



240 Continental Drive
Suite 200
Newark, Delaware 19713
Tel. (302) 738-7551
Fax (302) 454-5980

Addendum No. 1

BBTS – Septic Field Demolition
Bethany Beach Training Site (BBTS)

Delaware Army National Reserve Guard (DEARNG)
Bethany Beach, Delaware

Tt Project No. 213-76984-22001
DEARNG Contract No.: 2022-14

Addendum No. 01
to
Drawings and Project Manual

July 18, 2023

To: ALL BIDDERS

This ADDENDUM forms a part of the BIDDING AND CONTRACT DOCUMENTS and modifies the following documents:
Original DRAWINGS dated June 07, 2023
Document MANUAL dated July 13, 2023

Acknowledge receipt of the ADDENDUM in the space provided on the FORM OF PROPOSAL

This ADDENDUM consists of two (2) pages and the following:

A mandatory Pre-Bid Meeting for this project was held at the Delaware Army National Guard Biden Reserve Center on July 13, 2023. The following are items discussed during the Pre-Bid meeting, and clarifications / adjustments to the contractual requirements for this project.

1.1 GENERAL ADMINISTRATIVE DISCUSSION

- A. CONTRACT: This is a Design-Bid Build contract.
- B. Project description:

1. Construction to occur in two areas, one to the south (demolition area) along the southern perimeter and one within the existing track area (construction).
2. Demolition is to remove the old septic system, appurtenances, utilities, foundations, remnants, and to excavate to grade as required for the soil mound. The soil is to be transported and placed in the second area (Track area) to the depicted grade, to create a new AFT (Fitness Test) area.
3. The site will require a CCR (as part of the Contractor's effort) and all DNREC E&S measures will need to be followed including stripping and stockpiling of topsoil and other E&S measures. Revegetation will be required.
4. Suburban Propane will relocate the tank and concrete pad. Contractors should contact them and coordinate. Number is provided on the plans.
5. Existing trailer and appurtenances at south gate have been or will be removed by DEARNG.

6. Fence will need to be relocated / extended to ensure perimeter security.
7. Unsuitable material will be determined by visual methods. If the soil can not be handled, transported, or placed as required, it must be disposed of off base. Compaction is to be by geotechnical engineer –90% Modified maximum dry.
- C. All attendees will receive this addendum, subsequent addendums will be only issued to plan holders. See attached sign in sheet and Bid Register (current plan holders).
- D. All questions please email Tabi Heath at Tetra Tech tabi.heath@tetrattech.com. Please also copy the following addresses: michael.berninger@tetrattech.com, chuck.dobbs@tetrattech.com, IER.DENG@tetrattech.com.
- E. Critical Dates:
 1. **Bid Due Date: Monday, August 07, 2023 @ 1:00 PM.** by the Delaware Army National Guard by mail or at the Security Officers Desk in the Main Lobby of the Biden National Guard/Reserve Center, 1 Vavala Way, New Castle, Delaware 19720.
 2. Cut off for questions and clarifications: **Monday 07/31/23, by COB (EST).**
- F. This Project is governed by State of Delaware Title 29 and includes:
 1. State approved Prevailing Wage Rates, that are currently in places (as of 3/2023).
 2. Public bid opening (at DEARNG Guard Biden Reserve Center).
- G. See the attached Geotech report.
- H. The normal working hours are: 7:30 am – 4:30 pm. Other times can be arranged in coordination Base CE.

1.2 **REQUEST FOR PROPOSAL (RFP) & SCOPE OF WORK (SOW) MODIFICATIONS**

- A. Division 00- Procurement and Contracting Requirements
 1. B.1 Procurement Requirements; 00 41 13; Bid Form
 - a. **REPLACE** Specification Section in its entirety with 00 41 13 Bid Form attached to this addendum. Note the following:
 1. The following sub-contractors have been added to the list: Landscaping, Fencing, Plumbing, and Electrical. Another subcontractor is being added: Well Driller (license for well abandonment)

1.3 **DRAWING MODIFICATIONS**

1. No changes to the drawing

1.4 **QUESTIONS/CLARIFICATIONS - NA**

ATTACHMENTS

Pre-Bid Sign-In Sheet
Bid Register
Spec Section 00 41 13 Bid Form
Geotech Report
DEARNG FTS 2023/2024 Calendar

END OF ADDENDUM No. 1

P:\76984\213-76984-22001\Construction\BidSupport\23-07-13 Septic Demo Bid\Addendum No.1\213-76984-22001- Septic Demo Addendum 1.doc



TETRA TECH

240 Continental Drive, Suite 200, Newark, Delaware 19713

RFP MEETING SIGN-IN SHEET

Septic Field Demolition

DEARNG - Bethany Beach Training Site

Tt PROJECT NO.: 213-76984-22001

DATE: Tuesday, July 13, 2023

Meeting Start Time: End Time:

Name	Company	Best Contact #	E-mail address (print clearly)	Attendance Verified
1 Michael Berninger	Tetra Tech, Inc.	302-922-1317	michael.berninger@tetratech.com	
2 RINA MAZOL	CHESAPEAKE TURE, LLC		Rich@CHESAPEAKETURE.com	
3 Megan Brown	Gateway Construction	302-598-5962	gwc2001@gmail.com	
4 Jessica Faulkner	Zack Exc.	302-387-9011	afibellkorn@zackexc.com	
5 Kevin Figgins	GBL, Inc.	411-640-9778	ki@yahoos.com	
6 Joseph Cochran	Jos Cochran + Son	302-652-6628	joe@CochransExcavating.com	
7 SLIVER DIAZ	STRATIFIED	202-360-1913	cdiaz@stratified.us	
8 JOE JAKUBOWSKI	VERDANSAS	302-598-4962	j.jakubowski@verdantas.com	
9 Scott White	A-DEL.	443-880-3165	SWH17@A-DEL.com	
10 Ben MacGarrner	DECS	(302) 740-8409	Decservicecellc@gmail.com	
11 Lt. Lawrence	DEARNG	302-662-0885	brithney.m.Boire.mil@army.mil	
12				

PLEASE PRINT CLEARLY & LEGIBLY

Delaware Army National Guard
Bethany Beach Training Site - Septic Field Demolition

213-76984-22001
DEARNG 2020-14

Bids Due: 1:00pm, Monday, Aug 7, 2023
DEARNG
1 Vavala Way
New Castle, DE 19720

REGISTER OF BID DOCUMENTS
PLEASE PRINT CLEARLY

\$ 100.00 per set

#01	Name of Company: <u>Zack Excavating, Inc.</u>			
	Physical Address: <u>3935 S. Dupont Hwy</u>			
	City, State: <u>Smyrna, DE 19977</u>			
	Contact: <u>Jessica Faulkner</u>	GC:	☒	☐
	Phone: <u>302-223-6223</u>	Check #42043	☒	☐
	Fax: _____	Electronic Sent	☐	☐
	E-Mail: <u>jfaulkner@zackexc.com</u>	Date: <u>6/27/2023</u>		
#02	Name of Company: <u>Gateway Construction Inc.</u>			
	Physical Address: <u>498 Sudlersville Rd.</u>			
	City, State: <u>Clayton, DE 19938</u>			
	Contact: <u>Megan Bravo</u>	GC:	☒	☐
	Phone: <u>302-653-4400</u>	Check	☒	☐
	Fax: _____	Electronic Sent	☐	☐
	E-Mail: <u>gwc2001@gmail.com</u>	Date: <u>7/13/2023</u>		
#03	Name of Company: <u>Grassbusters Landscaping INC</u>			
	Physical Address: <u>935 Rahway Drive</u>			
	City, State: <u>Newark, DE</u>			
	Contact: <u>Rich Crouse</u>	GC:	☒	☐
	Phone: _____	Check	☒	☐
	Fax: _____	Electronic Sent	☒	☐
	E-Mail: <u>ricrouse@aol.com/shellyg@gblinc.net</u>	Date: _____		

Delaware Army National Guard
Bethany Beach Training Site - Septic Field Demolition

213-76984-22001
DEARNG 2020-14

Bids Due: 1:00pm, Monday, Aug 7, 2023
DEARNG
1 Vavala Way
New Castle, DE 19720

REGISTER OF BID DOCUMENTS
PLEASE PRINT CLEARLY

\$ 100.00 per set

#04	Name of Company:	<u>Stratified, Inc</u>		
	Physical Address:	<u>1140 3rd Street NE 2nd floor</u>		
	City, State:	<u>Washington DC 20002</u>		
	Contact:	<u>Clive Diaz</u>	GC:	YES ☒ NO ☐
	Phone:	<u>202-360-1913</u>	Check	☐ ☐
#05	Fax:	<u></u>	Electronic Sent	☐ ☐
	E-Mail:	<u>cdiaz@stratified.us</u>	Date:	<u>7/18/2023</u>
	Name of Company:	<u>A-Del Construction</u>		
	Physical Address:	<u>10 Adel Drive</u>		
	City, State:	<u>Newark, DE</u>		
#06	Contact:	<u>Scott Whitt</u>	GC:	YES ☐ NO ☐
	Cell:	<u>443-880-3165</u>	Check	☐ ☐
	Office:	<u></u>	Electronic Sent	☐ ☐
	E-Mail:	<u>swhitt@a-del.com</u>	Date:	<u>7/13/2023</u>
	Name of Company:	<u>DECS</u>		
#06	Physical Address:	<u>385 Hutton Rd</u>		
	City, State:	<u>Elkton, MD 21921</u>		
	Contact:	<u>Evan MacGuiness</u>	GC:	YES ☒ NO ☐
	Cell:	<u>302-740-9404</u>	Check	☐ ☐
	Office:	<u></u>	Electronic Sent	☐ ☐
E-Mail:	<u>decservicesllc@gmail.com</u>	Date:	<u>7/13/2023</u>	

SEPTIC FIELD DEMOLITION
DEARNG NO.: 2022-14

BID FORM

To: Delaware Army Reserve National Guard
1 Vavala Way
New Castle, DE 19720

Phone No.: () _____ - _____ **Fax No.:** () _____ - _____

\$ _____
(\$ _____)

\$ _____ (Date and Initial)

**SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
DELAWARE ARMY NATIONAL GUARD
163 SCANNELL BLVD.
BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14**

BID FORM

UNIT PRICES

Unit prices conform to applicable project specification section. Refer to the specifications for a complete description of the following Unit Prices:

	<u>ADD</u>	<u>DEDUCT</u>
UNIT PRICE No. 1: Per Ton for additional unsuitable material transport & disposal	\$ _____	\$ _____
UNIT PRICE No. 2: Per Foot for additional security fence installed	\$ _____	\$ _____
UNIT PRICE No. 3: Per CY General Fill – delivered, placed, and compacted	\$ _____	\$ _____
UNIT PRICE No. 4: Per CY Top Soil	\$ _____	\$ _____

ALTERNATES

Alternate prices conform to applicable project specification section. Refer to specifications for a complete description of the following Alternates. An “ADD” or “DEDUCT” amount is indicated by the crossed out part that does not apply.

ALTERNATE No. 1: Provide new fencing shown on drawing CC-07 and CC-09

Add/Deduct: _____
(\$ _____)

ALLOWANCES

ALLOWANCE No. 1: Contingency Allowance: Include a contingency allowance of \$2,000.00 for use according to Owner's written instructions to secure, relocate or manage miscellaneous unknown underground utilities not marked or located.

**SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
DELAWARE ARMY NATIONAL GUARD
163 SCANNELL BLVD.
BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14**

BID FORM

I/We acknowledge Addendums numbered _____ and the price(s) submitted include any cost/schedule impact they may have.

This bid shall remain valid and cannot be withdrawn for thirty (30) days from the date of opening of bids (60 days for School Districts and Department of Education), and the undersigned shall abide by the Bid Security forfeiture provisions. Bid Security is attached to this Bid.

The Owner shall have the right to reject any or all bids, and to waive any informality or irregularity in any bid received.

This bid is based upon work being accomplished by the Sub-Contractors named on the list attached to this bid.

Should I/We be awarded this contract, I/We pledge to achieve substantial completion of all the work within _____ calendar days of the Notice to Proceed.

The undersigned represents and warrants that he has complied and shall comply with all requirements of local, state, and national laws; that no legal requirement has been or shall be violated in making or accepting this bid, in awarding the contract to him or in the prosecution of the work required; that the bid is legal and firm; that he has not, directly or indirectly, entered into any agreement, participated in any collusion, or otherwise taken action in restraint of free competitive bidding.

Upon receipt of written notice of the acceptance of this Bid, the Bidder shall, within twenty (20) calendar days, execute the agreement in the required form and deliver the Contract Bonds, and Insurance Certificates, required by the Contract Documents.

I am / We are an Individual / a Partnership / a Corporation

By _____ Trading as _____
(Individual's / General Partner's / Corporate Name)

(State of Corporation)

Business Address: _____

Witness: _____ **By:** _____
(SEAL) (Authorized Signature)

(Title)
Date: _____

ATTACHMENTS

Sub-Contractor List
Non-Collusion Statement
Affidavit of Employee Drug Testing Program
Affidavit of Contractor Qualifications
Bid Security
(Others as Required by Project Manuals)

SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
DELAWARE ARMY NATIONAL GUARD
163 SCANNELL BLVD.
BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14

BID FORM

SUBCONTRACTOR LIST

In accordance with Title 29, Chapter 69, Section 6962(d)(10)b of the Delaware Code, the following subcontractor listing must accompany any bid submittal. The bidder must list **in each category** the full name and address (City & State) of the sub-contractor that the bidder will be using to perform the work and provide material for that subcontractor category. Should the bidder’s listed subcontractor intend to provide any of their subcontractor category of work through a third-tier contractor, the bidder shall list that third-tier contractor’s full name and address (City & State). **If the bidder intends to perform any category of work itself, it must list its full name and address.** For clarification, if the bidder intends to perform the work themselves, the bidder **may not** insert “not applicable”, “N/A”, “self” or anything other than its own full name and address (City & State). To do so shall cause the bid to be rejected. In addition, the failure to produce a completed subcontractor list with the bid submittal shall cause the bid to be rejected. If you have more than three (3) third-tier contractors to report in any subcontractor category, print out additional page(s) containing the appropriate category, complete the rest of your list of third-tier contractors for that category, notate the addition in parentheses as (CONTINUATION) next to the subcontractor category and an asterisk (*) next to any additional third-tier contractors, and submit it with your bid.

<u>Subcontractor Category</u>	<u>Subcontractor</u>	<u>Address (City & State)</u>	<u>Subcontractors tax-payer ID # or Delaware Business license #</u>
1. Well Driller	_____	_____	_____
A.	_____	_____	_____
B.	_____	_____	_____
C.	_____	_____	_____
2. Landscaping	_____	_____	_____
A.	_____	_____	_____
B.	_____	_____	_____
C.	_____	_____	_____

SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
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BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14

BID FORM (Continued)

3.	Fencing			
	A.			
	B.			
	C.			
4.	Plumbing			
	A.			
	B.			
	C.			
5.	Electrical			
	A.			
	B.			
	C.			

**SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
DELAWARE ARMY NATIONAL GUARD
163 SCANNELL BLVD.
BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14**

BID FORM

NON-COLLUSION STATEMENT

This is to certify that the undersigned bidder has neither directly nor indirectly, entered into any agreement, participated in any collusion or otherwise taken any action in restraint of free competitive bidding in connection with this proposal submitted this date (*to the Office of Management and Budget, Division of Facilities Management*).

All the terms and conditions of *DEARNG NO.: 2022-14* have been thoroughly examined and are understood.

NAME OF BIDDER: _____

**AUTHORIZED REPRESENTATIVE
(TYPED):** _____

**AUTHORIZED REPRESENTATIVE
(SIGNATURE):** _____

TITLE: _____

ADDRESS OF BIDDER: _____

E-MAIL: _____

PHONE NUMBER: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

**SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
DELAWARE ARMY NATIONAL GUARD
163 SCANNELL BLVD.
BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14**

**AFFIDAVIT
OF
EMPLOYEE DRUG TESTING PROGRAM**

4104 Regulations for the Drug Testing of Contractor and Subcontractor Employees Working on Large Public Works Projects requires that Contractors and Subcontractors implement a program of mandatory drug testing for Employees who work on Large Public Works Contracts funded all or in part with public funds.

We hereby certify that we have in place or will implement during the entire term of the contract a Mandatory Drug Testing Program for our employees on the jobsite, including subcontractors, that complies with this regulation:

Contractor/Subcontractor Name: _____

Contractor/Subcontractor Address: _____

Authorized Representative (typed or printed): _____

Authorized Representative (signature): _____

Title: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

**SEPTIC FIELD DEMOLITION
BETHANY BEACH TRAINING SITE
DELAWARE ARMY NATIONAL GUARD
163 SCANNELL BLVD.
BETHANY BEACH, DELAWARE 19930
DEARNG CONTRACT NO.: 2022-14**

**AFFIDAVIT
OF
CONTRACTOR QUALIFICATIONS**

We hereby certify that we will abide by the contractor's qualifications outlined in the construction bid specifications for the duration of the contract term.

In accordance with Title 29, Chapter 69, Section 6962(d)(10)b.3 of the Delaware Code, after a contract has been awarded the successful bidder shall not substitute another subcontractor whose name was submitted on the Subcontractor Form except for the reasons in the statute and not without written consent from the awarding agency. Failure to utilize the subcontractors on the list will subject the successful bidder to penalties as outlined in the General Requirements Section 5.2 of the contract.

Contractor Name: _____

Contractor Address: _____

Authorized Representative (typed or printed): _____

Authorized Representative (signature): _____

Title: _____

Sworn to and Subscribed before me this _____ day of _____ 20____.

My Commission expires _____. NOTARY PUBLIC _____.

THIS PAGE MUST BE SIGNED AND NOTARIZED FOR YOUR BID TO BE CONSIDERED.

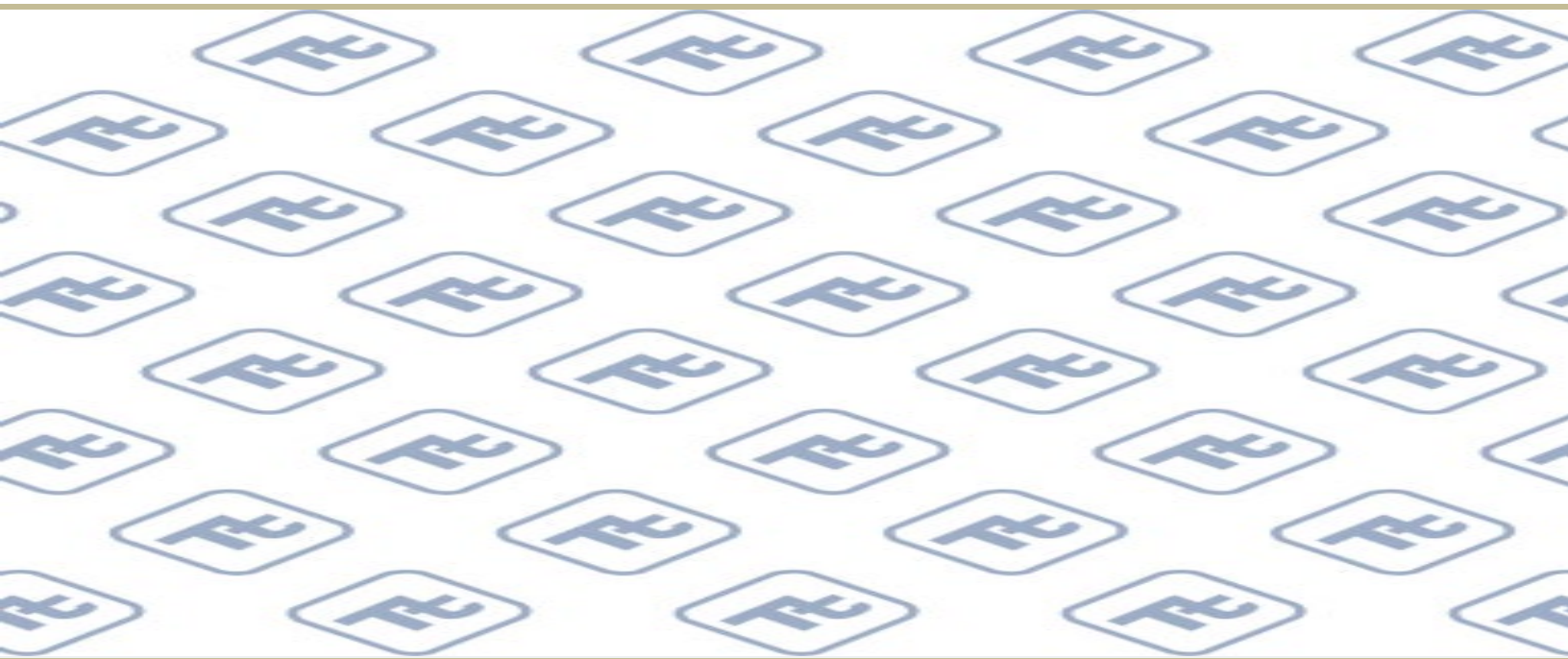


TETRA TECH

Geotechnical Subsurface Investigation Report

PROPOSED BBTS TRANSIENT OFFICER'S TRAINING BARRACKS

Delaware Army National Guard
163 Scannell Boulevard
Bethany Beach, Delaware



Prepared for:

DEARNG/FMO
1 Vavala Way
New Castle, DE 19720

103IG7931

May 2022

Geotechnical Subsurface Investigation Report

Proposed BBTS Transient Officer's Training Barracks

Delaware Army National Guard
163 Scannell Boulevard
Bethany Beach, Delaware

PRESENTED TO

DEARNG/FMO

1 Vavala Way
New Castle, DE 19720

PRESENTED BY

Tetra Tech, Inc.

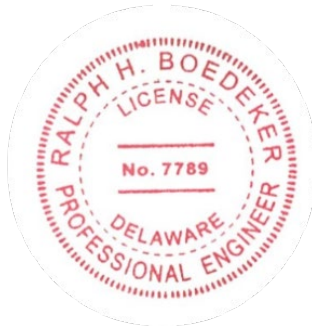
240 Continental Drive, Suite 200
Newark, DE 19713

P +1-302-738-7551

F +1-302-454-5988

tetrattech.com

Submitted by:



Ralph H. Boedeker, P.E.
Manager, Geotechnical Engineering and
Construction Services

May 25, 2022

103IG7931

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
1.0 INTRODUCTION.....	1
2.0 DESCRIPTIONS, INVESTIGATIONS, AND SUBSURFACE CONDITIONS	2
2.1 General Site Description and Proposed Facility Development.....	2
2.2 Geotechnical Subsurface Investigation Program	2
2.3 Subsurface Conditions	4
2.4 Regional Geology and Groundwater.....	5
2.5 Infiltration Testing.....	5
3.0 GEOTECHNICAL EVALUATION AND DESIGN RECOMMENDATIONS.....	7
3.1 Foundation Recommendations	8
3.1.1 Alternative 1 – Auger Pressure Grouted Piles	8
3.1.2 Alternative 2 – Timber Piles.....	10
3.2 Seismic Design	11
3.3 Groundwater	11
4.0 GENERAL CONSTRUCTION RECOMMENDATIONS	12
4.1 Proofrolling and Site Preparation	12
4.2 Engineered Fill.....	12
4.3 APG Pile Installation (Foundation Alternative 1).....	13
4.4 Driven Timber Pile Installation (Foundation Alternative 2)	14
4.5 Excavation Safety	15
4.6 Site Work Quality Control and Assurance.....	16
5.0 REPRESENTATIONS.....	17

APPENDICES

- Appendix A Site Development Plans and Test Boring Locations
- Appendix B Test Boring Logs
- Appendix C Laboratory Testing Results
- Appendix D Infiltration Testing Logs and Graphs
- Appendix E Pile Design Data and Figures

1.0 INTRODUCTION

This report presents results of a geotechnical subsurface investigation pertaining to the proposed Delaware Army National Guard (DEARNG) Bethany Beach Training Site (BBTS) Transient Training Officer's Barracks (the Site), Bethany Beach, Delaware. Purposes of this study were to investigate subsurface conditions within the Site, formulate foundation design criteria and SWM design criteria for proposed development of the Site, and offer pertinent geotechnical recommendations for construction at the Site.

This geotechnical study evaluated subsurface conditions within the Site, and the report offers recommendations based on an exploration of subsurface soil conditions by means of Standard Penetration Test (SPT) Borings (ASTM International [ASTM] D1586). The scope of this investigation included a test boring program, infiltration testing, laboratory testing of representative soil samples, engineering evaluation of the available data, and preparation of this engineering report. These services proceeded under supervision of a professional geotechnical engineer registered in the State of Delaware.

2.0 DESCRIPTIONS, INVESTIGATIONS, AND SUBSURFACE CONDITIONS

The following sections include a site description and discussions regarding proposed development of the facility, the geotechnical subsurface investigation program, subsurface conditions, and regional geology.

2.1 General Site Description and Proposed Facility Development

The Site is within the DEARNG BBTS facility at 163 Scannell Boulevard, Bethany Beach, Delaware. Proposed location of the training barracks is developed with grass, shrubs, trees, a small shed with chain-link fence, a manhole, monitoring well, and what appears to be a concrete water impoundment structure. The Site is relatively flat at the northern portions of the proposed building area, and includes a soil mound at its southern portion. Proposed development at the Site includes construction of a two-story building, pavements, and stormwater management (SWM) features. Appendix A depicts the proposed development.

The training barracks is to be a slab-on-grade, two-story structure with a finished floor elevation of 7.0 (project datum). The building is to measure approximately 56 x 115 feet in plan view. Existing grades vary across the building area at the Site; based on existing grades and a proposed finished floor elevation of 7.0, net cuts of up to approximately 7 feet (because of soil mound) and net fills of up to approximately 3.5 feet will be required during bulk grading activities.

The project structural engineer indicated that the building likely will be constructed of either load bearing concrete masonry unit (CMU) walls or steel framing with non-load bearing CMU wall infill, with the following estimated design loads (dead load plus live load), which have been assumed for purposes of analysis:

- Maximum column load: 70 kips (steel framing construction)
- Minimum wall loads: 10 kips per lineal foot (CMU load bearing wall construction).

If actual design values vary appreciably from the above values, Tetra Tech should be notified to determine if additional analyses are warranted.

2.2 Geotechnical Subsurface Investigation Program

On March 11, 2022, to collect representative soil samples and identify conditions of subsurface soil and groundwater, eight SPT exploratory soil borings (SB-01 through SB-04 and IT-01 through IT-04) were advanced at the site at approximate locations depicted in Appendix A. Borings SB-01 through SB-04

were advanced within the proposed building area to 20 feet below ground surface (bgs). Borings IT-01 through IT-04 were advanced at proposed SWM features to 10 feet bgs. Because of unsuitable soil conditions encountered within the building area, on May 03, 2022, two additional borings were advanced at the site (SB-05 and SB-06) to 60 feet bgs. These borings were advanced to obtain deeper subsurface soil data for eventual consideration of a deep pile foundation system.

The borings were advanced to collect representative soil samples and identify conditions of subsurface soil and groundwater. Advancements of borings proceeded by use of trailer-mounted drilling rigs. SPT split-spoon samples (ASTM D1586) were collected continuously from each boring to depth of 10 feet, and thereafter at 5-foot intervals. In the SPT procedure, a 2-inch-outside diameter (O.D.) split-barrel sampler is driven into the soil a distance of 18 or 24 inches by a 140-pound hammer falling 30 inches. The number of blows required to drive the sampler from the 6- to 18-inch interval is termed the Standard Penetration Resistance (SPR) N-value. This value can serve as a qualitative indication of in-place relative density of cohesionless (e.g., granular) soils. It is also a secondary indicator of consistency of cohesive soils. Gravel, cobbles, and boulders may induce high blow counts not representative of the soil's relative density/consistency. This indication is qualitative because many factors can significantly affect the SPR value (i.e., drilling crew procedures, drill rigs, and hammer-rod assemblies, etc.).

A Tetra Tech geotechnical staff engineer reviewed performances of the test borings. Test boring logs (Appendix B) include soil and groundwater data obtained from the explorations. Pocket penetrometer field-index testing was conducted on collected cohesive split-spoon soil samples to estimate shear strength characteristics; these test results were recorded in the boring logs. After completion of the test borings, they were backfilled with the auger soil cuttings. Surface elevations at all boring locations were surveyed, except for borings SB-05 and SB-06, surface elevations of which were approximated based on available topographic data.

All soil samples collected during this investigation were reviewed and described visually in Tetra Tech's geotechnical laboratory. Representative soil samples collected from the soil boring program were selected for geotechnical laboratory testing. Thirty-one Water Content Tests (ASTM: D2216) and Percent Finer than a No. 200 Sieve Tests (ASTM: D1140) were performed to assist in determining the general site stratigraphy, and to measure the amount of silt and clay particulate in the soil samples. Three Atterberg Limit Tests (ASTM D4318) were conducted to aid in classification of encountered select cohesive soils at boring locations. Results of the grain-size analysis and Atterberg Limits testing were referenced to determine the Unified Soil Classification System (USCS) designation for the soils

encountered, which provides information regarding soil engineering behavior. A summary of the laboratory testing results appears in Appendix C. Soil samples collected during this investigation will be retained for a period of 2 months, after which they will be discarded unless further instructions are received regarding their disposition.

2.3 Subsurface Conditions

Subsurface conditions throughout the investigation area can be described generally as a series of alluvial deposits varying in thickness, gradation, and density. Subsurface conditions encountered at boring locations are described in detail in the test boring logs (Appendix B). Subsurface conditions between boring locations were interpolated, and may not reflect actual conditions.

Beneath a surficial layer of topsoil, the predominant subsurface conditions within the investigation area can be described generally as a variable colored (brown, gray, or grayish brown) and variable matrix of fine, fine to medium, and fine to coarse sand, with a trace to a little silt (Stratum A on boring logs, USCS: SM, SP-SM, SW-SM, SP, SW, visual). Except at the soil mound on the Site, soils of Stratum A generally have a loose to medium-dense relative density. The mounded soils encountered at SB-03 and SB-04 have a very loose relative density—these soils are likely historically placed fill soils (not virgin soils).

Lenses of a dark gray organic silt (Stratum A1 on the boring logs, USCS: OL) were encountered within the shallower portions of Stratum A, ranging in depth from 2.5 to 11.5 feet bgs. These lenses of organic silt were encountered at each of the boring locations except SB-04 and SB-06. Consistency of the Stratum A1 organic silts is very soft.

A thick lense of gray clay with varying amounts of fine sand was encountered within the deeper advanced borings SB-05 and SB-06 (Stratum A2 on the boring logs, USCS: CL). The clay was encountered at depths ranging from 27 to 36.5 feet bgs at SB-05, and 31.5 to 41.5 feet bgs at SB-06. Consistency of the Stratum A2 clay is very soft.

Apparent groundwater was encountered within each of the soil borings (SBs and ITs), ranging in depth from 2 to 9.5 feet bgs, which corresponds to approximate elevations ranging from 0.5 to 3.4, project datum. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation. Variations in groundwater levels several feet higher or lower than those observed during this evaluation could occur.

2.4 Regional Geology and Groundwater

Generalized Regional Geology

The Site is within the Atlantic Coastal Plain physiographic province. Delaware Geologic Survey (DGS) mapping shows that the Site is underlain by two major geological units, the Omar Formation (Pleistocene Age) and underlying Beaverdam Formation (Miocene to late Pliocene Age). The Omar Formation generally consists of gray calyey-sand to sandy-silt that contains shell fragments. Scattered beds of fine sand and silty fine sand are common. The underlying Beaverdam Formation generally consists of fine to coarse sand with interbeds of fine silty sand and clayey-silt. Depth to bedrock in the general site area is on the order of 2,500 feet below surface grade.

Regional Groundwater

Tetra Tech reviewed the Delaware Geologic Information Resource (DGIR) to reference “normal year” and “wet year” water table mapping in the area of the Site. According to normal year water table mapping, depth to groundwater across the Site typically is less than 3 feet bgs. According to wet year water table mapping, depth to groundwater across the Site is also less than 3 feet bgs.

2.5 Infiltration Testing

Prior to infiltration testing, Tetra Tech provided to the project Civil Engineer for review, preliminary boring logs, including those for borings advanced at IT-01 through IT-04. Infiltrative surfaces have to be at least 2 feet above seasonal high groundwater elevations. Because of shallow groundwater at the Site, the project civil engineer instructed Tetra Tech to conduct infiltration testing near ground surface, below any topsoil or root zones. The purpose of this was to obtain information about infiltration of near-surface soils in the event that construction of designed SWM feature infiltrative surfaces results in elevations of them above current site grades.

On March 22, 2022, near-surface infiltration testing involving single-ring falling head infiltration tests occurred at offsets from boring locations IT-01 through IT-04 (see Appendix A for IT locations). Personnel conducting the infiltration tests used a 12-inch-diameter casing. They sealed the casing by pushing it into the subsurface a minimum 3 inches. During each test, a head of water was established over the testing depth. Testing included a “pre-soak” period. Infiltration testing generally accorded with Delaware Department of Natural Resources and Environmental Control (DNREC) 3.06.2.A-1 “Soil Investigation Procedures for Stormwater BMPs,” and with Appendix 1, “Soil Investigation Procedures for Stormwater Best Management Practices” to the *Delaware BMP Standards & Specifications* (February 2019).

Application of the falling head infiltration testing method accorded with ASTM International (ASTM) D5126. Infiltration testing logs and graphs appear in Appendix D. Laboratory index testing of soils at testing depth occurred for classification purposes, conveyed in Appendix C. Table 1 below summarizes infiltration testing results.

TABLE 1
SUMMARY OF RESULTS FROM INFILTRATION INVESTIGATION AND TESTING

Infiltration Test Location	Existing Surface Elev.	Depth of Off-Set Boring (feet)	Infiltration Test Depth (inches)	Field Infiltration Test Results (inches/hour)
IT-01	3.1	10	12	0.00
IT-02	2.8	10	7	0.30
IT-03	5.6	10	8	60.0
IT-04	5.9	10	14	24.6

Per DNREC regulations, a minimum factor safety of 2.0 should be applied for determination of infiltration design values, and infiltration design values cannot exceed 15 inches per hour.

The low infiltration values encountered at locations IT-01 and IT-02 likely traced to a thin confining lense of silt or organic silt in the subsurface. These near-surface confining levels are anticipated to be thin, and are readily removable to increase infiltration values.

The above-listed infiltration values are based on field data acquired at localized test locations and depths. Variations between test locations should be anticipated. The project civil engineer should determine final project infiltration design values for the various stormwater management features based on final layout and functioning of the features, final depths and site grades, and data provided herein. Design and construction of the SWM facilities should accord with the *Delaware Stormwater BMP Standards & Specifications* (February 2019).

3.0 GEOTECHNICAL EVALUATION AND DESIGN RECOMMENDATIONS

Tetra Tech, Inc. (Tetra Tech) evaluated suitability of subsurface conditions in the investigation area for the proposed barracks building. Tetra Tech considers the organic silts of Stratum A1 unsuitable for support of a conventional shallow foundation system, or for grade support of a heavily loaded floor slab.

The Stratum A1 organic silt has very low shear strength and high compressibility characteristics. Any structural loading of Stratum A1 could cause excessive total and differential settlement of proposed building structural elements, resulting from time-dependent primary consolidation and potentially secondary consolidation (creep). Existing site grades and current proposed design finished floor elevations will require engineered fills of up to 3.5 feet within the building area to achieve finished floor elevation. Consolidation of the Stratum A1 soils also could occur from overburden weight of engineered fill placed at the Site. Placement of shallow foundations and floor slabs over the poor quality Stratum A1 soils could cause excessive and detrimental differential settlement of building structural elements.

Tetra Tech considered removal of the organic soils with replacement by engineered fill. However, because of depths of encounter with organic silt soils, and shallow depths of encounter with groundwater, this alternative was deemed not feasible and/or not cost-effective.

Interim discussions with the project structural engineer resulted in decision to support the structure and floor slabs on a deep pile foundation system. Two pile types were evaluated—auger pressure grouted (APG) piles and timber piles. APG piles are within the industry-termed Auger Cast-in-place (ACIP) pile family. Desired pile structural loads, according to the project structural engineer, are as follows:

- Design axial load for a timber pile: 50 kips
- Design axial load for APG pile: 100 kips.

If actual design values vary appreciably from the above values, the Tetra Tech Geotechnical Department should be notified to determine if additional analyses are warranted.

The following sections discuss design of building foundations and other aspects of the proposed site development that geotechnical conditions would influence. Recommendations regarding general site construction are in Section 4.0.

3.1 Foundation Recommendations

The following sections describe both the APG pile and the timber pile alternatives:

3.1.1 Alternative 1 – Auger Pressure Grouted Piles

APG piles derive their support from a combination of frictional resistance and end bearing. An APG pile's capacity is based on the pile's diameter and embedment length. It is installed by first drilling a borehole to the required depth by use of a hollow-stem, continuous-flight auger. After attainment of the required depth, a high-strength grout is pumped under pressure through the hollow-stem auger to exit through the auger tip. A pre-established amount of grout is pumped before lifting the auger to build up a "grout head" around the outside of the auger. The auger is then withdrawn in a controlled manner as the grout pumping continues, both to maintain the head of grout and to avoid any intrusion of water or soil into the grout column. After completion of grout placement, a piling-reinforcement cage is inserted down into the fresh grout mixture and tied off in position at the surface. Installing APGs would generate auger soil-cutting spoils for either on-site relocation or off-site disposal.

Support for structures on APG piles can come from a concrete mat acting as a pier cap. With use of an APG pile foundation system, loads applied to the piles are transmitted to the soil partially through skin friction that develops on sides of the pile, and partially through end bearing. APG piles have the advantage of providing supporting capacity with a relatively small amount of movement.

Development of recommendations regarding design of the APG pile foundation began with determination of depth of embedment necessary to support the anticipated axial loading. Initial evaluation of both 16- and 18-inch-diameter piles led to selection by the geotechnical engineer of the 18-inch pile based on any potential lateral resistance requirements. Preliminary pile design proceeded by application of methods outlined in FHWA Geotechnical Engineering Circular (GEC) No. 8 – Design and Construction of Continuous Flight Auger Piles (April 2007). Based on depths of embedment required for axial loading and characteristics of existing on-site soils, the approximate maximum ultimate lateral load should not exceed 12 kips.

Tetra Tech recommends the following for design of APG pile foundation systems:

1. Design of APG piles should be based on allowable end bearing and allowable skin friction values specified in Appendix E. To achieve for an 18-inch-diameter pile an allowable axial bearing capacity of 100 kips, the pile should extend to minimum depth of 40 feet below bottom of pile cap

elevation. A factor of safety of 2 was applied to the ultimate axial capacity to obtain the allowable capacity shown on the graph, assuming project specifications will require a pile testing program.

2. Per Table 6.1 of FHWA GEC No. 8, maximum ultimate lateral loads should not exceed 12 kips for an 18-inch-diameter APG pile in soft or loose soil. Lateral deflection should be limited to 0.5 inch. An LPILE analysis should be completed to display deflection, moment, and shear graphs.
3. Total settlement of a pile designed as above is estimated at 0.5 inch or less. Differential settlement is estimated to be less than half total settlement.
4. A minimum spacing requirement between piles should be three diameters from center to center. Closer spacing may require a reduction in axial load capacity. If the pile cap is in firm contact with the ground, no reduction in efficiency is required.
5. Grout cover should be a minimum of 3 inches between the reinforcement and the soil. Grout compressive strength should be an average of 5,000 pounds per square inch (psi) for the 28-day break. Reinforcement cages should be installed within drilled piles within 30 minutes of grout placement.
6. Reinforcing bars should consist of a minimum ASTM A615 Grade 60 steel. Designers should include reinforcement cages that use fewer heavy bars instead of many smaller bars, and ensure that the cages are no longer than the minimum necessary to provide structural capacity and anchorage. Reinforcing cages should be fabricated so that lifting and handling does not cause permanent distortion or racking.
7. Piles undergoing uplift loads should have a minimum of one reinforcing bar centrally located and extending the full length of the pile.
8. Downdrag load is expected, caused by consolidation or deformation of a soft, cohesive soil layer over a stiff layer. Anticipation is for placement of fill on the Site to elevation 7 (project datum). Settlement due to fill placement should be monitored. Installation of piles shall not occur until fill loads have consolidated the underlying in-situ material to reduce downdrag loads.
9. A test pile program should be required in project specifications to demonstrate that the contractor's construction methods, equipment, standards of workmanship, and tolerances will

result in acceptable pile installation and confirm allowable load capacity of the piles. The pile load testing program should accord with ASTM Standards.

3.1.2 Alternative 2 – Timber Piles

Timber piles are usually of round, tapered cross section; most timber piles used in the eastern half of the United States are Southern Pine. ASTM D25, Standard Specification for Round Timber Piles, presents guidelines on the minimum timber pile parameters including dimensions, straightness, and knot sizes. Typical length of a timber pile ranges between 15 and 75 feet for Southern Pines; top (butt) diameter ranges between 12 and 22 inches.. The taper of a timber pile is effective in increasing shaft resistance, from which timber piles obtain their load-carrying capacity through friction.

Applied for preliminary design was the Effective Stress β -Method for mixed soil profiles, as outlined in Section 7.2.1.3.4 of FHWA GEC No. 12 – Design and Construction of Driven Pile Foundations. For final design considerations, timber piles should be sized so that uplift force due to transient loads from wind, snow, ice, seismic, and structural factors does not exceed dead weight of the pile plus frictional resistance between the pile and soil. Additionally, the design must account for uplift forces due to potential frost heave (adfreeze) and downdrag.

Evaluation of the driven timber pile foundations was based on pile dimensions, properties of existing on-site soils, and loading conditions conveyed by the structural engineer. Tetra Tech's recommendations regarding design of the driven timber pile foundation system are as follows:

1. Driven timber piles should be designed based on allowable end bearing and allowable skin friction values specified in Appendix E. To achieve an allowable axial bearing capacity of 25 tons (50 kips), the piles should extend to minimum depth of 40 feet below bottom of pile cap elevation. Minimum pile top (butt) and pile bottom (tip) diameters should be 16 inches and 12 inches, respectively. Tetra Tech applied a factor of safety of 2 to the ultimate axial capacity to obtain the allowable capacity shown on the graph, assuming requirement for a pile testing program in project specifications.
2. A minimum spacing requirement between piles should be three diameters from center to center. Closer spacing may require a reduction in axial load capacity. If the pile cap is in firm contact with the ground, no reduction in efficiency is required.
3. Downdrag load is expected, caused by consolidation or deformation of a soft, cohesive soil layer over a stiff layer. Anticipation is for placement of fill on the Site to elevation 7 (project datum).

Settlement due to fill placement should be monitored. Installation of piles shall not occur until fill loads have consolidated the underlying in-situ material to reduce downdrag loads.

4. A test pile program should be required in project specifications to demonstrate that the contractor's construction methods, equipment, standards of workmanship, and tolerances will result in acceptable pile installation and confirm allowable load capacity of the piles. The pile load testing program should accord with ASTM Standards.

3.2 Seismic Design

Based on subsurface conditions encountered during the test boring program and review of regional geologic maps, Tetra Tech recommends utilization of a site Class E for seismic design purposes. The site class definition is in Section 1613 of the International Building Code.

3.3 Groundwater

Based on measured groundwater depths and proposed building finished floor elevations, encounter with groundwater is possible during construction of pile caps, grade beams, and underground utilities. Apparent groundwater was encountered within each of the soil borings, ranging in depth from 2 to 9.5 feet bgs, corresponding to elevations 0.5 to 3.4, project datum. The awarded contractor should be prepared to conduct dewatering activities if groundwater is encountered within site excavations.

Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation. Variations in groundwater levels several feet higher or lower than those observed during this evaluation could occur.

4.0 GENERAL CONSTRUCTION RECOMMENDATIONS

The following sections discuss preparation of the Site, engineered fill, APG and timber piles, and quality control and quality assurance of site work.

4.1 Proofrolling and Site Preparation

At start of construction, all pavements, topsoil, vegetation, roots, structures, etc. should be stripped and entirely removed from all proposed bulk grading areas. Prior to foundation construction and placement of engineered fill in building and pavement bulk grading “fill” areas, the subgrade of fill areas should be proof-rolled with a minimum 15-ton roller in the presence of a qualified soils technician. Proof-rolling will increase density of exposed subgrade areas that will have been loosened or disturbed during stripping and clearing operations. Proof-rolling will also expose potential localized soft and yielding areas, particularly within the historical fill materials (soil mound at site). The exposed surfaces should be compacted to a visually firm and stable condition. Subgrade compaction will facilitate placement and compacting of embankment fill at the required densities. Proof-rolling should also occur at final “cut” or “at grade” areas (building and pavement areas) to ensure a firm and stable subgrade.

Soil subgrade disturbance should be minimized by providing positive surface drainage and limiting construction traffic on exposed subgrade soils. Moreover, excavations for foundation systems (pile caps, and grade beams) should not be left open for long periods of time because precipitation may result in collection of water within the excavation. Provisions for removal of water by drainage or sumping should be established. Subgrade soils disturbed by precipitation and construction traffic should be either (1) scarified, dried, and re-compacted, or (2) undercut and replaced with engineered fill.

4.2 Engineered Fill

Engineered fill required to bring structural building and pavement areas to grade should be free of organic material, topsoil, debris, and gravel greater than 3 inches in largest dimension. Engineered fill should also be used to backfill foundation excavations (e.g., shallow foundations, pile caps, and grade beams) and utility trenches within building and pavement areas.

The granular soils of Stratum A are considered suitable for use as engineered fill. Imported borrow material should meet the USCS classifications of SW, SM, SC, or GW, with no more than 25% passing a No. 200 sieve (ASTM D1140), and a plasticity index (ASTM D4318) not exceeding 6.

Engineered fill material should be placed in horizontal thin lifts with compacted thickness no greater than 8 inches. Engineered fill lifts for hand tampers should not exceed 4 inches. Each thin lift of fill/backfill material placed below structural elements (i.e., foundations and floor slabs) and pavements should be compacted to at least 95% of maximum dry density, as determined by the Standard Proctor Test (ASTM D698).

Moisture contents of placed engineered fill should facilitate compaction (typically at +/- 2-3% of optimum moisture, per ASTM D698). A qualified geotechnical technician should monitor and test placement and compaction of engineered fill on a full-time basis.

American Association of State Highway and Transportation Officials (AASHTO) No. 57 Stone could also be used as backfill within localized undercut zones—placed in maximum 12-inch lifts and compacted by use of a vibratory plate compactor.

4.3 APG Pile Installation (Foundation Alternative 1)

APG piles should have an embedment length of at least 40 feet below bottom of pile cap. Actual bearing elevation for each pile should be determined in the field by a qualified geotechnical technician working under supervision of a geotechnical engineer familiar with the recommendations of this report. During pile construction, after the hollow-stem auger has reached approved elevations and before raising the auger, a minimum theoretical initial grout head of 10 feet should be pumped. Positive rotation of the auger should be maintained at all times during grout placement.

The rate of grout injection and auger withdrawal should always be coordinated to maintain both the minimum grout head and total volume of grout (to be at least 125% of the theoretical volume for each 2-foot pile depth increment). If grout pumping is interrupted for any reason, or a loss of grouting pressure occurs, the pile auger should be lowered at least 5 feet below the level where the interruption or pressure loss occurred, with pumping of grout continuing. After observation of initial grout return, the pile contractor should continue pumping grout while removing the auger until the auger tip reaches the surface. A pile should not be installed within six pile diameters center-to-center of a pile that is filled with grout less than 24 hours old. If the grout level in any completed pile drops during installation of an adjacent pile, the pile should be replaced.

Drilling equipment for APG pile installations should be outfitted with an automated monitoring system to monitor and confirm pertinent installation parameters. Recorded parameters should include time, depth,

most inclination, drilling stem torque, and grout volume versus depth. The automated system should be able to measure and display volume of grout pumped per unit depth increment.

Methods applied and equipment used to install APGs can influence APG pile-bearing capacity, and these vary from contractor to contractor. The piling contractor should be solely responsible for quality control of the work, and should submit an installation work plan and quality control program before initiation of work. Only contractors that can demonstrate experience in installation of APGs for similar projects should be allowed to bid on this project.

A representative of a geotechnical engineer should observe installation of the piles on a full-time basis to check that the appropriate bearing stratum is penetrated and to monitor pile construction procedures.

4.4 Driven Timber Pile Installation (Foundation Alternative 2)

Driven timber piles should have an embedment length of at least 40 feet below bottom of pile cap, and minimum butt and tip diameters of 16 and 12 inches, respectively. The contract pile length should include an additional 2-foot embedment in the footing and a 1-foot allowance for cutoff due to driving damage. Actual bearing elevation for each timber pile should be determined in the field by a qualified geotechnical technician working under supervision of a geotechnical engineer familiar with the recommendations of this report. A pile driving installation record should be documented for each pile installed on the Site.

Lifespans of timber piles vary depending on their environment. Tetra Tech recommends treatment of all timber piles with an oil-borne system (primarily creosote). Treated timber piles can be used above or below water, and can retain function under most types of adverse conditions. Several factors can deteriorate them. Fungi that require moisture, oxygen, and favorable temperatures can decay timber piles—most prevalent in the uppermost 6 feet of soil. If the wood stays very dry, decay will be limited due to lack of moisture. Insects including termites, beetles, and marine borers may affect integrity of a timber pile if not treated properly. Fluctuation of the groundwater surface may subject the embedded pile to repeated cycles of wetting and drying. Timber piles will lose part of their strength if subjected to prolonged high temperatures; therefore, they should not be placed under hot structures such as blast furnaces.

Conventional pile driving equipment and methods can be applied to install timber pile foundations. Internal combustion impact (drop) hammers are the most commonly used devices to drive timber piles. Selection of hammer size affects efficiency of pile installation. Drop hammers can damage the pile head if driving stresses are not controlled by limitation of stroke distance and insertion of a hammer cushion

between the anvil, which sits on the pile head, and ram. For installation of timber piles, the hammer weight should not be less than 3500 pounds, and the drop should not exceed 12 feet.

Tetra Tech recommends that prior to construction, the contractor or contractor's engineer submit a wave equation analysis that determines optimal hammer size, required blow count to obtain the specified capacity, and driving stresses imparted to the pile. Overdriving of timber piles can result in damage to fibers or brooming at the pile head and damage to the pile toe. Overdriving results in degeneration of fibers, which hastens material decay, and subsequently reduces pile strength.

A pile load testing program, in accordance with ASTM Standards, should be implemented to ensure achievement of allowable capacities.

Tetra Tech recommends the following measures before, during, and following drives of timber piles:

Inspect timber piles prior to installation. Reject piles with knot clusters bends, sweeps, bows, or other irregularities. Apply preservative oil to cuts, holes, and abrasions in piles damaged during transportation or storage. Avoid splicing timber piles, particularly if they are expected to carry a tensile load or a lateral load. Best practice is to drive timber piles within 6 months after treatment.

During installation of each pile, an on-site geotechnical technician should complete a pile driving record pertaining to that pile. Use light-weight hammers with appropriate cushions between the hammer and the pile. Place steel bands near the pile head, and a steel shoe on the toe. Ensure that the pile is plumb prior to and during driving operations. Stop driving as soon as the pile has reached practical refusal. If the head of a timber pile starts splitting, and penetration and bearing are satisfactory, stop driving the pile. Do not drive timber piles to cutoff length because hammer impact causes some damage to the top wood fibers even though this may not be visible. Provide for at least 1 foot of cutoff. To protect ends of piles from degradation, treat pile cutoff surfaces in accordance with American Wood Protection Association (AWPA) Standard M-4 (or similar American National Standards Institute [ANSI] Accredited Standards). It is essential to cut piles at the exact elevation level; concave, convex, or inclined heads are not acceptable.

4.5 Excavation Safety

All utility and foundation excavation should accord with Occupational Safety and Health Administration (OSHA) guidelines.

4.6 Site Work Quality Control and Assurance

All site clearing, grading, proofrolling, fill placement, foundation construction, and pile installation should be monitored by a qualified geotechnical technician working under supervision of a geotechnical engineer. Typically, the owner retains the project geotechnical engineer to conduct third-party inspection or construction monitoring services. The technician should observe and document site preparation and proof-rolling, engineered fill construction, foundation subgrades, and foundation construction—and should conduct appropriate field tests, as necessary, to verify that construction proceeds in accordance with applicable plans, specifications, and acceptable construction practice. Conclusions and recommendations in this report are based on the premise of competent field engineering and monitoring during construction.

5.0 REPRESENTATIONS

Preparation of this report accorded with generally accepted engineering principles and practices, and was based on soil and groundwater conditions encountered during the field exploration. No warranty is expressed or implied. Although generalized subsurface conditions have been inferred through interpolation and/or extrapolation of acquired field and laboratory data, actual subsurface conditions between soil boring locations are unknown. As a result, recommendations in this report may require modifications based on subsurface conditions actually encountered during construction. Tetra Tech should be notified if conditions encountered during construction differ from those indicated by test borings, thus possibly requiring re-evaluation of recommendations offered in this report. This report applies solely to size, type, and location of the structure described herein. If changes are proposed, this report will not be considered valid unless and until Tetra Tech has reviewed the changes and accordingly altered and re-approved recommendations of this report.

Construction bidders should thoroughly familiarize themselves with the on-site subsurface soil and groundwater conditions described herein. Tetra Tech recommends provision of this report to bidding contractors so they can develop their own interpretations of the available data. Tetra Tech, DEARNG, and the State of Delaware assume no responsibility for interpretation or deductions by the awarded contractor based on information in this report. Variations in subsurface conditions are expected.

APPENDIX A

Site Development Plans and Test Boring Locations

[illegible]

APPENDIX B

Test Boring Logs

FIELD DESCRIPTION AND LOGGING SYSTEM FOR SOIL EXPLORATION

GRANULAR SOILS

(Sand, Gravel & Combinations)

<u>Density</u>	<u>N (blows)*</u>
Very Loose	5 or less
Loose	6 to 10
Medium Dense	11 to 30
Dense	31 to 50
Very Dense	51 or more

Relative Proportions

<u>Description Term</u>	<u>Percent</u>
Trace	1 - 10
Little	11 - 20
Some	21 - 35
And	36 - 50

Particle Size Identification

Boulders	8 in. diameter or more
Cobbles	3 to 8 in. diameter
Gravel	Coarse (C) 3 in. to ¾ in. sieve Fine (F) ¾ in. to No. 4 sieve
Sand	Coarse (C) No. 4 to No. 10 sieve (4.75mm-2.00mm) Medium No. 10 to No. 40 sieve (M) (2.00mm – 0.425mm) Fine (F) No. 40 to No. 200 sieve (0.425 – 0.074mm)
Silt/Clay	Less Than a No. 200 sieve (<0.074mm)

COHESIVE SOILS

(Silt, Clay & Combinations)

<u>Consistency</u>	<u>N (blows)*</u>
Very Soft	3 or less
Soft	4 to 5
Medium Stiff	6 to 10
Stiff	11 to 15
Very Stiff	16 to 30
Hard	31 or more

Plasticity

<u>Degree of Plasticity</u>	<u>Plasticity Index</u>
None to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	> 22

ROCK

(Rock Cores)

<u>Rock Quality Designation (RQD), %</u>	<u>Rock Quality Description</u>
0-25	Very Poor
25-50	Poor
50-75	Fair
75-90	Good
90-100	Excellent

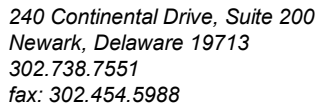
RQD: Rock Quality Designation

TCR: Total Core Recovery

SCR: Solid Core Recovery

***N - Standard Penetration Resistance.** Driving a 2.0" O.D., 1-3/8" I.D. sampler a distance of 18 inches into undisturbed soil with a 140 pound hammer free falling a distance of 30.0 inches. The number of hammer blows to drive the sampler through each 6 inch interval is recorded; the number of blows required to drive the sampler through the final 12 inch interval is termed the Standard Penetration Resistance (SPR) N-value. For example, blow counts of 6/8/9 (through three 6-inch intervals) results in an SPR N-value of 17 (8+9).

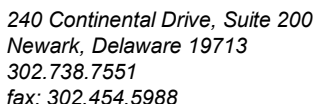
Groundwater observations were made at the times indicated. Groundwater elevations fluctuate throughout a given year, depending on actual field porosity and variations in seasonal and annual precipitation.



Project Name:	BBTS TRANSIENT TRANINING BARRACKS			Project No.: 103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE			Page 1 of 1
Boring No.:	SB-01	Dates(s) Drilled: 03/11/22	Inspector:	S. MCCOY
Surface Elev:	3.5	Drilling Method: SPT - ASTM D1586	Driller:	B. WALTERS
Drilling Contractor:	CGC	Groundwater Depth (ft): 3.0	Total Depth (ft):	20.0

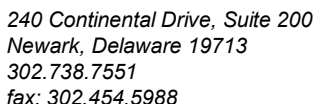
Notes/Comments:
Pocket Penetrometer Testing

N: Number of blows to drive spoon from 6" to 18" interval.



Project Name:	BBTS TRANSIENT TRANINING BARRACKS			Project No.: 103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE			Page 1 of 1
Boring No.:	SB-03	Dates(s) Drilled: 03/11/22	Inspector:	S. MCCOY
Surface Elev:	8.3	Drilling Method: SPT - ASTM D1586	Driller:	B. WALTERS
Drilling Contractor:	CGC	Groundwater Depth (ft): 6.5	Total Depth (ft):	25.0

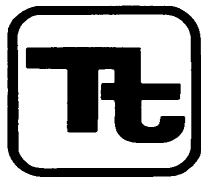
Notes/Comments: <u>Pocket Penetrometer Testing</u>	
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Project Name:	BBTS TRANSIENT TRANINING BARRACKS			Project No.: 103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE			Page 1 of 1
Boring No.:	SB-04	Dates(s) Drilled: 03/11/22	Inspector:	S. MCCOY
Surface Elev:	10.7	Drilling Method: SPT - ASTM D1586	Driller:	B. WALTERS
Drilling Contractor:	CGC	Groundwater Depth (ft): 9.5	Total Depth (ft):	20.0

Notes/Comments:
Pocket Penetrometer Testing

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

**TETRA TECH**

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302.738.7551
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TEST BORING LOG

Project Name:	BBTS TRANSIENT TRANINING BARRACKS	Project No.:	103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE	Page 1 of 1	
Boring No.:	SB-05	Dates(s) Drilled:	05/03/22
Surface Elev:	~3.5	Inspector:	S. MCCOY
Drilling Contractor:	CGC	Drilling Method:	SPT - ASTM D1586
		Driller:	B. WALTERS
		Groundwater Depth (ft):	3.0
		Total Depth (ft):	60.0

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
	From	To	From	To								
			0.0	0.5			APPARENT TOPSOIL (6")					
1	0.0	2.0	0.5		A (SM)		GRAYISH BROWN FINE TO MEDIUM SAND WITH SOME SILT.	4	5	6	6	11
				2.5								
2	2.0	4.0	2.5		A1 (OL)		DARK GRAY ORGANIC SILT AND FINE SAND.	4	2	2	2	4
				4.3								
3	4.0	6.0	4.3		SP-SM		LIGHT GRAY FINE TO MEDIUM SAND, TRACE SILT.	7	3	6	11	9
4	6.0	8.0			A (SP)		LIGHT GRAY FINE SAND, TRACE SILT.	10	6	9	7	15
5	8.0	10.0		9.5	A (SM)		LIGHT GRAY FINE SAND WITH SOME SILT.	2	3	4	1	7
			9.5	11.5	A1 (OL)		DARK GRAY ORANIC SILT WITH SOME FINE SAND.					
6	13.0	15.0	11.5				GRAY FINE SAND WITH A LITTLE SILT.	5	6	8	10	14
					A (SP-SM)							
7	18.0	20.0					GRAY FINE SAND WITH A LITTLE SILT.	4	5	5	9	10
8	23.0	25.0			SM		GRAY FINE TO MEDIUM SAND WITH A LITTLE SILT.	3	9	10	12	19
				27.0								
9	28.0	30.0	27.0				GRAY CLAY AND FINE SAND, TRACE SHELL FRAGMENTS.	1	1	1	1	2
					A2 (CL)							
10	33.0	35.0					GRAY CLAY WITH A LITTLE FINE SAND.	WH	WH	2	2	2
				36.5								
11	38.0	40.0	36.5		A (SM)		GRAY FINE SAND AND SILT	3	4	9	12	13
12	43.0	45.0		43.5			GRAY FINE SAND AND SILT.	2	3	4	5	7
			43.5									
13	48.0	50.0			A (SW)		LIGHT GRAY FINE TO COARSE SAND, TRACE SILT.	20	27	37	33	64
14	53.0	55.0					LIGHT GRAY FINE TO COARSE SAND, TRACE SILT.	20	37	50/5"		>50
15	58.0	60.0		60.0	A (SM)		LIGHT GRAY FINE TO MEDIUM SAND WITH A LITTLE SILT.	16	9	5	11	14

Notes/Comments:

Pocket Penetrometer Testing

S10: 0.5 TSF

S11: 1.75 TSF

S12: 1.5 TSF

BEGAN MUD ROTARY AT 25'.

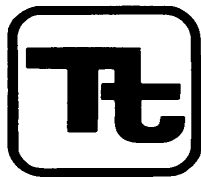
WET ON SPOON AT 3'.

WATER LEVEL THROUGH AUGERS AT 3.5'

WATER LEVEL END OF DRILLING AT 3.5'.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.

N: Number of blows to drive spoon from 6" to 18" interval.

**TETRA TECH**

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TEST BORING LOG

Project Name:	BBTS TRANSIENT TRANINING BARRACKS	Project No.:	103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE	Page 1 of 1	
Boring No.:	SB-06	Dates(s) Drilled:	05/03/22
Surface Elev:	~7.0	Inspector:	S. MCCOY
Drilling Contractor:	CGC	Driller:	B. WALTERS
		Groundwater Depth (ft):	6.0
		Total Depth (ft):	60.0

Sample No.	Sample Depth (ft)		Strata Depth (ft)		Recov. (in)	Strata (USCS)	Description of Materials	6" Increment Blows *				N
	From	To	From	To								
			0.0	0.5			APPARENT TOPSOIL (6")					
1	0.0	2.0	0.5			A (SM)	LIGHT BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	4	3	1	WH	4
							(PROBABLY FILL SOILS)					
2	2.0	4.0				A (SM)	LIGHT BROWN FINE TO MEDIUM SAND WITH A LITTLE SILT.	4	1	2	1	3
							(PROBABLY FILL SOILS)					
3	4.0	6.0		5.0		A (SP SM)	GRAYISH BROWN FINE TO MEDIUM SAND, TRACE SILT.	3	WH	1	1	1
4	6.0	8.0	5.0			A (SM)	GRAY FINE TO MEDIUM SAND WITH SOME SILT.	2	3	8	7	11
5	8.0	10.0				A (SP)	LIGHT GRAY FINE SAND, TRACE SILT	3	6	7	4	13
6	13.0	15.0					LIGHT GRAY FINE SAND, TRACE SILT	6	8	10	13	18
7	18.0	20.0					LIGHT GRAY FINE SAND, TRACE SILT	3	5	8	11	13
8	23.0	25.0				A (SM)	LIGHT GRAY FINE SAND, TRACE SILT	4	7	11	14	18
9	28.0	30.0				A (SM)	GRAY FINE SAND AND SILT	2	1	4	3	5
				31.5								
10	33.0	35.0	31.5			A2 (CL)	GRAY CLAY WITH SOME FINE SAND.	WH	1	1	1	2
11	38.0	40.0				A2 (CL)	GRAY CLAY WITH A LITTLE FINE SAND.	WH	1	1	2	2
				41.5								
12	43.0	45.0	41.5			A (SM)	GRAY FINE SAND AND SILT.	2	3	5	9	8
13	48.0	50.0					GRAY FINE TO MEDIUM SAND WITH SOME SILT	3	10	12	18	22
						A (SW)						
14	53.0	55.0					GRAY FINE TO COARSE SAND, TRACE SILT	30	44	50/4"		>50
15	58.0	60.0				A (SW)	GRAY FINE TO COARSE SAND, TRACE SILT	28	44	50/4"		>50

Notes/Comments:

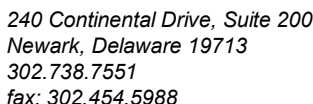
Pocket Penetrometer Testing

BEGAN MUD ROTARY AT 25'.

WET ON SPOON AT 6'.
WATER LEVEL THROUGH AUGERS AT 6'
WATER LEVEL END OF DRILLING AT 7'.

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.

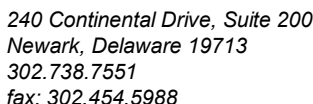
N: Number of blows to drive spoon from 6" to 18" interval.



Project Name:	BBTS TRANSIENT TRANINING BARRACKS			Project No.: 103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE			Page 1 of 1
Boring No.:	IT-01	Dates(s) Drilled: 03/11/22	Inspector:	S. MCCOY
Surface Elev:	3.1	Drilling Method: SPT - ASTM D1586	Driller:	B. WALTERS
Drilling Contractor:	CGC	Groundwater Depth (ft): 2.5	Total Depth (ft):	10.0

Notes/Comments:
Pocket Penetrometer Testing

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.



Project Name:	BBTS TRANSIENT TRAINING BARRACKS			Project No.: 103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE			Page 1 of 1
Boring No.:	IT-02	Dates(s) Drilled: 03/11/22	Inspector:	S. MCCOY
Surface Elev:	2.8	Drilling Method: SPT - ASTM D1586	Driller:	B. WALTERS
Drilling Contractor:	CGC	Groundwater Depth (ft): 2.0	Total Depth (ft):	10.0

Notes/Comments:
Pocket Penetrometer Testing

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

TETRA TECH

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TEST BORING LOG

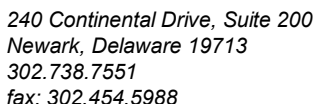
[illegible]

Notes/Comments:

Pocket Penetrometer Testing

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.

N: Number of blows to drive spoon from 6" to 18" interval.



Project Name:	BBTS TRANSIENT TRANINING BARRACKS			Project No.: 103P8038
Project Location:	DEARNG, 163 SCANNELL BLVD, BETHANY BEACH, DELAWARE			Page 1 of 1
Boring No.:	IT-04	Dates(s) Drilled: 03/11/22	Inspector:	S. MCCOY
Surface Elev:	5.9	Drilling Method: SPT - ASTM D1586	Driller:	B. WALTERS
Drilling Contractor:	CGC	Groundwater Depth (ft): 2.5	Total Depth (ft):	10.0

Notes/Comments:
Pocket Penetrometer Testing

* Number of blows of 140 lb. Hammer dropped 30 in. required to drive 2 in. split-spoon sampler in 6 in. increments.
N: Number of blows to drive spoon from 6" to 18" interval.

APPENDIX C

Laboratory Testing Results

**LABORATORY TESTING SUMMARY
BBTS TRANSIENT TRAINING BARRACKS
DEARNG, BETHANY BEACH, DELAWARE**

SPT Soil Boring No.	Sample No.	Stratum	Depth of Sample (ft.)		Water Content, % (ASTM D2216)	Percent Silts/Clays, % (ASTM D1140)	Atterberg Limits (ASTM D4318)			USCS Classif. (ASTM D2487)
			From	To			Liquid Limit, %	Plastic Limit, %	Plasticity Index, %	
SB-01	2	A	2.0	4.0	19.9	12.5	-	-	-	-
	3	A	4.0	6.0	14.9	24.0	-	-	-	-
	4	A	6.0	8.0	15.6	5.6	-	-	-	-
SB-02	2	A	2.0	4.0	18.4	3.0	-	-	-	-
	3	A	4.0	6.0	14.6	38.1	-	-	-	-
	4	A1	6.0	8.0	28.5	77.4	42	23	19	OL
SB-03	2	A	2.0	4.0	21.1	5.0	-	-	-	-
	3	A	4.0	6.0	3.4	1.8	-	-	-	-
	4	A	6.0	8.0	13.4	1.8	-	-	-	-
	5	A1	8.0	10.0	29.0	63.2	43	24	10	OL
	6	A	13.0	15.0	23.7	1.8	-	-	-	-
SB-04	2	A	2.0	4.0	5.4	1.9	-	-	-	-
	5	A	8.0	10.0	12.2	2.0	-	-	-	-
	6	A	13.0	15.0	21.3	27.9	-	-	-	-
SB-05	9	A2	28.0	30.0	39.1	75.4	-	-	-	-
	10	A2	33.0	35.0	39.2	87.7	42	20	22	CL
	11	A	38.0	40.0	21.2	45.5	-	-	-	-
SB-06	10	A2	33.0	35.0	36.7	78.7	-	-	-	-
	11	A2	38.0	40.0	35.2	87.1	-	-	-	-
	12	A	43.0	45.0	24.6	44.3	-	-	-	-
IT-01	1	A	0.0	2.0	13.2	1.6	-	-	-	-
	2	A	2.0	4.0	9.4	33.7	-	-	-	-
	3	A	4.0	6.0	24.3	10.6	-	-	-	-
IT-02	1	A	0.0	2.0	15.0	7.9	-	-	-	-
	2	A	2.0	4.0	16.5	17.7	-	-	-	-
	3	A	4.0	6.0	21.5	7.3	-	-	-	-
IT-03	1	A	0.0	2.0	13.0	16.9	-	-	-	-
	2	A	2.0	4.0	15.7	11.4	-	-	-	-
	3	A	4.0	6.0	17.8	1.7	-	-	-	-
IT-04	2	A	2.0	4.0	15.5	6.3	-	-	-	-
	3	A	4.0	6.0	21.6	2.7	-	-	-	-

Notes:

- 1) Sample depths based on feet below grade at time of exploration.

UNIFIED SOIL CLASSIFICATION SYSTEM [Casagrande (1948)]

Major Divisions			Group Symbols	Typical Descriptions	Laboratory Classifications			
Coarse Grained Soils (More than half of material is larger than No. 200 sieve)	Gravels More than half of coarse fraction is larger than No. 4 sieve size	Clean gravel (Little or no fines)	GW	Well-graded gravels, gravel-sand mixtures, little or no fines	Determine Percentage of sand and gravel from grain size curve. Depending on Percentage of fines (fraction smaller than No. 200 sieve), coarse-grained soils are classified as follows: Less than 5 percent GW, GP, SW, SP More than 12 percent GM, GC, SM, SC 5 to 12 percent Borderline cases requiring dual symbols ⁽¹⁾	$C_u = \frac{D_{60}}{D_{10}}$ greater than 4: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		
			GP	Poorly graded gravels, gravel-sand mixtures, little or no fines		Not meeting C_u or C_c requirements for GW		
		Gravel with fines (Appreciable amount of fines)	GM	Silty gravels, gravel-sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			GC	Clayey gravels, gravel-sand-clay mixtures		Atterberg limits above A line with I_p greater than 7		
	Sands (More than half of coarse fraction is smaller than No. 4 Sieve)	Clean sands (Little or no fines)	SW	Well graded sands, gravelly sands, little or no fines		$C_u = \frac{D_{60}}{D_{10}}$ greater than 6: $C_c = \frac{(D_{30})^2}{D_{10} \times D_{60}}$ between 1 and 3		
			SP	Poorly graded sands, gravelly sands, little or no fines		Not meeting C_u or C_c requirements for SW		
		Sands with fines (Appreciable amount of fines)	SM	Silty sands, sand-silt mixtures		Atterberg limits below A Line or I_p less than 4	Limits Plotting in hatched zone with I_p between 4 and 7 are borderline cases requiring use of dual symbols	
			SC	Clayey sands, sand-clay mixtures		Atterberg limits above A line with I_p greater than 7		

Major Divisions		Group Symbols	Typical Descriptions	For soils plotting nearly on A line use dual symbols i.e., $I_p = 29.5$, $w_L = 60$ gives CH-MH. When w_L is near 50 use CL-CH or ML-MH. Take near as ± 2 percent.
Fine-grained soils (More than half of material is smaller than No. 200 sieve)	Sils and clays (Liquid limit less than 50)	ML	Inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	
		CL	Inorganic clays of low to medium plasticity, gravelly clays, sandy clays, silty clays, lean clays	
		OL	Organic silts and organic silty clays of low plasticity	
	Sils and Clays (Liquid limit greater than 50)	MH	Inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	
		CH	Inorganic clays of high plasticity, fat clays	
		OH	Organic clays of medium to high plasticity, organic silts	
	Highly organic soils	Pt	Peat and other highly organic soils	

(1) Borderline classifications, used for soils possessing characteristics of two groups, are designated by combinations of group symbols. For example: GW-GC. well-graded gravel-sand mixture with clay binder.

APPENDIX D

Infiltration Testing Logs and Graphs

**Falling Head
Single Ring Infiltration Test
12 inch Ring**

Project: Tetra Tech-Bethany Beach

3/22/2022

Project No.: 10-22-131

Test Location: IT-1

Weather Sunny, 50

Depth of Ring Embedment: 3 in.

Test Depth: 12"

Tester/ Technician Performing Test: M. Hynes

	Time (t)	Time Elapsed (min)	Hydraulic Head (h) (in)	Change (Δh) (in)	Incremental Inf. Rate (in/hr)
Presoak	12:10	-	12.00	-	-
	1:10	60	12.00	0.00	N/A
Test 1	0	-	6.00	-	-
	15	15	6.00	0.00	0.0
	30	15	6.00	0.00	0.0
	45	15	6.00	0.00	0.0
	60	15	6.00	0.00	0.0
	Test 1		Avg. Inf. Rate (in./hr.):	0.0	
Test 2	0	-	6.00	-	-
	15	15	6.00	0.00	0.0
	30	15	6.00	0.00	0.0
	45	15	6.00	0.00	0.0
	60	15	6.00	0.00	0.0
	Test 2		Avg. Inf. Rate (in./hr.):	0.0	

**Falling Head
Single Ring Infiltration Test
12 inch Ring**

Project: Tetra Tech-Bethany Beach

3/22/2022

Project No.: 10-22-131

Test Location: IT-2

Weather Sunny, 50

Depth of Ring Embedment: 3 in.

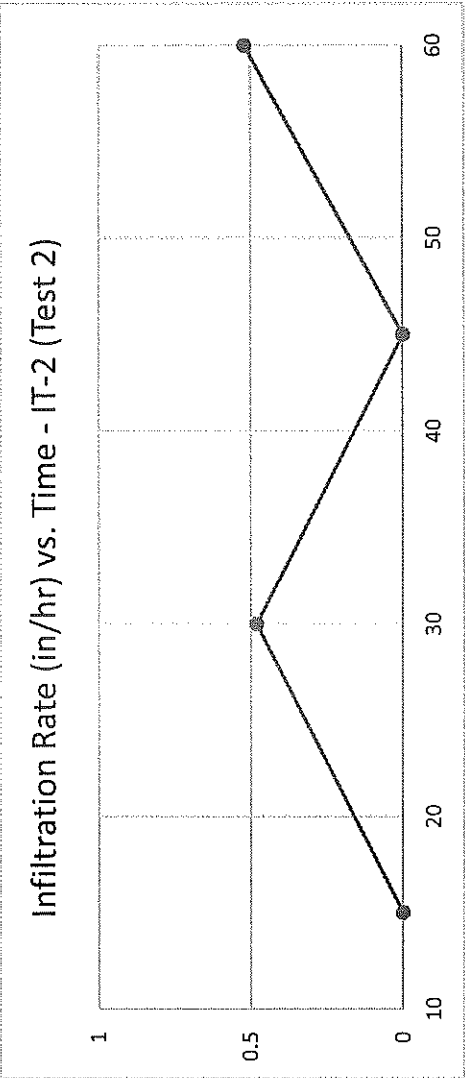
Test Depth: 7.0"

Tester/ Technician Performing Test: M. Hynes

	Time (t)	Time Elapsed (min)	Hydraulic Head (h) (in)	Change (Δh) (in)	Incremental Inf. Rate (in/hr)
Presoak	12:10	-	12.00	-	-
	1:10	60	11.75	0.25	N/A
Test 1	0	-	6.00	-	-
	15	15	6.00	0.00	0.0
	30	15	5.88	0.12	0.5
	45	15	5.88	0.00	0.0
	60	15	5.75	0.13	0.5
	Test 1		Avg. Inf. Rate (in./hr.):		0.3
Test 2	0	-	6.00	-	-
	15	15	6.00	0.00	0.0
	30	15	5.88	0.12	0.5
	45	15	5.88	0.00	0.0
	60	15	5.75	0.13	0.5
	Test 2		Avg. Inf. Rate (in./hr.):		0.3
Test 3	0	-	6.00	-	-
	15	15	6.00	0.00	0.0
	30	15	5.88	0.12	0.5
	45	15	5.88	0.00	0.0
	60	15	5.75	0.13	0.5
	Test 3		Avg. Inf. Rate (in./hr.):		0.3

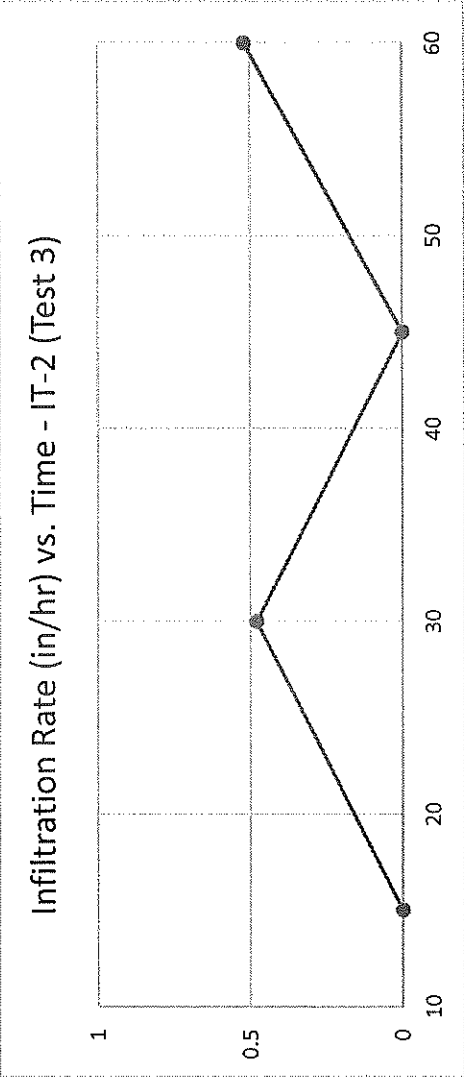
Tetra Tech-Bethany Beach
IT-2 Test 2

Interval #	Interval(min)	Cumulative Time	Rate(in/hr)
1	15	15	0
2	15	30	0.48
3	15	45	0
4	15	60	0.52



IT-2 Test 3

Interval #	Interval(min)	Cumulative Time	Rate(in/hr)
1	15	15	0
2	15	30	0.48
3	15	45	0
4	15	60	0.52



**Falling Head
Single Ring Infiltration Test
12 inch Ring**

Project: Tetra Tech-Bethany Beach

3/22/2022

Project No.: 10-22-131

Test Location: IT-3

Weather Sunny, 55

Depth of Ring Embedment: 3 in.

Test Depth: 8"

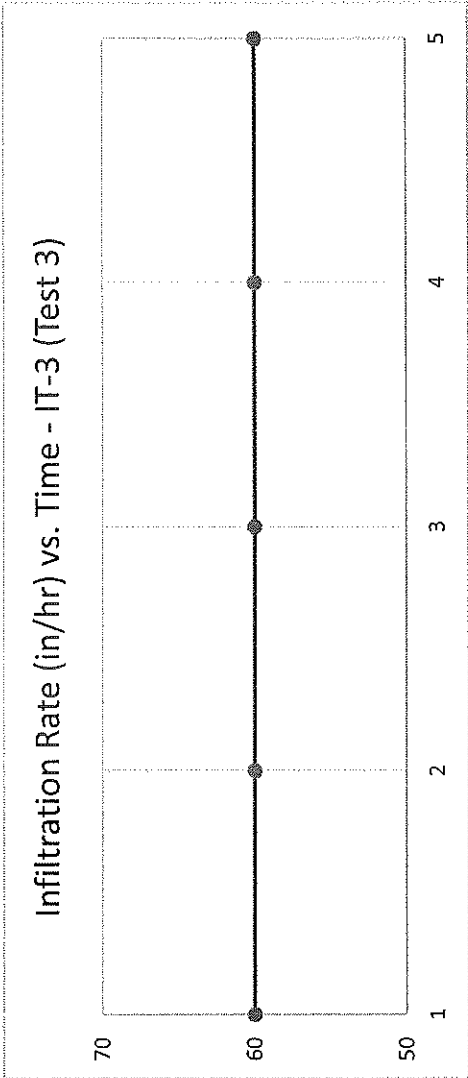
Tester/ Technician Performing Test: M. Hynes

	Time (t)	Time Elapsed (min)	Hydraulic Head (h) (in)	Change (Δh) (in)	Incremental Inf. Rate (in/hr)
Presoak	9:10	-	12.00	-	-
	9:25	15	0.00	12.00	N/A
Test 1	0	-	6.00	-	-
	1	1	5.00	1.00	60.0
	2	1	4.00	1.00	60.0
	3	1	3.00	1.00	60.0
	4	1	2.00	1.00	60.0
	5	1	1.00	1.00	60.0
	6	1	Dry	-	-
	Test 1		Avg. Inf. Rate (in./hr.):		60.0
Test 2	0	-	6.00	-	-
	1	1	5.00	1.00	60.0
	2	1	4.00	1.00	60.0
	3	1	3.00	1.00	60.0
	4	1	2.00	1.00	60.0
	5	1	1.00	1.00	60.0
	6	1	Dry	-	-
	Test 2		Avg. Inf. Rate (in./hr.):		60.0
Test 3	0	-	6.00	-	-
	1	1	5.00	1.00	60.0
	2	1	4.00	1.00	60.0
	3	1	3.00	1.00	60.0
	4	1	2.00	1.00	60.0
	5	1	1.00	1.00	60.0
	6	1	Dry	-	-
	Test 3		Avg. Inf. Rate (in./hr.):		60.0
Test 4	0	-	6.00	-	-
	1	1	5.00	1.00	60.0
	2	1	4.00	1.00	60.0
	3	1	3.00	1.00	60.0
	4	1	2.00	1.00	60.0
	5	1	1.00	1.00	60.0
	6	1	Dry	-	-
	Test 4		Avg. Inf. Rate (in./hr.):		60.0

Tetra Tech-Bethany Beach
IT-3

Test 3

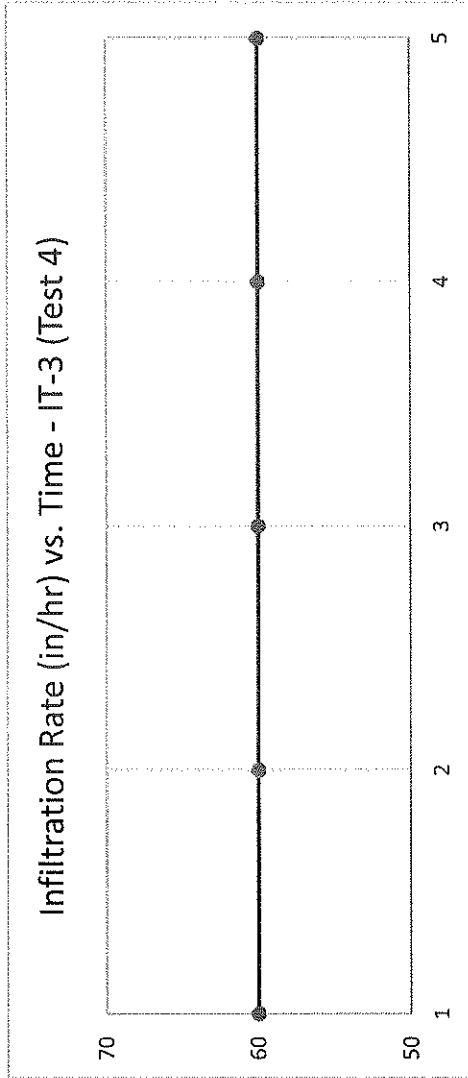
Interval #	Interval(min)	Cumulative Time	Rate(in/hr)
1	1	1	60
2	1	2	60
3	1	3	60
4	1	4	60
5	1	5	60



IT-3

Test 4

Interval #	Interval(min)	Cumulative Time	Rate(in/hr)
1	1	1	60
2	1	2	60
3	1	3	60
4	1	4	60
5	1	5	60



**Falling Head
Single Ring Infiltration Test
12 inch Ring**

Project: Tetra Tech-Bethany Beach

3/22/2022

Project No.: 10-22-131

Test Location: IT-4

Weather Sunny, 55

Depth of Ring Embedment: 3 in.

Test Depth: 14"

Tester/ Technician Performing Test: M. Hynes

	Time (t)	Time Elapsed (min)	Hydraulic Head (h) (in)	Change (Δh) (in)	Incremental Inf. Rate (in/hr)
Presoak	9:10	-	12.00	-	-
	9:25	15	0.00	12.00	N/A
Test 1	0	-	6.00	-	-
	1	1	5.00	1.00	60.0
	2	1	4.00	1.00	60.0
	3	1	3.38	0.63	37.5
	4	1	2.63	0.75	45.0
	5	1	2.00	0.63	37.5
	6	1	1.50	0.50	30.0
	7	1	0.88	0.63	37.5
	8	1	0.25	0.63	37.5
	9	1	Dry	-	-
	Test 1		Avg. Inf. Rate (in./hr.):		43.0
Test 2	0	-	6.00	-	-
	1	1	5.00	1.00	60.0
	2	1	4.38	0.63	37.5
	3	1	3.88	0.50	30.0
	4	1	3.38	0.50	30.0
	5	1	2.88	0.50	30.0
	6	1	2.38	0.50	30.0
	7	1	2.00	0.38	22.5
	8	1	1.50	0.50	30.0
	9	1	1.00	0.50	30.0
	10	1	0.50	0.50	30.0
	11	1	Dry	-	-
	Test 2		Avg. Inf. Rate (in./hr.):		33.0

**Falling Head
Single Ring Infiltration Test
12 inch Ring**

Project: Tetra Tech-Bethany Beach

3/22/2022

Project No.: 10-22-131

Test Location: IT-4

Weather Sunny, 55

Depth of Ring Embedment: 3 in.

Test Depth: 14"

Tester/ Technician Performing Test: M. Hynes

	Time (t)	Time Elapsed (min)	Hydraulic Head (h) (in)	Change (Δh) (in)	Incremental Inf. Rate (in/hr)
Test 3	0	-	6.00	-	-
	1	1	5.25	0.75	45.0
	2	1	4.50	0.75	45.0
	3	1	3.88	0.63	37.5
	4	1	3.38	0.50	30.0
	5	1	2.88	0.50	30.0
	6	1	2.50	0.38	22.5
	7	1	2.00	0.50	30.0
	8	1	1.63	0.38	22.5
	9	1	1.25	0.38	22.5
	10	1	0.75	0.50	30.0
	11	1	0.38	0.38	22.5
	12	1	0.25	0.13	7.5
	13	1	Dry	-	-
Test 3			Avg. Inf. Rate (in./hr.):	28.8	
Test 4	0	-	6.00	-	-
	1	1	5.50	0.50	30.0
	2	1	5.00	0.50	30.0
	3	1	4.50	0.50	30.0
	4	1	4.00	0.50	30.0
	5	1	3.63	0.38	22.5
	6	1	3.25	0.38	22.5
	7	1	2.88	0.38	22.5
	8	1	2.50	0.38	22.5
	9	1	2.13	0.38	22.5
	10	1	1.75	0.38	22.5
	11	1	1.38	0.38	22.5
	12	1	1.00	0.38	22.5
	13	1	0.63	0.38	22.5
	14	1	0.25	0.38	22.5
	15	1	Dry	-	-
Test 4			Avg. Inf. Rate (in./hr.):	24.6	

**Falling Head
Single Ring Infiltration Test
12 inch Ring**

Project: Tetra Tech-Bethany Beach

3/22/2022

Project No.: 10-22-131

Test Location: IT-4

Weather Sunny, 55

Depth of Ring Embedment: 3 in.

Test Depth: 14"

Tester/ Technician Performing Test: M. Hynes

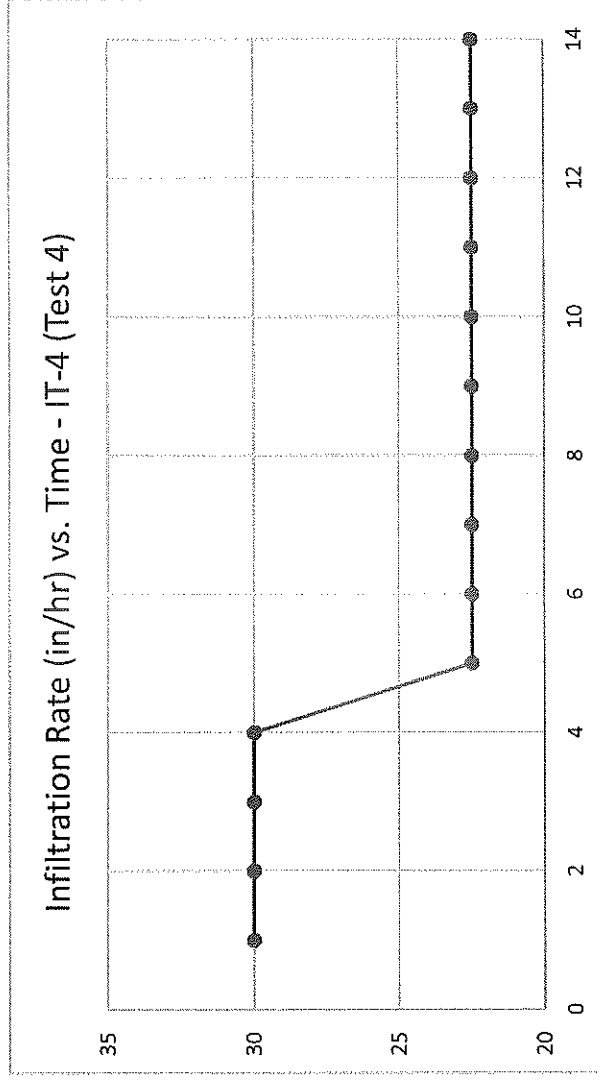
Time (t)	Time Elapsed (min)	Hydraulic Head (h)	Change (Δh)	Incremental
		(in)	(in)	Inf. Rate (in/hr)
Test 5	0	6.00	-	-
	1	5.50	0.50	30.0
	2	5.00	0.50	30.0
	3	4.50	0.50	30.0
	4	4.00	0.50	30.0
	5	3.63	0.38	22.5
	6	3.25	0.38	22.5
	7	2.88	0.38	22.5
	8	2.38	0.50	30.0
	9	2.00	0.38	22.5
	10	1.63	0.38	22.5
	11	1.25	0.38	22.5
	12	0.88	0.38	22.5
	13	0.50	0.38	22.5
	14	Dry	-	-
Test 5		Avg. Inf. Rate (in./hr.):		25.4

Tetra Tech-Bethany Beach

IT-4 Test 4

Interval # Interval(min) Cumulative Time Rate(in/hr)

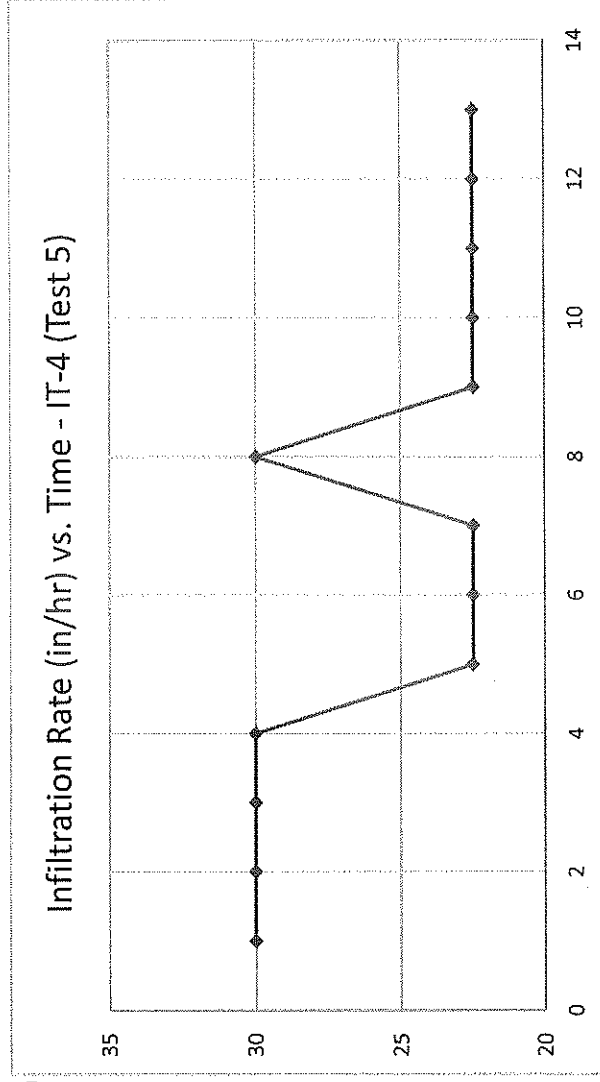
1	1	1	30
2	1	2	30
3	1	3	30
4	1	4	30
5	1	5	22.5
6	1	6	22.5
7	1	7	22.5
8	1	8	22.5
9	1	9	22.5
10	1	10	22.5
11	1	11	22.5
12	1	12	22.5
13	1	13	22.5
14	1	14	22.5



IT-4 Test 5

Interval # Interval(min) Cumulative Time Rate(in/hr)

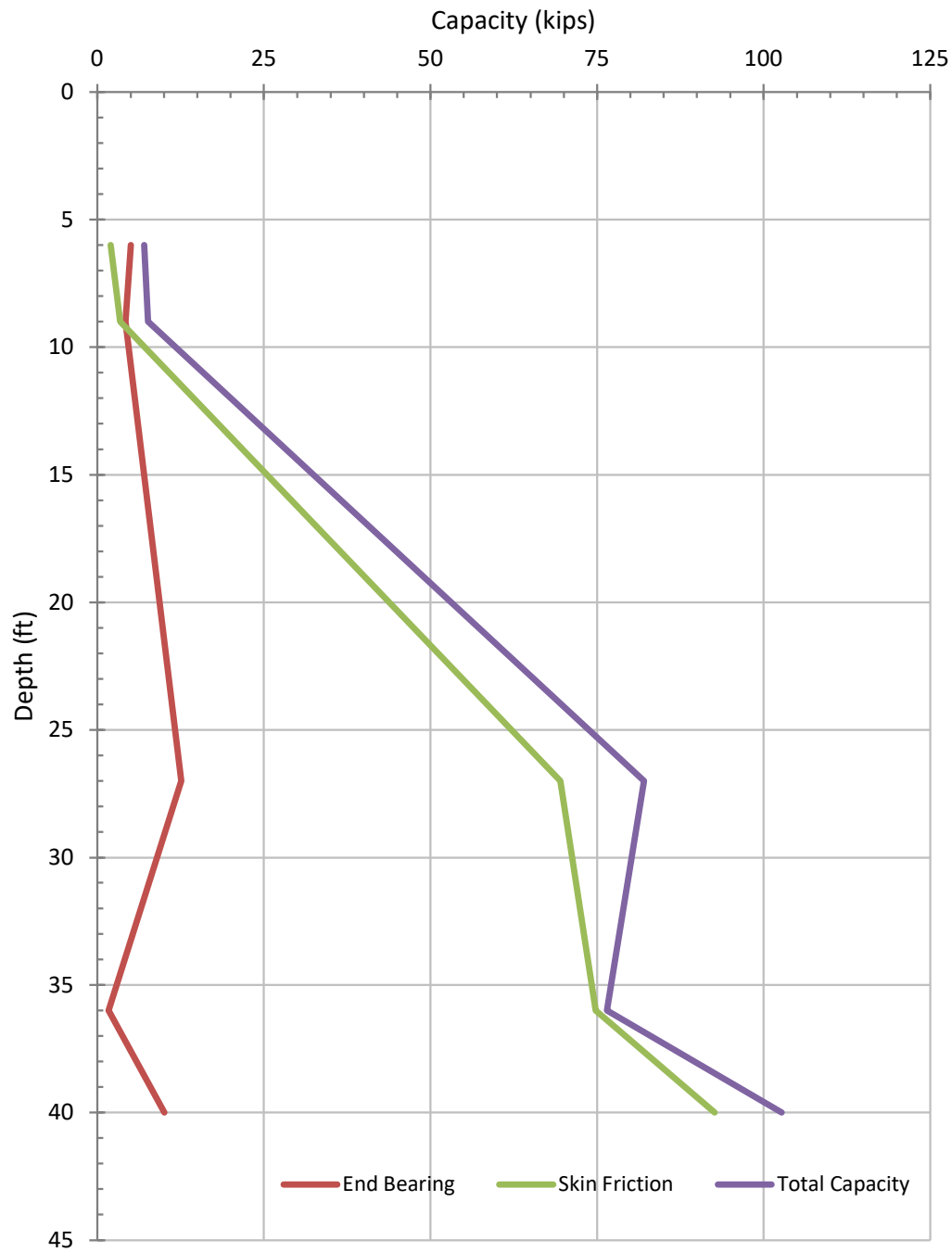
1	1	1	30
2	1	2	30
3	1	3	30
4	1	4	30
5	1	5	22.5
6	1	6	22.5
7	1	7	22.5
8	1	8	30
9	1	9	22.5
10	1	10	22.5
11	1	11	22.5
12	1	12	22.5
13	1	13	22.5



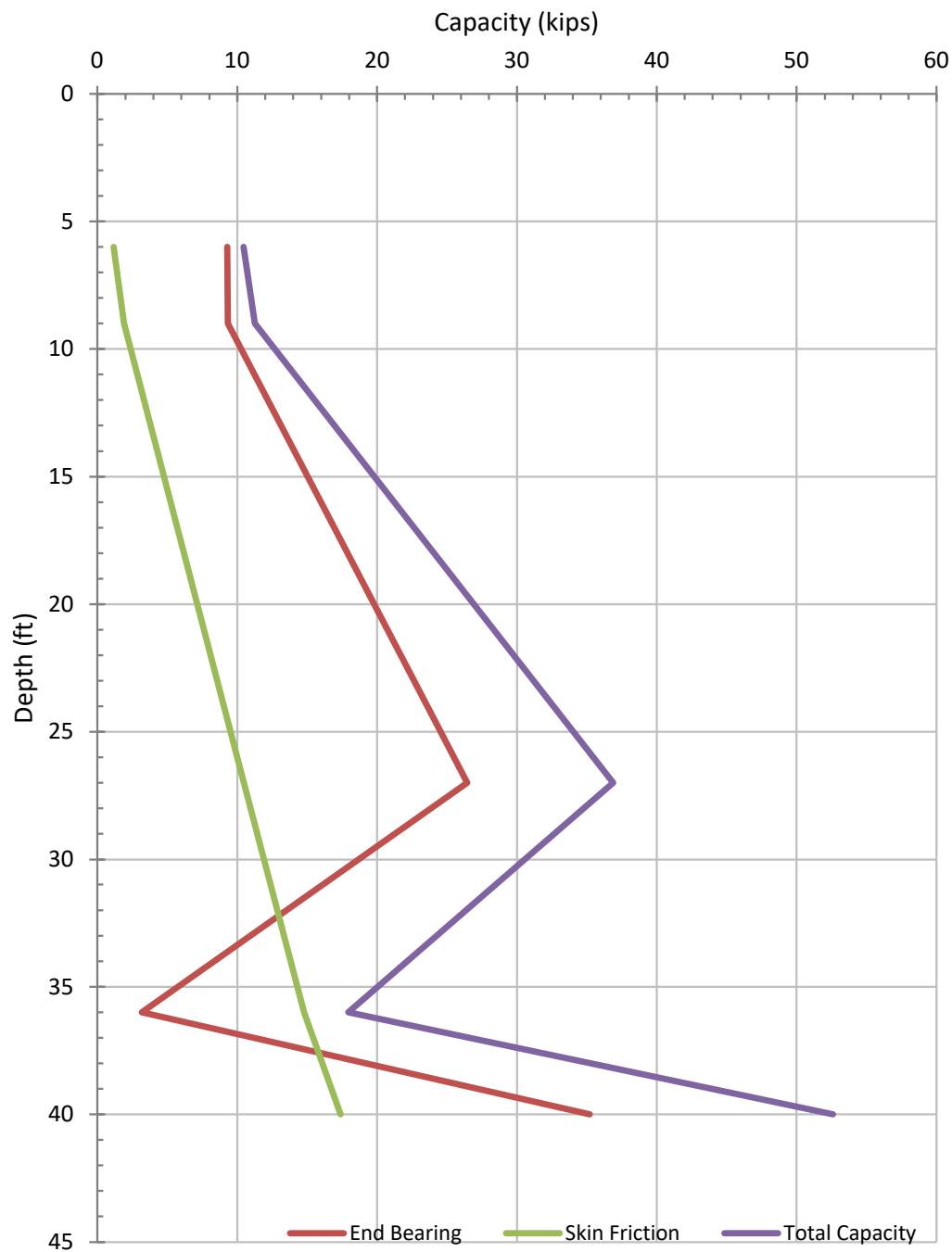
APPENDIX E

Pile Design Data and Figures

16" Auger Cast Pile Allowable Axial Capacity (FS=2)



16" Diameter Timber Pile
Allowable Axial Capacity (FS=2)



2023 DELAWARE NATIONAL GUARD CALENDAR (4/10)

S M T W T F S

JANUARY

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

FEBRUARY

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28				

MARCH

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

APRIL

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

MAY

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

JUNE

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

LEGEND

FEDERAL HOLIDAY

FED HOLIDAY (OBS)

FTS REGULAR DAY OFF

AIR FED PAY

ARMY FED PAY

STATE MUTA

ARMY MUTA

AIR MUTA

PAY PERIODS BRACKETED

FEDERAL HOLIDAYS

JANUARY

- 1 - New Year's Day
- 2 - New Year's Day (OBS)
- 16 - MLK's Birthday

FEBRUARY

- 20 - Presidents' Day

MAY

- 29 - Memorial Day

JUNE

- 19 - Juneteenth

JULY

- 4 - Independence Day

SEPTEMBER

- 4 - Labor Day

OCTOBER

- 9 - Columbus Day

NOVEMBER

- 9 - Veterans Day (OBS)
- 11 - Veterans Day
- 23 - Thanksgiving Day

DECEMBER

- 25 - Christmas Day

State MUTA dates are in accordance with Appendix 16, Tab B to Annex C of OPOD GRIFFIN. Verify MUTA dates with your individual unit of assignment.

S M T W T F S

JULY

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

* No Air Force MUTA *

AUGUST

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

SEPTEMBER

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

OCTOBER

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

NOVEMBER

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	

DECEMBER

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

S M T W T F S

S M T W T F S

2024 DELAWARE NATIONAL GUARD CALENDAR (4/10)

S M T W T F S

JANUARY

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31			

FEBRUARY

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29		

MARCH

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30
31						

APRIL

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30				

MAY

			1	2	3	4
5	6	7	8	9	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

JUNE

						1
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30						

LEGEND

FEDERAL HOLIDAY
FTS REGULAR DAY OFF
AIR FED PAY
ARMY FED PAY
STATE MUTA
ARMY MUTA
AIR MUTA

PAY PERIODS BRACKETED

FEDERAL HOLIDAYS

JANUARY

1 - New Year's Day
15 - Birthday of MLK, Jr.

FEBRUARY

19 - Washington's Birthday

MAY

27 - Memorial Day

JUNE

19 - Juneteenth Nat'l
Independence Day

JULY

4 - Independence Day

SEPTEMBER

2 - Labor Day

OCTOBER

14 - Columbus Day

NOVEMBER

11 - Veterans Day
28 - Thanksgiving Day

DECEMBER

25 - Christmas Day

State MUTA dates are in accordance with
Appendix 16, Tab B to Annex C of OPORD
GRIFFIN. Verify MUTA dates with your
individual unit of assignment.

S M T W T F S

JULY

	1	2	3	4	5	6
7	8	9	10	11	12	13
14	15	16	17	18	19	20
21	22	23	24	25	26	27
28	29	30	31	* NO AF MUTA		

AUGUST

				1	2	3
4	5	6	7	8	9	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

SEPTEMBER

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

OCTOBER

		1	2	3	4	5
6	7	8	9	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

NOVEMBER

					1	2
3	4	5	6	7	8	9
10	11	12	13	14	15	16
17	18	19	20	21	22	23
24	25	26	27	28	29	30

DECEMBER

1	2	3	4	5	6	7
8	9	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30	31				

S M T W T F S

S M T W T F S