SECTION 26 13 02 - METAL CLAD SWITCHGEAR, MEDIUM VOLTAGE 15 KV

PART 1 - GENERAL

1.01 WORK INCLUDED

A. Metal clad medium voltage 15 KV switchgear with ratings and configuration as indicated on Drawings.

B. Submit relay curves and bill of material to center Point for approval and setting of relays.

C. Relay settings shall be coordinated with Center Point and the Short circuit study.

D. Contractor shall be responsible for setting all realys.

1.02 REFERENCES

A. The metal-clad switchgear and all components shall be designed, manufactured and tested in accordance with the latest applicable standards of NEMA SG-4 and SG-5, IEEE, and but not limited to, ANSI 37.20.2.

B. ANSI C37.04 and 06 - Standard for Indoor AC Medium-Voltage Circuit Breakers used in Metal-Clad Switchgear

C. ANSI C37.55 - American National Standard for Metal-Clad Switchgear Assemblies Conformance Test Procedures.

D. ANSI C57.13 - Requirements for Instrument Transformers

E. ANSI C37.90a - Surge Withstand Capability Test.

F. ANSI 37.20.2 Standard for Metal-Clad Switchgear

G. NFP-70 - Medium Voltage Switchgear.

1.03 SUBMITTALS

A. Provide submittals in accordance with and in additional to Section 26 00 00 Basic Electrical Requirements, and Division 01 for submittal requirement.

B. Provide certified shop drawings, literature, and samples upon request showing proposed for use. Use NEMA device designations and symbols for all electric circuit diagrams submitted.

C. Submit dimensioned drawings of metal clad switchgear showing accurately scaled basic units including, but not necessarily limited to, front and side view elevations showing arrangement of all devices, auxiliary compartments, unit components and combination units, floor plan, top and bottom views showing entry and exit space for conduits. Submit schematic equipment schedules, and bill of materials.

D. Schematic diagram/one line including cable terminal sizes.

E. Component list.

F. Submit assembly ratings including, but not limited to, short-circuit rating, voltage, continuous current, and basic impulse level for equipment over 600 volts.

G. Submit major component rating including, but not limited to, voltage, continuous current, interrupting current, and coordination curves for each type and rating of circuit breaker.

H. Submit schematics and wiring diagrams for metering and controls.

I. Furnish, upon request, manufacturer's certification of rating of the basic switch and fusing components and the integrated metal-enclosed interrupter switchgear assembly.

J. Descriptive bulletins.

K. Product sheets.

L. Nameplate schedule.

M. All device or equipment nameplate numbers that appear on shop drawings shall be consistent with design drawings.

1.04 QUALIFICATIONS

A. The manufacturer of the assembly shall be the manufacturer of the major components within the assembly.

B. For the equipment specified herein, the manufacturer shall be ISO 9000, 9001 or 9002 certified.

C. The manufacturer of this equipment shall have produced similar electrical equipment for a minimum period of five (5) years. When requested by the Engineer, an acceptable list of installations with similar equipment shall be provided demonstrating compliance with this requirement.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Equipment shall be handled and stored in accordance with manufacturer's instructions. One (1) copy of these instructions shall be included with the equipment at time of shipment.

B. Deliver switchgear in factory fabricated water resistant wrapping.

C. Maintain factory wrapping or provide an additional heavy canvas or plastic cover.

D. Store switchgear in a clean and dry space and protected from weather in accordance with manufacturer’s instructions.

E. Switchgear being stored prior to installation shall be stored so as to maintain the equipment in a clean and dry condition. If stored outdoors indoor gear shall be covered and heated, and outdoor gear shall be heated.

F. Shipping groups shall be designed to be shipped by truck, rail, or ship. Circuit breakers and accessories shall be packaged and shipped separately. Switchgear shall be equipped to be handled by crane. Where cranes are not available, switchgear shall be suitable for skidding in place on rollers using jacks to raise and lower the groups. Handle switchgear carefully to avoid damage to material components, enclosure and finish.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Cutler-Hammer

B. General Electric

C. Square D

D. Siemens

2.02 SWITCHGEAR CONSTRUCTION

A. The switchgear assembly shall consist of individual vertical sections housing various combinations of circuit breakers and auxiliaries, bolted to form a rigid metal-clad switchgear assembly. Metal side sheets shall provide grounded barriers between adjacent structures and solid removable metal barriers shall isolate the major primary sections of each circuit. Each rear compartment shall have hinged lockable doors. Also provide infrared transparent crystal inspection ports for all cable and transformer termination connections.

B. The switchgear shall be designed for NEMA 3R outdoor Aisleless construction. The exterior doors shall be equipped to allow installation of both center point and customer-owned locks with access through either of the two.

C. The stationary primary contacts shall be silver-plated and recessed within insulating tubes. A steel shutter shall automatically cover the stationary primary disconnecting contacts when the breaker is in the disconnected position or out of the cell.

D. The main bus shall be 98 percent IACS conductivity copper bars with rounded edges, silver-plated and of bolted design and have fluidized bed epoxy flame-retardant and track-resistant insulation. Rate the main bus not less than as shown on the drawings, based on continuous duty, including skin and proximity effect, insulation, steel enclosure, and a 65 degree C maximum temperature rise with an ambient temperature of 40 degree C. The temperature rise of the bus and connections shall be in accordance with ANSI standards and documented by design tests. The bus supports between units shall be flame-retardant, track-resistant, glass polyester supports for 5-kV class. The switchgear shall be constructed so that all buses, bus supports and connections shall withstand stresses that would be produced by currents equal to the' momentary ratings of the circuit breakers. All bus joints shall be plated, bolted and insulated with easily installed boots. The bus shall be braced to withstand fault currents equal to the close and latch rating of the breakers. Lugs shall be tin-plated copper. Provide for future extension of bus at each end of switchgear where applicable.

E. Provide ground bus consisting of silver-plated copper bar in each section bolted to copper clad steel that is welded to the steel enclosure. Each individual ground connection, one per section, to have short circuit current capability consistent with the short circuit rating of integrated assembly. Extend ground bus through the entire length of the switchgear. Provide for future extension of ground bus at each end of switchgear where applicable.

F. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminal connections shall be provided. Two control circuit cutout devices shall be provided in each circuit breaker housing – one for the trip circuit and one for the close circuit. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

G. Incoming line and feeder cable lugs to fit the type and size cable indicated on the drawings shall be furnished. Lugs shall be two hole, long barrel compression copper.

H. Provide station class surge arresters, for type and rating as indicated on drawings. Surge arresters shall be solid-state type using metal oxide ceramic elements. Surge arresters shall be installed at the incoming terminations and securely grounded to the metal structure.

I. Provide Kirk key interlocks as shown on the drawings.

J. Make provisions for entrance of medium voltage conductors from the bottom of the switchgear. Make provisions for entrance of medium voltage conductors from the bottom of the switchgear for each feeder breaker section designated for future. Incoming cable termination shall be compression type. Provide adequate room for outdoor stress cones terminators, conductor size and quantity as shown on Drawings.

K. Barriers made of glass polyester meeting or exceeding the BIL of the bus insulation system shall be provided between fuse and switch compartments, between individual, and between outer phases and the enclosure. Finish in inaccessible areas shall have phosphatizing bath and iron oxide zinc-chromate anti-corrosion primer to ensure that all surfaces are protected.

L. A conductive zinc coating shall be applied to interior and exterior surfaces to furnish cathodic protection for the steel, promote neutralization of atmospheric contaminants, improve finished covering at sharp edges and retard under film propagation of rust. The intermediate coat to be epoxy ester primer. Final coat of epoxy modified alkyd resin, color ANSI 61, gray.

M. Ratings: The ratings for the integrated switchgear assembly shall be as follows:

1.	Nominal Voltage Class	15 KV
2.	Maximum Design Voltage	15 KV
3.	Basic Impulse Level	As shown on Drawings, 95 KV minimum.
4.	Main Bus	1200A
5.	Short Circuit	25 KA
6.	Three Second Rating	25 KA
7.	Rated Interrupting Time	3 Cycles

N. The switchgear manufacturer shall provide suitable terminal blocks for secondary wire terminations and a minimum of 10% spare terminal connections shall be provided. Two control circuit cutout device shall be provided in each circuit breaker housing; one for the close circuit and one for the trip circuit. Switchgear secondary wire shall be #14 AWG, type SIS rated 600 volt, 90 degrees C, furnished with wire markers at each termination. Wires shall terminate on terminal blocks with marker strips numbered in agreement with detailed connection diagrams.

O. Incoming line and feeder cable lugs to fit the type and size cable indicated on the drawings shall be furnished. Lugs shall be two hole, long barrel compression copper.

P. The finish shall consist of a coat of gray (ANSI-61), thermosetting, polyester powder paint applied electrostatically to pre-cleaned and phosphatized steel and aluminum for internal and external parts. The coating shall have corrosion resistance of 600 hours to 5% salt spray. Prior to shipment, the complete assemblies, indoor as well as outdoor, shall be given 1.5 to 2.0 mil thick exterior finish spray coat of air drying high-gloss gray enamel.

Q. Provide a freestanding separate crane hoist cart, which shall be used for moving the breaker elements. Provide all accessories. Sufficient room space shall be provided to accommodate such operation.

R. Each vertical section of the switchgear shall be provided with a thermostatically space heaters. Tubular type heaters operated at half voltage for long life shall be supplied. SOD-volt or 250-volt rated heaters shall be used at 240 or 120 volts, respectively. Power for space heaters shall be furnished from a control power transformer mounted in the switchgear. Provide a heater circuit disconnect device in each vertical section.

S. The switchgear bussing shall be designed for future extension.

T. The assembly shall be designed to allow for a future Main tie Main arrangement**.**

2.03 CIRCUIT BREAKERS

A. Provide horizontal drawout type vacuum circuit breakers designed for use in metal-clad switchgear. Make breakers of same current rating completely interchangeable. Provide circuit breakers capable of being withdrawn on rails. The circuit breakers shall be operated by a means of a stored energy mechanism, which is normally charged by a universal motor but can also be charged by the manual handle on each breaker for manual emergency closing or testing. The closing speed of the moving contacts shall be independent of both the control voltage and the operator. Provide a full front shield on the breaker.

B. The racking mechanism to move the breaker between positions shall be operable with the front door closed and position indication shall be visible with door closed. A Mechanical interlocking system shall be provided to prevent racking a closed circuit breaker to or from any position. An additional interlock shall automatically discharge the stored energy operating mechanism springs upon removal of the breaker out of the compartment.

C. The secondary contacts shall be silver-plated and shall automatically engage in the breaker operating position, which can be manually engaged in the breaker test position.

D. Interlocks shall be provided to prevent closing of a breaker between operating and test positions, to trip breakers upon insertion or removal from housing and to discharge stored energy mechanisms upon insertion or removal from the housing. The breaker shall be secured positively in the housing between and including the operating and test positions.

E. Provide breakers with current ratings as shown on drawings. Provide breakers with maximum symmetrical interrupting rating as shown on drawings.

F. Provide metering for each branch breaker as indicated on the drawings.

G. Each circuit breaker shall contain three vacuum interrupters separately mounted in a self-contained, self-aligning pole unit, which can be removed easily. The vacuum interrupt pole unit shall be mounted on glass polyester for rated voltage. An integral contact wear indicator indicating available contact life for each vacuum interrupter shall be easily visible when the breaker is removed from its compartment. The current transfer from the vacuum interrupter-moving stem to the breaker main conductor shall be a non-sliding design. The breaker front panel shall be removable when the breaker is withdrawn for ease of inspection and maintenance. Primary, main and secondary contacts shall be silver-plated copper.

H. Provide breakers operated by motor-charged-spring, stored-energy mechanisms. Additionally, provide a manual means of charging the mechanism and of slowly opening the contacts for inspection or adjustment. The circuit breaker control voltage shall be 120 volts or as indicated on drawings. Each breaker shall be complete with control switch and red and green indicating lights to indicate breaker contact position. Secondary control circuit shall be connected automatically with a self-aligning, self-engaging plug and receptacle arrangement when the circuit breaker is racked into the connected position. Provide capacitor trip stored energy mechanism for all breakers.

I. Provide a mechanism for moving the breaker from the connected to the test/disconnected position and for removal from the compartment. Provide padlocking capability for both positions.

J. Provide each breaker with six auxiliary MOC (Mechanism Operated Cell) contacts (3 normally open, and 3 normally closed) operated by the MOC auxiliary switch to indicate status of breaker in open or closed position. Provide each breaker with six auxiliary TOC (Truck Operated Cell) contacts (3 normally open, and 3 normally closed) operated by the TOC auxiliary switch to indicate status of breaker in connected or test/disconnected position.

K. Breakers shall have arm maintenance mode Arc flash reduction setting via panel mounted selector switch or switch on each breaker. Maintenance mode shall be accomplished via the protective relays by use of alternate trip settings for the “normal” and “maintenance” modes. A light shall be turn on to indicate breaker is in the arm maintenance mode.

L. Breakers shall be capable of being removed with electrical levering-in device with remote operator.

2.04 PROTECTIVE RELAYS

A. Provided factory installed microprocessor-based relays for overcurrent protection, in the metal clad switchgear. Relays shall be factory calibrated and blocked before shipment. All relays shall have integral test switches. If relay does not have integral test switches, separate mounted test switches shall be provided for the instrument transformer inputs.

B. The quantity, ANSI device function type and rating of protection relays shall be as indicated on the Drawings. Functions shall be adjustable.

C. Protective relay shall be drawout type, with test switches and devices incorporated in the relay unit. Include hand reset tripping indicators. Provide RS-485 port for external communications via ModBus RTU.

D. Relay shall have low burden characteristics, high thermal capacity and negligible temperature error. All settings shall be readily visible and accessible from the front of the relay.

E. Specific characteristics and relay settings shall be in accordance with the Short Circuit and Device Coordination Study.

F. Brushing current transformers located inside the Customers circuit breaker shall have relay accuracy of C 100 or better.

2.05 INSTRUMENT TRANSFORMERS

A. Install and connect at the factory instrument transformers with primary/secondary ratio specified on drawings, 60 hertz, burden and accuracy consistent with connected metering and relay devices.

B. Ring type current transformers shall be furnished as indicated on the contract drawings. The thermal and mechanical ratings of the current transformers shall be coordinated with the circuit breakers. Their accuracy rating shall be equal to or higher than ANSI standard requirements. The standard location for the current transformers on the bus side and line side of the breaker units shall be front accessible to permit adding or changing current transformers without removing high-voltage insulation connections. Shorting terminal blocks shall be furnished on the secondary of all the current transformers.

C. Voltage and control power transformers of the quantity and ratings indicated in the detail specification shall be supplied. Voltage transformers and control power transformers rated 15kVA, single phase shall be mounted in drawout drawers contained in an enclosed auxiliary compartment. Primary control power fuses for voltage transformers for switchgear shall be mounted on the drawout potential transformers. Secondary fuses shall be fixed mounted.. Rails shall be provided for each drawer to permit easy inspection testing and fuse replacement. Shutters shall isolate primary bus stabs when drawers are withdrawn.

D. A mechanical interlock shall be provided to require the secondary breaker to be open before the CPT drawer or CPT primary fuse drawer can be withdrawn.

E. Design instrument voltage transformers (PT) to fit into and coordinate with the complete switchgear units, including the instruments, relays, meters, and devices specified. Voltage transformers shall be per phase (3 per source) connected in a grounded wye-grounded wye configuration, drawout mounted, disconnecting type with integral primary and secondary fuses. Provide rails for each drawer to allow easy inspection, testing, and fuse replacement. Interlock with compartment access door to disconnect, ground and isolate from primary voltage when door is open.

F. Design instrument current transformers (CT) for installation on bushings of primary disconnecting contacts in circuit breakers. The standard location for the current transformers on the bus side and line side of the medium voltage switchgear shall be front accessible to allow adding or changing current transformers without removing medium voltage insulation connections.

G. Control transformers shall be 120V, 60 Hertz, 15 KVA minimum, single-phase, drawout mounted, disconnecting type with integral primary and secondary fuses. Provide 100amp 120V circuit breakers for control transformer secondary protection. Interlock with compartment access door to disconnect, ground and isolate from primary voltage when door is open.

2.06 LOW-VOLTAGE COMPONENTS

A. All low-voltage components, including meters, instruments, and relays, shall be located in grounded, steel-enclosed compartments separate from high voltage to provide isolation and shall be arranged to allow complete accessibility for test and maintenance without exposure to high voltage.

2.07 METERING

A. Provide microprocessor-based power monitoring device for each circuit breaker as indicated on drawings. Include associated instrument transformers.

B. Provide Digital meter with selector switch for each breaker as shown on the drawings.

C. Provide current transformers for each meter. Current transformers shall be wired to shorting type terminal blocks.

D. Potential transformers including primary and secondary fuses with disconnecting means for metering as shown on the drawings.

E. Microprocessor Metering Unit (MMU): Each switchgear main and branch shall be provided with: Microprocessor Metering Unit capable of monitoring the main breaker and downstream distribution breakers. The MMU shall be a digital line Meter Monitor and Protection (MM&P) device equal to Cutler Hammer IQ 250 having the features and functions specified below. The MMU shall be UL recognized. CSA certified and also meet ANSI Standard C37.90. The MMU shall provide direct reading metered or calculated values of the items listed below and shall auto range between Units, Kilo-units, and Mega-units for all metered values. Accuracy indicated below to be of displayed or calculated values.

1. AC amperes in each phase, 0.1% accuracy.
2. AC voltage. phase-to-phase, phase-to-neutral, 0.1% accuracy.
3. Watts, 0.2% accuracy.
4. Vars. 0.2% accuracy.
5. Power factor, 0.4 4% accuracy.
6. Frequency, 0.2% accuracy.
7. Watt Demand (5-, 10-, 15-. 30-minute interval programmable) 0.2% accuracy
8. Watt-hours, 0.2% accuracy.
9. Kva Demand (5-, 10-, 15-. 30-minute interval programmable) 0.2% accuracy.

F. The MMU shall allow the user to disable undesired values/functions and to later reactivate them if required. A neutral terminal shall be provided and wired for 4-wire, grounded systems. The 600-volt and below voltage power module shall be detachable from the chassis. Three (3) in-line fuses shall protect the MM&P from current overloads.

G. The MMU shall have non-volatile memory and not require battery backup; in the event of a power failure, the MMU shall retain all pre-set parameters, accumulated watt-hours, watt demand.

H. Input ranges of the MMU shall accommodate external current transformers. Provide three (3) external current transformers with rating sized for incoming service.

I. The MMU shall have an operating temperature range of 0 degrees C to 70 degrees C, and 0 to 95% relative humidity non-condensing.

J. The MMU shall have integral ModBus RTU communication capabilities via a RS485 network to the campus Andover BCAS system. The switchgear manufacturer shall provide the Modbus register maps for each meter used to the school’s building management as part of the submittal package.

K. **Electrical contractor shall contact the HCC site controls contractor (Kratos Control 713 937-8506) to provide necessary interface and programming to add the points to the site control panel. Allow for 5 point to be mapped per meter, coordinate point with HCC facility engineer**.

L. Provide a ABB type FT-11 test switch for the current and potential inputs complete with matching test plug.

2.08 ACCESSORIES

A. The following accessories will be provided for the circuit breaker switchgear

1. Tool for manually charging the breaker closing spring and manually opening.
2. Levering crank/remote electrical levering-in device for moving the breaker between test and connected position.
3. Test jumper for electrically operating the breaker while out of its compartment.
4. One breaker lifting yoke used for attachment to breaker for· lifting breaker on or off compartment rails
5. One set of rail extensions and rail clamps
6. Circuit breaker lifting device: Carriage and track on top of switchgear lineup with lifting device to serve draw out circuit breakers in switchgear, or manufacturer's standard device.
7. One portable lifting device for lifting the breaker on or off the rails
8. One electrical levering device
9. Circuit breaker control switch per breaker with red and green indicating lights, LED type.

B. High voltage Cable termination.

1. Each termination shall have removable cover/insulation caps provided by the switchgear supplier.

C. Wiring and Termination Blocks

1. All control, metering, and instrumentation wiring shall be terminated on 600V heavy-duty terminal blocks. CT terminal blocks shall be separately mounted with all CT secondary terminated on 4-point shorting type terminal blocks.
2. Test blocks shall be provided per the Drawings and mounted on hinged instrument panels and fully wired. Provide test plugs (four potential and six current).
3. All control wiring shall be 14 AWG minimum, 600V 90-degree C, type SIS. All control conductors shall be terminated in crimp-on lugs. All conductor leads shall be spade type except current leads, which shall be ring type.
4. Conductor and terminal block identification: All conductors shall have machine-lettered, PVC sleeve type wire markers. All terminal blocks shall be identified with phenolic nameplates as described herein. Individual terminals shall be clearly and neatly labeled with indelible, black marking pen.
5. Both sides of all trip and close coils shall be wired to terminal blocks.

D. Nameplates: Identification as per Section 26 05 53. Inscription shall be as per the Drawings. All exterior nameplates shall be attached with stainless steel screws. Interior nameplates may be attached with adhesives. Provide master nameplate on breaker cubicle indicating equipment name, voltage and service, and source of power. In addition, a "Danger High Voltage" sign shall be mounted on all doors providing access to high voltage. Arch flash rating name plates per study shall be submitted for review by the owner per the arc flash study.

E. Mimic Bus: Provide a plastic mimic bus over the face of the switchgear. Mimic bus shall depict incoming lines, outgoing lines, breakers, voltage transformer and control power transformer. Mimic shall be medium blue in color and fastened with countersunk screws. Mimic bus layout shall be submitted for review by the owner.

2.09 FACTORY TESTING

A. The following standard factory tests shall be performed on the circuit breaker element provided under this section. All tests shall be in accordance with the latest version of ANSI standards.

1. Alignment test with master cell to verify all interfaces and interchangeability
2. Circuit breakers operated over the range of minimum to maximum control voltage
3. Factory setting of contact gap
4. One-minute dielectric test per ANSI standards
5. Final inspections and quality checks

B. The following production test shall be performed on each breaker housing:

1. Alignment test with master breaker to verify interfaces
2. One-minute dielectric test per ANSI standards on primary and secondary circuits
3. Operation of wiring, relays and other devices verified by an operational sequence test
4. Final inspection and quality check.

C. The manufacturer shall provide three (3)-certified copies of factory test reports.

PART 3 - EXECUTION

3.01 INSPECTION

A. Installer shall examine the areas and conditions under which switchgear is to be installed and notify the Contractor in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION

A. Install switchgear as indicated in accordance with manufacturer's written instructions and applicable requirements of the NEC, ANSI, and NEMA. Secure the switchgear units rigidly on the concrete housekeeping pad with anchor bolts or other approved means recommended by the manufacturer.

B. Field Quality Control: Provide the services of a qualified factory-trained manufacturer's representative to assist the Contractor in installation and start-up of the equipment specified under this section for a period of 10 working days. The manufacturer's representative shall provide technical direction and assistance to the contractor in general assembly of the equipment, connections and adjustments, and testing of the assembly and components contained therein. The qualified factory trained manufacturer’s representative shall perform startup testing and commissioning. The Contractor shall provide three (3) copies of the manufacturer's field start-up report.

C. Relay Adjustments: The qualified factory trained manufacturer’s representative shall properly set adjustable current, voltage, and time settings in accordance with settings designated in a coordination study of the system as required elsewhere in the contract documents.

D. Relay Testing: A complete test of all relays shall be performed by manufacturer’s certified technician after installation and before acceptance by the Owner’s representative. This test shall involve passing a primary current through the current sensor with a suitable, low-voltage test set and timer, which shall allow verification that the protective relays track their published curves and that they actually trip the devices on which they applied. This test shall also include the polarity of the current sensors and give an indication of satisfactory operations. The field test of protective relays shall include testing of relays at their final settings. Provide manufacturer’s testing services using qualified personnel. Submit personnel qualifications, test equipment calibration reports, as well as final test reports to Owner and Architect/Engineer. Prior to energization of switchgear, Megger Test phase-to-phase and phase-to-ground insulation resistance.

E. Prior to energization, check metering and control wiring for correct polarity and proper interconnection.

F. Subsequent to wire and cable hook-ups, energize switchgear and verify functioning of all features, metering, controls and protective relaying.

G. Tighten all current-carrying bolted connections and all support framing and panels with a torque wrench to NEMA standards or manufacturer's recommendations. Mark bolts with paint after torqueing.

H. Adjust operating mechanism for free mechanical movement. Touch-up scratched or marred surfaces to match original finish.

3.03 CERTIFICATION

A. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations. The Contractor shall provide three (3) copies of the manufacturer's· representative's certification and test reports.

B. Provide the services of Professional Engineer, licensed in Texas, to certify in writing that the switchgear has been designed, manufactured, installed, and tested in full compliance with utility standards and requirements, with national standards, and with Owner’s requirements. Provide three copies of certification.

3.04 TRAINING

A. The Contractor shall provide a training session for up to (10) Owner’s representatives for (1) normal workday at a jobsite location determined by the Owner.

B. The training session shall be conducted by a qualified manufacturer’s representative. Training program shall include instruction on the assembly, circuit breaker, protective devices, and other major components. Training program shall also include instructions on maintenance procedures and troubleshooting procedure for all switchgear components.

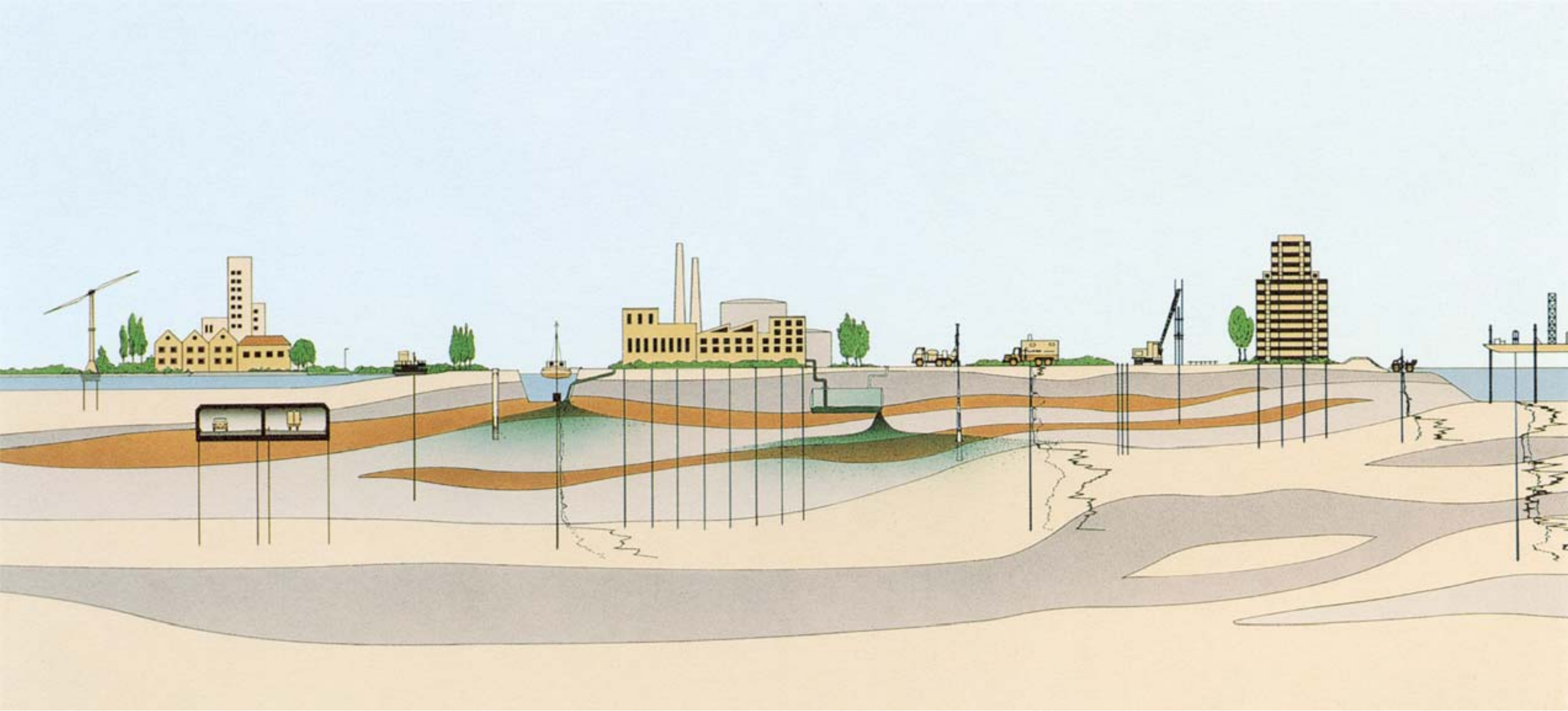
END OF SECTION

- 26 13 02 -

FUGRO CONSULTANTS, INC.

GEOTECHNICAL REPORT
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

LLEWELYN-DAVIES SAHNI
HOUSTON, TEXAS



FUGRO CONSULTANTS, INC.

6100 Hillcroft (77081)
P.O. Box 740010
Houston, Texas 77274
Tel: (713) 369-5400
Fax: (713) 369-5518

Report No. 04.12100054
November 7, 2012

LLEWELYN-DAVIES SAHNI
5120 Woodway Drive, Suite 8010
Houston, Texas 77055

Attention: Mr. Ranjan Roy

Geotechnical Report
HCC Central Campus Improvements
Houston Community College
Houston, Texas

Introduction

Fugro Consultants, Inc. (Fugro) is pleased to present this report of our geotechnical study for the above-referenced project. Mr. Ranjan Roy with Llewelyn-Davies Sahni (LDS) requested our services via e-mail addressed to Mr. Scott A. Marr, P.E. LEED AP of Fugro on March 11, 2010. Our services were authorized by The Houston Community College System (HCC) on May 3, 2011 via issuance of executed contract document *AIA Document G602-1993*.

Project Description. We understand that HCC plans to construct site improvements to their Central Campus located at 1300 Holman Street in Houston, Texas. A *Vicinity Map* of the site location is presented on Plate 1.

We understand that the project architect is LDS and the project civil engineer is ESPA Corp (ESPA). Based on information provided to us at the time of our proposal, we understand that site improvements would include the construction of paved parking areas, roadway improvements and architectural and landscaping improvements. The project was put on indefinite hold awaiting access to drill along La Branch Street. Mr. Roy contacted Fugro on October 19, 2012 and requested a report of our investigation including subgrade preparation recommendations for the proposed concrete pavers.

Purpose and Scope. The purposes of our geotechnical study were to: 1) explore and evaluate the general subsurface soil and depth-to-water conditions, 2) describe encountered subsurface conditions and 3) provide subgrade preparation recommendations for the proposed concrete pavers. The scope of this study included the following:

- Drilling 8 soil borings to explore subsurface conditions and obtain samples for geotechnical laboratory testing;

- Performing laboratory tests on selected soil samples to evaluate the engineering properties of the subsurface soils;
- Analyzing the field and laboratory data; and
- Preparing this report summarizing our findings.

Environmental assessments, compliance with State and Federal Regulatory requirements, and/or environmental analyses including those associated with mold, fungi, and other biologic agents were beyond the scope of this study. A geologic fault study was outside the scope of our services.

Applicability of Report. We have prepared this report exclusively for The Houston Community College System as described herein. We have conducted this study using the standard level of care and diligence normally practiced by recognized engineering firms now performing similar services under similar circumstances. We intend for this report, including all illustrations, to be used in its entirety. Furthermore, this report should ***not*** be construed to represent a warranty of subsurface conditions, nor should this report be used, whether in whole or part, as a stand-alone construction specification document. Site conditions may have changed since our field exploration performed in 2010. Fugro makes no claim or representation concerning any activity or condition falling outside the specified purpose to which this report is directed.

Field Exploration

Our field activities related to geotechnical soil borings are discussed in this section. We have included discussions relating to drilling and sampling methods, depth-to-water measurements, and borehole completion.

General. We explored the subsurface soil condition by drilling 8 soil borings, designated Borings B-1 through B-5 and B-9 through B-11, with our truck-mounted drilling equipment on May 9, 2010 and May 22, 2010. ESPA selected the boring locations on existing concrete pavements at the project site shown on the *Geotechnical Boring Layout*, dated March 11, 2010. At the time of our exploration, we were not granted access to drill Borings B-6 through B-8 along La Branch Street. Prior to drilling, Fugro marked the approximate locations of the borings at the project site and coordinated concrete coring of the existing concrete pavements. All the borings except Borings B-4 and B-5 were drilled to a depth of 10 feet below existing grade. While drilling Borings B-4 and B-5, we encountered unknown concrete obstructions about 4 feet and 6 feet below existing grade, respectively. Upon completion of drilling, we patched the concrete cores with quick drying cement. The approximate boring locations are shown on the *Plan of Borings* presented on Plate 2.

Drilling and Sampling Methods. The borings were drilled using dry-auger techniques. Soil samples were generally taken at 2-foot intervals to a depth of about 10 feet below existing grade (shallower depths of 4 feet and 6 feet below existing grade for Borings B-4 and B-5, respectively). Detailed descriptions of the soils encountered at Borings B-1 through B-5 and B-9 through B-11 are presented on the boring logs on Plates 3 through 10. A key identifying the terms and symbols on the boring logs is presented on Plates 11a and 11b.

Undisturbed samples of cohesive soils were generally obtained by hydraulically pushing a 3-inch diameter, thin-walled tube a distance of about 24 inches. Our field procedure for sampling cohesive soil was conducted in general accordance with ASTM D1587, *Standard Practice for Thin-Walled Tube Sampling of Soils*. The soil samples were extruded in the field and visually classified by our field technician. We obtained field estimates of the undrained shear strength of the recovered samples using a calibrated hand-held penetrometer. The field estimates were modified for stiff to hard, over-consolidated, ***natural***, cohesive soils, as described on Plate 11b. Portions of each recovered soil sample were placed into appropriate containers for transportation to our laboratory for additional geotechnical testing.

Depth-to-Water Measurements. Depth-to-water observations were performed in the open boreholes in an effort to identify the depth-to-water at the site. Discussion of our interpretation of the depth-to-water conditions is presented later in the *General Site Conditions* section of this report.

Borehole Completion. After completing the field activities, borings was backfilled with soil cuttings and bentonite chips, *i.e.* holeplug. The soil cuttings and bentonite chips were placed in the boreholes until relatively level with the bottom of pavement and patched pavement with quick drying cement.

Laboratory Testing

We directed our laboratory program toward classifying the foundation soils, identifying fill soils, and evaluating the undrained shear strength of the cohesive subsurface soils. Our laboratory testing also included analytical testing for corrosive potential of the subsurface soils. Our laboratory tests were performed in general accordance with the appropriate standards as tabulated at the end of this section.

Classification Tests. The classification tests included tests for natural moisture content, liquid and plastic limits (collectively termed Atterberg limits), and material finer than the No. 200 sieve (percent fines). These tests aid in classifying the soils and are used to correlate the results of other tests performed on samples taken from different borings and/or different depths. The results of the classification tests are recorded on the boring logs on Plates 3 through 10.

Undrained Shear Strength Tests. The undrained shear strength from selected undisturbed samples of cohesive soils was measured by performing unconfined compression (UC) tests. The natural moisture content and dry unit weights were determined as routine parts of the compression tests. The results of the laboratory shear strength test, along with the field estimates of shear strength, are presented on the boring logs.

Corrosion Potential Tests. The corrosion potential of the near-surface soils was evaluated using a series of analytical laboratory tests including pH, sulfate ion concentration, chloride ion concentration and electrical resistivity. The results of the analytical laboratory tests are presented in Appendix A of this report.

Summary of Laboratory Testing. Table 1 lists the type and number of laboratory tests performed for this study as well as the applicable test standard.

Table 1 – Laboratory Test Quantities and Testing Standards

Laboratory Test	***Quantity***	***Testing Standard***
Moisture Content	19	ASTM D2216
Atterberg Limits	7	ASTM D4318
Dry Unit Weight	5	ASTM D2166
Percent Passing No. 200 Sieve	1	ASTM D1140
Unconfined Compression	5	ASTM D2166
pH	3	ASTM G51
Sulfate Ion Concentration	3	ASTM D516
Chloride Ion Concentration	3	ASTM D512

General Site Conditions

The interpreted site and subsurface conditions based on our field exploration, laboratory testing, and our experience are discussed in this section.

Site Location and Description. The project site is located at the HCC Central Campus in Downtown Houston. It is enclosed by Holman Street, San Jacinto Street, Crawford Street and Alabama Street. The site is developed with existing academic buildings, parking garages, and concrete paved parking lots. A layout of the site location is presented on the *Plan of Borings* on Plate 2.

Subsurface Conditions. The subsurface conditions at the site consist primarily of cohesive fill soils overlying ***natural*** cohesive soils.

In some areas, undocumented fill soils were generally encountered beneath existing 5-inch to 1-foot thick asphalt and concrete paving to a depth of 1.5 feet to 6 feet below existing grade. The fill soils consist of highly plastic clays with a liquid limit 46, a plastic limit 10 and corresponding plasticity index of 36. Field estimates and laboratory tests indicates the undrained shear strength of the cohesive fill soils range from 2,000 psf (stiff) to greater than 4,500 psf (hard).

Natural cohesive soils were generally encountered beneath the undocumented fill soils or from beneath the existing paving and extend to a depth of 10 feet below existing grade, the maximum depth drilled for this study. The natural cohesive soils consist of highly plastic clays with liquid limits ranging from 40 to 60, plastic limits ranging from 10 to 13, and corresponding plasticity indices ranging from 29 to 47. Field estimates and laboratory tests indicates the undrained shear strength of the natural cohesive soils range from about 1,200 psf (stiff) to about 2,800 psf (very stiff). Shell fragments, ferrous nodules and calcareous nodules are observed in the natural cohesive soils.

Additional information about the soils encountered in the borings drilled for our study can be found on the boring logs on Plates 3 through 10.

Depth-to-Water Conditions. The borings were drilled using only dry-auger drilling technique in an effort to identify the depth-to-water condition at the site. Free water was not encountered in the borings to a depth of 10 feet. Standing water was observed at a depth of 4 feet in Boring B-4.

Please note that short-term depth-to-water observations recorded in open boreholes should ***not*** be considered to represent a long-term condition, especially in high plastic cohesive soils. The time associated with short-term observations may not be sufficient for the conditions in the open borehole to reach equilibrium. More accurate determinations of groundwater levels are usually made using long-term standpipe piezometer readings. It should be noted that groundwater levels will fluctuate with seasonal variations in rainfall, water level, and surface runoff especially during extended periods of heavy rainfall or dry weather. For design purposes, the groundwater level should be considered at the ground surface.

Variations in Subsurface Conditions. Our interpretations of soil conditions, as described in this report, are based on data obtained from our visual observations, sample borings, laboratory tests, and our experience. Although we have allowed for minor variations in the subsurface conditions, our recommendations may ***not*** be appropriate for subsurface conditions other than those reported herein. It is possible that some undisclosed variations in soil or groundwater conditions might occur outside the boring locations, especially with respect to the presence, depth, consistency, and extent of fill material at the site location. As mentioned earlier, site conditions may have changed since our field exploration performed in 2010. We recommend careful observations during any construction to verify our interpretations. Should variations from our interpretations be found, we recommend that we be notified and authorized to evaluate what, if any, revisions should be made to our recommendations.

Construction Considerations

Recommendation regarding subgrade preparation, shallow open-cut excavations, structural clay fill, lime-stabilized clay fill and construction monitoring are included in the following paragraphs.

Subgrade Preparation. As mentioned earlier, we understand that the proposed site improvement will only consist of removal of existing pavements and placement of proposed concrete pavers for this project. Therefore, we recommend that subgrade preparation include clearing and stripping of all significant vegetation, organic materials, debris, and other deleterious materials. Areas of exposed subgrade that are observed to be soft, wet, weak, or contain deleterious materials should be over-excavated to expose competent soils. Over-excavated areas should be backfilled with properly placed and compacted structural clay fill. Recommendations for structural clay fill are discussed later in this report.

After removing deleterious materials and stripping, the exposed subgrade should be proofrolled with a fully loaded dump truck or other heavy (20-ton), rubber-tired vehicle (where practical) and observed by the Geotechnical Engineer-of-Record or their qualified representative to evaluate the condition of the subgrade. We recommend scheduling these activities during a relatively dry period. We do not recommend that subgrade preparation activities begin immediately after or during a significant rain event. It may be necessary to wait for the site to dry prior to starting subgrade preparation activities depending on the effectiveness of onsite drainage.

Based on our study, we encountered some areas with more than 3-foot thick layers of undocumented fill soils beneath existing pavements. Typically, we do ***not*** recommend placing pavements or other structures on substantial undocumented fill areas because distress may result from differential settlements of subgrade fill soils. Thus, we recommend maintenance of the proposed concrete pavers be performed on a routine basis.

Shallow Open-Cut Excavation. Excavation safety systems should be in accordance with current federal Occupational Safety and Health Administration (OSHA) standards for excavations. The OSHA requirements do not generally require shallow excavations to depths of 4 feet or less to be sloped back or braced. However, if sloughing and caving is noticed, we recommend that slopes be cut back to a stable slope. Excavations deeper than 4 feet are required to be sloped back or braced, according to OSHA regulations.

Based on our interpretation of the regulations and anticipated soil conditions, ***natural*** cohesive soils would be classified as Type B soils and the cohesive fill would be Type C soils. Sides of temporary vertical excavations less than 4 feet deep may stay open for short periods of time. However, if sides of slopes begin to slough, the sides should be either braced or sloped back to a stable condition. Excavations deeper than about 4 feet should be either braced or sloped back no steeper than 1-horizontal to 1-vertical for Type B soils and 1.5-horizontal to 1-vertical for Type C soils. Flatter slopes or bracing should be used in either case if sloughing or raveling is observed. We recommend that positive surface drainage away from all excavations should be established to prevent surface runoff from either flooding excavations or ponding around completed foundations. Any seepage into excavations is expected to be minor. Pumps and sumps should be available onsite to handle seepage and water from surface runoff.

Structural Clay Fill. Structural clay fill may be used for subgrade material, or to replace unsuitable soils. We recommend using low plasticity cohesive soils for structural clay select fill. Structural clay fill should have a liquid limit of less than 40, a plasticity index between 8 and 20, and at least 60 percent of the material finer than the No. 200 Sieve. Structural clay select fill should be free of deleterious matter and should have an effective clod diameter less than 3 inches. We do ***not*** recommend mixing sand with high plasticity clay to develop structural clay fill.

Structural clay fill should be placed in 6- to 8-inch-thick loose lifts and uniformly compacted to 95 percent of the maximum dry density at a moisture content of 1 percent “dry” to 3 percent “wet” of optimum as determined by ASTM D698 (Standard Proctor). Structural clay select fill should be compacted by a sheepsfoot or padfoot type roller, or by alternative methods that provide a “kneading” compaction equivalent to the sheepsfoot or padfoot roller. We recommend using hand-operated compaction equipment and 4-inch thick loose lifts adjacent to foundations and in confined areas.

If wet weather or extended dry periods deteriorate the exposed surface whereby a good bond cannot be formed between successive lifts, the Contractor should prepare the surface as necessary. This preparation may include removing or scarifying the top couple of inches of the underlying material before placing the next lift.

Some of the onsite cohesive soils do not meet the plasticity requirement for structural clay fill. As such, we recommend that these cohesive soils be tested to verify the plasticity requirement prior to use or alternatively the soils may be lime-stabilized.

Lime-Stabilized Clay Fill. Lime-stabilization may be used to modify potential clay fill materials. Laboratory tests should be conducted at the time of construction to determine the optimum lime content. The optimum lime content is the amount of lime necessary to achieve a pH of 12.4 (which represents lime fixation), while trying to achieve a plasticity (PI) of less than 20. For estimation purposes, about 6 to 8 percent lime, by dry weight, may be required to stabilize the onsite high plasticity clay soils. Organics, chemical fertilizers, and some clay minerals can modify the amount of lime necessary for lime fixation. We recommend that a lime series be performed using the specific soil samples and proposed lime additive.

Lime-stabilization should be done in accordance with the Lime Association recommendations. Key items for lime-stabilizing the clay soils include placing the proper percentage of lime, thoroughly mixing the lime into the clay soils, bringing the stabilized soil to the proper moisture content, allowing the stabilized soil to cure for at least 48 hours, adjusting the moisture content from 1 percent “dry” to 3 percent “wet” of optimum moisture content, pulverizing the soils again until the lime is thoroughly blended, then placing the stabilized soil in accordance with the recommendations discussed herein. Lime-stabilized clay fill should be placed in 6- to 8-inch-thick loose lifts and uniformly compacted to 95 percent of the maximum dry density as determined by ASTM D698 (Standard Proctor).

The moisture-density relationship should be established based on a material sample obtained on-site after stabilization with lime. A combination of sheepsfoot or padfoot rollers and pneumatic rollers is recommended to compact the lime-stabilized clay fill.

Construction Monitoring. We recommend that the Geotechnical Engineer-of-Record or their qualified representative be present onsite during excavation to evaluate the suitability of subgrade soils. Onsite observations may also aid in recognizing and reconciling other unanticipated soil or groundwater conditions and endeavor to verify that design recommendations are appropriate and properly implemented during construction. We recommend that we be retained during subgrade preparation and construction phases to provide materials testing and construction surveillance to: (1) observe compliance with specifications and recommendations; (2) observe subsurface conditions during construction; (3) perform quality control tests.

* * *

The following illustrations are attached and complete this report:

Appendix A

Closing

We appreciate the opportunity to be of continued service to The Houston Community College System. Please call us if you have any questions or comments concerning this report or when we may be of further assistance.

Sincerely,
FUGRO CONSULTANTS, INC.
TBPE Firm Registration No. F-299

Julia P. Clarke
7 NOV 2012
Julia P. Clarke, P.E.
Project Professional

JULIA P CLARKE
111338

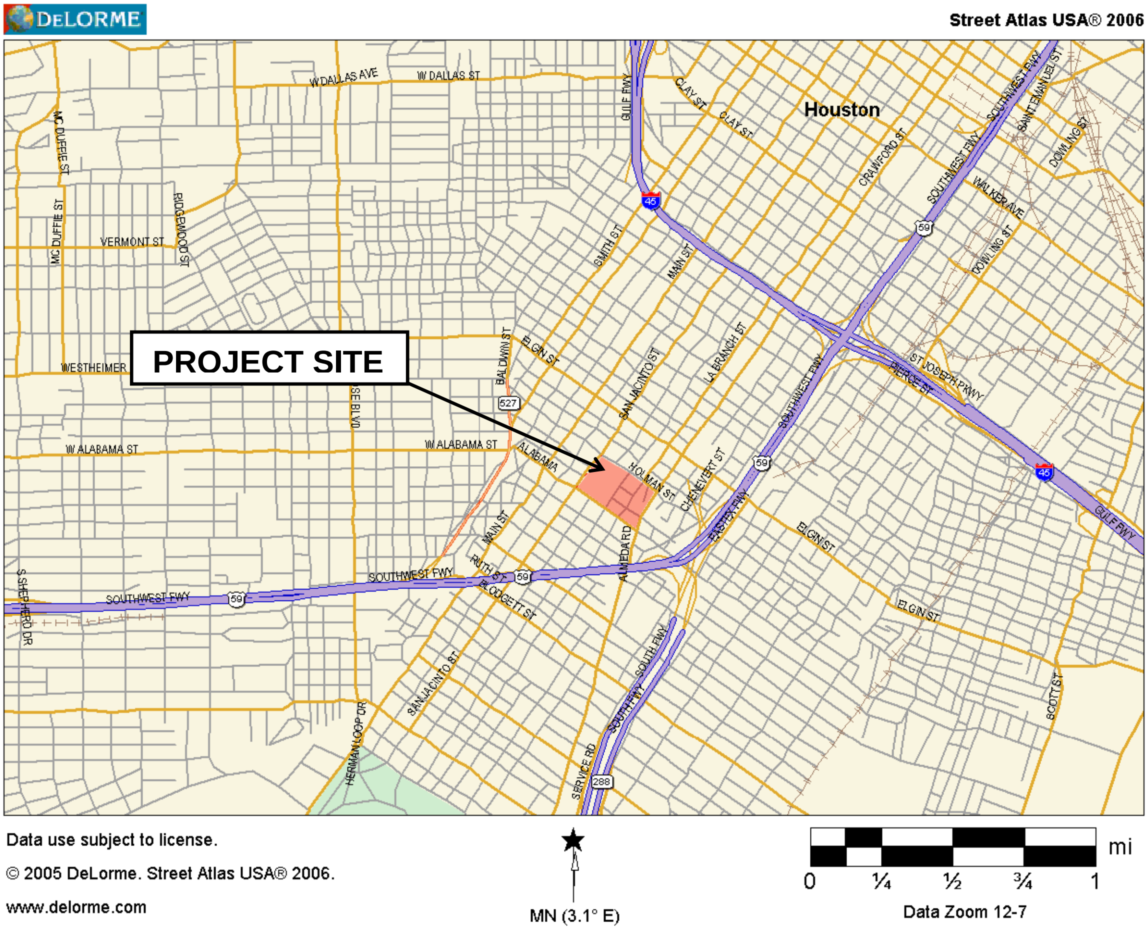
Scott A. Marr
7 Nov 2012
Scott A. Marr, P.E., LEED AP
Project Manager

SCOTT A. MARR
99309

Copies Submitted: Electronic PDF (1); Bound (4)

SV/JPC/SAM
R:\04120\2010 Projects\0001-0099\0412-10-0054\Reporting\04.12100054r.doc

ILLUSTRATIONS



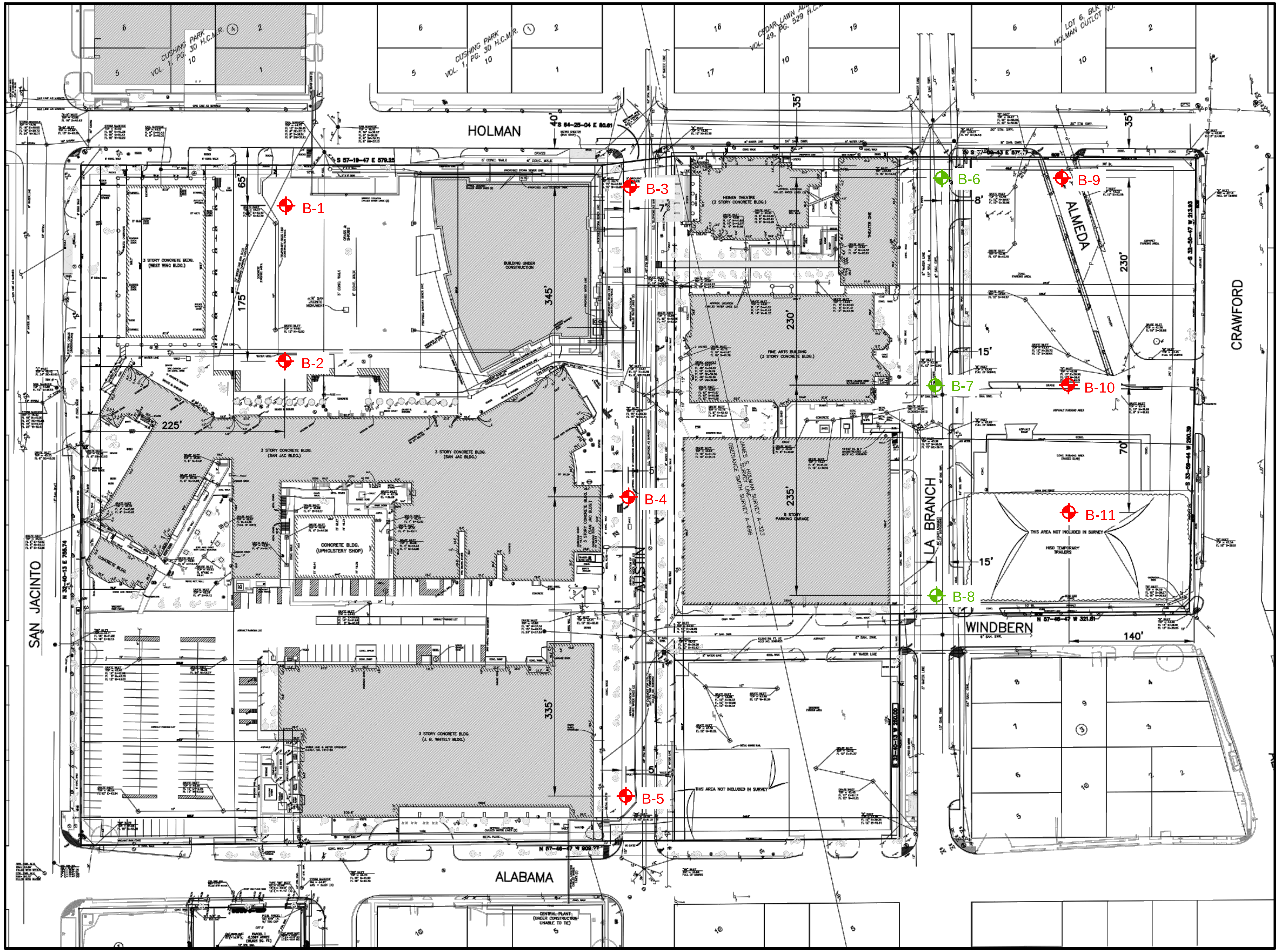
Data use subject to license.

© 2005 DeLorme. Street Atlas USA® 2006.

www.delorme.com

VICINITY MAP

HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS



LEGEND

⊕ B-1 GEOTECHNICAL BORING

⊕ B-6 GEOTECHNICAL BORING NOT EXPLORED

▨ EXISTING STRUCTURES

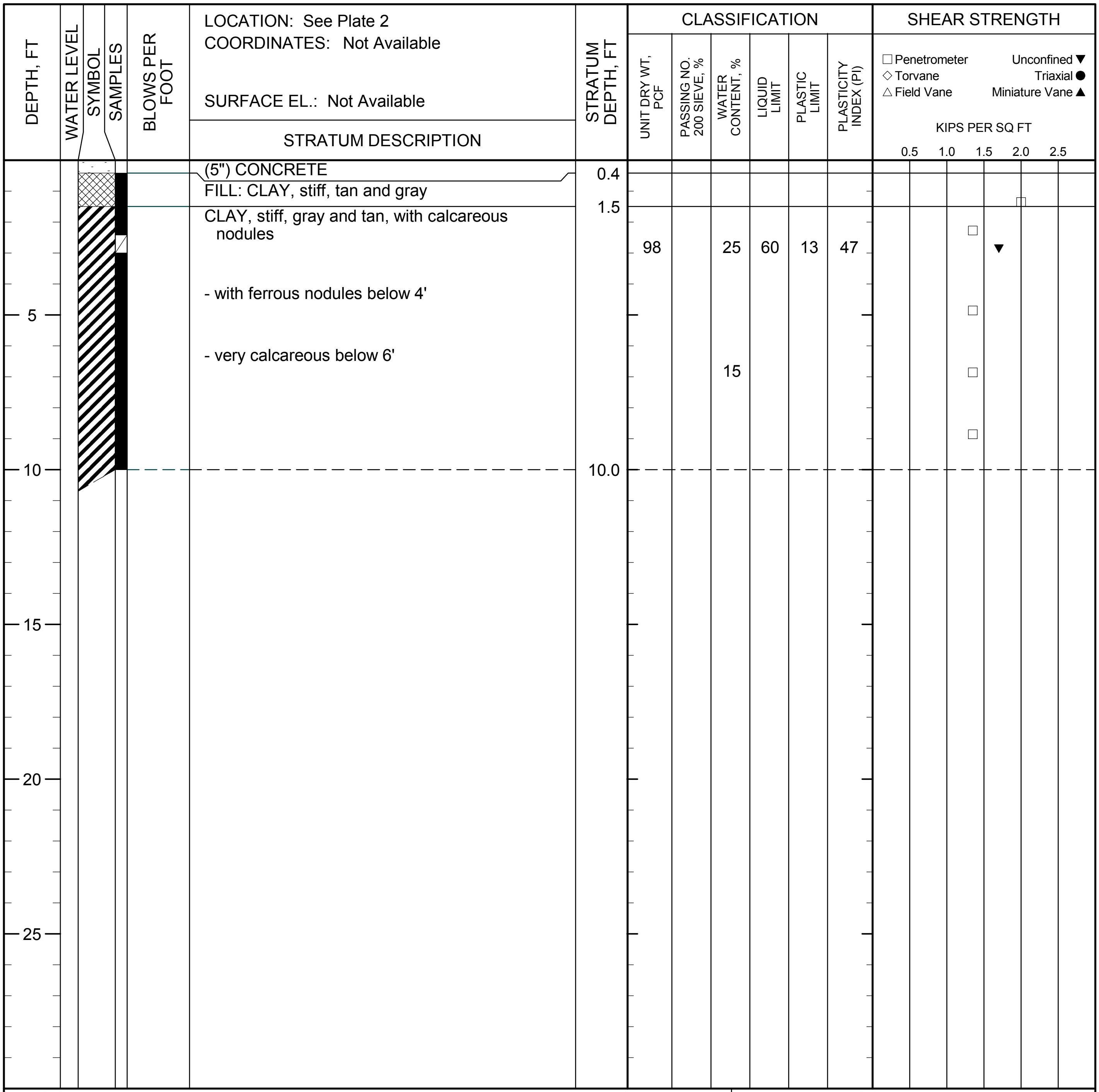
NOTES:
1. BORING LOCATIONS ARE APPROXIMATE.
2. BASE DRAWING PROVIDED BY ESPA CORP.

PLAN OF BORINGS

HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

0 120 240 FEET

PLATE 2



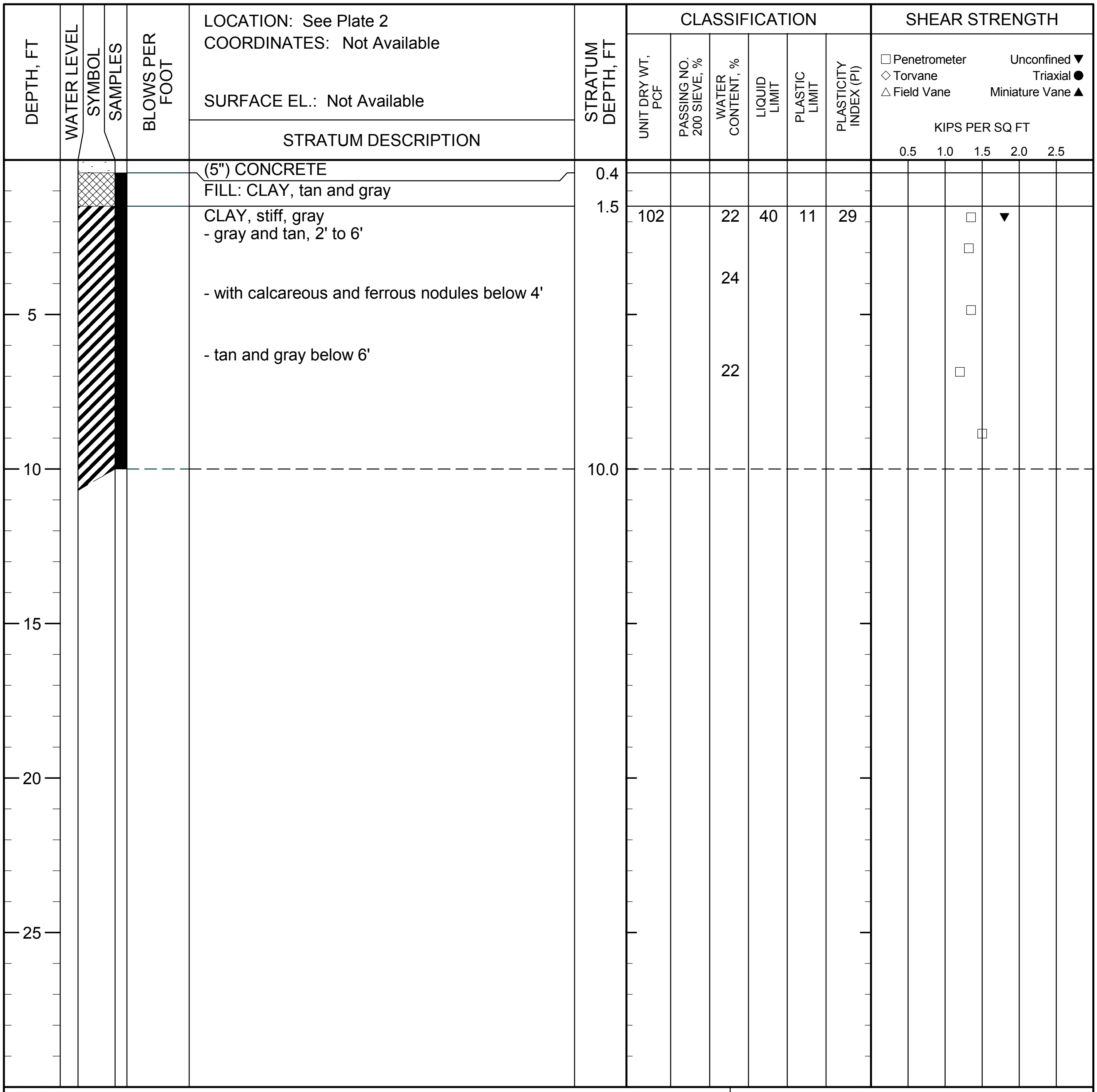
LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available

STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
(5") CONCRETE	0.4						
FILL: CLAY, stiff, tan and gray	1.5						
CLAY, stiff, gray and tan, with calcareous nodules		98		25	60	13	47
- with ferrous nodules below 4'							
- very calcareous below 6'				15			
	10.0						

NOTES:
1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

DATE: May 9, 2010
TOTAL DEPTH: 10'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 10'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: T. Mireles

LOG OF BORING NO. B-1
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS



LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	(5") CONCRETE	0.4						
	FILL: CLAY, tan and gray	1.5						
	CLAY, stiff, gray - gray and tan, 2' to 6'		102		22	40	11	29
	- with calcareous and ferrous nodules below 4'				24			
5								
	- tan and gray below 6'				22			
10		10.0						
15								
20								
25								

NOTES:
1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

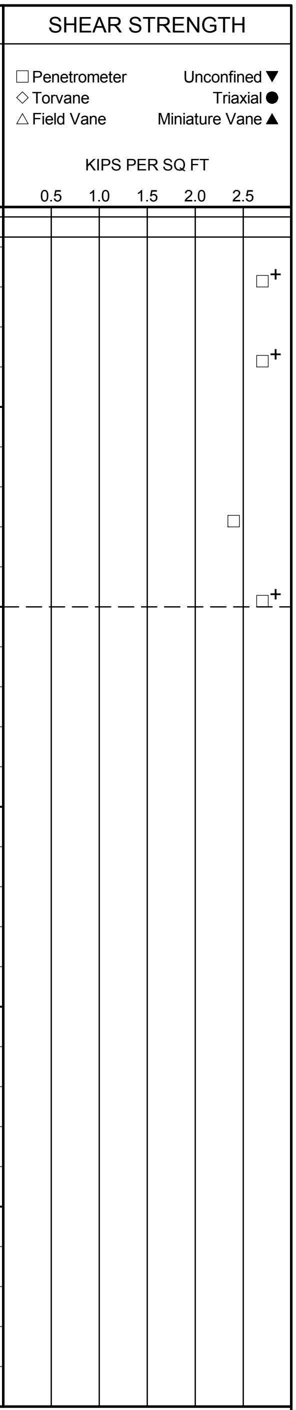
DATE: May 9, 2010
TOTAL DEPTH: 10'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 10'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: T. Mireles

R:\04120\2010 PROJECTS\0001-0099\0412-10-0054\DRAFTING\04.12100054.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 11/7/2012

LOG OF BORING NO. B-2
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	(3") ASPHALT	0.3						
	(6") CONCRETE	0.8						
	CLAY, very stiff, brown - with roots to 4'				10			
	- gray and black, with shell fragments, 4' to 8'							
5				86	16	48	10	38
	- brown and gray below 8'				18			
10		10.0						
15								
20								
25								

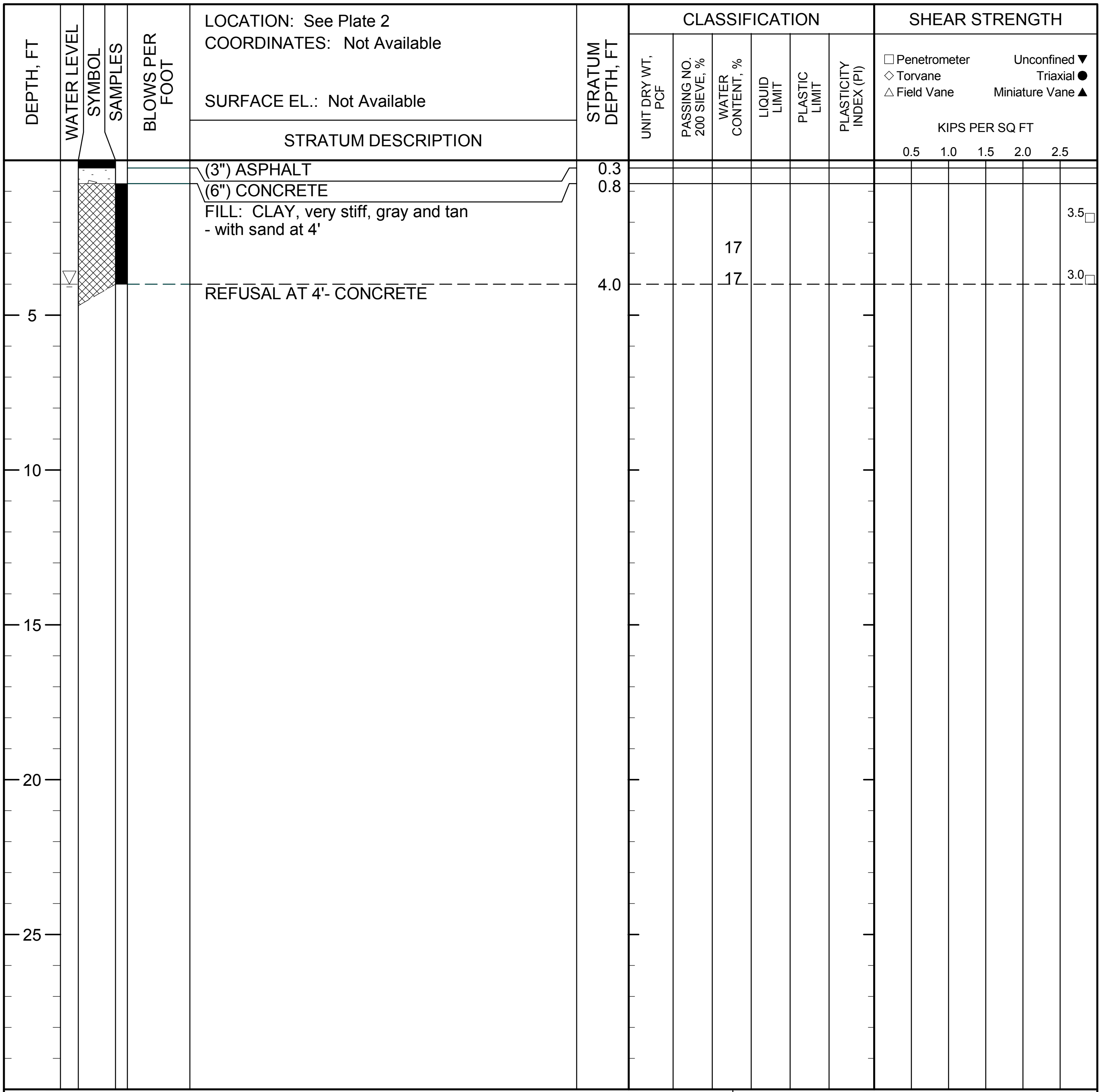


NOTES:
1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

DATE: May 22, 2010
TOTAL DEPTH: 10'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 10'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: B. Burkett

R:\04120\2010 PROJECTS\0001-0099\0412-10-0054\DRAFTING\04.12100054.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 11/7/2012

LOG OF BORING NO. B-3
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS



LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	WATER CONTENT, %	SHEAR STRENGTH, KIPS PER SQ FT (Penetrometer)
	(3") ASPHALT	0.3		
	(6") CONCRETE	0.8		
	FILL: CLAY, very stiff, gray and tan - with sand at 4'		17 17	3.5 3.0
	REFUSAL AT 4'- CONCRETE	4.0		

NOTES:
1. ▽: Water First Noticed.
2. Terms and symbols defined on Plates 11a and 11b.

DATE: May 22, 2010
TOTAL DEPTH: 4'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 4'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: B. Burkett

LOG OF BORING NO. B-4
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

LOCATION: See Plate 2
COORDINATES: Not Available

SURFACE EL.: Not Available

DEPTH, FT	WATER LEVEL	SYMBOL	SAMPLES	BLOWS PER FOOT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)	SHEAR STRENGTH, KIPS PER SQ FT
					(3") ASPHALT	0.3							
					(6") CONCRETE	0.8							
					FILL: CLAY, very stiff to hard, brown								4.0 ☐
													4.5 ☐+
5									12	46	10	36	
					REFUSAL AT 6'- CONCRETE	6.0							
10													
15													
20													
25													

CLASSIFICATION

SHEAR STRENGTH

☐ Penetrometer Unconfined ▼
◇ Torvane Triaxial ●
△ Field Vane Miniature Vane ▲

KIPS PER SQ FT

0.5 1.0 1.5 2.0 2.5

NOTES:
1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

DATE: May 22, 2010
TOTAL DEPTH: 6'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 6'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: B. Burkett

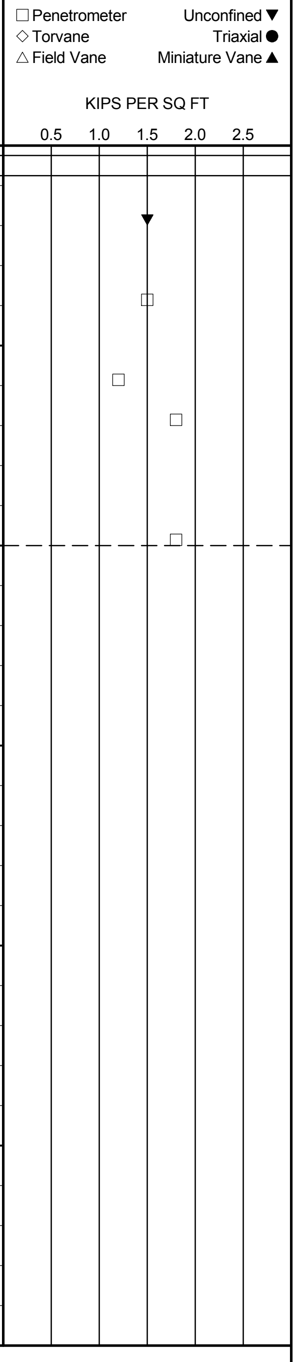
R:\04120\2010 PROJECTS\0001-0099\0412-10-0054\DRAFTING\04.12100054.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 11/7/2012

LOG OF BORING NO. B-5
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available

DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	(3") ASPHALT	0.3						
	(6") CONCRETE	0.8						
	CLAY, stiff, black		100		24	46	12	34
5					23			
	- gray and tan below 6'							
10		10.0						
15								
20								
25								

SHEAR STRENGTH

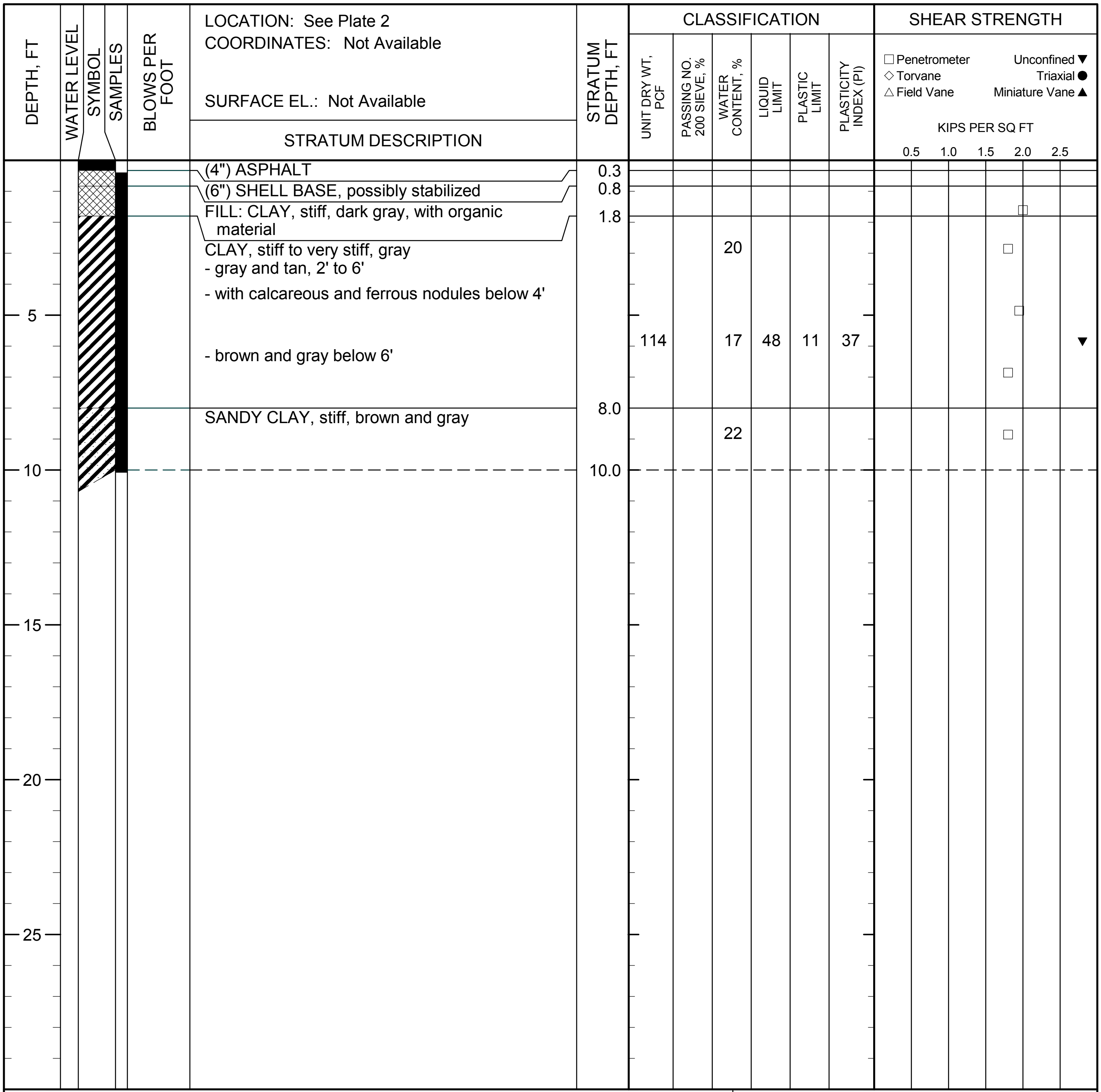


NOTES:
1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

DATE: May 22, 2010
TOTAL DEPTH: 10'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 10'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: B. Burkett

LOG OF BORING NO. B-9
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available



STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
(4") ASPHALT	0.3						
(6") SHELL BASE, possibly stabilized	0.8						
FILL: CLAY, stiff, dark gray, with organic material	1.8						
CLAY, stiff to very stiff, gray - gray and tan, 2' to 6' - with calcareous and ferrous nodules below 4'				20			
- brown and gray below 6'		114		17	48	11	37
	8.0						
SANDY CLAY, stiff, brown and gray				22			
	10.0						

NOTES:
1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

DATE: May 9, 2010
TOTAL DEPTH: 10'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 10'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: T. Mireles

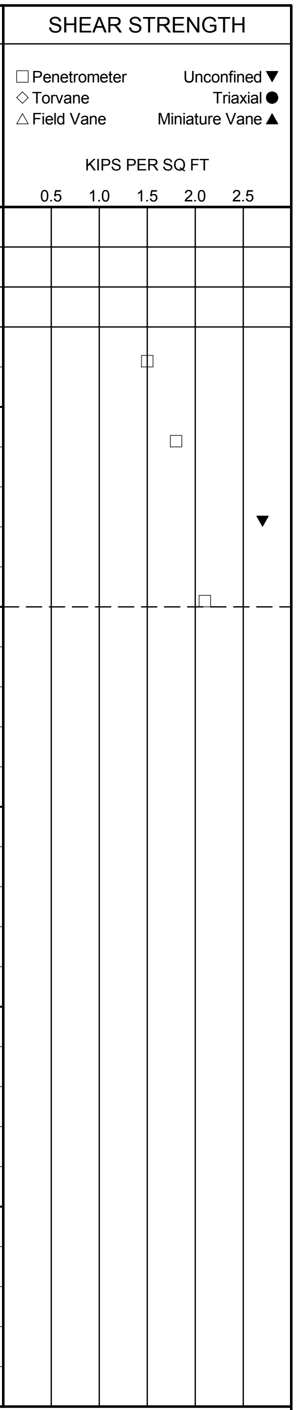
R:\04120\2010 PROJECTS\0001-0099\0412-10-0054\DRAFTING\04.12100054.GPJ FUGRO_SO (LAB DATA)_INDUSTRIAL GROUP 11/7/2012

LOG OF BORING NO. B-10
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

LOCATION: See Plate 2
COORDINATES: Not Available
SURFACE EL.: Not Available

			CLASSIFICATION					
DEPTH, FT	STRATUM DESCRIPTION	STRATUM DEPTH, FT	UNIT DRY WT, PCF	PASSING NO. 200 SIEVE, %	WATER CONTENT, %	LIQUID LIMIT	PLASTIC LIMIT	PLASTICITY INDEX (PI)
	(4") CONCRETE over (3") SAND over (5") CONCRETE	1.0						
	CLAY, brown	2.0						
	SAND, gray, fine-grained	3.0						
	CLAY, stiff to very stiff, black				21			
5					18			
	- gray and tan below 6'							
			102		18	47	11	36
10		10.0						
15								
20								
25								

SHEAR STRENGTH



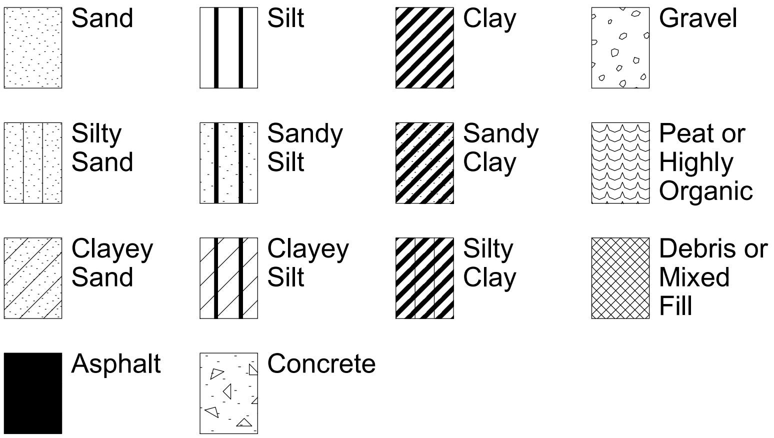
NOTES:

1. Free water was not encountered during drilling.
2. Terms and symbols defined on Plates 11a and 11b.

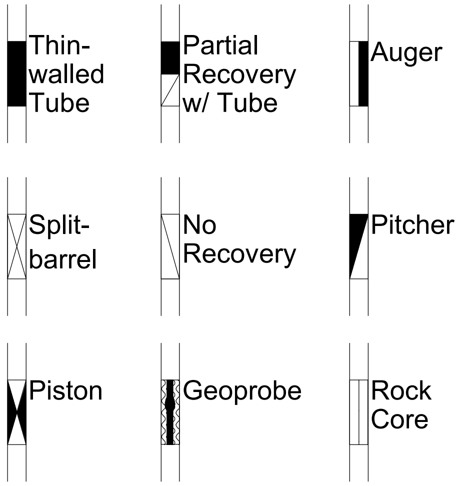
DATE: May 22, 2010
TOTAL DEPTH: 10'
CAVED DEPTH: Not Applicable
DRY AUGER: Surface to 10'
WET ROTARY: Not Applicable
BACKFILL: Holeplug and Drying Cement
LOGGER: B. Burkett

LOG OF BORING NO. B-11
HCC CENTRAL CAMPUS IMPROVEMENTS
HOUSTON COMMUNITY COLLEGE
HOUSTON, TEXAS

SOIL TYPES



SAMPLER TYPES



SOIL GRAIN SIZE

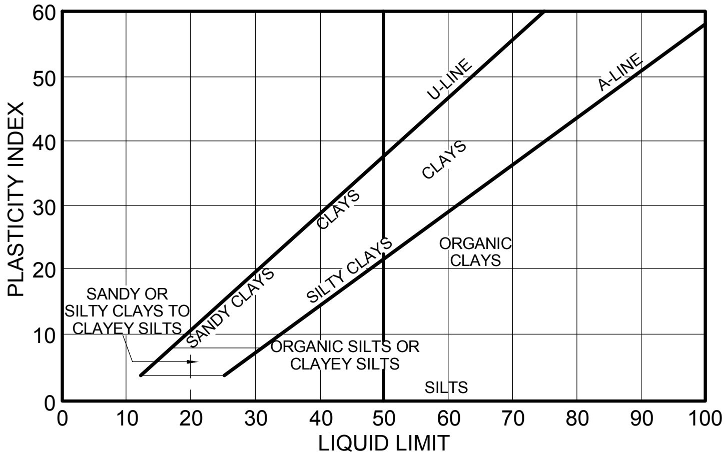
U.S. Standard Sieve

6" 3" 3/4" 4 10 40 200

Boulders	Cobbles	Gravel		Sand			Silt	Clay
		Coarse	Fine	Coarse	Medium	Fine		

152 76.2 19.1 4.76 2.00 0.420 0.074 0.002 (mm)

PLASTICITY CHART



SOIL STRUCTURE

Slickensided	Having planes of weakness that appear slick and glossy.
Fissured	Containing shrinkage or relief cracks, often filled with fine sand or silt; usually more or less vertical.
Pocket	Inclusion of material of different texture that is smaller than the diameter of the sample.
Parting	Inclusion less than 1/8 inch thick extending through the sample.
Seam	Inclusion 1/8 inch to 3 inches thick extending through the sample.
Layer	Inclusion greater than 3 inches thick extending through the sample.
Laminated	Soil sample composed of alternating partings or seams of different soil type.
Interlayered	Soil sample composed of alternating layers of different soil type.
Intermixed	Soil sample composed of pockets of different soil type and layered or laminated structure is not evident.
Calcareous	Having appreciable quantities of carbonate.
Carbonate	Having more than 50% carbonate content.

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL CLASSIFICATION (1 of 2)

STANDARD PENETRATION TEST (SPT)

A 2-in.-OD, 1-3/8-ID split spoon sampler is driven 1.5 ft into undisturbed soil with a 140-pound hammer free falling 30 in. After the sampler is seated 6 in. into undisturbed soil, the number of blows required to drive the sampler the last 12 in. is the Standard Penetration Resistance or "N" value, which is recorded as blows per foot as described below.

SPLIT-BARREL SAMPLER DRIVING RECORD

Blows Per Foot	Description
25	25 blows drove sampler 12 inches, after initial 6 inches of seating.
50/7"	50 blows drove sampler 7 inches, after initial 6 inches of seating.
Ref/3"	50 blows drove sampler 3 inches during initial 6-inch seating interval.

NOTE: To avoid damage to sampling tools, driving is limited to 50 blows during or after seating interval.

DENSITY OF GRANULAR SOILS

Descriptive Term	*Relative Density, %	**Blows Per Foot (SPT)
Very Loose	< 15	0 to 4
Loose	15 to 35	5 to 10
Medium Dense	35 to 65	11 to 30
Dense	65 to 85	31 to 50
Very Dense	> 85	> 50

*Estimated from sampler driving record.

**Requires correction for depth, groundwater level, and grain size.

STRENGTH OF COHESIVE SOILS

Term	Undrained Shear Strength, ksf	Blows Per Foot (SPT) (approximate)
Very Soft	< 0.25	0 to 2
Soft	0.25 to 0.50	2 to 4
Firm	0.50 to 1.00	4 to 8
Stiff	1.00 to 2.00	8 to 16
Very Stiff	2.00 to 4.00	16 to 32
Hard	> 4.00	> 32

SHEAR STRENGTH TEST METHOD

U - Unconfined Q = Unconsolidated - Undrained Triaxial

P = Pocket Penetrometer T = Torvane V = Miniature Vane F = Field Vane

HAND PENETROMETER CORRECTION

Our experience has shown that the hand penetrometer generally overestimates the in-situ undrained shear strength of over consolidated Pleistocene Gulf Coast clays. These strengths are partially controlled by the presence of macroscopic soil defects such as slickensides, which generally do not influence smaller scale tests like the hand penetrometer. Based on our experience, we have adjusted these field estimates of the undrained shear strength of natural, overconsolidated Pleistocene Gulf Coast soils by multiplying the measured penetrometer reading by a factor of 0.6. These adjusted strength estimates are recorded in the "Shear Strength" column on the boring logs. Except as described in the text, we have not adjusted estimates of the undrained shear strength for projects located outside of the Pleistocene Gulf Coast formations.

Information on each boring log is a compilation of subsurface conditions and soil or rock classifications obtained from the field as well as from laboratory testing of samples. Strata have been interpreted by commonly accepted procedures. The stratum lines on the logs may be transitional and approximate in nature. Water level measurements refer only to those observed at the time and places indicated, and can vary with time, geologic condition, or construction activity.

TERMS AND SYMBOLS USED ON BORING LOGS

SOIL CLASSIFICATION (2 of 2)

APPENDIX A

FUGRO CONSULTANTS, INC.

6100 HILLCROFT
PHONE (713) 369-5400

HOUSTON, TEXAS 77081
FAX (713) 369-5518

RESULTS OF TESTS

PROJECT:	B-2, S-4 @ 4'
FOR:	FUGRO CONSULTANTS, INC. HOUSTON, TEXAS
REPORTED TO:	SCOTT MARR
LAB NUMBER:	0528046

REPORT DATE:	06-02-10
CLIENT NUMBER:	
JOB NUMBER:	04.1210-0054
REPORT NUMBER:	
DATE SAMPLED:	
TIME SAMPLED:	
SAMPLED BY:	CLIENT
DATE RECEIVED:	05-28-10
TIME RECEIVED:	0700
RECEIVED BY:	SD

PARAMETER	RESULTS	UNITS	METHOD	TIME/DATE	ANALYST
pH	8.5	SU	ASTM G 51	1400/05-31-10	SD
Sulfate	< 100 *	mg/kg	ASTM D 516	1500/05-31-10	SD
Chloride	< 100 *	mg/kg	ASTM D 512	1430/05-31-10	SD

* Dry weight basis

SO4 023-10
SCL 013-10

Respectfully submitted,

Steve DeGregorio
Chemist

SD/mn

THE RESULTS RELATE AS TO THE LOCATION TESTED AND NO OTHER REFERENCE SHALL BE MADE.
THIS REPORT SHALL NOT BE REPRODUCED EXCEPT IN FULL WITHOUT THE WRITTEN APPROVAL OF THE LABORATORY.

FUGRO CONSULTANTS, INC.

6100 HILLCROFT
PHONE (713) 369-5400

HOUSTON, TEXAS 77081
FAX (713) 369-5518

RESULTS OF TESTS

PROJECT:	B-4, S-3 @ 4'	REPORT DATE:	06-02-10
		CLIENT NUMBER:	
		JOB NUMBER:	04.1210-0054
FOR:	FUGRO CONSULTANTS, INC. HOUSTON, TEXAS	REPORT NUMBER:	
		DATE SAMPLED:	
		TIME SAMPLED:	
REPORTED TO:	SCOTT MARR	SAMPLED BY:	CLIENT
		DATE RECEIVED:	05-28-10
		TIME RECEIVED:	0700
LAB NUMBER:	0528047	RECEIVED BY:	SD

PARAMETER	RESULTS	UNITS	METHOD	TIME/DATE	ANALYST
pH	8.3	SU	ASTM G 51	1400/05-31-10	SD
Sulfate	144 *	mg/kg	ASTM D 516	1500/05-31-10	SD
Chloride	215 *	mg/kg	ASTM D 512	1430/05-31-10	SD

* Dry weight basis

SO4 023-10
SCL 013-10

Respectfully submitted,

Steve DeGregorio
Chemist

SD/mn

FUGRO CONSULTANTS, INC.

6100 HILLCROFT
PHONE (713) 369-5400

HOUSTON, TEXAS 77081
FAX (713) 369-5518

RESULTS OF TESTS

PROJECT: B-11, S-3 @ 4'

FOR: FUGRO CONSULTANTS, INC.
HOUSTON, TEXAS

REPORTED TO: SCOTT MARR

LAB NUMBER: 0528048

REPORT DATE: 06-02-10
CLIENT NUMBER:
JOB NUMBER: 04.1210-0054
REPORT NUMBER:
DATE SAMPLED:
TIME SAMPLED:
SAMPLED BY: CLIENT
DATE RECEIVED: 05-28-10
TIME RECEIVED: 0700
RECEIVED BY: SD

PARAMETER	RESULTS	UNITS	METHOD	TIME/DATE	ANALYST
pH	8.3	SU	ASTM G 51	1400/05-31-10	SD
Sulfate	< 100 *	mg/kg	ASTM D 516	1500/05-31-10	SD
Chloride	< 100 *	mg/kg	ASTM D 512	1430/05-31-10	SD

* Dry weight basis

SO4 023-10
SCL 013-10

Respectfully submitted,

Steve DeGregorio
Chemist

SD/mn