FOUNDATION REPORT

SR 1 Southbound Auxiliary Lane
Cantilever Sign Structures
SR 273 to US 40
New Castle County, Delaware
Contract No. T201811001

Prepared for:
Delaware Department of Transportation

Commission No. 11009.007
February 8, 2019

Eric M. Klein, P.E., D.GE
Senior Manager, Geotechnical Engineering Department

Kevin P. Roberts, E.I.T.
Geotechnical Engineer

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1 INTRODUCTION

Rummel, Klepper & Kahl, LLP (RK&K) has completed the Foundation Report for the SR1 Southbound Auxiliary Lane Project from SR 273 to US 40 in New Castle County, Delaware.

The purpose of this study was to observe general subsurface conditions at the project site and to evaluate those conditions with respect to geotechnical engineering considerations for the proposed sign structure construction. The specific scope of our services on this project consisted of evaluating the subsurface conditions, developing geotechnical recommendations, and submitting our findings in a report. Based on this geotechnical study, recommendations are provided for the sign structure foundation design, earthwork, and other geotechnical concerns.

Also included in this report are descriptions of the field and laboratory testing on which this report is based. The results of this work are contained in the appendix of this report.

2 SITE AND PROJECT DESCRIPTION

2.1 SITE DESCRIPTION

The project site is located on southbound State Route (SR) 1 between the SR 273 and US 40 interchanges, in New Castle County, Delaware, as shown in Figure A-1 in Appendix A. SR 1 is a divided highway with a grass median. Southbound SR 1 currently consists of a 4-ft inside shoulder, two 12-ft travel lanes, and a 10-ft wide outside shoulder. The side slopes at the locations of the proposed sign structures will be 2(H):1(V). The site is surrounded by farm land on the west and northbound SR 1 on the east.

2.2 PROJECT DESCRIPTION

The Delaware Department of Transportation (DelDOT) is planning to improve traffic conditions (delay and congestion) occurring between the SR 273 interchange and the US 40 interchange, in the southbound direction. The project includes adding a 12-ft auxiliary lane along existing southbound SR 1 from the existing SR 273 southbound on-ramp, to the exit onto the US 40 interchange. The project will also add a 12-ft wide shoulder and overlay the existing SR 1 roadway and shoulder. Additionally, the project proposes three cantilever sign structures. The locations of the sign structures are shown in Table 2.1. The sign structures are proposed to extend approximately 33-ft across the travel lanes and will be approximately 28-ft tall. All improvements will be designed to remain within the existing DelDOT right-of-way.

Table 2.1 - Sign Structures Locations

Sign Structure	Northing	Easting	Station
SC-1	597372.315	589666.541	289+00
SC-2	599861.926	590501.423	295+50
SC-3	602460.724	590191.185	323+00

The following Table 2.2 provides the loads considered for each sign structure. The design criteria for deflection of the proposed sign structure drilled shafts was considered to not exceed 1-inch for service loading conditions.

Table 2.2 - Summary of Cantilever Sign Loads

Loads at Base of Post	Fx (k)	Fy (k)	Fz (k)	Mx (k-ft)	My (k-ft)	Mz (k-ft)
Strength I	15	0	0	-5	0	183
Extreme I	14	2	15	-368	-314	185
Service I/III	12	1	7	2	-137	157

3 *FIELD AND LABORATORY WORK*

3.1 FIELD EXPLORATION

The field exploration consisted of drilling three Standard Penetration Test (SPT) borings, TB-1 through TB-3, on September 11 through 13, 2018. The test borings were drilled by Hillis Carnes Engineering Associates under contract to DelDOT. Borings TB-1 through TB-3 were drilled at the approximate locations of the proposed cantilevered sign structures. The borings extended to depths of 50-ft below the existing ground surface. Boring locations are shown in Figure A-2, located in Appendix A of this report.

Soil samples were obtained continuously to a depth of 20-ft below the existing ground surface and at 5.0-ft intervals thereafter in accordance with the SPT. In general, the SPT consists of advancing a 2-inch outside diameter sampling spoon 24-inches by driving it with a 140-pound hammer falling 30-inches. The values reported on the boring logs are the blows required to advance three successive increments. The first 6-inch increment is considered as seating. The sum of the number of blows for the second and third increments is the "N" value.

The soils were classified in general accordance with the American Association of State Highway and Transportation Officials (AASHTO) classification system. Descriptions of the soils classification systems, sample procedures, and rock descriptions are also included in Appendix B.

Depth to groundwater was noted during the drilling operations and groundwater levels were measured at the completion of drilling and, when possible, 24 hours or longer after the completion of drilling. The depth to the bottom of each borehole was also measured after the removal of the drilling augers to determine the susceptibility of the borehole to collapse or cave.

3.2 LABORATORY TESTING

Laboratory testing for the soil samples was performed by Delaware Department of Transportation Materials and Research Laboratory, an AMRL accredited lab. The laboratory testing consisted of determining the natural moisture content, the grain-size distribution, and the Atterberg limits for selected samples. Results of the classification testing and natural moisture content are summarized in Table 3.2. Grain-size distribution graphs are included in Appendix C.

Table 3.1 - Summary of Laboratory Classification Testing

Boring No. / Sample	Depth (ft)	NMC	LL	PL	% Fines	USCS	AASHTO
TB-1 / S-1	0.0	23.8	26.1	2.5	62.9	ML	A-4 (0)
TB-1 / S-2	2.0	14.7	24.5	7	53.5	CL-ML	A-4 (1)
TB-1 / S-3	4.0	14.8	21.1	NP	49	SM	A-4 (0)
TB-1 / S-4	6.0	11.0	22.4	5	28.7	SC-SM	A-2-4 (0)
TB-1 / S-5	8.0	7.0	24.2	7.4	19.2	GC-GM	A-2-4 (0)
TB-1 / S-6	10.0	6.2	NV	NP	13.1	SM	A-1-b
TB-1 / S-7	12.0	5.4	NV	NP	13.2	SM	A-2-4 (0)
TB-1 / S-8	14.0	4.9	NV	NP	15.5	SM	A-2-4 (0)
TB-1 / S-9	16.0	5.4	NV	NP	17.9	SM	A-2-4 (0)
TB-1 / S-10	18.0	7.1	NV	NP	18.3	SM	A-2-4 (0)
TB-1 / S-11	23.0	5.8	NV	NP	15.1	SM	A-2-4 (0)
TB-1 / S-12	28.0	6.7	NV	NP	16.1	SM	A-2-4 (0)
TB-1 / S-13	33.0	6.3	NV	NP	16.5	SM	A-2-4 (0)
TB-1 / S-14	38.0	3.4	NV	NP	19.8	SM	A-2-4 (0)
TB-1 / S-15	43.0	7.4	NV	NP	19.9	ML	A-2-4 (0)
TB-1 / S-16	48.0	12.4	NV	NP	69.5	ML	A-4 (0)
TB-2 / S-1	0.0	11.3	NV	NP	25.8	SM	A-2-4 (0)
TB-2 / S-2	2.0	16.8	24.4	4.5	85.1	CL-ML	A-4 (2)

Table 3.1 - Summary of Laboratory Classification Testing							
Boring No. / Sample	**Depth (ft)**	**NMC**	**LL**	**PL**	**% Fines**	**USCS**	**AASHTO**
TB-2 / S-3	4.0	19.6	24.7	NP	74.9	ML	A-4 (0)
TB-2 / S-4	6.0	20.7	25.9	4.8	76.5	CL-ML	A-4 (2)
TB-2 / S-5	8.0	17.6	25.3	5.2	57	CL-ML	A-4 (1)
TB-2 / S-6	10.0	11.5	NV	NP	20.6	SM	A-1-b
TB-2 / S-7	12.0	9.3	NV	NP	17.3	SM	A-1-b
TB-2 / S-8	14.0	8.8	NV	NP	15.3	SM	A-1-b
TB-2 / S-9	16.0	8.5	NV	NP	12.3	SM	A-1-b
TB-2 / S-10	18.0	8.7	NV	NP	13.5	SM	A-1-b
TB-2 / S-11	23.0	14.8	20.5	NP	63.4	ML	A-4 (0)
TB-2 / S-12	28.0	11.6	NV	NP	35.6	SM	A-4 (0)
TB-2 / S-13	33.0	18.3	NV	NP	43.4	SM	A-4 (0)
TB-2 / S-14	38.0	17	NV	NP	11.4	SP-SM	A-2-4 (0)
TB-2 / S-15	43.0	16.6	17.8	NP	66.2	ML	A-4 (0)
TB-2 / S-16	48.0	24.5	19.6	NP	52.6	ML	A-4 (0)
TB-3 / S-1	0.0	15.9	22	2.6	48.2	SM	A-4 (0)
TB-3 / S-2	2.0	14.7	25.6	8	52.9	CL	A-4 (2)
TB-3 / S-3	4.0	14.5	23.3	5.6	47.2	SC-SM	A-4 (0)
TB-3 / S-4	6.0	11.4	17.4	NP	29.5	SM	A-2-4 (0)
TB-3 / S-5	8.0	7.9	24	6.6	18.7	SC-SM	A-2-4 (0)
TB-3 / S-6	10.0	4.9	NV	NP	11.5	SP-SM	A-1-b
TB-3 / S-7	12.0	5.2	NV	NP	12.8	SM	A-2-4 (0)
TB-3 / S-8	14.0	5.1	NV	NP	11.3	SP-SM	A-2-4 (0)
TB-3 / S-9	16.0	5	NV	NP	13.1	SM	A-2-4 (0)
TB-3 / S-10	18.0	6.9	NV	NP	18	SM	A-2-4 (0)
TB-3 / S-11	23.0	6.5	NV	NP	20	SM	A-2-4 (0)

Table 3.1 - Summary of Laboratory Classification Testing							
Boring No. / Sample	**Depth (ft)**	**NMC**	**LL**	**PL**	**% Fines**	**USCS**	**AASHTO**
TB-3 / S-12	28.0	7.3	NV	NP	17.2	SM	A-2-4 (0)
TB-3 / S-13	33.0	6.5	NV	NP	20.2	SM	A-2-4 (0)
TB-3 / S-14	38.0	8.2	NV	NP	17.5	SM	A-2-4 (0)
TB-3 / S-15	43.0	6	NV	NP	19.8	SM	A-2-4 (0)
TB-3 / S-16	48.0	16.2	NV	NP	42.6	SM	A-4 (0)

USCS: Unified Soil Classification System
AASHTO: American Association of State Highway and Transportation Officials
NMC: Natural Moisture Content (%) **LL:** Liquid Limit **PL:** Plastic Limit
% Fines: Percent of Material Passing No. 200 Sieve

4 SUBSURFACE CONDITIONS

4.1 GEOLOGY

According to the Geologic Map of New Castle County, Delaware (2005), the project site is mapped within the Coastal Plain Physiographic Province. Natural soils in this region mostly consist of the Columbia Formation. The Columbia Formation typically consists of yellowish- to reddish-brown, fine to coarse, feldspathic quartz sand with varying amounts of gravel. Typically, cross-bedded with cross-sets ranging from a few inches to over 3-ft in thickness. Scattered beds of tan to reddish-gray clayey silt are common in this formation. In places, the upper 5 to 25-ft consists of grayish to reddish-brown silt to very fine sand overlying medium to coarse sand. Near base of unit, clasts of cobble to small boulder-size have been found in a gravel bed ranging from a few inches to three feet thick. The gravel fraction consists primarily of quartz with lesser amounts of chert. Clasts of sandstone, siltstone, and shale from the Valley and Ridge Province, and pegmatite, micaceous schist, and amphibolite from the Piedmont are present.

The Columbia Formation fills an eroded surface and ranges from less than 10-ft thick to over 100-ft. It is primarily a body of glacial outwash sediment.

4.2 SUBSURFACE CONDITIONS

The Test Boring Logs in Appendix B provide details related to the subsurface conditions encountered in the various borings. The stratification lines shown on the Test Boring Logs represent approximate transitions between material types. In situ, strata changes could occur gradually or at slightly different levels. Also, the borings depict conditions at particular locations and at the particular times indicated. Some conditions, particularly groundwater conditions between borings, could vary from the conditions encountered at the particular boring locations.

The borings encountered the following two strata:

Stratum I – Sand and Gravel: The natural soils at the site generally consist of medium dense to very dense, Silty SAND with varying percentages of Silt and Clay [A-2-4, A-4], or GRAVEL with varying percentages of clay [A-1-b]. The SPT N-values typically ranged from 12 to 87-bpf,

averaging 42-bpf. The SPT N_{60}-values typically ranged from 24 to 72-bpf, averaging 41-bpf. The natural moisture content averaged 9 percent and ranged from 3 to 18 percent.

Stratum II – Silt and Clay: This stratum consists of medium stiff to hard CLAY and SILT [A-4]. The SPT N-values typically ranged from 9 to 54-bpf, averaging 25-bpf. The SPT N_{60}-values typically ranged from 7 to 39-bpf, averaging 18-bpf. The natural moisture content averaged 17 percent and ranged from 7 to 25 percent. The liquid limits ranged from 17 to 26 and the plastic limits ranged from 2 to 8.

4.3 GROUNDWATER

Groundwater was encountered at a depth of 39-ft below the existing ground surface at Boring TB-2. Table 4.1 summarizes the groundwater elevations at the boring locations. Groundwater was not encountered in boring TB-1 and TB-3 during the field exploration. A more accurate determination of the hydrostatic water table would require the installation of perforated pipes or piezometers, which could be monitored over an extended period of time. The actual level of the hydrostatic water table and the amount and level of perched water should be anticipated to fluctuate throughout the year, depending upon variations in precipitation, surface runoff, infiltration, site topography, and drainage.

It is generally desirable to allow test borings to remain open for at least 24 hours after the completion of drilling and the removal of the drill tools and casing from the borehole. The purpose of this procedure is to allow the groundwater level in each borehole to recover from the effects of the test drilling. In clay soils, the length of time may extend several days before the groundwater level recovers to the pre-drilling elevation.

In addition to groundwater levels, the depth to the bottom of each borehole was measured to determine the susceptibility of the borehole to collapse or cave. This information provides the contractor with information regarding the "stand-up" time of the soil or the ability of the sides of an excavation to remain vertical or near vertical during trench excavation.

It was necessary to backfill certain borings immediately after the completion of drilling. The reasons for backfilling these borings was the borings were located in areas frequented by motor vehicles. In cases where the boring was immediately backfilled, the boring logs note the depth

where groundwater was observed either within the recovered soil sample, on the split barrel sampler, on the drill rods, or in the soil brought to the surface by the hollow stem augers.

Table 4.1 - Groundwater Levels

Boring No.	Initial Groundwater Depth (ft)	Final Groundwater Depth (ft)	Final Caved Depth (ft)
TB-1	NE	NE	10
TB-2	40	39	11
TB-3	NE	NE	13

NE: Not Encountered

5 EVALUATIONS AND RECOMMENDATIONS

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

5.1 DRILLED SHAFT FOUNDATIONS

5.1.1 Design Recommendations

Based on the foundation loads described in Section 2.2 of this report, the results of the subsurface exploration and our experience in this area, we recommend that the proposed cantilever signs be supported on drilled shaft foundations. Typically, the lateral loads rather than the vertical loads control the diameter and depth of the drilled shaft.

5.1.2 Design for Lateral Loads

Design of the laterally loaded drilled shafts was performed using AllPile, considering the soil conditions represented on the test boring logs. Each drilled shaft was analyzed individually with the soil conditions represented on the test boring logs. The design was completed per the DelDOT Bridge Design Manual, 2017.

We estimate a 54-inch diameter drilled shaft with a minimum 20-ft embedment into natural ground will be required to support each sign structure. Our design considers a 2(H):1(V) slope at the ground surface of the structure and a 3-ft stick up of the drilled shaft above the finished ground surface. If the stick-up length is greater, or the slope is steeper, the shaft length will need to be reviewed and possibly revised. With these conditions, the deflection of the proposed sign structure drilled shafts does not exceed the design criteria of 1-inch for service loading conditions.

5.1.3 Construction and Monitoring Recommendations

We recommend that the installation of the drilled shafts be monitored by a Geotechnical Engineer or Engineering Geologist. The installation monitoring should be supervised by a Geotechnical Engineer licensed in the State of Delaware. During the installation of the drilled shafts, the depth of embedment, the diameter of the shafts, and appropriateness of the bearing materials should be verified.

A full-depth temporary protective steel casing will be required to maintain an open excavation due to sandy soil. This casing can be extracted as the concreting operation progresses. An alternative to the casing method would be to use drilling slurry, but we recommend at least the uppermost 10 to 15-ft of the excavation be supported with a casing.

Our experience and current research in the field indicates that concrete placement inside a dry drilled shaft can be placed by the “free fall” method without affecting the strength and quality of the concrete. The concrete should “free fall” without hitting the sides of the casing or reinforcing and there should be no more than 3-inches of water in the bottom of the drilled shaft. The use of a hopper or other suitable device is recommended to control concrete placement. The placement of concrete in the cased shaft should proceed until the concrete level is above the external fluid level and should be maintained above this level throughout casing removal. If water is present in the drilled shaft at the time of concrete placement, a tremie tube should be used to place the concrete below the level of water.

If a slurry solution is used during construction, the tremie tube method should be used during concrete placement. During excavation of the drilled shaft and just prior to the placement of concrete, the slurry, if used should be monitored for its density, viscosity, and pH value. The bottom of the excavation should be inspected to verify that all the soil and sediments have been removed from the excavation prior to the placement of concrete. To avoid excessive caking and a reduction in skin friction, the concreting operations should be completed within 8-hours of completing the excavation or a polymer slurry should be used.

Crosshole Sonic Logging (CSL) should be used to verify the structural integrity of the drilled shafts after the concrete has cured. CSL is a nondestructive technique used to determine the soundness of concrete within the drilled shaft inside the rebar cage. A minimum of one CSL tube per foot of shaft diameter should be installed in each drilled shaft inside the rebar cage. CSL testing detects defects such as soil intrusions, necking, sand lenses, and voids within the

foundation concrete. Where defects exist, CSL will determine the extent, nature, depth and lateral location of the defects so that remedial measures can be implemented. If anomalies are detected, it may be necessary to core the suspect areas. Coring through the drilled pier should be performed using a diamond core bit to retrieve samples to confirm the CSL testing results and for unconfined compression tests. The causes of the defects if present should be investigated to avoid installation of additional defective drilled shafts during the completion of the foundations.

Drilled shafts should be constructed and tested in accordance with Section 606 of the Delaware Department of Transportation *Standard Specifications for Road and Bridge Construction, 2016*.

5.2 DEWATERING AND DRAINAGE

If groundwater is encountered during construction, appropriate dewatering should be carried out so that construction will be performed in a relatively dry condition. The borings did not indicate static groundwater within the limits of the anticipated depth of excavations. Water trapped in sandy seams could cause construction difficulties. Pumping or using a slurry may be needed to stabilize the excavation even if casing is used. The site drainage should be such that the runoff onto adjacent properties is controlled properly.

6 BASIS OF RECOMMENDATIONS

This report has been prepared to present the geotechnical conditions at the site at the time of the subsurface exploration was conducted and the recommended method of founding the proposed construction. Adequate recommendations have been provided to serve as a basis for design and preparation of plans and specifications. The opinions, conclusions and recommendations contained in this report are based upon our professional judgment and generally accepted principles of geotechnical engineering. Inherent to these are the assumptions that the earthwork and foundation construction should be monitored and tested by an engineering technician acting under the guidance of a geotechnical engineer licensed in the State of Delaware.

These analyses and recommendations are, of necessity, based on the information available at the time of the actual writing of the report and on the site conditions, surface and subsurface, that existed at the time the exploratory borings were drilled. Further, assumptions have been made regarding the limited exploratory borings, in relation to both the lateral extent of the site conditions and to the depth.

The nature and extent of variations between borings may not become evident until construction. If variations from the anticipated conditions are encountered, it may be necessary to revise the recommendations in this report.

Our professional services have been performed in accordance with generally accepted engineering principles and practices; no other warranty, expressed or implied, is made. RK&K assumes no responsibility for interpretations made by others on the work performed by RK&K.

We recommend that this report be made available in its entirety to contractors for informational purposes only. The boring logs and laboratory test data contained in this report represent an integral part of this report and incorrect interpretation of the data may occur if the attachments are separated from the text. The project plans or specifications should include the following note:

A geotechnical report has been prepared for this project by Rummel, Klepper & Kahl, LLP. This report is for informational purposes only and shall not be considered to be part of the contract documents. The opinions and conclusions of RK&K represent RK&K's interpretation of the subsurface conditions and the planned construction at the time that such report was prepared. In addition, the data in such report may not be adequate for any estimating purposes of any contractor, subcontractor, consultant, or

subconsultant. Furthermore, any contractor, subcontractor, consultant, or subconsultant that makes use of this geotechnical report or any information set forth therein shall be deemed to release, discharge, and relinquish any claims of any kind that it may have now or in the future against RK&K arising out of or owing to such use by contractor, subcontractor, consultant, or subconsultant.

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Appendix A

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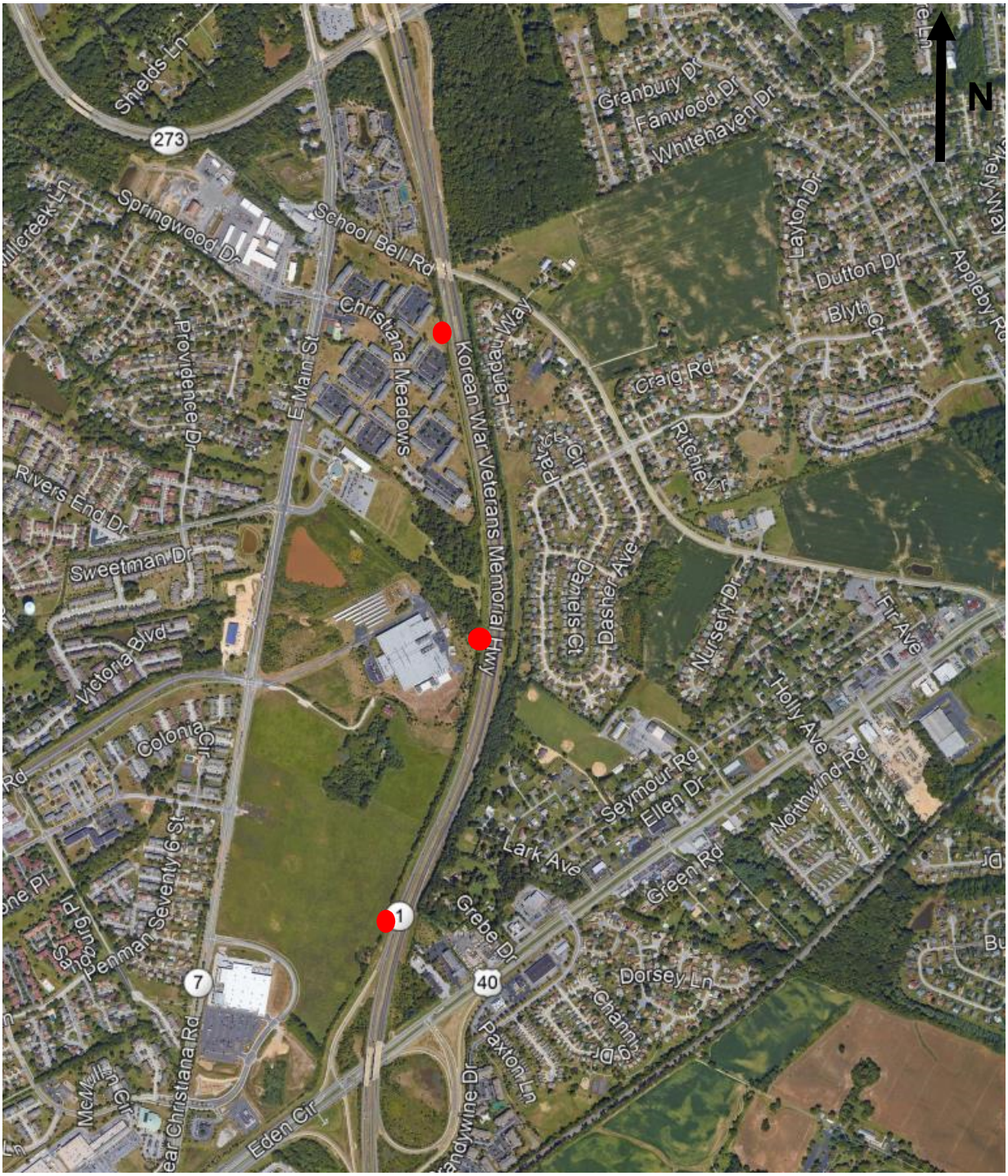


MAP DATA COPYRIGHT 2019 GOOGLE

APPROXIMATE CANTILEVER SIGN LOCATION

RK&K

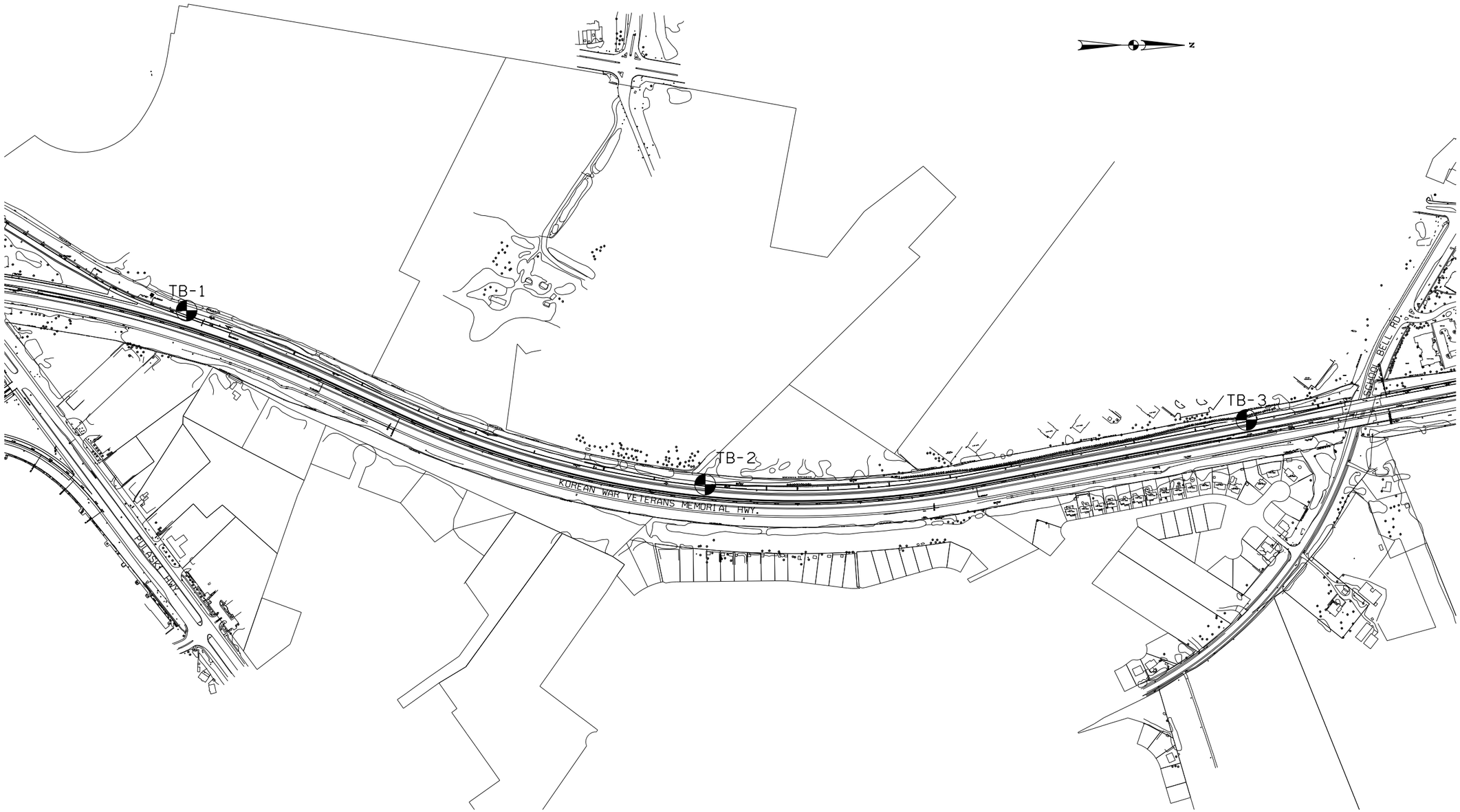
700 East Pratt Street, Suite 500
Baltimore, Maryland 21202
(410) 728-2900

SR 1 Southbound Auxiliary Lane

Vicinity Map

Figure No: A-1

DRAWN BY:	APPROVED BY:	SCALE:	DATE:	COMM. NO.
KPR	SAB	NTS	February 2019	11009.007



BORING LOCATION

500′ 250′ 0 500′ 1000′

Scale 1"=500′

RK&K
Rummel, Klepper & Kahl, LLP
Engineers | Construction Managers | Planners | Scientist
700 East Pratt Street, Suite 500
Baltimore, Maryland 21202-4919
410.728.2900

SR 1 SOUTHBOUND AUXILIARY LANE

BORING LOCATION PLAN

DRAWN BY	APPROVED BY	SCALE	DATE
TR	EMK	AS SHOWN	01/2019

FIGURE NO. A-2

COMMISSION. NO. 11009.007

SHEET NO. 01 of 01

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Appendix B

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STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

BORING TB-1

Project Name: SR1 Southbound
Location: New Castle County, DE
State Contract #: T201811001
Federal Contract #:
Station/Offset:
Northing: 597372.315
Easting: 589666.541
Boring Surface Elev.:
Reference:
Date Started: 9/13/18
Date Completed: 9/13/18

Wt. of Sample Hammer: 140 **Lbs.**
Type of: **D-Sampler:** Split Barrel **O.D.**
S-Sampler: **O.D.**
U-Sampler: **O.D.**
Core Bit: **O.D.**

Average Fall: 30 **IN.**
O.D. of Sampler: 2 **IN.**
O.D. of Samp. Tube: **IN.**
O.D. of Samp. Tube: **IN.**
O.D. of Rock Core: **IN.**

Hollow Stem Auger Diameter: 3 1/4" **Inches**
From Depth of: 0.0 **To:** 50.0
Mud Rotary:
From Depth of: **To:**

Water Level Readings

Date	Depth to Water (ft)	Caved Depth (ft)
9/13/18	N/A	
9/13/18	N/A	10.0

Boring Contractor: Hillis Carnes Engineering Associates
Equipment/Rig Type:
Driller:
Logged By:

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
		1	0.0'	2 4 7 7	Wet stiff brown fine sandy silt w/some coarse sand, trace of clay.	A-4(0)	
			2.0'		12" RECOVERY		
2.5		2	2.0'	5 4 10 13	Wet stiff brown clayey fine sandy silt w/some coarse sand, trace of fine gravel.	A-4(1)	
			4.0'		18" RECOVERY		
		3	4.0'	7 12 16 20	Wet very stiff brown fine sandy silt w/ some coarse sand and fine gravel.	A-4(0)	
5			6.0'		18" RECOVERY		
		4	6.0'	12 17 22 16	Wet dense brown silty fine gravel w/some coarse to fine sand and clay.	A-2-4(0)	
7.5			8.0'		18" RECOVERY		
		5	8.0'	18 20 12 14	Wet dense brown clayey fine gravel w/some coarse to fine sand and silt.	A-2-4(0)	
10			10.0'		18" RECOVERY		
		6	10.0'	25 20 17 12	Wet dense brown fine to coarse sand and fine gravel w/some silt.	A-1-b	
			12.0'		18" RECOVERY		
12.5		7	12.0'	17 25 20 28	Wet dense brown fine sand w/some coarse sand and silt.	A-2-4(0)	

Remarks:

Reviewed By: Hany Fekry
Soils Supervisor: Aaron Wieczorek

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STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

Project Name: SR1 Southbound
State Contract: T201811001

Boring No.: TB-1

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
			14.0'		18" RECOVERY		
		8	14.0'	20 33 37 44	Wet very dense brown fine sand w/some coarse sand and silt.	A-2-4(0)	
15							
			16.0'		18" RECOVERY		
		9	16.0'	30 39 46 50/3	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
17.5							
			18.0'		18" RECOVERY		
		10	18.0'	15 20 28 26	Wet dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
20			20.0'		18" RECOVERY		
22.5							
		11	23.0'	20 34 39 48	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
25			25.0'		18" RECOVERY		
27.5							
		12	28.0'	22 28 34 48	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
30			30.0'		18" RECOVERY		
32.5							
		13	33.0'	25 16 22 18	Wet dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
35			35.0'		18" RECOVERY		

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

Project Name: SR1 Southbound
State Contract: T201811001

Boring No.: TB-1

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
37.5							
40		14	38.0' 40.0'	7 11 22 15	Wet dense brown fine sand w/some silt, trace of coarse sand and fine gravel. 20" RECOVERY	A-2-4(0)	
42.5							
45		15	43.0' 45.0'	14 18 29 26	Wet dense brown fine sand w/some silt, trace of coarse sand and fine gravel. 20" RECOVERY	A-2-4(0)	
47.5							
50		16	48.0' 50.0'	8 17 22 25	Wet hard brown fine sandy silt w/trace coarse sand. 12" RECOVERY	A-4(0)	
52.5					End Boring		
55							
57.5							

KEY TO SYMBOLS

This is for informational purposes only.

Symbol	Description
Strata symbols	
	Silty soils
	Poorly graded, silty or clayey sands and gravel
	Well graded gravels and sands

Notes:

1. Exploratory borings were drilled using a 3 1/4 - inch diameter hollow stem auger.

2. These logs are subject to the limitations, conclusions, and recommendations in this report.

3. All blow counts are uncorrected.

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

BORING TB-2

Project Name: SR1 Southbound
Location: New Castle County, DE
State Contract #: T201811001
Federal Contract #:
Station/Offset:
Northing: 599861.926
Easting: 590501.423
Boring Surface Elev.:
Reference:
Date Started: 9/11/18
Date Completed: 9/11/18

Wt. of Sample Hammer: 140 Lbs.
Type of: D-Sampler: Split Barrel O.D.
S-Sampler: O.D.
U-Sampler: O.D.
Core Bit: O.D.

Average Fall: 30 IN.
O.D. of Sampler: 2 IN.
O.D. of Samp. Tube: IN.
O.D. of Samp. Tube: IN.
O.D. of Rock Core: IN.

Hollow Stem Auger Diameter: 3 1/4" Inches
From Depth of: 0.0 **To:** 50.0
Mud Rotary:
From Depth of: **To:**

Water Level Readings

Date	Depth to Water (ft)	Caved Depth (ft)
9/11/18	40.0	
9/11/18	39.0	11.0

Boring Contractor: Hillis Carnes Engineering Associates
Equipment/Rig Type:
Driller:
Logged By:

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
		1	0.0'	3 5 7 6	Moist medium dense brown silty coarse to fine sand w/some fine gravel.	A-2-4(0)	
			2.0'		24" RECOVERY		
2.5		2	2.0'	12 12 10 11	Wet very stiff brown silt w/some clay, trace of fine to coarse sand.	A-4(2)	
			4.0'		24" RECOVERY		
		3	4.0'	6 8 9 10	Wet very stiff brown silt w/some fine sand, trace of coarse sand.	A-4(0)	
5			6.0'		24" RECOVERY		
		4	6.0'	2 3 6 6	Wet stiff brown silt w/some fine sand and clay, trace of coarse sand.	A-4(2)	
7.5			8.0'		24" RECOVERY		
		5	8.0'	2 2 7 9	Wet stiff brown coarse sandy silt w/some fine sand and clay.	A-4(1)	
10			10.0'		24" RECOVERY		
		6	10.0'	5 7 10 10	Wet medium dense brown silty coarse to fine sand and fine gravel.	A-1-b	
			12.0'		24" RECOVERY		
12.5		7	12.0'	6 10 12 12	Wet medium dense brown coarse sand w/ some fine sand, fine gravel and silt.	A-1-b	

Remarks:

Reviewed By: Hany Fekry
Soils Supervisor: Aaron Wieczorek

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

Project Name: SR1 Southbound

State Contract: T201811001

Boring No.: TB-2

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
			14.0'		24" RECOVERY		
		8	14.0'	5 7 10 10	Wet medium dense brown coarse to fine sand w/some silt, trace of fine gravel.	A-1-b	
15							
			16.0'		24" RECOVERY		
		9	16.0'	7 11 14 18	Wet medium dense brown coarse sand w/ some fine sand and silt, trace of fine gravel.	A-1-b	
17.5							
			18.0'		24" RECOVERY		
		10	18.0'	8 10 20 20	Wet dense brown coarse sand and fine gravel w/some fine sand and silt.	A-1-b	
20			20.0'		24" RECOVERY		
22.5							
		11	23.0'	25 24 30 39	Wet hard brown fine sandy silt w/trace coarse sand.	A-4(0)	
25			25.0'		24" RECOVERY		
27.5							
		12	28.0'	6 21 21 20	Wet hard brown fine sandy silt w/trace coarse sand.	A-4(0)	
30			30.0'		24" RECOVERY		
32.5							
		13	33.0'	13 10 13 20	Wet very stiff brown fine sandy silt.	A-4(0)	
35			35.0'		24" RECOVERY		

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

Project Name: SR1 Southbound

State Contract: T201811001

Boring No.: TB-2

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
37.5							
40	▽	14	38.0' 40.0'	10 16 27 31	Wet dense brown fine to coarse sand w/some silt. 18" RECOVERY	A-2-4(0)	
42.5							
45		15	43.0' 45.0'	5 10 16 20	Wet very stiff brown fine sandy silt w/ trace coarse sand. 24" RECOVERY	A-4(0)	
47.5							
50		16	48.0' 50.0'	6 26 28 40	Wet hard brown fine sandy silt w/trace coarse sand. 24" RECOVERY	A-4(0)	
52.5					End Boring		
55							
57.5							

KEY TO SYMBOLS

This is for informational purposes only.

Symbol Description

Strata symbols

Poorly graded, silty or clayey sands and gravel

Silty soils

Well graded gravels and sands

Misc. Symbols

Description not given for: "WATER2"

Notes:

1. Exploratory borings were drilled using a 3 1/4 - inch diameter hollow stem auger.

2. These logs are subject to the limitations, conclusions, and recommendations in this report.

3. All blow counts are uncorrected.

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

BORING TB-3

Project Name: SR1 Southbound
Location: New Castle County, DE
State Contract #: T201811001
Federal Contract #:
Station/Offset:
Northing: 602460.724
Easting: 590191.185
Boring Surface Elev.:
Reference:
Date Started: 9/13/18
Date Completed: 9/13/18

Wt. of Sample Hammer: 140 Lbs.
Type of: D-Sampler: Split Barrel O.D.
S-Sampler: O.D.
U-Sampler: O.D.
Core Bit: O.D.

Average Fall: 30 IN.
O.D. of Sampler: 2 IN.
O.D. of Samp. Tube: IN.
O.D. of Samp. Tube: IN.
O.D. of Rock Core: IN.

Hollow Stem Auger Diameter: 3 1/4" Inches
Mud Rotary:

From Depth of: 0.0 **To:** 50.0
From Depth of: **To:**

Water Level Readings

Date	Depth to Water (ft)	Caved Depth (ft)
9/13/18	N/A	
9/13/18	N/A	13.0

Boring Contractor: Hillis Carnes Engineering Associates
Equipment/Rig Type:
Driller:
Logged By:

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
		1	0.0'	3 5 9 6	Wet stiff brown fine sandy silt w/some coarse sand, trace of fine gravel and clay.	A-4(0)	
			2.0'		18" RECOVERY		
2.5		2	2.0'	3 7 13 18	Wet very stiff brown clayey fine sandy silt w/ some coarse sand, trace of fine gravel.	A-4(2)	
			4.0'		18" RECOVERY		
		3	4.0'	5 10 20 14	Wet hard brown clayey fine sandy silt w/ some coarse sand and fine gravel.	A-4(0)	
5			6.0'		18" RECOVERY		
		4	6.0'	11 14 19 13	Wet dense brown silty fine sand and fine gravel w/some coarse sand.	A-2-4(0)	
7.5			8.0'		13" RECOVERY		
		5	8.0'	16 11 13 10	Wet medium dense brown clayey coarse sandy fine gravel w/some fine sand and silt.	A-2-4(0)	
10			10.0'		18" RECOVERY		
		6	10.0'	22 19 11 16	Wet dense brown fine sand and fine gravel w/ some coarse sand and silt.	A-1-b	
			12.0'		18" RECOVERY		
12.5		7	12.0'	11 20 25 30	Wet dense brown fine sand w/some coarse sand and silt.	A-2-4(0)	

Remarks:

Reviewed By: Hany Fekry
Soils Supervisor: Aaron Wieczorek

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

Project Name: SR1 Southbound

State Contract: T201811001

Boring No.: TB-3

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
			14.0'		18" RECOVERY		
		8	14.0'	14 28 32 48	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
15							
			16.0'		18" RECOVERY		
		9	16.0'	27 36 48 50	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
17.5							
			18.0'		18" RECOVERY		
		10	18.0'	12 17 23 23	Wet dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
20			20.0'		16" RECOVERY		
22.5							
		11	23.0'	16 28 32 40	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
25			25.0'		18" RECOVERY		
27.5							
		12	28.0'	29 37 50/7	Wet very dense brown fine sand w/some silt, trace of fine gravel.	A-2-4(0)	
30			30.0'		14" RECOVERY		
32.5							
		13	33.0'	48 50/14	Wet very dense brown fine sand w/some silt, trace of coarse sand.	A-2-4(0)	
35			35.0'		4" RECOVERY		

This is for informational purposes only.

STATE OF DELAWARE
DEPARTMENT OF TRANSPORTATION
MATERIALS AND RESEARCH

Project Name: SR1 Southbound
State Contract: T201811001

Boring No.: TB-3

Depth (ft.)	Water Level	No.	Sample Depth	Blows/6"	Sample Description	AASHTO Class.	Remarks
37.5							
40		14	38.0' 40.0'	4 14 19 11	Wet dense brown fine sand w/some silt, trace of coarse sand. 20" RECOVERY	A-2-4(0)	
42.5							
45		15	43.0' 45.0'	8 20 25 32	Wet dense brown fine sand w/some silt, trace of coarse sand. 16" RECOVERY	A-2-4(0)	
47.5							
50		16	48.0' 50.0'	13 22 31 28	Wet hard brown fine sandy silt w/trace coarse sand. 13" RECOVERY	A-4(0)	
52.5					End Boring		
55							
57.5							

KEY TO SYMBOLS

This is for informational purposes only.

Symbol	Description
Strata symbols	
	Silty soils
	Poorly graded, silty or clayey sands and gravel
	Well graded gravels and sands

Notes:

1. Exploratory borings were drilled using a 3 1/4 - inch diameter hollow stem auger.

2. These logs are subject to the limitations, conclusions, and recommendations in this report.

3. All blow counts are uncorrected.

This is for informational purposes only.

FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION

COHESIONLESS SOILS (Silt, Sand, Gravel, and Combinations)

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

Relative Proportions

Descriptive Term	Percent
Trace	1 to 10
Little	11 to 20
Some	21 to 35
And	35 to 50

Particle Size Identification

Boulders	12 inches diameter or more
Cobbles	3 to 12 inch diameter
Gravel	Coarse: 3/4 to 3 inch diameter
	Fine: 1/4 to 3/4 inch diameter
Sand	Coarse: 2 mm to 1/4 inch (diameter of pencil lead)
	Medium: 0.425 to 2 mm (diameter of broom straw)
	Fine: 0.075 to 0.425 mm (diameter of human hair)
Silt	0.005 to 0.075 mm (Cannot see particles)

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
Hard	31 blows/ft or more

Plasticity

Degree of Plasticity	Plasticity Index
No to Slight	0 - 4
Slight	5 - 7
Medium	8 - 22
High to Very High	over 22
High to Very High	over 22

Soil Classifications on Test Boring Logs are made by visual-manual inspection of samples. Soil classification symbols using lower case letters are based on a visual-manual classification. Soil classification symbols using upper case letters are based on laboratory testing.

Standard Penetration Test

Driving a 2.0-inch OD, 1 3/8-inch ID sampler a distance of 1.0-foot into undisturbed soil with a 140-lb hammer free falling a distance of 30.0-inches. It is required to drive the spoon 6.0-inches to seat into undisturbed soil, then perform the test. The number of hammer blows for seating and making the test are recorded each 6.0-inches of penetration on the Test boring Log (Example 6-8-9, 8+9=17 blows/ft). (ASTM D-1586)

Strata Changes

In the column "Soil Descriptions" on the Test Boring Logs, the horizontal lines represent strata changes. A solid line represents an actually observed change, a dashed line represents an estimated change.

Ground Water

Observations were made at the time indicated. Porosity of soil strata, weather conditions, site topography, etc. may cause changes in the water levels indicated on the Test Boring Log.

RK&K
700 East Pratt Street, Suite 500
Baltimore, Maryland 21202
(410) 728-2900

Title:	Figure No:
FIELD CLASSIFICATION SYSTEM FOR SOIL EXPLORATION	B-1

Drawn:	Approved:	Date:	Comm No:
JJV	GKG	August, 2015	General

Appendix C

This is for informational purposes only.

Boring Test number	Sample Number	Depth (feet)	Material description	Liquid limit	Plasticity index	Natural moisture %	USCS	AASHTO classification	Percent < than the #10 sieve	Percent < than the #200 sieve	Blow count #1	Blow count #2	Blow count #3	Blow count #4
TB-1														
	1		Wet stiff brown fine sandy silt w/some coarse sand, trace of clay.	26.1	2.5	23.8	ML	A-4(0)	100	62.9	2	4	7	7
	2	2	Wet stiff brown clayey fine sandy silt w/some coarse sand, trace of fine gravel.	24.5	7	14.7	CL-ML	A-4(1)	95.1	53.5	5	4	10	13
	3	4	Wet very stiff brown fine sandy silt w/ some coarse sand and fine gravel.	21.2	NP	14.8	SM	A-4(0)	84.2	49	7	12	16	20
	4	6	Wet dense brown silty fine gravel w/some coarse to fine sand and clay.	22.4	5	11	SC-SM	A-2-4(0)	63.8	28.7	12	17	22	16
	5	8	Wet dense brown clayey fine gravel w/some coarse to fine sand and silt.	24.2	7.4	7	GC-GM	A-2-4(0)	43.7	19.2	18	20	12	14
	6	10	Wet dense brown fine to coarse sand and fine gravel w/some silt.	NV	NP	6.2	SM	A-1-b	62	13.1	25	20	17	12
	7	12	Wet dense brown fine sand w/some coarse sand and silt.	NV	NP	5.4	SM	A-2-4(0)	100	13.2	17	25	20	28
	8	14	Wet very dense brown fine sand w/some coarse sand and silt.	NV	NP	4.9	SM	A-2-4(0)	100	15.5	20	33	37	44
	9	16	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	5.4	SM	A-2-4(0)	100	17.9	30	39	46	50/3
	10	18	Wet dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	7.1	SM	A-2-4(0)	100	18.3	15	20	28	26
	11	23	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	5.8	SM	A-2-4(0)	100	15.1	20	34	39	48
	12	28	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	6.7	SM	A-2-4(0)	100	16.1	22	28	34	48
	13	33	Wet dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	6.3	SM	A-2-4(0)	100	16.5	25	16	22	18
	14	38	Wet dense brown fine sand w/some silt, trace of coarse sand and fine gravel.	NV	NP	6.4	SM	A-2-4(0)	95.8	19.8	7	11	22	15
	15	43	Wet dense brown fine sand w/some silt, trace of coarse sand and fine gravel.	NV	NP	7.4	SM	A-2-4(0)	97.1	19.9	14	18	29	26
	1			26.1	2.5	23.8	ML	A-4(0)	100	62.9	2	4	7	7
	16	48	Wet hard brown fine sandy silt w/trace coarse sand.	NV	NP	12.4	ML	A-4(0)	100	69.5	8	17	22	25
		50	End Boring											
TB-2														
	1		Moist medium dense brown silty coarse to fine sand w/some fine gravel.	NV	NP	11.3	SM	A-2-4(0)	88.4	25.8	3	5	7	6
	2	2	Wet very stiff brown silt w/some clay, trace of fine to coarse sand.	24.4	4.5	16.8	CL-ML	A-4(2)	100	85.1	12	12	10	11
	3	4	Wet very stiff brown silt w/some fine sand, trace of coarse sand.	24.7	NP	19.6	ML	A-4(0)	100	74.9	6	8	9	10
	4	6	Wet stiff brown silt w/some fine sand and clay, trace of coarse sand.	25.9	4.8	20.7	CL-ML	A-4(2)	100	76.5	2	3	6	6
	5	8	Wet stiff brown coarse sandy silt w/some fine sand and clay.	25.3	5.2	17.6	CL-ML	A-4(1)	100	57	2	2	7	9
	6	10	Wet medium dense brown silty coarse to fine sand and fine gravel.	NV	NP	11.5	SM	A-1-b	78.6	20.6	5	7	10	10
	7	12	Wet medium dense brown coarse sand w/some fine sand, fine gravel and silt.	NV	NP	9.3	SM	A-1-b	89.3	17.3	6	10	12	12
	8	14	Wet medium dense brown coarse to fine sand w/some silt, trace of fine gravel.	NV	NP	8.8	SM	A-1-b	92.4	15.3	5	7	10	10
	9	16	Wet medium dense brown coarse sand w/some fine sand and silt, trace of fine gravel.	NV	NP	8.5	SM	A-1-b	90.3	12.3	7	11	14	18
	10	18	Wet dense brown coarse sand and fine gravel w/some fine sand and silt.	NV	NP	8.7	SM	A-1-b	69.8	13.5	8	10	20	20
	11	23	Wet hard brown fine sandy silt w/trace coarse sand.	20.5	NP	14.8	ML	A-4(0)	100	63.4	25	24	30	39
	12	28	Wet hard brown fine sandy silt w/trace coarse sand.	NV	NP	11.6	SM	A-4(0)	100	35.6	6	21	21	20
	13	33	Wet very stiff brown fine sandy silt.	NV	NP	18.3	SM	A-4(0)	100	43.4	13	10	13	20
	14	38	Wet dense brown fine to coarse sand w/some silt.	NV	NP	17	SP-SM	A-2-4(0)	100	11.4	10	16	27	31
	15	43	Wet very stiff brown fine sandy silt w/ trace coarse sand.	17.8	NP	16.6	ML	A-4(0)	100	66.2	5	10	16	20
	16	48	Wet hard brown fine sandy silt w/trace coarse sand.	19.6	NP	24.5	ML	A-4(0)	100	52.6	6	26	28	40
		50	End Boring											
TB-3														
	1		Wet stiff brown fine sandy silt w/some coarse sand, trace of fine gravel and clay.	22	2.6	15.9	SM	A-4(0)	90.5	48.2	3	5	9	6
	2	2	Wet very stiff brown clayey fine sandy silt w/some coarse sand, trace of fine gravel.	25.6	8	14.7	CL	A-4(2)	95.8	52.9	3	7	13	18
	3	4	Wet hard brown clayey fine sandy silt w/some coarse sand and fine gravel.	23.3	5.6	14.5	SC-SM	A-4(0)	88.2	47.2	5	10	20	14
	4	6	Wet dense brown silty fine sand and fine gravel w/some coarse sand.	17.4	NP	11.4	SM	A-2-4(0)	69.4	29.5	11	14	19	13
	5	8	Wet medium dense brown clayey coarse sandy fine gravel w/some fine sand and silt.	24	6.6	7.9	SC-SM	A-2-4(0)	57	18.7	16	11	13	10
	6	10	Wet dense brown fine sand and fine gravel w/some coarse sand and silt.	NV	NP	4.9	SP-SM	A-1-b	60.3	11.5	22	19	11	16

This is for informational purposes only.

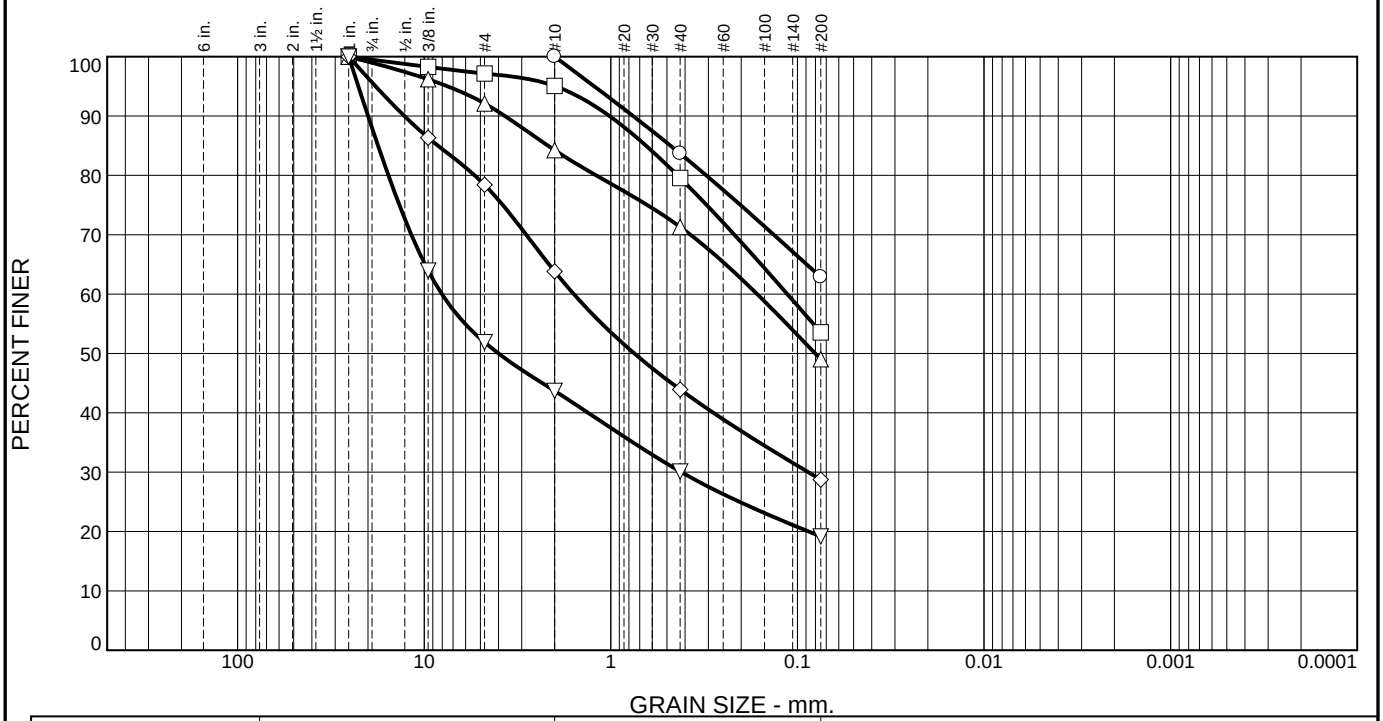
Boring Test number	Sample Number	Depth (feet)	Material description	Liquid limit	Plasticity index	Natural moisture %	USCS	AASHTO classification	Percent < than the #10 sieve	Percent < than the #200 sieve	Blow count #1	Blow count #2	Blow count #3	Blow count #4
	7	12	Wet dense brown fine sand w/some coarse sand and silt.	NV	NP	5.2	SM	A-2-4(0)	100	12.8	11	20	25	30
	8	14	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	5.1	SP-SM	A-2-4(0)	100	11.3	14	28	32	48
	9	16	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	5	SM	A-2-4(0)	100	13.1	27	36	48	50
	10	18	Wet dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	6.9	SM	A-2-4(0)	100	18	12	17	23	23
	11	23	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	6.5	SM	A-2-4(0)	100	20	16	28	32	40
	12	28	Wet very dense brown fine sand w/some silt, trace of fine gravel.	NV	NP	7.3	SM	A-2-4(0)	100	17.2	29	37	50/7	
	13	33	Wet very dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	6.5	SM	A-2-4(0)	100	20.2	48	50/14		
	14	38	Wet dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	8.2	SM	A-2-4(0)	100	17.5	4	14	19	11
	15	43	Wet dense brown fine sand w/some silt, trace of coarse sand.	NV	NP	6	SM	A-2-4(0)	100	19.8	8	20	25	32
	16	48	Wet hard brown fine sandy silt w/trace coarse sand.	NV	NP	16.2	SM	A-4(0)	100	42.6	13	22	31	28
		50	End Boring											

Project Name: SR1 Southbound- New Castle County, DE

State Contract #: T201811001

This is for informational purposes only.

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	16.3	20.8	62.9	
□	0.0	4.9	15.5	26.1	53.5	
△	0.0	15.8	12.9	22.3	49.0	
◇	0.0	36.2	19.9	15.2	28.7	
▽	0.0	56.3	13.6	10.9	19.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_C	C_u
○	26.1	23.6	0.4786							
□	24.5	17.5	0.6476	0.1132						
△	21.2	NP	2.1714	0.1644	0.0803					
◇	22.4	17.4	8.4432	1.5789	0.7482	0.0875				
▽	24.2	16.8	17.6826	8.0406	4.0010	0.4188				

Material Description	USCS	AASHTO
○ Wet stiff brown fine sandy silt w/some coarse sand, trace of clay.	ML	A-4(0)
□ Wet stiff brown clayey fine sandy silt w/some coarse sand, trace of fine gravel.	CL-ML	A-4(1)
△ Wet very stiff brown fine sandy silt w/ some coarse sand and fine gravel.	SM	A-4(0)
◇ Wet dense brown silty fine gravel w/some coarse to fine sand and clay.	SC-SM	A-2-4(0)
▽ Wet dense brown clayey fine gravel w/some coarse to fine sand and silt.	GC-GM	A-2-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-1 **Depth:** 0.0 **Sample Number:** 1

□ **Source of Sample:** TB-1 **Depth:** 2.0 **Sample Number:** 2

△ **Source of Sample:** TB-1 **Depth:** 4.0 **Sample Number:** 3

◇ **Source of Sample:** TB-1 **Depth:** 6.0 **Sample Number:** 4

▽ **Source of Sample:** TB-1 **Depth:** 8.0 **Sample Number:** 5

Remarks:

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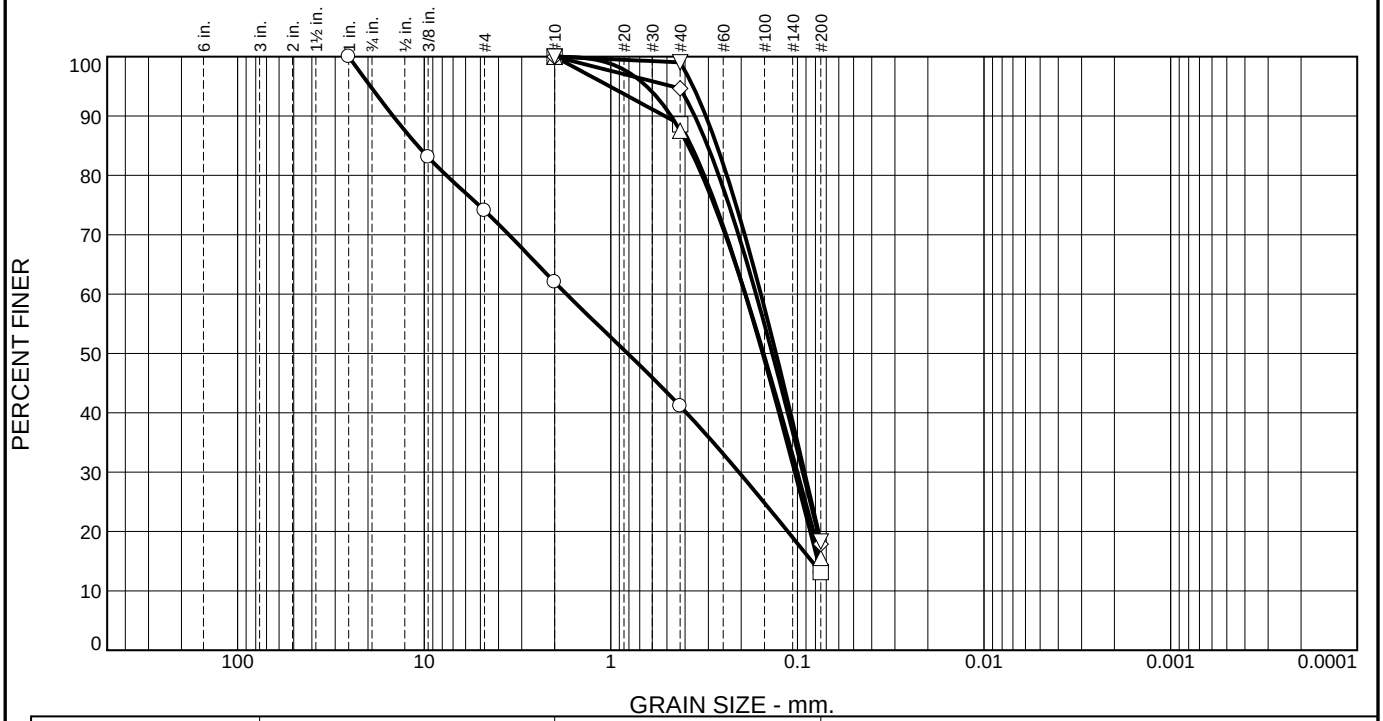
Figure

This is for informational purposes only.

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	38.0	20.9	28.0	13.1	
□	0.0	0.0	11.4	75.4	13.2	
△	0.0	0.0	12.5	72.0	15.5	
◇	0.0	0.0	5.3	76.8	17.9	
▽	0.0	0.0	1.0	80.7	18.3	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	10.8430	1.7283	0.8127	0.2060	0.0838			
□	NV	NP	0.3711	0.1904	0.1536	0.1032	0.0776			
△	NV	NP	0.3846	0.1901	0.1518	0.1001				
◇	NV	NP	0.3031	0.1666	0.1363	0.0935				
▽	NV	NP	0.2701	0.1569	0.1302	0.0916				

Material Description	USCS	AASHTO
○ Wet dense brown fine to coarse sand and fine gravel w/some silt.	SM	A-1-b
□ Wet dense brown fine sand w/some coarse sand and silt.	SM	A-2-4(0)
△ Wet very dense brown fine sand w/some coarse sand and silt.	SM	A-2-4(0)
◇ Wet very dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
▽ Wet dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-1 **Depth:** 10.0 **Sample Number:** 6

□ **Source of Sample:** TB-1 **Depth:** 12.0 **Sample Number:** 7

△ **Source of Sample:** TB-1 **Depth:** 14.0 **Sample Number:** 8

◇ **Source of Sample:** TB-1 **Depth:** 16.0 **Sample Number:** 9

▽ **Source of Sample:** TB-1 **Depth:** 18.0 **Sample Number:** 10

Remarks:

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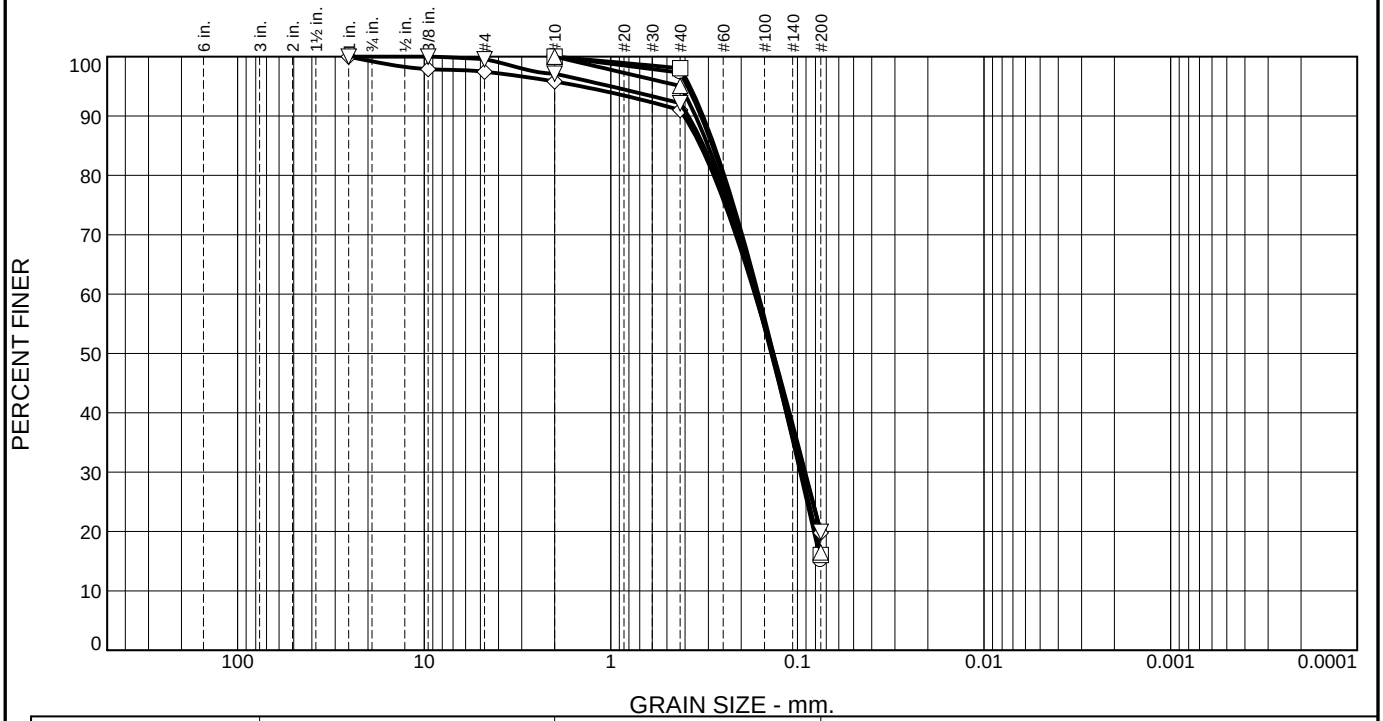
Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	2.7	82.2	15.1	
□	0.0	0.0	1.9	82.0	16.1	
△	0.0	0.0	4.9	78.6	16.5	
◇	0.0	4.2	4.8	71.2	19.8	
▽	0.0	2.9	4.9	72.3	19.9	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	0.2856	0.1650	0.1369	0.0965				
□	NV	NP	0.2792	0.1621	0.1346	0.0949				
△	NV	NP	0.3013	0.1679	0.1379	0.0954				
◇	NV	NP	0.3306	0.1690	0.1363	0.0914				
▽	NV	NP	0.3182	0.1661	0.1345	0.0908				

Material Description	USCS	AASHTO
○ Wet very dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
□ Wet very dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
△ Wet dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
◇ Wet dense brown fine sand w/some silt, trace of coarse sand and fine gravel.	SM	A-2-4(0)
▽ Wet dense brown fine sand w/some silt, trace of coarse sand and fine gravel.	SM	A-2-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-1 **Depth:** 23.0 **Sample Number:** 11

□ **Source of Sample:** TB-1 **Depth:** 28.0 **Sample Number:** 12

△ **Source of Sample:** TB-1 **Depth:** 33.0 **Sample Number:** 13

◇ **Source of Sample:** TB-1 **Depth:** 38.0 **Sample Number:** 14

▽ **Source of Sample:** TB-1 **Depth:** 43.0 **Sample Number:** 15

Remarks:

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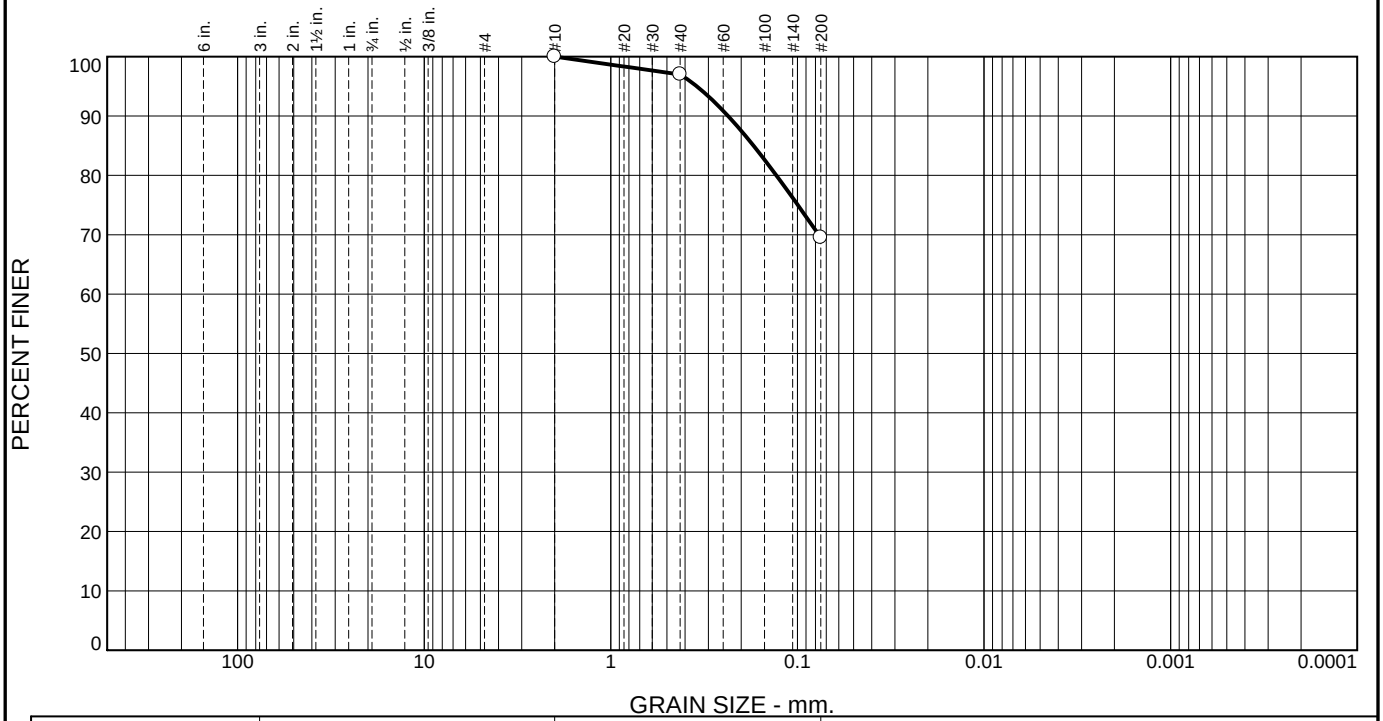
Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	3.0	27.5	69.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	0.1718							

Material Description	USCS	AASHTO
○ Wet hard brown fine sandy silt w/trace coarse sand.	ML	A-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-1 **Depth:** 48.0 **Sample Number:** 16

Remarks:

Delaware Department of Transportation
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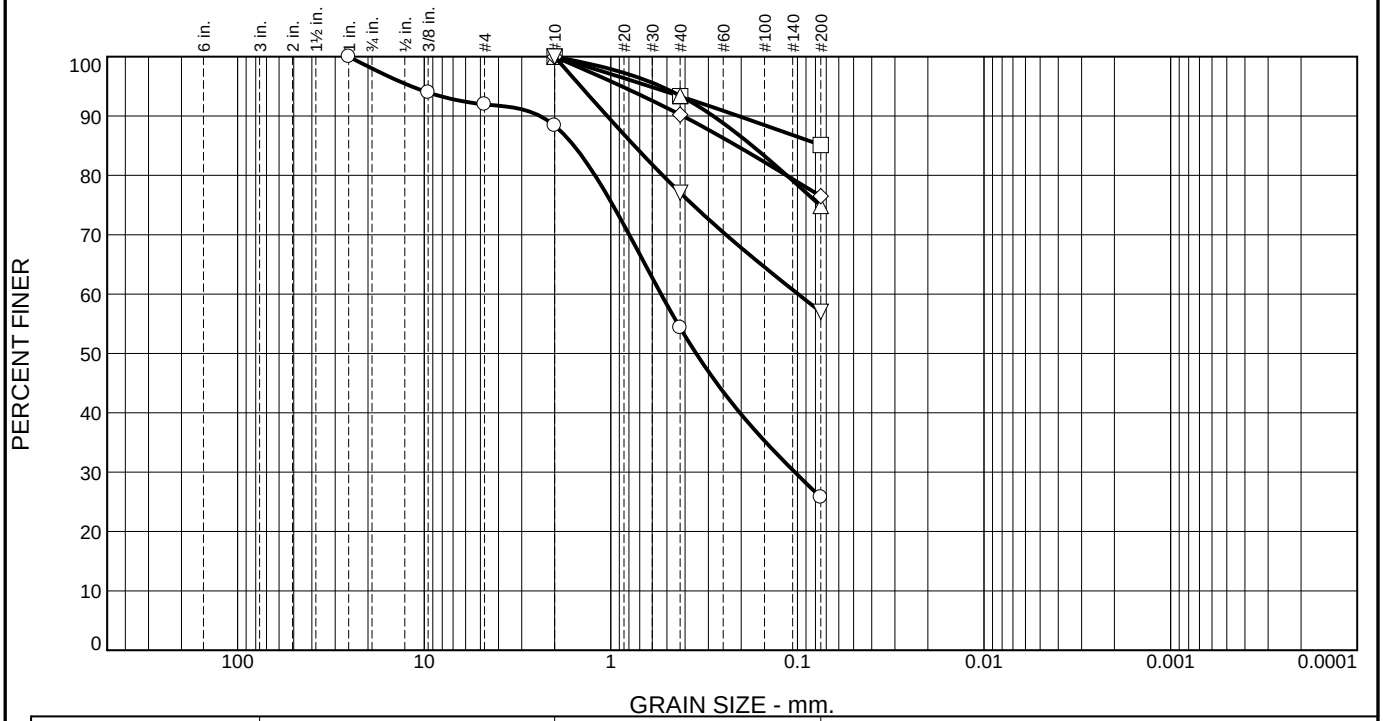
Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	11.6	34.1	28.5	25.8	
□	0.0	0.0	6.7	8.2	85.1	
△	0.0	0.0	6.6	18.5	74.9	
◇	0.0	0.0	9.8	13.7	76.5	
▽	0.0	0.0	22.9	20.1	57.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	1.5758	0.5379	0.3489	0.1032				
□	24.4	19.9								
△	24.7	NP	0.1747							
◇	25.9	21.1	0.2118							
▽	25.3	20.1	0.7479	0.0991						

	Material Description	USCS	AASHTO
○	Moist medium dense brown silty coarse to fine sand w/some fine gravel.	SM	A-2-4(0)
□	Wet very stiff brown silt w/some clay, trace of fine to coarse sand.	CL-ML	A-4(2)
△	Wet very stiff brown silt w/some fine sand, trace of coarse sand.	ML	A-4(0)
◇	Wet stiff brown silt w/some fine sand and clay, trace of coarse sand.	CL-ML	A-4(2)
▽	Wet stiff brown coarse sandy silt w/some fine sand and clay.	CL-ML	A-4(1)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-2 **Depth:** 0.0 **Sample Number:** 1

□ **Source of Sample:** TB-2 **Depth:** 2.0 **Sample Number:** 2

△ **Source of Sample:** TB-2 **Depth:** 4.0 **Sample Number:** 3

◇ **Source of Sample:** TB-2 **Depth:** 6.0 **Sample Number:** 4

▽ **Source of Sample:** TB-2 **Depth:** 8.0 **Sample Number:** 5

Remarks:

Delaware Department of Transportation
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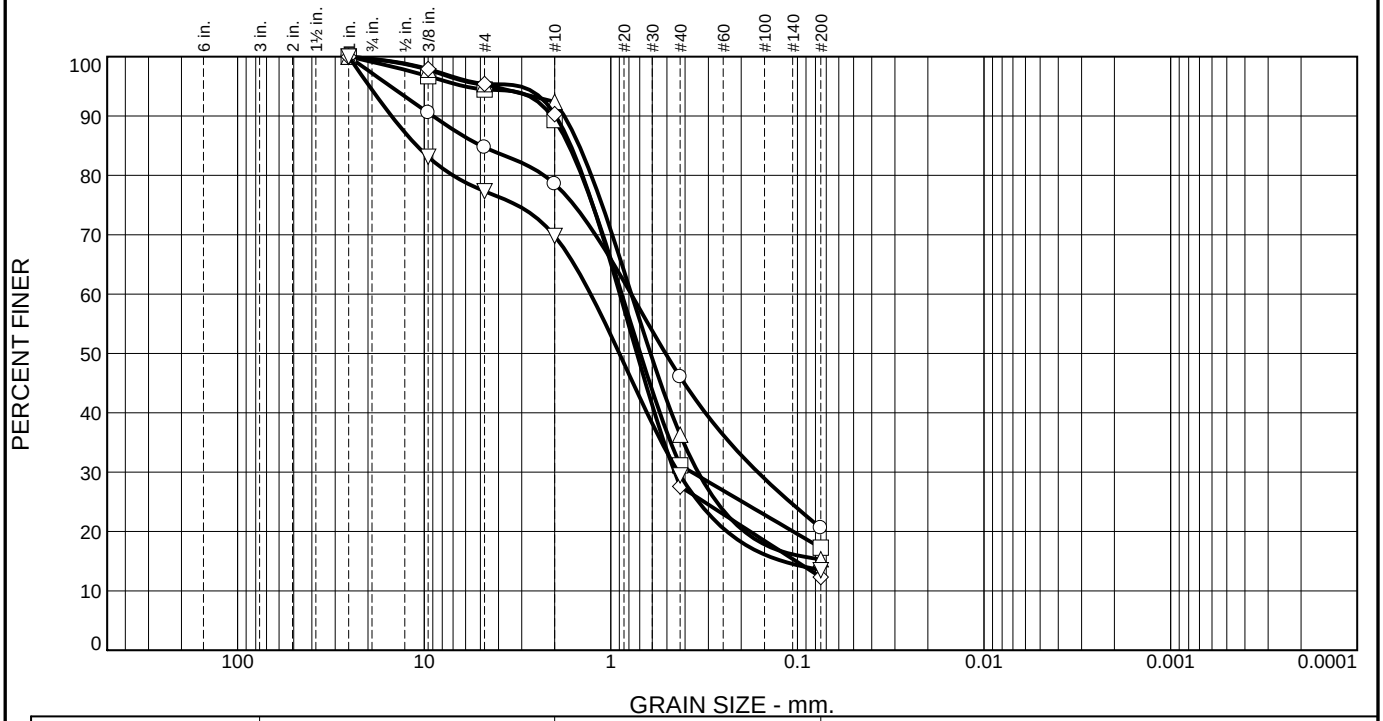
Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	21.4	32.6	25.4	20.6	
□	0.0	10.7	58.2	13.8	17.3	
△	0.0	7.6	56.1	21.0	15.3	
◇	0.0	9.7	62.7	15.3	12.3	
▽	0.0	30.2	40.3	16.0	13.5	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	4.9583	0.7780	0.5090	0.1630				
□	NV	NP	1.6757	0.8736	0.6953	0.3683				
△	NV	NP	1.4763	0.7760	0.6127	0.3410				
◇	NV	NP	1.6366	0.8951	0.7250	0.4551	0.1016			
▽	NV	NP	10.9587	1.2823	0.9004	0.4355	0.1199			

Material Description	USCS	AASHTO
○ Wet medium dense brown silty coarse to fine sand and fine gravel.	SM	A-1-b
□ Wet medium dense brown coarse sand w/some fine sand, fine gravel and silt.	SM	A-1-b
△ Wet medium dense brown coarse to fine sand w/some silt, trace of fine gravel.	SM	A-1-b
◇ Wet medium dense brown coarse sand w/some fine sand and silt, trace of fine gravel.	SM	A-1-b
▽ Wet dense brown coarse sand and fine gravel w/some fine sand and silt.	SM	A-1-b

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-2 **Depth:** 10.0 **Sample Number:** 6

□ **Source of Sample:** TB-2 **Depth:** 12.0 **Sample Number:** 7

△ **Source of Sample:** TB-2 **Depth:** 14.0 **Sample Number:** 8

◇ **Source of Sample:** TB-2 **Depth:** 16.0 **Sample Number:** 9

▽ **Source of Sample:** TB-2 **Depth:** 18.0 **Sample Number:** 10

Remarks:

Delaware Department of Transportation
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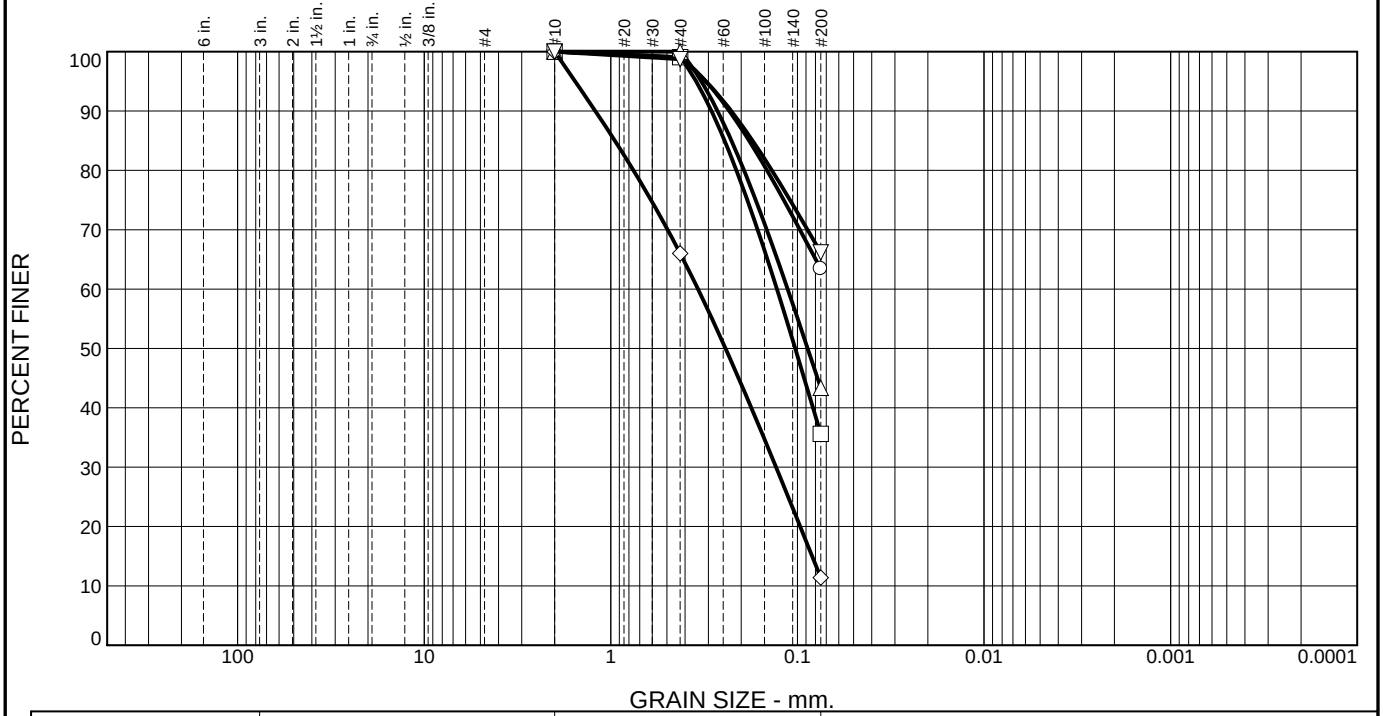
Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	1.0	35.6	63.4	
□	0.0	0.0	0.9	63.5	35.6	
△	0.0	0.0	0.0	56.6	43.4	
◇	0.0	0.0	34.0	54.6	11.4	
▽	0.0	0.0	1.3	32.5	66.2	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	20.5	NP	0.1815							
□	NV	NP	0.2456	0.1287	0.1027					
△	NV	NP	0.2257	0.1128	0.0881					
◇	NV	NP	0.9521	0.3412	0.2429	0.1302	0.0834			
▽	17.8	NP	0.1738							

Material Description	USCS	AASHTO
○ Wet hard brown fine sandy silt w/trace coarse sand.	ML	A-4(0)
□ Wet hard brown fine sandy silt w/trace coarse sand.	SM	A-4(0)
△ Wet very stiff brown fine sandy silt.	SM	A-4(0)
◇ Wet dense brown fine to coarse sand w/some silt.	SP-SM	A-2-4(0)
▽ Wet very stiff brown fine sandy silt w/ trace coarse sand.	ML	A-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-2 **Depth:** 23.0 **Sample Number:** 11

□ **Source of Sample:** TB-2 **Depth:** 28.0 **Sample Number:** 12

△ **Source of Sample:** TB-2 **Depth:** 33.0 **Sample Number:** 13

◇ **Source of Sample:** TB-2 **Depth:** 38.0 **Sample Number:** 14

▽ **Source of Sample:** TB-2 **Depth:** 43.0 **Sample Number:** 15

Remarks:

Delaware Department of Transportation
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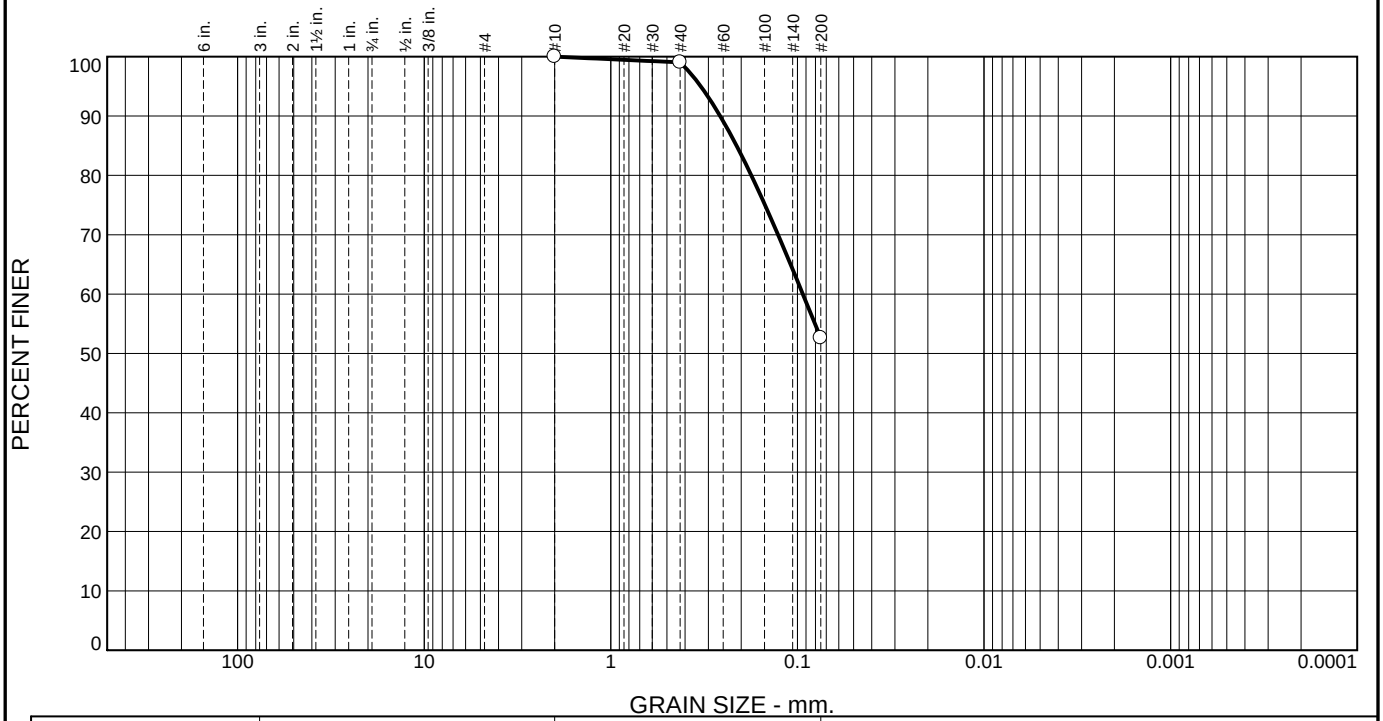
Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	1.0	46.4	52.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	19.6	NP	0.2118	0.0935						

Material Description	USCS	AASHTO
○ Wet hard brown fine sandy silt w/trace coarse sand.	ML	A-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

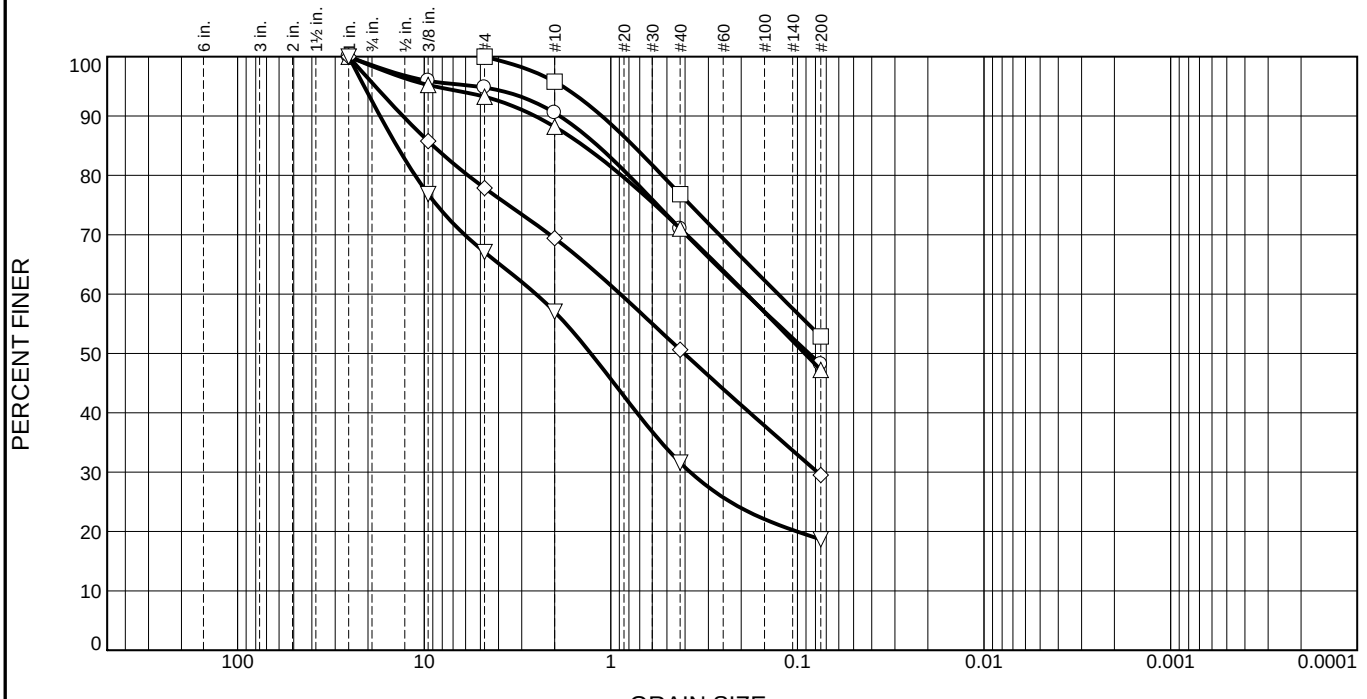
○ **Source of Sample:** TB-2 **Depth:** 48.0 **Sample Number:** 16

Remarks:

Delaware Department of Transportation
Materials and Research Laboratory

Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	9.5	19.5	22.8	48.2	
□	0.0	4.2	19.0	23.9	52.9	
△	0.0	11.8	17.2	23.8	47.2	
◇	0.0	30.6	18.8	21.1	29.5	
▽	0.0	43.0	25.4	12.9	18.7	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	22.0	19.4	1.1750	0.1885	0.0866					
□	25.6	17.6	0.7579	0.1268						
△	23.3	17.7	1.4016	0.1870	0.0914					
◇	17.4	NP	8.9649	0.8893	0.4045	0.0781				
▽	24.0	17.4	14.0379	2.5161	1.2803	0.3754				

Material Description	USCS	AASHTO
○ Wet stiff brown fine sandy silt w/some coarse sand, trace of fine gravel and clay.	SM	A-4(0)
□ Wet very stiff brown clayey fine sandy silt w/some coarse sand, trace of fine gravel.	CL	A-4(2)
△ Wet hard brown clayey fine sandy silt w/some coarse sand and fine gravel.	SC-SM	A-4(0)
◇ Wet dense brown silty fine sand and fine gravel w/some coarse sand.	SM	A-2-4(0)
▽ Wet medium dense brown clayey coarse sandy fine gravel w/some fine sand and silt.	SC-SM	A-2-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-3 **Depth:** 0.0 **Sample Number:** 1

□ **Source of Sample:** TB-3 **Depth:** 2.0 **Sample Number:** 2

△ **Source of Sample:** TB-3 **Depth:** 4.0 **Sample Number:** 3

◇ **Source of Sample:** TB-3 **Depth:** 6.0 **Sample Number:** 4

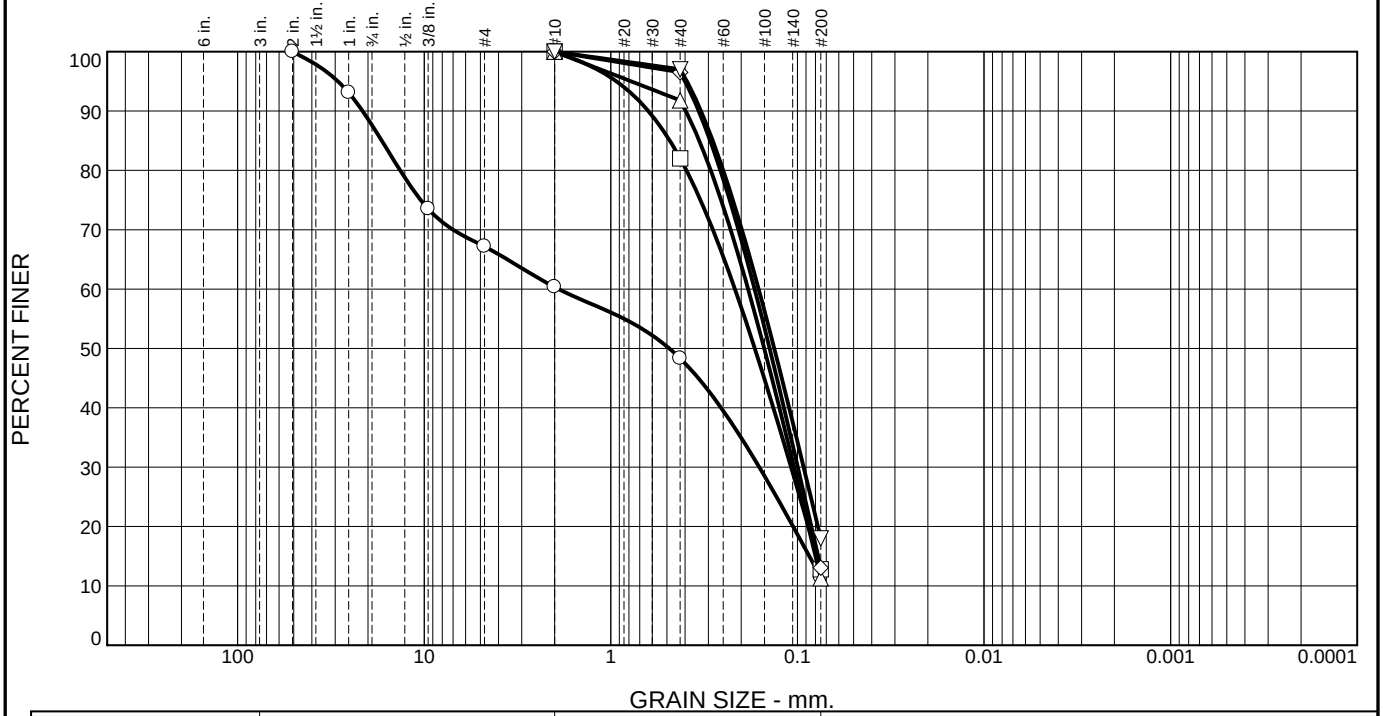
▽ **Source of Sample:** TB-3 **Depth:** 8.0 **Sample Number:** 5

Remarks:

Delaware Department of Transportation
Materials and Research Laboratory

Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	39.7	12.0	36.8	11.5	
□	0.0	0.0	18.0	69.2	12.8	
△	0.0	0.0	8.2	80.5	11.3	
◇	0.0	0.0	3.5	83.4	13.1	
▽	0.0	0.0	3.0	79.0	18.0	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	16.8898	1.9052	0.4860	0.1601	0.0863			
□	NV	NP	0.4829	0.2161	0.1692	0.1081	0.0786			
△	NV	NP	0.3359	0.1837	0.1506	0.1042	0.0800			
◇	NV	NP	0.2934	0.1695	0.1408	0.0995	0.0775			
▽	NV	NP	0.2843	0.1613	0.1330	0.0926				

Material Description	USCS	AASHTO
○ Wet dense brown fine sand and fine gravel w/some coarse sand and silt.	SP-SM	A-1-b
□ Wet dense brown fine sand w/some coarse sand and silt.	SM	A-2-4(0)
△ Wet very dense brown fine sand w/some silt, trace of coarse sand.	SP-SM	A-2-4(0)
◇ Wet very dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
▽ Wet dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-3 **Depth:** 10.0 **Sample Number:** 6

□ **Source of Sample:** TB-3 **Depth:** 12.0 **Sample Number:** 7

△ **Source of Sample:** TB-3 **Depth:** 14.0 **Sample Number:** 8

◇ **Source of Sample:** TB-3 **Depth:** 16.0 **Sample Number:** 9

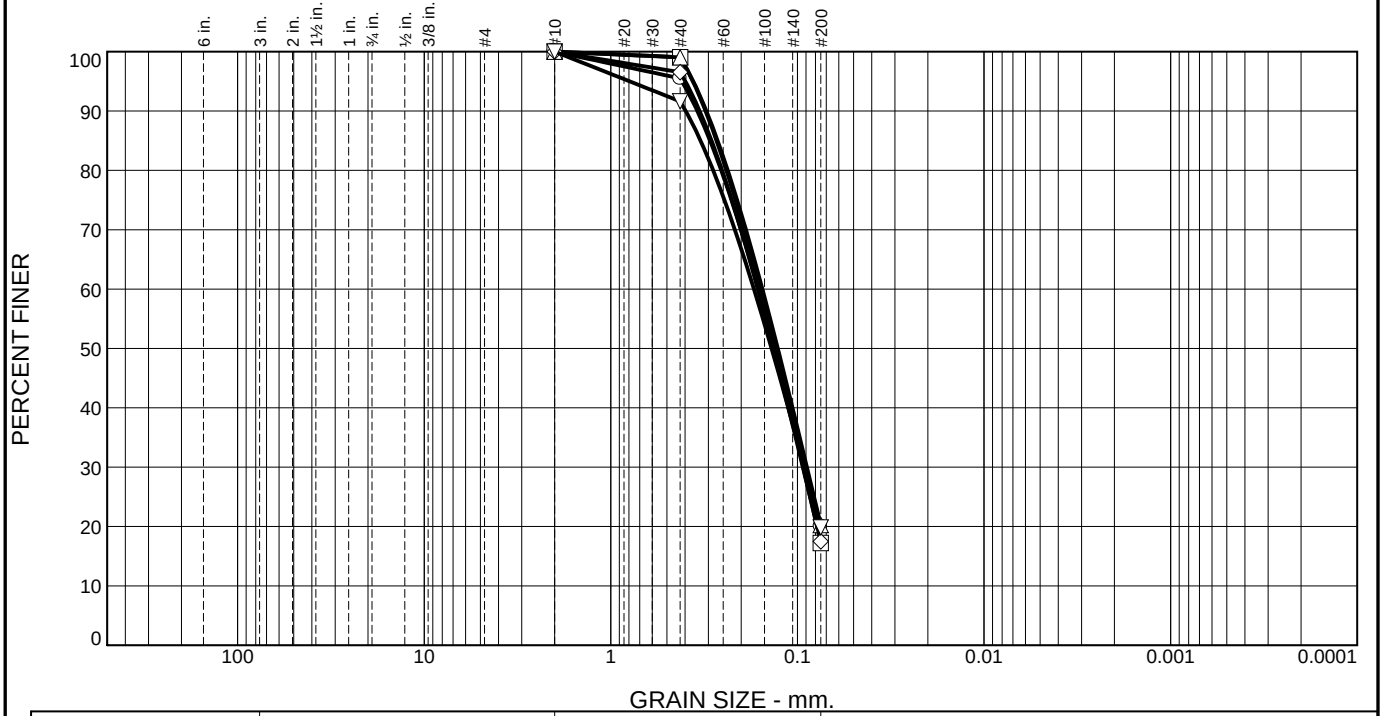
▽ **Source of Sample:** TB-3 **Depth:** 18.0 **Sample Number:** 10

Remarks:

Delaware Department of Transportation
Materials and Research Laboratory

Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	4.5	75.5	20.0	
□	0.0	0.0	0.9	81.9	17.2	
△	0.0	0.0	1.0	78.8	20.2	
◇	0.0	0.0	3.5	79.0	17.5	
▽	0.0	0.0	8.4	71.8	19.8	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	0.2938	0.1615	0.1319	0.0902				
□	NV	NP	0.2712	0.1584	0.1317	0.0930				
△	NV	NP	0.2677	0.1541	0.1274	0.0890				
◇	NV	NP	0.2885	0.1631	0.1344	0.0935				
▽	NV	NP	0.3304	0.1710	0.1376	0.0916				

	Material Description	USCS	AASHTO
○	Wet very dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
□	Wet very dense brown fine sand w/some silt, trace of fine gravel.	SM	A-2-4(0)
△	Wet very dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
◇	Wet dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)
▽	Wet dense brown fine sand w/some silt, trace of coarse sand.	SM	A-2-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-3 **Depth:** 23.0 **Sample Number:** 11

□ **Source of Sample:** TB-3 **Depth:** 28.0 **Sample Number:** 12

△ **Source of Sample:** TB-3 **Depth:** 33.0 **Sample Number:** 13

◇ **Source of Sample:** TB-3 **Depth:** 38.0 **Sample Number:** 14

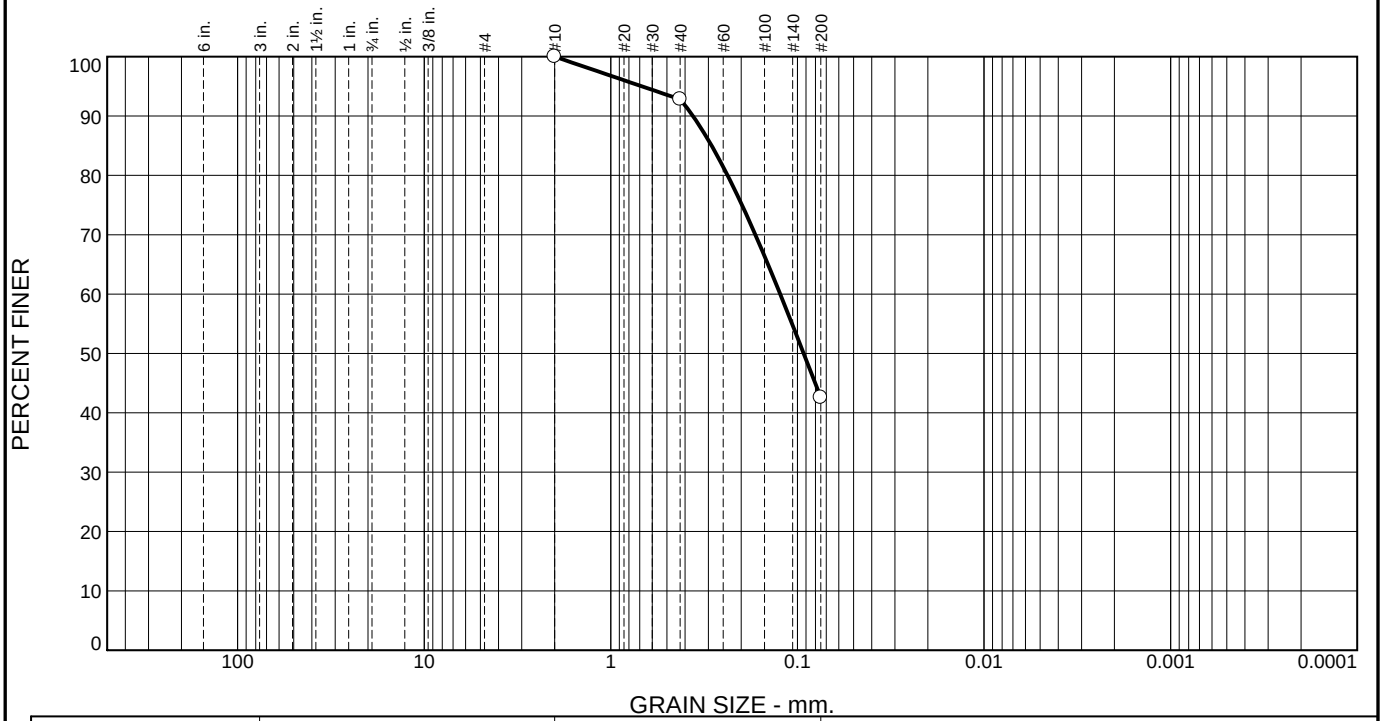
▽ **Source of Sample:** TB-3 **Depth:** 43.0 **Sample Number:** 15

Remarks:

Delaware Department of Transportation
Materials and Research Laboratory

Figure

Particle Size Distribution Report



	% +3"	% Gravel	% Sand		% Fines	
			Coarse	Fine	Silt	Clay
○	0.0	0.0	7.2	50.2	42.6	

	LL	PL	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○	NV	NP	0.2882	0.1236	0.0926					

Material Description	USCS	AASHTO
○ Wet hard brown fine sandy silt w/trace coarse sand.	SM	A-4(0)

Project No. T201811001 **Client:**

Project: SR1 Southbound

○ **Source of Sample:** TB-3 **Depth:** 48.0 **Sample Number:** 16

Remarks:

Delaware Department of Transportation
Materials and Research Laboratory

Figure