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PAVEMENT DESIGN REPORT

Approved
By: Elizabeth Nijkamp
Date:05/19/2020
El Paso County Planning & Community Development

Lorson Ranch East Filing No. 4
El Paso County, Colorado

PREPARED FOR:

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

SF-19-008

JOB NO. 173661

May 14, 2020

Respectfully Submitted,

RMG – Rocky Mountain Group

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Geotechnical Staff Engineer

Reviewed by,

RMG – Rocky Mountain Group

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Sr. Geotechnical Project Engineer

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1993 AASHTO Empirical Equation for Flexible Pavements

GENERAL SITE AND PROJECT DESCRIPTION

Location

Lorson Ranch East Filing No. 4 is located east of Marksheffel Road and between Fontaine Boulevard to the north and Lorson Boulevard to the south in El Paso County, Colorado. A portion of the development extends south of Lorson Boulevard. The location of the site is shown on the Site Vicinity Map, Figure 1

Existing Conditions

At the time of our field investigation, the proposed streets were close to grade and utility mains and services had been installed. Curb and gutter had not been installed.

Project Description

This Pavement Design Report was performed to determine the subsurface conditions present along the roadway alignments and to develop recommendations for the design and construction of the proposed flexible pavements.

The proposed streets included in this investigation are shown on Figure 2. The streets considered below are classified as Residential Urban Local as shown on Sheet number C1.3 of the Typical Sections Plan for Lorson Ranch East Filing No. 4. Vedder Drive, Rockcastle Drive, Tillamook Drive, Tiffin Drive, Nolin Drive, Aliso Drive, Magothy Drive, Volga Drive, Witcher Drive, Horton Drive, Yocona Drive, Abita Drive, and Skuna Drive all have a 50-foot wide Right- of-Way (ROW) and two 15-foot wide travel lanes.

Trappe Drive is classified as a Residential Urban Collector. Trappe Drive has a 60-ft ROW and two 18-foot wide travel lanes.

FIELD INVESTIGATION AND SUBSURFACE CONDITIONS

Drilling

The subsurface conditions on the site were investigated by drilling twenty-six (26) exploratory test borings at maximum 500-foot spacing along the roadways. The approximate locations of the test borings are presented in the Test Boring Location Plan, Figure 2.

The test borings were advanced with a power-driven, continuous-flight auger drill rig to depths of about 5 to 10 feet below the existing ground surface. Samples were obtained in general accordance with ASTM D-3550 utilizing a 2½-inch OD modified California sampler. Representative bulk samples of subsurface materials were obtained from each boring at a depth of approximately 0 to 2 feet below the existing ground surface. An Explanation of Test Boring Logs is presented in Figure 3. The Test Boring Logs are presented in Figures 4 through 16.

Subsurface Materials

The subsurface materials encountered in the test borings consisted primarily of sandy lean clay. Combined bulk samples of the material classified as CL according to the Unified Classification System. For pavement design, bulk samples of the soil classified as A-6 and A-7 soil with varying Group Indices in accordance with the American Association of State Highway and Transportation Officials (ASSHTO) classification system. A-6 and A-7-6 soil typically has high fines (+200 sieve) content, and will require improvement to prepare it to provide adequate subgrade support. Subgrade improvement recommendations are included herein.

Groundwater

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

LABORATORY TESTING

Laboratory Testing

The moisture content for the recovered samples was obtained in the laboratory. Grain-size analysis and Atterberg Limits tests were performed on selected samples to classify the soil and to develop pertinent engineering properties. Swell/consolidation tests were performed to determine the expansive potential of the soil. A Summary of Laboratory Test Results is presented in Figure 17. Soil Classification Data are presented in Figures 18 through 23.

Swell potential evaluation based upon laboratory testing indicates the subgrade soil exhibited a maximum swell potential of 1.6 percent, with an average swell potential of 0.74 percent. Swell test results are presented in Figures 24 through 26.

California Bearing Ratio tests (CBR) were performed for the A-6 soil, it being the predominant soil classification. Combined bulk samples of A-6 soil were tested to determine the optimum moisture-density relationship in accordance with ASTM D-698 (Standard Proctor compaction test). CBR tests were performed at varying densities with moisture content near optimum. At 95% of the maximum Standard Proctor Density, the CBR of the A-6 soil was 3.0. The Moisture-Density Relation Curve is presented in Figure 27. CBR Test Results are presented in Figures 28 and 29.

The developer intends to install a composite roadway section consisting of Hot Mix Asphalt over Cement-Treated Subgrade (CTS). RMG performed a CTS Mix Design for this composite section.

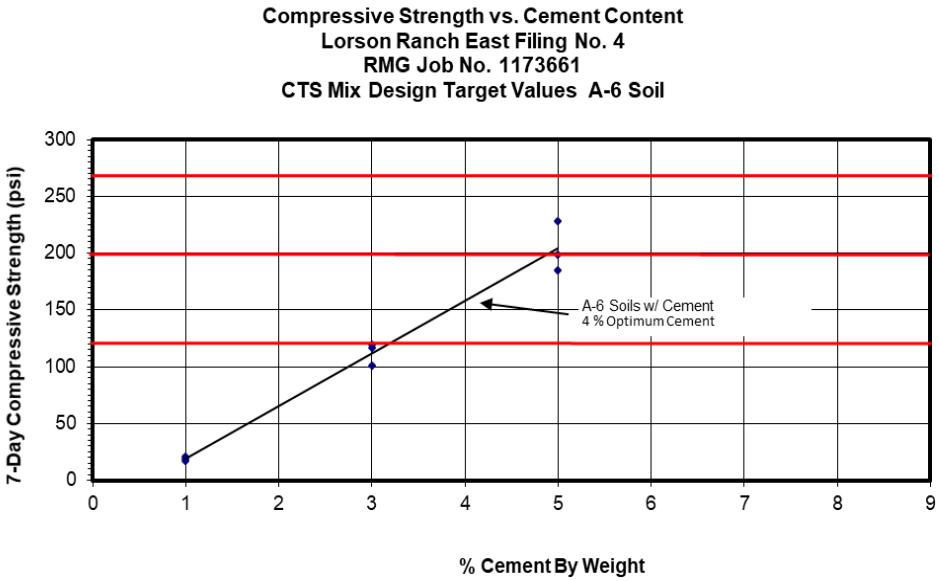
Specimens of soil composed of the A-6 subgrade materials and Portland cement were prepared by varying the “percent cement by weight” at target values of 1, 3, and 5 percent cement. Three specimens

(pucks) were prepared for each target cement value, compacted to 95% of the maximum Modified Proctor density and cured in a saturated condition for 7-days. The compressive strength of each specimen was then determined upon completion of the 7-day curing process. The A-6 compressive strengths are presented in the table below:

A-6 Soil Compressive Strength Calculations

CTS Puck	Age/Day	Cap & Plate	Area of Sample	Dial Reading	Load LBF	Total Load	PSI
1A	7	2.12	12.566	21	212.5	214.6	17
1B	7	2.12	12.566	26	263.0	265.2	21
1C	7	2.12	12.566	23	232.7	234.8	19
3A	7	2.12	12.566	148	1497.3	1499.4	119
3B	7	2.12	12.566	145	1467.0	1469.1	117
3C	7	2.12	12.566	125	1264.6	1266.7	101
5A	7	2.12	12.566	283	2863.1	2865.2	228
5B	7	2.12	12.566	229	2316.8	2318.9	185
5C	7	2.12	12.566	246	2488.8	2490.9	198

The data values were then plotted as a function of "7-day Compressive Strength versus Percent Cement by Weight". In accordance with the El Paso County Engineering Criteria Manual, the target "percent cement by weight" was selected to obtain strengths in the lower Strength Coefficient (SC) categories (SC = 0.11, 125-200 psi; SC = 0.12, 200-275 psi). A target SC = 0.11 is used for CTS soil in the pavement design procedure presented below. Based upon an evaluation of the test data, a target range of 4.0 percent cement is recommended in all roadway sections to maintain strengths below the 275-psi threshold stipulated in the Engineering Criteria Manual. See CTS Graph below.



PAVEMENT DESIGN

The discussion presented below is based on the subsurface conditions encountered in the test borings, laboratory test results and the project characteristics previously described. 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 pavement design was performed in accordance with the El Paso County Engineering Criteria Manual, Appendix D. Pavement design parameters and design calculations are presented below utilizing the CBR value for A-6 soil. The recommended pavement sections shown on Figure 2.1 are supported by the calculations below.

Street Classification – Residential Urban Collector

1) Trappe Drive
   ESAL = 821,000 (Table D-2)
   Serviceability Index = 2.5 (Table D-1)
   Reliability = 85% (Table D-1)

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

3) Subgrade
   M_r = CBR x 1500 = 3 x 1500 = 4,500 psi

4) Structural number (SN) = 3.8 (1993 AASHTO Empirical Equation, Appendix A)

5) Composite asphalt/base course section
   Minimum HMA thickness = D_1 = 4 inches (Table D-2)
   CTS thickness = $D_2 = \{SN – (D_1 \times a_1)\} / a_2 = \{4.0 – (4 \times 0.44)\} / 0.11 = 20.4$ inches

6) In accordance with El Paso County ECM, Section D.4, Paragraph F, *The base course thickness selected cannot exceed 2.5 times the HMA thickness selected.*
   Therefore, use Asphalt thickness = 5.75-inches and CTS thickness = 13 inches
   Check SN = (5.75 x 0.44) + (13 x 0.11) = 3.96 > 3.8 (Min. SN required) => OK

Street Classification – Residential Urban Local

1) Vedder Drive, Rockcastle Drive, Tillamook Drive, Tiffin Drive, Nolin Drive, Aliso Drive, Magothy Drive, Volga Drive, Witcher Drive, Horton Drive, Yocona Drive, Abita Drive, Skuna Drive

   ESAL = 292,000 (Table D-2)
   Serviceability Index = 2.5 (Table D-1)
   Reliability = 80% (Table D-1)

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

3) Subgrade
   M_r = CBR x 1500 = 3 x 1500 = 4,500 psi

4) Structural number (SN) = 3.2 (1993 AASHTO Empirical Equation, Appendix A)

5) Composite asphalt/base course section
   Minimum HMA thickness = D_1 = 3 inches (Table D-2)
   CTS thickness = $D_2 = \{SN – (D_1 \times a_1)\} / a_2 = \{3.2 – (3 \times 0.44)\} / 0.11 = 17.1$ inches

6) In accordance with El Paso County ECM, Section D.4, Paragraph F, *The base course thickness selected cannot exceed 2.5 times the HMA thickness selected.*
   Therefore, use Asphalt thickness = 4.75-inches and CTS thickness = 11-inches
   Check SN = (4.75 x 0.44) + (11 x 0.11) = 3.3 > 3.2 (Min. SN required) => OK

Pavement Thickness

Based on the soil types and the design calculations, the recommended pavement section is presented below and on Figure 2.1.

Recommended Pavement Sections

Streets	HMA (in)	CTS (in)
Trappe Drive	5.75	13
Vedder Drive, Rockcastle Drive, Tillamook Drive, Tiffin Drive, Nolin Drive, Aliso Drive, Magothy Drive, Volga Drive, Witcher Drive, Horton Drive, Yocona Drive, Abita Drive, Skuna Drive	4.75	11
Optimal CTS Percent Cement by Weight = 4 %		

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.

Soil Mitigation

The PDCM notes that mitigation measures may be required for expansive soils, shallow ground water, subgrade instability, etc. Based on the AASHTO classification of the soils in the subdivision and laboratory swell testing, the subgrade soils evaluated for this pavement design are expected to low expansive potential. Groundwater or wet and unstable soils were not encountered in the borings. Therefore, special mitigation measures do not appear to be necessary for subgrade preparation.

Subgrade Preparation

Subgrade for Lorson Ranch East, Filing No. 4 shall be Cement Treated Subgrade (CTS) composed of a mixture of local soil, water, and Portland cement compacted at optimum moisture. Prior to CTS construction, the existing soil should be proof-rolled to a firm and unyielding condition. Areas that deform under wheel loads should be removed and replaced. The soil should then be scarified, pulverized, 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 (4.0 % optimum), 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. 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. CTS compressive strength test results shall be submitted to the County prior to the placement of the asphalt, in part to confirm the requirement for micro fracturing (MF). Micro fracturing of the CTS shall be performed when 7-day compressive strength test results indicate CTS strength in excess of 275 psi. The subgrade should be kept in a moist cured condition for 48 to 72 hours before any micro fracturing is performed by a heavy (12-ton) steel drum vibratory roller operating at maximum amplitude. After satisfactory completion of micro fracturing the subgrade should continue to be moist cured by sprinkling or other means.

Surface Drainage

Surface drainage is important for the satisfactory performance of pavement. Wetting of the subgrade soils or base course will cause a loss of strength that can result in pavement distress. Surface drainage

should provide for efficient removal of storm-water runoff. Water should not pond on the pavement or at the edges of the pavement.

Subgrade Observations and Testing

The pavement thicknesses presented above assume pavement construction is completed in accordance with El Paso County specifications and the *Pikes Peak Region Asphalt Paving Specifications*. RMG should be present at the site during subgrade preparation, placement of fill, and construction of pavements to perform site observations and testing.

CLOSING

Our field exploration was conducted to provide geotechnical information for pavement thickness design. Variations in subsurface conditions not indicated by the borings may be encountered. This report has been prepared for **Landhuis Company** for application as an aid in the design of the proposed development in accordance with generally accepted geotechnical engineering practices. The analyses and recommendations in this report are based in part upon data obtained from exploratory borings and test pits, site observations and the information presented in referenced reports. The nature and extent of variations may not become evident until construction. If variations then become evident, RMG should be retained to re-evaluate the recommendations of this report, if necessary.

Our professional services were performed using that degree of care and skill ordinarily exercised, under similar circumstances, by geotechnical engineers practicing in this or similar localities. RMG Engineers does not warrant the work of regulatory agencies or other third parties supplying information which may have been used during the preparation of this report. No warranty, express or implied is made. Any contractor reviewing this report for bidding purposes must draw his own conclusions regarding site conditions and specific construction techniques to be used on this project.

This report is for the exclusive purpose of providing geotechnical information and pavement thickness design recommendations. The scope of services for this project does not include, either specifically or by implication, environmental assessment of the site or identification of contaminated or hazardous materials or conditions. Development of recommendations for the mitigation of environmentally related conditions, including but not limited to biological or toxicological issues, are beyond the scope of this report. If the Client desires investigation into the potential for such contamination or conditions, other studies should be undertaken.

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

FIGURES

NOT TO SCALE

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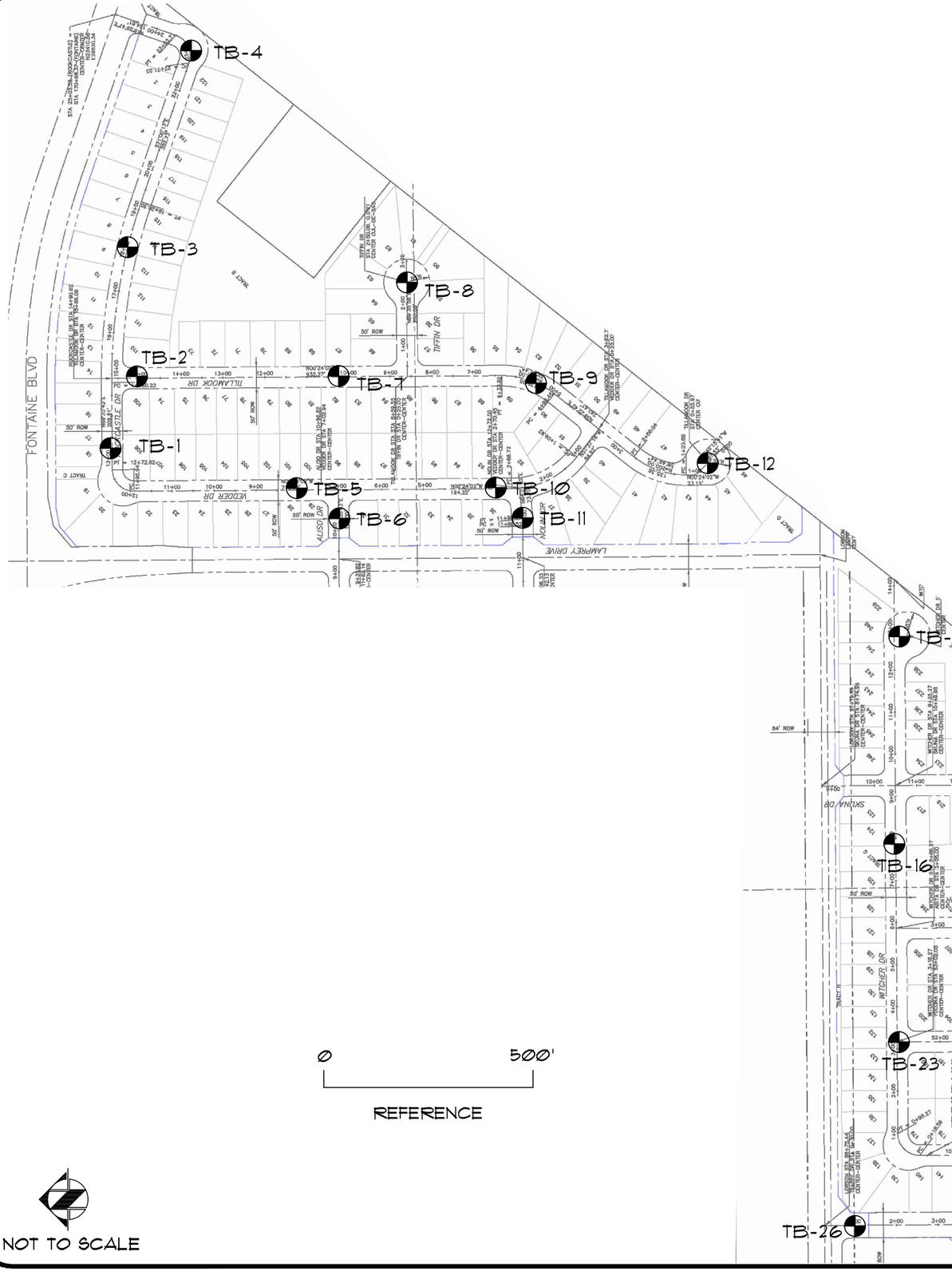
SITE VICINITY MAP

LORSON RANCH EAST FILING NO. 4
EL PASO COUNTY, COLORADO
LANDHUIS COMPANY

JOB No. 173661

FIG No. 1

DATE 5-14-2020



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Monument Office:
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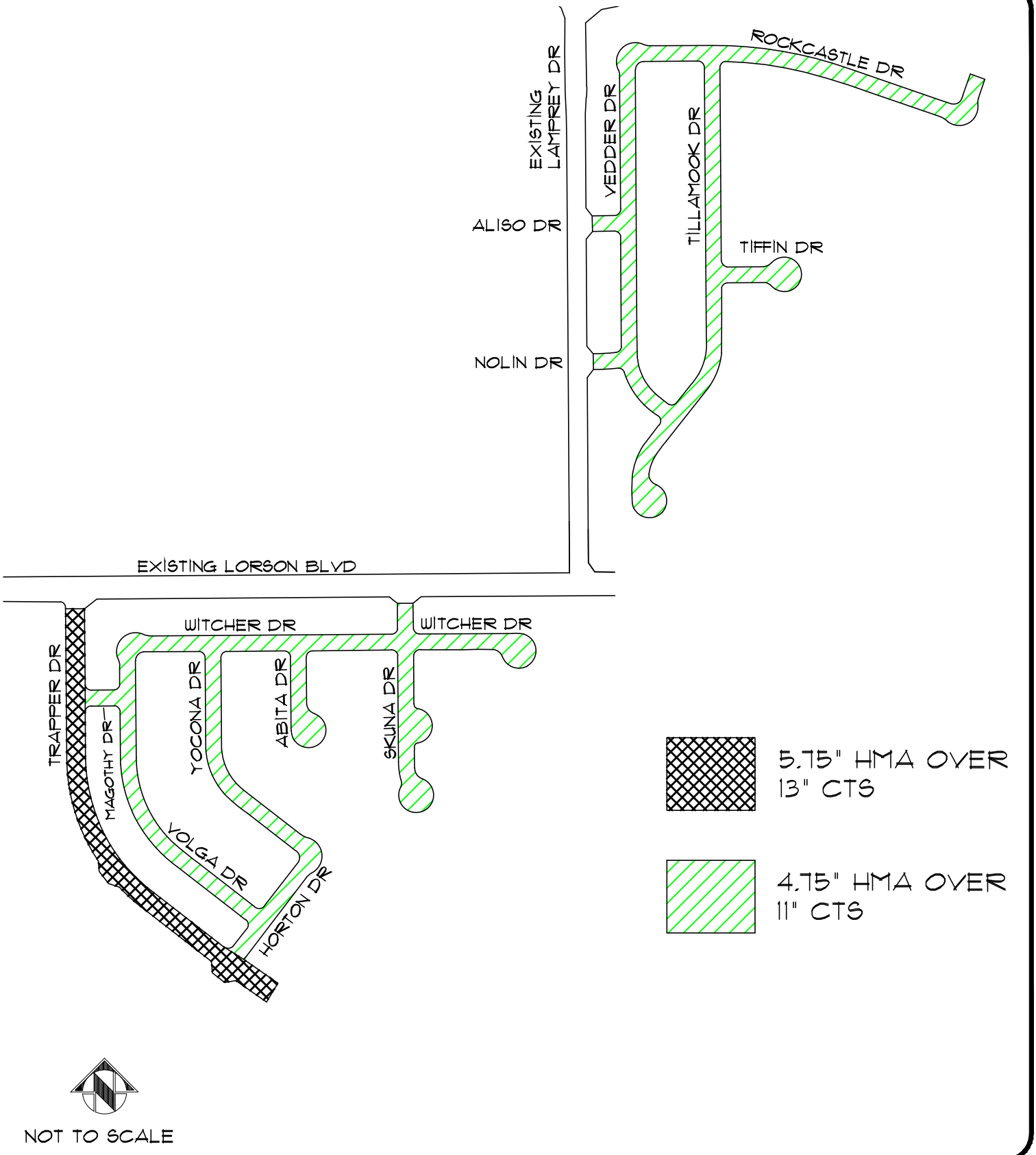
LANDHUIS COMPANY

ENGINEER:	TM
DRAWN BY:	BG
CHECKED BY:	TM
ISSUED:	5-11-2020

TEST BORING LOCATION PLAN

SHEET No.
FIG-2



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PAVEMENT DESIGN

LORSON RANCH EAST FILING NO. 4
EL PASO COUNTY, COLORADO
LANDHUIS COMPANY

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FIG No. 2.1

DATE 5-14-2020

SOILS DESCRIPTION


CLAYSTONE


FILL: CLAY, SANDY


SANDY CLAY

UNLESS NOTED OTHERWISE, ALL LABORATORY
TESTS PRESENTED HEREIN WERE PERFORMED BY:
RMG - ROCKY MOUNTAIN GROUP
2910 AUSTIN BLUFFS PARKWAY
COLORADO SPRINGS, COLORADO

SYMBOLS AND NOTES


XX — STANDARD PENETRATION TEST - MADE BY DRIVING A SPLIT-BARREL SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-1586. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


XX — UNDISTURBED CALIFORNIA SAMPLE - MADE BY DRIVING A RING-LINED SAMPLER INTO THE SOIL BY DROPPING A 140 LB. HAMMER 30", IN GENERAL ACCORDANCE WITH ASTM D-3550. NUMBER INDICATES NUMBER OF HAMMER BLOWS PER FOOT (UNLESS OTHERWISE INDICATED).


FREE WATER TABLE


DEPTH AT WHICH BORING CAVED


BULK — DISTURBED BULK SAMPLE


AUG — AUGER "CUTTINGS"

4.5 — WATER CONTENT (%)

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EXPLANATION OF TEST BORING LOGS

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FIGURE No. 3

DATE May/14/2020

TEST BORING: **1** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff, moist				18	11.1
				11	16.5

TEST BORING: **2** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, very stiff, moist				22	15.4
				23	15.9

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TEST BORING LOG

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FIGURE No. 4

DATE May/14/2020

TEST BORING: **3** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, very stiff, moist				29	8.6
				27	13.6
				29	14.0

TEST BORING: **4** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff to very stiff, moist				16	16.1
				19	12.6

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TEST BORING LOG

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FIGURE No. 5

DATE May/14/2020

TEST BORING: **5** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, very stiff, moist				29	8.7
				24	8.7

TEST BORING: **6** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff, moist				15	16.3
CLAY, SANDY, brown, very stiff, moist				33	14.6

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TEST BORING LOG

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FIGURE No. 6

DATE May/14/2020

TEST BORING: **7** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, very stiff, moist				30	7.5
				31	7.6

TEST BORING: **8** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff, moist				14	13.5
CLAY, SANDY, brown, stiff, moist				13	11.7

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TEST BORING LOG

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FIGURE No. 7

DATE May/14/2020

TEST BORING: **9** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, very stiff, moist				24	10.8
CLAY, SANDY, brown, hard, moist				45	13.4

TEST BORING: **10** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown to brown, very stiff, moist				32	8.2
				34	9.4
				28	13.2

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TEST BORING LOG

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FIGURE No. 8

DATE May/14/2020

TEST BORING: **11** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, very stiff, moist				26	10.8
				25	10.8

TEST BORING: **12** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown with rust staining, very stiff, moist				39	9.6
				26	9.0

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TEST BORING LOG

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FIGURE No. 9

DATE May/14/2020

TEST BORING: **13** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAYSTONE, SANDY, brown, hard, moist					
				50/5"	10.2
				50/5"	9.9

TEST BORING: **14** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown to dark brown with rust staining, very stiff, moist					
				20	15.8
				21	13.8

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TEST BORING LOG

JOB No. 173661

FIGURE No. 10

DATE May/14/2020

TEST BORING: **15** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown to brown, very stiff, moist				23	6.5
				20	4.9

TEST BORING: **16** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown to brown, stiff to very stiff, moist				15	9.9
				21	9.0
CLAYSTONE, SANDY, brown with rust staining, medim hard, moist				50/10"	14.1

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TEST BORING LOG

JOB No. 173661

FIGURE No. 11

DATE May/14/2020

TEST BORING: **17** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, very stiff, moist				24	10.5
				21	12.7
CLAY, SANDY, brown, stiff, moist				17	11.6

TEST BORING: **18** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown, stiff, moist				10	11.8
				13	8.2

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TEST BORING LOG

JOB No. 173661

FIGURE No. 12

DATE May/14/2020

TEST BORING: **19** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff, moist				13	11.7
CLAY, SANDY, brown, very stiff, moist				19	9.4

TEST BORING: **20** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff, moist				12	13.1
CLAY, SANDY, brown, stiff to very stiff, moist				19	8.9
				16	10.2

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TEST BORING LOG

JOB No. 173661

FIGURE No. 13

DATE May/14/2020

TEST BORING: **21** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
FILL: CLAY, SANDY, brown, stiff to very stiff, moist				11	10.1
CLAY, SANDY, brown, very stiff, moist				22	9.5

TEST BORING: **22** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, very stiff, moist				33	11.6
CLAYSTONE, SANDY, brown, medium hard, moist				50/8"	11.7

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TEST BORING LOG

JOB No. 173661

FIGURE No. 14

DATE May/14/2020

TEST BORING: **23** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, very stiff, moist				24	10.4
				29	8.4

TEST BORING: **24** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, stiff, moist				9	8.6
				10	8.6

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TEST BORING LOG

JOB No. 173661

FIGURE No. 15

DATE May/14/2020

TEST BORING: **25** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, brown, very stiff, moist				38	10.1
CLAYSTONE, SANDY, brown, medium hard, moist				50	10.2

TEST BORING: **26** ELEVATION (FT): DATE DRILLED: 4/30/20 NO GROUNDWATER ON 4/30/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
CLAY, SANDY, light brown, very stiff, moist				35	8.7
CLAYSTONE, SANDY, brown, medium hard, moist				50/11"	11.0

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TEST BORING LOG

JOB No. 173661

FIGURE No. 16

DATE May/14/2020

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.10 Sieve	% Retained No.40 Sieve	% Passing No. 200 Sieve	% Swell @ 100 psf	AASHTO Classification
1	2.0	11.1		36	21	1.3	3.1	77.9		A-6 (15)
1	4.0	16.5								
2	2.0	15.4		43	29	0.7	1.4	84.2		A-7-6 (24)
2	4.0	15.9								
3	2.0	8.6		37	21	1.4	2.8	82.0		A-6 (16)
3	4.0	13.6								
3	9.0	14.0								
4	2.0	16.1	108.1	40	27	0.0	0.5	86.3	1.2	A-6 (22)
4	4.0	12.6								
5	2.0	8.7		20	7	1.5	2.9	65.3		A-4 (2)
5	4.0	8.7								
6	2.0	16.3		39	25		0.2	89.0		A-6 (22)
6	4.0	14.6								
7	2.0	7.5		29	17		0.9	59.1		A-6 (7)
7	4.0	7.6								
8	2.0	13.5		37	23	0.9	1.8	85.8		A-6 (19)
8	4.0	11.7								
9	2.0	10.8	108.7	40	27		0.2	89.2	0.5	A-6 (23)
9	4.0	13.4								
10	2.0	8.2		36	21		0.0	77.3		A-6 (14)
10	4.0	9.4								
10	9.0	13.2								
11	2.0	10.8		33	20	0.4	0.7	79.1		A-6 (14)
11	4.0	10.8								
12	2.0	9.6		42	27		0.0	92.0		A-7-6 (25)
12	4.0	9.0								
13	2.0	10.2		37	24	0.8	2.2	91.6		A-6 (21)
13	4.0	9.9								
14	2.0	15.8		41	28	0.8	2.1	91.4		A-7-6 (25)
14	4.0	13.8								
15	2.0	6.5	112.6	29	12	1.0	2.2	75.0	0.0	A-6 (7)
15	4.0	4.9								
16	2.0	9.9		36	21	0.7	1.3	83.7		A-6 (16)
16	4.0	9.0								
16	9.0	14.1								
17	2.0	10.5		33	18		0.6	75.2		A-6 (11)
17	4.0	12.7								

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SUMMARY OF LABORATORY TEST RESULTS

JOB No. 173661
FIGURE No. 17

DATE May/14/2020

Test Boring No.	Depth	Water Content (%)	Dry Density (pcf)	Liquid Limit	Plasticity Index	% Retained No.10 Sieve	% Retained No.40 Sieve	% Passing No. 200 Sieve	% Swell @ 100 psf	AASHTO Classification
17	9.0	11.6								
18	2.0	11.8		32	19	0.3	1.2	69.5		A-6 (11)
18	4.0	8.2								
19	2.0	11.7	106.0	34	21		0.5	72.8	1.6	A-6 (13)
19	4.0	9.4								
20	2.0	13.1		35	20	1.4	2.6	78.5		A-6 (14)
20	4.0	8.9								
20	9.0	10.2								
21	2.0	10.1		34	20	2.4	3.4	71.0		A-6 (12)
21	4.0	9.5								
22	2.0	11.6		41	29	0.1	0.3	90.0		A-7-6 (26)
22	4.0	11.7								
23	2.0	10.4		40	25	1.4	2.1	83.3		A-6 (20)
23	4.0	8.4								
24	2.0	8.6	111.7	32	18	2.2	2.7	75.9	0.4	A-6 (11)
24	4.0	8.6								
25	2.0	10.1		38	25	1.9	3.4	88.0		A-6 (21)
25	4.0	10.2								
26	2.0	8.7		38	25		0.3	78.0		A-6 (18)
26	4.0	11.0								

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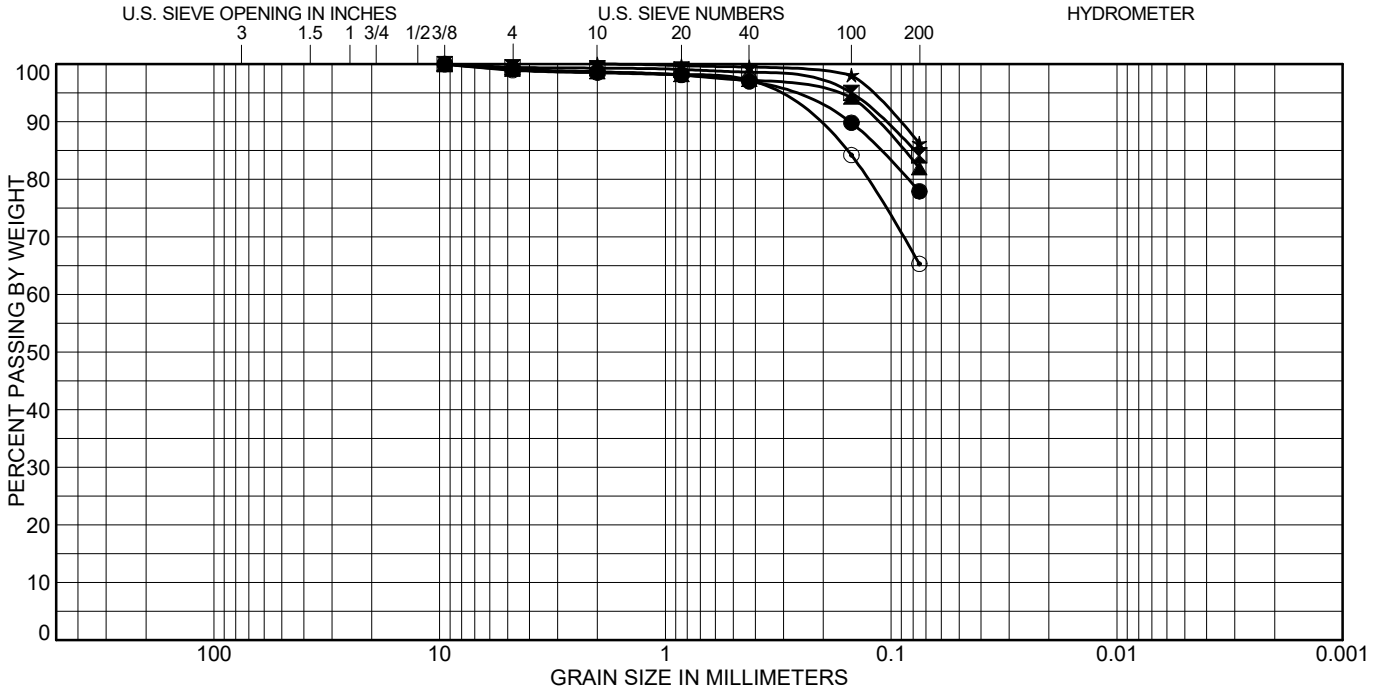
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 173661
FIGURE No. 17
PAGE 2 OF 2
DATE May/14/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	1	2.0	A-6 (15)	36	15	21		
⧓	2	2.0	A-7-6 (24)	43	14	29		
▲	3	2.0	A-6 (16)	37	16	21		
★	4	2.0	A-6 (22)	40	13	27		
⊙	5	2.0	A-4 (2)	20	13	7		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	2.0	0.9	21.2	77.9	
⧓	2	2.0	0.5	15.3	84.2	
▲	3	2.0	0.9	17.1	82.0	
★	4	2.0	0.0	13.8	86.3	
⊙	5	2.0	1.1	33.6	65.3	

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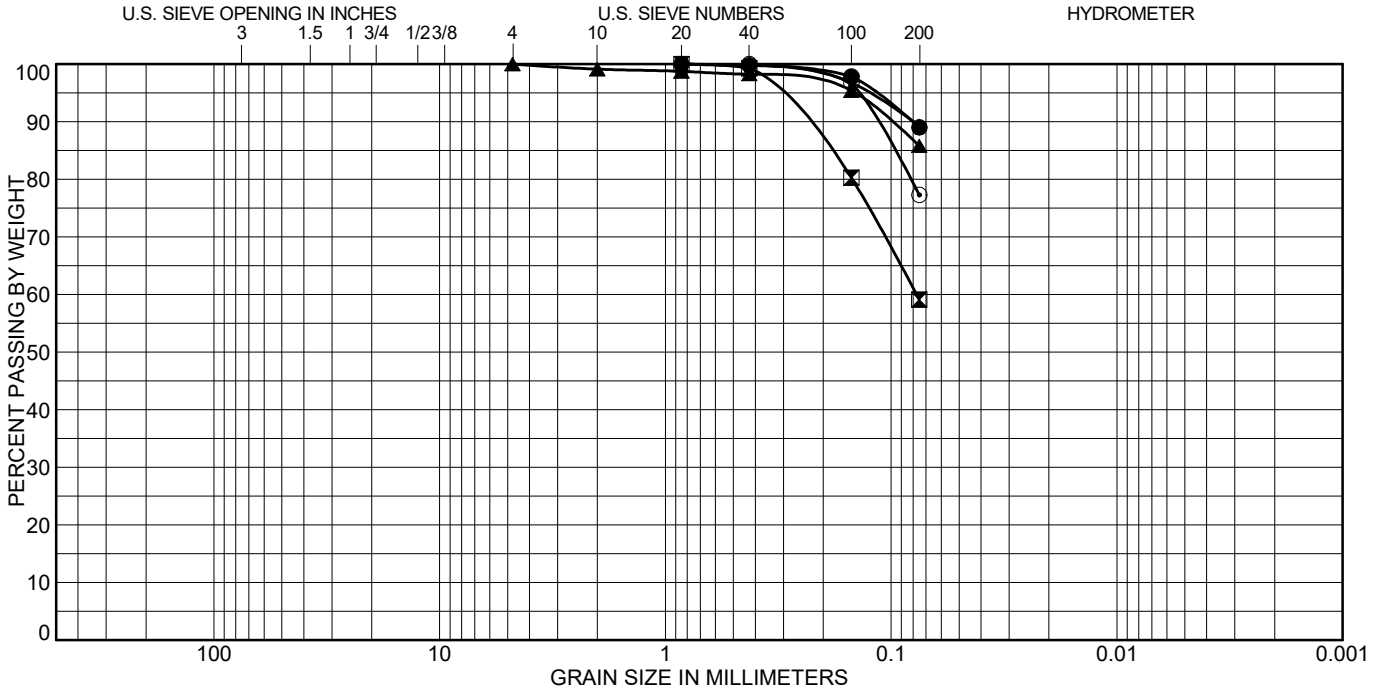
SOIL CLASSIFICATION DATA

JOB No. 173661

FIGURE No. 18

DATE May/14/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	6	2.0	A-6 (22)	39	14	25		
⧓	7	2.0	A-6 (7)	29	12	17		
▲	8	2.0	A-6 (19)	37	14	23		
★	9	2.0	A-6 (23)	40	13	27		
⊙	10	2.0	A-6 (14)	36	15	21		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	6	2.0	0.0	11.0	89.0	
⧓	7	2.0	0.0	40.9	59.1	
▲	8	2.0	0.0	14.2	85.8	
★	9	2.0	0.0	10.8	89.2	
⊙	10	2.0	0.0	22.7	77.3	

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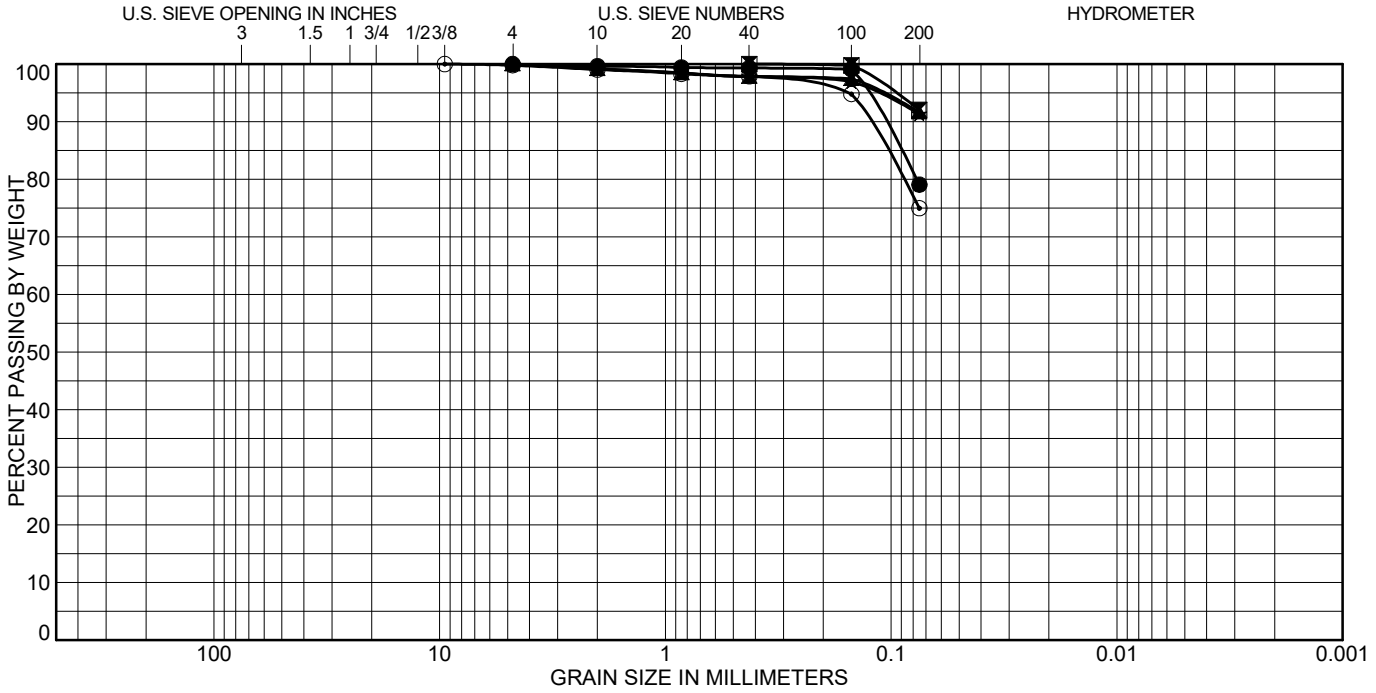
SOIL CLASSIFICATION DATA

JOB No. 173661

FIGURE No. 19

DATE May/14/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	11	2.0	A-6 (14)	33	13	20		
⧓	12	2.0	A-7-6 (25)	42	15	27		
▲	13	2.0	A-6 (21)	37	13	24		
★	14	2.0	A-7-6 (25)	41	13	28		
⊙	15	2.0	A-6 (7)	29	17	12		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	11	2.0	0.0	20.9	79.1	
⧓	12	2.0	0.0	8.0	92.0	
▲	13	2.0	0.0	8.4	91.6	
★	14	2.0	0.0	8.6	91.4	
⊙	15	2.0	0.2	24.8	75.0	

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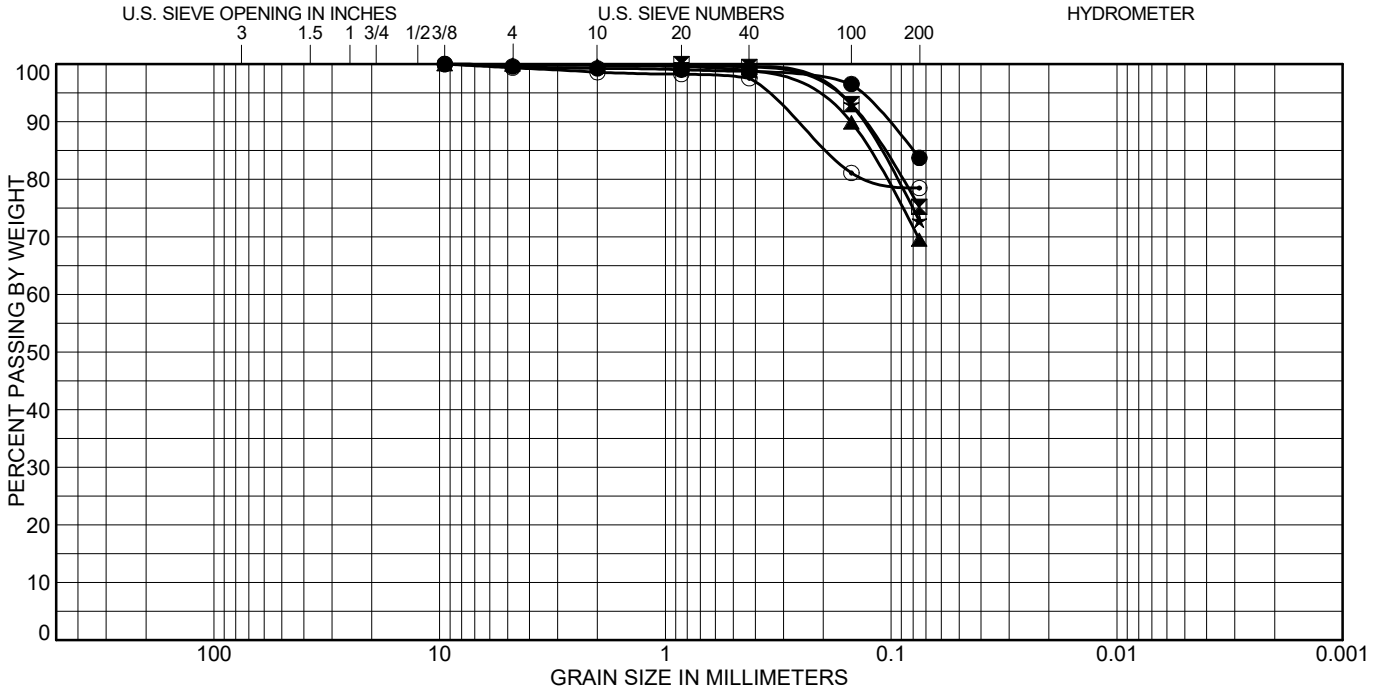
SOIL CLASSIFICATION DATA

JOB No. 173661

FIGURE No. 20

DATE May/14/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	16	2.0	A-6 (16)	36	15	21		
⧓	17	2.0	A-6 (11)	33	15	18		
▲	18	2.0	A-6 (11)	32	13	19		
★	19	2.0	A-6 (13)	34	13	21		
⊙	20	2.0	A-6 (14)	35	15	20		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	16	2.0	0.4	15.9	83.7	
⧓	17	2.0	0.0	24.8	75.2	
▲	18	2.0	0.1	30.4	69.5	
★	19	2.0	0.0	27.2	72.8	
⊙	20	2.0	0.6	20.9	78.5	

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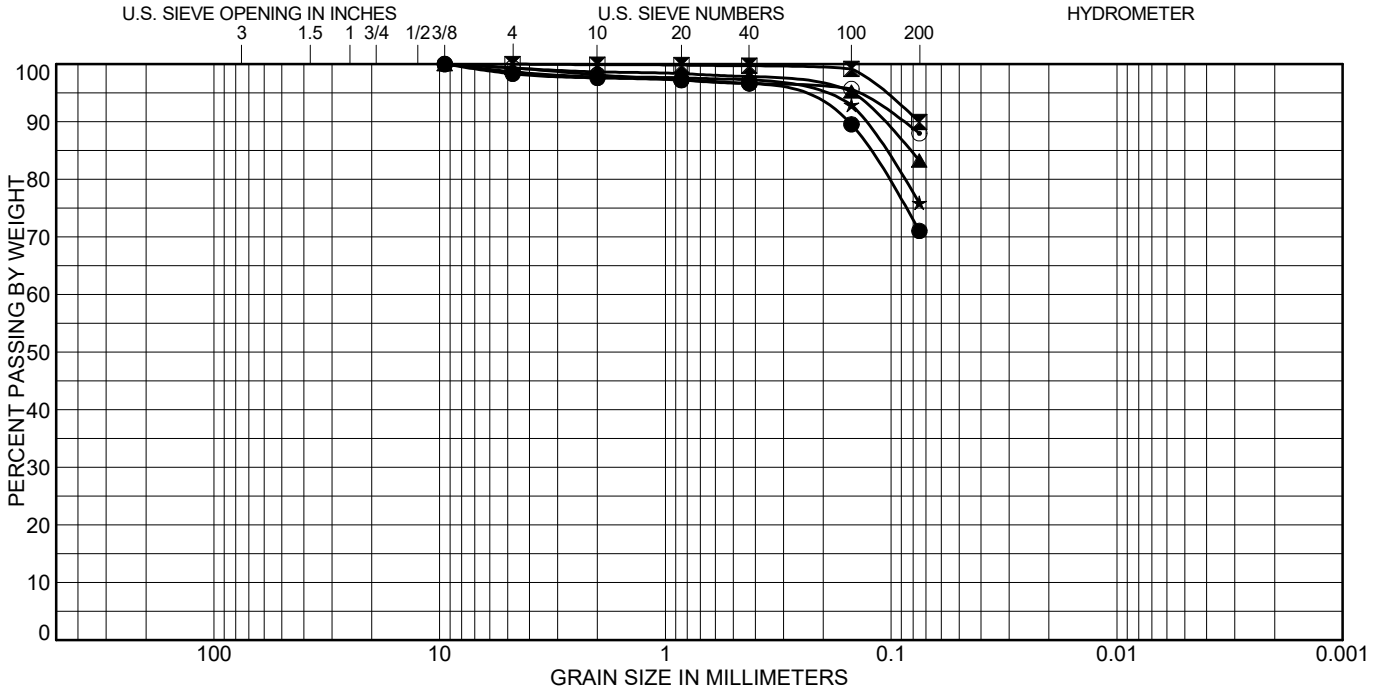
SOIL CLASSIFICATION DATA

JOB No. 173661

FIGURE No. 21

DATE May/14/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring		Depth (ft)	Classification	LL	PL	PI	Cc	Cu
●	21	2.0	A-6 (12)	34	14	20		
⧓	22	2.0	A-7-6 (26)	41	12	29		
▲	23	2.0	A-6 (20)	40	15	25		
★	24	2.0	A-6 (11)	32	14	18		
⊙	25	2.0	A-6 (21)	38	13	25		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	21	2.0	1.7	27.3	71.0	
⧓	22	2.0	0.0	10.0	90.0	
▲	23	2.0	0.7	16.0	83.3	
★	24	2.0	1.3	22.8	75.9	
⊙	25	2.0	0.7	11.4	88.0	

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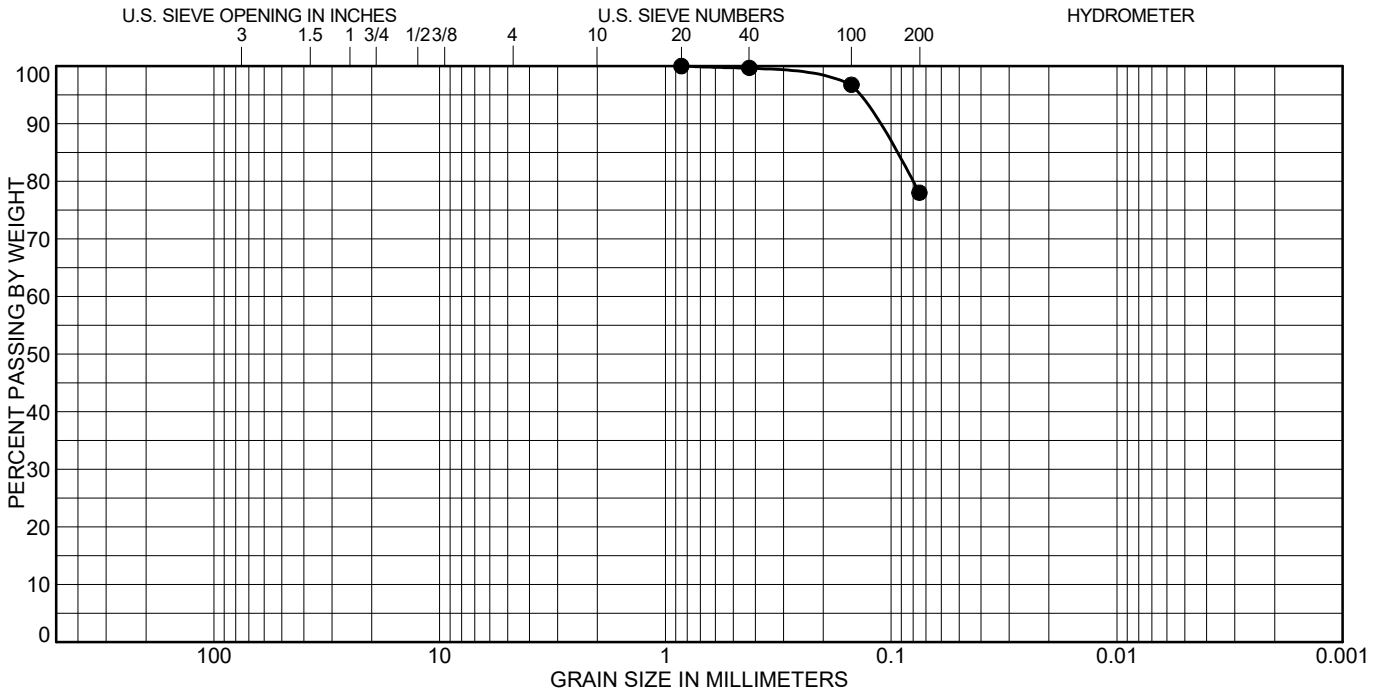
SOIL CLASSIFICATION DATA

JOB No. 173661

FIGURE No. 22

DATE May/14/2020



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Test Boring	Depth (ft)	Classification	LL	PL	PI	Cc	Cu
● 26	2.0	A-6 (18)	38	13	25		

Test Boring	Depth (ft)	%Gravel	%Sand	%Silt	%Clay
● 26	2.0	0.0	22.0	78.0	

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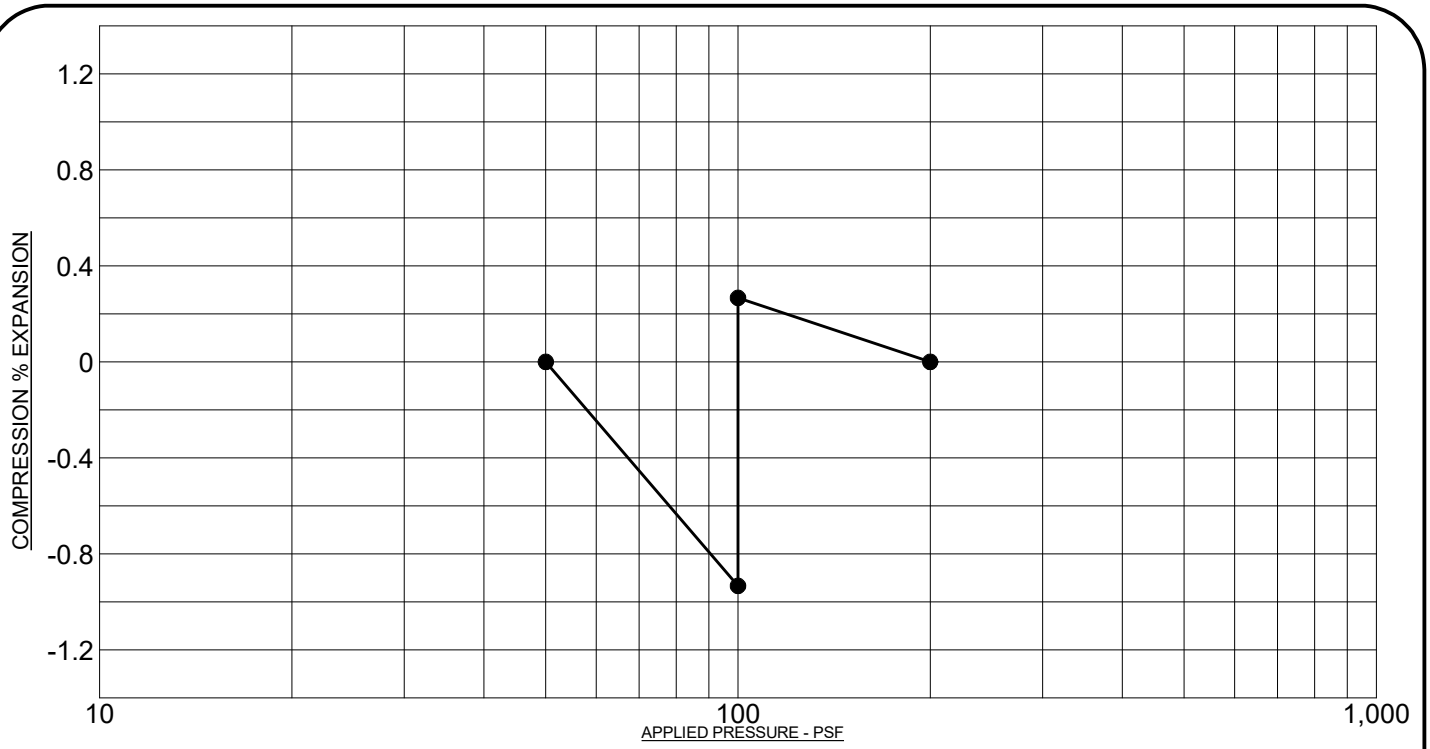
SOIL CLASSIFICATION DATA

JOB No. 173661

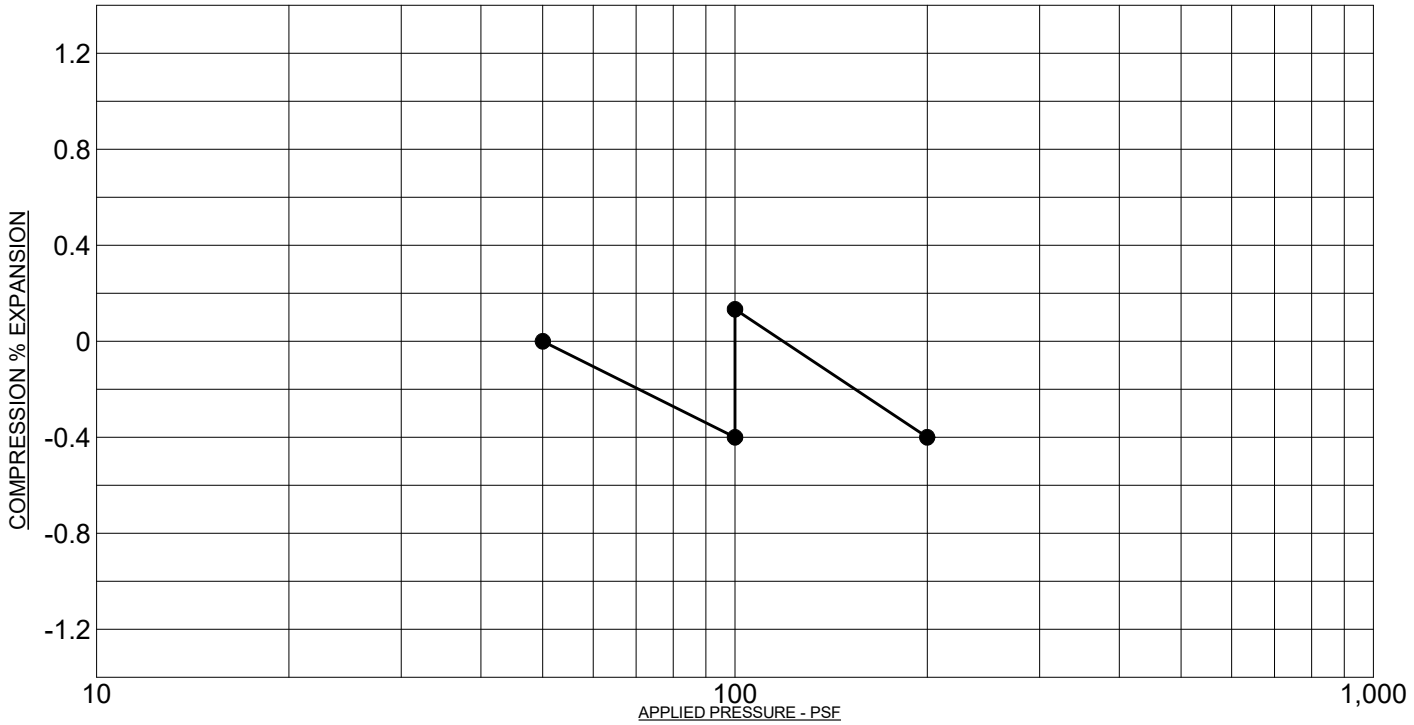
FIGURE No. 23

DATE May/14/2020



PROJECT: **Lorson Ranch East Filing No. 4, El Paso County, Colorado**
SAMPLE DESCRIPTION: **FILL: CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **4 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **108.1 PCF**
NATURAL MOISTURE CONTENT: **16.1%**
PERCENT SWELL/COMPRESSION: **1.2**



PROJECT: **Lorson Ranch East Filing No. 4, El Paso County, Colorado**
SAMPLE DESCRIPTION: **FILL: CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **9 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **108.7 PCF**
NATURAL MOISTURE CONTENT: **10.8%**
PERCENT SWELL/COMPRESSION: **0.5**

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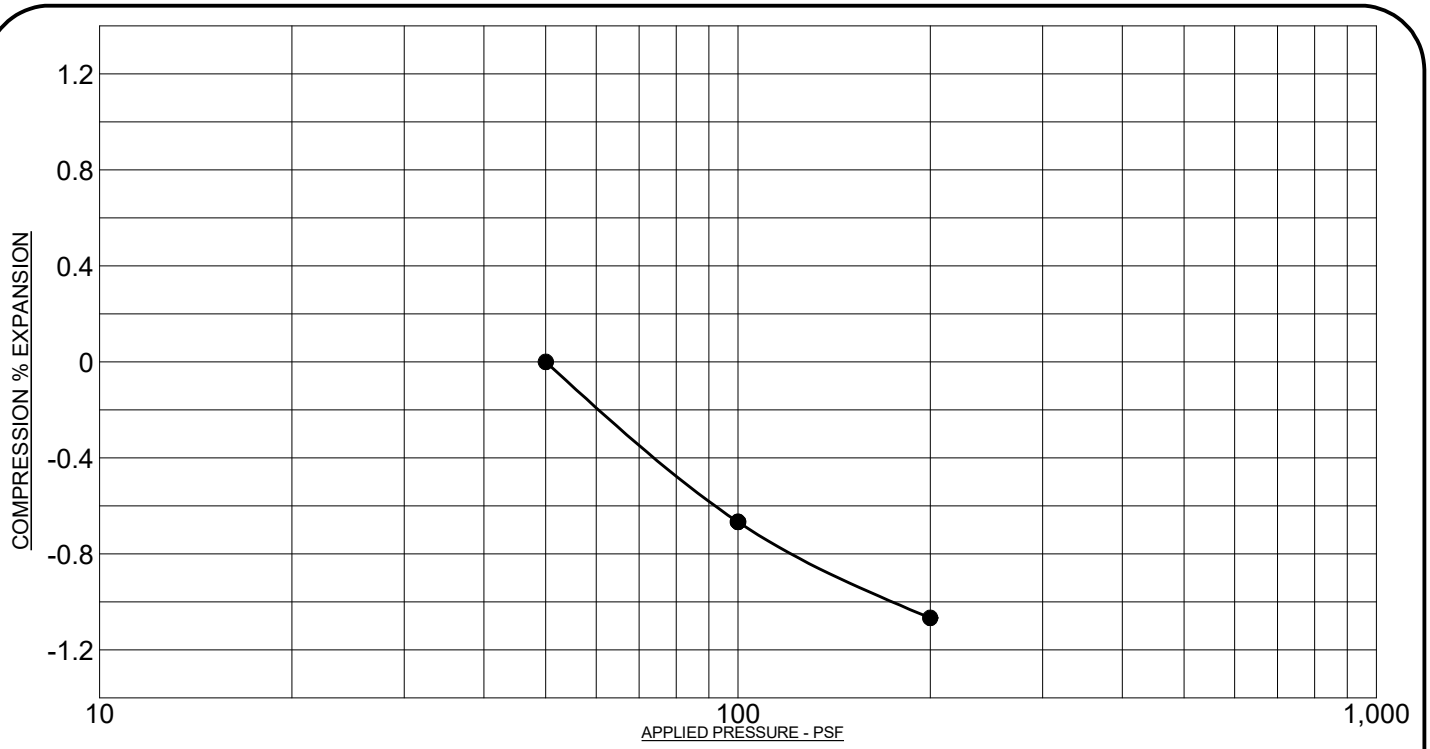
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 173661

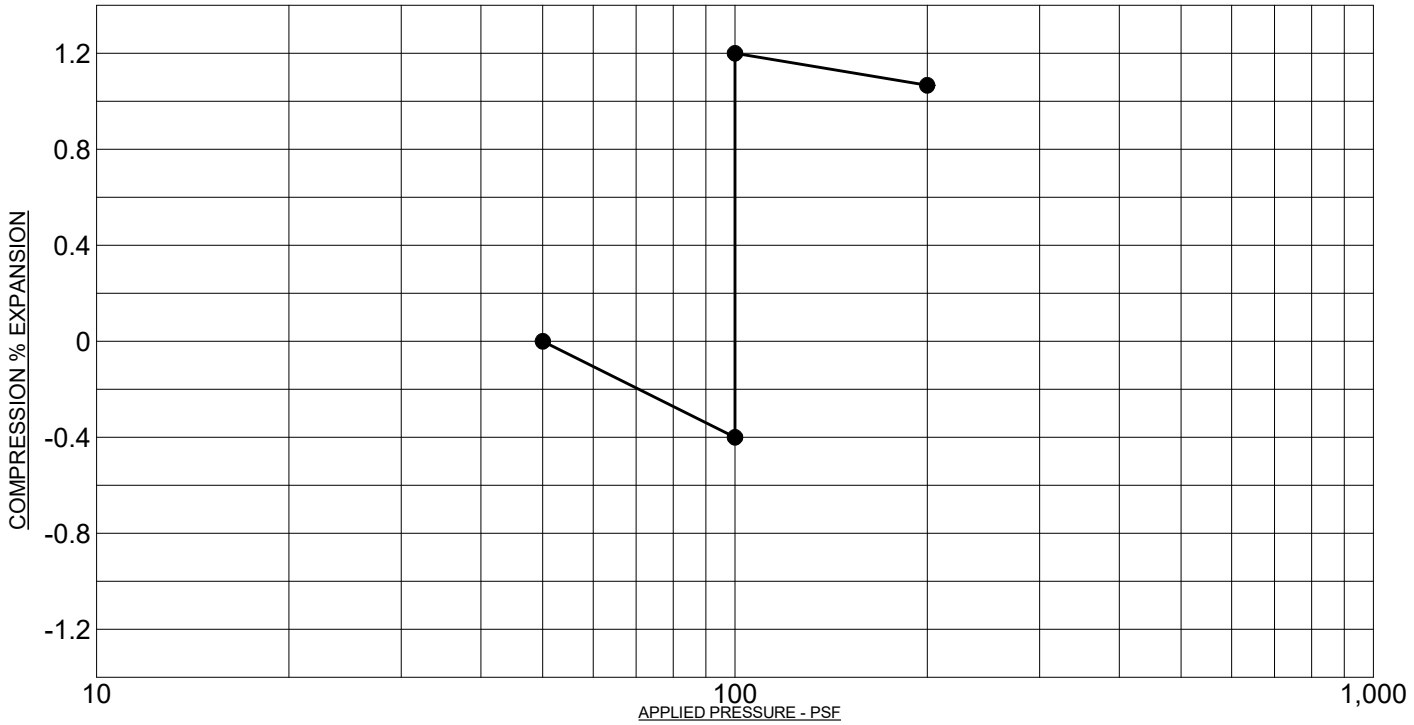
FIGURE No. 24

DATE May/14/2020



PROJECT: **Lorson Ranch East Filing No. 4, El Paso County, Colorado**
SAMPLE DESCRIPTION: **CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **15 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **112.6 PCF**
NATURAL MOISTURE CONTENT: **6.5%**
PERCENT SWELL/COMPRESSION: **0.0**



PROJECT: **Lorson Ranch East Filing No. 4, El Paso County, Colorado**
SAMPLE DESCRIPTION: **FILL: CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **19 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **106.0 PCF**
NATURAL MOISTURE CONTENT: **11.7%**
PERCENT SWELL/COMPRESSION: **1.6**

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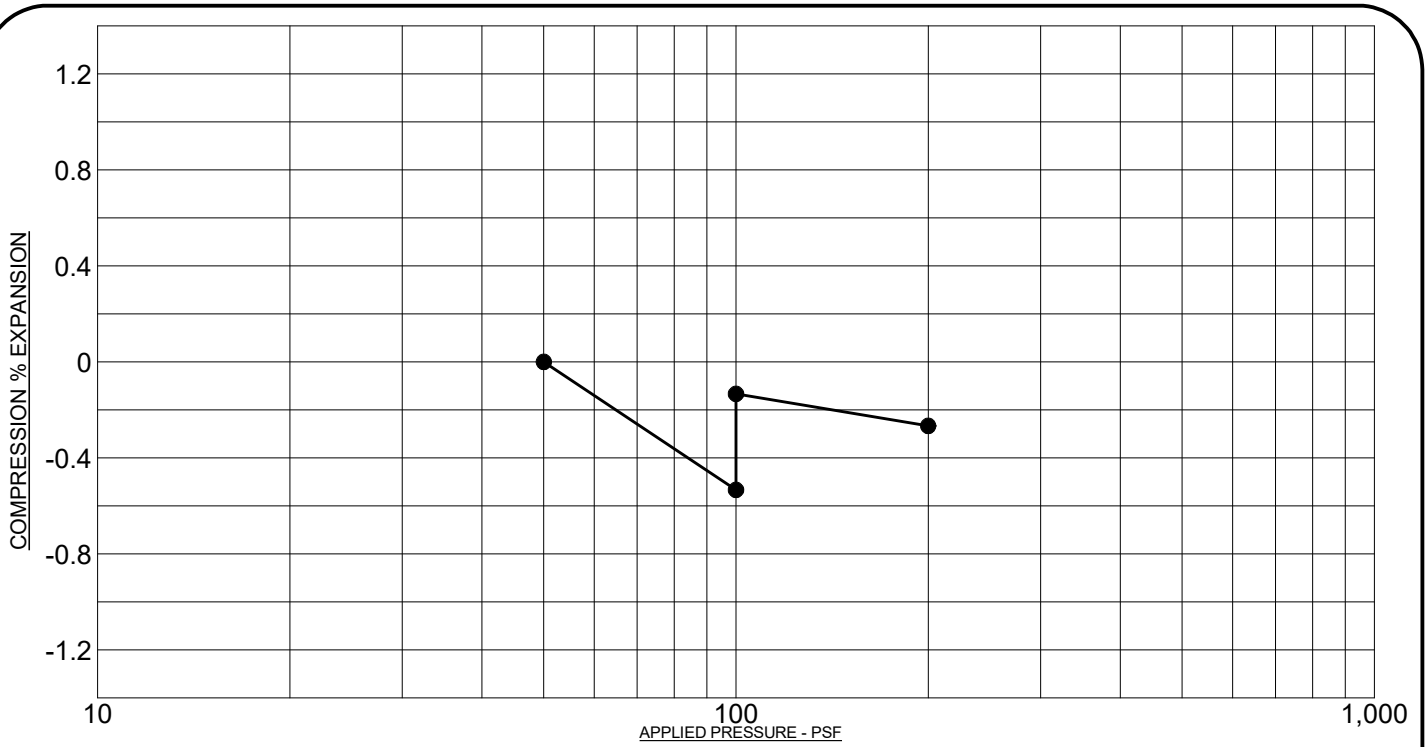
SWELL/CONSOLIDATION TEST RESULTS

JOB No. 173661

FIGURE No. 25

DATE May/14/2020



PROJECT: **Lorson Ranch East Filing No. 4, El Paso County, Colorado**
SAMPLE DESCRIPTION: **CLAY, SANDY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **24 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **111.7 PCF**
NATURAL MOISTURE CONTENT: **8.6%**
PERCENT SWELL/COMPRESSION: **0.4**

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SWELL/CONSOLIDATION TEST RESULTS

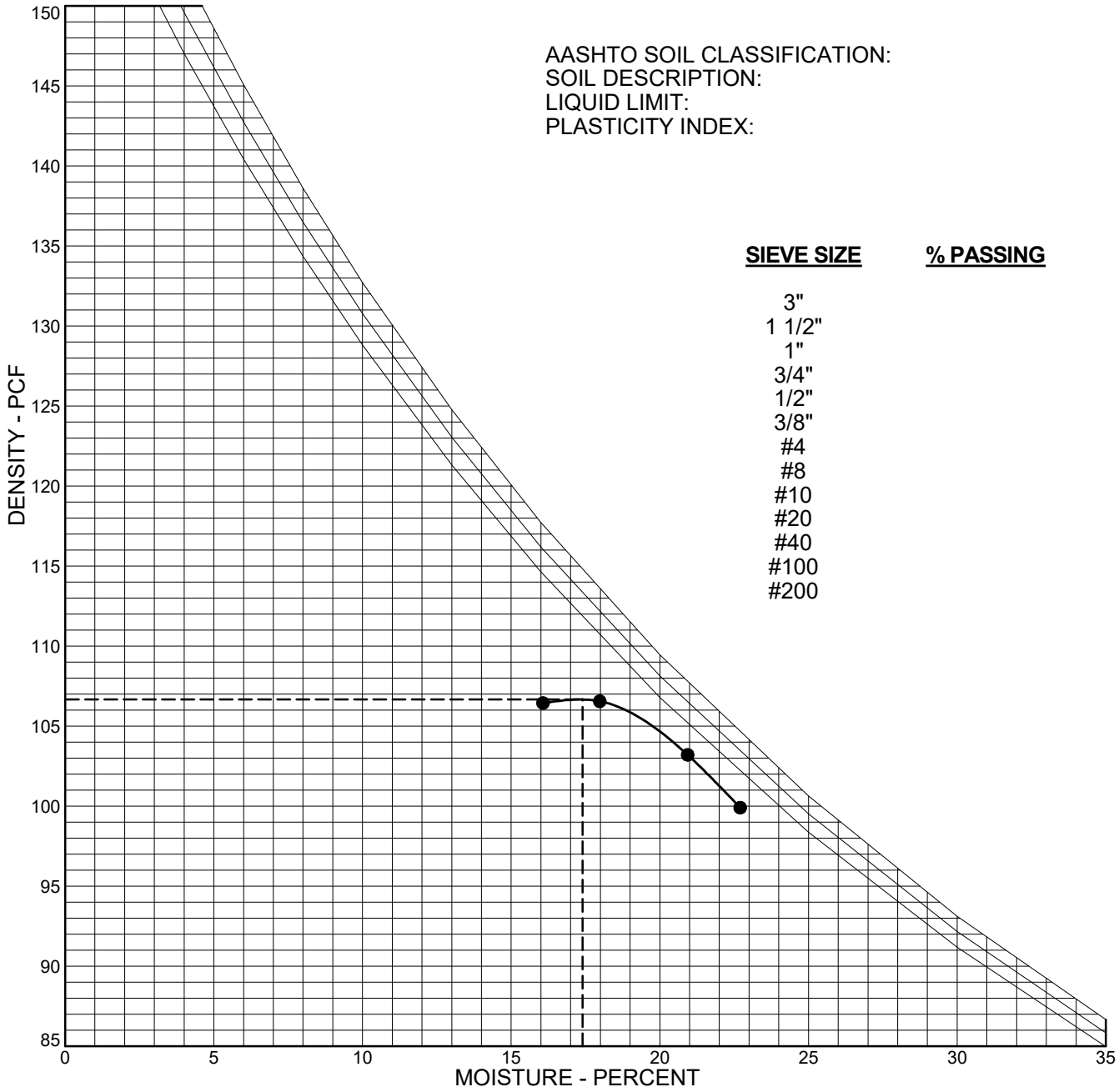
JOB No. 173661

FIGURE No. 26

DATE May/14/2020

CLIENT: **Landhuis Company** SAMPLE NUMBER: **A-6 PROCTOR**

PROJECT: Lorson Ranch East Filing No. 4, El Paso County, Colorado



AASHTO SOIL CLASSIFICATION:
SOIL DESCRIPTION:
LIQUID LIMIT:
PLASTICITY INDEX:

SIEVE SIZE	% PASSING
3"	
1 1/2"	
1"	
3/4"	
1/2"	
3/8"	
#4	
#8	
#10	
#20	
#40	
#100	
#200	

DESIGNATION **AASHTO 698A**
MAX. DRY DENSITY **106.8 pcf**
OPTIMUM MOISTURE **17.4 %**
FRACTION USED **#4**
MOLD VOLUME **0.0333 cu.ft.**

NOTE:
ZERO AIR VOIDS CURVES PLOTTED FOR:
Gs = 2.60
Gs = 2.65
Gs = 2.70

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MOISTURE-DENSITY RELATION CURVE

JOB No. 173661

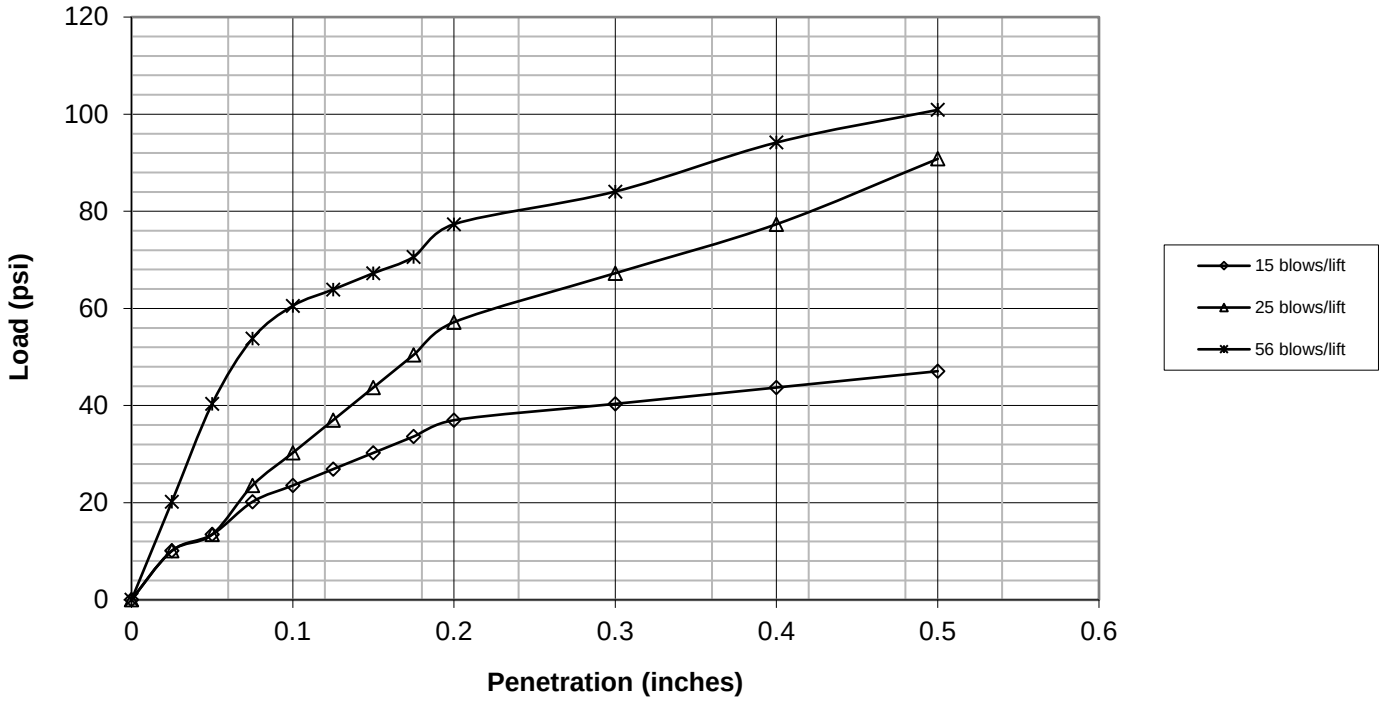
FIGURE No. 27

DATE May/14/2020

CALIFORNIA BEARING RATIO TEST RESULTS

PROJECT: Lorson Ranch East Filing 4
JOB NUMBER: 173661 TEST DATE: 5/8/2020
AASHTO A-6
SAMPLE NUMBER: CBR
SAMPLE LOCATION: Combined Bulk Sample
SOIL DESCRIPTION: Silty and Clayey Sand

	15 blows/lift	25 blows/lift	56 blows/lift
Penetration (in)	Load (psi)	Load (psi)	Load (psi)
0.000	0.0	0.0	0.0
0.025	10.1	10.1	20.2
0.050	13.5	13.5	40.4
0.075	20.2	23.5	53.8
0.100	23.5	30.3	60.5
0.125	26.9	37.0	63.9
0.150	30.3	43.7	67.3
0.175	33.6	50.4	70.6
0.200	37.0	57.2	77.3
0.300	40.4	67.3	84.1
0.400	43.7	77.3	94.2
0.500	47.1	90.8	100.9



	15 blows/lift	25 blows/lift	56 blows/lift
Corrected Penetration (in)	Corrected Load (psi)	Corrected Load (psi)	Corrected Load (psi)
0.1	2.4	3.0	6.1
0.2	2.5	3.8	5.2

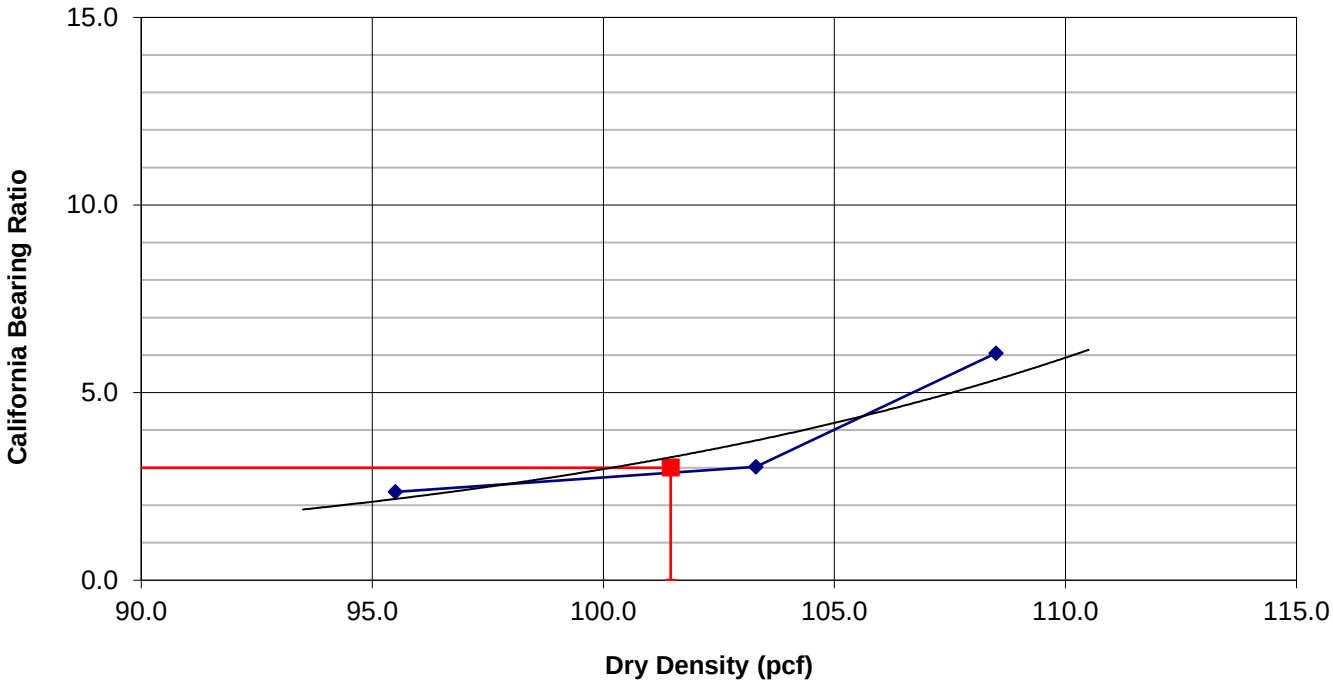
Figure No. 28

CALIFORNIA BEARING RATIO TEST RESULTS

PROJECT:	Lorson Ranch East Filing 4
JOB NUMBER:	173661
AASHTO CLASSIFICATION:	A-6
SAMPLE NUMBER:	CBR
SAMPLE LOCATION:	Combined Bulk Sample
SOIL DESCRIPTION:	Silty and Clayey Sand

TEST DATE: 5/8/2020

	15 blows/lift	25 blows/lift	56 blows/lift
Corrected California Bearing Ratio	2.4	3.0	6.1
Dry Density (pcf)	95.5	103.3	108.5
Percent Compaction	89	97	102
Percent Moisture After Soaking	30.4	24.3	25.3
Percent Expansion/Compression	1.8	1.5	1.0
Surcharge Weight (lbs)	12.60	12.60	12.60



California Bearing Ratio	**3.0**
Dry Density (pcf)	106.8
Percent Compaction	95.00%
Target Dry Density	101.5
Compaction Test Method	ASTM D-698
Condition of sample	Soaked

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Figure No. 29

APPENDIX A

1993 AASHTO Empirical Equation for Flexible Pavements

Equation Solver | Variable Descriptions and Typical Values | Precautions

Type in data in the grey boxes and click the calculate button to see the output. To make additional calculations, change the desired input data and click the calculate button again. Click on the text descriptions of the input or output variables for more information.

INPUT

1. Loading

Total Design ESALs (W_{18}): 821000

2. Reliability

Reliability Level in percent (R): 85

Combined Standard Error (S_0): 0.44

3. Serviceability

Initial Serviceability Index (p_i): 4.2

Terminal Serviceability Index (p_t): 2

4. Layer Parameters

Number of Base Layers: 0

	a	m	M_R	Min. Depth
Surface	0.44	1.0	N/A	0
Subgrade	N/A	N/A	4500	N/A

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R): -1.037

ΔPSI: 2.2

Design Structural Number (SN): 3.795

2. Layer Depths (to the nearest 1/2 inch)

Surface: 9

Total SN based on layer depths: 3.96

See Solution Details

Comments

Calculate

1993 AASHTO Empirical Equation for Flexible Pavements

Equation Solver | Variable Descriptions and Typical Values | Precautions

Type in data in the grey boxes and click the calculate button to see the output. To make additional calculations, change the desired input data and click the calculate button again. Click on the text descriptions of the input or output variables for more information.

INPUT

1. Loading

Total Design ESALs (W_{18}): 292000

2. Reliability

Reliability Level in percent (R): 80

Combined Standard Error (S_0): 0.44

3. Serviceability

Initial Serviceability Index (p_i): 4.2

Terminal Serviceability Index (p_t): 2

4. Layer Parameters

Number of Base Layers: 0

	a	m	M_R	Min. Depth
Surface	0.44	1.0	N/A	0
Subgrade	N/A	N/A	4500	N/A

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R): -0.841

ΔPSI: 2.2

Design Structural Number (SN): 3.145

2. Layer Depths (to the nearest 1/2 inch)

Surface: 7.5

Total SN based on layer depths: 3.3

See Solution Details

Comments

Calculate