# GEOTECHNICAL EVALUATION REPORT

*for*

**WEST PALO VERDE AVENUE SIDEWALK & ROADWAY IMPROVEMENT**
***FROM ARIZONA AVENUE & 4$^{TH}$ STREET***
***COOLIDGE, ARIZONA***

**Prepared For:**
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**Prepared By:**
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HA Project Number 16046
June 17, 2016

HOQUE & ASSOCIATES

*Consulting Geotechnical, Materials and Environmental Engineers*

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June 17, 2016

Denis Howe, P.E.
Entellus, Inc.
3033 North 44th Street
Suite 250
Phoenix, Arizona 85018

Subject: Geotechnical Exploration Report
West Palo Verde Avenue Sidewalk and Roadway Improvement
Between Arizona Avenue and 4th Street, Coolidge, Arizona

HA Project Number: 16046

Dear Mr. Howe:

Hoque & Associates, Inc. (HA) has completed a site geotechnical exploration including field exploration, laboratory testing, engineering analysis and pavement design services for the referenced project at the subject site. The geotechnical exploration program completed for this site consisted of drilling two test borings, collection of soil samples, field testing, laboratory testing of soil, field logging of the test borings, engineering analyses, and preparation of this Report.

The soil at the site primarily consisted of clayey SAND (SC) below surface grade. The SAND (SC) material was slightly plastic. Materials obtained from the subsurface were moist. These materials are acceptable for use as support for pavements and sidewalk subgrades, provided the recommendations provided in the following report are met.

HA appreciates the work on this project. If you have any questions, please contact us at 480 921 1368

Respectfully
Hoque & Associates, Inc.

Tracie Riggs, E.I.T.
Project Manager

Enamul Hoque, P.E.
President

REGISTERED PROFESSIONAL ENGINEER (CIVIL) CERTIFICATE NO. 20920 ENAMUL HOQUE Date Signed 6-17-16 ARIZONA U.S.A. EXPIRES: 03/31/2018

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**Appendices:**

# 1.0 INTRODUCTION

## 1.1 General

Hoque & Associates, Inc. (HA) has prepared this geotechnical exploration report for the sidewalk extension and roadway improvements of West Palo Verde Avenue between Arizona Avenue and 4th Street in Coolidge, Arizona. This work included field exploration, laboratory tests, engineering analysis and preparation of this Report. This work was completed in general compliance with a proposal and scope developed during the contract preparation. Appendix A includes a site location map detailing the location of the project site. This report contains:

- Purpose and scope of work;
- Project background information;
- Description of site surface and subsurface conditions relevant to the design and construction;
- Results of laboratory tests and data analysis;
- Engineering analysis including pavement section design; and
- Recommendations for construction and earthwork analysis.

## 1.2 Purpose and Scope

The objective of the Report is to document the site surface and subsurface conditions for developing design parameters for the pavement that would be utilized for the realignment. To accomplish this objective, the following scope of services was completed:

- Review project documents and project. Participation in project meetings and site visits;
- Coordinated with Blue Stake to locate underground and above ground utilities to complete the drilling operation;
- Performed site reconnaissance to document the site conditions including site features that could affect the design and construction;
- Monitor the drilling operation that included drilling of two test borings extending to 5 feet below the site grade;
- Collected undisturbed ring samples and performed standard penetration tests at designated intervals. Also collected bulk samples from each boring;
- Performed laboratory testing for gradation, plasticity indices, Proctor compaction, pH, resistivity, chloride, soluble salts and sulfate on samples collected during field exploration. Performed data analysis for selecting test parameters as well;
- Performed engineering analysis for pavement design, sidewalk construction and earthwork;
- Prepared this Report.

## 1.3 Project Background

Information on Project background was gathered from Entellus, Inc. (Entellus) during project meetings and telephone conversations.

The City of Coolidge is in the process of improving the existing roadway segment at the subject location, extending the sidewalk along the south side of West Palo Verde Avenue and constructing a new sidewalk along the north side of West Palo Verde Avenue. As such, the project will include new pavement throughout the area of the improvement and new sidewalk segments. The pavement sections will have a single lane in each direction with sidewalks along each side.

# 2.0 SITE CONDITIONS

## 2.1 Surface Conditions

Figure 1: Sidewalks along the Southwest Boundary of the Project Site

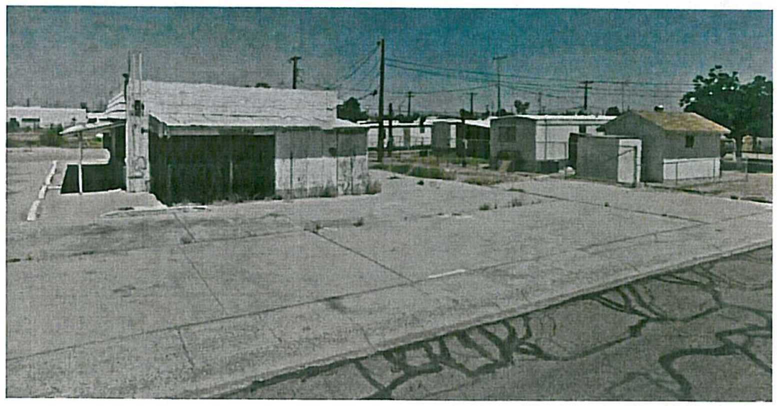


Figure 2: Sidewalks along the Northwest Boundary of the Project Site

Information on the surface conditions was gathered from a site visit to assess the drill rig access and mark boring locations for the utilities prior to drilling. HA's representatives were at the site during the drilling operation and observed the site conditions. The site surface conditions of surrounding areas consist of flat ground with urban development including housing and city services. A police department is located along the southern boundary of the site. An abandoned gas station is located at the northwestern boundary of the site at the intersection of West Palo Verde Avenue and Arizona Avenue. The remaining site boundary is composed of mobile homes and single family dwellings. A short segment of sidewalk associated with newer construction is located near the southwestern boundary between the site and the police department. A short segment of older sidewalk is located near the northwestern boundary of the site. This segment is in a deteriorated condition with exposed aggregate and is associated with the gas station construction.

The pavement was at the same grade as the roadway shoulder along the eastern portion of the roadway. Along the western portion of the roadway the adjacent grade as slightly elevated by curbs and sidewalks.

An overhead power line is located along the southern boundary of West Palo Verde Avenue. The powerlines cross the width of West Palo Verde Avenue at two locations along the project length. City sewer services run along the northern boundary of the site as an underground utility. Gas and communication services are also located at the site.

## 2.2 Existing Pavement

The pavement was found to be in deteriorated condition. There are signs of pavement distress, including consistent block cracking. The cracks were approximately ½ to 1 inch wide. These cracks had been sealed but distress was still evident. Many of the sealed cracks showed new signs of distress. The pavement aggregate is raveling in several locations, causing an uneven surface. The roadway is very rough while driving. Utility trenches that have been patched were evident on the roadway, as was a strip of pavement along the south side of the roadway that exhibited no block cracking, only transverse cracking.

Figure 3: Facing Northeast

Figure 4: Facing Southeast

The drainage of the roadway appeared efficient, and no ponding of water or signs of ponding of water were observed in any of the areas of the roadway pavement. The roadway side slopes also did not show any erosion gullies or rills; however, these side slopes had only a slight slope. Signs of ponding were noted in areas along both sides of the roadway.

## 2.3 Geologic Conditions

The site is composed of a single major geologic unit: Q, surficial deposits.

The surficial deposits date to less than 2 million years in the late Holocene. These deposits are found on alluvial fans and floodplains, as well as basins subjected to flooding. These materials occur in layers according to historic flood states and surrounding high ground materials.

# 3.0 GEOTECHNICAL CONDITIONS

## 3.1 Field Exploration Methods

Information on subsurface conditions was gathered by drilling two (2) borings located within the right-of-way of existing West Palo Verde Avenue. The locations of the test borings are provided in Appendix C. The deepest drilling extended to a depth of 5 feet below natural grade.

The drilling was completed on May 18, 2016. A truck mounted Mobile CME-55 drill rig equipped with an eight-inch diameter continuous flight hollow stem augers was used to complete the drilling. The drilling was monitored and documented by HA. HA collected soil samples at selected locations. Bulk, split spoon and ring samples were collected from each of the two bore holes drilled within the project area. Bulk samples were collected from the auger cuttings from zero to five feet depths. Relatively undisturbed samples were collected utilizing ring lined barrel samplers in accordance with ASTM D 3550.

Standard penetration tests in conformance with ASTM D 1588 were performed in the field during drilling utilizing a two inch diameter split spoon sampler driven 18 inches with a 140 pound hammer falling freely 30 inches. Relatively undisturbed ring samples were also collected from near surface soil layers. The resistance or number of blows required to drive the last 12 inches of the split spoon sampler was recorded as N-values. The number of blows required to drive the ring sampler 12 inches was recorded as the N-value. These N-values are indicative of the soil's relative density and consistency and are utilized for recommendations. The soil samples collected during the drilling operation were secured and transported to HA's laboratory for testing. For further information regarding soil classification and soil investigation methods, refer to Appendix B.

## 3.2 Subsurface Conditions

The soil at the site in the location of B-1 was composed of a single layer. This layer was composed of clayey SAND (SC) with slight plasticity. This layer was firm, but not dense. The pavement at the top of this layer was 1 to 3 inches in thickness. There was no indication that an aggregate base was present below the pavement.

The material at B-2 was composed of a single layer of clayey SAND (SC) with slight plasticity. This layer was firm, but not dense. The pavement at the top of this layer was 1 to 3 inches in thickness. There was no indication that an aggregate base was present below the pavement.

All material was dark brown in color and moist.

Standard penetration tests (SPT), bulk samples, and relatively undisturbed ring samples were collected during the subsurface exploration. The samples taken from the SPT and ring samplers all had consistent recovery and low blow counts. Additional information is provided in the boring logs in Appendix D.

### 3.3 Groundwater Information

Saturated conditions were no encountered in the borings. No water table was encountered.

# 4.0 LABORATORY TESTING

The following laboratory tests were performed:

- Two Gradation (ASTM D 1140);
- Two Atterberg Limits (ASTM D 4318);
- One Proctor Compaction (ASTM D 698);
- Two Density (ASTM D2937);
- One Sulfate/Chloride/Soluble Salts;
- One pH; and,
- One Resistivity

The fines content and Atterberg limits tests indicated that the soils are generally brown clayey SAND (SC) with slight plasticity. The fines content was determined to be 37 to 47 percent. The in-situ moisture results indicate that the on-site soils have a moisture content ranging from 9.1 to 10.2 percent.

While Appendix E contains all laboratory reports, some selected laboratory test results are provided below:

**LABORATORY TEST RESULTS SUMMARY**

| Boring Number | Depth (feet) | Fines Content ( % Passing #200 Sieve) | Liquid Limit (percent) | Plasticity Index (percent) | Soil Classification |
|---|---|---|---|---|---|
| B-1 | 0-5 | 37 | 26 | 10 | SC |
| B-2 | 0-5 | 47 | 27 | 11 | SC |

Correlated R-Values were calculated based off of laboratory results. The results of HA's tests on Atterberg limits, fines content and corresponding correlated resistance R-values on soils samples collected within upper five feet depths are provided in the following table:

| Boring Number | Percent Fines* | Liquid Limits | Plasticity Index | Correlated R-Value |
|---|---|---|---|---|
| B-1 | 37 | 26 | 10 | 40 |
| B-2 | 47 | 27 | 11 | 34 |

* Percent Fines designates materials finer than US Standard Sieve #200
**Laboratory Result, not correlated from Plasticity Index and Percent Fines

These correlated R-values have an average R-value of 37. The standard deviation would be = 4.24.

Laboratory testing revealed that the soil has a moderate resistivity/corrosion potential and slight alkalinity with a pH of 7.9.

# 5.0 EARTHWORK CONSTRUCTION AND ENGINEERING FILL

## 5.1 On-Site Materials

On site soils at the site consist of predominantly medium plastic clay type soil. These materials recovered from the grading work and free of oversized and deleterious materials can be utilized as fill provided the moisture content and compaction is kept within three percent point of its optimum moisture content and 95 percent relative compaction, respectively.

## 5.2 Fill Placement

Subgrade surfaces receiving fill should be scarified, moisture conditioned, and compacted to at least 95 percent of its standard Proctor maximum density placed at three percent point below or above the optimum moisture content. On-site soil free of debris or large rock (8 inches in any dimension) or concrete pieces may be utilized as fill soil. Soils from the excavation of the river channels should be suitable as fill soil. If necessary, import soils may also be utilized as fill. The swell potential of the compacted import soil should be less than 1.5 percent when tested under a vertical pressure of 100 psf in accordance with ASTM D4546 procedures.

The fill surface should be adequately maintained during construction in order to achieve acceptable compaction and interlift bonding. The surface should be sloped properly to prevent ponding and provide drainage of runoff water. If precipitation is anticipated, HA recommends that the fill surface be made smooth by rolling with a smooth drum roller.

## 5.3 Shrinkage and Ground Compaction Factor

The shrinkage factor is based on observations completed during the geotechnical exploration and the Proctor compaction testing performed on the site samples. Based on the available information, a shrinkage factor of 15% is estimate for on-site soils compacted to 95 percent of their standard Proctor density criteria.

HA recommends a ground compaction factor of 0.15 feet be used for this project.

## 5.4 Water Requirements

Based on HA's experience and the in-situ moisture condition of the soil, approximately 30 to 40 gallons of water may be needed to be applied during compaction of subgrade per cubic yard. The contractor should utilize water content slightly above optimum to achieve required compaction to account for evaporation and other losses. Aggregate base course materials may require 50 to 60 gallons of water per cubic yard due to the inherent dryness of the AB.

## 5.5 Slope Requirements

Excavation at the site should be able to be accomplished using conventional construction equipment. The disturbed soil during grading should be properly recompacted and the areas should be backfilled with compacted-engineered fill in compliance with the earthwork construction procedures recommended herein. All the soil generated from the grading work should be removed and disposed of in an acceptable manner. Utility trenches or other confined excavation extending more than 4 feet should conform to the OSHA safety regulations.

HA recommends that all excavation slopes should be maintained at 1.5:1 (horizontal to vertical) or flatter for the sand soils. If excavation remains open for a long time, to avoid raveling and spall off or localized caving, HA recommends that all cut slopes are stabilized with the application of shotcrete or gunite or polymer based spray.

## 5.6 Corrosion Potential

Corrosion resistive materials for concrete pipes, sign foundations, and metals for grounding should be utilized as the site does have low to moderate corrosive potential. **HA recommends that type II cement be utilized for all concrete, and all metal pipes or features that will be in contact with soil should be protected with anodization, galvanization or a bituminous protective coating.**

## 5.7 Construction Quality Control Testing

HA recommends that site preparation, subgrade preparation, backfill placement, re-compaction, and foundation subgrade be observed and/or tested by a qualified and experienced representative of the geotechnical engineer. This representative should at least observe and document the following:

- All deleterious objects are removed from the foundation, slabs, and pavement area subgrade;
- Foundations and other subgrade are compacted, firm, and do not contain deleterious objects;
- All compaction and moisture contents of backfill soils meet the specified minimum values;
- Footing excavations exposed the soil that was anticipated in the design and meet the recommended bearing values of 2000 psf;
- Perform on-site density testing in engineered fill or placement of ABC at every lift in foundation areas and at every 5,000 square feet or less; and
- Prepare a final report documenting all on-site activities, test results, and conclusions.

The prepared fill, foundation excavations, and utility trenches should not be exposed to the environment for long periods as this can affect the moisture content and density of the fill. During unavoidable exposure to the environment, moisture conditioning of these features should be maintained.

# 6.0 PAVEMENT, DRIVEWAY AND SIDEWALK RECOMMENDATIONS

## 6.1 Pavement Recommendations

The pavement section design analysis was completed using 1986 AASHTO's Guide for Design of Pavement Structures and Asphalt Institute's (MS-1) procedure. The AASHTO procedures utilizes the CBR value of subgrade soil, the traffic count reliability or probability that the designed pavement will perform satisfactorily, serviceability or ability of the pavement to serve the type of traffic the facility will use, and the material properties of the asphalt concrete (AC) and aggregate base course (ABC).

The traffic data was assumed by HA. Data on reliability, serviceability, and standard deviation values were assumed based on ADOT's procedure and the soil modulus were calculated based on correlation of soil properties with R-values. ADOT's Materials Preliminary Engineering and Design Manual (MPEDM) provided formula to calculate $R_{mean}$ value is not applicable as no laboratory R-value was collected. As such, an average correlated R-value is utilized as $R_{mean}$ (a value of 37) in design and in construction control. Based on this $R_{mean}$, HA calculated that the resilience modulus would be 22,000 psi. In HA's design, Figure 3.1, a nomograph presented in the AASHTO Guide, was used to calculate the structural numbers.

The thickness of AC and ABC were then calculated from the equation relating the structure number and the layer coefficients by assuming one thickness (AC).

The Asphalt Institute procedure utilizes an equation expressing a relationship between structure number (SN) and thickness of the pavement elements. The thickness of pavement elements is normalized with respective coefficients for different types of materials and are chosen based on the ADOT charts. The structure number is derived from a nomograph expressing the relationship between soil support value, traffic volume, and regional factor. The soil support value is calculated from a nomograph using plasticity index and fines content of the subgrade soil as input data.

A regional factor (effect of climatic and environmental condition) of one was used for this analysis. Based on the result of the analysis, HA recommends that the following pavements elements be utilized for parking areas:

- **Asphalt concrete : 3 inches**
- **Aggregate base course : 6 inches**

The pavement design provided above assumes that the upper 8 inches of sub-base soil (pavement subgrade) is recompacted to its 95 percent compaction.

HA recommends that the following conditions be implemented to enhance the performance of the pavements, by minimizing the infiltration of water into the pavement base:

- Provide a minimum of one percent, preferably two percent surface grade.
- Provide drainage for any water trapped in the aggregate base course.

## 6.2 Sidewalk and Driveway Recommendations

All concrete sidewalk subgrade shall be recompacted to a vertical extent of 8 inches and shall achieve 90 percent or more relative compaction. Curbs and gutters associated with sidewalks, including driveways to the development on the north side of the site, shall consist of the same subgrade.

Driveway concrete thickness should be 6 inches and shall have a turn down with compacted material at the edges that do not have a continuation of pavement. The compacted material shall extend 8 inches below and 30 inches beyond the edge of the driveways.

# 7.0 CONSTRUCTION CONSIDERATIONS/ EXCAVATION SUPPORT

Excavation at the site should be able to be accomplished using conventional construction equipment. Soil disturbed during grading should be properly recompacted and the areas should be backfilled with compacted-engineered fill in compliance with the earthwork construction procedures recommended herein. All the excess soil generated from the grading work should be removed and disposed of in an acceptable manner. Utility trenches or other confined excavation extending more than 4 feet should conform to OSHA safety regulations.

**The presence of above and below ground structures, foundations, underground features will complicate construction and grading work. All these features should be located and removed prior to start of grading work.**

HA recommends that all temporary construction and excavation slopes should be maintained at 1.5:1 (horizontal to vertical) or flatter for site sand soils. If excavations are required to be steeper than the recommended slope, HA recommends that a shoring system be designed and installed at the site. Earth pressure parameters for shoring design will be provided if requested. A shoring system may also have to be designed for vehicular traffic and highway loadings in excavations located within the vicinity of the roadways.

Care must be exercised during excavation adjacent to the existing buildings, walls, etc. so that the foundation subgrades are not exposed or undermined.

# 8.0 DISCLAIMER

Due to the inherent natural variations of soil stratification and the nature of geotechnical exploration, there is always a possibility that conditions between borings may be different from those encountered at the boring locations. Therefore, HA should observe and document the construction to verify that the site conditions are as we anticipated during the preparation of this report and to modify our recommendations to include any changed conditions, if encountered.

The practice of geotechnical engineering is such that the risks involved in building an efficient, functional, and economical structure cannot be assessed with confidence until construction begins. Therefore, we recommend that our input is sought during design and a competent engineer makes engineering observations during the construction.

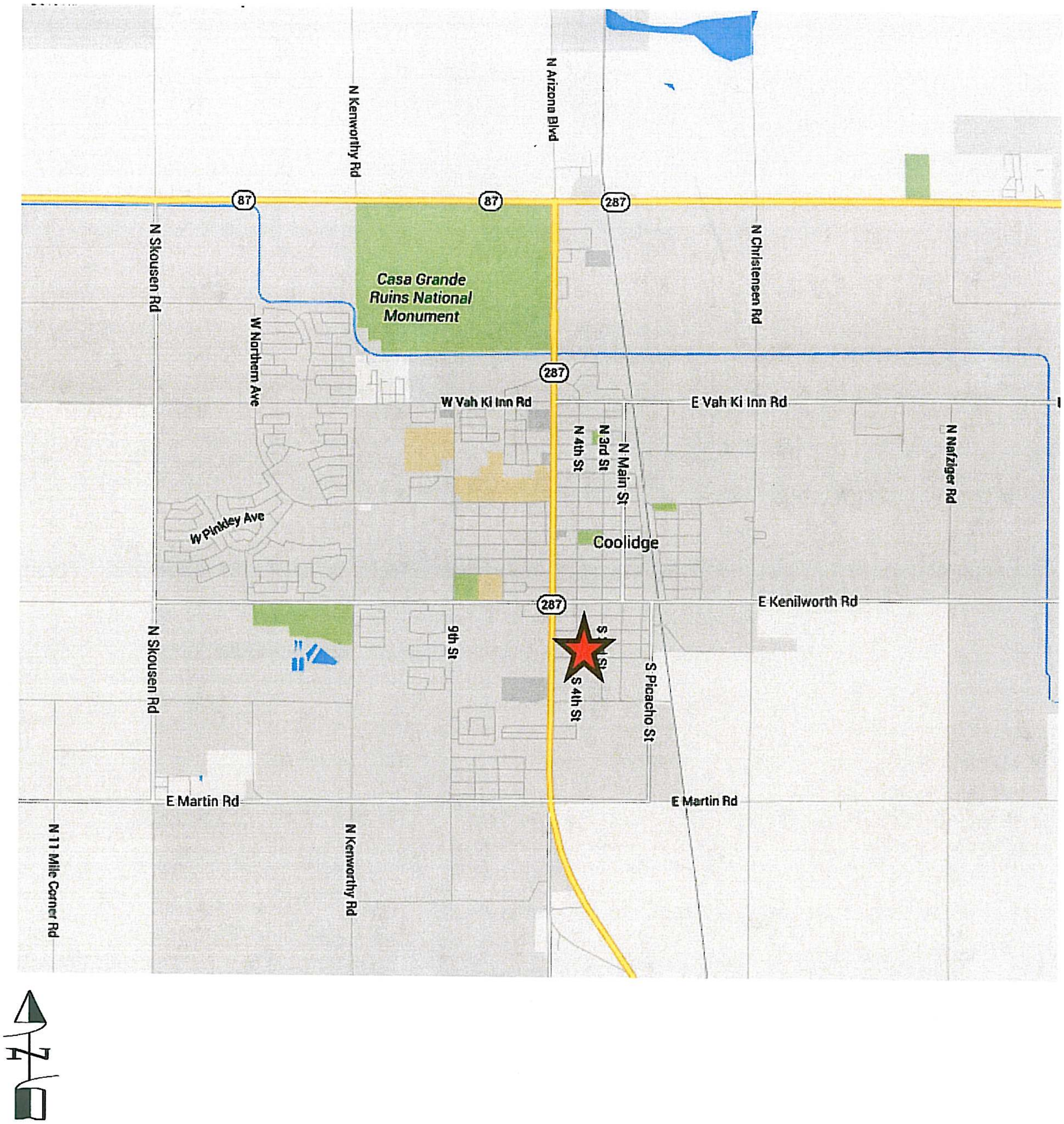
This report is not intended for use as a bid document. We provided some comments and discussed some construction techniques or procedures for the designer's guideline. HA's intentions are not to develop specifications. Therefore, this report should not be interpreted to dictate construction procedures or to relieve the contractor of his responsibility for construction.

Any structures built on soil are subject to risks that cannot be entirely calculated or eliminated. Detrimental hazards such as settlement, concentrated drainage, fatigue, hydro-compaction and expansive or collapsible soil movements due to unidentified geologic conditions are not uncommon. The geotechnical exploration performed with boreholes extending to limited depths and limited laboratory tests may not delineate these hazards. The geotechnical borings and laboratory tests can only identify the risks delineated in those points. However, risks from these hazards can be reduced by employing appropriate design professionals and qualified contractors to properly develop and maintain a property.

HA would also like to disclose that our recommendations are valid for this proposed development at the issuance date of this report. Changes in the site by human activities, changes in codes due to legislative action, or broadening of knowledge may affect the conclusions and recommendations. Accordingly, these findings may be invalidated.

**LIST OF APPENDICES**

## APPENDIX A – SITE LOCATION MAP




Not to Scale

# VICINITY MAP

West Palo Verde Avenue
From Arizona Avenue to 4$^{th}$ Street
Coolidge, Arizona

Project #: 16046
June 1, 2016

HOQUE & ASSOCIATES

# APPENDIX B – UNIFIED SOIL CLASSIFICATION SYSTEM AND SOIL INVESTIGATION METHODS

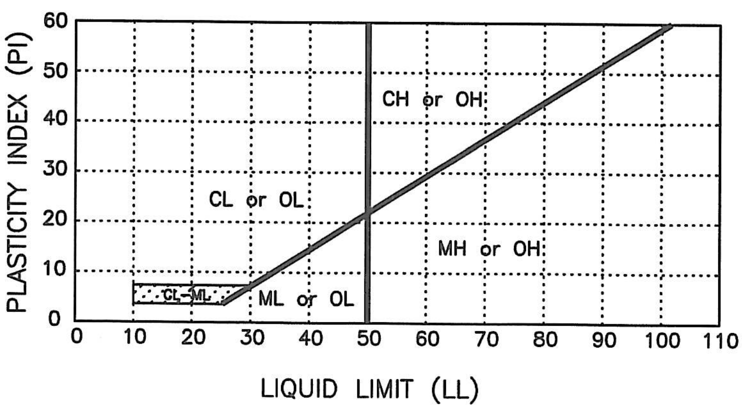
# UNIFIED SOIL CLASSIFICATION SYSTEM

Soils are visually classified by the United Soil Classification System (USCS) on the boring logs presented in this report. Grain size analysis and Atterberg limits tests are often performed on selected samples to aid in classification. The classification system is briefly outlined on this chart. For a more detailed description of the system, see "The Unified Soil Classification System" Corps of Engineers, US Army Technical Memorandum No. 3-357 (Revised April 1960) or ASTM Designation: D2487-66T.

| MAJOR DIVISIONS | | | | GROUP SYMBOL | TYPICAL NAMES |
|---|---|---|---|---|---|
| COARSE - GRAINED SOILS (Less than 50% passes No. 200 sieve) | GRAVELS (50% or less of coarse fraction passes No. 4 sieve) | CLEAN GRAVELS (Less than 5% passes No. 200 sieve) | | GW | Well graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures. |
| | | | | GP | Poorly graded gravels, gravel-sand mixtures, or sand-gravel-cobble mixtures. |
| | | GRAVELS WITH FINES (More than 12% passes No. 200 sieve) | Limits plot below the "A" line & hatched zone on plasticity chart | GM | Silty gravels, gravel-sand-silt mixtures. |
| | | | Limits plot above the "A" line & hatched zone on plasticity chart | GC | Clayey gravels, gravel-sand-clay mixtures. |
| | SANDS (More than 50% of coarse fraction passes No. 4 sieve) | CLEAN SANDS (Less than 5% passes No. 200 sieve) | | SW | Well graded sands, gravelly sands. |
| | | | | SP | Poorly graded sands, gravelly sands. |
| | | SANDS WITH FINES (More than 12% passes No. 200 sieve) | Limits plot below the "A" line & hatched zone on plasticity chart | SM | Silty sands, sand-silt mixtures. |
| | | | Limits plot above the "A" line & hatched zone on plasticity chart | SC | Clayey sands, sand-clay mixtures. |
| FINE - GRAINED SOILS (50% or more passes No. 200 sieve) | SILTS (Limits Plot Below "A" Line & hatched Zone on Plasticity Chart) | SILTS OF LOW PLASTICITY (Liquid Limit Less Than 50) | | ML | Inorganic silts, non-plastic or slightly plastic. |
| | | SILTS OF HIGH PLASTICITY (Liquid Limit More Than 50) | | MH | Inorganic silts, micaceous or diatomaceous silty soils, elastic silts. |
| | CLAYS (Limits Plot Above "A" Line & hatched Zone on Plasticity Chart) | CLAYS OF LOW PLASTICITY (Liquid Limit Less Than 50) | | CL | Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays. |
| | | CLAYS OF HIGH PLASTICITY (Liquid Limit More Than 50) | | CH | Inorganic clays of high plasticity, fat clays, sandy clays of high plasticity. |

NOTE:
Coarse grained soils with between 5% & 12% passing the No. 200 sieve and fine grained soils with Atterberg limits plotting in the hatched zone on the plasticity chart shall have dual symbol. In Arizona, local streams contain sand, gravel & cobble type material, which are locally known as SGC or riverrun material. The USCS is not used to divide and symbolize this material.

## PLASTICITY CHART




## DEFINITIONS OF SOIL FRACTIONS

| SOIL COMPONENT | PARTICLE SIZE RANGE |
|---|---|
| Cobbles | Above 3 in. |
| Gravel | 3 in. to No. 4 sieve |
| Coarse gravel | 3 in. to 3/4 in. |
| Fine gravel | 3/4 in. to No. 4 sieve |
| Sand | No. 4 to No. 200 |
| Coarse | No. 4 to No. 10 |
| Medium | No. 10 to No. 40 |
| Fine | No. 40 to No. 200 |
| Fines (silt & clay) | Below No. 200 sieve |
| Clay | Smaller than 2 microns |
| Colloid | Smaller than 5 microns |

# Subsurface Investigation Methods

Subsurface investigation methods include displacement boring, wash boring, percussion drilling, rotary drilling, auger boring and continuous sampling. For a particular site exploration, the preference of the particular method and drilling equipment are dependent upon various factors. These factors may include equipment suitability, site accessibility, geological surroundings, environmental factors and economic considerations.

## Displacement Borings

This technique is often used in preliminary exploration where prevalent subsurface information is required. Displacement borings are simple and most cost effective for non-caving ground. Without any effort to brace the borehole, sampling the soil at the desired depth is achieved by inserting samplers in the closed position, such as cup, piston or split tube samplers to the required depth.

## Wash Borings

This procedure is advantageous in that the equipment is relatively inexpensive and easily transferable. Wash borings entail the insertion of steel casing and washing out the material to the bottom of the casing or a depth below the steel casing. A re-circulating fluid that carries the cuttings to the surface accomplishes this wash. The drill rod and chopping bits that are used in this procedure alternately raise and drop with slight rotation to anatomize the material within the casing.

## Percussion Drilling

Also known as Churn or Cable Tool Drilling, this method is employed primarily in the well drilling industry. Due to potential sample disturbance, percussion drilling is not used extensively in geotechnical inquisitions. For this procedure, raising and dropping a heavy drill bit and removing the loose soil by bailing creates a borehole. Generally a traditional sampler is used in place of the drill bit to collect the sample after the slurry is removed.

## Rotary Drilling

This technique is flexible and adaptable which may be used with different equipment models and sampling apparatus. By advancing a cased or uncased borehole by rapid rotation and pressure, grinded material or cuttings are created at the bottom of the borehole. The removal of these cuttings are achieved by pumping air, water or drilling mud from a reservoir on the surface through the drill rods to the bottom of the borehole. After obtaining the desired depth, a sampling mechanism is used.

## Auger Boring

This method is popular because it is quick and economical in conducting subsurface investigations. Most often, augers are mounted on large rigs for rapid mobility. However, augers can be on track-mounted equipment as well. This type of boring is subdivided into three categories depending on the type of equipment used. These are construction augers, solid flight augers and hollow stem augers. Construction augers are usually large in diameter and primarily used for shallow inspection of soil. Although not designed for sampling, construction augers can be used for bulk sampling. Solid flight augers, sometimes called continuous flight augers are the most expedient of the augers in obtaining a borehole. Samples are obtained from auger flights. An improvement to the continuous auger is the hollow stem auger. A center plug that is removed from the auger permits sampling tools to be used in the borehole without the removal of the auger.

## Continuous Sampling

This type of sampling may provide more infallible and detailed information about subsurface conditions than any other sampling. This reliability is enhanced because continuous sampling utilizes a variance of sampling tools and test boring procedures.

# Soil Sampling Methods

## Split-Spoon

The most common method for obtaining representative samples are done with the split-spoon. Associated with the Standard Penetration Test (SPT), split-spoon sampling is acquired immediately beneath the borehole near the ground surface.

## Ring Sampling

Ring sampling consists of using six rings that are driven beneath the borehole to obtain an undisturbed sample. This type of representation is used in the laboratory to obtain parameters for foundation analysis.

## Bulk Sampling

Bulk sampling is performed when an undisturbed specimen is not required. This type of sampling is less time consuming and thus more cost efficient, and is desirable when a Proctor, gradation or plastic index is needed.

## APPENDIX C – BORING LOCATION MAP

Not to Scale

**LEGEND**

● Approximate Boring Locations


| SOIL BORING LOCATIONS MAP<br>West Palo Verde Avenue<br>From Arizona Avenue to 4th Street<br>Coolidge, Arizona | Project #: 16046<br>June 1, 2016<br>HOQUE & ASSOCIATES |
|---|---|

## APPENDIX D - BORING LOGS

# KEY TO SYMBOLS

| Symbol | Description |
|---|---|
| **Strata symbols** | |
| | Asphaltic Concrete |
| | Clayey sand |
| **Misc. Symbols** | |
| △ | N-value standard penetration test |
| × | Description not given for: "X" |
| **Soil Samplers** | |
| ☒ | Bulk sample |
| | Ring sampler |
| | Standard penetration test |

**Notes:**

1. Exploratory borings were drilled on 5-18-16 using a CME-55 drill rig with 8" Continuous Flight Auger.
2. Boring locations were selected by Hoque & Asssociates, Inc.
3. Results of tests conducted on recovered samples are reported on the logs and/or attachments.
4. These logs are subject to the limitations, conclusions, and recommendations in this report.

# BORING LOG

## BORING NO. B-1

File: 16046 - Coolidge    Date Printed: 6/16/2016

| | | | |
|---|---|---|---|
| **PROJECT:** | Coolidge | **PROJECT NO.:** | 16046 |
| **CLIENT:** | Entellus, Inc. | **DATE:** | 5-18-16 |
| **LOCATION:** | W. Palo Verde Ave. from S. AZ Blvd to 4th St. | **ELEVATION:** | |
| **DRILLER:** | D&S Drilling | **LOGGED BY:** | TR |
| **DRILLING METHOD:** | CME 55 with 8" Hollow Stem Auger | | |
| **DEPTH TO - WATER> INITIAL:** | n/a | **AFTER 24 HOURS:** | n/a |

| DEPTH (feet) | Bulk | Samplers | Soil Type | USCS | Description |
|---|---|---|---|---|---|
| 0 | | | SC | | 1-2" of Asphalt<br>No discernable ABC material |
| | | | | | Dark brown<br>Moist<br>Slightly Plastic<br>Clayey SAND |
| 2.5 | | | | | Ring Sample at 2'<br>Good Recovery<br>Blow Counts: 2/4 |
| 5 | | | | | SPT Sample at 5'<br>12" Recovery - Stiff Material<br>Blow Counts: 3/5/7 |
| | | | SC | | |

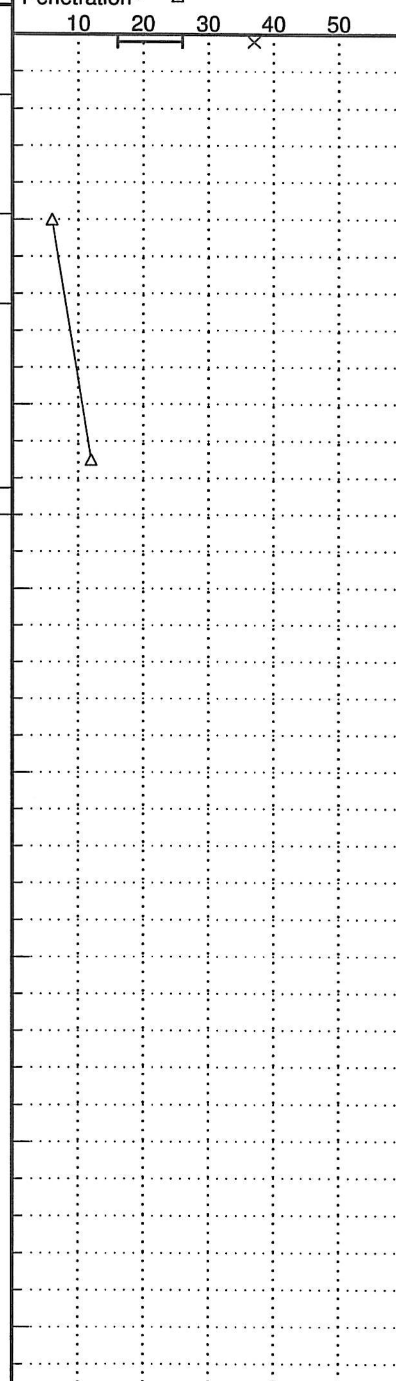
TEST RESULTS

Percent Passing #200 ×

Plastic Limit ├──┤ Liquid Limit

Water Content - ●

Penetration - △




This information pertains only to this boring and should not be interpreted as being indicitive of the site.

HOQUE & ASSOCIATES

# BORING LOG

## BORING NO. B-2

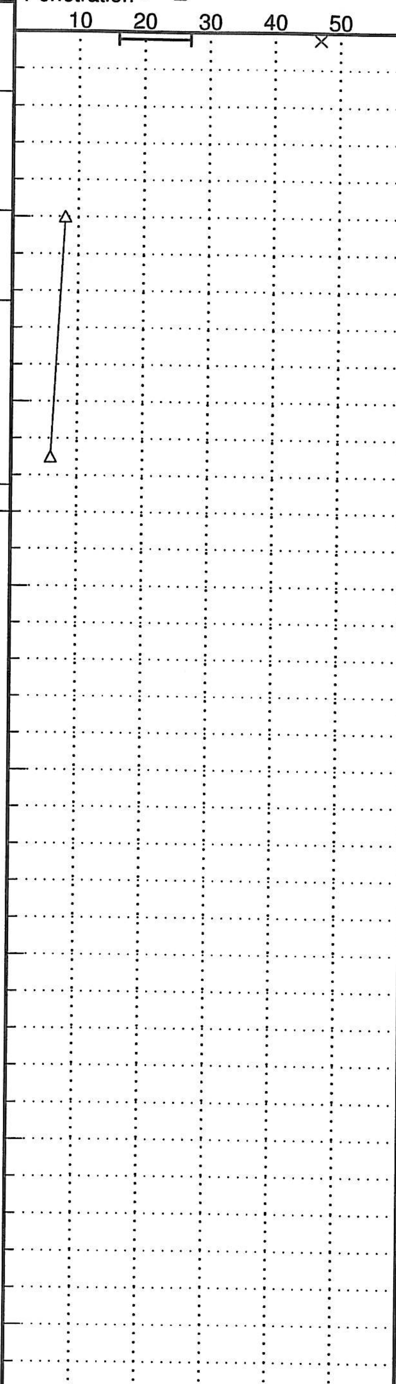
File: 16046 - Coolidge | Date Printed: 6/16/2016

**PROJECT:** Coolidge
**CLIENT:** Entellus, Inc.
**LOCATION:** W. Palo Verde Ave. from S. AZ Blvd to 4th St.
**DRILLER:** D&S Drilling
**DRILLING METHOD:** CME 55 with 8" Hollow Stem Auger
**DEPTH TO - WATER> INITIAL:** n/a

**PROJECT NO.:** 16046
**DATE:** 5-18-16
**ELEVATION:**
**LOGGED BY:** TR
**AFTER 24 HOURS:** n/a

| DEPTH (feet) | Bulk | Samplers | Soil Type | USCS | Description |
|---|---|---|---|---|---|
| 0 | | | SC | | 1-2" of Asphalt<br>No discernable ABC material |
| | | | | | Dark brown<br>Moist<br>Slightly Plastic<br>Clayey SAND w/ trace gravel |
| 2.5 | | | | | Ring Sample at 2'<br>Good Recovery<br>Blow Counts: 4/4 |
| 5 | | | | | SPT Sample at 5'<br>10" Recovery - Firm Material<br>Blow Counts: 3/3/3 |
| | | | SC | | |

TEST RESULTS
Percent Passing #200 ×
Plastic Limit ├──┤ Liquid Limit
Water Content - ●
Penetration - △




This information pertains only to this boring and should not be interpreted as being indicitive of the site.

HOQUE & ASSOCIATES

# APPENDIX E – LABORATORY TEST RESULTS

HOQUE & ASSOCIATES

| | | | |
|---|---|---|---|
| **PROJECT:** | Coolidge Sodewalk geotech | **CLIENT:** | Entellus Inc. |
| **LOCATION:** | Palo verde Ave. 4th St. to AZ Ave. | **JOB NO:** | 16046 |
| **MATERIAL:** | Clayey Sand | **LAB NO:** | See below |
| **SAMPLE SOURCE:** | See below | **DATE ASSIGNED:** | 05/18/16 |

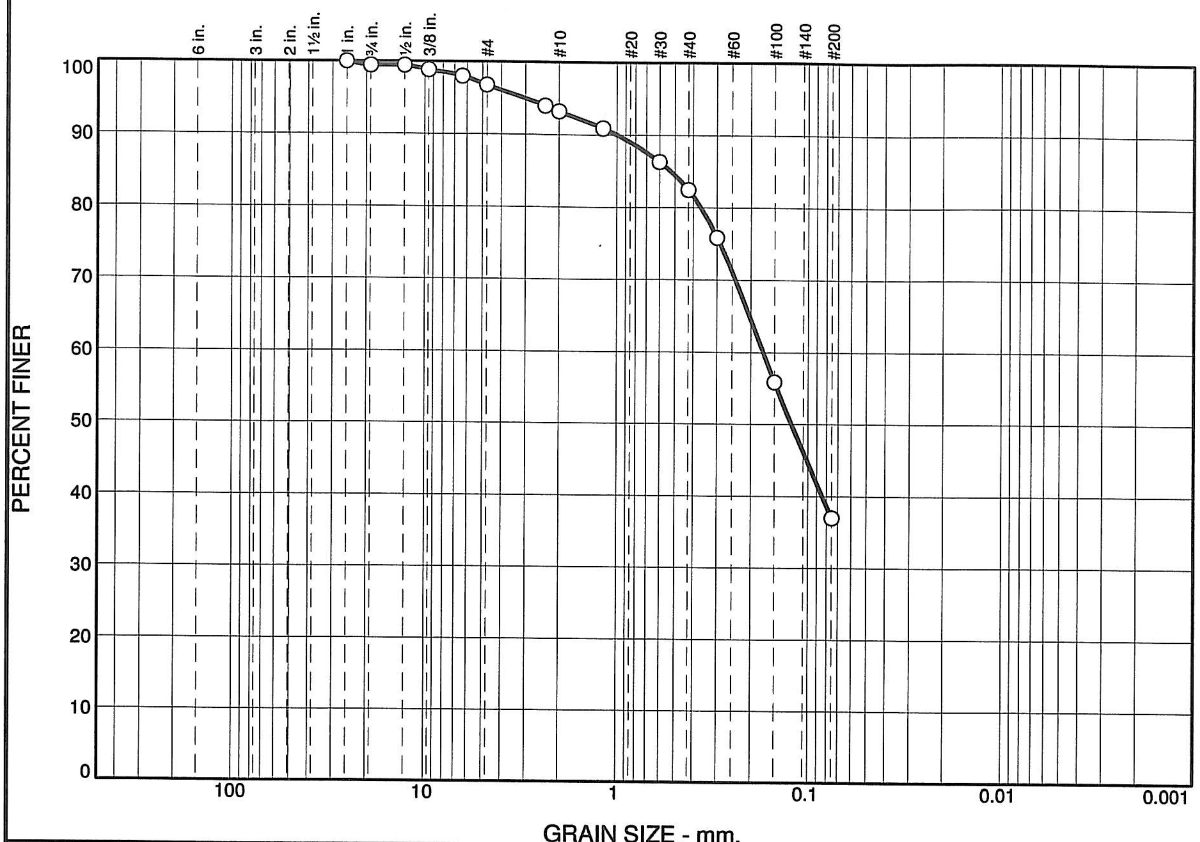
**pH & RESISTIVITY (AZ 236)**

| LAB NO | SAMPLE SOURCE | RESISTIVITY (Ohm-cm) | pH |
|---|---|---|---|
| 16L0133 | B-1 @ 0-5' | 2,370 | 7.9 |

REVIEWED BY

**Trent Titchenal**
**Lab Manager**

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 1 | 2 | 4 | 11 | 45 | 37 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1" | 100 | | |
| 3/4" | 99 | | |
| 1/2" | 99 | | |
| 3/8" | 99 | | |
| 1/4" | 98 | | |
| #4 | 97 | | |
| #8 | 94 | | |
| #10 | 93 | | |
| #16 | 91 | | |
| #30 | 86 | | |
| #40 | 82 | | |
| #50 | 76 | | |
| #100 | 56 | | |
| #200 | 37 | | |

* (no specification provided)

**Soil Description**

clayey sand

**Atterberg Limits**

PL= 16 LL= 26 PI= 10

**Coefficients**

$D_{90}$= 0.9976 $D_{85}$= 0.5232 $D_{60}$= 0.1720
$D_{50}$= 0.1221 $D_{30}$= $D_{15}$=
$D_{10}$= $C_u$= $C_c$=

**Classification**

USCS= SC AASHTO= A-4(0)

**Remarks**

**Location:** B-1 @ 0-5'
**Sample Number:** 16L0133

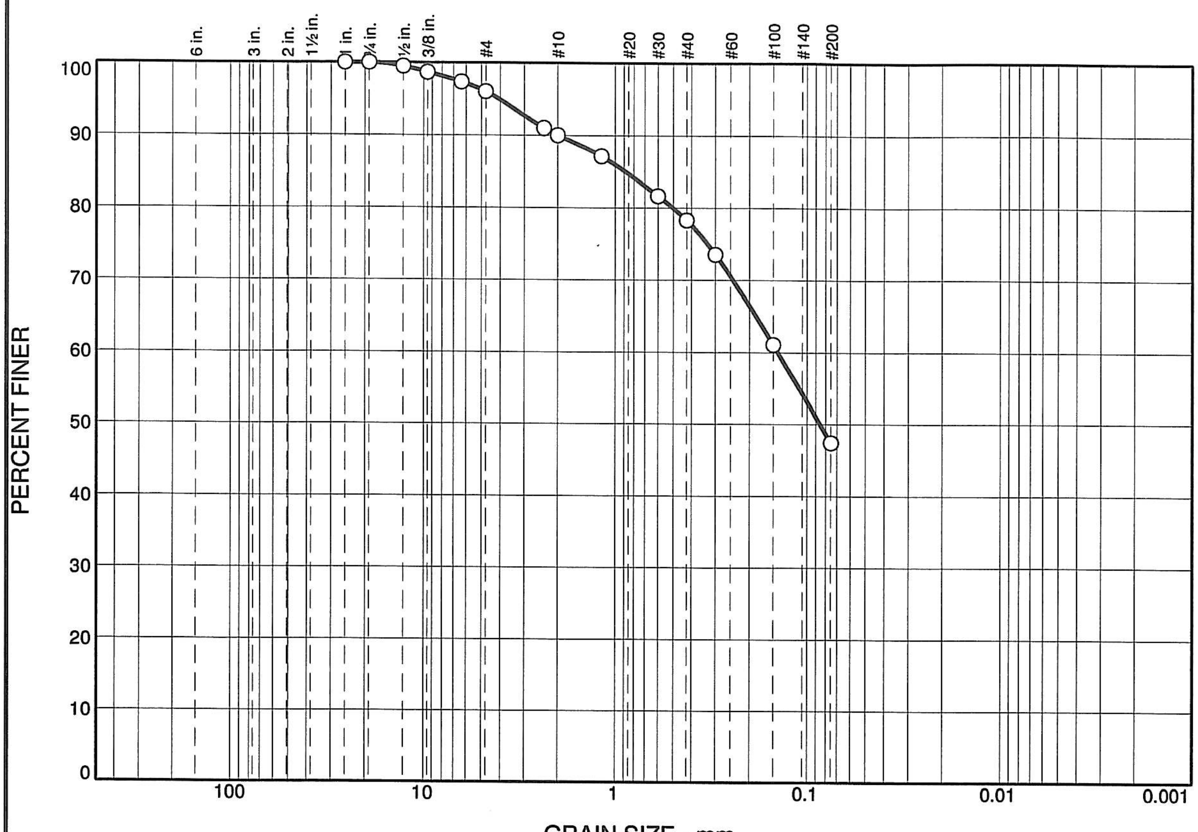
**Date:** 5-18-16

**Hoque & Associates, Inc.**
**4325 South 34th Street**
**Phoenix, Arizona 85040**

**Client:** Entellus Inc.
**Project:** Coolidge Sidewalk Geotech
**Project No:** 16046 **Lab Number** 16L0133

**Tested By:** AJ **Checked By:** TT

# Particle Size Distribution Report




| % +3" | % Gravel | | % Sand | | | % Fines | |
|---|---|---|---|---|---|---|---|
| | Coarse | Fine | Coarse | Medium | Fine | Silt | Clay |
| 0 | 0 | 4 | 6 | 12 | 31 | 47 | |

| SIEVE SIZE | PERCENT FINER | SPEC.* PERCENT | PASS? (X=NO) |
|---|---|---|---|
| 1" | 100 | | |
| 3/4" | 100 | | |
| 1/2" | 99 | | |
| 3/8" | 99 | | |
| 1/4" | 97 | | |
| #4 | 96 | | |
| #8 | 91 | | |
| #10 | 90 | | |
| #16 | 87 | | |
| #30 | 82 | | |
| #40 | 78 | | |
| #50 | 74 | | |
| #100 | 61 | | |
| #200 | 47 | | |

* (no specification provided)

**Soil Description**

clayey sand

**Atterberg Limits**

PL= 16 LL= 27 PI= 11

**Coefficients**

$D_{90}$= 1.9901 $D_{85}$= 0.8827 $D_{60}$= 0.1421
$D_{50}$= 0.0855 $D_{30}$= $D_{15}$=
$D_{10}$= $C_u$= $C_c$=

**Classification**

USCS= SC AASHTO= A-6(2)

**Remarks**

**Location:** B-2 @ 0-5'
**Sample Number:** 16L0135

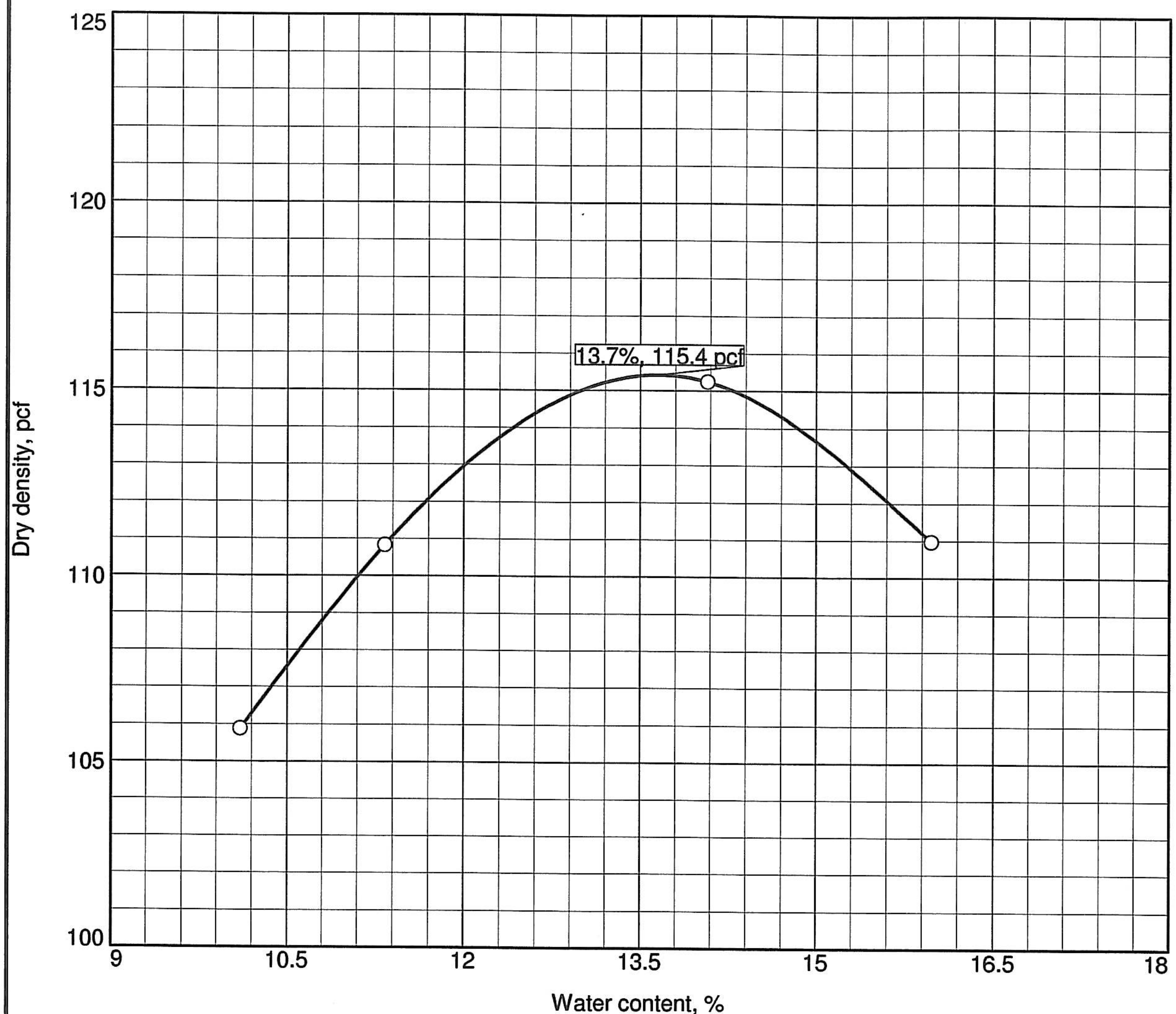
**Date:** 5-18-16

**Hoque & Associates, Inc.**
**4325 South 34th Street**
**Phoenix, Arizona 85040**

**Client:** Entellus Inc.
**Project:** Coolidge Sidewalk Geotech
**Project No:** 16046 **Lab Number** 16L0135

**Tested By:** AJ **Checked By:** TT

# COMPACTION TEST REPORT




Test specification: ASTM D 1557-00 Method A Modified

| Elev/ Depth | Classification | | Nat. Moist. | Sp.G. | LL | PI | % > #4 | % < No.200 |
|---|---|---|---|---|---|---|---|---|
| | USCS | AASHTO | | | | | | |
| | SC | A-4(0) | | | 26 | 10 | 3 | 37 |

| TEST RESULTS | MATERIAL DESCRIPTION |
|---|---|
| Maximum dry density = 115.4 pcf<br>Optimum moisture = 13.7 % | clayey sand |

**Project No.** 16046 **Client:** Entellus Inc.
**Project:** Coolidge Sidewalk Geotech

o **Location:** B-1 @ 0-5' **Sample Number:** 16L0133

**Hoque & Associates, Inc.**
**4325 South 34th Street**
**Phoenix, Arizona 85040**

**Remarks:**

**Lab Number** 16L0133

**Tested By:** AJ **Checked By:** TT

HOQUE & ASSOCIATES

| | | | |
|---|---|---|---|
| **PROJECT:** | Coolidge Sodewalk geotech | **CLIENT:** | Entellus Inc. |
| **LOCATION:** | Palo verde Ave. 4th St. to AZ Ave. | **JOB NO:** | 16046 |
| **MATERIAL:** | Clayey Sand | **LAB NO:** | SEE BELOW |
| **SAMPLE SOURCE:** | SEE BORING | **DATE ASSIGNED:** | 5/18/16 |

## DENSITY OF SOIL IN PLACE BY THE DRIVE-CYLINDER METHOD(ASTM D2937)

| | | MOISTURE | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **LAB #** | **BORING** | **WET WT. (g)** | **DRY WT. (g)** | **MOISTURE CONTENT** | **NUMBER OF RINGS** | **WET WEIGHT & RINGS (g)** | **WEIGHT OF RINGS (g)** | **DRY DENSITY (pcf)** |
| 16L0134 | B-1 @ 2' | 387.5 | 351.7 | 10.2% | 3.0 | 513.6 | 124.1 | 97.6 |
| 16L0136 | B-2 @ 2' | 381.1 | 349.4 | 9.1% | 3.0 | 513.6 | 132.5 | 96.4 |

REVIEWED BY [signature]

Trent Titchenal
Lab Manager

# IAS Laboratories

2515 East University Drive
Phoenix, Arizona 85034
(602) 273-7248


Today's Date: 5/31/2016 

Project #: Coolidge Sidewalk

Submitted By: Hoque Associates

Send Report To: Hoque Associates

Report Number: 6653046

Date Received: 5/25/2016

## Soil Analysis Report

| Sender Sample ID | Depth | Lab # | [1] Sulfate ppm | [2] Chloride ppm | [3] Soluble Salts ppm | [3] pH | Other |
|---|---|---|---|---|---|---|---|
| 16L0133 | | 458 | 10 | 25 | 262 | | |

Comments:

Reference:

[1] ADOT Method ARIZ 733

[2] ADOT Method ARIZ 736

[3] ADOT Method ARIZ 237b