Structural
Geotechnical

Materials Testing
Forensic

PAVEMENT EVALUATION

The Ridge at Lorson Ranch, Filing No. 2
El Paso County, Colorado

PREPARED FOR:

Landhuis Company
212 N. Wahsatch Ave. Ste 301
Colorado Springs, CO

JOB NO. 196427

May 20, 2024
REV: June 4, 2024

Respectfully Submitted,

RMG – Rocky Mountain Group

Jared McElmeel, E.I.
Geotechnical Staff Engineer

Reviewed by,

RMG – Rocky Mountain Group

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PROFESSIONAL ENGINEER

Tony Munger, P.E.
Sr. Geotechnical Project Manager

Scope of Investigation

It is our understanding that the existing pavement on the subdivision and filing referenced above is exhibiting signs of apparent heave below the pavement. RMG – Rocky Mountain Group performed testing on the areas of pavement that are experiencing movement and areas that are not.

The purpose of this investigation is to perform limited sampling and laboratory testing to evaluate the apparent heave. RMG drilled 6 test borings (three groups of two) at the above-referenced address on April 15, 2024. A Site Vicinity Map and Test Boring Location Plan are presented in Figures 1 and 2, respectively. Our findings are provided in this report.

A scope of work was undertaken that could readily be performed with a truck-mounted drill rig and limited disturbance to the existing pavement. If additional soil information and/or a more in-depth investigation are desired, please contact personnel of RMG for a proposal for these additional services.

The following is excluded from the scope of this report including but not limited to foundation repair recommendations, site grading/surface drainage recommendations, subsurface drainage recommendations, geologic, natural and environmental hazards such as landslides, unstable slopes, seismicity, snow avalanches, water flooding, corrosive soils, erosion, radon, wild fire protection, hazardous waste and natural resources.

Subsurface Materials

The apparent heave observed by RMG was primarily located along the edges of the pavement, adjacent to the curb and gutter, or at the pavement penetrations (manholes, shutoff valves, etc.). The test borings and sampling performed by RMG consisted of three groups of two test borings, with each group including one boring in the portion of pavement exhibiting signs of heave (typically adjacent to the gutter), and one boring near the middle of the roadway where heaving was not observed. RMG did not perform test borings near the pavement penetrations due to the risk of damaging the utilities below. The subsurface materials encountered in the test borings generally consisted of overlot fill composed of silt to clay extending to the 4-foot termination depths of the test borings.

Groundwater was not encountered in the test borings at the time of drilling. Fluctuations in groundwater and subsurface moisture conditions may occur due to variations in rainfall and other factors not readily apparent at this time. Development of the property and adjacent properties may also affect groundwater levels.

A Summary of Laboratory Test Results are presented in Figure 3. Swell/Consolidation Test Results are presented in Figure 4.

Findings and Conclusions

The laboratory test results for borings TB-1 and TB-2 (the two borings performed within Buckner Way, with TB-1 near the gutter and TB-2 near the middle of the road) exhibited similar soil density,

Atterberg limits, and swell values. The laboratory test results for borings TB-4 (western end of Jasons Ridge Way, near the middle of the road) and TB-5 (Donnas Drive cul-de-sac, near the gutter) exhibited similar soil density Atterberg limits, and swell values. These results suggest that the fill materials in each portion of the site are relatively consistent. However, there were two notable differences. The materials in the areas of apparent heave exhibited higher moisture contents and lower blow counts than the materials in areas where heave was not apparent. The moisture content and blow count results were:

Test Boring	Location	Heaving?	Moisture Content	Blow Counts
TB-1	Buckner Way	Yes	18.4%	6
TB-2	Buckner Way	No	15.3%	37
TB-3	Jasons Ridge Way	Yes	44.5%	8
TB-4	Jasons Ridge Way	No	19.3%	26
TB-5	Donnas Drive	Yes	29.9%	7
TB-6	Donnas Drive	No	15.0%	23

The locations with apparent heaving exhibited higher moisture contents (ranging from 3.1 to 25.2 percent higher) and a corresponding decrease in blow counts (ranging from 16 to 31 fewer blows), when compared to the samples from the areas where heave was not apparent. Additionally, the degree of pavement heave observed in the areas of TB-1 and TB-2 (where the moisture increase was only 3.1%) was observed to be significantly less than the degree of pavement heave observed in the vicinity of the other 4 borings (Jasons Ridge Way and Donnas Drive), where the moisture increases ranged from 14.9 to 25.2 percent.

RMG also performed sulfate testing on selected samples, with all results ranging from 0.70 to 0.77 percent (by weight). There was not a significant difference in sulfate content between the samples in areas of heave and the samples in areas where no heave was observed. Additionally, personnel of RMG visually observed the samples from each test boring. We did not observe obvious indications of sulfate crystallization in any of the samples.

Based on our site observations and laboratory test results, "sulfate heave" appears to be an unlikely (though still possible) explanation for the observed pavement heave. A more likely cause, in our opinion, is heave of the expansive (on-site) soil used for fill after the subexcavation and replacement which was performed below the roadways throughout this filing. However, the mechanism which caused the expansive soils to swell is less apparent. While water infiltration into the soil is typically the instigating factor in the swelling of expansive soils, the roadways for virtually all of the previous filings throughout Lorson Ranch East (and of Lorson Ranch as a whole) are comprised of similar pavement sections of Cement-Treated Subgrade (CTS) atop on-site expansive soils (either undisturbed or moisture-conditioned and placed as fill). Many of those previous filings contain fill with the same (or greater) degree of swell potential as the fill soils used within the Ridge at Lorson Ranch, Filing No. 2, but did not exhibit the pavement heave observed in Filing No. 2. It is currently unclear why Filing No. 2 experienced the degree of heave observed, but the previous filings did not.

Findings and Conclusions

The discussion presented below is based on the subsurface conditions encountered in the test borings, laboratory test results and the project characteristics previously described, both in this evaluation report and in the original pavement design report for this subdivision and filing. If the subsurface conditions are different from those described in this report or the project characteristics change, RMG should be retained to review our recommendations and modify them, if necessary. The conclusions and recommendations presented in this report should be verified by RMG during construction.

The original pavement design was performed using the El Paso County Engineering Criteria Manual, Appendix D. The pavement design parameters and design calculations are presented below.

Street Classification – Urban Local

1) Jasons Ridge Drive, Meridith Ridge Drive, Sanderling Street, Gray Wolf Court, Snowfield Court, Buckner Way, Donnas Drive, and Danis Drive
   ESAL = 292,000 (Table D-2)
   Serviceability Index = 2.0 (Table D-1)

2) Strength coefficients (Table D-3)
   Asphalt (HMA): $a_1 = 0.44$
   Cement-Treated Subgrade (CTS): $a_2 = 0.11$

3) Subgrade
   M_r = CBR x 1500 = 1.35 x 1500 = 2,025 psi

4) Structural number (SN) = 3.93 (per 1993 AASHTO Nomograph for Flexible Pavements)

5) Composite asphalt/CTS section
   Minimum HMA thickness = D_1 = 3 inches (Table D-2)
   CTS thickness = $D_2 = \{SN – (D_1 \times a_1)\} / a_2 = \{3.93 – (3 \times 0.44)\} / 0.11 = 22.0$ inches
   SN = (5.75 x 0.44) + (12.75 x 0.11) = 3.93 ≥ 3.93 (Min. SN required)
   Use HMA thickness = 5.75 inches over CTS thickness = 12.75 inches

Recommended Pavement Sections

HMA Over CTS Jasons Ridge Drive, Meridith Ridge Drive, Sanderling Street, Gray Wolf Court, Snow Field Court, Buckner Way, Donnas Drive, and Danis Drive	5.75" HMA	12.75" CTS
Optimal CTS Percent Cement by Weight = 5.25%		

Proposed Pavement Repairs

In the areas where pavement repairs are to be performed, our recommendations for localized subgrade stabilization and replacement of HMA are as follows:

Pavement Materials

Pavement materials should be selected, prepared, and placed in accordance with El Paso County specifications and the *Pikes Peak Region Asphalt Paving Specifications*. Tests should be performed in accordance with the applicable procedures presented in the specifications.

Subgrade Stabilization

The existing roadway should be milled to a depth of twice the existing pavement depth (but not less than 11.5 inches) until the asphalt is suitably pulverized and thoroughly mixed into the existing subgrade soil. Excess material should be removed as required to establish the final desired subgrade elevation.

The remaining soil/asphalt mixture should then be mixed with cement and water, compacted, finished, and cured in lengths that allow the full roadway width to be completed in not more than 4 hours from the time that cement is exposed to water.

The quantity of cement shall be by weight as a percentage of the dry weight of the soil as specified herein (Optimal CTS Percent Cement by Weight = 5.25%), and should be applied uniformly on the soil to create a cement and water mixture for the full design width and depth. Mixing should be continuous until the mixture is at optimum moisture and ready for compacting and finishing. Compaction should begin within 30 minutes of mixing. The CTS should be maintained in a moist condition during the curing process, and all traffic except for necessary construction equipment should be kept off the CTS for a minimum of 7 days or until the final pavement structure layers are placed.

CTS testing shall be in accordance with the El Paso County Engineering Criteria Manual. The subgrade should be kept in a moist cured condition by sprinkling or other means.

After completion of the subgrade stabilization operations, a minimum 5.5 inches of HMA shall be placed as indicated in the original pavement design.

General Remarks

The information provided in this report is based upon the subsurface conditions encountered in the test boring(s) and accepted engineering procedures. The information is based on accepted local engineering practice and is intended for individuals familiar with local construction practices and standards.

RMG does not assure the existence of and/or the compliance with design recommendations. This is the responsibility of the client referenced on the first page. RMG does not supervise, direct or control the implementation of the design recommendations.

If we can be of further assistance in discussing the contents of this report or analysis of the proposed project, from a geotechnical engineering point-of-view, please feel free to contact us.

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SITE VICINITY MAP

THE RIDGE AT LORSON RANCH, FILING NO. 2
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FIG No. 1

DATE 5-20-2024

DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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THE RIDGE AT LORSON RANCH, FILING NO. 2
PAVEMENT INVESTIGATION
EL PASO COUNTY, COLORADO
LANDHUIS COMPANY

ENGINEER:	TM
DRAWN BY:	JM
CHECKED BY:	TM
ISSUED:	5-20-2024

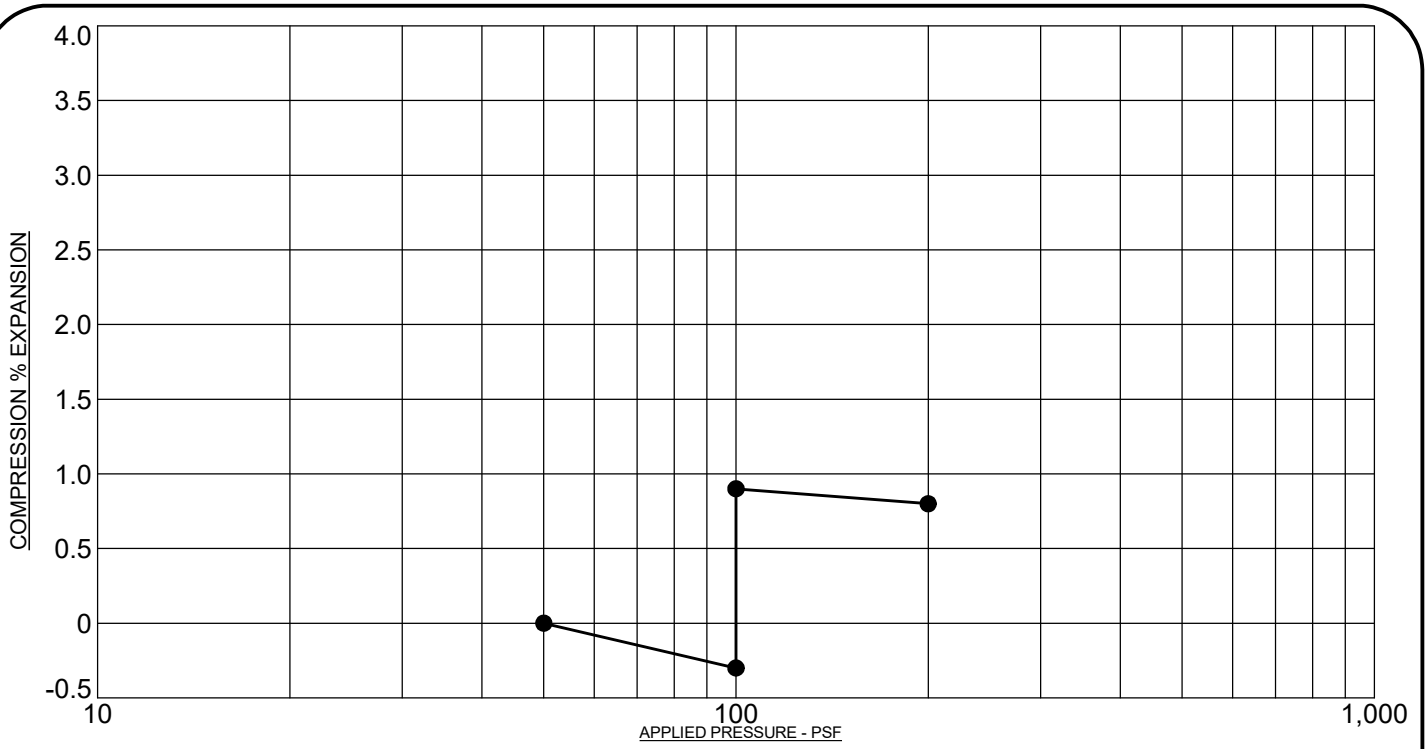
TEST BORING LAYOUT PLAN

SHEET No.
FIG-2

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.4 Sieve	% Passing No. 200 Sieve	Load at Saturation (psf)	% Swell/ Collapse	USCS Classification
1	3.0	18.4	102.8	45	25		86.2	100	1.2	CL
2	3.0	15.3	104.3	49	19		59.4	100	1.5	ML
3	3.0	44.5								
4	3.0	19.3	89.8	51	25		73.8	100	3.5	CH
5	3.0	29.9	85.6	56	21		54.0	100	3.9	MH
6	3.0	15.0								

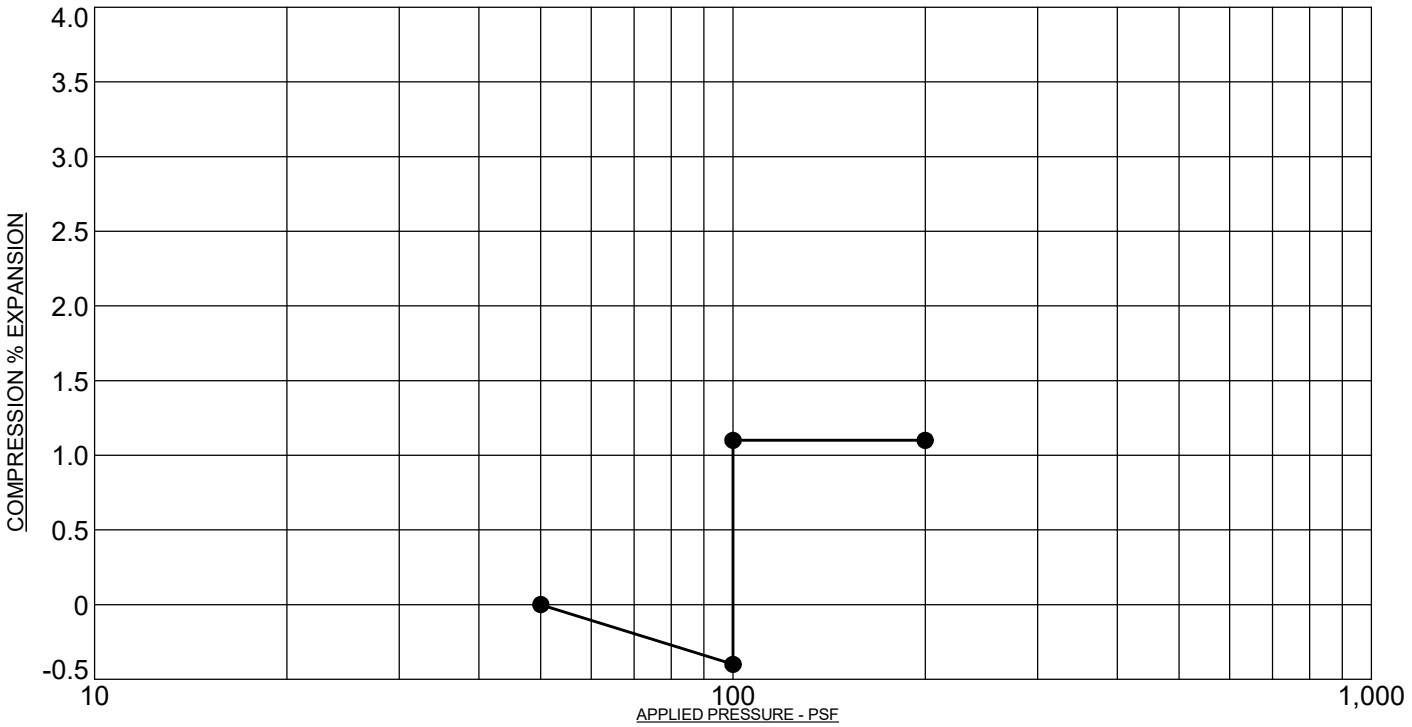
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 196427
FIGURE No. 3
PAGE 1 OF 1
DATE May/20/2024



PROJECT: **Ridge at Lorson Ranch F2 El Paso County, Colorado**
SAMPLE DESCRIPTION:
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **1 @ 3 FT**
NATURAL DRY UNIT WEIGHT: **102.8 PCF**
NATURAL MOISTURE CONTENT: **18.4%**
PERCENT SWELL/COMPRESSION: **1.2**



PROJECT: **Ridge at Lorson Ranch F2 El Paso County, Colorado**
SAMPLE DESCRIPTION:
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **2 @ 3 FT**
NATURAL DRY UNIT WEIGHT: **104.3 PCF**
NATURAL MOISTURE CONTENT: **15.3%**
PERCENT SWELL/COMPRESSION: **1.5**

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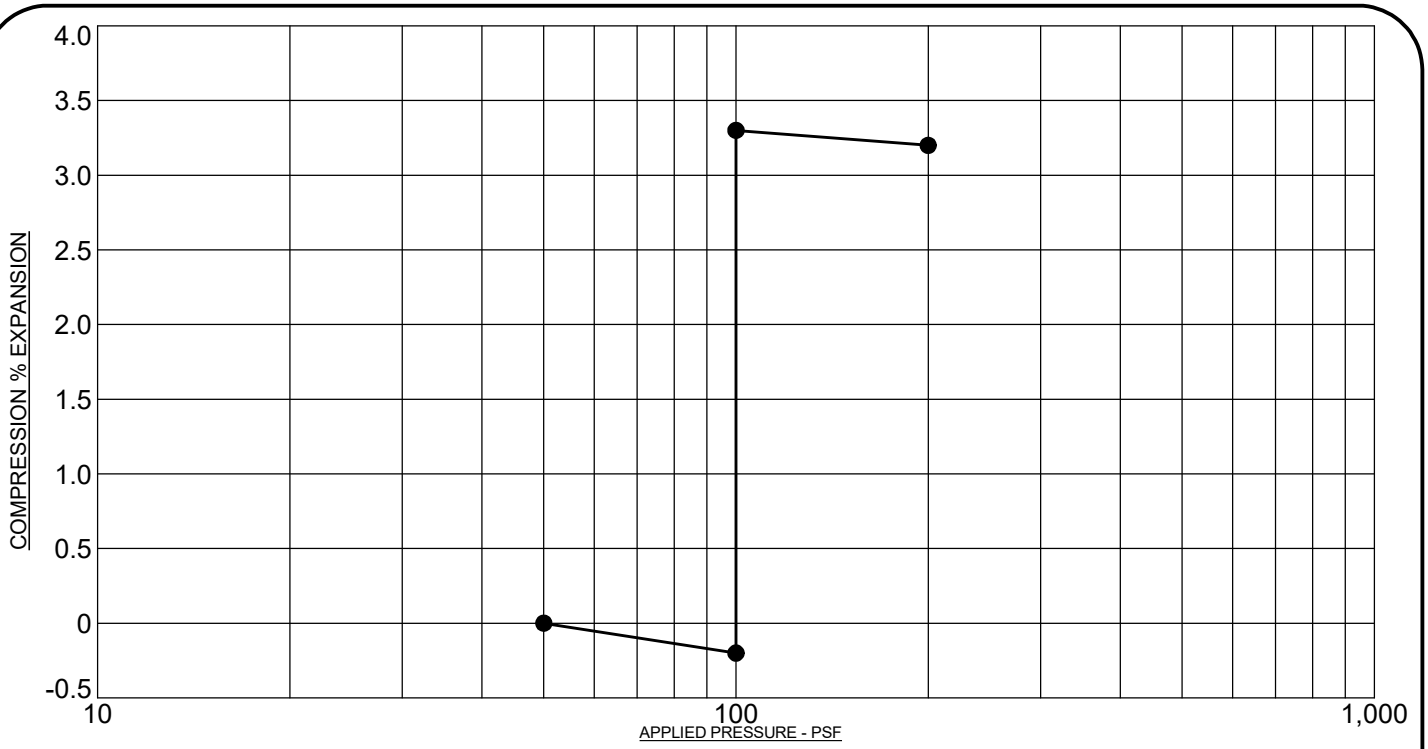
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 196427

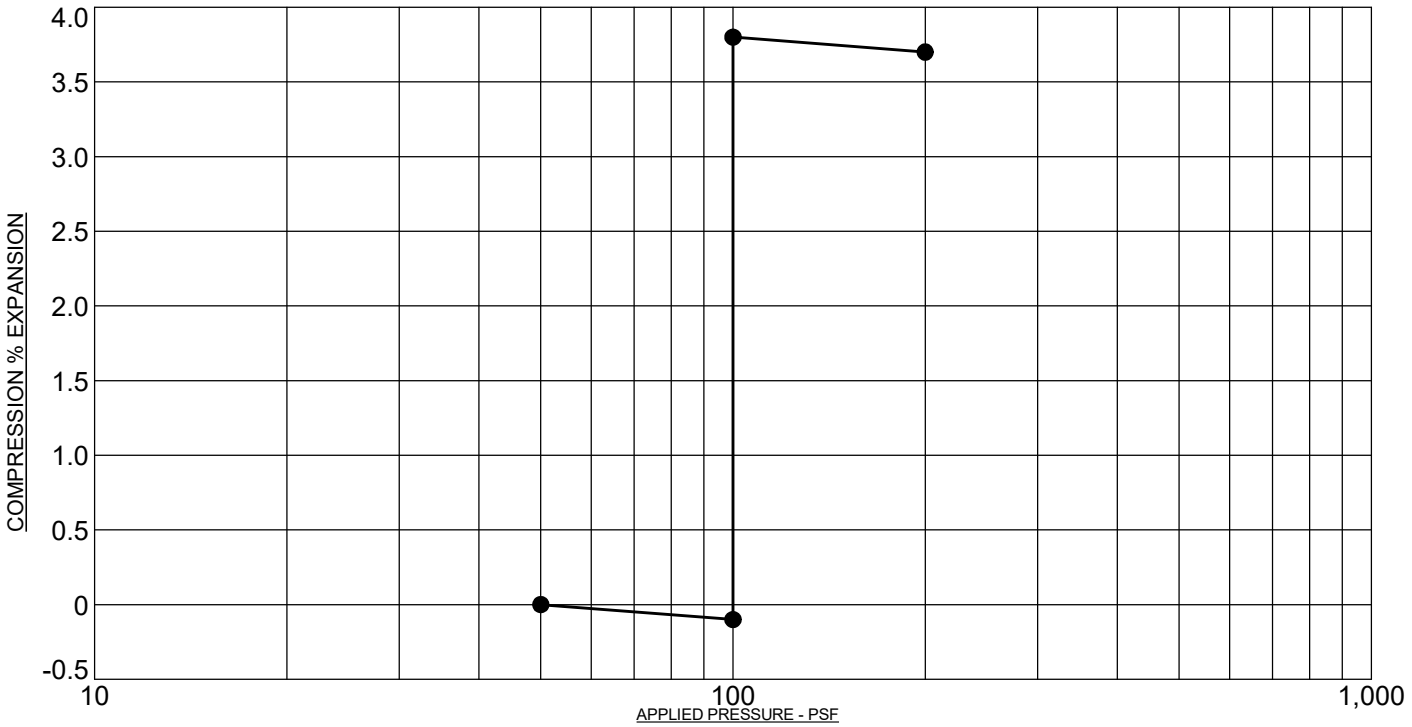
FIGURE No. 4

DATE May/20/2024



PROJECT: **Ridge at Lorson Ranch F2 El Paso County, Colorado**
SAMPLE DESCRIPTION:
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **4 @ 3 FT**
NATURAL DRY UNIT WEIGHT: **89.8 PCF**
NATURAL MOISTURE CONTENT: **19.3%**
PERCENT SWELL/COMPRESSION: **3.5**



PROJECT: **Ridge at Lorson Ranch F2 El Paso County, Colorado**
SAMPLE DESCRIPTION:
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **5 @ 3 FT**
NATURAL DRY UNIT WEIGHT: **85.6 PCF**
NATURAL MOISTURE CONTENT: **29.9%**
PERCENT SWELL/COMPRESSION: **3.9**

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SWELL/CONSOLIDATION TEST RESULTS

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FIGURE No. 5

DATE May/20/2024