Geotechnical Data Report

Thornton Source Water Pump Station

Larimer County, Colorado

Submitted to:
Carollo Engineers
11030 Circle Point Rd, Suite 400
Westminster, CO 80020

Submitted by:
GEI Consultants, Inc.
350 Indiana Street, Suite 750
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September 10, 2025

Project No. 2406846

September 10, 2025
Project No. 2406846

Mr. Bart Giles, PE
Project Manager / Associate

Carollo Engineers
11030 Circle Point Road, Suite 400
Westminster, CO 80020

Re: Geotechnical Data Report
Thornton Source Water Pump Station
Fort Collins, CO

Dear Mr. Giles:

Submitted herewith is the Geotechnical Data Report for the Thornton Source Water Pump Station. This report was prepared in general accordance with the Agreement between GEI Consultants and Carollo Engineers dated August 27th, 2024. The Geotechnical Data Report contains the results of our findings in support of the subject project.

If you have any questions regarding the contents of this report, please contact the undersigned.

Sincerely,

GEI Consultants, Inc.

Sarah Myers
Project Professional

Lance Heyer, PE
Senior Project Engineer

Colby Carlson
Staff Geologist

GEI Consultants, Inc.
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Table of Contents

1. Introduction **1**
1.1. Site Description 1
1.2. Proposed Construction 1

2. Geologic Setting and Geologic Hazards **2**
2.1. Regional Geology 2
2.1.1. Expansive Soils and Bedrock 2
2.1.2. Steeply Dipping Bedrock 3

3. Geotechnical Investigation **4**
3.1. Subsurface Investigation 4
3.2. Geotechnical Laboratory Testing 4
3.3. Corrosion Potential Testing 5

4. Subsurface Conditions **6**
4.1. Subsurface Materials 6
4.1.1. Non-cohesive Soil 6
4.1.2. Cohesive Soil 6
4.1.3. Pierre Shale (Middle Shale Member and Richard Sandstone Member) 7
4.2. Groundwater 7

5. Limitations **8**

6. References **9**

List of Tables

Table 3-1. Subsurface Investigation ASTM Standards 4
Table 3-2. Geotechnical Laboratory Testing 5
Table 3-3. Corrosion Laboratory Testing 5
Table 4-1. Groundwater Depth (ft.)[1] 7

Figures

Figure 1. Site Vicinity
Figures 2a, 2b. Boring Location Maps

Appendices

Appendix A Standard Geotechnical Drilling Keys and Boring Logs
Appendix B Geotechnical Laboratory Testing Results
Appendix C Bedrock Core Photo Log

1. Introduction

The Thornton Source Water Pump Station Project (Project) includes a raw water pump station and approximately 0.56 miles of water pipeline extending into an existing water supply reservoir in Northern Fort Collins, Colorado. The Owner of the Project is the City of Thornton (City) and the lead engineer for the project is Carollo Engineers (Carollo). Carollo retained GEI Consultants, Inc. (GEI) to function as the Project's geotechnical and trenchless design engineer. The purpose of this report is to provide data collected during the Geotechnical Investigation at the Project site. The following sections generally describe the site and proposed construction.

1.1. Site Description

The Project site is located north of Fort Collins, Colorado, in what is predominantly a rural, residential area (Figure 1). Current access to the pump station site is along the Larimer County Canal and dirt access road located between Water Supply and Storage Company (WSSC) Reservoir No. 3 and Rocky Ridge Lake Reservoir No. 1. Existing infrastructure in the immediate vicinity of the proposed pump station consists of a concrete culvert interconnect structure between Rocky Ridge Lake Reservoir No. 1 and WSSC Reservoir No. 3; the dirt access road was constructed over the interconnect. The earthen dam embankment for Rocky Ridge Lake Reservoir No. 1 is located approximately 1,000 feet southeast of the proposed pump station.

1.2. Proposed Construction

The City intends to install a new pump station and inlet pipe connecting to the WSSC Reservoir No. 3. The proposed pump station will be located near the existing concrete culvert interconnect, at the narrow point between the two reservoirs. From the pump station, approximately 975-feet of inlet pipe will extend into the WSSC Reservoir No. 3. Inlet pipeline construction via conventional open cut. The pipeline extending from the pump station to the southeast will ultimately connect to the larger Thornton Raw Water Pipeline which is in various stages of design and construction. Specifically, Segment F of the pipeline will extend from the pump station; design of this pipeline segment will be by others.

The City also intends to improve the existing access roads leading to the project site for construction and for future vehicle access and water operations. The proposed road will extend east from Highway 1 following the existing eastern access road to the bottom of a hill bordering the canal. The new access road will turn to the southwest and cross the canal over the proposed LCC bridge, before joining the existing west access road, running to the northwest. The proposed conduction is presented in Figure 2.

2. Geologic Setting and Geologic Hazards

2.1. Regional Geology

Geologically, the site is located on the western-most flank of the Colorado Piedmont section of the Great Plains Physiographic Province. The Colorado Piedmont is defined as a north/south trending, asymmetrical basin that formed during the uplift of the Rocky Mountains to the west and was later incised by streams and rivers. The area is generally lower than the Great Plains Province to the east and characterized by broad alluvial and pediment deposits over dipping and flat lying bedrock. The Geologic Map of the Fort Collins 30'x60' Quadrangle, Larimer and Jackson Counties, Colorado, and Albany and Laramie Counties, Wyoming (Workman et al., 2018) was used in determining the overall site geology, including overburden and bedrock units and the structural geology of the site. In general, the bedrock at the site includes Upper and Lower Cretaceous-aged marine sandstone, shale, claystone, and limestone.

The geologic formations underlying the site include, from youngest to oldest, the Richard Sandstone Member (Unit Kpr), Middle Shale Member (Unit Kpm), and Hygiene Sandstone Member (Unit Kph) of the Pierre Shale (Workman et al., 2018). The Richard Sandstone is exposed in outcrops on the east side of the site and expected in the near surface in the eastern portion of the project site. The Richard Sandstone Member is described as a light brown to brownish-yellow micaceous or glauconitic sandstone that is interlayered with gray shale. The Middle Shale is expected in the near surface approximately at the proposed pump station and inlet pipe. The Middle Shale is a claystone and sandy siltstone with light-gray or yellowish-gray calcareous sandstone. The Hygiene Sandstone is expected to be at the near surface on the west side of the WSSC Reservoir No. 3. The Hygiene Member consists of an upper hard, glauconitic, gray, ridge-forming sandstone separated by shale from a lower, friable sandstone.

2.1.1. Expansive Soils and Bedrock

Swelling soil and bedrock is widespread throughout the Front Range of Colorado and in some mountain valleys. The phenomenon occurs when certain types of clay minerals undergo a change in moisture content. Historically, structures and other infrastructure underlain by dipping and expansive bedrock have experienced differential movement due to the geologic mechanism known as heaving bedrock (Colorado Geological Survey, 1997). Heaving bedrock is the result of dipping bedrock with hydration-induced expansion properties, confined by non-expansive bedrock. As a result, heaving bedrock is heterogeneous and can produce differential expansive properties and associated risk of overlying structure movement. Workman et al. (2018) noted clay-rich expansive or swelling soils have caused damage to foundations, structures, and roads due to expansion and contraction resulting from wetting and drying and flat-lying and gently inclined beds of the Pierre Shale are most susceptible to this process due to the presence of zones rich in expansive clays.

Results of Atterberg limits and swell tests generally agree with published physical properties of local expansive bedrock and reflect that measured site-specific values indicate low to high risk for bedrock heave (Nelson and Miller, 1992). Different bedrock units and/or beds will expand varying amounts upon water introduction producing differential movement for directly bearing foundation elements and other

improvements such as pipelines and roadways. Heaving bedrock typically requires a different mitigation approach from those conventionally used for expansive soils such as over-excavation or deep foundations.

2.1.2. Steeply Dipping Bedrock

Steeply dipping bedrock is a geological hazard that is common along Colorado's Front Range piedmont where steeply dipping sedimentary bedrock containing layers of expansive claystone is encountered near the ground surface. These expansive materials are composed of clay particles that expand upon exposure to introduced water (Noe and Dodson, 1999). The heave features associated with heaving bedrock are distinctly linear and are caused by differential swelling and/or rebound movements within the bedrock (Noe, 1997). Steeply inclined beds are susceptible to bedrock heaving due to vertical variations in expansive clays, and of particular concern are the lower, middle, and upper shale members of the Pierre Shale which contain discrete bentonite layers as well as significant bentonitic claystones (Workman et al., 2018).

3. Geotechnical Investigation

GEI conducted a geotechnical investigation for the Project consisting of a subsurface investigation and a geotechnical laboratory testing program. The subsurface investigation included five borings for the proposed inlet, five borings for the pump station location, five borings for the access road, and two borings for the canal bridge crossing. Borings were drilled between August and October of 2024, and July of 2025. Boring locations are included in Figures 2a – 2b. Results from the subsurface investigation and the laboratory testing program are presented in Section 4.

3.1. Subsurface Investigation

Geotechnical borings were advanced to depths between 10 and 101 feet below the existing ground surface. GEI subcontracted geotechnical drilling to Terracon Consultants who utilized a barge-mounted 7822 DT Geoprobe for inlet sampling and a truck-mounted CME 75 rig for all other sampling. Drilling and sampling procedures were conducted in general accordance with the ASTM standards identified in the following table:

Table 3-1. Subsurface Investigation ASTM Standards

Procedure	ASTM Standard
Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils	D 1586
Standard Practice for Thick Wall, Ring-Line, Split Barrel, Drive Sampling of Soils	D 3550
Standard Practice for Rock Core Drilling and Sampling of Rock for Site Exploration	D 2113

For the inlet pipeline sampling, continuous-flight, hollow-stem augers were used to advance borings below the reservoir water level to the existing reservoir bottom surface through soil and into the bedrock. During boring advancement, Modified California (2.0-inch inner diameter) or split-spoon (1.5-inch inner diameter) samples were obtained in 5-foot intervals. For the pump station, access road, and bridge boreholes, continuous-flight, solid-stem augers were used to advance borings below the existing ground surface through soil and into the bedrock. During boring advancement, Modified California (2.0-inch inner diameter) samples were obtained in 2.5- and 5-foot intervals. The modified California barrel sampler was utilized to obtain relatively undisturbed samples of cohesive materials. The split-spoon sampler was used to obtain disturbed samples of non-cohesive materials. The number of blows by a 140-pound hammer falling 30 inches required for 12 inches of sampler penetration (recorded in 6-inch increments) are presented on the boring logs (Appendix A). Blow counts with less than six inches of penetration are presented showing the number of blows for the resulting depth of penetration (50/2” = 50 blows to drive the sampler 2 inches). Additionally, two of the five pump station borings were advanced into bedrock using NQ (1.87-inch inner diameter) core barrel to collect samples. Rock coring techniques were implemented to collect continuous samples of rock core suitable for logging and laboratory testing.

3.2. Geotechnical Laboratory Testing

A geotechnical laboratory testing program was developed by GEI on representative samples collected during the subsurface investigation. A laboratory summary table and graphical testing results are provided

in Appendix B. Laboratory tests conducted in general accordance with associated ASTM standards are presented in the table below.

Table 3-2. Geotechnical Laboratory Testing

Test	Standard
Grain Size Distribution	ASTM D422
#200 Sieve Wash	ASTM D1140
Unconfined Compressive Strength	ASTM D2166
Swell / Consolidation	ASTM D4546
Atterberg Limits	ASTM D4318
Moisture Content & Dry Density	ASTM D2216 & D2937
Hydrometer	ASTM D77928
Corrosion Suite	ASTM G162-18
R-Value	ASTM D2844
Proctor	ASTM D698-12
Organics	ASTM D2974

If field characterized soil and bedrock descriptions differed from results indicated by laboratory classification testing, the boring logs presented in Appendix A were amended to reflect laboratory testing results.

3.3. Corrosion Potential Testing

Corrosion laboratory tests conducted in general accordance with associated ASTM and AASHTO standards are presented in the table below. Results of the laboratory testing are presented at the end of Appendix B.

Table 3-3. Corrosion Laboratory Testing

Test	Standard
Chloride	AASHTO T291-91/ASTM D4327
pH	AASHTO T289-91
Redox Potential	ASTM D1498
Water-Soluble Sulfate	AASHTO T290-91/ASTM D4327
Sulfide	AWWA C105
Resistivity	AASHTO T288-91
Total Salts	ASTM B117

Corrosion laboratory tests conducted in general accordance with associated ASTM and AASHTO standards are presented in the table below. Results of the laboratory testing are presented at the end of Appendix B. Field resistivity testing using a Wenner 4 Probe test was not completed as part of this study.

4. Subsurface Conditions

Subsurface conditions were assessed based on the findings of the geotechnical investigation described in the previous section. Soil and rock descriptions noted on the boring logs and below are in general accordance with ASTM D 2487 – *Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System, USCS)* and ASTM D 2488 – *Standard Practice for Description and Identification of Soils (Visual-Manual Procedure)*.

4.1. Subsurface Materials

Primary materials encountered during the subsurface investigation include non-cohesive soil, cohesive soil, and shale, siltstone, claystone, and sandstone bedrock of the Middle Shale Member and Richard Members of the Pierre Shale. Boring logs including a supplementary boring log key explaining boring log details and additional details regarding sampled materials are provided in Appendix A.

4.1.1. Non-cohesive Soil

Non-cohesive soil was encountered in two out of the 17 borings and extended from ground surface to depths ranging from 4.0 to 6.0 feet below ground surface. It was classified as the following in accordance with USCS:

- Silty Sand (SM)
- Poorly Graded Sand with clay (SP-SC)

Non-cohesive soil contained mostly fine sand, little fine gravel, few clay, and some silt. Based on recorded blow-counts, non-cohesive soil relative density ranges from loose to medium dense.

4.1.2. Cohesive Soil

Cohesive soil was encountered in 16 out of the 17 borings and extended from ground surface or beneath non-cohesive soil to depths up to 24.5 feet below ground surface. It was classified as the following in accordance with USCS:

- Sandy Lean Clay (CL)
- Lean Clay with sand (CL)
- Clayey Sand (SC)
- Fat Clay with sand (CH)
- Clayey Sand with gravel (SC)
- Fat Clay (CH)
- Lean Clay (CL)

Cohesive soil contained mostly to some clay, little to mostly fine- to coarse-grained sand, and trace to little fine gravel. Based on recorded blow-counts, cohesive soil consistency ranges from weight of hammer (WOH) or very soft to very stiff. Very soft cohesive soil was encountered during inlet pipe sampling at the bottom of the reservoir.

4.1.3. Pierre Shale (Middle Shale Member and Richard Sandstone Member)

Shale, claystone, siltstone, and sandstone bedrock of the Middle Shale Member and Richard Sandstone Member of the Pierre Shale were encountered in 16 out of the 17 borings. Bedrock was encountered at depths ranging from 6.5 to 24.5 feet and extended to between 25.0 and 101.0 feet. Bedrock was classified as the following:

- Clayey Sandstone
- Sandstone
- Sandy Shale
- Claystone
- Sandy Claystone
- Siltstone

The Middle Shale Member of the Pierre Shale bedrock encountered was described as completely weathered to fresh, very soft to medium hardness, very fine to medium grained, and olive brown to gray. Richard Sandstone Member of the Pierre Shale bedrock encountered was described as highly to moderately weathered, very soft, fine grained, and tan. In borings B-1, B-3, and B-4 practical auger refusal was encountered and drilling was terminated.

Twenty unconfined compressive strength tests were conducted on representative samples of bedrock with results ranging from 15.6 to 4,125.0 pounds per square inch (psi). Sixteen representative samples of bedrock were tested for swelling characteristics. Based on swell testing, the swell potential of bedrock ranges from low to high (Colorado Association of Geotechnical Engineers, 1996).

4.2. Groundwater

Groundwater was encountered during the subsurface investigation at depths ranging from 29 to 34 feet. Groundwater was not encountered in borings B-8, B-9, B-10, B-11, B-13, B-14, and B-15. Reservoir levels were low at an approximate elevation of 5,113 feet during barge drilling, ranging in depth from 7.0 to 29.0 feet deep. Additionally, a monitoring well was installed in boring B-6-MW for future water quality sampling and to measure seasonable changes in the groundwater table elevation. The table below presents initial groundwater levels in the borings and groundwater fluctuations in the monitoring wells as measured after drilling.

Table 4-1. Groundwater Depth (ft.)[1]

Boring	Date					
	Initial[2]	02/18/25	04/01/25	05/05/25	06/05/25	07/23/25
B-6 MW	34.0’	21.8’	21.8’	22.0’	14.0’	12.6’

Notes:
1. Groundwater depth as measured below the existing ground surface.
2. Reading collected immediately after drilling (see boring logs in Appendix A for date). Groundwater should be expected to fluctuate based on precipitation, localized irrigation, water levels in nearby water bodies and irrigation ditches, site development, and seasonal variations.

5. Limitations

This study was conducted in accordance with generally accepted geotechnical engineering and engineering geologic practices and principles; no warranty, express or implied is made. The subsurface conditions described in this report were based on data obtained from widely spaced exploratory borings, geotechnical laboratory testing, information provided by the Client, engineering judgement, and our experience with similar subsurface conditions and projects. The boring logs presented in this report only depict the subsurface conditions at the actual boring locations. Subsurface conditions are typically variable, both laterally and vertically, and the nature and extent of the subsurface variations across the site may not become evident until construction. The boundaries between different soil types presented in this report are approximate, and in some cases may be more abrupt or gradational than described herein. Groundwater levels may vary with time, adjacent water source levels, precipitation, and changes to the hydrogeological conditions at or surrounding the project site.

This report has been prepared exclusively for our client for design purposes for the subject project. GEI is not responsible for technical interpretations by others of the data presented in this report or use of this report by others for the subject project or other projects. If differing site conditions are encountered during further evaluation of the subsurface conditions by others or during construction, GEI should be notified immediately to determine if any changes to our recommendations presented in this report are warranted.

An environmental assessment was not included in GEI's scope of work for this project. Any statements regarding the absence or presence of hazardous and/or toxic substances presented herein are only intended for informational purposes. If the client is concerned about the environmental conditions at the site, GEI recommends the client and/or owner retain a qualified environmental firm to conduct an environmental site assessment.

6. References

ASTM Standards, ASTM International, West Conshohocken, PA (2012).

Colorado Association of Geotechnical Engineers (CAGE), 1996, Guideline for Slab Performance Risk Evaluation and Residential Basement Floor System Recommendations (Denver Metropolitan Area), 11 p.

Nelson, J.D., Miller, D.J., 1992, Expansive Soils: Problems and Practice in Foundation and Pavement Engineering, John Wiley and Sons Inc., New York, 259 pp, ISBN 0 471 51186 2.

Noe, D.C., Dodson, M.D., 1999, Heaving-Bedrock Hazards Associated with Expansive, Steeply Dipping Bedrock in Douglas County, Colorado, Colorado Geological Survey Special Publication 42, 80p.

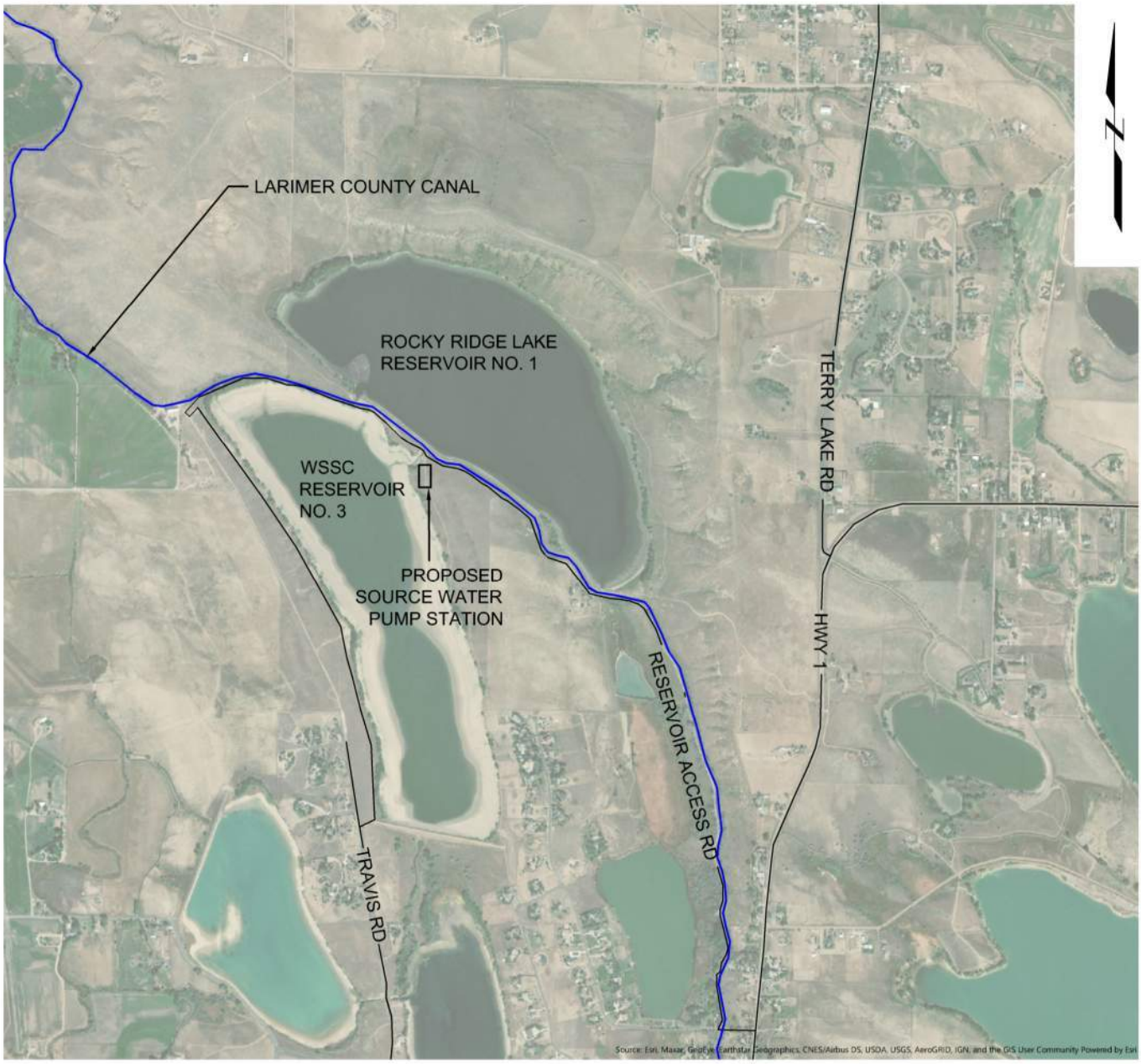
Noe, D.C., 1997, Heaving-Bedrock Hazards, Mitigation, and Land-Use Policy: Front Range Piedmont, Colorado, Colorado Geological Survey Special Publication 45, 13 p.

Workman, J. B., Cole, J. C., Shroba, R. R., Kellogg, K. S., & Premo, W. R., 2018, Geologic map of the Fort Collins 30'×60' quadrangle, Larimer and Jackson Counties, Colorado, and Albany and Laramie Counties, Wyoming, U.S. Geological Survey Scientific Investigations Map SIM-3399, 1:100,000 scale, https://doi.org/10.3133/sim3399

Figures

Figure 1. Site Vicinity

Figures 2a, 2b. Boring Location Maps



0 1000 2000

SCALE, FEET

LEGEND:

LOCAL ROADWAYS

SOURCE:

1. MAP BASED ON PLAN PROVIDED BY CLIENT AND ESRI IMAGERY

THORNTON SOURCE WATER PUMP STATION LARIMER COUNTY, CO	GEI Consultants	SITE VICINITY MAP
CAROLLO ENGINEERS	Project 2406846	September, 2025 Fig. 1

CARLSON, COLBY B:\Working\CAROLLO ENGINEERS\2406846 Thornton Source Water Pump Stn Proj\DESIGN\DWGS\Site Vicinity Map.dwg - 9/3/2025

0 300 600

SCALE, FEET

THORNTON SOURCE
WATER PUMP STATION
LARIMER COUNTY, CO

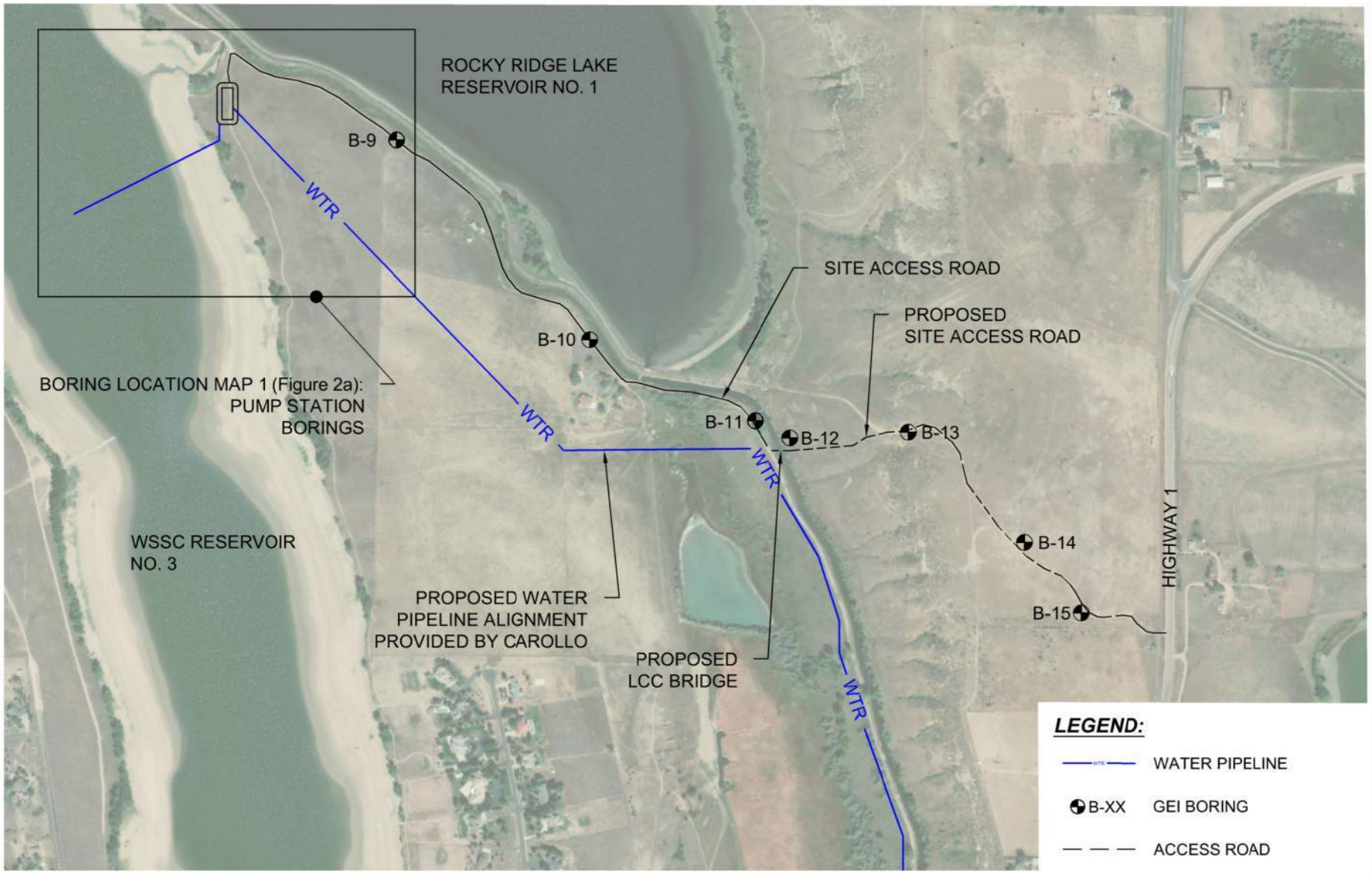
CAROLLO ENGINEERS

GEI Consultants

BORING LOCATION MAP

Project 2406846 | September, 2025 | Fig. 2a

CARLSON, COLBY B:\Working\CAROLLO ENGINEERS\2406846 Thornton Source Water Pump Stn Proj\DESIGN\DWGS\Boring Location Maps.dwg - 9/3/2025



0 750 1500

SCALE, FEET

THORNTON SOURCE
WATER PUMP STATION
LARIMER COUNTY, CO

CAROLLO ENGINEERS

GEI Consultants

BORING LOCATION MAP

Project 2406846 | September, 2025 | Fig. 2b

CARLSON, COLBY B:\Working\CAROLLO ENGINEERS\2406846 Thornton Source Water Pump Stn Proj\DESIGN\DWGS\Boring Location Maps.dwg - 9/3/2025

Appendix A Standard Geotechnical Drilling Keys and Boring Logs

BORING LOG KEY

STANDARD GEOTECHNICAL DRILLING

Soil Classifications:

Clear Square Sieve Openings				U.S. Standard Series Sieve Sizes			
12"	3"	3/4"	4	10	40	200	
Boulders	Cobbles	Gravel		Sand			Silts and Clays
		Coarse	Fine	Coarse	Medium	Fine	
300mm	75mm	19mm	4.75mm	2.0mm	0.42mm	0.075mm	

Gradation Estimates by Field Observation	
Description	**Quantity (%)**
Trace	<5
Few	5 to 10
Little	15 to 25
Some	30 to 45
Mostly	> 50

Relative Density or Consistency of Non-cohesive and Cohesive Soils			
Non-cohesive Soils		**Cohesive Soils**	
Classification	**Blows per 12 in**	**Classification**	**Blows per 12 in**
Very Loose	0 to 4	Very Soft	0 to 2
Loose	5 to 10	Soft	3 to 4
Medium Dense	11-30	Medium Stiff	5 to 8
		Stiff	9 to 15
Dense	31 to 50	Very Stiff	16 to 30
Very Dense	>50	Hard	>30

Color: Sample colors are in general accordance with basic brown, red, yellow, and gray combinations

Description of Moisture	
Description	**Criteria**
Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, usually soil below the groundwater table

Plasticity	
Description	**Criteria**
Nonplastic	A $\frac{1}{8}$" diameter thread cannot be rolled
Low	A $\frac{1}{8}$" in diameter thread can be rolled with difficulty; a lump cannot be formed at a moisture lower than the plastic limit
Medium	A $\frac{1}{8}$" in diameter thread can be rolled easily; a crumbly lump can be formed at a moisture lower than the plastic limit
High	A $\frac{1}{8}$" in diameter thread can be rolled very easily; a lump can be formed at a moisture lower than the plastic limit

Description of Odor	
Description	**Criteria**
No Organic Odor	Organic odor is not present
Trace Organic Odor	Mild organic odor; mixture of soil and organics
Strong Organic Odor	Prominent organic odor; sample is primarily organic

Cementation	
Description	Criteria
Weak	Crumbles with light finger pressure
Moderate	Crumbles with considerable finger pressure
Strong	Will not crumble with finger pressure

Rock Descriptions:

Weathering	
Description	**Criteria**
Fresh	No visible sign of rock material weathering: perhaps slight discoloration on major discontinuity surfaces.
Slightly Weathered	Discoloration of rock material on discontinuity surfaces.
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to soil. Fresh or discolored rock is present either as a continuous framework or as corestones.
Highly Weathered	More than half of the rock material is decompsed and/or disintegrated to a soil. Fresh or discolored rock is present either as a discontinuous framework or as corestones
Completely Weathered	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact.

Texture	
Description	**Criteria**
Very Fine Grained	Grains not individually visible to the unaided eye
Fine Grained	Grains barely visible to the unaided eye, up to $\frac{1}{16}$" diameter
Medium Grained	Grain diameter between $\frac{1}{16}$" and $\frac{3}{16}$"
Coarse Grained	Grains diameter between $\frac{3}{16}$" and $\frac{1}{4}$"
Very Coarse Grained	Grains larger than $\frac{1}{4}$" in diameter

Field Hardness	
Description	**Criteria**
Very Hard	Cannot be scratched with a knife or sharp pick.
Hard	Can be scratched with a knife or pick only with difficulty
Medium	Can be gouged $\frac{1}{16}$" deep by firm pressure on knife or pick point
Soft	Can be grooved or gouged readily with knife or pick point
Very Soft	Can be carved with knife and scratched readily by fingernail

Geologic Interpretation:

A ***Geologic Interpretation*** of encountered soil and bedrock units is provided for each specific ***Visual Material Description***. Examples of geologic interpretations for soil that may be presented include: FILL, ALLUVIUM, AEOLIAN, AND GLACIAL TILL, AND RESIDUUM. Rock geologic interpretations are referenced based on a combination of field classifications and applicable geologic maps.

Sample Graphics and Descriptions:

California Barrel Sampler: Barrel sampler loaded with sample liners and driven to collect a relatively representative and intact specimen of soil or weak rock.

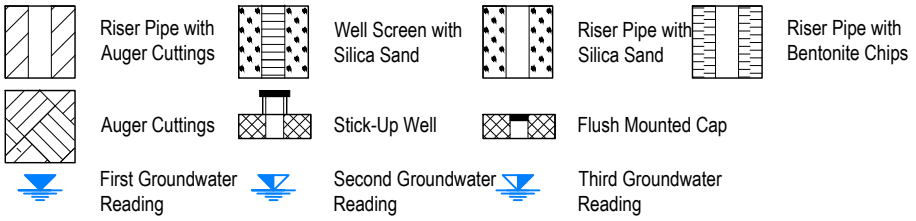
Split-Spoon Sampler: Split-barrel sampler driven in accordance with ASTM D1586 used to provide visual material descriptions and collect a disturbed specimen.

Shelby Tube Sampler: Thin wall tube hydraulically pushed into the subsurface to collect a representative and intact specimen of soil.

Bulk Sample: Bulk or bagged sample taken from auger cuttings.

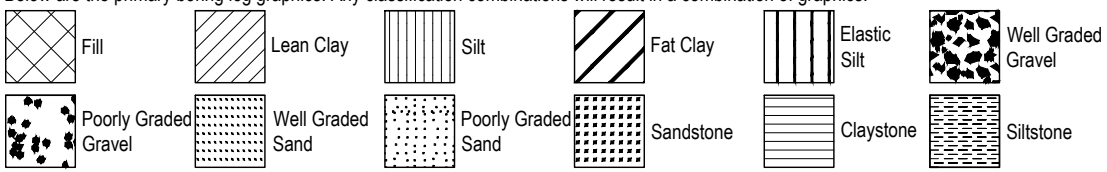
Continuous Sampler: A 5-foot long sampler barrel that is driven to collect a continuous 5-foot run of cohesive and non-cohesive soil.

Groundwater Monitoring Well Graphics:



Boring Graphics:

Below are the primary boring log graphics. Any classification combinations will result in a combination of graphics.



GEI Consultants

BORING: B-1

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 28AUG24 - 29AUG24

Drilling and Sampling Methods

Drill Make and Model: 7822 DT Geoprobe
Drilling Method: Hollow Stem Auger
Bit Type: Cutting Head
Casing Description: 4.25-inch HSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., Split-Spoon
Sampler Diameter(s): 2.5-,2.0-inches

GEI Consultants

Boring Location: 40.667819, -104.090943
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL** Note: Reservoir water depth 29-feet.												
5			1 2 4	18			LEAN CLAY with sand (CL), some fine sand, medium stiff, greenish black to olive, wet.												
10			4 7	0			No Recovery.												
15			6 9	12			As above except olive, some calcite deposits.		22	108				72	40	26	2233		
20			12 17	0			No Recovery.												
			9 11 12	6			As above except no calcite. Note: Blow counts inaccurate due to sampling at 20-feet through previous sample material.												
							23.0 ft.												
25			50/9"	7			**PIERRE SHALE, MIDDLE MEMBER** Clayey SANDSTONE, very soft, completely to highly weathered, olive brown to brown, very fine- to fine-grained, no bedding, wet, few calcite.		16	111				48	37	22			
			50/5"	5			As above except highly weathered, dark brown, trace calcite. Note: Sampled after refusal at 27-feet.												
							28.0 ft.												
30							**END OF EXPLORATION**												

Sampling Data | Visual Material Description | Laboratory Testing Results (In-Situ States | INDEX DATA | Strength & Compressibility)

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		BARGE DRILLNG

BORING: B-1C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 23rd, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669582, -105.088145
Boring Elevation:
Notes: Location from handheld GPS unit.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)	Visual Material Description
0																	**COHESIVE SOIL**
5		4 4	12									36	17				Clayey SAND (SC), mostly fine sand, little clay, few silt, medium stiff, pale olive, moist, sulfates and roots.
10		6 8	11			14	112					42	24				As above except little to some clay, no silt, stiff, olive.
					(12.6 ft.)												
15		10 11	8			20	106				85						LEAN CLAY with sand (CL), little fine sand, very stiff, olive brown moist. Note: groundwater measurement from B-6-MW, not observed in bore hole.
																	18.0 ft.
20		19 31	12														**PIERRE SHALE, MIDDLE MEMBER** Sandy SHALE, very soft, completely to highly weathered, olive, very fine- to fine-grained, thin laminations.
25		28 50/5"	11														As above except highly to moderately weathered.
			60 50	0.47								16	114		1,593	+0.8	As above.
30																	As above except soft, olive gray.
																	Sandy SHALE, very soft to soft, moderately weathered,

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
23JUL25	2 hr	12.55'

BORING: B-1C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 23rd, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669582, -105.088145
Boring Elevation:
Notes: Location from handheld GPS unit.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Visual Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
	60 / 90	0.53	yellowish brown to olive gray, very fine- to fine-grained, thin laminations.			27,936		
35			As above except soft, slightly weathered, iron oxidation staining, calcite veins.					
	60 / 53.3	0.74						
40			SANDSTONE with interbedded Shale, medium, slightly weathered to fresh, gray to dark gray, very fine- to medium-grained, shale often dark and washed out, bioturbation.					
	60 / 73.3	0.76						
45			As above except hard, fresh.					
	60 / 95	0.63						
50			As above except no shale, bivalve shells in top foot.	6	135	311,040	1,582	+0.3
	60 / 100	0.64		7	131		766	+0.2
55			As above except 3-inch sand nodule in top foot and bioturbation throughout.					
	60 / 100	0.66						
60			As above.			410,967		
	65.3 / 100	0.66				410,976		

Laboratory Testing Results: In-Situ States (Moisture Content (%), Dry Unit Weight (pcf), Water Soluble Sulfates (%)); INDEX DATA (Gravel Content (%), Sand Content (%), Fines Content (%), Liquid Limit (%), Plasticity Index (%)); Strength & Compressibility (UCS (psf), Swell Pressure (psf), Swell Percent (%))

Groundwater Depth / Monitoring Well Configuration

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
23JUL25	2 hr	12.55'

BORING: B-1C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 23rd, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669582, -105.088145
Boring Elevation:
Notes: Location from handheld GPS unit.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Visual Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
65			As above except lots of calcite crystallization and shell fragments.					
	52 / 87	0.66						
70			As above.					
	60 / 95	0.73						
			CLAYSTONE, soft to medium, fresh, gray to olive gray, very fine-grained.					
75			SANDSTONE, medium, fresh, dark gray, medium-grained, bivalve fossil.	22	105		5,574	+2.1
	62 / 95	0.85				479,664		
80			SILTSTONE, medium, fresh, dark gray, very fine-grained, no bedding, some fossils and calcite.					
	58.5 / 100	0.73						
85			As above except high density of fossils.					
	59 / 100	0.72						
90			As above.			490,032		
	58 / 100	0.76						
95			As above.					

Groundwater Depth / Monitoring Well Configuration

Laboratory Testing Results
In-Situ States: Moisture Content (%), Dry Unit Weight (pcf), Water Soluble Sulfates (%)
INDEX DATA: Gravel Content (%), Sand Content (%), Fines Content (%), Liquid Limit (%), Plasticity Index (%)
Strength & Compressibility: UCS (psf), Swell Pressure (psf), Swell Percent (%)

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
23JUL25	2 hr	12.55'

BORING: B-1C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 23rd, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669582, -105.088145
Boring Elevation:
Notes: Location from handheld GPS unit.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
100				55 95	0.87		As above except light gray. 100.4 ft. **END OF EXPLORATION**										515,808		
105																			
110																			
115																			
120																			
125																			

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
23JUL25	2 hr	12.55'

BORING: B-2

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 27AUG24 - 28AUG24

Drilling and Sampling Methods

Drill Make and Model: 7822 DT Geoprobe
Drilling Method: Hollow Stem Auger
Bit Type: Cutting Head
Casing Description: 4.25-inch HSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., Split-Spoon
Sampler Diameter(s): 2.5-,2.0-inches

GEI Consultants

Boring Location: 40.668180, -105.090051
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL** Note: Reservoir water depth at 27-feet.												
5			2 6 8	181			LEAN CLAY with sand (CL), little fine sand, stiff, greenish black to olive gray, wet.												
10			7 11	12			As above except little to some fine to medium sand, very stiff, brown.		22	108	0.0463			74	47	33			
15			6 9	12			As above except little to some fine to coarse sand, stiff, brown to yellowish brown.												
20			5 6	12			Sandy LEAN CLAY (CL), some fine to coarse sand, stiff, brown, wet.		22	108				65	37	23			
							23.0 ft.												
25			13 24	12			**PIERRE SHALE, MIDDLE MEMBER** CLAYSTONE, very soft, highly weathered, dark brown, very fine-grained, no bedding, wet.		20	106								1208	+0.6
30			50/7"	7			Sandy CLAYSTONE, very soft, moderately to slightly weathered, brown to gray brown, very fine- to fine-grained, wet. Note: Sampled at 29-feet after augers hit refusal.		18	112		0	7	93	50	33	6542		
							30.0 ft.												
							END OF EXPLORATION												

Sampling Data | Visual Material Description | Laboratory Testing Results (In-Situ States; INDEX DATA; Strength & Compressibility)

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		BARGE DRILLNG

BORING: B-2C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 24th, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669384, -105.088141
Boring Elevation:
Notes: Location from handheld GPS unit.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**												
5			3 3	8			CLAYEY SAND (SC), mostly fine sand, little clay, medium stiff, olive, moist, sulfates.		14					57					
10			0 2	12			Sandy LEAN CLAY (CL), some fine sand, trace gravel, very soft, olive, wet.	(11.0 ft.)											
15			0 3	12			LEAN CLAY with sand (CL), little fine sand, soft, olive, wet.		24	97				73	47	27			
20			0 2	12			As above except with iron oxidation staining.												
25			4 6	12			FAT CLAY with sand (CH), little fine sand, soft, olive, wet. 24.5 ft. **PIERRE SHALE, MIDDLE MEMBER** Sandy SHALE, very soft, completely to highly weathered, yellowish brown to olive gray, very fine- to fine-grained, thin laminations, wet.		22	100				80	52	27			
30			50/6"	5			As above except highly to moderately weathered.		13	117								1,777	+1.0

Sampling Data | Laboratory Testing Results: In-Situ States | INDEX DATA | Strength & Compressibility

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
24JUL25	2 hr	11'

BORING: B-2C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 24th, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669384, -105.088141
Boring Elevation:
Notes: Location from handheld GPS unit.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
35			50/2"	3			As above except moderately to slightly weathered.												
							As above except soft, fresh, olive yellow to gray.												
				54 73	0.62														
40							SANDSTONE, soft, fresh, gray, fine to medium grained, calcareous. As above except a few fossils.										215,712		
				59 100	0.88														
45							As above except 1.25-inch sand nodule.		3	138					26	9		2,275	+0.5
				60 100	0.62														
50							As above.		5	133					28	12		2,000	+0.5
				60 100	0.56														
55							As above except higher density of shell fragments and calcite.								47	29	331,920		
				60 100	0.55														
60							As above.		8	129								4,135	+1.4
				60 100	0.70														

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
24JUL25	2 hr	11'

BORING: B-2C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 24th, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669384, -105.088141
Boring Elevation:
Notes: Location from handheld GPS unit.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Visual Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
65			As above.	21	106			2,920	+1.9
			CLAYSTONE, very soft, fresh, white to gray, very fine-grained, bentonitic with calcite crystals. Depth: 66.4'						
	57.5 / 85	0.92	SANDSTONE, soft, fresh, gray, fine to medium grained, calcareous. Depth: 67.2'						
70							365,616		
			As above except medium hardness.						
	61 / 100	0.69							
75			As above.						
	56.5 / 100	0.69							
80			As above except 1" Claystone seam and possible nodule based on color change to light gray in last 2-inches.						
	61 / 98	0.72	CLAYSTONE, very soft, fresh, gray, very fine grained.						
85			SANDSTONE, soft, fresh, gray, fine to medium grained, calcareous, 3-inch light gray concretion, shell fragments.						
	59 / 100	0.71							
90									
	32 / 100	0.68	SILTSTONE, medium, fresh, gray, very fine-grained, no lamination. Note: Did full run but lost half of core, ran full run from 93.66-ft to recover. As above.						
95									
	55 / 100	0.76					594,000		

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
24JUL25	2 hr	11'

BORING: B-2C

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: July 24th, 2025

Drilling and Sampling Methods

Drill Make and Model: Truck-Mounted CME-75
Drilling Method: HSA / HQ Coring
Bit Type: Cutting Head / HQ Core Bit
Casing Description: 4.25-inch / 3.75-inch
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., HQ
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669384, -105.088141
Boring Elevation:
Notes: Location from handheld GPS unit.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
100				26 100	1.23		As above.											7,000	+1.1
							101.0 ft. **END OF EXPLORATION**												
105																			
110																			
115																			
120																			
125																			

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
24JUL25	2 hr	11'

BORING: B-3

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 27AUG24

Drilling and Sampling Methods

Drill Make and Model: 7822 DT Geoprobe
Drilling Method: Hollow Stem Auger
Bit Type: Cutting Head
Casing Description: 4.25-inch HSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., Split-Spoon
Sampler Diameter(s): 2.5-,2.0-inches

GEI Consultants

Boring Location: 40.668506, -105.089588
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL** Note: Reservoir water depth at 25-feet.												
5			WOH	0			No Recovery. Note: USCS inferred from material on cutting head.												
10			WOH	12			Sandy LEAN CLAY (CL), some fine sand, trace fine gravel, very soft, brown, wet.		25	102							820		
15			0 3	12			As above except soft.		27	98				58	35	21			
20			7 12	0			No Recovery.												
25			18 40	12			24.0 ft. **PIERRE SHALE, MIDDLE MEMBER** CLAYSTONE, few sand, very soft, highly weathered, yellowish brown, very fine-grained, wet. 26.5 ft. **END OF EXPLORATION** Exploration ceased due to auger refusal.		21	109		0	7	93	45	28	2242		
30																			

Sampling Data | Visual Material Description | Laboratory Testing Results (In-Situ States; INDEX DATA; Strength & Compressibility)

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		BARGE DRILLNG

BORING: B-4

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 29AUG24

Drilling and Sampling Methods

Drill Make and Model: 7822 DT Geoprobe
Drilling Method: Hollow Stem Auger
Bit Type: Cutting Head
Casing Description: 4.25-inch HSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal., Split-Spoon
Sampler Diameter(s): 2.5-,2.0-inches

GEI Consultants

Boring Location: 40.668621, -105.088831
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL** Note: Reservoir water depth at 7-feet.												
5			2 3 8	11			LEAN CLAY (CL), few fine sand, stiff, dark brown to greenish black, wet, little organics.		18					91	40	24			
							9.0 ft.												
10			10 20	12			**PIERRE SHALE, MIDDLE MEMBER** CLAYSTONE, little sand, very soft, highly weathered, olive brown to brown, very fine-grained, wet.		16	116							2457		
15			50/9"	10			As above except moderately weathered, yellowish brown to brown, very fine- to fine-grained, little iron oxidation.		13	122				89	39	22	9871		
20			50/8"	8			Sandy CLAYSTONE, very soft, slightly weathered to fresh, olive brown, very fine- to fine-grained, no oxidation, few clacite, wet.												
25			50/6"	6			As above except fresh.				0.0588								
							25.0 ft.												
							END OF EXPLORATION Exploration ceased due to auger refusal.												
30																			

Sampling Data | Visual Material Description | Laboratory Testing Results (In-Situ States | INDEX DATA | Strength & Compressibility)

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		BARGE DRILLNG

BORING: B-5

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.668796, -105.088401
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**												
			3 6	12			Clayey SAND (SC), mostly fine sand, some clay, stiff, grayish brown, moist.		10			1	54	45	27	25			
			3 2	12			As above except medium stiff, brown.												
5			2 8	12			As above except stiff, gray to yellowish brown, little organics.												
			11 18	12			Sandy LEAN CLAY (CL), some fine sand, very stiff, gray to yellowish brown, moist. Hydrometer Results: Silt 26%, Clay 32%. See Appendix B.		14			1	41	58	21	36			
10							-10.0 ft.-												
			14 31	12			**PIERRE SHALE, MIDDLE MEMBER** Sandy CLAYSTONE, very soft, highly weathered, gray to yellowish brown, fine- to very fine-grained, sulfates, moist.												
			12 30	12			As above except moderately weathered, mica and calcite crystallization. As above except slightly weathered, brown, no sulfates.												
15			14 18	11			As above except gray brown.		16	114									
			24 50/4	12			As above except yellow.												
20																			
			50/5	12			As above except gray brown.		10	122				66			3159		
25																			
			50/5	5			As above except fresh, gray.		9	127				68	38	24		7067	+5.0
30																			

Sampling Data | Visual Material Description | Laboratory Testing Results (In-Situ States | INDEX DATA | Strength & Compressibility)

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-5

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.668796, -105.088401
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
35			50/1	1			Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions As above.													
40			50/1	1			As above. 40.0 ft. **END OF EXPLORATION**												
45																			
50																			
55																			
60																			

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-6-MW

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Hollow Stem Auger
Bit Type: Cutting Head
Casing Description: 4.25-inch HSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669238, -105.087970
Boring Elevation:
Notes: Location from handheld GPS in the field.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Sample ID	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Visual Material Description	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0					**NON-COHESIVE SOIL**											
		7 7	9		Poorly-Graded SAND with clay (SP-SC), mostly fine sand, few clay, medium dense, tan, moist.											
		6 6	8		4.0 ft. **COHESIVE SOIL** Sandy LEAN CLAY (CL), some fine sand, stiff, tan to olive, moist.	11			0	33	68	36	22			
5		4 4	6		As above except medium stiff.											
		3 5	7		As above except brown.											
10		3 4	6		As above. (12.6 ft)	20					65	40	26			
		5 6	11		As above except stiff.			0.0609								
15		5 7	12		As above.											
		3 4	12		As above except medium stiff.											
20																
		7 12	12		24.0 ft. **PIERRE SHALE, MIDDLE MEMBER** Clayey SANDSTONE, very soft, moderately weathered, gray, fine-grained, moist.	24	100				68			2934		
25																
30		50/6	6		As above except slightly weathered, light brownish gray.											

Groundwater Depth / Monitoring Well Configuration

Laboratory Testing Results: In-Situ States; INDEX DATA; Strength & Compressibility

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
30OCT24	1 hr	34.0'
23JUL25	266 days	12.55'

BORING: B-6-MW

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Hollow Stem Auger
Bit Type: Cutting Head
Casing Description: 4.25-inch HSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669238, -105.087970
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description		Laboratory Testing Results											
									In-Situ States			INDEX DATA						Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
35			50/4	4			As above except fresh, wet.													
40			50/3	3			As above.													
							40.0 ft.													
							END OF EXPLORATION													
45																				
50																				
55																				
60																				

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
30OCT24	1 hr	34.0'
23JUL25	266 days	12.55'

BORING: B-7

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669368, -105.088230
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**												
			10 13	12			LEAN CLAY with sand (CL), little fine sand, very stiff, tan, moist.												
			10 18	12			As above except brown, sulfates.				0.0221								
5			7 9	12			LEAN CLAY (CL), very stiff, dark brown, moist.												
			7 12	12			FAT CLAY (CH), very stiff, dark brown, moist.		22	102				91	61	42		2104	+1.2
10			3 6	12			As above except stiff.												
			5 8	12			As above.												
15			3 5	12			16.5 ft. **PIERRE SHALE, MIDDLE MEMBER** Sandy CLAYSTONE, very soft, highly weathered, tan, very fine-grained, moist.												
			2 2	12			As above except moderately weathered.		26	99				64	33	20		0	-0.1
20																			
			6 10	12			Clayey SANDSTONE, very soft, moderately weathered, yellowish brown, fine-grained, moist.												
25																			
			50/6	6			As above except moderately weathered, light brownish gray, wet.	(29.0 ft.)											
30																			

Sampling Data | Laboratory Testing Results | In-Situ States | INDEX DATA | Strength & Compressibility

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
30OCT24	1 hr	29.0'

BORING: B-7

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669368, -105.088230
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
35			50/1	3			As above.		10	121							8484		
40			50/1	3			As above. 40.0 ft. **END OF EXPLORATION**												
45																			
50																			
55																			
60																			

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
30OCT24	1 hr	29.0'

BORING: B-8

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669725, -105.087965
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	In-Situ States: Moisture Content (%)	In-Situ States: Dry Unit Weight (pcf)	In-Situ States: Water Soluble Sulfates (%)	INDEX DATA: Gravel Content (%)	INDEX DATA: Sand Content (%)	INDEX DATA: Fines Content (%)	INDEX DATA: Liquid Limit (%)	INDEX DATA: Plasticity Index (%)	Strength & Compressibility: UCS (psf)	Strength & Compressibility: Swell Pressure (psf)	Strength & Compressibility: Swell Percent (%)
0							**COHESIVE SOIL**												
			5 7	12			CLAYEY SAND with gravel (SC), mostly fine sand, some clay, little fine gravel, stiff, tan to olive brown, moist.		8					49					
5			6 6	12			As above except olive brown.								62	42			
			50/6	12			6.5 ft. **PIERRE SHALE, MIDDLE MEMBER** SANDSTONE, very soft, highly weathered, tan, fine-grained, moist.												
10			37 50/6	12			As above except moderately weathered.												
			20 50/6	12			As above.												
15			24 50/5	9			As above except slightly weathered.		14	115							8273		
			12 40	12			As above except olive brown.												
20			28 50/4	12			As above except olive.												
25			50/5	6			As above.												
30			27 50/5	12			As above.												

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-8

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 30OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.669725, -105.087965
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description		Laboratory Testing Results												
									In-Situ States			INDEX DATA						Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
35			50/6	6			As above except fresh.		16	113					48	31		9135	+4.6
40			50/5	5			As above.												
							40.0 ft. **END OF EXPLORATION**												
45																			
50																			
55																			
60																			

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-9

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.668893, -105.084838
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**												
			6 5	12			LEAN CLAY with sand (CL), little fine sand, stiff, tan, moist.												
			6 5	12			As above.		10					76	38	25			
5																			
			16 30	12			9.0 ft. **PIERRE SHALE, MIDDLE MEMBER** SANDSTONE, very soft, highly weathered, tan, fine-grained, moist.												
10							10.0 ft. **END OF EXPLORATION**												
15																			
20																			
25																			
30																			

Sampling Data
Visual Material Description
Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions
Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions
Laboratory Testing Results
In-Situ States
INDEX DATA
Strength & Compressibility

General Notes:

1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-10

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.666052, -105.081254
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**													
			5 6	12			LEAN CLAY with sand (CL), little fine sand, stiff, tan, moist.													
5			4 5	11			As above except olive.													
			2 3	9			As above except medium stiff.													
10							10.0 ft. **END OF EXPLORAITON**													
15																				
20																				
25																				
30																				

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-11

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.664923, -105.078179
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA						Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**NON-COHESIVE SOIL**													
			4 4	12			SILTY SAND (SM), mostly fine sand, some silt, loose, pale olive, moist.													
5			5 5	0			No Recovery.													
			5 6	12			6.5 ft. **COHESIVE SOIL** LEAN CLAY with sand (CL), little fine sand, stiff, olive brown, moist.													
10			3 5	10			As above except medium stiff.													
			3 4	12			As above.		19	103				75	37	23		975	+0.3	
15			2 3	12	1		As above.													
			3 3	12			As above.													
			3 4	12			19.0 ft. **PIERRE SHALE, MIDDLE MEMBER** CLAYSTONE, very soft, moderately weathered, olive gray, very fine-grained, moist.		22	107										
25			13 28	12			As above except slightly weathered, gray to yellow.													
30			25 50/3	8			As above.		13	125							25842			

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-11

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.664923, -105.078179
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic			Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
35			50/6	6			Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions As above.		14					100	44	25			
40			25 50/4	4			As above. 40.0 ft. **END OF EXPLORATION**													
45																				
50																				
55																				
60																				

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-12

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.664652, -105.077553
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**												
			6 7	12			CLAYEY SAND (SC), mostly fine sand, some clay, stiff, tan, moist.												
			6 8	12			Sandy LEAN CLAY (CL), some fine sand, stiff, olive, moist, sulfates.				0.0175								
5			4 8	6			LEAN CLAY with sand (CL), little fine sand, stiff, olive, moist.		12					74	41	28			
			5 8	12			As above except little sulfates.												
10			4 7	12			As above except no sulfates.		20	106							2339		
			3 6	11			As above except little iron oxide staining.		22	103									
15							16.5 ft.												
			10 24	12			**PIERRE SHALE, MIDDLE MEMBER** CLAYSTONE, very soft, moderately weathered, yellow to gray, very fine-grained, moist.		17	104								1878	+0.7
			22 50/5	12			As above.												
20																			
			36 50/4	12			As above except slightly weathered.		12	125				98	39	25		2892	+1.1
25																			
			50/6	6			As above.												
30							SANDSTONE, very soft, slightly weathered, gray to yellow, very fine-grained, moist.												

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
31OCT24	1 hr	33.0'

BORING: B-12

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.664652, -105.077553
Boring Elevation:
Notes: Location from handheld GPS in the field.

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)	Visual Material Description
35			50/6	6			(33.0 ft.)	11	123				99			20223			As above exept fresh, wet.
40			50/4	4															As above.
																			40.0 ft.
																			END OF EXPLORATION
45																			
50																			
55																			
60																			

Laboratory Testing Results: In-Situ States; INDEX DATA; Strength & Compressibility

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
31OCT24	1 hr	33.0'

BORING: B-13

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.664730, 105.075446
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration
0							**PIERRE SHALE, RICHARD SANDSTONE MEMBER**	
			50/4	4			SANDSTONE, very soft, moderately weathered, tan, fine-grained, moist.	
5			50/1	4			As above.	
			50/1	1			As above.	
10							10.0 ft.	
							END OF EXPLORATION	
15								
20								
25								
30								

Sampling Data

Visual Material Description

Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions

Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions

Laboratory Testing Results

In-Situ States			INDEX DATA					Strength & Compressibility		
Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-14

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.663460, -105.073626
Boring Elevation:
Notes: Location from handheld GPS in the field.

Sampling Data							Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Laboratory Testing Results											
									In-Situ States			INDEX DATA					Strength & Compressibility		
Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Soil: -GEOLOGIC INTERPRETATION- USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions. Rock: -GEOLOGIC INTERPRETATION- Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions		Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**													
			6 8	12			Sandy LEAN CLAY (CL), some fine sand, stiff, tan, moist, sulfates.													
5			7 9	12			LEAN CLAY with sand (CL), little fine sand, very stiff, tan, moist.		10					77	44	29				
			12 20	12			9.0 ft. **PIERRE SHALE, RICHARD SANDSTONE MEMBER** SANDSTONE, very soft, highly weathered, tan, fine-grained, moist.													
10							10.0 ft. **END OF EXPLORATION**													
15																				
20																				
25																				
30																				

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

BORING: B-15

Project Name: Thornton Pump Station
Project Number: 2406846
Client's Name: Carollo Engineers
Owner's Name: City of Thornton
Drilling Subcontractor: Terracon Consultants
GEI Representative: Colby C.
Date(s) of Drilling: 31OCT2024

Drilling and Sampling Methods

Drill Make and Model: CME-75
Drilling Method: Solid Stem Auger
Bit Type: Cutting Head
Casing Description: 4.0-inch SSA
Hammer Weight (lbs)/Fall (in): 140lbs./30-inches
Sampler Type(s): Mod. Cal.
Sampler Diameter(s): 2.5-inches

GEI Consultants

Boring Location: 40.662167, -105.072082
Boring Elevation:
Notes: Location from handheld GPS in the field.

Depth (ft)	Elevation (ft)	Sample Identification	Blow Count/6 in	Recovery (in) / RQD (%)	Drilling Rate (min./ft.)	Geologic Graphic	Visual Material Description	Groundwater Depth / Monitoring Well Configuration	Moisture Content (%)	Dry Unit Weight (pcf)	Water Soluble Sulfates (%)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Liquid Limit (%)	Plasticity Index (%)	UCS (psf)	Swell Pressure (psf)	Swell Percent (%)
0							**COHESIVE SOIL**												
			3 6	12			Sandy LEAN CLAY (CL), some fine sand, stiff, tan, moist.		6					52	30	16			
5			8 8	12			As above except very stiff.												
			50/6	6			9.0 ft. **PIERRE SHALE, RICHARD SANDSTONE MEMBER** SANDSTONE, completely to highly weathered, tan, fine-grained, moist.												
10							10.0 ft. **END OF EXPLORATION**												
15																			
20																			
25																			
30																			

Sampling Data
Visual Material Description
Soil:
-GEOLOGIC INTERPRETATION-
USCS Classification (group symbol), particle sizes, density or consistency, color, moisture, odor, other descriptions
Rock:
-GEOLOGIC INTERPRETATION-
Bedrock Classification, hardness, weather, color, texture, joint size, other descriptions
Laboratory Testing Results
In-Situ States
INDEX DATA
Strength & Compressibility

General Notes:
1) Soil classificaitons are in general accordance with ASTM D2487
2) The maximum particle size identified in the material description is dependent on sampler dimensions.
3) Additional information is provided on the Boring Log Key.
4) Groundwater measurements for monitoring wells present water levels at the time of drilling, highest level, and lowest level. Refer to the respective report for a complete history of groundwater values.

Groundwater Data:

Date:	Elapsed Time:	Depth to Groundwater:
		NA

Appendix B Geotechnical Laboratory Testing Results

Geotechnical Laboratory Testing Results

Sample Identification		In-Place States		Proctor		Corrosion		Material Classification and Index Testing					One Dimensional Compression Testing					
								Particle Size			Atterberg Limits							
Boring	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Max Dry Density (pcf)	Optimum Water Content (%)	Water Soluble Sulfates (%)	Organic Content (%)	Gravel (%)	Sand (%)	Fines (%)	Liquid Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Swell Percent / Inundation Pressure (%/psf)	Swell Pressure (psf)	R-value	USCS[1, 2]	Geologic Classification
B-1	15	22	108							72	40	26	2,233				CL	Lean Clay with Sand
B-1	25	16	111							48	37	22					BR	Clayey Sandstone
B-2	10	22	108			0.0463				74	47	33					CL	Lean Clay with Sand
B-2	20	22	108							65	37	23					CL	Sandy Lean Clay
B-2	25	20	106											+0.6 / 500	1,208		BR	Claystone
B-2	30	18	112					0	7	93	50	33	6,542				BR	Claystone
B-3	10	25	102										820				CL	Sandy Lean Clay
B-3	15	27	98							58	35	21					CL	Sandy Lean Clay
B-3	25	21	109					0	7	93	45	28	2,242				BR	Claystone
B-4	5	18								91	40	24					CL	Lean Clay
B-4	10	16	116										2,457				BR	Claystone
B-4	15	13	122							89	39	22	9,871				BR	Claystone
B-4	25					0.0588											BR	Clayey Sandstone
B-5	2.5	10						1	54	45	27	25					SC	Clayey Sand
B-5	10	14						1	41	58	21	36					CL	Sandy Lean Clay
B-5	17.5	16	114														BR	Sandy Claystone
B-5	25	10	112							66			3,159				BR	Sandy Claystone
B-5	30	9	127							68	38	24		+5.0 / 500	7,067		BR	Sandy Claystone
B-6	5	11						0	33	68	36	22					CL	Sandy Lean Clay
B-6	12.5	20								65	40	26					CL	Sandy Lean Clay
B-6	15					0.0609											CL	Sandy Lean Clay
B-6	25	24	100							68			2,934				BR	Clayey Sandstone
B-7	5					0.0221											CL	Lean Clay with Sand
B-7	7.5						1.6										CL	Lean Clay
B-7	10	22	102							91	61	42		+1.2 / 500	2,104		CH	Fat Clay
B-7	20	26	99							64	33	20		-0.1 / 500	0		BR	Sandy Claystone
B-7	35	10	121										8,484				BR	Clayey Sandstone
B-8	2.5	8								49							SC	Clayey Sand with Gravel
B-8	5										62	42					SC	Clayey Sand with Gravel
B-8	15	14	115										8,273				BR	Sandstone
B-8	35	16	113								48	31		+4.6 / 500	9,135		BR	Sandstone
B-9	5	10								76	38	25					CL	Lean Clay with Sand
B-11	12.5	19	103							75	37	23		+0.3 / 500	975		CL	Lean Clay with Sand
B-11	20	22	107														BR	Claystone
B-11	30	13	125										25,842				BR	Claystone
B-11	35	14								100	44	25					BR	Claystone
B-12	5					0.0175											CL	Sandy Lean Clay
B-12	7.5	12								74.4	41	28					CL	Lean Clay with Sand

[1]Where Atterberg Limits and Fines Content testing was not performed, USCS Classifications visually determined in the field during the subsurface investigation.

[2]"BR" indicates bedrock.

Geotechnical Laboratory Testing Results

Sample Identification		In-Place States		Proctor		Corrosion		Material Classification and Index Testing					One Dimensional Compression Testing					
								Particle Size			Atterberg Limits							
Boring	Sample Depth (ft)	Moisture Content (%)	Dry Density (pcf)	Max Dry Density (pcf)	Optimum Water Content (%)	Water Soluble Sulfates (%)	Organic Content (%)	Gravel (%)	Sand (%)	Fines (%)	Liquid Limit	Plasticity Index	Unconfined Compressive Strength (psf)	Swell Percent / Inundation Pressure (%/psf)	Swell Pressure (psf)	R-value	USCS[1, 2]	Geologic Classification
B-12	12.5	20	106										2,339				CL	Lean Clay with Sand
B-12	15	22	103														CL	Lean Clay with Sand
B-12	17.5	17	114											+0.7 / 500	1,878		BR	Claystone
B-12	25	12	125							98	39	25		+1.1 / 500	2,892		BR	Claystone
B-12	35	11	123							99			20,223				BR	Sandstone
B-14	5	10								77	44	29					CL	Lean Clay with Sand
B-15	2.5	6								52	30	16					CL	Sandy Lean Clay
B-9 & B-10	Bulk															< 5	CL	Lean Clay with Sand
B-11 & B-12	Bulk			105	18												SC	Clayey Sand
B-14 & B-15	Bulk															< 5	CL	Sandy Lean Clay
B-1C	5										36	17					SC	Clayey Sand
B-1C	10	14	112								42	24					SC	Clayey Sand
B-1C	15	20	106							85							CL	Lean Clay with Sand
B-1C	29	16	114											+0.8/500	1,593		BR	Sandy Shale
B-1C	33												27,936				BR	Sandy Shale
B-1C	50												311,040				BR	Sandstone
B-1C	50.5	6	135											+0.3/500	1,582		BR	Sandstone
B-1C	53	7	131											+0.2/500	766		BR	Sandstone
B-1C	59												410,976				BR	Sandstone
B-1C*	65																BR	Sandstone
B-1C	75	22	105											+2.1/500	5,574		BR	Claystone
B-1C	77												479,664				BR	Sandstone
B-1C	91												490,032				BR	Siltstone
B-1C	99												515,808				BR	Siltstone
B-2C	5	14								57							CL	Sandy Lean Clay
B-2C	15	24	97							73	47	27					CL	Lean Clay with Sand
B-2C	25	22	100							80	53	27					CL	Lean Clay with Sand
B-2C	30	13	117											+1.0/500	1,777		BR	Sandy Shale
B-2C	40												215,712				BR	Sandstone
B-2C	45	3	138								26	9		+0.5/500	2,275		BR	Sandstone
B-2C	49	5	133								28	12		+0.5/500	2,000		BR	Sandstone
B-2C	56										47	29	331,920				BR	Sandstone
B-2C	61	8	129											+1.4/500	4,135		BR	Sandstone
B-2C	66	21	106											+1.9/500	2,920		BR	Claystone
B-2C	70 - 71												365,616				BR	Sandstone
B-2C	96												594,000				BR	Siltstone
B-2C	97	8	132											+1.1/500	7,000		BR	Siltstone

[1]Where Atterberg Limits and Fines Content testing was not performed, USCS Classifications visually determined in the field during the subsurface investigation.

[2]"BR" indicates bedrock.

*Lab test was not able to be completed.

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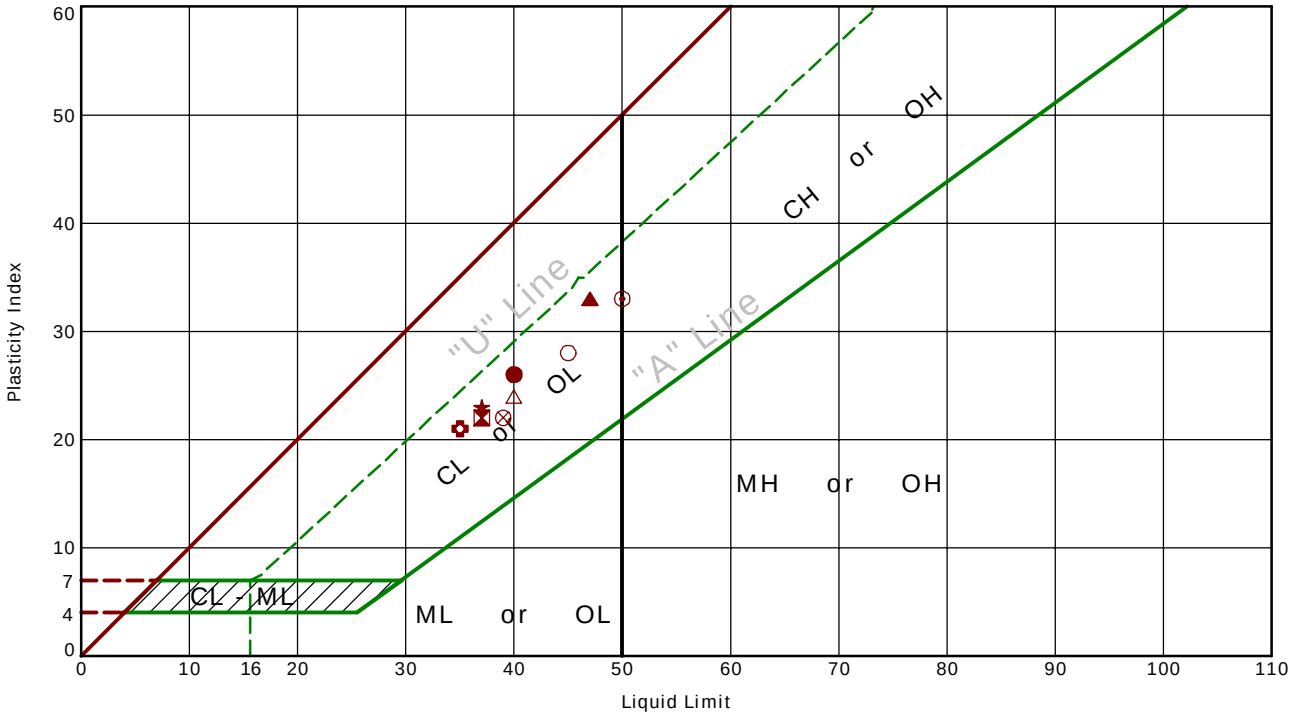
Fort Collins, CO

Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1	15	40	14	26	71.9	CL	LEAN CLAY with SAND
⊠	B-1	25	37	15	22	47.5	SC	CLAYEY SAND
▲	B-2	10	47	14	33	73.7	CL	LEAN CLAY with SAND
★	B-2	20	37	14	23	65.2	CL	SANDY LEAN CLAY
⊙	B-2	30	50	17	33	93.4	CH	FAT CLAY
✿	B-3	15	35	14	21	58.4	CL	SANDY LEAN CLAY
○	B-3	25	45	17	28	93.2	CL	LEAN CLAY
△	B-4	5	40	16	24	91.2	CL	LEAN CLAY
⊗	B-4	15	39	17	22	89.2	CL	LEAN CLAY

Thornton Barge Drilling | Lithos Job No. 2405883
Terracon Project No. 20245005

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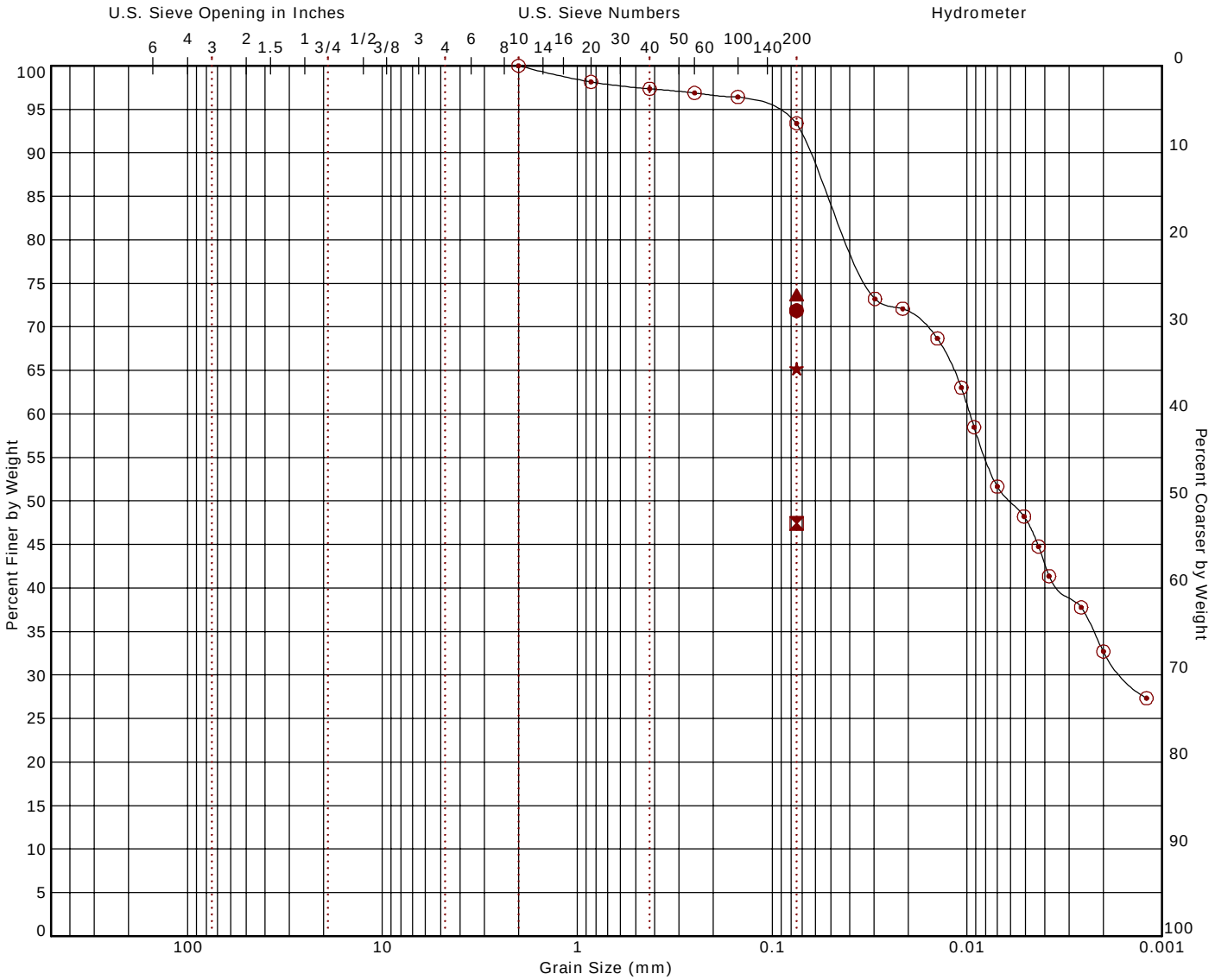
Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	USCS Classification	USCS	AASHTO	LL	PL	PI	Cc	Cu
●	B-1	15	LEAN CLAY with SAND	CL	A-6 (17)	40	14	26		
⊠	B-1	25	CLAYEY SAND	SC	A-6 (6)	37	15	22		
▲	B-2	10	LEAN CLAY with SAND	CL	A-7-6 (23)	47	14	33		
★	B-2	20	SANDY LEAN CLAY	CL	A-6 (12)	37	14	23		
⊙	B-2	30	FAT CLAY	CH	A-7-6 (32)	50	17	33		

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-1	15	0.075							71.9		
⊠	B-1	25	0.075							47.5		
▲	B-2	10	0.075							73.7		
★	B-2	20	0.075							65.2		
⊙	B-2	30	2	0.01	0.002		0.0	0.0	6.6		45.6	47.8

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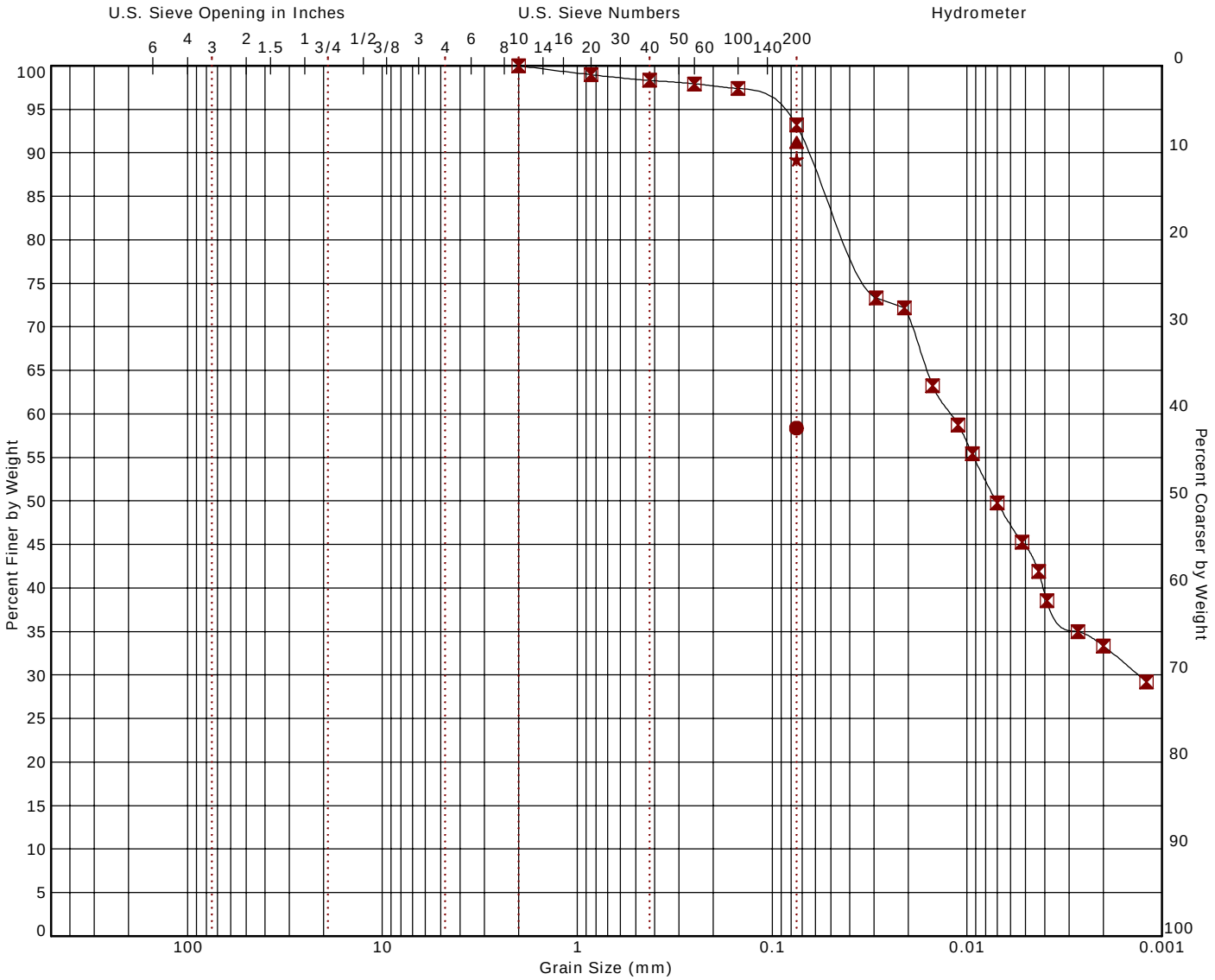
Fort Collins, CO

Grain Size Distribution

ASTM D422 / ASTM C136



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

Boring ID		Depth (Ft)	USCS Classification	USCS	AASHTO	LL	PL	PI	Cc	Cu
●	B-3	15	SANDY LEAN CLAY	CL	A-6 (9)	35	14	21		
⊠	B-3	25	LEAN CLAY	CL	A-7-6 (27)	45	17	28		
▲	B-4	5	LEAN CLAY	CL	A-6 (22)	40	16	24		
★	B-4	15	LEAN CLAY	CL	A-6 (19)	39	17	22		

Boring ID		Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
●	B-3	15	0.075							58.4		
⊠	B-3	25	2	0.012	0.001		0.0	0.0	6.8		48.6	44.6
▲	B-4	5	0.075							91.2		
★	B-4	15	0.075							89.2		

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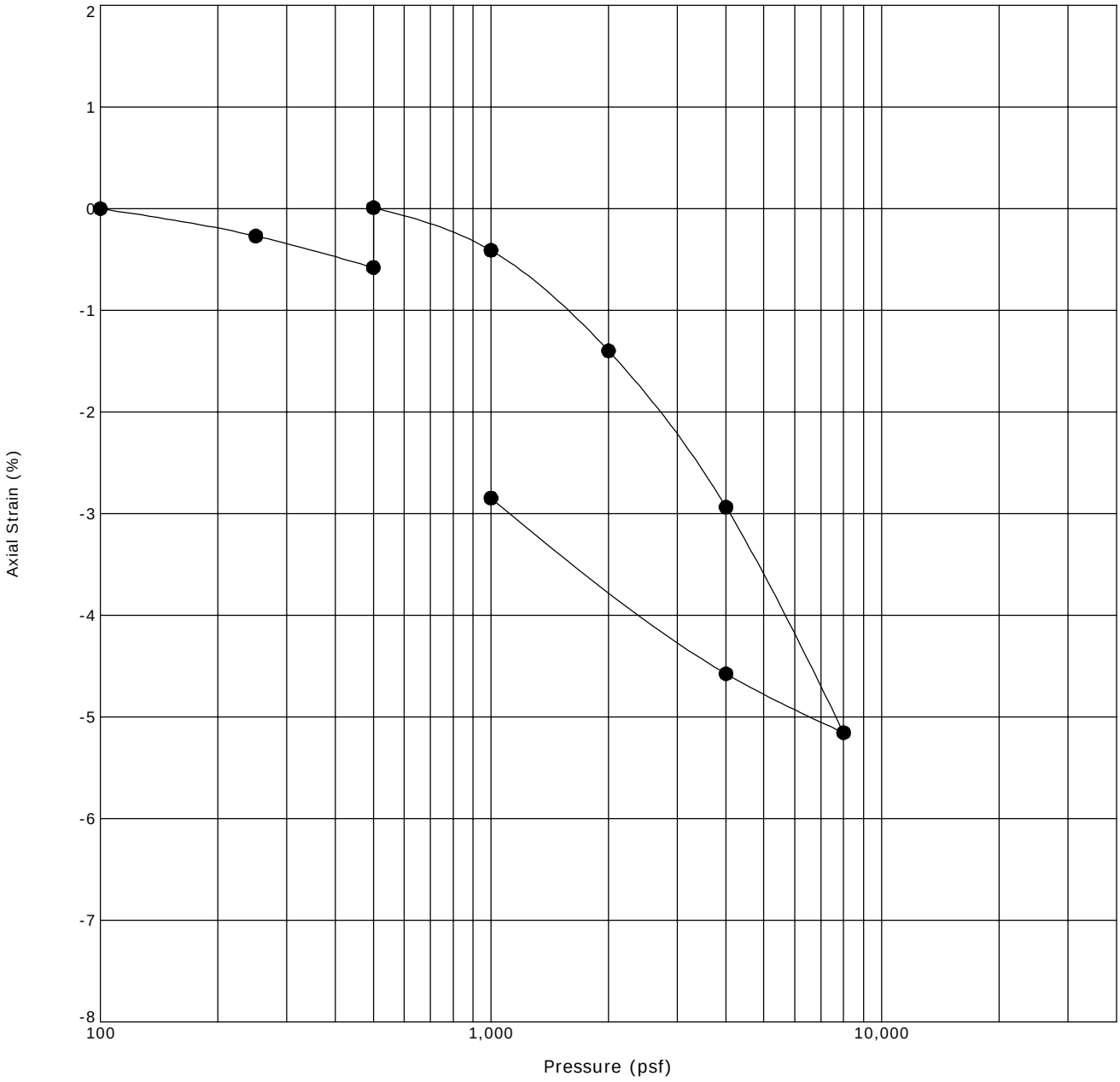
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2	25			106	20.1

Notes: Sample exhibited 0.6 percent swell upon wetting under an applied pressure of 500 psf.

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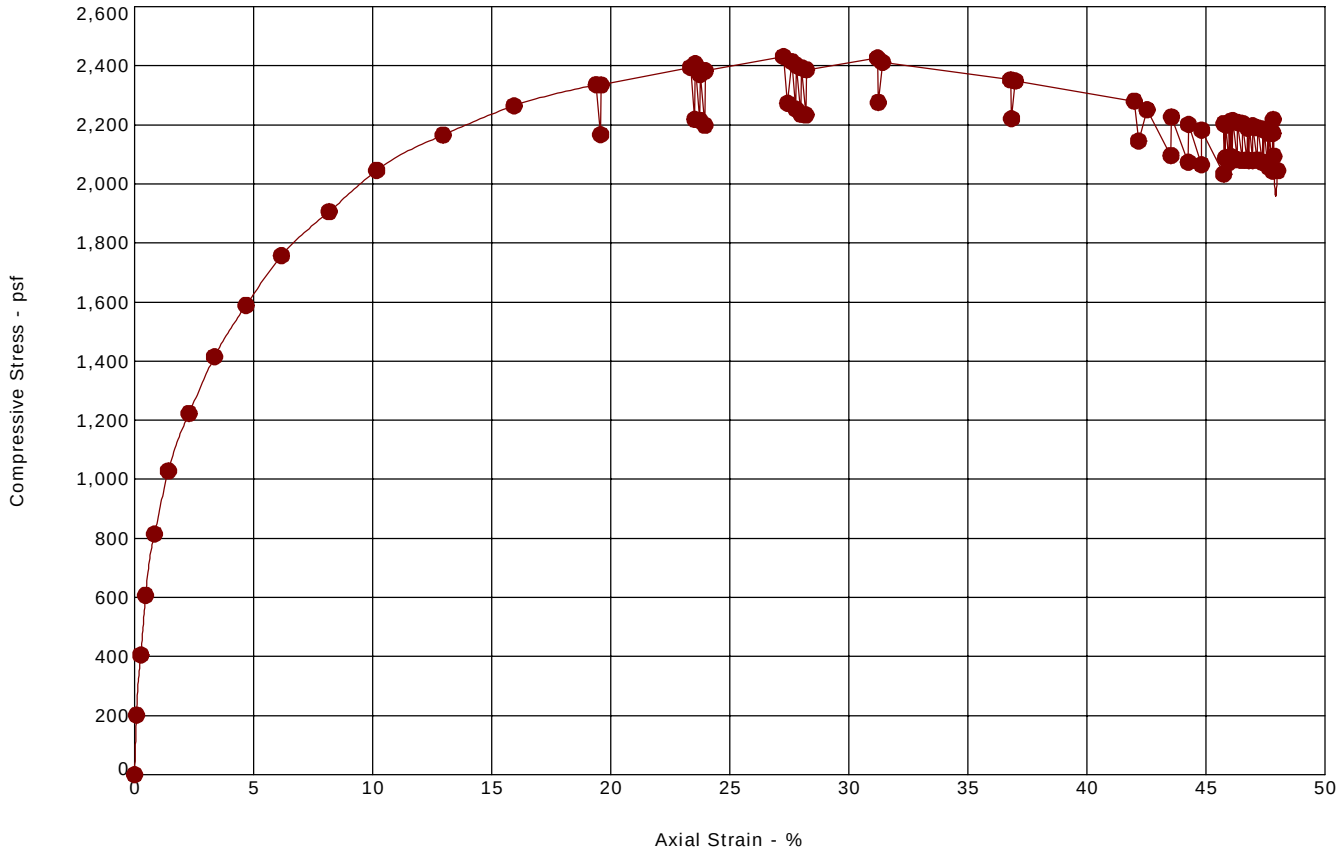
Fort Collins, CO

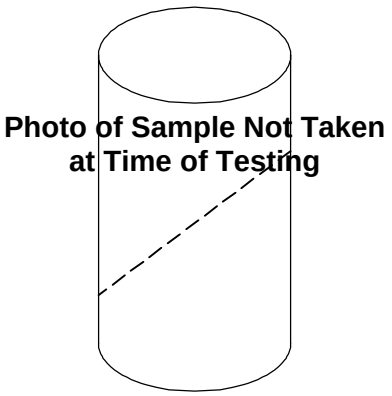
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-1	15	CARS	40	14	26	71.9	LEAN CLAY with SAND(CL)

Specimen Failure Mode



Failure Mode: Shear (dashed)

Specimen Test Data

Moisture Content (%):	21.9
Dry Density (pcf):	108
Diameter (in.):	1.93
Height (in.):	3.98
Height / Diameter Ratio:	2.07
Calculated Saturation (%):	105.47
Calculated Void Ratio:	0.56
Assumed Specific Gravity:	2.7
Failure Strain (%):	15.00
Unconfined Compressive Strength (psf):	2233
Undrained Shear Strength (psf):	1117
Strain Rate (in/min):	0.0800
Remarks:	

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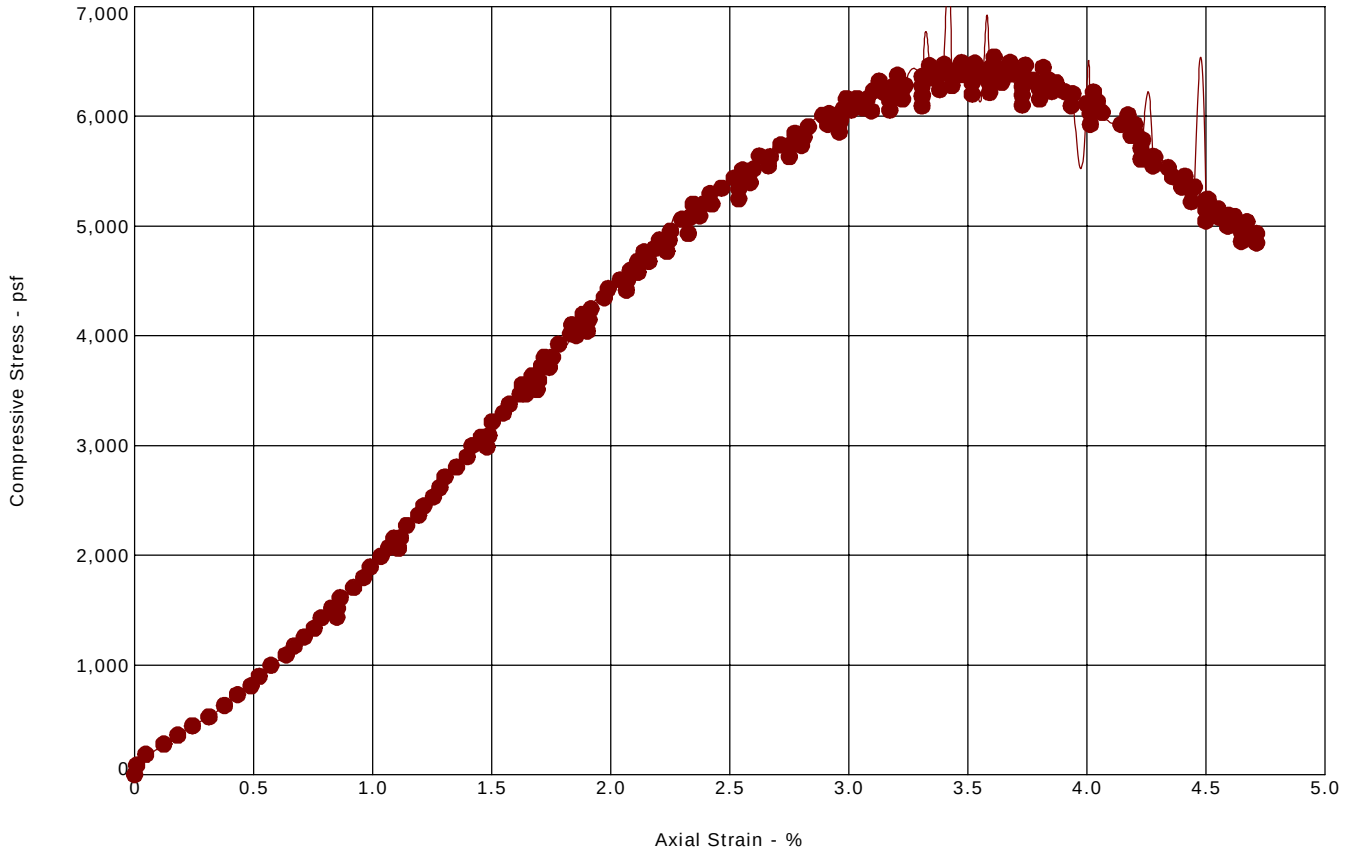
Fort Collins, CO

Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-2	30	CARS	50	17	33	93.4	FAT CLAY(CH)

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	17.8
Dry Density (pcf):	112
Diameter (in.):	1.93
Height (in.):	4.00
Height / Diameter Ratio:	2.07
Calculated Saturation (%):	96.16
Calculated Void Ratio:	0.50
Assumed Specific Gravity:	2.7
Failure Strain (%):	3.61
Unconfined Compressive Strength (psf):	6542
Undrained Shear Strength (psf):	3271
Strain Rate (in/min):	0.0800
Remarks:	

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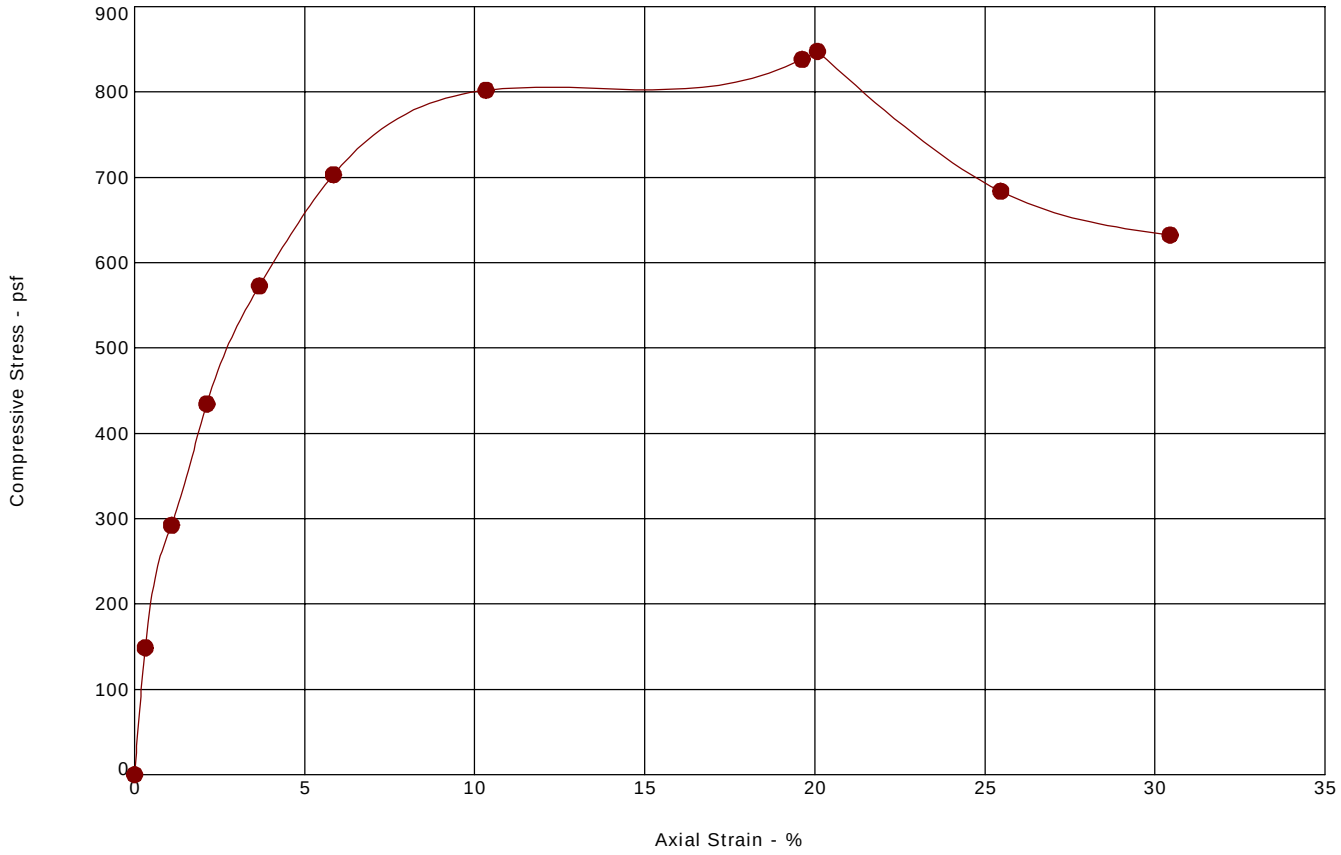
Fort Collins, CO

Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-3	10	CARS					

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	24.7
Dry Density (pcf):	102
Diameter (in.):	1.93
Height (in.):	3.93
Height / Diameter Ratio:	2.04
Calculated Saturation (%):	100.99
Calculated Void Ratio:	0.66
Assumed Specific Gravity:	2.7
Failure Strain (%):	15.00
Unconfined Compressive Strength (psf):	820
Undrained Shear Strength (psf):	410
Strain Rate (in/min):	0.0800
Remarks:	

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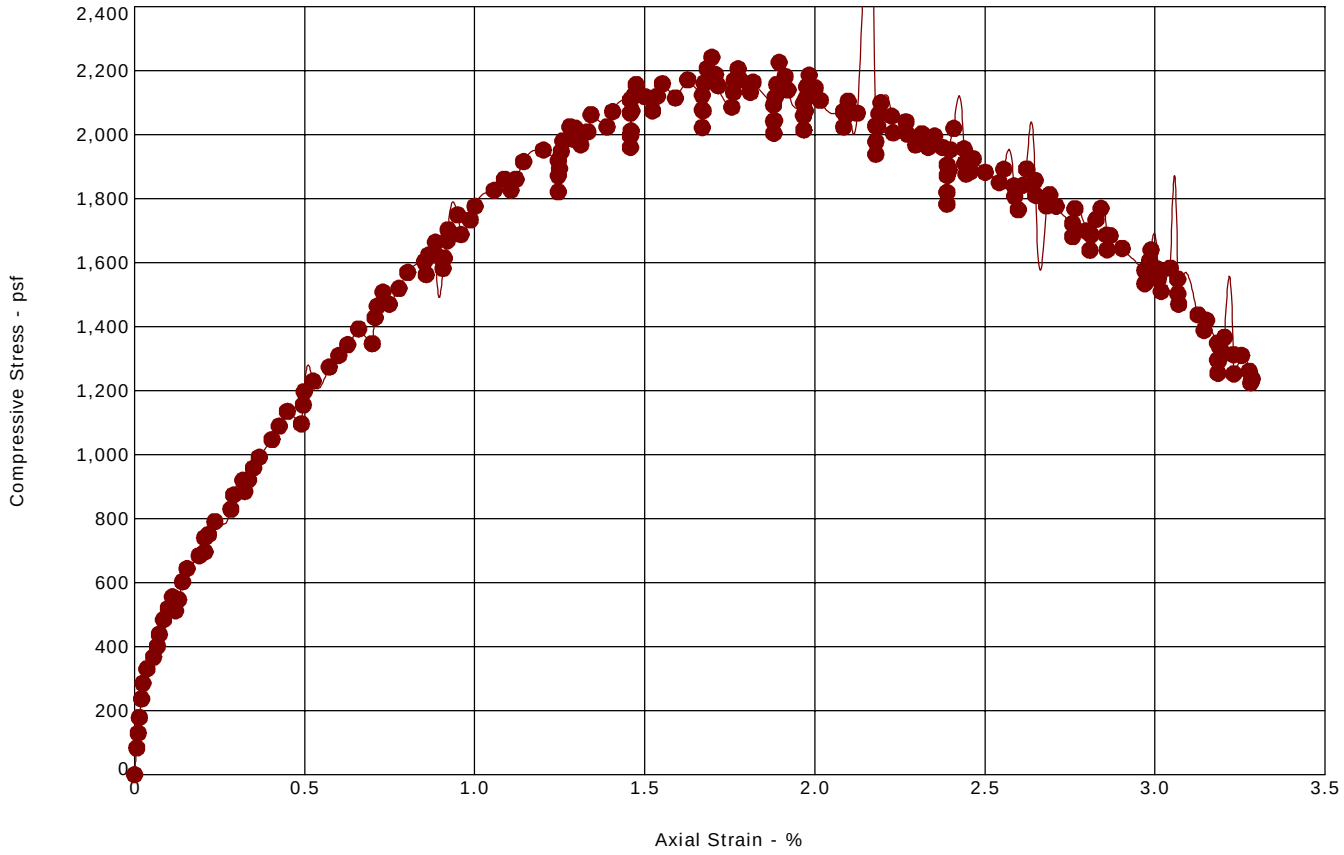
Fort Collins, CO

Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-3	25	CARS	45	17	28	93.2	LEAN CLAY(CL)

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	20.8
Dry Density (pcf):	109
Diameter (in.):	1.92
Height (in.):	3.99
Height / Diameter Ratio:	2.08
Calculated Saturation (%):	102.14
Calculated Void Ratio:	0.55
Assumed Specific Gravity:	2.7
Failure Strain (%):	1.70
Unconfined Compressive Strength (psf):	2242
Undrained Shear Strength (psf):	1121
Strain Rate (in/min):	0.0800
Remarks:	

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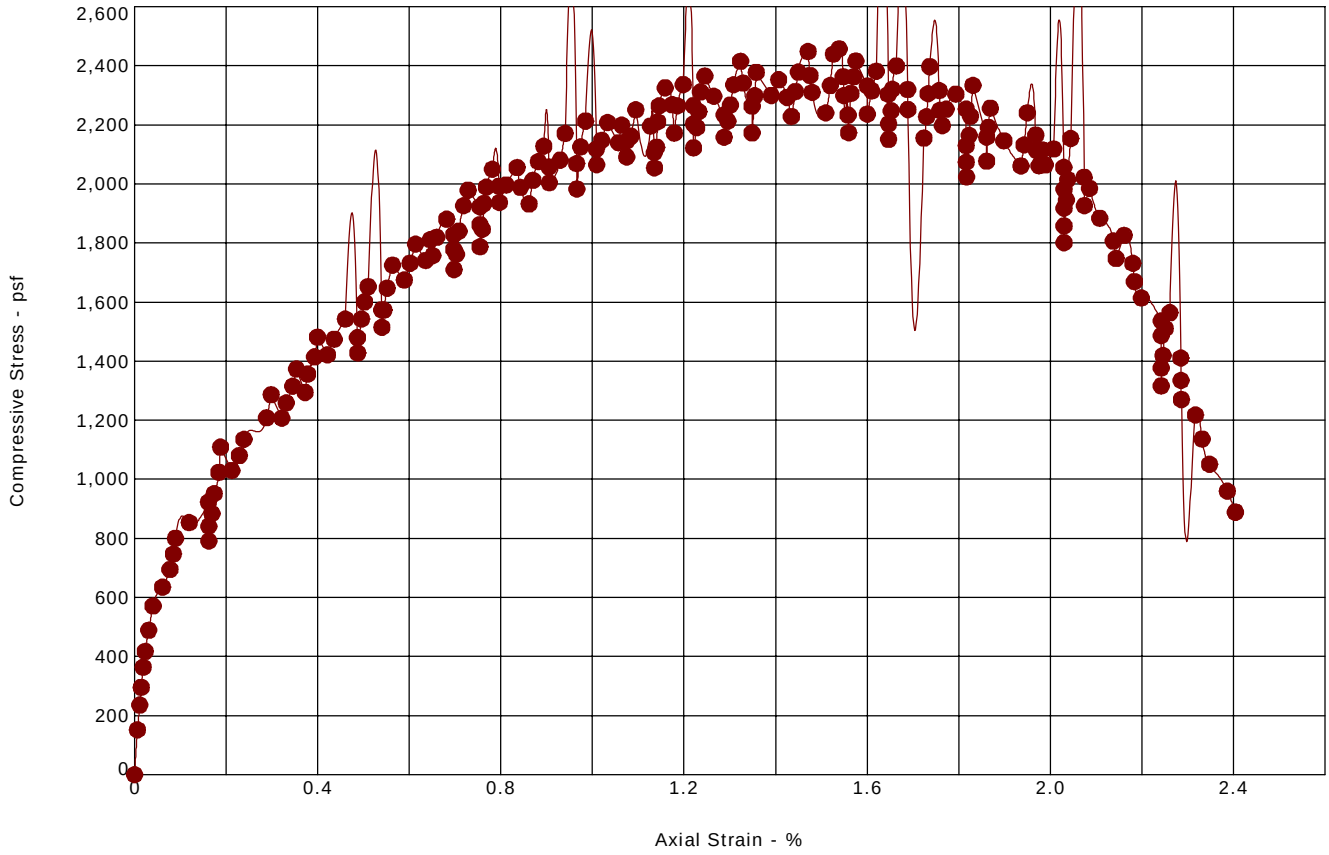
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-4	10	CARS					

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	16.1
Dry Density (pcf):	116
Diameter (in.):	1.92
Height (in.):	3.98
Height / Diameter Ratio:	2.08
Calculated Saturation (%):	95.32
Calculated Void Ratio:	0.46
Assumed Specific Gravity:	2.7
Failure Strain (%):	1.54
Unconfined Compressive Strength (psf):	2457
Undrained Shear Strength (psf):	1229
Strain Rate (in/min):	0.0800
Remarks:	

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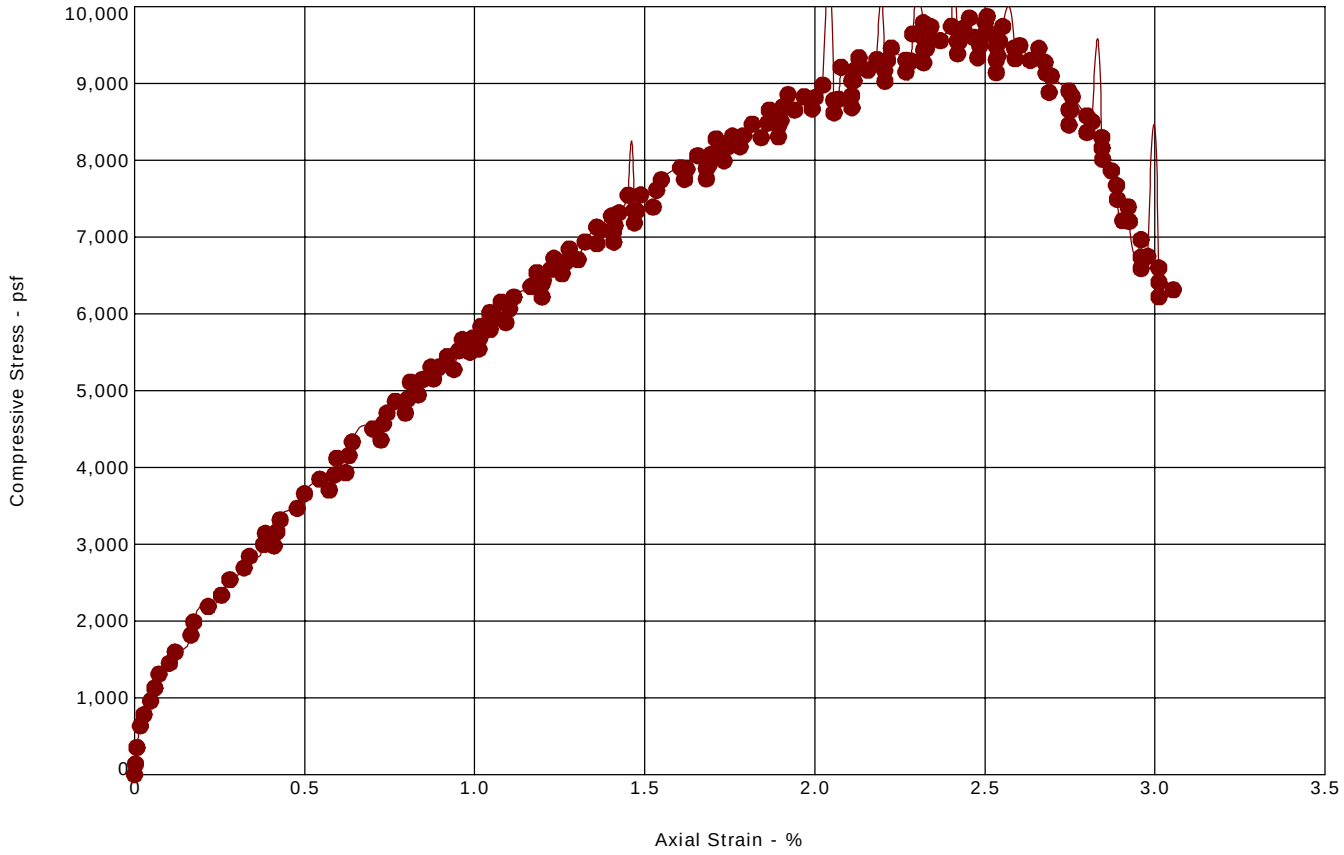
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-4	15	CARS	39	17	22	89.2	LEAN CLAY(CL)

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	12.8
Dry Density (pcf):	122
Diameter (in.):	1.92
Height (in.):	3.98
Height / Diameter Ratio:	2.07
Calculated Saturation (%):	91.03
Calculated Void Ratio:	0.38
Assumed Specific Gravity:	2.7
Failure Strain (%):	2.51
Unconfined Compressive Strength (psf):	9871
Undrained Shear Strength (psf):	4936
Strain Rate (in/min):	0.0800
Remarks:	

Client
Lithos Engineering
Fort Collins, CO

Project
Thornton Barge Drilling
20245005-19

Date Received: 11/11/2024

Results from Corrosion Testing

Sample Location	B-2	B-4
Sample Depth (ft.)	10.0'	25.0'
pH Analysis, AASHTO T289	8.51	7.85
Water Soluble Sulfate, ASTM C1580, (mg/kg)	463	588
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil
Chloride, ASTM D512, (mg/kg)	52	8
Red-Ox, ASTM G200, (mV)	+215	+297
Total Salts, AWWA 2520 B, (mg/kg)	6950	5950
Resistivity (Saturated), ASTM G57, (ohm-cm)	190	670

Analyzed By: ChrisAnne Ross
Staff Geologist

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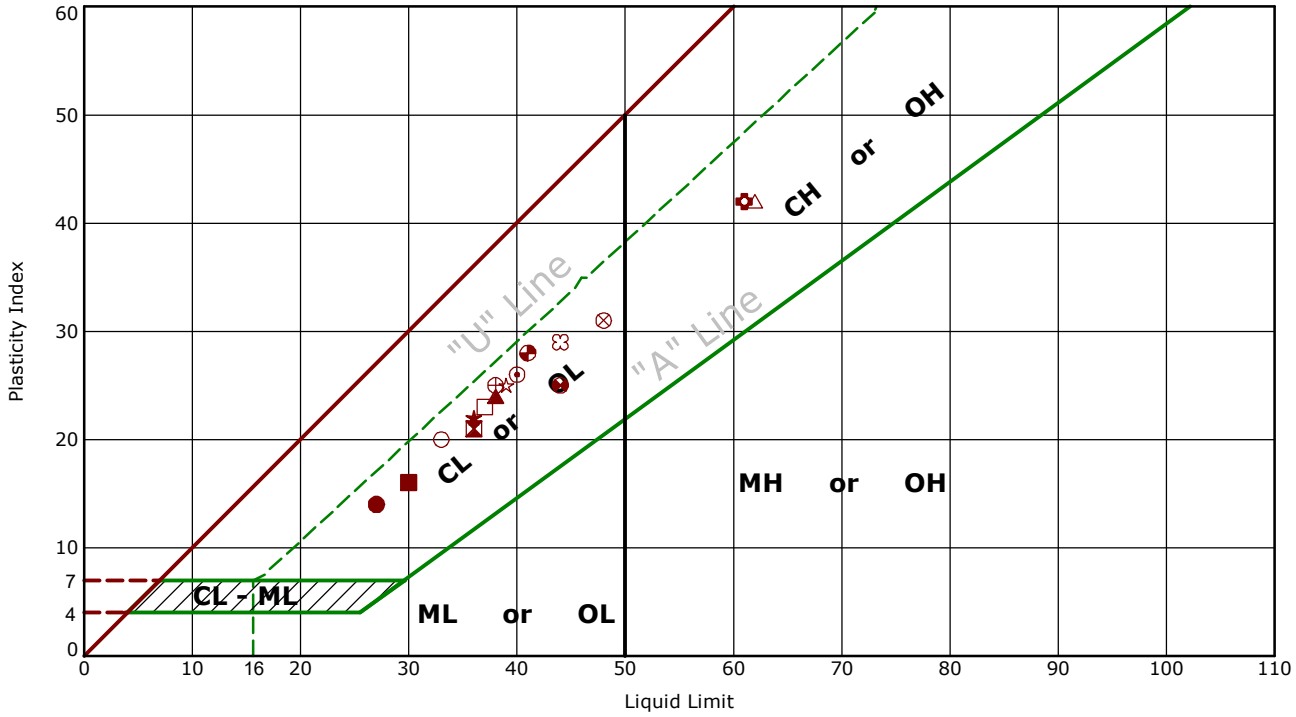
Fort Collins, CO

Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-5	2	27	13	14	45.0	SC	CLAYEY SAND
⊠	B-5	10	36	15	21	58.0	CL	SANDY LEAN CLAY
▲	B-5	30	38	14	24	67.9	CL	SANDY LEAN CLAY
★	B-6	5	36	14	22	67.5	CL	SANDY LEAN CLAY
⊙	B-6	12.5	40	14	26	65.4	CL	SANDY LEAN CLAY
✿	B-7	10	61	19	42	90.9	CH	FAT CLAY
○	B-7	20	33	13	20	53.7	CL	SANDY LEAN CLAY
△	B-8	5	62	20	42			
⊗	B-8	35	48	17	31			
⊕	B-9	5	38	13	25	75.8	CL	LEAN CLAY with SAND
□	B-11	12.5	37	14	23	74.8	CL	LEAN CLAY with SAND
⊗	B-11	35	44	19	25	99.7	CL	LEAN CLAY
◒	B-12	7.5	41	13	28	74.4	CL	LEAN CLAY with SAND
☆	B-12	25	39	14	25	97.5	CL	LEAN CLAY
⊠	B-14	5	44	15	29	77.2	CL	LEAN CLAY with SAND
■	B-15	2.5	30	14	16	51.8	CL	SANDY LEAN CLAY

Terracon
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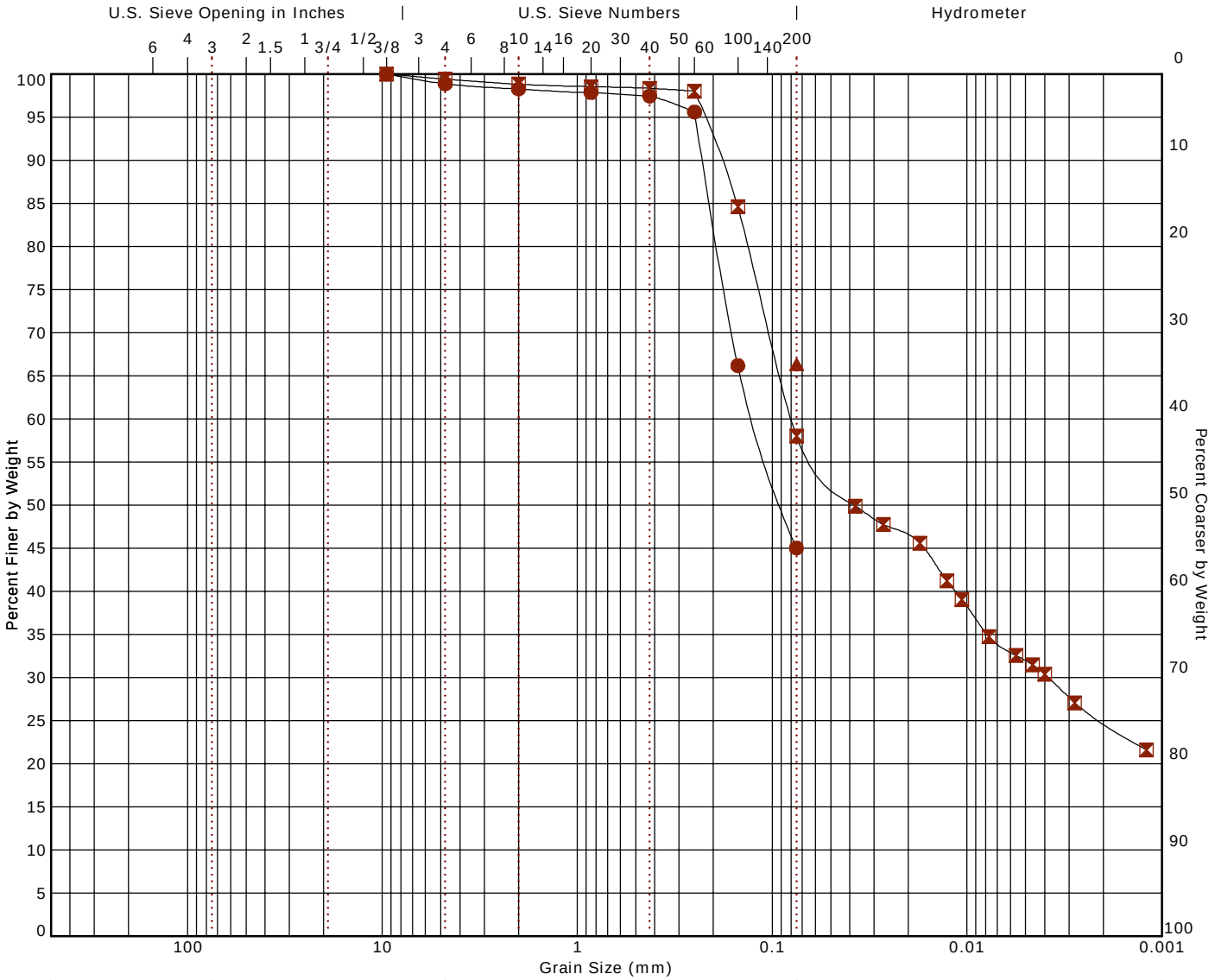
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-5	2	0.0	1.1	53.9	45.0			SC
⊠	B-5	10	0.0	0.6	41.4		26.1	31.9	CL
▲	B-5	25				66.3			

	Description
●	CLAYEY SAND
⊠	SANDY LEAN CLAY
▲	

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
3/8"	100.0	3/8"	100.0	#200	66.32
#4	98.88	#4	99.43		
#10	98.26	#10	98.83		
#20	97.85	#20	98.54		
#40	97.45	#40	98.36		
#60	95.61	#60	98.03		
#100	66.18	#100	84.61		
#200	45.02	#200	58.03		

Grain Size	●	⊠	▲
D_{60}	0.123	0.079	
D_{10}			

Coefficients	●	⊠	▲
C_c			
C_u			

1901 Sharp Point Dr Ste C
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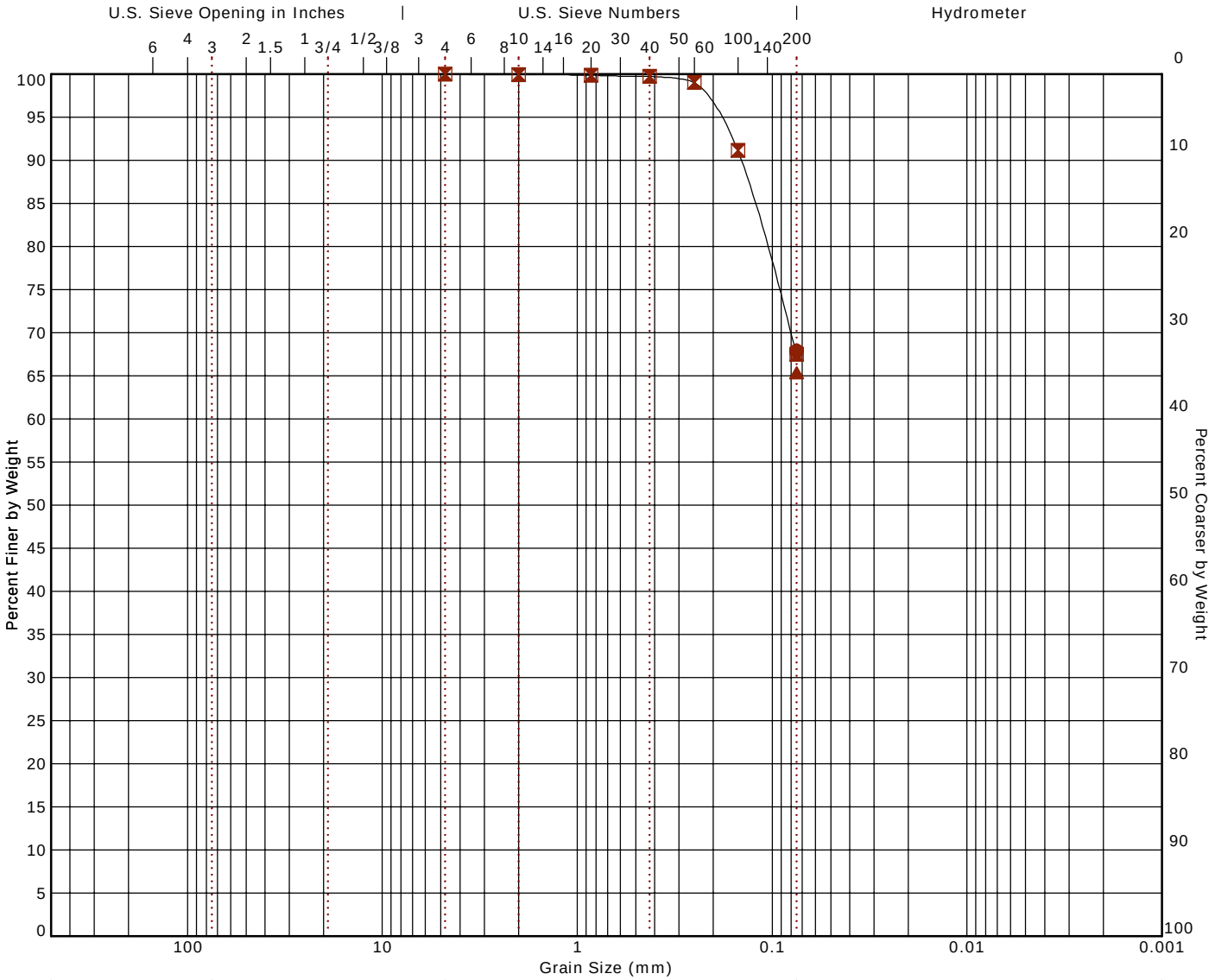
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-5	30				67.9			CL
⊠	B-6	5	0.0	0.0	32.5	67.5			CL
▲	B-6	12.5				65.4			CL

	Description
●	SANDY LEAN CLAY
⊠	SANDY LEAN CLAY
▲	SANDY LEAN CLAY

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#200	67.87	#4	100.0	#200	65.37
		#10	99.93		
		#20	99.86		
		#40	99.73		
		#60	99.04		
		#100	91.14		
		#200	67.5		

Grain Size	●	⊠	▲
D_{60}			
D_{10}			

Coefficients	●	⊠	▲
C_C			
C_U			

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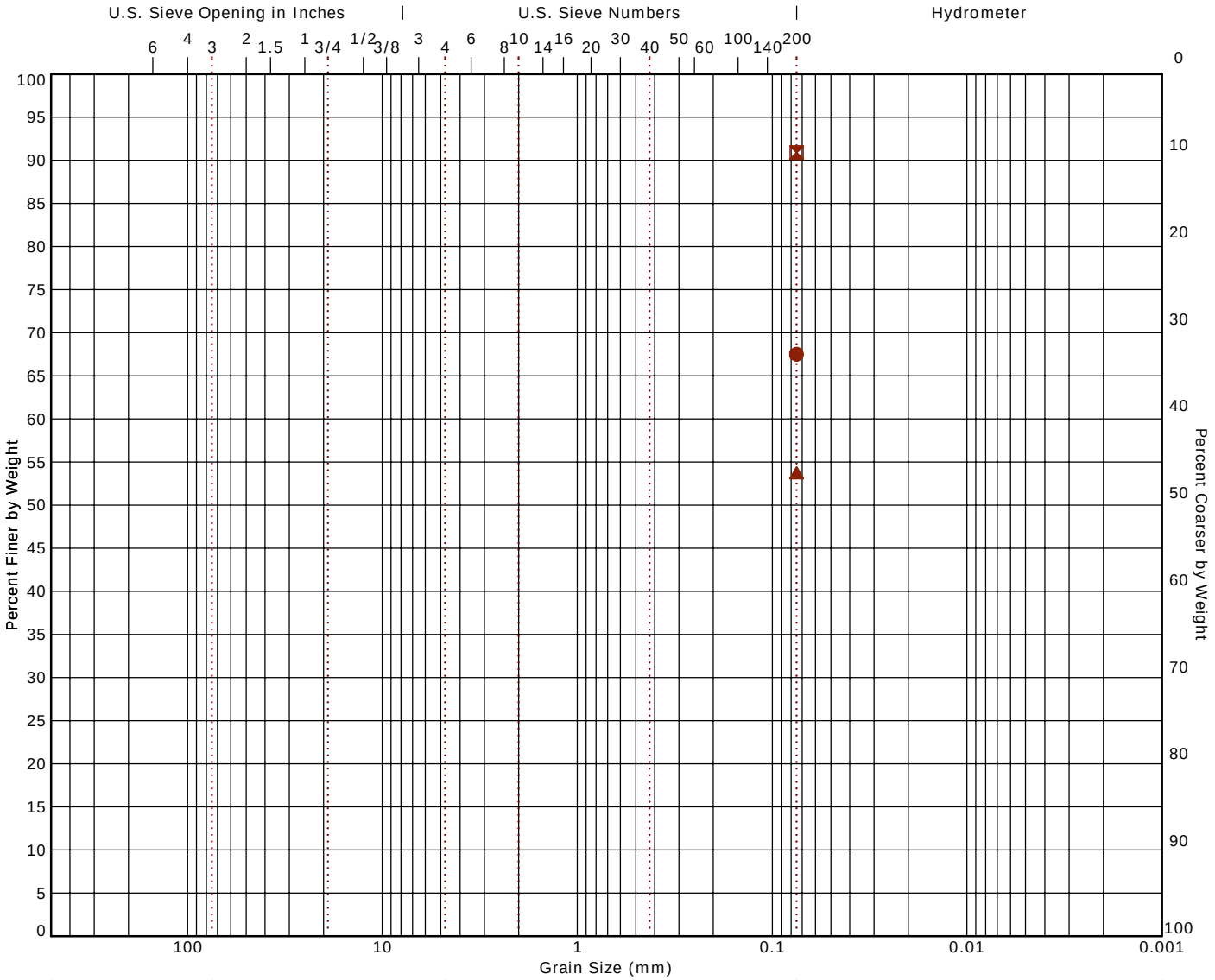
Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-6	25				67.5			
⊠	B-7	10				90.9			CH
▲	B-7	20				53.7			CL

	Description
●	
⊠	FAT CLAY
▲	SANDY LEAN CLAY

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#200	67.5	#200	90.93	#200	53.75

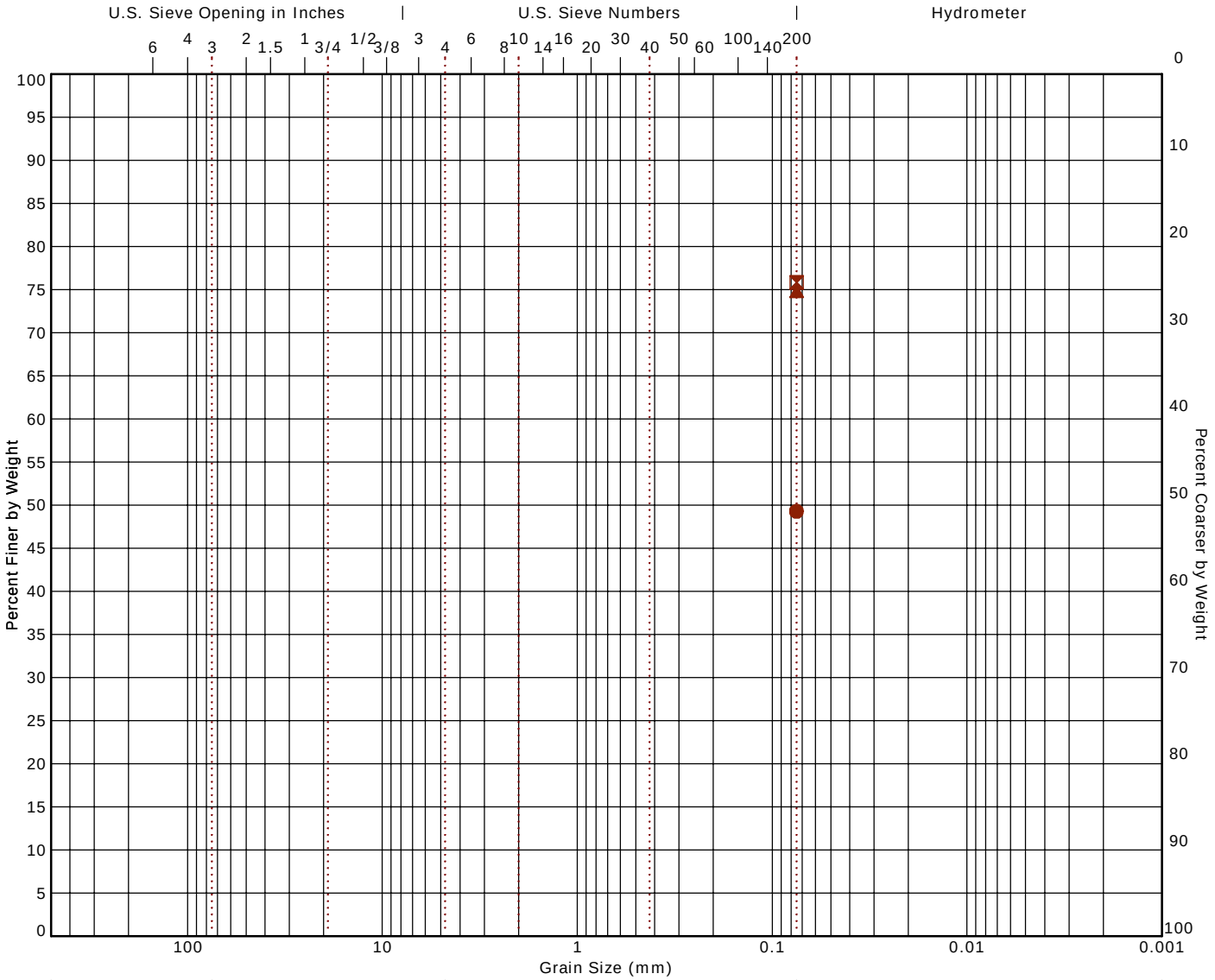
Grain Size	●	⊠	▲
D_{60}			
D_{10}			

Coefficients	●	⊠	▲
C_c			
C_u			

1901 Sharp Point Dr Ste C
Fort Collins, CO

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-8	2.5				49.3			
⊠	B-9	5				75.8			CL
▲	B-11	12.5				74.8			CL

	Description
●	
⊠	LEAN CLAY with SAND
▲	LEAN CLAY with SAND

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#200	49.28	#200	75.81	#200	74.79

Grain Size			
	●	⊠	▲
D_{60}			
D_{10}			

Coefficients			
	●	⊠	▲
C_c			
C_u			

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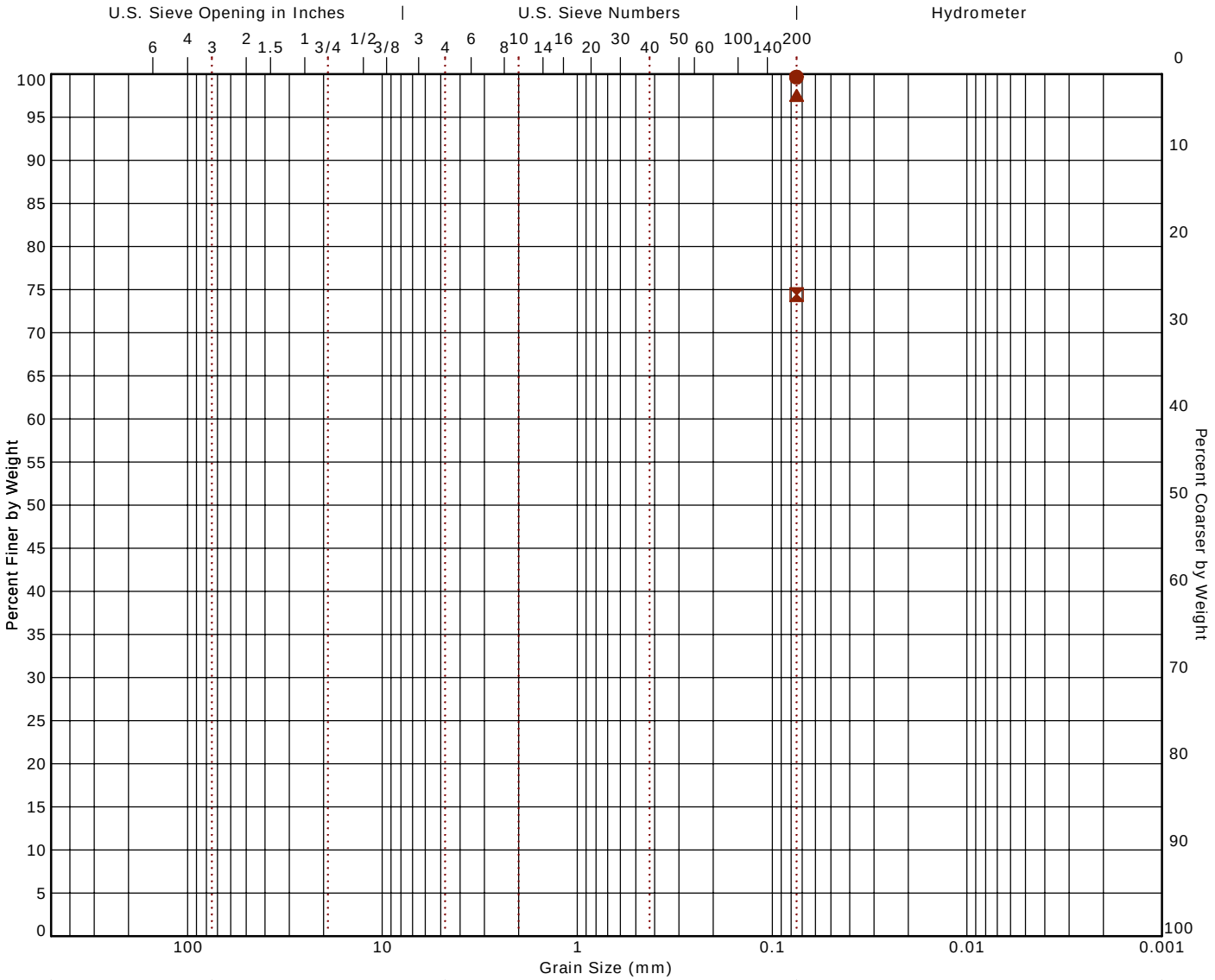
Fort Collins, CO

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-11	35				99.7			CL
⊠	B-12	7.5				74.4			CL
▲	B-12	25				97.5			CL

	Description
●	LEAN CLAY
⊠	LEAN CLAY with SAND
▲	LEAN CLAY

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#200	99.66	#200	74.41	#200	97.52

Grain Size			
	●	⊠	▲
D_{60}			
D_{10}			

Coefficients			
	●	⊠	▲
C_c			
C_u			

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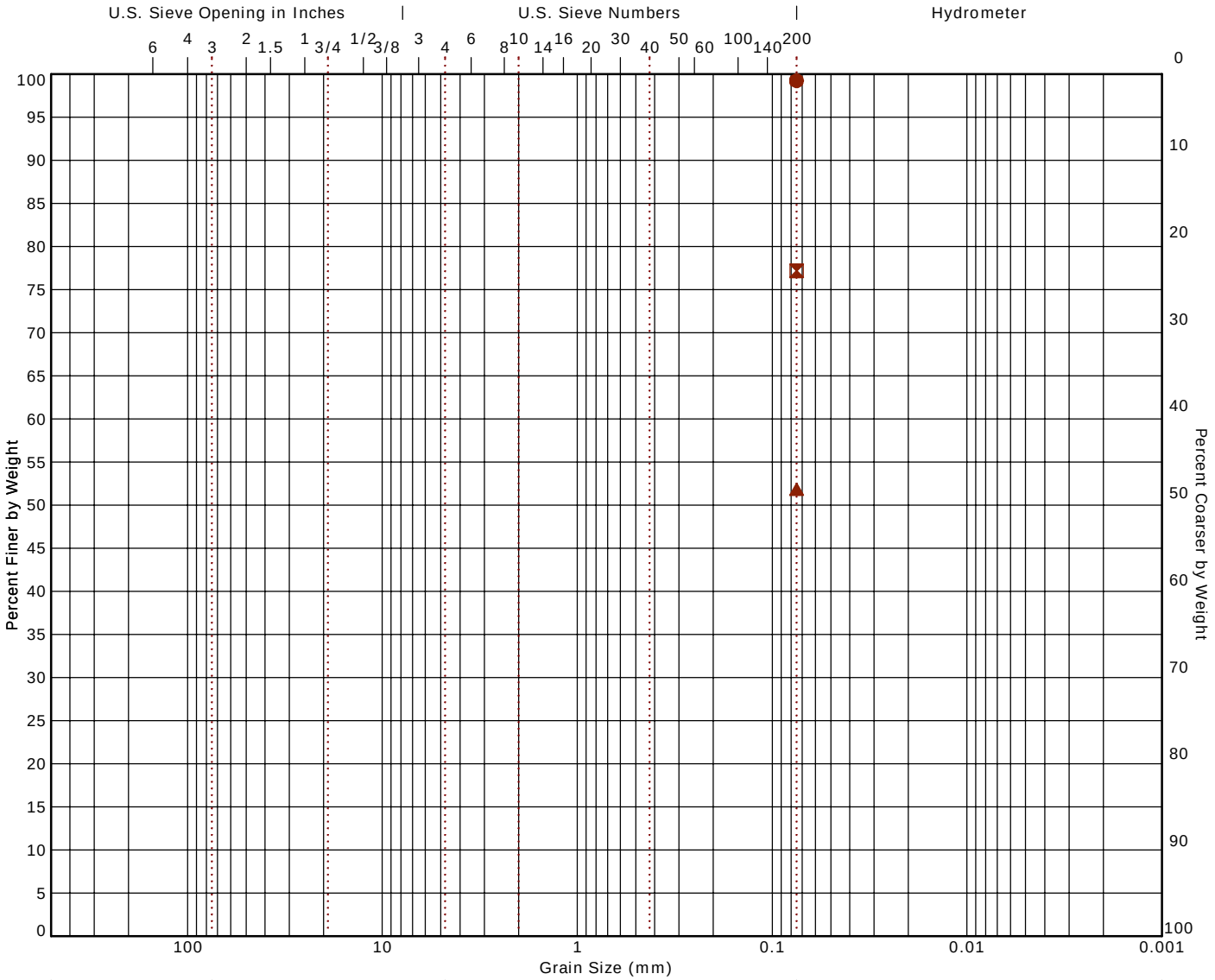
Fort Collins, CO

Grain Size Distribution

ASTM D422 / ASTM C136 / AASHTO T27



Cobbles	Gravel		Sand			Silt or Clay
	coarse	fine	coarse	medium	fine	

	Boring ID	Depth	% Cobbles	% Gravel	% Sand	% Fines	% Silt	% Clay	USCS
●	B-12	35				99.2			
⊠	B-14	5				77.2			CL
▲	B-15	2.5				51.8			CL

	Description
●	
⊠	LEAN CLAY with SAND
▲	SANDY LEAN CLAY

Remarks
●
⊠
▲

●		⊠		▲	
Sieve	% Finer	Sieve	% Finer	Sieve	% Finer
#200	99.23	#200	77.16	#200	51.82

Grain Size			
	●	⊠	▲
D_{60}			
D_{10}			

Coefficients			
	●	⊠	▲
C_c			
C_u			

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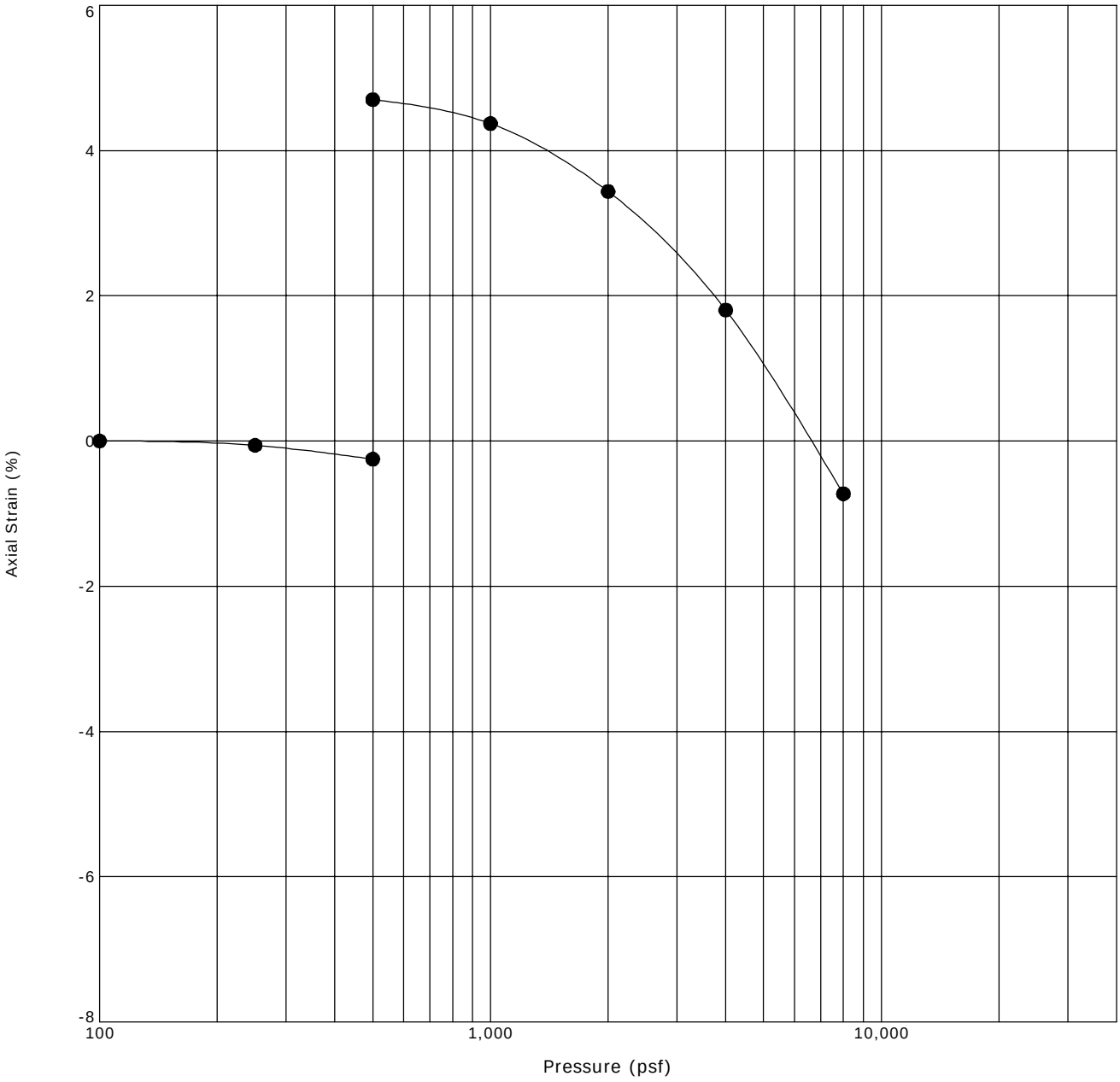
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-5	30	SANDY LEAN CLAY (CL)	CL	127	9.4

Notes: Sample exhibited approximately 5.0 percent swell upon wetting under an applied pressure of 500 psf.

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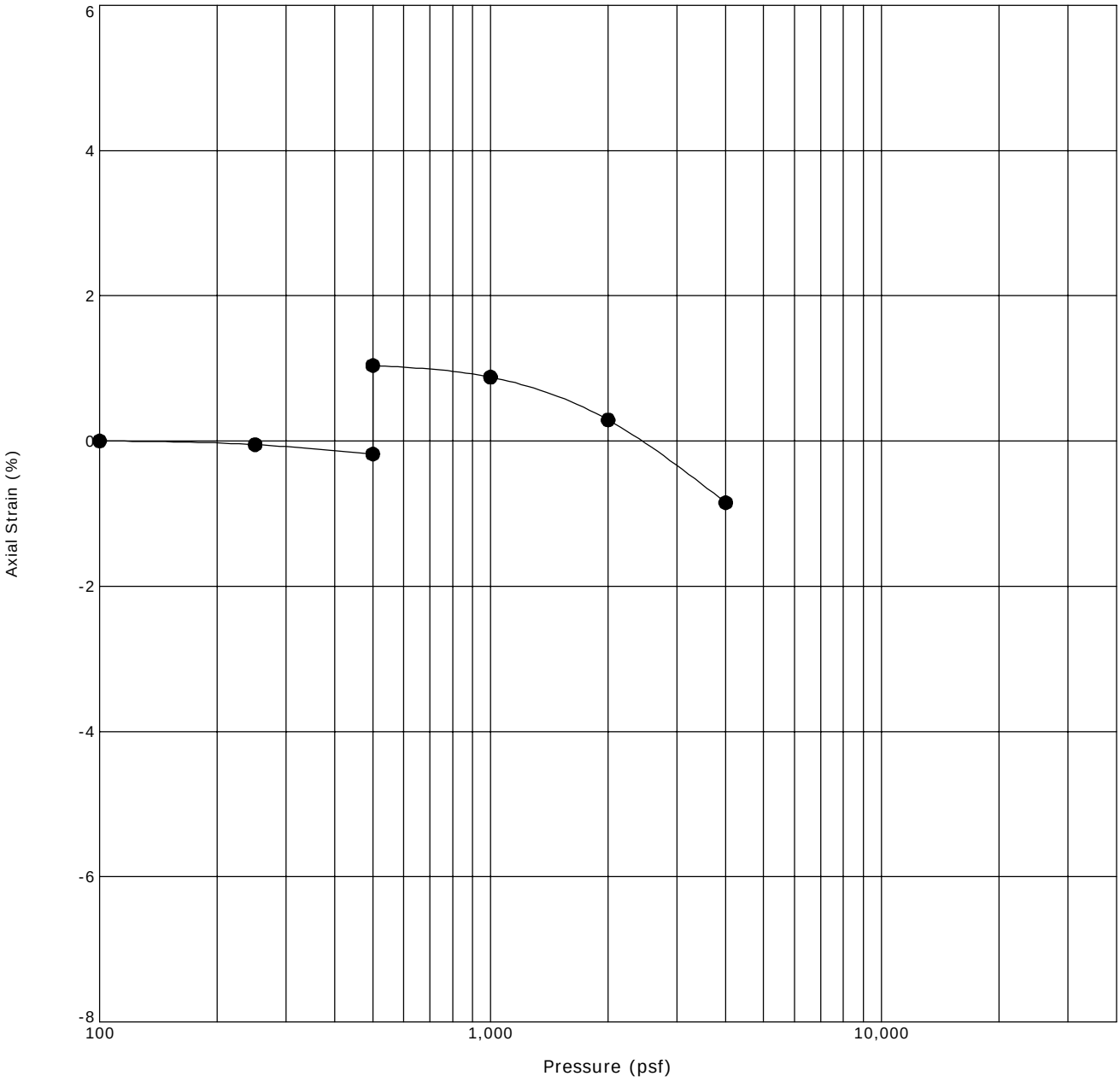
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-7	10	FAT CLAY (CH)	CH	102	22.4

Notes: Sample exhibited approximately 1.2 percent swell upon wetting under an applied pressure of 500 psf.

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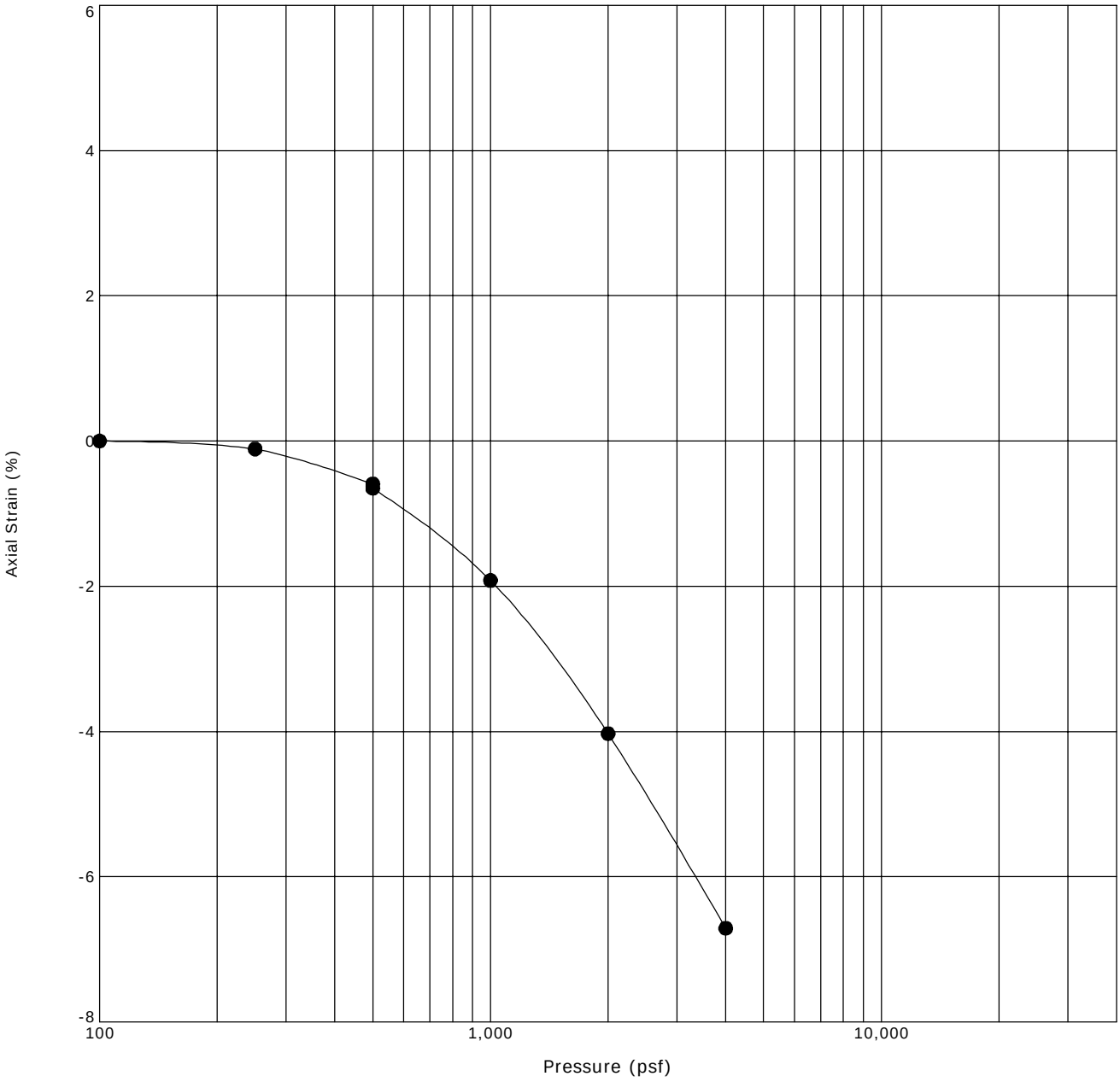
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-7	20	SANDY LEAN CLAY (CL)	CL	100	26.4

Notes: Sample exhibited less than 0.1 compression upon wetting under an applied pressure of 500 psf.

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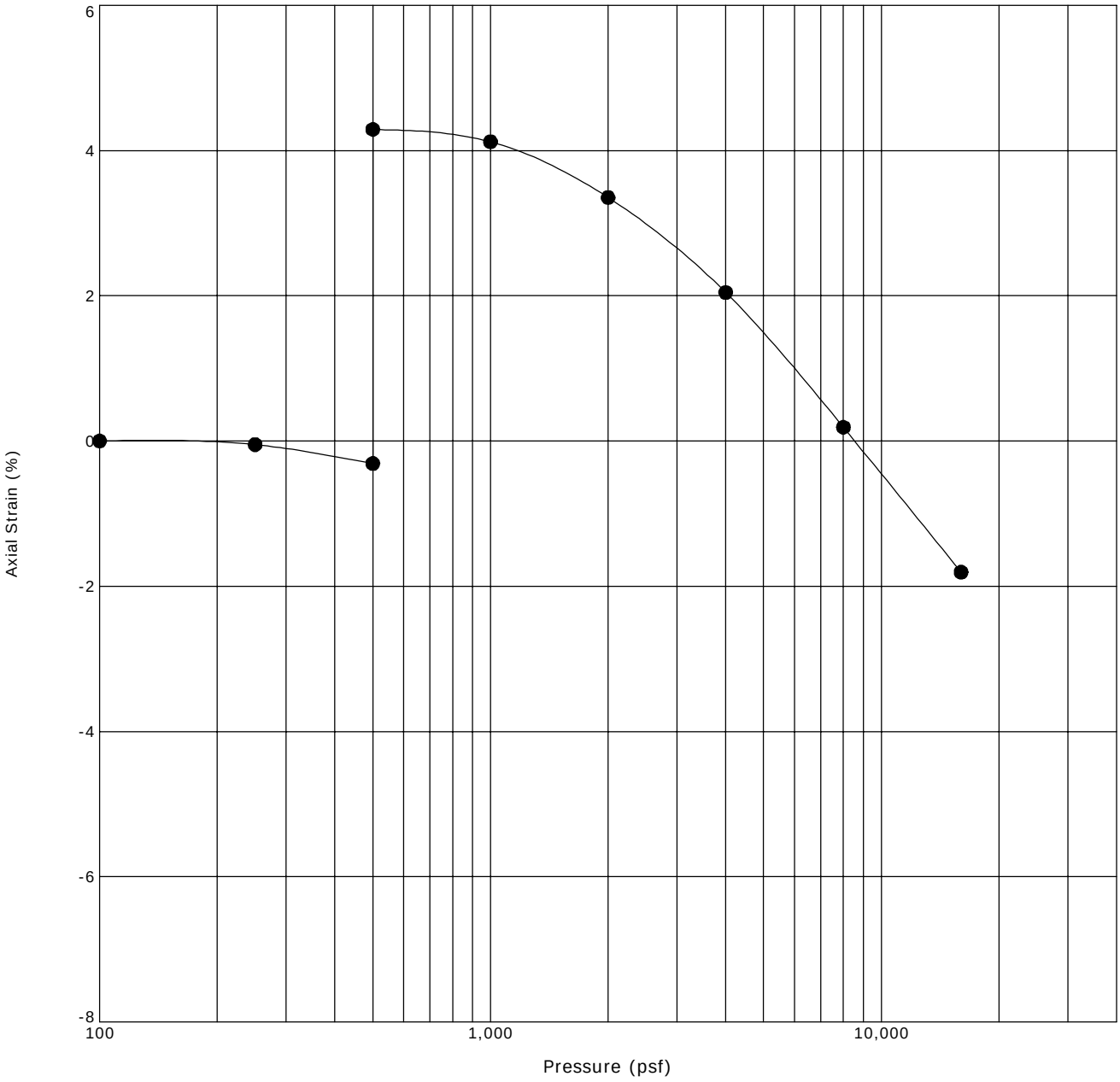
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-8	35			113	16.3

Notes: Sample exhibited approximately 4.6 percent swell upon wetting under an applied pressure of 500 psf.

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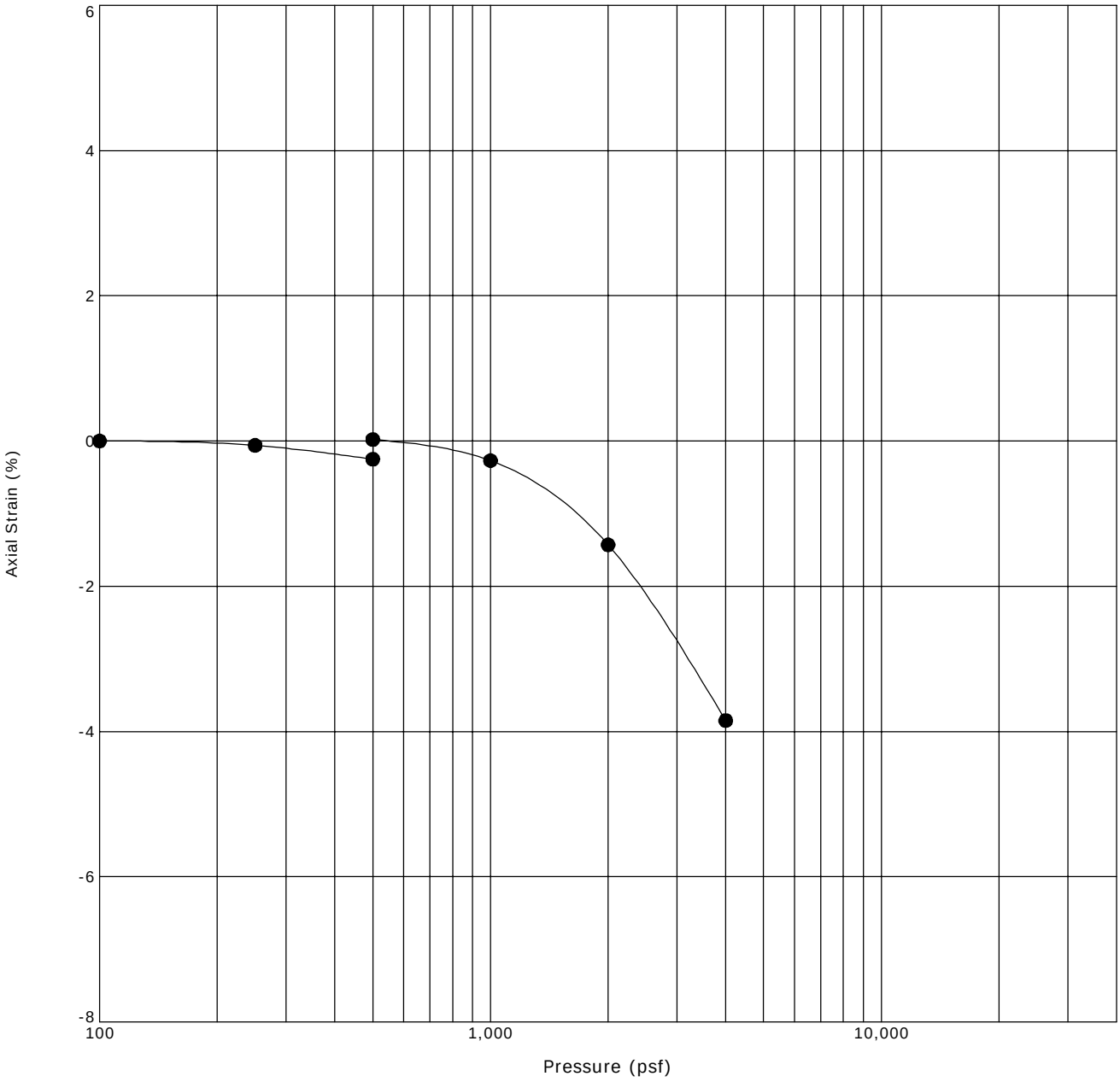
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-11	12.5	LEAN CLAY with SAND (CL)	CL	103	19.4

Notes: Sample exhibited approximately 0.3 percent swell upon wetting under an applied pressure of 500 psf.

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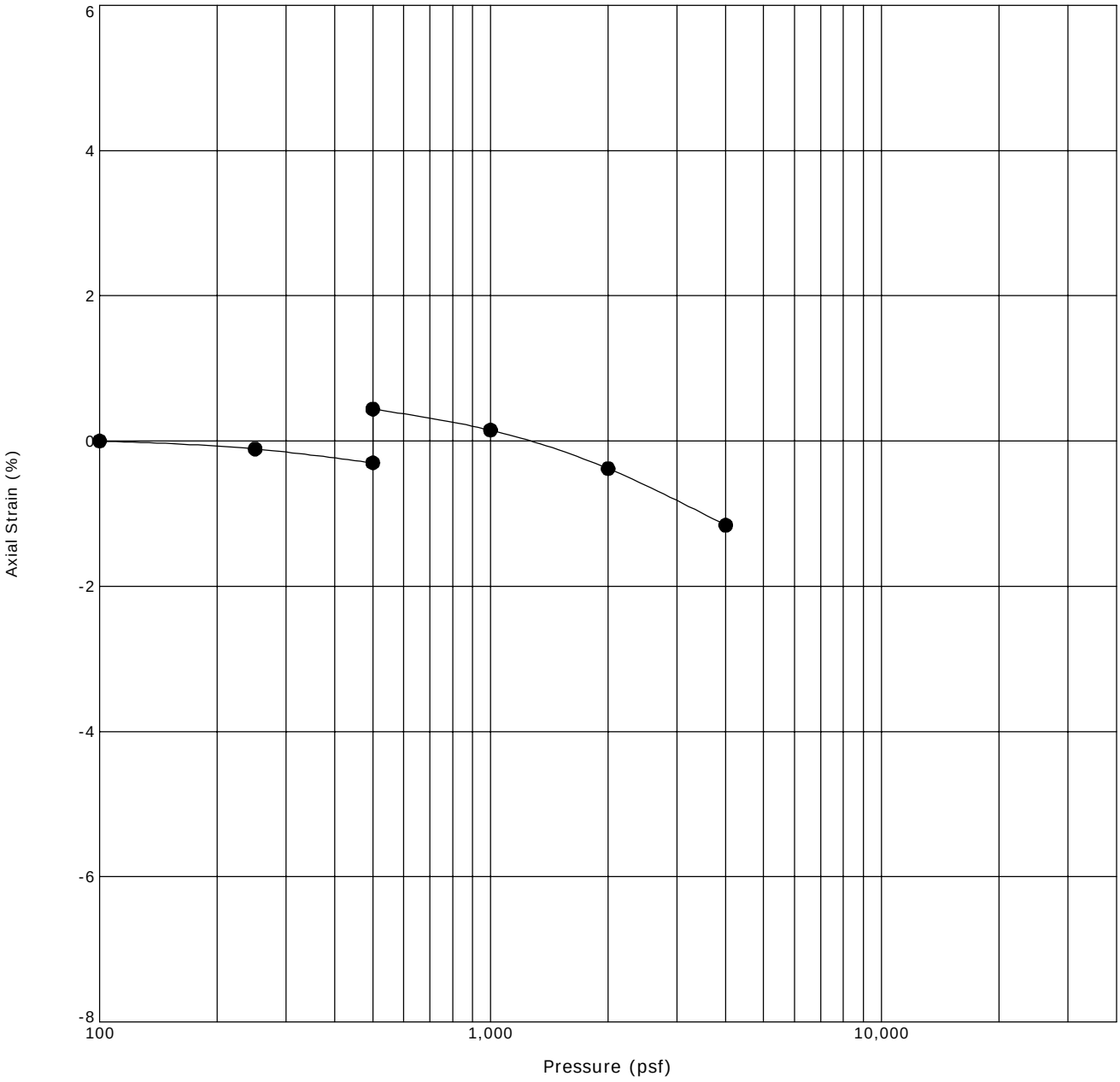
One-Dimensional Swell or Collapse



Boring ID		Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
●	B-12	17.5			114	16.5

Notes: Sample exhibited approximately 0.7 percent swell upon wetting under an applied pressure of 500 psf.

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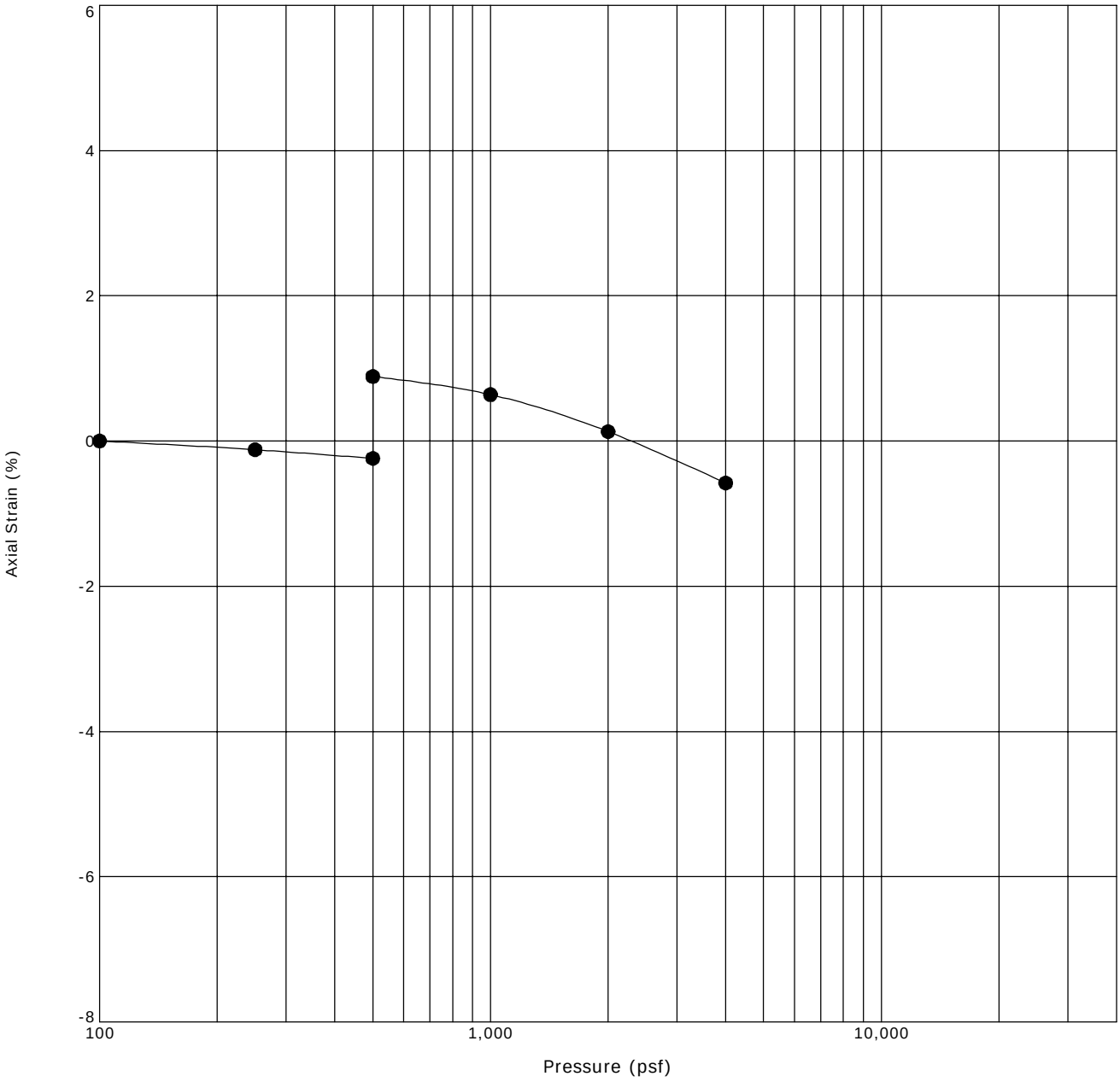
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-12	25	LEAN CLAY (CL)	CL	124	12.1

Notes: Sample exhibited approximately 1.1 percent swell upon wetting under an applied pressure of 500 psf.

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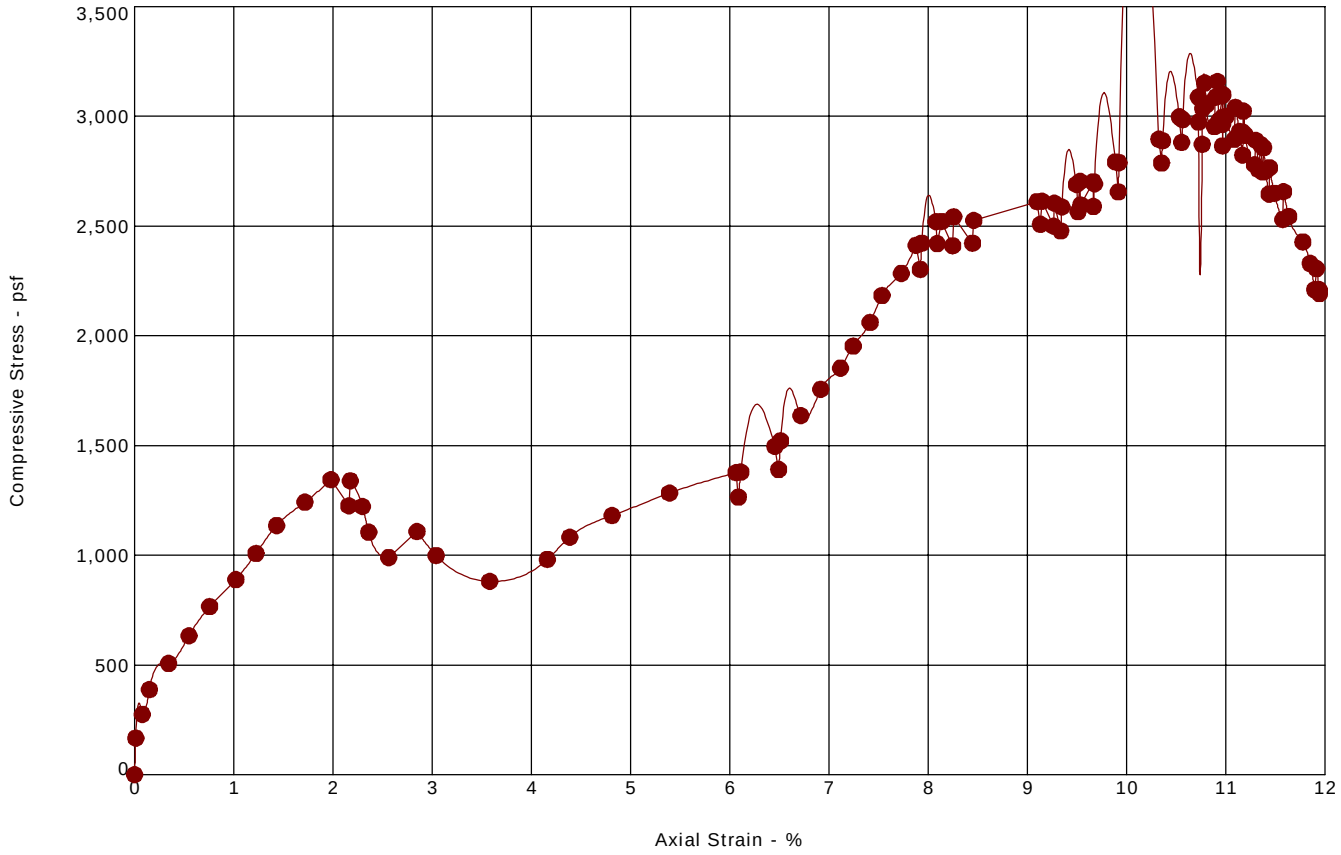
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-5	25	CARS				66.3	

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	10.4
Dry Density (pcf):	112
Diameter (in.):	1.92
Height (in.):	4.16
Height / Diameter Ratio:	2.16
Calculated Saturation (%):	55.05
Calculated Void Ratio:	0.51
Assumed Specific Gravity:	2.7
Failure Strain (%):	10.92
Unconfined Compressive Strength (psf):	3159
Undrained Shear Strength (psf):	1579
Strain Rate (in/min):	0.0800
Remarks:	

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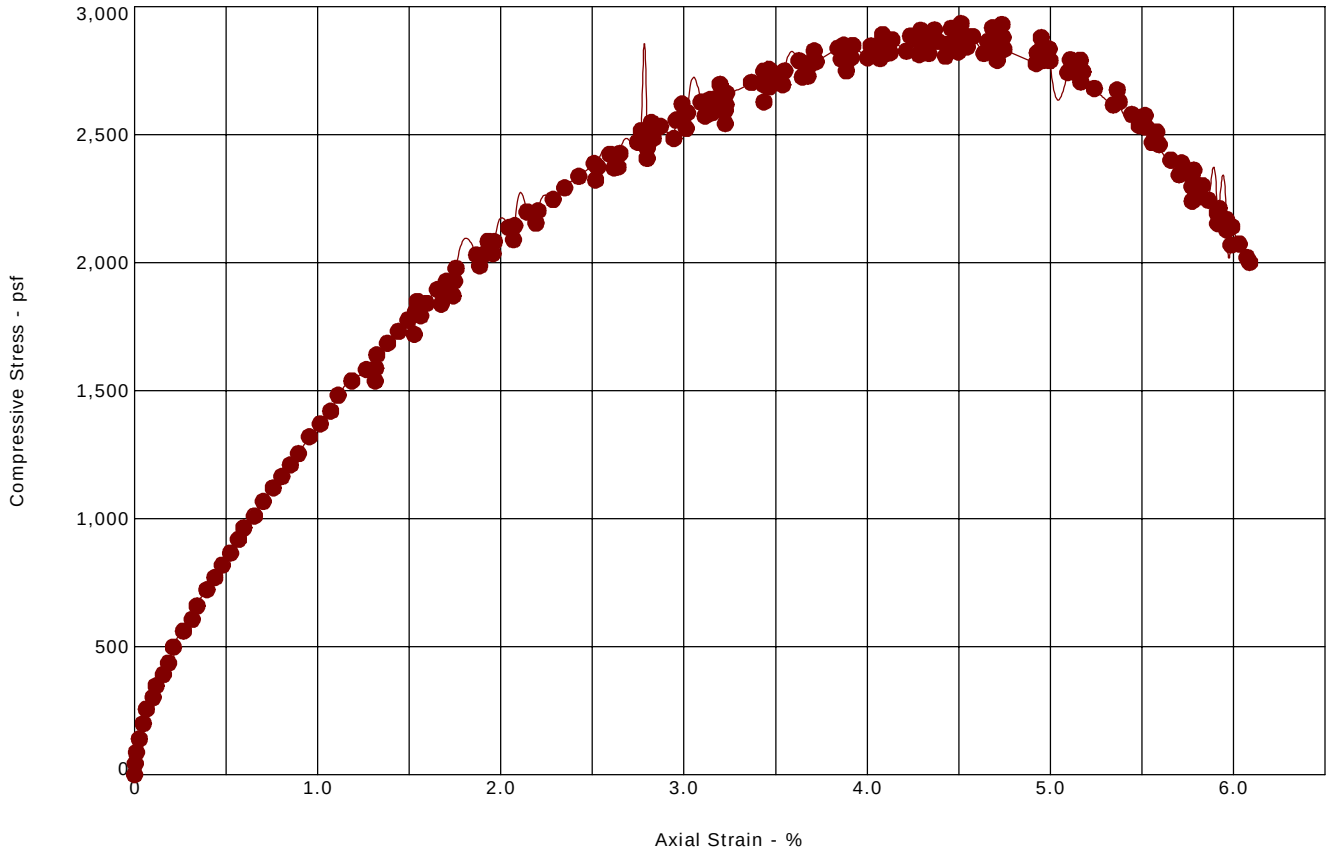
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-6	25	CARS				67.5	

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	23.5
Dry Density (pcf):	100
Diameter (in.):	1.94
Height (in.):	3.98
Height / Diameter Ratio:	2.05
Calculated Saturation (%):	93.17
Calculated Void Ratio:	0.68
Assumed Specific Gravity:	2.7
Failure Strain (%):	4.51
Unconfined Compressive Strength (psf):	2934
Undrained Shear Strength (psf):	1467
Strain Rate (in/min):	0.0800
Remarks:	

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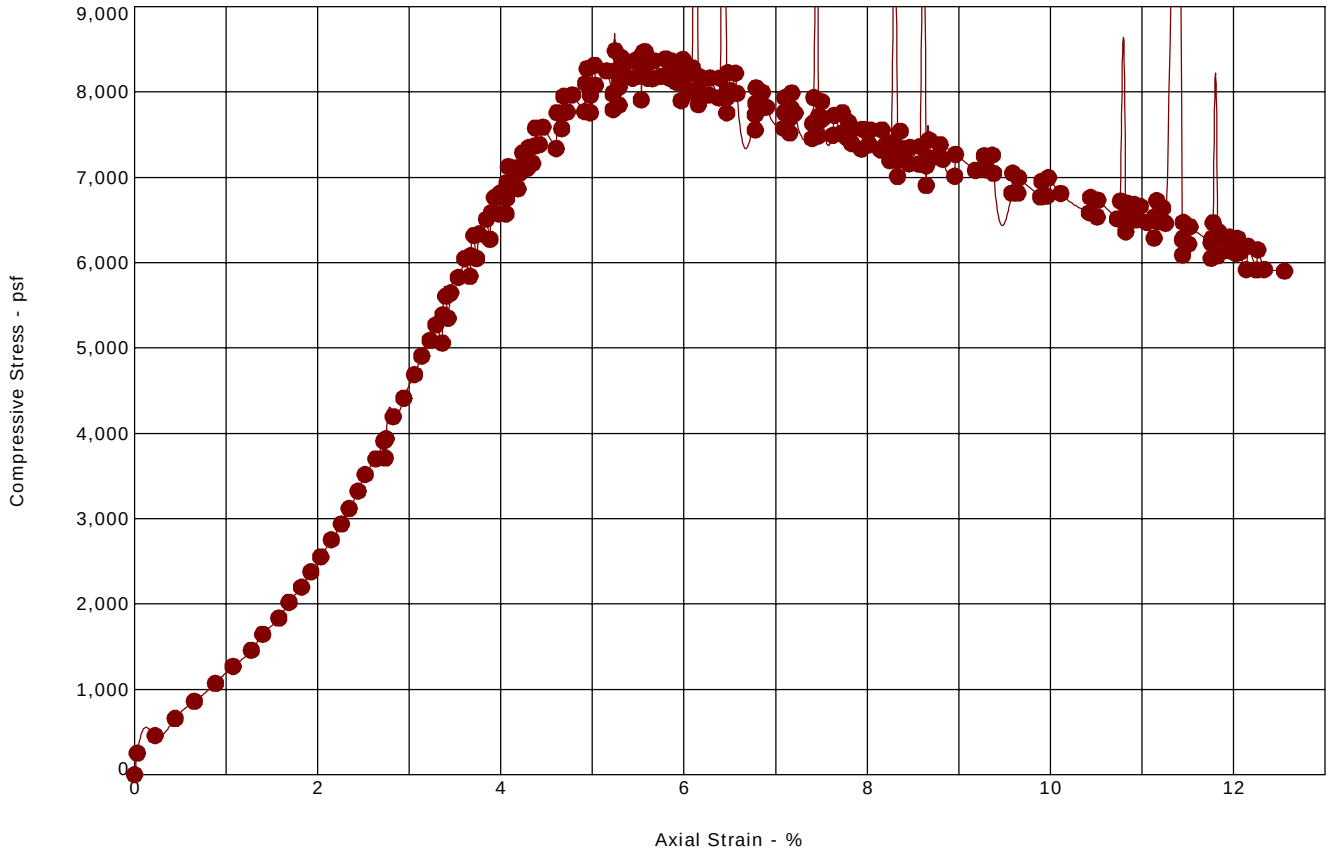
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-7	35	CARS					

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	9.7
Dry Density (pcf):	121
Diameter (in.):	1.94
Height (in.):	2.71
Height / Diameter Ratio:	1.40
Calculated Saturation (%):	66.24
Calculated Void Ratio:	0.40
Assumed Specific Gravity:	2.7
Failure Strain (%):	5.25
Unconfined Compressive Strength (psf):	8484
Undrained Shear Strength (psf):	4242
Strain Rate (in/min):	0.0800
Remarks:	

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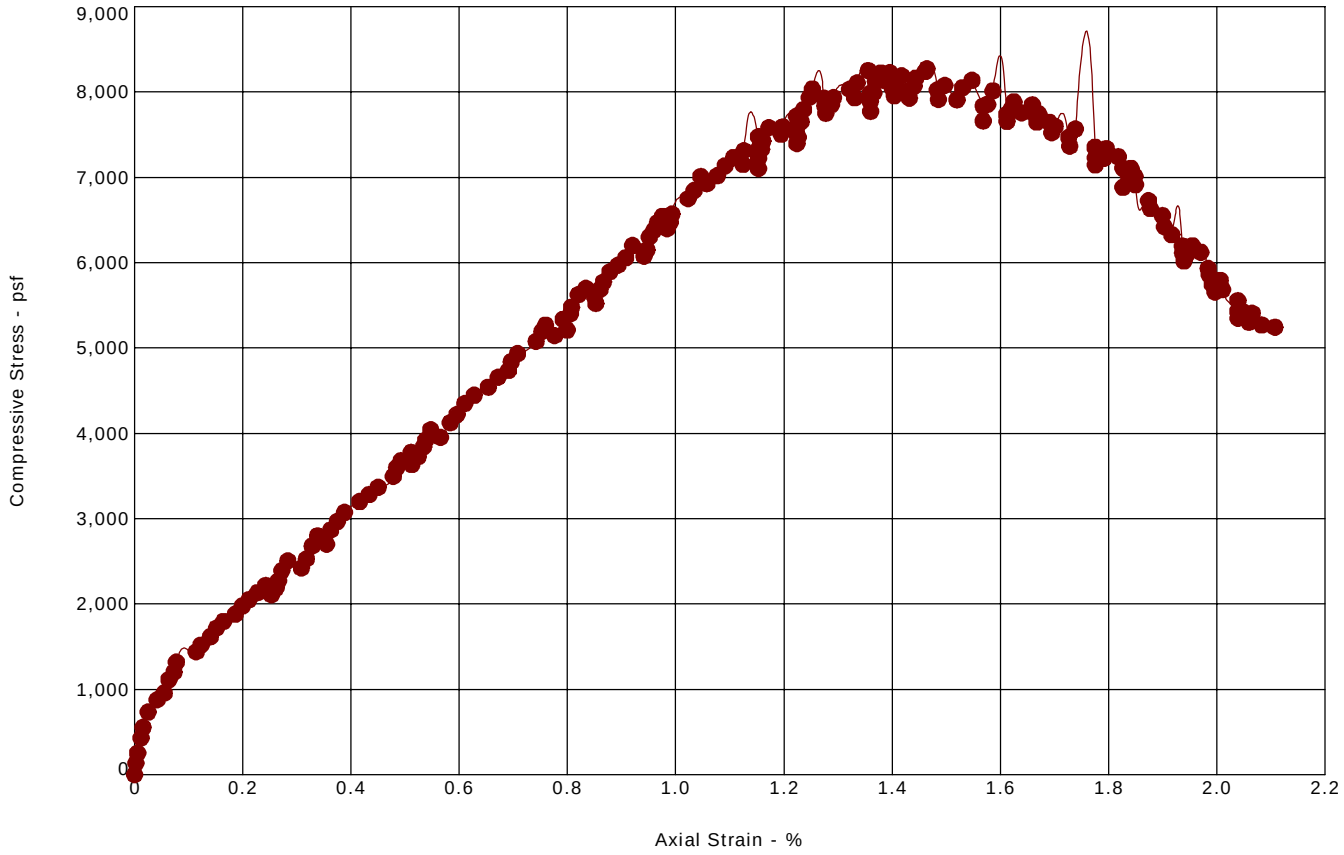
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-8	15	CARS					

Specimen Failure Mode	Specimen Test Data	
	Moisture Content (%):	13.5
	Dry Density (pcf):	115
	Diameter (in.):	1.94
	Height (in.):	4.02
	Height / Diameter Ratio:	2.06
	Calculated Saturation (%):	78.65
	Calculated Void Ratio:	0.46
	Assumed Specific Gravity:	2.7
	Failure Strain (%):	1.46
	Unconfined Compressive Strength (psf):	8273
	Undrained Shear Strength (psf):	4136
	Strain Rate (in/min):	0.0800
	Remarks:	

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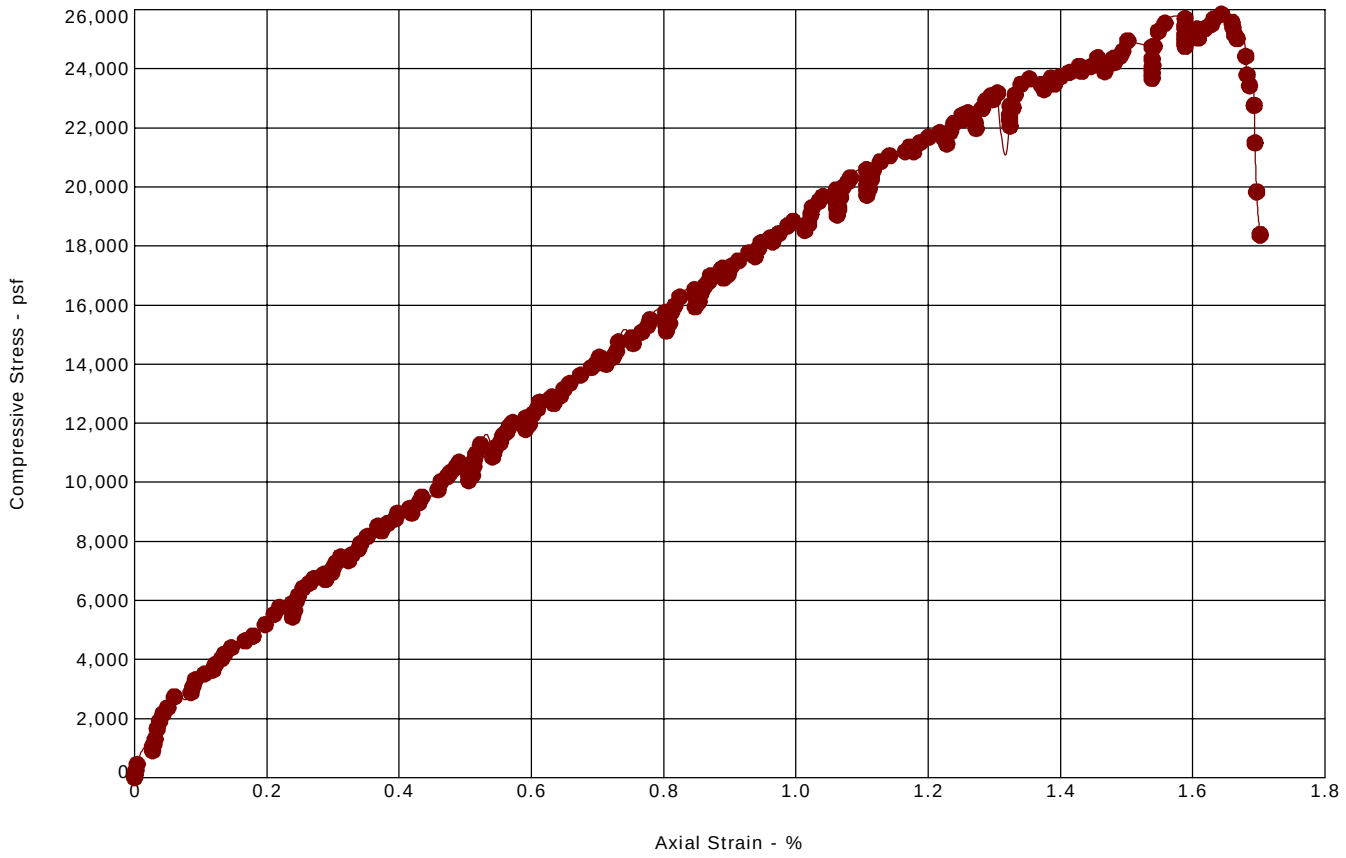
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-11	30	CARS					

Specimen Failure Mode	Specimen Test Data	
	Moisture Content (%):	12.5
	Dry Density (pcf):	125
	Diameter (in.):	1.93
	Height (in.):	3.95
	Height / Diameter Ratio:	2.05
	Calculated Saturation (%):	95.98
	Calculated Void Ratio:	0.35
	Assumed Specific Gravity:	2.7
	Failure Strain (%):	1.64
	Unconfined Compressive Strength (psf):	25842
	Undrained Shear Strength (psf):	12921
	Strain Rate (in/min):	0.0800
	Remarks:	

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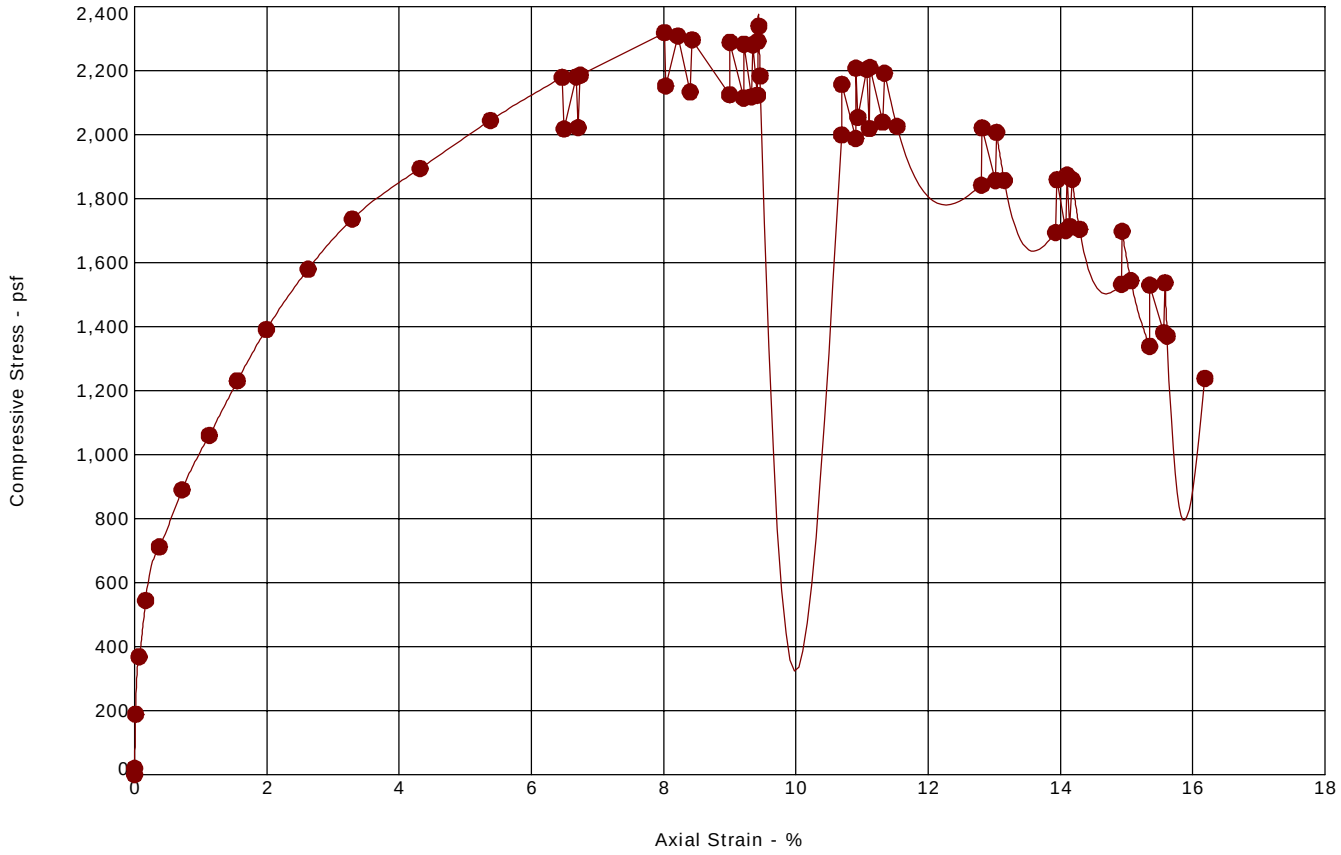
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-12	12.5	CARS					

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	20.2
Dry Density (pcf):	106
Diameter (in.):	1.94
Height (in.):	3.98
Height / Diameter Ratio:	2.06
Calculated Saturation (%):	92.23
Calculated Void Ratio:	0.59
Assumed Specific Gravity:	2.7
Failure Strain (%):	9.44
Unconfined Compressive Strength (psf):	2339
Undrained Shear Strength (psf):	1170
Strain Rate (in/min):	0.0800
Remarks:	

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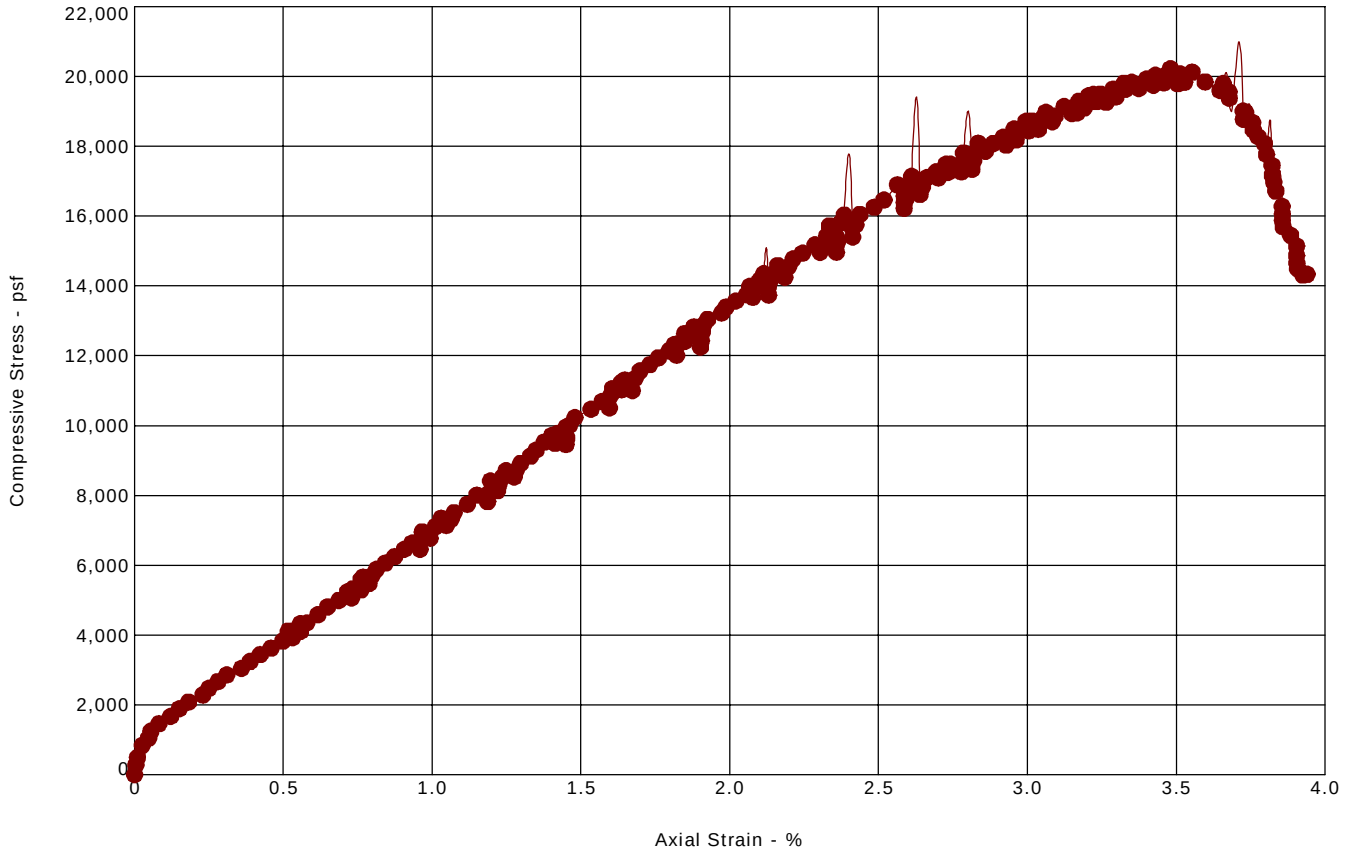
Unconfined Compression Test

ASTM D2166



Boring ID	Depth (Ft)	Sample type	LL	PL	PI	Fines (%)	Description
B-12	35	CARS				99.2	

Specimen Failure Mode

Specimen Test Data

Moisture Content (%):	10.5
Dry Density (pcf):	123
Diameter (in.):	1.94
Height (in.):	3.70
Height / Diameter Ratio:	1.90
Calculated Saturation (%):	75.90
Calculated Void Ratio:	0.37
Assumed Specific Gravity:	2.7
Failure Strain (%):	3.48
Unconfined Compressive Strength (psf):	20223
Undrained Shear Strength (psf):	10112
Strain Rate (in/min):	0.0800
Remarks:	

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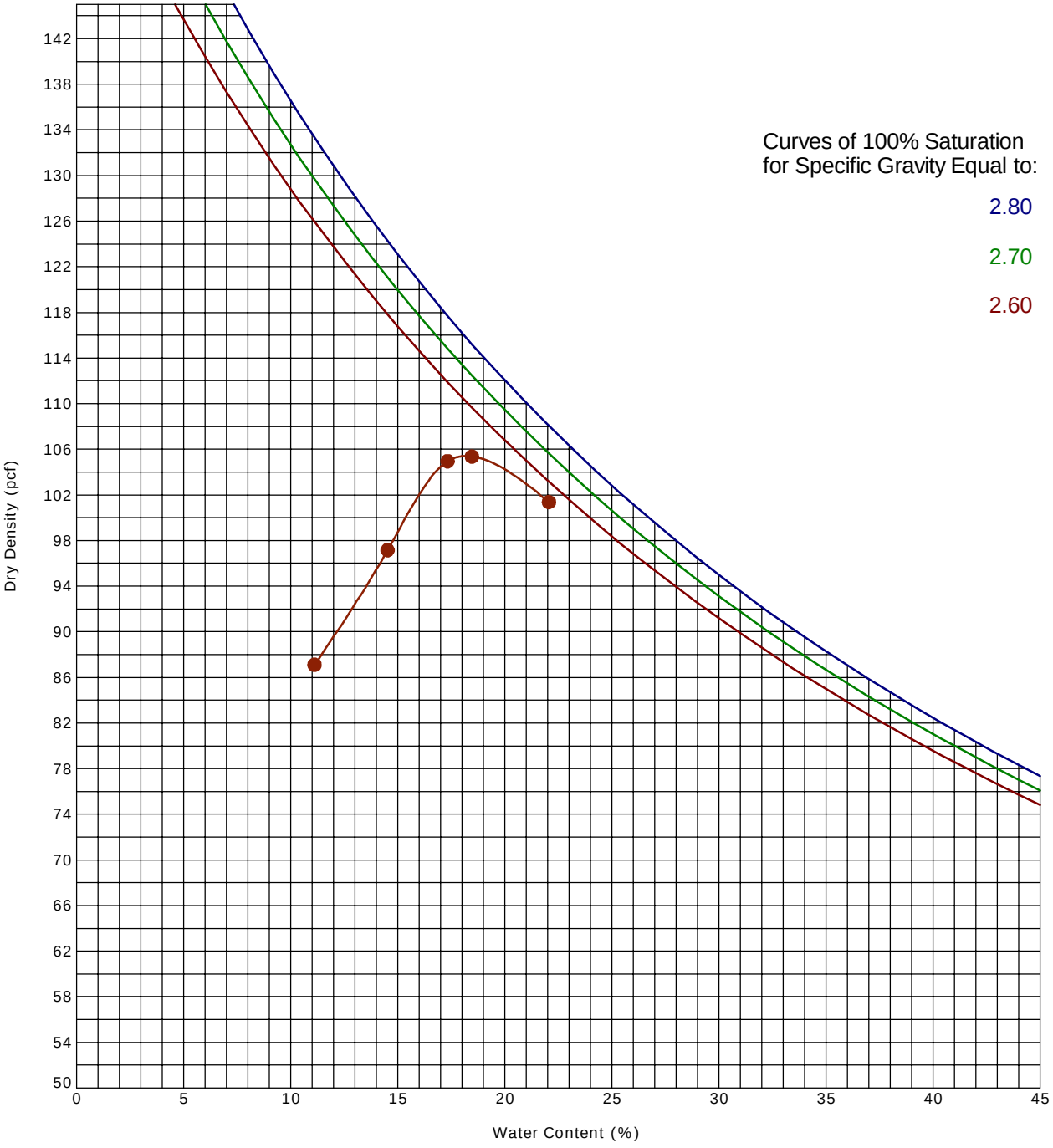
Moisture-Density Relationship

ASTM D698-Method B



Boring ID	Depth (Ft)	Description of Materials
B-12 & B-11 Bulk		

Fines (%)		LL	PL	PI	Test Method	Maximum Dry Density (pcf)	Optimum Water Content (%)
					ASTM D698-Method B	105.4	18.2

Client
Lithos Engineering
Fort Collins, CO

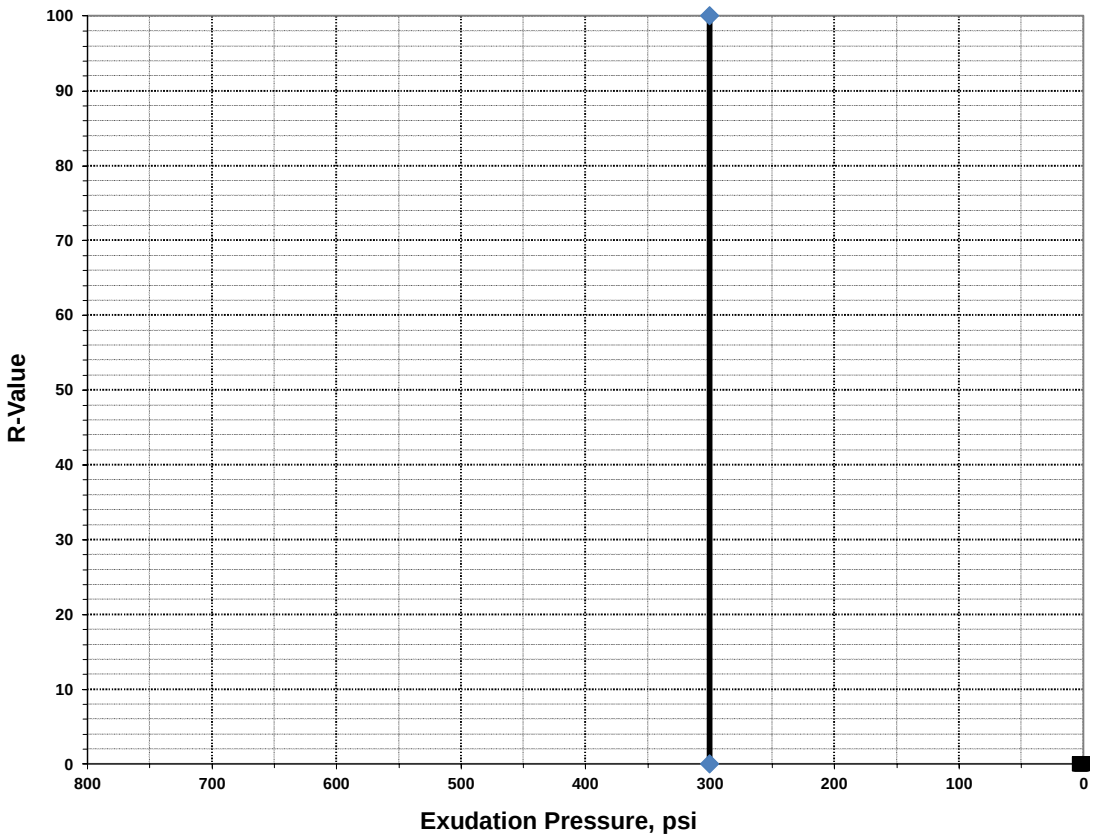
Project
Lithos Engineering-GEI Consultants Lab Testing
20245005

Date Received: 12/20/2024

Results from Corrosion Testing

Sample Location	B-6	B-7	B-12
Sample Depth (ft.)	15.0'	5.0'	5.0'
pH Analysis, AASHTO T289	7.58	8.19	8.25
Water Soluble Sulfate, ASTM C1580, (mg/kg)	609	221	175
Sulfides, AWWA 4500-S D, (mg/kg)	Nil	Nil	Nil
Chloride, ASTM D512, (mg/kg)	14	365	212
Red-Ox, ASTM G200, (mV)	+208	+206	+189
Total Salts, AWWA 2520 B, (mg/kg)	6350	4885	3150
Resistivity (Saturated), ASTM G57, (ohm-cm)	350	370	430

Analyzed By: ChrisAnne Ross
Staff Geologist

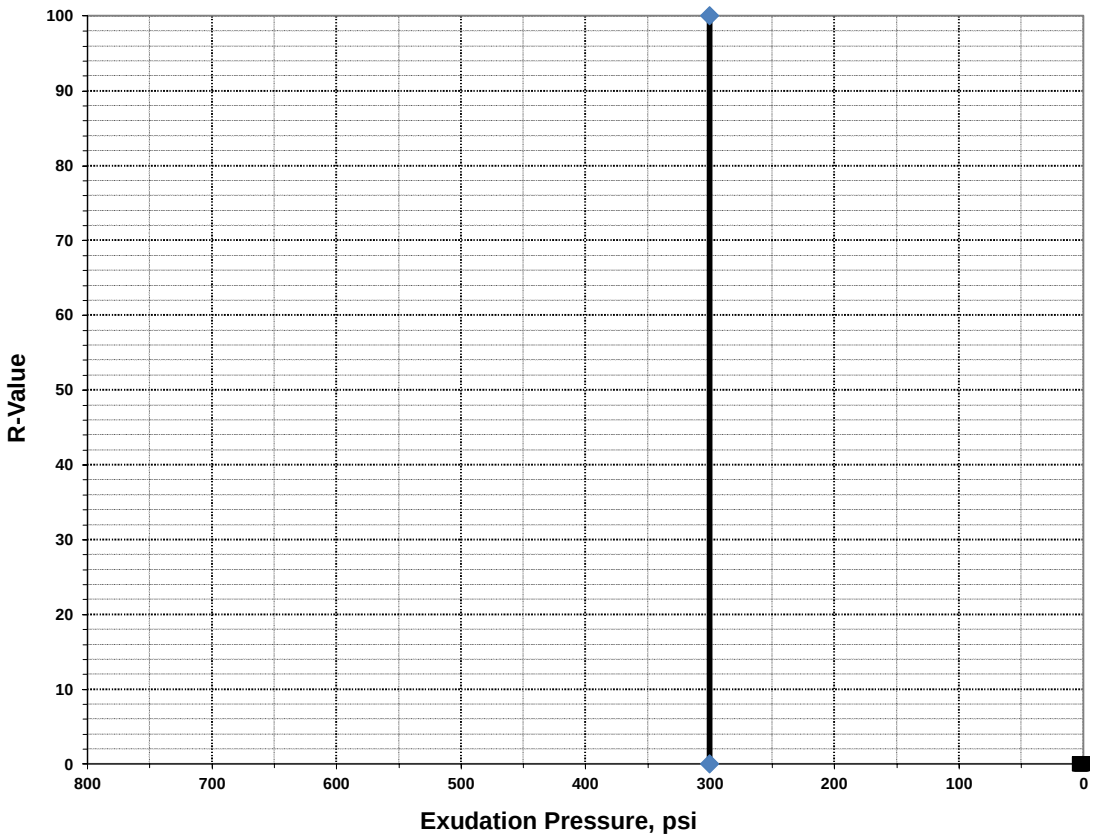


Specimen Identification	Compaction Pressure (psi)	R-Value at 300 psi
B-9 & B10 Blend	**90.0**	**<5**

Material extruded from bottom of mold during exudation. Test aborted. Material has an R-value of <5

R-Value Test

Client:	Lithos Engineering
Project:	Lithos Engineering - GEI Consultants Lab Testing
Site:	1901 Sharp Point Drive, Fort Collins, Colorado
Project No.:	20245005



Specimen Identification	Compaction Pressure (psi)	R-Value at 300 psi
B-14 & B15 Blend	**90.0**	**<5**

Material extruded from bottom of mold during exudation. Test aborted. Material has an R-value of <5

R-Value Test

Client:	Lithos Engineering
Project:	Lithos Engineering - GEI Consultants Lab Testing
Site:	1901 Sharp Point Drive, Fort Collins, Colorado
Project No.:	20245005

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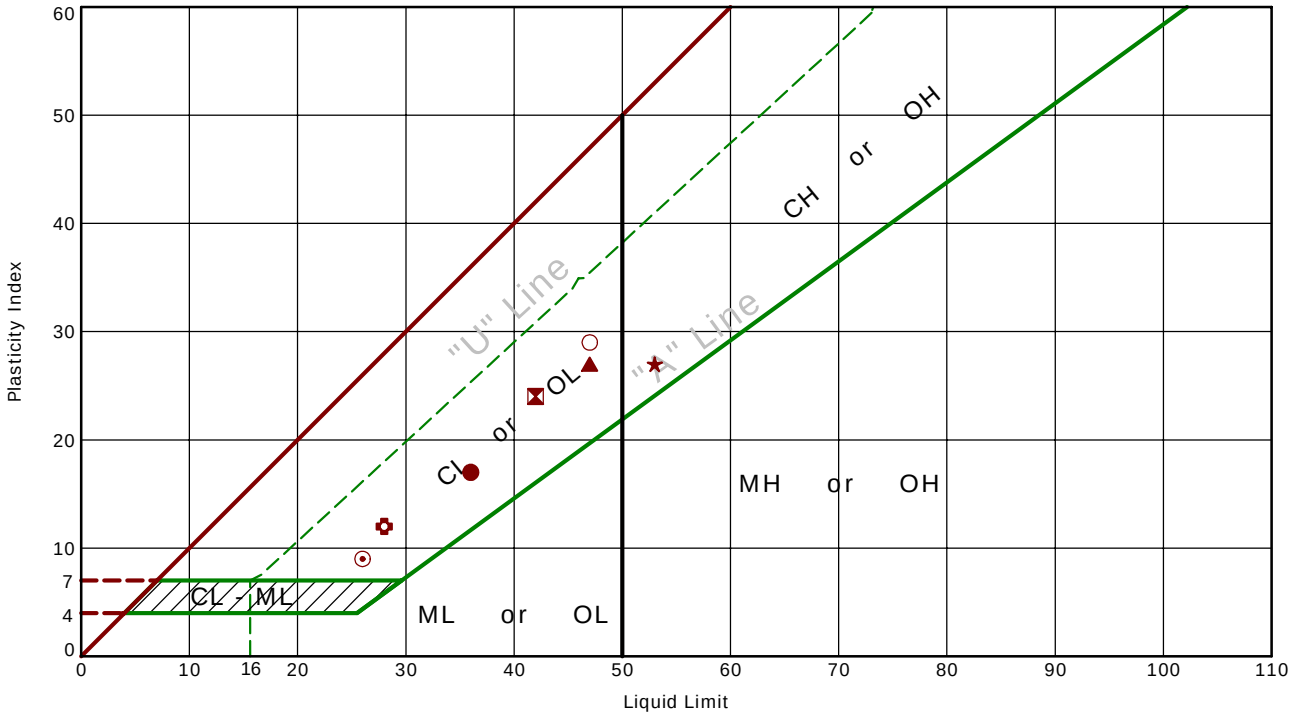
Atterberg Limit Results

ASTM D4318



	Boring ID	Depth (Ft)	LL	PL	PI	Fines	USCS	Description
●	B-1C	5	36	19	17			
⊠	B-1C	10	42	18	24			
▲	B-2C	15	47	20	27	72.9	CL	LEAN CLAY with SAND
★	B-2C	25	53	26	27	80.4	CH	FAT CLAY with SAND
⊙	B-2C	45	26	17	9			
✿	B-2C	49	28	16	12			
○	B-2C	61	47	18	29			

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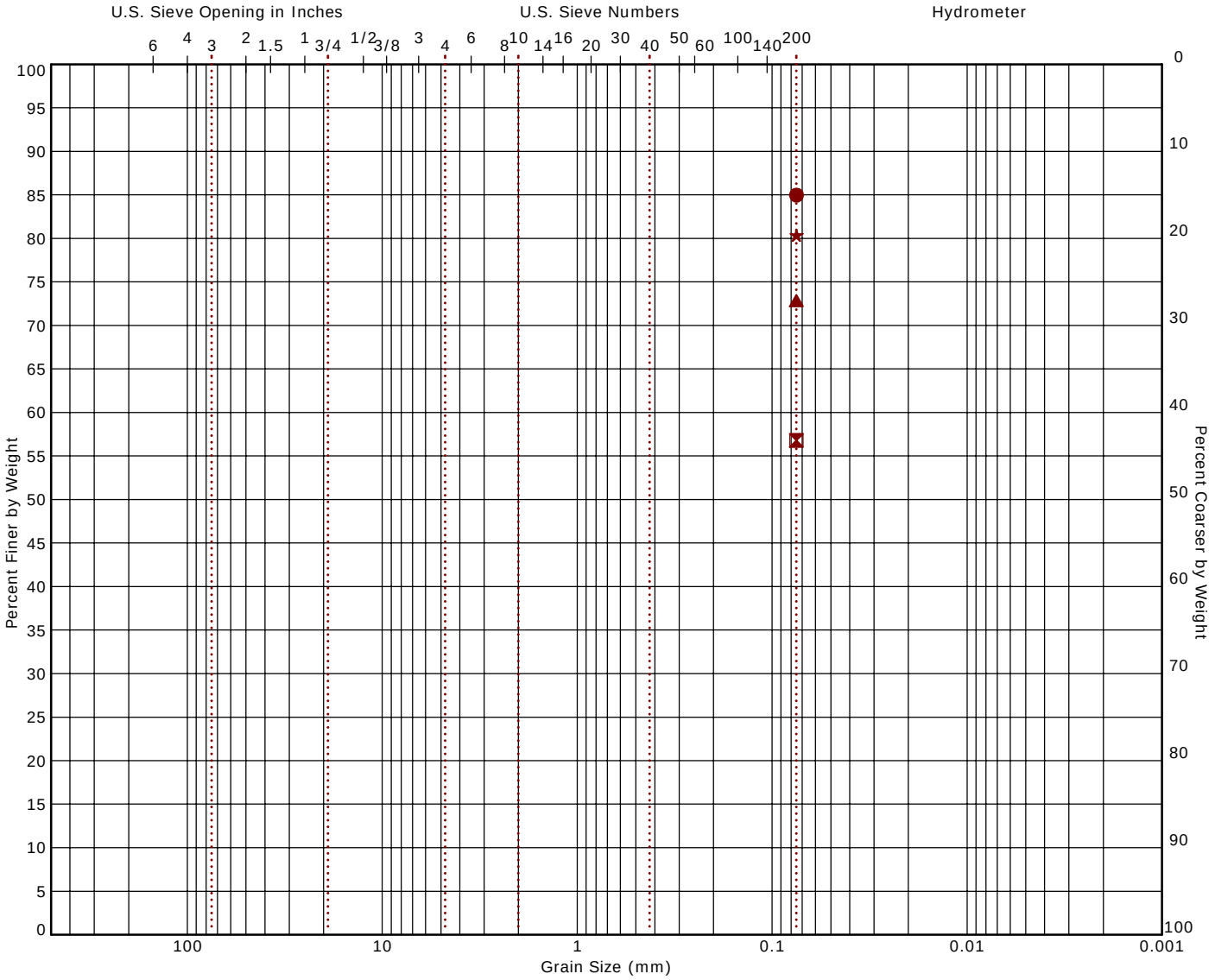
Grain Size Distribution

ASTM D422 / ASTM C136



Boring ID	Depth (Ft)	USCS Classification	USCS	AASHTO	LL	PL	PI	Cc	Cu
● B-1C	15								
⊠ B-2C	5								
▲ B-2C	15	LEAN CLAY with SAND	CL	A-7-6 (19)	47	20	27		
★ B-2C	25	FAT CLAY with SAND	CH	A-7-6 (23)	53	26	27		

Boring ID	Depth (Ft)	D_{100}	D_{60}	D_{30}	D_{10}	%Cobbles	%Gravel	%Sand	%Fines	%Silt	%Clay
● B-1C	15	0.075							85.0		
⊠ B-2C	5	0.075							56.8		
▲ B-2C	15	0.075							72.9		
★ B-2C	25	0.075							80.4		

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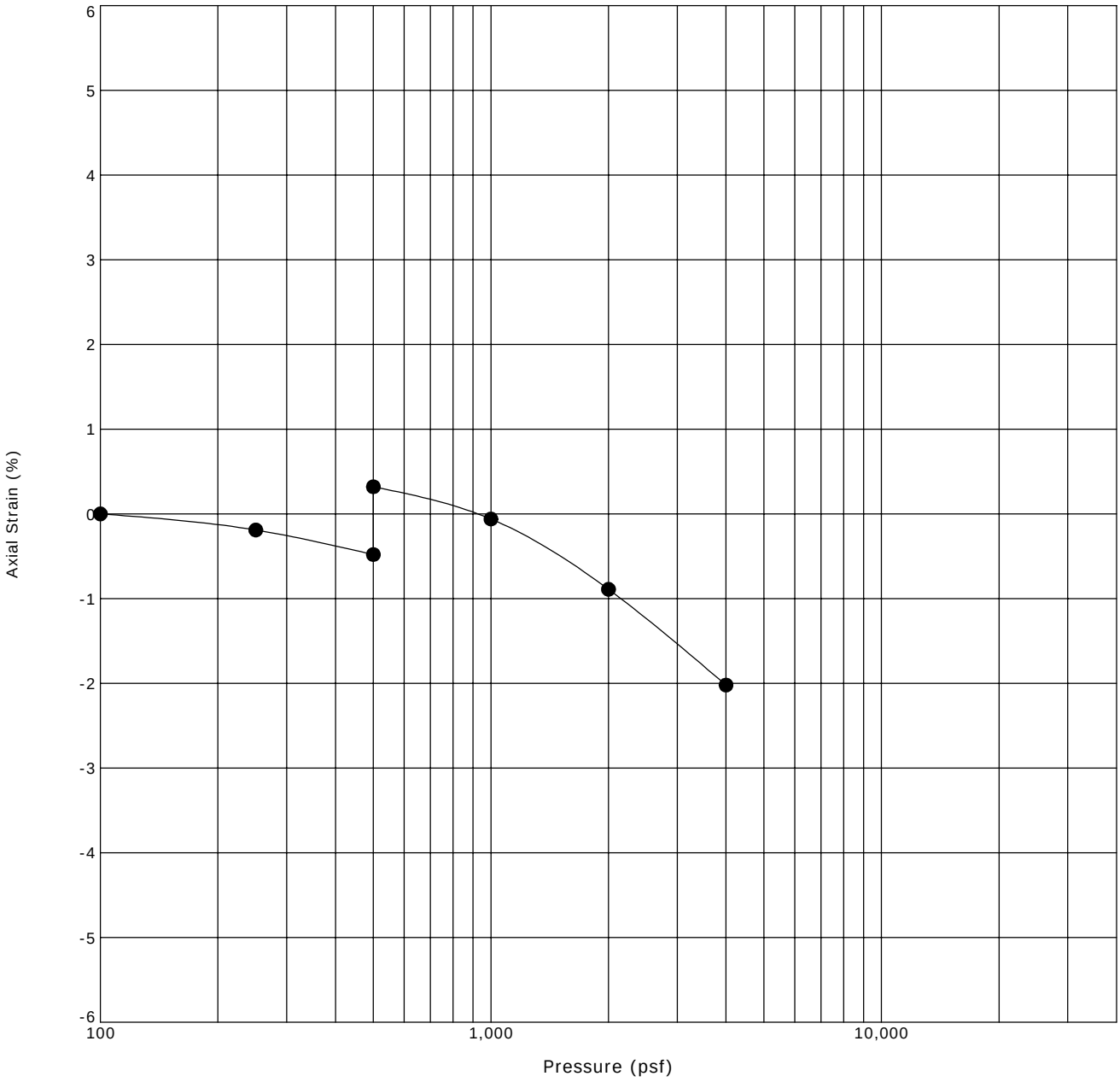
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-1C	29			106	16.4

Notes: Sample exhibited 0.8 percent swell upon wetting under an applied pressure of 500 psf.

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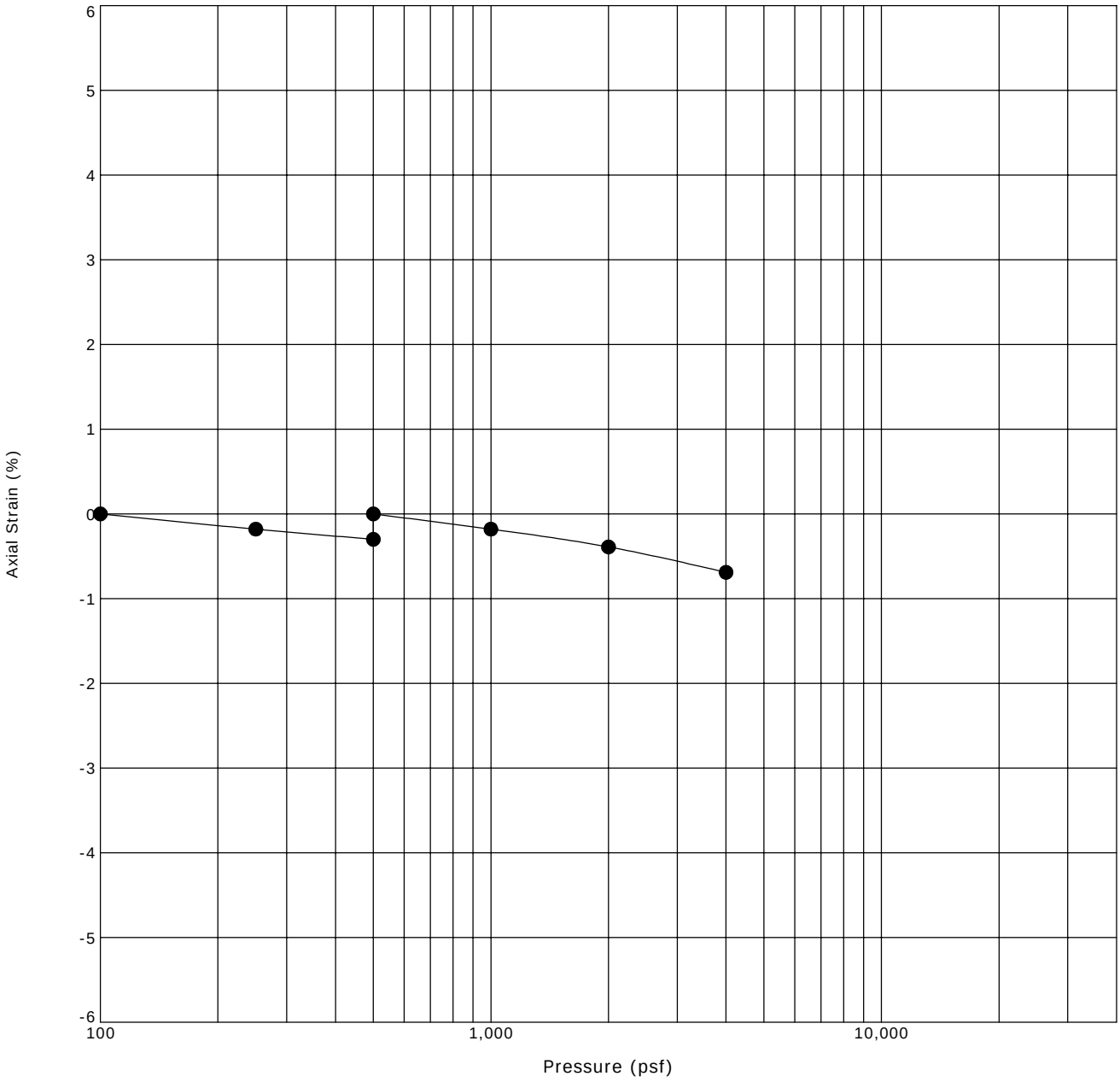
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-1C	50.5			135	5.9

Notes: Sample exhibited 0.3 percent swell upon wetting under an applied pressure of 500 psf.

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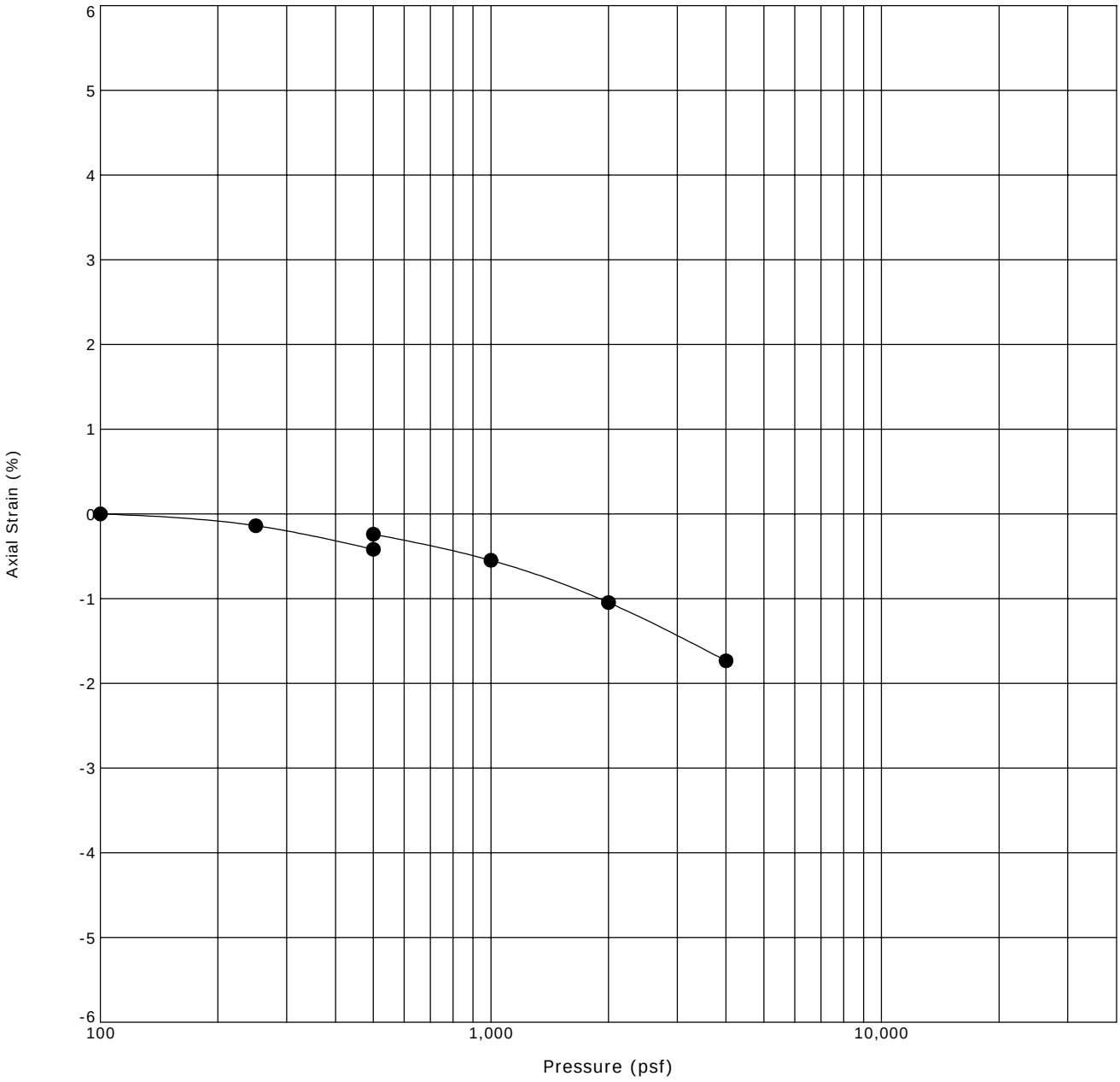
Fort Collins, CO

One-Dimensional Swell or Collapse



Boring ID		Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
●	B-1C	53			131	6.6

Notes: Sample exhibited 0.2 percent swell upon wetting under an applied pressure of 500 psf.

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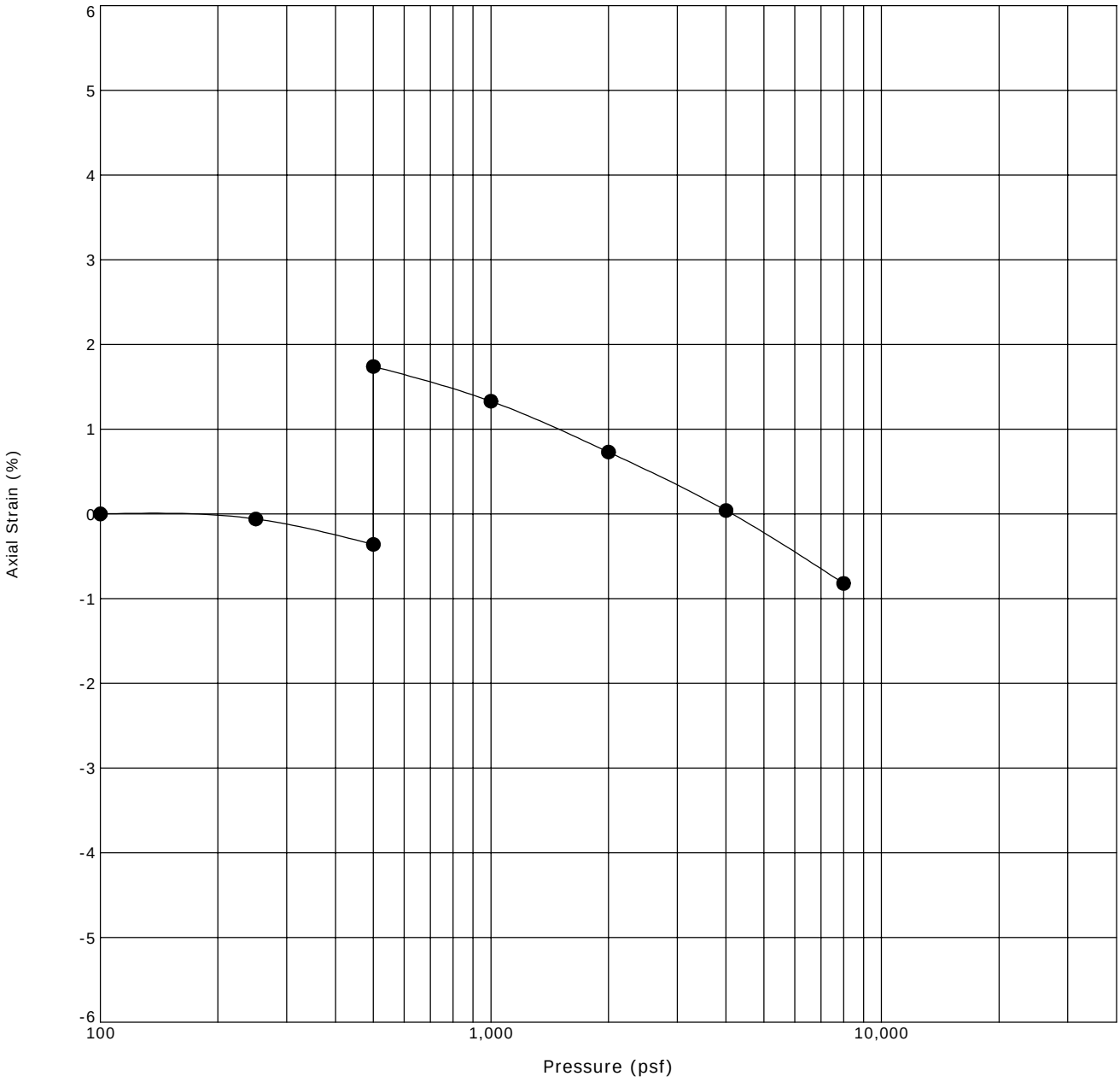
Fort Collins, CO

One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-1C	75			105	21.7

Notes: Sample exhibited 2.1 percent swell upon wetting under an applied pressure of 500 psf.

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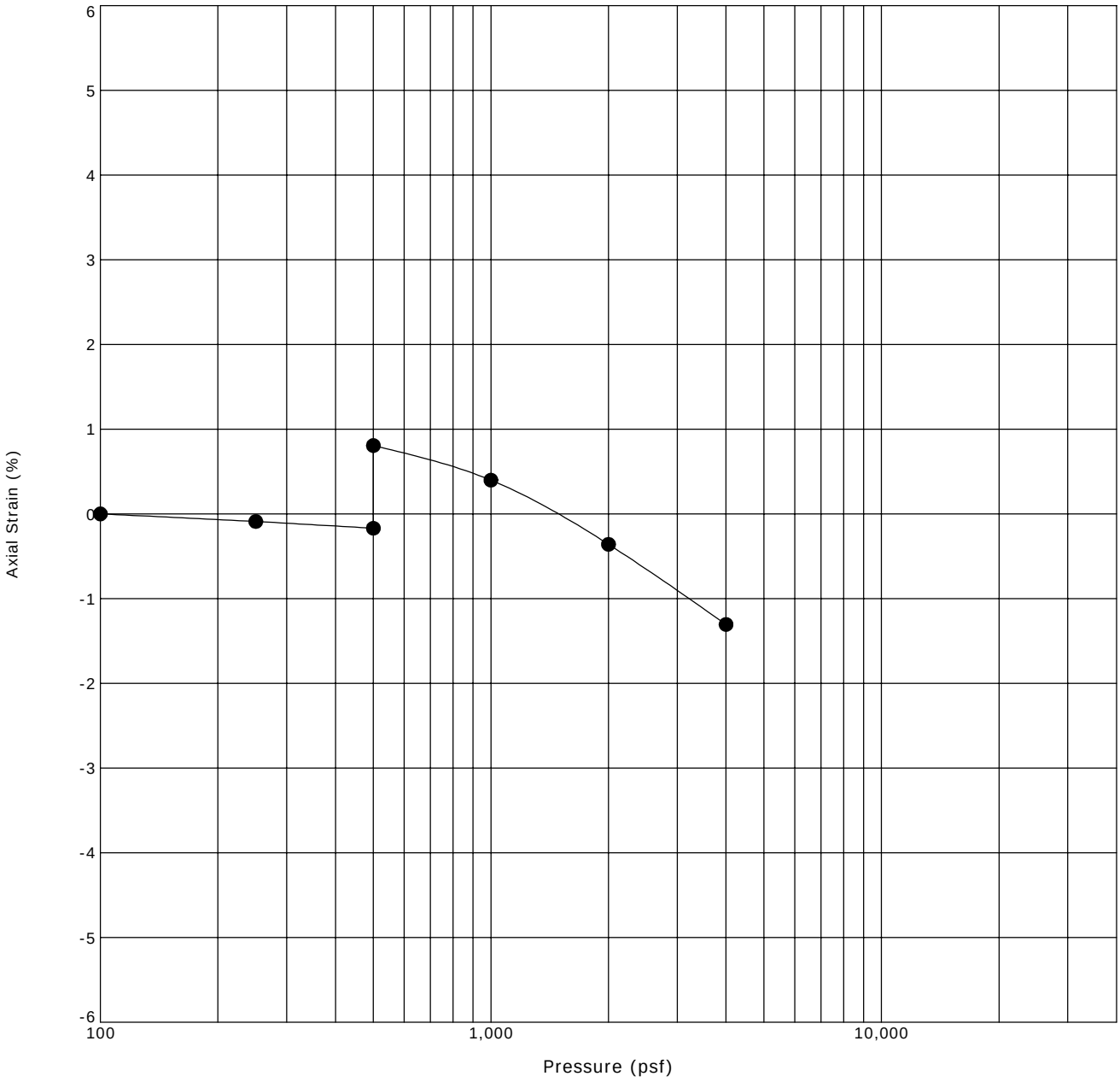
One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2C	30			117	12.8

Notes: Sample exhibited 1.0 percent swell upon wetting under an applied pressure of 500 psf.

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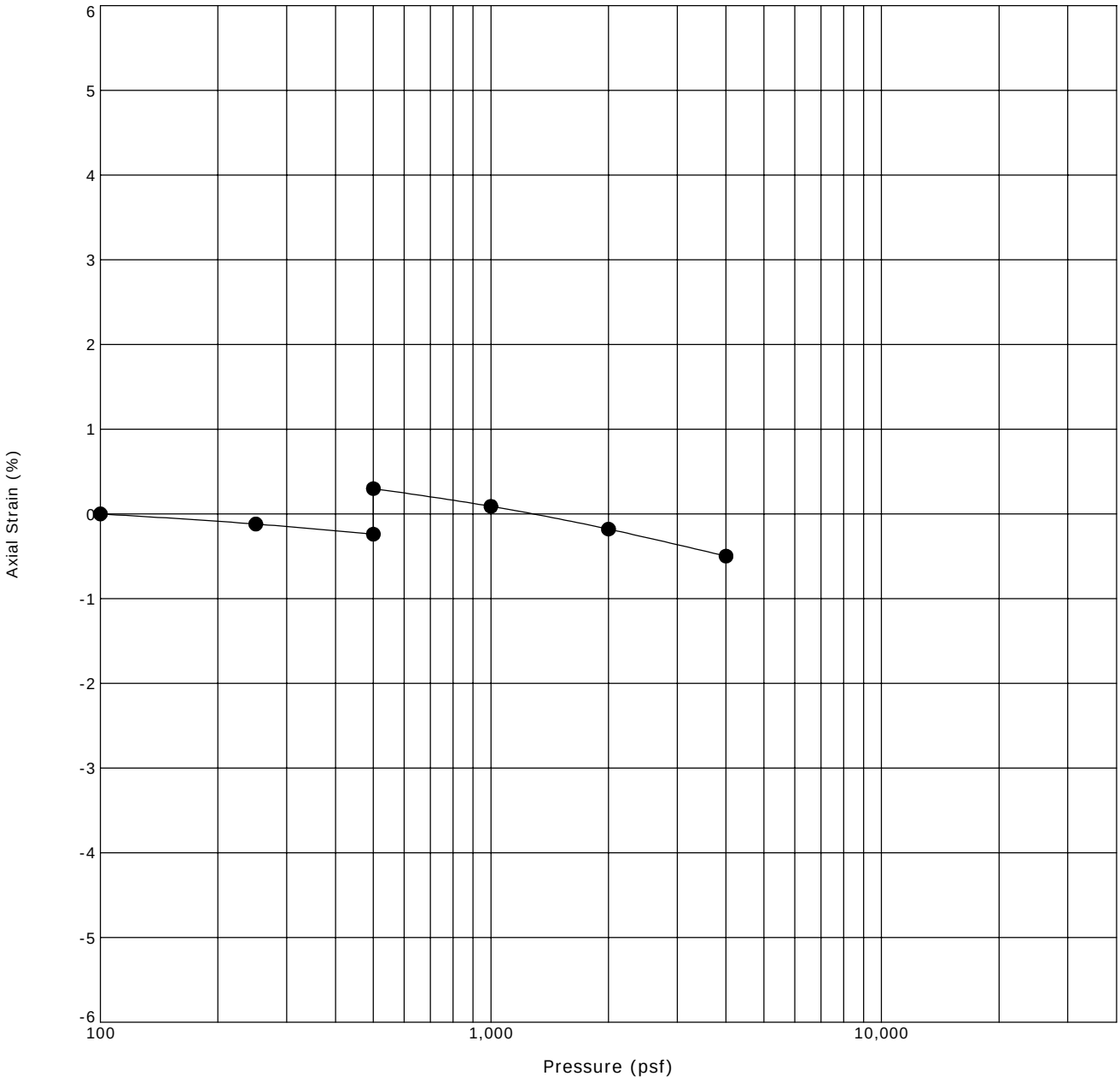
Fort Collins, CO

One-Dimensional Swell or Collapse

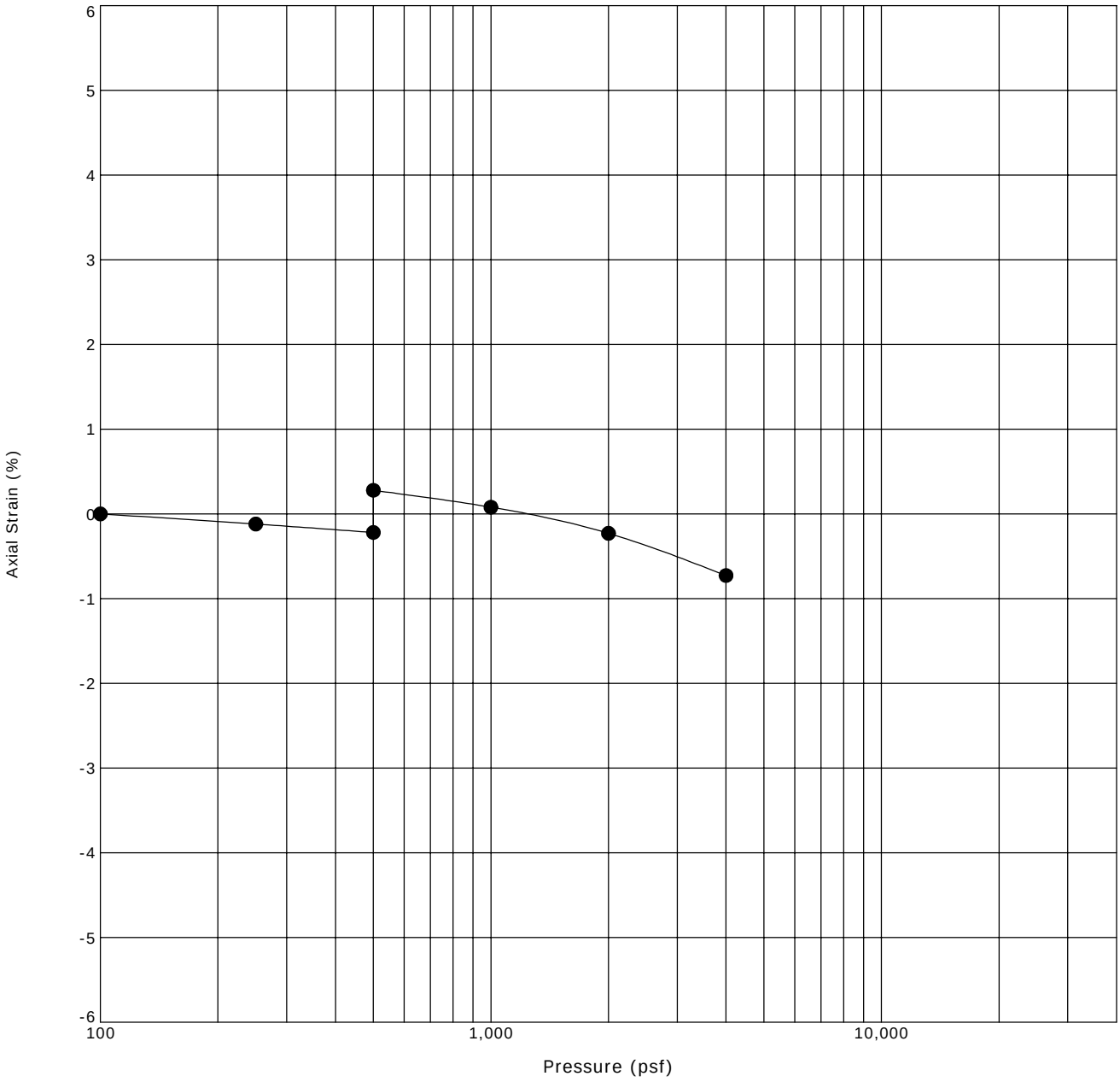


Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2C	45			138	3.4

Notes: Sample exhibited 0.5 percent swell upon wetting under an applied pressure of 500 psf.

1901 Sharp Point Dr Ste C
Fort Collins, CO

One-Dimensional Swell or Collapse

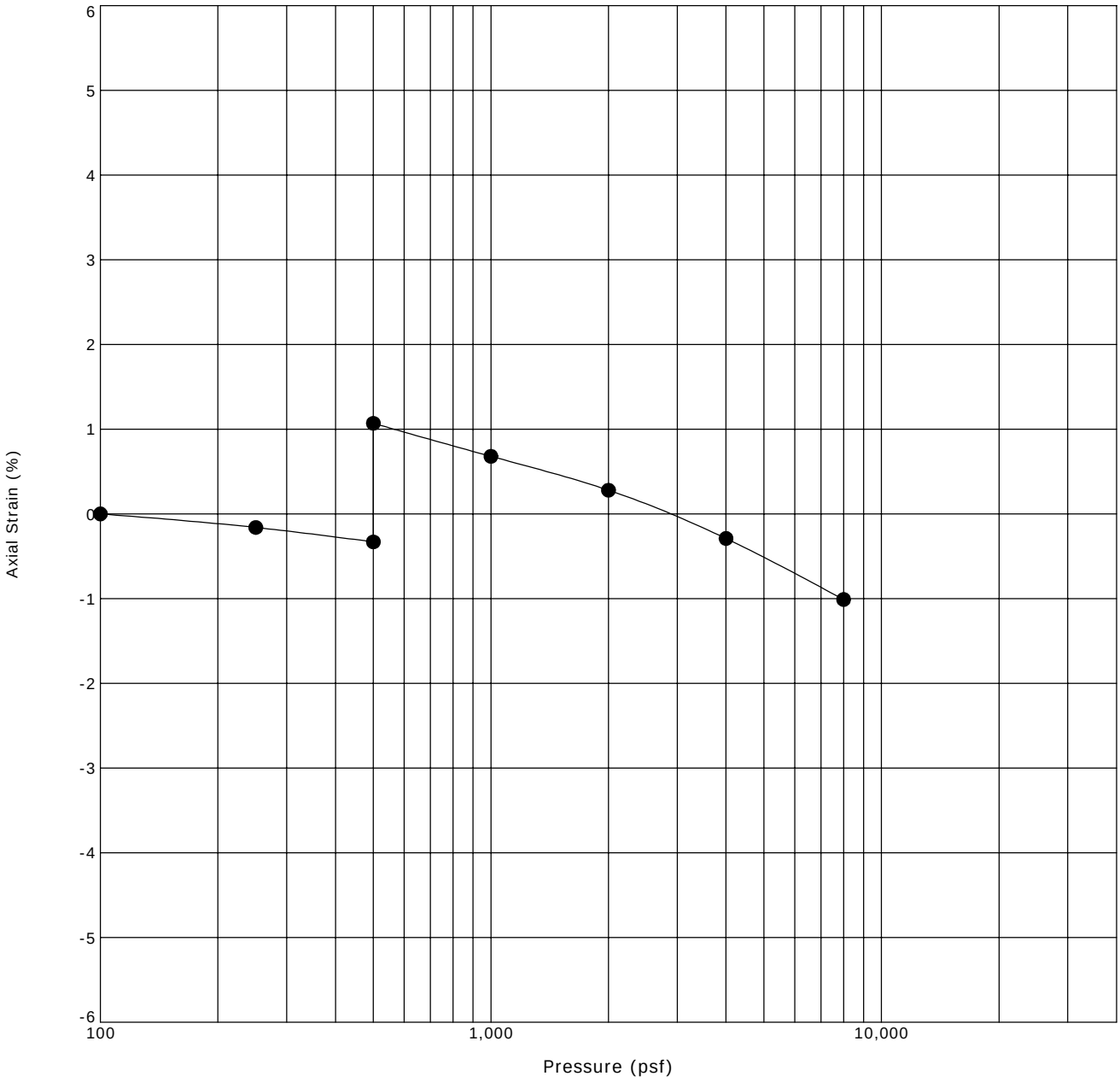


Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2C	49			133	4.8

Notes: Sample exhibited 0.5 percent swell upon wetting under an applied pressure of 500 psf.

1901 Sharp Point Dr Ste C
Fort Collins, CO

One-Dimensional Swell or Collapse

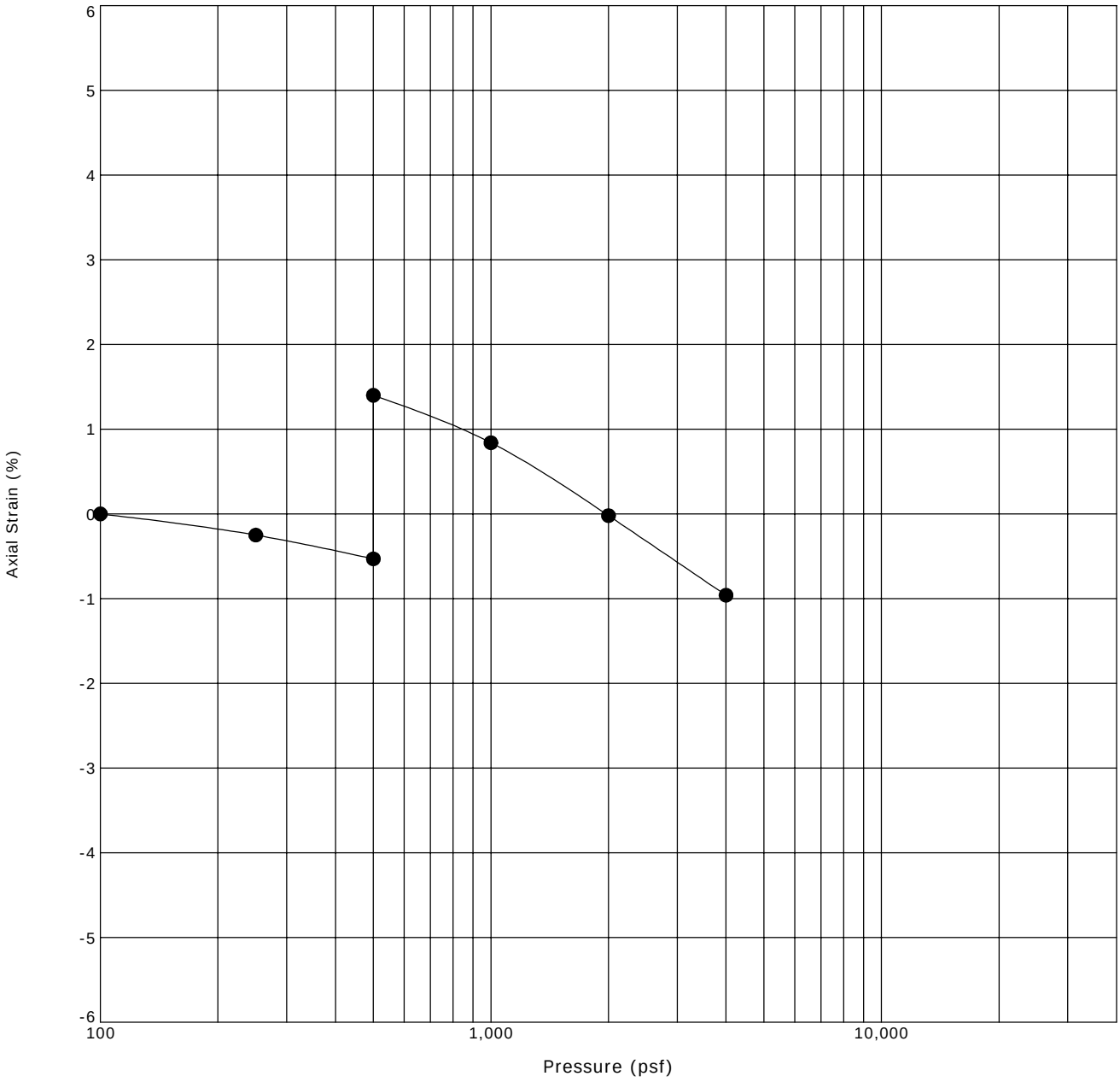


Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2C	61			129	7.7

Notes: Sample exhibited 1.4 percent swell upon wetting under an applied pressure of 500 psf.

1901 Sharp Point Dr Ste C
Fort Collins, CO

One-Dimensional Swell or Collapse

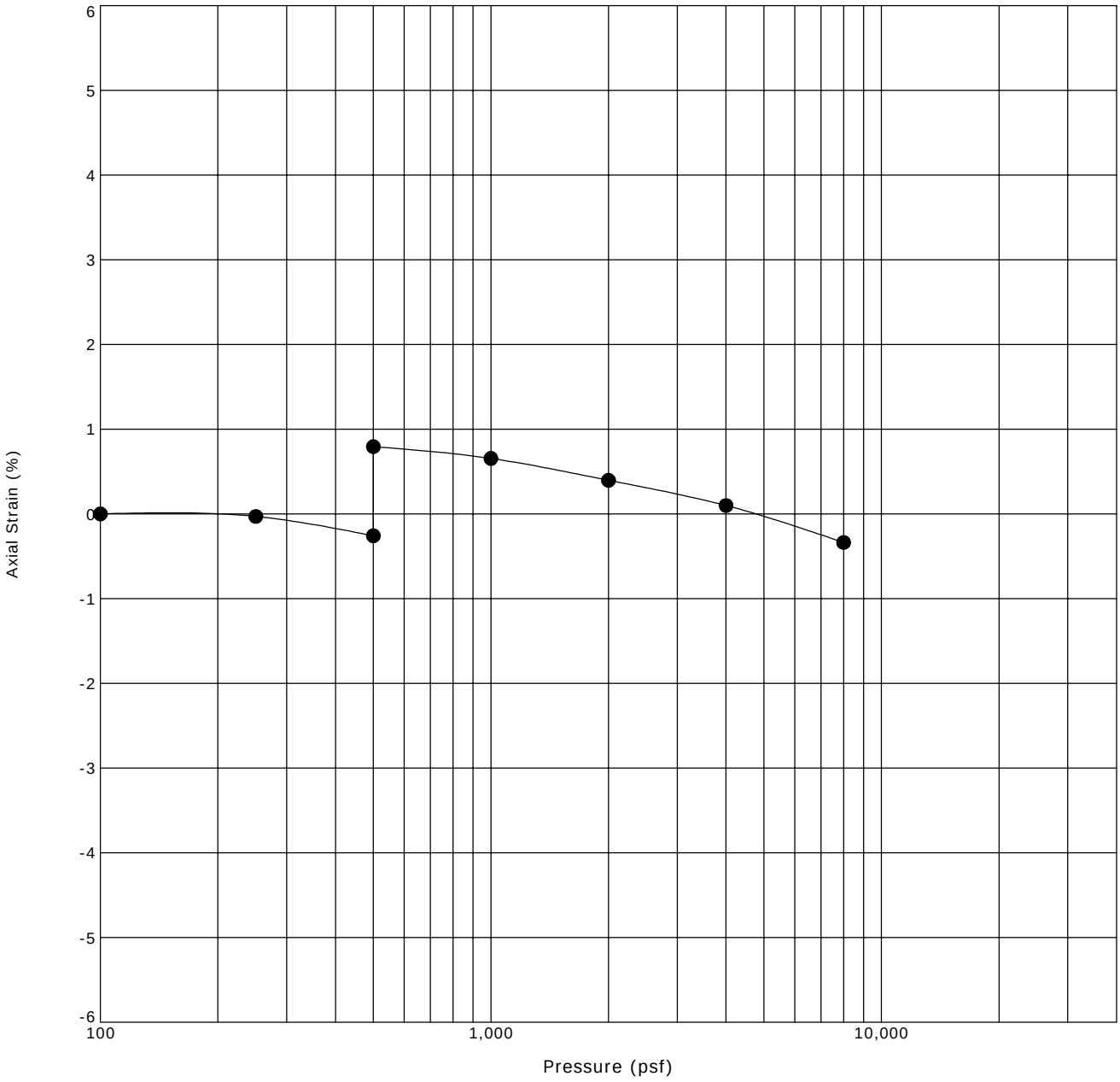


Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2C	66			106	21.3

Notes: Sample exhibited 1.9 percent swell upon wetting under an applied pressure of 500 psf.

1901 Sharp Point Dr Ste C
Fort Collins, CO

One-Dimensional Swell or Collapse



Boring ID	Depth (Ft)	Description	USCS	γ_d(pcf)	WC (%)
● B-2C	97			132	7.6

Notes: Sample exhibited 1.1 percent swell upon wetting under an applied pressure of 500 psf.

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	33
PROJECT	Thornton Pump Station	SAMPLE NO.	1
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	1000
Load Rate (N/min):	4448

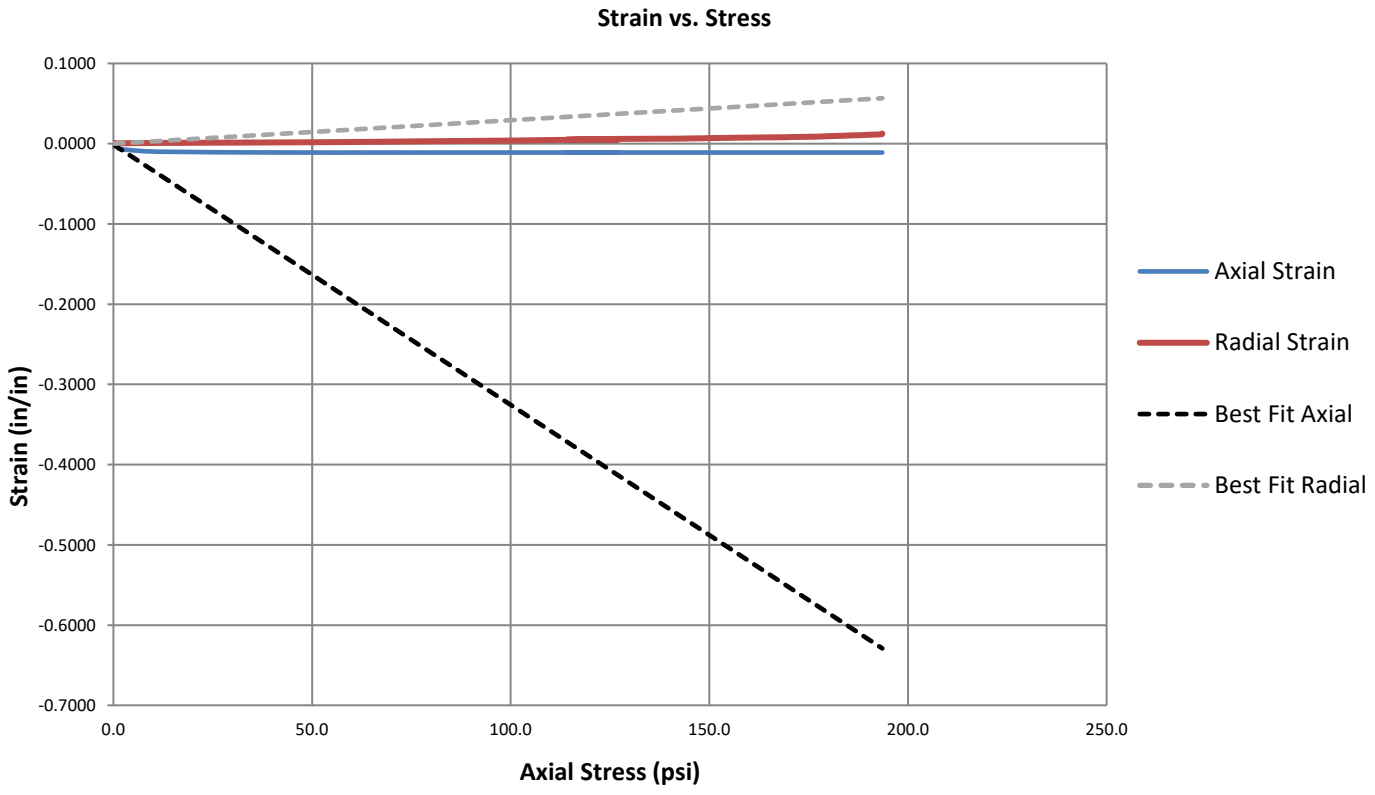
Raw Data Files: 1.txt, 0

Density Data

Mass of Rock (g):	795.4	Initial Wet Density (pcf):	130.7
Initial Diameter (in):	2.402	Initial Wet Density (kg/m³):	2094
Initial Height (in):	5.115		

Test Results

Peak Load (lbs):	877	Failure Type:	Fracture / Bedding
Compressive Strength (psi):	194	Height to Diameter Ratio:	2.13:1
Compressive Strength (MPa):	1	Poisson's Ratio:	0.090
		** Young's Modulus (psi):	308



NOTES: ** Sample was very weak as a result with a very low calculated Young's Modulus.

Data entry by:	HN	Date:	08/14/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_7.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	33
PROJECT	Thornton Pump Station	SAMPLE NO.	1
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

Before Test

NOTES	** Sample was very weak as a result with a very low calculated Young's Modulus.

Picture File: 1.JPG
File name: 2261288__RockTx ASTM 7012 B and D_7.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	33
PROJECT	Thornton Pump Station	SAMPLE NO.	1
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

After Test

NOTES	** Sample was very weak as a result with a very low calculated Young's Modulus.

Picture File: 1a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_7.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	50
PROJECT	Thornton Pump Station	SAMPLE NO.	2
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

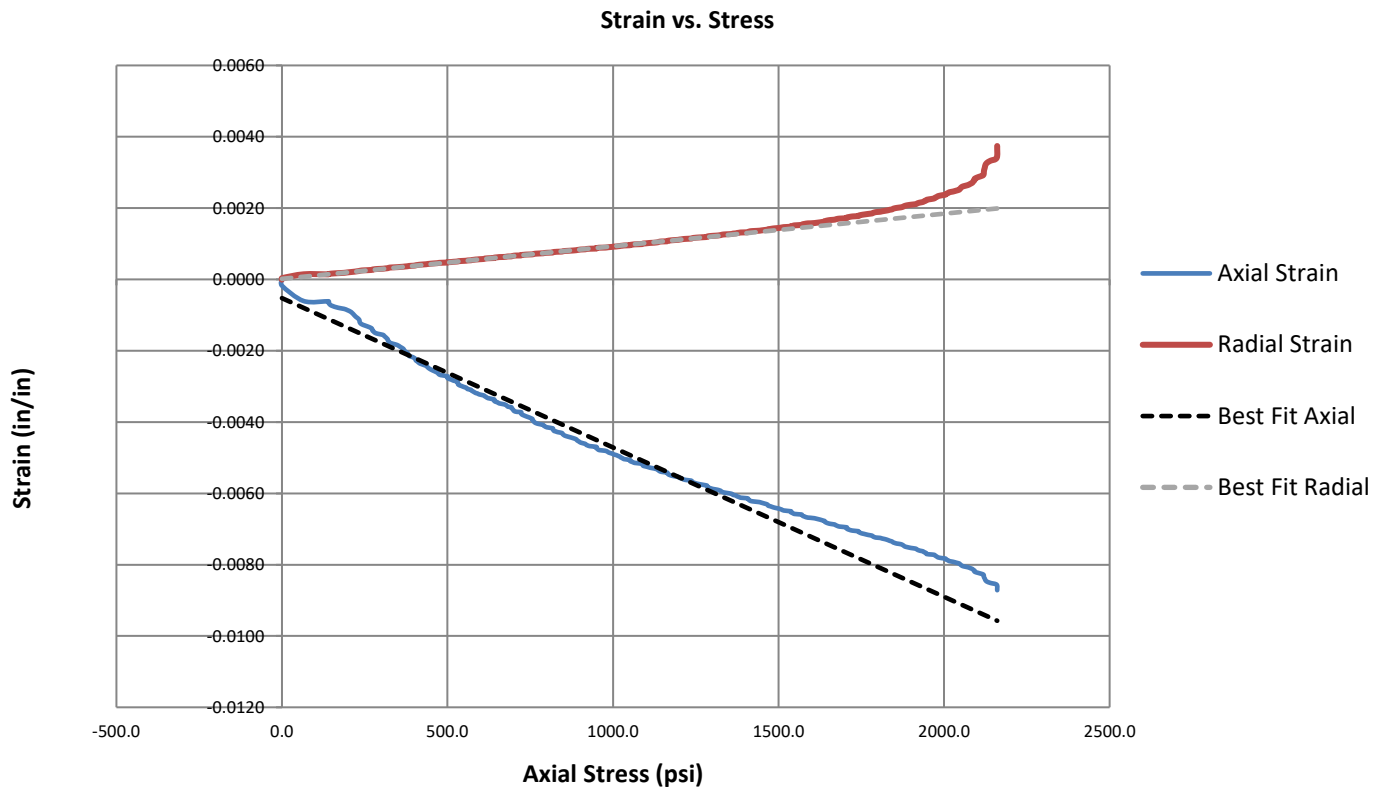
Raw Data Files: 2.txt, 0

Density Data

Mass of Rock (g):	926.3	Initial Wet Density (pcf):	148.1
Initial Diameter (in):	2.390	Initial Wet Density (kg/m³):	2372
Initial Height (in):	5.311		

Test Results

Peak Load (lbs):	9692	Failure Type:	Fracture / Bedding
Compressive Strength (psi):	2160	Height to Diameter Ratio:	2.22:1
Compressive Strength (MPa):	15	Poisson's Ratio:	0.218
		Young's Modulus (psi):	0.24 x10^6



NOTES:

Data entry by:	HN	Date:	08/14/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_8.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	50
PROJECT	Thornton Pump Station	SAMPLE NO.	2
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

Before Test

NOTES

Picture File: 2.JPG
File name: 2261288__RockTx ASTM 7012 B and D_8.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	50
PROJECT	Thornton Pump Station	SAMPLE NO.	2
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 2a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_8.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	59
PROJECT	Thornton Pump Station	SAMPLE NO.	3
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

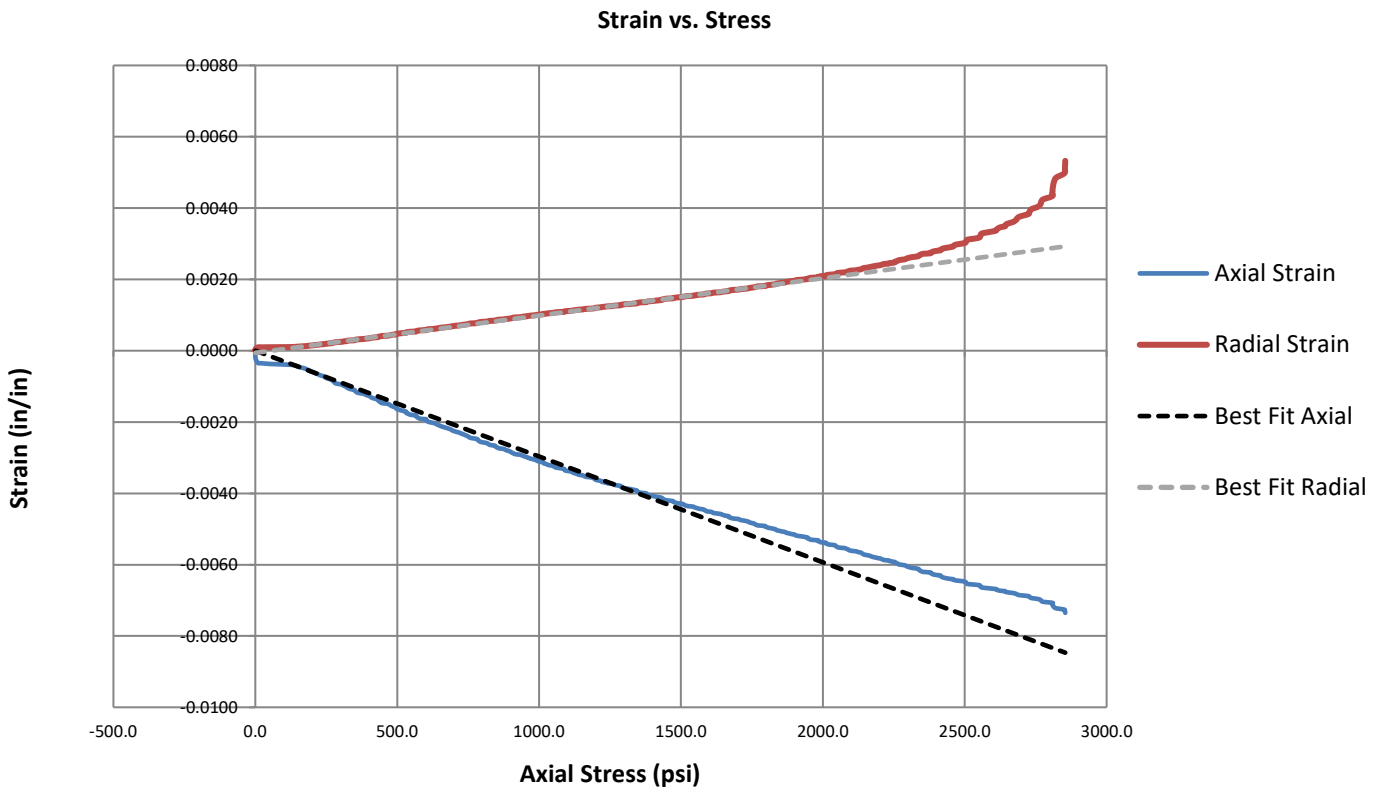
Raw Data Files: 3.txt, 0

Density Data

Mass of Rock (g):	880.0	Initial Wet Density (pcf):	150.0
Initial Diameter (in):	2.386	Initial Wet Density (kg/m³):	2403
Initial Height (in):	4.998		

Test Results

Peak Load (lbs):	12762	Failure Type:	Shear
Compressive Strength (psi):	2854	Height to Diameter Ratio:	2.09:1
Compressive Strength (MPa):	20	Poisson's Ratio:	0.352
		Young's Modulus (psi):	0.34 x10^6



NOTES:

Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_0.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	59
PROJECT	Thornton Pump Station	SAMPLE NO.	3
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Before Test

NOTES

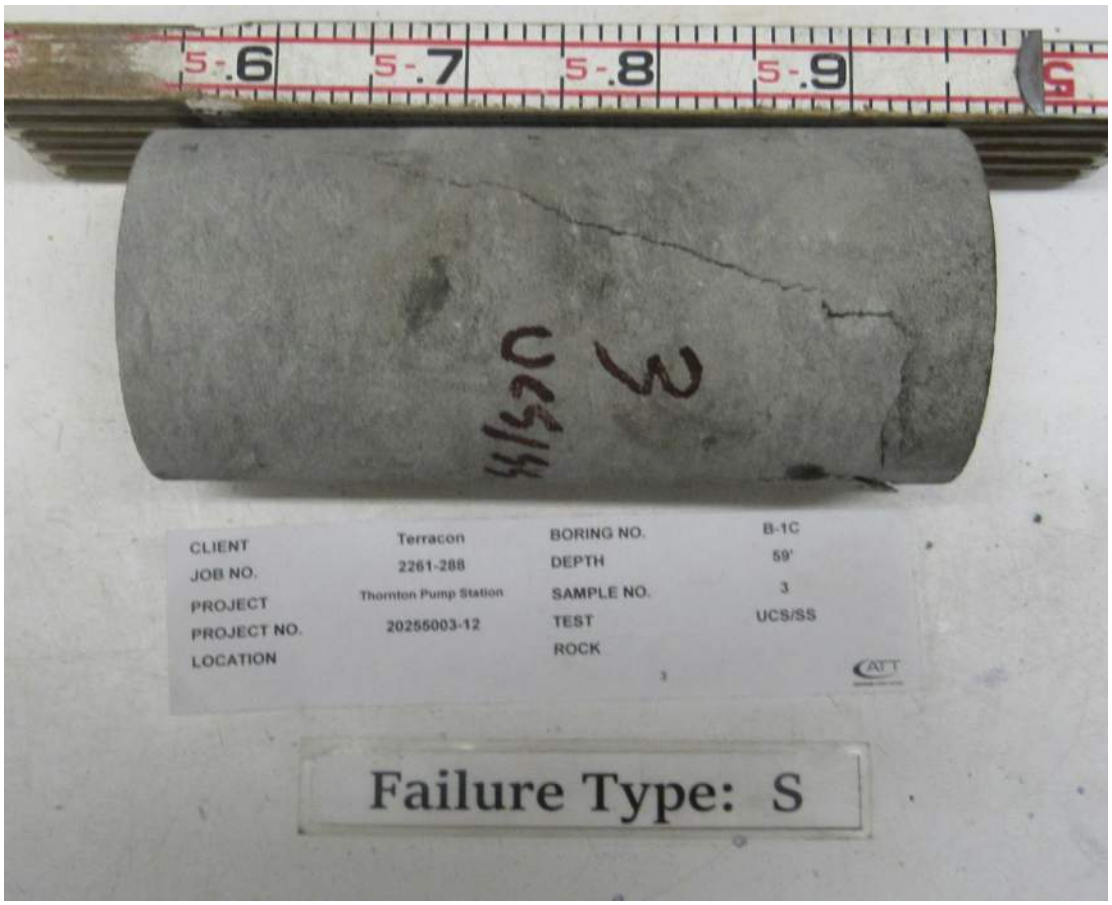
Picture File: 3.JPG
File name: 2261288__RockTx ASTM 7012 B and D_0.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	59
PROJECT	Thornton Pump Station	SAMPLE NO.	3
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test



NOTES

Picture File: 3a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_0.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	77
PROJECT	Thornton Pump Station	SAMPLE NO.	4
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

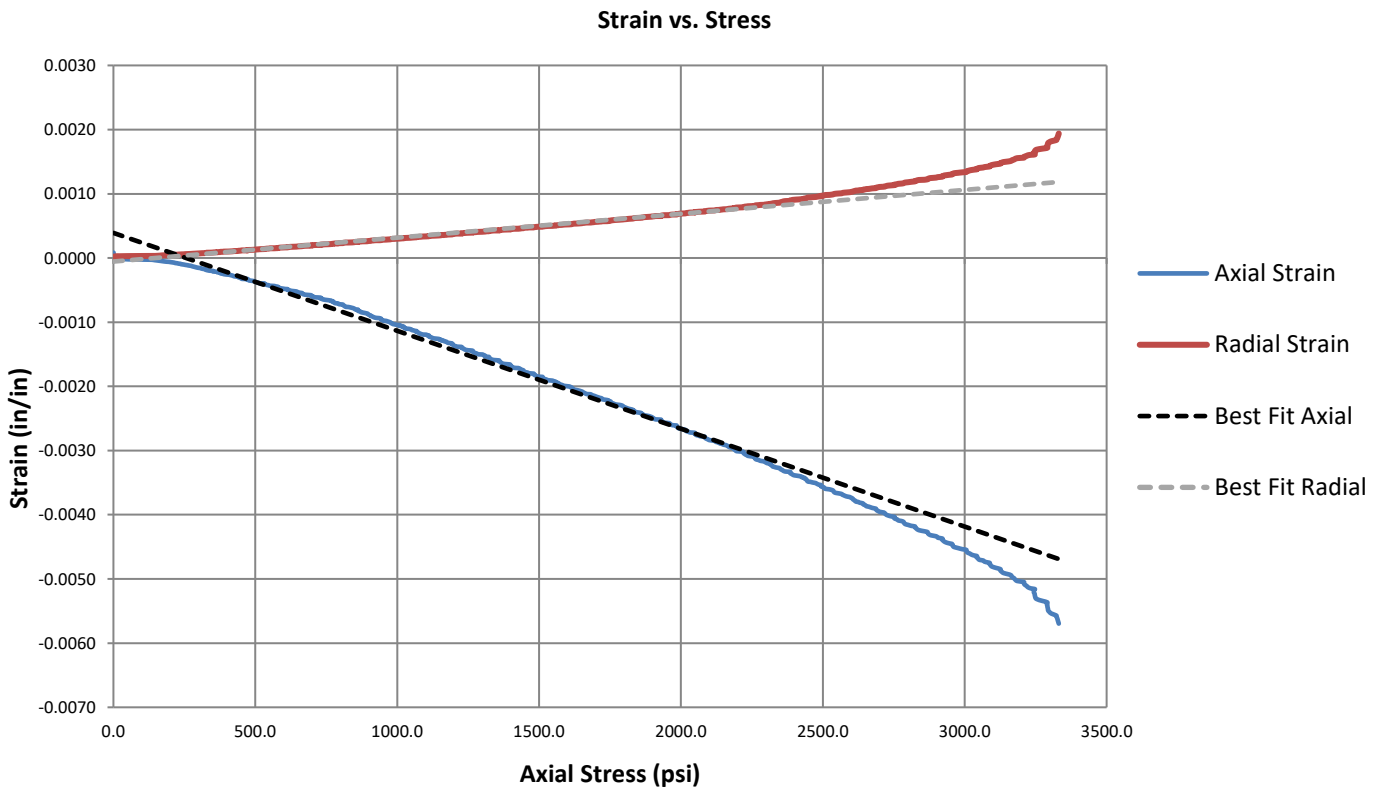
Raw Data Files: 4.txt, 0

Density Data

Mass of Rock (g):	872.1	Initial Wet Density (pcf):	149.2
Initial Diameter (in):	2.385	Initial Wet Density (kg/m³):	2390
Initial Height (in):	4.985		

Test Results

Peak Load (lbs):	14883	Failure Type:	Shear / Fracture
Compressive Strength (psi):	3331	Height to Diameter Ratio:	2.09:1
Compressive Strength (MPa):	23	Poisson's Ratio:	0.244
		Young's Modulus (psi):	0.66 x10^6



NOTES:

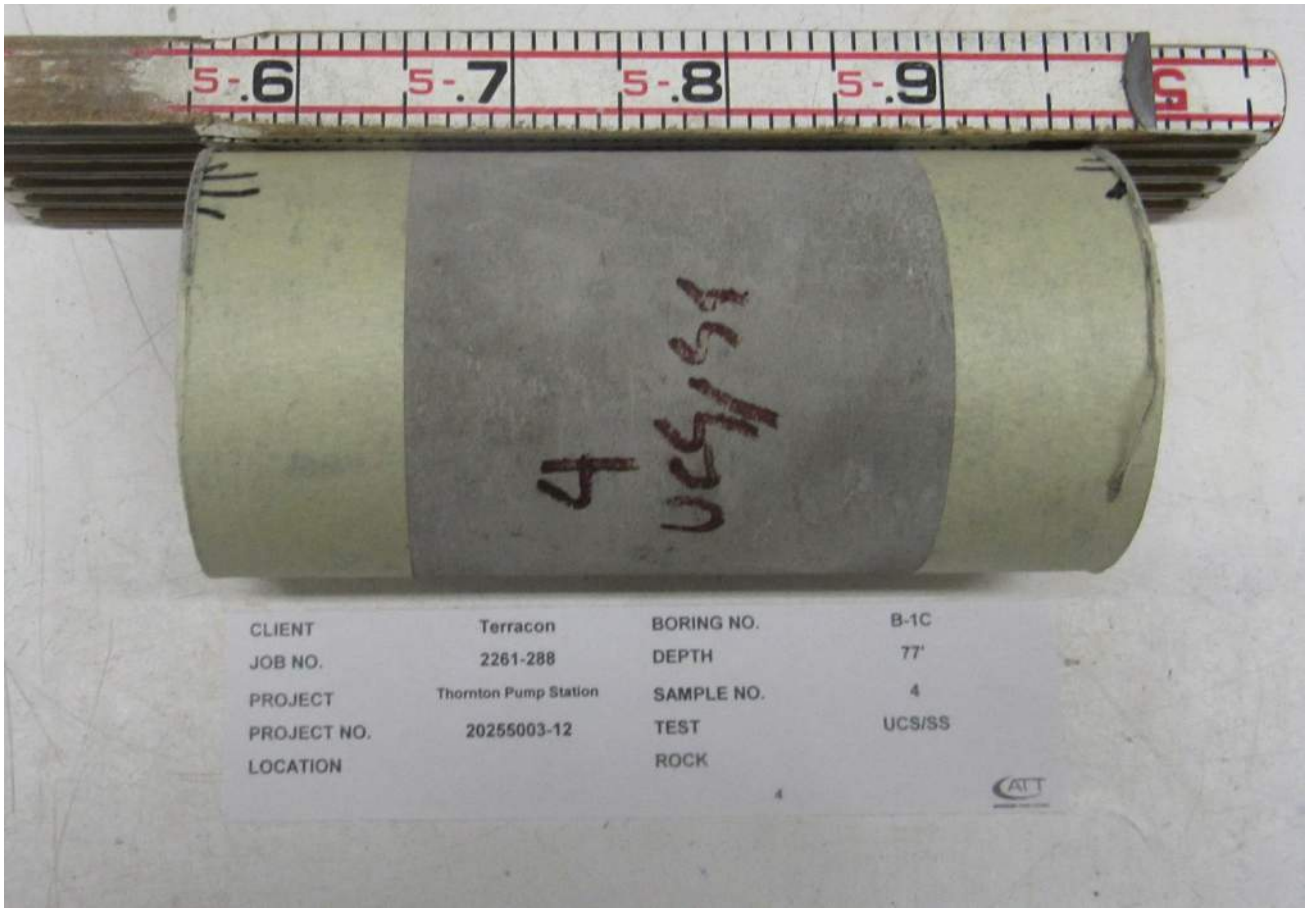
Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_1.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	77
PROJECT	Thornton Pump Station	SAMPLE NO.	4
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Before Test



NOTES

Picture File: 4.JPG
File name: 2261288__RockTx ASTM 7012 B and D_1.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	77
PROJECT	Thornton Pump Station	SAMPLE NO.	4
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 4a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_1.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	91
PROJECT	Thornton Pump Station	SAMPLE NO.	5
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

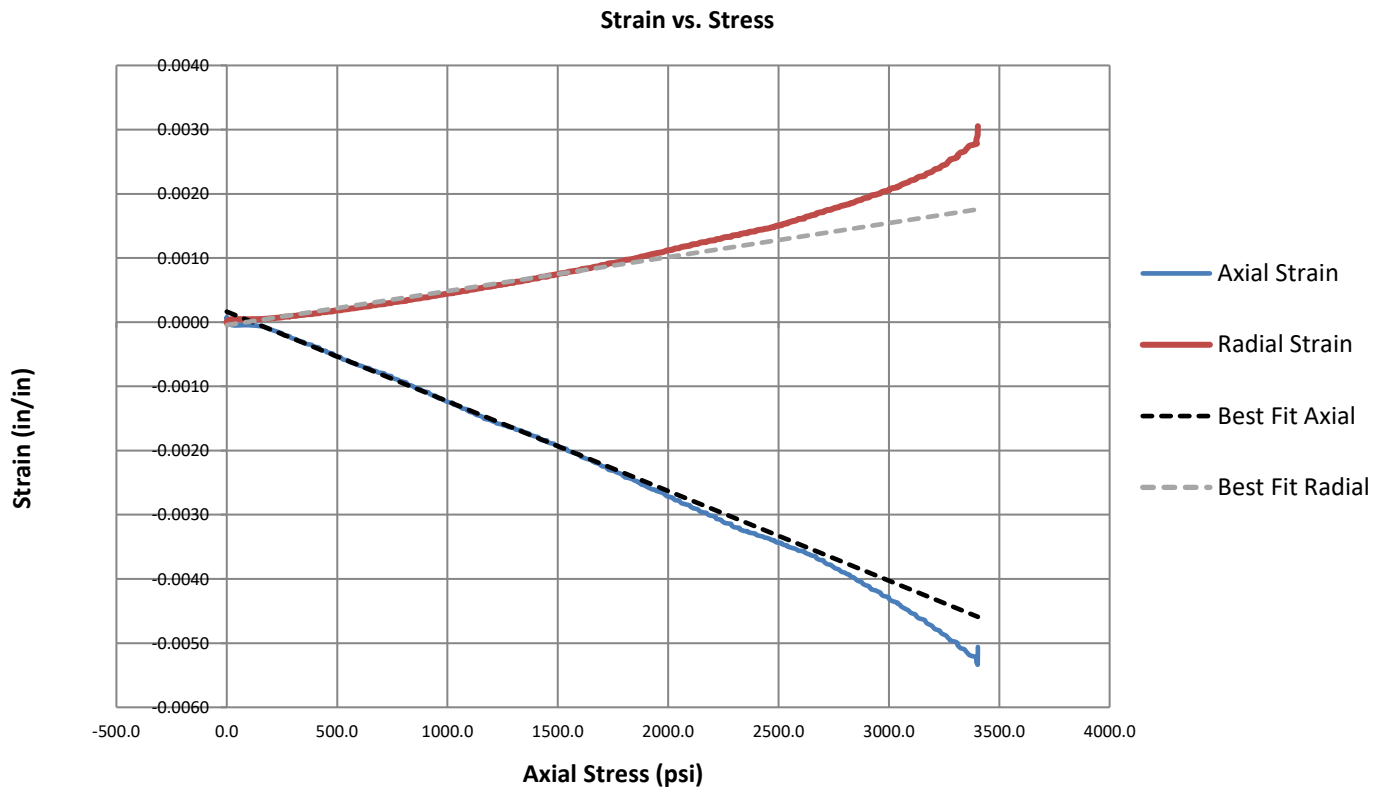
Raw Data Files: 5.txt, 0

Density Data

Mass of Rock (g):	886.4	Initial Wet Density (pcf):	151.0
Initial Diameter (in):	2.385	Initial Wet Density (kg/m³):	2419
Initial Height (in):	5.006		

Test Results

Peak Load (lbs):	15203	Failure Type:	Fracture / Bedding
Compressive Strength (psi):	3403	Height to Diameter Ratio:	2.10:1
Compressive Strength (MPa):	23	Poisson's Ratio:	0.379
		Young's Modulus (psi):	0.72 x10^6



NOTES:

Data entry by:	HN	Date:	08/14/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_9.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	91
PROJECT	Thornton Pump Station	SAMPLE NO.	5
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

Before Test

NOTES

Picture File: 5.JPG
File name: 2261288__RockTx ASTM 7012 B and D_9.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	91
PROJECT	Thornton Pump Station	SAMPLE NO.	5
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/14/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 5a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_9.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	99
PROJECT	Thornton Pump Station	SAMPLE NO.	6
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

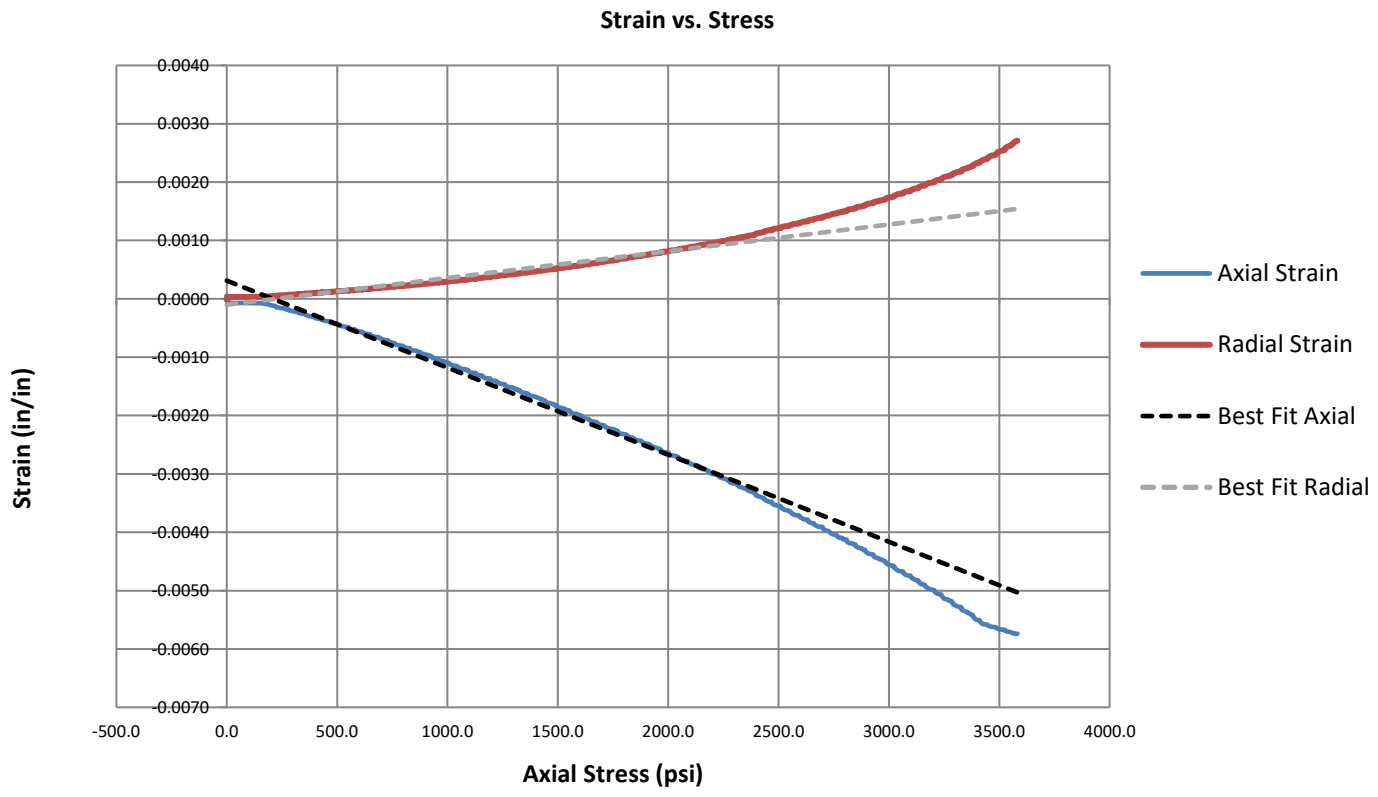
Raw Data Files: 6.txt, 0

Density Data

Mass of Rock (g):	918.3	Initial Wet Density (pcf):	153.4
Initial Diameter (in):	2.382	Initial Wet Density (kg/m³):	2457
Initial Height (in):	5.119		

Test Results

Peak Load (lbs):	15963	Failure Type:	Fracture / Bedding
Compressive Strength (psi):	3582	Height to Diameter Ratio:	2.15:1
Compressive Strength (MPa):	25	Poisson's Ratio:	0.307
		Young's Modulus (psi):	0.67 x10^6



NOTES:

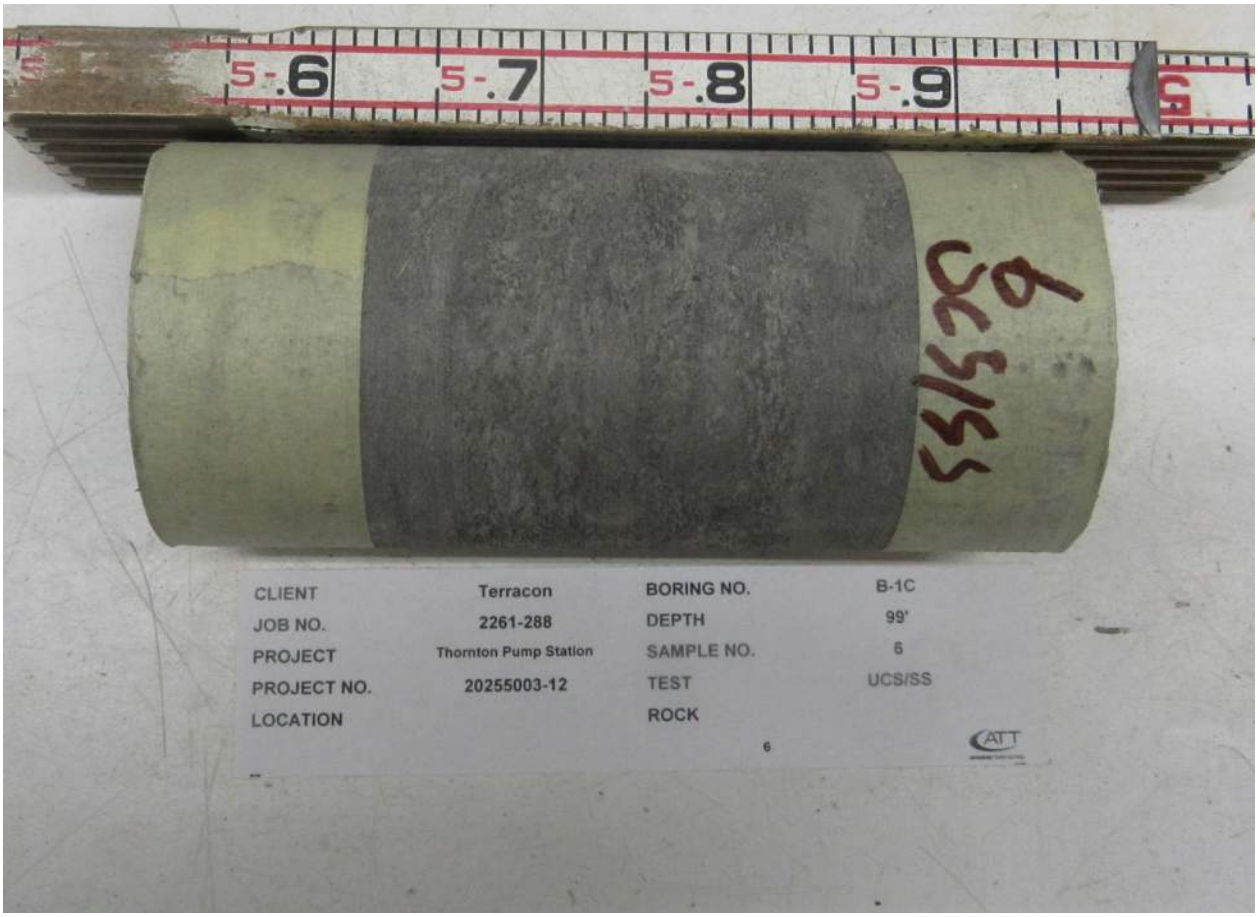
Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_2.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	99
PROJECT	Thornton Pump Station	SAMPLE NO.	6
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Before Test



NOTES

Picture File: 6.JPG
File name: 2261288__RockTx ASTM 7012 B and D_2.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-1C
JOB NO.	2261-288	DEPTH	99
PROJECT	Thornton Pump Station	SAMPLE NO.	6
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 6a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_2.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	40
PROJECT	Thornton Pump Station	SAMPLE NO.	7
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

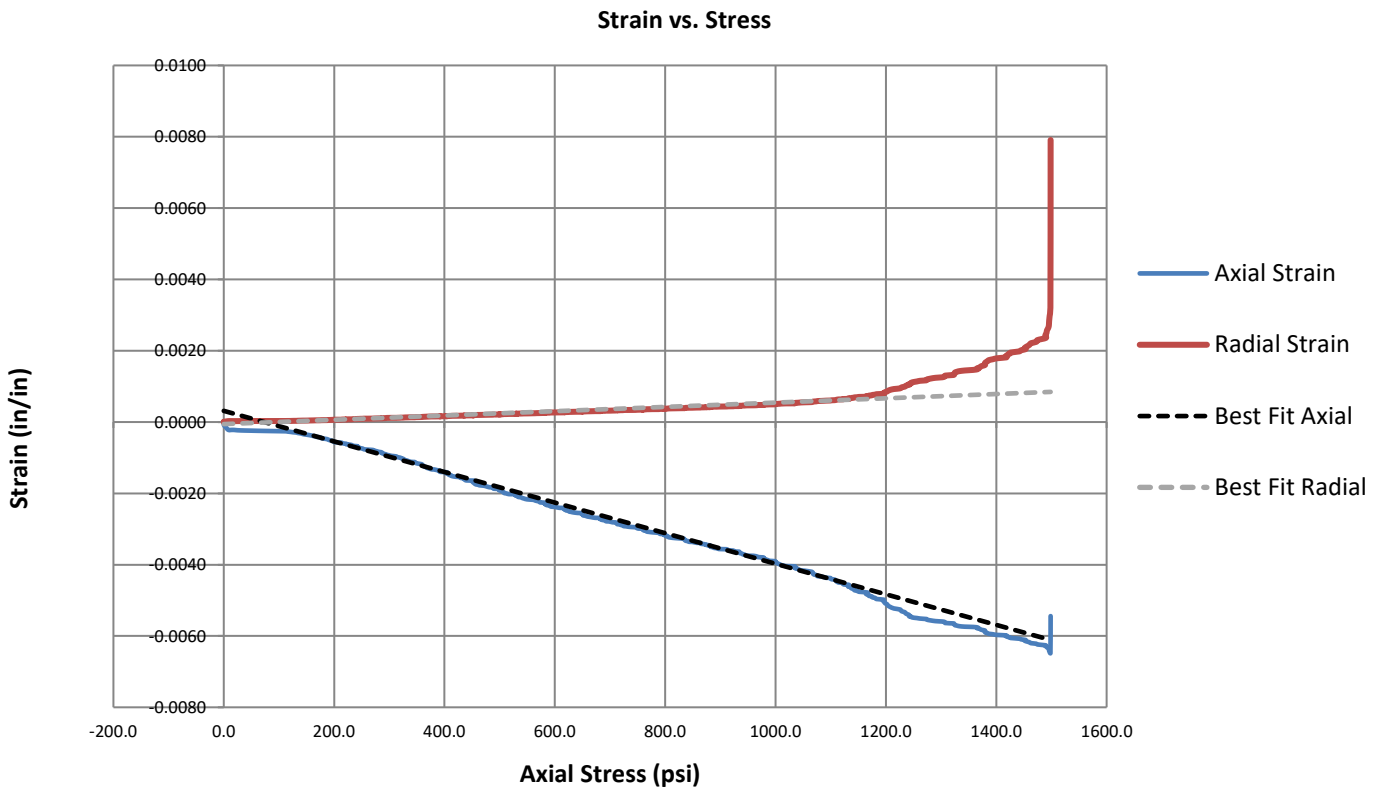
Raw Data Files: 7.txt, 0

Density Data

Mass of Rock (g):	841.2	Initial Wet Density (pcf):	140.9
Initial Diameter (in):	2.391	Initial Wet Density (kg/m³):	2257
Initial Height (in):	5.066		

Test Results

Peak Load (lbs):	6728	Failure Type:	Shear
Compressive Strength (psi):	1498	Height to Diameter Ratio:	2.12:1
Compressive Strength (MPa):	10	Poisson's Ratio:	0.140
		Young's Modulus (psi):	0.23 x10^6



NOTES:

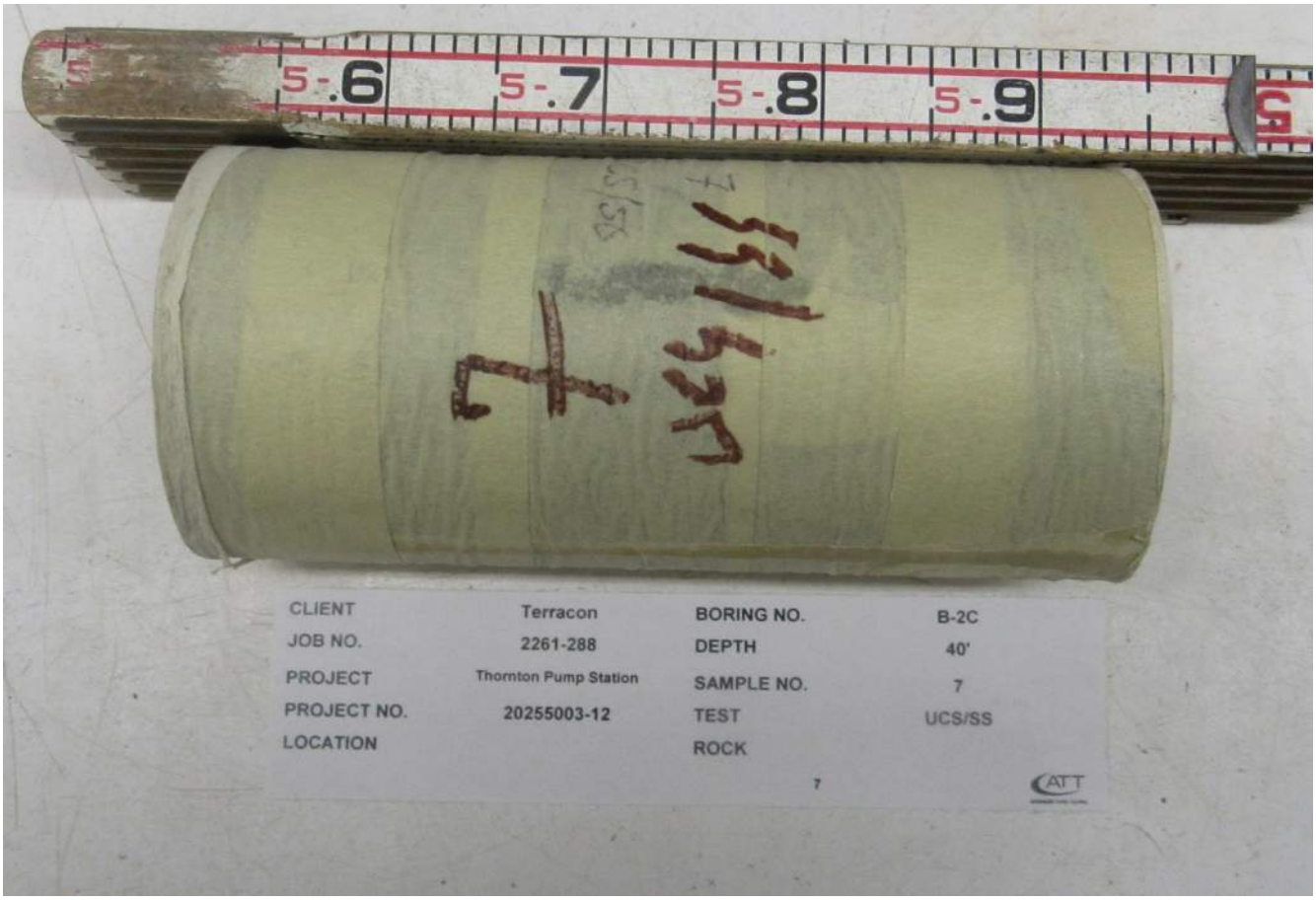
Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_3.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	40
PROJECT	Thornton Pump Station	SAMPLE NO.	7
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Before Test



NOTES

Picture File: 7.JPG
File name: 2261288__RockTx ASTM 7012 B and D_3.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	40
PROJECT	Thornton Pump Station	SAMPLE NO.	7
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 7a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_3.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	56
PROJECT	Thornton Pump Station	SAMPLE NO.	8
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

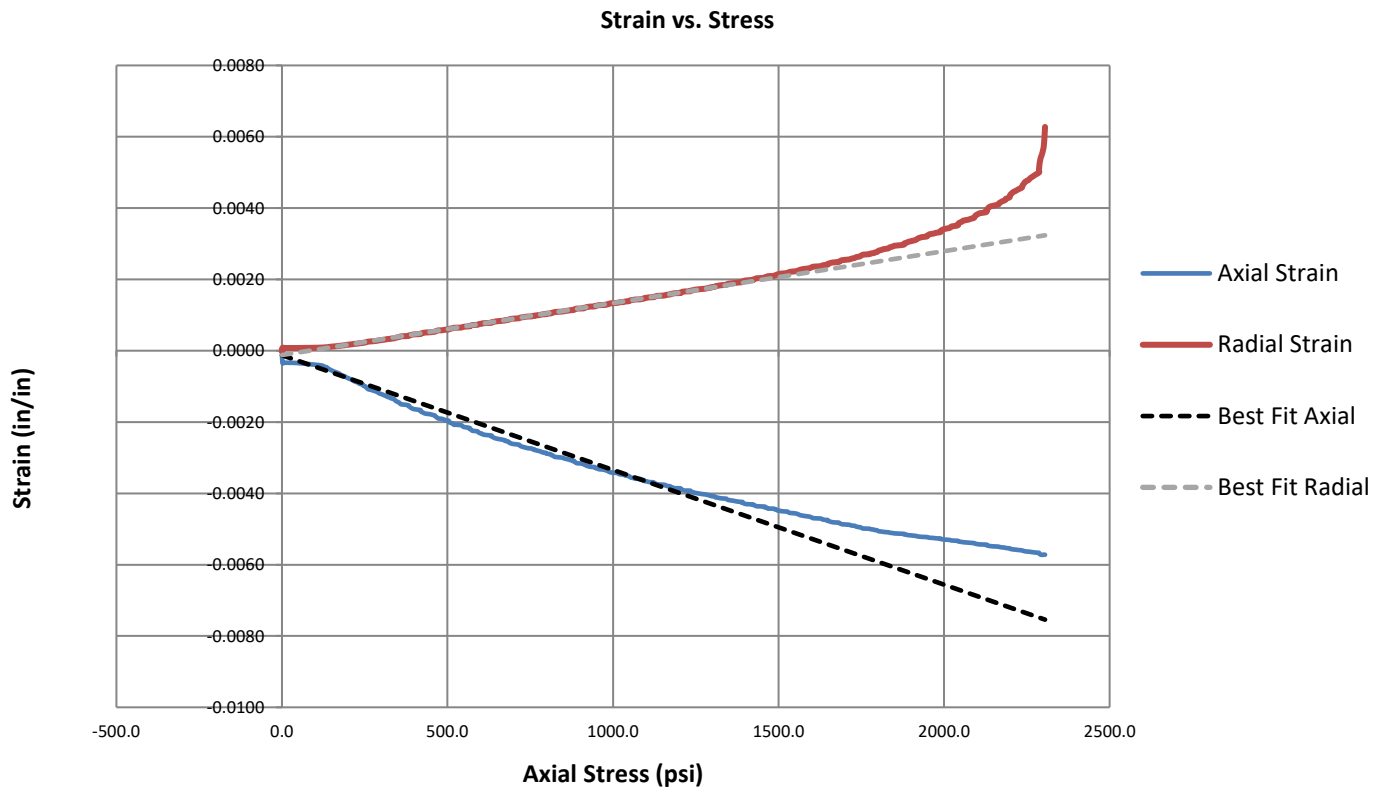
Raw Data Files: 8.txt, 0

Density Data

Mass of Rock (g):	870.1	Initial Wet Density (pcf):	147.0
Initial Diameter (in):	2.380	Initial Wet Density (kg/m³):	2354
Initial Height (in):	5.070		

Test Results

Peak Load (lbs):	10254	Failure Type:	Fracture / Bedding
Compressive Strength (psi):	2305	Height to Diameter Ratio:	2.13:1
Compressive Strength (MPa):	16	Poisson's Ratio:	0.453
		Young's Modulus (psi):	0.31 x10^6



NOTES:

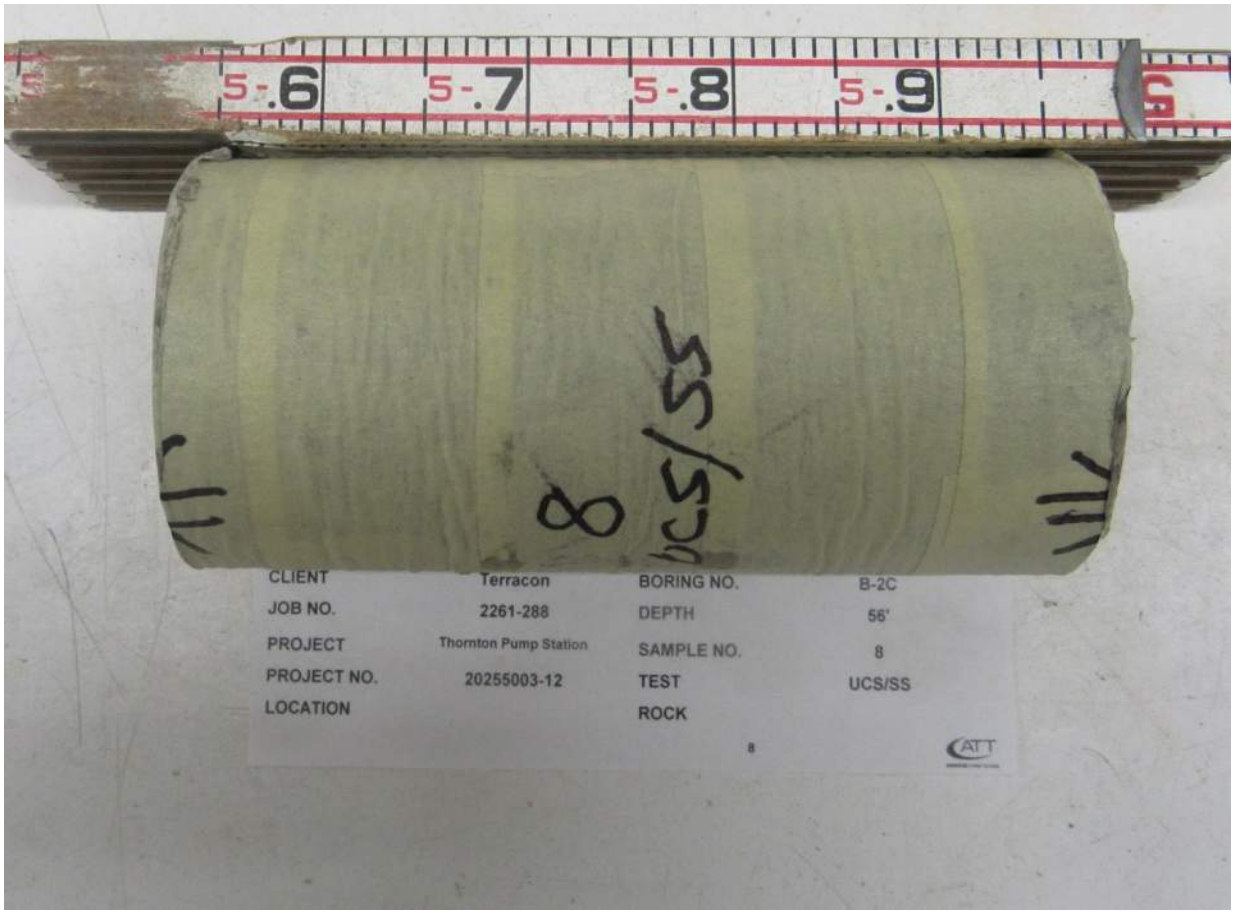
Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_4.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	56
PROJECT	Thornton Pump Station	SAMPLE NO.	8
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Before Test



NOTES

Picture File: 8.JPG
File name: 2261288__RockTx ASTM 7012 B and D_4.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	56
PROJECT	Thornton Pump Station	SAMPLE NO.	8
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 8a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_4.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	70.0-71.0
PROJECT	Thornton Pump Station	SAMPLE NO.	9
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

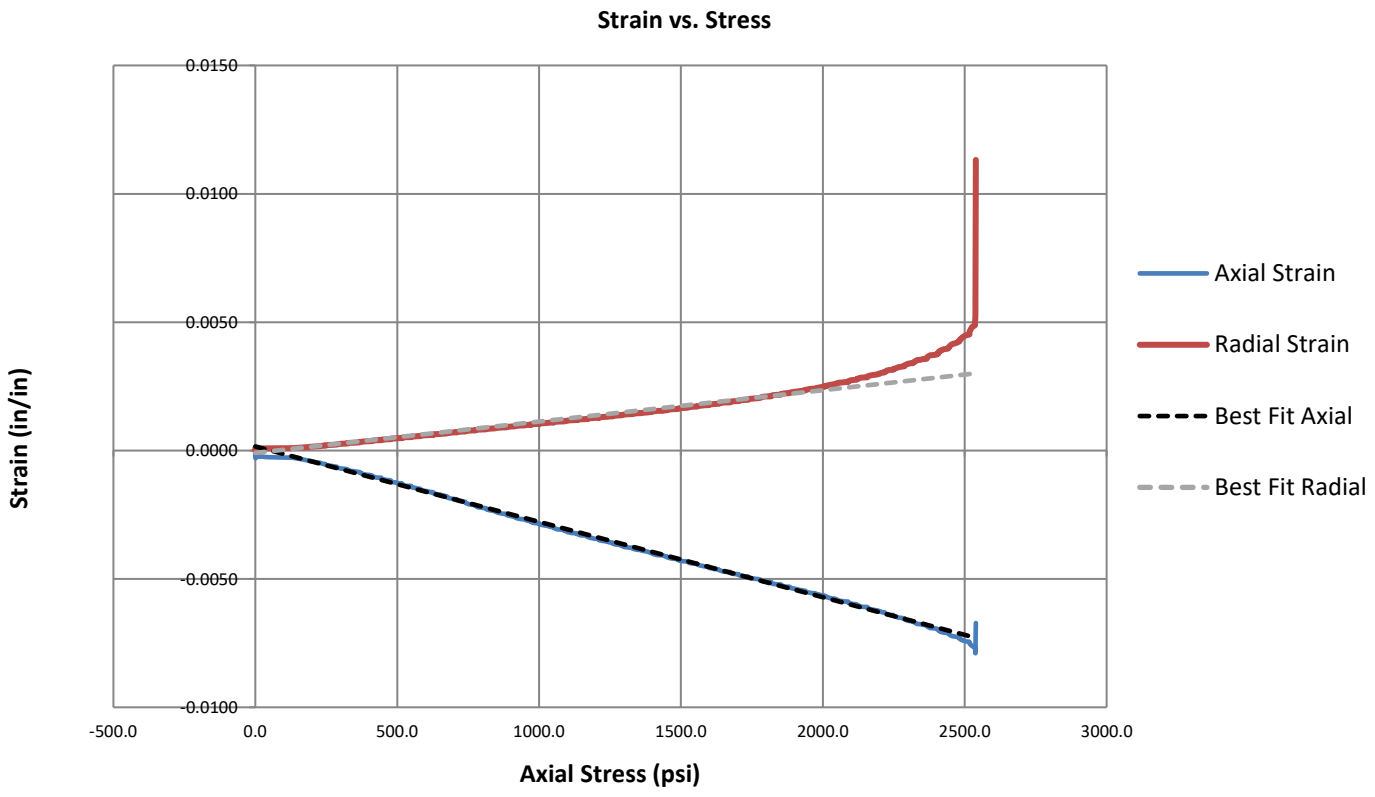
Raw Data Files: 9.txt, 0

Density Data

Mass of Rock (g):	881.5	Initial Wet Density (pcf):	148.5
Initial Diameter (in):	2.383	Initial Wet Density (kg/m³):	2379
Initial Height (in):	5.069		

Test Results

Peak Load (lbs):	11324	Failure Type:	Shear
Compressive Strength (psi):	2539	Height to Diameter Ratio:	2.13:1
Compressive Strength (MPa):	18	Poisson's Ratio:	0.416
		Young's Modulus (psi):	0.34 x10^6



NOTES:

Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_5.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	70.0-71.0
PROJECT	Thornton Pump Station	SAMPLE NO.	9
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 9a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_5.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	96'
PROJECT	Thornton Pump Station	SAMPLE NO.	10
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Test Parameters

Load Rate (lb/min):	3000
Load Rate (N/min):	13345

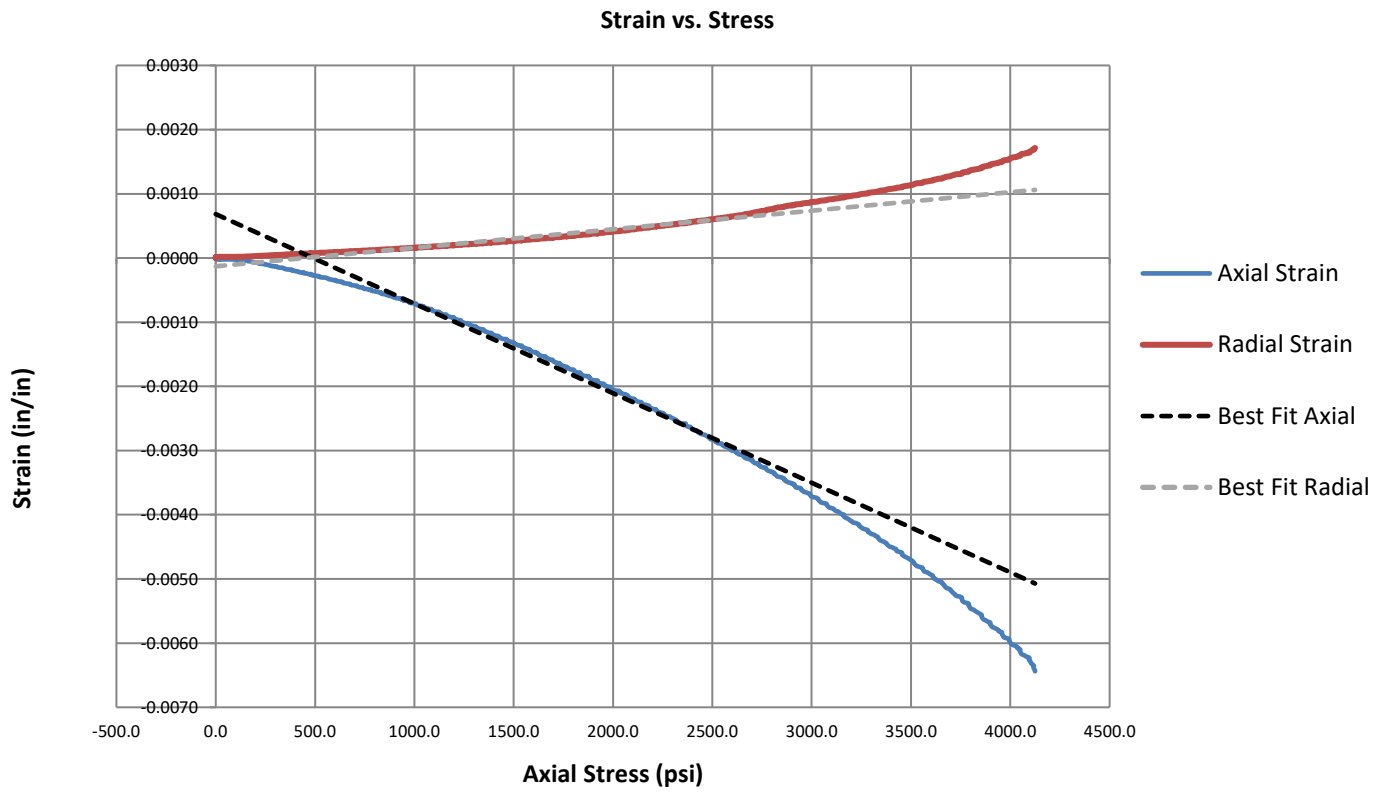
Raw Data Files: 10.txt, 0

Density Data

Mass of Rock (g):	868.1	Initial Wet Density (pcf):	150.3
Initial Diameter (in):	2.377	Initial Wet Density (kg/m³):	2408
Initial Height (in):	4.957		

Test Results

Peak Load (lbs):	18303	Failure Type:	Fracture / Shear
Compressive Strength (psi):	4125	Height to Diameter Ratio:	2.09:1
Compressive Strength (MPa):	28	Poisson's Ratio:	0.207
		Young's Modulus (psi):	0.72 x10^6



NOTES:

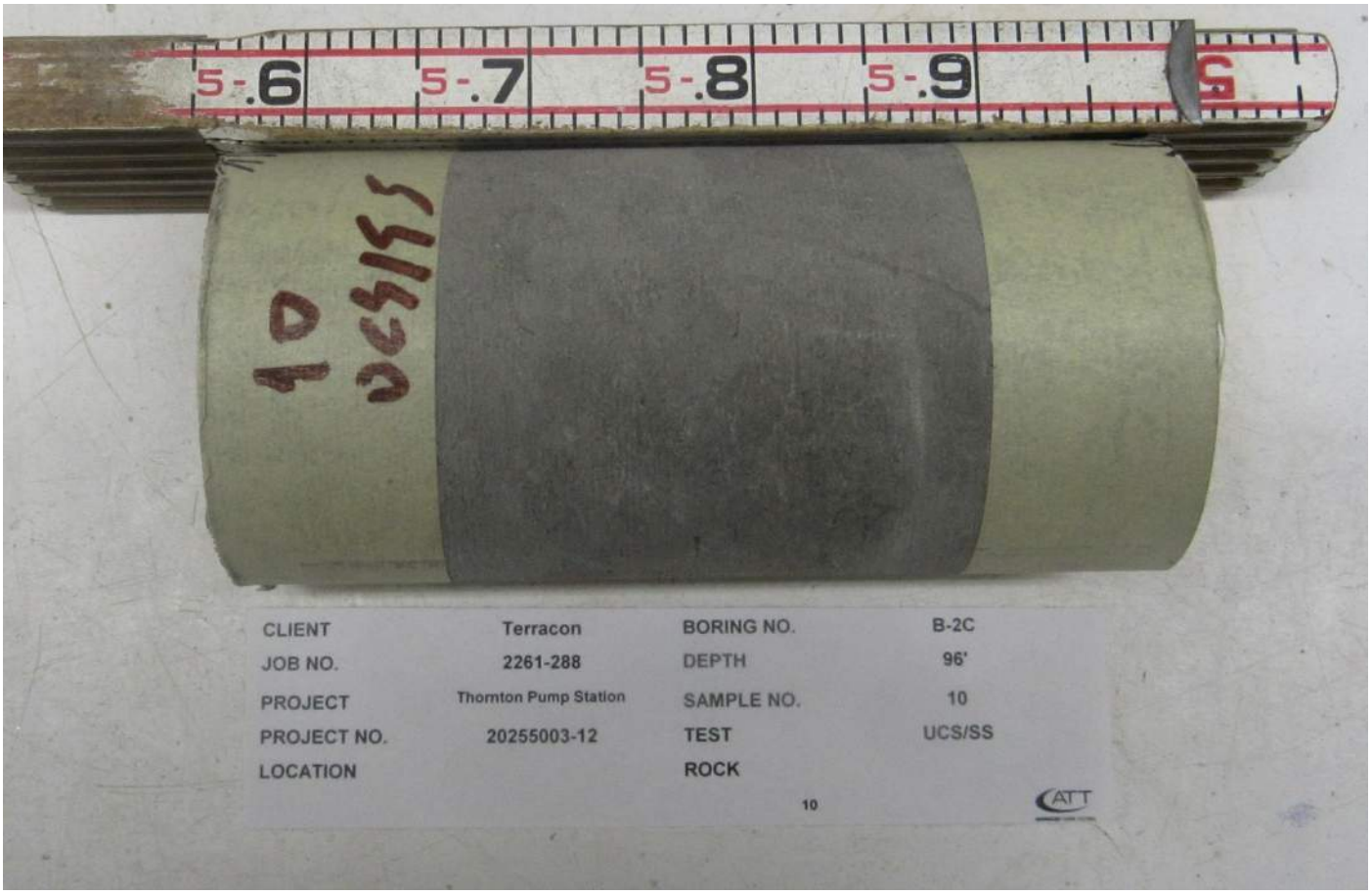
Data entry by:	HN	Date:	08/13/25
Checked by:	DL	Date:	08/14/25
File name:	2261288__RockTx ASTM 7012 B and D_6.xlsm		

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	96'
PROJECT	Thornton Pump Station	SAMPLE NO.	10
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

Before Test



NOTES

Picture File: 10.JPG
File name: 2261288__RockTx ASTM 7012 B and D_6.xlsm

ADVANCED TERRA TESTING

Unconfined Compressive Strength
ASTM D7012 Method D

CLIENT	Terracon	BORING NO.	B-2C
JOB NO.	2261-288	DEPTH	96'
PROJECT	Thornton Pump Station	SAMPLE NO.	10
PROJECT NO.	20255003-12	DATE SAMPLED	--
LOCATION	--	ROCK TYPE	--
DATE TESTED	08/13/25		
TECHNICIAN	HN		

After Test

NOTES

Picture File: 10a.JPG
File name: 2261288__RockTx ASTM 7012 B and D_6.xlsm

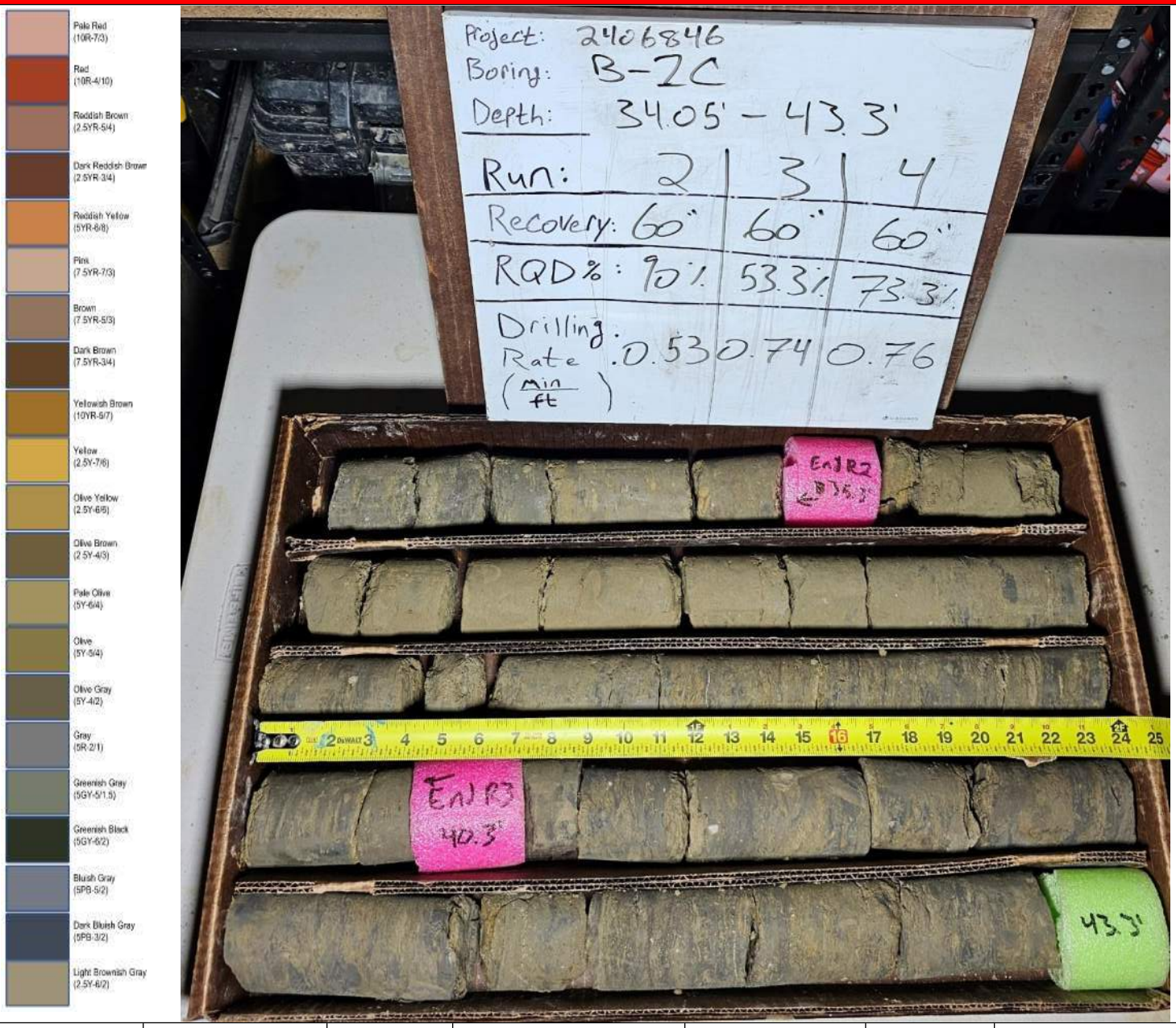
Appendix C Bedrock Core Photo Log

BORING B-1C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
1 OF 9	25.3 TO 34.05	1	25.3 – 30.3	60	50	0.47
		2	30.3 – 34.05	60	90	0.53

GEI Consultants

BORING B-1C



CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
2 OF 9	34.05 – 43.3	2	30.3 – 35.3	60	90	0.53
		3	35.3 – 40.3	60	53.3	0.74
		4	40.3 – 45.3	60	73.3	0.76

BORING B-1C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
3 OF 9	43.3 – 51.42	4	40.3 – 45.3	60	73.3	0.56
		5	45.3 – 50.3	60	95	0.63
		6	50.3 – 55.3	60	100	0.64

GEI Consultants

BORING B-1C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
4 OF 9	51.42 – 60.3	6	50.3 – 55.3	60	100	0.64
		7	55.3 – 60.3	60	100	0.66

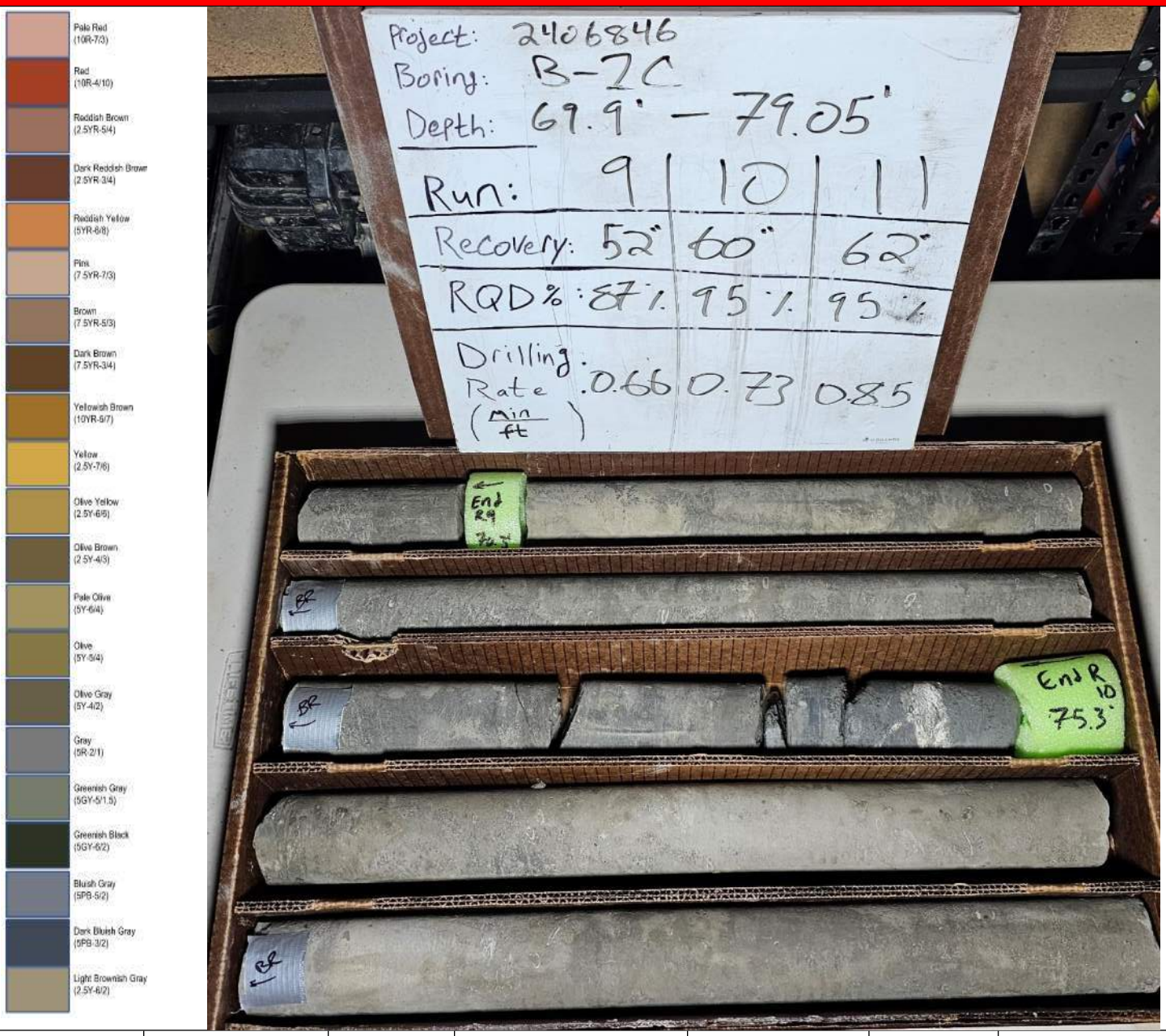
GEI Consultants

BORING B-1C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
5 OF 9	60.3 – 69.9	8	60.3 – 65.3	60	100	0.66
		9	65.3 – 70.3	52	87	0.66

GEI Consultants

BORING B-1C



CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
6 OF 9	69.9 – 79.05	9	65.3 – 70.3	52	87	0.66
		10	70.3 – 75.3	60	95	0.73
		11	75.3 – 80.3	62	95	0.85

BORING B-1C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
7 OF 9	79.05 – 87.97	11	75.3 – 80.3	62	95	0.85
		12	80.3 – 85.3	58.5	100	0.73
		13	85.3 – 90.3	59	100	0.72

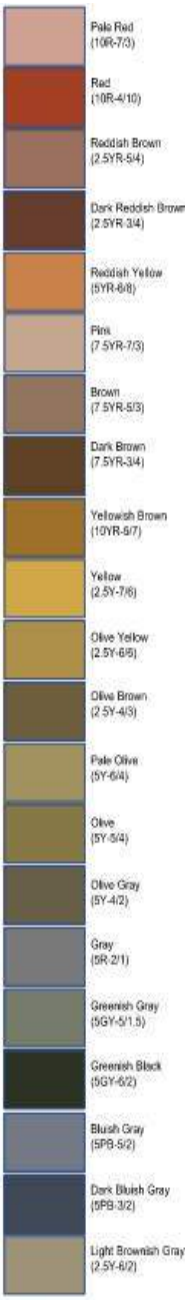
GEI Consultants

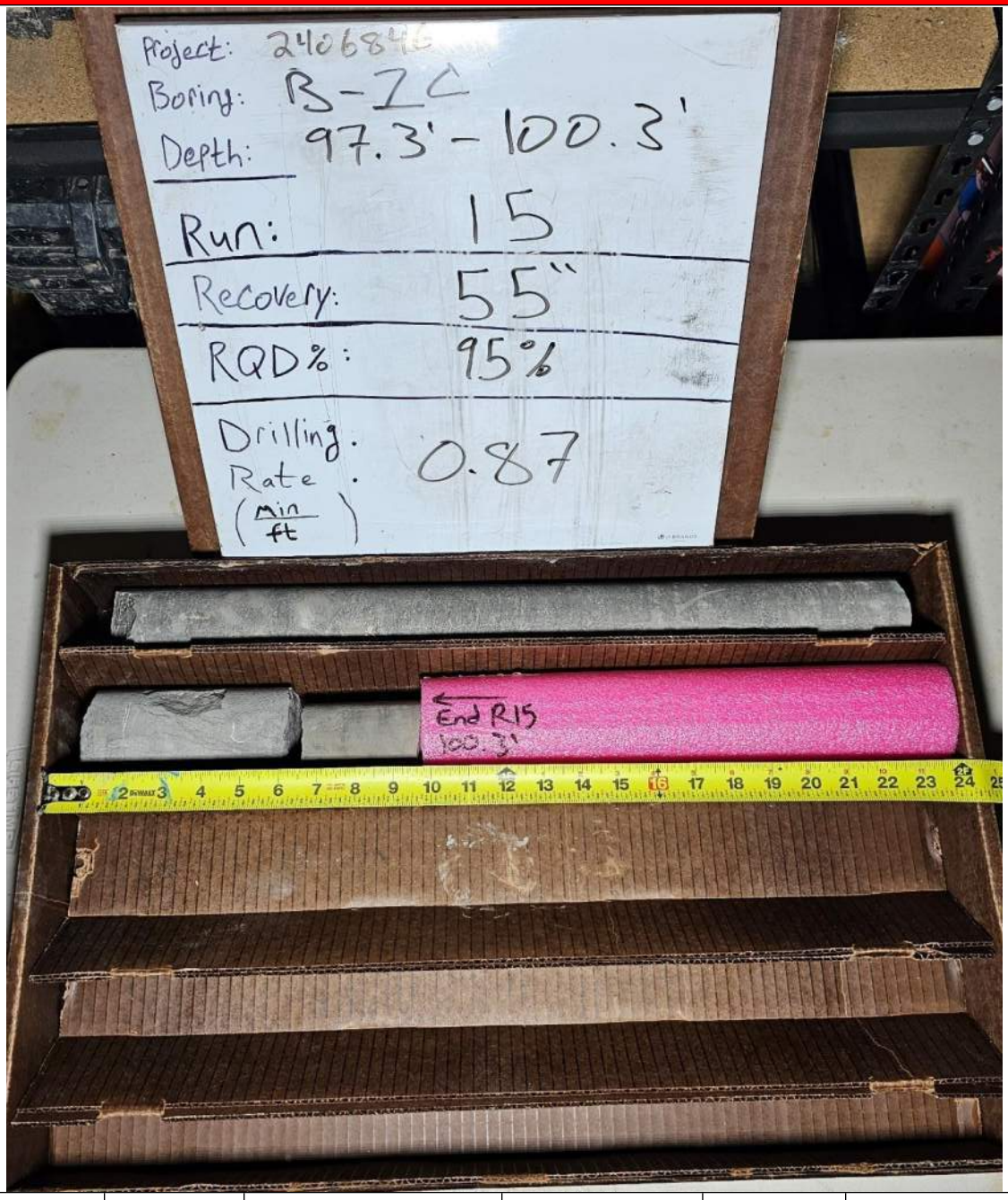
BORING B-1C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
8 OF 9	87.97 – 97.3	13	85.3 – 90.3	59	100	0.72
		14	90.3 – 95.3	58	100	0.76
		15	95.3 – 100.3	55	95	0.87

GEI Consultants

BORING B-1C



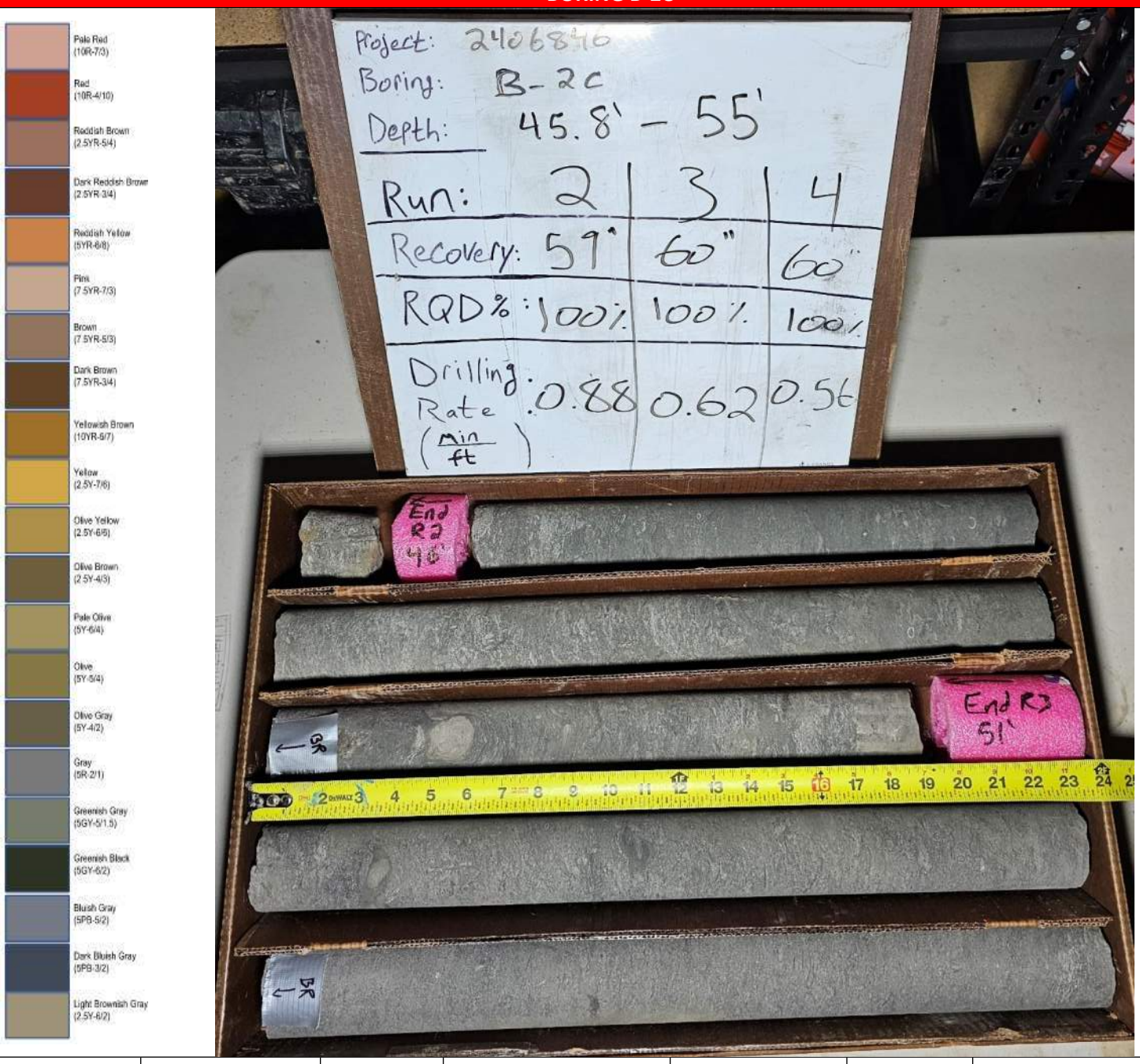


CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
9 of 9	97.3 – 100.3	15	95.3 – 100.3	55	95	0.87

BORING B-2C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
1 OF 7	36 – 45.8	1	36 - 41	54	73	0.62
		2	41 - 46	59	100	0.88

BORING B-2C



CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
2 of 7	45.8 - 55	2	41 - 46	59	100	0.88
		3	46 – 51	60	100	0.62
		4	51 - 56	60	100	0.56

GEI Consultants

BORING B-2C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
3 of 7	55 – 64.2	4	51 - 56	60	100	0.56
		5	56 - 61	60	100	0.55
		6	61 - 66	60	100	0.70

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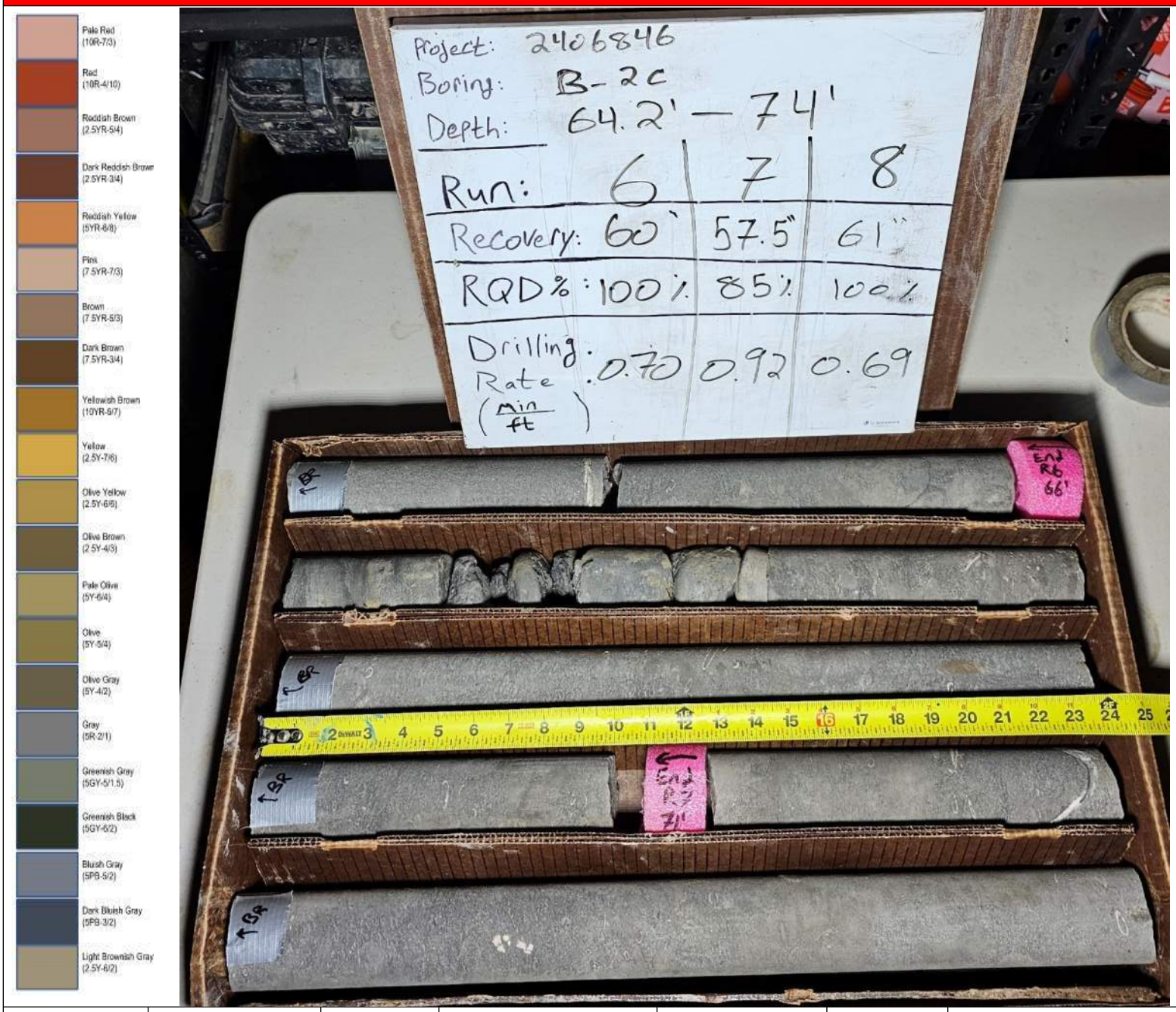
BORING B-2C



CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
4 of 7	64.2 - 74	6	61 - 66	60	100	0.70
		7	66 – 71	57.5	85	0.92
		8	71 - 76	61	100	0.69

BORING B-2C

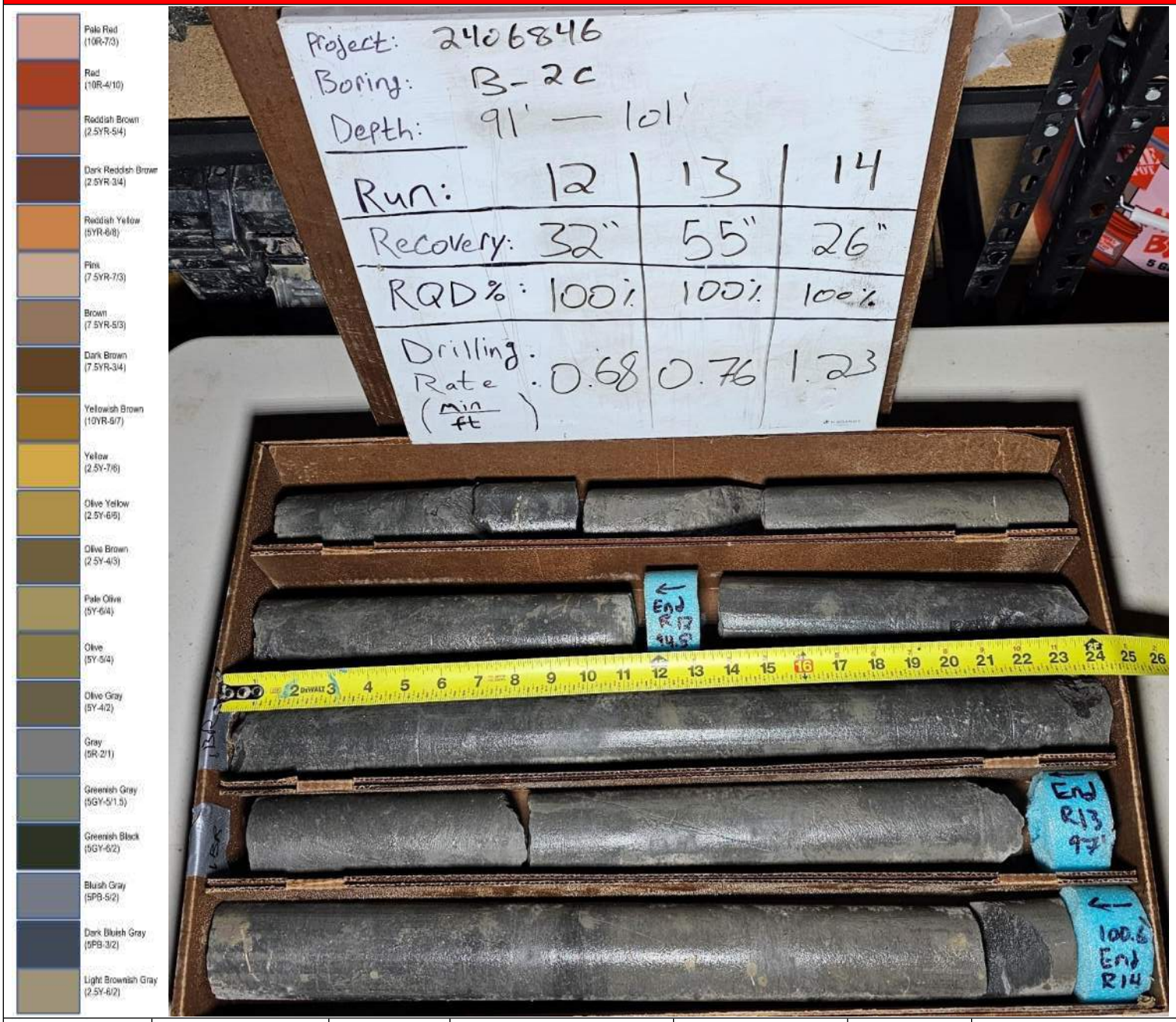
CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
5 of 7	74 - 83	8	71 - 76	61	100	0.69
		9	76 – 81	56.5	100	0.69
		10	81 - 86	61	100	0.72

GEI Consultants

BORING B-2C

CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
6 of 7	83 - 91	10	81 - 86	61	100	0.72
		11	86 - 91	59	100	0.71

BORING B-2C



CORE PHOTO NO.	DEPTH TOTAL IN BOX (FT)	RUN NO.	DEPTH OF RUN (FT)	RECOVERY (IN)	RQD (%)	DRILLING RATE (IN/MIN)
7 of 7	91 - 101	12	91 – 94.6	32	100	0.68
		13	94.6 – 97	55	100	0.76
		14	97 - 101	26	100	1.23

GEI Consultants