HILLIS-CARNES
ENGINEERING ASSOCIATES

Geotechnical Engineering Study
5Kv South Distribution Center (SDC) Relocation and Replacement
at
Ronald Reagan Washington National Airport (DCA)
Arlington, Virginia
HCEA Job No.: H17108

July 24, 2018

Prepared for:

Burns Engineering, Inc.
2001 Market Street, Suite 600
Philadelphia, PA 19103

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July 24, 2018

Mr. Patrick Keeny, P.E.
Burns Engineering, Inc.
2001 Market Street, Suite 600
Philadelphia, PA 19103

Re: Geotechnical Engineering Study
5Kv South Distribution Center (SDC) Relocation and Replacement
Ronald Reagan Washington National Airport
Arlington, Virginia
HCEA Job No.: H17108

Dear Mr. Keeny:

Hillis-Carnes Engineering Associates, Inc. is pleased to submit this copy of our report concerning the subsurface exploration and geotechnical evaluation for the proposed new 5Kv South Distribution Center project to be located at the Ronald Reagan Washington National Airport in Arlington, Virginia.

The exploration consisted of drilling Standard Penetration Test borings at designated boring locations, performing engineering analyses, and preparing this written report of findings and conclusions.

We recommend that construction-monitoring services be performed by HCEA. This will help verify that the project design and construction are consistent with the assumptions made in the analyses and conclusions contained in this report.

Boring samples will be stored at our Hagerstown, Maryland office for a minimum period of 30 days from the date of this letter. Should you wish the samples to be stored for a longer period of time or to be delivered to you or another party, please advise us.

Should you have any questions or require additional information, please contact us.

Sincerely,
HILLIS-CARNES ENGINEERING ASSOCIATES, INC.

COMMONWEALTH OF VIRGINIA
MICHAEL P. JOHNSON
Lic. No. 17611
PROFESSIONAL ENGINEER

Cindy S. Shepeck Michael P. Johnson, P.E.

EXECUTIVE SUMMARY
5Kv SOUTH DISTRIBUTION CENTER (SDC) RELOCATION AND REPLACEMENT
RONALD REAGAN WASHINGTON NATIONAL AIRPORT

A subsurface exploration and geotechnical evaluation have been conducted for the proposed new 5Kv South Distribution Center (SDC) that is to be located at the Ronald Reagan Washington National Airport in Arlington, Virginia. The site of the proposed SDC is located south of the existing building located at 1000 Air Cargo Drive and within the fence-in area that contains two concrete open pits for stormwater containment. Foundation design criteria have been provided and possible design and construction problems have been discussed. The exploration and analysis of the site conditions reported herein is considered to be in sufficient detail and scope to form a reasonable basis for the final design.

The Geologic Map of Arlington County, Virginia, and Vicinity by Arlington County GIS Department 2013, indicates that the site may be underlain by either the Terrace Deposits Stage of the Middle Pleistocene Era of the sedimentary rock materials from the Lowland Terrace Deposits Formation or what is designated as Artificial Fill. The soils encountered at the test boring locations generally reflect the description of the materials described in the geologic references.

Our findings indicate that future settlements may be prevented by the installation of a pile support underpinning system. Typical pile support systems include but are not limited to pin piles, helical piles and auger-cast piles. Due to the existence of man-placed fill materials and site access, it is our opinion that a support system consisting of helical piles may be best suited for this project.

Groundwater observations were made during the drilling of the soil borings and after completion of the borings. Water was encountered during drilling within both of the test borings ranging from 13 to 13.5 feet below existing site grades. It should be noted that variations in the presence of, and the depth to, groundwater should be expected to occur due to seasonal fluctuations, surface runoff, evaporation, construction activity, etc.

Recommendations dealing with the earthwork and inspection during construction are also included. The inspection is considered necessary to verify the subsurface conditions and to verify that the soils-related construction phases are performed properly.

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HCEA JOB NO.: H17108

1.0 PURPOSE AND SCOPE

The purpose of this study was to determine the general subsurface conditions at the boring locations and to evaluate those conditions with respect to concept and design of a foundation system for the proposed construction.

The evaluations and recommendations presented in this report were developed from an analysis of project characteristics and an interpretation of the general subsurface conditions at the site based on the boring information. The stratification lines indicated on the Records of Exploration (boring logs) represent the approximate boundaries between soil types. In-situ, however, the transitions may be gradual. Such variations can best be evaluated during construction and, if necessary, any minor design changes can be made at that time.

An evaluation of the site with respect to potential construction problems and recommendations dealing with the installation of the helical piles are also included. The inspection is considered necessary to verify the subsurface conditions and to verify that the soils-related construction phases are performed properly.

The Appendix contains a summary of the field work on which this report is based.

2.0 PROJECT CHARACTERISTICS

The portion of the project site that this report addresses is located to the south of 1000 Air Cargo Drive, just east of the southern portion of the long term economy parking area, within the Ronald Reagan Washington National Airport in Arlington, Virginia.

Planned for construction is a 5Kv South Distribution Center (SDC) relocation and realignment by the airport facility. According to information provided to Hillis-Carnes via your office, the SDC is to be approximately 16.0-feet in height and founded on a concrete pad approximately 15-feet by 60-feet in size. According to the structural engineer, the following summarizes the foundation loading conditions due to the structure:

- Average bearing pressure applied to underlying soil (considering gravity loads only): 485 psf (lbs per sq ft)
- Maximum bearing pressure on underlying soil (considering effect from lateral loads also): 546 psf
- Loads provided are un-factored (service loads)

3.0 FIELD EXPLORATION

Standard Penetration Test (SPT) soil borings were drilled at the site at the locations designated by our office. Two (2) test borings were drilled within the proposed electrical pad location area to depths ranging from 25 feet to 35 feet below existing site grades. The approximate boring locations are shown on the Boring Location Plan (Figure 1) that is included in the Appendix.

The borings were advanced with hollow-stem augers and the subsurface soils were sampled at 2.5 ft and 5.0 ft intervals. Samples were taken by driving a 1-3/8 inch I.D. (2-inch O.D.) split-spoon sampler in accordance with ASTM D-1586 specifications. The sampler was first seated 6 inches to penetrate any loose cuttings and then was driven an additional foot with blows of a 140-pound hammer falling 30 inches. The number of hammer blows required to drive the sampler the final foot is designated as the "Penetration Resistance" or "N" value. The penetration resistance, when properly evaluated, is an index of the soil strength and compression characteristics.

Representative portions of each soil sample were placed in glass jars and transported to Hillis-Carnes' laboratory. In the laboratory, the samples were visually examined by the Geotechnical Engineer to verify the driller's field classifications. The samples were visually classified in general accordance with the Unified Soil Classification System and the field classifications were revised where necessary. The Unified Soil Classification Symbols appear on the boring logs and the system nomenclature is briefly described in the Appendix.

4.0 SUBSURFACE CONDITIONS

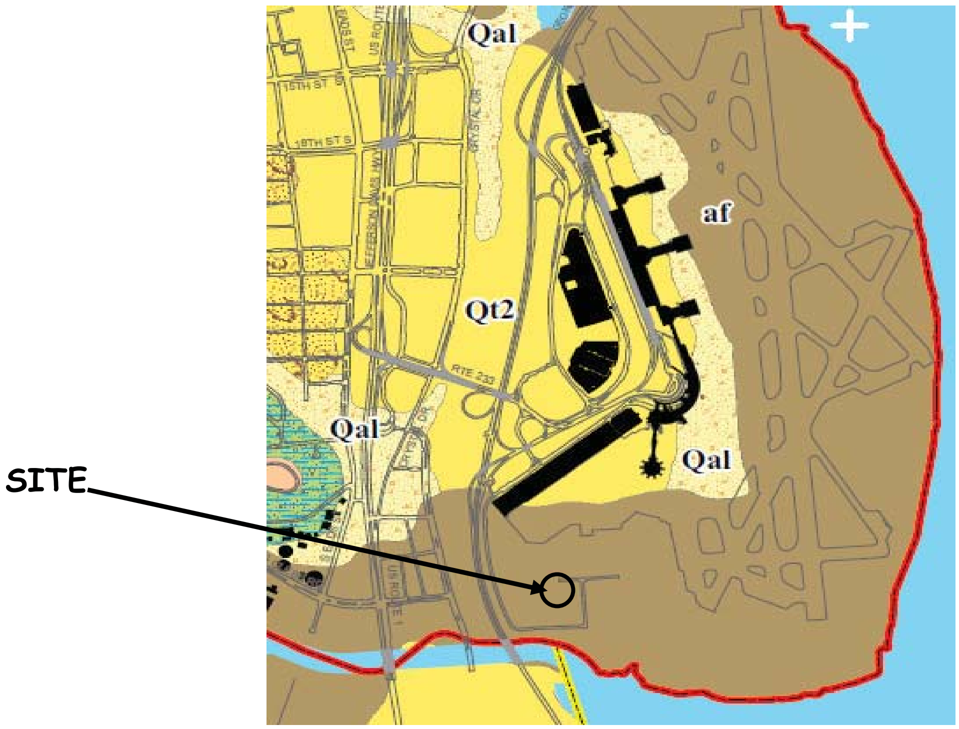
Details of the subsurface conditions encountered at the site are shown on the Records of Soil Exploration (boring logs). A brief description of the subsurface conditions and pertinent engineering characteristics of the soils are given below.

Strata divisions shown on the boring logs have been estimated based on visual examinations of the recovered boring samples. In the field, strata changes could occur gradually and/or at slightly different levels than indicated. Also, groundwater conditions indicated on the boring logs are those observed during the period of the subsurface exploration. Fluctuations in groundwater levels could occur seasonally and might also be influenced by changes in grading, runoff and infiltration rates, and other influencing factors.

Generalized subsurface conditions based on the results of the borings are discussed in detail in the following report sections. For more specific information on soil and groundwater conditions, please refer to the individual boring logs in the Appendix.

4.1 General Site Geology

The Simplified Geologic Map of Arlington County, Virginia, and Vicinity by Arlington County GIS Department 2013, indicates that the site may be underlain by either the Terrace Deposits Stage of the Middle Pleistocene Era of the sedimentary rock materials from the Lowland Terrace Deposits Formation or what is designated as Artificial Fill. More detailed descriptions of these formations are described on the following page.



(Copyright 2013 by Arlington County, Virginia)

ARTIFICIALLY CHANGED GROUND

Af	**Artificial Fill** -- Heterogeneous materials found in large areas regraded, leveled, or filled for construction. Also includes fill of marshes or low-lying areas and those formerly mined for sand, gravel, or clay. Smaller scale fills of variable composition and thickness found throughout the urbanized area have not been mapped.
Qt2	**Terrace Deposits (middle Pleistocene)** -- Gravel, sand, silt, and clay , gray brown to medium orange, crudely to well bedded. Found in a terrace below a 50 ft (15 m) elevation west of the Potomac River. Minerology similar to Qal but more deeply weathered. Where unstripped, the upper few feet is yellow to medium orange due to accumulation of iron oxide. Thickness may be up to 35 feet (10 m).

The soils encountered at the test boring locations generally reflect the description of the materials described in the geologic references.

4.2 Topsoil

A topsoil layer, extending to depths of approximately 4-inches to 4.5-inches below existing site grades, was encountered in both of the test borings. It should be noted that soil borings should not be utilized for determining the topsoil quantities as they may vary from one location to another within a landscaped area such as in this drilling area.

4.3 Man-Placed Fill Materials

Materials identified as man-placed fill or possible man-placed fill extended to depths up to 11.0± feet below existing site grades and generally consisted of SAND (SP) with varying amounts of clay, gravel, deleterious materials and silt within both boring locations.

Please note that test borings are not a definitive method of evaluating the presence of existing fill materials because of the limited size of the hole diameters and the very limited sample sizes obtained in comparison to the areal extent of the site. Also, the fill materials may be similar in composition to the on-site natural soils and therefore would be difficult to distinguish in the relatively small boring samples obtained. It should be anticipated that man-placed fill materials may be encountered at other locations and to different depths due to the construction that has previously occurred at the site.

4.4 Natural Materials

The natural soils encountered during subsurface exploration generally reflect the description of the materials described in the geologic references. These materials were encountered at approximately 11.0 feet in both borings locations. The soils encountered consisted of CLAY with varying amounts of sand, gravel, and organics which exhibited relative consistencies of soft to medium stiff; and SAND (SM) with various amounts of gravel, clay, and organics which exhibited relative densities in the very loose to loose range.

Test borings B-1 and B-2 were terminated at depths of 30-feet and 35-feet, below existing site grades, respectively. For more specific information, refer to the Records of Soil Exploration in the Appendix.

4.5 Groundwater

Groundwater was observed in both of the test borings during the drilling operations at depths ranging from 13.0 to 13.5 feet below existing site grades. Groundwater levels were obtained approximately 24 hours after their completion with no water being present at that time. As such, some groundwater-related construction problems are a possibility at the site during foundation construction and anywhere that deep excavations are required during the project construction. The groundwater conditions encountered at the time of our subsurface exploration are indicated on the Boring Logs and Summary of Subsurface Conditions in the Appendix.

A more accurate determination of the hydrostatic water table would require the installation of perforated pipes or piezometers that could be monitored over an extended period of time. The actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending on variations in precipitation, surface run-off, infiltration, site topography, and drainage.

4.6 Site Seismicity

Based on the 2009 International Building Code (IBC), Section 1613, the site has the following design criteria:

Site Class	=	E
S_s	=	≤ 0.25
Fa	=	2.5
S_1	=	≤ 0.1
Fv	=	3.5

5.0 EVALUATIONS AND RECOMMENDATIONS

Our findings indicate that electrical pad foundation can be supported by the installation of a pile supported foundation which is terminated within the naturally occurring soils. However, the owner must realize that there is risk involved with constructing over man-placed fill materials and that future maintenance and/or repair of the structure may be required. It would be necessary to completely remove and replace all existing fill materials in order to reduce this type of risk entirely.

The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions. If there are any changes to the project characteristics or if different subsurface conditions are encountered during construction, Hillis-Carnes should be consulted so that the recommendations of this report can be reviewed and revised, if necessary.

Due to the existence of man-placed fill materials and the uncertainty of their method of placement, it is our opinion that a support system consisting of helical piles may be best for the project.

Helical piles consist of a central shaft with one or multiple helix-shaped bearing flights. The piles are torqued into the substrate with high-torque mechanical equipment. The helical piles should include underpinning brackets and should extend through the fill layer into the naturally existing soils or until suitable bearing materials are encountered.

The helical piles should be installed by a contractor which is experienced in the design and construction of helical piles. The geometry and quantity of helical piles should be determined by the installation contractor. This information should be reviewed and approved by the structural engineer of record and the geotechnical engineer of record.

It is recommended that a HCEA representative is present during the installation of the helical piles in order to verify installation procedures.

The following recommendations have been developed on the basis of the previously described project characteristics and subsurface conditions. If there are any changes to the project characteristics or if different subsurface conditions are encountered during construction, HCEA should be consulted so that the recommendations of this report can be reviewed and revised, if necessary.

5.1 General Site Preparations

Any existing below ground structures within the areas to be developed should be removed prior to the initiation of new construction. We suggest that all available information regarding the existing utilities at the site be reviewed prior to construction.

Removal should include all underground pipes, utilities, and underground structures that might interfere with the new construction. If abandoned underground utilities are to be removed prior to the initiation of construction, provisions should be made in the construction specifications and budget to restore the subgrade to stable condition. Restoration should include backfilling and compaction of the excavation areas.

A Geotechnical Engineer or experienced Soils Inspector should witness the near surface compaction of the subgrade for foundation pad support, as well as proofrolling operations and determine whether any areas require undercutting and/or stabilization.

5.2 Fill Selection, Placement and Compaction

All material to be used as fill or backfill should be inspected, tested and approved by the Geotechnical Engineer. In general, the on-site soils which are free from organic and other deleterious components can be re-used as general site fill. Materials suitable for various construction purposes can be identified by an experienced Soils Inspector during grading operations.

Moisture conditioning (that is, wetting or drying) of the soils should be anticipated to achieve proper compaction, particularly if earthwork is performed other than in the summer months. The moisture contents of the soils should be controlled properly to avoid extensive construction delays. If imported fill material is required, those materials should have Unified Soil Classifications of SM or better.

All fill should be placed in relatively horizontal 8-inch (maximum) loose lifts and should be compacted to a minimum of 95 percent of the Modified Proctor (ASTM D-698) maximum dry density. Fill materials in landscape and other non-structural areas should be compacted to at least 92 percent of the Standard Proctor maximum dry density if significant subsidence of the fill under its own weight is to be avoided. In general, field moisture contents should be maintained within 2 percentage points of the optimum moisture content in order to provide adequate compaction.

Structural fill should extend a minimum of ten feet beyond structural fill pads. Fill slopes no steeper than 2(H):1(V), or flatter, should be used. New fills should be properly benched into existing slopes. A sufficient number of in-place density tests should be performed by an experienced Engineering Technician on a full-time basis to verify that the proper degree of compaction is being obtained.

5.3 Foundations

Our findings indicate that the site can be developed for the proposed electrical base pad utilizing a deep foundation system, such as helical piles.

Helical piers can be utilized for the support of the structure. According to the structural engineer, the projected loading pressures of the electrical pad will consist of an estimated gravity loading condition of 485 psf and a maximum bearing pressure including the lateral loads will be on the range of 548 psf onto the in-situ soils conditions encountered. Furthermore, perimeter helical piles can be battered if necessary at an approximate ratio of 1H:4V. Additionally, we recommend that the structural engineer be given the opportunity to design for the anticipated field changes prior to construction. Cast-in-place grade beams could be utilized to span between the pier caps, with a thickened slab that should be cast monolithically.

It should be further noted that each specialty contractor has proprietary means and methods of designing and installing these types of foundation systems; as such, each design-build submittal should be evaluated individually for compliance to the site specific design characteristics.

5.4 Groundwater and Drainage

As previously mentioned, groundwater was encountered in both of the borings drilled at the site. Any water infiltration resulting from a shallow interception of the groundwater table and/or perched water should be able to be controlled by means of sump pits and pumps if only a minor lowering is required.

6.0 RECOMMENDED ADDITIONAL SERVICES

Additional soil and foundation engineering, testing, and consulting services recommended for this project are summarized on the following page:

Helical Pile Inspections: A Geotechnical Engineer or experienced Soils Inspector should inspect the helical pile installations within the foundations. He should verify that the design bearing pressure is available and that proper torque has been achieved during installation. Based on the inspection, the Inspector would either approve the bearing, type, and size of helical piles to ensure it meets design recommendations.

7.0 REMARKS

This report has been prepared to aid in the evaluation of the site for the proposed construction. It is considered that adequate recommendations have been provided to serve as a basis for design and preparation of plans and specifications. Additional recommendations can be provided as needed.

These analyses and recommendations are, of necessity, based on the information made available to us at the time of the actual writing of the report and the on-site surface and subsurface conditions which existed at the time the exploratory borings were drilled. Further assumption has been made that the limited exploratory borings, in relation both to the areal extent of the site and to depth, are representative of conditions across the site.

If subsurface conditions are encountered which differ from those reported herein, this Office should be notified immediately so that the analyses and recommendations can be reviewed and/or revised as necessary. It is also recommended that:

1. We are given the opportunity to review any plans and specifications in order to comment on the interaction of the soil conditions as described herein and the design requirements.

2. A Geotechnical Engineer or experienced Soils Inspector is present at the site during the construction phase to verify installation according to the approved plans and specifications.

Please note that successful completion of the project is dependent on your compliance with all of the recommendations provided in this report. While represented separately, the recommendations represent work that is intertwined. The successful completion of the project is specifically conditioned on your complying with all recommendations.

Our professional services have been performed, our findings obtained, and our recommendations prepared in accordance with generally accepted engineering principles and practices. This warranty is in lieu of all other warranties either implied or expressed. HCEA assumes no responsibility for interpretations made by others based on work or recommendations by us.

APPENDIX

Site Location Plan

Boring Location Plan

Records of Soil Exploration (3 pages)

Field Classification Sheet

HILLIS-CARNES
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Figure 1: Site Location Plan

5Kv South Distribution Center Relocation & Replacement
At Ronald Reagan Washington National Airport
Arlington, Virginia
HCEA Project No.: H17108

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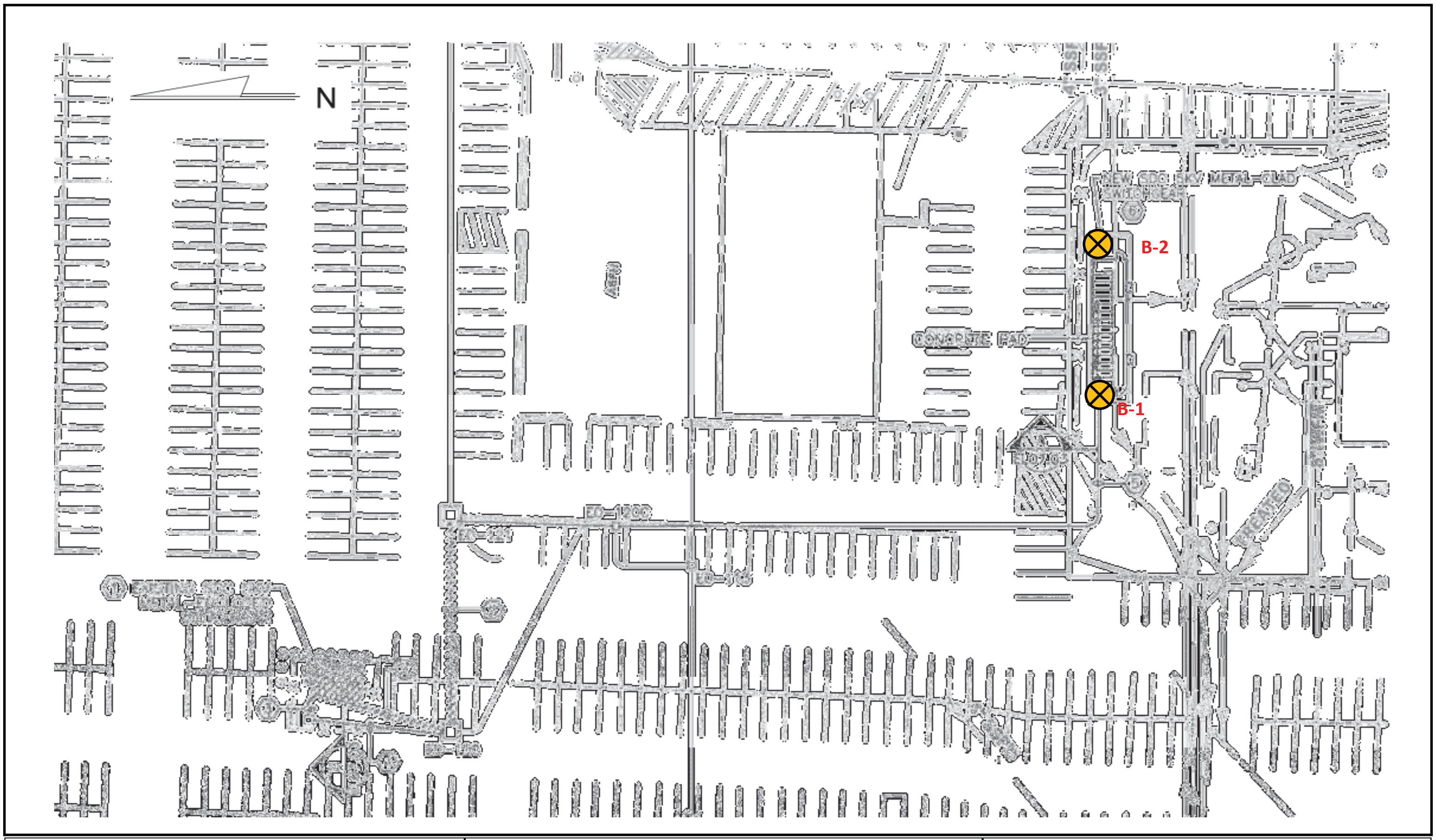

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Figure 2: Test Boring Location Plan

5Kv South Distribution Center Relocation & Replacement

At Ronald Reagan Washington National Airport

Arlington, Virginia

HCEA Project No.: H17108

10228 Governor Lane Boulevard
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HILLIS - CARNES ENGINEERING ASSOCIATES, INC.

RECORD OF SOIL EXPLORATION

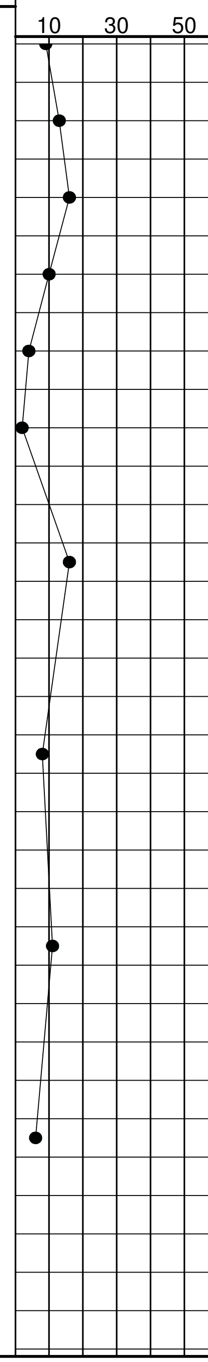
Project Name: **5Kv South Distribution Center (SDC) Relocation and Replacement** — Boring No. B-1

Location: Ronald Reagan National Airport — Job # H17108

SAMPLER

Datum	MSL	Hammer Wt.	140 lbs. lbs.	Hole Diameter	8"	Foreman	B. VanDoren
Surf. Elev.	ft	Hammer Drop	30" in	Rock Core Diameter		Inspector	C. Shepeck
Date Started	1/17/2018	Pipe Size	2.0" OD in	Boring Method	HSA	Date Completed	1/17/2018

Elevation/ Depth	SOIL SYMBOLS/ SAMPLE CONDITIONS	Description	Boring and Sampling Notes	No.	Rec.	SPT Blows	SPT Blows/Foot N	NM
0		Topsoil, Grassmat: 4.5"		1	12"	3-4-5-5	9	
	D	Brown, moist, medium dense to loose silty fine SAND, trace clay (OLD FILL MATERIALS)		2	16"	3-4-9-11	13	
	D		Bag sample taken at 3.0'-5.0'	3	16"	4-6-10-11	16	
5	D			4	22"	7-6-4-3	10	
	D			5	3"	3-2-2-2	4	
	D			6	13"	WOH/6"-1, 1-1	2	
10	I	Gray, moist, very loose silty, clayey, fine SAND with little fine gravel (SC)						
	D	Gray, wet, medium dense silty fine to coarse SAND and gravel (SM)	Goundwater encountered at 13.5' while drilling	7	12"	8-9-7	16	
15	D			8	11"	6-4-4	8	
20	I	Dark gray, moist to wet, medium stiff silty, CLAY with trace fine sand (CL)		9	12"	4-5-6	11	
25	D	Dark gray, wet, loose clayey fine SAND (SC)		10	9"	4-3-3	6	
30		Bottom of hole at 30.0'						



SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

	GROUND WATER	CAVE IN DEPTH
AT COMPLETION	Dry ft	7.0' ft
AFTER 24 HRS.	Dry ft	6.9' ft
AFTER ___ HRS.	ft	ft

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.

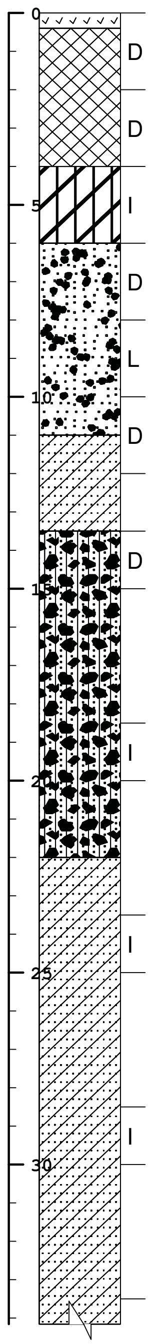
RECORD OF SOIL EXPLORATION

Project Name	5Kv South Distribution Center (SDC) Relocation and Replacement	Boring No.	B-2
Location	Ronald Reagan National Airport	Job #	H17108

SAMPLER

Datum	MSL	Hammer Wt.	140 lbs. lbs.	Hole Diameter	6"	Foreman	B. VanDoren
Surf. Elev.	ft	Hammer Drop	30" in	Rock Core Diameter		Inspector	C. Shepeck
Date Started	1/17/2018	Pipe Size	2.0" OD in	Boring Method	HSA	Date Completed	1/17/2018

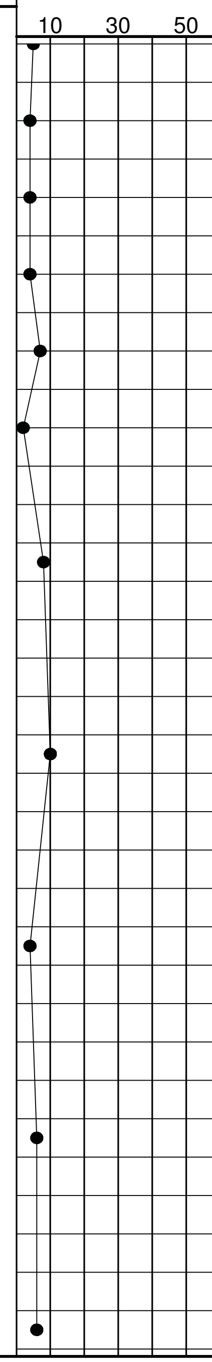
Elevation/Depth — SOIL SYMBOLS/SAMPLE CONDITIONS



Description	Boring and Sampling Notes
Topsoil: 4.0"	
Brown, moist, medium stiff to soft, sandy CLAY, trace of gravel (OLD FILL MATERIALS)	
Brown, moist, soft CLAY, trace of bricks (OLD FILL MATERIALS)	Bag sample taken between 3' to 8'
Light brown, dry, loose to very loose, sand and gravel, trace clay (POSSIBLE OLD FILL MATERIALS)	
Brown, moist, very loose, clayey SAND (SC/CL)	
Dark brown and gray, wet loose, fine SAND, some fine gravel (SM/GM)	Water encountered at 13'
Very dark gray, moist, soft to medium stiff CLAY, trace of sand (CL/SC)	Boring left open

Sample Condition	No.	Rec.	SPT Blows	N
D	1	4"	2-2-3-3	5
D	2	10"	2-2-2-2	4
I	3	10"	2-2-2-2	4
D	4	3"	2-2-2-4	4
L	5	0"	3-3-4-6	7
D	6	2"	2-1-1-1	2
D	7	12"	2-2-6	8
I	8	14"	3-4-6	10
I	9	18"	2-2-2	4
I	10	12"	2-3-3	6
	11	18"	3-3-3	6

SPT Blows/Foot — Curve — NM



	GROUND WATER	CAVE IN DEPTH
AT COMPLETION	Dry ft	9.5' ft
AFTER 24 HRS.	Dry ft	9.75' ft
AFTER ____ HRS.	ft	ft

SAMPLER TYPE
DRIVEN SPLIT SPOON UNLESS OTHERWISE
PT - PRESSED SHELBY TUBE
CA - CONTINUOUS FLIGHT AUGER
RC - ROCK CORE

SAMPLE CONDITIONS
D - DISINTEGRATED
I - INTACT
U - UNDISTURBED
L - LOST

BORING METHOD
HSA - HOLLOW STEM AUGERS
CFA - CONTINUOUS FLIGHT AUGERS
DC - DRIVING CASING
MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS - CARNES
ENGINEERING ASSOCIATES, INC.

RECORD OF SOIL EXPLORATION

Project Name: **5Kv South Distribution Center (SDC) Relocation and Replacement** Boring No.: B-2

Location: Ronald Reagan National Airport Job #: H17108

SAMPLER

Datum: MSL Hammer Wt.: 140 lbs. lbs. Hole Diameter: 6" Foreman: B. VanDoren

Surf. Elev.: ____ ft Hammer Drop: 30" in Rock Core Diameter: ____ Inspector: C. Shepeck

Date Started: 1/17/2018 Pipe Size: 2.0" OD in Boring Method: HSA Date Completed: 1/17/2018

Elevation/ Depth	SOIL SYMBOLS/ SAMPLE CONDITIONS	Description	Boring and Sampling Notes	No.	Rec.	SPT Blows	SPT Blows/Foot N	Curve (10 30 50)	NM
35	I	Bottom of boring 35.0'							
40									
45									
50									
55									
60									
65									

SAMPLER TYPE	SAMPLE CONDITIONS		GROUND WATER	CAVE IN DEPTH	BORING METHOD
DRIVEN SPLIT SPOON UNLESS OTHERWISE	D - DISINTEGRATED	AT COMPLETION	Dry ft	9.5' ft	HSA - HOLLOW STEM AUGERS
PT - PRESSED SHELBY TUBE	I - INTACT	AFTER 24 HRS.	Dry ft	9.75' ft	CFA - CONTINUOUS FLIGHT AUGERS
CA - CONTINUOUS FLIGHT AUGER	U - UNDISTURBED	AFTER ____ HRS.	ft	ft	DC - DRIVING CASING
RC - ROCK CORE	L - LOST				MD - MUD DRILLING

STANDARD PENETRATION TEST-DRIVING 2" O.D. SAMPLER 1' WITH 140# HAMMER FALLING 30": COUNT MADE AT 6" INTERVALS.

HILLIS-CARNES

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Description of Soils – per ASTM D2487

Major Component	Component Type	Component Description	Symbol	Group Name
Coarse-Grained Soils, More than 50% is retained on the No. 200 sieve	**Gravels** – More than 50% of the coarse fraction is retained on the No. 4 sieve. Coarse = 1" to 3" Medium = ½" to 1" Fine = ¼" to ½"	Clean Gravels <5% Passing No. 200 sieve	**GW**	Well Graded Gravel
			GP	Poorly Graded Gravel
		Gravels with fines, >12% Passing the No. 200 sieve	**GM**	Silty Gravel
			GC	Clayey Gravel
	Sands – More than 50% of the coarse fraction passes the No. 4 sieve. Coarse = No.10 to No.4 Medium = No. 10 to No. 40 Fine = No. 40 to No. 200	Clean Sands <5% Passing No. 200 sieve	**SW**	Well Graded Sand
			SP	Poorly Graded Sand
		Sands with fines, >12% Passing the No. 200 sieve	**SM**	Silty Sand
			SC	Clayey Sand
Fine Grained Soils, More than 50% passes the No. 200 sieve	Silts and Clays Liquid Limit is less than 50 Low to medium plasticity	Inorganic	**ML**	Silt
			CL	Lean Clay
		Organic	**OL**	Organic silt
				Organic Clay
	Silts and Clays Liquid Limit of 50 or greater Medium to high plasticity	Inorganic	**MH**	Elastic Silt
			CH	Fat Clay
		Organic	**OH**	Organic Silt
				Organic Clay
Highly Organic Soils	Primarily Organic matter, dark color, organic odor		**PT**	Peat

Proportions of Soil Components

Component Form	Description	Approximate percent by weight
Noun	Sand, Gravel, Silt, Clay, etc.	50% or more
Adjective	Sandy, silty, clayey, etc.	35% to 49%
Some	Some sand, some silt, etc.	12% to 34%
Trace	Trace sand, trace mica, etc.	1% to 11%
With	With sand, with mica, etc.	Presence only

Particle Size Identification

Particle Size	Particle dimension
Boulder	12" diameter or more
Cobble	3" to 12" diameter
Gravel	¼" to 3" diameter
Sand	0.005" to ¼" diameter
Silt/Clay (fines)	Cannot see particle

Cohesive Soils

Field Description	Consistency
Easily Molded in Hands	Very Soft
Easily penetrated several inches by thumb	Soft
Penetrated by thumb with moderate effort	Medium
Penetrated by thumb with great effort	Stiff
Indented by thumb only with great effort	Hard

Granular Soils

No. of SPT Blows/ft	Relative Density
0 – 4	Very Loose
5 – 10	Loose
11 – 30	Medium Dense
31 – 50	Dense
Greater than 50	Very Dense

Other Definitions:

- **Fill:** Encountered soils that were placed by man. Fill soils may be controlled (engineered structural fill) or uncontrolled fills that may contain rubble and/or debris.
- **Saprolite**: Soil material derived from the in-place chemical and physical weathering of the parent rock material. May contain relic structure. Also called residual soils. Occurs in Piedmont soils, found west of the fall line.
- **Disintegrated Rock**: Residual soil material with rock-like properties, very dense, N = 60 to 51/0".
- **Karst:** Descriptive term which denotes the potential for solutioning of the limestone rock and the development of sinkholes.
- **Alluvium:** Recently deposited soils placed by water action, typically stream or river floodplain soils.
- Groundwater Level: Depth within borehole where water is encountered either during drilling, or after a set period of time to allow groundwater conditions to reach equilibrium.
- Caved Depth: Depth at which borehole collapsed after removal of augers/casing. Indicative of loose soils and/or groundwater conditions.