# Speesoil Inc.

**Preliminary Soil Study**
**Peyton Pass Commercial**
**El Paso County, Texas**


**Contract Drilling**
**Soil & Material Testing**
**Geotechnical Consultant**

3600 Esper Drive, El Paso, TX 79936 Tel: 921-1314 Fax: 921-9339

Speesoil Inc.
SPG11070 3600 Esper Drive, El Paso, Texas 79936 Tel: 915-921-1314 Fax: 921-9339

April 25, 2011

Hunt Communities, LLC
4401 North Mesa
El Paso, Texas 79902

Attn: Mr. Jose L. Lares, Jr., P.E.

Re: Preliminary Soil Study
Peyton Pass Commercial
El Paso County, Texas

## INTRODUCTION

This geotechnical engineering report is prepared pursuant to a subsurface soil investigation conducted at the proposed Peyton Pass Commercial to be developed in El Paso County, Texas.

The purpose of this soil study is to investigate the subsurface soil conditions underlying the proposed construction site in order to provide soil information and earthwork recommendations for the development of Peyton Pass Commercial in El Pass County, Texas.

This soil study was authorized by Mr. Jose L. Lares, Jr., P.E. on behalf of Hunt Communities, LLC.

## SCOPE OF WORK

Our soil study conducted at the proposed Peyton Pass Commercial consisted of field explorations at the site, laboratory tests on soil samples collected from the field and earthwork recommendations for the development of the new subdivision.

## FIELD INVESTIGATION

Our field investigation program consisted of both site observation and test boring explorations. The site observation was made on foot to scrutinize the kind of vegetation, evidence of any soil erosion and gullying, the character of the terrain, and the structural condition of any nearby buildings.

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The test boring exploration consisted of drilling four (4) test holes. The location of the test borings is shown on the Plan of Borings, Plate 1 in the Appendix of this report.

Test borings were drilled in accordance with ASTM D1586 using a CME-55 Drilling Rig equipped with 6-in hollow stem augers. Test boring B-1 was completed to the depths of 25-ft while test borings B-2, B-3 and B-4 to the depths of 15-ft. The relative density of the soils was determined by conducting Standard Penetration Tests at the depths of 0 to 1.5, 1.5 to 3, 3 to 4.5, 4.5 to 6, 7.5 to 9, 10 to 11.5, 13.5 to15, 18.5 to 20 and 23.5 to 25-ft using a 2-in split spoon sampler. The Standard Penetration tests were conducted by a 140-pound automatic drop hammer.

Split Spoon sampling was the method used in the field to collect soil samples. All samples were examined and logged in accordance with the soil's color, moisture, consistency and texture by our engineering staff at the site. Split spoon samples collected in the field were sealed in moisture proof plastic bags and delivered to our laboratory for further study and testing.

Field Percolation Tests

A percolation test was conducted at the proposed ponding area. The percolation rate of water in the sandy soil was 2.5 minutes per inch. The results of the percolation test are shown on Plate 7 in the Appendix of this report.

## SOIL LABORATORY TESTING

All soil samples collected in the field were delivered to our laboratory for further examination and classification by our soil engineer. Soil tests were conducted on the samples to determine the Atterberg Limits, Moisture Content and Percent Passing #200 Mesh Sieve.

Test results were used to determine the engineering behavior of subsurface soils at the site. They were also used to aid the classification of soil samples and identification of soil strata. The results of all the field and laboratory tests are presented on the boring logs as shown on Plates 2 through 5 in the Appendix of this report.

## CONSTRUCTION SITE CONDITION

Geological Setting

According to the USDA Soil Survey of El Paso County, the referenced property is located in the Hueco Bolson.

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Soils in this region belong to the Bluepoint Association, which consists primarily of nearly level and gently sloping soils that have a fine sandy loam subsoil and are moderately deep over caliche.

Site Condition & Vegetation

At the time when we conducted the field exploration at the site, the site appeared to be virgin desert land. The site was covered by desert vegetation. Vegetation appeared to be health.

No surface water was retained at the site. The site slopes from east to west gently.

Soil Stratigraphy

Subsurface soils encountered at the site were predominantly poorly graded sand with silt. The maximum depth explored was 25-ft.

Soil was at a loose to dense relative density. The Standard Penetration Test conducted at the site revealed 7 to 40 blow counts per foot. The sandy soil was non-cohesive. The soil is classified as SM-SP and SP in accordance with the Unified Soil Classification System.

Soils encountered at the site are classified as Class "D" in accordance with International Building Code.

Clay was not totally exclusive at the site. It exists at some isolated spots occasionally. In test boring B-2, a stratum of highly plastic clay was encountered at the depths of 3.5 to 4.5-ft. The clay has tested liquid limit of 80 and plasticity index of 52.

Groundwater

No groundwater was encountered at the site at the time of our field explorations on April 18, 2011. Soil was at a dry condition. The maximum depth explored in our test borings was 25-ft.

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## DISCUSSION AND RECOMMENDATIONS

### Geotechnical Engineering Discussion

1. Poorly graded sand was the dominant material encountered at the site. Soil was generally at a medium dense relative density. We believe the soil can provide enough bearing capacity to support the proposed structures at the site. However, some surface loose sand was found in test boring B-3.

2. The poorly graded sand encountered at the site was totally non-cohesive. Most of the sandy soil contains less than 5 percent of silty material passing No. 200 Sieve.

3. Clay was not completely exclusive at the site. In test boring B-2, a small stratum of clay was encountered at the depths of 3.5 to 4.5-ft. The clay has tested liquid limit of 80 and plasticity index of 52.

4. Desert vegetation at the site appeared to be health.

5. The site slopes gently from east to west. The proposed development will involve earthworks of both cut and fill.

6. No groundwater was encountered at the site at the time of our field explorations.

### Structure Information

The proposed construction site will be developed into a commercial estate. It consists of commercial lots and city streets. A retention pond will be constructed to the west of Peyton Drive. The earthwork for the development of the commercial property involves of both cut and fill.

### Potential Vertical Rise (PVR) of Clayey Soil

Poorly graded sand was the dominant material encountered at the site. The sandy material is non-plastic in nature. It will not create any significant amount of potential vertical movement.

Occasionally, some small amounts of clay was encountered at the site as we found a stratum of clay in test boring B-2 at the depths of 3.5 to 4.5-ft. We believe the clay does not exist in a significant amount.

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## SOIL RECOMMENDATIONS

### Earthwork Operations

Based on the four (4) test borings conducted at the site, we understand non-cohesive poorly graded sand was the dominant material encountered at the property. Soils were generally at medium dense relative density.

We understand the development at Peyton Pass Commercial will involve earthworks of both cut and fill. We recommend the earthwork at the subdivision be conducted as follows.

### Cut Areas

Once the soil has been excavated down to the finish grade, we recommend a minimum of 12-inches of native soil below the finish grade be scarified and then re-compacted to at least 95% of the maximum dry density per ASTM D 1557. Field density tests should be performed at the site to confirm the compaction.

### Fill Areas

For the portions of the construction site which will be developed by filling methods, we recommend the earthwork operations be conducted as follows.

1 Prior to the placement of any fill material at the site, the exposed subgrade should be scarified to the depths of 12-inches and then re-compacted to at least 95% of the maximum dry density per ASTM D 1557.

2 All fill material to be placed at the site should be placed at 8-inches loose lifts. Each lift should be compacted to at least 95% of the maximum dry density per ASTM D 1557.

3 All fill material to be placed at the site should be engineered fill. The specifications for engineered fill and compaction requirements are detailed on the following section. Native sandy soil excavated from the site with tested plasticity index less than 12 could be stockpiled at the site to be used as engineered fill.

4 Prior to the construction, all surface organic soil and vegetation should be removed and disposed of off the construction site.

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## SPECIFICATION FOR EARTHWORK

Engineered Fill (Structural Fill)

Material used as engineered fill should be granular, free of clay and organic soil and shall not contain gravel larger than 3-inches in its greatest dimension. Engineered fill should not possess plasticity index larger than 12. Native soil with tested plasticity index less than 12 could be used as engineered fill.

Soils classified in the following list according to the Unified Soil Classification System are considered satisfactory for engineered fill:

| | |
|---|---|
| Silty sand, | SM |
| Well/Poorly graded sand with silt | SM-SW, SM-SP |
| Sandy gravel with silt | GM |
| Well/Poorly graded gravel with sand/silt | GM-GW, GM-GP |

Soils classified in the following list according to the Unified Soil Classification System **are not** considered satisfactory for engineered fill.

| | |
|---|---|
| Fat Plastic Clay, | CH |
| Lean Plastic Clay | CL |
| Silt, Clayey slightly | ML |
| Silt, Clayey highly | MH |
| Organic silt or clay | OL, OH |
| Peat, | Pt |

Compaction of Fill

We recommend engineered fill be placed in 8-inches loose lifts. Each lift should be compacted to at least 95% of maximum density as determined by the ASTM D 1557 compaction test.

The water content of the fill should be maintained at ±3 percent of the optimum water content until the engineered fill is permanently covered.

Moisture-Density Relationship Proctor Curve should be developed for each kind of fill material to be placed at the site. We only recommend engineered fill be used as backfill material at construction site. SpeeSoil, Inc. can provide these testing services.

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## LIMITATIONS

This soil study is conducted in accordance with the professional geotechnical engineering practice and principles.

Soil analysis and recommendations provided in this report are based on soil data obtained from the four (4) test borings drilled at the site on April 18, 2011. The engineering behavior of soil is often controlled by its fracture, joints and weak layer in the material.

However, it should be understood that soil engineering is more a state-of-art. It is highly empirical. Soils are more heterogeneous than homogeneous in nature. The engineering properties of the soil are not same in all directions. It is quite common to find the variations of soil conditions within a distance of even few feet. It is possible that soil samples collected from our four (4) test borings may not reflect the change of soil conditions across the site. At the time of construction, if variations of soil conditions were observed at the site, it is necessary to inform us to reevaluate the recommendations of this report.

SpeeSoil, Inc. appreciates the opportunity to conduct the soil study on this project. We are looking forward to providing you soil engineering and material testing services in the future. Should any questions arise concerning this report, please feel free to discuss with us.

Respectfully submitted,

**SpeeSoil Incorporated**

**Patrick L. Shing, P.E.**
Principal

PLS/yc
Copies submitted: Above (3)

# APPENDIX

# SpeeSoil, Inc.

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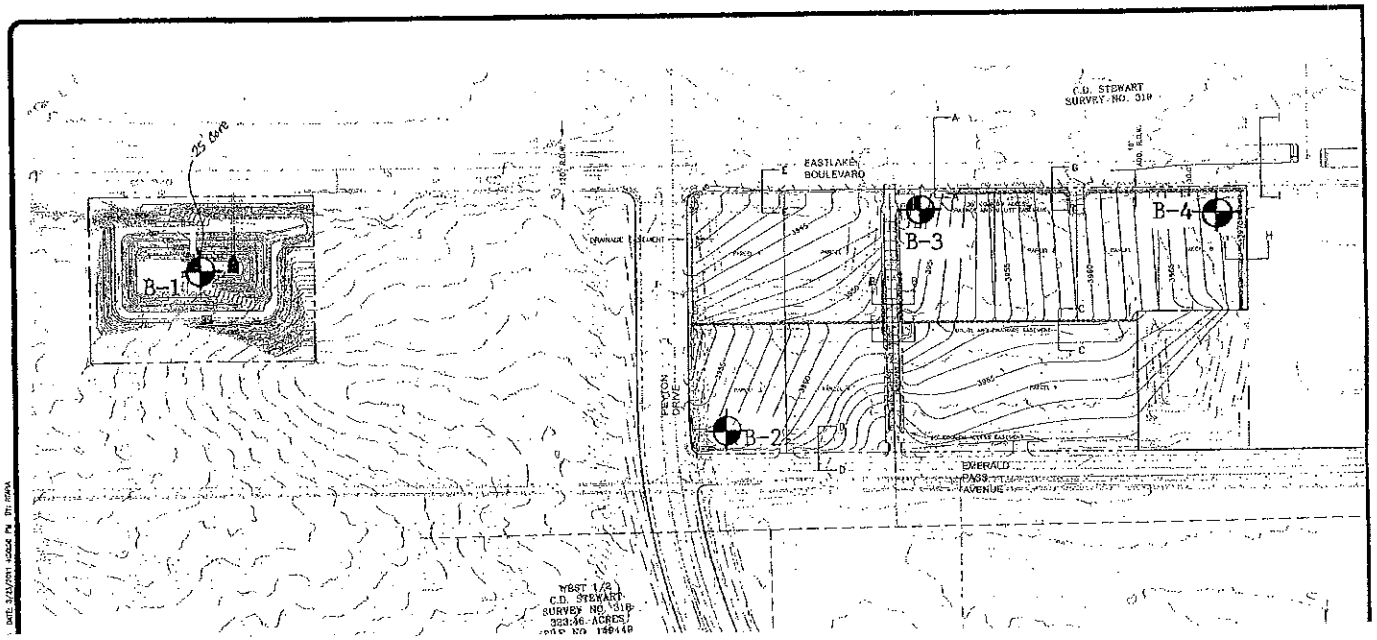
## BORING PLAN

Preliminary SOil Study
Peyton Pass Commercial
El Paso County, Texas




B-1 BORING NO. & LOCATION

PLATE 1

**SpeeSoil Inc.**

3600 Esper Drive, El Paso, TX 79936
(915) 921-1314
patshing@gmail.com

# TEST BORING LOG NO: B-1

**Project Name:** Peyton Pass Commercial, El Paso County, Texas SPG11070
**Test Boring Location:** See Boring Plan, Plate 1
**Date of Drilling:** 4-18-11 **Driller :** JD/KW **Logger:** PS
**Rig & Boring Type:** CME-55 with 6" OD Hollow Stem Auger

| Depth(ft) | Symbol | Sam. | Visual Soil Classification | USCS | SPT | -200 | LL | PL | PI | MC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | | | SAND, fine to medium, silty, light brown, poorly graded, medium | SM | | | | | | |
| 1 | | X | dense, dry | SP | | | | | | |
| 1.5 | | X | | | 22 | 8 | | | | 3 |
| 2 | | | | | | | | | | |
| 2.5 | | X | | | | | | | | |
| 3 | | X | | | 12 | | | | | |
| 3.5 | | | SAND, fine to medium, light brown, poorly graded, medium | SP | | | | | | |
| 4 | | X | dense, dry | | | | | | | |
| 4.5 | | X | | | 17 | 1 | | | | 2 |
| 5 | | | | | | | | | | |
| 5.5 | | X | | | | | | | | |
| 6 | | X | | | 17 | | | | | |
| 6.5 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 7.5 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 8.5 | | X | | | | | | | | |
| 9 | | X | | | 15 | | | | | |
| 9.5 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 10.5 | | | | | | | | | | |
| 11 | | X | | | | | | | | |
| 11.5 | | X | | | 17 | | | | | |
| 12 | | | | | | | | | | |
| 12.5 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 13.5 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 14.5 | | X | | | | | | | | |
| 15 | | X | | | 28 | 4 | | | | 3 |
| 15.5 | | | | | | | | | | |
| 16 | | | | | | | | | | |
| 16.5 | | | | | | | | | | |
| 17 | | | Please see Plate 3 for the remaining depths. | | | | | | | |
| 17.5 | | | | | | | | | | |

Boring Completed at the depth of 25-ft

**Notes:**

Sample ~ 2" O.D. split spoon sample
USCS ~ Unified Soil Classification System
SPT ~ Standard Penetration Test, blows per foot
-200 ~ Soil Passing No. 200 sieve
LL ~ Liquid Limit
PL ~ Plastic Limit
PI ~ Plasticity Index
MC ~ Moisture Content of Soil Sample

**Groundwater: None Observed**

**SpeeSoil Inc.**

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# TEST BORING LOG NO: B-1

**Project Name:** Peyton Pass Commercial, El Paso County, Texas SPG11070
**Test Boring Location:** See Boring Plan, Plate 1
**Date of Drilling:** 4-18-11 **Driller :** JD/KW **Logger:** PS
**Rig & Boring Type:** CME-55 with 6" OD Hollow Stem Auger

| Depth(ft) | Symbol | Sam. | Visual Soil Classification | USCS | SPT | -200 | LL | PL | PI | MC |
|---|---|---|---|---|---|---|---|---|---|---|
| 18 | | | SAND, fine to medium, light brown, poorly graded, dense, dry | SP | | | | | | |
| 18.5 | | | | | | | | | | |
| 19 | | | | | | | | | | |
| 19.5 | | X | | | | | | | | |
| 20 | | X | | | 40 | | | | | |
| 20.5 | | | | | | | | | | |
| 21 | | | | | | | | | | |
| 21.5 | | | | | | | | | | |
| 22 | | | | | | | | | | |
| 22.5 | | | | | | | | | | |
| 23 | | | | | | | | | | |
| 23.5 | | | | | | | | | | |
| 24 | | | | | | | | | | |
| 24.5 | | X | | | | | | | | |
| 25 | | X | | | 32 | 4 | | | | 2 |

Boring Completed at the depth of 25-ft

**Notes:**

Sample ~ 2" O.D. split spoon sample
USCS ~ Unified Soil Classification System
SPT ~ Standard Penetration Test, blows per foot
-200 ~ Soil Passing No. 200 sieve
LL ~ Liquid Limit
PL ~ Plastic Limit
PI ~ Plasticity Index
MC ~ Moisture Content of Soil Sample

**Groundwater: None Observed**

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# TEST BORING LOG NO: B-2

**Project Name:** Peyton Pass Commercial, El Paso County, Texas SPG11070
**Test Boring Location:** See Boring Plan, Plate 1
**Date of Drilling:** 4-18-11 **Driller :** JD/KW **Logger:** PS
**Rig & Boring Type:** CME-55 with 6" OD Hollow Stem Auger

| Depth(ft) | Symbol | Sam. | Visual Soil Classification | USCS | SPT | -200 | LL | PL | PI | MC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | | | SAND, fine to medium, light brown, poorly graded, medium dense, dry | SP | | | | | | |
| 1 | | X | | | 15 | | | | | |
| 1.5 | | X | | | | | | | | |
| 2 | | | | | | | | | | |
| 2.5 | | X | | | | | | | | |
| 3 | | X | | | 20 | 1 | | | | 2 |
| 3.5 | | | | | | | | | | |
| 4 | | X | CLAY, sandy, silty, brown, very stiff, moist | CH | 20 | 79 | 80 | 28 | 52 | 27 |
| 4.5 | | X | | | | | | | | |
| 5 | | | SAND, fine to medium, light brown, poorly graded, dense to medium dense, moist to dry | SP | | | | | | |
| 5.5 | | X | | | 32 | 2 | | | | 4 |
| 6 | | X | | | | | | | | |
| 6.5 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 7.5 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 8.5 | | X | | | | | | | | |
| 9 | | X | | | 28 | | | | | |
| 9.5 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 10.5 | | | | | | | | | | |
| 11 | | X | | | | | | | | |
| 11.5 | | X | | | 30 | 2 | | | | 4 |
| 12 | | | | | | | | | | |
| 12.5 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 13.5 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 14.5 | | X | | | | | | | | |
| 15 | | X | | | 21 | | | | | |

Boring Completed at the depth of 15-ft

**Notes:**

Sample ~ 2" O.D. split spoon sample
USCS ~ Unified Soil Classification System
SPT ~ Standard Penetration Test, blows per foot
-200 ~ Soil Passing No. 200 sieve
LL ~ Liquid Limit
PL ~ Plastic Limit
PI ~ Plasticity Index
MC ~ Moisture Content of Soil Sample

**Groundwater: None Observed**

**SpeeSoil Inc.**

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# TEST BORING LOG NO: B-3

**Project Name:** Peyton Pass Commercial, El Paso County, Texas SPG11070
**Test Boring Location:** See Boring Plan, Plate 1
**Date of Drilling:** 4-18-11 **Driller :** JD/KW **Logger:** PS
**Rig & Boring Type:** CME-55 with 6" OD Hollow Stem Auger

| Depth(ft) | Symbol | Sam. | Visual Soil Classification | USCS | SPT | -200 | LL | PL | PI | MC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | | | SAND, fine, silty, brown, loose, dry | SM | | | | | | |
| 1 | | X | | | | | | | | |
| 1.5 | | X | NP - non plastic | | 8 | 25 | NP | NP | NP | 4 |
| 2 | | | SAND, fine, silty, brown, poorly graded, loose to medium | SM | | | | | | |
| 2.5 | | X | dense, dry | SP | | | | | | |
| 3 | | X | | | 7 | | | | | |
| 3.5 | | | | | | | | | | |
| 4 | | X | | | | | | | | |
| 4.5 | | X | | | 8 | 6 | | | | 3 |
| 5 | | | | | | | | | | |
| 5.5 | | X | | | | | | | | |
| 6 | | X | | | 10 | | | | | |
| 6.5 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 7.5 | | | SAND, fine to medium, light brown, poorly graded, medium | SP | | | | | | |
| 8 | | | dense, dry | | | | | | | |
| 8.5 | | X | | | | | | | | |
| 9 | | X | | | 18 | 3 | | | | 3 |
| 9.5 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 10.5 | | | | | | | | | | |
| 11 | | X | | | | | | | | |
| 11.5 | | X | | | 20 | | | | | |
| 12 | | | | | | | | | | |
| 12.5 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 13.5 | | | | | | | | | | |
| 14 | | | SAND, fine to medium, silty, brown, poorly graded, medium | SM | | | | | | |
| 14.5 | | X | dense, dry | SP | | | | | | |
| 15 | | X | - some clay nodules at 14' | | 16 | 6 | | | | 4 |

Boring Completed at the depth of 15-ft

**Notes:**

Sample ~ 2" O.D. split spoon sample
USCS ~ Unified Soil Classification System
SPT ~ Standard Penetration Test, blows per foot
-200 ~ Soil Passing No. 200 sieve
LL ~ Liquid Limit
PL ~ Plastic Limit
PI ~ Plasticity Index
MC ~ Moisture Content of Soil Sample

**Groundwater: None Observed**

**SpeeSoil Inc.**

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# TEST BORING LOG NO: B-4

**Project Name:** Peyton Pass Commercial, El Paso County, Texas SPG11070
**Test Boring Location:** See Boring Plan, Plate 1
**Date of Drilling:** 4-18-11 **Driller :** JD/KW **Logger:** PS
**Rig & Boring Type:** CME-55 with 6" OD Hollow Stem Auger

| Depth(ft) | Symbol | Sam. | Visual Soil Classification | USCS | SPT | -200 | LL | PL | PI | MC |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.5 | | | SAND, fine to medium, light brown, poorly graded, medium | SP | | | | | | |
| 1 | | X | dense, moist to dry | | | | | | | |
| 1.5 | | X | | | 17 | | | | | |
| 2 | | | | | | | | | | |
| 2.5 | | X | | | | | | | | |
| 3 | | X | | | 19 | 4 | | | | 4 |
| 3.5 | | | | | | | | | | |
| 4 | | X | | | | | | | | |
| 4.5 | | X | | | 23 | | | | | |
| 5 | | | | | | | | | | |
| 5.5 | | X | | | | | | | | |
| 6 | | X | | | 16 | 2 | | | | 4 |
| 6.5 | | | | | | | | | | |
| 7 | | | | | | | | | | |
| 7.5 | | | | | | | | | | |
| 8 | | | | | | | | | | |
| 8.5 | | X | | | | | | | | |
| 9 | | X | | | 18 | | | | | |
| 9.5 | | | | | | | | | | |
| 10 | | | | | | | | | | |
| 10.5 | | | | | | | | | | |
| 11 | | X | | | | | | | | |
| 11.5 | | X | | | 16 | 2 | | | | 5 |
| 12 | | | | | | | | | | |
| 12.5 | | | | | | | | | | |
| 13 | | | | | | | | | | |
| 13.5 | | | | | | | | | | |
| 14 | | | | | | | | | | |
| 14.5 | | X | | | | | | | | |
| 15 | | X | | | 15 | | | | | |

Boring Completed at the depth of 15-ft

**Notes:**

Sample ~ 2" O.D. split spoon sample
USCS ~ Unified Soil Classification System
SPT ~ Standard Penetration Test, blows per foot
-200 ~ Soil Passing No. 200 sieve
LL ~ Liquid Limit
PL ~ Plastic Limit
PI ~ Plasticity Index
MC ~ Moisture Content of Soil Sample

**Groundwater: None Observed**

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# PERCOLATION TEST P-1

## (PERCOLATION RATE: 2.5 minutes per inch in poorly graded sand )

**Project Name: Peyton Pass Commercial, El Paso County, Texas**

**Date of Test**: April 21, 2011

**Test Completed By**: RF

**Test Location** : Proposed Ponding Area

**Test Hole Diameter**: 10" (12-ft below existing street grade of Eastlake Blvd.)

**Soil Classification: SAND, fine, silty, brown, poorly graded, SP-SM**

**PERCOLATION RATE: 2.50 minutes per inch poorly graded sand.**

| TEST RESULTS | | | | | | | |
|---|---|---|---|---|---|---|---|
| Run No. | Time (min) | | | Water Level (in) | | | Percolation Rate |
| | Start | End | Change | Start | End | Change | (Min per in) |
| 1 | 3:35 | 3:48 | 0:13 | 20 | 13¾ | 6¼ | 2.08 |
| 2 | 3:48 | 3:55 | 0:07 | 13¾ | 8¾ | 5 | 1.40 |
| 3 | 3:55 | 4:05 | 0:10 | 8¾ | 4 | 4¾ | 2.10 |
| 4 | 4:15 | 4:25 | 0:10 | 20 | 16 | 4 | 2.50 |
| 5 | 4:25 | 4:35 | 0:10 | 16 | 12½ | 3½ | 2.86 |
| 6 | 4:35 | 4:45 | 0:10 | 12½ | 8½ | 4 | **2.50** |

**Remarks: Test was conducted in accordance with percolation Test procedure of "Construction Standards for On-site Sewerage Facilities" by Texas Department of Health.**

**Certified by:**

**Patrick L Shing, P.E.**
**Principal**

Date: April 21, 2011

# *SpeeSoil Inc.*

## TERMINOLOGY DESCRIBING RELATIVE DENSITY AND CONSISTENCY OF SOIL

The terminology appears on the boring logs to describe the relative density, consistency of soils determined by the Standard Penetration Tests is presented below.

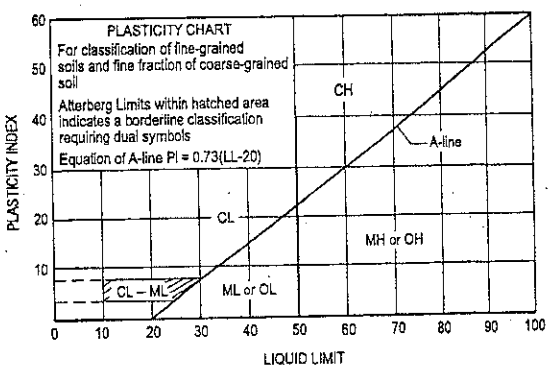
In the Standard Penetration Test (ASTM D 1586) the split spoon had an outside diameter of 2 in. and an inside diameter of 1-3/8 in. This split spoon sampler is driven into the soil stratum by means of a 140-lb hammer falling a distance of 30-inches and striking an anvil at the upper end of the drill rod to which the spoon is attached. When the sampler is so driven the operation is known as the Standard Penetration Test and the number of blows of the hammer required to cause the sampler to penetrate 12-inches into the soil is called the Standard Penetration Values or the N Values. The relation between the N values and the relative density and consistency of soil is presented as follows.

Relative Density of Gravel, Sand

| N Values | Relative Density |
|---|---|
| 0 - 4 | very loose |
| 5 - 10 | loose |
| 11 - 30 | medium dense |
| 31 - 50 | dense |
| 50+ | very dense |

Relative Consistency of Clay

| N Values | Relative Consistency |
|---|---|
| 0 - 2 | very soft |
| 3 - 4 | soft |
| 5 - 8 | firm |
| 9 - 15 | stiff |
| 16 - 30 | very stiff |
| 30+ | hard |

| MAJOR DIVISIONS | | | GROUP SYMBOLS | TYPICAL NAMES | CLASSIFICATION CRITERIA | | |
|---|---|---|---|---|---|---|---|
| COARSE-GRAINED SOILS<br>More than 50% retained on 0.075 mm (No. 200) sieve | GRAVELS<br>50% or more of coarse fraction retained on 4.75 mm (No. 4) sieve | CLEAN GRAVELS | GW | Well-graded gravels and gravel-sand mixtures, little or no fines | Classification on basis of percentage of fines<br>Less than 5% Pass 0.075 mm sieve GW, GP, SW, SP<br>More than 12% Pass 0.075 mm sieve GM, GC, SM, SC<br>5% to 12% Pass 0.075 mm sieve Border Classification requiring use of dual symbols | $C_u = D_{60}/D_{10}$ Greater than 4<br>$C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | |
| | | | GP | Poorly graded gravels and gravel-sand mixtures, little or no fines | | Not meeting both criteria for GW | |
| | | GRAVELS WITH FINES | GM | Silty gravels, gravel-sand-silt mixtures | | Atterberg limits plot below "A" line or plasticity index less than 4 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols |
| | | | GC | Clayey gravels, gravel-sand-clay mixtures | | Atterberg limits plot above "A" line and plasticity index greater than 7 | |
| | SANDS<br>More than 50% of coarse fraction passes 4.75 mm (No. 4) sieve | CLEAN SANDS | SW | Well-graded sands and gravelly sands, little or no fines | | $C_u = D_{60}/D_{10}$ Greater than 6<br>$C_z = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ Between 1 and 3 | |
| | | | SP | Poorly graded sands and gravelly sands, little or no fines | | Not meeting both criteria for SW | |
| | | SANDS WITH FINES | SM | Silty sands, sand-silt mixtures | | Atterberg limits plot below "A" line or plasticity index less than 4 | Atterberg limits plotting in hatched area are borderline classifications requiring use of dual symbols |
| | | | SC | Clayey sands, sand-clay mixtures | | Atterberg limits plot above "A" line and plasticity index greater than 7 | |
| FINE-GRAINED SOILS<br>50% or more passing 0.075 mm (No. 200) sieve | SILTS AND CLAYS<br>Liquid limit 50% or less | | ML | Inorganic silts, very fine sands, rock flour, silty or clayey fine sands |  | |
| | | | 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 | | | |
| | SILTS AND CLAYS<br>Liquid limit 50% or greater | | MH | Inorganic silts, micaceous or diatomaceous fine sands or silts, elastic silts | | | |
| | | | CH | Inorganic clays of high plasticity, fat clays | | | |
| | | | OH | Organic clays of medium to high plasticity | | | |
| Highly Organic Soils | | | PT | Peat, muck and other highly organic soils | Visual-manual identification, See ASTM Designation D 2488. | | |