Geotechnical Data Report

Cagnon Road GST and Pump Station Improvements
5940 Cagnon Road
San Antonio, Texas

Arias Job No. 2020-810

ARIAS
GEOPROFESSIONALS

Prepared For
Tetra Tech, Inc.

June 17, 2021

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FINAL REVIEW

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF FINAL REVIEW UNDER THE AUTHORITY OF

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06/17/2021

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GEOTECHNICAL DATA REPORT

FOR

Cagnon Road GST and Pump Station Improvements

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INTRODUCTION

The Geotechnical Data Report (GDR) presented herein is for the proposed improvements at the existing Cagnon Pump Station in San Antonio, Texas. This project was authorized via the executed Subconsultant Services Agreement between Tetra Tech, Inc. (Tetra Tech) and Arias & Associates, Inc. (Arias), dated October 30, 2020. Our scope of work was performed in general accordance with the services outlined in Arias Proposal No. 2020-810, dated July 24, 2020 (Revised September 23, 2020).

SCOPE OF SERVICES

The scope of services for this Project was to:

- Perform geotechnical borings to obtain soil/material samples for subsequent laboratory testing, as well as to characterize subsurface stratigraphic and groundwater conditions at the site;
- Perform laboratory testing on recovered soil/material samples to evaluate engineering properties of the subgrade soils/materials, as well as for subsurface soil/material characterization; and,
- Present the results of the field and laboratory test data in this GDR.

Environmental services or studies of any kind as well as analyses of slopes and/or retaining walls and the preparation of a Geotechnical Baseline Report (GBR) were beyond our authorized scope of services for this project. As requested by the Client, one (1) boring (i.e., Boring B-4) was drilled for the proposed GST to develop preliminary design information which is provided in the Geotechnical Design Memorandum (GDM) under separate a cover. *We understand that the tank manufacturer will perform additional borings in accordance with ACI and/or AWWA criteria, as applicable, prior to the final design of the GST.*

PROJECT DESCRIPTION

We understand that Tetra Tech is assisting SAWS with the design, bid, and construction for the following improvements at the existing Cagnon Pump Station:

- Removal of the existing 1.0 million gallon (MG) welded steel ground storage tank (GST) and installation of a new 2.0 MG pre-stressed concrete GST,
- Inclusion of a flow control valve assembly from the WRIP Pipeline, and
- Construction of a concrete driveway, surface parking and access road.

The existing Cagnon Road GST and Pump Station is located at 5940 Cagnon Road in San Antonio, Texas. The approximate site location is presented on the Vicinity Map included as Figure 1 in Appendix A.

Based on our desktop review of Google Earth imagery, we understand that the existing pump station consists of a ground storage tank, elevated storage tank, and other ancillary structures.

FIELD EXPLORATION

As requested by Tetra Tech, a total of four (4) borings were drilled for this project near the locations of proposed improvements between March 16 and March 17, 2021. The borings were drilled to depths ranging from approximately 10 to 65 feet below the existing ground surface. Table 1 presented subsequently includes the (1) GPS coordinates obtained using a hand-held GPS unit, (2) surveyed locations (i.e., northing and easting) and surface elevations, and (3) boring depths. The surveyed locations and surface elevations were provided to Arias by Tetra Tech, and are also included on the boring logs provided in Appendix B. The approximate locations of the borings are shown on the Boring Location Plan included as Figure 2 in Appendix A.

Table 1: Boring Locations and Depths

Boring No.	GPS Coordinates		Surveyed State Plane Surface Coordinates		Surveyed Surface Elevation, (feet)	Proposed Structure	Approximate Boring Depth (feet)
	Latitude	Longitude	Northing	Easting			
B-1	N 29° 22' 22.48"	W 98° 42' 24.19"	13685427.39	2062247.89	789.94	Pavement	10
B-2	N 29°22' 20.68"	W 98° 42' 24.05"	13685242.60	2062243.95	789.92	Pavement	10
B-3	N 29°22' 23.27"	W 98° 42' 22.50"	13685515.23	2062389.57	790.40	Valve Assembly	25
B-4	N 29°22' 22.26"	W 98° 42' 22.50"	13685410.49	2062398.56	786.54	2 MG GST	65

Note: Surface elevations and State Plane Coordinates of the as-drilled borings locations were provided to Arias by Tetra Tech.

Borings B-1 through B-4 were drilled with a truck-mounted drilling rig using continuous flight augers. Samples of encountered materials at the boring locations were obtained by either using a split-barrel sampler while performing the Standard Penetration Test (ASTM D 1586) or by using a thin-walled tube sampler (ASTM D 1587) as described in Appendix C. The sample depth interval and type of sampler used is included on the boring logs. Arias' field representative, working under the supervision of the project Geotechnical Engineer visually logged each recovered sample and placed a portion of the recovered sample into a plastic

bag for transport to our laboratory. After completion of drilling, the boreholes were backfilled using cuttings generated during the drilling process mixed with bentonite. Select site photographs taken at the time of drilling are included in Appendix A of this report.

Final classifications, as seen on the attached boring logs, were determined by the project Geotechnical Engineer based on laboratory and field test results and applicable ASTM procedures.

LABORATORY TESTING

As a supplement to the field exploration, laboratory testing was conducted to determine water content, Atterberg Limits, percent passing the US Standard No. 200 sieve, soluble sulfate and unconsolidated undrained triaxial compressive strength tests. The laboratory results are reported in the boring logs included in Appendix B. A key to the terms and symbols used on the logs is also included in Appendix B. The laboratory testing for this project was done in general accordance with applicable ASTM procedures with the specifications and definitions for these tests listed in Appendix C. Partial grain size distribution curves are included in Appendix D.

Remaining samples recovered from this exploration will be routinely discarded following submittal of this report.

Sulfate Testing Results

Laboratory testing was conducted on samples recovered from the Borings B-1 and B-2 to determine the soluble sulfate content. Testing was performed in accordance with TxDOT test method Tex-145-E "Determining Sulfate Content in Soils." The test results indicated that the sulfate contents of the samples tested range from 120 to 140 parts per million (ppm). Sulfate test results performed on the samples are presented in Table 2 below.

Table 2: Sulfate Test Results

Boring No.	Depth, feet	Description	Soluble Sulfate, parts per million (ppm)
B-1	0 – 2	Brown CLAYEY GRAVEL (GC)	120
B-2	0 – 2	Brown CLAYEY GRAVEL (GC)	140

Corrosivity Testing

Corrosivity tests were performed on one (1) selected composite sample. As a part of the corrosivity testing, analytical tests (i.e., Sulfate, pH, Oxidation-Reduction Potential, and Chloride) were conducted in accordance with Tex-145-E, Tex-128-E, ASTM D1498 and Tex-620-J standard methods, respectively. Analytical test results are presented in Table 3 subsequently.

Table 3: Analytical Test Results

Boring No.	Depth, feet	Sulfate, ppm	pH	Oxidation-Reduction Potential, mV	Chloride, mg/Kg
B-4	0 – 6	1,700	10.9	16.3	40

Bulk Sample Testing

A bulk sample of the near-surface soils was obtained near Boring B-1. The bulk sample was obtained to aid in developing a subgrade-support value for the pavement design. Laboratory testing performed on the bulk sample; included Atterberg limits, percent passing the US Standard No. 200 sieve, moisture-density relationship, CBR, and lime series. The moisture-density relationship, using the Standard Proctor (ASTM D 698) method, was performed to establish the optimum moisture content and the maximum dry density of the composite sample when subjected to a specified compactive effort. A laboratory CBR test was performed using the three-point method in accordance with ASTM D 1833 standard method. The test results are shown in Table 4 subsequently and included in Appendix E.

Table 4: CBR Test Results

Sample Location	Near Boring B-1
Sample Classification	Clayey Gravel with Sand (GC)
Plasticity Index (PI)	23
% Passing #200 Sieve	42
Maximum Dry Density (pcf)	118.9
Optimum Moisture Content (%)	11.1
CBR at 95% Compaction	3.5

SUBSURFACE CONDITIONS

Geology, generalized stratigraphy, and groundwater conditions at the project site are discussed in the following sections. The subsurface and groundwater conditions are based on the conditions encountered at the boring locations to the depths explored.

Geology

A Geologic Map is included as Figure 3 in Appendix A. The site is mapped as being Uvalde Gravel (Q-Tu) underlain by Navarro Group and Marlbrook Marl (Kknm) formation.

The Uvalde Gravel formation (Q-Tu) primarily consists of gravel and cobble-sized particles of chert, quartz, limestone, and igneous rock. The material is often cemented with calcium deposits and is typically quite dense. Oftentimes, the gravel is water bearing.

The Navarro Group and Marlbrook Marl formation (Kknm) of the Taylor Group consists mainly of clay, marl, sandstone, and siltstone. Locally, the formation consists of clay, dominantly montmorillonitic, greenish gray to brownish gray weathering to a dark gray to black clay soil. The clay soil is considered highly expansive (very high shrink/swell potential) and generally becomes more competent with depth, grading to clay-shale.

Generalized Site Stratigraphy

The borings generally encountered predominantly medium dense to dense clayey gravel and clayey sand (*variable fill/possible fill material*) followed by stiff to hard/very hard fat to lean clays with varying amounts of sand and gravel. At the location of Boring B-4, very hard claystone was encountered at the approximate 53-foot depth and continued to the boring termination depth of 65-feet.

Based on our review of the historical aerials, we anticipate presence of fill material on the east and south sides of the existing pump station. Consideration can be given to drill additional borings to determine the presence and thickness of the fill material prior to final design.

The presence and thickness of the various subsurface materials can be expected to vary away from the exploration locations.

Groundwater

A dry sampling method was used to obtain the samples. Groundwater was not encountered during drilling in any of the four (4) borings at the time of field exploration.

Water levels in open boreholes may require several hours to several days to stabilize depending on the permeability of the soils/materials. Groundwater levels at this site may differ during construction because fluctuations in groundwater levels can result from seasonal conditions, rainfall, drought, or temperature effects. Pockets or seams of gravels, sands, silts or open fractures and joints can store and transmit “perched” groundwater flow or seepage.

Groundwater levels will often change significantly over time; accordingly, they should be verified immediately prior to construction. *Should dewatering become necessary, it is considered “means and methods” and is solely the responsibility of the Contractor.*

GENERAL COMMENTS

This report was prepared as an instrument of service for this project exclusively for the use of Tetra Tech, SAWS, and the project design team.

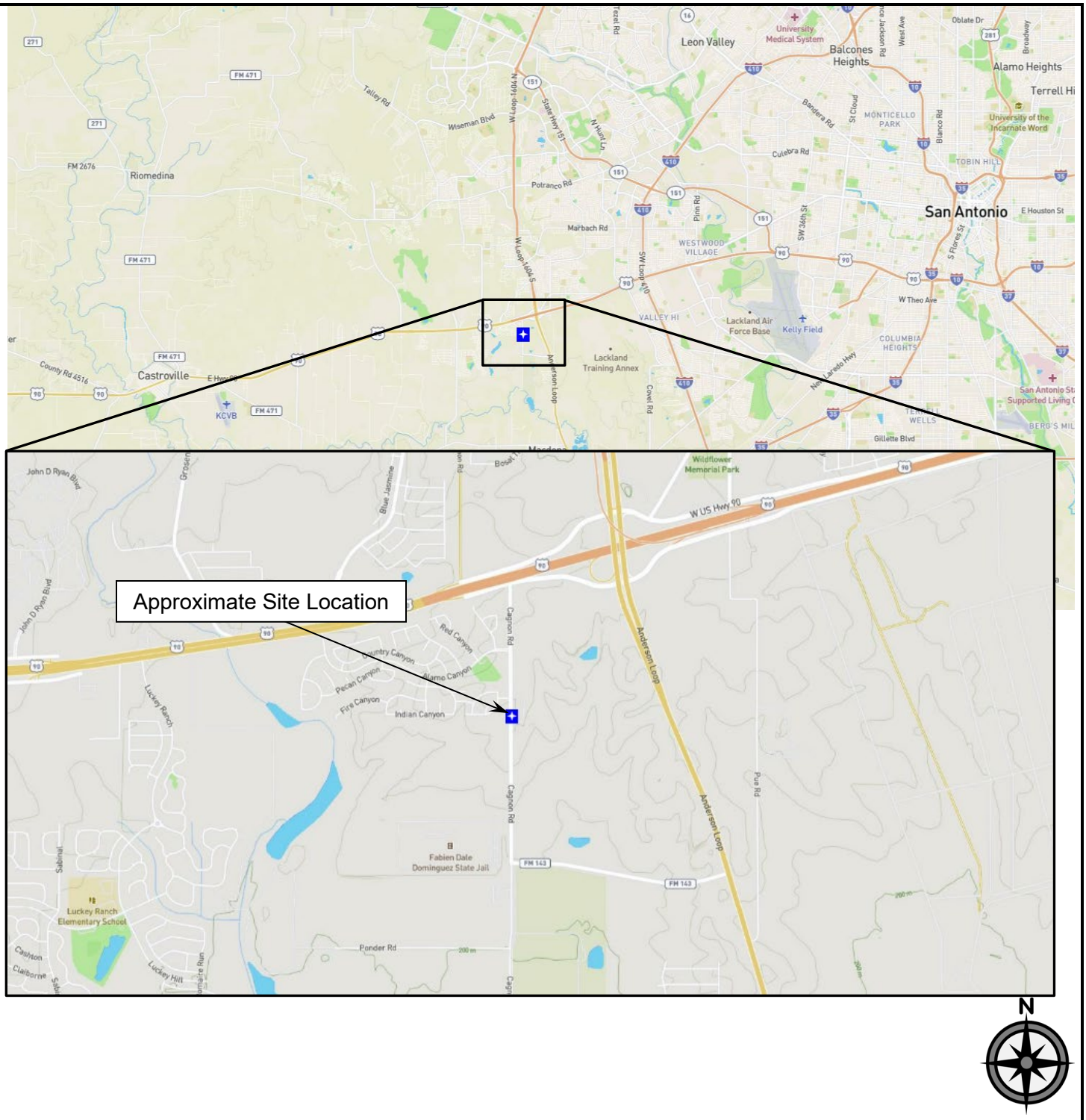
Subsurface Variations

Soil/material and groundwater conditions may vary between and away from the sample boring locations. Transition boundaries or contacts, noted on the boring logs to separate soil/material types, are approximate. Actual contacts may be gradual and vary at different locations. The Contractor should verify that similar conditions exist throughout the proposed area of excavation.

Standard of Care

Subject to the limitations inherent in the agreed scope of services as to the degree of care and amount of time and expenses to be incurred, and subject to any other limitations contained in the agreement for this work, Arias has performed its services consistent with that level of care and skill ordinarily exercised by other professional engineers practicing in the same locale and under similar circumstances at the time the services were performed.

APPENDIX A: FIGURES AND SITE PHOTOGRAPHS



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VICINITY MAP

Cagnon Road GST and Pump Station Improvements
5940 Cagnon Road
San Antonio, Texas

Date: December 7, 2020	Job No.: 2020-810
Drawn By: RWL	Checked By: AM
Approved By: GK	Scale: N.T.S.

Figure 1

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REVISIONS:

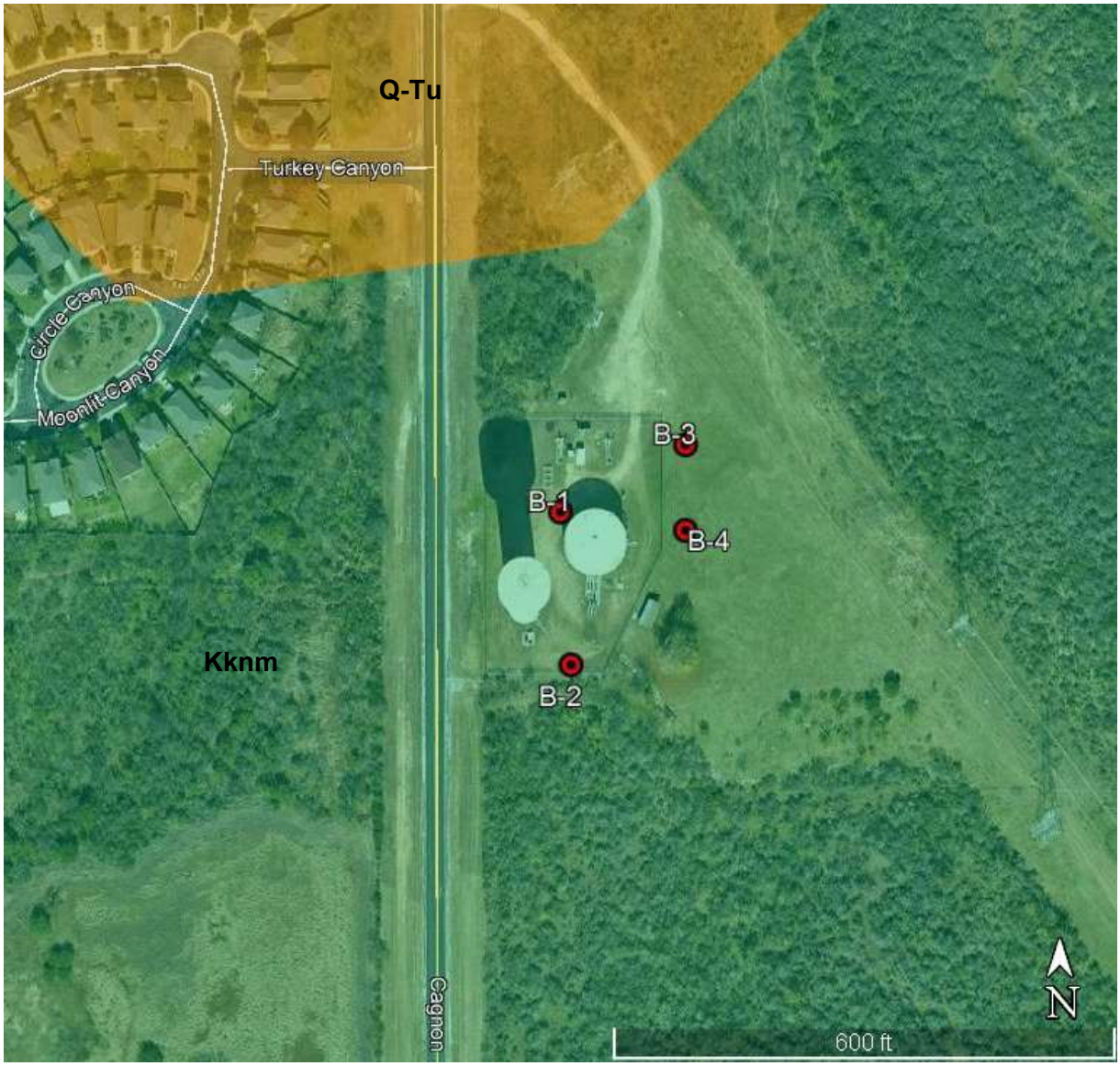
No.:	Date:	Description:

BORING LOCATIONS PLAN

Cagnon Road GST and Pump Station Improvements
5940 Cagnon Road
San Antonio, Texas

Date: April 5, 2021	Job No.: 2020-810
Drawn By: AM	Checked By: GK
Approved By: CMS	Scale: N.T.S.

Figure 2



Symbol	Name	Age
Kknm	Navarro Group and Marlbrook Marl	Upper Cretaceous Period
Q-Tu	Uvalde Gravel	Quaternary Period / Holocene

Fault Segment with Indication of Relative Movement

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GEOLOGIC MAP

Cagnon Road GST and Pump Station Improvements
5940 Cagnon Road
San Antonio, Texas

Date: November 13, 2020	Job No.: 2020-810
Drawn By: AM	Checked By: GK
Approved By: GK	Scale: N.T.S.

Figure 3

View looking at drilling operations for boring B-2.

View looking at drilling operations for boring B-3.

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SITE PHOTOS

Cagnon Road GST and Pump Station Improvements
5940 Cagnon Road
San Antonio, Texas

Date: April 6, 2021	Job No.: 2020-810
Drawn By: CLC	Checked By: AM
Approved By: GK	Scale: N.T.S.

Appendix A

View looking at drilling operations for boring B-4.

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SITE PHOTOS

Cagnon Road GST and Pump Station Improvements
5940 Cagnon Road
San Antonio, Texas

Date: April 6, 2021	Job No.: 2020-810
Drawn By: CLC	Checked By: AM
Approved By: GK	Scale: N.T.S.

Appendix A

APPENDIX B: BORING LOGS AND KEY TO TERMS

Boring Log No. B-1

Project: **Cagnon Tank**
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 3/16/21
Elevation: 789.94 ft (By survey)
Coordinates: N: 13685427.39 E: 2062247.89
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
CLAYEY GRAVEL (GC), medium dense, brown, (Possible Fill)		T	15	19	50	31			36
CLAYEY GRAVEL (GC), medium dense to dense, tan, with trace calcareous deposits		SS	4					20	
	5	SS	6					32	35
FAT CLAY (CH), hard, light tan and gray, with calcareous deposits and ferrous stains		T	29	27	87	60	4.5+		
		T	26				4.5+		
	10								

Borehole terminated at 10 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Survey
Logged By: L. Arizola
Driller: Tero Drilling
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Thin-walled tube (T) Split Spoon (SS)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

Arias Geoprofessionals

Job No.: 2020-810

Boring Log No. B-2

Project: **Cagnon Tank**
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 3/16/21
Elevation: 789.92 ft (By survey)
Coordinates: N: 13685242.60 E: 2062243.95
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200
CLAYEY GRAVEL (GC), medium dense, brown, (Possible Fill)		SS	3	19	40	21		20	21
CLAYEY GRAVEL (GC), tan, with calcareous deposits		SS	4					22	
LEAN CLAY with Gravel (CL), stiff, tan, with calcareous deposits	5	SS	6					14	70
FAT CLAY with Gravel (CH), hard, light tan and gray, with calcareous deposits		T	11	21	57	36	4.5+		
		T	9				4.5+		
	10								

Borehole terminated at 10 feet

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Survey
Logged By: L. Arizola
Driller: Tero Drilling
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 10 ft

Nomenclature Used on Boring Log

Split Spoon (SS)
Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

N = SPT Blow Count
-200 = % Passing #200 Sieve

Arias Geoprofessionals

Job No.: 2020-810

Boring Log No. B-3

Project: **Cagnon Tank**
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 3/16/21
Elevation: 790.40 ft (By survey)
Coordinates: N: 13685515.23 E: 2062389.57
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uu
CLAYEY GRAVEL with Sand (GC), medium dense, brown, (Possible Fill)		SS	6	19	52	33		23	41		
CLAYEY GRAVEL with Sand (GC), medium dense, dark brown and brown		SS	7					24			
CLAYEY SAND with Gravel (SC), medium dense, brown, with calcareous deposits	5	SS	7	17	37	20		28			
SANDY FAT CLAY with Gravel (CH), hard, brown to tan, with calcareous deposits and ferrous stains		SS	11					47			
		T	18	20	55	35	4.5+		64	110	9.38 (6)
FAT CLAY (CH), hard, light tan to gray, with calcareous deposits and ferrous stains	10	T	25				4.5+				
- very stiff, slickensided from 13' to 15'		T	27	26	82	56	4.5+		100	95	2.35 (10)
	15										
- becomes tan below 18'		T	18				4.5+				
	20										
LEAN CLAY (CL), very hard, reddish brown, with heavy ferrous stains		SS	13					50/5"			
	25										
Borehole terminated at 25 feet											

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Survey
Logged By: L. Arizola
Driller: Tero Drilling
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 25 ft

Nomenclature Used on Boring Log

Split Spoon (SS)
Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uu = UU Triaxial Strength (tsf)

Arias Geoprofessionals

Job No.: 2020-810

Boring Log No. B-4

Project: **Cagnon Tank**
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 3/16/2021 - 3/17/2021
Elevation: 786.54 ft (By survey)
Coordinates: N: 13685410.49 E: 2062398.56
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uu
FILL: GRAVELLY LEAN CLAY with Sand (CL), very stiff, brown and tan, with calcareous deposits		SS	7	19	47	28		20	58		
CLAYEY SAND with Gravel (SC), dense to medium dense, dark brown to brown, (Possible Fill)		SS	6					35	48		
	5	SS	5	20	52	32		20			
CLAYEY GRAVEL (GC), medium dense, dark brown		T	18	22	66	44			38		
FAT CLAY with Gravel (CH), stiff, tan and gray		SS	14					14			
	10										
FAT CLAY (CH), very stiff to stiff, light tan and gray, slickensided, with interbedded calcareous seams		T	20	21	57	36	4.5+		97	100	2.92 (8)
		T	20				4.5+			102	1.95 (10)
	15										
LEAN CLAY with Sand (CL), hard to very hard, reddish tan, with ferrous stains		SS	13	17	37	20		49	75		
	20										
		SS						**50/2"			
	25										
FAT CLAY (CH), hard, tan and gray, with ferrous stains (continued)		SS	16					50			
	30										

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Survey
Logged By: L. Arizola
Driller: Tero Drilling
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 25 ft
Air rotary: 25 - 65 ft

Nomenclature Used on Boring Log

Split Spoon (SS) Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uu = UU Triaxial Strength (tsf)

Arias Geoprofessionals

Job No.: 2020-810

Boring Log No. B-4 (continued)

Project: **Cagnon Tank**
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 3/16/2021 - 3/17/2021
Elevation: 786.54 ft (By survey)
Coordinates: N: 13685410.49 E: 2062398.56
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	N	-200	DD	Uu
FAT CLAY (CH), hard, tan and gray, with ferrous stains *(continued)*											
- very hard from 33' to 38'	35	SS	20	26	83	57		57			
- hard from 38' to 48'	40	SS	24					34			
	45	SS	24					43			
- very hard below 48'	50	SS	19					50/6"			
CLAYSTONE, very hard, dark gray and tan, with ferrous stains and interbedded gypsum seams	55	SS	26	27	87	60		90/11"			
(continued)	60	SS	27					88/11"			

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Survey
Logged By: L. Arizola
Driller: Tero Drilling
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 25 ft
Air rotary: 25 - 65 ft

Nomenclature Used on Boring Log

Split Spoon (SS) Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
LL = Liquid Limit
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
N = SPT Blow Count
** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uu = UU Triaxial Strength (tsf)

Boring Log No. B-4 (continued)

Project: **Cagnon Tank**
San Antonio, Texas

Location: See Boring Location Plan

Sampling Date: 3/16/2021 - 3/17/2021
Elevation: 786.54 ft (By survey)
Coordinates: N: 13685410.49 E: 2062398.56
Backfill: Cuttings/bentonite

Soil Description	Depth (ft)		SN	WC	PL	LL	PI	PP	N	-200	DD	Uu
CLAYSTONE, very hard, dark gray and tan, with ferrous stains and interbedded gypsum seams *(continued)*			SS	27					90/10"			
	65											
Borehole terminated at 65 feet												

Groundwater Data:
During drilling: Not encountered

Field Drilling Data:
Coordinates: Survey
Logged By: L. Arizola
Driller: Tero Drilling
Equipment: Truck-mounted drill rig

Single flight auger: 0 - 25 ft
Air rotary: 25 - 65 ft

Nomenclature Used on Boring Log

Split Spoon (SS) Thin-walled tube (T)

WC = Water Content (%)
PL = Plastic Limit
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** = Blow Counts During Seating Penetration
-200 = % Passing #200 Sieve
DD = Dry Density (pcf)
Uu = UU Triaxial Strength (tsf)

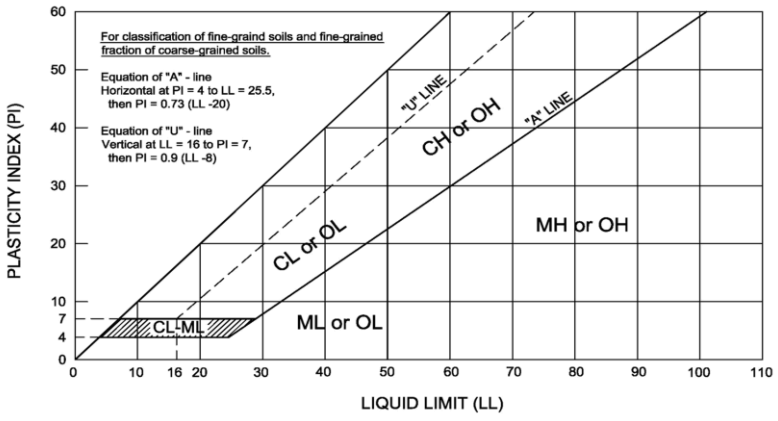
KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

MAJOR DIVISIONS					GROUP SYMBOLS		DESCRIPTIONS
COARSE-GRAINED SOILS	More than half of material LARGER than No. 200 Sieve size	GRAVELS	More than Half of Coarse fraction is LARGER than No. 4 Sieve size	Clean Gravels (little or no Fines)	GW		Well-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
					GP		Poorly-Graded Gravels, Gravel-Sand Mixtures, Little or no Fines
				Gravels with Fines (Appreciable amount of Fines)	GM		Silty Gravels, Gravel-Sand-Silt Mixtures
					GC		Clayey Gravels, Gravel-Sand-Clay Mixtures
		SANDS	More than half of Coarse fraction is SMALLER than No. 4 Sieve size	Clean Sands (little or no Fines)	SW		Well-Graded Sands, Gravelly Sands, Little or no Fines
					SP		Poorly-Graded Sands, Gravelly Sands, Little or no Fines
				Sands with Fines (Appreciable amount of Fines)	SM		Silty Sands, Sand-Silt Mixtures
					SC		Clayey Sands, Sand-Clay Mixtures
FINE-GRAINED SOILS	More than half of material SMALLER than No. 200 Sieve size	SILTS & CLAYS		Liquid Limit less than 50	ML		Inorganic Silts & Very Fine Sands, Rock Flour, Silty or Clayey Fine Sands or Clayey Silts with Slight Plasticity
					CL		Inorganic Clays of Low to Medium Plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		SILTS & CLAYS		Liquid Limit greater than 50	MH		Inorganic Silts, Micaceous or Diatomaceous Fine Sand or Silty Soils, Elastic Silts
					CH		Inorganic Clays of High Plasticity, Fat Clays
FORMATIONAL MATERIALS		SANDSTONE					Massive Sandstones, Sandstones with Gravel Clasts
		MARLSTONE					Indurated Argillaceous Limestones
		LIMESTONE					Massive or Weakly Bedded Limestones
		CLAYSTONE					Mudstone or Massive Claystones
		CHALK					Massive or Poorly Bedded Chalk Deposits
		MARINE CLAYS					Cretaceous Clay Deposits
		GROUNDWATER					Indicates Final Observed Groundwater Level Indicates Initial Observed Groundwater Location

Density of Granular Soils	
Number of Blows per ft., N	Relative Density
0 - 4	Very Loose
4 - 10	Loose
10 - 30	Medium
30 - 50	Dense
Over 50	Very Dense

Consistency and Strength of Cohesive Soils		
Number of Blows per ft., N	Consistency	Unconfined Compressive Strength, q_u (tsf)
Below 2	Very Soft	Less than 0.25
2 - 4	Soft	0.25 - 0.5
4 - 8	Medium (Firm)	0.5 - 1.0
8 - 15	Stiff	1.0 - 2.0
15 - 30	Very Stiff	2.0 - 4.0
Over 30	Hard	Over 4.0

PLASTICITY CHART (ASTM D 2487-11)



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KEY TO TERMS AND SYMBOLS USED ON BORING LOGS

TABLE 1 Soil Classification Chart (ASTM D 2487-11)

Criteria of Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
COARSE-GRAINED SOILS	Gravels (More than 50% of coarse fraction retained on No. 4 sieve)	Clean Gravels (Less than 5% fines[C])	Cu ≥ 4 and 1 ≤ Cc ≤ 3[D]	GW	Well-Graded Gravel[E]
			Cu < 4 and/or [Cc < 1 or Cc > 3][D]	GP	Poorly-Graded Gravel[E]
		Gravels with Fines (More than 12% fines[C])	Fines classify as ML or MH	GM	Silty Gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey Gravel[E,F,G]
More than 50% retained on No. 200 sieve	Sands (50% or more of coarse fraction passes No. 4 sieve)	Clean Sands (Less than 5% fines[H])	Cu ≥ 6 and 1 ≤ Cc ≤ 3[D]	SW	Well-Graded Sand[I]
			Cu < 6 and/or [Cc < 1 or Cc > 3][D]	SP	Poorly-Graded Sand[I]
		Sands with Fines (More than 12% fines[H])	Fines classify as ML or MH	SM	Silty Sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey Sand[F,G,I]
FINE-GRAINED SOILS	Silts and Clays Liquid limit less than 50	inorganic	PI > 7 and plots on or above "A" line[J]	CL	Lean Clay[K,L,M]
			PI < 4 or plots below "A" line[J]	ML	Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OL	Organic Clay[K,L,M,N] / Organi Silt[K,L,M,O]
50% or more passes the No. 200 sieve	Silts and Clays Liquid limit 50 or more	inorganic	PI plots on or above "A" line	CH	Fat Clay[K,L,M]
			PI plots on or below "A" line	MH	Elastic Silt[K,L,M]
		organic	Liquid limit - oven dried / Liquid limit - not dried < 0.75	OH	Organic Clay[K,L,M,P] / Organic Silt[K,L,M,Q]
HIGHLY ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor			PT	Peat

[A] Based on the material passing the 3-inch (75mm) sieve

[B] If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name

[C] Gravels with 5% to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly-graded gravel with silt
- GP-GC poorly-graded gravel with clay

[D] $Cu = D_{60}/D_{10}$ $\quad Cc = \frac{(D_{30})^2}{D_{10} \times D_{60}}$

[E] If soil contains ≥ 15% sand, add "with sand" to group name

[F] If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM

[G] If fines are organic, add "with organic fines" to group name

[H] Sand with 5% to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly-graded sand with silt
- SP-SC poorly-graded sand with clay

[I] If soil contains ≥ 15% gravel, add "with gravel" to group name

[J] If Atterberg limits plot in hatched area, soil is a CL-ML, silty clay

[K] If soil contains 15% to < 30% plus No. 200, add "with sand" or "with gravel," whichever is predominant

[L] If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name

[M] If soil contains ≥ 30% plus No. 200, predominantly gravel, add "gravelly" to group name

[N] PI ≥ 4 and plots on or above "A" line

[O] PI < 4 or plots below "A" line

[P] PI plots on or above "A" line

[Q] PI plots below "A" line

TERMINOLOGY

Boulders	Over 12-inches (300mm)	**Parting**	Inclusion < 1/8-inch thick extending through samples
Cobbles	12-inches to 3-inches (300mm to 75mm)	**Seam**	Inclusion 1/8-inch to 3-inches thick extending through sample
Gravel	3-inches to No. 4 sieve (75mm to 4.75mm)	**Layer**	Inclusion > 3-inches thick extending through sample
Sand	No. 4 sieve to No. 200 sieve (4.75mm to 0.075mm)		
Silt or Clay	Passing No. 200 sieve (0.075mm)		
Calcareous	Containing appreciable quantities of calcium carbonate, generally nodular		

Stratified	Alternating layers of varying material or color with layers at least 6mm thick
Laminated	Alternating layers of varying material or color with the layers less than 6mm thick
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided	Fracture planes appear polished or glossy sometimes striated
Blocky	Cohesive soil that can be broken down into small angular lumps which resist further breakdown
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay
Homogeneous	Same color and appearance throughout

APPENDIX C: FIELD AND LABORATORY EXPLORATION

FIELD AND LABORATORY EXPLORATION

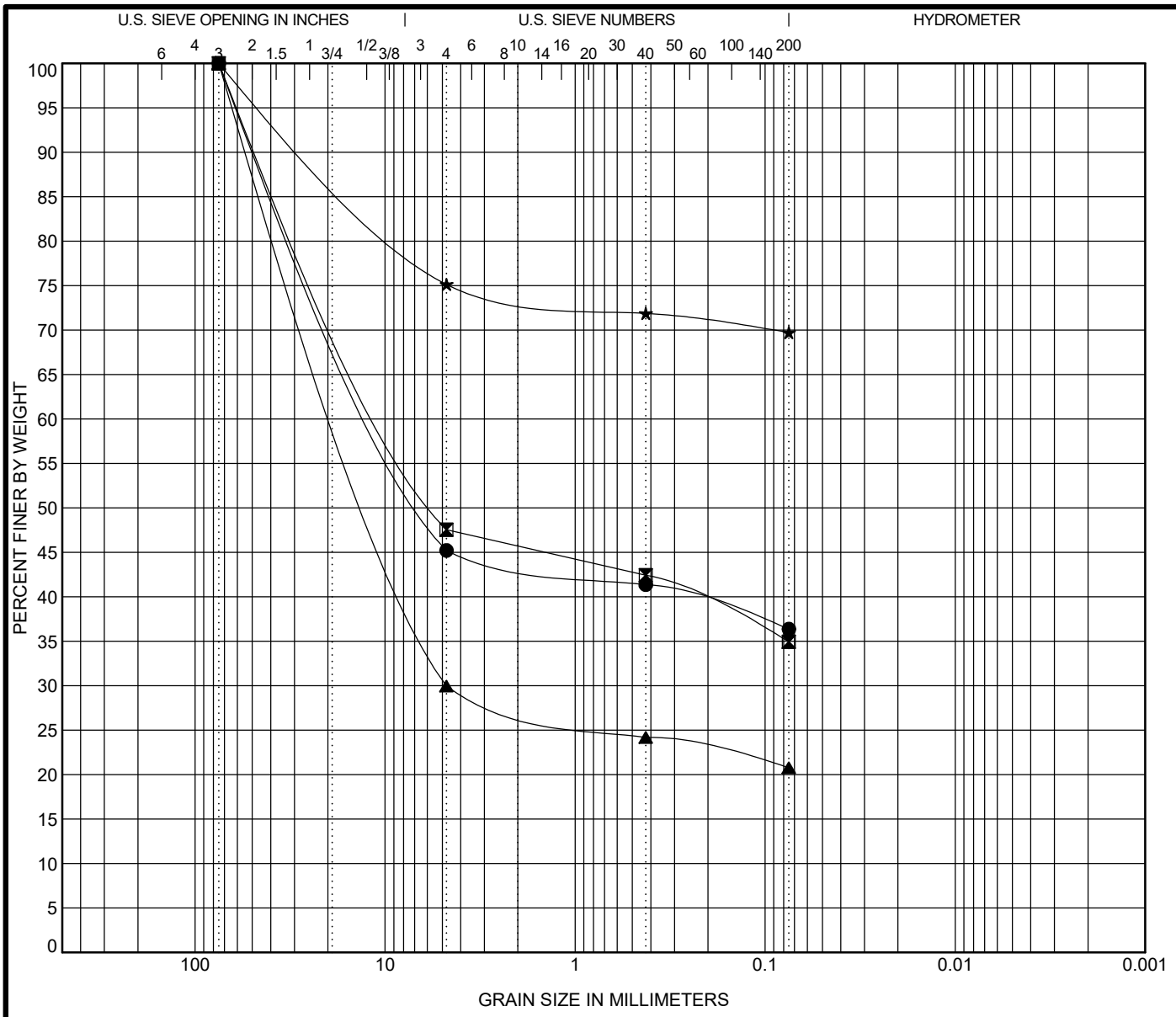
The field exploration program included drilling at selected locations within the site and intermittently sampling the encountered materials. The boreholes were drilled predominantly with single flight augers, with air rotary utilized beginning at 25 feet at the location of Boring B-4. Samples of encountered materials were obtained using a split-barrel sampler while performing the Standard Penetration Test (ASTM D 1586) or ASTM D1587 for a thin-walled tube sampler technique. The sample depth interval and type of sampler used is included on the boring log. Arias' field representative visually logged each recovered sample and placed a portion of the recovered sampled into a plastic bag for transport to our laboratory.

SPT N-values and blow counts for those intervals where the sampler could not be advanced for the required 18-inch penetration are shown on the boring log. If the test was terminated during the 6-inch seating interval or after 10 hammer blows were applied and no advancement of the sampler was noted, the log denotes this condition as blow count during seating penetration.

Arias performed laboratory tests on selected samples to aid in soil/material classification and to determine engineering properties. Tests commonly used in geotechnical exploration, the method used to perform the test, and the column designation on the boring log where data are reported are summarized as follows:

Test Name	Test Method	Log Designation
Water (moisture) content of soil and rock by mass	ASTM D 2216	WC
Liquid limit, plastic limit, and plasticity index of soils/materials	ASTM D 4318	PL, LL, PI
Amount of material in soils/materials finer than the No. 200 sieve	ASTM D 1140	-200
Unconsolidated Undrained Triaxial Test	ASTM D 2850	Uu (Confining pressure in psi)

APPENDIX D: PARTIAL GRAIN SIZE DISTRIBUTION CURVES



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	**B- 1**		**0.5**	**CLAYEY GRAVEL (GC)**	**50**	**19**	**31**		
⊠	**B- 1**		**4.0**	**CLAYEY GRAVEL (GC)**					
▲	**B- 2**		**0.5**	**CLAYEY GRAVEL (GC)**	**40**	**19**	**21**		
★	**B- 2**		**4.0**	**LEAN CLAY with Gravel (CL)**					

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	**B- 1**	**0.5**	**75**	**10.003**			**54.8**	**8.9**	**36.4**	
⊠	**B- 1**	**4.0**	**75**	**9.148**			**52.5**	**12.6**	**35.0**	
▲	**B- 2**	**0.5**	**75**	**15.513**	**4.758**		**70.0**	**9.2**	**20.8**	
★	**B- 2**	**4.0**	**75**				**24.9**	**5.4**	**69.7**	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

GRAIN SIZE DISTRIBUTION

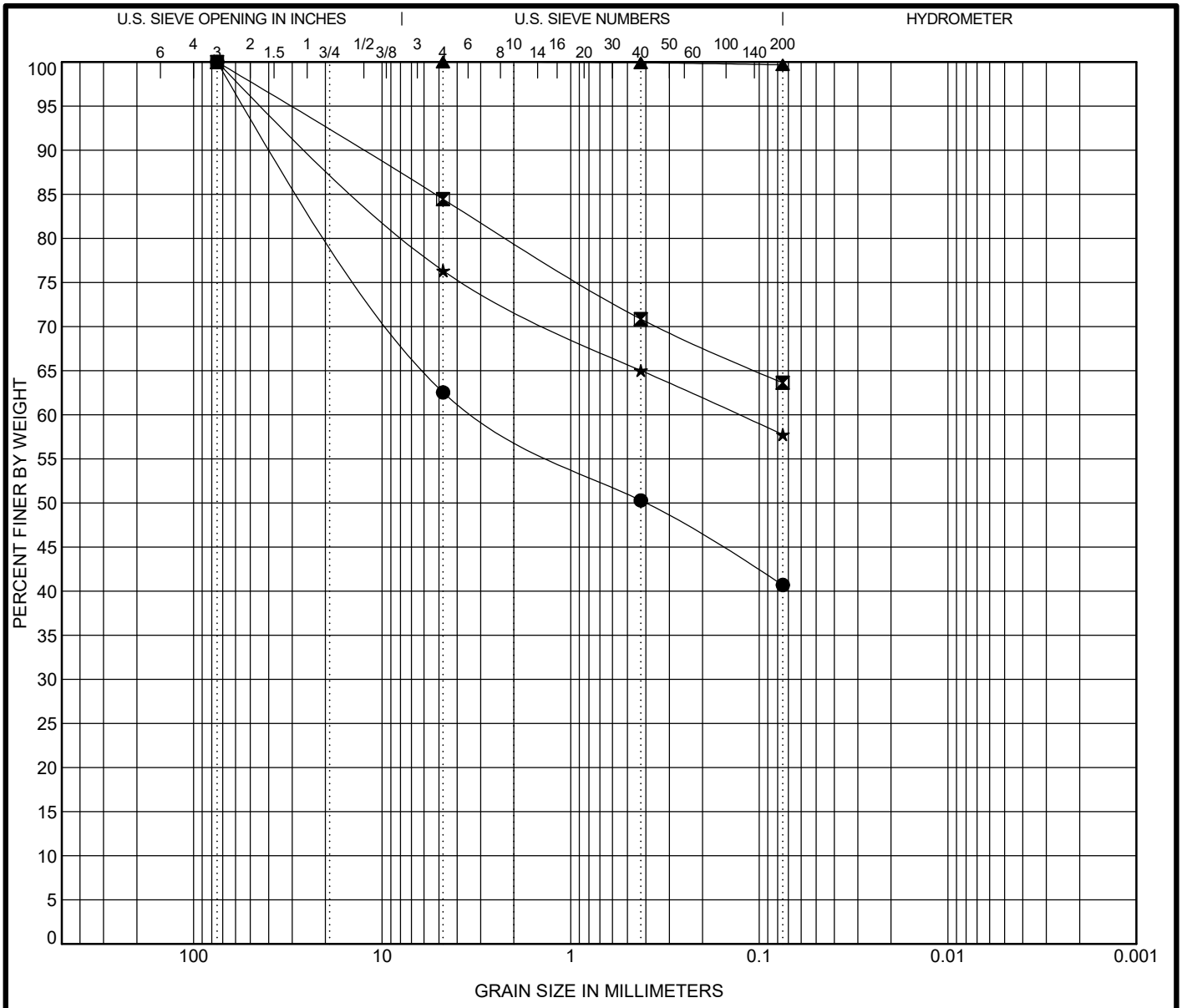
Project: Cagnon Tank

Location: See Boring Location Plan

Job No.: 2020-810

2020-810.GPJ 4/7/21 (GRAIN SIZE ARIAS.US LAB.GDT LIBRARY2013-01.GLB)

Arias Geoprofessionals



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	B- 3		0.5	CLAYEY GRAVEL with SAND (GC)	52	19	33		
⊠	B- 3		8.0	SANDY FAT CLAY with GRAVEL (CH)	55	20	35		
▲	B- 3		13.0	FAT CLAY (CH)	82	26	56		
★	B- 4		0.5	GRAVELLY LEAN CLAY with SAND (CL)	47	19	28		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B- 3	0.5	75	2.883			37.5	21.8	40.7	
⊠	B- 3	8.0	75				15.5	20.8	63.6	
▲	B- 3	13.0	4.75				0.0	0.3	99.7	
★	B- 4	0.5	75	0.128			23.7	18.6	57.8	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

GRAIN SIZE DISTRIBUTION

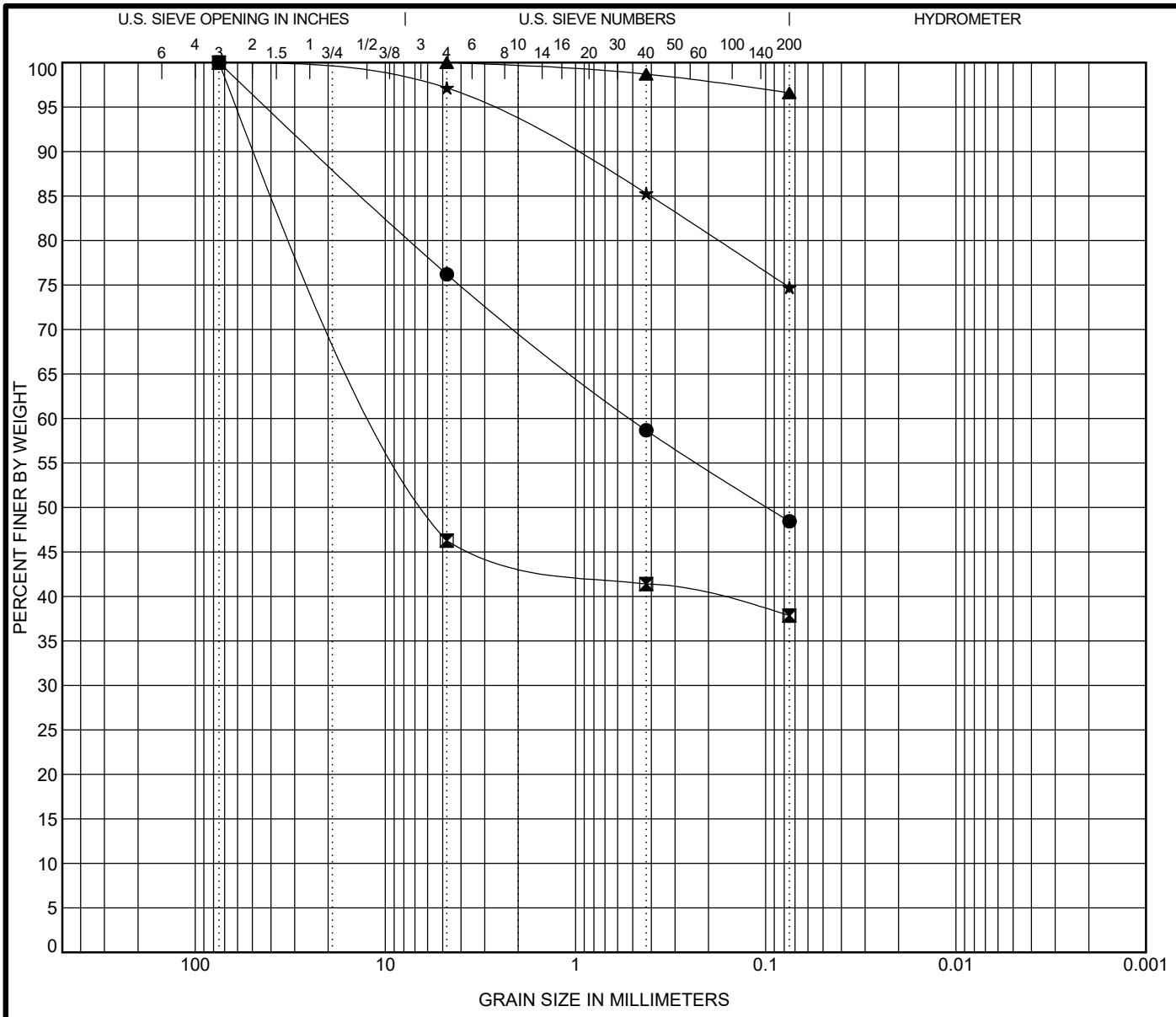
Project: Cagnon Tank

Location: See Boring Location Plan

Job No.: 2020-810

2020-810.GPJ 4/7/21 (GRAIN SIZE ARIAS.US LAB.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Boring	Elev	Depth	Classification	LL	PL	PI	Cc	Cu
●	B- 4		2.0	CLAYEY SAND with Gravel (SC)					
⊠	B- 4		6.0	CLAYEY GRAVEL (GC)	66	22	44		
▲	B- 4		10.0	FAT CLAY (CH)	57	21	36		
★	B- 4		18.0	LEAN CLAY with SAND (CL)	37	17	20		

	Boring	Depth	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B- 4	2.0	75	0.51			23.8	27.8	48.4	
⊠	B- 4	6.0	75	9.61			53.7	8.4	37.9	
▲	B- 4	10.0	4.75				0.0	3.4	96.6	
★	B- 4	18.0	75				2.8	22.4	74.7	

Silt and clay fractions were determined using 0.002 mm as the maximum particle size for clay.

GRAIN SIZE DISTRIBUTION

Project: Cagnon Tank

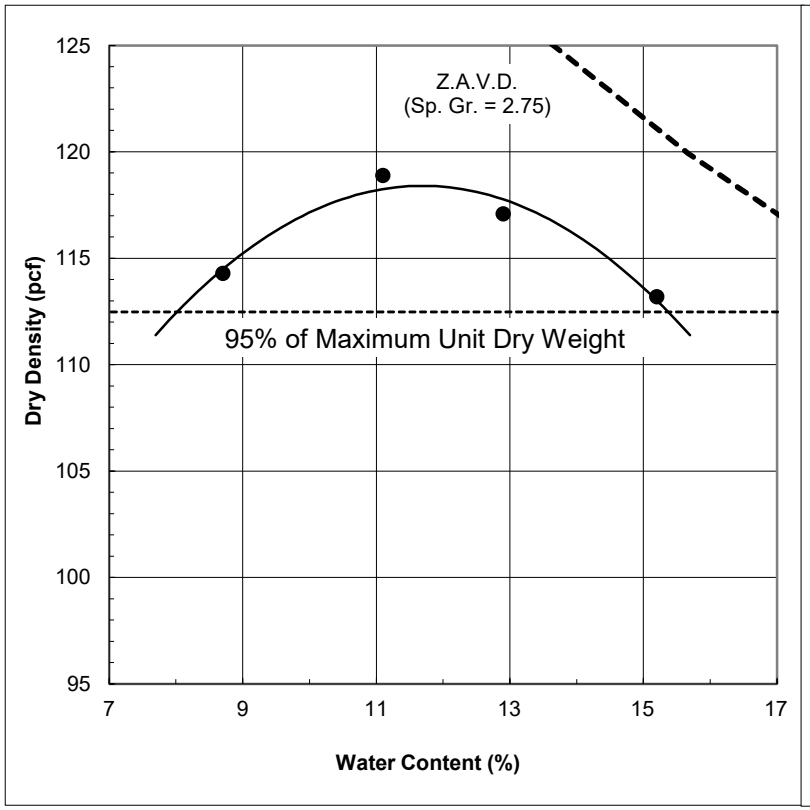
Location: See Boring Location Plan

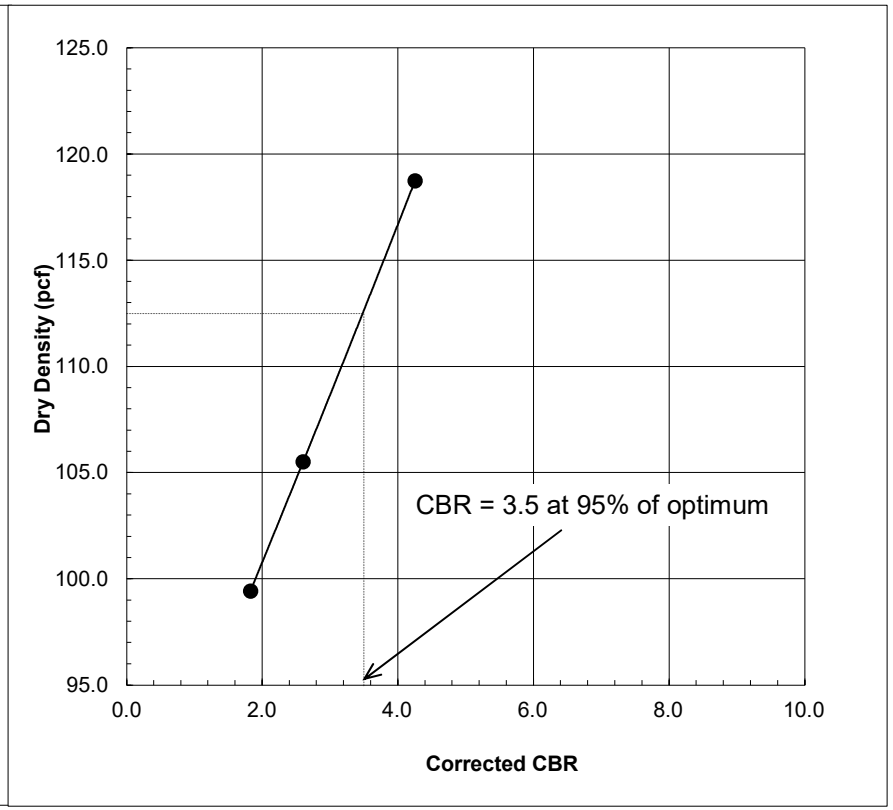
Job No.: 2020-810

2020-810.GPJ 4/7/21 (GRAIN SIZE ARIAS.US LAB.GDT.LIBRARY2013-01.GLB)

Arias Geoprofessionals

APPENDIX E: CBR RESULTS





Sample: 21-322
Test Method: D698 C
Material: Clayey Gravel with Sand (GC), Brown

Optimum Water Content:	11.1 %
Maximum Unit Dry Weight:	118.9 pcf
Liquid Limit:	39
Plasticity Index:	23
% Passing #200 Sieve:	42

% SWELL	
56 Blows:	0.6
25 Blows:	1.0
10 Blows:	0.7

MOISTURE-DENSITY AND CBR TEST RESULTS
SAWS Cagnon Tank
SAN ANTONIO, TEXAS