LONE STAR GEOTECHNICAL & TESTING LABORATORY, INC.

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Texas Registered Engineering Firm F-2615

August 5, 2020

Chad Stultz
Chadwick Homes
2257 N. Loop 336 West, Suite 140-314
Conroe, Texas 77304

Re: Soil Foundation Investigation
Residence at 168 April Cove
Lot 5, Block 29, April Sound Section 8
Conroe, Montgomery County, Texas

Project No.: 2007-031
Report No.: 2007031-1

Dear Chad,

We are pleased to submit this report on the soil foundation investigation made at the site referenced above.

This investigation reveals high plasticity clay with an intermediate layer of medium plasticity sandy clay extending to the maximum explored depth. This soil is suitable for slab-on-grade and drilled pier foundations with considerations as addressed in this report.

For a pier supported structure, it is recommended that the structural loads be supported on drilled piers founded at the 12-foot depth below existing grade and be proportioned for a safe bearing capacity of 4500 PSF for total dead and live loads. Parameters for a shallow foundation system supported on continuous beams, such as a post-tensioned slab or a waffle slab, are also addressed in the report.

It has been a pleasure being of service to you on this project. If we may be of any further assistance, please call us.

Respectfully,

Laique Haider, P.E.; PMP

STATE OF TEXAS
8/5/2020
LAIQUE HAIDER
72959
LICENSED PROFESSIONAL ENGINEER

5815 BENDER ROAD • HUMBLE, TEXAS 77396

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PLATES AND CHARTS

SUBJECT: REPORT OF SOIL FOUNDATION INVESTIGATION
RESIDENCE AT 168 APRIL COVE
LOT 5, BLOCK 29, APRIL SOUND SECTION 8
CONROE, MONTGOMERY COUNTY, TEXAS

TO:
CHAD STULTZ
CHADWICK HOMES
2257 N. LOOP 336 WEST, SUITE 140-314
CONROE, TEXAS 77304

SCOPE AND PURPOSE:

This report presents the results of the foundation investigation made recently at the subject site to determine the nature and condition of surface and sub-surface soils as affects the design of foundations. In particular, it was desirable to determine the safe soil bearing capacity for foundation systems, depth to water table where encountered and optimum type and depth of structural foundations. The investigation was made in accordance with your instructions.

PROCEDURES: FIELD

Two (2) borings were made to a depth of 15 feet each, at the locations shown on the Location of Test Borings plate - Figure 1. The borings were made with a truck mounted, Mobile B-47 rotary drill rig using no drilling water in order to secure unaffected soil samples and reliable data on groundwater levels. The soil was sampled by pushing thin-walled Shelby tube samplers into the soil in accordance with ASTM Procedure D1587. The borings were logged by a geotechnical engineering technician who noted the consistency, color, composition, and classification of the soil as encountered. The unconfined compressive strength of the cohesive soil was measured in the field by use of a Soiltest Cl-700 Penetrometer.

The samples were examined and classified in accordance with the Unified Soil Classification System. They were then sealed to prevent moisture loss and transported to the laboratory for subsequent testing.

PROCEDURES: LABORATORY

The following tests were performed in the laboratory on the select samples to determine applicable engineering characteristics necessary to make the foundation design and construction recommendations.

Moisture Content/Density	ASTM D2216
Unconfined Compressive Strength	ASTM D2166
Atterberg Limits	ASTM D4318

The final boring logs were prepared by a geotechnical engineer after examining the samples and reviewing the laboratory test results. The results of these tests are shown on the Boring Logs.

PROJECT DESCRIPTION AND AUTHORIZATION:

The project consists of a 30 foot by 65 foot, 1 story residence, with wood frame and stucco exterior. Wall loads are not known at this time but are not expected to exceed 1.0 kip per foot. The pier/column loads are not known but are not expected to exceed 20 kips. The soil investigation was authorized by Chad Stultz with Chadwick Homes, the builder.

GEOLOGY:

The surficial soil at this site is underlain by the Fleming formation of the Miocene era. This formation consists of clays, silts, and sands, mostly clay; commonly calcareous concretions locally, silt and sand indurated, locally predominant, light gray; weathers light gray to medium gray, locally red beneath Willis, forms brownish black soil; thickness 1,300 – 1,450 feet.

A fault study is beyond the scope of this report. For information on area faulting, it is recommended that a professional geologist be consulted.

SITE DESCRIPTION:

The site consists of a slightly sloping lot, with grass, fronting at 168 April Cove and located in the April Sound subdivision in Conroe, Montgomery County, Texas. The site was drained at the time of the investigation.

VARIATIONS:

The recommendations contained in this report are based on data gained from the test borings at the location shown on the Location of Test Borings plate - Figure 1 at the time of investigation; a reasonable extent of laboratory tests results, and professional interpretation and evaluation of this data in view of the project information provided to this firm. Should soil conditions differing from those described in this report be encountered at other locations in the course of construction, or should the design data change significantly, this firm should be notified immediately so that the conditions and their effect may be evaluated. It is recommended that a Geotechnical Engineer from this firm or elsewhere be retained to monitor the construction activities and ensure proper interpretation of this report.

SOIL STRATIGRAPHY:

The soil at the site consists of stiff to hard, dark gray, brown, tan and light gray, high plasticity clay, with calcareous nodules, and with an intermediate layer of stiff to hard, tan and light gray, medium plasticity sandy clay, from 8 to 13 feet of depth, extending to the maximum explored depth of 15 feet. A detailed stratigraphy can be seen on the logs of borings.

Groundwater was not encountered during the boring operations. However, it should be noted that ground water levels are subject to the influence of seasonal variations as well as other factors and should be checked prior to the initiation of any construction that could be affected.

ENGINEERING ANALYSIS:

The expansive potential of the surface and shallow formations was determined by comparison of the natural moisture content of the soil with the results of Atterberg limit tests. Experience has shown that plastic soils having moisture contents equal to or less than the plastic limits, are potentially expansive with the expansion pressure varying directly with the plasticity index and inversely with the moisture content. On the other hand, soils having low or moderate plasticity indices and moisture contents above the plastic limit are essentially non-expansive. Soils with high plasticity indices are practically always subject to volume changes regardless of the moisture.

Safe soil bearing pressures for cohesive formations are calculated from the depth and undrained shear strength of the soil determined by unconfined compression tests and field penetrometer values. Safe soil bearing pressures for cohesionless soils are determined from the values established by the Standard Penetration Test and interpretation of these values. A safety factor of two (2) is used for total dead and live load. A safety factor of three (3) is used for dead load and sustained live load.

Surficial soil is studied for the ease of compactability and manipulation in the field during construction. Also, should the site have poor soil or should drainage conditions be restricted, consideration is given to the alternatives for stabilization or removal and replacement of the surficial soil with select compactable soil.

Other tests are performed for building conditions in which certain characteristics of the soil are critical to the design of the structure. When long-term settlement analysis is required, consolidation tests are performed. Triaxial tests are performed to measure shear strength and pore pressure in sandier soil. Permeability tests are performed when the loss of fluids through the soil is critical. However, these are not considered critical tests for this project.

SITE PREPARATION:

It is recommended that the following procedures be implemented in preparation of the site for construction:

1) Strip the surface soil and any loose soils and organic materials to a minimum depth of 6 inches and remove all tree stumps, trash, debris, and other deleterious materials. Where trees are removed, the root system should be removed to a depth where the maximum root diameter size is less than 1/2 inch with a minimum depth of 2 feet.

2) After stripping, the exposed surface soil should be proof-rolled to locate any wet, pumping areas or dry unstable areas and these areas should be treated with the proper stabilizing agents such as fly ash/lime, or be excavated and re-compacted in smooth, thin lifts.

3) For slab-on-grade construction, a minimum of 18 inches of structural fill is recommended in the building area. The structural fill material should be select soil consisting of sandy clay and/or silty clay free of any organics, trash, or other deleterious materials and with a liquid limit in the range of 25 - 40. The plasticity index (PI) should range from 10 to 20. Prior to the placement of structural fill, the exposed surface should be scarified to a minimum depth of 6 inches. The structural fill should be placed in 6 inch lifts and compacted to 95 percent of Standard Proctor Density, in conformance with the standard procedure, ASTM D 698, at or within 2 percent of optimum moisture. The elevation can be controlled by the removal of the surface soil or placement of compacted select fill. The building pad should extend a minimum of 4 feet beyond the periphery of the building and be sloped to drain away from the building. The compaction should be monitored by this firm or another approved geotechnical firm.

4) Establish positive drainage by sloping, cross drainage, and directing the runoff away from the building site. This includes all roof drain downspouts after construction extending the outfall beyond the building pad. Exposed ground areas adjacent to the building pad should be sodded or otherwise protected.

5) Any fill above existing grade should have the side sloped, no steeper than 3H:1V.

FOUNDATION CONSIDERATIONS:

1. Swell Potential/PVR

The plasticity index test results for the sub soils are characterized to have medium to high swell potential, due to increases in the moisture content of the clay soils. The resulting vertical movement of subsoils can cause foundation displacement and distress. The magnitude of this vertical movement due to an increase in the moisture of this subsoil, can be estimated by using Potential Vertical Rise (PVR) Test Method Tex 124-E, by TX DOT. Using the Tex 124-E method, the PVR was found to be 1.6 inches. PVR is only an indication of the swell potential of the soil at the time of the investigation. The maximum swell pressure potential of this soil at the time of the soil investigation was 1000 PSF.

2. Foundation Recommendations

A suitable foundation for any structure must satisfy two basic independent criteria with respect to the underlying foundation soils. The foundation must have an adequate factor of safety against the bearing capacity of the foundation soils, and the vertical movements of the foundation due to settlement or swelling of the foundation soils must be within tolerable limits of the structure.

Various types of foundations such as Shallow Foundations and Drilled Pier Foundations are discussed below for the support of the proposed building. The underlying soil is an active clay, with medium to high shrink/swell potential. For a pier foundation design, drilled and under-reamed (bell bottom) piers are recommended for the support of the structural loads as addressed below. Parameters for shallow foundations, such as a waffle slab with stiffener interior beams or a post-tensioned slab with continuous beams, are also included for the use of your designer. It is recommended that a Geotechnical Engineer be retained to monitor the foundation construction process.

The most suitable type of foundation is determined by review of the job requirements, the logs of borings, and the test results. The most suitable depth is selected as the minimum depth below the zone of seasonal moisture fluctuations affording reasonably uniform footing support, reasonably high strength subsoil, and adequate vertical clearance with physical features of the proposed structure.

2.1 Slab-On-Grade:

The soil conditions, found from the boring logs description and laboratory testing results, are suitable for the structure to be supported on a foundation system comprised of a post-tensioned slab or a waffle slab with considerations as detailed in this report. Shallow Foundation details are included in Section 2.2.

The following are Post-Tensioning Institute, Inc (PTI) parameters for the DESIGN OF POST-TENSIONED SLABS-ON-GROUND, 3rd Edition.

Thornwaite Index: 17
Soil Suction: pF: 3.4
Activity Ratio, Ac: 0.70
Clay Type: Montmorillonite
Effective PI: 34
Climatic Index: 25
CEAc: 0.70

The VOLFLO 1.5 computer program was used for the following site stratigraphy determined from the boring logs:

Stratum 1: 0 – 8 feet, CH, PI= 34
Stratum 2: 8 – 13 feet, CL, PI= 21
Stratum 3: 13 – 15 feet, CH, PI= 54

The program predicts the edge moisture variation distance - e_m and maximum unrestrained differential soil displacement - y_m, as required by PTI for the structural design of a slab. Results are illustrated below for different grade beam depths.

Edge Moisture Variation Distance, Em:	Edge Drop = 7.8 Feet Edge Lift = 4.8 Feet
Differential Displacement (for grade beam 2 feet deep), Ym:	Swell = 1.37 inch Shrink = 1.0 inch
Differential Displacement (for grade beam 3 feet deep), Ym:	Swell = 0.85 inch Shrink = 0.67 inch
Differential Displacement (for grade beam 3.5 feet deep), Ym:	Swell = 0.64 inch Shrink = 0.53 inch

2.2 Shallow Foundations:

After proper site preparation, continuous beams founded at the 3 foot depth below final grade, to provide additional support for the slab-on-grade, should be proportioned for a safe bearing capacity of 1750 PSF. This value incorporates a safety factor of over 2.

2.3 Drilled Piers:

Drilled piers founded at a depth of 12 feet below existing grade should be proportioned for a safe bearing capacity of 4500 PSF for total dead and live loads incorporating a minimum safety factor of 2. For total dead and sustained live loads, the footings should be proportioned for a safe bearing capacity of 3000 PSF incorporating a minimum safety factor of 3. A shaft to bell ratio between 1:2 and 1:3 is recommended. If sloughing occurs, straight-sided piers with an increased diameter could be used. Casing and/or dewatering of the pier excavations may be required, especially during the rainy season. It is recommended that pilot borings be made to verify the integrity of the soil to the bearing depth.

SUPPLEMENTAL DATA

As water evaporates, it is replaced through capillary action by water from below. When a slab is constructed, the evaporation is effectively cut off from the surface. However, the moisture continues to be drawn upward until a balanced condition is attained. Along the edges, the moisture can evaporate, but not toward the middle of the slab. The difference in moisture content can cause differential volume change and can induce stress that will produce distress in the slab. Analysis by VOLFLO is performed to estimate these differential volume changes.

There are several approaches to minimizing moisture loss around the edges due to evaporation. Deep beams can be effective, and it is recommended. Flower beds kept continually wet around the periphery of the slab have been found to be effective. Extending the periphery of the drying area beyond the slab by lime stabilizing and/or paving a four (4) foot strip around the slab can also be beneficial.

PVR (Potential Vertical Rise) is the theoretical possible movement in a swelling situation being more substantial in high plasticity clay. Since the PVR curves are based on the soil index, Liquid Limit, and the moisture content of the soil, this value can vary with changes in moisture content. The largest range is from a "bone dry" state to a wet (saturated) state. This value is not a design parameter, but, rather a "red flag" that can indicate the possibility of swell in dry soil. In a high plasticity clay with a high moisture content, the PVR is low when compared to the dry condition.

The addition of select fill is a rational attempt to reduce the effective plasticity index of the soil, thereby, reducing the shrink/swell potential. All drain spouts should be extended, and hose connections & sprinkler systems placed, at a distance that is substantially away from the building to prevent spillage that may infiltrate the soil.

Where trees are removed, the voids should be wetted in the areas of high plasticity clay, pre-swelling the soil, and should be backfilled as addressed under site preparation.

All trees should be planted at a minimum distance equivalent to the height of the mature tree, and the drip line should be kept at a minimum distance of 10 feet away from the structure if space allows. Plants that require constant watering should not be planted next to the structure.

Location of Test Borings
** NOT TO SCALE **

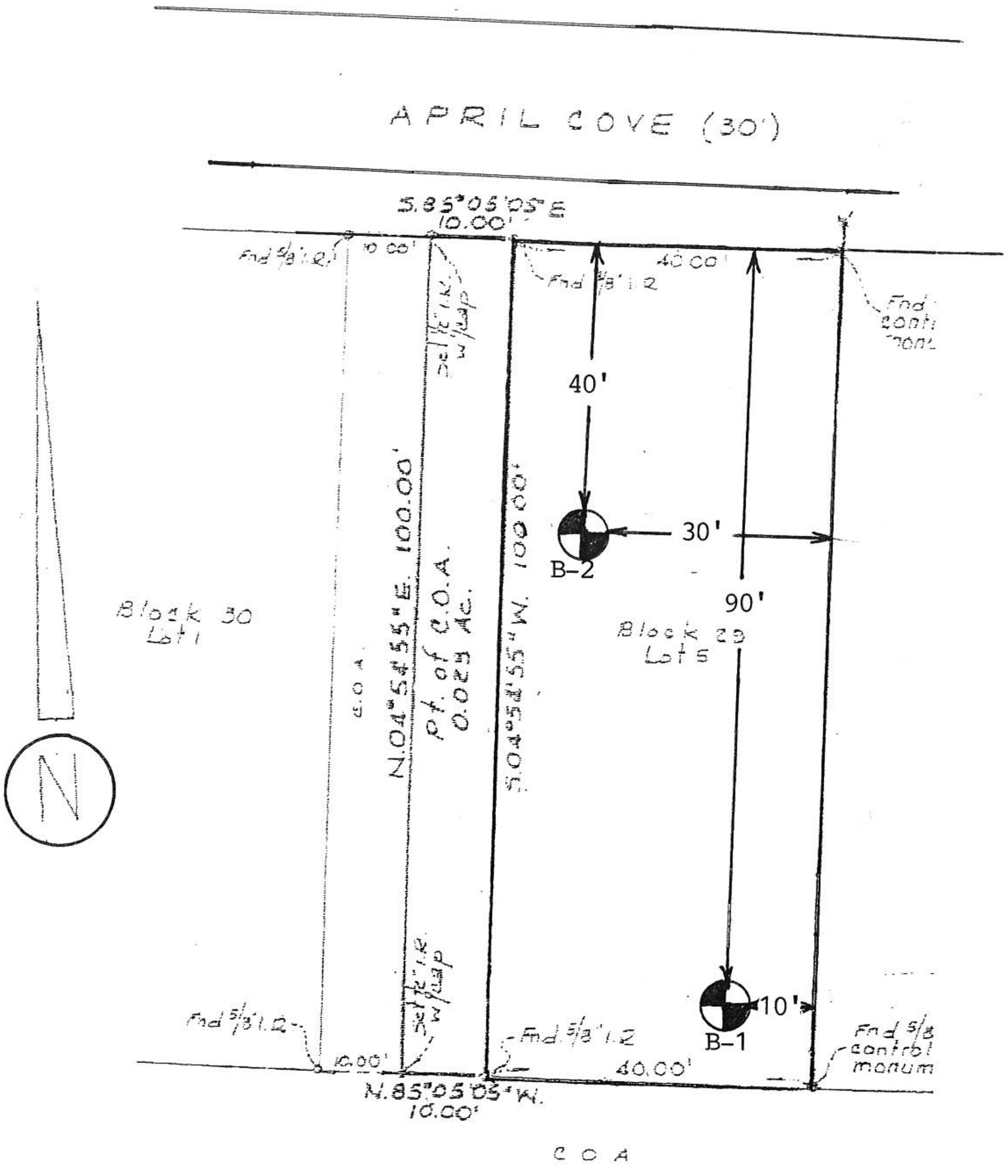

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Figure 1

LOG OF BORING
BORING NO: B-1

PROJECT: Residence at 168 April Cove
FOR: Chadwick Homes

DATE: 7-21-2020
DRILLER: J H Drilling

JOB NO: 2007-031
BORING METHOD: Core
AUGER: X
WASH:
GROUND ELEV: Existing

■ Shelby Tube
☒ Standard Penetration Test
▨ No Recovery
▽ Initial Water Level
▼ Water Level After

Depth (Feet)	Sample Method	Water Levels	Penetrometer or Blow Count	Compressive Strength Tons/Sq. Ft.	Moisture Content (%)	Dry Density Lbs./Cu. Ft.	Liquid Limit %	Plasticity Index	
	■		4.5		24		53	34	Hard, dark gray & brown clay(CH)
	■		4.5		21				...tan, with calcareous nodules
5	■		4.2		20				...same
	■		4.5		21				...tan & light gray
	■		3.4	1.5	21	98	38	21	Stiff, tan & light gray sandy clay(CL)
10	■								
	■		4.5		29				Hard, tan & light gray clay(CH)
15									

Boring terminated at 15'
No ground water encountered

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LOG OF BORING

BORING NO: B-2

PROJECT: Residence at 168 April Cove
FOR: Chadwick Homes

DATE: 7-21-2020
DRILLER: J H Drilling

JOB NO: 2007-031
BORING METHOD: Core
AUGER: X
WASH:
GROUND ELEV: Existing

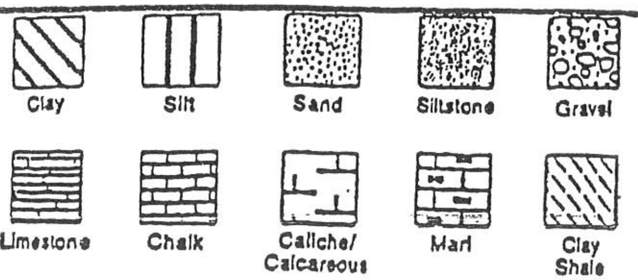
- ■ Shelby Tube
- ☒ Standard Penetration Test
- ▨ No Recovery
- ▽ Initial Water Level
- ▼ Water Level After

Depth (Feet)	Sample Method	Water Levels	Penetrometer or Blow Count	Compressive Strength Tons/Sq. Ft.	Moisture Content (%)	Dry Density Lbs./Cu. Ft.	Liquid Limit %	Plasticity Index	
	■		4.0		25				Hard, dark gray clay(CH)
	■		3.4	1.6	24	96	51	32	...stiff, dark gray & brown
5	■		4.5		21				...hard, tan, with calcareous nodules
	■		4.5		23				...tan & light gray
	■		4.0		17				Hard, tan & light gray sandy clay(CL)
10									
	■		4.5	2.2	29	91	81	54	Very stiff, tan & light gray clay(CH)
15									

Boring terminated at 15'
No ground water encountered

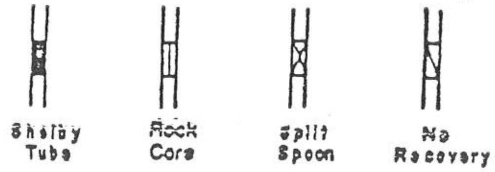
Lone Star Geotechnical & Testing Laboratory, Inc.

SYMBOLS AND TERMS USED ON BORING LOGS



SAMPLER TYPES

(SHOWN IN SAMPLES COLUMN)



TERMS DESCRIBING CONSISTENCY OR CONDITION

COARSE GRAINED SOILS (Major Portion Retained on No.200 Sieve): Includes (1) clean gravels and sands, and (2) silty or clayey gravels and sands. Condition is rated according to relative density, as determined by laboratory tests.

Descriptive Term	Standard Penetration, Resistance, Blows/Ft.	Relative Density
Loose	0 - 10	0 to 40%
Medium dense	10 - 30	40 to 70%
Dense	30 - 50	70 to 100%

FINE GRAINED SOILS (Major portion passing No. 200 sieve): Includes (1) inorganic and organic silts and clays, (2) gravelly, sandy, or silty clays, and (3) clayey silts. Consistency is rated according to shearing strength, as indicated by penetrometer readings or by unconfined compression tests.

DESCRIPTIVE TERM	UNCONFINED COMPRESSIVE STRENGTH TONS / Sq. Ft.
Very soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	4.00 and higher

Note: Slickensided and fissured clays may have lower unconfined compressive strengths than shown above, because of planes of weakness or cracks in the soil. The consistency ratings of such soils are based on penetrometer readings.

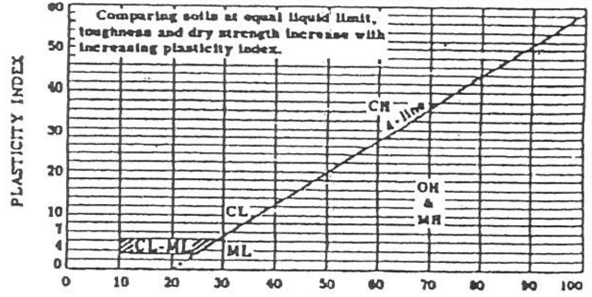
TERMS CHARACTERIZING SOIL STRUCTURE

Parting: - paper thin in size   Seam: - 1/8"-3" thick   Layer: - greater than 3"

Slickensided	- having inclined planes of weakness that are slick and glossy in appearance.
Fissured	- containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical.
Laminated	- composed of thin layers of varying color and texture.
Interbedded	- composed of alternate layers of different soil types.
Calcareous	- containing appreciable quantities of calcium carbonate.
Well graded	- having wide range in grain sizes and substantial amounts of all intermediate particle sizes.
Poorly graded	- predominantly of one grain size, or having a range of sizes with some intermediate size missing.
Flocculated	- pertaining to cohesive soils that exhibit a loose knit or flakey structure.

LONE STAR GEOTECHNICAL & TESTING LABORATORY, INC.

UNIFIED SOIL CLASSIFICATION SYSTEM

Major Divisions			Group Symbols	Typical Names	Field Identification Procedures (excluding particles larger than 3 in. and basing fractions on estimated weights)			Information Required for Describing Soils	Laboratory Classification Criteria			
(1)	(2)		(3)	(4)	(5)			(6)	(7)			
Coarse-grained Soils (More than half of material is larger than No. 200-sieve size.) (The No. 200-sieve size is about the smallest particle visible to the naked eye.)	Gravels (More than half of coarse fraction is larger than No. 4-sieve size.) (For visual classification, the 1/4-in. size may be used as equivalent to the No. 4-sieve size.)	Clean Gravels (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Wide range in grain sizes and substantial amounts of all intermediate particle sizes			For undisturbed soils, add information on stratification, degree of compactness, cementation, moisture conditions, and drainage characteristics. Give typical name; indicate approximate percentages of sand and gravel; maximum size; angularity, surface condition and hardness of the coarse grains; local or geologic name and other pertinent descriptive information; and symbol in parentheses. Example: Silty sand, gravelly; about 20% hard, angular gravel; particles 1/2-in. maximum size; rounded and subangular sand grains coarse to fine; about 15% nonplastic fines with low dry strength; well compacted and moist in place; alluvial sand; (SM).	Use grain-size curve in identifying the fractions as given under field identification.	Determine percentages of gravel and sand from grain-size curve. Depending on percentage of fines (fraction smaller than No. 200-sieve size), coarse-grained soils are classified as follows: Less than 5% GW, GP, SW, SP More than 12% GM, GC, SM, SC 5% to 12% Borderline cases requiring use of dual symbols.	$C_u = \frac{D_{60}}{D_{10}}$ (greater than 6) $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ (between one and 3)	
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Predominantly one size or a range of sizes with some intermediate sizes missing						Not meeting all gradation requirements for GW	
		Gravels with Fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures	Nonplastic fines or fines with low plasticity (for identification procedures see ML below)						Atterberg limits below A-line or PI less than 4	Above A-line with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			GC	Clayey gravels, gravel-sand-clay mixtures	Plastic fines (for identification procedures see CL below)						Atterberg limits above A-line with PI 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	Wide range in grain size and substantial amounts of all intermediate particle sizes						$C_u = \frac{D_{60}}{D_{10}}$ (greater than 4) $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ (between one and 3)	
			SP	Poorly graded sands, gravelly sands, little or no fines	Predominantly one size or a range of sizes with some intermediate sizes missing						Not meeting all gradation requirements for SW	
		Sands with Fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures	Nonplastic fines or fines with low plasticity (for identification procedures see ML below)						Atterberg limits below A-line or PI less than 4	Limits plotting in hatched zone with PI between 4 and 7 are borderline cases requiring use of dual symbols.
			SC	Clayey sands, sand-clay mixtures	Plastic fines (for identification procedures see CL below)						Atterberg limits above A-line with PI greater than 7	
Fine-grained Soils (More than half of material is smaller than No. 200-sieve size.)	Silts and Clays (Liquid limit less than 50)				Identification Procedures on Fraction Smaller than No. 40-Sieve Size					 Liquid Limit Plasticity Chart (for laboratory classification of fine-grained soils)		
					Dry Strength (Crushing characteristics)	Dilatancy (Reaction to shaking)	Toughness (Consistency near PL)					
			ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	None to slight	Quick to slow	None	Give typical name; indicate degree and character of plasticity; amount and maximum size of coarse grains; color in wet condition, odor if any, local or geologic name, and other pertinent descriptive information; and symbol in parentheses. For undisturbed soils add information on structure, stratification, consistency in undisturbed and remolded states, moisture and drainage conditions. Example: Clayey silt, brown, slightly plastic, small percentage of fine sand, numerous vertical root holes, firm and dry in place, loess, (ML).				
			CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	Medium to high	None to very slow	Medium					
			OL	Organic silts and organic silty clays of low plasticity	Slight to medium	Slow	Slight					
	Silts and Clays (Liquid limit greater than 50)		MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	Slight to medium	Slow to none	Slight to medium					
			CH	Inorganic clays of high plasticity, fat clays	High to very high	None	High					
			OH	Organic clays of medium to high plasticity, organic silts	Medium to high	None to very slow	Slight to medium					
Highly Organic Soils			Pt	Peat and other highly organic soils	Readily identified by color, odor, spongy feel, and frequently by fibrous texture							

(1) Boundary classifications: Soils possessing characteristics of two groups are designated by combinations of group symbols, for example, GW-GC, well-graded gravel-sand mixture with clay binder.

(2) All sieve sizes on this chart are U. S. standard.

Field Identification Procedures for Fine-grained Soils or Fractions

These procedures are to be performed on the minus No. 40-sieve-size particles, approximately 1/64 in. For field classification purposes, screening is not intended; simply remove by hand the coarse particles that interfere with the tests.

Dilatancy (reaction to shaking)

After removing particles larger than No. 40-sieve size, prepare a pat of moist soil with a volume of about 1/2 cu. in. Add enough water if necessary to make the soil soft but not sticky.

Place the pat in the open palm of one hand and shake horizontally, striking vigorously against the other hand several times. A positive reaction consists of the appearance of water on the surface of the pat, which changes to a livery consistency and becomes glossy. When the sample is squeezed between the fingers, the water and gloss disappear from the surface, the pat stiffens, and finally it cracks or crumbles. The rapidity of appearance of water during shaking and of its disappearance during squeezing assist in identifying the character of the fines in a soil.

Very fine clean sands give the quickest and most distinct reaction, whereas a plastic clay has no reaction. Inorganic silts, such as a typical rock flour, show a moderately quick reaction.

Dry Strength (crushing characteristics)

After removing particles larger than No. 40-sieve size, mold a pat of soil to the consistency of putty, adding water if necessary. Allow the pat to dry completely by oven, sun, or air drying, and then test its strength by breaking and crumbling it between the fingers. This strength is a measure of the character and quantity of the colloidal fraction contained in the soil. The dry strength increases with increasing plasticity.

High dry strength is characteristic for clays of the CH group. A typical inorganic silt possesses only very slight dry strength. Silty fine sands and silts have about the same slight dry strength but can be distinguished by the feel when powdering the dried specimen. Fine sand feels gritty, whereas a typical silt has the smooth feel of flour.

Toughness (consistency near plastic limit)

After removing particles larger than the No. 40-sieve size, a specimen of soil about 1/2-in. cube in size is molded to the consistency of putty. If too dry, water must be added, and if sticky, the specimen should be spread out in a thin layer and allowed to lose some moisture by evaporation. Then the specimen is rolled out by hand on a smooth surface or between the palms into a thread about 1/8 in. in diameter. The thread is then folded and rerolled repeatedly. During this manipulation the moisture content is gradually reduced and the specimen stiffens, finally loses its plasticity, and crumbles when the plastic limit is reached.

After the thread crumbles, the pieces should be lumped together and a slight kneading action continued until the lump crumbles.

The tougher the thread near the plastic limit and the stiffer the lump when it finally crumbles, the more potent is the colloidal clay fraction in the soil. Weakness of the thread at the plastic limit and quick loss of coherence of the lump below the plastic limit indicate either inorganic clay of low plasticity or materials such as kaolin-type clays and organic clays which occur below the A-line.

Highly organic clays have a very weak and spongy feel at the plastic limit.

Adopted by Corps of Engineers and Bureau of Reclamation. January, 1952.