GEO-TECHNOLOGY ASSOCIATES, INC.

GEOTECHNICAL AND
ENVIRONMENTAL CONSULTANTS

A Practicing Geoprofessional Business Association Member Firm

April 18, 2019

CDA Engineering, Inc.
6 Larch Avenue, Suite 401
Wilmington, Delaware 19804

Attn: Mr. Colm DeAscanis

Re: Report of Geotechnical Exploration
Wildlife Viewing Enhancement Project at Ted Harvey Wildlife Area
Kent County, Delaware

Gentlemen:

Per our agreement, Geo-Technology Associates, Inc. (GTA) has performed a preliminary geotechnical evaluation for the two proposed viewing enhancements at the Ted Harvey Wildlife Area, located in Kent County, Delaware. The scope of this study included a field exploration and engineering analyses. The field exploration consisted of drilling 2 Standard Penetration Test Borings (SPT) within the proposed footprint of each viewing enhancement platform. Conclusions and recommendations regarding the design and construction of the proposed site improvements were derived from engineering analysis of field data provided herein.

Site Description and Proposed Construction

The subject site is generally situated south of Kitts Hummock Road within the Ted Harvey Conservation Area in Kent County, Delaware. Specifically, the locations of the proposed viewing platforms which were the focus of this exploration are described herein. The general location of the site and surrounding features are shown on *Figure 1*: *Site Location Map,* in Appendix A.

The general area is a tidal and fresh water marsh that is close to mean sea level with top of berm elevations estimated to be about Elevation (EL) 3 to 5. The upland areas and farmland in the vicinity of the spillway and levee are at about EL 3 to 10. Two control structures (weirs) were identified at the eastern and western ends of the levee. No survey of the area was available at the time this report was prepared. However, based visual observations and data obtained from Google Earth imagery the levee berm appears to be about 40 to 70 feet wide at the base and approximately 10 to 20 feet wide at the top.

The general location of the site and proposed viewing areas, along with surrounding features, are shown on the *Site Location Plan* (Figure 1). According the plans provided by CDA Engineering, Inc, the existing elevations range from elevation (EL) 2 to EL 4 at the location of the proposed north viewing platform and EL 3 to EL 6 at the location of the proposed south viewing platform.

The northern viewing platform will be constructed adjacent to the fresh water impoundment at the end of an existing cul-de-sac used to access permitted hunting and viewing stands. Using the plan titled *North Viewing Platform* by CDA Engineering, Inc. dated August 1, 2018, it is understood that the construction for the north viewing platform will consist of a small handicapped parking area and a ramp leading up to a viewing platform overlooking a wetlands area. The proposed ramp will start at EL 4.1, leading up to a 24-foot by 16-foot platform at EL 9.25 with a maximum slope of 5%. The ramp will be approximately 104 feet long.

The southern viewing platform will be constructed near the entrance to the existing levee which separates the wildlife area from the St. Jones River. Using the plan titled *South Viewing Platform* by CDA Engineering, Inc. dated August 1, 2018, it is understood that the construction of the south viewing platform will consist of a small handicapped parking area, a kiosk, and a ramp leading up to a viewing platform overlooking a wetlands area. The proposed ramp will start at EL 5.5, leading up to a 24-foot by 16-foot platform at EL 10.5 with a maximum slope of 5%. The ramp will be approximately 113 feet long.

Site Geology

Based on the Geologic Map of Kent County, Delaware (2007), prepared by the Delaware Geological Survey (DGS), the area is situated in the Coastal Plain Physiographic Province, which is characterized by undifferentiated and interlayered sedimentary deposits. Specifically, the site is mapped as underlain by Holocene Age Marsh Deposits that are underlain by the Pleistocene Age Scotts Corner Formation. The Marsh Deposits are described as structure-less to finely laminated, black to dark gray, organic-rich, silty clay to clayey silt, with discontinuous beds of peat and rare shells. The marsh deposits are mapped to range from 1 to 40 foot in thickness. The Scotts Corner Formation is described as alluvial sands with lesser percentages of silt and clay and can be 20 feet thick. The Lynch Heights formation is mapped below the Scotts Corner formation and extends to a depth of about 50 feet. This formation is described as predominately sandy materials. Refer to the publication for more detailed information.

Subsurface Exploration

The subsurface exploration was performed on March 13, 2019. The field exploration included drilling 4 SPT borings, identified as B-1 through B-4, to scheduled depths of 30 feet below the existing grades. Borings B-1 and B-2 were performed within the northern viewing areas, and Borings B-3 and B-4 were performed within the southern viewing area. The test borings were drilled by GTA with an ATV mounted Diedrich D50 drill rig equipped with 3¼-inch hollow-stem augers and an automatic hammer. The approximate locations are indicated on the *Exploration Location Plan, Figure 2.*

Standard Penetration testing as performed in the boreholes located in the proposed construction area, with continuous sampling performed in the upper 10 feet of drilling and at 5-foot intervals thereafter. SPT involves driving a 2-inch outside diameter (O.D.), 1⅜-inch inside diameter (I.D.) split-spoon sampler with a 140-pound hammer free-falling 30 inches. The number of blows required to drive the sampler was recorded in intervals of 6 inches. The total number of hammer blows required to drive the sampler from the 6 to 18-inch interval is the SPT N-value. Samples were visually classified in the field by engineering personnel using the Unified Soil Classification System (USCS) in accordance with ASTM D2488 (Visual-Manual Procedure); therefore, descriptions provided on the logs are visual. The soil samples were delivered to GTA's laboratory for further visual classification and testing by engineering personnel, the results are summarized in the *Notes for Exploration Logs*, included in Appendix B.

An instrument survey for elevation or location was not performed at the boring locations and the elevations indicated were interpolated from the site topography indicated on plans. Therefore, it should be understood that all elevations, as well as transitions in soil strata indicated on the boring logs, are approximate.

Subsurface Conditions

In general agreement with the known site conditions and the published geology, the test borings encountered up to 16 inches of topsoil and forest debris at the ground surface. Underlying the topsoil, the test borings typically encountered fine-grained materials visually classified as sandy silt at depths ranging from 1 foot to 3 feet. The SPT test results indicated that the fine-grained soils were very soft to soft in consistency. Beneath the fine-grained materials, the test borings were underlain by course-grained materials visually classified as poorly-graded sand with silt and silty sand to depths ranging from 2 feet to 8 feet. The SPT test results indicated that the course-grained soils were loose in consistency. The test borings located in the northern region of the site, Borings B-1 and B-2, encountered granular materials, primarily comprised of poorly-graded sand with varying amounts of silt and gravel, at depths ranging from 6 feet to termination depth of 30 feet. The SPT test results indicated the granular materials were loose to medium dense. The test borings located in the southern region of the site, B-3 and B-4, encountered the granular materials at depths of 3 feet to 18 feet, which were underlain by fine-grained materials visually classified as sandy lean clay at depths ranging from 15 feet to termination depth of 30 feet. The SPT test results indicated the fine-grained soils ranged from very soft to medium stiff in consistency.

Groundwater was initially encountered during drilling at depths ranging from 2 feet to 5 feet below existing surface grades. The test borings were backfilled upon completion, therefore there were no recorded cave depths or additional water level readings. The groundwater elevation likely fluctuates with the level of the water in the St. Jones River and tidal changes in Delaware Bay.

Conclusions and Recommendations

Based upon the results of this study, it is our opinion that construction of the proposed site improvements is feasible, given that the geotechnical recommendations outlined herein are followed, and that the standard level of care is maintained during construction. It should be noted that problems could be encountered with soft, wet, surficial soils, and shallow groundwater. A discussion of geotechnical issues and general site preparation procedures are included in the following paragraphs.

Viewing Platform Foundation Design Considerations

Although final details have not been prepared, it is likely that concrete aprons and landing pads, and portions of the ramp leading up to the platforms, may be constructed on shallow foundations or turned down slabs depending on where the boardwalk terminates. However, the remaining sections will need to be supported on helical piers because of the shallow water, limit of disturbance area, and elevated sections with greater uplift loads.

The soil conditions at this site can be categorized as Site Class D per the 2015 International Building Code. This categorization is based on the near surface borings, general geologic information for the region, and the information contained in the code.

Shallow Foundations

Footings be designed for a maximum net allowable bearing pressure of 1,500 pounds per square foot (psf). Footings should be supported on loose to medium dense natural soils. Where soft/loose natural soils are encountered at the footing subgrade, the foundation subgrades should be over-excavated to a suitable stratum under the observation of the geotechnical engineer or his qualified representative. The footing over-excavations should be backfilled to the design subgrade elevation with open-graded stone as soon as they are completed since the excavations will likely extend below the water level.

Based on the estimated loads, foundation settlement on the order of 1-inch total and ½-inch differential can be anticipated, when supported on the loose to medium dense, natural soils. The loads and settlement tolerances should be reviewed prior to final design to verify our assumptions are accurate. If the foundation loads differ, the settlements estimated and design bearing pressure should be re-evaluated. The footings should be founded a minimum of 32 inches below the final exterior grades to provide protection from frost action. Deeper embedment may be required for uplift or overturning.

Groundwater was encountered within 3 to 5 feet of the ground surface during our exploration. Therefore, the foundation excavations will likely encounter water. The use of sumps and pumps will be marginally effective to temporarily control water seepage. If groundwater is encountered during excavations, the footings subgrade can be vertically over-excavated 4 to 6 inches and backfilled with open-graded aggregate. If a running sand condition is encountered, the holes may need to be temporarily or permanently sleeved or cased. Consideration should be given to performing the work during low tide, when water levels will be lower.

Detailed foundation excavation evaluations should be performed in each footing excavation prior to placing crushed stone, reinforcing steel, or concrete. These evaluations should be performed by a representative of the registered Geotechnical Engineer to confirm that the design allowable soil bearing pressure is available. The foundation bearing surface evaluations should be performed using a combination of visual observation, hand-rod probing, comparison with the hand auger logs, and Dynamic Cone Penetrometer (DCP) testing, as applicable. Concrete placement should generally be performed the same day the footings are excavated to prevent exposure and potential weather and weakening of the foundation subgrade.

Helical Piers Northern Viewing Platform

We anticipate that the northern viewing platform pier bents and abutments may be subjected to lateral and uplift loads in addition to compression loads. Helical piers can be used to resist uplift forces where the dead weight of the structure is insufficient or using larger foundations is impractical. Based on the encountered soils profile, a 2⅞-inch shaft with a helix configuration of 12-inch, 14-inch, and 14-inch can generate an allowable axial capacity of about 10 kips when installed to about 15 to 25 feet below the existing grades. The uplift capacity will be dependent on the number and size(s) of the helices, depth of embedment, and soil types; however, this arrangement will provide an allowable tension capacity of about 5 kips. Other helix configurations and installation depths can be used for different capacities. A minimum depth of embedment of 15 to 20 feet is generally recommended regardless of installation torque or required capacity. If lateral capacity is needed the piles can be installed on a batter or diagonally braced.

Helical Piers Southern Viewing Platform

We anticipate that the southern viewing platform pier bents and abutments may be subjected to lateral and uplift loads in addition to compression loads. Helical piers can be used to resist uplift forces where the dead weight of the structure is insufficient or using larger foundations is impractical. Based on the encountered soils profile, a 2⅞-inch shaft with a helix configuration of 12-inch, 12-inch, and 14-inch can generate an allowable axial capacity of about 10 kips when installed to about 20 to 30 feet below the existing grades. The uplift capacity will be dependent on the number and size(s) of the helices, depth of embedment, and soil types; however, this arrangement will provide an allowable tension capacity of about 5 kips. Other helix configurations and installation depths can be used for different capacities. A minimum depth of embedment of 15 to 20 feet is generally recommended regardless of installation torque or required capacity. If lateral capacity is needed the piles can be installed on a batter or diagonally braced.

Limitations

This report, including all supporting logs, field data, field notes, laboratory test data, calculations, estimates and other documents prepared by GTA in connection with this project have been prepared in accordance with generally accepted engineering practice. All terms and conditions set forth in the Agreement and the General Provisions attached thereto are incorporated herein by reference. No warranty, express or implied, is made herein. Use and reproduction of this report by any other person without the expressed written permission of GTA

is unauthorized and such use is at the sole risk of the user.

The analysis and recommendations contained in this report are based on the data obtained from limited observation and testing of the encountered materials. Explorations indicate soil conditions only at specific locations and times and only at the depths penetrated. They do not necessarily reflect strata or variations that may exist between exploration locations. Consequently, the analysis and recommendations must be considered preliminary until the subsurface conditions can be verified by direct observation at the time of construction. If variations of subsurface conditions from those described in this report are noted during construction, recommendations in this report may need to be re-evaluated. In the event that any changes in the nature, design, or location of the facilities are planned, the conclusions and recommendations contained in this report should not be considered valid unless the changes are reviewed and conclusions of this report are verified in writing. Geo- Technology Associates, Inc. is not responsible for any claims, damages, or liability associated with interpretation of subsurface data or reuse of the subsurface data or engineering analysis without the expressed written authorization of Geo-Technology Associates, Inc.

We appreciate the opportunity to be of assistance on this project. Should you have questions, please contact our office at (302) 326-2100.

Very truly yours,
GEO-TECHNOLOGY ASSOCIATES, INC.

Meghan Lester, P.E.
Principal

MEGHAN LESTER REGISTERED No. 13632 DELAWARE PROFESSIONAL ENGINEER

ML/amd
190254

GBA—Important Information About Your Geotechnical Engineering Report
Figure No. 1 – Site Location Map
Figure No. 2 – Exploration Location Plan
Notes For Exploration Logs
Test Boring Logs (B-1 through B-4, 4 Sheets)

Important Information about This

Geotechnical-Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical-engineering study conducted for a civil engineer may not fulfill the needs of a constructor — a construction contractor — or even another civil engineer. Because each geotechnical- engineering study is unique, each geotechnical-engineering report is unique, prepared *solely* for the client. No one except you should rely on this geotechnical-engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply this report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical-engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

Geotechnical Engineers Base Each Report on a Unique Set of Project-Specific Factors

Geotechnical engineers consider many unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk-management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical-engineering report that was:

- not prepared for you;
- not prepared for your project;
- not prepared for the specific site explored; or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical-engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light-industrial plant to a refrigerated warehouse;
- the elevation, configuration, location, orientation, or weight of the proposed structure;
- the composition of the design team; or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical-engineering report is based on conditions that existed at the time the geotechnical engineer performed the study. *Do not rely on a geotechnical-engineering report whose adequacy may have been affected by*: the passage of time; man-made events, such as construction on or adjacent to the site; or natural events, such as floods, droughts, earthquakes, or groundwater fluctuations. *Contact the geotechnical engineer before applying this report to determine if it is still reliable.* A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ — sometimes significantly — from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide geotechnical-construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are Not Final

Do not overrely on the confirmation-dependent recommendations included in your report. *Confirmation-dependent recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations *only* by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's confirmation-dependent recommendations if that engineer does not perform the geotechnical-construction observation required to confirm the recommendations' applicability.*

A Geotechnical-Engineering Report Is Subject to Misinterpretation

Other design-team members' misinterpretation of geotechnical-engineering reports has resulted in costly

problems. Confront that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Constructors can also misinterpret a geotechnical-engineering report. Confront that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing geotechnical construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical-engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Constructors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make constructors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give constructors the complete geotechnical-engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise constructors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure constructors have sufficient time* to perform additional study. Only then might you be in a position to give constructors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and constructors fail to recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations," many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Environmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform an *environmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical-engineering report does not usually relate any environmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own environmental information, ask your geotechnical consultant for risk-management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold-prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, many mold- prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical- engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; *none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.*

Rely, on Your GBC-Member Geotechnical Engineer for Additional Assistance

Membership in the Geotechnical Business Council of the Geoprofessional Business Association exposes geotechnical engineers to a wide array of risk-confrontation techniques that can be of genuine benefit for everyone involved with a construction project. Confer with you GBC-Member geotechnical engineer for more information.

GEOTECHNICAL BUSINESS COUNCIL
of the Geoprofessional Business Association

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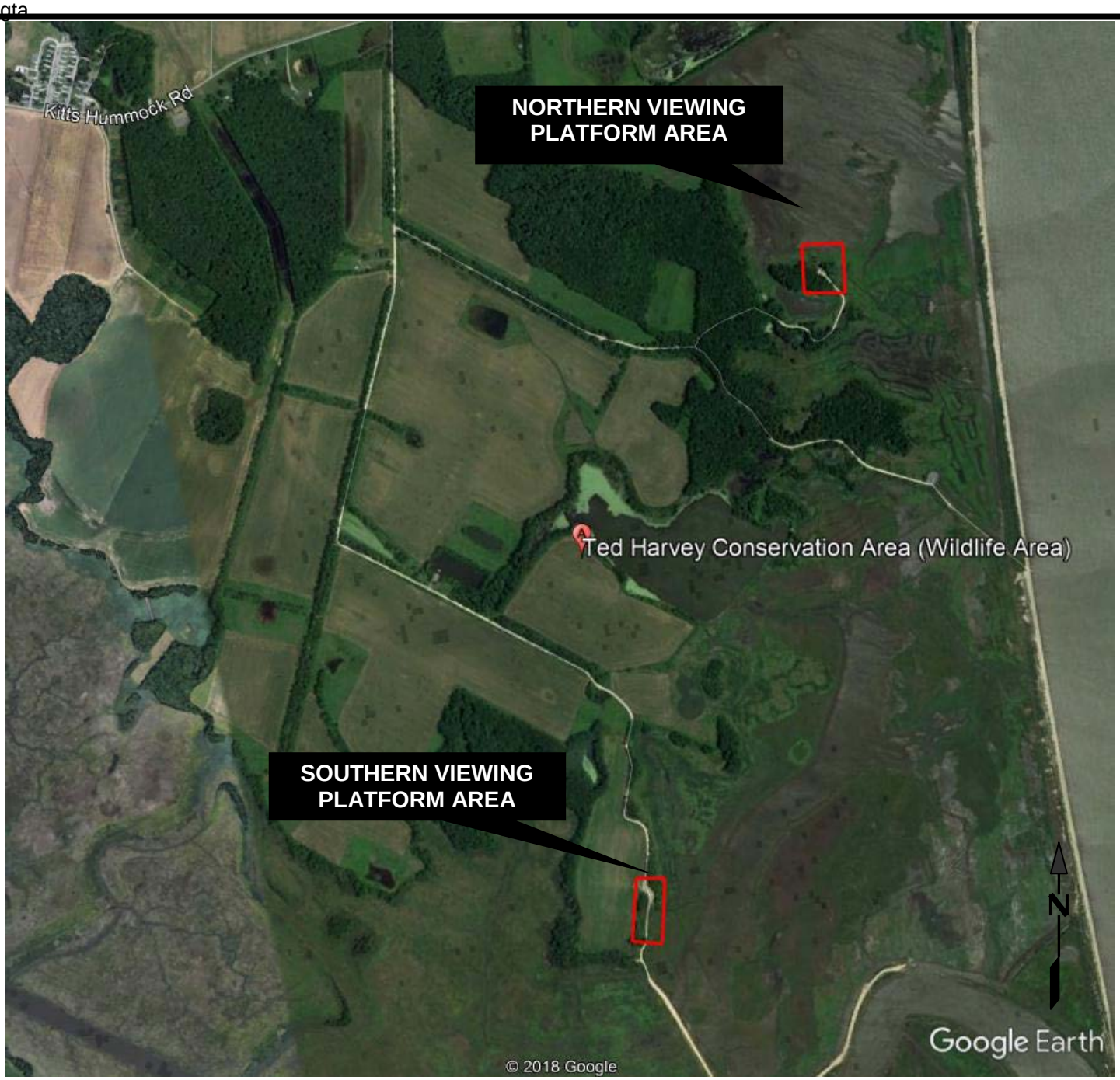
gta



Notes:

1) Base map obtained from Google Earth Imagery, Inc. from June 13, 2018.
2) Site Location Map should be reviewed in conjunction with GTA Report Ted Harvey Scenic Overlook, Job No. 190254.

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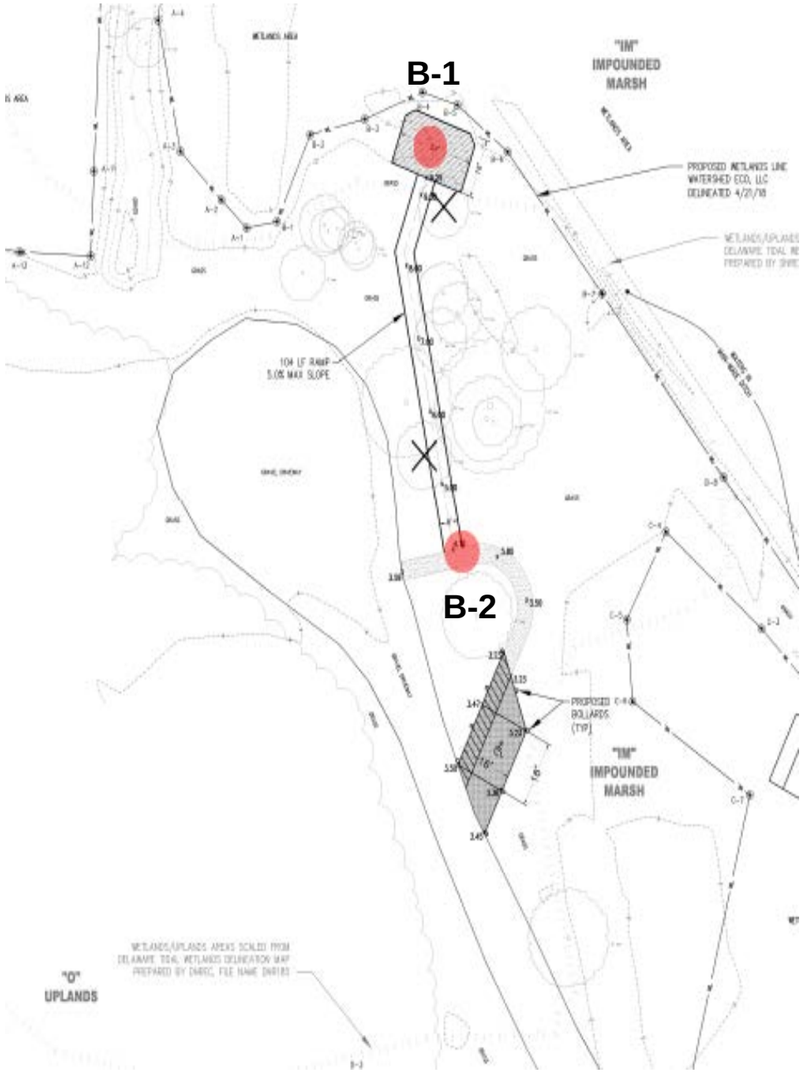
SITE LOCATION MAP

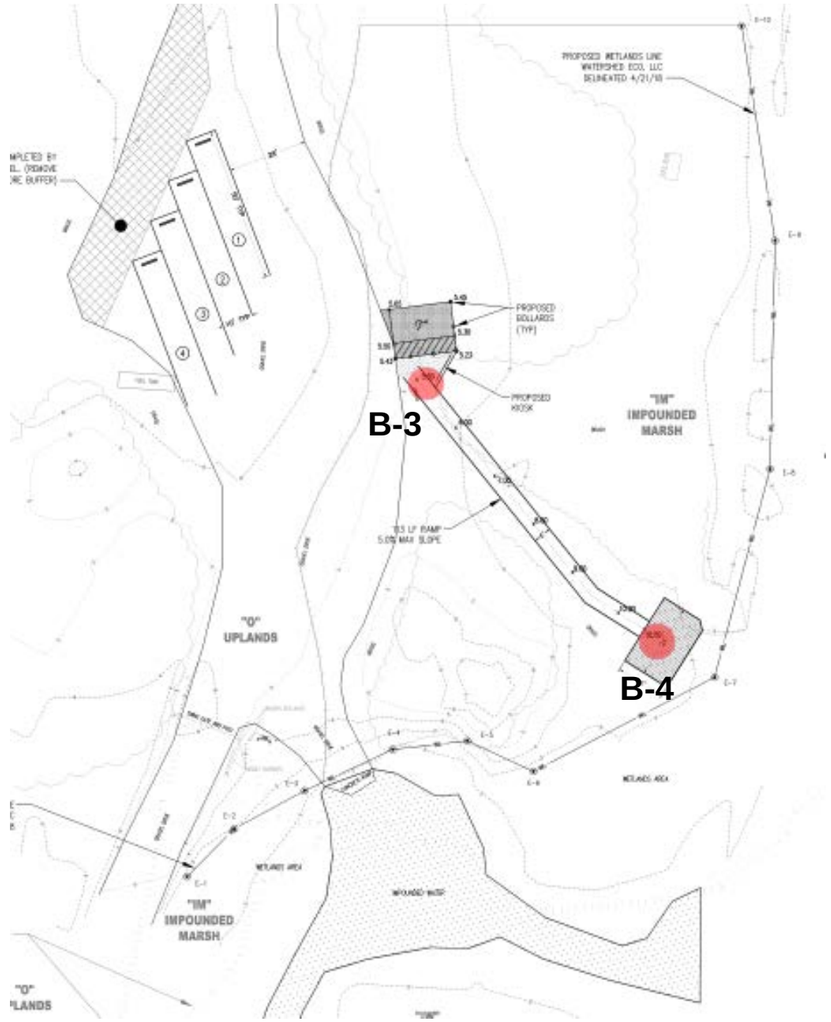
WILDLIFE VIEWING ENHANCEMENT PROJECT AT TED HARVEY WILDLIFE AREA

KENT COUNTY, DELAWARE

SCALE	DATE	DRAWN BY	REVIEW BY	JOB NO.	FIGURE NO.
NTS	APRIL 2019	GOOGLE	ML	190254	1



North Viewing Platform



South Viewing Platform

Key:

B-# Number and approximate location of Test Borings performed for this study

Notes: (1) Layout was obtained from a drawing titled “North Viewing Platform” and “South Viewing Platform” prepared by CDA Engineering Inc., dated Aug. 1, 2018.
(2) Exploration Location Plan should be read together with GTA Report Job No. 190254 for complete evaluation.
(3) The approximate locations of the explorations were measured from site features and should be considered accurate to the degree implied by these methods.

JOB NUMBER.:
190254

FIGURE:
2

REVIEW BY:
ML

SCALE:
NTS

DATE:
APRIL 2019

EXPLORATION LOCATION PLAN
WILDLIFE VIEWING ENHANCEMNT
PROJECT AT TED HARVEY
WILDLIFE AREA
KENT COUNTY, DELAWARE

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NOTES FOR EXPLORATION LOGS

KEY TO USCS TERMINOLOGY AND GRAPHIC SYMBOLS

MAJOR DIVISIONS (BASED UPON ASTM D 2488)			SYMBOLS GRAPHIC	SYMBOLS LETTER
COARSE - GRAINED SOILS MORE THAN 50% OF MATERIAL IS LARGER THAN NO. 200 SIEVE SIZE	GRAVEL AND GRAVELY SOILS MORE THAN 50% OF COARSE FRACTION RETAINED ON NO. 4 SIEVE	CLEAN GRAVELS (LESS THAN 5% PASSING THE NO. 200 SIEVE)		GW
				GP
		GRAVELS WITH FINES (MORE THAN 15% PASSING THE NO. 200 SIEVE)		GM
				GC
	SAND AND SANDY SOILS MORE THAN 50% OF COARSE FRACTION PASSING ON NO. 4 SIEVE	CLEAN SANDS (LESS THAN 5% PASSING THE NO. 200 SIEVE)		SW
				SP
		SANDS WITH FINES (MORE THAN 15% PASSING THE NO. 200 SIEVE)		SM
				SC
FINE - GRAINED SOILS MORE THAN 50% OF MATERIAL IS SMALLER THAN NO. 200 SIEVE SIZE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50	SILT OR CLAY (<15% RETAINED THE NO. 200 SIEVE)		ML
		SILT OR CLAY WITH SAND OR GRAVEL (15% TO 30% RETAINED THE NO. 200 SIEVE)		CL
		SANDY OR GRAVELY SILT OR CLAY (>30% RETAINED THE NO. 200 SIEVE)		OL
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50	SILT OR CLAY (<15% RETAINED THE NO. 200 SIEVE)		MH
		SILT OR CLAY WITH SAND OR GRAVEL (15% TO 30% RETAINED THE NO. 200 SIEVE)		CH
		SANDY OR GRAVELY SILT OR CLAY (>30% RETAINED THE NO. 200 SIEVE)		OH
HIGHLY ORGANIC SOILS				PT

NOTE: DUAL SYMBOLS ARE USED TO INDICATE COARSE-GRAINED SOILS CONTAINING AN ESTIMATED 10% FINES BY VISUAL CLASSIFICATION OR WHEN THE SOIL HAS BETWEEN 5 AND 12 PERCENT FINES FROM LABORATORY TESTS; AND FOR FINE-GRAINED SOILS WHEN THE PLOT OF LIQUID LIMIT & PLASTICITY INDEX VALUES FALLS IN THE PLASTICITY CHART'S CROSSHATCHED AREA. RESULTS OF LABORATORY TESTING ARE USED TO SUPPLEMENT THE CLASSIFICATION OF THE SOILS BASED ON THE VISUAL-MANUAL PROCEDURES OF ASTM D2488.

ADDITIONAL TERMINOLOGY AND GRAPHIC SYMBOLS

	DESCRIPTION		GRAPHIC SYMBOLS
ADDITIONAL DESIGNATION	TOPSOIL		
	MAN-MADE FILL		
	GLACIAL TILL		
	COBBLES AND BOULDERS		
RESIDUAL SOIL DESIGNATION	DESCRIPTION	"N" VALUE	
	HIGHLY WEATHERED ROCK	50 TO 50/1"	
	PARTIALLY WEATHERED ROCK	MORE THAN 50 BLOWS FOR 1" PENETRATION, AUGER PENETRABLE	

COARSE-GRAINED SOILS
(GRAVEL AND SAND)

DESIGNATION	BLOWS PER FOOT (BPF) "N"
VERY LOOSE	0 - 4
LOOSE	5 - 10
MEDIUM DENSE	11 - 30
DENSE	31 - 50
VERY DENSE	>50

NOTE: "N" VALUE DETERMINED AS PER ASTM D1586

FINE-GRAINED SOILS
(SILT AND CLAY)

CONSISTENCY	BPF "N"
VERY SOFT	<2
SOFT	2 - 4
MEDIUM STIFF	5 - 8
STIFF	9 - 15
VERY STIFF	16 - 30
HARD	>30

NOTE: ADDITIONAL DESIGNATIONS TO ADVANCE SAMPLER INDICATED IN BLOW COUNT COLUMN:
WOH = WEIGHT OF HAMMER
WOR = WEIGHT OF ROD(S)

SAMPLE TYPE

DESIGNATION	SYMBOL
SPLIT-SPOON	S-
SHELBY TUBE	U-
ROCK CORE	R-

WATER DESIGNATION

DESCRIPTION	SYMBOL
ENCOUNTERED DURING DRILLING	▽
UPON COMPLETION OF DRILLING	▼
24 HOURS AFTER COMPLETION	⧩

NOTE: WATER OBSERVATIONS WERE MADE AT THE TIME INDICATED. POROSITY OF SOIL STRATA, WEATHER CONDITIONS, SITE TOPOGRAPHY, ETC. MAY CAUSE WATER LEVEL CHANGES.

LOG OF BORING NO. B-1

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft):	2.4	1.2	BOC
DATE:	3/13/19	3/13/19	
CAVED (ft):	In Augers	13.5	

DATE STARTED: **3/13/19**
DATE COMPLETED: **3/13/19**
DRILLING CONTRACTOR: **GTA**
DRILLER: **D. Hans, Jr.**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**

WATER ENCOUNTERED DURING DRILLING (ft) **2.4**
GROUND SURFACE ELEVATION: **3.0**
DATUM: **Topo**
EQUIPMENT: **Diedrich D50**
LOGGED BY: **M. Emrey**
CHECKED BY: **M. Lester**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
					3.0	0			Topsoil +/- 10 inches	
S-1	0.0	15	1-1-1-2	2	2.2		ML		Tan, wet, soft, Sandy SILT	▽
S-2	2.0	16	1-1-3-2	4	1.0	3	SM		Tan, wet, loose, Silty SAND	▽
S-3	4.0	10	WH/24	1					Same, very loose	
S-4	6.0	5	6-6-6-6	12	-3.0	6	SP-SM		Gray, wet, medium dense, Poorly-graded SAND with Silt, contains gravel	
S-5	8.0	18	3-3-3-4	6		9			Same, loose	
						12				
S-6	13.0	24	3-4-6-7	10					Same, loose	
						15				

NOTES: **Elevation and location should be considered approximate.**

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LOG OF BORING NO. B-1

LOG OF BORING NO. B-1

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft):	2.4	1.2	BOC
DATE:	3/13/19	3/13/19	
CAVED (ft):	In Augers	13.5	

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
						18			Same, medium dense	
S-7	18.0	18	3-5-7-11	12						
						21				
									Same, medium dense	
S-8	23.0	24	5-6-7-7	13		24				
						27				
									Same, medium dense	
S-9	28.0	18	5-7-9-12	16						
					-27.0	30			Boring terminated at 30.0 feet	
						33				
						36				
						39				

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LOG OF BORING NO. B-2

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft): **2.0** | **BOC** |
DATE: **3/13/19** | **3/13/19** |
CAVED (ft): **In Augers** |

DATE STARTED: **3/13/19**
DATE COMPLETED: **3/13/19**
DRILLING CONTRACTOR: **GTA**
DRILLER: **D. Hans, Jr.**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**

WATER ENCOUNTERED DURING DRILLING (ft) **2.0**
GROUND SURFACE ELEVATION: **3.0**
DATUM: **Topo**
EQUIPMENT: **Diedrich D50**
LOGGED BY: **M. Emrey**
CHECKED BY: **M. Lester**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
					3.0	0			Topsoil +/- 11 inches	
S-1	0.0	15	1-1-2-3	3	2.1		ML		Tan, moist, soft, Sandy SILT	
S-2	2.0	12	2-3-3-3	6	1.0	3	SM		Tan and gray, wet, loose, Silty SAND, contains gravel	▼
S-3	4.0	13	1-3-7-14	10					Same, loose	
S-4	6.0	24	8-12-13-14	25		6			Same, medium dense	
S-5	8.0	24	3-5-8-8	13	-5.0	9	SP-SM		Tan and orange, wet, medium dense, Poorly-graded SAND with Silt	
S-6	13.0	18	2-5-8-10	13		12			Same, contains gravel	
						15				

NOTES: **Elevation and location should be considered approximate.**

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LOG OF BORING NO. B-2

LOG OF BORING NO. B-2

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft): **2.0** **BOC**
DATE: **3/13/19** **3/13/19**
CAVED (ft): **In Augers**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
						18			Same, loose	
S-7	18.0	20	2-2-2-2	4						
						21				
S-8	23.0	18	3-6-10-15	16		24			Same, medium dense	
						27				
S-9	28.0	24	4-8-10-14	18					Same, medium dense	
					-27.0	30			Boring terminated at 30.0 feet	
						33				
						36				
						39				

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LOG OF BORING NO. B-2

LOG OF BORING NO. B-3

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft): **5.0** | **BOC** |
DATE: **3/13/19** | **3/13/19** |
CAVED (ft): **In Augers** |

DATE STARTED: **3/13/19**
DATE COMPLETED: **3/13/19**
DRILLING CONTRACTOR: **GTA**
DRILLER: **D. Hans, Jr.**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**

WATER ENCOUNTERED DURING DRILLING (ft) **5.0**
GROUND SURFACE ELEVATION: **3.0**
DATUM: **Topo**
EQUIPMENT: **Diedrich D50**
LOGGED BY: **M. Emrey**
CHECKED BY: **M. Lester**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
					3.0	0			Topsoil +/- 16 inches	
S-1	0.0	16	WH/24	1	1.6		ML		Tan and gray, moist, very soft, Sandy SILT	
									Same, soft	
S-2	2.0	18	WH/12-3-4	7	0.0	3	SP-SM		Tan and gray, wet, loose, Poorly-graded SAND with Silt	
									Same, contains gravel	
S-3	4.0	15	3-4-6-6	10						▼
						6			Same	
S-4	6.0	24	3-4-4-5	8						
									Same	
S-5	8.0	20	4-4-4-5	8		9				
						12			Same	
S-6	13.0	24	3-5-5-8	10						
						15				

NOTES: **Elevation and location should be considered approximate.**

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LOG OF BORING NO. B-3

LOG OF BORING NO. B-3

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft): 5.0 | BOC |
DATE: 3/13/19 | 3/13/19 |
CAVED (ft): In Augers | |

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
					-15.0	18	CL		Gray, wet, very soft, Sandy Lean CLAY	
S-7	18.0	12	WH/24	1						
						21				
S-8	23.0	15	1-1-1-1	2		24			Same, soft	
						27				
S-9	28.0	20	3-4-5-6	9					Same, soft	
					-27.0	30			Boring terminated at 30.0 feet	
						33				
						36				
						39				

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LOG OF BORING NO. B-4

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft): **3.5** **BOC**
DATE: **3/13/19** **3/13/19**
CAVED (ft): **In Augers**

DATE STARTED: **3/13/19**
DATE COMPLETED: **3/13/19**
DRILLING CONTRACTOR: **GTA**
DRILLER: **D. Hans, Jr.**
DRILLING METHOD: **Hollow Stem Auger**
SAMPLING METHOD: **Split Spoon**

WATER ENCOUNTERED DURING DRILLING (ft) **3.5**
GROUND SURFACE ELEVATION: **5.0**
DATUM: **Topo**
EQUIPMENT: **Diedrich D50**
LOGGED BY: **M. Emrey**
CHECKED BY: **M. Lester**

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
					5.0	0			Topsoil +/- 11 inches	
S-1	0.0	20	2-2-2-2	4	4.1		ML		Tan, moist, soft, Sandy SILT	
									Same	
S-2	2.0	18	2-2-1-1	3	2.0	3	SM		Tan, wet, loose, Silty SAND	▼
									Same, very loose	
S-3	4.0	12	WH/12-1-1	2						
						6			Same, loose	
S-4	6.0	15	2-2-3-2	5						
					-3.0					
S-5	8.0	13	2-3-7-9	10		9	SP-SM		Tan and gray, wet, loose, Poorly-graded SAND with Silt, contains gravel	
						12			Same	
S-6	13.0	24	2-2-2-2	4	-9.5					
						15	CL		Tan and gray, wet, soft, Sandy Lean CLAY	

NOTES: **Elevation and location should be considered approximate.**

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LOG OF BORING NO. B-4

LOG OF BORING NO. B-4

PROJECT: **Wildlife Viewing Enhancement Project**
PROJECT NO.: **190254**
PROJECT LOCATION: **Kent County, Delaware**

WATER LEVEL (ft): 3.5 | BOC |
DATE: 3/13/19 | 3/13/19 |
CAVED (ft): In Augers | |

SAMPLE NUMBER	SAMPLE DEPTH (ft.)	SAMPLE RECOVERY (in.)	SAMPLE BLOWS/6 inches	N (blows/ft.)	ELEVATION (ft.)	DEPTH (ft.)	USCS	GRAPHIC SYMBOL	DESCRIPTION	REMARKS
S-7	18.0	15	1-1-1-1	2		18			Same, very soft	
						21				
S-8	23.0	18	2-2-2-2	4		24			Same	
						27				
S-9	28.0	24	2-3-3-4	6					Same, medium stiff	
					-25.0	30			Boring terminated 30.0 feet	
						33				
						36				
						39				

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