· Geotechnical Engineering
· Construction Materials Engineering & Testing
· Soils · Asphalt · Concrete

October 21, 2015

HDR Engineering, Inc.
555 North Carancahua Street, Suite 1600
Corpus Christi, Texas 78401

Attention: Mr. Philip Blackmar, Coastal Engineer

SUBJECT: **SUBSURFACE INVESTIGATION, LABORATORY TESTING PROGRAM AND GEOTECHNICAL RECOMMENDATIONS FOR THE PROPOSED MOSES LAKE: WETLANDS RESTORATION PROJECTS**
Moses Lake/Dollar Bay
Galveston, Texas
RETL Job No.: G115189

Dear Mr. Blackmar,

In accordance with our agreement, we have conducted a subsurface exploration and soils evaluation for the above referenced project. The results of this investigation, together with our recommendations, are to be found in the accompanying report, an electronic copy of which is being transmitted herewith for distribution to the design team.

Often, because of design and construction details that occur on a project, questions arise concerning soil conditions, and Rock Engineering and Testing Laboratory, Inc. (RETL), a Texas Professional Engineering Firm (No. – 2101), would be pleased to continue its role as Geotechnical Engineer during the project implementation.

RETL also has great interest in providing materials testing and observation services during the construction phase of this project. If you will advise us of the appropriate time to discuss these engineering services, we will be pleased to meet with you at your convenience.

Sincerely,

Mark C. Rock, P.E.
Vice President of Operations

Rock Engineering & Testing Laboratory, Inc.
www.rocktesting.com

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SUBSURFACE EXPLORATION, LABORATORY TESTING PROGRAM AND GEOTECHNICAL RECOMMENDATIONS FOR THE PROPOSED MOSES LAKE: WETLANDS RESTORATION PROJECTS MOSES LAKE/DOLLAR BAY GALVESTON, TEXAS

RETL JOB NUMBER: G115189

PREPARED FOR:

HDR ENGINEERING, INC.
555 NORTH CARANCAHUA STREET, SUITE 1600
CORPUS CHRISTI, TEXAS 78401

OCTOBER 21, 2015

PREPARED BY:

ROCK ENGINEERING AND TESTING LABORATORY, INC.
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INTRODUCTION

This report presents the results of a soils exploration and geotechnical analysis for the proposed Moses Lake: Wetlands Restoration Projects located near Galveston, Texas. This study was conducted for HDR Engineering, Inc.

Authorization

The work for this project was performed in accordance with Rock Engineering and Testing Laboratory, Inc. (RETL) Proposal No. P070615D (Revision 1) dated July 21, 2015. The proposal was approved and incorporated into HDR Engineering, Inc. "Geotech Subconsultant Agreement" executed on August 13, 2014.

Purpose and Scope

Based on information provided to RETL, the project will include construction of marsh areas and a shoreline protection system within Moses Lake.

Three options are being considered for construction of the proposed marsh areas. The first option is to construct mounds by pumping dredge slurry and allowing it to free flow to create the mound. Mounds created using this technique are anticipated to have a crest elevation of approximately +2½-feet, a crest diameter of approximately 40-feet, side slopes ranging from 30H:1V to 50H:1V, and a base elevation of approximately -2-feet. The second option is to construct terraces using mechanical excavation and placement. The proposed terraces are anticipated to have a crest elevation of approximately +3-feet, a crest width of approximately 10-feet, side slopes of approximately 4H:1V, and a base elevation of approximately -2-feet. The third option is to construct a containment berm with dimensions similar to the terraces and pump dredge material inside of the berm with fill thicknesses similar to the mounds. The soils to construction the proposed marsh areas may be obtained from a borrow source within Dollar Bay or from upland areas.

Shoreline protection is planned to be accomplished by using a rock breakwater system. The proposed breakwater is planned to have a crest elevation of approximately +3-feet, a crest width of approximately 5-feet, and side slopes of approximately 3H:1V. The base elevation of the breakwater is anticipated to be between -2 and -3-feet.

The scope of the exploration and analysis included the sampling and in-situ strength testing, field and laboratory testing, and engineering analysis. The geotechnical recommendations will include:

- Estimated allowable ground contact pressures,
- Estimated settlements associated with any potential elastic soil displacement or mudwaving during construction and
- Estimated differential and long term settlements.

The scope of services did not include an environmental assessment. Any statements in this report, or on the boring logs, regarding odors, colors, unusual or suspicious items or conditions are strictly for the information of the client.

General

The exploration and analysis of the subsurface conditions reported herein are considered sufficient in detail and scope to assist the designers in preliminary design of this project. The recommendations submitted for the proposed project are based on the available soil information and the preliminary design details provided to RETL by HDR Engineering, Inc.

The Geotechnical Engineer states that the findings, recommendations, specifications or professional advice contained herein, have been presented after being prepared in a manner consistent with that level of care and skill ordinarily exercised by reputable members of the Geotechnical Engineer's profession practicing contemporaneously under similar conditions in the locality of the project. No other representations are expressed or implied, and no warranty or guarantee is included or intended.

This report has been prepared for the exclusive use of HDR Engineering, Inc. for the specific application to the proposed Moses Lake: Wetlands Restoration Projects located near Galveston, Texas. Specifically the site is located in Moses Lake in the vicinity of Dollar Bay and near the southwest portion of Moses Lake.

FIELD EXPLORATION

Scope

The field exploration, to identify and evaluate the engineering characteristics of the subsurface conditions encountered included reconnaissance of the project site, performing strength testing, and recovering disturbed soil samples.

Twenty-one borings were performed at the site to a maximum depth of 10-feet below the bay bottom. The number of borings, boring locations and termination depths were determined with collaboration from HDR Engineering, Inc.

The boring identification, location, depth, and GPS coordinates are provided in the Summary of Boring Information table provided below.

SUMMARY OF BORING INFORMATION			
Boring I.D.	**Boring Location**	**Boring Depth (ft)**	**GPS Coordinates**
B-1	Moses Lake: Site B, Marsh Area	10	N 29.421342° W 94.912535°
B-2	Moses Lake: Site B, Marsh Area	7½	N 29.419007° W 94.909785°
B-3	Moses Lake: Site B, Marsh Area	10	N 29.421602° W 94.910181°
B-4	Moses Lake: Site B, Marsh Area	10	N 29.420176° W 94.910554°
B-5	Moses Lake: Site B, Marsh Area	9	N 29.421681° W 94.914693°
B-6	Moses Lake: Site B, Marsh Area	10	N 29.419021° W 94.911743°
B-7	Moses Lake: Site B, Marsh Area	5	N 29.420419° W 94.914561°
B-8	Moses Lake: Site B, Marsh Area	10	N 29.420145° W 94.913042°
B-9	Moses Lake: Site B, Marsh Area	5	N 29.418483° W 94.913578°
B-10	Moses Lake: Site B, Marsh Area	5	N 29.419755° W 94.915731°
B-11	Moses Lake: Site B, Marsh Area	7½	N 29.418250° W 94.915859°
B-12	Moses Lake: Site B, Marsh Area	7½	N 29.418021° W 94.910185°
B-13	Moses Lake: Site D, Marsh Area	5	N 29.419797° W 94.951053°
B-14	Moses Lake: Site D, Marsh Area	4½	N 29.418929° W 94.950279°
B-15	Moses Lake: Site D, Marsh Area	2½	N 29.418965° W 94.951697°
B-16	Moses Lake: Site D, Marsh Area	4½	N 29.418049° W 94.951083°
B-17	Dollar Bay, Potential Borrow Area	10	N 29.429551° W 94.920912°
B-18	Dollar Bay, Potential Borrow Area	10	N 29.425659° W 94.918583°
B-19	Dollar Bay, Potential Borrow Area	10	N 29.427925° W 94.913016°
B-20	Dollar Bay, Potential Borrow Area	10	N 29.429619° W 94.904736°
B-21	Dollar Bay, Potential Borrow Area	10	N 29.425608° W 94.903854°

The boring depths referred to in the tables above are measured from the bay bottom at the test locations during the time of our field investigation. RETL performed the boring operations. Boring Location Plans are included in the Appendix of this report.

Drilling and Sampling Procedures

The soils samples were obtained using a sediment sampler. All the samples were identified according to boring number and depth, encased in polyethylene plastic wrapping to protect against moisture loss and transported to the laboratory in special containers.

Field Tests and Measurements

Static Cone Tests - Portable static cone penetrometer tests were performed at select boring locations. The portable static cone penetrometer is a device used for measuring soil consistency. This test was performed on areas with apparent fine grained, soft soils. The device is equipped with dual rods enabling the cone stress to be measured directly. Soil friction on the outer rod does not influence the reading. The cone is forced into the soil in increments and retracted slightly after each increment to zero the gauge, then the cone is advanced to obtain the cone index (Qc). The cone index is always read directly from the gauge. It has units of kg/cm^2 that is essentially equal to $tons/ft^2$. The results of the portable static cone penetrometer tests are provided on the boring logs using the notation Qc.

Estimates of unconfined compressive strengths, cohesion, standard penetration test values "N" and CBR values can be derived from the cone index. The correlation between the cone index and soil constants is not absolute. The following empirical formulas were provided by the portable static cone penetrometer manufacturer, Boart Longyear Company, and have been determined through extensive field use of the unit:

1. Standard Penetration Test Value "N"
   N = Qc/4

2. Unconfined Compressive Strength "Qu" (tsf)
   Uniform clay and silty clays: Qu = Qc/5
   Clayey silts: Qu = Qc/(10 to 20)

3. Cohesion "C" or Undrained Shear Strength (tsf)
   Uniform clay and silty clays: C = Qc/10
   Clayey silts: C = Qc/(20 to 40)

Vane Shear Testing – A GEONOR Inspection Vane Tester Model H-60 was used to measure the in-situ undrained shear strength of the soils. The test is performed by forcing a vane into the soil and twisting the vane to shear or fail a wedge of soil. The measuring part of the instrument is a spiral spring. When the handle is turned, the spring deforms and the upper and lower parts of the instrument receive a mutual angular displacement. The size of the displacement is dependent on the torque applied. A graduated scale is used to measure the displacement. The scale ring follows the upper part of the instrument and when shear failure in the soil occurs, the scale ring will remain in its position while the upper handle part of the instrument will return to the zero position. The distance the scale ring traveled is measured. This measurement has been correlated to a known torque force and converted to an undrained soil shear strength value: Undrained Shear Strength (tsf): C = Tv*2.

LABORATORY TESTING PROGRAM

In addition to the field investigation, a laboratory testing program was conducted to determine additional pertinent engineering characteristics necessary in analyzing the behavior of the soils at the project location.

The laboratory testing included the following test procedures:

- Supplementary visual classification (ASTM D2487)
- Moisture content tests (ASTM D2216)
- Atterberg limits tests (ASTM D4318)
- Percent material finer than the #200 sieve tests (ASTM D1140)

All phases of the laboratory testing program were performed in general accordance with applicable ASTM Specifications. All field and laboratory tests results are included on the boring logs in the Appendix or in this report.

SUBSURFACE CONDITIONS

General

The types of subsurface soil materials encountered in the test borings have been visually classified and are described in detail on the boring logs. The soil classification, laboratory testing, estimated undrained shear strength for fine grained soils and the estimated angle of internal friction for course grained soils are provided in the following tables. More detailed results of the field investigation and laboratory tests are provided on the boring logs in the Appendix.

Representative samples of the soils were placed in polyethylene bags and are now stored in the laboratory for further analysis, if desired. Unless notified to the contrary, all samples will be disposed of three months after issuance of this report.

The stratification of the soil, as shown on the boring logs, represents the soil conditions at the actual boring locations. Variations may occur between, or beyond, the boring locations. Lines of demarcation represent the approximate boundary between soil types, but the transition may be gradual, or not clearly defined.

It is to be noted that, whereas the test borings were drilled and sampled by experienced drillers, it is sometimes difficult to record changes in stratification within narrow limits. In the absence of foreign substances, it is also difficult to distinguish between discolored soils and clean fill soil.

The soil profile tables below provide a summary of the average soil conditions encountered at the boring locations:

Soil Profile Table for Moses Lake: Site B (Borings B-1 through B-12)

D	GENERALIZED SOIL DESCRIPTION	LL	PI	C	ϕ	γ_e	-#200
0-4	Avg. Water Depth						
4-7	Fat/Lean **CLAY** & **CLAYEY** Sand	33-70	21-50	400	0	55	37-89
7-14	Fat/Lean **CLAY** & **CLAYEY** Sand	28-51	13-37	1,600	0	55	29-94

Soil Profile Table for Moses Lake: Site D (Borings B-13 through B-16)

D	GENERALIZED SOIL DESCRIPTION	LL	PI	C	ϕ	γ_e	-#200
0-3	Avg. Water Depth						
3-4	Fat/Lean **CLAY** & **CLAYEY** Sand	---	---	500	0	55	91
4-8	Fat **CLAY**	50-85	36-59	1,100	0	55	89-95

Soil Profile Table for Moses Lake: Dollar Bay (Borings B-17 through B-21)

D	GENERALIZED SOIL DESCRIPTION	LL	PI	C	ϕ	γ_e	-#200
0-6	Avg. Water Depth						
6-9	Fat **CLAY**	---	---	80	0	55	66-77
9-16	Fat **CLAY** & **CLAYEY** Sand	31	20	300	0	55	42-89

Where: D = Approximate Depth Below Bay Bottom
LL = Liquid limit (%)
PI = Plasticity index
C = Soil Cohesion, psf (undrained)
ϕ = Angle of Internal Friction, deg. (undrained)
γ_e = Effective soil unit weight, pcf
-#200 = Material passing #200 sieve, %

Exceptions to the stratigraphy provided in the soil profile tables above were observed. Of particular note, was the silty clayey sand and silty sand soils encountered at boring location B-3 between the mudline and the boring termination depth of 10-feet. A detailed description of the soils encountered are provided on the boring logs included in the Appendix.

GEOTECHNICAL DISCUSSION AND RECOMMENDATIONS

Project Description

Based on information provided to RETL, the proposed project will include both wetland restoration and shoreline protection components. The project is planned to consist of the installation of a rock breakwater system to protect the marsh shoreline from erosion due to wave action and the construction of marsh mounds or terraces.

It is understood that specific locations for the wetland restoration and shoreline protection have not be determined within the areas of Site B and Site D in Moses Lake. Therefore, the recommendations provided within this report are general recommendations based on the soil conditions encountered at the boring locations throughout the Site B and Site D areas.

Three options are being considered for construction of the proposed marsh areas. The first option is to construct mounds by pumping dredge slurry and allowing it to free flow to create the mound. Mounds created using this technique are anticipated to have a crest elevation of approximately +2½-feet, a crest diameter of approximately 40-feet, side slopes ranging from 30H:1V to 50H:1V, and a base elevation of approximately -2-feet. The second option is to construct terraces using mechanical excavation and placement. The proposed terraces are anticipated to have a crest elevation of approximately +3-feet, a crest width of approximately 10-feet, side slopes of approximately 4H:1V, and a base elevation of approximately -2-feet. The third option is to construct a containment berm with dimensions similar to the terraces and pump dredge material inside of the berm with fill thicknesses similar to the mounds. The soils to construct the proposed marsh areas may be obtained from Dollar Bay or from upland areas.

Although it is understood the actual dimensions of the breakwater may vary, the assumptions stated in this report concerning assumed geometries of the breakwater are sufficient for this preliminary phase of the project.

Shoreline Protection

A stone breakwater will likely be utilized to stabilize the shoreline and protect the proposed wetlands by reducing erosion caused by dissipating wave action. The proposed breakwater is planned to have a crest elevation of approximately +3-feet, a crest width of approximately 5-feet, and side slopes of approximately 3H:1V. The base elevation of the breakwater is anticipated to be between -2 and -3-feet. It is anticipated that the material used to construct the breakwater will have a unit weight of approximately 165-pcf resulting in a maximum ground contact pressure on the order of 700 to 810 psf.

The geotechnical considerations for the rock breakwater, both during and after construction, are discussed below:

- Estimated ground contact pressures,
- Classification and bearing capacity of the supporting soils and
- Estimated immediate, differential and long-term settlements.

As depicted in the soil profile table provided above for borings B1 through B-16, the predominate soils encountered are plastic clay soils. The bearing capacity calculated for clay soils is dependent on the undrained shear strength of the clay soils. RETL estimates that the calculated ultimate bearing pressure at Site B (boring locations B-1 through B-12) is approximately 2,000 psf and at Site D (boring locations B-13 through B-16) on the order of 2,500 psf. The ultimate capacity of 2,000 to 2,500 psf is greater than the estimated ground contact pressure of 700 to 810 psf. Therefore, the in-situ soils encountered at the site should accommodate ground contact pressures of the magnitude exerted by the breakwater without the possibility of a classical bearing failure. RETL does not expect a classical bearing failure but initial settlement in areas with low soil strengths may create an associated mud wave. Estimated initial mudwave settlement in soft soil areas are estimated to be on the order of 1-foot.

Utilizing the information obtained within the scope of this project to a depth of 10-feet, the estimated calculated long term consolidation settlement is on the order of 6 to 8-inches. Differential settlement is anticipated to be approximately one-half the total settlement. Soft soils at depths greater than 10-feet below the bay bottom, if present, will contribute to the settlement discussed above, but the magnitude of the settlement is impossible to predict given the lack of information on these deeper soils at depths greater than 10-feet below the bay bottom. If this information is desired, then it will be necessary for RETL to obtain additional soils data to a minimum depth of 70-feet below the bay bottom if the soils encountered exhibit normally consolidated or underconsolidated cohesive soil conditions or to a depth that preconsolidated clays are encountered to perform a more detailed settlement analysis.

Wetlands Restoration

Based on preliminary information provided to RETL by HDR Engineering, Inc., it is understood that the wetlands restoration work will include either a series of mounds or terraces using either material dredged from the borrow area or imported from an upland source. The borrow source materials encountered at borings B-17 through B-21 from the bay bottom and extending to a depth of approximately 10-feet consisted primarily of fine grained clay soils.. Due to the fines, clays and silts encountered at the boring locations, the discharge water velocity during dredging will have a significant impact on how quickly the soils will settle out of the discharge water. It is RETL's opinion that soils with a higher percentage of sand in a prospective borrow source will hasten construction of the proposed mounds.

Maximum ground contact pressure of a mound, given the proposed dimensions provided, is on the order of 420 psf. Maximum ground contact pressure of a terrace, given the proposed dimensions provided, is on the order of 480 psf. Utilizing generally accepted bearing capacity equations, RETL's analysis indicates that the in-situ soils have an ultimate bearing capacity of approximately 2,000 to 2,500 psf. The ultimate capacity of 2,000 to 2,500 psf is greater than the estimated ground contact pressure of 420 to 480 psf. Therefore, the in-situ soils encountered at the site should accommodate ground contact pressures of the magnitude exerted by the mounds and terraces without the possibility of a classical bearing failure.

Settlement of the supporting soils at the mound or terrace locations is a result of the ground contact pressure due to the placement fill soils used to construct the mounds or terraces and settlement of the soils making the mounds or terraces. Consolidation settlements of the soils supporting the mounds or terraces are estimated to be on the order of 4-inches to 7-inches and 90-percent of the total settlement can be expected to occur within 1 to 2-years of the load application. Consolidation settlement for soils supporting a containment berm and dredge soils are anticipated to be of a similar magnitude to that of the mounds or terraces.

Settlement of the soils within the mounds will be dependent upon what type of soils are selected for use to construct the mounds and the construction method. Sand soils, if used to construct the mounds, will experience relatively immediate settlements. Repeated tidal changes will result in a reduction if effective stress during high tides and and increase in the effective stress during low tide conditions which may delay the "loading" of the soils until extreme low tide events. Immediate settlements of sand soils within the mounds, which occur within approximately 7-days after the application of the load, are estimated to be on the order of 2-inches to 3-inches. Sands will only experience additional settlement if additional stress is applied above the previous maximum stress. Conversely, settlement of soils with significantly more fines, such as the clay soils encountered in most of the boring locations are more difficult to predict.

Due to the unpredictable nature of hydraulically placed clay soils, RETL recommends using sand soils to construct the mounds. Total settlement, taking into account the settlement of the supporting soils and settlement of the soils within the mounds constructed using sand soils is estimated to be on the order of 6 to 10-inches.

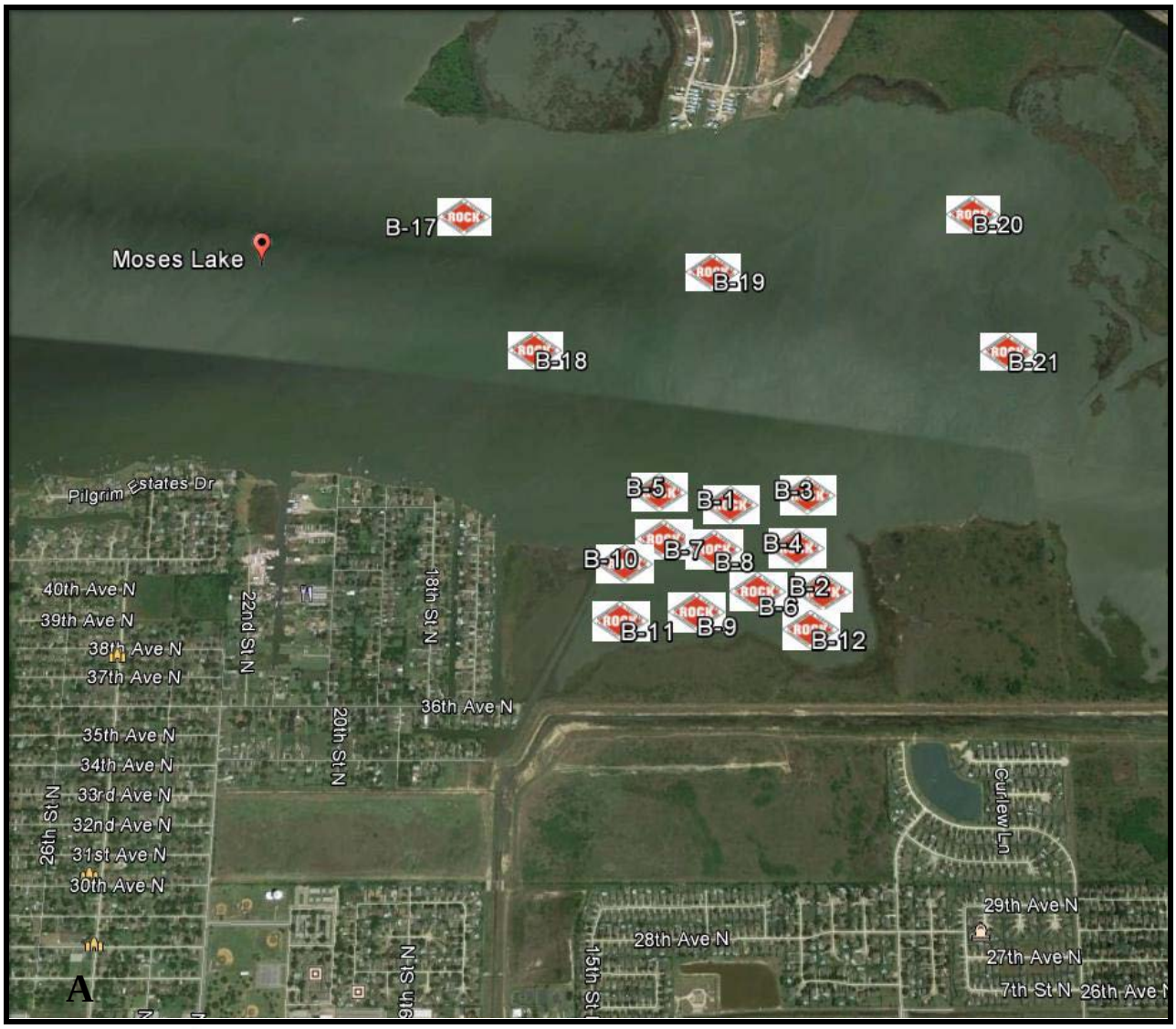
GENERAL COMMENTS

If significant changes are made in the character or location of the proposed project, a consultation should be arranged to review any changes with respect to the prevailing soil conditions. At that time, it may be necessary to submit supplementary recommendations.

It is recommended that the services of RETL be engaged to test and evaluate the soils and to verify that the soils are consistent with those encountered by the boring operations. RETL cannot accept any responsibility for any conditions that deviate from those described in this report, nor for the performance of the project if not engaged to also provide construction observation and testing for this project. If it is required for RETL to accept any liability, then RETL must agree with the plans and perform such observation during construction as we recommend.

APPENDIX

• Geotechnical Engineering
• Construction Materials Engineering & Testing
• Soils • Asphalt • Concrete



BORING LOCATION PLAN

October 21, 2015
Attn.: Mr. Philip Blackmar
RETL Job No.: G115189

MOSES LAKE: WETLANDS RESTORATION PROJECTS
Moses Lake/Dollar Bay
Galveston, Texas

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• Geotechnical Engineering
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BORING LOCATION PLAN

October 21, 2015
Attn.: Mr. Philip Blackmar
RETL Job No.: G115189

MOSES LAKE: WETLANDS RESTORATION PROJECTS
Moses Lake/Dollar Bay
Galveston, Texas

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LOG OF BORING B-1

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/14/15 - 9/14/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA				LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											
	3											**WATER DEPTH: 5.0'**
	4											
	5	AUGER S-1		Qc= 1	32						37	**CLAYEY SAND**, gray, moist, very soft.
	6											Same as above, stiff.
	7	AUGER S-2		Qc= 10	31							
	8											
	9	AUGER S-3		Qc= 12	30	28	15	13			29	Same as above, very stiff.
	10											
	11											Same as above.
	12	AUGER S-4		Qc= 14	31						36	
	13											
	14	AUGER S-5			39							Same as above.
	15											Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.421342° W 94.912535°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-2

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)		
	1												
	2												**WATER DEPTH: 3.0'**
	3	AUGER S-1		Tv= 0.14	41								**LEAN CLAY**, gray, moist, very soft.
	4												
	5	AUGER S-2		Tv= 0.34	32	51	15	36			84		**FAT CLAY**, gray, moist, very soft.
	6												
	7	AUGER S-3		Tv= 0.84	48						84		Same as above, soft.
	8												
	9												
	10	AUGER S-4		Tv= 0.66									Same as above.
													Boring was terminated at a depth of 7½-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.419007° W 94.909785°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-3

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)		
	1												
	2												
	3												**WATER DEPTH: 5.0'**
	4												
	5	AUGER S-1		Qc= 1	36								**SILTY CLAYEY SAND**, gray, moist, very loose.
	6												
	7	AUGER S-2		Qc= 6	29	NP	NP	NP			24		**SILTY SAND**, gray, moist, very loose. (SM)
	8												
	9	AUGER S-3		Qc= 15	29								Same as above.
	10												
	11												
	12	AUGER S-4		Qc= 15	26						19		Same as above.
	13												
	14	AUGER S-5		Qc= 7	24								Same as above.
	15												Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.421602° W 94.910181°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-4

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA							
						ATTERBERG LIMITS						
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 4.0'**
	3											
	4	AUGER S-1		Tv= 0.18	31	33	12	21			54	**SANDY LEAN CLAY**, gray, moist, very soft. (CL)
	5											
	6	AUGER S-2		Tv= 0.56	30							Same as above, soft.
	7											
	8	AUGER S-3		Tv= 0.70	30	44	16	28			69	Same as above. (CL)
	9											
	10											Same as above.
	11	AUGER S-4			46							
	12											
	13	AUGER S-5			61						72	**FAT CLAY**, gray, moist.
	14											Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.420176° W 94.910554°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-5

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 8/31/15 - 8/31/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											
	3											**WATER DEPTH: 4.8'**
	4											
	5	AUGER S-1		Qc= 0	43							**CLAYEY SAND**, gray, moist, very soft.
	6											Same as above.
	7	AUGER S-2		Qc= 0	36							
	8											
	9	AUGER S-3		Qc= 5	29	29	13	16			36	Same as above, firm. (SC)
	10											
	11											Same as above, very stiff.
	12	AUGER S-4		Qc= 15	28							
	13	AUGER S-5		Qc= 18	28	32	14	18			39	Same as above. (SC)
												Boring was terminated at a depth of 9-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.421681° W 94.914693°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-6

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/14/15 - 9/14/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)		
	1												
	2												**WATER DEPTH: 4.0'**
	3												
	4												
	5	AUGER S-1		Tv= 0.20	58	70	20	50			89		**FAT CLAY**, gray, moist, very soft. (CH)
	6	AUGER S-2		Tv= 0.20	69								Same as above.
	7												
	8	AUGER S-3		Tv= 0.26	68						94		Same as above.
	9												
	10												
	11	AUGER S-4		Tv= 0.20	74								Same as above.
	12												
	13	AUGER S-5		Tv= 0.30									Same as above.
	14												Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.419021° W 94.911743°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-7

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 8/31/15 - 8/31/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 3.0'**
	3	AUGER S-1		Tv= 0.16	33							**CLAYEY SAND**, gray, moist, very soft.
	4											Same as above, stiff. (SC)
	5	AUGER S-2		Tv= 1.04	36	36	11	25			48	
	6											
	7	AUGER S-3		Tv= 1.04	34	42	13	29			59	**SANDY LEAN CLAY**, gray, moist, stiff. (CL)
	8											Boring was terminated at a depth of 5-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.420419° W 94.914561°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-8

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/14/15 - 9/14/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA				LABORATORY DATA								
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 4.5'**
	3											
	4											
	5	AUGER S-1		Tv= 0.80	47							**CLAYEY SAND**, gray, moist, firm.
	6	AUGER S-2		Tv= 0.02	60						82	**FAT CLAY**, gray, moist, very soft.
	7											
	8											
	9	AUGER S-3		Tv= 0.76	33	39	12	27			48	**CLAYEY SAND**, gray, moist, firm. (SC)
	10											
	11											
	12											
	13											
	14	AUGER S-4			66						78	**FAT CLAY**, gray, moist.
												Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.420145° W 94.913042°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-9

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/14/15 - 9/14/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)		
	1												
	2												**WATER DEPTH: 4.0'**
	3												
	4	AUGER S-1		Tv= 0.18	39	49	11	38			75		**LEAN CLAY**, gray, moist, very soft. (CL)
	5												
	6	AUGER S-2		Tv= 0.24	44								Same as above.
	7												
	8	AUGER S-3		Tv= 0.48	29						30		**CLAYEY SAND**, gray, moist, very soft.
	9												Boring was terminated at a depth of 5-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.418483° W 94.913578°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-10

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 8/31/15 - 8/31/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											**WATER DEPTH: 2.2'**
	2											
	3	AUGER S-1		Tv= 0.62	51							**SANDY FAT CLAY**, gray, moist, firm.
	4	AUGER S-2		Tv= 0.12	27						47	**CLAYEY SAND**, gray, moist, very soft.
	5											
	6	AUGER S-3		Tv= 0.90	36	51	14	37			61	**SANDY FAT CLAY**, gray, moist, firm. (CH)
	7											Boring was terminated at a depth of 5-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.419755° W 94.915731°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-11

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 8/31/15 - 8/31/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA							
						ATTERBERG LIMITS						
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											**WATER DEPTH: 2.0'**
	2											
	3	AUGER S-1		Qc= 1, Tv= 0.56	41							**CLAYEY SAND**, gray, moist, very soft.
	4	AUGER S-2		Qc= 3, Tv= 0.46	32							Same as above, firm.
	5											
	6	AUGER S-3		Qc= 10, Tv= 0.06	31						48	Same as above, stiff.
	7											
	8	AUGER S-4		Qc= 28, Tv= 0.40	30	32	11	21			42	Same as above, hard. (SC)
	9											Boring was terminated at a depth of 7½-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.418250° W 94.915859°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-12

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 3.5'**
	3											
	4	AUGER S-1		Tv= 0.24	33							**CLAYEY SAND**, gray, moist, very soft.
	5	AUGER S-2		Tv= 0.60	35	39	11	28			58	**SANDY LEAN CLAY**, gray, moist, soft. (CL)
	6											
	7											
	8	AUGER S-3		Tv= 0.60	35							**CLAYEY SAND**, gray, moist, soft.
	9											
	10	AUGER S-4		Tv= 1.34	31						48	Same as above, firm.
	11											Boring was terminated at a depth of 7½-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.418021° W 94.910185°.
Boring Location: Site B, Proposed Marsh Areas

LOG OF BORING B-13

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 3.5'**
	3											
	4	AUGER S-1		Tv= 0.22	46							**SANDY LEAN CLAY**, gray moist, very soft.
	5	AUGER S-2		Tv= 0.22	34						89	**FAT CLAY**, gray, moist, very soft.
	6											
	7											Same as above, soft. (CH)
	8	AUGER S-3		Tv= 1.00	32	85	27	58			95	
												Boring was terminated at a depth of 5-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.419797° W 94.951053°.
Boring Location: Site D, Proposed Marsh Areas

LOG OF BORING B-14

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/16/15 - 9/16/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA							
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 2.5'**
	3	AUGER S-1		Tv= 0.24	46							**CLAYEY SAND**, gray, moist, very soft.
	4	AUGER S-2		Tv= 0.34	34						95	**FAT CLAY**, gray, moist, very soft.
	5											
	6	AUGER S-3		Tv= 0.48	33	50	14	36			92	Same as above, very soft. (CH)
	7											Boring was terminated at a depth of 4½-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.418929° W 94.950279°.
Boring Location: Site D, Proposed Marsh Areas

LOG OF BORING B-15

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/16/15 - 9/16/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA							
						ATTERBERG LIMITS						
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 4.0'**
	3											
	4	AUGER S-1		Tv= 0.20	57							**FAT CLAY**, gray, moist, very soft.
	5											Same as above, soft. (CH)
	6	AUGER S-2		Tv= 0.68	40	72	13	59			95	

Boring was terminated at a depth of 2½-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.418965° W 94.951697°.
Boring Location: Site D, Proposed Marsh Areas

LOG OF BORING B-16

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/16/15 - 9/16/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LL	ATTERBERG LIMITS PL	ATTERBERG LIMITS PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											**WATER DEPTH: 3.0'**
	3	AUGER S-1		Tv= 0.36	48						91	**FAT CLAY**, gray, moist, very soft.
	4											Same as above, soft. (CH)
	5	AUGER S-2		Tv= 0.64	30	67	12	55			94	
	6											Same as above.
	7	AUGER S-3		Tv= 0.74								
												Boring was terminated at a depth of 4½-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.418049° W 94.951083°.
Boring Location: Site D, Proposed Marsh Areas

LOG OF BORING B-17

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)		
	1												
	2												
	3												**WATER DEPTH: 6.0'**
	4												
	5												
	6	AUGER S-1		Tv= 0.02	73								**FAT CLAY**, gray, moist, very soft.
	7												Same as above.
	8	AUGER S-2		Tv= 0.04	67						74		
	9												
	10	AUGER S-3		Tv= 0.18	74								Same as above.
	11												
	12												Same as above.
	13	AUGER S-4		Tv= 0.16	68						83		
	14												
	15	AUGER S-5		Tv= 0.24	59								Same as above.
	16												Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.429551° W 94.920912°.
Boring Location: Dollar Bay, Prospective Borrow Source Area

LOG OF BORING B-18

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA					LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)		
	1												
	2												
	3												**WATER DEPTH: 6.0'**
	4												
	5												
	6	AUGER S-1		Tv= 0.02	88						77		**FAT CLAY**, gray, moist, very soft.
	7												
	8	AUGER S-2		Tv= 0.02	77								Same as above.
	9												
	10	AUGER S-3		Tv= 0.16	77						89		Same as above.
	11												
	12	AUGER S-4		Tv= 0.16	84								Same as above.
	13												
	14												
	15	AUGER S-5		Tv= 0.24	70						86		Same as above.
	16												Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.425659° W 94.918583°.
Boring Location: Dollar Bay, Prospective Borrow Source Area

LOG OF BORING B-19

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA				LABORATORY DATA								DESCRIPTION OF STRATUM
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	
	1											
	2											
	3											**WATER DEPTH: 5.5'**
	4											
	5											
	6	AUGER S-1		Tv= 0.08	64							**FAT CLAY**, gray, moist, very soft.
	7	AUGER S-2		Tv= 0.02	75						77	Same as above.
	8											
	9											Same as above.
	10	AUGER S-3		Tv= 0.12	77							
	11											
	12	AUGER S-4		Tv= 0.10	75						85	Same as above.
	13											
	14											Same as above.
	15	AUGER S-5		Tv= 0.24								
												Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.427925° W 94.913016°.
Boring Location: Dollar Bay, Prospective Borrow Source Area

LOG OF BORING B-20

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA				LABORATORY DATA								
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											
	3											**WATER DEPTH: 6.0'**
	4											
	5											
	6	AUGER S-1		Tv= 0.02	72							**FAT CLAY**, gray, moist, very soft.
	7											Same as above.
	8	AUGER S-2		Tv= 0.08	68							
	9											
	10	AUGER S-3		Tv= 0.92	29	31	11	20			42	**CLAYEY SAND**, gray, moist, soft.
	11											
	12											Same as above.
	13	AUGER S-4		Tv= 0.54	29						42	
	14											
	15	AUGER S-5			94							**FAT CLAY**, gray, moist.
	16											Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.429619° W 94.904736°.
Boring Location: Dollar Bay, Prospective Borrow Source Area

LOG OF BORING B-21

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

CLIENT: HDR Engineering, Inc.
PROJECT: Moses Lake/Dollar Bay
LOCATION: Galveston, Texas
NUMBER: G115189
DATE(S) DRILLED: 9/15/15 - 9/15/15

DRILLING METHOD(S):
Hand Auger

GROUNDWATER INFORMATION:
Due to the location of the project site, groundwater readings were not obtained.

SURFACE ELEVATION:

FIELD DATA				LABORATORY DATA								
SOIL SYMBOL	DEPTH (FT)	SAMPLE NUMBER	SAMPLES	N: BLOWS/FT P: TONS/SQ FT T: TONS/SQ FT Qc: TONS/SQ FT	MOISTURE CONTENT (%)	ATTERBERG LIMITS LIQUID LIMIT LL	ATTERBERG LIMITS PLASTIC LIMIT PL	ATTERBERG LIMITS PLASTICITY INDEX PI	DRY DENSITY POUNDS/CU.FT	COMPRESSIVE STRENGTH (TONS/SQ FT)	MINUS NO. 200 SIEVE (%)	DESCRIPTION OF STRATUM
	1											
	2											
	3											**WATER DEPTH: 6.0'**
	4											
	5											
	6	AUGER S-1		Tv= 0	64						66	**SANDY FAT CLAY**, gray, moist, very soft.
	7											Same as above.
	8	AUGER S-2		Tv= 0.12	52							
	9											
	10	AUGER S-3		Tv= 0.08	58						69	Same as above.
	11											
	12	AUGER S-4		Tv= 0.08	58							Same as above.
	13											
	14											
	15	AUGER S-5		Tv= 0.14								Same as above.
	16											Boring was terminated at a depth of 10-feet below the mudline.

N - STANDARD PENETRATION TEST RESISTANCE
Qc - STATIC CONE PENETROMETER TEST INDEX
Tv - VANE SHEAR TEST INDEX

REMARKS:
Boring location and depth were determined by RETL. Drilling operations were performed by RETL at GPS Coord. N 29.425608° W 94.903854°.
Boring Location: Dollar Bay, Prospective Borrow Source Area

Engineering & Testing
Laboratory, Inc.

Rock Engineering & Testing Laboratory
6817 Leopard Street
Corpus Christi, TX 78409-1703
Telephone: 361-883-4555
Fax: 361-883-4711

KEY TO SOIL CLASSIFICATION AND SYMBOLS

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		SYMBOL	NAME
COARSE GRAINED SOILS	GRAVEL AND GRAVELLY SOILS	GW	Well Graded Gravels or Gravel-Sand mixtures, little or no fines
		GP	Poorly Graded Gravels or Gravel-Sand mixtures, little or no fines
		GM	Silty Gravels, Gravel-Sand-Silt mixtures
		GC	Clayey Gravels, Gravel-Sand-Clay Mixtures
	SAND AND SANDY SOILS	SW	Well Graded Sands or Gravelly Sands, little or no fines
		SP	Poorly Graded Sands or Gravelly Sands, little or no fines
		SM	Silty Sands, Sand-Silt Mixtures
		SC	Clayey Sands, Sand-Clay mixtures
FINE GRAINED SOILS	SILTS AND CLAYS LL < 50	ML	Inorganic Silts and very fine Sands, Rock Flour, Silty or Clayey fine Sands or Clayey Silts
		CL	Inorganic Clays of low to medium plasticity, Gravelly Clays, Sandy Clays, Silty Clays, Lean Clays
		OL	Organic Silts and Organic Silt-Clays of low plasticity
	SILTS AND CLAYS LL > 50	MH	Inorganic Silts, Micaceous or Diatomaceous fine Sandy or Silty soils, Elastic Silts
		CH	Inorganic Clays of high plasticity, Fat Clays
		OH	Organic Clays of medium to high plasticity, Organic Silts
HIGHLY ORGANIC SOILS		PT	Peat and other Highly Organic soils

TERMS CHARACTERIZING SOIL STRUCTURE

SLICKENSIDED - having inclined planes of weakness that are slick and glossy in appearance

FISSURED - containing shrinkage cracks, frequently filled with fine sand or silt; usually more or less vertical

LAMINATED (VARVED) - composed of thin layers of varying color and texture, usually grading from sand or silt at the bottom to clay at the top

CRUMBLY - cohesive soils which break into small blocks or crumbs on drying

CALCAREOUS - containing appreciable quantities of calcium carbonate, generally nodular

WELL GRADED - having wide range in grain sizes and substantial amounts of all intermediate particle sizes

POORLY GRADED - predominantly of one grain size uniformly graded) or having a range of sizes with some intermediate size missing (gap or skip graded)

SYMBOLS FOR TEST DATA

- Groundwater Level (Initial Reading)
- Groundwater Level (Final Reading)
- Shelby Tube Sample
- SPT Samples
- Auger Sample
- Rock Core

TERMS DESCRIBING CONSISTENCY OF SOIL

COARSE GRAINED SOILS		FINE GRAINED SOILS		
DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	DESCRIPTIVE TERM	NO. BLOWS/FT. STANDARD PEN. TEST	UNCONFINED COMPRESSION TONS PER SQ. FT.
Very Loose	0 - 4	Very Soft	< 2	< 0.25
Loose	4 - 10	Soft	2 - 4	0.25 - 0.50
Medium	10 - 30	Firm	4 - 8	0.50 - 1.00
Dense	30 - 50	Stiff	8 - 15	1.00 - 2.00
Very Dense	over 50	Very Stiff	15 - 30	2.00 - 4.00
		Hard	over 30	over 4.00

Field Classification for "Consistency" is determined with a 0.25" diameter penetrometer