Roadway Geotechnical Engineering Report

CRAYCROFT RD TI OP STR #594 & #595

I-10 Temporary Bridge at Craycroft Road, Tucson, Arizona

ADOT TRACS No.: 010 PM 267 H8774 01C

Federal Aid Project No.: NHPP-010-E(219)T

Terracon Project No. 65155090R1

June 14, 2016

Prepared for:

T.Y. Lin International, Inc.
Tempe, Arizona

Prepared by:

Terracon Consultants, Inc.
Tempe, Arizona

June 14, 2016

Terracon

T.Y. Lin International, Inc.
60 East Rio Salado Parkway
Tempe, Arizona 85281

Attn: Mr. Jim Pyne, P.E.

Re: Roadway Geotechnical Engineering Report
CRAYCROFT RD TI OP STR #594 & #595
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Dear Mr. Pyne:

Terracon completed the geotechnical engineering services for the Interstate 10 (I-10) Temporary Bridge Structure proposed across Craycroft Road in Tucson, Arizona. The extents of the project are between I-10 Mileposts (MP) 267.75 and MP 268.36. This study was performed in general accordance with our proposal titled *Scope of Services and Cost Proposal, Geotechnical Scope and Fees, Craycroft Road Bridge, Tucson, Arizona, Contract 2015-001*, Terracon Project No. 65155090, Revision No. 2, dated December 23, 2015. Terracon has prepared a Structures Geotechnical Engineering Report, Pavement Design Summary, and Materials Design Report for the project which are being issued under separate covers.

We appreciate being of service to you during this phase of the 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.

Ramon Padilla, P.E.
Geotechnical Project Manager

Donald R. Clark, P.E.
Senior Principal

Copies to: Addressee (1 via email)

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ROADWAY GEOTECHNICAL ENGINEERING REPORT
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1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services for the proposed Interstate 10 Temporary Bridge at Craycroft Road project in Tucson, Arizona. The purpose of these services is to provide information and geotechnical engineering recommendations relative to the planned 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 eight (8) soil borings, laboratory testing, geotechnical engineering analysis, and preparation of this report. Logs of the borings along with a Site Plan and Boring Locations diagram (Exhibits A-1 through A-3) 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 Project Description

ITEM	DESCRIPTION
Project Layout	Refer to the Site Plan and Boring Location Diagrams (Exhibits A-1 through A-3, in Appendix A) for the specific locations of each boring within the project limits.
Proposed Improvements	The existing I-10 bridges over Craycroft Road will be rehabilitated and receive new decks. A new single-span temporary bridge will be constructed in the existing median to facilitate replacement of the bridge decks. Temporary pavement will be placed in the median leading to the temporary bridge during the construction period which is estimated not to exceed one year in duration.

ITEM	DESCRIPTION
Pavements	Asphalt concrete pavement is anticipated for the temporary detours in the median. The mainline may be raised up to about 4 inches and tapered back over a distance of about 150 feet and may include minor widening. It is expected that new mainline widening pavements will match the existing mainline pavement thickness.

2.2 Site Description

ITEM	DESCRIPTION
Location	The project site is located at the intersection of I-10 and Craycroft Road in Tucson, Arizona.
Existing Site Features	The project site includes the existing I-10 Craycroft Road TI OP EB & WB Structures Nos. 594 & 595. Embankment fills elevate the I-10 EB & WB travel lanes to the TI OP bridge structures over Craycroft Road. Based on information provided, we understand the embankment slope between the TI OP bridge structures slopes down to Craycroft Road at slope of 1.5H:1V (horizontal to vertical). The site is surrounded by existing commercial developments.
Current Ground Cover	At the location of the planned temporary bridge abutments, the ground consists of exposed embankment soil with some sparse vegetation; and the slope down to Craycroft had a thin (1- to 2-inch thick) grout or concrete cover for erosion control. A mature tree was observed near the area of proposed Abutment 2.
Existing Topography	At the location of the planned temporary bridge abutments, the embankment ground surface slopes down to Craycroft Road between the existing bridge structures; and as the embankment ground surface extends away from Craycroft Road, the ground surface is generally sloped down towards the I-10 centerline forming a v-ditch between the existing travel lanes.

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 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

[1] Cooley, M.E., 1967, **Arizona Highway Geologic Map**, Arizona Geological Society.
[2] Stern, C.W., et al, 1979, **Geological Evolution of North America**, John Wiley & Sons, Santa Barbara, California.

during middle and late Tertiary time (100 to 15 million years 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.

Surficial geologic conditions mapped at the site ([3]Richard, et al, 2000) consist of Quaternary surficial deposits. This unit is described as unconsolidated to strongly consolidated alluvial and eolian deposits. This unit includes: coarse, poorly sorted alluvial fan and terrace deposits on middle and upper piedmonts and along large drainages; sand, silt and clay on alluvial plains and playas; and wind-blown sand deposits.

3.2 Seismic Considerations

Based on our subsurface explorations, the subsurface soil types can be classified as stiff soils with average penetration resistance (blow count) ranging between 15 and 50 blows per foot. The site is classified as Site Class D as per Table 3.10.3.1-1 of the American Association of State Highway and Transportation Officials (AASHTO) Load-and-Resistance Factor Design (LRFD) Bridge Design Manual ([4]AASHTO, 2012). The following table presents the seismic site classification and site coefficients based on the AASHTO LRFD Bridge Design Manual:

Description	Value
Site Class	D
Site Latitude	32.12531° N
Site Longitude	110.87519° W
PGA	0.072[1]
S_s	0.167
S_1	0.048
F_{pga}	1.6
F_a	1.6
F_v	2.4

Notes:
[1]AASHTO's recommended PGA maps have a return period of 1000 years, which corresponds to a 7% probability of exceedance in 75 years.

The Design Response Spectrum for the bridge structures should be constructed based on the information presented in the table above and the procedure outlined in Section 3.10.4.1 of the AASHTO LRFD Bridge Design Manual.

[3] Richard, S. M., Reynolds, S.J., Spencer, J. E., and Pearthree, P. A., 2000, ***Geologic Map of Arizona***: Arizona Geological Survey Map 35, 1 sheet, scale 1:1,000,000.

[4] American Association of State Highway and Transportation Officials, ***AASHTO LRFD Bridge Design Specifications,*** 2012

3.3 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 results of the field and laboratory testing indicated similar subsurface conditions and similar engineering characteristics at the boring locations. Therefore, subsurface conditions on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Relative Density / Consistency
Stratum 1	3.5 to 24	EMBANKMENT FILL: Clayey Sand	Medium Dense to Dense
Stratum 2	27 to 28	Clayey Sand or Sandy Lean Clay	Dense / Very Stiff
Stratum 3	42 to 43	Silty Sand	Medium Dense to Dense
Stratum 4	55 (Maximum depth explored)	Clayey Sand or Sandy Lean Clay	Medium dense to Dense / Very Stiff

3.4 Field and Laboratory Test Data

Laboratory tests were conducted on selected soil samples and the test results are presented in Appendix B. The following is a summary of laboratory testing performed for the project.

The Atterberg limits test results of the near surface embankment fill clayey sand soils exhibit medium plasticity characteristics (with plastic limits of 14 and 25). The gradation test results of the near surface embankment fill clayey sand soils indicate these soils contain percent fines (percent passing the sieve No. 200) ranging from approximately 21 to 42 percent, percent sand ranged from approximately 47 to 59 percent, and percent gravel ranged from about 5 to 32 percent.

Testing of selected samples obtained from the borings at depths within the embankment fill clayey sand soils (upper 22 to 24 feet) indicated in-situ moisture contents ranging from approximately 5 to 9 percent with an average of approximately 7 percent; and in-situ dry densities ranging from approximately 95 to 121 pounds per cubic foot (pcf) with an average of approximately 113 pcf. Standard Proctor (ASTM D698) test results indicated maximum dry densities of the site embankment fill clayey sand soils range from approximately 116.9 to 120.0 pounds per cubic foot (pcf) at optimum moisture contents ranging from approximately 11.8 to 13.5 percent. Testing of selected samples obtained from the borings at depths underlying the embankment fill soils indicated in-situ moisture contents ranging from approximately 2 to 16

percent with an average of approximately 8 percent; and in-situ dry densities ranging from approximately 110 to 115 pounds per cubic foot (pcf) with an average of approximately 112 pcf.

In-situ samples of embankment fill soils tested for consolidation and response to wetting exhibited low hydro-compaction (collapse) potential when wetted while supporting typical foundation pressures. The percent collapse on the samples tested was less than 1 percent.

A direct shear test was performed on an in-situ sample obtained from Boring B1 at a depth between 9 and 10 feet below the existing ground surface. The direct shear test results of the in-situ sample indicated a soil friction angle of approximately 62 degrees and a cohesion value of approximately 216 pounds per square foot (psf). There test results were inconsistent with the type of soils encountered; therefore, the direct shear test results from the in-situ sample were excluded from our analyses. Subsequently, two additional direct shear tests, one for each abutment, were performed by compositing samples obtained from the embankment soils and remolding the samples to approximately 95 percent compaction at 2 percent below optimum. Both direct shear test results of the remolded samples indicated a soil friction angle of approximately 38 degrees and a cohesion value of approximately 1,500 pounds per square foot (psf).

3.5 Groundwater

Groundwater was not observed in any of the test borings at the time of the field exploration nor when checked immediately upon completion of drilling. 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, the depth to groundwater was measured in February 2012 at approximately 234 feet below the ground surface (approximate elevation of 2,487 feet above mean sea level) at an Arizona Department of Water Resources (ADWR) monitored well site (Local I.D.: D-15-14 13CBC) located approximately 500 feet southeast 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. Geotechnical engineering analyses and

recommendations specifically for the temporary bridge abutment foundations are provided in our Structures Geotechnical Engineering Report submitted under separate cover.

The geotechnical issues associated with construction of this project as addressed in this report include:

- **Subgrade Support:** The recommended resilient modulus for use in design of pavements is presented in Section 4.2.
- **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 4.3.

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 existing subgrade soils at the site have relatively poor support characteristics for the planned pavement sections.

For purposes of pavement subgrade evaluation, the results of the laboratory testing, including correlated and tested R-Values, in accordance with the ADOT Preliminary Engineering and Design Manual (PEDM) are summarized in the following table:

SUMMARY OF TESTED AND CORRELATED R-VALUES							
Boring	**Approx. Station; Offset**	**Depth (ft.)**	**LL**	**PI**	**-#200**	**R-Value Tested**	**R-Value Correlated**
B-1	I-10 EB 373+30;40'L±	0-5	36	18	31		32
B-2	I-10 EB 375+30;60'L±	0-5	34	16	33		34
R-1	I-10 EB 361+40; 20'L±	0-3.5	34	17	31	16	33
R-2	I-10 WB 366+20; 20'R±	0-4	34	17	31	---	33
R-3	I-10 EB 368+90; 45'L±	0-4	38	22	33	15	27
R-4	I-10 EB 379+20;45'L±	0-4	42	25	42	13	21
R-5	I-10 WB 382+10; 20'R±	0-5	39	22	31	---	28
R-6	I-10 EB 386+20; 20'L±	0-4	34	14	21	28	43
					Count	**4**	**8**
					Average	**18.0**	**31.5**
					Standard Deviation	**6.8**	**6.5**
					Rmean	**27.2**	

The calculated mean R-Value for the project is 27; however, we recommend an R-value of 20 be used for design purposes. The corresponding resilient modulus is 8,819 pounds per square inch (psi) for a seasonal variation factor of 1.7 for Tucson, Arizona.

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 shallow excavations for much of the proposed temporary pavement 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 or other factors.

Exposed areas which will receive fill or aggregate base course, once properly cleared and benched where necessary, should be scarified to a minimum depth of six (6) inches, moisture conditioned, and compacted in accordance with ADOT specifications. Exposed surfaces should be free of mounds and depressions which could prevent uniform compaction.

For purposes of design and new construction, it is assumed that soils placed within 3 feet of the finished roadway subgrade will exhibit an R-value of 20 or more. The on-site soils to be utilized within the top 3 feet below the proposed pavement base may need improvement if the material does not meet the requirements of the Subgrade Acceptance Chart provided in the Materials Design Report. Improvement may include overexcavation, geogrid reinforcement, or other techniques approved by the Engineer.

4.4 Earthwork Factors and Slopes

We understand the existing traffic interchange embankments are sloped at approximately 1.5H:1V (horizontal : vertical). Recommended fill 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)
All	**5% shrink**	**0.2**	**Fill Slopes: 2:1, 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 Corrosion Potential

Laboratory testing was performed on select samples obtained from borings B-1 and B-2 near the proposed temporary bridge. Based on the soluble sulfate test results, ASTM Type I/II portland cement is considered suitable for all concrete on and below grade in contact with similar soluble sulfate concentrations. The results of the laboratory testing are summarized in the following table:

Summary of Chemical Laboratory Testing					
Boring	**Depth (feet)**	**pH**	**Minimum Resistivity (ohm-cm)**	**Chlorides (ppm)**	**Sulfates (ppm)**
B-1	0 - 5	8.6	1,496	79	85
B-2	0 - 5	8.5	1,050	131	146

These values should be used to help determine potential corrosive characteristics of the on-site soils with respect to contact with the various underground materials which will be used for project construction. Refer to Summary of Laboratory Results contained in Appendix B for the complete results of the corrosivity testing performed on the site soils in conjunction with this geotechnical exploration.

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.

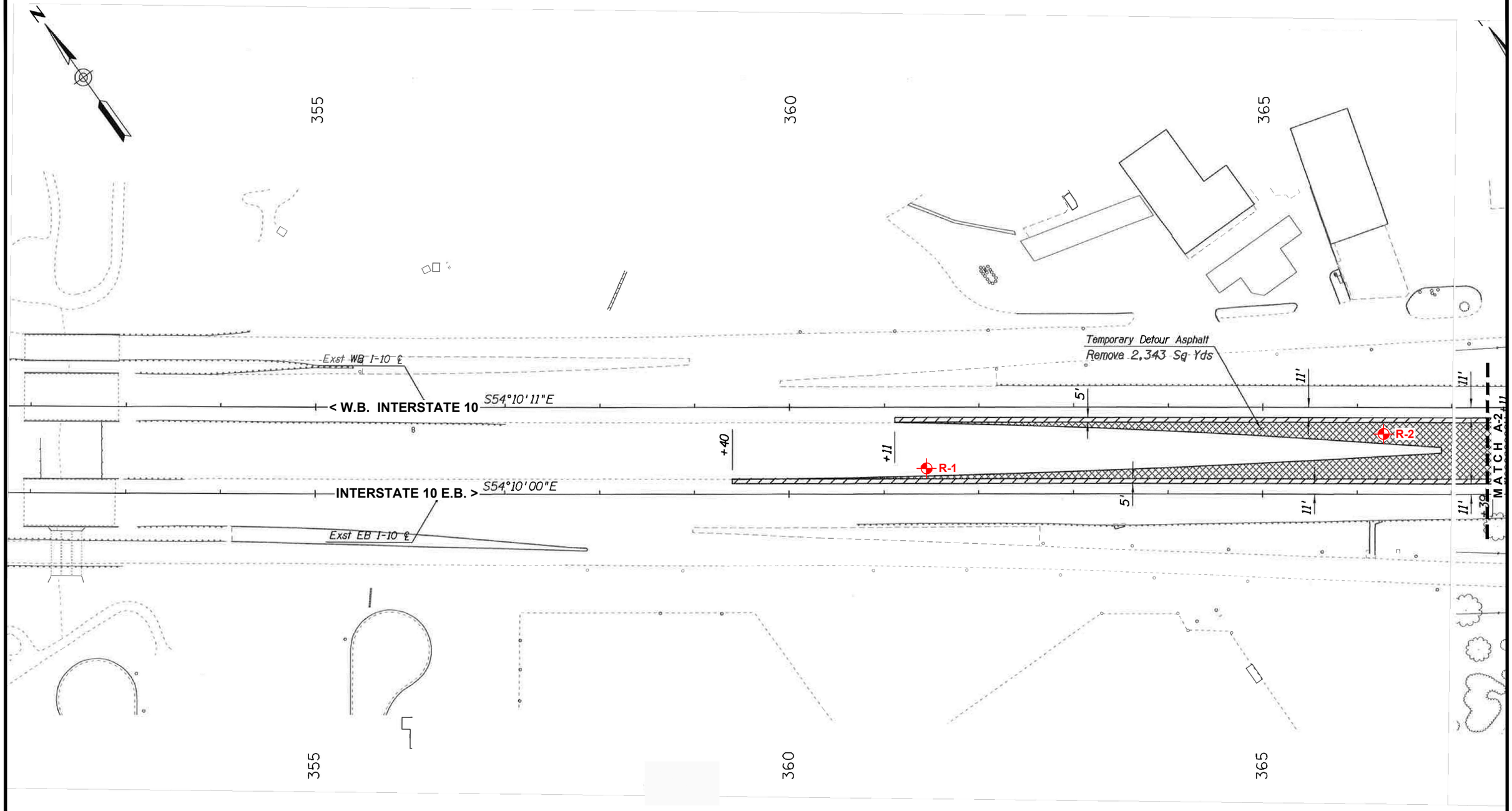
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between boring locations, across the site, or due 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.

APPENDIX A

FIELD EXPLORATION



0 50' 100'
APPROXIMATE SCALE

LEGEND:

APPROXIMATE BORING LOCATION

NOTE: SITE IMAGES FROM 60% PROJECT PLANS, GOOGLE EARTH PRO, AND ESRI ONLINE MAPS, 2016

Project Mngr:	RP
Drawn By:	KLJ
Checked By:	RP
Approved By:	DRC

Project No.	65155090
Scale:	AS SHOWN
File No.	65155090.DWG
Date:	06/14/2016

Terracon
Consulting Engineers and Scientists
4685 South Ash Avenue, Suite H-4 Tempe, AZ 85282
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SITE PLAN AND BORING LOCATIONS

CRAYCROFT RD TI OP STR #594 & #595

I-10 TEMPORARY BRIDGE AT CRAYCROFT ROAD, TUCSON, ARIZONA
ADOT TRACS No.: 010 PM 267 H8774 -01C Ferderal Aid Project No.: NHPP 010-E(219)T

EXHIBIT

A-1

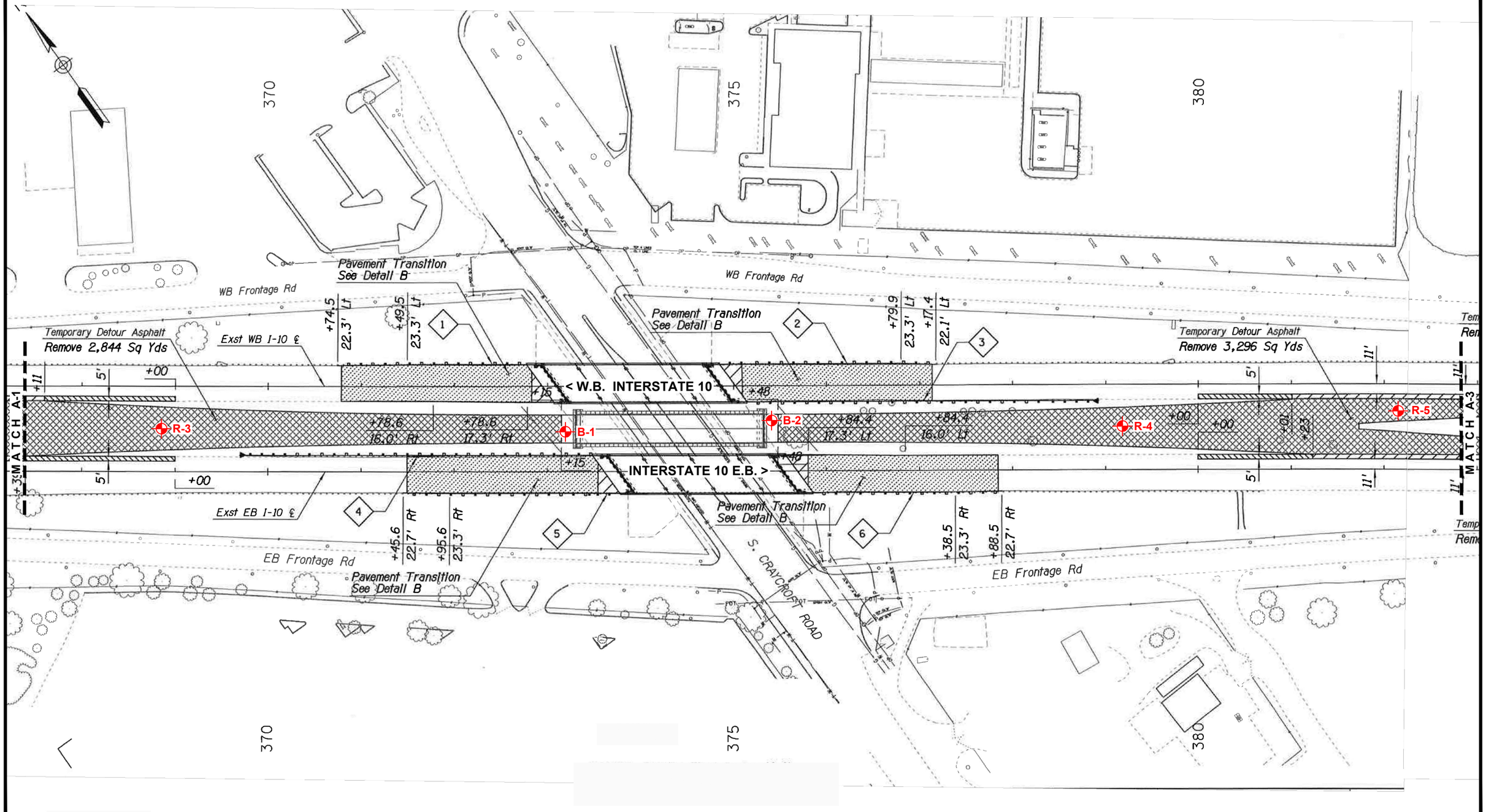

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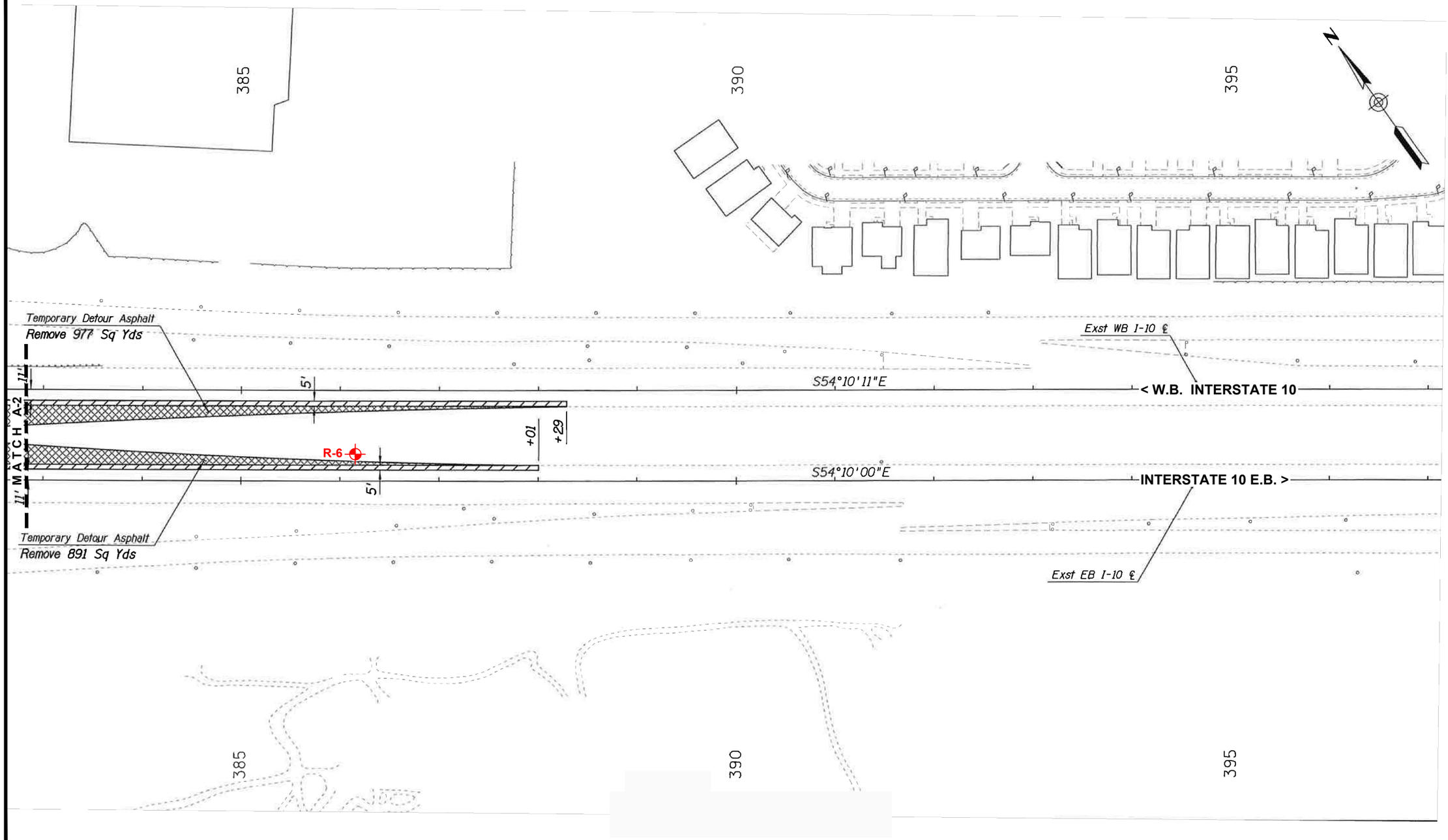
EXHIBIT

A-2



0 50' 100'
APPROXIMATE SCALE

LEGEND:

APPROXIMATE BORING LOCATION

NOTE: SITE IMAGES FROM 60% PROJECT PLANS, GOOGLE EARTH PRO, AND ESRI ONLINE MAPS, 2016

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EXHIBIT

A-3

Field Exploration Description

A total of eight (8) test borings were drilled at the site on February 5, 2016. The borings were drilled to depths of approximately 5 to 55½ feet below the ground surface. The approximate boring locations are shown on the attached Site Plan and Boring Locations diagrams, Exhibits A-1 through A-3.

The test borings were advanced with a truck-mounted CME-75 drill rig utilizing 8-inch outside diameter hollow-stem augers. The borings were located in the field utilizing an aerial photograph and a hand held GPS unit. Latitude and longitude coordinates for each boring were obtained from Google Earth Pro and should be considered approximate.

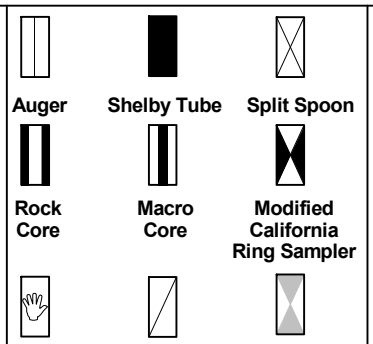
A continuous lithologic log of each boring was recorded by the field engineer during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon (SPT) or ring-lined barrel samplers in general accordance with ASTM Standards. Penetration resistance measurements were obtained by driving the split-spoon and ring-lined 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. Bulk samples of subsurface materials were also obtained from the auger cuttings.

Groundwater conditions were evaluated in the borings at the time of site exploration.

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING



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

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]	$Cu \geq 4$ and $1 \leq Cc \leq 3$ [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]	$Cu \geq 6$ and $1 \leq Cc \leq 3$ [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] $Cu = D_{60}/D_{10}$ $\quad Cc = \dfrac{(D_{30})^2}{D_{10} \times D_{60}}$

[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.

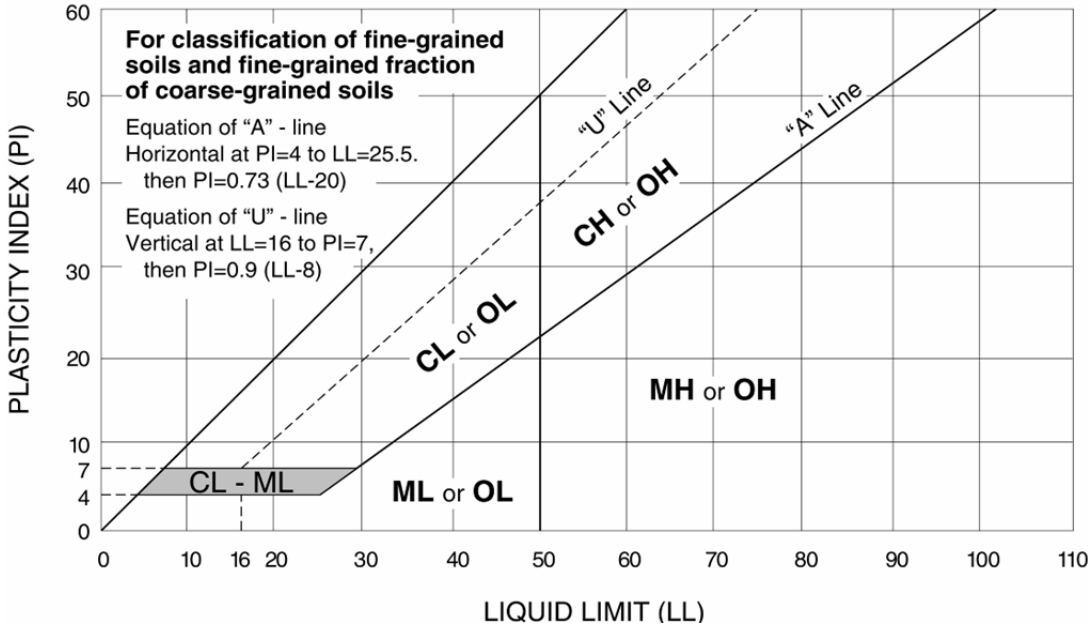
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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.



Terracon

Exhibit: A-6

BORING LOG NO. B1

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.125446° Longitude: -110.875434°

Surface Elev.: 2736 (Ft.)

DEPTH	ELEVATION (Ft.)	DESCRIPTION	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		FILL - CLAYEY SAND (SC), trace gravel, brown to light brown, dense					
			36-50/5"	5	121	36-18-18	31
5			14-19-18 N=37				
		medium dense	21-27	7	117		
10							
15			8-13-13 N=26				
		ring sample disturbed	14-20	9	95		
20							
	24.0 2712	**CLAYEY SAND (SC)**, brown to light brown, dense, weak cementation	13-27-29				
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-4 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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-7

BORING LOG NO. B1

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road, Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.125446° Longitude: -110.875434°

Surface Elev.: 2736 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		CLAYEY SAND (SC), brown to light brown, dense, weak cementation *(continued)*				N=56				
	28.0	2708								
		SILTY SAND (SM), trace gravel, brown, medium dense, stratified with poorly graded sand	30			14-21	2	115		
			35			11-13-14 N=27				
			40			17-34	2	111		
	42.0	2694								
		CLAYEY SAND (SC), brown to dark brown, medium dense to dense, weak cementation, stratified with sandy clay	45			7-10-15 N=25				
			50			7-14-16	16			

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-4 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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

Boring Started: 2/5/2016 | Boring Completed: 2/5/2016

Drill Rig: CME-75 | Driller: Southlands Engineering

Project No.: 65155090 | Exhibit: A-8

BORING LOG NO. B1

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.125446° Longitude: -110.875434°

Surface Elev.: 2736 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						N=30				
	55.5	2680.5	55			3-7-11 N=18				

CLAYEY SAND (SC), brown to dark brown, medium dense to dense, weak cementation, stratified with sandy clay *(continued)*

Boring Terminated at 55.5 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-4 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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-9

BORING LOG NO. B2

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.125094° Longitude: -110.874809°

Surface Elev.: 2737 (Ft.)

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						15-18-19 N=37			34-18-16	33
			5			21-20	6	110		
						12-21-19 N=40				
			10							
						13-14	9	121		
			15							
						10-10-8 N=18				
			20							
						11-21	7	112		
			25							

FILL - CLAYEY SAND (SC), trace gravel, light brown, dense

medium dense

22.0 2715

SANDY LEAN CLAY (CL), light brown, very stiff, no to weak cementation

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-4 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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-10

BORING LOG NO. B2

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.125094° Longitude: -110.874809°

Surface Elev.: 2737 (Ft.)

DEPTH	ELEVATION (Ft.)	GRAPHIC LOG	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
SANDY LEAN CLAY (CL), light brown, very stiff, no to weak cementation *(continued)*										
27.0	2710									
SILTY SAND (SM), trace gravel, brown, dense, stratified with poorly graded sand										
			30			11-15-16 N=31				
medium dense, stratified with clayey sand			35			11-21	4	110		
			40			13-18-20 N=38				
43.0	2694									
SANDY LEAN CLAY (CL), light brown, very stiff			45			13-21	13	110		
			50			10-16-19				

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-4 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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-11

BORING LOG NO. B2

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.125094° Longitude: -110.874809°

Surface Elev.: 2737 (Ft.)

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						N=35				
	55.5	2681.5	55			6-10-12 N=22	10			

SANDY LEAN CLAY (CL), light brown, very stiff *(continued)*

Boring Terminated at 55.5 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-4 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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-12

BORING LOG NO. R1

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.127408° Longitude: -110.878602°

GRAPHIC LOG	DEPTH / ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - CLAYEY SAND WITH GRAVEL (SC), brown to light brown, dense								
					18-17-31 N=48			34-17-17	31
	3.5								
	CLAYEY SAND WITH GRAVEL (SC), light brown, dense								
		5			11-17-20 N=37				
	5.5								
	Boring Terminated at 5.5 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-4 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, AZ

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-13

BORING LOG NO. R2

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.126863° Longitude: -110.87748°

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						6-8-8 N=16			34-17-17	31
			5			9-12-14 N=26				
	5.5									

FILL - CLAYEY SAND (SC), trace gravel, light brown, medium dense

Boring Terminated at 5.5 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-4 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, AZ

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-14

BORING LOG NO. R3

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.126031° Longitude: -110.876387°

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						6-5-10 N=15			38-16-22	33
			5			8-14-14 N=28				

FILL - CLAYEY SAND WITH GRAVEL (SC), brown to light brown, medium dense

5.5

Boring Terminated at 5.5 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-4 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, AZ

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-15

BORING LOG NO. R4

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.124503° Longitude: -110.873906°

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - CLAYEY SAND (SC), trace gravel, brown, medium dense					6-7-7 N=14			42-17-25	42
	dense		5			8-18-19 N=37				
	5.5									
	Boring Terminated at 5.5 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-4 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 Ste H-4
Tempe, AZ

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-16

BORING LOG NO. R5

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.124057° Longitude: -110.873116°

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
						15-15-17 N=32				
									39-17-22	31
						11-25-21 N=46				
	5.5		5							

FILL - CLAYEY SAND (SC), brown to light brown, dense

increased sand from 2' to 2.5'

Boring Terminated at 5.5 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-4 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, AZ

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-17

BORING LOG NO. R6

PROJECT: I-10 Temporary Bridge at Craycroft Road

CLIENT: T.Y. Lin International, Inc.

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

LOCATION See Exhibit A-1

Latitude: 32.123333° Longitude: -110.872114°

GRAPHIC LOG	DEPTH	ELEVATION (Ft.)	DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
		FILL - CLAYEY SAND WITH GRAVEL (SC), brown to light brown, medium dense								
						2-4-8 N=12			34-20-14	21
						5-9-12 N=21				
	5.5		5							
		Boring Terminated at 5.5 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-4 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, AZ

Boring Started: 2/5/2016 Boring Completed: 2/5/2016

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-18

APPENDIX B

LABORATORY TESTING

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.

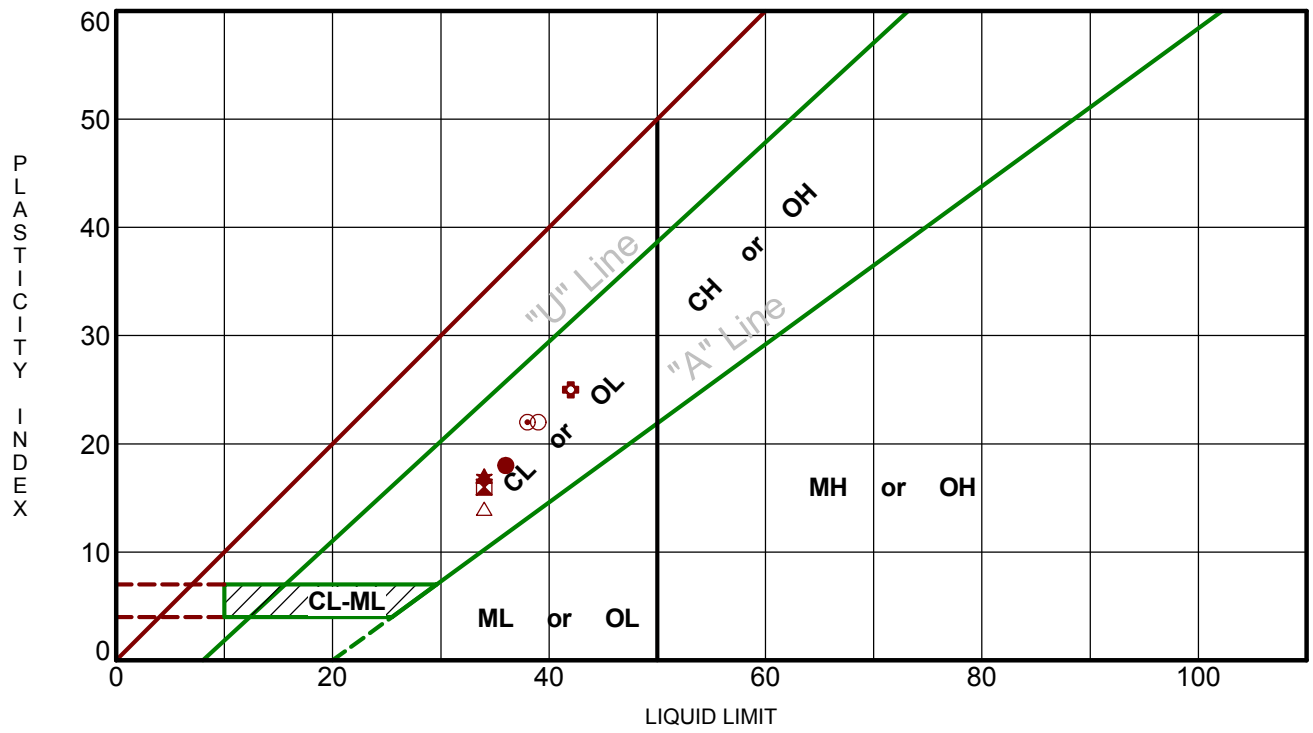
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of recommendations. Laboratory tests were performed in general accordance with the applicable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

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

- Sieve Analysis
- Moisture Content
- Direct Shear
- Minimum Resistivity
- Soluble Sulfates
- Atterberg Limits
- Consolidation Test
- R-Value
- pH
- Soluble Chlorides

ATTERBERG LIMITS RESULTS

ASTM D4318



Boring ID	Depth	LL	PL	PI	Fines	USCS	Description
● B1	0 - 5	36	18	18	31	SC	CLAYEY SAND
⊠ B2	0 - 5	34	18	16	33	SC	CLAYEY SAND
▲ R1	0 - 3.5	34	17	17	31	SC	CLAYEY SAND with GRAVEL
★ R2	0 - 4	34	17	17	31	SC	CLAYEY SAND
⊙ R3	0 - 4	38	16	22	33	SC	CLAYEY SAND with GRAVEL
✿ R4	0 - 4	42	17	25	42	SC	CLAYEY SAND
○ R5	0 - 5	39	17	22	31	SC	CLAYEY SAND
△ R6	0 - 4	34	20	14	21	SC	CLAYEY SAND with GRAVEL

PROJECT: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

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

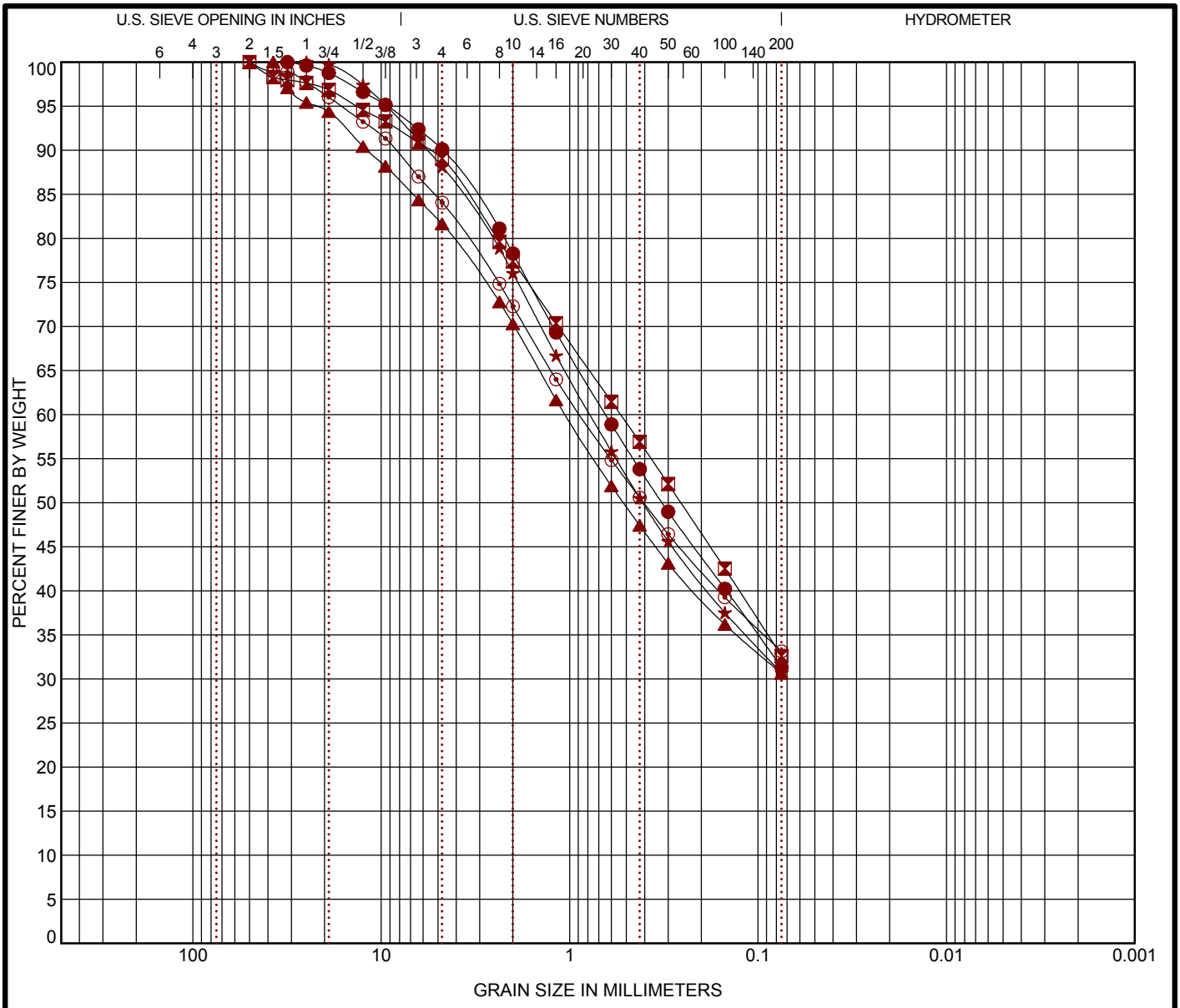
PROJECT NUMBER: 65155090

CLIENT: TY Lin

EXHIBIT: B-2

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	B1	0 - 5	CLAYEY SAND (SC)	36	18	18		
⊠	B2	0 - 5	CLAYEY SAND (SC)	34	18	16		
▲	R1	0 - 3.5	CLAYEY SAND with GRAVEL (SC)	34	17	17		
★	R2	0 - 4	CLAYEY SAND (SC)	34	17	17		
⊙	R3	0 - 4	CLAYEY SAND with GRAVEL (SC)	38	16	22		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
●	B1	0 - 5	31.5	0.645			9.9	58.8	31.3
⊠	B2	0 - 5	50	0.537			11.0	56.4	32.6
▲	R1	0 - 3.5	37.5	1.052			18.4	51.0	30.6
★	R2	0 - 4	25	0.778			11.9	57.5	30.7
⊙	R3	0 - 4	50	0.878			15.9	50.9	33.1

PROJECT: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

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

PROJECT NUMBER: 65155090

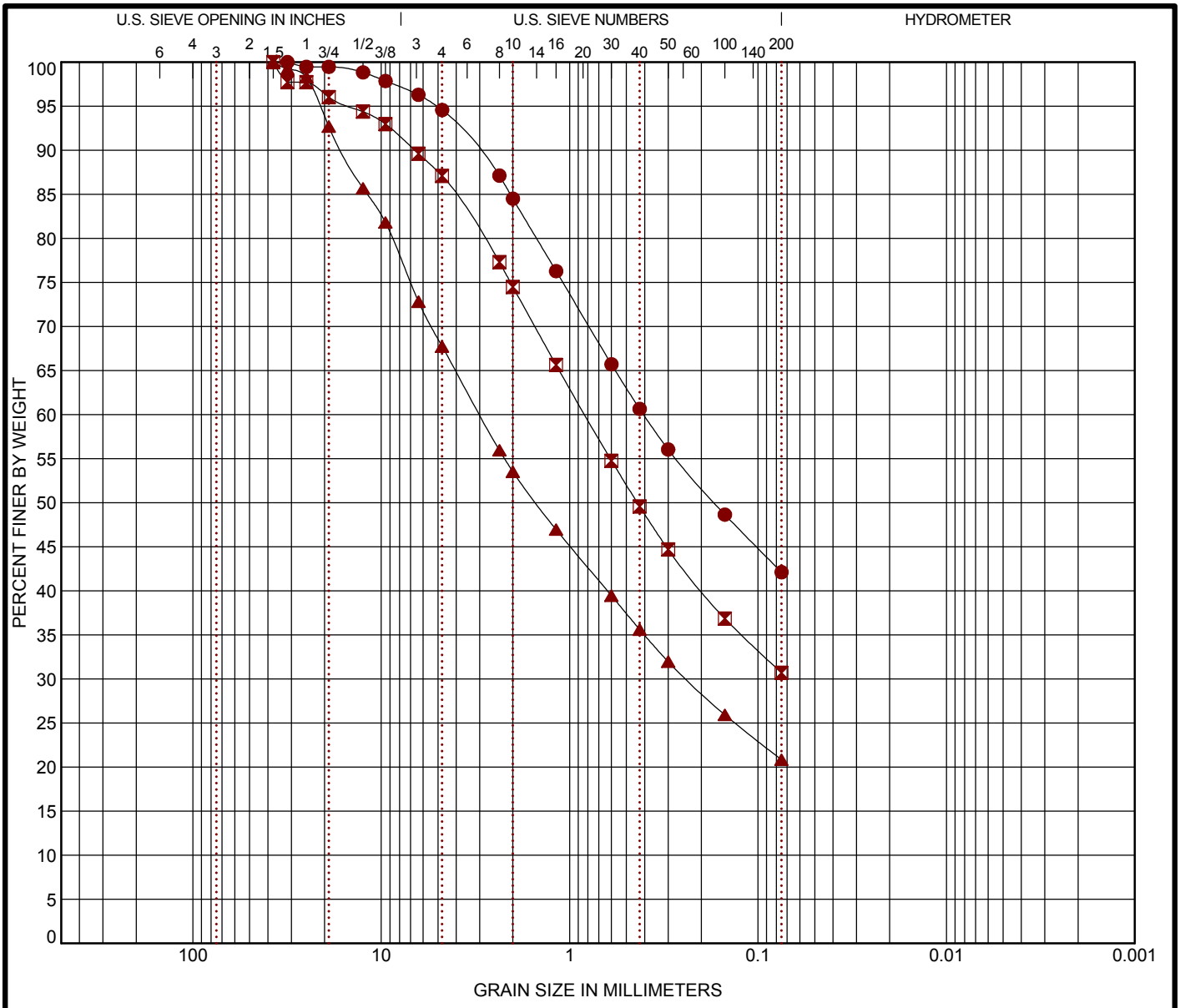
CLIENT: TY Lin

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 65155090.GPJ 35159097 - ATTERBERG ISSUE.GPJ 2/26/16

GRAIN SIZE DISTRIBUTION

ASTM D422



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Boring ID		Depth	USCS Classification	LL	PL	PI	Cc	Cu
●	R4	0 - 4	CLAYEY SAND (SC)	42	17	25		
⊠	R5	0 - 5	CLAYEY SAND (SC)	39	17	22		
▲	R6	0 - 4	CLAYEY SAND with GRAVEL (SC)	34	20	14		

Boring ID		Depth	D_{100}	D_{60}	D_{30}	D_{10}	%Gravel	%Sand	%Fines
●	R4	0 - 4	31.5	0.405			5.4	52.5	42.1
⊠	R5	0 - 5	37.5	0.831			12.9	56.4	30.7
▲	R6	0 - 4	37.5	3.002	0.239		32.3	46.9	20.8

PROJECT: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

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

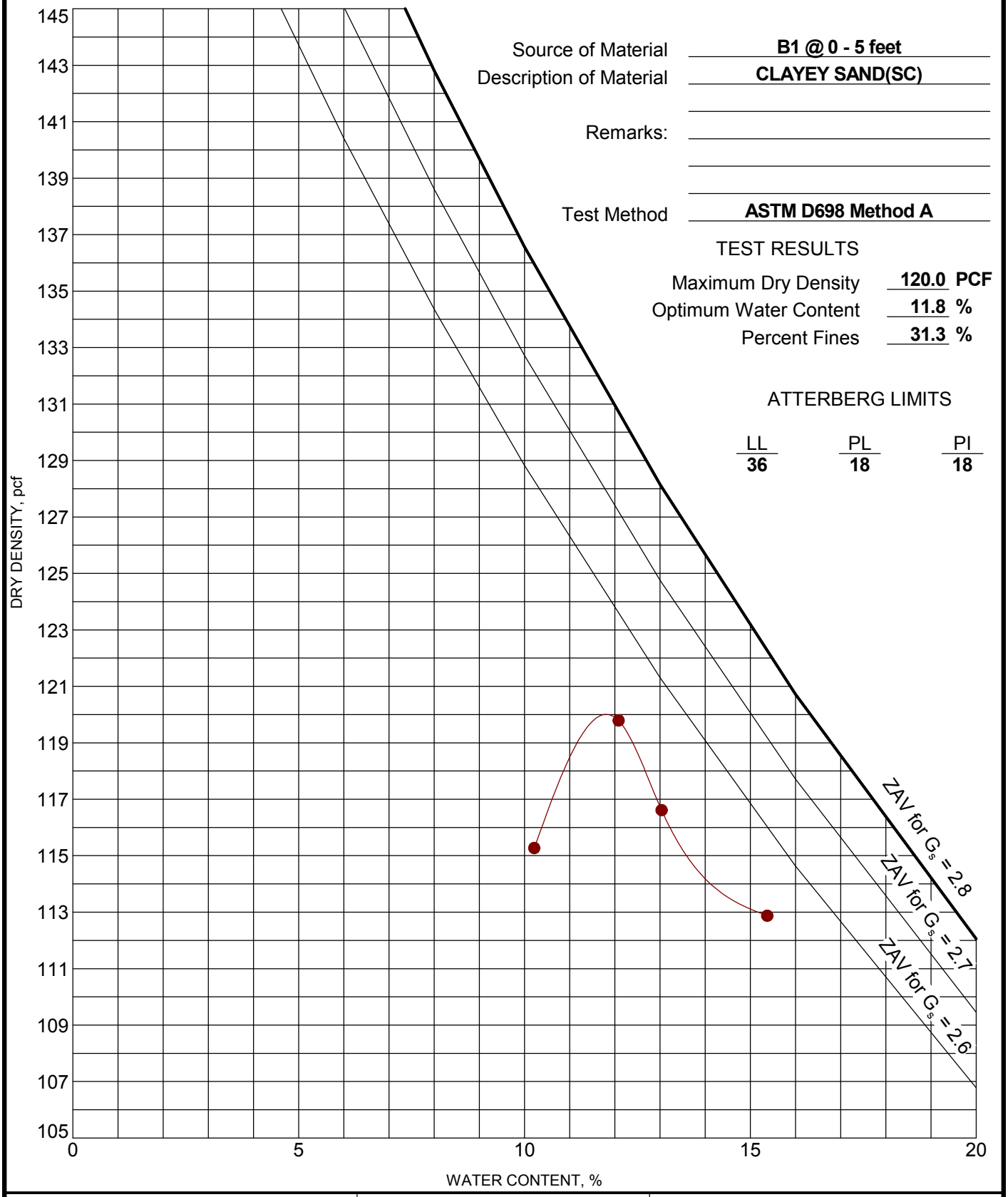
PROJECT NUMBER: 65155090

CLIENT: TY Lin

EXHIBIT: B-4

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B1 @ 0 - 5 feet**

Description of Material: **CLAYEY SAND(SC)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**120.0 PCF**
Optimum Water Content	**11.8 %**
Percent Fines	**31.3 %**

ATTERBERG LIMITS

LL	PL	PI
36	**18**	**18**

PROJECT: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

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

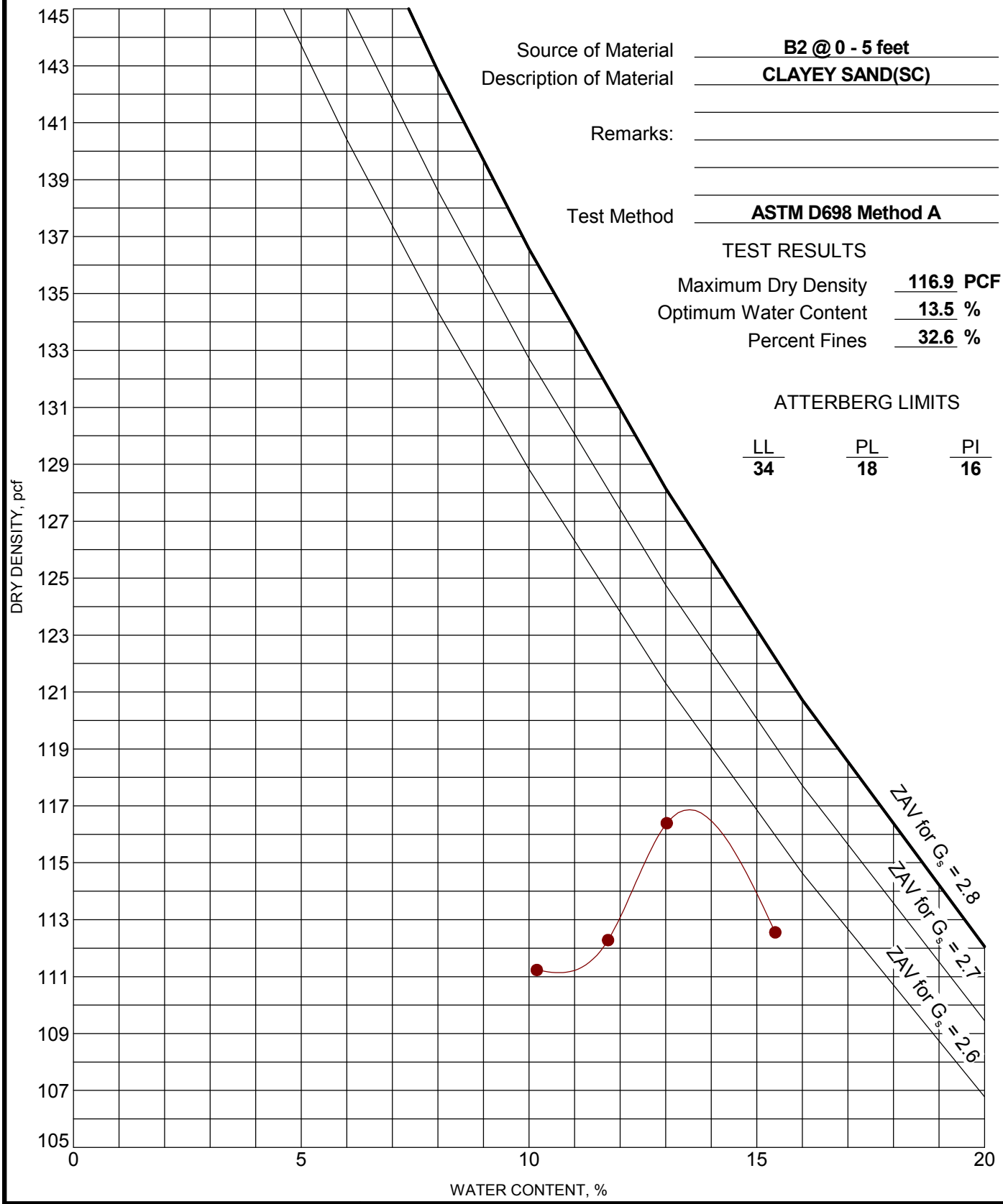
PROJECT NUMBER: 65155090

CLIENT: TY Lin

EXHIBIT: B-5

MOISTURE-DENSITY RELATIONSHIP

ASTM D698/D1557



Source of Material: **B2 @ 0 - 5 feet**

Description of Material: **CLAYEY SAND(SC)**

Remarks:

Test Method: **ASTM D698 Method A**

TEST RESULTS

Maximum Dry Density	**116.9 PCF**
Optimum Water Content	**13.5 %**
Percent Fines	**32.6 %**

ATTERBERG LIMITS

LL	PL	PI
34	**18**	**16**

PROJECT: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

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

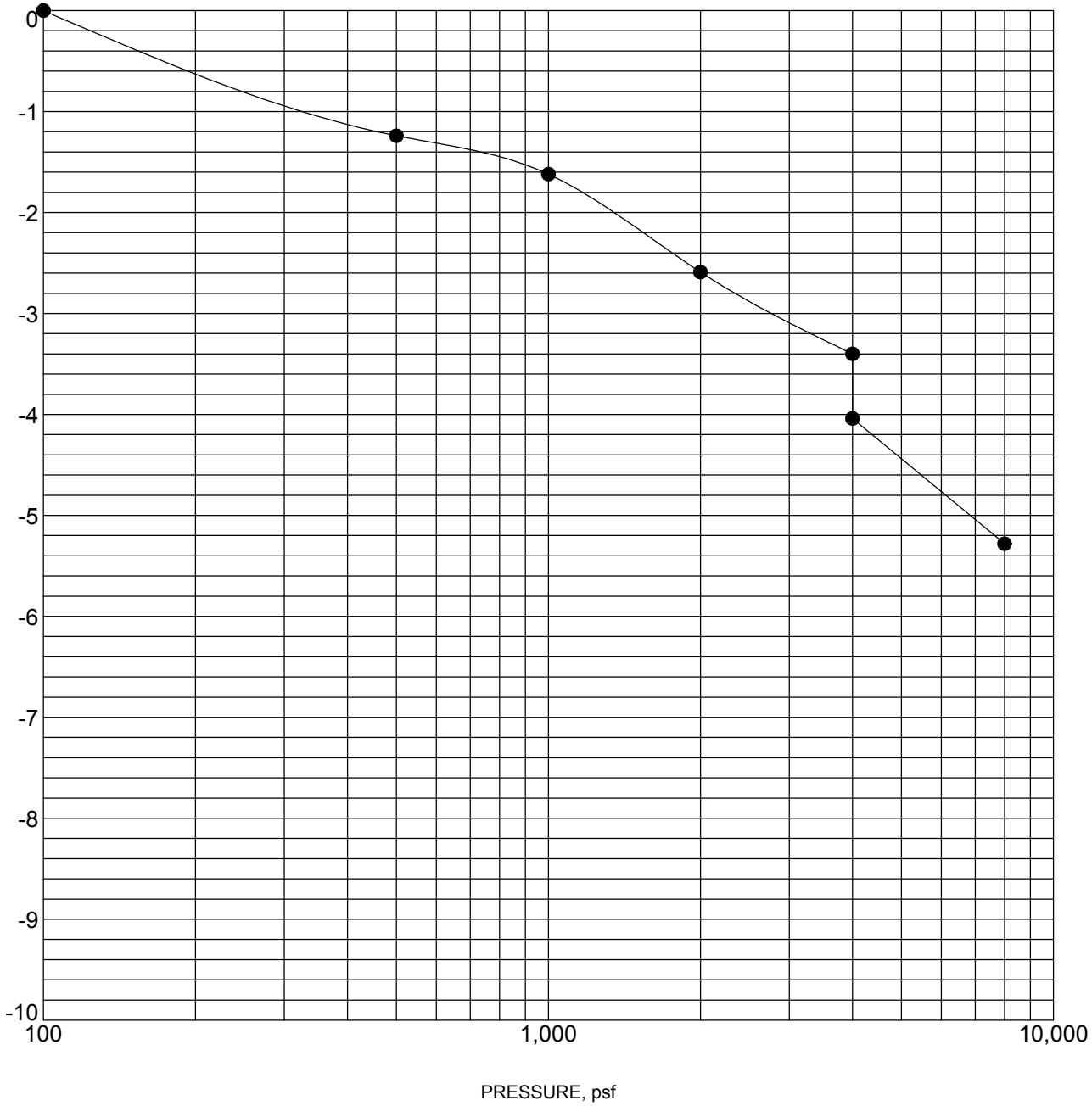
PROJECT NUMBER: 65155090

CLIENT: TY Lin

EXHIBIT: B-6

SWELL CONSOLIDATION TEST

ASTM D2435



Specimen Identification		Classification	γ_d, pcf	WC, %
●	B2 14.0 - 15.0 ft	CLAYEY SAND (SC)	120	10

NOTES: water added at 4,000 psf

PROJECT: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road Tucson, Arizona

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

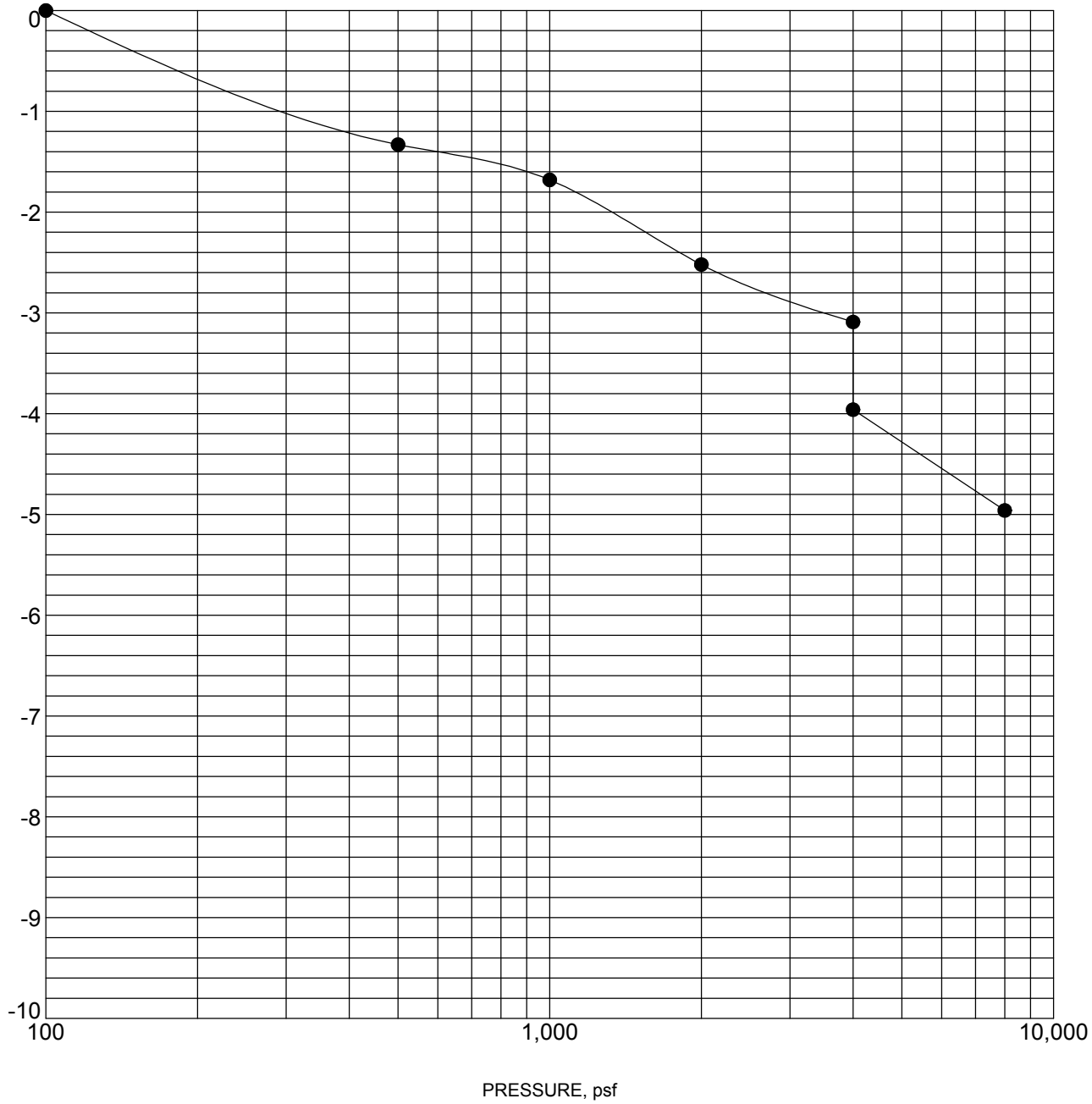
PROJECT NUMBER: 65155090

CLIENT: TY Lin

EXHIBIT: B-7

SWELL CONSOLIDATION TEST

ASTM D2435



Specimen Identification		Classification	γ_d, pcf	WC, %
●	B2 24.0 - 25.0 ft	SANDY LEAN CLAY (CL)	121	6

NOTES: water added at 4,000 psf

PROJECT: I-10 Temporary Bridge at Craycroft Road	Terracon 4685 S. Ash Ave., Suite H-4 Tempe, Arizona	PROJECT NUMBER: 65155090
SITE: Interstate 10 and Craycroft Road Tucson, Arizona		CLIENT: TY Lin
		EXHIBIT: B-8

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										
B1	0.0 - 5.0	SC			31	36	18	18	114	9.8	100	1.9		8.6	1496	85	79	
B1	2.0 - 2.9	SC	121	5														1, 2
B1	9.0 - 10.0	SC	117	7														1, 2
B1	19.0 - 20.0	SC	95	9														1, 2
B1	29.0 - 30.0	SP	115	2														1, 2
B1	39.0 - 40.0	SP-SC	111	2														1, 2
B1	49.0 - 50.5	CL		16														2
B2	0.0 - 5.0	SC			33	34	18	16	111	11.5	100	1.9		8.5	1050	146	131	
B2	5.0 - 6.0	SC	110	6														1, 2
B2	14.0 - 15.0	SC	121	9														1, 2
B2	24.0 - 25.0	CL	112	7														1, 2
B2	34.0 - 35.0	SP-SC	110	4														1, 2
B2	44.0 - 45.0	CL	110	13														1, 2
B2	54.0 - 55.5	CL		10														2
R1	0.0 - 3.5	SC			31	34	17	17										
R2	0.0 - 4.0	SC			31	34	17	17										
R3	0.0 - 4.0	SC			33	38	16	22										
R4	0.0 - 4.0	SC			42	42	17	25										
R5	0.0 - 5.0	SC			31	39	17	22										
R6	0.0 - 4.0	SC			21	34	20	14										

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: I-10 Temporary Bridge at Craycroft Road

SITE: Interstate 10 and Craycroft Road
Tucson, Arizona

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

PROJECT NUMBER: 65155090

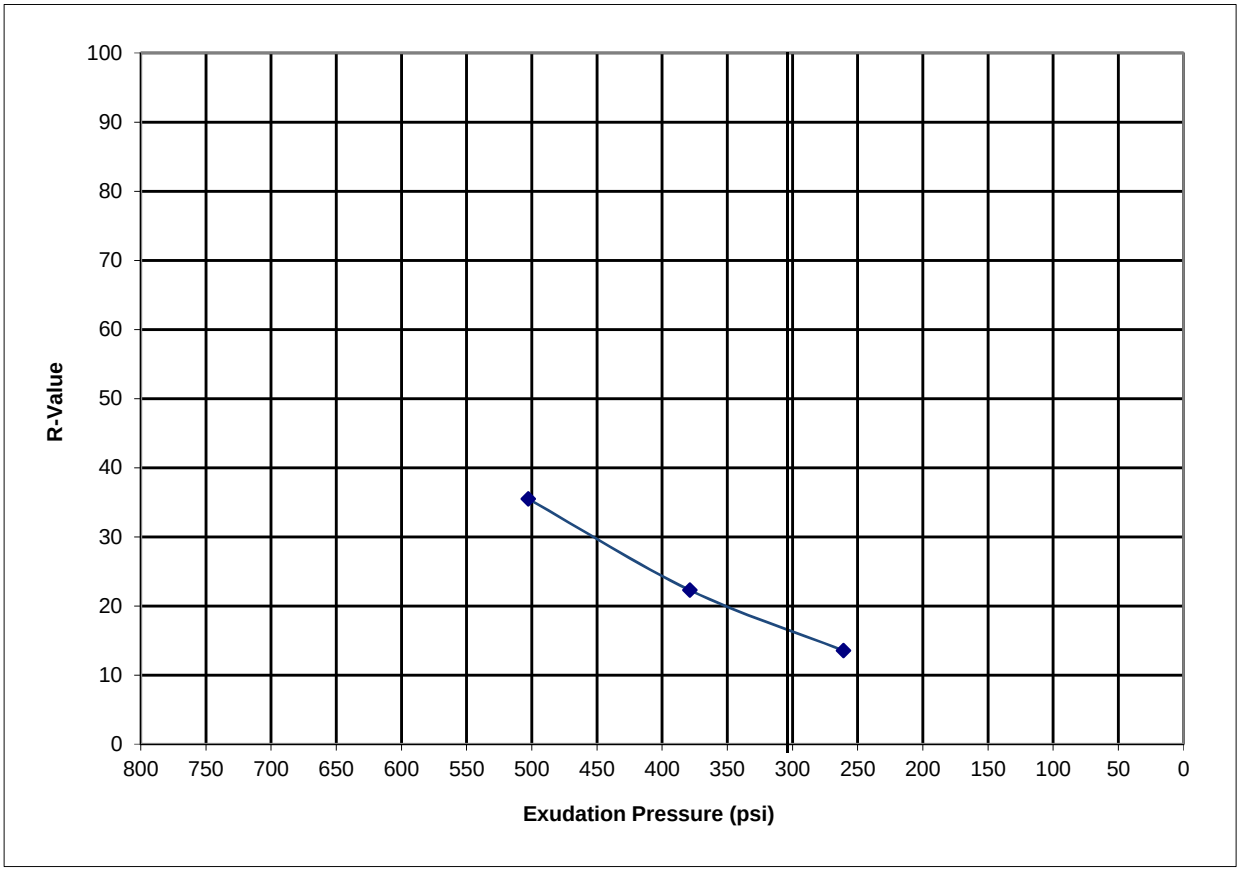
CLIENT: TY Lin

EXHIBIT: B-9

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	1
MATERIAL:	Fill: Clayey Sand with Gravel	**LAB NO:**	27
SAMPLE SOURCE:	R1 @ 0.0'-3.5'	**DATE SAMPLED:**	02/09/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	22.8%	20.9%	19.2%
Compaction Pressure (psi)	130	190	230
Specimen Height (inches)	2.58	2.53	2.52
Dry Density (pcf)	109.2	114.5	117.7
Horiz. Pres. @ 1000lbs (psi)	55.0	44.0	39.0
Horiz. Pres. @ 2000lbs (psi)	129.0	109.0	86.0
Displacement	4.14	4.08	3.91
Expansion Pressure (psi)	0.0	0.0	0.3
Exudation Pressure (psi)	261	379	503
R Value	14	22	35



AASHTO R18

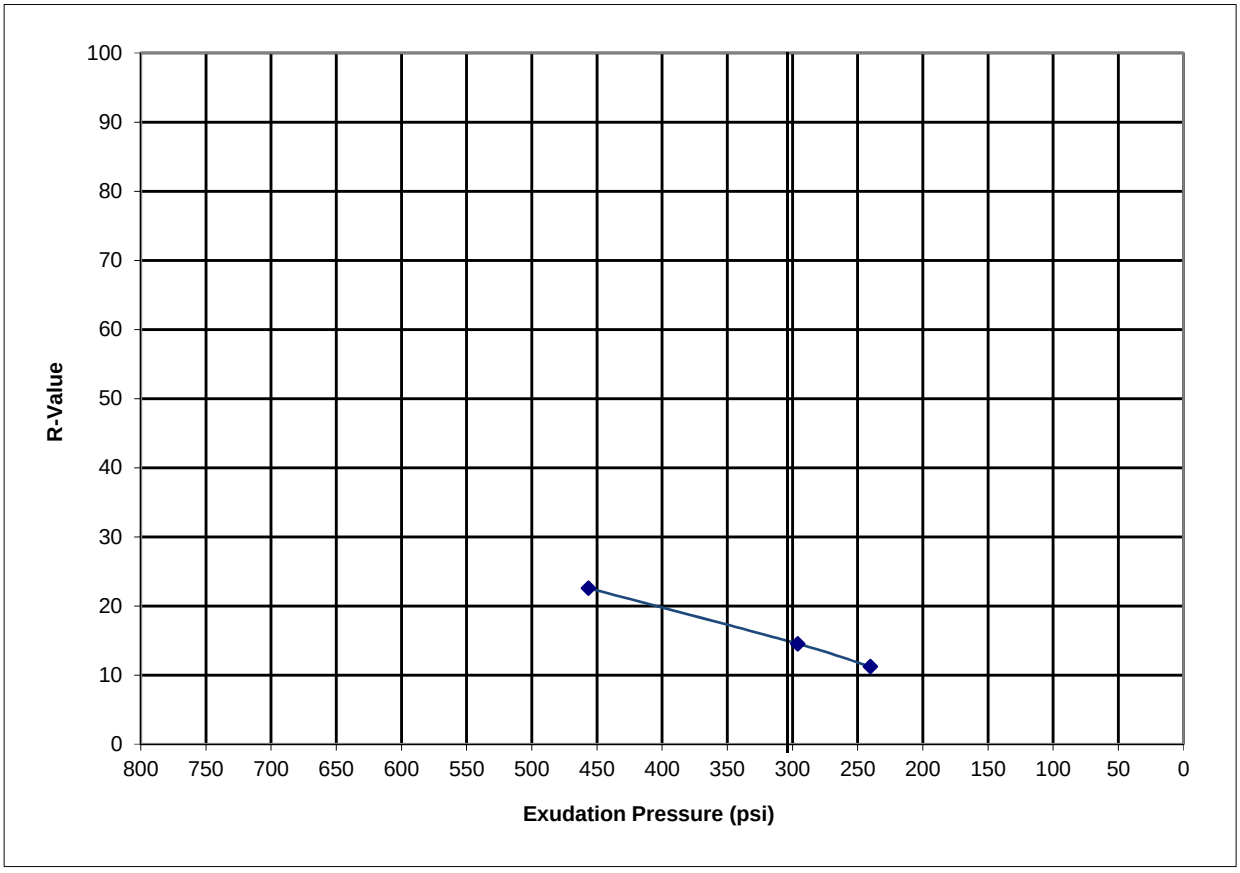
R Value at 300 PSI = 16.0

Exhibit B-10

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	1
MATERIAL:	Fill: Clayey Sand with Gravel	**LAB NO:**	33
SAMPLE SOURCE:	R3 @ 0.0'-4.0'	**DATE SAMPLED:**	02/09/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	13.4%	13.0%	11.3%
Compaction Pressure (psi)	85	115	190
Specimen Height (inches)	2.57	2.58	2.49
Dry Density (pcf)	120.8	120.1	124.5
Horiz. Pres. @ 1000lbs (psi)	57.0	54.5	45.0
Horiz. Pres. @ 2000lbs (psi)	134.0	128.0	112.0
Displacement	4.11	3.97	3.67
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	240	296	457
R Value	11	15	23



AASHTO R18

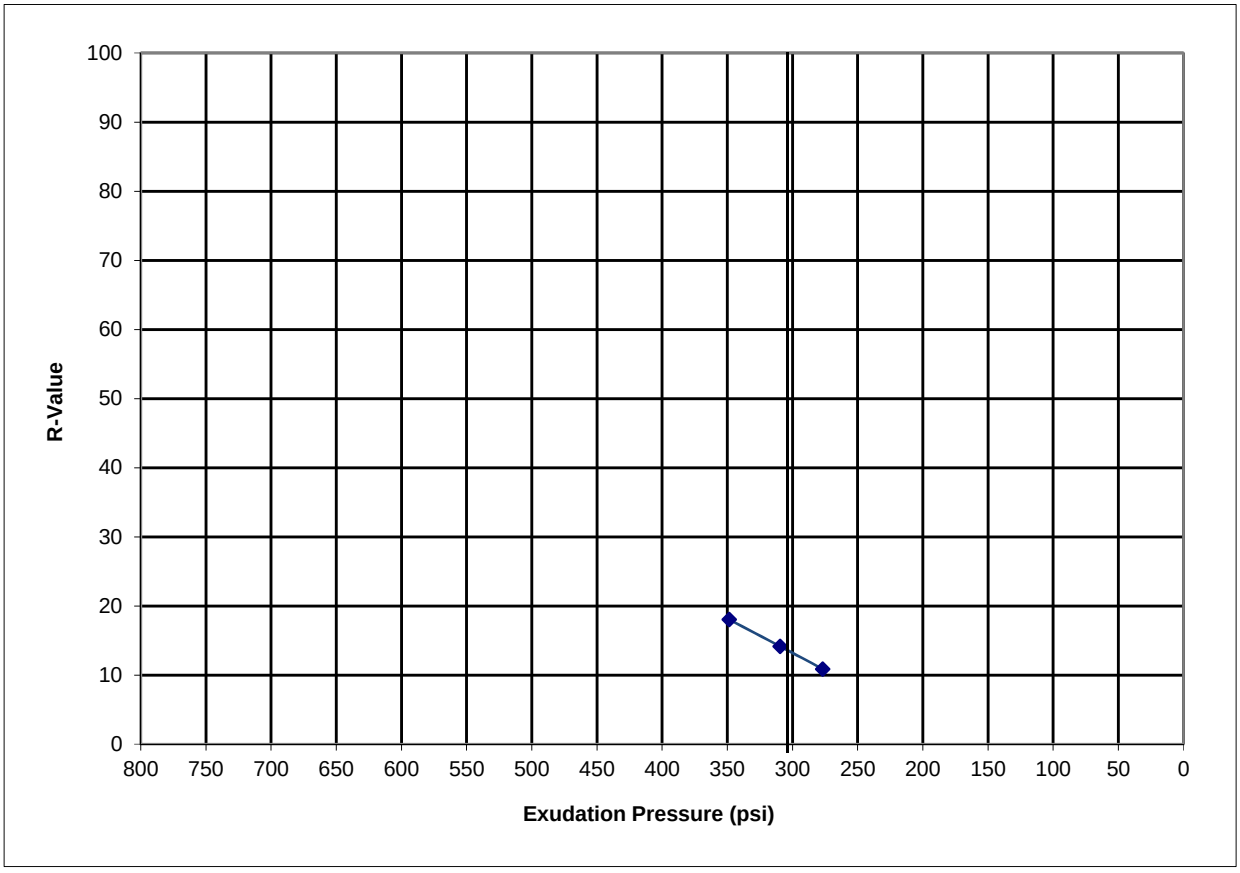
R Value at 300 PSI = 14.8

Exhibit B-11

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	1
MATERIAL:	Fill: Clayey Sand	**LAB NO:**	36
SAMPLE SOURCE:	R4 @ 0.0'-4.0'	**DATE SAMPLED:**	02/09/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	26.6%	24.7%	22.5%
Compaction Pressure (psi)	95	130	155
Specimen Height (inches)	2.57	2.58	2.49
Dry Density (pcf)	103.8	106.6	122.0
Horiz. Pres. @ 1000lbs (psi)	59.0	55.0	49.0
Horiz. Pres. @ 2000lbs (psi)	135.0	130.0	122.0
Displacement	4.06	3.78	3.54
Expansion Pressure (psi)	0.0	0.0	0.0
Exudation Pressure (psi)	277	309	348
R Value	11	14	18



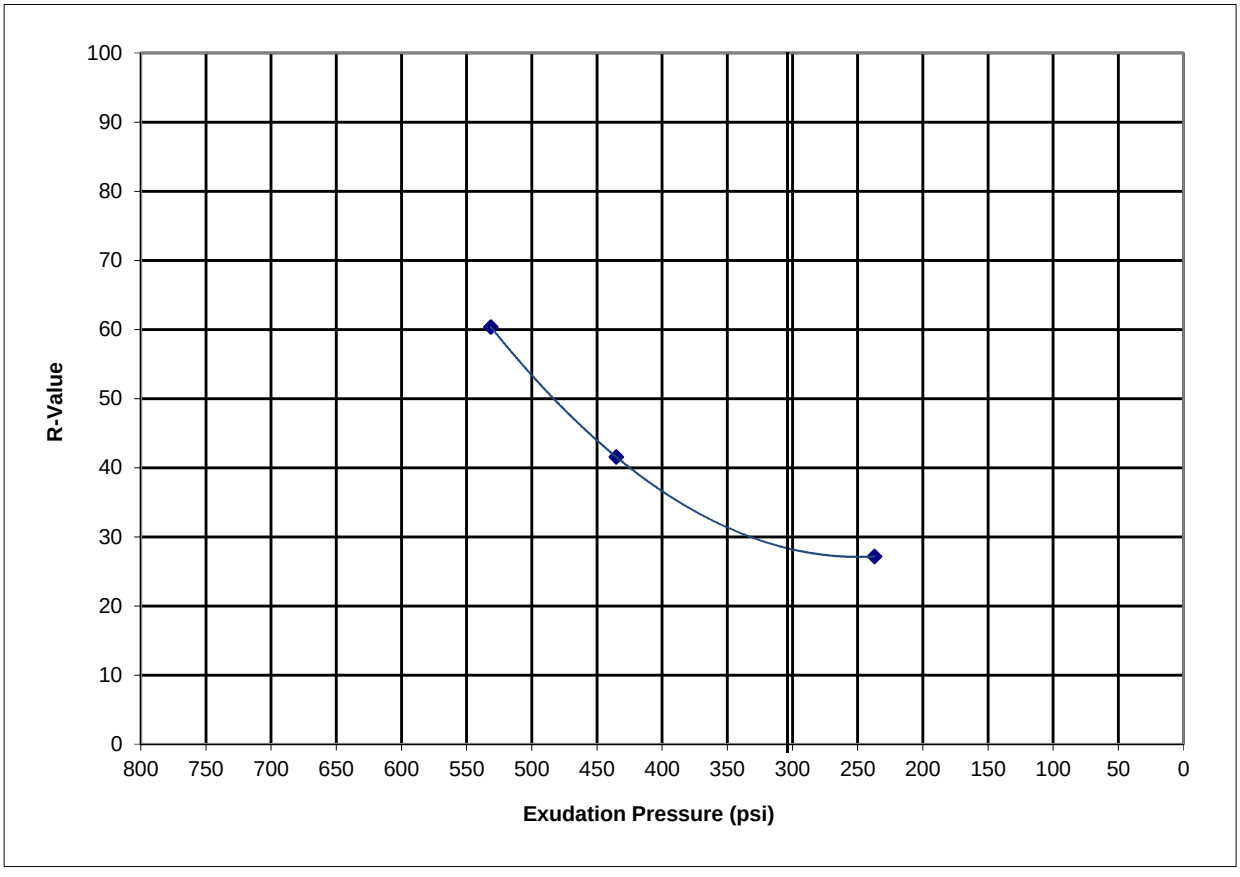
AASHTO R18

R Value at 300 PSI = 13.2

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	1
MATERIAL:	Fill: Clayey Sand with Gravel	**LAB NO:**	42
SAMPLE SOURCE:	R6 @ 0.0'-4.0'	**DATE SAMPLED:**	02/09/16

RESISTANCE R-VALUE AND EXPANSION PRESSURE OF COMPACTED SOILS (ASTM D2844)

SPECIMEN I. D.	**A**	**B**	**C**
Moisture Content	14.3%	13.3%	12.4%
Compaction Pressure (psi)	220	310	350
Specimen Height (inches)	2.58	2.50	2.54
Dry Density (pcf)	120.2	122.3	123.2
Horiz. Pres. @ 1000lbs (psi)	43.0	32.5	22.0
Horiz. Pres. @ 2000lbs (psi)	103.5	78.5	50.0
Displacement	3.96	3.65	3.61
Expansion Pressure (psi)	0.0	0.4	0.5
Exudation Pressure (psi)	237	435	531
R Value	27	42	60



AASHTO R18

R Value at 300 PSI = 28.2

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	65155090
MATERIAL:	Clayey Sand	**LAB NO:**	4
SAMPLE SOURCE:	B1 @ 9.0'-10.0'	**DATE SAMPLED:**	2/9/2016

Sample Preparation: Insitu density and moisture
Unsaturated Shear

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	118.33	129.96	123.87
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.416	2.416	2.416
Moisture, %:	7.1	7.0	7.0
Dry Density (pcf):	98.3	108.0	102.9
Saturation, %:	28	35	31
Void Ratio:	0.67	0.52	0.60

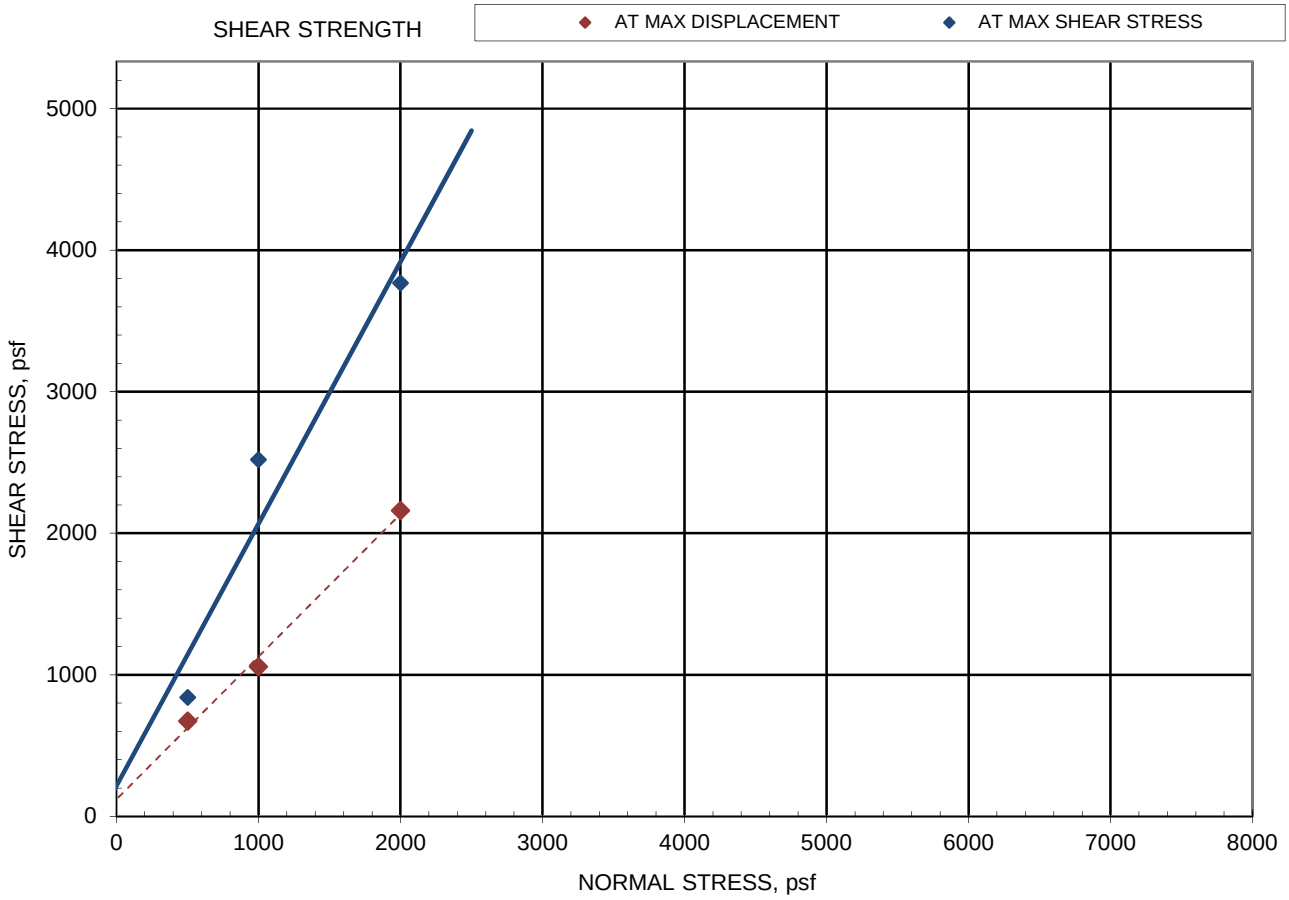
Final Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	118.33	129.96	123.87
height (in):	0.9948	0.9904	0.9821
Diameter (in):	2.416	2.416	2.416
Moisture, %:	7.0	6.8	6.7
Dry Density (pcf):	98.9	109.1	104.8
Saturation, %:	28	35	31
Void Ratio:	0.66	0.51	0.57

Normal Stress (psf):	500	1000	2000
Maximum Shear Stress, (psf):	840	2520	3768
Displacement at Maximum Shear, (in):	0.101	0.157	0.215
Shear Stress at Max Displacement, (psf)	672	1056	2160
Maximum Displacement, (in):	0.451	0.451	0.451
Rate of Deformation, in/min	0.0160	0.0160	0.0160

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

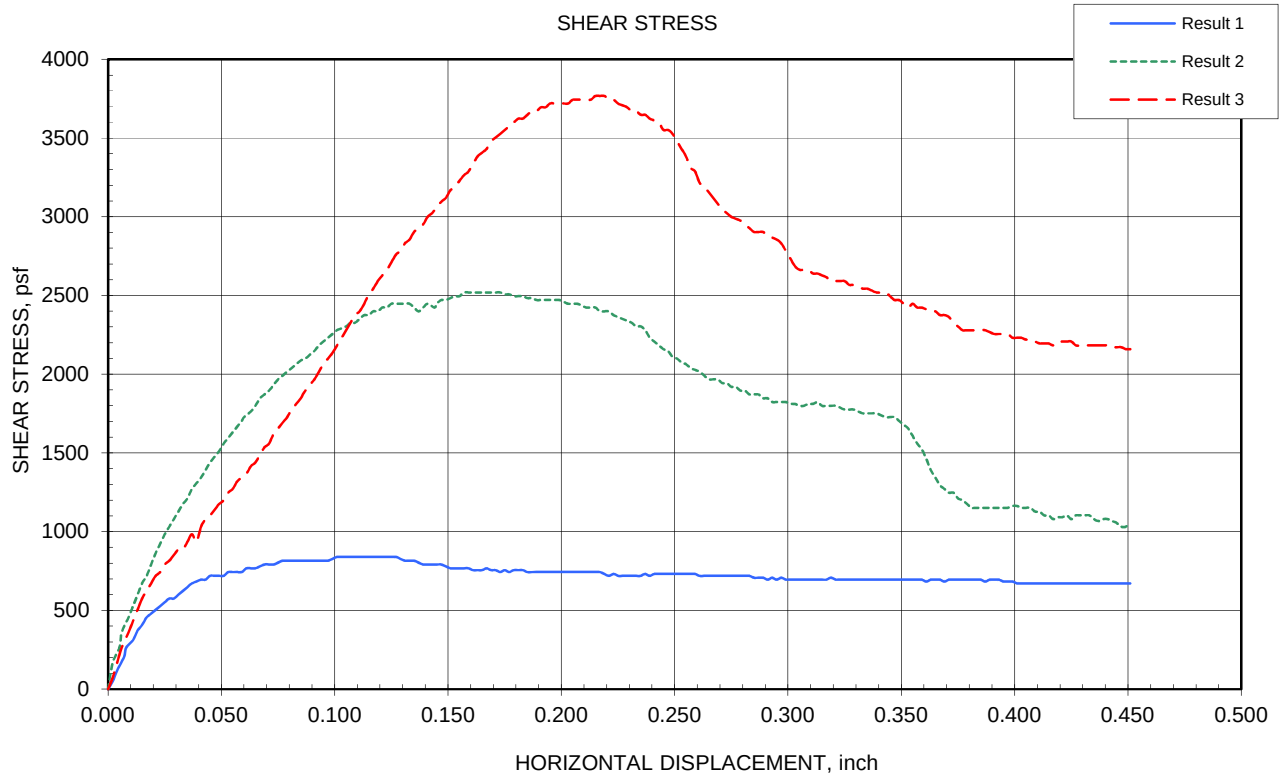
	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**61.6**	**216**
Specs:		
AT MAX DISPLACEMENT	45.2	120
Specs:		



Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	65155090
MATERIAL:	Clayey Sand	**LAB NO:**	4
SAMPLE SOURCE:	B1 @ 9.0'-10.0'	**DATE SAMPLED:**	2/9/2016



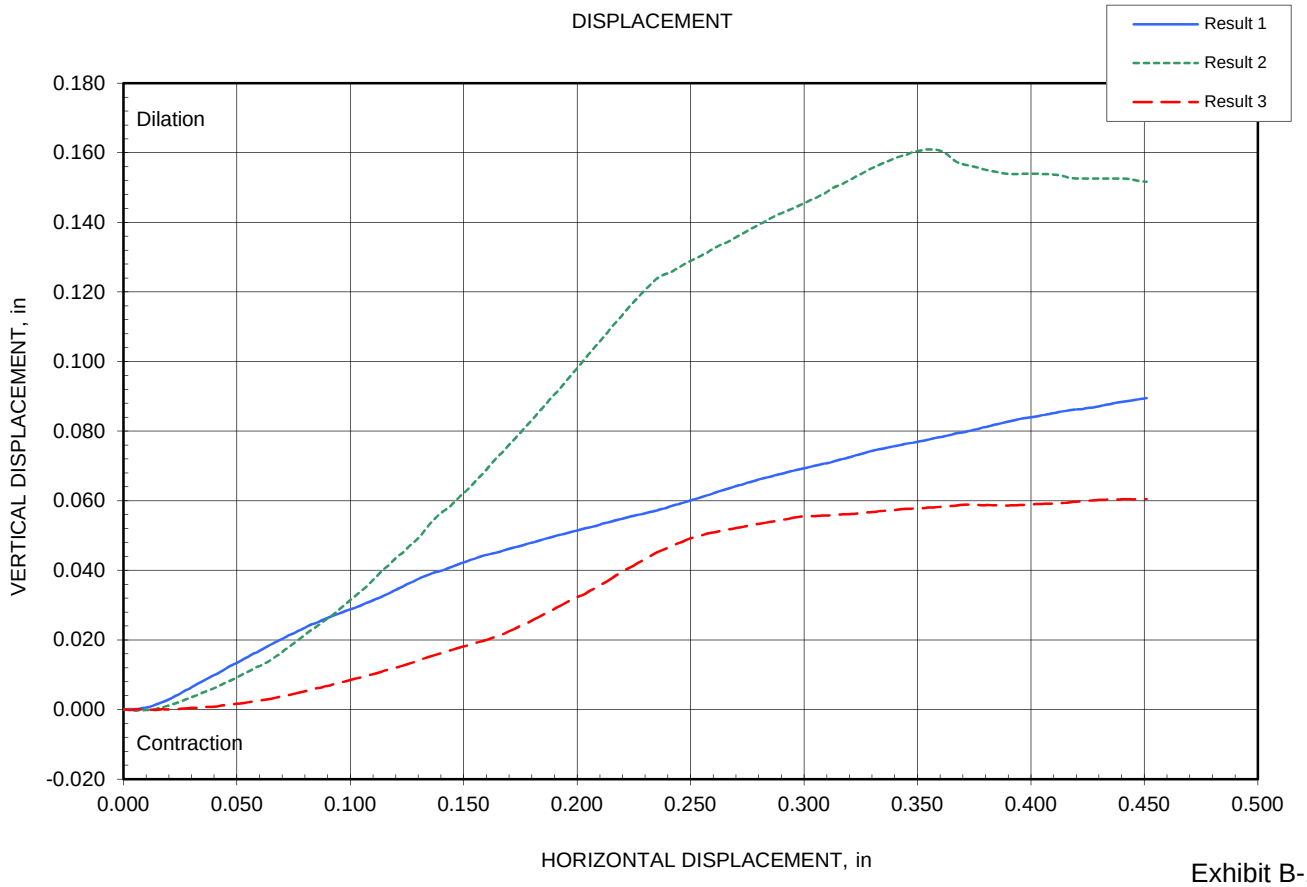


Exhibit B-15

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	65155090
MATERIAL:	Composite Sample, Clayey Sand	**LAB NO:**	N/A
SAMPLE SOURCE:	B1@0-5'; B1@5'; B1@14'	**DATE SAMPLED:**	3/4/2016

Sample Preparation: Remolded to 95% max dry density at 2% below optimum moisture. Max dry density D698A 120.0 pcf @ 11.8% opt. moisture. Specimens consolidation and shear on unsaturated condition.

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	137.18	137.19	137.18
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.416	2.416	2.416
Moisture, %:	9.8	9.8	9.8
Dry Density (pcf):	114.0	114.0	114.0
Saturation, %:	59	59	59
Void Ratio:	0.44	0.44	0.44

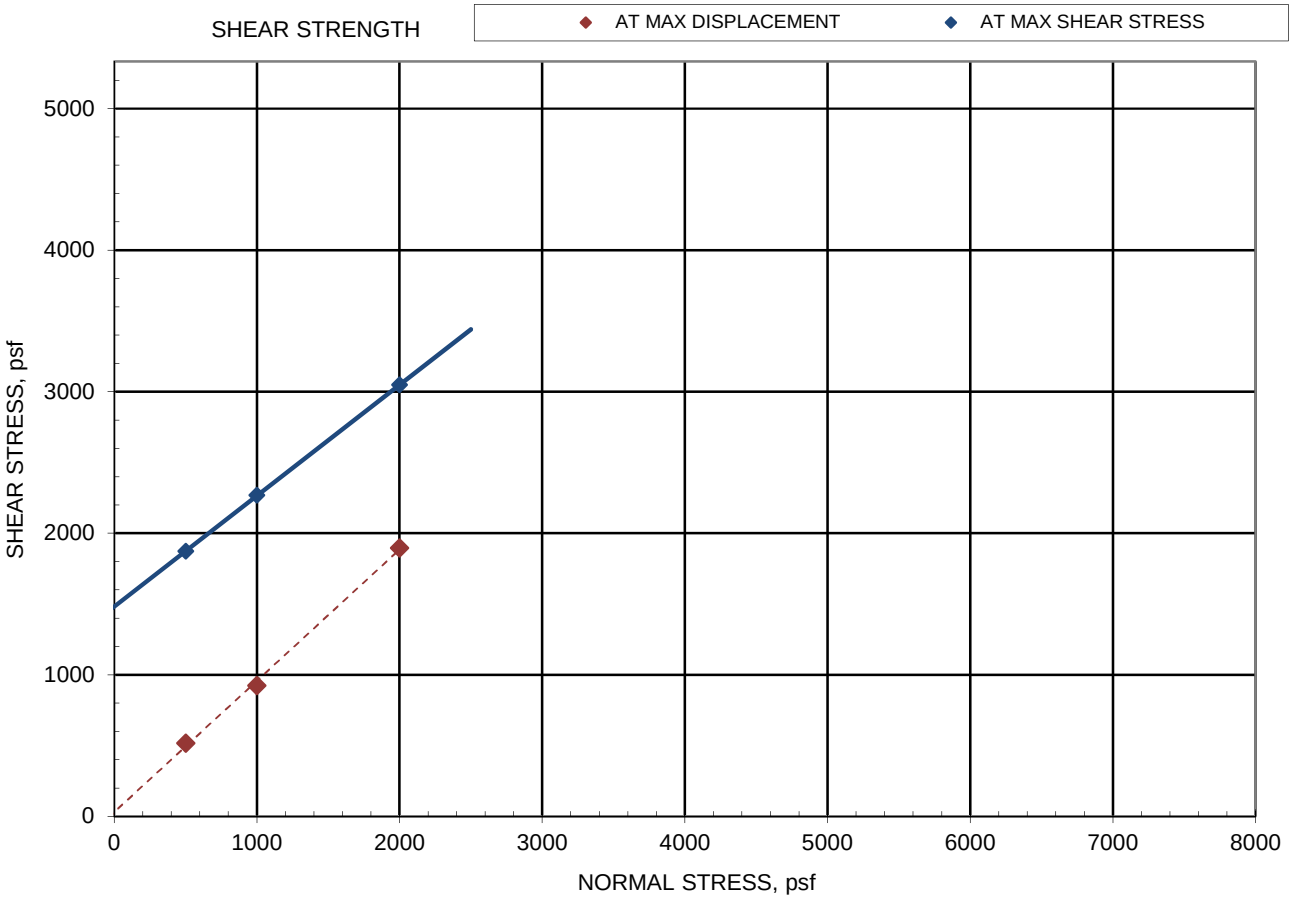
Final Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	137.18	137.19	137.18
Height (in):	0.9972	0.9913	0.9868
Diameter (in):	2.416	2.416	2.416
Moisture, %:	9.7	9.7	9.5
Dry Density (pcf):	114.3	115.0	115.5
Saturation, %:	59	59	59
Void Ratio:	0.44	0.43	0.42

Normal Stress (psf):	500	1000	2000
Maximum Shear Stress, (psf):	1872	2268	3048
Displacement at Maximum Shear, (in):	0.071	0.063	0.067
Shear Stress at Max Displacement, (psf)	516	924	1896
Maximum Displacement, (in):	0.451	0.451	0.451
Rate of Deformation, in/min	0.0160	0.0160	0.0160

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

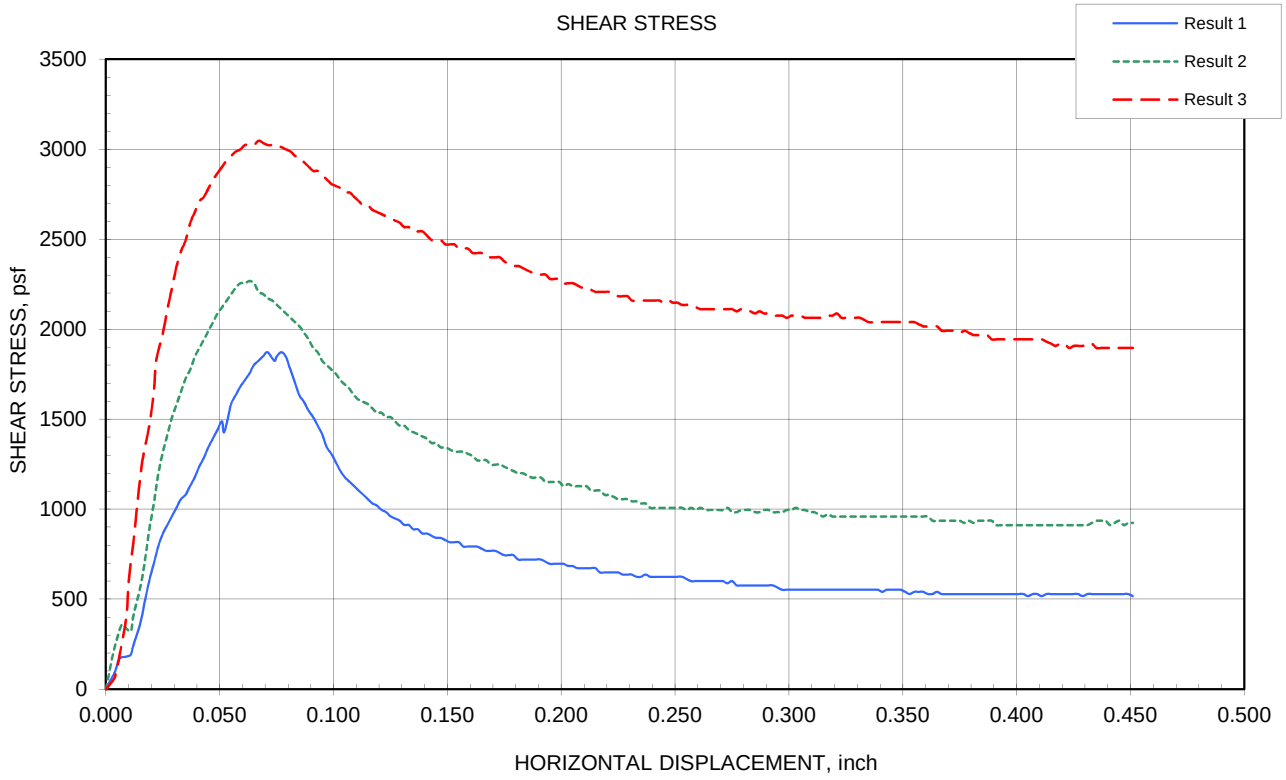
	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**38.1**	**1482**
Specs:		
AT MAX DISPLACEMENT	42.8	30
Specs:		

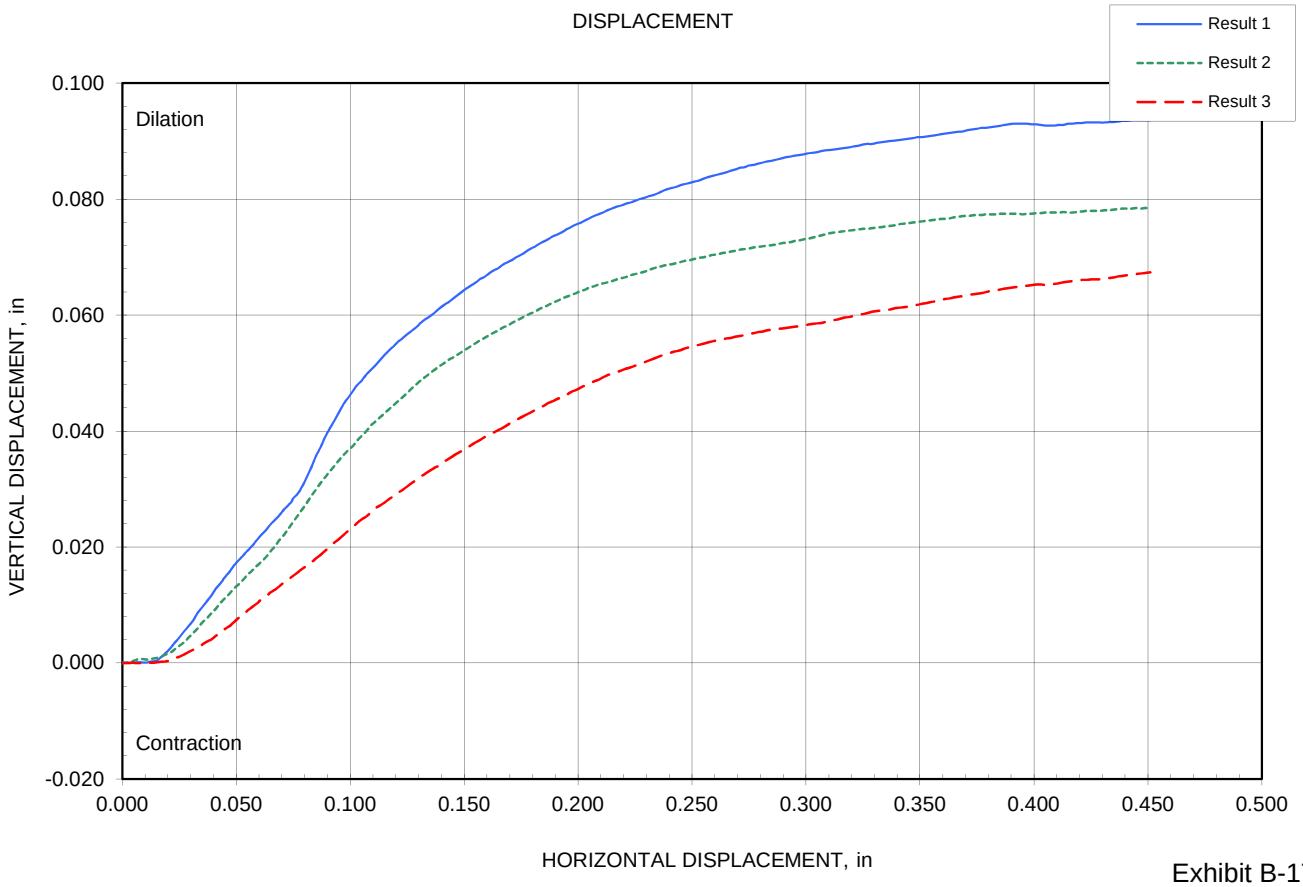


Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	65155090
MATERIAL:	Composite Sample, Clayey Sand	**LAB NO:**	N/A
SAMPLE SOURCE:	B1@0-5'; B1@5'; B1@14'	**DATE SAMPLED:**	3/4/2016





DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

Terracon

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	65155090
MATERIAL:	Composite Sample, Clayey Sand	**LAB NO:**	N/A
SAMPLE SOURCE:	B2@0-5': B2@9'; B2@14'-15'	**DATE SAMPLED:**	3/4/2016

Sample Preparation: Remolded to 95% max dry density at 2% below optimum moisture. Max dry density D698A 116.9 pcf @ 13.5% opt. moisture. Specimens consolidation and shear on unsaturated condition.

Initial Parameters of specimen:

	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	133.64	133.63	133.63
Height (in):	1.0000	1.0000	1.0000
Diameter (in):	2.416	2.416	2.416
Moisture, %:	11.5	11.5	11.5
Dry Density (pcf):	111.1	111.0	111.0
Saturation, %:	63	63	63
Void Ratio:	0.48	0.48	0.48

Final Parameters of specimen:

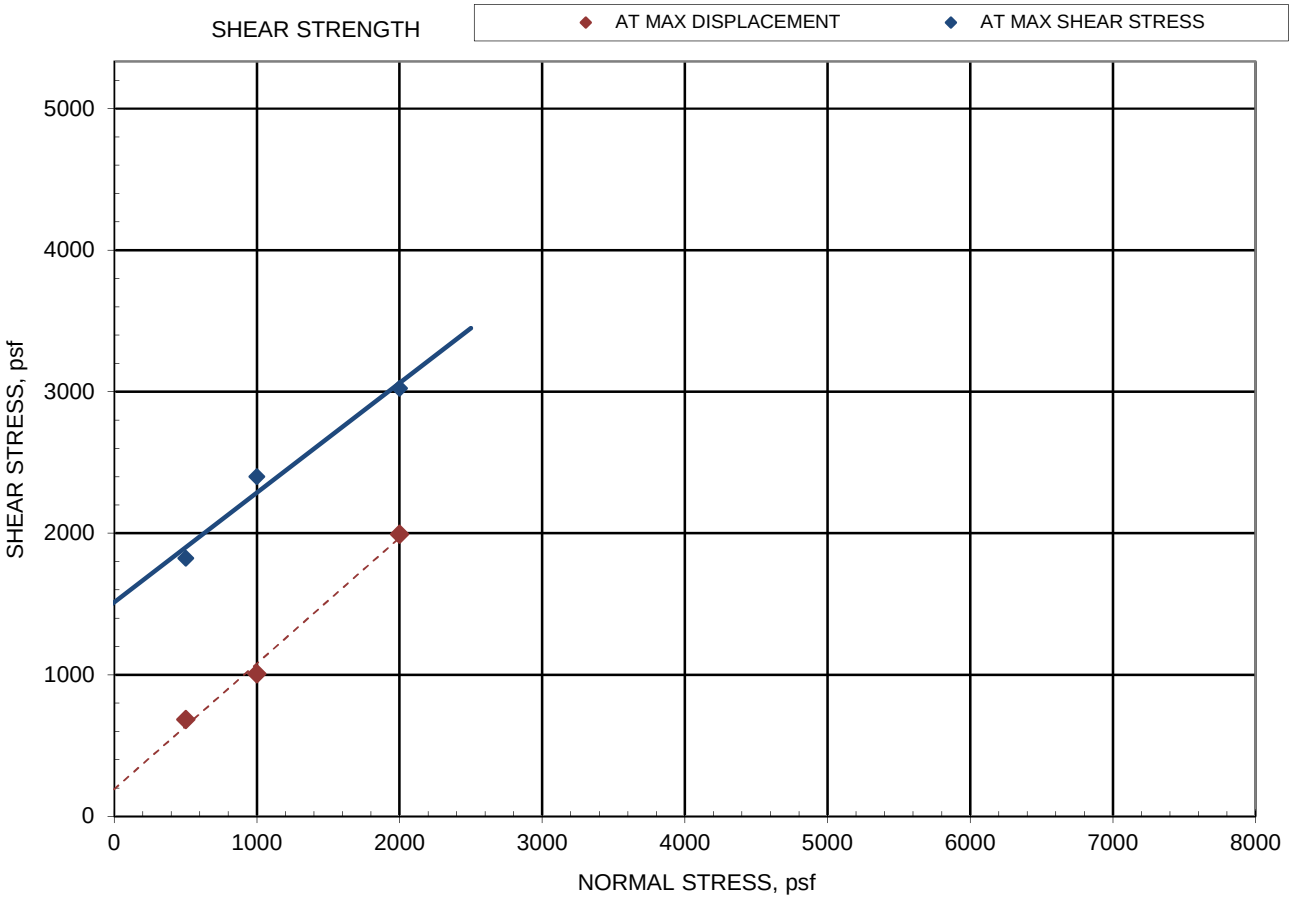
	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	133.64	133.63	133.63
Height (in):	0.9961	0.9945	0.9818
Diameter (in):	2.416	2.416	2.416
Moisture, %:	11.4	11.4	11.2
Dry Density (pcf):	111.5	111.7	113.1
Saturation, %:	64	63	65
Void Ratio:	0.47	0.47	0.45

Normal Stress (psf):	500	1000	2000
Maximum Shear Stress, (psf):	1824	2400	3024
Displacement at Maximum Shear, (in):	0.101	0.077	0.087
Shear Stress at Max Displacement, (psf)	684	1008	1992
Maximum Displacement, (in):	0.451	0.451	0.449
Rate of Deformation, in/min	0.0160	0.0160	0.0160

SHEAR DEVICE: Geomatic model 8914, Dead Weight load force

	FRICTION ANGLE	COHESION
AT MAX SHEAR STRESS	**37.8**	**1512**
Specs:		
AT MAX DISPLACEMENT	41.6	192
Specs:		

SHEAR STRENGTH



Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

DIRECT SHEAR TEST OF SOILS UNDER CONSOLIDATED DRAINED CONDITIONS ASTM D3080

PROJECT:	I-10 Temporary Bridge at Craycroft Road	**JOB NO:**	65155090
LOCATION:	Tucson, Arizona	**WORK ORDER NO:**	65155090
MATERIAL:	Composite Sample, Clayey Sand	**LAB NO:**	N/A
SAMPLE SOURCE:	B2@0-5': B2@9'; B2@14'-15'	**DATE SAMPLED:**	3/4/2016