GREENBAUM ASSOCIATES, INC.
GEOTECHNICAL & MATERIALS ENGINEERS
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December 21, 2016

Mr. Michael Salsman
BCD, Inc.
1200 Atkinson Hill Road
Bardstown, Kentucky 40004

Re: Geotechnical Investigation
Hampton Inn Suites
Old Rybolt Road
Cincinnati, Ohio
Project Number 16-291G

Dear Mr. Salsman:

Attached is the report of the geotechnical investigation that we carried out for the above referenced Hampton Inn Suites hotel.

A major concern at this site is the relatively steep slopes underlain by a bedrock formation known for its landslide potential. We have discussed measures to be taken when cutting and filling on these slopes. This includes:

- Benching into bedrock prior to placement of fill on slopes.
- Cut slopes in rock being not steeper than ½ to 1 with an 8 foot catchment area at its base.
- Placement of a soil pad below foundations that encounter bedrock.

More detail is provided in the text of the report.

If you have any questions in regard to this report, please call.

Sincerely,

GREENBAUM ASSOCIATES, INC.

Sandor R. Greenbaum, P.E.
Principal Engineer

GEOTECHNICAL INVESTIGATION

FOR

HAMPTON INN SUITES

OLD RYBOLT ROAD

CINCINNATI, OHIO

FOR

BCD, INC.

1200 ATKINSON HILL AVENUE

BARDSTOWN, KENTUCKY 40004

BY

GREENBAUM ASSOCIATES, INC.

994 LONGFIELD AVENUE

LOUISVILLE, KENTUCKY 40215

DECEMBER 21, 2016

SANDOR R. GREENBAUM
E-59681

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APPENDIX

1.0 Introduction

BCD, Inc. has been contracted to build a new Hampton Inn Suites on a vacant parcel of land on Old Rybolt Road in Cincinnati, Ohio, just southwest of the Interstate 74-Harrison Avenue interchange. This site includes the bottom and side slopes of a relatively steep ravine. The hotel is to be four floors plus basement with 82 guest rooms and a 100-space parking lot. A site location plan is included in the appendix of this report along with a boring location plan that shows the footprint of the proposed building and pavement.

We were contracted by BCD, Inc. to carry out a geotechnical investigation directed at determining foundation support characteristics of the materials upon which this hotel and associated pavement will be supported. Work was coordinated through Mr. Michael Salsman of BCD, Inc.

2.0 General Geology

The soils below this site are shown by the Ohio Geological Survey to be residuum, the residual product of weathering of the local bedrock. Bedrock is shown to be the Miamitown Shale-Fairview Formation, the two not being differentiated on the mapping.

Both formations are interbedded shale and limestone, the major difference being that the Miamitown Shale is 90 percent shale while the Fairview Formation is 50 percent shale. Both formations are prone to landslide, especially the Miamitown Shale. Landslides tend to occur in the thick colluvium developed when excessive hydrostatic pressure builds up in this zone.

3.0 Investigation

Seven borings were carried out in the area of the proposed building and pavement by standard penetration procedures to auger refusal or 16.5 feet depth, the shallower. A CME-550 all-terrain-vehicle mounted drill rig was used to carry out the borings through the use of 3-¼ inch inside diameter hollow stem augers and a safety hammer. Boring locations were staked using a 300-foot nylon tape from existing topography, so boring locations are only as accurate at this method allows.

The standard penetration procedure involves driving a standard 2-inch diameter split spoon in the formation at selected intervals using a 140-pound hammer falling through 30 inches. The blow counts for each 6 inches of drive, to a total of 18 inches, are recorded and the number of blows for the 12 inches after the first 6 inches is a standard measure of the condition of the soil. As the split spoon is removed from the ground, it retrieves a sample of the soil in a disturbed condition. Nevertheless, this sample is suitable for certain classification tests and is representative of the soils at the depth tested.

Soil samples were returned to the laboratory where a program of testing was carried out. This testing included a grain size analysis, an Atterberg Limits test and natural moisture determinations on all of the soil samples recovered.

Grain size determination arrives at a curve of grain size against that fraction of the soil that is finer than that particular grain size. It also allows the determination of the clay fraction, silt fraction, sand fraction, etc. in any particular soil sample. Based on this division of grain sizes, the field soils classifications are refined and the boring logs adjusted. In the case of fine grained soils, the soils are largely silt and clay; thus requiring that the soils be suspended in an aqueous medium and the rate at which the particles drop out is measured in order to arrive at the grain size distribution. Silt and clay grains are so fine that sieve analysis alone will not function in this range. The coarse fraction of this sample is separated from the fine and run through a nest of sieves in order to further detail the grain size distribution in the coarse range.

The Atterberg Limits determination arrives at those moisture contents at which the soil turns from a solid state to a plastic condition (the Plastic Limit) and then from a plastic condition to a liquid condition (The Liquid Limit). The points in question are arrived at by standard procedures that accept specific cohesive and flow properties of the soil as standards for these limits. Knowing the moisture content of the soil in relation to these limits provides a broad measure of the soil strength and soil characteristics. The arithmetic difference between these two limits is called the Plasticity Index and all three together are used for classifying the soils in a number of standard systems.

The natural moisture determination arrives at the in-situ moisture content of the soil and is useful for correlating the strength of various samples of like texture and in conjunction with the Atterberg limits, gives a strong measure of the strength range the soils are likely to be found in.

4.0 Findings

4.1 Boring Results

This site is covered by about six inches of topsoil. Below this soils are lean clay with chert or limestone. Soils are relatively shallow on at the higher elevations and on sideslopes, but are deeper at lower elevations, especially in boring B-6 in the northwest section of the site. Boring B-6 is also the only boring with soft soils, the soft soil possibly being fill. Soils in the area of the proposed building are very stiff to hard.

The table below provides a tabulation of N-values in the borings as determined by the Standard Penetration Test along with depth to auger refusal, where encountered.

Depth	B-1	B-2	B-3	B-4	B-5	B-6	B-7
2 – 3.5 feet	20	50/1"	27	50/1"	25	4	9
5 – 6.5 feet	30		50/1"		17	4	21
10 – 11.5 feet						11	
15 – 16.5 feet						21	
Refusal	7.2'	4.0'	7.0'	3.5'	7.5'		9.0'

No groundwater was encountered in any of the borings immediately after drilling was complete, however, groundwater is likely to be present at the lower elevations and seasonally elsewhere.

4.2 Laboratory Results

A sample of soil taken from boring B-1 at a depth of 2 to 3.5 feet was tested and classified. This sample was found to be lean clay with sand containing 17 percent sand, 31 percent silt and 52 percent clay. An Atterberg limits test indicated a liquid limit of 44, a plastic limit of 14 and a plasticity index of 30. This soil is classified as CL by the Unified system and as A-7-6 by the AASHTO system.

4.3 Seismicity

By the 2012 edition of the International Building Code, this is a very dense soil and soft rock profile, site class C. The Spectral Response Acceleration Coefficients, for this area, as provided by U.S.G.S., FEMA Design Parameters are:

$S_S = 0.142$ g	$S_{MS} = 0.171$ g	$S_{DS} = 0.114$ g
$S_1 = 0.078$ g	$S_{M1} = 0.133$ g	$S_{D1} = 0.089$ g

5.0 Recommendations

5.1 Foundations

The proposed building, as presently proposed, may be supported on spread footings bearing on shallow soil or structural fill placed in accordance with section 5.3 of this report. These foundations may be designed based on an allowable net bearing capacity of up to 2,500 pounds per square foot.

Cut and fill may place foundations on the uphill side of the building on or very near bedrock while foundations on the downhill side of the building may be on substantial fill. This will result in higher than normal differential settlement between those foundations on shallow soils and those on deep fill. To limit differential settlement to the extent possible, where foundations encounter bedrock in the bearing surface the rock should be removed to at least 18 inches below the foundation bearing surface and should be refilled with lean clay or sand compacted to between 88 and 92 percent of the soils maximum dry density as determined by the Standard Proctor (ASTM D698).

Once foundation bearing surfaces are exposed, an engineer or senior engineering technician from this office should be present to view all bearing surfaces. If soft areas are encountered, undercut will need to extend to firm material or to a level determined to be acceptable by the geotechnical engineer and should be refilled with either lean concrete ($f_c' = 2{,}000$ psi) or open-graded stone such as Number 57 stone.

Soil bearing foundations exposed must bear at least 30 inches below finished grade in order to insulate the bearing strata from freezing. Interior foundations protected from freezing are exempt from this requirement. Continuous footings must be at least 16 inches wide and isolated footings must be at least 24 inches wide.

Settlement of foundations designed based on the above criteria should be below that which is considered acceptable for this type of construction; that is total settlement should be less than one inch and differential settlement should be less than three quarters of an inch. However, where height of fill is greater than 20 feet, settlement may exceed one inch and differential settlement will be affected accordingly.

For shallow foundations, friction along the base of the footing can be used to resist lateral forces. A friction coefficient of 0.35 may be used, which assumes that the footing concrete is placed directly against the natural cut faces. The coefficient of friction value recommended is an ultimate value and a minimum factor of safety of 1.5 must be applied when determining the allowable sliding resistance.

5.2 Slab-On-Grade

Prior to placement of the fill in the slab area, the subgrade must be proofrolled and carefully examined by a geotechnical engineer for areas of soft soil. If soft soils are encountered, they must be undercut and refilled in accordance with instructions given by the geotechnical engineer's on-site representative.

Undercut and refill in soft areas consists of excavating to a depth two feet below subgrade elevation and refill should be with "Surge Rock", 6 inch minus or Number 3 stone. Undercut and refill can be kept to a minimum if construction vehicles traveling over the building pad is kept to a minimum, perhaps delineating areas where construction traffic is acceptable and areas where it is not. Control of construction traffic can prove difficult, but has been found to work in some cases.

Once necessary corrections are made, a conventionally designed slab-on-grade should perform satisfactorily. A floor slab that is structurally separated from the walls, columns and foundations is preferable, though thickened slab may be used. Separation of slab-on-grade from foundations will minimize the stress caused by possible differential settlement between the slabs and the foundations and between adjacent slabs. A vapor barrier must be incorporated into the design and at least four inches of Dense Graded Aggregate (DGA) should underlie the slab. The floor slab may be designed based on a Modulus of Subgrade Reaction of 100 pounds per cubic inch.

5.3 Site Preparation and Earthwork

The site topography is that of a ravine with relatively steep sideslopes and some soft soils at the lowest elevations. The building will probably be on a combination of cut and fill, cut extending into rock. Rock is interlayered limestone and shale that is prone to landslide.

Where fill is to be placed on existing slopes, benches will have to be cut into the rock of those slopes upon which fill may be placed. This is necessary to prevent landslide by removing any possible plane of weakness along which that landslide may develop.

Rock cut should be no steeper than ½ horizontal to one vertical and an 8 foot bench should be present between the base of the cut face and the building or any area subject to parking or pedestrian traffic. This bench is to catch rock that will fall from the rock face as it weathers.

Soil fill must be no steeper than 2 horizontal to 1 vertical in order that it remain stable. Where there is a steep angle in the slope, such as near the corner of a building or pavement corner, the slope must be no steeper than 2.5 to 1. If the slope is to be mowed with normal lawncare equipment, it should be no steeper than 3 to 1.

All fill should be placed in lifts not exceeding 8 inches in uncompacted thickness and must be compacted to at least 98 percent of the soils maximum dry density as determined by the Standard Proctor (ASTM D-698). Soil moisture content should be within 2 percent of optimum as determined from the Standard Proctor

Rock fill should only be used in the deeper cut below the parking lot and in landscape areas. It should never be used below the building or in fill slopes.

Soil from any off-site borrow sources should be tested and approved by this office prior to being used on the site. Satisfactory borrow materials are those falling in one of the following classifications: GC, SM, SC, ML, or CL. Soil types MH, CH and OH soils and peat are unsatisfactory borrow materials.

The site should be maintained in a well-drained condition both during and after construction. Site grading should provide for drainage of surface run-off away from the building and pavement.

The placement of compacted fill should be carried out by an experienced excavator with the proper materials. The excavator must be prepared to adapt his procedures, equipment and materials to the type of project, to weather conditions, and the structural requirements of the engineer. Methods and materials used in summer may not be applicable in winter; soil used in proposed fill may require wetting or drying for proper placement and compaction. Conditions may also vary during the course of a project or in different areas of this site. These needs should be addressed in the project drawings and specifications.

During freezing conditions, the fill must **not** be frozen when delivered to the site. It also must not be allowed to freeze during or after compaction. Since the ability to work the soil while keeping it from freezing depends in part on the soil type, the specifications should require the contractor to submit a sample of his proposed fill before construction starts, for laboratory testing. If the soil engineer determines that it is not suitable, it should be rejected. In general, silty sand, clayey sand, and cohesive/semi-cohesive soils should not be used as fill under freezing conditions. All frozen soil of any type should be rejected for use as compacted fill.

It is important that compacted fill be protected from freezing after it is placed. The excavator should be required to submit a plan for protecting the soil. The plan should include details on the type and amount of material (straw, blankets, extra loose fill, topsoil, etc.) proposed for use as frost protection. The need to protect the soil from freezing is ongoing throughout construction and applies both before **and** after concrete is placed, until backfilling for final frost protection is completed. Foundations placed on frozen soil can experience heaving and significant settlement, rotation, or other movement as the soil thaws. Such movement can also occur if the soil is allowed to freeze **after** the concrete is placed and then allowed to thaw. The higher the percentage of fines (clay and silt) in the fill, the more critical is the need for protection from freezing.

The contractor should be required to adjust the moisture content of the soil to within a narrow range near the optimum moisture content (as defined by the applicable Proctor or AASHTO Test). In general, fill should be placed within 2% of optimum moisture. The need for moisture control is more critical as the percentage of fines increases. Naturally occurring cohesive/semi-cohesive soil are often much wetter than the optimum. Placing and attempting to compact such soils to the specified density may be difficult. Even if compacted to the specified density, excessively wet soils may not be suitable as pavement subgrades due to pumping under applied load. This is especially true when wet cohesive/semi-cohesive soil is used as backfill in utility trenches and like situations. Excessively wet soil in thick fill sections may cause post-construction settlement beyond that estimated for fill placed at or near (±2%) the optimum moisture content.

5.4 Earth Pressures

Any retaining walls should be constructed with a drainage blanket of sand or a synthetic drainage material. Synthetic drainage media should be available from suppliers of geotextile. The wall should be drained at its base by a perforated PVC underdrain or weepholes at a spacing of not more than 10 feet. Where a relatively thin drainage blanket is used, the retaining wall should be designed based on a coefficient of active earth pressure (K_a) of 0.36 and a soil unit weight (γ_w) of 130 pounds per cubic foot. This results in an equivalent fluid pressure of 47 pounds per cubic foot. Where granular backfill completely fills the area defined by a plane extending upward from the base of the wall at a 45 degree angle, the retaining wall may be designed based on a coefficient of active earth pressure (K_a) of 0.27 and a soil unit weight (γ_w) of 130 pounds per cubic foot. This results in an equivalent fluid pressure of 35 pounds per cubic foot.

However, where the wall is restrained from movement, as in the case of building basement walls bearing against the basement slab or building frame, the wall must be designed based on the "at rest" earth pressure. The coefficient of "at rest" earth pressure (K_0) is 0.47 with a soil unit weight (γ_w) of 130 pounds per cubic foot in the case of a thin drainage blanket behind the wall, resulting in an equivalent fluid of 61 pounds per cubic foot unit weight. Where granular backfill completely fills the area defined by a plane extending upward from the base of the wall at a 45 degree angle, the retaining wall may be designed based on a coefficient of "at rest" earth pressure (K_0) of 0.43 and a soil unit weight (γ_w) of 130 pounds per cubic foot. This results in an equivalent fluid pressure of 56 pounds per cubic foot.

The table below summarizes the design earth pressures.

	Active Earth Pressure Coefficient (K_a)	Passive Earth Pressure Coefficient (K_p)	Coefficient of Earth Pressure at Rest (K_0)	Equivalent Fluid Pressure on Cantilever Walls	Equivalent Fluid Pressure on Braced Walls
Fill Material/Local Soils	0.36	2.77	0.47	47 pcf	61 pcf
Granular Backfill	0.27	3.69	0.43	35 pcf	56 pcf

Surcharge above the wall will add additional load. A uniform surcharge must be multiplied by the appropriate coefficient of earth pressure to determine the additional load applied to the wall.

Any retaining wall design must use appropriate factors of safety. It is critical that drainage be provided as mentioned earlier in this section in order to avoid hydrostatic pressure. Hydrostatic pressure would increase pressure against the wall substantially.

5.5 Light- and Heavy-Duty Pavement

Pavement subgrade should be examined and proofrolled as described under "Floor Slabs". If soft areas are encountered, the soft soils will need to be undercut and refilled in accordance with the instructions of the geotechnical engineer's on-site representative. Subgrade stabilization was discussed in section 5.2 for slab-on-grade. The same approach should be taken for pavement subgrade, but the requirement for a stable, non-yielding subgrade is even more important in the case of asphalt pavement.

A pavement analysis was conducted using a life cycle of 20 years and a cumulative 18-kip equivalent single axle load of 20,000 for light traffic loads and 80,000 for moderate traffic loads. Recommendations are provided for both flexible and rigid pavement systems. However, rigid pavement should be used in special truck traffic areas, such as those areas which receive frequent traffic by fire trucks. The concrete pavement should extend throughout the areas that require extensive turning and maneuvering of fire or other trucks like at garage entrances. Heavily loaded pavement areas that are not designed to accommodate these conditions often experience localized pavement failures, particularly if flexible pavement sections are used.

The minimum recommended thickness for both hot mixed asphalt concrete (HMAC) and reinforced Portland cement concrete (PCC) pavement sections are presented in the following table for the described light, moderate and special traffic condition.

Recommended Pavement Section

Component	Light		Moderate		Special
	Rigid	Flexible	Rigid	Flexible	Rigid
Reinforced Portland Cement Concrete (PCC)	5 inches		6 inches		7 inches
Hot Mixed Asphalt Concrete (HMAC)		3 inches		4 inches	
Crushed Limestone Base (dense graded crushed stone)	4 inches	8 inches	4 inches	8 inches	4 inches
Prepared Subgrade	6 inches	6 inches	6 inches	6 inches	6 inches

The Portland cement concrete should be air-entrained and conform to ASTM C-94 (Standard Specifications for Ready-Mixed Concrete) and have a minimum compressive strength of 4,000 pounds per square foot. Reinforcing should meet the requirements of ACI.

Hot mix asphalt concrete and dense graded crushed stone base should meet the requirements of the Ohio Department of Transportation. The top inch of asphalt should be a surface mix, the remainder being a base mix.

5.6 Temporary Earth Slopes or Cuts

Temporary earth cuts necessary to construct foundations or utility lines should be no deeper than 4 feet without benching or sloping. Cuts deeper than this should be sloped no steeper than one horizontal to one vertical or should have benches every 2 feet of height equating to this slope. If vertical faces deeper than 4 feet are used, bracing designed for short term loads may be used. Excavations should comply with OSHA regulations. If soft soils are encountered, Greenbaum Associates, Inc. should view the cut face prior to personnel entering the excavation.

5.7 Limitations

We strongly recommend that bearing surfaces and compaction be monitored by Greenbaum Associates, Inc. Our technicians will be available to further assist you in providing these and other normally specified quality control services. The report is preliminary until such time as these examinations are completed to confirm conditions consistent with those discovered in the investigation.

The conclusions and recommendations offered in this report are based on the subsurface conditions encountered in the borings. No warranties can be made regarding the continuity of conditions between or beyond borings. If, during construction, soil conditions are encountered that differ from those indicated in this report, a representative of Greenbaum Associates, Inc. should inspect the site to determining if design modification is required.

This study was directed at a specific hotel and associated pavement at this location to be constructed within a reasonably short period after this study. Once the development is better defined, a geotechnical investigation specific to that construction should be performed.

This study is directed at mechanical properties of the soils and includes no sampling, testing or evaluation for environmental considerations.

Important Information about This

Geotechnical-Engineering Report

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

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

The Geoprofessional Business Association (GBA) has prepared this advisory to help you – assumedly a client representative – interpret and apply this geotechnical-engineering report as effectively as possible. In that way, clients can benefit from a lowered exposure to the subsurface problems that, for decades, have been a principal cause of construction delays, cost overruns, claims, and disputes. If you have questions or want more information about any of the issues discussed below, contact your GBA-member geotechnical engineer. Active involvement in the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project.

Geotechnical-Engineering 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 given civil engineer will not likely meet the needs of a civil-works constructor or even a different civil engineer. Because each geotechnical-engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. *Those who rely on a geotechnical-engineering report prepared for a different client can be seriously misled.* No one except authorized client representatives should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one – not even you – should apply this report for any purpose or project except the one originally contemplated.*

Read this Report in Full

Costly problems have occurred because those relying on a geotechnical-engineering report did not read it *in its entirety*. Do not rely on an executive summary. Do not read selected elements only. *Read this report in full.*

You Need to Inform Your Geotechnical Engineer about Change

Your geotechnical engineer considered unique, project-specific factors when designing the study behind this report and developing the confirmation-dependent recommendations the report conveys. A few typical factors include:

- the client's goals, objectives, budget, schedule, and risk-management preferences;
- the general nature of the structure involved, its size, configuration, and performance criteria;
- the structure's location and orientation on the site; and
- other planned or existing site improvements, such as retaining walls, access roads, parking lots, and underground utilities.

Typical changes that could erode the reliability of this report include those that affect:

- the site's size or shape;
- 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;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the 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. *The geotechnical engineer who prepared this report cannot accept responsibility or liability for problems that arise because the geotechnical engineer was not informed about developments the engineer otherwise would have considered.*

This Report May Not Be Reliable

Do not rely on this report if your geotechnical engineer prepared it:

- for a different client;
- for a different project;
- for a different site (that may or may not include all or a portion of the original site); or
- before important events occurred at the site or adjacent to it; e.g., man-made events like construction or environmental remediation, or natural events like floods, droughts, earthquakes, or groundwater fluctuations.

Note, too, that it could be unwise to rely on a geotechnical-engineering report whose reliability may have been affected by the passage of time, because of factors like changed subsurface conditions; new or modified codes, standards, or regulations; or new techniques or tools. *If your geotechnical engineer has not indicated an "apply-by" date on the report, ask what it should be*, and, in general, *if you are the least bit uncertain* about the continued reliability of this report, contact your geotechnical engineer before applying it. A minor amount of additional testing or analysis – if any is required at all – could prevent major problems.

Most of the "Findings" Related in This Report Are Professional Opinions

Before construction begins, geotechnical engineers explore a site's subsurface through various sampling and testing procedures. *Geotechnical engineers can observe actual subsurface conditions only at those specific locations where sampling and testing were performed.* The data derived from that sampling and testing were reviewed by your geotechnical engineer, who then applied professional judgment to form opinions about subsurface conditions throughout the site. Actual sitewide-subsurface conditions may differ – maybe significantly – from those indicated in this report. Confront that risk by retaining your geotechnical engineer to serve on the design team from project start to project finish, so the individual can provide informed guidance quickly, whenever needed.

This Report's Recommendations Are Confirmation-Dependent

The recommendations included in this report – including any options or alternatives – are confirmation-dependent. In other words, *they are not final*, because the geotechnical engineer who developed them relied heavily on judgment and opinion to do so. Your geotechnical engineer can finalize the recommendations *only after observing actual subsurface conditions* revealed during construction. If through observation your geotechnical engineer confirms that the conditions assumed to exist actually do exist, the recommendations can be relied upon, assuming no other changes have occurred. *The geotechnical engineer who prepared this report cannot assume responsibility or liability for confirmation-dependent recommendations if you fail to retain that engineer to perform construction observation.*

This Report Could Be Misinterpreted

Other design professionals' misinterpretation of geotechnical-engineering reports has resulted in costly problems. Confront that risk by having your geotechnical engineer serve as a full-time member of the design team, to:

- confer with other design-team members,
- help develop specifications,
- review pertinent elements of other design professionals' plans and specifications, and
- be on hand quickly whenever geotechnical-engineering guidance is needed.

You should also confront the risk of constructors misinterpreting this report. Do so by retaining your geotechnical engineer to participate in prebid and preconstruction conferences and to perform construction observation.

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can shift unanticipated-subsurface-conditions liability to constructors by limiting the information they provide for bid preparation. To help prevent the costly, contentious problems this practice has caused, include the complete geotechnical-engineering report, along with any attachments or appendices, with your contract documents, *but be certain to note conspicuously that you've included the material for informational purposes only.* To avoid misunderstanding, you may also want to note that "informational purposes" means constructors have no right to rely on the interpretations, opinions, conclusions, or recommendations in the report, but they may rely on the factual data relative to the specific times, locations, and depths/elevations referenced. Be certain that constructors know they may learn about specific project requirements, including options selected from the report, *only* from the design drawings and specifications. Remind constructors that they may perform their own studies if they want to, and *be sure to allow enough time* to permit them to do so. Only then might you be in a position to give constructors the information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions. Conducting prebid and preconstruction conferences can also be valuable in this respect.

Read Responsibility Provisions Closely

Some client representatives, design professionals, and constructors do not realize that geotechnical engineering is far less exact than other engineering disciplines. That lack of understanding has nurtured unrealistic expectations that have resulted in disappointments, delays, cost overruns, claims, and disputes. To confront that risk, geotechnical engineers commonly include 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 personnel, equipment, and techniques used to perform an environmental study – e.g., a "phase-one" or "phase-two" environmental site assessment – differ significantly from those used to perform a geotechnical-engineering study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated subsurface environmental problems have led to project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. As a general rule, *do not rely on an environmental report prepared for a different client, site, or project, or that is more than six months old.*

Obtain Professional Assistance to Deal with Moisture Infiltration and Mold

While your geotechnical engineer may have addressed groundwater, water infiltration, or similar issues in this report, none of the engineer's services were designed, conducted, or intended to prevent uncontrolled migration of moisture – including water vapor – from the soil through building slabs and walls and into the building interior, where it can cause mold growth and material-performance deficiencies. Accordingly, ***proper implementation of the geotechnical engineer's recommendations will not of itself be sufficient to prevent moisture infiltration.*** Confront the risk of moisture infiltration by including building-envelope or mold specialists on the design team. ***Geotechnical engineers are not building-envelope or mold specialists.***

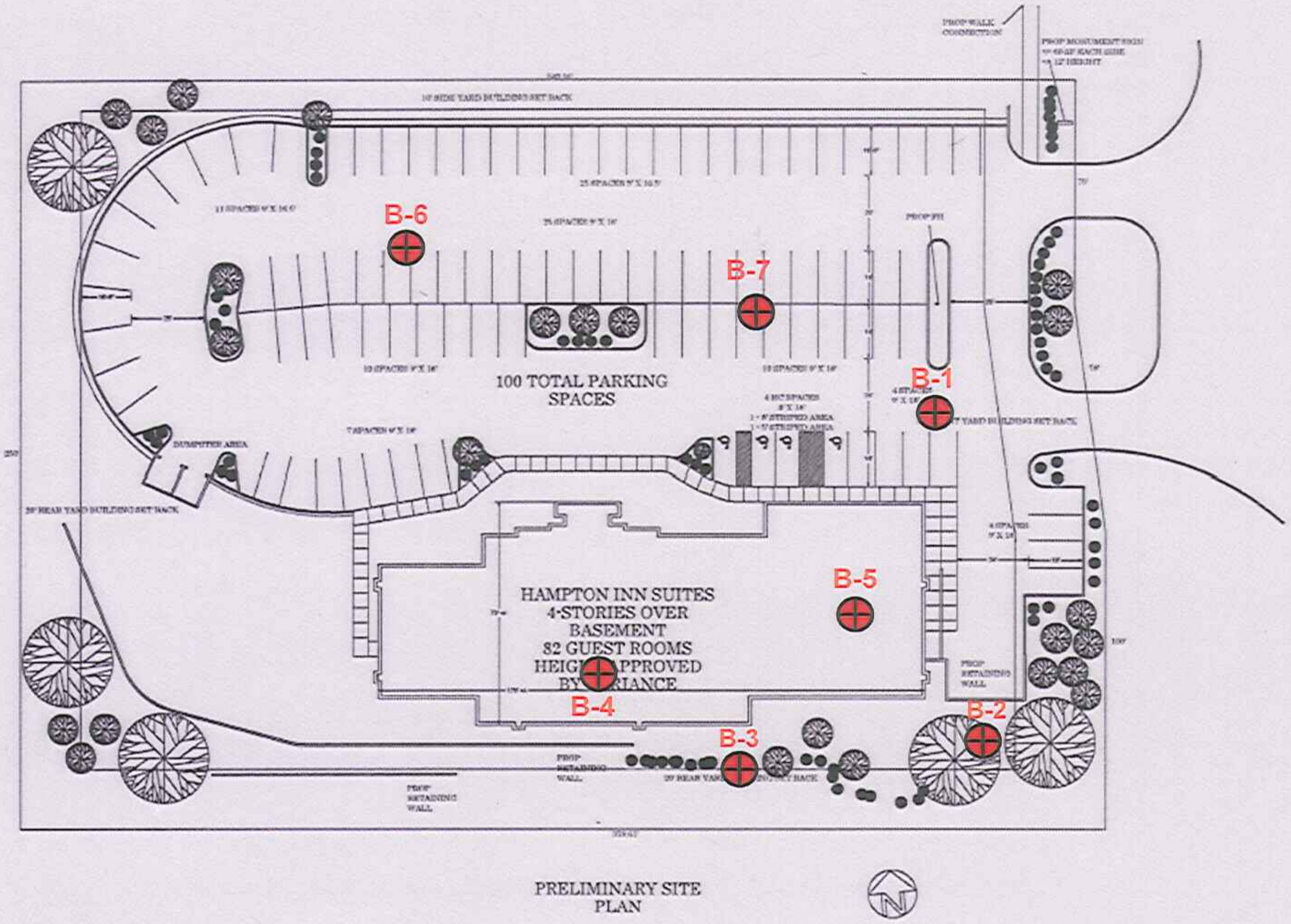
GBA
GEOPROFESSIONAL
BUSINESS
ASSOCIATION

Telephone: 301/565-2733
e-mail: info@geoprofessional.org   www.geoprofessional.org

BCD, Inc.

Greenbaum
Associates, Inc.

Site Location Plan
Hampton Inn
Old Rybolt Road, Cincinnati, Ohio
Greenbaum Project Number: 16-291G



BCD, Inc.

Greenbaum
Associates, Inc.

Boring Location Plan
Hampton Inn
Old Rybolt Road, Cincinnati, Ohio
Greenbaum Project Number: 16-291G

SOIL DESCRIPTION TERMINOLOGY

Soils are identified and classified in this report according the the Unified Classification System with the following modifiers:

RELATIVE DENSITY OF GRANULAR SOILS

Description	Blows/Foot
Very Loose	0 to 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	50 to 80
Extremely Dense	80+

CONSISTENCY OF COHESIVE SOILS

Description	N-value	q_u (tsf)
Very Soft	0 to 2	0 to 0.25
Soft	3 to 4	0.26 to 0.50
Medium Stiff	5 to 8	0.51 to 1.0
Stiff	9 to 15	1.1 to 2.0
Very Stiff	16 to 30	2.1 to 4.0
Hard	>30	4.1 to 8.0
Very Hard		8.1+

PARTICAL SIZES

Components		Size or Sieve No.
Boulders		over 12 inches
Cobbles		3 to 12 inches
Gravel -	Coarse	$^3/_4$ to 3 inches
	Fine	No. 4 to $^3/_4$ inch
Sand -	Coarse	No. 10 to No. 4
	Medium	No. 40 to No. 10
	Fine	No. 200 to No. 40
Fines (silt and clay)		Finer than No. 200

SOIL MOISTURE

	Descriptive Term
Dry	Dry of Standard Proctor Optimum
Damp	Moist (sand only)
Moist	Near Standard Proctor Optimum
Wet	Wet of Standard Proctor Optimum
Saturated	Free Water in Sample

ROCK DESCRIPTION TERMINOLOGY

The Rock Quality Determination (Deere et. Al., 1969) method of determining rock quality as reported here was obtained by summing up the total length of core recovered in each run, counting only those pieces of core which are four inches (10 cm.) in length or longer and which are hard and sound. The sum is then represented as a percentage over the length of the run. If the core is broken by handling or by the drilling process, the fresh broken pieces are fitted together and counted as one piece provided that they the requisite length of four inches (10 cm.). RQD is reported as a percentage.

RELATIONSHIP BETWEEN RQD AND ROCK QUALITY

RQD (%)	Description of Rock Quality
0 to 25	Very Poor
26 to 50	Poor
51 to 75	Fair
76 to 90	Good
91 to 100	Excellent

Greenbaum Associates, Inc.
Louisville, KY 40215 (502) 361-8447

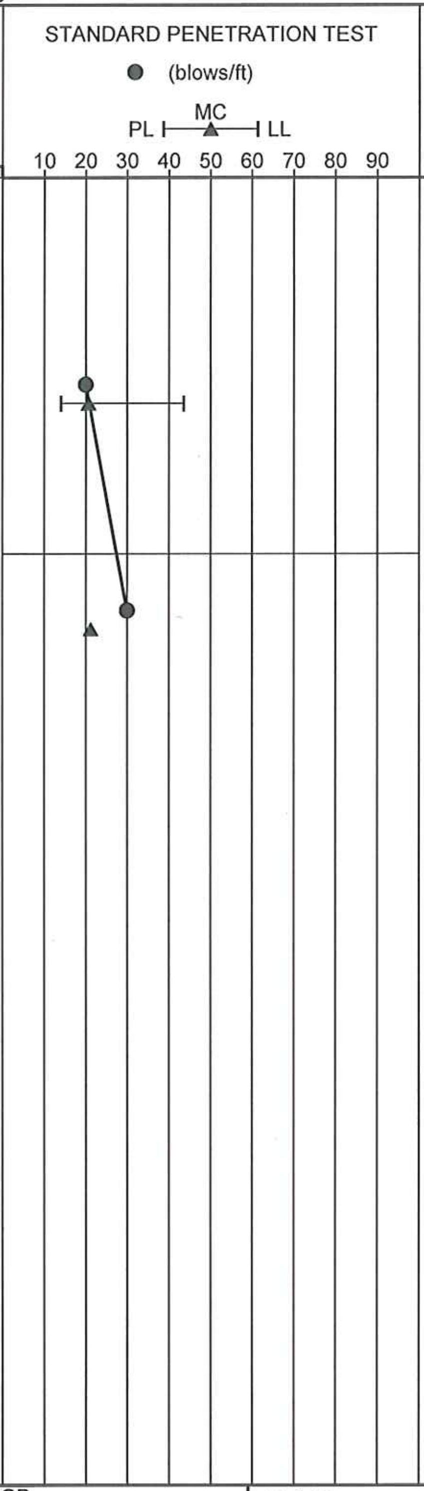
Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

HOLE No. B-1

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **7.2** Rock: **0** Total Depth: **7.2**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/15/16 - 12/15/16**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (6 inches)	OL	Ground	
					Moist, Very Stiff, Brown Lean Clay with Chert	CL		
		SPT	100					20
5		SPT	100					30
					AUGER REFUSAL @ 7.2 FEET			



SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
HQ - Rock Core, 2-1/2"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. B-1

LOG WITH WELL AND SPT GRAPH 16-291G.GPJ 08-053.GPJ 12/21/16

HOLE No. B-2

Sheet 1 of 1

Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **4** Rock: **0** Total Depth: **4.0**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/15/16 - 12/15/16**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	STANDARD PENETRATION TEST ● (blows/ft) PL ⊢ MC ▲ ⊣ LL 10 20 30 40 50 60 70 80 90	N VALUE
					Topsoil (6 inches)	OL	Ground		
					Moist, Medium Stiff, Brown Lean Clay with Limestone	CL			
		SPT	6					>>●	50/ 1"
					AUGER REFUSAL @ 4.0 FEET				

SAMPLER TYPE	
SS - Split Spoon	NX - Rock Core, 2-1/8"
ST - Shelby Tube	CU - Cuttings
HQ - Rock Core, 2-1/2"	CT - Continuous Tube

DRILLING METHOD	
HSA - Hollow Stem Auger	RW - Rotary Wash
CFA - Continuous Flight Augers	RC - Rock Core
DC - Driving Casing	

Hole No.
B-2

Greenbaum Associates, Inc.
Louisville, KY 40215 (502) 361-8447

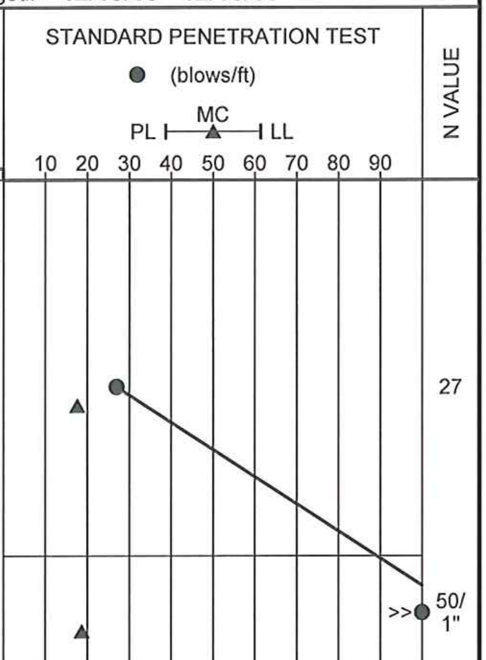
Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

HOLE No. B-3

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **7** Rock: **0** Total Depth: **7.0**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/15/16 - 12/15/16**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (6 inches)	OL	Ground	
					Moist, Hard, Brown Lean Clay with Limestone	CL		
		SPT	100					27
5		SPT	22					50/ 1"
					AUGER REFUSAL @ 7.0 FEET			



SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
HQ - Rock Core, 2-1/2"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No.
B-3

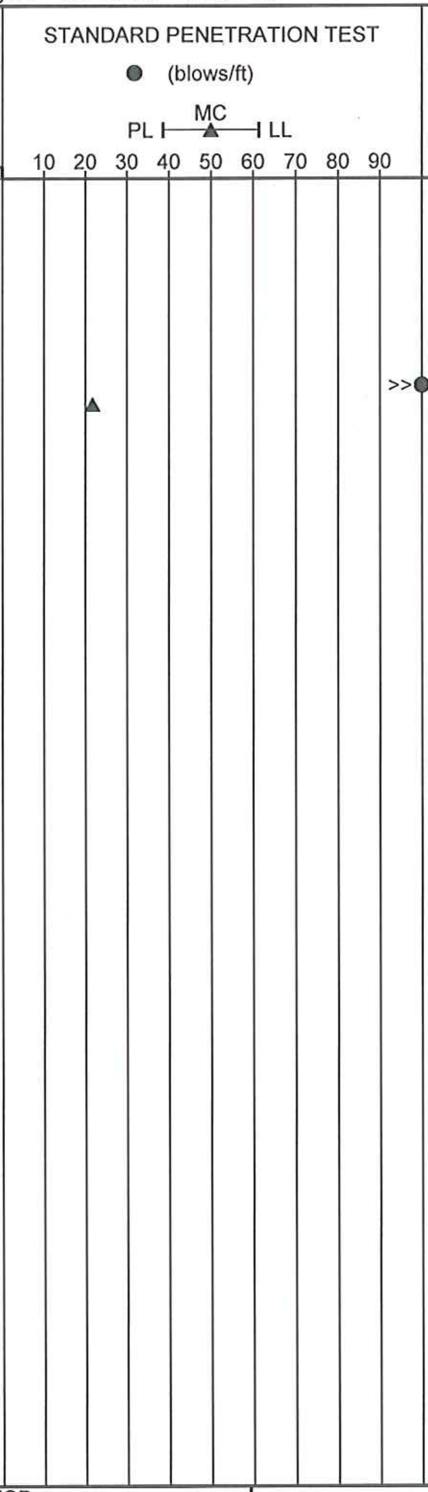
Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

HOLE No. B-4

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **3.5** Rock: **0** Total Depth: **3.5**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/16/16 - 12/16/16**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (6 inches)	OL	Ground	
					Moist, Medium Stiff, Brown Lean Clay	CL		
		SPT	67					50/ 1"
					AUGER REFUSAL @ 3.5 FEET			



SAMPLER TYPE		DRILLING METHOD		Hole No.
SS - Split Spoon	NX - Rock Core, 2-1/8"	HSA - Hollow Stem Auger	RW - Rotary Wash	
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core	
HQ - Rock Core, 2-1/2"	CT - Continuous Tube	DC - Driving Casing		B-4

Greenbaum Associates, Inc.
Louisville, KY 40215 (502) 361-8447

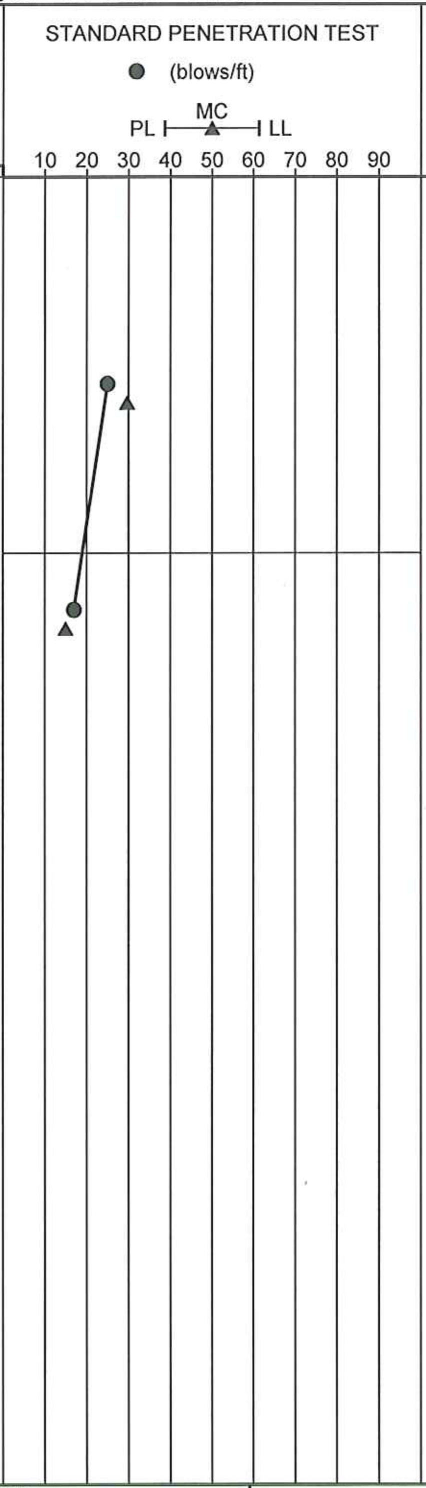
Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

HOLE No. B-5

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **7.4** Rock: **0** Total Depth: **7.4**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/16/16 - 12/16/16**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (6 inches)	OL	Ground	
	▨				Moist, Stiff, Brown Lean Clay	CL		
	▨	SPT	25					25
5	▨							
	▨	SPT	67					17
					AUGER REFUSAL @ 7.5 FEET			



SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
HQ - Rock Core, 2-1/2"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No. **B-5**

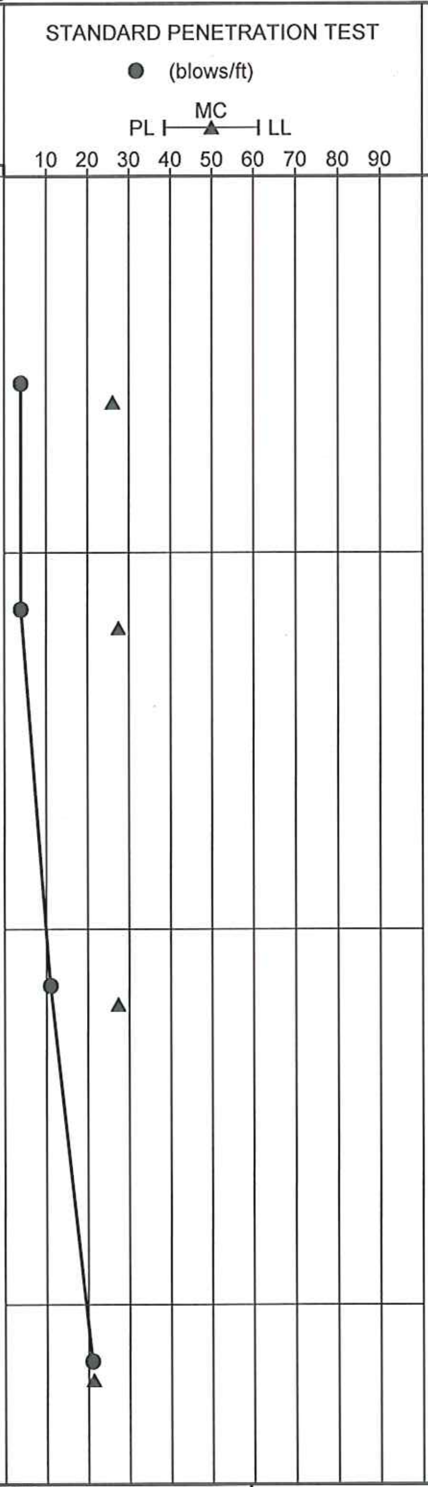
Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

HOLE No. B-6

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **16.5** Rock: **0** Total Depth: **16.5**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/16/16 - 12/16/16**

DEPTH (feet)	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
				Topsoil (6 inches)	OL	Ground	
				Moist, Soft, Brown Lean Clay	CL		
	SPT	25					4
5				Moist, Stiff, Gray Lean Clay	CL		
	SPT	100					4
10	SPT	100					11
				Moist, Very Stiff, Brown Lean Clay	CL		
15	SPT	100					21
				TERMINATED @ 16.5 FEET			



SAMPLER TYPE		DRILLING METHOD	
SS - Split Spoon	NX - Rock Core, 2-1/8"	HSA - Hollow Stem Auger	RW - Rotary Wash
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core
HQ - Rock Core, 2-1/2"	CT - Continuous Tube	DC - Driving Casing	

Hole No. **B-6**

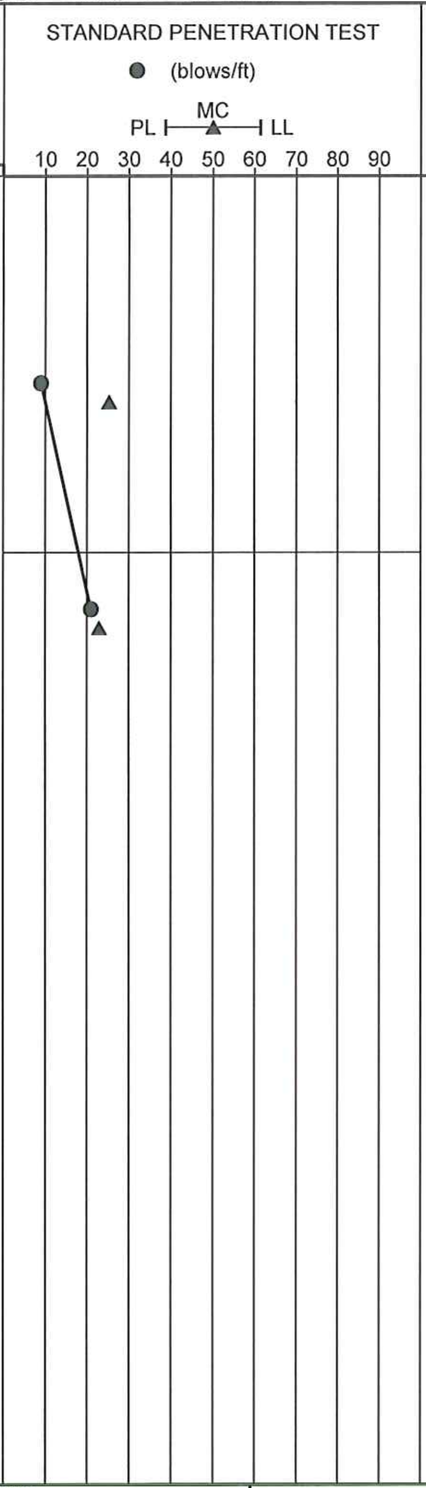
Client: BCD, Inc.
Project: Hampton Inn, Old Rybolt Road, Cincinnati, Ohio
Project No.: 16-291G

HOLE No. B-7

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **CME-55 with Automatic Hammer** Drilling Method: **3 1/4 Inch Hollow Stem Auger**
Depth to water immediately: **Dry** Overburden: **9** Rock: **0** Total Depth: **9.0**
Logged By: **S. Greenbaum** Driller: **M. Wells** Date Logged: **12/15/16 - 12/15/16**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION	ELEVATION (feet)	N VALUE
					Topsoil (6 inches) OL	Ground	
					Moist, Very Stiff, Brown Lean Clay with Chert CL		
		SPT	100				9
5							
		SPT	100				21
					AUGER REFUSAL @ 9.0 FEET		



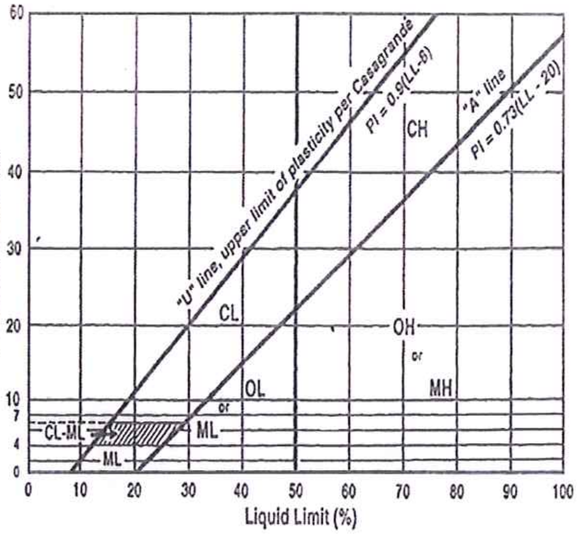
SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
HQ - Rock Core, 2-1/2"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

DRILLING METHOD
HSA - Hollow Stem Auger
CFA - Continuous Flight Augers
DC - Driving Casing
RW - Rotary Wash
RC - Rock Core

Hole No.
B-7

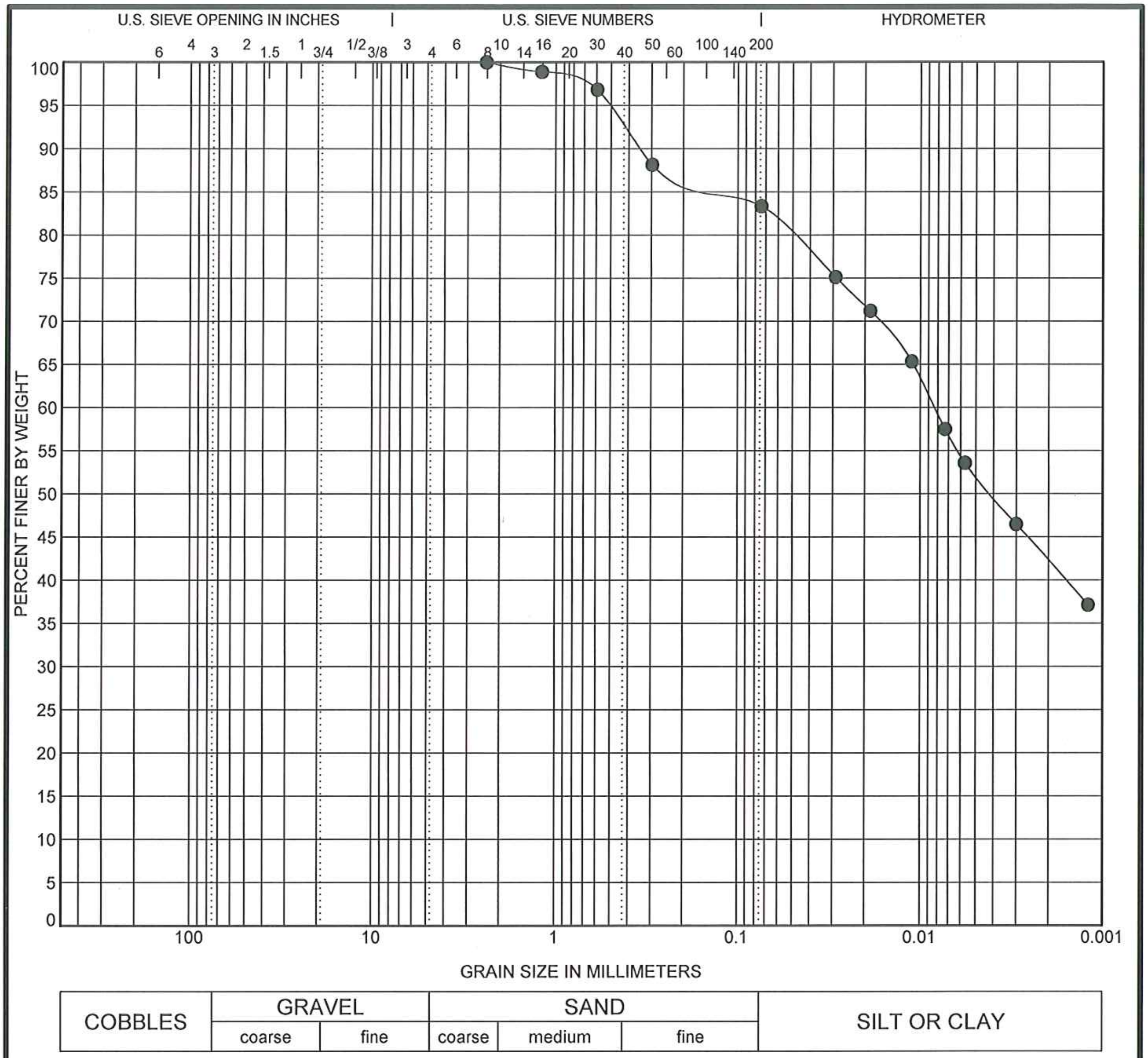
CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES

ASTM D2487 and D2488

Major Divisions			Group Symbols		Typical Names	Laboratory Classification Criteria		
Coarse-grained soils (More than half of material is *larger* than No. 200 sieve size)	**Gravels** (More than half of coarse fraction larger than No. 4 sieve size)	**Clean Gravels** (Little or no fines)	**GW**		Well-graded gravels, gravel-sand mixtures, little or no fines	Determine percentages of sand and gravel from grain-size curve. Depending on percentage of fines (fraction smaller that No. 200 sieve size), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent *Borderline* cases requireing dual symbols[b]	C_u=D_{60}/D_{10} greater than 4 C_u=$(D_{30})^2/(D_{10}\times D_{60})$ between 1 and 3	
			GP		Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting all gradation requirements for GW	
		Gravels with fines (Appreciable amount of fines)	**GM**[a]	d	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below "A" line with P. I. less than 4	Above "A" line with P. I. between 4 and 7 are *borderline* cases requireing us of dual symbols
				u				
			GC		Clayey gravels, gravel-sand-clay mixtures		Atterberg limits below "A" line with P. I. greater than 7	
	Sands (More than half of coarse fraction is smaller than No. 4 sieve size)	**Clean Sands** (Little or no fines)	**SW**		Well-graded sands, gravelly sands, little or no fines		C_u=D_{60}/D_{10} greater than 6 C_u=$(D_{30})^2/(D_{10}\times D_{60})$ between 1 and 3	
			SP		Poorly graded sands, gravelly sands, little or no fines		Not meeting all gradation requirements for SW	
		Sands with fines (Appreciable amount of fines)	**SM**[a]	d	Silty sands, sand-silt mixtures		Atterberg limits above "A" line or P.I. < 4	Limits plotting in hatched zone with P.I. between 4 and 7 are *borderline* cases requireing use of dual symbols
				u				
			SC		Clayey sands, sand-clay mixtures		Atterberg limits above "A" lime with P.I. > 7	
Fine-grained soils (More than half meterial is smaller than No. 200 sieve)	Silts and clays (Liquid limit less than 50)		**ML**		Inorganic silts and very fine sands, silty or clayey fine sands, or clayey silts with slight plasticity	 Plasticity Chart		
			CL		Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays			
			OL		Organic silts and organic siltyclays of low plasticity			
	Silts and clays (Liquid limit less that 50)		**MH**		Inorganic silts, micaceous or diatomaceous fine sand or silty soils, elastic silts			
			CH		Inorganic slays of high plasticity, fat clays			
			OH		Organic clays of medium to high plasticity, organic silts			
	Highly organic soils		**Pt**		Peat and other highly organic soils			

[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits :suffix d used when L. L. is 28 or less and the P. I. is 6 or les; the suffix u used when L. L. is greater than 28.

[b] Borderline classifications, used for soils possessing characeristics of two groups, are sesignated by combinations of group symbols. For exampls: GW-GC, well-graded gravel-sand misture with clay binder.



	Specimen Identification		Classification	LL	PL	PI	Cc	Cu
●	**B-1**	**3.0**	**LEAN CLAY with SAND(CL)**	**44**	**14**	**30**		

	Specimen Identification		D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-1**	**3.0**	**2.38**	**0.008**			**0.0**	**16.6**	**31.3**	**52.1**

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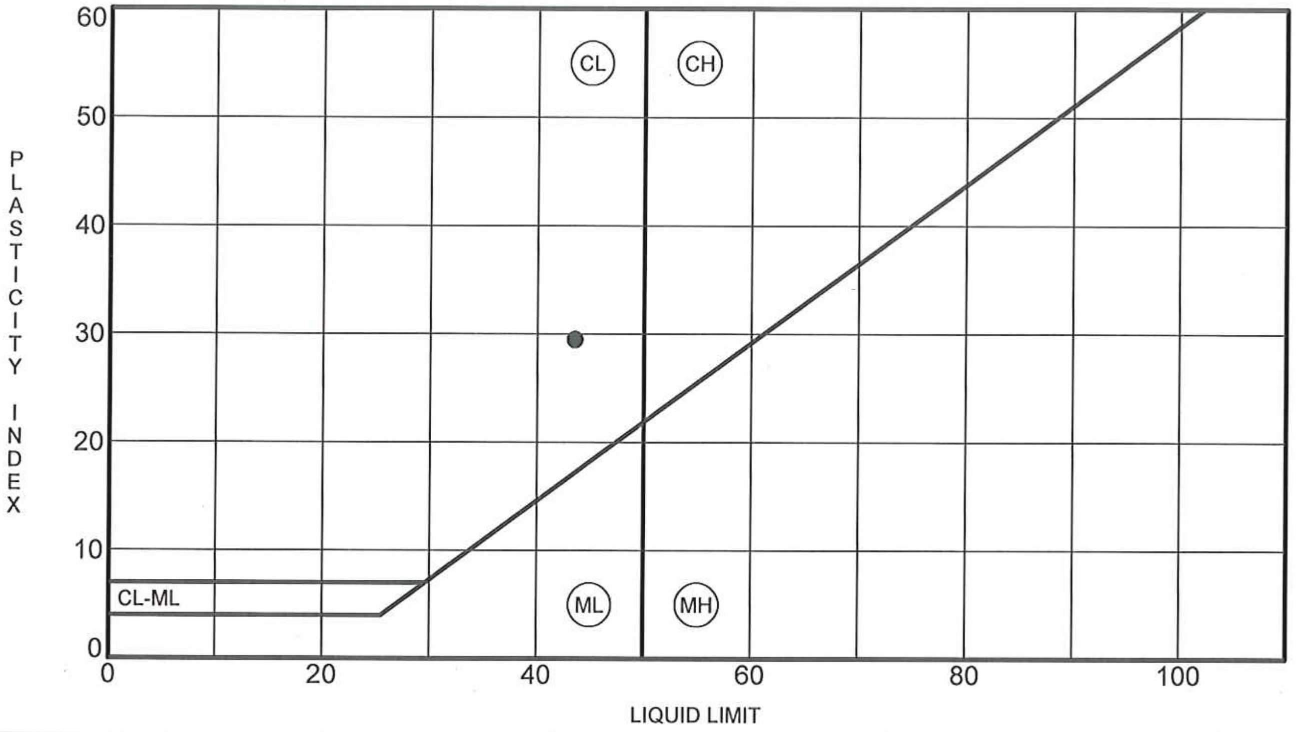
5028360739

GRAIN SIZE DISTRIBUTION

Project: Hampton Inn,

Location: Old Rybolt Road, Cincinnati, Ohio

Number: 16-291G



	Specimen Identification	LL	PL	PI	Fines	Classification
●	**B-1 3.0**	**44**	**14**	**30**	**83**	**LEAN CLAY with SAND(CL)**

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5028360739

ATTERBERG LIMITS' RESULTS

Project: Hampton Inn,

Location: Old Rybolt Road, Cincinnati, Ohio

Number: 16-291G