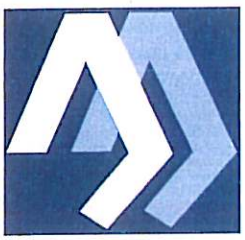
Geotechnical Engineering Study
Proposed Hidden Canyon Subdivision
Hardy Oak Blvd & Canyon Golf Road
San Antonio, Texas

ARIAS Job No. 07-2570



ARIAS & ASSOCIATES

Geotechnical • Environmental • Testing

Prepared For
M.W. Cude Engineers, LLC

July 15, 2008

ARIAS & ASSOCIATES
Geotechnical • Environmental • Testing

July 15, 2008
ARIAS Job No. 07-2570

Mr. Patrick Murphy, E.I.T.
M.W. Cude Engineers, L.L.C.
10325 Bandera Road
San Antonio, Texas 78250

RE: Geotechnical Engineering Study
Proposed Hidden Canyon Subdivision (Streets)
Hardy Oak Blvd & Canyon Golf Road
San Antonio, Texas

Dear Mr. Murphy:

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 roadways. Please consult with us as needed during any part of the design or construction process.

We recommend that the site work and pavement construction be tested and observed by one of our representatives in accordance with the report recommendations. We can contribute to the success of the project by performing the construction observation and materials testing services during construction.

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

Cordially,
Arias & Associates, Inc.

Christopher M. Szymczak, P.E.
Project Geotechnical Engineer

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PROFESSIONAL ENGINEER
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INTRODUCTION

The results of a geotechnical study for the proposed Hidden Canyon Subdivision Streets in San Antonio, Texas are presented in this report. This project was authorized by means of ARIAS Proposal No. 07-2570P, dated December 20, 2007.

SCOPE OF SERVICES

The purpose of this engineering study was to conduct a subsurface exploration and perform laboratory testing to establish pavement engineering properties of the subsurface soil, rock, and groundwater conditions present on the site of the proposed development. This information was used to develop geotechnical engineering criteria for use by design engineers in preparing the pavement design(s). Environmental and foundation engineering studies of any kind were not a part of our scope of work or services.

PROJECT AND SITE DESCRIPTION

It is understood that the proposed project is to consist of new subdivision streets totaling approximately 7,400 linear feet. It is our understanding that the Street Classifications for this project will consist of Local Type "B" Streets and Local Type "A" Streets without Bus Traffic according to the City of San Antonio Unified Development Code (UDC). If different street classifications are to be utilized, then we should be contacted to provide additional recommendations. The property is located north of Stone Oak Parkway, between Hardy Oak Boulevard and Canyon Golf Road in San Antonio, Texas. A Vicinity Map is provided in the Enclosures of this report.

At the time of our study, the property was in a near natural condition and appears to have been used in the past for agricultural purposes. Existing vegetation consisted of a dense cover of medium sized oak and cedar trees, shrubs and wild grass. Onsite utilities include overhead electrical lines and sewer lines. A dry creek bed was also observed throughout the property in the northeast-southwest direction. There appears to be a significant elevation difference between the adjacent western property and the proposed project area. Adjacent development includes residential subdivisions to the north, east, south and west. Representative photographs of the project area are provided in the Enclosures of this report.

TEST PITS AND LABORATORY TESTS

A total of eighteen (18) test pits were excavated within the area of the proposed development. The test pits were excavated to depths ranging from approximately 0 to 4.5 feet below the existing ground surface utilizing a backhoe. The shallower depths were generally caused by refusal on very hard limestone bedrock. The test pits were located approximately as shown on the Test Pit Location Plan attached as part of this report.

As a supplement to the field study, laboratory testing was conducted to determine water content, plasticity index and percent passing the #200 sieve. The laboratory results are reported in the attached test pit logs. Samples were examined, classified and tested both in the field during the sampling operation and after being received into the laboratory in accordance with the procedures stated in the Appendix of this report.

Sample Disposal *Remaining soil samples recovered from this exploration will be routinely discarded following submittal of this report.*

SUBSURFACE CONDITIONS

Geology

The earth materials underlying the project site have been regionally mapped as the Dolomitic member of the Kainer Formation that is within the Edwards Limestone Group of lower Cretaceous age. Locally, the materials encountered in the test borings consist primarily of 1 to 4.5 feet of clayey natural surface soils overlying limestone bedrock in a very dense and well cemented condition. The upper few feet of limestone commonly has many red clay filled fractures. The Dolomitic member is characterized as having some cave development; however, it is also considered as being non fabric implying the inherent solution features are widely spaced and not interconnected. The exploration and delineation of caves or solution features was beyond the scope of this study.

Site Stratigraphy and Engineering Properties

The table below outlines the approximate generalized stratigraphy at the test pits:

Generalized Stratigraphy Conditions

Stratum	Depth (ft)	Material Type	PI range / PI avg.	-No. 200 range / -No. 200 avg.	PP range / PP avg.
Ia	0 to (1-2.5)	*Dark Brown, Gravelly CLAYS (CH) with sand, very hard*	35-48	68	14+
			42	--	--
Ib	(0-2.5) to (1-4.5)	*Dark Grayish Brown and Grayish Brown, Clayey GRAVELS (GC) with cobbles and boulders*	18-51*	40-46	--
			38*	43	--
II	(0-4.5) to 4.5+	*Weathered LIMESTONE to LIMESTONE, light tan, very hard*	--	--	--
			--	--	--

**Test performed on material passing the No. 40 sieve.*

Where:
Depth - Stratum depth from the existing ground surface at the time of geotechnical study.
PI - Plasticity Index
-No. 200 – Percent passing the #200 sieve
PP – Pocket Penetrometer (tons per square foot)

Exceptions to the above generalized conditions are noted below:

- *The Stratum Ia clays (CH) were only observed at the locations of test pits TP-3, TP-4, TP-5 and TP-10 within the test depths explored. Clays may be observed in other areas during construction.*

- *The Stratum Ib clayey gravels (GC) were <u>not</u> observed at the locations of test pits TP-5, TP-10 and TP-14 within the test depths explored. The clayey gravels may not be encountered at all locations during construction.*

Groundwater

A dry soil sampling method was used to obtain the soil samples at the project site. Groundwater was not observed within the sampling test pits during or after completion of the sampling activities. Clay soils are generally not conducive to the presence of groundwater; however, pockets or seams of gravels, sands, silts or open fractures and joints can store and transmit "perched" groundwater flow or seepage. Seasonal weather conditions or other factors may dictate actual shallow groundwater conditions at the time of construction.

Gravels and sand soils as well as seams of these more permeable type materials can transmit "perched" groundwater into intercepting utility backfills. This may allow a conduit for water to collect under residential foundations and can lead to roadway and foundation distress. Provisions to intercept and divert the "perched" water off-site should be made if this condition is encountered during construction. The means and methods for dewatering the site are solely the responsibility of the contractor.

It should be noted that water levels may require several hours to several days to stabilize depending on the permeability of the soils and that groundwater levels at this site may be subject to seasonal conditions, recent rainfall, drought or temperature affects.

After sampling, the test pits were backfilled with excavated soil and the site was cleaned as required.

Variations

Conditions may vary between the test pit locations. Contacts, noted on the test pit logs to separate soil/rock 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.

PAVEMENT RECOMMENDATIONS

Accumulation of water beneath the asphaltic surface course or concrete can cause progressive and rapid deterioration of the pavement section. Similarly, pavement surfaces should be well drained to eliminate ponding with a two-percent minimum slope, as possible. Based on the results of our fieldwork and associated laboratory testing, it appears that the roadway subgrade could consist predominantly of clayey gravel material, weathered limestone or competent limestone bedrock.

We have provided pavement design recommendations for areas where the subgrade consists of clayey gravel or friable, weathered or chalky limestone and areas where the subgrade consists of competent bedrock. In areas where the subgrade consists of clayey gravel or friable, weathered or chalky limestone, we recommend that a subgrade CBR value of 6 be utilized and the subgrade is moisture conditioned as outlined below. Due to the predominance of coarse materials in the clayey gravels, it is not deemed feasible or necessary to lime stabilize these materials. In areas where the subgrade consists of competent bedrock or rock millings installed as properly compacted fill over competent bedrock, we recommend that a subgrade CBR value greater than 10 be utilized and the subgrade be proofrolled as outlined below. The competent bedrock subgrade may also be incorporated into the pavement design as an overall structural layer.

Based on the results of our test pits, it appears that areas of high plasticity clays will most likely be encountered near the locations of TP-3, TP-4, TP-5 and TP-10. Clays may also be encountered in other areas as well. ***We recommend that any areas of clay encountered during construction be removed down to the clayey gravel or limestone and properly backfilled with clayey gravel material having a CBR value equal to or exceeding 6.*** This will eliminate the need for lime or geogrid stabilization. If areas of clay are not removed, then a lower CBR value and a higher Structural Number and thicker pavement section will result. If this occurs, we should be contacted to provide additional recommendations. The exact extents of clay "areas" or "pockets" will need to be determined in the field.

For localized sections of the roadways which may require an increase in the existing grade, it is assumed that all clays will be removed to clayey gravel or limestone bedrock. We recommend that general fill used to increase sections of the roadway grade then have a CBR value equal to or exceeding the clayey gravel or limestone bedrock.

It should be noted that the conditions and recommendations contained herein are based on the materials encountered at the time of field exploration. These conditions may differ once the road grading (cut/fill) operations are performed. At the time of this report, we have not received plan and profile sheets for this project. We recommend that a representative of Arias & Associates be retained to observe that our recommendations are followed and to assist in determining the actual subgrade material classification at a particular location.

It should be noted that heavy duty excavating equipment will be required for excavating/digging in the dense and hard materials encountered at this site. The contractor should be prepared for such conditions.

Recommendations in this section were prepared in accordance with the 1993 AASHTO Guide for Design of Pavement Structures and the City of San Antonio UDC dated May 3, 2001. The following design parameters were used:

Pavement Design Parameters

Material	Structural Coefficient
Hot Mix Asphaltic Concrete – Type "D" Surface Course	0.44
Hot Mix Asphaltic Concrete – Type "C" Surface Course	0.44
Hot Mix Asphaltic Concrete – Type "B" Base Course	0.38
Flexible Base Course – TxDOT Item 247, Type A, Grades 1 or 2	0.14
Moisture Conditioned Subgrade	--
Competent Bedrock Subgrade	0.08

Flexible Pavement Design Parameters

Street Classification	Local Type "B"	Local Type "A" without Bus Traffic
Reliability Factor	90%	70%
Overall Standard Deviation	0.45	0.45
Initial Serviceability Index	4.2	4.2
Terminal Serviceability Index	2.0	2.0
18-kip Equivalent Axle Loads (ESALs)	2,000,000	100,000

Note: Values above are based on City of San Antonio Unified Development Code.

Local Type "B" Streets

Areas with Clayey GRAVEL (GC) or Friable, Chalky or Weathered LIMESTONE Subgrade: CBR=6

(Moisture Condition Subgrade)

Based on the above parameters, a subgrade CBR=6 and the City of San Antonio UDC, a structural number, SN of 3.46 was attained (Local Type "B" Streets). This number is higher than the City of San Antonio minimum of 2.92 and lower than the maximum of 5.08. Therefore, the use of a structural number of 3.46 is recommended in the clayey gravel or friable, chalky or weathered limestone subgrade areas.

The following pavement thickness options may be considered in order to meet the design requirements. Many other choices or alternatives are possible.

Local Type "B" Streets –Clayey GRAVEL *or Friable, Chalky or Weathered LIMESTONE* Subgrade: CBR=6
(Moisture Condition Subgrade)

Option	Moisture Conditioned Subgrade	Crushed Limestone Flexible Base	Type "B" HMAC Base Course	Type "C" HMAC Surface Course	Type "D" HMAC Surface Course	Calculated Structural Number (SN)
A	6"	15½"	--	--	3"	3.49
B	6"	--	7"	--	2"	3.54
C	6"	12½"	--	2"	2"	3.51

Areas with Competent Bedrock Subgrade: CBR>10
(Proofroll Subgrade)

Based on the above parameters, a subgrade CBR>10 and the City of San Antonio UDC, a structural number, SN of 2.89 was attained (Local Type "B" Streets). This number is lower than the City of San Antonio minimum of 2.92. Therefore, the use of a structural number of 2.92 is recommended in the competent bedrock subgrade areas. The competent bedrock subgrade may also be incorporated into the overall pavement design as a structural number.

The following pavement thickness option may be considered in order to meet the design requirements.

Local Type "B" Streets – Competent Bedrock Subgrade: CBR>10
(Proofroll Subgrade)

Option	Competent Bedrock Subgrade	Crushed Limestone Flexible Base	Type "B" HMAC Base Course	Type "D" HMAC Surface Course	Calculated Structural Number (SN)
A	6"	8"	--	3"	2.92
B	6"	--	4½"	2"	3.07

Local Type "A" Streets without Bus Traffic

Areas with Clayey GRAVEL (GC) or Friable, Chalky or Weathered LIMESTONE Subgrade: CBR=6
(Moisture Condition Subgrade)

Based on the above parameters, a subgrade CBR=6 and the City of San Antonio UDC, a structural number, SN of 1.92 was attained (Local Type "A" Street without Bus Traffic). This number is less than the City of San Antonio minimum of 2.02. Therefore, the use of a structural number of 2.02 is recommended in the clayey gravel or friable, chalky or weathered limestone subgrade areas.

The following pavement thickness options may be considered in order to meet the design requirements. Many other choices or alternatives are possible.

Local Type "A" w/o Bus Traffic –Clayey GRAVEL *or Friable, Chalky or Weathered LIMESTONE* Subgrade: CBR=6
(Moisture Condition Subgrade)

Option	Moisture Conditioned Subgrade	Crushed Limestone Flexible Base	Type "D" HMAC (Surface Course)	Calculated Structural Number (SN)
A	6"	7"	2½"	2.08
B	6"	8½"	2"	2.07

Areas with Competent Bedrock Subgrade: CBR>10
(Proofroll Subgrade)

Based on the above parameters, a subgrade CBR>10 and the City of San Antonio UDC, a structural number, SN less than 2.02 was attained (Local Type "A" Street without Bus Traffic). Therefore, the use of a structural number of 2.02 is recommended in the competent bedrock subgrade areas. The competent bedrock subgrade may also be incorporated into the overall pavement design as a structural layer.

The following pavement thickness option may be considered in order to meet the design requirements.

Local Type "A" w/o Bus Traffic – Competent Bedrock Subgrade: CBR>10
(Proofroll Subgrade)

Option	Competent Bedrock Subgrade	Crushed Limestone Flexible Base	Type "D" HMAC (Surface Course)	Calculated Structural Number (SN)
A	6"	6"	2"	2.20

PAVEMENT CONSTRUCTION

Site Preparation

Topsoil stripping should be performed as needed to remove existing organic materials, loose soils, vegetation, roots, and stumps. A minimum depth of 3 to 4 inches should be planned. Additional excavation may be required due to encountering deleterious materials such as concrete, organics, trash, soft materials, etc. In addition, "nesting" of cobbles/boulders should be avoided.

If areas of clay are encountered during construction, they should be removed down to clayey gravel or limestone with a CBR equal to or exceeding 6 and backfilled as described in this section. If the clay is not removed, a lower CBR value will result and we should be contacted to provide additional recommendations.

Moisture Conditioned Subgrade

In areas where the subgrade consists of clayey gravel, the subgrade should be moisture conditioned to a minimum depth of 6 inches, to within optimum to plus 3 percent of optimum moisture, and compacted to at least 95% of the standard Proctor maximum dry density per TxDOT 114-E. Compaction tests should be performed as outlined in the Quality Control section below. If density testing is not possible due to shallow cemented materials, a loaded dump truck should be utilized to proofroll over the given Subgrade area and a representative of the Geotechnical Engineer should witness the operation. Areas of excessive deflection should be removed and replaced as per the representative of the Geotechnical Engineer.

Component Bedrock Subgrade

In areas where the subgrade consists of competent limestone bedrock or rock millings placed as properly compacted fill over competent bedrock, a loaded dump truck should be utilized to proofroll over the given Subgrade area and a representative of the Geotechnical Engineer should witness the operation. Areas of deflection should be removed and replaced as per the representative of the Geotechnical Engineer.

Fill Requirements

Should fill be required in areas where the subgrade consists of clayey gravel, all fill should consist of materials with a CBR equal to or exceeding 6. A well graded rock/soil fill is desired. Onsite material with a CBR greater than or equal to 6 may be used provided it is placed in maximum 8" loose lifts and compacted to at least 95% of the Standard Proctor dry density (TxDOT 114-E) at minus 1 to plus 3 percent of optimum. This fill should not have any organics or deleterious materials. When fill material includes rock, the maximum rock size acceptable shall be six inches (6"). No large rocks (>6 inches) shall be allowed to nest and all voids must be carefully filled with small stones or earth and properly compacted.

The CBR of all fill materials used should be equal to or exceed the existing subgrade CBR at each particular location. The suitability of all fill materials should be approved by the Geotechnical Engineer. Conformance testing during construction to assure quality will be necessary for this process. If fill is required to raise paving grades, the above compaction criteria should be utilized with the fill placed in maximum 8" thick loose lifts. It should be noted that if fill materials with lower CBR values are placed, then a higher Structural Number and a thicker pavement section would be necessary.

The CBR>10 for competent bedrock should only be utilized in "cut" areas where intact competent bedrock is exposed or in areas where all clayey materials are removed down to competent bedrock and properly backfilled with rock millings. The CBR>10 should not be utilized in any areas where rock millings from excavation operations are utilized as fill over existing clayey materials. In these areas as well as areas with chalky or weathered bedrock, a CBR=6 should be used and the subgrade should be moisture conditioned. No credit should be given to rock millings fill as a structural layer if they are installed over anything other than competent bedrock.

Flexible Base Course

The base material should comply with TxDOT Standard Specifications Item 247 Type A or B Grade 1 or 2. The base should be compacted in maximum eight (8) inch loose lifts to 95% density per TxDOT 113-E within plus or minus 3 percent of optimum moisture content. Compaction tests should be performed as outlined in the Quality Control section below.

Asphaltic Concrete Base Course

The asphalt should comply with TxDOT Standard Specifications Item 340 Type B, and be compacted to 95% of the maximum molded laboratory density. Compaction tests should be performed as outlined in the Quality Control section below. On a daily basis, the asphaltic concrete should be tested for oil content, gradation, and stability to verify compliance with the job mix formula, which should be submitted by the manufacturer for approval.

Asphaltic Concrete Surface Course

The asphalt should comply with TxDOT Standard Specifications Item 340 Type D or C, and be compacted to 95% of the maximum molded laboratory density. Compaction tests should be performed as outlined in the Quality Control section below. On a daily basis, the asphaltic concrete should be tested for oil content, gradation, and stability to verify compliance with the job mix formula, which should be submitted by the manufacturer for approval.

Drainage

Good positive drainage during and after construction is very important to reduce the magnitude of expansive soil volume changes, which can detrimentally affect the performance of the new roads. Proper attention to drainage details during the design and construction phase of development can prevent many potential soil shrink-swell related problems during and following the completion of the project as previously noted.

CONSTRUCTION CRITERIA

Site Preparation

Topsoil stripping in developed (non-landscaped) areas should be performed as needed to remove organic materials, loose soils, vegetation, roots, and stumps. A minimum depth of 3 to 4 inches should be planned. Additional excavation may be required due to encountering deleterious materials such as concrete. Exposed subgrade from excavations or grading operations should be prepared as outlined previously, and compacted to a density of at least 95% of the standard Proctor maximum dry density per TxDOT 114-E requirements. If density testing is not possible due to very dense shallow cemented material, a loaded dump truck should be utilized to proofroll over the given subgrade area and a representative of the Geotechnical Engineer should witness the operation. Areas of excessive deflection should be removed and replaced as per the representative of the Geotechnical Engineer.

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 all excavations be extended to final grade and constructed as soon as possible in order to reduce the risk of significant damage to bearing materials. If bearing materials are exposed to severe drying or wetting, the unsuitable material must be re-conditioned or removed as appropriate. The bearing level should be free of loose soil, ponded water or debris, and should be observed by the representative of the Geotechnical Engineer.

Subgrade preparation and fill placement operations should be monitored by the Geotechnical Engineer or his representative. Compaction tests should be performed as outlined in the Quality Control section. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

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; (2) monitor and test the fill placement and subgrade preparation; and (3) monitor and test the base material and asphalt placement and compaction. 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 according to the table below, with a minimum of 3 tests per lift. Any areas not meeting the required compaction should be recompacted and retested until compliance is met.

Density Test Requirements for Roadway Elements

Element	Street Classification	Pavement Width	Frequency of Density Tests
Subgrade, Flexible Base, Asphaltic Base, Asphalt Course(s)	Local A	28' to 30'	Every 150 Linear Feet for each Lift
Subgrade, Flexible Base, Asphaltic Base, Asphalt Course(s)	Collector or Local B	40' to 44'	Every 125 Linear Feet for each Lift
Subgrade, Flexible Base, Asphaltic Base, Asphalt Course(s)	Primary or Secondary Arterial	60' or more	Every 100 Linear Feet for each Lift

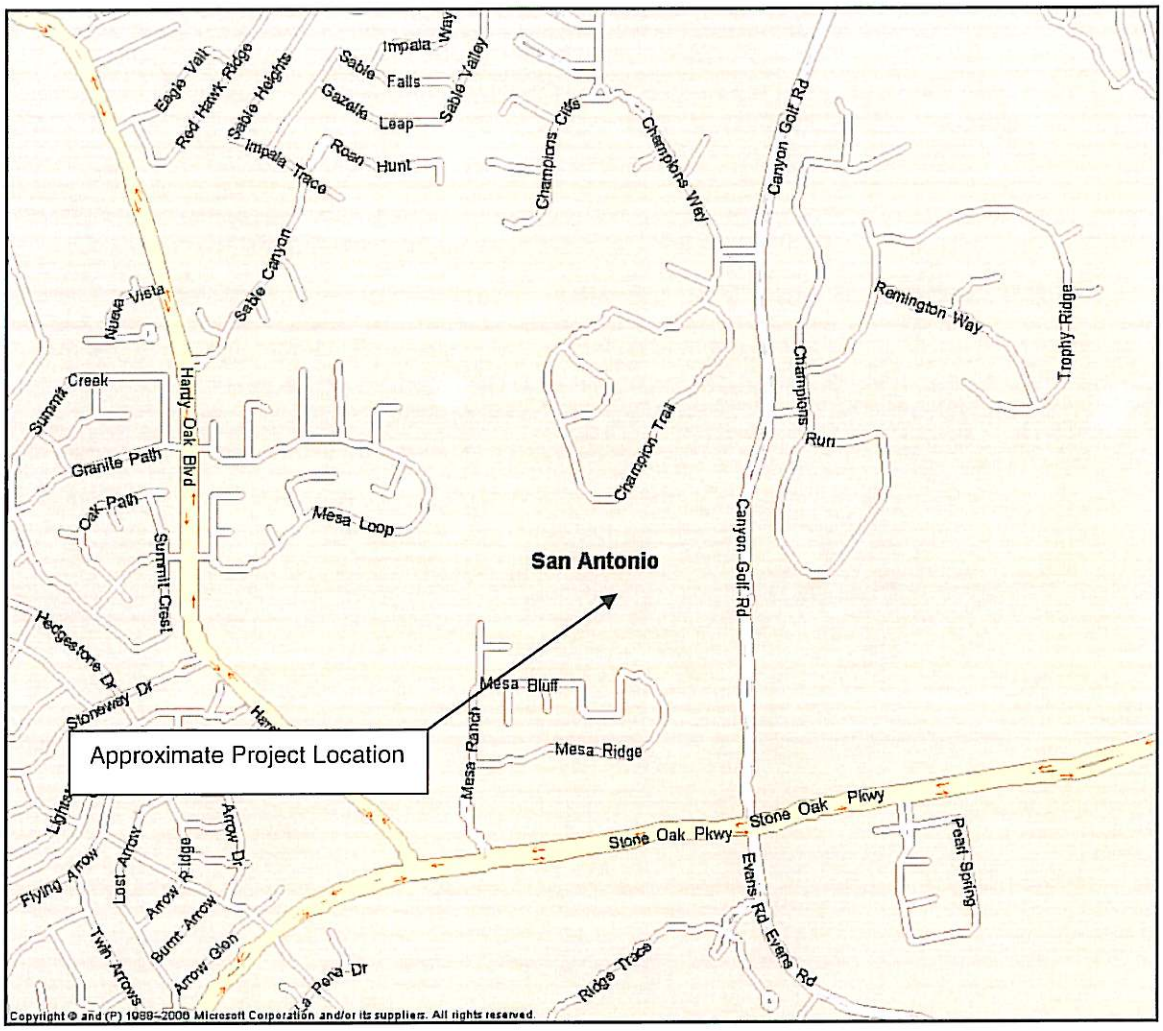
The table above is based on the City of San Antonio requirements.

GENERAL COMMENTS

This report was prepared for this project exclusively for the use of Mr. Patrick Murphy, E.I.T. of M.W. Cude Engineers, LLC and his design team. If the development plans change relative to roadway layout, size or street classifications, 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.

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 Hidden Canyon Subdivision
Hardy Oak Boulevard & Canyon Golf Road
San Antonio, Texas

Representative Photographs of Project Area
Proposed Hidden Canyon Subdivision

Site Photo 1

Site Photo 2

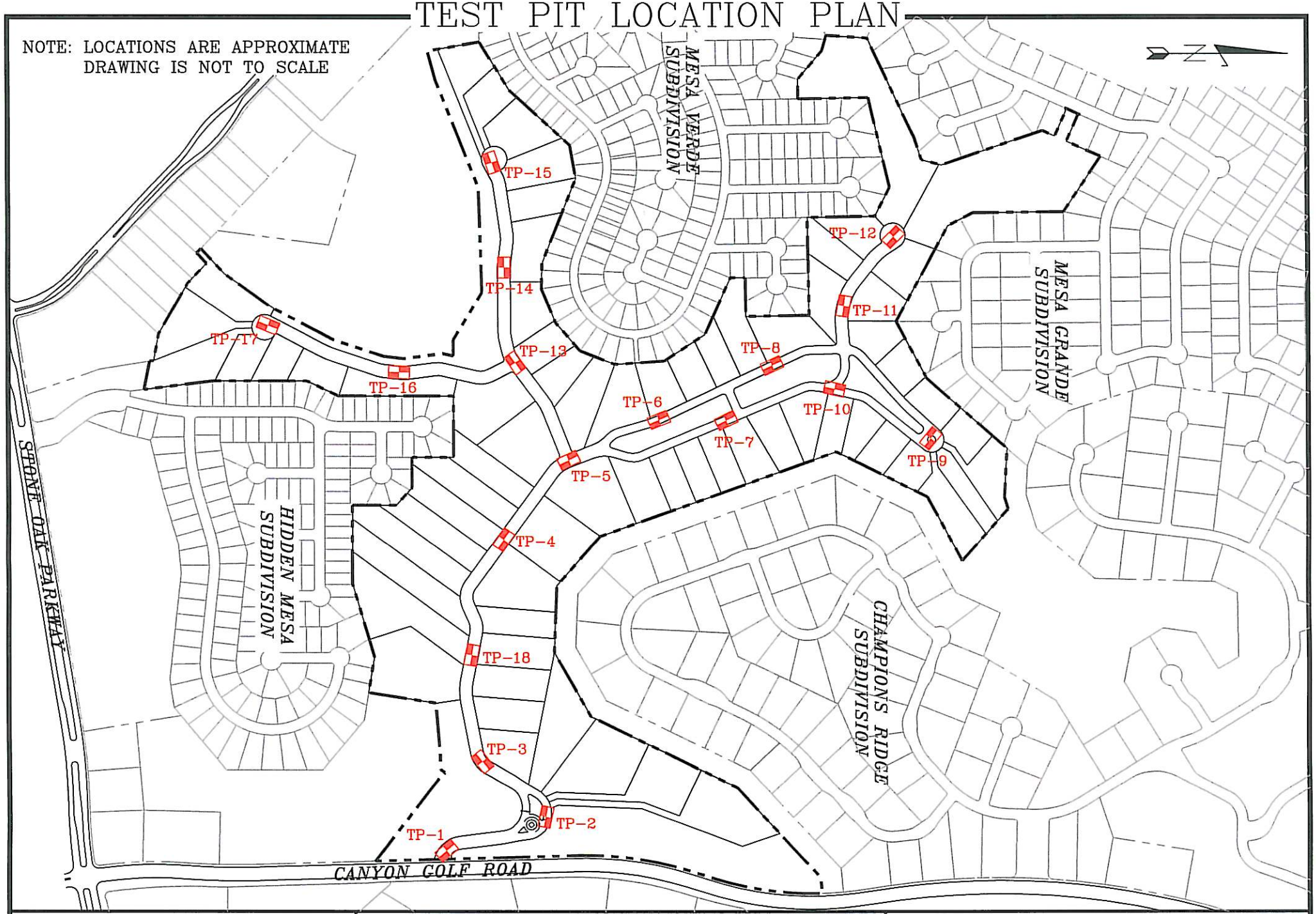
Representative Photographs of Project Area
Proposed Hidden Canyon Subdivision

Site Photo 3

Site Photo 4

TEST PIT LOCATION PLAN

NOTE: LOCATIONS ARE APPROXIMATE
DRAWING IS NOT TO SCALE



ARIAS Job No. 07SA-2570	Proposed Hidden Canyon Subdivision Hardy Oak Boulevard & Canyon Golf Road San Antonio, Texas	ARIAS & ASSOCIATES, INC.

Boring Log No. TP-1

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC
Clayey GRAVEL (GC), with Sand and Cobbles, dark brown	1	1: GB	5
Weathered LIMESTONE tan	2	2: GB	
Completion Depth: 2.5 ft. (Refusal on Limestone)	3, 4, 5, 6, 7		

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.
GB = Grab Bag Sample
WC = Water Content (%)

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Arias & Associates, Inc.

File No.: 07SA-2570

Boring Log No. TP-2

Address: San Antonio, Texas
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	-200
Clayey GRAVEL (GC), with Sand and Cobbles, dark brown	1	1: GB	12	28	79	51	
Clayey GRAVEL (GC), with Sand, reddish brown	2	2: GB	5	19	37	18	46
	3						
Completion Depth: 3.0 ft. (Refusal on Limestone)	4						
	5						
	6						
	7						

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Test Pit No. TP-3

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP	-200
Gravelly CLAY (CH), some Sand, dark brown	0–2	1: GB	15	26	74	48	14+	68
Clayey GRAVEL (GC), with cobbles, reddish brown	2–4	2: GB	16	24	64	40		
Completion Depth: 4.5 ft. (Refusal on Limestone)	4–7							

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)
-200 = % Passing #200 Sieve

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Arias & Associates, Inc.

File No.: 07SA-2570

Boring Log No. TP-4

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PP
Gravelly CLAY (CH), some Sand, dark brown	1	1: GB	20	14+
Clayey GRAVEL (GC), with Sand and Cobbles, brown	2 3 4	2: GB		
Completion Depth: 4.5 ft. (Refusal on Limestone)	5 6 7			

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.
GB = Grab Bag Sample
WC = Water Content (%)
PP = Pocket Penetrometer (tsf)

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Boring Log No. TP-5

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	PP
Gravelly CLAY (CH), some Sand and Boulders, dark brown	1	1: GB	14	27	62	35	14+
	2						
Completion Depth: 2.0 ft. (Refusal on Limestone)	3						
	4						
	5						
	6						
	7						

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
PP = Pocket Penetrometer (tsf)

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Arias & Associates, Inc.

File No.: 07SA-2570

Test Pit No. TP-6

Address: San Antonio, Texas
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC
Clayey GRAVEL (GC), some Sand, dark brown	1	1: GB	10
Clayey GRAVEL (GC), with Sand and Cobbles, brown	2	2: GB	
Completion Depth: 3.0 ft. (Refusal on Limestone)	3		
	4		
	5		
	6		
	7		

- 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.
GB = Grab Bag Sample
WC = Water Content (%)

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Arias & Associates, Inc.

File No.: 07SA-2570

Test Pit No. TP-7

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI
Clayey GRAVEL (GC), some Sand, dark brown	1	1: GB	13	28	76	48
Completion Depth: 1.5 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7					

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Arias & Associates, Inc.

File No.: 07SA-2570

Test Pit No. TP-8

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI	-200
Clayey GRAVEL (GC), some Sand and Cobbles, gray brown	1	1: GB	4	21	44	23	40
Completion Depth: 1.5 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7						

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index
-200 = % Passing #200 Sieve

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Arias & Associates, Inc.

File No.: 07SA-2570

Test Pit No. TP-9

Address: San Antonio, Texas
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC
Clayey GRAVEL (GC), some Sand and Cobbles, dark gray brown	1	1: GB	12
Completion Depth: 1.5 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7		

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.
GB = Grab Bag Sample
WC = Water Content (%)

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Boring Log No. TP-10

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PP
Gravelly CLAY (CH), some Sand, dark brown	1	1: GB	15	14+
Completion Depth: 1.5 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7			

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.
GB = Grab Bag Sample
WC = Water Content (%)
PP = Pocket Penetrometer (tsf)

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Arias & Associates, Inc.

File No.: 07SA-2570

Boring Log No. TP-11

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI
Clayey GRAVEL (GC), with Sand and Cobbles, gray brown	1	1: GB	9	27	67	40
	2					
Completion Depth: 2.0 ft. (Refusal on Limestone)	3					
	4					
	5					
	6					
	7					

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Arias & Associates, Inc.

File No.: 07SA-2570

Boring Log No. TP-12

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC
Clayey GRAVEL (GC), with Sand and Cobbles, dark gray brown	1	1: GB	17
Completion Depth: 1.0 ft. (Refusal on Limestone and Cobbles and Boulders)	2, 3, 4, 5, 6, 7		

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.
GB = Grab Bag Sample
WC = Water Content (%)

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Test Pit No. TP-13

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI
Clayey GRAVEL (GC), with Sand and Cobbles, dark gray brown	1	1: GB	17	30	78	48
Clayey GRAVEL (GC), with Sand and Cobbles, brown	2	2: GB				
Completion Depth: 2.5 ft. (Refusal on Limestone)	3, 4, 5, 6, 7					

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Arias & Associates, Inc.

File No.: 07SA-2570

Test Pit No. TP-14

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN
SURFACE LIMESTONE WITH COBBLES AND BOULDERS Completion Depth: 0 feet	1 2 3 4 5 6 7	1: GB

- 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.
GB = Grab Bag Sample

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Arias & Associates, Inc.

File No.: 07SA-2570

Test Pit No. TP-15

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC
Clayey GRAVEL (GC), with Sand (Cobbles and Boulders at surface), dark brown	1	1: GB	9
Completion Depth: 1.5 ft. (Refusal on weathered Limestone)	2, 3, 4, 5, 6, 7		

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.
GB = Grab Bag Sample
WC = Water Content (%)

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Test Pit No. TP-16

Address: San Antonio, Texas
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI
Clayey GRAVEL (GC), with Sand (Cobbles and Boulders at surface), dark gray brown	1	1: GB	13	31	68	37
Completion Depth: 1.5 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7					

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.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index

TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

Boring Log No. TP-17

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC
Clayey GRAVEL (GC), with Sand (Cobbles and Boulders at surface), dark gray brown	1	1: GB	11
Completion Depth: 1.0 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7		

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.
GB = Grab Bag Sample
WC = Water Content (%)

BORING LOG 07SA-2570.GPJ ARIAS.GDT 7/10/08

Test Pit No. TP-18

Address: **San Antonio, Texas**
Location:

Project: **Hidden Canyon - 112 Acres - Streets**
Logged By: **FR** Elev.:
Sampling Date: **6/26/08**

Soil Description	Depth (ft)	SN	WC	PL	LL	PI
Clayey GRAVEL (GC), with Sand (Cobbles and Boulders at surface), gray brown	1	1: GB	13	25	63	38
Completion Depth: 1.5 ft. (Refusal on Limestone)	2, 3, 4, 5, 6, 7					

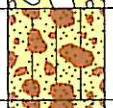
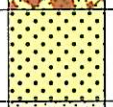
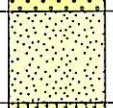
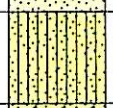
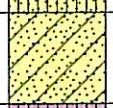
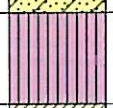
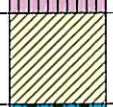
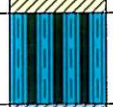
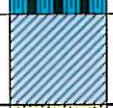
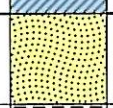
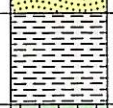
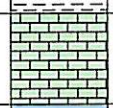
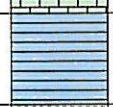
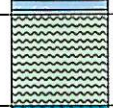
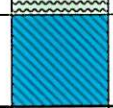
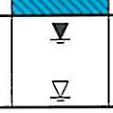
Grab Bag Sample (GB)
Shelby Tube Sample (ST)
Split Spoon Sample (SS)
Water encountered during drilling
Delayed water reading

Refer to Appendix for Additional Information

SN = Sample Type and No.
GB = Grab Bag Sample
WC = Water Content (%)
PL = Plastic Limit (%)
LL = Liquid Limit (%)
PI = Plasticity Index

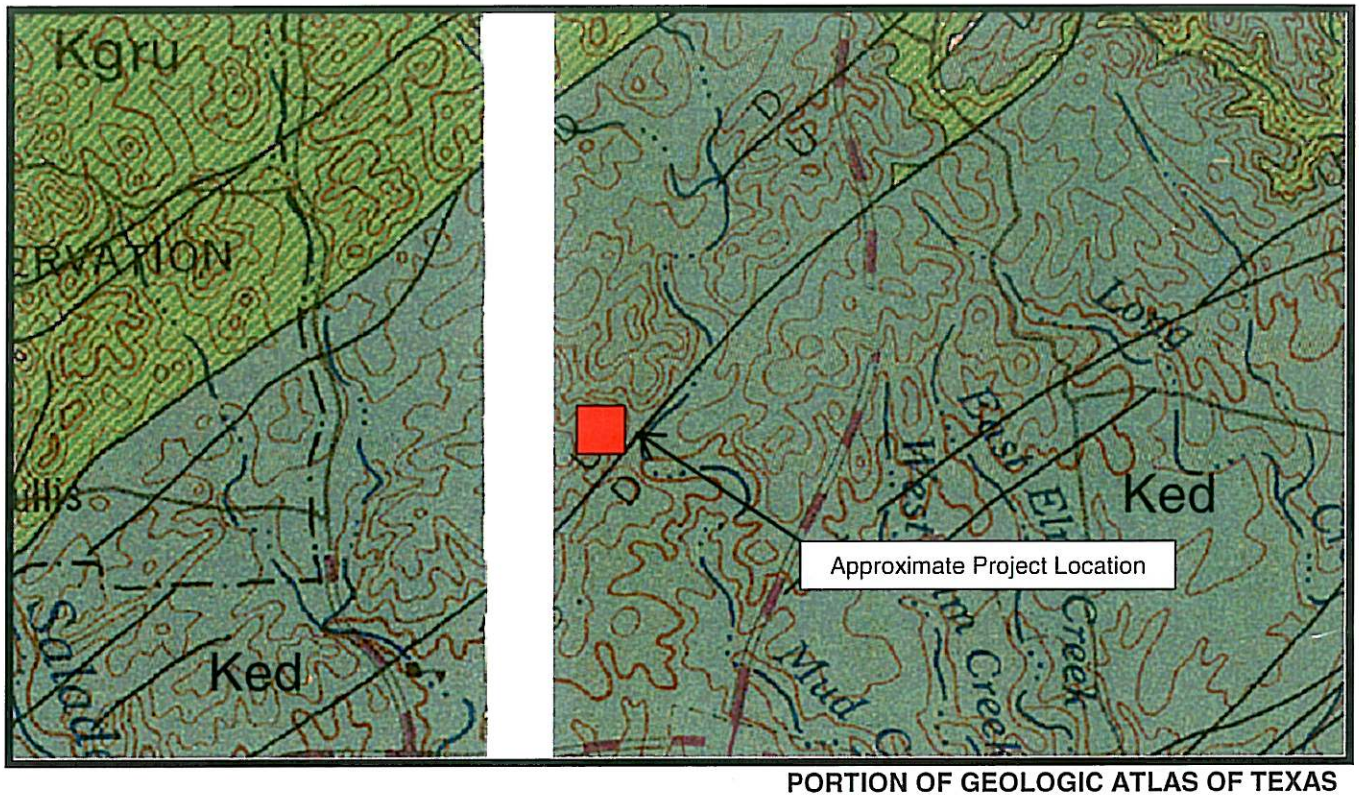
TEST PIT LOG 07SA-2570.GPJ ARIAS.GDT 7/14/08

KEY TO CLASSIFICATION SYMBOLS USED ON TEST PITS

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
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 Hidden Canyon Subdivision
Hardy Oak Boulevard & Canyon Golf Road
San Antonio, Texas

Laboratory and Field Test Procedures

Soil Classification, ASTM D2487 - Soil testing standard used for classifying soils according to the Unified Soil Classification System. The soil classifications of the earth materials encountered are as noted on the boring logs.

Soil Water Content, ASTM D2216 - 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, ASTM D4318 - 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 on the boring logs.

Soil Plastic Limit, ASTM D4318 - 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 on the boring logs.

Plasticity Index, ASTM D4318 - The soil Plasticity Index 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. Results are listed under PI on the boring logs.

Standard Penetration Test (SPT) and Split Spoon Sampler (SS), ASTM D 1586 - 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), ASTM D 1586 - 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), ASTM D 1587 – Procedure for using a thin-walled metal tube to recover relatively undisturbed soil samples suitable for laboratory tests of physical properties.

Rock Core, ASTM D 2113 – Procedure 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), ASTM D 2937 - Procedure used for the determination of in-place density of soil. The test results are measured in pounds per cubic foot, pcf.

Unconfined Compression Test (UC), ASTM D 2166 - 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, ASTM D 1140 - 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) - 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 - Illustrate a summary of the above described information at each boring location.