GEOTECHNICAL ENGINEERING STUDY

CLEARWATER CREEK SUBDIVISION
BEXAR COUNTY, TEXAS
LOCAL "B" & COLLECTOR
PAVEMENT DESIGN

FROST GEOSCIENCES, INC. PROJECT NO.: FGS-G 20020-S2

REVISED

FEBRUARY 7, 2022

Prepared Exclusively for:

Mr. Allen Hoover
Mosiac Land Development
6812 West Avenue, Suite 100
San Antonio, Texas 78213

Frost GeoSciences
Construction Materials ▪ Forensics
Environmental ▪ Geotechnical

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Environmental ▪ Geotechnical

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TBPE Firm Registration # F-9227
TBPG Firm Registration # 50040

February 7, 2022

Mr. Allen Hoover
Mosiac Land Development
6812 West Avenue, Suite # 100
San Antonio, Texas 78213

SUBJECT:
Clearwater Creek Subdivision
San Antonio, Texas
FGS Project No: FGS-G20020-S2

Dear Mr. Hoover;

Attached are the revised flexible pavement designs for a Local "B" and Collector type street having a CBR value of 2.0 for the Clearwater Creek Subdivision. These designs meet ALL of the Bexar County Paving Design Criteria.

We appreciate the opportunity to be of service to you in this phase of your project and future projects. If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
Frost GeoSciences, Inc.

STATE OF TEXAS
F. J. CABALLERO
66952
LICENSED
PROFESSIONAL ENGINEER

F. J. Caballero, P.E.
Project Engineer

JOT – FGS-G20020-S2

Copies Submitted:
i. One (1) Electronic: Mr. Allen Hoover, Mosiac Land Development, San Antonio, Texas
ii. One (1) Electronic: Mr. Michael Richards, P. E., KFW Engineers

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for **LOCAL "B" Streets** on a Clay subgrade with a CBR value of 2.0.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)			
	Local "B" Streets			
	Option # 1	Option # 2	Option # 3	Option # 4
Type D HMAC Surface	3.0 inches	3.0 inches	4.5 inches	3.0 inches
Type B HMAC Base	6.0 inches	6.0 inches	NO	NO
Flexible Base, (Type B, Grade 2), Pit Run	8.0 inches	8.0 inches	18 inches	16.75 inches
Lime Treated Subgrade (6 inch Min.)	YES	YES	YES	YES
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES
Design ESAL Value	2,000,000	2,000,000	2,000,000	2,000,000
Actual ESAL Value	2,840,600	8,344,400	2,055,500	2,012,100

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for **Collector Streets** on a Clay subgrade with a CBR value of 2.0.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)			
	COLLECTOR STREETS			
	Option # 1	Option # 2	Option # 3	Option # 4
Type D HMAC Surface	3.0 inches	3.0 inches	5.5 inches	3.5 inches
Type B HMAC Base	6.0 inches	6.0 inches	NO	NO
Flexible Base, (Type B, Grade 2), Pit Run	9.00 inches	8.0 inches	18 inches	18 inches
Lime Treated Subgrade (6 inch Min.)	YES	YES	YES	YES
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES
Design ESAL Value	2,000,000	2,000,000	2,000,000	2,000,000
Actual ESAL Value	2,018,200	4,678,000	2,247,400	2,095,800

Pavement Optimization

Design Analysis

Parameters

Project Information

Subgrade resilient modulus	Target ESALs	Reliability	Standard deviation	Serviceability	
				Initial	Terminal
3,000 psi	2,000,000	90%	0.45	4.2	2

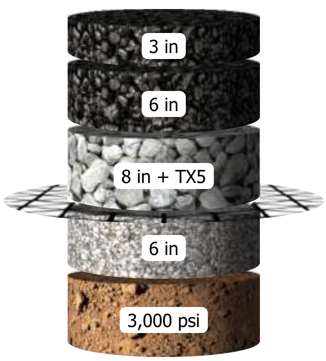
Results

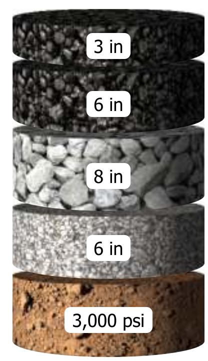
TriAx Stabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	3 in	0.440	1.320
HMA layer 2	6 in	0.380	2.280
Mechanically stabilized layer	8 in	0.238	1.904
Subbase	6 in	0.080	0.480
Structural number (SN)			5.984
Calculated traffic (ESALs)			8,344,400

Unstabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	3 in	0.440	1.320
HMA layer 2	6 in	0.380	2.280
Aggregate base	8 in	0.140	1.120
Subbase	6 in	0.080	0.480
Structural number (SN)			5.200
Calculated traffic (ESALs)			2,840,600





Limitations of this Report
The designs, illustration, and other content included in this report are necessarily general and conceptual in nature and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Design	02-04-2022, Revised, local "B", BLACK BASE	Project	CLEARWATER CREEK
Company	FROST GEOSCIENCES, Inc.	Location	Bexar County, TX, USA
Designer	FLORENTINO CABALLERO, P. E.	Date	2/4/2022

This report was prepared using Tensar+ 2.2.4

Tensar

Pavement Optimization

Design Analysis

Parameters

Project Information

Subgrade resilient modulus	Target ESALs	Reliability	Standard deviation	Serviceability	
				Initial	Terminal
3,000 psi	2,000,000	90%	0.45	4.2	2.5

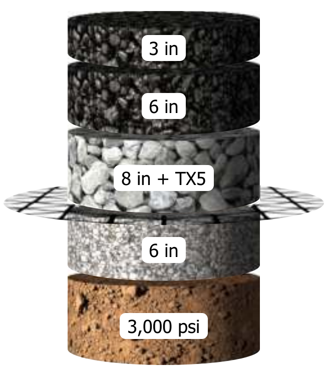
Results

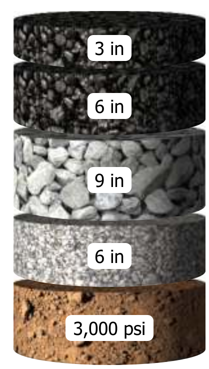
TriAx Stabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	3 in	0.440	1.320
HMA layer 2	6 in	0.380	2.280
Mechanically stabilized layer	8 in	0.238	1.904
Subbase	6 in	0.080	0.480
Structural number (SN)			5.984
Calculated traffic (ESALs)			4,678,000

Unstabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	3 in	0.440	1.320
HMA layer 2	6 in	0.380	2.280
Aggregate base	9 in	0.140	1.260
Subbase	6 in	0.080	0.480
Structural number (SN)			5.340
Calculated traffic (ESALs)			2,018,200





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Design	01-04-2022, Revised, Collector, BLACK BASE	Project	CLEARWATER CREEK
Company	FROST GEOSCIENCES, Inc.	Location	Bexar County, TX, USA
Designer	FLORENTINO CABALLERO, P. E.	Date	2/4/2022

Pavement Optimization

Design Analysis

Parameters

Project Information

Subgrade resilient modulus	Target ESALs	Reliability	Standard deviation	Serviceability	
				Initial	Terminal
3,000 psi	2,000,000	90%	0.45	4.2	2

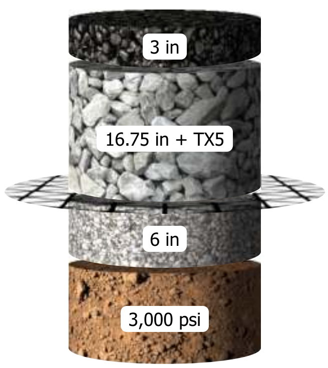
Results

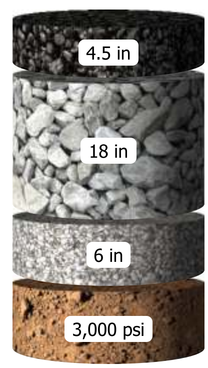
TriAx Stabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	3 in	0.440	1.320
Mechanically stabilized layer	16.75 in	0.189	3.166
Subbase	6 in	0.080	0.480
Structural number (SN)			4.966
Calculated traffic (ESALs)			2,012,100

Unstabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	4.5 in	0.440	1.980
Aggregate base	18 in	0.140	2.520
Subbase	6 in	0.080	0.480
Structural number (SN)			4.980
Calculated traffic (ESALs)			2,055,500





Limitations of this Report
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Design	O2-07-2022, Revised, local "B", ALL ASPHALT	Project	CLEARWATER CREEK
Company	FROST GEOSCIENCES, Inc.	Location	Bexar County, TX, USA
Designer	FLORENTINO CABALLERO, P. E.	Date	2/7/2022

Tensar

Pavement Optimization

Design Analysis

Parameters

Project Information

Subgrade resilient modulus	Target ESALs	Reliability	Standard deviation	Serviceability	
				Initial	Terminal
3,000 psi	2,000,000	90%	0.45	4.2	2.5

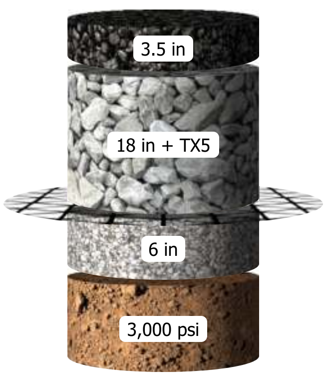
Results

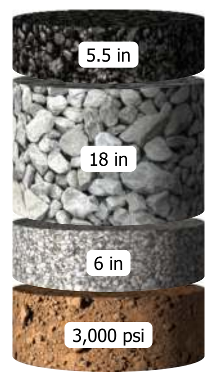
TriAx Stabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	3.5 in	0.440	1.540
Mechanically stabilized layer	18 in	0.186	3.348
Subbase	6 in	0.080	0.480
Structural number (SN)			5.368
Calculated traffic (ESALs)			2,095,800

Unstabilized Pavement Section

	Thickness	Coeff.	SN
HMA layer 1	5.5 in	0.440	2.420
Aggregate base	18 in	0.140	2.520
Subbase	6 in	0.080	0.480
Structural number (SN)			5.420
Calculated traffic (ESALs)			2,247,400





Limitations of this Report
The designs, illustration, and other content included in this report are necessarily general and conceptual in nature and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Design	O1-07-2022, Revised, Collector, ALL ASPHALT	Project	CLEARWATER CREEK
Company	FROST GEOSCIENCES, Inc.	Location	Bexar County, TX, USA
Designer	FLORENTINO CABALLERO, P. E.	Date	2/7/2022

This report was prepared using Tensar+ 2.2.4

GEOTECHNICAL ENGINEERING STUDY

CLEARWATER CREEK SUBDIVISION
MARION, TEXAS
PAVEMENT DESIGN

FROST GEOSCIENCES, INC. PROJECT NO.: FGS-G 20020

OCTOBER 2, 2020

Prepared Exclusively for:

Mr. Allen Hoover
Mosiac Land Development
6812 West Avenue, Suite 100
San Antonio, Texas 78213

Frost GeoSciences

Construction Materials ▪ Forensics
Environmental ▪ Geotechnical

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TBPG Firm Registration # 50040

October 2, 2020

Mr. Allen Hoover
Mosiac Land Development
6812 West Avenue, Suite # 100
San Antonio, Texas 78213

SUBJECT:
Geotechnical Engineering Services
Clearwater Subdivision
San Antonio, Texas
FGS Project No: FGS-G20020

Dear Mr. Hoover;

Frost GeoSciences, Inc. (FGS) is a geotechnical engineering company registered with the Texas Board of Professional Engineers, with registration No. F-9227, and is pleased to submit the results of our Geotechnical Engineering Study for the above referenced project. This report includes the results of field and laboratory testing along with our recommendations for use in preparation of the appropriate design and construction documents for this project.

We appreciates the opportunity to be of service to you in this phase of your project and future projects . If you have any questions pertaining to this report, or if we may be of further service, please contact our office.

Respectfully submitted,
Frost GeoSciences, Inc.

STATE OF TEXAS
F. J. CABALLERO
66952
LICENSED
PROFESSIONAL ENGINEER

F. J. Caballero, P.E.
Project Engineer

JOT – FGS-G20020

Copies Submitted:
i. One (1) Electronic: Mr. Allen Hoover, Mosiac Land Development, San Antonio, Texas
ii. One (1) File

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PROJECT INFORMATION

Project Authorization:

Frost GeoSciences, Inc. (FGS) has completed a geotechnical engineering study for new pavements to be constructed in the **Clearwater Creek Subdivision, in** Bexar County Texas. This project was authorized by Mr. Allen Hoover of Mosiac Land Development, through acceptance of Frost GeoSciences **Proposal No.: FGS-P-G20043 dated July 8, 2020.** Our scope of services for this project is as outlined in that proposal.

Project Description:

We understand that the **CLEARWATER SUBDIVISIION development** involves the design and construction of both Type "A" and Type "B" residential streets and ARTERIAL streets. The pavement section design will be in accordance with the Bexar County Flexible Pavement Design Criteria. A Vicinity Map showing the location of the project is included in the section of this report entitled Illustrations.

Purpose and Scope of Services:

The purpose of the geotechnical investigation is to evaluate the subsurface conditions at the project site and develop geotechnical engineering recommendations and guidelines for use in preparing the appropriate design and other related construction documents for this project. Therefore, our scope of services for this project include the following:

- Drill borings and excavate test pits at selected locations within the project limits to evaluate subsurface conditions and to observe the potential presence of subsurface water;
- Perform geotechnical engineering laboratory tests on selected samples recovered during our field activities to evaluate their physical and engineering properties;
- Perform Engineering analyses to develop the appropriate geotechnical engineering recommendations and guidelines, to include:
  - Appropriate pavement section thickness recommendations;
  - Pavement section material requirements and specifications;
  - General site and subgrade preparation within the construction limits; and

- General comments regarding construction methods, sequences and potential difficulties that may arise during overall construction as it relates to the geotechnical engineering aspects of this project.

- Prepare a written report that includes a boring location plan, boring log at each bore site, and results of the laboratory testing program, descriptions of the subsurface conditions encountered and our geotechnical engineering recommendations and guidelines developed for this project.

Our scope of services for this project did not include the assessment of any potential environmental concerns at this site. Therefore, such concerns are not addressed in this report.

SITE AND SUBSURFACE CONDITIONS

Site Description:

The site conditions were assessed using a combination of aerial photography and observations made by the FGS personnel during our field operations. The following site conditions were noted:

- The site is the **Clearwater Creek Subdivision**, located on the southwest side of I-10, off of Trainer Hale Road in Marion, Texas.

Site Geology:

According to the Bureau of Economic Geology, and The University of Texas at Austin Geologic Atlas of Texas – San Antonio Sheet (1982), the Site is located on the following Geological Groups:

- **The Leona Formation (Qle) -** is fine calcareous silt that begins grading down into coarse gravel.

Soil Description:

According to the United States Department of Agricultural (USDA) Natural Resources Conservation Service (NRCS) Soil Survey of Bexar County (1966), the Site is located on the following soils:

- **Lewisville silty clay, 0 to 1 percent slopes (LvA) –** The Lewisville Silty Clay, 0-1% slopes (LvA) consists of moderately deep, dark colored, nearly level alluvial soils. These soils occur mainly on terraces bordering the San Antonio and Medina Rivers and their main tributaries. The surface layer is very dark grayish brown to brown silty clay and is about 24 inches thick. It has fine sub-angular blocky or blocky structure, and is firm and crumbly when moist. This layer contains a few fine concretions of lime carbonate. The subsurface layer is brown silty clay and is about 20 inches thick. It has fine, sub-angular blocky or blocky structure and is very firm but crumbly when moist. This layer is limy. The underlying material is reddish yellow silty clay. It has weak, blocky structure, is very firm when moist, and contains large amounts of lime. Beneath this layer there may be deep beds of water rounded limestone gravel. Lewisville soils have slow or medium surface drainage and medium internal drainage. Permeability is slow to moderate. The capacity to hold water is good. Natural fertility is high. The hazard of water erosion is serious on the more sloping parts but is very slight on the nearly level areas.

- **The Houston Black Clay, terrace, 1-3% slopes (HtB) -** This soil occurs as long, narrow slopes, generally adjacent to the larger drainage-ways. It is mainly in the southcentral and southwestern parts of the county. The surface layer is dark gray, about 34" thick. The subsurface layer is gray, approximately 20" thick, and has a blocky, crumbly structure. This layer may have a few lime concretions. Water erosion is a hazard, water intake is slow, and a plow-pan is likely to form.

Subsurface Conditions:

Subsurface conditions at the site were evaluated by drilling a total of THIRTEEN (13) soil borings to a depth of FIFTEEN (15) feet and THREE (3) test pits to approximately two (2) feet depth were excavated to obtain soil samples to determine the California Bearing Ratio (CBR) of the soil samples. The number of borings and test pits, their locations and their depths were selected by FGS. The borings and test pits were located in the field by FGS personnel using Global Positioning System (GPS) technology. The borings were advanced using solid flight auger drilling methods and soil samples were routinely obtained during the drilling process; the test pits are routinely excavated to the appropriate depth. Drilling and sampling techniques were accomplished in general accordance with ASTM procedures. Logs of the borings are presented in the Appendix section at the end of the report. A Borehole Location Plan with the location of each boring is presented in the Illustrations section of this report.

The soil samples obtained during our field exploration were transported to our laboratory where they were reviewed by qualified geotechnical engineering personnel. Representative samples were selected and tested to determine pertinent engineering properties and characteristics for use in evaluating the project site. Laboratory testing and soil classification were accomplished in general accordance with ASTM procedures.

Based on the field and laboratory data, it is determined that the stratigraphy of the site is generally as follows:

Stratum	Range of Depth, (feet)	Stratum Description and Classification
I	0.0 to 3.0	Fat Clay (CH), Dark Brown
II	3.0 to 15.0	Chalky Clay (CL), Light Tan

The subsurface descriptions shown above are general in nature and highlight major subsurface stratification features and material types. The boring logs included in Appendix A should be reviewed for specific information such as soil or rock material descriptions, stratifications, sampling depths and intervals, field test data and laboratory test data. The stratifications shown on each boring log only represent the conditions and approximate boundaries between strata at that actual boring location. The actual transitions between strata may be gradual. Variations will occur and should be expected at locations away from each boring location. Subsurface water level observations made during field operations are also shown on the boring logs. The indicated stratum depths and any subsurface water levels are measured from the ground surface and are estimated to the nearest one-half (½) foot. Portions of any samples that are not altered or consumed by laboratory testing will be retained for 30 days from the date of issuance of this report. Unless otherwise requested by the client and/or depending upon project requirements, all soil samples will be discarded after that retention period.

The P.I. values obtained from the soil samples taken **near the surface ranged from 37 to 46 in** the CLAY subgrade soil. Due to the characteristics of the materials found in the area, FGS is of the opinion that the sulfate contents of the materials will pose a problem if not treated with lime. In the case where the P.I. value of the material near the surface is greater than 20 the PI could be reduced if lime is applied to the subgrade material or the native Clay material is replaced with a more suitable material.

Subsurface Water Information:

The borings were advanced using dry drilling techniques to their full depths in an attempt to detect the potential presence of subsurface water in the material. Subsurface water was not encountered either during or upon completion of drilling or sampling operations. The boreholes were backfilled with soil cuttings upon completion of drilling and sampling operations. Short-term field observations generally do not provide accurate subsurface water levels for evaluation at most sites. Subsurface water levels are generally influenced by seasonal and climatic conditions that result in fluctuations of subsurface water levels over time. The earthwork contractor should check for subsurface water during excavation activities especially when sand and/or gravel are encountered. No specific notations concerning subsurface water are indicated on the boring logs in Appendix A since no subsurface water was observed.

ENGINEERING ANALYSIS AND RECOMMENDATIONS

Pavement Design:

Flexible pavements should be designed and constructed in accordance with the requirements established by local municipalities and the American Association of State Highway and Transportation Officials (AASHTO) "Guide for Design of Pavement Structures", for this project, the Bexar County Flexible Pavement Design Criteria was used.

Below is a table which outlines the Bexar County Flexible Pavement Design Criteria, which was used in the design of the proposed street sections for this project:

Input Parameters used in Asphalt Pavement Section Calculation

San Antonio Pavement Specifications								
	Primary and Secondary Arterials		Local Type "B" & Collector Streets		Local Type "A" Streets with **Bus Traffic**		Local Type "A" Streets with **NO Bus Traffic**	
W18	ESAL = 3,000,000		ESAL = 2,000,000		ESAL = 1,000,000		ESAL = 100,000	
R	95%		90%		70%		70%	
So	Flexible	Rigid	Flexible	Rigid	Flexible	Rigid	Flexible	Rigid
	0.45	0.35	0.45	0.35	0.45	0.35	0.45	0.35
Po	4.2	4.5	4.2	4.5	4.2	4.5	4.2	4.5
Pt	2.5	2.5	2.0 / 2.5	2.5	2.0	2.5	2.0	2.0
ΔPSI	1.7	2.0	2.2 / 1.7	2.0	2.2	2.0	2.2	2.5
T	20		20		20		20	
SN	Min.	Max	Min.	Max.	Min.	Max.	Min.	Max.
	3.80	5.76	2.92	5.05	2.58	4.20	2.02	3.18

In addition to the parameters shown above, the soil resilient modulus, M_R, of the subgrade soil, must be determined. Typically, this value is obtained through California Bearing Ratio (CBR) testing. Field investigations show that all the soil samples obtained within the subgrade at the site are very similar with very similar (CBR) values. These soils are **Dark Brown Fat Clay (CH) with** CBR values ranging between 1.9 and 2.1. We will use the 2.0 CBR value to design our pavement sections.

Information regarding the moisture density relationships of the bulk samples of subgrade soil collected at this site and the CBR test results are presented in the Appendix section of this report.

The Pavement Sections for Clay soils with a CBR value of 2.0 are presented in the tables below.

It should be noted, the P.I. value of the Clay subgrade at this site varies between 37 and 46. The Clay soils may have areas with a P.I. value of 20 or more. While the Chalk soils will generally have a P.I. value of 20 or less. The subgrade soils with a P.I. value greater than 20 should be treated with lime to reduce their P.I. value or be replaced with better material approved by the Project Engineer. It will be important that once the field work starts, personnel from FGS be present to identify the areas where lime should be applied to reduce the P.I. value of the subgrade soil.

For the purposes of developing layer thicknesses for the pavement sections shown below, we have used the following structural coefficients in the calculation of pavement structural numbers:

Material Type	Structural Coefficient	Drainage Coefficient
TXDOT Item 340, Hot Mixed Asphaltic Concrete	0.44	1.00
TXDOT Items 292 or 340, Asphalt Treated Base	0.38	1.00
TXDOT Item 247, Flexible Base - Crushed Limestone	0.14	1.00
TXDOT Item 247, Flexible Base	0.08	1.00
Lime Stabilized Subgrade, (6 inch Min.)	0.08	1.00

Based on the design parameters and the structural coefficients discussed above, the minimum required Structural Number, SN, for the existing soil conditions may be determined using equation found in Appendix CC-1 of the Guide for Mechanistic-Empirical Design of New and Rehabilitated Pavement Structures prepared for the National Cooperative Highway Research Program

$$MR = 2555\,(CBR)^{0.64}$$

Where: MR = the DESIGN Resilient Modulus

$$MR = 2555\,(2.0)^{0.64}$$

MR = 3,981.53 psi

WE WILL USE MR=3,980 PSI FOR OUR PAVEMENT DESIGNS

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for Local "A" Streets with bus Traffic on a Clay subgrade.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)			
	Local "A" Streets with Bus Traffic			
	Option # 1	Option # 2	Option # 3	Option # 4
Type D HMAC Surface	2.0 inches	2.0 inches	2.75 inches	2.0 inches
Type B HMAC Base	N/A	N/A	N/A	N/A
Flexible Base, (Type B, Grade 2), Pit Run	16.75 inches	11.0 inches	18.0 inches	13.75 inches
Lime Treated Subgrade (6 inch Min.)	YES	YES	NO	NO
3 X 5 Rock Wrapped in Mirafi 180N Filter Fabric	NO	NO	YES	YES
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES
Design ESAL Value	1,000,000	1,000,000	1,000,000	1,000,000
Actual ESAL Value	1,054,000	1,016,000	1,104,000	1,069,000

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for Local "B" Streets on a Clay subgrade.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)			
	Local "B" Streets			
	Option # 1	Option # 2	Option # 3	Option # 4
Type D HMAC Surface	3.0 inches	3.0 inches	3.0 inches	3.0 inches
Type B HMAC Base	4.0 inches	4.0 inches	4.0 inches	4.0 inches
Flexible Base, (Type B, Grade 2), Pit Run	8.75 inches	6.0 inches	12.25 inches	6.75 inches
Lime Treated Subgrade (6 inch Min.)	YES	YES	NO	NO
3 X 5 Rock Wrapped in Mirafi 180N Filter Fabric	NO	NO	YES	YES
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES
Design ESAL Value	2,000,000	2,000,000	2,000,000	2,000,000
Actual ESAL Value	2,025,000	3,256,000	2,058,000	2,015,000

In accordance with Bexar County design parameters we have developed the following flexible pavement recommendations for Arterial Streets on a Clay subgrade.

COMPONENT	FLEXIBLE DESIGN SECTION (inches)			
	Arterial Streets			
	Option # 1	Option # 2	Option # 3	Option # 4
Type D HMAC Surface	4.0 inches	4.0 inches	4.0 inches	4.0 inches
Type B HMAC Base	4.0 inches	N/A	4.0 inches	4.0 inches
Flexible Base, (Type B, Grade 2), Pit Run	12.0 inches	17.50 inches	15.50 inches	9.25 inches
Lime Treated Subgrade (6 inch Min.)	YES	YES	NO	NO
3 X 5 Rock Wrapped in Mirafi 180N Filter Fabric	NO	NO	YES	YES
TENSAR GEOGRID (TX-5)	NO	YES	NO	YES
Design ESAL Value	3,000,000	3,000,000	3,000,000	3,000,000
Actual ESAL Value	3,052,000	3,022,000	3,093,000	3,147,000

Note: Asterisk (*) If the P.I. value of the Clay Subgrade is 20 or less, than Moisture Conditioning may be substituted for Lime Treatment, see Pavement Analysis section for additional details.
Double Asterisk (**) the design was calculated using Tensar Spectra Pave4 PRO software.

Pavement Analysis:

The pavement designs presented in the previous paragraphs include designs for lime stabilized subgrade and lime treated subgrade, to be used on pavement sections with a Clay subgrade and a P.I. value greater than 20. The Bexar County pavement design criteria requires that a minimum of six (6) inches of subgrade soil below the pavement structure be treated or stabilized if the subgrade has a P.I. value greater than 20. If a Geogrid fabric is used to reduce the base course thickness, treatment or stabilization of the underlying high P.I. soil is still required, although The City and County could allow 3 X 5 Rock wrapped in a Filter Fiber.

In the case that subgrade fill is required to bring the subgrade elevation up to final grade, fills should be made with flexible base, on-site Chalk millings or other material approved by the Project Engineer. Fill material compaction shall be in accordance with subgrade compaction requirement for Bexar County.

Pavement Material Specifications:

The following guidelines have been prepared for use in the selection and preparation of various materials that may be used to construct the pavement sections. Submittals should be made for each pavement material and should be reviewed by the Geotechnical Engineer and other appropriate members of the design team. The submittals should provide the test information necessary to verify full compliance of the materials with the recommended or specified material properties.

Fill Material - If fill is used to raise the grade, approved fill material underneath the pavement should be used. The fill should be free of deleterious material with a minimum CBR value of 4.5 and preferably a Plastic Index below 20. If the material has a PI greater than 20 the lime application rates should be re-evaluated and sulfate content tested for the fill material. The material should be placed as per applicable city or county guidelines.

Hot-Mix Asphaltic Surface Course – Asphaltic concrete should be plant mixed, hot laid, Type D meeting the 2014 TX DOT Standard Specification Item 340. Mix should be compacted to between 92 and 97 percent of the maximum theoretical density as determined by TEX-227-F.

Asphalt Treated Base – Asphalt treated base should be placed in maximum six (6) inch compacted lifts. These materials should conform to the requirements of the 2014 TX DOT Standard Specification Item 292, Grade 1 or Item 340, Type A or B.

Flexible Base Course – Flexible base materials should be placed in maximum eight (8) inch compacted lifts. The base materials should be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 1557. Flexible base materials should be moisture conditioned to between plus or minus two (+-2) percentage points of the optimum moisture content. Flexible base materials should meet all requirements specified in 2014 TX DOT Standard Specification Item 247, Type A or B, Grade 1 or 2.

Lime Treated Subgrade – Clay subgrade (with P.I. values greater than 20) should be treated with hydrated lime to reduce its plasticity and improve its strength and load carrying ability. Hydrated lime should be mixed with the subgrade soils in accordance with Bexar County Specifications for Lime Treatment to reduce the P.I. value to 20 or less.

Lime Stabilized Subgrade – Clay subgrade (with P.I. values greater than 20) should be stabilized with hydrated lime to reduce its plasticity and improve its strength and load carrying ability. Hydrated lime should be mixed with the subgrade soils in accordance with Bexar County Specifications for Lime Stabilization. We estimate that approximately six (6) percent (by weight) hydrated lime will be required to properly stabilize these soils. This is equivalent to about 27 pounds of hydrated lime per square yard for a six (6) inch depth. The optimum lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977, Appendix XI and should reduce the P.I. to 20 or less.

3 X 5 Rock Wrapped in Filter Fabric – The County may allow 3 X 5 rock wrapped in Filter Fabric instead of lime stabilization. However the wrapping fabric must be Mirafi 180N Filter Fabric or equal, and prior approval must be obtained.

Geogrid – Tensar TX5 geogrid may be used to provide additional structural support to flexible base materials. The geogrid should be placed as per manufacturer's recommendations at the interface between the flexible base and subgrade.

Moisture Conditioned Subgrade – Exposed subgrade soils that do not need to be stabilized or treated should be scarified and moisture conditioned to between plus or minus three (+-3) percentage points of optimum to a depth of at least six (6) inches. The soils should then be compacted to at least 95 percent of the maximum dry density as determined by ASTM D 698.

Lime Series Curve and Unconfined Compressive Strength:

A Lime Series Curve was developed for the project to determine the optimum amount of hydrated lime required to stabilize the subgrade in accordance with Bexar County criteria. The optimum lime content should result in a soil-lime mixture with a pH of at least 12.4 when tested in accordance with ASTM C 977 and should reduce the Plasticity Index to 20 or less. The lime series curve depicts the percent lime added to the subgrade and the resulting pH/P.I. A strength verification test was performed on the lime stabilized subgrade to determine the Unconfined Compressive Strength (UCS) of the soil-lime mixture. Bexar County **requires an UCS of 160 psi, a pH of 12.4 or greater and a P.I. of 20 or less. Results of the** Lime Series Curve and the Unconfined Compressive Strength test are presented in the Appendix section of this report. Additional field verification testing will be required during the subgrade stabilization process once the project has started.

Subgrade Preparation:

The pavement alignment should be stripped of topsoil, vegetation, roots, loose or soft soils and any other deleterious materials. The stripped materials should be removed from the site and properly disposed of or used elsewhere on site. Upon completion of stripping operations, the alignment may be either excavated or filled as necessary to achieve the desired pavement elevation. Prior to the placement of any fill for grade adjustments or the construction of the pavement section, the exposed subgrade should be proof rolled with appropriate construction equipment weighing at least 20 tons. Unstable or non-uniform areas should be removed to expose stable soils and may be replaced with clean, properly compacted flexible base material or other more suitable material approved by the Project Engineer. All fill placed within the paved areas should be free of any deleterious materials and should not contain stones larger than the maximum lift thickness. The fill materials should be placed on prepared surfaces in lifts not to exceed eight (8) inches compacted measure. All fill materials placed in paved areas should be moisture conditioned to between plus or minus three (+-3) percentage points of the optimum moisture content and compacted to at least 95 percent of the maximum dry density as determined by ASTM D 698.

Drainage:

Proper pavement perimeter drainage should be provided and maintained to minimize the infiltration of surface water into the pavement section from surrounding unpaved areas. The infiltration of water into the pavement section typically results in the accelerated degradation of the section with time as vehicular traffic traverses the infiltrated area. Curbs used in paved areas should extend at least three (3) inches into the base materials to help reduce the potential for water infiltration into the pavement section. Prefabricated strip drains or small "French" drains may also be installed behind curbs to intercept and remove water from the pavement perimeter before water infiltrates the pavement section. Furthermore, all concrete and asphalt interfaces should be sealed using a sealant that is compatible with both asphalt and concrete.

Proper pavement drainage is a critical component in the long-term performance of a pavement section. The pavement section recommendations shown above are based on generally recognized structural coefficients. These coefficients reflect the relative strength of each pavement material type and their contribution to the structural integrity of the pavement. The infiltration of water into these pavement materials will generally weaken the materials and result in the degradation of the pavement's performance. Therefore, proper drainage of the pavement should be carefully considered by the project design team to ensure that water rapidly drains from the pavement and does not pond on or around the pavement.

Utilities:

Care should be exercised to make sure that utility lines do not serve as conduits that transmit water beneath foundations or pavements at this site. Secondary backfill for utility lines that are located beneath pavement, sidewalk and building areas should consist of lean clay (CL), flowable fill or other material in accordance with local municipality or utility provider specifications. Proper compaction of trench backfill is essential in pavement areas where settlement of the trench backfill can cause significant distress to the overlaying pavement. Flowable fill materials should be as described in the American Concrete Institute ACI 229R. Granular materials such as sand or gravel are not recommended as secondary backfill in utility trenches located in building pad or pavement areas.

Excavations:

As was discussed previously, these materials that are penetrated by geotechnical augers can generally be excavated with conventional earthmoving equipment. It should be noted that excavation equipment varies and field conditions may vary. Generally, geologic processes (such as faulting, weathering, etc.) are erratic and large variations can occur in small lateral distances. Details regarding "means and methods" to accomplish the work (such as excavation equipment and technique selection) are the sole responsibility of the project contractor.

The Occupational Safety and Health Administration (OSHA) Safety and Health Standards (29 CFR Part 1926, Revised October 1989), require that excavations be constructed in accordance with the current OSHA guidelines. Furthermore, the State of Texas requires that detailed plans and specifications meeting OSHA standards be prepared for trench and excavation retention systems used during construction. The contractor is solely responsible for designing and constructing stable, temporary excavations and should shore, slope, or bench the sides of the excavations as required to maintain stability of both the excavation sides and bottom. The contractor's "responsible person", as defined in 29 CFR Part 1926, should evaluate the soil exposed in the excavation as part of the contractor's safety procedures.

In no case should slope height, slope inclination or excavation depth exceed those specified in local, state and Federal safety regulations. OSHA addresses the construction of slopes in large excavations that are less than 20 feet deep on OSHA Table B-1. We have provided this information solely as a service to our client. The OSHA regulations and OSHA Table B-1 should be consulted prior to any excavations that would be subject to OSHA regulations. FGS does not assume responsibility for construction site safety or the contractor's or other parties' compliance with local, state and Federal safety or other regulations.

QUALITY CONTROL

Document Review:

Due to the uniqueness of each project and construction site, it is important that all engineering reports, drawings, specifications, change orders and other related documents accurately reflect the recommendations intended by the respective design professionals involved in the project. The performance of the pavements planned for this project will depend on the correct interpretation and implementation of our geotechnical engineering report and guidelines. We should be provided the opportunity to review the final design and construction documents to check that our geotechnical recommendations are properly interpreted and implemented in these documents. This review is not a part of our scope of services for this project and would be an additional service. We cannot be responsible for misinterpretation of our geotechnical recommendations if we have not had an opportunity to review these documents.

Construction Materials Testing:

As the Geotechnical Engineer of Record, we recommend that Frost GeoSciences be retained to monitor the pavement installation and earthwork related activities for this project. Due to our familiarity with this project, it is important that FGS provide these services to make certain that our geotechnical recommendations are interpreted properly and to make certain that actual field conditions are those described in our geotechnical report. We believe this technical overview and on-site surveillance during these activities is essential to provide well-constructed pavements and to check that the intent of these geotechnical recommendations is met.

REPORT LIMITATIONS

The recommendations and guidelines submitted in this report are based on the available subsurface information developed by FGS and project information provided by the client. If there are any changes in the nature, design or location of the project, the opinions, conclusions, recommendations and guidelines submitted in this report should not be used until we are able to review the changes and respond in writing as to whether the information contained within this report remains applicable.

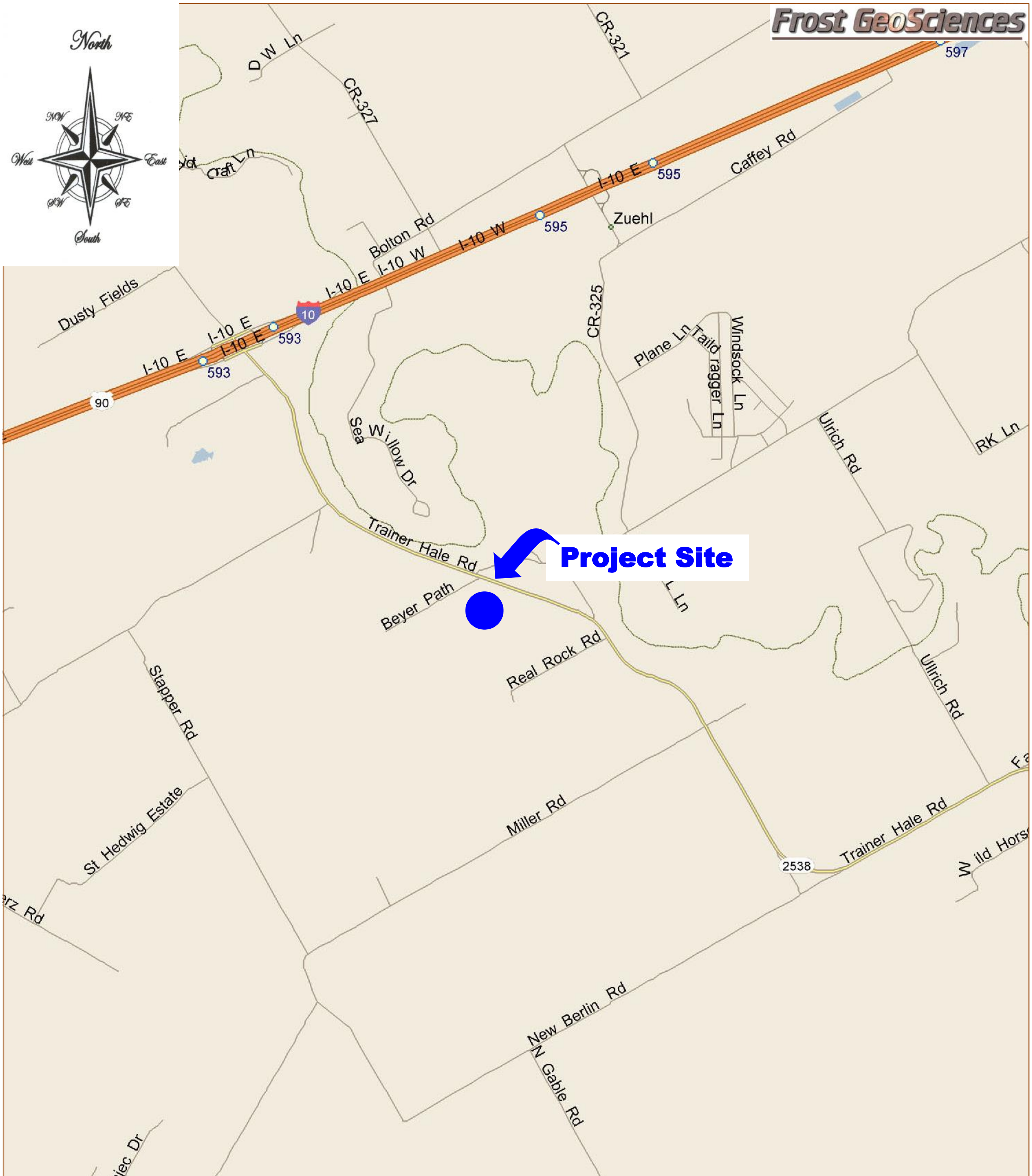
Subsurface conditions at this site have been observed and interpreted at the Boring Locations only. Substantial variations in subsurface materials resulting from local geologic conditions or previous site use may occur away from the boring locations. These variations may not become evident until construction begins. Therefore, any conditions that vary significantly from those described in our report should be reported to FGS immediately. FGS will then determine whether our conclusions, opinions and recommendations remain valid or whether additional investigation and/or engineering analysis is required.

This study has been performed in accordance with accepted geotechnical engineering practice using the standard of care and skill currently exercised by geotechnical engineers practicing in this area. No warranty, expressed or implied, is made or intended. This report has been prepared exclusively for the specified client; project and client's authorized project team for use in preparing the appropriate design and construction documents for this project. This report may be included in the construction documents for this project provided the report is reproduced in its entirety. This report shall not be reproduced or used for any other purpose without the express written consent of Frost GeoSciences, Inc.

ILLUSTRATIONS

Vicinity Map
Boring Location Plan

VICINITY MAP



PROJECT NAME:

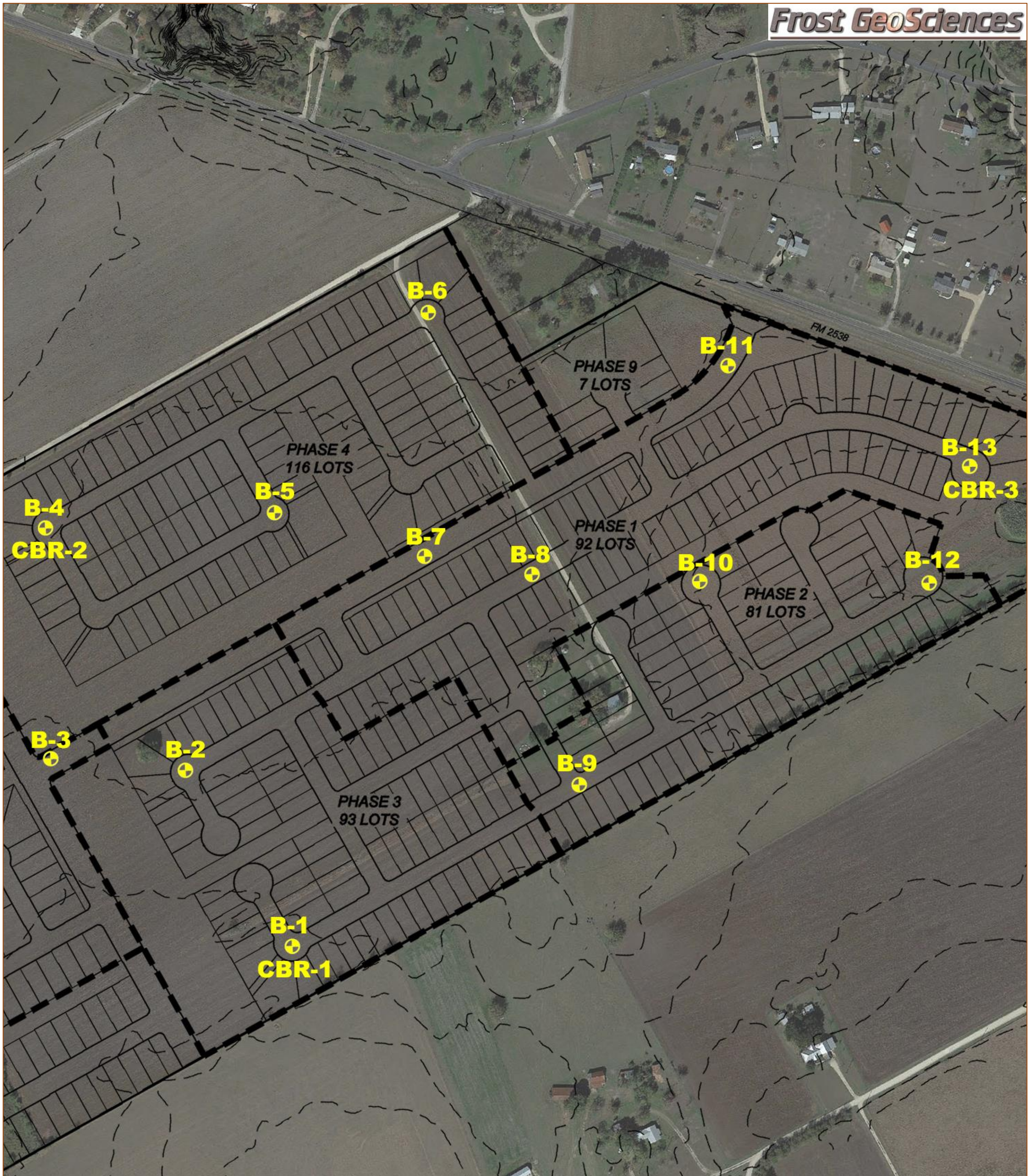
Geotechnical Engineering Study
CLEARWATER SUBDIVISION
MARION, TEXAS

VICINITY MAP

PROJECT N0.: FGS-G-20020

DATE CREATED: Oct. 3, 2020

BORING PLAN



PROJECT NAME:

Geotechnical Engineering Study
CLEARWATER SUBDIVISION
MARION, TEXAS

Boring Locations

PROJECT NO.: FGS-G-20020

DATE CREATED: Oct. 3, 2020

APPENDIX "A"

Boring Logs

Symbol Key Sheet

BORING LOGS

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-01
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

DEPTH (FT)	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
0		10	58	14	44						Dark Brown Clay
5		3	36	9	27						Light Tan Chalky Clay at 5'
13		7	35	10	25						
15											Boring Terminated at 15 feet of Depth
20											

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report.

LOG OF BORING

Frost GeoSciences
Geologic ▪ Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-02
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0												Dark Brown Clay
				12	56	10	46						
	5												Light Tan Chalky Clay at 5'
				9	37	10	27						
	10												
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
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REMARKS:

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-03
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

PAGE 1 of 1

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				9	54	14	40						Dark Brown Clay
	5												
				6	34	9	25						Light Tan Chalky Clay at 5'
	10												
				8	38	10	28						
	15												Boring Terminated at 15 feet of Depth
	20												

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RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report.

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-04
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													Dark Brown Clay
				10	59	14	45						
	5												Light Tan Chalky Clay at 5'
				8	35	10	25						
	10												
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
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RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

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LOG OF BORING

Frost GeoSciences
Geologic • Environmental Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-05
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0			7	57	14	43						Dark Brown Clay
	5			13	35	10	25						Light Tan Chalky Clay at 5'
	10			10	36	9	27						
	15												Boring Terminated at 15 feet of Depth
	20												

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REMARKS:

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-06
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

PAGE 1 of 1

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
													Dark Brown Clay
				12	58	15	43						
	5												Light Tan Chalky Clay at 5'
				25	35	9	26						
	10												
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report

LOG OF BORING

Frost GeoSciences Geologic • Environmental Geotechnical	**PROJECT:** Clearwater Creek Subdivision Marion Marion, Tx	**PROJECT NO.:** **BORING NO.:** **DRILLING DATE:** **SURFACE ELEVATION:**	FGS-G20020 B-07 7/20/2020
	CLIENT: Mosiac Land Development		PAGE 1 of 1

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				9	56	14	42						Dark Brown Clay
	5			5	35	9	26						Light Tan Chalky Clay at 5'
	10												
				3	19	10	9						
	15												Boring Terminated at 15 feet of Depth
	20												

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P - POCKET PENETROMETER RESISTANCE
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R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report.

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-08
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

DEPTH (FT)	N: BLOWS/FT, P: TONS/SQ FT, T: BLOWS, R: %, RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
0											Dark Brown Clay
		4	51	14	37						
5											Light Tan Chalky Clay at 5'
		2	20	8	12						
10											
15											Boring Terminated at 15 feet of Depth
20											

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P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report

LOG OF BORING

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-09
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

FIELD DATA				LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				6	55	14	41						Dark Brown Clay
	5			5	36	10	26						Light Tan Chalky Clay at 5'
	10			5	34	9	25						
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-10
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

PAGE 1 of 1

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

DEPTH (FT)	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
0											Dark Brown Clay
		8	55	13	42						
5											Light Tan Chalky Clay at 5'
		2	19	10	9						
10											
15											Boring Terminated at 15 feet of Depth
20											

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report

LOG OF BORING

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-11
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

PAGE 1 of 1

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0			5	56	14	42						Dark Brown Clay
	5			2	19	9	10						Light Tan Chalky Clay at 5'
	10												
				1	20	9	11						
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

LOG OF BORING

Frost GeoSciences
Geologic • Environmental
Geotechnical

PROJECT: Clearwater Creek Subdivision
Marion
Marion, Tx

CLIENT: Mosiac Land Development

PROJECT NO.: FGS-G20020
BORING NO.: B-12
DRILLING DATE: 7/20/2020
SURFACE ELEVATION:

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
				5	53	14	39						Dark Brown Clay
	5												
				1	19	9	10						Light Tan Chalky Clay at 5'
	10												
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

This log is not valid if separated from the report.

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

LOG OF BORING

Frost GeoSciences
Geologic ▪ Environmental
Geotechnical

PROJECT:	Clearwater Creek Subdivision Marion Marion, Tx	PROJECT NO.:	FGS-G20020
		BORING NO.:	B-13
		DRILLING DATE:	7/20/2020
		SURFACE ELEVATION:	
CLIENT:	Mosiac Land Development		PAGE 1 of 1

DRILLING METHOD(S):
Dry auger drilling techniques were used to the termination depth of the boring.

SUBSURFACE WATER INFORMATION:
Subsurface water was not encountered either during or upon completion of drilling operations and subsurface water observations.

FIELD DATA				LABORATORY DATA									
SOIL SYMBOL	DEPTH (FT)	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: BLOWS R: % RQD: %	MOISTURE CONTENT (%)	ATTERBERG LIMITS: LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	FAILURE STRAIN (%)	CONFINING PRESSURE (POUNDS/SQ IN)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	0			7	60	14	46						Dark Brown Clay
	5			3	57	14	43						
	10												Light Tan Chalky Clay at 5'
				3	35	9	26						
	15												Boring Terminated at 15 feet of Depth
	20												

N - STANDARD PENETRATION TEST RESISTANCE
P - POCKET PENETROMETER RESISTANCE
T - TXDOT CONE PENETRATION RESISTANCE
R - ROCK CORE RECOVERY
RQD - ROCK QUALITY DESIGNATION

REMARKS:

FROST LOG FGS-G20020.GPJ FROST.GDT 9/8/20

This log is not valid if separated from the report

SYMBOL KEY

Symbol Key Sheet

Material Symbols

"FILL"	Clay (CH)	Sandy Clay (CL)	Silty Clay (CL)	Gravelly Clay (CL)
Asphalt	Clayey Sand (SC)	Sand (SP)	Silty Sand (SM)	Gravelly Sand (SP)
Base	Clayey Silt (ML)	Sandy Silt (ML)	Silt (ML)	Gravelly Silt (ML)
Concrete	Clayey Gravel (GC)	Sandy Gravel (GP)	Silty Gravel (GM)	Gravel (GP or GW)
Conglomerate	Limestone	Marl	Sandstone	Shale

Strength of Cohesive Soils

Consistency	Undrained Shear Strength, KSF
Very Soft	less than 0.25
Soft	0.25 to 0.50
Firm	0.50 to 1.00
Stiff	1.00 to 2.00
Very Stiff	2.00 to 4.00
Hard	greater than 4.00

Soil Plasticity

Degree of Plasticity	Plasticity Index (PI)
None	0 to 5
Low	5 to 10
Moderate	10 to 20
Plastic	20 to 40
Highly Plastic	more than 40

Density of Granular Soils

Descriptive Term	SPT Blow Count (blows/ft)
Very Loose	less than 4
Loose	4 to 10
Medium Dense	10 to 30
Dense	30 to 50
Very Dense	more than 50

Standard Penetration Test (ASTM D 1586) Driving Record

Note: Driving is limited to 50 blows per interval, or 25 blows for 0.25 inch advancement, whichever controls. This is done to avoid damaging sampling tools.

Blows Per Foot	Description
25	Sampler was seated 6 inches, then 25 blows were required to advance the sampler 12 inches.
75/8"	Sampler was seated 6 inches, 25 blows were required for the second 6 inch increment and the 50 blow limit was reached at 2 inches of the last increment.
Ref/2"	Sampler could only be driven 2 inches of the 6 inch seating penetration before the 50 blow limit was reached.

Terms Characterizing Structure

Soil Terms	Description
Blocky	Contains cracks or failure planes resulting in rough cubes of material.
Calcareous	Contains appreciable quantities of calcium carbonate.
Fissured	Contains shrinkage cracks, which are frequently filled with fine sand or silt. The fissures are usually near vertical in orientation.
Interbedded	Composed of alternating layers of different soil types.
Laminated	Composed of thin layers of varying color and texture.
Nodules	Secondary inclusions that appear as small lumps about 0.1 to 0.3 inch in diameter.
Partings	Inclusion of different material less than 1/8 inch thick extending through the sample.
Pockets	Inclusion of different material that is smaller than the diameter of the sample.
Seams	Inclusion of different material between 1/8 and 3 inches thick, and extends through the sample.
Slickensided	Has inclined planes of weakness that are slick and glossy in appearance. Slickensides are commonly thought to be randomly oriented.
Streaks or Stains	Stains of limited extent that appear as short stripes, spots or blotches.

Rock Terms	
Bedding Plane	A surface parallel to the surface of deposition, generally marked by changes in color or grain size.
Fracture	A natural break in rock along which no displacement has occurred.
Joint	A natural break along which no displacement has occurred, and which generally intersects primary surfaces.
% Recovery	The ratio of total length of recovery to the total length of core run, expressed as a percentage.
RQD - Rock Quality Designation	The ratio of total recovered length of fragments longer than 4 inches to the total run length, expressed as a percentage.
Weathering	The process by which rock is broken down and decomposed.

Sampler Symbols

Flight Auger | Core Barrel (NX) | Disturbed Sample | No Recovery | Piston Sampler | Shelby Tube (3") | Split Barrel (SPT)

Frost GeoSciences

APPENDIX "B"

Moisture Density Relationship
CBR Test Results
Lime Series Curve & Unconfined Compressive Strength Chart
Spectra Pave Design Analysis

MOISTURE DENSITY

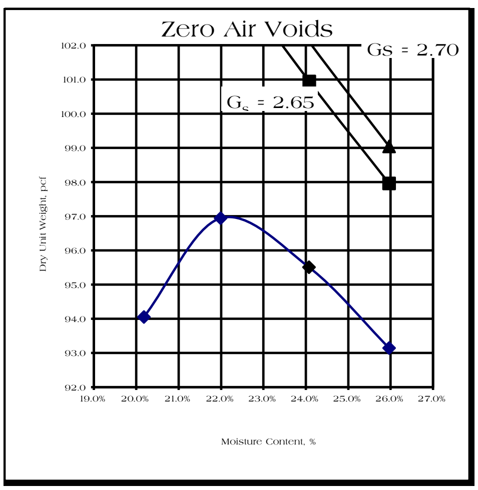
13406 Western Oak
Helotes, TX 78023
(210) 372-1315 phone (210) 372-1318 fax

[illegible] FGS-G20020

[illegible] Clearwater Creek Subdivision

[illegible]

Moisture-Density Relationship - Subgrade Soil



Test Results

[illegible]

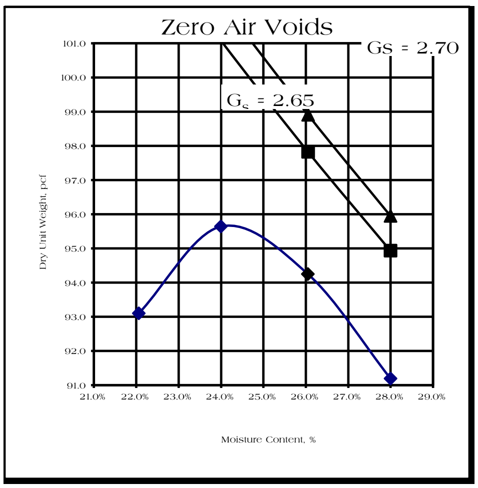
[illegible]

13406 Western Oak
Helotes, TX 78023
(210) 372-1315 phone (210) 372-1318 fax

[illegible] FGS-G20020

[illegible] Clearwater Creek Subdivision

Moisture-Density Relationship - Subgrade Soil



Test Results

[illegible]

Respectfully submitted,

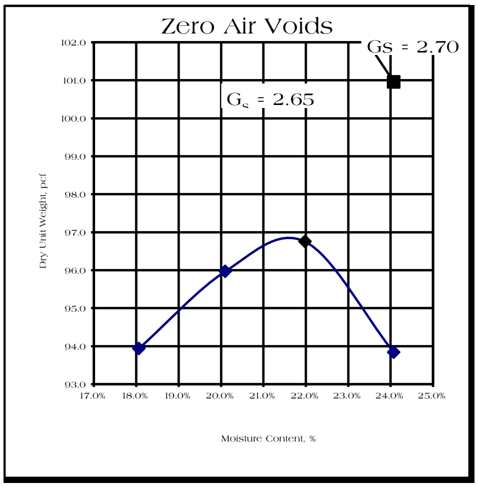
[illegible]

13406 Western Oak
Helotes, TX 78023
(210) 372-1315 phone (210) 372-1318 fax

[illegible] FGS-G20020

[illegible] Clearwater Creek Subdivision

Moisture-Density Relationship - Subgrade Soil



Test Results

[illegible]

CBR RESULTS

Frost GeoSciences, Inc.
13406 Western Oak
Helotes, Texas 78023

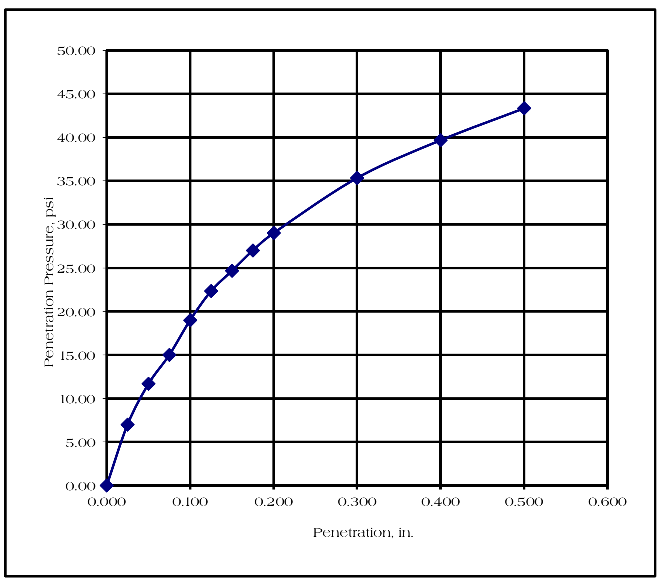
CBR (California Bearing Ratio)
ASTM D1883

ASTM D2216 Moisture Content

Compaction	Project #	Can No.	Wet Wt. (1)	Dry Wt. (2)	Tare Wt. (3)	(1) - (2) = A	(2) - (3) = B	%MC = A/B*100
Before								
After								

ASTM D1883

Strain, in.	Load, lbs	Stress, psi	CBR
0.000	0.00	0.00	
0.025	21.00	7.00	
0.050	35.00	11.67	
0.075	45.00	15.00	
0.100	57.00	19.00	1.9
0.125	67.00	22.33	
0.150	74.00	24.67	
0.175	81.00	27.00	
0.200	87.00	29.00	1.9
0.300	106.00	35.33	
0.400	119.00	39.67	
0.500	130.00	43.33	



Frost GeoSciences, Inc.
13406 Western Oak
Helotes, Texas 78023

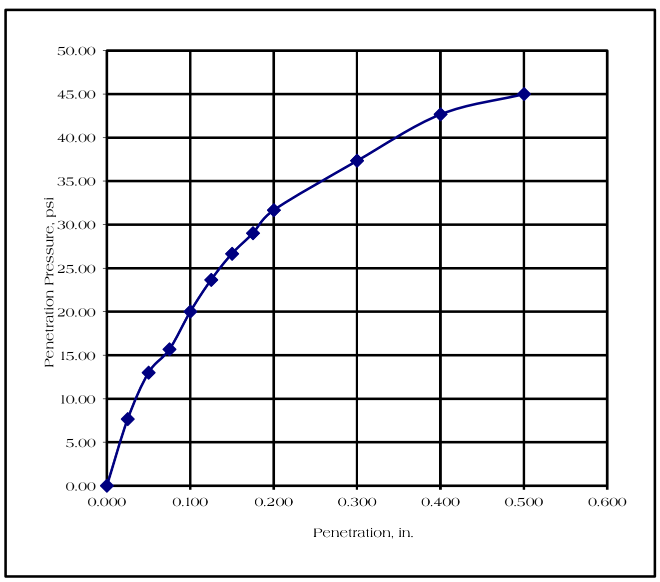
CBR (California Bearing Ratio)
ASTM D1883

ASTM D2216 Moisture Content

Compaction	Project #	Can No.	Wet Wt. (1)	Dry Wt. (2)	Tare Wt. (3)	(1) - (2) = A	(2) - (3) = B	%MC = A/B*100
Before								
After								

ASTM D1883

Strain, in.	Load, lbs	Stress, psi	CBR
0.000	0.00	0.00	
0.025	23.00	7.67	
0.050	39.00	13.00	
0.075	47.00	15.67	
0.100	60.00	20.00	2.0
0.125	71.00	23.67	
0.150	80.00	26.67	
0.175	87.00	29.00	
0.200	95.00	31.67	2.1
0.300	112.00	37.33	
0.400	128.00	42.67	
0.500	135.00	45.00	



Frost GeoSciences, Inc.
13406 Western Oak
Helotes, Texas 78023

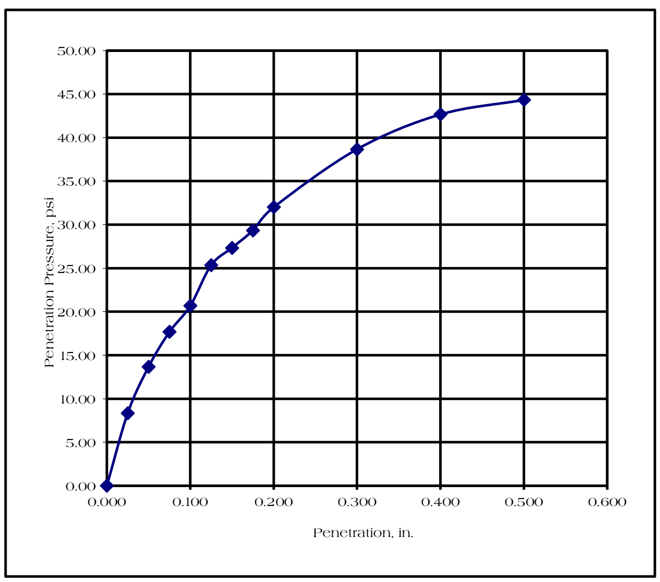
CBR (California Bearing Ratio)
ASTM D1883

ASTM D2216 Moisture Content

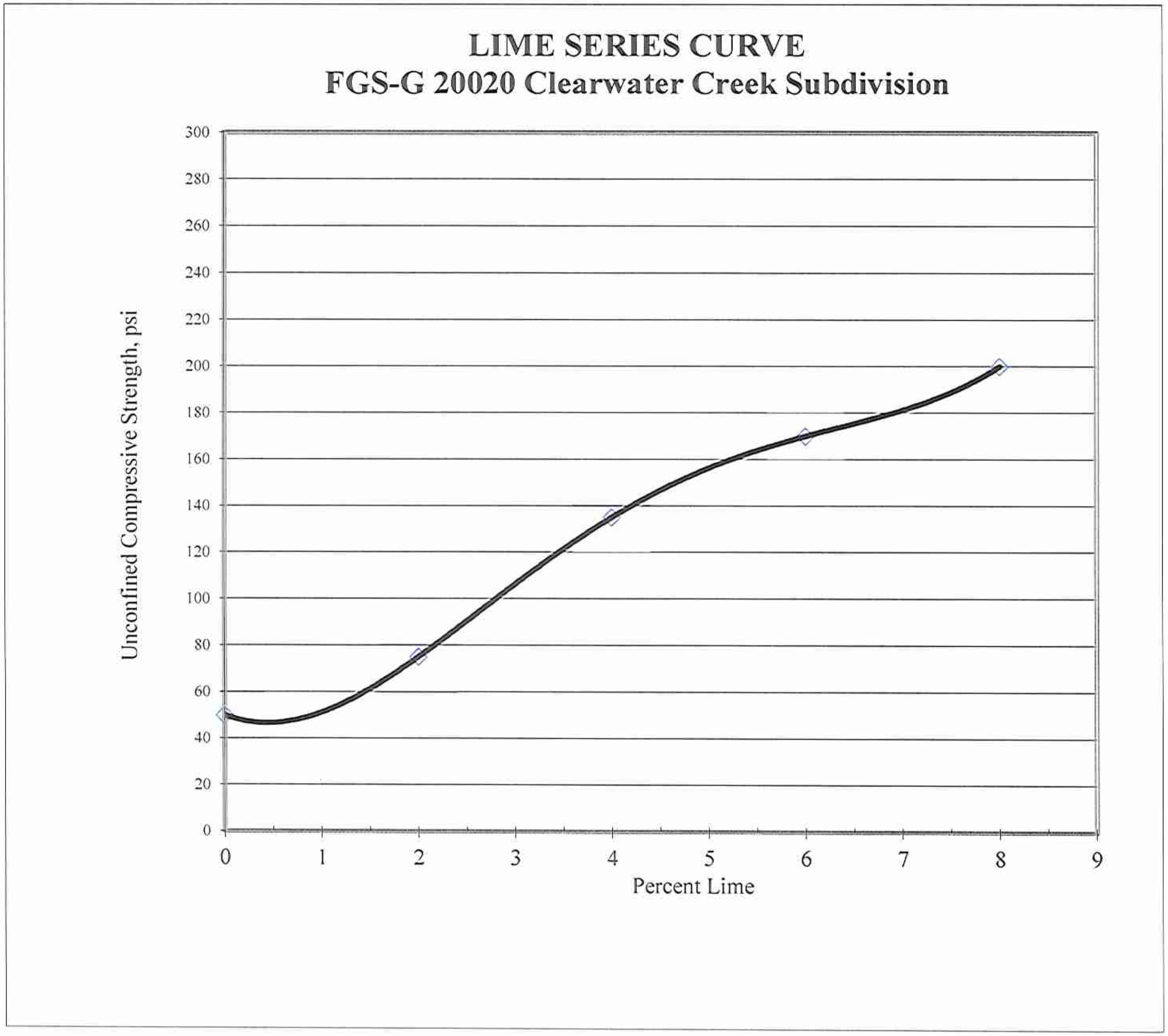
Compaction	Project #	Can No.	Wet Wt. (1)	Dry Wt. (2)	Tare Wt. (3)	(1) - (2) = A	(2) - (3) = B	%MC = A/B*100
Before								
After								

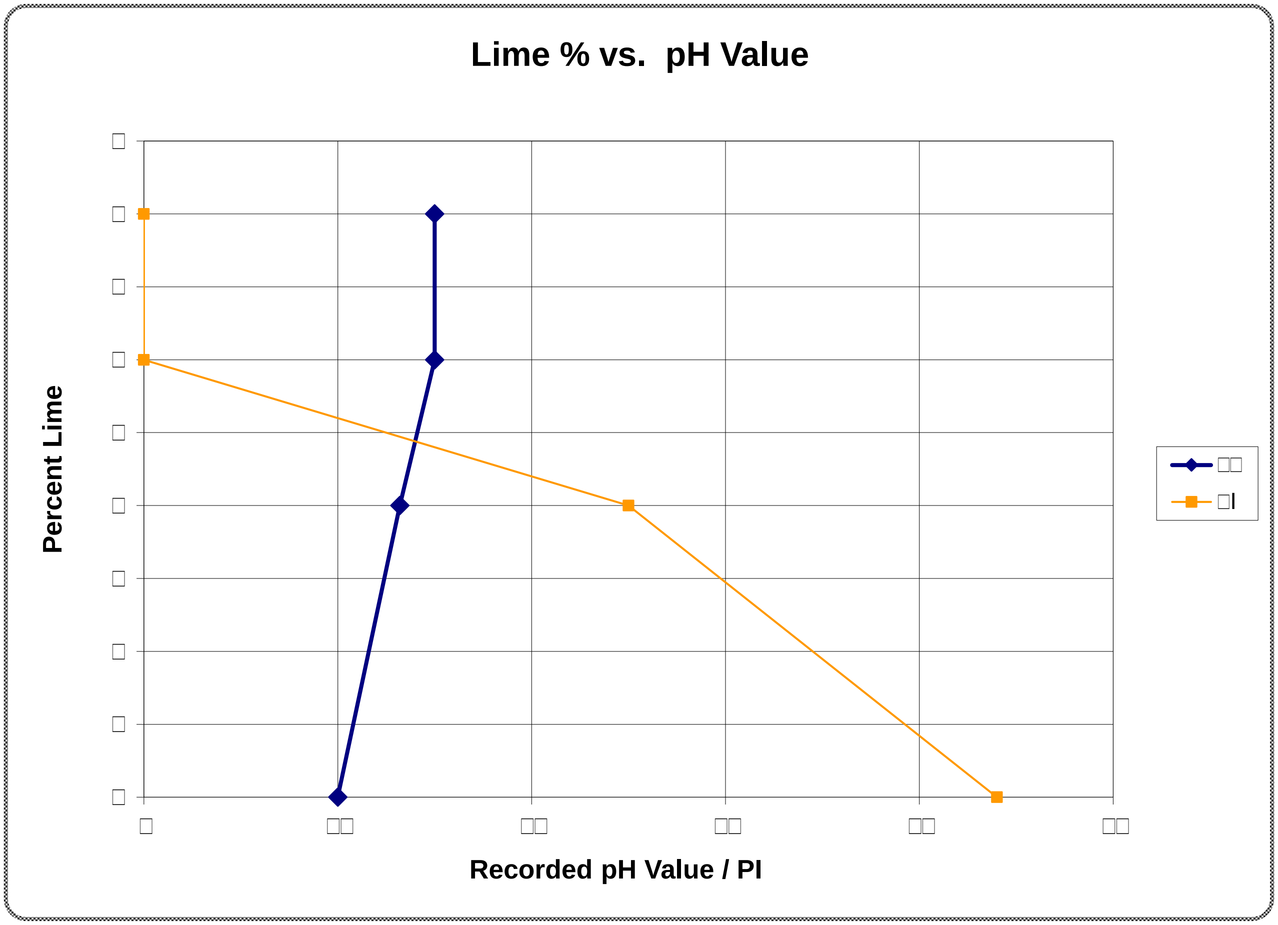
ASTM D1883

Strain, in.	Load, lbs	Stress, psi	CBR
0.000	0.00	0.00	
0.025	25.00	8.33	
0.050	41.00	13.67	
0.075	53.00	17.67	
0.100	62.00	20.67	2.1
0.125	76.00	25.33	
0.150	82.00	27.33	
0.175	88.00	29.33	
0.200	96.00	32.00	2.1
0.300	116.00	38.67	
0.400	128.00	42.67	
0.500	133.00	44.33	



LIME SERIES CURVE


LIME SERIES CURVE
FGS-G 20020 Clearwater Creek Subdivision
Unconfined Compressive Strength, psi
0
20
40
60
80
100
120
140
160
180
200
220
240
260
280
300
0
1
2
3
4
5
6
7
8
9
Percent Lime

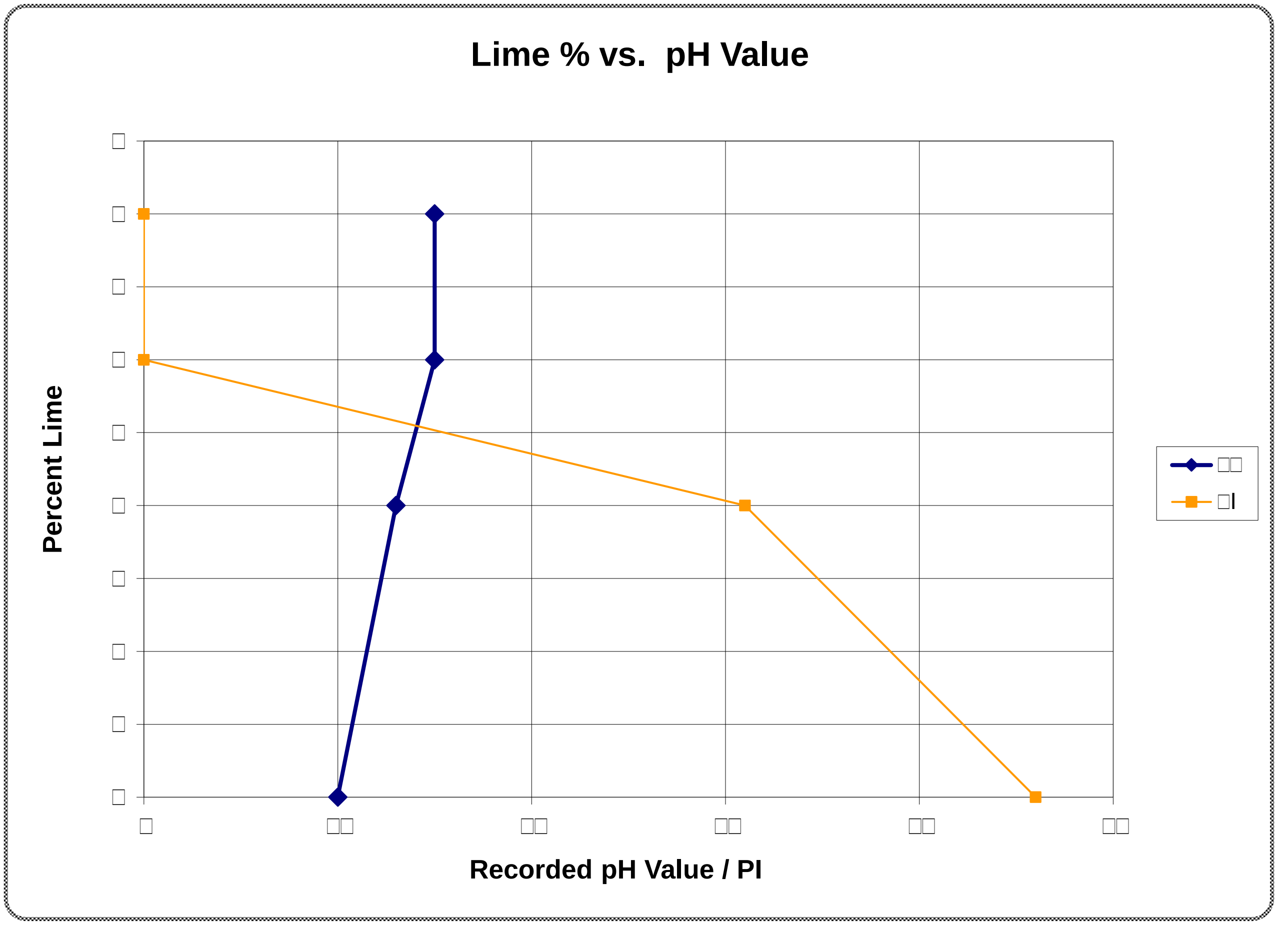


Project Name: Clearwater Creek Subdivision
Project Number: FGSG20020
Soil Description: Dark Brown Clay

%Lime	pH	PI
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

LIME

LIME

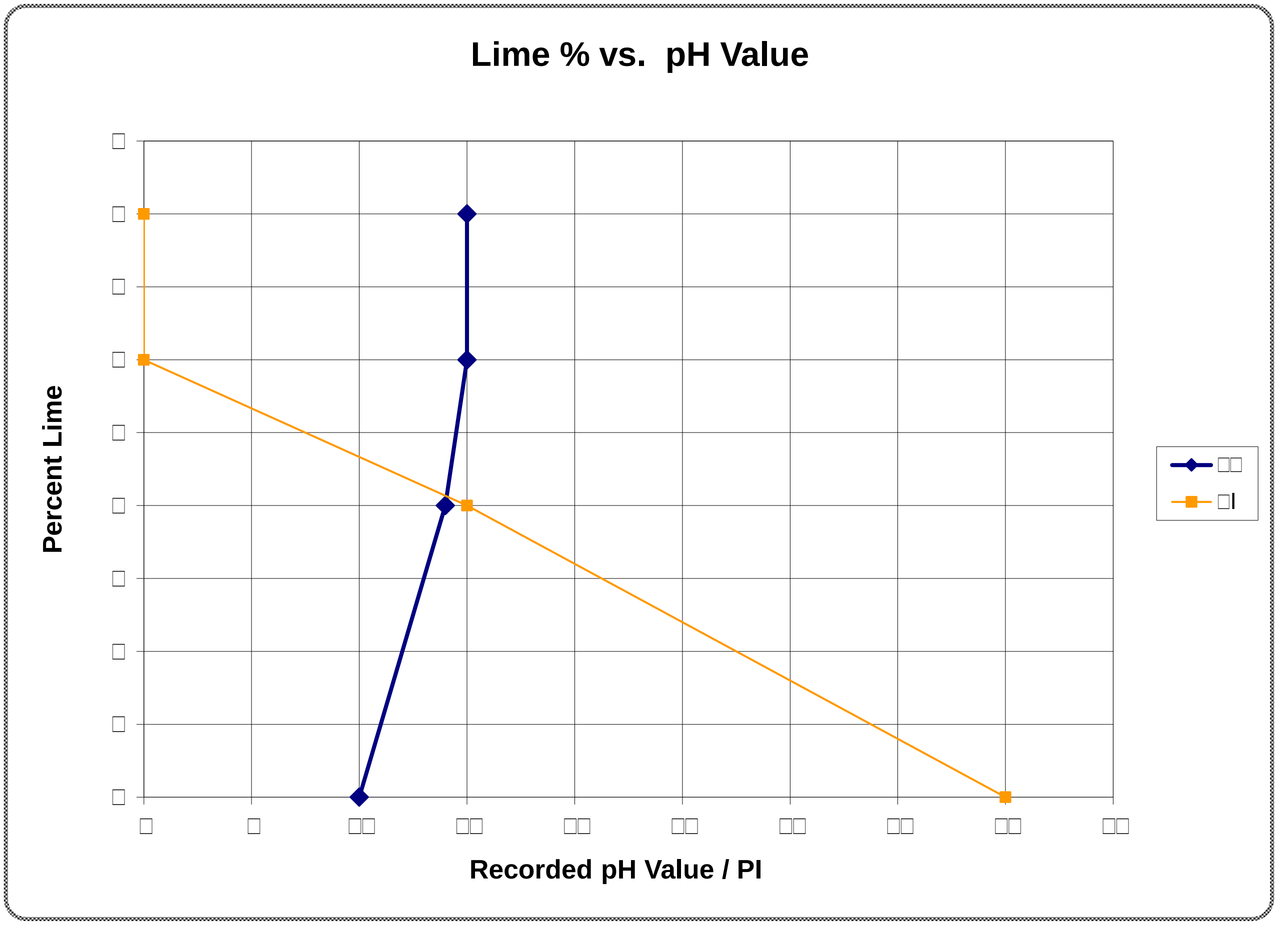


Project Name: Clearwater Creek Subdivision
Project Number: FGSG20020
Soil Description: Dark Brown Clay

%Lime	pH	PI
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

LIME

LIME



Project Name: Clearwater Creek Subdivision
Project Number: FGSG20020
Soil Description: Dark Brown Clay

%Lime	pH	PI
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]
[illegible]	[illegible]	[illegible]

LIME LIME

SPECTRA PAVE

LOCAL “A”

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

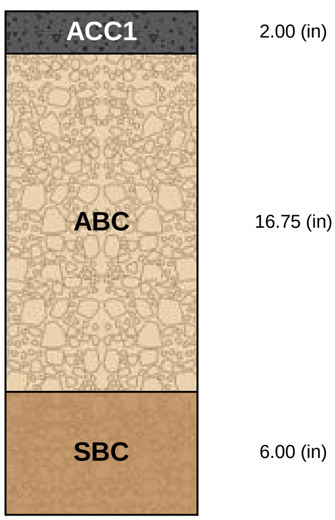
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

Stabilized Section Material Properties

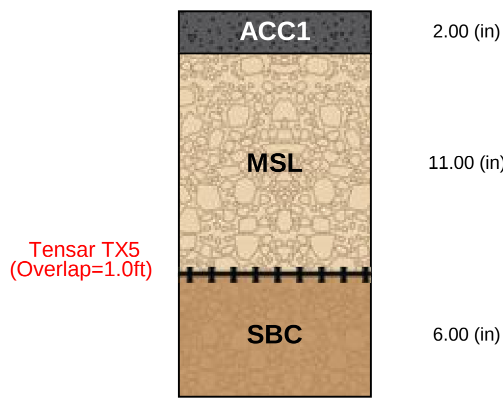
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.215	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 3.705
Calculated Traffic (ESALs) = 1,054,000

Stabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 3.685
Calculated Traffic (ESALs) = 1,016,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Project Name	CLEARWATER CREEK, (Local "A"), □□□□□ □ □, LIME		
Company Name	FROST GEOSCIENCES		
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 70	Initial Serviceability	= 4.2
Standard Normal Deviate	= -.524	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

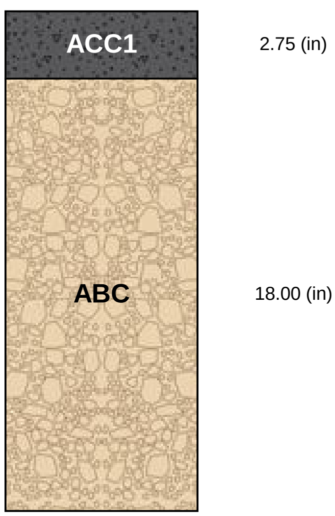
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

Stabilized Section Material Properties

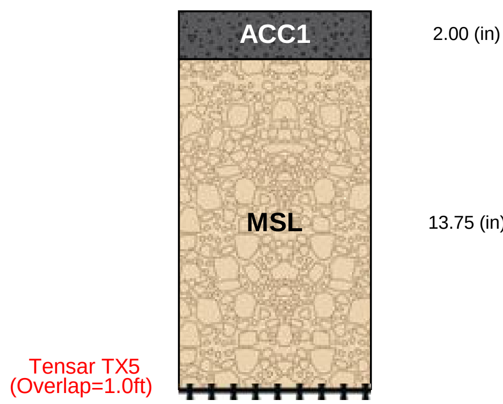
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.206	1.0

Unstabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 3.730
Calculated Traffic (ESALs) = 1,104,000

Stabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 3.712
Calculated Traffic (ESALs) = 1,069,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Project Name	Clearwater Creek (Local A), Opt. 3 & 4, ROCK		
Company Name	FROST GEOSCIENCES		
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020

LOCAL “B”

Tensar

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

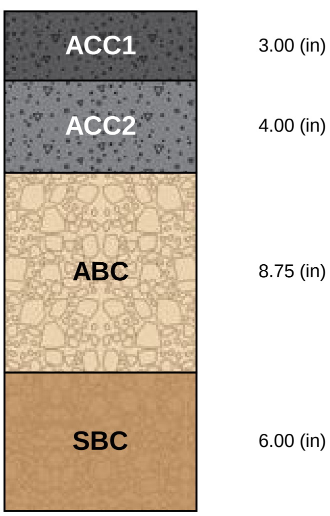
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

Stabilized Section Material Properties

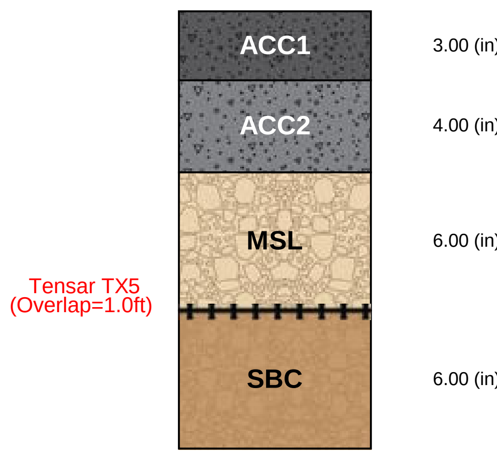
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.265	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 4.545
Calculated Traffic (ESALs) = 2,025,000

Stabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 4.850
Calculated Traffic (ESALs) = 3,256,000

LIMITATIONS OF THE REPORT

The designs, illustrations, information and other content included in this report are necessarily general and conceptual in nature, and do not constitute engineering advice or any design intended for actual construction. Specific design recommendations can be provided as the project develops.

Project Name	CEARWATER CREEK (Local "B") Opt. 1 & 2, LIME		
Company Name	FROST GEOSCIENCES		
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 90	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.282	Terminal Serviceability	= 2.0
Standard Deviation	= 0.45	Change in Serviceability	= 2.2

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

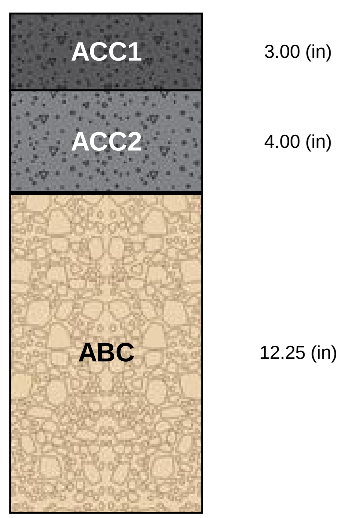
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

Stabilized Section Material Properties

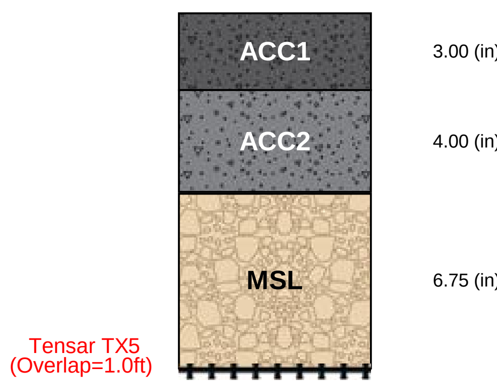
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.261	1.0

Unstabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 4.555
Calculated Traffic (ESALs) = 2,058,000

Stabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 4.542
Calculated Traffic (ESALs) = 2,015,000

LIMITATIONS OF THE REPORT

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Project Name	Clearwater Creek (Local "B") Opt. 3 & 4, ROCK		
Company Name	FROST GEOSCIENCES		
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020

ARTERIAL

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

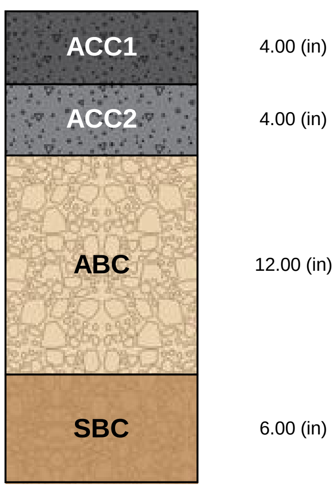
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0
SBC	Subbase Course	16.00	0.080	1.0

Stabilized Section Material Properties

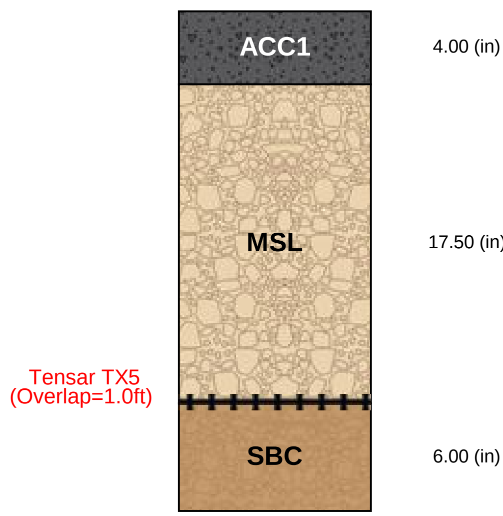
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.187	1.0
SBC	Subbase Course	16.00	0.080	1.0

Unstabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 5.440
Calculated Traffic (ESALs) = 3,052,000

Stabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 5.432
Calculated Traffic (ESALs) = 3,022,000

LIMITATIONS OF THE REPORT

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Project Name	Clearwater Creek (ARTERIAL) Opt. 1 & 2, LIME		
Company Name	FROST GEOSCIENCES		
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020

SpectraPave™
Pavement Optimization Design Analysis

Design Parameters for AASHTO (1993) Equation

Reliability (%)	= 95	Initial Serviceability	= 4.2
Standard Normal Deviate	= -1.645	Terminal Serviceability	= 2.5
Standard Deviation	= 0.45	Change in Serviceability	= 1.7

Aggregate fill shall conform to following requirement:

D50 <= 27mm (Base course)

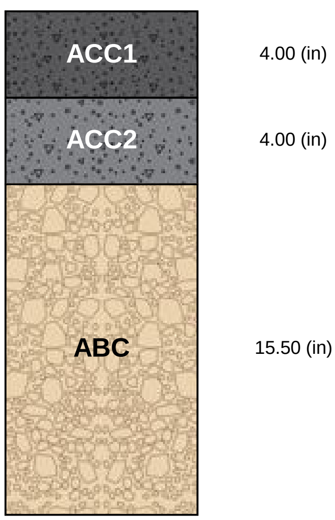
Unstabilized Section Material Properties

Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.440	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.380	N/A
ABC	Aggregate Base Course	20.00	0.140	1.0

Stabilized Section Material Properties

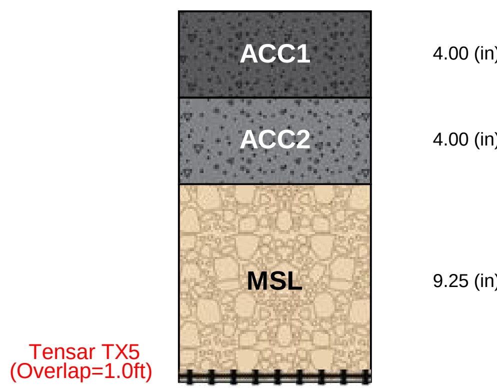
Layer	Description	Cost ($/ton)	Layer coefficient	Drainage factor
ACC1	Asphalt Wearing Course	70.00	0.420	N/A
ACC2	Dense-graded Asphalt Course	70.00	0.400	N/A
MSL	Mechanically Stabilized Base Course	20.00	0.236	1.0

Unstabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 5.450
Calculated Traffic (ESALs) = 3,093,000

Stabilized Pavement



Subgrade Modulus = 3,980 (psi)
Structural Number = 5.463
Calculated Traffic (ESALs) = 3,147,000

LIMITATIONS OF THE REPORT

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Project Name	Clearwater Creek (ARTERIAL) Opt. 3 & 4, ROCK		
Company Name	FROST GEOSCIENCES		
Designer	F. J. CABALLERO, P. E.	Date	October 2, 2020