

**Attachment E**

**Geotechnical Investigation for WCS CISF**

(83 pages)



August 20, 2015

Waste Control Specialists, LLC  
Three Lincoln Center  
Suite 1700  
Dallas, Texas 75240

ATTENTION: Mr. Ken Caldwell, PE – Senior Engineer  
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Subject: **REPORT OF GEOTECHNICAL EXPLORATION**  
Consolidated Interim Storage Facility  
Andrews, Texas  
GEOServices Project No. 31-151247

Dear Mr. Caldwell:

We are submitting the results of the geotechnical exploration performed for the proposed Consolidated Interim Storage Facility (CISF) in Andrews, Texas. The geotechnical exploration was performed in accordance with GEOServices' Proposal No. 13-151124Rev1 dated June 23, 2015 and authorized by you.

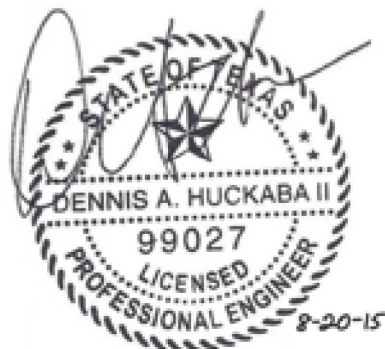
The following report presents our findings and recommendations for the proposed construction of the Consolidated Interim Storage Facility project. Should you have any questions regarding this report, or if we can be of any further assistance, please contact us at your convenience.

Sincerely,

**GEOServices, LLC**

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# **REPORT OF GEOTECHNICAL EXPLORATION**

## **CONSOLIDATED INTERIM STORAGE FACILITY (CISF)**

**ANDREWS, TEXAS**

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**GEOSERVICES, LLC  
PROJECT NO. 31-151247**

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## **1.0 INTRODUCTION**

### **1.1 PURPOSE**

The purpose of this geotechnical exploration was to characterize the subsurface conditions for the design and construction of the Consolidated Interim Storage Facility (CISF) in Andrews, Texas. This report provides recommendations for general site preparation, foundation design, slab-on-grade construction, seismic considerations, and pavement design recommendations.

### **1.2 PROJECT DESCRIPTION**

The project site is located at the existing Waste Control Specialists (WCS) Andrews facility located at 9998 Highway 176 West in Andrews, Texas. The proposed construction will consist of a 200-acre storage facility. The Consolidated Interim Storage Facility (CISF) will consist of eight consolidated interim storage facilities, transfer facility, administration building, concrete batch plant (future) and a retention basin. Each of the consolidated interim storage facilities are planned to be 210,000 square feet (700 feet by 300 feet) in size. At the time of this proposal, we understand that typical mat foundation loading of 3,000 pounds per square foot (psf) is expected for each of the storage facilities. We understand that the construction of the storage facilities are planned to consist of concrete cast-in-place construction supported on mat foundations. We understand that various materials are planned to be stored inside the structures. This exploration was performed for one of the consolidated interim storage facilities, the transfer facility, and the administration building.

The 200-acre tract of land is currently undeveloped with the exception of access roads that cross from one property to the adjacent property. Based on information obtained from internet research, site elevations range from approximately 3,505 feet Mean Sea Level (MSL) along the eastern property boundary to approximately 3,490 feet MSL along the western property boundary. At this

time, we have not been provided with any final grading plans for this project. Based on the existing elevations, maximum earthwork cuts and fills of 10 feet or less are anticipated for this project.

### **1.3 SCOPE OF SERVICES**

This geotechnical exploration involved a site reconnaissance, field exploration, laboratory testing, and engineering analysis. The following sections of this report present discussions of the field exploration, laboratory testing programs, site conditions, and conclusions and recommendations. Following the text of this report, figures, boring logs, and laboratory test results are provided in the appendices. Appendix A provides figures and boring logs. Appendix B provides laboratory tests performed and the results of these tests.

The scope of services did not include an environmental assessment for determining the presence or absence of wetlands, or hazardous or toxic materials in the soil, bedrock, surface water, subsurface water, or air, on, or below, or around this site. Any statements in this report or on the boring logs regarding odors, colors, and unusual or suspicious items or conditions are strictly for informational purposes.

## 2.0 EXPLORATION AND TESTING PROGRAMS

### 2.1 FIELD EXPLORATION

The site subsurface conditions were explored with eighteen soil test borings. The following is a breakdown of the boring layout:

| STRUCTURE                  | Number of Borings | Boring Designation   |
|----------------------------|-------------------|----------------------|
| Proposed Transfer Facility | 5                 | TF-1 and TF-4        |
|                            |                   | TF-2, TF-3, and TF-5 |
| CISF – Phase I             | 11                | B-101 and B-111      |
|                            |                   | B-102 through B-110  |
| Administration Building    | 2                 | AB-1 and AB-2        |

The boring locations and depths were selected by GEOServices. The borings were surveyed in the field by WCS personnel. Drilling was performed between July 13<sup>th</sup> and July 21<sup>th</sup>, 2015. The soil test borings were advanced using a Cannon skid rig (air rotary) and a CME-55 track rig. The drill crew worked in general accordance with ASTM D6151 (HSA Drilling). Sampling of overburden soils was accomplished using the standard penetration test procedure (ASTM D1586). The borings were backfilled with soil cuttings prior to leaving the site.

In split-spoon sampling, a standard 2-inch O.D. split-spoon sampler is driven into the bottom of the boring with a 140 pound hammer falling a distance of 30 inches. The number of blows required to advance the sampler the last 12 inches of the standard 18 inches of total penetration is recorded as the Standard Penetration Resistance (N-value). These N-values are indicated on the boring logs at the testing depth, and provide an indication of the relative density of granular materials and strength of cohesive materials.

## 2.2 LABORATORY TEST PROGRAM

Soil samples collected during drilling were transported to our laboratory for visual classification and laboratory testing. The following laboratory testing was performed on select samples to determine the various soil properties.

- Atterberg Limits (ASTM D4318): Three Atterberg Limits tests were performed. These tests help us to confirm our visual classifications according to the AASHTO Classification System and the Unified Soil Classification System (USCS). The plastic limit and liquid limit represent the moisture content at which a cohesive soil changes from a semi-solid to a plastic state and from a plastic state to liquid state, respectively.
- Natural Moisture Content (ASTM D2216): One-hundred thirty-four moisture content determinations were performed. The natural moisture content is defined as the ratio of the weight of water present in the soil to the dry weight of soil.
- Particle Size Analysis (ASTM D1140): Nine particle size analyses were performed. The particle size analysis is used to determine the soil classification and determine drainage properties of the material.
- Resistivity of Soil (ASTM G187): Four soil resistivity tests were performed. The resistivity tests provide information related to corrosive properties of soil.
- Consolidated Undrained Triaxial Test (ASTM D4767): Consolidated undrained triaxial tests were planned, however, undisturbed Shelby tubes were not able to be performed due to the caliche present. This test provides data useful in determining strength and deformation properties of cohesive soils.
- Standard Proctor Moisture-Density Tests (ASTM D698): One standard Proctor test was performed on a composite soil sample. This test provides information concerning the relationship between moisture content, compaction effort, and density.



- California Bearing Ratio (CBR) Tests (ASTM D1883): One CBR test was performed on a composite soil sample. This test provides a CBR value, which is used in pavement design to represent the support of the soil subgrade.
- Consolidation (ASTM D2435): Consolidation tests were originally planned, however, undisturbed Shelby tube samples could not be obtained due to the caliche. The test results are used to evaluate the settlement potential of the clay stratum.

At the time this report was prepared, some of the laboratory testing was still on-going. The test results of the laboratory that has already been completed are presented in the Soil Data Summary enclosed in Appendix B.

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### **3.0 SITE CONDITIONS**

#### **3.1 GEOLOGIC CONDITIONS**

The WCS site is located over the north-central portion of a prominent subsurface structural feature known as the Central Basin Platform. The geologic formations of concern, beneath of the WCS facility comprise, from oldest to youngest, the Triassic Dockum Group, the Cretaceous Trinity Group Antlers Formation, the Late Tertiary Ogallala Formation, the Late Tertiary/Quaternary Gatuña Formation or Cenozoic Alluvium (note that the Gatuña Formation and Cenozoic Alluvium are sometimes used interchangeably), the Pleistocene windblown sands of the Blackwater Draw Formation, Holocene windblown sands and playa deposits. A regional hard caliche pedisol, termed the Caprock caliche, developed on all pre-Quaternary formations before the Blackwater Draw sands were deposited.

#### **3.2 SUBSURFACE CONDITIONS**

##### ***3.2.1 Residual Soils***

At the surface of each of the eighteen soil test borings, residual soils were encountered to auger refusal and/or boring termination depths ranging from 25 to 45 feet below the existing surface elevation. Residual soils are formed from the in-place weathering of the underlying bedrock. The residual soils encountered were generally brown, orangish brown; fine grained silty sands with caliche. The N-values of the standard penetration resistance test (SPT) are used to evaluate the relative consistency or density of the subsurface soils. The N-values for the residual sands ranged from 4 bpf to 100 blows per 1 inch of penetration, indicating a relative density of very loose to very dense. The relative density of the residual sands were most commonly medium dense to very dense. The standard penetration resistance values have likely been inflated due to the caliche.



The natural moisture content of the residual soils ranged from 2.5 to 9 percent. Atterberg limits testing on three selected residual samples revealed liquid limits (LL) ranging from 26 to 29 percent and each sample was non-plastic. Wash 200 tests performed on eight soil samples revealed 24 to 45 percent finer than the 200 sieve.

### **3.2.2 Subsurface Water**

Subsurface water was not observed in any of the soil test borings either during or at the completion of drilling activities. Subsurface water levels may fluctuate due to seasonal changes in precipitation amounts or due to construction activities in the area. The groundwater information presented in this report is the information that was collected at the time of our field activities.

### **3.2.3 Auger Refusal Conditions**

Auger refusal materials were encountered in four of the eighteen soil test borings (B-101, B-111, TF-1, and TF-4) to depths ranging from 37 to 45 feet below the existing ground surface elevation. The remaining soil test borings were terminated at a depth of 25 feet prior to encountering refusal materials. Refusal is a designation applied to any material that cannot be penetrated by the power auger. The following table presents the auger refusal depths. Auger refusal may indicate dense gravel or cobble layers, boulders, and/or the very dense caliche. Rock coring was beyond the scope of this exploration; therefore, the character and continuity of the refusal materials were not determined. The following table should be reviewed for auger refusal depths:

| AUGER REFUSAL<br>DEPTHS |                      |
|-------------------------|----------------------|
| Location                | Refusal Depth (feet) |
| B-101                   | 45                   |
| B-111                   | 37                   |
| TF-1                    | 40                   |
| TF-4                    | 40                   |

#### **3.2.4 General**

The above subsurface description is of a generalized nature to highlight the major subsurface stratification features and material characteristics. The boring logs included in Appendix A should be reviewed for specific information at individual boring locations. The depth and thickness of the subsurface strata indicated on the test records were generalized from and interpolated between boring locations. The transition between materials will be more or less gradual than indicated and may be abrupt. Information on actual subsurface conditions exists only at the specific test locations and is relevant to the time the exploration was performed. Variations may occur and should be expected between boring locations. The stratification lines were used for our analytical purposes and, unless specifically stated otherwise, should not be used as the basis for design or construction cost estimates.

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## **4.0 CONCLUSIONS AND RECOMMENDATIONS**

### **4.1 SITE ASSESSMENT**

The results of the subsurface exploration indicate that the site is adaptable for the proposed construction. However, as is the case with most sites, some inherent challenges are associated with this development of this site. These challenges include the presence of isolated zones of loose residual soils and the proposed foundation loading.

As mentioned previously, very loose to loose sands were encountered in five of the eighteen soil test borings (AB-2, B-101, B-102, B-103, TF-2, and TF-5) to depths ranging from 2.5 to 6.5 feet. At this time the grading plan has not yet been developed for the proposed construction. Depending on the proposed mat bearing elevation, we anticipate that some undercutting of the existing very loose to loose silty sands will be required to provide uniform settlement for the proposed mat foundation (Storage Building). The undercut depths and replacement materials should be provided by the geotechnical engineer of record once mat bearing elevations and mat pressure distributions are known. The following sections of this report provide general recommendations for the grading activities and foundation support. We request the opportunity to revisit these recommendations once the final design is completed.

### **4.2 SITE PREPARATION**

#### ***4.2.1 Subgrade***

All vegetation, organic soils, rock fragments greater than 6 inches, and other debris should be removed from the proposed construction area. The actual depth of removal should be determined by a representative of the geotechnical engineer at the time of construction.

After completion of stripping operations and any required excavations to reach planned subgrade elevation, we recommend that the subgrade be proofrolled with a fully-loaded, tandem-axle dump truck or other pneumatic-tired construction equipment of similar weight. The geotechnical engineer or his representative should observe proofrolling. Areas to receive structural soil fill should also be proofrolled prior to the placement of any fill. Based on the results of the drilling activities, very loose to loose sands were encountered in five of the 18 soil test borings (AB-2, B-101, B-102, B-103, TF-2, and TF-5) to depths ranging from 2.5 to 6.5 feet. We anticipate that these soils encountered will perform unsatisfactorily during proofroll activities. The project budget should include a contingency for required undercutting of the upper weak residual soils within the proposed building and roadway sections.

#### ***4.2.2 Structural Soil Fill***

Characteristics of recommended fill soils and the placement and compaction criteria for fill are provided in the table on the following page. The results of our limited laboratory testing indicate that **SOME** of the on-site materials **DO** meet the criteria for reuse as structural fill. However, we recommend that the near surface silty sands **NOT** be reused as compacted fill. Therefore, dependent on grading requirements, some fill materials may need to be imported during grading. The grading contractor should include provisions in their bid for importing new soil materials and exporting excess materials (silty sands).

The near surface fill materials consists of sands that contain more than 15 percent fines. Experience indicates these materials can be moisture sensitive and degrade rapidly under heavy rubber-tired equipment. Therefore, the contractor should be aware that if these materials will be reused as fill or are present at the subgrade level, some repairs of subgrades that degrade during the construction may be required prior to pavement construction.

Prior to initiating grading activities, samples of proposed fill soils should be submitted for Atterberg limits and moisture-density relationship determination testing (i.e., standard

Proctor). This testing typically requires at least 3 to 4 days to complete. To avoid delays during grading, samples of proposed fill materials (both on-site and off-site) should be collected during site preparation activities.

### SUMMARY OF RECOMMENDED FILL CRITERIA

| MATERIAL TYPE        | CHARACTERISTICS                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | COMPACTION PROCEDURES                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                         | COMPACTION CONTROL                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|----------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| COMPACTED CLAY FILL  | <ul style="list-style-type: none"> <li>▪ Liquid Limit – less than 40</li> <li>▪ Plasticity Index – between 10 and 20</li> <li>▪ Maximum particle size – 3 inches</li> <li>▪ Maximum gravel or oversize particle content – 30 percent retained on a 3/4-inch sieve</li> <li>▪ Maximum allowable organic content – 3 percent by weight, but no large roots should be allowed</li> <li>▪ Percent passing No. 200 sieve – greater than 35 percent</li> <li>▪ USCS Classifications – CL, GC or SC</li> </ul> | <ul style="list-style-type: none"> <li>▪ Maximum loose lift thickness – 8 inches</li> </ul> <p><b><u>Compaction requirement<sup>1</sup>:</u></b></p> <ul style="list-style-type: none"> <li>▪ The fill should be compacted by making multiple passes with an appropriately sized sheepsfoot roller.</li> <li>▪ Compaction should be at least 95 percent of the standard Proctor maximum (ASTM D 698)</li> </ul> <p><b><u>Moisture content for fill:</u></b></p> <ul style="list-style-type: none"> <li>▪ At time of compaction – within minus 2 and plus 2 percent of the optimum moisture content</li> </ul> | <p><b><u>Building and pavement areas:</u></b></p> <ul style="list-style-type: none"> <li>▪ One test every 2,500 to 5,000 square feet per lift, with a minimum of two tests per lift</li> </ul> <p><b><u>Trench areas:</u></b></p> <ul style="list-style-type: none"> <li>▪ One test every 100 linear feet per lift</li> </ul> <p><b><u>Minimum requirement:</u></b></p> <ul style="list-style-type: none"> <li>▪ Two tests per lift</li> </ul> <p><i>(for preliminary planning only, our technician or engineer should determine the actual test frequency)</i></p> |
| COARSE-GRAINED SOILS | <ul style="list-style-type: none"> <li>▪ Maximum gravel size – 3 inches</li> <li>▪ Maximum gravel content – 30 percent retained on a 3/4-inch sieve</li> <li>▪ Maximum allowable organic content – 5 percent by weight, but no large roots should be allowed</li> <li>▪ USCS Classification SP, SC, SM</li> </ul>                                                                                                                                                                                       | <p><b><u>Moisture content for fill:</u></b></p> <ul style="list-style-type: none"> <li>▪ At time of compaction – within minus 2 and plus 2 percent of the optimum moisture content</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                 | <p><b><u>Minimum requirement:</u></b></p> <ul style="list-style-type: none"> <li>▪ Two tests per lift</li> </ul> <p><i>(for preliminary planning only, our technician or engineer should determine the actual test frequency)</i></p>                                                                                                                                                                                                                                                                                                                               |

<sup>1</sup> In addition, the fill must be stable under the influence of the compaction equipment. After the soil fill is properly placed and compacted, it will be advisable to limit the amount of heavy construction traffic on the soil subgrade.

On-site soils should be used for backfilling of utility trenches. The purpose of this detail is so that utility trench backfill does not respond differently to moisture variations than the surrounding soils (i.e., shrink or swell differently).

## **4.3 FOUNDATIONS**

### ***4.3.1 Shallow Foundations (Security and Admin Building)***

Foundations for the proposed construction will be supported on residual soils and/or properly compacted structural fill materials. The recommended allowable bearing capacity for design of the foundations is 3,000 pounds per square foot (psf) or less. We recommend that continuous foundations be a minimum of 18 inches wide and isolated spread footings be a minimum of 24 inches wide to reduce the possibility of a localized punching shear failure. All exterior footings should be designed to bear at least 24 inches below finished exterior grade.

Foundation excavations should be opened, the subgrade evaluated, remedial work performed, and concrete placed in an expeditious manner. Exposure to weather often reduces foundation support capabilities, thus necessitating remedial measures prior to concrete placement. It is also important that proper surface drainage be maintained both during construction (especially in terms of maintaining dry footing trenches) and after construction.

### ***4.3.2 Mat Foundations (Storage Building)***

Foundations for the proposed storage building will be supported on residual soils and/or properly compacted structural fill materials. The recommended allowable bearing capacity for design of the foundations is 3,000 pounds per square foot (psf) or less. All exterior footings should be designed to bear at least 24 inches below finished exterior grade.

Based on the conditions encountered at the site, we recommend that the mat foundation be designed using a preliminary subgrade modulus of 150 pounds per cubic inch (pci). This value was obtained



using a mat size of 700 feet by 300 feet and a uniform bearing pressure of 3,000 psf. As with all non-rigid method solutions, the process is iterative and requires the close coordination between the geotechnical engineer and the structural engineer during design. Once a pressure distribution is determined, we can utilize finite element methods to more accurately predict the settlement and provide detailed modulus calculations.

#### ***4.3.3 Slabs-on-Grade (Administration Building)***

For slab-on-grade construction for the administration building, the site should be prepared as previously described. We recommend that the subgrade be topped with a minimum 4-inch layer of crushed stone. A polyethylene vapor barrier is not required if the designer utilizes a dense graded aggregate base. The subgrade should be proofrolled and approved prior to the placement of the crushed stone. Based on the conditions encountered on this site, we recommend that the floor slabs be designed using a subgrade modulus of 150 pounds per cubic inch (pci). This subgrade modulus value is for small diameter loads (i.e., a 1 foot by 1 foot plate) and should be adjusted for wider loads such as large mat foundations.

#### ***4.3.4 Seismic Conditions***

We evaluated the site seismic class of the upper 100 feet to determine the seismic site class per the criteria in Table 1613.5.2 of the International Building Code (IBC, 2006/2012). The on-site shear wave velocity was determined using the refraction micro-tremor (ReMi) method. The testing used a Seismic Source DAQ Link II 24 seismograph and 10 Hz vertical geophones. The geophones were deployed along an approximately 300-foot long linear array and spaced on approximately 26-foot centers. Once the field data was collected, a computer model was used to determine the subsurface shear wave velocity profile. The test results are attached to this report.

The attached seismic velocity model displays the shear-wave velocity profiles for the upper 100 feet. The results of the models revealed an average shear wave velocity of about 1,762 feet per second. The average shear-wave velocities obtained were used to evaluate the seismic site class definition and



design category using the procedures provided in the 2012 International Building Code. Based on the information obtained from the geophysical surveys, the site class for the development would be site class "C". Therefore, seismic design parameters for a site class "C" are provided below:

| STRUCTURE                             | IBC  | S <sub>s</sub> | S <sub>1</sub> | S <sub>DS</sub> | S <sub>D1</sub> |
|---------------------------------------|------|----------------|----------------|-----------------|-----------------|
|                                       |      | G              | g              | G               | G               |
| Consolidated Interim Storage Facility | 2006 | 0.259          | 0.044          | 0.207           | 0.050           |
|                                       | 2012 | 0.192          | 0.043          | 0.154           | 0.049           |

#### 4.3.5 Settlement

We have estimated the total and differential settlements expected at this site based on the Federal Highways Administration (FHWA) Empirical Settlement Analysis Procedure. This FHWA empirical method allows the use of the SPT N-values in this calculation and includes the type of soil encountered. Based on the conditions encountered in our borings, we anticipate that total settlements will be less one inch for the administration building and be on the order of about 1 ¼ to 1 ½ inches for the mat foundation. These settlements should be revisited (especially for the mat foundation) once the load distribution and the bearing elevations have been finalized.

#### 4.4 LATERAL EARTH PRESSURES

At this time, we understand that design services are in conceptual design phase. The possibility exists that portion of the CISF walls will be located below grade. Therefore, we are providing equivalent fluid pressures for three backfill conditions for cantilever-type walls. These are 1) active earth pressure for granular backfill (clean sand or gravel), 2) at-rest earth pressure for granular backfill, and 3) at-rest earth pressure for fine-grained (silt or clay) backfill.

Condition 1 - The active earth pressure for granular backfill will result in an equivalent fluid

pressure of 40 pounds per cubic foot (pcf). If the granular backfill is to develop active earth pressure conditions, walls must be flexible and/or free to rotate or translate at the top approximately one inch laterally for every 20 feet of wall height.

Condition 2 - The at-rest earth pressure for granular backfill will result in an equivalent fluid pressure of 50 pcf. For retaining walls that will not rotate or translate, such as building walls or other walls rigidly connected to structures, at-rest conditions will develop.

Condition 3 - Walls backfilled with fine-grained material (silt or clay) should be designed using the at-rest earth pressure whether restrained at the top, or not. Fine-grained soils typically creep over time which produces additional lateral stresses to the wall. The equivalent fluid pressure for this case is 70 pcf.

In all cases, forces from any expected surcharge loading including sloping backfill should be added to the equivalent fluid pressures. The walls should be properly drained to remove water or hydrostatic pressure should be added to the design pressure. Also, all backfill for the walls should be placed in accordance with the structural fill recommendations described hereinafter.

For rigid, cast-in-place concrete walls, a friction factor of 0.35 between foundation concrete and the bearing soils may be used when evaluating friction. If a 12-inch stone leveling course is utilized beneath the foundation, a friction factor of 0.45 between foundation concrete and the dense graded aggregate base may be used when evaluating friction. Also, an ultimate passive earth pressure resistance of well-compacted soil fill can be approximated by a uniformly acting resistance of 333 psf. However, to limit deformation when relying on passive strength, we recommend using a minimum safety factor of 3.0 applied to the ultimate passive resistance value.

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## **5.0 CONSTRUCTION CONSIDERATIONS**

### **5.1 EXCAVATIONS**

Auger refusal materials were encountered in four of the 18 soil test borings (B-101, B-111, TF-1, and TF-4) at depths ranging from 37 to 40 feet below the existing ground surface elevation. Typically, soils penetrated by augers can be removed with conventional earthmoving equipment. However, excavation equipment varies, and field refusal conditions may vary. Some of the very dense caliche may require difficult excavation techniques such as ripping, prior to excavation.

#### **Excavation Safety**

Excavations should be sloped or shored in accordance with local, state, and federal regulations, including OSHA (29 CFR Part 1926) excavation trench safety standards. The contractor is usually solely responsible for site safety. This information is provided only as a service and under no circumstances should GEOServices be assumed to be responsible for construction site safety.

### **5.2 FOUNDATION CONSTRUCTION**

Foundation excavations should be opened, the subgrade evaluated, remedial work performed, and concrete placed in an expeditious manner. Exposure to weather often reduces foundation support capabilities, thus necessitating remedial measures prior to concrete placement. It is also important that proper surface drainage be maintained both during construction (especially in terms of maintaining dry footing trenches) and after construction. Soil backfill for footings should be placed in accordance with the recommendations for structural fill presented herein.

Foundation subgrade observations should be performed by a GEOServices geotechnical engineer, or his qualified representative, so that the recommendations provided in this report are consistent with the site conditions encountered. A dynamic cone penetrometer (DCP) is commonly utilized to

provide information that is compared to the data obtained in the geotechnical report. Where unacceptable materials are encountered, the material should be excavated to stiff, suitable soils or remediated at the geotechnical engineer's direction. Typical remedial measures consist of undercutting, overexcavation, or combinations thereof.

### 5.3 MOISTURE SENSITIVE SOILS

The fine-grained soils encountered at this site will be sensitive to disturbances caused by construction traffic and changes in moisture content. During wet weather periods, increases in the moisture content of the soil can cause significant reduction in the soil strength and support capabilities. Construction traffic patterns should be varied to prevent the degradation of previously stable subgrade.

In addition, soils which become wet may be slow to dry and thus significantly retard the progress of grading and compaction activities. It will, therefore, be advantageous to perform earthwork and foundation construction activities during dry weather. Climate data for Andrews, Texas, obtained from Weatherbase indicate in the following table the average monthly precipitation. The average amount of precipitation does not vary much throughout the year.

#### PRECIPITATION AVERAGES

| Month    | Monthly Precipitation<br>Average (Inches) | Month     | Monthly Precipitation<br>Average (Inches) |
|----------|-------------------------------------------|-----------|-------------------------------------------|
| January  | 0.7                                       | July      | 1.9                                       |
| February | 0.5                                       | August    | 1.5                                       |
| March    | 0.3                                       | September | 1.5                                       |
| April    | 0.9                                       | October   | 1.8                                       |
| May      | 2.1                                       | November  | 0.4                                       |
| June     | 1.6                                       | December  | 0.6                                       |

## **5.4 DRAINAGE AND SURFACE WATER CONCERNS**

To reduce the potential for undercut activities, water should not be allowed to collect in the foundation excavations, on floor slab areas, or on prepared subgrades of the construction area either during or after construction. Undercut or excavated areas should be sloped toward one corner to facilitate removal of any collected rainwater, subsurface water, or surface runoff. Positive site surface drainage should be provided to reduce infiltration of surface water around the perimeter of the building and beneath the floor slab. The grades should be sloped away from the building and surface drainage should be collected and discharged such that water is not permitted to infiltrate the backfill and floor slab areas of the building.

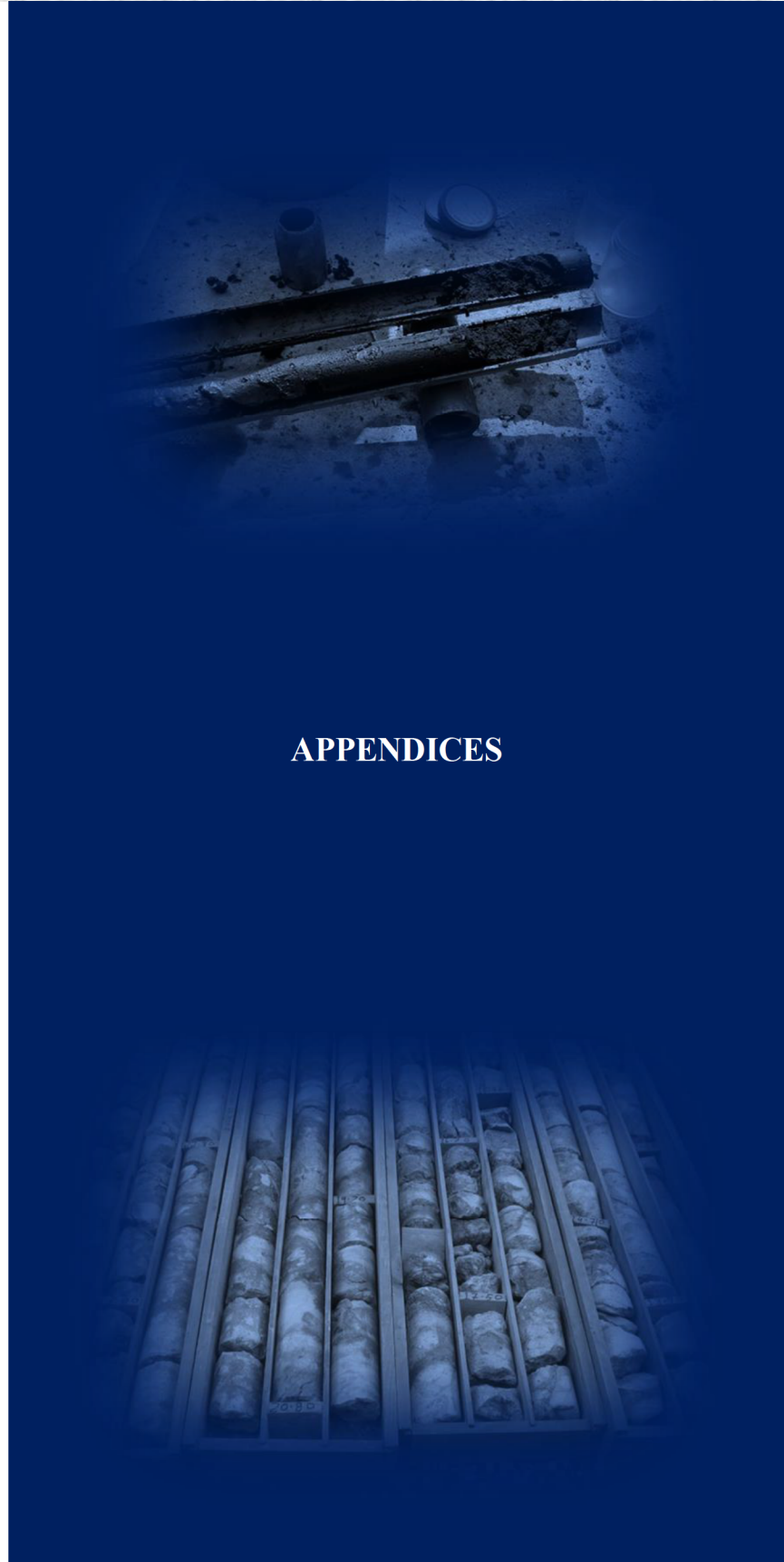
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## **6.0 LIMITATIONS**

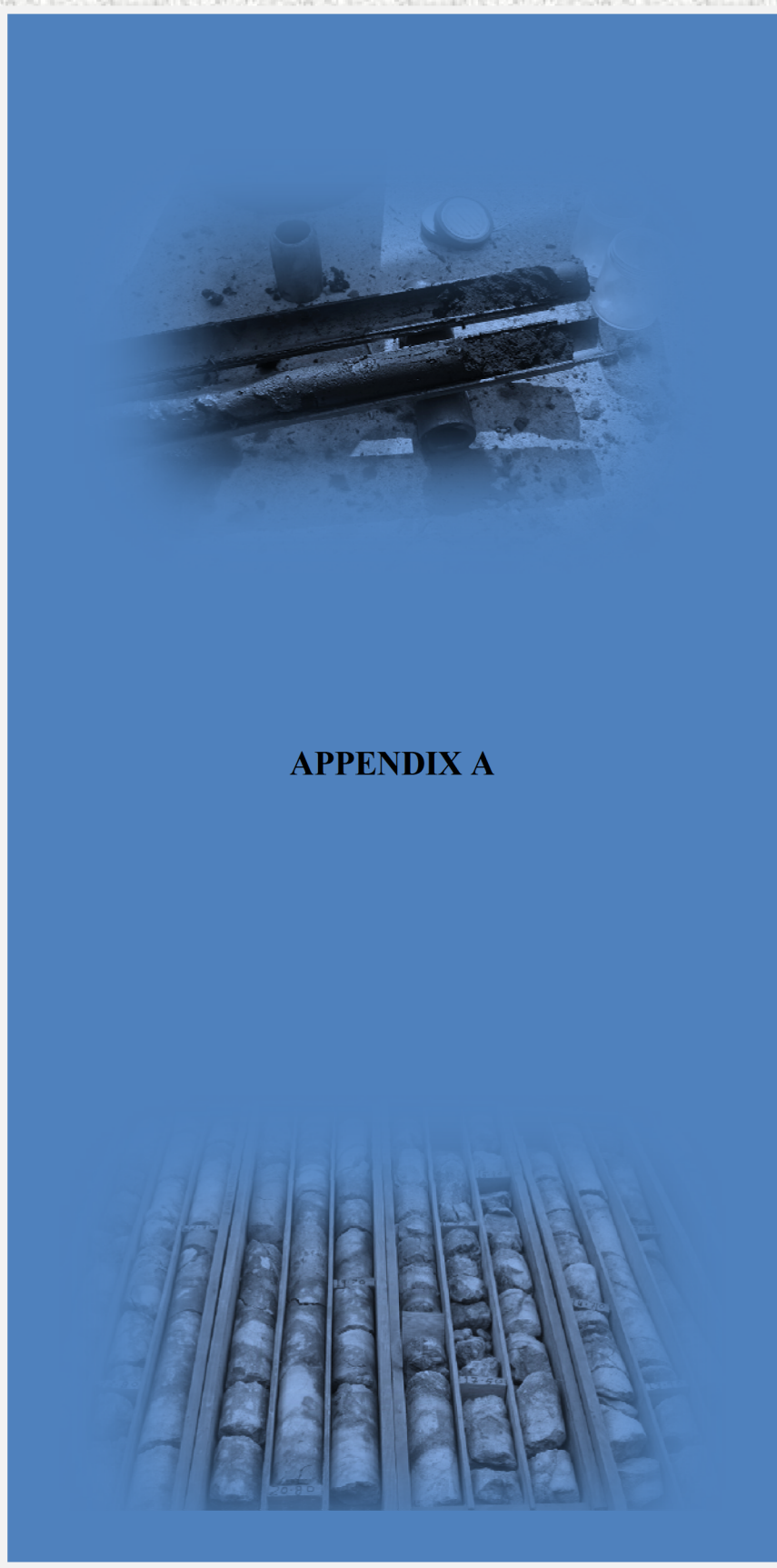
This report has been prepared in accordance with generally accepted geotechnical engineering practice for specific application to this project. This report is for our geotechnical work only, and no environmental assessment efforts have been performed. The conclusions and recommendations contained in this report are based upon applicable standards of our practice in this geographic area at the time this report was prepared. No other warranty, express or implied, is made.

The analyses and recommendations submitted herein are based, in part, upon the data obtained from the exploration. The nature and extent of variations between the borings will not become evident until construction. We recommend that GEOServices be retained to observe the project construction in the field. GEOServices cannot accept responsibility for conditions which deviate from those described in this report if not retained to perform construction observation and testing. If variations appear evident, then we will re-evaluate the recommendations of this report. In the event that any changes in the nature, design, or location of the structures are planned, the conclusions and recommendations contained in this report will not be considered valid unless the changes are reviewed and conclusions modified or verified in writing. Also, if the scope of the project should change significantly from that described herein, these recommendations may have to be re-evaluated.



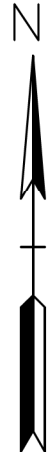


## APPENDICES



## APPENDIX A





**Notes:**

- 1) Aerial Provided by: Google Earth Pro, (02/12/2014)