San Antonio Water System

SAN ANTONIO WATER SYSTEM
WATER TRANSMISSION MAIN – ROGERS RANCH TO I.H. 10 PROJECT

SAWS JOB NUMBER 07-7003

ADDENDUM NO. 1
October 6th, 2010

To Bidder of Record:

This addendum, applicable to work referenced above, is an amendment to the bidding documents and as such will be a part of and included in the Contract Documents. Acknowledge receipt of this addendum by entering the addendum number and issue date in the space provided in submitted copies of the proposal.

SPECIFICATIONS:

1. **Geotechnical Engineering Study**

   Add the following reports as separate documents:

   Proposed Water Transmission Main Rogers Ranch to IH-10 Project (Arias Job No. 2010-695) Utility Easement along 20-foot Wide Portion of Line A & B, 30-inch Water Main

   Proposed Water Transmission Main Rogers Ranch to IH-10 Project (Arias Job No. 2010-697) Utility Easement along 50-foot Wide Portion for Line C, 20-inch Water Main

2. **Section 02630 – High Density Polyethylene (HDPE) Solid Wall Pipe, Paragraph VI, Section C, Paragraph VII, Section B (1) & (2):**

   Delete the following at the end of these statements:

   "...Pipe shall be a minimum DR 9."

   Add the following at the end of these statements:

   "...Pipe shall be a minimum SDR 9."

Questions and Answers:

1. Could SAWS schedule a site visit for Contractors to visit the project sites and coordinate with the property owners to secure access to the private properties?
   SAWS has contacted the property owners to request access to these private properties. A site visit has been scheduled for Monday, October 11th, 2010 leaving promptly at 9:00 AM. All interested parties shall meet at the SAWS Headquarters located at 2800 U.S. Highway North, San Antonio, Texas 78212 at the front entrance of the Tower 2 Customer Service Building. In

order to view the site, SAWS staff must escort you to the property site and shall depart promptly at 9:00 AM from the SAWS headquarters. Limited vehicles are allowed inside the premises which may require car pooling to visit the sites.

2. Is the Contractor responsible for Testing with a Third-Party Laboratory?
   Contractor shall be responsible for testing as per Specification Item 01451, Paragraph 1.08.

3. Is the Contractor responsible for Surveying for this project?
   Contractor shall be responsible for field surveying and engineering services required for the construction of the project as specified on Specification Item01720, Paragraph 1.01 and the Special Conditions Section SC-1.2.

4. Can native soil be allowed to be used as backfill?
   Contractor shall backfill all trenches per project Specification Item02317, Paragraph 2.01.

5. For the HDPE Pipe, Section 02630, the DR 9 pipe is not manufactured at the pipe size required of 30-inch inside diameter (I.D.)?
   DR 9 is not a pipe that is available for the dimensions and pressure rating required for this project. Reference the addition of SDR 9 as described in Item 2 aforementioned.

6. When does SAWS anticipate providing the Notice to Proceed and Start of Construction?
   It is SAWS intentions to award the contract for this project on the December 7th, 2010 SAWS Board Meeting and contract shall be executed within 3-4 weeks after the aforementioned date. A scheduled Pre-Construction Conference will be in mid January 2011 at which a Notice to Proceed will be provided to the selected Contractor. Start of Construction is estimated between end of January or early February 2011.

Each bidder is requested to acknowledge receipt of this Addendum No. 1 by his/her signature affixed hereto and to file same with and attach to his/her bid.

STATE OF TEXAS
JUAN G. RODRIGUEZ
101255
LICENSED
PROFESSIONAL ENGINEER

10-6-10

P.E.

Juan G. Rodriguez, P. E.
Project Engineer
Production & Transmission Engineering

The undersigned acknowledges receipt of this Addendum No. 1 and the bid submitted herewith is in accordance with the information and stipulations set forth.

________________________ ____________________________
Date Signature of Bidder

This Addendum, including these two (2) pages, is 61 pages with attachment in its entirety.

San Antonio Water System

MEETING SIGN-IN SHEET

Project:	Water Transmission Main – Rogers Ranch to I.H. 10 Project (Job No. 07-7003)	**Meeting Date:**	October 5th, 2010
Subject:	Pre-Bid Meeting	**Place/Room:**	CR-C137

Name	Company	Phone	E-Mail
Jeff Ballard	Gamcor Trenching	512-636-5500	Jeff.gamcor@yahoo.com
KEITH DRAKE	PESADO	210-651-9452	Keith@pesadocontractorco.com
Augie Luna	Don Kelly Const.	817 472 8169	BillG@DonKellyconstruction.com
Ben Arnold	Cravens Services	713-300-1530	estimating@cravensInc.com
Gilbert Pena	SAWS	210-233-7603	gpena@saws.org
JUAN G. RODRIGUEZ	SAWS	210-233-3598	jgrodriguez@saws.org
Diana W. Dwyer	SAWS Contracting	2102-233-3372	ddwyer@saws.org
JIM PEDRAZA	SAWS	210-233-3594	jpedraza@saws.org

ROGERS RANCH MINUTES

MEETING DATE/TIME: **October 5, 2010 10:00am to 11:00am**

LOCATION: **SAWS Main Office - Tower II CR-C137**

ATTENDANTS: **Gramcor Trenching - Jeff Ballard**
Pesado - Keith Drake
Don Kelly Construction - Augie Luna
Cravens Services - Ben Arnold

SAWS Attendees:
Production Engineering Manager – Jim Pedraza
Production Project Engineer – Juan G. Rodriguez
Contract Administrator – Diana Dwyer
Project Technicians – Gilbert Pena & Todd Jenkins

PURPOSE: **Pre-Bid Meeting**

The following is our understanding of the subject matter covered in this meeting. If this differs with your understanding, please notify us.

Juan Rodriguez conducted the meeting and started by introducing SAWS personal to the bidders. He then proceeded to talk about the project and gave us an overview of property descriptions, pipe material to be installed and job requirements. This Project is being advertised with bid opening on October 15, 2010 at 10:00 am. Plans and specifications are available.

Diana Dwyer explained the requirements needed to qualify to bid and be awarded the project. Her main comments were as follows:

- **Any additional questions will be received Friday the 8th of October after 4pm. Marisa Robles will help with questions up to the bid date on October the 15th.**
- **Bidders must show references of similar work done within the past 5 years.**
- **Bidders must meet insurance certificate requirements and submit a complete package.**

Q&A:

Question:
When will the project begin?
Answer:
Work should begin in mid-January or in February.

San Antonio Water System

Q&A:

Question:
Can we see the sites?
Answer:
Yes. But, permission must be granted on some sites. We will make arrangements for a site visit.

Question:
HDPE directional drill DR9 & DR11 pipe do not meet 200psi pressure rating?
Answer:
We will use another HDPE pipe that meets the requirement. We will look at SDR pipe.

ADDITIONAL COMMENTS:
Juan tells the contractors about the tree permit acquired by SAWS from the City Arborist and the need to follow the requirements as shown on the plans as well as the erosion control plan requirements. The TXDoT highway & Tree bore permits will also be acquired by SAWS. He requested 'Special Conditions' for Line C be observed and regular contact and cooperation with the owner.

Geotechnical Engineering Study

Proposed Water Transmission Main
Rogers Ranch to IH-10 Project
San Antonio, Texas

Utility Easement along a 20-foot Wide Portion for Line A & B, 30-inch Water Main

SAWS Job No. 07-7003
Arias Job No. 2010-695

ARIAS & ASSOCIATES
Geotechnical · Environmental · Testing

Prepared For
San Antonio Water System

September 29, 2010

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

September 29, 2010
Arias Job No. 2010-695

Mr. Juan G. Rodriguez, P.E.
Project Engineer
San Antonio Water System
2800 U.S. Hwy 281 North
San Antonio, TX 78212

Re: Geotechnical Engineering Study
Proposed Water Transmission Main
Rogers Ranch to IH-10 Project (Job No. 07-7003)
San Antonio, Texas

Dear Mr. Rodriguez:

The results of our Geotechnical Engineering Study for the subject project are presented in this report. Our findings and recommendations should be incorporated into the design and construction documents for the proposed 30-inch Water Main. Please consult with us, as needed, during any part of the design or construction process.

We recommend that the site work and construction be tested and observed by one of our representatives in accordance with the report recommendations. In addition, we can and would like to perform construction observation and materials testing services during construction.

Thank you for the opportunity to be of service to you.

Sincerely,
Arias & Associates, Inc.
TBPE Registration No: F-32

Rebecca R. Bennett, M.S., E.I.T.
Geotechnical Project Engineer

Rene P. Gonzales, P.E.
Senior Geotechnical Engineer

STATE OF TEXAS
RENE P. GONZALES
86259
LICENSED
PROFESSIONAL ENGINEER
9/29

1295 Thompson Rd.
Eagle Pass, Texas 78852
(830) 757-8891
(830) 757-8899 Fax

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San Antonio, Texas 78232
(210) 308-5884
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1030 Logandale
Houston, Texas 77032
(281) 227-2243
(281) 227-7088 Fax

Park 37 Industrial Complex
5233 IH 37, Ste B-12
Corpus Christi, Texas 78408
(361) 288-2670
(361) 288-4672 Fax

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INTRODUCTION

This report presents the results of a Geotechnical Engineering Study for the proposed San Antonio Water System (SAWS) Water Transmission Main, Rogers Ranch to IH-10 Project in San Antonio, Texas. This study was performed in general accordance with the scope of services outlined in Arias Proposal No. 2010-695, dated August 2, 2010, and was authorized to proceed by Mr. Jim Pedraza, P.E., of SAWS, via memorandum dated August 9, 2010.

SCOPE OF SERVICES

The purpose of this engineering study was to

- conduct a geotechnical subsurface exploration along the proposed alignment of the 30-inch water main in order to establish trenching engineering properties of the subsurface materials and groundwater conditions at the site, and
- perform laboratory testing on the subsurface samples obtained at the site as need to classify the materials and their engineering properties.

The information from the field exploration and laboratory testing was used to develop the geotechnical engineering criteria presented in this report. This report was prepared for use by the design engineers and their team to assist in the design and construction of the 30-inch water main within the proposed 20-foot wide easement area.

PROJECT AND SITE DESCRIPTION

General Site Location

The proposed project site is located on the northwest side of San Antonio, Texas. The alignment of the new water main begins approximately 0.28 mile (1,500 feet) north of the intersection of Loop 1604 and NW Military Highway and ends approximately 0.5 mile (2,640 feet) east of IH-10 at the La Cantera/Worth Parkway intersection inside the Rim Shopping Center. The portion of the alignment addressed in this study lies within a 20-foot easement extending along the eastern side of NW Military Highway, continuing along the eastern and then northern perimeter of the Redland Worth Property and further continuing along the northern perimeter of the Martin Marietta property line. A Vicinity Map is provided in the attachments to this report.

Project Description

The project includes the construction of 12,400 LF of a 30-inch (I.D.) water main. We understand that the new water main will tie into an existing 20-inch water main located at the east side of NW Military Highway and ultimately tie into an existing 16-inch water main located at the La Cantera/Worth Parkway intersection. We understand that the depth of the trenching for this new water main will vary from approximately 8 feet to 12 feet within the 20-foot easement section of the alignment. The standard minimum of five (5) feet of cover above the crest of the pipeline will be maintained.

Existing Site Description

The north-south portion of the project alignment addressed in this study parallels NW Military Highway and private/commercial property. This area is in a near natural condition and is covered with dense vegetation consisting of natural grasses, weeds, brush and juniper trees. The east-west portion of the project alignment addressed in this study abuts private and commercial property. The commercial property (*i.e.*, the Martin Marietta property) is generally clear of vegetation. The topography observed within the project alignment varies from sloping gently to sloping at approximately 11 degrees. The alignment has several road crossings in its central area. The east-west portion of the alignment parallels the existing electrical transmission line easement. Representative Site Photographs showing the local site conditions at the time of the field exploration are provided in the attachments to this report.

SOIL BORINGS AND LABORATORY TESTS

The geotechnical field exploration was conducted on August 20, 2010. A total of seven (7) test borings were drilled at the approximate locations shown on the attached Boring Location Plan. Three (3) of the test borings were located along the proposed north-south project alignment and four (4) of the test borings were located along the proposed east-west project alignment. The locations of the test borings were chosen to adhere to a spacing of approximately 2,000 LF. The test borings were each drilled to a depth of approximately 15 feet as referenced from the ground surface as it existed at the time of the field exploration. The test boring locations and boring depths are summarized in Table 1.

Table 1. Summary of Test Boring Locations

Test Boring	Depth of Test Boring	General Location along the Project Alignment
B-1	15 ft.	General north-south alignment within the 20-foot wide easement
B-2	15 ft.	
B-3	15 ft.	
B-4	15 ft.	General east-west alignment within the 20-foot wide easement
B-5	15 ft.	
B-6	15 ft.	
B-7	15 ft.	

The drilling was performed in general accordance with ASTM D1586 procedures for the Split Spoon sampling technique as described in the Appendix. A truck-mounted drill rig using the air rotary drilling method together with the sampling tool noted were used to secure the subsurface samples. Borehole logging and preliminary classification of the collected subsurface samples were conducted during the exploration by one our field engineering staff.

As a part of the field data collection activities, Standard Penetration Test (SPT) N-value blow counts were recorded during the drilling activities. The SPT N-values provide information on the relative consistency/density of the subsurface material. As a supplement to the field exploration, laboratory testing to determine soil water content, grain size, and expansion characteristics was conducted. The laboratory results are reported in the attached test boring logs and summarized in Table 2. Samples were examined, classified and tested both in the field during the drilling and sampling operation and after being received into the laboratory in accordance with the procedures stated in the Appendix of this report.

Sample Disposal *Once this report is submitted, remaining soil samples recovered from this exploration will be routinely discarded unless requested otherwise*.

SUBSURFACE CONDITIONS

Geology

The earth materials underlying the project site have been regionally mapped as the Edwards Limestone Group (Ked) Formation of lower Cretaceous age. Locally, the materials encountered in the test borings consist primarily of limestone bedrock with some overlying alluvial soils. The alluvial soils are considered to be comprised of both active and recent deposits (Qal) and older Terrace deposits (Qt) of Pleistocene age. Active alluvial soils were noted in Test Boring B-7 and consist of silty sands in a loose condition. The older Terrace deposits were encountered in Test Borings B-4 & B-7 and consist of very stiff clays and dense to very dense clayey gravels. The underlying limestone bedrock was found to be in a very dense and well cemented condition and contained scattered red clay filled fractures.

A fault segment of the Balcones Fault System has been mapped to cross through the western portion of the project area near Test Boring B-7. The Balcones Fault System has not had any known surface activity following the end of the Miocene epoch, approximately 5 million years before present, and from a geologic point of view the fault system is considered to be inactive and should pose minimal seismic risk to the proposed development.

It should be noted that the Edward Limestone formation is characterized by the presence of solution cavities/voids and is often vuggy. While solution voids were not observed at the boring locations, they may be encountered during the open-cut trenching that will be conducted during the installation of the proposed water main.

Site Stratigraphy and Engineering Properties

The generalized subsurface soil conditions as determined from the field and laboratory data are summarized in Table 2 for the portion of the proposed 30-inch Water Main alignment addressed in this study. Differences in the subsurface stratigraphy along each project site cross-section may be due, in part, to:

- localized deposition and erosion of the alluvial soils (as discussed previously in the *Geology* section of this report),
- differences in the ground surface elevation among the test borings which off-sets the depth to the contacts between similar soil/rock types, and
- past grading activities in the areas associated with, for example, construction of the NW Military Highway roadway.

20-foot Utility Easement: The subsurface samples obtained from Test Borings B-1 through B-7 represent the general subsurface conditions within the 20-foot wide easement associated with the alignment of the proposed water main. The subsurface samples from the locations of Test Borings B-1, B-2 and B-3, and from the locations of Test Borings B-5 and B-6 indicate that a thin veneer of gravelly top soil exists over the formational limestone bedrock material. The limestone bedrock observed was in a very dense condition. No karst features were encountered at the boring locations.

The subsurface stratigraphy at the locations of Test Borings B-4 and B-7 differs from that observed at Test Borings B-1, B-2, B-3, B-5 and B-6. The conditions at the Test Boring B-4 location consist of approximately ten (10) feet of alluvial materials over limestone bedrock. The upper alluvial soils consist of a clayey gravel (GC) material generally in a medium dense condition. The underlying CH clays and clayey gravels (GC) are generally in a hard or very dense condition, respectively. At the location of Test Boring B-7 the observed subsurface stratigraphy consist of alluvial materials to the boring completion depth of approximately 15 feet. Near the existing ground surface are silty sands (SM) generally in a loose to medium dense condition. The underlying materials include clayey gravels in a medium dense condition, clays in a very stiff condition, and clayey gravels in a dense condition.

Table 2. Generalized Material Stratigraphy in the Area of the Proposed Main Pipeline Site

Depth (feet)	Description	WC range / WC avg.	PI range / PI avg.	#200 range / #200 avg.	N range / N avg.
Test Borings B-1, B-2, B-3 – North-South Portion of the Project Alignment					
0 to (0-1)	**Clayey GRAVEL(GC)** with cobbles and boulders, dark brown, in a very dense condition or **CLAY(CH)**, reddish-brown, in a hard condition	9 – 12	24 – 28	17 – 75	--
		11	**26**	**46**	****10/0"**
(0-1) to 15	**LIMESTONE,** white, in a very dense condition	0 – 3	NP – 14	--	--
		1	**4**	**--**	****10/0"**
Test Boring B-4 – Eastern-most Portion of the East-West Portion of the Project Alignment					
0 to 2	**Clayey GRAVEL(GC),** dark brown, in a medium dense condition	--	--	--	--
		5	**45**	**24**	**17**
2 to 6	**CLAY(CH),** with Gravel, gray with dark brown, in a very hard condition	9 – 17	--	--	39 – 65
		13	**35**	**63**	**52**
6 to 10	**Clayey GRAVEL(GC)**, brown to light brown, very dense	8 – 22	--	--	--
		15	**46**	**27**	****50/4"**
10 to 15	**LIMESTONE**, white, in a very dense condition	1 – 4	--	--	--
		3	**3**	**--**	****10/0"**
Test Borings B-5 and B-6 – Mid Portion of the East-West Portion of the Project Alignment					
0 to (0.25-1)	**Clayey GRAVEL(GC)**, with cobbles and boulders, gray-brown, in a very dense condition	2 – 7	--	--	50/3" - **10/0"
		5	**36**	**33**	**>50/3"**
(0.25-1) to 15	**LIMESTONE**, white, in a very dense condition	0 – 9	NP-5	--	--
		3	**2**	**--**	****10/0"**
Test Boring B-7 –Western most Portion of the East-West Portion of the Project Alignment					
0 to 4	**Silty SAND(SM)**, tan, in a loose to medium dense condition	2 – 4	--	--	6 – 11
		3	**NP**	**46**	**9**
4 to 8	**Clayey GRAVEL(GC)**, dark brown, in a medium dense condition	12 – 23	--	--	17 – 23
		18	**35**	**32**	**20**
8 to 13	**CLAY(CL),** dark brown, in a very stiff condition	22 – 25	--	--	20 – 21
		24	**27**	**80**	**21**
13 to 15	**Clayey GRAVEL(GC),** dark brown, in a dense condition	--	--	--	--
		19	**29**	**35**	**42**

Where: **Depth -** Soil stratum depth (ft.) from existing ground surface at the time of geotechnical investigation
WC – Moisture Content, %
PI - Plasticity Index
NP – Non-Plastic
#200 - Percent passing #200 sieve, %
N - Standard Penetration Test (SPT) value, blows per foot
**** -** Standard Penetration Test (SPT) value measured during the seating operation

Groundwater

A dry soil sampling method was used to obtain the soil samples at the project site. Groundwater was not observed to the 15-foot completion depth of the test borings. Clay soils are generally not conducive to the presence of groundwater; however, gravelly strata such as observed in Test Boring B-4 and B-7 can store and transmit “perched” groundwater flow or seepage. Highly fractured and weathered zones or karst features within the limestone bedrock are also potential conduits for subsurface groundwater that has percolated from the surface.

Upon completion of the drilling and exploration activities the drill holes were grouted closed and the site cleaned as required.

Variations

Conditions may vary between the sample boring locations. Transition boundaries or contacts noted on the boring logs to separate material types are approximate. Actual contacts may be gradual and vary at different locations. ***If conditions encountered during construction indicate more variation than established as a result of this study, we should be contacted to evaluate the significance of the changed conditions relative to our recommendations.***

ENGINEERING ANALYSIS AND DESIGN

Lateral Earth Pressure

Lateral earth pressure for design of trench shoring can use the following design parameters for short term conditions:

Table 3. Summary of Parameters for Lateral Earth Pressure Calculations

Test Boring	Depth (ft.)	Description	γ_e	C	φ	k_a	k_p
B-1 B-2 B-3	0 to 1	Clayey GRAVEL(GC) or CLAY(CH)	120	0	30	0.4	2.5
	1 to 15	LIMESTONE	130	10,000	0	NA	3.0
B-4	0 to 2	Clayey GRAVEL(GC)	120	0	30	0.4	2.5
	2 to 6	CLAY(CH)	120	1,000	0	0.6	1.7
	6 to 10	Clayey GRAVEL(GC)	120	0	30	0.4	2.5
	10 to 15	LIMESTONE	130	10,000	0	NA	3.0
B-5 B-6	0 to 1	Clayey GRAVEL(GC)	120	0	30	0.4	2.5
	1 to 15	LIMESTONE	130	10,000	0	NA	3.0
B-7	0 to 4	Silty SAND(SM)	120	0	28	0.4	2.5
	4 to 8	Clayey GRAVEL(GC)	120	0	30	0.4	2.5
	8 to 13	CLAY(CL)	120	1,000	0	0.6	1.7
	13 to 15	Clayey GRAVEL(GC)	120	0	30	0.4	2.5

where: **γ_e** = effective soil unit weight, pcf
C = undrained soil shear strength, psf
φ = angle of internal friction, deg.
k_a = coefficient of active earth pressure
k_p = coefficient of passive earth pressure
NA (not applicable) – sound intact limestone should not apply a lateral pressure to the shoring

Lateral earth pressures on the trench shoring can be calculated considering a rectangular pressure diagram having a magnitude of:

$$(\gamma_e)(H)(k_a)$$

where γ and k_a are provided above and H is the depth of excavation in feet. Any surcharge loads including equipment loads, and soil stockpiles and hydrostatic pressures should be added to this value as required.

Pipe Deflection Parameters

We have compiled the parameters that will be needed for pipe deflection calculations. The soil reaction, E_n, may be computed using the following equation:

$$E_n = (e)(r)$$

where: E_n = soil reaction, psi
e = Modulus of subgrade reaction, pci
r = radius of pipe, inches

The following table outlines the modulus of subgrade reaction, e, values for the materials encountered at this site.

Table 4. Modulus of Subgrade Reaction Parameters

Description	e (pci)
CLAY (CL-CH)	**50**
Clayey GRAVEL(GC)	**60**
Formational: LIMESTONE	**125**

Trench Excavations and Slopes

We understand that the depth of the open-cut trenches within the project alignment will range between 8 feet and 12 feet. Occupational Safety and Health Administration (OSHA) regulations must be followed concerning temporary allowable slopes.

Trench excavations should not be left open for long periods of time in order to minimize soil moisture changes. If bearing soils are exposed to severe drying or wetting, the unsuitable soil must be re-conditioned or removed as appropriate, prior to placement of the proposed Water Main.

The contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, *e.g.,* OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, dated October 31, 1989. Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties. The soils encountered at this site were classified as to type in accordance with this publication. ***For this site the clays (CH-CL), silty sands (SM) and clayey gravels (GC) observed at the project site are classified as "Type C" soils. The limestone bedrock may be classified as stable rock.*** It is very important to note that the OSHA soil classifications are based upon the soil/rock profiles observed *at the locations of the test borings*. It is possible that differences in the subsurface stratigraphy or groundwater conditions exist at other locations at the site.

The following must be noted regarding the excavation-trenching operations:

- For excavations less than 20 feet deep, the maximum allowable slope for Type "C" soils is 1.5H:1V (34°). The sides of the excavation in competent limestone bedrock may be vertical. It must be noted that layered slopes cannot be steeper at the top than the underlying slope and that all materials other than stable rock below the water table must be classified as Type "C" soils. The OSHA publication should be referenced for layered soil conditions, benching, etc.

- The OSHA soil classifications and slope information provided above are for <u>temporary</u> slopes. Permanent slopes at this site would require slope stability analysis and very flat slopes may be required in gravelly/sandy areas.
- The subsurface clay and clayey gravel materials encountered during this study were generally in a hard condition or medium dense to dense condition respectively. Heavy duty excavating equipment will be required for excavating in the hard clays and dense clayey gravels observed along the proposed Water Main alignment. The contractor should provide such heavy duty excavating equipment.
- The soils encountered in Test Borings B-4 and B-7 during our study contained clayey gravel strata. These clayey gravels would be more susceptible to caving and sloughing during excavation or boring operations, particularly if groundwater is encountered. The contractor should be prepared for such conditions and ensure that adequate safety measures are provided to protect workers as well as structures and pavements from caving or sloughing.
- Minimum cover and installation means and methods for the new Water Main should be approved by the appropriate governing agency and should conform to all appropriate design requirements.

The materials to be penetrated by excavations may vary across the site. Our soil classification is based solely on the materials encountered in seven test borings placed along the proposed Water Main alignment. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that Arias be contacted immediately to evaluate the conditions encountered. Flatter slopes and dewatering techniques may be required for conditions differing from those observed during the field exploration.

As stated previously, the Edward Limestone formation is characterized by the presence of solution cavities/voids and is often vuggy. ***While solution voids were not observed at the boring locations, they may be encountered during the open-cut trenching that will be conducted during the installation of the proposed water main.*** Proper treatment of these features will be required to maintain the integrity of the pipeline bearing surface and adhere to governmental regulations.

Trenches less than 5 feet deep are generally not required to be sloped back or braced following federal OSHA requirements for excavations. Sides of temporarily vertical excavations less than 5 feet deep may stay open for short periods of time, however, the clayey or gravelly soils that may be encountered in trench excavations are subject to random caving and sloughing. If side slopes begin to slough, the sides should be either braced or be sloped back to at least 1V: 1H.

If any excavation, including a utility trench, is extended to a depth of more than twenty (20) feet, it will be necessary to have the side slopes designed by a professional engineer registered in Texas.

As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to no less than the slope height.

Specific surcharge loads such as traffic, heavy cranes, earth stockpiles, pipe stacks, etc., should be considered by the Trench Safety Engineer. It is also important to consider any vibratory loads such as heavy truck traffic.

It is required by OSHA that the excavations be carefully monitored by a competent person making daily construction inspections. These inspections are required to verify that the excavations are constructed in accordance with the intent of OSHA regulations and the Trench Safety Design. If deeper excavations are necessary or if actual soil/rock conditions vary from the borings, the trench safety design may have to be revised. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation and the presence of any surface slope cracks should also be carefully monitored.

Excavated materials should not be placed close to the top of slope of the excavation so as not to cause instability in the excavation/trench.

Subgrade Considerations

The bottoms of trench excavations should expose strong competent soils or bedrock and should be dry and free of loose, soft, or disturbed soil. If fill soils are encountered at the base of trench excavations, their competency should be verified through probing and density testing. Soft, wet, weak, or deleterious materials should be over-excavated to expose strong competent soils. At locations where soft or weak soils extend for some depth, over-excavation to stronger soils may prove infeasible and/or uneconomical. In the event of encountering these areas of deep soft or weak soils, we recommend that the bottom of the trench be over-excavated by one to two feet, and replaced with an open-graded aggregate (such as a uniform gradation of gravel between 0.5 to 2.0 inches). This aggregate will allow for drainage of water, as well as providing a stable working platform.

We recommend good surface drainage away from excavations be established to prevent surface runoff from flooding excavations. The Water Main should be installed and backfilled as soon after excavation as possible.

Bedding & Backfill of Utilities

We recommend good surface drainage away from excavations be established to prevent surface runoff from flooding excavations. The utilities should be installed and backfilled as soon after excavation as possible.

Bedding: The granular bedding materials should be placed in lifts around the sides and crown of the pipe in accordance with the ***Project Specifications, Section 02317, Excavating, Backfilling and Compaction*** as required to prevent void areas. Mechanical tampers are often used for this purpose. All granular bedding materials should comply with SAWS gradation requirements. The bedding material should extend at least one (1) foot above the crown of the pipe in accordance with ***Section 02317, 3.07(A)***.

Secondary Backfill: The secondary backfill operations for trenches should not be started until the Water Main is properly bedded in accordance with the above referenced recommendations. Soils/rock millings removed from the trench excavations will generally be suitable as secondary backfill above the bedding provided they are not saturated and do not contain organics, debris, or other deleterious material. Secondary backfill materials for all types and sizes of pipe shall be as defined in ***Section 02317, 3.07 (B)*** and shall be free from clods of such size as to interfere with compaction (3” maximum particle size).

The secondary backfill should be placed in loose lifts not exceeding 9 inches. The backfill should be placed at a moisture content of –1 to +3% of optimum, and then uniformly compacted to at least 90 percent of the maximum dry density as determined by ASTM D-698. If pavement overlays the pipeline(s), the secondary backfill shall be compacted to at least 98 percent of the standard Proctor (ASTM D-698) maximum dry density.

If wet weather or extended dry periods deteriorate the surface whereby a good bond cannot be formed between successive lifts, the earthwork contractor should prepare the surface as necessary. This preparation may include removing or scarifying the top two of inches of the underlying material, or wetting the material before placing the next lift.

CONSTRUCTION CRITERIA

Site Drainage

Poor drainage, and the resulting ponded water, can cause high plasticity clays to swell and may compromise the strength of the side excavation soils We recommend that an effective site drainage plan be devised by others prior to commencement of construction to provide positive drainage away from the excavation perimeters and off the site for both during and after construction. It should be noted that while groundwater was not encountered during the field exploration, its potential presence within the project alignment may be related to the actual climatic conditions at the time of construction.

We recommend that one of our representatives be scheduled to observe that the site preparation operations are performed in accordance with our recommendations.

If existing structures are discovered during excavation, we should be informed immediately to determine the impact of those structures on our recommendations.

Earthwork
Exposure to the environment may weaken the soils at the bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that the waterline be installed and the excavation is backfilled as soon as possible to minimize potential damage to bearing soils (such as those anticipated in the areas of Test Borings B-4 and B-7). If bearing soils are exposed to severe drying or wetting, the unsuitable materials must be re-conditioned or removed as approximate. The bearing level should be free of loose soil, ponded water or debris, and should be observed prior to the water main placement by the representative of the Geotechnical Engineer.

Subgrade preparation and backfill placement operations should be monitored by the soil engineer or his representative. As a guideline, at least one in-place density test should be performed for each 400 linear feet of compacted surface per lift and in accordance with ***Section 01451, Quality Control*** and ***Section 02317, 3.10***. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

It should be noted that heavy duty excavating equipment may be required for excavating in hard/dense materials.

Excavations
Excavations should comply with OSHA Standard 29CFR, Part 1926, Subpart P and all State of Texas and local requirements. Trenches 20 feet deep or greater require that the protective system be designed by a registered professional engineer. A trench is defined as a narrow excavation in relation to its depth. In general, the depth is greater than the width, but the bottom width of the trench is not greater than 15 feet. Trenches greater than 5 feet in depth require a protective system such as trench shields, trench shoring, or sloping back of the excavation side slopes.

The Contractor's "Competent Person" should perform daily inspections of the trench to verify that: (1) the trench is properly constructed; (2) surcharge and vibratory loads are not excessive; (3) excavation spoils are sufficiently away from the edge of the trench; (4) proper ingress and egress into the trench is provided; and (5) all other items are performed as outlined in these OSHA regulations. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation, and the presence of any surface slope cracks, should also be carefully monitored.

Although the geotechnical report provides an indication of material types to be anticipated, actual material and groundwater conditions could vary along the excavation. The "Competent Person" must evaluate the materials and groundwater in the excavation at the time of construction to verify that proper sloping or shoring measures are performed.

Appendix B to the regulations has sloping and benching requirements for short-term trench exposure for various soil types up to the maximum allowable 20-foot depth requirement.

QUALITY CONTROL

As Geotechnical Engineer of record, we should be engaged to: (1) observe and evaluate earthwork for site subgrade improvement activities to determine that the actual bearing materials are consistent with those encountered during the field exploration; and (2) monitor and test the fill placement and subgrade preparation. It is also important that we be given the opportunity to review the design and construction documents. The purpose of this review is to check to see if our recommendations are properly interpreted into the project plans and specifications.

Subgrade preparation and fill placement operations should be monitored by the Geotechnical Engineer or his representative. As a guideline, at least one in-place density test should be performed for each 400 linear feet per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

If there are any revisions to the plans for the proposed project, or if deviations from the subsurface conditions noted in this report are encountered during construction, Arias should be retained to determine if changes in the geotechnical recommendations are required. If Arias is not retained to perform these functions, Arias will not be responsible for the impact of those conditions.

It is recommended that Arias be retained to provide observation and testing of construction activities involved in the earthwork and related activities of this project. Arias cannot accept any responsibility for any conditions which deviate from those described in this report or for the performance of the project elements if not engaged to also provide construction observation and testing for this project.

All sheeting, shoring, and bracing of trenches, pits, horizontal borings and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration.

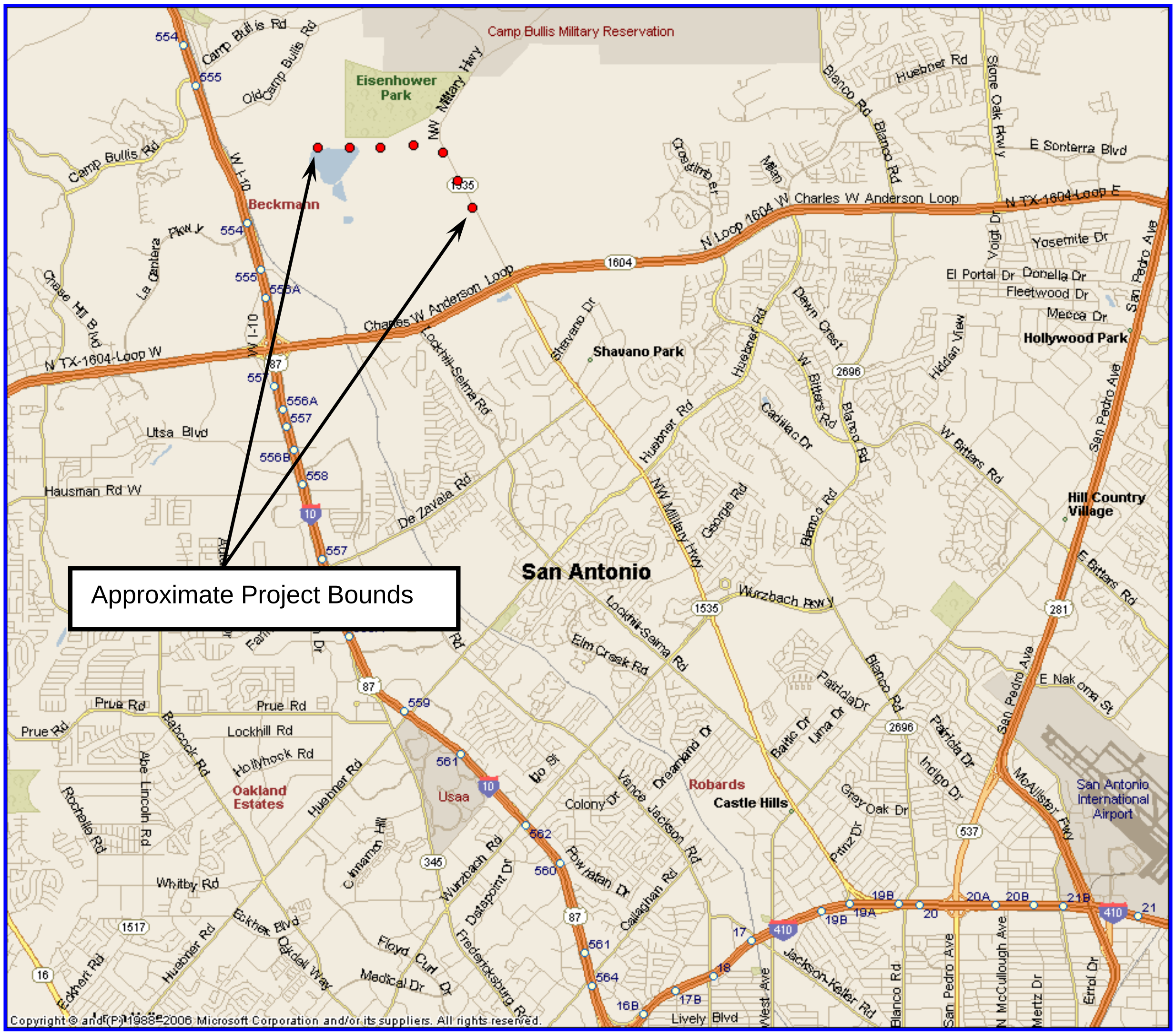
GENERAL COMMENTS

This report was prepared for this project exclusively for the use of Mr. Juan G. Rodriguez, P.E., of San Antonio Water System, and his design team. If the development plans change or if different subsurface conditions are encountered, we should be informed and retained to ascertain the impact of these changes on our recommendations. We cannot be responsible for the potential impact of these changes if we are not informed.

The materials to be penetrated by excavations may vary significantly across the site. Our classification is based solely on the materials encountered in widely spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that Arias be contacted immediately to evaluate the conditions encountered.

This report has been prepared in accordance with generally accepted geotechnical engineering practice with a degree of care and skill ordinarily exercised by reputable geotechnical engineers practicing in this area.

VICINITY MAP



Proposed SAWS Water Transmission Main
Rogers Ranch to IH-10 Project
SAWS Job No. 07-7003

Study Bounds Limited to the Alignment within the
20-foot Easement for Line A and B

San Antonio, Texas

Representative Photographs of Project Area

Site Photograph 1. General View Looking West from the Vicinity of Test Boring B-4.

Site Photograph 2. General View of the Vicinity near Test Boring B-4.

Site Photograph 3. General View of the Project Location between Test Borings B-4 and B-5. Note the debris present within the general alignment of the proposed Water Main.

Site Photograph 4. General View of the Location between Test Borings B-4 and B-5.

Site Photograph 5. General Site View looking West.

Site Photograph 6. General Site View from the area of Test Boring B-6 looking westward down towards Test Boring B-7.

BORING LOCATION PLAN

NOTE: Locations are approximate. Drawing is not to scale.

Boring Log No. B-1

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
Clayey GRAVEL (GC), cobbles, boulders, dark brown, very dense		1: SS	9	29	53	24	10/0"	17
LIMESTONE white, very dense	2	2: SS	1				**10/0"	
	4	3: SS	1	19	23	4	**10/0"	
	6	4: SS	1				**10/0"	
	8	5: SS	1				**10/0"	
- weathered LIMESTONE with red clay seams	10	6: SS	2	16	30	14	**50/2"	
	12							
	14	7: SS	1				**10/0"	
Completion Depth: 15 feet	16							

Groundwater Observed: None

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

Boring Log No. B-2

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
CLAY (CH), reddish brown, hard		1: SS	12	22	50	28	10/0"	75
LIMESTONE white, very dense	2	2: SS	3				**10/0"	
	4	3: SS	2				**10/0"	
	6	4: SS	1	17	18	1	**10/0"	
	8	5: SS	2				**10/0"	
	10	6: SS	3	14	25	11	**10/0"	
- weathered LIMESTONE with red clay seams	12							
	14	7: SS	1				**10/0"	
Completion Depth: 15 feet	16							

Groundwater Observed: None

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG REVISED 2010-695.GPJ ARIAS.GDT 9/28/10

Arias & Associates, Inc.

Job No.: 2010-695

Boring Log No. B-3

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N
LIMESTONE white, very dense		1: SS	1				**10/0"
	2	2: SS	1	16	14	NP	**10/0"
	4	3: SS	1				**10/0"
	6	4: SS	0				**10/0"
- weathered LIMESTONE with red clay seams							
	8	5: SS	2	15	14	NP	**10/0"
	10	6: SS	2				**10/0"
	12						
	14	7: SS	1	16	18	2	**10/0"
Completion Depth: 15 feet	16						

Groundwater Observed: None

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
NP = Non-plastic

BORING LOG REVISED 2010-695.GPJ ARIAS.GDT 9/28/10

Arias & Associates, Inc.

Job No.: 2010-695

Boring Log No. B-4

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
Clayey GRAVEL (GC), gray with dark brown, medium dense		1: SS	5	24	69	45	17	24
	2							
CLAY (CH), gray with dark brown, very hard								
- trace Gravel, very hard		2: GB	9	22	57	35	65	63
	4							
- hard		3: SS	17				39	
	6							
Clayey GRAVEL (GC), brown, very dense		4: SS	22	22	71	49	**50/4"	27
	8							
- brown to light brown		5: SS	8				**50/4"	
	10							
LIMESTONE white, very dense		6: SS	4				**10/0"	
	12							
		7: SS	1	18	21	3	**10/0"	
	14							
Completion Depth: 15 feet								
	16							

Groundwater Observed: None

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
GB = Grab Bag Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

Boring Log No. B-5

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N
Clayey GRAVEL (GC), with cobbles and boulders, gray brown		1: SS	2				50/3"
LIMESTONE white, very dense	2	2: SS	3				**10/0"
	4	3: SS	2				**10/0"
	6	4: SS	2	19	16	NP	**10/0"
	8	5: SS	9				**10/0"
	10	6: SS	7				**10/0"
	12						
	14	7: SS	5				**10/0"
Completion Depth: 15 feet	16						

Groundwater Observed: None

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
NP = Non-plastic

Boring Log No. B-6

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
Clayey GRAVEL (GC), with cobbles and boulders, dark gray, very dense		1: SS	7	30	66	36	**10/0"	33
LIMESTONE white, very dense	2							
		2: SS	1				**10/0"	
	4							
		3: SS	0				**10/0"	
	6							
		4: SS	0	18	23	5	**10/0"	
	8							
		5: SS	0				**10/0"	
	10							
		6: SS	2				**10/0"	
- weathered seam	12							
		7: SS	1				**10/0"	
	14							
Completion Depth: 15 feet	16							

Groundwater Observed: None

Grab Bag Sample (GB)
Shelby Tube Sample (ST)
Split Spoon Sample (SS)
Water encountered during drilling
Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

Boring Log No. B-7

Address: **20-ft easement - Rogers Ranch to IH-10**
San Antonio, Texas
Location: **See Boring Locaton Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
Silty SAND (SM), tan, loose (possibly fill)		1: SS	2	NP	NP	NP	6	46
	2							
- medium dense		2: SS	4				11	
	4							
Clayey GRAVEL (GC), dark brown, medium dense		3: SS	23	25	60	35	23	32
	6							
		4: SS	12				17	
	8							
CLAY (CL), dark brown, very stiff		5: SS	22	22	49	27	20	80
	10							
		6: SS	25				21	
	12							
Clayey GRAVEL (GC), dark brown, dense	14	7: SS	19	22	51	29	42	35
Completion Depth: 15 feet	16							

Groundwater Observed: None

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
NP = Non-plastic

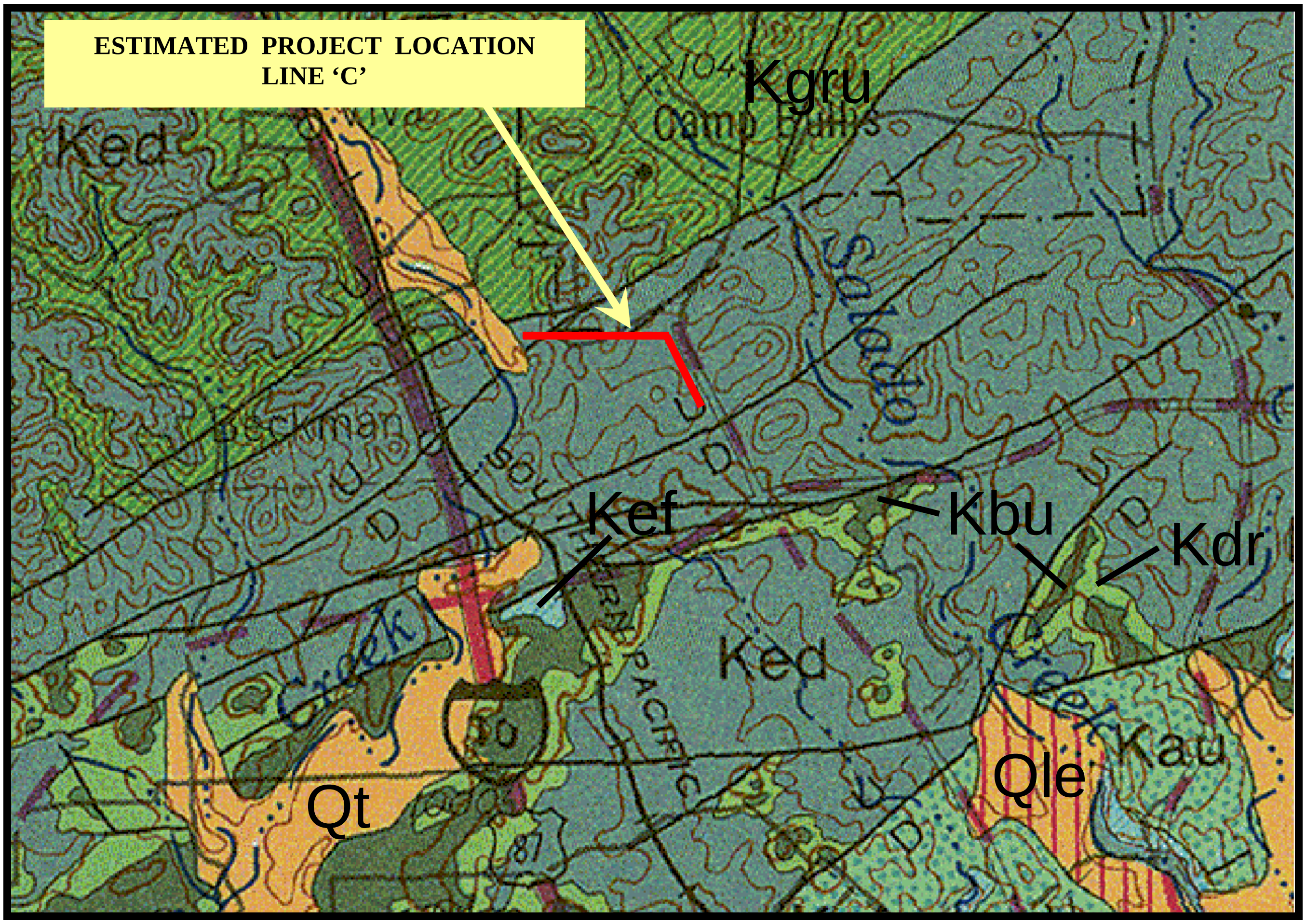
-200 = % Passing #200 Sieve

KEY TO CLASSIFICATION 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 is 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

Arias & Associates, Inc.

GEOLOGIC MAP



PORTION OF GEOLOGIC ATLAS OF TEXAS

LEGEND

Symbol	Name	Age
Qal	Active Alluvial Deposits	Quaternary Period / Holocene Epoch
Qt	Alluvial Terrace Deposits	Quaternary Period / Pleistocene Epoch
Qle	Leona Formation (Alluvium)	Quaternary Period / Pleistocene Epoch
Kau	Austin Chalk Formation	Upper Cretaceous Period
Kef	Eagle Ford Formation	Upper Cretaceous Period
Kbu	Buda Limestone Formation	Upper Cretaceous Period
Kdr	Del Rio Clay Formation	Upper Cretaceous Period
Ked	Edwards Group Limestone	Lower Cretaceous Period
Kgru	Upper Glen Rose Formation	Lower Cretaceous Period
U / D	Fault Segment with Indication of Relative Movement	

Proposed SAWS Water Transmission Main
Rogers Ranch to IH-10 Project
SAWS Job No. 07-7003
San Antonio, Texas

Arias & Associates, Inc. Arias Job No.: 2010-695

APPENDIX

Laboratory and Field Test Procedures

Soil Classification Per ASTM D2487-93
This soil testing standard was used for classifying soils according to the Unified Soil Classification System. The soil classifications of the earth materials encountered are as noted in the attached boring logs.

Soil Water Content Per ASTM D2216-92
This test determines the water content of soil or rock expressed as a percentage of the solid mass of the soil. The test results are listed under **MC** in the attached boring logs.

Soil Liquid Limit Per ASTM D4318-93
The soil Liquid Limit identifies the upper limit soil water content at which the soil changes from a moldable (plastic) physical state to a liquid state. The Liquid Limit water content is expressed as a percentage of the solid mass of the soil. The test results are listed under **LL** in the attached boring logs.

Soil Plastic Limit Per ASTM D4318-93
The soil Plastic Limit identifies a lower limit soil water content at which the soil changes from a moldable (plastic) physical state to a non-moldable (semi-solid) physical state. The Plastic Limit water content is expressed as a percentage of the solid mass of the soil. The test results are listed under **PL** in the attached boring logs.

Plasticity Index Per ASTM D4318-93
This is the numeric difference between the Liquid Limit and Plastic Limit. This index also defines the range of water content over which the soil-water system acts as a moldable (plastic) material. Higher Plasticity Index (PI) values indicate that the soil has a greater ability to change in soil volume or shrink and swell with lower or higher water contents, respectively. The test results are listed under **PI** in the attached boring logs.

Standard Penetration Test (SPT) and Split Spoon Sampler (SS) per ASTM D 1586
This is the standard test method for both the penetration test and split-barrel (spoon) sampling of soils. This sampling method is used for soils or rock too hard for sampling using Shelby Tubes. The method involves penetration of a split spoon sampler into the soil or rock through successive blows of a 140 pound hammer in a prescribed manner.

Blow Counts (N) per ASTM D 1586
This is the number of blows required to drive a Split Spoon Sampler by means of a 140 pound hammer for a distance of 12 inches in accordance with the variables stated in the test procedures.

Shelby Tube (ST) per ASTM D 1587
This procedure is for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of physical properties.

Rock Core per ASTM D 2113
This procedure is for using diamond core drilling equipment to obtain core samples of rock and some soils that are too hard to sample by soil-sampling methods.

Dry Density (DD) per ASTM D 2937
This procedure is for the determination of in-place density of soil. The test results are measured in pounds per cubic foot, pcf.

Unconfined Compression Test (UC) per ASTM D 2166
This test method covers the determination of the unconfined compressive strength of cohesive soil in the undisturbed, remolded, or compacted condition, using strain-controlled application of the axial load.

Minus No. 200 Sieve per ASTM D 1140
This test method covers determination of the amount of material finer than a Number 200 sieve by washing. The results are stated as a percent of the total dry weight of the sample.

Pocket Penetrometer (PP): This test method is an accepted modification of ASTM D 1558 test method for establishing the moisture-penetration resistance relationships of fine-grained soils. The test results are measured in tons per square foot, tsf. The strength values provided by this method should be considered qualitatively.

Rock Quality Designation (RQD) : The measure of the quality of a rock mass defined by adding intact rock core pieces greater than four inches in length by the total length of core advance per ASTM 6032.

Recovery Ratio (REC): The Recovery Ratio is equal to the total length of core recovered divided by the total length of core advance.

Boring Logs: This is a summary of the above described information at each boring location.

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
THE BEST PEOPLE ON EARTH

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Telephone: 301/565-2733 Facsimile: 301/589-2017
e-mail: info@asfe.org www.asfe.org

Geotechnical Engineering Study

Proposed Water Transmission Main
Rogers Ranch to IH-10 Project
San Antonio, Texas

Utility Easement along a 50-foot Wide Portion for Line C, 20-inch Water Main

SAWS Job No. 07-7003
Arias Job No. 2010-697

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

Prepared For
San Antonio Water System

September 29, 2010

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

September 29, 2010
Arias No. 2010-697

Mr. Juan G. Rodriguez, P.E.
Project Engineer
San Antonio Water System
2800 U.S. Hwy 281 North
San Antonio, TX 78212

Re: **Geotechnical Engineering Study**
Proposed Water Transmission Main
Rogers Ranch to IH-10 (Job No. 07-7003)
San Antonio, Texas

Dear Mr. Rodriguez:

The results of our Geotechnical Engineering Study for the subject project are presented in this report. Our findings and recommendations should be incorporated into the design and construction documents for the proposed Water Main. Please consult with us, as needed, during any part of the design or construction process.

We recommend that the site work and construction be tested and observed by one of our representatives in accordance with the report recommendations. In addition, we can and would like to perform construction observation and materials testing services during construction.

Thank you for the opportunity to be of service to you.

Sincerely,
Arias & Associates, Inc.
TBPE Registration No: F-32

Ricardo Cruz, E.I.T.
Geotechnical Project Engineer

Rene P. Gonzales, P.E.
Senior Geotechnical Engineer

STATE OF TEXAS
RENE P. GONZALES
86259
LICENSED
PROFESSIONAL ENGINEER

TABLE OF CONTENTS

INTRODUCTION

This report presents the results of a Geotechnical Engineering Study for the proposed San Antonio Water System (SAWS) Water Transmission Main, Rogers Ranch to IH-10 Project in San Antonio, Texas. This study was performed in general accordance with the scope of services outlined in Arias Proposal No. 2010-697, dated August 2, 2010, and was authorized to proceed by Mr. Jim Pedraza, P.E., of SAWS, via memorandum dated August 9, 2010.

SCOPE OF SERVICES

The purpose of this engineering study was to

- conduct a geotechnical subsurface exploration along the proposed alignment of the 20-inch water main in order to establish trenching engineering properties of the subsurface materials and groundwater conditions at the site, and
- perform laboratory testing on the subsurface samples obtained at the site as need to classify the materials and their engineering properties.

The information from the field exploration and laboratory testing was used to develop the geotechnical engineering criteria presented in this report. This report was prepared for use by the design engineers and their team to assist with the design and construction of the 20-inch water main.

PROJECT AND SITE DESCRIPTION

General Site Location

The proposed project site is located on the northwest side of San Antonio, Texas, and outside of Loop 1604. The alignment of the new water main extends approximately 0.28 mile (1,550 feet). The portion of the alignment addressed in this study is that which lies within a 50-foot easement extending along the western side of NW Military Highway, within the Presidio Heights Subdivision. A Vicinity Map showing the approximate location of the project alignment addressed in this study is provided in the attachments to this report.

Project Description

The project includes the construction of 1,550 LF of a 20-inch (I.D.) water main. We understand that the new water main will tie into an existing 20-inch water main located at the existing east end of Muir Glen Drive within the Presidio Heights Subdivision. We understand that the depth of the trenching for this new water main will vary from approximately 8 feet to 12 feet; however, the standard minimum of five (5) feet of cover above the crest of the pipeline will be maintained.

Existing Site Description

This area is generally covered with light to medium dense vegetation consisting of natural grasses, weeds, brush and trees. Representative Site Photographs showing the local site conditions at the time of the field exploration are provided in the attachments to this report.

BORINGS AND LABORATORY TESTS

The geotechnical field exploration was conducted on August 20, 2010. A total of two (2) test borings were drilled at the approximate locations shown on the attached Boring Location Plan. The test borings were each drilled to a depth of approximately 15 feet as referenced from the ground surface as it existed at the time of the field exploration.

The drilling was performed in general accordance with ASTM D1586 procedures for the Split Spoon sampling technique as described in the Appendix. A truck-mounted drill rig using the air rotary drilling method together with the sampling tool noted were used to secure the subsurface samples. Borehole logging and preliminary classification of the collected subsurface samples were conducted during the exploration by one our field engineering staff.

As a part of the field data collection activities, Standard Penetration Test (SPT) N-value blow counts were recorded during the drilling activities. The SPT N-values provide information on the relative consistency/density of the subsurface material. As a supplement to the field exploration, laboratory testing to determine soil water content, grain size, and expansion characteristics was conducted. The laboratory results are reported in the attached test boring logs and summarized in Table 1. Samples were examined, classified and tested both in the field during the drilling and sampling operation and after being received into the laboratory in accordance with the procedures stated in the Appendix of this report.

Sample Disposal *Once this report is submitted, remaining soil samples recovered from this exploration will be routinely discarded unless requested otherwise*.

SUBSURFACE CONDITIONS

Geology

The earth materials underlying the project site have been mapped by others as part of the Edwards Limestone Group of lower Cretaceous age. Locally, the materials encountered in the test borings consist primarily of clayey gravel with sand and topsoil overlying limestone bedrock generally in a very hard and well-cemented condition. The formation is characterized as having scattered cave development and the potential to encounter solution features does exist within the limestone underlying the project area. It is recommended that a Geologic Site Assessment be performed to help identify possible features. The delineation or observation of such features is beyond the scope of this study.

Locally, the materials encountered in the borings consist primarily of 1 to 3 feet of variable surface soils overlying limestone bedrock. The limestone is generally in a very hard and cemented condition; however, the upper 8 to 10 feet is generally in a moderate to very fractured condition with red clay infilling.

Site Stratigraphy and Engineering Properties

The generalized subsurface soil conditions as determined from the field and laboratory data are summarized in Table 1 for the portion of the proposed 30-inch Water Main alignment addressed in this study.

<u>50-foot Utility Easement</u>: The subsurface samples obtained from Test Borings B-1 and B-2 are used in this study to represent the general subsurface conditions within the 20-foot wide easement associated with the alignment of the proposed water main. The subsurface samples from the locations of Test Borings B-1 and B-2 indicate that a surface layer of clayey gravel exists over the formational limestone bedrock material.

Table 1: Generalized Material Stratigraphy Main Pipeline Site

Depth (feet)	Description	WC range / WC avg.	PI range / PI avg.	#200 range / #200 avg.	N range / N avg.
0 to (0-1)	**Clayey GRAVEL(GC)** with cobbles and boulders, dark brown, in a very dense condition or **CLAY(CH)**, reddish-brown, in a hard condition	4 – 20	24	38	25-70
		12	**--**	**--**	**47**
(0-1) to 15	**LIMESTONE,** white, in a very dense condition	0 – 15	1 – 7	--	--
		3	**4**	**--**	****10/0”**

Where:
Depth - Soil stratum depth (ft.) from existing ground surface at the time of geotechnical investigation
WC – Moisture Content, %
PI - Plasticity Index
#200 - Percent passing #200 sieve, %
N - Standard Penetration Test (SPT) value, blows per foot
**** -** Standard Penetration Test (SPT) value measured during the seating operation

Groundwater

A dry soil sampling method was used to obtain the soil samples at the project site. Groundwater was not observed to the 15-foot completion depth of the test borings. Clay soils are generally not conducive to the presence of groundwater; however, gravelly strata can store and transmit “perched” groundwater flow or seepage. Highly fractured and weathered zones or karst features within the limestone bedrock are also potential conduits for subsurface groundwater that has percolated from the surface.

Upon completion of the drilling and exploration activities the drill holes were backfilled with bentonitic clay and the site cleaned as required.

Variations

Conditions may vary between the sample boring locations. Transition boundaries or contacts noted on the boring logs to separate material types are approximate. Actual contacts may be gradual and vary at different locations. ***If conditions encountered during construction***

indicate more variation than established as a result of this study, we should be contacted to evaluate the significance of the changed conditions relative to our recommendations.

ENGINEERING ANALYSIS AND DESIGN

Lateral Earth Pressure

Lateral earth pressure for design of trench shoring can use the following soil design parameters for short term conditions:

Table 2: Summary of Parameters for Lateral Earth Pressure Calculations

Test Boring	Depth (ft.)	Description	γ_e	C	φ	k_a	k_p
B-1 B-2	0 to 3	Clayey GRAVEL(GC)	120	0	30	0.40	2.5
	3 to 15	LIMESTONE	130	9,000	0	0.30	3.0

Where: γ_e = effective soil unit weight, pcf
C = undrained soil shear strength, psf
φ = angle of internal friction, deg.
k_a = coefficient of active earth pressure
k_p = coefficient of passive earth pressure

Vertical cuts in the sound intact limestone would not be expected to apply a lateral pressure to the pipe. The active pressure coefficients provided above are considered to be applicable to the rock cuttings generated from trenching.

Lateral earth pressures on the trench shoring can be calculated considering a rectangular pressure diagram having a magnitude of:

$$(\gamma_e)(H)(k_a)$$

where γ_e and k_a are provided above and H is the depth of excavation in feet. Any surcharge loads including equipment loads, and soil stockpiles and hydrostatic pressures should be added to this value as required.

Pipe Deflection Parameters

We have compiled the parameters that will be needed for pipe deflection calculations. The soil reaction, E_n , may be computed using the following equation:

$$E_n = (e)(r)$$

where: E_n = soil reaction, psi
e = Modulus of subgrade reaction, pci
r = radius of pipe, inches

The following table outlines e values for the materials encountered at this site.

Table 3: Modulus of Subgrade Reaction Parameters

Description	e (pci)
Clayey Gravels (GC)	**60**
Formational: LIMESTONE	**125**

Trench Excavations and Slopes

It is anticipated that open-cut excavation depths of greater than 5 feet will be required to install the proposed Water Main within the areas of B-1 and B-2. Occupational Safety and Health Administration (OSHA) regulations must be followed concerning temporary allowable slopes.

Trench excavations should not be left open for long periods of time in order to minimize soil moisture changes. If bearing soils are exposed to severe drying or wetting, the unsuitable soil must be re-conditioned or removed as appropriate, prior to placement of the proposed Water Main.

The contractor should be aware that slope height, slope inclination, or excavation depths (including utility trench excavations) should in no case exceed those specified in local, state, or federal safety regulations, *e.g.,* OSHA Health and Safety Standards for Excavations, 29 CFR Part 1926, dated October 31, 1989. Such regulations are strictly enforced and, if they are not followed, the Owner, Contractor, and/or earthwork and utility subcontractors could be liable for substantial penalties. The soils encountered at this site were classified as to type in accordance with this publication. ***For this site the clayey gravels and Weathered Limestone observed at the project site are classified as "Type C" and "Type A" soils respectively.*** It is very important to note that the OSHA soil classifications provided below are based upon the soil profiles observed *at the locations of the test borings*. It is possible that differences in the subsurface stratigraphy or groundwater conditions exist at other locations at the site.

It may be considered conservative to assume that the soils are "Type C" should variations in the stratigraphy be encountered along the alignment during construction.

Table 4: OSHA Soil Classifications

Stratum	Description	OSHA Classification
I	*Brown and Dark Brown, Clayey Gravel (GC)*	C
II	*Light Tan to White, Fractured LIMESTONE*	A

The following must be noted regarding the excavation-trenching operations:

- For excavations less than 20 feet deep, the maximum allowable slope for Type "C" soils is 1.5H:1V (34°) and for Type "A" soils is ¾ H:1V (53°). It must be noted that layered slopes cannot be steeper at the top than the underlying slope and that all materials other than stable rock below the water table must be classified as Type "C" soils. The OSHA publication should be referenced for layered soil conditions, benching, etc.

- The OSHA soil classifications and slope information provided above are for temporary slopes. Permanent slopes at this site would require slope stability analysis and very flat slopes may be required in gravelly/sandy areas.
- The subsurface clayey gravel materials encountered during this study were generally in a very stiff to hard condition. Heavy duty excavating equipment will be required for excavating in the hard clays and dense clayey gravels observed along the proposed Water Main alignment. The contractor should provide such heavy duty excavating equipment.
- The soils encountered in Test Borings B-1 and B-2 during our study contained clayey gravel material. These clayey gravels would be more susceptible to caving and sloughing during excavation or boring operations, particularly if groundwater is encountered. The contractor should be prepared for such conditions and ensure that adequate safety measures are provided to protect workers as well as structures and pavements from caving or sloughing.
- Minimum cover and installation means and methods for the new Water Main should be approved by the appropriate governing agency and should conform to all appropriate design requirements.

Appropriate trench excavation methods will depend on the various soil and groundwater conditions encountered. We emphasize that undisclosed soil conditions may be present at locations and depths other than those encountered in our borings. Consequently, flatter slopes and dewatering techniques may be required in these areas.

The soils to be penetrated by excavations may vary across the site. Our soil classification is based solely on the materials encountered in borings placed along the proposed Water Main alignment. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that ARIAS be contacted immediately to evaluate the conditions encountered.

Trenches less than 5 feet deep are generally not required to be sloped back or braced following federal OSHA requirements for excavations. Sides of temporarily vertical excavations less than 5 feet deep may stay open for short periods of time, however, the clayey or gravelly soils that may be encountered in trench excavations are subject to random caving and sloughing. If side slopes begin to slough, the sides should be either braced or be sloped back to at least 1V: 1H.

If any excavation, including a utility trench, is extended to a depth of more than twenty (20) feet, it will be necessary to have the side slopes designed by a professional engineer registered in Texas. As a safety measure, it is recommended that all vehicles and soil piles be kept a minimum lateral distance from the crest of the slope equal to no less than the slope height.

Specific surcharge loads such as traffic, heavy cranes, earth stockpiles, pipe stacks, etc., should be considered by the Trench Safety Engineer. It is also important to consider any vibratory loads such as heavy truck traffic.

It is required by OSHA that the excavations be carefully monitored by a competent person making daily construction inspections. These inspections are required to verify that the excavations are constructed in accordance with the intent of OSHA regulations and the Trench Safety Design. If deeper excavations are necessary or if actual soil conditions vary from the borings, the trench safety design may have to be revised. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation and the presence of any surface slope cracks should also be carefully monitored.

Excavated materials should not be placed close to the top of slope of the excavation so as not to cause slope instability.

Subgrade Considerations

The bottoms of trench excavations should expose strong competent soils and should be dry and free of loose, soft, or disturbed soil. If fill soils are encountered at the base of trench excavations, their competency should be verified through probing and density testing. Soft, wet, weak, or deleterious materials should be over-excavated to expose strong competent soils. At locations where soft or weak soils extend for some depth, over-excavation to stronger soils may prove infeasible and/or uneconomical. In the event of encountering these areas of deep soft or weak soils, we recommend that the bottom of the trench be over-excavated by one to two feet, and replaced with an open-graded aggregate (such as a uniform gradation of gravel between 0.5 to 2.0 inches). This aggregate will allow for drainage of water, as well as providing a stable working platform.

We recommend good surface drainage away from excavations be established to prevent surface runoff from flooding excavations. The Water Main should be installed and backfilled as soon after excavation as possible.

Bedding & Backfill of Utilities

We recommend good surface drainage away from excavations be established to prevent surface runoff from flooding excavations. The utilities should be installed and backfilled as soon after excavation as possible.

<u>Bedding:</u> The granular bedding materials should be placed in lifts around the sides and crown of the pipe in accordance with the ***Project Specifications, Section 02317, Excavating, Backfilling and Compaction*** as required to prevent void areas. Mechanical tampers are often used for this

purpose. All granular bedding materials should comply with SAWS gradation requirements. The bedding material should extend at least one (1) foot above the crown of the pipe in accordance with ***Section 02317, 3.07 (A).***

Secondary Backfill: The secondary backfill operations for trenches should not be started until the Water Main is properly bedded in accordance with the above referenced recommendations. Soils/rock millings removed from the trench excavations will generally be suitable as secondary backfill above the bedding provided they are not saturated and do not contain organics, debris, or other deleterious material. Secondary backfill materials for all types and sizes of pipe shall be as defined in ***Section 02317, 3.07 (B)*** and shall be free from clods of such size as to interfere with compaction (3” maximum particle size).

The secondary backfill should be placed in loose lifts not exceeding 9 inches. The backfill should be placed at a moisture content of –1 to +3% of optimum, and then uniformly compacted to at least 90 percent of the maximum dry density as determined by ASTM D-698. If pavement overlays the pipeline(s), the secondary backfill shall be compacted to at least 98 percent of the standard Proctor (ASTM D-698) maximum dry density.

If wet weather or extended dry periods deteriorate the surface whereby a good bond cannot be formed between successive lifts, the earthwork contractor should prepare the surface as necessary. This preparation may include removing or scarifying the top two of inches of the underlying material, or wetting the material before placing the next lift.

CONSTRUCTION CRITERIA

Site Drainage

We recommend that an effective site drainage plan be devised by others prior to commencement of construction to provide positive drainage away from the excavation perimeters and off the site, both during and after construction. An effective drainage plan will have to be implemented for this project site should rainy climatic conditions exist at the time of construction. It should be noted that groundwater may be encountered primarily related to the actual climatic conditions at the time of line construction.

We recommend that one of our representatives be scheduled to observe that the site preparation operations are performed in accordance with our recommendations.

If existing structures are discovered during excavation, we should be informed immediately to determine the impact of those structures on our recommendations.

Earthwork
Exposure to the environment may weaken the soils at the bearing level if the excavation remains open for long periods of time. Therefore, it is recommended that the waterline be installed and the excavation is backfilled as soon as possible to minimize potential damage to bearing soils. If bearing materials are exposed to severe drying or wetting, the unsuitable materials must be re-conditioned or removed as approximate. The bearing level should be free of loose soil, ponded water or debris, and should be observed prior to the water line placement by the representative of the Geotechnical Engineer.

Subgrade preparation and backfill placement operations should be monitored by the soil engineer or his representative. As a guideline, at least one in-place density test should be performed for each 400 linear feet of compacted surface per lift and in accordance with ***Section 01451, Quality Control*** and ***Section 02317, 3.10***. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

It should be noted that heavy duty excavating equipment may be required for excavating in hard materials.

Excavations
Excavations should comply with OSHA Standard 29CFR, Part 1926, Subpart P and all State of Texas and local requirements. Trenches 20 feet deep or greater require that the protective system be designed by a registered professional engineer. A trench is defined as a narrow excavation in relation to its depth. In general, the depth is greater than the width, but the bottom width of the trench is not greater than 15 feet. Trenches greater than 5 feet in depth require a protective system such as trench shields, trench shoring, or sloping back of the excavation side slopes.

The Contractor’s “Competent Person” should perform daily inspections of the trench to verify that: (1) the trench is properly constructed; (2) surcharge and vibratory loads are not excessive; (3) excavation spoils are sufficiently away from the edge of the trench; (4) proper ingress and egress into the trench is provided; and (5) all other items are performed as outlined in these OSHA regulations. It is especially important for the inspector to observe the effects of changed weather conditions, surcharge loadings, and cuts into adjacent backfills of existing utilities. The flow of water into the base and sides of the excavation, and the presence of any surface slope cracks, should also be carefully monitored.

Although the geotechnical report provides an indication of material types to be anticipated, actual material and groundwater conditions could vary along the excavation. The “Competent Person” must evaluate the materials and groundwater in the excavation at the time of construction to verify that proper sloping or shoring measures are performed.

Appendix B to the regulations has sloping and benching requirements for short-term trench exposure for various soil types up to the maximum allowable 20-foot depth requirement.

QUALITY CONTROL

As Geotechnical Engineer of record, we should be engaged to: (1) observe and evaluate earthwork for site subgrade improvement activities to determine that the actual bearing materials are consistent with those encountered during the field exploration; and (2) monitor and test the fill placement and subgrade preparation. It is also important that we be given the opportunity to review the design and construction documents. The purpose of this review is to check to see if our recommendations are properly interpreted into the project plans and specifications.

Subgrade preparation and fill placement operations should be monitored by the Geotechnical Engineer or his representative. As a guideline, at least one in-place density test should be performed for each 400 linear feet per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

If there are any revisions to the plans for the proposed project, or if deviations from the subsurface conditions noted in this report are encountered during construction, Arias Inc., should be retained to determine if changes in the geotechnical recommendations are required. If ARIAS Inc., is not retained to perform these functions, Arias Inc., will not be responsible for the impact of those conditions.

It is recommended that Arias Inc., be retained to provide observation and testing of construction activities involved in the earthwork and related activities of this project. Arias Inc., cannot accept any responsibility for any conditions which deviate from those described in this report or for the performance of the project elements if not engaged to also provide construction observation and testing for this project.

All sheeting, shoring, and bracing of trenches, pits, horizontal borings and excavations should be made the responsibility of the contractor and should comply with all current and applicable local, state and federal safety codes, regulations and practices, including the Occupational Safety and Health Administration.

GENERAL COMMENTS

This report was prepared for this project exclusively for the use of Mr. Juan G. Rodriguez, P.E., of San Antonio Water System, and his design team. If the development plans change or if different subsurface conditions are encountered, we should be informed and retained to ascertain the impact of these changes on our recommendations. We cannot be responsible for the potential impact of these changes if we are not informed.

The materials to be penetrated by excavations may vary significantly across the site. Our classification is based solely on the materials encountered in widely spaced exploratory test borings. The contractor should verify that similar conditions exist throughout the proposed area of excavation. If different subsurface conditions are encountered at the time of construction, we recommend that Arias be contacted immediately to evaluate the conditions encountered.

This report has been prepared in accordance with generally accepted geotechnical engineering practice with a degree of care and skill ordinarily exercised by reputable geotechnical engineers practicing in this area.

VICINITY MAP

Proposed Water Transmission Main
Rogers Ranch to I.H. 10 Project
San Antonio, Texas

Representative Photographs of Project Area

Site Photo 1 – Near Boring B-2

Site Photo 2 – Near Boring B-1

BORING LOCATION PLAN

NOTE: Locations are approximate. Drawing is not to scale.

Boring Log No. 1

Address: **50 ft. Easement, Rogers Rd to IH10**
San Antonio, TX
Location: **See Boring Location Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N
Clayey GRAVEL (GC), brown, hard		1: SS	13 5	28	52	24	35/6"
LIMESTONE, white, very dense	2	2: SS	1				**10/0"
- weathered LIMESTONE, 3' to 3.5'	4	3: SS	0				**10/0"
	6	4: SS	4	17	24	7	**10/0"
- weathered LIMESTONE, 7' to 10'	8	5: SS	2				**10/0"
	10	6: SS	1				**10/0"
	12						
	14	7: SS	0				**10/0"
COMPLETION DEPTH: 15 ft.	16						

Groundwater During Drilling: None Observed

- Grab Bag Sample (GB)
- Shelby Tube Sample (ST)
- Split Spoon Sample (SS)
- Water encountered during drilling
- Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index

BORING LOG REVISED 2010-697.GPJ ARIAS.GDT 9/28/10

Arias & Associates, Inc.

Job No.: 2010-697

Boring Log No. 2

Address: **50 ft. Easement, Rogers Rd to IH10**
San Antonio, TX
Location: **See Boring Location Plan**

Project: **Water Transmission Main**
Logged By: **RC** Elev.:
Sampling Date: **8/20/10**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	N	-200
Clayey GRAVEL (GC), dark brown, very stiff to hard		1: SS	20				25	38
	2	2: SS	4				10/0"	
Weathered LIMESTONE, white, dense	4	3: SS	15	21	26	5	50/5"	
- less weathered, very dense, below 6'	6	4: SS	1				**10/0"	
	8	5: SS	1	17	18	1	**10/0"	
	10	6: SS	2				**10/0"	
	12	7: SS	1				**10/0"	
	14							
COMPLETION DEPTH: 15 ft.	16							

Groundwater During Drilling: None Observed

Grab Bag Sample (GB)
Shelby Tube Sample (ST)
Split Spoon Sample (SS)
Water encountered during drilling
Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
SS = Split Spoon Sample
WC = Water Content (%)
N = SPT Blow Counts
** = Blow Counts During Seating Penetration
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG REVISED 2010-697.GPJ ARIAS.GDT 9/28/10

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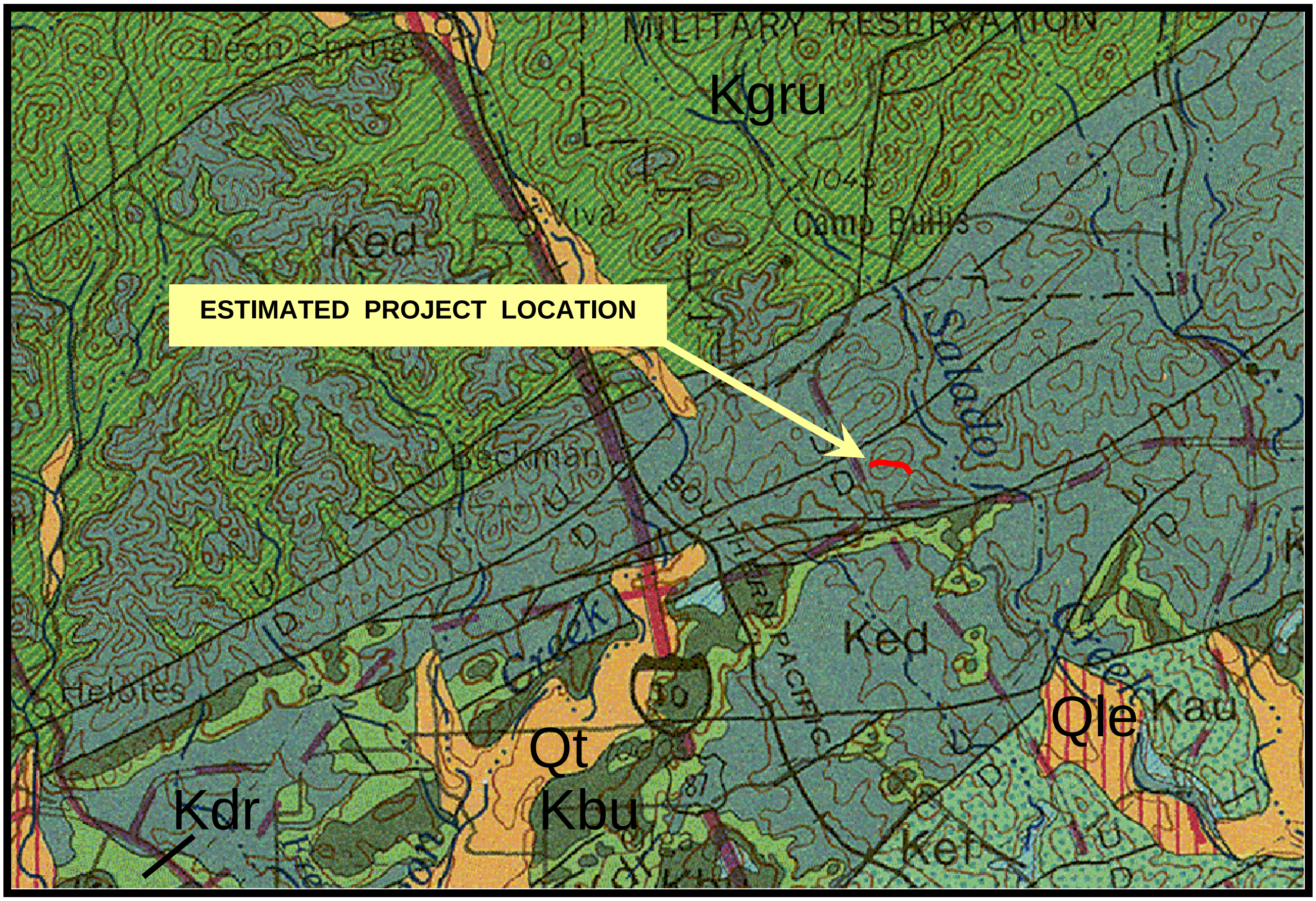
Job No.: 2010-697

KEY TO CLASSIFICATION 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 is 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

Arias & Associates, Inc.

GEOLOGIC MAP



PORTION OF GEOLOGIC ATLAS OF TEXAS

LEGEND

Symbol	Name	Age
Qt	Alluvial Terrace Deposits	Quaternary Period / Pleistocene Epoch
Qle	Leona Formation (Alluvium)	Quaternary Period / Pleistocene Epoch
Kau	Austin Chalk Formation	Upper Cretaceous Period
Kef	Eagle Ford Formation	Upper Cretaceous Period
Kbu	Buda Limestone Formation	Upper Cretaceous Period
Kdr	Del Rio Clay Formation	Upper Cretaceous Period
Ked	Edwards Group Limestone	Lower Cretaceous Period
Kgru	Upper Glen Rose Formation	Lower Cretaceous Period
U / D	Fault Segment with Indication of Relative Movement	

Proposed Water Transmission Main
Rogers Ranch to IH-10 Project
San Antonio, Texas

ARIAS & ASSOCIATES, Inc. Arias Job No.: 2010-697

APPENDIX

Laboratory and Field Test Procedures

Soil Classification Per ASTM D2487-93
This soil testing standard was used for classifying soils according to the Unified Soil Classification System. The soil classifications of the earth materials encountered are as noted in the attached boring logs.

Soil Water Content Per ASTM D2216-92
This test determines the water content of soil or rock expressed as a percentage of the solid mass of the soil. The test results are listed under **MC** in the attached boring logs.

Soil Liquid Limit Per ASTM D4318-93
The soil Liquid Limit identifies the upper limit soil water content at which the soil changes from a moldable (plastic) physical state to a liquid state. The Liquid Limit water content is expressed as a percentage of the solid mass of the soil. The test results are listed under **LL** in the attached boring logs.

Soil Plastic Limit Per ASTM D4318-93
The soil Plastic Limit identifies a lower limit soil water content at which the soil changes from a moldable (plastic) physical state to a non-moldable (semi-solid) physical state. The Plastic Limit water content is expressed as a percentage of the solid mass of the soil. The test results are listed under **PL** in the attached boring logs.

Plasticity Index Per ASTM D4318-93
This is the numeric difference between the Liquid Limit and Plastic Limit. This index also defines the range of water content over which the soil-water system acts as a moldable (plastic) material. Higher Plasticity Index (PI) values indicate that the soil has a greater ability to change in soil volume or shrink and swell with lower or higher water contents, respectively. The test results are listed under **PI** in the attached boring logs.

Standard Penetration Test (SPT) and Split Spoon Sampler (SS) per ASTM D 1586
This is the standard test method for both the penetration test and split-barrel (spoon) sampling of soils. This sampling method is used for soils or rock too hard for sampling using Shelby Tubes. The method involves penetration of a split spoon sampler into the soil or rock through successive blows of a 140 pound hammer in a prescribed manner.

Blow Counts (N) per ASTM D 1586
This is the number of blows required to drive a Split Spoon Sampler by means of a 140 pound hammer for a distance of 12 inches in accordance with the variables stated in the test procedures.

Shelby Tube (ST) per ASTM D 1587
This procedure is for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of physical properties.

Rock Core per ASTM D 2113
This procedure is for using diamond core drilling equipment to obtain core samples of rock and some soils that are too hard to sample by soil-sampling methods.

Dry Density (DD) per ASTM D 2937
This procedure is for the determination of in-place density of soil. The test results are measured in pounds per cubic foot, pcf.

Unconfined Compression Test (UC) per ASTM D 2166
This test method covers the determination of the unconfined compressive strength of cohesive soil in the undisturbed, remolded, or compacted condition, using strain-controlled application of the axial load.

Minus No. 200 Sieve per ASTM D 1140
This test method covers determination of the amount of material finer than a Number 200 sieve by washing. The results are stated as a percent of the total dry weight of the sample.

Pocket Penetrometer (PP): This test method is an accepted modification of ASTM D 1558 test method for establishing the moisture-penetration resistance relationships of fine-grained soils. The test results are measured in tons per square foot, tsf. The strength values provided by this method should be considered qualitatively.

Rock Quality Designation (RQD) : The measure of the quality of a rock mass defined by adding intact rock core pieces greater than four inches in length by the total length of core advance per ASTM 6032.

Recovery Ratio (REC): The Recovery Ratio is equal to the total length of core recovered divided by the total length of core advance.

Boring Logs: This is a summary of the above described information at each boring location.

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.

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