PAVEMENT DESIGN CONCEPT CONFERENCE AGENDA

CSJ	0915-46-052
HIGHWAY	Cordova Rd
LIMITS	SH 46 to SH 123
COUNTY	Guadalupe
LENGTH	3.48 Miles
SCOPE	Full depth reconstruction. Expand roadway from 2 to 4 lanes with raised center median.
PRELIMINARY CONSTRUCTION ESTIMATE	$39.7M
READY TO LET DATE	11/2025

1. Type of facility
    a. Urban Arterial
2. Design Criteria (2R, 3R, 4R)
    a. 4R
3. Traffic Data (TPP data considering traffic volumes, ESALS, ATHWLD, local traffic generators)
    a. Option C Traffic Projections
        i. 2028- 18,285
        ii. 2048- 23,060
        iii. 2058- 25,440
    b. ESALS estimated for pavement design, pending TPP ESALS
        i. Rigid- 6,162,430
        ii. Flexible- 2,358,900

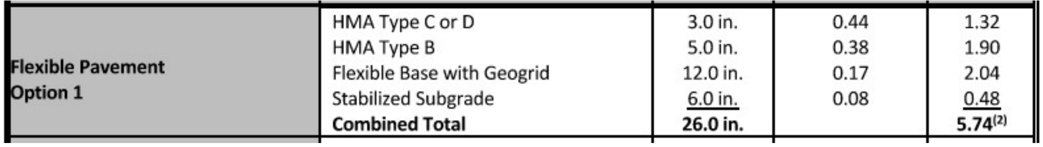
4. Soils / Subgrade characteristics (utilize nomenclature in soils_series.xls)
    a. Clay to depths>10’
    b. High PI’s 30-50 typ

5. Existing Pavement History (Include location map, typical sections, date(s) of construction, materials, maintenance and existing distresses / motivation for construction)
    a. Area of rapid development, narrow existing road bed (22’-24’), degrading pavement

6. Pavement Management (PMIS, Skid, Ride, 4 Yr PMP)
    a. N/A

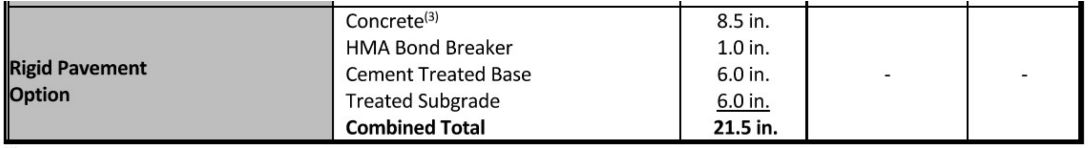
7. Pavement Forensics (cores/bores, FWD, GPR, DCP)
    a. Borings- see attached

8. Material considerations (HMA types, seal coat binder selection, flex base, treatment / stabilization, recycling or conservation of materials, alternates, availability, local materials, cure times, multiple pavement designs)
    a. Considering the following pavement sections
        i.



Flexible Pavement Option 1	HMA Type C or D	3.0 in.	0.44	1.32
	HMA Type B	5.0 in.	0.38	1.90
	Flexible Base with Geogrid	12.0 in.	0.17	2.04
	Stabilized Subgrade	6.0 in.	0.08	0.48
	Combined Total	**26.0 in.**		**5.74**(2)

            1. Concern for water infiltration and geotechnical engineer recommended full-depth curb and gutter (20")
                a. Discuss other mitigation strategies:
                    i. Flex base offset (2')
                    ii. TxDOT input
            2. TxDOT review of report recommended:
                a. Decrease C/D to 2" and increase B to 6"
                b. Type D flex base
        ii.



Rigid Pavement Option	Concrete(3)	8.5 in.	-	-
	HMA Bond Breaker	1.0 in.		
	Cement Treated Base	6.0 in.		
	Treated Subgrade	6.0 in.		
	Combined Total	**21.5 in.**		

            1. The City of Seguin is increasingly interested in constructing the project with rigid pavement to decrease lifecycle cost, lessen shrink/swell impacts, lessen water infiltration concern/need for full depth curb.
            2. From a LG perspective, JRCP is easier to maintain
                a. TxDOT opinion on JRCP vs CRCP
            3. The City of Seguin is considering rigid section that removes base.

nerates more
t CRCP handles
er

to failure- uneven

se.

ted

n trt base performs

onstructability considerations (traffic control, construction phasing, detours, project location/limits)
    a. Construct temp widening to maintain two lanes of travel
    b. Construct half of divided road
    c. Move traffic to new pavement, construct other half
    d. Temporary pavement section needed for phase one. Approx. 12 mo duration

10. Computer Analysis using approved pavement design software (FPS 21, DarWin 3.1, TxCRCP-ME)
    a. FPS 21 - check

11. Maintenance History & Concerns
    a. Existing outside portions of lanes are "sloughing off" due to assumed soil shrinkage

12. Is this roadway on a load zone?
    a. No

13. Is there any projects under construction or planned within your project limits or adjacent to your project?
    a. SH 46- 09/2034 letting
    b. SH 123 – 09/2025 letting

Plotted on: 10/16/2023

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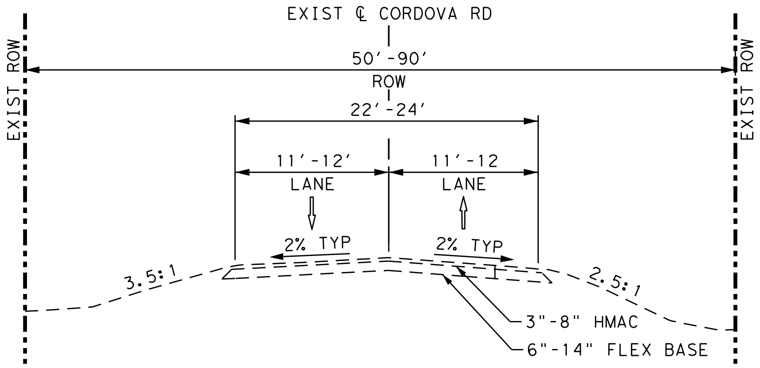
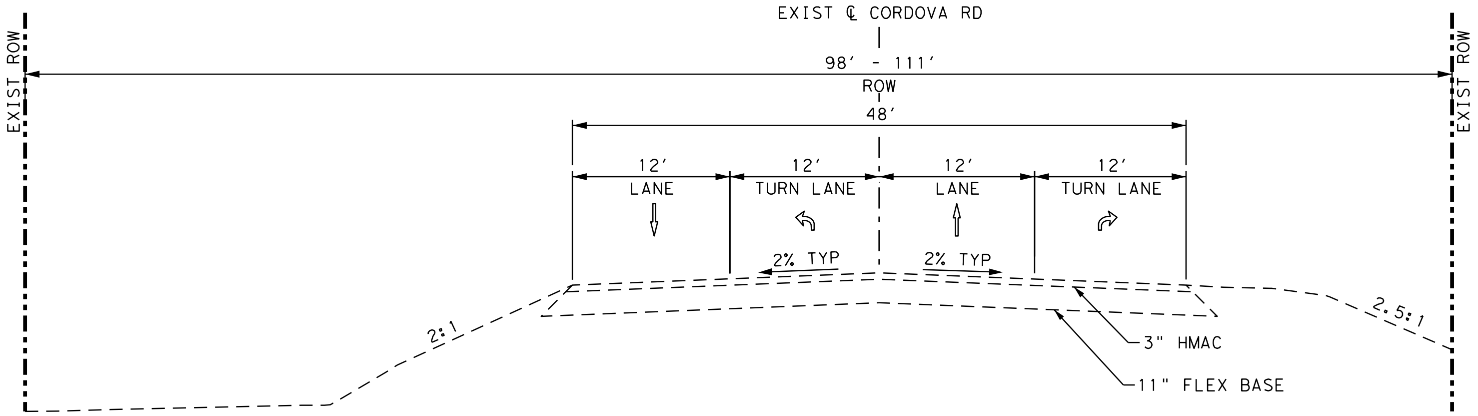


EXISTING TYPICAL SECTION

CORDOVA RD
NTS
STA 112+00 TO STA 162+00
STA 165+00 TO STA 242+00
STA 244+70 TO STA 294+00



EXISTING TYPICAL SECTION

CORDOVA RD
NTS
STA 163+00 TO STA 164+00

DESIGN

INTERIM REVIEW
DOCUMENT INCOMPLETE. NOT INTENDED FOR
PERMIT, BIDDING OR CONSTRUCTION.
ENGINEER: STEVEN J. TATE
P.E. SERIAL NO: 131443
DATE: 10/16/2023

APPROVAL

INTERIM REVIEW
DOCUMENT INCOMPLETE. NOT INTENDED FOR
PERMIT, BIDDING OR CONSTRUCTION.
ENGINEER: JOHN A. TYLER
P.E. SERIAL NO: 105193
DATE: 10/16/2023

REV. NO.	DATE	DESCRIPTION	BY

PAPE-DAWSON ENGINEERS
SAN ANTONIO I AUSTIN I HOUSTON I FORT WORTH I DALLAS
2000 NW LOOP 410 I SAN ANTONIO, TX 78213 I 210.375.9000
TEXAS ENGINEERING FIRM #470 I TEXAS SURVEYING FIRM #10028800

SEGUIN TEXAS
It's real.

THE STATE OF TEXAS GUADALUPE COUNTY

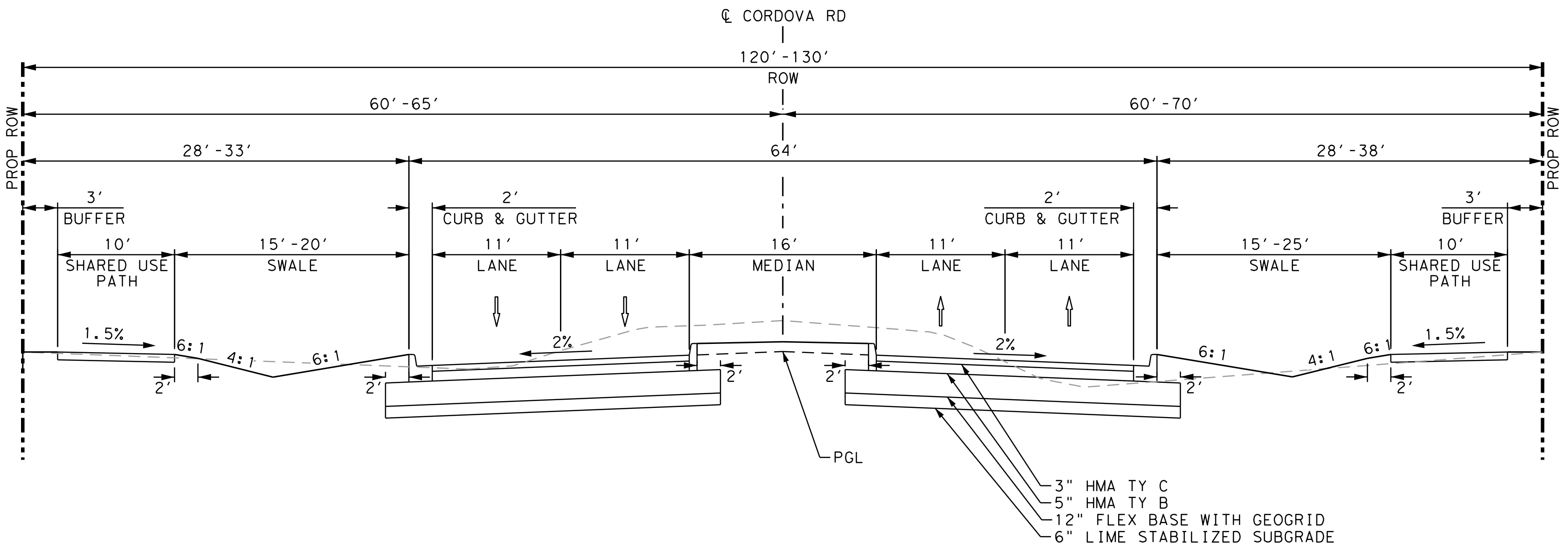
Texas Department of Transportation

TYPICAL SECTIONS

SHEET 1 OF 12

DGN:	FED. RD. DIV. NO.	STATE	FEDERAL AID PROJECT NO.			HIGHWAY NO.
CHK DGN:	6	TEXAS				CORDOVA
DWG:	DIST.	COUNTY	CONT. NO.	SECT. NO.	JOB NO.	SHEET NO.
CHK DWG:	SAT	GUADALUPE	0915	46	052	9

Plotted on: 10/16/2023



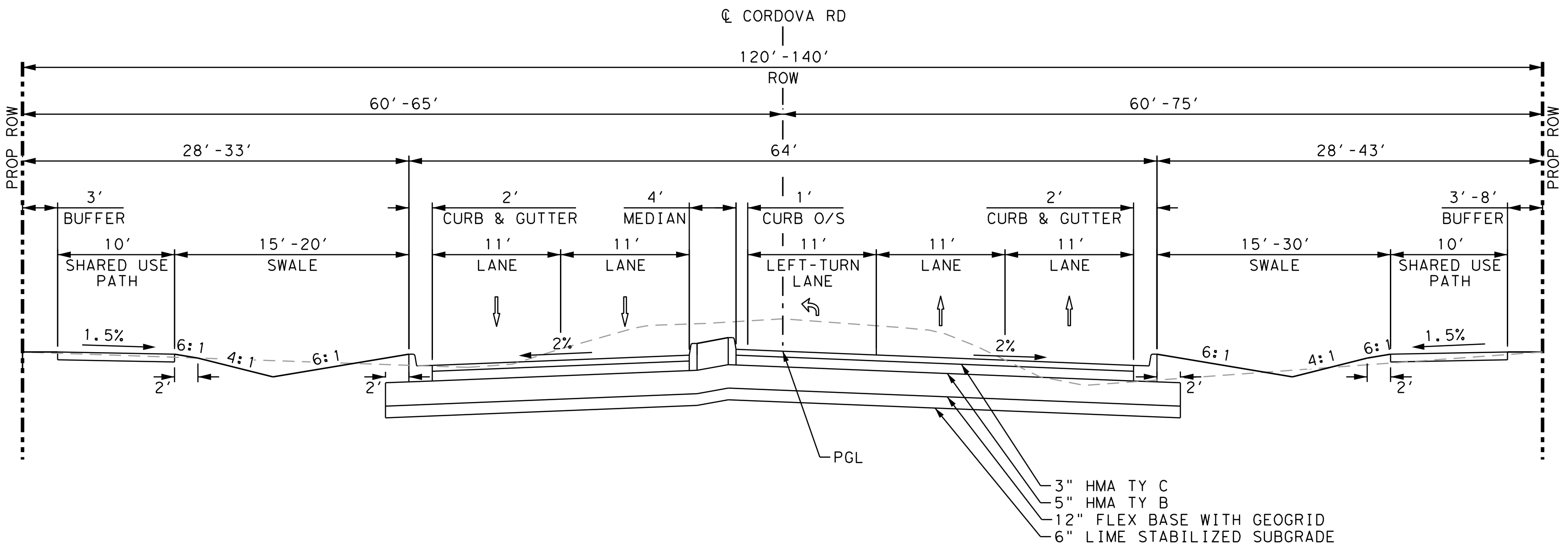
PROPOSED TYPICAL SECTION

CORDOVA RD

NTS

STA 138+00 TO STA 142+87
STA 148+14 TO STA 151+66
STA 155+05 TO STA 157+52

STA 167+27 TO STA 174+30
STA 224+20 TO STA 230+00
STA 233+70 TO STA 241+41



PROPOSED TYPICAL SECTION

CORDOVA RD

NTS

STA 143+87 TO STA 145+37
STA 152+66 TO STA 154+16

STA 175+30 TO STA 176+80
STA 213+54 TO STA 215+04

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DESIGN

INTERIM REVIEW

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PAPE-DAWSON ENGINEERS

SAN ANTONIO | AUSTIN | HOUSTON | FORT WORTH | DALLAS
2000 NW LOOP 410 | SAN ANTONIO, TX 78213 | 210.375.9000
TEXAS ENGINEERING FIRM #470 | TEXAS SURVEYING FIRM #10028800

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TYPICAL SECTIONS

SHEET 5 OF 12

DGN:	FED. RD. DIV. NO.	STATE	FEDERAL AID PROJECT NO.			HIGHWAY NO.
CHK DGN:	6	TEXAS				CORDOVA
DWG:	DIST.	COUNTY	CONT. NO.	SECT. NO.	JOB NO.	SHEET NO.
CHK DWG:	SAT	GUADALUPE	0915	46	052	13

RABA KISTNER

GEOTECHNICAL ENGINEERING PAVEMENT STUDY

FOR

CORDOVA ROAD
SEGUIN , TEXAS

RABA KISTNER

211 Trade Center, Suite 300
New Braunfels, TX 78130

P 830.214.0544
F 830.214.0627
TBPE Firm F-3257

WWW.RKCI.COM

Project No. ANA22-047-00
April 18, 2023

Mr. John Tyler, P.E., RAS
Pape-Dawson Engineers, Inc
2000 NW Loop 410
San Antonio, Texas 78213

RE: **Geotechnical Engineering Pavement Study**
Cordova Road
Seguin, Texas

Dear Mr. Tyler:

Raba Kistner, Inc. (RKI) is pleased to submit the report of our pavement design recommendations for the above-referenced project. This study was performed in accordance with the scope and fee, PNA22-052-00 dated September 6, 2022. The purpose of this study was to drill borings along the proposed roadway improvement alignment, to perform laboratory testing to classify and characterize subsurface conditions, and to prepare an engineering report presenting pavement design recommendations and pavement construction considerations.

The following report contains our design recommendations and considerations based on our current understanding of the project information provided to our office. There may be alternatives for value engineering of the pavement systems, and RKI recommends that a meeting be held with the Owner and design team to evaluate these alternatives.

We appreciate the opportunity to be of service to you on this project. Should you have any questions about the information presented in this report, or if we may be of additional assistance with value engineering or on the materials testing-quality control program during construction, please call.

Very truly yours,

RABA KISTNER, INC.

ISAAC MOLINA
124165

Santosh Shrestha, E.I.T.
Graduate Engineer

Isaac Molina, P.E.
Project Manager

SS/IM/mmd

Attachments
Copies Submitted: Above (Electronic)

GEOTECHNICAL ENGINEERING PAVEMENT STUDY

For

CORDOVA ROAD
SEGUIN, TEXAS

Prepared for

PAPE-DAWSON ENGINEERS, INC.
San Antonio, Texas

Prepared by

RABA KISTNER, INC.
New Braunfels, Texas

PROJECT NO. ANA22-047-00

April 18, 2023

RABAKISTNER

TABLE OF CONTENTS

TABLE OF CONTENTS

ATTACHMENTS

PROJECT DESCRIPTION

Raba Kistner, Inc. (RKI) has completed the authorized subsurface exploration and prepared design recommendations for the Cordova Road located just north of IH-10 in the City of Seguin, Guadalupe County, Texas, and is approximately 3.4 miles long with project limits from SH 46 to SH 123. The proposed City of Seguin project includes widening Cordova Road to four-lanes with raised medians and left-turn bays or a five-lane section with two-way left-turn lane (TWLTL), drainage improvements, and pedestrian/bicycle shared use paths along both sides of the project. The proposed roadway improvements were evaluated in general accordance with Pavement Design Standards from City of Seguin and checked with TxDOT FPS 21 design methods. This report briefly describes the procedures utilized during this study and presents the pavement recommendations and construction considerations.

LIMITATIONS

This engineering report has been prepared in accordance with accepted Geotechnical Engineering practices in the region of south/central Texas and for the use of the City of Seguin and Pape-Dawson Engineers, Inc. (Client) for design purposes. This report may not contain sufficient information for purposes of other parties or other uses. This report is not intended for use in determining construction means and methods.

The recommendations submitted in this report, per our scope, are based on the data obtained from eighteen (18) borings drilled at this site specifically for the pavements and our understanding of the project information provided to us. If the project information described in this report is incorrect, is altered, or if new information is available, we should be retained to review and modify our recommendations.

This report may not reflect the actual variations of the subsurface conditions across the site. The nature and extent of variations across the site may not become evident until construction commences. The construction process itself may also alter subsurface conditions. If variations appear evident at the time of construction, it may be necessary to reevaluate our recommendations after performing on-site observations and tests to establish the engineering impact of the variations.

Our scope does not include an environmental assessment of the air, soil, rock, or water conditions either on or adjacent to the site. No environmental opinions are presented in this report.

BORINGS AND LABORATORY TESTS

Subsurface conditions at the site were evaluated by eighteen (18) pavement borings, drilled at the locations shown on the Boring Location Map, Figure 1. These locations are approximate and distances were measured using a hand-held, recreational-grade GPS locator. The borings were drilled to approximately 10 ft below the existing ground surface using a truck-mounted drilling rig. During drilling operations split-spoon (with standard penetration test) samples were collected.

Each sample was visually classified in the laboratory by a member of our geotechnical engineering staff. The geotechnical engineering properties of the strata encountered in our borings were evaluated by natural moisture content, Atterberg limits tests and sieve analyses results.

The laboratory test results are presented in graphical and numerical form on the boring logs illustrated on Figures 2 through 19. A key to classification terms and symbols used on the logs is presented on Figure 20. The results of the laboratory and field testing are also tabulated on Figure 21 for ease of reference.

Standard penetration test results are noted as “blows per ft” on the boring logs and Figure 21, where “blows per ft” refers to the number of blows by a falling hammer required for 1 ft of penetration into the soil/weak rock. Where hard or dense materials were encountered, the tests were terminated at 50 blows even if one foot of penetration had not been achieved. When all 50 blows fall within the first 6 in. (seating blows), refusal “ref” for 6 in. or less will be noted on the boring logs and on Figure 21.

In addition to the above listed testing and sampling, composite bulk samples of anticipated subgrade soils near Boring P-1, P-5, P-11 and P-15, were collected for use in pH-lime series (Figure 22), and sulfate content tests. Texas Triaxial classification chart is presented in Figure 23. The results from the DCP field testing are presented in Figure 33.

Samples will be retained in our laboratory for 30 days after submittal of this report. Other arrangements may be provided at the request of the Client.

GENERAL SITE CONDITIONS

GEOLOGY

A review of the *Geologic Atlas of Texas, San Antonio Sheet*, indicates that the proposed roadway alignments are naturally underlain with the soils of the Leona Formations.

The Leona Formation is associated with terrace deposits of the Nueces and Leona Rivers and typically consists of clays/silts grading down into coarse gravel and cobbles. The Leona Formation can be highly variable and can therefore result in highly variable conditions over relatively short distances. Key geotechnical engineering concerns for development supported on the Leona Formation are the expansive nature of the clays, the consistency and/or relative density of the deposits, and the absence/presence as well as thickness of potentially water-bearing gravels.

EXISTING PAVEMENT SECTION AND STRATIGRAPHY

The existing pavement sections determined by auger drilling methods at the boring locations are summarized in the following table:

Boring No.	Roadway	Asphalt Thickness (in.)	Base Thickness (in.)
P-1	Cordova Road	4	10
P-2		6-1/2	6
P-3		4	12-1/2
P-4		3-1/2	13-1/2
P-5		3	11
P-6		3-1/2	12-1/2
P-7		8	8
P-8		3	9
P-9		5-1/2	-
P-10		6	8
P-11		6	10
P-12		3	9
P-13		4-1/2	9
P-14		3	10
P-15		5	11
WC-1	Low Water Crossing	7	10
WC-2		6	10
WC-3		7	10

Below the pavement section, the natural stratigraphy consists of alternate layer of highly plastic reddish to dark brown clay and low plasticity tan clay to boring termination.

Each stratum has been designated by grouping materials that possess similar physical and engineering characteristics. The boring logs should be consulted for more specific stratigraphic information. Unless noted on the boring logs, the lines designating the changes between various strata represent approximate boundaries. The transition between materials may be gradual or may occur between recovered samples. The stratification given on the boring logs, or described herein, is for use by RKI in its analyses and should not be used as the basis of design or construction cost estimates without realizing there can be variation from that shown or described.

The boring logs and related information depict subsurface conditions only at the specific locations and times where sampling was conducted. The passage of time may result in changes in conditions interpreted to exist at or between the locations where sampling was conducted.

PAVEMENT DISTRESS WINDSHIELD STUDY

A pavement distress windshield study was conducted by RKI on February 2, 2023. This was conducted to visually assess the roadway conditions of Cordova Road from State Highway 46 to State Highway 123. The severity classifications listed below were observed and recorded in general accordance with the Federal

Highway Administration (FHWA) document ”Distress Identification Manual”. The following list presents the observations noted during the study.

Cordova Road – from SH 46 to Cordova Loop (Both lanes):

- Lane-to-shoulder dropoff throughout the road section on both lanes;
- Moderate severity longitudinal cracks along edges;
- Low to moderate severity edge cracking;
- Bleeding; and
- Low severity patching.

Cordova Road – from Cordova Loop to County Road 105 (East Bound):

- Bleeding; and
- Lane-to-shoulder dropoff.

Cordova Road – from County Road 105 to Eric Path (East Bound):

- Lane-to-shoulder dropoff on both lanes;
- Potholes of approximately 6 in. diameter; and
- Bleeding.

Cordova Road – from Eric Path to SH 123 (Both lanes):

- Lane-to-shoulder dropoff on both lanes;
- Moderate severity longitudinal cracks along edges;
- High severity rutting on both lanes; and
- High severity bleeding near intersection of SH 123.

GROUNDWATER

Groundwater was not observed in the borings either during or immediately upon completion of the drilling operations. However, it is possible for groundwater to exist beneath this site at shallow depths on a transient basis following periods of precipitation. Fluctuations in groundwater levels occur due to variation in rainfall and surface water run-off. The construction process itself may also cause variations in the groundwater level.

DEGRADATION OF CONCRETE

The degradation of concrete is caused by chemical agents in the soil or groundwater that react with concrete to either dissolve the cement paste or precipitate larger compounds which cause cracking and flaking. The concentration of water-soluble sulfates in the soils is a good indicator of the potential for chemical attack of concrete. Sulfate concentrations in soil can be used to evaluate the need for protection of concrete based on the general guidelines shown in the table below.

Sulfate Attack Potential	
Sulfate Ion Concentration, ppm or mg/kg	**Aggressiveness[1]**
>20,000	Very Severe
2,000 to 20,000	Severe
1,000 to 2,000	Moderate
< 1,000	Negligible

[1]ACI 318-05/ACI 318R-05

Sulfate Attack Potential	
Sulfate Ion Concentration, ppm or mg/kg	Exposure Class
SO4 > 10,000	S3
1,500 ≤ SO4≤ 10,000	S2
150 ≤ SO4≤ 1,500	S1
< 150	S0

[1]ACI 318-14 (Table 19.3.1.1)

Sulfate testing was completed on anticipated subgrade samples taken from Borings P-1, P-5, P-11, and P-15. The results for all the samples showed a sulfate contents of less than 100 ppm. The general guidelines from the above table indicate the soils have a "*Negligible*" potential for attacking concrete. Based on testing of the measured soil sulfate concentration for the soils at the site, the sulfate content exposure class is S0 thus there are no type restrictions on the cementitious materials.

Also, another purpose of the sulfate testing was to determine the concentration of soluble sulfates in the subgrade soils, in order to investigate the potential for an adverse reaction to lime in sulfate-containing soils. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

Based on the laboratory test results, the reported sulfate concentrations above 3,000 ppm are known to cause sulfate induced heaving when the soils are mixed with lime. It should be understood that the identification of sulfates based on discrete soil samples cannot totally identify sulfates in all areas. If the option for lime is considered, a quality assurance program should be implemented to assist in reducing the risk of sulfate induced heaving.

PAVEMENT RECOMMENDATIONS

TRAFFIC DATA

Traffic loading and frequencies for Cordova Road were provided by Mr. Steven Tate, P.E, from Pape-Dawson Engineers, Inc. The provided data along with assumed input parameters and are summarized below.

Cordova Road	2025	2045
Average Daily Traffic (ADT)	17,700	22,700
18-kip Equivalent Single Axle Loads (ESALs), 20 Year – Flexible Pavement	2,358,900	
Growth Rate	5.0 %	
Dir Dist (D-Factor)	60 %	
Percent Trucks in ADT	4 %	
# of Lanes	4	
Initial Serviceability Index	4.2	
Final Serviceability Index	2.5	
Confidence (%)	95 %	
Roadbed Soil Resilient Modulus for Soil Subgrade	3 ksi	
Modulus of Subgrade reaction (k-value) for Soil Subgrade	300 pci	

SWELL/HEAVE POTENTIAL

The subgrade soils at this site are classified as highly plastic, and the potential exists for the soils to expand or heave when water is introduced, causing the pavement to become rough or uneven over time. Pavement roughness is generally defined as an expression of irregularities in the pavement surface that adversely affect the ride quality of a vehicle (and thus the user). Roughness is an important pavement characteristic because it affects not only ride quality but also fuel consumption as well as vehicle maintenance costs. Pavement heave can be reduced through various measures but cannot be totally eliminated without full removal of the problematic soil. Measures available for reducing heave include:

- Soil Treatment with Lime or Other Chemicals
- Removal and Replacement of Moderate to High PI Soils
- Drains or Barriers to Collect or Inhibit Moisture Infiltration

Soil treatment with lime (or other chemicals) is typically used to reduce the swelling potential of the upper portion of the pavement subgrade containing plastic soils. Lime and water are mixed with the top 6 to 12 inches (or possibly more) of the subgrade and allowed to mellow or cure for a period of time. After mellowing, the soil-lime mixture is compacted to form a relatively strong soil matrix that can improve pavement performance and potentially reduce soil heave. However, the chemical reaction between the calcium-based additives and the sulfates and/or sulfide minerals in the soil can create a heaving problem on the pavement. Laboratory testing performed on site and on imported fills can be used to evaluate the concentration of soluble sulfates in the subgrade soils. Since the soil soluble sulfate content is less than 3,000 ppm, the use of lime to treat the soils can be considered. Furthermore, in highly plastic soils, lime treatment of only the top portion of the expansive subgrade may not provide an acceptable reduction in PVR. For a more substantial reduction in PVR, removal and replacement or treatment of the high plasticity index (PI) soil may be the only method available to reduce the potential vertical rise of the pavement to an acceptable level. As stated previously though, it must be recognized that partial removal of expansive clay soil only reduces the potential (or risk) of the damage swell can cause to a pavement and does not completely eliminate this risk.

In addition, capturing water infiltration via French drains, pavement edge drains, or horizontal/vertical moisture barriers would reduce the potential for heave since one important component of the heaving mechanism, water, would be reduced. Geogrid is also another tool available that may help reduce the damage that heaving subgrades cause to flexible pavements and may be considered in addition to or as an alternative to other mitigation techniques.

It should be noted that the pavement sections recommended in subsequent sections of this report are structurally adequate for the given traffic levels and subgrade strength, but do not consider the long-term effects of pavement roughness due to heave, which can only be addressed by the measures discussed in this section.

PAVEMENT SECTION RECOMMENDATIONS

Utilizing the pavement design parameters and traffic data, discussed previously, along with TxDOT's pavement design program FPS 21, the optional pavement sections presented below are recommended. Other pavement section options are available and can be provided upon request. The output FPS 21 files are provided in Figures 24-32.

Pavement Design Cross Sections	Layer Description	Layer Thickness[1]	Recommended SN Coeff.	SN Extension
Flexible Pavement Option 1	HMA Type C or D	3.0 in.	0.44	1.32
	HMA Type B	5.0 in.	0.38	1.90
	Flexible Base with Geogrid	12.0 in.	0.17	2.04
	Stabilized Subgrade	6.0 in.	0.08	0.48
	Combined Total	**26.0 in.**		**5.74[2]**
Flexible Pavement Option 2	HMA Type C or D	6.0 in.	0.44	2.64
	Flexible Base	18.0 in.	0.14	2.52
	Stabilized Subgrade	8.0 in.	0.08	0.64
	Combined Total	**32.0 in.**		**5.80[2]**
Flexible Pavement Option 3	HMA Type C or D	2.0 in.	0.44	0.88
	HMA Type B	6.0 in.	0.38	2.28
	Flexible Base	14.0 in.	0.14	1.96
	Stabilized Subgrade	8.0 in.	0.08	0.64
	Combined Total	**30.0 in.**		**5.76[2]**
Rigid Pavement Option	Concrete[3]	8.5 in.		
	HMA Bond Breaker	1.0 in.		
	Cement Treated Base	6.0 in.	-	-
	Treated Subgrade	6.0 in.		
	Combined Total	**21.5 in.**		

[1] Other pavement section thicknesses are available and can be provided upon request.

[2] SN exceeds the maximum SN (SN=5.08) provided by City of Seguin Pavement Design Standards.

[3] Concrete pavement should consist of continuously reinforced concrete pavement (CRCP), or jointed plain concrete pavement with load transfer devices at control joints. See Figure 34 for joint details.

The above presented flexible pavement sections passed FPS 21's mechanistic and triaxial checks.

PAVEMENT CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

The roadways and all areas to support fill should be stripped of all existing asphalt, base material, etc. Exposed subgrades should be thoroughly proofrolled in order to locate and densify any weak, compressible zones. A fully-loaded dump truck or a similar heavily-loaded piece of construction equipment should be used for planning purposes. Proofrolling operations should be observed by the Geotechnical Engineer or his representative to document subgrade condition and preparation. Weak or soft areas identified during proofrolling should be removed and replaced with a suitable, compacted backfill.

After completion of the proofrolling operations and just prior to treated or flexible base placement, the exposed subgrade should be moisture conditioned by scarifying to a minimum depth of 6 in. and recompacting to a minimum of 95 percent of the maximum density determined from the Texas Department of Transportation Compaction Test (TxDOT, Tex-114-E). The moisture content of the subgrade should be maintained within the range of optimum moisture content to 3 percentage points above optimum until permanently covered.

DRAINAGE CONSIDERATIONS

As with any soil-supported structure, the satisfactory performance of a pavement system is contingent on the provision of adequate surface and subsurface drainage. Insufficient drainage which allows saturation of the pavement subgrade and/or the supporting granular pavement materials will greatly reduce the performance and service life of the pavement systems.

Surface and subsurface drainage considerations crucial to the performance of pavements at this site include (but are not limited to) the following:

1) Any known natural or man-made subsurface seepage at the site which may occur at sufficiently shallow depths as to influence moisture contents within the subgrade should be intercepted by drainage ditches or below grade French drains.
2) Final site grading should eliminate isolated depressions adjacent to curbs which may allow surface water to pond and infiltrate into the underlying soils. **Curbs should completely penetrate base materials and should be installed to sufficient depth to reduce infiltration of water beneath the curbs**.
3) Pavement surfaces should be maintained to help minimize surface ponding and to provide rapid sealing of any developing cracks. These measures will help reduce infiltration of surface water downward through the pavement section.

ON-SITE SOIL FILL

As discussed previously, the pavement recommendations presented in this report were prepared assuming that on-site soils will be used for fill grading in proposed pavement areas. If used, we recommend that on-site soils be placed in loose lifts not exceeding 8 in. in thickness and compacted to at least 95 percent of the maximum density as determined by TxDOT, Tex-114-E. The moisture content of the fill should be maintained within the range of optimum water content to 3 percentage points above the optimum water content until permanently covered. We recommend that fill materials be free of roots and other organic or degradable material. We also recommend that the maximum particle size not exceed 4 in. or one half the lift thickness, whichever is smaller.

TREATMENT OF SUBGRADE

Lime or cement treatment of the subgrade soils, if utilized, should be in accordance with the TxDOT Standard Specifications, Item 260 or Item 275, respectively. A sufficient quantity of hydrated lime or cement should be mixed with the subgrade soils to reduce the soil plasticity index to 20 or less. Based on the results of the pH-Lime Series Curves, we recommend that at least 3 percent hydrated lime treatment by weight be used to increase the pH of the subgrade clays to 12.4 or higher. For construction purposes, we recommend that the optimum lime or cement content of the subgrade soils be determined by laboratory testing with representative samples of the subgrade materials being used for this project. Treated subgrade soils should be compacted to a minimum of 95 percent of the maximum density at a moisture content within the range of optimum moisture content to 3 percentage points above the optimum moisture content as determined by Tex-113-E.

We recommend that during site grading operations additional laboratory testing be performed to determine the concentration of soluble sulfates in the subgrade soils. If present, the sulfate in the soil may react with calcium-based stabilizers such as lime or cement. The adverse reaction, referred to as sulfate-induced heave, has been known to cause cohesive subgrade soils to swell in short periods of time, resulting in pavement heaving and possible failure.

PRIME COAT

A prime coat should be placed on top of any compacted base course and should be a MC-30 or AE-P conforming to TxDOT Standard Specifications 2014, Item 300 – Asphalts, Oils or Emulsions. Prime coat application rates are generally dependent upon the absorption rate of the granular base and other environmental conditions at the time of placement. For construction, the application rate shall not exceed 0.2 gal/yd^2.

TACK COAT

A tack coat should be placed between asphaltic concrete base and/or surface lifts and should be a PG binder with a minimum high-temperature grade of PG 58, SS-1H, CSS-1H, or EAP&T conforming to the TxDOT Standard Specifications 2014, Item 300 – Asphalts, Oils or Emulsions. For construction, the application rate shall not exceed 0.1 gal/yd^2.

FLEXIBLE BASE COURSE

The flexible base course should be crushed limestone conforming to TxDOT 2014 Standard Specifications, Item 247, Type A, Grade 1-2. The base course should be placed in lifts with a maximum compacted thickness of 8 in. (10 in. loose) and compacted to a minimum of 95 percent of maximum dry density as determined by TxDOT Tex-113-E Compaction Test. The moisture content of the material should be maintained within the range of 2 percentage points below to 2 percentage points above the optimum moisture content until final compaction. For estimating purposes we estimate a total density of approximately 145 pcf for flexible base material.

CEMENT TREATED BASE COURSE

The cement treated base course should conform to TxDOT 2014 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 275 or 276. For estimating purposes we estimate a total density of approximately 145 pcf for cement treated base material. In our experience, cement percentages typically range from 2 to 5 percent, but should be verified with laboratory testing. For estimating purposes we estimate 5% cement be included. We recommend microcracking be performed approximately 1 - 3 days after placement.

ASPHALTIC CONCRETE SURFACE AND/OR BINDER COURSES

The asphaltic concrete surface and/or binder courses should conform to TxDOT Standard Specifications 2014, 341 – Dense Graded Hot-Mix Asphalt, Types C or D, and Type B for the base, if the full depth asphalt section is selected for construction. Recycled asphalt pavement (RAP) should be limited to 20 percent of the total weight of the mix for Types C and D mixes, and 30 percent for Type B mixes. Higher percentages of RAP may be permissible depending on the material source. If higher percentages of RAP are desired, contact RKI for consideration. Asphalt cement grades should conform to the table shown below.

Street Classification	Minimum PG Asphalt Cement Grade		
	Surface Courses	Binder & Level Up Courses	Base Courses
Secondary Arterial	PG 76-22	PG 70-22	PG 64-22

The asphaltic concrete should be compacted on the roadway to contain from 5 to 9 percent air voids computed using the maximum theoretical specific gravity (Rice) of the mixture determined according to Test Method Tex-227-F. Pavement specimens, which shall be either cores or sections of asphaltic pavement, will be tested according to Test Method Tex-207-F. The nuclear-density gauge or other methods which correlate satisfactorily with results obtained from project roadway specimens may be used when approved by the Engineer. Unless otherwise shown on the plans, the Contractor shall be responsible for obtaining the required roadway specimens at their expense and in a manner and at locations selected by the Engineer.

It is recommended that the hot mix asphalt concrete pavement be placed with a paving machine only and not with a motor grader unless prior approval is granted by the Engineer for special circumstances.

HOT-MIX ASPHALT BOND BREAKER

The hot-mix asphalt bond breaker should be in accordance with the TxDOT 2014 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 340, Dense-Graded Hot-Mix

Asphalt (Small Quantity), Type D, a Performance Graded Binder 76-22 (PG-76-22), and designed with a laboratory density target of 97.5 percent.

PORTLAND CEMENT CONCRETE

The Portland cement concrete should be in accordance with Class P concrete of the TxDOT 2014 Standard Specifications for Construction and Maintenance of Highways, Streets and Bridges, Item 421, Portland Cement Concrete. Requirements include concrete designed to meet a minimum average compressive strength of 3,500 psi at 7-days or a minimum average compressive strength of 4,400 psi at 28-days in accordance with TxDOT standard laboratory test procedure Tex-448-A or Tex-418-A. Liquid membrane-forming curing compound should be applied as soon as practical after broom finishing the concrete surface. The curing compound will help reduce the loss of water from the concrete. The reduction in the rapid loss in water will help reduce shrinkage cracking of the concrete.

MISCELLANEOUS PAVEMENT RELATED CONSIDERATIONS

Longitudinal Cracking

It should be understood that asphalt pavement sections in expansive soil environments can develop longitudinal cracking along unprotected pavement edges. In the semi-arid climate of south central Texas this condition typically occurs along the unprotected edges of pavements where moisture fluctuation is allowed to occur over the lifetime of the pavements.

Pavements that do not have a protective barrier to reduce moisture fluctuation of the expansive clay subgrade between the exposed pavement edge and that beneath the pavement section tend to develop longitudinal cracks 1 to 4 ft from the edge of the pavement. Once these cracks develop, further degradation and weakening of the underlying granular base may occur due to water seepage through the cracks. The occurrence of these cracks can be more prevalent in the absence of lateral restraint and embankments. This problem can best be addressed by providing either a horizontal or vertical moisture barrier at the unprotected pavement edge.

At a minimum, we recommend that the curbs are constructed such that the depth of the curb extends through the entire depth of the granular base material and into the subgrade to act as a protective barrier against the infiltration of water into the granular base.

In most cases, a longitudinal crack does not immediately compromise the structural integrity of the pavement system. However, if left unattended, infiltration of surface water runoff into the crack will result in isolated saturation of the underlying base. This will result in pumping of the flexible base, which could lead to rutting, cracking, and potholes. For this reason, we recommend that cracks be immediately sealed.

Utilities

Our experience indicates that significant settlement of backfill can occur in utility trenches, particularly when trenches are deep, when backfill materials are placed in thick lifts with insufficient compaction, and when water can access and infiltrate the trench backfill materials. The potential for water to access the backfill is increased where water can infiltrate flexible base materials due to insufficient penetration of curbs, and at sites where geological features can influence water migration into utility trenches. It is our belief that another factor which can significantly impact settlement is the migration of fines within the backfill into the open voids in the underlying free-draining bedding material.

To reduce the potential for settlement in utility trenches, we recommend that consideration be given to the following:

- All backfill materials should be placed and compacted in controlled lifts appropriate for the type of backfill and the type of compaction equipment being utilized and all backfilling procedures should be tested and documented.
- Consideration should be given to wrapping free-draining bedding gravels with a geotextile fabric (similar to Mirafi 140N) to reduce the infiltration and loss of fines from backfill material into the interstitial voids in bedding materials.

Curb and Gutter

It is good practice to construct curbs such that the depth of the curb extends through the entire depth of the granular base material to act as a protective barrier against the infiltration of water into the granular base. Pavements that do not have this protective barrier to moisture tend to develop longitudinal cracks 1 to 2 ft from the edge of the pavement. Once these cracks develop, further degradation and weakening of the underlying granular base may occur due to water seepage through the cracks.

Pavement Maintenance

Regular pavement maintenance is critical in maintaining pavement performance over a period of several years. All cracks that develop in asphalt pavements should be regularly sealed. Areas of moderate to severe fatigue cracking (also known as alligator cracking) should be sawcut and removed. The underlying base should be checked for contamination or loss of support and any insufficiencies fixed or removed and the entire area patched. All cracks that develop in concrete pavements should be routed and sealed regularly. Joints in concrete pavements should be maintained to reduce the influx of incompressible materials that restrain joint movement and cause spalling and/or cracking. Other typical TxDOT maintenance techniques should be followed as required.

Construction Traffic

Construction traffic on prepared subgrade, granular base or asphalt treated base (black base) should be restricted as much as possible until the protective asphalt surface pavement is applied. Significant damage to the underlying layers resulting in weakening may occur if heavily loaded vehicles are allowed to use these areas.

BOX CULVERT RECOMMENDATIONS

BEARING CAPACITIES

Box culverts bearing on natural soil or compacted fill may be designed for a net allowable bearing pressure of 1,500 pounds per square foot (psf), or less. Settlement of soil is estimated to be approximately 1 inch or less. If higher bearing pressures are required, Raba Kistner should be contacted to evaluate. The bottom of the excavation should generally be level. Loose materials should be removed from all foundation excavations.

BOX CULVERT EARTH/SOIL LOADS

The weight of the soil over the top of a buried culvert is dependent upon the installation method, the backfill materials, and the degree of compaction achieved during construction. For calculations related to the loading on the culvert a total unit weight for soil should be 120 or 140 pounds per cubic foot (pcf) for fine-grained soils or granular fill, respectively.

CONSTRUCTION RELATED SERVICES

CONSTRUCTION MATERIALS TESTING AND OBSERVATION SERVICES

As presented in the attachment to this report, *Important Information About Your Geotechnical Engineering Report*, subsurface conditions can vary across a project site. The conditions described in this report are based on interpolations derived from a limited number of data points. Variations will be encountered during construction, and only the geotechnical design engineer will be able to determine if these conditions are different than those assumed for design.

Construction problems resulting from variations or anomalies in subsurface conditions are among the most prevalent on construction projects and often lead to delays, changes, cost overruns, and disputes. These variations and anomalies can best be addressed if the geotechnical engineer of record, Raba-Kistner, is retained to perform construction observation and testing services during the construction of the project. This is because:

- RKI has an intimate understanding of the geotechnical engineering report's findings and recommendations. RKI understands how the report should be interpreted and can provide such interpretations on site, on the client's behalf.
- RKI knows what subsurface conditions are anticipated at the site.
- RKI is familiar with the goals of the owner and project design professionals, having worked with them in the development of the geotechnical workscope. This enables RKI to suggest remedial measures (when needed) which help meet the owner's and the design teams' requirements.
- RKI has a vested interest in client satisfaction, and thus assigns qualified personnel whose principal concern is client satisfaction. This concern is exhibited by the manner in which contractors' work is tested, evaluated and reported, and in selection of alternative approaches when such may become necessary.
- RKI cannot be held accountable for problems which result due to misinterpretation of our findings or recommendations when we are not on hand to provide the interpretation which is required.

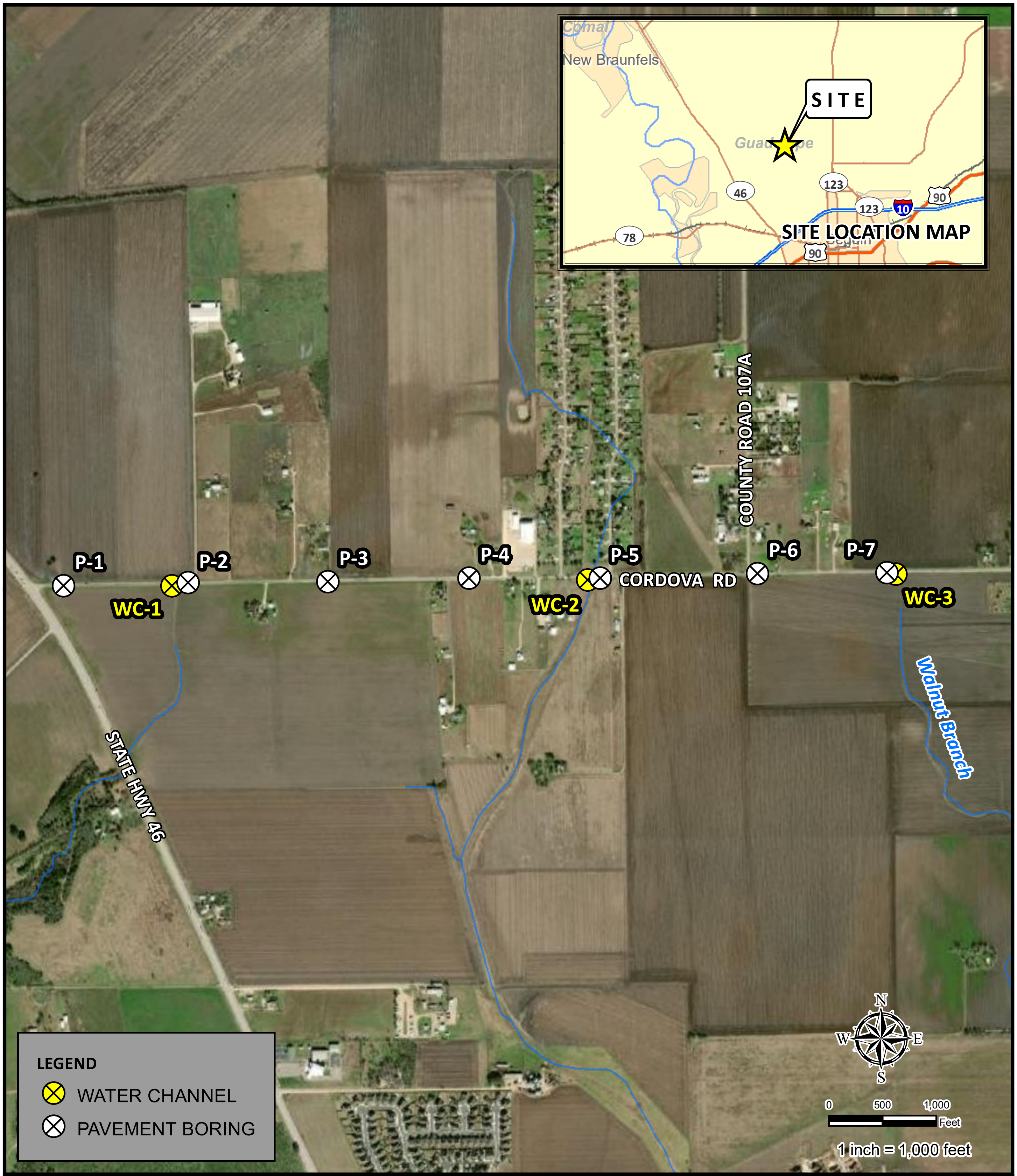
BUDGETING FOR CONSTRUCTION TESTING

Appropriate budgets need to be developed for the required construction testing and observation activities. At the appropriate time before construction, we advise that RKI and the project designers meet and jointly develop the testing budgets, as well as review the testing specifications as it pertains to this project.

Once the construction testing budget and scope of work are finalized, we encourage a preconstruction meeting with the selected contractor to review the scope of work to make sure it is consistent with the construction means and methods proposed by the contractor. RKI looks forward to the opportunity to provide continued support on this project, and would welcome the opportunity to meet with the Project Team to develop both a scope and budget for these services.

* * * * * * * * * * * * * * * * * *

ATTACHMENTS



RABA KISTNER

211 Trade Center, Suite 300
New Braunfels, Texas 78130

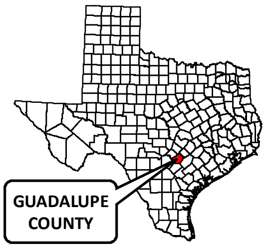
(830)214-0544 TEL
(830)214-0627 FAX
www.rkci.com

TBPE Firm Number 3257

SOURCE: Aerial imagery from Google Earth Pro - 2021

BORING LOCATION MAP

Cordova Road
Seguin, Texas



PROJECT No.: ANA22-047-00

ISSUE DATE:	10/06/2022
DRAWN BY:	BM
CHECKED BY:	SS
REVIEWED BY:	IM

FIGURE

1A

RABA KISTNER

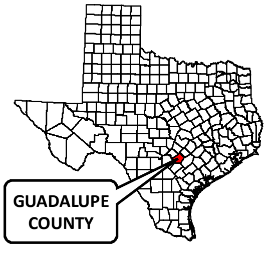
211 Trade Center, Suite 300
New Braunfels, Texas 78130
(830)214-0544 TEL
(830)214-0627 FAX
www.rkci.com

TBPE Firm Number 3257

SOURCE: Aerial imagery from Google Earth Pro - 2021

BORING LOCATION MAP

Cordova Road
Seguin, Texas



PROJECT No.: ANA22-047-00

ISSUE DATE:	10/06/2022
DRAWN BY:	BM
CHECKED BY:	SS
REVIEWED BY:	IM

FIGURE

1B

NOTE: This Drawing is Provided for Illustration Only, May Not be to Scale and is Not Suitable for Design or Construction Purposes

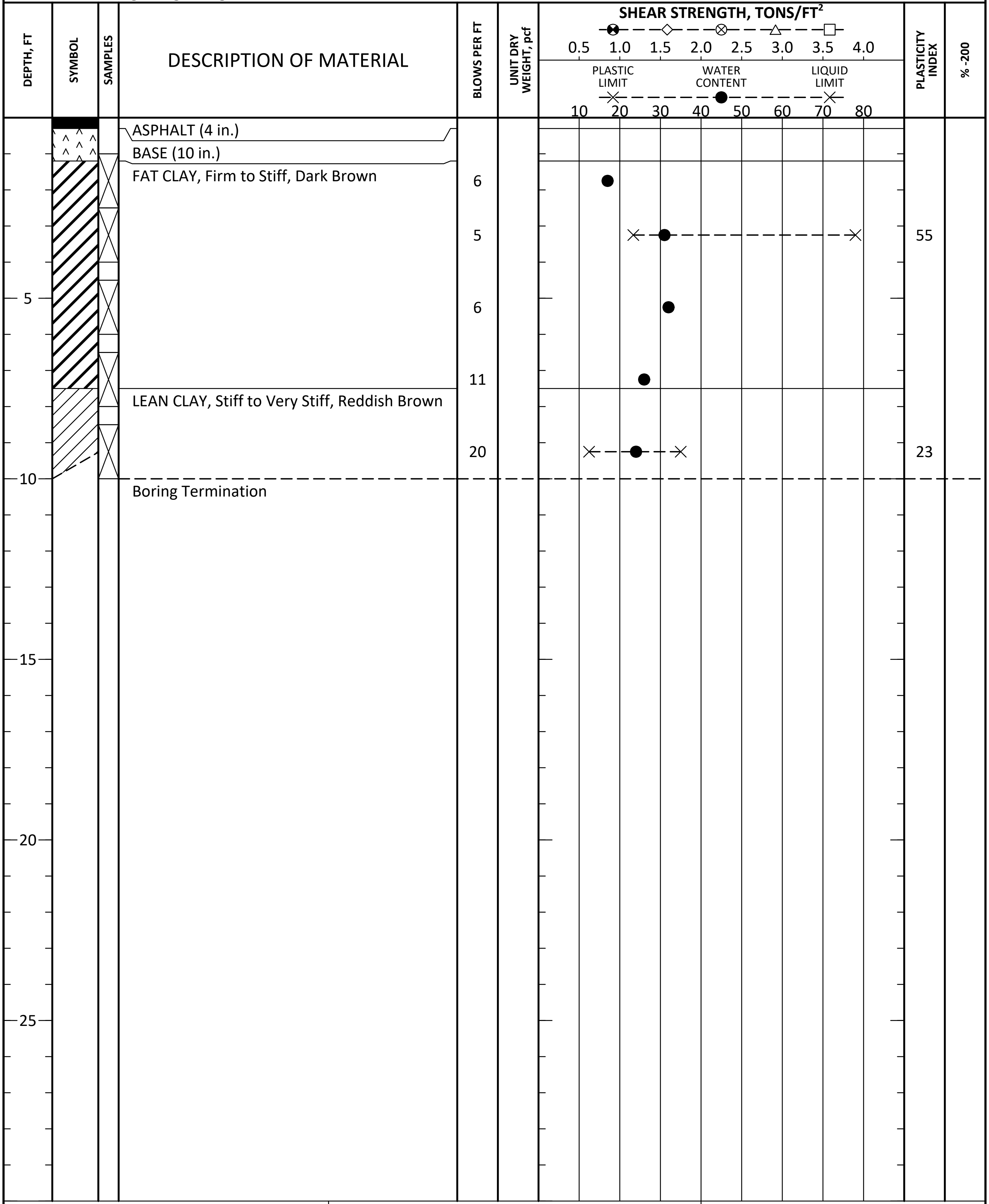
LOG OF BORING NO. P-1

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62816; W 98.02338



DESCRIPTION OF MATERIAL	BLOWS PER FT	PLASTICITY INDEX
ASPHALT (4 in.)		
BASE (10 in.)		
FAT CLAY, Firm to Stiff, Dark Brown	6	
	5	55
	6	
	11	
LEAN CLAY, Stiff to Very Stiff, Reddish Brown	20	23
Boring Termination		

DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA22-047-00
DATE DRILLED:	12/12/2022	**DATE MEASURED:**	12/12/2022	**FIGURE:**	2

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

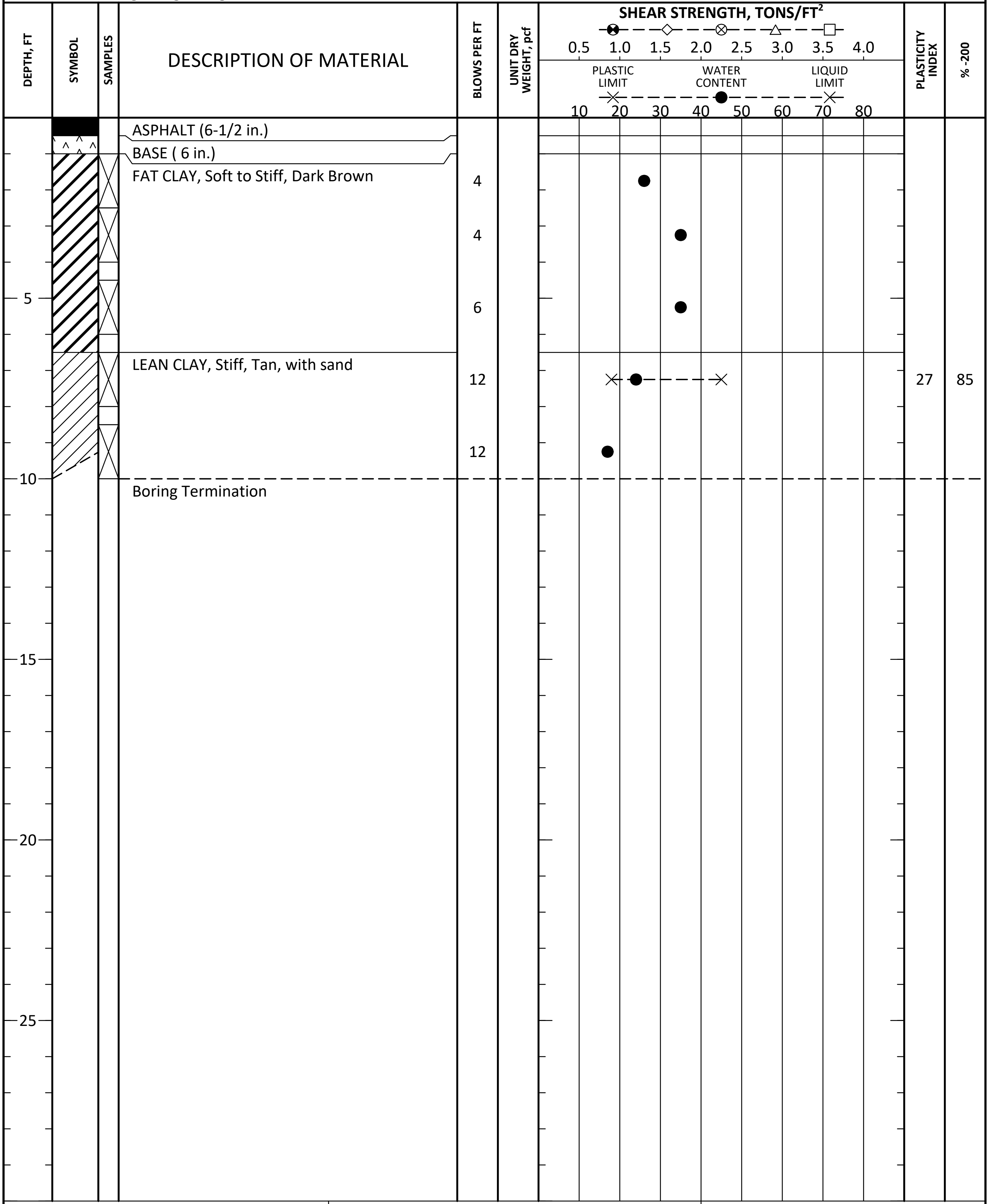
LOG OF BORING NO. P-2

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62821; W 98.01973



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/13/2022
DEPTH TO WATER: Dry
DATE MEASURED: 12/13/2022
PROJ. No.: ANA22-047-00
FIGURE: 3

LOG OF BORING NO. P-3

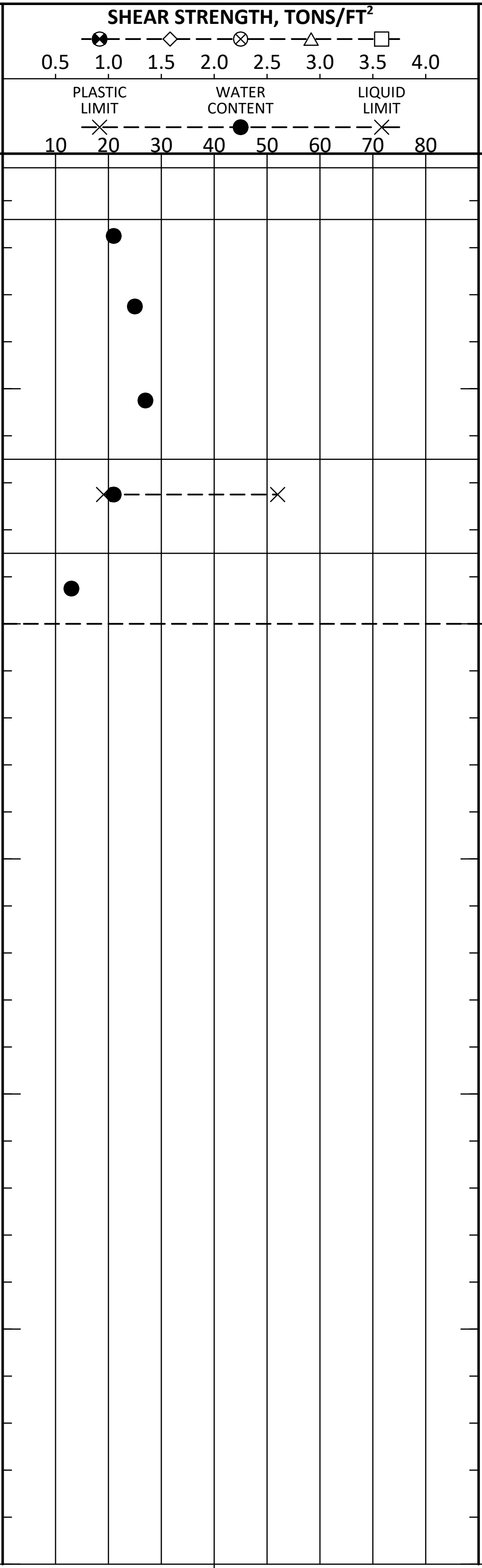
Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62820; W 98.01564

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			ASPHALT (4 in.)				
			BASE (12-1/2 in.)				
			FAT CLAY, Firm, Dark Brown	6			
				6			
5				8			
			FAT CLAY, Stiff, Reddish Brown, with gravel	12		33	
			LEAN CLAY, Very Stiff, Tan, with sand	17			
10			Boring Termination				
15							
20							
25							



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/12/2022
DEPTH TO WATER: Dry
DATE MEASURED: 12/12/2022
PROJ. No.: ANA22-047-00
FIGURE: 4

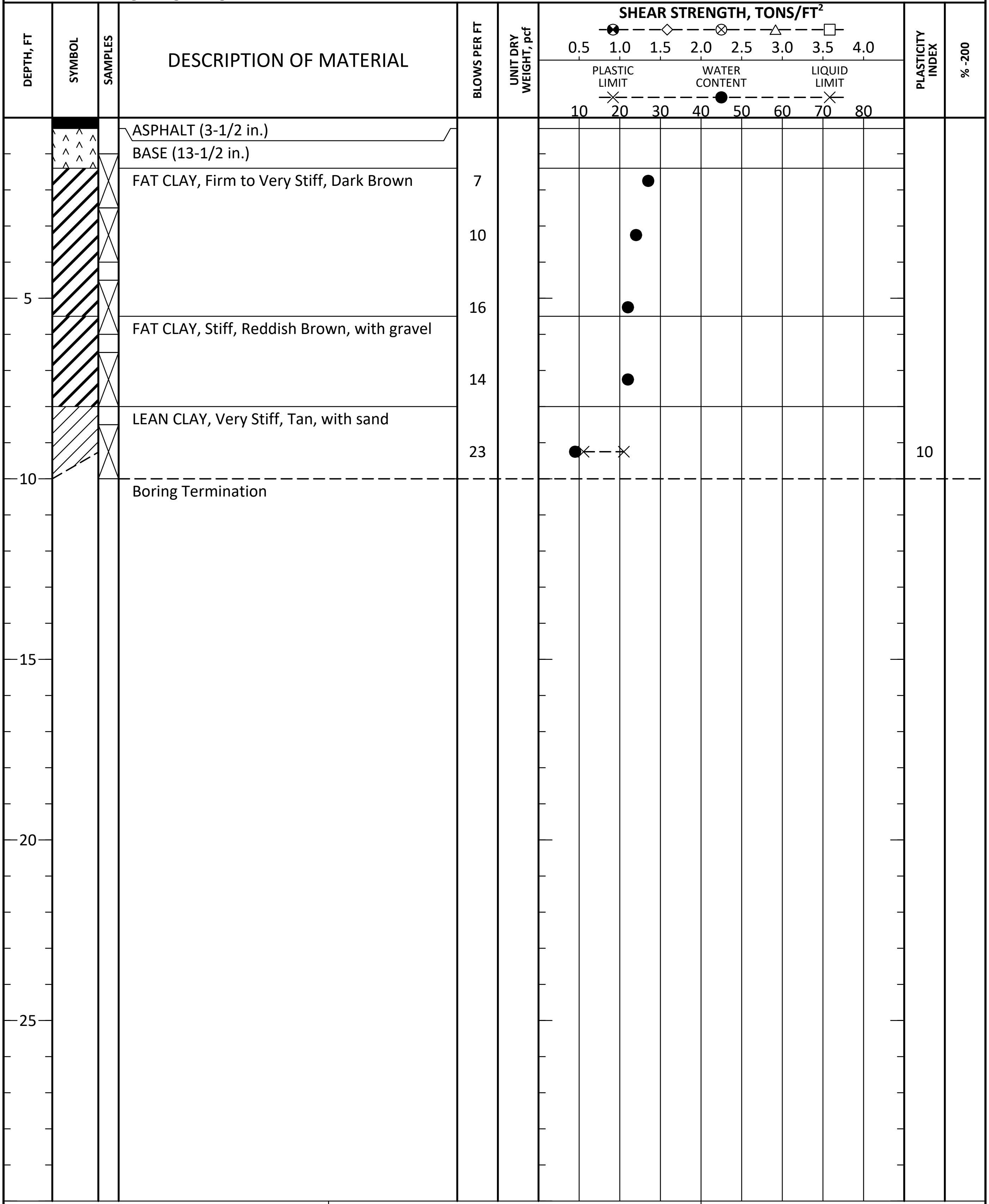
LOG OF BORING NO. P-4

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62827; W 98.01150



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (3-1/2 in.)				
BASE (13-1/2 in.)				
FAT CLAY, Firm to Very Stiff, Dark Brown	7 10 16			
FAT CLAY, Stiff, Reddish Brown, with gravel	14			
LEAN CLAY, Very Stiff, Tan, with sand	23		10	
Boring Termination				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/12/2022
DEPTH TO WATER: Dry
DATE MEASURED: 12/12/2022
PROJ. No.: ANA22-047-00
FIGURE: 5

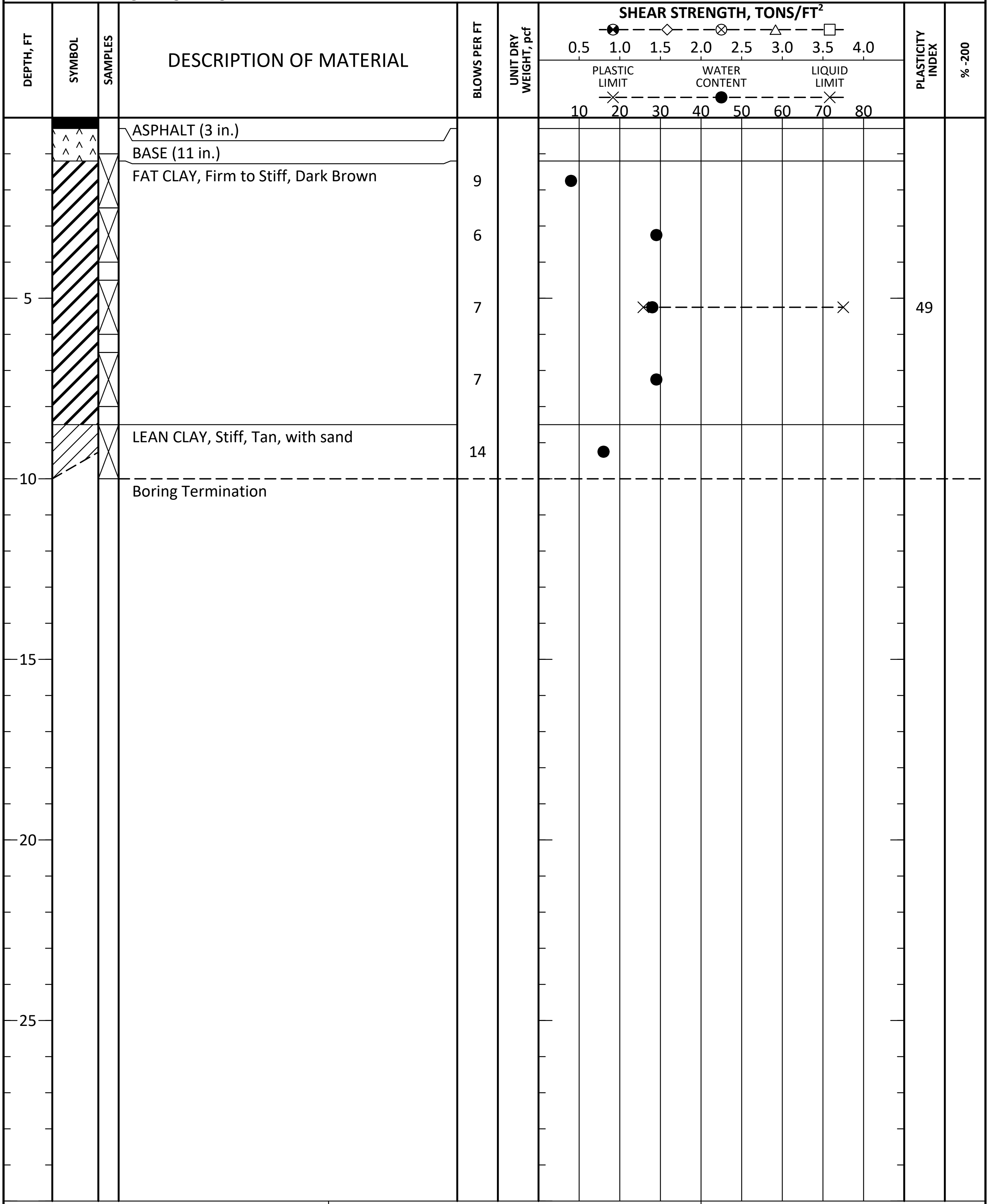
LOG OF BORING NO. P-5

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62824; W 98.00765



ASPHALT (3 in.)		
BASE (11 in.)		
FAT CLAY, Firm to Stiff, Dark Brown	9	
	6	
	7	49
	7	
LEAN CLAY, Stiff, Tan, with sand	14	
Boring Termination		

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/12/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/12/2022

PROJ. No.: ANA22-047-00
FIGURE: 6

LOG OF BORING NO. P-6

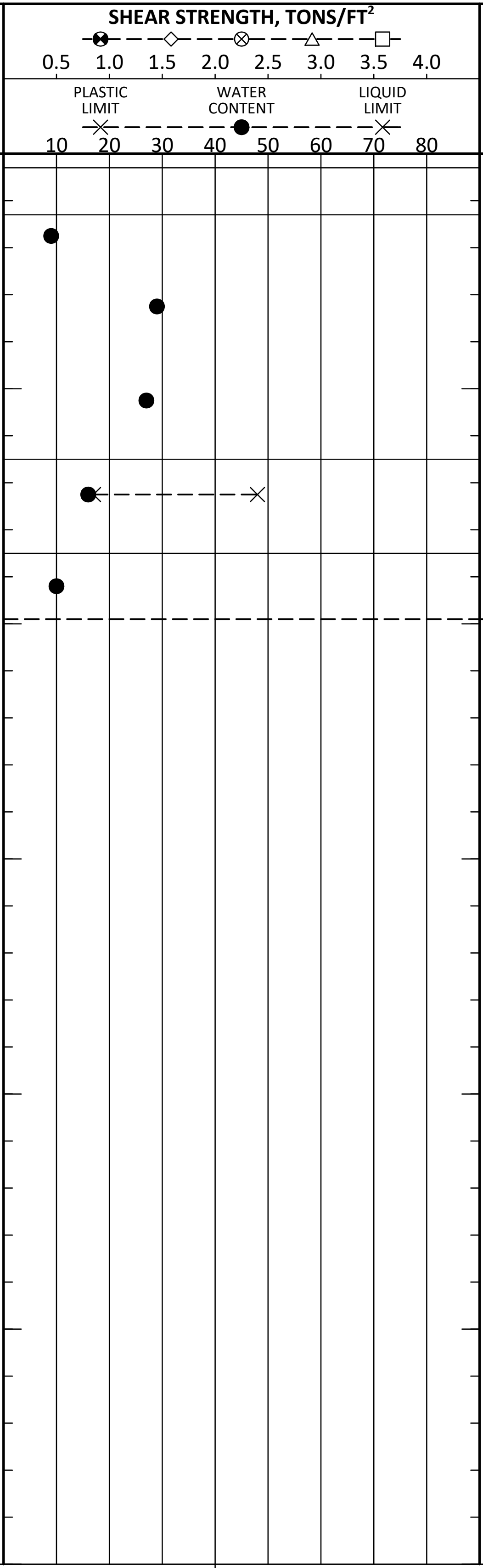
Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62833; W 98.00306

DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
			ASPHALT (3-1/2 in.)				
			BASE (12-1/2 in.)				
			FAT CLAY, Firm, Dark Brown	8			
				8			
5				10			
			LEAN CLAY, Stiff, Reddish Brown, with gravel	12		31	79
			LEAN CLAY, Very Stiff, Tan, with sand	50/11"			
10			Boring Termination				
15							
20							
25							



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 9.9 ft
DATE DRILLED: 12/12/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/12/2022

PROJ. No.: ANA22-047-00
FIGURE: 7

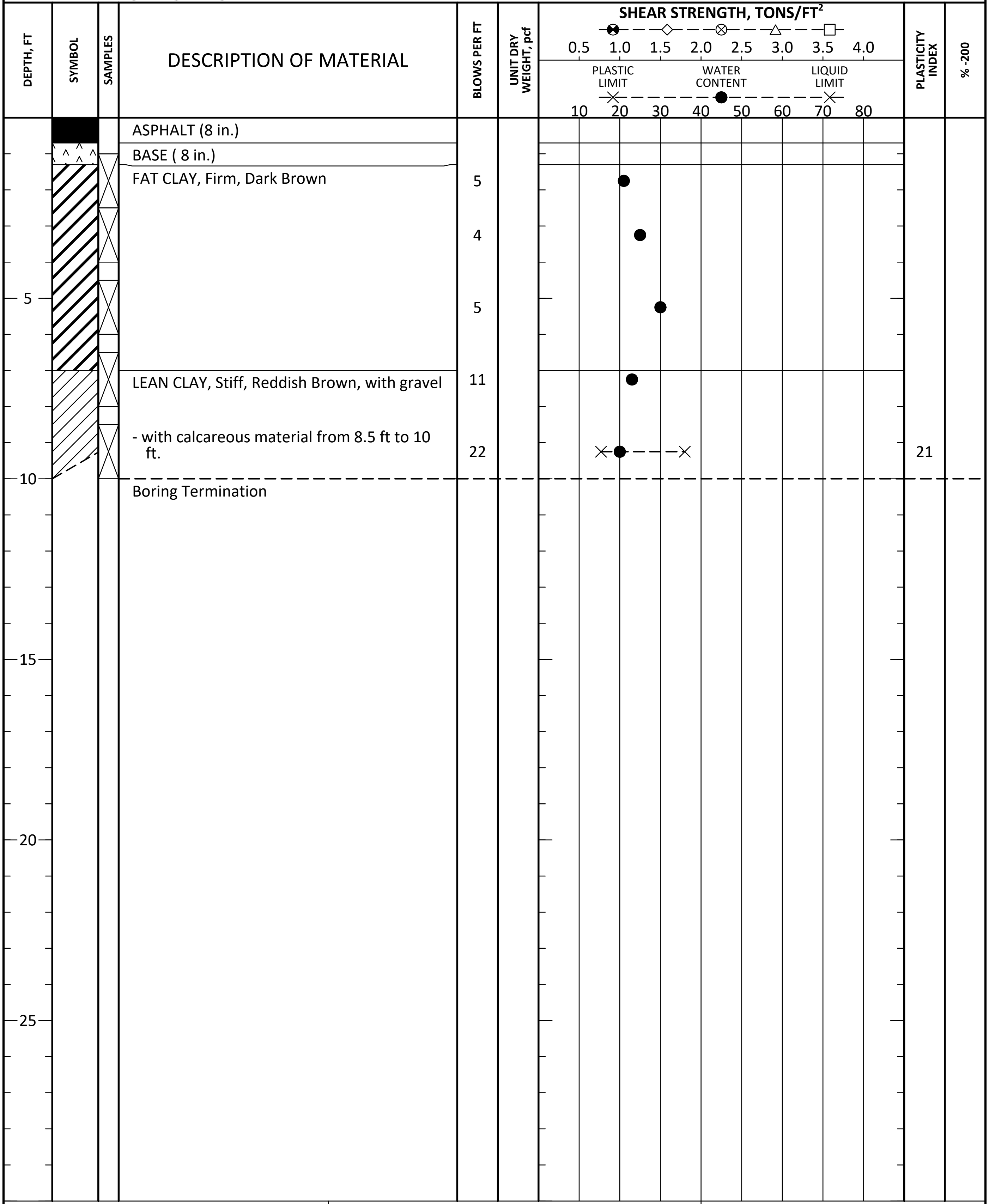
LOG OF BORING NO. P-7

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62832; W 97.99928



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (8 in.)				
BASE (8 in.)				
FAT CLAY, Firm, Dark Brown	5			
	4			
	5			
LEAN CLAY, Stiff, Reddish Brown, with gravel	11			
- with calcareous material from 8.5 ft to 10 ft.	22		21	
Boring Termination				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/12/2022
DEPTH TO WATER: Dry
DATE MEASURED: 12/12/2022
PROJ. No.: ANA22-047-00
FIGURE: 8

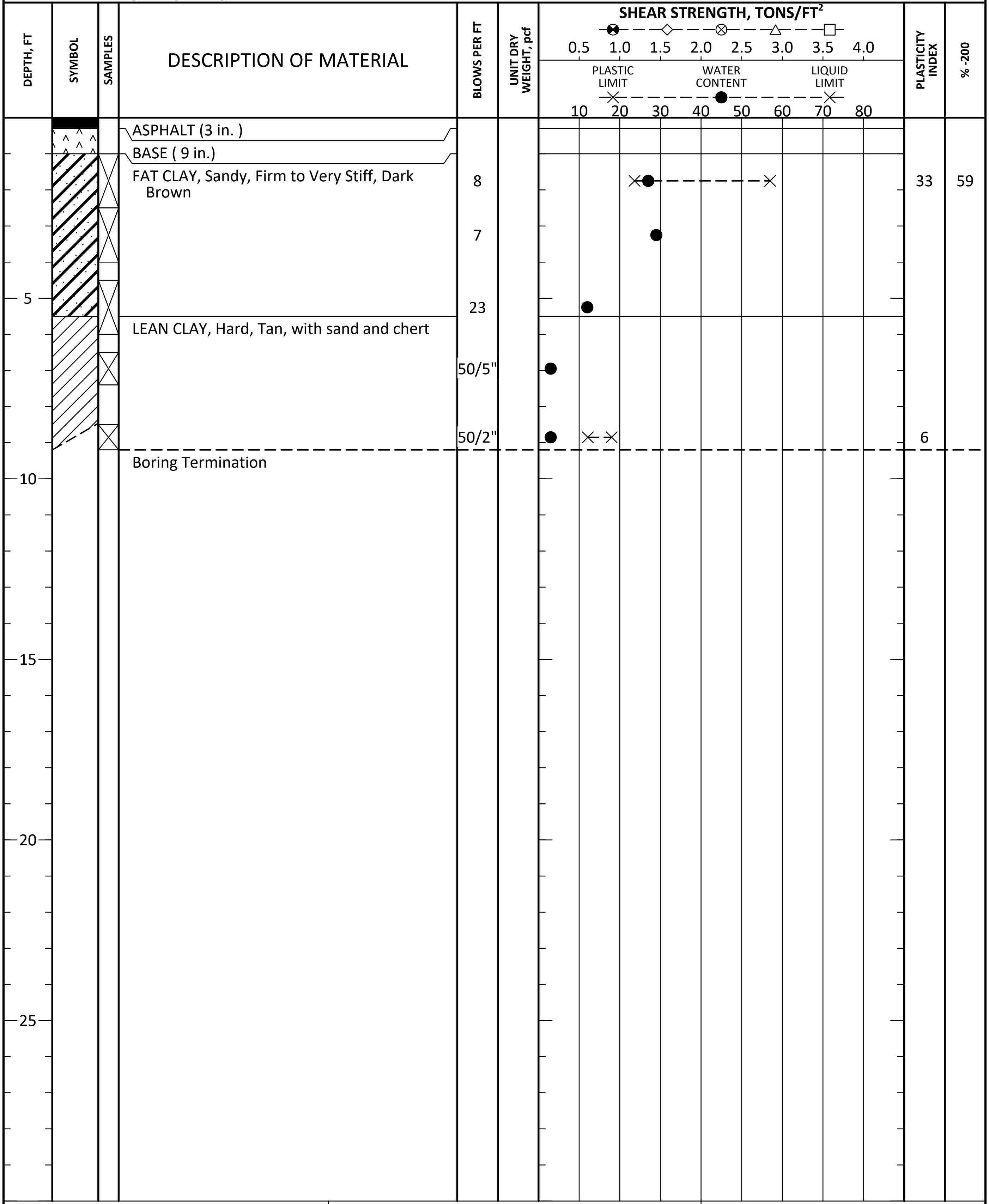
LOG OF BORING NO. P-8

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62837; W 97.99514



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (3 in.)				
BASE (9 in.)				
FAT CLAY, Sandy, Firm to Very Stiff, Dark Brown	8		33	59
	7			
	23			
LEAN CLAY, Hard, Tan, with sand and chert	50/5"			
	50/2"		6	
Boring Termination				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	9.2 ft	**DEPTH TO WATER:**	Dry
DATE DRILLED:	12/12/2022	**DATE MEASURED:**	12/12/2022
PROJ. No.:	ANA22-047-00	**FIGURE:**	9

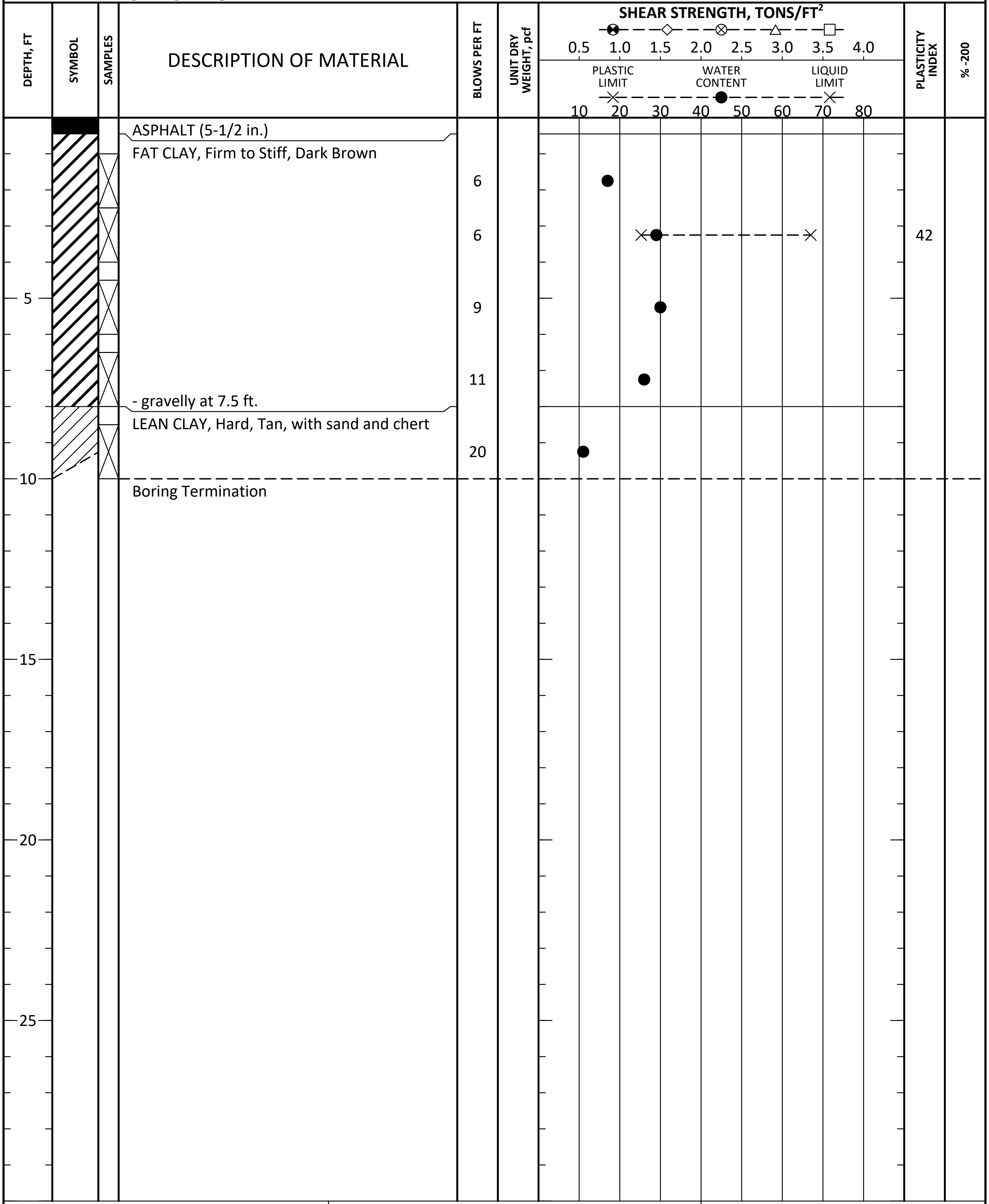
LOG OF BORING NO. P-9

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62836; W 97.99089



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/12/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/12/2022

PROJ. No.: ANA22-047-00
FIGURE: 10

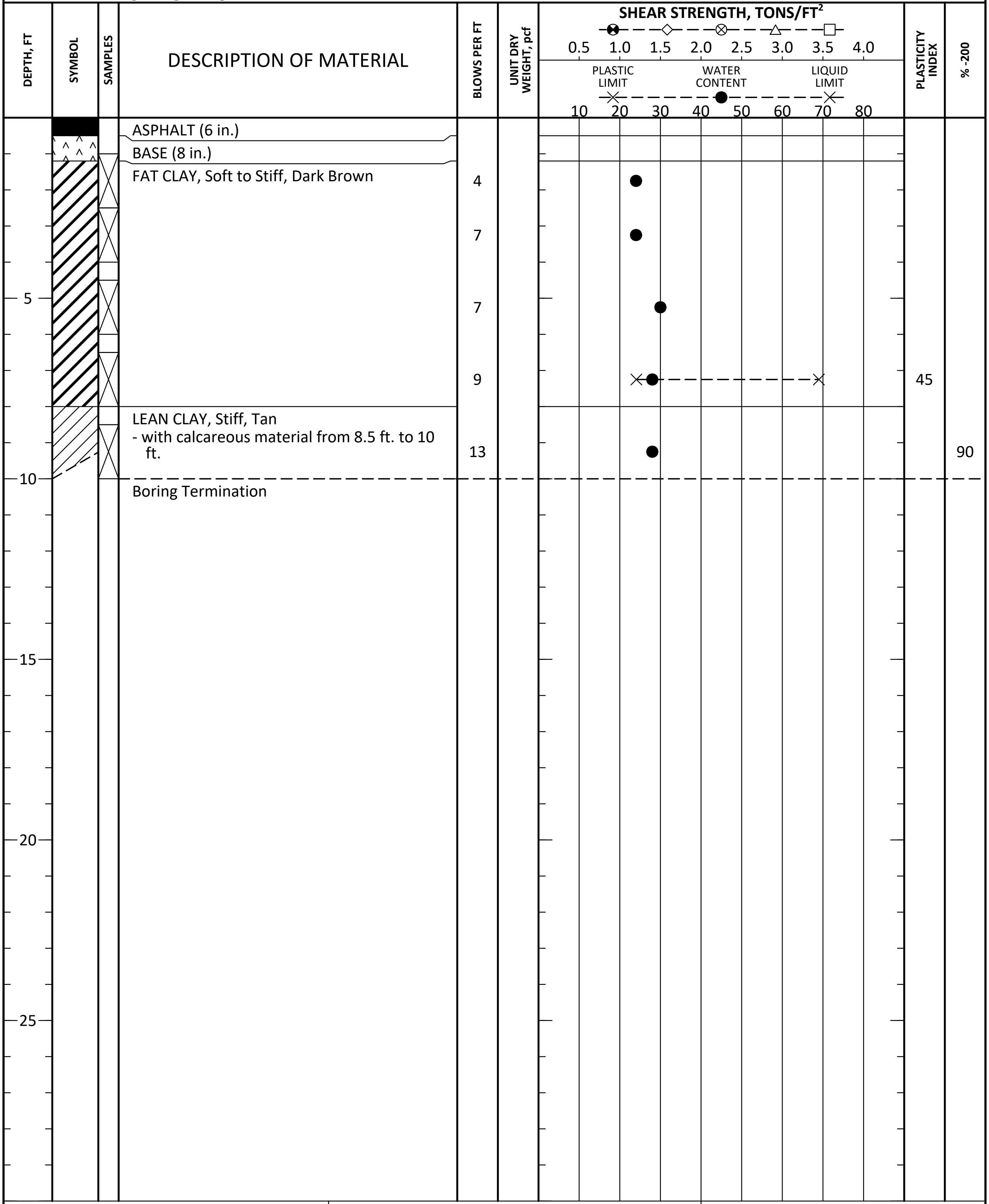
LOG OF BORING NO. P-10

Cordova Rd
Seguin, Texas

TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62828; W 97.98685



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (6 in.)				
BASE (8 in.)				
FAT CLAY, Soft to Stiff, Dark Brown	4			
	7			
	7			
	9		45	
LEAN CLAY, Stiff, Tan - with calcareous material from 8.5 ft. to 10 ft.	13			90
Boring Termination				

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/13/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/13/2022

PROJ. No.: ANA22-047-00
FIGURE: 11

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

LOG OF BORING NO. P-11

Cordova Rd
Seguin, Texas

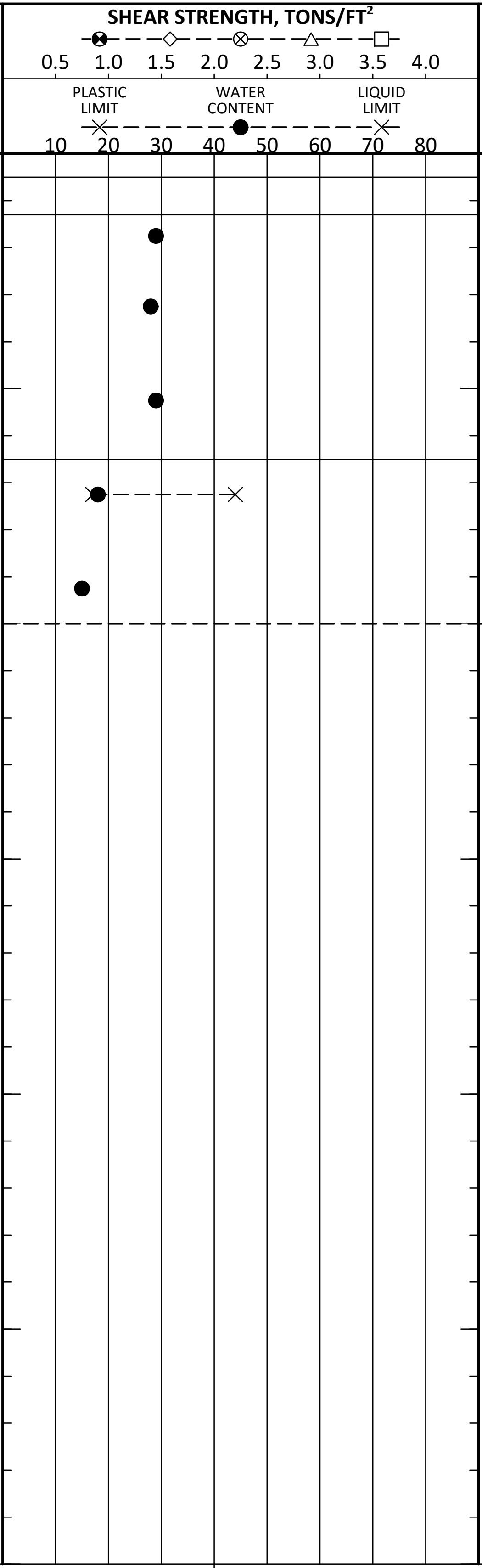
RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62812; W 97.98287

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (6 in.)				
BASE (10 in.)				
FAT CLAY, Firm to Stiff, Dark Brown	6			
	7			
	10			
LEAN CLAY, Stiff, Tan	13		27	
	10			90
Boring Termination				

DEPTH, FT: 5, 10, 15, 20, 25



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/13/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/13/2022

PROJ. No.: ANA22-047-00
FIGURE: 12

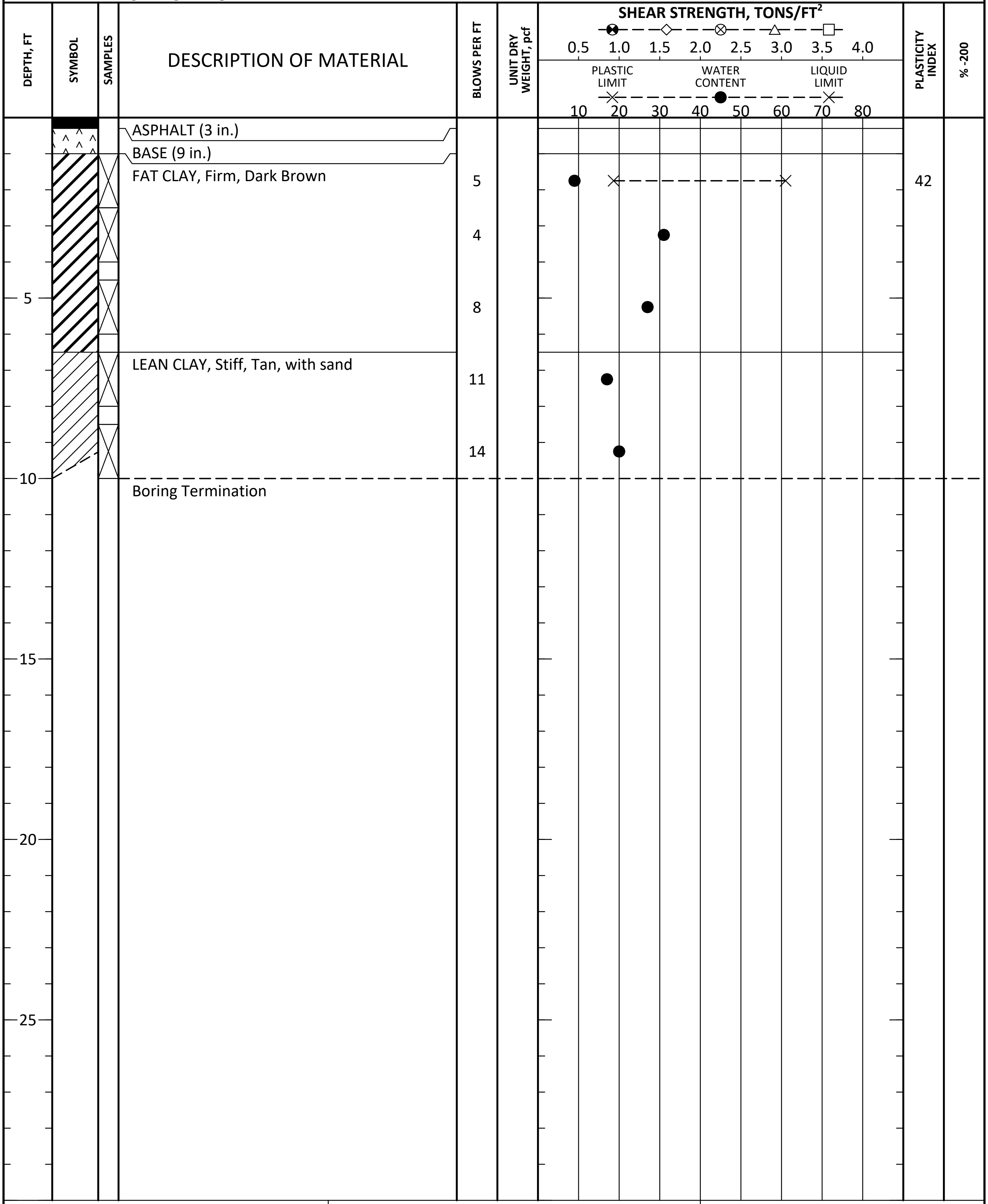
LOG OF BORING NO. P-12

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62803; W 97.97821



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/13/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/13/2022

PROJ. No.: ANA22-047-00
FIGURE: 13

LOG OF BORING NO. P-13

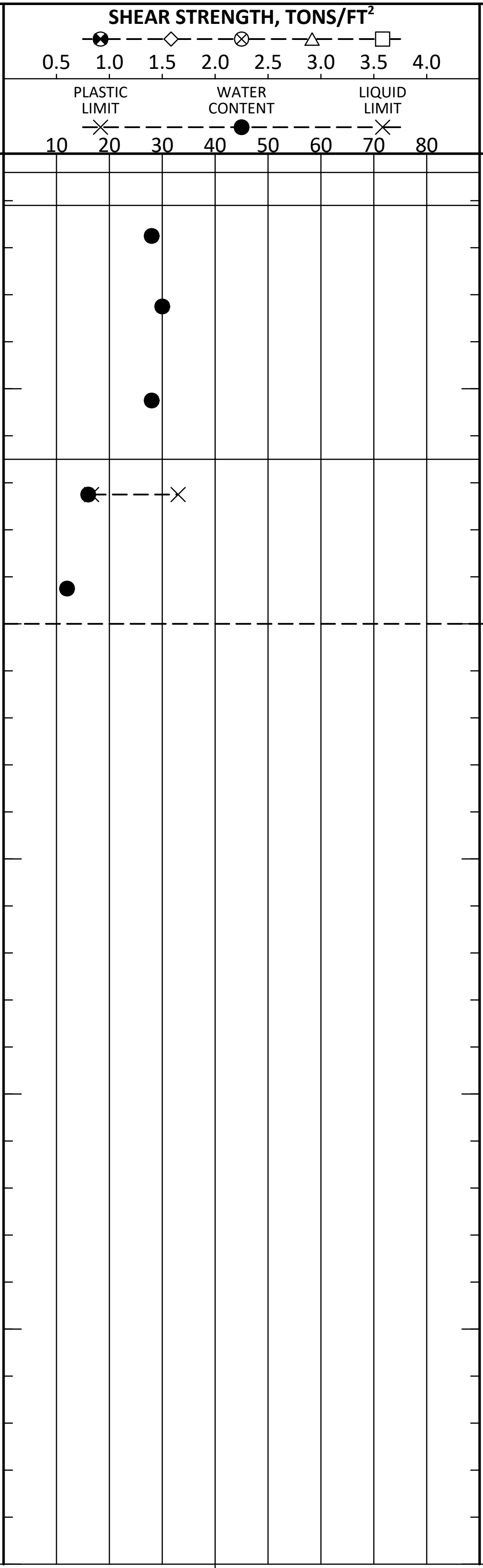
Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62798; W 97.97445

DEPTH, FT	DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
	ASPHALT (4-1/2 in.)				
	BASE (9 in.)				
	FAT CLAY, Firm, Dark Brown	6			
		6			
5		7			
	LEAN CLAY, Stiff, Tan, with sand	13		16	
	- with calcareous material above 8'				
	- with gravel from 9 ft to 10 ft.	14			
10	Boring Termination				
15					
20					
25					



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 10.0 ft
DATE DRILLED: 12/13/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/13/2022

PROJ. No.: ANA22-047-00
FIGURE: 14

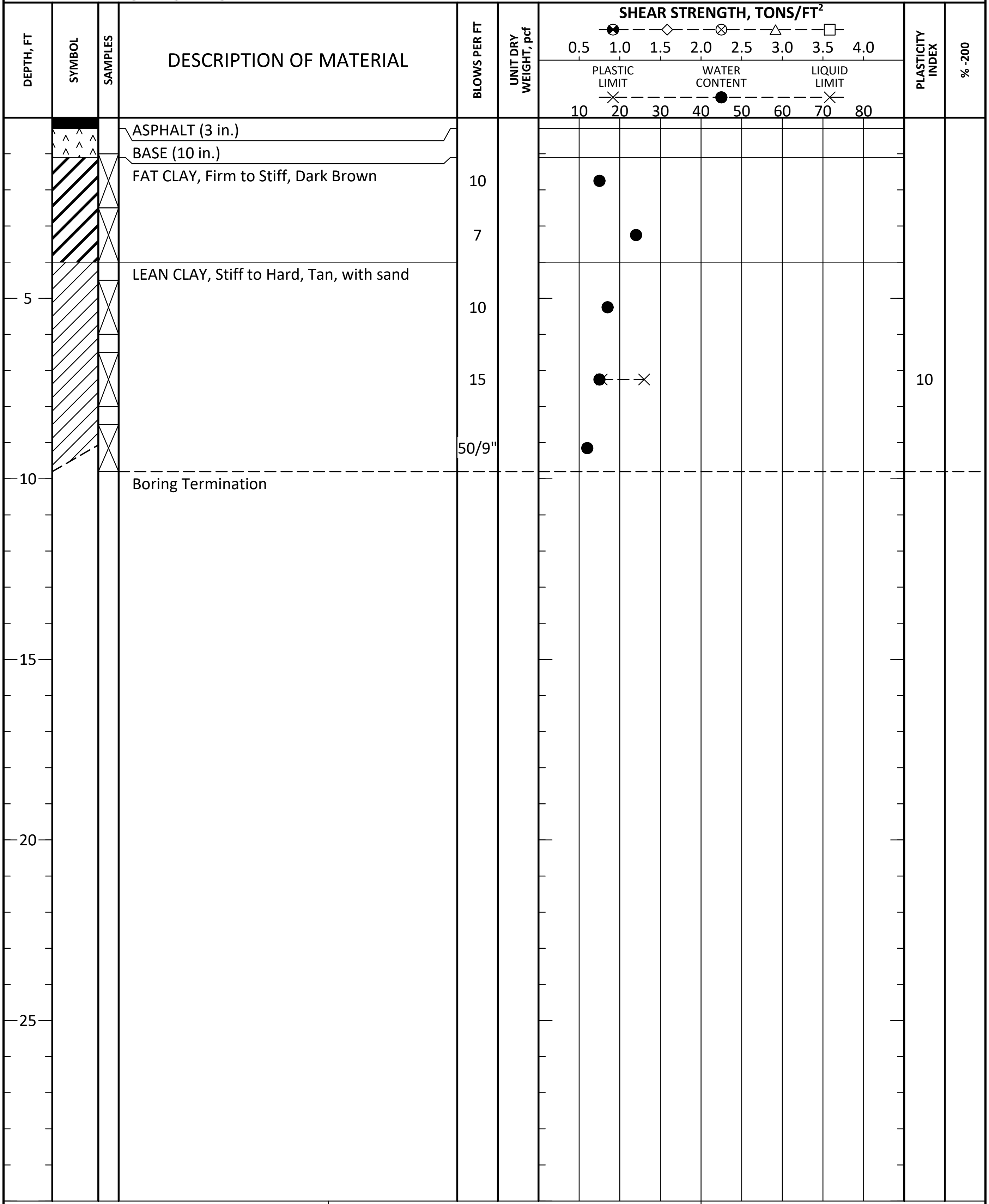
LOG OF BORING NO. P-14

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62803; W 97.97098



ASPHALT (3 in.)		
BASE (10 in.)		
FAT CLAY, Firm to Stiff, Dark Brown	10	
	7	
LEAN CLAY, Stiff to Hard, Tan, with sand	10	
	15	10
	50/9"	
Boring Termination		

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 9.8 ft
DATE DRILLED: 12/13/2022
DEPTH TO WATER: Dry
DATE MEASURED: 12/13/2022
PROJ. No.: ANA22-047-00
FIGURE: 15

LOG OF BORING NO. P-15

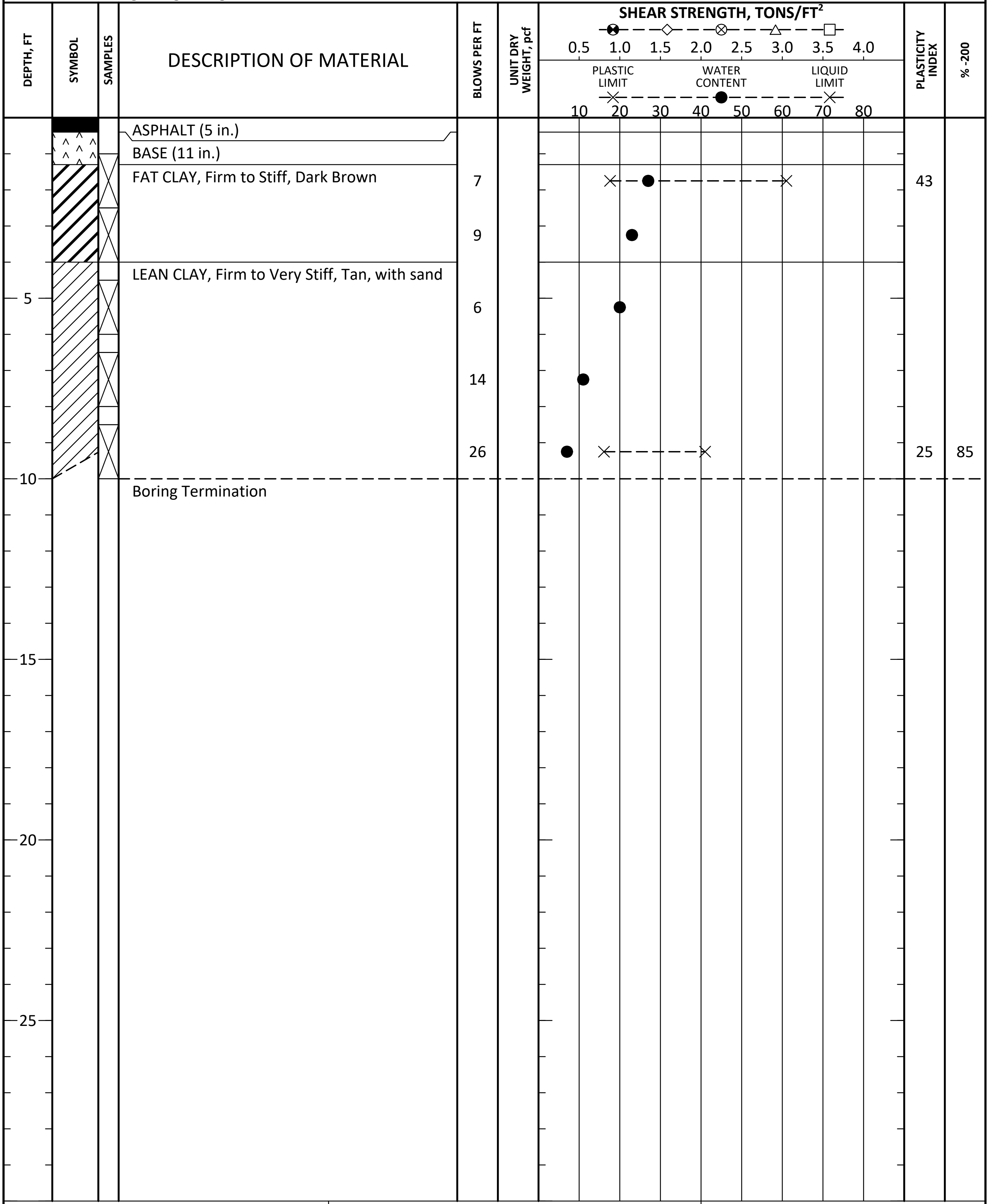
Cordova Rd
Seguin, Texas

TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62799; W 97.96833

DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (5 in.)				
BASE (11 in.)				
FAT CLAY, Firm to Stiff, Dark Brown	7		43	
	9			
LEAN CLAY, Firm to Very Stiff, Tan, with sand	6			
	14			
	26		25	85
Boring Termination				



DEPTH DRILLED:	10.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA22-047-00
DATE DRILLED:	12/13/2022	**DATE MEASURED:**	12/13/2022	**FIGURE:**	16

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

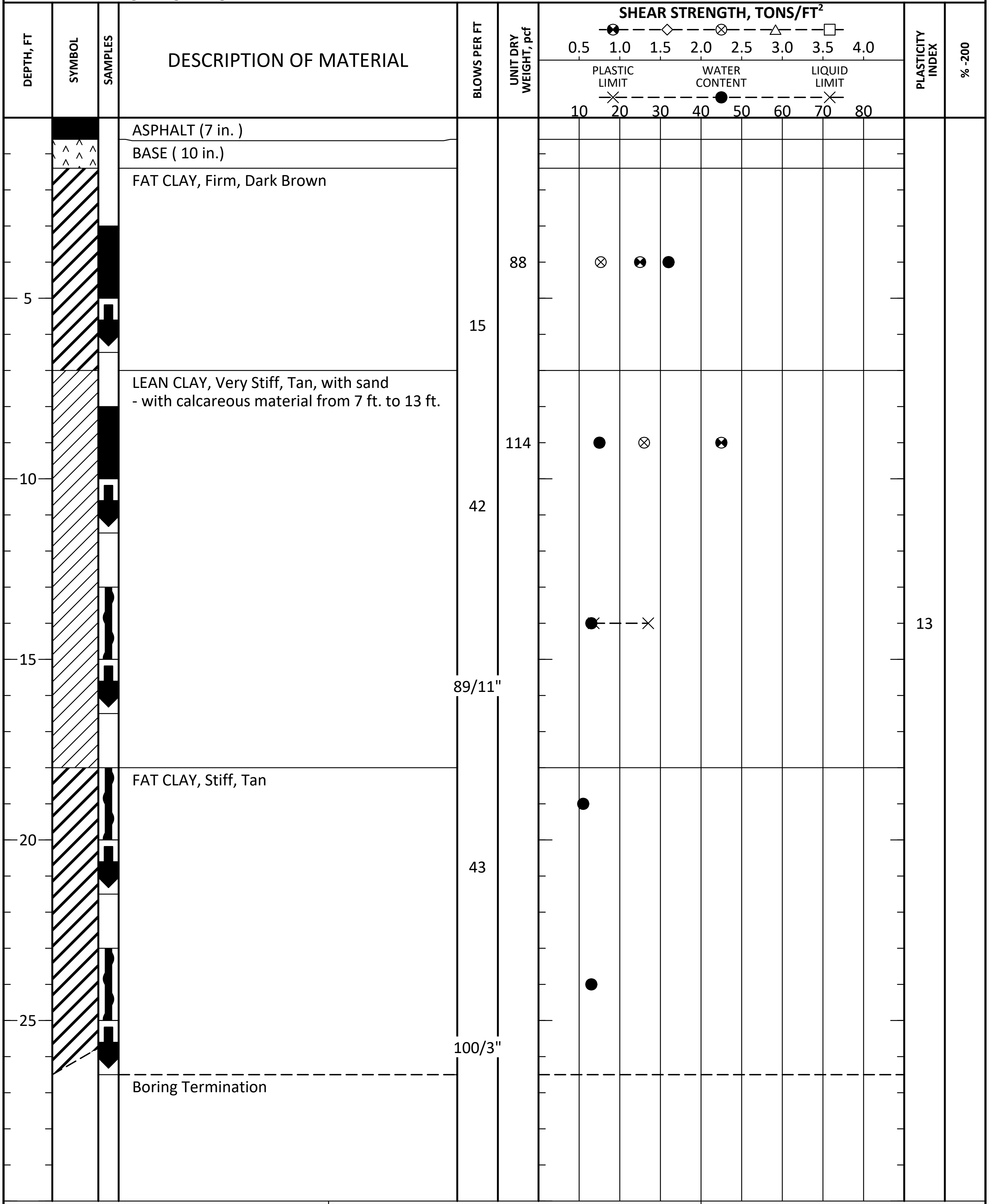
LOG OF BORING NO. WC-1

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62817; W 98.02023



DESCRIPTION OF MATERIAL	BLOWS PER FT	UNIT DRY WEIGHT, pcf	PLASTICITY INDEX	% -200
ASPHALT (7 in.)				
BASE (10 in.)				
FAT CLAY, Firm, Dark Brown	15	88		
LEAN CLAY, Very Stiff, Tan, with sand - with calcareous material from 7 ft. to 13 ft.	42 89/11"	114	13	
FAT CLAY, Stiff, Tan	43 100/3"			
Boring Termination				

NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 25.0 ft
DATE DRILLED: 12/14/2022
DEPTH TO WATER: Dry
DATE MEASURED: 12/14/2022
PROJ. No.: ANA22-047-00
FIGURE: 17

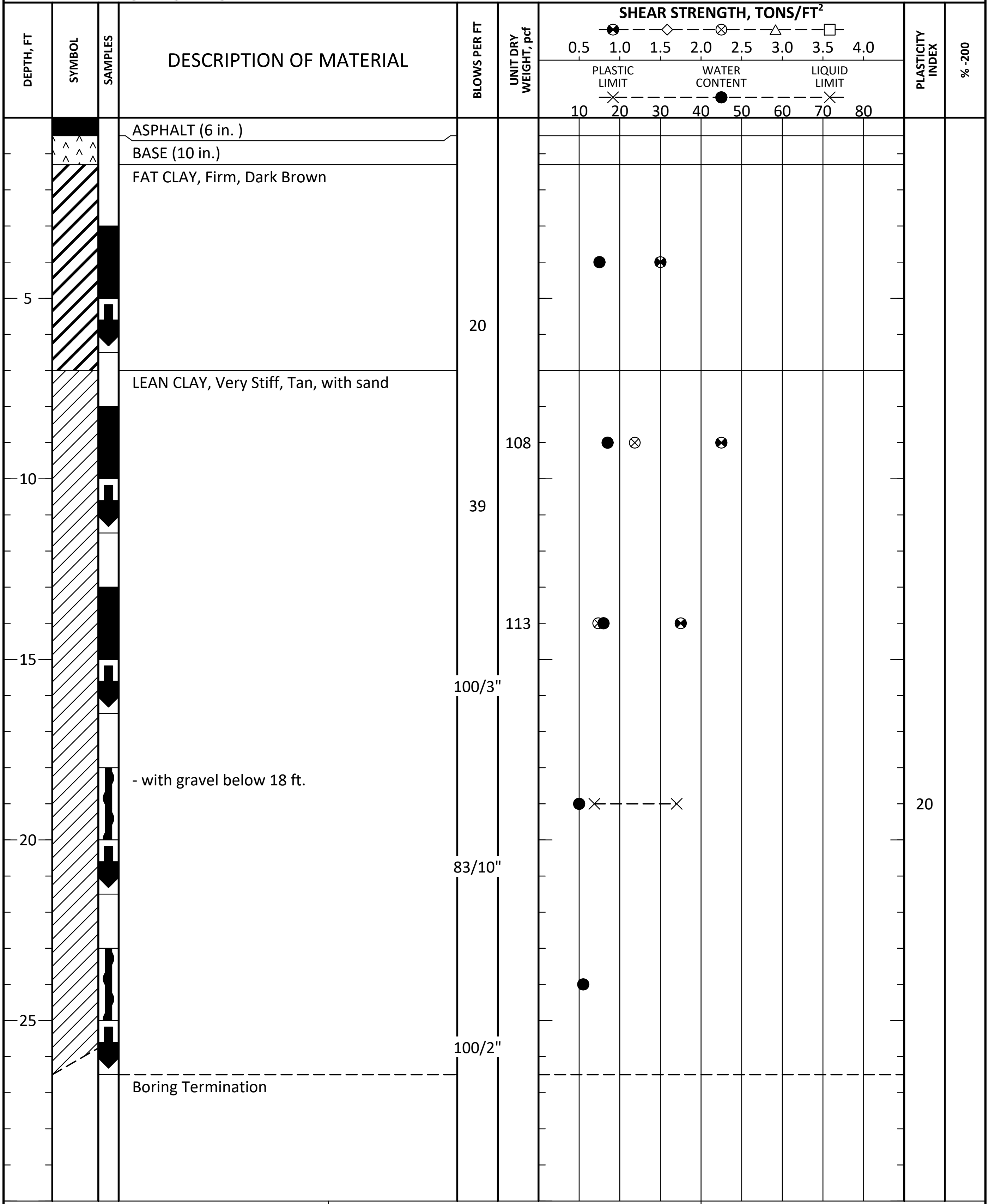
LOG OF BORING NO. WC-2

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62826; W 98.00808



NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED: 25.0 ft
DATE DRILLED: 12/14/2022

DEPTH TO WATER: Dry
DATE MEASURED: 12/14/2022

PROJ. No.: ANA22-047-00
FIGURE: 18

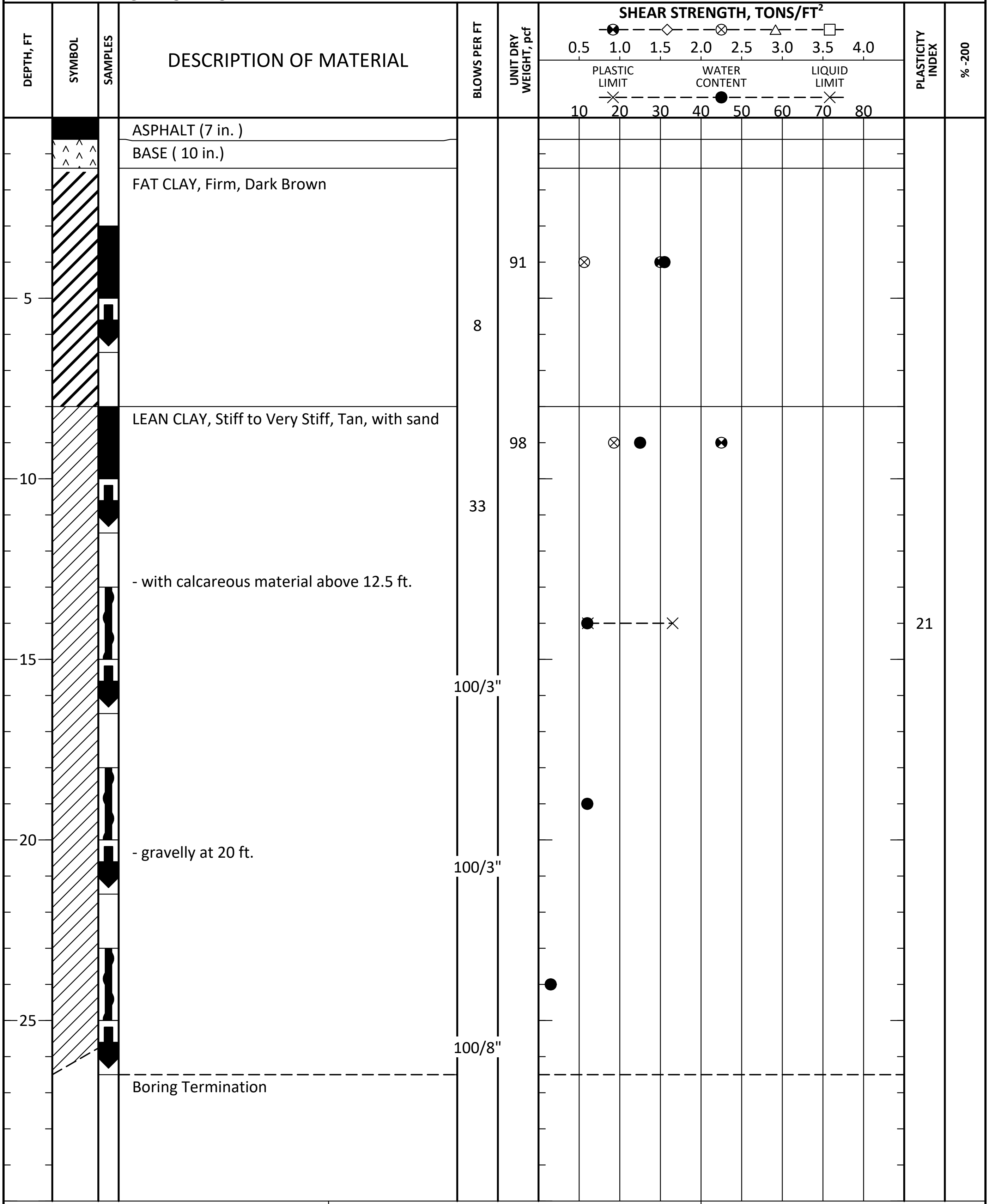
LOG OF BORING NO. WC-3

Cordova Rd
Seguin, Texas

RABA KISTNER
TBPE Firm Registration No. F-3257

DRILLING METHOD: Straight Flight Auger

LOCATION: N 29.62831; W 97.99887



ASPHALT (7 in.)

BASE (10 in.)

FAT CLAY, Firm, Dark Brown

LEAN CLAY, Stiff to Very Stiff, Tan, with sand

- with calcareous material above 12.5 ft.

- gravelly at 20 ft.

Boring Termination

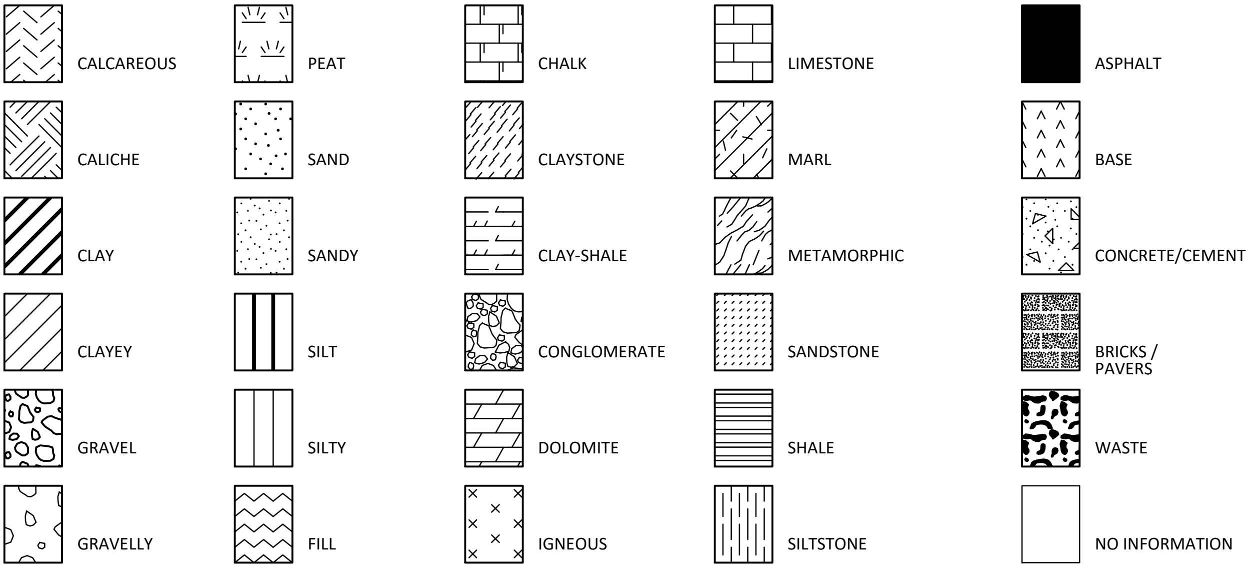
NOTE: THESE LOGS SHOULD NOT BE USED SEPARATELY FROM THE PROJECT REPORT

DEPTH DRILLED:	25.0 ft	**DEPTH TO WATER:**	Dry	**PROJ. No.:**	ANA22-047-00
DATE DRILLED:	12/14/2022	**DATE MEASURED:**	12/14/2022	**FIGURE:**	19

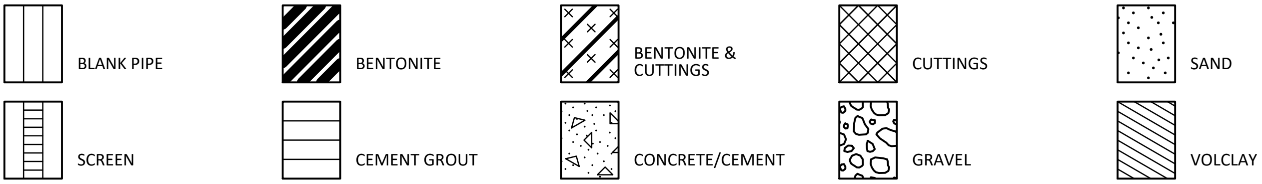
KEY TO TERMS AND SYMBOLS

MATERIAL TYPES

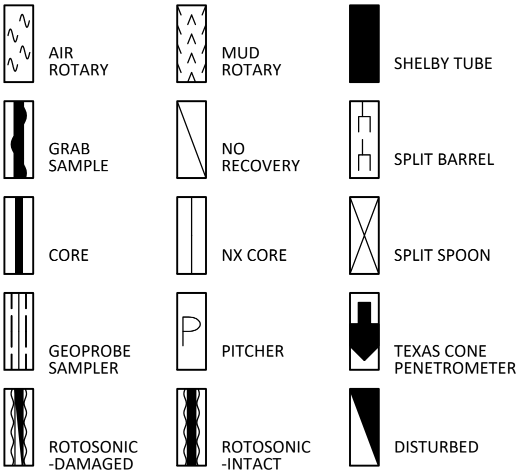
SOIL TERMS | ROCK TERMS | OTHER



WELL CONSTRUCTION AND PLUGGING MATERIALS



SAMPLE TYPES



STRENGTH TEST TYPES

⊗	POCKET PENETROMETER
◇	TORVANE
⊗	UNCONFINED COMPRESSION
△	TRIAXIAL COMPRESSION UNCONSOLIDATED-UNDRAINED
□	TRIAXIAL COMPRESSION CONSOLIDATED-UNDRAINED

NOTE: VALUES SYMBOLIZED ON BORING LOGS REPRESENT SHEAR STRENGTHS UNLESS OTHERWISE NOTED

PROJECT NO. ANA22-047-00

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

Terms used in this report to describe soils with regard to their consistency or conditions are in general accordance with the discussion presented in Article 45 of SOILS MECHANICS IN ENGINEERING PRACTICE, Terzaghi and Peck, John Wiley & Sons, Inc., 1967, using the most reliable information available from the field and laboratory investigations. Terms used for describing soils according to their texture or grain size distribution are in accordance with the UNIFIED SOIL CLASSIFICATION SYSTEM, as described in American Society for Testing and Materials D2487-06 and D2488-00, Volume 04.08, Soil and Rock; Dimension Stone; Geosynthetics; 2005.

The depths shown on the boring logs are not exact, and have been estimated to the nearest half-foot. Depth measurements may be presented in a manner that implies greater precision in depth measurement, i.e 6.71 meters. The reader should understand and interpret this information only within the stated half-foot tolerance on depth measurements.

RELATIVE DENSITY

Penetration Resistance Blows per ft	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium Dense
30 - 50	Dense
> 50	Very Dense

COHESIVE STRENGTH

Resistance Blows per ft	Consistency	Cohesion TSF
0 - 2	Very Soft	0 - 0.125
2 - 4	Soft	0.125 - 0.25
4 - 8	Firm	0.25 - 0.5
8 - 15	Stiff	0.5 - 1.0
15 - 30	Very Stiff	1.0 - 2.0
> 30	Hard	> 2.0

PLASTICITY

Plasticity Index	Degree of Plasticity
0 - 5	None
5 - 10	Low
10 - 20	Moderate
20 - 40	Plastic
> 40	Highly Plastic

ABBREVIATIONS

B = Benzene
T = Toluene
E = Ethylbenzene
X = Total Xylenes
BTEX = Total BTEX
TPH = Total Petroleum Hydrocarbons
ND = Not Detected
NA = Not Analyzed
NR = Not Recorded/No Recovery
OVA = Organic Vapor Analyzer
ppm = Parts Per Million

Qam, Qas, Qal = Quaternary Alluvium
Qat = Low Terrace Deposits
Qbc = Beaumont Formation
Qt = Fluviatile Terrace Deposits
Qao = Seymour Formation
Qle = Leona Formation
Q-Tu = Uvalde Gravel
Ewi = Wilcox Formation
Emi = Midway Group
Mc = Catahoula Formation
El = Laredo Formation
Kknm = Navarro Group and Marlbrook Marl
Kpg = Pecan Gap Chalk
Kau = Austin Chalk

Kef = Eagle Ford Shale
Kbu = Buda Limestone
Kdr = Del Rio Clay
Kft = Fort Terrett Member
Kgt = Georgetown Formation
Kep = Person Formation
Kek = Kainer Formation
Kes = Escondido Formation
Kew = Walnut Formation
Kgr = Glen Rose Formation
Kgru = Upper Glen Rose Formation
Kgrl = Lower Glen Rose Formation
Kh = Hensell Sand

KEY TO TERMS AND SYMBOLS (CONT'D)

TERMINOLOGY

SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

SAMPLING METHODS

RELATIVELY UNDISTURBED SAMPLING

Cohesive soil samples are to be collected using three-inch thin-walled tubes in general accordance with the Standard Practice for Thin-Walled Tube Sampling of Soils (ASTM D1587) and granular soil samples are to be collected using two-inch split-barrel samplers in general accordance with the Standard Method for Penetration Test and Split-Barrel Sampling of Soils (ASTM D1586). Cohesive soil samples may be extruded on-site when appropriate handling and storage techniques maintain sample integrity and moisture content.

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-in.-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Cordova Rd
Seguin, Texas

FILE NAME: ANA22-047-00.GPJ 2/9/2023

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
P-1	1.0 to 2.5	6	17								
	2.5 to 4.0	5	31	78	23	55	CH				
	4.5 to 6.0	6	32								
	6.5 to 8.0	11	26								
	8.5 to 10.0	20	24	35	12	23	CL				
P-2	1.0 to 2.5	4	26								
	2.5 to 4.0	4	35								
	4.5 to 6.0	6	35								
	6.5 to 8.0	12	24	45	18	27	CL		85		
	8.5 to 10.0	12	17								
P-3	1.0 to 2.5	6	21								
	2.5 to 4.0	6	25								
	4.5 to 6.0	8	27								
	6.5 to 8.0	12	21	52	19	33	CH				
	8.5 to 10.0	17	13								
P-4	1.0 to 2.5	7	27								
	2.5 to 4.0	10	24								
	4.5 to 6.0	16	22								
	6.5 to 8.0	14	22								
	8.5 to 10.0	23	9	21	11	10					
P-5	1.0 to 2.5	9	8								
	2.5 to 4.0	6	29								
	4.5 to 6.0	7	28	75	26	49	CH				
	6.5 to 8.0	7	29								
	8.5 to 10.0	14	16								
P-6	1.0 to 2.5	8	9								
	2.5 to 4.0	8	29								
	4.5 to 6.0	10	27								
	6.5 to 8.0	12	16	48	17	31	CL		79		
	8.5 to 9.9	50/11"	10								
P-7	1.0 to 2.5	5	21								
	2.5 to 4.0	4	25								
	4.5 to 6.0	5	30								
	6.5 to 8.0	11	23								
	8.5 to 10.0	22	20	36	15	21					
P-8	1.0 to 2.5	8	27	57	24	33	CH		59		
	2.5 to 4.0	7	29								
	4.5 to 6.0	23	12								
	6.5 to 7.4	50/5"	3								

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Cordova Rd
Seguin, Texas

FILE NAME: ANA22-047-00.GPJ 2/9/2023

Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
P-8	8.5 to 9.2	50/2"	3	18	12	6					
P-9	1.0 to 2.5	6	17								
	2.5 to 4.0	6	29	67	25	42					
	4.5 to 6.0	9	30								
	6.5 to 8.0	11	26								
	8.5 to 10.0	20	11								
P-10	1.0 to 2.5	4	24								
	2.5 to 4.0	7	24								
	4.5 to 6.0	7	30								
	6.5 to 8.0	9	28	69	24	45					
	8.5 to 10.0	13	28						90		
P-11	1.0 to 2.5	6	29								
	2.5 to 4.0	7	28								
	4.5 to 6.0	10	29								
	6.5 to 8.0	13	18	44	17	27					
	8.5 to 10.0	10	15						90		
P-12	1.0 to 2.5	5	9	61	19	42					
	2.5 to 4.0	4	31								
	4.5 to 6.0	8	27								
	6.5 to 8.0	11	17								
	8.5 to 10.0	14	20								
P-13	1.0 to 2.5	6	28								
	2.5 to 4.0	6	30								
	4.5 to 6.0	7	28								
	6.5 to 8.0	13	16	33	17	16					
	8.5 to 10.0	14	12								
P-14	1.0 to 2.5	10	15								
	2.5 to 4.0	7	24								
	4.5 to 6.0	10	17								
	6.5 to 8.0	15	15	26	16	10					
	8.5 to 9.8	50/9"	12								
P-15	1.0 to 2.5	7	27	61	18	43					
	2.5 to 4.0	9	23								
	4.5 to 6.0	6	20								
	6.5 to 8.0	14	11								
	8.5 to 10.0	26	7	41	16	25	CL		85		
WC-1	3.0 to 5.0		32					88		0.77	UC
	5.0 to 6.5	15									
	8.0 to 10.0		15					114		1.30	UC

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

PROJECT NO. ANA22-047-00

RABAKISTNER

RESULTS OF SOIL SAMPLE ANALYSES

PROJECT NAME: Cordova Rd
Seguin, Texas

FILE NAME: ANA22-047-00.GPJ 2/9/2023

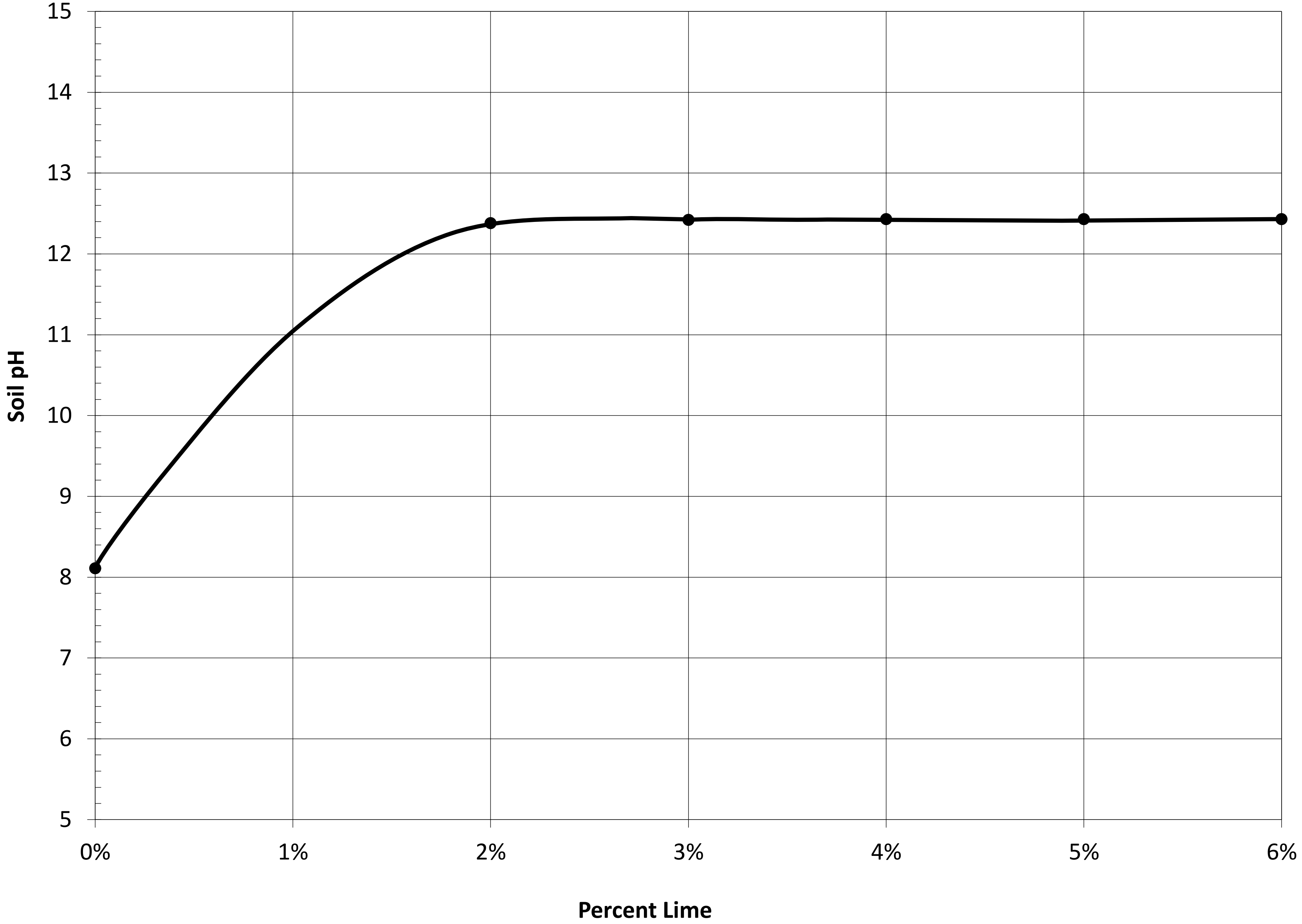
Boring No.	Sample Depth (ft)	Blows per ft	Water Content (%)	Liquid Limit	Plastic Limit	Plasticity Index	USCS	Dry Unit Weight (pcf)	% -200 Sieve	Shear Strength (tsf)	Strength Test
WC-1	10.0 to 11.5	42									
	13.0 to 15.0		13	27	14	13					
	15.0 to 16.5	89/11"									
	18.0 to 20.0		11								
	20.0 to 21.5	43									
	23.0 to 25.0		13								
	25.0 to 26.5	100/3"									
WC-2	3.0 to 5.0		15							1.50	PP
	5.0 to 6.5	20									
	8.0 to 10.0		17					108		1.18	UC
	10.0 to 11.5	39									
	13.0 to 15.0		16					113		0.74	UC
	15.0 to 16.5	100/3"									
	18.0 to 20.0		10	34	14	20					
	20.0 to 21.5	83/10"									
	23.0 to 25.0		11								
	25.0 to 26.5	100/2"									
WC-3	3.0 to 5.0		31					91		0.56	UC
	5.0 to 6.5	8									
	8.0 to 10.0		25					98		0.93	UC
	10.0 to 11.5	33									
	13.0 to 15.0		12	33	12	21					
	15.0 to 16.5	100/3"									
	18.0 to 20.0		12								
	20.0 to 21.5	100/3"									
	23.0 to 25.0		3								
	25.0 to 26.5	100/8"									

PP = Pocket Penetrometer TV = Torvane UC = Unconfined Compression FV = Field Vane UU = Unconsolidated Undrained Triaxial

CU = Consolidated Undrained Triaxial

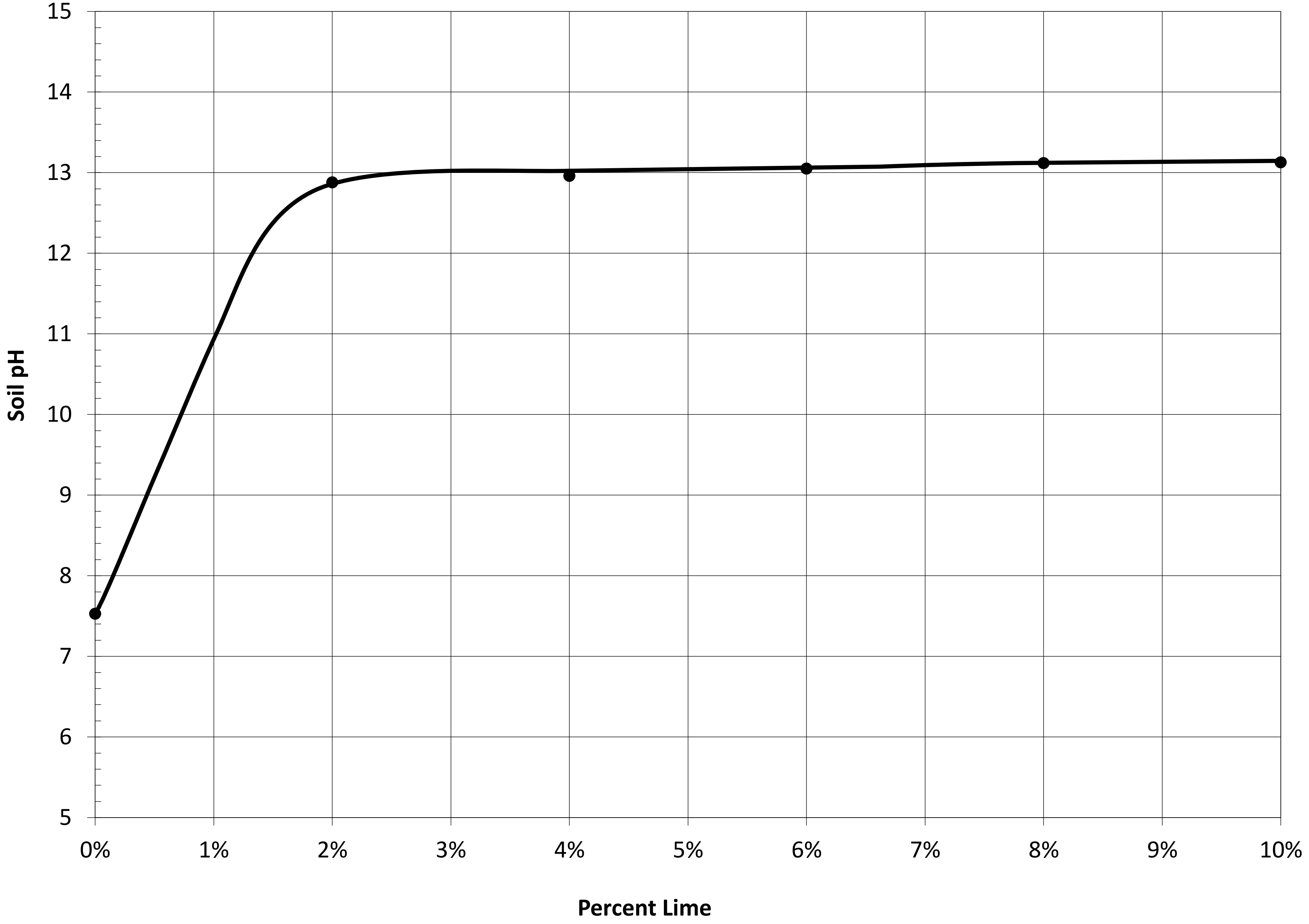
pH-LIME SERIES CURVE (P-1)

Cordova Road
Seguin, Texas



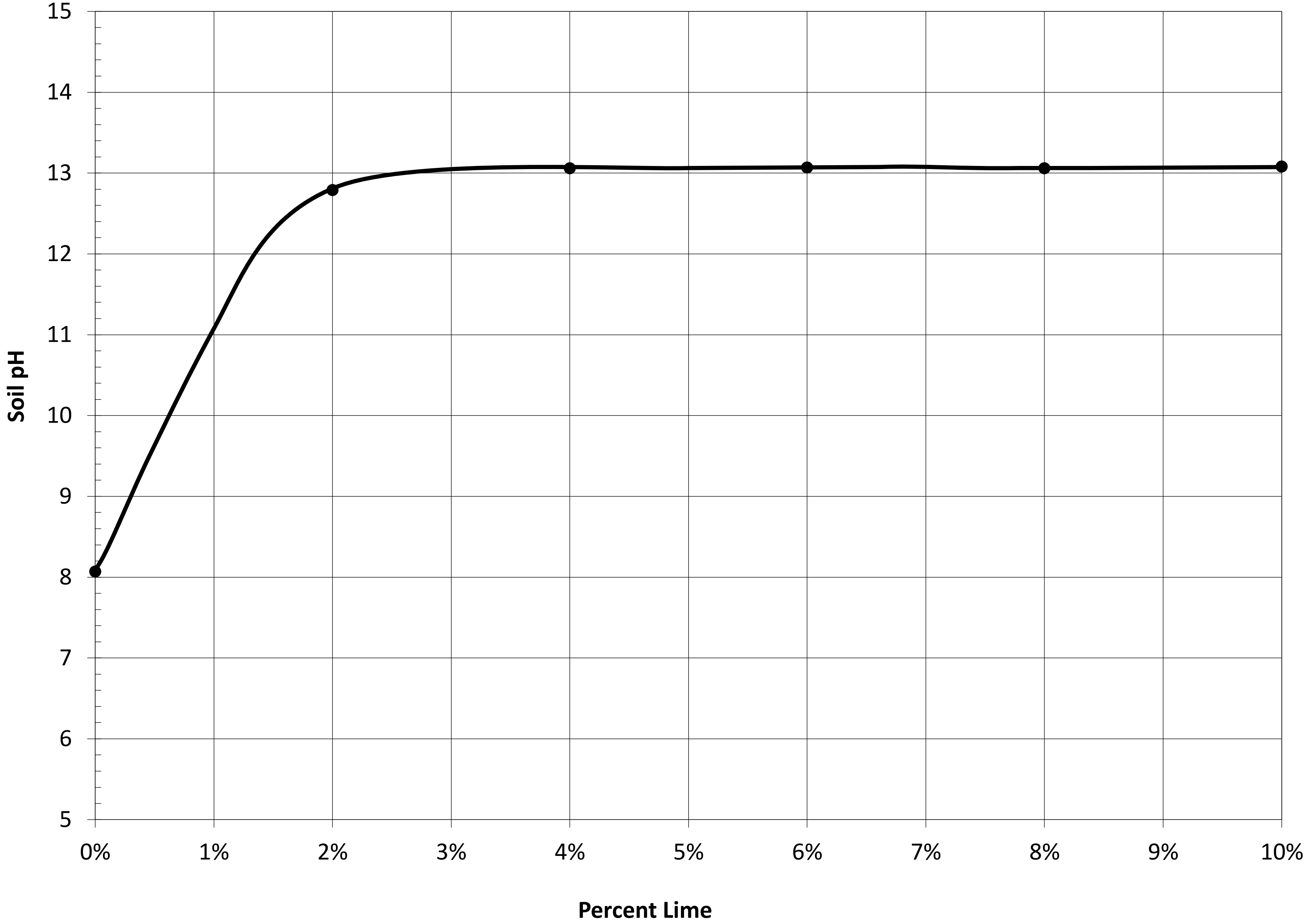
pH-LIME SERIES CURVE (P-5)

Cordova Road
Seguin, Texas



pH-LIME SERIES CURVE (P-11)

Cordova Road
Seguin, Texas



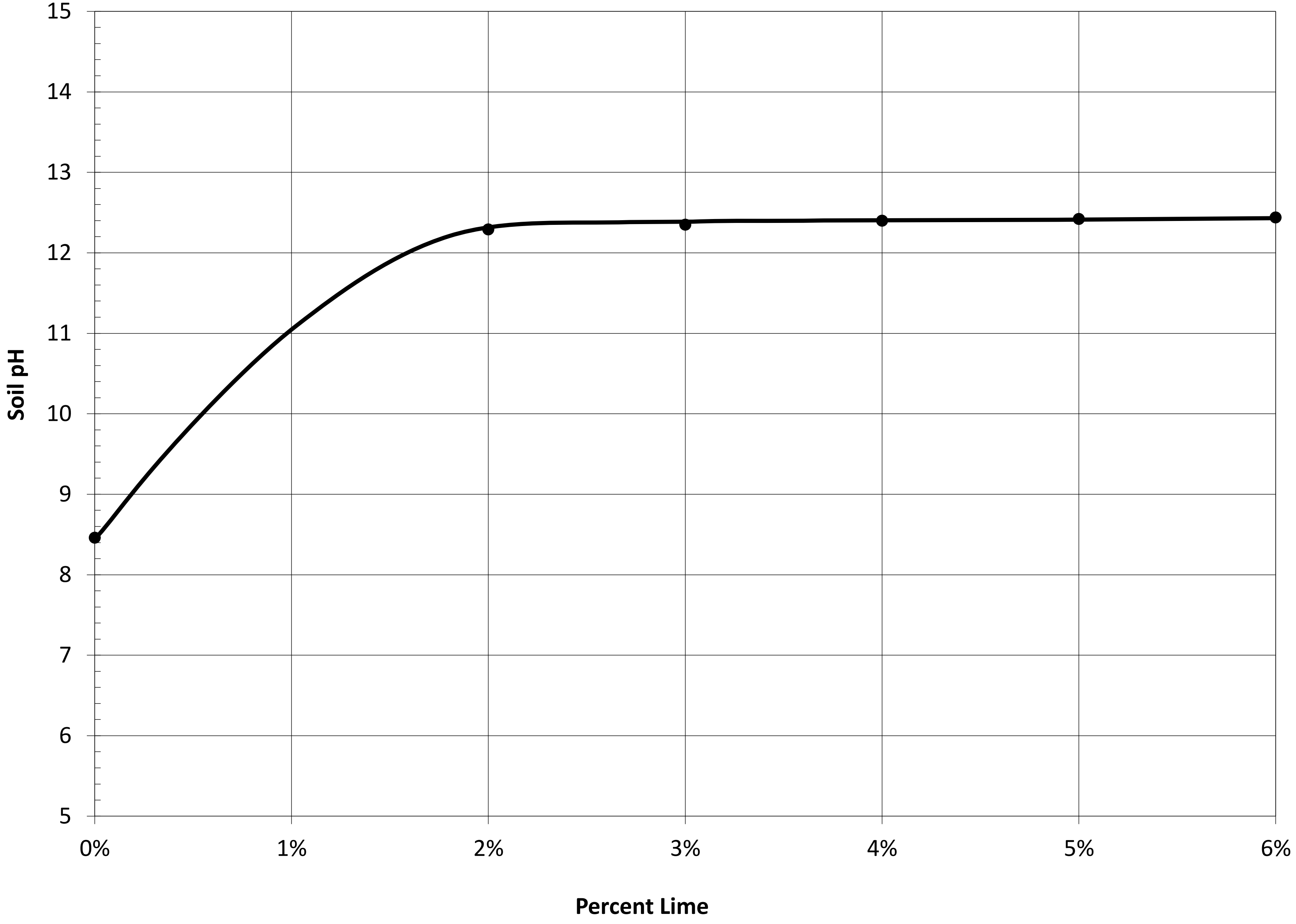
2/9/2023

RABAKISTNER

ANA22-047-00
FIGURE 22c

pH-LIME SERIES CURVE (P-15)

Cordova Road
Seguin, Texas



2/9/2023

RABAKISTNER

ANA22-047-00
FIGURE 22d

TEXAS DEPARTMENT OF TRANSPORTATION

TRIAXIAL COMPRESSION TESTS
Tex-117-E

Refresh Workbook

TX117 - File Version: 07/02/21 22:12:59

SAMPLE ID:	P-11	SAMPLED DATE:	12/16/2022
TEST NUMBER:		LETTING DATE:	
SAMPLE STATUS:		CONTROLLING CSJ:	
COUNTY:	Guadalupe County	SPEC YEAR:	2014
SAMPLED BY:	Ryan Boatright	SPEC ITEM:	
SAMPLE LOCATION:	P-11	SPECIAL PROVISION:	
MATERIAL CODE:		GRADE:	1
MATERIAL NAME:	Dark Brown Fat Clay		
PRODUCER:			
AREA ENGINEER:	Santosh Shrestha	PROJECT MANAGER:	Isaac Molina

COURSE\LIFT:		STATION:		DIST. FROM CL:	

Moisture-Density Data

Maximum Dry Density (pcf):	99.3
Optimum Moisture Content (%):	21.0
Hygroscopic Moisture Content (%):	8.1

Mass of Mold (universal), (lb):	10.37
Volume of Mold per Linear Inch (universal) (in^3/in):	0.0166
Check here if multiple molds are used:	☐
Mass of Material per Specimen (lb):	14.255
Mass of Water per Specimen (lb):	1.701

Performed By Tex-117-E:	Automated : Part I (Classification)

Triaxial Test Data Sheet

Specimen Data

Specimen Number:	1	2	3	4	5	6	7	8	9
Cell No.:									
Wet Mass Spec. & Mold, (lb):	26.131	26.145	26.139	26.161	26.152	26.141			
Mass of Mold (universal), (lb):	10.370	10.370	10.370	10.370	10.370	10.370	10.370	10.370	10.370
Vol. of Mold (universal) (in^3/in):	0.0166	0.0166	0.0166	0.0166	0.0166	0.0166	0.0166	0.0166	0.0166
Wet Mass Specimen, (lb):	15.761	15.775	15.769	15.791	15.782	15.771			
Initial Height of Specimen, in.:									
New Height of Specimen, in.:	7.935	7.983	7.904	7.922	7.971	7.983			
Average Diameter, in.:	6.00	6.00	6.00	6.00	6.00	6.00			
Circumference, in. (manual):									
Circumference, in. (auto):	18.850	18.850	18.850	18.850	18.850	18.850			
Area, in.^2:	28.27	28.27	28.27	28.27	28.27	28.27			
Avg. Cross Sectional Area, in^2:	29.38	29.58	29.76	30.13	29.88	30.55			

Dry-Back Data

Wet Mass of Pan & Specimen, (lb)	18.637	18.696	18.656	18.714	18.659	18.658			
Dry Mass of Pan & Specimen, (lb):	16.126	16.031	16.039	16.141	16.121	16.322			
Mass of Pan, (lb):	3.027	3.039	3.037	3.095	3.037	3.070			
Dry Mass of Material, (lb):	13.099	12.992	13.002	13.046	13.084	13.252			
Mass of Water, (lb):	2.511	2.665	2.617	2.573	2.538	2.336			
Moisture Content, (%):	19.2	20.5	20.1	19.7	19.4	17.6			
Wet Density, (pcf).:	119.7	119.0	120.2	120.1	119.3	119.0			
Dry Density, (pcf):	100.4	98.8	100.0	100.3	99.9	101.2			

FIGURE 23a

Strength Data									
Lateral Pressure, psi.:	0	3	5	10	15	20			
Evaluated Lateral Pressure, psi.:	**0-Void**	3	**5-Void**	10	15	20			
Calibration Factor:	-4662376.89	-4662376.89	-4662376.89	-4662376.89	-4662376.89	-4662376.89			
Excitation:	10.02810669	10.02810669	10.02810669	10.02810669	10.02810669	10.02810669			
Zero:	-0.00011199	-0.00010789	-0.00013784	-0.00013667	-0.0001305	-0.0001225			
Dead Load, lbs.:	8.320	8.320	8.320	8.320	8.320	8.320			
Piston Correction, lbs.:	-0.0454	0.5930	0.9823	1.9612	2.9806	3.9111			
Max. Load Reading, div.:	-0.0052	-0.0054	-0.0060	-0.0067	-0.0065	-0.0071			
Max Load, lbs.:	2356.9	2478.5	2727.0	3038.1	2987.3	3269.9			
Deformation at Max Load, in.:	0.30	0.35	0.40	0.49	0.43	0.60			
Uncorrected Stress, psi.:	83.7	88.0	96.7	107.7	105.9	115.9			
% Strain , in./in.:	3.78	4.40	5.00	6.15	5.37	7.46			
I-Strain, in./in.:	0.9622	0.9560	0.9500	0.9385	0.9463	0.9254			
Corrected Stress, psi.:	80.5	84.1	91.9	101.1	100.3	107.3			

Classification:	**4.4**
Internal Angle of Friction:	**9.2**
Cohesion, psi:	**34.8**
Correlation Factor:	**0.7123**

15 psi

Test results may be omitted by typing 'VOID' in the '<u>Laterial Pressure, psi'</u> cell.

SCA Data (Imported)									
Total Energy (lb-ft) Lift 1:	756.33	759.29	761.93	759.32	753.35	756.16			
Total Energy (lb-ft) Lift 2:	755.94	751.41	762.79	757.76	758.26	763.60			
Total Energy (lb-ft) Lift 3:	751.58	752.35	758.40	750.74		762.07			
Total Energy (lb-ft) Lift 4:	763.47	755.52	754.02	760.70	758.45	752.31			
Energy/Lift (lb-ft) Lift 1:	13.51	13.56	13.61	13.56	13.45	13.50			
Energy/Lift (lb-ft) Lift 2:	13.50	13.66	13.62	13.53	13.54	13.40			
Energy/Lift (lb-ft) Lift 3:	13.67	13.68	13.79	13.65	NaN	13.61			
Energy/Lift (lb-ft) Lift 4:	13.63	13.74	13.71	13.58	13.54	13.68			
Avg. Drop Ht. (lb-ft) Lift 1:	18.34	18.31	18.30	18.33	18.32	18.31			
Avg. Drop Ht. (lb-ft) Lift 2:	18.33	18.30	18.28	18.32	18.27	18.30			
Avg. Drop Ht. (lb-ft) Lift 3:	18.30	18.28	18.28	18.34	NaN	18.33			
Avg. Drop Ht. (lb-ft) Lift 4:	18.29	18.27	18.27	18.30	17.82	18.32			
No. of Blows (lb-ft) Lift 1:	56	56	56	56	56	56			
No. of Blows (lb-ft) Lift 2:	56	55	56	56	56	57			
No. of Blows (lb-ft) Lift 3:	55	55	55	55		56			
No. of Blows (lb-ft) Lift 4:	56	55	55	56	56	55			

Remarks:

Test Method:	Tested By:	Tech Cert No.:	Tested Date:
TX117	A.Segovia		03/02/23
TX117PI			
TX117PII			
TX117PIII			

Test Stamp Code:	Omit Test:	Completed Da	Reviewed By:

Locked By:	TxDOT:	District:	Area:

Authorized By:	Authorized Date:	
		5

FIGURE 23b

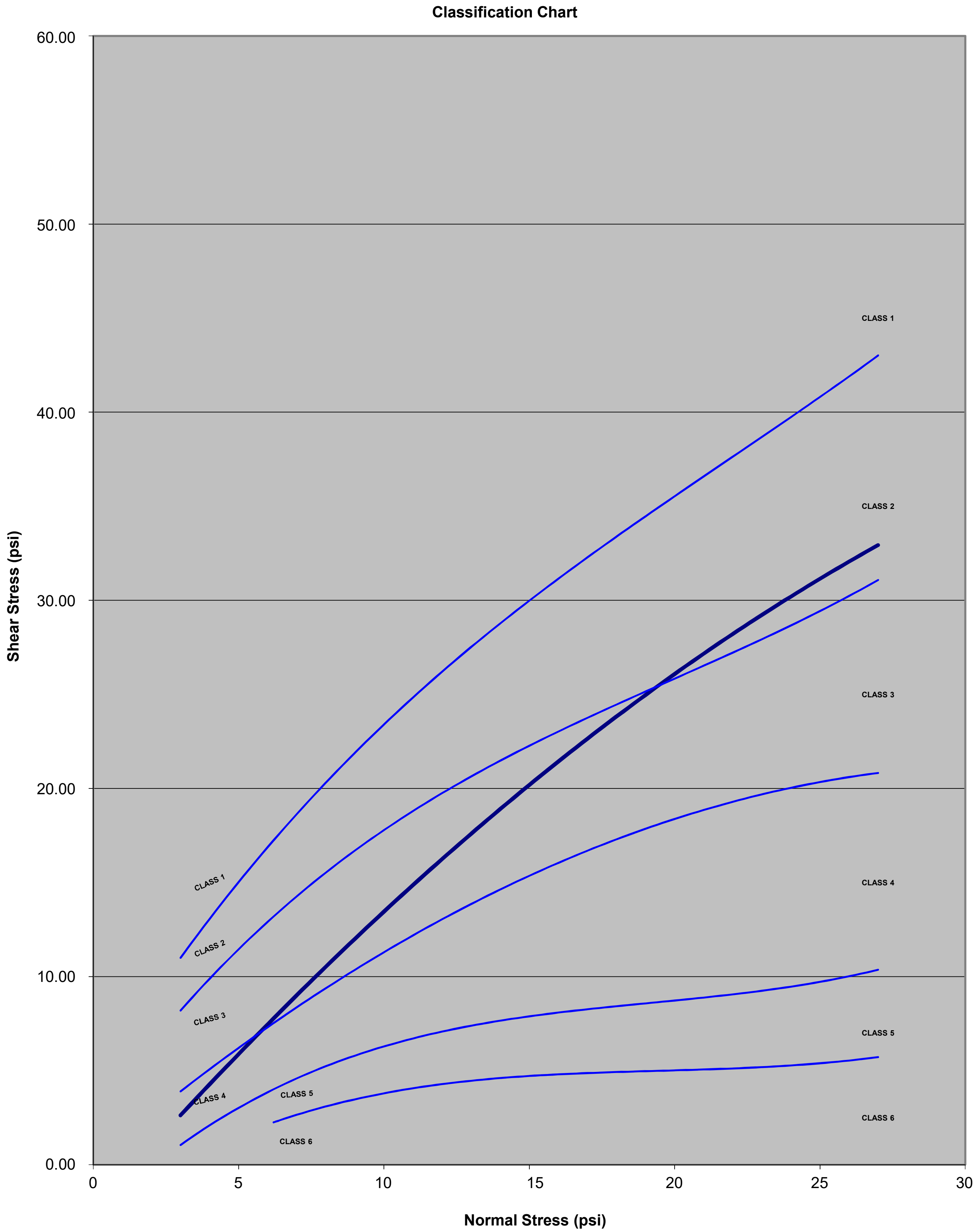

Classification Chart
60.00
50.00
40.00
30.00
20.00
10.00
0.00
Shear Stress (psi)
0
5
10
15
20
25
30
Normal Stress (psi)
CLASS 1
CLASS 2
CLASS 3
CLASS 4
CLASS 5
CLASS 6
CLASS 1
CLASS 2
CLASS 3
CLASS 4
CLASS 5
CLASS 6

FIGURE 23c

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

```
PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   1
--------------------------------------------------------------------------------
                        COMMENTS ABOUT THIS PROBLEM


Option 1 for Cordova Rd
Traffic  2.36 million ESAL

--------------------------------------------------------------------------------
```

BASIC DESIGN CRITERIA

```
  LENGTH OF THE ANALYSIS PERIOD (YEARS)                                   20.0
  MINIMUM TIME TO FIRST OVERLAY (YEARS)                                    8.0
  MINIMUM TIME BETWEEN OVERLAYS (YEARS)                                    3.0
  DESIGN CONFIDENCE LEVEL ( 95.0%)                                          C
  SERVICEABILITY INDEX OF THE INITIAL STRUCTURE                            4.2
  FINAL SERVICEABILITY INDEX P2                                            2.5
  SERVICEABILITY INDEX P1 AFTER AN OVERLAY                                 4.2
  DISTRICT TEMPERATURE CONSTANT                                           31.0
  SUBGRADE ELASTIC MODULUS by COUNTY (ksi)                                 3.00
  INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)                           7.0
```

PROGRAM CONTROLS AND CONSTRAINTS

```
  NUMBER OF SUMMARY OUTPUT PAGES DESIRED ( 8 DESIGNS/PAGE)                3
  MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)            99.00
  MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)             69.0
  ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)     6.0
```

TRAFFIC DATA

```
  ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)                   17700.
  ADT AT END OF TWENTY YEARS (VEHICLES/DAY)                            22700.
  ONE-DIRECTION 20YEAR 18 kip ESAL (millions)                           2.360
  AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)                         70.0
  AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)             45.0
  AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)        50.0
  PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)           6.0
  PERCENT TRUCKS IN ADT                                                    4.0
--------------------------------------------------------------------------------
```

FIGURE 24a

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

```
PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   2
--------------------------------------------------------------------------------

                        INPUT DATA CONTINUED
```

CONSTRUCTION AND MAINTENANCE DATA

```
 MINIMUM OVERLAY THICKNESS (INCHES)                                        1.5
 OVERLAY CONSTRUCTION TIME (HOURS/DAY)                                    12.0
 ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)                          1.90
 ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)                          200.0
 WIDTH OF EACH LANE (FEET)                                                12.0
 FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)                0.00
 ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)      0.00
```

DETOUR DESIGN FOR OVERLAYS

```
 TRAFFIC MODEL USED DURING OVERLAYING                                     2
 TOTAL NUMBER OF LANES OF THE FACILITY                                    2
 NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)              0
 NUMBER OF OPEN LANES  IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)         1
 DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)                   0.60
 DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)               0.60
 DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)                          0.00
```

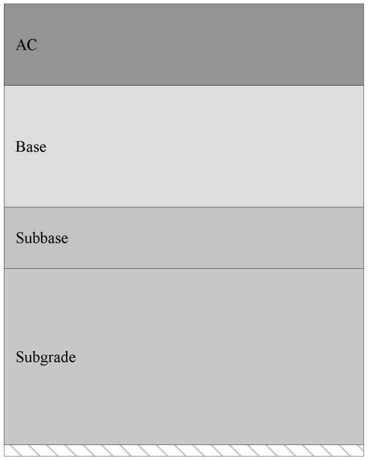
PAVING MATERIALS INFORMATION

```
           MATERIALS       COST     E    POISSON   MIN.    MAX. SALVAGE
LAYER CODE        NAME        PER CY MODULUS  RATIO   DEPTH   DEPTH   PCT.
  1     A  ASPH CONC PVMT    150.00  500000.   0.35    8.00    8.00   30.00
  2     B  FLEXIBLE BASE      54.00   65000.   0.35   12.00   12.00   75.00
  3     C  STABILIZED SUBGR   15.00   35000.   0.30    6.00    6.00   90.00
  4     D  SUBGRADE(200)       2.00    3000.   0.40  200.00  200.00   90.00
```

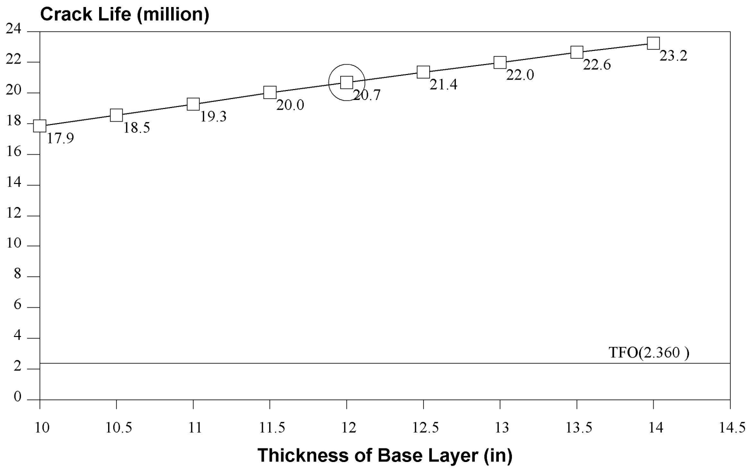
FIGURE 24b

```
--------------------------------------------------------------------------------
                    TEXAS DEPARTMENT OF TRANSPORTATION
 F P S21-1.5                  FLEXIBLE PAVEMENT SYSTEM             Release:12-12-2018

--------------------------------------------------------------------------------

          PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   3
--------------------------------------------------------------------------------


     C. LEVEL C       SUMMARY OF THE BEST DESIGN STRATEGIES
                        IN ORDER OF INCREASING TOTAL COST
                          1
--------------------------------------------------------------------------------
MATERIAL ARRANGEMENT   ABC
INIT. CONST. COST     53.83
OVERLAY CONST. COST    0.00
USER COST              0.00
ROUTINE MAINT. COST    0.00
SALVAGE VALUE         -6.65
--------------------------------------------------------------------------------
TOTAL COST            47.18
--------------------------------------------------------------------------------
NUMBER OF LAYERS        3
--------------------------------------------------------------------------------
LAYER DEPTH (INCHES)
     D(1)              8.00
     D(2)             12.00
     D(3)              6.00
--------------------------------------------------------------------------------
NO.OF PERF.PERIODS      1
--------------------------------------------------------------------------------
PERF. TIME (YEARS)
     T(1)              35.
--------------------------------------------------------------------------------
OVERLAY POLICY(INCH)
(INCLUDING LEVEL-UP)
--------------------------------------------------------------------------------


        THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS         1
```

FIGURE 24C



	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
AC	8.00	500.00	0.35	ASPH CONC PVMT
Base	12.00	65.00	0.35	FLEXIBLE BASE
Subbase	6.00	35.00	0.30	STABILIZED SUBGR
Subgrade	200.00	3.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

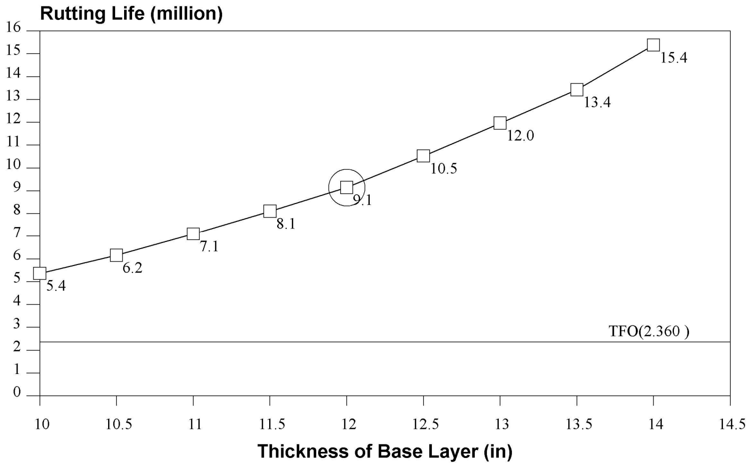
$$N_f = f_1(\varepsilon_t)^{-f_2}\ (E_1)^{-f_3}$$

f_1 =7.96E-02
f_2 = 3.291
f_3 = .854

Rutting Model:

$$N_d = f_4(\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09
f_5 = 4.477



TFO(Traffic to 1st Overlay): 2.36 (million)

Crack Life:	20.68 (million)	ε_τ =	92.10 (με)
Rut Life:	9.15 (million)	ε_v =	-292.00 (με)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.36millions.
Also the start ADT:17700.0 and ending ADT:22700.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)

Highway	Cordova Rd	Problem	1
C-S-J	0000 - 00 - 000	Date	4/14/2023
District	San Antonio	County	GUADALUPE

Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade

FIGURE 25

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	8.00	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	12.00	65.00	0.35	FLEXIBLE BASE
STABILIZED SUBGR	6.00	35.00	0.30	STABILIZED SUBGR
SUBGRADE(200)	200.00	3.00	0.40	SUBGRADE(200)
Bed Rock		300.00	0.15	Bed Rock

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12000.0 (lb)
Percentage of TandemAxles	50.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	15600.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	4.40

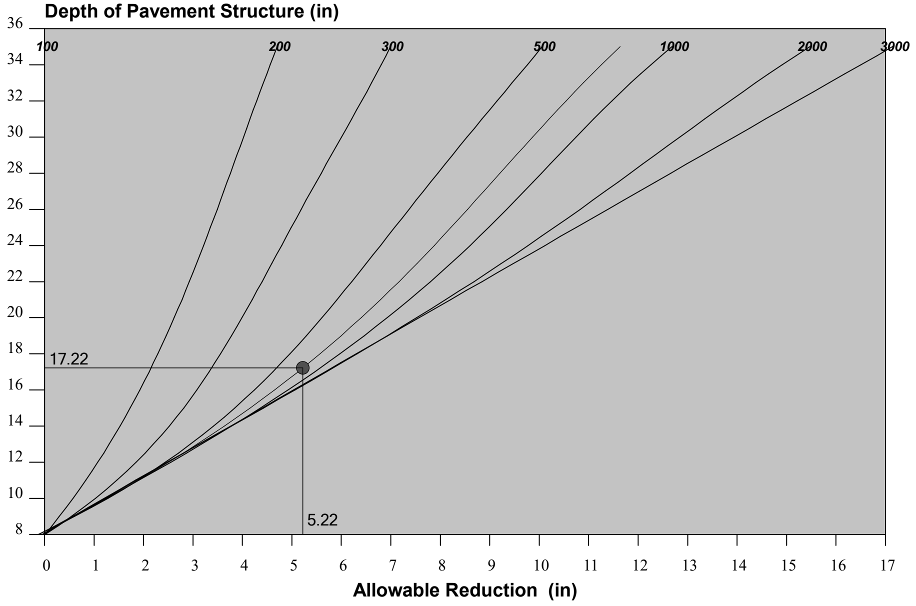
User Input TTC based on historical TEX-117-E

RESULT:

Triaxial Thickness Required	17.2 (in)
The FPS Design Thickness	26.0 (in)
Allowable Thickness Reduction	5.2 (in)
Modified Triaxial Thickness	12.0 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !



Thickness Reduction Chart for Stabilized Layers

FPS 21 Triaxial Design Check Output	(FPS21-1.5Release:12-12-2018)		
Highway	Cordova Rd	Problem	1
C-S-J	0000 - 00 - 000	Date	4/14/2023
District	San Antonio	County	GUADALUPE
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

FIGURE 26

```
--------------------------------------------------------------------------------
```

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

```
--------------------------------------------------------------------------------
```

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

```
PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   1
--------------------------------------------------------------------------------
                        COMMENTS ABOUT THIS PROBLEM


Option 2 for Cordova Rd
Traffic  2.36 million ESAL


--------------------------------------------------------------------------------
```

BASIC DESIGN CRITERIA

```
  LENGTH OF THE ANALYSIS PERIOD (YEARS)                                   20.0
  MINIMUM TIME TO FIRST OVERLAY (YEARS)                                    8.0
  MINIMUM TIME BETWEEN OVERLAYS (YEARS)                                    3.0
  DESIGN CONFIDENCE LEVEL ( 95.0%)                                          C
  SERVICEABILITY INDEX OF THE INITIAL STRUCTURE                            4.2
  FINAL SERVICEABILITY INDEX P2                                            2.5
  SERVICEABILITY INDEX P1 AFTER AN OVERLAY                                 4.2
  DISTRICT TEMPERATURE CONSTANT                                           31.0
  SUBGRADE ELASTIC MODULUS by COUNTY (ksi)                                 3.00
  INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)                           7.0
```

PROGRAM CONTROLS AND CONSTRAINTS

```
  NUMBER OF SUMMARY OUTPUT PAGES DESIRED ( 8 DESIGNS/PAGE)                 3
  MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)             99.00
  MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)              69.0
  ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)      6.0
```

TRAFFIC DATA

```
  ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)                   17700.
  ADT AT END OF TWENTY YEARS (VEHICLES/DAY)                            22700.
  ONE-DIRECTION 20YEAR 18 kip ESAL (millions)                           2.360
  AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)                         70.0
  AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)             45.0
  AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)        50.0
  PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)           6.0
  PERCENT TRUCKS IN ADT                                                    4.0

--------------------------------------------------------------------------------
```

FIGURE 27a

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

```
PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   2
-------------------------------------------------------------------------------

                           INPUT DATA CONTINUED
```

CONSTRUCTION AND MAINTENANCE DATA

```
  MINIMUM OVERLAY THICKNESS (INCHES)                                        1.5
  OVERLAY CONSTRUCTION TIME (HOURS/DAY)                                    12.0
  ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)                          1.90
  ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)                          200.0
  WIDTH OF EACH LANE (FEET)                                                12.0
  FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)                0.00
  ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)      0.00
```

DETOUR DESIGN FOR OVERLAYS

```
  TRAFFIC MODEL USED DURING OVERLAYING                                     2
  TOTAL NUMBER OF LANES OF THE FACILITY                                    2
  NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)              0
  NUMBER OF OPEN LANES  IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)         1
  DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)                   0.60
  DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)               0.60
  DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)                          0.00
```

PAVING MATERIALS INFORMATION

```
           MATERIALS       COST      E    POISSON   MIN.    MAX. SALVAGE
LAYER CODE      NAME        PER CY MODULUS  RATIO   DEPTH   DEPTH   PCT.
  1    A  ASPH CONC PVMT   150.00  500000.   0.35    6.00    6.00   30.00
  2    B  FLEXIBLE BASE     37.00   65000.   0.35   18.00   18.00   75.00
  3    C  STABILIZED SUBGR  15.00   35000.   0.20    8.00    8.00   90.00
  4    D  SUBGRADE(200)      2.00    3000.   0.40  200.00  200.00   90.00
```

FIGURE 27b

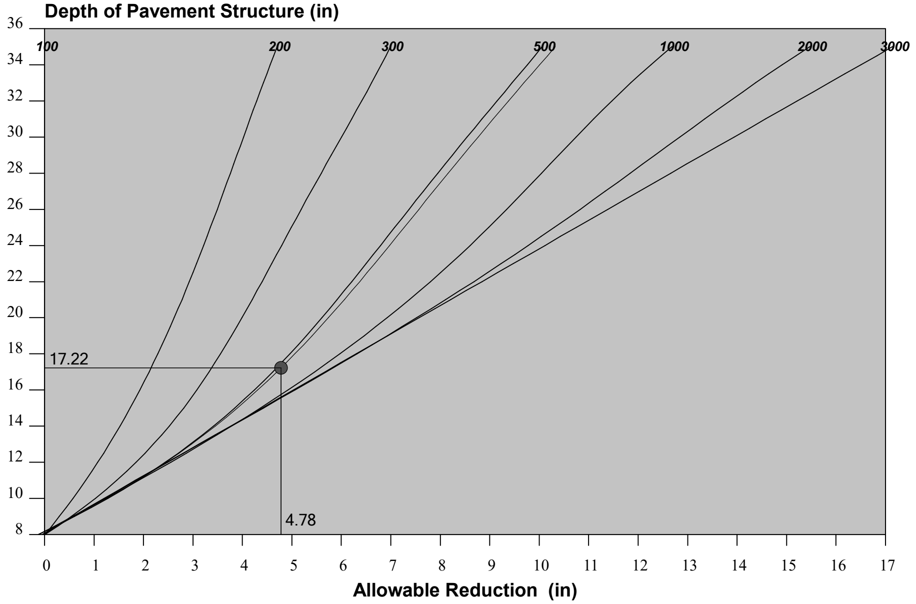
TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

```
------------------------------------------------------------------------------

          PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   3
------------------------------------------------------------------------------


     C. LEVEL C       SUMMARY OF THE BEST DESIGN STRATEGIES
                        IN ORDER OF INCREASING TOTAL COST
                         1
------------------------------------------------------------------------------
MATERIAL ARRANGEMENT   ABC
INIT. CONST. COST     46.83
OVERLAY CONST. COST    0.00
USER COST              0.00
ROUTINE MAINT. COST    0.00
SALVAGE VALUE         -6.30
------------------------------------------------------------------------------
TOTAL COST            40.53
------------------------------------------------------------------------------
NUMBER OF LAYERS        3
------------------------------------------------------------------------------
LAYER DEPTH (INCHES)
     D(1)              6.00
     D(2)             18.00
     D(3)              8.00
------------------------------------------------------------------------------
NO.OF PERF.PERIODS      1
------------------------------------------------------------------------------
PERF. TIME (YEARS)
     T(1)              40.
------------------------------------------------------------------------------
OVERLAY POLICY(INCH)
(INCLUDING LEVEL-UP)
------------------------------------------------------------------------------


        THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS         1
```

FIGURE 27c

	Thickness (inches)	Modulus (ksi)	Poisson's Ratio	Material Name
ASPH CONC PVMT	6.00	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	18.00	65.00	0.35	FLEXIBLE BASE
STABILIZED SUBGR	8.00	35.00	0.20	STABILIZED SUBGR
SUBGRADE(200)	200.00	3.00	0.40	SUBGRADE(200)
Bed Rock		300.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12000.0 (lb)
Percentage of TandemAxles	50.0 (%)
Modified Cohesionmeter Value	550.0
Design Wheel Load	15600.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	4.40

User Input TTC based on historical TEX-117-E

RESULT:

Triaxial Thickness Required	17.2 (in)
The FPS Design Thickness	32.0 (in)
Allowable Thickness Reduction	4.8 (in)
Modified Triaxial Thickness	12.4 (in)

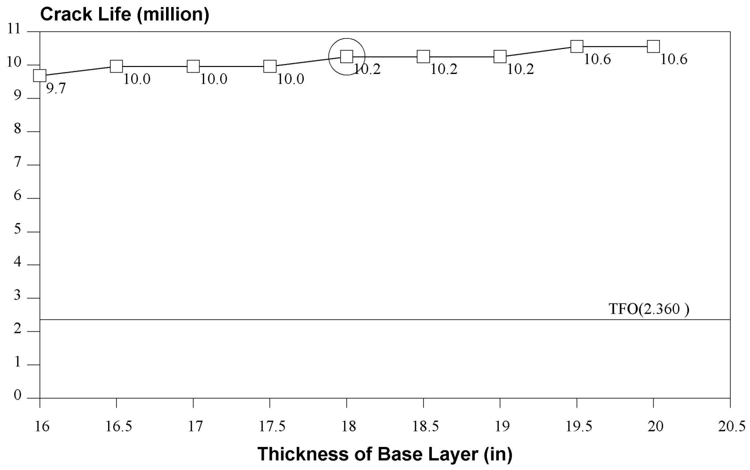
TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	Cordova Rd	Problem	1
C-S-J	0000 - 00 - 000	Date	4/14/2023
District	San Antonio	County	GUADALUPE
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

FIGURE 28

	Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
AC	6.00	500.00	0.35	ASPH CONC PVMT
Base	18.00	65.00	0.35	FLEXIBLE BASE
Subbase	8.00	35.00	0.20	STABILIZED SUBGR
Subgrade	200.00	3.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

$$N_f = f_1(\varepsilon_t)^{-f_2}\ (E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

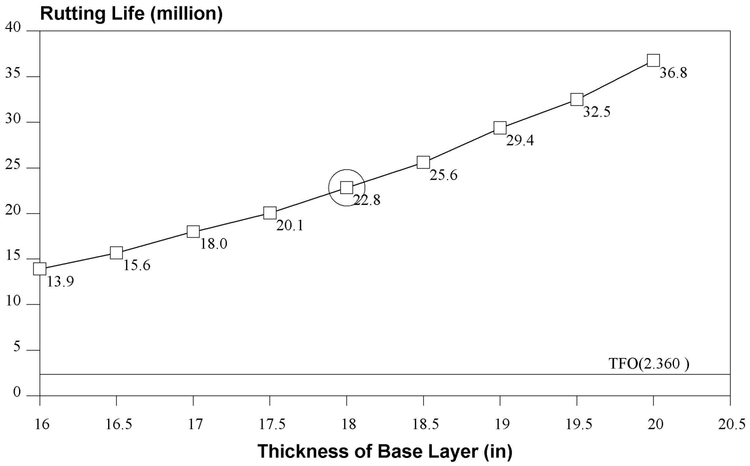
f_3 = .854

Rutting Model:

$$N_d = f_4(\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477



TFO(Traffic to 1st Overlay): 2.36 (million)

Crack Life: 10.25 (million) ε_τ = 114.00 (με)

Rut Life: 22.84 (million) ε_v = -238.00 (με)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.36millions.
Also the start ADT:17700.0 and ending ADT:22700.0

Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)

Highway	Cordova Rd	Problem	1
C-S-J	0000 - 00 - 000	Date	4/14/2023
District	San Antonio	County	GUADALUPE

Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade

FIGURE 29

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

```
PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   1
```

```
                        COMMENTS ABOUT THIS PROBLEM


Option 3 for Cordova Rd
Traffic  2.36 million ESAL
```

BASIC DESIGN CRITERIA

```
  LENGTH OF THE ANALYSIS PERIOD (YEARS)                                    20.0
  MINIMUM TIME TO FIRST OVERLAY (YEARS)                                     8.0
  MINIMUM TIME BETWEEN OVERLAYS (YEARS)                                     3.0
  DESIGN CONFIDENCE LEVEL ( 95.0%)                                           C
  SERVICEABILITY INDEX OF THE INITIAL STRUCTURE                             4.2
  FINAL SERVICEABILITY INDEX P2                                             2.5
  SERVICEABILITY INDEX P1 AFTER AN OVERLAY                                  4.2
  DISTRICT TEMPERATURE CONSTANT                                            31.0
  SUBGRADE ELASTIC MODULUS by COUNTY (ksi)                                  3.00
  INTEREST RATE OR TIME VALUE OF MONEY (PERCENT)                            7.0
```

PROGRAM CONTROLS AND CONSTRAINTS

```
  NUMBER OF SUMMARY OUTPUT PAGES DESIRED ( 8 DESIGNS/PAGE)                 3
  MAX FUNDS AVAILABLE PER SQ.YD. FOR INITIAL DESIGN (DOLLARS)             99.00
  MAXIMUM ALLOWED THICKNESS OF INITIAL CONSTRUCTION (INCHES)              69.0
  ACCUMULATED MAX DEPTH OF ALL OVERLAYS (INCHES) (EXCLUDING LEVEL-UP)      6.0
```

TRAFFIC DATA

```
  ADT AT BEGINNING OF ANALYSIS PERIOD (VEHICLES/DAY)                    17700.
  ADT AT END OF TWENTY YEARS (VEHICLES/DAY)                             22700.
  ONE-DIRECTION 20YEAR 18 kip ESAL (millions)                            2.360
  AVERAGE APPROACH SPEED TO THE OVERLAY ZONE(MPH)                          70.0
  AVERAGE SPEED THROUGH OVERLAY ZONE (OVERLAY DIRECTION)(MPH)              45.0
  AVERAGE SPEED THROUGH OVERLAY ZONE (NON-OVERLAY DIRECTION) (MPH)         50.0
  PROPORTION OF ADT ARRIVING EACH HOUR OF CONSTRUCTION (PERCENT)            6.0
  PERCENT TRUCKS IN ADT                                                     4.0
```

FIGURE 30a

Texas Department of Transportation

TEXAS DEPARTMENT OF TRANSPORTATION

F P S21-1.5 *FLEXIBLE PAVEMENT SYSTEM* *Release:12-12-2018*

```
          PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   2
```

```
                              INPUT DATA CONTINUED
```

CONSTRUCTION AND MAINTENANCE DATA

```
MINIMUM OVERLAY THICKNESS (INCHES)                                      1.5
OVERLAY CONSTRUCTION TIME (HOURS/DAY)                                  12.0
ASPHALTIC CONCRETE COMPACTED DENSITY (TONS/C.Y.)                        1.90
ASPHALTIC CONCRETE PRODUCTION RATE (TONS/HOUR)                        200.0
WIDTH OF EACH LANE (FEET)                                              12.0
FIRST YEAR COST OF ROUTINE MAINTENANCE (DOLLARS/LANE-MILE)              0.00
ANNUAL INCREMENTAL INCREASE IN MAINTENANCE COST (DOLLARS/LANE-MILE)     0.00
```

DETOUR DESIGN FOR OVERLAYS

```
TRAFFIC MODEL USED DURING OVERLAYING                                   2
TOTAL NUMBER OF LANES OF THE FACILITY                                  2
NUMBER OF OPEN LANES IN RESTRICTED ZONE (OVERLAY DIRECTION)            0
NUMBER OF OPEN LANES  IN RESTRICTED ZONE (NON-OVERLAY DIRECTION)       1
DISTANCE TRAFFIC IS SLOWED (OVERLAY DIRECTION) (MILES)                 0.60
DISTANCE TRAFFIC IS SLOWED (NON-OVERLAY DIRECTION) (MILES)             0.60
DETOUR DISTANCE AROUND THE OVERLAY ZONE (MILES)                        0.00
```

PAVING MATERIALS INFORMATION

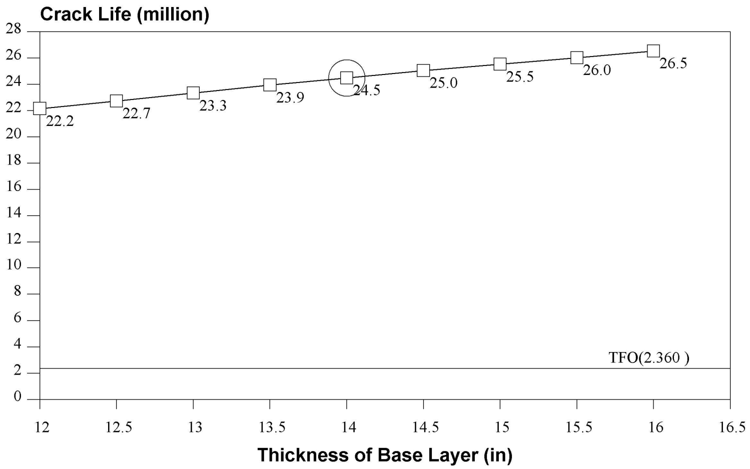
```
             MATERIALS       COST      E     POISSON   MIN.     MAX. SALVAGE
LAYER CODE      NAME        PER CY MODULUS  RATIO    DEPTH    DEPTH   PCT.
  1    A  ASPH CONC PVMT   150.00  500000.   0.35     8.00     8.00   30.00
  2    B  FLEXIBLE BASE     54.00   65000.   0.35    14.00    14.00   75.00
  3    C  STABILIZED SUBGR  15.00   35000.   0.30     8.00     8.00   90.00
  4    D  SUBGRADE(200)      2.00    3000.   0.40   200.00   200.00   90.00
```

FIGURE 30b

```
--------------------------------------------------------------------------------
                 TEXAS DEPARTMENT OF TRANSPORTATION
 F P S21-1.5             FLEXIBLE PAVEMENT SYSTEM              Release:12-12-2018

--------------------------------------------------------------------------------

           PAVEMENT DESIGN TYPE # 5 -- ACP + FLEX BASE + STAB SBGR OVER SUBGRADE

PROB   DIST.-15   COUNTY- 95   CONT.  SECT.  JOB     HIGHWAY       DATE    PAGE

1     San Antonio   GUADALUPE    0000    00    000    Cordova Rd 4/14/2023   3
--------------------------------------------------------------------------------


     C. LEVEL C       SUMMARY OF THE BEST DESIGN STRATEGIES
                        IN ORDER OF INCREASING TOTAL COST
                          1
--------------------------------------------------------------------------------
MATERIAL ARRANGEMENT   ABC
INIT. CONST. COST     57.67
OVERLAY CONST. COST    0.00
USER COST              0.00
ROUTINE MAINT. COST    0.00
SALVAGE VALUE         -7.43
--------------------------------------------------------------------------------
TOTAL COST            50.24
--------------------------------------------------------------------------------
NUMBER OF LAYERS        3
--------------------------------------------------------------------------------
LAYER DEPTH (INCHES)
     D(1)              8.00
     D(2)             14.00
     D(3)              8.00
--------------------------------------------------------------------------------
NO.OF PERF.PERIODS      1
--------------------------------------------------------------------------------
PERF. TIME (YEARS)
     T(1)             40.
--------------------------------------------------------------------------------
OVERLAY POLICY(INCH)
(INCLUDING LEVEL-UP)
--------------------------------------------------------------------------------


        THE TOTAL NUMBER OF FEASIBLE DESIGNS CONSIDERED WAS         1









--------------------------------------------------------------------------------
```

FIGURE 30c

	Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
AC	8.00	500.00	0.35	ASPH CONC PVMT
Base	14.00	65.00	0.35	FLEXIBLE BASE
Subbase	8.00	35.00	0.30	STABILIZED SUBGR
Subgrade	200.00	3.00	0.40	SUBGRADE(200)



Fatigue Crack Model:

$$N_f = f_1(\varepsilon_t)^{-f_2}\,(E_1)^{-f_3}$$

f_1 =7.96E-02

f_2 = 3.291

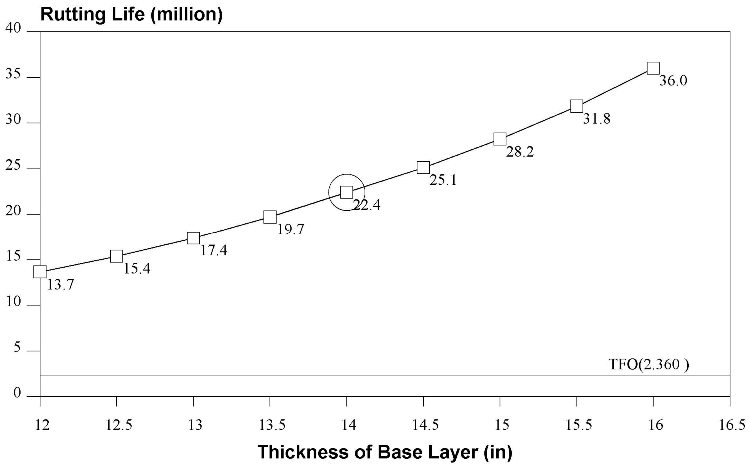
f_3 = .854

Rutting Model:

$$N_d = f_4(\varepsilon_v)^{-f_5}$$

f_4 =1.37E-09

f_5 = 4.477



TFO(Traffic to 1st Overlay): 2.36 (million)

Crack Life: 24.48 (million) ε_τ = 87.50 ($\mu\varepsilon$)

Rut Life: 22.42 (million) ε_v = -239.00 ($\mu\varepsilon$)

Traffic to 1st Overlay is calculated by analysis period: 20years and 18 kips:2.36millions.
Also the start ADT:17700.0 and ending ADT:22700.0

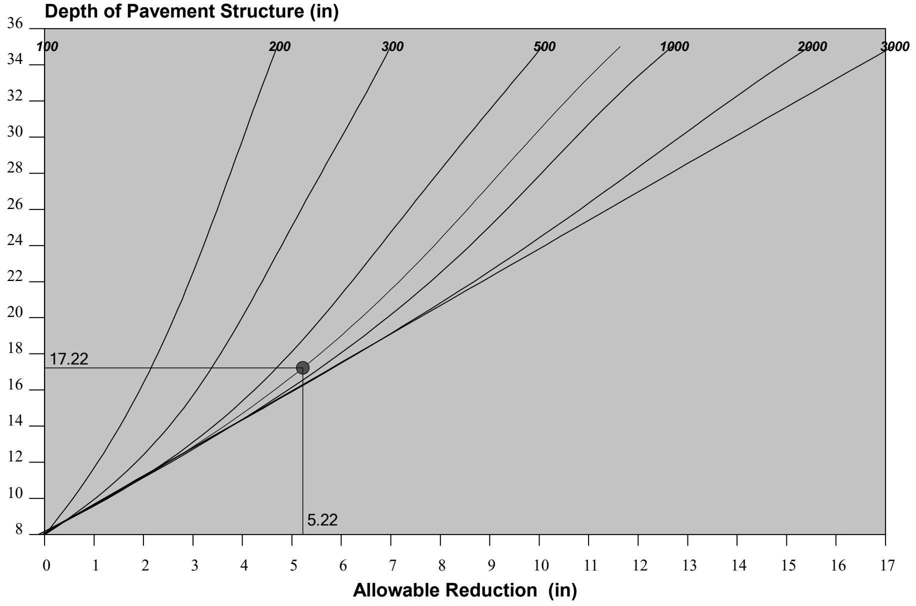
Mechanistic Check Conclusion:

The design is OK !

FPS 21 Mechanistic Design Check Output (FPS21-1.5Release:12-12-2018)			
Highway	Cordova Rd	Problem	1
C-S-J	0000 - 00 - 000	Date	4/14/2023
District	San Antonio	County	GUADALUPE
Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade			

FIGURE 31

	Thickness (inches)	*Modulus (ksi)*	*Poisson's Ratio*	*Material Name*
ASPH CONC PVMT	8.00	500.00	0.35	ASPH CONC PVMT
FLEXIBLE BASE	14.00	65.00	0.35	FLEXIBLE BASE
STABILIZED SUBGR	8.00	35.00	0.30	STABILIZED SUBGR
SUBGRADE(200)	200.00	3.00	0.40	SUBGRADE(200)
Bed Rock		300.00	0.15	Bed Rock



Thickness Reduction Chart for Stabilized Layers

INPUT PARAMETERS:

The Heaviest Wheel Loads Daily (ATHWLD)	12000.0 (lb)
Percentage of TandemAxles	50.0 (%)
Modified Cohesionmeter Value	800.0
Design Wheel Load	15600.0 (lb)
Subgrade Texas Triaxial Class Number (TTC)	4.40

User Input TTC based on historical TEX-117-E

RESULT:

Triaxial Thickness Required	17.2 (in)
The FPS Design Thickness	30.0 (in)
Allowable Thickness Reduction	5.2 (in)
Modified Triaxial Thickness	12.0 (in)

TRIAXIAL CHECK CONCLUSION:

The Design OK !

FPS 21 Triaxial Design Check Output (FPS21-1.5Release:12-12-2018)

Highway	Cordova Rd	Problem	1
C-S-J	0000 - 00 - 000	Date	4/14/2023
District	San Antonio	County	GUADALUPE

Design Type:Asphalt concrete + Flexible Base + Stabilized Subgrade over Subgrade

FIGURE 32

Project Number: ANA22-047-00

Test Date: December 18, 2022

DCP TEST DATA

P-1

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	115	4.5	1	1.5	0.55
1	1	35	5.9	5	7.5	1.59
1	1	40	7.5	5	7.5	1.59
1	1	115	12	1	1.5	0.55
1	1	150	17.9	1	1.5	0.55
1	1	105	22	2	3	0.87
1	1	105	26.2	2	3	0.87
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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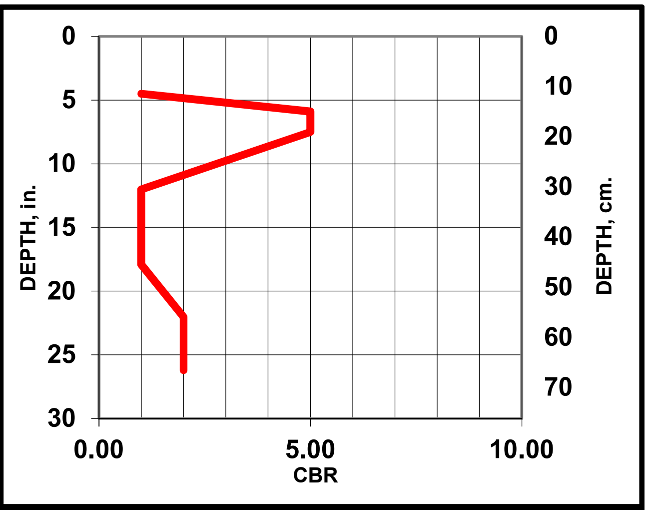
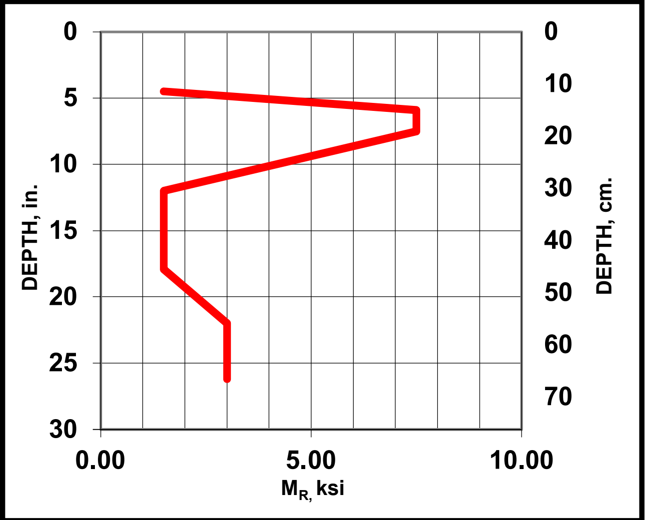
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





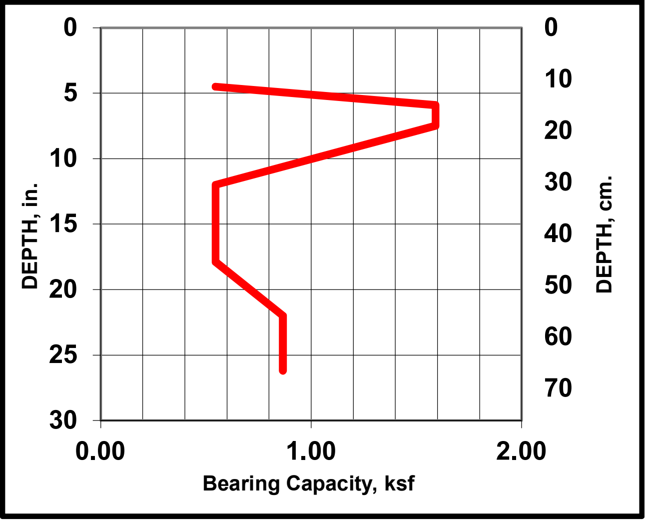


FIGURE 33a

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-2

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	110	4.3	2	3	0.87
1	1	100	8.3	2	3	0.87
1	1	105	12.4	2	3	0.87
1	1	125	17.3	1	1.5	0.55
1	1	125	22.2	1	1.5	0.55
1	1	80	25.4	2	3	0.87
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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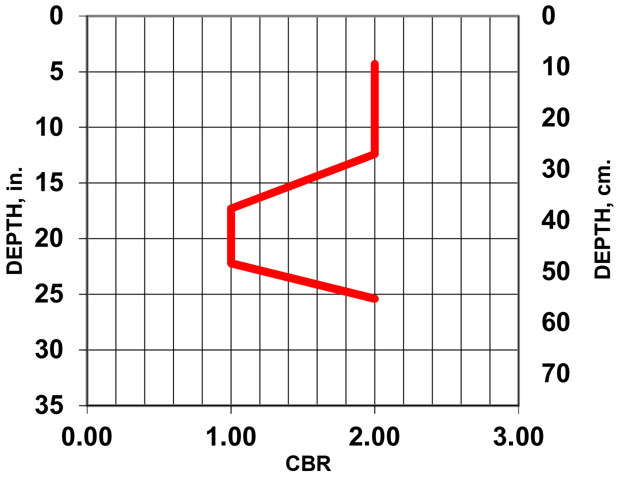
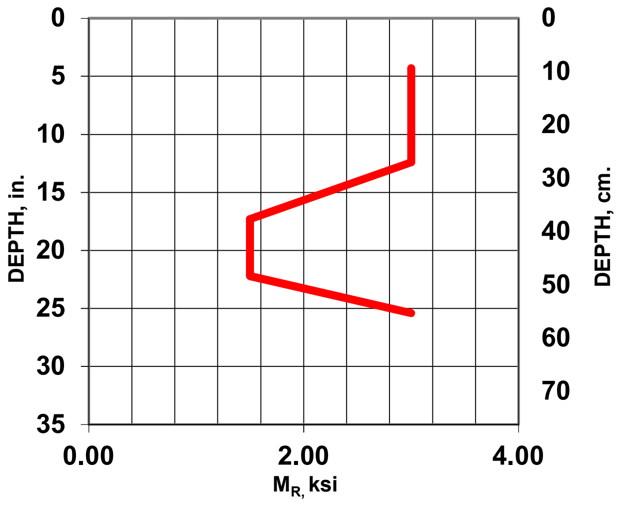
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





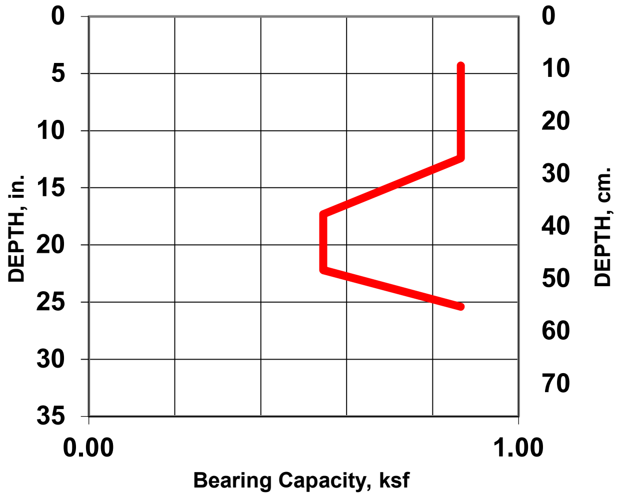


FIGURE 33b

Project Number: ANA22-047-00
Test Date: December 18, 2022

RABA KISTNER

DCP TEST DATA

P-3

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	65	2.6	3	4.5	1.13
1	1	85	5.9	2	3	0.87
1	1	90	9.4	2	3	0.87
1	1	105	13.6	2	3	0.87
1	1	120	18.3	1	1.5	0.55
1	1	150	24.2	1	1.5	0.55
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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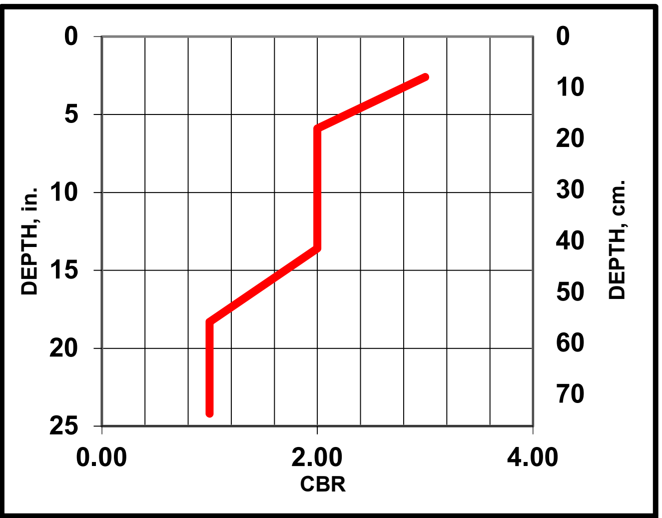
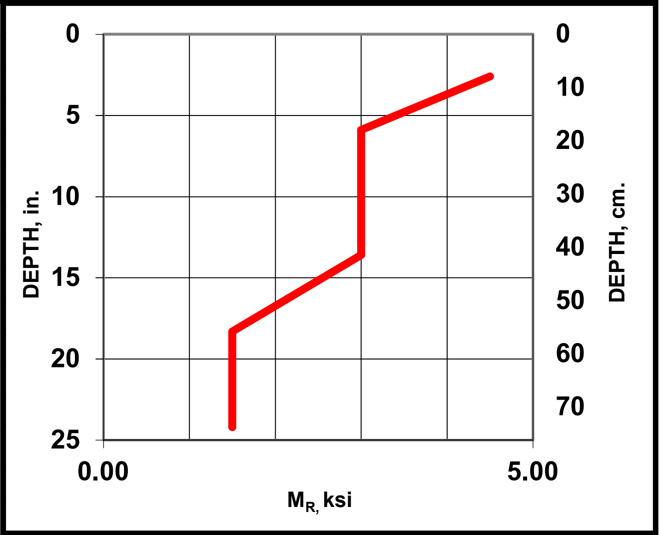
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





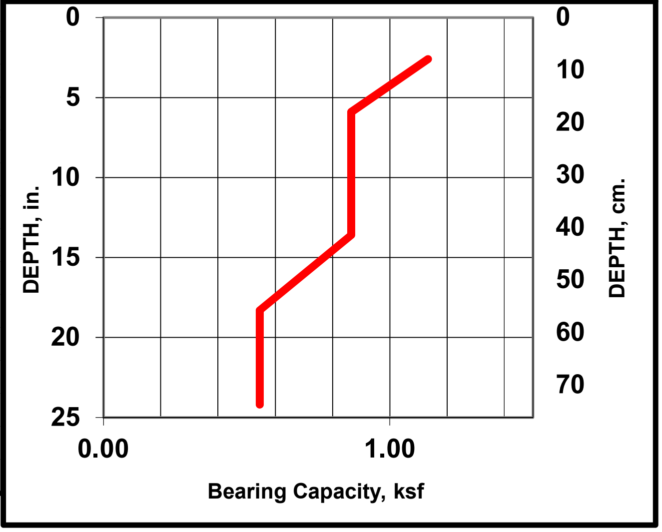


FIGURE 33c

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-4

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	85	3.3	2	3	0.87
1	1	25	4.3	8	12	2.17
1	1	50	6.3	4	6	1.37
1	1	55	8.5	3	4.5	1.13
1	1	45	10.2	4	6	1.37
1	1	45	12	4	6	1.37
1	1	50	14	4	6	1.37
1	1	35	15.4	5	7.5	1.59
1	1	35	16.7	5	7.5	1.59
1	1	25	17.7	8	12	2.17
1	1	20	18.5	10	15	2.52
1	1	50	20.5	4	6	1.37
1	1	35	21.9	5	7.5	1.59
1	1	25	22.8	8	12	2.17
1	1	35	24.2	5	7.5	1.59
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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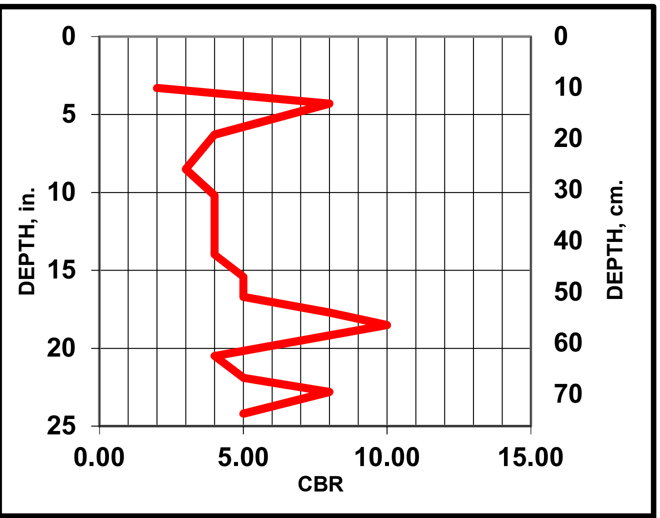
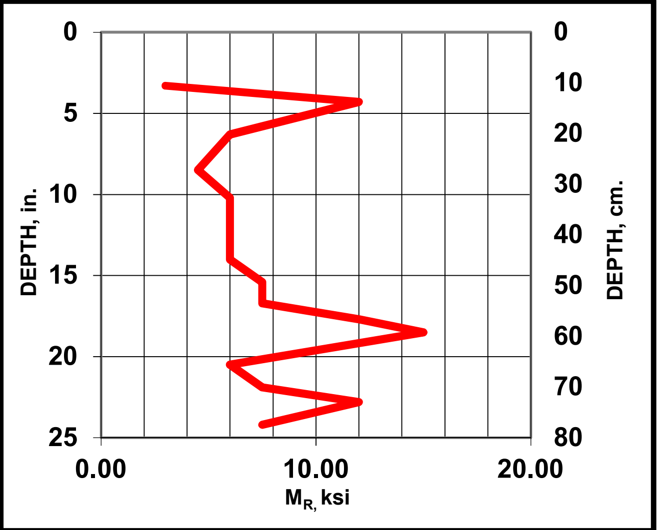
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





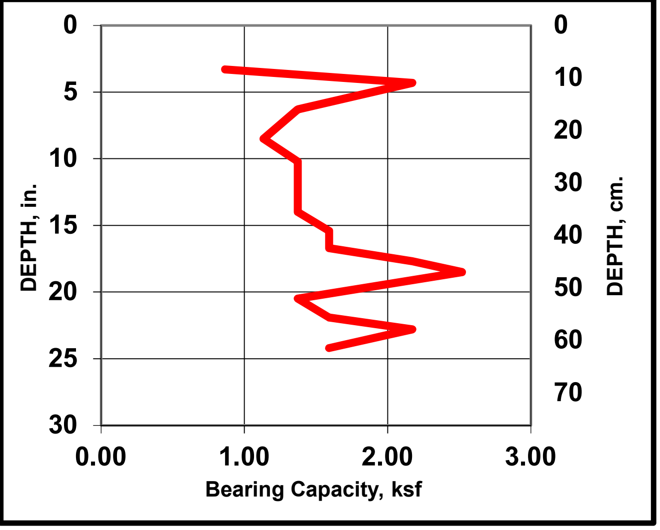


FIGURE 33d

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-5
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	90	3.5	2	3	0.87
1	1	65	6.1	3	4.5	1.13
1	1	60	8.5	3	4.5	1.13
1	1	60	10.8	3	4.5	1.13
1	1	60	13.2	3	4.5	1.13
1	1	50	15.2	4	6	1.37
1	1	45	16.9	4	6	1.37
1	1	45	18.7	4	6	1.37
1	1	40	20.3	5	7.5	1.59
1	1	35	21.7	5	7.5	1.59
1	1	30	22.8	6	9	1.80
1	1	35	24.2	5	7.5	1.59
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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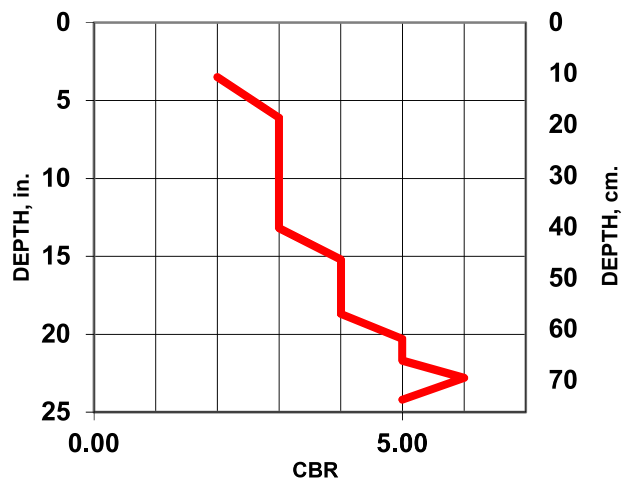
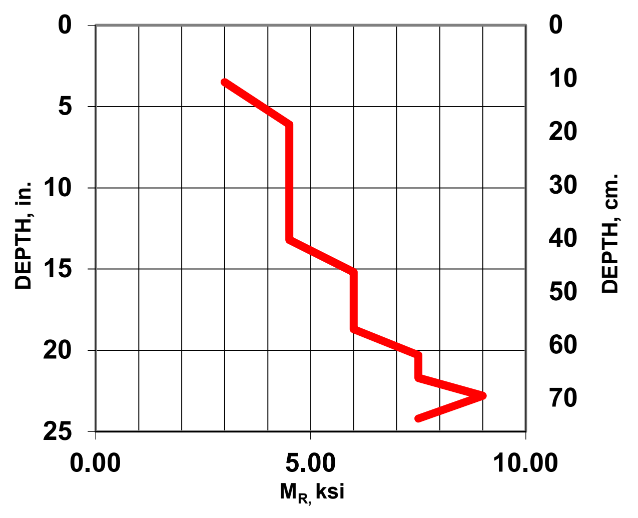
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





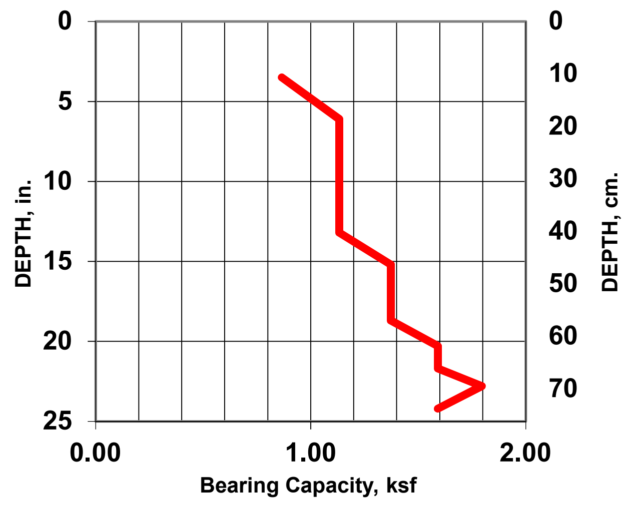


FIGURE 33e

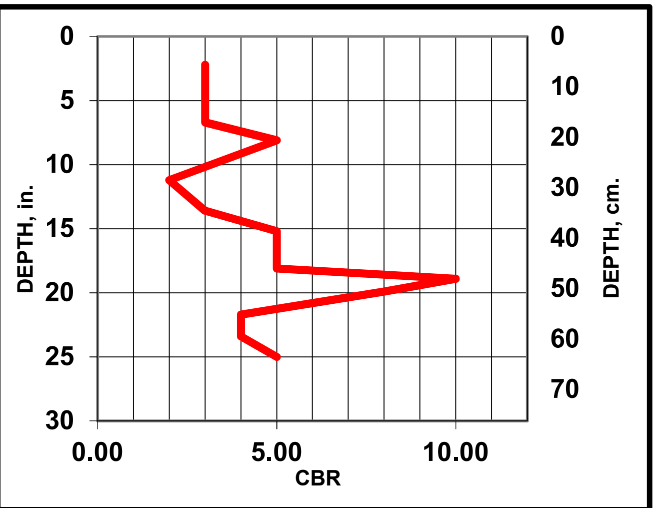
Project Number: ANA22-047-00
Test Date: December 18, 2022

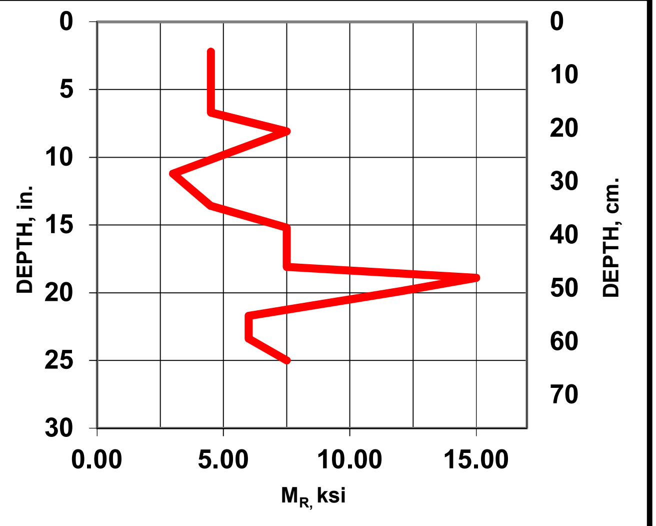
DCP TEST DATA

P-6
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR	M_R	q_{ult}
		Incre. (mm)	Cumm. (in)	(%)	(ksi)	(ksf)
1	1	55	2.2	3	4.5	1.13
1	1	55	4.3	3	4.5	1.13
1	1	60	6.7	3	4.5	1.13
1	1	35	8.1	5	7.5	1.59
1	1	80	11.2	2	3	0.87
1	1	60	13.6	3	4.5	1.13
1	1	40	15.2	5	7.5	1.59
1	1	40	16.7	5	7.5	1.59
1	1	35	18.1	5	7.5	1.59
1	1	20	18.9	10	15	2.52
1	1	25	19.9	8	12	2.17
1	1	45	21.7	4	6	1.37
1	1	45	23.4	4	6	1.37
1	1	40	25	5	7.5	1.59
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





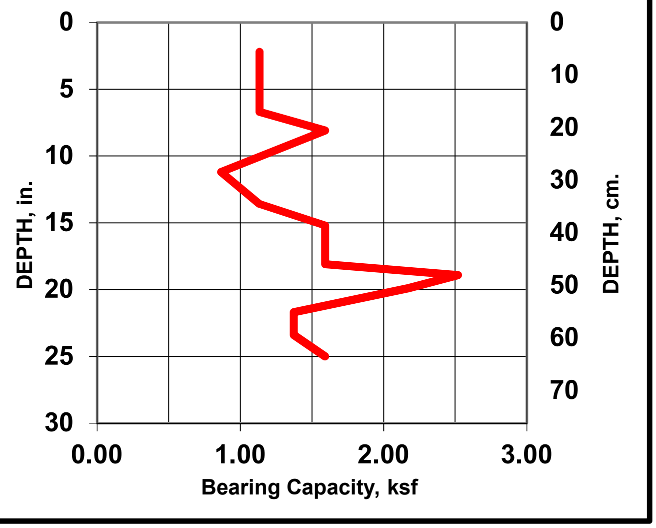


FIGURE 33f

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-7

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	50	2	4	6	1.37
1	1	20	2.8	10	15	2.52
1	1	50	4.7	4	6	1.37
1	1	80	7.9	2	3	0.87
1	1	70	10.6	3	4.5	1.13
1	1	65	13.2	3	4.5	1.13
1	1	70	15.9	3	4.5	1.13
1	1	95	19.7	2	3	0.87
1	1	90	23.2	2	3	0.87
1	1	120	28	1	1.5	0.55
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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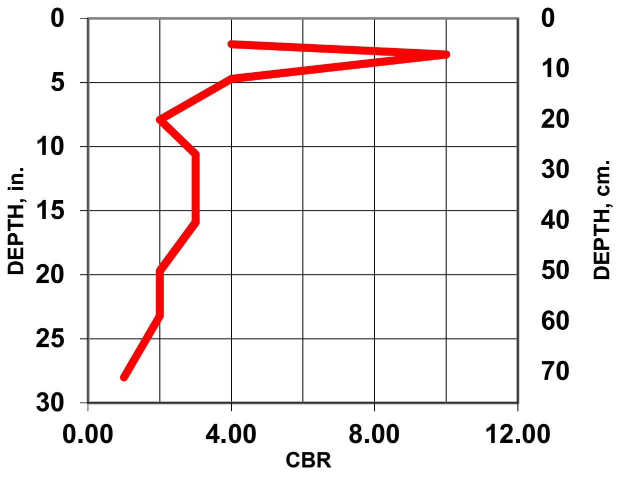
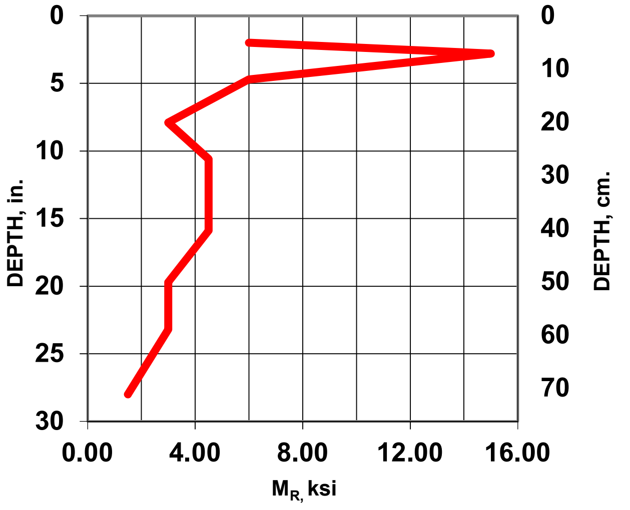
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





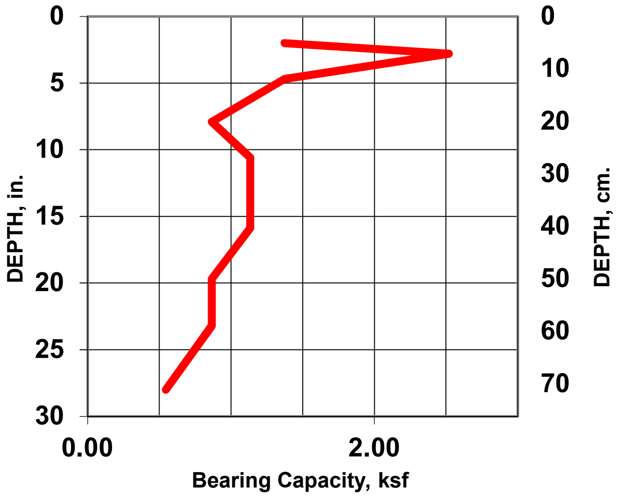


FIGURE 33g

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-8
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR	M_R	q_{ult}
		Incre. (mm)	Cumm. (in)	(%)	(ksi)	(ksf)
1	1	60	2.4	3	4.5	1.13
1	1	55	4.5	3	4.5	1.13
1	1	55	6.7	3	4.5	1.13
1	1	50	8.7	4	6	1.37
1	1	45	10.4	4	6	1.37
1	1	50	12.4	4	6	1.37
1	1	40	14	5	7.5	1.59
1	1	30	15.2	6	9	1.80
1	1	30	16.3	6	9	1.80
1	1	25	17.3	8	12	2.17
1	1	25	18.3	8	12	2.17
1	1	25	19.3	8	12	2.17
1	1	20	20.1	10	15	2.52
1	1	25	21.1	8	12	2.17
1	1	20	21.9	10	15	2.52
1	1	20	22.6	10	15	2.52
1	1	25	23.6	8	12	2.17
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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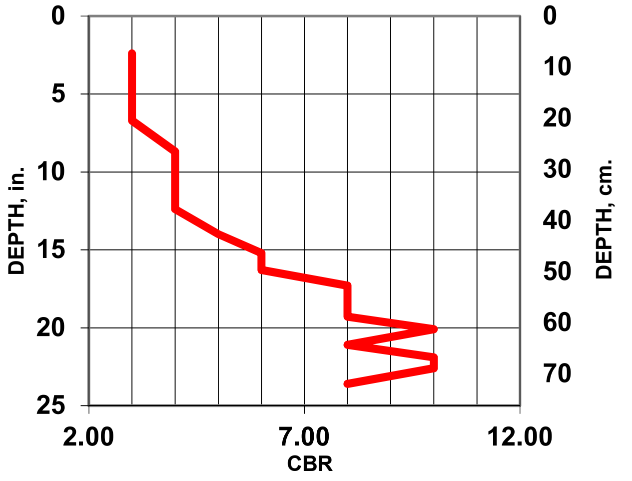
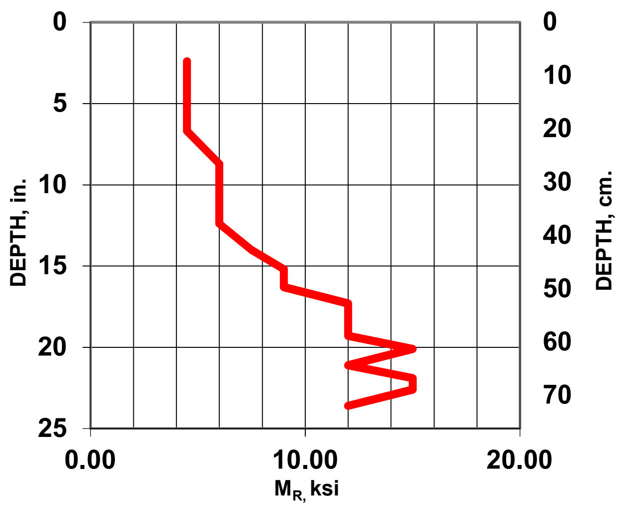
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





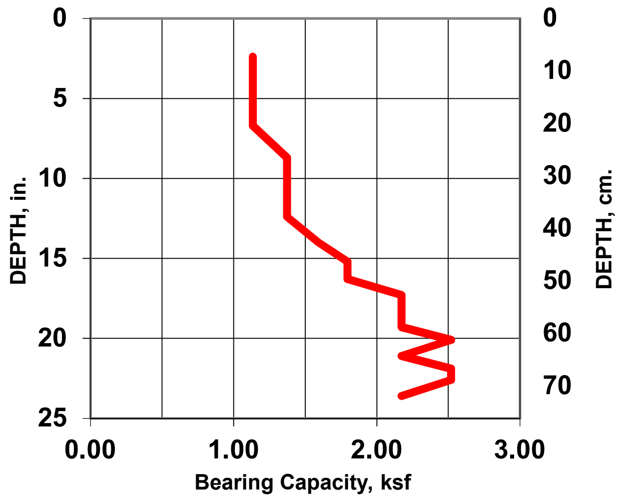


FIGURE 33h

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-9
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR	M_R	q_{ult}
		Incre. (mm)	Cumm. (in)	(%)	(ksi)	(ksf)
1	1	70	2.8	3	4.5	1.13
1	1	55	4.9	3	4.5	1.13
1	1	50	6.9	4	6	1.37
1	1	45	8.7	4	6	1.37
1	1	40	10.2	5	7.5	1.59
1	1	35	11.6	5	7.5	1.59
1	1	25	12.6	8	12	2.17
1	1	20	13.4	10	15	2.52
1	1	20	14.2	10	15	2.52
1	1	30	15.4	6	9	1.80
1	1	35	16.7	5	7.5	1.59
1	1	35	18.1	5	7.5	1.59
1	1	40	19.7	5	7.5	1.59
1	1	30	20.9	6	9	1.80
1	1	20	21.7	10	15	2.52
1	1	20	22.4	10	15	2.52
1	1	20	23.2	10	15	2.52
1	1	15	23.8	14	21	3.15
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
-	-	-	-	-	-	-
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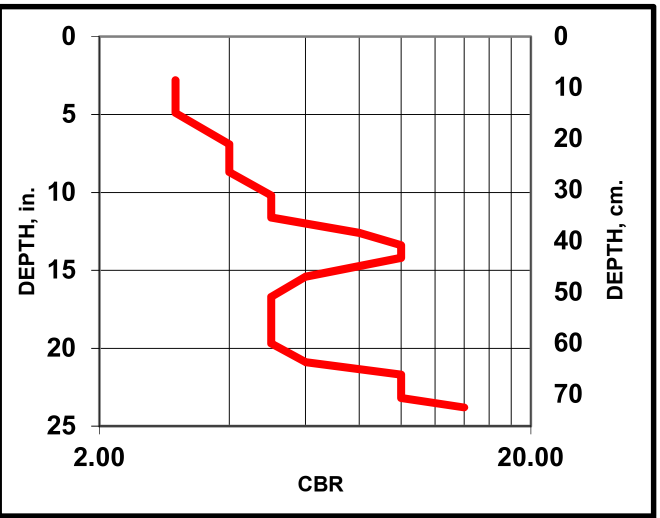
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2



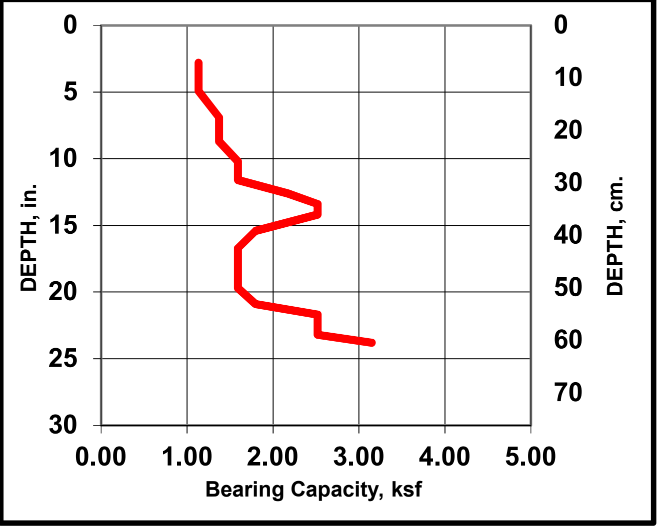


FIGURE 33i

Project Number: ANA22-047-00
Test Date: December 18, 2022

RABA KISTNER

DCP TEST DATA

P-10
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration Incre. (mm)	Penetration Cumm. (in)	CBR (%)	M_R (ksi)	q_{ult} (ksf)
1	1	85	3.3	2	3	0.87
1	1	55	5.5	3	4.5	1.13
1	1	55	7.7	3	4.5	1.13
1	1	65	10.2	3	4.5	1.13
1	1	60	12.6	3	4.5	1.13
1	1	60	15	3	4.5	1.13
1	1	70	17.7	3	4.5	1.13
1	1	70	20.5	3	4.5	1.13
1	1	45	22.2	4	6	1.37
1	1	30	23.4	6	9	1.80
1	1	20	24.2	10	15	2.52
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
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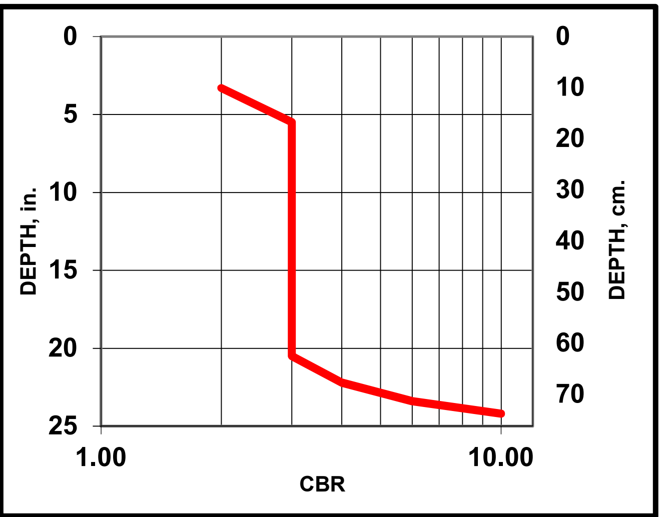
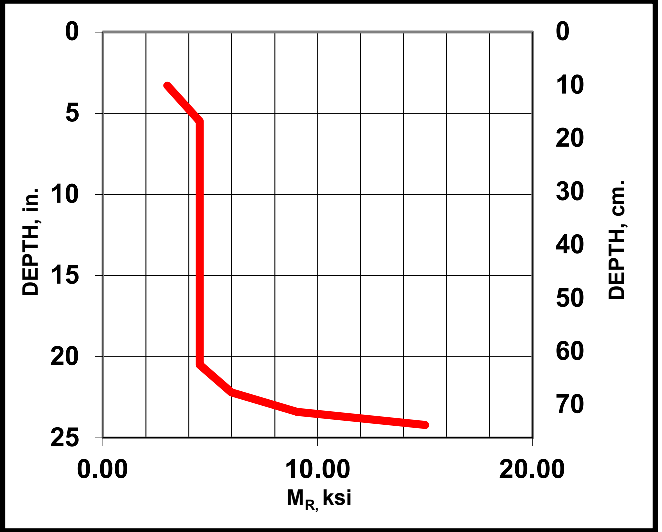
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





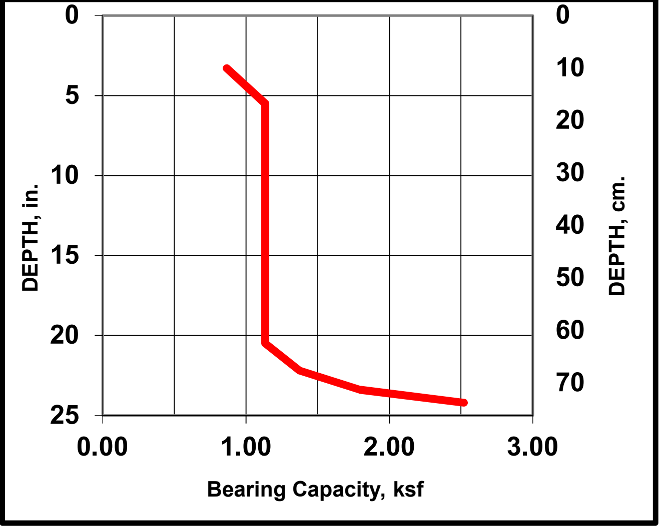


FIGURE 33j

Project Number: ANA22-047-00

Test Date: December 18, 2022

DCP TEST DATA

P-11

Cordova Rd

New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	125	4.9	1	1.5	0.55
1	1	75	7.9	2	3	0.87
1	1	55	10	3	4.5	1.13
1	1	45	11.8	4	6	1.37
1	1	35	13.2	5	7.5	1.59
1	1	30	14.4	6	9	1.80
1	1	25	15.4	8	12	2.17
1	1	25	16.3	8	12	2.17
1	1	30	17.5	6	9	1.80
1	1	25	18.5	8	12	2.17
1	1	25	19.5	8	12	2.17
1	1	20	20.3	10	15	2.52
1	1	20	21.1	10	15	2.52
1	1	20	21.9	10	15	2.52
1	1	20	22.6	10	15	2.52
1	2	30	23.8	14	21	3.15
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
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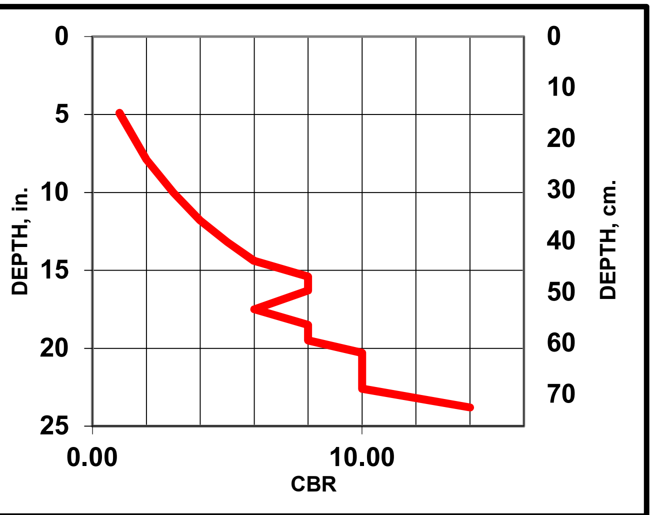
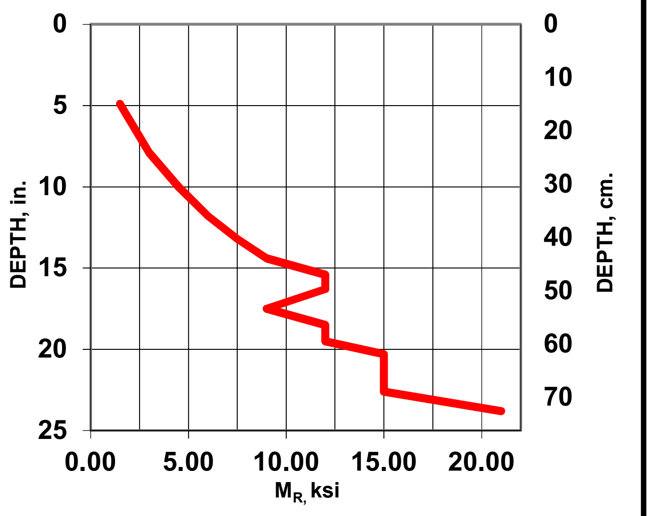
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





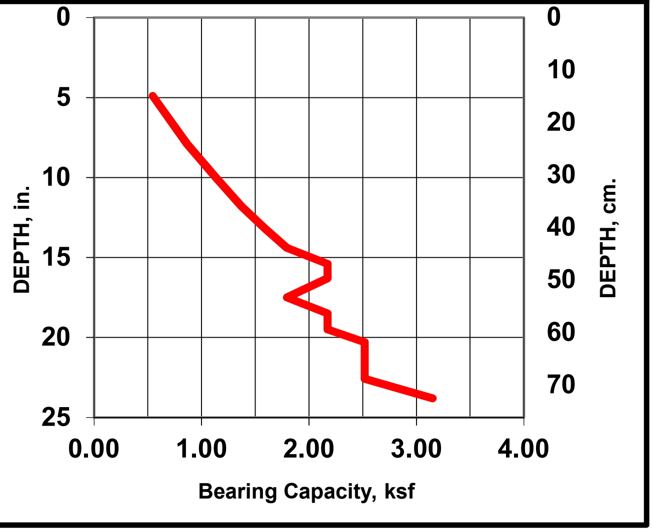


FIGURE 33k

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-12
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	75	3	2	3	0.87
1	1	35	4.3	5	7.5	1.59
1	1	35	5.7	5	7.5	1.59
1	1	40	7.3	5	7.5	1.59
1	1	30	8.5	6	9	1.80
1	1	50	10.4	4	6	1.37
1	1	45	12.2	4	6	1.37
1	1	35	13.6	5	7.5	1.59
1	1	40	15.2	5	7.5	1.59
1	1	35	16.5	5	7.5	1.59
1	1	35	17.9	5	7.5	1.59
1	1	30	19.1	6	9	1.80
1	1	25	20.1	8	12	2.17
1	1	30	21.3	6	9	1.80
1	1	30	22.4	6	9	1.80
1	1	30	23.6	6	9	1.80
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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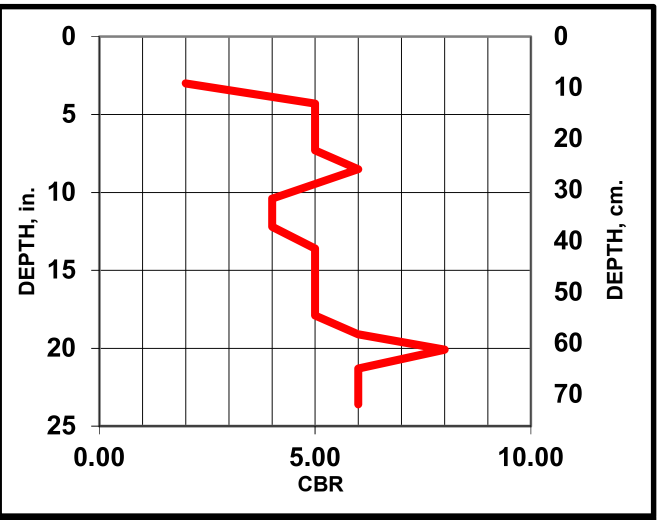
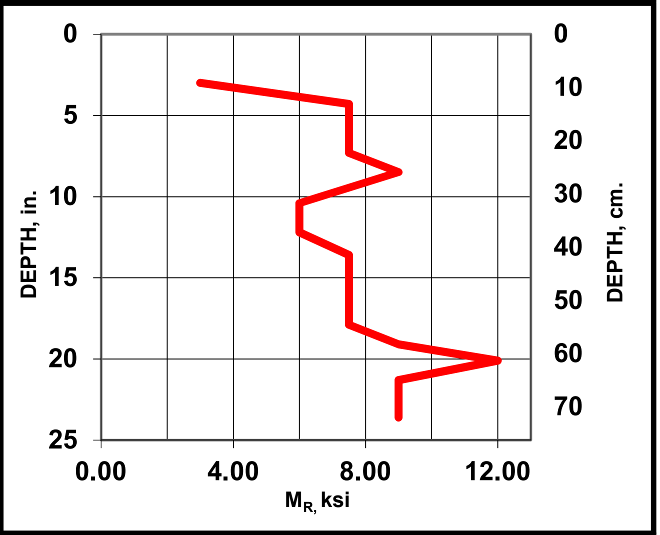
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





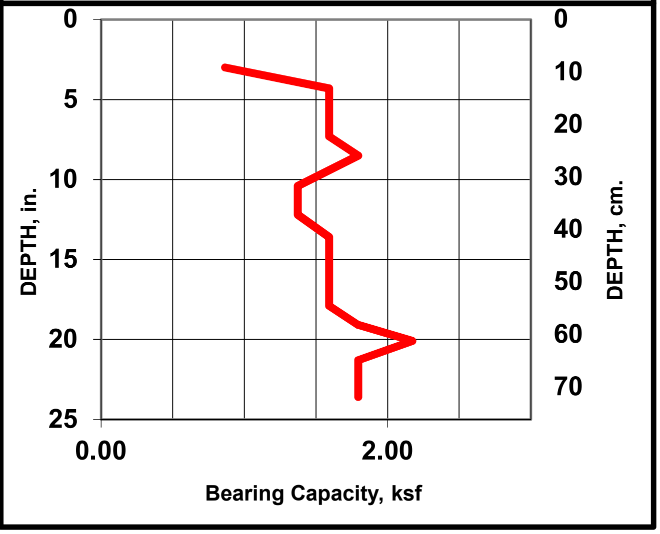


FIGURE 33l

Project Number: ANA22-047-00
Test Date: December 18, 2022

RABA KISTNER

DCP TEST DATA

P-13
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration Incre. (mm)	Penetration Cumm. (in)	CBR (%)	M_R (ksi)	q_{ult} (ksf)
1	1	60	2.4	3	4.5	1.13
1	1	75	5.3	2	3	0.87
1	1	70	8.1	3	4.5	1.13
1	1	55	10.2	3	4.5	1.13
1	1	60	12.6	3	4.5	1.13
1	1	60	15	3	4.5	1.13
1	1	50	16.9	4	6	1.37
1	1	45	18.7	4	6	1.37
1	1	40	20.3	5	7.5	1.59
1	1	40	21.9	5	7.5	1.59
1	1	35	23.2	5	7.5	1.59
1	1	30	24.4	6	9	1.80
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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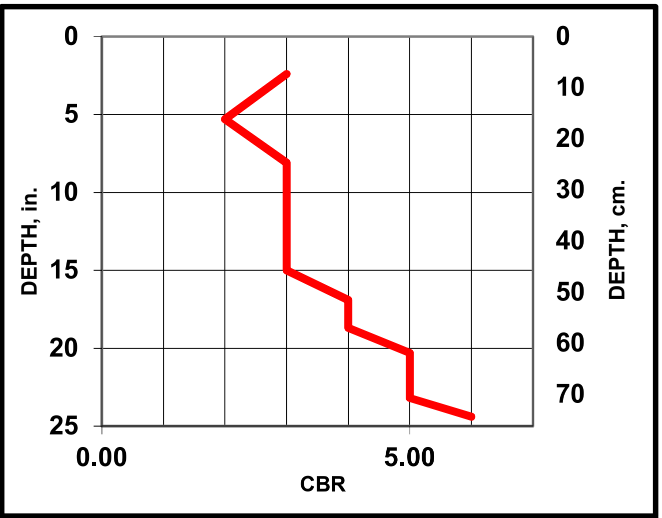
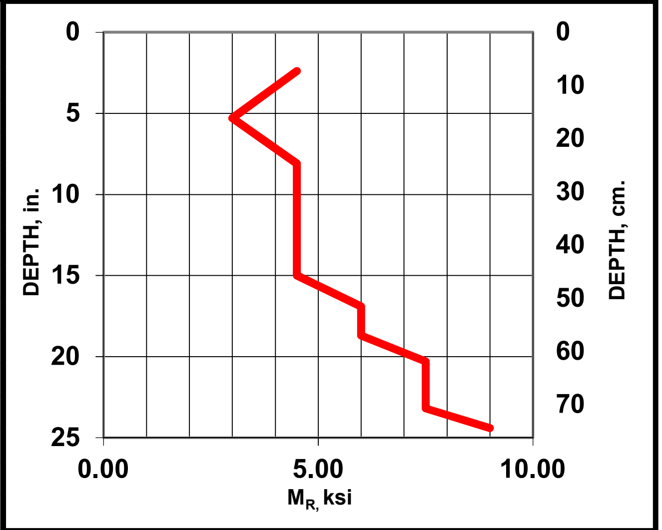
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





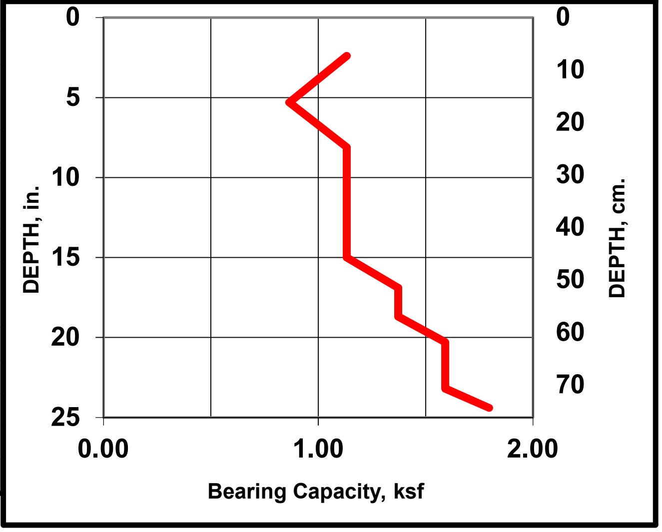


FIGURE 33m

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-14

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	65	2.6	3	4.5	1.13
1	1	65	5.1	3	4.5	1.13
1	1	45	6.9	4	6	1.37
1	1	45	8.7	4	6	1.37
1	1	45	10.4	4	6	1.37
1	1	35	11.8	5	7.5	1.59
1	1	30	13	6	9	1.80
1	1	35	14.4	5	7.5	1.59
1	1	25	15.4	8	12	2.17
1	1	25	16.3	8	12	2.17
1	1	25	17.3	8	12	2.17
1	1	20	18.1	10	15	2.52
1	1	20	18.9	10	15	2.52
1	1	20	19.7	10	15	2.52
1	1	20	20.5	10	15	2.52
1	2	20	21.3	22	33	4.25
1	2	20	22	22	33	4.25
1	2	20	22.8	22	33	4.25
1	2	20	23.6	22	33	4.25
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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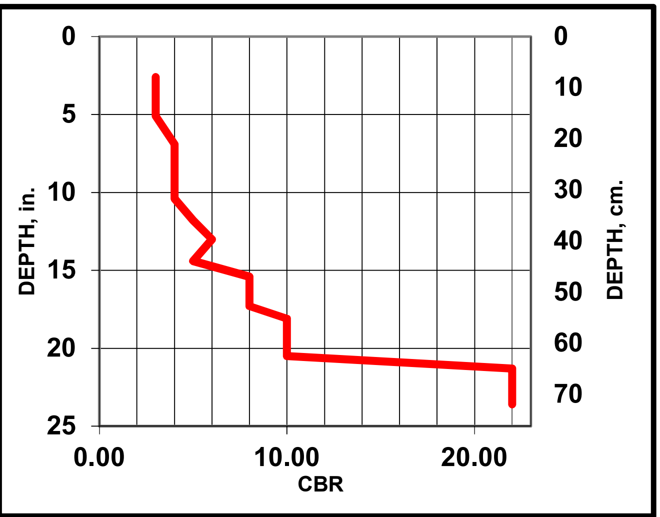
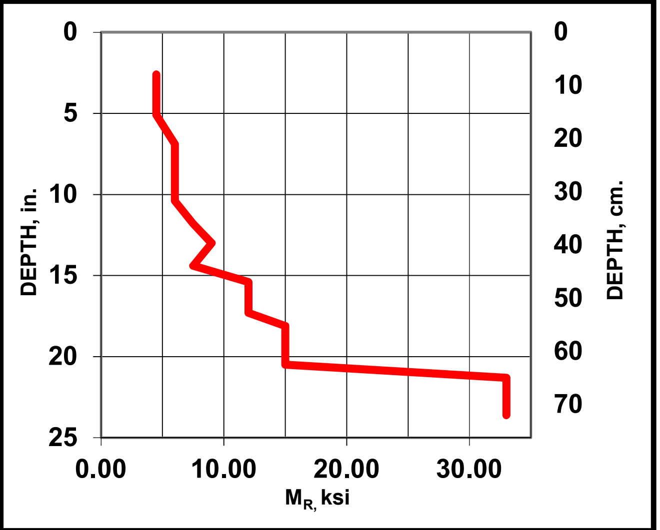
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





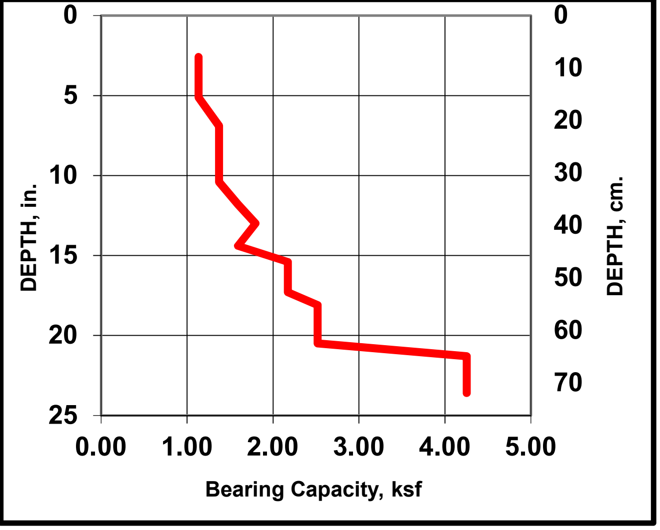


FIGURE 33n

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

P-15
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	35	1.4	5	7.5	1.59
1	1	40	3	5	7.5	1.59
1	1	35	4.3	5	7.5	1.59
1	1	35	5.7	5	7.5	1.59
1	1	30	6.9	6	9	1.80
1	1	30	8.1	6	9	1.80
1	1	30	9.3	6	9	1.80
1	1	30	10.4	6	9	1.80
1	1	30	11.6	6	9	1.80
1	1	30	12.8	6	9	1.80
1	1	25	13.8	8	12	2.17
1	1	25	14.8	8	12	2.17
1	1	30	15.9	6	9	1.80
1	1	30	17.1	6	9	1.80
1	1	25	18.1	8	12	2.17
1	1	25	19.1	8	12	2.17
1	1	20	19.9	10	15	2.52
1	2	25	20.9	17	25.5	3.59
1	2	30	22	14	21	3.15
1	2	30	23.2	14	21	3.15
1	2	25	24.2	17	25.5	3.59
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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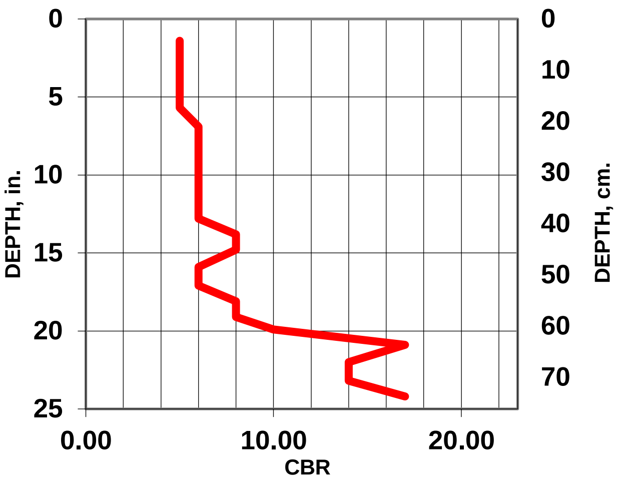
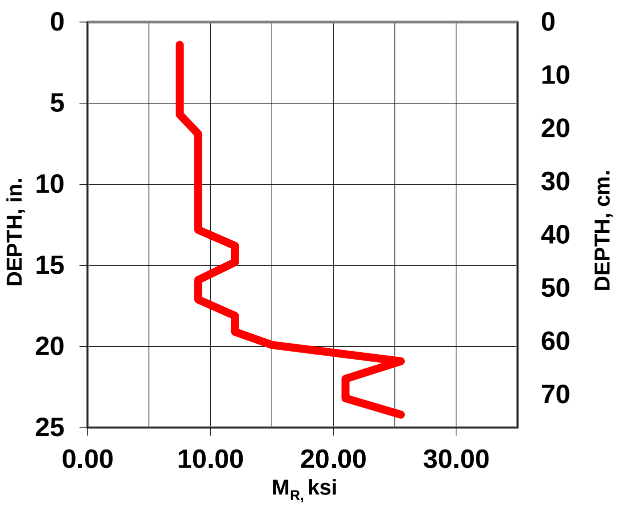
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





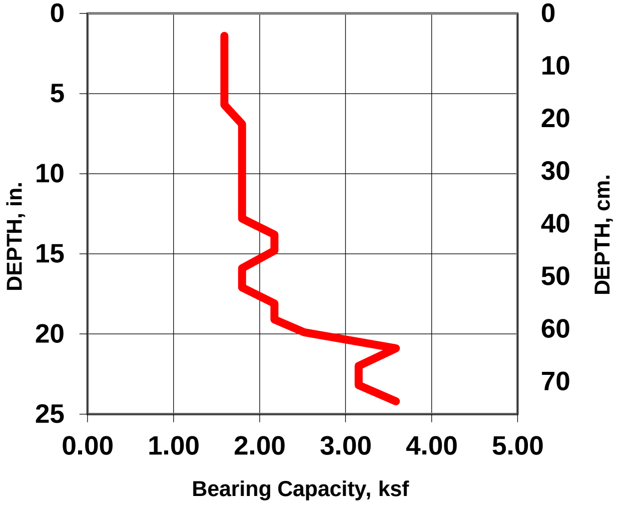


FIGURE 33o

Project Number: ANA22-047-00
Test Date: December 18, 2022

RABA KISTNER

DCP TEST DATA

WC-1
Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	75	3	2	3	0.87
1	1	80	6.1	2	3	0.87
1	1	70	8.9	3	4.5	1.13
1	1	65	11.4	3	4.5	1.13
1	1	60	13.8	3	4.5	1.13
1	1	65	16.3	3	4.5	1.13
1	1	50	18.3	4	6	1.37
1	1	30	19.5	6	9	1.80
1	1	30	20.7	6	9	1.80
1	1	30	21.9	6	9	1.80
1	1	40	23.4	5	7.5	1.59
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
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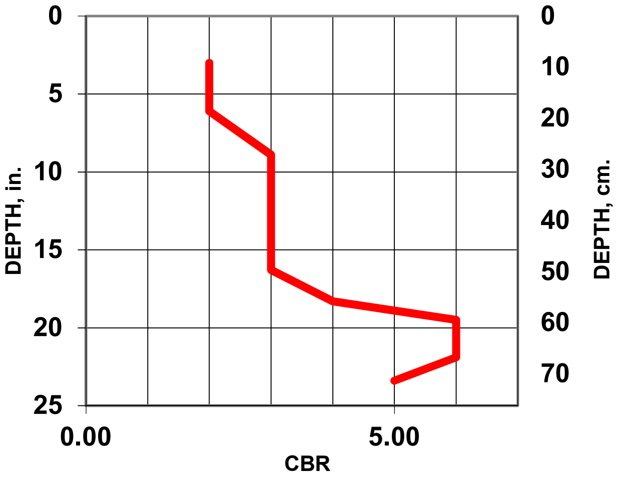
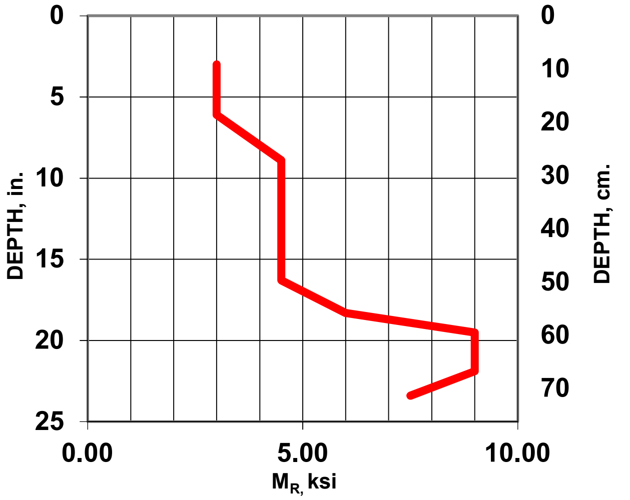
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-

NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





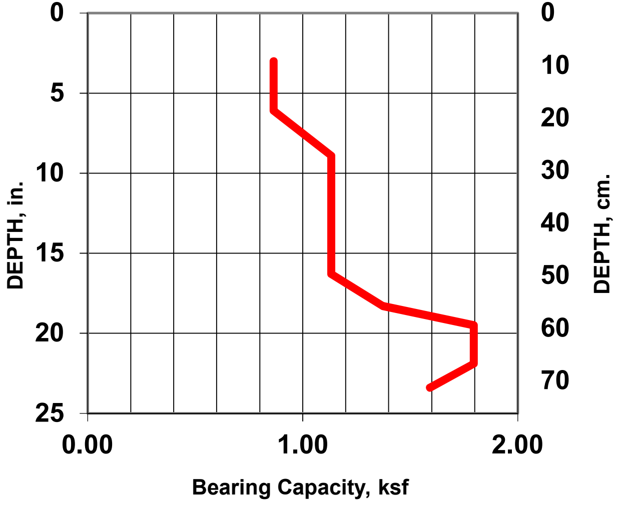


FIGURE 33p

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

WC-2

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	55	2.2	3	4.5	1.13
1	1	60	4.5	3	4.5	1.13
1	1	80	7.7	2	3	0.87
1	1	55	9.8	3	4.5	1.13
1	1	45	11.6	4	6	1.37
1	1	35	13	5	7.5	1.59
1	1	35	14.4	5	7.5	1.59
1	1	30	15.6	6	9	1.80
1	1	20	16.3	10	15	2.52
1	1	20	17.1	10	15	2.52
1	2	30	18.3	14	21	3.15
1	2	40	19.9	10	15	2.52
1	1	40	21.5	5	7.5	1.59
1	1	15	22	14	21	3.15
1	1	20	22.8	10	15	2.52
1	1	20	23.6	10	15	2.52
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
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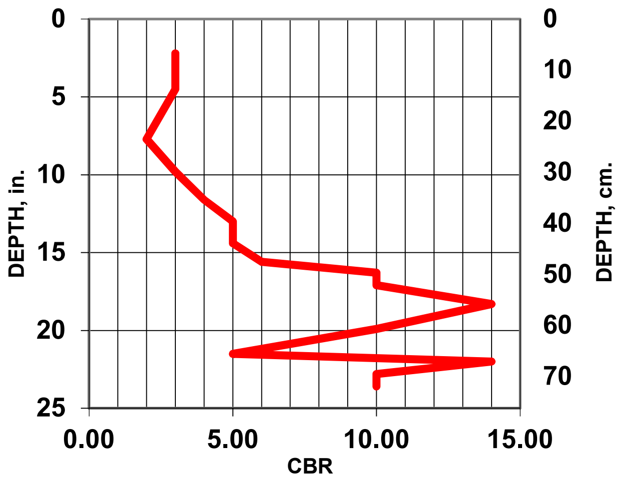
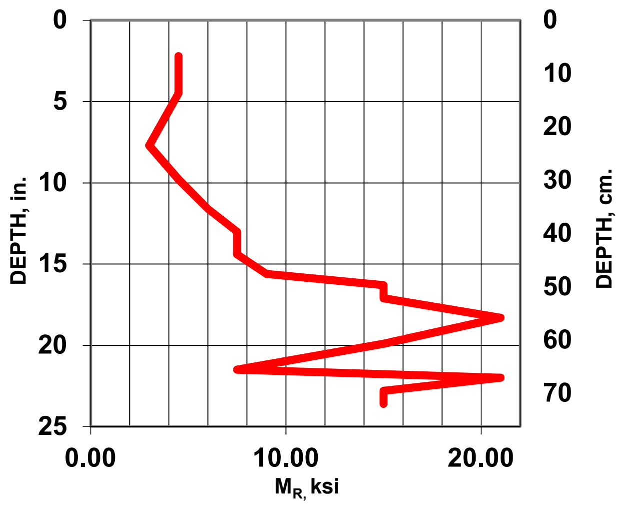
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





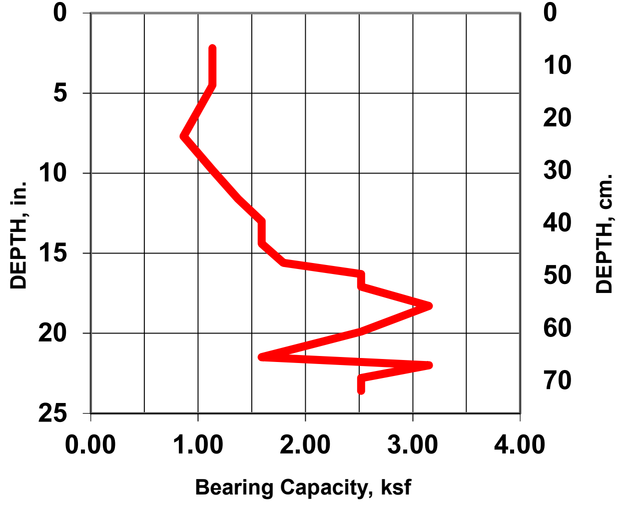


FIGURE 33q

Project Number: ANA22-047-00
Test Date: December 18, 2022

DCP TEST DATA

WC-3

Cordova Rd
New Braunfels, Texas

Type of Ham.	No. of Blows	Penetration		CBR (%)	M_R (ksi)	q_{ult} (ksf)
		Incre. (mm)	Cumm. (in)			
1	1	195	7.7	1	1.5	0.55
1	1	135	13	1	1.5	0.55
1	1	80	16.1	2	3	0.87
1	1	55	18.3	3	4.5	1.13
1	1	55	20.5	3	4.5	1.13
1	1	85	23.8	2	3	0.87
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
-	-	-	-	-	-	-
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-	-	-	-	-	-	-
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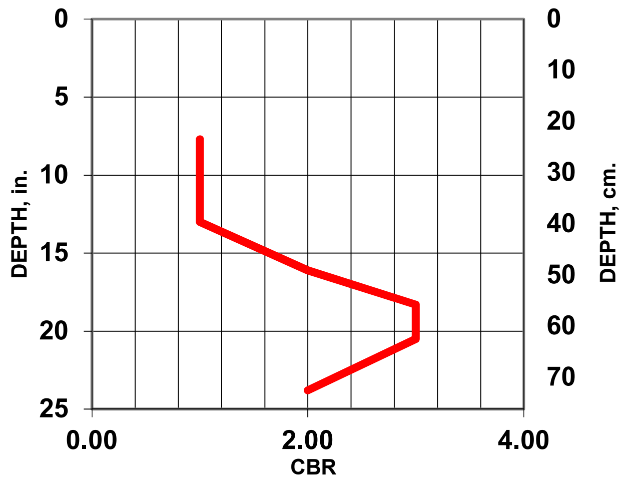
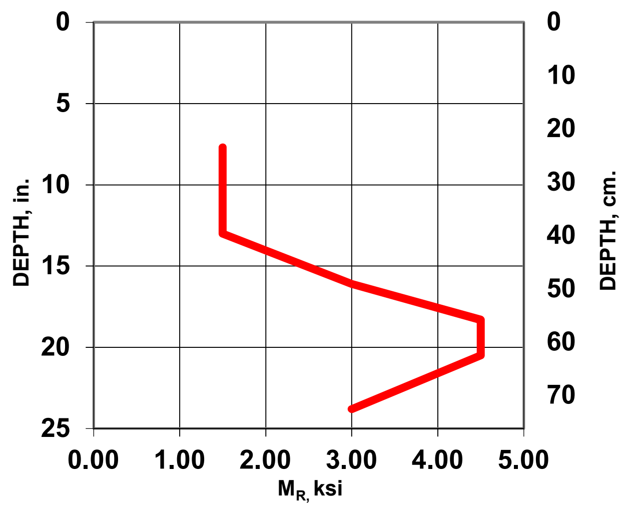
NOTES: Hammer 17.6 lbs = 1 Hammer 10.1 lbs = 2





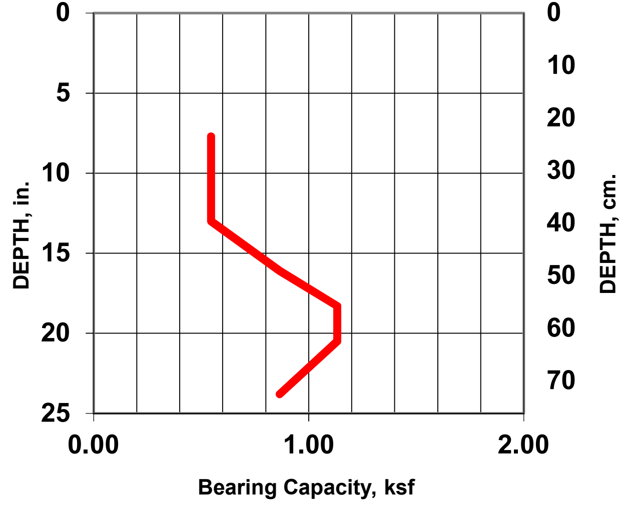
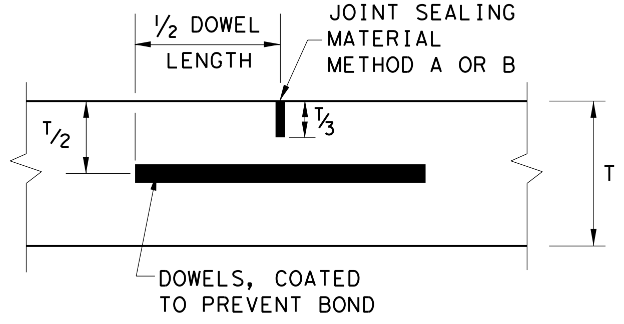
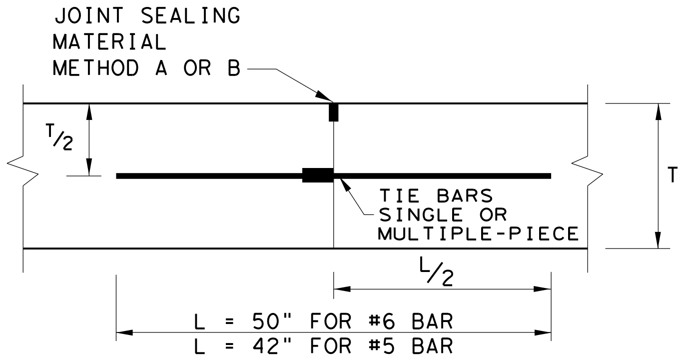


FIGURE 33r



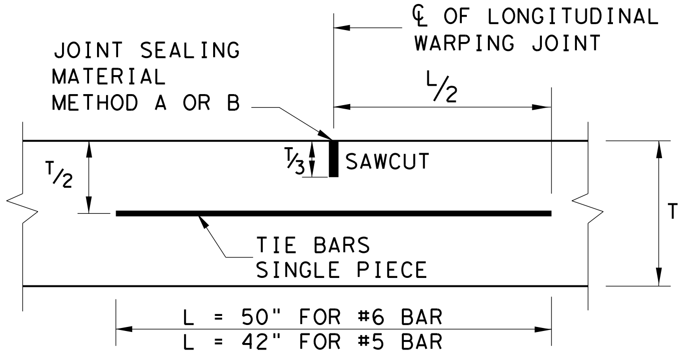
TRANSVERSE CONTRACTION JOINT

SECTION X-X



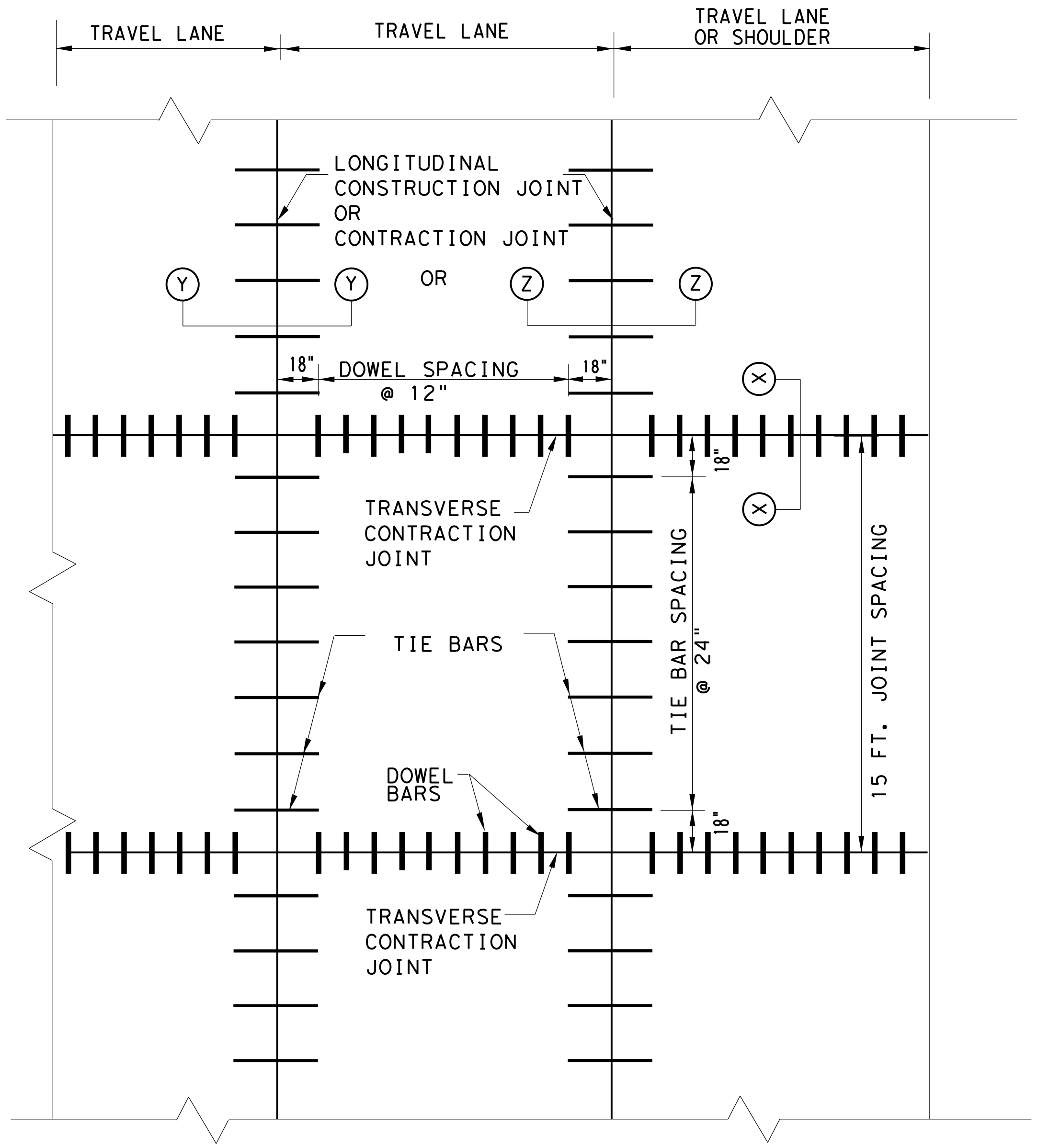
LONGITUDINAL CONSTRUCTION JOINT

SECTION Y-Y



LONGITUDINAL CONTRACTION JOINT

SECTION Z-Z



TYPICAL PAVEMENT LAYOUT

PLAN VIEW (NOT TO SCALE)

GENERAL NOTES

1. DETAILS FOR PAVEMENT WIDTH, PAVEMENT THICKNESS AND THE CROWN CROSS-SLOPE SHALL BE SHOWN ELSEWHERE IN THE PLANS. PAVEMENTS WIDER THAN 100 FT. WITHOUT A FREE LONGITUDINAL JOINT ARE NOT COVERED BY THIS STANDARD.
2. FOR FURTHER INFORMATION REGARDING THE PLACEMENT OF CONCRETE AND LOAD TRANSFER DEVICES REFER TO THE GOVERNING SPECIFICATION FOR "CONCRETE PAVEMENT".
3. THE SPACING BETWEEN TRANSVERSE CONTRACTION JOINTS SHALL BE 15 FT. UNLESS OTHERWISE SHOWN IN THE PLANS.
4. TRANSVERSE CONSTRUCTION JOINTS MAY BE FORMED BY USE OF METAL OR WOOD FORMS EQUAL IN DEPTH TO THE DEPTH OF PAVEMENT, OR BY METHODS APPROVED BY THE ENGINEER.
5. USE HAND-OPERATED IMMERSION VIBRATORS TO CONSOLIDATE THE CONCRETE ADJACENT TO ALL THE FORMED JOINTS.
6. PAVEMENT WIDTHS OF MORE THAN 15 FT. SHALL HAVE A LONGITUDINAL JOINT (SECTION Z-Z OR SECTION Y-Y). THESE JOINTS SHALL BE LOCATED WITHIN 6 IN. OF THE LANE LINE UNLESS THE JOINT LOCATION IS SHOWN ELSEWHERE ON THE PLANS.
7. THE JOINT BETWEEN OUTSIDE LANE AND SHOULDER SHALL BE A LONGITUDINAL CONTRACTION JOINT (SECTION Z-Z) UNLESS OTHERWISE SHOWN IN THE PLANS. THE SAW CUT DEPTH FOR THE LONGITUDIANL CONTRACTION JOINT (SECTION Z-Z) SHALL BE ONE THIRD OF THE SLABTHICKNESS (T/3).
8. WHEN TYING CONCRETE GUTTER AT A LONGITUDINAL JOINT, THE TIE BAR LENGTH OR POSITION MAY BE ADJUSTED. PROVIDE 3 IN. OF CONCRETE COVER FROM THE BACK OF GUTTER TO THE END OF TIE BAR.
9. REPLACE MISSING OR DAMAGED TIE BARS WITHOUT ADDITIONAL COMPENSATION BY DRILLING MIN. 10 IN. DEEP AND GROUTING TIE BARS WITH TYPE III, CLASS C EPOXY. MEET THE PULL-OUT TEST REQUIREMENTS IN ITEM 361.
10. WHEN AN MONOLITHIIC CURB IS SPECIFIED, THE JOINT IN THE CURB SHALL COINCIDE WITH PAVEMENT JOINTS AND MAY BE FORMED BY ANY MEANS APPROVED BY THE ENGINEER.
11. DOWEL BAR PLACEMENT TOLERANCE SHALL BE +/- 1/4 IN. HORIZONTALLY AND VERTICALLY UNLESS OTHERWISE SPECIFIED.WHERE DOWEL BAR BASKETS ARE USED, REMOVE THE SHIPPING WIRES.
12. THE DETAIL FOR JOINT SEALANT AND RESERVOIR IS SHOWN ON STANDARD SHEET "CONCRETE PAVING DETAILS, JOINT SEALS."

TABLE NO.1 DOWELS (SMOOTH BARS)

SLAB THICKNESS T (IN.)	BAR DIA. AND LENGTH	AVERAGE SPACING (IN.)
6 to 7.5	1" X 18"	12
8 to 10	1 1/4" X 18"	12
>= 10.5	1 1/2" X 18"	12

TABLE NO.2 TIE BARS (DEFORMED BARS)

SLAB THICKNESS T (IN.)	BAR SIZE	AVERAGE SPACING (IN.)
6 to 7.5	#5	24
>= 8	#6	24

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CONCRETE PAVEMENT DETAILS

CONTRACTION DESIGN

T-6 to 12 INCHES

CPCD-14

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DIST | COUNTY | SHEET NO.

Figure 34a

DATE:
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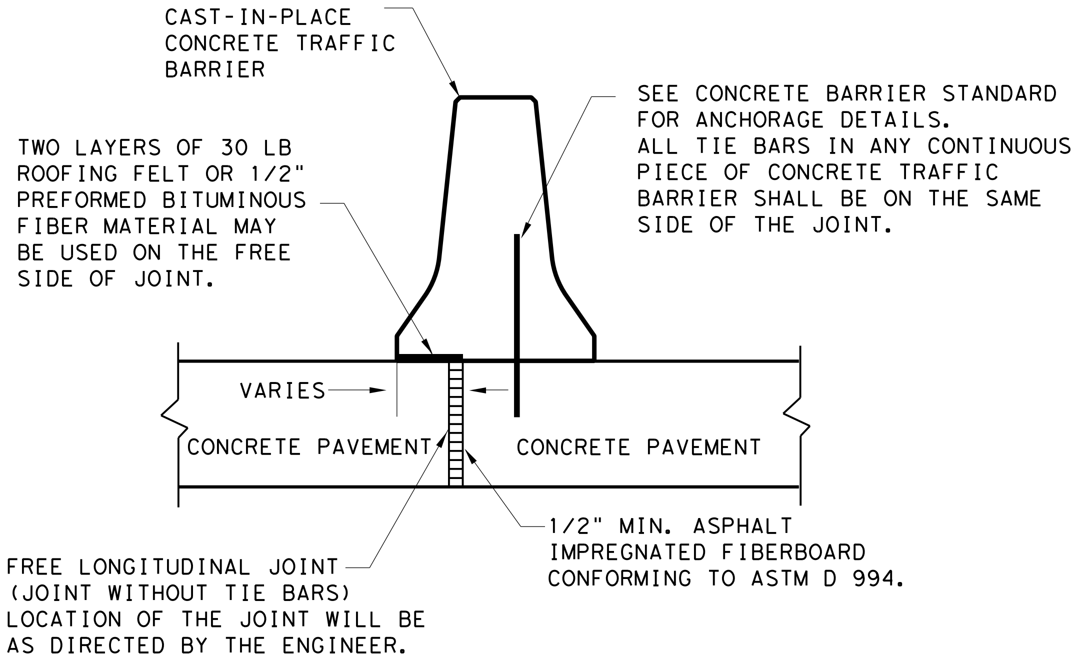
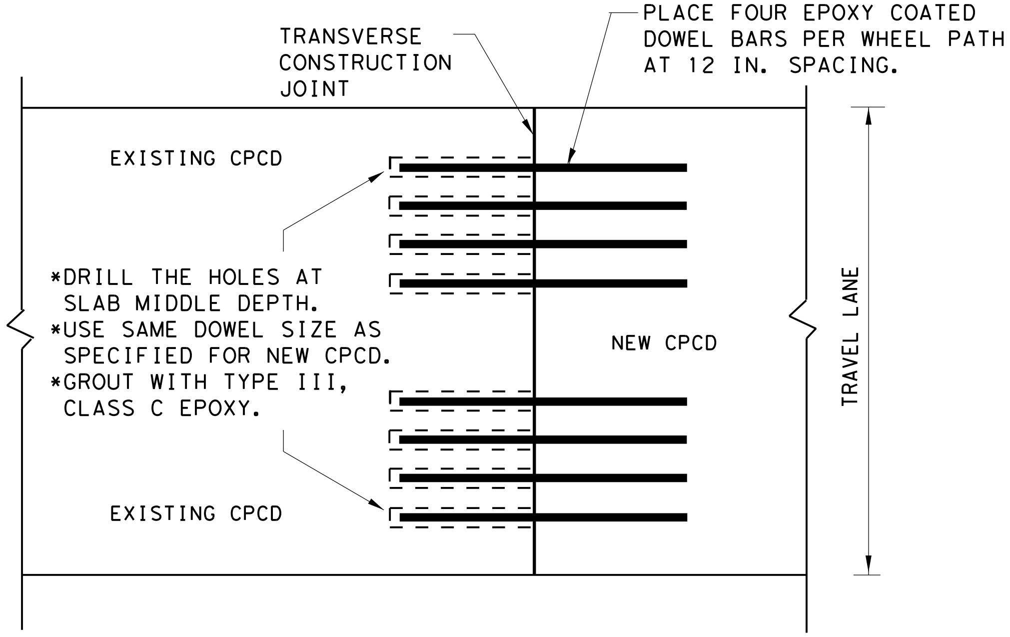


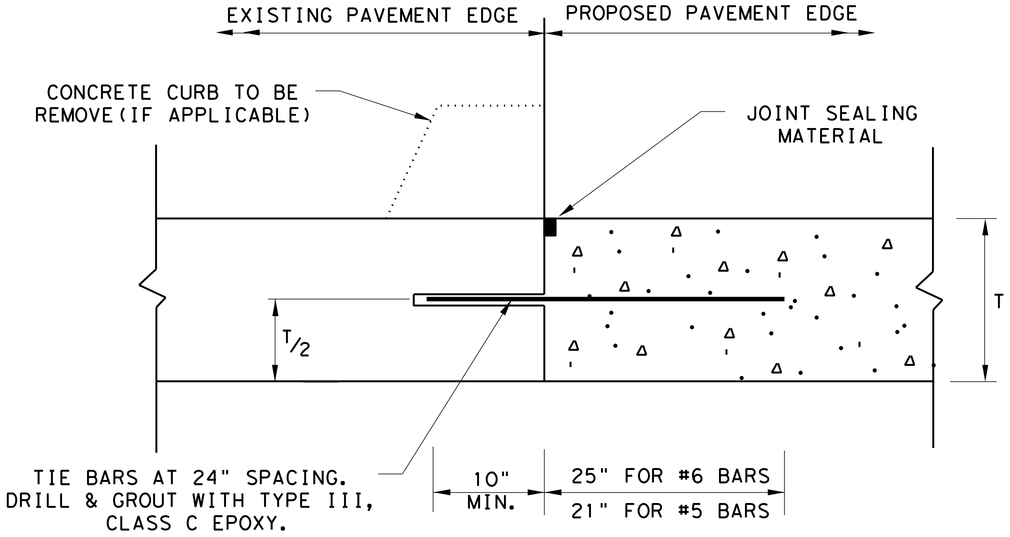
FREE LONGITUDINAL JOINT DETAIL



TRANSVERSE JOINT DETAIL

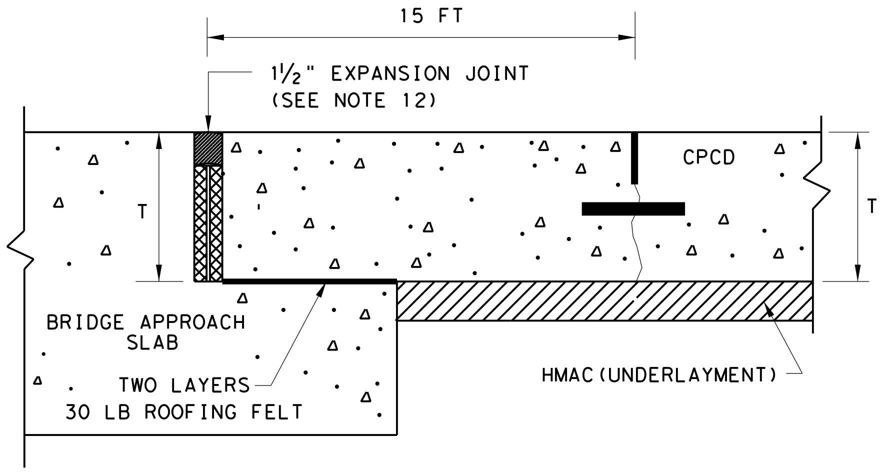
EXISTING CPCD TO NEW CPCD

PLAN VIEW (NOT TO SCALE)



1. BEFORE WIDENING WORK, DEMONSTRATE THAT THE BOND STRENGTH OF THE EPOXY-GROUTED TIE BARS MEETS THE REQUIREMENTS OF PULL-OUT TEST SPECIFIED IN ITEM 361.
2. SPACE TIE BARS AT 24" SPACING. USE #6 BARS FOR 8" AND THICKER SLABS, USE #5 BARS FOR LESS THAN 8" THICK SLABS.
3. THE TRANSVERSE JOINTS OF PROPOSED PAVEMENT SHALL COINCIDE WITH EXISTING PAVEMENT JOINTS UNLESS OTHERWISE SHOWN ON THE PLANS.

LONGITUDINAL WIDENING JOINT DETAIL



TRANSVERSE EXPANSION JOINT DETAIL

AT BRIDGE APPROACH

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CONCRETE PAVEMENT DETAILS
CONTRACTION DESIGN
T-6 to 12 INCHES

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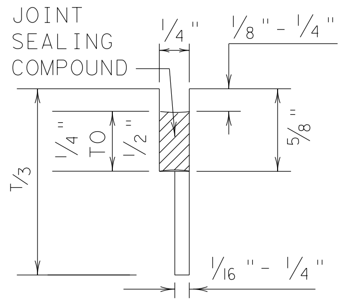
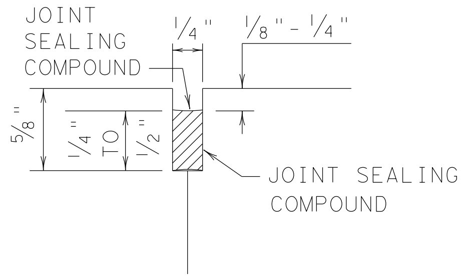
Figure 34b

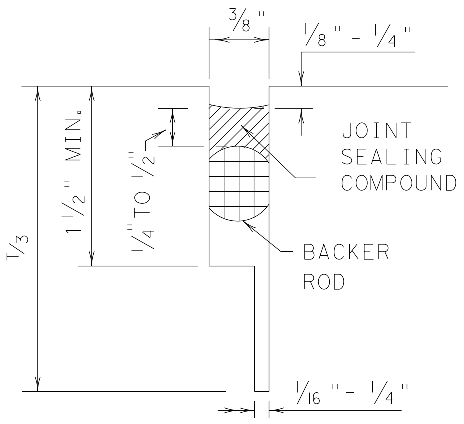
METHOD B: JOINT SEALING COMPOUND



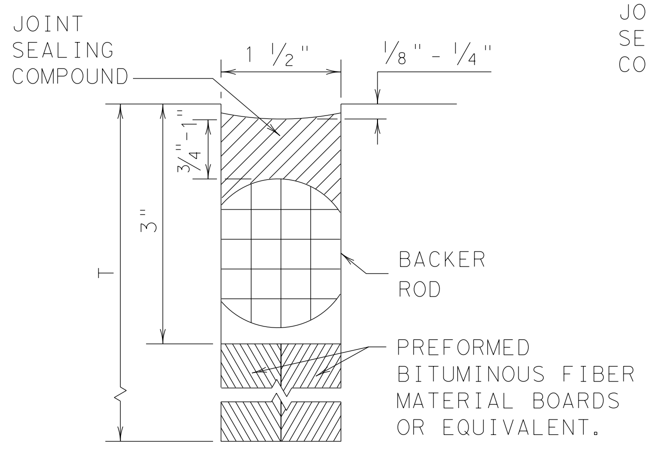
LONGITUDINAL SAWED CONTRACTION JOINT



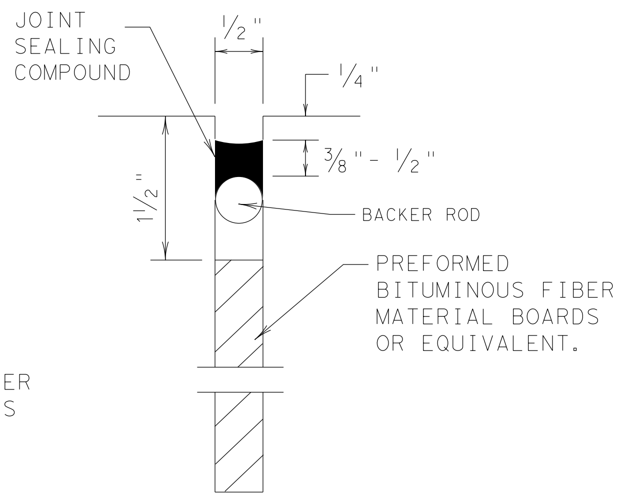
LONGITUDINAL OR TRANSVERSE CONSTRUCTION JOINT



TRANSVERSE SAWED CONTRACTION JOINT

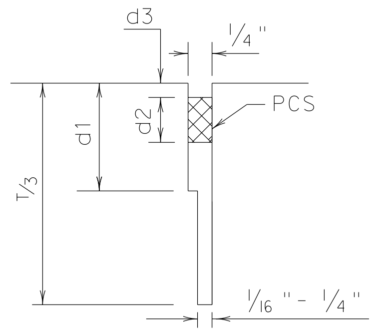


TRANSVERSE FORMED EXPANSION JOINT

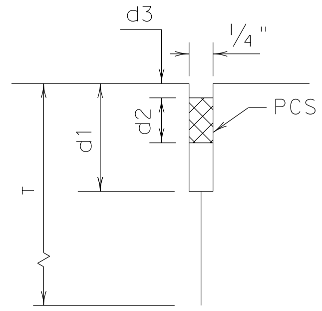


FORMED ISOLATION JOINT

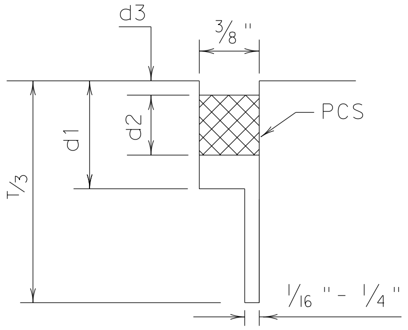
METHOD A: PREFORMED COMPRESSION SEALS (PCS)(DMS-6310 CLASS 6)



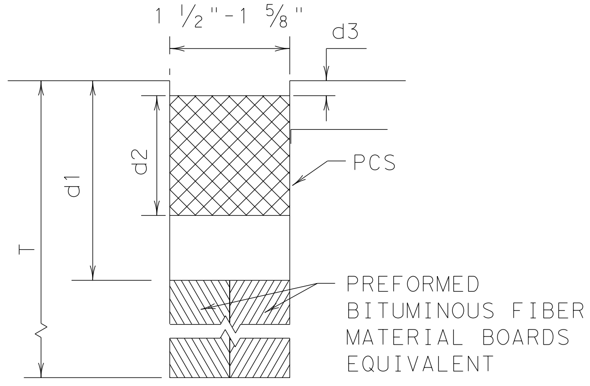
LONGITUDINAL SAWED CONTRACTION JOINT



LONGITUDINAL CONSTRUCTION JOINT



TRANSVERSE SAWED CONTRACTION JOINT



TRANSVERSE FORMED EXPANSION JOINT

GENERAL NOTES

1. UNLESS OTHERWISE SHOWN IN THE PLANS, EITHER METHOD "A" OR METHOD "B" MAY BE USED.
2. THE LOCATION OF JOINTS SHALL BE AS SHOWN ELSEWHERE IN THE PLANS.
3. THE JOINT RESERVOIR FOR SEALANT OR PCS SHALL BE SAWED UNLESS OTHERWISE SHOWN ON THE PLANS FOR THE LONGITUDINAL AND TRANSVERSE CONSTRUCTION JOINTS AND THE SAWED JOINTS.
4. DIMENSIONS d1, d2, AND d3 SHOWN IN METHOD A SHALL BE IN ACCORDANCE WITH THE PREFORMED COMPRESSION SEAL MANUFACTURER'S RECOMMENDATION.
5. REFER TO DMS-6310 "JOINT SEALANTS AND FILLERS" FOR THE CLASSIFICATIONS.
6. FOR SAWED LONGITUDINAL JOINT, LONGITUDINAL OR TRANSVERSE CONSTRUCTION JOINT, USE JOINT SEALANT CLASS 5 OR 8 UNLESS OTHERWISE SHOWN ON THE PLAN OR APPROVED.
7. FOR TRANSVERSE SAWED CONTRACTION, TRANSVERSE FORMED EXPANSION JOINT, AND ISOLATION JOINT USE JOINT SEALANT CLASS 5 OR 8 AT NEW JOINTS. USE JOINT SEALANT CLASS 4,5,7,OR 8 FOR MAINTAINING EXISTING JOINTS.
8. THE JOINTS SHALL BE CLEANED IN ACCORDANCE WITH THE ITEM 438 "CLEANING AND SEALING JOINTS" OR ITEM 713 "CLEANING AND SEALING JOINTS AND CRACKS (CONCRETE PAVEMENT)".
9. ISOLATION JOINTS ACCOMMODATE HORIZONTAL AND VERTICAL MOVEMENTS THAT OCCUR BETWEEN A PAVEMENT AND A STRUCTURE. ISOLATION JOINTS MAY BE USED FOR BRIDGE ABUTMENTS, INTERSECTIONS, CURB AND GUTTER, OLD AND NEW PAVEMENTS, OR AROUND DRAINAGE INLETS, MANHOLES, FOOTINGS AND LIGHTING STRUCTURES.

Figure 34c

Texas Department of Transportation

Design Division Standard

CONCRETE PAVING DETAILS

JOINT SEALS

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