ENTECH
ENGINEERING, INC.

505 ELKTON DRIVE
COLORADO SPRINGS, CO 80907
PHONE (719) 531-5599
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March 13, 2020
Revised March 19, 2020

Tech Contractors
3575 Kenyon Street, Suite 200
San Diego, California 92110

Attn: Raul Guzman

Re: Pavement Recommendations
PCD File No. SF1823
Stonebridge, Filing No. 4, Phase 2
El Paso County, Colorado

Dear Mr. Guzman:

As requested, Entech Engineering, Inc. has obtained samples of the subgrade soils from sections of the roadways in the Stonebridge Filing No. 4 Subdivision, in El Paso County, Colorado. Laboratory testing to determine the pavement support characteristics of the soils was performed. This letter presents the results of the laboratory testing and pavement recommendations for the roadways.

Project Description

The project lies within portions of the initial existing phase of the development. The extent of the roadway construction is conceptually shown in Figure 1.

The roadways in this project consist of Enclave Scenic Drive, Hidden Enclave Court, Granite Park Lane, Marble Canyon Way, Ranch Gate Trail, Hidden Ranch Court, and sections of Granite Ridge Drive. The site layout and the locations of the test borings, drilled at approximate 500-foot intervals, are shown on the Test Boring Location Plan, Figure 1.

Subgrade Conditions

Eleven exploratory test borings were drilled in the roadways to depths of approximately 5 to 10 feet. The Boring Logs are presented in Appendix A. Sieve Analysis and Atterberg Limit testing were performed on soil samples obtained from the test borings for the purpose of classification. Sieve analyses performed indicated the percent passing the No. 200 sieve for the roadway subgrade soils ranged from approximately 13 to 31 percent. Atterberg Limit Tests performed on the samples resulted in Liquid Limits ranging from 20 to 35 and no-value, and Plastic Indexes of 3 to 15 and non-plastic. One general soil type was encountered at the subgrade depth (Soil Type 1). Soil Type 1 consisted of silty to clayey sand which classified as A-2-4, A-2-6 and A-1-b soils based on the AASHTO classification system. The Type 1 soils have good pavement support characteristics. Sulfate testing of the subgrade indicated that the soils exhibit a negligible potential for sulfate attack. Groundwater was not encountered in the test borings.

Swell testing was not required on the Soil Type 1 soils based on their AASHTO classifications. Mitigation for swell is not required. Laboratory test results are presented in Appendix B and are summarized on Table 1.

California Bearing Ratio (CBR) testing was performed on a sample of Soil Type 1 to determine the support characteristic of the subgrade soils for the roadway sections. The results of the CBR testing, are presented in Appendix B and summarized as follows:

Soil Type1 – Clayey Sand	
R @ 90% = 71.0	
R @ 95% = 81.0	
Use R = 50.0 for design*	
Classification Testing	
Liquid Limit	32
Plasticity Index	15
Percent Passing 200	27.2
AASHTO Classification	A-2-6
Group Index	1
Unified Soils Classification	SC

* An R Value of 50 is used for design calculations due to slight variability of the soils between borings and it results in minimum sections for the roadways.

Pavement Design

The CBR testing was used to determine pavement sections for this site. The pavement sections were determined utilizing the El Paso County "Pavement Design Criteria and Report". The following classifications and ESAL values were used for this portion of the filing. The cul-de-sac sections of Ranch Gate Trail, Hidden Ranch Court, Marble Canyon Way, Granite Park Lane, and Hidden Enclave Court classify as local low-volume roads. An 18k ESAL value of 36,500 was used for design. Enclave Scenic Way, Granite Ridge Drive, and Marble Canyon Way, Hidden Ranch Court Ranch Gate Trail, excluding the cul-de-sac sections, classify as urban local roads; an 18k ESAL value of 292,000 was used for design. Pavement alternatives for asphalt over aggregate basecourse and cement stabilized subgrade sections are provided. Design parameters used in the pavement analysis are as follows:

Reliability (Local Roads)	80%
Serviceability Index Local Low Volume, Local Roads	2.2
Resilient Modulus	13,168 psi
"R" Value Subgrade, Soil Type 1	50.0
Structural Coefficients:	
Hot Bituminous Pavement	0.44
Aggregate Base Course	0.11
Cement Stabilized Subgrade	0.12

Pavement calculations are attached in Appendix C. Pavement sections recommended for this phase of the filing are summarized as follows:

Pavement Sections – Soil Type 1

Local Low Volume – ESAL = 36,500 – Cul-De-Sac Sections

Alternative	Asphalt (in)	Base Course (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Base Course	3.0*	4.0*	--
2. Cement Stabilized Subgrade	4.0*	--	10.0

Urban Local – ESAL = 292,000 – All roads (Non Cul-De-Sac)

Alternative	Asphalt (in)	Base Course (in)	Cement Stabilized Subgrade (in.)
1. Asphalt Over Base Course	3.5	8.0*	--
2. Cement Stabilized Subgrade	4.0*	--	10.0

* Minimum sections required by the El Paso County Pavement Design Criteria and Report.

Mitigation

El Paso County criteria requires mitigation of expansive soils for roadway subgrade that have a swell of 2 percent or greater with a 150 pound per square foot surcharge. Due to the AASHTO classifications, mitigation for expansive soils will not be required.

Roadway Construction - Full Depth Asphalt and Asphalt on Aggregate Base Course Alternatives

Prior to placement of the asphalt, the subgrade should be proofrolled and compacted to a minimum of 95 percent of its maximum Standard Proctor Dry Density, ASTM D-698 at 0 to +3 percent of optimum moisture content or 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ±2 percent of optimum moisture content. Any loose or soft areas should be removed and replaced with suitable materials. Base course materials should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557 at ± 2 percent of optimum moisture content. Special attention should be given to areas adjacent to manholes, inlet structures and valves.

Roadway Construction – Cement Stabilized Subgrade Alternative

Prior to placement of the asphalt, the subgrade shall be stabilized by addition of cement to a depth of at least 10 inches. The depth of the required cement stabilized subgrade is shown in the previous table. The amount of cement applied shall be 2.0 percent (by weight) of the subgrade's maximum dry density as determined by the Modified Proctor Test (ASTM D-1557) based on laboratory cement stabilization testing. The cement should be spread evenly on the subgrade surface and be thoroughly mixed into the subgrade over a 10-inch depth such that a uniform blend of soil and cement is achieved. Prior to application or mixing of the cement, the upper 10 inches of subgrade should be thoroughly moisture conditioned to the soil's optimum water content or as much as 2 percent more than the optimum water content as necessary to provide a compactable soil condition. Densification of the cement-stabilized subgrade should be completed to obtain a compaction of at least 95 percent of the subgrade maximum dry density as determined by the Modified Proctor Test (ASTM D-1557).

Satisfactory compaction of the subgrade shall occur within 90 minutes from the time of mixing the cement into the subgrade.

The following conditions shall be observed as part of the subgrade stabilization:

- Type I/II cement as supplied, a local supplier shall be used. All cement used for stabilization should come from the same source. If cement sources are changed a new laboratory mix design should be completed.

- Moisture conditioning of the subgrade and/or mixing of the cement into the subgrade shall not occur when soil temperatures are below 40° F. Cement treated subgrades should be maintained at a temperature of 40° F or greater until the subgrade has been compacted as required.

- Cement placement, cement mixing and compaction of the cement treated subgrade should be observed by a Soils Engineer. The Soils Engineer should complete in situ compaction tests and construct representative compacted specimens of the treated subgrade material for subsequent laboratory quality assurance testing.

- Microfracturing of the stabilized subgrade is recommended.

If significant grading is performed, the soils at subgrade may change. Modification to the pavement sections should be evaluated after site grading is completed.

In addition to the above guidance, the asphalt, cement, subgrade conditions, compaction of materials and roadway construction methods shall meet the El Paso County specifications.

We trust that this has provided you with the information you required. If you have any questions or need additional information, please do not hesitate to contact us.

Respectfully Submitted,

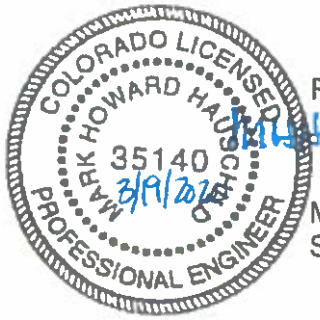
ENTECH ENGINEERING, INC.

Daniel P. Stegman

DPS/ao

Encl.

Entech Job No. 200189
AAprojects/2020/200189 pr-rev



Reviewed by:

Mark H. Hauschild, P.E.
Senior Engineer

TABLE

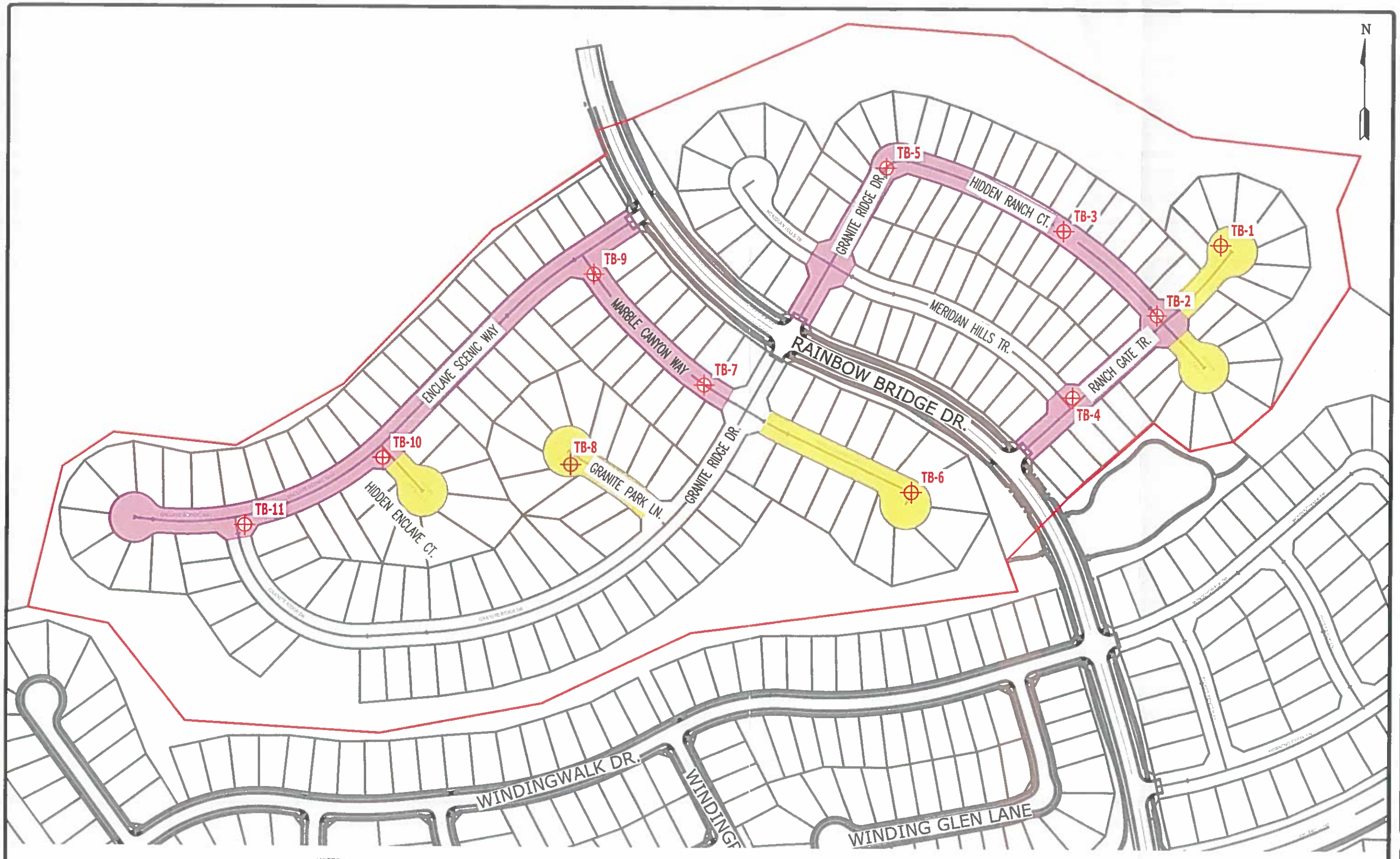
TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT TECH CONTRACTORS
PROJECT STONEBRIDGE, FILING 4
JOB NO. 200189

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	AASHTO CLASS.	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1, CBR	4	0-3			27.2	32	15		A-2-6		SC	SAND, CLAYEY
1	1	1-2			27.9	20	3		A-2-4		SM	SAND, SILTY
1	2	1-2			22.4	33	13		A-2-6		SC	SAND, CLAYEY
1	3	1-2			16.5	35	11	<0.01	A-2-6		SM	SAND, SILTY
1	4	1-2			31.4	35	14		A-2-6		SC	SAND, CLAYEY
1	5	1-2	12.1	111.3	30.8	29	8	<0.01	A-2-4	-0.4	SC	SAND, CLAYEY
1	6	1-2			21.5	28	9		A-2-4		SC	SAND, CLAYEY
1	7	1-2			12.6	NV	NP		A-1-b		SM	SAND, SILTY
1	8	1-2			29.9	25	6	<0.01	A-2-4		SC-SM	SAND, CLAYEY, SILTY
1	9	1-2			18.6	NV	NP	<0.01	A-1-b		SM	SAND, SILTY
1	10	1-2			20.6	26	8		A-2-4		SC	SAND, CLAYEY
1	11	1-2			21.0	27	10		A-2-4		SC	SAND, CLAYEY
2	4	10			14.2	NV	NP	<0.01	A-1-b		SM	SANDSTONE, SILTY
2	9	10			31.9	27	11		A-2-6		SC	SANDSTONE, CLAYEY
2	10	10			12.3	NV	NP	<0.01	A-1-b		SM	SANDSTONE, SILTY
3	5	5			48.9	28	7	<0.01	A-4		SC	SANDSTONE, VERY CLAYEY

FIGURE



NOTES:

: URBAN LOCAL LOW VOLUME – SOIL TYPE 1: (36,500) – 3.0" ASPHALT OVER 4.0" BASECOURSE, OR 4.0" ASPHALT OVER 10.0" OF CEMENT–TREATED SUBGRADE.

: URBAN LOCAL – (292,000) – SOIL TYPE 1: 3.5" ASPHALT OVER 8.0" BASECOURSE, OR 4.0" ASPHALT OVER 10.0" OF CEMENT–TREATED SUBGRADE.

TB-2 - APPROXIMATE TEST BORING LOCATION AND NUMBER

REVISIONS	BY:

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, CO. 80907 (719) 531-5599

TEST BORING LOCATION PLAN
STONEBRIDGE, FILING 4
EL PASO COUNTY, CO
FOR: TECH CONTRACTORS

DRAWN BY:	JAC
DESIGNED BY:	KAH
CHECKED BY:	DS
DATE:	03/06/20
SCALE:	AS SHOWN
JOB NO.:	200189
FIGURE NO.:	1

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 1/30/2020
Job # 200189

REMARKS

DRY TO 5', 1/30/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			8	8.4	1	SAND, SILTY, FINE TO COARSE GRAINED, BROWN, LOOSE TO MEDIUM DENSE, MOIST
5			26	6.1	1	
10						
15						
20						

TEST BORING NO. 2
DATE DRILLED 1/30/2020
CLIENT TECH CONTRACTORS
LOCATION STONEBRIDGE, FILING 4

REMARKS

DRY TO 10', 1/30/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			12	6.8	1	SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO LOOSE, MOIST
5			8	8.3	1	
10			48	7.5	2	WEATHERED SANDSTONE, SILTY, FINE TO COARSE GRAINED, BROWN, DENSE, MOIST
15						
20						

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 3/5/20

JOB NO.: 200189
FIG NO.: A-1

TEST BORING NO. 3
DATE DRILLED 1/30/2020
Job # 200189

REMARKS

DRY TO 5', 1/30/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			11	8.5	1	SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
5				7.5	1	
10						
15						
20						

TEST BORING NO. 4
DATE DRILLED 1/30/2020
CLIENT TECH CONTRACTORS
LOCATION STONEBRIDGE, FILING 4

REMARKS

DRY TO 10', 1/30/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type	
			16	10.8	1	SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST
5			18	7.9	1	
10			50/9"	5.4	2	SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST
15						
20						

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 3/5/20

JOB NO: 200189
FIG NO: A-2

TEST BORING NO. 5
DATE DRILLED 1/30/2020
Job # 200189

REMARKS

DRY TO 5', 1/30/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			15	9.2	1
			50/7"	10.5	3
5					
10					
15					
20					

SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST

SANDSTONE, VERY CLAYEY, FINE GRAINED, GRAY BROWN, VERY DENSE, MOIST

TEST BORING NO. 6
DATE DRILLED 1/30/2020
CLIENT TECH CONTRACTORS
LOCATION STONEBRIDGE, FILING 4

REMARKS

DRY TO 5', 1/30/20

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			11	7.4	1
			6	7.2	1
5					
10					
15					
20					

SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE TO LOOSE, MOIST

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 3/5/20

JOB NO.: 200189
FIG NO.: A-3

TEST BORING NO. 7
DATE DRILLED 1/30/2020
Job # 200189

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/30/20						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				10	7.7	1
	5				8.8	1
	10					
	15					
	20					

TEST BORING NO. 8
DATE DRILLED 1/30/2020
CLIENT TECH CONTRACTORS
LOCATION STONEBRIDGE, FILING 4

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/30/20						
SAND, CLAYEY, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				11	10.7	1
	5				9.5	1
	10					
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE: 3/5/20

JOB NO: 200189
FIG NO: A-4

TEST BORING NO. 9
DATE DRILLED 2/13/2020
Job # 200189

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 2/13/20						
SAND, SILTY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				12	7.6	1
	5			22	7.7	1
SANDSTONE, CLAYEY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST	10			50/10"	12.1	2
	15					
	20					

TEST BORING NO. 10
DATE DRILLED 2/13/2020
CLIENT TECH CONTRACTORS
LOCATION STONEBRIDGE, FILING 4

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/30/20						
SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, LOOSE TO MEDIUM DENSE, MOIST				7	6.6	1
CLAY LENSE	5			18	14.0	1
WEATHERED SANDSTONE, SILTY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE, MOIST	10			37	6.9	2
	15					
	20					

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TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO.: 200189
FIG NO.: A-5

TEST BORING NO. 11
DATE DRILLED 2/13/2020
Job # 200189

TEST BORING NO.
DATE DRILLED
CLIENT TECH CONTRACTORS
LOCATION STONEBRIDGE, FILING 4

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
DRY TO 5', 1/30/20						
SAND, CLAYEY, FINE TO COARSE GRAINED, BROWN, MEDIUM DENSE, MOIST				10	7.3	1
	5			13	9.6	1
	10					
	15					
	20					

REMARKS	Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
	5					
	10					
	15					
	20					

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TEST BORING LOG

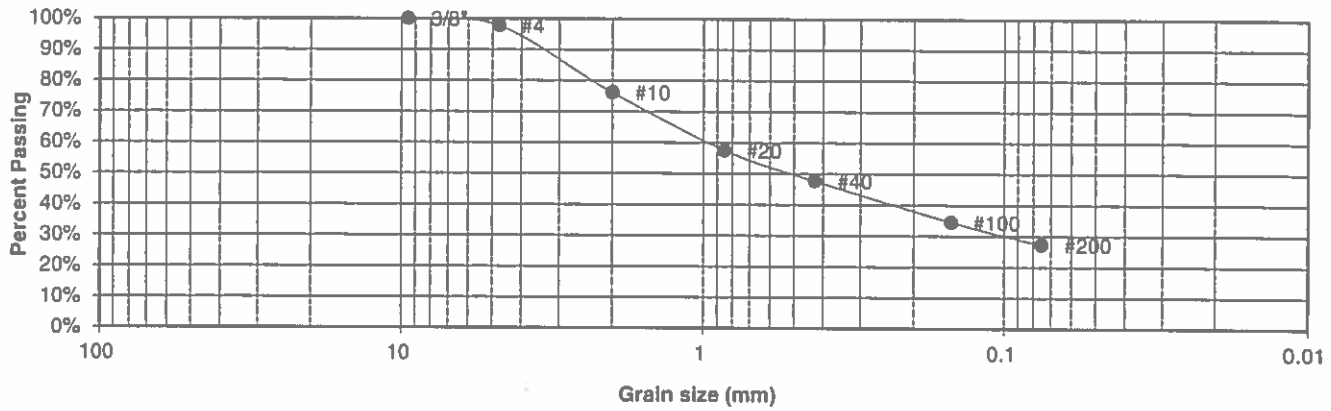
DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO.: 200189
FIG NO.: A-6

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1, CBR	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	4	JOB NO.	200189
DEPTH (FT)	0-3	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.7%
10	76.1%
20	57.5%
40	47.7%
100	34.5%
200	27.2%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	32
Plastic Index	15

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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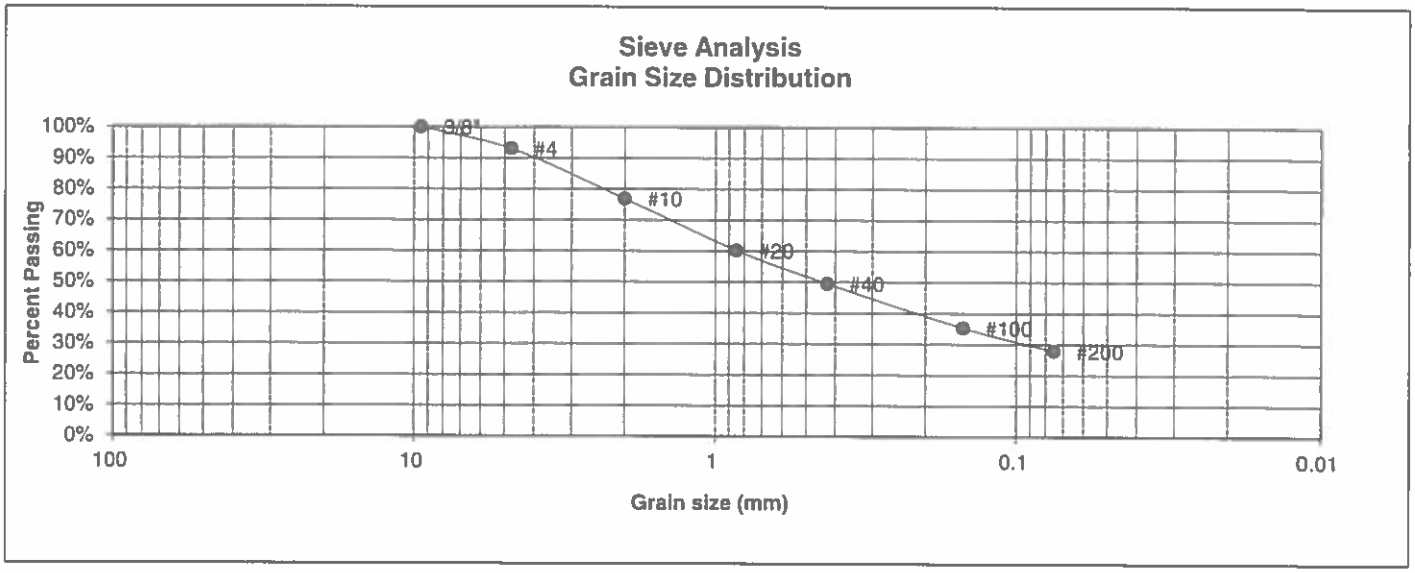
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
		DS	3/19/12

JOB NO. 200189
FIG NO. B-1

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	1	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.0%
10	76.8%
20	60.2%
40	49.5%
100	35.3%
200	27.9%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	20
Plastic Index	3

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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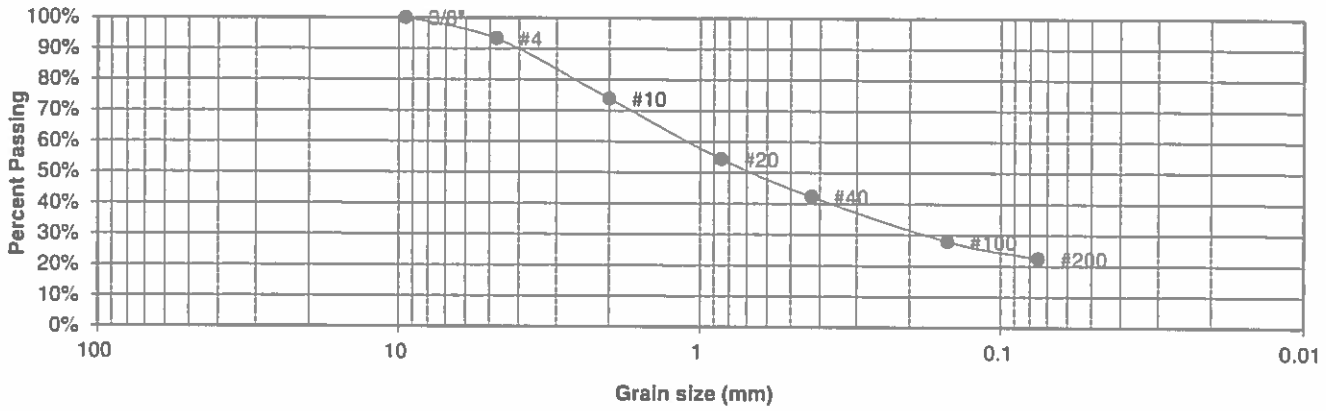
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
			3/5/20

JOB NO.: 200189
FIG NO.: B-2

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	2	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	93.2%
10	73.9%
20	54.4%
40	42.3%
100	27.8%
200	22.4%

Atterberg Limits

Plastic Limit	20
Liquid Limit	33
Plastic Index	13

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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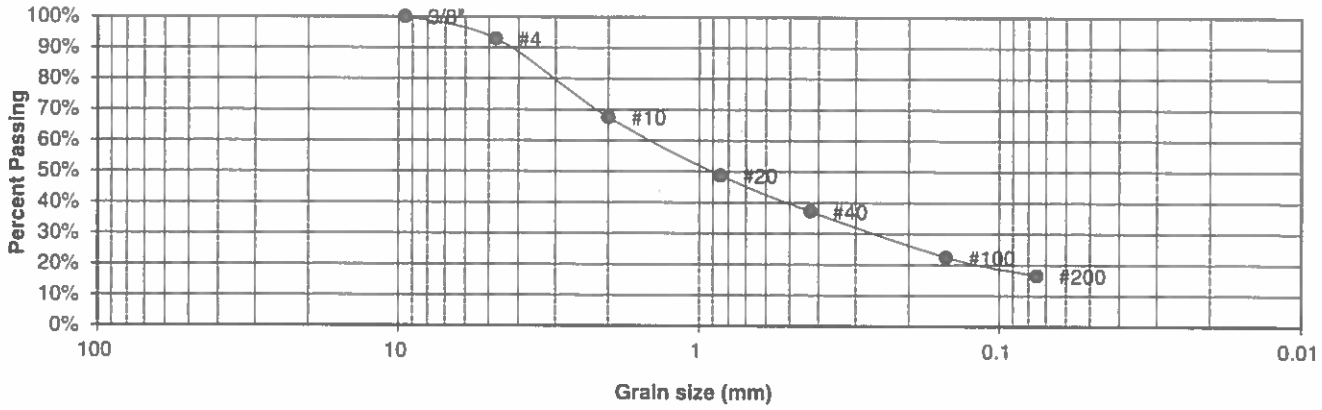
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 3/5/20

JOB NO.: 200189
FIG NO.: B-3

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	3	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	92.9%
10	67.5%
20	48.8%
40	37.2%
100	22.4%
200	16.5%

Atterberg Limits	
Plastic Limit	24
Liquid Limit	35
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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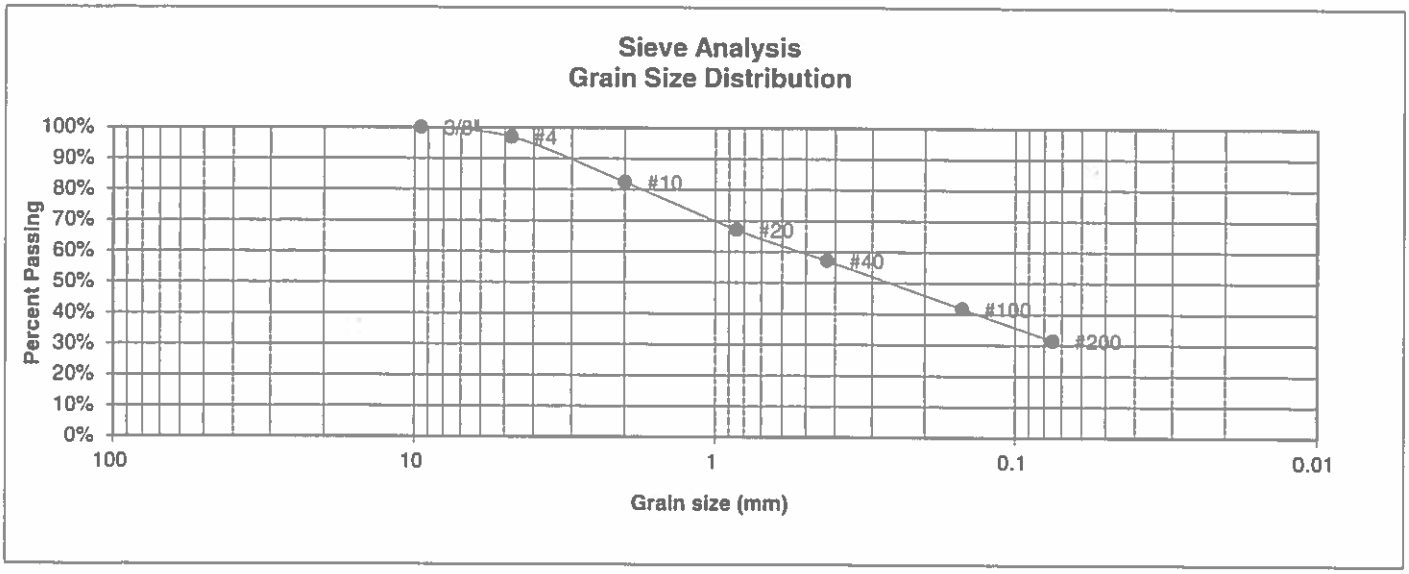
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 3/15/20

JOB NO. 200189
FIG NO. B-4

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	4	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	97.0%
10	82.4%
20	67.1%
40	57.1%
100	41.7%
200	31.4%

Atterberg Limits

Plastic Limit	21
Liquid Limit	35
Plastic Index	14

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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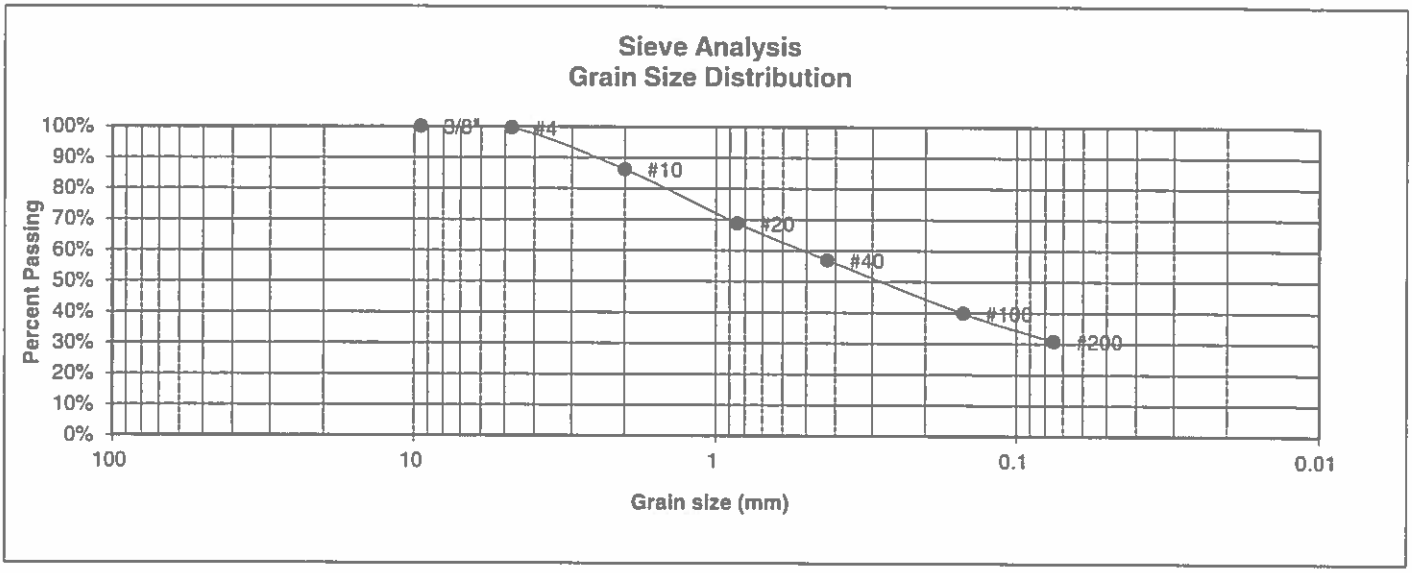
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 2/5/20

JOB NO. 200189
FIG NO. B-5

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	5	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.6%
10	86.2%
20	68.8%
40	57.0%
100	39.8%
200	30.8%

Atterberg Limits

Plastic Limit	21
Liquid Limit	29
Plastic Index	8

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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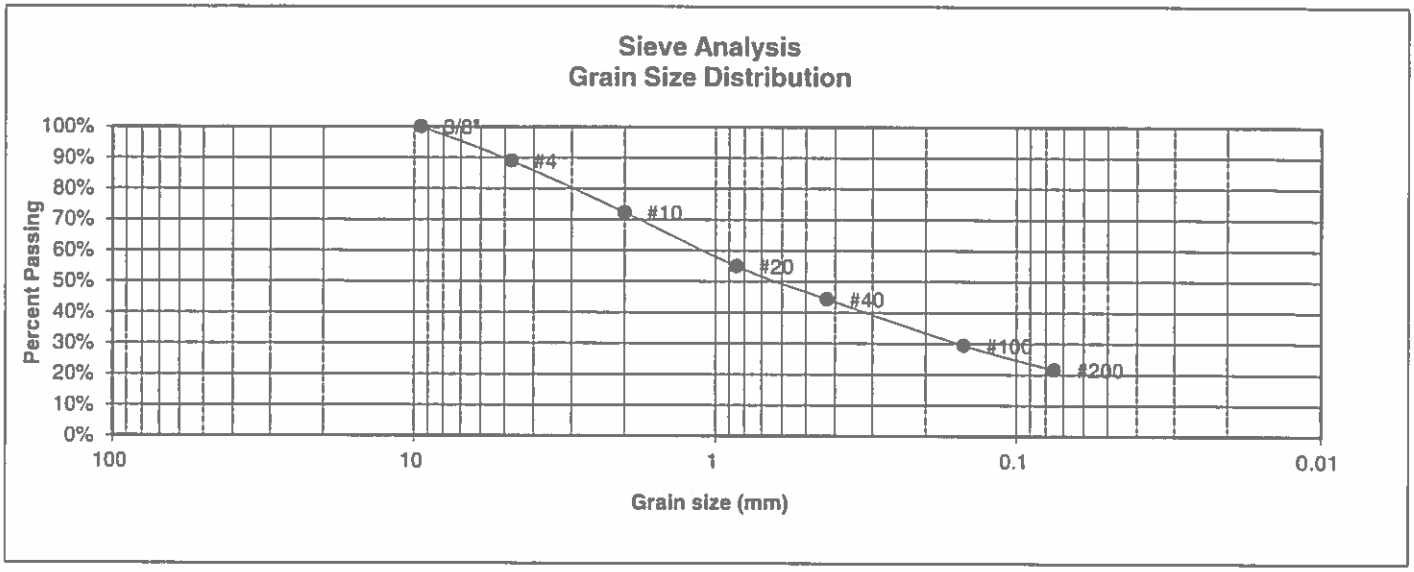
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO.: 200189
FIG NO.: B-6

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	6	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	89.0%
10	72.3%
20	55.0%
40	44.3%
100	29.4%
200	21.5%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	28
Plastic Index	9

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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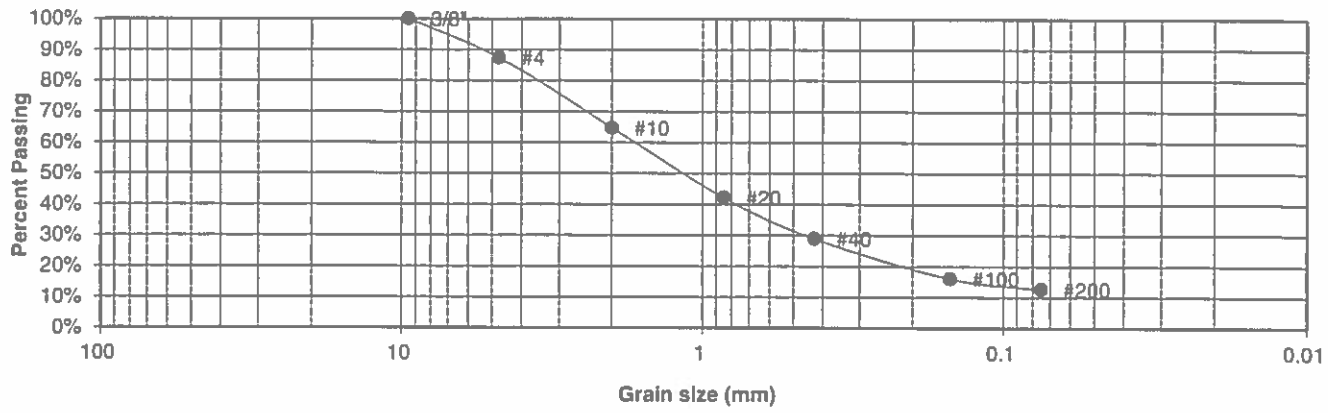
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		TDS	3/19/12

JOB NO.: 200189
FIG NO.: B-7

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	7	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	87.4%
10	64.8%
20	42.2%
40	28.9%
100	16.0%
200	12.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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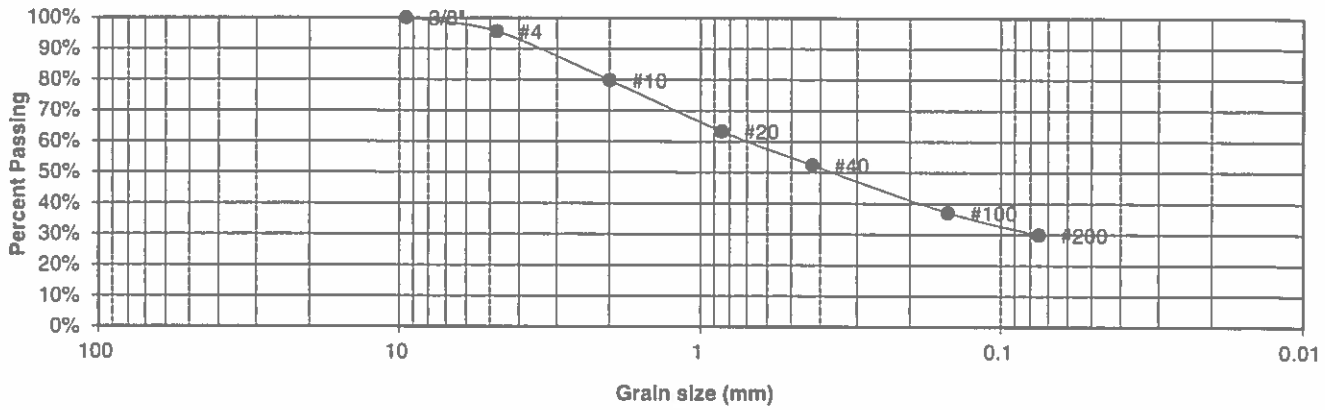
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO.: 200189
FIG NO.: B-8

UNIFIED CLASSIFICATION	SC-SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	8	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.6%
10	79.8%
20	63.3%
40	52.4%
100	37.1%
200	29.9%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	25
Plastic Index	6

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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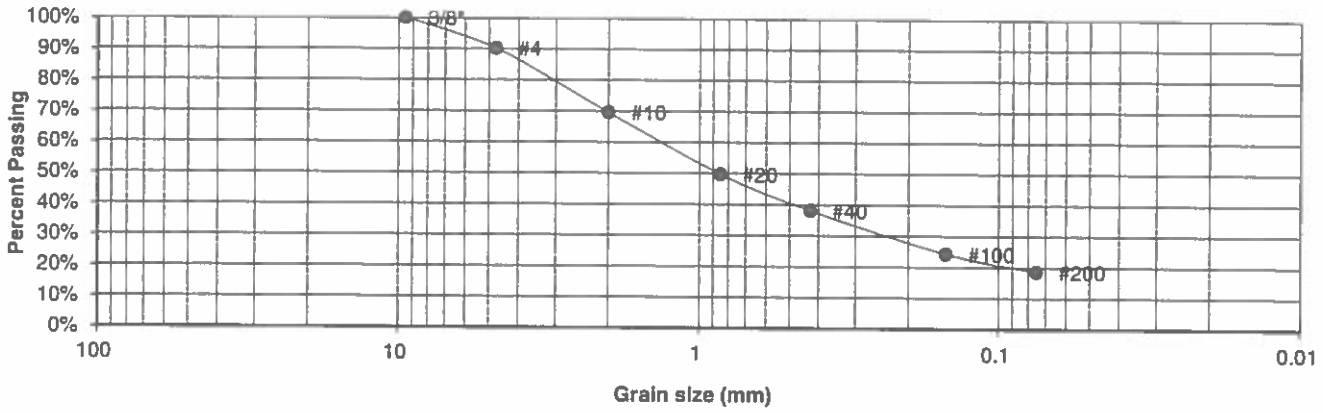
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO. 200189
FIG NO. B-9

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	9	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	90.2%
10	69.6%
20	49.7%
40	38.1%
100	24.3%
200	18.6%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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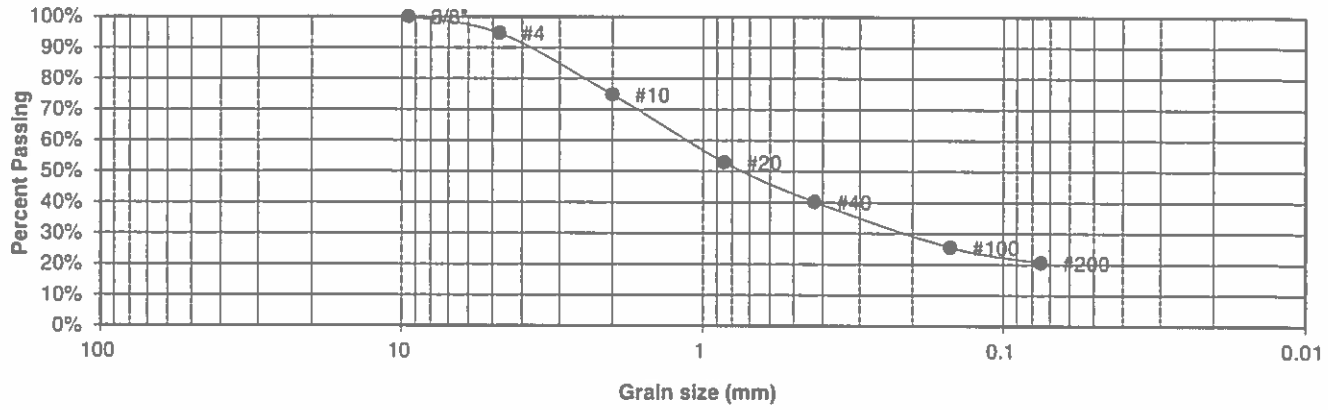
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED:	DATE:
			3/5/20

JOB NO: 200189
FIG NO: 6-10

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	10	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	94.7%
10	74.8%
20	52.9%
40	40.2%
100	25.5%
200	20.6%

Atterberg Limits	
Plastic Limit	19
Liquid Limit	26
Plastic Index	8

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

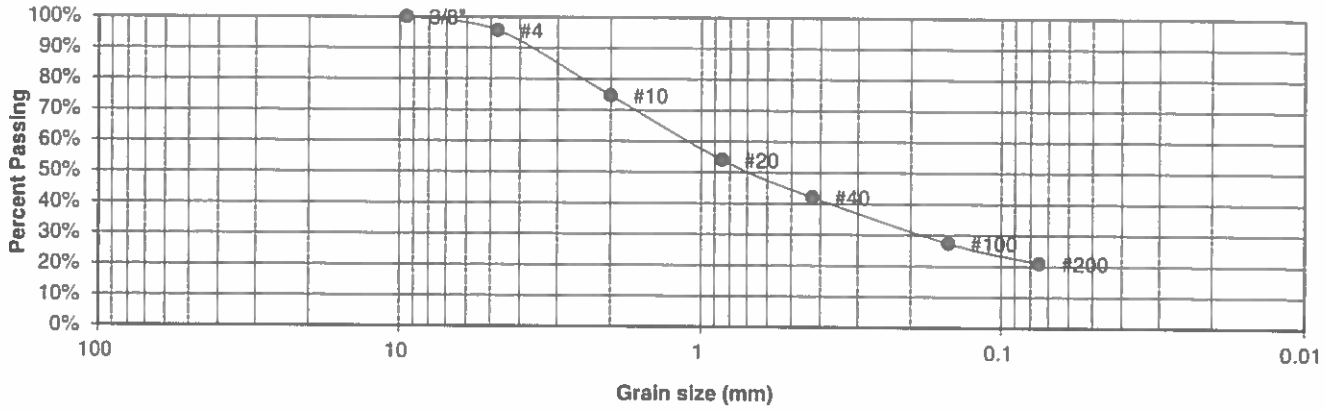
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO: 200189
FIG NO: B-11

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	1	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	11	JOB NO.	200189
DEPTH (FT)	1-2	TEST BY	BL
AASHTO CLASSIFICATION	A-2-4	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	95.7%
10	74.7%
20	54.0%
40	42.1%
100	27.4%
200	21.0%

Atterberg Limits	
Plastic Limit	17
Liquid Limit	27
Plastic Index	10

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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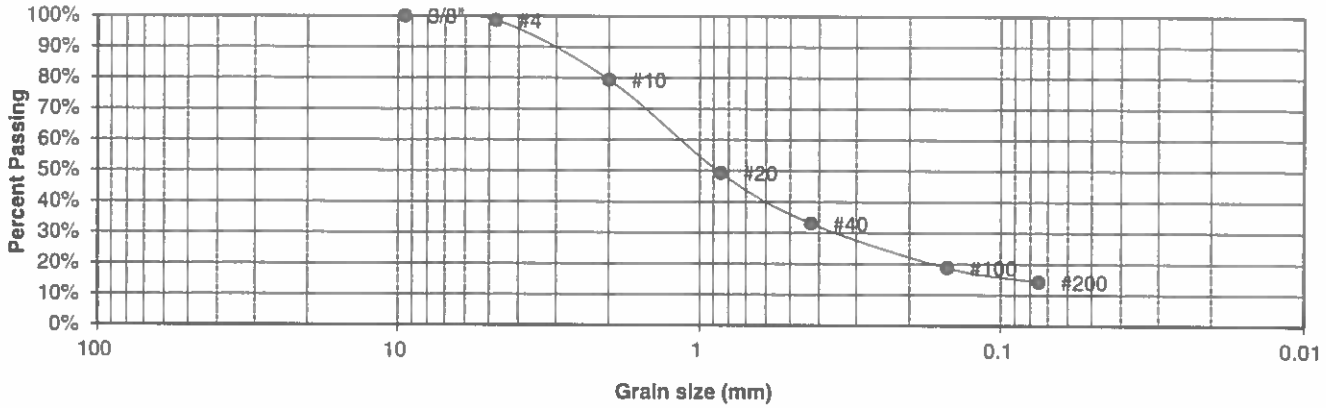
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/27/20

JOB NO: 200189
FIG NO: B-12

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	2	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	4	JOB NO.	200189
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.6%
10	79.4%
20	49.2%
40	33.0%
100	18.7%
200	14.2%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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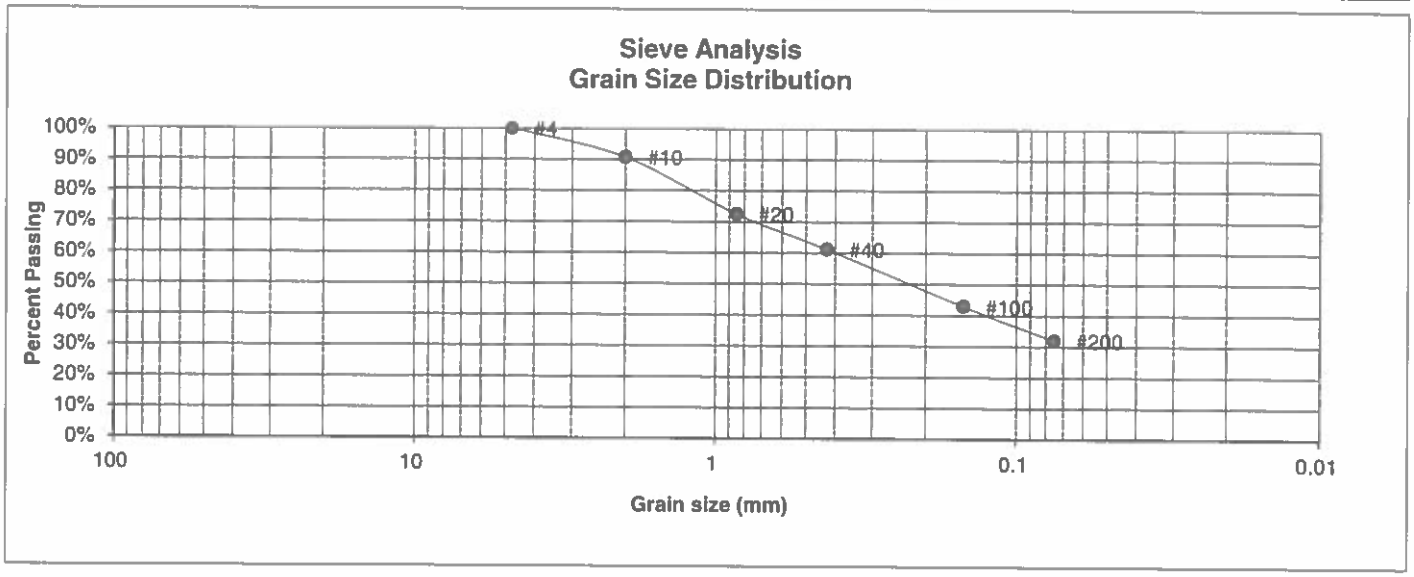
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO.: 200189
FIG NO.: B-13

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	2	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	9	JOB NO.	200189
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-2-6	GROUP INDEX	0



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	90.7%
20	72.5%
40	61.2%
100	42.9%
200	31.9%

Atterberg Limits	
Plastic Limit	16
Liquid Limit	27
Plastic Index	11

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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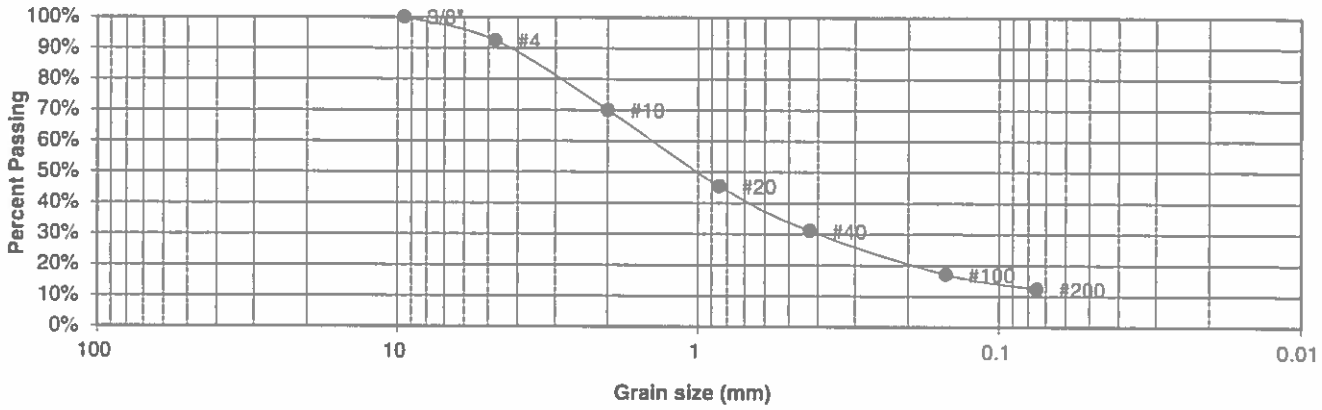
LABORATORY TEST RESULTS

DRAWN	DATE	CHECKED	DATE
			3/15/22

JOB NO. 200189
FIG NO. B-14

UNIFIED CLASSIFICATION	SM	CLIENT	TECH CONTRACTORS
SOIL TYPE #	2	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	10	JOB NO.	200189
DEPTH (FT)	10	TEST BY	BL
AASHTO CLASSIFICATION	A-1-b	GROUP INDEX	0

Sieve Analysis
Grain Size Distribution



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	92.5%
10	70.0%
20	45.5%
40	31.1%
100	17.1%
200	12.3%

Atterberg Limits

Plastic Limit	NP
Liquid Limit	NV
Plastic Index	NP

Swell

Moisture at start

Moisture at finish

Moisture increase

Initial dry density (pcf)

Swell (psf)

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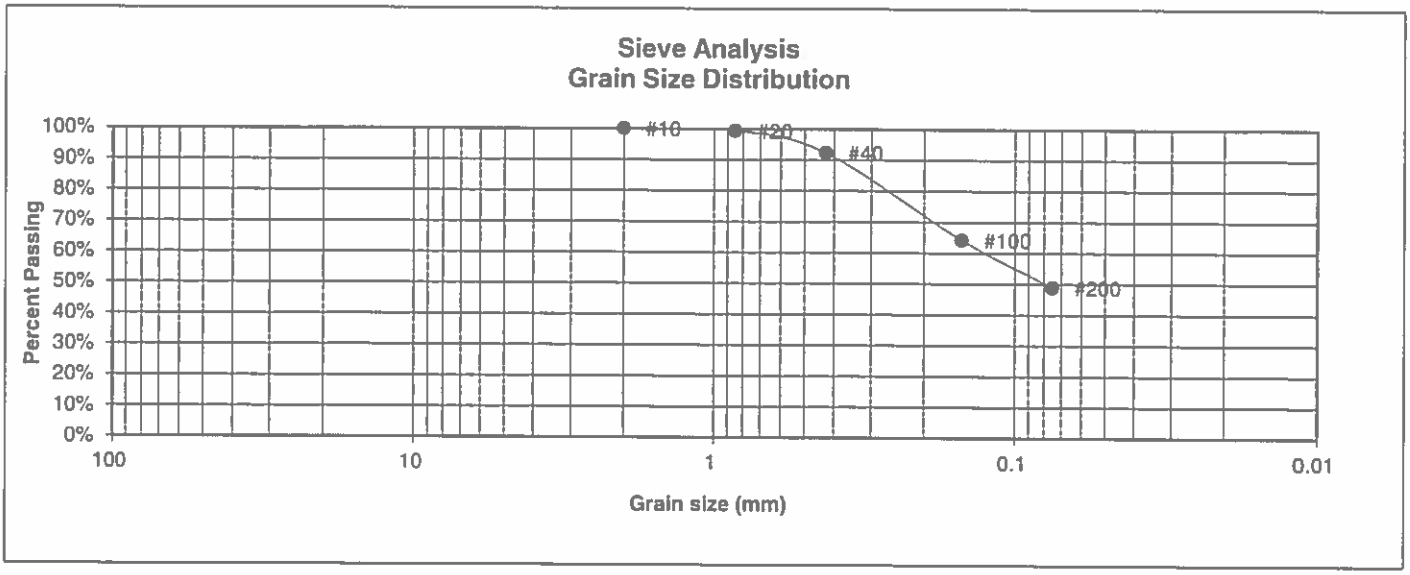
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 2/25/20

JOB NO. 200189
FIG NO. B-15

UNIFIED CLASSIFICATION	SC	CLIENT	TECH CONTRACTORS
SOIL TYPE #	3	PROJECT	STONEBRIDGE, FILING 4
TEST BORING #	5	JOB NO.	200189
DEPTH (FT)	5	TEST BY	BL
AASHTO CLASSIFICATION	A-4	GROUP INDEX	1



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	
10	100.0%
20	99.4%
40	92.3%
100	64.2%
200	48.9%

Atterberg Limits	
Plastic Limit	21
Liquid Limit	28
Plastic Index	7

Swell	
Moisture at start	
Moisture at finish	
Moisture increase	
Initial dry density (pcf)	
Swell (psf)	

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LABORATORY TEST RESULTS

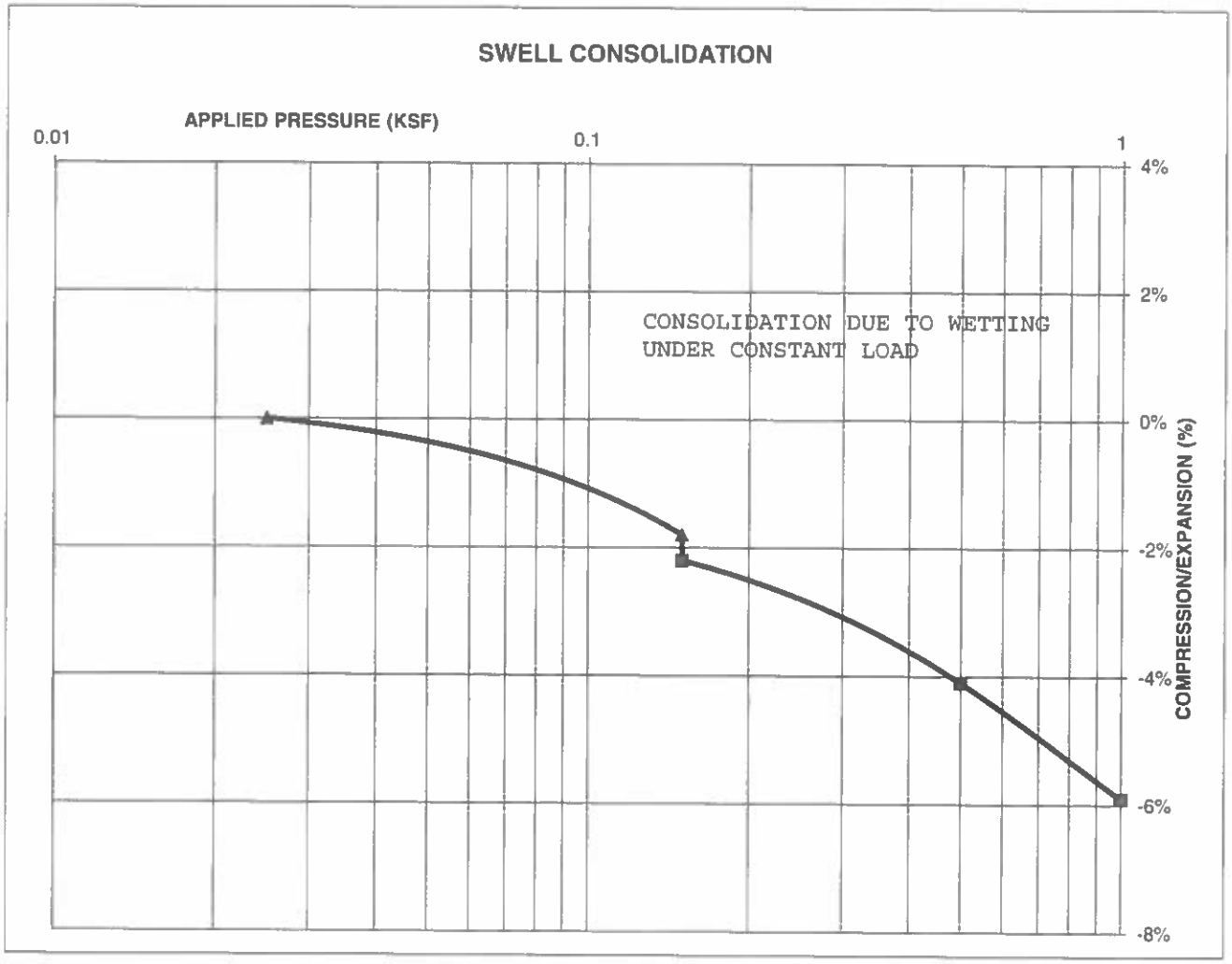
DRAWN	DATE	CHECKED:	DATE
			3/5/20

JOB NO. 200189
FIG NO. B-16

CONSOLIDATION TEST RESULTS

TEST BORING #	5	DEPTH(ft)	1-2
DESCRIPTION	SC	SOIL TYPE	1
NATURAL UNIT DRY WEIGHT (PCF)			111
NATURAL MOISTURE CONTENT			12.1%
SWELL/CONSOLIDATION (%)			-0.4%

JOB NO. 200189
CLIENT TECH CONTRACTORS
PROJECT STONEBRIDGE, FILING 4



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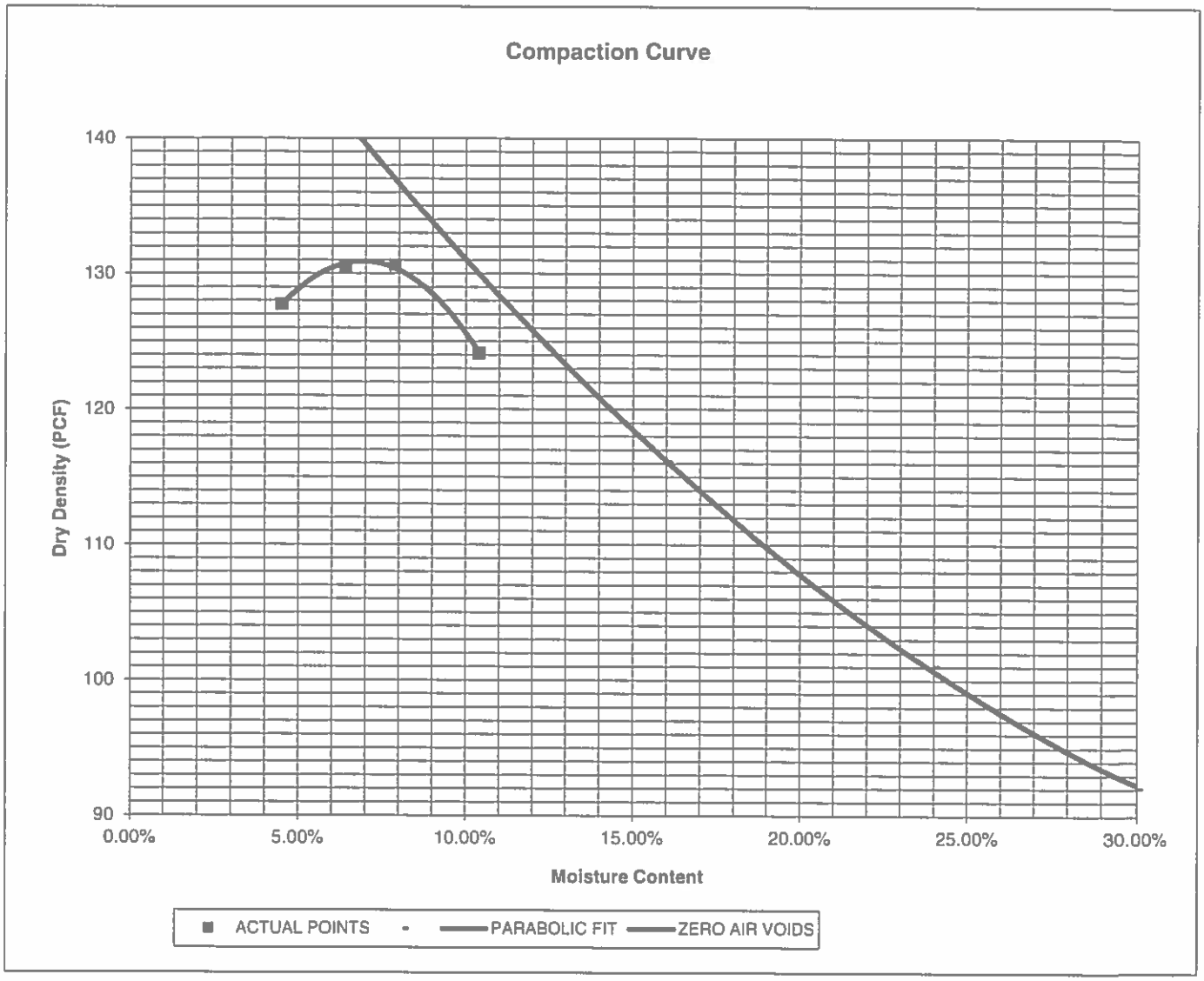
SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			3/13/20

JOB NO.: 200189
FIG NO.: 17

PROJECT	STONEBRIDGE, FILING 4	CLIENT	TECH CONTRACTORS
SAMPLE LOCATION	TB-4 @ 0-3'	JOB NO.	200189
SOIL DESCRIPTION	SAND, CLAYEY, BROWN	DATE	02/03/20

IDENTIFICATION	SC	COMPACTION TEST #	I
TEST DESIGNATION / METHOD	ASTM D-1557-A	TEST BY	AL
MAXIMUM DRY DENSITY (PCF)	130.9	OPTIMUM MOISTURE	7.0%



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MOISTURE DENSITY RELATION

DRAWN:	DATE:	CHECKED:	DATE:
			3/5/20

JOB NO. 200189

FIG NO. 6-18

CBR TEST LOAD DATA

JOB NO: 200189
CLIENT: TECH CONTRACTORS
PROJECT: STONEBRIDGE, FILING 4
SOIL TYPE: 1

PISTON DIAMETER (cm)	PISTON AREA (in^2)
4.958	2.99250919

PENETRATION DEPTH (INCHES)	*10 BLOWS* MOLD # 1 LOAD(LBS) (LBS)	STRESS (PSI)	*25 BLOWS* MOLD # 2 LOAD(LBS) (LBS)	STRESS (PSI)	*56 BLOWS* MOLD # 3 LOAD(LBS) (LBS)	STRESS (PSI)
0.000	0	0.00	0	0.00	0	0.00
0.025	120	40.10	339	113.28	557	186.13
0.050	165	55.14	597	199.50	1049	350.54
0.075	194	64.83	779	260.32	1515	506.26
0.100	236	78.86	1012	338.18	2261	755.55
0.125	269	89.89	1215	406.01	2897	968.08
0.150	296	98.91	1409	470.84	3393	1133.83
0.175	339	113.28	1568	523.97	3713	1240.76
0.200	362	120.97	1708	570.76	4110	1373.43
0.300	482	161.07	2264	756.56	5521	1844.94
0.400	598	199.83	2633	879.86	6000	2005.01
0.500	715	238.93	2987	998.16		

FINAL MOISTURE CONTENT

	MOLD # 1	MOLD # 2	MOLD # 3
CAN #	354	353	99
WT. CAN	6.69	6.82	6.97
WT. CAN+WET	182.73	197.54	153.76
WT. CAN+DRY	162.59	178.37	140.21
WT. H20	20.14	19.17	13.55
WT. DRY SOIL	155.9	171.55	133.24
MOISTURE CONTENT	12.92%	11.17%	10.17%
WET DENSITY (PCF)	121.4	128.9	135.3
DRY DENSITY (PCF)	113.4	120.5	126.4
BEARING RATIO	7.89	33.82	75.56

90% OF DRY DENSITY	117.8
95% OF DRY DENSITY	124.4

BEARING RATIO AT 90% OF MAX	24.04	~ R VALUE	71
BEARING RATIO AT 95% OF MAX	60.95	~ R VALUE	81

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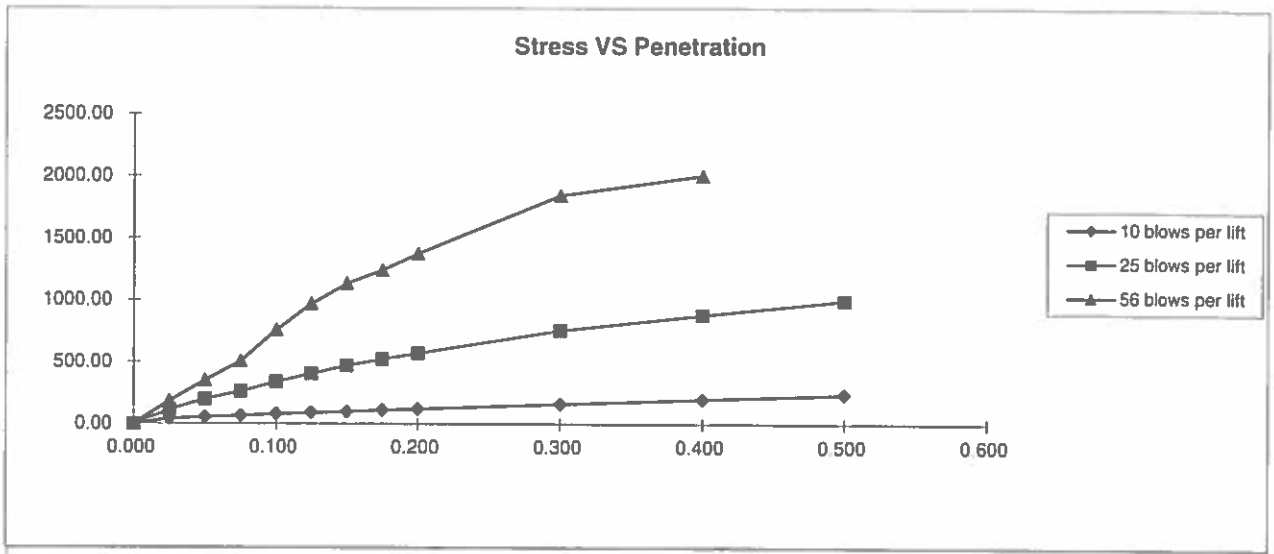
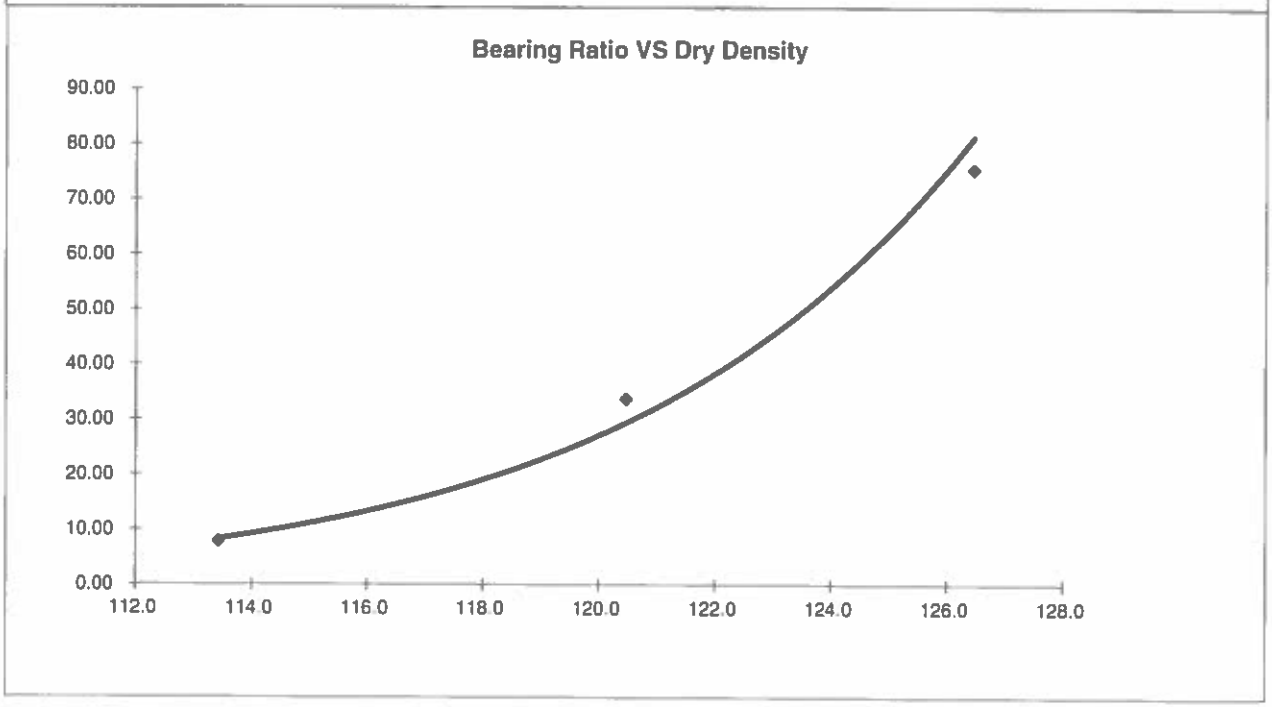
CBR TEST DATA

DRAWN:	DATE:	CHECKED:	DATE:
		DS	3/17/20

JOB NO.: 200189
FIG NO.: B-19





BEARING RATIO AT 90% OF MAX	24.04 ~ R VALUE	71.00
BEARING RATIO AT 95% OF MAX	60.95 ~ R VALUE	81.00

JOB NO: 200189
SOIL TYPE: 1

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CALIFORNIA BEARING RATIO

DRAWN:	DATE:	CHECKED:	DATE:
		DS	2/13/20

JOB NO: 200189
FIG NO: B-20

CLIENT	TECH CONTRACTORS	JOB NO.	200189
PROJECT	STONEBRIDGE, FILING 4	DATE	3/4/2020
LOCATION	STONEBRIDGE, FILING 4	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-3	1-2	1	SM	<0.01
TB-5	1-2	1	SC	<0.01
TB-8	1-2	1	SC-SM	<0.01
TB-4	10	2	SM	<0.01
TB-5	5	3	SC	<0.01
TB-9	1-2	1	SM	<0.01
TB-10	10	2	SM	<0.01

QC BLANK PASS

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COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE	CHECKED:	DATE
			3/31/20

JOB NO.: 200189
FIG NO.: B-21

APPENDIX C: Pavement Design Calculations

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA — STONEBRIDGE FILING NO. 4 - LOCAL LOW-VOLUME - ESAL 36,500

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	36,500
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.2
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Weighted Structural Number (WSN): → WSN = 1.46

DESIGN TABLES AND EQUATIONS

$S_1 = [(R - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10}W_{18} = Z_R * S_O + 9.36*\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32*\log_{10}M_R - 8.07$$

Left	Right	Difference
4.56	4.56	0.0

Job No. 200189
Fig. No. C-1

DESIGN CALCULATIONS

DESIGN DATA STONEBRIDGE FILING NO. 4 - LOCAL LOW-VOLUME - ESAL 36,500

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	1.46

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 1.2 inches of Aggregate
Base Course, use 4.0 inches

RECOMMENDED ALTERNATIVES

1. 3.0 inches of Asphalt + 4.0 inches of Aggregate Base Course, or
2. 5.0 inches of Full Depth Asphalt

Job No. 200189
Fig. No. C-2

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA:

"STONEBRIDGE FILING NO. 4 - LOCAL LOW-VOLUME - ESAL 36,500"
SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	36,500
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	1.46

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Cement Treated Subgrade.

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Cement Treated Subgrade (inches)

FOR FULL DEPTH ASPHALT SECTION - (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 3.3 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = -2.7 inches
Use 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade.
2. 5.0 inches of Full Depth Asphalt

Job No. 200189
Fig. No. C-3

FLEXIBLE PAVEMENT DESIGN

DESIGN DATA STONEBRIDGE FILING NO. 4 - URBAN LOCAL - ESAL = 292,000

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL (W_{18}) =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Standard Deviation	S_o =	0.45
Loss in Serviceability	Δpsi =	2.2
Reliability	Reliability =	80
Reliability (z-statistic)	Z_R =	-0.84
Soil Resilient Modulus	M_R =	13168

Weighted Structural Number (WSN): → WSN = 2.09

DESIGN TABLES AND EQUATIONS

$S_1 = [(R - 5) / 11.29] + 3$

$M_R = 10^{[(S_1 + 18.72) / 6.24]}$

$k = M_R / 19.4$

Where:

M_R = resilient modulus (psi)

S_1 = the soil support value

R = R-value obtained from the Hveem stabilometer

CBR = California Bearing Ratio

Reliability (%)	Z_R (z-statistic)
80	-0.84
85	-1.04
90	-1.28
93	-1.48
94	-1.56
95	-1.65
96	-1.75
97	-1.88
98	-2.05
99	-2.33
99.9	-3.09
99.99	-3.75

$$\log_{10}W_{18} = Z_R * S_O + 9.36*\log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32*\log_{10}M_R - 8.07$$

Left	Right	Difference
5.47	5.47	0.0

Job No. 200189
Fig. No. C-4

DESIGN CALCULATIONS

DESIGN DATA STONEBRIDGE FILING NO. 4 - URBAN LOCAL - ESAL = 292,000

SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.08

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Aggregate Base Course

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Base Course (inches)

FOR FULL DEPTH ASPHALT SECTION (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 4.7 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + AGGREGATE BASE COURSE SECTION

Asphalt Thickness (t) = [3.5] inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 4.9 inches of Aggregate
Base Course, use 8.0 inches

RECOMMENDED ALTERNATIVES

1. 3.5 inches of Asphalt + 8.0 inches of Aggregate Base Course, or
2. 5.0 inches of Full Depth Asphalt

Job No. 200189
Fig. No. C-5

DESIGN CALCULATIONS

CEMENT TREATED SECTIONS

DESIGN DATA:

"STONEBRIDGE FILING NO. 4 - URBAN LOCAL - ESAL 292,000"
SOIL TYPE 1, CBR # 1

Equivalent (18 kip) Single Axle Load Applications (ESAL):	ESAL =	292,000
Hveem Stabilometer (R Value) Results:	R =	50
Weighted Structural Number (WSN):	WSN =	2.08

DESIGN EQUATION

$$WSN = C_1D_1 + C_2D_2$$

C_1 = 0.44 Strength Coefficient - Hot Bituminous Asphalt
C_2 = 0.11 Strength Coefficient - Cement Treated Subgrade.

D_1 = Depth of Asphalt (inches)
D_2 = Depth of Cement Treated Subgrade (inches)

FOR FULL DEPTH ASPHALT SECTION - (CURRENTLY NOT ALLOWED)

$D_1 = (WSN)/C_1$ = 4.7 inches of Full Depth Asphalt
Use 5.0 inches Full Depth

FOR ASPHALT + CEMENT TREATED SUBGRADE SECTION

Asphalt Thickness (t) = 4 inches
$D_2 = ((WSN) - (t)(C_1))/C_2$ = 2.9 inches
Use 10.0 inches of Cement Treated Subgrade.

RECOMMENDED ALTERNATIVES

1. 4.0 inches of Asphalt + 10 inches of Cement Treated Subgrade.
2. 5.0 inches of Full Depth Asphalt

Job No. 200189
Fig. No. C-6