



**GEOTECHNICAL ENGINEERING INVESTIGATION (REVISED)**

**PROPOSED DOLLAR GENERAL STORE  
OAK HILL ROAD AND MARINER DRIVE  
EVANSVILLE, INDIANA**

**ATC PROJECT NO. 86.31212.0010**

**FEBRUARY 2, 2009**

**PREPARED FOR:**

**FOSTER BUILDERS, INC.  
8436 WEST COUNTY ROAD 400 NORTH  
SULLIVAN, INDIANA 47882**

**ATTENTION: MR. SCOTT FOSTER**

February 2, 2009

Foster Builders, Inc.  
8436 West County Road 400 North  
Sullivan, Indiana 47882

Attention: Mr. Scott Foster

Re: **Geotechnical Engineering Investigation (Revised)**  
**Proposed Dollar General Store**  
Oak Hill Road and Mariner Drive  
Evansville, Indiana  
ATC Project No. 86.31212.0010

Gentlemen:

Submitted herewith is the report of our geotechnical engineering investigation for the referenced project. This study was authorized in accordance with our Proposal-Agreement No. PE-09-8024 dated January 22, 2009.

This report contains the results of our field and laboratory testing program, an engineering interpretation of this data with respect to the available project characteristics and recommendations to aid design and construction of the foundations and other earth-connected phases of this project. We wish to remind you that we will store the samples for 30 days after which time they will be discarded unless you request otherwise.

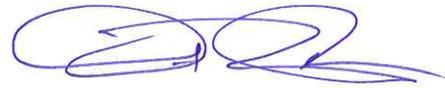
We appreciate the opportunity to be of service to you on this project. If we can be of any further assistance, or if you have any questions regarding this report, please do not hesitate to contact either of the undersigned.

Sincerely,

**ATC Associates Inc.**



David McIlwaine, E.I.  
Staff Engineer



David L. Warder, Ph.D., P.E.  
Principal Engineer

Copies: (3) Foster Builders; Attn: Mr. Scott Foster

## TABLE OF CONTENTS

	<u>Page</u>
<b>1.0 PURPOSE AND SCOPE</b> -----	<b>1</b>
<b>2.0 PROJECT CHARACTERISTICS</b> -----	<b>1</b>
<b>3.0 GENERAL SUBSURFACE CONDITIONS</b> -----	<b>2</b>
<b>4.0 DESIGN RECOMMENDATIONS</b> -----	<b>3</b>
4.1 Footings-----	3
4.2 Floor Slabs -----	5
4.3 Pavement -----	5
4.3.1 Asphalt Pavement -----	7
4.3.2 Concrete Pavement -----	7
4.3 Site Grading-----	8
<b>5.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS</b> --	<b>9</b>
5.1 Site Preparation-----	9
5.2 Fill Compaction -----	10
5.3 Foundation Excavations-----	10
5.4 Construction Dewatering-----	12
<b>6.0 FIELD INVESTIGATION</b> -----	<b>12</b>
<b>7.0 LABORATORY INVESTIGATION</b> -----	<b>13</b>
<b>APPENDIX</b>	

## **GEOTECHNICAL ENGINEERING INVESTIGATION (Revised)**

**PROPOSED DOLLAR GENERAL STORE  
OAK HILL ROAD AND MARINER DRIVE  
EVANSVILLE, INDIANA**

**ATC PROJECT NO. 86.31212.0010**

### **1.0 PURPOSE AND SCOPE**

The purpose of this study was to determine the general subsurface conditions at the project site by drilling four test borings and to evaluate this data with respect to foundation concept and design for the proposed Dollar General Store. Also included is an evaluation of the site with respect to potential construction problems and recommendations dealing with earthwork and quality control during construction.

### **2.0 PROJECT CHARACTERISTICS**

Foster Builders, Inc. is planning the construction of a Dollar General Store on a site that is located northeast of the intersection of Oak Hill Road and Mariner Drive in Evansville, Indiana. The general location of the project site is shown on the Vicinity Map (Figure 1 in the Appendix). The site is grass covered with an open lot immediately to the east and a subdivision to the north. The ground surface at the project site has an elevation difference of about 7 ft, with the low end near Mariner Drive and the topography rising toward the north side of the site.

The proposed Dollar General Store building will be a single-story, pre-engineered, steel-frame building that will have a slab-on-grade floor with no basement and plan dimensions of approximately 130 ft by 70 ft. There will be parking lots and driveways on the south

and east sides of the proposed building. It is assumed that no more than about 5 ft of grade raise fill or 3 ft of cut will be required to establish the finish floor elevation. The general location of the building on the site is shown in Figure 2 in the Appendix.

It has been assumed that the maximum column, wall and floor loads for the proposed building will not exceed about 75 kips/column, 5 kips/lin.ft and 200 lbs/sq.ft, respectively. No unusual loading conditions or settlement restrictions have been specified.

### **3.0 GENERAL SUBSURFACE CONDITIONS**

The general subsurface conditions were investigated by drilling four test borings to a depth of 15 ft at the locations shown on the Boring Plan (Figure 2 in the Appendix). The subsurface conditions disclosed by the field investigation are summarized in the following paragraphs. Detailed descriptions of the subsurface conditions encountered in each test boring are presented on the "Test Boring Logs" in the Appendix. The letters in parentheses following the soil descriptions are the soil classifications in accordance with the Unified Soil Classification System. It should be noted that the stratification lines shown on the soil boring logs represent approximate transitions between material types. In-situ stratum changes could occur gradually or at slightly different depths.

The test borings revealed about 0.6 to 0.8 ft of topsoil underlain by medium stiff to very stiff silty clay (CL-ML) and silt (ML) to depths ranging from about 8.0 to 13.0 ft below the existing ground surface. Below the cohesive soils, the test borings encountered sandstone bedrock that was weathered to varying degrees to the termination depth of 15.0 ft. The consistency of the cohesive soils was estimated based on the results of the standard penetration test (ASTM D-1586).

No free ground water was noted during or at completion of drilling in any of the borings. However, it must be noted that fluctuations in the level of the ground water will occur due to variations in rainfall and other factors.

#### **4.0 DESIGN RECOMMENDATIONS**

The following design recommendations have been developed on the basis of the previously described project characteristics (Section 2.0) and subsurface conditions (Section 3.0). If there is any change in these project criteria, including project location on the site, a review should be made by this office.

##### **4.1 Footings**

Our findings show that the proposed Dollar General Store building can be supported on shallow spread footings. Footings that bear on firm natural soil (or on well-compacted engineered fill that is placed over firm natural soil) can be designed for a net allowable soil bearing pressure of 2,500 lbs/sq.ft for column (square type) and wall (strip type) footings. It is important that the soil at the base of each footing excavation be carefully inspected as described in Section 5.3 to assure that any very soft soils and otherwise unsuitable materials (such as debris and old fill) are identified and removed and that the footings will bear on suitable materials.

In using net pressure, the weight of the footing and backfill over the footing including the weight of the floor slab need not be considered; hence, only loads applied at or above the finished floor need to be used for dimensioning the footings.

Wall footings should be at least 18 in. wide and column footings should be at least 2.5 ft wide for bearing capacity considerations. All exterior footings and footings in unheated areas should be located at a depth of at least 2.5 ft below the final exterior grade for frost

protection. Interior footings can be located at nominal depths below the finished floor provided the topsoil and other undesirable materials are removed at the footing locations.

Provided the footings are designed as prescribed herein and inspected as outlined in Section 5.3, it is estimated that the total and differential foundation settlements should not exceed about 1 in. and ½ in., respectively. Careful field control will contribute substantially to minimizing the settlements.

Based on geologic mapping and the results of the test borings, it is our opinion that the subsurface conditions at this site meet the criteria for Site Class C based on Sections 1613.5.2 and 1613.5.5 of the 2006 International Building Code.

Uplift forces on the footings can be resisted by the weight of the footings and the soil material that is placed over the footings. It is recommended that the soil weight considered to resist uplift loads be limited to that immediately above and within the perimeter of the footings (unless a much higher factor of safety is used). A total soil unit weight of 110 lbs/cu.ft can be used for the backfill material placed above the footings, provided it is compacted as recommended in Section 5.2. It is also recommended that a factor of safety of at least 1.3 be used for calculating uplift resistance from the footings (provided only the weight of the footing and the soil immediately above it are used to resist uplift forces).

Lateral forces on a shallow spread footing can be resisted by the passive lateral earth pressure against the side of the footing and by friction between the subgrade soil and the base of the footing. A uniform allowable passive pressure of 500 lbs/sq.ft can be used for that portion of the footing that is below a depth of 2.5 ft below the final exterior grade (no portion of the footing above this depth should be used for lateral resistance). An allowable coefficient of friction (between the base of the footing and the underlying soil) of 0.20 can be used in conjunction with the minimum downward load on the base of the footing.

## **4.2 Floor Slabs**

Floor slabs can be supported on firm natural soils or on new compacted structural fill. The slab subgrade should be prepared and inspected as described in Section 5.1 of this report.

It is recommended that all floor slabs be "floating", that is, fully ground supported and not structurally connected to walls or foundations. This is to minimize the possibility of cracking and displacement of the floor slabs because of differential movements between the slab and the foundation. Although the movements are estimated to be within the tolerable limits for structural safety, such movements could be detrimental to the slabs if they were rigidly connected to the foundations.

It is furthermore recommended that the floor slab be supported on a 4 in. layer of relatively clean granular material such as sand and gravel or crushed stone. This is to help distribute concentrated loads and equalize moisture conditions beneath the slab. Provided that a minimum of 4 in. of granular material is placed below the slab, a modulus of subgrade reaction ( $k_{30}$ ) of 100 lbs/cu.in. can be used for design of the floor slabs.

## **4.3 Pavement**

Details regarding site grading in pavement areas are not available at this time; however, depending upon grading requirements and seasonal conditions, it is likely that the pavement subgrade in some areas of the site will be wet, soft or yielding at the time of construction (particularly in cut areas). If at the time of construction the subgrade is found to be excessively wet, soft or yielding, it is recommended that the subgrade soils be stabilized by discing, aerating and recompacting. However, if it is not possible to improve the subgrade soils in this manner because of weather conditions, scheduling or other conditions (which is often the case); it is recommended that the subgrade soils be stabilized using chemical stabilization (i.e., quicklime or lime-byproduct), mechanical stabilization (i.e., a geogrid

with additional crushed limestone placed over the subgrade), or by removing and replacing the unsuitable soils with crushed limestone. The best method for stabilizing the pavement subgrade should be determined in the field at the time of construction based upon the actual field conditions in conjunction with the specific soil type encountered at the locations requiring stabilization, the size of the areas requiring stabilization and the construction schedule.

The pavement subgrade surface should be uniformly sloped to facilitate drainage through the granular base and to avoid any ponding of water beneath the pavement. The storm water catch basins in pavement areas should be designed to allow water to drain from the aggregate base into the catch basins. At a minimum, subsurface trench drains should be included that extend out at least 20 ft from the catchbasins.

Based on the results of classification tests and our experience with similar soils, a California Bearing Ratio (CBR) value of 3 has been estimated for use in pavement design for the clayey subgrade soils encountered at this site. The subgrade soils should be prepared and inspected as described in Sections 5.1 and 5.2 of this report.

The following report sections outline recommendations for asphalt and concrete pavements for automobile parking areas and truck zones. It is important to note that the recommendations for the automobile parking areas are based on the assumption that these areas will not be subject to any heavy truck traffic. Therefore, in areas where truck traffic cannot be controlled (i.e., driveways), it is suggested that the thicker pavement section be utilized.

#### **4.3.1 Asphalt Pavement**

Based on a CBR value of 3, a design period of 15 years, an average of no more than five trucks per day in heavy-duty pavement areas and the conditions encountered at the site, the following asphalt pavement sections are recommended:

<u>Automobile Parking Areas</u>	3 in. of asphaltic concrete over 6 in. of granular base.
<u>Driveway Areas and Truck Zones</u>	5 in. of asphaltic concrete over 10 in. of granular base.

The base should be a well-graded crushed stone with a maximum of 10 percent (by weight) finer than the No. 200 sieve such as coarse aggregate size No. 53 in accordance with Indiana Department of Transportation-INDOT-Standard Specifications (“commercial grade” No. 53 crushed stone should not be used as pavement base material). The asphaltic concrete pavement should be constructed in accordance with the INDOT Standard Specifications Section 402-Hot Mix Asphalt, HMA, Pavement.

#### **4.3.2 Concrete Pavement**

Concrete pavement thicknesses were determined from methods developed by the Portland Cement Association (PCA), the American Association of State Highway and Transportation Officials (AASHTO) and the American Concrete Institute (ACI). These methods assume that the subgrade is firm, well-compacted and non-pumping and that all joints are properly designed, located and sealed to minimize moisture seepage into the subgrade. It is also important to insure that proper concrete curing practices will be employed and that traffic will not be allowed until the concrete has had sufficient time to cure.

For design calculation purposes, the compressive strength of the concrete was assumed to be 4,000 lbs/sq.in. (or a modulus of rupture of about 600 lbs/sq.in.). The modulus of subgrade reaction ( $k_{30}$ ) was estimated to be 100 lbs/cu.in.

Based on the above information, the following concrete pavement sections were determined:

Automobile Parking Areas

6 in. of concrete over a well-compacted, non-pumping subgrade.

Driveway Areas  
and Truck Zones

8 in. of concrete over a well-compacted, non-pumping subgrade.

The performance of the concrete paving section is highly dependent on controlling the pumping of the subgrade soils. Although no wet surface soils were noted at the time of this study, it is important that surface drainage be controlled to prevent water from ponding in pavement areas.

#### 4.3 Site Grading

Proper surface drainage should be provided at the site to minimize any increase in moisture content of the foundation soils. The exterior grade should be sloped away from the structure to prevent ponding of water.

## **5.0 GENERAL CONSTRUCTION PROCEDURES AND RECOMMENDATIONS**

Since this investigation identified actual subsurface conditions only at the test boring locations, it was necessary for our geotechnical engineers to extrapolate these conditions in order to characterize the entire project site. Even under the best of circumstances, the conditions encountered during construction can be expected to vary somewhat from the test boring results and may, in the extreme case, differ to the extent that modifications to the foundation recommendations become necessary. Therefore, we recommend that ATC be retained as geotechnical consultant through the earth-related phases of this project to correlate actual soil conditions with test boring data, identify variations, conduct additional tests that may be needed and recommend solutions to earth-related problems that may develop.

### **5.1 Site Preparation**

All areas that will support floor slabs should be properly prepared. After rough grade has been established in cut areas and prior to placement of fill in all fill areas, the exposed subgrade should be carefully inspected by the geotechnical engineer or a qualified soils technician by probing and testing as needed. All topsoil and other organic material still in place, frozen, wet, soft or loose soil and other undesirable materials should be removed from the building area. The exposed subgrade should furthermore be inspected by proofrolling with suitable equipment to check for pockets of soft material hidden beneath a thin crust of better soil. Any unsuitable materials thus exposed should be removed and replaced with well-compacted, engineered fill as outlined in Section 5.2, or stabilized in-place using chemical stabilization or mechanical stabilization as described in Section 4.3.

Care should be exercised during the grading operations at the site. Due to the nature of the near surface soils, the traffic of construction equipment may create pumping and general

deterioration of the shallower soils, especially if excess surface water is present. The grading, therefore, should be done during a dry season, if at all possible.

## **5.2 Fill Compaction**

All engineered fill beneath floor slabs and footings should be compacted to a dry density of at least 98 percent of the standard Proctor maximum dry density (ASTM D-698). The compaction should be accomplished by placing the fill in about 8 in. (or less) loose lifts and mechanically compacting each lift to at least the specified minimum dry density. Field density tests should be performed on each lift as necessary to insure that adequate moisture conditioning and compaction is being achieved.

Compaction of any fill by flooding is not considered acceptable. This method will generally not achieve the desired compaction and the large quantities of water will tend to soften the foundation soils. All soils encountered in the test borings made at this site are considered suitable as general fill material with the exception of topsoil. The need for some aeration of the more clayey soils should be expected before they can be placed and compacted to the specified density.

## **5.3 Foundation Excavations**

The soil at the base of each foundation excavation should be inspected by a geotechnical engineer or a qualified soils technician to insure that all remnants from previous construction, loose, very soft or otherwise undesirable material is removed at footing locations and that the footing will bear on satisfactory material. At the time of such inspection, it will be necessary to make hand auger borings or use a hand penetration device in the base of the foundation excavation to insure that the soils below the base are satisfactory for foundation support. The necessary depth of penetration will be established during inspection.

Where undercutting is required to remove unsuitable materials and it is inconvenient to lower the footing, the proposed footing elevation may be re-established by backfilling after all undesirable materials have been removed. The undercut excavation beneath each footing should extend to suitable bearing soils. The dimensions of the excavation base should be determined by imaginary planes extending outward and downward on a 2 (vertical) to 1 (horizontal) slope from the base perimeter of the footing (see Figure 3 in the Appendix). The entire excavation should then be refilled with engineered fill. The engineered fill should be limited to well-graded sand and gravel or crushed stone (e.g., Indiana Department of Transportation coarse aggregate size No. 53 crushed stone) compacted to the minimum dry density recommended in Section 5.2; or lean concrete may be used. Special care should be exercised to remove any sloughed, loose or soft materials near the base of the excavation slopes. In addition, special care should be taken to "tie-in" the compacted fill with the excavation slopes with benches as necessary. This is to insure that no pockets of loose or soft materials will be left in place along the excavation slopes below the foundation bearing level.

Soils exposed in the bases of all satisfactory foundation excavations should be protected against any detrimental change in condition such as from disturbance, rain and freezing. Surface run-off water should be drained away from the excavation and not allowed to pond. If possible, all footing concrete should be placed the same day the excavation is made. If this is not practical, the footing excavations should be adequately protected.

Although no final grading plan was provided, it seems unlikely that any footing excavations will extend deep enough to encounter the weathered sandstone, which was encountered as shallow as 8 ft below the existing ground surface in Boring No. B-4. If weathered sandstone is encountered in a footing or utility excavation, it may be possible to remove the upper, weathered portion with soil excavation or ripping equipment. However, any

excavation extending deeper into bedrock will likely require pneumatic equipment such as a hoe-ram or jackhammer.

#### **5.4 Construction Dewatering**

At the time of our investigation, the ground water level appeared to be below the anticipated footing excavation depths. Depending on the seasonal conditions, some seepage into excavations may be experienced. It is anticipated that any such seepage can be handled by conventional dewatering methods such as by pumping from sumps. However, the best dewatering system for each case must be determined at the time of construction based upon actual field conditions.

### **6.0 FIELD INVESTIGATION**

Four test borings were drilled at the locations shown on the Boring Plan (Figure 2 in the Appendix). The borings were extended to a depth of 15 ft below the existing grade. Split-spoon samples were obtained by the standard penetration test procedures (ASTM D-1586) at 2.5 ft intervals.

Logs of all borings, which show visual descriptions of all soil strata encountered using the Unified Soil Classification System, have been included in numerical order in the Appendix. Ground water observations, sampling information and other pertinent field data and observations are also included. In addition, a "Field Classification System for Soil Exploration" document defining the terms and symbols used on the logs and explaining the standard penetration test procedure is provided immediately following the boring logs.

## **7.0 LABORATORY INVESTIGATION**

The disturbed samples were inspected and classified in accordance with the Unified Soil Classification System and the boring logs were edited as necessary. To aid in classifying the soils and to determine general soil characteristics, natural moisture content tests were performed on selected samples. The results of these tests are included in the Appendix.

## **8.0 LIMITATIONS OF STUDY**

An inherent limitation of any geotechnical engineering study is that conclusions must be drawn on the basis of data collected at a limited number of discrete locations. The recommendations provided in this report were developed from the information obtained from the test borings that depict subsurface conditions only at these specific locations and at the particular time designated on the logs. Soil conditions at other locations may differ from conditions occurring at these boring locations. The nature and extent of variations between the borings may not become evident until the course of construction. If variations then appear evident, it will be necessary to re-evaluate the recommendations of this report after performing on-site observations during the excavation period and noting the characteristics of any variation.

Our professional services have been performed, our findings obtained and our recommendations prepared in accordance with generally accepted geotechnical engineering principles and practices. This warranty is in lieu of all other warranties either expressed or implied. This company is not responsible for the independent conclusions, opinions or recommendations made by others based on the field exploration and laboratory test data presented in this report.

The scope of our services does not include any environmental assessment or investigation for the presence or absence of hazardous or toxic materials in the soil, ground water or surface water within or beyond the site studied.

## APPENDIX

Figure 1 - Vicinity Map

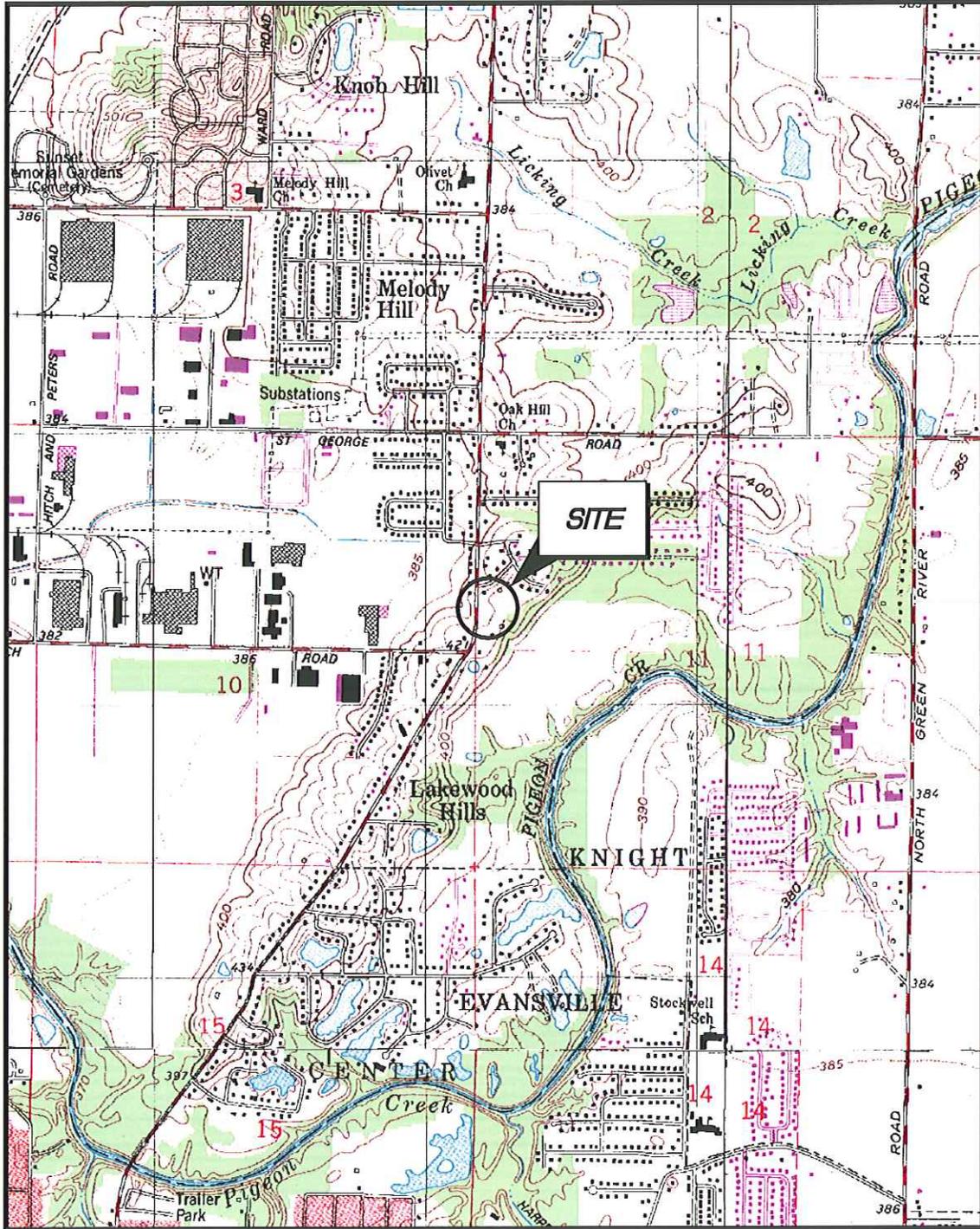
Figure 2 - Boring Plan

Figure 3 - Design Illustration - Footings in  
Undercut Area

Boring Logs (4)

"Field Classification System for Soil Exploration"

"Important Information About Your  
Geotechnical Engineering Report"

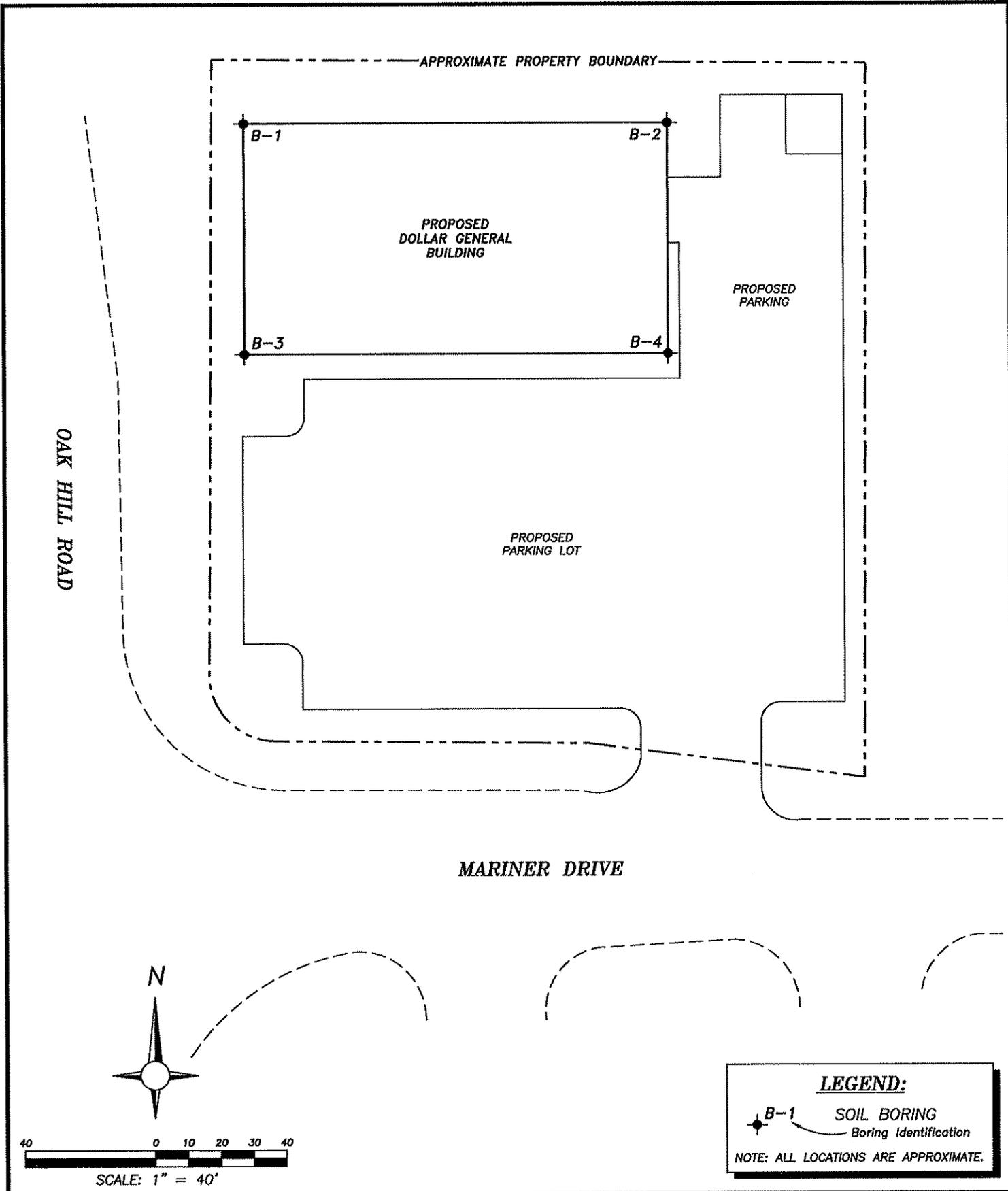


H:\2009\31212\0010\

**VICINITY MAP**

PROPOSED DOLLAR GENERAL STORE  
 OAK HILL ROAD AND MARINER DRIVE  
 EVANSVILLE, INDIANA

Project Number: 86.31212.0010		Drn. By: SP
Drawing File: 31212~10A		Ckd. By: DM
Date: 1/09	Scale: 1" = 2000'	App'd By:
		Figure: <b>1</b>



**LEGEND:**

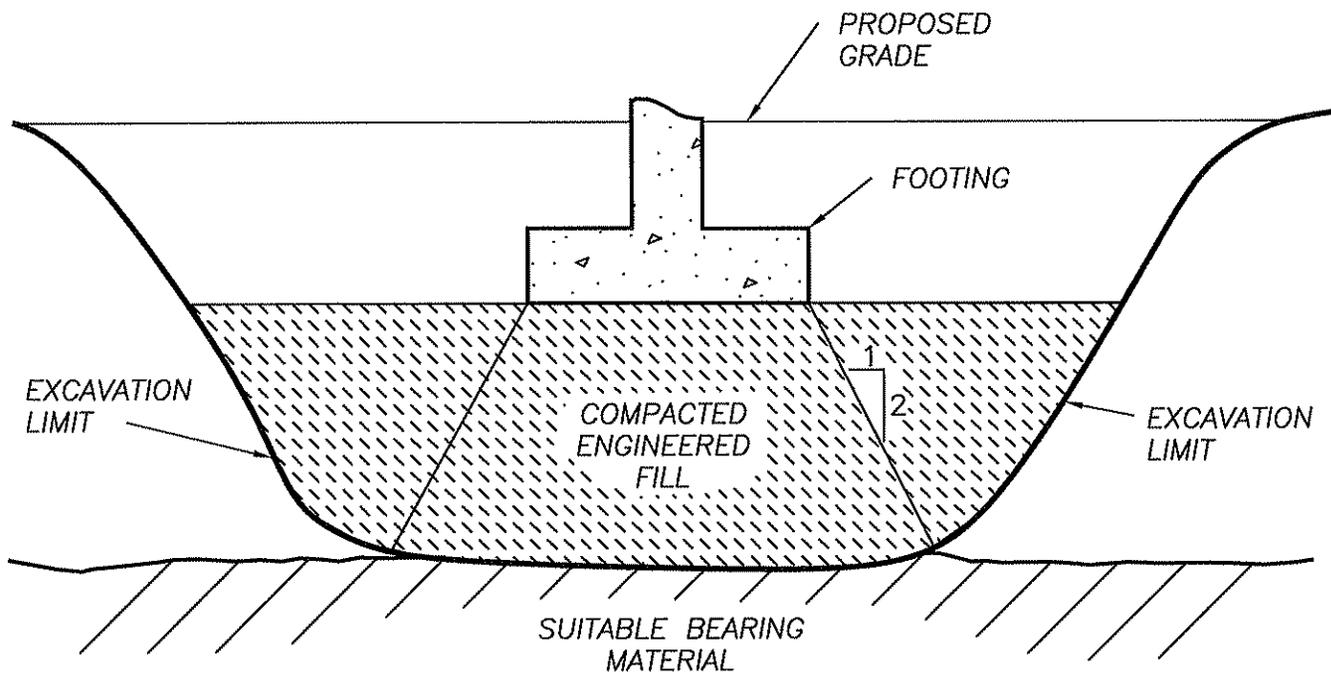
**B-1** SOIL BORING  
 Boring Identification

NOTE: ALL LOCATIONS ARE APPROXIMATE.

**BORING PLAN**  
 PROPOSED DOLLAR GENERAL STORE  
 OAK HILL ROAD AND MARINER DRIVE  
 EVANSVILLE, INDIANA

Project Number: 86.31212.0010		Dm. By: SP
Drawing File: 31212~10A		Ckd. By: DM
Date: 1/09	Scale: AS SHOWN	App'd By:
		Figure: <b>2</b>

H:\2009\31212\0010\



**DESIGN ILLUSTRATION  
FOOTINGS IN UNDERCUT AREA**

PROPOSED DOLLAR GENERAL STORE  
OAK HILL ROAD AND MARINER DRIVE  
EVANSVILLE, INDIANA

Project Number: 86.31212.0010		Drn. By: SP
Drawing File: 31212~10A		Ckd. By: DM
Date: 1/09	Scale: NONE	App'd By:



Figure:  
**3**

H:\2009\31212\0010\



CLIENT Foster Builders, Inc. BORING # B-1  
 PROJECT NAME Proposed Dollar General Store JOB # 86.31212.0010  
 PROJECT LOCATION Oak Hill Road and Mariner Drive  
Evansville, Indiana

DRILLING and SAMPLING INFORMATION

TEST DATA

Date Started 1/26/09 Hammer Wt. 140 lbs.  
 Date Completed 1/26/09 Hammer Drop 30 in.  
 Drill Foreman W. Bates Spoon Sampler OD 2.0 in.  
 Inspector D. McIlwaine Rock Core Dia. -- in.  
 Boring Method HSA Shelby Tube OD -- in.

SOIL CLASSIFICATION	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics	Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil	0.7										
Brown, moist, medium stiff SILTY CLAY (CL-ML) with trace sand and roots			1	SS				4-3-3	22.5	1.75	
	3.0										
Brown, slightly moist to moist, stiff to medium stiff SILT (ML) with trace sand			2	SS				4-5-7	23.5	2.25	
	5										
			3	SS				4-4-4	21.5	1.0	
			4	SS				3-4-4	19.5	1.0	
	10.5	10									
Reddish brown, weathered sandstone			5	SS				4-7-10		3.0	
			6	SS				12-20-25		4.5+	
Bottom of Test Boring at 15.0 ft	15.0	15									

Sample Type

- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Depth to Groundwater

- Noted on Drilling Tools None ft.
- ▽ At Completion Dry ft.
- ▼ After -- hours -- ft.
- ⊗ Cave Depth 10.5 ft.

Boring Method

- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- DC - Driving Casing
- MD - Mud Drilling
- HA - Hand Auger



CLIENT Foster Builders, Inc. BORING # B-2  
 PROJECT NAME Proposed Dollar General Store JOB # 86.31212.0010  
 PROJECT LOCATION Oak Hill Road and Mariner Drive  
Evansville, Indiana

DRILLING and SAMPLING INFORMATION

TEST DATA

Date Started 1/26/09 Hammer Wt. 140 lbs.  
 Date Completed 1/26/09 Hammer Drop 30 in.  
 Drill Foreman W. Bates Spoon Sampler OD 2.0 in.  
 Inspector D. McIlwaine Rock Core Dia. -- in.  
 Boring Method HSA Shelby Tube OD -- in.

SOIL CLASSIFICATION	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics	Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
SURFACE ELEVATION											
Topsol!	0.8										
Brown to brown and gray, moist, medium stiff to very stiff SILTY CLAY (CL-ML) with trace sand and roots			1	SS				4-5-4	26.9		
			2	SS				5-7-9	20.3		
	5.5	5									
Brown, moist, medium stiff to very stiff SILTY CLAY (CL-ML) with trace sand			3	SS				5-5-6	17.9	2.0	
			4	SS				4-5-5	18.2	2.25	
		10									
			5	SS				5-9-11		2.0	
	13.0										
Reddish brown, weathered sandstone			6	SS				26-50/0.3'			
Bottom of Test Boring at 14.3 ft	14.3										

**Sample Type**  
 SS - Driven Split Spoon  
 ST - Pressed Shelby Tube  
 CA - Continuous Flight Auger  
 RC - Rock Core  
 CU - Cuttings  
 CT - Continuous Tube

**Depth to Groundwater**  
 ● Noted on Drilling Tools None ft.  
 ∇ At Completion Dry ft.  
 ▼ After -- hours -- ft.  
 ☒ Cave Depth 8.5 ft.

**Boring Method**  
 HSA - Hollow Stem Augers  
 CFA - Continuous Flight Augers  
 DC - Driving Casing  
 MD - Mud Drilling  
 HA - Hand Auger



CLIENT Foster Builders, Inc. BORING # B-3  
 PROJECT NAME Proposed Dollar General Store JOB # 86.31212.0010  
 PROJECT LOCATION Oak Hill Road and Mariner Drive  
Evansville, Indiana

DRILLING and SAMPLING INFORMATION

TEST DATA

Date Started 1/26/09 Hammer Wt. 140 lbs.  
 Date Completed 1/26/09 Hammer Drop 30 in.  
 Drill Foreman W. Bates Spoon Sampler OD 2.0 in.  
 Inspector D. McIlwaine Rock Core Dia. -- in.  
 Boring Method HSA Shelby Tube OD -- in.

SOIL CLASSIFICATION	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics	Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-tsf	Remarks
Topsoil	0.6		1	SS				4-4-4	25.7		
Brown, moist, medium stiff SILTY CLAY (CL-ML) with trace sand and roots											
Brown, moist, very stiff to medium stiff SILTY CLAY (CL-ML) with trace sand	3.0		2	SS				7-9-11	20.1	3.0	
		5									
			3	SS				3-4-4	18.8	1.25	
			4	SS				3-5-7	18.9	3.0	
		10									
Reddish brown to gray, weathered sandstone	10.5		5	SS				18-26-29		4.0	
			6	SS				14-20-33			
Bottom of Test Boring at 15.0 ft	15.0	15									

**Sample Type**  
 SS - Driven Split Spoon  
 ST - Pressed Shelby Tube  
 CA - Continuous Flight Auger  
 RC - Rock Core  
 CU - Cuttings  
 CT - Continuous Tube

**Depth to Groundwater**  
 ● Noted on Drilling Tools None ft.  
 ∇ At Completion Dry ft.  
 ▼ After -- hours -- ft.  
 ☒ Cave Depth 9.5 ft.

**Boring Method**  
 HSA - Hollow Stem Augers  
 CFA - Continuous Flight Augers  
 DC - Driving Casing  
 MD - Mud Drilling  
 HA - Hand Auger



CLIENT Foster Builders, Inc.  
 PROJECT NAME Proposed Dollar General Store  
 PROJECT LOCATION Oak Hill Road and Mariner Drive  
Evansville, Indiana

BORING # B-4  
 JOB # 86.31212.0010

DRILLING and SAMPLING INFORMATION

TEST DATA

Date Started 1/26/09 Hammer Wt. 140 lbs.  
 Date Completed 1/26/09 Hammer Drop 30 in.  
 Drill Foreman W. Bates Spoon Sampler OD 2.0 in.  
 Inspector D. McIlwaine Rock Core Dia. -- in.  
 Boring Method HSA Shelby Tube OD -- in.

SOIL CLASSIFICATION	Stratum Depth, ft	Depth Scale, ft	Sample No.	Sample Type	Sampler Graphics	Recovery Graphics	Groundwater	Standard Penetration Test, Blows per 6 in. Increments	Moisture Content, %	Pocket Penetrometer PP-4sf	Remarks
Topsoil	0.8										
Brown, moist, medium stiff SILTY CLAY (CL-ML) with trace sand			1	SS				3-3-4	28.5	1.25	
	3.0										
Brown, moist, medium stiff CLAYEY SILT (ML) with trace sand			2	SS				4-4-4	24.6	2.0	
	5										
			3	SS				3-4-6	22.2	1.75	
	8.0										
Reddish brown and brown, weathered sandstone			4	SS				7-5-6			
	10										
			5	SS				7-12-16			
	13.0										
Brown, slightly weathered sandstone			6	SS				50/0.5'			
Bottom of Test Boring at 14.0 ft	14.0										

Sample Type

- SS - Driven Split Spoon
- ST - Pressed Shelby Tube
- CA - Continuous Flight Auger
- RC - Rock Core
- CU - Cuttings
- CT - Continuous Tube

Depth to Groundwater

- Noted on Drilling Tools None ft.
- ∇ At Completion Dry ft.
- ▼ After -- hours -- ft.
- ⊠ Cave Depth 9.5 ft.

Boring Method

- HSA - Hollow Stem Augers
- CFA - Continuous Flight Augers
- DC - Driving Casing
- MD - Mud Drilling
- HA - Hand Auger

# FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

## NON-COHESIVE SOILS (Silt, Sand, Gravel and Combinations)

<u>Density</u>		<u>Particle Size Identification</u>	
Very Loose	- 5 blows/ft or less	Boulders	- 8 inch diameter or more
Loose	- 6 to 10 blows/ft	Cobbles	- 3 to 8 inch diameter
Medium Dense	- 11 to 30 blows/ft	Gravel	- Coarse - 1 to 3 inch
Dense	- 31 to 50 blows/ft		Medium - ½ to 1 inch
Very Dense	- 51 blows/ft or more		Fine - ¼ to ½ inch
		Sand	- Coarse 2.00mm to ¼ inch (dia. of pencil lead)
			Medium 0.42 to 2.00mm (dia. of broom straw)
			Fine 0.074 to 0.42mm (dia. of human hair)
		Silt	0.074 to 0.002mm (cannot see particles)

<u>Relative Proportions</u>	
Descriptive Term	Percent
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

## COHESIVE SOILS (Clay, Silt and Combinations)

<u>Consistency</u>		<u>Plasticity</u>	
Very Soft	- 3 blows/ft or less	Degree of Plasticity	Plasticity Index
Soft	- 4 to 5 blows/ft	None to slight	0 - 4
Medium Stiff	- 6 to 10 blows/ft	Slight	5 - 7
Stiff	- 11 to 15 blows/ft	Medium	8 - 22
Very Stiff	- 16 to 30 blows/ft	High to Very High	over 22
Hard	- 31 blows/ft or more		

Classification on the logs are made by visual inspection of samples.

**Standard Penetration Test** — Driving a 2.0" O.D. 1-3/8" I.D. sampler a distance of 1.0 foot into undisturbed soil with a 140 pound hammer free falling a distance of 30 inches. It is customary for ATC to drive the spoon 6 inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating the spoon and making the test are recorded for each 6 inches of penetration on the drill log (Example — 6-8-9). The standard penetration test result can be obtained by adding the last two figures (i.e., 8 + 9 = 17 blows/ft). (ASTM D-1586-08).

**Strata Changes** — In the column "Soil Descriptions" on the drill log the horizontal lines represent strata changes. A solid line (\_\_\_\_\_) represents an actually observed change. A dashed line (\_\_\_\_\_) represents an estimated change.

**Ground Water** observations were made at the times indicated. Porosity of soil strata, weather conditions, site topography, etc., may cause changes in the water levels indicated on the logs.

# Important Information About Your Geotechnical Engineering Report

*Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.*

*The following information is provided to help you manage your risks.*

## **Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects**

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you — should apply the report for any purpose or project except the one originally contemplated.*

## **Read the Full Report**

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

## **A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors**

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,

- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

## **Subsurface Conditions Can Change**

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

## **Most Geotechnical Findings Are Professional Opinions**

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

## **A Report's Recommendations Are *Not* Final**

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final*, because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual

subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

### **A Geotechnical Engineering Report Is Subject to Misinterpretation**

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

### **Do Not Redraw the Engineer's Logs**

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

### **Give Contractors a Complete Report and Guidance**

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

### **Read Responsibility Provisions Closely**

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that

have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

### **Geoenvironmental Concerns Are Not Covered**

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

### **Obtain Professional Assistance To Deal with Mold**

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

### **Rely, on Your ASFE-Member Geotechnical Engineer for Additional Assistance**

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you ASFE-member geotechnical engineer for more information.



8811 Colesville Road/Suite G106, Silver Spring, MD 20910  
Telephone: 301/565-2733 Facsimile: 301/589-2017  
e-mail: [info@asfe.org](mailto:info@asfe.org) [www.asfe.org](http://www.asfe.org)

*Copyright 2004 by ASFE, Inc. Duplication, reproduction, or copying of this document, in whole or in part, by any means whatsoever, is strictly prohibited, except with ASFE's specific written permission. Excerpting, quoting, or otherwise extracting wording from this document is permitted only with the express written permission of ASFE, and only for purposes of scholarly research or book review. Only members of ASFE may use this document as a complement to or as an element of a geotechnical engineering report. Any other firm, individual, or other entity that so uses this document without being an ASFE member could be committing negligent or intentional (fraudulent) misrepresentation.*