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30 October 2013

Thomas E. Klein, Jr., P.E., PMP
Project Engineer
Replacements & Improvements
San Antonio Water System
2800 U.S. Hwy 281 North, Suite 300
San Antonio, Texas 78212

VIA E-MAIL: Thomas.Klein@saws.org

RE: Olmos Basin Central Watershed Sewer Relief Line (C-3) Project: Geotechnical Data Study Line C
SAWS Job No. 08-2512
WESTON WO# 10412.015.001

Dear Mr Klein:

The attached geotechnical report prepared by Fugro Consultants, Inc., dated 16 October 2012, is being provided as supplemental information only. Please note that this document does not supersede the San Antonio Water System construction documents, specifications, special conditions or the Contract Documents.

If you have any questions please call me at 210-248-2425.

Very truly yours,

WESTON SOLUTIONS, INC.

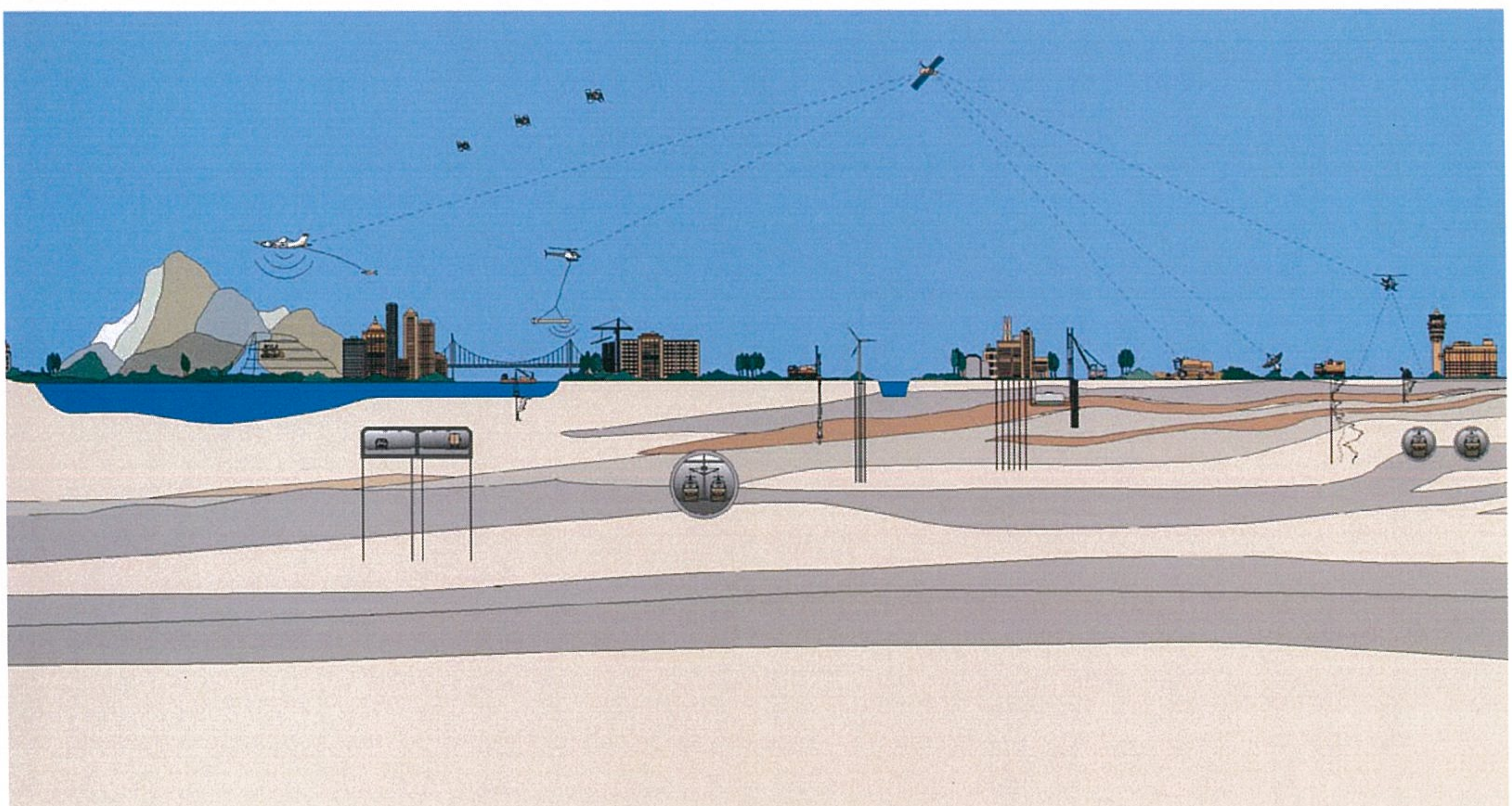
Abdel Hamed, P.E.
Project Manager

cc: Project File
Ms. Maridel Jimenez, P.E. WESTON

FUGRO CONSULTANTS, INC.

GEOTECHNICAL DATA STUDY
LINE C AND LINE E
OLMOS BASIN CENTRAL WATERSHED SEWER RELIEF LINE
SAN ANTONIO WATER SYSTEM
SAN ANTONIO, TEXAS

WESTON SOLUTIONS, INC.
San Antonio, Texas



Project No. 04.60081210-3
October 16, 2012

11009 Osgood
San Antonio, Texas 78233
Phone: 210-655-9516
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Weston Solutions, Inc.
70 NE Loop 410, Suite 600
San Antonio, Texas 78216

Attention: Mr. Abdel Hamed, P.E. and
Ms. Maridel R. Jimenez, P.E.

Geotechnical Data Study
Line C and Line E
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

Introduction

Fugro Consultants, Inc. (Fugro) is submitting this report on the geotechnical study for the above-referenced project. This study was performed in general accordance with Weston Solutions, Inc. Modification #2 of Purchase Order 0072512, dated June 13, 2012, which included the Consulting Services Agreement. Fugro's scope of services is set forth in our proposal for Geotechnical Study, dated June 11, 2012 (Revised).

Project Description

The project will include Line C, a new parallel relief line for the existing Line C. Line C generally runs north-south to the east of US Highway 281. Line C will consist of 54-inch diameter FRPM pipe and will be 3,038 linear feet in length. Line E will be a rerouted replacement line and generally runs east-west along Alamo Heights Boulevard from the existing Line D to the new Line C. Line E will consist of 24-inch diameter PVC pipe and will be 1,479 linear feet in length. The project is located within Olmos Basin Park. Most of the project is within San Antonio city limits; however, a portion of rerouted replacement Line E is located in the City of Alamo Heights.

Purpose

The purpose of this geotechnical study was to obtain samples of the subsurface soils along the alignment to measure pertinent physical characteristics of the materials. This purpose was accomplished by:

1. advancing ten borings, at locations selected by a representative of Weston Solution, along the sewer line alignment to explore the subsurface conditions, and to obtain soil samples;

2. performing laboratory tests on selected soil samples recovered from the borings to evaluate pertinent physical properties; and

3. preparing a data report.

Field Investigation

The subsurface exploration program consisted of ten 15- to 20-ft deep borings, designated as borings B-1 through B-10. The approximate locations of the borings are illustrated on a Plan of Borings, Plate 2. A summary of the borings drilled including boring number, line designation, approximate station of boring, approximate depth to the bottom of pipe, and depth of boring are listed in the table below.

Boring Number	Line Designation	Approximate Station of Boring Location	Approximate Depth to Bottom of Pipe (feet)	Boring Depth (feet)
B-1	C	0+00	13	19.1
B-2	C	4+64	14.5	18.8
B-3	C	9+82	17	18.9
B-4	C	15+39	18	18.7
B-5	C	20+65	17	20
B-6	C	25+67	16	20
B-7	C	30+00	9.5	15
B-8	E	5+11	11	13.6
B-9	E	8+85	12.5	13.9
B-10	E	13+14	12	13.8

Detailed descriptions of the subsurface strata encountered are presented on the Logs of Borings, Plates 3 through 12. Pocket penetrometer values in tons per square foot (tsf) and SPT N-values in blows per foot (bpf) are also shown on the logs of borings. Keys to Terms and Symbols used on the boring logs are set forth on Plate 13 and 14. Groundwater notes are presented at the bottom of the boring logs. Weston Solutions provided the coordinates and ground surface elevations of the actual boring locations shown on the boring logs.

The borings were drilled with a truck-mounted drill rig equipped with 1) continuous flight augers for advancing the holes dry and recovering disturbed samples (ASTM D 1452), 2) seamless push-tubes for obtaining samples of cohesive strata (ASTM D 1587), 3) split-barrel samplers and drive-weight assembly for obtaining representative samples and measuring penetration resistance (N-values) of non-cohesive soil strata (ASTM D 1586), and 4) double-tube core barrels equipped with carbide or diamond impregnated bits for obtaining nominal 2-inch diameter rock cores (ASTM D 2113). In general, soil samples were obtained at about 2-ft intervals to the 10-ft depth, and then at 5-ft intervals thereafter to the boring completion depth.

The boreholes were backfilled with soil cuttings and bentonite pellets, and capped with asphaltic concrete cold patch, where appropriate.

Laboratory Testing

The laboratory testing program was directed toward identification and classification of the soils encountered at the boring locations. To aid in soil classification, Atterberg limits (ASTM D4318) and the percentage of material passing selected U.S. Standard sieves (ASTM D 422) were performed on selected soil samples. Water content measurements were performed on samples in which classifications tests were performed. Unconfined compressive strength tests (ASTM D 2850) were also performed on selected samples; moisture content and unit dry weights were measured as routine portions of the compression tests. The results of the laboratory classification tests are presented on the individual boring logs.

The laboratory testing program also included natural pH, soluble chloride, soluble sulfate and electrical resistivity tests. A summary of the analytical laboratory test results is presented in the following table.

Boring Number	Sample Depth (feet)	PH	Electrical Resistivity (ohm-cm)	Soluble * Sulfate Content (ppm)	Soluble * Chloride Content (ppm)
B-3	7 – 8	8.3	2,080	< 100	< 100
B-10	2 – 3	8.0	1,095	< 100	< 100
* based on dry weight of soil					

Soil Descriptions and Classifications

Descriptions of strata made in the field at the time the borings were drilled were modified in accordance with results of laboratory tests and visual evaluation in the laboratory. All recovered soil samples were evaluated and classified in general accordance with ASTM D 2487 and described as recommended in ASTM D 2488. Classifications of the soils and finalized descriptions of the soil strata are shown on the logs of borings.

Subsurface Conditions

Geologic Setting. A review of available geologic information[1] indicates the alignment is underlain by alluvial soils overlying the Austin Chalk. Alluvium (floodplain deposits) consists of various amounts of clay, silt, sand, and gravel. The Austin Chalk consists of a fairly thick-bedded impure chalk, interstratified with marly beds.

1 Fisher, W.L. (1983), "Geologic Atlas of Texas, San Antonio Sheet," Bureau of Economic Geology. The University of Texas at Austin, map and accompanying explanatory bulletin.

Stratigraphy. Subsurface conditions at the site can be understood by a thorough review of the ten boring logs presented on Plates 3 through 12. Boring B-10 was drilled in a parking lot located south of Alamo Heights Boulevard. Fill material was encountered at the surface of boring B-10 and consisted of two inches of asphaltic concrete overlying 7 inches of crushed limestone base material. A brief summary of the subsurface conditions is provided in the following paragraphs.

Alluvial soils were encountered at each of the boring locations at the surface or below the fill material. These soils generally consisted of fine-grained material (lean and fat clay) and coarser grained soil (clayey gravel with sand). The clay soils have moisture contents between 11 and 38 (average 16), liquid limits between 39 and 124 (average 60), plasticity indices between 23 and 91 (average 42), percentage of material passing the No. 4 sieve between 91 and 100 (average 98), and percentage of material passing the No. 200 sieve between 79 and 97 (average 89). Measured unconfined compressive strengths in the fine-grained deposits were between 3.2 and 11.9 tsf (average 8.0 tsf).

The coarser grained deposits (clayey gravel with sand) have moisture contents between 4 and 15 (average 8), liquid limits between 26 and 79 (average 42), plasticity indices between 12 and 58 (average 27), percentage of material passing the No. 4 sieve between 50 and 65 (average 59), and percentage of material passing the No. 200 sieve between 22 and 41 (average 32). The gravels have SPT N-values between 25 bpf and over 50 bpf.

Weathered Limestone of the Austin Chalk Formation was encountered at four of the ten boring locations, B-2, B-4, B-8, and B-9, at depths of 16, 17, 19 and 13.5 feet, respectively. SPT N-values within the limestone were all greater than 50 bpf.

Groundwater

The borings were advanced using a dry technique; no water or other drilling fluid was introduced to promote the drilling operation. No free water was observed in the boreholes However, groundwater levels will fluctuate with seasonal variations in precipitation and gravel layers will be water bearing during and after rainfall events. Amounts of water will depend on antecedent rainfall and location of site drainage features.

Dewatering

The design of dewatering systems and groundwater control is the sole responsibility of the contractor. This is very appropriate since water control affects construction operations, including excavation and scheduling. However, specifications are necessary to ensure the support properties of subsoil strata are not reduced and adjacent structures are not endangered.

The following technical specification[2] regulating dewatering could be used: "Control of groundwater shall be accomplished in a manner that will preserve the strength of the foundation soils, will not cause instability of the excavated slopes, and will not result in damage to existing structures. Where necessary to this purpose, the water will be lowered in advance of excavation, by wells, wellpoints, or similar methods. Open pumping will not be permitted if it results in boils, loss of fines, softening of the subgrade, or slope instability. Wells and wellpoints will be installed with suitable screen and filters so that pumping of fines does not occur. Discharge will be arranged to facilitate sampling by the engineer."

OSHA Soil/Rock Classifications for Temporary Trench Design

The design of construction and/or temporary slopes and temporary retainage systems are the sole responsibility of the contractor. Suggestions are set forth below in accordance with OSHA[3] for classifying soil and rock encountered in our investigation. It is stressed that these are suggestions only for preliminary planning based on apparent conditions, and the actual trench safety system design, installation, and performance are the contractor's sole responsibility.

Material	OHSA Classification	OSHA Slope
Soil (CH, CL, GC), except loose fill	Type B	1H to 1V
Saturated Soil (CH, CL, GC) including loose fill	Type C	1.5H to 1V or flatter
** Sloping and benching for excavation greater than 20 ft deep shall be designed by a registered professional engineer.		

Soil Corrosion Potential

Steel and concrete elements in contact with soil are subject to degradation due to corrosion or chemical attack. Therefore, buried steel and concrete elements should be designed to resist corrosion and degradation based on accepted practices. General discussions regarding the corrosion of steel and the degradation of concrete with respect to the results of the analytical tests are provided in the following sections of this report.

Corrosion of Steel. Corrosion is a major factor in the life of steel elements in contact with soil. Corrosion is caused by migration of electrons from the steel into the surrounding soil. Three measurable soil properties that indicate the corrosion potential for steel in contact with soil are: 1) soluble chloride, 2) pH, and 3) resistivity. Analytical test results are presented earlier in this report in the "Laboratory Testing" section. It is generally accepted that corrosion of steel is most likely to occur in environments that have chloride ions (even in low concentrations) and low pH.

2 Fang (1991), Chapter 7, "Dewatering Groundwater Control" by Powers, J.P., p. 244.

3 Code of Federal Regulations Title 29 Part 1926 (1989), "Labor", Occupational Safety and Health Administration, Department of Labor, Subpart P - Excavations, pgs 45963-45971.

The following table presents some general guidelines concerning the corrosion potential of soil on steel pipe as a function of soluble chloride and electrical resistivity. If the pH is less than 7, the soil is acidic and corrosive conditions are indicated[4].

Soluble Chloride Concentration[5] (ppm)	Electrical Resistivity[6] (ohm-cm)	Corrosion Potential
> 500	0 –1,000	Very Severe
100 – 500	1,000 – 2,000	Severe
25 – 100	2,000 – 5,000	Moderate
10 – 25	5,000 – 10,000	Mild
-----	10,000 +	Very Mild

Each variable should be used independently of the others when evaluating soil corrosion potential. For example, it is not necessary to have both a resistivity between 0 and 1,000 ohm-cm and a pH less than 7 to indicate a very high corrosion potential.

Measured pH values between 8.0 and 8.3 indicate the soils have a low corrosion potential; measured soluble chloride contents less than 100 ppm indicate the soils have a mild to moderate corrosion potential; and measured electrical resistivity values between 1,095 and 2,080 ohm-cm indicate the soils have a moderate to severe corrosion potential. Based on the results of our analyses, the soils at the site appear to exhibit a severe tendency to corrode buried steel, such as underground steel piping. A Corrosion Engineer should review the test results discussed herein when designing appropriate methods of protecting buried steel.

Degradation of Concrete

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

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4 Johnson Division, UOP Inc., (1975), Ground Water and Wells, Saint Paul, Minnesota, pg. 194.

5 Department of the Navy, Bureau of Yards and Docks, Design Manual, Civil Engineering, NAVDOCKS DM-5, pg. 5-9-53.

6 Palmer, J. F., "Soil Resistivity Measurements and Analysis," *Materials Performance*, Vol. 13, January 1974.

Water Soluble Sulfate Content In Soil[7], (percent)	Water Soluble Sulfate Content In Soil, (ppm)	Degradation Potential
> 2.0	> 20,000	Very Severe
0.2 – 2.0	2,000 – 20,000	Severe
0.1 – 0.2	1,000 – 2,000	Moderate
0.0 – 0.1	0 – 1,000	Mild

Measured soluble sulfate content values were less than 100 ppm, which indicate the soils have a mild potential for the degradation of concrete. For this sulfate concentration level, ACI indicates any type of cement can be used for concrete that comes in contact with the subgrade soils at this site.

Conditions

Our interpretations of subsurface conditions are based on data obtained at the soil boring locations only. Subsurface variations may exist between the boring locations and at areas not explored by soil borings. Statements in this report as to subsurface variation over given areas are intended only as estimations from the data obtained at specific boring locations. In addition, the condition of the soils may change subsequent to our field exploration. Significant variations in subsurface conditions or changed soil conditions may require changes to our conclusions and recommendations. Observations during construction are recommended to check for variations in subsurface conditions and possible changed conditions.

The professional services that form the basis for this report have been performed using that degree of care and skill ordinarily exercised, under similar circumstances, by reputable geotechnical engineers practicing in the same locality. No warranty, express or implied, is made as to the professional advice set forth. Fugro's scope of work does not include the investigation, detection, or design related to the presence of any biological pollutants. The term 'biological pollutants' includes, but is not limited to, mold, fungi, spores, bacteria, and viruses, and the byproducts of any such biological organisms.

The results, conclusions, and recommendations contained in this report are directed at, and intended to be utilized within the scope of work contained in this report. This report is not intended to be used for any other purposes. Fugro Consultants, Inc. makes no claim or representation concerning any activity or condition falling outside the specified purposes to which this report is directed, said purposes being specifically limited to the scope of work as defined in said agreement. Inquiries as to said scope of work or concerning any activity or

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7 American Concrete Institute, *ACI Manual of Concrete Practice*, 1998, Part 1, Materials and General Properties of Concrete, Section 201.2R-10.

condition not specifically contained therein should be directed to Fugro Consultants, Inc. for a determination and, if necessary, further investigation.

This report was prepared for the sole and exclusive use by the client, as an instrument of service. This report shall remain the property of Fugro Consultants, Inc. No third party may use or rely upon the information provided in this report without our express written consent. We assume no responsibility for the unauthorized use of this report by other parties and for purposes beyond the stated project objectives and scope limitations.

* * *

The following plates are attached and complete this report:

	Plate
Vicinity Map	1
Plan of Borings	2
Boring Logs	3 to 12
Keys to Terms and Symbols Used on Boring Logs for Soil and Rock	13 and 14

We appreciate the opportunity to be of service to Weston Solutions and SAWS on this project. Please call if we can be of additional assistance.

Sincerely,

FUGRO CONSULTANTS, INC.
TBPE Firm Registration No. F-299

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Project Engineer

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JUNE M. POTTER
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LICENSED
PROFESSIONAL ENGINEER
10-16-12

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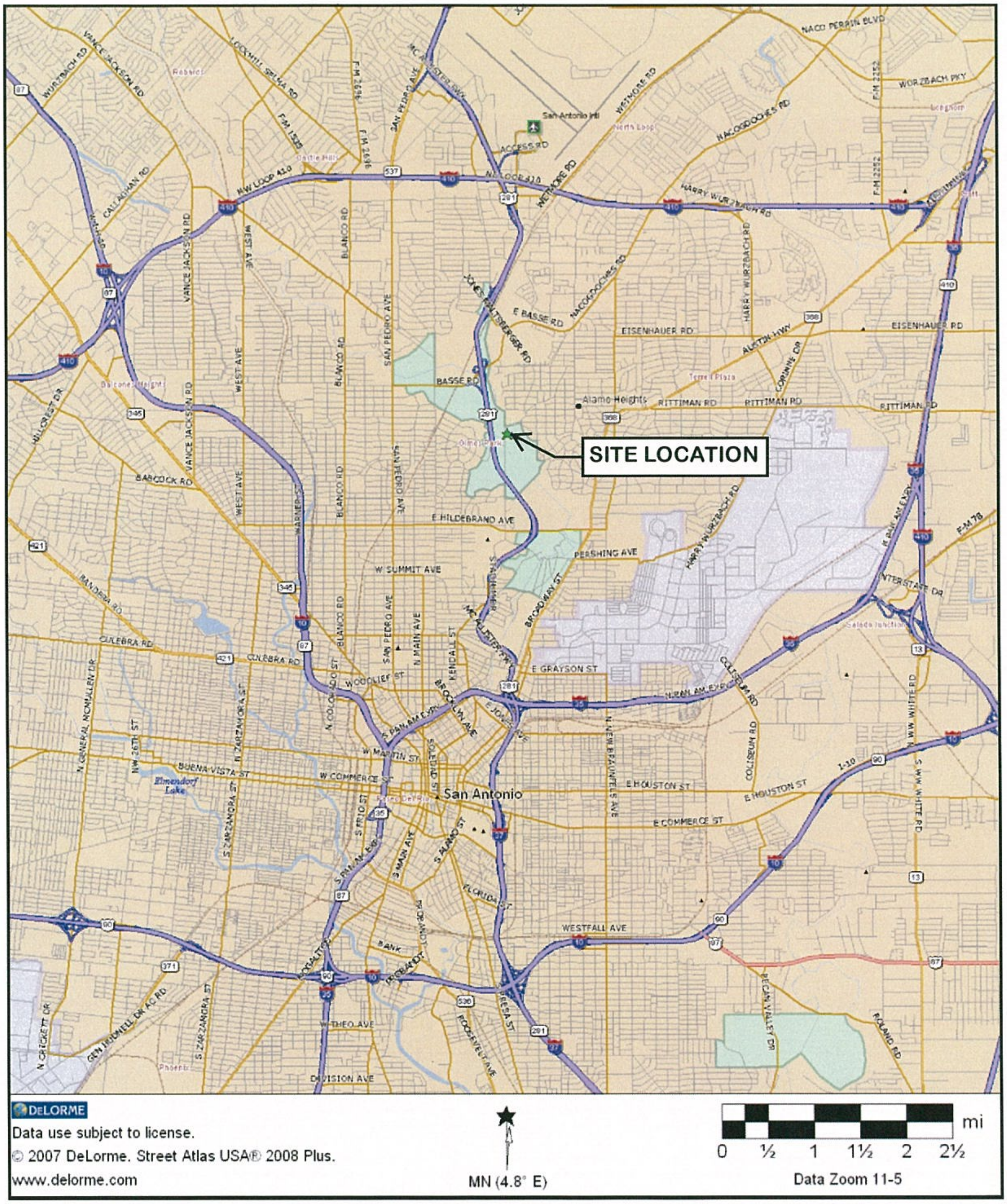
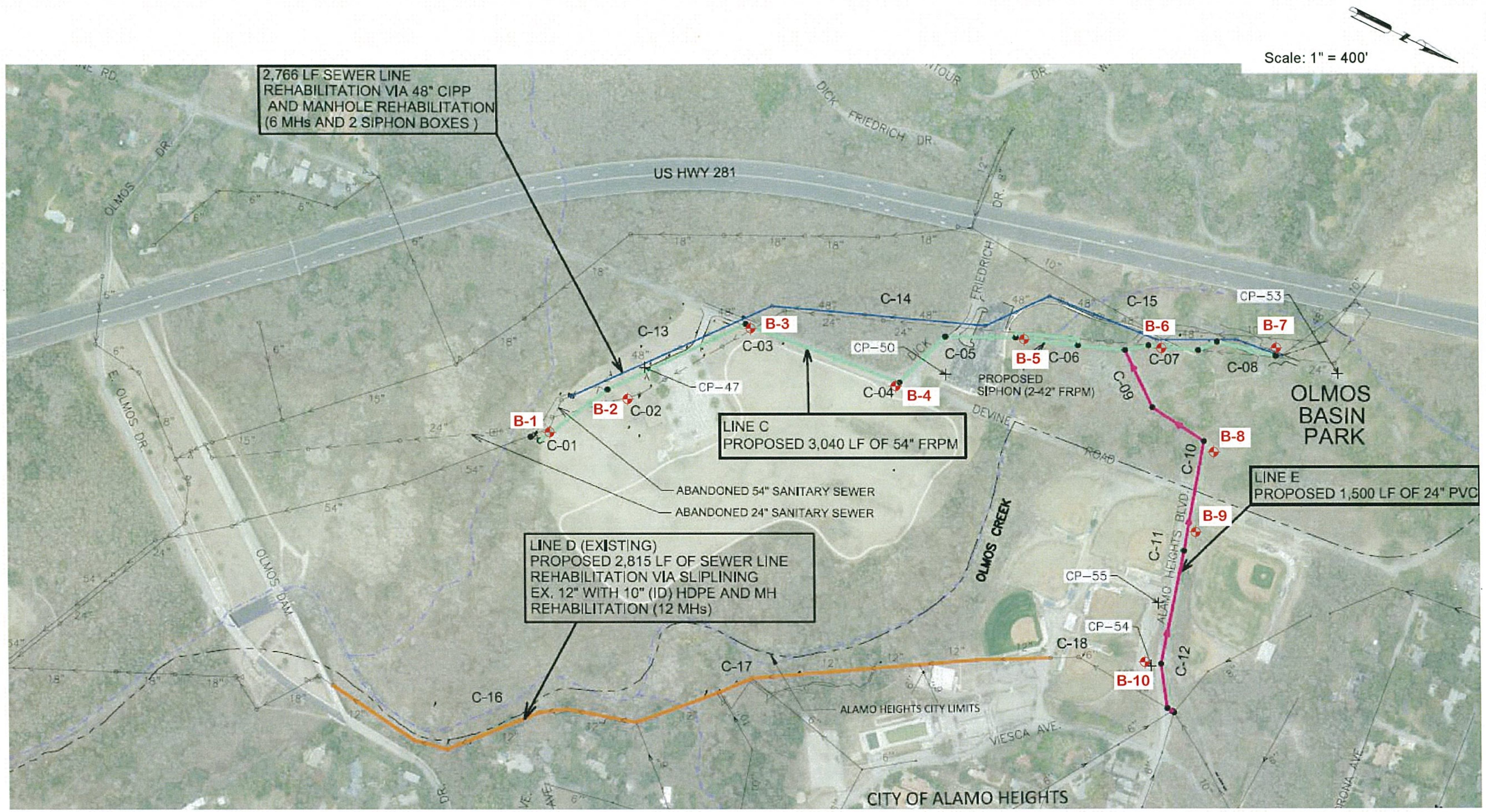
Copies Submitted: (4)
(Geotech:\Geotech 2008\04.60081210-3\report\60081210-3 Rpt Olmos Basin Line C and E)



VICINITY MAP

Line C and Line E
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, Texas

PLATE 1



Note: Plan provided by Weston Solutions, Inc.

PLAN OF BORINGS
Line C and Line E
Olmos Basin Central Watershed Sewer Relief Line
San Antonio Water System
San Antonio, State

PLATE 2

LOG OF BORING NO. B-1

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION (SURF. ELEVATION: 691.73 ft±)	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
			N = 18	FAT CLAY (CH), dark brown, very stiff to hard, with sand (Alluvium)								
			N = 44			17	67	49	100	95		
5			N = 30		685.7 / 6.0							
			P = 4.0	FAT CLAY (CH), brown and gray, very stiff to hard (Alluvium)		21					105	3.2(Q)
			P = 4.5+									
10												
			P = 4.5+		677.7 / 14.0							
15				CLAYEY GRAVEL WITH SAND (GC), light brown to tan, very dense (Alluvium)								
			26 / 50/1"		672.6 / 19.1							
20				Notes: 1) Boring drilled near Station 0+00. 2) Boring was advanced dry and groundwater was not encountered.								

FUGRO
Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 19.1
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'36.01" W
LATITUDE: 29°28'32.26" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 3

FUGRO STD SA (SOIL KSF) 04.60081210-3 BL.GPJ SAN ANTONIO DATA TEMPLATE.GDT 10/16/12

LOG OF BORING NO. B-2

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

SURF. ELEVATION: 694.40 ft±

DEPTH, FT	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
0	N = 26	FAT CLAY (CH), dark brown, very stiff to hard, with sand (Alluvium)								
	P = 4.5+									
	P = 4.5+			13	53	36	99	91		
5			689.4 / 5.0							
		FAT CLAY (CH), brown and gray, hard (Alluvium)								
	P = 4.5+									
	P = 4.5+									
				15					110	11.9(Q)
10										
			681.4 / 13.0							
	N = 53	CLAYEY GRAVEL WITH SAND (GC), brown to light brown, very dense (Alluvium)	680.4 / 14.0							
		FAT CLAY (CH), light brown, hard, with sand and trace gravel (Alluvium)		13	57	41	99	87		
15			678.4 / 16.0							
		LIMESTONE, tan, weathered (Austin Chalk)								
	50/4"		675.6 / 18.8							
20										

Notes:
1) Boring drilled near Station 4+64.
2) Boring was advanced dry and groundwater was not encountered.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 18.8
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'40.91" W
LATITUDE: 29°28'33.96" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 4

LOG OF BORING NO. B-3

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

SURF. ELEVATION: 696.25 ft±

DEPTH, FT	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
	P = 4.5+	FAT CLAY (CH), dark brown to brown, hard, with sand and trace gravel (Alluvium)								
				17	55	39	99	91		
	P = 4.5+			17					89	6.9(Q)
5	P = 4.5+									
	P = 2.0	- very stiff below 6 ft	688.3							
	P = 4.0	LEAN CLAY (CL), brown, tan and gray, very stiff to hard, with gravel layers and sand (Alluvium)	8.0	19	49	34	100	92		
10		- gravel layer at 10 ft								
15	N = 22									
	50/5"		677.4	13	42	25	100	97		
			18.9							
20		Notes: 1) Boring drilled near Station 9+82. 2) Boring was advanced dry and groundwater was not encountered.								

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 18.9
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'44.31" W
LATITUDE: 29°28'37.63" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 5

LOG OF BORING NO. B-4

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

SURF. ELEVATION: 697.85 ft±

DEPTH, FT	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
0	P = 3.5	FAT CLAY (CH), dark brown to brown, very stiff to hard (Alluvium)								
	P = 4.5+									
	P = 4.5+			16					110	5.6(Q)
5										
6	P = 4.5+	LEAN CLAY WITH SAND (CL), brown, hard, with gravel layers and calcareous deposits (Alluvium)	691.9 / 6.0							
				13	48	33	90	79		
	N = 35									
10										
12		CLAYEY GRAVEL WITH SAND (GC), tan, dense (Alluvium)	685.9 / 12.0							
	N = 42			8	27	12	50	22		
15										
17		LIMESTONE, tan, weathered (Austin Chalk)	680.9 / 17.0							
18.7	50/2"		679.2 / 18.7							
20										

Notes:
1) Boring drilled near Station 15+39.
2) Boring was advanced dry and groundwater was not encountered.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 18.7
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'44.34" W
LATITUDE: 29°28'43.14" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 6

FUGRO STD SA (SOIL KSF) 04.60081210-3 BL.GPJ SAN ANTONIO DATA TEMPLATE.GDT 10/16/12

LOG OF BORING NO. B-5

Line C and Line E

Olmos Basin Central Watershed Relief Line

San Anonio, Texas

REPORT NO. 04.60081210-3

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
				SURF. ELEVATION: 697.42 ft±								
			P = 4.5+	LEAN CLAY WITH SAND (CL), brown, hard, with gravel (Alluvium)		12	46	28	94	82		
			P = 4.5+									
			P = 4.5+		692.4							
5				CLAYEY GRAVEL WITH SAND (GC), light brown to tan, medium dense to very dense (Alluvium)	5.0							
			N = 46			8	26	12	54	27		
			N = 25									
10												
			50/3"									
15												
			N = 50			15	79	58	58	33		
					677.4							
20					20.0							

Notes:
1) Boring drilled near Station 20+65.
2) Boring was advanced dry and groundwater was not encountered.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'47.79" W
LATITUDE: 29°28'46.68" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 7

LOG OF BORING NO. B-6

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

SURF. ELEVATION: 697.79 ft±

DEPTH, FT	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
	N = 29	FAT CLAY (CH), brown, very stiff (Alluvium)	695.8							
	N = 52	CLAYEY GRAVEL WITH SAND (GC), tan, dense to very dense (Alluvium)	2.0							
5	30 50/3"			4	50	37	65	32		
	N = 44									
	N = 38									
10										
	N = 26	- medium dense below 13 ft								
15			680.8							
		FAT CLAY (CH), light brown and gray, very stiff (Alluvium)	17.0							
	N = 18		677.8	38	124	91	100	97		
20			20.0							

Notes:
1) Boring drilled near Station 25+67.
2) Boring was advanced dry and groundwater was not encountered.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 20.0
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'50.2" W
LATITUDE: 29°28'51.44" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 8

FUGRO STD SA (SOIL KSF) 04.60081210-3 BL.GPJ SAN ANTONIO DATA TEMPLATE.GDT 10/16/12

LOG OF BORING NO. B-7

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION SURF. ELEVATION: 695.55 ft±	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
			N = 24	FAT CLAY (CH), brown, very stiff (Alluvium)	693.6							
			P = 4.5+	LEAN CLAY (CL), brown to tan, hard, with sand (Alluvium)	2.0							
						12	49	32	100	92		
			P = 4.5+		690.6							
5				FAT CLAY (CH), brown to tan, hard, with gravel layers and sand (Alluvium)	5.0	12					117	7.8(Q)
			P = 4.5+	- gravel layer at 6 ft								
						19	55	38	100	94		
			N = 59									
10				-gravel layer at 10 ft	683.6							
				FAT CLAY WITH SAND (CH), light gray, very stiff (Alluvium)	12.0							
			N = 17			20	89	60	100	76		
15					680.6 15.0							
20				Notes: 1) Boring drilled near Station 30+00. 2) Boring was advanced dry and groundwater was not encountered.								

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 15.0
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'51.77" W
LATITUDE: 29°28'55.46" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 9

LOG OF BORING NO. B-8

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

SURF. ELEVATION: 699.89 ft±

DEPTH, FT	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
	N = 26	FAT CLAY (CH), dark brown, hard, with sand and trace gravel (Alluvium)								
	P = 4.5+			13	58	43	98	88		
				14					111	13.0(Q)
			695.9							
	P = 4.5+	LEAN CLAY WITH SAND (CL), brown, hard, with roots (Alluvium)	4.0							
5			693.9							
	50/5"	CLAYEY GRAVEL WITH SAND (GC), brown, very dense (Alluvium)	6.0							
				5	34	23	68	42		
	39 60/1"		690.9							
		LIMESTONE, tan, weathered (Austin Chalk)	9.0							
10										
			686.3							
	50/1"		13.6							
15										
20										

Notes:
1) Boring drilled near Station 5+11.
2) Boring was advanced dry and groundwater was not encountered.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 13.6
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'46.63" W
LATITUDE: 29°28'54.97" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 10

LOG OF BORING NO. B-9

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

DEPTH, FT	SYMBOL	SAMPLES	POCKET PEN, tsf Blows/ft. REC/RQD, %	STRATUM DESCRIPTION (SURF. ELEVATION: 702.94 ft±)	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
			N = 31	FAT CLAY WITH SAND (CH), dark brown to light brown, hard, with gravel (Alluvium)								
			N = 58			15	73	51	97	85		
5			N = 55		696.9							
			N = 64	CLAYEY GRAVEL WITH SAND (GC), tan, very dense (Alluvium)	6.0							
			40 50/6"			6	32	18	62	35		
10				LEAN CLAY (CL), tan, hard (Alluvium)	692.9 / 10.0							
			50/5"	LIMESTONE, tan, weathered (Austin Chalk)	689.4 / 13.5							
					689.0 / 13.9							
15												
20												

Notes:
1) Boring drilled near Station 8+85.
2) Boring was advanced dry and groundwater was not encountered.

Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 13.9
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'42.39" W
LATITUDE: 29°28'55.34" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

PLATE 11

LOG OF BORING NO. B-10

Line C and Line E
Olmos Basin Central Watershed Relief Line
San Anonio, Texas
REPORT NO. 04.60081210-3

SURF. ELEVATION: 709.84 ft±

DEPTH, FT	POCKET PEN, tsf / Blows/ft. / REC/RQD, %	STRATUM DESCRIPTION	LAYER ELEV./ DEPTH, FT	WATER CONTENT, %	LIQUID LIMIT, %	PLASTICITY INDEX (PI), %	PASSING NO. 4 SIEVE, %	PASSING NO. 200 SIEVE, %	UNIT DRY WEIGHT, PCF	UNDRAINED SHEAR STRENGTH KSF
	N = 25	2" Hot Mix Asphaltic Concrete	709.6 / 0.2							
		7" Fill: Crushed Limestone	709.0 / 0.8							
	P = 3.5	FAT CLAY (CH), dark brown to brown, very stiff to hard (Alluvium)								
5	N = 23		703.8 / 6.0							
	N = 46	CLAYEY GRAVEL WITH SAND (GC), light brown, dense (Alluvium)								
				9	40	26	65	41		
	N = 35									
10			699.8 / 10.0							
		LEAN CLAY (CL), light brown to tan, hard, with sand (Alluvium)								
				11	39	23	100	93		
	50/4"		696.0 / 13.8							
15										
20										

Notes:
1) Boring drilled near Station 13+14.
2) Boring was advanced dry and groundwater was not encountered.

FUGRO
Fugro Consultants, Inc.

COMPLETION DEPTH, FT: 13.8
DATE DRILLED: 7-30-12
LONGITUDE: 98°28'37.28" W
LATITUDE: 29°28'55.44" N

KEY:
N = Standard Penetration Test, bpf
P = Pocket Penetrometer, tsf
U = Unconfined
Q = Unconsolidated Undrained Triaxial

TERMS AND SYMBOLS USED ON BORING LOGS FOR SOIL

SOIL TYPES

CH, fat clays

SC, clayey sands

GC, clayey gravels

CL, lean clays

SM, silty sands

GM, silty gravels

ML, silts

SW, well graded

GW, well graded gravels

Fill, unclassified

SP, poorly-graded sands

GP, poorly graded gravels

SAMPLER TYPES

Thin-Walled Tube

Auger Sample

Standard Penetration Test

SOIL GRAIN SIZE

U.S. STANDARD SIEVE

6"		3"	3/4"	4	10	40	200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT		CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE			
152	76.2	19.1	4.76	2.00	0.420	0.074		0.002	

SOIL GRAIN SIZE IN MILLIMETERS

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNDRAINED [2] SHEAR STRENGTH Kips Per Sq. Ft.	NUMBER OF BLOWS [3] PER FT., N
Very Soft	Less Than 0.25	Less Than 2
Soft	0.25 to 0.50	2 to 4
Firm	0.5 to 1.00	4 to 8
Stiff	1.00 to 2.00	8 to 16
Very Stiff	2.00 to 4.00	16 to 32
Hard	greater than 4.00	greater than 32

CONDITION OF GRANULAR SOILS [2]

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

STRUCTURE [1]

DESCRIPTION	CRITERIA
Stratified	Alternating layers of varying material or color with layers at least 6 mm thick.
Laminated	Alternating layers of varying material or color with the layers less than 6 mm thick.
Fissured	Breaks along definite planes of fracture with little resistance to fracturing
Slickensided Fissured	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	Inclusions of small pockets of different soils

MOISTURE [1]

Dry	-No water evident in sample; fines less than plastic limit.
Moist	-Sample feels damp; fines near the plastic limit
Wet	-Sample bears free water; fines greater than liquid limit
▽	-Free water first observed during drilling.
▼	-Final water measurement at completion of boring.

INCLUSIONS [1]

Parting	-Inclusion <1/8" thick extending through sample.
Seam	-Inclusion 1/8" to 3" thick extending through sample.
Layer	-Inclusion >3" thick extending through sample.
Trace	-<5% of sample.
Few	-5% to 10% of sample.
Little	-10% to 25 % of sample.
Some	-30% to 45% of sample.

REFERENCES:
1) ASTM D 2488
2) Peck, Hanson, and Thornburn, (1974), Foundation Engineering.
3) Das, Braja M., (2002), Principles of Geotechnical Engineering, 5th Edition

Information on each boring log is a compilation of subsurface conditions and soil and rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the times and places indicated, and may vary with time, geologic condition or construction activity.

TERMS AND SYMBOLS USED ON BORING LOGS FOR ROCK

ROCK TYPES

LIMESTONE | DOLOMITE | SANDSTONE

HIGHLY WEATHERED LIMESTONE | HIGHLY WEATHERED DOLOMITE | SHALE

DOLOMITIC LIMESTONE | GRANITE | CLAYSHALE

SAMPLER TYPES

Seamless Push Tube | Core

Standard Penetration Test | Auger

TxDOT Cone Penetration Test | Auger Sample

HARDNESS

Friable	-Crumbles under hard pressure
Low Hardness	-Can be carved with a knife
Moderately Hard	-Can be scratched easily with a knife
Very Hard	-Cannot be scratched with a knife

SOLUTION & VOID CONDITIONS

Void	Interstice; a general term for pore space or other openings in rock.
Cavities	Small solutional concavities.
Vuggy	Containing small cavities, usually lined with a mineral of different composition from that of the surrounding rock.
Vesicular	Containing numerous small, unlined cavities, formed by expansion of gas bubbles or steam during solidification of the rock.
Porous	Containing pore, interstices, or other openings which may or may not interconnect.
Cavernous	Containing cavities or caverns, sometimes quite large. Most frequent in limestones and dolomites.

WEATHERING GRADES OF ROCKMASS [(1)]

TERM	DESCRIPTION
Slightly	Discoloration indicates weathering of rock material And discontinuity surfaces.
Moderately	Less than half of the rock material is decomposed or disintegrated to a soil.
Highly	More than half of the rock material is decomposed or disintegrated to a soil.
Completely	All rock material is decomposed and/or disintegrated to soil. The original mass structure is still largely intact
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed.

JOINT DESCRIPTION

SPACING

- Very Close <2"
- Close 2"-12"
- Medium Close 12"-3'
- Wide >3'

INCLINATION

- Horizontal 0-5
- Shallow 5-35
- Moderate 35-65
- Steeply 65-85
- Vertical 85-90

SURFACES

- Slickensided-Polished, grooved
- Smooth-Planar
- Irregular-Undulating or granular
- Rough-Jagged or pitted

BEDDING

Very Thick	>4'
Thick	2'-4'
Thin	2"-2'
Very Thin	½"-2"
Laminated	0.08"- ½"
Thinly-Laminated	<0.08"

DRILL CORE QUALITY RQD

Excellent quality	90-100%
Good quality	75-90%
Fair quality	50-75%
Poor quality	25-50%
Very poor quality	<25%

RQD = Rock Quality Designation

REFERENCES:
1) British Standard (1981) Code of Practice for Site Investigation, BS 5930
2) The Bridge Div.,Tx. Highway Department Foundation Exploration & Design Manual 2nd Edition, revised June, 1974
3) ASTM D 5878 - 05

Information on each boring log is a compilation of subsurface conditions and soil and rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and observed at the time and places indicated, and may vary with time, geologic condition or construction activity.

Important Information about Your

Geotechnical Engineering Report

Subsurface problems are a principal cause of construction delays, cost overruns, claims, and disputes.

While you cannot eliminate all such risks, you can manage them. The following information is provided to help.

Geotechnical Services Are Performed for Specific Purposes, Persons, and Projects

Geotechnical engineers structure their services to meet the specific needs of their clients. A geotechnical engineering study conducted for a civil engineer may not fulfill the needs of a construction contractor or even another civil engineer. Because each geotechnical engineering study is unique, each geotechnical engineering report is unique, prepared *solely* for the client. No one except you should rely on your geotechnical engineering report without first conferring with the geotechnical engineer who prepared it. *And no one — not even you* — should apply the report for any purpose or project except the one originally contemplated.

Read the Full Report

Serious problems have occurred because those relying on a geotechnical engineering report did not read it all. Do not rely on an executive summary. Do not read selected elements only.

A Geotechnical Engineering Report Is Based on A Unique Set of Project-Specific Factors

Geotechnical engineers consider a number of unique, project-specific factors when establishing the scope of a study. Typical factors include: the client's goals, objectives, and risk management preferences; the general nature of the structure involved, its size, and configuration; the location of the structure on the site; and other planned or existing site improvements, such as access roads, parking lots, and underground utilities. Unless the geotechnical engineer who conducted the study specifically indicates otherwise, do not rely on a geotechnical engineering report that was:

- not prepared for you,
- not prepared for your project,
- not prepared for the specific site explored, or
- completed before important project changes were made.

Typical changes that can erode the reliability of an existing geotechnical engineering report include those that affect:

- the function of the proposed structure, as when it's changed from a parking garage to an office building, or from a light industrial plant to a refrigerated warehouse,
- elevation, configuration, location, orientation, or weight of the proposed structure,
- composition of the design team, or
- project ownership.

As a general rule, *always* inform your geotechnical engineer of project changes—even minor ones—and request an assessment of their impact. *Geotechnical engineers cannot accept responsibility or liability for problems that occur because their reports do not consider developments of which they were not informed.*

Subsurface Conditions Can Change

A geotechnical engineering report is based on conditions that existed at the time the study was performed. *Do not rely on a geotechnical engineering report* whose adequacy may have been affected by: the passage of time; by man-made events, such as construction on or adjacent to the site; or by natural events, such as floods, earthquakes, or groundwater fluctuations. *Always* contact the geotechnical engineer before applying the report to determine if it is still reliable. A minor amount of additional testing or analysis could prevent major problems.

Most Geotechnical Findings Are Professional Opinions

Site exploration identifies subsurface conditions only at those points where subsurface tests are conducted or samples are taken. Geotechnical engineers review field and laboratory data and then apply their professional judgment to render an opinion about subsurface conditions throughout the site. Actual subsurface conditions may differ—sometimes significantly—from those indicated in your report. Retaining the geotechnical engineer who developed your report to provide construction observation is the most effective method of managing the risks associated with unanticipated conditions.

A Report's Recommendations Are *Not* Final

Do not overrely on the construction recommendations included in your report. *Those recommendations are not final,* because geotechnical engineers develop them principally from judgment and opinion. Geotechnical engineers can finalize their recommendations only by observing actual subsurface conditions revealed during construction. *The geotechnical engineer who developed your report cannot assume responsibility or liability for the report's recommendations if that engineer does not perform construction observation.*

A Geotechnical Engineering Report Is Subject to Misinterpretation

Other design team members' misinterpretation of geotechnical engineering reports has resulted in costly problems. Lower that risk by having your geotechnical engineer confer with appropriate members of the design team after submitting the report. Also retain your geotechnical engineer to review pertinent elements of the design team's plans and specifications. Contractors can also misinterpret a geotechnical engineering report. Reduce that risk by having your geotechnical engineer participate in prebid and preconstruction conferences, and by providing construction observation.

Do Not Redraw the Engineer's Logs

Geotechnical engineers prepare final boring and testing logs based upon their interpretation of field logs and laboratory data. To prevent errors or omissions, the logs included in a geotechnical engineering report should *never* be redrawn for inclusion in architectural or other design drawings. Only photographic or electronic reproduction is acceptable, *but recognize that separating logs from the report can elevate risk.*

Give Contractors a Complete Report and Guidance

Some owners and design professionals mistakenly believe they can make contractors liable for unanticipated subsurface conditions by limiting what they provide for bid preparation. To help prevent costly problems, give contractors the complete geotechnical engineering report, *but* preface it with a clearly written letter of transmittal. In that letter, advise contractors that the report was not prepared for purposes of bid development and that the report's accuracy is limited; encourage them to confer with the geotechnical engineer who prepared the report (a modest fee may be required) and/or to conduct additional study to obtain the specific types of information they need or prefer. A prebid conference can also be valuable. *Be sure contractors have sufficient time* to perform additional study. Only then might you be in a position to give contractors the best information available to you, while requiring them to at least share some of the financial responsibilities stemming from unanticipated conditions.

Read Responsibility Provisions Closely

Some clients, design professionals, and contractors do not recognize that geotechnical engineering is far less exact than other engineering disciplines. This lack of understanding has created unrealistic expectations that have led to disappointments, claims, and disputes. To help reduce the risk of such outcomes, geotechnical engineers commonly include a variety of explanatory provisions in their reports. Sometimes labeled "limitations" many of these provisions indicate where geotechnical engineers' responsibilities begin and end, to help others recognize their own responsibilities and risks. *Read these provisions closely.* Ask questions. Your geotechnical engineer should respond fully and frankly.

Geoenvironmental Concerns Are Not Covered

The equipment, techniques, and personnel used to perform a *geoenvironmental* study differ significantly from those used to perform a *geotechnical* study. For that reason, a geotechnical engineering report does not usually relate any geoenvironmental findings, conclusions, or recommendations; e.g., about the likelihood of encountering underground storage tanks or regulated contaminants. *Unanticipated environmental problems have led to numerous project failures.* If you have not yet obtained your own geoenvironmental information, ask your geotechnical consultant for risk management guidance. *Do not rely on an environmental report prepared for someone else.*

Obtain Professional Assistance To Deal with Mold

Diverse strategies can be applied during building design, construction, operation, and maintenance to prevent significant amounts of mold from growing on indoor surfaces. To be effective, all such strategies should be devised for the *express purpose* of mold prevention, integrated into a comprehensive plan, and executed with diligent oversight by a professional mold prevention consultant. Because just a small amount of water or moisture can lead to the development of severe mold infestations, a number of mold prevention strategies focus on keeping building surfaces dry. While groundwater, water infiltration, and similar issues may have been addressed as part of the geotechnical engineering study whose findings are conveyed in this report, the geotechnical engineer in charge of this project is not a mold prevention consultant; ***none of the services performed in connection with the geotechnical engineer's study were designed or conducted for the purpose of mold prevention. Proper implementation of the recommendations conveyed in this report will not of itself be sufficient to prevent mold from growing in or on the structure involved.***

Rely, on Your ASFE-Member Geotechncial Engineer for Additional Assistance

Membership in ASFE/The Best People on Earth exposes geotechnical engineers to a wide array of risk management techniques that can be of genuine benefit for everyone involved with a construction project. Confer with your ASFE-member geotechnical engineer for more information.

ASFE
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