Structures 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:

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Tempe, Arizona

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June 14, 2016

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Attn: Mr. Jim Pyne, P.E.

Re: **Structures 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
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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. The temporary bridge structure is planned in order to re-route traffic and allow deck rehabilitation of the existing I-10 east- and west-bound traffic interchange (TI) overpass (OP) bridges across Craycroft Road. The temporary bridge structure will consist of a two-lane steel truss bridge with a span of approximately 200 feet. 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. The results of our engineering analyses, including the results of the subsurface engineering exploration and foundation design analyses recommendations for construction of foundations for the temporary bridge are attached.

If you have any questions concerning this report or any of our testing, design and consulting services, please do not hesitate to contact us.

Sincerely,
Terracon Consultants, Inc.

Registered Professional Engineer (Civil) CERTIFICATE NO. 43838 RAMON PADILLA Date Signed 6/14/16 ARIZONA, U.S.A. Expires 3-31-2018

Ramon Padilla, P.E.
Geotechnical Project Manager

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Senior Principal

Copies to: Addressee (1 electronic)

STRUCTURES GEOTECHNICAL ENGINEERING REPORT

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1.0 INTRODUCTION

This report presents the results of our geotechnical engineering services performed for the proposed Interstate 10 (I-10) Temporary Bridge at Craycroft Road in Tucson, Arizona. The purpose of these services is to provide information and geotechnical engineering recommendations relative to the following:

- subsurface soil conditions
- earthwork
- seismic considerations
- groundwater conditions
- foundation design and construction

Our geotechnical engineering scope of work for the proposed I-10 Temporary Bridge at Craycroft Road included drilling borings for subsurface exploration, laboratory testing, geotechnical engineering analysis, and preparation of this report. The subsurface exploration consisted of drilling a total of two (2) borings, one (1) boring for each proposed temporary bridge abutment, to a depth of approximately 55 feet below the existing ground surface. Logs of the borings along with a Site Plan and Boring Locations diagram (Exhibit A-1) are included in Appendix A of this report. The results of the laboratory testing performed on soil samples obtained from the site during the field exploration are included in Appendix B of this report. Descriptions of the field exploration and laboratory testing are included in their respective appendices.

2.0 PROJECT INFORMATION

2.1 Project Description

ITEM	DESCRIPTION
Site Layout	See Exhibit A-1 in Appendix A
Description	The purpose of the project is to rehabilitate the bridge deck of the I-10 Craycroft Road TI OP eastbound (EB) & westbound (WB) Structures Nos. 594 & 595. The proposed temporary bridge structure is planned between the two existing TI OP structures in order to re-route traffic in a phased approach to allow the bridge deck rehabilitation.
Structures	The temporary bridge structure will consist of a two-lane steel truss bridge with a (single) span of approximately 200 feet. The temporary bridge structure is planned to be supported at each abutment by a shallow continuous footings with a width of approximately 10 feet and a length of approximately 42 feet.
Structure construction	We understand the temporary bridge structure construction will consist of assembling bridge structure segments across Craycroft Road until reaching the approximately 200-foot span.
Finished grade elevation	Based on 60% plans, finished grade elevations are anticipated to be approximately 2,734 feet for Abutment 1 and approximately 2,735 feet for Abutment 2.
Maximum loads	The following loads (for each abutment) were provided by T.Y. Lin: Strength: 1,350 kips Strength with AC overlay: 1,463 kips Service: 950 kips Service with AC overlay: 1,025 kips
Grading	Final grades are anticipated to be within five feet of existing grades.

2.2 Site Location and Description

ITEM	DESCRIPTION
Location	The project site is located at the intersection of I-10 and Craycroft Road in Tucson, Arizona. See Exhibit A-1 in Appendix A.
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 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.

[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.

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,*** 6th Edition, 2012

3.3 Typical Subsurface Profile

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 for both planned temporary bridge abutments (Bridge Abutments 1 and 2). Therefore, subsurface conditions for both abutment locations on the project site can be generalized as follows:

Description	Approximate Depth to Bottom of Stratum (feet)	Material Encountered	Relative Density / Consistency
Stratum 1	22 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 16 and 18). The gradation test results of the near surface embankment fill clayey sand soils indicate these soils contain slightly over 30 percent fines (percent passing the sieve No. 200), slightly less than 60 percent sand, and approximately 10 percent gravel.

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 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 either boring 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

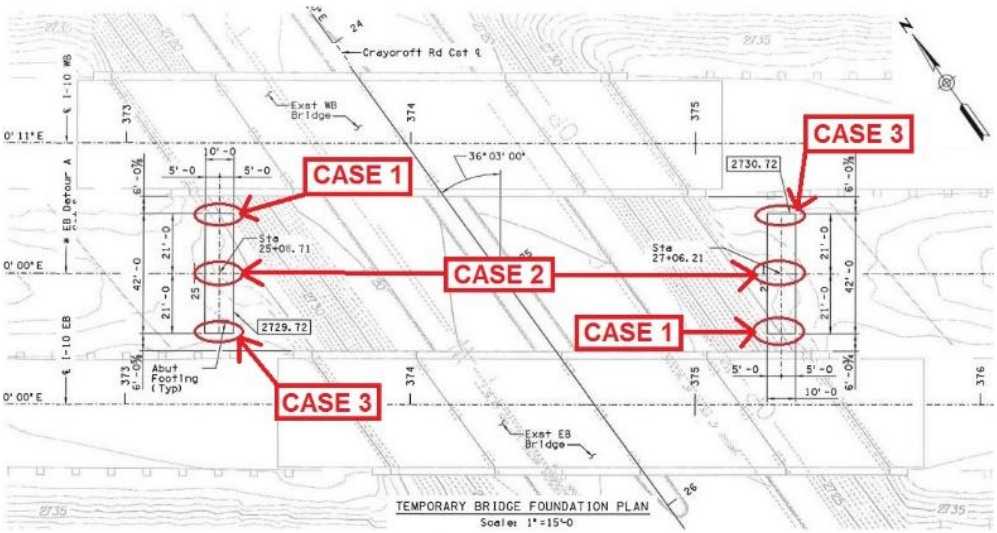
Geotechnical engineering recommendations for foundation design and construction and other earth connected phases of the project are outlined below. The recommendations contained in this report are based upon the results of field and laboratory testing (which are presented in

Appendices A and B), engineering analyses, and our current understanding of the proposed project.

Based on the 60% Design Plans for the project, we understand the temporary bridge structure is planned to be supported at each abutment by a shallow continuous footing with an initial estimated width of approximately 10 feet and length of approximately 42 feet. The proposed foundations for the temporary bridge will be located relatively close to the embankment slope (between the east- and west-bound I-10 travel lanes) that extends down towards Craycroft Road. Interstate 10 is oriented northwest to southeast and Craycroft Road is oriented north to south, which results in skew of the foundations of approximately 36 degrees. Because of this, the northern edge of the proposed foundation of Abutment 1 will be located adjacent to the top of the slope and the southern edge of this proposed foundation is located at approximately 25 feet away from the top of the slope. Similarly, the southern edge of the proposed foundation of Abutment 2 will be located adjacent to the top of the slope and the northern edge of this proposed foundation is located at approximately 25 feet away from the top of the slope. Terracon evaluated the following scenarios for both factored net bearing resistance and slope stability:

- **Case 1 -** Foundation edge adjacent to embankment slope. This scenario occurs at the northern portion of the Abutment 1 footing and at the southern portion of the Abutment 2 footing.
- **Case 2 -** Foundation edge at approximately 10 feet away from the embankment slope. This scenario occurs at roughly the central portion of both abutment footings.
- **Case 3 -** Foundation edge at approximately 25 feet away from the embankment slope. This scenario occurs on the southern portion of the Abutment 1 footing and on the northern portion of the Abutment 2 footing.

The red ovals on the following figure indicate the portions of the temporary bridge foundation described above:



4.2 Spread Footing Foundations - Factored Net Bearing Resistance

The temporary bridge structure is planned to be supported at each abutment by a shallow continuous footing. We understand each abutment footing was sized with a width of 10 feet, a length of 42 feet, and a minimum embedment depth of three (3) feet is recommended for the proposed temporary bridge foundations. In addition, the abutment foundations are planned to be underlain by a 2-foot thick lean concrete base.

Terracon performed LRFD design of spread footings for Abutments 1 and 2. The recommendations for design and construction of shallow foundations at the site were developed in general accordance with Section 10 of the [5]AASHTO LRFD Bridge Design Specifications (2012) and the [6]ADOT Geotechnical Design Policy SF-1 dated December 1, 2010. The strength and service limit state design analyses for spread footings were completed per the methods presented in Sections 10.5 and 10.6, respectively, of AASHTO LRFD Bridge Design Specifications, and ADOT Geotechnical Design Policy SF-1.

The factored net bearing resistance, q_{Rn}, for the strength limit state design was determined using the net nominal bearing resistance (ultimate bearing capacity), q_{nn}, calculated per Section 10.6.3.1.2a and bearing resistance factor, φ_b, from Section 10.5.5.2.2 of AASHTO LRFD (2012). The parameters presented below in the following table were assumed for the nominal resistance and strength limit state analyses. The following table shows the assumed soil parameters, which were based on the conditions encountered in the borings drilled at the site.

Parameter	Symbol	Value
Soil Angle of Internal Friction	f_f	35°
Soil Unit Weight	g	110 pcf
Cohesion	C	1,000 psf
Footing Length	L	42 ft
Minimum Footing (Embedment) Bearing Depth	D_f	3 ft
Estimated Footing Width	B	10 ft
Bearing Resistance Factor	φ_b	0.45

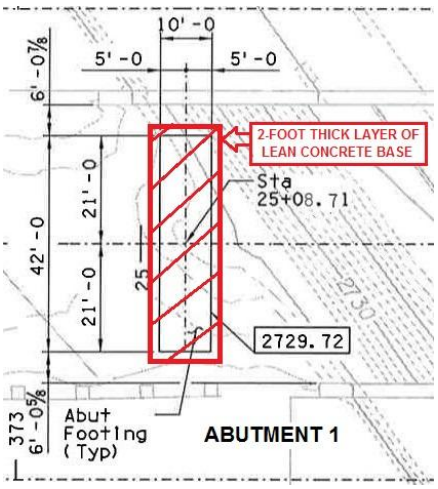
[5] American Association of State Highway and Transportation Officials, ***AASHTO Load-and-Resistance Factor Design (LRFD) Bridge Design Specifications,*** 6th Edition, 2012

[6]Arizona Department of Transportation (ADOT), Geotechnical Design Section, Memorandum dated December 1, 2010 with the following subject: Geotechnical Design Policy SF-1, *Load Resistance Factor Design (LRFD), Development of Factored Bearing Resistance Chart by a Geotechnical Engineer for Use by a Bridge Engineer to Size Spread Footings on Soils based on Load and Resistance Factor Design (LRFD) Methodology.*

Due to the proximity of the proposed temporary bridge foundations to the existing embankment slopes, the bearing capacity factors were reduced in general accordance with Section 10.6.3.1.2c of AASHTO LRFD Bridge Design Specifications, summarized as follows:

Case Evaluated	Symbol	Slope Adjusted Value
***Case 1 -** Foundation edge adjacent to embankment slope. This scenario occurs at the northern portion of the Abutment 1 footing and at the southern portion of the Abutment 2 footing.	N_c	3.8*
	N_q	0
	Ng	5*
Case 2 - Foundation edge at approximately 10 feet away from the embankment slope. This scenario occurs at roughly the central portion of both abutment footings.	N_c	4.5
	N_q	0
	Ng	15
Case 3 - Foundation edge at approximately 25 feet away from the embankment slope. This scenario occurs on the southern portion of the Abutment 1 footing and on the northern portion of the Abutment 2 footing.	N_c	5.1
	N_q	0
	Ng	25

***Note:** The slope adjusted bearing capacity factors for Case 1 resulted in factored net bearing resistances below resistances required for the support of the anticipated loads. Therefore, we recommend over-excavating the soils underlying the entire footing width. The over-excavation should extend a minimum of two (2) feet below the bottom of the footing and a minimum of two (2) feet beyond the edges of the proposed footing. The over-excavated soils should be replaced with a lean concrete base (ADOT Standard Specification, Section 305) with a minimum compressive strength of 500 pounds per square inch (psi). Detailed dimensions of the lean concrete base will be provided in the project plans. The following figures indicate the approximate location the lean concrete base is recommended in order to provide additional support for the temporary bridge abutment foundations:



The bearing capacity factors were re-evaluated incorporating the recommended 2-foot thick lean concrete base as providing an additional 2-feet of foundation embedment, which resulted increased bearing capacity factors. Based on the additional support the 2-foot thick layer of lean concrete base will provide the portion of the footings nearest to the slope, the following bearing capacity factors were used for Case 1:

Case Evaluated	Symbol	Slope Adjusted Value
Case 1 with Lean Concrete Base - Foundation edge adjacent to embankment slope with a 2-foot thick layer of lean concrete base supporting entire footing.	N_c	4.5
	N_q	0
	Ng	10

Due to the greater bearing resistance factors for Cases 2 and 3, the resulting strength limits were greater than the strength limit for Case 1. Our evaluation of Case 1 with a 2-foot thick layer of lean concrete base resulted in the lowest strength limit from the three cases evaluated, while still providing the anticipated bearing resistance for the proposed temporary bridge foundation. Therefore, the bearing resistance design chart included as Exhibit C-1 of Appendix C is based on Case 1 with a 2-foot thick layer of lean concrete base, which is applicable for use in the foundation design of the proposed temporary bridge abutment footings. The resulting factored net bearing resistance, q_{Rn}, versus effective footing width, B_f, is shown as the "Strength Limit State" line in Exhibit C-1. Based on information provided by TY Lin, we understand the anticipated service load limit on the abutment foundations result in an estimated settlement of approximately 5/8-inch.

Per the ADOT Geotechnical Design Policy SF-1, the Schmertmann method presented in Section 8.5 of the [7]FHWA Soils and Foundations Reference Manual (2006) was used to calculate settlements for the service limit state analysis. The parameters assumed for each depth interval for this analysis are presented in the following table:

[7]Federal Highway Administration, ***Soils and Foundations-Reference Manual***, Volumes I and II, Publication Nos. FHWA NHI-06-088 and FHWA NHI-06-89, December, 2006

Parameter	Symbol	0 - 10 feet	10 - 28 feet	28 - 42 feet	42 - 55 feet
Soil Type	--	Fill SC	Fill SC & SC / CL	SM	SC / CL
Soil Unit Weight (pcf)	g	110	110	110	110
Overburden-Normalized Engergy-Corrected SPT N-value	$N1_{60}$	50	23	23	20
*Elastic Modulus (ksf)	E_s	$2.5N1_{60}$	$2.5N1_{60}$	$3.5N1_{60}$	$2N1_{60}$

*Elastic modulus used for analyses includes a shape/influence factor (X Factor) for a plane strain case of L_f/B_f>=10 (FHWA, 2006), or reduced for L_f/B_f<10.

The parameters are based on estimated soil densities, $N1_{60}$ values, and on the E_s-$N1_{60}$ correlations from Section 5.9 of FHWA (2006). Exhibit C-1 present the family of service limit state curves developed per the ADOT Geotechnical Design Policy SF-1 for design settlements including 0.25, 0.5, 0.75, 1.0, 1.5 and 2.0 inches and effective footing width, B_f.

We estimate a modulus of subgrade reaction (k_s) value of 180 pounds per square inch per inch of deflection (pci) for compacted embankment fill soils.

The entire abutment foundation is recommended to be supported by a lean concrete base. The embankment fill soils exposed by the foundation over-excavations should be scarified to a minimum depth of 8 inches, moisture conditioned to within two (2) percent of optimum moisture content (ASTM D698), and compacted to a minimum of 95 percent of their maximum dry density (ASTM D698). Alternatively, exposed areas can be proof-rolled provided compaction is met to a minimum depth of 8 inches. Exposed surfaces should be flat and free of mounds and depressions which could prevent uniform compaction. Foundation excavations should be observed by the geotechnical engineer or their qualified representative to evaluate the bearing conditions prior to the placement of reinforcement and concrete. If the soil conditions encountered differ significantly from those presented in this report, supplemental recommendations will be required. If unsuitable soils (loose, disturbed, etc.) are encountered, these soils should be removed to the extents indicated by the geotechnical engineer and replaced with engineered (compacted) fill or lean concrete base.

Foundations should be reinforced as necessary to reduce the potential for differential foundation movement. Additional post-construction movements of similar or greater magnitude than those estimated could occur if the compacted fill and/or natural soils beneath the foundation level were to experience an increase in moisture content. Therefore, the recommendations presented in this report are intended to reduce the potential for additional post-construction movements.

The following are limitations or conditions assumed in development of the resistance curves presented in Exhibit C-1:

- The loads on each footing are applied within the central one-third of the footing (width wise). Large moments or eccentricities of loading are not accounted for in this design.
- Each footing will be constructed horizontally. Inclination base correction factors have not been included in our analyses.

4.3 Lateral Earth Pressures Parameters

Retaining walls are not anticipated as part of the temporary bridge structure. Therefore, active and at-rest earth pressure parameters are excluded from this section. Evaluation of earth pressures for the abutment foundations should be considered in accordance with the provisions of Section 11 of AASHTO 2012. Horizontal loads acting on foundations cast in open excavations against undisturbed soil or properly placed and compacted fill will be resisted by friction acting along the base of the footing and by passive earth pressures against the loaded side of the footing. If design makes use of passive earth pressure against backfill, it is important that a representative of the engineer of record be present to monitor and test backfill placement and compaction. Foundations designed to provide passive resistance should have the backfill soils adjacent to the footings compacted to a minimum of 95 percent of the maximum ASTM D698 dry density in order to develop passive resistance with low strains.

Provided the lean concrete base is hardened and the surface is intentionally roughened to a full amplitude of ¼-inch as specified in the Shear Friction Section of the American Concrete Institute (ACI) 318[8] (2014 or other applicable edition), a coefficient of base friction of 0.7 may be used in the design of spread footings that will support abutment or retaining walls on the project cast-in-place on a lean concrete base. A coefficient of base friction of 0.5 may be used in the design of the lean concrete base cast-in-place with undisturbed soils. A resistance factor of 0.80 should be applied in the design for sliding of cast-in-place lean concrete base on undisturbed soils at the site in accordance with Table 10.5.5.2.2-1 of AASHTO 2012. Similarly, we recommend a resistance factor of 0.80 should be applied in the design for sliding of cast-in-place footing concrete bearing on lean concrete base.

Note: Because the temporary bridge foundations are planned adjacent to the embankment slope, passive resistance of the abutment foundations towards the slope (towards Craycroft Road) should be neglected. We understand the structural design considers the anticipated lateral forces to be resisted by base friction only, and passive resistance is excluded from the design.

[8] American Concrete Institute, Structural Concrete Building Code, ACI-318 (2014 or other applicable edition), Shear Friction Section.

For the case passive resistance is considered against the side of the abutment foundation facing away from the embankment slope (away from Craycroft Road), an ultimate lateral passive earth pressure may be computed using an equivalent fluid weighing 360 pcf for the sides of footings cast against undisturbed soil or properly placed and compacted backfill. A resistance factor of 0.50 should be applied in the design for passive earth pressure component of sliding resistance in accordance with Table 10.5.5.2.2-1 of AASHTO 2012.

4.4 Slope Stability Evaluation

Due to the proximity of the foundation to the edge of the embankment slope, the three different cases (Case 1 – Footing at the edge of slope; Case 2 – Footing approximately 10 feet away from slope; and Case 3 – Footing approximately 25 feet away from slope) previously described were evaluated for slope stability. Slope stability was evaluated using the using the computer program Slope/W 2012 by Geo-Slope International. Direct shear laboratory testing indicated cohesion values of approximately 1,500 psf for the tested embankment fill soils. As a conservative measure and to account for some possible variability in the embankment fill soils, a cohesion value of 500 psf was used for the analyses. Additional analyses were also performed iterating the 500 psf cohesion value to find the minimum cohesion value resulting in a factor of safety of approximately 1.5. The results of the slope stability evaluations for each of the cases previously described are shown on Exhibits D-1 through D-8 in Appendix D. The results of the slope stability evaluation for the different cases evaluated indicated stable conditions, with a minimum slope stability factor of safety of 1.5. Factors of safety for the different cases evaluated ranged between approximately 1.5 and 2.4.

4.5 Grading and Drainage

All grades must provide effective drainage away from the proposed structures during and after construction. Water permitted to pond next to the structures can result in moisture content increases in bearing soils and consequently greater soil movements than those discussed in this report. These greater movements can result in unacceptable differential movements. Estimated movements described in this report are based on effective drainage for the life of the structure and cannot be relied upon if effective drainage is not maintained.

We understand storm water drainage will extend down away from Craycroft Road at the top of the embankment slopes. We understand the embankment slopes include an existing grout cover preventing surface water infiltration. Embankment slope grout cover affected by construction of the temporary bridge should be restored, and special precautions should be taken to prevent surface water infiltrating under the protective grout cover.

Positive drainage should be provided during construction and maintained throughout the life of the temporary bridge structure at the site. Infiltration of water into trenches or foundation excavations should be prevented during construction. Surface features such as exposed graded areas which could retain water in areas adjacent to the foundations and other structural elements should be sealed or eliminated. In areas where impermeable covers such as paving do not immediately adjoin the structures, we recommend that protective slopes be provided with a minimum grade of approximately five percent for at least 10 feet from the structures. Backfill against footings or other structures at the site should be well compacted and free of all construction debris to reduce the possibility of moisture infiltration.

4.6 Excavation Characteristics

Excavations are anticipated to generally extend to depths of approximately 5 feet (or less than 10 feet). 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 precipitation, repetitive construction traffic or other factors.

The individual contractor(s) is responsible for designing and constructing stable, temporary excavations as required to maintain stability of both the excavation sides and bottoms. Excavations should be sloped or shored in the interest of safety following local and federal regulations, including current OSHA excavation and trench safety standards.

4.7 Corrosion Potential

Results of soluble sulfate testing indicate that tested on-site soils have soluble sulfate contents ranging between 85 and 146 parts per million. Therefore, ASTM Type I/II portland cement is considered suitable for all concrete on and below grade in contact with soils with similar soluble sulfate concentrations. The soluble sulfate test results indicate foundation concrete should be designed in accordance with the provisions of the ACI Design Manual, Section 318, Chapter 4 for low sulfate exposure.

Laboratory test results indicate that on-site soils have minimum resistivity values ranging from 1,050 to 1,496 ohm-centimeters, pH values ranging between 8.5 and 8.6, and soluble chloride contents ranging between 79 and 131 parts per million. 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.

4.8 Recommended Specifications

The following is a summary of the anticipated specifications that will need to be developed by the bridge designer:

- A specification for pre-loading the bridge prior to the temporary bridge opening to traffic. We understand the dead load for the temporary bridge structure will be about 70 to 80 percent of the anticipated service load, and that the temporary bridge structure will be constructed in segments and placed on the abutment foundations. The specification should include the abutment foundations supporting the temporary bridge structure (dead load) for at least two (2) weeks before the temporary bridge opens to traffic. Subsequent to applying the dead load for a minimum of two (2) weeks and before the temporary bridge opens to traffic, the specification should include loading the bridge with the anticipated traffic service load for a minimum of 24 hours. The specification should include monitoring the bridge abutment foundations by performing surveys at different load increments in order to evaluate bridge foundation settlement and assess the need for possible bridge adjustments. Each abutment foundation structure should have established survey monuments to allow for reoccurring measurements and monitoring of foundation structure movements. Survey measurements should have an accuracy to the nearest 0.1 inches and the date and time for each survey should be recorded with the survey measurements. As each of the surveys is completed, the results should be provided to Terracon and the ADOT Bridge (Geotechnical) Group for review. Performing surveys of the bridge abutment foundations are recommended at the following times:
  - Prior to any loading
  - Within four (4) hours after loading with the bridge structure dead load
  - Once every three (3) days during the minimum 2 week dead load loading period
  - At the end of the dead load loading period
  - Within four (4) hours after loading with the anticipated traffic service load
  - Once every eight (8) hours during the minimum 24 hour traffic service loading
  - At the end of the traffic service loading period

- A specification for bridge adjustments, if needed, by jacking up the bridge and placing a shim or shims. The specification should describe the differential settlement tolerances and provide differential settlement limits that would result in requiring bridge adjustment. We understand the bridge can accommodate some differential settlement on the order of approximately ¾ inches. We also understand that the bridge can be adjusted by jacking any of the bridge corners and placing shims in order to re-level the bridge, if needed. The substructure should include the necessary elements to accommodate the bridge jack, such as a jacking pad. We understand the temporary bridge designer will be responsible for specifications for shims describing the material type, dimensions and minimum dimensions, in order for the shims to resist the load (and not crack).

- A specification to survey the bridge abutments at the end of Phase 1 (after re-decking the existing I-10 eastbound bridge and prior to reversing the flow of traffic on the temporary bridge) in order to evaluate if bridge re-adjusting is required. A specification to re-adjust the bridge for the case bridge re-adjusting is needed between Phase 1 and Phase 2. This specification should be by force account to avoid the expense if re-adjustment is not needed. The specification should include traffic control requirements during bridge re-adjustment to route traffic through the existing bridges, or if needed, to re-route traffic to the exit and entrance ramps during bridge re-adjustment. Bridge re-adjustment, if needed, is anticipated to take one night to complete.

6.0 GENERAL COMMENTS

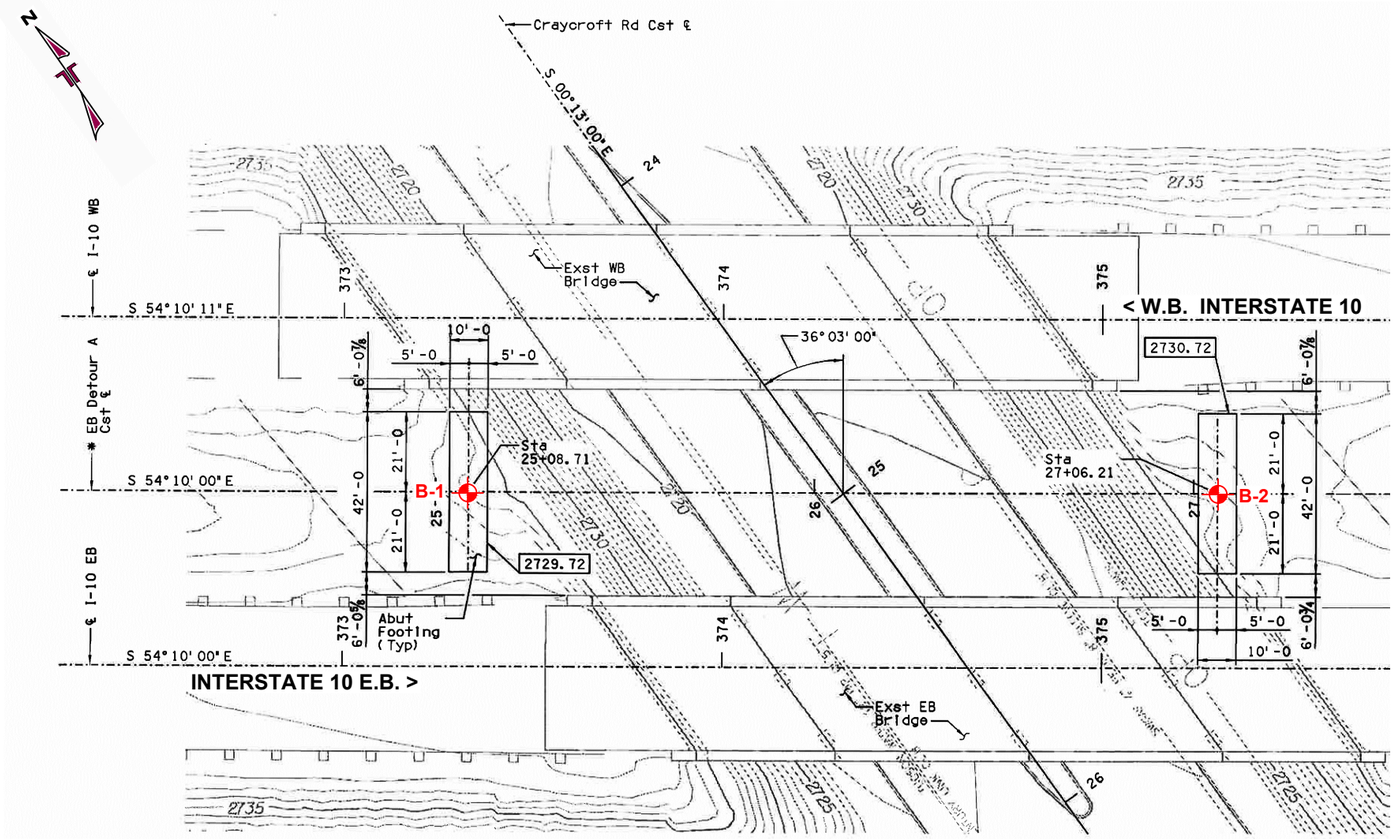
Terracon should be retained to review the final design plans and specifications so comments can be made regarding interpretation and implementation of our geotechnical recommendations in the design and specifications. Terracon also should be retained to provide observation and testing services during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

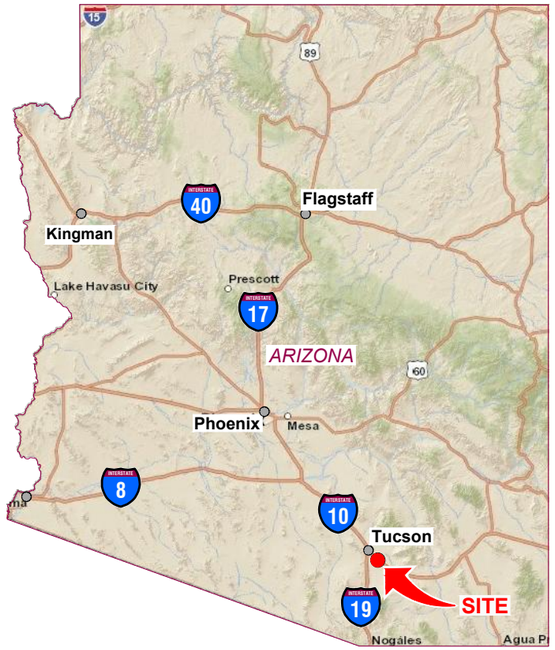
The analysis and recommendations presented in this report are based upon the data obtained from the borings performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between boring locations, across the site, or due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

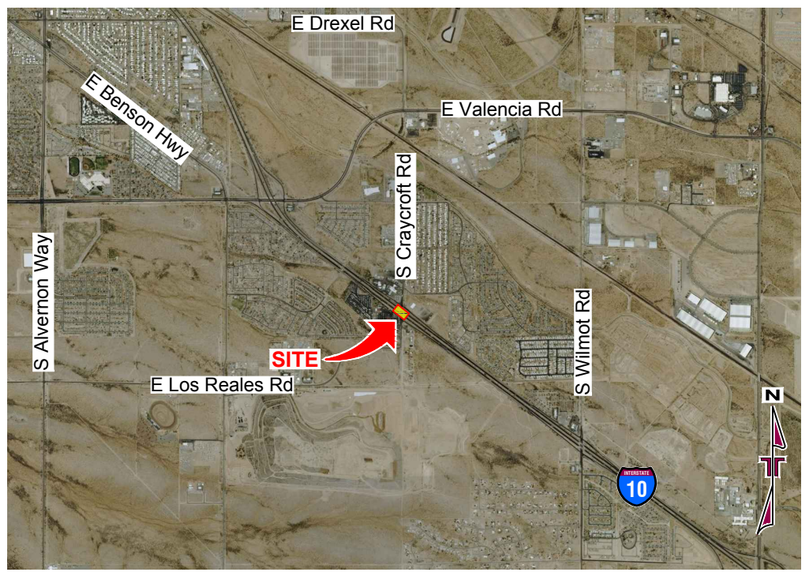
This report has been prepared for the exclusive use of our client for specific application to the project discussed and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either express or implied, are intended or made. Site safety, excavation support, 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







VICINITY MAPS
NOT TO SCALE

0 20' 40'
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
PH. (480) 897-8200 FAX. (480) 897-1133

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

Field Exploration Description

A total of two (2) test borings were drilled at the site on February 5, 2016. The borings were drilled to a depth of approximately 55½ feet below the ground surface. The approximate boring locations are shown on the attached Site Plan and Boring Locations diagram, Exhibit A-1.

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.

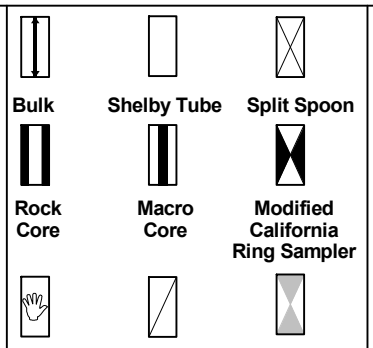
A continuous lithologic log of each boring was recorded by the field engineer during the drilling operations. At selected intervals, samples of the subsurface materials were taken by driving split-spoon (SPT) or ring-lined barrel samplers in general accordance with ASTM Standards. Penetration resistance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

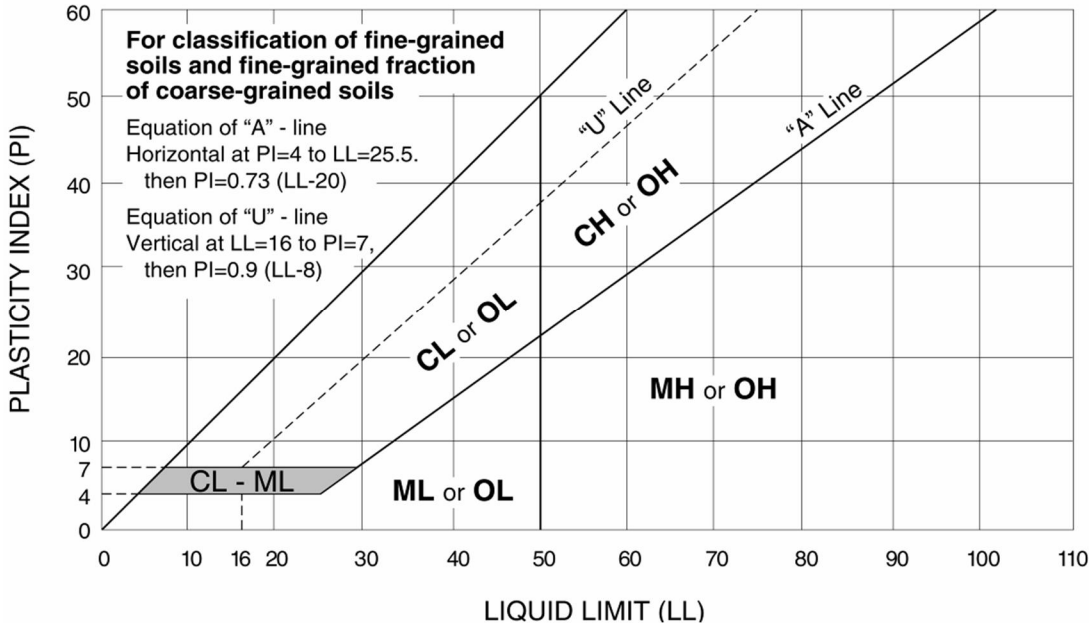
[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name.

[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-4

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	DEPTH (Ft.)	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 to light brown, dense			36-50/5"	5	121	36-18-18	31
			5		14-19-18 N=37				
		medium dense	10		21-27	7	117		
			15		8-13-13 N=26				
		ring sample disturbed	20		14-20	9	95		
24.0	2712								
		CLAYEY SAND (SC), brown to light brown, dense, weak cementation	25		13-27-29 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				
42.0	2694		40		17-34	2	111		
		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 N=30	16			
55.5	2680.5		55		3-7-11 N=18				
		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-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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

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

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-5

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.)	DEPTH (Ft.)	SAMPLE TYPE	FIELD TEST RESULTS	WATER CONTENT (%)	DRY UNIT WEIGHT (pcf)	ATTERBERG LIMITS LL-PL-PI	PERCENT FINES
	FILL - CLAYEY SAND (SC), trace gravel, light brown, dense							
		5		15-18-19 N=37			34-18-16	33
				21-20	6	110		
		10		12-21-19 N=40				
	medium dense	15		13-14	9	121		
22.0	2715	20		10-10-8 N=18				
	SANDY LEAN CLAY (CL), light brown, very stiff, no to weak cementation	25		11-21	7	112		
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 N=35				
55.5	2681.5	55		6-10-12 N=22	10			
	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-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.
Elevations were interpolated from 60% plans.

Notes:

WATER LEVEL OBSERVATIONS

Groundwater not encountered

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

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

Drill Rig: CME-75 Driller: Southlands Engineering

Project No.: 65155090 Exhibit: A-6

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.

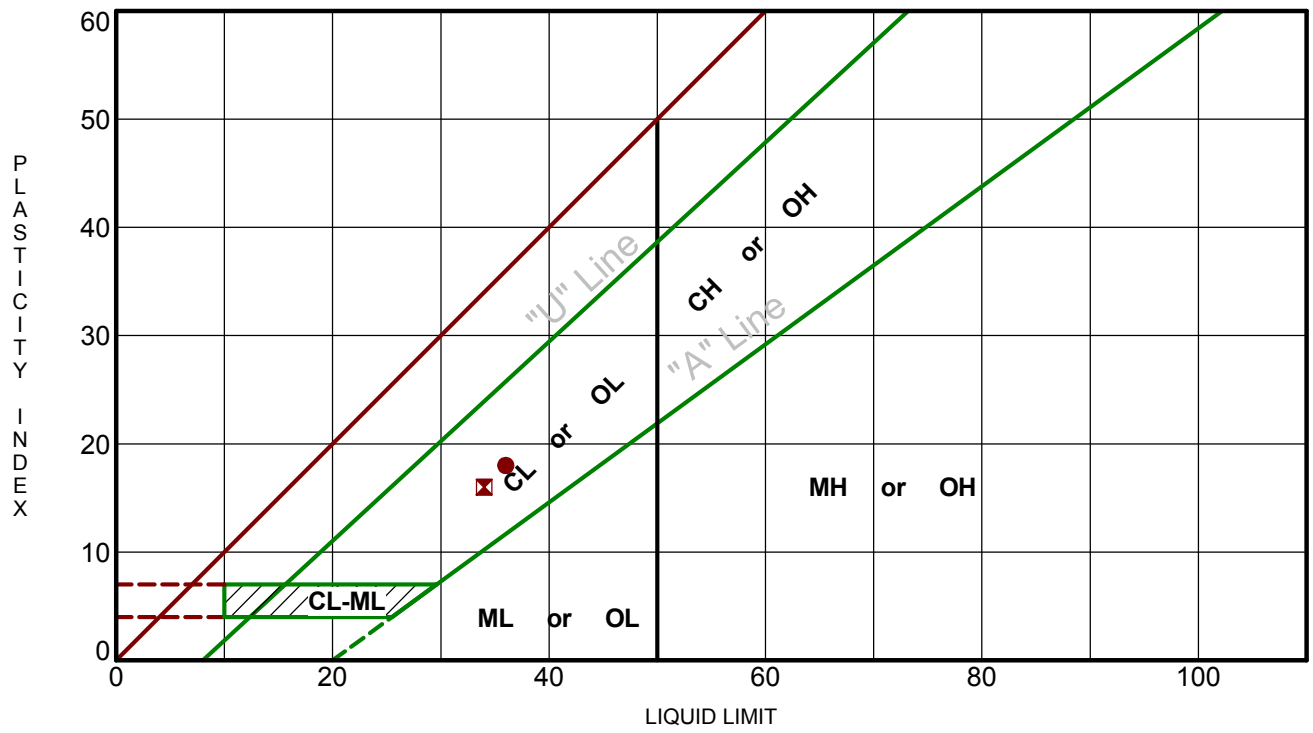
Laboratory tests were conducted on selected soil samples and the test results are presented in this appendix. The laboratory test results were used for the geotechnical engineering analyses, and the development of foundation, floor slab, and pavement recommendations. Laboratory tests were performed in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

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

- Sieve Analysis
- Atterberg Limits
- 1-D Consolidation
- Collapse Potential
- Remolded Swell
- pH & Resistivity
- In-Situ Moisture Content
- In-Situ Dry Density
- Direct Shear
- Standard Proctor
- Soluble Sulfate
- Soluble Chloride

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

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

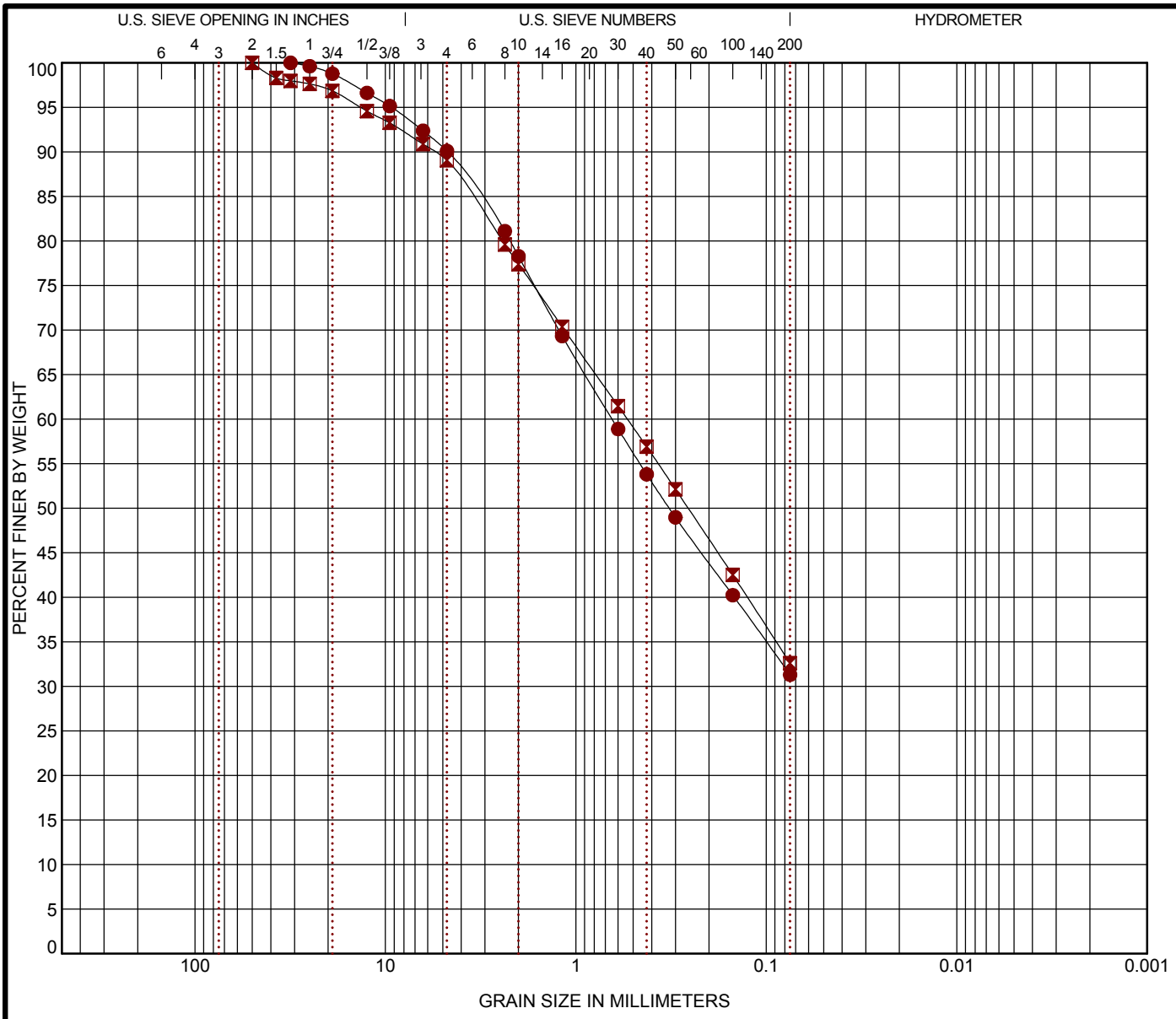
CLIENT: T.Y. Lin International, Inc.

EXHIBIT: B-2

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. ATTERBERG LIMITS 65155090.GPJ TERRACON2015.GDT 3/7/16

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
●	B1	0 - 5	CLAYEY SAND (SC)	36	18	18		
⊠	B2	0 - 5	CLAYEY SAND (SC)	34	18	16		

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

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

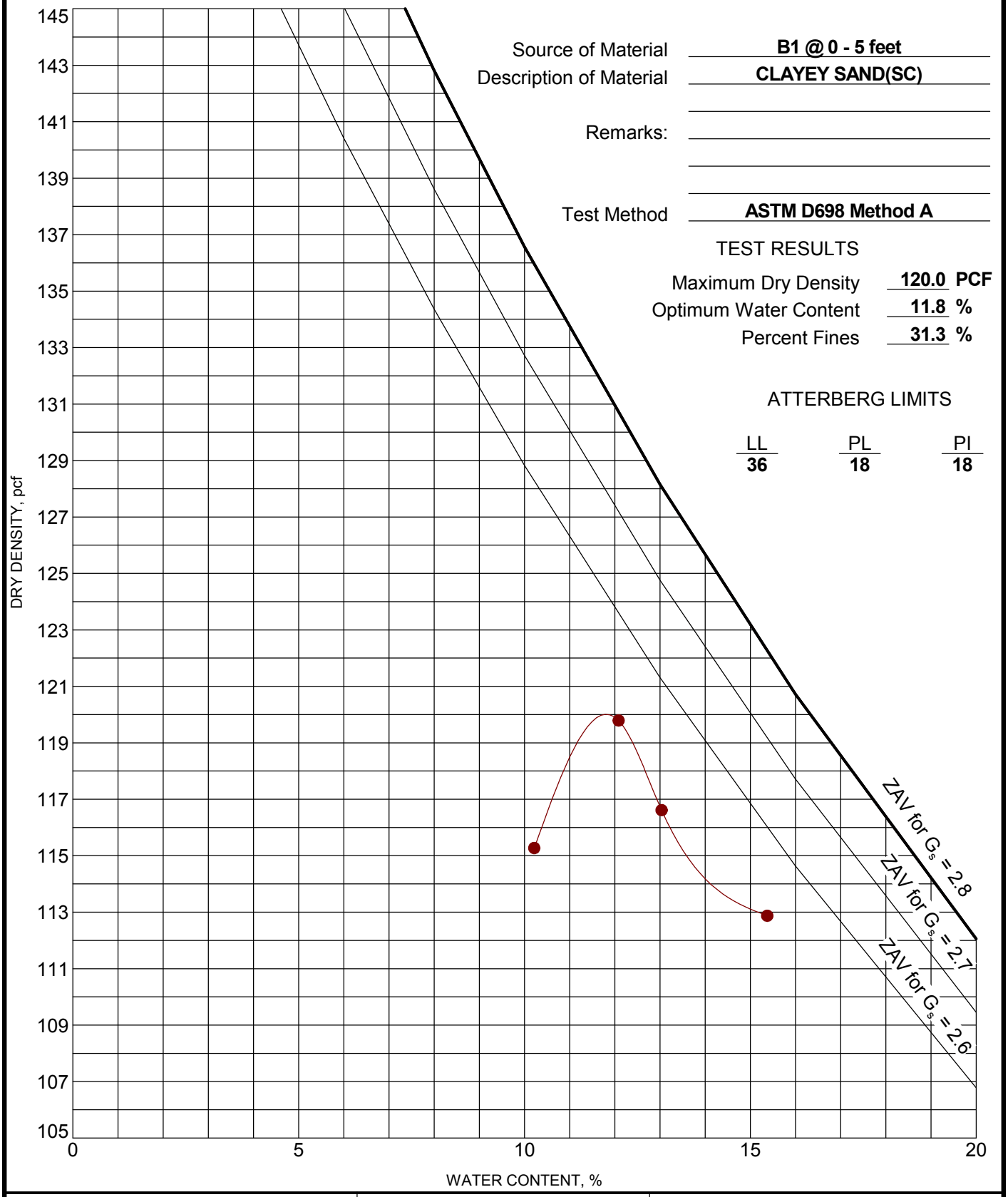
CLIENT: T.Y. Lin International, Inc.

EXHIBIT: B-3

LABORATORY TESTS ARE NOT VALID IF SEPARATED FROM ORIGINAL REPORT. GRAIN SIZE: USCS-2 65155090.GPJ 35159097 - ATTERBERG ISSUE.GPJ 3/7/16

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

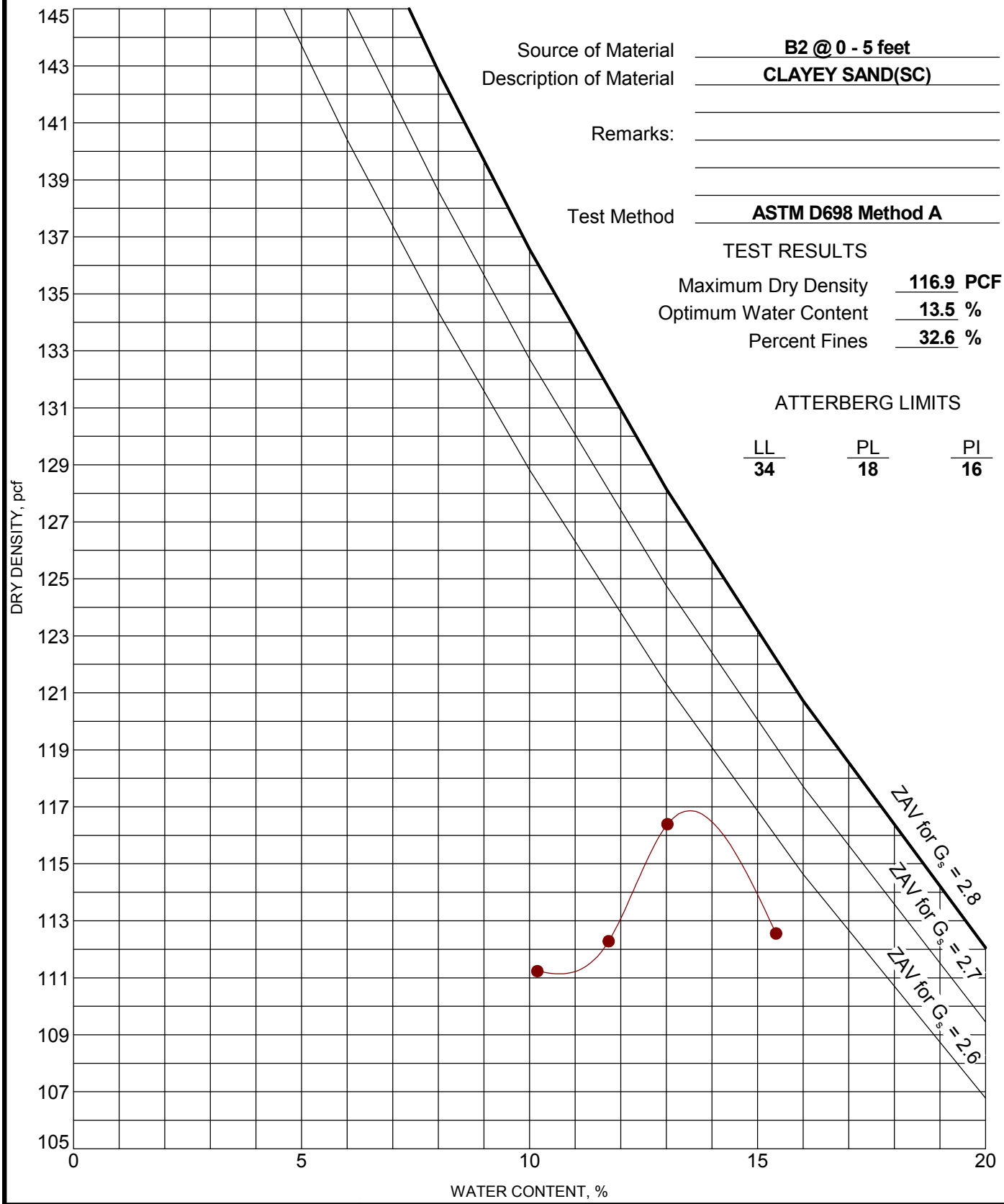
PROJECT NUMBER: 65155090

CLIENT: T.Y. Lin International, Inc.

EXHIBIT: B-4

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

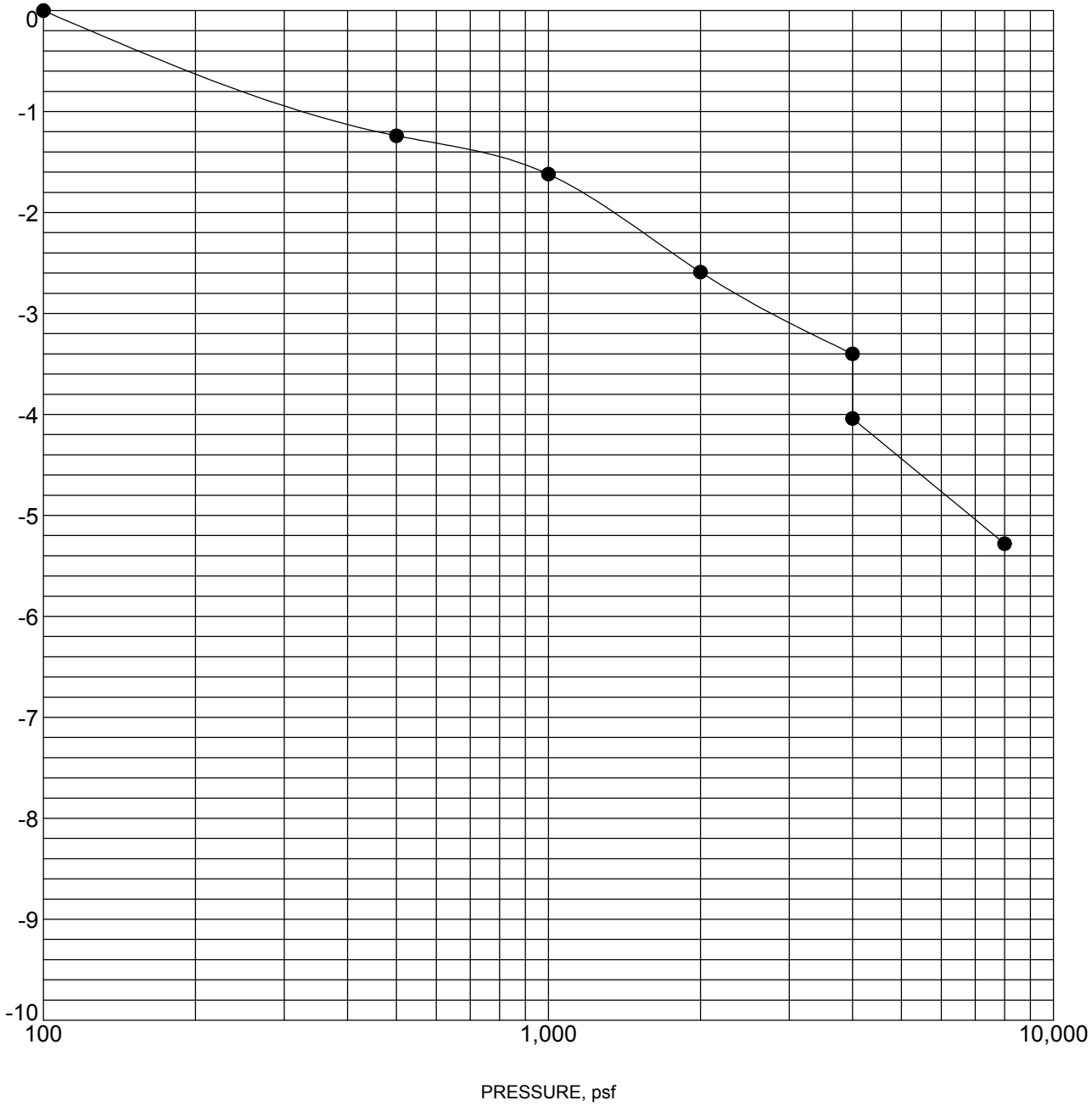
PROJECT NUMBER: 65155090

CLIENT: T.Y. Lin International, Inc.

EXHIBIT: B-5

SWELL CONSOLIDATION TEST

ASTM D2435



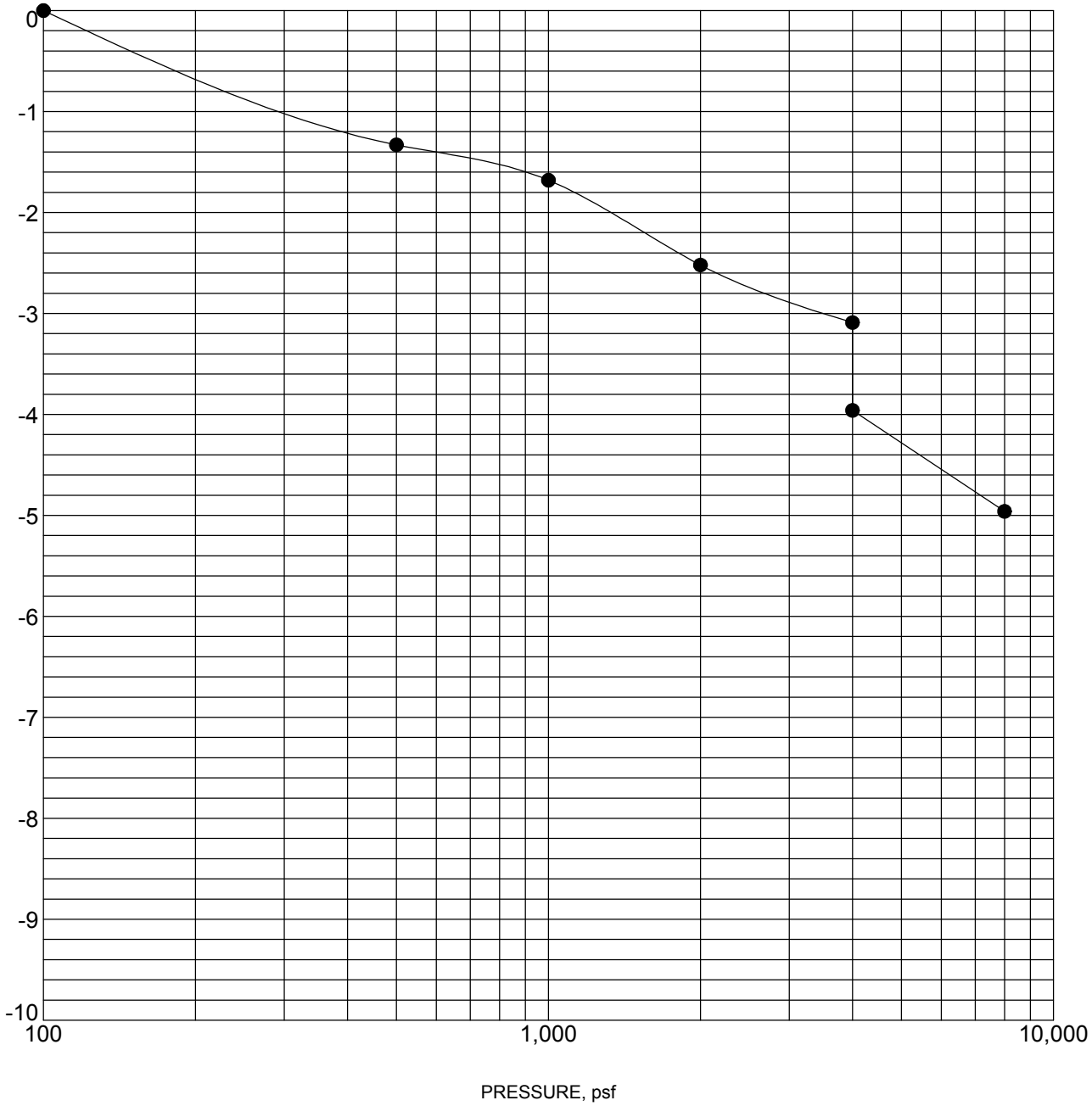
Specimen Identification		Classification	γ_d, pcf	WC, %
●	B2 14.0 - 15.0 ft	CLAYEY SAND (SC)	120	10

NOTES: water added at 4,000 psf

PROJECT: I-10 Temporary Bridge at Craycroft Road	Terracon 4685 S. Ash Ave., Suite H-4 Tempe, Arizona	PROJECT NUMBER: 65155090
SITE: Interstate 10 and Craycroft Road Tucson, Arizona		CLIENT: T.Y. Lin International, Inc.
		EXHIBIT: B-6

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: T.Y. Lin International, Inc.
		EXHIBIT: B-7

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

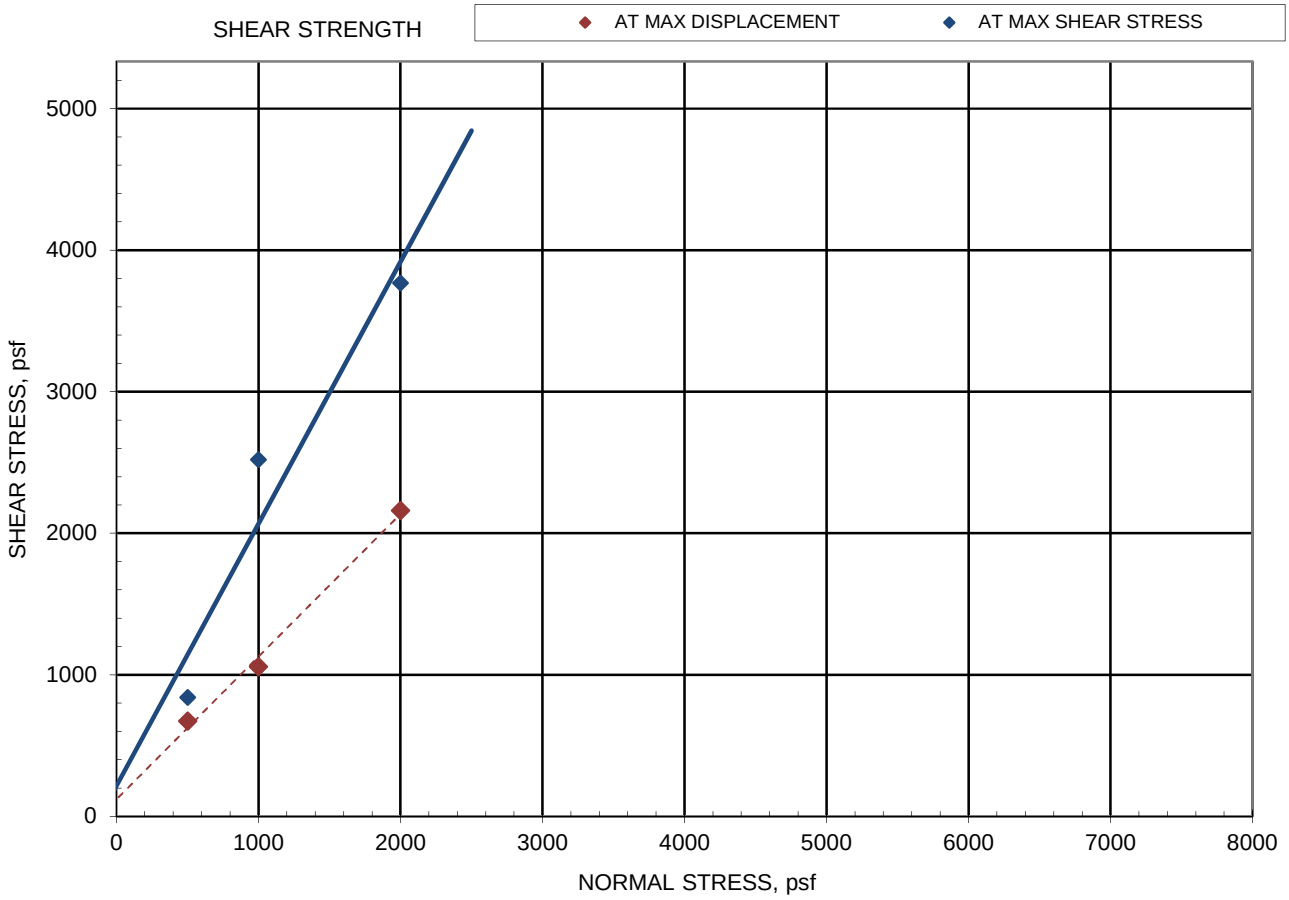
Final Parameters of specimen:

	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:		

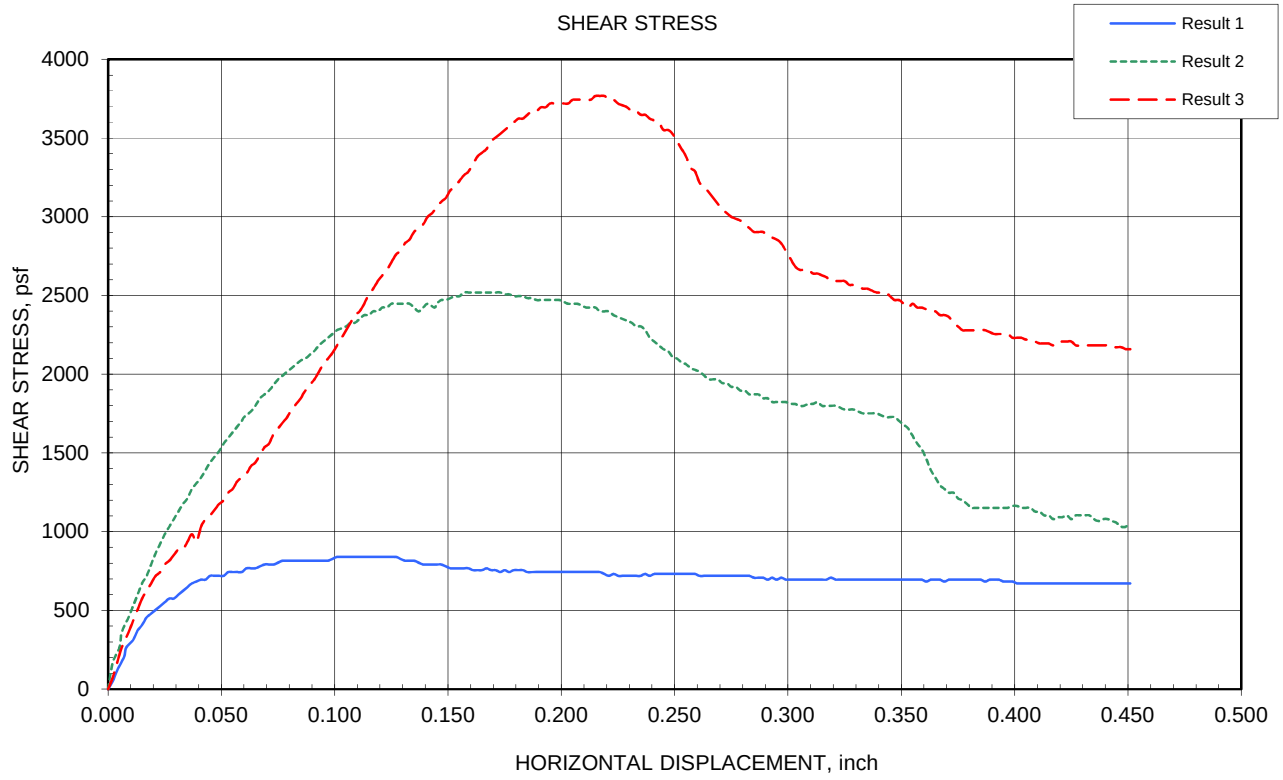


Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Exhibit: B-8

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



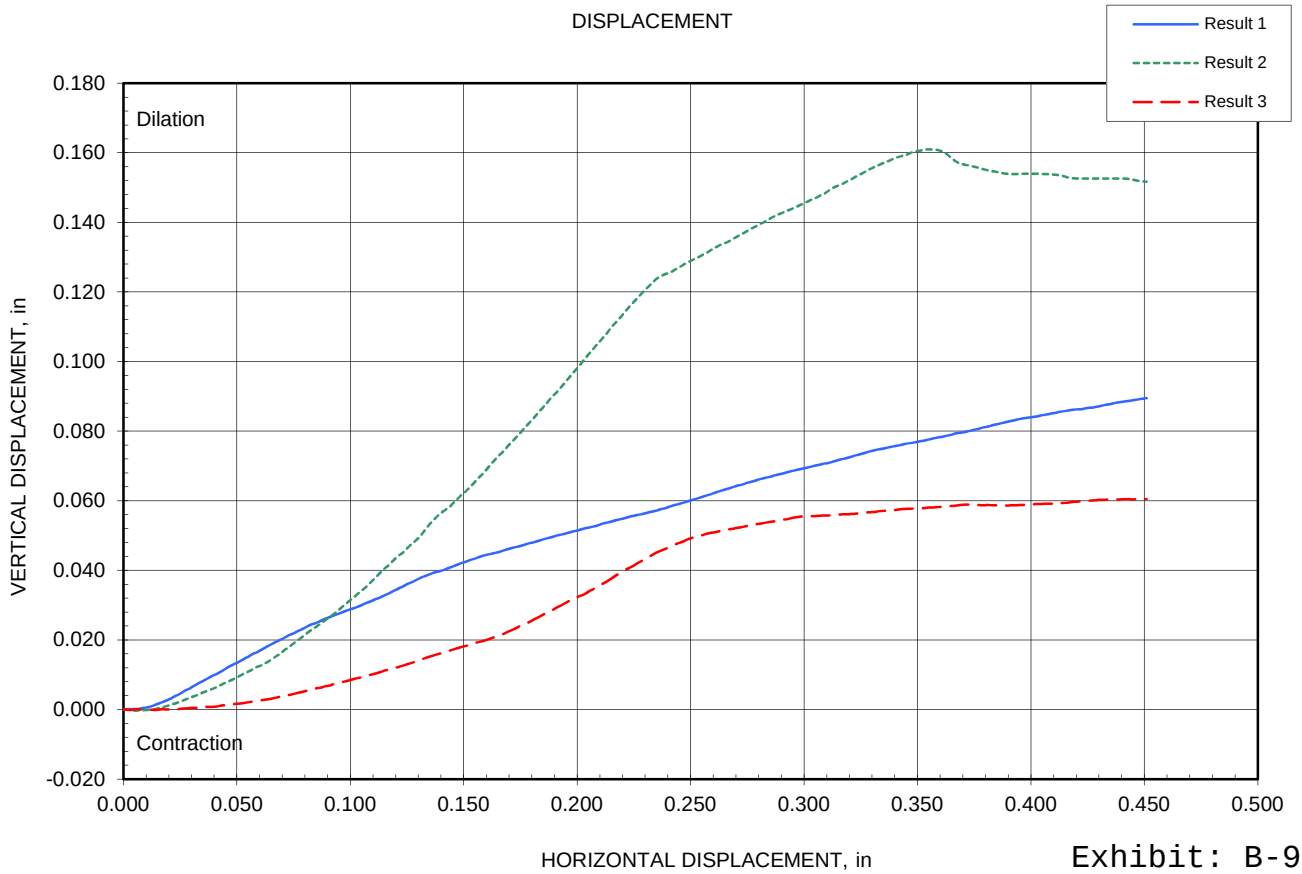


Exhibit: B-9

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:

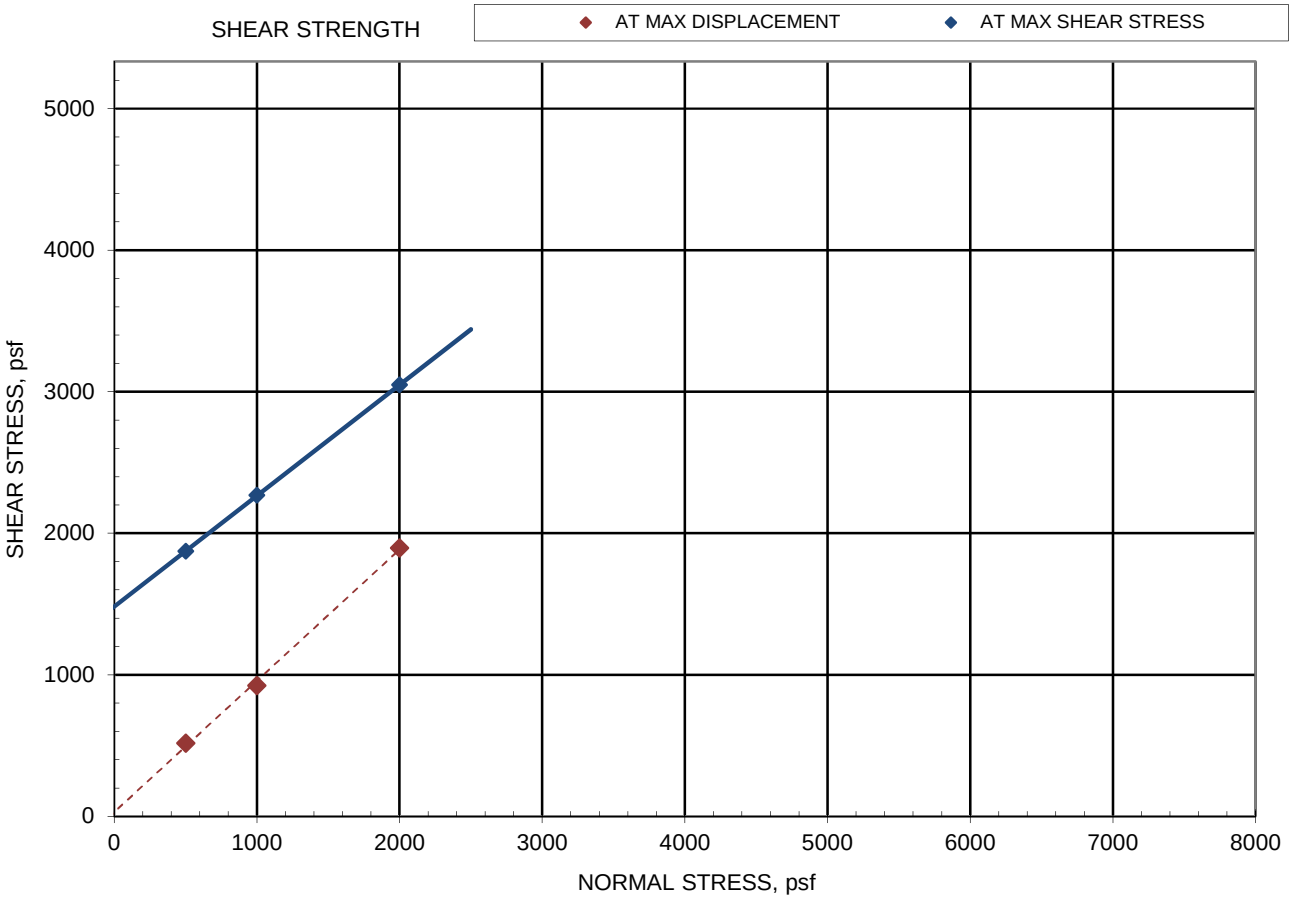
	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	137.18	137.19	137.18
Height (in):	0.9972	0.9913	0.9868
Diameter (in):	2.416	2.416	2.416
Moisture, %:	9.7	9.7	9.5
Dry Density (pcf):	114.3	115.0	115.5
Saturation, %:	59	59	59
Void Ratio:	0.44	0.43	0.42

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:		

SHEAR STRENGTH

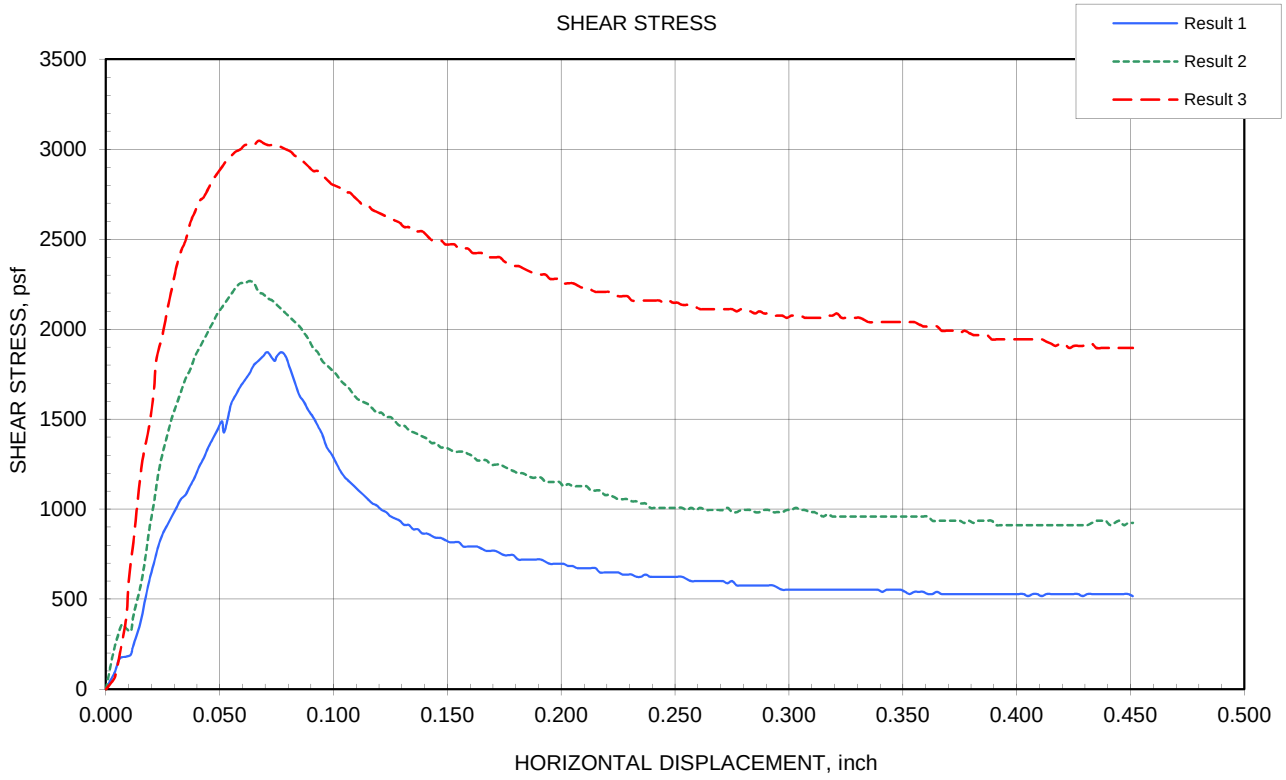


Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Exhibit: B-10

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



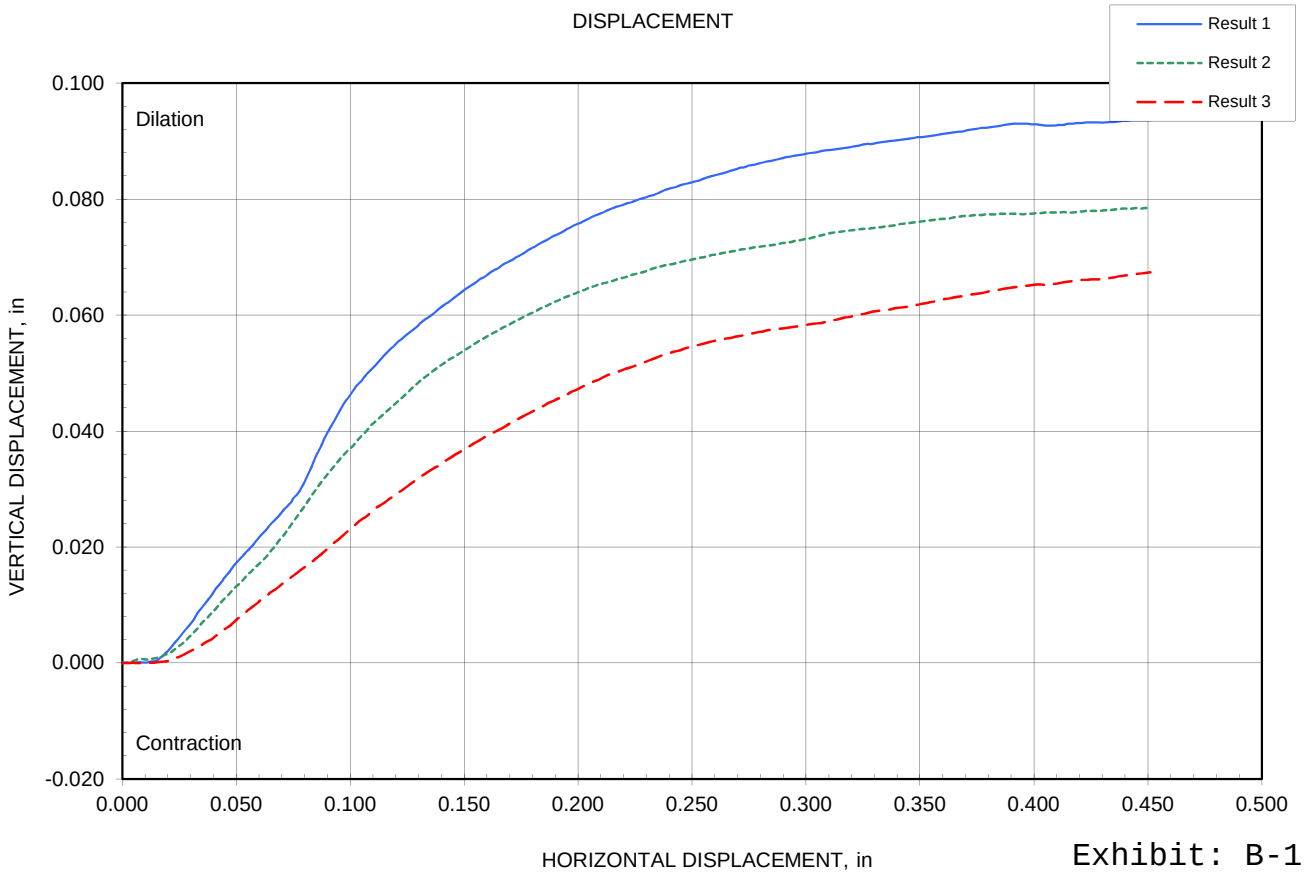


Exhibit: B-11

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:

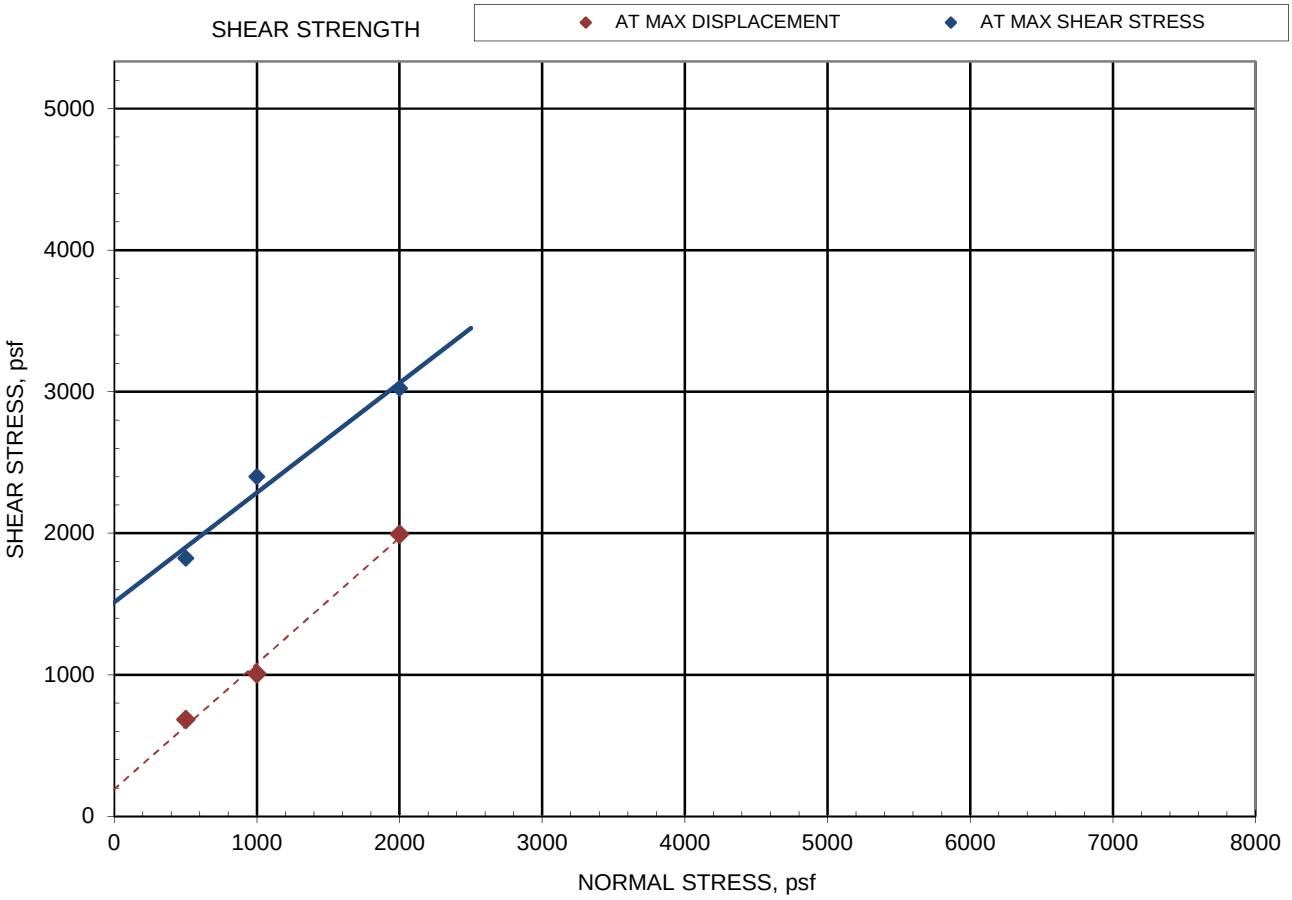
	Point 1	Point 2	Point 3
Normal Stress (psf):	**500**	**1000**	**2000**
Dry mass (g):	133.64	133.63	133.63
Height (in):	0.9961	0.9945	0.9818
Diameter (in):	2.416	2.416	2.416
Moisture, %:	11.4	11.4	11.2
Dry Density (pcf):	111.5	111.7	113.1
Saturation, %:	64	63	65
Void Ratio:	0.47	0.47	0.45

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

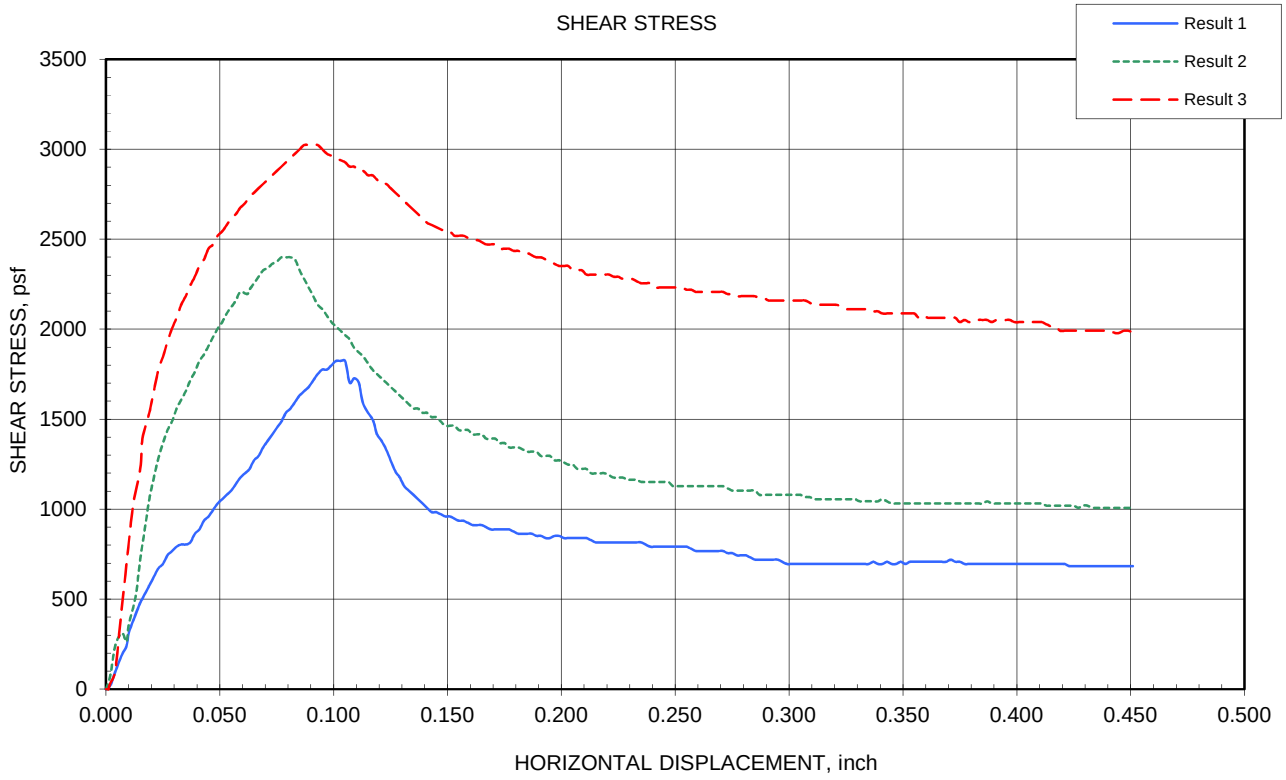


Note: The friction angle presented is applicable only to the load ranges and sample conditions tested

Exhibit: B-12

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



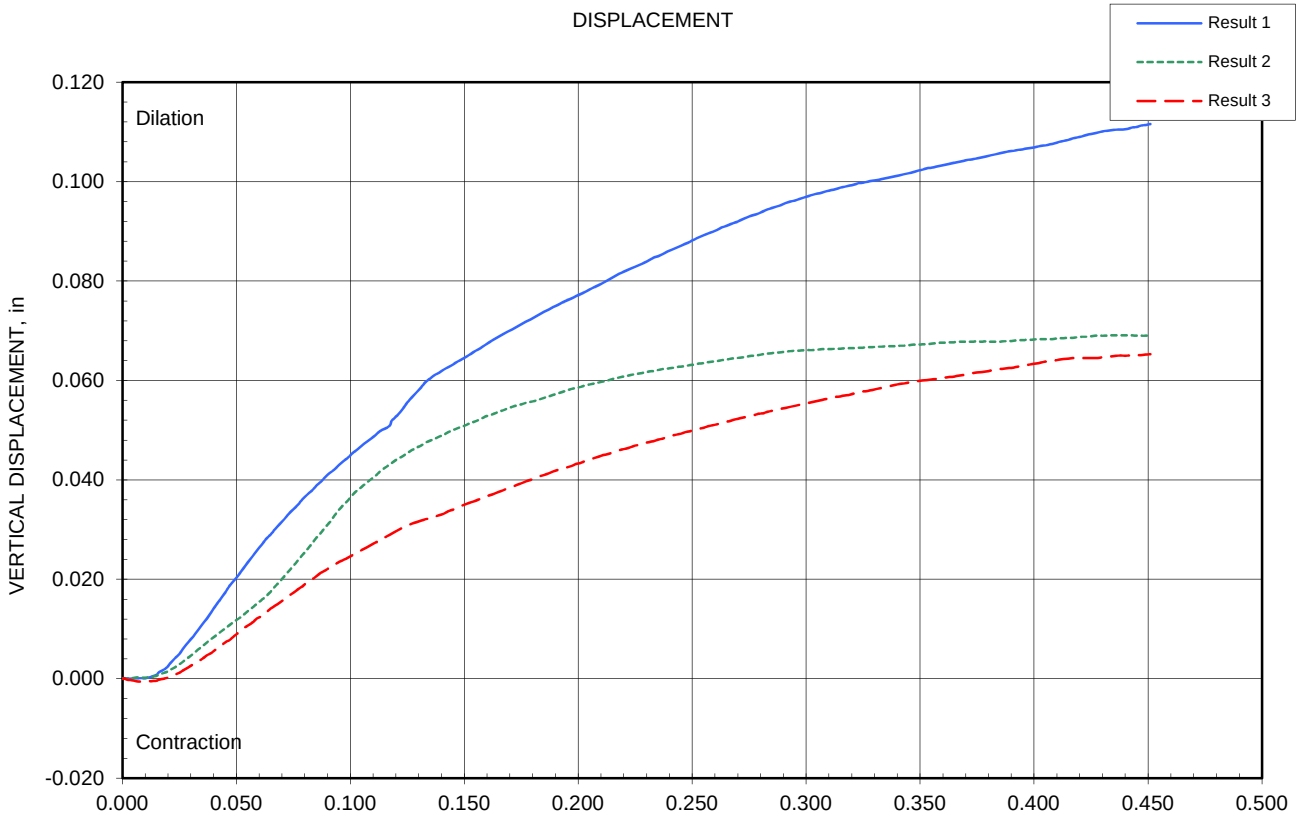


Exhibit: B-13

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

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: T.Y. Lin International, Inc.

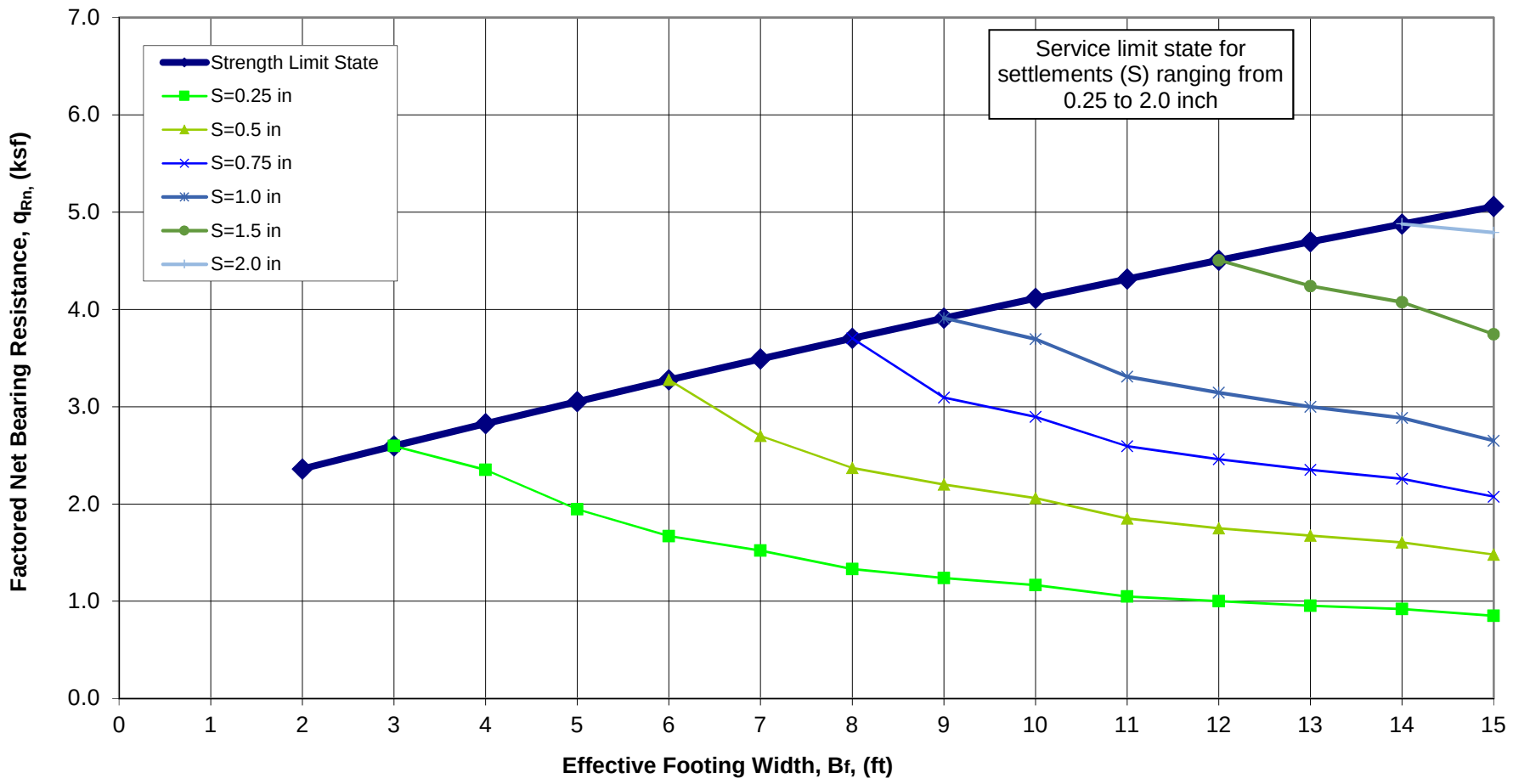
EXHIBIT: B-14

APPENDIX C

EFFECTIVE FOOTING WIDTH

VS.

FACTORED NET BEARING RESISTANCE GRAPH



Terracon

4685 S. Ash Avenue, Suite H-4
Tempe, Arizona 85282-6767

TERRACON PROJECT NO.:	65155090
ADOT TRACS No.:	010 PM 267 H8774 01C
Federal Aid Project No.:	NHPP-010-E(219)T
Date:	3/9/2016

FACTORED NET BEARING RESISTANCE CHART
I-10 Temporary Bridge Foundations for Abutments 1 and 2

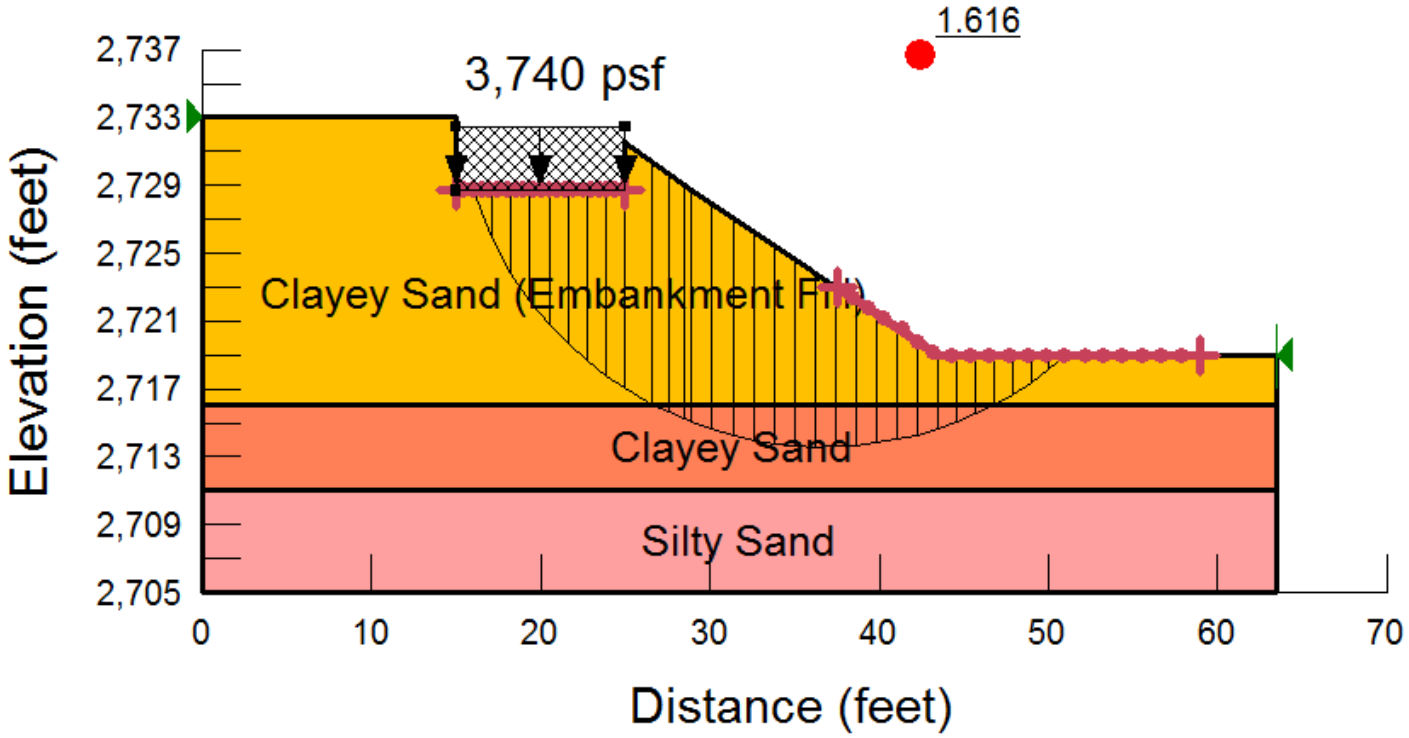
I-10 Temporary Bridge at Craycroft Road,
Interstate 10 and Craycroft Road
Tucson, Arizona

EXHIBIT

C-1

APPENDIX D

RESULTS OF SLOPE STABILITY EVALUATIONS



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	500	35
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

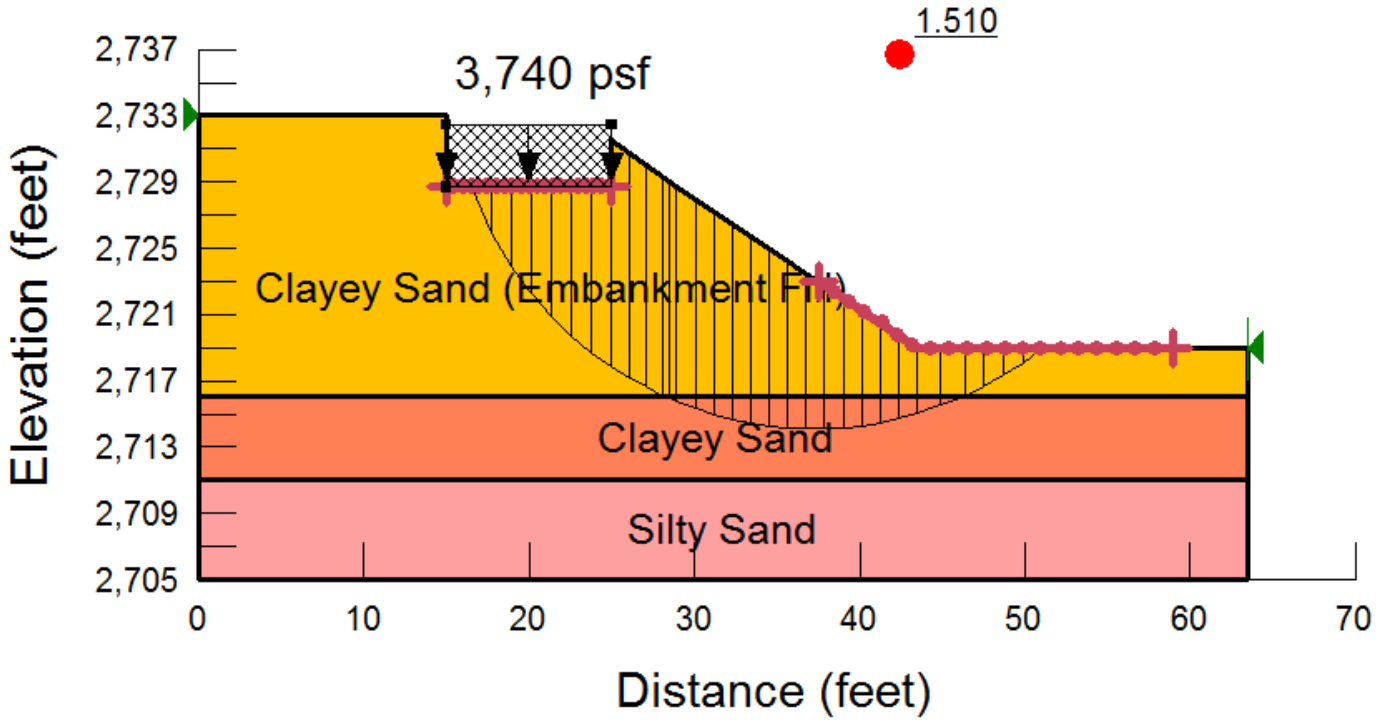
Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT EDGE OF SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit

D-1



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	350	35
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

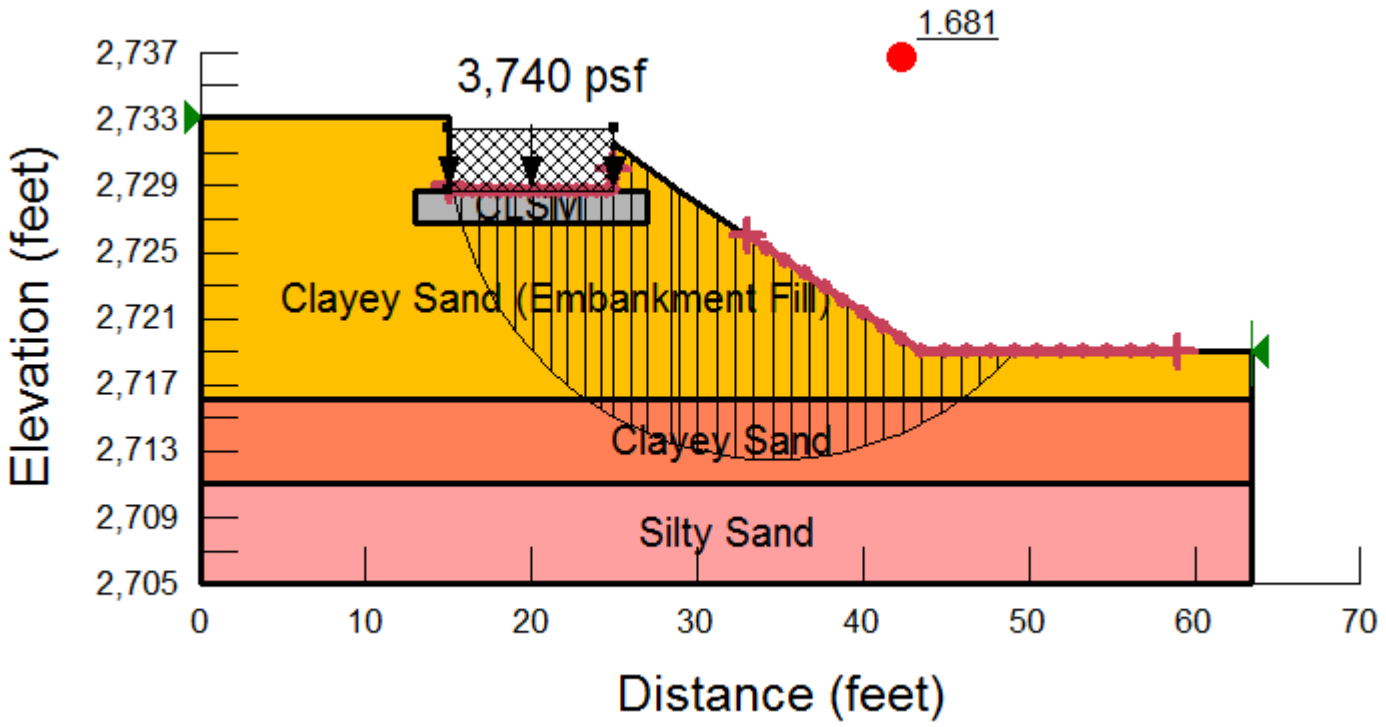
Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT EDGE OF SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit

D-2



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	500	35
CLSM	140	3,000	40
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

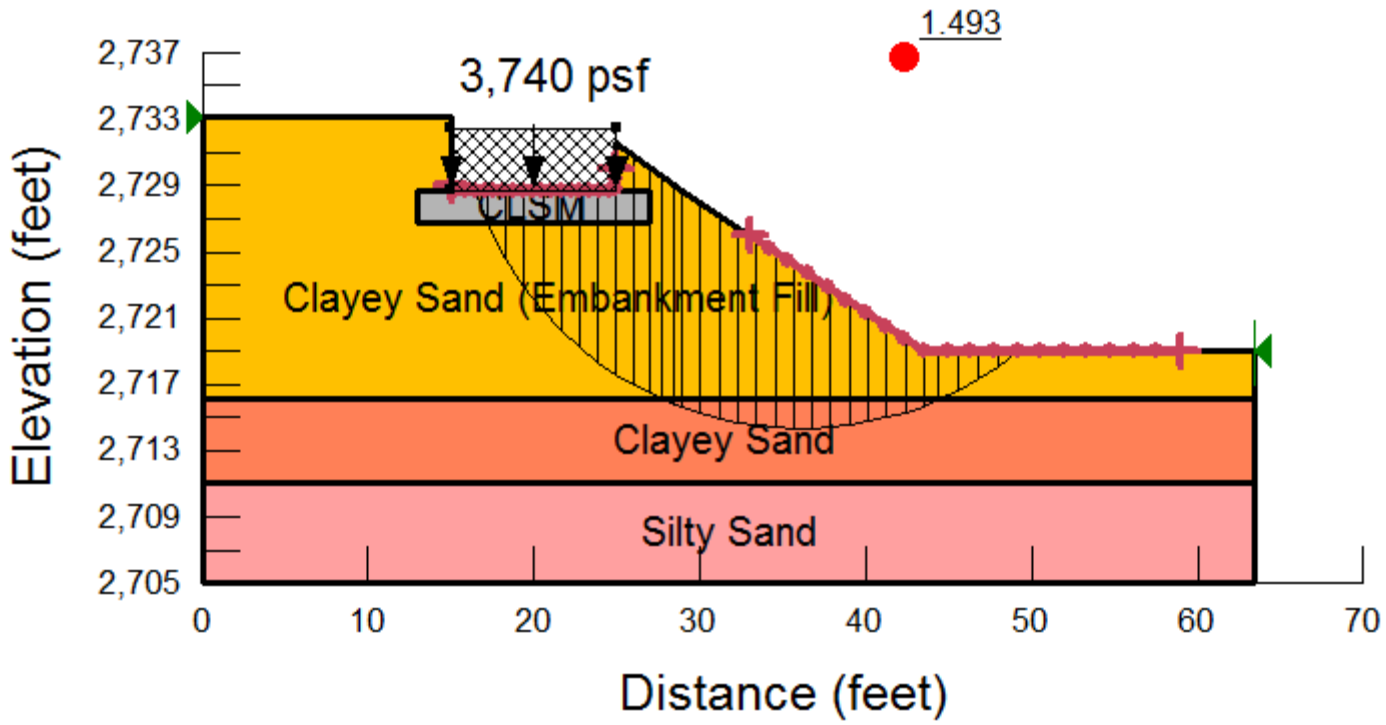
Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT EDGE OF SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit
D-3



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	200	35
CLSM	140	3,000	40
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

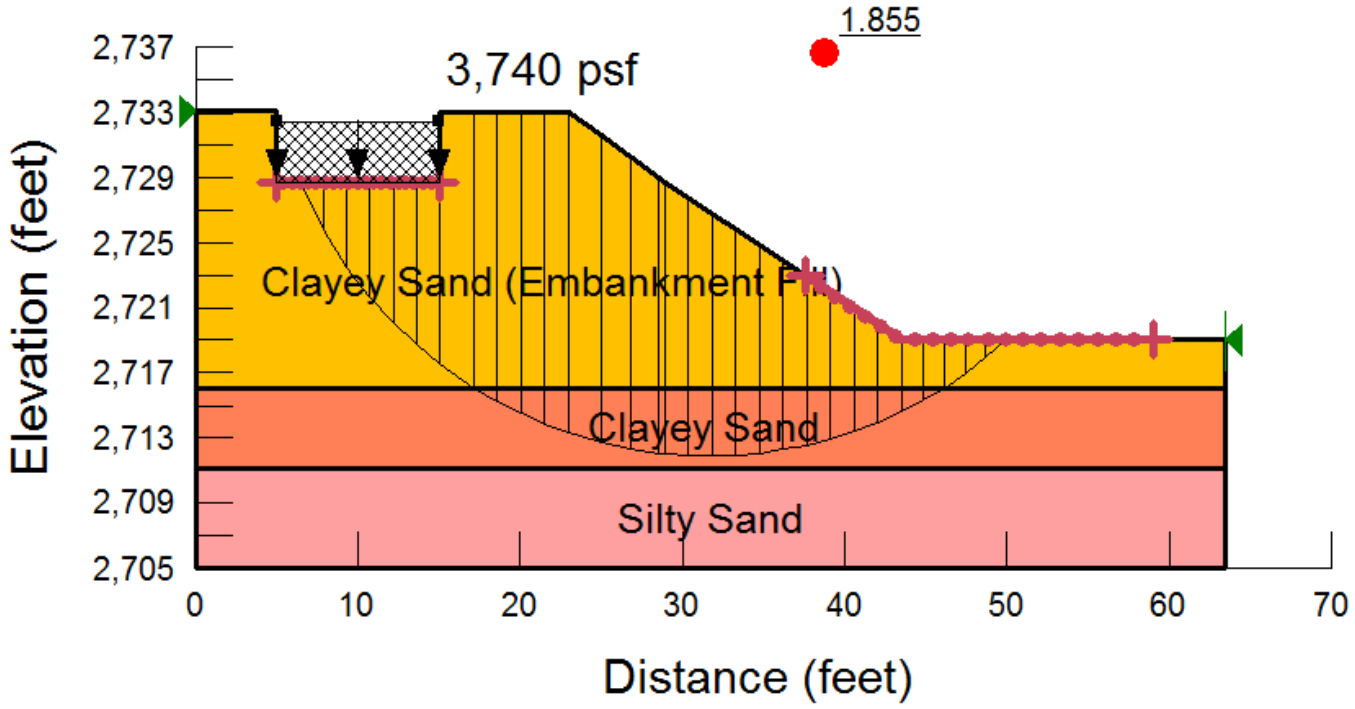
Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT EDGE OF SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit
D-4



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	500	35
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

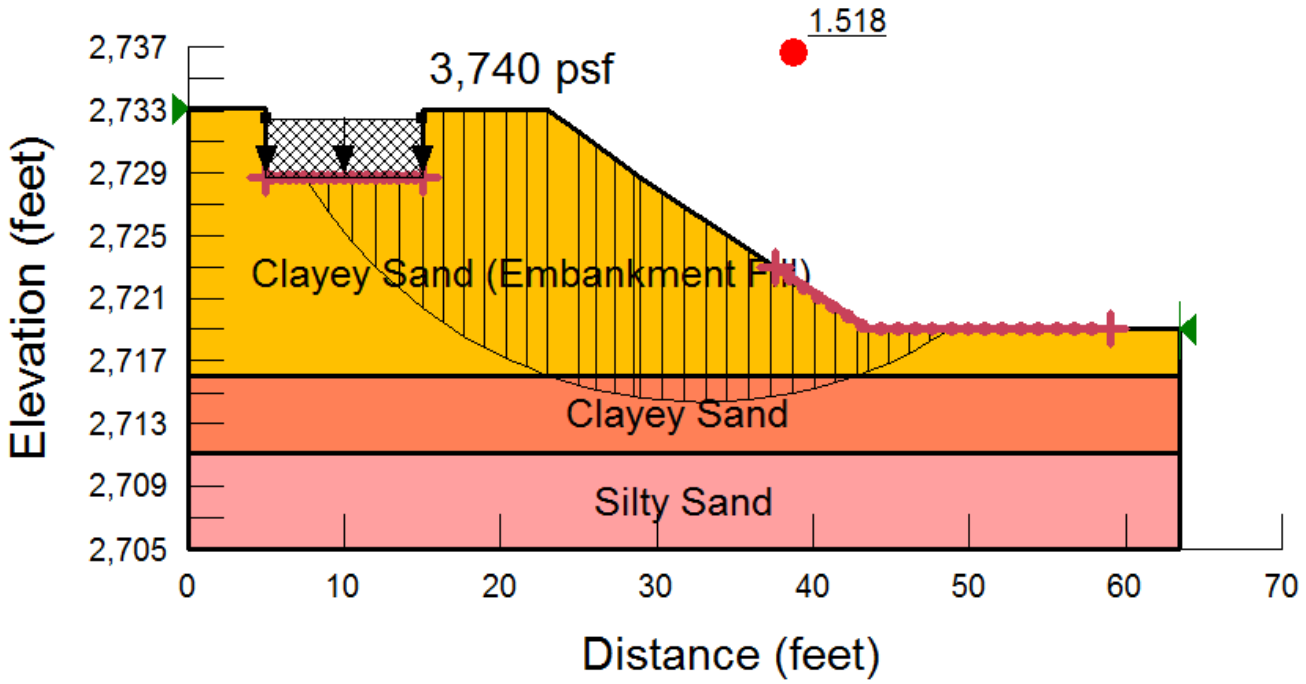
Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT APPROX.10 FEET FROM SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit

D-5



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	50	35
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

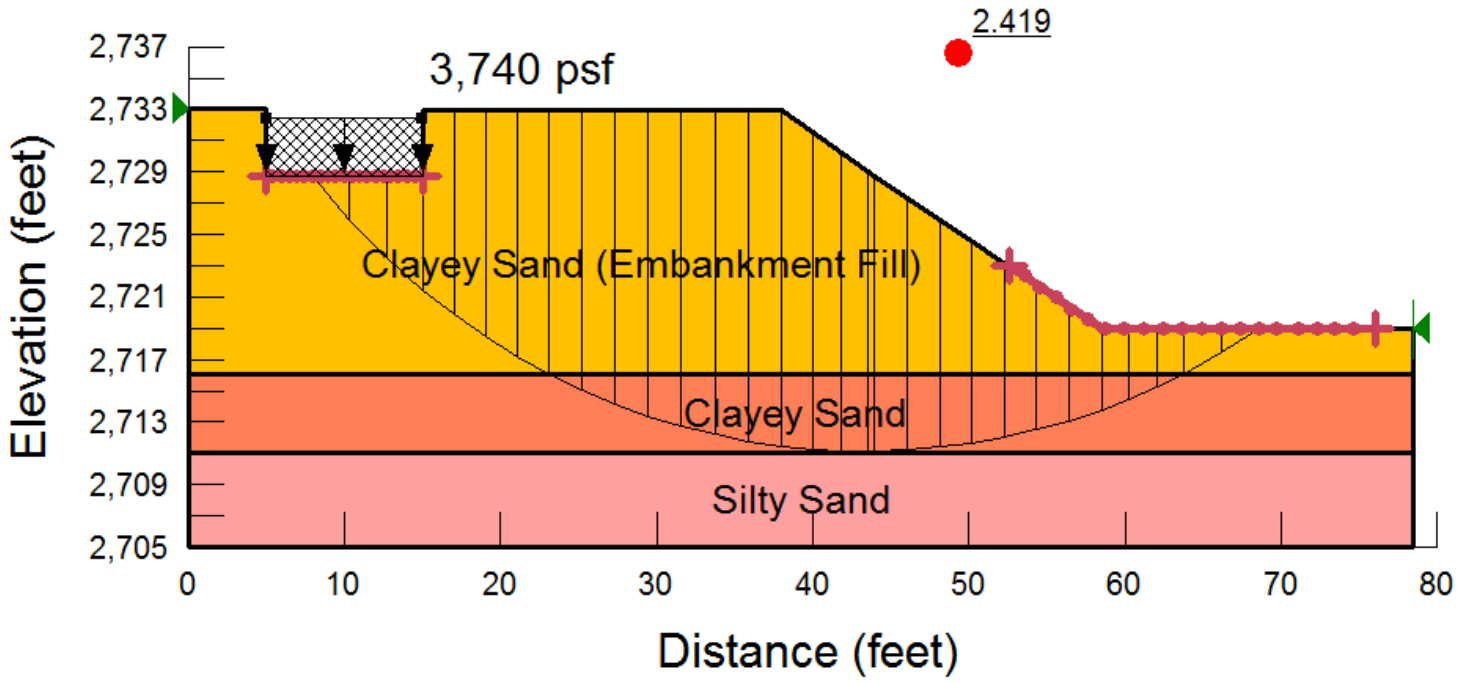
Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT APPROX.10 FEET FROM SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit
D-6



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	500	35
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

Project No.	65155090
Scale:	AS SHOWN
File Name:	SS_Figs
Date:	3/9/2016

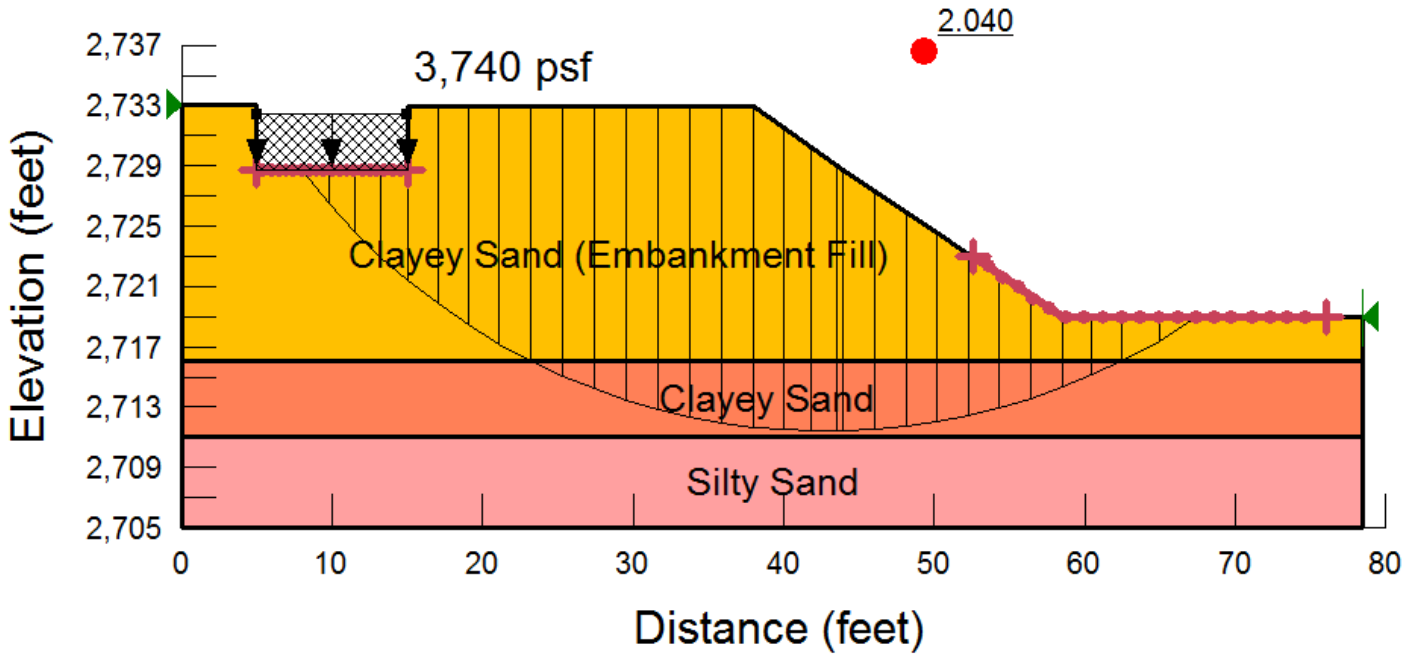
Terracon
4685 S Ash Avenue, Suite H-4
Tempe, AZ 85282-6767

SLOPE STABILITY EVALUATION OF FOUNDATION LOCATED AT APPROX. 25 FEET FROM SLOPE

I-10 Temporary Bridge at Craycroft Road
Interstate 10 and Craycroft Road
Tucson, AZ

Exhibit

D-7



Material	Unit Weight (pcf)	Cohesion (psf)	Phi (°)
Clayey Sand (Embankment Fill)	110	0	35
Clayey Sand	110	50	28
Silty Sand	110	0	35

IMAGE GENERATED USING SLOPE/W FROM GEOSTUDIO 2012.

SURCHARGE INCLUDES PRESSURE FROM FOOTING AND SURCHAGE FROM SOIL ABOVE FOOTING.

DIAGRAM IS FOR GENERAL LOCATION ONLY, AND IS NOT INTENDED FOR CONSTRUCTION PURPOSES

Project Manager:	RP
Drawn by:	KPM
Checked by:	RP
Approved by:	DRC

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Exhibit

D-8