GRANITE ENGINEERING GROUP

May 22, 2024 PCD File NO. PAV 244
Project No. 24-041

Mr. Shay Miles, PE
Lodestar Engineering, LLC
PB Box 88461
Colorado Springs, CO 80908

Subject: Memorandum for Pavement Thickness Design
Fox Creek Lane Extension at Terra Ridge North
Black Forest, El Paso County, Colorado

Dear Mr. Miles,

Granite Engineering Group, Inc. (GEG) has completed the engineering evaluation and prepare this memorandum to address the pavement thickness design for the Fox Creek Lane extension at the Terra Ridge North Community in El Paso County, Colorado.

Project Background
Based on the information provided to us, it is our understanding that the development consists of 13 new custom-home lots accessed via an approximate 1000' extension of Fox Creek Lane. The existing Fox Creek Lane is paved with Hot Mix Asphalt (HMA). At the time of exploration, the roadway extension was a graded, soil roadway and will be paved with HMA in the near future. Light gravel had been placed at the southern end of the extension.

It is our understanding that the proposed roadway will be a lightly trafficked, residential 2-way street consisting of HMA

1 FIELD EXPLORATION AND LABORATORY TESTING

A total of four (4) borings were performed at the approximate locations as shown in the Boring Location Plan. These borings were performed at approximately 250 feet spacing along the graded roadway extension. These borings were explored with hand auger to approximately 5 feet below existing ground surface (bgs) or hand auger refusal, whichever occurred first. Drive samples with hand driver were obtained in Borings D-1, D-3 and D-4. The strength of the existing subgrade was evaluated using Dynamic Cone Penetration (DCP) tests. The DCP apparatus consists of a 5/8" diameter steel rod with a 60 degrees conical tip. The rod is topped with an anvil that is connected to a second rod. The rod is used as a guide to allow an 8kg hammer to be repeatedly raised and dropped from a height of 575 mm. The connection between the two rods consists of an anvil to allow for quick connections between the rods and for efficient energy transfer from the falling weight to the penetrating rod. The penetration of the rod is measured after each drop. The penetration value can be correlated to the common engineering parameters.

All borings were dry at the completion of testing.

The samples were tested for soil classification and swell-consolidation tests. Analytical testing was not performed since hot mix asphalt will be used for the pavement and Portland cement concrete is not planned. The boring logs and the laboratory test results are presented in Appendix B and C, respectively.

2 PAVEMENT THICKNESS RECOMMENDATIONS

The pavement thickness design was performed in accordance with El Paso County Engineering Criteria Manual.

2.1 SUBGRADE STRENGTH

The subgrade strength is evaluated using DCP tests. The blow counts and penetration of the DCP are used to calculate the DCP index. The DCP index paired with the soil type were correlated to the CBR of the in-situ subgrade soils based on the correlations published by US Army Corp of Engineers. The calculated CBR values and the DCP results are attached to this memo. Based on the results of the DCP and field exploration, a CBR of 3 is selected, which is correlated to a resilient modulus (Mr) value of 4,500 psi and was used for the prepared subgrade along the new extension for the pavement thickness design. Laboratory testing of subgrade strength including R-value or CBR was not performed since DCP was used to test the in-place pavement subgrade strength.

2.2 TRAFFIC LOADING

Traffic information was provided in the Terra Ridge North Transportation Memorandum dated February 9, 2023 prepared by LSC Transportation Consultants, Inc. based on the report, it is estimated that the pavement will subject to 104 vehicles per day. We also estimate that 20 delivery trucks and 2 trash or trailer truck per day. An ESAL of 27,277 was estimated based on the traffic. The El Paso County Engineering Criteria Manual has a minimum ESAL of 36,500 for Local Road in Rural area, and it was used for the pavement thickness design.

2.3 PAVEMENT THICKNESS DESIGN

Pavement thickness design was performed using the WinPAS Version 12. The designs was performed in accordance with the 1993 AASHTO Pavement Design Guide and El Paso County Engineering Criteria Manual. Tables 1-1 and 1-2 present a summary of the design input parameters.

Table 1-1. Pavement Design Parameters

Parameter	Value
Design Period (year)	20
18-kip ESAL over design period	36,500 for flexible
Reliability (%)	75
Overall Standard Deviation	0.44 for flexible
Initial Serviceability Index	4.5
Terminal Serviceability Index	2.5

Table 1-2. Pavement Design Strength Coefficients

Parameter	Value
New Hot Mix Asphalt (HMA) Layer Coefficient	0.44

Drainage Coefficient	1.0
Aggregate Base Course (ABC)[1] Layer Coefficient	0.11
Subgrade Soil Resilient Modulus (psi)	4,500

[1] ABC meeting El Paso County Engineering Criteria Manual

Based on the above design parameters, the recommended reconstruction sections for flexible pavements are presented in Table 1-3.

Table 1-3. Recommended Minimum Pavement Sections

Pavement Reconstruction	HMA Pavement Section
Fox Creek Lane Extension	-4.5 inches HMA -6.0 inches ABC -Subgrade[1]

PCC= Portland cement concrete HMA= Hot mixed asphalt
[1] Subgrade should be prepared in accordance with Section 3 of the report.

2.4 PAVEMENT MATERIALS

2.4.1 Base Course

We recommend aggregate meetings Class 5 or Class 6 of the El Paso County Engineering Criteria Manual, Appendix D, Table D-6 to be used for the aggregate base materials. The material should be placed in a uniform layer without segregation of size and compacted in loose lifts not to exceed 8-inches.

2.4.2 Hot Mix Asphalt

Hot mix asphalt materials, placement procedures, and testing should follow The Pike Peak Region Asphalt Specification. We recommend PG 58-28 HMA binder with Grading S or SX aggregate, and gyration of 75.

3. CONSTRUCTION RECOMMENDATIONS

3.1 SUBGRADE PREPARATION AND EARTHWORK

3.1.1 Site Preparation

Site preparation should begin by stripping and removal of vegetation, existing structures, and other deleterious materials. Clearing and Grubbing operations and removal of existing structure should be performed in accordance with El Paso County Engineering Criteria Manual (EPCECM). All exposed surfaces should be free of mounds and depressions, which may prevent uniform compaction. Stripped materials consisting of vegetation and organic materials should be removed from the site or be used to re-vegetate landscaped areas and exposed slopes after completion of grading operations. The site should be initially graded to create an appropriate surface to receive fill. All exposed areas which will receive fill, once properly cleared and benched, should be scarified to a minimum depth of 12 inches, moisture conditioned and recompacted in accordance with Section 4.2.4 of this report. Based upon the subsurface conditions encountered, subgrade soils exposed during construction are anticipated to be relatively stable. However, the stability of the subgrade may be affected by drainage and precipitation. If unstable conditions are encountered or develop during construction, stability may be improved by scarifying and drying the subgrade soils or with other ground improvement techniques. A typical stabilization method may include utilizing gravel with the combination of

geo-grid (e.g. Tensar NX650) to create a stable base. Other stabilization methods may also be appropriate.

3.1.2 Fill Materials and Subgrade Preparation

Following initial excavation and subgrade preparation in the construction areas, visual inspection and proof rolling of the exposed subgrade is required to identify potential areas where the subgrade contains soft / loose soils. The proof roll should be performed in accordance with EPCECM. Areas which deform non-uniformly under heavy wheel loads should either be moisture conditioned and recompacted or excavated and replaced with properly compacted structural fill. The depth of over-excavation, if required, should be determined during construction. We recommend that the proof rolling activities and visual inspection of the foundation soils be observed and evaluated by an experienced geotechnical engineer or engineer's representative.

Fill placed on existing slopes that are steeper than 4H:1V should be properly benched in accordance with EPCECM. All compaction efforts should be performed in horizontal lifts that are 8-inches or less in loose thickness, using equipment and procedures that will produce a uniform fill with the required moisture contents and densities throughout the lift. The required percent of relative compaction and moisture content for the fill materials are presented in the EPCECM.

Fill materials should be tested for severity of sulfate exposure prior to placement. We recommend that the subgrade preparation process including soil excavation, the placement and compaction of materials, proof rolling and visual inspection of subgrade soils be observed and evaluated by the geotechnical engineer of record or the engineer's representative.

3.1.3 Excavation and Trench Grading

All site excavation and embankment grading should conform to EPCECM.
Cut slopes should be protected from surface water runoff to prevent erosion and slope failure. Landscape sprinklers if present should be frequently checked for leaks and maintained in good working order. Surface drainage should be provided around all permanent cuts and fills to direct surface runoff away from the slope faces. Concentrated runoff should be prevented in areas susceptible to erosion or slope instability.

Excavations into the on-site soils will encounter a variety of conditions. All excavations must comply with the applicable local, State, and Federal safety regulations, and particularly with the excavation standards of the Occupational Safety and Health Administration (OSHA). Construction site safety, including excavation safety, is the sole responsibility of the Contractor as part of its overall responsibility for the means, methods, and sequencing of construction operations. GEG recommendations for excavation support is provided for the Client's sole use in planning the project, in no way do they relieve the Contractor of its responsibility to construct, support, and maintain safe slopes. Under no circumstances should the following recommendations be interpreted to mean that GEG is assuming responsibility for either construction site safety or the Contractor's activities.

We believe the overburden soil encountered at this site will classify as a Type C material, using OSHA criteria. OSHA requires that unsupported cuts be no steeper than 1½:1 for Type C for unbraced excavations up to 20 feet in height. In general, we believe that these slope ratios will be temporarily stable under unsaturated conditions. Flattened slopes may be required if excavations encounter groundwater or the slopes will be exposed for an extended period of time. Please note that the Contractor's OSHA-qualified "competent person" must make the actual determination of soil type and allowable sloping in the field.

The soils encountered by the proposed excavations may vary significantly across the site. The preliminary classifications presented above are based solely on the materials encountered in

widely spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation.

As a safety measure, it is recommended that all vehicles and soil piles be kept to a lateral distance equal to at least the depth of the excavation from the crest of the slope. The exposed slope face should be protected against the elements and monitored by the contractor on at least a daily basis.

3.2 DRAINAGE CONSIDERATIONS

During construction, grade the site such that surface water can drain readily away from the pavement areas. Promptly pump out or otherwise remove water that accumulates in the excavations or on subgrade surfaces and allow these areas to dry before resuming construction. The use of berms, ditches, and similar means may be used to prevent stormwater from entering the work area and to convey water off site efficiently.

Limitations

The findings and recommendations presented in this memorandum are based upon data obtained from available information and previous studies, our understanding of the proposed construction, and other sources of information referenced in this memorandum. It is possible that subsurface conditions may vary between or beyond the locations explored. If subsurface conditions are encountered that vary from those described herein, we should be notified immediately so a review may be made, and any supplemental recommendations provided.

This memorandum was prepared in in a manner consistent with that level of care and skill ordinarily exercised by other members of GEG's profession practicing in the same locality, under similar conditions and at the date the services are provided. GEG makes no other representation, guarantee, or warranty, express or implied, regarding the services, communication (oral or written), report, opinion, or instrument of service provided.

The scope of services for this geotechnical memorandum did not include environmental assessments or evaluations regarding the presence or absence of wetlands or hazardous substances in the soil, surface water, or groundwater.

This memorandum may be used only by the Client and the registered design professional in responsible charge and only for the purposes stated for this specific engagement within a reasonable time from its issuance, but in no event later than three years from the date of the report.

Respectfully,
GRANITE ENGINEERING GROUP, INC.

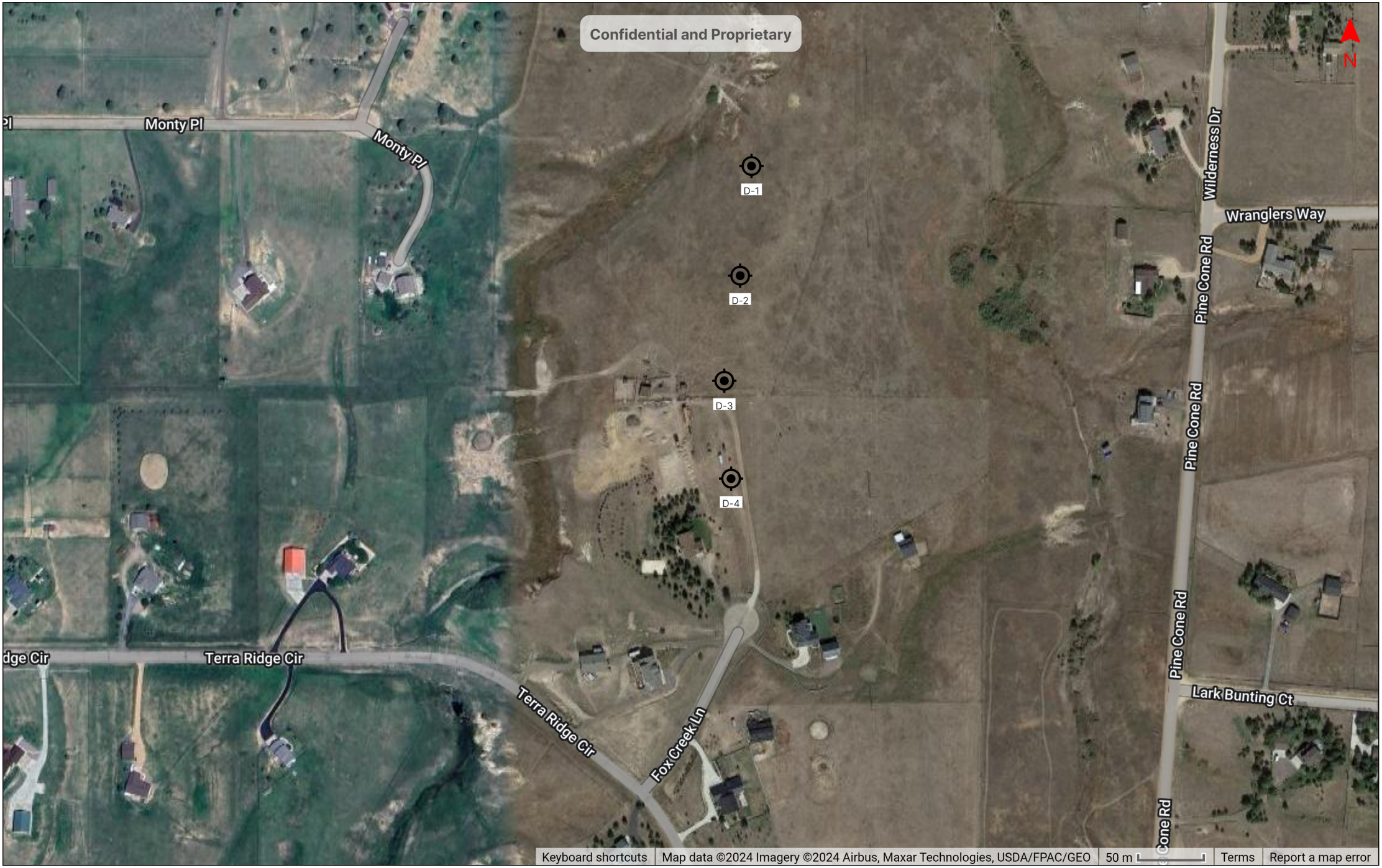
COLORADO LICENSED
HAI MING LIM
51650
PROFESSIONAL ENGINEER

Hai Ming Lim PE 5-23-24
Project Manager

Attachment: Appendix A- Boring Location Plan
Appendix B- Boring Logs
Appendix C- Lab Results
Appendix D- Pavement Design Output

Appendix A

BORING LOCATION PLAN



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PREPARED BY

Granite Engineering Group
Colorado Springs, Colorado

PROJECT

Name: Terra Ridge North Pavement
Number: 24-041

LOCATION

39.05935, -104.69314
Colorado Springs, CO

SYMBOL KEY

Soil Borings

Appendix B

BORING LOGS

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Project: Terra Ridge North Pavement

Project Number: 24-041

Legend for Symbols Used on Borehole Logs

Sample Types


Bulk Sample of auger/odex cuttings


Modified California Sampler (2.5 inch OD, 2.0 inch ID)

Lithology Symbols (see Boring Logs for complete descriptions)


USCS Low Plasticity Clay


USCS Low Plasticity Sandy Clay


Sandstone


USCS Clayey Sand


USCS Silty Sand

Lab Test Standards

Moisture Content	ASTM D2216
Dry Density	ASTM D7263
Sand/Fines Content	ASTM D421, ASTM C136, ASTM D1140
Atterberg Limits	ASTM D4318
AASHTO Class.	AASHTO M145, ASTM D3282
USCS Class.	ASTM D2487

(Fines = % Passing #200 Sieve
Sand = % Passing #4 Sieve, but not passing #200 Sieve)

Other Lab Test Abbreviations

pH	Soil pH (AASHTO T289-91)
S	Water-Soluble Sulfate Content (AASHTO T290-91, ASTM D4327)
Chl	Water-Soluble Chloride Content (AASHTO T291-91, ASTM D4327)
S/C	Swell/Consolidation (ASTM D4546)
UCCS	Unconfined Compressive Strength (ASTM D2166)
R-Value	Resistance R-Value (ASTM D2844)
DS (C)	Direct Shear cohesion (ASTM D3080)
DS (phi)	Direct Shear friction angle (ASTM D3080)
Re	Electrical Resistivity (AASHTO T288-91)
PtL	Point Load Strength Index (ASTM D5731)

Notes

1. "Penetration Resistance" on the Boring Logs refers to the uncorrected N value for SPT samples only, as per ASTM D1586. For samples obtained with a Modified California (MC) sampler, drive depth is 12 inches, and "Penetration Resistance" refers to the sum of all blows. Where blow counts were > 50 for the 3rd increment (SPT) or 2nd increment (MC), "Penetration Resistance" combines the last and 2nd-to-last blows and lengths; for other increments with > 50 blows, the blows for the last increment are reported.

2. The Modified California sampler used to obtain samples is a 2.5-inch OD, 2.0-inch ID (1.95-inch ID with liners), split-barrel sampler with internal liners, as per ASTM D3550. Sampler is driven with a 140-pound hammer, dropped 30 inches per blow.

3. "ER" for the hammer is the Reported Calibrated Energy Transfer Ratio for that specific hammer, as provided by the drilling company.

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Project Name: Terra Ridge North Pavement
Fox Creek Lane, Colorado Springs, CO

Project Number: 24-041 *Boring No.:* **D1**

Boring Began: 3/12/2024
Boring Completed: 3/12/2024
Drilling Method(s): Hand Auger
Driller:
Drill Rig:
Hammer Type: , ER: %

Total Depth: 4.0 ft
Ground Elevation:
Coordinates: Lat: 39.0617 Long: -104.69312
Location:
Logged By: J. Shekoski
Final By: HML

Weather Notes: Mostly Sunny
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
						0.0 - 0.2 ft. SILTY SAND, brown, low to no plasticity, dry.									
						0.2 - 0.3 ft. LEAN CLAY w/ SAND, brown, medium plasticity, moist, stiff.									
						0.3 - 1.3 ft. CLAYEY SAND, light yellowish brown, medium plasticity, moist, hard.									
						1.3 - 4.0 ft. CLAYEY SANDSTONE, SC, gray to white, low plasticity, dry.	15.9	92.5							S/C=0% @ 250 psf
							17.8		*11*	*40*	49.1	*41*	*25*	A-7-6 (8) SC	

Bottom of Hole at 4.0 ft.

GRANITE ENGINEERING GROUP

Project Name: Terra Ridge North Pavement
Fox Creek Lane, Colorado Springs, CO

Project Number: 24-041 *Boring No.:* **D2**

Boring Began: 3/12/2024
Boring Completed: 3/12/2024
Drilling Method(s): Hand Auger
Driller:
Drill Rig:
Hammer Type: , ER: %

Total Depth: 5.0 ft
Ground Elevation:
Coordinates: Lat: 39.06095 Long: -104.69322
Location:
Logged By: J. Shekoski
Final By: HML

Weather Notes: Mostly Sunny
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed

Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifi-cations	Field Notes and Other Lab Tests
						0.0 - 0.1 ft. CLAYEY SAND, brown, low to no plasticity, dry, organics observed.							
						0.1 - 5.0 ft. SILTY SAND, brown, medium plasticity, moist, stiff.							

Bottom of Hole at 5.0 ft.

GRANITE ENGINEERING GROUP

Project Name: Terra Ridge North Pavement
Fox Creek Lane, Colorado Springs, CO

Project Number: 24-041 *Boring No.:* **D3**

Boring Began: 3/12/2024
Boring Completed: 3/12/2024
Drilling Method(s): Hand Auger
Driller:
Drill Rig:
Hammer Type: , ER: %

Total Depth: 4.5 ft
Ground Elevation:
Coordinates: Lat: 39.06023 Long: -104.69336
Location:
Logged By: J. Shekoski
Final By: HML

Weather Notes: Mostly Sunny
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed

Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
						0.0 - 4.5 ft. SANDY LEAN CLAYfill. RAP and organics observed at 4'., CL, brown, low plasticity, dry to moist.									
							12.2	112.3							S/C=0.5% @ 250 psf
							11.2		*1*	*38*	60.5	*32*	*15*	A-6 (6) CL	

Bottom of Hole at 4.5 ft.

GRANITE ENGINEERING GROUP

Project Name: Terra Ridge North Pavement
Fox Creek Lane, Colorado Springs, CO

Project Number: 24-041 *Boring No.:* **D4**

Boring Began: 3/12/2024
Boring Completed: 3/12/2024
Drilling Method(s): Hand Auger
Driller:
Drill Rig:
Hammer Type: , ER: %

Total Depth: 2.7 ft
Ground Elevation:
Coordinates: Lat: 39.05956 Long: -104.6933
Location:
Logged By: J. Shekoski
Final By: HML

Weather Notes: Mostly Sunny
Inclination from Horiz.: Vertical
Night Work: ☐

Groundwater Levels: Not Observed			
Symbol			
Depth	-	-	-
Date	-	-	-

Elevation (feet)	Depth (feet)	Sample Type/ Advancement Method	Soil Samples: Blows per 6 in	Soil Samples: Penetration Resistance	Lithology	Material Description	Moisture Content (%)	Dry Density (pcf)	Gravel Content (%)	Sand Content (%)	Fines Content (%)	Atterberg Limits: Liquid Limit	Atterberg Limits: Plasticity Index	AASHTO & USCS Classifications	Field Notes and Other Lab Tests
						0.0 - 2.0 ft. LEAN CLAY w/ SAND, CL, brown, low to no plasticity, dry.	*14.3*		*1*	*27*	71.9	*42*	*28*	A-7-6 (18) CL	
							11.7	88.2							S/C=-0.3% @ 250 psf
						2.0 - 2.6 ft. SILTY SAND, brown, medium plasticity, moist, stiff.									
						2.6 - 2.7 ft. SILTY SANDSTONEcoarse grained, gray to white, no plasticity, dry, auger refusal.									
						Bottom of Hole at 2.7 ft.									

DCP TEST DATA

Test#: D1 39.06170, -104.69312

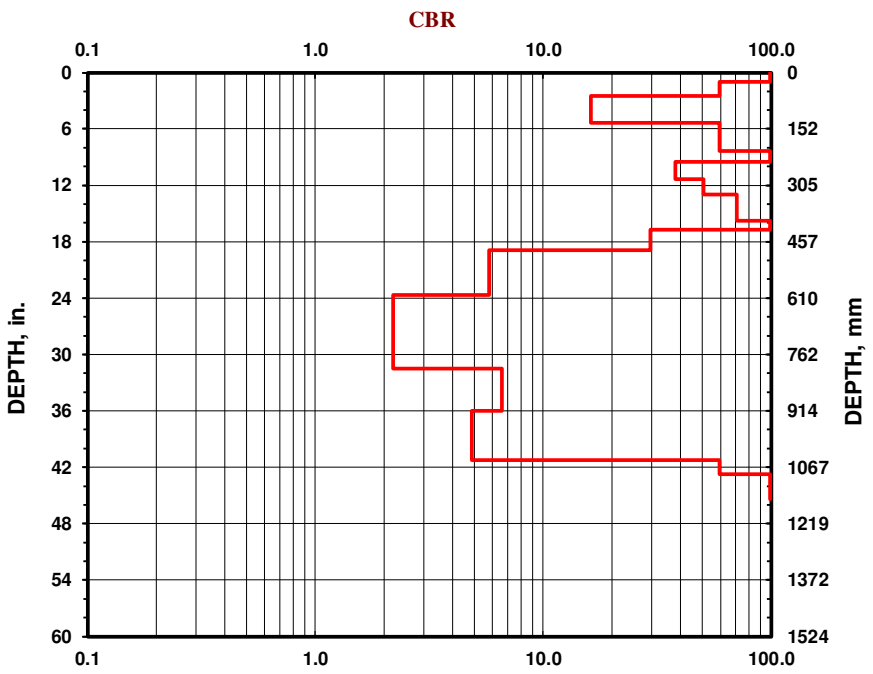
Project: *Terra Ridge North Pavement* **Date:** 12-Mar-24

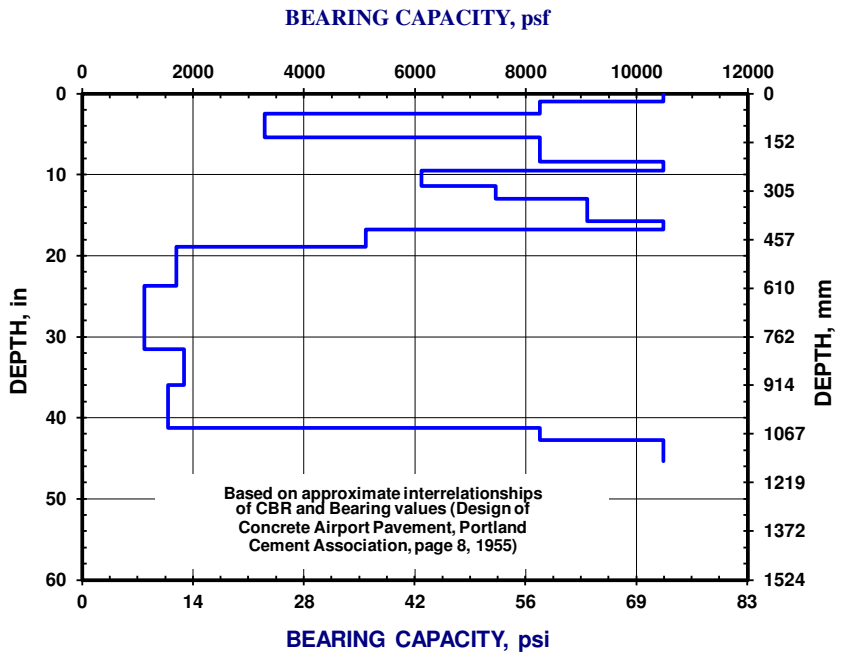
Location: Black Forest, CO **Soil Type(s):** Low plasticity Clay with CBR<10

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ◉ CL
- ○ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	1
5	25.4	1
5	63.5	1
5	136.525	1
5	174.625	1
5	212.725	1
5	241.3	1
5	288.925	1
5	330.2	1
5	365.125	1
5	400.05	1
5	425.45	1
5	479.425	1
5	601.6625	1
5	800.1	1
5	914.4	1
5	1047.75	1
5	1085.85	1
5	1103.3125	1
5	1120.775	1
5	1130.3	1
5	1146.175	1
5	1152.525	1





DCP TEST DATA

Test#: D2 39.06095, -104.69322

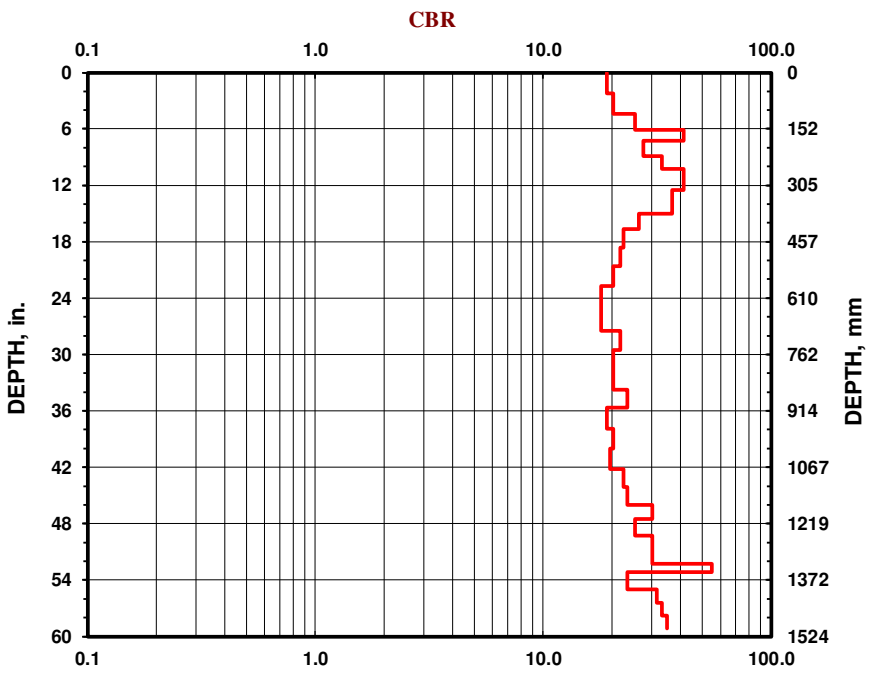
Project: *Terra Ridge North Pavement* **Date:** 12-Mar-24

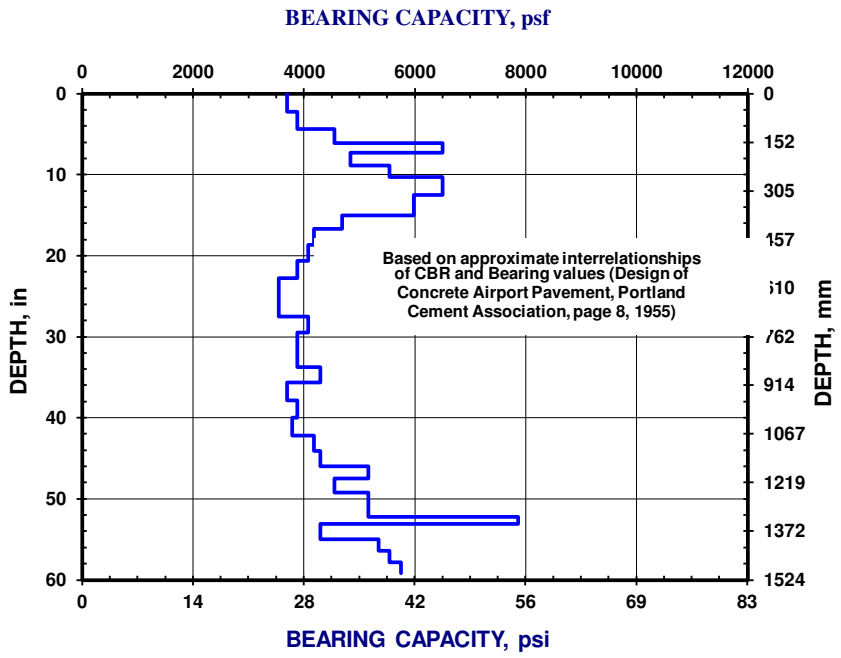
Location: Black Forest, CO **Soil Type(s):** Type in the soil type

Hammer
- ○ 10.1 lbs.
- ● 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ● All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	1
5	57.15	1
5	111.125	1
5	155.575	1
5	184.15	1
5	225.425	1
5	260.35	1
5	288.925	1
5	317.5	1
5	349.25	1
5	381	1
5	423.8625	1
5	473.075	1
5	523.875	1
5	577.85	1
5	638.175	1
5	698.5	1
5	749.3	1
5	803.275	1
5	857.25	1
5	904.875	1
5	962.025	1
5	1016	1
5	1071.5625	1
5	1120.775	1
5	1168.4	1
5	1206.5	1
5	1250.95	1
5	1289.05	1
5	1327.15	1
5	1349.375	1
5	1397	1
5	1433.5125	1
5	1468.4375	1
5	1501.775	1





DCP TEST DATA

Test#: D3 39.06023, -104.69336

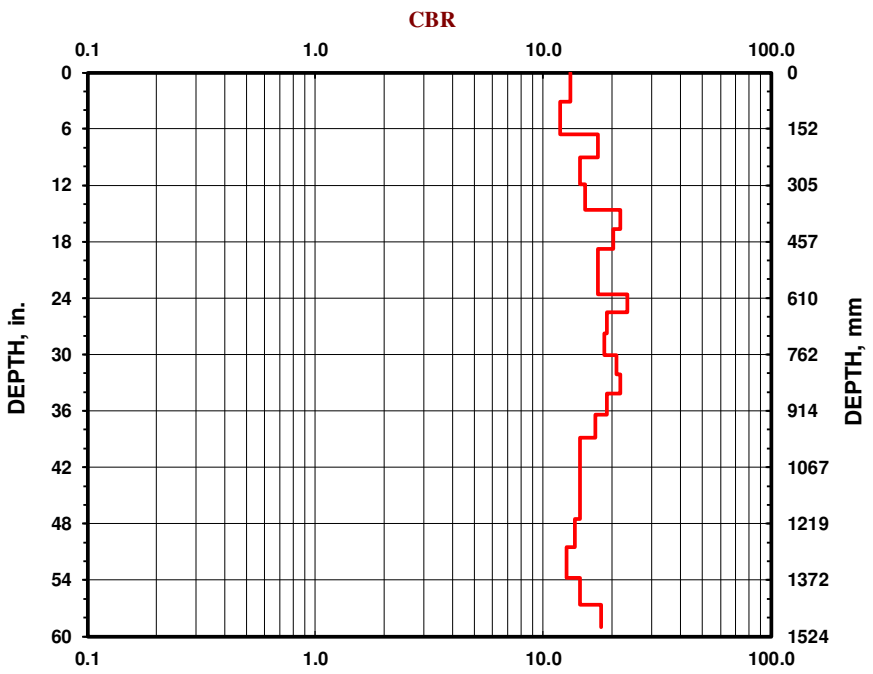
Project: *Terra Ridge North Pavement* **Date:** 12-Mar-24

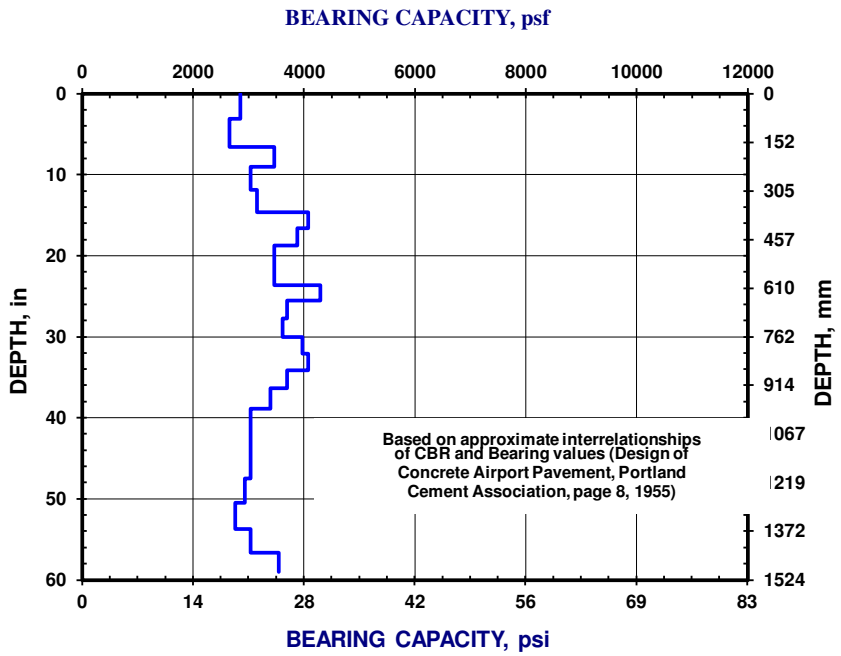
Location: Black Forest, CO **Soil Type(s):** Type in the soil type

Hammer
- ○ 10.1 lbs.
- ◉ 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ◉ All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	1
5	79.375	1
5	166.6875	1
5	228.6	1
5	301.625	1
5	371.475	1
5	422.275	1
5	476.25	1
5	538.1625	1
5	600.075	1
5	647.7	1
5	704.85	1
5	763.5875	1
5	815.975	1
5	866.775	1
5	923.925	1
5	987.425	1
5	1060.45	1
5	1133.475	1
5	1206.5	1
5	1282.7	1
5	1365.25	1
5	1438.275	1
5	1498.6	1
5	0	1
5	0	1
5	0	1
5	0	1
5	0	1
5	0	1
5	0	1
5	0	1
5	0	1
5	0	1





DCP TEST DATA

Test#: D4 39.05956, -104.69330

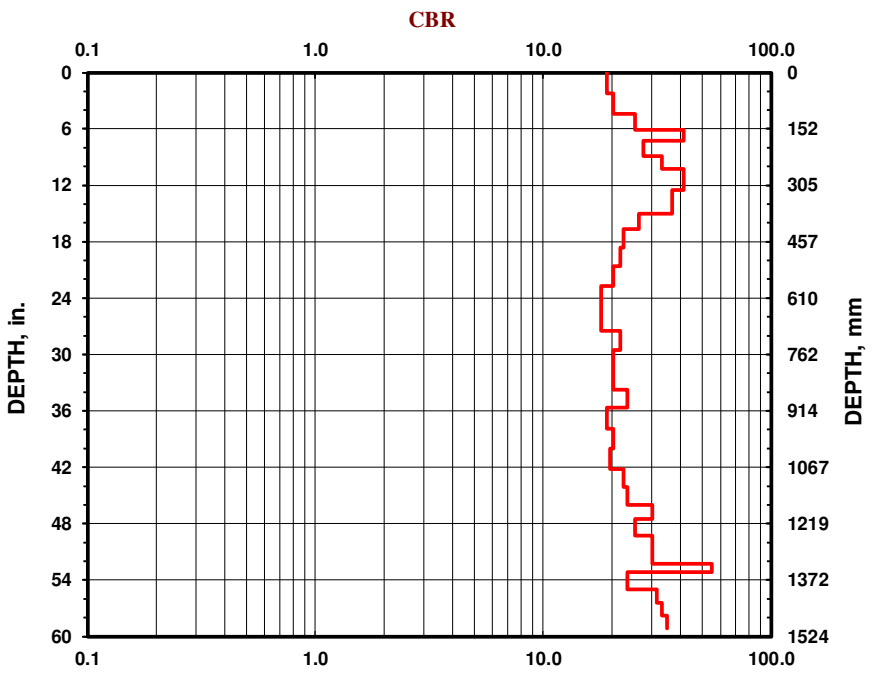
Project: *Terra Ridge North Pavement* **Date:** 12-Mar-24

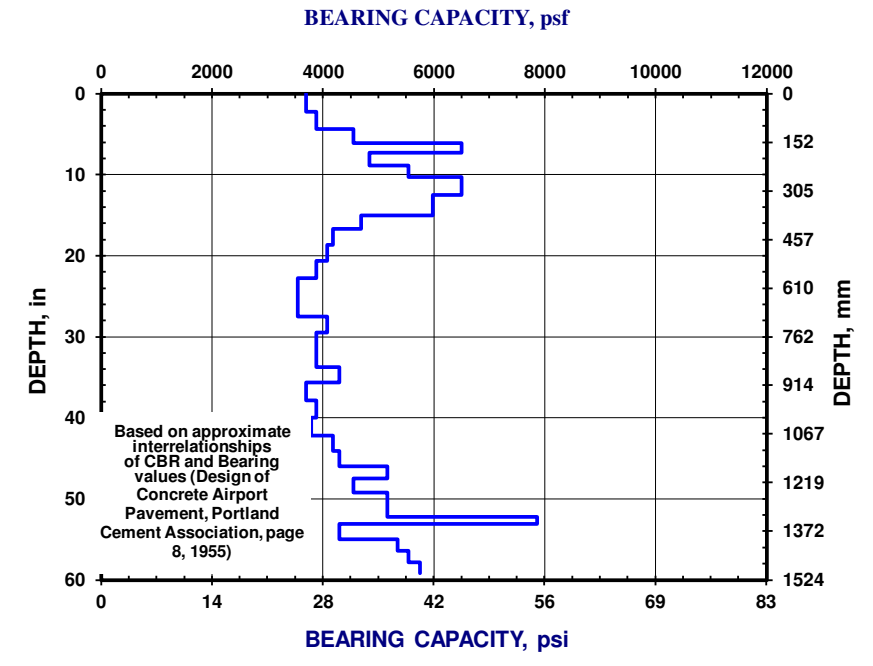
Location: Black Forest, CO **Soil Type(s):** Type in the soil type

Hammer
- ○ 10.1 lbs.
- ● 17.6 lbs.
- ○ Both hammers used

Soil Type
- ○ CH
- ○ CL
- ● All other soils

No. of Blows	Accumulative Penetration (mm)	Type of Hammer
0	0	1
5	57.15	1
5	111.125	1
5	155.575	1
5	184.15	1
5	225.425	1
5	260.35	1
5	288.925	1
5	317.5	1
5	349.25	1
5	381	1
5	423.8625	1
5	473.075	1
5	523.875	1
5	577.85	1
5	638.175	1
5	698.5	1
5	749.3	1
5	803.275	1
5	857.25	1
5	904.875	1
5	962.025	1
5	1016	1
5	1071.5625	1
5	1120.775	1
5	1168.4	1
5	1206.5	1
5	1250.95	1
5	1289.05	1
5	1327.15	1
5	1349.375	1
5	1397	1
5	1433.5125	1
5	1468.4375	1
5	1501.775	1





Appendix C

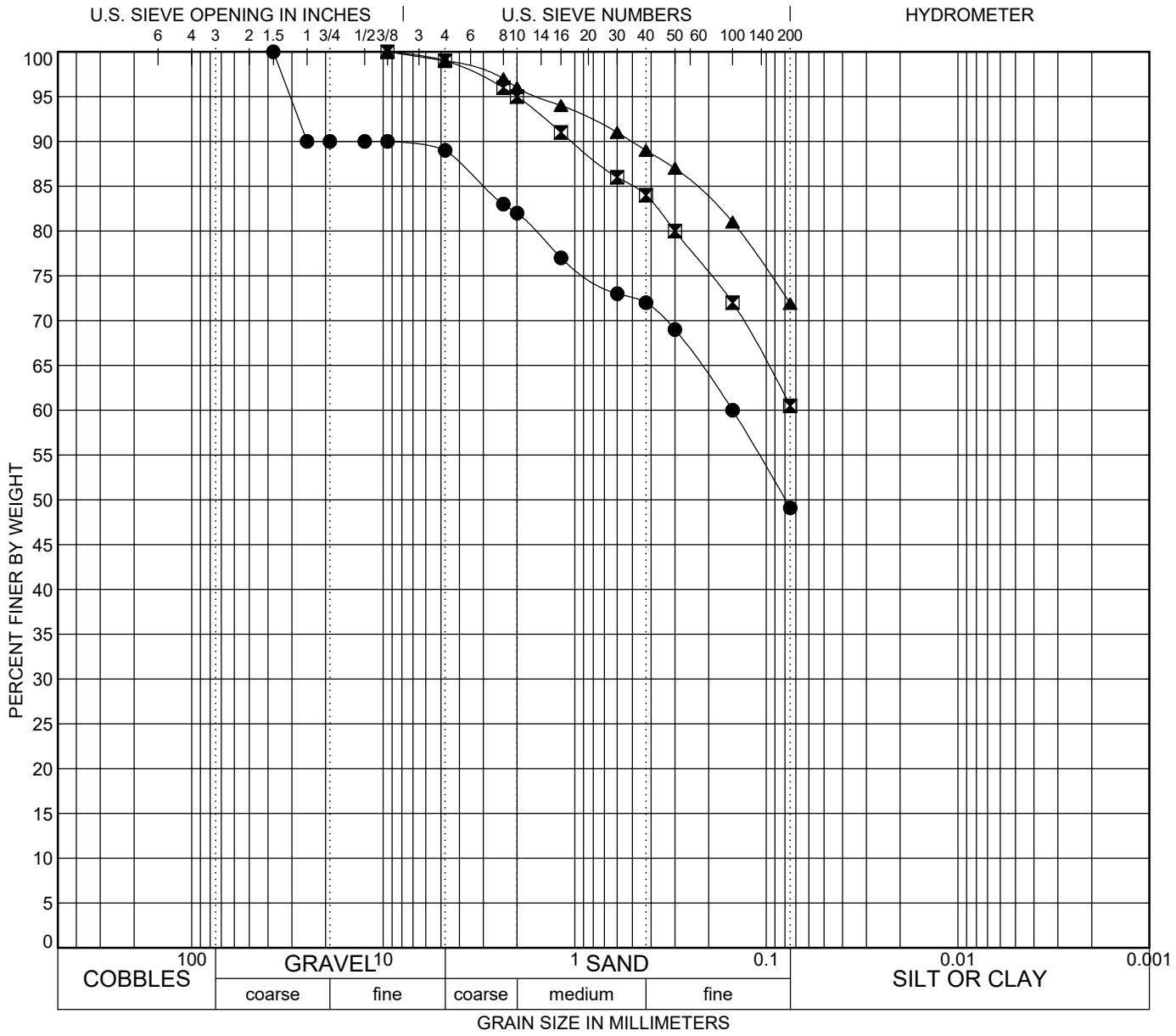
LAB RESULTS

Summary of Laboratory Test Results

GRANITE ENGINEERING GROUP

Project No: 24-041 Project Name: Terra Ridge North Pavement, Fox Creek Lane, Colorado Springs, CO

Sample Location			Natural Moisture Content (%)	Natural Dry Density (pcf)	Gradation			Atterberg			pH	Water Soluble Sulfate (%)	% Swell (+) / Consolidation (-)	Unconf. Comp. Strength (psf)	R-Value	Classification	
Boring No.	Depth (ft)	Sample Type			Gravel > #4 (%)	Sand (%)	Fines < #200 (%)	LL	PL	PI						AASHTO	USCS
D1	1.3~1.8	MC	15.9	92.5									0.0% @ 250 psf		--	--	--
D1	3.5~4.0	BULK	17.8		11.0	39.9	49.1	41	16	25						A-7-6(8)	SC
D1	6.0~	AUGER														--	--
D3	0.0~4.5	BULK	11.2		1.0	38.5	60.5	32	17	15						A-6(6)	CL
D3	1.0~1.5	MC	12.2	112.3									0.5% @ 250 psf		--	--	--
D4	0.0~2.0	BULK	14.3		1.0	27.1	71.9	42	14	28						A-7-6(18)	CL
D4	1.0~1.5	MC	11.7	88.2									-0.3% @ 250 psf		--	--	--



	BOREHOLE	DEPTH	AASHTO Classification	USCS Classification	LL	PL	PI	%Gravel	%Sand	%Fines	
										%Silt	%Clay
●	**D1**	**3.5**	**A-7-6(8)**	**SC**	**41**	**16**	**25**	**11.0**	**39.9**	**49.1**	
⊠	**D3**	**0.0**	**A-6(6)**	**CL**	**32**	**17**	**15**	**1.0**	**38.5**	**60.5**	
▲	**D4**	**0.0**	**A-7-6(18)**	**CL**	**42**	**14**	**28**	**1.0**	**27.1**	**71.9**	

GRANITE ENGINEERING GROUP

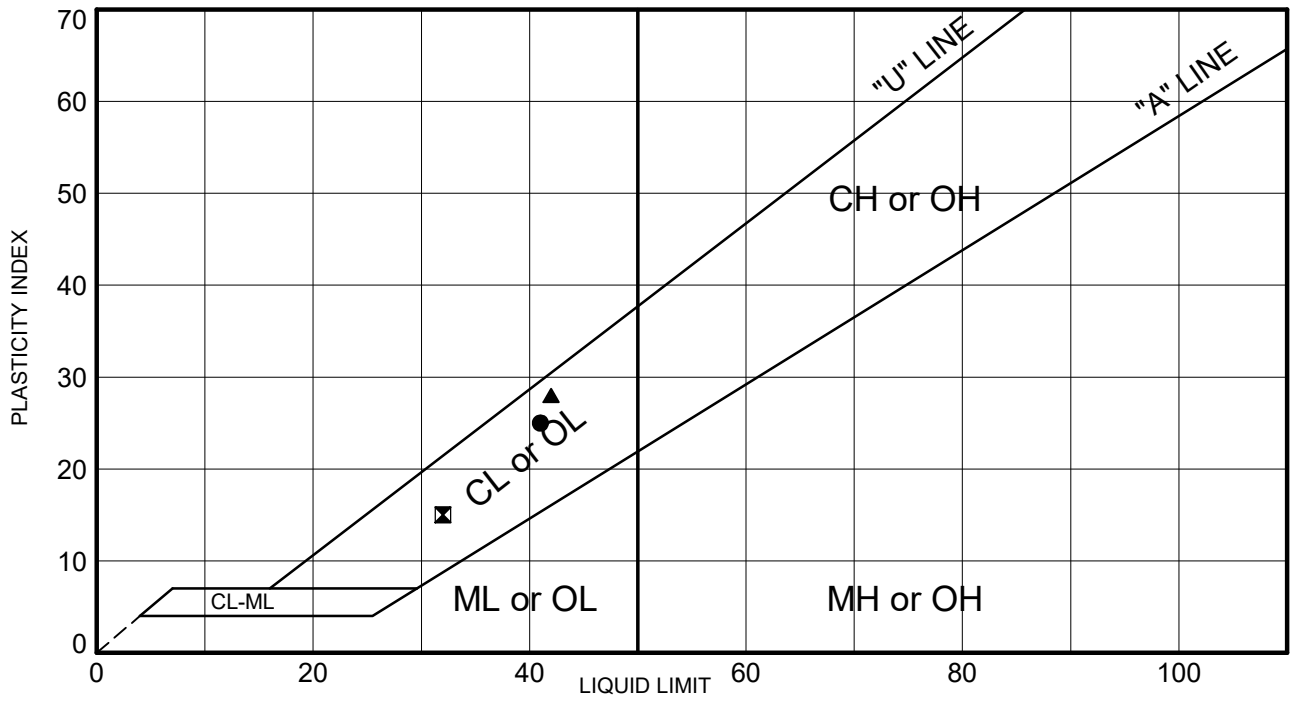
SIEVE ANALYSIS

FIGURE

C- 1

Project No. 24-041 Date: 5/23/2024
Drawn By: EC
Checked By: HML

Terra Ridge North Pavement
Fox Creek Lane, Colorado Springs, CO



	BOREHOLE	DEPTH	LL	PL	PI	Passing #200	USCS Sample Description	AASHTO Class.
●	**D1**	**3.5**	**41**	**16**	**25**	**49**	**CLAYEY SAND(SC)**	**A-7-6(8)**
⊠	**D3**	**0.0**	**32**	**17**	**15**	**61**	**SANDY LEAN CLAY(CL)**	**A-6(6)**
▲	**D4**	**0.0**	**42**	**14**	**28**	**72**	**LEAN CLAY with SAND(CL)**	**A-7-6(18)**

GRANITE ENGINEERING GROUP

ATTERBERG LIMITS

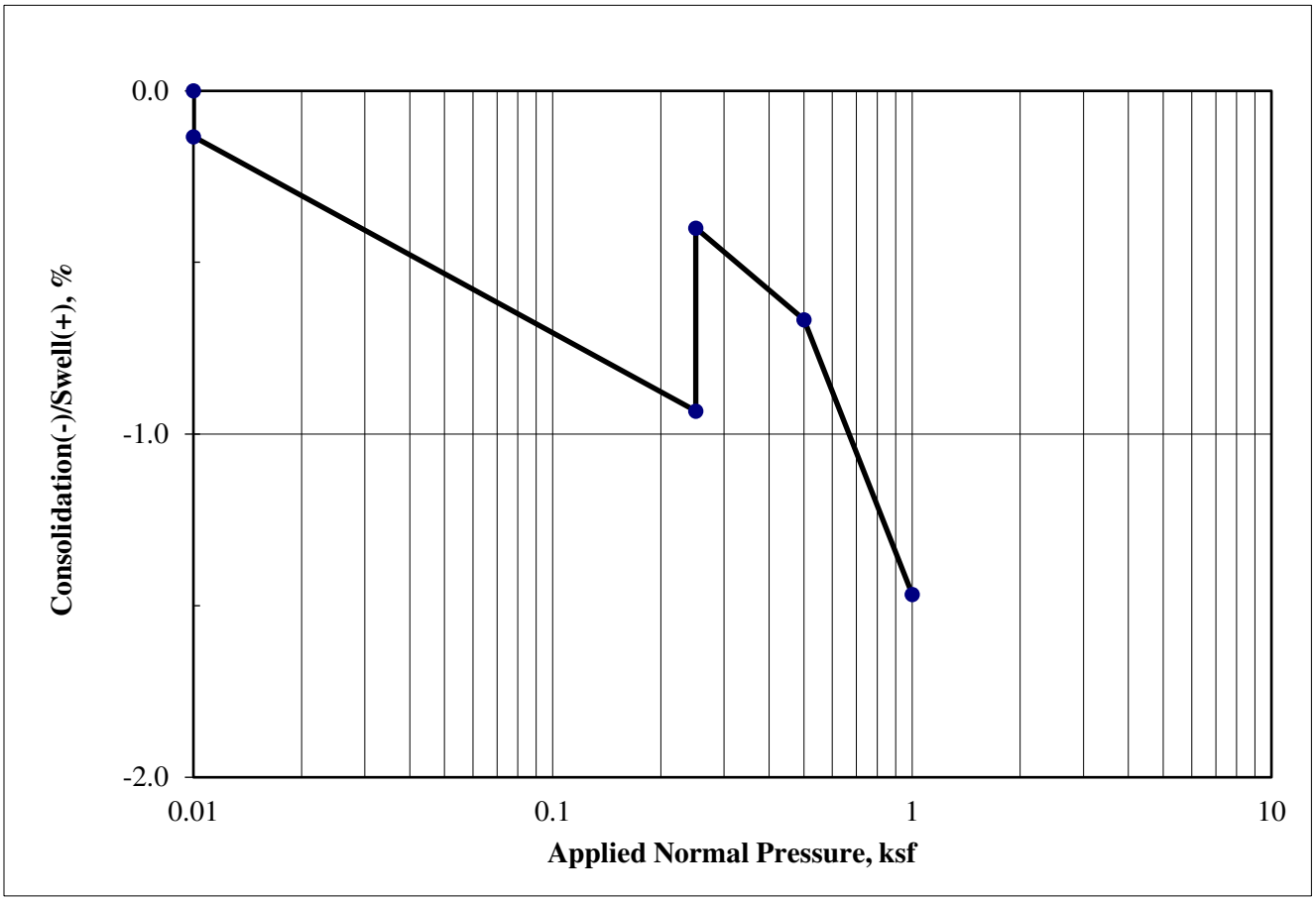
FIGURE

C - 2

Project No. 24-041
Drawn By: EC
Checked By: HML
Date: 5/23/2024

Terra Ridge North Pavement
Fox Creek Lane, Colorado Springs, CO

SWELL/CONSOLIDATION TEST - ASTM D 4546

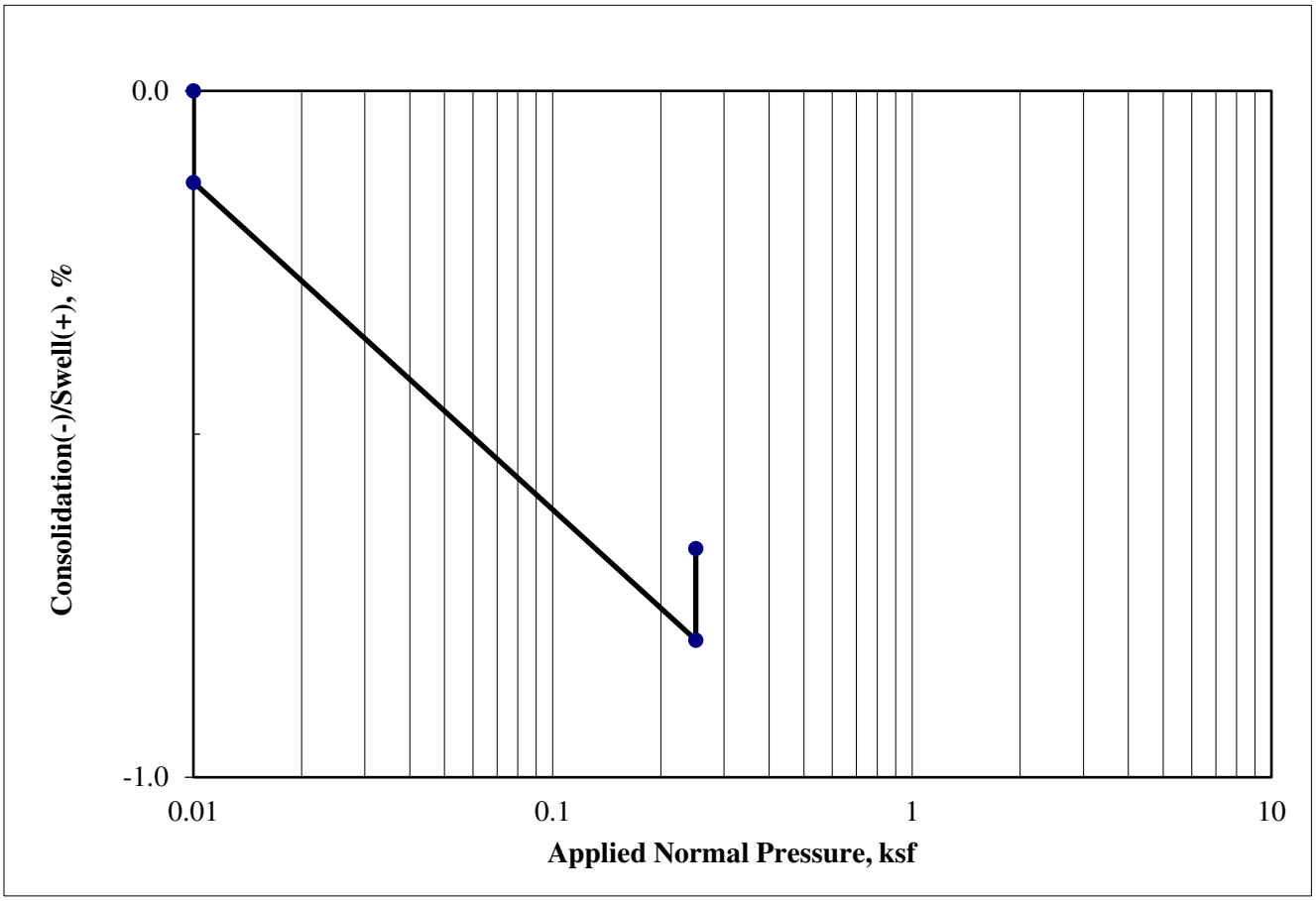


Boring ID	D-1 @
Sample Depth (ft)	1.3'
Date Sampled	3/12/2024

Swell/ Consolidation (%)	0.5
Natural Moisure Content (%)	12.2
Saturated Moisture Content (%)	19.4
Dry Density (pcf)	112.3

GRANITE ENGINEERING GROUP	**SWELL/ CONSOLIDATION TEST RESULTS**	**FIGURE**
Project No. 24-041 Date: 3/12/2024 Report By: JLS Checked By: HML	Terra Ridge North Black Forest, CO	**C-1**

SWELL/CONSOLIDATION TEST - ASTM D 4546

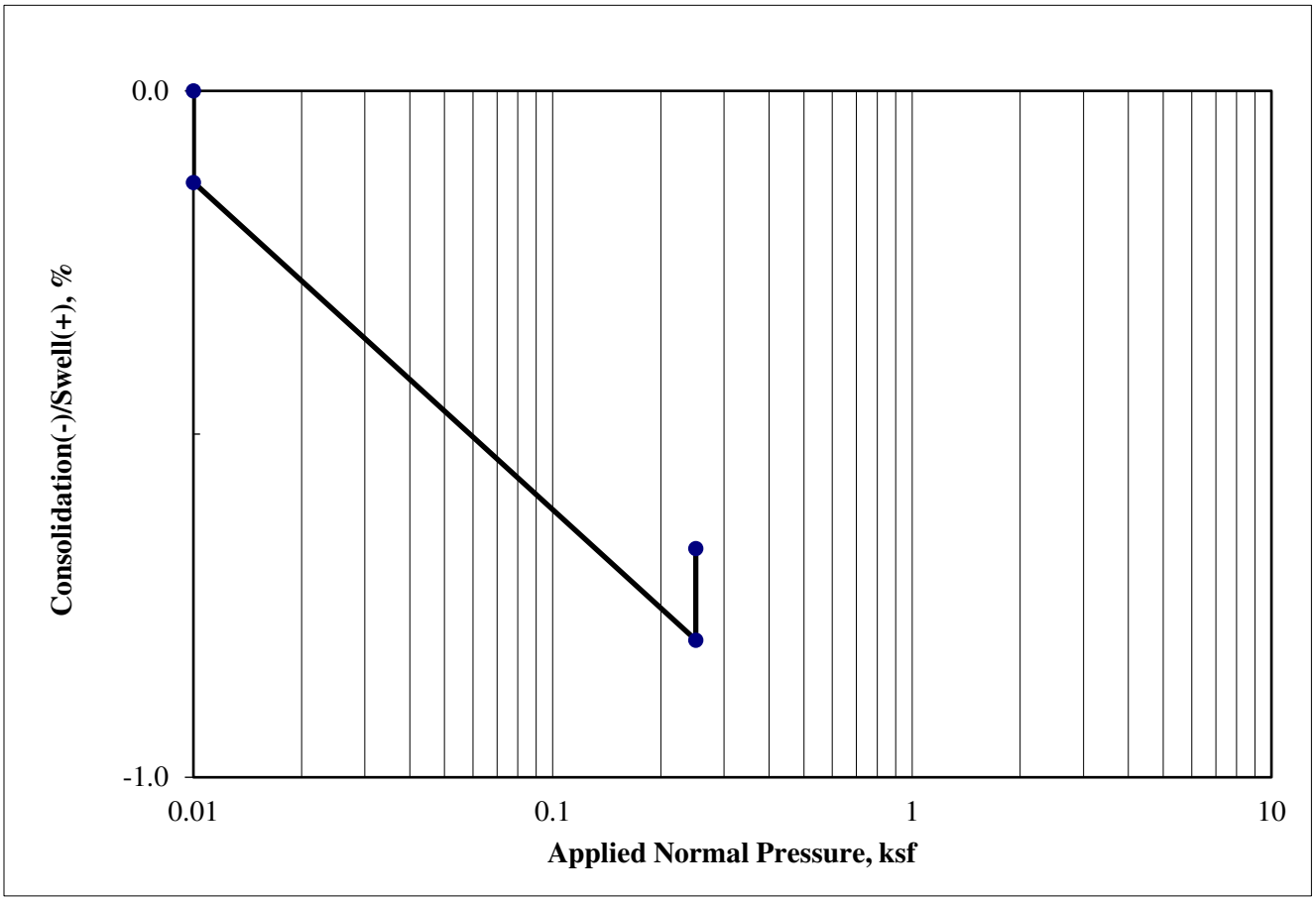


Boring ID	P-2
Sample Depth (ft)	4'
Date Sampled	1/9/2024

Swell/ Consolidation (%)	0.1
Natural Moisure Content (%)	11.7
Saturated Moisture Content (%)	17.3
Dry Density (pcf)	115.8

GRANITE ENGINEERING GROUP	**SWELL/ CONSOLIDATION TEST RESULTS**	**FIGURE**
Project No. 24-041 Date: 3/12/2024 Report By: JLS Checked By: HML	Terra Ridge North Black Forest, CO	**C-2**

SWELL/CONSOLIDATION TEST - ASTM D 4546



Boring ID	P-2
Sample Depth (ft)	4'
Date Sampled	1/9/2024

Swell/ Consolidation (%)	0.1
Natural Moisure Content (%)	11.7
Saturated Moisture Content (%)	17.3
Dry Density (pcf)	115.8

GRANITE ENGINEERING GROUP				**SWELL/ CONSOLIDATION TEST RESULTS**	**FIGURE**
Project No.	24-041	Date:	3/12/2024	Terra Ridge North	**C-3**
Report By:	JLS			Black Forest, CO	
Checked By:	HML				

Appendix D

PAVEMENT DESIGN OUTPUT

WinPAS

Pavement Thickness Design According to

1993 AASHTO Guide for Design of Pavements Structures

American Concrete Pavement Association

Flexible Design Inputs

Project Name:
Route:
Location:
Owner/Agency:
Design Engineer:

Flexible Pavement Design/Evaluation

Structural Number	2.64		**Subgrade Resilient Modulus**	4,500.00	**psi**
Total Flexible ESALs	36,500		**Initial Serviceability**	4.50	
Reliability	75.00	**percent**	**Terminal Serviceability**	2.50	
Overall Standard Deviation	0.45				

Layer Pavement Design/Evaluation

Layer Material	Layer Coefficient	Drainage Coefficient	Layer Thickness	Layer SN
Asphalt Cement Concrete	0.44	1.00	4.50	1.98
Graded Stone Base	0.11	1.00	6.00	0.66
			ΣSN	2.64