Briargate Parkway – Sterling Ranch Road East of Sand Creek

Soils and Geology

Soil and Geology reports for BGP crossing and SR Rd cossing have been included for this initial submittal

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SUBSURFACE SOIL INVESTIGATION
BRIARGATE BOULEVARD OVER SAND CREEK
EL PASO COUNTY, COLORADO

Prepared for:

C&C Land
20 Boulder Crescent, 2nd Floor
Colorado Springs, Colorado 80903

Attn: Chaz Collins

July 29, 2021

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Daniel P. Stegman

Reviewed by:

Austin M. Nossokoff, P.E.

AMN/amn

Encl.

Entech Job No. 211647
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SUBSURFACE SOIL INVESTIGATION
BRIARGATE BOULEVARD OVER SAND CREEK
EL PASO COUNTY, COLORADO

1.0 INTRODUCTION

C&C Land is planning the construction of a vehicular bridge over sand creek for the proposed Briargate Boulevard in El Paso County northeast of Colorado Springs, Colorado. The approximate location of the site is shown on the Vicinity Map, Figure 1. The planned layout of the proposed bridge is shown on Figure 2, the Site Plan/Test Boring Map.

This report describes the subsurface investigation conducted for the planned bridge and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling test borings at two (2) locations within the footprints of the planned bridge foundations, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. All drilling and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech's understanding that the project will consist of the construction of a vehicular bridge spanning Sand Creek with driven H-pile foundations and associated site improvements. At the time of drilling, the site for the proposed bridge was vacant. The crossing for the proposed Briargate Boulevard had been graded at the time of drilling. Sand Creek flows to the south. Current vegetation on the site consisted of grasses and small shrubs.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling two (2) exploratory test borings, one at each bridge abutment. The borings were drilled to depths 20 feet below the existing ground surface using a truck-mounted continuous flight auger-drilling rig supplied and operated by Entech Engineering, Inc. Boring Logs descriptive of the subsurface conditions encountered during drilling and subsequent to drilling are presented in Appendix A. At the conclusion of drilling, observations of groundwater levels were made in each of the open borings. The approximate locations of the test borings are indicated on Figure 2.

Soil samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using a California Sampler. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the Test Boring Logs. It should be understood that the soil descriptions shown on the Test Boring Logs may vary between boring location and sample depth.

It should also be noted that the lines of stratigraphic separation shown on the Test Boring Logs represent approximate boundaries between soil types and the actual stratigraphic transitions may be more gradual and vary with location. The Test Boring Logs are presented in Appendix A.

Moisture Content, ASTM D-2216, was obtained in the laboratory for all recovered samples. Grain-Size, ASTM D-422, and Atterberg Limits, ASTM D-4318, were determined for various samples for the purpose of classification and to obtain pertinent engineering characteristics. Volume change testing was performed on selected samples using the Swell/Consolidation Test (ASTM D-4546) in order to evaluate potential expansion/consolidation characteristics of the soil and bedrock. Sulfate testing was performed on select samples to determine the corrosive characteristics of the soils. The Laboratory Test Results are included in Appendix B and summarized in Table 1.

4.0 SUBSURFACE CONDITIONS

One (1) soil type and two (2) bedrock types were encountered in the borings drilled for the subsurface investigation: Type 1: slightly silty to silty sand (SM-SW), Type 2: slightly silty sandstone (SM-SW), and Type 3: sandy siltsone (ML). The soils were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

4.1 Soil and Rock

Soil Type 1 is a slightly silty to silty sand (SM-SW). The sand was encountered in both of the test borings at the existing ground surface extending to depths of 4 to 5 feet. Standard Penetration Testing conducted on the sand resulted in an SPT N-value of 47 blows per foot (bpf), which indicates dense states. Moisture content and grain size testing resulted in a moisture content of 17 percent with approximately 8 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing was performed on a sample of sand and resulted in a liquid limit of no value with a plastic index of non-plastic. Sulfate tests performed on a sample of

the sand resulted in less than 0.01 percent sulfate by weight, indicating the sand exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Soil Type 2 is a slightly silty sandstone bedrock (SM). The sandstone was encountered in both of the test borings at depths ranging from 4 to 5 feet bgs and extending to depths of 9 to 14 feet and again at depths ranging from 16 to 19 feet bgs and extending to the termination of the borings (20 feet). Standard Penetration Testing conducted on the sandstone resulted in N-values of 50 to greater than 50 blows per foot (bpf), indicating the sandstone is dense to very dense in terms of density. Moisture content and grain size testing resulted in moisture contents of 11 to 16 percent with approximately 8 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing was performed on a sample of sand and resulted in a liquid limit of no value with a plastic index of non-plastic. Sulfate tests performed on a sample of the sandstone resulted in 0.00 percent sulfate by weight, indicating the sandstone exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Soil Type 3 is a sandy siltstone bedrock (ML). The siltstone was encountered in both of the test borings at depths of 9 to 14 feet bgs and extending to depths of 16 to 19 feet bgs. Standard Penetration Testing conducted on the soil resulted in N-values of greater than 50 blows per foot (bpf), indicating the soil is hard in terms of consistency. Moisture content and grain size testing resulted in moisture contents of 14 to 17 percent with approximately 70 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing resulted in a liquid limit of 36 and a plastic index of 8. Swell/Consolidation Testing resulted in a volume change of 3.7 percent, indicating the siltstone exhibits a high expansion potential. Sulfate tests performed on a sample of the siltstone resulted in 0.00 percent sulfate by weight, indicating the siltstone exhibits negligible potential for concrete degradation due to below grade sulfate attack.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs. Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

4.2 Groundwater

Groundwater was encountered at depths ranging from 1-1/2 to 3-1/2 feet in the test borings drilled on this site. Groundwater will affect development of significant foundation excavations or during installation of deep utilities depending on the final grading plans. Creek flow will vary due to rainfall, drainage, and other factors not readily apparent at this time. Unstable conditions may be encountered where excavations approach the groundwater level. Stabilization using shot rock or geogrids may be necessary. It should be noted that groundwater levels, observed at the time of the subsurface investigation, could change due to seasonal variations, changes in land runoff characteristics and future development including of nearby areas.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled in the planned bridge footprint. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

The site will be developed by constructing a bridge over Sand Creek and associated site improvements at the Briargate Boulevard Crossing. The proposed bridge is expected to utilize a driven H-pile foundation.

Subsurface soil conditions encountered in the test borings drilled for the planned interchanges consisted of slightly silty to silty sand overlying interbedded slightly silty sandstone and sandy siltstone. Bedrock was encountered at depths of 4 to 5 feet in the test borings. The surficial sands and were encountered in dense states. The underlying sandstone was encountered in dense to very dense states, and the underlying siltsone was encountered at hard consistencies.

5.1 Foundation Recommendations

The main purpose of the subsurface investigation was to gather soil and bedrock information for the proposed bridge abutments for use in providing foundation recommendations and design values. Recommendations for bridge supports using driven H-piles, shallow spread footings, and parameters for retaining walls are provided.

5.1.1 Deep Foundation Systems (Driven H-piles)

Based on evaluation of the site subsurface conditions, it is believed that the planned H-piles will achieve most of their compressive strength through end bearing and skin friction in the underlying sandstone and siltsone bedrock (Soil Types 2 and 3). Some frictional resistance will also be developed in the overburden sand (Soil Type 1). Design parameters for use in the H-pile design, which include allowable end bearing, side resistance, and resisting factors are presented in Table 2. L Pile parameters for the sand, sandstone, and siltstone are also included in Table 2. The recommendations and parameters apply to piles spaced by horizontal distances of at least 3 times the pile width. If the piles are spaced closer, reductions in the allowable pile capacity may be warranted. The following unit weights are recommended for the site soil and bedrock.

Unit weight of native overburden sand	120 pcf
Unit weight of sandstone bedrock	125 pcf
Unit weight of siltstone bedrock	125 pcf

It is recommended that full-time observation of the H-pile installation be performed to compile driving logs for each pile. At a minimum, the log should include: the driving resistance per foot of pile and per inch of pile over the last 3 inches; the pile driver make and model; rated energy; pile cushion/condition; observed damage; and final pile top location. The guidance set forth in the State of Colorado Standard Specifications for Road and Bridge Construction, Section 502, Piling, is recommended. Piles should be driven 10 feet into bedrock or refusal.

5.1.2 Shallow Foundation Parameters

Structures associated with the bridges can be supported with shallow foundations resting on the native sands, recompacted loose sands, or sandstone. It should be noted that due to potential shallow groundwater on this site (due to the proximity to Sand Creek), extensive subgrade improvements are anticipated to support shallow foundations. The foundation members should bear on the native site sands, sandstone, or be recompacted according to the "Structural Fill" paragraph. Any topsoil must be removed and the existing subgrade cleared of any debris prior to excavation. Loose soils or uncontrolled fill material beneath foundation components will require removal and recompaction. Any expansive soils encountered beneath the foundation will require removal and replacement with non-expansive structural fill compacted according to the "Structural Fill" paragraph. Any new fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill as approved by Entech. Any import material should be approved by Entech prior to hauling to the site.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for the native sands. For recompacted sands or imported granular structural fill, an allowable bearing capacity of 3000 psf is recommended. An allowable bearing capacity of 3500 psf is recommended for undisturbed sandstone. Footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection. Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs which should limit total and differential vertical movements.

Foundation excavations are recommended to extend at least 3 feet horizontally beyond the foundation limits in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of $1^1/_2$ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe overexcavated subgrades as well as the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this

report. Entech should also provide recommendations for overexcavation depth and other subgrade improvements, if necessary, and the need for drain systems based on the excavation conditions observed at that time.

5.1.3 Retaining Wall Parameters

The following values are recommended for use in designing retaining walls with unbalanced lateral loading that may be associated with this project. Roadway/Vehicle surcharge loading is required for wall design.

Recommended Design Values – Lateral Loading

Equivalent fluid density for lateral earth pressure (active), pcf (site granular soils)	45
Equivalent fluid density for lateral earth pressure (passive), pcf	300
Equivalent fluid density for lateral earth pressure (at rest), pcf	60
Soil density (compacted sand), pcf	125
Angle of Internal Friction (loose silty sand)	26°
Angle of Internal Friction (compacted silty sand)	34°
Coefficient of sliding between concrete and silty gravelly sand	0.35
Bearing capacity of sand, psf	2400 psf
Bearing capacity of sandstone, psf	3500 psf

*Note: The above lateral loading design values are for level back slope angles and no surcharge loads. If wall backfill is submerged, water pressures must be taken into account as additional wall loading. If backfill slope angles are greater than zero degrees, or if the backfill is surcharged, the design values must be adjusted to account for additional lateral loading.

5.2 Site Seismic Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2015 International Building Code (IBC), the site meets the conditions of a Site Class C.

5.3 Surface and Subsurface Drainage

Positive surface drainage must be maintained around structures to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation components is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from structures.

5.4 Concrete

Soluble sulfate testing was conducted on three samples of the site soils to evaluate the potential for sulfate attack on concrete placed below the surface grade. The test results indicated 0.00 to less than 0.01 percent soluble sulfate by weight for the site soils. The test results indicate the sulfate component of the in-place site soils present a negligible exposure threat to concrete placed below grade that comes into contact with the site soils.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in foundation excavations prior to the placement of concrete. If standing water is present in the foundation excavations, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.5 Foundation Excavation Observations

Subgrade preparation for bridge foundations and associated improvements should be observed by Entech Engineering prior to construction of the foundation elements in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Pile driving should be observed to verify proper embedment or refusal. Piles should be driven 10 feet into bedrock or refusal.

Entech should make final recommendations for over-excavation or stabilization, if required, at the time of excavation observation, if necessary.

5.6 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within ±2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill. New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components. All fill placed within the foundation areas should be non-expansive and be compacted to a minimum of 95 percent of the soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Fill material placed beneath floor slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to achieving adequate compaction, usually within ±2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from the structure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of fill material.

5.7 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within $\pm$2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

Trench backfill placement should be performed in accordance with El Paso County specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

5.8 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12-inches and moisture conditioned to ± 2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches, beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

5.9 Excavation Stability

Excavation sidewalls must be properly sloped, benched and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

5.10 Winter Construction

In the event construction of the planned construction occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to avoid burial of snow, ice or frozen material within the planned construction area.

5.11 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- H-Pile Installation
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components and retaining walls.
- Placement/compaction of utility bedding and trench backfill.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use of C&C Land with application to the proposed bridge over Sand Creek at Briargate Boulevard and associated site improvements, in El Paso County northeast of Colorado Springs, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLES

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT C&C LAND
PROJECT BRIARGATE BRIDGE
JOB NO. 211647

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	5			7.6	NV	NP	<0.01			SM-SW	SAND, SLIGHTLY SILTY
2	1	20			8.0	NV	NP	0.00			SM-SW	SANDSTONE, SLIGHTLY SILTY
3	2	10	14.7	120.5	70.3	36	8	0.00		3.7	ML	SILTSTONE, SANDY

TABLE 2

Briargate Boulevard over Sand Creek Bridge - LPile Design Parameters

Depth Below Existing Ground Surface		Groundwater Elevation (ft) Below Existing Ground	Soil/Rock Description	Axial Pile Capacity Parameters		PRELIMINARY LPile Parameters					
Top	Bottom			Allowable Side Resistance (ksf)	Allowable End Bearing (ksf)	p-y Curve	Unit Weight γ[1] (pcf)	Peak Friction Angle ϕ (deg)	Initial Static Modulus of Subgrade Reaction, k (pci)	Undrained Cohesion s_u (psf)	Strain Factor ε_{50} (in/in)
0	4 to 5	1.5 to 3.5	Slightly Silty Sand	—	—	Sand	120 62[1]	32	25 20[1]	N/A	N/A
4 to 5 16 to 19	9 to 14 BOE		Slightly Silty Sandstone	3	30	Sand	125 67[1]	34	225 125[1]	N/A	N/A
9 to 14	16 to 19		Sandy Siltstone	3	30	Clay	115 57[1]	N/A	500	1500	0.005

[1] = Submerged

FIGURES

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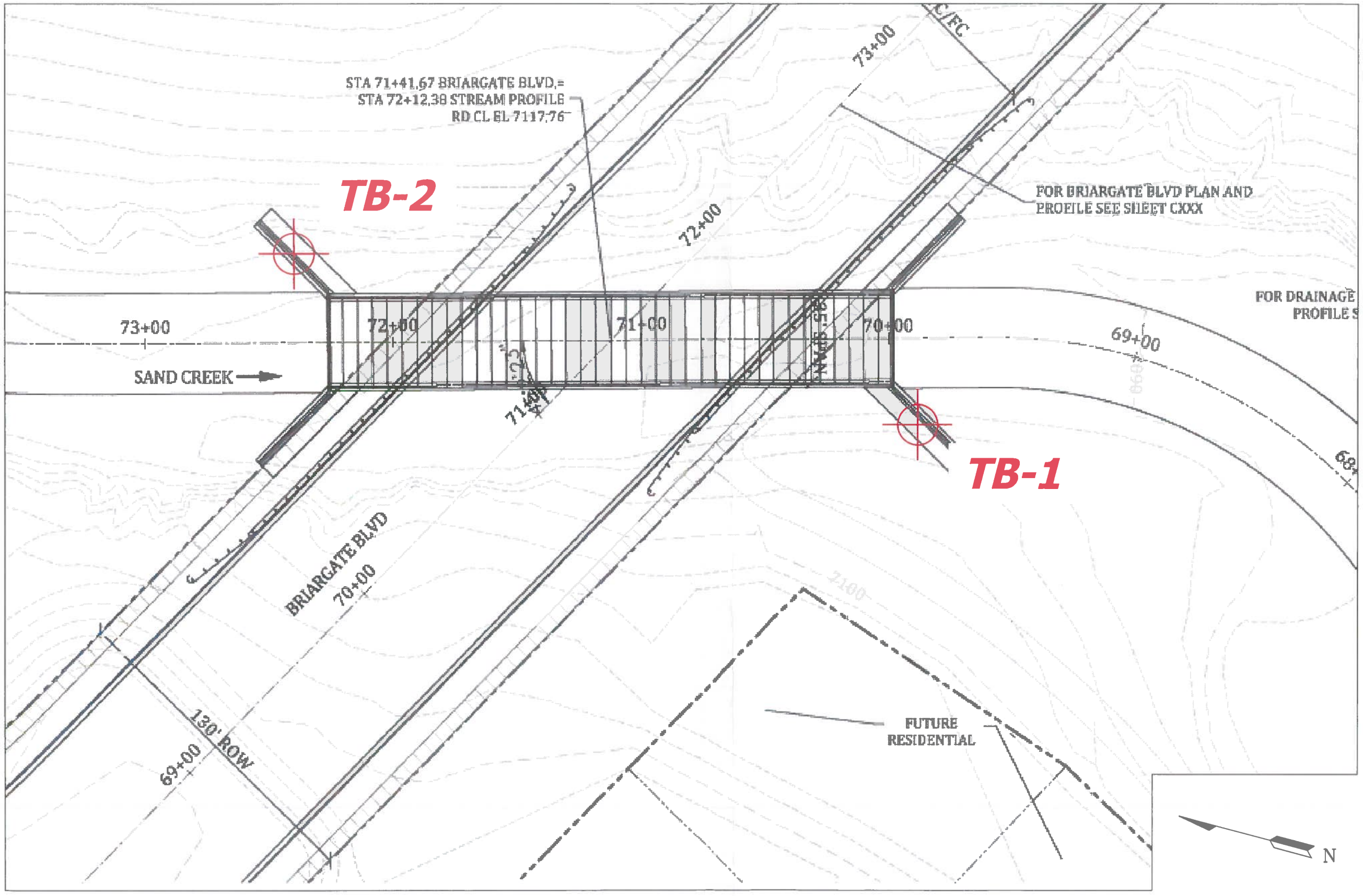
Vicinity Map
Briargate Blvd Over Sand Creek
El Paso County, CO
For: C & C Land

DRAWN:	DATE:	CHECKED:	DATE:
AMN	7/26/21		

JOB NO.: 211647

FIG NO.: 1

TB-2- APPROXIMATE TEST BORING LOCATION AND NUMBER



REVISIONS	BY:

ENTECH
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Site Plan/Test Boring Map
Briargate Blvd Over Sand Creek
El Paso County, CO
For: C & C Land

DRAWN BY:	AMN
DESIGNED BY:	AMN
CHECKED BY:	
DATE:	07/28/2021
SCALE:	AS SHOWN
JOB NO:	211847
FIGURE NO.:	2

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 7/13/2021
Job # 211647

REMARKS

WATER @ 1.5', 7/20/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE, VERY MOIST					
5			47	16.5	1
SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, DENSE TO VERY DENSE, VERY MOIST					
10			50/6"	11.5	2
SILTSTONE, SANDY, GRAY BROWN, HARD, MOIST					
15			50/5"	16.0	3
SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, VERY MOIST					
20			50/5"	15.5	2

TEST BORING NO. 2
DATE DRILLED 7/13/2021
CLIENT C&C LAND
LOCATION BRIARGATE BRIDGE

REMARKS

WATER @ 3.5', 7/20/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
SAND, SILTY, BROWN					1
5			50	13.2	2
SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE, MOIST					
10			50/11"	14.3	3
SILTSTONE, SANDY, GRAY BROWN, HARD, MOIST					
15			50/4"	16.6	3
SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, VERY DENSE,					
20			50/4"	10.8	2

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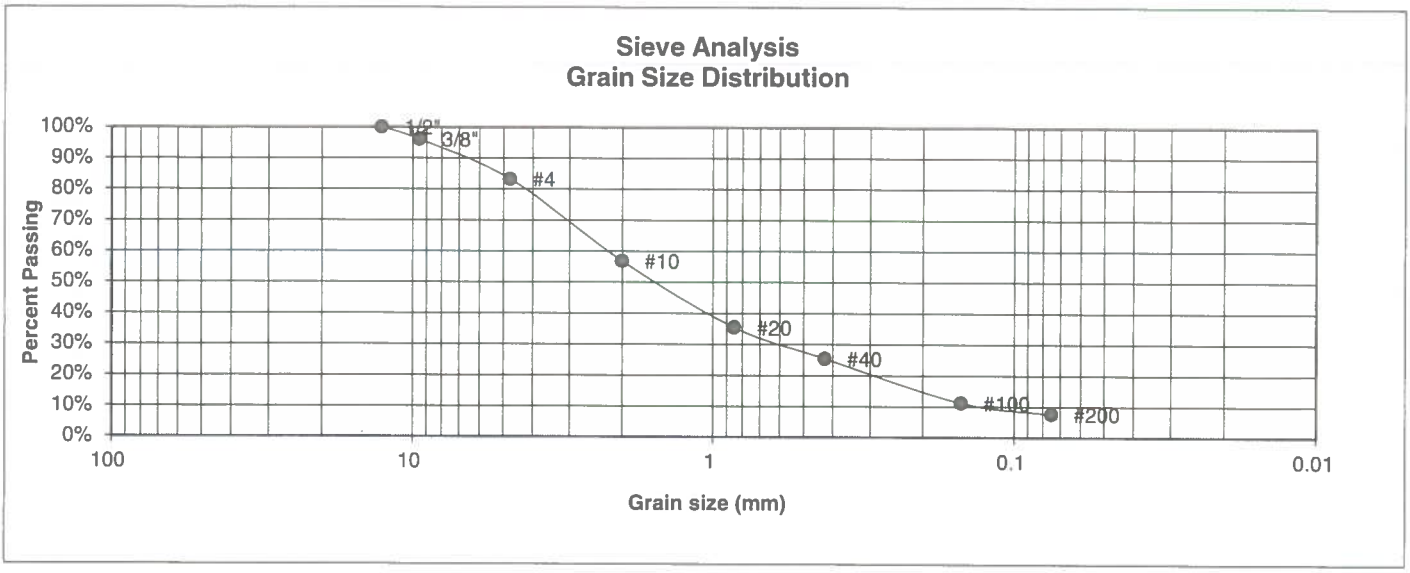
TEST BORING LOG

DRAWN:	DATE:	CHECKED:	DATE:
			7/23/21

JOB NO.: 211647
FIG NO.: A- 1

APPENDIX B: Laboratory Test Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	BRIARGATE BRIDGE
TEST BORING #	1	JOB NO.	211647
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	96.1%
4	83.2%
10	56.8%
20	35.4%
40	25.4%
100	11.2%
200	7.6%

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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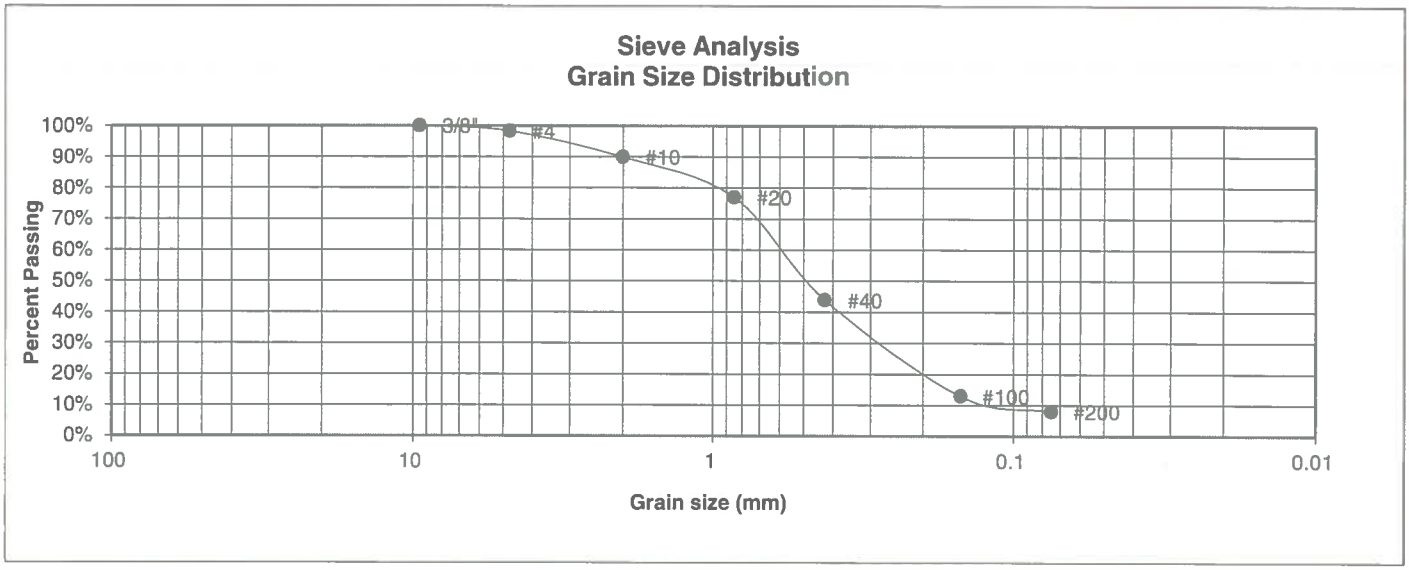
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			7/23/21

JOB NO.: 211647

FIG NO.: B-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	2	PROJECT	BRIARGATE BRIDGE
TEST BORING #	1	JOB NO.	211647
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.3%
10	89.9%
20	77.0%
40	43.8%
100	12.9%
200	8.0%

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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505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

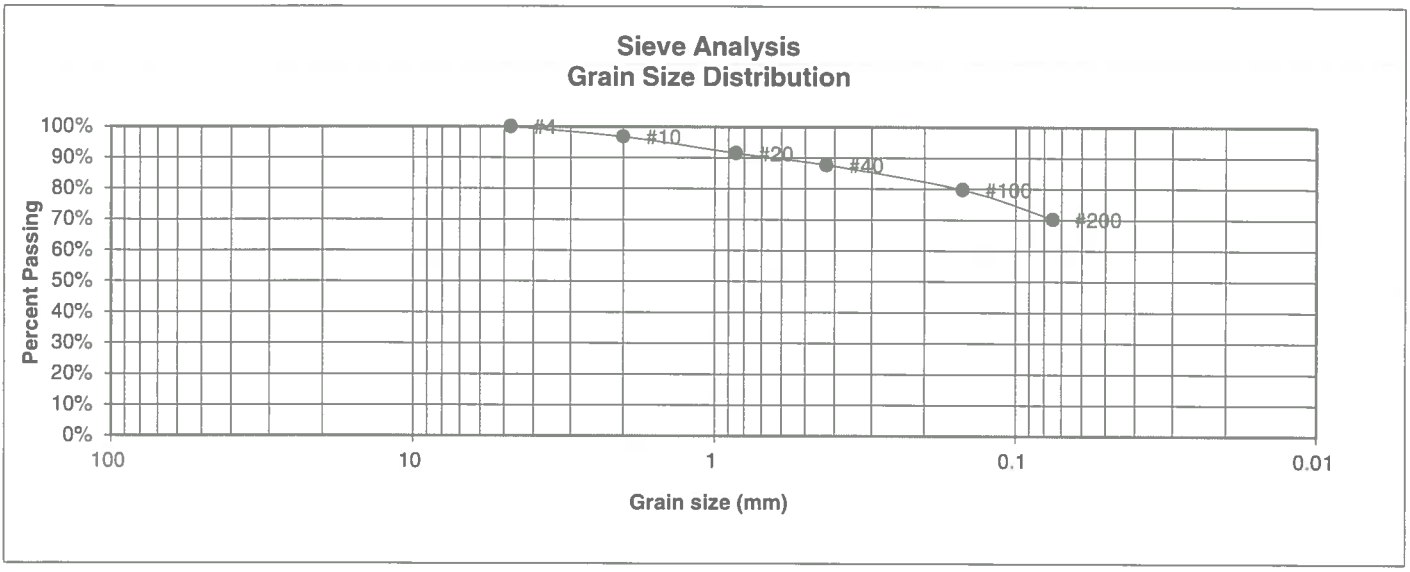
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		AW	7-29-21

JOB NO.: 211647

FIG NO.: B-2

UNIFIED CLASSIFICATION	ML	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	BRIARGATE BRIDGE
TEST BORING #	2	JOB NO.	211647
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	
4	100.0%
10	96.8%
20	91.5%
40	87.7%
100	79.8%
200	70.3%

Atterberg Limits	
Plastic Limit	28
Liquid Limit	36
Plastic Index	8

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

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COLORADO SPRINGS, COLORADO 80907

LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		A	7/23/21

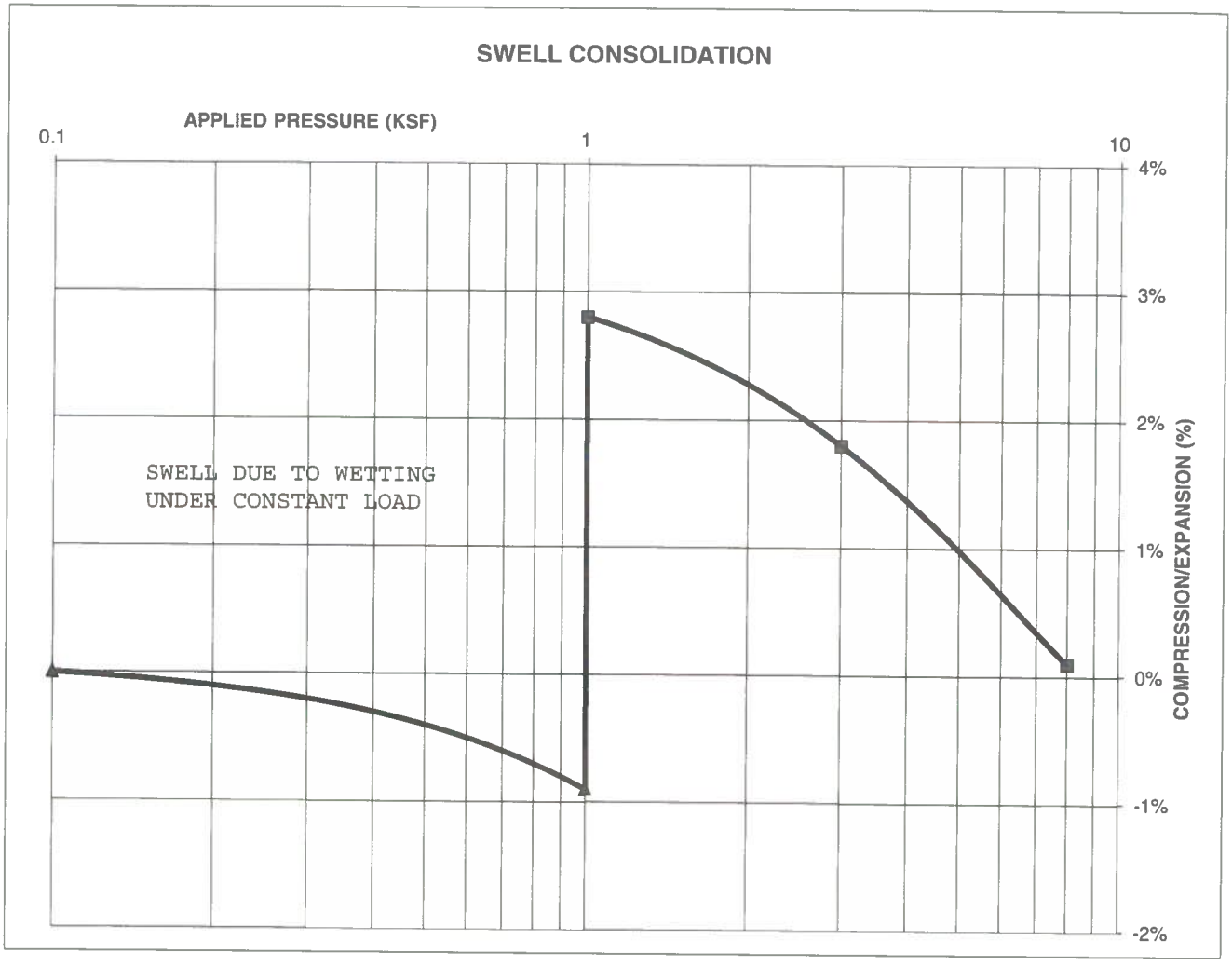
JOB NO.: 211647

FIG NO.: B-3

CONSOLIDATION TEST RESULTS

TEST BORING #	2	DEPTH(ft)	10
DESCRIPTION	ML	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			121
NATURAL MOISTURE CONTENT			14.7%
SWELL/CONSOLIDATION (%)			3.7%

JOB NO. 211647
CLIENT C&C LAND
PROJECT BRIARGATE BRIDGE



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COLORADO SPRINGS, COLORADO 80907

SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
			7/23/21

JOB NO.: 211647

FIG NO.: B-4

CLIENT	C&C LAND	JOB NO.	211647
PROJECT	BRIARGATE BRIDGE	DATE	7/19/2021
LOCATION	BRIARGATE BRIDGE	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	5	1	SM-SW	<0.01
TB-2	10	3	ML	0.00
TB-1	20	2	SM-SW	0.00

QC BLANK PASS

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LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE: 7/23/21

JOB NO.: 211647

FIG NO.: B-5

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SUBSURFACE SOIL INVESTIGATION
STERLING RANCH BRIDGE
STERLING RANCH ROAD OVER SAND CREEK
EL PASO COUNTY, COLORADO

Prepared for:

C&C Land
20 Boulder Crescent, 2nd Floor
Colorado Springs, Colorado 80903

Attn: Chaz Collins

November 4, 2021

Respectfully Submitted,

ENTECH ENGINEERING, INC.

Stuart Wood
Geologist

Reviewed by:

Austin M. Nossokoff, P.E.

SW/bs

Encl.

Entech Job No. 200045
F:\AA projects\2020\200045-C&C LAnd-Sterling Ranch Bridges-220-SS\200045 ssi - 2.doc

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SUBSURFACE SOIL INVESTIGATION
STERLING RANCH BRIDGES
STERLING RANCH ROAD OVER SAND CREEK
EL PASO COUNTY, COLORADO

1.0 INTRODUCTION

C&C Land is planning the construction of a vehicular bridge over Sand Creek for the proposed Sterling Ranch Road in El Paso County northeast of Colorado Springs, Colorado. The approximate location of the site is shown on the Vicinity Map, Figure 1. The planned layout of the proposed bridge is shown on Figure 2, Test Boring Location Map.

This report describes the subsurface investigation conducted for the planned bridge and provides recommendations for foundation design and construction. The subsurface soil investigation included drilling test borings at four (4) locations, in the creek bed near the bridge crossing and in the footprint of the proposed bridge abutments, collecting samples of soil, and conducting a geotechnical evaluation of the investigation findings. All drilling and subsurface investigation activities were performed by Entech Engineering, Inc. (Entech). The contents of this report, including the geotechnical evaluation and recommendations, are subject to the limitations and assumptions presented in Section 6.0.

2.0 PROJECT AND SITE DESCRIPTION

It is Entech's understanding that the project will consist of the construction of a vehicular bridge spanning Sand Creek with driven H-pile foundations and associated site improvements. At the time of drilling, the site for the proposed bridge was vacant. The crossing for the proposed Sterling Ranch Road had been rough graded at the time of drilling. Sand Creek flows to the south and east. Current vegetation on the site consisted of grasses and small shrubs.

3.0 SUBSURFACE EXPLORATIONS AND LABORATORY TESTING

The subsurface conditions were investigated by drilling four (4) exploratory test borings, in the creek bed near the proposed bridge crossing and in the footprint of the proposed bridge abutments. The borings were drilled to depths of 20 and 30 feet below the existing ground surface using a truck-mounted continuous flight auger-drilling rig supplied and operated by Entech Engineering, Inc. Boring Logs descriptive of the subsurface conditions encountered during drilling and subsequent to drilling are presented in Appendix A. At the conclusion of drilling, observations of groundwater levels were made in each of the open borings. The approximate locations of the test borings are indicated on Figure 2.

Soil samples were obtained from the borings utilizing the Standard Penetration Test (ASTM D-1586) using a California Sampler. Results of the Standard Penetration Test (SPT) are included on the Test Boring Logs in terms of N-values expressed in blows per foot (bpf). Soil samples recovered from the borings were visually classified and recorded on the Test Boring Logs. The soil classifications were later verified utilizing laboratory testing and grouped by soil type. The soil type numbers are included on the Test Boring Logs. It should be understood that the soil descriptions shown on the Test Boring Logs may vary between boring location and sample depth.

It should also be noted that the lines of stratigraphic separation shown on the Test Boring Logs represent approximate boundaries between soil types and the actual stratigraphic transitions

may be more gradual and vary with location. The Test Boring Logs are presented in Appendix A.

Moisture Content, ASTM D-2216, was obtained in the laboratory for all recovered samples. Grain-Size, ASTM D-422, and Atterberg Limits, ASTM D-4318, were determined for various samples for the purpose of classification and to obtain pertinent engineering characteristics. Volume change testing was performed on selected samples using the Swell/Consolidation Test (ASTM D-4546) in order to evaluate potential expansion/consolidation characteristics of the bedrock. Sulfate testing was performed on select samples to determine the corrosive characteristics of the soils. The Laboratory Test Results are included in Appendix B and summarized in Table 1.

4.0 SUBSURFACE CONDITIONS

One (1) soil type and two (2) bedrock types were encountered in the borings drilled for the subsurface investigation: Type 1: slightly silty to well graded sand (SM-SW, SW), Type 2: silty to slightly silty sandstone (SM, SM-SW), and Type 3: very sandy claystone to siltstone bedrock (CL, ML). The soils were classified in accordance with the Unified Soil Classification System (USCS) using the laboratory testing results and the observations made during drilling.

4.1 Soil and Rock

Soil Type 1 is a slightly silty to well graded clean sand (SM-SW, SW). The sand was encountered in all the test borings at the existing ground surface extending to a depth of up to 9 feet. Standard Penetration Testing conducted on the sand resulted in N-values of 8 to 21 blows per foot (bpf), which indicates loose to medium dense states. Moisture content and grain size testing resulted in moisture contents of 10 to 15 percent with approximately 5 to 10 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing was performed on a sample of native sand and resulted in a liquid limit of no value with a plastic index of non-plastic. Sulfate testing on the sand resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 2 is a silty to slightly silty sandstone (SM, SM-SW). The sandstone was encountered in three of the test borings at depths ranging from 2 to 4 feet bgs and extending to depths of 25 feet or the depths explored (20 feet). Standard Penetration Testing conducted on the sandstone resulted in N-values of 50 to greater than 50 blows per foot (bpf), indicating the sandstone is very dense in terms of density. Moisture content and grain size testing resulted in moisture contents of 9 to 21 percent with approximately 10 percent of the soil size particles passing the No. 200 sieve in the sample tested. Atterberg limit testing resulted in liquid limits of no value and plastic indexes of non-plastic. Sulfate testing on the sandstone resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Soil Type 3 is very sandy claystone to very sandy siltstone (CL, ML). The claystone/siltstone was encountered in Test Borings 1 and 4 at a depth of 9 to 25 feet bgs and extending to the termination of the borings (20 to 30 feet). Standard Penetration Testing conducted on the bedrock resulted in N-values of greater than 50 blows per foot (bpf), indicating the bedrock is hard in terms of consistency. Moisture content and grain size testing resulted in moisture contents of 10 to 22 percent with approximately 52 and 59 percent of the soil size particles passing the No. 200 sieve. Atterberg limit testing on the siltstone resulted in a liquid limit no value and a plastic index of non-plastic. Swell/Consolidation Testing on samples of the claystone/siltstone resulted in volume changes of 0.0 to 0.1 percent, indicating a low potential for expansion/consolidation. Sulfate testing on the sandstone resulted in 0.00 percent soluble sulfate by weight, indicating negligible potential for below grade concrete degradation due to sulfate attack.

Additional descriptions and engineering properties of the soil encountered during drilling are included on the boring logs. Laboratory Testing Results are summarized on Table 1 and presented in Appendix B. It should be understood that the soil descriptions reported on the boring logs may vary between boring locations and sampling depths. Similarly, the lines of stratigraphic separation shown on the boring logs represent approximate boundaries between soil types and the actual transitions between types may be more gradual or variable.

4.2 Groundwater

Groundwater was encountered at depths of 1 foot during and subsequent to drilling. Groundwater will affect development of significant foundation excavations or during installation of deep utilities depending on the final grading plans. Creek flow will vary due to rainfall, drainage, and other factors not readily apparent at this time. It should be noted that groundwater levels, observed at the time of the subsurface investigation, could change due to seasonal variations, changes in land runoff characteristics and future development including nearby areas.

5.0 GEOTECHNICAL EVALUATION AND RECOMMENDATIONS

The following discussion is based on the subsurface conditions encountered in the borings drilled in the creek bed near the planned bridge. If subsurface conditions different from those described herein are encountered during construction or if the project elements change from those described, Entech Engineering, Inc. should be notified so that the evaluation and recommendations presented can be reviewed and revised if necessary.

The site will be developed by constructing a vehicle traffic bridge over Sand Creek and associated site improvements on Sterling Ranch Road. The proposed bridge is expected to utilize driven H-pile foundations

Subsurface soil conditions encountered in the test borings drilled for the planned bridge structure consisted of fine to coarse grained to well graded sand overlying silty to slightly silty sandstone and very sandy claystone and siltstone. Bedrock was encountered at depths of 2 to 9 feet in the test borings. The surficial sands were encountered at loose to medium dense states. The underlying sandstone was encountered in very dense states, and the underlying claystone/siltstone were encountered at hard consistencies.

5.1 Foundation Recommendations

The main purpose of the subsurface investigation was to gather soil and bedrock information for the proposed bridge abutments for use in providing foundation recommendations and design values. Recommendations for bridge supports using driven H-piles, shallow spread footings, and parameters for retaining walls are provided.

5.1.1 Deep Foundation Systems (Driven H-piles)

Based on evaluation of the site subsurface conditions, it is believed that the planned H-piles will achieve most of their compressive strength through end bearing and skin friction in the underlying sandstone and claystone bedrock (Soil Types 2 and 3). Some frictional resistance will also be developed in the overburden sand (Soil Type 1). Design parameters for use in the H-pile design, which include allowable end bearing, side resistance, and resisting factors are presented in Table 2. L Pile parameters for the sand, sandstone, and claystone are also included in Table 2. The recommendations and parameters apply to piles spaced by horizontal distances of at least 3 times the pile width. If the piles are spaced closer, reductions in the allowable pile capacity may be warranted. The following unit weights are recommended for the site soil and bedrock.

Unit weight of native overburden sand	120 pcf
Unit weight of sandstone bedrock	125 pcf
Unit weight of siltstone and claystone bedrock	115 pcf

It is recommended that full-time observation of the H-pile installation be performed to compile driving logs for each pile. At a minimum, the log should include: the driving resistance per foot of pile and per inch of pile over the last 3 inches; the pile driver make and model; rated energy; pile cushion/condition; observed damage; and final pile top location. The guidance set forth in the State of Colorado Standard Specifications for Road and Bridge Construction, Section 502, Piling, is recommended. Piles should be driven 10 feet into bedrock or refusal.

5.1.2 Shallow Foundation Parameters

Structures associated with the bridges can be supported with shallow foundations resting on the native sands, recompacted loose sands, or sandstone. It should be noted that due to potential shallow groundwater on this site (due to the proximity to Sand Creek), extensive subgrade improvements are anticipated to support shallow foundations. The foundation members should bear on the native site sands, sandstone, or granular soils compacted according to the "Structural Fill" paragraph. Any topsoil must be removed and the existing subgrade cleared of any debris to expose suitable native soils prior to fill placement. Loose soils or uncontrolled fill material beneath foundation components will require removal and recompaction. Any expansive soils encountered beneath the foundation will require removal and replacement with non-expansive structural fill compacted according to the "Structural Fill" paragraph. Any new fill should be placed to the requirements of the "Structural Fill" paragraph. On-site granular sands may be used as structural fill as approved by Entech. Any import material should be approved by Entech prior to hauling to the site.

Provided the above recommendations are followed, an allowable bearing pressure of 2400 psf is recommended for the recompacted sands. For recompacted sand fills or imported granular structural fill, an allowable bearing capacity of 2800 psf is recommended. An allowable bearing capacity of 4000 psf is recommended for undisturbed sandstone. Footings should extend a minimum of 30 inches below the adjacent exterior surface grade for frost protection. Following the above foundation subgrade preparation recommendations, and adhering to the recommended maximum allowable bearing pressure, it is expected to result in foundation designs which should limit total and differential vertical movements.

Foundation excavations are recommended to extend at least 3 feet horizontally beyond the foundation limits in order to provide adequate space for installation of drain materials (if necessary) and placement of controlled fill. All foundation excavation side slopes should be inclined at angles of $1^1/_2$ horizontal to 1 vertical or flatter, as necessary, to provide for excavation sidewall stability during construction or as required by OSHA regulations.

Entech should observe overexcavated subgrades as well as the overall foundation excavation subgrade and evaluate if the exposed conditions are consistent with those described in this

report. Entech should also provide recommendations for overexcavation depth and other subgrade improvements, if necessary, and the need for drain systems and stabilization methods based on the excavation conditions observed at that time.

5.1.3 Retaining Wall Parameters

The following values are recommended for use in designing retaining walls with unbalanced lateral loading that may be associated with this project. Roadway/Vehicle surcharge loading is required for wall design.

Recommended Design Values – Lateral Loading

Equivalent fluid density for lateral earth pressure (active), pcf (site granular soils)	45
Equivalent fluid density for lateral earth pressure (passive), pcf	300
Equivalent fluid density for lateral earth pressure (at rest), pcf	60
Soil density (compacted sand), pcf	125
Angle of Internal Friction (loose silty sand and sandy clay-silt)	26°
Angle of Internal Friction (compacted silty sand)	34°
Coefficient of sliding between concrete and silty gravelly sand	0.35
Bearing capacity of sand, psf	2400 psf
Bearing capacity of sandstone, psf	4000 psf

*Note: The above lateral loading design values are for level back slope angles and no surcharge loads. If wall backfill is submerged, water pressures must be taken into account as additional wall loading. If backfill slope angles are greater than zero degrees, or if the backfill is surcharged, the design values must be adjusted to account for additional lateral loading.

5.2 Site Seismic Classification

Based on the subsurface conditions encountered at the site and in accordance with Section 1613 of the 2015 International Building Code (IBC), the site meets the conditions of a Site Class C.

5.3 Surface and Subsurface Drainage

Positive surface drainage must be maintained around structures to minimize infiltration of surface water. A minimum gradient of 5 percent in the first 10 feet adjacent to foundation components is recommended. A minimum gradient of 2 percent is recommended for paved areas. All grades should be directed away from structures.

To help minimize infiltration of water into foundation zones, vegetative plantings placed close to foundation components should be limited to those species having low watering requirements and irrigated grass should not be located within 5 feet of foundation components. Similarly, sprinklers are not recommended to discharge water within 5 feet of foundation components. Irrigation near foundations should be limited to the minimum amount sufficient to maintain vegetation. Application of more irrigation water than necessary can increase the potential for foundation movement.

5.4 Concrete

Soluble sulfate testing was conducted on three samples of the site soils to evaluate the potential for sulfate attack on concrete placed below the surface grade. The test results indicated 0.00 percent soluble sulfate by weight for the site soils. The test results indicate the sulfate component of the in-place site soils present a negligible exposure threat to concrete placed below grade that comes into contact with the site soils.

Type II cement is recommended for concrete at this site. To further avoid concrete degradation during construction it is recommended that concrete not be placed on frozen or wet ground. Care should be taken to prevent the accumulation or ponding of water in foundation excavations prior to the placement of concrete. If standing water is present in the foundation excavations, it should be removed by ditching to sumps and pumping the water away from the foundation area prior to concrete placement. If concrete is placed during periods of cold temperatures, the concrete must be kept from freezing. This may require covering the concrete with insulated blankets and adding heat to prohibit freezing.

5.5 Foundation Excavation Observations

Subgrade preparation for bridge foundations and associated improvements should be observed by Entech Engineering prior to construction of the foundation elements in order to verify that (1) no anomalies are present, (2) materials of the proper bearing capacity have been encountered or placed, and (3) no soft, loose, uncontrolled fill material, expansive soil or debris are present in the foundation area prior to concrete placement or backfilling. Pile driving should be observed to verify proper embedment or refusal. Piles should be driven 10 feet into bedrock or refusal. Entech should make final recommendations for over-excavation or stabilization, if required, at the time of excavation observation, if necessary.

5.6 Structural Fill

Areas to receive fill should have all topsoil, organic material or debris removed. Fill must be properly benched. The surface should be scarified and moisture conditioned to within ±2 percent of its optimum moisture content and compacted to 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557) beneath footings or floor slabs prior to placing new fill. New fill beneath footings should be non-expansive and be placed in thin lifts not to exceed 6 inches after compaction while maintaining at least 95 percent of its maximum Modified Proctor Dry Density (ASTM D-1557). These materials should be placed at a moisture content conducive to compaction, usually ±2 percent of Proctor optimum moisture content. The placement and compaction of fill should be observed and tested by Entech Engineering, Inc. Imported soils should be approved by Entech Engineering, Inc. prior to being hauled to the site and on-site granular soils prior to placement.

Compacted, non-expansive granular soil, free of organics, debris and cobbles greater than 3-inches in diameter, is recommended for filling foundation components. All fill placed within the foundation areas should be non-expansive and be compacted to a minimum of 95 percent of the soils maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). Fill material placed beneath floor slabs should be compacted to a minimum of 95 percent of its maximum Modified Proctor Dry Density, ASTM D-1557. Fill material should be placed in horizontal lifts such that each finished lift has a compacted thickness of six inches or less. Fill should be placed at water contents conducive to achieving adequate compaction, usually within

±2 percent of the optimum water content as determined by ASTM D-1557. Mechanical methods can be used for placement and compaction of fill; however, heavy equipment should be kept at distance from foundation walls and below slab infrastructure to avoid overstressing. No water flooding techniques of any type should be used for compaction or placement of foundation or floor slab fill material.

5.7 Utility Trench Backfill

Fill placed in utility trenches should be compacted to a minimum of 95 percent of its maximum dry density as determined by the Standard Proctor Test (ASTM D-698) for cohesive soils and 95 percent as determined by the Modified Proctor Test (ASTM D-1557) for cohesionless soils. Fill should be placed in horizontal lifts having a compacted thickness of six inches or less and at a water content conducive to adequate compaction, within ±2 percent of the optimum water content. Mechanical methods should be used for fill placement; however, heavy equipment should be kept at a distance from foundation walls. No water flooding techniques of any type should be used for compaction or placement of utility trench fill.

Trench backfill placement should be performed in accordance with El Paso County specifications. All excavation and excavation shoring/bracing should be performed in accordance with OSHA guidelines.

5.8 General Backfill

Any areas to receive fill outside the foundation limits should have all topsoil, organic material, and debris removed. Fill must be properly benched into existing slopes in order to be adequately compacted. The fill receiving surface should be scarified to a depth of 12-inches and moisture conditioned to ± 2 percent of the optimum water content, and compacted to a minimum of 95 percent of the ASTM D-1557 maximum dry density before the addition of new fill. Fill should be placed in thin lifts not to exceed 6 inches in thickness after compaction while maintaining at least 95 percent of the ASTM D-1557 maximum dry density. Fill material should be free of vegetation and other unsuitable material and shall not contain rocks or fragments greater than 3-inches. Topsoil and strippings should be segregated from all other fill sources on the site. Fill placement and compaction beneath and around foundations, in utility trenches,

beneath roadways or other structural features of the project should be observed and tested by Entech during construction.

5.9 Excavation Stability

Excavation sidewalls must be properly sloped, benched and/or otherwise supported in order to maintain stable conditions. All excavation openings and work completed therein shall conform to OSHA Standards as put forward in CFR 29, Part 1926.650-652, (Subpart P).

5.10 Winter Construction

In the event construction of the planned facility occurs during winter, foundations and subgrades should be protected from freezing conditions. Concrete should not be placed on frozen soil and once concrete has been placed, it should not be allowed to freeze. Similarly, once exposed, the foundation subgrade should not be allowed to freeze. During site grading and subgrade preparation, care should be taken to eliminate burial of snow, ice or frozen material within the planned construction area.

5.11 Construction Observations

It is recommended that Entech observe and document the following activities during construction of the building foundations.

- Excavated subgrades and subgrade preparation.
- Driven H-Pile Installation
- Placement of drains (if installed).
- Placement/compaction of fill material for the foundation components and retaining walls.
- Placement/compaction of utility bedding and trench backfill.

6.0 CLOSURE

The subsurface investigation, geotechnical evaluation and recommendations presented in this report are intended for use of C&C Land with application to the proposed bridge over Sand Creek at Sterling Ranch Road and the associated site improvements, in El Paso County northeast of Colorado Springs, Colorado. In conducting the subsurface investigation, laboratory testing, engineering evaluation and reporting, Entech Engineering, Inc. endeavored to work in accordance with generally accepted professional geotechnical and geologic practices and principles consistent with the level of care and skill ordinarily exercised by members of the geotechnical profession currently practicing in same locality and under similar conditions. No other warranty, expressed or implied is made. During final design and/or construction, if conditions are encountered which appear different from those described in this report, Entech Engineering, Inc. requests that it be notified so that the evaluation and recommendations presented herein can be reviewed and modified as appropriate.

If there are any questions regarding the information provided herein or if Entech Engineering, Inc. can be of further assistance, please do not hesitate to contact us.

TABLE

TABLE 1

SUMMARY OF LABORATORY TEST RESULTS

CLIENT C&C LAND
PROJECT STERLING RANCH BRIDGES
JOB NO. 200045

SOIL TYPE	TEST BORING NO.	DEPTH (FT)	WATER (%)	DRY DENSITY (PCF)	PASSING NO. 200 SIEVE (%)	LIQUID LIMIT (%)	PLASTIC INDEX (%)	SULFATE (WT %)	FHA SWELL (PSF)	SWELL/ CONSOL (%)	UNIFIED CLASSIFICATION	SOIL DESCRIPTION
1	1	5			10.0	NV	NP	0.00			SM-SW	SAND, SLIGHTLY SILTY
1	2	10			7.5						SM-SW	SAND, SLIGHTLY SILTY
1	4	2-3			4.5						SW	SAND
2	3	20			9.9	NV	NP	0.00			SM-SW	SANDSTONE, SLIGHTLY SILTY
3	4	15	16.1	114.3	59.0					0.1	CL	CLAYSTONE, VERY SANDY
3	1	30	14.4	113.5	51.9	NV	NP	0.00		0.0	ML	SILTSTONE, VERY SANDY

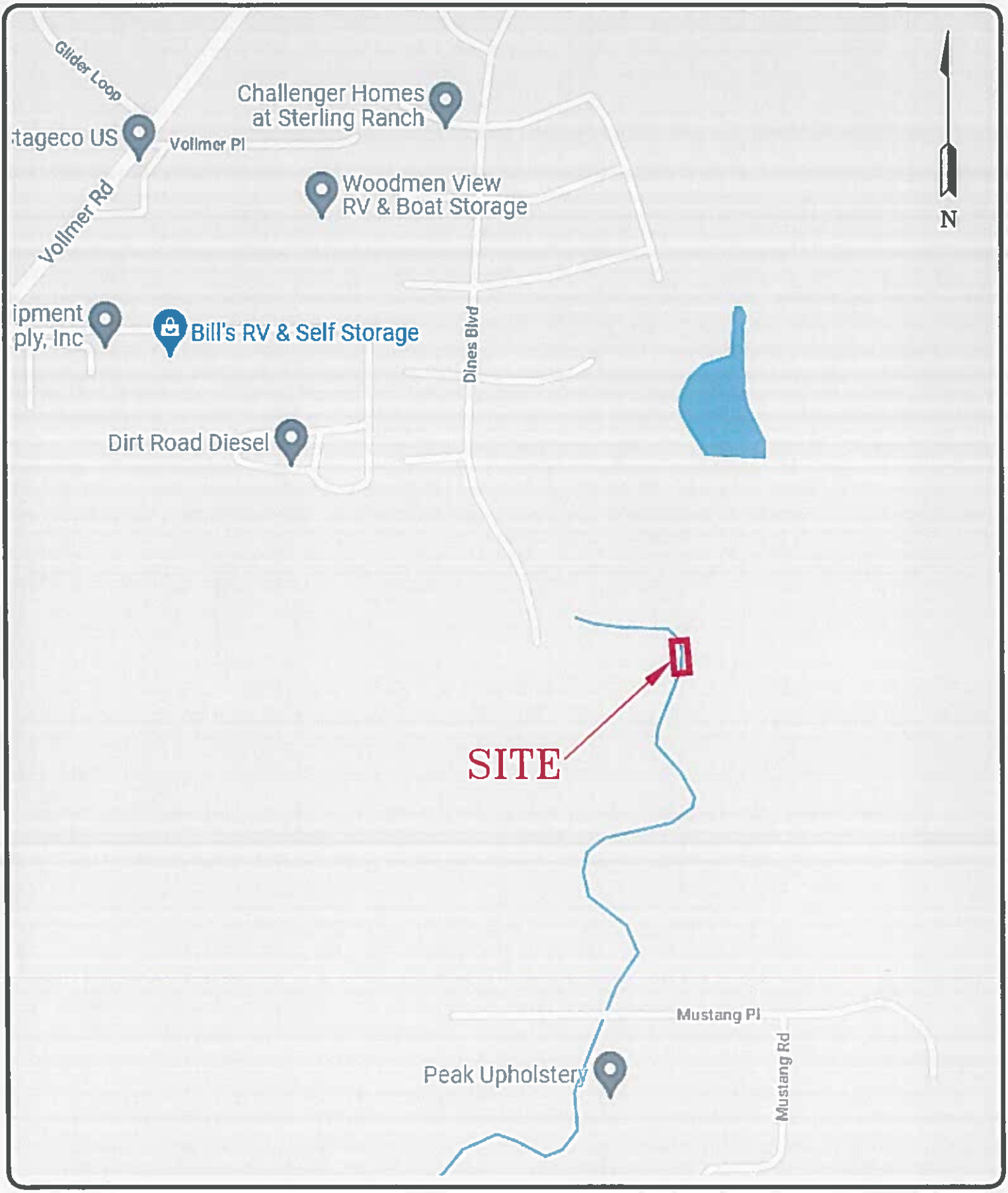
TABLE 2

Sterling Ranch Bridges - LPile Design Parameters

Depth Below Existing Ground Surface		Groundwater Elevation (ft) Below Existing Ground	Soil/Rock Description	Axial Pile Capacity Parameters		PRELIMINARY LPile Parameters					
Top	Bottom			Allowable Side Resistance (ksf)	Allowable End Bearing (ksf)	p-y Curve	Unit Weight γ[1] (pcf)	Peak Friction Angle ϕ (deg)	Initial Static Modulus of Subgrade Reaction, k (pci)	Undrained Cohesion s_u (psf)	Strain Factor ε_{50} (in/in)
0	2 to 9	1	Slightly Silty Sand to Sand	—	—	Sand	120 62[1]	30	25 20[1]	N/A	N/A
2 to 10	25 to BOE		Slightly Silty Sandstone	3	30	Sand	125 67[1]	34	225 125[1]	N/A	N/A
9 to 25	BOE		Very Sandy Claystone & Very Sandy Siltstone	3	30	Clay	115 57[1]	N/A	500	1500	0.005

[1] = Submerged

FIGURES



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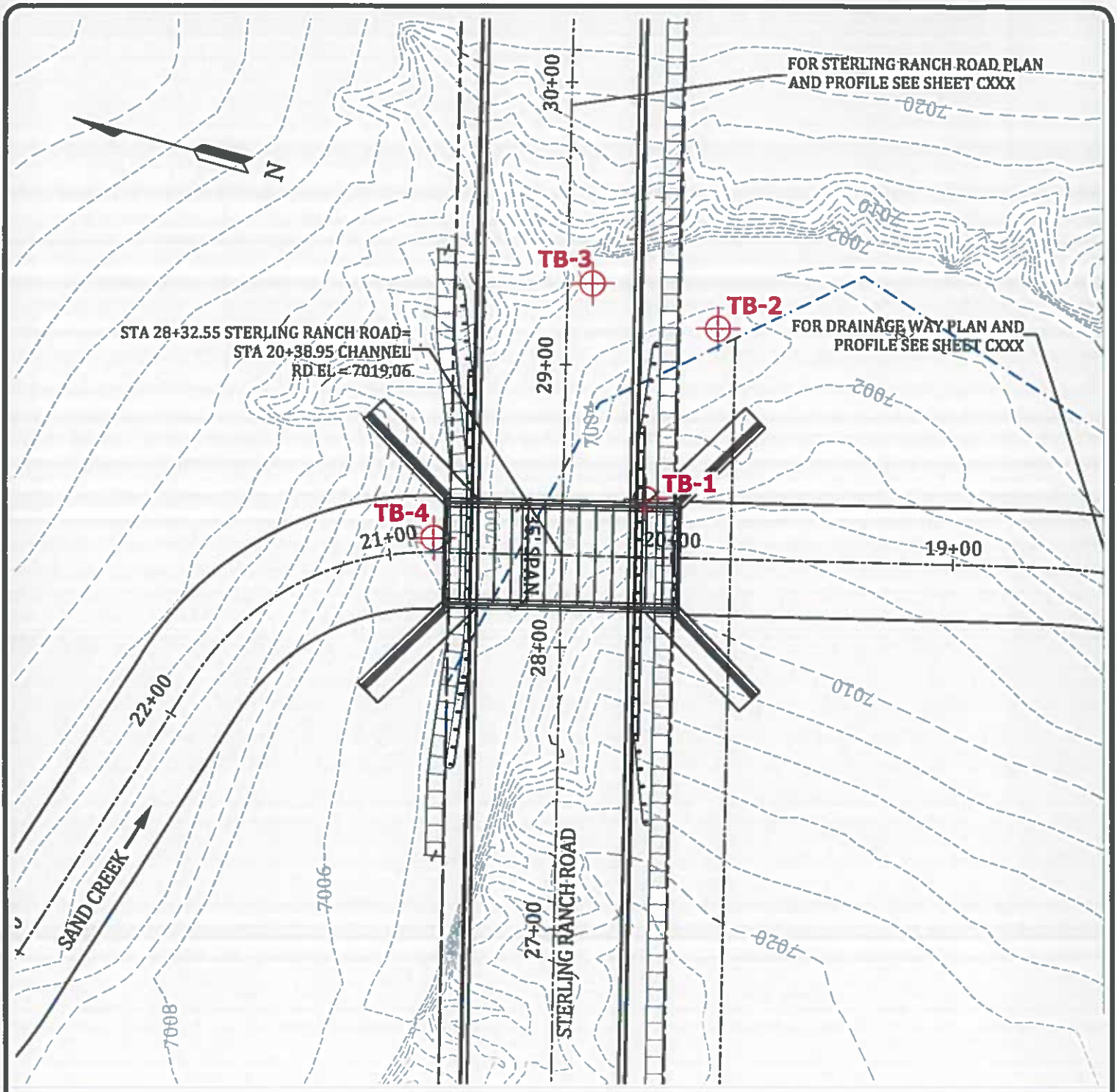
VICINITY MAP
STERLING RANCH ROAD BRIDGE
COLORADO SPRINGS, CO.
FOR: C&C LAND

DRAWN:	DATE:	CHECKED:	DATE:
JAC	10/25/21	DPS	10/25/21

JOB NO.: 200045

FIG NO.: 1



TB- APPROXIMATE TEST BORING LOCATION AND NUMBER

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595 ELKTON DRIVE
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TEST BORING LOCATION MAP
STERLING RANCH ROAD BRIDGE
COLORADO SPRINGS, CO.
FOR: C&C LAND

DRAWN:	DATE:	CHECKED:	DATE:
JAC	10/25/21	DPS	10/25/21

JOB NO.: 200045

FIG NO.: 2

APPENDIX A: Test Boring Logs

TEST BORING NO. 1
DATE DRILLED 10/2/2021
Job # 200045

REMARKS

WATER @ 1', 10/2/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			21	13.8	1
5			50	11.1	2
10			50 6"	13.8	2
15			50 6"	13.0	2
20			50 7"	8.8	2
25					
30			50 5"	12.3	3

SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, MEDIUM DENSE, WET

SANDSTONE, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY, VERY DENSE, WET

SILTSTONE, VERY SANDY, GRAY BROWN, HARD, MOIST

TEST BORING NO. 2
DATE DRILLED 10/2/2021
CLIENT C&C LAND
LOCATION STERLING RANCH BRIDGES

REMARKS

WATER @ 1', 10/2/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
					1
			50	5.2	2
5			50 6"	20.5	2
10			50 8"	14.9	2
15			50 7"	9.7	2
20			50 6"	11.6	2

SAND, SILTY, TAN

SANDSTONE, SLIGHTLY SILTY WITH THIN SILTSTONE INTERBEDS, FINE TO COARSE GRAINED, GRAY, VERY DENSE, WET

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COLORADO SPRINGS, COLORADO 80907

TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 10-15-21

JOB NO.: 200045
FIG NO.: A- 1

TEST BORING NO. 3
DATE DRILLED 10/2/2021
Job # 200045

REMARKS

WATER @ 1', 10/2/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			11	10.2	1
			50/8"	11.8	2
10			50/8"		2
15			50/6"	19.3	2
20			50/3"	18.6	2

SAND, SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY BROWN, MEDIUM DENSE, WET

SANDSTONE, SILTY TO SLIGHTLY SILTY, FINE TO COARSE GRAINED, GRAY, VERY DENSE, WET

TEST BORING NO. 4
DATE DRILLED 10/2/2021
CLIENT C&C LAND
LOCATION STERLING RANCH BRIDGES

REMARKS

WATER @ 1', 10/2/21

Depth (ft)	Symbol	Samples	Blows per foot	Watercontent %	Soil Type
			12	10.9	1
			8	14.6	1
10			50/5"	22.1	3
15			50/4"	15.8	3
20			50/4"	9.8	3

SAND, FINE GRAINED, GRAY BROWN, MEDIUM DENSE TO LOOSE, WET

CLAYSTONE, VERY SANDY, DARK GRAY BROWN, HARD, WET

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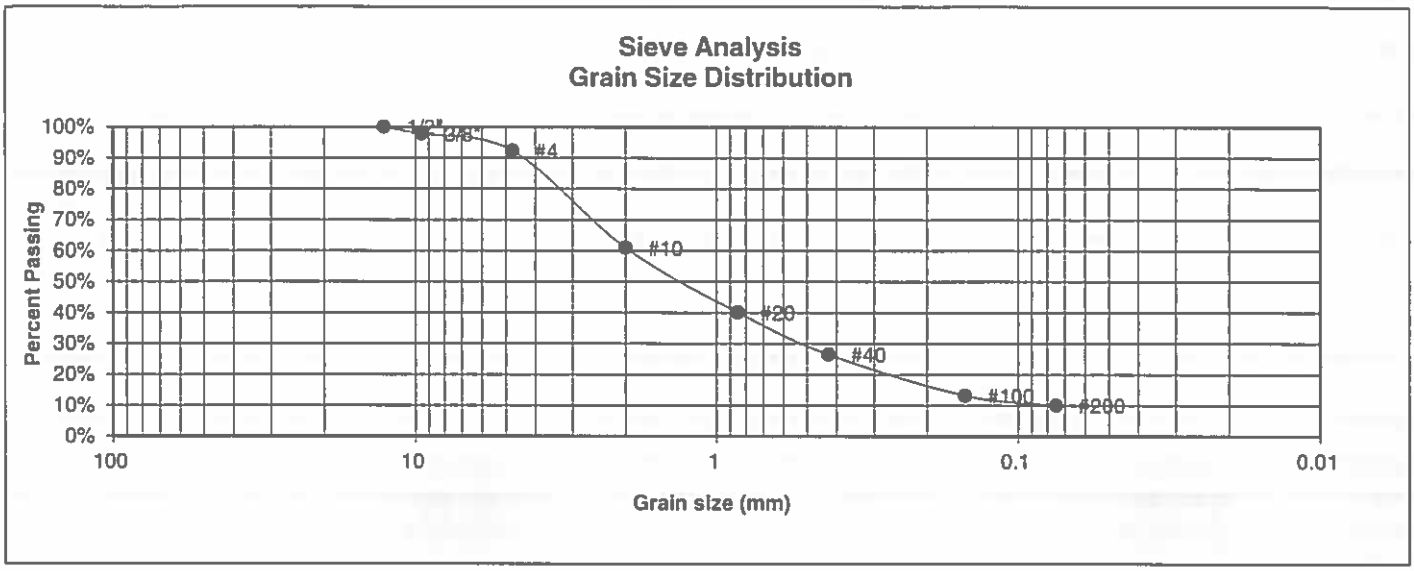
TEST BORING LOG

DRAWN:	DATE:	CHECKED: SW	DATE: 11-9-21

JOB NO. 200045
FIG NO. A- 2

APPENDIX B: Laboratory Testing Results

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	1	JOB NO.	200045
DEPTH (FT)	5	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	100.0%
3/8"	97.8%
4	92.3%
10	61.0%
20	40.1%
40	26.5%
100	13.2%
200	10.0%

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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COLORADO SPRINGS, COLORADO 80907

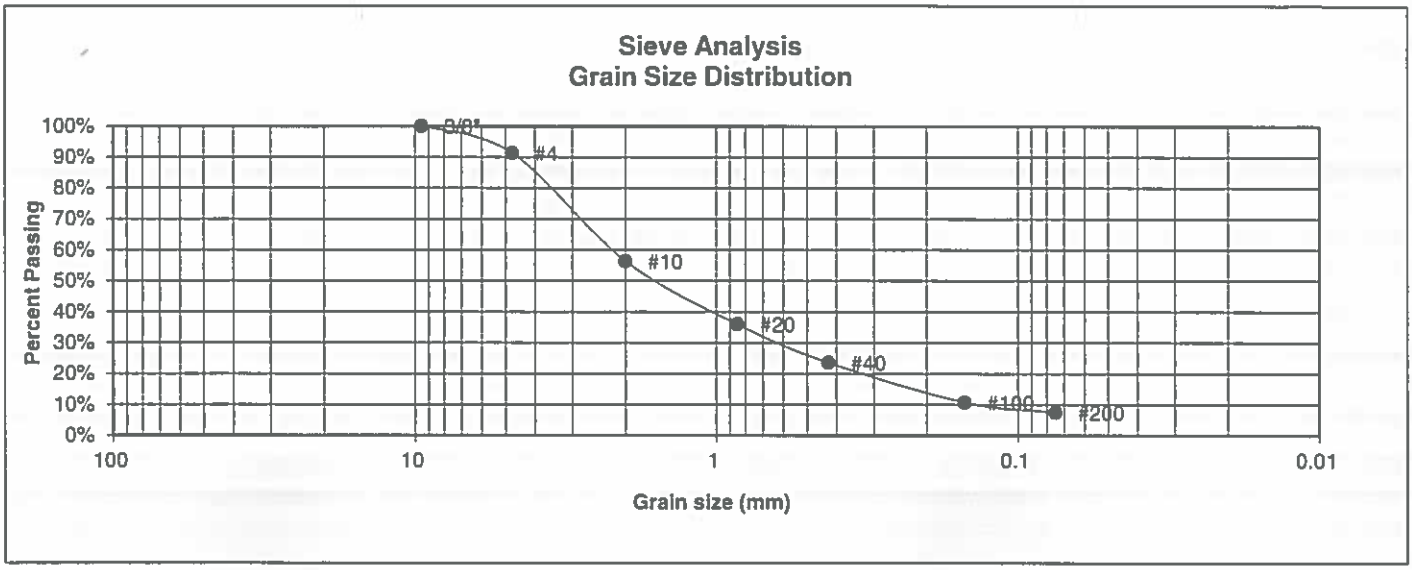
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SW	10-18-21

JOB NO: 200045

FIG NO: B-1

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	2	JOB NO.	200045
DEPTH (FT)	10	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	91.3%
10	56.4%
20	36.0%
40	23.5%
100	10.7%
200	7.5%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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COLORADO SPRINGS, COLORADO 80907

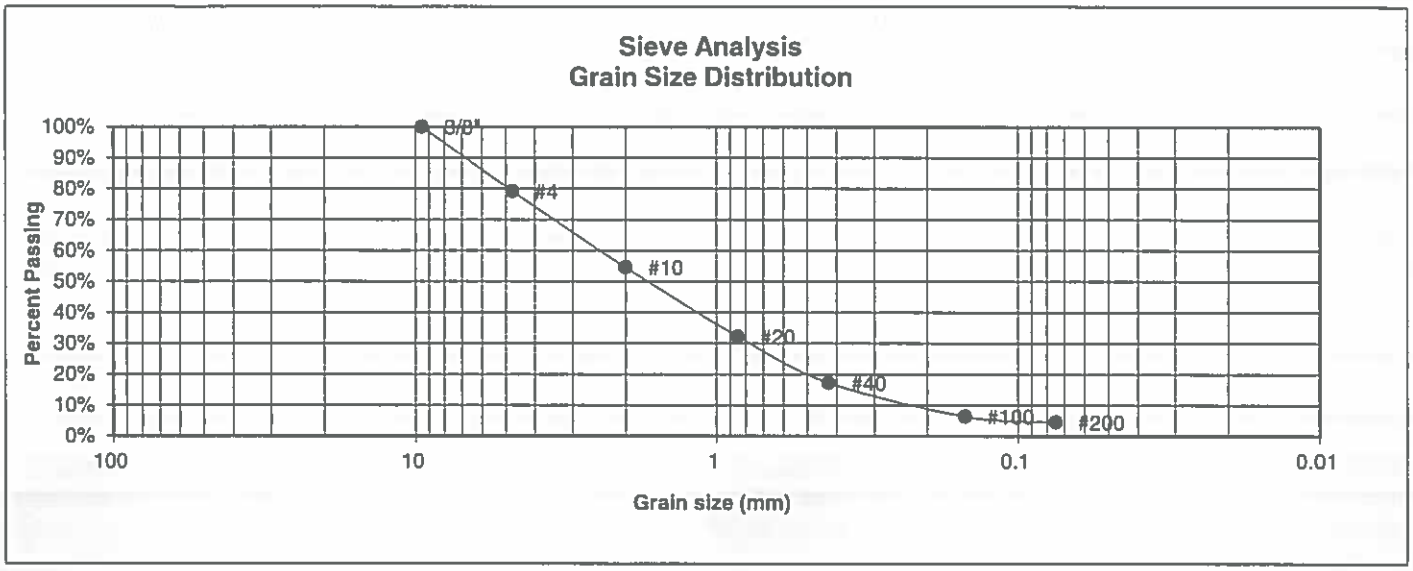
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SW	10-18-21

JOB NO.: 200045

FIG NO.: B-2

UNIFIED CLASSIFICATION	SW	CLIENT	C&C LAND
SOIL TYPE #	1	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	4	JOB NO.	200045
DEPTH (FT)	2-3	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	79.2%
10	54.5%
20	32.2%
40	17.2%
100	6.4%
200	4.5%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

ENTECH ENGINEERING, INC.
505 ELKTON DRIVE
COLORADO SPRINGS, COLORADO 80907

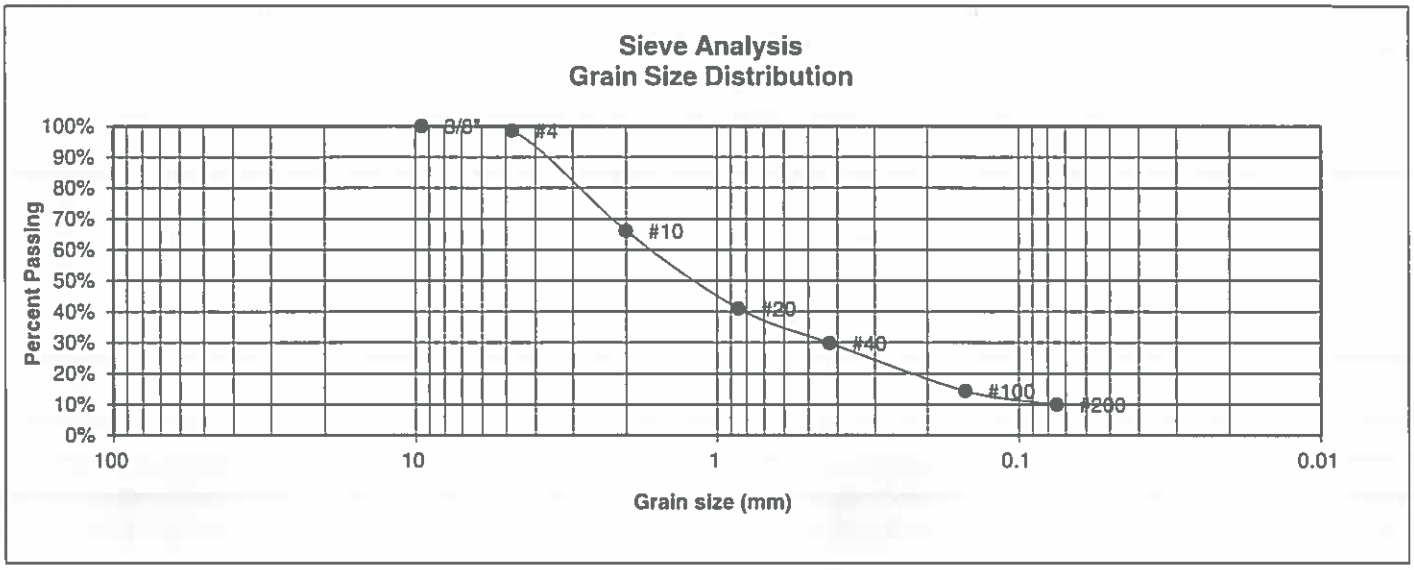
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SW	10-18-21

JOB NO.: 200045

FIG NO.: B-3

UNIFIED CLASSIFICATION	SM-SW	CLIENT	C&C LAND
SOIL TYPE #	2	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	3	JOB NO.	200045
DEPTH (FT)	20	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	98.6%
10	66.1%
20	41.0%
40	29.8%
100	14.4%
200	9.9%

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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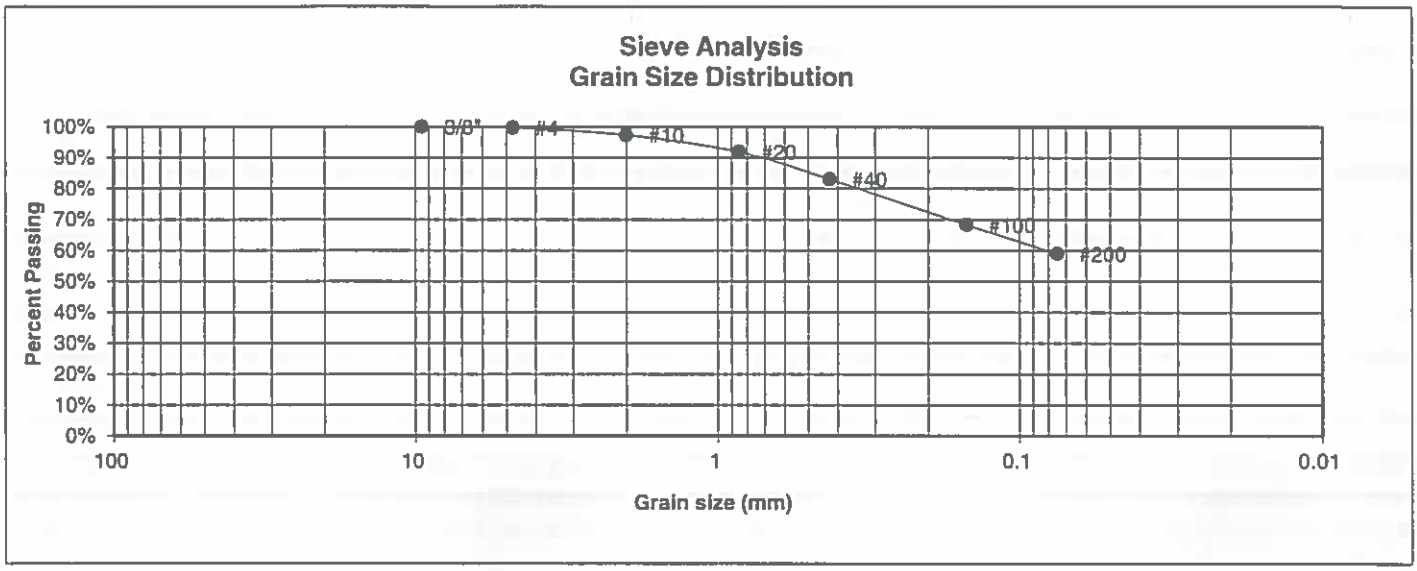
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 10-18-21

JOB NO.: 200045

FIG NO.: B-4

UNIFIED CLASSIFICATION	CL	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	4	JOB NO.	200045
DEPTH (FT)	15	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	99.7%
10	97.3%
20	91.9%
40	83.0%
100	68.3%
200	59.0%

Atterberg Limits
Plastic Limit
Liquid Limit
Plastic Index

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

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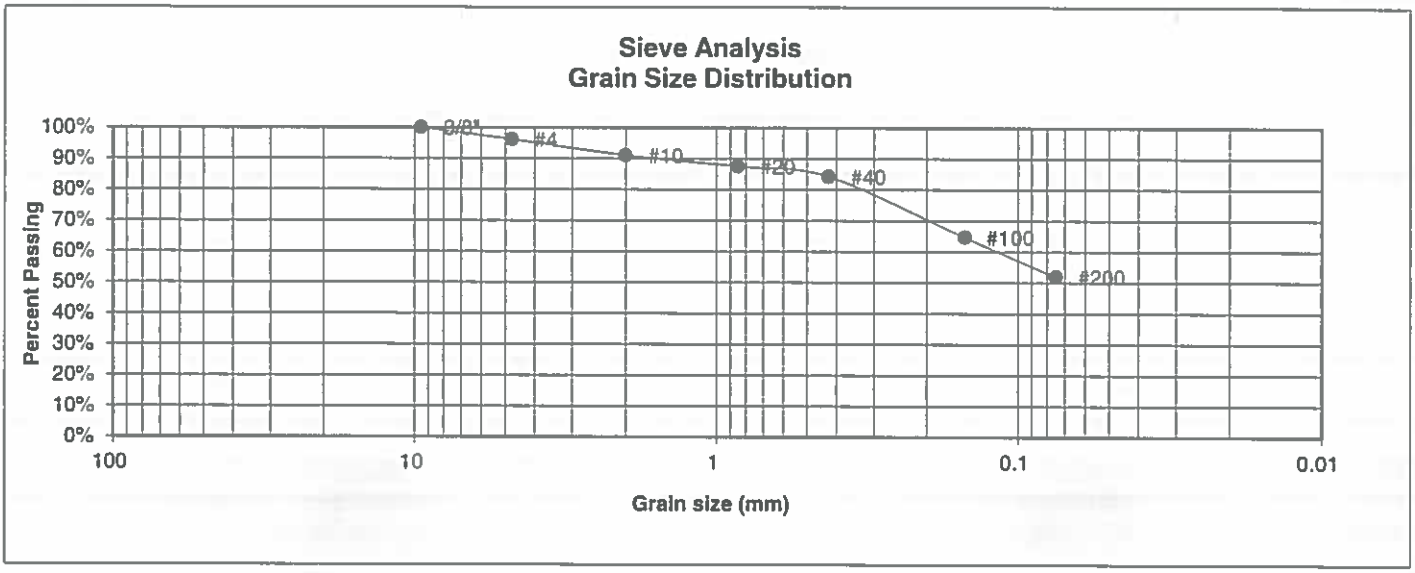
LABORATORY TEST RESULTS

DRAWN:	DATE:	CHECKED: SW	DATE: 10-18-21

JOB NO.: 200045

FIG NO.: B-5

UNIFIED CLASSIFICATION	ML	CLIENT	C&C LAND
SOIL TYPE #	3	PROJECT	STERLING RANCH BRIDGES
TEST BORING #	1	JOB NO.	200045
DEPTH (FT)	30	TEST BY	BL



U.S. Sieve #	Percent Finer
3"	
1 1/2"	
3/4"	
1/2"	
3/8"	100.0%
4	96.2%
10	91.0%
20	87.6%
40	84.2%
100	64.7%
200	51.9%

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: SW	DATE: 10-18-21

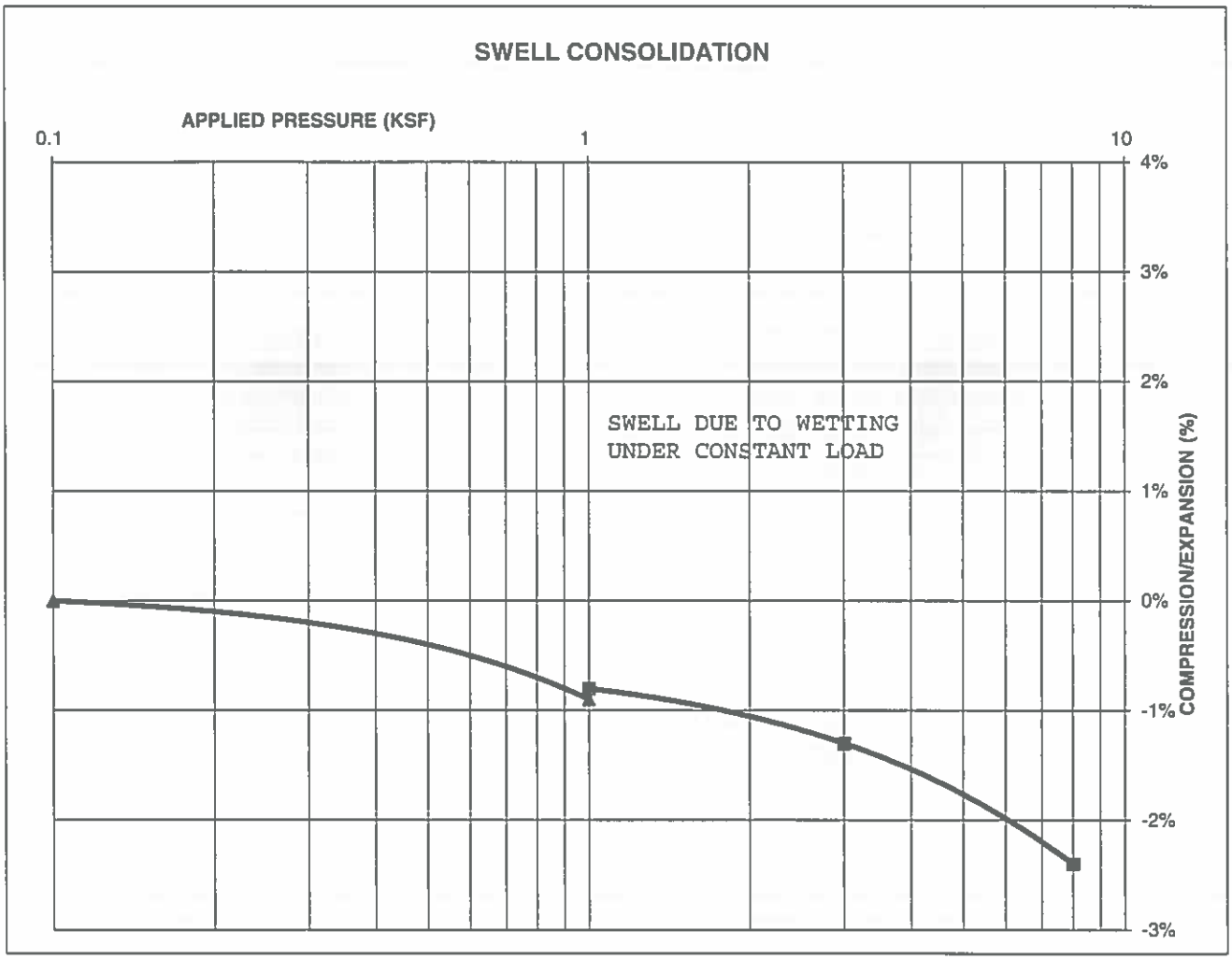
JOB NO: 200045

FIG NO: B-6

CONSOLIDATION TEST RESULTS

TEST BORING #	4	DEPTH(ft)	15
DESCRIPTION	CL	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			114
NATURAL MOISTURE CONTENT			16.1%
SWELL/CONSOLIDATION (%)			0.1%

JOB NO. 200045
CLIENT C&C LAND
PROJECT STERLING RANCH BRIDGES



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SWELL CONSOLIDATION
TEST RESULTS

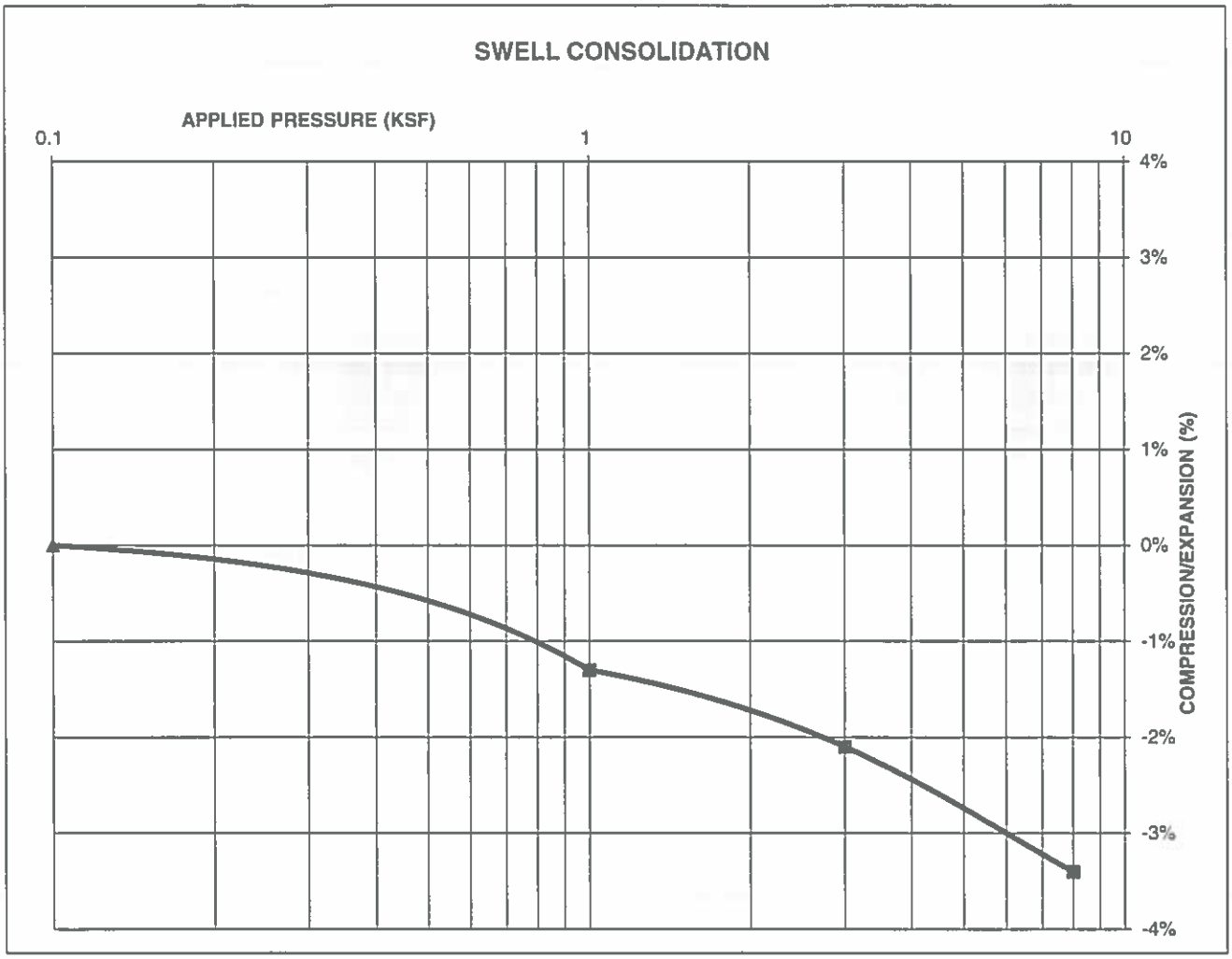
DRAWN:	DATE:	CHECKED:	DATE:
		SW	10-18-21

JOB NO.: 200045
FIG NO.: B-7

CONSOLIDATION TEST RESULTS

TEST BORING #	1	DEPTH(ft)	30
DESCRIPTION	ML	SOIL TYPE	3
NATURAL UNIT DRY WEIGHT (PCF)			113
NATURAL MOISTURE CONTENT			14.4%
SWELL/CONSOLIDATION (%)			0.0%

JOB NO. 200045
CLIENT C&C LAND
PROJECT STERLING RANCH BRIDGES



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SWELL CONSOLIDATION
TEST RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SW	10-21-21

JOB NO.: 200045
FIG NO.: B-8

CLIENT	C&C LAND	JOB NO.	200045
PROJECT	STERLING RANCH BRIDGES	DATE	10/13/2021
LOCATION	STERLING RANCH BRIDGES	TEST BY	BL

BORING NUMBER	DEPTH, (ft)	SOIL TYPE NUMBER	UNIFIED CLASSIFICATION	WATER SOLUBLE SULFATE, (wt%)
TB-1	5	1	SM-SW	0.00
TB-1	30	3	ML	0.00
TB-3	20	2	SM-SW	0.00

QC BLANK PASS

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LABORATORY TEST
SULFATE RESULTS

DRAWN:	DATE:	CHECKED:	DATE:
		SW	10-18-21

JOB NO.: 200045

FIG NO.: B-9