GREENBAUM ASSOCIATES, INC.
GEOTECHNICAL & MATERIALS ENGINEERS
994 Longfield Avenue
Louisville, Kentucky 40215
502/361-8447
FAX 502/361-4793

March 14, 2022

Mr. Moshe Herskovich
Saint Anthony Gardens P2 LLC
1 Hillcrest Center Drive, Suite 232
Spring Valley, NY 10977

**SUBJECT: GEOTECHNICAL INVESTIGATION
MULTI-FAMILY RESIDENTIAL DEVELOPMENT
2900 FORDHAVEN ROAD
LOUISVILLE, KENTUCKY
GREENBAUM PROPOSAL 22-008G**

Dear Mr. Herskovich:

Attached is the report of the geotechnical investigation that we carried out for the above referenced multi-family residential development. This building may be supported on soil-bearing, spread footings. However, the shallow soils at this site are wet and loose. It is likely that chemical stabilization of the subgrade will be required prior to placement of fill. If earthwork is to occur other than during summer, lime drying of soil may be necessary. Also, retaining walls will need to be founded on the shale that is present at this site to prevent landslide. Further detail on foundations and other geotechnical considerations are provided in the body of the attached report.

If you have any questions regarding this report, please call.

Sincerely,

GREENBAUM ASSOCIATES, INC.

Sandor R. Greenbaum

Sandor R. Greenbaum, P.E.
Principal Engineer

RECEIVED
APR 18 2022
PLANNING & DESIGN
SERVICES

21-CAT3-0021

GEOTECHNICAL INVESTIGATION

FOR

MULTI-FAMILY RESIDENTIAL DEVELOPMENT

2900 FORDHAVEN ROAD

LOUISVILLE, KENTUCKY

FOR

SAINT ANTHONY GARDENS P2 LLC

1 HILLCREST CENTER DRIVE, SUITE 232

SPRING VALLEY, NY 10977

BY

GREENBAUM ASSOCIATES, INC.

994 LONGFIELD AVENUE

LOUISVILLE, KY 40215

MARCH 17, 2022

SANDOR R. GREENBAUM
15067

Table of Contents

APPENDIX

1.0 Introduction

Saint Anthony Gardens P2 LLC intends to build a new multi-family residential development on a 13.37± tract of vacant land located at 2900 Fordhaven Road in Louisville, Kentucky. This is a hillside slope, sloping upward from Fordhaven Road with much of the site being wooded. This housing development, as proposed, will consist of a nine two-story, 16-unit residential buildings, each 17,286 square feet, plus a gym and a pool. A boring location plan is included in the appendix of this report that shows the approximate locations of the borings and the proposed site development. A site location plan is also included in the appendix of this report.

We were contracted by Saint Anthony Gardens P2 LLC to carry out a geotechnical investigation directed at determining the foundation support characteristics of the materials upon which these residential buildings and associated pavement will be supported. Work was coordinated through Mr. Moshe Herskovich with Saint Anthony Gardens P2 LLC.

2.0 General Geology

Soils at this site are shown by the Kentucky Geological Survey to be covered by loess except in the far northeast corner where soils are mapped as alluvium. The Geological Survey describes loess as:

> Silt and minor sand, light olive gray, calcareous where fresh; weathers yellowish brown to grayish brown, light brown to medium yellowish orange, non-calcareous; small irregular calcareous concretions locally abundant near base. Exposures below elevation of 500 feet locally include interbeds of quartzose, silty, crossbedded fluvial and eolian sand; grains are very fine to fine, subangular to subrounded. Loess mantles most of upland area, is thickest near base of slopes bordering Ohio River valley, particularly at mouth of Big Run valley and on some east facing slopes, indicating deposition mainly by westerly wind. Erosion on many steep slopes has exposed small patches of bedrock that were not mapped; where bedrock patches are numerous, loess was not mapped. Areas mantled by thick loess coincide generally with distribution of Memphis and Loring soils as shown on the soils map of Jefferson County; in areas underlain by Memphis and Loring soils, loess is 42 inches thick or more.

The Geological Survey describes alluvium as:

> Silt, clay, sand, and gravel, grayish brown to moderate-yellowish-brown. Silt, clay and sand as a 10- to 30-foot-thick veneer along the Ohio River; silt, sand, and gravel of local origin along smaller streams; gravel chiefly pebbles of chert and iron cemented siltstone; siltstone cobbles abundant in alluvium of streams that drain knobs of Mississippian bedrock. Soils developed on this unit include Huntington, Newark, Melvin, and Lindside Series.

Bedrock at this site is shown to be the Borden Formation except in the far southwest corner of the site where the Kenwood Siltstone is present near the top of the hill. The Kentucky Geological Survey describes the New Providence Shale, which makes up the bulk of the Borden Formation, as:

> Clay shale and minor limestone: Clay shale, silty, olive gray to grayish green, weathers yellowish gray to light greenish gray; locally iron stained; contains scattered light brown to dark yellowish brown ellipsoidal ironstone concretions, commonly 4 inches across and as much as one foot long, particularly abundant along bedding planes within 70 feet below Kenwood Siltstone Member. Unit micaceous, illitic, plastic when wet. Clay filled worm(?) trails common, resemble Scalarituba missouriensis Weller. Crinoids, brachiopods, corals, pelecypods, gastropods, bryozoans, trilobites, and cephalopods rare to abundant in scattered thin limestone lenses 80 to 100 feet below the Kenwood. Limestone commonly underlain by persistent bed of concretionary siderite with double cone in cone structure; concretions are pale to grayish brown in middle with a dark-yellowish orange rind: bed exposed on lower northwestern part of Kenwood Hill nearly due west of north end of hilltop. An upper tongue 0 to 55 feet thick is separated from main unit by the Kenwood in southwestern part of area. Base of unit distinct; where exposed, base is marked by persistent zone of brownish gray phosphatic nodules and scattered glauconite, except at two localities where underlain by Rockford Limestone.

3.0 Investigation

Nine borings were carried out across the site by standard penetration procedures to 15 feet depth or auger refusal. A Diedrich D-25 track-mounted drill rig was used to carry out the borings through the use of 2 ¼-inch inside diameter hollow stem augers and an automatic hammer. The boring locations were staked using a 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 a natural moisture determination.

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. In this case only the sieve analysis portion of the test was performed since little sand and silt was present in the soil samples selected for testing.

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

Much of this site is covered by 6- to 10-inches of topsoil. The uppermost soil is loess consisting of moist, very loose to loose, brown, silt. Below the three buildings at the front of the site this loess extends the full 15 feet of the borings, generally becoming medium dense to dense below about 6 feet depth. Groundwater was encountered at about 3.5- to 8.5-feet depth in these borings, but bedrock was not encountered above the 15-foot termination depth.

Further back on the site where the site is rising toward the more steeply sloping rear of the site, New Providence Shale was encountered at 6- to 10-feet depth. The borings at the higher elevations did not encounter groundwater, but boring B-5 found groundwater at 9 feet depth

The table below provides a tabulation of N-values as measured by the standard penetration test, corrected for the energy of the automatic hammer, along with depth to auger refusal, where encountered.

Depth	B-01	B-02	B-03	B-04	B-05	B-06	B-07	B-08	B-09	B-10	B-11
1 – 2.5 feet	4	10	3	4	7	4	7	3	7	4	9
3.5 – 5 feet	8	7	7	18	5	18	9	16	12	9	16
6 – 7.5 feet	14	5	29	20	9	20	23	31	33	22	20
8.5 – 10 feet	13	7	20	16	8	16	18	21	40	20	4
13.5 – 15 ft.	21	7	42	53		53	50/5"	50/5"	50/5"	50/4"	50/5"
Auger Refusal								14.5'	14.5'	14.5'	14.5'

4.2 Laboratory Results

A sample of soil from shallow depth was tested and classified and was found to be silt. The result of this testing is summarized in the table that below with more detailed results provided in the appendix of this report. Moisture content is shown graphically on the boring logs.

Soil Sample	Grain Size Distribution			Atterberg Limits			Soil Classification	
	Percent Sand	Percent Silt	Percent Clay	Liquid Limit	Plastic Limit	Plasticity Index	Unified	AASHTO
B-2 @ 1′ – 2.5′	3	72	24	29	29	NP	ML	A-4

4.3 Historic Aerial Photographs

Aerial photographs dating back to 1985, available on Google Earth, were examined. The 1985 photograph was of such a scale that the site was not discernable in any detail. The next photograph, taken in 1992, has several structures near the center of the property, possible a residence and storage buildings/barns. In the 1998 and 2002 images only one of the structures remain. In later photographs, no structures remain.

4.4 Seismicity

By the 2018 edition of the Kentucky/2015 International Building Code, this is a Stiff Soil Profile, Site Class D. The Spectral Response Acceleration Coefficients, for this area, as provided by U.S.G.S., FEMA Design Parameters are:

$S_S = 0.213$ g $S_{MS} = 0.256$ g $S_{DS} = 0.171$ g

$S_1 = 0.109$ g $S_{M1} = 0.184$ g $S_{D1} = 0.123$ g

5.0 Recommendations

5.1 Foundations

The proposed buildings 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 2,000 pounds per square foot.

Structures were once present near the center of this site. Any foundations that remain must be removed in their entirety below the footprint of the new building. Foundations may remain below pavement and landscape areas if they are removed to below the level of pavement subgrade. If a basement or cellar is present, the walls will have to be removed consistent with the previous discussion. Any uncontrolled fill within an abandoned basement or cellar will have to be removed and it will be necessary to perforate the basement slab on a four-foot grid pattern or the slab may be removed in its entirety to allow drainage. Then the basement should be refilled with engineered fill, free of debris, in accordance with criteria provided in section 5.3 of this report.

Once foundation bearing surfaces are exposed, an engineer or senior engineering technician from this office should be present to view all bearing surfaces to determine the presence of soft soils. Where 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 (fc′ = 2,000 psi) or open-graded stone such as Number 57 stone. Soft areas where undercut and refill will be required should be expected since the boring found areas of soft soil. Areas of soft soil at the foundation bearing level are expected.

Soil bearing foundations exposed to weather 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.

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 or loose soil. If soft or loose 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 up to two feet below subgrade elevation and refill should be with "Surge Rock", 6-inch minus or Number 3 stone. Large rock should not be used in areas where trenching will be required to install piping or conduit.

A slab-on-grade 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 75 kips per cubic foot.

5.3 Site Preparation and Earthwork

Prior to fill placement all vegetation and topsoil (soil containing more than 4 percent organic content) must be removed from below the area to be filled. Where trees or bushes have been present, the entire rootball should be removed and the resulting excavation should be refilled with soil compacted as described in this section of the report. Then, prior to placement of fill, the exposed subgrade should be proofrolled by a fully loaded tri-axle truck to delineate any yielding or rutting areas that may require treatment such as undercut and refill or drying.

The uppermost 3 feet plus/minus of soil at this site is soft and wet. I is likely that the site will need to be stabilized by placement of a bridging coarse of rock or through the used of chemical stabilization by means of the addition of Portland Cement to these silty soils. Given the size of this project, cement stabilization is likely to be more cost-effective than placement of stone, unless the site requires import. Shallow soils from the borrow area are also likely to be wet, but these can be dried if the work is to be performed in the summer. If the work is to be performed on other than the summer, lime drying may be necessary.

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.

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 proposed 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

A retaining wall is planned for the rear of the site to support the hillside with the buildings at the rear of the site being in cut. This retaining wall or walls will need to be founded on New Providence shale. Hillsides in this area are subject to landslide along the surface of the shale, therefore the need to place the wall foundation directly on the shale bedrock. If the wall is to be a mechanically stabilized earth (MSE) wall, the shale will need to be benched to accommodate the full length of the geogrid reinforcement. The design of the wall will need to take into account the slope behind the wall.

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_o) 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_o) 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_o)	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. Since the soils at this site are silt, these soils are subject to softening when exposed to moisture. Chemical stabilization of soils was discussed in section 5.3 of this report, but this may become necessary for pavement subgrade or it may require extensive undercut and refill.

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 160,000 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 garbage trucks. The concrete pavement should extend throughout the areas that require extensive turning and maneuvering of garbage trucks or other heavy trucks. 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 table below 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 (INDOT Number 53 Stone)	4 inches	8 inches	4 inches	8 inches	4 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 inch. Reinforcing should meet the requirements of ACI.

Hot mix asphalt concrete and Number 53 Stone should meet the requirements of the Indiana Department of Transportation. The top inch and a half 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. Excavations must comply with OSHA regulations.

5.7 Limitations

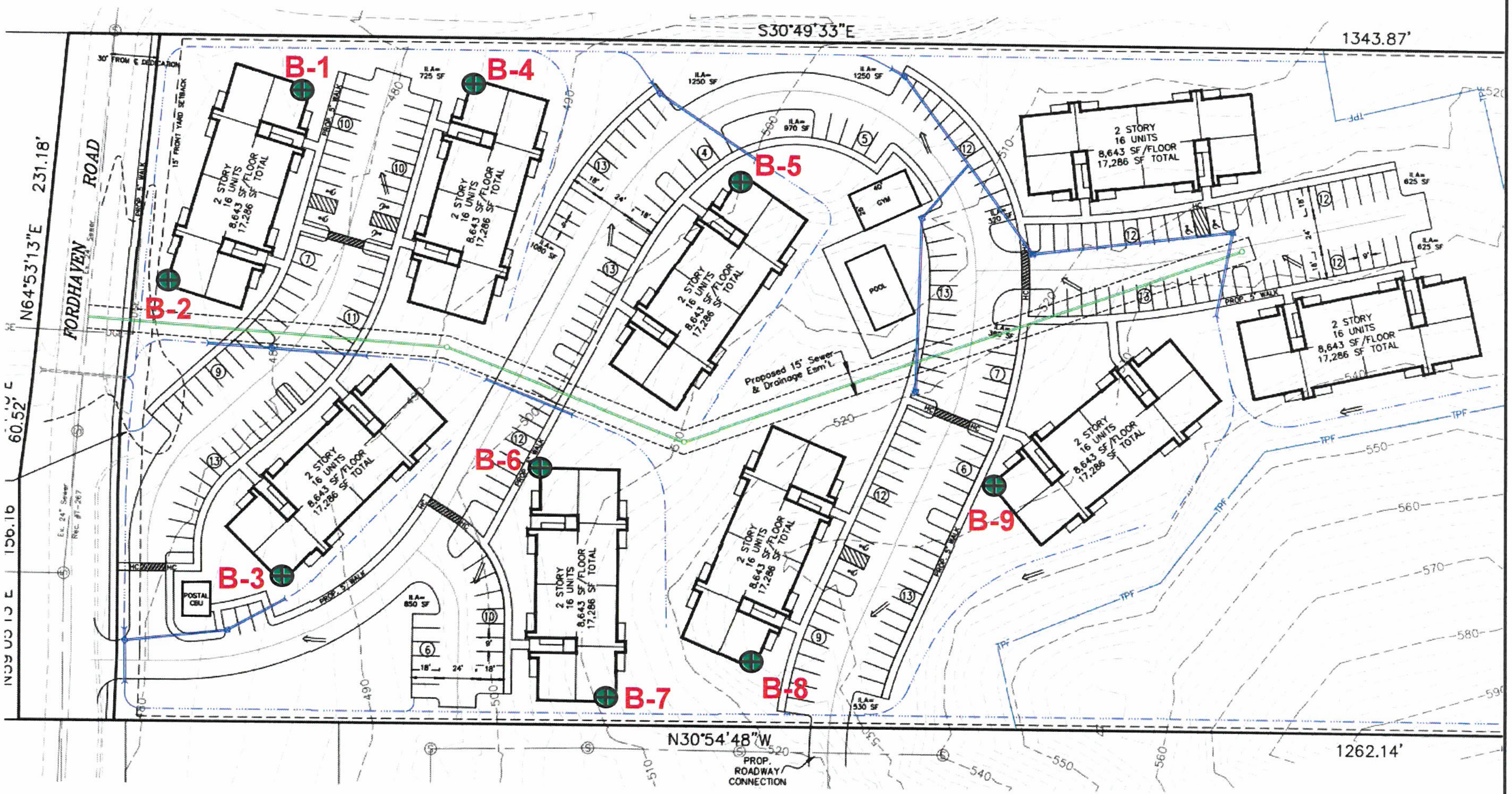
We strongly recommend that bearing surfaces and compaction be monitored by Greenbaum Associates, Inc. Our technicians will be available to further assist you in providing these and other normally specified quality control services. The report is preliminary until such time as these examinations are completed 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 specific multi-family residential buildings and associated pavement at specific locations on this site to be constructed within a reasonably short period after this study. Use for any other location, structures or substantial changes in construction period may invalidate the recommendations. The geotechnical engineer should be consulted relative to any substantial change in these.

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

St. Anthony Groups **P2, LLC**	Greenbaum Associates, Inc.	**Site Location Plan** Proposed Apartment Complex 2900 Fordhaven Road, Louisville, KY Greenbaum Project Number: 22-008G



St. Anthony Gardens
P2, LLC

Greenbaum
Associates, Inc.

Boring Location Plan
Multi-Family Residential Development
2900 Fordhaven Road, Louisville, KY
Greenbaum Project Number: 22-008G

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	5 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51 to 80
Extremely Dense	81+

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

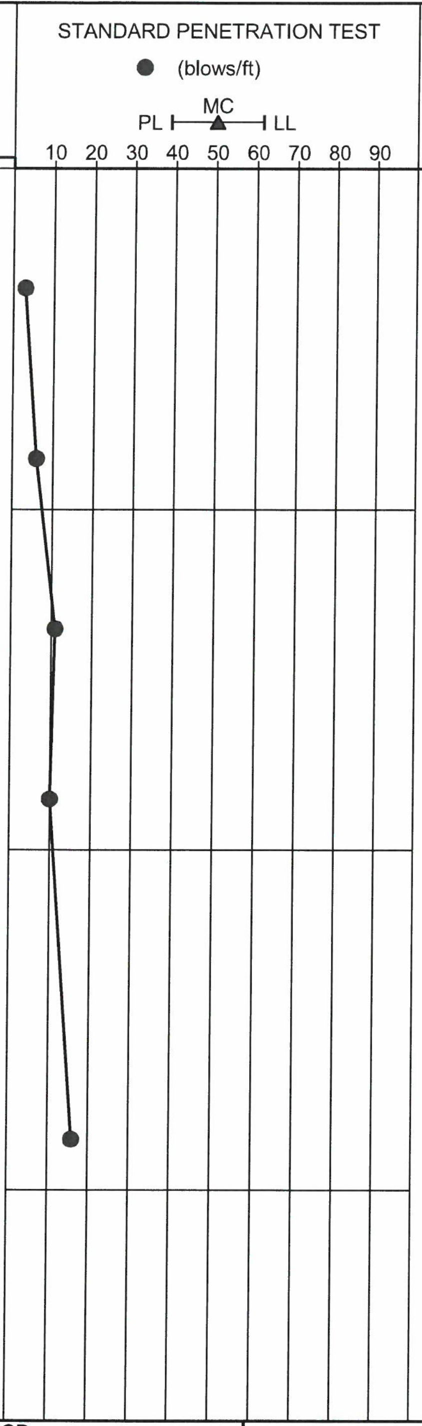
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-1

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **8.0** Overburden: **15** Rock: **0** Total Depth: **15.0**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (10 inches)	OL	Ground	
		SPT			Moist, Very Loose, Brown, Silt	ML		3
5		SPT			Same, Loose	ML		6
		SPT			Same, Medium Dense	ML		11
10		SPT					∇	10
15		SPT			Same, Brown and Gray Mottled	ML		16
					TERMINATED @ 15.0 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-1**

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

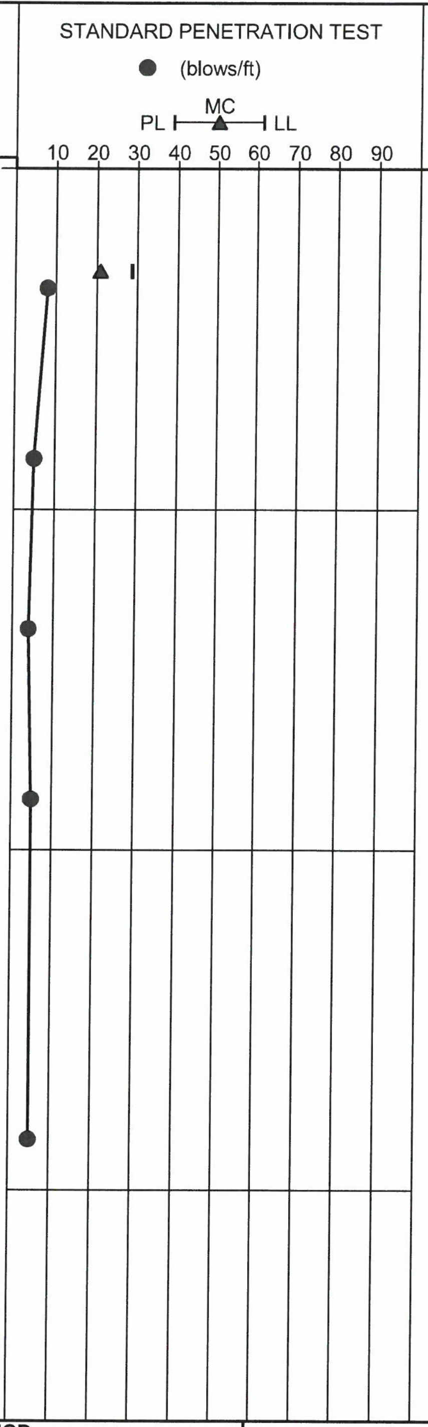
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-2

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **8.5** Overburden: **15** Rock: **0** Total Depth: **15.0**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (8 inches)	**OL**	Ground	
					Moist, Loose, Brown, Silt	**ML**		
		SPT						8
		SPT						5
5								
					Same, Brown and Gray Mottled	**ML**		
		SPT						4
					Same, Wet	**ML**	▽	
		SPT						5
10								
		SPT						5
15					TERMINATED @ 15.0 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-2

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

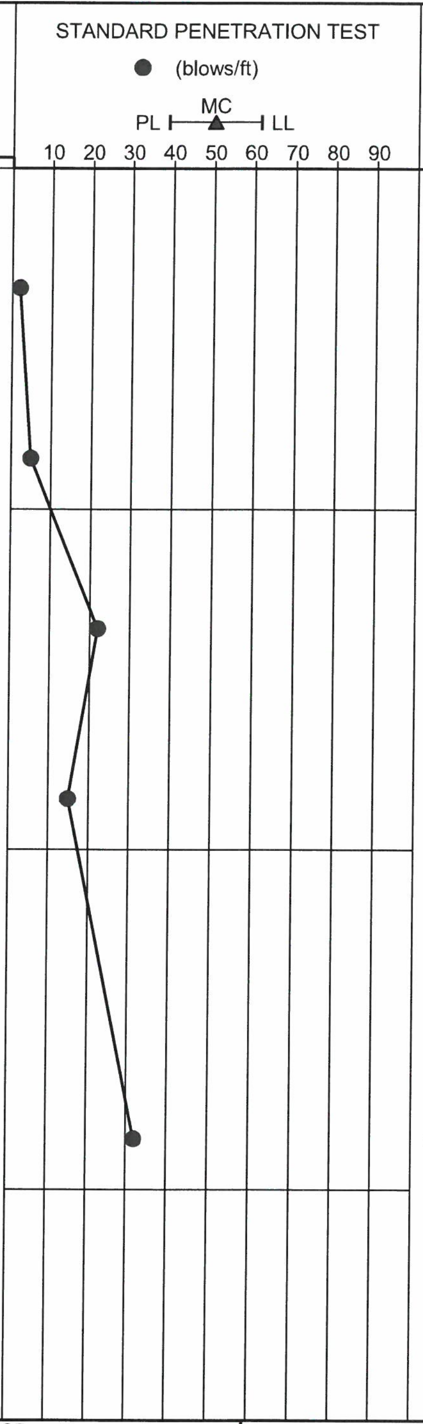
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-3

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **3.5** Overburden: **15** Rock: **0** Total Depth: **15.0**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (10 inches)	OL	Ground	
		SPT			Moist, Very Loose, Brown, Silt	ML		2
		SPT			Same, Loose	ML	▽	5
5								
		SPT			Same, Medium Dense, Brown and Gray Mottled	ML		22
		SPT			Same, Gray	ML		15
10								
		SPT			Same, Dense	ML		32
15					TERMINATED @ 15.0 FEET			



SAMPLER TYPE		DRILLING METHOD		Hole No.
SS - Split Spoon	NX - Rock Core, 2-1/8"	HSA - Hollow Stem Auger	RW - Rotary Wash	B-3
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core	
HQ - Rock Core, 2-1/2"	CT - Continuous Tube	DC - Driving Casing		

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

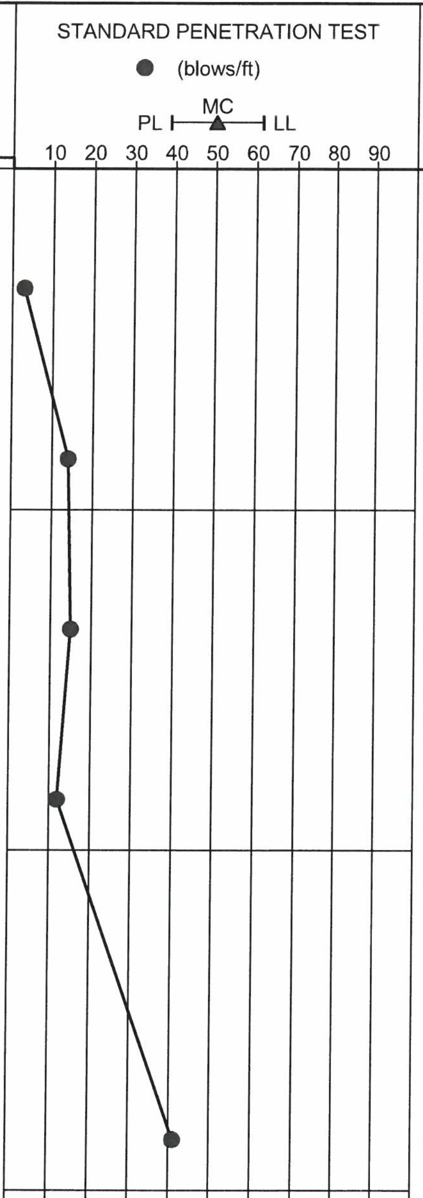
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-4

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **8.5** Overburden: **15** Rock: **0** Total Depth: **15.0**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (8 inches)	**OL**	Ground	
		SPT			Moist, Very Loose, Brown, Silt	**ML**		3
5		SPT			Same, Medium Dense	**ML**		14
		SPT			Same, Brown and Gray Mottled	**ML**	∇	15
10		SPT						12
		SPT			Same, Dense	**ML**		41
15					TERMINATED @ 15.0 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-4

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

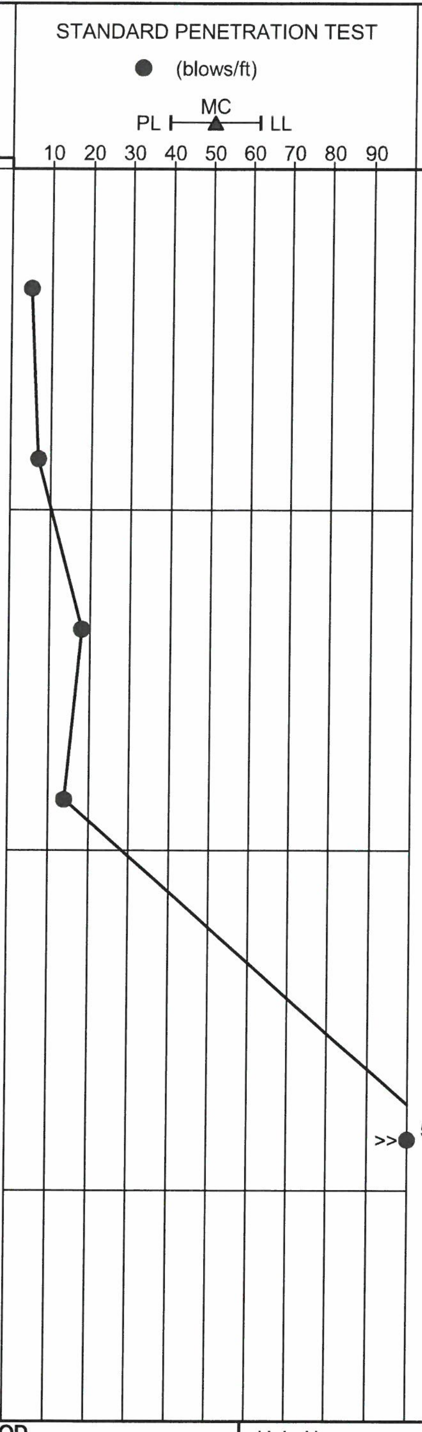
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-5

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **9.0** Overburden: **15** Rock: **0** Total Depth: **15.0**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
				Topsoil (6 inches)	OL	Ground	
				Moist, Loose, Brown, Silt	ML		
	SPT						5
	SPT						7
5							
	SPT						18
				Same, Medium Dense, Brown and Gray Mottled, with Weathered Shale	ML		
						∇	
	SPT						14
10							
	SPT						50/ 5"
15				TERMINATED @ 15.0 FEET			



SAMPLER TYPE		DRILLING METHOD		Hole No.
SS - Split Spoon	NX - Rock Core, 2-1/8"	HSA - Hollow Stem Auger	RW - Rotary Wash	B-5
ST - Shelby Tube	CU - Cuttings	CFA - Continuous Flight Augers	RC - Rock Core	
HQ - Rock Core, 2-1/2"	CT - Continuous Tube	DC - Driving Casing		

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

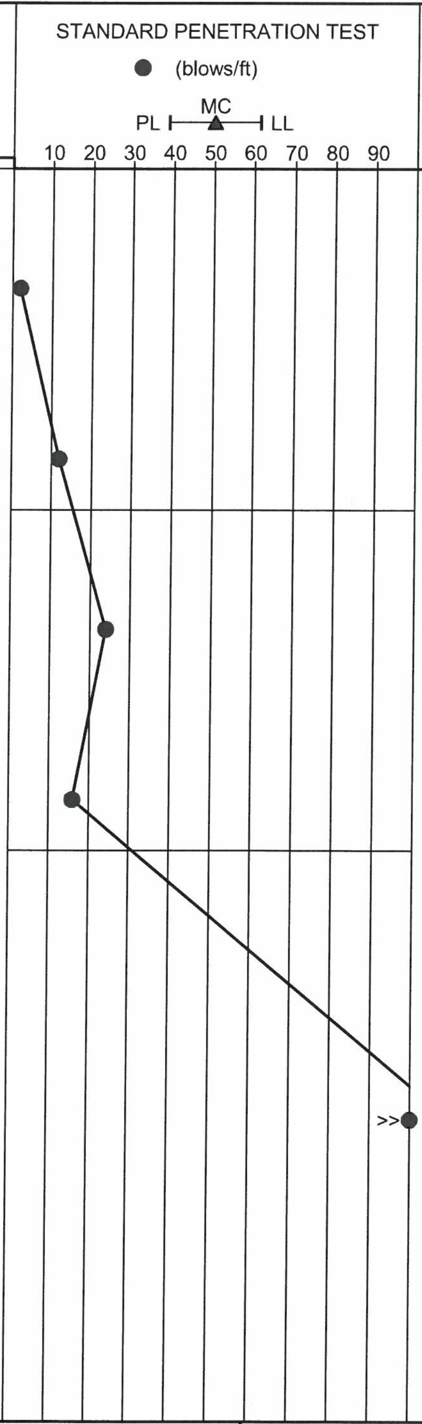
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-6

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **Dry** Overburden: **14.5** Rock: **0** Total Depth: **14.5**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
				Topsoil (6 inches)	**OL**	Ground	
				Moist, Very Loose, Brown, Silt	**ML**		
	SPT						2
				Same, Medium Dense	**ML**		
	SPT						12
5							
	SPT						24
				Gray, Weathered Shale			
	SPT						16
10							
	SPT						50/ 5"
				AUGER REFUSAL @ 14.5 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

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

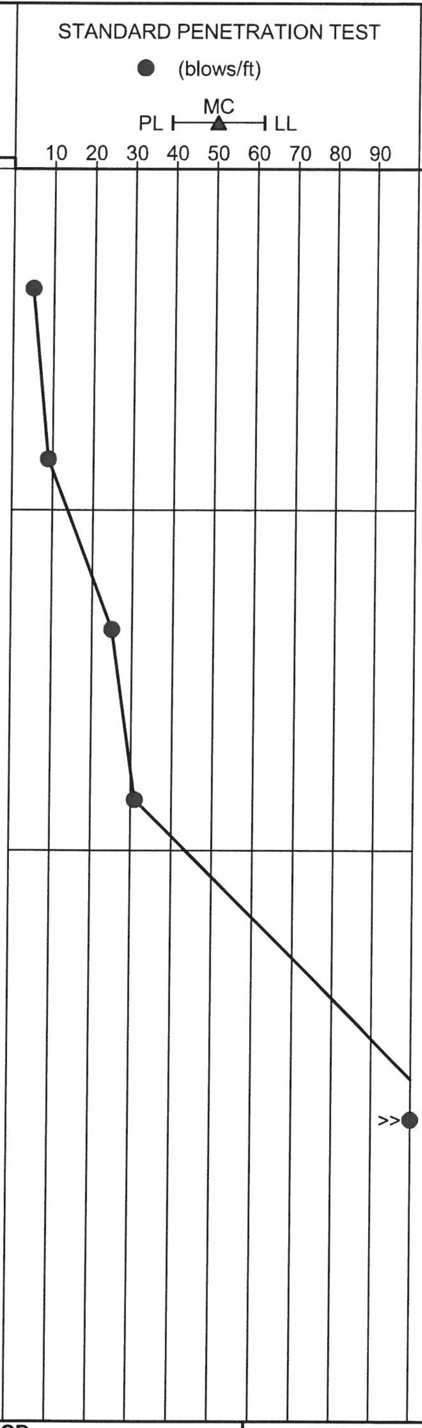
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-7

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **Dry** Overburden: **14.5** Rock: **0** Total Depth: **14.5**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (10 inches)	**OL**	Ground	
		SPT			Moist, Loose, Brown and Gray Mottled, Silt	**ML**		5
		SPT			Same, Medium Dense	**ML**		9
5								
		SPT			Gray, Weathered Shale			25
		SPT						31
10								
		SPT						50/ 5"
					AUGER REFUSAL @ 14.5 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-7

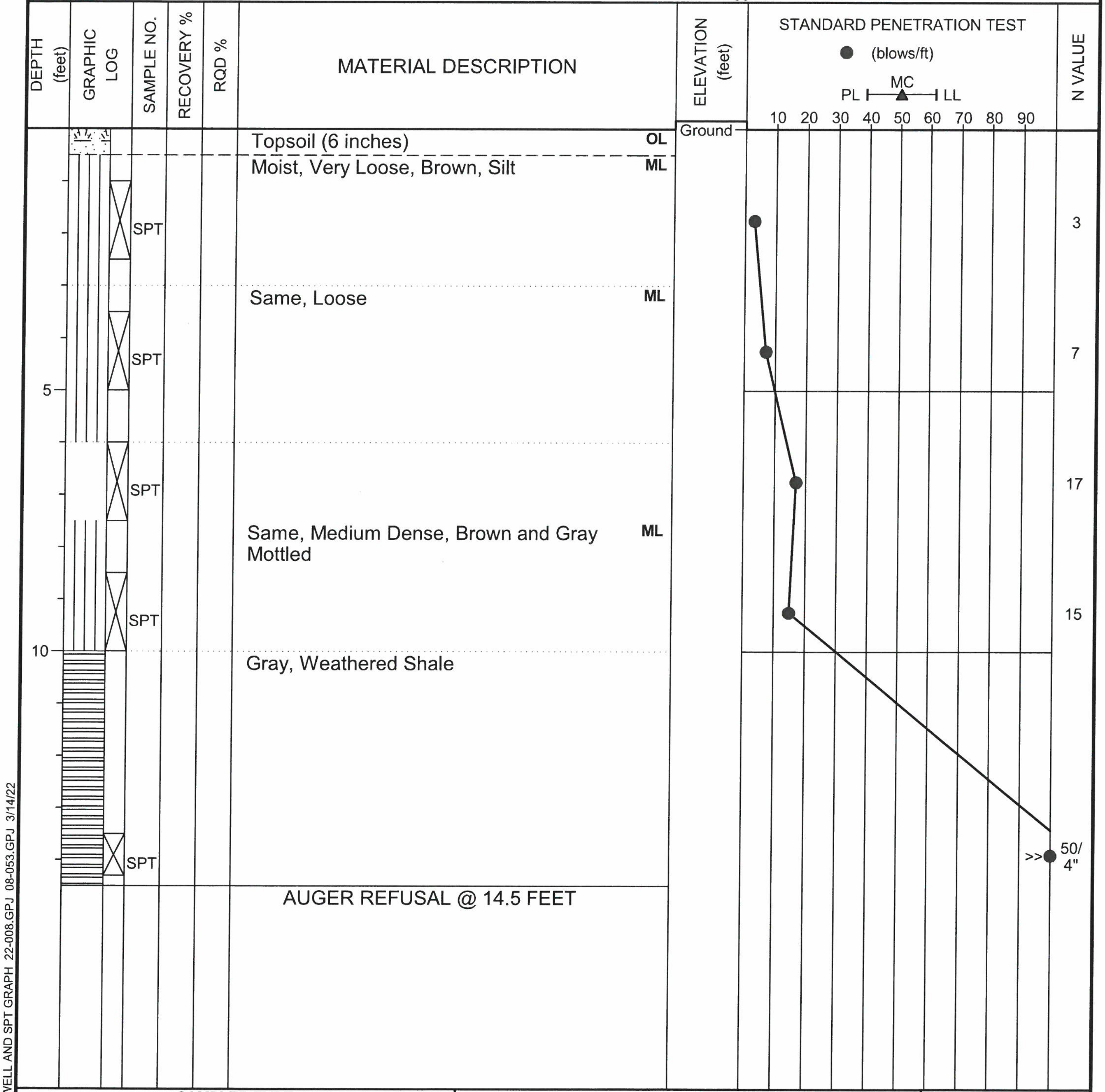
Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-8

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **Dry** Overburden: **14.5** Rock: **0** Total Depth: **14.5**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**



SAMPLE NO.	MATERIAL DESCRIPTION		N VALUE
	Topsoil (6 inches)	OL	
	Moist, Very Loose, Brown, Silt	ML	
SPT			3
	Same, Loose	ML	
SPT			7
SPT			17
	Same, Medium Dense, Brown and Gray Mottled	ML	
SPT			15
	Gray, Weathered Shale		
SPT			50/ 4"
	AUGER REFUSAL @ 14.5 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-8**

Greenbaum Associates Inc
Louisville, Ky 40215 502-361-8447

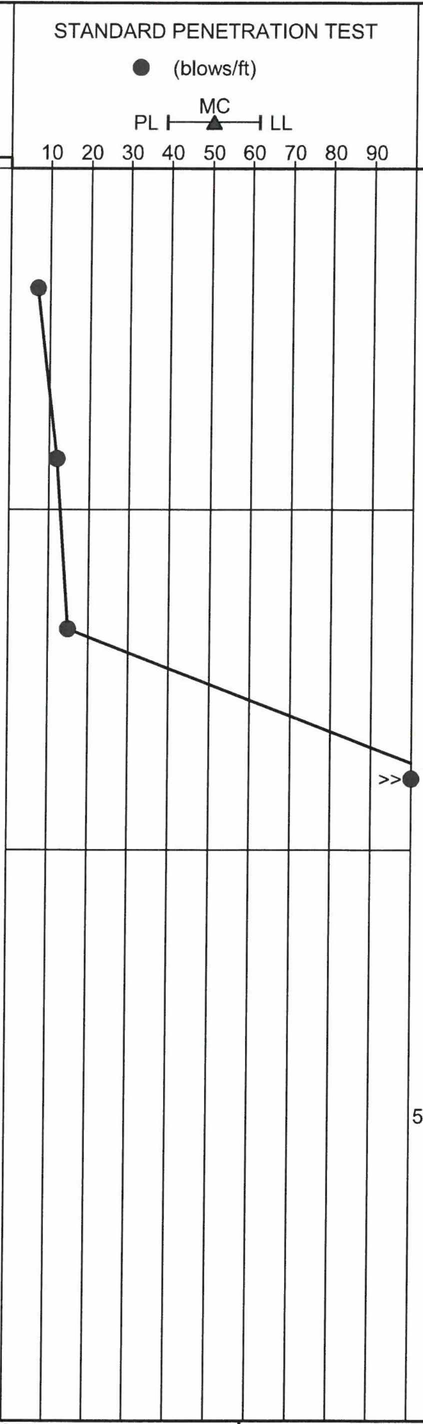
Client: St. Anthony Gardens P2 LLC
Project: Multi-Family Residential Dev., 2900 Fordhaven Rd., Louisville, KY
Project No.: 22-008G

HOLE No. B-9

Sheet 1 of 1

Boring Location: **See Boring Location Plan** Surface Elevation: **Ground** Station: **n/a**
Drilling Equipment: **Mobile B-53 Track Mounted Drill w/Auto Hammer** Drilling Method: **4 Inch Solid Flight Auger**
Depth to water immediately: **Dry** Overburden: **14.5** Rock: **0** Total Depth: **14.5**
Logged By: **S. Greenbaum** Driller: **R. Mathes** Date Logged: **2/12/22 - 2/12/22**

DEPTH (feet)	GRAPHIC LOG	SAMPLE NO.	RECOVERY %	RQD %	MATERIAL DESCRIPTION		ELEVATION (feet)	N VALUE
					Topsoil (6 inches)	**OL**	Ground	
					Moist, Loose, Brown, Silt	**ML**		
		SPT						7
					Moist, Medium Dense, Gray, Silt	**ML**		
		SPT						12
5								
					Gray, Weathered Shale			
		SPT						15
		SPT						50/ 5"
10								
		SPT						50.3"
					AUGER REFUSAL @ 14.5 FEET			



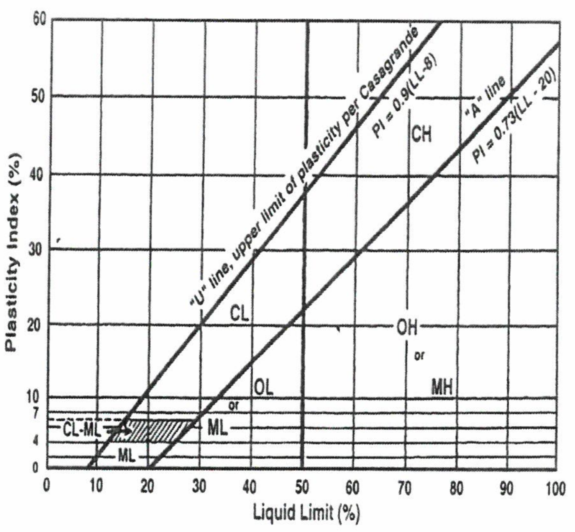
SAMPLER TYPE
SS - Split Spoon
ST - Shelby Tube
HQ - Rock Core, 2-1/2"
NX - Rock Core, 2-1/8"
CU - Cuttings
CT - Continuous Tube

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

Hole No.
B-9

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)	**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			

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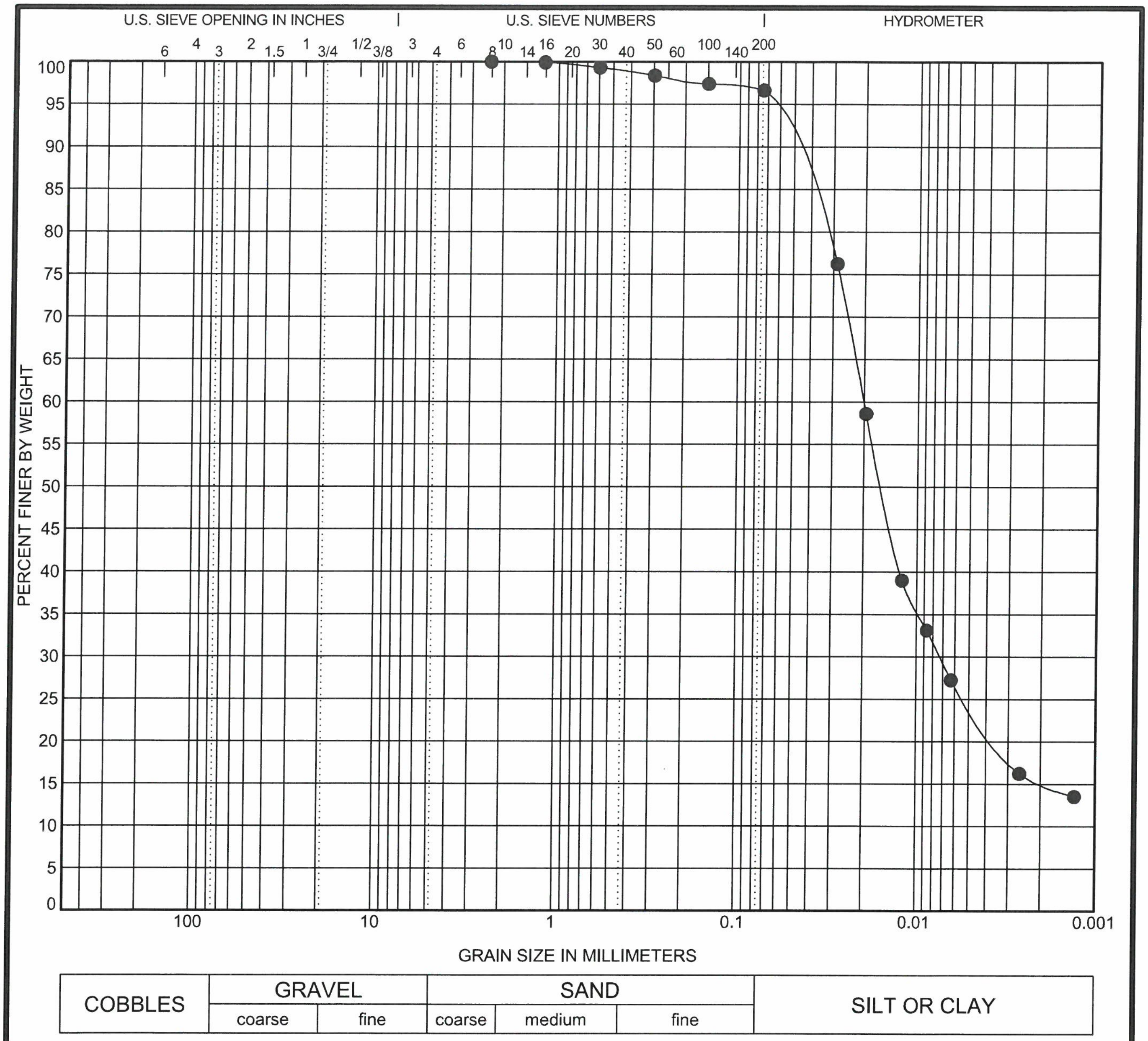
[a] Division of GM and SM groups into subdivisions of d and u are for roads and airfields only. Subdivision is based on Atterberg limits :suffix d used when L. L. is 28 or less and the P. I. is 6 or les; the suffix u used when L. L. is greater than 28.

[b] Borderline classifications, used for soils possessing characteristics of two groups, are designated 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-2**	**1.5**	**SILT(ML)**	**29**	**29**	**NP**		

Specimen Identification			D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B-2**	**1.5**	**2.38**	**0.02**	**0.007**		**0.0**	**3.3**	**72.3**	**24.4**

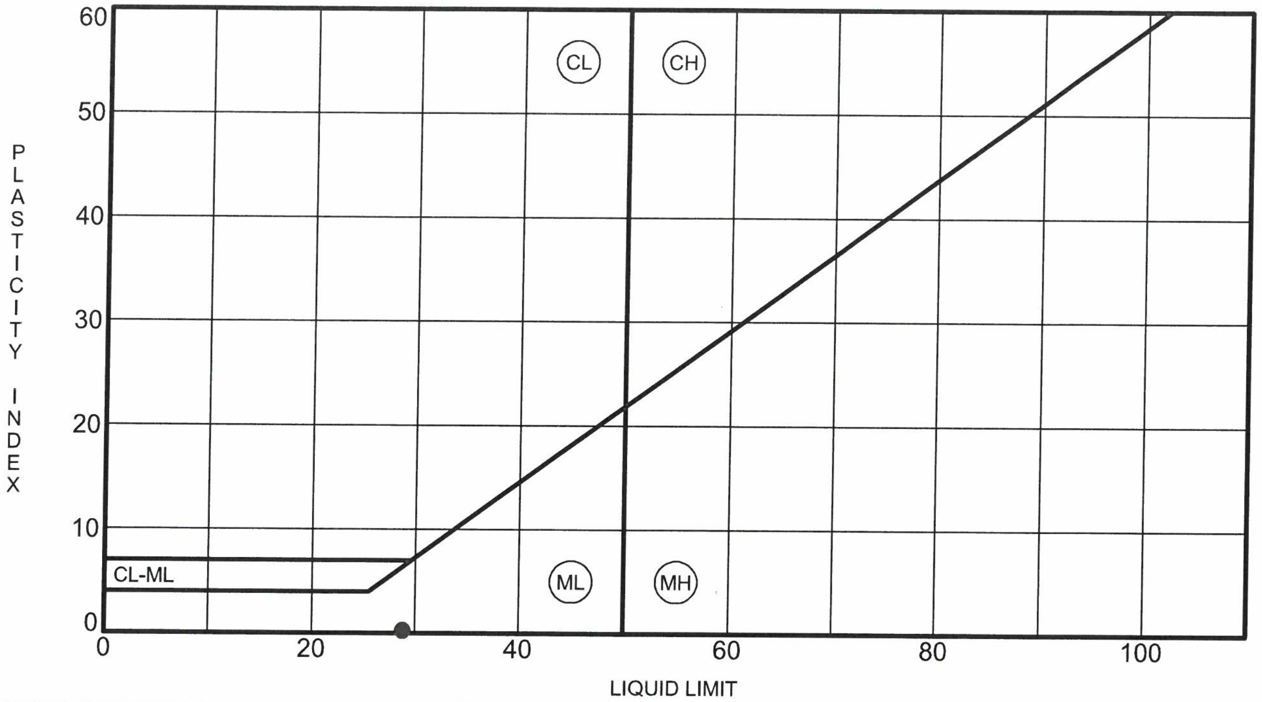
Greenbaum Associates Inc
Louisville, Ky 40215
502-361-8447

GRAIN SIZE DISTRIBUTION

Project: Multi-Family Residential Dev.,

Location: 2900 Fordhaven Rd., Louisville, KY

Number: 22-008G



	Specimen Identification		LL	PL	PI	Fines	Classification
●	**B-2**	**1.5**	**29**	**29**	**NP**	**97**	**SILT(ML)**

Greenbaum Associates Inc
Louisville, Ky 40215
502-361-8447

ATTERBERG LIMITS' RESULTS

Project: Multi-Family Residential Dev.,

Location: 2900 Fordhaven Rd., Louisville, KY

Number: 22-008G