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Materials Testing
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Approved
By: Elizabeth Nijkamp
Date:08/13/2020
El Paso County Planning & Community Development

PAVEMENT DESIGN REPORT

Carriage Meadows South Filing No. 2
at Lorson Ranch
El Paso County, Colorado

SF-20-011

PREPARED FOR:

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

JOB NO. 176256

Revised August 3, 2020
July 23, 2020

Respectfully Submitted,

RMG – Rocky Mountain Group

Brian Griffith, E.I.
Geotechnical Staff Engineer

Reviewed by,

RMG – Rocky Mountain Group

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Sr. Geotechnical Project Engineer

COLORADO LICENSED
GEOFF WEBSTER
8/3/20
45046
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

GENERAL SITE AND PROJECT DESCTIPTION

Location

Carriage Meadows South Filing No. 2 is located southeast of the intersection of Fontaine Boulevard and Marksheffel Road in El Paso County, Colorado. Jimmy Camp Creek forms the eastern boundary of the development. 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 subdivision is a mixture of public streets, private streets, and private driveways.

The proposed streets included in this investigation are shown on Figure 2. Rubicon Drive and Firesteel Drive are classified as Residential Urban Local as shown on Sheet Number C0.4 of the Typical Sections Plan for Carriage Meadows South Filing 2 (SF-20-001). Rubicon Drive and Firesteel Drive will be public streets within 50-foot wide Public Right-of-Ways (ROW), and will have two 15-foot wide travel lanes.

Rubicon Heights is classified as Residential Urban Local Low Volume as shown on Sheet Number C0.4. Rubicon Heights will be a private street within a 50-foot wide Public Access/Drainage/Utility Tract, with 24-feet of paved driving surface.

Ambling Heights, Paluxy Heights, and Chagrin Heights will be private driveways within 40-foot drainage/utility easements. These three streets will consist of Portland Cement Concrete Pavement (PCCP). Pavement recommendations are provided herein.

FIELD INVESTIGATION AND SUBSURFACE CONDITIONS

Drilling

The subsurface conditions on the site were investigated by drilling four (4) exploratory test borings at approximately 250-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 and 5.

Subsurface Materials

The subsurface materials encountered in the test borings consisted primarily of silty and clayey sand. Combined bulk samples of the material classified as SM and SC according to the Unified Classification System. For pavement design, bulk samples of the soil classified as A-2-4 and A-6 soils in accordance with the American Association of State Highway and Transportation Officials (ASSHTO) classification system.

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. A Summary of Laboratory Test Results is presented in Figure 6. Soil Classification Data are presented in Figure 7.

Swell/consolidation tests were performed to determine the expansive potential of the soil. Swell potential evaluation based upon laboratory testing indicates the subgrade soil exhibited an average swell potential of 0.5 percent. Swell/Consolidation Test results are presented in Figure 8.

California Bearing Ratio tests (CBR) were performed for the A-6 soil. 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 11. The Moisture-Density Relation Curve is presented in Figure 9. CBR Test Results are presented in Figures 10 and 11.

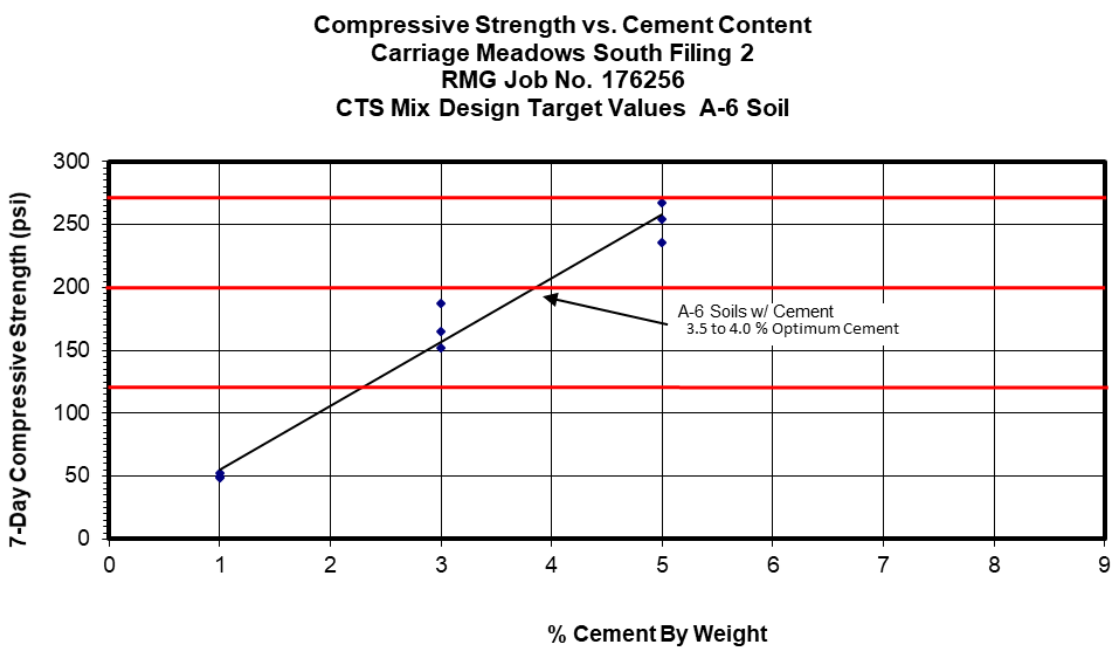
The developer may elect to install a composite roadway section consisting of Hot Mix Asphalt over Cement-Treated Subgrade (CTS). RMG performed a Mix Design for this composite section. Specimens of soil composed of the A-6 subgrade materials and Portland cement were prepared by varying the "percent cement 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	60	607.0	609.1	48
1B	7	2.12	12.566	65	657.6	659.7	53
1C	7	2.12	12.566	61	617.1	619.3	49
3A	7	2.12	12.566	233	2357.3	2359.4	188
3B	7	2.12	12.566	189	1912.1	1914.2	152
3C	7	2.12	12.566	205	2074.0	2076.1	165
5A	7	2.12	12.566	332	3358.8	3361.0	267
5B	7	2.12	12.566	316	3197.0	3199.1	255
5C	7	2.12	12.566	293	2964.3	2966.4	236

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 3.5 to 4.0 percent cement is recommended in all roadway sections to develop mid-range 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. Pavement designs have been prepared using a strength coefficient of 0.11 for both CTS and ABC (Table D-3). The recommended pavement sections shown on Figure 2.1 are supported by the calculations below.

Street Classification – Residential Urban Local

1) Rubicon Drive, Firesteel Drive
   ESAL = 292,000 (Table D-2)
   Serviceability Index = 2.0 (Table D-1)
   Reliability = 80 percent (Table D-1)

2) Strength coefficients (Table D-3)
   Asphalt (HMA): $a_1 = 0.44$
   CTS/ABC: $a_2 = 0.11$

3) Subgrade
   M_r = CBR x 1500 = 11 x 1500 = 16,500 psi

4) Structural number (SN) = 1.95 (1993 AASHTO Empirical Equation, Appendix A)

5) Composite asphalt/base course section
   Minimum HMA thickness = D_1 = 3 inches (Table D-2)
   CTS/ABC thickness = $D_2 = \{SN - (D_1 \times a_1)\} / a_2 = \{1.95 - (3 \times 0.44)\} / 0.11 = 5.7$ inches
   Use Minimum CTS/ABC Thickness = 8-inches (Table D-2)

6) Check SN = (3 x 0.44) + (8 x 0.11) = 2.2 > 1.95 (Min. SN required) => OK

Street Classification – Residential Urban Local - Low Volume

1) Rubicon Heights
   ESAL = 36,500 (Table D-2)
   Serviceability Index = 2.0 (Table D-1)
   Reliability = 80 percent (Table D-1)

2) Strength coefficients (Table D-3)
   Asphalt (HMA): $a_1 = 0.44$
   CTS/ABC: $a_2 = 0.11$

3) Subgrade
   M_r = CBR x 1500 = 11 x 1500 = 16,500 psi

4) Structural number (SN) = 1.35 (1993 AASHTO Empirical Equation, Appendix A)

5) Composite asphalt/base course section
   Minimum HMA thickness = D_1 = 3 inches (Table D-2)
   CTS/ABC thickness = $D_2 = \{SN - (D_1 \times a_1)\} / a_2 = \{1.35 - (3 \times 0.44)\} / 0.11 = 0.3$ inches
   Use Minimum ABC Thickness = 4-inches (Table D-2)

6) Check SN = (3 x 0.44) + (4 x 0.11) = 1.76 > 1.35 (Min. SN required) => OK

Pavement Thickness

Based on the soil types and the design calculations, the recommended pavement sections are presented below and on Figure 2.1. Recommended pavement sections are shown for both the CTS option and an ABC over prepared subgrade option.

Recommended Pavement Sections – Public Streets

Public Streets	HMA (in)	CTS (in)	ABC (in)	Prepared Subgrade (in)
Rubicon Drive, Firesteel Drive	3.0	8.0	-	-
Rubicon Drive, Firesteel Drive	3.0	-	8.0	12.0
Optimal CTS Percent Cement by Weight = 3.5 to 4.0%				

Recommended Pavement Sections – Private Streets

Private Streets	HMA (in)	CTS (in)	ABC (in)	Prepared Subgrade (in)
Rubicon Heights	3.0	4.0	-	-
Rubicon Heights	3.0	-	4.0	12.0
Optimal CTS Percent Cement by Weight = 3.5 to 4.0%				

Recommended Pavement Sections – Private Driveways

Private Streets	Portland Cement Concrete Pavement (PCCP) (in.)	CTS (in)	Prepared Subgrade (in)
Ambling Heights, Paluxy Heights, Chagrin Heights	5.0	8.0	-
Ambling Heights, Paluxy Heights, Chagrin Heights	5.0	-	12.0
Optimal CTS Percent Cement by Weight = 3.5 to 4.0%			

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*.

Concrete pavement mix design should emphasize strength and durability, and be prepared by a pavement engineer registered in the State of Colorado. All aspects of concrete pavement design should be in accordance with ACI 330R-08, or latest edition.

Concrete Pavement Joints

Concrete pavement does not require distributed steel reinforcement. Random cracking is best controlled by the judicious use of contraction joints. Contraction joints should be constructed and spaced in accordance with guidelines presented in ACI 330R-08, or latest edition. Contraction joint patterns should divide the pavement into approximately square panels. For 5-inch thick concrete pavement, joint spacing should not exceed 12.5 feet in any direction.

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

<u>CTS Option</u>

Subgrade for Carriage Meadows South, Filing No. 2 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 (3.5 to 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 is 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.

ABC Option

A composite section of HMA over ABC may be placed atop a 12-inch layer of prepared subgrade. Pavement areas should have topsoil, organic material, and debris removed, and be cleared and grubbed to minimum 24-inches. The upper 6 inches of exposed soil should be scarified and moisture conditioned to facilitate compaction (usually within 2 percent of the optimum moisture content) and compacted to firm and unyielding condition. Subgrade should then be brought to grade by installing clean granular, non-expansive soil in 8-inch loose lifts and compacted to 95 percent of the maximum dry density as determined by the Modified Proctor test (ASTM D-1557). The subgrade should then be proof-rolled with a heavy, pneumatic tired vehicle, and any areas that deform under wheel loads should be removed and replaced with clean material and recompacted. Subgrade construction should continue until 12-inches of prepared subgrade has been placed.

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

This report has been prepared for the exclusive purpose of providing geotechnical engineering information and recommendations for development described in this report. RMG should be retained to review the final construction documents prior to construction to verify our findings, conclusions and recommendations have been appropriately implemented.

This report has been prepared for the exclusive use by the **Landhuis Company** as an aid in the design and construction 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 test borings, 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 review the recommendations presented in this report considering the varied condition, and either verify or modify them in writing.

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 does not warrant the work of regulatory agencies or other third parties supplying information that may have been

used during the preparation of this report. No warranty, express or implied is made by the preparation of this report. Third parties reviewing this report should draw their own conclusions regarding site conditions and specific construction techniques to be used on this project.

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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Northern Office:
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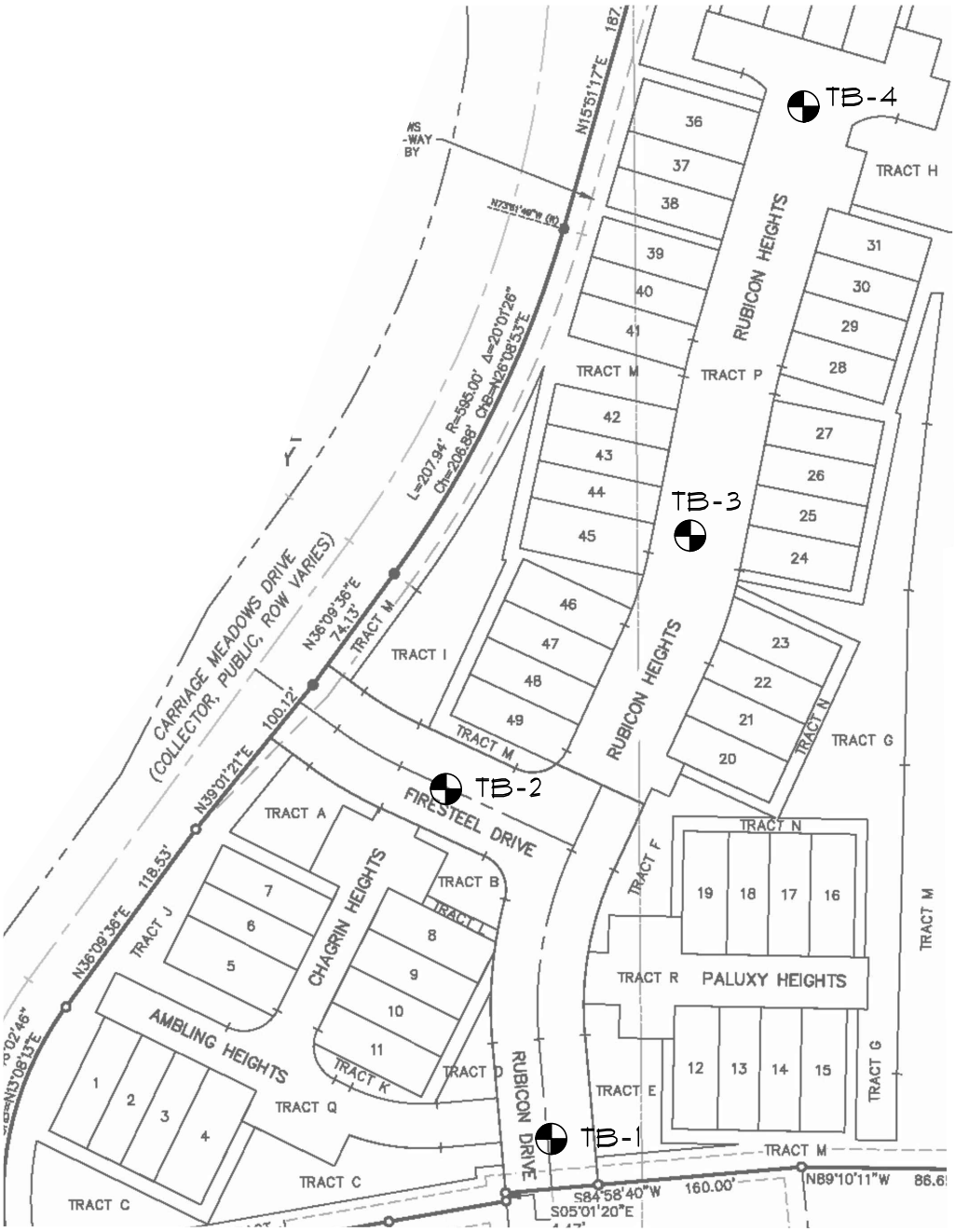
SITE VICINITY MAP

CARRIAGE MEADOWS SOUTH
AT LORSON RANCH, FILING NO. 2
EL PASO COUNTY, COLORADO
LANDHUIS COMPANY

JOB No. 176256

FIG No. 1

DATE 7-23-2020



REFERENCE

NOT TO SCALE

DENOTES APPROXIMATE LOCATION OF TEST BORINGS

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(970) 330-1071

TEST BORING LOCATION PLAN

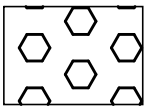
CARRIAGE MEADOWS SOUTH
AT LORSON RANCH, FILING NO. 2
EL PASO COUNTY, COLORADO
LANDHUIS COMPANY

JOB No. 176256

FIG No. 2

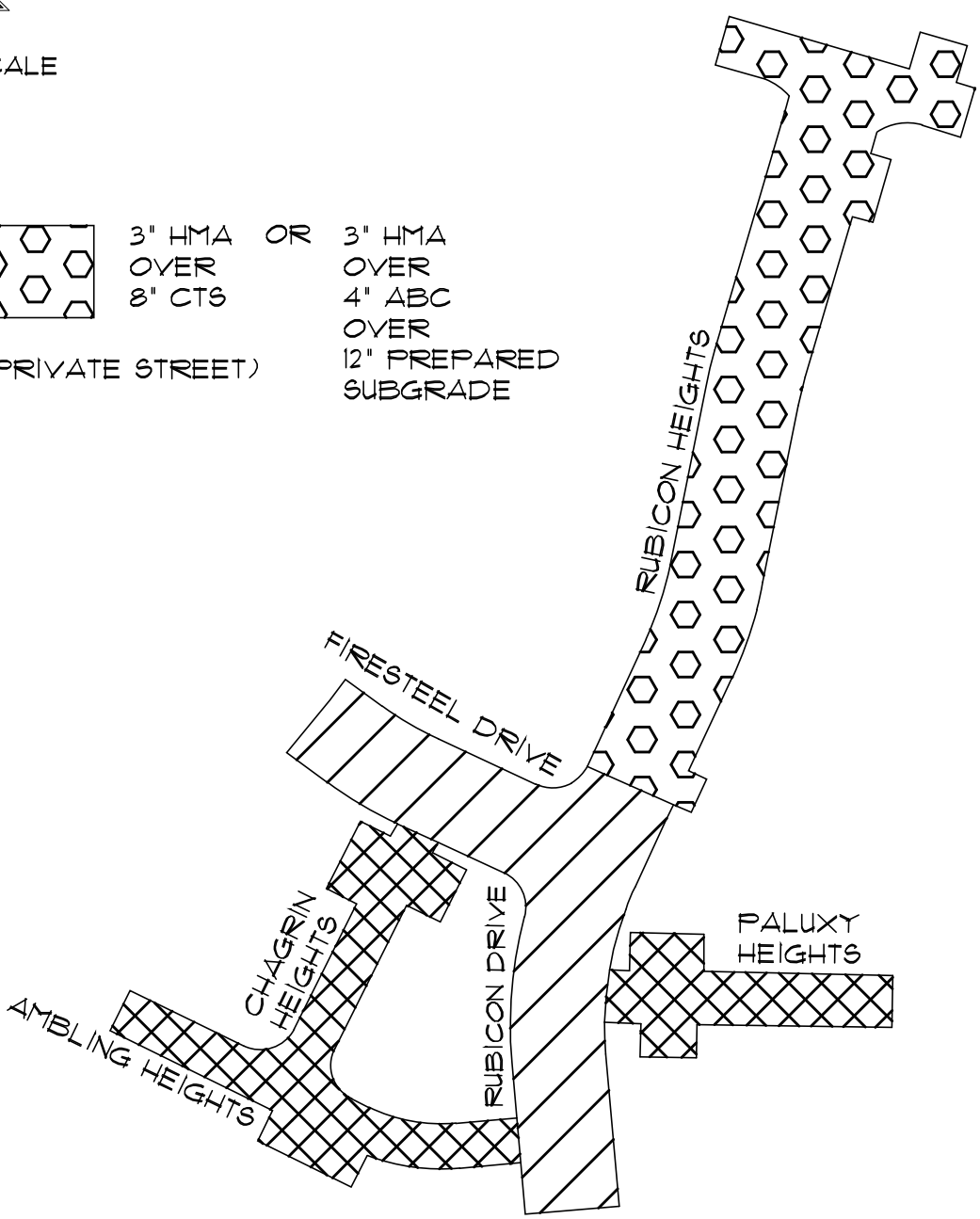
DATE 7-23-2020

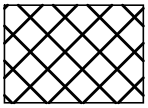
NOT TO SCALE



3" HMA OVER 8" CTS OR 3" HMA OVER 4" ABC OVER 12" PREPARED SUBGRADE

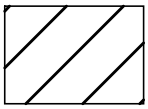
(PRIVATE STREET)





5" PCCP OVER 8" CTS OR 5" PCCP OVER 12" PREPARED SUBGRADE

(PRIVATE DRIVEWAYS)



3" HMA OVER 8" CTS OR 3" HMA OVER 8" ABC OVER 12" PREPARED SUBGRADE

(PUBLIC STREETS)

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RECOMMENDED PAVEMENT SECTIONS

CARRIAGE MEADOWS SOUTH
AT LORSON RANCH, FILING NO. 2
EL PASO COUNTY, COLORADO
LANDHUIS COMPANY

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FIG No. 2.1

DATE 8-3-2020

SOILS DESCRIPTION

CLAYEY SAND

SILTY SAND

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

JOB No. 176256

FIGURE No. 3

DATE Jul/23/2020

TEST BORING: **1** ELEVATION (FT): DATE DRILLED: 6/18/20 NO GROUNDWATER ON 6/18/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, light brown, loose, moist					
				13	6.1
				17	5.2
	5				

TEST BORING: **2** ELEVATION (FT): DATE DRILLED: 6/18/20 NO GROUNDWATER ON 6/18/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, SILTY, light brown, loose, moist					
				12	5.3
				14	4.8
	5				

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TEST BORING LOG

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FIGURE No. 4

DATE Jul/23/2020

TEST BORING: **3** ELEVATION (FT): DATE DRILLED: 6/18/20 NO GROUNDWATER ON 6/18/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, CLAYEY, brown, loose to medium dense, moist				11	13.8
	5			19	9.9
SAND, SILTY, brown, loose to medium dense, moist					
	10			8	9.2

TEST BORING: **4** ELEVATION (FT): DATE DRILLED: 6/18/20 NO GROUNDWATER ON 6/18/20	DEPTH (FT)	SYMBOL	SAMPLES	BLOWS PER FT.	WATER CONTENT %
SAND, CLAYEY, brown, loose, moist				13	11.2
SAND, SILTY, brown, loose to medium dense, moist				23	5.9
	5				

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TEST BORING LOG

JOB No. 176256

FIGURE No. 5

DATE Jul/23/2020

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	6.1		NP	NP	2.6	36.5	18.9		A-2-4 (0)
1	4.0	5.2								
2	2.0	5.3		NP	NP	2.1	45.6	15.0		A-2-4 (0)
2	4.0	4.8								
3	2.0	13.8	96.7	27	12	1.9	22.6	37.6	0.1	A-6 (1)
3	4.0	9.9								
3	9.0	9.2								
4	2.0	11.2	98.7	28	12	5.9	25.7	37.6	1.0	A-6 (1)
4	4.0	5.9								

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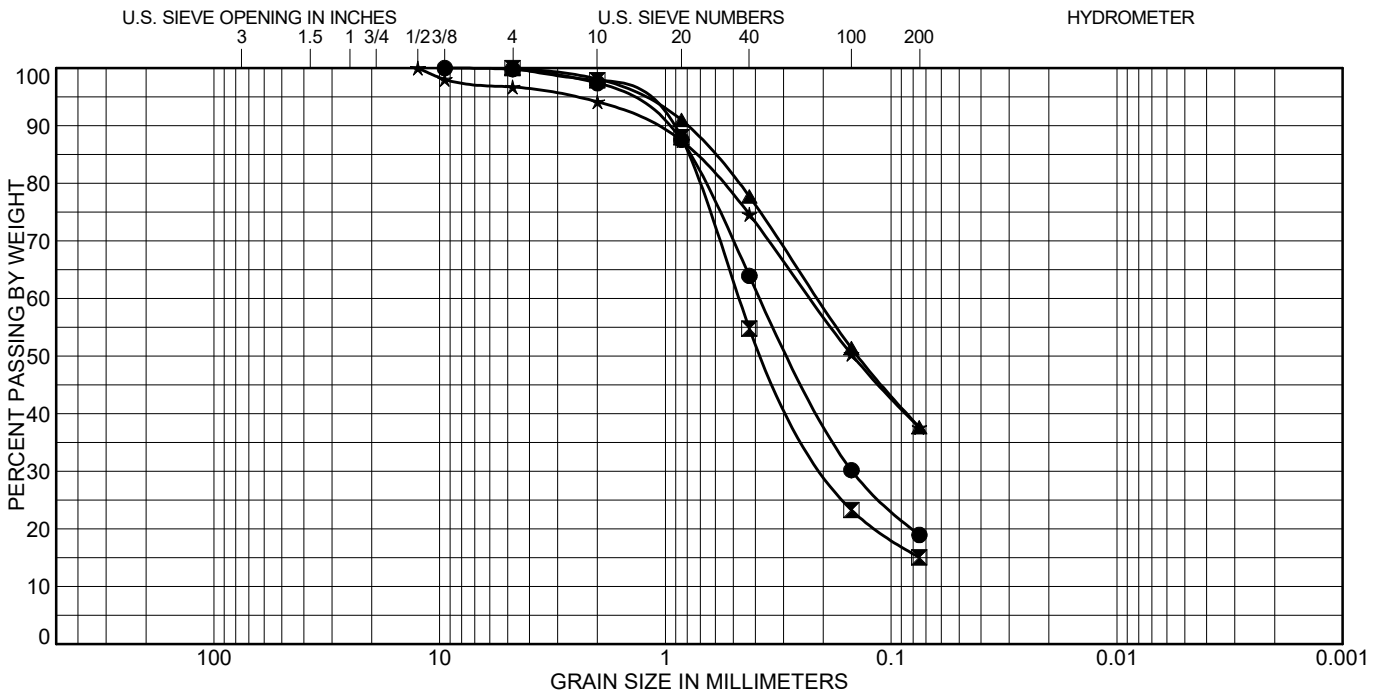
SUMMARY OF LABORATORY TEST RESULTS

JOB No. 176256
FIGURE No. 6
PAGE 1 OF 1
DATE Jul/23/2020



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-2-4 (0)	NP	NP	NP		
⧗	2	2.0	A-2-4 (0)	NP	NP	NP		
▲	3	2.0	A-6 (1)	27	15	12		
★	4	2.0	A-6 (1)	28	16	12		

Test Boring		Depth (ft)	%Gravel	%Sand	%Silt	%Clay
●	1	2.0	0.2	80.9	18.9	
⧗	2	2.0	0.0	85.0	15.0	
▲	3	2.0	0.0	62.4	37.6	
★	4	2.0	3.3	59.1	37.6	

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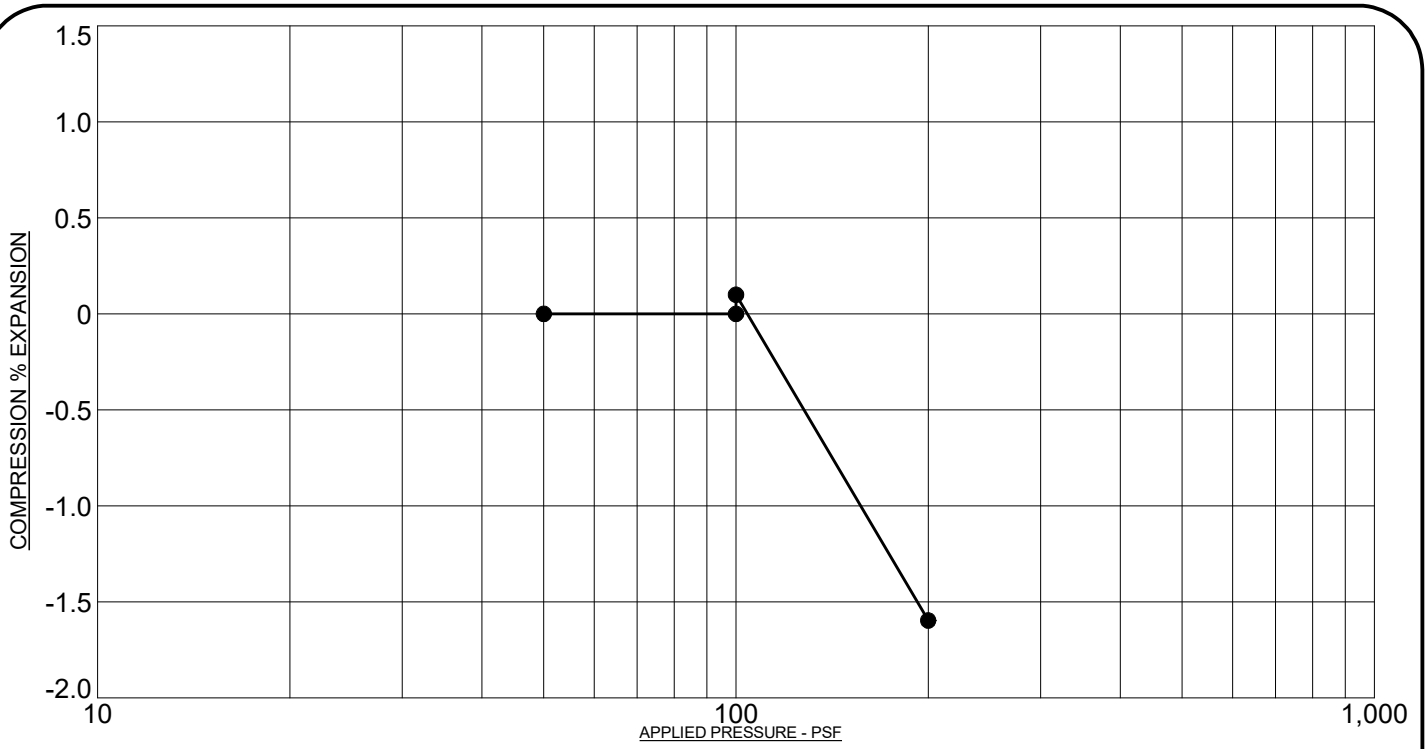
SOIL CLASSIFICATION DATA

JOB No. 176256

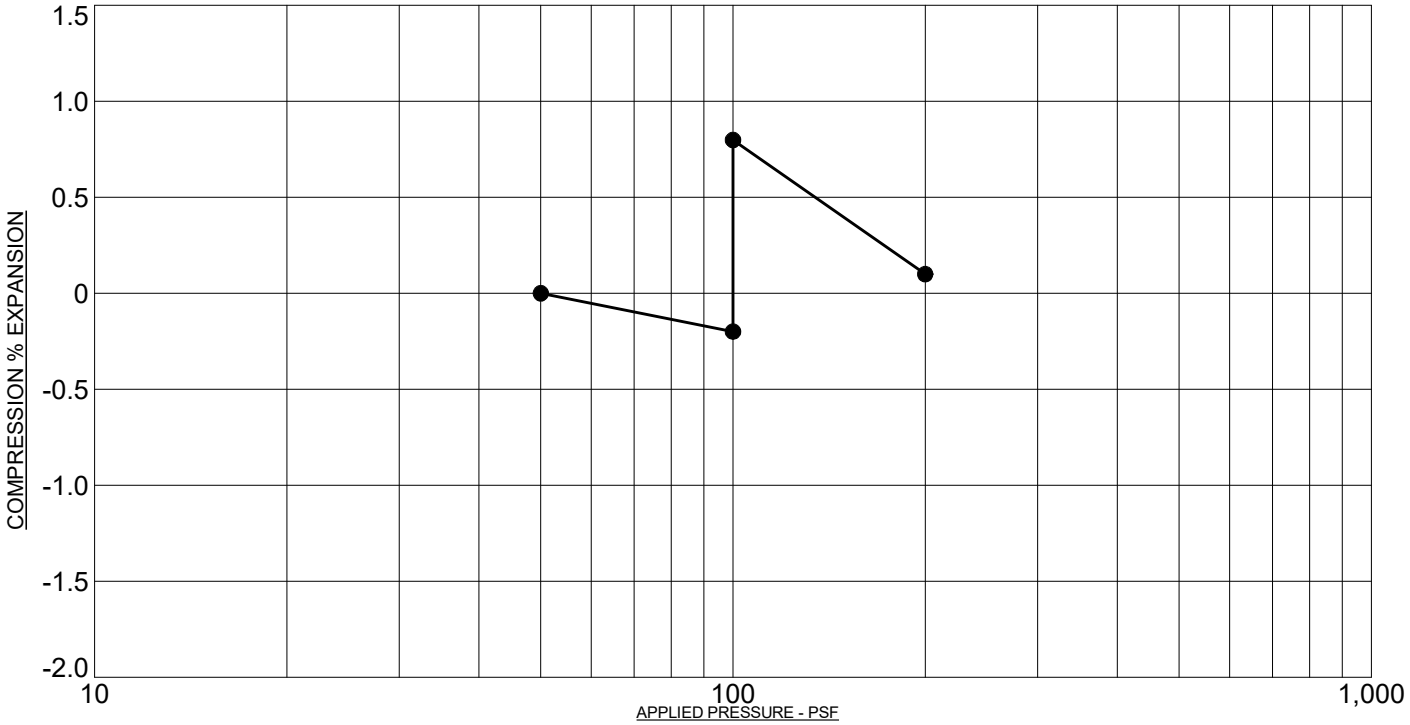
FIGURE No. 7

DATE Jul/23/2020



PROJECT: **Carriage Meadows South, Filing No. 2, El Paso County, Colorado**
SAMPLE DESCRIPTION: **SAND, CLAYEY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **3 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **96.7 PCF**
NATURAL MOISTURE CONTENT: **13.8%**
PERCENT SWELL/COMPRESSION: **0.1**



PROJECT: **Carriage Meadows South, Filing No. 2, El Paso County, Colorado**
SAMPLE DESCRIPTION: **SAND, CLAYEY**
NOTE: SAMPLE WAS INUNDATED WITH WATER AT 100 PSF

SAMPLE LOCATION: **4 @ 2 FT**
NATURAL DRY UNIT WEIGHT: **98.7 PCF**
NATURAL MOISTURE CONTENT: **11.2%**
PERCENT SWELL/COMPRESSION: **1.0**

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SOUTHERN COLORADO, DENVER METRO, NORTHERN COLORADO

SWELL/CONSOLIDATION TEST RESULTS

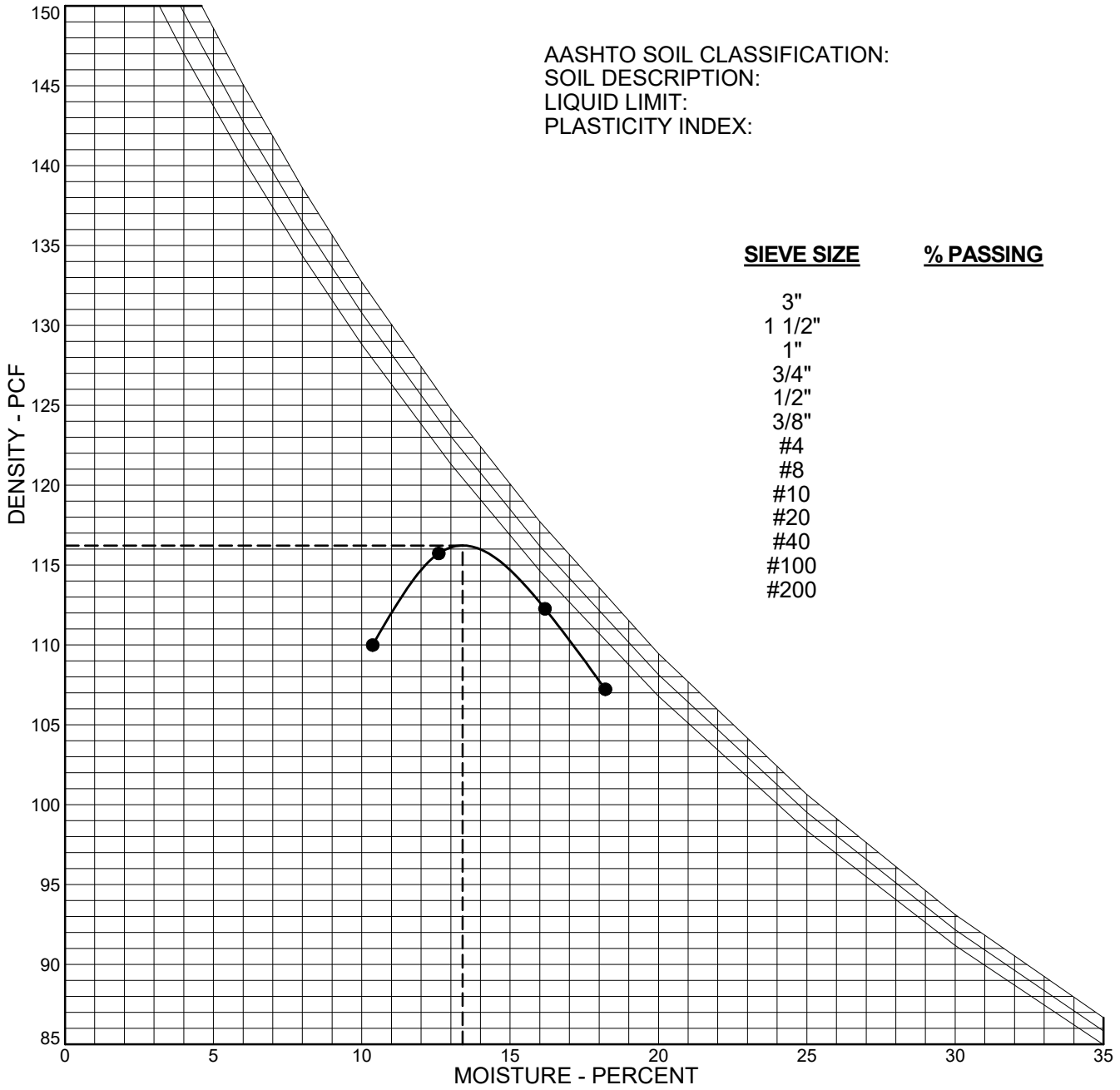
JOB No. 176256

FIGURE No. 8

DATE Jul/23/2020

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

PROJECT: Carriage Meadows South, Filing No. 2, 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 **116.2 pcf**
OPTIMUM MOISTURE **13.4 %**
FRACTION USED **#4**
MOLD VOLUME **0.0332 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. 176256

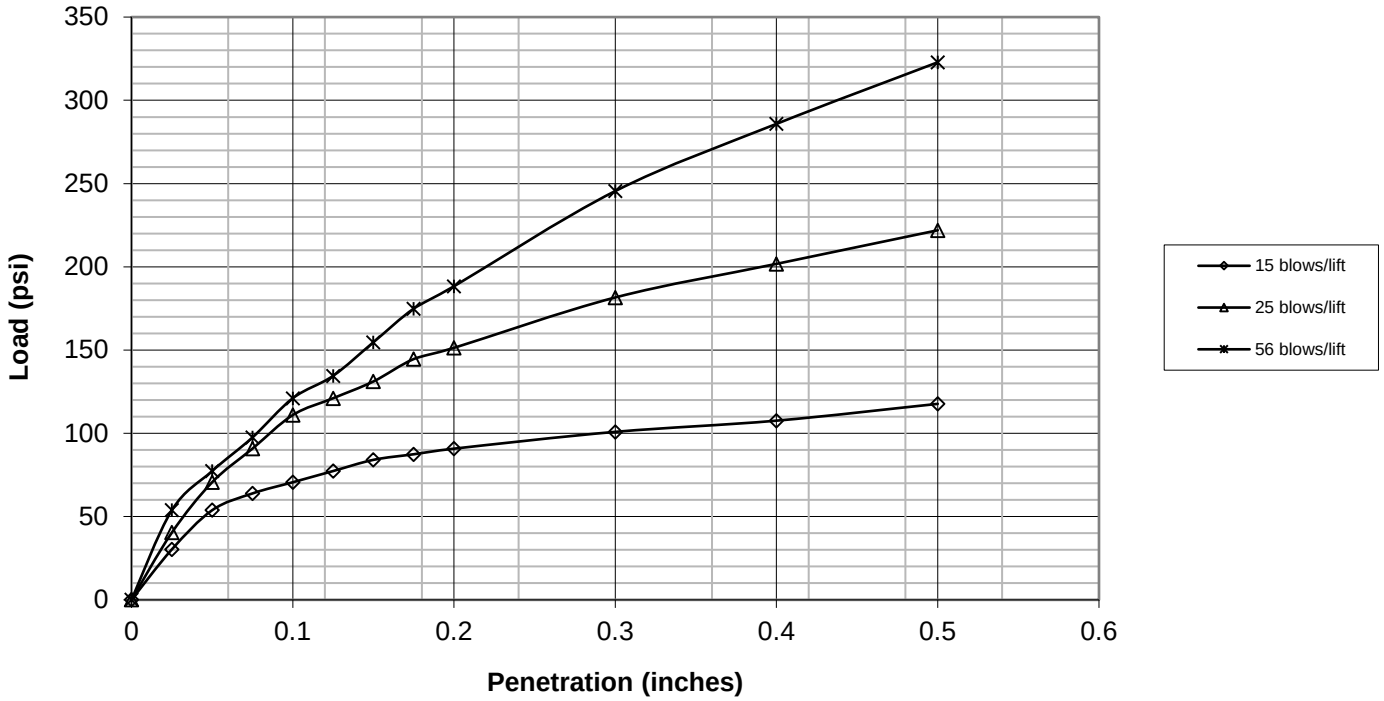
FIGURE No. 9

DATE Jul/23/2020

CALIFORNIA BEARING RATIO TEST RESULTS

PROJECT:	Carriage Meadows South Filing 2	
JOB NUMBER:	176256	TEST DATE: 7/2/2020
AASHTO	A-6	
SAMPLE NUMBER:	CBR	
SAMPLE LOCATION:	Combined Bulk Sample	
SOIL DESCRIPTION:	Silty and Clayey Sand	

Penetration (in)	15 blows/lift Load (psi)	25 blows/lift Load (psi)	56 blows/lift Load (psi)
0.000	0.0	0.0	0.0
0.025	30.3	40.4	53.8
0.050	53.8	70.6	77.3
0.075	63.9	90.8	97.5
0.100	70.6	111.0	121.1
0.125	77.3	121.1	134.5
0.150	84.1	131.2	154.7
0.175	87.4	144.6	174.9
0.200	90.8	151.3	188.3
0.300	100.9	181.6	245.5
0.400	107.6	201.8	285.9
0.500	117.7	222.0	322.8



Corrected Penetration (in)	15 blows/lift Corrected Load (psi)	25 blows/lift Corrected Load (psi)	56 blows/lift Corrected Load (psi)
0.1	7.1	11.1	12.1
0.2	6.1	10.1	12.6

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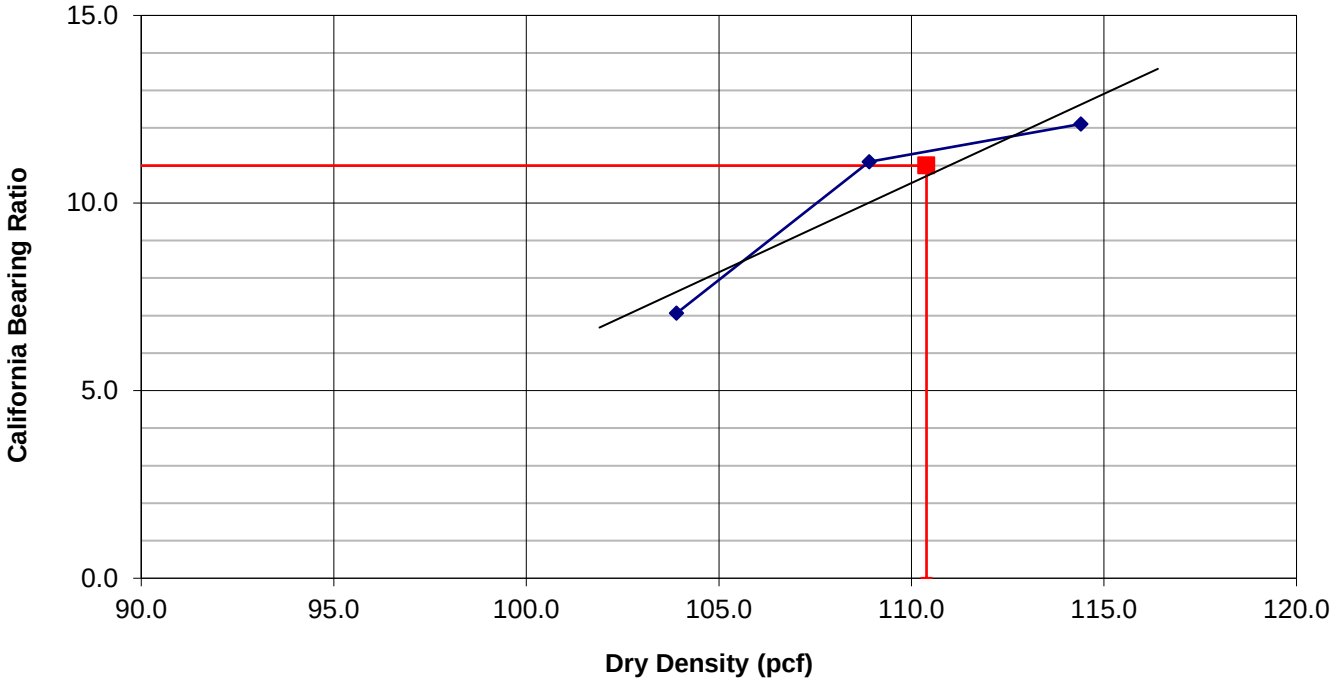
Figure No. 10

CALIFORNIA BEARING RATIO TEST RESULTS

PROJECT:	Carriage Meadows South Filing 2	
JOB NUMBER:	176256	TEST DATE: 7/2/2020
AASHTO CLASSIFICATION:	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
Corrected California Bearing Ratio	7.1	11.1	12.1
Dry Density (pcf)	103.9	108.9	114.4
Percent Compaction	89	94	98
Percent Moisture After Soaking	19.2	19.2	18.0
Percent Expansion/Compression	0.5	0.5	0.4
Surcharge Weight (lbs)	12.60	12.60	12.60



California Bearing Ratio	**11.0**
Dry Density (pcf)	116.2
Percent Compaction	95.00%
Target Dry Density	110.4
Compaction Test Method	ASTM D-698
Condition of sample	Soaked

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Figure No. 11

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}): 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	16500	N/A

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R): -0.841

ΔPSI: 2.2

Design Structural Number (SN): 1.945

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

Surface: 4.5

Total SN based on layer depths: 1.98

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}): 36500

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	16500	N/A

OUTPUT

1. Calculation Parameters

Standard Normal Deviate (z_R): -0.841

ΔPSI: 2.2

Design Structural Number (SN): 1.345

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

Surface: 3.5

Total SN based on layer depths: 1.54

See Solution Details

Comments

Calculate