

Geotechnical Engineering Report

Longmore Road Pedestrian Improvements
McDowell Road to Osborn Road
Salt River Pima-Maricopa Indian Community, Arizona

ADOT Tracs No. 0000 MA SRI SZ155 01C

Terracon Project No. 65155025

Federal Aid No. CM SRI-0(202)T

June 17, 2016

Prepared for:

Engineering and Environmental Consultants, Inc.
Tucson, Arizona

Prepared by:

Terracon Consultants, Inc.
Tempe, Arizona



EXPIRES 12/31/2016

terracon.com

Terracon

Environmental



Facilities



Geotechnical



Materials

June 17, 2016



Engineering and Environmental Consultants, Inc.
4625 East Fort Lowell Road
Tucson, Arizona 85712

Attention: Craig Allison, P.E.
E: callison@eecorp.com

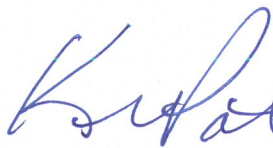
**Re: Geotechnical Engineering Report
Longmore Road Pedestrian Improvements
McDowell Road to Osborn Road
Salt River Pima-Maricopa Indian Community, Arizona
TRACS No. 0000 MA SRI SZ155 01C
Federal Aid No. CM SRI-0(202)T
Terracon Project No. 65155025**

Dear Mr. Allison:

Terracon Consultants, Inc. (Terracon) has completed geotechnical engineering services for the proposed Longmore Road Pedestrian Improvements project located in the Salt River Pima-Maricopa Indian Community, Arizona. This study was performed in general accordance with our revised proposal number P65150023, dated March 13, 2015. Terracon has prepared a Materials Design Report for the project issued under separate cover.

We appreciate being of service to you in the pavement engineering phase of this project. If you have any questions concerning this report or any of our testing, inspection, design and consulting services, please do not hesitate to contact us.

Sincerely,
Terracon Consultants, Inc.



Kevin L. Porter, P.E.
Geotechnical Department Manager

EXPIRES 12/31/2016



Donald R. Clark, P.E.
Senior Principal

65155025.EEC.Longmore.GeoRpt.docx

Copies to: Addressee (1 via email)



Terracon Consultants, Inc. 4685 South Ash Avenue, Suite H-4, Tempe, Arizona 85282
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Environmental



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**GEOTECHNICAL ENGINEERING REPORT
LONGMORE ROAD PEDESTRIAN IMPROVEMENTS
MCDOWELL ROAD TO OSBORN ROAD
SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY, ARIZONA**

Terracon Project No. 65155025
June 17, 2016

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Longmore Road Pedestrian Improvements project in the Salt River Pima-Maricopa Indian Community (SRPMIC), Arizona. A Materials Design Report for the project has been prepared by Terracon Consultants, Inc. (Terracon) and issued under separate cover. The purpose of these services is to provide information and geotechnical engineering recommendations relative to the planned earthwork and pavement improvements. The conclusions and recommendations in this report are based on the results of field and laboratory testing, experience with similar soil conditions and pavements, and our understanding of the proposed project.

Our geotechnical engineering scope of work for this project included the advancement of 11 shallow borings, laboratory testing, geotechnical and pavement engineering analysis, and preparation of this report. Logs of the borings along with a Site Plan and Boring Locations diagram (Exhibit A-1) are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT INFORMATION

2.1 Site Description

ITEM	DESCRIPTION
Location	The project site is located along Longmore Road, between McDowell Road and Osborn Road, on the Salt River Pima-Maricopa Indian Community, Arizona.

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June 17, 2016 ■ Terracon Project No. 65155025



ITEM	DESCRIPTION
Existing Improvements	Longmore Road within the project limits is generally a two-lane asphalt concrete paved roadway with curb and gutter in some portions. There are scattered residential developments, commercial buildings, and agricultural lands along the roadway alignment. There are driveways associated with the residential and commercial properties.
Current Ground Cover	Portland cement concrete, asphalt concrete, and bare soil.
Existing Topography	Appears to be relatively flat.

2.2 Project Description

ITEM	DESCRIPTION
Improvements	Pedestrian improvements to Longmore Road, located between McDowell Road and Osborn Road, in the Salt River Pima-Maricopa Indian Community, Arizona. The project includes an 8-foot wide sidewalk with trees and benches along Longmore Road for a length of about 1.5 miles and a short portion along Osborn Road, east of Longmore Road. Minor widening to Longmore Road is planned in some locations and the pavement section will match the existing pavement section.
Grading	Minor cuts and fills (less than 1-foot) are anticipated for the project.

3.0 SUBSURFACE CONDITIONS

3.1 Subsurface Soil Conditions

Specific conditions encountered at each boring location are indicated on the individual boring logs included in Appendix A of this report. Stratification boundaries on the boring logs represent the approximate location of changes in soil types; in-situ, the transition between materials may be gradual.

The borings were generally located outside of the roadway and along the proposed pedestrian path alignment. Based on conditions encountered in the borings, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered
Stratum 1	0 to 3 (maximum depth explored)	Silty sand, clayey sand, and sandy clay with varying gravel content, and no to weak cementation.

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Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered
-------------	---	----------------------

Undocumented fill was observed in borings B-3, B-8, and B-10 and extended to the total depths explored.

Laboratory tests consisting of grain size distribution, Atterberg Limits, and laboratory moisture-density relationships (Proctor) were conducted on selected soil samples and the test results are summarized below and presented in Appendix B.

3.2 Existing Pavement Section

The existing Longmore Road is paved with asphalt concrete (AC) over aggregate base (AB) material. Based on the record drawings provided to us, the thickness of the existing pavement section along the Longmore Road alignment consists of 4 inches of AC over 10 inches of AB.

3.3 Laboratory Test Data – Subgrade Soils

For purposes of subgrade evaluation, the results of the laboratory testing, including correlated R-Values, are summarized in the following table:

SUMMARY OF TESTED AND CORRELATED R-VALUES						
Boring	Approx. Station; Offset	Depth (ft.)	LL	PI	-#200	R-Value Correlated
B-1	101+10; 30'R	0-3	26	2	42	51.8
B-2	87+50; 40'L	0-3	23	2	33	58.6
B-3	76+00; 40'L	0-0.8	NP	NP	14	82.4
B-4	67+50; 40'L	0-3	26	6	42	44.3
B-5	60+25; 40'L	0-3	24	5	54	39.0
B-6	51+30; 40'L	0-3	27	8	57	33.3
B-7	43+00; 40'L	0-2	22	3	49	45.2
B-8	35+00; 40'L	0-2	20	1	45	51.6
B-9	27+50; 40'L	0-2.5	24	5	54	39.0
B-10	19+50; 30'L	0-1	25	4	41	48.5
B-11	11+50; 30'L	0-3	25	6	60	34.5
Count						11
Average						48.0
Standard Deviation						13.8

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Based on the site explorations and results of the laboratory testing, the subgrade soils in the sidewalk areas are considered suitable for support of the planned improvements. The following sections present recommendations regarding pavement and earthwork construction.

4.2 Pavement Subgrade Parameters

The laboratory test data was used to establish one mean R-Value for pavement design within the project limits. The data indicates the subgrade soils at the site have good support characteristics for the planned pavement sections. The calculated mean R-Value for the project is 48, however we recommend an R-value of 25 be used for design purposes. The corresponding resilient modulus is 14,900 pounds per square inch (psi) for a seasonal variation factor of 1.0 at the location of the project.

4.3 General Earthwork Considerations

The following presents recommendations for excavation and subgrade preparation on the project. Earthwork on the project should be observed and evaluated by a licensed geotechnical engineer. The evaluation of earthwork should include observation and testing of engineered fill, subgrade preparation, and other geotechnical conditions exposed during the construction of the project.

It is anticipated that excavations for much of the proposed construction can be accomplished with conventional earthmoving equipment. Based upon the subsurface conditions determined from the geotechnical exploration, the subgrade soils exposed during construction are expected to be relatively stable. However, the stability of the subgrade may be affected by repetitive construction traffic, moisture, or other factors.

Exposed areas which will receive fill, aggregate base course, or concrete sidewalk once properly cleared and benched where necessary, should be scarified to a minimum depth of six (6) inches, moisture conditioned, and compacted to a minimum of 95% of the maximum dry density as determined by ARIZ 225 (standard Proctor) in accordance with ADOT specifications. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

All fill that will be placed in the project should conform to the latest ADOT standard specifications for embankment material.

4.4 Earthwork Factors and Slopes

Recommended cut slopes and shrinkage due to re-compaction of materials is presented in the following table:

Location	Earthwork Factor	Ground Compaction (feet)	Recommend Slope (horizontal: vertical)
Longmore Road	15% shrink	0.2	Fill Slopes: 3:1, or flatter Cut Slopes: 3:1, or flatter

Construction of fill slopes should be in accordance with Section 203-10 of the ADOT Standard Specifications (ADOT, 2008). Slopes constructed at slope inclinations steeper than 3H:1V should have surface erosion measures considered in the design.

The face of all slopes should be compacted to the minimum specification for fill embankments. Fill slopes can be over-built and trimmed to expose a compacted slope surface.

4.5 Water

For balancing grading plans, approximately 90 gallons of water per cubic yard should be estimated for compaction of base materials. Approximately 90 gallons of water per cubic yard should be estimated for compaction of subgrade materials.

The application of water estimated for subgrade materials is considerably higher than the amount calculated based upon the difference between in-situ and optimum compaction moisture content, and includes a conservative overrun for losses due to seepage, evaporation, inadequate mixing, spillage, etc. Precipitation during and/or before construction, or other weather conditions may reduce the required amount of water.

4.6 Pavement Thickness Recommendations

We recommend the pavement thicknesses presented in the table below be used for the project. Pavement thickness recommendations for Longmore Road and miscellaneous driveways are based on the record drawings we received and local standards. Traffic count information was not available for this project. Pavement design analyses using traffic loading information was not performed to verify the pavement thickness is adequate to support the traffic loading over a particular design period. As such, increased pavement inspection and/or maintenance should be anticipated based on traffic loading, weather effects, and other site conditions.

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Roadway Designation	Concrete Sidewalk (inches)	AC Thickness (Inches)	AB Thickness (Inches)	Total Thickness
Pedestrian Path ¹	4.0	-	-	4.0
Longmore Road ²	-	4.0	10.0	14.0
Miscellaneous Driveways	-	4.0	-	4.0

¹ Pedestrian path per Detail C-05.20 of the ADOT Standard Details

² Longmore Road pavement to match existing pavement section

5.0 GENERAL COMMENTS

Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during grading, excavation, foundation construction and other earth-related construction phases of the project.

The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between boring locations, across the site, or due to the modifying effects of construction or weather. The nature and extent of such variations may not become evident until during or after construction. If variations appear, we should be immediately notified so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or conditions. If the owner is concerned about the potential for such contamination or pollution, other studies should be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes and either verifies or modifies the conclusions of this report in writing.

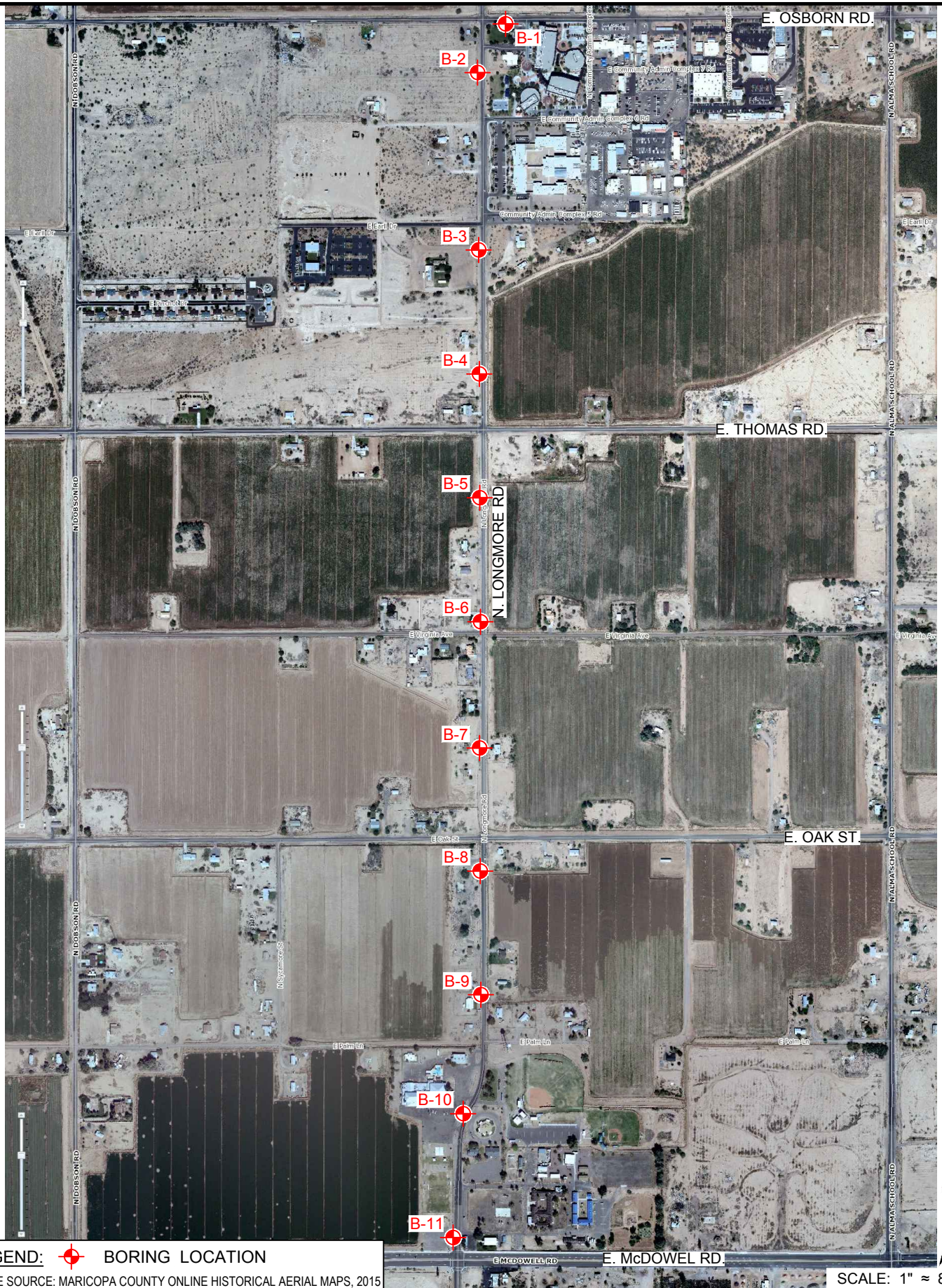
Geotechnical Engineering Report

Longmore Road Pedestrian Improvements ■ SRPMIC, Arizona

June 17, 2016 ■ Terracon Project No. 65155025



APPENDIX A
FIELD EXPLORATION



Project Mngr:	KLP
Drawn By:	KLJ
Checked By:	KLP
Approved By:	KLP

Project No.	65155025
Scale:	AS SHOWN
File No.	65155025.DWG
Date:	06/01/2016

Terracon
Consulting Engineers and Scientists

4685 South Ash Avenue, Suite H-4 Tempe, AZ 85282
PH. (480) 897-8200 FAX. (480) 897-1133

SITE PLAN AND BORING LOCATION DIAGRAM

Longmore Road Pedestrian Improvements

MCDOWELL ROAD TO OSBORN ROAD

SALT RIVER PIMA-MARICOPA INDIAN COMMUNITY

ARIZONA

EXHIBIT

A-1

Geotechnical Engineering Report

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June 17, 2016 ■ Terracon Project No. 65155025

Field Exploration Description

A total of 11 borings were advanced at the site on May 18, 2016. The borings were advanced utilizing hand auger methods to depths of up to approximately 3 feet below the existing ground surface. The approximate boring and pavement core locations are shown on the attached Site Plan and Boring Locations diagram, Exhibit A-1.

The borings were located in the field utilizing a general plan and measurements off of the existing site features. The borings were backfilled with cuttings.

Continuous lithologic logs of each boring were recorded by the field geologist during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon or ring-barrel samplers. Bulk samples of subsurface materials were also obtained.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING				WATER LEVEL		Water Initially Encountered	FIELD TESTS	(HP) Hand Penetrometer
						Water Level After a Specified Period of Time		(T) Torvane
						Water Level After a Specified Period of Time		(b/f) Standard Penetration Test (blows per foot)
					Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.			N N value
								(PID) Photo-Ionization Detector
								(OVA) Organic Vapor Analyzer

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STRENGTH TERMS	RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.			CONSISTENCY OF FINE-GRAINED SOILS (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance			
	Descriptive Term (Density)	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.	Descriptive Term (Consistency)	Unconfined Compressive Strength, Qu, psf	Standard Penetration or N-Value Blows/Ft.	Ring Sampler Blows/Ft.
	Very Loose	0 - 3	0 - 6	Very Soft	less than 500	0 - 1	< 3
	Loose	4 - 9	7 - 18	Soft	500 to 1,000	2 - 4	3 - 4
	Medium Dense	10 - 29	19 - 58	Medium-Stiff	1,000 to 2,000	4 - 8	5 - 9
	Dense	30 - 50	59 - 98	Stiff	2,000 to 4,000	8 - 15	10 - 18
	Very Dense	> 50	≥ 99	Very Stiff	4,000 to 8,000	15 - 30	19 - 42
				Hard	> 8,000	> 30	> 42

RELATIVE PROPORTIONS OF SAND AND GRAVEL

<u>Descriptive Term(s) of other constituents</u>	<u>Percent of Dry Weight</u>
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

<u>Major Component of Sample</u>	<u>Particle Size</u>
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm)
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

<u>Descriptive Term(s) of other constituents</u>	<u>Percent of Dry Weight</u>
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

<u>Term</u>	<u>Plasticity Index</u>
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests ^A					Soil Classification	
					Group Symbol	Group Name ^B
Coarse Grained Soils: More than 50% retained on No. 200 sieve	Gravels: More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels: Less than 5% fines ^C	Cu ≥ 4 and 1 ≤ Cc ≤ 3 ^E		GW	Well-graded gravel ^F
			Cu < 4 and/or 1 > Cc > 3 ^E		GP	Poorly graded gravel ^F
		Gravels with Fines: More than 12% fines ^C	Fines classify as ML or MH		GM	Silty gravel ^{F,G,H}
			Fines classify as CL or CH		GC	Clayey gravel ^{F,G,H}
	Sands: 50% or more of coarse fraction passes No. 4 sieve	Clean Sands: Less than 5% fines ^D	Cu ≥ 6 and 1 ≤ Cc ≤ 3 ^E		SW	Well-graded sand ^I
			Cu < 6 and/or 1 > Cc > 3 ^E		SP	Poorly graded sand ^I
		Sands with Fines: More than 12% fines ^D	Fines classify as ML or MH		SM	Silty sand ^{G,H,I}
			Fines classify as CL or CH		SC	Clayey sand ^{G,H,I}
Fine-Grained Soils: 50% or more passes the No. 200 sieve	Silts and Clays: Liquid limit less than 50	Inorganic:	PI > 7 and plots on or above “A” line ^J		CL	Lean clay ^{K,L,M}
			PI < 4 or plots below “A” line ^J		ML	Silt ^{K,L,M}
		Organic:	Liquid limit - oven dried	< 0.75	OL	Organic clay ^{K,L,M,N}
			Liquid limit - not dried			Organic silt ^{K,L,M,O}
	Silts and Clays: Liquid limit 50 or more	Inorganic:	PI plots on or above “A” line		CH	Fat clay ^{K,L,M}
			PI plots below “A” line		MH	Elastic Silt ^{K,L,M}
		Organic:	Liquid limit - oven dried	< 0.75	OH	Organic clay ^{K,L,M,P}
			Liquid limit - not dried			Organic silt ^{K,L,M,Q}
Highly organic soils:	Primarily organic matter, dark in color, and organic odor				PT	Peat

^A Based on the material passing the 3-inch (75-mm) sieve

^B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

^C Gravels with 5 to 12% fines require dual symbols: 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.

^D Sands with 5 to 12% fines require dual symbols: 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

$$^E Cu = D_{60}/D_{10} \quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$$

^F If soil contains $\geq 15\%$ sand, add "with sand" to group name.

^G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

^H If fines are organic, add "with organic fines" to group name.

^I If soil contains $\geq 15\%$ gravel, add "with gravel" to group name.

^J If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

^K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel," whichever is predominant.

^L If soil contains $\geq 30\%$ plus No. 200 predominantly sand, add "sandy" to group name.

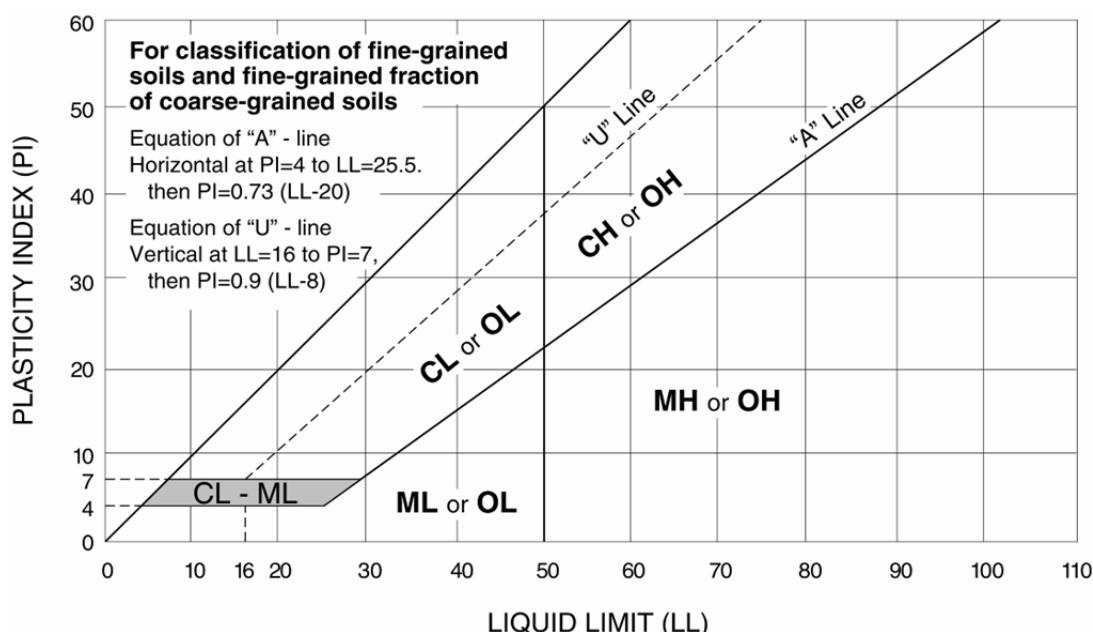
^M If soil contains $\geq 30\%$ plus No. 200, predominantly gravel, add "gravelly" to group name.

^N $PI \geq 4$ and plots on or above "A" line.

^O $PI < 4$ or plots below "A" line.

^P PI plots on or above "A" line.

^Q PI plots below "A" line.



BORING LOG NO. B-1

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PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.48768° Longitude: -111.86489° Station: 101+10 Offset: 30'R	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
DEPTH									
	SILTY SAND (SM) , brown								
						8	96		
								26-24-2	42
3.0	Boring Terminated at 3 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hand Auger

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 5/18/2016

Boring Completed: 5/18/2016

Drill Rig: Hand Auger

Driller: Terracon

Project No.: 65155025

Exhibit: A-5

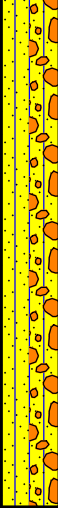
BORING LOG NO. B-2

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PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.48682° Longitude: -111.8654° Station: 87+50 Offset: 40'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
	DEPTH								
	SILTY SAND WITH GRAVEL (SM), brown								
						6	98		
								23-21-2	33
	3.0								
	Boring Terminated at 3 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method: Hand Auger	See Exhibit A-2 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix A for explanation of symbols and abbreviations.	Notes:	
Abandonment Method: Borings backfilled with soil cuttings upon completion.			
WATER LEVEL OBSERVATIONS	 4685 S Ash Ave Ste H-4 Tempe, AZ	Boring Started: 5/18/2016	Boring Completed: 5/18/2016
Groundwater not encountered		Drill Rig: Hand Auger	Driller: Terracon
		Project No.: 65155025	Exhibit: A-6

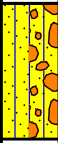
BORING LOG NO. B-3

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PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.48368° Longitude: -111.86546° Station: 76+00 Offset: 40'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
	DEPTH								
	FILL - SILTY SAND WITH GRAVEL (SM) , brown							NP	14
	0.8								
	Auger Refusal at 0.8 Foot								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method: Hand Auger	See Exhibit A-2 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix A for explanation of symbols and abbreviations.	Notes:	
Abandonment Method: Borings backfilled with soil cuttings upon completion.			
WATER LEVEL OBSERVATIONS	 4685 S Ash Ave Ste H-4 Tempe, AZ	Boring Started: 5/18/2016	Boring Completed: 5/18/2016
Groundwater not encountered		Drill Rig: Hand Auger	Driller: Terracon
		Project No.: 65155025	Exhibit: A-7

BORING LOG NO. B-4

Page 1 of 1

PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.48148° Longitude: -111.86544° Station: 67+50 Offset: 40'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
	SILTY CLAYEY SAND (SC-SM) , brown					10	101	26-20-6	42
	Boring Terminated at 3 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hand Auger

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 5/18/2016

Boring Completed: 5/18/2016

Drill Rig: Hand Auger

Driller: Terracon

Project No.: 65155025

Exhibit: A-8

BORING LOG NO. B-6

Page 1 of 1

PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.4771° Longitude: -111.86542° Station: 51+30 Offset: 40'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
DEPTH									
	SANDY LEAN CLAY (CL) , brown								
						9	88		
								27-19-8	57
3.0	Boring Terminated at 3 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hand Auger

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 5/18/2016

Boring Completed: 5/18/2016

Drill Rig: Hand Auger

Driller: Terracon

Project No.: 65155025

Exhibit: A-10

BORING LOG NO. B-7

Page 1 of 1

PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.47486° Longitude: -111.86543° Station: 43+00 Offset: 40'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
DEPTH									
	SILTY SAND (SM) , brown, calcite cemented nodules								
								22-19-3	49
2.0									
	Auger Refusal at 2 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method: Hand Auger	See Exhibit A-2 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix A for explanation of symbols and abbreviations.	Notes:	
Abandonment Method: Borings backfilled with soil cuttings upon completion.			
WATER LEVEL OBSERVATIONS	 4685 S Ash Ave Ste H-4 Tempe, AZ	Boring Started: 5/18/2016	Boring Completed: 5/18/2016
Groundwater not encountered		Drill Rig: Hand Auger	Driller: Terracon
		Project No.: 65155025	Exhibit: A-11

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 65155025.GPJ TERRACON2015.GDT 6/17/16

BORING LOG NO. B-8

Page 1 of 1

PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.47268° Longitude: -111.86542° Station: 35+00 Offset: 40'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
DEPTH									
	FILL - SILTY SAND (SM) , brown								
						7	96		
								20-19-1	45
2.0									
	Auger Refusal at 2 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method: Hand Auger	See Exhibit A-2 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix A for explanation of symbols and abbreviations.	Notes:
Abandonment Method: Borings backfilled with soil cuttings upon completion.		
WATER LEVEL OBSERVATIONS	 4685 S Ash Ave Ste H-4 Tempe, AZ	Boring Started: 5/18/2016
<i>Groundwater not encountered</i>		Boring Completed: 5/18/2016
		Drill Rig: Hand Auger
		Driller: Terracon
		Project No.: 65155025
		Exhibit: A-12

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 65155025.GPJ TERRACON2015.GDT 6/17/16

BORING LOG NO. B-10

Page 1 of 1

PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.46838° Longitude: -111.86579° Station: 19+50 Offset: 30'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
	FILL - SILTY CLAYEY SAND WITH GRAVEL (SC-SM), brown 1.0					8	81	25-21-4	41
	Auger Refusal at 1 Foot								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method: Hand Auger	See Exhibit A-2 for description of field procedures See Appendix B for description of laboratory procedures and additional data (if any). See Appendix A for explanation of symbols and abbreviations.	Notes:	
Abandonment Method: Borings backfilled with soil cuttings upon completion.			
WATER LEVEL OBSERVATIONS	 4685 S Ash Ave Ste H-4 Tempe, AZ	Boring Started: 5/18/2016	Boring Completed: 5/18/2016
<i>Groundwater not encountered</i>		Drill Rig: Hand Auger	Driller: Terracon
		Project No.: 65155025	Exhibit: A-14

BORING LOG NO. B-11

Page 1 of 1

PROJECT: Longmore Road Pedestrian Improvements

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

GRAPHIC LOG	LOCATION See Exhibit A-1 Latitude: 33.46619° Longitude: -111.866° Station: 11+50 Offset: 30'L	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS	PERCENT FINES
								LL-PL-PI	
DEPTH									
	SANDY SILTY CLAY (CL-ML) , brown								
						11	103		
								25-19-6	60
3.0	Boring Terminated at 3 Feet								

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:
Hand Auger

See Exhibit A-2 for description of field procedures
See Appendix B for description of laboratory procedures and additional data (if any).
See Appendix A for explanation of symbols and abbreviations.

Notes:

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

Boring Started: 5/18/2016

Boring Completed: 5/18/2016

Drill Rig: Hand Auger

Driller: Terracon

Project No.: 65155025

Exhibit: A-15

THIS BORING LOG IS NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GEO SMART LOG-NO WELL 65155025 GPJ TERRACON2015.GDT 6/17/16

Geotechnical Engineering Report

Longmore Road Pedestrian Improvements ■ SRPMIC, Arizona

June 17, 2016 ■ Terracon Project No. 65155025



APPENDIX B
LABORATORY TESTING

Geotechnical Engineering Report

Longmore Road Pedestrian Improvements ■ SRPMIC, Arizona

June 17, 2016 ■ Terracon Project No. 65155025



Laboratory Testing

Samples retrieved during the field exploration were taken to the laboratory for further observation by the project geotechnical engineer and were classified in accordance with the Unified Soil Classification System (USCS) described in Appendix A. At that time, the field descriptions were confirmed or modified as necessary and an applicable laboratory testing program was formulated to determine engineering properties of the subsurface materials.

Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of recommendations. Laboratory tests were performed in general accordance with the applicable ASTM, local or other accepted standards.

Selected soil samples obtained from the site were tested for the following engineering properties:

- | | | | |
|---|---|---|----------------|
| n | Atterberg Limits | n | Sieve Analysis |
| n | Laboratory Moisture-Density Relationships (Proctor) | n | Unit Weight |
| n | Moisture Content | | |

ASTM D4318

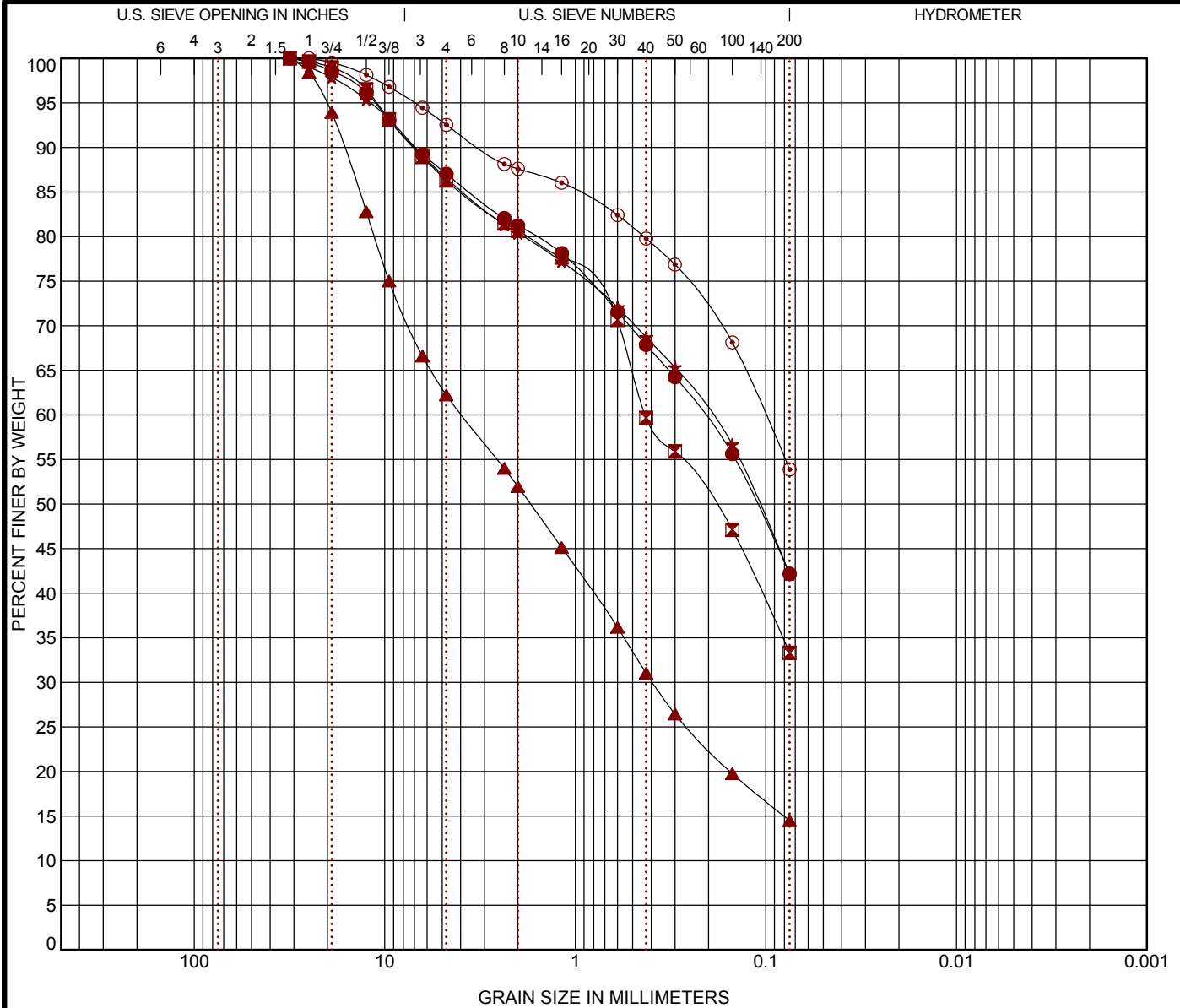


LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS 65155025.GPJ TERRACON2015.GDT 6/17/16

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification				LL	PL	PI	Cc	Cu
● B-1	0 - 3	SILTY SAND (SM)				26	24	2		
⊠ B-2	0 - 3	SILTY SAND (SM)				23	21	2		
▲ B-3	0 - 0.8	SILTY SAND with GRAVEL (SM)				NP	NP	NP		
★ B-4	0 - 3	SILTY, CLAYEY SAND (SC-SM)				26	20	6		
⊙ B-5	0 - 3	SANDY SILTY CLAY (CL-ML)				24	19	5		
Boring ID	Depth	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Gravel	%Sand	%Fines		
● B-1	0 - 3	31.5	0.213			13.0	44.9	42.2		
⊠ B-2	0 - 3	31.5	0.43			13.7	53.0	33.3		
▲ B-3	0 - 0.8	31.5	3.93	0.393		37.8	47.8	14.5		
★ B-4	0 - 3	31.5	0.196			13.4	44.5	42.1		
⊙ B-5	0 - 3	25	0.101			7.5	38.7	53.9		

PROJECT: Longmore Road Pedestrian Improvements

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

PROJECT NUMBER: 65155025

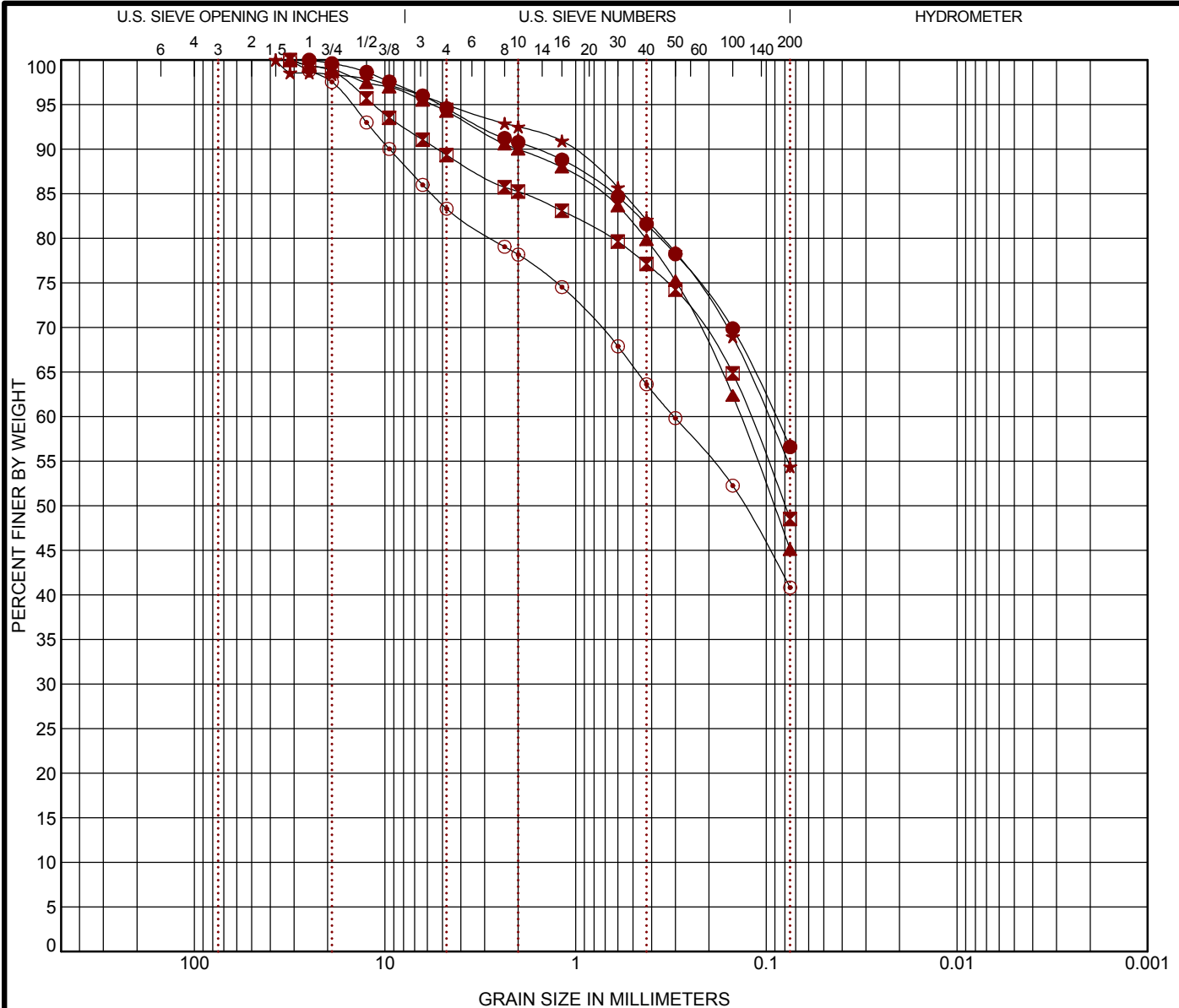
CLIENT: Engineering and Environmental
Consultants, Inc.
Tucson, Arizona

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 65155025 GPJ 35159097 - ATTERBERG ISSUE GPJ 6/17/16

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification				LL	PL	PI	Cc	Cu
● B-6	0 - 3	SANDY LEAN CLAY (CL)				27	19	8		
⊠ B-7	0 - 2	SILTY SAND (SM)				22	19	3		
▲ B-8	0 - 2	SILTY SAND (SM)				20	19	1		
★ B-9	0 - 2.5	SANDY SILTY CLAY (CL-ML)				24	19	5		
⊙ B-10	0 - 1	SILTY, CLAYEY SAND with GRAVEL (SC-SM)				25	21	4		
Boring ID	Depth	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Gravel	%Sand	%Fines		
● B-6	0 - 3	25	0.09			5.4	38.0	56.6		
⊠ B-7	0 - 2	31.5	0.122			10.7	40.8	48.5		
▲ B-8	0 - 2	31.5	0.136			5.8	49.1	45.1		
★ B-9	0 - 2.5	37.5	0.098			5.0	40.6	54.4		
⊙ B-10	0 - 1	31.5	0.305			16.7	42.5	40.8		

PROJECT: Longmore Road Pedestrian Improvements

SITE: McDowell Road to Osborn Road
SRPMIC, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

PROJECT NUMBER: 65155025

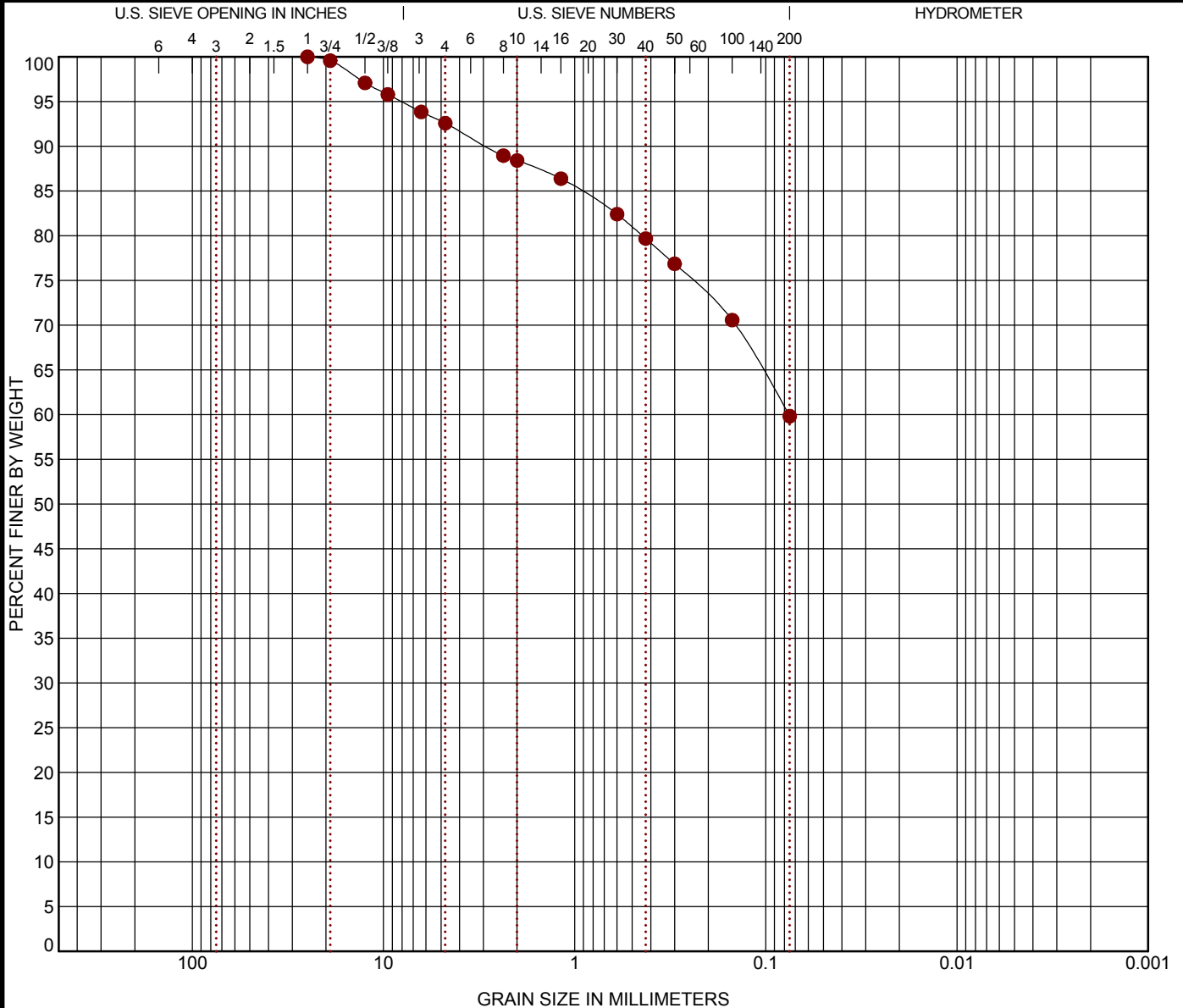
CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

EXHIBIT: B-4

GRAIN SIZE DISTRIBUTION

ASTM D422 / ASTM C136

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 65155025 GPJ 35159097 - ATTERBERG ISSUE GPJ 6/17/16



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID	Depth	USCS Classification				LL	PL	PI	Cc	Cu
B-11	0 - 3	SANDY SILTY CLAY (CL-ML)				25	19	6		

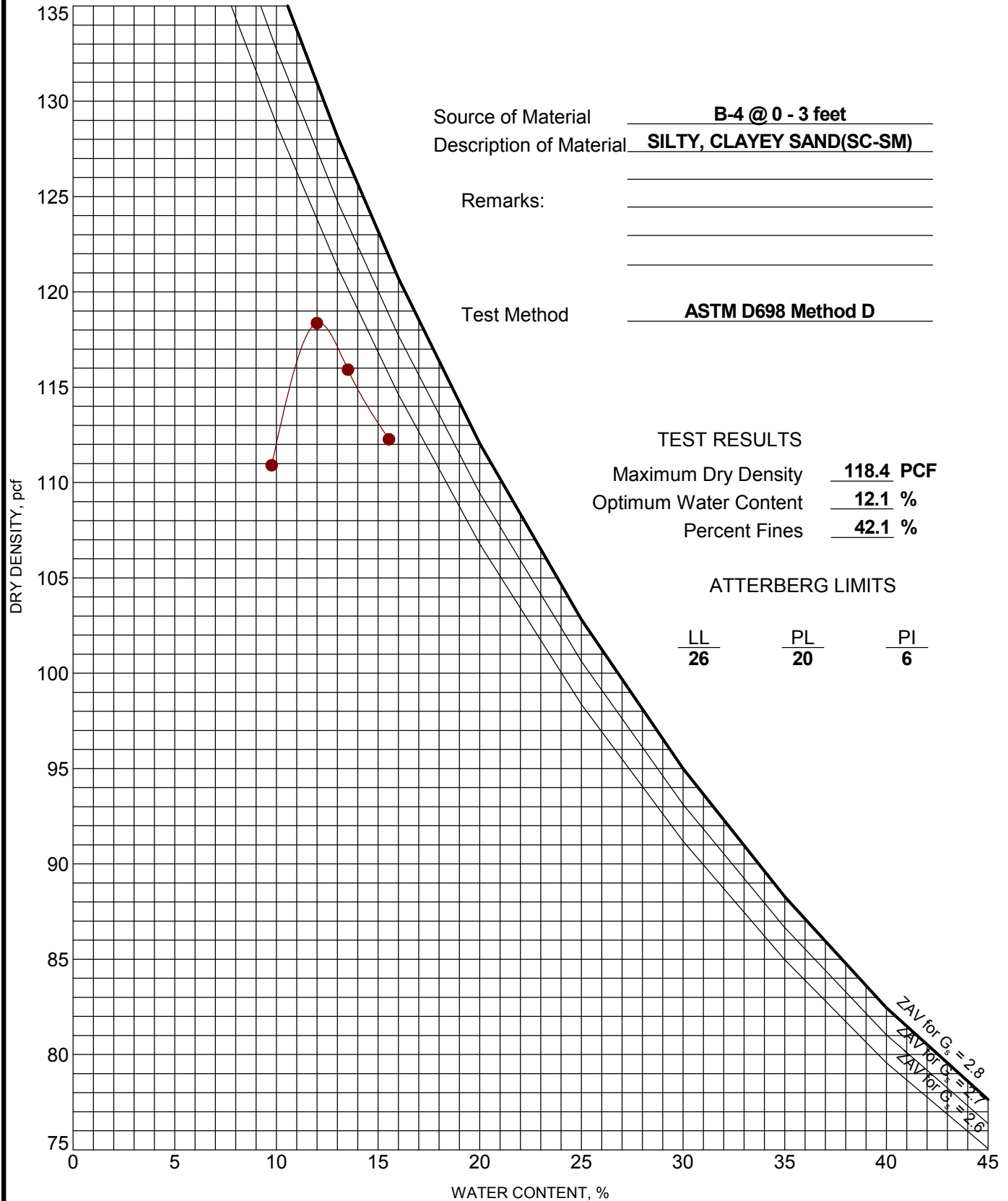
Boring ID	Depth	D ₁₀₀	D ₆₀	D ₃₀	D ₁₀	%Gravel	%Sand	%Fines
B-11	0 - 3	25	0.076			7.4	32.8	59.8

PROJECT: Longmore Road Pedestrian Improvements	4685 S Ash Ave Ste H-4 Tempe, AZ	PROJECT NUMBER: 65155025
SITE: McDowell Road to Osborn Road SRPMIC, Arizona		CLIENT: Engineering and Environmental Consultants, Inc. Tucson, Arizona
		EXHIBIT: B-5

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 65155025.GPJ TERRACON2012.GDT 6/17/16



PROJECT: Longmore Road Pedestrian Improvements

SITE: McDowell Road to Osborn Road SRPMIC, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

PROJECT NUMBER: 65155025

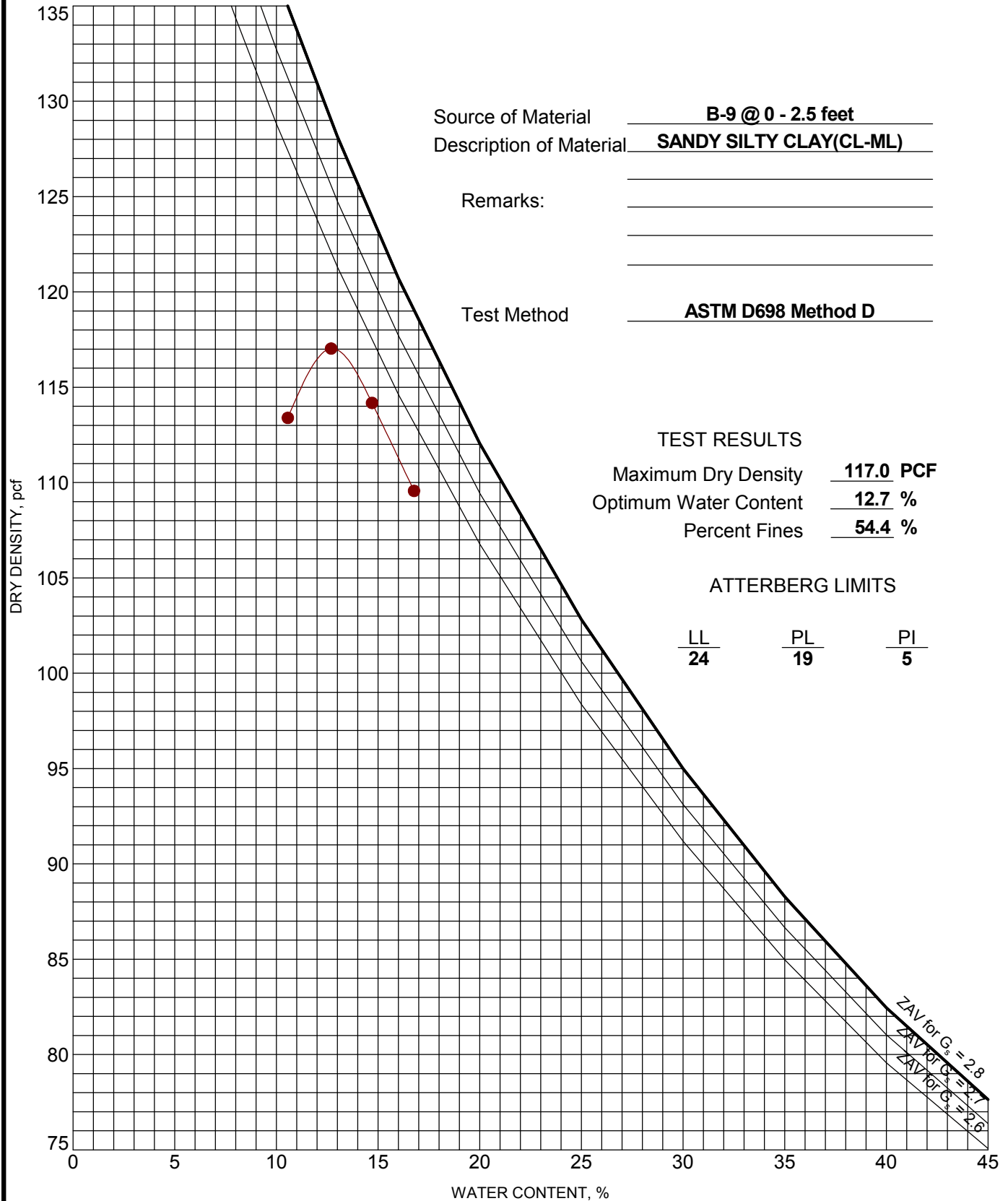
CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

EXHIBIT: B-6

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. COMPACTION - V2 65155025.GPJ TERRACON2012.GDT 6/17/16



PROJECT: Longmore Road Pedestrian Improvements

SITE: McDowell Road to Osborn Road SRPMIC, Arizona

Terracon
4685 S Ash Ave Ste H-4
Tempe, AZ

PROJECT NUMBER: 65155025

CLIENT: Engineering and Environmental Consultants, Inc.
Tucson, Arizona

EXHIBIT: B-7

SUMMARY OF LABORATORY RESULTS

Borehole No.	Depth (ft.)	USCS Soil Class.	In-Situ Properties		Classification				Expansion Testing					Corrosivity				Remarks
			Dry Density (pcf)	Water Content (%)	Passing #200 Sieve (%)	Atterberg Limits			Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index E ₁₅₀	pH	Resistivity (ohm-cm)	Sulfates (ppm)	Chlorides (ppm)	
						LL	PL	PI										
B-1	0.0 - 3.0	SM			42	26	24	2										
B-1	0.5 - 1.5	SM	96	8														1, 2
B-2	0.0 - 3.0	SM			33	23	21	2										
B-2	0.5 - 1.1	SM	98	6														1, 2
B-3	0.0 - 0.8	SM			14	NP	NP	NP										
B-4	0.0 - 3.0	SC-SM			42	26	20	6										
B-4	0.5 - 1.5	SC-SM	101	10														1, 2
B-5	0.0 - 3.0	CL-ML			54	24	19	5										
B-6	0.0 - 3.0	CL			57	27	19	8										
B-6	0.5 - 1.2	CL	88	9														1, 2
B-7	0.0 - 2.0	SM			49	22	19	3										
B-8	0.0 - 2.0	SM			45	20	19	1										
B-8	0.5 - 1.0	SM	96	7														1, 2
B-9	0.0 - 2.5	CL-ML			54	24	19	5										
B-9	0.5 - 1.5	CL-ML	93	10														1, 2
B-10	0.0 - 1.0	SC-SM			41	25	21	4										
B-10	0.5 - 0.9	SC-SM	81	8														1, 2
B-11	0.0 - 3.0	CL-ML			60	25	19	6										
B-11	0.5 - 1.3	CL-ML	103	11														1, 2
REMARKS 1. Dry Density and/or moisture determined from one or more rings of a multi-ring sample. 2. Visual Classification. 3. Submerged to approximate saturation. 4. Expansion Index in accordance with ASTM D4829-95. 5. Air-Dried Sample																		
PROJECT: Longmore Road Pedestrian Improvements			Terracon 4685 S Ash Ave Ste H-4 Tempe, AZ								PROJECT NUMBER: 65155025							
SITE: McDowell Road to Osborn Road SRPMIC, Arizona											CLIENT: Engineering and Environmental Consultants, Inc. Tucson, Arizona							
			PH. 480-897-8200 FAX. 480-897-1133								EXHIBIT: B-8							