DARE COUNTY EMS STATION 1 AND FIRE STATION 14 SITE REDEVELOPMENT

TOWN OF KILL DEVIL HILLS, DARE COUNTY, NORTH CAROLINIA

DRAINAGE NARRATIVE

FEBRUARY 17, 2023
REVISED MARCH 3, 2023

PREPARED BY:

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

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NORTH CAROLINA PROFESSIONAL ENGINEER SEAL 042614 KIMBERLY D. HAMBY
3-3-23

Drainage Narrative
Dare County EMS Station 1 and Fire Station 14
Site Redevelopment

Dare County and the Town of Kill Devil Hills are proposing a joint development on an existing site adjacent to the current EMS and fire stations. The site area is 4.47 acres (194,765 sf) and includes a parcel owned by the County and portions of parcels owned by the Town. The site is located at 1630 N. Croatan Highway. It is bounded on the north by the existing fire station, a water treatment facility and a public athletic complex; on the east by Croatan Hwy; on the south by a parking lot for a putt-putt golf course, and on the west by a residential development. The property is zoned commercial and service by the Town's public water system. The existing buildings utilize on-site septic for wastewater disposal, but the new building will be connected to a privately owned sewer system.

Existing development on the site includes a closed restaurant and the existing EMS station and entrance road. The existing EMS station will remain and the entrance and parking lot improved. The restaurant site will be completely demolished including the existing LPP septic field.

With regard to State Stormwater permitting, the site is considered to be low density based on being a redevelopment site that contains a large amount of existing coverage. Existing coverage within the site area totals 85,176 sf leaving 109,598 sf of pervious area. The coverage increase caused by the redevelopment is 23,375 sf which is equal to 21.33% of the existing pervious area.

While treatment is not required based on the NCDEQ State Stormwater Program, the Town of Kill Devil Hills has a requirement to store the runoff from a 4.3" rainfall. Several methods have been used to help meet this requirement.

- We have incorporated 20,219 sf of permeable pavers in three different areas. Each of the areas exceed state design requirements and show storage volumes well above what is required for their direct drainage areas. (Drainage Areas 1, 4 and 8)
- A Stormtech Chamber System with Isolator Row will receive the runoff from the largest area of impervious surface that includes the rear of the building and the concrete apron for the rear access by the EMS and fire vehicles. The system was designed to meet NCDEQ requirements but provides more storage than required by Kill Devil Hills. (Drainage Area 6)
- Areas surrounding the building and parking that do not drain to the permeable pavement or Stormtech Chambers, will drain to the surround grassed areas. The areas are comprised mostly of the north and south sides of the building where runoff cannot be easily captured and the front concrete apron. These areas do not all provide the full storage needed for the individual drainage areas; however, the overall storage volume for the site is approximately double what is required. As the stored groundwater will equalize, the additional storage for these areas is provided in the adjacent drainage areas. (Drainage Areas 2, 3, 5, 7 & 9)

Included in the appendices of this report are curve number calculations showing a breakdown of impervious coverage for each drainage area; storage calculations for each area; and a copy of the Geotechnical engineering report noting SHWT and permeability rates for the site.

Drainage Area 1 contains a portion of the southeast corner of the building, sidewalk and permeable pavement. The SHWT was identified as 3.25' in this area. Due to the installation of perforated sock pipe with an invert of 2.5', an effective SHWT of 3.0' was used. Calculations reflect a design volume of 924 cf and a storage volume of 5,924 cf.

Drainage Area 2 is contains a portion of the front of the building and the southern half of the concrete apron as well as part of the land receiving the runoff, including the portion of the r/w between the site development and the new perforated sock pipe being installed along the site frontage. Calculations reflect a design volume of 3,658 cf and a storage volume of 1,496 cf. The calculated storage does not include the pipe or sand within the street r/w. While this area contains less storage than required, it is directly adjacent to Drainage Area 1 which can more than compensate for this underage. SHWT conditions are the same as Drainage Area 1.

Drainage Area 3 is contains a portion of the front of the building and the northern half of the concrete apron as well as part of the land receiving the runoff, including the portion of the r/w between the site development and the new perforated sock pipe being installed along the site frontage. The SHWT in this area was identified to be 4.0'. This has been adjusted to 3.0' based on the invert of the perforated sock pipe in the area. Calculations reflect a design volume of 3,599 cf and a storage volume of only 950 cf. While this area contains substantially less storage than required, it is directly adjacent to Drainage Area 4 which can more than compensate for this underage.

Drainage Area 4 contains a portion of the northeast corner of the building, sidewalk and permeable pavement. The SHWT conditions are the same as Drainage Area 3. Calculations reflect a design volume of 768 cf and a storage volume of 5,562 cf.

Drainage Area 5 contains the south side of the building and the area between the building and property line. The SHWT for this area is 2.4'. The entire length of pipe along the southern property line was included in this Drainage Area for ease of calculations; however, it does originate in Drainage Area # 2 and extends through Drainage Area #9. Calculations reflect a design volume of 2,543 cf and a storage volume of 2,108 cf. While this area contains 435 cf less storage than required, it is directly adjacent to Drainage Area 1 which will compensate for this underage.

Drainage Area 6 contains the rear of the building and the concrete apron behind the building. The SHWT for this area is 2.4'. All runoff from this drainage area is routed to a Stormtech Chamber system with an isolator row. Calculations reflect a design volume of 9,485 cf and a storage volume of 13,531 cf.

Drainage Area 7 contains the north side of the building and a portion of the entrance road. The grassed area between the building and driveway captures this runoff. The SHWT is 4.0'. Calculations reflect a design volume of 3,755 cf and a storage volume of 3,851 cf.

Drainage Area 8 contains half of the existing EMS building, a portion of the entrance drive behind the new building and the permeable paver parking lot in front of the new building. SHWT for this drainage area is 4.5'. Calculations reflect a design volume of 3,732 cf and a storage volume of 15,002 cf.

Drainage Area 9 contains the area at the southwest corner of the building where the electrical equipment and a patio are located. In this area all runoff sheet flows to the grassed area. SHWT for this area is 2.4'. Calculations reflect a design volume of 326 cf and a storage volume of 4,110 cf.

The following chart shows the above breakdowns and storage values.

Drainage Area	Design Storage Volume (cf)	Provided Storage Volume (cf)	Difference (cf)
1	924	5924	5,000
2	3658	1496	(2162)
3	3599	950	(2649)
4	768	5562	4794
5	2543	2108	(435)
6	9485	13531	4046
7	3755	3851	96
8	3732	15002	11270
9	326	4110	3784
TOTALS	28790	49133	20343

Based on the results of the storage analysis, the site meets the requirements to store the 4.3" rainfall. This site will be an improvement over the existing site which only allows for storage in the pervious areas and includes a large septic field. Additionally, the drainage structures in the highway right-of-way and the perforated sock drainage pipe will improve drainage of the roadside.

Appendix A

Curve Number Calculations

Area and Curve Number Computations

Stormwater Quantity Analysis

TIMMONS GROUP
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Project Name: Dare EMS #1 & KDH Fire
Timmons Group Project No. 52044.001
Date: 1-12-23
Calculated By: KDH

Areas and Curve Numbers (NRCS TR-55)

Analysis Point	Area (SF)	Area (AC)	Impervious Cover				Turf & Mulch Cover				Weighted CN	I_a
			HSG	SF	Acres	CN[1]	HSG	SF	Acres	CN[1]		
DA-1	6,146	0.14	A	2,523	0.058	98	A	3,269	0.075	39	**61**	0.41
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-2	13,457	0.31	A	10,596	0.243	98	A	2,861	0.066	39	**85**	0.79
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-3	13,346	0.31	A	10,418	0.239	98	A	2,928	0.067	39	**85**	0.78
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-4	5,955	0.14	A	2,052	0.047	98	A	3,903	0.090	39	**59**	0.34
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-5	8,669	0.20	A	7,391	0.170	98	A	1,278	0.029	39	**89**	0.85
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-6	27,862	0.64	A	27,862	0.640	98	A			39	**98**	1.00
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-7	15,534	0.36	A	10,780	0.247	98	A	4,754	0.109	39	**80**	0.69
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-8	26,667	0.61	A	10,092	0.232	98	A	16,575	0.381	39	**61**	0.38
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		
DA-9	4,563	0.10	A	757	0.017	98	A	3,806	0.087	39	**49**	0.17
			B			98	B			61		
			C			98	C			74		
			D			98	D			80		

Appendix B

Storage Calculations

Runoff & Storage Calculations

TIMMONS GROUP
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Project Name: Dare EMS #1 KDH
TG Project No. 52044.001
Date: 3/3/2023
Calculated By: Kim Hamby

Drainage Area Properties - DA #1

Data Input		Notes and Descriptions
Drainage Area, A_{TOT}	6,146 SF	
(as acreage)	0.14 AC	
Impervious Area	2,523 SF	
(as acreage)	0.06 AC	
Percent Impervious	41.05 %	Does not include permeable pavers
Rainfall Depth	4.30 inches	Based on KDH requirement
Runoff Coefficient	0.42	$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	3.25	Per Geotech Report
Effective SHWT	3.00	Based on reduced water level from perforated pipe

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	924	CF	DV = 3630 * R_D * R_V * A
Storage Provided	5,924	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	3.00	3,623		
Elev. Top of Storage	6.85	3,623	13,949	< Layer Volume
Adjustment for Pipe				
Void Ratio	Sand	0.30	**4,185**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.85	3,623		
Elev. Top of Storage	8.05	3,623	4,348	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**1,739**	<Layer Storage
Pipe Volume				
Diameter (In)	0.0			
Length (LF)	0.0		**0**	<Pipe Volume
Cumulative Storage Volume				
			5,924	<Storage Provided

Runoff & Storage Calculations

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

Project Name: Dare EMS #1 KDH
TG Project No. 52044.001
Date: 3/3/2023
Calculated By: Kim Hamby

Drainage Area Properties - DA #2

Data Input		Notes and Descriptions
Drainage Area, A_{TOT} (as acreage)	13,457 SF 0.31 AC	
Impervious Area (as acreage)	10,596 SF 0.24 AC	
Percent Impervious	78.74 %	Does not include permeable pavers
Rainfall Depth	4.30 inches	Based on KDH requirement
Runoff Coefficient	0.76	$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	3.25	Per Geotech Report
Effective SHWT	3.00	Based on reduced water level from perforated pipe

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	3,658	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	1,496	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	3.00	1,477		
Elev. Top of Storage	6.50	1,477	5,170	< Layer Volume
Adjustment for Pipe			184	
Void Ratio	Sand	0.30	**1,496**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.50	0		
Elev. Top of Storage	0.00	0	0	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**0**	<Layer Storage
Pipe Volume				
Diameter (In)	15			
Length (LF)	0		**0**	<Pipe Volume
Cumulative Storage Volume				
			1,496	<Storage Provided

***NOTE: For this drainage area, little storage is calculated as most of it occurs within the NCDOT r/w. The area is directly adjacent to DA #1 which has excess storage beneath permeable pavers.**

Runoff & Storage Calculations

TIMMONS GROUP
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Project Name: Dare EMS #1 KDH
TG Project No. 52044.001
Date: 3/3/2023
Calculated By: Kim Hamby

Drainage Area Properties - DA #3

Data Input		Notes and Descriptions
Drainage Area, A_{TOT}	13,346 SF	
(as acreage)	0.31 AC	
Impervious Area	10,418 SF	
(as acreage)	0.24 AC	
Percent Impervious	78.06 %	Does not include permeable pavers
Rainfall Depth	4.30 inches	Based on KDH requirement
Runoff Coefficient	0.75	$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	4.00	Per Geotech Report
Effective SHWT	3.00	Based on reduced water level from perforated pipe

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	3,599	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	950	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	3.00	905		
Elev. Top of Storage	6.50	905	3,168	< Layer Volume
Adjustment for Pipe			0	
Void Ratio	Sand	0.30	**950**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.50	0		
Elev. Top of Storage	0.00	0	0	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**0**	<Layer Storage
Pipe Volume				
Diameter (In)	15			
Length (LF)	0		**0**	<Pipe Volume
Cumulative Storage Volume				
			950	<Storage Provided

***NOTE: For this drainage area, very little storage is calculated as most of it occurs within the NCDOT r/w. The area is directly adjacent to DA #4 which has excess storage beneath permeable pavers.**

Runoff & Storage Calculations

TIMMONS GROUP
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Project Name:	Dare EMS #1 KDH
TG Project No.	52044.001
Date:	3/3/2023
Calculated By:	Kim Hamby

Drainage Area Properties - DA #4

Data Input		Notes and Descriptions
Drainage Area, A_{TOT}	5,955 SF	
(as acreage)	0.14 AC	
Impervious Area	2,052 SF	
(as acreage)	0.05 AC	
Percent Impervious	34.46 %	Does not include permeable pavers
Rainfall Depth	4.30 inches	Based on KDH requirement
Runoff Coefficient	0.36	$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	4.00	Per Geotech Report
Effective SHWT	3.00	Based on reduced water level from perforated pipe

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	768	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	5,562	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	3.00	3,903		
Elev. Top of Storage	6.15	3,903	12,294	< Layer Volume
Adjustment for Pipe				
Void Ratio	Sand	0.30	**3,688**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.15	3,903		
Elev. Top of Storage	7.35	3,903	4,684	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**1,873**	<Layer Storage
Pipe Volume				
Diameter (In)	0.0			
Length (LF)	0.0		**0**	<Pipe Volume
Cumulative Storage Volume				
			5,562	<Storage Provided

Runoff & Storage Calculations

TIMMONS GROUP
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Project Name:	Dare EMS #1 KDH
TG Project No.	52044.001
Date:	3/3/2023
Calculated By:	Kim Hamby

Drainage Area Properties - DA #5

Data Input			Notes and Descriptions
Drainage Area, A_{TOT}	8,869	SF	
(as acreage)	0.20	AC	
Impervious Area	7,391	SF	
(as acreage)	0.17	AC	
Percent Impervious	83.34	%	Does not include permeable pavers
Rainfall Depth	4.30	inches	Based on KDH requirement
Runoff Coefficient	0.80		$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	2.40		Per Geotech Report
Effective SHWT	2.40		Based on reduced water level from perforated pipe

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	2,543	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	2,108	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	2.40	1,478		
Elev. Top of Storage	6.25	1,478	5,690	< Layer Volume
Adjustment for Pipe			572	
Void Ratio	Sand	0.30	**1,535**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.25	0		
Elev. Top of Storage	7.35	0	0	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**0**	<Layer Storage
Pipe Volume				
Diameter (In)	18.0			
Length (LF)	324.0		**572**	<Pipe Volume
Cumulative Storage Volume				
			2,108	<Storage Provided

***NOTE: The entire length of 18" pipe is accounted for in this drainage basin. For this drainage area, storage volume is slightly less than required. It is located between DA's #1 & #9 which have excess storage.**

Runoff & Storage Calculations

TIMMONS GROUP
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Project Name:	Dare EMS #1 KDH
TG Project No.	52044.001
Date:	3/3/2023
Calculated By:	Kim Hamby

Drainage Area Properties - DA #6

Data Input		Notes and Descriptions
Drainage Area, A_{TOT}	27,862 SF	
(as acreage)	0.64 AC	
Impervious Area	27,862 SF	
(as acreage)	0.64 AC	
Percent Impervious	100.00 %	Does not include permeable pavers
Rainfall Depth	4.30 inches	Based on KDH requirement
Runoff Coefficient	0.95	$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	2.40	Per Geotech Report
Effective SHWT	2.40	

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	9,485	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	13,531	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	2.40	7,522		
Elev. Top of Storage	4.17	7,522	13,314	< Layer Volume
Adjustment for Pipe				
Void Ratio	Sand	0.30	**3,994**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	4.17	0		
Elev. Top of Storage	7.35	0	0	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**0**	<Layer Storage
Volume provided by Stormtech Chambers				
			9,537	<Pipe Volume
Cumulative Storage Volume				
			13,531	<Storage Provided

***NOTE: This drainage area drains to the stormtech chamber system. Storage volume provided in chamber system =9537 cf. Additional storage is contained within the sand beneath the chambers.**

Runoff & Storage Calculations

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Project Name: Dare EMS #1 KDH
TG Project No. 52044.001
Date: 3/3/2023
Calculated By: Kim Hamby

Drainage Area Properties - DA #7

Data Input		Notes and Descriptions
Drainage Area, A_{TOT} (as acreage)	15,534 SF 0.36 AC	
Impervious Area (as acreage)	10,780 SF 0.25 AC	
Percent Impervious	69.40 %	Does not include permeable pavers
Rainfall Depth	4.30 inches	Based on KDH requirement
Runoff Coefficient	0.67	R_V = 0.05 + 0.9 * I_A I_A = Impervious Fraction
Seasonal High Water Table	4.00	Per Geotech Report
Effective SHWT	4.00	

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	3,755	CF	DV = 3630 * R_D * R_V * A
Storage Provided	3,851	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	4.00	4,754		
Elev. Top of Storage	6.70	4,754	12,836	< Layer Volume
Adjustment for Pipe				
Void Ratio	Sand	0.30	**3,851**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.70	0		
Elev. Top of Storage	7.35	0	0	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**0**	<Layer Storage
Pipe Volume				
Diameter (In)	0.0			
Length (LF)	0.0		**0**	<Pipe Volume
Cumulative Storage Volume				
			3,851	<Storage Provided

Runoff & Storage Calculations

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Project Name: Dare EMS #1 KDH
TG Project No. 52044.001
Date: 3/3/2023
Calculated By: Kim Hamby

Drainage Area Properties - DA #8

Data Input			Notes and Descriptions
Drainage Area, A_{TOT}	26,667	SF	
(as acreage)	0.61	AC	
Impervious Area	10,092	SF	
(as acreage)	0.23	AC	
Percent Impervious	37.84	%	Does not include permeable pavers
Rainfall Depth	4.30	inches	Based on KDH requirement
Runoff Coefficient	0.39		$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	4.50		Per Geotech Report
Effective SHWT	4.50		

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	3,732	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	15,002	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	4.50	16,575		
Elev. Top of Storage	6.25	16,575	29,006	< Layer Volume
Adjustment for Pipe			2,205	*
Void Ratio	Sand	0.30	**8,040**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.25	16,575		
Elev. Top of Storage	7.45	16,575	19,890	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.35	**6,962**	<Layer Storage
Pipe Volume				
Diameter (In)	0.0			
Length (LF)	140.0		**2,205**	<Pipe Volume
Cumulative Storage Volume				
			15,002	<Storage Provided

***NOTE: The portion of the 72" pipe and structure above the water table have been excluded from the storage volume of sand . A void ratio of 0.35 has been used for stone since it is not within all impervious area. This is a conservative adjustment as most of the pervious area in the Drainage Area is permeable pavers.**

Runoff & Storage Calculations

TIMMONS GROUP
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Project Name: Dare EMS #1 KDH
TG Project No. 52044.001
Date: 3/3/2023
Calculated By: Kim Hamby

Drainage Area Properties - DA #9

Data Input			Notes and Descriptions
Drainage Area, A_{TOT}	4,563	SF	
(as acreage)	0.10	AC	
Impervious Area	757	SF	
(as acreage)	0.02	AC	
Percent Impervious	16.59	%	Does not include permeable pavers
Rainfall Depth	4.30	inches	Based on KDH requirement
Runoff Coefficient	0.20		$R_V = 0.05 + 0.9 * I_A$ I_A = Impervious Fraction
Seasonal High Water Table	2.40		Per Geotech Report
Effective SHWT	2.40		

Volume Summary

Data Input			Notes and Descriptions
Design Volume (Stg Req'd based on 4.3" rain)	326	CF	$DV = 3630 * R_D * R_V * A$
Storage Provided	4,110	CF	See calculations below

Storage Volume Calculations

Description		Area SF	Volume CF	
Layer One				
Elev. SHWT	2.40	3,806		
Elev. Top of Storage	6.00	3,806	13,702	< Layer Volume
Adjustment for Pipe				
Void Ratio	Sand	0.30	**4,110**	<Layer Storage
Layer Two				
Elev. Bottom of Storage	6.00	0		
Elev. Top of Storage	7.35	0	0	< Layer Volume
Adjustment for Pipe				
Void Ratio	Gravel	0.40	**0**	<Layer Storage
Pipe Volume				
Diameter (In)	0.0			
Length (LF)	0.0		**0**	<Pipe Volume
Cumulative Storage Volume				
			4,110	<Storage Provided

Project: **52044.001 - Dare EMS #1 KDH**

Chamber Model -	SC-160	
Units -	Imperial	
Number of Chambers -	456	
Voids in the stone (porosity) -	40	%
Base of Stone Elevation -	4.17	ft
Amount of Stone Above Chambers -	6	in
Amount of Stone Below Chambers -	16	in

6500

StormTech SC-160 Cumulative Storage Volumes

Height of System *(inches)*	Incremental Single Chamber *(cubic feet)*	Incremental Total Chamber *(cubic feet)*	Incremental Stone *(cubic feet)*	Incremental Ch & St *(cubic feet)*	Cumulative Chamber *(cubic feet)*	Elevation *(feet)*
34	0.00	0.00	225.36	225.36	9537.42	7.00
33	0.00	0.00	225.36	225.36	9312.06	6.92
32	0.00	0.00	225.36	225.36	9086.70	6.84
31	0.00	0.00	225.36	225.36	8861.34	6.75
30	0.00	0.00	225.36	225.36	8635.98	6.67
29	0.00	0.00	225.36	225.36	8410.62	6.59
28	0.05	23.36	216.02	239.37	8185.25	6.50
27	0.13	61.30	200.84	262.14	7945.88	6.42
26	0.29	132.51	172.36	304.87	7683.74	6.34
25	0.44	201.52	144.75	346.27	7378.88	6.25
24	0.54	245.86	127.02	372.88	7032.60	6.17
23	0.62	281.05	112.94	393.99	6659.73	6.09
22	0.68	310.42	101.19	411.61	6265.74	6.00
21	0.74	335.56	91.14	426.70	5854.12	5.92
20	0.78	357.23	82.47	439.70	5427.43	5.84
19	0.82	376.16	74.90	451.06	4987.73	5.75
18	0.86	392.32	68.43	460.75	4536.67	5.67
17	0.89	407.96	62.18	470.14	4075.92	5.59
16	0.00	0.00	225.36	225.36	3605.78	5.50
15	0.00	0.00	225.36	225.36	3380.42	5.42
14	0.00	0.00	225.36	225.36	3155.06	5.34
13	0.00	0.00	225.36	225.36	2929.69	5.25
12	0.00	0.00	225.36	225.36	2704.33	5.17
11	0.00	0.00	225.36	225.36	2478.97	5.09
10	0.00	0.00	225.36	225.36	2253.61	5.00
9	0.00	0.00	225.36	225.36	2028.25	4.92
8	0.00	0.00	225.36	225.36	1802.89	4.84
7	0.00	0.00	225.36	225.36	1577.53	4.75
6	0.00	0.00	225.36	225.36	1352.17	4.67
5	0.00	0.00	225.36	225.36	1126.81	4.59
4	0.00	0.00	225.36	225.36	901.44	4.50
3	0.00	0.00	225.36	225.36	676.08	4.42
2	0.00	0.00	225.36	225.36	450.72	4.34
1	0.00	0.00	225.36	225.36	225.36	4.25

Appendix C

Geotechnical Report

TIMMONS GROUP
YOUR VISION ACHIEVED THROUGH OURS.

August 4, 2022

TO: Timmons Group
1805 West City Drive, Unit E
Elizabeth City, NC 27909

Attn: Mrs. Kim Hamby, PE

RE: Geotechnical Engineering Report
Dare County EMS/Fire Station #1 – Stormwater Design
Kill Devil Hills, North Carolina
Terracon Project No: K5225045

Dear Mrs. Hamby:

As requested, Terracon Consultants Inc has completed a limited Geotechnical Engineering study for the above referenced project. The scope of services and associated results discussed herein are limited to the proposed stormwater management area.

Project Site and Proposed Construction Characteristics

The project site is located at 1630 North Croatan Hwy in Kill Devil Hills, North Carolina. The site was previously developed including an existing structure along with its associated pavement areas. Existing site elevations within the proposed construction areas were unknown at this time. However, the site generally appeared to be relatively level with elevation changes less than 1-foot in 50 linear feet.

The proposed development consists of the demolition of the structure and pavements as well as building a new EMS and Fire Station facility including a single-story building, parking lots, and stormwater management areas along with other associated infrastructure components.

Field and Laboratory Test Results

Field Exploration:

In order to explore the general subsurface soil types and to aid in developing associated design parameters and recommendations associated with the proposed stormwater basin the following exploration program was performed:

- Four (4) 4.5-to 5-foot deep hand auger borings (designated as B-1 through B-4) were drilled within the stormwater basin construction limits. The exploration depths indicated herein were limited to that indicated above due to cave-ins as a result of the encountered groundwater level.

The hand auger borings were performed continuously from the existing ground surface to the depths indicated above. The soil samples were obtained, placed and sealed in plastic bags, and returned to our laboratory for review.

The boring locations were established by Timmons Group and subsequently located in the field by **Terracon** with the use of the site plan (developed by Timmons Group) and by measuring from easily identifiable landmarks. Approximate soil boring locations are shown on the attached “Boring Location Plan” which was developed by **Terracon** with the use of Google Earth imagery while referencing the above referenced conceptual site plan.

Laboratory Testing:

Soil testing provided by **Terracon** was performed in accordance with American Society for Testing and Materials (ASTM) standards. All soils and materials tests were performed in **Terracon’s** AASHTO re:source (formally AMRL) certified Elizabeth City, North Carolina laboratory.

Representative portions of all soil samples collected during drilling operations were labeled, preserved, and transferred to our laboratory in accordance with ASTM D4220 for classification and analysis. Soil descriptions on the boring logs are provided using visual-manual methods in general accordance with ASTM D2488 using the Unified Soil Classification System (USCS). Soil samples that were selected for index testing were classified in general accordance with ASTM D2487. It should be noted that some variation can be expected between samples classified using the visual-manual procedure (ASTM D2488) and the USCS (ASTM D2487). A summary of the soil classification system is attached to this report.

Representative portions of the soil samples were selected and subjected to natural moisture and gradation testing in order to corroborate the visual classification. These test results are presented in the Laboratory test Results summary attached to this report.

Field Testing:

Constant-Head Borehole Permeameter Testing was performed adjacent to boring locations B-1 through B-4 at approximate depths ranging from 1 to 1.5 feet below existing grades. The boreholes were prepared utilizing a hand auger to remove soil clippings from the base. Permeability testing was then conducted within the vadose zone utilizing a Johnson Permeameter™ and the following testing procedures:

A support stand was assembled and placed adjacent to the boreholes. This stand holds a calibrated reservoir and a cable used to raise and lower the water control unit (WCU). The WCU establishes a constant water head within the borehole during testing by use of a precision valve and float assembly. The WCU was attached to the flow reservoir with a braided PVC hose and then lowered by cable into the borehole to the test depth elevation. As required by the Glover solution, the WCU was suspended above the bottom of the borehole. The shut-off valve was then opened allowing water to pass through the WCU to fill the borehole to the constant water level elevation. The absorption rate slowed as the soil voids became filled and an equilibrium developed as a wetting bulb developed around the borehole. Water was continuously added until the flow rate stabilized. The reservoir was then re-filled in order to begin testing. During testing, as the water drained into the borehole and surrounding soils, the water level within the calibrated reservoir was recorded as well as the elapsed time during each interval. The test was continued until relatively consistent flow rates were documented. During testing the quick release connections and shutoff valve were monitored to ensure that no leakage occurred.

The flow rate (Q), height of the constant water level (H), and borehole diameter (D) were used to calculate Ks utilizing the Glover Solution. Based on the field testing, the hydraulic conductivities of the soils are presented in Table I below. The comprehensive hydraulic conductivity worksheets are attached to this report.

Table I – Infiltration Test Results

Boring ID	Test Depth (ft) (1)	K_{sat} Value (in/hr)	K_{sat} Class	USCS Classification
B-1	1	6.6	High	SP
B-2	1	3.6	High	SP
B-3	1	5.9	High	SP
B-4	1.5	5.5	High	SP

Note(s): (1) Test depth refers to depth below the existing grade at the test location.

The hydraulic conductivity (permeability) test results provided in this report are the result of permeability testing at the locations and depths indicated. Varying site conditions, including soil composition, soil density, stratum depth, and stratum thickness should be expected throughout the site. As such, the test results should not be assumed for all locations and depths across the project site. Additionally, a safety factor has not been applied to the values provided in Table I.

Subsurface Soil Conditions

The surficial and/or shallow subsurface soils encountered at the boring locations generally consisted of 2 to 4 inches of Sandy Topsoil to SAND (SP) with trace Organics. The underlying soils consisted of SAND (SP) having varying amounts of Silt. A summary of the subsurface soil conditions encountered at the boring locations is presented in Table II below.

Table II – Subsurface Soil Conditions

Average Depth (ft)	Stratum	Description
0 to 0.2 – 0.3	Surficial Organic Laden Soils	Sandy Topsoil to SAND (SP) with trace Organics
0.2 – 0.3 to 4.5 - 5	I (1)	SAND (SP) having varying amounts of Silt

Note(s): (1) All Borings terminated in this stratum

Groundwater Discussion

The groundwater level, where encountered, was recorded at the boring locations and as observed through the relative wetness of the recovered soil samples during the drilling operations. The initial groundwater level was measured to occur at depths ranging from 3.5 to 4 feet below existing grades at borings B-1 through B-4. Existing topographic information was not available at this time. As such, the groundwater elevations could not be estimated.

As previously indicated, the soils recovered from boring locations were classified in general accordance with ASTM D 2488 test method. Also, the soils recovered from borings B-1 through B-4 were classified using the Munsell® Soil Color Charts to aid in indicating the estimated normal Seasonal High Water Table (SHWT). Based on the soil texture classifications located throughout the storm water management construction areas, the shallow subsurface soils appeared to be relatively homogenous consisting of SAND (SP) with varying amounts of Silt.

The "Soil Survey of Dare County, North Carolina" provided by the U.S. Department of Agriculture indicates that soils located within the vicinity of the above noted borings performed at the project site consists of the Duckston fine sand (DtA). More detailed information regarding these soil conditions as noted in the "Custom Soil Resource Report for Currituck County, North Carolina" is provided in the following table (Table III – USDA Soil Descriptions and Characteristics).

Table III – USDA Soil Descriptions and Characteristics

Boring Nos.	Soil Series	Natural Drainage Class	Run Off Class	Hydrologic Soil Group
B-1 through B-4	DtA	Poorly Drained	Very High	A/D

Based on our field observations and experience with similar soil conditions, the near surface soils recovered at the project site appear to be consistent with the information provided on the "Custom Soil Resource Report for Currituck County, North Carolina". More detailed information regarding the above identified soil descriptions and their orientations throughout the development are provided in the attached "Custom Soil Resource Report for Currituck County, North Carolina".

Color changes in the recovered soils, when encountered, were compared using the Munsell® Soil Color Charts to aid in determining the estimated normal Seasonal High Water Table (SHWT) level. It is noted that soil morphology is not a reliable indicator of the SHWT in drained soils, as indicated in the "Soil Morphology as an Indicator of Seasonal High Water Tables" (prepared by Peter C. Fletcher; U.S. Department of Agriculture Soil Conservation Service). As such, the normal SHWT depths were estimated based on a combination of slight color transitions of the subsurface soils (when encountered), the groundwater level encountered during our field exploration and testing activities, existing site grade elevations noted on the project site plan, our site observations of the existing topography, as well as our experience with the project area. Detailed information regarding the encountered ground water depths and the estimated normal SHWT depths for each boring location are provided in Table IV on the following page of this report.

Table IV – Groundwater

BORING	INITIAL WATER DEPTH (Ft.)(1)	ESTIMATED EXISTING SURFACE ELEVATION (Ft NAVD88)	INITIAL GROUNDWATER ELEVATION (Ft. NAVD88)	ESTIMATED NORMAL SHWT DEPTH (Ft) (1)
B-1	3.5	-	-	2.5
B-2	3.5	-	-	3
B-3	3.5	-	-	3
B-4	4	-	-	3.5

Notes: (1) The depths noted above are referenced below existing grades respective of each boring location

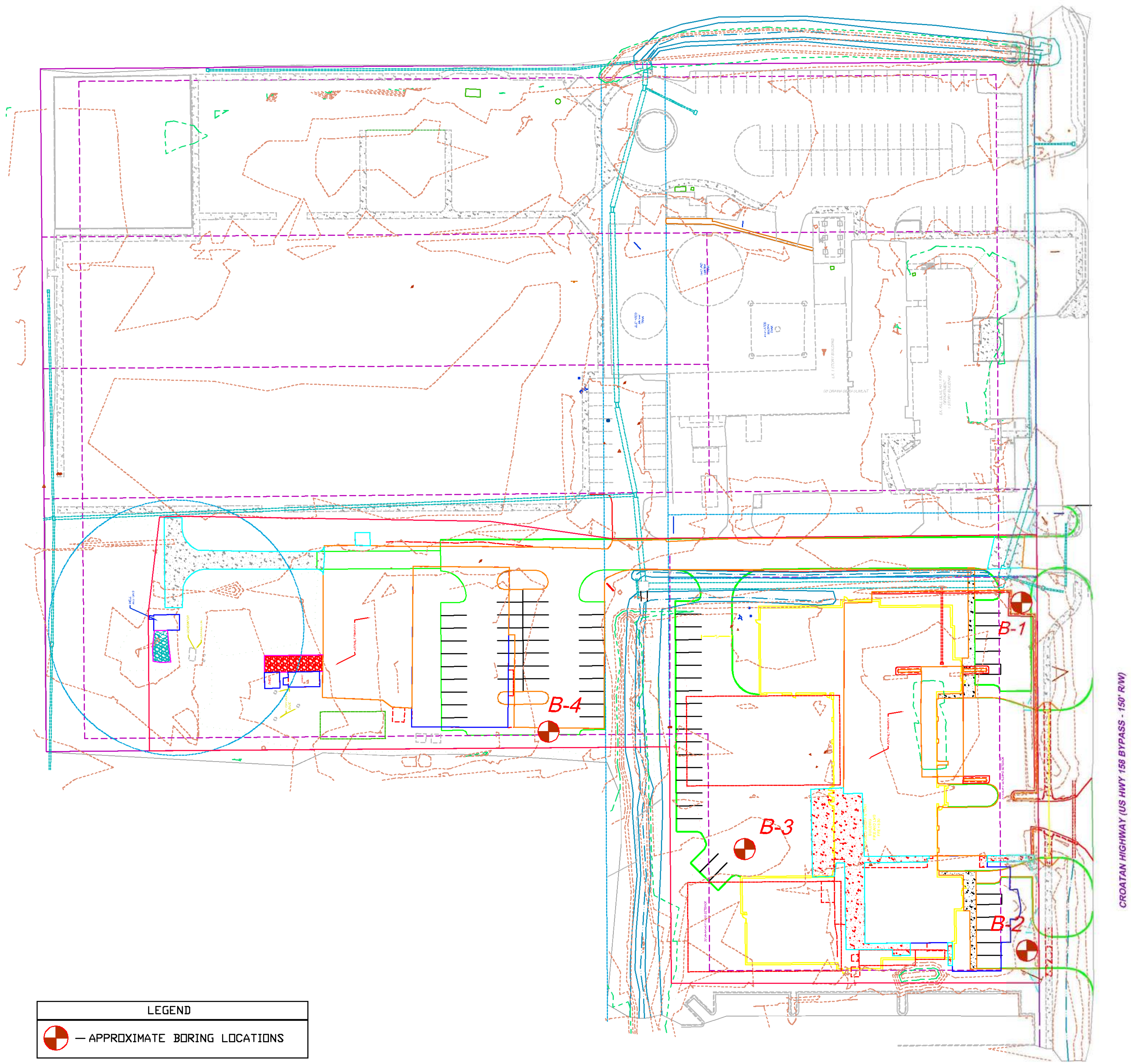
Groundwater conditions will vary with environmental variations and seasonal conditions, such as the frequency and magnitude of rainfall patterns, as well as man-made influences, such as existing swales, drainage ponds, underdrains and areas of covered soil (paved parking lots, sidewalks, etc.). In the project's area, seasonal groundwater fluctuations of +/-2 to 3 feet or more are common; however, greater fluctuations have been documented. We recommend that the Contractor determine the actual groundwater levels at the time of the construction to determine groundwater impact on the construction procedures, if necessary.

We appreciate the opportunity to offer our services to you and trust you will call this office with any questions that you may have.

Respectfully Submitted,
G E T Solutions, Inc.

Gerald W. Stalls Jr., P.E.
Senior Project Engineer
NC Lic. #034336

Attachments:
- Boring Location Plan
- Classification System for Soil Exploration
- Key to Material Graphics
- Summary of Laboratory Results
- Record of Subsurface Exploration (Boring Logs)
- Generalized Soil Profile
- Constant-Head Borehole Permeameter Test Reports
- Custom Soil Resource Report for Currituck County, North Carolina



LEGEND

— APPROXIMATE BORING LOCATIONS

Terracon

KILL DEVIL HILLS EMS/FIRE STATION 1
KILL DEVIL HILLS, NORTH CAROLINA

Project No: K5225045	Date: 7/21/2022	Figure No.: 1
BORING LOCATION PLAN		SCALE: NOT TO SCALE

Virginia Beach
5465 Greenwich Road
Virginia Beach, VA 23462
(757) 518-1703

Williamsburg
701 Alexander Lee Parkway
Williamsburg, Virginia 23185
(757) 564-6452

Elizabeth City
106 Capital Trace, Unit E
Elizabeth City, NC 27909
(252) 335-9765

Jacksonville
415-A Western Boulevard
Jacksonville, NC 28546
(910) 478-9915

CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

Standard Penetration Test (SPT), N-value

Standard Penetration Tests (SPT) were performed in the field in general accordance with ASTM D 1586. The soil samples were obtained with a standard 1.4" I.D., 2" O.D., 30" long split-spoon sampler. The sampler was driven with blows of a 140 lb. hammer falling 30 inches. The number of blows required to drive the sampler each 6-inch increment (4 increments for each soil sample) of penetration was recorded and is shown on the boring logs. The sum of the second and third penetration increments is termed the SPT N-value.

NON COHESIVE SOILS

(SILT, SAND, GRAVEL and Combinations)

Relative Density

Very Loose	4 blows/ft. or less
Loose	5 to 10 blows/ft.
Medium Dense	11 to 30 blows/ft.
Dense	31 to 50 blows/ft.
Very Dense	51 blows/ft. or more

COHESIVE SOILS

(CLAY, SILT and Combinations)

Consistency

Very Soft	2 blows/ft. or less
Soft	3 to 4 blows/ft.
Medium Stiff	5 to 8 blows/ft.
Stiff	9 to 15 blows/ft.
Very Stiff	16 to 30 blows/ft.
Hard	31 blows/ft. or more

Particle Size Identification

Boulders	8 inch diameter or more	
Cobbles	3 to 8 inch diameter	
Gravel	Coarse	1 to 3 inch diameter
	Medium	$^1/_2$ to 1 inch diameter
	Fine	$^1/_4$ to $^1/_2$ inch diameter
Sand	Coarse	2.00 mm to $^1/_4$ inch (diameter of pencil lead)
	Medium	0.42 to 2.00 mm (diameter of broom straw)
	Fine	0.074 to 0.42 mm (diameter of human hair)
Silt		0.002 to 0.074 mm (cannot see particles)

Relative Proportions

Descriptive Term	Percent
Trace	0-5
Few	5-10
Little	15-25
Some	30-45
Mostly	50-100

Strata Changes

In the column "Description" on the boring log, the horizontal lines represent approximate strata changes.

Groundwater Readings

Groundwater conditions will vary with environmental variations and seasonal conditions, such as the frequency and magnitude of rainfall patterns, as well as tidal influences and man-made influences, such as existing swales, drainage ponds, underdrains and areas of covered soil (paved parking lots, side walks, etc.).

CLASSIFICATION SYMBOLS (ASTM D 2487 and D 2488)

Coarse Grained Soils

More than 50% retained on No. 200 sieve

GW - Well-graded Gravel
GP - Poorly graded Gravel
GW-GM - Well-graded Gravel w/Silt
GW-GC - Well-graded Gravel w/Clay
GP-GM - Poorly graded Gravel w/Silt
GP-GC - Poorly graded Gravel w/Clay
GM - Silty Gravel
GC - Clayey Gravel
GC-GM - Silty, Clayey Gravel
SW - Well-graded Sand
SP - Poorly graded Sand
SW-SM - Well-graded Sand w/Silt
SW-SC - Well-graded Sand w/Clay
SP-SM - Poorly graded Sand w/Silt
SP-SC - Poorly graded Sand w/Clay
SM - Silty Sand
SC - Clayey Sand
SC-SM - Silty, Clayey Sand

Fine-Grained Soils

50% or more passes the No. 200 sieve

CL - Lean Clay
CL-ML - Silty Clay
ML - Silt
OL - Organic Clay/Silt

Liquid Limit 50% or greater

CH - Fat Clay
MH - Elastic Silt
OH - Organic Clay/Silt

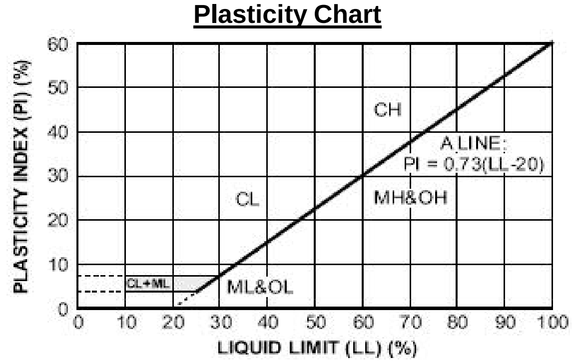
Highly Organic Soils

PT - Peat

Depending on percentage of fines (fraction smaller than No. 200 sieve size), 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

Plasticity Chart



Form 18.03.01 Revision 2/11/2019

(1) GET - MATERIAL GRAPHICS - GET_STANDARD_DATATEMPLATE(03-17-14).GDT - 8/4/22 12:20 - N:\PROJECTS\2022\K5225045\WORKING FILES\LABORATORY-FIELD DATA-BORING LOGS\K5225045 KILL DEVIL HILLS EMS FIRE STATION 1_LEGACY .GPJ

Terracon

KEY TO MATERIAL GRAPHICS

CLIENT Timmons Group

PROJECT NAME Dare County EMS/Fire Station #1 - Stormwater Design

PROJECT NUMBER K5225045

PROJECT LOCATION Kill Devil Hills, North Carolina

LITHOLOGIC SYMBOLS
(Unified Soil Classification System)

SP-SM: USCS Poorly-graded Sand with Silt

TOPSOIL: Topsoil

SUMMARY OF LABORATORY RESULTS

GET Solutions, Inc.
Geotechnical • Environmental • Testing

Terracon

CLIENT Timmons Group

PROJECT NAME Dare County EMS/Fire Station #1 - Stormwater Design

PROJECT NUMBER K5225045

PROJECT LOCATION Kill Devil Hills, North Carolina

Borehole	Depth	Liquid Limit	Plastic Limit	Plasticity Index	Maximum Size (mm)	%<#200 Sieve	Class-ification	Water Content (%)	Dry Density (pcf)	Satur-ation (%)	Void Ratio
B-1	1.0				0.075	0	SP	18.9			
B-2	1.5				0.075	0	SP	17.3			
B-3	1.5				0.075	0	SP	13.2			
B-4	2.0				0.075	0	SP	4.3			

RECORD OF SUBSURFACE EXPLORATION

GET Solutions, Inc.
Geotechnical • Environmental • Testing

Virginia Beach	Williamsburg	Elizabeth City	Jacksonville
5465 Greenwich Road	1592-E Penniman Road	106 Capital Trace Unit E	415-A Western Blvd
Virginia Beach, VA 23642	Williamsburg, VA 23185	Elizabeth City, NC 27909	Jacksonville, NC 28546
757-518-1703	757-564-6452	252-335-9765	910-478-9915

HAND AUGER BORING ID B-1

PROJECT NAME: **Dare County EMS/Fire Station #1 - Stormwater Design**
PROJECT NUMBER: **K5225045**
CLIENT: **Timmons Group**
SURFACE ELEVATION (MSL) (ft):
PROJECT LOCATION: **Kill Devil Hills, North Carolina**
LOGGED BY: **G. Stalls, P.E.**
BORING LOCATION: **See Attached Boring Location Plan**
DATE STARTED: **7/18/2022**
DRILLING METHOD(S): **Hand Auger**
DATE COMPLETED: **7/18/2022**
GROUNDWATER*: INITIAL (ft) ∇: **3.5** AFTER ____ HOURS (ft) ▼: ____ CAVE-IN (ft) ⊆: **4.5**
DRILLER: **Terracon**

The initial groundwater readings are not intended to indicate the static groundwater level.

Elevation (ft)	Depth (ft)	STRATA DESCRIPTION	Strata Legend	Sample ID	Sample Type	Sample Recovery (in.)	%<#200	TEST RESULTS (Plastic Limit X—X Liquid Limit; Water Content - ●; Penetration - ▨; 10 20 30 40 50 60 70)
	0.2	2 Inches Sandy Topsoil to SAND (SP) with trace Organics						
		Tan, moist to wet, poorly graded SAND (SP) with trace Silt		1	▨	12		
	1						0	●
				2	▨	12		
	2	Tan-Gray from 2.5 Feet		3	▨	12		
	3							
∇		Wet from 3.5 Feet		4	▨	12		
	4							
⊆	4.5	Cave-In at 4.5 Feet		5	▨	6		
		Boring terminated at 4.5 feet below existing grade.						

Sample Type(s):
▨ AUGER - Auger Sample

Notes:

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

RECORD OF SUBSURFACE EXPLORATION

GET Solutions, Inc.
Geotechnical • Environmental • Testing

Virginia Beach	Williamsburg	Elizabeth City	Jacksonville
5465 Greenwich Road	1592-E Penniman Road	106 Capital Trace Unit E	415-A Western Blvd
Virginia Beach, VA 23642	Williamsburg, VA 23185	Elizabeth City, NC 27909	Jacksonville, NC 28546
757-518-1703	757-564-6452	252-335-9765	910-478-9915

HAND AUGER BORING ID B-2

PROJECT NAME: **Dare County EMS/Fire Station #1 - Stormwater Design**
PROJECT NUMBER: **K5225045**
CLIENT: **Timmons Group**
SURFACE ELEVATION (MSL) (ft):
PROJECT LOCATION: **Kill Devil Hills, North Carolina**
LOGGED BY: **G. Stalls, P.E.**
BORING LOCATION: **See Attached Boring Location Plan**
DATE STARTED: **7/18/2022**
DRILLING METHOD(S): **Hand Auger**
DATE COMPLETED: **7/18/2022**
GROUNDWATER*: INITIAL (ft) ▽: **3.5** AFTER ____ HOURS (ft) ▼: ____ CAVE-IN (ft): **4.5**
DRILLER: **Terracon**

The initial groundwater readings are not intended to indicate the static groundwater level.

Elevation (ft)	Depth (ft)	Strata Description	Sample ID	Sample Type	Sample Recovery (in.)	%<#200	Water Content
	0.2	2 Inches Sandy Topsoil to SAND (SP) with trace Organics					
		Tan, moist to wet, poorly graded SAND (SP) with trace Silt	1	AUGER	12		
	1		2	AUGER	12	0	~17
	2	Tan-Gray from 3 Feet	3	AUGER	12		
▽	3	Wet from 3.5 Feet	4	AUGER	12		
Cave-in	4 / 4.5	Cave-In at 4.5 Feet	5	AUGER	6		
		Boring terminated at 4.5 feet below existing grade.					

TEST RESULTS: Plastic Limit X——X Liquid Limit; Water Content - ●; Penetration - ////; scale 10 20 30 40 50 60 70

Sample Type(s):
AUGER - Auger Sample

Notes:

RECORD OF SUBSURFACE EXPLORATION

GET Solutions, Inc. — Geotechnical • Environmental • Testing

Virginia Beach — *5465 Greenwich Road, Virginia Beach, VA 23642, 757-518-1703*
Williamsburg — *1592-E Penniman Road, Williamsburg, VA 23185, 757-564-6452*
Elizabeth City — *106 Capital Trace Unit E, Elizabeth City, NC 27909, 252-335-9765*
Jacksonville — *415-A Western Blvd, Jacksonville, NC 28546, 910-478-9915*

HAND AUGER BORING ID B-3

PROJECT NAME: **Dare County EMS/Fire Station #1 - Stormwater Design**
PROJECT NUMBER: **K5225045**
CLIENT: **Timmons Group**
SURFACE ELEVATION (MSL) (ft):
PROJECT LOCATION: **Kill Devil Hills, North Carolina**
LOGGED BY: **G. Stalls, P.E.**
BORING LOCATION: **See Attached Boring Location Plan**
DATE STARTED: **7/18/2022**
DRILLING METHOD(S): **Hand Auger**
DATE COMPLETED: **7/18/2022**
GROUNDWATER*: INITIAL (ft) ▽: **3.5** AFTER ____ HOURS (ft) ▼: ____ CAVE-IN (ft): **4.5**
DRILLER: **Terracon**

The initial groundwater readings are not intended to indicate the static groundwater level.

TEST RESULTS legend: Plastic Limit X———X Liquid Limit; Water Content - ●; Penetration - (hatched bar); scale 10 20 30 40 50 60 70

Elevation (ft)	Depth (ft)	Strata Description	Strata Legend	Sample ID	Sample Type	Sample Recovery (in.)	%<#200	Test Results
	0.2	2 Inches Sandy Topsoil to SAND (SP) with trace Organics	Topsoil					
		Tan, moist to wet, poorly graded SAND (SP) with trace Silt	SP	1	AUGER	12		
	1			2	AUGER	12	0	Water Content ● (~13)
	2	Tan-Gray from 3 Feet		3	AUGER	12		
▽	3	Wet from 3.5 Feet		4	AUGER	12		
Cave-in	4 / 4.5	Cave-In at 4.5 Feet		5	AUGER	6		
		Boring terminated at 4.5 feet below existing grade.						

Sample Type(s): AUGER - Auger Sample

Notes:

This information pertains only to this boring and should not be interpreted as being indicitive of the site.

RECORD OF SUBSURFACE EXPLORATION

GET Solutions, Inc. — Geotechnical • Environmental • Testing

Virginia Beach, 5465 Greenwich Road, Virginia Beach, VA 23642, 757-518-1703
Williamsburg, 1592-E Penniman Road, Williamsburg, VA 23185, 757-564-6452
Elizabeth City, 106 Capital Trace Unit E, Elizabeth City, NC 27909, 252-335-9765
Jacksonville, 415-A Western Blvd, Jacksonville, NC 28546, 910-478-9915

HAND AUGER BORING ID B-4

PROJECT NAME: Dare County EMS/Fire Station #1 - Stormwater Design
PROJECT NUMBER: K5225045
CLIENT: Timmons Group
SURFACE ELEVATION (MSL) (ft):
PROJECT LOCATION: Kill Devil Hills, North Carolina
LOGGED BY: G. Stalls, P.E.
BORING LOCATION: See Attached Boring Location Plan
DATE STARTED: 7/18/2022
DRILLING METHOD(S): Hand Auger
DATE COMPLETED: 7/18/2022
GROUNDWATER*: INITIAL (ft) ∇: 4 AFTER ____ HOURS (ft) ▼: ____ CAVE-IN (ft): 5
DRILLER: Terracon

The initial groundwater readings are not intended to indicate the static groundwater level.

Elevation (ft)	Depth (ft)	Strata Description	Sample ID	Sample Type	Sample Recovery (in.)	%<#200	Test Results (Water Content)
	0.3	4 Inches Sandy Topsoil to SAND (SP) with trace Organics					
		Tan, moist to wet, poorly graded SAND (SP) with trace Silt	1	AUGER	12		
	1		2	AUGER	12		
	2	Tan-Gray from 3.5 Feet	3	AUGER	12	0	● (~5)
	3		4	AUGER	12		
∇	4	Wet from 4 Feet	5	AUGER	12		
Cave-in	5.0	Cave-In at 5 Feet					
		Boring terminated at 5 feet below existing grade.					

TEST RESULTS: Plastic Limit X——X Liquid Limit; Water Content - ●; Penetration - ▨; scale 10 20 30 40 50 60 70

Sample Type(s): AUGER - Auger Sample

Notes:

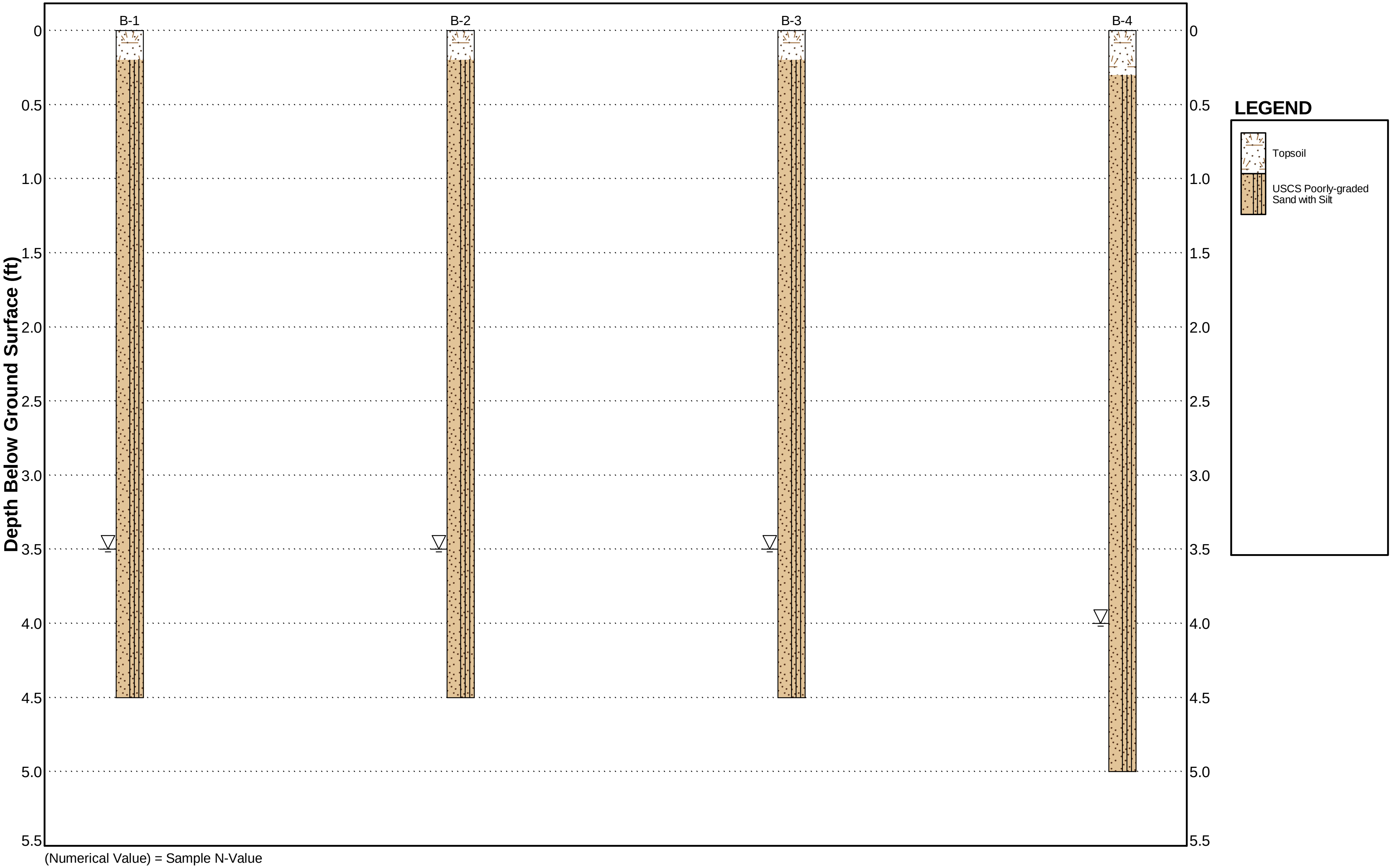
GENERALIZED SOIL PROFILE

PROJECT NAME: Dare County EMS/Fire Station #1 - Stormwater Design

PROJECT NUMBER: K5225045

PROJECT LOCATION: Kill Devil Hills, North Carolina

CLIENT: Timmons Group



(Numerical Value) = Sample N-Value

Constant-Head Borehole Permeameter Test	Analytical Method: Glover Solution	GET Solutions, Inc.

				Terminology and Solution (R. E. Glover Solution)*	
Project Name......:	Kill Devil Hills EMS/Fire Station 1	Project No......:	K5225045		
Boring No...........:	B-1	Proj. Location...:	Kill Devil Hills, NC	$Ksat_B$: (Coefficient of Permeability) @ Base Tmp. T_B (ºC)	24
Investigators.......:	T. Kellogg	Date..................:	7/18/22	Q: Rate of flow of water from the borehole	
Boring Depth......:	1 ft (m, cm, ft, in)	WCU Base Ht. h:	15.0 cm	H: Constant height of water in the borehole	
Boring Diameter..:	8.3 cm	WCU Susp. Ht. S:	10.2 cm	r: Radius of the cylindrical borehole	
Boring Radius r...:	4.15 cm	Const. Wtr. Ht. H:	25.2 cm	V: Dyn. Visc. of water @ Tmp. T °C/Dyn. Visc. of water @ T_B	
Soil/Water Tmp. T:	25 °C	H/r **..................:	6.1	$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solu.]	
Dyn. Visc. @ T °C.:	0.000891 kg/m·s	Dyn. Visc. @ T_B °C.:	0.000911 kg/m·s	$Ksat_B = QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Tmp. Correction]	

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	Interval Elapsed Time (min)	Flow Rate Q (ml/min)	$Ksat_B$ Equivalent Values (cm/min)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
2,000		10:00:00 AM								
1,900	100	10:00:04 AM	0:00:04	0.07	1,500.00	0.608	1.01E-02	876.151	14.373	28.745
1,800	100	10:00:13 AM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,700	100	10:00:20 AM	0:00:07	0.12	857.14	0.348	5.79E-03	500.657	8.213	16.426
1,600	100	10:00:30 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,500	100	10:00:39 AM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,400	100	10:00:48 AM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,300	100	10:00:58 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,200	100	10:01:07 AM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,100	100	10:01:18 AM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
1,000	100	10:01:28 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
900	100	10:01:37 AM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
800	100	10:01:47 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
700	100	10:01:57 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
600	100	10:02:08 AM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
500	100	10:02:18 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
400	100	10:02:27 AM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
300	100	10:02:37 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.5	5.749	11.50
200	100	10:02:47 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.5	5.749	11.50
100	100	10:02:58 AM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45
0	100	10:03:08 AM	0:00:10	0.17	600.00	0.243	4.06E-03	350.5	5.749	11.50

Natural Moisture......:	18.9	Consistency...............:	Loose	Field-Estimated Ksat:	0.280	4.67E-03	403.323	6.616	13.232
USDA Txt./USCS Class:	SP	Water Table Depth...:	3.5 ft	Notes: Estimated field Ksat is determined by averaging and/or rounding of test results for the final three or four stabilized values and analyzing the graph.					
Struct./% Pass. #200.:	0.4	Init. Saturation Time.:	9:30:00 AM						

*Glover, R. E. I953. Flow from a test-hole located above groundwater level, pp. 69-7I. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least twice the depth of the water in the well. **H/r>5 to >10 Johnson Permeameter, LLC Revised 11/29/13

Constant-Head Borehole Permeameter Test

Analytical Method: Glover Solution

Project Name......:	Kill Devil Hills EMS/Fire Station 1	Project No......:	K5225045
Boring No...........:	B-2	Proj. Location...:	Kill Devil Hills, NC
Investigators.......:	T. Kellogg	Date.................:	7/18/22
Boring Depth......:	1 ft (m, cm, ft, in)	WCU Base Ht. h:	15.0 cm
Boring Diameter..:	8.3 cm	WCU Susp. Ht. S:	10.2 cm
Boring Radius r...:	4.15 cm	Const. Wtr. Ht. H:	25.2 cm
Soil/Water Tmp. T:	25 °C	H/r **..................:	6.1
Dyn. Visc. @ T °C.:	0.000891 kg/m·s	Dyn. Visc. @ T_B °C.:	0.000911 kg/m·s

Terminology and Solution (R. E. Glover Solution)*

$Ksat_B$: (Coefficient of Permeability) @ Base Tmp. T_B (ºC)	24
Q: Rate of flow of water from the borehole	
H: Constant height of water in the borehole	
r: Radius of the cylindrical borehole	
V: Dyn. Visc. of water @ Tmp. T °C/Dyn. Visc. of water @ T_B	
$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solu.]	
$Ksat_B = QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Tmp. Correction]	

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	Interval Elapsed Time (min)	Flow Rate Q (ml/min)	$Ksat_B$ Equivalent Values (cm/min)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
2,000		11:00:00 AM								
1,900	100	11:00:12 AM	0:00:12	0.20	500.00	0.203	3.38E-03	292.050	4.791	9.582
1,800	100	11:00:28 AM	0:00:16	0.27	375.00	0.152	2.54E-03	219.038	3.593	7.186
1,700	100	11:00:43 AM	0:00:15	0.25	400.00	0.162	2.70E-03	233.640	3.833	7.665
1,600	100	11:01:00 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.153	3.382	6.764
1,500	100	11:01:15 AM	0:00:15	0.25	400.00	0.162	2.70E-03	233.640	3.833	7.665
1,400	100	11:01:32 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.153	3.382	6.764
1,300	100	11:01:47 AM	0:00:15	0.25	400.00	0.162	2.70E-03	233.640	3.833	7.665
1,200	100	11:02:03 AM	0:00:16	0.27	375.00	0.152	2.54E-03	219.038	3.593	7.186
1,100	100	11:02:19 AM	0:00:16	0.27	375.00	0.152	2.54E-03	219.038	3.593	7.186
1,000	100	11:02:35 AM	0:00:16	0.27	375.00	0.152	2.54E-03	219.038	3.593	7.186
900	100	11:02:52 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.153	3.382	6.764
800	100	11:03:09 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.153	3.382	6.764
700	100	11:03:26 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.153	3.382	6.764
600	100	11:03:41 AM	0:00:15	0.25	400.00	0.162	2.70E-03	233.640	3.833	7.665
500	100	11:03:58 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.153	3.382	6.764
400	100	11:04:14 AM	0:00:16	0.27	375.00	0.152	2.54E-03	219.038	3.593	7.186
300	100	11:04:31 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.2	3.382	6.76
200	100	11:04:46 AM	0:00:15	0.25	400.00	0.162	2.70E-03	233.6	3.833	7.67
100	100	11:05:03 AM	0:00:17	0.28	352.94	0.143	2.39E-03	206.2	3.382	6.76
0	100	11:05:19 AM	0:00:16	0.27	375.00	0.152	2.54E-03	219.0	3.593	7.19

Natural Moisture......:	17.3	Consistency...............:	Loose		Field-Estimated Ksat:	0.154	2.57E-03	222.420	3.649	7.297
USDA Txt./USCS Class:	SP	Water Table Depth...:	3.5 ft							
Struct./% Pass. #200.:	0.3	Init. Saturation Time.:	10:30:00 AM							

Notes: Estimated field Ksat is determined by averaging and/or rounding of test results for the final three or four stabilized values and analyzing the graph.

*Glover, R. E. I953. Flow from a test-hole located above groundwater level, pp. 69-7I. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least twice the depth of the water in the well. **H/r>5 to >10 Johnson Permeameter, LLC Revised 11/29/13

Constant-Head Borehole Permeameter Test	Analytical Method: Glover Solution	GET Solutions, Inc.

				Terminology and Solution (R. E. Glover Solution)*	
Project Name......:	Kill Devil Hills EMS/Fire Station 1	Project No......:	K5225045		
Boring No...........:	B-3	Proj. Location...:	Kill Devil Hills, NC	$Ksat_B$: (Coefficient of Permeability) @ Base Tmp. T_B (ºC)	24
Investigators.......:	T. Kellogg	Date..................:	7/18/22	Q: Rate of flow of water from the borehole	
Boring Depth......:	1 ft (m, cm, ft, in)	WCU Base Ht. h:	15.0 cm	H: Constant height of water in the borehole	
Boring Diameter..:	8.3 cm	WCU Susp. Ht. S:	10.2 cm	r: Radius of the cylindrical borehole	
Boring Radius r...:	4.15 cm	Const. Wtr. Ht. H:	25.2 cm	V: Dyn. Visc. of water @ Tmp. T °C/Dyn. Visc. of water @ T_B	
Soil/Water Tmp. T:	25 °C	H/r **...................:	6.1	$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solu.]	
Dyn. Visc. @ T °C.:	0.000891 kg/m·s	Dyn. Visc. @ T_B °C.:	0.000911 kg/m·s	$Ksat_B = QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Tmp. Correction]	

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	Interval Elapsed Time (min)	Flow Rate Q (ml/min)	$Ksat_B$ Equivalent Values (cm/min)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
2,000		12:00:00 PM								
1,900	100	12:00:07 PM	0:00:07	0.12	857.14	0.348	5.79E-03	500.657	8.213	16.426
1,800	100	12:00:17 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,700	100	12:00:27 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,600	100	12:00:36 PM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,500	100	12:00:46 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,400	100	12:00:56 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,300	100	12:01:05 PM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,200	100	12:01:15 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,100	100	12:01:25 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,000	100	12:01:34 PM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
900	100	12:01:44 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
800	100	12:01:55 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
700	100	12:02:06 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
600	100	12:02:17 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
500	100	12:02:28 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
400	100	12:02:39 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
300	100	12:02:49 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.5	5.749	11.50
200	100	12:03:00 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45
100	100	12:03:11 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45
0	100	12:03:22 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45

Natural Moisture......:	13.2	Consistency...............:	Loose	Field-Estimated Ksat:	0.248	4.13E-03	357.193	5.859	11.719
USDA Txt./USCS Class:	SP	Water Table Depth...:	3.5 ft	Notes: Estimated field Ksat is determined by averaging and/or rounding of test results for the final three or four stabilized values and analyzing the graph.					
Struct./% Pass. #200.:	0.3	Init. Saturation Time.:	11:30:00 AM						

*Glover, R. E. I953. Flow from a test-hole located above groundwater level, pp. 69-7I. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least twice the depth of the water in the well. **H/r>5 to >10 Johnson Permeameter, LLC Revised 11/29/13

Constant-Head Borehole Permeameter Test	Analytical Method: Glover Solution	GET Solutions, Inc.

Project Name......:	Kill Devil Hills EMS/Fire Station 1	Project No......:	K5225045	Terminology and Solution (R. E. Glover Solution)*
Boring No...........:	B-4	Proj. Location...:	Kill Devil Hills, NC	$Ksat_B$: (Coefficient of Permeability) @ Base Tmp. T_B (ºC) 24
Investigators.......:	T. Kellogg	Date..................:	7/18/22	Q: Rate of flow of water from the borehole
Boring Depth......:	1.5 ft (m, cm, ft, in)	WCU Base Ht. h:	15.0 cm	H: Constant height of water in the borehole
Boring Diameter..:	8.3 cm	WCU Susp. Ht. S:	10.2 cm	r: Radius of the cylindrical borehole
Boring Radius r...:	4.15 cm	Const. Wtr. Ht. H:	25.2 cm	V: Dyn. Visc. of water @ Tmp. T °C/Dyn. Visc. of water @ T_B
Soil/Water Tmp. T:	25 °C	H/r **...................:	6.1	$Ksat = Q[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Basic Glover Solu.]
Dyn. Visc. @ T °C.:	0.000891 kg/m·s	Dyn. Visc. @ T_B °C.:	0.000911 kg/m·s	$Ksat_B = QV[\sinh^{-1}(H/r) - (r^2/H^2+1)^{.5} + r/H]/(2\pi H^2)$ [Tmp. Correction]

VOLUME (ml)	Volume Out (ml)	TIME (h:mm:ss A/P)	Interval Elapsed Time (hr:min:sec)	Interval Elapsed Time (min)	Flow Rate Q (ml/min)	$Ksat_B$ Equivalent Values (cm/min)	(cm/sec)	(cm/day)	(in/hr)	(ft/day)
2,000		2:00:00 PM								
1,900	100	2:00:09 PM	0:00:09	0.15	666.67	0.270	4.51E-03	389.400	6.388	12.776
1,800	100	2:00:19 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,700	100	2:00:29 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,600	100	2:00:39 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
1,500	100	2:00:50 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
1,400	100	2:01:01 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
1,300	100	2:01:12 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
1,200	100	2:01:23 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
1,100	100	2:01:34 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
1,000	100	2:01:45 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
900	100	2:01:55 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
800	100	2:02:06 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
700	100	2:02:17 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
600	100	2:02:27 PM	0:00:10	0.17	600.00	0.243	4.06E-03	350.460	5.749	11.498
500	100	2:02:38 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
400	100	2:02:49 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.600	5.226	10.453
300	100	2:03:01 PM	0:00:12	0.20	500.00	0.203	3.38E-03	292.1	4.791	9.58
200	100	2:03:12 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45
100	100	2:03:23 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45
0	100	2:03:34 PM	0:00:11	0.18	545.45	0.221	3.69E-03	318.6	5.226	10.45

Natural Moisture......:	4.3	Consistency...............:	Loose	Field-Estimated Ksat:	0.231	3.85E-03	332.981	5.462	10.925
USDA Txt./USCS Class:	SP	Water Table Depth...:	4 ft	Notes: Estimated field Ksat is determined by averaging and/or rounding of test results for the final three or four stabilized values and analyzing the graph.					
Struct./% Pass. #200.:	0.3	Init. Saturation Time.:	1:30:00 AM						

*Glover, R. E. I953. Flow from a test-hole located above groundwater level, pp. 69-7I. in: Theory and Problems of Water Percolation. (C. N. Zanger. ed.). USBR. The condition for this solution exists when the distance from the bottom of the borehole to the water table or an impervious layer is at least twice the depth of the water in the well. **H/r>5 to >10 Johnson Permeameter, LLC Revised 11/29/13

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for

Dare County, North Carolina

August 4, 2022

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.

Soil Map

Map Scale: 1:1,690 if printed on A landscape (11" x 8.5") sheet.

N

Meters: 0, 25, 50, 100, 150

Feet: 0, 50, 100, 200, 300

Map projection: Web Mercator   Corner coordinates: WGS84   Edge tics: UTM Zone 18N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Dare County, North Carolina
Survey Area Data: Version 22, Jan 21, 2022

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Dec 31, 2009—Oct 19, 2017

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
CoB	Corolla fine sand, 0 to 6 percent slopes, rarely flooded	0.1	0.4%
DtA	Duckston fine sand, 0 to 2 percent slopes, occasionally flooded	12.4	87.6%
NhC	Newhan-Corolla complex, 0 to 10 percent slopes	1.7	12.0%
Totals for Area of Interest		**14.1**	**100.0%**

Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Dare County, North Carolina

CoB—Corolla fine sand, 0 to 6 percent slopes, rarely flooded

Map Unit Setting

National map unit symbol: 3qgs
Elevation: 0 to 10 feet
Mean annual precipitation: 42 to 58 inches
Mean annual air temperature: 61 to 64 degrees F
Frost-free period: 190 to 270 days
Farmland classification: Not prime farmland

Map Unit Composition

Corolla and similar soils: 85 percent
Minor components: 7 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Corolla

Setting

Landform: Troughs on barrier islands
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Eolian sands and/or beach sand

Typical profile

A - 0 to 3 inches: fine sand
C - 3 to 26 inches: fine sand
Ab - 26 to 32 inches: sand
Cg - 32 to 80 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 39.96 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Maximum salinity: Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water supply, 0 to 60 inches: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Duckston

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Hydric soil rating: Yes

Carteret, high

Percent of map unit: 2 percent
Landform: Tidal marshes
Down-slope shape: Linear
Across-slope shape: Linear
Hydric soil rating: Yes

DtA—Duckston fine sand, 0 to 2 percent slopes, occasionally flooded

Map Unit Setting

National map unit symbol: 3qgw
Elevation: 0 to 10 feet
Mean annual precipitation: 42 to 58 inches
Mean annual air temperature: 61 to 64 degrees F
Frost-free period: 190 to 270 days
Farmland classification: Not prime farmland

Map Unit Composition

Duckston and similar soils: 90 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Duckston

Setting

Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Eolian sands and/or beach sand

Typical profile

A - 0 to 8 inches: fine sand
Cg - 8 to 13 inches: sand
Ab - 13 to 17 inches: sand
C'g - 17 to 80 inches: sand

Properties and qualities

Slope: 0 to 2 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Poorly drained
Runoff class: Very high

Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 39.96 in/hr)
Depth to water table: About 0 to 6 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Maximum salinity: Moderately saline to strongly saline (8.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water supply, 0 to 60 inches: Very low (about 3.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7w
Hydrologic Soil Group: A/D
Hydric soil rating: Yes

NhC—Newhan-Corolla complex, 0 to 10 percent slopes

Map Unit Setting

National map unit symbol: 3qh6
Elevation: 0 to 20 feet
Mean annual precipitation: 42 to 58 inches
Mean annual air temperature: 61 to 64 degrees F
Frost-free period: 190 to 270 days
Farmland classification: Not prime farmland

Map Unit Composition

Newhan and similar soils: 50 percent
Corolla and similar soils: 40 percent
Minor components: 5 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Newhan

Setting

Landform: Dunes
Landform position (two-dimensional): Shoulder, backslope
Landform position (three-dimensional): Side slope
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Eolian sands and/or beach sand

Typical profile

A - 0 to 2 inches: fine sand
C1 - 2 to 50 inches: fine sand
C2 - 50 to 80 inches: sand

Properties and qualities

Slope: 0 to 10 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Excessively drained
Runoff class: Very low

Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 to 39.96 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Maximum salinity: Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water supply, 0 to 60 inches: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 8s
Hydrologic Soil Group: A
Hydric soil rating: No

Description of Corolla

Setting

Landform: Troughs on barrier islands
Landform position (two-dimensional): Backslope, toeslope
Landform position (three-dimensional): Base slope
Down-slope shape: Concave
Across-slope shape: Concave
Parent material: Eolian sands and/or beach sand

Typical profile

A - 0 to 3 inches: fine sand
C - 3 to 26 inches: fine sand
Ab - 26 to 32 inches: sand
Cg - 32 to 60 inches: sand

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: More than 80 inches
Drainage class: Moderately well drained
Runoff class: Very high
Capacity of the most limiting layer to transmit water (Ksat): Very high (19.98 in/hr)
Depth to water table: About 18 to 36 inches
Frequency of flooding: Rare
Frequency of ponding: None
Maximum salinity: Slightly saline to strongly saline (4.0 to 16.0 mmhos/cm)
Sodium adsorption ratio, maximum: 20.0
Available water supply, 0 to 60 inches: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: A
Hydric soil rating: No

Minor Components

Duckston

Percent of map unit: 5 percent
Landform: Depressions
Down-slope shape: Concave
Across-slope shape: Concave

Hydric soil rating: Yes

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