CTL Engineering, Inc.
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e-mail: ctlcle@ctleng.com **_AN EMPLOYEE OWNED COMPANY_** Established 1927
Consulting Engineer – Testing – Inspection Services – Analytical Laboratories

January 12, 2015

Boyas Excavating, Inc.
11311 Rockside Road
Valley View, Ohio 44125

Attention: Mr. Mike Boyas,
President

Reference: Geotechnical Engineering Report
Storage Accessory Building
979 Top-O-Hill Drive
Bath Township, Summit County, Ohio

CTL Project No. 15050039CLE

Dear Mr. Boyas:

CTL Engineering, Inc. has completed the subsurface exploration for the above referenced project. This exploration was completed in general accordance with our proposal dated November 5, 2015. This report addresses geotechnical and construction issues related to the construction of proposed Storage Accessory building structure. Enclosed is a pdf copy of this Report.

Thank you for the opportunity to work with you on this project. If you have any questions or need further information, please feel free to contact our office.

Respectfully Submitted

CTL ENGINEERING, INC.

Pietro Bonanni
Project Manager

Matthew Kairouz, P.E.
Technical Reviewer

GEOTECHNICAL ENGINEERING REPORT

PROPOSED STORAGE ACCESSORY BUILDING
979 TOP-O-HILL DRIVE
BATH TOWNSHIP, SUMMIT COUNTY, OHIO

CTL PROJECT NO. 12050039CLE

PREPARED FOR:

BOYAS EXCAVATING 11311
ROCKSIDE ROAD VALLEY
VIEW, OHIO 44125

PREPARED BY:

CTL ENGINEERING, INC.
3085 INTERSTATE PARKWAY
BRUNSWICK, OHIO 44212
www.ctleng.com

January 12, 2015

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I. PROJECT LOCATION AND DESCRIPTION

The project consists of developing a single story, slab-on-grade building structure measuring approximately 50 feet by 100 feet in plan dimensions. The project site is located at 979 Top-O-Hill Drive, in Bath Township, Summit County Ohio. The proposed site is located on top of slope above Yellow Creek Road.

Based on the planned finished floor elevation of 987 feet MSL and existing topography, it is anticipated that that maximum fill operations of approximately 15 feet within the foot print of proposed building will be required to achieve the finished floor elevation.

II. SUBSURFACE EXPLORATION

Soil Borings

On November 19, 2015, CTL Engineering, Inc. advanced three (3) soil test borings to depths ranging from 20 to 60 feet below existing grades. . The soil borings were field located by CTL using conventional taping procedures, the locations of which are shown on the Boring Location Plan in Appendix A. The boring surface elevations were interpolated from the provided topographical site plan prepared by Donald G. Bohning & Associates, Inc. dated September 2015.

The borings were advanced using an All-Terrain Vehicle (ATV) drill rig. The drilling crew obtained soil samples through 2-inch O.D. split barrel samplers advanced in accordance with the Standard Penetration Test (SPT) procedure. Ground water levels were recorded for each boring during drilling and at completion. The open boreholes were back-filled with soil cuttings upon completion of drilling.

The drillers prepared field logs, secured the soil samples in glass jars, and delivered the samples to our laboratory for further testing.

Laboratory Testing

A CTL geologist performed the following laboratory testing:

- 32 Soil Samples Classifications
- 32 Moisture Contents
- 7 Sieve Analysis
- 5 Atterberg Limit Determinations
- 2 Direct Shear Tests

The laboratory test results are summarized on the enclosed boring logs in Appendix B and the laboratory test reports are included in Appendix C.

III. SITE CONDITIONS

The proposed development site is located within residential properties. The majority of the building site area is cleared covered by brush and grass. The site is surrounded by wooded areas. The surface of the site generally slopes downward from north to south, there being an elevational change of approximately 115 feet from the northern property boundary to the centerline of Yellow Creek Road (Elev. 1005' to 889' MSL). The surface grades within the proposed building footprint range from 986' to 974' MSL (elevation change of roughly 12 feet).

To the south of the proposed building, the property consists of very steep slopes ranging from about 1H:1V to 2H:1V. Slope failures by sloughing are evident at various steep sections of the slopes. The proposed building is positioned about 70 feet away from top of severe slopes and away from potential slope failures. It should be noted that the region is known to exhibit slope movement and failures.

CTL did not observe deep seated failure in the immediate vicinity of the property. Slope failures in form of erosion and shallow sloughing are evident by shallow benches and tilted trees. Also we are not aware of any historic slope failures in the immediate vicinity of the site. However, it should be noted that our investigation was limited the subject property and did not include any further investigation outside the subject property.

IV. SUBSURFACE CONDITIONS

The surface of the site, at all the test borings, was covered with topsoil of about 5 to 9 inches in thickness. The topsoil was underlain by miscellaneous fill soils consisting of lean clay, silty clay, siltstone fragments, and gravel, containing varying degrees of sand, cobbles and organics. The fill soils extended to depths of approximately 6 feet and 16 feet at borings B-1 and B-3, respectively (Elev. 974' and 949' MSL). The Standard Penetration Tests (SPT) within the fill varied from 4 to 33 blows per foot (bpf) and moisture contents ranging from 5 to 21 percent. The depth and lateral limits of the fill soils and topsoil should be expected to vary across the site. Also, the engineering characteristics of the fill soils, such as composition, strength and compressibility, are considered to be highly variable.

Beneath the topsoil or fill soils, the natural soil formation consisted predominately of granular soils such as silty sand, sandy silt, and silt, with layers/pockets of cohesive soils consisting of silty clay and lean clay. The granular natural soils exhibited a loose to medium-dense relative density with corresponding Standard Penetration Tests (SPT N_{60} values) ranging from 7 to 34 bpf. The cohesive natural soils exhibited a stiff to hard consistency with corresponding Standard Penetration Tests (SPT N_{60} values) ranging from 11 to 35 bpf. The moisture content of the natural soils ranged from 5 to 25 percent.

Groundwater was encountered at test boring B-2 at a depth of about 8.5 feet below the existing surface grade (Elev. 966' MSL). Groundwater was not encountered at the remaining

test borings during or upon completion of drilling. However, groundwater levels fluctuate seasonally as a function of rainfall and seasonal precipitation. Actual groundwater levels at the site can be determined by longer duration readings of groundwater monitoring wells.

V. ANALYSIS & RECOMMENDATIONS

A. Slope Stability Analysis

CTL Engineering, Inc. performed slope stability analysis within the property limit at a critical cross section identified as section A-A for the proposed building. The analyzed section is shown on the enclosed boring Location Plan in Appendix A.

The soil parameters representing the soil are summarized in Table 1:

Table 1. Soil Parameters for Local Slope Stability Analysis

N_{60} (bpf)	γ_m (pcf)	γ_{sat} (pcf)	C (psf)	$\varnothing^0$	Soil
10	125	---	Neg.	27-29	Random Fill 1: Sandy clays with rock, slightly organic.
>30	130	---	Neg.	36	Random Fill 2: Gravel with sand, Cobble
12	130	---	Neg	32	Loose – Medium Dense Silty Sand/Silt/Sandy Silt
23	132	---	1,500 V Neg. H	Neg. V 36 H	Silty Clay Seams/Pockets, Varved
33	135	138	Neg.	36	Medium Dense – Dense Silty Sand/Sandy Silt/Silt

Where:

γ_m = Moist Unit weight (pcf)
γ_{sat} = Saturated Unit weight (pcf)
C = Cohesion (psf)
$\varnothing^0$ = Friction Angle
Neg. = Negligible

The soil parameters were estimated through lab tests, correlation with SPT data, moisture content, literature, and our experience with similar soil conditions.

Stability analysis was performed using Slope/W computer software licensed by Geo-Slope Ltd. Circular failure surfaces were generated and analyzed in determining the slopes' factor of safety (FOS) against failure using the Bishop Method. Summaries of the analyses are included in Appendix D of this report. The results indicate that the minimum Factors of Safety (FOS) against global rotational failure was on the

order 1.5 which is an indication of stable condition with respect to global stability.

For our analysis, CTL Engineering assumed that during development, all excavated material that is not incorporated in the proposed fill is hauled off site and all water runoff is collected and diverted away from the slopes or controlled over riprap to prevent erosion.

The building is proposed to be constructed about 70 feet north of the existing top of severe/steep slope in an area considered acceptable against shallow slough slope failure.

B. General Construction and Earthwork

General construction and earthwork recommendations are provided below. Site preparation and earthwork should be performed as follows:

1. Remove all trees, tree stumps, vegetation, topsoil and debris from all proposed construction areas plus 10 feet beyond the perimeter of proposed building.

2. Remove any existing structures and substructures in their entirety from the proposed buildings areas. Within the perimeter of the building limits, all fill should be excavated to a depth of at least 3 feet below the subgrade elevation. In areas where organic material or soft soils are encountered, then additional excavation may be necessary. All excavated material should be removed off the site, dumping over the slopes is not permitted.

3. Subsequent to vegetation and topsoil/debris removal and excavation of unsuitable soils, the exposed surface should be compacted with a vibratory roller and/or proof-rolled until a relatively unyielding surface is achieved. Soft or loose soils, wherever encountered, should be stabilized with stone, or undercut and replaced with compacted engineered fill, or otherwise as directed by the Soils Engineer.

4. Proper site drainage should be maintained during earthwork operations and permanently to minimize wet weather delays and reduce accumulation of moisture. If the surface soils become softened during wet weather or freezes, these soils should be removed before additional fill is placed. Ground surface in the vicinity of the construction site should be graded so that surface water flows away from the site. It is recommended that the surface of all fill areas be sealed with a smooth-wheel roller at the completion of each day's earthwork activities. Further protection of the site should include the construction of temporary ditches, berms or other surface water diversion devices in order to divert surface water from and not across the site.

5. All surface water runoff should be collected and diverted away from the slopes or controlled in such a way to prevent erosion of slopes by providing riprap at discharge points.

6. Engineered fill should be placed in layers not to exceed 8 inches in loose thickness when heavy self-propelled compaction equipment is used, and in lifts not to exceed 6 inches when light portable compaction equipment is used. In structural areas, such as below footings, floor slabs, pavements and sidewalks, each layer of fill should be compacted to at least 98 percent of the maximum dry density as determined by ASTM D-698 standard method (AASHTO T-99), or as otherwise directed by the Soils Engineer. Soils weighing less than 120 pcf should be compacted to 100 percent of the standard Proctor maximum dry density. In non-structural areas such as landscape areas, the fill should be compacted to at least 95 percent. In all areas, the fill should be placed with moisture content within the range of ±3% of the optimum moisture content.

7. Fill material may consist of onsite suitable soils, or imported soils with Liquid Limit (LL) and Plasticity Index (PI) values that do not exceed 40% and 12%, respectively, crushed limestone such as ODOT Item #304 or granular soils may be used. Topsoil and organically contaminated materials are not suitable for use as fill. All fill materials should be observed and approved by the Soils Engineer.

8. Fill placement where feasible should extend beyond the limits of all buildings or parking/driveway areas a minimum horizontal distance equal to the height of fill or five (5) feet, whichever is greater. Fill placement adjacent to slopes or cuts steeper than 8:1 Horizontal to Vertical (H:V) should be benched to tie the new fill to existing soils. Fill over existing slopes beyond proposed building is not permitted without evaluation and approval from the Geotechnical Engineer.

9. Permanently exposed slopes should be laid back at a slope rate no steeper than 2:1 H:V. These slopes should be seeded and vegetation growth permitted to limit sloughing or surface erosion.

10. Temporary excavations in excess of 4.0 feet in depth should be sloped or shored in accordance with OSHA regulations assuming soil type “C”. All excavation sidewalls should be observed and approved by the Soils Engineer.

11. Excavation sidewalls for proposed temporary excavation of utility lines or any incidental retaining walls, should be laid back at a slope rate no steeper than 1.5:1 H:V in the clay formation. If groundwater or sand seams are

encountered during construction, then excavation sidewalls may need to be laid back at a flatter rate.

C. Foundation Support

Proposed building structure may be supported on continuous wall or spread column footings bearing on natural soils or newly placed engineered fill. All footing bearing surfaces should be observed and approved by the Geotechnical Engineer. The adequacy of existing fill requires verification during foundation construction, a contingency plan to remove any possible existing fill should be considered.

1. Shallow foundation units placed into natural medium dense to dense native soils at elevations ranging from 968 to 974 feet or newly placed engineered fill may be proportioned using a net allowable soil bearing capacity not exceeding 2,500 pounds per square foot (psf). These values apply to the total of all design loads while using a Factor of Safety of 3.0.

   In the event that soft and/or loose conditions are encountered at the footing bearing level, the soft soils should be excavated from below the footings. Lean concrete may be used to backfill the excavation up to the proposed footing bearing level.

2. All footing bearing surfaces should be free of water, loose cuttings, and frost and inspected and approved by the Soils Engineer.

3. The minimum width for wall footing should be per Ohio Building Code but no less than 2 feet to prevent punching shear.

4. Exterior footings should be constructed at a minimum depth of 3.5 feet below the lowest adjacent grade to offset the effect of frost penetration. Interior footings in heated areas could be placed at a depth of 3 feet below proposed finished floor elevation.

5. Settlement of footings supported as recommended may vary across the site due to variations in the soil's composition, void ratio and loading. Total settlement is expected to be less than 1 inch and differential settlements less than ½ inch. To minimize distress associated with differential settlements, an expansion joint should be provided to separate the proposed addition from the existing building. See Special Consideration for settlement monitoring.

Special Considerations

Prior to engineered fill placement within proposed deep fill areas of greater than 5

feet in thickness, settlement monitoring plates should be installed and monitored on a weekly basis upon completion of fill placement. When settlement attenuate 0.01 foot/week, then foundation or structural element construction can proceed. The length of time needed will depend on final grading and depth of fill but is not expected to be more than 3 weeks.

Please note that the recommendations included herein are based on shallow footings and slab-on-grade building structure. Other alternatives exist, such as deep foundations and/or extending the finished floor slab elevation deeper or to include a lower level basement. However, it is understood that these alternatives are not considered feasible for this project at this time.

D. Floor Slab Support

Care should be made in verifying that the subgrade soils are considered acceptable per the project specifications. Subgrades of paved and slab areas should be observed and approved by the Geotechnical Engineer. Subsequent to site clearing, exposed surface soils should be proof-rolled or inspected to verify that a relatively unyielding surface is achieved. Soft or loose soils should be undercut and replaced with compacted-engineered fill, or otherwise as directed by the Geotechnical Engineer. In the event that excessive rutting or deflections occur during proof-rolling operations, then any soft/loose soils may be excavated to a maximum depth of 24 inches below the exposed grade level. If the soils at the excavated depth of 24 inches still exhibit soft/loose conditions, then a layer of geogrid may be placed to provide a stable working surface. In the event that geogrid is used, a minimum of 12 inches of properly compacted crushed aggregate material should be placed directly over the geogrid.

1. The building floor slab should be supported directly on a base course of approved aggregate material placed on top of the engineered fill.

2. The aggregate base should be of adequate thickness (at least 6 inches) to provide support and to act as a capillary moisture break.

3. If the site is prepared as previously described and the controlled fill is placed as described in this report using onsite clay fill, then a CBR of 5 or an effective modulus of subgrade reaction of 110 pci may be used for the design of the slabs-on-grade.

E. Lateral Loads

The building's wall to be utilized as a retaining wall may be designed using test boring logs along with the soil parameters provided below in Table 2.

Table 2. Soil Parameters for Lateral Load.

Soil Parameters	Materials		
	Existing Fill	Top 5 -10 ft Natural Deposits	Engineered Granular FILL
Unit Weight, pcf	125	130	135
Angle of Internal Friction, degrees	27	32	34
Soil/Concrete Friction Angle, degrees	18	21	23
Cohesion, ksf	Neg	Neg	Neg
At Rest Pressure Coefficient, Ko	0.55	0.47	0.44
Active Pressure Coefficient, Ka	0.38	0.31	0.28
Passive Pressure Coefficient, Kp	2.63	3.23	3.57

Lateral pressure equivalent to the applied vertical load should be added to the soil pressure when designing these walls. In addition, it is assumed that hydrostatic pressure is not present and therefore a drainage system is provided in the design of the wall.

We recommend that a wedge of free draining material consisting of crushed stone, sand or other type of granular, porous or non-plastic soils to be utilized to backfill a wedge behind all retaining walls where applicable. The wedge of freely draining material should have a minimum width of one (1) foot at the base of the wall footing and increase in width by a minimum of 0.8 feet per 1.0 foot of wall height. A footing drain wrapped with filter fabric should be used in conjunction with the free-draining backfill. We consider any clayey soils to be unsuitable for use as backfill since these soils have a tendency to "creep" with time. In addition, these soils provide minimal drainage of water behind the retaining wall. It is recommended for those walls which are restrained from rotating to be designed based on at-rest earth pressure conditions, and those walls which are allowed to rotate be designed based on the active earth pressure conditions.

F. Seismic Considerations

Based upon Section 1615.1 of the 2003 Ohio Building Code (OBC), Site Class D may be used for seismic design of the building. This Site Class was determined using the information obtained in the test borings as well as published information in the vicinity of the project site.

VI. CHANGED CONDITIONS

The evaluations, conclusions, and recommendations in this report are based on our interpretation of the field and laboratory data obtained during the exploration, our

understanding of the available project information and our experience with similar sites and subsurface conditions using generally accepted geotechnical engineering practices. Although individual test borings are representative of the subsurface conditions at the boring locations on the dates drilled, they are not necessarily representative of the subsurface conditions between boring locations or subsurface conditions during other seasons of the year.

In the event that changes in the project are proposed, additional information becomes available, or if it is apparent that subsurface conditions are different from those provided in this report, CTL Engineering should be notified so that our recommendations can modified, if required.

VII. TESTING AND OBSERVATION

During the design process, it is recommended that CTL Engineering work with the project designers to confirm that the geotechnical recommendations are properly incorporated into the final plans and specifications, and to assist with establishing criteria for the construction observation and testing.

CTL Engineering is not responsible for independent conclusions, opinions and recommendations made by others based on the data and recommendations provided in this report. It is recommended that CTL be retained to provide construction quality control services on this project. If CTL Engineering is not retained for these services, CTL shall assume no responsibility for compliance with the design concepts or recommendations provided.

VIII. CLOSURE

The report was prepared by CTL Engineering, Inc. (Consultant) solely for the use of the Client in accordance with an executed contract. The Client's use of or reliance on this report is limited by the terms and conditions of the contract and by the qualifications and limitations stated in the report. It is also acknowledged that the Client's use of and reliance of this report is limited for reasons which include: actual site conditions that may change with time; hidden conditions, not discoverable within the scope of the assessment, may exist at the site; and the scope of the investigation may have been limited by time, budget and other constraints imposed by the Client.

Neither the report, nor its contents, conclusions nor recommendations are intended for the use of any party other than the Client. Consultant and the Client assume no liability for any reliance placed on this report by such party. The rights of the Client under contract may not be assigned to any person or entity, without the consent of the Consultant which consent shall not be unreasonably withheld.

This geotechnical report does not address the environmental conditions of the site. The

Consultant is not responsible for consequences or conditions arising from facts that were concealed, withheld, or not fully disclosed at the time the assessment was conducted.

To the fullest extent permitted by law, the Consultant and Client agree to indemnify and hold each other, and their officers and employees harmless from and against claims, damages, losses and expenses arising out of unknown or concealed conditions. Furthermore, neither the Consultant nor its employees shall be liable to the Owner in an amount in excess of the available professional liability insurance coverage of the Consultant. In addition, Client and Consultant agree neither shall be liable for any special, indirect or consequential damages of any kind or nature. The Consultant's services have been provided consistent with its professional standard of care. No other warranties are made, either expressed or implied.

Respectfully Submitted,

CTL ENGINEERING, INC.

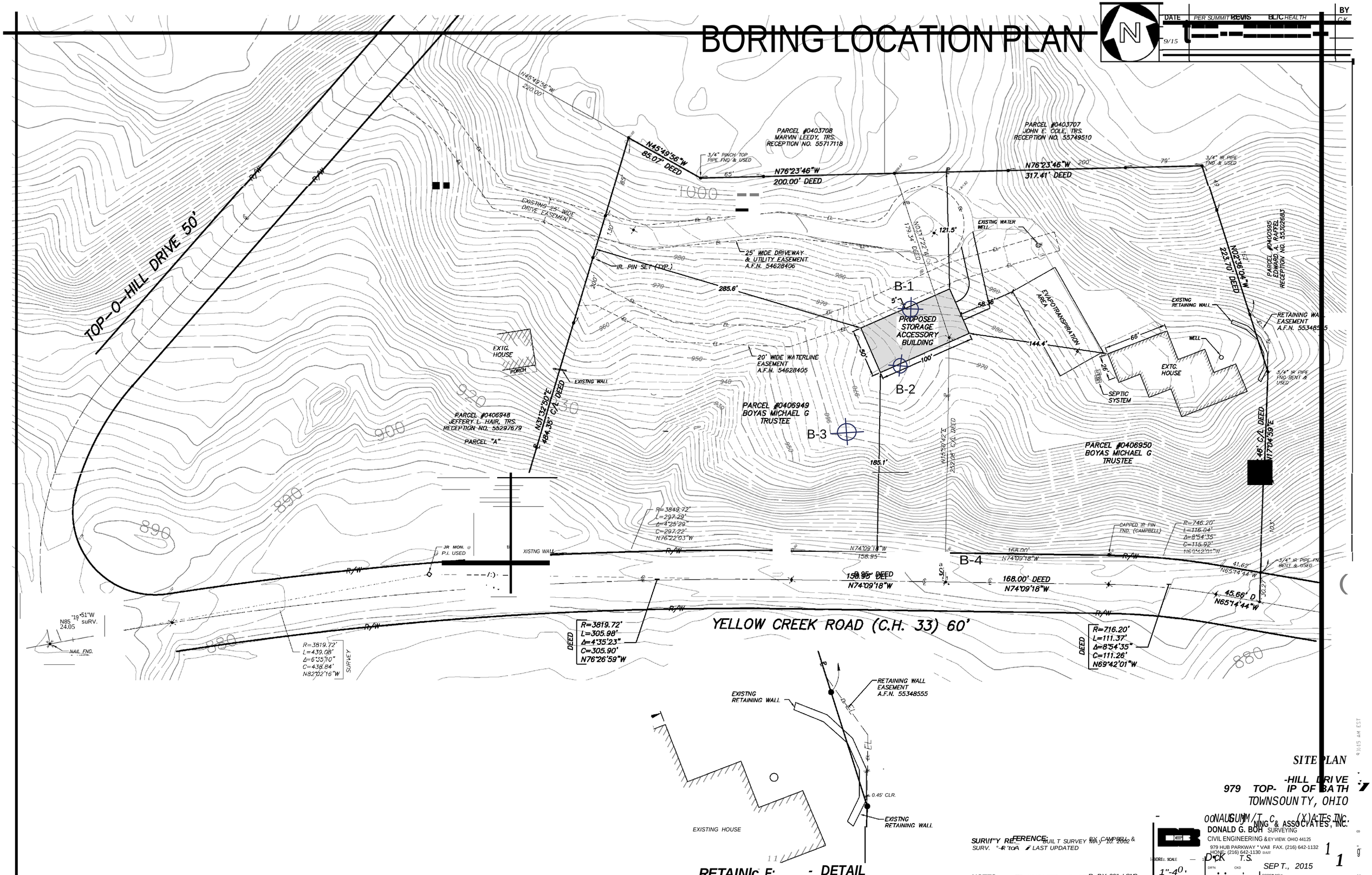
Pietro Bonanni	Matthew Kairouz, P.E.
Project Manager	Technical Reviewer

APPENDIX A

- **SITE LOCATION MAP**
- **TEST BORING LOCATION**
- **SOIL PROFILE**

	SITE LOCATION MAP			
	Date 1/12/2016	Storage Accessory Building Top-O-Hill Drive Bath Township, Summit County Ohio		
CTL ENGINEERING, INC. GEOTECHNICAL ENGINEERS TESTING * INSPECTION LABORATORY SERVICES	**Scale** None			
	Drawn By pb	**Reviewed By**	**Page** 1 of 1	**Project No.** 15050039CLE

BORING LOCATION PLAN



RETAINIc E: ; DETAIL

SITE PLAN

-HILL DRIVE
979 TOP- IP OF BATH
TOWNSOUNTY, OHIO

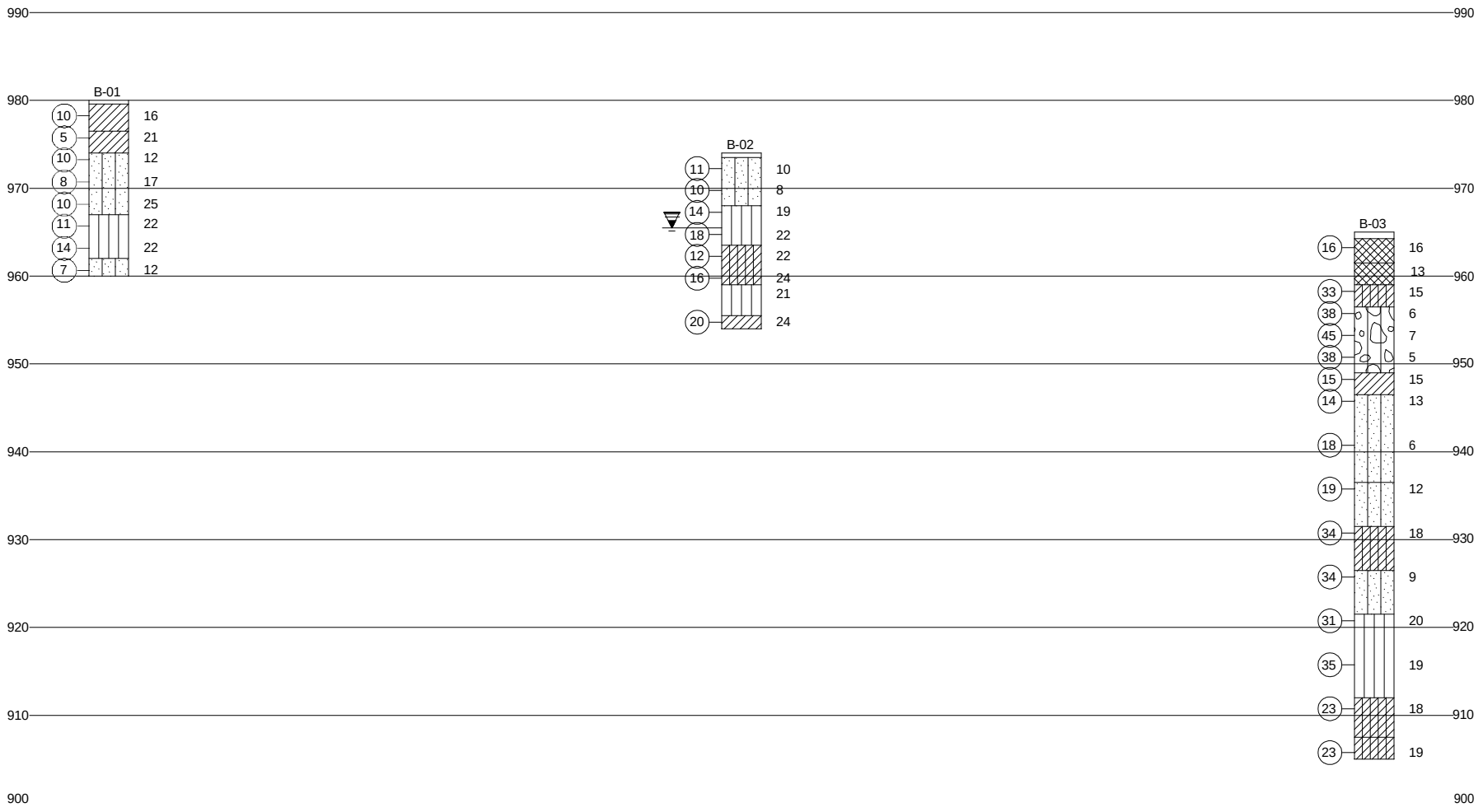
ONAUGUM/T. C. (X)ATES INC.

NING & ASSOCIATES, INC.
DONALD G. BOH SURVEYING
CIVIL ENGINEERING & EY VIEW. OHIO 44125
979 HUB PARKWAY * VAII FAX. (216) 642-1132
HONE: (216) 642-1130 DAIT

SURVEY REFERENCE: BUILT SURVEY MAY 10, 2002 & SURV. °-R to A LAST UPDATED

NOTES: 1" PIN SET DENTIFICATION 1" NING ASSOC. REBAR WITH

DCK T.S.
SEPT., 2015
1"-40'
4098
409800SV



LEGEND

TOPSOIL
ASPHALT
GW
GP
GW-GM
GW-GC
GP-GM
GP-GC
GM
GC
GC-GM
SW
SP
SW-SM
SW-SC
SP-SM
SP-SC
SM
SC
SC-SM
ML
CL
CL-ML
OL
CH
MH
OH
PT
SHALE
SILTSTONE
LIMESTONE
FILL

GROUND WATER DURING

GROUND WATER AT

GROUND WATER AT "N" HOURS AFTER COMPLETION

W — MOISTURE CONTENT IN

N — STANDARD PENETRATION IN BLOWS PER FOOT (N)

B-01

CTL ENGINEERING, INC.
CONSULTING ENGINEERS
3085 Interstate Parkway
Brunswick, Ohio 44212

SOIL PLAN/PROFILE

DATE	Boyas Excavating, Inc.
1/6/2016	Storage Accessory Building
SCALE AS SHOWN	979 Top-O-Hill Dr., Bath Twp., Ohio

DRAWN BY	PAGE	PROJECT NUMBER
MK	1 OF 1	15050039CLE

APPENDIX B

- **TEST BORING RECORDS**

SOIL DESCRIPTIONS BASED ON THE UNIFIED SOIL CLASSIFICATION SYSTEM

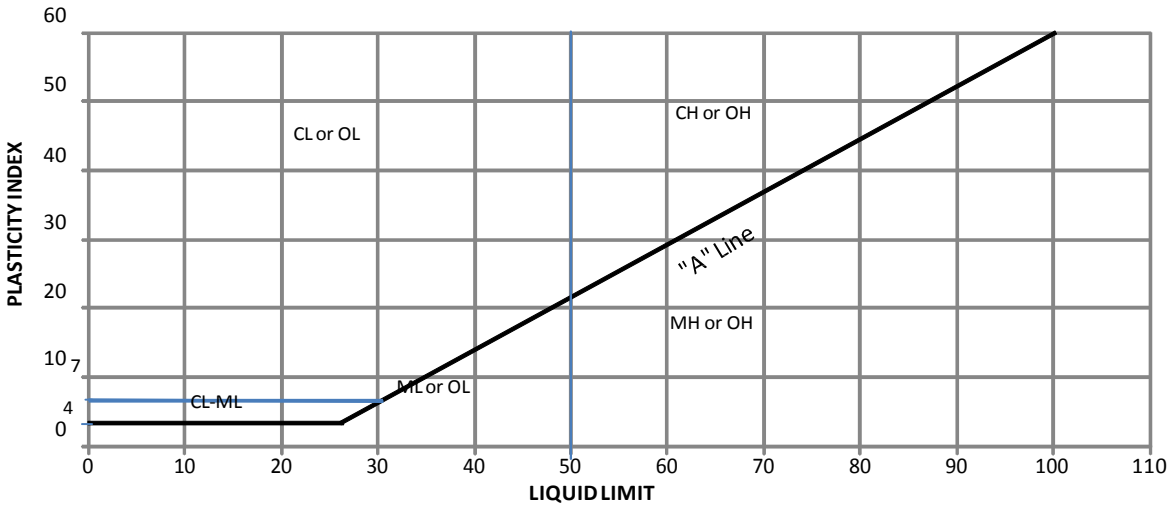
ASTM D 2487 and D 2488

Major Division			Group Symbol	Letter Symbol	Group Name*
Coarse Grained Soils Less Than 50 Percent Passing the # 200 Sieve	Gravel - Percent GRAVEL > percent SAND	Gravel with < 5% Fines		GW	Well Graded GRAVEL
				GP	Poorly Graded GRAVEL
		Gravel with Between 5 and 15% Fines		GW-GM	Well Graded GRAVEL with silt
				GW-GC	Well Graded Gravel with clay
				GP-GM	Poorly Graded GRAVEL with silt
				GP-GC	Poorly Graded GRAVEL with clay
		Gravel with ≥ 15% Fines		GM	Silty GRAVEL
				GC	Clayey GRAVEL
	Sand - Percent SAND ≥ percent GRAVEL	Sand with < 5% Fines		SW	Well Graded SAND
				SP	Poorly Graded SAND
		Sand with Between 5 and 15% Fines		SW-SM	Well Graded SAND with silt
				SW-SC	Well Graded SAND with clay
				SP-SM	Poorly Graded SAND with silt
				SP-SC	Poorly Graded SAND with clay
		Sand with ≥ 15% Fines		SM	Silty SAND
				SC	Clayey SAND
Fine Grained Soils 50 percent or more Passing the # 200 Sieve	SILT and CLAY	Liquid Limit Less Than 50		ML	SILT
				CL	Lean CLAY
				CL-ML	SILTY CLAY
				OL	Organic SILT, CLAY, or SILTY CLAY
		Liquid Limit 50 or Greater		MH	Elastic SILT
				CH	Fat CLAY
				OH	Organic SILT or CLAY
Highly Organic Soils				PT	Peat

	Coarse Grained Soils	with silt or clay	5 to 12 % Silt or Clay by weight
		Silty or Clayey	more than 12 % Silt or Clay by weight
	Fine Grained Soils	with sand or gravel	15 to 29 % Sand or Gravel by weight
		Sandy or Gravelly	30 % or more Sand or Gravel by weight

* Additional Modifiers

"A" LINE GRAPH



SOIL DESCRIPTION

NON-COHESIVE SOIL DESCRIPTION	STANDARD PENETRATION BLOWCOUNTS PER FOOT (bpf)
Very Loose	0 – 4
Loose	5 – 10
Medium Dense	11 – 30
Dense	31 – 50
Very Dense	Over 50

COHESIVE SOIL DESCRIPTION	STANDARD PENETRATION BLOWCOUNTS PER FOOT (bpf)
Very Soft	0 – 1
Soft	2 – 4
Medium Stiff	5 – 8
Stiff	9 – 15
Very Stiff	16 – 30
Hard	Over 30

GRADATION COMPONENT	SIZE
Boulders	Larger Than 8”
Cobbles	8” – 3”
Coarse Gravel	Passing 3” Retained on ¾”
Fine Gravel	Passing ¾” Retained on #10
Coarse Sand	Passing #10 Retained #40
Fine Sand	Passing #40 Retained on #200
Silt	0.074 mm to 0.005 mm
Clay	Smaller Than 0.005 mm

COMPONENT MODIFIERS	SIZE
Trace	> 0 – 10%
Little	11 – 20%
Some	21 – 35%
And	36 – 50%

MOISTURE TERMS	DESCRIPTION
Dry	Powdery
Damp	Below Plastic Limit
Moist	Above Plastic Limit, Below Liquid Limit
Wet	Above Liquid Limit

TEST BORING RECORD

CLIENT	: Boyas Excavating, Inc.	BORING NO.:	**B-01**
PROJECT	: Storage Accessory Building	SHEET	1 OF 1
LOCATION	: 979 Top-O-Hill Dr., Bath Twp., Ohio	DATE STARTED	: 11-19-15
PROJECT NO.	: 15050039CLE	DATE COMPLETED	: 11-19-15

BORING ELEVATION	: 980.0 Feet	RIG TYPE	: R 487	DRILLER	: LH
STATION	: N/A	CASING DIA.	: 3.25"	TEMPERATURE	: 60°
OFFSET	: N/A	CORE SIZE	: N/A	WEATHER	: Sunny
DEPTH	: 20.0 Feet	HAMMER	: AUTO		
BORING METHOD: HSA		ENERGY RATIO	: 81.9		

GROUNDWATER: Encountered at None At completion None ▨ Caved in at 2.0'

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
979.6		5" TOPSOIL	0.4										
		Stiff, brown, LEAN CLAY with SAND, some silt, trace gravel, (FILL), moist		SS-1	3 3 4	10	100	16		5.0*			
976.5			3.5										
	5	Medium stiff, brownish gray, SANDY LEAN CLAY, some silt, trace gravel, roots, slightly organic, (possible FILL), moist		SS-2	1 2 2	5	100	21		1.5*	35	19	16
974.0			6.0										
		Loose, brown, SILTY SAND, trace clay, damp to moist		SS-3	1 3 4	10	10	12					
	10			SS-4	2 3 3	8	100	17					
				SS-5	2 3 4	10	100	25			NP	NP	NP
967.0			13.0										
	15	Medium dense, brown, SANDY SILT, trace clay, moist		SS-6	2 4 4	11	100	22					
				SS-7	4 6 4	14	100	22					
962.0			18.0										
		Loose, brown, SILTY SAND with GRAVEL, damp		SS-8	2 2 3	7	100	12					
960.0	20	End of Boring at 20.0 Feet	20.0										

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HSA - Hollow Stem Auger
SFA - Solid Flight Auger
RC - Rock Coring
MD - Mud Drilling
WD - Wash Drilling
HA - Hand Auger

SAMPLING METHOD
SS - Split Spoon Sample
ST - Shelby Tube Sample
CR - Rock Core Sample
BS - Bag Sample

ABBREVIATIONS
* - Hand Penetrometer
LL - Liquid Limit
PL - Plastic Limit
PI - Plasticity Index
SPT - Standard Penetration Test
N_{60} - Standard Penetration Normalized to 60% Drill Rod ER

TEST BORING RECORD

CLIENT	: Boyas Excavating, Inc.	BORING NO.:	**B-02**
PROJECT	: Storage Accessory Building	SHEET	1 OF 1
LOCATION	: 979 Top-O-Hill Dr., Bath Twp., Ohio	DATE STARTED	: 11-19-15
PROJECT NO.	: 15050039CLE	DATE COMPLETED	: 11-19-15

BORING	ELEVATION	: 974.0 Feet	RIG TYPE	: R 487	DRILLER : LH
	STATION	: N/A	CASING DIA.	: 3.25"	TEMPERATURE : 60°
	OFFSET	: N/A	CORE SIZE	: N/A	WEATHER : Sunny
	DEPTH	: 20.0 Feet	HAMMER	: AUTO	
	BORING METHOD: HSA		ENERGY RATIO	: 81.9	

GROUNDWATER: Encountered at 8.5' At completion None Caved in at 8.5'

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
973.5		6" TOPSOIL	0.5										
		Medium dense to loose, brown, SILTY SAND, damp		SS-1	2 5 3	11	100	10					
	5			SS-2	2 3 4	10	100	8					
968.0			6.0										
		Medium dense, brown, SANDY SILT, trace clay, moist		SS-3	2 4 6	14	100	19			NP	NP	NP
	10			SS-4	4 5 8	18	100	22					
963.5			10.5										
		Stiff, brown, SILTY CLAY, trace sand, varved, moist		SS-5	3 4 5	12	100	22		3.0*	27	21	6
				SS-6	3 5 7	16	100	24		2.5*			
959.0	15		15.0										
		Stiff, brown and gray, SILT, varved, moist		ST-7				21	132	2.5*			
955.5			18.5										
		Very stiff, brown, SANDY LEAN CLAY, and silt, trace gravel, varved, moist		SS-8	5 6 9	20	100	24		5.5*			
954.0	20	End of Boring at 20.0 Feet	20.0										

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TEST BORING RECORD

CLIENT	: Boyas Excavating, Inc.	BORING NO.:	**B-03**
PROJECT	: Storage Accessory Building	SHEET	1 OF 2
LOCATION	: 979 Top-O-Hill Dr., Bath Twp., Ohio	DATE STARTED	: 11-19-15
PROJECT NO.	: 15050039CLE	DATE COMPLETED	: 11-19-15

BORING	ELEVATION	: 965.0 Feet	RIG TYPE	: R 487	DRILLER : LH
	STATION	: N/A	CASING DIA.	: 3.25"	TEMPERATURE : 65°
	OFFSET	: N/A	CORE SIZE	: N/A	WEATHER :
	DEPTH	: 60.0 Feet	HAMMER	: AUTO	
	BORING METHOD: HSA		ENERGY RATIO	: 81.9	

GROUNDWATER: Encountered at None At completion None Caved in at 47.0'

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
964.3		9" TOPSOIL	0.8										
		Very stiff, brown, SILTY CLAY, trace gravel, roots, (FILL), moist		SS-1	4 5 7	16	100	16		9.0*			
961.5			3.5										
	5	SILTSTONE fragments, tan, (FILL), damp		ST-2				13					
959.0			6.0										
		Hard, brown, SILTY CLAY, little sand, (possible FILL), moist		SS-3	10 12 12	33	100	15			24	19	5
956.5			8.5										
	10	Dense, Brown, SILTY GRAVEL with SAND, (possible FILL), damp		SS-4	7 12 16	38	100	6					
				SS-5	15 20 13	45	100	7					
		@13.5'; Limestone Cobble		SS-6	10 15 13	38	100	5					
	15												
949.0			16.0										
		Stiff, gray, SANDY LEAN CLAY, some silt, trace gravel, moist		SS-7	3 5 6	15	100	15		4.5*	19	15	4
946.5			18.5										
	20			SS-8	2 3 7	14	100	13					
		Medium dense, brown, SILTY SAND, trace clay, moist to damp											
	25			SS-9	5 6 7	18	100	6					
936.5			28.5										
	30	Medium dense, brown, SILTY SAND, trace clay, gravel, moist		SS-10	6 5 9	19	100	12					

Continued on next page

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TEST BORING RECORD

CLIENT : Boyas Excavating, Inc.

BORING NO.: **B-03**

PROJECT : Storage Accessory Building

SHEET 2 OF 2

STRATUM ELEVATION	SAMPLE DEPTH	SOIL/MATERIAL DESCRIPTION	STRATUM DEPTH	SAMPLE NUMBER	SPT per 6"	N_{60}	RECOVERY (%)	MOISTURE CONTENT	TOTAL UNIT WEIGHT pcf	UNCONF. COMP., ksf	ATTERBERG LIMITS LL	PL	PI
		Medium dense, brown, SILTY SAND, trace clay, gravel, moist											
931.5			33.5										
	35			SS-11	12 10 15	34	100	18		1.0*	25	20	5
		Hard, brown, SILTY CLAY with SAND, moist											
926.5			38.5										
	40			SS-12	7 12 13	34	100	9					
		Medium dense, brown, SILTY SAND, moist											
921.5			43.5										
	45			SS-13	8 10 13	31	100	20		2.5*			
		Dense, gray, SILT, little sand, trace clay, moist											
	50			SS-14	9 13 13	35	100	19		1.5*			
912.0			53.0										
	55			SS-15	7 7 10	23	100	18		3.0*			
		Very stiff, gray, SILTY CLAY, trace sand, moist											
907.5			57.5										
		Very stiff, gray, SANDY SILTY CLAY, trace gravel, moist											
905.0	60		60.0	SS-16	6 10 7	23	100	19		2.0*			
		End of Boring at 59.0 Feet											
	65												

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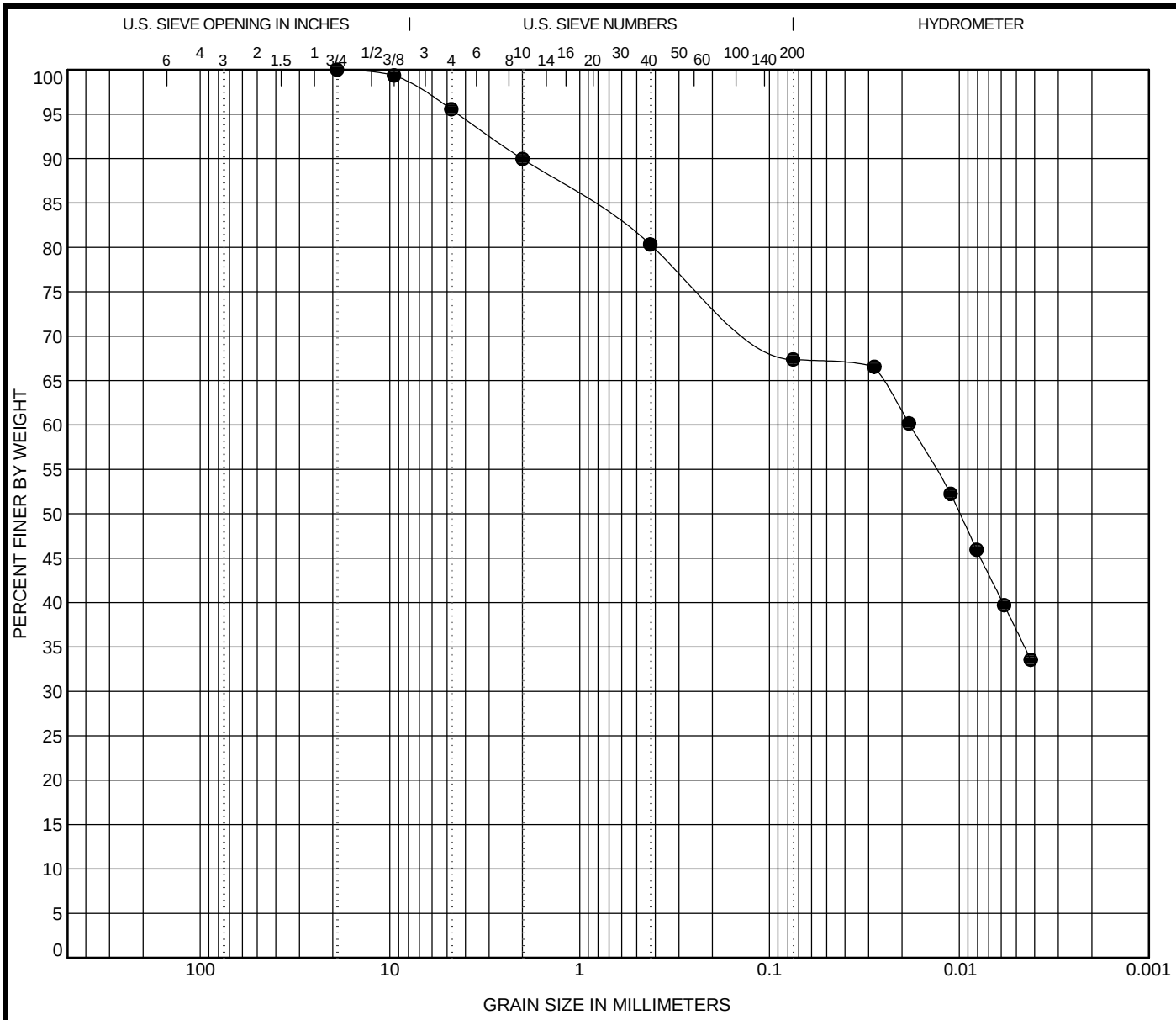
APPENDIX C

- **LABORATORY TEST RESULTS**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-01**	**SS-2**	**3.5**	**A-6b**	**21**	**35**	**19**	**16**		
			SILTY CLAY						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-01**	**SS-2**	**3.5**	**19**	**0.018**	**0.01**			**4**	**28**	**31**	**37**

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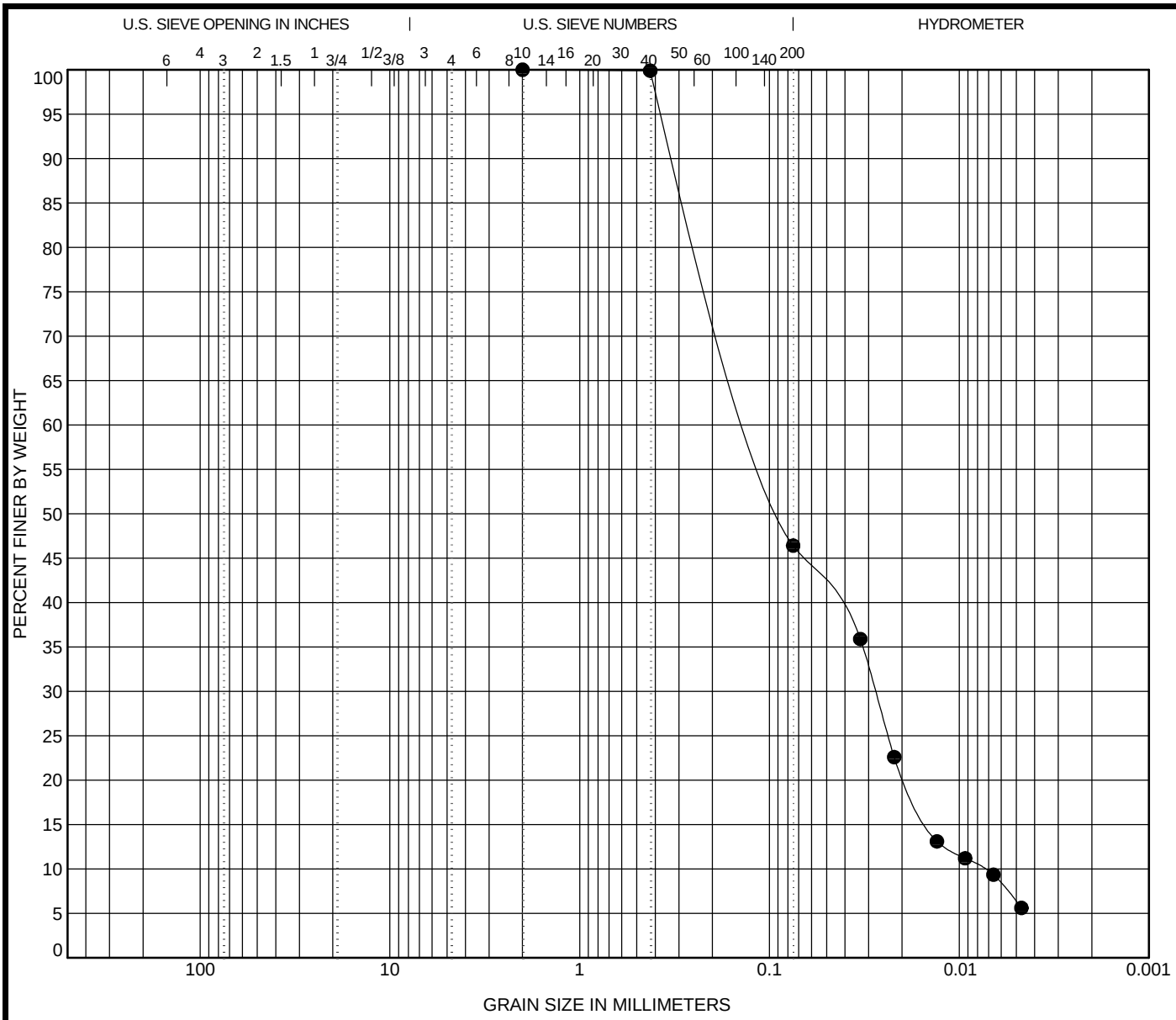
GRAIN SIZE DISTRIBUTION

Project: Storage Accessory Building

Location: 979 Top-O-Hill Dr., Bath Twp., Ohio

CTL Project Number: 15050039CLE

CTL GRAINSIZE 15050039CLE BORING LOGS & LAB GPJ CTL CORPORATE GDT 1/18/16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-01**	**SS-5**	**11.0**	**A-4a**	**25**	**NP**	**NP**	**NP**	**0.88**	**15.66**
			SANDY SILT						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-01**	**SS-5**	**11.0**	**2**	**0.117**	**0.084**	**0.028**	**0.007**	**0**	**54**	**40**	**6**

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CTL Project Number: 15050039CLE

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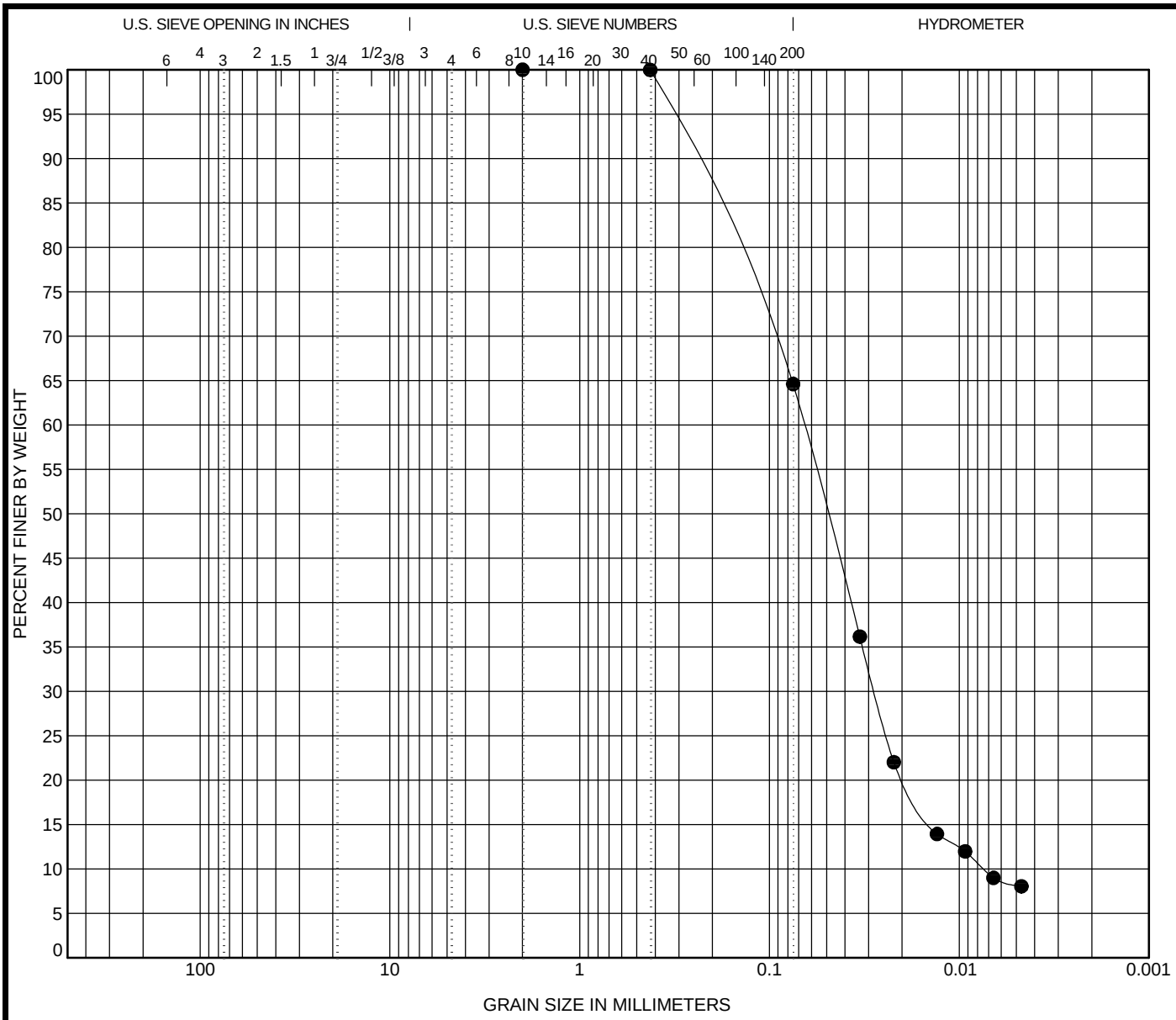

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-02**	**SS-3**	**6.0**	**A-4**	**19**	**NP**	**NP**	**NP**	**1.6**	**8.88**
			OTHER						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-02**	**SS-3**	**6.0**	**2**	**0.066**	**0.05**	**0.028**	**0.007**	**0**	**35**	**57**	**8**

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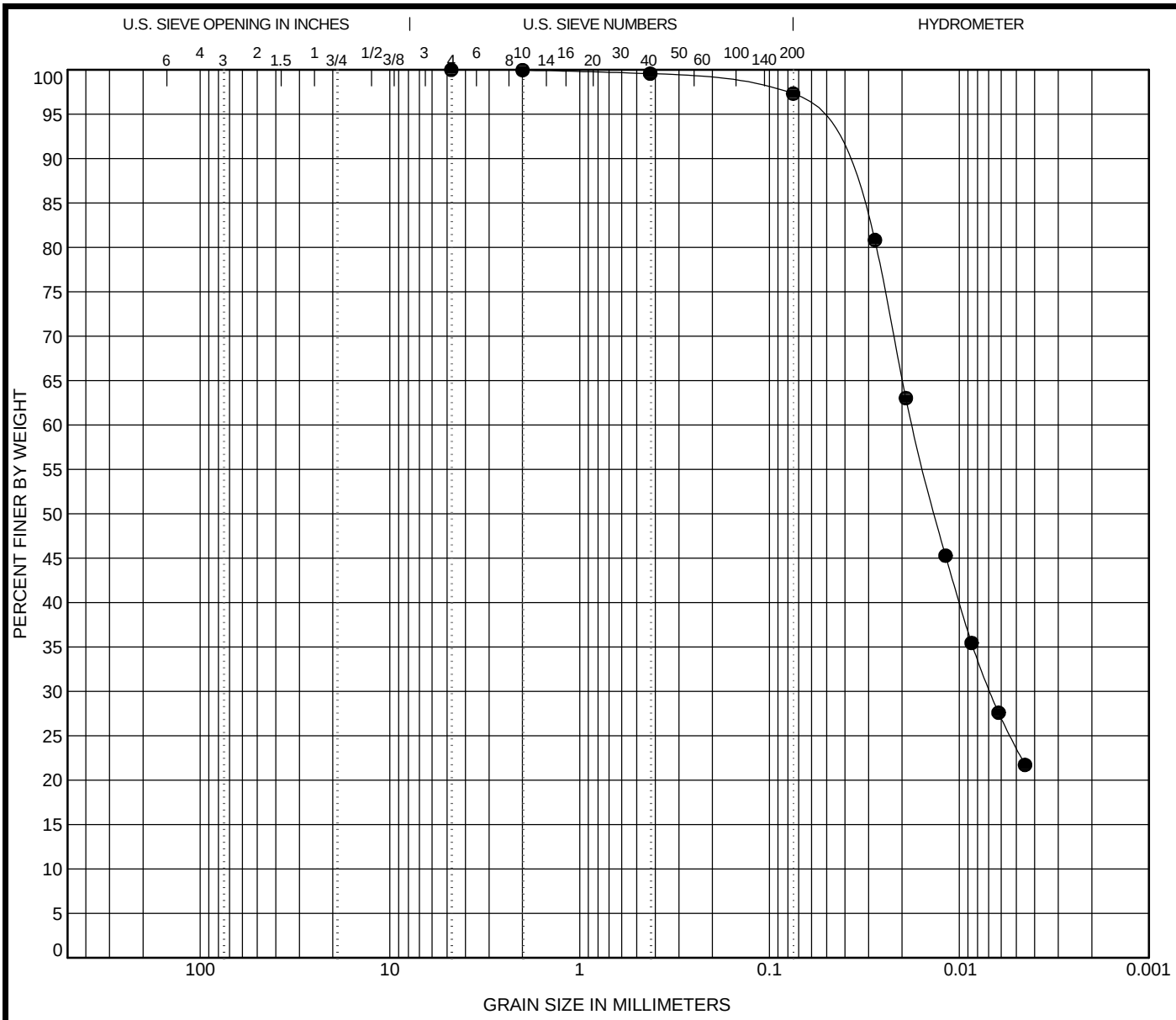

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-02**	**SS-5**	**11.0**	**A-4**	**22**	**27**	**21**	**6**		
			OTHER						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-02**	**SS-5**	**11.0**	**4.75**	**0.018**	**0.013**	**0.007**		**0**	**3**	**73**	**24**

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GRAIN SIZE DISTRIBUTION

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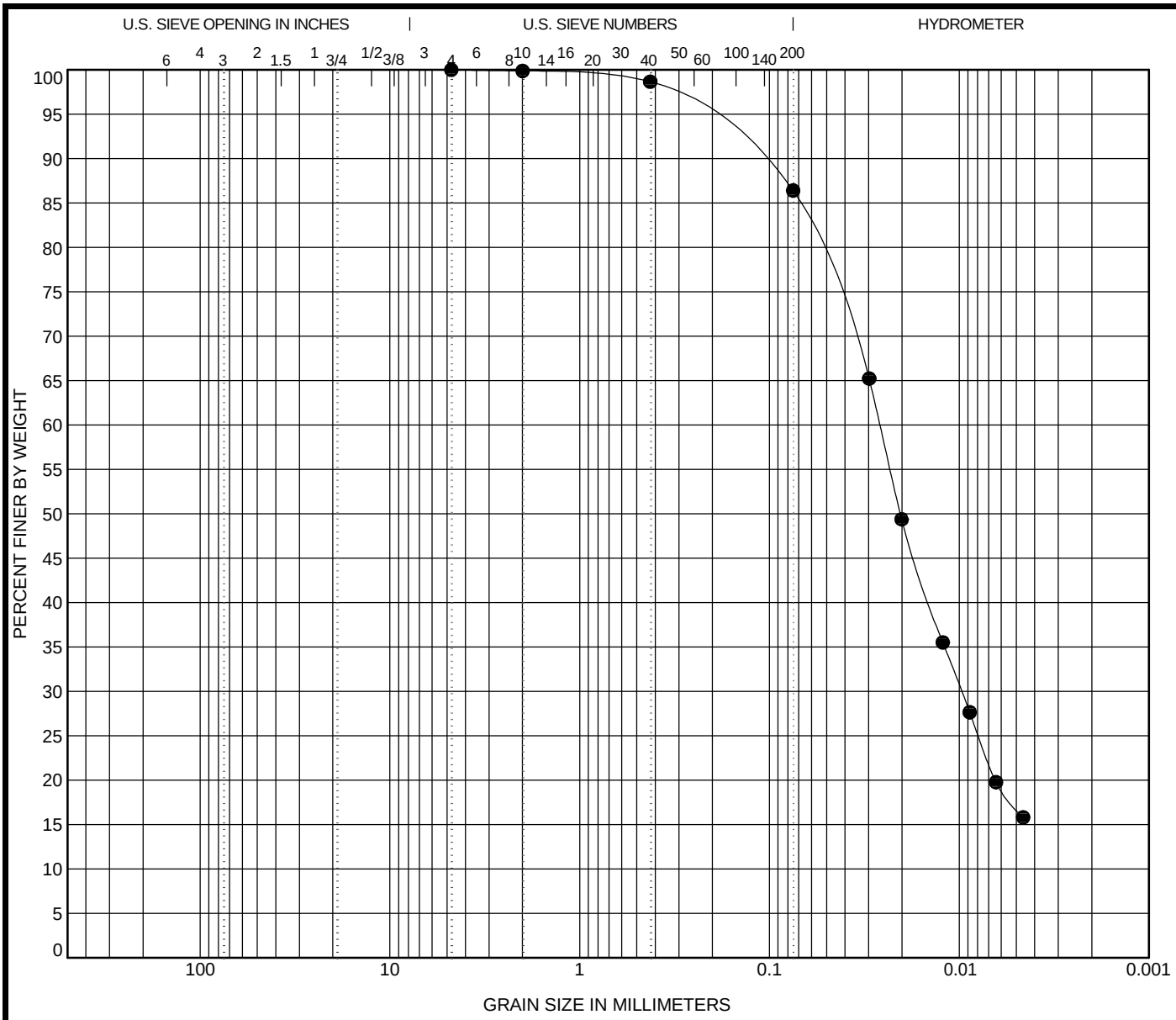

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-03**	**SS-3**	**6.0**	**A-4**	**15**	**24**	**19**	**5**		
			OTHER						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-03**	**SS-3**	**6.0**	**4.75**	**0.026**	**0.02**	**0.01**		**0**	**14**	**69**	**17**

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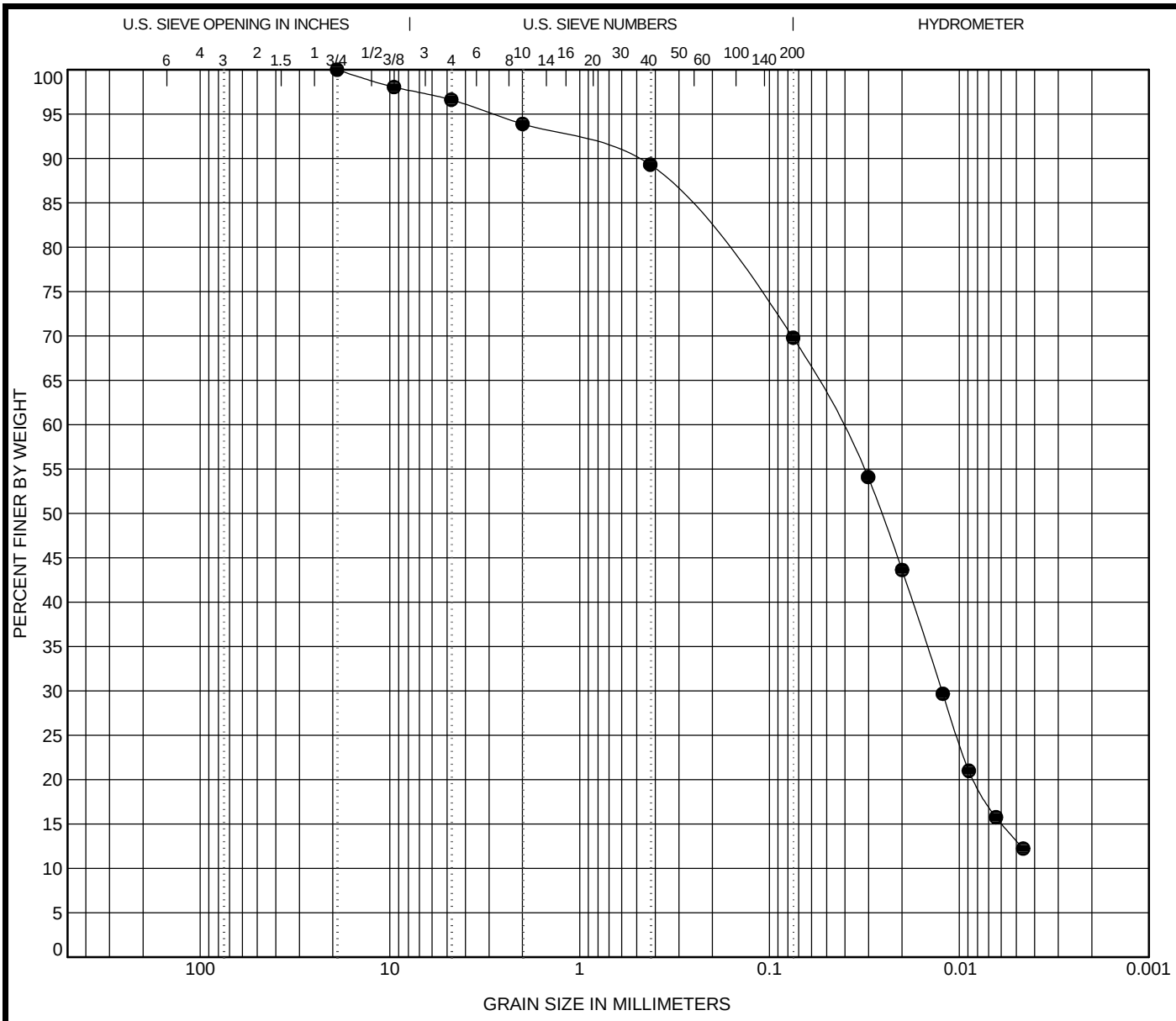

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-03**	**SS-8**	**16.0**	**A-4**	**15**	**19**	**15**	**4**		
			OTHER						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-03**	**SS-8**	**16.0**	**19**	**0.043**	**0.026**	**0.012**		**3**	**27**	**57**	**13**

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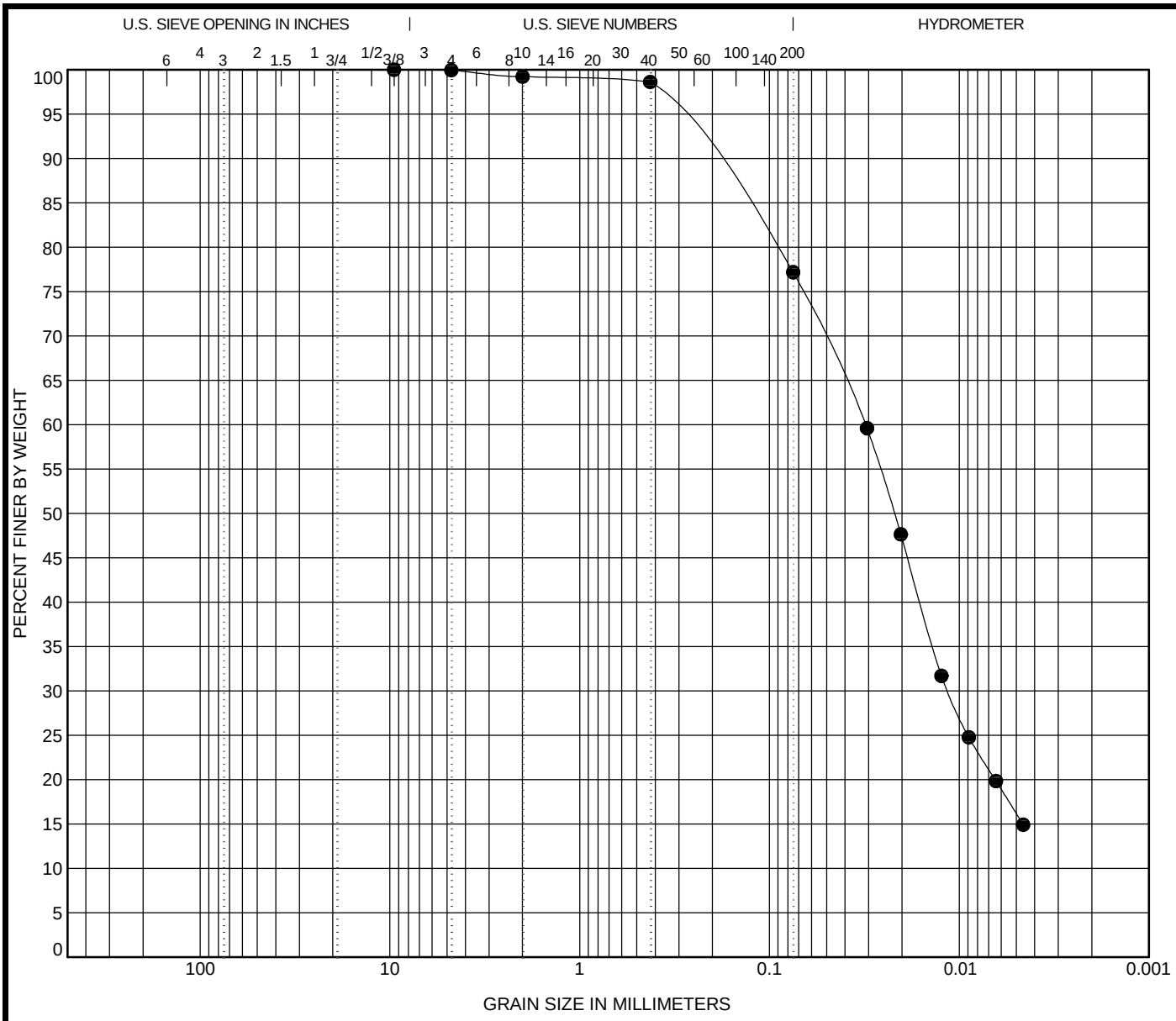

COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring No.	Sample	Depth	Classification	%MC	LL	PL	PI	Cc	Cu
● **B-03**	**SS-12**	**33.5**	**A-4**	**18**	**25**	**20**	**5**		
			OTHER						

Boring No.	Sample	Depth	D100	D60	D50	D30	D10	%Gravel	%Sand	%Silt	%Clay
● **B-03**	**SS-12**	**33.5**	**9.525**	**0.031**	**0.022**	**0.011**		**0**	**23**	**61**	**16**

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GRAIN SIZE DISTRIBUTION

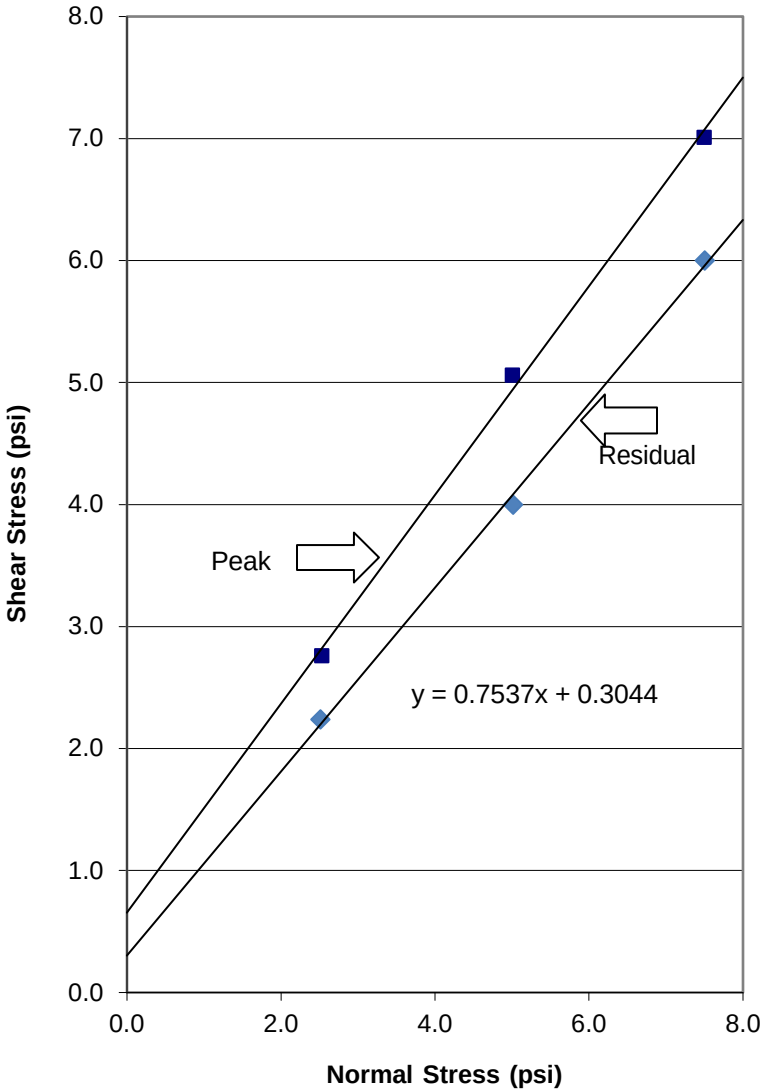
Project: Storage Accessory Building

Location: 979 Top-O-Hill Dr., Bath Twp., Ohio

CTL Project Number: 15050039CLE

CTL GRAINSIZE 15050039CLE BORING LOGS & LAB GPJ CTL CORPORATE GDT 1/18/16

DIRECT SHEAR TEST
AASHTO T 236



Client: Boyas Excavating, Inc.
Project: Storage Accessory Building
Project Number: 15050039CLE
Lab Code: 15050788COL
Sample ID: B-2, ST 15'-17', Test 2

Peak
Angle of Friction = 40.5 Degrees
Cohesion = 94.6 psf

Residual
Angle of Friction = 37.0 Degrees
Cohesion = 43.8 psf

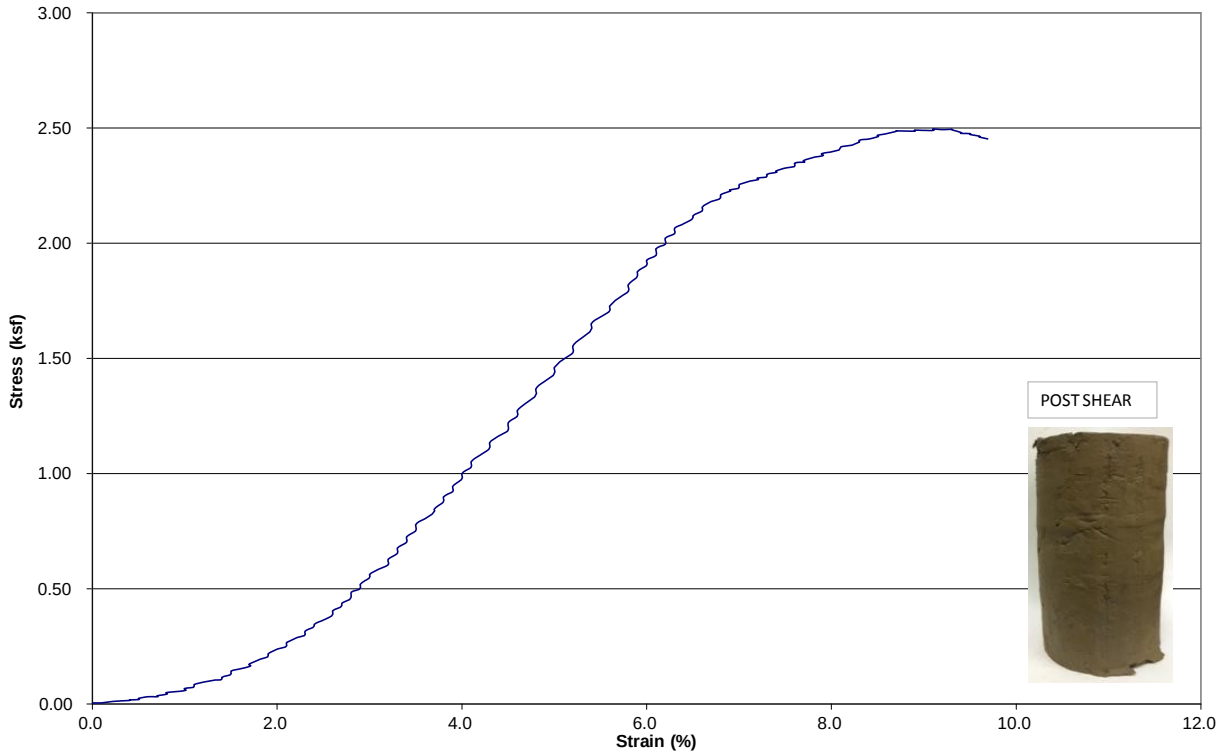
Dry Density = 106.2 pcf
Initial Moisture Content = 22.3%
Final Moisture Content = 23.7%

Sample: Gray Silty Clay (CL-ML), Moist

Reviewed by: RE

CTL ENGINEERING INC.

Unconfined Compression Test Results ASTM D 2166, D 5102	CTL ENGINEERING, INC. 2860 Fisher Road Columbus, Ohio 43204
Sample ID: B-2 ST, 15'-17'	
Avg. Sample Height (in.): 5.7448 Avg. Sample Diameter (in.): 2.8350 Height-to-diameter ratio: 2.03	Client: Boyas Excavating, Inc. Project: Storage Accessory Building
Ultimate Strength (ksf): 2.5 Ultimate Strain (%): 9.1 Wet Density (pcf): 131.7	Location: Summit Co., OH Project No. 15050039CLE Lab Code No. 15050788COL Date Tested: 12/7/2015 Reviewed by: MK
Moisture Content (%): 21.3 (obtained post-shear from specimen)	
Visual Description: Gray and Brown Silt (ML)	



CTL Engineering, Inc.
Moisture Content of Soil
ASTM D2216

Client: Boyas Excavating, Inc.
Project: Storage Accessory Building
Project No.: 15050039CLE

Tech: MU
Reviewed by: MK
Date: 12/8/2015

Boring No.	Sample No.	Moisture (%)
B-3	ST, 3.5'-5.5'	13.4

Visual ID: Siltstone, Tan, Severly Weathered (Soil-Like), Very Weak, Damp

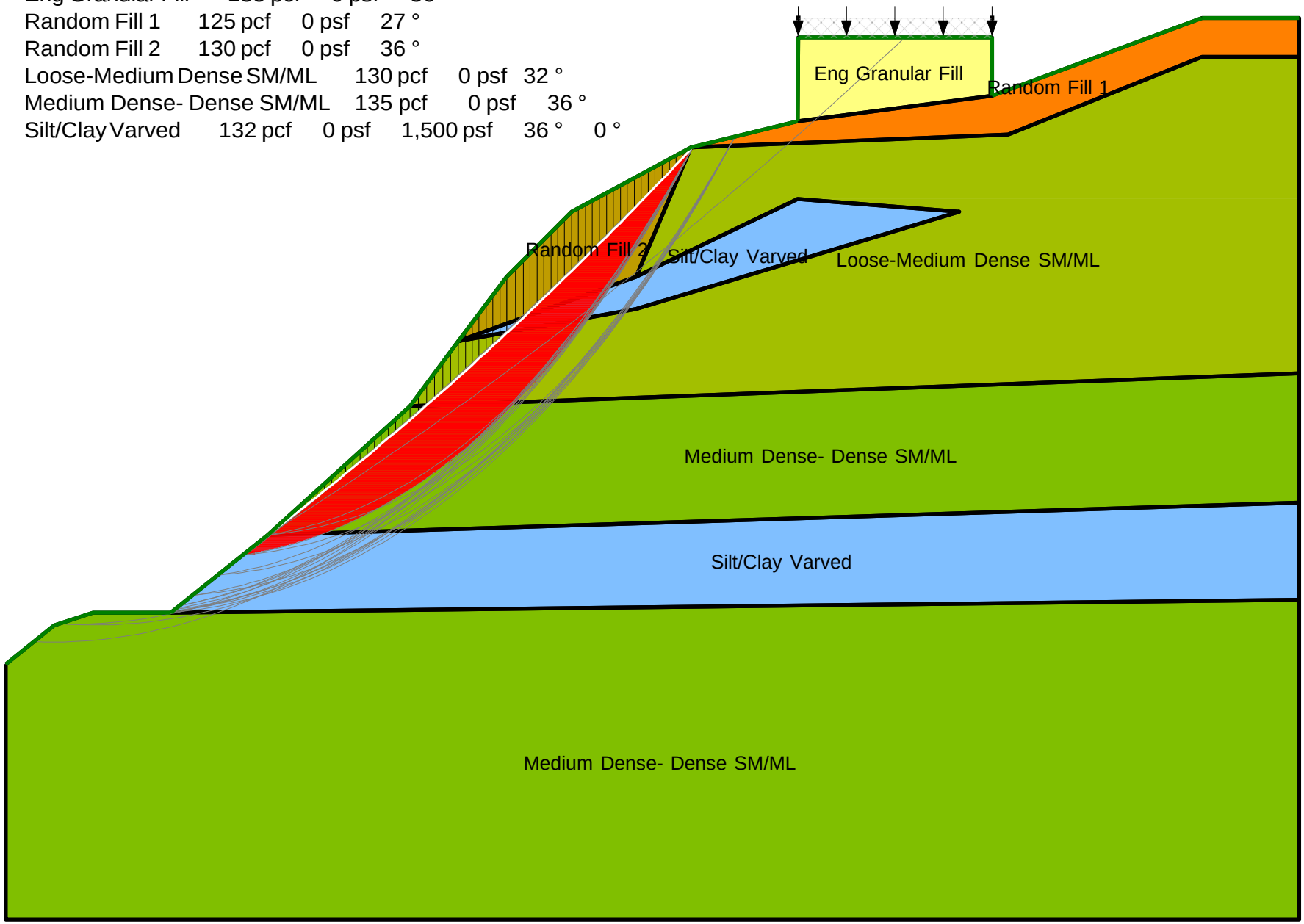
Calculations based on Dry Weight

APPENDIX D

- **SLOPE STABILITY ANALYSIS SUMMARY**

Boyas Storage Building

Section A-A

Bishop Factor of Safety 1.50

Eng Granular Fill	135 pcf	0 psf	36 °		
Random Fill 1	125 pcf	0 psf	27 °		
Random Fill 2	130 pcf	0 psf	36 °		
Loose-Medium Dense SM/ML	130 pcf	0 psf	32 °		
Medium Dense- Dense SM/ML	135 pcf	0 psf	36 °		
Silt/Clay Varved	132 pcf	0 psf	1,500 psf	36 °	0 °