REPORT
GEOTECHNICAL INVESTIGATION
PROPOSED WATER PLANT IMPROVEMENTS
PACKAGE B
WBS NO. S-001000-0046-4
CITY OF HOUSTON, TEXAS

FOR

KLOTZ ASSOCIATES, INC.
1166 DAIRY ASHFORD, SUITE 500
HOUSTON, TEXAS 77079

PREPARED BY
ASSOCIATED TESTING LABORATORIES, INC.
HOUSTON, TEXAS

ATL REPORT G14-197

March 12, 2015

ESTABLISHED 1959

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

Date: March 12, 2015

ATL Job No: G14-197

Klotz Associates, Inc.
1166 Dairy Ashford, Suite 500
Houston, Texas 77079

Attention: Mr. Alexander Kuzovkov, P.E. / Mr. Sylvester Johnson, P.E.

Reference: Report
Geotechnical Investigation
Proposed Water Plant Improvements – Package B
WBS NO. S-001000-0046-4
City of Houston, Texas

Gentlemen:

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, M.S.C.E., P.E.
Manager, Geotechnical Services

Jasbir Singh, P.E.
President

TABLE OF CONTENTS

DESCRIPTION **PAGE**

LIST OF FIGURES

LIST OF APPENDICES

EXECUTIVE SUMMARY

Associated Testing Laboratories, Inc. (ATL) has conducted a Geotechnical Investigation in support of the design and construction of the proposed improvements at the District 111 #2, West Houston #3, Park Ten Central and Sharpstown #1 Water Plants for the City of Houston, Texas. ATL understands that the proposed improvements include construction of pre-cast concrete buildings, pumps, piping, transformers, generators and etc.

For this geotechnical investigation, a total of seven (7) soil borings to a depth of 20 feet below the existing ground surface were drilled in the 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 District 111 #2 Water Plant (Boring B-1): The subsurface soils based on Boring B-1 consist of about 2 feet of stiff, very high plasticity Fat Clay (CH), underlain by stiff to hard, medium plasticity Sandy Lean Clay (CL) to a depth of about 12 feet, and followed by loose to medium dense Silty Sand (SM) to the bottom of boring at 20 feet below existing grade.

At West Houston Water Plant #3 (Borings B-2 through B-4): The subsurface soils as found in the borings can upper stratum of high to very high plasticity, firm to hard Fat Clays (CH) to a depth of about 12 to 14 feet, followed by a stratum of soft to stiff, medium plasticity Lean Clays (CL) to bottom of borings at 20 feet below the existing ground surface.

At Park Ten Central Water Plant (Boring B-5): The subsurface soils as found the boring consist of a thick stratum of soft to very stiff, medium to moderately high plasticity Sandy Lean Clays (CL) to a depth of about 18 feet, followed by a stratum of dense Silty Sands (SM) to the bottom of the boring at 20 feet below the existing grade.

At Sharpstown Water Plant #1 (Boring B-6 and B-7): The originally proposed Boring B-6 located was drilled to a depth of about 2 feet when hard material was encountered, and boring was terminated. Boring B-6 was moved to the existing driveway as shown in Figure 2d.

Groundwater was encountered during and at completion of drilling in Borings B-1 through B-4 at depths ranging between about 12 and 18 feet below existing grade. Borings B-5 through B-7 were dry during and at completion of drilling. 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

Based on the field investigation, laboratory testing, records and document review, the following findings and recommendations are provided:

- No observable unusual staining or hydrocarbon odor was noted during our inspection of the soil samples.
- A preliminary fault evaluation based on review of available fault maps indicates that the closest known fault to the Park Ten Central Water Plant is located just northwest of the northeast end of the Addicks South Fault; no documented faults are located close to the remaining three sites. ATL does not recommend a Phase I fault investigation for these water plant sites.
- Foundation and construction recommendations for the proposed precast buildings, pads for supporting the generators, transformer, pumps and fuel tanks, as well as site and subgrade preparation are presented in Section 5 of this report.
- Concrete pavement design and construction recommendations for the parking and driveway addition, including pavement thickness, subgrade preparation and stabilization requirements are presented in Section 5 of this report.

GEOTECHNICAL INVESTIGATION
PROPOSED WATER PLANT IMPROVEMENTS
PACKAGE B
CITY OF HOUSTON, TEXAS

1.0 INTRODUCTION

1.1 General

This investigation was authorized by Klotz Associates, Inc (KAI), with the acceptance of Associated Testing Laboratories, Inc. (ATL) Proposal No. CP14-06903 dated July 1, 2014, and execution of Subcontract for Consultant Services Agreement between KAI and ATL on July 14, 2014. Project details were provided by KAI. This report includes results of the field investigation, laboratory testing, geotechnical engineering analysis, and recommendations for the design and construction of proposed improvements at four water plants.

1.2 Location and Description of the Project

General site vicinity maps for each project site is shown on Figures 1a through 1d. The site layout and proposed improvements are shown on Figures 2a through 2d. ATL understands that the Proposed Water Plants Improvements – Package B entails improvements at four of City of Houston water plants indicated in the table below. Also indicated in the table are the plant addresses, the key map block each project is located in, and the number of borings requested and drilled at each site.

TABLE 1

Plant No.	Plant Name	Address	Key Map	Number of 20-ft Borings Requested by Klotz Associates, Inc.
1	District 111 Water Plant #2	10301 Sun City Court, Houston, Texas	528 V	1

Plant No.	Plant Name	Address	Key Map	Number of 20-ft Borings Requested by Klotz Associates, Inc.
2	West Houston Water Plant #3	14925 South Richmond Avenue, Houston, Texas	487 Z	3
3	Park Ten Central Water Plant	1300 Langham Creek, Houston, Texas	447 Y	1
4	Sharpstown Water Plant #1	6910 Bintliff Drive, Houston, Texas	530 H	2
Total Number of Requested 20-ft Deep Borings				**7**

1.3 Scope of Work

ATL understands that the proposed improvements entails structural work at the water plant sites including construction of pre-cast concrete buildings, pumps, piping, transformers, generators and etc. ATL was requested and provided the following geotechnical services in support of the proposed improvements at the four water plants:

- Drilling and sampling a total of seven (7) soil borings at selected locations, to a depth of 20-ft below the existing ground surface in the areas of the proposed improvements. Boring B-6 was moved due to presence of hard material at the original.
- Conduct laboratory testing on select soil samples recovered from the soil borings.
- Develop boring logs based on field and laboratory information to present the subsurface soil and groundwater conditions.
- Perform preliminary fault evaluation of each project site based on the review of available published fault maps and literature.
- Based on results from the field investigation, laboratory testing and gathered geological and subsurface information, perform geotechnical engineering analyses to develop geotechnical recommendations for the design and construction of the proposed improvements at the four water plants.

2.0 SUBSURFACE INVESTIGATION PROGRAM

Seven (7) 20-ft deep soil borings were drilled at locations selected by and staked in the field at/near the proposed improvement sites at the four water plants. Approximate locations of the boring locations drilled for this geotechnical exploration are shown in Figures 2a through 2d.

The soil borings were drilled dry to the bottom of the borings. 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 soil 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. Overall numbers and types of tests performed for this study for this project are presented below:

TABLE 2

TYPE OF TEST	NUMBER OF TEST
Dry Density	25
Moisture Content	70
Atterberg Limits	21
Unconfined Compression	19
Sieve Analysis through No. 200 Sieve	21
Unconsolidated Undrained Triaxial	6

4.0 SUBSURFACE AND SITE CONDITIONS

4.1 Area Geology

The projects sites are 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 surface materials are often altered and weakened by the weathering process.

The sites of the Sharpstown #1 Water Plant, the West Houston #3 Water Plant and the District 111 #2 Water Plant are underlain by the Beaumont Formation of the Pleistocene age. This 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 materials of Beaumont Formation were deposited during the last of the interglacial periods. During interglacial periods when water from the melting glaciers flowed back into the ocean, the sea rose, the depended valley backfilled and several Pleistocene formations were deposited. Beaumont Formation may have been deposited during a mid-Wisconsin interglacial interval or during the Sangamon Stage, an interval between the Wisconsin and Illinoian

Glaciations. The Sangamon Stage is currently estimated as taking place about 70,000 years ago. The Beaumont formation is the youngest formation of Pleistocene age that crops out in the proposed project area. Its origins are mainly fluvial and deltaic, but probably some small areas originated as coastal marsh and lagoonal deposits.

The site of the Park Ten Central Water Plant is underlain by the Lissie Formation of the Pleistocene age. This formation consists of sand, silt, clay, and minor amount of gravel. Iron oxide and iron-manganese nodules common in zone of weathering and contains locally calcareous material. The surface is fairly flat and featureless except for many shallow depressions and pimple mounds.

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, the closest known fault to the Park Ten Central Water Plant is located just northwest of the northeast end of the Addicks South Fault; no documented faults are located close to the remaining three sites. ATL does not recommend a Phase I fault investigation for the proposed structures at these water plant sites. However, if a Phase I fault study is desired to gather more detailed information regarding growth faults in the vicinity of the project areas, ATL recommends contracting a professional geologist with extensive knowledge of the Houston area growth faults.

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 District 111 #2 Water Plant (Boring B-1): The subsurface soils based on Boring B-1 consist of about 2 feet of stiff, very high plasticity Fat Clay (CH), underlain by stiff to hard, medium plasticity Sandy Lean Clay (CL) to a depth of about 12 feet, and followed by loose to medium dense Silty Sand (SM) to the bottom of boring at 20 feet below existing grade.

At West Houston Water Plant #3 (Borings B-2 through B-4): The subsurface soils as found in the borings can upper stratum of high to very high plasticity, firm to hard Fat Clays (CH) to a depth of about 12 to 14 feet, followed by a stratum of soft to stiff, medium plasticity Lean Clays (CL) to bottom of borings at 20 feet below the existing ground surface.

At Park Ten Central Water Plant (Boring B-5): The subsurface soils as found the boring consist of a thick stratum of soft to very stiff, medium to moderately high plasticity Sandy Lean Clays (CL) to a depth of about 18 feet, followed by a stratum of dense Silty Sands (SM) to the bottom

of the boring at 20 feet below the existing grade.

At Sharpstown Water Plant #1 (Boring B-6 and B-7): The originally proposed Boring B-6 located was drilled to a depth of about 2 feet when hard material was encountered, and boring was terminated; please notify the Contractor that underground obstructions exists at this and possible other locations. Boring B-6 was moved to a location on the existing driveway as shown in Figure 2d and drilled to a depth of 20 feet below existing grade.

The subsurface soils as found in the two borings consist predominantly of firm to very stiff, high to very high plasticity Fat Clays (CH) to the bottom of borings at 20 feet. In Boring B-7, a stratum of very stiff, high plasticity Lean Clays (CL) was found between depths of about 8 and 10 feet.

The Fat Clays found in the borings drilled in this project are of high to very high plasticity, with liquid limits (LL) ranging between about 51 and 81, and plasticity indices (PI) ranging between about 32 and 57. The Lean Clays found in the borings drilled in this project are of medium to high plasticity, with LL ranging between about 29 and 46, and plasticity indices (PI) ranging between about 14 and 28.

CH, CL 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.

4.4.1 Suitability of Onsite Soils As Fill Material

The on-site Lean Clays (CL) are typically of medium to high plasticity. Clean Lean Clays with PI between 8 and 20 are suitable as select fill. The on-site Fat Clays (CH) are not suitable as select fill. The on-site Lean Clays not meeting select fill criteria and Fat Clays may be used as general fill in non-structural areas. Clean Lean Clays and Fat Clays 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 clay soils can be determined by conducting lime vs PI and/or pH series tests.

The onsite Silty Sands (SM) 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 information observed in the boreholes during and at completion of drilling are summarized below:

TABLE 3

Boring	Groundwater Information		Caved in Depth
	During Drilling	At Completion of Drilling	
B-1	17.5’	N/A	14.5’
B-2	15’	12.5’	None
B-3	15’	13’	None
B-4	15.5’	12.5’	None
B-5	Dry	Dry	None
B-6	Dry	Dry	None
B-7	Dry	Dry	None

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 the following improvements are planned at the four water plant sites:

TABLE 4

Water Plant	Proposed Improvements	Footprint	Other Information
District 111 Water Plant #2 (B-1)	Concrete Pad Supporting Pump	8' x 13'	Estimated load = 20,000 lbs
West Houston Water Plant #3 (B-2 through B-4)	Pad for Existing Fuel Tank Relocation	6' x 11'	Estimated load = 52,400 lbs
	Transformer Pad	11' x 9'	Estimated load = 43,000 lbs
	Precast LAS Chemical Feed Building	8' x 8'	Estimated load is 19,200 lbs
	LAS Chemical Containment Area	12' x 9'	Estimated load is 6000 lbs
Park Ten Central Water Plant (B-5)	Precast Building	20' x 40'	Total estimated load = 154,000 lbs
	Transformer Pad	11' x 9'	Estimated load = 43,000 lbs
Sharpstown Water Plant #1 (B-6 and B-7)	Precast Building	30' by 75'	Total estimated load (incl. pumps, valves, piping, equipment) = 340,000 lbs
	Transformer Pad (elevated)	16' x 45'	Estimated load = 86,000 lbs

5.1 Potential Vertical Rise of Onsite Soils

The surface soils at the four sites possess varying degrees of shrink/swell potential. Based on Test Method TEX-124-E by the Texas State Department of Highways and Public Transportation, Materials and Tests Division, the onsite soils at the four project sites have potential vertical rise (PVR) ranging from less than 0.5 to about 3.2 inches. A moisture variation zone of 9 feet was used for calculating the above PVR. Foundations should be designed accordingly.

At sites with high PVR surface soils, in order to mitigate the soils' PVR movements and to provide a competent subgrade to support the floor slab, a stratum of select fill may be placed

under slabs supported on subgrade. The select fill should extend at least 5-feet beyond the perimeter of the slabs supported on subgrade. The subgrade must be graded such that effective drainage away from the buildings/structures is maintained at all times.

Replacing the various thicknesses of the on-site high plasticity clays with non-active select fill will reduce the resultant PVR movements, as summarized in the table below.

TABLE 5

Select Fill Replacement Thickness, feet	Estimated Resultant Total PVR Movement, inches						
	B-1	**B-2**	**B-3**	**B-4**	**B-5**	**B-6**	**B-7**
0	1.8	2.3	3.2	2.1	<0.5	2.2	2.1
1	1.3	2.0	2.8	1.9		1.9	1.8
2	0.6	1.5	2.2	1.6		1.5	1.3
3		1.3	1.8	1.3		1.2	1.1
4		1.0	1.4	1.0		1.0	0.9
5		0.8	1.0	0.8		0.7	
6			0.6				

The actual thickness of select fill replacement to be used should be determined by the structural engineer based on the PVR requirements of the structural design and other client/project requirements. However, ATL recommends placing at least 2 feet of compacted select fill beneath slab-on-grade in areas with high plasticity surface soils to mitigate the PVR movements of high plasticity surface clay soils and to provide a uniform and competent foundation support for the building floor slabs. A minimum one foot stratum of select fill is also recommended beneath slab-on-grade in areas with low to PVR movements to ensure that slab is supported on a competent foundation support that is stable and resistant to erosion. Clean onsite lean clays field verified to meeting select fill requirements, when compacted to meet the density requirements, are acceptable as select fill.

5.2 Proposed Precast Buildings, Fuel Tank/Transformer/Generator/Pump Pads

ATL understands that precast buildings, and pads supporting fuel tanks, generators and transformers will be constructed at these four sites. The proposed finished floor elevations are assumed to be slightly above the existing grade.

5.2.1 Foundation Recommendations

ATL understands that slab-on-grade foundation is the selected foundation option for this project due to the nature and low magnitude of loading. The anticipated loadings from buildings and equipment are estimated to be less than 100 to 800 PSF. Table 6 below presents the foundation and subgrade preparation recommendations for the proposed structures at these four sites:

TABLE 6

Water Plant	Proposed Structures	Footprint	Foundation Recommendations
District 111 Water Plant #2	Concrete Pad Supporting Pump	8’ x 16’	Slab-on-grade with grade beams on at least 2 feet of select fill. Use an allowable soil bearing capacity of 1,500 psf for slab-on-grade design.
West Houston Water Plant #3	Generator Pad	32’ x 5’	Slab-on-grade with grade beams on at least 2 feet of select fill. Use an allowable soil bearing capacity of 1,500 psf for slab-on-grade design.
	Fuel Tank Pad	8’ x 12.5’	
	Transformer Pad	11’ x 9’	
	Precast LAS Chemical Feed Building	8’ x 8’	
	LAS Chemical Containment Area	12’ x 9’	

Water Plant	Proposed Structures	Footprint	Foundation Recommendations
Park Ten Central Water Plant	Precast Building	20’ x 40’	Slab-on-grade with grade beams on at least one foot of compacted select fill. Use an allowable soil bearing capacity of 1,500 psf for slab-on-grade design. Clean onsite sandy lean clays exposed after the surface clearing and grubbing, field verified to meet select fill criteria, are acceptable as select fill and shall be scarified and compacted to meet density requirements.
	Transformer Pad	11’ x 9’	
Sharpstown Water Plant #1	Precast Building (elevated about 2 to 3 feet above existing grade by fill)	27’ by 72’	Fill used to elevate the structures shall consist of compacted select fill. Fill to be retained by retaining walls shall be designed for a lateral earth pressure equivalent to 100 pcf fluid pressure; footings of retaining walls shall be founded at least 24 inches below existing grade and designed for a net allowable bearing pressure of 1,500 psf. The structures constructed within the 2 to 3 feet of fill placed above the existing grade shall be supported on slab-on-grade with grade beams extends at least 18 inches below the existing grade in fill retained by retaining walls (and to at least 18 inches below the existing grade in fill not retained by retaining walls). Use a net allowable soil bearing capacity of 1,500 psf for slab-on-grade design. Fill placed outside the perimeter grade beams and retaining walls building shall be sloped at 3H:1V or flatter to meet the existing grade.
	Transformer Pad (elevated about 2 to 3 feet above existing grade by fill)	11’ x 9’	

5.2.2 Subgrade Preparation

The surface soils at the four sites range from sandy lean clays of medium to high plasticity to

clays of high to very high plasticity. The high plasticity clays are susceptible to undergo significant shrink and swell movements with changes in moisture content. Based on Test Method TEX-124-E by the Texas State Department of Highways and Public Transportation, Materials and Tests Division, the potential vertical rise (PVR) of the surface soils at the four sites range from less than 0.5 to about 3.2 inches.

The following system of construction procedures is recommended:

1. Establish positive site drainage. Install surface and/or storm drainage structures if required.
2. Existing above- and below grade structures such as floor slabs, foundations, septic tanks or utilities located in the proposed construction area, that are designated to be removed (if any), should be removed and holes resulted from such removal should be backfilled with compacted select fill material.
3. Strip and remove all surface organics, topsoil and unsuitable materials from proposed construction and paving areas. Excavate the subgrade to design grade, and proof-roll the subgrade to detect any wet, soft, or pumping areas. Treat these areas with drying or stabilizing agents as necessary or remove and replace them with clean and compacted select fill or approved onsite soils matching the subgrade soils' properties.
4. 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).
5. Additional fill material within the structure area should be a sandy lean clay (CL) having a plasticity index (P.I.) of ten (10) to twenty (20) and a liquid limit of 28 or more. Fill materials should be placed in six (6) to eight (8) inch loose lifts and compacted at plus or minus 2 percent of optimum moisture content to ninety-five (95) percent of their maximum dry density as determined by the Standard Proctor Compaction Test. On-site soils meeting select fill requirements may be used; on-site high plasticity clay soils may be stabilized with an adequate amount of lime and used as select fill (optimum lime stabilization shall be determined by conducting lime vs PI and/or pH series tests).

Presented below are design data for the foundation options to allow you or your designers to select the most suitable system for the proposed building.

5.2.3 Slab-on-Grade on Select Fill

A feasible shallow foundation system to support buildings at these sites is an engineered post-tensioned foundation or conventional ribbed and reinforced slab-on-grade, typically with perimeter and interior thickened sections (grade beams) to enhance structural stiffness and provide foundation soil confinement, 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. The following are PTI design parameters assuming the minimum thickness of compacted select fill recommended in the preceding Table 6 is placed under the slab-on-grade:

TABLE 7

Boring No.		**B-1**	**B-2 through B-4**	**B-5**	**B-6 and B-7**
Weighted LL		36	56	34	46
Weighted PL		16	19	16	17
Weighted PI		20	37	18	29
Thornwaite Moisture Index (I_m)		18	18	18	18
Constant Suction Value (P_F)		3.45	3.45	3.45	3.45
Edge Moisture Variation (e_m)	Center, ft.	9	7.8	9	8.8
	Edge, ft.	4.7	4.4	4.6	4.4
Estimated Differential Swell (y_m)	Center, in.	0.44	0.94	0.50	0.64
	Edge, in.	0.20	0.47	0.23	0.30

5.2.4 Foundation Settlement

Although detailed settlement analysis for the proposed building is not within the scope of this study, it is our opinion that foundations designed based on the recommendations given here will experience settlement that should be within the tolerable limit of the structure.

5.3 Concrete Paving

We understand that additional parking and driveways may be added to serve the proposed improvements areas. 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 a subgrade prepared as recommended in the Section 5.2.2. The pavement should be supported on a subbase consisting of 8 inches of clean clay soils stabilized with the following preliminary recommended lime dosage:

TABLE 8

Location	Preliminary Recommended Lime Dosage (% on Weight Basis)
At B-1 through B-4, B-6 and B-7	6
At B-5	5 (COH recommended minimum)

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.

Parking Area	*Driveways*	*Truck Lane*
6"	8"	9”
8” Stabilized Subgrade	8” Stabilized Subgrade	8” Stabilized Subgrade

5.3.1 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.

5.3.2 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 pavement 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.

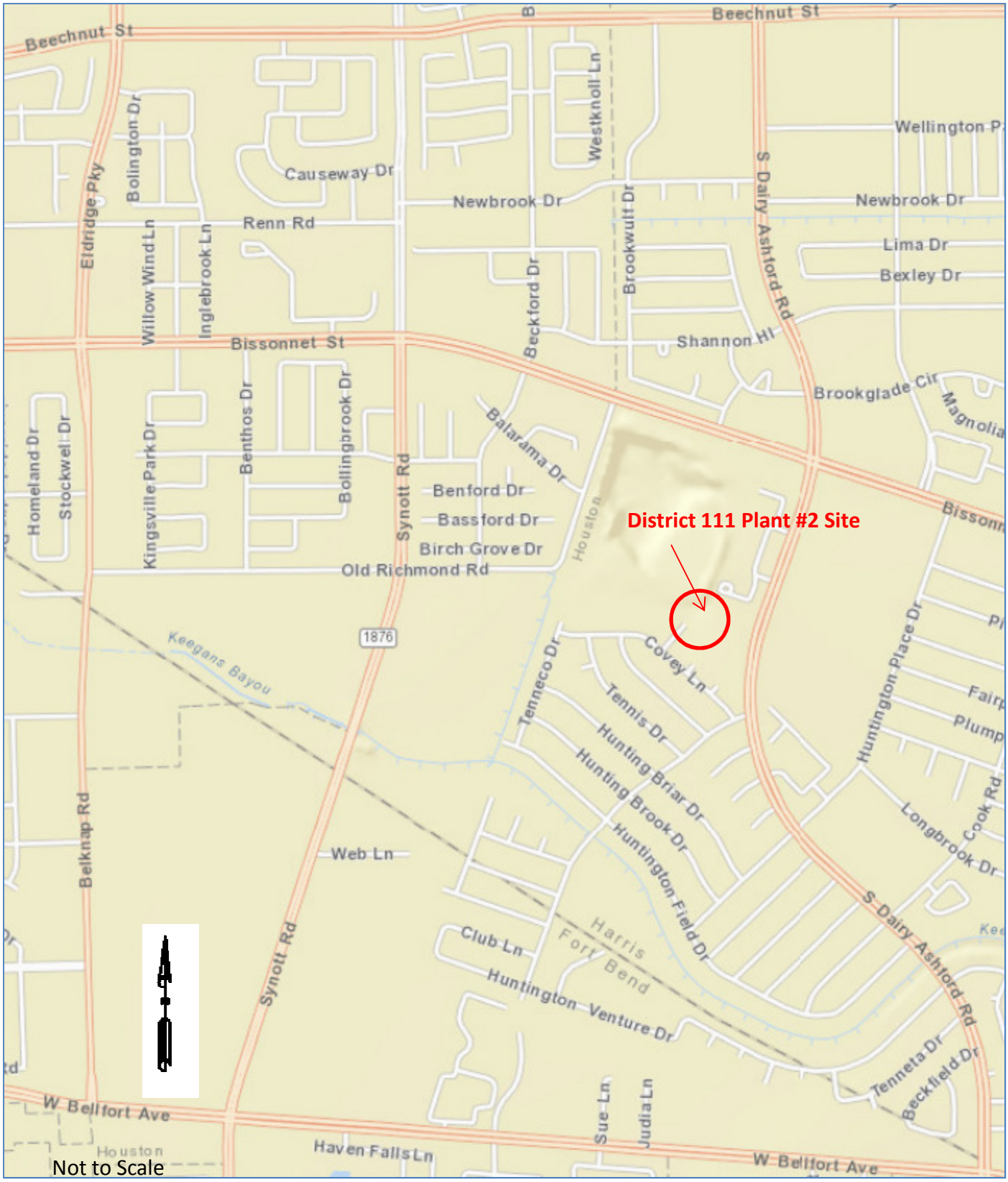
7.0 LIMITATIONS

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



Drawing Source: City of Houston GIMS

SITE VICINITY MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B CITY OF HOUSTON, TEXAS	WBS NO. S-001000-0046-4
	PROJECT NO. : G14-197 / FIGURE 1a

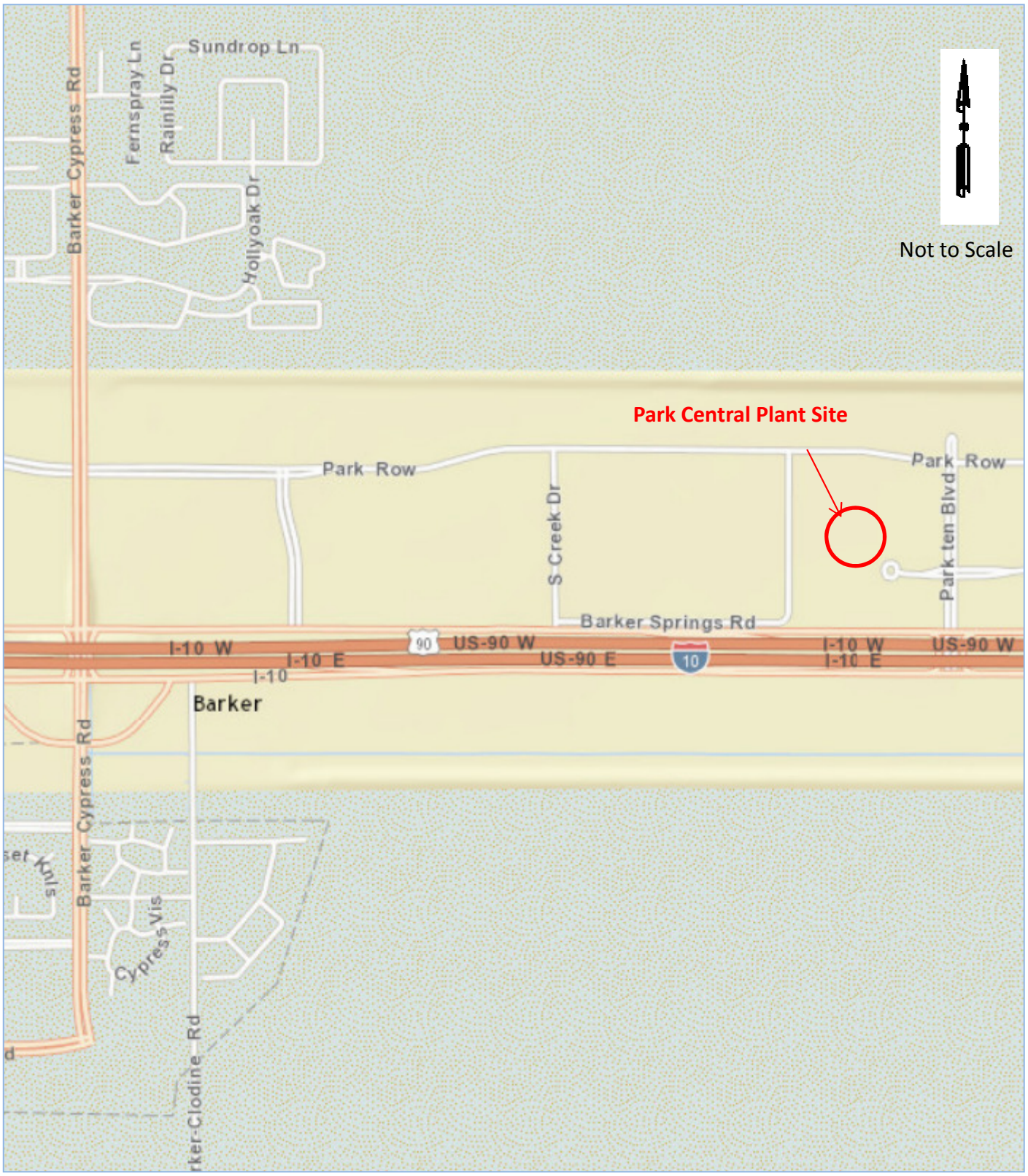
PST 8/28/12

Not to Scale

Drawing Source: City of Houston GIMS

SITE VICINITY MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B CITY OF HOUSTON, TEXAS	WBS NO. S-001000-0046-4
	PROJECT NO. : G14-197 / FIGURE 1b

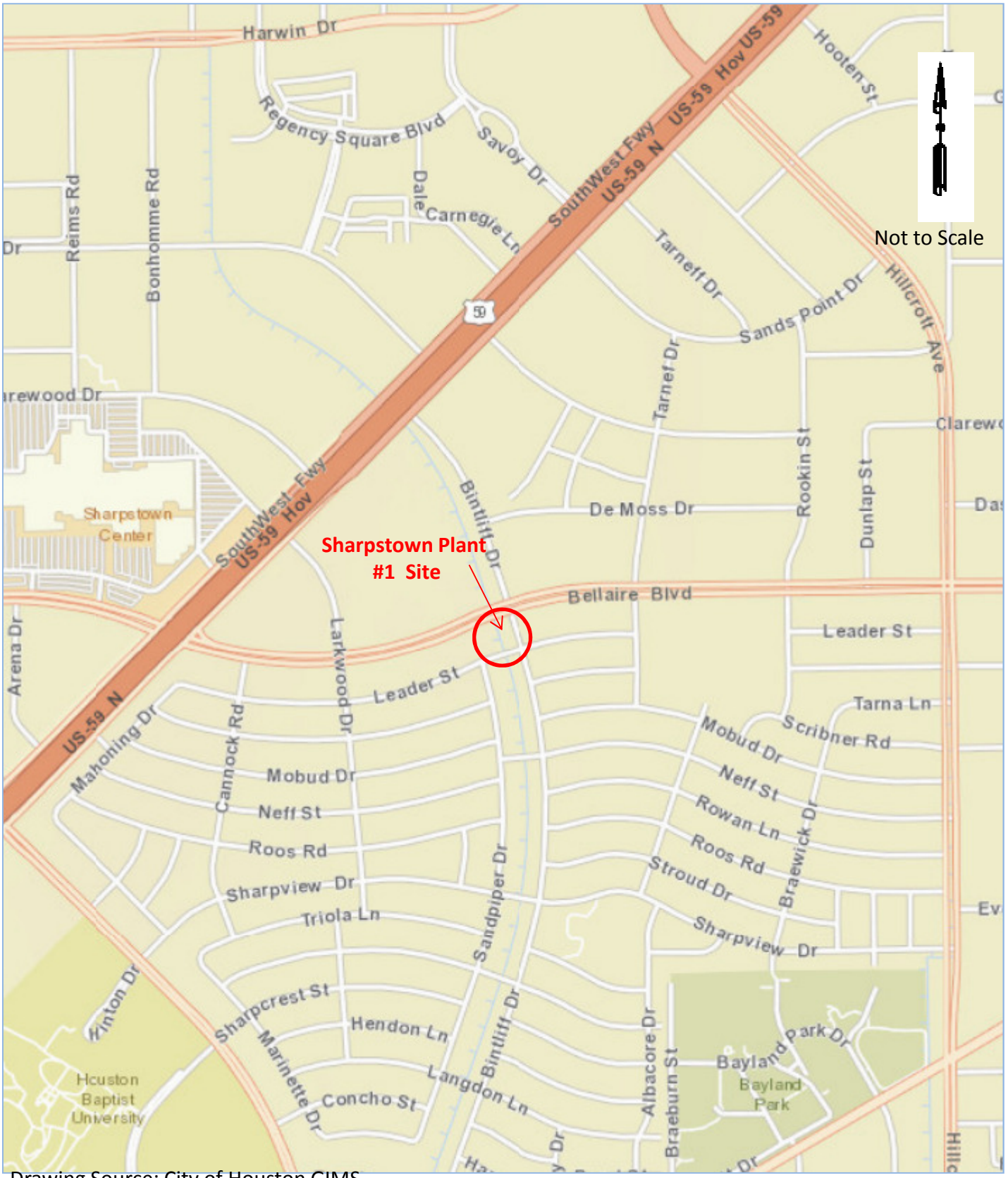
PST 8/28/12



Drawing Source: City of Houston GIMS

SITE VICINITY MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B CITY OF HOUSTON, TEXAS	WBS NO. S-001000-0046-4
	PROJECT NO. : G14-197 / FIGURE 1c

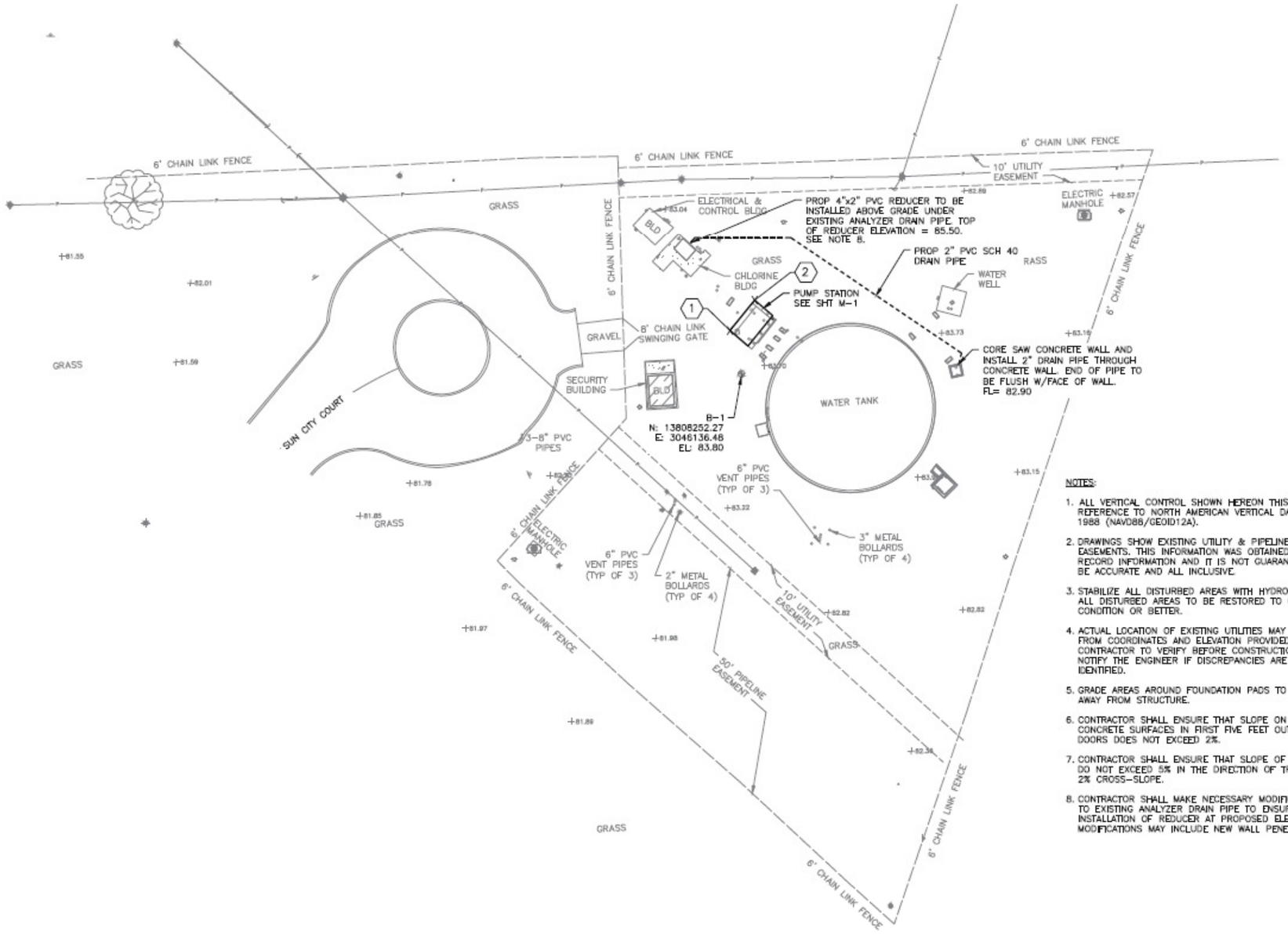
PST 8/28/12



Drawing Source: City of Houston GIMS

SITE VICINITY MAP	ASSOCIATED TESTING LABAORATORIES, INC. 3143 YELLOWSTONE BLVD., HOUSTON, TEXAS TEL: (713) 748-3717 Fax: (713) 748-3748
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B CITY OF HOUSTON, TEXAS	WBS NO. S-001000-0046-4
	PROJECT NO. : G14-197 / FIGURE 1d

PST 8/28/12



SCALE 1"=40'

HORIZONTAL CONTROL POINTS				
PT #	EASTING	NORTHING	ELEV.	DESC.
1	3,046,132.69	13,808,266.91	84.74	TP
2	3,046,140.98	13,808,277.14	84.24	TP

FLOODPLAIN NOTES:

ACCORDING TO MAP 48201C0840L OF THE FEDERAL EMERGENCY MANAGEMENT AGENCY'S FLOOD INSURANCE RATE MAPS FOR HARRIS COUNTY, TEXAS DATED JUNE 18, 2007, THE SUBJECT PROJECT AREA IS SITUATED WITHIN ZONE AE DESCRIBED AS SPECIAL FLOOD HAZARD AREAS SUBJECT TO THE 1% ANNUAL CHANCE FLOOD EVENT.

1% ANNUAL CHANCE FLOOD ELEVATION: 82.50 FEET

0.2% ANNUAL CHANCE FLOOD ELEVATION: 84.24 FEET

GEOTECHNICAL INFORMATION:

REFER TO GEOTECHNICAL REPORT ENTITLED: GEOTECHNICAL INVESTIGATION PROPOSED WATER PLANT IMPROVEMENTS PACKAGE B BY ASSOCIATED TESTING LABORATORIES, INC.

REPORT NUMBER: 614-197, DATED: SEPT 10, 2014

NOTES:

1. ALL VERTICAL CONTROL SHOWN HEREON THIS MAP IS REFERENCE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88/GEOID12A).
2. DRAWINGS SHOW EXISTING UTILITY & PIPELINE EASEMENTS. THIS INFORMATION WAS OBTAINED FROM RECORD INFORMATION AND IT IS NOT GUARANTEED TO BE ACCURATE AND ALL INCLUSIVE.
3. STABILIZE ALL DISTURBED AREAS WITH HYDROMULCH. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER.
4. ACTUAL LOCATION OF EXISTING UTILITIES MAY VARY FROM COORDINATES AND ELEVATION PROVIDED. CONTRACTOR TO VERIFY BEFORE CONSTRUCTION AND NOTIFY THE ENGINEER IF DISCREPANCIES ARE IDENTIFIED.
5. GRADE AREAS AROUND FOUNDATION PADS TO DRAIN AWAY FROM STRUCTURE.
6. CONTRACTOR SHALL ENSURE THAT SLOPE ON FINISHED CONCRETE SURFACES IN FIRST FIVE FEET OUTSIDE DOORS DOES NOT EXCEED 2%.
7. CONTRACTOR SHALL ENSURE THAT SLOPE OF SIDEWALKS DO NOT EXCEED 5% IN THE DIRECTION OF TRAVEL AND 2% CROSS-SLOPE.
8. CONTRACTOR SHALL MAKE NECESSARY MODIFICATIONS TO EXISTING ANALYZER DRAIN PIPE TO ENSURE INSTALLATION OF REDUCER AT PROPOSED ELEVATION. MODIFICATIONS MAY INCLUDE NEW WALL PENETRATION.

KIT Professionals, Inc.
Engineers ● Planners ● Construction Managers
2000 W. Sam Houston Pkwy S., Suite 1400
Houston, Texas 77042
Phone: (713) 783-8700 Fax: (713) 783-8747
TBPE Firm Registration No. F-4991

klotz associates
1160 Dairy Ashford, Suite 500
Houston, Texas 77079
T 281.589.7257 F 281.589.7309
houston.office@klotz.com
Texas PE Firm Reg. # F-929

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF REVIEW UNDER THE AUTHORITY OF PIERO BATTISTINI, P.E. LICENSE NO. 104895 JANUARY 26, 2015 IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.
KIT PROFESSIONALS, INC. TBPE FIRM REG. NO. F-4991

SURVEYED BY: TSC FB No. –

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

REHABILITATION OF PUMPS, MOTORS, VALVES, PIPING & BUILDINGS AT VARIOUS FACILITIES
PACKAGE B
111#2 WATER PLANT
10301 SUN CITY COURT, HOUSTON, TEXAS
PROPOSED SITE PLAN

CIVIL

LOCATION OF BORINGS

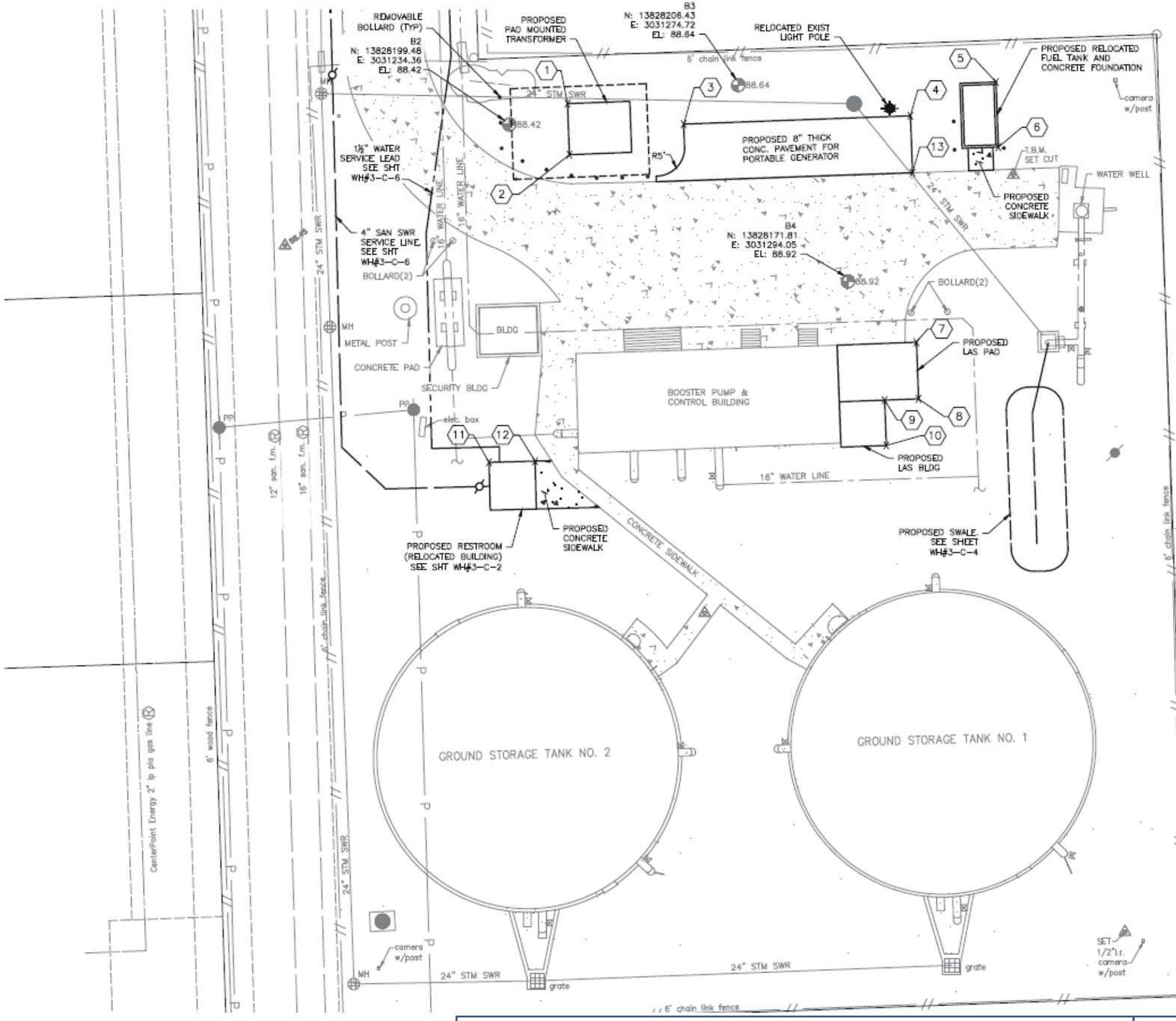
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B
CITY OF HOUSTON, TEXAS

ASSOCIATED TESTING LABAORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS
TEL: (713) 748-3717 Fax: (713) 748-3748

WBS NO. S-001000-0046-4

PROJECT NO. : G14-197

FIGURE 2a



REV	DESCRIPTION	BY	DATE

SCALE 1"=40'

NOTES:

1. DRAWINGS SHOW EXISTING UTILITY & PIPELINE EASEMENTS. THIS INFORMATION WAS OBTAINED FROM RECORD INFORMATION AND IT IS NOT GUARANTEED TO BE ACCURATE AND ALL INCLUSIVE.
2. STABILIZED ALL DISTURBED AREAS WITH HYDROMULCH. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER.
3. ACTUAL LOCATION OF EXISTING UTILITIES MAY VARY FROM COORDINATES AND ELEVATION PROVIDED. CONTRACTOR TO VERIFY BEFORE CONSTRUCTION AND NOTIFY THE ENGINEER IF DISCREPANCIES ARE IDENTIFIED.
4. GRADE AREAS AROUND FOUNDATION PADS TO DRAIN AWAY FROM STRUCTURE.
5. CONTRACTOR SHALL ENSURE THAT SLOPE ON FINISHED CONCRETE SURFACES IN FIRST FIVE FEET OUTSIDE DOORS DOES NOT EXCEED 2%.
6. CONTRACTOR SHALL ENSURE THAT SLOPE OF SIDEWALKS DO NOT EXCEED 5% IN THE DIRECTION OF TRAVEL AND 2% CROSS-SLOPE.
7. ADJUST EXISTING MANHOLE FRAME, RIM AND COVER TO FIT NEW GRADE.
8. RELOCATION OF EXIST FUEL TANK INCLUDES REMOVAL AND INSTALLATION OF EXISTING STAIRS AND PIPING AT NEW LOCATION.

HORIZONTAL CONTROL POINTS

PT #	EASTING	NORTHING	ELEV.	DESC.
1	3,031,244.61	13,828,203.16	88.90	TP
2	3,031,244.95	13,828,194.17	88.90	TP
3	3,031,265.10	13,828,199.56	88.90	TP
4	3,031,305.07	13,828,201.02	88.90	TP
5	3,031,320.17	13,828,206.97	88.90	TP
6	3,031,320.57	13,828,195.50	88.90	TP
7	3,031,306.14	13,828,161.10	89.50	TP
8	3,031,306.51	13,828,151.11	89.50	TP
9	3,031,300.52	13,828,150.88	89.50	TP
10	3,031,300.83	13,828,142.89	89.50	TP
11	3,031,230.78	13,828,139.91	89.50	TP
12	3,031,238.90	13,828,140.11	89.50	TP
13	3,031,305.44	13,828,190.99	88.90	TP

PROJECT BENCHMARK:

CITY OF HOUSTON MONUMENT ——/—— A BRASS DISC, LOCATED ON THE MEDIAN OF S. RICHMOND AVE. APPROXIMATELY 312' EAST OF THE CENTERLINE OF OAK PARK BLVD.
N: 13828538.69
E: 3031179.80
ELEV.=88.48 FEET (NAVD88, CORS96)

TEMPORARY BENCHMARK:

SET CUT X ON THE CONCRETE DRIVEWAY LOCATED AT NE CORNER OF THE SUBJECT SITE.
N: 13828190.57
E: 3031323.20
ELEV.=88.61 FEET

KIT Professionals, Inc.
Engineers ● Planners ● Construction Managers
2000 W. Sam Houston Pkwy S., Suite 1400
Houston, Texas 77042
Phone: (713) 783-8700; Fax: (713) 783-8747
TBPE Firm Registration No. F-4991
Challenging Challenges...

klotz associates
1160 Dairy Ashford, Suite 500
Houston, Texas 77079
T 281.589.7257 F 281.589.7309
houston.office@klotz.com
Texas PE Firm Reg. # F-929

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF REVIEW UNDER THE AUTHORITY OF PIERO BATTISTINI, P.E. LICENSE NO. 104895 JANUARY 26, 2015 IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.
KIT PROFESSIONALS, INC. TBPE FIRM REG. NO. F-4991

SURVEYED BY: TSC FB No. –

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

REHABILITATION OF PUMPS, MOTORS, VALVES, PIPING & BUILDINGS AT VARIOUS FACILITIES
PACKAGE B
WEST HOUSTON #3 WATER PLANT
14925 SOUTH RICHMOND AVENUE, HOUSTON, TEXAS
PROPOSED SITE PLAN

CIVIL

LOCATION OF BORINGS

PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B
CITY OF HOUSTON, TEXAS

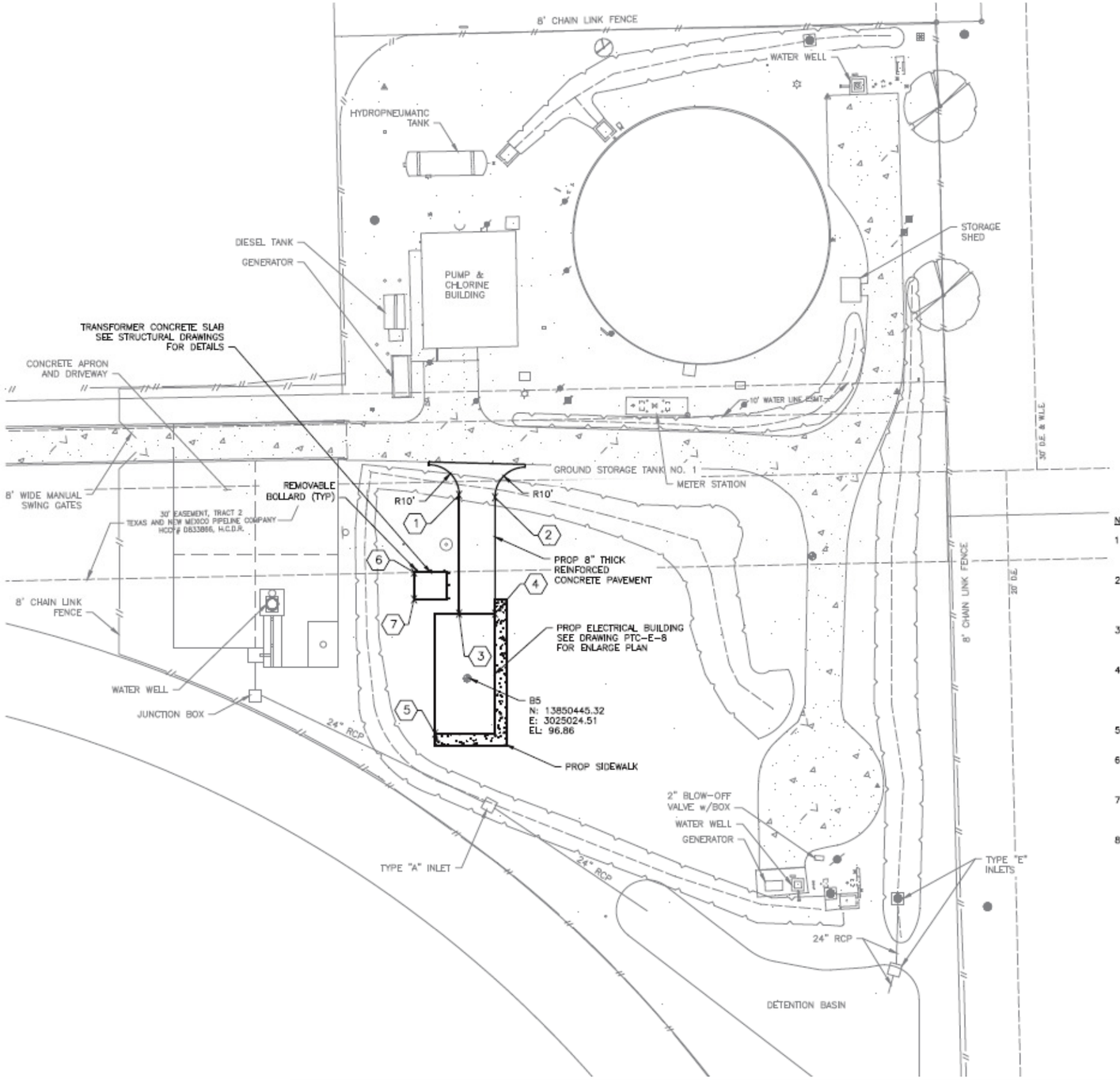
ASSOCIATED TESTING LABAORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS
TEL: (713) 748-3717 Fax: (713) 748-3748

WBS NO. S-001000-0046-4

PROJECT NO. : G14-197

FIGURE 2b

REV	DESCRIPTION	BY	DATE



HORIZONTAL CONTROL POINTS				
PT #	EASTING	NORTHING	ELEV.	DESC.
1	3,025,021.79	13,850,506.56	96.25	TP
2	3,025,033.76	13,850,505.75	96.25	TP
3	3,025,021.78	13,850,466.93	97.40	TP
4	3,025,033.78	13,850,466.93	97.40	TP
5	3,025,013.78	13,850,426.93	97.40	TP
6	3,025,006.78	13,850,480.69	97.40	TP
7	3,025,006.78	13,850,471.69	97.40	TP

SCALE 1"=40'

PROJECT BENCHMARK:

CITY OF HOUSTON MONUMENT 4658/8514, A BRASS DISC, LOCATED ON THE SOUTH SIDE OF PARK ROW, APPROXIMATELY 270' EAST OF THE INTERSECTION OF LANGHAM CREEK DR.
N: 13851039.37
E: 3024969.96
ELEV.=97.55 FEET (NAVD88, CORS96)

TEMPORARY BENCHMARK:

SET CUT X ON THE CONCRETE DRIVEWAY LOCATED NEAR THE NORTHEAST CORNER OF DRIVEWAY T INTERSECTION WITHIN THE SUBJECT SITE.
N: 13850639.0833
E: 3025144.5077
ELEV.=96.81'

NOTES:

1. ALL VERTICAL CONTROL SHOWN HEREON THIS MAP IS REFERENCE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88/GEOID12A).
2. DRAWINGS SHOW EXISTING UTILITY & PIPELINE EASEMENTS. THIS INFORMATION WAS OBTAINED FROM RECORD INFORMATION AND IT IS NOT GUARANTEED TO BE ACCURATE AND ALL INCLUSIVE.
3. STABILIZED ALL DISTURBED AREAS WITH HYDROMULCH. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER.
4. ACTUAL LOCATION OF EXISTING UTILITIES MAY VARY FROM COORDINATES AND ELEVATION PROVIDED. CONTRACTOR TO VERIFY BEFORE CONSTRUCTION AND NOTIFY THE ENGINEER IF DISCREPANCIES ARE IDENTIFIED.
5. GRADE AREAS AROUND FOUNDATION PADS TO DRAIN AWAY FROM STRUCTURE.
6. CONTRACTOR SHALL ENSURE THAT SLOPE ON FINISHED CONCRETE SURFACES IN FIRST FIVE FEET OUTSIDE DOORS DOES NOT EXCEED 2%.
7. CONTRACTOR SHALL ENSURE THAT SLOPE OF SIDEWALKS DO NOT EXCEED 5% IN THE DIRECTION OF TRAVEL AND 2% CROSS-SLOPE.
8. ADJUST EXISTING MANHOLE FRAME, RIM AND COVER TO FIT NEW GRADE.

KIT Professionals, Inc.
Engineers ● Planners ● Construction Managers
2000 W. Sam Houston Pkwy S., Suite 1450
Houston, Texas 77042
Phone: (713) 783-8700 Fax: (713) 783-8747
TBPE Firm Registration No. F-4991
Challenging Challenges.

klotz associates
1160 Dairy Ashford, Suite 500
Houston, Texas 77079
T 281.589.7257 F 281.589.7309
houston.office@klotz.com
Texas PE Firm Reg. # F-929

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF REVIEW UNDER THE AUTHORITY OF PIERO BATTISTINI, P.E. LICENSE NO. 104895 JANUARY 26, 2015 IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES.
KIT PROFESSIONALS, INC. TBPE FIRM REG. NO. F-4991

SURVEYED BY: TSC FB No. –

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

REHABILITATION OF PUMPS, MOTORS, VALVES, PIPING & BUILDINGS AT VARIOUS FACILITIES
PACKAGE B
PARK 10 CENTRAL WATER PLANT
1300 LANGHAM CREEK, HOUSTON, TEXAS
PROPOSED SITE PLAN

CIVIL

LOCATION OF BORINGS

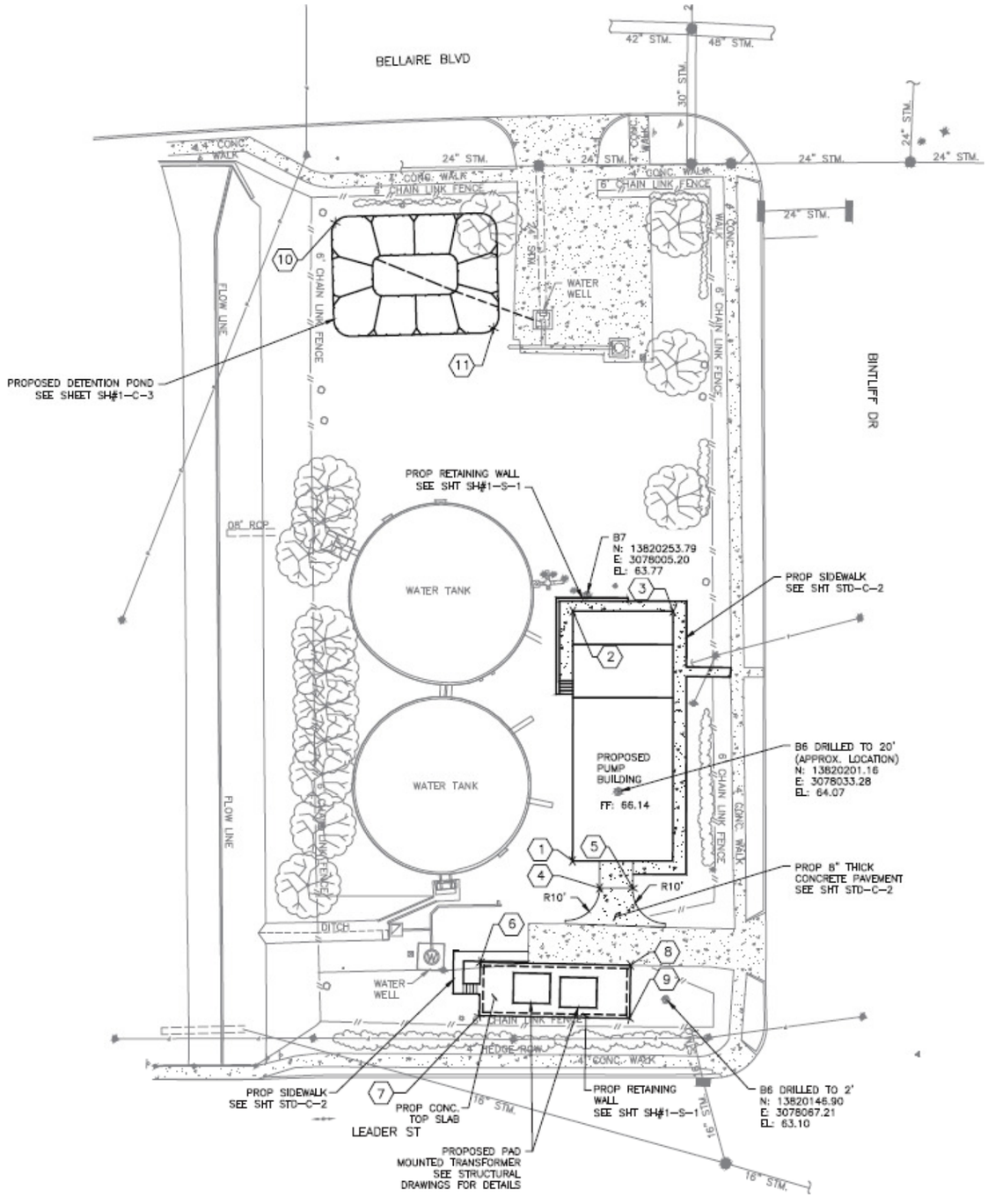
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B
CITY OF HOUSTON, TEXAS

ASSOCIATED TESTING LABAORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS
TEL: (713) 748-3717 Fax: (713) 748-3748

WBS NO. S-001000-0046-4

PROJECT NO. : G14-197

FIGURE 2c



HORIZONTAL CONTROL POINTS				
PT #	EASTING	NORTHING	ELEV.	DESC.
1	3,078,027.24	13,820,177.04	66.14	TP
2	3,078,002.73	13,820,247.92	66.14	TP
3	3,078,031.09	13,820,257.73	66.14	TP
4	3,078,037.54	13,820,171.99	66.04	TP
5	3,078,046.98	13,820,175.23	66.04	TP
6	3,078,011.12	13,820,139.28	65.64	TP
7	3,078,016.07	13,820,124.06	65.64	TP
8	3,078,053.91	13,820,153.19	65.64	TP
9	3,078,058.86	13,820,137.98	65.64	TP
10	3,077,897.29	13,820,334.72	63.10	TB
11	3,077,952.48	13,820,320.27	63.28	TB

LEGEND:

FF: XX.XX FINISH FLOOR ELEVATION
MEP: XX.XX MATCH EXISTING PAVEMENT ELEVATION

NOTES:

1. ALL VERTICAL CONTROL SHOWN HEREON THIS MAP IS REFERENCE TO NORTH AMERICAN VERTICAL DATUM OF 1988 (NAVD88/GEOID12A).
2. DRAWINGS SHOW EXISTING UTILITY & PIPELINE EASEMENTS. THIS INFORMATION WAS OBTAINED FROM RECORD INFORMATION AND IT IS NOT GUARANTEED TO BE ACCURATE AND ALL INCLUSIVE.
3. STABILIZED ALL DISTURBED AREAS WITH HYDROMULCH. ALL DISTURBED AREAS TO BE RESTORED TO ORIGINAL CONDITION OR BETTER.
4. ACTUAL LOCATION OF EXISTING UTILITIES MAY VARY FROM COORDINATES AND ELEVATION PROVIDED. CONTRACTOR TO VERIFY BEFORE CONSTRUCTION AND NOTIFY THE ENGINEER IF DISCREPANCIES ARE IDENTIFIED.
5. GRADE AREAS AROUND FOUNDATION PADS TO DRAIN AWAY FROM STRUCTURE.
6. CONTRACTOR SHALL ENSURE THAT SLOPE ON FINISHED CONCRETE SURFACES IN FIRST FIVE FEET OUTSIDE DOORS DOES NOT EXCEED 2%.
7. CONTRACTOR SHALL ENSURE THAT SLOPE OF SIDEWALKS DO NOT EXCEED 5% IN THE DIRECTION OF TRAVEL AND 2% CROSS-SLOPE.
8. ADJUST EXISTING MANHOLE FRAME, RIM AND COVER TO FIT NEW GRADE.

SCALE 1”=40’

KIT Professionals, Inc.
Engineers ● Planners ● Construction Managers
2000 W. Sam Houston Pkwy S., Suite 1400
Houston, Texas 77042
Phone: (713) 783-8700; Fax: (713) 783-8747
TBPE Firm Registration No. F-4991

klotz associates
1160 Dairy Ashford, Suite 500
Houston, Texas 77079
T 281.589.7257 F 281.589.7309
houston.office@klotz.com
Texas PE Firm Reg. # F-929

THIS DOCUMENT IS RELEASED FOR THE PURPOSE OF REVIEW UNDER THE AUTHORITY OF PERRI BATTISTINI, P.E. LICENSE NO. 104895 JANUARY 26, 2015 IT IS NOT TO BE USED FOR CONSTRUCTION, BIDDING OR PERMIT PURPOSES. KIT PROFESSIONALS, INC. TBPE FIRM REG. NO. F-4991

SURVEYED BY: TSC FB No. –

CITY OF HOUSTON
DEPARTMENT OF PUBLIC WORKS AND ENGINEERING

REHABILITATION OF PUMPS, MOTORS, VALVES, PIPING & BUILDINGS AT VARIOUS FACILITIES
PACKAGE B
SHARPSTOWN #1 WATER PLANT
6910 BINTLIFF DRIVE, HOUSTON, TEXAS
PROPOSED SITE PLAN

CIVIL

LOCATION OF BORINGS

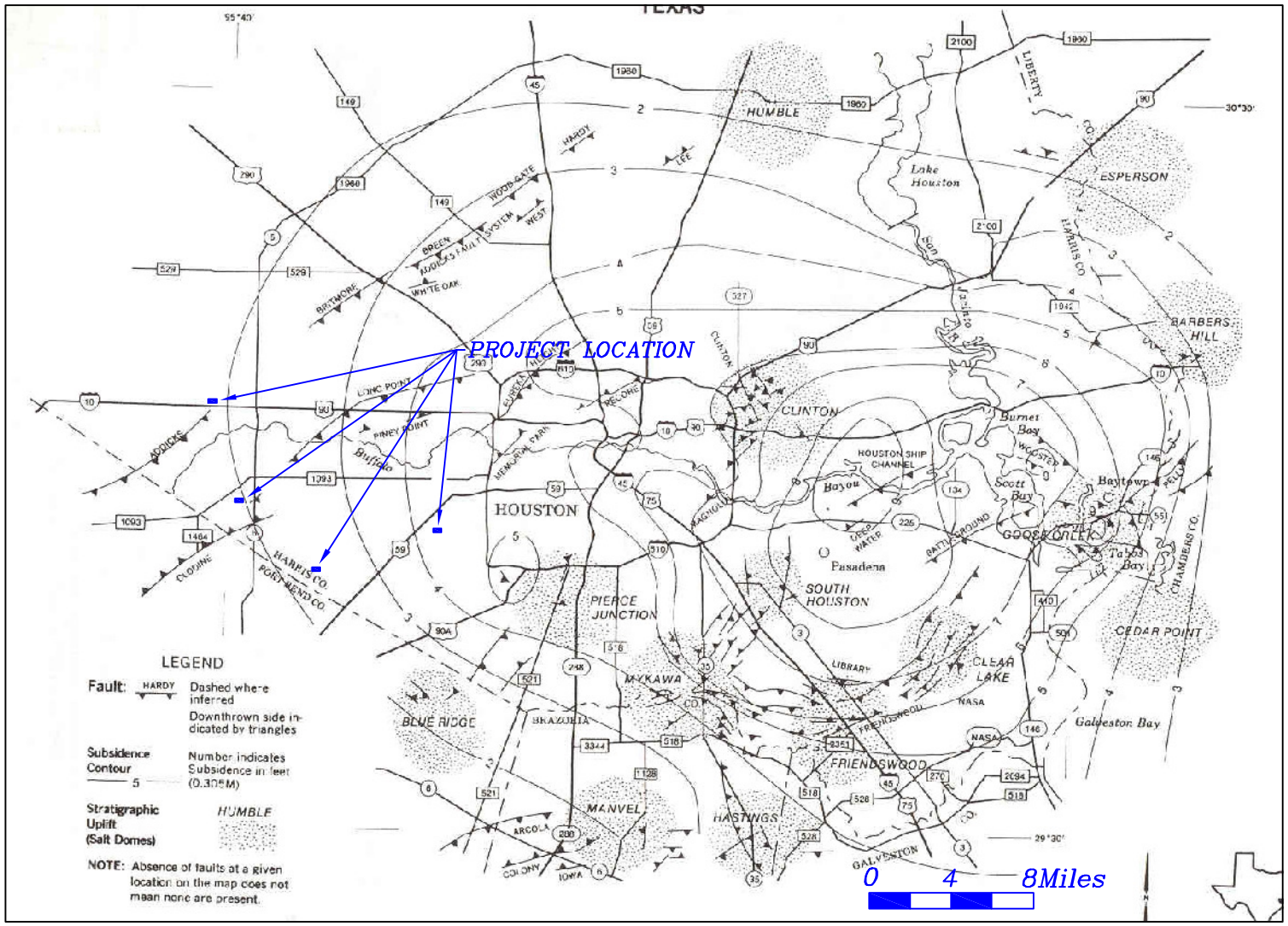
PROPOSED WATER PLANT IMPROVEMENTS-PACKAGE B
CITY OF HOUSTON, TEXAS

ASSOCIATED TESTING LABAORATORIES, INC.
3143 YELLOWSTONE BLVD., HOUSTON, TEXAS
TEL: (713) 748-3717 Fax: (713) 748-3748

WBS NO. S-001000-0046-4

PROJECT NO. : G14-197

FIGURE 2d



PRINCIPAL ACTIVE FAULTS IN HOUSTON AREA

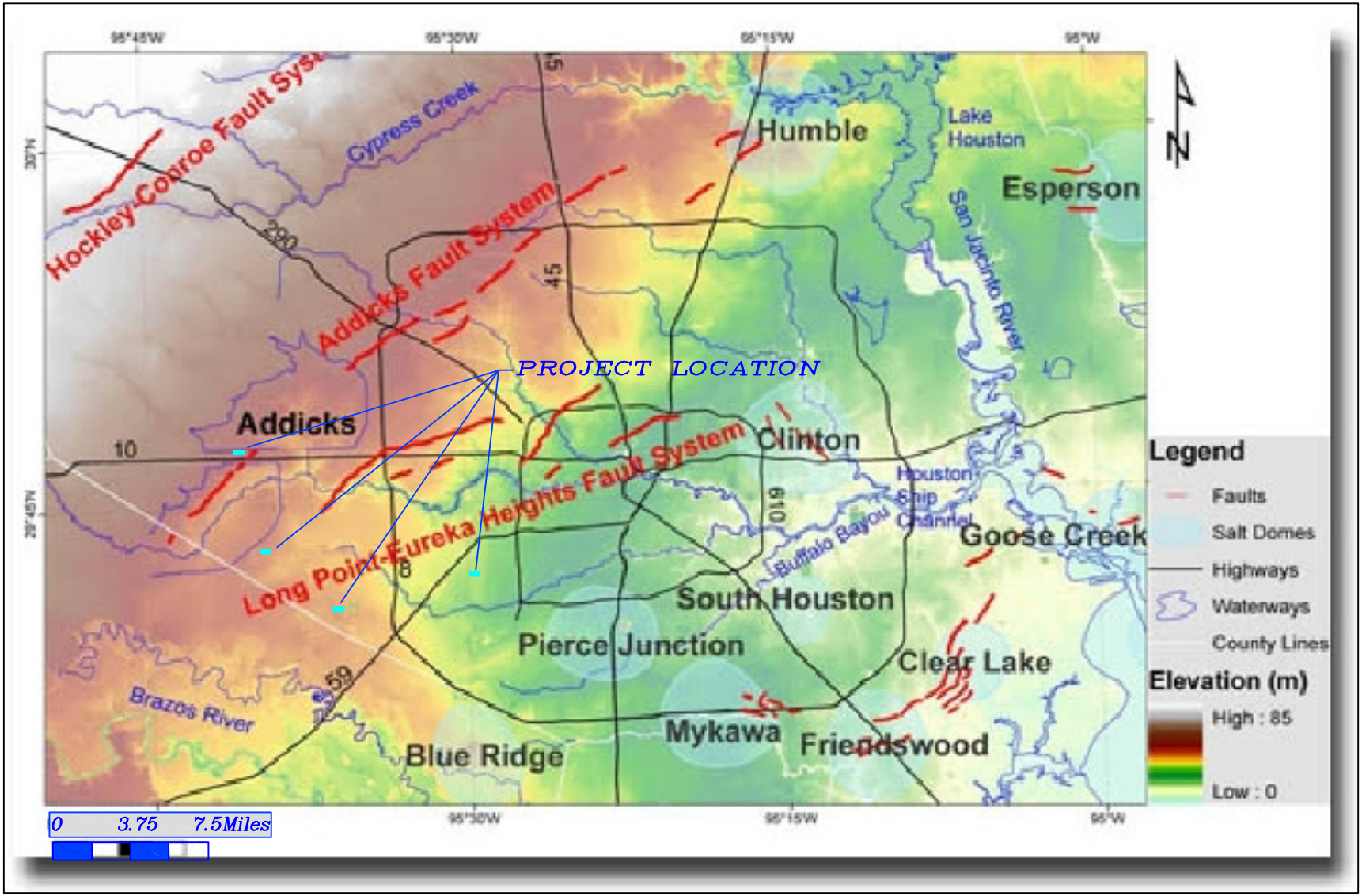
PROPOSED GROUNDWATER PLANTS
IMPRROVEMENTS – PACKAGE B
CITY OF HOUSTON, TEXAS

Associated Testing Laboratories, Inc.
3143 Yellowstone Blvd. Houston, Texas
Tel: (713) 748-3717 Fax: (713) 748-3748

WBS NO.: S-001000-0046-4

PROJECT NO. G14-197

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 GROUNDWATER PLANTS IMPRROVEMENTS – PACKAGE B CITY OF HOUSTON, TEXAS	*WBS NO.: S-001000-0046-4*
	PROJECT NO. G14-197 — *FIGURE. 3b*

APPENDIX 1

BORING LOGS AND KEY TO LOG TERMS AND SYMBOLS

LOG OF BORING B-1

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13808252.27; E 3046136.48
10301 Sun City Court

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 83.80 FT

DATE: 8/22/2014

SAMPLER: Shelby Tube/Split Spoon
DRY AUGER: 0 TO 20 FT
WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0	Fat Clay (CH), very stiff, very high plasticity, light gray and tan		95		28	73	22	51
		Sandy Lean Clay (CL), very stiff, high plasticity, light gray and tan			117	14			
80	5	..hard with ferrous nodules below 4'				14			
		..with calcareous nodules below 6'				15	38	17	21
75		..stiff below 8'			115	13			
	10	..very stiff below 10'			114	13	36	17	19
		Silty Sand (SM), non plastic, light gray and tan				7			
70	15	..medium dense below 14'	15			20			
▽			11	15		25			
65		..loose below 18'	5			22			
	20								

UNDRAINED SHEAR STRENGTH, TSF
○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE
0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING:
▽ *FREE WATER 1ST ENCOUNTERED AT 17.5 FT. DURING DRILLING; AFTER 15.0 MIN. AT 17.0 FT.*
▼ *WATER DEPTH AT N/A FT., HOLE OPEN TO 20.0 FT. ON 8/22/2014*

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

LOG OF BORING B-2

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13828199.48; E 3031234.36
14925 South Richmond Avenue

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 88.42 FT

DATE: 8/22/2014

SAMPLER: Shelby Tube/Split Spoon
DRY AUGER: 0 TO 20 FT
WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0	*Fat Clay (CH), stiff, high plasticity, dark gray*		86		23	52	19	33
85					104	21			
	5	*..light gray and tan with calcareous nodules below 4'*				18			
					107	21			
80		*..with ferrous nodules below 8'*							
	10			92	102	26	57	20	37
		..reddish brown below 10'							
						24			
		Lean Clay (CL), firm, high plasticity, reddish brown							
75						22			
	15	*..stiff below 14'*			103	22			
		..with calcareous nodules below 16'				27			
70		*..firm below 18'*							
	20			97		27	38	17	21

UNDRAINED SHEAR STRENGTH, TSF
○ *HAND PENETROMETER*
● *UNCONFINED COMPRESSION*
■ *UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION*
△ *TORVANE*
0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING:
▽ *FREE WATER 1ST ENCOUNTERED AT 15.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 12.8 FT.*
▼ *WATER DEPTH AT 12.5 FT., HOLE OPEN TO 20.0 FT. ON 8/22/2014*

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

LOG OF BORING B-3

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13828206.43; E 3031274.72
14925 South Richmond Avenue

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 88.64 FT

DATE: 8/26/2014

SAMPLER: Shelby Tube/Split Spoon
DRY AUGER: 0 TO 20 FT
WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0	*Fat Clay (CH), hard, very high plasticity, dark gray*				17			
		..very stiff below 2'		94		23	69	22	47
85	5	*..light gray and tan below 4'*			116	14			
		..with ferrous nodules below 6'				21			
80	10	*..reddish brown with calcareous nodules below 8'*				25			
		Fat Clay with Sand (CH), stiff, high plasticity, reddish brown		84	107	20	59	20	39
		Lean Clay (CL), soft, medium plasticity, reddish brown				22			
75	15	*..firm below 14'*			107	22			
		..soft below 16'		94	102	24	30	16	14
70		*..firm below 18'*				24			
	20								

UNDRAINED SHEAR STRENGTH, TSF
○ *HAND PENETROMETER*
● *UNCONFINED COMPRESSION*
■ *UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION*
△ *TORVANE*
0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING:
▽ *FREE WATER 1ST ENCOUNTERED AT 15.0 FT. DURING DRILLING; AFTER 15.0 MIN. AT 13.0 FT.*
▼ *WATER DEPTH AT 13.0 FT., HOLE OPEN TO 20.0 FT. ON 8/26/2014*

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

LOG OF BORING B-4

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13828171.81; E 3031294.05
14925 South Richmond Avenue

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 88.92 FT

DATE: 8/26/2014

SAMPLER: Shelby Tube/Split Spoon

DRY AUGER: 0 TO 20 FT

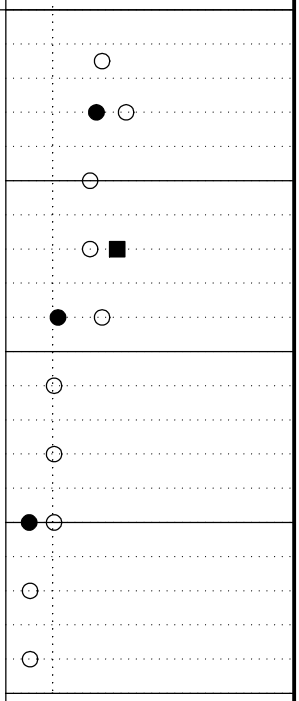
WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0	7" Concrete							
		6" Base		78		18	44	18	26
		Lean Clay with Sand (CL), stiff, high plasticity, dark gray			112	19			
85	5	Fat Clay (CH), very stiff, high plasticity, light gray and tan				19			
		..stiff with ferrous nodules below 4'							
		..very stiff below 6'			111	21			
80		..stiff below 8'			102	23			
	10	..firm below 10'		89		28	55	20	35
						19			
75	15	Lean Clay (CL), firm, medium plasticity, reddish brown			122	9			
		..soft below 16'				25			
70	20			94		27	34	16	18

UNDRAINED SHEAR STRENGTH, TSF

○ *HAND PENETROMETER*
● *UNCONFINED COMPRESSION*
■ *UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION*
△ *TORVANE*

0.5 1.0 1.5 2.0 2.5



DEPTH TO WATER IN BORING:

▽ *FREE WATER 1ST ENCOUNTERED AT 15.5 FT. DURING DRILLING; AFTER 15.0 MIN. AT 12.8 FT.*

▼ *WATER DEPTH AT 12.5 FT., HOLE OPEN TO 20.0 FT. ON 8/26/2014*

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

LOG OF BORING B-5

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13850445.32; E 3025024.51
1300 Langham Creek

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 96.86 FT

DATE: 8/26/2014

SAMPLER: Shelby Tube/Split Spoon

DRY AUGER: 0 TO 20 FT

WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0	Sandy Lean Clay (CL), medium plasticity, dark gray		69		7	33	16	17
95		..very stiff, light gray and tan below 2'			113	14			
	5	..stiff with calcareous nodules below 4'				17			
90		..with ferrous nodules below 6'			118	12			
	10			69		16	39	17	22
85					108	21			
		..firm below 12'			107	21			
	15	..stiff below 14'				13			
80		..soft with sandy layers below 16'		51		13	29	15	14
	20	Silty Sand (SM), dense, non plastic, light gray and tan	37	24		7			

UNDRAINED SHEAR STRENGTH, TSF

○ HAND PENETROMETER
● UNCONFINED COMPRESSION
■ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
△ TORVANE

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING:

▽ FREE WATER 1ST ENCOUNTERED AT Dry FT. DURING DRILLING; AFTER 15.0 MIN. AT Dry FT.

▼ WATER DEPTH AT Dry FT., HOLE OPEN TO 20.0 FT. ON 8/26/2014

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

LOG OF BORING B-6

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13820201.16; E 3078033.28
6910 Bintliff Drive

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 64.07 FT

DATE: 9/04/2014

SAMPLER: Shelby Tube/Split Spoon

DRY AUGER: 0 TO 20 FT

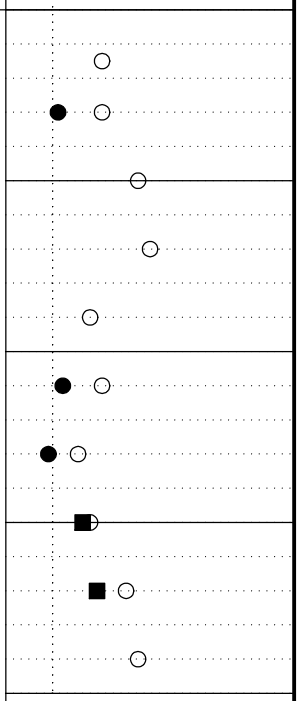
WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0			6" Concrete							
				6" Crushed Gravel Base		86		21	53	19	34
				Fat Clay (CH), stiff, high plasticity, dark gray			96	27			
60	5			..very stiff, light gray and tan below 4'				19			
				..with ferrous nodules below 6'				18			
				..stiff with calcareous nodules below 8'							
55	10					87		21	52	19	33
							108	20			
				..firm below 12'			99	25			
50	15			..stiff, reddish brown below 14' (slickensided)			93	30			
				..very stiff below 16'			92	33			
45	20					99		33	81	24	57

UNDRAINED SHEAR STRENGTH, TSF

○ *HAND PENETROMETER*
● *UNCONFINED COMPRESSION*
■ *UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION*
△ *TORVANE*

0.5 1.0 1.5 2.0 2.5



DEPTH TO WATER IN BORING:

▽ *FREE WATER 1ST ENCOUNTERED AT Dry FT. DURING DRILLING; AFTER 15.0 MIN. AT Dry FT.*

▼ *WATER DEPTH AT Dry FT., HOLE OPEN TO 20.0 FT. ON 9/4/2014*

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

LOG OF BORING B-7

PROJECT: Proposed Groundwater Plants Improvements-Package B City of Houston, Texas (WBS No. S-001000-0046-4)

PROJECT NO.: G14-197

LOCATION: N 13820253.79; E 3078005.2
6910 Bintliff Drive

COMPLETION DEPTH: 20 FT

SURFACE ELEVATION: 63.77 FT

DATE: 8/22/2014

SAMPLER: Shelby Tube/Split Spoon

DRY AUGER: 0 TO 20 FT

WET ROTARY: No TO No FT

ELEVATION, FT	DEPTH, FT	SYMBOL	SAMPLES	DESCRIPTION OF MATERIAL	STANDARD PENETRATION TEST, BLOWS PER FOOT	PERCENT PASSING NO. 200 SIEVE	DRY UNIT WEIGHT, PCF	MOISTURE CONTENT, %	LIQUID LIMIT, %	PLASTIC LIMIT, %	PLASTICITY INDEX, %
	0										
				Fat Clay with Sand (CH), very stiff, high plasticity, light gray and tan		81		18	51	19	32
				..firm, dark gray below 2'			103	20			
60	5			*..light gray and tan with calcareous nodules below 4'*				23			
				..very stiff below 6'				21			
55	10			*Lean Clay with Sand (CL), very stiff, high plasticity, light gray and tan*		83		19	46	18	28
				Fat Clay (CH), very stiff, high plasticity, reddish brown				25			
				..with slickensided layers below 12'			101	26			
50	15							32			
				..stiff below 16'			91	35			
45	20			*..very stiff below 18'*		99		34	78	23	55

UNDRAINED SHEAR STRENGTH, TSF

○ *HAND PENETROMETER*
● *UNCONFINED COMPRESSION*
■ *UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION*
△ *TORVANE*

0.5 1.0 1.5 2.0 2.5

DEPTH TO WATER IN BORING:

▽ *FREE WATER 1ST ENCOUNTERED AT Dry FT. DURING DRILLING; AFTER 15.0 MIN. AT Dry FT.*

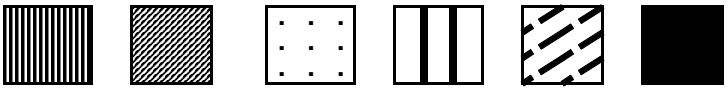
▼ *WATER DEPTH AT Dry FT., HOLE OPEN TO 20.0 FT. ON 8/22/2014*

Drilled By: Jesus Logged By: PV

Associated Testing Lab, Inc

KEY TO LOG TERMS AND SYMBOLS

SOIL TYPE

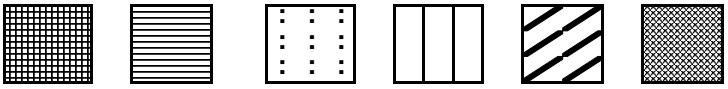


ROCK | GRAVEL | SAND | SILT | CLAY | PEAT

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