of shear strength. However, they may be used as a general indication of strength.

Designation: D 1586 - 67 (Reapproved 1974)

Standard Method for PENETRATION TEST AND SPLIT BARREL SAMPLING of SOILS[1]

This standard is issued under the fixed designation D 1586; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number of parentheses indicates the year of this re-approval.

This method has been approved for use by agencies of the Department of Defense and for listing in the DoD Index of Specifications and Standards.

1. Scope

1.1 This method describes a procedure for using a split-barrel sampler to obtain representative samples of soil for identification purposes and other laboratory tests, and to obtain a measure of the resistance of the soil to penetration of the sampler.

2. Apparatus

2.1 Drilling Equipment - any drilling equipment shall be acceptable that providesareasonably clean hold before insertion of the sampler to ensure that the penetration test is performed on undisturbed soil, and that will permit the driving of the sampler to obtain the sample and penetration record in accordance with the procedure described in Section 3. To avoid "whips" under the blows of the hammer, it is recommended that the drill rod have a stiffness equal to or greater than the A-rod. An "A" rod is a hollow drill rod or "steel" having an outside diameter of 1 5/8 inch (41.2 mm) and an inside diameter of 1 1/8 inch (28.5 mm), through which the rotary motion of drilling is transferred from the drilling motor to the cutting bit. A stiffer drill rod is suggested for holes deeper than 50.0 ft. (15 m). The hole shall be limited in diameter to between 2 1/4 and 6 inches (57.2 and 152 mm).[2]

2.2 Split-Barrel Sampler - the sampler shall be constructed with the dimensions indicated in Fig. 1. The drive shoe shall be of hardened steel and shall be replaced or repaired when it becomes dented or distorted. The coupling head shall have four ½ inch (12.7 mm) (minimum diameter) vent ports and shall contain a ball check valve. If sizes other than the 2 inch (50.8mm) sampler are permitted, the size shall be conspicuously noted on all penetration records.

2.3 Drive Weight Assembly - the assembly shall consist of a 140 lb. (63.5 kg) weight, a driving head, and a guide permitting a free fall of 30 inches (0.76 m). Special precautions shall be taken to ensure that the energy of the falling weight is not reduced by friction between the drive weight and the guides.

2.4 Accessory Equipment - labels, data sheets, sample jars, paraffin, and other necessary supplies should accompany the sampling equipment.

3. Procedure

3.1 Clear out the hole to sampling elevation using equipment that will ensure that the material to be sampled is not disturbed by the operation. In saturated sand and silts withdraw the drill bit slowly to prevent loosing of the soil around the hole. Maintain the water level in the hole at or above ground water level.

3.2 In no case shall a bottom-discharge bet be permitted. (side discharge bits are permissible). The process of jetting through an open tub sampler and then sampling when the desired depth is reached shall not be permitted. Where casing is used, it may not be driven below sampling elevation. Record any loss of circulation or excess pressure in drilling fluid during advancing of holes.

3.3 With the sampler resting on the bottom of the hole, drive the sampler with blows from the 140 lb. (63.5 kg) hammer falling 30 inches (0.76 m) until either 18 inches (0.45) have been penetrated or 100 blows have been applied.

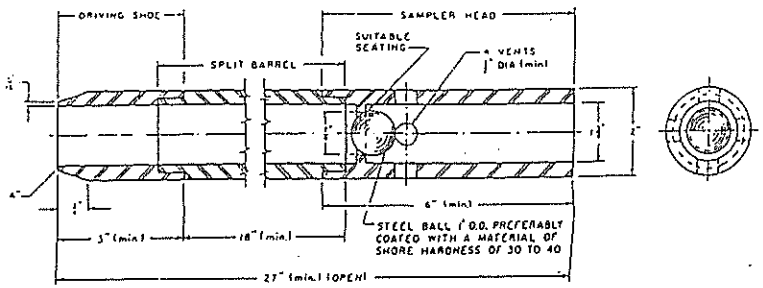
3.4 Repeat this operation at intervals not longer than 5.0 ft. (1.5m) in homogeneous strata and at every change of strata.

3.5 Record the number of blows required to effect each 6 inch (0.15m) of penetration or fractions thereof. The first 6 inches (0.15 m) is considered to be a seating drive. The number of blows required for the second and third 6 inches (0.15 m) of penetration added is termed the penetration resistance, N. If the sampler is driven less than 18 inches (0.45 m) the penetration resistance is that for the last 1.0 ft. (0:30m) of penetration (if less than 1.0 ft. (0.30m) is penetrated, the logs shall state the number of blows and the fraction of 1.0 ft. (0.30m) penetrated).

3.6 Bring the sampler to the surface and open. Describe carefully typical samples of soils recovered as to composition, structure, consistency, color, and condition; then put into jars without ramming. Seal then with wax or hermetically seal to prevent evaporation of the soil moisture. Affix labels to the jar or make notations on the covers (or both) bearing job designation, boring number, sample number, depth penetration record, and length of recovery. Protect samples against extreme temperature changes.

4. Report

4.1 Data obtained in borings shall be recorded in the field and shall include the following:
4.1.1 Name and location of job
4.1.2 Date of boring - start, finish
4.2.3 Boring number and coordinate, if available
4.1.4 Surface elevation, if available
4.1.5 Sample number and depth
4.1.6 Method of advancing sampler, penetration and recovery lengths.
4.1.7 Type and size of sampler
4.1.8 Description of soil
4.1.9 Thickness of layer
4.1.10 Depth to water surface; to loss of water; to artesian head; time at which reading was made.
4.1.11 Type and make of machine
4.1.12 Size of casing, depth of cased hole
4.1.13 Number of blows per 6 inches (0.15 m)
4.1.14 Names of crewmen and
4.1.15 Weather, remarks



NOTE 1—Split barrel may be 1½ in. inside diameter provided it contains a liner of 16-gage wall thickness.
NOTE 2—Core retainers in the driving shoe to prevent loss of sample are permitted.
NOTE 3—The corners at A may be slightly rounded.

[1] This method is under the jurisdiction of ASTM Committee D-18 on soil and Rock for Engineering Pruposes. current edition aaproved Oct.20, 1967. Originally issued 1958. Replaces

[2] Hvorsley, M.J., surface exploration and Sampling of Soils for Civil Engineering Purposes. The Engineering Foundation. 345 East

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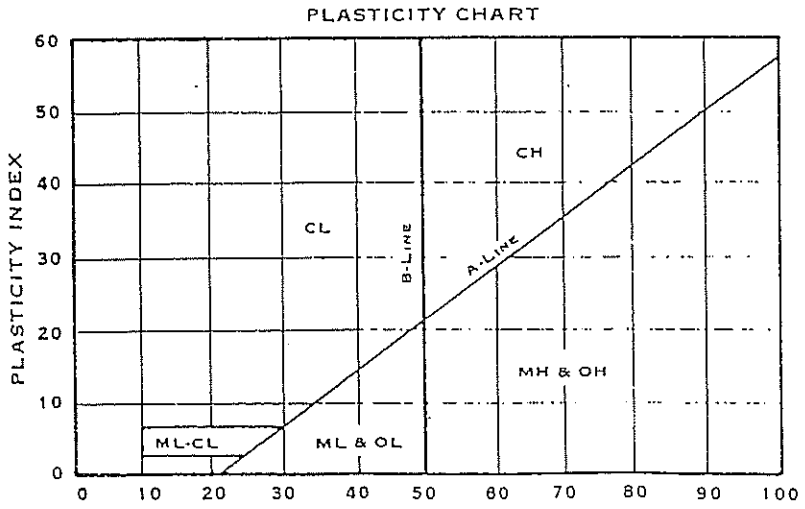
Unified Soil Classification System Chart

Major Divisions			Letter Symbol	Typical Descriptions
Coarse Grained Soils More than 50% of material is larger than no.200 sieve size	gravel and gravelly soils more than 50% of coarse fraction retained on no.4 sieve	clean gravels little or no fines	GW	well graded gravels, gravel-sand fixtures, little or no fines
			GP	poorly graded gravels, gravel-sand mixtures, little or no fines
		gravel w/fines appreciable amt.of fines	GM	silty gravels, gravel-sandy-clay mixtures
			GC	well graded sands, gravelly sands, little or no fines
	Sand and Sandy Soils more than 50% of coarse fraction passing no.4 sieve	clean sand little or no fines	SW	well graded sands, gravelly sands, little or no fines
			SP	poorly graded sands, gravelly sands, little or no fines
		sand w/fines appreciable amt.of fines	SM	silty sands, sand-silt mixtures
			SC	clayey sands, sand-clay mixtures
Fine Grained Soils More than 50% of material is smaller than no.200 sieve size	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 or low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays
			OL	organic silts and organic silty clays or low plasticity
	silts and clays liquid limit greater than 50		MH	inorganic silts, micaceous or diatomaceous fine sand of silty soils
			CH	inorganic clays of high plasticity, fat clays
			OH	organic clays or medium to high plasticity, organic silts
	Highly organic soils		PT	peat, humus, swamp soils with high organic contents

FOR LABORATORY CLASSIFICATION OF FINE GRAINED SOILS



Important Information about your Geotechnical Report

This report is based on a given set of circumstances regarding site orientation of structures and surrounding improvements. The report should not be used without consulting our office if:

- ✓ The structure is relocated
- ✓ The site and configuration is altered
- ✓ There is a change of ownership
- ✓ Adjacent sites have had buildings constructed in the interim between the date of the exploration and the date of new construction on the site.

The report is prepared for a specific purpose. The report may not be used for another purpose without approval from our office.

We recommend that construction plans be reviewed by our office to help avoid any misinterpretation of the geotechnical report. This review will also help determine the adequacy of the plans relative to geotechnical recommendations.

The complete unaltered report should be made available to contractors and contractors should be encouraged to contact our office for explanations if there are any questions.

We recommend that a geotechnical consultant be involved throughout the project from inception to completion.