SUBSOIL INVESTIGATION
TERREBONNE PARISH
CONSOLIDATED GOVERNMENT
NORTH LAKE BOUDREAUX
FORCED DRAINAGE PROJECT
TERREBONNE PARISH, LOUISIANA
AAI REPORT NO. 09-L3176

Ardaman & Associates, Inc.

OFFICES

Orlando, 8008 S. Orange Avenue, Orlando, Florida 32809, Phone (407) 855-3860
Alexandria, 3609 Mac Lee Drive, Alexandria, Louisiana 71302 Phone (318) 443-2888
Bartow, 1525 Centennial Drive, Bartow, Florida 33830, Phone (863) 533-0858
Baton Rouge, 316 Highlandia Drive, Baton Rouge, Louisiana 70884, Phone (225) 752-4790
Cocoa, 1300 N. Cocoa Blvd., Cocoa, Florida 32922, Phone (321) 632-2503
Fort Myers, 9970 Bavaria Road, Fort Myers, Florida 33913, Phone (239) 768-6600
Miami, 2608 W. 84th Street, Hialeah, Florida 33016, Phone (305) 825-2683
Monroe, 1122 Hayes Street, West Monroe, Louisiana 71292, Phone (318) 387-4103
New Orleans, 1305 Distributors Row, Suite I, Jefferson, Louisiana 70123, Phone (504) 835-2593
Port Charlotte, 740 Tamiami Trail, Unit 3, Port Charlotte, Florida 33954, Phone (941) 624-3393
Port St. Lucie, 460 Concourse Place NW, Unit 1, Port St. Lucie, Florida 34986, Phone (772) 878-0072
Sarasota, 78 Sarasota Center Blvd., Sarasota, Florida 34240, Phone (941) 922-3526
Shreveport, 7222 Greenwood Road, Shreveport, Louisiana 71119, Phone (318) 636-3673
Tallahassee, 3175 West Tharpe Street, Tallahassee, Florida 32303, Phone (850) 576-6131
Tampa, 3925 Coconut Palm Drive, Suite 115, Tampa, Florida 33619, Phone (813) 620-3389
West Palm Beach, 2200 North Florida Mango Road, Suite 101, West Palm Beach, Florida 33409, Phone (561) 687-8200

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Ardaman & Associates, Inc.

Geotechnical, Environmental and
Materials Consultants

27 January 2010

T. Baker Smith, Inc.
P. O. Box 2266
Houma, Louisiana 70361

Attention: Marc J. Rogers, P.E.

Subsoil Investigation
Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
AAI Project No. 09-L3176

Gentlemen:

Herein is our report on the results of a subsoil foundation investigation made for the subject project. We appreciate the opportunity to serve you. Please contact us should you have any questions.

Yours very truly,

ARDAMAN & ASSOCIATES, INC.

ALEXANDER JARAMILLO, E.I.

Reviewed By:

CHAD M. POCHE, P.E.
Vice President/Branch Manager

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SUBSOIL INVESTIGATION
TERREBONNE PARISH CONSOLIDATED GOVERNMENT
NORTH LAKE BOUDREAUX FORCED DRAINAGE PROJECT
TERREBONNE PARISH, LOUISIANA
AAI PROJECT NO. 09-L3176

1.0 INTRODUCTION

This report contains the results of a subsoil foundation investigation made at the subject site. Instructions to proceed with the investigation were provided on October 23, 2009 from Mr. Marc J. Rogers, P.E. of T. Baker Smith, Inc. the design engineers for the project. A statement of limitations is provided following the text of this report.

The study included the drilling of soil test borings to determine subsurface conditions and stratification and the performance of soil mechanics laboratory tests on samples obtained from the borings to evaluate their physical characteristics. Engineering analyses were made based on the borings and test data to develop criteria to be used in foundation design.

2.0 SOIL BORINGS

2.1. Field Exploration

Five (5) undisturbed sample type soil test borings (B-1 through B-5) were drilled to depths of 40 feet to 100 feet on October 26 through October 29, 2009. The borings were made with a marsh buggy drill rig at designated locations approximately as shown in plan on Figure 1. Logs of the borings showing the detailed stratification and sample depths are given in the Appendix.

Undisturbed sampling was performed continuously in the upper 10 feet of the ground surface and on approximate five (5) foot centers thereafter in all cohesive or semi-cohesive materials with a three inch diameter thin wall tube sampler. Representative samples were cut from the cores and placed in moisture proof containers for preservation until laboratory testing could be performed.

3.0 LABORATORY TESTS

In order to develop the physical properties of the soils, soil mechanics laboratory tests were performed on samples obtained from the borings. This testing consisted primarily of natural moisture content, unit weight and unconfined compression. Atterberg limits were performed on selected cohesive samples. Atterberg Limits tests were performed on selected cohesive samples. The results of all the laboratory tests are tabulated along side the boring logs at the appropriate sample and depth in the Appendix.

The Unconfined Compression strength tests are used in analyses to determine soil bearing values. They also give a measure of "strength" used in slope stability and pile load capacity analyses. The Atterberg Limits along with the Natural Moisture Content tests give an indication of the compressibility of the soils and are used empirically to estimate settlements and the susceptibility of soils to volumetric change.

4.0 SUBSOIL CONDITIONS

4.1. Borings (B-1 through B-5)

Reference to the logs of borings B-1 through B-5 shows that beginning at the ground surface there is very soft to soft gray clay or organic clay to the borings' termination of 40 ft. in borings B-1, B-2 and B-4 and continues to the 66 ft. and 78 ft. depths in borings B-2 and B-5. This clay layer is underlain by soft to medium stiff gray clay or silty clay to the borings' termination depth of 100 ft.

4.2. Groundwater

The borings were made within standing water and wet site conditions. Groundwater can fluctuate due to seasonal precipitation, drainage, prolonged drought, etc. In view of this, groundwater should be measured at the time of construction.

5.0 FURNISHED INFORMATION AND FOUNDATION ANALYSIS

We understand that the project consists of raising the "back levee" in the vicinity of the Lake Boudreaux Diversion Project in Terrebonne Parish. The project will comprise of raising 6,000 linear feet of levee approximately 3 ft. to 4 ft. above its current height and constructing a new pump station. A borrow canal will be excavated to approximately Elev. -9 near the levee to obtain material for the levee raising.

Analyses were made based on the soil borings and laboratory test data to develop geotechnical related parameters for use in design of the levee and the new pump station. These include evaluation of the global stability of the new levee height including settlement and pile capacities for the pump station.

In addition, the vertical capacity of sheet piles driven near or for the pump station was requested. The vertical capacity for the steel sheet piles driven at the pump station site was calculated as 400 psf per foot of length, per foot of depth. This value is applicable for fully embedded sections of sheet pile.

6.0 STABILITY ANALYSIS

Geotechnical analyses with regard to overall stability were made based on the cross-sections sections provided and data obtained from the site. The analyses were based on the "Wedge Method" or "Method of Planes", developed by the U.S. Army Corps of Engineers, New Orleans District, to determine the driving and resisting forces involved. The effects of strength gain due to additional fill placement were not considered in our analyses.

The most critical cross-sections were analyzed to determine the factor of safety for the new construction. The results of the slope stability analyses are given on Figures 2 through 6 and are tabulated below.

CASE	APPROX. LEVEE HEIGHT.	APPROX. BORROW CANAL BOTTOM WIDTH. (FT.)	ASSUMED FLOOD SIDE WATER ELEV.	CRITICAL FAILURE ELEV.	MINIMUM FACTOR OF SAFETY AT CRITICAL FAILURE ELEV.
Case 1 (Figure 2)	El. +8	37	El. +1	El. -55	1.22
Case 2 (Figure 3)	El. +8	37	El. +4	El. -55	1.20
Case 3 (Figure 4)	El. +8	43	El. +4	El. -55	1.20
Case 4 (Figure 5)	El. +8	43	El. +8	El. -55	1.05
Case 5 (Figure 6)	El. +10	43	El. +4	El. -55	1.01

In general, a minimum factor of safety of 1.3 is believed needed to assure good stability against a deep seated slope type failure. However, lesser factors of safety on the order of 1.2 could be considered if the risks associated with localized bank instability of excavated side slopes are relatively small. For water at the top of the levee, a minimum factor of safety of 1.05 was calculated.

We do not recommend the levee be built higher than Elev. +8 and that the borrow canal be excavated a minimum distance of 50 feet from the protected side toe of the levee.

7.0 SETTLEMENT ANALYSES

Settlement analyses were performed for the proposed levee. The total amount of settlement depends on the geometry and intensity of the applied load and on the compressibility of the underlying soil strata. As settlement progresses, the net intensity of the applied load decreases. Note that this decrease occurs if the levee is not periodically maintained to its initial elevations. The results of our analyses indicate long term settlement along the centerline of the proposed levee will be on the order of 10 to 12 inches for construction to Elev. +8. Settlement at the toe of the slopes is estimated to be ½ (or less) of these values.

7.1 Time Rate

The estimated settlement values are approximate long-term estimates. Additional analyses were made to determine the estimated time to achieve various degrees of consolidation (percent of ultimate settlement). The results of our analyses are provided on the following table.

Approximate Time Rate of Consolidation	
Percent Primary Consolidation (% of Ultimate Primary Settlement)	**Time**
30	Immediate to 1 month
50	6 months to 1 year
90	10 to 15 years

It should be noted that time rate estimates are difficult to predict. Actual values may vary 20 to 30% from our predicted values.

8.0 PILE FOUNDATIONS

Analyses were made based on the borings and laboratory test data to estimate the load carrying capacities of several lengths of timber piles having a 7 inch diameter tip and a 12 inch butt (ASTM D-25), and 12 inch and 14 inch square pre-stressed concrete (SPC) piles.

The piles will receive their support through "skin friction" along their embedment length since no stratum was encountered that would offer good additional "point" support.

8.1 Estimated Pile Load Capacities

The results of analyses to estimate pile load capacities in compression and tension are given on Figure 7. For the purpose of analysis, pile lengths given on Figure 7 are as measured from the existing ground surface and assume the pile butt is located at or near the existing ground surface. The capacities for piles located in the Intake Basin of the pump station are provided on Figure 8 assume the pile butt will be located at approximately 20 ft. below the existing ground surface, or at the intake basin slab.

The estimated pile load capacities given on Figures 7 and 8 contain factors of safety of 2 against failure in compression and 3 in tension which are recommended for design. They do not consider drag load, group effect, or settlements, as will be discussed.

8.2 Drag Load

When fill is placed on the site, the underlying compressible soils consolidate, resulting in surface settlement. As the compressible soils consolidate, "negative skin friction" or downdrag may be imparted on piles. This could result in an extraneous load, additive to any structural load, on the piles and could increase settlements of the structure. It is our opinion that drag load is dependent on the thickness of fill, compressibility of the soils, time-rate of consolidation and pile length. If 2 feet of new fill or less is required, drag load should be unimportant to design. However, it is recommended that this fill be placed as soon as practical prior to construction, If more than 2 feet of new fill is required, further consideration should be given to the effects of drag load.

8.3 Group Effect

The effect of pile grouping on pile load capacities is dependent on pile spacing, pile lengths and soil characteristics throughout the pile length and below the pile tips. Assuming a minimum center to center spacing of 3 feet, group effect should be unimportant for pile clusters of less than 6 piles for this project. Group effect could become important for larger clusters and should be evaluated when actual pile layout is known.

8.4 Pile Estimated Settlements

No detailed settlement analyses were made since the exact design structural loads, pile layout, etc. are not known at the present time. However, settlement of a pile supported footing using the provided pile load capacities is estimated to be on the order of ½ to 1 inch. Settlements may increase with the size of the pile cluster and, if larger clusters of closely spaced piles are needed for support, detailed settlement analyses should be made.

8.5 Pile Driving

In general, driving of timber piles should be limited to the rate of 25 blows per foot using a Vulcan No. 1 hammer or a 2000 to 3000 pound drop hammer falling 5 feet. Driving of the square pre-stressed concrete piles should be limited to the rate of 75 blows per foot using a Vulcan No. 8 hammer, or equivalent. These recommendations are given in order to minimize possible damage to the piles.

8.6 Vibrations

Vibrations due to pile driving activities should be expected and should be monitored during the driving of probe piles and job piles. In general, vibrations should be limited to about 0.25 inches per second (peak particle velocity) at all existing nearby sensitive structures. If this value is exceeded, further consideration should be given to the effects of vibrations.

9.0 CONSTRUCTION CONDITIONS

9.1 Excavation Cofferdams

It is our opinion that the methods, means and sequence of the construction excavation for the pump station should be the responsibility of the general contractor who should be experienced in this type construction. No detailed analyses were made with regard to construction excavation cofferdam. The excavation for construction of the station should be sheeted and internally braced, as needed, to assure good stability and to minimize lateral soil movements. The design of the cofferdam system should be the responsibility of the contractor and their engineers.

9.2 Dewatering

It is our opinion that the methods, means and sequence of dewatering should also be the responsibility of the general contractor who should be experienced in this type construction. However, the following general discussion with regard to dewatering is offered. As discussed previously, the subsoils encountered at the invert of the proposed intake basin are subject to a loss in shear strength due to reworking or poor groundwater control. Therefore, it is believed that the structure excavation could be effectively unwatered with normal sumps and pumps. In any event, it is recommended that construction should proceed as quickly as possible and that the excavation be backfilled as soon as practical to avoid long term pumping which could result in a general lowering of the water table and associated areal settlements.

9.3 Borrow Canal Excavations

Consideration should be given to the effects of bank sloughing, particularly if hydraulic dredging results in near vertical cuts. In this regard, an allowance should be made for the sloughing by considering the side slopes discussed above that are needed to assure an adequate factor of safety against slope stability type failure. Even though this slope area may not be physically excavated, sufficient right-of-way should be provided to account for instability of the steeper hydraulic side slopes. Also, consideration should be given to initially dredging near the center of the borrow canal and progressing gradually toward both banks with successive passes. In this manner, the potential for sloughing of the side slopes can be better evaluated prior to nearing the limits of the top of bank and right-of-way.

10.0 CLOSING

Often during final design and /or construction, questions can arise which are not specifically covered in the report. They can normally be handled by a brief phone call or conference with the designers.

ARDAMAN & ASSOCIATES, INC.

STATE OF LOUISIANA
CHAD M. POCHE
License No. 27667
PROFESSIONAL ENGINEER
IN
CIVIL ENGINEERING

CHAD M. POCHE, P.E.
Branch Manager/Vice President

(Alex Jaramillo)

LIMITATIONS AND CONDITIONS

The analyses and recommendations presented in this report are based on the provided project information and the results of the investigation. While it is not likely that conditions will differ greatly from those observed in the soil borings it is always possible that variations can occur away from the borehole locations. If it becomes apparent during construction that subsurface conditions differing significantly from those observed in our borings are being encountered, this office should be notified at once so their effects can be determined and any remedial measures necessary can be prescribed. Also, should the nature of the project change, the recommendations provided in this report may have to be re-evaluated.

This report has been prepared for the exclusive use of T. Baker Smith, Inc. and its clients for the purpose of constructing the proposed project features as generally described in this report. The recommendations provided in this report are site specific and are not intended for use at any other site or for any other facility. This report provides recommendations for design and construction and should not be used as construction specifications.

Jan 27, 2010 - 8:59am

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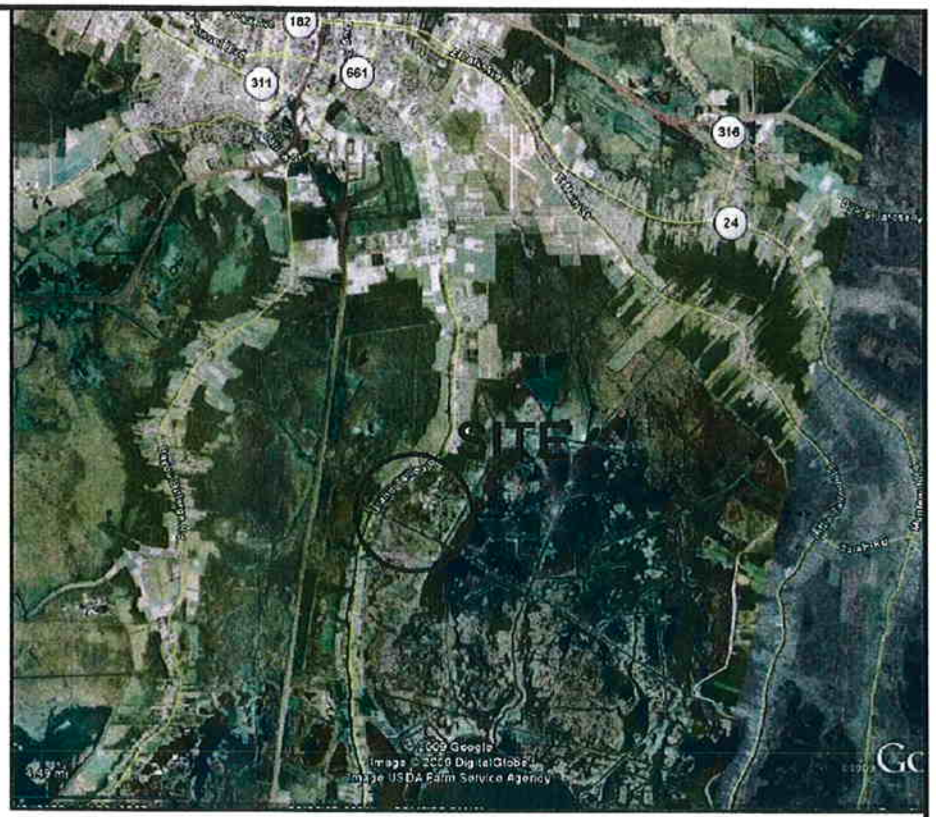


VICINITY MAP

NOT TO SCALE

REFERENCE:
SITE IMAGE BY GOOGLE.

NORTH LAKE BOUDREAUX
FORCED DRAINAGE
PROJECT
TERREBONNE PARISH, LOUISIANA

for
T. BAKER SMITH, INC.
HOUMA, LOUISIANA

AAI
Ardaman & Associates, Inc.
Baton Rouge, LA   Jefferson, LA

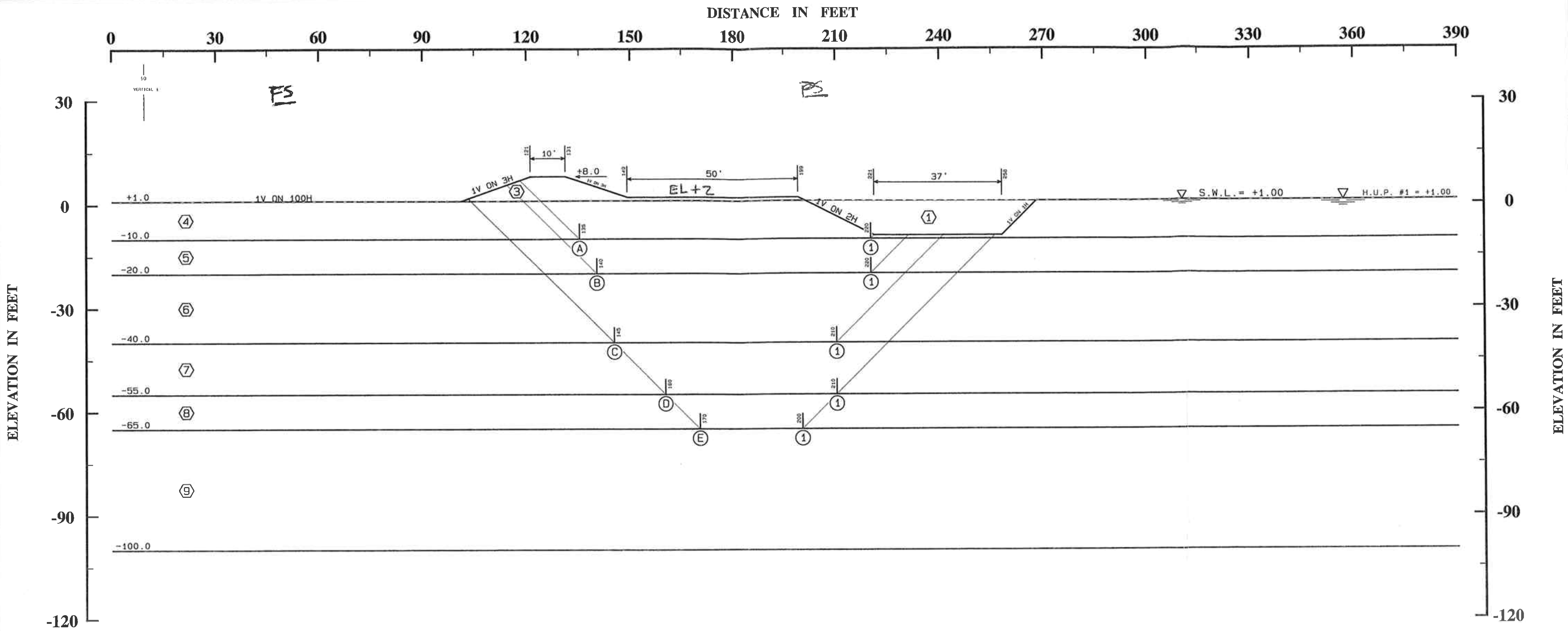
Project Engineer: L. GILBERT	Drawn by: NMS	Checked by:
File No.: 09-L3176	Date: 11-30-09	Figure No.: 1

Title:
BORING PLAN

REFERENCE:
PLAN BY OTHERS.

NOTE:
BORING LOCATIONS ARE APPROXIMATE.

P:\2009\09-L3176\cadd\09-L3176 Boring Plan.dwg



STRATUM NUMBER	SOIL TYPE	UNIT WEIGHT (POUNDS PER CUBIC FOOT)	UNIT COHESION (POUNDS PER SQUARE FOOT)		FRICTION ANGLE (DEGREES)
			AVERAGE	BOTTOM OF STRATUM	
		VERTICAL 1	VERTICAL 1	VERTICAL 1	
1	Water	62.0	0.0	0.0	0.0
2	Water	62.0	0.0	0.0	0.0
3	Clay	110.0	400.0	400.0	0.0
4	Clay/Peat	105.0	300.0	300.0	0.0
5	Clay	92.0	230.0	230.0	0.0
6	Clay	90.0	200.0	200.0	0.0
7	Clay	104.0	250.0	250.0	0.0
8	Clay	102.0	280.0	280.0	0.0
9	Clay	100.0	600.0	600.0	0.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NUMBER	ELEVATION	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-10.00	13601	25500	800	17305	3787	39901	13518	2.95
B 1	-20.00	16401	18400	6601	39421	16283	41402	23138	1.79
C 1	-40.00	21202	13000	14403	105199	68223	48605	36976	1.31
> D 1	-55.00	26002	10000	19205	174990	129626	55207	45364	1.22 <
E 1	-65.00	32502	7500	25705	237213	189905	65707	47308	1.39

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

ARDAMAN & ASSOCIATES, INC.

Geotechnical, Environmental and
Materials Consultants

SLOPE STABILITY ANALYSIS

"AAI 09-L3176, "FLOOD SIDE WATER @ +1.0 FT.(LWL) "
"37 FT. WIDE BORROW CANAL, 50 FT. WIDE BERM"
"TOP OF LEVEE @ ELEVATION +8.0 FT.
CASE 1

S.W.L. :: SURFACE WATER LEVEL

H.U.P. :: HYDROSTATIC UPLIFT PROFILE

SCALE : 1 INCH = 30 FEET

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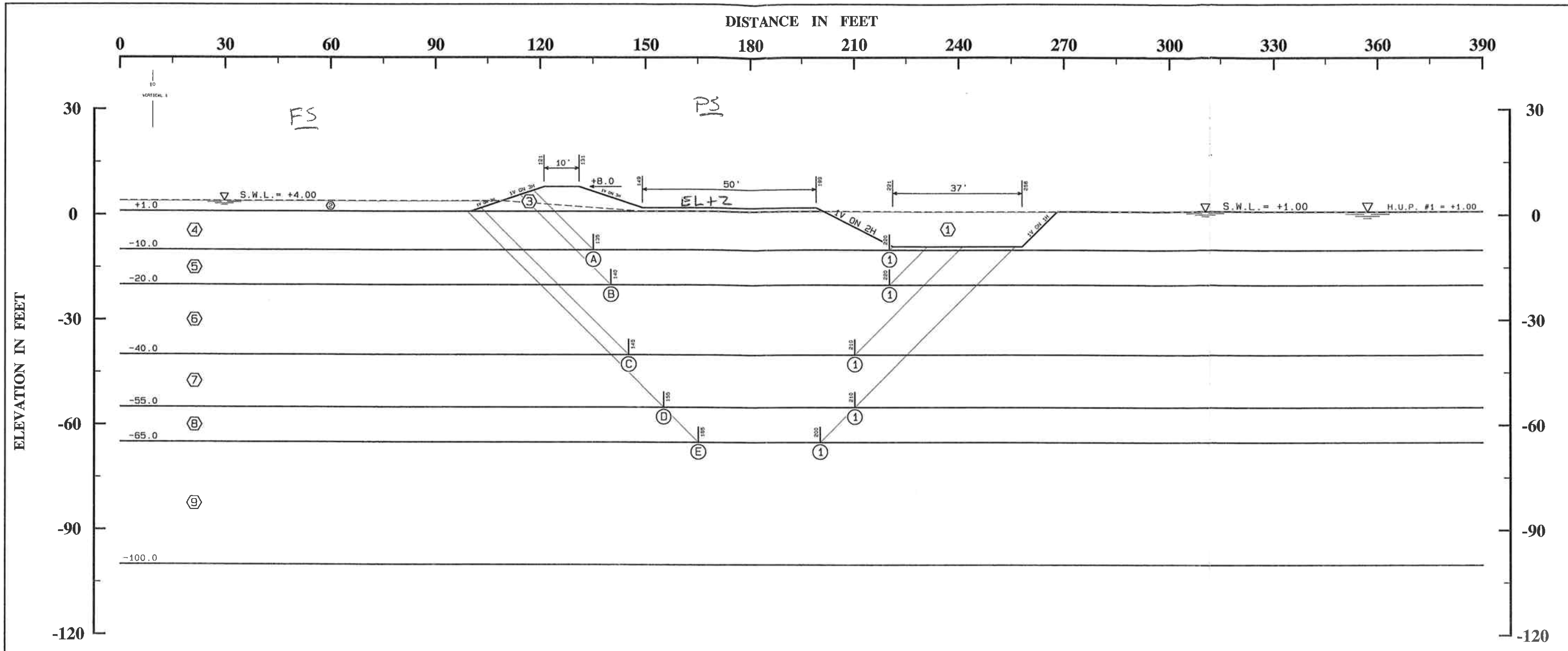
PLOT DATA FILE : 3176h.plt

DIRECTORY : C:\ULWEDGE

FIG. 2



STRATUM NUMBER	SOIL TYPE	UNIT WEIGHT (POUNDS PER CUBIC FOOT) VERTICAL 1	UNIT COHESION (POUNDS PER SQUARE FOOT) AVERAGE VERTICAL 1	BOTTOM OF STRATUM VERTICAL 1	FRICTION ANGLE (DEGREES)
1	Water	62.0	0.0	0.0	0.0
2	Water	62.0	0.0	0.0	0.0
3	Clay	110.0	400.0	400.0	0.0
4	Clay/Peat	105.0	300.0	300.0	0.0
5	Clay	92.0	230.0	230.0	0.0
6	Clay	90.0	200.0	200.0	0.0
7	Clay	104.0	250.0	250.0	0.0
8	Clay	102.0	280.0	280.0	0.0
9	Clay	100.0	600.0	600.0	0.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NUMBER	ELEVATION	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-10.00	13601	25500	800	17304	3787	39901	13517	2.95
B 1	-20.00	16401	18400	6601	39415	16283	41402	23132	1.79
C 1	-40.00	21202	13000	14403	105647	68223	48605	37424	1.30
> D 1	-55.00	25202	11000	19205	175915	129626	55407	46289	1.20 <
E 1	-65.00	31702	8750	25705	238137	189905	66157	48232	1.37

FACTOR OF SAFETY = $\frac{R_A + R_B + R_P}{D_A - D_P}$

ARDAMAN & ASSOCIATES, INC.

Geotechnical, Environmental and
Materials Consultants

SLOPE STABILITY ANALYSIS

"AAI 09-L3176, "FLOOD SIDE WATER @ +4 FT" (HWL)
"37 FT. WIDE BORROW CANAL, 50 FT. WIDE BERM"
"TOP OF LEVEE @ ELEVATION +8.0 FT."
CASE 2

S.W.L. :: SURFACE WATER LEVEL

H.U.P. :: HYDROSTATIC UPLIFT PROFILE

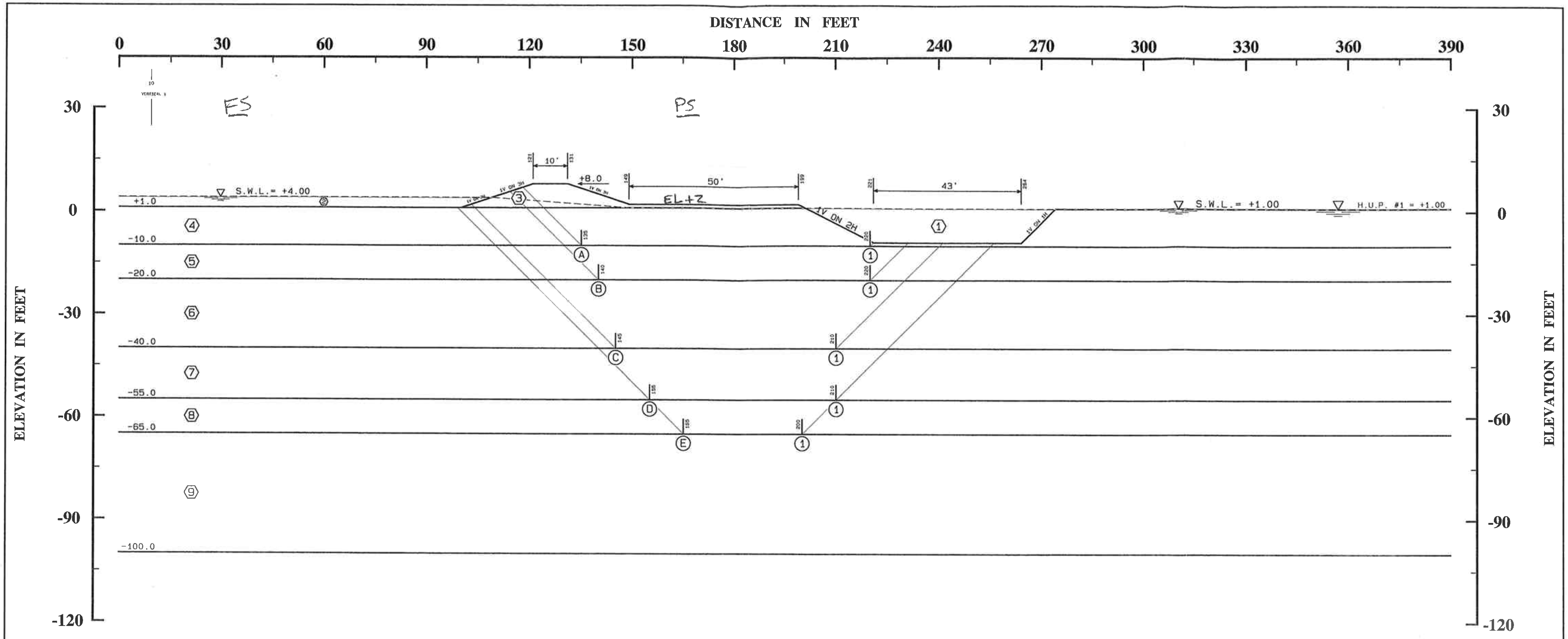
SCALE : 1 INCH = 30 FEET

GEOTECHNICAL DATA FILE : 3176g.in

PLOT DATA FILE : 3176g.plt

DIRECTORY : C:\ULWEDGE

FIG. 3



STRATUM NUMBER	SOIL TYPE	UNIT WEIGHT (POUNDS PER CUBIC FOOT)	UNIT COHESION (POUNDS PER SQUARE FOOT)		FRICTION ANGLE (DEGREES)
			AVERAGE	BOTTOM OF STRATUM	
		VERTICAL 1	VERTICAL 1	VERTICAL 1	
1	Water	62.0	0.0	0.0	0.0
2	Water	62.0	0.0	0.0	0.0
3	Clay	110.0	400.0	400.0	0.0
4	Clay/Peat	105.0	300.0	300.0	0.0
5	Clay	92.0	230.0	230.0	0.0
6	Clay	90.0	200.0	200.0	0.0
7	Clay	104.0	250.0	250.0	0.0
8	Clay	102.0	280.0	280.0	0.0
9	Clay	100.0	600.0	600.0	0.0

S.W.L. :: SURFACE WATER LEVEL

H.U.P. :: HYDROSTATIC UPLIFT PROFILE

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NUMBER	ELEVATION	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-10.00	13601	25500	800	17304	3787	39901	13517	2.95
B 1	-20.00	16401	18400	6601	39415	16283	41402	23132	1.79
C 1	-40.00	21202	13000	14403	105647	68223	48605	37424	1.30
> D 1	-55.00	25202	11000	19204	175915	129625	55406	46290	1.20 <
E 1	-65.00	31702	8750	25704	238137	189904	66156	48233	1.37

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

ARDAMAN & ASSOCIATES, INC.

Geotechnical, Environmental and
Materials Consultants

SLOPE STABILITY ANALYSIS

"AAI 09-L3176, FLOOD SIDE WATER @ ELEVATION +4 FT." (HWL)

"43 FT. WIDE BORROW CANAL, 50 FT. WIDE BERM"

"TOP OF LEVEE @ ELEVATION +8.0 FT."

CASE 3

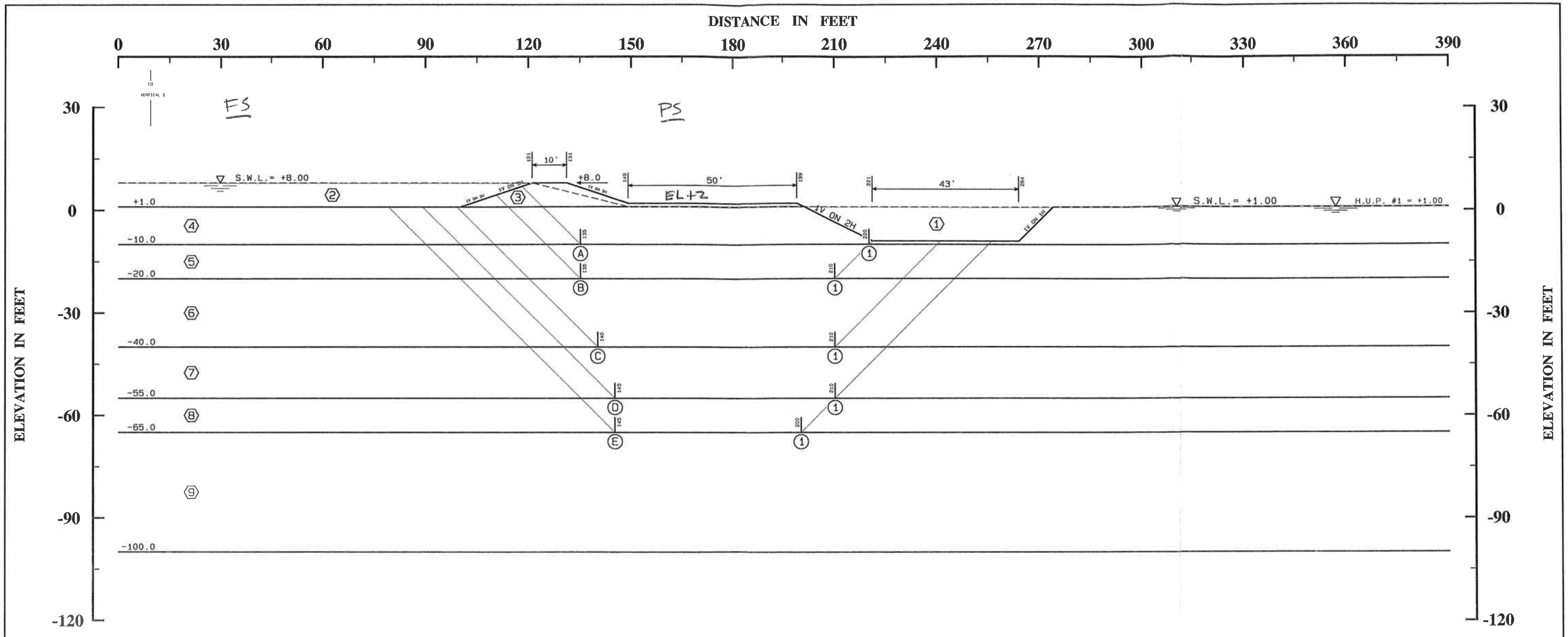
SCALE : 1 INCH = 30 FEET

GEOTECHNICAL DATA FILE : 3176f.in

PLOT DATA FILE : 3176f.plt

DIRECTORY : C:\ULWEDGE

FIG, 4



STRATUM NUMBER	SOIL TYPE	UNIT WEIGHT (POUNDS PER CUBIC FOOT)	UNIT COHESION (POUNDS PER SQUARE FOOT)		FRICTION ANGLE (DEGREES)
			AVERAGE	BOTTOM OF STRATUM	
		VERTICAL 1	VERTICAL 1	VERTICAL 1	
1	Water	62.0	0.0	0.0	0.0
2	Water	62.0	0.0	0.0	0.0
3	Clay	110.0	400.0	400.0	0.0
4	Clay/Peat	105.0	300.0	300.0	0.0
5	Clay	92.0	230.0	230.0	0.0
6	Clay	90.0	200.0	200.0	0.0
7	Clay	104.0	250.0	250.0	0.0
8	Clay	102.0	280.0	280.0	0.0
9	Clay	100.0	600.0	600.0	0.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NUMBER	ELEVATION	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-10.00	13601	25500	800	17427	3787	39901	13640	2.93
B 1	-20.00	15402	17250	6600	40545	17572	39252	22973	1.71
C 1	-40.00	20402	14000	14403	110138	68223	48805	41915	1.16
> D 1	-55.00	25202	13000	19204	184069	129625	57406	54444	1.05 <
E 1	-65.00	31702	13750	25704	249533	189904	71156	59629	1.19

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

S.W.L. :: SURFACE WATER LEVEL

H.U.P. :: HYDROSTATIC UPLIFT PROFILE

ARDAMAN & ASSOCIATES, INC.

Geotechnical, Environmental and
Materials Consultants

SLOPE STABILITY ANALYSIS

AAI 09-L3176, FLOOD SIDE WATER @ ELEVATION +8 FT." (TOL)

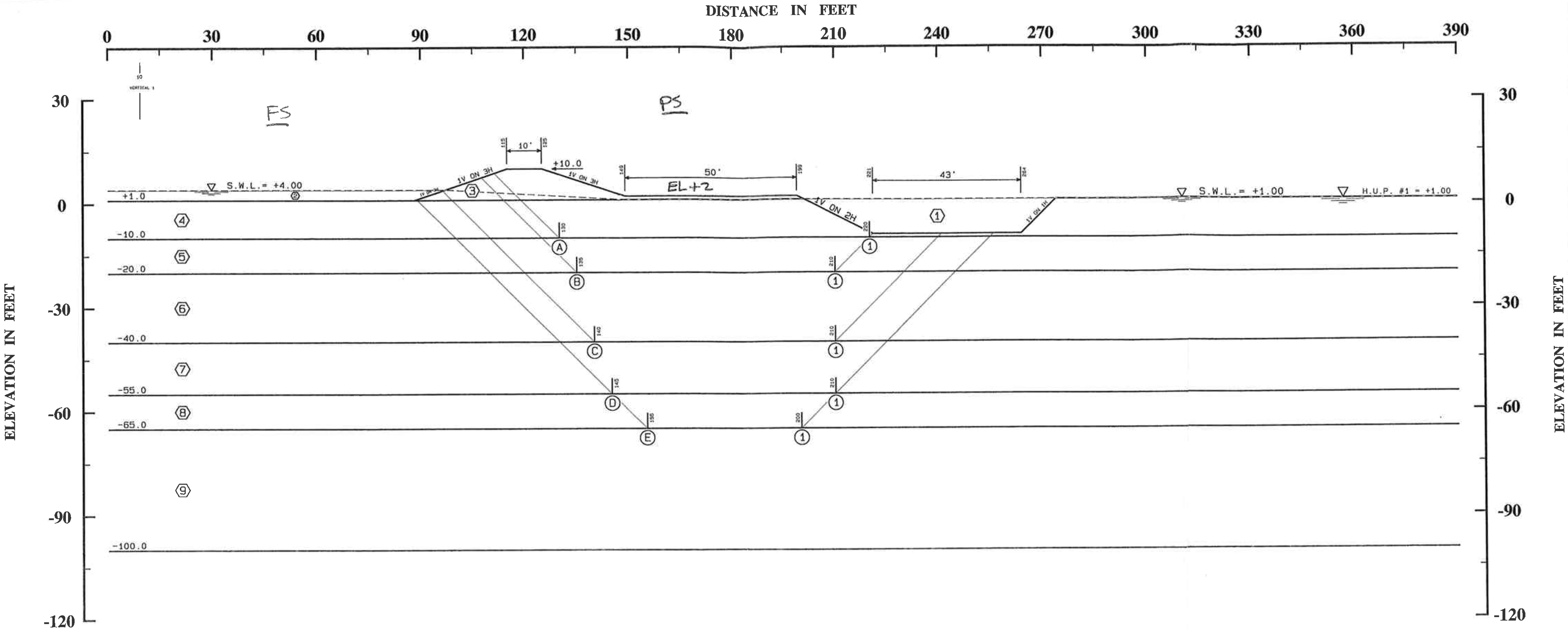
43 FT. WIDE BORROW CANAL, 50 FT. WIDE BERM

TOP OF LEVEE @ ELEVATION +8.0 FT.

CASE 4

SCALE : 1 INCH = 30 FEET GEOTECHNICAL DATA FILE : 3176i.in PLOT DATA FILE : 3176i.plt DIRECTORY : C:\ULWEDGE

FIG. 5



STRATUM NUMBER	SOIL TYPE	UNIT WEIGHT (POUNDS PER CUBIC FOOT)	UNIT COHESION (POUNDS PER SQUARE FOOT)		FRICTION ANGLE (DEGREES)
			AVERAGE	BOTTOM OF STRATUM	
		VERTICAL 1	VERTICAL 1	VERTICAL 1	
1	Water	62.0	0.0	0.0	0.0
2	Water	62.0	0.0	0.0	0.0
3	Clay	110.0	400.0	400.0	0.0
4	Clay/Peat	105.0	300.0	300.0	0.0
5	Clay	92.0	230.0	230.0	0.0
6	Clay	90.0	200.0	200.0	0.0
7	Clay	104.0	250.0	250.0	0.0
8	Clay	102.0	280.0	280.0	0.0
9	Clay	100.0	600.0	600.0	0.0

ASSUMED FAILURE SURFACE		RESISTING FORCES			DRIVING FORCES		SUMMATION OF FORCES		FACTOR OF SAFETY
NUMBER	ELEVATION	R_A	R_B	R_P	D_A	$-D_P$	RESISTING	DRIVING	
A 1	-10.00	15001	27000	800	21194	3787	42801	17407	2.46
B 1	-20.00	17801	17250	6600	45184	17572	41651	27612	1.51
C 1	-40.00	22602	14000	14403	114732	68223	51005	46509	1.10
> D 1	-55.00	25402	13000	19204	186904	129625	57606	57279	1.01 <
E 1	-65.00	31902	11250	25704	249420	189904	68856	59516	1.16

$$\text{FACTOR OF SAFETY} = \frac{R_A + R_B + R_P}{D_A - D_P}$$

ARDAMAN & ASSOCIATES, INC.

Geotechnical, Environmental and
Materials Consultants

SLOPE STABILITY ANALYSIS

"AAI 09 09-L3176, FLOOD SIDE WATER @ +4.0 FT (HWL)"
"43 FT. WIDE BORROW CANAL, 50 FT. WIDE BERM"
"TOP OF LEVEE @ ELEVATION +10 FT"
CASE 5

S.W.L. :: SURFACE WATER LEVEL

H.U.P. :: HYDROSTATIC UPLIFT PROFILE

SCALE : 1 INCH = 30 FEET

GEOTECHNICAL DATA FILE : 3176j.in

PLOT DATA FILE : 3176j.plt

DIRECTORY : C:\ULWEDGE

FIG. 6

SUBSOIL INVESTIGATION
TERREBONNE PARISH CONSOLIDATED GOVERNMENT
NORTH LAKE BOUDREAUX FORCED DRAINAGE PROJECT
TERREBONNE PARISH, LOUISIANA
AAI PROJECT NO. 09-L3176

ALLOWABLE PILE LOAD CAPACITIES

TREATED ASTM D 25 QUALITY TIMBER, COMPOSITE TIMBER PILES, AND SQUARE PRESTRESSED CONCRETE PILES (SPC)

LENGTH OF PILE IN FEET	ESTIMATED SINGLE PILE LOAD CAPACITY IN TONS FACTOR OF SAFETY = 2.0 IN COMPRESSION FACTOR OF SAFETY = 3.0 IN TENSION					
	Small Timber 7" tip – 12" butt		12" Square Prestressed Concrete (SPC)		16" Square Prestressed Concrete (SPC)	
	Comp.	Tens.	Comp.	Tens.	Comp.	Tens.
40	6	3	11	7	14	9
45	7	4	12	8	16	11
50	8	5	13	9	17	12
55	9	6	14	10	19	13
60	11	7	16	11	21	14
65	12	8	18	13	24	16
70	13	9	20	14	25	17
75	14	10	22	16	28	18
80	15	11	24	17	32	19
85	17	12	27	18	35	21
90	18	13	29	19	39	23
95	20	14	32	21	43	26
100	21	15	35	23	47	30

* All piles lengths are measured from the existing ground surface

SUBSOIL INVESTIGATION
TERREBONNE PARISH CONSOLIDATED GOVERNMENT
NORTH LAKE BOUDREAUX FORCED DRAINAGE PROJECT
TERREBONNE PARISH, LOUISIANA
AAI PROJECT NO. 09-L3176

ALLOWABLE PILE LOAD CAPACITIES FOR PUMP STATION INTAKE BASIN

TREATED ASTM D 25 QUALITY TIMBER, COMPOSITE TIMBER PILES, AND SQUARE PRESTRESSED CONCRETE PILES (SPC)

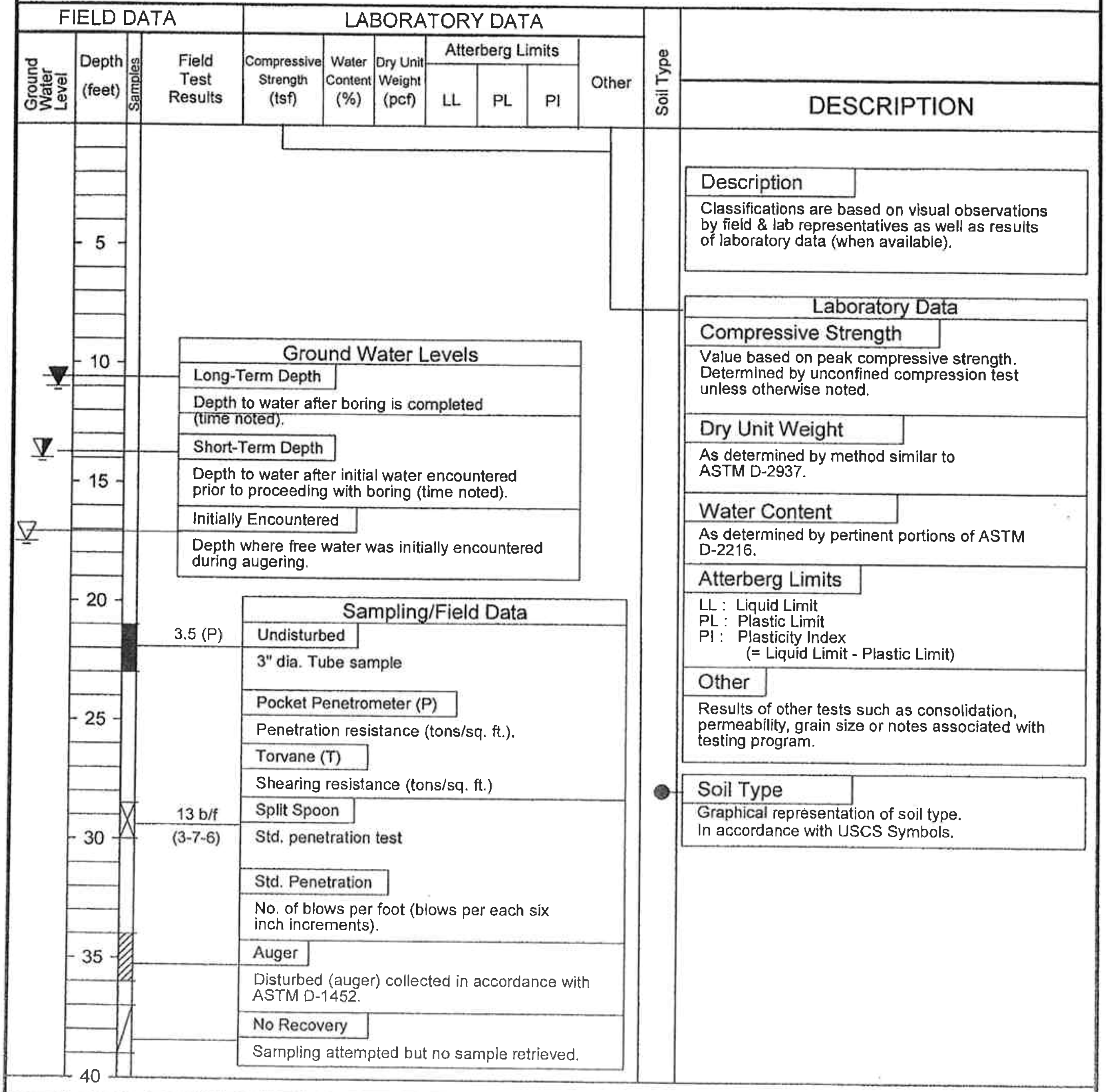
LENGTH OF PILE BENEATH IN FEET	ESTIMATED SINGLE PILE LOAD CAPACITY IN TONS FACTOR OF SAFETY = 2.0 IN COMPRESSION FACTOR OF SAFETY = 3.0 IN TENSION					
	Small Timber 7" tip - 12" butt		12" Square Prestressed Concrete (SPC)		16" Square Prestressed Concrete (SPC)	
	Comp.	Tens.	Comp.	Tens.	Comp.	Tens.
20	2	1	5	4	6	4
25	3	2	6	4	8	5
30	4	3	7	5	9	6
35	5	4	8	6	11	7
40	6	4	10	7	13	8
45	7	5	12	8	16	10
50	8	6	14	10	18	11
55	9	6	16	11	20	13
60	10	7	18	12	24	15
65	12	8	21	14	27	17
70	13	9	23	15	30	20
75	15	10	26	17	34	22
80	16	11	29	19	38	24

* All piles lengths are measured from bottom of intake basin (assumed to be 20 ft. below existing ground surface).

APPENDIX

BORING LOGS

DESCRIPTION OF TERMS AND SYMBOLS USED ON SOIL BORING LOG



Description

Classifications are based on visual observations by field & lab representatives as well as results of laboratory data (when available).

Laboratory Data

Compressive Strength

Value based on peak compressive strength. Determined by unconfined compression test unless otherwise noted.

Dry Unit Weight

As determined by method similar to ASTM D-2937.

Water Content

As determined by pertinent portions of ASTM D-2216.

Atterberg Limits

LL : Liquid Limit
PL : Plastic Limit
PI : Plasticity Index
(= Liquid Limit - Plastic Limit)

Other

Results of other tests such as consolidation, permeability, grain size or notes associated with testing program.

Soil Type

Graphical representation of soil type. In accordance with USCS Symbols.

Ground Water Levels

Long-Term Depth

Depth to water after boring is completed (time noted).

Short-Term Depth

Depth to water after initial water encountered prior to proceeding with boring (time noted).

Initially Encountered

Depth where free water was initially encountered during augering.

Sampling/Field Data

Undisturbed

3" dia. Tube sample

Pocket Penetrometer (P)

Penetration resistance (tons/sq. ft.).

Torvane (T)

Shearing resistance (tons/sq. ft.)

Split Spoon

Std. penetration test

Std. Penetration

No. of blows per foot (blows per each six inch increments).

Auger

Disturbed (auger) collected in accordance with ASTM D-1452.

No Recovery

Sampling attempted but no sample retrieved.

Ground Water Level Data	Boring Advancement Method	Notes
	Boring Abandonment Method	

Form LOGTERMS

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-1

Ardaman
& Associates, Inc.

Sheet 1 of 1

File: 09-L3176
Date: 10/26/09
Logged by: J.H. Binder III
Driller: T. Jeansonne
Rig: Marsh Buggy

Location: Lat. 29° 29' 47.8"
Long. 90° 40' 42.64"
Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Percent Passing #200 Sieve	Organic Content	Soil Type	Description
▽			No (P)									▨	Soft gray CLAY (CH) with organic matter, silt, and wood
			No (P)									▨	
	5		0.25 (P)	0.37	42	114	60	23	37			▨	
			0.25 (P)		78							▨	Very soft gray CLAY (CH) with organic matter and silt and sand
			< 0.25 (P)	0.23	105	93	141	45	96			▨	
	10											▨	
			No (P)									▨	Soft gray CLAY (CH) with organic matter and sand traces
	15											▨	
			< 0.25 (P)		47							▨	
	20											▨	
			< 0.25 (P)	0.26	104	89						▨	Very soft to soft brown CLAY (CH) with organic matter
	25											▨	
			< 0.25 (P)		104							▨	
			< 0.25 (P)		385							▨	- with organic clay layer
	30											▨	
			< 0.25 (P)	0.09	114	86	149	50	99			▨	
	35											▨	
			< 0.25 (P)	0.27	66	102						▨	- with silt layers
	40												Boring completed at 40 ft

Ground Water Level Data

▽ Free water first encountered

Boring Advancement Method

3" Nom. Dia. Short Flight Auger:
0 to 10 ft.
3" Dia. Rotary Wash:
10 to 40 ft.

Boring Abandonment Method

Borehole grouted with cement/ bentonite upon completion

Notes

Boring Drilled in Marsh

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-2

Ardaman & Associates, Inc.

Sheet 1 of 1

File:	09-L3176
Date:	10/26/09
Logged by:	J.H. Binder III
Driller:	T. Jeansonne
Rig:	Marsh Buggy

Location: Lat. 29° 29' 42.22"
Long. 90° 40' 54.05"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits LL	PL	PI	Percent Passing #200 Sieve	Organic Content	Soil Type	Description
▽			No (P)									▨	Soft gray CLAY (CH) with organic matter and wood
			No (P)									▨	
	5		No (P)									▨	
			0.25 (P)	0.48	53	109	73	29	44			▨	
	10		< 0.25 (P)		79							▨	Very soft gray CLAY (CH) with organic matter
	15		< 0.25 (P)	0.20	85	95						▨	
	20		< 0.25 (P)	0.17	84	91						▨	
	25		< 0.25 (P)	0.39	149	84	203	98	105			▨	Soft dark gray ORGANIC CLAY (OH) with roots
	30		< 0.25 (P)		112							▨	Soft gray CLAY (CH) with organic matter
	35		< 0.25 (P)	0.27	85	94	107	35	72			▨	- with sand layers
	40		< 0.25 (P)		97							▨	

Boring completed at 40 ft.

Ground Water Level Data	Boring Advancement Method	Notes
▽ Free water first encountered	3" Nom. Dia. Short Flight Auger: 0 to 10 ft. 3" Dia. Rotary Wash: 10 to 40 ft.	Boring Drilled in Marsh
	Boring Abandonment Method Borehole grouted with cement/ bentonite upon completion	

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-3

Ardaman & Associates, Inc.

Sheet 1 of 3

File: 09-L3176
Date: 10/26/09
Logged by: J.H. Binder III
Driller: T. Jeansonne
Rig: Marsh Buggy

Location: Lat. 29° 29' 34.73"
Long. 90° 41' 6.25"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Percent Passing #200 Sieve	Organic Content	Soil Type	Description
▽			No (P)									▨	Very soft to soft gray SILTY CLAY (CL) with sand and organic matter lenses
			No (P)									▨	
	5		No (P)									▨	
			No (P)									▨	
	10	■	< 0.25 (P)	0.18	37	116						▨	
	15	■	< 0.25 (P)		37							▨	
	20	■	< 0.25 (P)	0.28	57	106	77	28	49			▨	Soft gray CLAY (CH) with organic matter and silt seams
	25	■	< 0.25 (P)		109							▨	Soft gray CLAY (CH) with organic matter
	30	■	< 0.25 (P)	0.26	132	85						▨	
	35	■	< 0.25 (P)		413							▨	- with peat and roots
	40	■	< 0.25 (P)	0.25	99	89	144	44	100			▨	

Continued Next Page

Ground Water Level Data

▽ Free water first encountered

Boring Advancement Method

3" Nom. Dia. Short Flight Auger:
0 to 10 ft.
3" Dia. Rotary Wash:
10 to 100 ft.

Boring Abandonment Method

Borehole grouted with cement/
bentonite upon completion

Notes

Boring Drilled in Marsh

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-3

Ardaman
& Associates, Inc.

Sheet 2 of 3

File:	09-L3176
Date:	10/26/09
Logged by:	J.H. Binder III
Driller:	T. Jeansonne
Rig:	Marsh Buggy

Location: Lat. 29° 29' 34.73"
Long. 90° 41' 6.25"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA										
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits			Percent Passing #200 Sieve	Organic Content	Soil Type	Description
							LL	PL	PI				
												▨	Soft gray CLAY (CH) with sand layers and shells
		■	< 0.25 (P)		40							▨	
	45											▨	
		■	< 0.25 (P)	0.32	67	103						▨	
	50											▨	
		■	< 0.25 (P)	0.32	47	110						▨	
	55											▨	
		■	< 0.25 (P)	0.26	49	104	65	26	39			▨	
	60											▨	
		■	< 0.25 (P)		64							▨	
	65											▨	
												▨	Medium stiff gray CLAY (CH) with some sand and shells
		■	0.25 (P)	0.52	57	104	78	30	48			▨	
	70											▨	
		■	0.25 (P)		43							▨	
	75											▨	
		■	0.5 (P)	0.84	82	90	155	58	97			▨	
	80											▨	- with organic matter

Continued Next Page

Ground Water Level Data

∇ Free water first encountered

Boring Advancement Method

3" Nom. Dia. Short Flight Auger:
0 to 10 ft.
3" Dia. Rotary Wash:
10 to 100 ft.

Boring Abandonment Method

Borehole grouted with cement/
bentonite upon completion

Notes

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-3

Ardaman & Associates, Inc.

Sheet 3 of 3

File:	09-L3176
Date:	10/26/09
Logged by:	J.H. Binder III
Driller:	T. Jeansonne
Rig:	Marsh Buggy

Location: Lat. 29° 29' 34.73"
Long. 90° 41' 6.25"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits			Percent Passing #200 Sieve	Organic Content	Soil Type	Description
							LL	PL	PI				
												▨	Medium stiff gray CLAY (CH) with some sand and shells
	85	■	0.5 (P)	0.61	64	96						▨	- with organic matter
	90	■	0.5 (P)	0.95	78	100						▨	
	95	■	0.25 (P)		93					99		▨	
	100	■	0.5 (P)		42		44	20	24			▨	
													Boring completed at 100 ft.
	105												
	110												
	115												
	120												

Ground Water Level Data

∇ Free water first encountered

Boring Advancement Method

3" Nom. Dia. Short Flight Auger:
0 to 10 ft.
3" Dia. Rotary Wash:
10 to 100 ft.

Boring Abandonment Method

Borehole grouted with cement/bentonite upon completion

Notes

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-4

Ardaman
& Associates, Inc.

Sheet 1 of 1

File:	09-L3176
Date:	10/26/09
Logged by:	J.H. Binder III
Driller:	T. Jeansonne
Rig:	Marsh Buggy

Location: Lat. 29° 29' 28.61"
Long. 90° 41' 15.4"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level ∇	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Percent Passing #200 Sieve	Organic Content	Soil Type	Description
		▨	No (P)									▨	Very soft to soft brown and gray organic CLAY (OH)
		▨	No (P)									▨	
	5	▨	No (P)									▨	
		■	< 0.25 (P)	0.31	107	89	148	52	96			▨	
		■	< 0.25 (P)		172							▨	
	10											▨	Very soft gray CLAY (CH) w/ much organic matter
		■	< 0.25 (P)		70							▨	
	15											▨	- with silt
		■	< 0.25 (P)	0.20	87	94	114	34	80			▨	
	20											▨	
		■	< 0.25 (P)	0.24	87	92	99	31	68			▨	
	25											▨	
		■	< 0.25 (P)	0.17	72	98						▨	
	30											▨	
		■	0.25 (P)									▨	
	35											▨	
		■	< 0.25 (P)	0.11	86	94						▨	
	40												Boring completed at 40 ft.

Ground Water Level Data

∇ Free water first encountered

Boring Advancement Method

3" Nom. Dia. Short Flight Auger:
0 to 10 ft.
3" Dia. Rotary Wash:
10 to 40 ft.

Boring Abandonment Method

Borehole grouted with cement/ bentonite upon completion

Notes

Boring Drilled in Marsh

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-5

Ardaman & Associates, Inc.

Sheet 1 of 3

File:	09-L3176
Date:	10/27/09
Logged by:	J.H. Binder III
Driller:	T. Jeansonne
Rig:	Marsh Buggy

Location: Lat. 29° 29' 7.91"
Long. 90° 41' 35.2"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level ▽	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits			Percent Passing #200 Sieve	Organic Content	Soil Type	Description
							LL	PL	PI				
		/	No (P)									▨	Very soft gray SILTY CLAY (CL) with roots
		/	No (P)										
	5	■	< 0.25 (P)		41		48	25	23				
		■	0.25 (P)		39								
		/	No (P)									▨	Very soft to medium stiff gray and brown CLAY (CH) with organic matter and roots
	10	■	0.5 (P)	0.52	49	110							
	15	■	0.25 (P)		53								
	20	■	< 0.25 (P)	0.19	49	107	81	27	54				
	25	■	< 0.25 (P)		120							▨	Very soft gray and brown CLAY (CH) with organic matter
	30	■	< 0.25 (P)	0.09	102	86							
	35	■	< 0.25 (P)		124								
	40	■	< 0.25 (P)	0.13	120	86							

Continued Next Page

Ground Water Level Data	Boring Advancement Method	Notes
▽ Free water first encountered	3" Nom. Dia. Short Flight Auger: 0 to 10 ft. 3" Dia. Rotary Wash: 10 to 100 ft.	Boring Drilled in Marsh
	Boring Abandonment Method	
	Borehole grouted with cement/ bentonite upon completion	

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-5

Ardaman & Associates, Inc.

Sheet 2 of 3

File:	09-L3176
Date:	10/27/09
Logged by:	J.H. Binder III
Driller:	T. Jeansonne
Rig:	Marsh Buggy

Location: Lat. 29° 29' 7.91"
Long. 90° 41' 35.2"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Percent Passing #200 Sieve	Organic Content	Soil Type	Description
	45	■	< 0.25 (P)	0.20	63	102	81	29	52			▨	Very soft to soft gray CLAY (CH) with shells
	50	■	< 0.25 (P)		71							▨	
	55	■	0.5 (P)	0.24	55	105						▨	Very soft to soft gray CLAY (CH) with organic matter and silt
	60	■	0.5 (P)		61							▨	
	65	■	0.75 (P)	0.27	57	102	79	30	49			▨	
	70	■	0.75 (P)		51							▨	
	75	■	0.5 (P)	0.48	63	101						▨	
	80	■	0.75 (P)	0.79	66	100						▨	Soft to medium stiff gray CLAY (CH) with organic matter and silt

Continued Next Page

Ground Water Level Data

∇ Free water first encountered

Boring Advancement Method

3" Nom. Dia. Short Flight Auger:
0 to 10 ft.
3" Dia. Rotary Wash:
10 to 100 ft.

Boring Abandonment Method

Borehole grouted with cement/ bentonite upon completion

Notes

Strata Boundaries May Not Be Exact

Terrebonne Parish Consolidated Government
North Lake Boudreaux Forced Drainage Project
South Pump Station and Levee
Terrebonne Parish, Louisiana
T. Baker Smith, Inc.
Houma, Louisiana

LOG OF SOIL BORING B-5

Ardaman & Associates, Inc.

Sheet 3 of 3

File: 09-L3176
Date: 10/27/09
Logged by: J.H. Binder III
Driller: T. Jeansonne

Rig: Marsh Buggy

Location: Lat. 29° 29' 7.91"
Long. 90° 41' 35.2"

Surface Elevation: N/A (ft., NAVD)

FIELD DATA				LABORATORY DATA									
Ground Water Level	Depth (feet)	Samples	Field Test Results	Compressive Strength (tsf)	Water Content (%)	Wet Unit Weight (pcf)	Atterberg Limits LL	Atterberg Limits PL	Atterberg Limits PI	Percent Passing #200 Sieve	Organic Content	Soil Type	Description
												▨	Soft to medium stiff gray CLAY (CH) with organic matter and silt
	85	■	0.75 (P)	0.57	50	105	93	25	68			▨	
	90	■	0.5 (P)		35							▨	- with silt
	95	■	0.75 (P)	0.30	39	112						▨	
	100	■	1.0 (P)		62							▨	
													Boring completed at 100 ft.
	105												
	110												
	115												
	120												

Ground Water Level Data	Boring Advancement Method	Notes
▽ Free water first encountered	3" Nom. Dia. Short Flight Auger: 0 to 10 ft. 3" Dia. Rotary Wash: 10 to 100 ft.	
	Boring Abandonment Method	
	Borehole grouted with cement/ bentonite upon completion	

Strata Boundaries May Not Be Exact

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