

January 18, 2019
Project No.: 1150-1C

Mr. Dan Zaich, Ed.D
Senior Director – Capital Facilities
San Rafael City Schools
310 Nova Albion Way
San Rafael, CA 94903
dzaich@srcs.org

**RE: Summary of Supplemental Test Pit Investigation & Geotechnical Recommendations
Terra Linda High School Student Commons Project
San Rafael, California**

Dear Mr. Zaich:

This letter presents a summary of A3GEO's recent supplemental test pit investigation, performed on 10 January 2019 at the Terra Linda High School Student Commons Project site in San Rafael, California. A3GEO's work was performed in accordance with the scope of work outlined in our 28 December 2018 proposal, and your subsequent authorization. Previously, A3GEO conducted a design-level geotechnical investigation for the subject project and presented the results in a report titled "Design Level Geotechnical Investigation and Geologic Hazards Study Report, Terra Linda High School, 320 Nova Albion Way, San Rafael, Marin County, California", dated 16 February 2018.

BACKGROUND & SCOPE

Our 16 February 2018 Design Level Geotechnical Investigation and Geologic Hazards Study Report discussed the presence of a surficial layer of expansive soils present near ground surface in portions of the site. The presence of this layer was determined by: 1) visual-manual observation of fat clays near ground surface in parts of the site; and 2) measured plasticity index (PI) values of 17 or greater in shallow soils in at least four locations in the general vicinity of the proposed Student Commons. Expansive materials have the potential to damage overlying improvements unless mitigated. Our report recommended the following mitigation measures be incorporated into the project design to mitigate the potentially damaging effects of expansive soils:

- Footings for the new Student Commons should be founded on deepened spread footings, bearing a minimum of 30 inches below the lowest adjacent firm finished grade, below the depth of shrink-swell behavior;
- The lowest level slab for the Student Commons should be designed as a soil-supported slab-on-grade, underlain by at least 18 inches of Non-Expansive Fill. Specifically, the upper 6 inches of this layer should consist of a moisture retarder comprised of 6 inches of compacted AB, overlain by a heavy-duty impermeable membrane (Stego® wrap 15-mil or an approved equivalent), installed and taped in accordance with the manufacturer's recommendations. The aggregate base should be underlain by a 12-inch thick layer of Non-Expansive Fill; and
- Exterior flatwork, including patios, sidewalks, and both asphalt-concrete (AC) and Portland cement concrete (PCC) pavements, should be underlain by a minimum 12-inch thick layer of Non-Expansive Fill.

On 28 December 2018, A3GEO participated in a conference call with representatives of the San Rafael City Schools and the contractor regarding the potential for value engineering related to the aforementioned geotechnical recommendations. Specifically, the team inquired whether it was possible to eliminate or modify the existing geotechnical recommendations for: 1) a 12 inch thick layer of Non-Expansive Fill below the 6-inch AB layer of AB below the lowest level building slab; and 2) a 12-inch thick layer of Non-Expansive Fill below exterior flatwork sections.

In response to the team's questions, A3GEO proposed collection of supplemental shallow soil samples for Atterberg Limits analysis. The objective of the supplemental study was to evaluate Atterberg Limits data, including PI and Liquid Limit (LL), from the supplemental samples alongside existing data from previous investigations, and to subsequently determine whether the existing geotechnical recommendations, summarized above, could be modified.

SUPPLEMENTAL SUBSURFACE INVESTIGATIONS

On January 10, A3GEO collected soil samples from five test pits, identified as TP-1 through TP-5, with locations shown on Figure 1. Test pit locations were selected by A3GEO, but excavation was coordinated and executed by the contractor, Greystone West Company. Test pits were excavated to total depths ranging from approximately 3.0 to 4.0 feet (ft) below ground surface (bgs). For each pit, the contractor surveyed both the ground surface elevation surrounding the pit, and the elevation of the bottom of the pit. Elevations (El.s) in this memo are reported in ft and reference the North American Vertical Datum of 1988 (NAVD 88).

Subsurface conditions were observed to be relatively uniform across the pits. A description of subsurface strata encountered is provided below:

- *Gravel pad* – approximately 3 to 5 inches of gravel fill, placed following demolition of the previously existing structures, was encountered at the top of each pit.
- *Dark brown sandy clay* – a layer of dark brown sandy clay, interpreted to be naturally deposited alluvium/colluvium, was encountered immediately below the gravel pad in each of the five test pits. The thickness of the dark brown sandy clay ranged from approximately 0.5 to 2.1 ft.
- *Yellow/orange-brown sandy clay* – a layer of yellow/orange-brown sandy clay, interpreted to be naturally deposited alluvium/colluvium, was encountered immediately below the dark brown sandy clay in each of the five test pits. The bottom of this unit was not encountered in any of the pits.

A summary of the subsurface conditions encountered in each pit is provided in the table below:

Summary of Subsurface Conditions Encountered in Test Pits

Test Pit ID	Ground Surface El.	Total Pit Depth	Gravel Pad		Dark Brown Sandy Clay		Yellow/Orange-Brown Sandy Clay	
			Depth to Top	Thickness	Depth to Top	Thickness	Depth to Top	Thickness
	[ft]	[ft]	[ft]	[ft]	[ft]	[ft]	[ft]	[ft]
TP-1	77.9	3.2	0.0	0.4	0.4	2.1	2.5	>0.7
TP-2	78.4	3.0	0.0	0.3	0.3	0.8	1.0	>2
TP-3	80.0	3.1	0.0	0.3	0.3	1.2	1.5	>1.6
TP-4	80.9	4.0	0.0	0.3	0.3	1.0	1.3	>2.8
TP-5	80.9	4.0	0.0	0.3	0.3	0.5	0.8	>3.3

Water was encountered in test pits TP-4 and TP-5 at depths of approximately 3.6 and 3.8 ft bgs, respectively, corresponding to approximately El. 77.3 and El. 77.1.

Plasticity Index (PI) Analysis

Soil samples were collected from various depths within the test pits, and were transported back to A3GEO's laboratory in Berkeley, California, for review. Following review, five samples were selected for PI testing

(Atterberg Limits), following ASTM D4318. Generally, samples were selected to target both the dark brown sandy clay layer and the underlying yellow/orange-brown sandy clay. Geotechnical laboratory testing was performed by B. Hillebrandt Soils Testing, Inc., of Alamo, California. Geotechnical laboratory testing data sheets from this study are attached as Attachment A.

A summary of the results of geotechnical laboratory testing results from this study, together with data collected during previous A3GEO studies, is presented in the table below. Data is also summarized on Figure 1.

Summary of Atterberg Limits Data

Test Pit ID	Sample Depth	Liquid Limit (LL)	Plastic Limit (PL)	Plasticity Index (PI) ¹
	[ft]			
TP-1	1.0	33	18	15
TP-1	3.0	47	19	28
TP-2	1.5	25	17	8
TP-4	0.5	32	18	14
TP-4	2.0	37	18	19
A3-17-4	3.0 - 3.5	37	17	20
A3-17-8	6.0 – 6.5	39	18	21
A3-17-9	3.0 – 3.5	33	16	17
B-2	1.0	37	17	20

Based on the available data for samples within the general vicinity of the proposed Student Commons building and patio, the PI of the shallow soils typically ranges from approximately 15 to 21, with liquid limit (LL) generally ranging from approximately 32 to 39.

GEOTECHNICAL CONCLUSIONS & RECOMMENDATIONS

PI and LL values observed in recent test pits were generally consistent with those observed during earlier investigative phases, and indicate that shallow soils at the site have a “moderate” expansion potential. As such, the recommendations for mitigation of expansive soils and subgrade preparation contained in our 16 February 2018 Geotechnical Investigation and Geologic Hazards Study Report remain unchanged.

Reuse of Excavated Material

Over-excavated soils within the footprints of the proposed Student Commons building and exterior flatwork areas will likely be acceptable for use as General Fill, provided it can be processed (i.e. by sorting or crushing) to meet the requirements stated in our Geotechnical Report. General Fill can be used anywhere except where Non-Expansive Fill is required.

¹ Note, PI = LL - PL

CLOSURE

The conclusions and recommendations presented in this letter were developed in accordance with generally-accepted geotechnical principles and practices at the time this letter was prepared. No other warranty, expressed or implied, is made.

Thank you for inviting us to complete this work, and we look forward to our continued service on this project. Should you have any questions or concerns regarding our findings, the design concepts discussed, or our recommendations, please do not hesitate to call.

Sincerely,

A3GEO, Inc.



Laura Buchanan, PE
Senior Engineer
(510) 919-0280

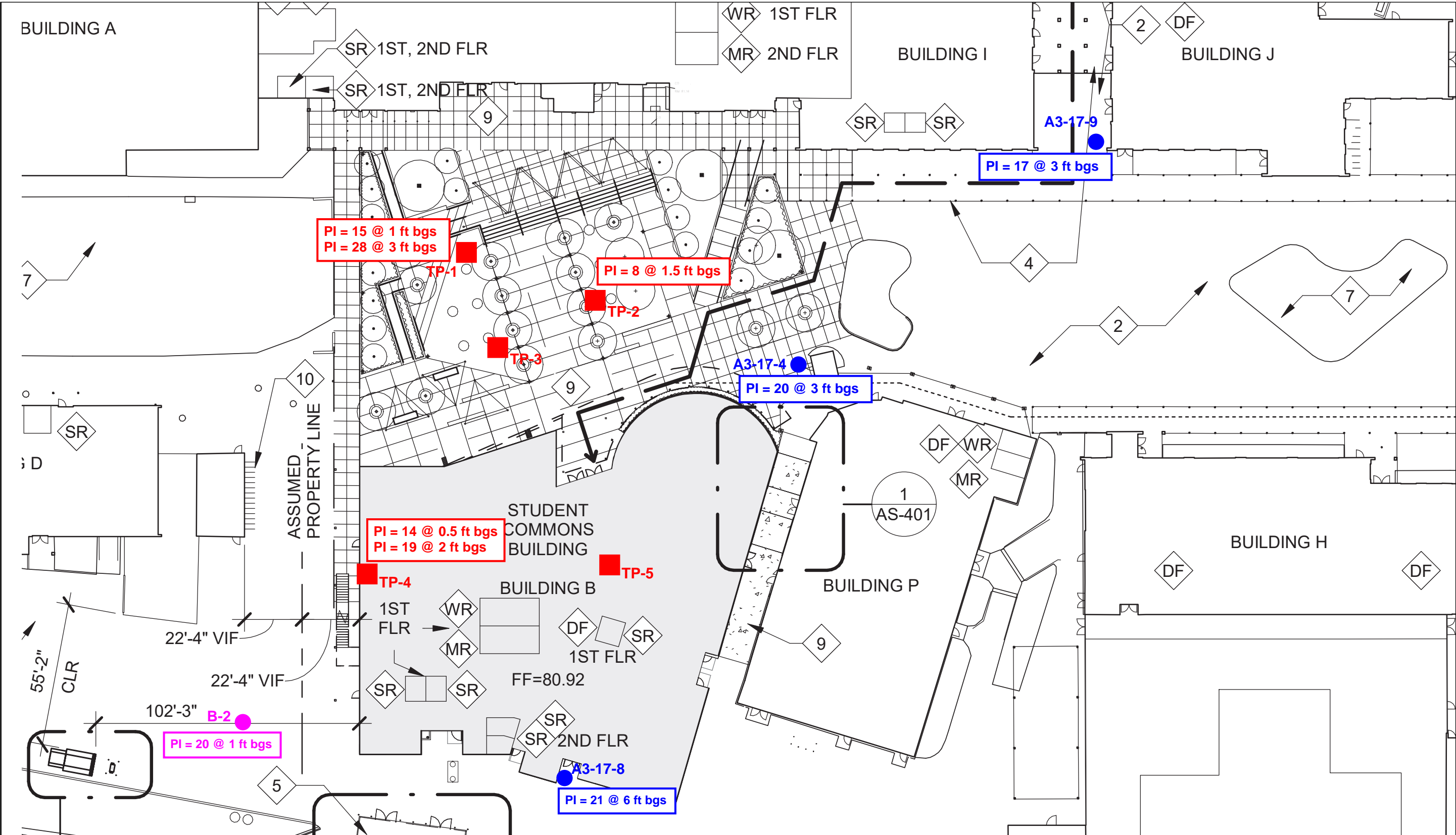


Wayne Magnusen, PE, GE
Principal Engineer
(510) 325-5724



Attachments: Figure 1 – Locations of Test Pits and PI Samples
Attachment A – Geotechnical Laboratory Testing Data Sheets

Figures



A3-17-4

●

A3GEO PHASE 2 TEST BORING (NOV. 2017)

B-2

●

A3GEO PHASE 1 TEST BORING (FEB. 2017)

TP-1

■

TEST PIT (JAN. 2019)

EXPLANATION

Indicates Plasticity Index (PI) measured by laboratory testing

PI = 20 @ 4 ft bgs

Indicates sample depth, where:
ft = feet
bgs = depth below ground surface

TERRA LINDA HIGH SCHOOL
SAN RAFAEL, CALIFORNIA

Project No. 1150-1C

LOCATIONS OF TEST PITS & PI SAMPLES

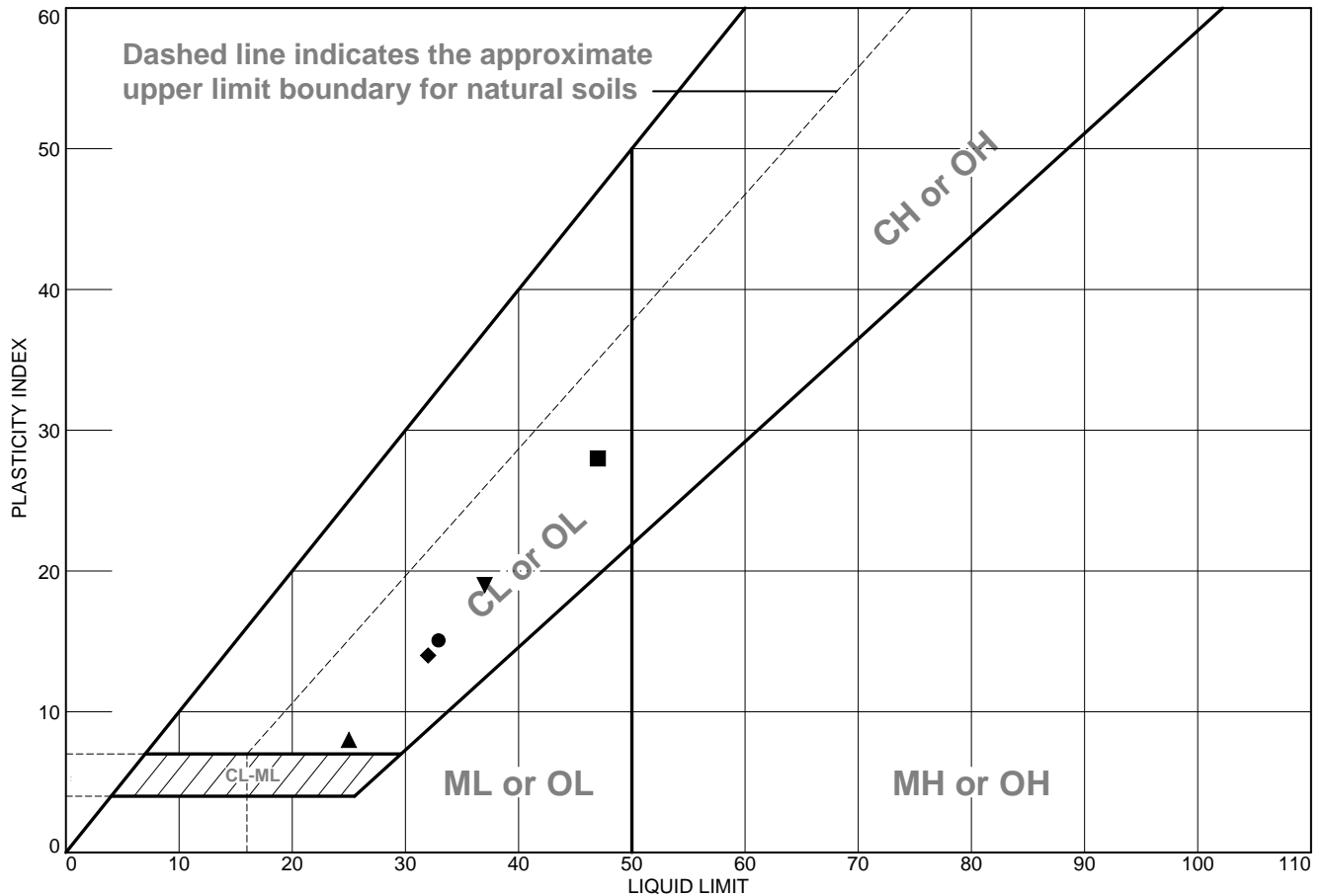
A3GEO

FIGURE 1

Attachment A

Geotechnical Laboratory Testing Data Sheets

LIQUID AND PLASTIC LIMITS TEST REPORT



MATERIAL DESCRIPTION		LL	PL	PI	%<#40	%<#200	USCS
●	Dark brown lean CLAY with sand	33	18	15			CL
■	Olive brown lean CLAY with some sand	47	19	28			CL
▲	Brown sandy lean CLAY	25	17	8			CL
◆	Dark brown sandy CLAY	32	18	14			CL
▼	Yellowish brown sandy lean CLAY	37	18	19			CL

Project No. 1150-1C Client: A3Geo Project: Terra Linda High School ● Source of Sample: TP-1 Depth: 1.0' ■ Source of Sample: TP-1 Depth: 3.0' ▲ Source of Sample: TP-2 Depth: 1.5' ◆ Source of Sample: TP-4 Depth: 0.5' ▼ Source of Sample: TP-4 Depth: 2.0'	Remarks:
B. HILLEBRANDT SOILS TESTING, INC. +1 510-409-2816 SoilTesting@aol.com	Figure

Tested By: BH _____

LIQUID AND PLASTIC LIMIT TEST DATA

1/17/2019

Client: A3Geo

Project: Terra Linda High School

Project Number: 1150-1C

Location: TP-1

Depth: 1.0'

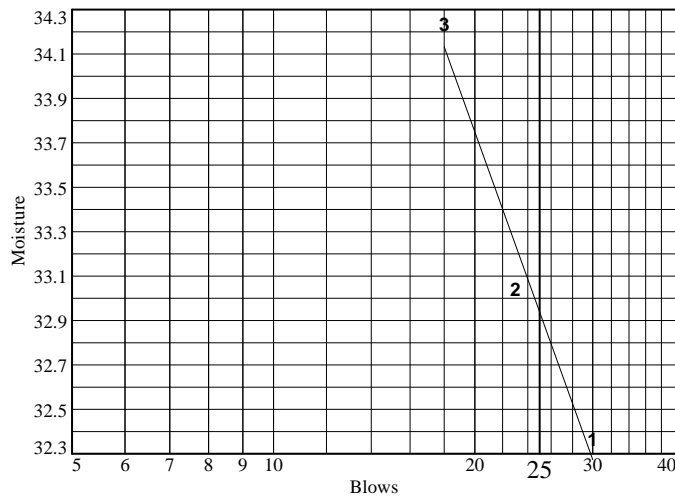
Material Description: Dark brown lean CLAY with sand

USCS: CL

Tested by: BH

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	28.94	28.17	32.95			
Dry+Tare	24.58	23.98	27.38			
Tare	11.11	11.30	11.11			
# Blows	30	23	18			
Moisture	32.4	33.0	34.2			



Liquid Limit= 33
 Plastic Limit= 18
 Plasticity Index= 15

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	19.95	17.96			
Dry+Tare	18.58	16.92			
Tare	11.25	11.16			
Moisture	18.7	18.1			

LIQUID AND PLASTIC LIMIT TEST DATA

1/17/2019

Client: A3Geo

Project: Terra Linda High School

Project Number: 1150-1C

Location: TP-1

Depth: 3.0'

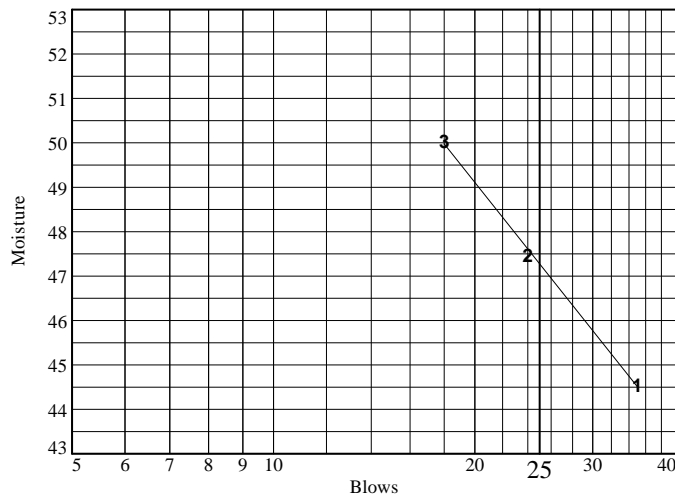
Material Description: Olive brown lean CLAY with some sand

USCS: CL

Tested by: BH

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	28.28	28.37	27.18			
Dry+Tare	23.04	22.88	21.80			
Tare	11.28	11.32	11.05			
# Blows	35	24	18			
Moisture	44.6	47.5	50.0			



Liquid Limit= 47
 Plastic Limit= 19
 Plasticity Index= 28

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	17.60	17.17			
Dry+Tare	16.58	16.27			
Tare	11.28	11.31			
Moisture	19.2	18.1			

LIQUID AND PLASTIC LIMIT TEST DATA

1/17/2019

Client: A3Geo

Project: Terra Linda High School

Project Number: 1150-1C

Location: TP-2

Depth: 1.5'

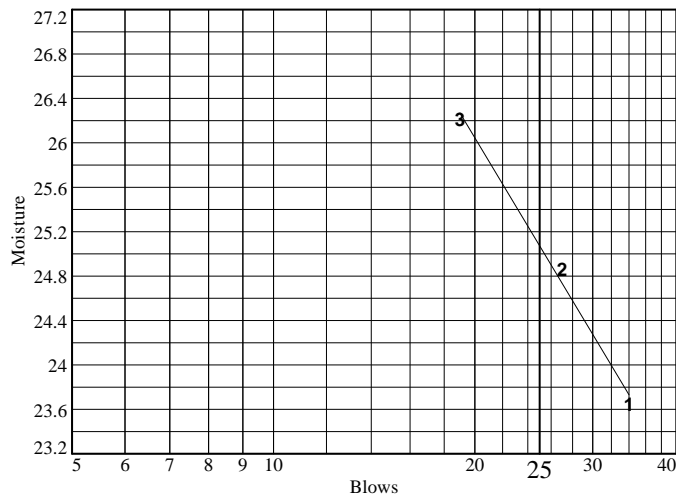
Material Description: Brown sandy lean CLAY

USCS: CL

Tested by: BH

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	29.04	25.26	25.57			
Dry+Tare	25.66	22.49	22.61			
Tare	11.37	11.35	11.32			
# Blows	34	27	19			
Moisture	23.7	24.9	26.2			



Liquid Limit= 25
Plastic Limit= 17
Plasticity Index= 8

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	18.77	17.90			
Dry+Tare	17.70	16.97			
Tare	11.35	11.27			
Moisture	16.9	16.3			

LIQUID AND PLASTIC LIMIT TEST DATA

1/17/2019

Client: A3Geo

Project: Terra Linda High School

Project Number: 1150-1C

Location: TP-4

Depth: 0.5'

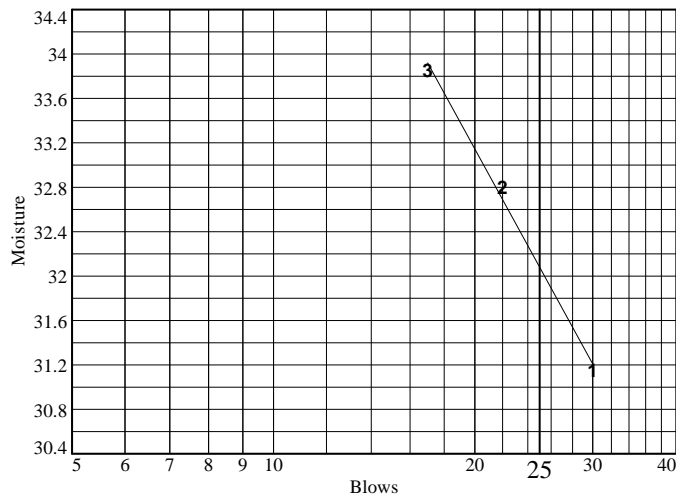
Material Description: Dark brown sandy CLAY

USCS: CL

Tested by: BH

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	27.77	30.54	28.41			
Dry+Tare	23.86	25.76	24.09			
Tare	11.31	11.19	11.33			
# Blows	30	22	17			
Moisture	31.2	32.8	33.9			



Liquid Limit= 32
Plastic Limit= 18
Plasticity Index= 14

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	18.46	17.63			
Dry+Tare	17.35	16.68			
Tare	11.20	11.31			
Moisture	18.0	17.7			

LIQUID AND PLASTIC LIMIT TEST DATA

1/17/2019

Client: A3Geo

Project: Terra Linda High School

Project Number: 1150-1C

Location: TP-4

Depth: 2.0'

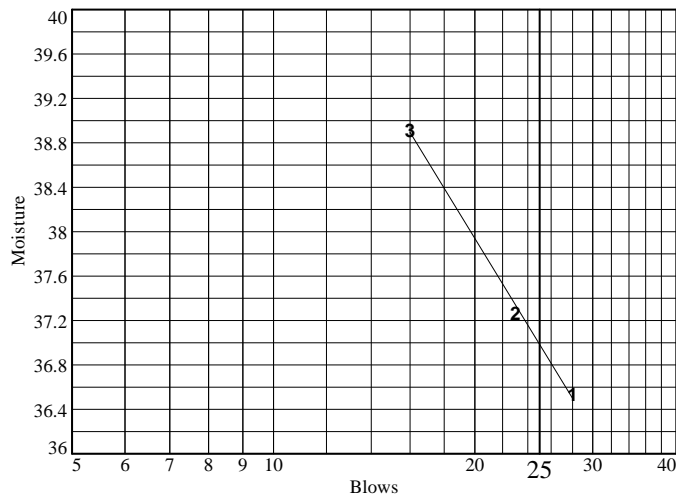
Material Description: Yellowish brown sandy lean CLAY

USCS: CL

Tested by: BH

Liquid Limit Data

Run No.	1	2	3	4	5	6
Wet+Tare	28.55	32.44	27.16			
Dry+Tare	23.92	26.67	22.70			
Tare	11.25	11.19	11.24			
# Blows	28	23	16			
Moisture	36.5	37.3	38.9			



Liquid Limit= 37
Plastic Limit= 18
Plasticity Index= 19

Plastic Limit Data

Run No.	1	2	3	4	
Wet+Tare	17.25	17.28			
Dry+Tare	16.33	16.34			
Tare	11.33	11.07			
Moisture	18.4	17.8			