REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED CHEMICAL SYSTEMS IMPROVEMENTS
AT PLANT 1 & 2 (WBS NO. S-000056-0071-3)
AND PLANT 3 (WBS NO. S-000056-0061-3)
EAST WATER PURIFICATION PLANT
CITY OF HOUSTON, TEXAS

FOR:

HDR, INC.

4635 SOUTHWEST FREEWAY, SUITE 1000

HOUSTON, TEXAS 77027

PREPARED BY:

ASSOCIATED TESTING LABORATORIES, INC.

HOUSTON, TEXAS

ATL REPORT G13-229

March 10, 2014

ESTABLISHED 1959

3143 Yellowstone Blvd., Houston, Texas 77054
Tel: (713) 748-3717 Fax: (713) 748-3748

Date: March 10, 2014
ATL Job No: G13-229

HDR, Inc.
4635 Southwest Freeway, Suite 1000
Houston, Texas 77027

Attention: Mr. Richard Gerlach, P.E.

Reference: Report
Geotechnical Investigation for Proposed Chemical Systems Improvements
At Plant 1 & 2 (WBS No. S-000056-0071-3) and
Plant 3 (WBS No. S-000056-0061-3)
East Water Purification Plant (EWPP)
City of Houston, Texas

Dear Mr. Gerlach:

We have completed our report for the geotechnical investigation at the above referenced locations. Our findings, analysis and recommendations are submitted herein.

It has been a pleasure working with you on this project. Should you have any questions concerning this project work, please call us at (713) 748-3717.

Sincerely,

ASSOCIATED TESTING LABORATORIES, INC.

Peng Sia Tang; P.E.
Manager, Geotechnical Services

Jasbir Singh, P.E.
President

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EXECUTIVE SUMMARY

Associated Testing Laboratories, Inc. (ATL) has conducted a Geotechnical Investigation for the proposed design and construction of the proposed improvements at East Water Purification Plant (EWPP) for the City of Houston, Texas. ATL understands that the proposed improvements at Plant 1 & 2 and Plant 3 consisting of miscellaneous concrete paving/slab to support minor chemical tanks and the associated truck traffic as well as chemical containment area in case of spill. Major structures proposed are pads for the supporting new 12-ft diameter lime tanks that are about 26 feet tall.

For this geotechnical investigation, a total of seven (7) soil borings to a depth of 20 to 50 feet below the existing ground surface were drilled in select areas of the proposed improvements. Based on the soil borings drilled at the project site, the subsurface conditions at the project site can be generalized as follows:

At Plant 1 and 2 (Borings B-1 through B-4): The existing concrete apron at Boring B-1 consists of about 5 inches of portland cement concrete (PCC); the existing roadway at Boring B-2 consists of about 10.75 inches of PCC. The subsurface soils in this area consist of an upper soft to hard Fat Clays (CH) and Lean Clays (CL) stratum to a depth of about 33, 8 and 23 feet in Borings B-1, B-2 and B-3, and to the bottom of Boring B-4 at 20 feet below existing grade. Below the clay stratum, loose to very dense Silty Sand (SM) was found to the bottom of Boring B-2 at 20 feet, and to a depth of about 38 feet in Boring B-1 and B-3. Below the silty sand stratum, firm to very stiff Fat Clays (CH) and Lean Clays (CL) exists to the bottom of Boring B-1 and B-3 at 50 feet.

At Plant 3 (Boring B-5 through B-7): The subsurface soils in this area consist of an upper firm to very stiff Fat Clays (CH) and Lean Clays (CL) stratum to the bottom of Boring B-6 and B-7 at 20 feet, and to a depth of about 14 feet in Boring B-5, followed by a stratum of loose to very dense Silty Sand (SM) to a depth of about 38 feet, which in turn is underlain by stiff to hard Fat Clays (CH) and Lean Clays (CL) to the bottom of boring at 50 feet.

Based on the field investigation, laboratory testing, records and document review, the conclusions and recommendations are summarized as below:

- A preliminary fault evaluation based on review of available fault maps indicates that the project site is not impacted by any documented growth faults. Therefore, ATL does not recommend a Phase I fault investigation for this site.
- Feasible foundation types, subgrade improvements, allowable soil bearing capacity, and design parameters are provided in Section 5.1 if this report.
- Concrete pavement design and construction recommendations for the proposed concrete paving and containment areas, including pavement thickness, subgrade preparation and stabilization requirements are presented in Section 5.2 of this report.

GEOTECHNICAL INVESTIGATION
PROPOSED CHEMICAL SYSTEMS IMPROVEMENTS
AT PLANT 1 & 2 (WBS NO. S-000056-0071-3)
AND PLANT 3 (WBS NO. S-000056-0061-3)
EAST WATER PURIFICATION PLANT

1.0 INTRODUCTION

1.1 General

This investigation was authorized by HDR, Inc. by the Geotechnical Subconsultant Agreeemnet executed on October 30, 2013, and with the acceptance of Associated Testing Laboratories, Inc. (ATL) Proposal No. CP13-0705R1 dated September 3, 2013. Project details were provided by Mr. Richard Gerlach, P.E. of KGI. This report includes results of the field investigation, laboratory testing, geotechnical engineering analysis, and recommendations for the design and construction of proposed chemical delivery systems improvements at the East Water Purification Plant (EWPP).

1.2 Location and Description of the Project

EWPP is located in east Houston, Texas (Key Map 496 U and Y). A general site vicinity map of the project site is shown on Figure 1. The project site layout is shown the Boring Location Plans in Figure 1.

We understand that improvements to the existing chemical systems are planned at the East Water Purification Plant (EWPP). The proposed improvements will be conducted at Plant 1 &2 (WBS No. S-000056-0071-3) and Plant 3 (WBS No. S-000056-0061-3). The proposed improvements at Plant 1 & 2 are shown in the enclosed Sheet 5.3-1 (Figure 2a), and the proposed improvements at Plant 3 are shown in the enclosed Sheet 5.3-2 (Figure 2b).

1.3 Scope of Work

ATL has completed a subsurface exploration program for this project, which consisted of the following scope, to determine subsurface soil conditions in the proposed project area and to develop geotechnical engineering recommendations for the design and construction of proposed improvements at EWPP:

- At Plant 1 & 2: Drilled Boring B-1 to 50 feet below the existing concrete pavement at/near the proposed new lime tanks area. Drilled Borings B-2 and B-4, through existing concrete pavement, to 20 feet below existing grade for the proposed new concrete paving and chemical containment areas. Drilled Boring B-3 to a depth of 50 feet below the existing grade, in the proposed new lime tanks and delivery area.
- At Plant 3: Drilled Boring B-5 to 50 feet below the existing grade near the proposed new lime tanks area. Drilled Borings B-6 and B-7, through existing concrete pavement, to 20 feet below existing grade for the proposed new concrete paving and chemical containment areas.
- Conducted laboratory testing on select soil samples recovered from the soil borings.
- Developed boring logs based on field and laboratory information to present the subsurface soil and groundwater conditions.
- Performed preliminary fault evaluation of the proposed project site based on the review of available published fault maps literature.

Based on results from the field investigation, laboratory testing and gathered geological and subsurface information, ATL performed geotechnical engineering analyses to develop geotechnical recommendations for the design and construction of the proposed improvements at EWPP.

2.0 SUBSURFACE INVESTIGATION PROGRAM

Approximate locations of borings drilled in this geotechnical exploration are shown in Figure 1. The soil borings were drilled dry to the bottom of a boring or until a borehole starts caving in. In cohesive soils, undisturbed soil samples were collected using a conventional 3-inch O.D. Shelby tube in general accordance with ASTM D1587. Cohesionless soils were sampled using split spoon sampler in general accordance with ASTM D1586. The borings were grouted with cement-bentonite using tremie at the completion of drilling.

All soil samples were examined, classified and logged in the field. A representative portion of each sample was sealed in aluminum foil and placed in containers to prevent moisture loss. All soil samples were properly labeled and subsequently transported to the ATL laboratory. All soil samples were classified according to Unified Soil Classification System (ASTM D-2487). The subsurface information is presented in the individual boring logs and a key to soil classifications and symbols used in the boring logs are presented in Appendix 1.

3.0 LABORATORY TESTING PROGRAM

Samples obtained from the field were examined and classified again in our soil laboratory by a geotechnical technician under the supervision of an engineer. Laboratory testing was performed on select representative soil samples collected during the field investigation. The laboratory testing program included Atterberg Limits (ASTM D-4318), Percent Finer than No. 200 Sieve (ASTM D-1140, Density, Moisture Content (ASTM D-2216), Unconfined Compressive Strength (ASTM D-2166) and Unconsolidated Undrained Triaxial Strength (ASTM D-2850 tests. The results of laboratory tests are presented on the boring logs in Appendix 1 and summarized in the Summary of Test Results table in Appendix 4. Overall numbers and types of tests performed for this study for this project are presented below:

TABLE 1 SUMMARY OF LABORATORY TESTS

TYPE OF TEST	NUMBER OF TEST
Dry Density	30
Moisture Content	86
Atterberg Limits	31
Unconfined Compression	22
Sieve Analysis through No. 200 Sieve	28
Unconsolidated Undrained Triaxial	8

4.0 SUBSURFACE AND SITE CONDITIONS

4.1 Area Geology

The proposed project area is located within the Gulf Coast Structural Province, a huge sedimentary basin containing several thousand feet of sediments. In general, these sediments consist of loose sands, silts and clays which slope gently toward the Gulf of Mexico.

The proposed project site is underlain by both the Beaumont Formation of the Pleistocene age and the Alluvium Formation of Holocene age. The Beaumont Formation consists of over consolidated clays, silts and sands with some shell, calcium carbonate and iron oxides. These formations are quite strong and extend to an approximate depth of 100 feet. The Alluvium Formation of Holocene age consists of clays, silts and sands with features such as point bars, stream channel and mud flats. These are recent deposit and are typically normally consolidated. The surface materials are often weakened by the weathering process.

4.2 Geological Hazards

Among the geologic and geo-morphological features in this region are sedimentary deposits broken by structure such as normal faults, salt domes, etc. The sedimentary deposits slope gently toward the Gulf of Mexico. They are broken by normal faults, most of which dip toward the Gulf and extend downward many thousands of feet. The earth movements that caused these faults took place within the last 50,000 years. In general, the regional faults in the Houston area trend parallel to the Gulf Coast. Only the local faults over the salt domes show a radial pattern associated with the upthrust of the salt mass.

There are numerous faults and fault systems in the Greater Houston and surrounding area. The movement of many of these faults has been affected in recent history by area subsidence. The subsidence is theorized to have been exacerbated by the removal of oil and groundwater. As much as nine (9) feet of subsidence has taken place in the area east of Houston in the last 70 years. Conversion to surface water usage and the limiting of oil production has greatly reduced the subsidence rate in the area east of Houston.

Figure 3a and 3b show the documented principal active growth faults in the Houston area. Based on the published fault map and a cursory site visit, it appears that no documented geologic faults are located close to the project site. Therefore, ATL does not recommend a Phase I fault investigation for this site.

4.3 Potentially Hazardous Material

No observable unusual staining or hydrocarbon odors were noted during our inspection of the soil samples.

4.4 Site Stratigraphy and Geotechnical Characterization

At Plant 1 and 2 (Borings B-1 through B-4): The existing concrete apron at Boring B-1 consists of about 5 inches of portland cement concrete (PCC); the existing roadway at Boring B-2 consists of about 10.75 inches of PCC. The subsurface soils in this area consist of an upper soft to hard Fat Clays (CH) and Lean Clays (CL) stratum to a depth of about 33, 8 and 23 feet in Borings B-1, B-2 and B-3, and to the bottom of Boring B-4 at 20 feet below existing grade. Below the clay stratum, loose to very dense Silty Sand (SM) was found to the bottom of Boring B-2 at 20 feet, and to a depth of about 38 feet in Boring B-1 and B-3. Below the silty sand stratum, firm to very stiff Fat Clays (CH) and Lean Clays (CL) exists to the bottom of Boring B-1 and B-3 at 50 feet.

At Plant 3 (Boring B-5 through B-7): The subsurface soils in this area consist of an upper firm to very stiff Fat Clays (CH) and Lean Clays (CL) stratum to the bottom of Boring B-6 and B-7 at 20 feet, and to a depth of about 14 feet in Boring B-5, followed by a stratum of loose to very dense Silty Sand (SM) to a depth of about 38 feet, which in turn is underlain by stiff to hard Fat Clays (CH) and Lean Clays (CL) to the bottom of boring at 50 feet.

The Fat Clays found at this site are of high to very high plasticity, with liquid limits (LL) ranging between about 52 and 91, and plasticity indices (PI) ranging between about 32 and 66. The Sandy Lean Clays found at this site are of low to high plasticity, with LL ranging between about 30 and 48, and plasticity indices (PI) ranging between about 8 and 30. The letters (CL, CH, SM, SC) in parenthesis indicate soils classification in accordance with Unified Soils Classification System. The detailed subsurface soils and stratigraphy are shown in the individual boring logs in Appendix 1, and in the Boring Log Profiles in Figures 4a and 4b.

CH, CL, SC and SM are soil classification in accordance with Unified Soils Classification System. Detailed stratigraphy and a key to terms and symbols used in the boring logs are

presented in Appendix 1. Boring log profiles were developed based on the boring locations and the subsurface soils encountered in each boring. The boring logs profiles are presented in Figure 4.

4.4.1 Suitability of Onsite Soils As Fill Material

Clean onsite Lean Clays (CL) with PI between about 10 and 20 may be used as select fill. Clean onsite clay soils with PI above 20 are not suitable as select fill, but they may be used as general fill for non-structural areas. Clean clay soils with PI above 20 may be used as select fill when treated with an adequate amount of lime. The optimum amount of lime to be used to stabilize the sandy lean clays can be determined by conducting lime vs PI and/or pH series tests.

The silty sands (SM) and clayey sands (SC) are not suitable as select fill, they may be used as general fill in non-structural areas that are protected from erosion.

4.5 Groundwater

Groundwater conditions were observed in Boring B-2 through B-7 during drilling at a depth of about 11, 20, 18, 18, 16.5 and 14 feet below existing grade, respectively, and at a depth of about 12.5, 9, 13, 14 and 14 feet after 15 minutes. Boring B-1 was drilled dry to 20 feet, and wash boring commenced below 20 feet; no free water was encountered before wash boring.

It should be noted that the groundwater level would fluctuate according to factors such as the amount of precipitations and ambient temperature preceding and at the time of construction, and the topography, surface drainage and the subsurface soil stratigraphy, etc. It should be noted that a detailed hydrogeological investigation of the proposed project area is beyond the scope of this investigation.

5.0 GEOTECHNICAL ENGINEERING RECOMMENDATIONS

We understand that improvements at Plant 1 & 2 and Plant 3 consisting of miscellaneous concrete paving/slab to support minor chemical tanks and the associated truck traffic as well as chemical containment area in case of spill. Major structures proposed are pads for the supporting new 12-ft diameter lime tanks that are about 26 feet tall.

5.1 Proposed Foundation for Lime Tanks

ATL understands that the proposed lime tanks are approximately 12 feet in diameter and about 26 feet tall. Based on the subsurface conditions of Borings B-1, B-3 and B-5, ATL recommends that a structural slab on grade foundation system on improved subgrade to support the lime tanks.

TABLE 2 LIME TANKS FOUNDATION RECOMMENDATIONS

Location	Proposed Structures	Foundation Recommendations
Plant 1 & 2	Lime Tanks Foundation at B-1	Slab-on-grade with grade beams on at least 24 inches of compacted select fill. Use an allowable soil bearing capacity of 1,500 psf for slab-on-grade design.
	Lime Tanks Foundation at B-3	Slab-on-grade with grade beams on at least 30 inches of compacted select fill. Use an allowable soil bearing capacity of 1,500 psf for slab-on-grade design.
Plant 3	Lime Tanks Foundation at B-5	Slab-on-grade with grade beams on at least 30 inches of compacted select fill. Use an allowable soil bearing capacity of 1,500 psf for slab-on-grade design.

Recommended Foundation Soils Preparation: The following system of construction procedures is recommended:

1. Sawcut existing pavements within proposed structure. Strip and remove all surface organics, topsoil and unsuitable materials from all structure and paving areas. The subgrade improvement area should extend at least 5 feet beyond the footprint of the

structural slab-on-grade.

2. Excavate the existing subgrade soils to the recommended select fill depth. Proof-roll the subgrade to detect any wet, soft, or pumping areas. Remove any soft/wet soils.
3. Compact the subgrade to a minimum of ninety-five (95) percent of its maximum dry density as determined by the Standard Proctor compaction Test (ASTM D 698).
4. Place compacted select fill to the design subgrade elevation. Select fill should consist of clean sandy lean clays (CL) having a plasticity index (P.I.) of ten (10) to twenty (20) and a liquid limit of 28 or more. The fill should be placed in six (6) to eight (8) inch loose lifts and compacted at optimum and +2 percent of optimum moisture content to at least ninety-five (95) percent of the maximum dry density as determined by the Standard Proctor Compaction Test. Clean on-site soils meeting select fill requirements may be used; clean on-site high plasticity clay soils may be stabilized with an adequate amount of lime and used as select fill. Optimum amount of lime stabilization shall be determined by conducting lime vs PI and/or pH series tests.

Slab-on-Grade Design Parameters: An engineered post-tensioned foundation or conventional ribbed and reinforced slab-on-grade with perimeter and interior thickened sections (grade beams) may be designed according to Design of Post-Tensioned Slabs-on-Ground, 3rd Edition. The grade beams should be founded at a minimum depth of 18-inches below final grade and designed for an allowable soil bearing capacity of 1,500 psf. The following are PTI design parameters assuming the compacted select fill recommended in Table 2:

TABLE 3 SLAB-ON-GRADE DESIGN PARAMETERS

Boring No.		B-1	B-3	B-5
Weighted LL		35	50	56
Weighted PL		16	19	20
Weighted PI		18	31	36
Thornwaite Moisture Index (I_m)		18	18	18
Constant Suction Value (P_F)		3.45	3.45	3.45
Edge Moisture Variation (e_m)	Center, ft.	9	8.0	7.9
	Edge, ft.	5.0	4.3	4.1
Estimated Differential Swell (y_m)	Center, in.	0.16	0.78	0.93
	Edge, in.	0.14	0.76	0.92

A conventional slab-on-grade (mat) design shall be provided with a minimum 18-inches thick thickened edge on the outside perimeters to mitigate edge soils' erosion potential, and designed for an allowable soil bearing capacity of 1,500 psf, and a modulus of subgrade reaction of 75 pci considering the recommended subgrade preparation.

5.2 Concrete Paving for Containment Areas

We understand that improvements at Plant 1 & 2 and Plant 3 will entail miscellaneous concrete paving/slab to support minor chemical tanks and the associated truck traffic as well as chemical containment area in case of spill. Traffic and loading information is not available to us and thus reasonable traffic loadings for this type of facility are assumed. The pavement designs presented below are based on the use of a prepared subgrade. Stabilization of the top 8 inches of subgrade with approximately 7 percent lime is recommended to provide a competent and durable subbase; the optimum amount of lime required shall be determined by conducting lime vs PI and/or pH series tests at the time of construction. The pavement design utilizes a Portland cement concrete with a design 28-day compressive strength of 3,500 psi.

8" Portland Concrete
8" Stabilized Subgrade

5.2.1 Reinforcement Design

Reinforcing steel is required to control pavement cracks, deflections across pavement joints and resist warping stresses. The cross-sectional area of steel (A_s) required per foot of slab width can be calculated as follows:

$$A_s = FLW / (2f_s)$$

Where: A_s = Required cross-sectional area of reinforcing steel per foot of width
F = Coefficient of resistance between slab and subgrade

L = Distance between free transverse joints or between free longitudinal edges, ft.

W = Weight of pavement slab per foot of width

f_s = Allowable working stress in steel, psi

Based on AASHTO, a coefficient of resistance, F = 1.8 may be used in the above equation. The above equation is for both longitudinal and transverse steel.

5.2.2 Pavement Subgrade Preparation and Construction

Pavement subgrade excavation and preparation shall be carried out in accordance with requirements of City of Houston Department of Public Works and Engineering (COHDPWE) Standard Specifications Section 02315. Lime stabilization of the top 8 inches of the existing subgrade shall be in accordance with COHDPWE Standard Specifications Section 02336. Design and construction of the concrete pavements, including reinforcement and jointing details, should meet the COHDPWE Standard Specifications Section 02751 and 02752, as well as the standard details drawings No. 02751-1 and 02752-1, as applicable.

6.0 CONSTRUCTION REVIEW

6.1 Quality Control

Associated Testing Laboratories, Inc. (ATL) recommends implementation of a quality control program under the supervision of a Professional Engineer. Structural integrity and stability is particularly dependent on quality foundation installation. An independent testing laboratory should be assigned to test and inspect construction materials during the construction phase.

6.2 Monitoring

Despite the thoroughness of this geotechnical exploration, there is always the possibility that actual subsurface conditions may differ from the predicted conditions because conditions between soil borings can be different from those at specific boring locations. Associated Testing Laboratory, Inc. (ATL) recommends a regular inspection and overall project monitoring by a geotechnical engineer during the construction phase. The purpose of inspection is to provide sound engineering and judgement alternatives during construction, if unanticipated conditions occur.

7.0 LIMITATIONS

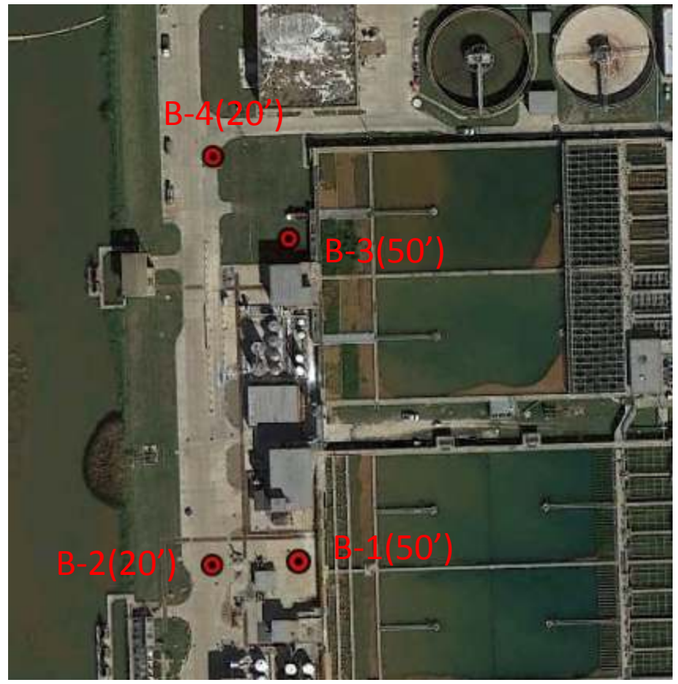
The recommendations contained in this report are based on data gained from test borings at the locations shown in Figures 2a through 2d, a reasonable volume of laboratory tests, and professional interpretation and evaluation of such data, from the project information furnished. Should it become apparent during construction that soil conditions differ significantly from those discussed in this report, this office should be notified immediately so that an evaluation and any necessary adjustments can be made. Evaluation of any existing structures was not in our scope. Any analysis of slope stability, bulkhead or other buildings or features at the site, not within the scope of this investigation, ATL is not responsible for any problems caused by these features.

8.0 REFERENCES

1. Joseph E. Bowles (1982), Foundation Analysis and Design, 3rd ed., McGraw-Hill Book Company.
2. Braja M. Das (1985), Principles of Geotechnical Engineering, PWS Engineering.
3. Merlin G. Spangler and Richard L. Handy (1982), Soil Engineering, Fourth Edition, Harper & Row Publishers.
4. Alfreds R. Jumikis (1971), Foundation Engineering, Intext Educational Publishers.
5. W.L. Schroeder (1980), Soils in Construction, Second Edition, John Wiley & Sons.
6. Annual Book of ASTM Standards for Soils and Rock; Building Stones.
7. Harris County Soil Survey; USDA Soil Conservation Services.
8. Geologic Atlas of Texas; Bureau of Economic Geology, The University of Texas.
9. Groundwater Quality in Texas; Texas Natural Resources Conservation Commission.
10. E.J. Yoder and M.W. Witczak (1975), Principles of Pavement Design, John Wiley & Sons, Inc., Second Edition
11. Design of Pavement Structure; AASHTO 1993.
12. International Building Code (IBC) – 2006 and 2012.

FIGURES

Vicinity Map

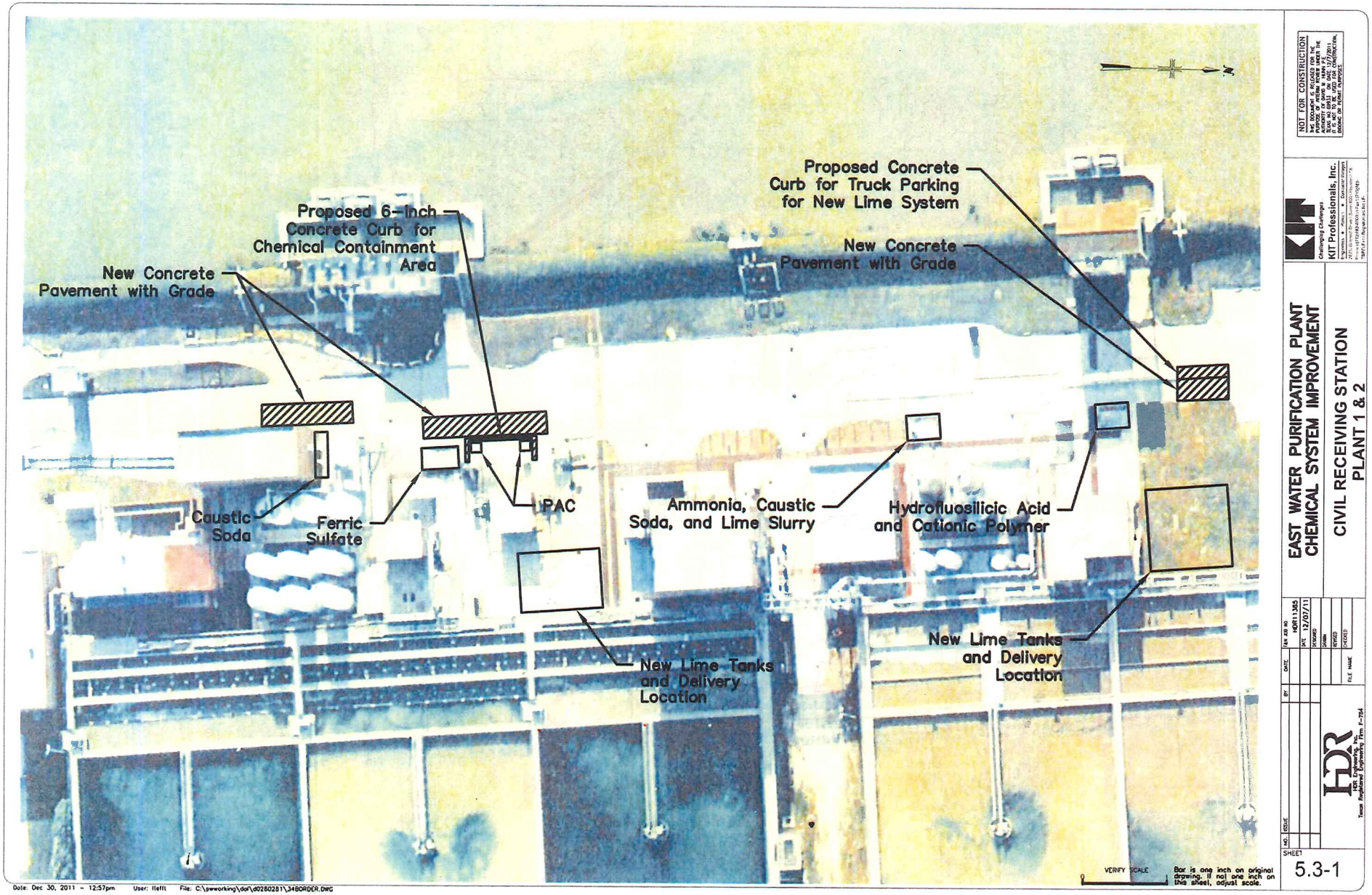


Boring Location Plan - Plant 1 & 2
(WBS No. S-000056-0071-3)

Boring Location Plan – Plant 3
WBS No. S-000056-0061-3

SITE VICINITY AND BORING LOCATION MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748	
EWPP CHEMICAL SYSTEM IMPROVEMENTS AT PLANT 1 & 2 AND 3	WBS NO. S-000056-0071-3 / S-000056-0061-3	
	PROJECT NO. : G13-229	FIGURE 1

FIGURE 2a



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NOT FOR CONSTRUCTION

KIT Professionals, Inc.
Challenging Challenges

EAST WATER PURIFICATION PLANT
CHEMICAL SYSTEM IMPROVEMENT

CIVIL RECEIVING STATION
PLANT 1 & 2

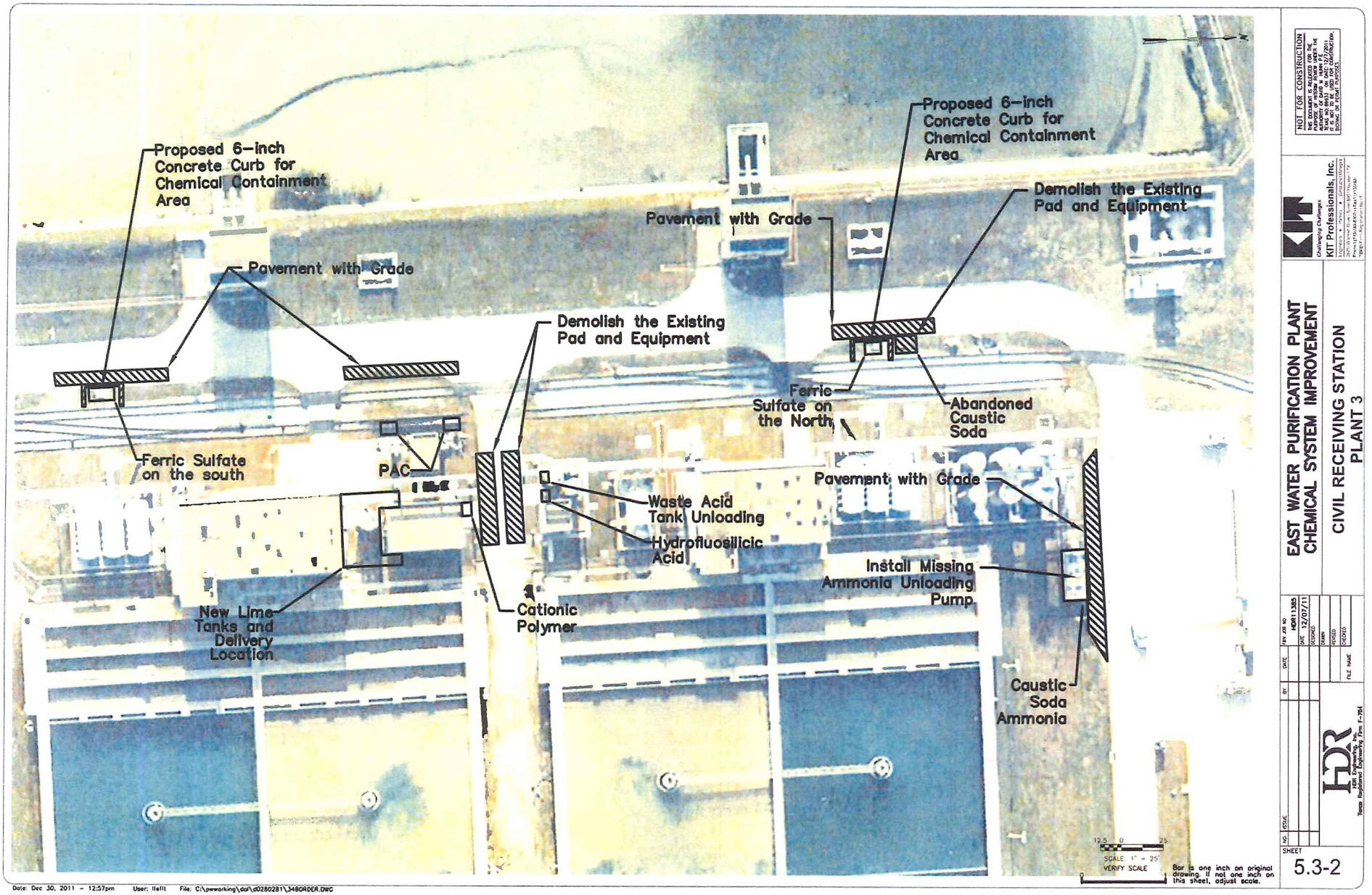
HDR Engineering, Inc.
Texas Registered Engineering Firm F-754

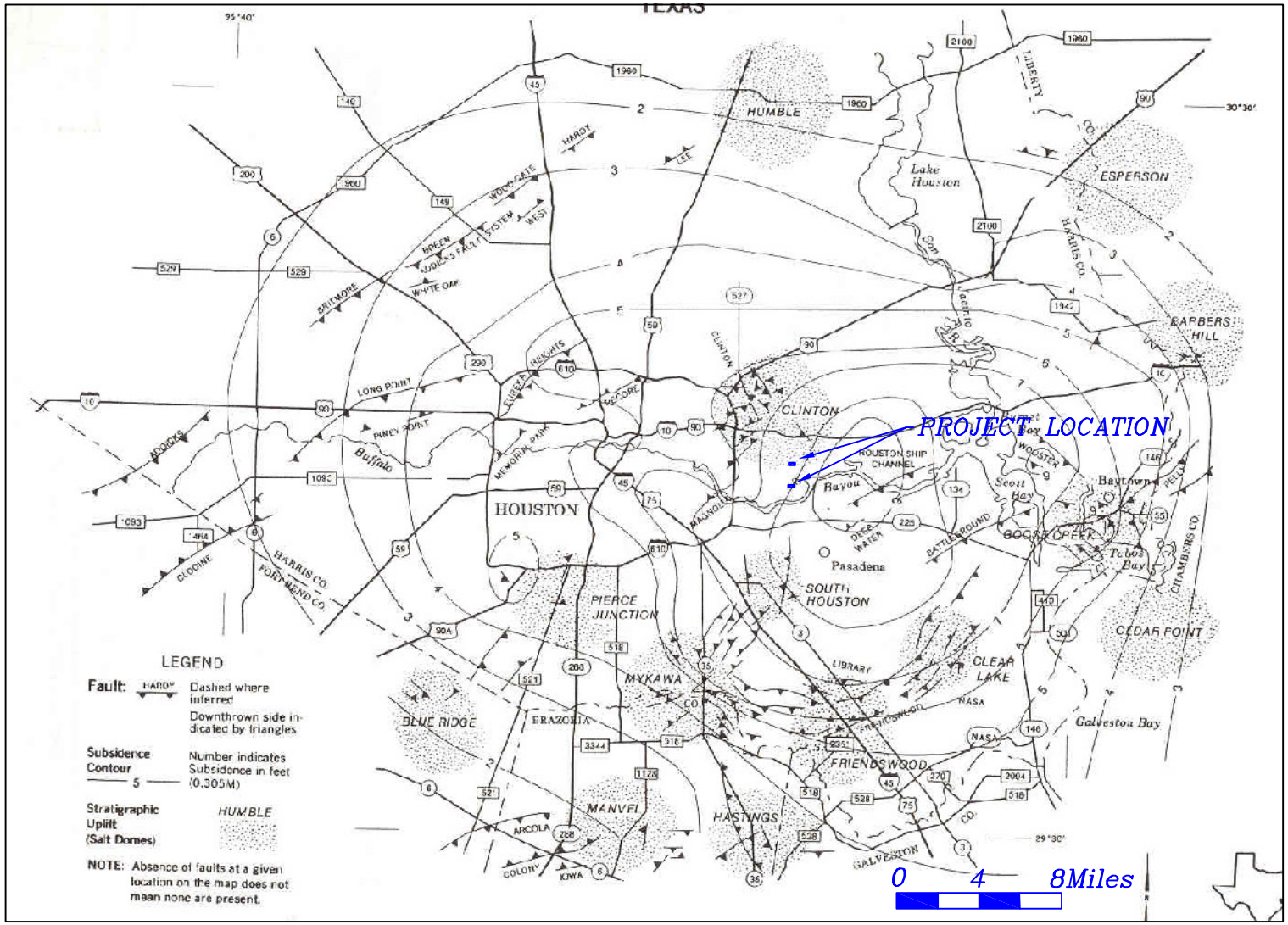
NO.	ISSUE	BY	DATE

FAX JOB NO: HDR11385
DATE: 12/07/11
DESIGNED
DRAWN
REVIEWED
CHECKED
FILE NAME

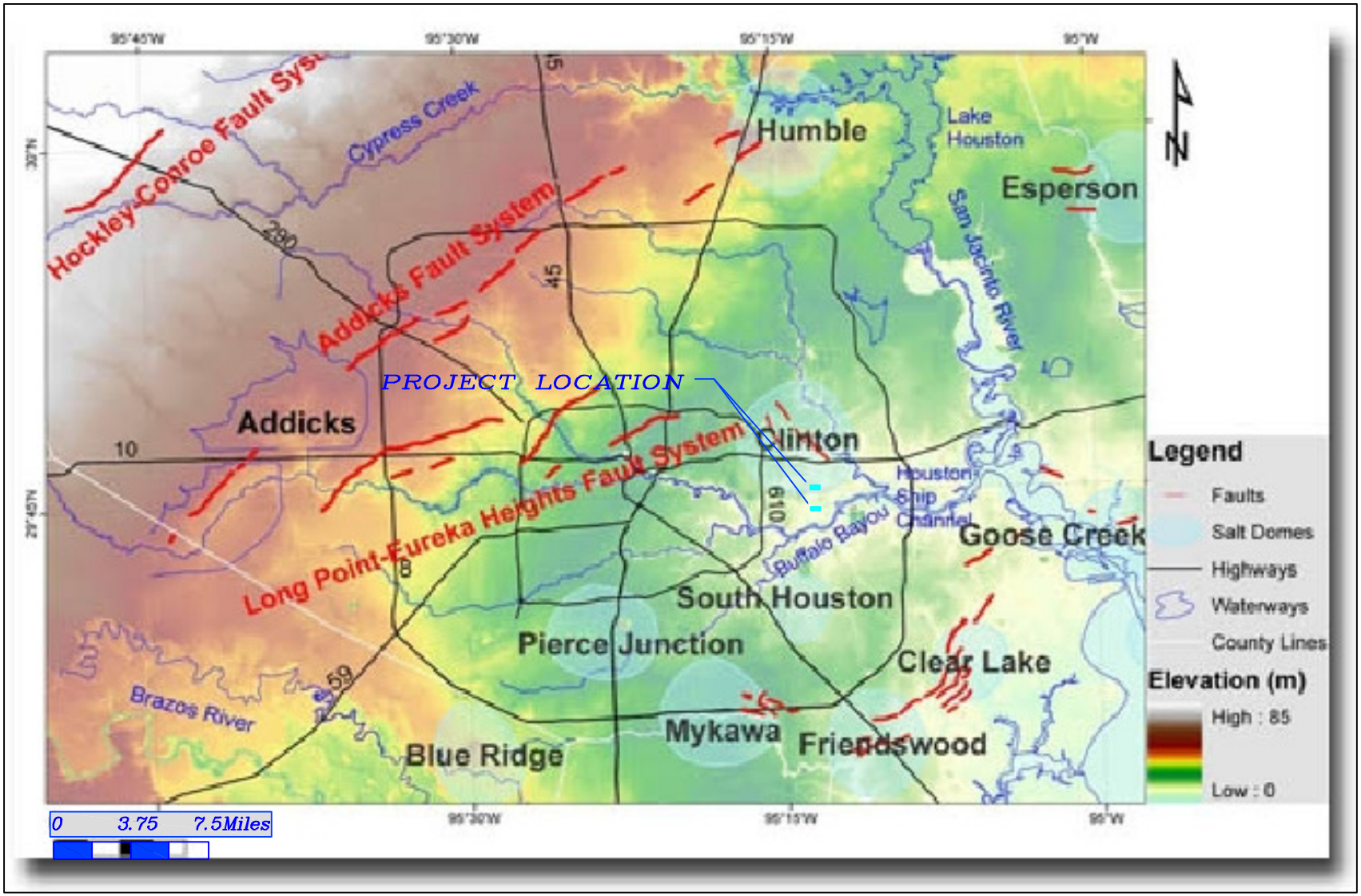
SHEET
5.3-1

FIGURE 2b


Proposed 6-inch Concrete Curb for Chemical Containment Area
Pavement with Grade
Ferric Sulfate on the south
PAC
New Lime Tanks and Delivery Location
Demolish the Existing Pad and Equipment
Waste Acid Tank Unloading
Hydrofluosilicic Acid
Cationic Polymer
Pavement with Grade
Proposed 6-inch Concrete Curb for Chemical Containment Area
Demolish the Existing Pad and Equipment
Ferric Sulfate on the North
Abandoned Caustic Soda
Pavement with Grade
Install Missing Ammonia Unloading Pump
Caustic Soda Ammonia
NOT FOR CONSTRUCTION
KIT Professionals, Inc.
EAST WATER PURIFICATION PLANT
CHEMICAL SYSTEM IMPROVEMENT
CIVIL RECEIVING STATION
PLANT 3
HDR Engineering, Inc.
SCALE: 1" = 25'
VERIFY SCALE
Bar is one inch on original drawing. If not one inch on this sheet, adjust scale.
SHEET
5.3-2



PRINCIPAL ACTIVE FAULTS IN HOUSTON AREA	*Associated Testing Laboratories, Inc.* *3143 Yellowstone Blvd. Houston, Texas* *Tel: (713) 748-3717 Fax: (713) 748-3748*
PROPOSED CHEMICAL SYSTEMS IMPROVEMENTS AT PLANT 1 & 2 AND PLANT 3	*WBS No.: S-000056-0071-3 / S-000056-0061-3* *PROJECT NO. G13-229* *FIGURE. 3a*

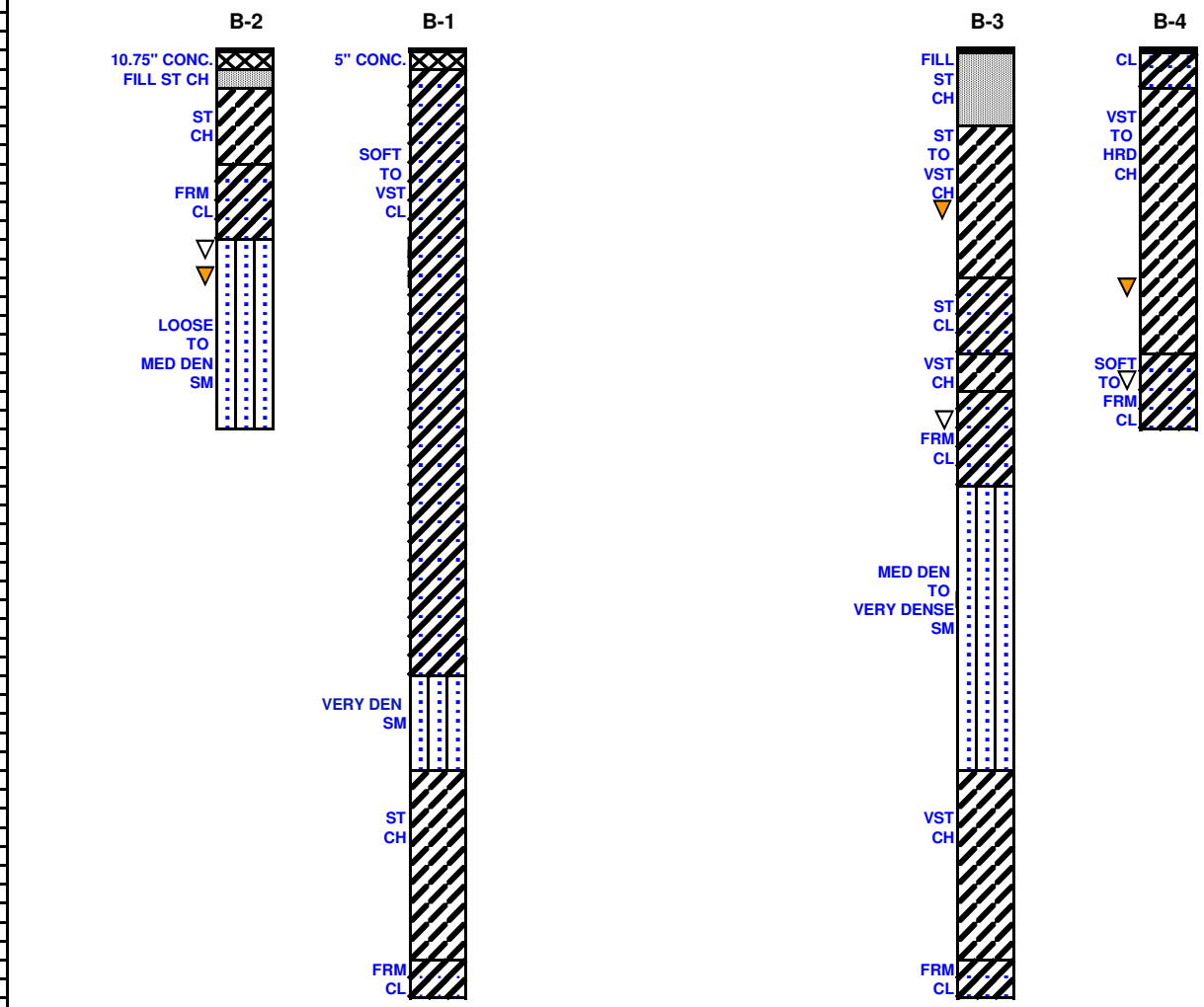


ACTIVE SURFACE FAULTS ON LIDAR IMAGERY	*Associated Testing Laboratories, Inc.* *3143 Yellowstone Blvd. Houston, Texas* *Tel: (713) 748-3717 Fax: (713) 748-3748*
PROPOSED CHEMICAL SYSTEMS IMPROVEMENTS AT PLANT 1 & 2 AND PLANT 3	*WBS No.: S-000056-0071-3 / S-000056-0061-3*
	PROJECT NO. G13-229 — *FIGURE. 3b*

ASSOCIATED TESTING LAB, INC.

PROJECT NAME : PROPOSED CHEMICAL SYSTEMS IMPROVEMENTS AT PLANT 1 & 2 AND PLANT 3 — **PROJECT NO. G13-229**

Depth (ft.) — WBS No.: S-000056-0071-3 / S-000056-0061-3



▽	Water First Noticed
▼	Depth To Water At Completion

KEY		
CH- Fat Clay		ST - Stiff
CL- Lean Clay With sand		VST - Very Stiff
CL- Sandy Lean Clay		FRM - Firm
SM- Silty Sand		HRD - Hard
CH- Fat Clay With Sand		MED DEN - Medium Dense
		SLIGHT.COMP-Slightly Compact

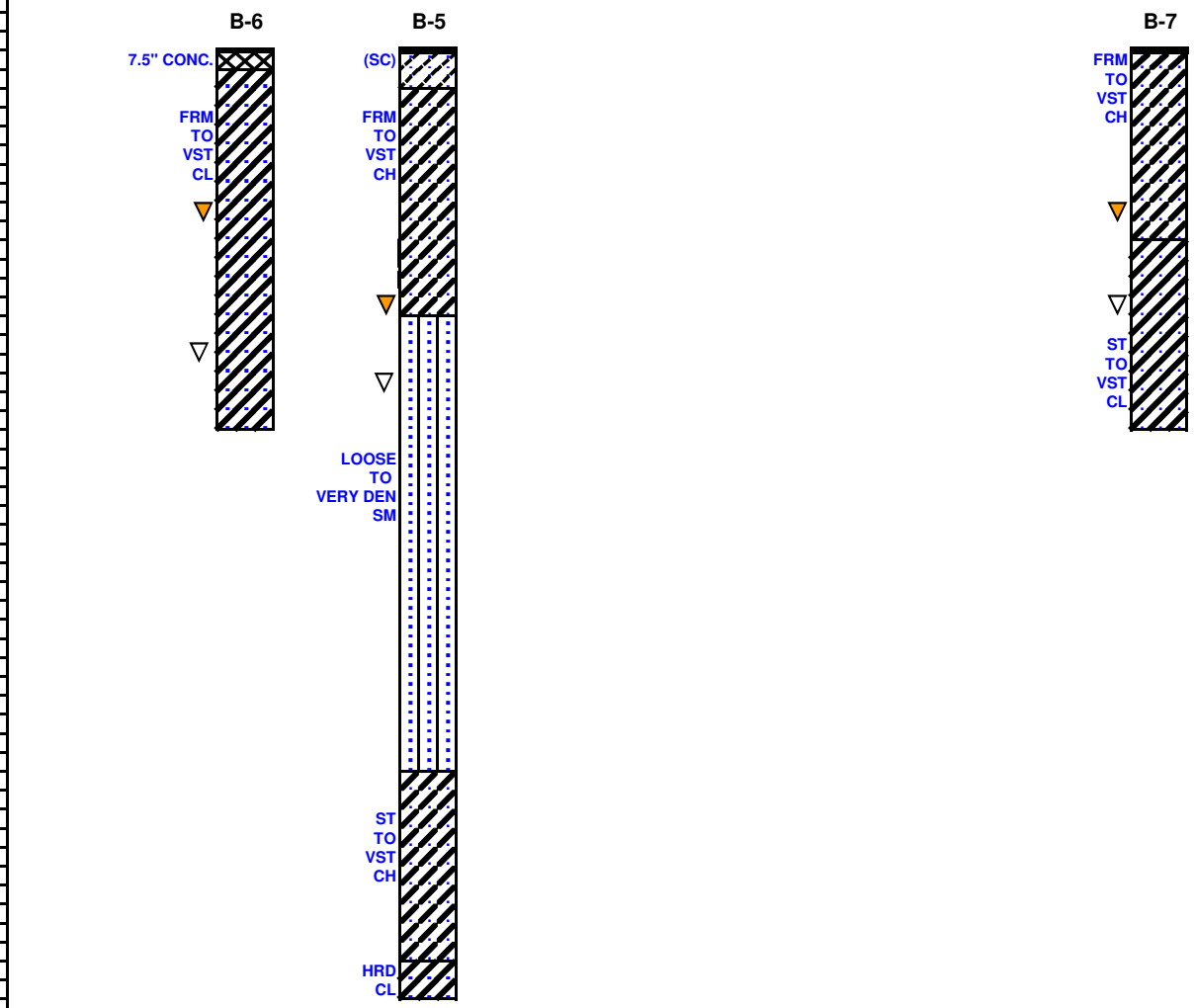
SCALE
Horizontal Scale: N.T.S.
Vertical Scale: 1" = 10'

Figure 4a

ASSOCIATED TESTING LAB, INC.

PROJECT NAME : PROPOSED CHEMICAL SYSTEMS IMPROVEMENTS AT PLANT 1 & 2 AND PLANT 3 — **PROJECT NO. G13-229**

Depth (ft.) — WBS No.: S-000056-0071-3 / S-000056-0061-3



▽	Water First Noticed
▼	Depth To Water At Completion

KEY	
CH- Fat Clay	
CL- Lean Clay With sand	
CL- Sandy Lean Clay	
SM- Silty Sand	
CH- Fat Clay With Sand	

ST - Stiff	
VST - Very Stiff	
FRM - Firm	
HRD - Hard	
MED DEN - Medium Dense	
SLIGHT.COMP-Slightly Compact	

SCALE
Horizontal Scale: N.T.S.
Vertical Scale: 1" = 10'

Figure 4b

APPENDIX 1

BORING LOGS AND KEY TO LOG TERMS AND SYMBOLS

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-1

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/18/2013

SURFACE ELEVATION

LOCATION

Plant 1 & 2

Northing:

Easting:

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		5" Concrete												
	CL	Sandy Lean Clay (CL), very stiff, medium plasticity, light gray and tan	3.0						15	32	16	16	51	
		..stiff below 2'	1.75						23					
		..firm below 4'	1.0						36					
5		..stiff with ferrous nodules below 6'	2.0		89	0.65		0	30					
			2.0						22					
10			1.75						19	39	17	22	58	
			2.0		115	1.03		9	19					
			1.75						19					
15			2.0		109	0.55		0	18	30	16	14		
		..very stiff below 18'	3.25		117	1.42		12	15					
20														
		..firm below 23'	1.0						19	22	14	8		

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

ATTERBERG LIMITS(%)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: N/A, After Drilling Water Level:N/A

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Wash Boring below 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-1

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/18/2013

SURFACE ELEVATION

LOCATION
Plant 1 & 2
Northing:
Easting:

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT LL	PLASTIC LIMIT PL	PLASTICITY INDEX PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
25				..soft below 28'	0.5						22	23	15	8		
30		CL														
				Silty Sand (SM), very dense, non plastic, light gray and tan		58					22				15	
35		SM														
				Fat Clay (CH), stiff, very high plasticity, light gray and tan	2.0		90	0.8		0	29	81	24	57		
40																
		CH		no recovery												
45																
		CL		Lean Clay with Sand (CL), firm, medium plasticity, reddish brown	0.75						23	31	16	15	85	

N (blows/ft) 20 40 60 80
Q_u (tsf) 1.0 2.0 3.0 4.0
DD (pcf) 90 100 110 120
P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits
Plastic Limit — Moisture Content — Liquid Limit
20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: N/A, After Drilling Water Level:N/A

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Wash Boring below 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-2

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/18/2013

SURFACE ELEVATION

LOCATION

Plant 1 & 2

Northing:

Easting:

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		10.75" Concrete												
	CH	Fat Clay (CH), stiff, high plasticity, light gray and tan with rocks (FILL 2 feet)	2.0						24					
		Fat Clay (CH), stiff, very high plasticity, light gray and tan	1.75						31	91	25	66	88	
	CH		2.0						24					
5		Sandy Lean Clay (CL), firm, medium plasticity, light gray and tan	1.25		109	0.35		0	20					
	CL	..firm, very sandy below 8'	0.5						20	27	15	12	57	
10		Silty Sand (SM), medium dense, non plastic, light gray and tan (wet)	0.5						22					
				12					23				48	
	SM	..loose below 14' (wet)		9					24					
15				8					25					
				8					25				47	
20														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: 11', 15 Min Water Level: 12.5', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Hole Caved at 16', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-3

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/19/2013

SURFACE ELEVATION

LOCATION

Plant 1 & 2

Northing:

Easting:

DEPTH (ft.)	SAMPLES	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		CH	Fat Clay with Sand (CH), stiff, high plasticity, light gray and tan (FILL 4 feet)	2.0						18	52	19	33	76	
				2.0		97	0.65		0	28					
			Fat Clay (CH), stiff, very high plasticity, light gray and tan	1.75						28					
5			..very stiff below 6'	3.5		107	1.05		0	20	65	21	44		
		CH	..stiff with ferrous nodules below 8'	1.75						21					
10				2.5		105	0.85		0	20					
			Sandy Lean Clay (CL), stiff, high plasticity, light gray and tan	2.0						19	48	18	30		
		CL		1.75		104	0.89		10	21					
15				3.0						23	68	22	46		
		CH	Fat Clay (CH), very stiff, very high plasticity, light gray and tan												
			Sandy Lean Clay (CL), firm, medium plasticity, light gray and tan	1.0		108	0.3		0	20	32	16	16	51	
20		CL													
		SM	Silty Sand (SM), medium dense, non plastic, light gray and tan		26					23				15	

Natural Moisture Content and Atterberg Limits (Plastic Limit – Moisture Content – Liquid Limit; 20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: 20', 15 Min Water Level: 9', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Wash Boring below 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-3

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/19/2013

SURFACE ELEVATION

LOCATION

Plant 1 & 2

Northing:

Easting:

MATERIAL DESCRIPTION

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
25																
				..dense below 28'		38					20				15	
30		SM														
				..very dense below 33'		60					22				16	
35																
				Fat Clay (CH), very stiff, very high plasticity, reddish brown	3.25						32	81	24	57		
40																
		CH			3.75						29	73	22	51	95	
45																
		CL		Sandy Lean Clay (CL), firm, medium plasticity, light gray and tan	1.5		103	0.45		0	23	29	15	14		

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

N (blows/ft) 20 40 60 80; Q_u (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: 20', 15 Min Water Level: 9', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☒ Shelby Tube ☒ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Wash Boring below 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-4

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/19/2013

SURFACE ELEVATION

LOCATION

Plant 1 & 2

Northing:
Easting:

MATERIAL DESCRIPTION

DEPTH (ft.)	USC	Material Description	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)
0	CL	Sandy Lean Clay (CL), medium plasticity, light gray and tan							13				
		Fat Clay (CH), very stiff, high plasticity, light gray and tan	2.75						22	57	20	37	96
		..hard below 4'	4.5		112	2.25		0	18				
5		..very stiff below 6'	3.75						21	88	25	63	97
	CH		4.0		104	3.3		6	22				
10		..with slickensided layers below 10'	4.0		101	1.7		0	22				
			3.5		102	1.17		9	25				
		..with calcareous nodules below 14'	4.0						22	68	22	46	81
15		Sandy Lean Clay (CL), soft, medium plasticity, light gray and tan	0.75		110	0.2		0	20				
	CL	..firm below 18'	1.0						20				
20													

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: 18', 15 Min Water Level : 13', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-5

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/20/2013

SURFACE ELEVATION

LOCATION

Plant 3

Northing:
Easting:

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0	SC	Clayey Sand (SC), medium plasticity, light gray and tan							13	27	15	12	35	
		Fat Clay with Sand (CH), firm, very high plasticity, light gray and tan	1.5		97	0.4		0	27					
5		..stiff below 4'	2.0						25					
		..with ferrous nodules below 6'	2.0						36					
	CH		2.0						25	71	22	49	82	
10			2.0		107	0.65		0	18					
		..very stiff below 12'	3.0		115	1.01		9	19					
15		Silty Sand (SM), medium dense, non plastic, lifght gray and tan ..with sandy clay seams to 18'		17					23					
				22					22				21	
		..loose, reddish brown below 18'		10					22					
20	SM													
				10					23				24	

Natural Moisture Content and Atterberg Limits (Plastic Limit, Moisture Content, Liquid Limit; 20 40 60 80)

N (blows/ft) 20 40 60 80; Q_u (tsf) 1.0 2.0 3.0 4.0; DD (pcf) 90 100 110 120; P (tsf) 1.0 2.0 3.0 4.0

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼

Water Observations: Initial Water Level: 18', 15 Min Water Level: 14', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Wash Boring below 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-5

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE 11/20/2013

SURFACE ELEVATION

LOCATION
Plant 3
Northing:
Easting:

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LIQUID LIMIT (LL)	PLASTIC LIMIT (PL)	PLASTICITY INDEX (PI)	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
25				..very dense below 28'		50					23					
30		SM		..no recovery		50										
35				Fat Clay with Sand (CH), very stiff, very high plasticity, light gray and tan	3.5		104	1.45		0	21	70	22	48	76	
40		CH		..stiff below 43'	2.0		102	0.6		0	23	75	23	52		
45		CL		Sandy Lean Clay (CL), hard, high plasticity, light gray and tan	4.5		116	2.25		0	16	46	18	28		

N (blows/ft) 20 40 60 80
Q_u (tsf) 1.0 2.0 3.0 4.0
DD (pcf) 90 100 110 120
P (tsf) 1.0 2.0 3.0 4.0

Natural Moisture Content and Atterberg Limits
Plastic Limit | Moisture Content | Liquid Limit
20 40 60 80

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 18', 15 Min Water Level: 14', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Wash Boring below 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-6

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE: 11/18/2013

SURFACE ELEVATION:

LOCATION: Plant 3
Northing:
Easting:

DEPTH (ft.)	SAMPLES	USC	WATER LEVEL	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0				7.5" Concrete												
				Sandy Lean Clay (CL), very stiff, high plasticity, light gray and tan	3.75						15	41	17	24	61	
				..stiff below 2'	2.5		95	0.9		0	28					
					1.75						34					
5				..with ferrous nodules below 6'	2.0						19					
				..very stiff below 8'	3.75						18	43	18	25	68	
10		CL			3.0						18					
					3.25		110	1.09		9	19					
				..firm below 14'	1.0		109	0.4		0	19					
15			▽	..stiff, reddish brown with calcareous nodules below 16'	2.0						17	26	15	11	58	
				..firm below 18'	1.0						23					
20																

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

N (blows/ft) 20 40 60 80 ● ; Q_u (tsf) 1.0 2.0 3.0 4.0 ▲ ; DD (pcf) 90 100 110 120 ★ ; P (tsf) 1.0 2.0 3.0 4.0 ◆

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 16.5', 15 Min Water Level: 9', After Drilling Water Level: N/A

Sample Key: ☒ SPT ☐ Shelby Tube ▤ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd
Houston, Texas-77054

LOG OF BORING B-7

PROJECT: Chemical Systems Improvements at Plant 1, 2, 3 EWPP
WBS No. S-000056-0071-3 / S-000056-0061-3

PROJECT NO.: G13-229 BORING TYPE: Auger

DATE: 11/18/2013

SURFACE ELEVATION:

LOCATION: Plant 3
Northing:
Easting:

DEPTH (ft.)	USC	MATERIAL DESCRIPTION	POCKET PENETROMETER(P,tsf)	BLOW COUNT (N, Blows/Foot)	DRY DENSITY (pcf)	UNCONFINED COMP. STRENGTH (tsf)	FAILURE STRAIN (%)	CONFINING PRESSURE (psi)	MOISTURE CONTENT (%)	ATTERBERG LIMITS(%) LL	PL	PI	PASSING #200 SIEVE (%)	ESTIMATED ANGLE OF INTERNAL FRICTION (°), OTHER TESTS & REMARKS
0		Fat Clay with Sand (CH), very stiff, high plasticity, light gray and tan	4.0						17					
		..stiff below 2'	1.5						19	53	19	34	71	
			2.0		99	0.6		0	25					
5	CH	..firm below 6'	1.0						30					
		..very stiff with calcareous nodules below 8'	3.25						20					
10		Lean Clay with Sand (CL), very stiff, medium plasticity, light gray and tan	3.0						18	33	16	17	83	
		..stiff with calcareous nodules below 12'	2.0		105	0.6		0	21					
		..very stiff, reddish brown below 14'	4.0		106	1.16		10	22					
15	CL	..stiff below 16'	1.5						21					
		..very stiff below 18'	3.5		103	1.2		0	21	47	18	29	85	
20														

Natural Moisture Content and Atterberg Limits: Plastic Limit, Moisture Content, Liquid Limit (20 40 60 80)

Water Level Intial: ▽ After Drilling: ▼ 24 Hrs: ▼
Water Observations: Initial Water Level: 14', 15 Min Water Level: 9', After Drilling Water Level: N/A

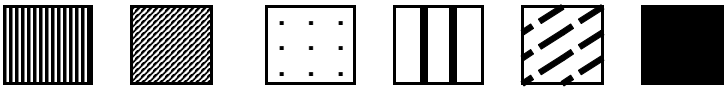
Sample Key: ☒ SPT ☐ Shelby Tube ☐ Disturbed

Key to Abbreviations:
N - SPT Data (Blows/Ft)
P - Pocket Penetrometer (tsf)
T - Torvane (psf)
Q_u - Unconfined Comp. Strength (tsf)
DD - Dry Density (pcf)

Notes:
Augered Dry to 20', Hole Grouted after Drilling. Drilled By: Soltek,LLC , Logged BY: PV, Checked By: Jitu/John, QC/QA By: PST

KEY TO LOG TERMS AND SYMBOLS

SOIL TYPE

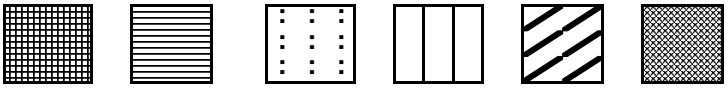


ROCK | GRAVEL | SAND | SILT | CLAY | PEAT

SAMPLER TYPE

NO SAMPLE | AUGER SAMPLE | SHELBY TUBE | SPLIT SPOON

MODIFIER



STONE | GRAVELY | SANDY | SILTY | CLAYEY | FILL

NO RECOVERY | ROCK CORE | 2" SHELBY TUBE | TXDOT CONE

UNIFIED SOIL CLASSIFICATION SYSTEM - ASTM D 2487

MAJOR DIVISIONS			LETTER SYMBOL	TYPICAL DESCRIPTIONS
COARSE GRAINED SOILS LESS THAN 50% PASSING No. 200 SIEVE	GRAVEL & GRAVELY SOILS LESS THAN 50% PASSING No.4 SIEVE	CLEAN GRAVELS LITTLE OR NO FINES	GW	WELL GRADEED GRAVELS,GRAVELSAND MIXTURES WITH LITTLE OR NO FINES
			GP	POORLY GRADED GRAVELS,GRAVEL SAND MIXTURES WITH LITTLE OR NO FINES
		W/ APPRECIATEBLE FINES	GM	SILTY GRAVELS,GRAVEL SAND-SILT MIXTURES
			GC	CLAYEY GRAVELS,GRAVEL SAND-CLAY MIXTURES
	SANDS MORE **THAN 50%** PASSING No.4 SIEVE	CLEAN SANDS LITTLE FINES	SW	WELL GRADED SAND,GRAVELY SAND (LITTLE FINES)
			SP	POORLY GRADED SANDS,GRAVELY SAND(L. FINES)
		SANDS WITH APPREA. FINES	SM	SILTY SANDS,SAND-SILT MIXTURES
			SC	CLAYEY SANDS,SAND-CLAY MIXTURES
FINE GRAINED SOILS LESS THAN 50% PASSING NO. 200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	INORGANIC SILTS & VERY FINE SANDS,ROCK FLOUR SILTY OR CLAYEY FINE SANDS OR CLAYEY SILT W/PI
			CL	INORGANIC CLAY OF LOW TO MEDIUM PI LEAN CLAY, GRAVELY CLAYS,SANDY CLAYS,SILTY CLAYS
			OL	ORGANIC SILTS & ORGANIC SILTY CLAYS OF LOW PI
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 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 MED TO HIGH PI, ORGANIC SILT
HIGHLY ORGANIC SOIL			FT	PEAT AND OTHER HIGHLY ORGANIC SOILS
UNCLASSIFIED FILL MATERIALS			ARTIFICIALLY DEPOSITED AND OTHER UNCLASSIFIED SOILS FILL MATERIALS	

CONSISTENCY OF COHESIVE SOILS

CONSISTENCY	UNCONFINED COMP. STRENGTH IN TSF
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.5
FIRM	0.5 TO 1.0
STIFF	1.0 TO 2.0
VERY STIFF	2.0 TO 4.0
HARD	GREATER THAN 4.0

CONSISTENCY	UNCORR. POCKET PENTROMETER READ.
VERY SOFT	LESS THAN 0.25
SOFT	0.25 TO 0.5
FIRM	> 0.50 TO 1.50
STIFF	> 1.50 TO 3.00
VERY STIFF	> 3.0 TO 4.50
HARD	4.5+

RELATIVE DENSITY - GRANULAR SOILS

CONSISTENCY	N-VALUE (BLOWS PER FT)
VERY LOOSE	<4
LOOSE	5-10
MEDIUM DENSE	11-30
DENSE	31-50
VERY DENSE	>50 OR 50+

CLASSIFICATION OF GRANULAR SOILS

U.S.STANDARD SIEVE SIZE(S)

6"	3"	3/4"	4	10	40	200		
BOULDERS	COBBLES	GRAVEL		SAND			SILT OR CLAY	CLAY
		COARSE	FINE	COARSE	MEDIUM	FINE		
152	76.2	19.1	4.76	2.0	0.42	0.074	0.002	

GRAIN SIZE IN MM