LONE STAR GEOTECHNICAL & TESTING LABORATORY, INC.

P.O. BOX 60791 • HOUSTON, TEXAS 77205

(281) 441-1462 • FAX: (281) 441-2367

Texas Registered Engineering Firm F-2615

February 20, 2023

[redacted]

Re: Soil Foundation Investigation
Residence on Inscription Lane at Sky Oak Lane
Lot 5, Block 26, Texas Grand Ranch Subdivision Section 5
Walker County, Texas

Project No.: 2302-001
Report No.: 2302001-1

[redacted]

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

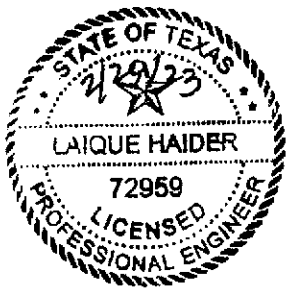
This investigation reveals loose sand, underlain by stiff to hard, low to medium plasticity sandy clay extending to the maximum explored depth. This soil is suitable for shallow foundations or drilled piers with considerations as addressed in this report.

For a pier supported structure, it is recommended that the structural loads be supported on drilled piers founded at the 11-foot depth below existing grade and be proportioned for 4500 PSF for total dead and live loads. Parameters for a slab-on-grade foundation system supported on continuous beams, such as a post-tensioned slab or a conventional slab; and spread/strip footing foundations 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.



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PLATES AND CHARTS

SUBJECT: REPORT OF SOIL FOUNDATION INVESTIGATION
RESIDENCE ON INSCRIPTION LANE AT SKY OAK LANE
LOT 5, BLOCK 26, TEXAS GRAND RANCH SUBDIVISION SECTION 5
WALKER COUNTY, TEXAS

TO: [redacted]

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 encountered and optimum type and depth of structural foundation. The investigation was made in accordance with your instructions.

PROCEDURES: FIELD

Two (2) borings were made to a depth of 20 feet each, at the locations as shown on the Locations of Test Boring plate - Figure 1. The borings were made with a truck mounted, LS-300 rotary drill rig using no drilling water in order to secure unaffected soil samples and reliable data on groundwater levels. Cohesive soil was sampled by pushing thin-walled Shelby tube samplers into the soil in accordance with ASTM Procedure D1587. The relative density of the sand was determined by noting the resistance to penetration of 2-inch split spoon samplers driven by a 140 pound hammer dropping 30 inches per blow in conformance with ASTM Standard Procedure ASTM D-1586, as in the Standard Penetration Test. 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 CI-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
Materials Finer than No. 200 Sieve	ASTM D1140
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 4,400 square foot, 1-story residence with wood frame and brick exterior, and with an attached garage. Wall loads are not known at this time but are not expected to exceed 1 kip per foot. The pier/column loads are not known but are not expected to exceed 15 kips. Slope stability analysis is not included in the scope of the project. The soil investigation was authorized by William Ferebee, the owner.

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 relatively level lot (with uneven terrain), with trees, fronting on Inscription Lane at Sky Oak Lane, and located in the Texas Grand Ranch subdivision near Huntsville in Walker 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 loose, brown sand, to a depth of 4 feet; underlain by stiff to hard, reddish tan low to medium plasticity sandy clay, with ferrous nodules, extending to the maximum explored depth of 20 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 groundwater 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:

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 of the standard penetration tests 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:

The building area should be levelled as necessary to ensure a level foundation and positive drainage. 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) The surficial sand, where encountered in the building area, should be stabilized with 5% Portland Cement or 10% Fly Ash (Class C), to a minimum depth of 2 feet, or it should be removed and replaced with compacted select fill, after positive proof-rolling of the underlying soil.

3) For slab-on-grade construction, a minimum of 12 inches of structural fill is recommended over the stabilized sand. The building floor elevation can be controlled by removal of the surface soil or placement of structural fill. 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 to 40. The plasticity index (PI) should be in the range 10 to 20. The structural fill should be compacted in 6 inch lifts 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 building pad should extend a minimum of 3 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.

6) For a structurally isolated slab with a crawl space or void boxes (6 inches thick), only stripping, proof rolling and proper grading for positive drainage away from the building are required.

1.0 Shallow Foundations:

1.1 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 conventional reinforced slab, with considerations as detailed in this report. Slab-On-Grade Foundation details are included in Section 1.1.1.

The following are Post-Tensioning Institute, Inc (PTI) parameters for the DESIGN OF POST-TENSIONED SLABS-ON-GROUND, 3rd Edition. For a design on an inactive site, the commonly used parameters are:

Thornwaite Index: 17
Soil Suction: pF: 3.4
Effective PI: 15, Climatic Index: 25
Em: 9 feet (center lift), 5.5 feet (edge lift)
Ym: 0.47 (Swell), 0.35 (Shrink)

1.1.1 Slab-On-Grade Foundations:

After proper site preparation, continuous beams founded at a minimum depth of 2 feet below final grade, on the stabilized sands (or select fill if sand is replaced), should be proportioned for a safe bearing capacity of 1300 PSF. This value incorporates a safety factor of over 2.

1.2 Spread/Strip Footing Foundations:

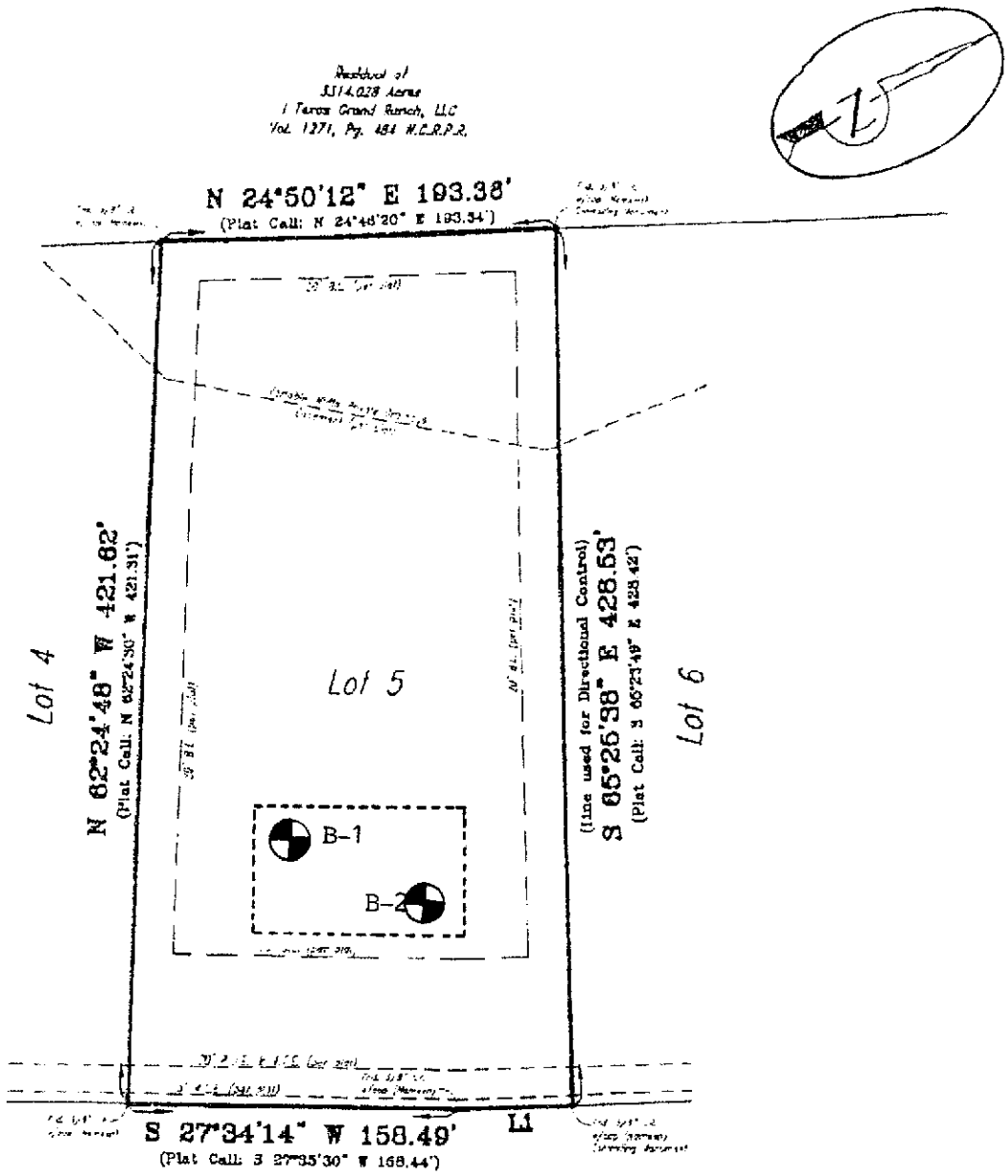
After proper site preparation, isolated spread (pad) footings or continuous strip (wall) footings founded at a minimum depth of 5 feet below existing grade, on the existing sandy clay stratum, should be proportioned for a safe bearing capacity of 3000 PSF for total dead and live loads. This value incorporates a minimum safety factor of 2.

2.0 Drilled Piers:

Drilled Piers founded at a depth of 11 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. The piers should be spaced (edge to edge at bell) at a minimum of 2 bell diameters. 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 prior to the start of construction, to verify the integrity of the soil to the bearing depth.

Location of Test Borings

** NOT TO SCALE **



Project No.: 2302-001
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Figure 1

LOG OF BORING

BORING NO: B-1

PROJECT: Texas Grand Ranch S/D
Residence at Lot 5, Block 26, Section 5

FOR: William C. Ferebee

JOB NO: 2302-001

BORING METHOD: Core

AUGER: X

WASH:

DATE: 2-8-2023

DRILLER: DLT Drilling

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	
					8				Brown sand(SM)
			6		8			NP	...loose Minus #200: 15%
5			4.5		18				Hard, reddish tan sandy clay(CL)
			4.5		10				...with sand seams
			4.5	1.2	10	102	23	8	...stiff
10									
			4.5		9				...hard
15									
			4.5		10				...same
20									

Boring terminated at 20'
No groundwater encountered

Lone Star Geotechnical & Testing Laboratory, Inc.

LOG OF BORING

BORING NO: B-2

PROJECT: Texas Grand Ranch S/D
Residence at Lot 5, Block 26, Section 5

FOR: William C. Ferebee

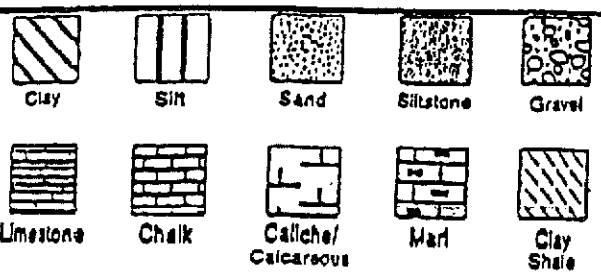
JOB NO: 2302-001
BORING METHOD: Core
AUGER: X
WASH:
GROUND ELEV: Existing

DATE: 2-8-2023
DRILLER: DLT Drilling

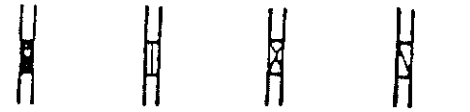
Depth (Feet)	Sample Method	Water Levels	Penetrometer or Blow Count	Compressive Strength Tons/Sq. Ft.	Moisture Content (%)	Dry Density Lbs./Cu. Ft.	Liquid Limit %	Plasticity Index	
					10				Brown sand(SM)
			7		7				...loose
5			4.0	2.1	21	104	40	23	Very stiff, reddish tan sandy clay(CL), with ferrous nodules
			4.5		11				...hard
			4.5		10				...same
10									
			4.5	1.0	9	99	22	8	...stiff
15									
			4.5		9				...hard
20									
									Boring terminated at 20'
									No groundwater encountered

Shelby Tube
Standard Penetration Test
No Recovery
Initial Water Level
Water Level After

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.

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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.)	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).	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.
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines	Predominantly one size or a range of sizes with some intermediate sizes missing		
		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)		
			GC	Clayey gravels, gravel-sand-clay mixtures	Plastic fines (for identification procedures see CL below)		
	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 sizes and substantial amounts of all intermediate particle sizes		
			SP	Poorly graded sands, gravelly sands, little or no fines	Predominantly one size or a range of sizes with some intermediate sizes missing		
		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)		
			SC	Clayey sands, sand-clay mixtures	Plastic fines (for identification procedures see CL below)		
Fine-grained Soils (More than half of material is smaller than No. 200-sieve size.) (The No. 200 sieve size is about the smallest particle visible to the naked eye.)	Silts and Clays (Liquid limit less than 50)				Identification Procedures on Fraction Smaller than No. 40 Sieve Size		
					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).	Use grain-size curve in identifying the fractions as given under field identification.
			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		

Laboratory Classification Criteria

$C_u = \frac{D_{60}}{D_{10}}$ (greater than 6) $\quad C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$ (between one and 3)

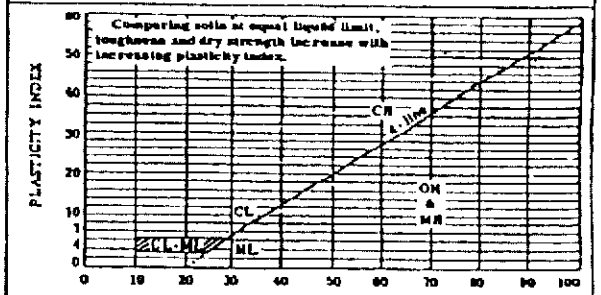
Not meeting all gradation requirements for GW

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.
Atterberg limits above A-line with PI greater than 7	

$C_u = \frac{D_{60}}{D_{10}}$ (greater than 4) $\quad C_c = \frac{(D_{30})^2}{D_{60} \times D_{10}}$ (between one and 3)

Not meeting all gradation requirements for SW

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.
Atterberg limits above A-line with PI greater than 7	



Liquid Limit Plasticity Chart
(For laboratory classification of fine-grained soils)

(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.