Geotechnical Engineering Investigation

Kelly Hill Road Disposal Center
Garden City, Chatham County, Georgia

April 25, 2018
Terracon Project No. ES185060

Prepared for:
Chatham County Public Works
Savannah, Georgia

Prepared by:
Terracon Consultants, Inc.
Savannah, Georgia

Terracon

April 25, 2018

Chatham County Public Works
7226 Varnedoe Dr.
Savannah, Georgia 31406

Attn: William Wright
P: (912) 652-6869
E: wewright@chathamcounty.org

Re: Geotechnical Engineering Investigation
Kelly Hill Road Disposal Center
Garden City, Chatham County, Georgia
Terracon Proposal No. ES185060

Dear Mr. Wright:

Terracon Consultants, Inc. (Terracon) has completed our Geotechnical Engineering Investigation for the above-referenced project. The services were performed in general accordance with our proposal No. PES185060 dated March 12, 2018. This report presents the findings of the subsurface exploration and provides geotechnical recommendations for the proposed construction.

We appreciate the opportunity to be of service to you. Should you have any questions concerning this report, or if we may be of further service, please contact us.

Sincerely,
Terracon Consultants, Inc.

Guoming Lin

Thomas C. Brackett “Chap”, P.G., E.I.T.
Senior Staff Engineer

Guoming Lin, Ph.D., P.E., D.GE.
Senior Principal

cc: 1 – Client (PDF)
1 – File

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APPENDICES

EXECUTIVE SUMMARY

This report presents the results of our Geotechnical Engineering Investigation for the proposed replacement of a retaining wall structure and concrete support slab at a public waste facility in Garden City, Chatham County, Georgia. The site is located near a capped and abandoned municipal landfill. The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations. Based on the results of the subsurface exploration and analyses, the following geotechnical considerations were identified:

- The existing retaining wall structure consists of a series of approximately 10-inch thick by 80-inch tall concrete blocks surrounding an open disposal pit. Eight, 6-inch thick concrete slabs are positioned along the base of the retaining wall and are designed to support dumpster bins. The retaining wall showed signs of significant distress such as cracking and separation between adjacent blocks. The concrete slabs at the base of the retaining wall, however, did not show significant signs of damage.
- The subsurface profile primarily consists of a clayey landfill cap with layers of buried waste material extending to the exploration depth of 25 feet below ground surface (BGS). The soils in the upper 2 to 4 feet BGS are mostly loose clayey sand and GAB material, followed by soft to medium stiff clays to the exploration depth of 25 feet BGS. C&D (construction and demolition) waste material was encountered at various depths from the surface down to the termination of borings. A detailed discussion about the subsurface conditions is provided in **Section 3.1**.
- The groundwater depths were measured within the SPT borings and ranged from approximately 6.5 to 14.5 feet BGS. **Please note** the near surface soils are predominantly clays which have relatively poor drainage characteristics. The depth of groundwater encountered during borings may not accurately represent the actual groundwater elevation.
- The damage to the current structure is indicative of lateral movement. This is likely caused by a combination of the soft clays used to backfill the retaining wall and possible lack of design plans and calculations for the retaining wall. After removal of the existing wall, the existing backfill should be excavated to allow for the new retaining wall construction. The temporary excavation should be sloped at a 1 horizontal to 1 vertical slope relative to the subgrade. We anticipate some undercutting will be needed as identified in the proofroll, in isolated weak/soft areas to achieve a stable subgrade.
- We recommend using granular material as backfill meeting the specifications in **Section 4.2.**
- **Please note** Earth pressure recommendations assume the replacement retaining wall will have a similar height as the existing wall and will be backfilled with granular fill soils.

- We recommend that 6 inches of graded aggregate base (GAB) be used below the new concrete slabs along the floor of the disposal center.

This summary should be used in conjunction with the entire report for design purposes. It should be recognized that details were not included or fully developed in this section, and the report must be read in its entirety for a comprehensive understanding of the findings and recommendations contained herein. The section titled **GENERAL COMMENTS** should be read for an understanding of the report's limitations.

GEOTECHNICAL ENGINEERING INVESTIGATION

Kelly Hill Road Disposal Center
Garden City, Chatham County, Georgia

Terracon Project No. ES185060
April 25, 2018

1.0 INTRODUCTION

Terracon Consultants (Terracon) has completed our Geotechnical Engineering Investigation for the proposed retaining wall and concrete slab replacement at the Kelly Hill Road Disposal Center in Garden City, Chatham County, Georgia. The general location of the project site and its vicinity are shown on the Site Location Map in **Exhibit A-1**, **Appendix A**.

The investigation included a field exploration program and engineering evaluation of the subsurface conditions and foundation recommendations. The existing retaining wall was also surveyed to observe general structural deterioration. Photographs of the existing wall are shown in **Exhibit B-1, Appendix B**. The subsurface conditions within the proposed site were explored with a total of four Standard Penetration Test (SPT) borings and four hand auger borings. The SPT borings are labeled B1 through B4, the hand auger borings are labeled HA1 through HA4 on the exploration plan in **Exhibit A-2**, **Appendix A**.

The SPT borings were performed behind the retaining wall for backfill considerations and extended to a depth of 25 feet below ground surface (BGS). The hand auger borings were performed to approximately 5 feet BGS beneath the existing concrete pavement slabs at the base of the retaining walls.

A detailed presentation of the subsurface soils encountered at the borehole locations can be found in the SPT and hand auger boring logs included in **Appendix A** of this report, along with a site location map and exploration location plan.

The purpose of our investigation was to evaluate the existing subsurface conditions at the project site and develop conclusions and geotechnical recommendations for the proposed construction. The following study was conducted in accordance with our scope of services outlined in our proposal (Proposal No. PES185060) dated March 12, 2018:

- subsurface soil conditions
- site preparation
- groundwater conditions
- retaining wall design and construction
- concrete slab recommendations

2.0 PROJECT INFORMATION

Item	Description
Site location	The site is located at 50 Kelly Hill Rd, Garden City, Georgia 31408. Latitude: 32.084599°, Longitude: -81.172393°
Existing improvements	Gravel road and dumpster pit dump site.
Current ground cover and access conditions	The site is developed and accessible by a public gravel road.
Existing topography	Relatively level with a sloped gravel drive to access the top of the pit.
Proposed Improvements	The proposed improvements include the removal and replacement of a retaining wall and concrete slabs.
Grading	It is anticipated that the site work will involve the removal and replacement of backfill behind the retaining wall structure.

Should any of the above information or assumptions be inconsistent with the planned construction, Terracon should be informed so that modifications to this report can be made as necessary.

3.0 SUBSURFACE CONDITIONS

3.1 Typical Profile

Based on the results of our field exploration, the subsurface conditions at the project site can be generalized as follows:

Behind the Retaining Wall:

Description	Approximate Depth to Bottom of Stratum Below Ground Surface	Material Encountered	SPT - N_{60}
Surface	0.5 feet	Loose to dense GAB material.	
Stratum 1 (varying soils)	2 to 6 feet	Loose clayey sands.	5 to 10
		Medium stiff sandy clays.	4 to 8
Stratum 2	13 to 23 feet	Soft to very stiff sandy clays.	2 to 27
Stratum 3 (varying soils)	18 to 25 (termination of boring)	Medium dense to dense silty sand to silty clay with C&D waste debris (mulch, brick, lumber).	13 to 29

Concrete Slab Subgrade:

Description	Approximate Depth to Bottom of Stratum Below Ground Surface	Material Encountered	Equivalent SPT - N_{60}
Surface	0.5 feet	Concrete slab with rebar and GAB.	
Stratum 1	3 to 4 feet	Stiff to very stiff sandy clay with C&D waste debris (brick, lumber, roots).	8 to 30
Stratum 2	5 feet (termination of boring)	Loose silty sand to clayey sand with C&D waste debris (brick, mulch, lumber).	4 to 9

Details of the subsurface conditions encountered at each test location are presented on the individual SPT borings and hand auger boring logs in **Appendix A** of this report. Stratification boundaries on the logs represent the approximate depth of changes in soil types; the transition between materials may be gradual.

3.2 Groundwater

Groundwater depth measurements varied within the SPT boring from 6.5 to 14.5 feet BGS at the time of our field exploration. Groundwater was not encountered in any of the 5-foot hand auger borings at the time of our field exploration. However, mottling, which infers seasonal high groundwater level, was determined in all hand auger borings at depths of approximately 2.5 to 3.5 feet BGS.

It should be noted that groundwater levels tend to fluctuate with seasonal and climatic variations, as well as with construction activities. **The near surface, poorly draining clayey soils are prone to perched ground water conditions, making the groundwater table shallower than the likely long-term stabilized groundwater level.**

As such, the possibility of groundwater level fluctuations should be considered when developing the design and construction plans for the project. The groundwater table should be checked prior to construction to assess its effect on site work and other construction activities.

4.0 RECOMMENDATIONS FOR DESIGN AND CONSTRUCTION

The following evaluation and recommendations are based upon our understanding of the proposed construction and the results from our field exploration. If the above-described project conditions are incorrect or changed after this report, or subsurface conditions encountered during construction are significantly different from those reported, Terracon should be notified, and these recommendations must be re-evaluated to make appropriate revisions.

4.1 Geotechnical Considerations

The subsurface conditions at this site are considered relatively poor due to the nature of the material used during previous landfill development. Soft clays and waste debris were encountered in the upper 2 to 10 feet behind the retaining wall. These backfill conditions and retaining wall construction methods likely contributed to the lateral movement and foundation settlement. Based on the information made available, we understand the existing retaining wall and concrete slabs will be removed and replaced. We recommend the soft clays and waste debris be excavated and replaced with suitable fill soils to avoid unstable conditions.

Upon removal of the existing retaining wall structure, soil material behind the wall should be excavated as necessary to allow for the construction of the new retaining wall structure. The temporary slope into the existing backfill should be a 1:1 (horizontal to vertical) slope. We recommend compacted, granular fill material be used as replacement backfill. Fill material considerations and lateral earth pressure values can be found in **Sections 4.2 & 4.4**, respectively.

It is anticipated that the dimensions of the replacement retaining wall will be relatively consistent with that of the current structure. If the design is modified, or if the site will receive significantly more fill, Terracon should be retained to perform the additional evaluation.

4.2 Earthwork

The site work conditions will be largely dependent on the weather conditions and the contractor's means and methods in controlling surface drainage and protecting the subgrade. Site preparation should include the installation of a site drainage system, removal and existing retaining wall and concrete slabs, subgrade preparation, densification, and proofrolling.

4.2.1 Site Drainage

An effective drainage system should be installed prior to the site preparation and grading activities to intercept surface water and to improve overall shallow drainage. The drainage system may consist of perimeter ditches supplemented with parallel ditches and swales. The site should be graded to shed water and avoid ponding over the subgrade.

4.2.2 Densification and Proofrolling

Proofrolling of the existing subgrade may be difficult in periods of wet weather. We highly recommend performing the site work during drier periods. The extents of the proofrolling program prior to fill placement should be determined based on the location of structures, amount of fill in that area, and the condition of the subgrade.

Prior to fill placement, the entire retaining wall and concrete slab area should be densified with a heavy-duty vibratory roller to achieve a uniform subgrade. The subgrade should be thoroughly proofrolled after the completion of densification. Proofrolling will help detect any isolated soft or loose areas that "pump", deflect or rut excessively, and also densify the near-surface soils for floor slab support.

A loaded tandem axle dump truck, capable of transferring a load in excess of 20 tons, should be utilized for this operation. Proofrolling should be performed under the Geotechnical Engineer's observation. Areas where pumping, excessive deflection or rutting is observed after successive passes of the proofrolling equipment should be undercut, backfilled and then properly compacted.

4.2.3 Fill Material Consideration

Granular backfill should be placed over a stable or stabilized subgrade behind the retaining wall or in undercut areas below the concrete slab. The properties of the fill will affect the performance of the retaining wall and concrete slabs. The structural fill should be free of organics, roots, or other deleterious materials. It should be non-plastic granular material containing less than 25 percent fines passing the No. 200 sieve.

We recommend the initial structural fill layer placed on the existing clay soils should contain less than 15 percent fines. The soil at this level may be difficult to compact and lowering the fine content should help ease compaction efforts on this layer.

All structural fills should be placed in thin (8 to 10 inches loose) lifts and compacted to a minimum of 95% of the soil's Modified Proctor maximum dry density (ASTM D-1557). Fill brought to the site should be within 3 percent (wet or dry) of the optimum moisture content.

Some manipulation of the moisture content (such as wetting, drying) will be required during the filling operation to obtain the required degree of compaction. The manipulation of the moisture content is highly dependent on weather conditions and site drainage conditions. Therefore, the contractor should prepare both dry and wet fill materials to obtain the specified compaction during grading. A sufficient number of density tests should be performed to confirm the required compaction of the fill material.

4.3 Retaining Wall Foundations

After the subgrade has been improved as discussed in **Section 4.2**, the proposed retaining wall can be supported on a shallow foundation system. The following sections present design recommendations and construction considerations for the shallow foundations for the proposed retaining wall and related structural elements.

4.3.1 Foundation Design Recommendations

Description	Wall
Net allowable bearing pressure[1]	2,000 psf
Minimum embedment below finished grade	12 inches
Approximate total settlement[2]	<1 inch
Estimated differential settlement	<1/2 inch over 40 feet
Ultimate Coefficient of sliding friction[3]	0.32

1. The recommended net allowable bearing pressure is the pressure in excess of the minimum surrounding overburden pressure at the foundation base elevation. It assumes any unsuitable fill or soft soils, if encountered, will be replaced with compacted structural fill.
2. The foundation settlement will depend upon the variations within the subsurface soil profile, the structural loading conditions, the embedment depth of the footings, the thickness of compacted fill, and the quality of the earthwork operations. Footings should be proportioned to reduce differential settlements. Proportioning on the basis of equal total settlement is recommended; however, proportioning to relative constant dead-load pressure will also reduce differential settlement between adjacent footings.
3. Sliding friction along the base of the footing will not develop where net uplift conditions exist.

The design bearing pressure may be increased by one-third when considering the total load that includes the wind or seismic conditions. The weight of the foundation concrete below grade may be neglected in dead load computations.

Footings, foundations, and masonry walls should be reinforced as necessary to reduce the potential for the distress caused by the differential foundation movement. The use of joints at openings or other discontinuities in masonry walls is recommended.

Foundation excavations should be observed by Terracon. If the soil conditions encountered differ significantly from those presented in this report, Terracon should be contacted to provide additional evaluation and supplemental recommendations.

4.3.2 Foundation Construction Considerations

The bottom of all foundation excavations should be free of water and loose soil and rock prior to placing concrete. Concrete should be placed soon after excavating to reduce bearing soil disturbance.

Care should be taken to prevent wetting or drying of the bearing materials during construction. Extremely wet or dry material or any loose or disturbed material in the bottom of the foundation excavations should be removed before foundation concrete is placed. If the soils at bearing level become excessively dry, disturbed or saturated, the affected soil should be removed prior to placing concrete. A lean concrete mud-mat should be placed over the bearing soils if the excavations must remain open for an extended period of time.

Regarding the construction of foundations, we generally anticipate material suitable for the recommended design bearing pressure will be present at the bottom of the foundation. However, there is a possibility that isolated zones of soft or loose native soils could be encountered below the foundation bearing level, even though field density tests are expected to be performed during the fill placement operations. Therefore, it is important that Terracon be retained to observe, test, and evaluate the bearing soil prior to placing reinforcing steel and concrete to determine if additional foundation excavation or other subgrade repair is needed for the design loads.

If unsuitable bearing soils are encountered in foundation excavations, the excavations should be extended deeper to suitable soils and the foundations could bear directly on those soils at the lower level or on lean concrete backfill placed in the excavations. As an alternative, the foundation could also bear on properly compacted structural backfill extending down to the suitable soils. Over-excavation for compacted backfill placement below foundations should extend laterally beyond all edges of the footings at least 8 inches per foot of over-excavation depth below foundation base elevation.

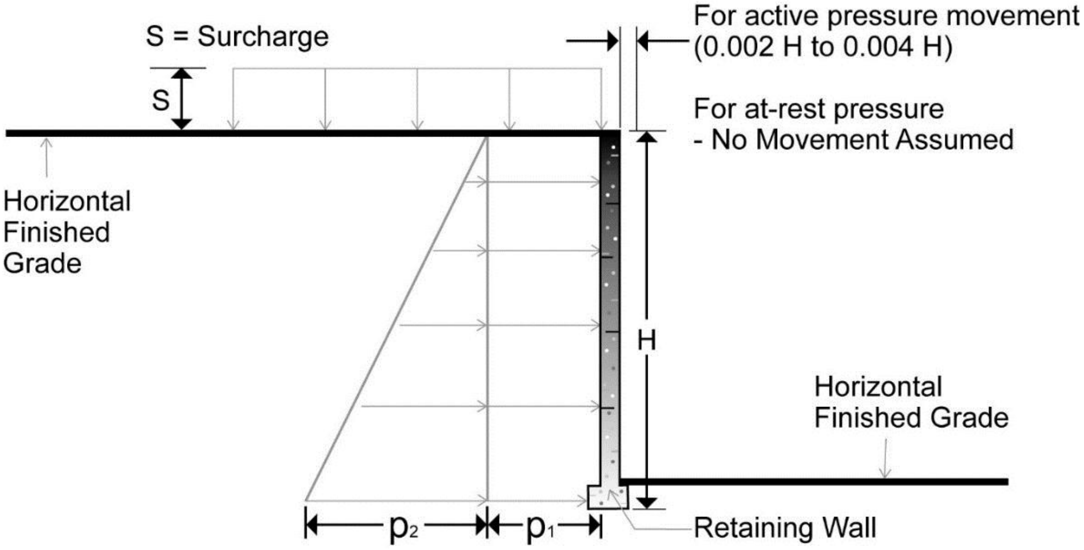
The over-excavation should be backfilled up to the foundation base elevation with well-graded granular material placed in lifts of 8 to 10 inches or less in loose thickness and compacted to at least 95 percent of the material's maximum dry density as determined by the Modified Proctor test (ASTM D-1557).

No. 57 stone is recommended in lieu of structural fill when the volume of excavation is relatively small, re-compaction of the fill is difficult or the weather conditions or construction schedule becomes a controlling factor.

4.4 Lateral Earth Pressure Considerations

The foundation walls with unbalanced backfill levels on opposite sides should be designed for earth pressures at least equal to those indicated in the following table. The earth pressure parameters are recommended based on the structural fills specified in **Section 4.2**.

Earth pressures will be influenced by structural design of the walls, conditions of wall restraint, methods of construction and/or compaction and the strength of the materials being restrained. Two wall restraint conditions are shown. Active earth pressure is commonly used for design of free-standing cantilever retaining walls and assumes wall movement. The "at-rest" condition assumes no wall movement. The recommended design lateral earth pressures do not include a factor of safety or possible hydrostatic pressure on the walls.



Earth Pressure Coefficients

Earth Pressure Conditions	**Coefficient for Backfill Type**	**Equivalent Fluid Density** (pcf)	**Surcharge Pressure, p_1** (psf)	**Earth Pressure, p_2** (psf)
Active (K_a)	Granular - 0.33	40	(0.33)S	(40)H
At-Rest (K_o)	Granular - 0.46	55	(0.46)S	(55)H
Passive (K_p)	Granular - 3.00	360	---	---

Applicable conditions to the above include:

- For active earth pressure, wall must rotate about base, with top lateral movements of about 0.002 **H** to 0.004 **H**, where **H** is wall height
- For passive earth pressure to develop, wall must move horizontally against the fill to mobilize resistance
- Uniform surcharge, where S is surcharge pressure
- Compacted soil backfill weight a maximum of 120 pcf
- Horizontal backfill, compacted between 95 percent of modified Proctor maximum dry density
- Loading from heavy compaction equipment or dynamic loading not included
- No hydrostatic pressures acting on wall
- No safety factor included in soil parameters

Backfill placed against structures should consist of granular soils. The granular backfill must extend out from the base of the wall at an angle of at least 45 and 60 degrees from vertical for the active and passive cases, respectively. To calculate the resistance to sliding, a value of 0.32 should be used as the ultimate coefficient of friction between the footing and the underlying soil. We recommend the friction between the soils and sides of footings be ignored due to the shallow depth of footings.

Depending on the depth of excavation and long term groundwater conditions, the unbalanced hydrostatic pressure may be considered in the design of the retaining wall. To control hydrostatic pressure behind the wall, we recommend that a drain be installed in the retaining wall with a collection pipe leading to a reliable discharge. If this is not possible, hydrostatic pressure should be added to the lateral earth pressures recommended above. These pressures do not include the influence of surcharge, equipment or floor loading, which should be added.

Heavy equipment should not operate within a distance closer than the exposed height of retaining walls to prevent lateral pressures more than those provided.

4.5 Pavements

We understand that the proposed development will include concrete slabs to support dumpster bins. This section presents thickness recommendations for Portland cement concrete slabs and general considerations for slab construction.

For the concrete slab support, the subgrade conditions can often be the overriding factor in slab performance. The subgrade conditions will depend on the in-situ soils at the subgrade level, characteristics of fill material for the subgrade as well as the site preparation procedures. Based on the condition observations of the existing concrete slabs, we are recommending a similar concrete slab profile.

4.5.1 Concrete Slab Design Recommendations

Material	**Minimum Section Thickness** (inch)
	Concrete Slab Section
Concrete[1]	6
Graded aggregate base[2]	6

1. The concrete should be air entrained and have a minimum compressive strength of 4,000 psi after 28 days of lab curing per ASTM C-31.
2. Graded aggregate base should conform to the GDOT material specification Section 815.

- Some subgrade soil undercutting and backfilling with suitable structural fill will be required if unstable subgrade soils are encountered during subgrade preparation. The need for undercutting and backfilling should be determined in the field during subgrade preparation.

We emphasize the use of the stone base under the concrete slab even though the stone base is not part of the structural design. Based on our experience, the stone base can be significantly help improve the constructability during construction especially in rainy seasons. Furthermore, the stone base will help maintain subgrade stability and support when the subgrade is wet due to rise of groundwater or infiltration of surface water through the joints or cracks. We recommend the use of stone base be considered based on the cost benefit analysis.

The above concrete slab section represents the minimum design thickness and, as such, periodic maintenance should be anticipated. Prior to the placement of the GAB, the subgrade should be thoroughly proofrolled.

4.5.2 Construction Considerations

Soil subgrades prepared early in the project should be carefully evaluated as the time for concrete slab construction approaches. We recommend the concrete slab areas be rough graded and then thoroughly proofrolled with a loaded tandem-axle dump truck.

5.0 GENERAL COMMENTS

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

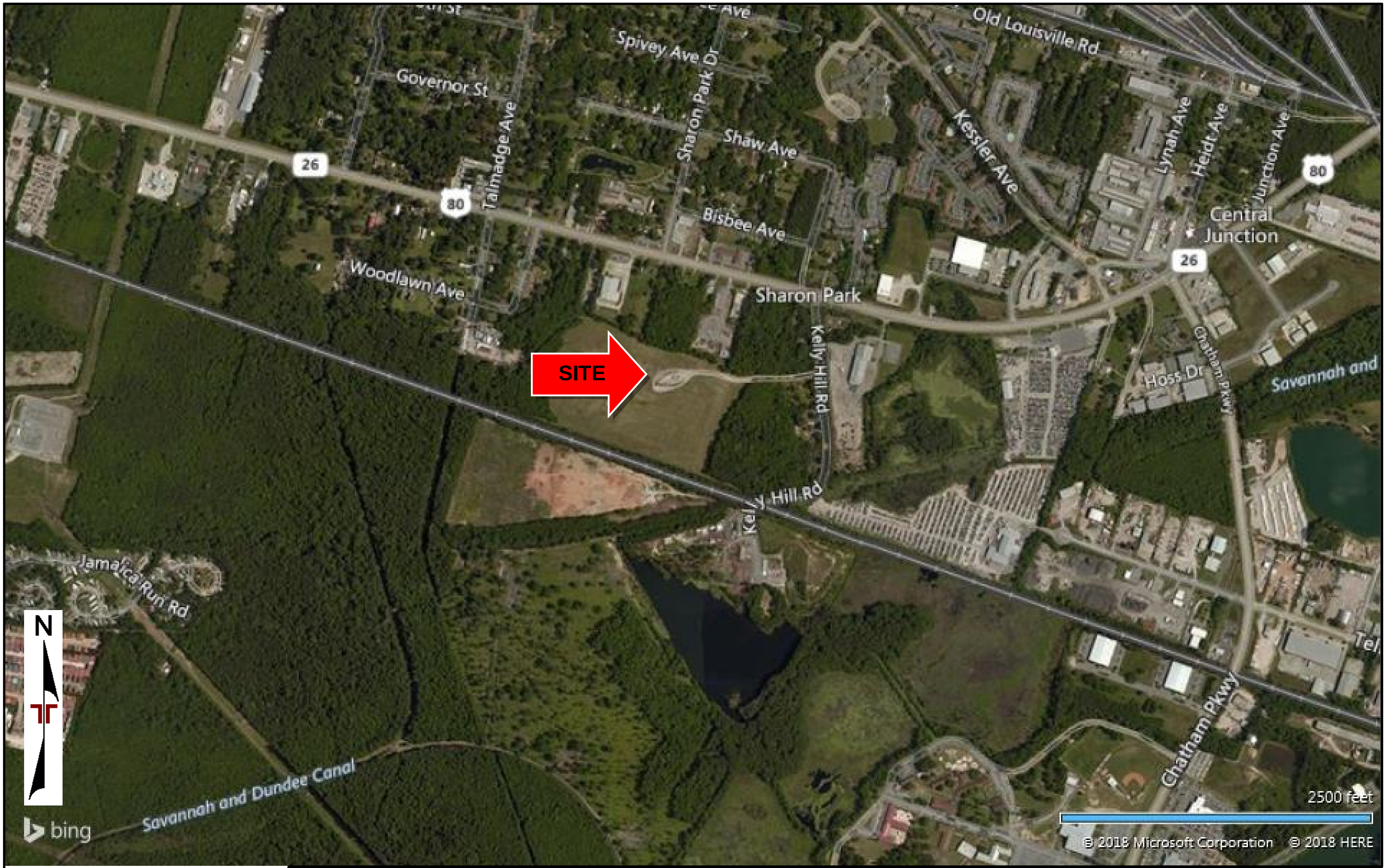
The analyses and recommendations presented in this report are based upon the data obtained from the explorations performed at the indicated locations and from other information discussed in this report. This report does not reflect variations that may occur between exploration locations, across the site, or may be caused due to the modifying effects of construction or weather. Bear in mind that the nature and extent of such variations may not become evident until construction has started or until construction activities have ceased. If variations do appear, Terracon should be notified immediately so that further evaluation and supplemental recommendations can be provided.

The scope of services for this project does not include either specifically or by implication any environmental or biological (e.g., mold, fungi, and bacteria) assessment of the site or identification or prevention of pollutants, hazardous materials or hazardous conditions. If the owner is concerned about the potential for such contamination or pollution, please advise so that additional studies may be undertaken.

This report has been prepared for the exclusive use of our client for specific application to the project and site discussed, and has been prepared in accordance with generally accepted geotechnical engineering practices. No warranties, either expressed or implied, are intended or made. Site safety, excavation support and dewatering requirements are the responsibility of others. In the event that changes in the nature, design, or location of the project as outlined in this report are planned, the conclusions and recommendations contained in this report shall not be considered valid unless Terracon reviews the changes, and then either verifies or modifies the conclusions of this report in writing.

APPENDIX A

Field Exploration



AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

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

Project Manager:	TCB
Drawn by:	TCB
Checked by:	CWB
Approved by:	GL

Project No.	ES185060
Scale:	1"=2,000'
File Name:	
Date:	04-24-18

Terracon
2201 Rowland Ave
Savannah, GA 31404-4434

SITE LOCATION

Kelly Hill Road Disposal Center
50 Kelly Hill Road
Garden City, GA

Exhibit

A-1

AERIAL PHOTOGRAPHY PROVIDED BY
MICROSOFT BING MAPS

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

Project Manager: TCB	Project No. ES185060
Drawn by: TCB	Scale: N.T.S.
Checked by: GL	File Name:
Approved by: GL	Date: 4-24-2018

Terracon
2201 Rowland Ave
Savannah, GA 31404-4434

EXPLORATION PLAN

Kelly Hill Road Disposal Center
50 Kelly Hill Road
Garden City, GA

Exhibit

A-2

Field Exploration Description

The locations of Standard Penetration Test (SPT) soundings and Hand Auger borings are determined by Terracon based on the proposed development and were located in the field using hand-held GPS units and in reference to existing features. These locations are shown in the Exploration Location Plan and should be considered approximate.

Hand Auger Borings

Hand auger borings were conducted in general accordance with ASTM D 1452-80, Standard Practice for Soil Investigation and Sampling by Auger Borings. In this test, hand auger borings are drilled by rotating and advancing a bucket auger to the desired depths while periodically removing the auger from the hole to clear and examine the auger cuttings. The soils were classified in accordance with ASTM D2488.

Soil Test Borings

The soil borings were performed with a truck-mounted rotary type drill rig equipped with a hydraulic head employed in drilling and sampling operations. The borings were advanced using 6-inch diameter continuous flight augers.

Soil samples were obtained using spilt-barrel sampling procedures in accordance with ASTM Specifications D1586. In the split-barrel sampling procedure the number of blows required to advance a standard 2-inch O.D., 1-3/8-inch I.D spilt-barrel sampler from 6 to 18 inches of penetration by means of a 140-pound hammer with a free fall of 30 inches is used to obtain the Standard Penetration Test (SPT) or N-value. The SPT is used to estimate the in-situ relative density of cohesionless soils and the consistency of cohesive soils.

BORING LOG NO. B1

Page 1 of 1

PROJECT: **Kelly Hill Road Disposal Center**

CLIENT: **Chatham County GA**
Savannah, GA

SITE: **50 Kelly Hill Road**
Garden City, GA

LOCATION See Exhibit A-2

Latitude: 32.0847° Longitude: -81.1725°

DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
0.5	**AGGREGATE BASE COURSE**, with gravel				
2.0	**POORLY GRADED SAND WITH GRAVEL (SP)**, trace clay, dark gray, medium dense			☒	8-7-5-5 N=12
	SANDY LEAN CLAY (CL), dark gray, stiff			☒	3-4-5-4 N=9
	trace gravel, dark gray, medium stiff	5		☒	2-2-3-3 N=5
	gray and orange, medium stiff		▽	☒	2-3-2-3 N=5
13.5	reddish orange to brown, stiff	10		☒	2-4-5-9 N=9
18.5	**SILTY CLAY WITH SAND (CL-ML)**, trace gravel, dark gray and orange, very stiff, construction and demolition waste debris, organic odor	15		☒	6-12-9 N=21
	SANDY LEAN CLAY (CL), red brown and gray, medium stiff, construction and demolition waste debris, mulch	20		☒	10-4-3 N=7
25.0	red brown and gray, very stiff	25		☒	21-7-9 N=16
	Boring Terminated at 25 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:

Abandonment Method:

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 04-04-2018	Boring Completed: 04-04-2018
Drill Rig: CME 45	Driller:
Project No.: ES185060	Exhibit: A-4-1

BORING LOG NO. B2

PROJECT: **Kelly Hill Road Disposal Center**

CLIENT: **Chatham County GA**
Savannah, GA

SITE: **50 Kelly Hill Road**
Garden City, GA

LOCATION See Exhibit A-2

Latitude: 32.0845° Longitude: -81.1727°

DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
0.5	**AGGREGATE BASE COURSE**, with gravel				
	SANDY LEAN CLAY WITH GRAVEL (CL), very stiff			☒	9-10-11-10 N=21
	stiff			☒	6-4-5-7 N=9
	gray and brown, soft to medium stiff	5		☒	2-2-2-2 N=4
6.0	**SANDY LEAN CLAY (CL)**, brown and dark gray, soft		▽	☒	1-1-1-3 N=2
	brownish gray and orange, soft to medium stiff	10		☒	1-2-2-1 N=4
	brownish gray and orange, stiff	15		☒	5-6-6 N=12
	brownish gray and orange, very stiff	20		☒	9-8-19 N=27
23.5	**SILTY CLAY WITH SAND (CL-ML)**, trace gravel, very stiff, construction and demolition waste debris, mulch	25		☒	9-16-11 N=27
25.0	***Boring Terminated at 25 Feet***				

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:	See Exhibit A-3 for description of field procedures. See Appendix B for description of laboratory procedures and additional data (if any). See Appendix C for explanation of symbols and abbreviations.	Notes:
Abandonment Method:		

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 04-04-2018	Boring Completed: 04-04-2018
Drill Rig: CME 45	Driller:
Project No.: ES185060	Exhibit: A-4-2

BORING LOG NO. B3

Page 1 of 1

PROJECT: Kelly Hill Road Disposal Center

CLIENT: Chatham County GA
Savannah, GA

SITE: 50 Kelly Hill Road
Garden City, GA

LOCATION See Exhibit A-2

Latitude: 32.0845° Longitude: -81.1725°

DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
0.5	**AGGREGATE BASE COURSE**, with gravel				
2.0	**SANDY LEAN CLAY (CL)**, with gravel, gray and orange, medium stiff			☒	5-3-3-4 N=6
4.0	**CLAYEY SAND (SC)**, brown and orange, loose			☒	3-2-3-5 N=5
	SANDY LEAN CLAY (CL), trace gravel, gray and orange, soft	5		☒	1-1-1-1 N=2
	with gravel, gray and orange, soft			☒	0-0-2-2 N=2
	gray and orange, soft	10		☒	1-1-1-3 N=2
18.5	gray and brown, very stiff, construction and demolition waste debris, mulch	15	▽	☒	4-8-11 N=19
23.4	**FILL - GRAVEL** , dark gray, very stiff, construction and demolition waste debris, mulch	20		☒	14-16-13 N=29
25.0	**SILTY SAND (SM)**, dark gray, medium dense, construction and demolition waste debris, mulch	25		☒	6-5-8 N=13
	Boring Terminated at 25 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:

Abandonment Method:

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon

2201 Rowland Ave
Savannah, GA

Boring Started: 04-04-2018	Boring Completed: 04-04-2018
Drill Rig: CME 45	Driller:
Project No.: ES185060	Exhibit: A-4-3

BORING LOG NO. B4

Page 1 of 1

PROJECT: Kelly Hill Road Disposal Center

CLIENT: Chatham County GA
Savannah, GA

SITE: 50 Kelly Hill Road
Garden City, GA

LOCATION See Exhibit A-2

Latitude: 32.0845° Longitude: -81.1723°

DEPTH		DEPTH (Ft.)	WATER LEVEL OBSERVATIONS	SAMPLE TYPE	FIELD TEST RESULTS
0.5	**AGGREGATE BASE COURSE**, with gravel				
2.0	**SANDY LEAN CLAY (CL)**, trace gravel, orange and brown, stiff			☒	5-5-5-8 N=10
	SANDY LEAN CLAY, orange and brown, stiff			☒	7-7-7-9 N=14
	orange and brown, medium stiff	5		☒	3-3-3-4 N=6
	gray, medium stiff to stiff		▽	☒	2-4-4-6 N=8
	orange and brownish gray, medium stiff			☒	3-2-3-6 N=5
		10			
18.5	gray, very stiff, construction and demolition waste debris, mulch	15		☒	8-13-8 N=21
23.5	**FILL - GRAVEL** , dark brown, hard, construction and demolition waste debris, wood	20		☒	6-27-50 N=77
25.0	**SILTY SAND (SM)**, dark brown, medium dense, mulch	25		☒	8-6-8 N=14
	Boring Terminated at 25 Feet				

Stratification lines are approximate. In-situ, the transition may be gradual.

Advancement Method:

Abandonment Method:

See Exhibit A-3 for description of field procedures.

See Appendix B for description of laboratory procedures and additional data (if any).

See Appendix C for explanation of symbols and abbreviations.

Notes:

WATER LEVEL OBSERVATIONS

▽ *While drilling*

Terracon
2201 Rowland Ave
Savannah, GA

Boring Started: 04-04-2018	Boring Completed: 04-04-2018
Drill Rig: CME 45	Driller:
Project No.: ES185060	Exhibit: A-4-4

Hand Auger Boring Log

Project Name: Kelly Hill Road Disposal Center
Project No.: ES185060
Project Location: Garden City, Georgia

HA1		
Depth Below Grade (inch)	**Material Description**	**USCS CLASSIFICATION**
0 to 6	Concrete	
6 to 8	GAB	
8 to 18	Brown sandy CLAY and brick fragments	CL
18 to 30	Brown and gray sandy CLAY	CL
30 to 46	Brown, gray and red stiff CLAY	CL
46 to 52	Dark gray clayey SAND with brick and mulch	SC
52 to 60	Brown and gray silty SAND with clay	SM
	No Groundwater encountered	**Mottling @ 30" BGS**

HA2		
Depth Below Grade (inch)	**Material Description**	**USCS CLASSIFICATION**
0 to 6	Concrete	
6 to 8	GAB	
8 to 24	Reddish brown and gray sandy CLAY w/ roots and brick fragments	CL
24 to 40	Reddish brown and gray CLAY	CL
40 to 56	Brown and gray sandy CLAY with construction & demolition waste	CL
56 to 60	Brown silty SAND with clay	SM
	No Groundwater encountered	**Mottling @ 32" BGS**

HA3		
Depth Below Grade (inch)	**Material Description**	**USCS CLASSIFICATION**
0 to 4	Concrete with rebar	
4 to 24	Reddish brown and gray clayey SAND with roots	SC
24 to 36	Red and gray CLAY	CL
36 to 60	Gray and brown clayey SAND with roots and mulch	SC
	No Groundwater encountered	**Mottling @ 32" BGS**

HA4		
Depth Below Grade (inch)	**Material Description**	**USCS CLASSIFICATION**
0 to 6	Concrete with rebar	
6 to 22	Orange and brown sandy CLAY	CL
22 to 32	Orange and gray sandy CLAY	CL
32 to 48	Gray and red stiff CLAY with construction & demolition waste	CL
48 to 50	Gray and red sandy CLAY	CL
50 to 60	Gray and brown silty SAND with clay	SM
	No Groundwater encountered	**Mottling @ 40" BGS**

BGS = Below existing Ground Surface

Exhibit A-5

APPENDIX B

Supporting Information

Exhibit B-1	Site Photos
Exhibit B-2	General Notes
Exhibit B-3	Unified Soil Classification System

Project Manager:	TCB
Drawn by:	TCB
Checked by:	GL
Approved by:	GL

Project No.:	ES185060
Scale:	None
File Name:	
Date:	4/28/2018

Terracon
Consulting Engineers & Scientists

2201 Rowland Avenue Garden City, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

PHOTOGRAPH OF WALL CONDITION

KELLY HILL ROAD DISPOSAL CENTER
Garden City, Chatham County, Georgia

Exhibit:

B-1-1

Project Manager: TCB
Drawn by: TCB
Checked by: GL
Approved by: GL

Project No.: ES185060
Scale: None
File Name:
Date: 4/28/2018

Terracon
Consulting Engineers & Scientists
2201 Rowland Avenue Garden City, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

PHOTOGRAPH OF WALL CONDITION

KELLY HILL ROAD DISPOSAL CENTER
Garden City, Chatham County, Georgia

Exhibit:
B-1-2

Project Manager:	TCB
Drawn by:	TCB
Checked by:	GL
Approved by:	GL

Project No.:	ES185060
Scale:	None
File Name:	
Date:	4/28/2018

Terracon
Consulting Engineers & Scientists
2201 Rowland Avenue Garden City, Georgia 31404
Phone (912) 629 4000 Fax (912) 629 4001

PHOTOGRAPH OF WALL CONDITION

KELLY HILL ROAD DISPOSAL CENTER
Garden City, Chatham County, Georgia

Exhibit:

B-1-3

GENERAL NOTES

DESCRIPTION OF SYMBOLS AND ABBREVIATIONS

SAMPLING

▯ **Auger**	⊠ **Split Spoon**
■ **Shelby Tube**	▥ **Macro Core**
▱ **No Recovery**	▮ **Rock Core**
⊠ **Ring Sampler**	

GROUNDWATER

▽	**Groundwater Initially Encountered**
▽	**Groundwater Level After a Specified Period of Time**
▼	**Static Groundwater Level After a Specified Period of Time**
⊠	**No Groundwater Observed**

Water levels indicated on the soil boring logs are the levels measured in the borehole at the times indicated. Groundwater level variations will occur over time. In low permeability soils, accurate determination of groundwater levels is not possible with short term water level observations.

FIELD TESTS

(HP)	**Hand Penetrometer**
(T)	**Torvane**
(b/f)	**Standard Penetration Test (blows per foot)**
(PID)	**Photo-Ionization Detector**
(OVA)	**Organic Vapor Analyzer**

DESCRIPTIVE SOIL CLASSIFICATION

Soil classification is based on the Unified Soil Classification System. Coarse Grained Soils have more than 50% of their dry weight retained on a #200 sieve; their principal descriptors are: boulders, cobbles, gravel or sand. Fine Grained Soils have less than 50% of their dry weight retained on a #200 sieve; they are principally described as clays if they are plastic, and silts if they are slightly plastic or non-plastic. Major constituents may be added as modifiers and minor constituents may be added according to the relative proportions based on grain size. In addition to gradation, coarse-grained soils are defined on the basis of their in-place relative density and fine-grained soils on the basis of their consistency.

LOCATION AND ELEVATION NOTES

Unless otherwise noted, Latitude and Longitude are approximately determined using a hand-held GPS device. The accuracy of such devices is variable. Surface elevation data annotated with +/- indicates that no actual topographical survey was conducted to confirm the surface elevation. Instead, the surface elevation was approximately determined from topographic maps of the area.

STENGTH TERMS

RELATIVE DENSITY OF COARSE-GRAINED SOILS (More than 50% retained on No. 200 sieve.) Density determined by Standard Penetration Resistance Includes gravels, sands and silts.		**CONSISTENCY OF FINE-GRAINED SOILS** (50% or more passing the No. 200 sieve.) Consistency determined by laboratory shear strength testing, field visual-manual procedures or standard penetration resistance		
Descriptive Term (Density)	**Std. Penetration Resistance (blows per foot)**	**Descriptive Term (Consistency)**	**Undrained Shear Strength (kips per square foot)**	**Std. Penetration Resistance (blows per foot)**
Very Loose	0 - 3	Very Soft	less than 0.25	0 - 1
Loose	4 - 9	Soft	0.25 to 0.50	2 - 4
Medium Dense	10 - 29	Medium-Stiff	0.50 to 1.00	5 - 7
Dense	30 - 50	Stiff	1.00 to 2.00	8 - 14
Very Dense	> 50	Very Stiff	2.00 to 4.00	15 - 30
		Hard	above 4.00	> 30

RELATIVE PROPORTIONS OF SAND AND GRAVEL

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 15
With	15 - 29
Modifier	> 30

GRAIN SIZE TERMINOLOGY

Descriptive Term(s) of other constituents	Percent of Dry Weight
Boulders	Over 12 in. (300 mm)
Cobbles	12 in. to 3 in. (300mm to 75mm)
Gravel	3 in. to #4 sieve (75mm to 4.75 mm)
Sand	#4 to #200 sieve (4.75mm to 0.075mm
Silt or Clay	Passing #200 sieve (0.075mm)

RELATIVE PROPORTIONS OF FINES

Descriptive Term(s) of other constituents	Percent of Dry Weight
Trace	< 5
With	5 - 12
Modifier	> 12

PLASTICITY DESCRIPTION

Term	Plasticity Index
Non-plastic	0
Low	1 - 10
Medium	11 - 30
High	> 30

Terracon

Exhibit B-2

UNIFIED SOIL CLASSIFICATION SYSTEM

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]					Soil Classification	
					Group Symbol	Group Name[B]
Coarse Grained Soils More than 50% retained on No. 200 sieve	Gravels More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines[C]	Cu ≥ 4 and 1 ≤ Cc ≤ 3[E]		GW	Well-graded gravel[F]
			Cu < 4 and/or 1 > Cc > 3[E]		GP	Poorly graded gravel[F]
		Gravels with Fines More than 12% fines[C]	Fines classify as ML or MH		GM	Silty gravel[F,G, H]
			Fines classify as CL or CH		GC	Clayey gravel[F,G,H]
	Sands 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines[D]	Cu ≥ 6 and 1 ≤ Cc ≤ 3[E]		SW	Well-graded sand[I]
			Cu < 6 and/or 1 > Cc > 3[E]		SP	Poorly graded sand[I]
		Sands with Fines More than 12% fines[D]	Fines classify as ML or MH		SM	Silty sand[G,H,I]
			Fines Classify as CL or CH		SC	Clayey sand[G,H,I]
Fine-Grained Soils 50% or more passes the No. 200 sieve	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above “A” line[J]		CL	Lean clay[K,L,M]
			PI < 4 or plots below “A” line[J]		ML	Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OL	Organic clay[K,L,M,N]
			Liquid limit - not dried			Organic silt[K,L,M,O]
	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above “A” line		CH	Fat clay[K,L,M]
			PI plots below “A” line		MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried	< 0.75	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried			Organic silt[K,L,M,Q]
Highly organic soils	Primarily organic matter, dark in color, and organic odor				PT	Peat

[A] Based on the material passing the 3-in. (75-mm) sieve

[B] If field sample contained cobbles or boulders, or both, add “with cobbles or boulders, or both” to group name.

[C] Gravels with 5 to 12% fines require dual symbols: GW-GM well-graded gravel with silt, GW-GC well-graded gravel with clay, GP-GM poorly graded gravel with silt, GP-GC poorly graded gravel with clay.

[D] Sands with 5 to 12% fines require dual symbols: SW-SM well-graded sand with silt, SW-SC well-graded sand with clay, SP-SM poorly graded sand with silt, SP-SC poorly graded sand with clay

[E] $Cu = D_{60}/D_{10} \qquad Cc = \frac{(D_{30})^2}{D_{10} \text{ x } D_{60}}$

[F] If soil contains ≥ 15% sand, add “with sand” to group name.

[G] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

[H] If fines are organic, add “with organic fines” to group name.

[I] If soil contains ≥ 15% gravel, add “with gravel” to group name.

[J] If Atterberg limits plot in shaded area, soil is a CL-ML, silty clay.

[K] If soil contains 15 to 29% plus No. 200, add “with sand” or “with gravel,” whichever is predominant.

[L] If soil contains ≥ 30% plus No. 200 predominantly sand, add “sandy” to group name.

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

[N] PI ≥ 4 and plots on or above “A” line.

[O] PI < 4 or plots below “A” line.

[P] PI plots on or above “A” line.

[Q] PI plots below “A” line.

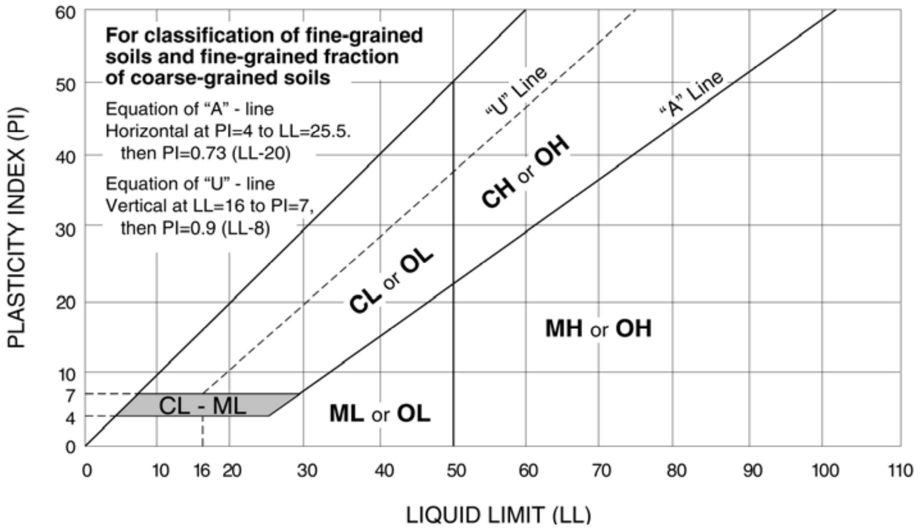


Exhibit B-3