**W.W. ENTERPRISES** Consulting Engineering
2115 9th Street, P.O. Box 1242, Limon, Colorado 80828 (719) 775-9314



*Revised April 19, 2022*
Revised April 5, 2022
Revised March 23, 2022
March 4, 2022
Project No. 19-3028

Ms. Alice Jolene Owens
PO Box 2764
Florence, AZ 85132

RE: Gravel Roadway Recommendations for Pine View Estates, El Paso County, Colorado.
PCD File No. SF-2019

Dear Ms. Owens;

WW Enterprises obtained samples of the subgrade soil from the proposed subdivision on August 1, 2019, and August 14, 2020. Five (5) test borings were drilled and sampled on August 1, 2019, to evaluate the soil for house foundations. Four (4) test pits were observed and sampled on August 14, 2020, to evaluate the soil for residential Onsite Wastewater Treatment Systems (OWTS). These soil testing results are to be used to determine roadway support characteristics of the soil for the roadway at the above referenced subdivision. This letter presents the results of the laboratory testing and gravel recommendation for the roadway.

## PROJECT DESCRIPTION

The project will consist of gravel sections for Red Barn Road in the Pine View Estates subdivision. Red Barn Road is to be approximately 680 feet long from the approximate east center of the subdivision to the approximate center of the property, where a cul-de-sac is to be placed on the west end of the road. Red Barn Road will be a local (low volume) gravel road. The previous Subsurface Investigations and laboratory testing done for residential foundations and OWTSs were used to determine the roadway support characteristics for the site subgrade soils. The general layout of the roadway within the subdivision is presented in the Location Map (Figure 1 in Appendix A). The location of the test borings and test pits previously evaluated are also shown.

## SUBGRADE CONDITIONS

Five (5) test borings were drilled in the subdivision and roadway to depths of 12 feet. Four (4) test pits were evaluated to depths of 8 feet. Sieve Analysis and Atterberg Limits were performed on selected soil samples obtained from the test boring for the purpose of classification. Sieve analyses had been performed on the soils sampled across the subdivision.

The percent of the soil size particles passing the No. 200 sieve are 62 to 79 percent for the native sandy silt (Soil Type 2), 96 percent for the native lean clay (Soil Type 2), 71 percent for the native sandy silty lean clay (Soil Type 2), 85 percent for the native lean clay with sand (Soil Type 1), and 46 percent for the native clayey sand (Soil Type 1).

Atterberg Limit Testing performed on the Soil Type 1 native lean clay with sand and clayey sand resulted in Liquid Limits of 32 and Plastic Indexes from 11 to 17. Atterberg Limit Testing performed on the Soil Type 2 sandy silt, lean clay, and sandy silty lean clay resulted in Liquid Limits of 25 to 31 and Plastic Indexes from 4 to 9.

Based on the AASHTO classification system, the subgrade soils classify as A-6 (Soil Type 1) for the lean clay with sand and clayey sand and A-4 (Soil Type 2) for the sandy silt, lean clay, and sandy silty lean clay. Soil Type 1 typically provide poor roadway support and Soil Type 2 typically provides fair roadway support characteristics. Even though the majority of the soils tested across the site are Soil Type 2, the pavement section was calculated using the Soil Type 1 testing data. Because the road will be a gravel road, sulfate testing is not required, per Section D.6. Groundwater was not encountered in the test borings drilled in the subdivision. The subgrade was encountered at what appeared to be medium dense states for the sand and stiff consistencies for the clay. The Summary of Test Results is shown in Table 1. The Test Boring Logs and Test Pit Logs (Figure Nos. 2-1 to 2-5) and Grain-Size Distribution Curves (Figure Nos. 3-1 to 3-3) in Appendix A.

Swell/Consolidation testing is done for on the cohesive subgrade soils based on their AASHTO classification. It is assumed that the swells are above the maximum 2.0% swell limit, so mitigation for expansive soils is required.

For the soil types encountered, the R-Value was determined using the "Approximate Interrelationships of Soil Classifications and Bearing Values" (Figure No 4 in Appendix A). For the Soil Type 1 (A-6) soils encountered on the property, an assumed R-Value of 6 will be used.

Typical design parameters used in the gravel section analysis for the project are as follows:

| | |
|---|---|
| Reliability | 75% |
| Serviceability Index | 2.0 |
| "R" Value Subgrade (Soil Type 1) | 6.0 |

GRAVEL ROAD DESIGN PARAMETERS

The generated R-Value test results was used to determine the required gravel section for the roadway. The gravel section was determined using the design criteria in the El Paso County Engineering Criteria Manual. An 18k ESAL value of 36,500 is used for rural local (Low-Volume) roads. Per Section D.3.6. - Gravel Roads in Appendix D - Pavement Design Criteria and Report, a minimum thickness of 6" shall be used on all newly constructed gravel roads meeting material specifications presented in table D-7. Figure No. 5 in Appendix A is the Nomograph - Pavements showing the design values and Nomograph for determining the Structural Number (SN) for the needed roadway. The gravel section recommended is summarized as follows:

Pavement Section - Soil Type 1
8" of Gravel

MITIGATION

With the Soil Type 1 soils at the site, mitigation for expansive soils will be required for this subdivision of Pine View Estates. Mitigation of the subgrade soils will consist of scarification and moisture conditions. To provide a uniform roadway subgrade, it is recommended the subgrade soils be scarified to a depth of 12 inches and be moisture-conditions and recompacted. Personnel of WW Enterprises should be on site to verify and test the conditioned an recompacted subgrade during the subgrade preparation. Density testing should be performed on all fill placed within the roadway alignment.

ROADWAY CONSTRUCTION

Prior to placement of the gravel, the subgrade should be scarified moisture-conditioned, compacted to a minimum of 95% of its maximum Standard Proctor Dry Density (ASTM D-698) at 0 to 4 percent over optimum moisture content and proofrolled after properly compacted. Any soft areas should be removed and replaced with suitable materials approved by WW Enterprises.

Figure No. 6 in Appendix A is the Gradation Analysis by Schmidt Aggregates for Class 6 Base Course (sample date 3/1/22) for the Fountain Pit. *The gradation was performed and approved for the CDOT Class 6 Base Course specification. This is the gravel to be used for the roadway. The results are comparable to Table D-7 - Gravel for Gravel Roads in Appendix D - Pavement Design Criteria and Report, including the Plasticity Index (PI). This is the proposed gravel to be used for the roadway.*

Approval from El Paso should be given before the proposed sand and gravel material is used for the proposed roadway. The gravel placed for the roadway should be well compacted. The roads should be crowned and graded so as to prevent ponding. Special attention should be given to areas adjacent to manholes, inlet structures, and valves.

If significant grading is performed, the soils at subgrade may change. Modification to the gravel section should be evaluated after site grading is completed.
In addition to the above guidance, the gravel materials, subgrade conditions, compaction of materials, testing, inspections, roadway construction methods, and recommended maintenance programs shall meet the latest version of the El Paso County Engineering Criteria Manual.

The gravel section provided are based on general site soil types and roadway to be constructed. If you have any question or need additional information, please do not hesitate to contract us.

Respectfully;
WW Enterprises

Anthony J. Wernsman, P.E.


attachments

# APPENDIX A

# TABLE 1
# SUMMARY OF LABORATORY TEST RESULTS

CLIENT JOLENE OWENS
PROJECT RED BARN ROAD
PROJECT NO. 19-3028

| SOIL TYPE | TEST BORING NO. | DEPTH (FT) | WATER (%) | PASSING NO. 200 SIEVE (%) | LIQUID LIMIT (%) | PLASTIC INDEX (%) | AASHTO CLASS. | UNIFIED CLASSIFICATION | SOIL DESCRIPTION |
|---|---|---|---|---|---|---|---|---|---|
| 1 | A-1 | 3-4 | 10.2 | 79 | 31 | 4 | A-4 | ML | SANDY SILT |
| 1 | A-1 | 8-9 | 8.9 | 62 | 31 | 4 | A-4 | ML | SANDY SILT |
| 1 | A-3 | 3-4 | 20.4 | 96 | 30 | 9 | A-4 | CL | LEAN CLAY |
| 1 | A-3 | 8-9 | 20.7 | 71 | 25 | 5 | A-4 | CL-ML | SANDY SILTY LEAN CLAY |
| 2 | A-4 | 3-4 | 7.7 | 85 | 32 | 11 | A-6 | CL | LEAN CLAY WITH SAND |
| 2 | A-4 | 8-9 | 5.9 | 46 | 32 | 17 | A-6 | SC | CLAYEY SAND |

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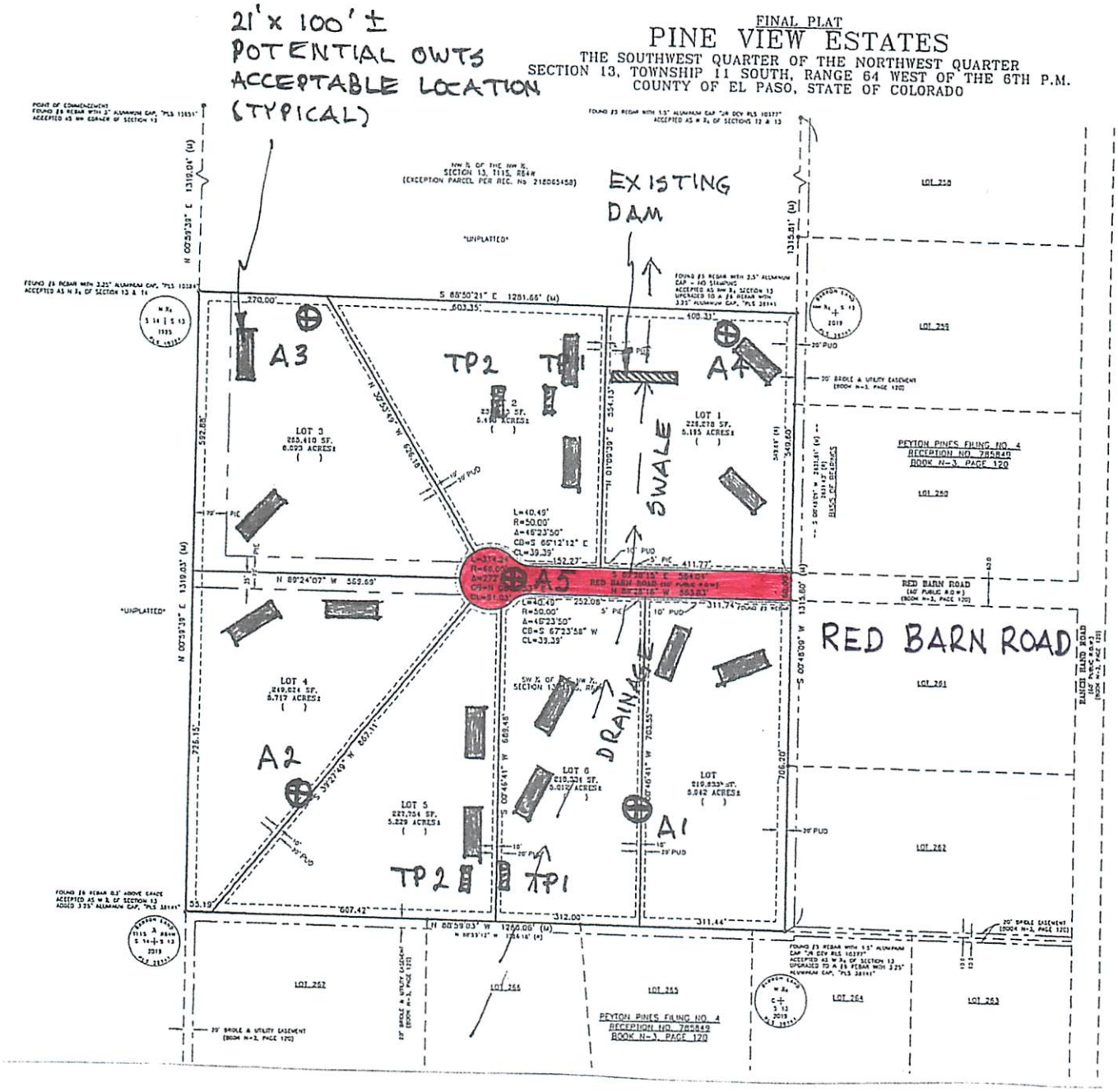
## LOCATION MAP - FINAL PLAT




⊕ A - APPROXIMATE TEST BORING LOCATIONS AND NUMBERS

▮ TP - APPROXIMATE TEST PIT LOCATIONS AND NUMBERS

**LEGEND:**

▭ = LOCAL (LOW VOLUME) ESAL = 36,500
8" GRAVEL LAYER

SCALE: 1" = 333'

0 111 222 333 666 999 1332

FIGURE NO. 1

Name: Owens
Project No.: 19-3028

17055 Red Barn Road, Peyton, El Paso County, Colorado.

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# LOG OF TEST HOLES

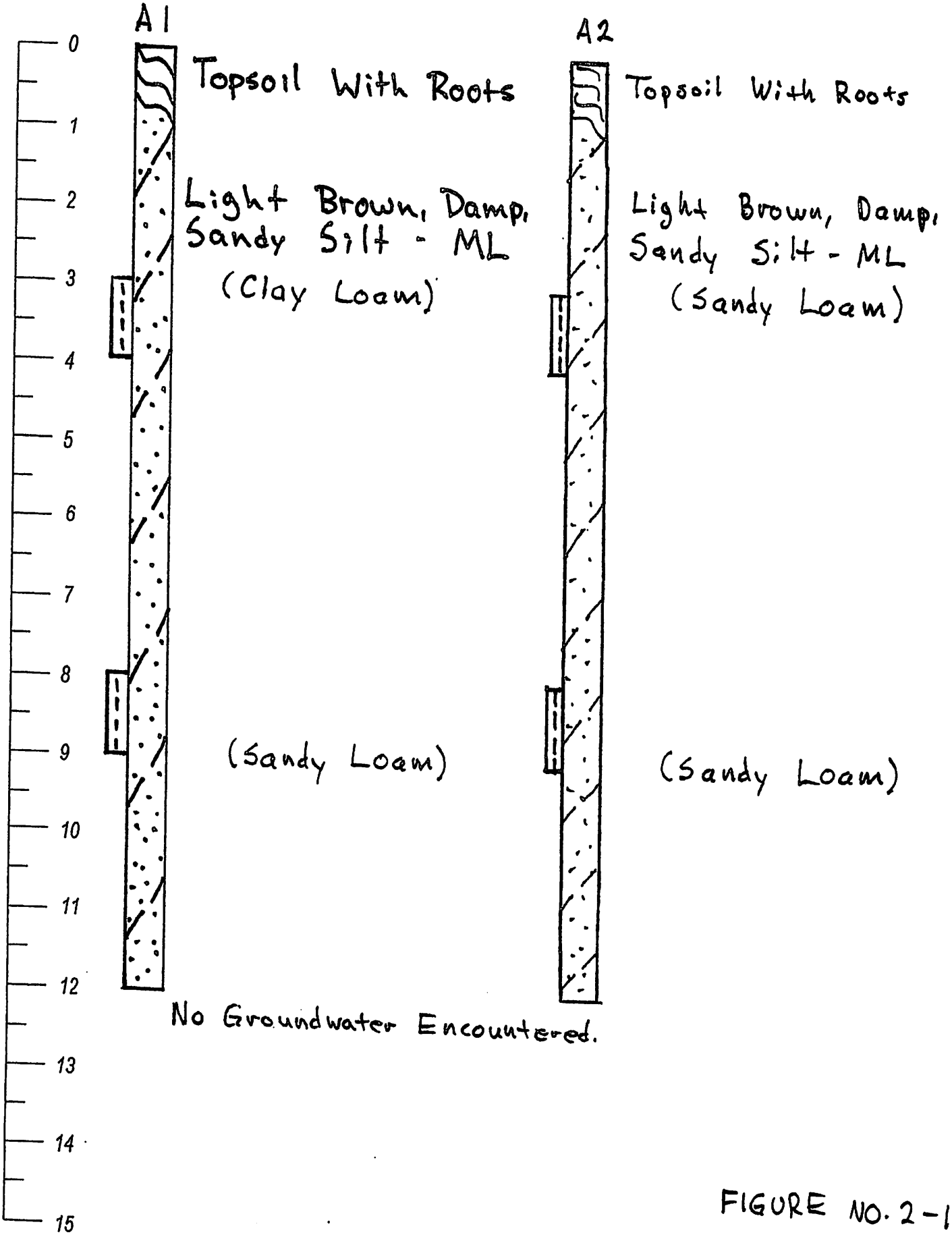


FIGURE NO. 2-1

Name: Alice Owens
Project No.: 19-3028

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# LOG OF TEST HOLES

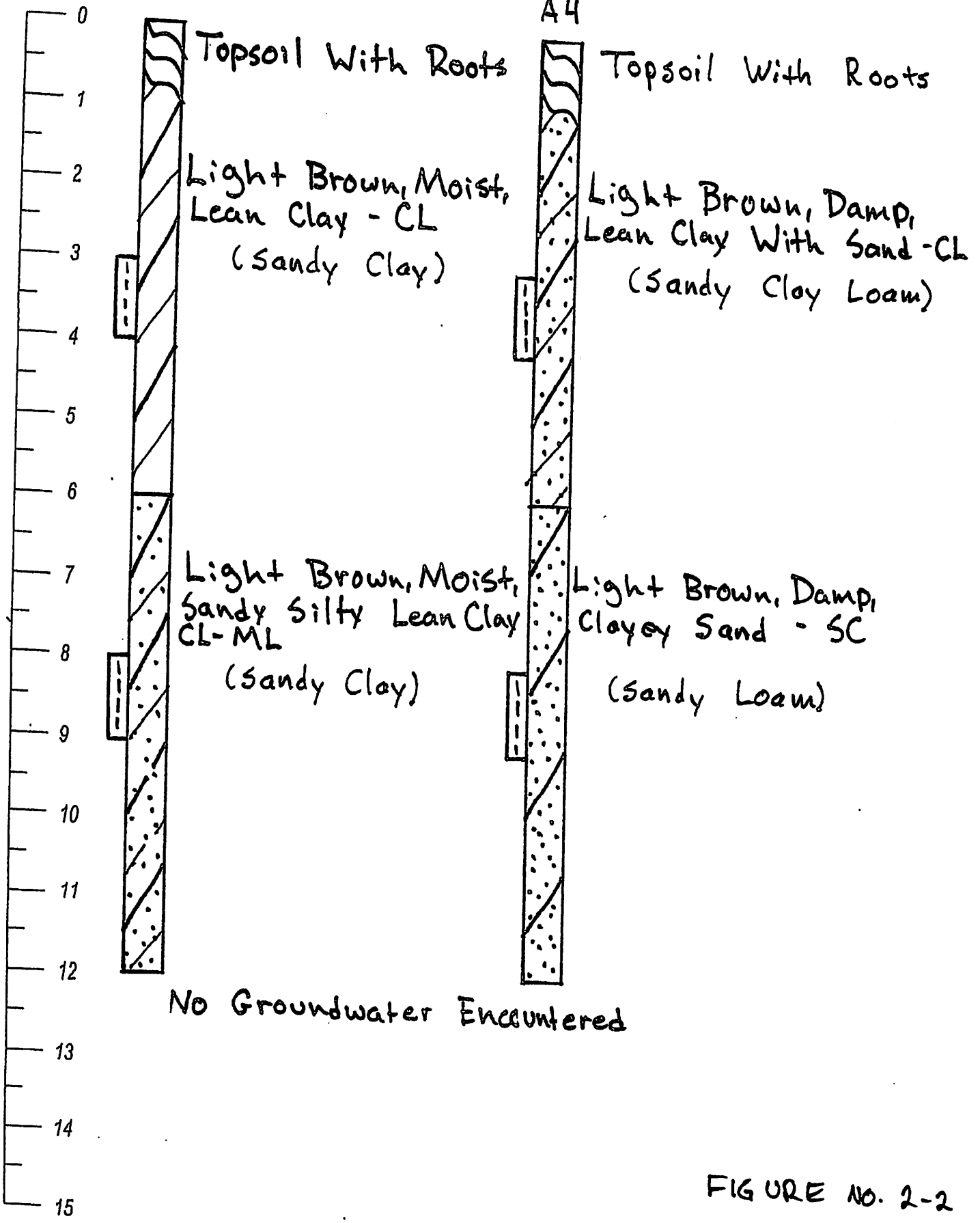


FIGURE NO. 2-2

Name: Alice Owens
Project No.: 19-3028

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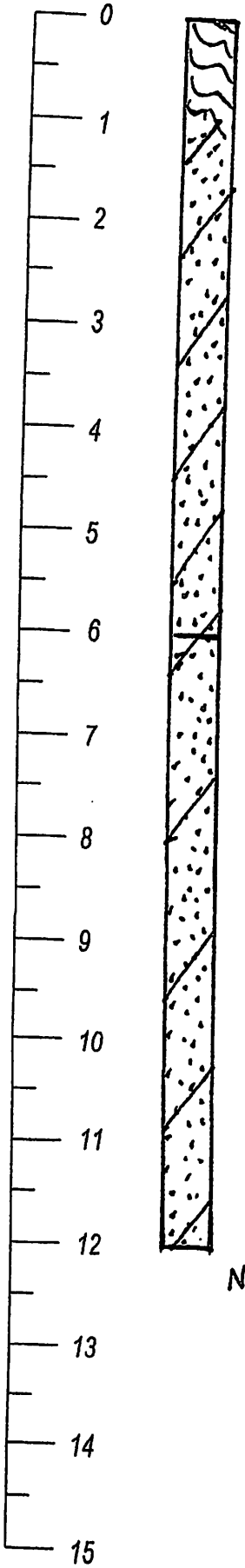
# LOG OF TEST HOLES

A5




Topsoil With Roots

Light Brown, Damp,
Lean Clay With Sand - CL
(Sandy Clay Loam)

Light Brown, Damp,
Clayey Sand - SC
(Sandy Loam)

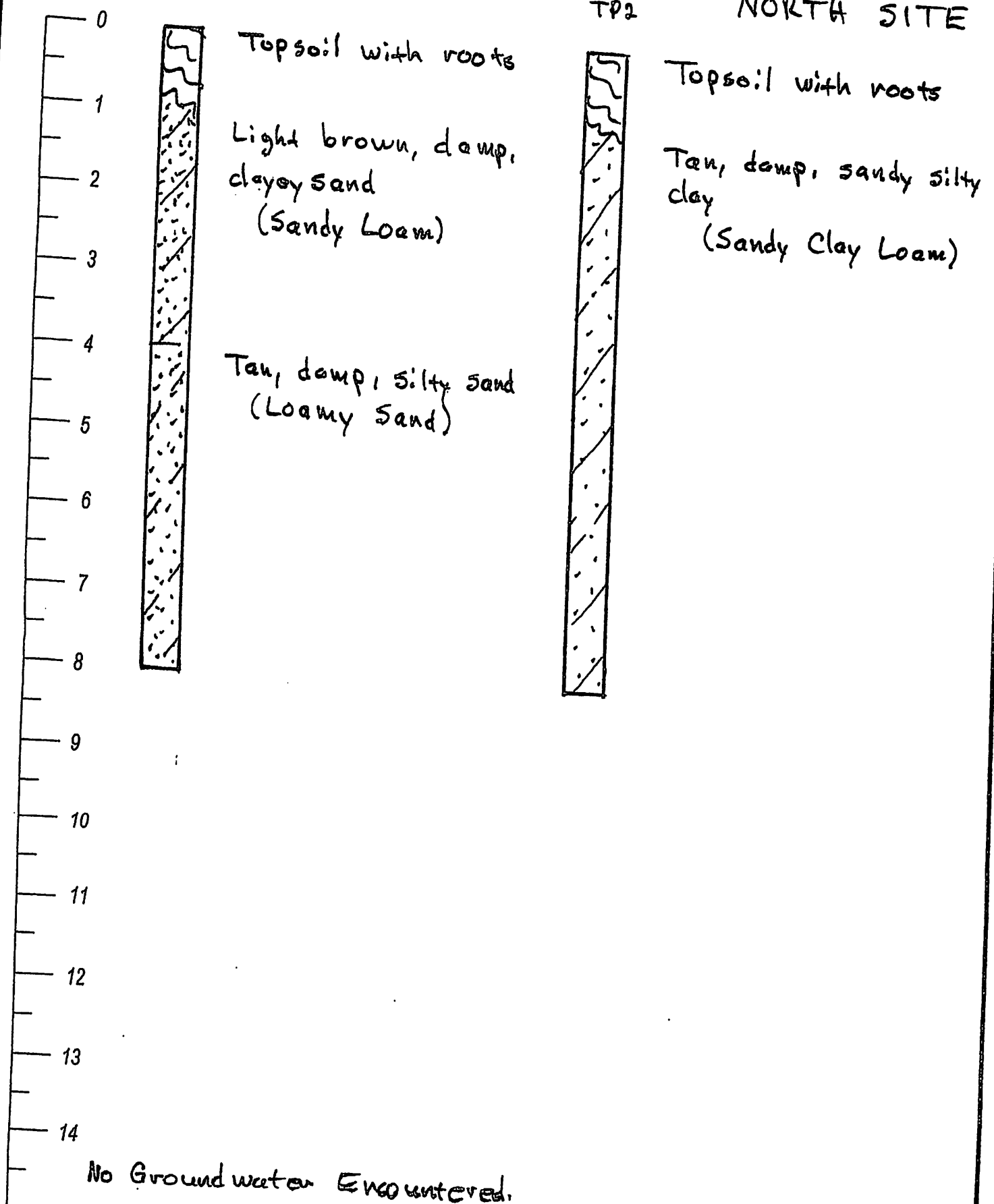
No Groundwater Encountered.

FIGURE NO. 2-3

Name: Owens
Project No.: 19-3028

# LOG OF TEST PITS

NORTH SITE




No Groundwater Encountered.

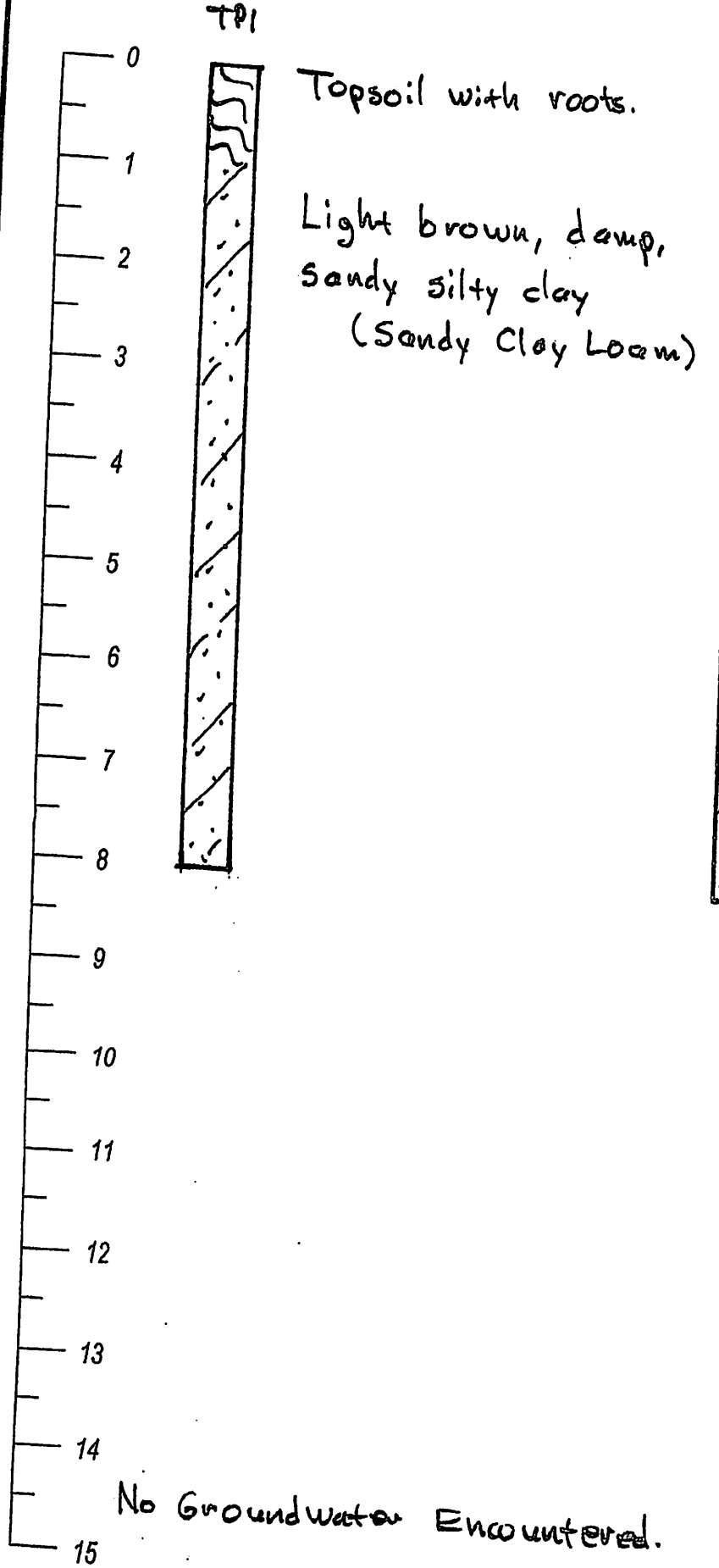
FIGURE NO. 2-4

Name: Owens

Project No.: 19-3028

# LOG OF TEST PITS

## SOUTH SITE




TP1: Topsoil with roots.

Light brown, damp, sandy silty clay (Sandy Clay Loam)

TP2: Topsoil with roots

Light brown, damp, sandy silty clay (Sandy Clay Loam)

No Groundwater Encountered.

FIGURE NO. 2-5

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Project No.: 19-3028

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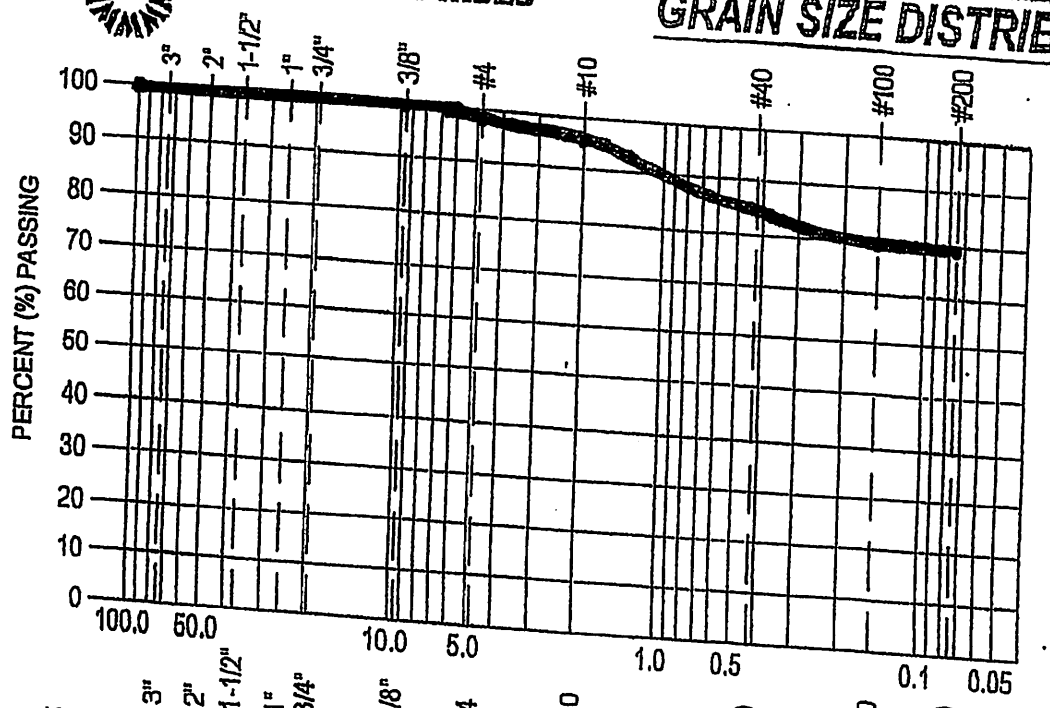
# GRAIN SIZE DISTRIBUTION CURVES




A1 @3'-4' LEVEL

A-4 (0) AASHTO

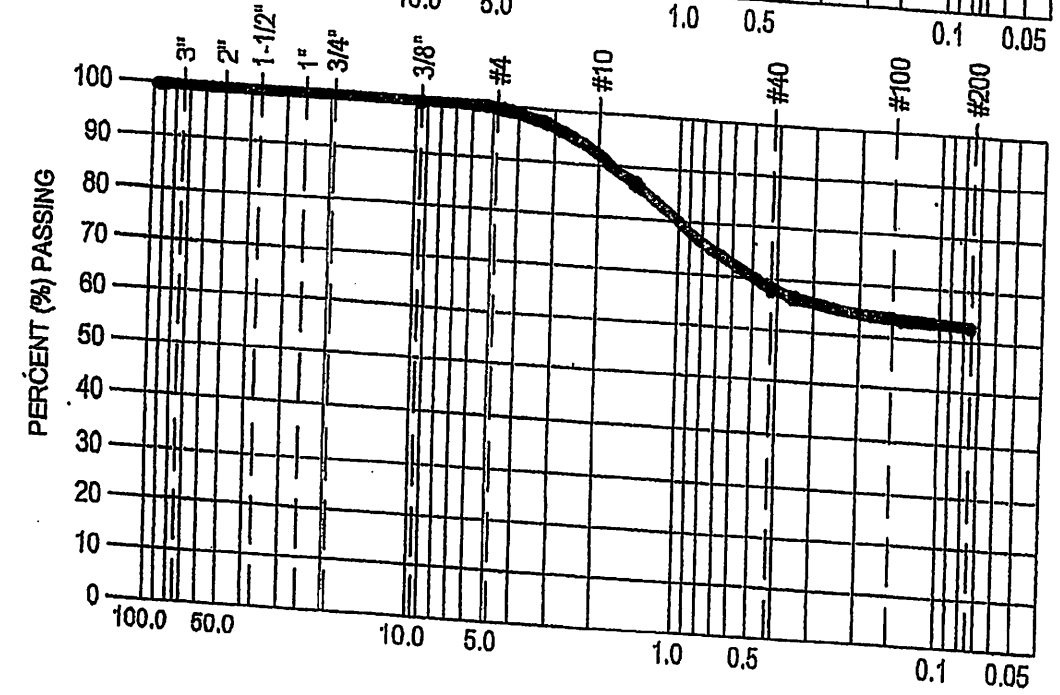
ML ASTM

| SIEVE | % PASSING |
|---|---|
| 3/4" | 100 |
| 3/8" | 100 |
| #4 | 98 |
| #10 | 95 |
| #40 | 84 |
| #100 | 80 |
| #200 | 79 |

LL-31, PL-27, PI-4

Low SWELLING

NATURAL MOISTURE CONTENT = 10.2 %




A1 @8'-9' LEVEL

A-4 (0) AASHTO

ML ASTM

| SIEVE | % PASSING |
|---|---|
| 3/4" | 100 |
| 3/8" | 100 |
| #4 | 99 |
| #10 | 92 |
| #40 | 67 |
| #100 | 63 |
| #200 | 62 |

LL-31, PL-27, PI-4

Low SWELLING

NATURAL MOISTURE CONTENT = 8.9 %

FIGURE NO. 3-1

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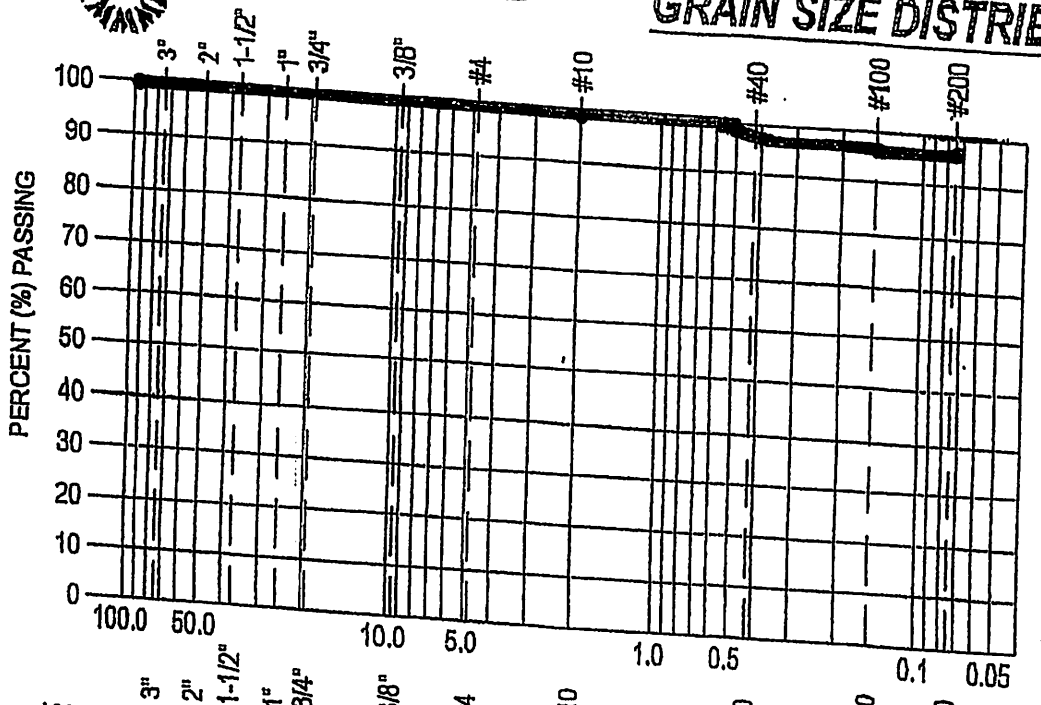
# GRAIN SIZE DISTRIBUTION CURVES




A3 @ 3-4' LEVEL

A-4 (0) AASHTO

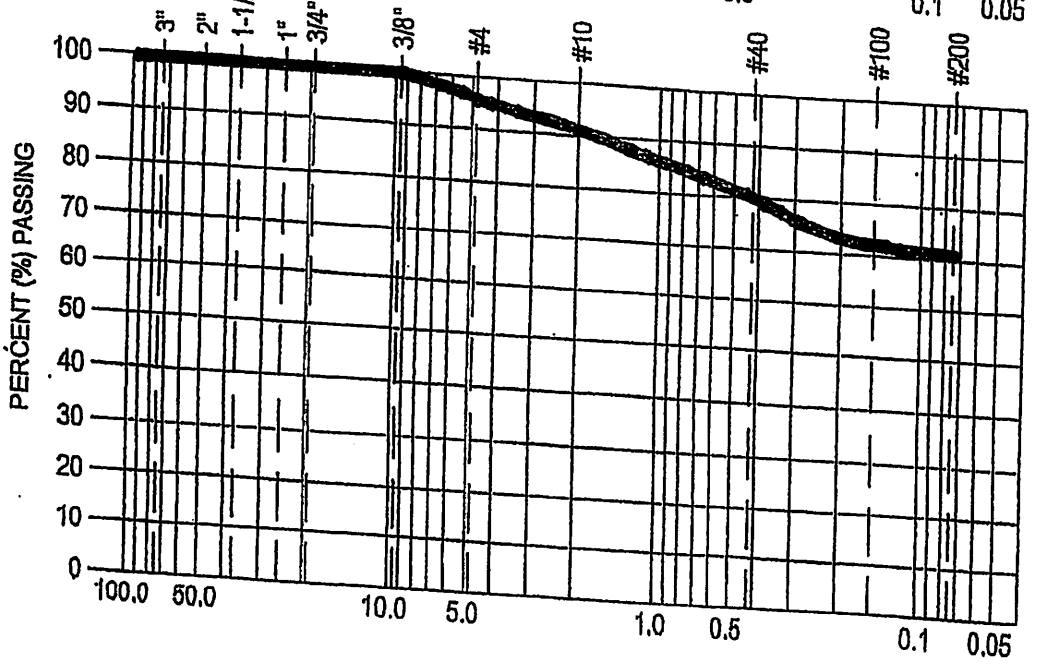
CL ASTM

| SIEVE | % PASSING |
|---|---|
| 3/4" | 100 |
| 3/8" | 100 |
| #4 | 100 |
| #10 | 100 |
| #40 | 97 |
| #100 | 96 |
| #200 | 96 |

LL-30, PL-21, PI-9

Low SWELLING

NATURAL MOISTURE CONTENT = 20.4 %




A3 @ 8'-9' LEVEL

A-4 (0) AASHTO

CL-ML ASTM

| SIEVE | % PASSING |
|---|---|
| 3/4" | 100 |
| 3/8" | 100 |
| #4 | 95 |
| #10 | 91 |
| #40 | 80 |
| #100 | 72 |
| #200 | 71 |

LL-25, PL-20, PI-5

Low SWELLING

NATURAL MOISTURE CONTENT = 20.7 %

FIGURE NO. 3-2

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Project No.: 19-3028

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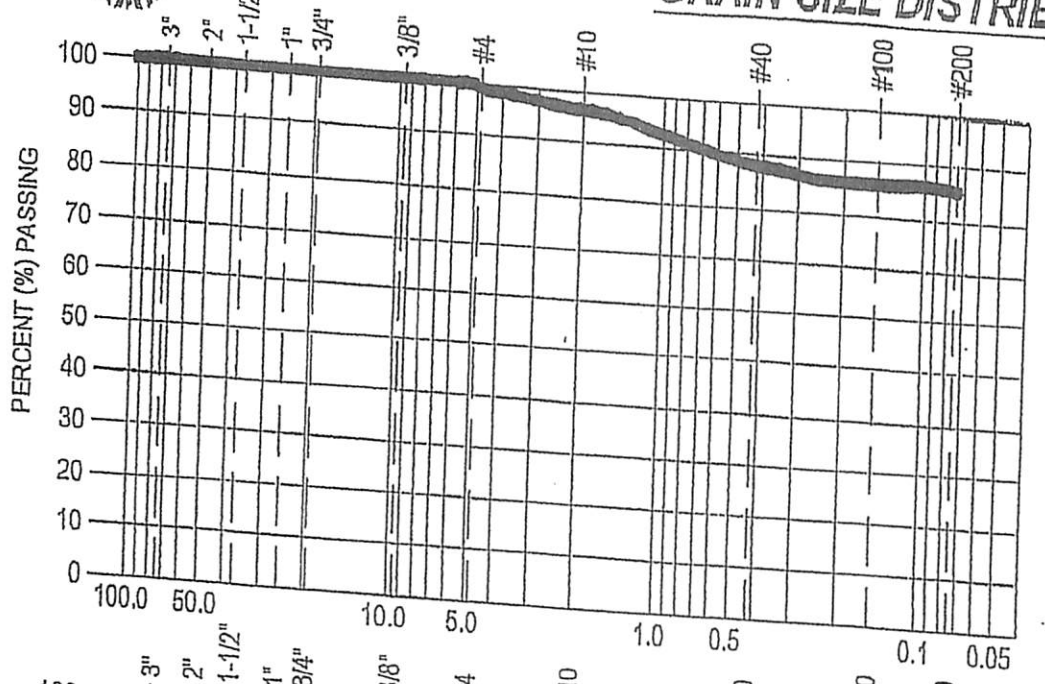
# GRAIN SIZE DISTRIBUTION CURVES




A4 @ 3'-4' LEVEL

A-6 (1) AASHTO

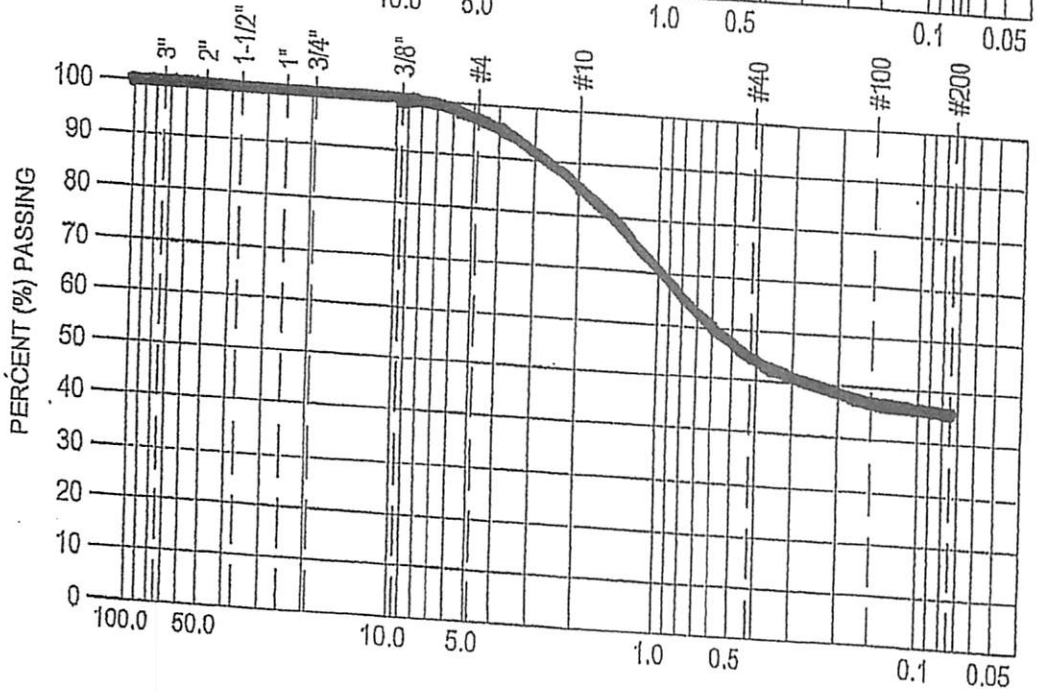
CL ASTM

| SIEVE | % PASSING |
|---|---|
| 3/4" | 100 |
| 3/8" | 100 |
| #4 | 99 |
| #10 | 96 |
| #40 | 88 |
| #100 | 86 |
| #200 | 85 |

LL-32, PL-21, PI-11

Low SWELLING

NATURAL MOISTURE CONTENT = 7.7 %




A4 @ 8'-9' LEVEL

A-6 (2) AASHTO

SC ASTM

| SIEVE | % PASSING |
|---|---|
| 3/4" | 100 |
| 3/8" | 100 |
| #4 | 97 |
| #10 | 84 |
| #40 | 53 |
| #100 | 47 |
| #200 | 46 |

LL-32, PL-15, PI-17

Low SWELLING

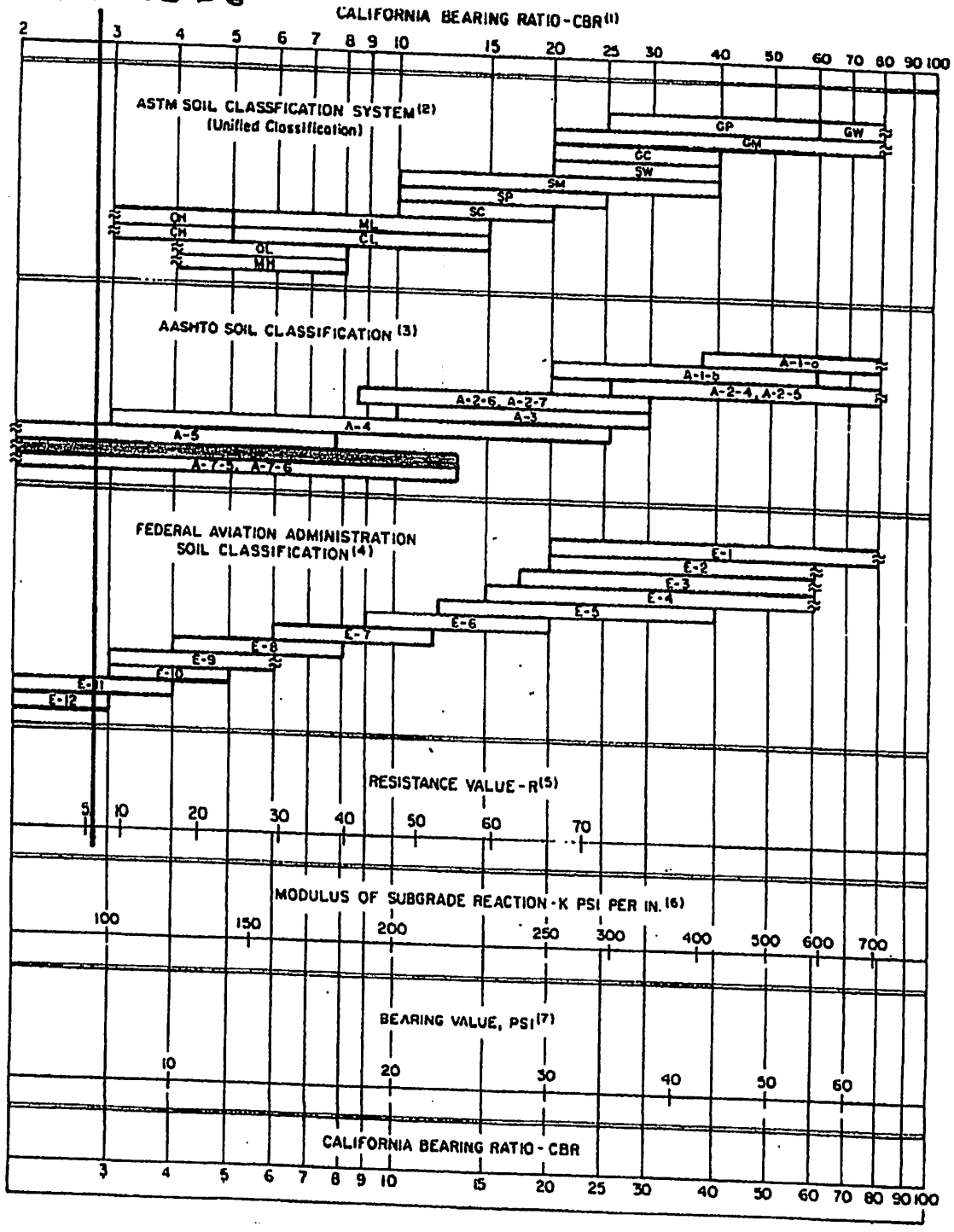
NATURAL MOISTURE CONTENT = 5.9 %

FIGURE NO. 3-3

Name: Alice Owens

Project No.: 19-3028

R-VALUE = 6



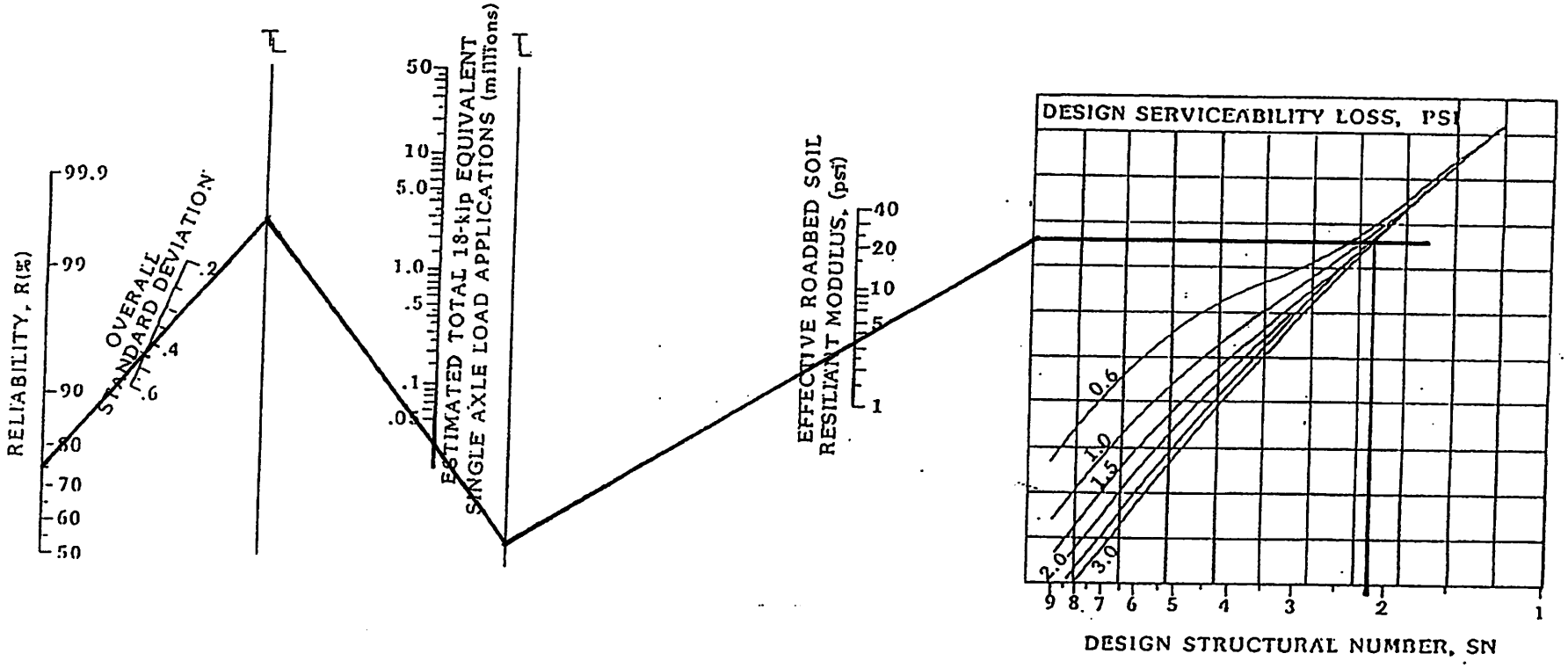

(1) For the basic idea, see O. J. Porter, "Foundations for Flexible Pavements," Highway Research Board *Proceedings of the Twenty-second Annual Meeting*, 1942, Vol. 22, pages 100-136.
(2) ASTM Designation D2487.
(3) "Classification of Highway Subgrade Materials," Highway Research Board *Proceedings of the Twenty-fifth Annual Meeting* 1945, Vol. 25, pages 376-392.
(4) *Airport Paving*, U.S. Department of Commerce, Federal Aviation Agency, May 1948, pages 11-16. Estimated using values given in FAA *Design Manual for Airport Pavements*.(Formerly used FAA Classification: Unified Classification now used.)
(5) C. E.Warnes, "Correlation Between *R* Value and *k* Value," unpublished report, Portland Cement Association, Rocky Mountain-Northwest Region, October 1971 (best-fit correlation with correction for saturation).
(6) See T. A. Middlebrooks and G. E. Bertram, "Soil Tests for Design of Runway Pavements," Highway Research Board *Proceedings of the Twenty-second Annual Meeting*, 1942, Vol. 22, page 152.
(7) See item (6), page 184.

**Approximate interrelationships of soil classifications and bearing values.**

FIGURE NO. 4

NOMOGRAPH SOLVES:

$$\log_{10} 18^{K}ESAL = Z_R * S_o + 9.36 * \log_{10}(SN+1) - 0.20 + \frac{\log_{10}\left[\frac{\Delta PSI}{4.2 - 1.5}\right]}{0.40 + \frac{1094}{(SN+1)^{5.19}}} + 2.32 * \log_{10} M_R - 8.07$$




Reliability (R) = 75

Standard Deviation ($S_0$) = 0.44

Estimated Total 18K ESAL = 36,500

Effective Resiliant Modulus ($M_R$) = 3176 psi

Design Serviceablility Loss = 2.0

SOLUTION: SN = 2.15

SN GRAVEL BASE SUBGRADE

2.16 = 8" (0.12) + 12" (0.10)

W.W. ENTERPRISES
P.O. Box 1242
Limon, CO 80828

| NOMOGRAPH - PAVEMENTS | JOB NO. 19-3028 |
|---|---|
| | DATE |
| | FIGURE NO. 5 |

SCHMIDT CONSTRUCTION TESTING LABORATORIES

2635 DELTA DRIVE
COLORADO SPRINGS, COLORADO 809
719-392-6253

1101 TOPEKA WAY
CASTLE ROCK, COLORADO 80104
303-660-1439

# SIEVE ANALYSIS

TEST PROCEDURE [X] AASHTO T 11, T 27, T 30, T 37 [ ] CP -31A, 31B

JOB NO.:

SOURCE: FOUNTAIN PIT PROJECT:

MATERIAL: CLASS 6 BASE COURSE SAMPLE SOURCE: SAMPLE PAD

SAMPLE DATE: 3/1/2022 SAMPLED BY: TC/JM

| WASHED SAMPLE | | | SAMPLE MOISTURE | |
|---|---|---|---|---|
| PAN I.D. | | | PAN I.D. | |
| PAN TARE | | | PAN TARE | |
| WET WEIGHT | 2110.9 | | WET WEIGHT | 2773.5 |
| DRY WEIGHT | 2049.6 | T 11 | DRY WEIGHT | 2692.9 |
| | | WASH LOSS % | LOSS | 80.6 |
| WASHED/DRY SAMPLE BEFORE SIEVING | 1857.5 | 9.37 | % MOISTURE | 3.0 |

| SIEVE | | WEIGHT RETAINED | PERCENT RETAINED | PERCENT PASSING | SPECIFICATION CDOT CLASS 6 BC | QUARRY AVG. |
|---|---|---|---|---|---|---|
| 50mm | 2" | 0 | 0 | 100 | | |
| 37.5mm | 1 1/2" | 0 | 0 | 100 | | |
| 25mm | 1" | 0 | 0 | 100 | 100 | |
| 19mm | 3/4" | 88.1 | 4.3 | 96 | 95-100 | 100 |
| 12.5mm | 1/2" | 272.8 | 13.3 | 82 | | 84 |
| 9.5mm | 3/8" | 137.8 | 6.7 | 76 | | 74 |
| 4.75mm | # 4 | 307.6 | 15.0 | 61 | 30-65 | 58 |
| 2.36mm | # 8 | 195.8 | 9.6 | 51 | 20-55 | 46 |
| 1.18mm | # 16 | 172.0 | 8.4 | 43 | | 37 |
| 0.6mm | # 30 | 162.0 | 7.9 | 35 | | 28 |
| 0.3mm | # 50 | 160.0 | 7.8 | 27 | | 20 |
| 0.15mm | # 100 | 155.8 | 7.6 | 19 | | 14 |
| 0.075mm | # 200 | 159.0 | 7.8 | 11.6 | 3-12 | 9.7 |
| | PAN | 46.2 | MARK WITH X FOR F.M. [ ] | | | |
| | TOTAL WEIGHT INCLUDING PAN | 1857.4 | | 0.01 | PERCENT OF SAMPLE BEFORE SIEVING:(<0.3%) | |
| | SUM OF SCREENS+PAN | 1857.1 | | | | |

TESTERS INIT.: TC

COMMENTS:

DEVIATION FROM TEST PROCEDURE.

PLASTICITY

| | WET W/PAN | DRY W/PAN | LOSS | DRY SOIL | PAN WT |
|---|---|---|---|---|---|
| LIQUID LIMIT | | | | | |
| PLASTIC LIMIT | | | | | |

L.L (30 MAX) N.V. P.L P.I (8 MAX) 4.

*Revised: 010620: Reviewed: 010620*

FNTN CLASS 6 BASE;FNTN CLASS 6 BASE

FIGURE NO. 6

SCHMIDT CONSTRUCTION QUALITY CONTROL LABORATORY 719-392-6253

MATERIAL: FOUNTAIN PIT
CLASS 6 BASE

MAXIMUM DENSITY: 136.6 LBS/FT$^3$

METHOD: AASHTO T-180 "D"

OPTIMUM MOISTURE: 5.0%

DATE:

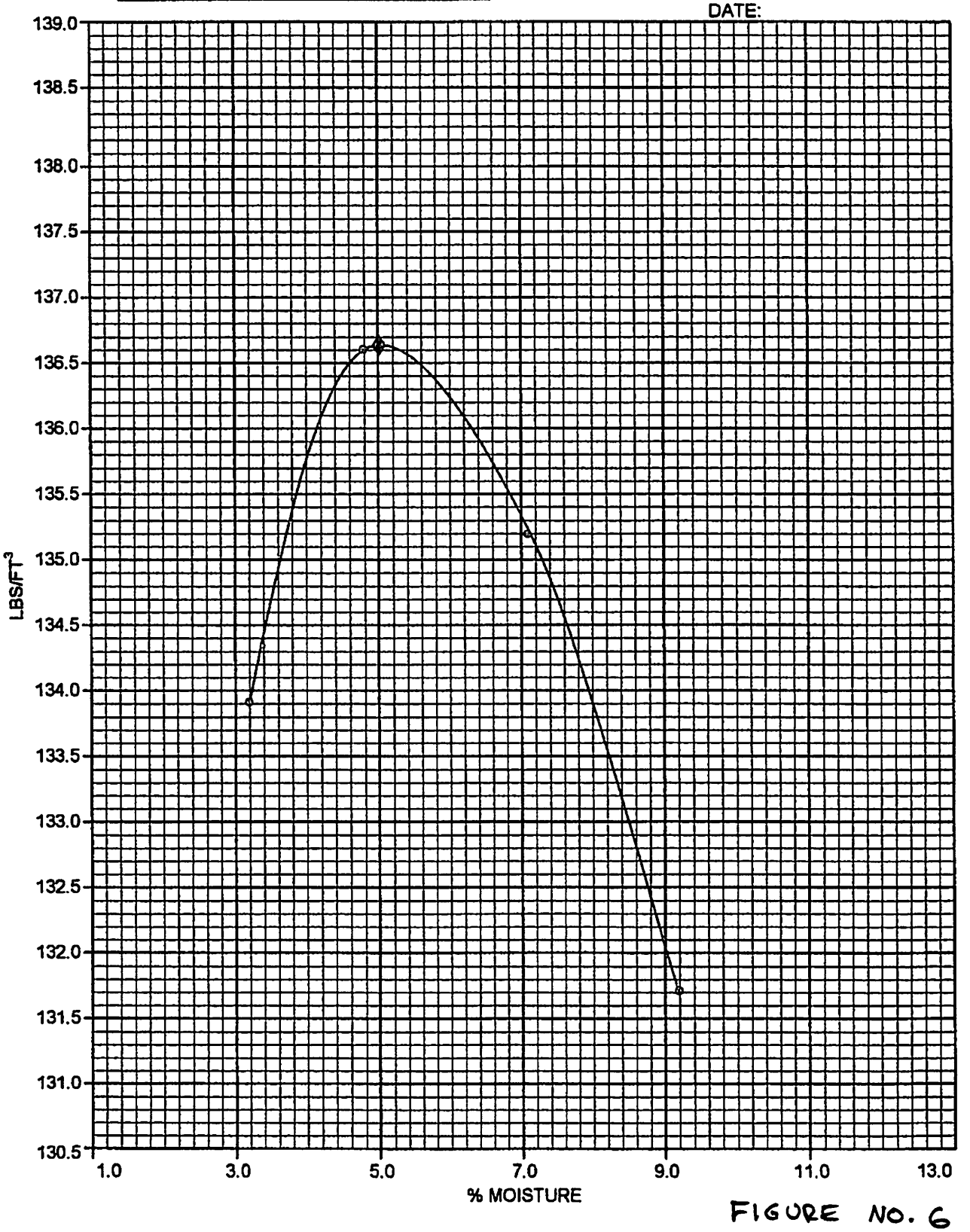



FIGURE NO. 6