**GEOTEK ENGINEERING**
**& TESTING SERVICES, INC.**
909 East 50th Street North
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September 3, 2019

City of Colton
PO Box 66
309 E. 4th Street
Colton, South Dakota 57018

Attn: Rick Lehman, Mayor

Subj: Geotechnical Exploration
Proposed Street & Utility Improvements
S. Glenn Avenue, W. 2nd Street & W. 4th Street
Colton, South Dakota
GeoTek #19-E13

This correspondence presents our written report of the geotechnical exploration program for the referenced project. Our work was performed in accordance with your authorization. We are transmitting an electronic copy of our report for your use. An additional copy of our report is also being sent as noted below.

We thank you for the opportunity of providing our services on this project and look forward to continued participation during the design and construction phases. If you have any questions regarding this report, please contact our office at (605) 335-5512.

Respectfully Submitted,
GeoTek Engineering & Testing Services, Inc.

*Jared Haskins*

Jared Haskins, PE
Geotechnical Manager

Cc: Banner Associates, Inc., Attn: Weston Blasius, PE

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**COLTON, SOUTH DAKOTA**
**GEOTEK #19-E13**

## INTRODUCTION

### Project Information

This report presents the results of the recent geotechnical exploration program for the proposed street and utility improvements on S. Glenn Avenue, W. 2nd Street and W. 4th Street in Colton, South Dakota.

### Scope of Services

Our work was performed in accordance with the authorization of Rick Lehman with the City of Colton. The scope of work as presented in this report is limited to the following:

1. To perform 4 standard penetration test (SPT) borings to gather data on the subsurface conditions at the project areas.

2. To perform laboratory tests that include moisture content, dry density and standard Proctor.

3. To prepare an engineering report that includes the results of the field and laboratory tests as well as our geotechnical engineering opinions and recommendations regarding the following:

    - Existing pavement section;
    - Underground utility excavation and backfilling;
    - Subgrade strength and potential corrective measures;
    - Pavement section thicknesses;
    - Corrosive potential of the soils;
    - Special geotechnical conditions that may impact the constructability and final performance of the project;
    - Quality control observation and testing.

The scope of our work was intended for geotechnical purposes only. This scope of work did not include determining the presence or extent of environmental contamination at the project areas or to characterize the project areas relative to wetlands status.

## SITE & SUBSURFACE CONDITIONS

### Site Locations & Description

The project areas are located on the following streets: S. Glenn Avenue (W. 1st Street to W. 5th Street), W. 2nd Street (S. Glenn Avenue to S. Main Avenue) and W. 4th Street (S. Glenn Avenue to S. Main Avenue) in Colton, South Dakota. The existing pavement surfacing consists of asphalt. Portions of the roads have curb and gutter. Railroad tracks run along S. Glenn Avenue from W. 1st Street to W. 2nd Street and through W. 2nd Street (approximately 80 feet east of S. Glenn Avenue).

### Ground Surface Elevations & Test Boring Locations

We did not determine the ground surface elevations at the test boring locations. A test boring location map (Figure 1) is attached showing the relative location of the test borings.

### Existing Asphalt Pavement & Gravel Base Thicknesses

Table 1 summarizes the thicknesses of the existing asphalt pavement and gravel base encountered at the respective test boring locations.

**Table 1. Thicknesses of the Existing Asphalt Pavement & Gravel Base**

| Test Boring | Street | Asphalt Thickness, in | Gravel Base, in |
|---|---|---|---|
| 1 | S. Glenn Avenue | 3 | 14 |
| 2 | S. Glenn Avenue | 5 | 13 |
| 3 | S. Glenn Avenue | 3 | 4 |
| 4 | W. 4th Street | 3 | 9 |

**Subsurface Conditions**

The test borings were performed on August 19, 2019. The subsurface conditions encountered at the test boring locations are illustrated by means of the boring logs included in Appendix A.

At the test boring locations, the subgrade soils consisted of the following soil types: existing fill materials, topsoil materials, loess soils, glacial fluvial soils and glacial till soils. The existing fill materials were encountered at all of the test borings and extended to depths of 2 feet and 2 ½ feet. The topsoil materials were only encountered at test boring 1 and extended to a depth of 3 ½ feet. The loess soils were encountered beneath the existing fill materials and topsoil materials. The loess soils extended to depths varying from 7 feet to 9 ½ feet. The glacial fluvial soils and glacial till soils were encountered beneath the loess soils.

The existing fill materials consisted of lean clay soils. The topsoil materials consisted of lean clay soils. The loess soils consisted of lean clay soils. The glacial fluvial soils consisted of lean clay soils. The glacial till soils consisted of lean clay with sand soils and sandy lean clay soils.

The consistency or relative density of the soils is indicated by the standard penetration resistance ("N") values as shown on the boring logs. A description of the soil consistency or relative density based on the "N" values can be found on the attached Soil Boring Symbols and Descriptive Terminology data sheet.

We wish to point out that the subsurface conditions at other times and locations at the site may differ from those found at our test boring locations. If different conditions are encountered during construction, then it is important that you contact us so that our recommendations can be reviewed.

**Water Levels**

Measurements to record the groundwater levels were made at the test boring locations. The time and level of the groundwater readings are recorded on the boring logs. Groundwater was measured at depths varying from 6 feet to 12 feet at the test boring locations.

The water levels indicated on the boring logs may or may not be an accurate indication of the depth or lack of subsurface groundwater. The limited length of observation restricts the accuracy of the measurements. Long term groundwater monitoring was not included in our scope of work.

## ENGINEERING REVIEW & RECOMMENDATIONS

### Project Design Data

We understand that the project will consist of street and utility improvements on S. Glenn Avenue, W. 2nd Street and W. 4th Street in Colton, South Dakota. The street improvements will consist of a new asphalt pavement section. The utility improvements will consist of new water main and sanitary sewer. The sanitary sewer will have a maximum depth of 14 feet. Minimum grade changes are expected for the project.

The information/assumptions detailed in the project design data section are important factors in our review and recommendations. If there are any corrections or additions to the information detailed in this section, then it is important that you contact us so that we can review our recommendations with regards to the revised plans.

### Utility Improvements

#### Subgrade Soils

The subgrade soils anticipated at the invert depths for the underground utilities will likely consist of clay soils. Where soils having moderate moisture and density values are encountered at the bottom of the trench excavations, it is our opinion that the soils are considered suitable for support of the proposed utilities, provided they are adequately dewatered and are not disturbed by construction traffic. Localized areas of wet or soft soils may be encountered at the bottom of the trench excavations. These areas will require subexcavation and trench stabilization methods and materials. Appropriate bedding materials should be used for the utility pipes.

**Water Control**

Water may enter the utility trench excavations as a result of subsurface water, precipitation or surface run off. Dewatering procedures may be required in order to control and remove water entering the utility trench excavations. Where clay soils are encountered, it may be possible to remove and control water entering the excavations using normal sump pumping techniques. However, if waterbearing sand soils are encountered, then extensive dewatering techniques will likely be required due to the potentially large volumes of water. The contractor should provide appropriate dewatering methods and equipment. Again, groundwater was measured at depths varying from 6 feet to 12 feet at the test boring locations. Based on the measured groundwater depths, dewatering will likely be needed for the deeper utilities (sanitary sewer). Any water that accumulates at the bottom of the excavations should be immediately removed and surface drainage away from the excavations should be provided during construction.

**OSHA Requirements**

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches". This document states that the excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

**Trench Backfill**

We performed 2 standard Proctor tests for the project (1 on the loess soils and 1 on the glacial till soils). The results of the standard Proctor tests are shown in Table 2.

**Table 2. Standard Proctor Test Results**

| Test Boring | Depth (ft) | Soil Type | Optimum Moisture Content (%) | Maximum Dry Density (pcf) |
|---|---|---|---|---|
| 1 | 3 to 7 | Lean Clay (Loess) | 18.1 | 107.1 |
| 3 | 9 ½ to 14 ½ | Sandy Lean Clay (Glacial Till) | 14.6 | 114.6 |

Based on the results of the moisture content and standard Proctor tests, the loess soils generally have in-situ moisture content levels that are 5 percent to 9 percent above the optimum moisture content. Regarding the glacial fluvial soils and glacial till soils, it is our opinion that the glacial fluvial soils and glacial till soils generally have in-situ moisture content levels that are 1 percent to 4 percent above the optimum moisture content.

In our opinion, the majority of the glacial fluvial soils and glacial till soils can likely be reused as trench backfill. Some wetting or drying should be expected with the on-site glacial fluvial soils and glacial till soils. In contrast, the majority of the loess soils should not be used as trench backfill. Our opinion of the loess soils is based on the high moisture content levels and the difficulties that the contractor will likely have trying to dry the wet soils within the project limits. With that said, it is our opinion that the majority of the loess soils should be replaced with an off-site borrow material. The off-site borrow material should consist of either a granular or clay material. If a granular material is used, then it should consist of a pit-run or processed sand or gravel having a maximum particle size of 1 inch. The granular material can be placed in lifts of up to 1 foot in thickness. If a clay material is selected, then it should consist of a non-organic clay having a liquid limit less than 45. Scrutiny on the clay material's moisture content should be made prior to the acceptance and use. The clay fill should be placed in lifts of up to 6 inches in thickness. The moisture content of the clay backfill soils should be within plus or minus 2 percent of the optimum moisture content as determined by standard Proctor (ASTM:D698). The trench backfill should be compacted to a minimum of 95 percent of standard Proctor density (ASTM:D698). If granular materials are used, then the upper 3 feet of the trench backfill should consist of a clay material in order to provide a consistent subgrade condition beneath the pavement section.

Regarding the on-site existing fill materials, it is our opinion that some of the on-site existing fill materials could be used as trench backfill. Some wetting or drying should be expected with the on-site existing fill materials. In regards to the on-site topsoil materials, it is our opinion that they should not be used as trench backfill.

**Street Improvements**

**Discussion**

Based on the test borings, existing fill materials, topsoil materials and loess soils are expected to be encountered as subgrade soils. The existing fill materials, topsoil materials and loess soils have a Unified Soils Classification System symbol of CL and AASHTO classifications of A-6 and A-7. In our opinion, the existing fill materials, topsoil materials and loess soils have low strength characteristics and are prone to instability during freeze-thaw cycles. In addition, the existing fill materials, topsoil materials and loess soils are prone to instability from normal construction traffic and additional moisture. Our opinions are based on our observations of the collected samples, the results of the laboratory tests and the generally low “N” values within the soils.

We estimate California Bearing Ratio (CBR) values of 1.0 to 2.0 for the existing fill materials, topsoil materials and loess soils. CBR values of 1.0 to 2.0 are considered low CBR values. The CBR value is a measure of the supporting value of the subgrade soils. The value can be determined from a soaked test or an unsoaked test. The value from a soaked test is used to simulate the worst conditions (wet periods of the year and the spring thaw), while the value from an unsoaked test is used to simulate normal field conditions (summer and fall). Values from soaked tests are much lower than values from unsoaked tests. The values discussed above would represent values from soaked tests.

In order to provide a stable and uniform subgrade condition throughout the areas of the project, it is our opinion that subgrade reinforcement (option 1) or cement stabilization (option 2) will be needed. The subgrade reinforcement should consist of a woven geotextile fabric with granular subbase.

**Stripping & Removals**

We recommend removing the existing pavement section (asphalt and gravel base). Low-ground-pressure construction equipment or excavators with smooth-edged buckets should be used for the stripping and removals. We recommend limiting the amount of heavy wheeled construction traffic on the subgrade.

**Filling**

If filling is required to achieve the design subgrade elevations, then the fill materials should consist of non-organic lean clay or sandy lean clay soils having a liquid limit less than 45 and a plasticity index between 15 and 35. The moisture content of the fill soils should be 1 percent to 4 percent below the optimum moisture content. The fill soils should be placed in compacted lifts having a maximum thickness of 6 inches. We recommend a minimum compaction specification of 95 percent of standard Proctor (ASTM:D698) for the fill soils.

**Subgrade Preparation Option 1 – Subgrade Reinforcement**

For this option, a layer of granular subbase should be placed on top of a geotextile fabric that is overlying the subgrade. The aggregate base course material is installed above the granular subbase. Regarding the geotextile fabric, we recommend using Mirafi HP 370, Propex Geotex 3x3 HF, Huesker Comtrac P 45/45, or an approved alternative. The granular subbase should consist of crushed quartzite, recycled concrete or a crushed pit-run material meeting the gradation specifications shown in Table 3. The granular subbase should be compacted to a minimum of 97 percent of standard Proctor density (ASTM:D698). It should be noted that compaction testing may not be practical for the granular subbase due to the large aggregate.

**Table 3. Granular Subbase Gradation Specifications**

| Sieve Size | Percent Passing |
|---|---|
| 4-inch | 100 |
| 3-inch | 70 – 90 |
| 2-inch | 60 – 80 |
| 1-inch | 40 – 70 |
| #4 | 10 – 50 |
| #40 | 5 – 20 |
| #200 | 0 – 8 |

**Subgrade Preparation Option 2 – Cement Stabilization**

The cement stabilization option should consist of blending the subgrade soils with cement to a minimum depth of 12 inches. The percentage of cement used typically ranges from 5 percent to 7 percent and should be based on a site specific mix design. For bidding purposes, the percentage of cement used should be 5 percent (example: if the in-place dry density equals 105 pounds per cubic foot (pcf), then 5.25 pounds of cement should be applied to the subgrade, per square foot). We recommend that the percentage of cement used during the blending process be determined by a mix design that should be performed when the subgrade soils are exposed. The mix design typically takes 2 weeks to perform.

Once the percentage of cement is determined, the cement should be placed uniformly over the subgrade surface at the specified percentage with a truck-mounted cement spreader. In addition to the cement being placed uniformly, the truck-mounted spreader will help control the spread of cement dust. Then, a self-propelled pulvimixer/reclaimer should be used to reclaim the upper 12 inches of the subgrade along with the cement. Some (several inches) of the existing gravel base could be blended into the subgrade during the cement stabilization process. Within 30 minutes, the reclaimed mixture of soil and cement should be initially compacted with a large (60-inch to 72-inch diameter) vibratory sheepsfoot roller to a minimum of 95 percent of the maximum dry density as determined by Moisture-Density Relations of Soil-Cement Mixtures (ASTM:D558). The moisture content of the material should be adjusted to a moisture level that is within 3 percent below to 3 percent above the optimum moisture content determined by Moisture-Density Relations of Soil-Cement Mixtures (ASTM:D558). After initial compaction, the subgrade should be graded to design elevations, rolled with a pneumatic tire roller and watered with a commercial water truck. Construction traffic should not be allowed on the subgrade for 48 hours after the final watering. This delay allows for the cement to properly hydrate without being disturbed. If at any time during or after the cement stabilization process it is determined that the subgrade is not performing as expected, then the problem should be assessed to determine the best course of action. This may include an additional application of cement.

**Asphalt Pavement Section Thicknesses**

We were not provided traffic volumes for the streets. We assume that the traffic will consist of mostly automobiles with some trucks. Table 4 summarizes the recommended asphalt pavement section thicknesses for S. Glenn Avenue, W. 2nd Street and W. 4th Street. Again, option 1 consists of granular subbase overlying a geotextile fabric (subgrade reinforcement) and option 2 consists of cement stabilization.

**Table 4. Asphalt Pavement Section Thicknesses**

| Option | Asphalt Pavement Thickness, in | Aggregate Base Course Thickness, in | Granular Subbase Thickness, in | Subgrade Reinforcement | Cement Stabilization |
|---|---|---|---|---|---|
| 1 | 3 ½ | 6* | 10** | Geotextile Fabric | - |
| 2 | 3 ½ | 8* | - | - | Yes*** |

*The aggregate base course material could consist of reclaimed material.
**The thickness of the granular subbase may need to be increased if very poor subgrade conditions are encountered.
***The percentage of cement may need to be increased if very poor subgrade conditions are encountered.

We recommend that routine maintenance such as crack filling, localized patching and seal coating be performed. The design sections could be reduced if the owner is willing to assume additional maintenance costs or potentially shorter pavement life.

**Asphalt & Aggregate Base Course Materials**

The asphalt pavement should meet the requirements of sections 320 and 321 for Class G. If virgin (non-reclaimed) aggregate base course materials are used, then they should meet the requirements of Sections 260 and 882 of the SDDOT Standard Specifications. The aggregate base course materials should be compacted to a minimum of 97 percent of standard Proctor (ASTM:D698).

**Existing Asphalt Pavement & Gravel Base**

Reclaiming of the existing asphalt pavement and gravel base for use as aggregate base course material could be considered for both options. Samples of the reclaimed material should be collected for analysis during construction in order to approve the material for use as aggregate base course material. The reclaimed material should be compacted to a minimum of 97 percent of standard Proctor (ASTM:D698).

**Corrosive Potential**

Our scope of work did not include performing resistivity, pH, chloride content or sulfate content tests to determine the corrosive potential of the on-site soils. Based on previous resistivity tests on similar soils, the on-site soils would be considered extremely corrosive to highly corrosive. Based on previous chloride content and sulfate content tests on similar soils, the on-site soils would be considered mildly corrosive. Regarding granular soils (potential off-site borrow material), granular soils are typically considered corrosive (dirty sands) to mildly corrosive (clean sands).

## CONSTRUCTION CONSIDERATIONS

**Groundwater & Surface Water**

Water may enter the excavations due to subsurface water, precipitation or surface run off. Any water that accumulates in the bottom of the excavations should be immediately removed and surface drainage away from the excavations should be provided during construction.

**Disturbance of Soils**

The soils encountered at the test boring locations are susceptible to disturbance and can experience strength loss caused by construction traffic and/or additional moisture. Precautions will be required during earthwork activities in order to reduce the risk of soil disturbance. Where soft/wet soils are encountered, the excavations should be performed with low-ground-pressure construction equipment or an excavator (backhoe) having a smooth cutting edge on the bucket.

**Cold Weather Precautions**

If site preparation and construction is anticipated during cold weather, then we recommend all subgrades, slabs and other improvements that may be affected by frost movements be insulated from frost penetration during freezing temperatures. If filling is performed during freezing temperatures, then all frozen soils, snow and ice should be removed from the areas to be filled prior to placing the new fill. The new fill should not be allowed to freeze during transit, placement and compaction. Concrete and asphalt should not be placed on frozen subgrades. If subgrades freeze, then we recommend that the frozen soils be removed and replaced, or completely thawed. The subgrade soils will likely require reworking and recompacting due to the loss of density caused by the freeze/thaw process.

## Excavation Sideslopes

All excavations must comply with the requirements of OSHA 29 CFR, Part 1926, Subpart P, "Excavations and Trenches". This document states that the excavation safety is the responsibility of the contractor. Reference to this OSHA requirement should be included in the project specifications.

## Observations & Testing

This report was prepared using a limited amount of information for the project and a number of assumptions were necessary to help us develop our conclusions and recommendations. It is recommended that our firm be retained to review the geotechnical aspects of the final design plans and specifications to check that our recommendations have been properly incorporated into the design documents.

The recommendations submitted in this report have been made based on the subsurface conditions encountered at the test boring locations. It is possible that there are subsurface conditions at the site that are different from those represented by the test borings. As a result, on-site observation during construction is considered integral to the successful implementation of the recommendations. We believe that qualified field personnel need to be on-site at the following times to observe the site conditions and effectiveness of the construction.

### Excavation

We recommend that a geotechnical engineer or geotechnical engineering technician working under the direct supervision of a geotechnical engineer observe all excavations for utilities, slabs and pavements. These observations are recommended to determine if the exposed soils are similar to those encountered at the test boring locations, if unsuitable soils have been adequately removed and if the exposed soils are suitable for support of the proposed construction.

**Testing**

After the subgrade is observed by a geotechnical engineer/technician and approved, we recommend a representative number of compaction tests be taken during the placement of the backfill placed below slabs and pavements. The tests should be performed to determine if the required compaction has been achieved. As a general guideline, we recommend at least 1 test be taken for every 10,000 square feet of embankment fill placed, at least 1 test for every 500 feet in trench fill, and for every 2-foot thickness of fill or backfill placed. The actual number of tests should be left to the discretion of the geotechnical engineer. Samples of proposed fill and backfill materials should be submitted to our laboratory for testing to determine their compliance with our recommendations and project specifications.

## SUBSURFACE EXPLORATION PROCEDURES

### Test Borings

We performed 4 SPT borings on August 19, 2019 with a truck rig equipped with hollow-stem auger. Soil sampling was performed in accordance with the procedures described in ASTM:D1586. Using this procedure, a 2-inch O.D. split barrel sampler is driven into the soil by a 140-pound weight falling 30 inches. After an initial set of 6 inches, the number of blows required to drive the sampler an additional 12 inches is known as the penetration resistance, or “N” value. The “N” value is an index of the relative density of cohesionless soils and the consistency of cohesive soils. In addition, thin walled tube samples were obtained according to ASTM:D1587, where indicated by the appropriate symbol on the boring logs.

The test borings were backfilled with on-site materials and some settlement of these materials can be expected to occur. Final closure of the holes is the responsibility of the client or property owner.

The soil samples collected from the test boring locations will be retained in our office for a period of 1 month after the date of this report and will then be discarded unless we are notified otherwise.

**Soil Classification**

As the samples were obtained in the field, they were visually and manually classified by the crew chief according to ASTM:D2488. Representative portions of all samples were then sealed and returned to the laboratory for further examination and for verification of the field classification. In addition, select samples were then submitted to a program of laboratory tests. Where laboratory classification tests (sieve analysis and Atterberg limits) have been performed, classifications according to ASTM:D2487 are possible. Logs of the test borings indicating the depth and identification of the various strata, the "N" value, the laboratory test data, water level information and pertinent information regarding the method of maintaining and advancing the drill holes are also attached in Appendix A. Charts illustrating the soil classification procedures, the descriptive terminology and the symbols used on the boring logs are also attached in Appendix A.

**Water Level Measurements**

Subsurface groundwater levels should be expected to fluctuate seasonally and yearly from the groundwater readings recorded at the test boring locations. Fluctuations occur due to varying seasonal and yearly rainfall amounts and snowmelt, as well as other factors. It is possible that the subsurface groundwater levels during or after construction could be significantly different than the time the test borings were performed.

**Laboratory Tests**

We performed laboratory tests on select samples to aid in determining the index properties of the soils. The tests consisted of moisture content, dry density and standard Proctor. The laboratory tests were performed in accordance with the appropriate ASTM procedures. The results of the laboratory tests are shown on the boring logs opposite the samples upon which the tests were performed or on the attached data sheets.

## LIMITATIONS

The recommendations and professional opinions submitted in this report were based upon the data obtained through the sampling and testing program at the test boring locations. We wish to point out that because no exploration program can totally reveal the exact subsurface conditions for the entire site, conditions between test borings and between samples and at other times may differ from those described in our report. Our exploration program identified subsurface conditions only at those points where samples were retrieved or where water was observed. It is not standard engineering practice to continuously retrieve samples for the full depth of the test borings. Therefore, strata boundaries and thicknesses must be inferred to some extent. Additionally, some soils layers present in the ground may not be observed between sampling intervals. If the subsurface conditions encountered at the time of construction differ from those represented by our test borings, it is necessary to contact us so that our recommendations can be reviewed. The variations may result in altering our conclusions or recommendations regarding site preparation or construction procedures, thus, potentially affecting construction costs.

This report is for the exclusive use of the addressee and its representatives for use in design of the proposed project described herein and preparation of construction documents. Without written approval, we assume no responsibility to other parties regarding this report. Our conclusions, opinions and recommendations may not be appropriate for other parties or projects.

## STANDARD OF CARE

The recommendations submitted in this report represent our professional opinions. Our services for your project were performed in a manner consistent with that level of care and skill ordinarily exercised by members of the engineering profession currently practicing at this time and area.

This report was prepared by:
GeoTek Engineering & Testing Services, Inc.

Jared Haskins, PE
Geotechnical Manager

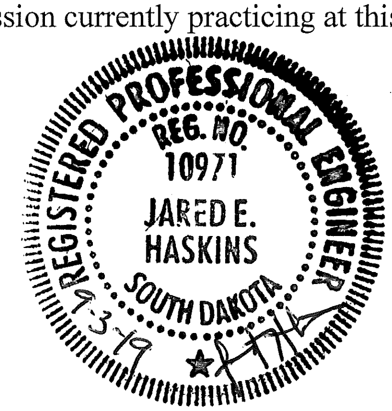


FIGURE 1
TEST BORING LOCATION MAP
STREET & UTILITY IMPROVEMENTS
S. GLENN AVE., W. 2ND ST., & W. 4TH ST.
COLTON, SD

ACAD/GEOTEK/JARED/19-E13

PROJECT#: 19-E13

DRAWN BY: DHP

GEOTEK

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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **19-E13** BORING NO. **1 (1 of 1)**

PROJECT **Proposed Street & Utility Improvements, S. Glenn Avenue, W. 2nd Street & W. 4th Street, Colton, SD**

| DEPTH in FEET | DESCRIPTION OF MATERIAL | GEOLOGIC ORIGIN | N | WL | SAMPLE NO. | SAMPLE TYPE | WC | D | LL | PL | QU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | **ASPHALT**: 3" thick | | | | | | | | | | |
| 1.4 | **FILL, MOSTLY CLAYEY SAND**: with gravel, medium grained, brown, moist, 14" thick | EXISTING GRAVEL BASE | | | 1 | HSA | | | | | |
| 2 | **FILL, MOSTLY LEAN CLAY**: dark brown, moist | FILL | | | | | | | | | |
| 3½ | **LEAN CLAY**: very dark brown to black, moist, firm, (CL) | TOPSOIL | 7 | | 2 | SPT | 30 | 86 | | | |
| | **LEAN CLAY**: mottled brown and gray, wet, soft to firm, (CL) | LOESS | | | 8 | BAG | | | | | |
| | | | 5 | | 3 | SPT | 26 | 96 | | | |
| | | | | ▼ | | | | | | | |
| 8½ | | | 4 | | 4 | SPT | 27 | | | | |
| | **SANDY LEAN CLAY**: a little gravel, brown, wet, stiff, with lenses of sand (CL) | GLACIAL TILL | | | | | | | | | |
| 12 | | | 10 | | 5 | SPT | 15 | | | | |
| | **LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL) | GLACIAL TILL | 9 | | 6 | SPT | 19 | | | | |
| 16 | | | 9 | | 7 | SPT | | | | | |
| | Bottom of borehole at 16 feet. | | | | | | | | | | |

WATER LEVEL MEASUREMENTS

| DATE | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | WATER LEVEL |
|---|---|---|---|---|---|
| 8-19-19 | 12:53 pm | 16 | -- | 10 | ▼ 6 |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |

START 8-19-19 COMPLETE 8-19-19 9:50 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

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& TESTING SERVICES, INC.
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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **19-E13** BORING NO. **2 (1 of 1)**

PROJECT **Proposed Street & Utility Improvements, S. Glenn Avenue, W. 2nd Street & W. 4th Street, Colton, SD**

| DEPTH in FEET | DESCRIPTION OF MATERIAL | GEOLOGIC ORIGIN | N | WL | SAMPLE NO. | SAMPLE TYPE | WC | D | LL | PL | QU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.4 | **ASPHALT**: 5" thick | | | | | | | | | | |
| 1½ | **FILL, MOSTLY CLAYEY SAND**: with gravel, medium grained, brown, moist, 13" thick | EXISTING GRAVEL BASE | | | 1 | HSA | | | | | |
| 2 | **FILL, MOSTLY LEAN CLAY**: dark brown, moist | FILL | | | | | | | | | |
| | **LEAN CLAY**: mottled brown and gray, wet, firm, (CL) | LOESS | 5 | | 2 | SPT | 26 | 94 | | | |
| | | | 6 | | 3 | SPT | 24 | | | | |
| | | | 5 | | 4 | SPT | 23 | | | | |
| | | | | ▼ | | | | | | | |
| 9½ | **LEAN CLAY WITH SAND**: a little gravel, brown, moist to wet, firm, with a few lenses of sand (CL) | GLACIAL TILL | 7 | | 5 | SPT | 17 | 114 | | | |
| | | | | | 8 | BAG | | | | | |
| | | | 7 | | 6 | SPT | 21 | | | | |
| 16 | | | 7 | | 7 | SPT | | | | | |
| | Bottom of borehole at 16 feet. | | | | | | | | | | |

WATER LEVEL MEASUREMENTS

| DATE | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | WATER LEVEL |
|---|---|---|---|---|---|
| 8-19-19 | 1:01 pm | 16 | -- | 9 | ▼ 9 |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |

START 8-19-19 COMPLETE 8-19-19 10:40 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
Sioux Falls, South Dakota, 57104
605-335-5512 Fax
jhaskins@geotekeng.com

# GEOTECHNICAL TEST BORING LOG

GEOTEK # **19-E13** BORING NO. **3 (1 of 1)**

PROJECT **Proposed Street & Utility Improvements, S. Glenn Avenue, W. 2nd Street & W. 4th Street, Colton, SD**

| DEPTH in FEET | DESCRIPTION OF MATERIAL | GEOLOGIC ORIGIN | N | WL | SAMPLE NO. | SAMPLE TYPE | WC | D | LL | PL | QU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | **ASPHALT**: 3" thick | | | | | | | | | | |
| 0.6 | **FILL, MOSTLY CLAYEY SAND**: with gravel, medium grained, brown, moist, 4" thick | EXISTING GRAVEL BASE | | | | | | | | | |
| 2 | **FILL, MOSTLY LEAN CLAY**: dark brown, moist | FILL | 12 | | 1 | SPT | 22 | 103 | | | |
| 9½ | **LEAN CLAY**: mottled brown and gray, moist to wet, soft to firm, (CL) | LOESS | 5 | | 2 | SPT | 20 | 102 | | | |
| | | | 4 | | 3 | SPT | 23 | | | | |
| | | | 4 | | 4 | SPT | 26 | | | | |
| 14½ | **LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL) | GLACIAL TILL | 9 | | 5 | SPT | 19 | | | | |
| | | | | ▼ | | | | | | | |
| | | | 11 | | 6 | SPT | 15 | | | | |
| 16 | **LEAN CLAY WITH SAND**: a trace of gravel, brown, moist, firm, (CL) | GLACIAL TILL | 6 | | 7 | SPT | | | | | |
| | Bottom of borehole at 16 feet. | | | | | | | | | | |

WATER LEVEL MEASUREMENTS

| DATE | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | WATER LEVEL |
|---|---|---|---|---|---|
| 8-19-19 | 1:08 pm | 16 | -- | 12 | ▼ 12 |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |

START 8-19-19 COMPLETE 8-19-19 11:41 am

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 E 50th St N
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# GEOTECHNICAL TEST BORING LOG

GEOTEK # **19-E13** BORING NO. **4 (1 of 1)**

PROJECT **Proposed Street & Utility Improvements, S. Glenn Avenue, W. 2nd Street & W. 4th Street, Colton, SD**

| DEPTH in FEET | DESCRIPTION OF MATERIAL | GEOLOGIC ORIGIN | N | WL | SAMPLE NO. | SAMPLE TYPE | WC | D | LL | PL | QU |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 0.3 | **ASPHALT**: 3" thick | | | | | | | | | | |
| 1 | **FILL, MOSTLY CLAYEY SAND**: with gravel, medium grained, brown, moist, 9" thick | EXISTING GRAVEL BASE | | | | | | | | | |
| 2½ | **FILL, MOSTLY LEAN CLAY**: dark brown, moist | FILL | 9 | | 1 | SPT | 22 | 105 | | | |
| 7 | **LEAN CLAY**: mottled brown and gray, moist to wet, firm, (CL) | LOESS | 6 | | 2 | SPT | | | | | |
| | | | 7 | | 3 | SPT | 23 | 99 | | | |
| 9½ | **SANDY LEAN CLAY**: a little gravel, brown, moist, stiff, (CL) | GLACIAL TILL | 13 | | 4 | SPT | | | | | |
| 12 | **LEAN CLAY WITH SAND**: a little gravel, brown, moist, stiff, (CL) | GLACIAL TILL | 9 | | 5 | SPT | 15 | | | | |
| | **LEAN CLAY**: a trace of gravel, brown, moist, firm, (CL) | GLACIAL FLUVIAL | | ▼ (12) | | | | | | | |
| | | | 6 | | 6 | SPT | 21 | | | | |
| 16 | | | 8 | | 7 | SPT | | | | | |
| | Bottom of borehole at 16 feet. | | | | | | | | | | |

WATER LEVEL MEASUREMENTS

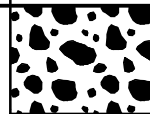
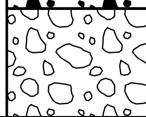
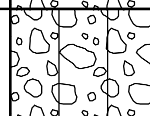
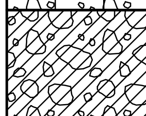
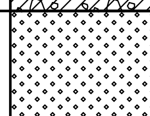
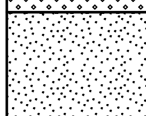
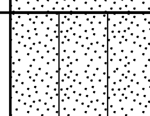
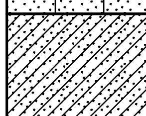
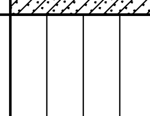
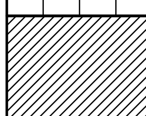
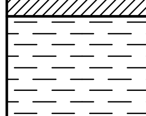
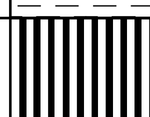
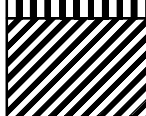
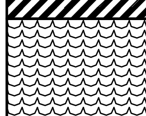
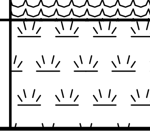
| DATE | TIME | SAMPLED DEPTH | CASING DEPTH | CAVE-IN DEPTH | WATER LEVEL |
|---|---|---|---|---|---|
| 8-19-19 | 1:14 pm | 16 | -- | 14 | ▼ 12 |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |
| -- | -- | -- | -- | -- | -- |

START 8-19-19 COMPLETE 8-19-19 12:42 pm

METHOD
3.25" ID Hollow Stem Auger

CREW CHIEF Mike Wagner

# SOIL CLASSIFICATION CHART

| MAJOR DIVISIONS | | | SYMBOLS GRAPH | SYMBOLS LETTER | TYPICAL DESCRIPTIONS |
|---|---|---|---|---|---|
| COARSE GRAINED SOILS | GRAVEL AND GRAVELLY SOILS | CLEAN GRAVELS |  | GW | WELL-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | | (LITTLE OR NO FINES) |  | GP | POORLY-GRADED GRAVELS, GRAVEL - SAND MIXTURES, LITTLE OR NO FINES |
| | MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE | GRAVELS WITH FINES |  | GM | SILTY GRAVELS, GRAVEL - SAND - SILT MIXTURES |
| | | (APPRECIABLE AMOUNT OF FINES) |  | GC | CLAYEY GRAVELS, GRAVEL - SAND - CLAY MIXTURES |
| MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE | SAND AND SANDY SOILS | CLEAN SANDS |  | SW | WELL-GRADED SANDS, GRAVELLY SANDS, LITTLE OR NO FINES |
| | | (LITTLE OR NO FINES) |  | SP | POORLY-GRADED SANDS, GRAVELLY SAND, LITTLE OR NO FINES |
| | MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE | SANDS WITH FINES |  | SM | SILTY SANDS, SAND - SILT MIXTURES |
| | | (APPRECIABLE AMOUNT OF FINES) |  | SC | CLAYEY SANDS, SAND - CLAY MIXTURES |
| FINE GRAINED SOILS | SILTS AND CLAYS | LIQUID LIMIT LESS THAN 50 |  | ML | INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS OR CLAYEY SILTS WITH SLIGHT PLASTICITY |
| | | |  | CL | INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS |
| | | |  | OL | ORGANIC SILTS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY |
| MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE | SILTS AND CLAYS | LIQUID LIMIT GREATER THAN 50 |  | MH | INORGANIC SILTS, MICACEOUS OR DIATOMACEOUS FINE SAND OR SILTY SOILS |
| | | |  | CH | INORGANIC CLAYS OF HIGH PLASTICITY |
| | | |  | OH | ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS |
| HIGHLY ORGANIC SOILS | | |  | PT | PEAT, HUMUS, SWAMP SOILS WITH HIGH ORGANIC CONTENTS |

NOTE: DUAL SYMBOLS ARE USED TO INDICATE BORDERLINE SOIL CLASSIFICATIONS

# BORING LOG SYMBOLS AND DESCRIPTIVE TERMINOLOGY

## SYMBOLS FOR DRILLING AND SAMPLING

| Symbol | Definition |
|---|---|
| Bag | Bag sample |
| CS | Continuous split-spoon sampling |
| DM | Drilling mud |
| FA | Flight auger; number indicates outside diameter in inches |
| HA | Hand auger; number indicates outside diameter in inches |
| HSA | Hollow stem auger; number indicates inside diameter in inches |
| LS | Liner sample; number indicates outside diameter of liner sample |
| N | Standard penetration resistance (N-value) in blows per foot |
| NMR | No water level measurement recorded, primarily due to presence of drilling fluid |
| NSR | No sample retrieved; classification is based on action of drilling equipment and/or material noted in drilling fluid or on sampling bit |
| SH | Shelby tube sample; 3-inch outside diameter |
| SPT | Standard penetration test (N-value) using standard split-spoon sampler |
| SS | Split-spoon sample; 2-inch outside diameter unless otherwise noted |
| WL | Water level directly measured in boring |
| ▼ | Water level symbol |

## SYMBOLS FOR LABORATORY TESTS

| Symbol | Definition |
|---|---|
| WC | Water content, percent of dry weight; ASTM:D2216 |
| D | Dry density, pounds per cubic foot |
| LL | Liquid limit; ASTM:D4318 |
| PL | Plastic limit; ASTM:D4318 |
| QU | Unconfined compressive strength, pounds per square foot; ASTM:D2166 |

## DENSITY/CONSISTENCY TERMINOLOGY

| Density Term | N-Value | Consistency Term |
|---|---|---|
| Very Loose | 0-4 | Soft |
| Loose | 5-8 | Firm |
| Medium Dense | 9-15 | Stiff |
| Dense | 16-30 | Very Stiff |
| Very Dense | Over 30 | Hard |

## DESCRIPTIVE TERMINOLOGY

| Term | Definition |
|---|---|
| Dry | Absence of moisture, powdery |
| Frozen | Frozen soil |
| Moist | Damp, below saturation |
| Waterbearing | Pervious soil below water |
| Wet | Saturated, above liquid limit |
| Lamination | Up to ½” thick stratum |
| Layer | ½” to 6” thick stratum |
| Lens | ½” to 6” discontinuous stratum |

## PARTICLE SIZES

| Term | Particle Size |
|---|---|
| Boulder | Over 12” |
| Cobble | 3” – 12” |
| Gravel | #4 – 3” |
| Coarse Sand | #10 – #4 |
| Medium Sand | #40 – #10 |
| Fine Sand | #200 – #40 |
| Silt and Clay | passes #200 sieve |

## GRAVEL PERCENTAGES

| Term | Range |
|---|---|
| A trace of gravel | 2-4% |
| A little gravel | 5-15% |
| With gravel | 16-50% |

GEOTEK ENGINEERING
& TESTING SERVICES, INC.
909 East 50th Street North
Sioux Falls, SD 57104
605-335-5512 Fax 605-335-0773
www.geotekeng.com

# MOISTURE - DENSITY TEST REPORT

**REPORTED TO:**

City of Colton
Rick Lehman
309 E 4th St
PO Box 66
Colton, SD 57018

**PROJECT:** 19-E13

Proposed Street & Utility Improvements
S. Glenn Avenue, W. 2nd Street & W. 4th Street
Colton, SD

**COPIES TO:**

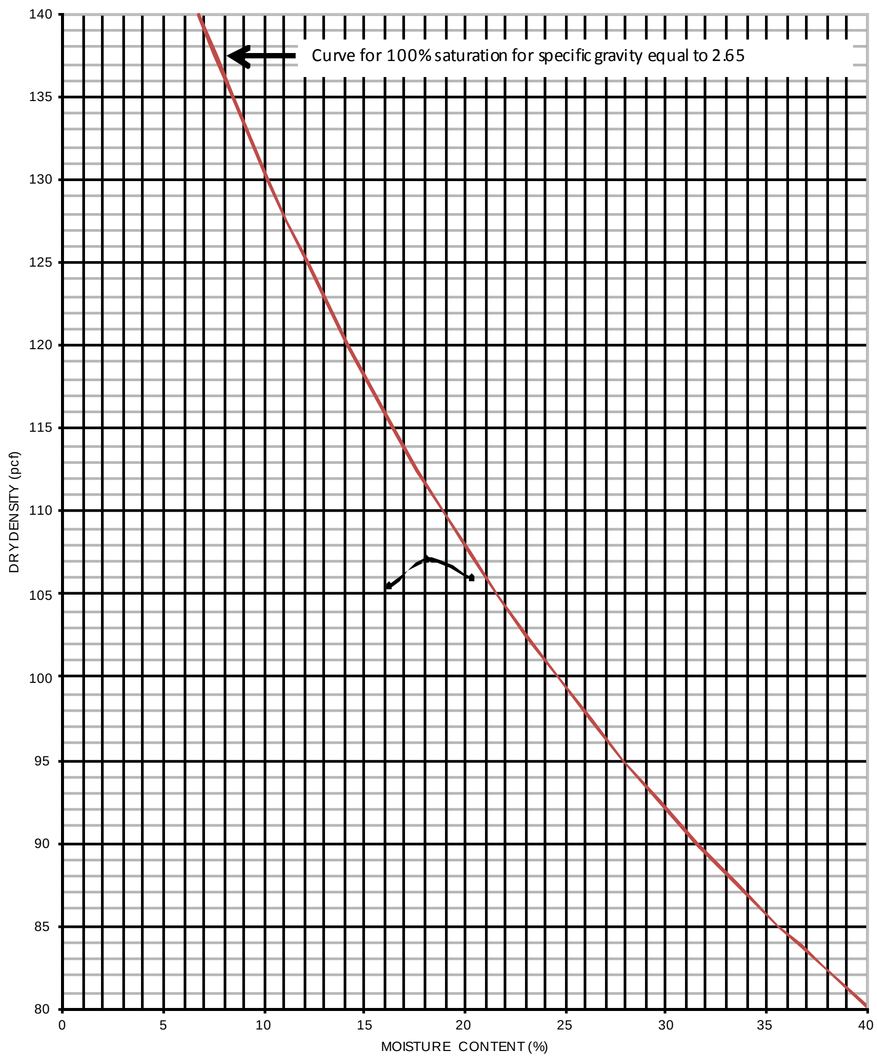
**DATE REPORTED:** 8/26/2019

## SAMPLE DATA

**Sample No.:** 1
**ASTM Test Method:** D698B Manual
**Soil Classification:** Lean Clay, Brown (CL) -1
**Remarks:** SB 1 (3' - 7')

**Date Received:** 8/19/2019
**Date Tested:** 8/21/2019

## TEST DATA




| | |
|---|---|
| **Maximum Density, pcf:** | 107.1 |
| **Optimum Moisture, %:** | 18.1 |
| **Percent Passing, %:** | |
| **3/4":** | 100 |
| **3/8":** | 100 |
| **#4:** | 100 |
| **#200:** | 92 |

**Atterberg Limits (ASTM: D4318):**
**Liquid Limit:**
**Plastic Limit:**
**Plasticity Index:**

Nick Bierle, Staff Engineer

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# MOISTURE - DENSITY TEST REPORT

**REPORTED TO:**

City of Colton
Rick Lehman
309 E 4th St
PO Box 66
Colton, SD 57018

**PROJECT:** 19-E13

Proposed Street & Utility Improvements
S. Glenn Avenue, W. 2nd Street & W. 4th Street
Colton, SD

**COPIES TO:**

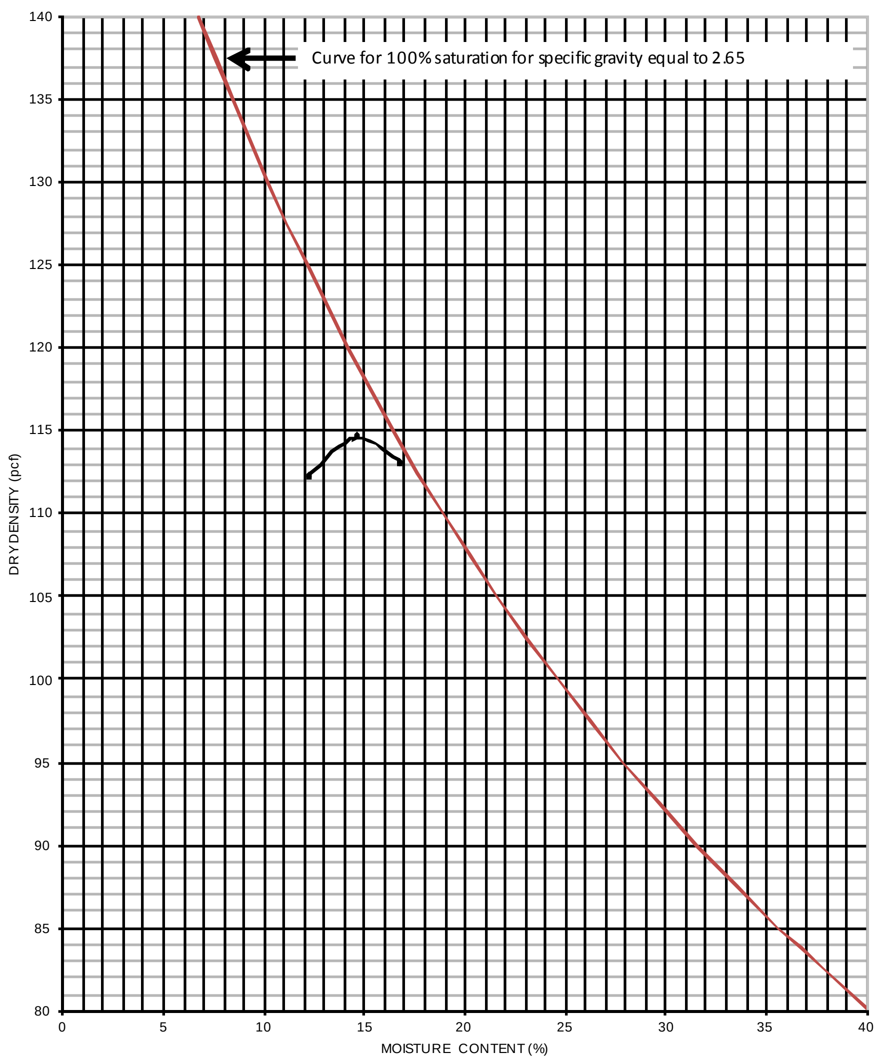
**DATE REPORTED:** 8/26/2019

## SAMPLE DATA

**Sample No.:** 2
**ASTM Test Method:** D698B Manual
**Soil Classification:** Sandy Lean Clay, Brown (CL) -2
**Remarks:** SB 3 (9 1/2' - 14 1/2')

**Date Received:** 8/19/2019
**Date Tested:** 8/21/2019

## TEST DATA




| | |
|---|---|
| **Maximum Density, pcf:** | 114.6 |
| **Optimum Moisture, %:** | 14.6 |
| **Percent Passing, %:** | |
| **3/4":** | 100 |
| **3/8":** | 100 |
| **#4:** | 100 |
| **#200:** | 69 |
| **Atterberg Limits (ASTM: D4318):** | |
| **Liquid Limit:** | |
| **Plastic Limit:** | |
| **Plasticity Index:** | |

Nick Bierle, Staff Engineer