Geotechnical Engineering Report

West Quartzsite Traffic Interchange: Quartzsite Boulevard and I-10

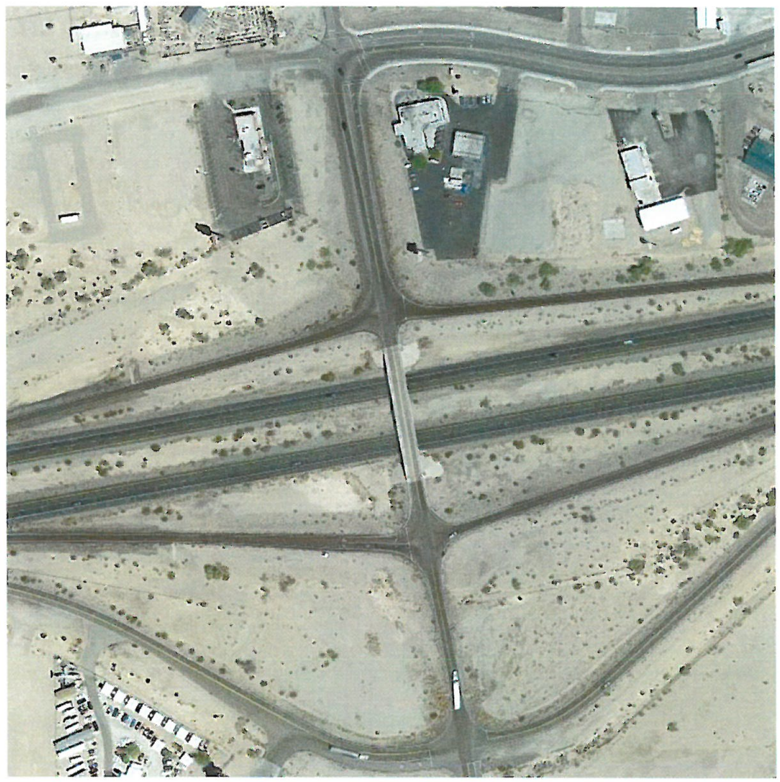
Quartzsite, Arizona

March 17, 2015

Terracon Project No. 65145257

ADOT Tracs No. 010 LA 017 H8517 0IC

Federal Aid No. STP-010-A(219)S



REGISTERED PROFESSIONAL ENGINEER (Civil)
CERTIFICATE NO.
25003
SCOTT D
NEELY
Date Signed 3-17-15
ARIZONA U.S.A.
Expires 9/30/2015

Prepared for:
Parson Brinkerhoff
Tempe, Arizona

Prepared by:
Terracon Consultants, Inc.
Tempe, Arizona

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Geotechnical ■ Environmental ■ Construction Materials ■ Facilities

March 17, 2015

Parson Brinkerhoff
350 West Washington Street
Tempe, Arizona 85281

Attn: Gregory Fly, P.E.
P: (480) 449-4603
E: flyg@pbworld.com

Re: **Geotechnical Engineering Report**
West Quartzsite Traffic Interchange
Quartzsite Boulevard and I-10
Quartzsite, Arizona
TRACS No. 010 LA 017 H8517 01C
Federal Aid No. STP-010-A(219)S
Terracon Project No. 65145257

Report Type: Final

Terracon has completed geotechnical engineering services for the proposed traffic interchange improvements along Quartzsite Boulevard and the frontage roads of Interstate Highway 10 (I-10). The project is located at the traffic interchange of Quartzsite Boulevard and I-10 at milepost (MP) 17 in Quartzsite, Arizona. This study was performed in general accordance with our proposal P65130608-Revision No. 3 dated April 23, 2013. The results of our engineering study, including the geotechnical engineering exploration and laboratory test results for this project are attached.

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.

REGISTERED PROFESSIONAL ENGINEER (Civil)
CERTIFICATE NO.
25003
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NEELY
Date Signed 3-17-15
ARIZONA U.S.A.
Expires 9/30/2015

Scott D. Neely, P.E.
Principal

Donald R. Clark, P.E.
Senior Principal

n:project/65145257/…/65145257.PB.Quartzsite Blvd. & I-10.geotech.rpt.final.doc

Copies to: Addressee (1 via email)

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WEST QUARTZSITE TRAFFIC INTERCHANGE
QUARTZSITE BOULEVARD AND I-10
QUARTZSITE, ARIZONA

Terracon Project No. 65145257
March 17, 2015

1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed traffic interchange improvements along Quartzsite Boulevard and the frontage roads of Interstate Highway 10 (I-10). The project is located at the Quartzsite Boulevard and I-10 traffic interchange in Quartzsite, Arizona.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site layout	Refer to the Site Plan and Boring Locations Diagram (Exhibit A-1 in Appendix A) for the location of the project.
Structures / Type of construction	Major elements of the project will include: • New traffic signals at the existing TI frontage road intersections • Widening of Quartzsite Boulevard between each existing ramp and the corresponding frontage road intersection. The widening will generally be 14 feet on each side of the roadway with new roadway embankment at 4H:1V sloping down to the bottom of the slope. • Widening of the frontage roads to accommodate the new widening of Quartzsite Boulevard. • Three retention basins. The project will not include any roadway widening between the ramps or the bridge over I-10. The only changes in grade anticipated for the project will be associated with the placement of new embankment to support the widening of Quartzsite Boulevard and the frontage roads to accommodate the Quartzsite Boulevard widening and retention basins.
Traffic loading	According to ADOT's Multimodal Planning Division information for I-10 from MP 17.49 to 19.80, the Average Annual Daily Traffic (AADT) in the year 2010 is 22,500 vehicles per day (VPD) at this project site. The AADT in 2030 will be 38,500 VPD. The truck percentage is 37.9.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	Quartzsite Boulevard traffic interchange with I-10 in Quartzsite, Arizona.
Existing site features	The existing roadway embankment slopes that support Quartzsite Boulevard are 28 feet wide south of the eastbound (EB) ramps and 42 feet wide north of the westbound (WB) ramps. The existing embankment slopes north of the WB on/off ramps are at approximately 5H:1V. The existing embankment slopes south of the EB on/off ramps are at approximately 3H:1V. There are no traffic signals and no passing lanes within the project limits. There is one proposed corrugated metal pipe extension planned to be located beneath the EB on ramp and two extensions planned beneath the portion of Quartzsite Boulevard that is south of the EB on/off ramps. The pipe extensions are shown on Exhibit A-1.
Existing Pavement Condition	The existing pavement shows slight distress along Quartzsite Boulevard with higher amount of distress along the frontage road around the Love's Truck Stop site. The distress in Kuehn Street and Dome Rock Road consisted of alligator cracking.
Surrounding developments	There is a Love's Truck Stop facility located along the frontage road on the south side of the traffic interchange. There are two small fast foot restaurants along the frontage road on the north side of the traffic interchange.
Existing topography	The topography in the area is relatively flat throughout most of the project area. The elevation of the project limits is approximately 910 feet MSL. The design elevation of Quartzsite Boulevard is near the original native ground surface grade at the frontage roads and increases in height above I-10 to the level (elevation) of the on/off ramp intersections. The change in height is approximately 15 to 20 feet from the frontage road to the on/off ramp.

3.0 SUBSURFACE CONDITIONS

3.1 Site Geology

The project area is located in the Basin and Range physiographic province ([1]Cooley, 1967) of the North American Cordillera ([2]Stern, et al, 1979) of the southwestern United States. The

[1]Cooley, M.E., 1967, ***Arizona Highway Geologic Map***, Arizona Geological Society.

southern portion of the Basin and Range province is situated along the southwestern flank of the Colorado Plateau and is bounded by the Sierra Nevada Mountains to the west. Formed during middle and late Tertiary time (100 to 15 m.y. ago), the Basin and Range province is dominated by fault controlled topography. The topography consists of mountain ranges and relatively flat alluviated valleys. These mountain ranges and valleys have evolved from generally complex movements and associated erosional and depositional processes. Structurally, the site lies within the Phoenix Basin. Drainage flows to the Gila River during late Tertiary time, coupled with structural activity discussed above, are generally responsible for the present day topography within the basin.

Surficial geologic conditions mapped at the site ([3]Wilson, 1960) consist of alluvium of Holocene to middle Pleistocene age. The alluvial materials have been described as young and weakly to moderately consolidated deposits consisting of silt, sand, and gravel. Locally, the alluvium can include clay deposits.

3.2 Typical Subsurface Profile

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

As presented on the Logs of Boring, surface soils near the on/off ramp roads consisted of fill materials comprised of gravel and/or sand soils with variable amounts of gravel to depths of 18 to 19 feet. The thickness of fill materials decreases to about seven feet in the borings at the frontage roads. The materials underlying the surface fill materials and extending to the maximum depth of exploration consisted of sands and/or gravel soils. The maximum depth of exploration varied from 2½ feet for the percolation test holes to 50 feet for the borings located at the higher elevations of Quartzsite Boulevard.

The sand and gravel soils are generally medium dense in relative density throughout the fill zone stratum and to depths of 5 to 10 feet in the native soils beneath the fills. Below the medium dense soils the soils are dense to very dense in relative density.

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[2]Stern, C.W., et al, 1979, ***Geological Evolution of North America***, John Wiley & Sons, Santa Barbara, California.

[3]Wilson, E. D., 1960, ***Geologic Map of Yuma County, Arizona***, Arizona Bureau of Mines, University of Arizona.

3.3 Laboratory Test Data

For purposes of pavement thickness design, the results of the laboratory testing, including the correlated R-Values and tested R-Values are summarized as shown in the following table:

SUMMARY OF TESTED AND CORRELATED R-VALUES							
Point ID	**Boring Location**	**Depth (ft.)**	**LL**	**PI**	**-#200**	**R-Value Tested**	**R-Value Correlated**
B-1	EB Off Ramp near Quartzsite Blvd.	1-5	---	NP	12	---	85
B-2	Quartzsite Blvd. just north of WB On Ramp	0-5	---	NP	7	---	91
B-3	Along Dome Rock Rd. west of Quartzsite Blvd.	1-5	---	NP	11	73	86
B-4	Along Kuehn St. east of Quartzsite Blvd.	0-4	22	7	13	---	64
B-5	Quartzsite Blvd. near Main St.	0-5	---	NP	10	---	87
B-6	South of EB off ramp and west of Quartzsite Blvd. in interior	0-4	---	NP	13	---	84
B-7	South of EB on ramp and east of Quartzsite Blvd. in interior	0-4	---	NP	23	77	73
B-8	North of WB on ramp and west of Quartzsite Blvd. in interior	0-4	21	2	22	---	68
					Count	**2**	**8**
					Average	**75**	**79.6**
					Standard Deviation	**2.83**	**9.98**

3.4 Percolation Test Results

Percolation testing conducted at the location of the proposed retention basins are summarized as follows:

Percolation Test Results			
Test Hole	**Depth (inches)**	**Soil Classification**	**Percolation Rate (minutes/inch)**
Perc-1	30	SM	16
Perc-2	30	SM	7
Perc-3	30	SM	8

It should be noted that siltation and vegetation growth along with other factors may effect the percolation rates of the on-site retention basin areas. The actual percolation rate of each retention area may vary from the values reported here.

3.5 Groundwater

Groundwater was not observed in any test boring at the time of the field exploration. These observations represent groundwater conditions at the time of the field exploration and may not be indicative of other times, or at other locations. Groundwater conditions can change with varying seasonal and weather conditions, and other factors.

Based on information obtained from the Arizona Department of Water Resources – Groundwater Data website (https://gisweb.azwater.gov/gwsi/Default.aspx), the depth to groundwater was measured in 2009 to be approximately 510 feet below the ground surface (approximate elevation of 430 feet above mean sea level) at an Arizona Department of Water Resources (ADWR) monitored well site located about one-half mile west of the site.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

4.1 Geotechnical Considerations

Geotechnical engineering recommendations for design and construction of earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of the test borings performed by Terracon (which are presented in Appendix A) and laboratory testing (which is presented in Appendix B), engineering analyses, and our current understanding of the proposed project.

The geotechnical issues associated with construction of this project will be:

- **Embankment Settlement:** The proposed widening is to be constructed on fill embankments up to 10 feet high. The analyses and results are presented in Section 4.2.
- **Subgrade Support:** The recommended resilient modulus for use in design of pavements is presented in Section 4.3.
- **Retention Basin:** Three retention basins are planned at the locations of Perc-1, Perc-2 and Perc-3. Recommendations for the excavated slopes are presented in Section 4.4.
- **General Earthwork Recommendations:** The placement of the embankment materials should be comprised of select granular materials and placed in accordance with ADOT requirements. These recommendations are outlined in Section 4.5.

Prior to placement of embankment fill materials, we recommend the Geotechnical engineering recommendations for roadway construction and other earth connected phases of the project are outlined below.

4.2 Compression Due To Embankment Fill

Terracon has analyzed the settlement of the fill materials and native soils due to the pressure increase from the proposed embankment fill construction proposed for the project. At STA 13+00 the fill thickness will be about 10 feet, and appears to be the location with the thickest amount of new fill. This location has been analyzed for settlement as the area representing the highest proposed stress increase on the project.

The Hough method of computing compression was used to estimate the compression of the existing soils due to the new embankment fill construction. Groundwater was not encountered in our exploratory borings as previously discussed. Fluctuation of groundwater which would cause a significant change in moisture conditions of the in-situ soils is not expected. Therefore, for purposes of our settlement analyses, all the soil types encountered in the borings were modeled for elastic settlement. Consolidation settlement due to change in moisture was not considered in the analysis.

The subsurface soils and the proposed embankments were analyzed using the Hough method. The input data and output results for the settlement analyses are presented as Exhibit 1 at the end of the text of this report.

The compression of the existing soils at STA 13+00 due to the new embankment fill construction is estimated to be on the order of ½ inch.

Compression within the new embankment fill is estimated to be about 1½% of the new embankment height. Thus the estimated compression within the embankment south of the EB on/off ramps will be about 1½ to 2 inches where the new fill is estimated to have a maximum thickness of about 10 feet. The estimated compression within the embankment north of the WB on/off ramps will be about ½ to ¾ inches where the new fill is estimated to have a maximum thickness of about 3 to 4 feet. Based on the granular characteristic of the existing fill materials, on-site soils, compression of the existing soils is anticipated to take place during placement of the new fill. We anticipate approximately 80% of the estimated compression of the new embankment fill will occur during construction of the project with the remaining 20% occurring subsequent to project completion.

4.3 Subgrade Support

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 excellent support characteristics for the planned pavement sections. The mean R-Value for the project is 76. The corresponding resilient modulus is 74,220 pounds per square inch (psi) for a seasonal variation factor of 0.6. For design of pavements the resilient modulus should be limited to 26,000 psi in accordance with the ADOT Preliminary Engineering and Design Manual (PE & D manual).

The recommended pavement section designs are being prepared by ADOT.

4.4 Earthwork Factors and Slopes

Location	Earthwork Factor	Recommend Slope Cut (horizontal: vertical)
Retention Basins	**10% shrink**	**3:1**

Consideration of erosion of the slope surface for both cut and fill slopes is recommended.

All non-stabilized fill slopes should be constructed no steeper than 3(H):1(V) in accordance with ADOT Standard Drawing C-02.10. Construction of fill slopes should be in accordance with Section 203-10 of the ADOT Standard Specifications (ADOT, 2008).

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 General Earthwork

The project will require a significant amount of import materials to construct the new embankment fills. The on-site soils are generally considered good for limiting long term settlement. Therefore, we recommend the import borrow be comprised of select material that will limit long term settlement similar to on-site soils. The borrow should be comprised of material having the following gradation and plasticity requirements:

<u>Gradation</u>	**Percent finer by weight <u>(ASTM C136)</u>**
6"	100
3"	70-100
No. 4 Sieve	50-100
No. 200 Sieve	25 (max)

- Liquid Limit .... 30 (max)
- Plasticity Index .... 15 (max)

The new embankment fill should be benched into the existing embankment such that the maximum bench height is 2 feet or less to reduce the chance for sloughing to occur.

4.6 Water

For balancing grading plans, approximately 90 gallons of water per cubic yard should be estimated for compaction of embankment fill and aggregate base materials. Approximately 70 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.

4.7 Corrosion Potential

Considering the only on-site soils that may be used for new embankment fill will come from the three proposed retention basins, we performed corrosivity laboratory testing on samples obtained from the borings located at the proposed retention basins. Laboratory testing indicates that the pH varied from 6.8 to 7.5, and the minimum resistivity varied from 590 ohm-cm to 670 ohm-cm. Laboratory testing indicates that the soluble chloride contents varied from 390 ppm to 450 ppm, and the soluble sulfate contents varied from 54 ppm to 890 ppm. Based on the soluble sulfate test results, ASTM Type I/II portland cement is considered suitable for all concrete on and below grade. The results of the lab testing are summarized in the following table:

Summary of Chemical Laboratory Testing					
Boring	Depth (feet)	pH	Minimum Resistivity (ohm-cm)	Chloride (ppm)	Sulfate (ppm)
B-6	0.0 - 4.0	6.8	630	390	130
B-7	0.0 - 4.0	7.5	670	440	54
B-8	0.0 - 4.0	7.2	590	450	890

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, pavement 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 borings, 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.

HOUGH METHOD OF COMPUTING COMPRESSION		
Water Level (ft)	510	☑ USE CORRECTED N VALUES?

JOB NAME	West Quartzsite Traffic Interchange
JOB NUMBER	65145257
NOTES	Borings B-1 & B-2

Top of Stratum (ft)	Bottom of Stratum (ft)	Moist Density (pcf)	Saturated Density (pcf)	Average N-Value for Stratum	Change in Stress at Center (psf)	Center of Stratum (ft)	Buoyant Density (pcf)	Effective Stress at Center (pcf)	Effective Stress at Bottom (pcf)	Total Stress at Center (pcf)	Total Stress at Bottom (pcf)	Select a Soil Type for each Layer
0	13	125	130	22	813	6.5	67.6	813	1625	813	1625	Clean uniform medium SAND
13	17	125	130	37	475	15.0	67.6	1875	2125	1875	2125	Clean uniform medium SAND
17	24	120	130	12	350	20.5	67.6	2545	2965	2545	2965	Clean uniform medium SAND
24	28	120	130	25	288	26	67.6	3205	3445	3205	3445	Clean uniform medium SAND
28	33	125	130	37	250	30.5	67.6	3758	4070	3758	4070	Clean uniform medium SAND
33	43	125	130	54	225	38	67.6	4695	5320	4695	5320	Clean uniform medium SAND
43	56	125	130	73	175	49.5	67.6	6133	6945	6133	6945	Clean uniform medium SAND

Top of Stratum (ft)	Bottom of Stratum (ft)	Corrected N-Values	C'	σ_{vo}'	$\Delta\sigma_v'$	Settlement (in)	$C\varepsilon c$
0	13	35	151	813	813	0.31	0.007
13	17	39	170	1875	475	0.03	0.006
17	24	11	62	2545	350	0.08	0.016
24	28	20	88	3205	288	0.02	0.011
28	33	28	116	3758	250	0.01	0.009
33	43	36	155	4695	225	0.02	0.006
43	56	43	192	6133	175	0.01	0.005
Total Settlement for Profile (in) =						0.47	

NOTES:

This spreadsheet is based on a method presented by Hough, which was later modified by Cheney and Chassie.

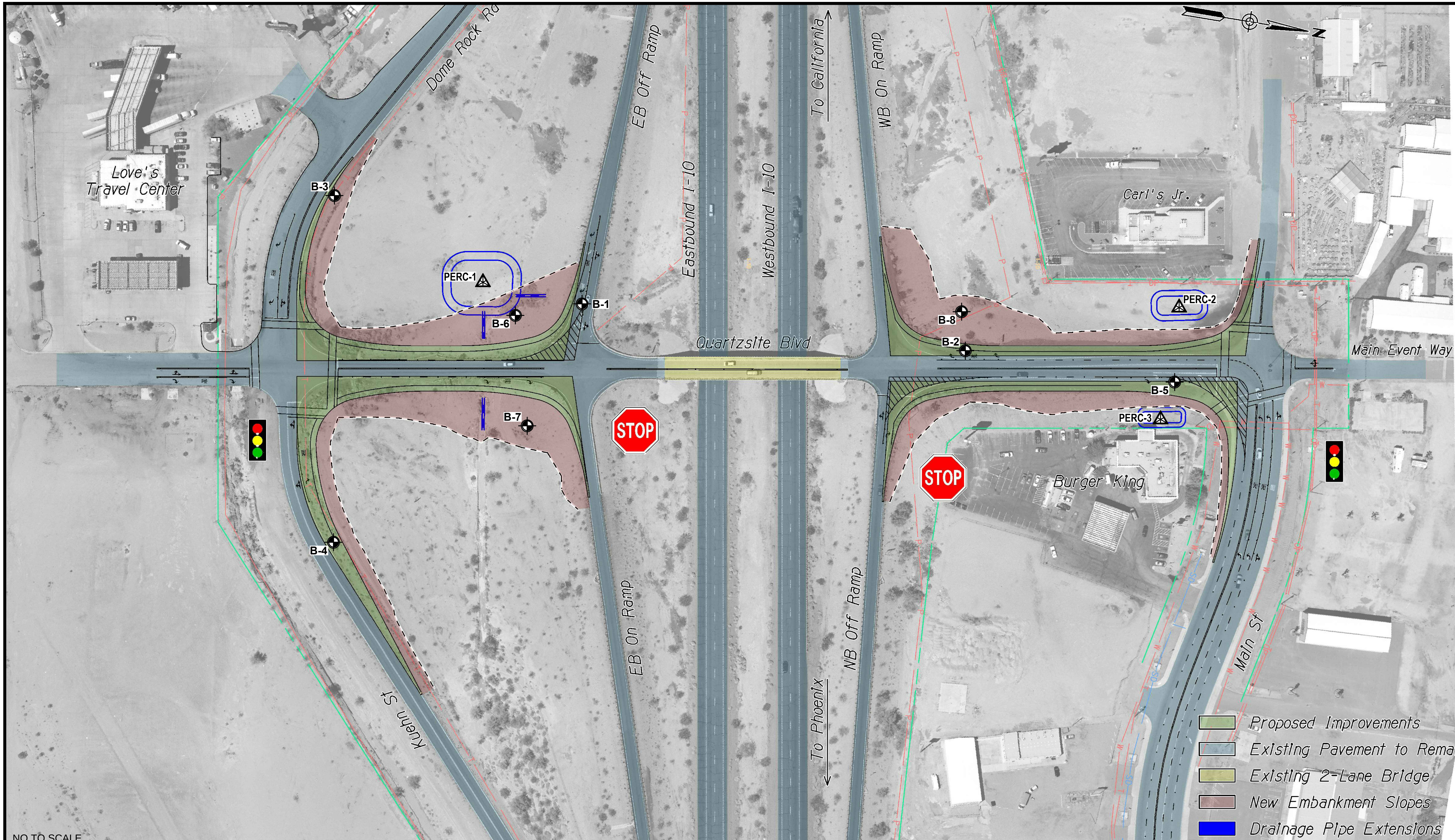
This method is applicable only for normally consolidated cohesionless soils.

N-values are corrected based on the method proposed by Liao & Whitman.

Please see FHWA-IF-02-054 "Shallow Foundations" for more info.

APPENDIX A

FIELD EXPLORATION



LEGEND:

- APPROXIMATE BORING LOCATION
- PERCOLATION TEST HOLE

NOTE: SITE PLAN BASE MAP PROVIDED BY ADOT

Project Mngr:	SDN	Project No.	65145257
Drawn By:	KLJ	Scale:	AS SHOWN
Checked By:	SDN	File No.	65145257.DWG
Approved By:	DRC	Date:	01/13/2015

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

WEST QUARTZSITE TRAFFIC INTERCHANGE

QUARTZSITE BOULEVARD INTERSECTION WITH I-10

QUARTZSITE ARIZONA

EXHIBIT

A-1

Field Exploration Description

The field exploration was performed on October 20 and 21, 2014. The borings were drilled to depths of approximately 2½ to 50 feet below existing grade at the approximate locations shown on the attached Site Plan and Boring Locations diagrams, Exhibit A-1 in Appendix A.

The test borings were advanced with a truck-mounted CME-75 drill rig utilizing 4½-inch inside diameter hollow-stem augers. The borings were located in the field by using an aerial photograph of the site, and measuring from existing physiographic features with a wheel tape. The accuracy of boring locations should only be assumed to the level implied by the method used.

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. Logs were prepared for each test boring and are presented in this appendix.

Penetration resistance measurements were obtained by driving the split-spoon and ring-barrel samplers into the subsurface materials with a 140-pound automatic hammer falling 30 inches. The penetration resistance value is a useful index in estimating the consistency or relative density of materials encountered.

A CME automatic SPT hammer was used to advance the split-barrel sampler in the borings performed on this site. A greater efficiency is typically achieved with the automatic hammer compared to the conventional safety hammer operated with a cathead and rope. Published correlations between the SPT values and soil properties are based on the lower efficiency cathead and rope method. This higher efficiency affects the standard penetration resistance blow count (N) value by increasing the penetration per hammer blow over what would be obtained using the cathead and rope method.

Groundwater conditions were evaluated in each boring at the time of site exploration, and immediately upon completion of drilling.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

Bulk	Shelby Tube	Split Spoon
Rock Core	Macro Core	Modified California Ring Sampler
Grab Sample	No Recovery	Modified Dames & Moore Ring Sampler

WATER LEVEL

- Water Initially Encountered
- Water Level After a Specified Period of Time
- Water Level After a Specified Period of Time

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.

FIELD TESTS

(HP)	Hand Penetrometer
(T)	Torvane
(b/f)	Standard Penetration Test (blows per foot)
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

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

GRAIN SIZE TERMINOLOGY

Major Component of Sample	Particle Size
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

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

PLASTICITY DESCRIPTION

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

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UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests [A]					Soil Classification: Group Symbol	Soil Classification: 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] $Cu = D_{60}/D_{10} \qquad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[F] If soil contains ≥ 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 ≥ 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 ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

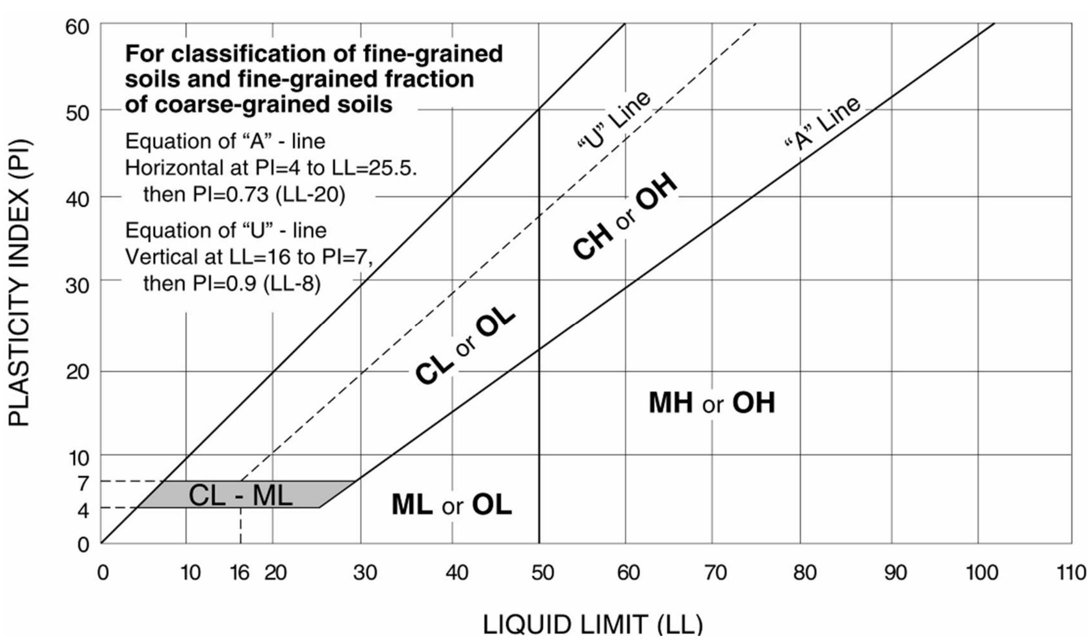
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add “gravelly” to group name.

[N] PI ≥ 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

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - SILTY SAND WITH GRAVEL (SM), brown, medium dense							NP	12
					22-28/4"	3	127		
5.0	**FILL - SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, medium dense	5							
					15-31	3	123		
		10							
	medium dense to dense								
					22-28/3"	4	125		
		15							
19.0	**SILTY SAND WITH GRAVEL (SM)**, brown, loose to medium dense				8-12	2	114		
		20							
	medium dense								
					23-27/5"	1	120		
		25							

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-5

BORING LOG NO. B-1

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, loose to medium dense *(continued)* medium dense to dense, weak cementation								
		30			25-25/3"	2	122		
32.0	**CLAYEY SAND WITH GRAVEL (SC)**, brown to light brown, very dense, weak to moderate cementation								
		35			11-39-50/4"				
38.0	**POORLY GRADED GRAVEL WITH SILT AND SAND (SP-SM)**, brown, very dense, no to weak cementation								
		40			39-39-50/5"				
		45			50/6"				
					34-50/4"				
50.0	***Boring Terminated at 50 Feet***	50							

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-5

BORING LOG NO. B-2

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - WELL GRADED GRAVEL WITH SILT AND SAND (GW-GM), brown, medium dense							NP	7
		5			17-22	3	120		
		10			21-33				
		15			10-40/2"				
18.0	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, medium dense								
		20			8-6-7 N=13				
	very dense	25			29-34-50/5"				

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-6

BORING LOG NO. B-2

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
27.0	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, medium dense *(continued)*								
	CLAYEY SAND WITH GRAVEL (SC), brown to light brown, very dense, weak to moderate cementation	30		X	23-37-50/5"				
		35		X	12-22-30 N=52				
38.0	**SILTY SAND WITH GRAVEL (SM)**, brown, very dense, no to weak cementation	40		X	16-25-32 N=57				
41.0	**CLAYEY SAND WITH GRAVEL (SC)**, brown to light brown, very dense, weak cementation	45		X	25-37-35 N=72				
49.5				X	50/6"				
	Boring Terminated at 49.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-6

BORING LOG NO. B-3

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

DEPTH	Description	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
1.0	**FILL - SILTY GRAVEL WITH SAND (GM)**, brown								
5.0	**WELL GRADED SAND WITH SILT AND GRAVEL (SW-SM)**, brown, medium dense, no to weak cementation				5-11	4	112	NP	11
7.0	**SILTY GRAVEL WITH SAND (GM)**, brown, very dense	5			19-24	3	114		
9.0	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown, medium dense, no to weak cementation				7-9	5	118		
18.0	**SILTY GRAVEL WITH SAND (GM)**, brown to light brown, very dense	10			24-26/4"	4	133		
		15			34-32-36 N=68				
20.5	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown to light brown, very dense, no to weak cementation	20			25-27-18 N=45				
	Boring Terminated at 20.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-7

BORING LOG NO. B-4

PROJECT: West Quartzsite Traffic Interchange

**CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ**

**SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ**

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - SILTY CLAYEY SAND WITH GRAVEL (SC-SM), brown, medium dense				12-18	3	130	22-15-7	13
		5			15-29	3	127		
	7.0								
	CLAYEY SAND WITH GRAVEL (SC), brown to light brown, loose				4-3-4 N=7				
	medium dense	10			8-10-13 N=23				
		15			10-9-12 N=21				
	dense, weak to moderate cementation								
	20.5	20			17-14-21 N=35				
	Boring Terminated at 20.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-8

BORING LOG NO. B-5

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

GRAPHIC LOG DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - WELL GRADED SAND WITH GRAVEL (SW-SM), brown, medium dense								
					17-33/4"	3	121	NP	10
		5			22-28	2	123		
7.0	**CLAYEY SAND WITH GRAVEL (SC)**, brown to light brown, medium dense, no to weak cementation				11-20	4	120		
9.0	**SILTY CLAYEY SAND WITH GRAVEL (SC-SM)**, brown to light brown, medium dense, weak cementation				15-35/5"	5	121		
		10							
	dense	15			17-19-25 N=44				
18.0	**SILTY SAND WITH GRAVEL (SM)**, brown, dense								
20.5		20			11-20-21 N=41				
	Boring Terminated at 20.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-9

BORING LOG NO. B-6

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

LOCATION See Exhibit A-1

GRAPHIC LOG	DEPTH	DESCRIPTION	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		SILTY SAND WITH GRAVEL (SM), brown, loose								
						7-7	4		NP	13
	4.0	**CLAYEY SAND WITH GRAVEL (SC)**, brown to light brown, medium dense, weak to moderate cementation				16-34	4	125		
	5.0	***Boring Terminated at 5 Feet***	5							

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/21/2014	Boring Completed: 10/21/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-10

BORING LOG NO. B-7

PROJECT: West Quartzsite Traffic Interchange

**CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ**

**SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ**

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, loose							NP	23
					8-10	3	116		
	4.0								
	CLAYEY SAND WITH GRAVEL (SC), brown to light brown, medium dense, weak to moderate cementation								
	5.0	5			11-21	5	112		
	Boring Terminated at 5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/21/2014	Boring Completed: 10/21/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-11

BORING LOG NO. B-8

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown, medium dense							21-19-2	22
					13-15	3	122		
	4.0								
	CLAYEY SAND WITH GRAVEL (SC), brown to light brown, medium dense, moderate cementation				7-30	6	109		
	5.0	5							
	Boring Terminated at 5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Hollow Stem Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/21/2014	Boring Completed: 10/21/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-12

BORING LOG NO. PERC-1

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

GRAPHIC LOG	LOCATION See Exhibit A-1 / DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown								
	2.5								
	Boring Terminated at 2.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Solid Stem Perc Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS
Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-13

BORING LOG NO. PERC-2

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown 2.5								
	Boring Terminated at 2.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Solid Stem Perc Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-14

BORING LOG NO. PERC-3

PROJECT: West Quartzsite Traffic Interchange

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

GRAPHIC LOG	LOCATION See Exhibit A-1 DEPTH	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	SILTY SAND WITH GRAVEL (SM), brown								
	2.5								
	Boring Terminated at 2.5 Feet								

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

Hammer Type: Automatic

Advancement Method:
Solid Stem Perc Auger

Abandonment Method:
Borings backfilled with soil cuttings upon completion.

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:

WATER LEVEL OBSERVATIONS
Groundwater not encountered

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

Boring Started: 10/20/2014	Boring Completed: 10/20/2014
Drill Rig: CME-75	Driller: Southlands Drilling
Project No.: 65145257	Exhibit: A-15

APPENDIX B

LABORATORY TEST RESULTS

Laboratory Testing Description

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 B. 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.

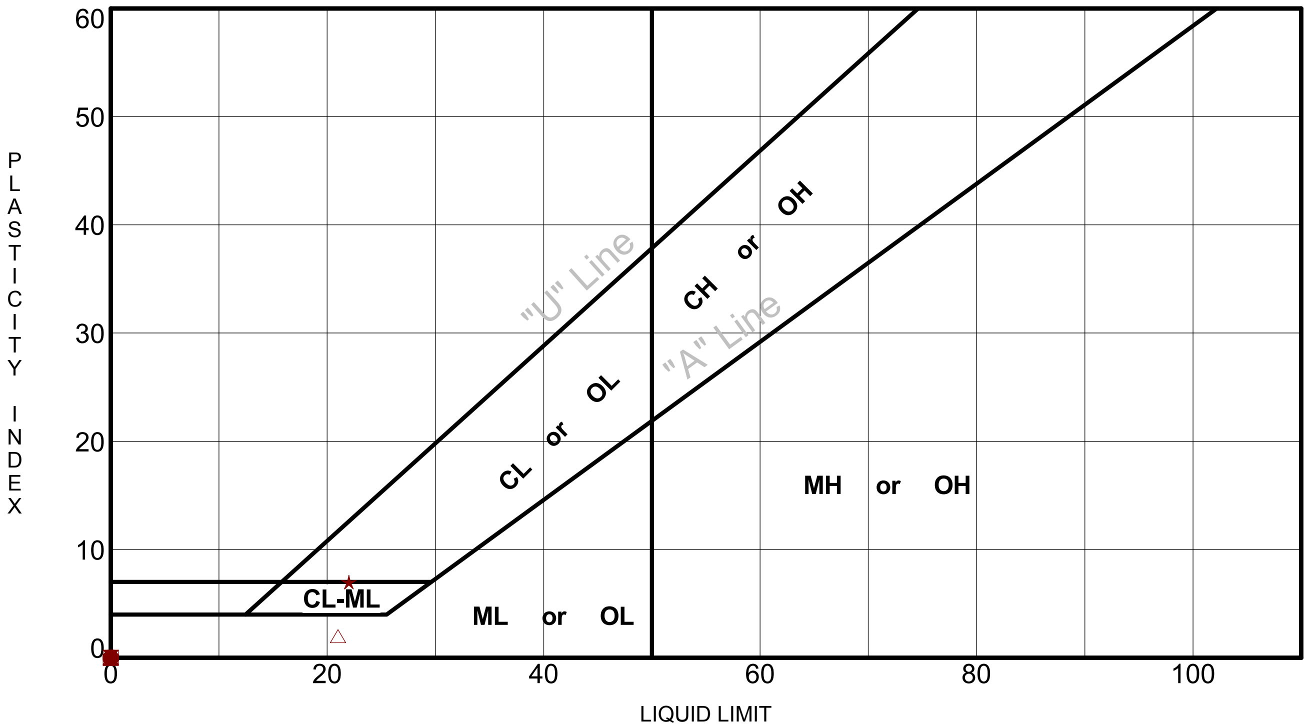
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. Selected bulk or driven samples of the site soils were combined to make composite samples, and these composite samples were tested in the laboratory. The laboratory test results were used for the geotechnical engineering analyses, and the development of roadway, foundation and earthwork 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:

- In-situ Dry Density
- In-situ Water Content
- Sieve Analysis
- Moisture-Density Relationship
- Atterberg Limits
- R-Value
- Consolidation
- pH and Minimum Resistivity
- Soluble Chloride
- Soluble Sulfate

ATTERBERG LIMITS RESULTS

ASTM D4318



	Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
●	B-1	1.0 - 5.0	NP	NP	NP	12	SM	SILTY SAND with GRAVEL
⧗	B-2	0.0 - 5.0	NP	NP	NP	7	GW-GM	WELL-GRADED GRAVEL with SILT and SAND
▲	B-3	1.0 - 5.0	NP	NP	NP	11	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
★	B-4	0.0 - 4.0	22	15	7	13	SC-SM	SILTY, CLAYEY SAND with GRAVEL
⊙	B-5	0.0 - 5.0	NP	NP	NP	10	SW-SM	WELL-GRADED SAND with SILT and GRAVEL
✿	B-6	0.0 - 4.0	NP	NP	NP	13	SM	SILTY SAND with GRAVEL
○	B-7	0.0 - 4.0	NP	NP	NP	23	SM	SILTY SAND with GRAVEL
△	B-8	0.0 - 4.0	21	19	2	22	SM	SILTY SAND with GRAVEL

PROJECT: West Quartzsite Traffic Interchange

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona

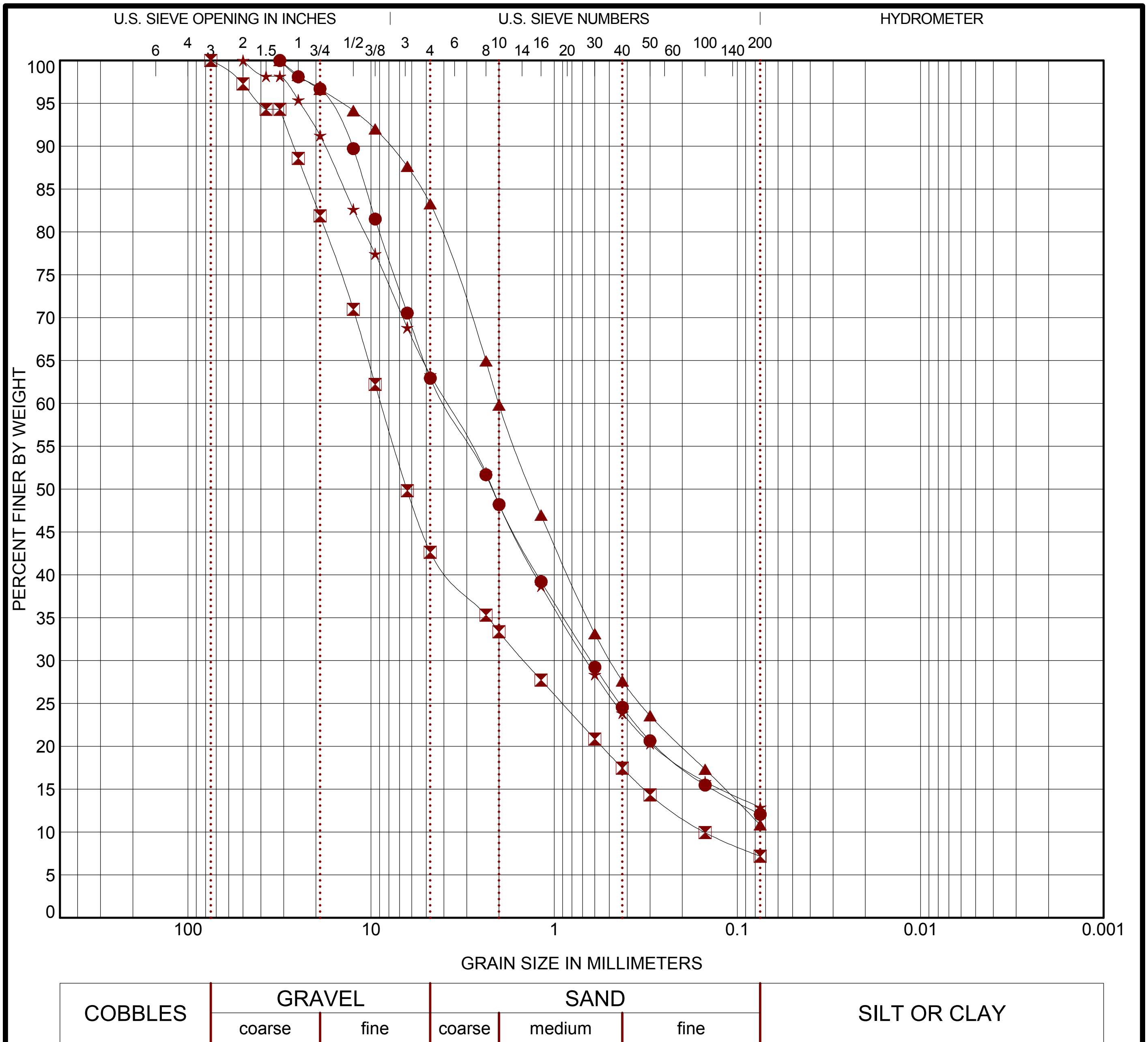
PROJECT NUMBER: 65145257

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



Boring ID	Depth	USCS Classification	AASHTO Classification	LL	PL	PI	Cc	Cu
B-1	1 - 5	SILTY SAND with GRAVEL(SM)	0(A-1-a)	NP	NP	NP	2.05	80.23
B-2	0 - 4.999	WELL-GRADED GRAVEL with SILT and SAND(GW-GM)	0(A-1-a)	NP	NP	NP	1.59	58.27
B-3	1 - 5	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	0(A-1-b)	NP	NP	NP	1.76	29.31
B-4	0 - 4	SILTY, CLAYEY SAND with GRAVEL(SC-SM)	0(A-2-4)	22	15	7		

Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
B-1	1 - 5	31.5	3.958	0.632		37.1	50.9	12.1	
B-2	0 - 4.999	75	8.842	1.46	0.152	57.3	35.5	7.2	
B-3	1 - 5	31.5	2.012	0.493		16.7	72.5	10.8	
B-4	0 - 4	50	3.877	0.668		36.7	50.4	12.9	

PROJECT: West Quartzsite Traffic Interchange

SITE: Quartzsite Blvd. and I-10 T.I. Quartzsite, AZ

Terracon

4685 S. Ash Ave., Suite H-4
Tempe, Arizona

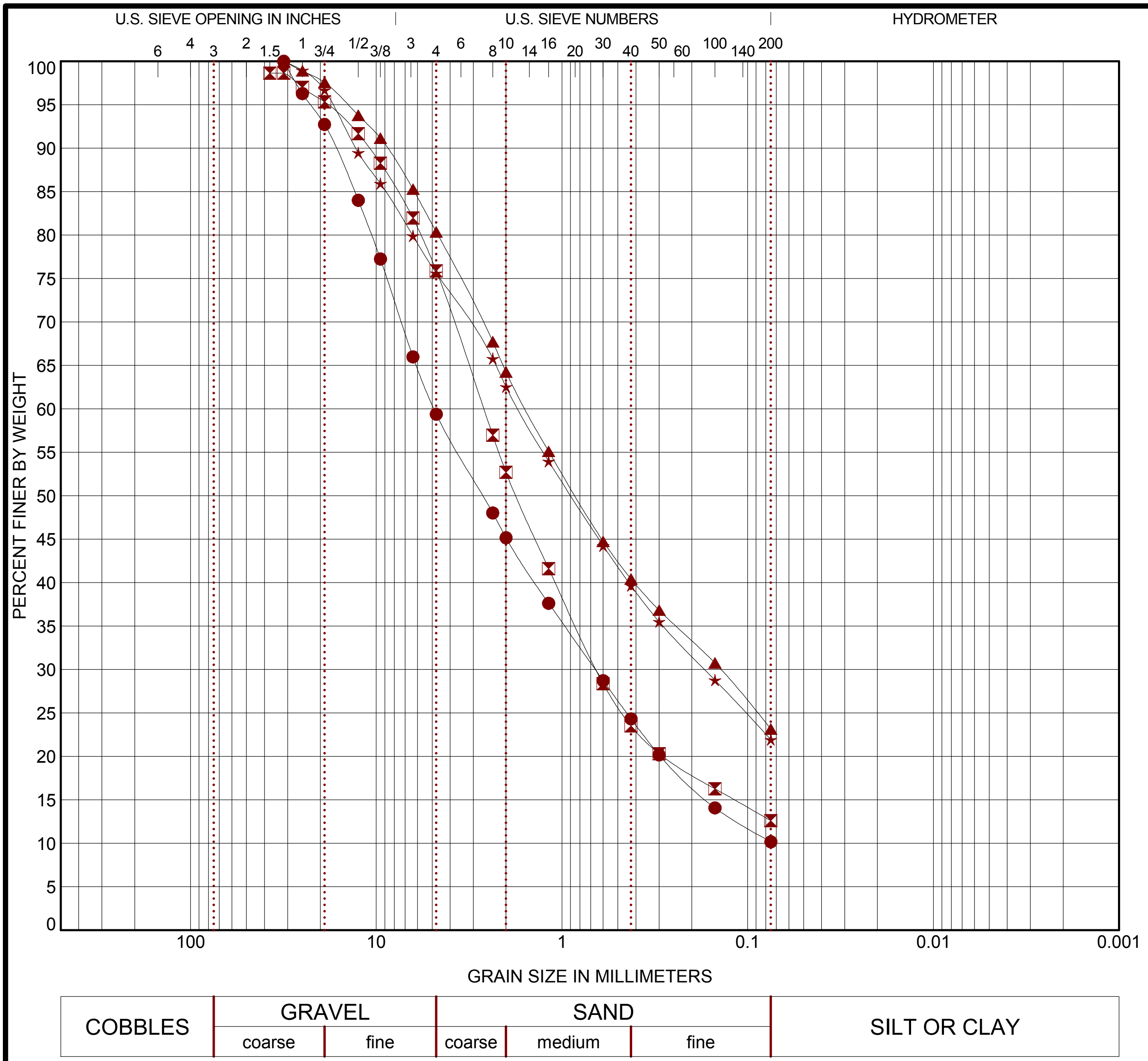
PROJECT NUMBER: 65145257

CLIENT: Parsons Brinkerhoff, Inc. Tempe, AZ

EXHIBIT: B-3

GRAIN SIZE DISTRIBUTION

ASTM D422



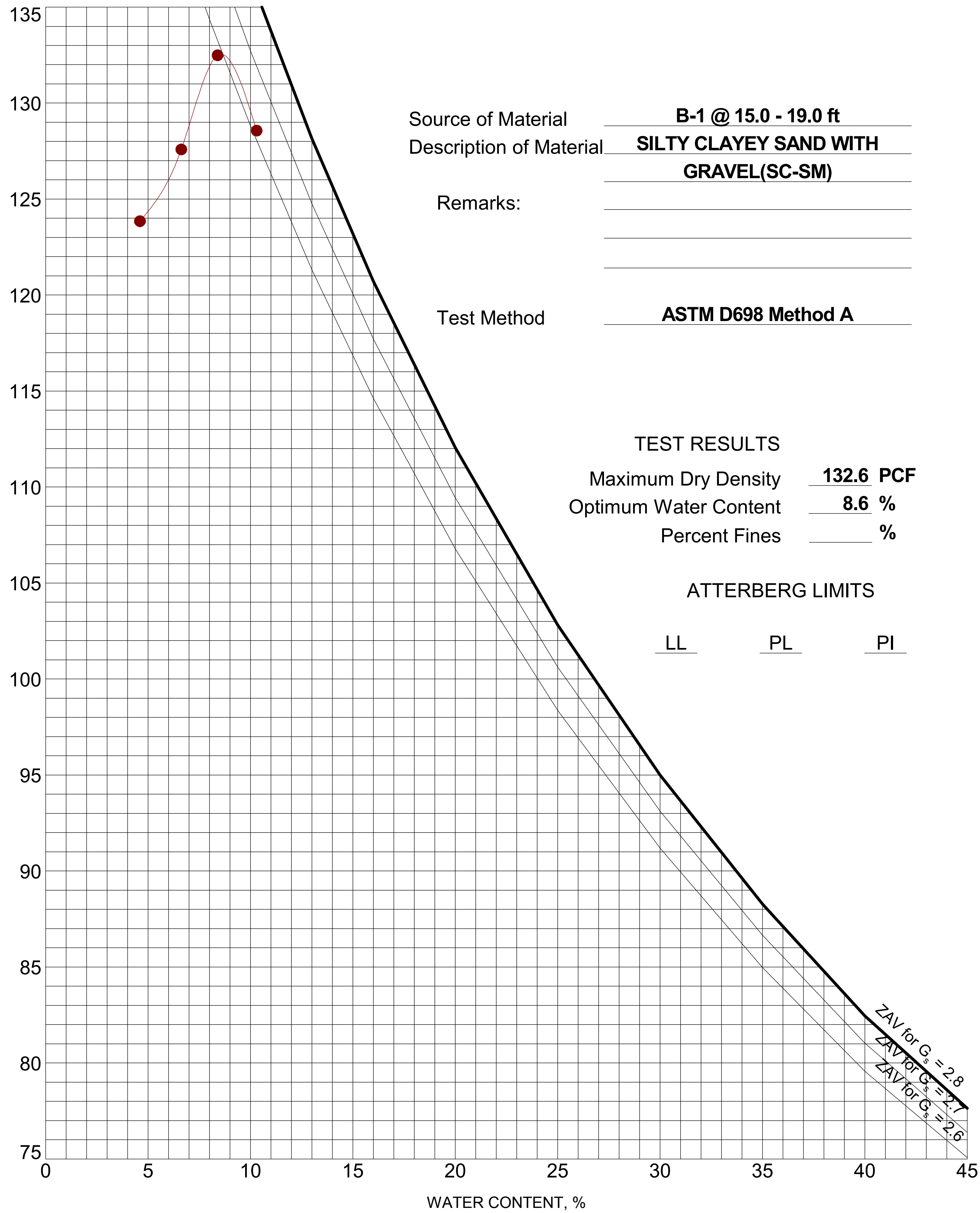
	Boring ID	Depth	USCS Classification	AASHTO Classification	LL	PL	PI	Cc	Cu
●	B-5	0 - 5	WELL-GRADED SAND with SILT and GRAVEL(SW-SM)	0(A-1-a)	NP	NP	NP	1.23	67.03
⧗	B-6	0 - 4	SILTY SAND with GRAVEL(SM)	0(A-1-b)	NP	NP	NP		
▲	B-7	0 - 4	SILTY SAND with GRAVEL(SM)	0(A-1-b)	NP	NP	NP		
★	B-8	0 - 4	SILTY SAND with GRAVEL(SM)	0(A-1-b)	21	19	2		

	Boring ID	Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Silt	%Clay
●	B-5	0 - 5	31.5	4.881	0.661		40.6	49.2	10.2	
⧗	B-6	0 - 4	37.5	2.64	0.653		22.8	63.3	12.6	
▲	B-7	0 - 4	31.5	1.565	0.14		19.6	57.2	23.2	
★	B-8	0 - 4	31.5	1.712	0.17		24.4	53.7	21.9	

PROJECT: West Quartzsite Traffic Interchange	Terracon	PROJECT NUMBER: 65145257
SITE: Quartzsite Blvd. and I-10 T.I. Quartzsite, AZ	4685 S. Ash Ave., Suite H-4 Tempe, Arizona	CLIENT: Parsons Brinkerhoff, Inc. Tempe, AZ
		EXHIBIT: B-4

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-1 @ 15.0 - 19.0 ft**
Description of Material	**SILTY CLAYEY SAND WITH GRAVEL(SC-SM)**
Remarks:	
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**132.6**	**PCF**
Optimum Water Content	**8.6**	**%**
Percent Fines		**%**

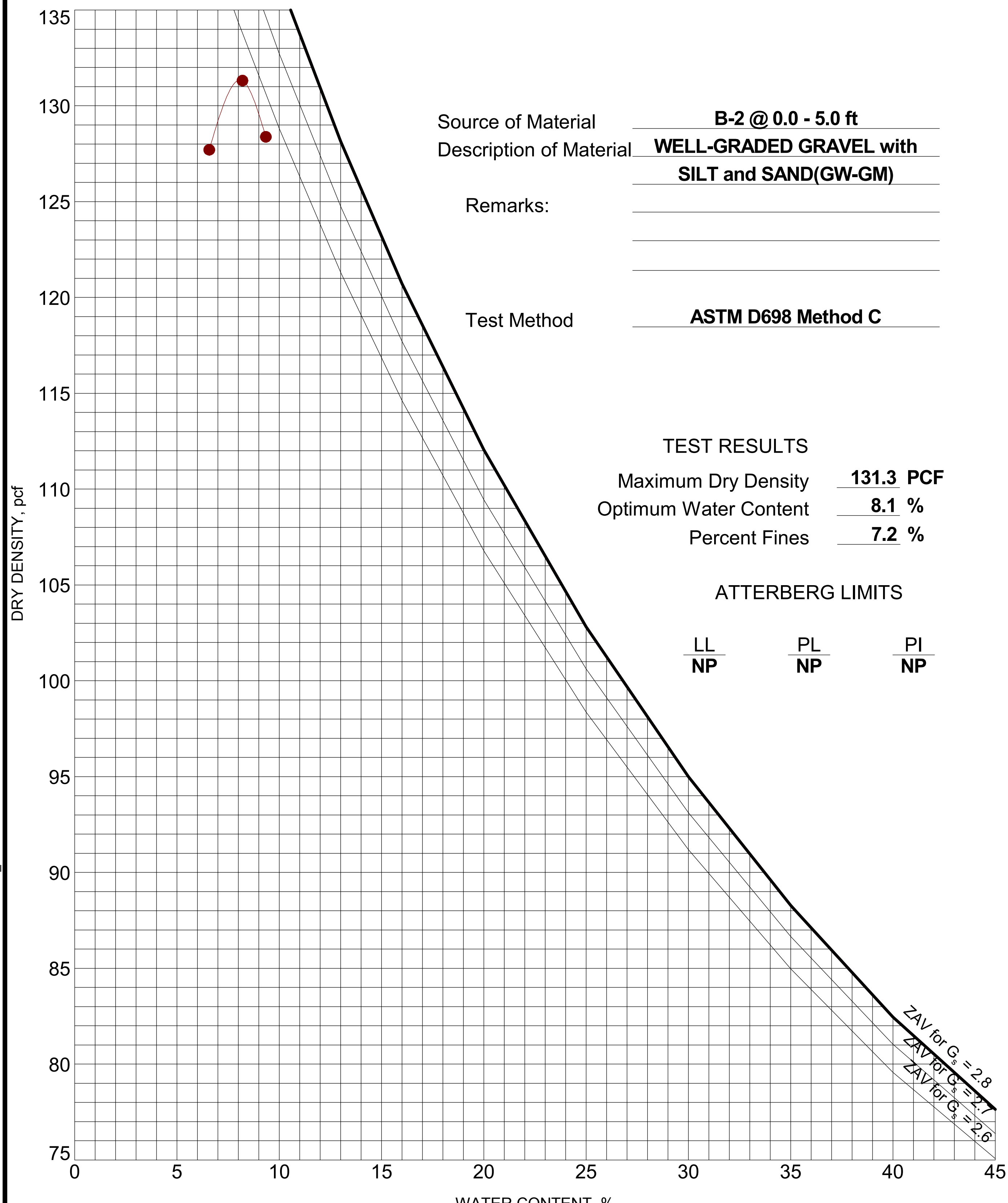
ATTERBERG LIMITS

LL	PL	PI

PROJECT: West Quartzsite Traffic Interchange	Terracon	PROJECT NUMBER: 65145257
SITE: Quartzsite Blvd. and I-10 T.I. Quartzsite, AZ	4685 S. Ash Ave., Suite H-4 Tempe, Arizona	CLIENT: Parsons Brinkerhoff, Inc. Tempe, AZ
		EXHIBIT: B-5

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B-2 @ 0.0 - 5.0 ft**

Description of Material: **WELL-GRADED GRAVEL with SILT and SAND(GW-GM)**

Remarks:

Test Method: **ASTM D698 Method C**

TEST RESULTS

Maximum Dry Density **131.3 PCF**

Optimum Water Content **8.1 %**

Percent Fines **7.2 %**

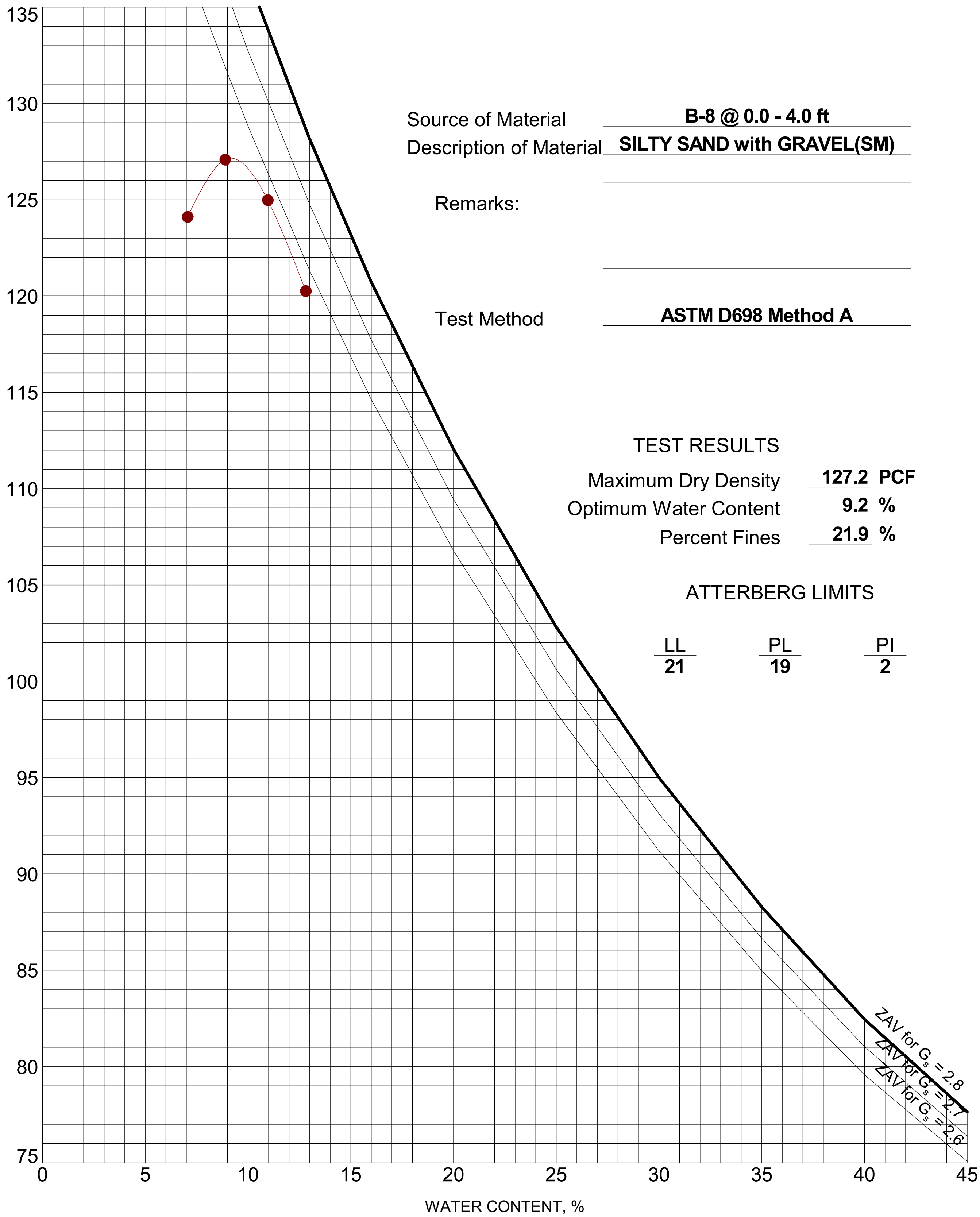
ATTERBERG LIMITS

LL	PL	PI
NP	**NP**	**NP**

PROJECT: West Quartzsite Traffic Interchange	Terracon	PROJECT NUMBER: 65145257
SITE: Quartzsite Blvd. and I-10 T.I. Quartzsite, AZ	4685 S. Ash Ave., Suite H-4 Tempe, Arizona	CLIENT: Parsons Brinkerhoff, Inc. Tempe, AZ
		EXHIBIT: B-6

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material	**B-8 @ 0.0 - 4.0 ft**
Description of Material	**SILTY SAND with GRAVEL(SM)**
Remarks:	
Test Method	**ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**127.2 PCF**
Optimum Water Content	**9.2 %**
Percent Fines	**21.9 %**

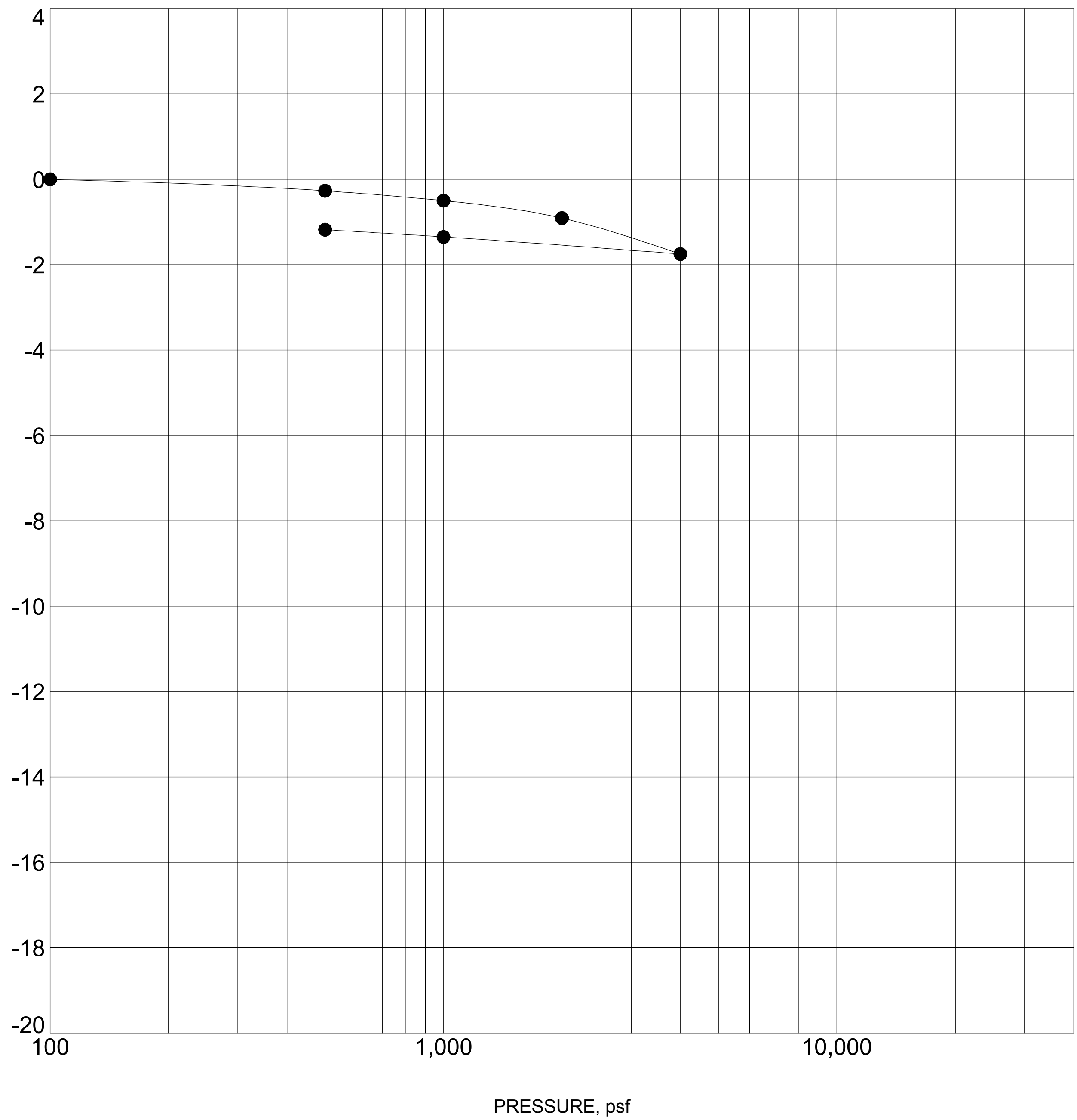
ATTERBERG LIMITS

LL	PL	PI
21	**19**	**2**

PROJECT: West Quartzsite Traffic Interchange	Terracon	PROJECT NUMBER: 65145257
SITE: Quartzsite Blvd. and I-10 T.I. Quartzsite, AZ	4685 S. Ash Ave., Suite H-4 Tempe, Arizona	CLIENT: Parsons Brinkerhoff, Inc. Tempe, AZ
		EXHIBIT: B-7

SWELL CONSOLIDATION TEST

ASTM D2435

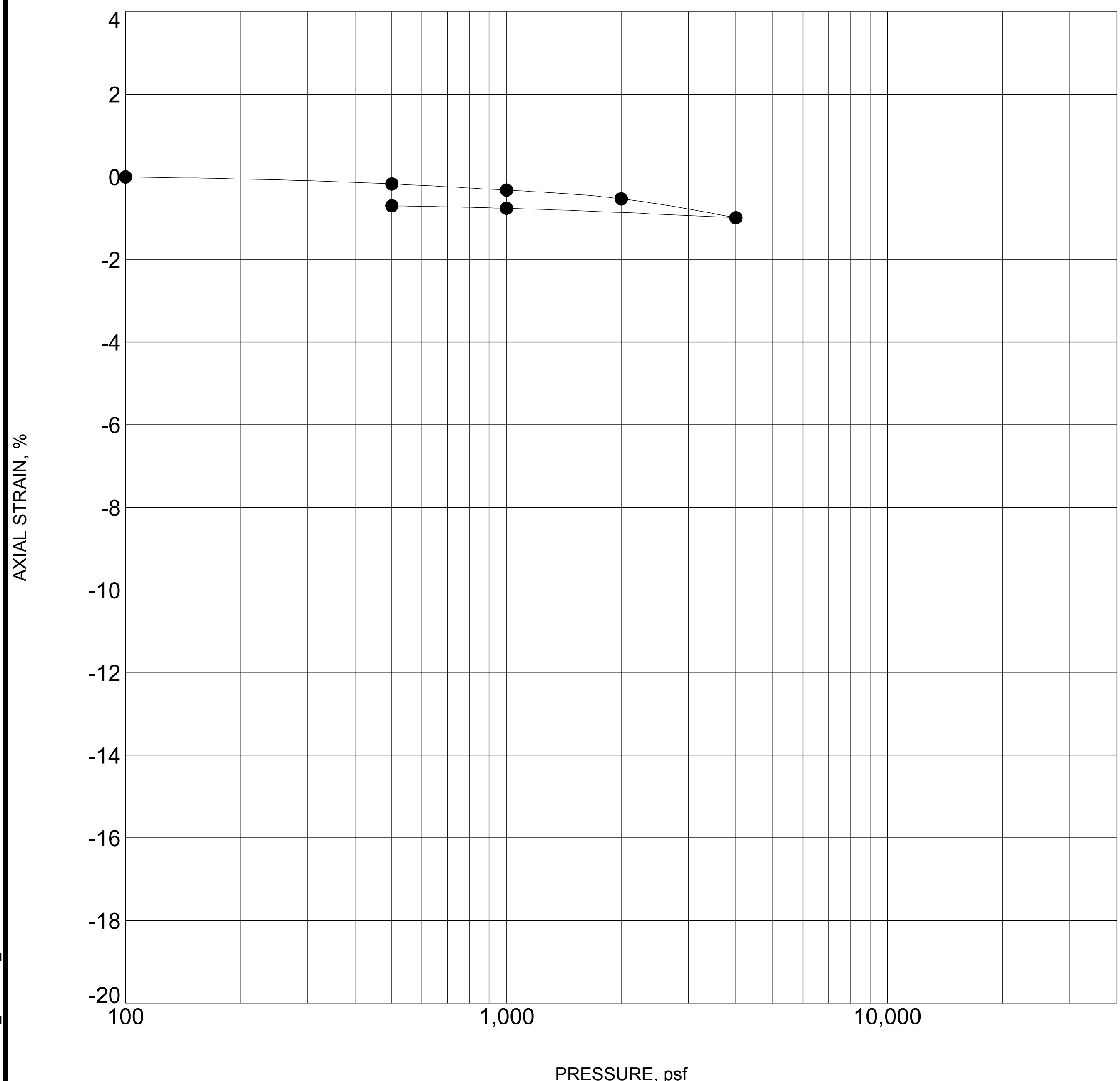


Specimen Identification		Classification	γ_d, pcf	WC, %
●	B-2 4.0 - 5.0 ft	CLAYEY SAND WITH GRAVEL(SC)	120	3

NOTES:

SWELL CONSOLIDATION TEST

ASTM D2435



Specimen Identification		Classification	γ_d, pcf	WC, %
●	B-7 2.0 - 3.0 ft	SILTY SAND WITH GRAVEL(SM)	118	3

NOTES:

PROJECT: West Quartzsite Traffic Interchange	Terracon	PROJECT NUMBER: 65145257
SITE: Quartzsite Blvd. and I-10 T.I. Quartzsite, AZ	4685 S. Ash Ave., Suite H-4 Tempe, Arizona	CLIENT: Parsons Brinkerhoff, Inc. Tempe, AZ
		EXHIBIT: B-9

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

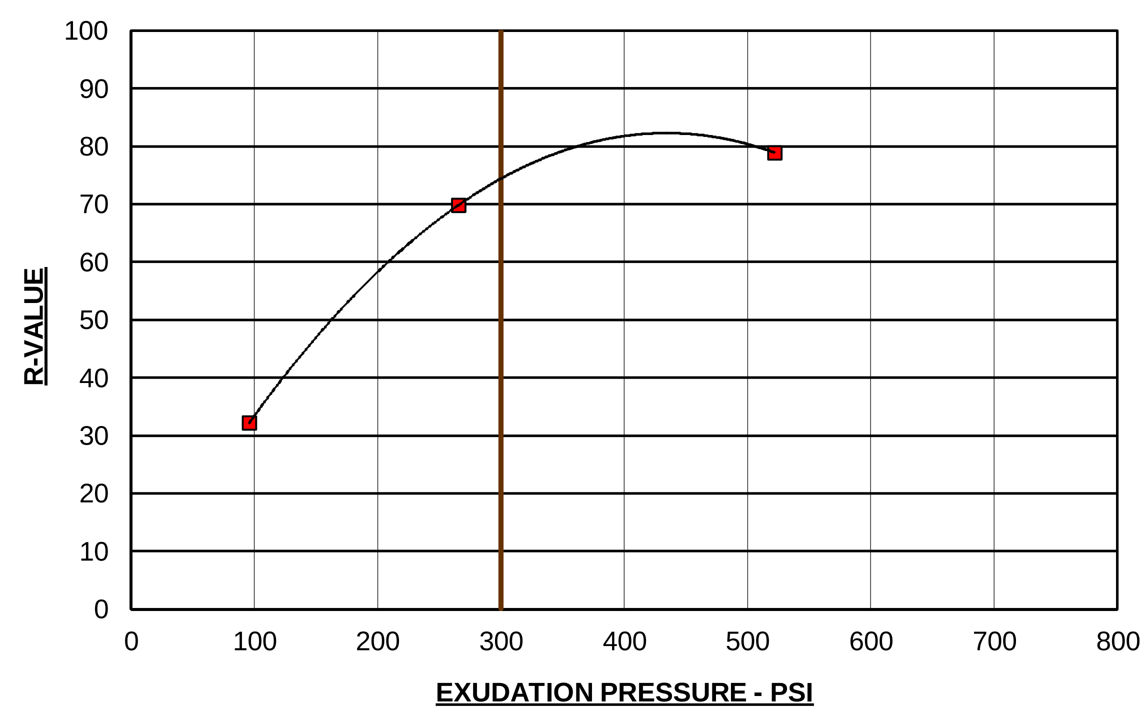
RESISTANCE R-VALUE & EXPANSION PRESSURE OF COMPACTED SOIL ASTM D2844

PROJECT: Quartzsite Blvd. Widening Improvements
LOCATION: Quartzsite Blvd. & I-10 T.I.
PROJECT NO. 65125257
CLASSIFICATION: WELL GRADED SAND WITH SILT AND GRAVEL(SW-SM)
SAMPLE: B-3 @ 1

SAMPLE DATA TEST RESULTS

TEST SPECIMEN NO.	1	2	3
COMPACTION PRESSURE (PSI)	110	150	200
DENSITY (PCF)	125.3	126.1	130.6
MOISTURE CONTENT (%)	9.3	8.4	7.1
EXPANSION PRESSURE (PSI)	-0.25	-0.06	0.12
HORIZONTAL PRESSURE @ 160 PSI	90	34	18
SAMPLE HEIGHT (INCHES)	2.43	2.48	2.40
EXUDATION PRESSURE (PSI)	95.9	265.7	521.9
CORRECTED R-VALUE	32.2	69.8	78.9
UNCORRECTED R-VALUE	33.2	69.8	82.2

R-VALUE @ 300 PSI EXUDATION PRESSURE = 73



Terracon

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

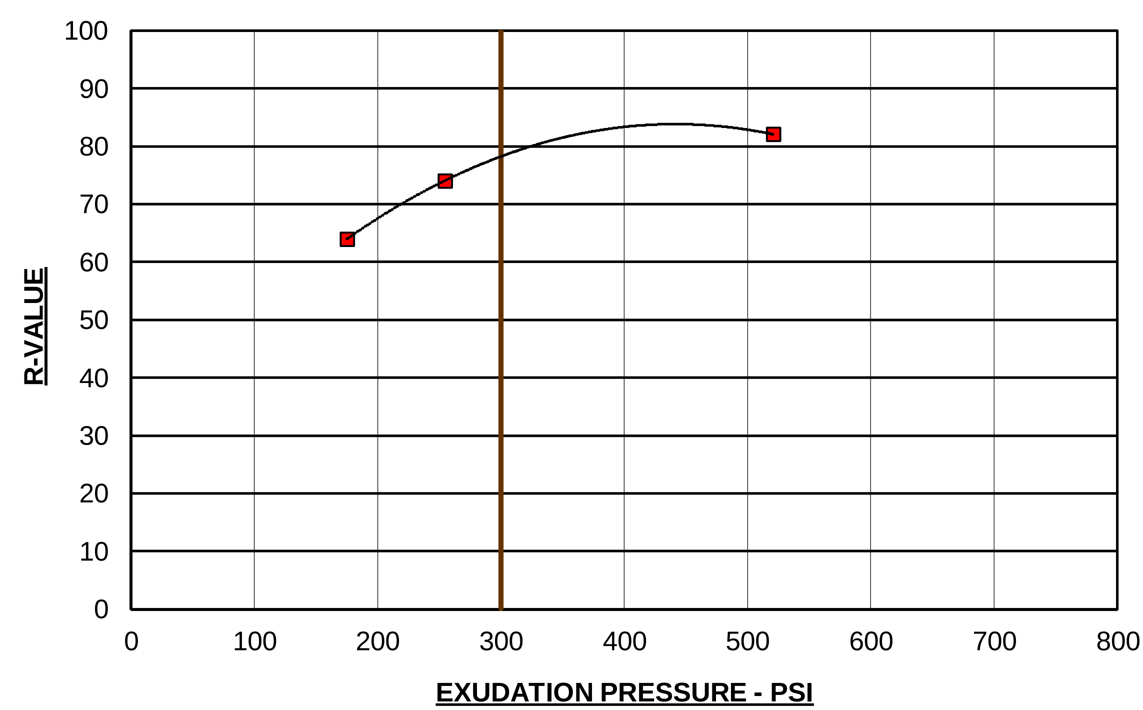
RESISTANCE R-VALUE & EXPANSION PRESSURE OF COMPACTED SOIL
ASTM D2844

PROJECT: Quartzsite Blvd. Widening Improvements
LOCATION: Quartzsite Blvd. & I-10 T.I.
PROJECT NO. 65125257
CLASSIFICATION: SILTY SAND WITH GRAVEL(SM)
SAMPLE: B-7 @ 0

SAMPLE DATA TEST RESULTS

TEST SPECIMEN NO.	1	2	3
COMPACTION PRESSURE (PSI)	150	200	250
DENSITY (PCF)	128.7	130.7	133.9
MOISTURE CONTENT (%)	8.3	7.7	5.6
EXPANSION PRESSURE (PSI)	-0.28	-0.06	0.31
HORIZONTAL PRESSURE @ 160 PSI	35	25	18
SAMPLE HEIGHT (INCHES)	2.53	2.53	2.53
EXUDATION PRESSURE (PSI)	175.0	254.6	520.7
CORRECTED R-VALUE	64.0	74.1	82.1
UNCORRECTED R-VALUE	64.0	74.1	82.1

R-VALUE @ 300 PSI EXUDATION PRESSURE = $\boxed{77}$



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 LL	Atterberg Limits PL	Atterberg Limits PI	Dry Density (pcf)	Water Content (%)	Surcharge (psf)	Expansion (%)	Expansion Index EI_{50}	pH	Resistivity (ohm-cm)	Sulfates (ppm)	Chlorides (ppm)	
B-1	1.0 - 5.0	SM			12	NP	NP	NP										
B-1	4.0 - 4.9	SM	127	3														1, 2
B-1	9.0 - 10.0	SC-SM	123	3														1, 2
B-1	14.0 - 14.8	SC-SM	125	4														1, 2
B-1	19.0 - 20.0	SM	114	2														1, 2
B-1	24.0 - 24.9	SM	120	1														1, 2
B-1	29.0 - 29.8	SM	122	2														1, 2
B-2	0.0 - 5.0	GW-GM			7	NP	NP	NP										
B-2	4.0 - 5.0	SC	120	3														1, 2
B-3	1.0 - 5.0	SW-SM			11	NP	NP	NP										
B-3	2.0 - 3.0	SW-SM	112	4														1, 2
B-3	5.0 - 6.0	GM	114	3														1, 2
B-3	7.0 - 8.0	SC-SM	118	5														1, 2
B-3	9.0 - 9.9	GM	133	4														1, 2
B-4	0.0 - 4.0	SC-SM			13	22	15	7										
B-4	2.0 - 3.0	SC-SM	130	3														1, 2
B-4	5.0 - 6.0	SC-SM	127	3														1, 2
B-5	0.0 - 5.0	SW-SM			10	NP	NP	NP										
B-5	2.0 - 2.9	SW-SM	121	3														1, 2
B-5	5.0 - 6.0	SW-SM	123	2														1, 2
B-5	7.0 - 8.0	SC	120	4														1, 2
B-5	9.0 - 9.9	SC-SM	121	5														1, 2
B-6	0.0 - 4.0	SM			13	NP	NP	NP						6.8	630	130	390	
B-6	2.0 - 3.0	SM		4														2
B-6	4.0 - 5.0	SC	125	4														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: West Quartzsite Traffic Interchange

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona
PH. 480-897-8200 FAX. 480-897-1133

PROJECT NUMBER: 65145257

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

EXHIBIT: B-12

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 EI_{50}	pH	Resistivity (ohm-cm)	Sulfates (ppm)	Chlorides (ppm)	
						LL	PL	PI										
B-7	0.0 - 4.0	SM			23	NP	NP	NP						7.5	670	54	440	
B-7	2.0 - 3.0	SM	116	3														1, 2
B-7	4.0 - 5.0	SC	112	5														1, 2
B-8	0.0 - 4.0	SM			22	21	19	2						7.2	590	890	450	
B-8	2.0 - 3.0	SM	122	3														1, 2
B-8	4.0 - 5.0	SC	109	6														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: West Quartzsite Traffic Interchange

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona
PH. 480-897-8200 FAX. 480-897-1133

PROJECT NUMBER: 65145257

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

EXHIBIT: B-13

SUMMARY OF GRAIN SIZE DISTRIBUTION

Borehole No.	Depth (ft.)	USCS Soil Class.	Atterberg Limits		SILT or CLAY	SAND								GRAVEL								COBBLES and BOULDERS
						Fine			Medium			Coarse		Fine				Coarse				
			LL	PI	#200	#100	#50	#40	#30	#16	#10	#8	#4	1/4"	3/8"	1/2"	3/4"	1"	1½"	2"	3"	>3"
B-1	1	SM	NP	NP	12	15	21	25	29	39	48	52	63	71	82	90	97	98				
B-2	0	GW-GM	NP	NP	7	10	14	17	21	28	33	35	43	50	62	71	82	89	94	97	100	100
B-3	1	SW-SM	NP	NP	11	17	24	28	33	47	60	65	83	88	92	94	97	98				
B-4	0	SC-SM	22	7	13	16	20	24	28	39	48	52	63	69	77	83	91	95	98	100		
B-5	0	SW-SM	NP	NP	10	14	20	24	29	38	45	48	59	66	77	84	93	96				
B-6	0	SM	NP	NP	13	16	20	24	28	42	53	57	76	82	88	92	95	97	99			
B-7	0	SM	NP	NP	23	31	37	40	45	55	64	68	80	85	91	94	98	99				
B-8	0	SM	21	2	22	29	36	40	44	54	63	66	76	80	86	89	97	99				

REMARKS
1.
2.
3.
4.

PROJECT: West Quartzsite Traffic Interchange

SITE: Quartzsite Blvd. and I-10 T.I.
Quartzsite, AZ

Terracon
4685 S. Ash Ave., Suite H-4
Tempe, Arizona
PH. 480-897-8200 FAX. 480-897-1133

PROJECT NUMBER: 65145257

CLIENT: Parsons Brinkerhoff, Inc.
Tempe, AZ

EXHIBIT: B-14