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February 13, 2017

Mr. Paul Cho
California Regional Water Quality Control Board
Los Angeles Region
320 West 4th Street, Suite 200
Los Angeles, California 90013

Dear Mr. Cho:

Attached is the *TF-18 Area LNAPL Recovery Report and Interim Work Plan* for Defense Fuel Support Point (DFSP) Norwalk (Geotracker ID SLT43185183) located at 15306 Norwalk Boulevard, Norwalk, California.

This Work Plan presents the results of the completed LNAPL investigation and LNAPL skimming system reconfiguration in the eastern-central part of the site and proposes pilot testing tasks to evaluate enhanced LNAPL recovery methods. Prevention of LNAPL migration and the reduction in the potential for continued dissolved-phase hydrocarbon plume development are remedial goals applicable to the TF-18 area as well as the DFSP facility. This Work Plan proposes installing four new testing wells and conducting pilot testing to evaluate efficacy of enhanced LNAPL recovery methods (pneumatic skimming, vacuum-enhanced skimming, and total fluids extraction). Additionally, this Work Plan proposes a bench scale study for surfactants to evaluate efficacy of LNAPL mobilization enhancement.

If you have any questions or need additional information concerning this document, please contact Ms. Carol Devier-Heeney at (703) 767-9813 or carol.devier-heeney@dla.mil.

Sincerely,

Laura A Fleming

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Laura A. Fleming
Chief, Environmental Division

Enclosure
As stated

cc:
Carol Devier-Heeney, DLA
Paul Parmentier, Principal Hydrogeologist, The Source Group, Inc.

TF-18 AREA LNAPL RECOVERY REPORT AND INTERIM WORK PLAN
Defense Fuel Support Point - Norwalk
15306 Norwalk Boulevard
Norwalk, CA 90650

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Prepared For:

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January 18, 2017

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1.0 INTRODUCTION

On behalf of our client, Defense Logistics Agency Installation Support for Energy (DLA), The Source Group, Inc. (SGI) is submitting this *TF-18 Area LNAPL* (light non-aqueous phase liquid) *Recovery Report and Interim Work Plan* (Work Plan) for the former Defense Fuel Support Point (DFSP) Norwalk facility located at 15306 Norwalk Boulevard, Norwalk, California (Site; Figure 1). This Work Plan summarizes completed LNAPL investigation results, current interim LNAPL recovery efforts, and proposed future actions to remove free-phase LNAPL that is present in the central-eastern portion of the Site, in the vicinity of existing LNAPL recovery well TF-18 which is located between former above ground fuel storage tank (AST) Basins 55004 and 80008 (Figure 2).

Recovery well TF-18 was installed as part of the original groundwater remediation system installed within the former tank farm of DFSP Norwalk in the mid-1990s and was used as a total fluids (TF) recovery point for the extraction of groundwater and LNAPL for over 10 years. More recently, the well has been for used LNAPL skimming and LNAPL-only pumping. This well and the surrounding area is the focus of the work described herein as one to three-foot thick LNAPL has consistently accumulated in the well since early 2013. The persistence of this LNAPL occurrence has been interpreted to be the result of a significant mass of recoverable LNAPL present in the subsurface and thus should be a focus of future remedial efforts.

Recent remediation at the Site has focused on shallow soil remediation, with excavation and on-site treatment of approximately 65,000 cubic yards of petroleum-containing soil. This shallow soil remediation was presented in the November 2014 *Soil Remediation Action Plan* (RAP; SGI, 2014a), and in a subsequent addendum (SGI, 2014b). The approval of the RAP by the Los Angeles Regional Water Quality Control Board (RWQCB; RWQCB, 2015) also included several requirements, including a condition that a work plan for enhanced LNAPL removal was to be submitted by June 30, 2015. As described in Section 1.4, recent LNAPL recovery efforts have been focused on the TF-18 area located in the central part of the Site.

1.1 Objectives of the Work Plan

This Work Plan presents the results of the completed LNAPL investigation and LNAPL skimming system reconfiguration in the central part of the site and proposes pilot testing tasks to evaluate enhanced LNAPL recovery methods.

1.2 Work Plan Outline

The Work Plan includes the following sections: Section 1 – introduction; Section 2 - LNAPL investigation and central area LNAPL skimming; Section 3 – proposed enhanced recovery methods pilot testing; Section 4 – limitations; and Section 5 - references.

1.3 Site Location and Vicinity

The DFSP Norwalk facility is a 50-acre facility that formerly included 12 aboveground storage tanks used for storage of jet propellant (JP)-4, JP-5, and JP-8. Aviation gasoline was reportedly distributed at the truck rack, but not stored in the above ground tanks. Santa Fe Pacific Pipeline, L.P. (SFPP), an operating partner of Kinder Morgan Energy Partners, L.P. (KMEP), leases a 2-acre easement along the southern and eastern boundaries of DFSP for operation of its pipelines, which convey gasoline, diesel, and jet fuel. Within the southern easement lie three active pipelines, one of which is a 16-inch diameter pipeline, designated LS-1. LS-1 bends at the southeastern corner of the facility and continues northward within the eastern easement. An abandoned pipeline also runs along the eastern boundary of the Site. The DLA has decommissioned and removed all fuel storage and handling assets from the site; SFPP pipelines remain in operation.

1.4 Background

On June 30, 2015, SGI submitted a work plan for the evaluation of LNAPL recovery methods (SGI, 2015), to be implemented in the northeastern portion of the Site in the area generally referred to as the “GMW-62 area.” The 2015 LNAPL recovery work plan included proposed additional ultraviolet optical screening tool (UVOST) soundings and discussed the potential for the pilot testing of enhanced LNAPL removals through the use of surfactant flush methods. However, during the summer of 2015 gauging of GMW-62 and surrounding monitoring wells demonstrated that the LNAPL thickness in the GMW-62 area had significantly decreased (from measured thicknesses of 5.5 feet measured in October 2014 to 0.01 feet measured in October 2016). Confirming these observations, additional assessment completed in the Holifield Park located east of the GMW-62 area indicated that the extent of LNAPL in the GMW-62 area is laterally limited. Therefore, expanded recovery of LNAPL in the vicinity of GMW-62 is not warranted at this time.

Subsequently, due to the presence and recovery of a significant mass of LNAPL at TF-18 and the nearby well TF-19, during the summer of 2016 LNAPL removal efforts were refocused on the TF-18 area in the northern portion of former AST Basin 55004. To evaluate the lateral extent of the LNAPL detected in TF-18 and to evaluate the need for additional LNAPL recovery wells, field investigations of LNAPL distribution and depth were conducted and additional wells were installed. Testing of LNAPL occurrence in the central part of the site, particularly at well TF-18, indicated consistent LNAPL thicknesses of approximately three feet, and LNAPL recovery enhancement efforts were subsequently focused on the TF-18 area.

The additional LNAPL investigations conducted in the TF-18 area were previously summarized in the May 31, 2016, report on soil conditions in the eastern part of the site (“Addendum to Shallow Soil Closure Report”; SGI, 2016). That report includes the results of LNAPL transmissivity testing (Tn testing) and provides LNAPL accumulation estimates based on Tn testing and soundings results. This Work Plan presents in greater detail the findings from the TF-18 area LNAPL investigation, Tn testing, LNAPL skimming, and proposes next steps to continue and expand the recovery of LNAPL from the area surrounding TF-18. Once completed, the data obtained from this proposed work will form the basis for expanding, where necessary, LNAPL recovery efforts at the Site.

At the request of RWQCB, an LNAPL conceptual site model (LCSM) will also be submitted to provide a site-wide approach to *in-situ* remediation and a path to closure. The LCSM will be provided in a separate document upon completion of the work proposed herein.

2.0 TF-18 AREA LNAPL INVESTIGATION AND ON-GOING LNAPL REMOVAL

In the eastern-central part of the site, LNAPL has been consistently reported in wells (including TF-18 and TF-19; reference Figure 6) in an area centered in the northern portion of former AST Basin 55004. LNAPL has previously been removed by automated pumping (total fluids extraction wells) and then after site demolition activities were completed by Parsons in 2012, through the periodic extraction of LNAPL using vacuum trucks and hand-bailing.

To prepare for the shallow soil remediation by excavation and on-site soil treatment, remediation wells, including LNAPL-removal wells, that were present within proposed areas of excavation or soil treatment were abandoned in accordance with state of California water well requirements. As outlined in the November 2014 RAP (SGI 2014 a; Section 7.11), the previous remediation system was to be recommissioned after shallow soil excavation, treatment, and backfilling operations were completed. The recommissioning of remedial systems at the Site was to include the preparation and submittal of work plans for pilot testing of additional remediation technologies. Excavation of contaminated soil was conducted in Basins 80008 and 55004, north and south of TF-18. LNAPL removal in TF-18 by periodic pumping continued during the surrounding soil excavation and backfilling operations.

The investigation and enhanced removal of LNAPL in the central part of the site included a targeted cone penetrometer (CPT) / UVOST investigation, installation of additional LNAPL recovery wells near existing recovery well TF-18, LNAPL transmissivity testing of the recovery wells, and LNAPL skimming/automated extraction in the recovery wells. These activities and subsequent data analyses efforts for remedial optimization are discussed in more detail in the following sections.

2.1 UVOST Investigation

Beginning in 2010, several rounds of CPT/UVOST profiling investigations were conducted to further define the LNAPL nature and extent in those portions of the Site which previous work had demonstrated that fuel releases from past operation of military fuel handling and storage infrastructure had occurred. These investigations were performed to provide a more comprehensive understanding of the occurrence of recoverable LNAPL and to serve as a basis for enhancing future LNAPL recovery efforts.

In October 2010, Parsons conducted a CPT/UVOST investigation which entailed the completion of fifteen (15) locations across the Site. These locations are identified as UV-1 through UV-15 (Figure 2).

The second CPT/UVOST investigation was performed by SGI in November and December 2015, with 29 soundings completed (locations UV-CPT-1 through UV-CPT-29). An additional supplemental investigation was completed in August 2016 which involved 10 sounding locations identified as UV-CPT-30 through UV-CPT-39. Sounding locations for all three sets of CPT/UVOST profiling are listed on Table 1 and shown on Figure 2. The CPT and UVOST profiles for each location including the 2010 UVOST sounding results, and a sounding location map are included in Appendix B.

The 2010, 2015, and 2016 CPT/UVOST soundings were conducted by Gregg Drilling of Signal Hill, CA. Figure 3 illustrates an example of UVOST response where LNAPL was reported at location UV-CPT 1 northwest of TF-18. As shown on Figure 3, the signal intensity response, indicative of LNAPL, was reported as significant at two principal depths: 25 feet below ground surface (ft bgs), the area of shallow historical groundwater (consistent with groundwater levels at the site in the 1990's and early 2000s), and in the interval of 31-34 ft bgs, with a 3.2 % signal recovery over a 2.5 ft thickness where LNAPL has been recently reported and has been the focus of LNAPL removal.

Each CPT/UVOST log was subsequently evaluated for indications that significant occurrences of LNAPL were present. Table 1 presents a list of UVOST soundings and the interpreted presence and depth interval containing significant indications of LNAPL. Appendix C presents a detailed evaluation of the CPT/UVOST profiles and includes an estimate and significance of the UVOST signal, the estimated thickness of LNAPL, and the overall lateral distribution of LNAPL at the Site. As described in Appendix C, the interpreted volume of LNAPL in the central portion of the site is estimated at approximately 370,000 gallons. The UVOST investigation indicated that the LNAPL in TF-18 is at the southwestern edge of a LNAPL plume which extends from the northeastern end of Former Basin 80006 to Basins 80008 and 55004 (Appendix C and Figure 2).

Based on the UVOST-interpreted presence of apparent thickest LNAPL over an area near and generally west of TF-18, five LNAPL recovery wells were installed to supplement the LNAPL removal conducted from TF-18 and TF-19. The installation and subsequent testing of these wells is described in Section 2.2.

2.2 TF-18 Area Wells: Installation and LNAPL Transmissivity Testing

Five additional LNAPL recovery wells were installed near existing well TF-18 in late December 2015, after permits were obtained from the Los Angeles County Health Department (Appendix A). The well installation was performed by BC2 Environmental and supervised by a SGI geologist working under the oversight of a California Professional Geologist. All wells encountered a similar lithology, with a sandy interval encountered from the surface to a depth of 20 ft bgs, a silty layer from 20-25 or 30 ft bgs (well RTF-18W), and finally a poorly graded sand was present at depths greater than 30 ft bgs. Consistent with the findings of the UVOST soundings, LNAPL was found to occur primarily in a poorly graded sandy layer present at a depth of 32-34 feet; well logs are included in Appendix D.

To evaluate the potential recoverability of LNAPL in the TF-18 area, SGI completed LNAPL bail-down/recovery tests of well TF-18 and the five newly installed recovery wells. The bail-down test performed entailed the removal of accumulated LNAPL followed by monitoring of the recovery rate of LNAPL into the well to allow LNAPL transmissivity (Tn) to be calculated. The bail-down tests were planned, conducted, and analyzed in general accordance with ASTM Standard Guide for Estimation of LNAPL Transmissivity (E2856 − 13). The ITRC Technical/Guidance Document Evaluating LNAPL Remedial Technologies for Achieving Project Goals (December 2009) was consulted during the compilation and interpretation of test results. Tn testing is useful for evaluating potential LNAPL recoverability using conventional techniques such as LNAPL- only skimming, total fluids recovery (water and LNAPL), and/or hand-bailing.

Bail-down testing of the original well TF-18 was performed in November 2015. Testing of the five other TF-18 area wells was performed in April 2016. Field and data analysis details are described in Appendix C. A graphical plot of recovery data for well TF-18 is provided in Figure 4. Calculated Tn values ranged from 0.3 ft^2/day at well RTF-18-W to 15.1 ft^2/day at well RTF-18-E, with a simple average of 6.3 ft^2/day:

- TF-18 (tested 11/23/15): Tn = 4.0 ft^2/day
- RTF-18-E (tested 4/28/16): Tn = 15.1 ft^2/day
- RTF-18-N (tested 4/13/16): Tn = 4.9 ft^2/day
- RTF-18-W (tested 4/13/16): Tn = 0.3 ft^2/day
- RTF-18-NW (tested 4/28/16): Tn = 10.8 ft^2/day
- RTF-18-NNW (tested 4/13/16): Tn = 2.5 ft^2/day

According to ITRC guidance, Tn values above 0.1 to 0.8 ft^2/day are indicative of conditions that will readily support simple hydraulic recovery of LNAPL via such methods as skimming or total fluids extraction (water and product). Hydraulic LNAPL removal is typically conducted until Tn values decrease to below the 0.1 to 0.8 ft^2/day range. The determination of whether the remaining LNAPL represents a short term concern or a longer term risk is site-specific. If the formation is relatively permeable, and the Tn has declined solely due to the removal of the most mobile fraction, more advanced LNAPL recovery techniques such as surfactant and polymer flushing can be employed to increase LNAPL recovery to achieve remedial objectives.

2.3 Comparison of Tn Values with CPT/ROST Findings

An evaluation was performed to determine whether the CPT/UVOST profile information and the estimated Tn values could be correlated to improve planning and LNAPL recovery in the TF-18 Area. The evaluation included more detailed CPT/UVOST data interpretation, estimation of LNAPL volume in the saturated core of the central LNAPL body, estimation of the LNAPL achievable recovery volume in the TF-18 Area currently accessible using simple hydraulic techniques, and assessment of correlation between UVOST indicators and bail-down test results.

The results of this data evaluation revealed that there does not appear to be a strong correlation between the CPT/UVOST data and the bail-down testing data (Appendix C). However, it is important to note that predictions of LNAPL recovery based solely on the bail-down Tn estimates are only modestly consistent with actual LNAPL recovery results achieved to date at the Site. The field applicability of both sets of data is at this time somewhat limited however, LNAPL removal by continued pumping is expected to provide additional understanding of LNAPL recoverability and LNAPL occurrence and mobility within the subsurface at the Site.

2.4 TF-18 Area LNAPL Skimming

Based on the results of Tn testing and UVOST data interpretation, an automated LNAPL skimming system was installed in August 2016 in the TF-18 area wells. The product recovery system began operating on August 8, 2016 following the completion of permitting and installation work. The system consists of four pneumatically-activated, 2-inch diameter product removal skimmers (Xitech instruments, Inc. Model ADJ200) deployed in key wells located in the TF-18 area. The extracted LNAPL is routed to a 1,500-gallon, Hoover Vault aboveground storage tank located within the existing DLA treatment compound in the former Powerine Basin (Figure 6). The treatment compound is equipped with an integrated secondary containment, as well as intrinsically safe high level system shutdown switches. LNAPL is routed from the skimmers to the tank via double-contained conveyance piping for temporary storage within the storage tank. The recovered LNAPL is removed from the tank by a licensed transporter for delivery to a licensed disposal/recycling facility.

The skimmers are operated via a programmable controller (Xitech Instruments, Inc. Model 500ES) that provides individual intermittent control for each skimmer through an internal solenoid assembly. Compressed air is supplied to the controller which distributes the supply to each skimmer in the well field. Individual skimmer cycling times/frequencies and on/off durations are adjusted regularly to optimize recovery.

During the third quarter of 2016, a total of approximately 2,338 gallons (16,003 pounds) of LNAPL was pumped from wells TF-18, RTF-18-N, RTF-18-E., RTF-18-W, RTF-18-NW and RTF-18-NNW (Figure 5). Approximately 75% of this volume was removed from wells TF-18 and RTF-18-NW, with wells RTF-18-N and RTF-18-E accounting for nearly the remainder of the LNAPL volume removed by the system during. Mass and volume removal estimates from these wells along with LNAPL gauging results are summarized in quarterly remediation reports submitted to the RWQCB.

When LNAPL yields decline and there is limited recovery occurring from the skimmers, follow-up bail-down testing will be conducted to establish updated Tn values and as a means to further evaluate any correlation between apparent (field measured) and actual (within the surrounding soil) product thicknesses. As described in the following section, pilot testing is proposed to evaluate the feasibility of system expansion and/or the use of enhanced recovery technologies to allow for LNAPL removal to the maximum extent practicable.

3.0 PROPOSED PILOT TESTING OF ENHANCED LNAPL RECOVERY METHODS

Prevention of LNAPL migration and the reduction in the potential for continued dissolved-phase hydrocarbon plume development are remedial goals applicable to the TF-18 area as well as the Site as a whole. This section of the Work Plan presents proposed technologies that will be evaluated and field tested to allow a determination to be made as to the approach that is most practical for the Site. Data and insights obtained from these activities will inform decision making concerning LNAPL management in the TF-18 area as well as other areas of the Norwalk facility. The location of the proposed pilot test area, as shown on Figure 6, will be centered at well RTF-18E.

The proposed evaluation of LNAPL recovery enhancement methods will include:

- The addition of LNAPL recovery/testing wells and the collection of soil samples for laboratory bench-scale testing.
- LNAPL skimming from a set of closely spaced wells to allow more detailed analysis of the lateral influence of LNAPL extraction on the surrounding LNAPL-saturated soils.
- LNAPL recovery under vacuum.
- LNAPL recovery using total fluids extraction, and
- Flush testing using water flooding, surfactant, and polymer flushing.

The following sections present the proposed approach to accomplish this evaluation.

3.1 Preparatory Tasks

The site- and task-specific health and safety plan (HASP) will be updated prior to field work. SGI and subcontractor personnel will be required to familiarize themselves with the HASP, sign the HASP prior to working on site, and adhere to the provisions of the HASP during all aspects of field work. The HASP identifies the specific chemical compounds known to exist in the subsurface at the site. In addition, the HASP presents the chemical properties of the identified and typical compounds and identifies task-specific health and safety risks.

Prior to the initiation of field activities, drilling permits will be obtained from the Los Angeles County Department of Health Services. Additionally, the proposed drilling locations will be pre-marked at the Site. Underground Service Alert (USA) will be notified to identify any potential subsurface utilities.

The RWQCB will be notified a minimum of 48 hours prior to the initiation of field activities.

3.2 Test Wells Installation

This section presents specifications for drilling, construction, and development of four test wells. The testing well array will consist of one (existing) central well and four new “radial” wells centered on this well. Coring of the LNAPL target zone will be conducted at one location mid-distance between the central test well and one of the radial test wells to provide pre-testing baseline LNAPL data and soil/groundwater samples for potential use in future bench testing of surfactant formulations.

Drilling and Construction of Test Wells

Four pilot test wells will be installed around a central (existing) extraction well, RTF-18NW. The pattern will consist of a central test well (RTF-18NW) and four test wells (EP-71 to EP-74) installed at four cardinal points, 15 feet from RTF-18NW (Figure 7). All test wells will be used for both monitoring and fluids extraction, depending on the objectives of each test. Additionally, as described above, a soil boring will be advanced at a point mid-distance between RTF-18NW and one of the four proposed test wells. Note that existing well RTF-18NW will be used for the field studies of chemically enhanced product recovery (flushing, as described below in Section 3) if this testing is deemed necessary per Section 3.4 below.

The wells will be installed using a hollow-stem auger (HSA) drill rig with equipped with 10-inch-outside diameter augers and operated by a California-licensed drilling contractor. SGI will supervise the drilling, installation, and development of the test wells.

While the test wells will be constructed in general accordance with the June 2014 CalEPA guidance manual *Well Design and Construction for Monitoring Groundwater at Contaminated Sites,* these test wells are not intended to function as long-term groundwater monitoring wells. The following describes proposed construction of the four test wells:

- The total depth of the four extraction wells is expected to be approximately 40 ft-bg. Due to the lithology contrasts over short vertical distances, the performance of individual test wells and the pilot testing as a whole is sensitive to screen interval placement. Therefore, the final selection of the screen intervals of the wells will be dependent on observations made during the completion of the soil borings
- Casing will be 4-inch diameter, PVC Schedule 40 flush thread.
- Screens will be 4-inch diameter, 304 Stainless Johnson standard “V” wire wrap screen with 20 slot for the screen size and a compatible sand pack (e.g., #2 sand).
- The annulus seal will include hydrated bentonite placed immediately above the sand pack to approximately 5 ft-bgs and then cement grout to ground surface. Prior to placing the bentonite chips and cement grout, the test wells will be surged to settle the sand pack.

Pre-test baseline data will be collected to allow an evaluation of the extent and nature of impacted soils and groundwater to a depth of approximately 40 ft-bg. This will be accomplished by the collection for laboratory analysis of soil samples collected during boring operations. A minimum of three soil samples will be collected from each soil boring and submitted for hydrocarbon chain characterization using EPA Method 8015 and for volatile organic chemicals using EPA Method 8260. Field monitoring and recording of conditions will be conducted during the installation of the four test wells with laboratory analysis to include the evaluation of LNAPL saturation of one soil sample from each well collected from the interval which field evaluation indicates contains the highest concentration of hydrocarbons.

Well Development

Following a 48-hour curing period, each test well will be developed to increase sand pack area for fluids flow (injection or extraction), remove fine particles/debris, and increase the potential for collection of representative fluids samples (e.g., groundwater and soil gas).

The test wells will be developed as follows:

- Water-jet the screen, operate the surge block, and then pump or air lift at a rate that is twice the projected injection/extraction rate.
- Repeat above process, based on turbidity measurements, until such time that fines and suspended solids have been removed and a maximum turbidity target of 10 nephelometric turbidity units (NTU) has been achieved, or until 200 gallons of development water have been removed from a given well.

Due to the special purpose of the test wells, the level of effort in development will be determined by SGI with consideration given to the effects of development on the formation immediately surrounding the test well adjacent to the screen interval. General guidance for the test wells will include 1) removal of a minimum of ten casing volumes, and 2) stabilization of water quality indicator parameters. Water quality parameters including pH, temperature, conductivity, and turbidity will be monitored to calculate stabilization within 10% of each successive parameter measurement. Stabilization provides an indication that representative groundwater is entering the well and that drilling-induced changes to the water quality have been eliminated.

During development of the test wells, measurements and observations of general fluid character including the potential presence of hydrocarbons including LNAPL will be recorded. Following development, the test well will be allowed to recover to within 2 feet of the initial water level prior to sampling (or monitoring) or 24 hours, whichever comes first.

Waste Management

Investigation-derived waste (soil cuttings, development fluids, and decontamination water) will be placed in lined soil bins and/or Department of Transportation (DOT)-approved 55-gallon steel drums that will be sealed, labeled, and stored at the Site pending characterization and disposal. Waste will be handled, transported, and disposed of according to applicable State and Federal regulations.

Waste will be profiled in accordance with California Code of Regulations, Title 22, Division 4.5, Chapters 10 through 32, and Federal RCRA regulations. After analytical results have been received and evaluated, the waste will be transported off site under manifest to a permitted recycling/disposal facility.

Survey

SGI will coordinate the surveying of all borehole locations or test well top of casings installed as a part of the pilot testing scope of work.

3.3 Pilot Testing

After the test wells have been installed and developed, a series of field pilot tests will be implemented to evaluate the efficacy of several enhanced LNAPL recovery methods. The proposed tests will be conducted over several consecutive weeks in the order listed below:

- *Pneumatic skimming*: The test objectives include estimating the radius of capture (ROC) based on drawdown during skimming from the test well and the four monitoring wells, which represent a much denser network of LNAPL recovery wells than the current six TF-18 area wells. As part of this work, LNAPL transmissivity (Tn) changes will be evaluated over time based on operational data for drawdown and recovery. Product skimming will continue elsewhere within the Site from wells not included in the LNAPL recovery enhancement testing described below.
- *Vacuum-enhanced skimming:* The test objectives include quantifying the change in LNAPL recovery rate and ROC observed under different vacuums applied at the test well, and evaluating the additional mass removal provided by via vapor extraction. It should be noted that, as the LNAPL in the TF 18 area is found in relatively permeable sands, a high vacuum may not be achievable and thus the efficacy of vacuum-enhanced LNAPL recovery may prove to be limited.
- *Total fluids extraction:* The test objectives include quantifying the change in LNAPL recovery rate and ROC observed under total fluids pumping (i.e. combined LNAPL and groundwater extraction), and evaluating the groundwater drawdown and ROC for different pumping rates.

The LNAPL drawdown and groundwater elevations will be monitored continuously in all five wells in the pilot test area before, during, and after each test. The LNAPL recovery volumes will be monitored at regular intervals during each test. For the vacuum-enhanced skimming test, the vacuum applied at the test well and vacuum responses at nearby monitoring wells will be monitored at regular intervals, and the flowrate and vapor concentrations will be measured periodically in the extraction vapor. Additionally, the volume and flowrates of the groundwater pumped will be monitored at regular intervals during the total fluid extraction test.

3.4 Surfactant Screening and Formulation Development

A limited-scope bench scale treatability study involving Site groundwater, LNAPL, soil, and several candidate surfactant and electrolyte/alkalinity agent formulations will be completed to evaluate the efficacy of LNAPL mobilization enhancement. To conduct the bench scale test, approximately four liters of groundwater, three liters of LNAPL, and 4.5 kilograms of LNAPL impacted soil will be obtained by drilling a soil boring within the proposed test area, as discussed previously. Several surfactant formulations/dosage levels will be developed and tested; surfactant concentration will be limited to two percent by weight or less. Effluent physical and chemical characteristics for the surfactant solution of apparent superior formulation/dosage will be considered. Only those surfactants and polymer chemicals that are listed on the approved RWQCB General Waste Discharge Requirement (WDR) permit (R4-2014-0187) will be tested or used during laboratory and any subsequent field trials.

In general, any chemical that has some surfactancy or co-solvency property will enhance LNAPL solubilization and mobilization. However, the goal of these studies will be to develop a means of optimizing LNAPL mobilization and/or solubilization to allow for the removal of up to 80 percent of the LNAPL mass present in water-saturated soils. Integration of polymer flush technology during and/or following a surfactant flush can lead to increased subsurface LNAPL "sweep" efficiency and up to a doubling of LNAPL recovery.

Enhancement of LNAPL through Flush Testing

After the completion of the bench test to determine the optimum formulation for chemically enhanced flushing of LNAPL in the TF-18 area, a field pilot test will be proposed if the skimming, vacuum-assisted, and total fluids removal methods described above are not considered sufficiently effective to reach LNAPL recovery rates appropriate for Site closure. The pilot test will be conducted with the site-specific surfactant/polymer formulation determined by the bench test, and would consist of a series of injection stages in existing well RTF-18NW after additional redevelopment, with groundwater extraction from the four perimeter wells. The stages include injection of potable water flushing followed by surfactant solution flushing followed by polymer flushing and finally additional water flushing. The test will continue until essentially all of the introduced solution has been recovered.

Data will be collected before, during, and after testing to evaluate hydrogeologic conditions, LNAPL mobility and recoverability, and hydraulic capture of the injected fluids. The detailed procedure for performance of a field pilot test was already previously included in the *Work Plan for LNAPL Mitigation Methods Evaluation, Northeastern LNAPL Ar*ea (SGI, 2015) submitted on June 30, 2015 for the mitigation of the presumed LNAPL in the northeastern (GMW-62) part of the Site. The procedures submitted in that Work Plan, and Waste Discharge Requirements permitting would similarly be applied to the TF-18 area pilot testing.

The pilot test of chemically enhanced LNAPL flushing will be designed to provide data of increased LNAPL removal rates that may be achieved by surfactant or polymer flushing; the resulting data will be used to develop estimates of cost to implement and conceptual design.

4.0 DATA ANALYSIS AND REPORTING

An integrated analysis of data from the testing detailed in this work plan will provide an effective means of determining the most effective method to address LNAPL present in the saturated zone at the Site. The integration of the newly collected and interpreted data will assist in development of a site-specific correlation relating lithology and LNAPL occurrence to the LNAPL recoverability and potential mobility.

A report detailing the completed scope of work, laboratory analytical results, field data and interpretation, and conclusions and recommendations to removal LNAPL from the TF-18 area and site-wide will be prepared and presented to the RWQCB.

The report will include the following:

- Test well installation: installation methods, field observations and results of laboratory testing.
- Surfactant bench testing results to provide the basis for developing a field pilot test.
- Pilot test results including information on LNAPL presence, mobility, and recovery rates under the various test conditions.
- Data Evaluation, and
- Conclusions.

It is anticipated that a report of findings will be issued within 45 days of the completion of all field and laboratory studies.

5.0 LIMITATIONS

This Work Plan was prepared for the exclusive use of Defense Logistics Agency Installation Support for Energy (DLA) for the express purpose of complying with regulatory directives for environmental investigation, in accordance with the scope of work, methodologies, and assumptions outlined in SGI's contract with DLA and as applicable to the location of the proposed investigation. Any re-use of this work product, in whole or in part, for a different purpose, or by others must be approved by SGI and DLA in writing. If any such unauthorized use occurs, it shall be at the user's sole risk without liability to SGI. To the extent that this plan is based on information provided to SGI by third parties, including DLA, their direct-contractors, previous workers, and other stakeholders, SGI cannot guarantee the completeness or accuracy of this information, even where efforts were made to verify third-party information. SGI has exercised professional judgment to collect and present a scope of work and opinions of a scientific and technical nature. The opinions expressed are based on the conditions of the site existing at the time of this plan preparation, current regulatory requirements, and any specified assumptions. Findings or conclusions presented in this plan are intended to be taken in their entirety to assist DLA and regulatory personnel in applying their own professional judgment in making decisions related to the property. SGI cannot provide conclusions on environmental conditions outside the completed scope of work. SGI cannot guarantee that future conditions will not change and affect the validity of the presented scope of work and any conclusions presented. No warranty or guarantee, whether expressed or implied, is made with respect to the data, observations, recommendations, and conclusions.

6.0 REFERENCES

The California Environmental Protection Agency, 2014. *Well Design and Construction for Monitoring Groundwater at Contaminated Sites, FINAL,* June.

The Source Group, Inc., 2015. *Work Plan for LNAPL Mitigation Methods Evaluation, Northeastern LNAPL Area,* June 30.

The Source Group, Inc., 2014 a. *Soil Remedial Action Plan*. November 30.

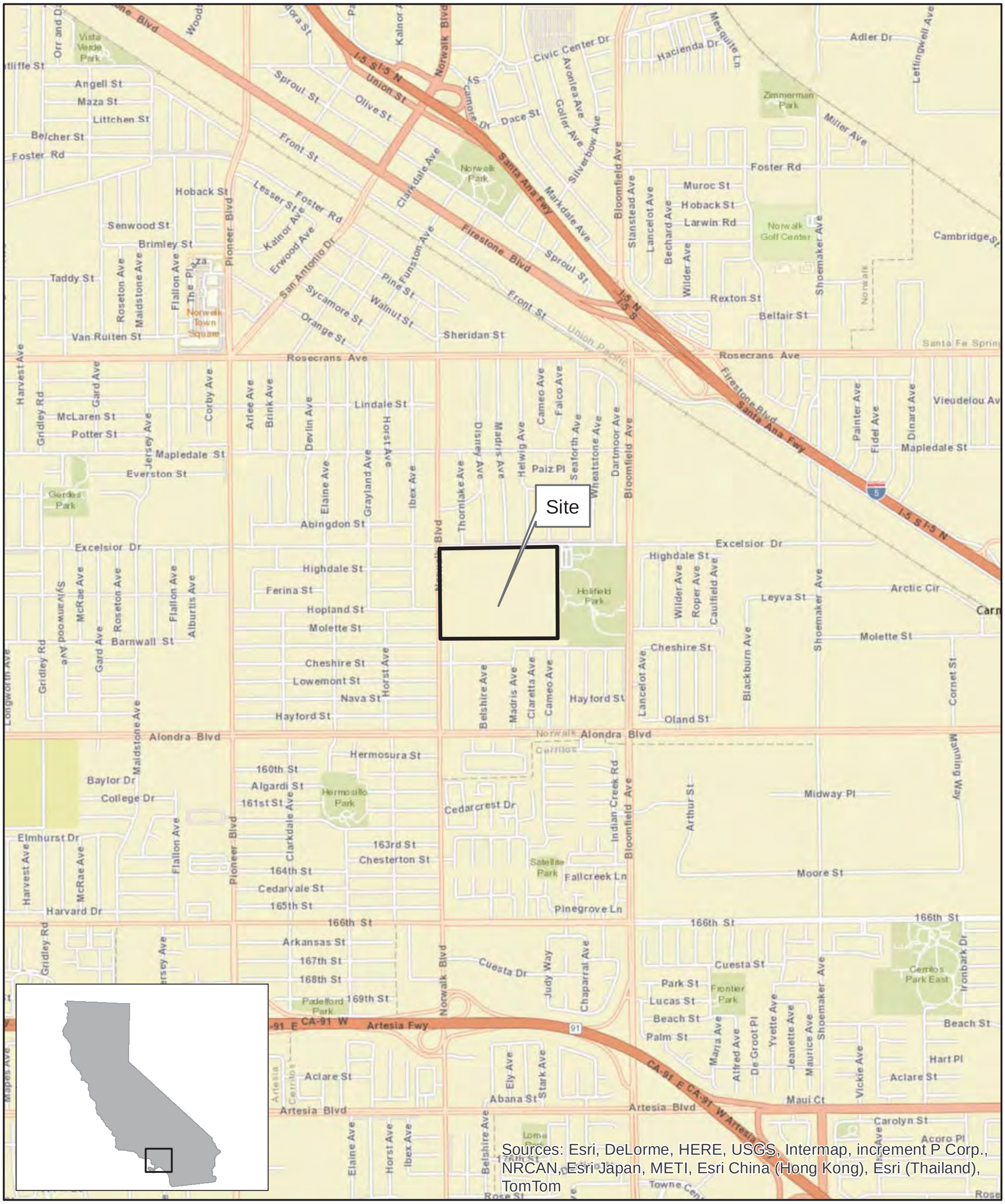
The Source Group, Inc., 2014 b. *Addendum to the Soil Remedial Action Plan (Description of F4 Bioremediation)*, December 10.

The Source Group, Inc., 2015. *Work Plan for LNAPL Mitigation Methods Evaluation, Northeastern LNAPL Area.* June 30.

The Source Group, Inc., 2016. *Addendum to Shallow Soil Closure Report.* May 31.

Regional Water Quality Control Board (RWQCB). 2015*. Review of Soil Remediation Action Plan and Soil Management Plan.* January 7.

FIGURES



Document Name: Fig-1 Norwalk Site Location Map

SOURCE: ESRI 7.5 MINUTE TOPOGRAPHIC MAP. http://resources.esri.com/arcgisonlineservices	PROJECT NO.: 04-NDLA-001	DATE: 5/28/2014	DR.BY: JK	APP.BY: PP	SCALE= 1:24,000 (0, 1,000, 2,000, 4,000 Feet)	N

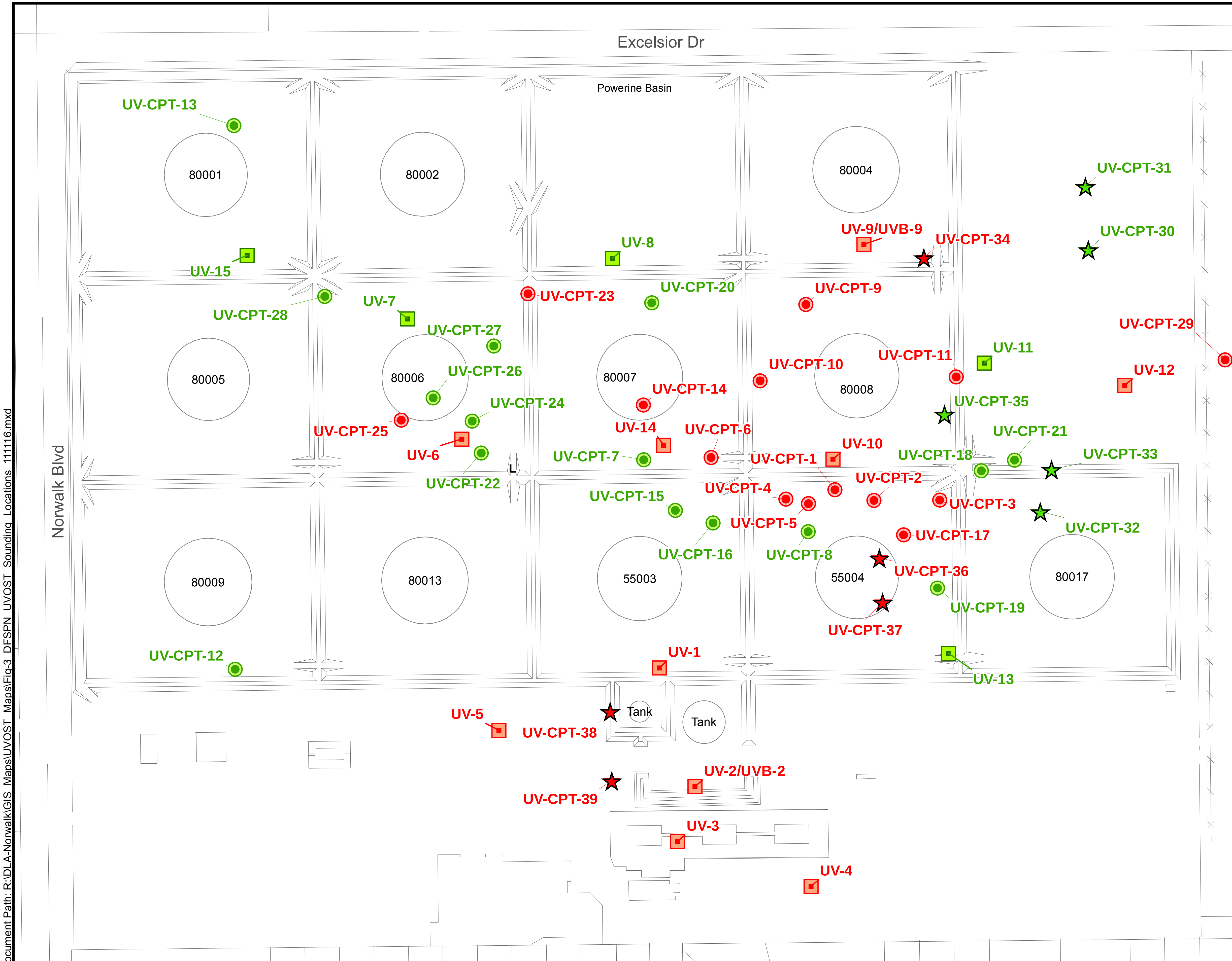
SGI environmental THE SOURCE GROUP, INC.
1962 FREEMAN AVENUE
SIGNAL HILL, CA 90755
(562) 597-1055

DEFENSE FUEL SUPPORT POINT NORWALK

15306 NORWALK BOULEVARD
NORWALK, CALIFORNIA

SITE LOCATION MAP

FIGURE
1



Legend

- Former Above Ground Storage Tanks
- DFSP Norwalk Border
- SGI UVOST Locations with TPH Detection at 25-40 ft bgs (>2%RE); 2016
- SGI UVOST Locations without TPH Detection at 25-40 ft bgs (≤2%RE); 2016
- SGI UVOST Locations with TPH Detection at 25-40 ft bgs (>2%RE); 2015
- SGI UVOST Locations without TPH Detection at 25-40 ft bgs (≤2%RE); 2015
- Parsons UVOST Locations with TPH Detection at 25-40 ft bgs (>2%RE); 2010
- Parsons UVOST Locations without TPH Detection at 25-40 ft bgs (≤2%RE); 2010

Notes:

TPH = Total Petroleum Hydrocarbons
ft bgs = Feet Below Ground Surface
RE = Reference Emitter

N

DFSP Norwalk
15306 Norwalk Boulevard
Norwalk, California

Project Number:	Date:	Drawn By:	Approved By:
04-NDLA-007	11/11/2016	PW	PP

0 70 140 280 Feet

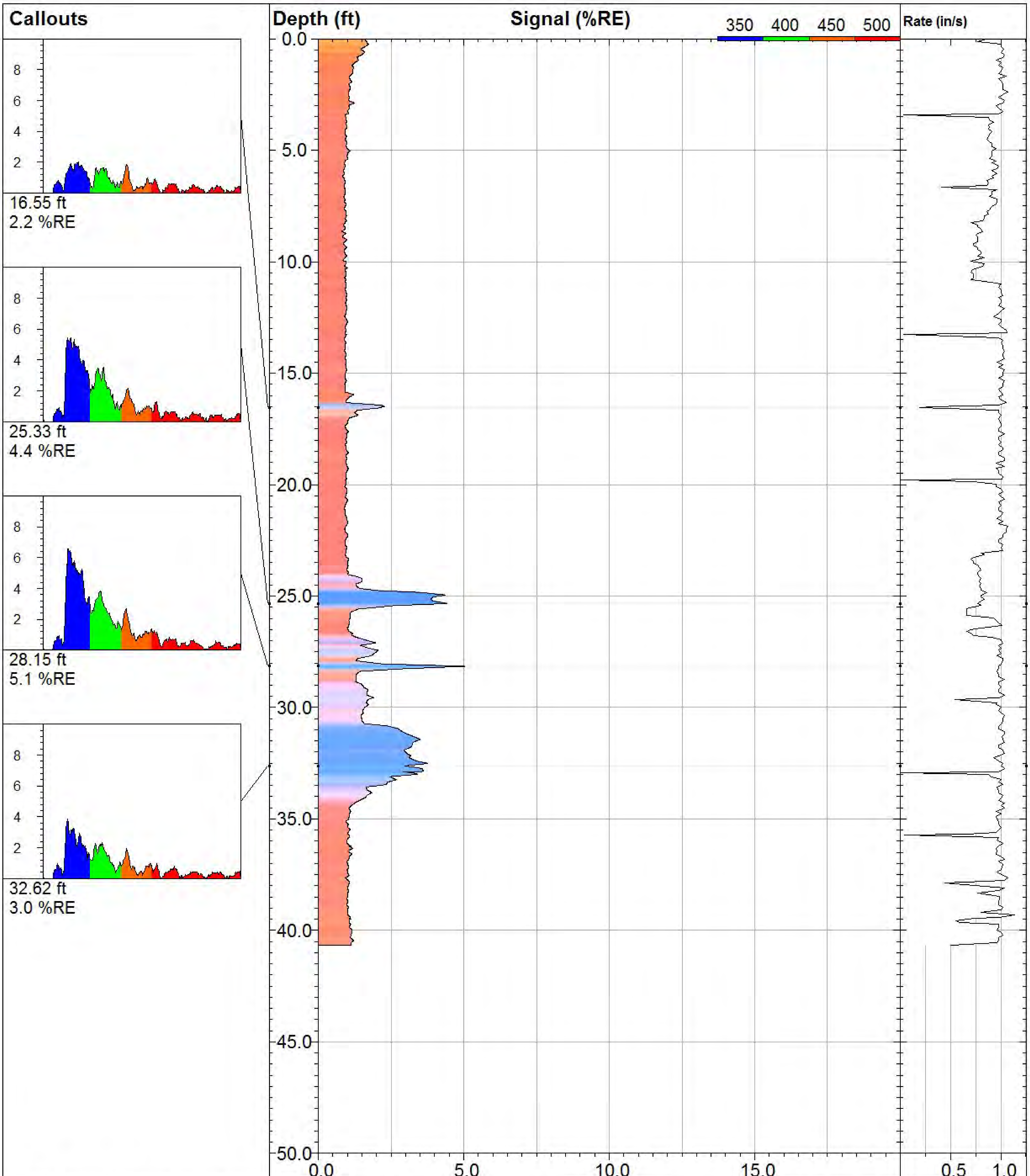
UVOST Sounding Locations

SGI environmental
APEX
1962 Freeman Avenue
Signal Hill, CA 90755
(562) 597-1055

Figure 2

Document Path: R:\DLA-Norwalk\GIS Maps\UVOST Maps\Fig-3_DFSPN_UVOST_Sounding_Locations_111116.mxd

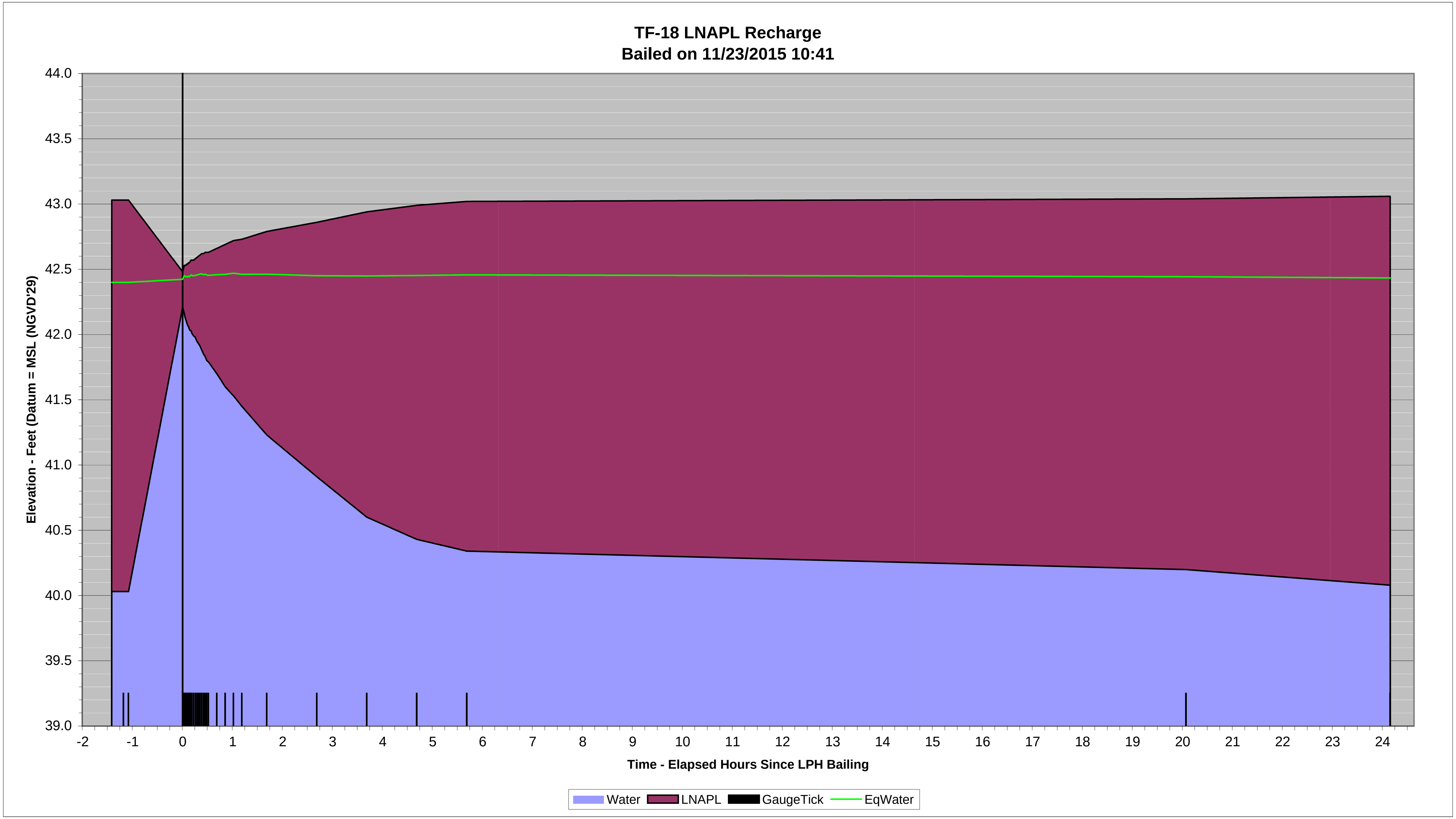
Figure 3 - UVOST Sounding Example: UV-CPT-1



GREGG

UV-CPT-1		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.67 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.1 %RE @ 28.15 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 07:48 PST**

Figure 4
TF-18 Tn Testing Gauging Data



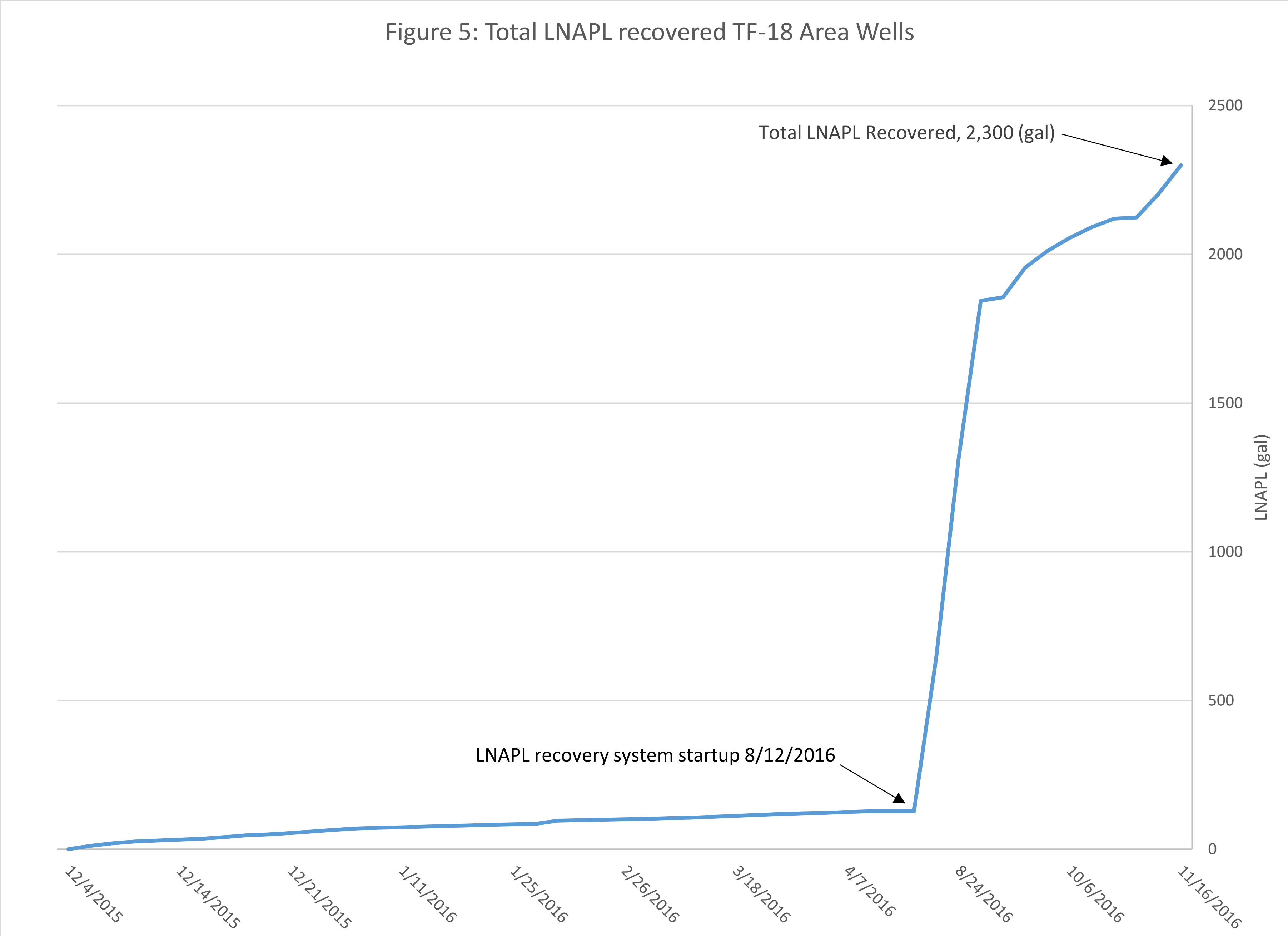
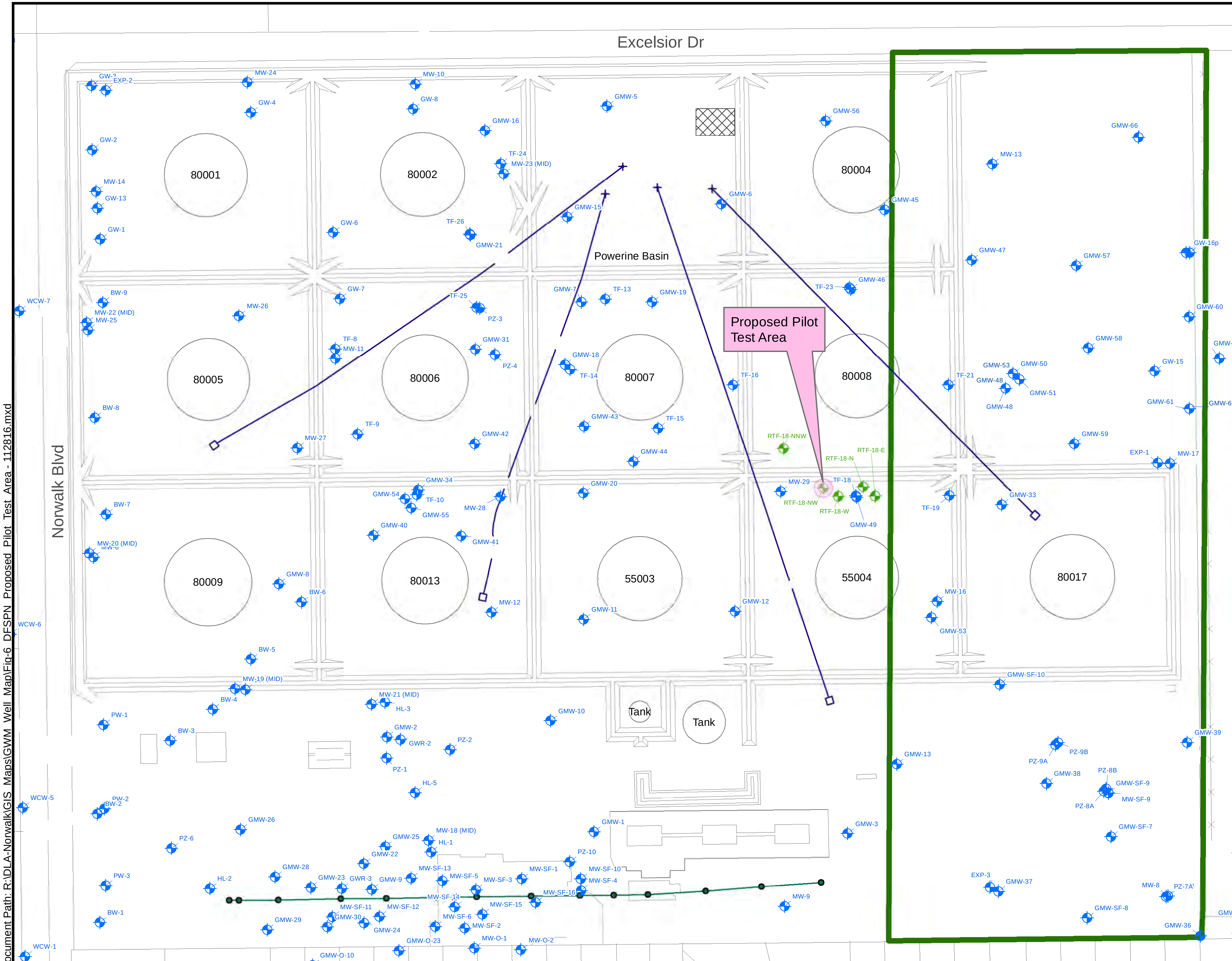


Figure 5: Total LNAPL recovered TF-18 Area Wells
Total LNAPL Recovered, 2,300 (gal)
LNAPL recovery system startup 8/12/2016
LNAPL (gal)
0
500
1000
1500
2000
2500
12/4/2015
12/14/2015
12/21/2015
1/11/2016
1/25/2016
2/26/2016
3/18/2016
4/7/2016
8/24/2016
10/6/2016
11/16/2016



Legend

- Former Above Ground Storage Tanks
- RTF Wells around TF-18 (Installed 2016)
- Groundwater Monitoring Wells
- Horizontal Wells
- Kinder Morgan Biosparge Well Locations (2015)
- Kinder Morgan Biosparge Well Line (2015)
- Existing Treatment System
- 15 Acre Expanded Holifield Park Area

DFSP Norwalk
15306 Norwalk Boulevard
Norwalk, California

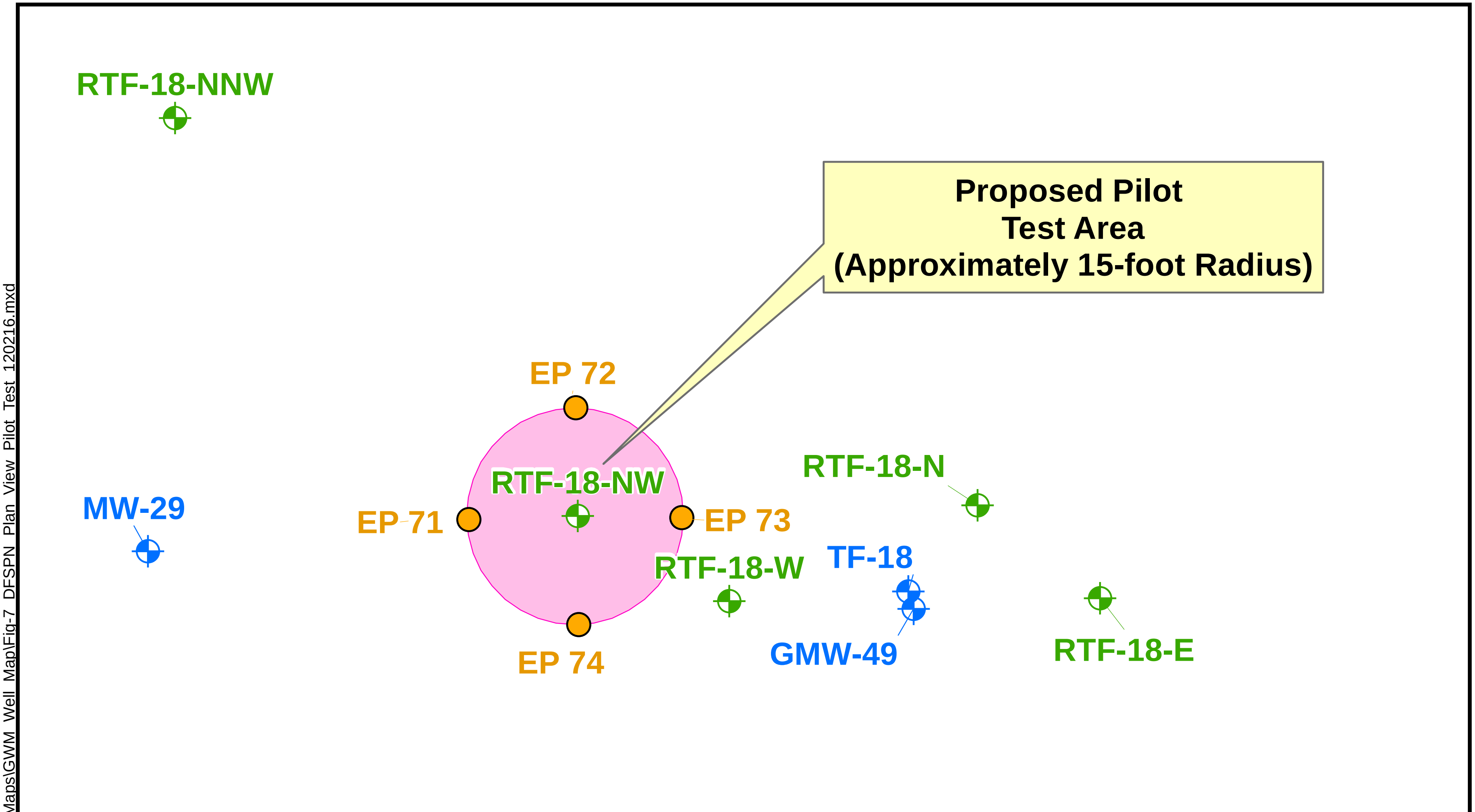
Project Number:	Date:	Drawn By:	Approved By:
04-NDLA-007	11/28/2016	AC/PW	PP

0 70 140 280 Feet

Site Map and Proposed Pilot Test Area

SGI environmental THE SOURCE GROUP, INC.
1962 Freeman Avenue
Signal Hill, CA 90755
(562) 597-1055

Figure 6



Legend

- Extraction Test Points
- RTF Wells around TF-18 (Installed 2016)
- Groundwater Monitoring Wells

N

0 15 30 60 Feet

Project Number:	Date:	Drawn By:	Approved By:
04-NDLA-007	12/02/2016	PW	PP

DFSP Norwalk
15306 Norwalk Boulevard
Norwalk, California

Plan View Showing Pilot Test Point Locations

SGI environmental
The Source Group, Inc.
1962 Freeman Avenue
Signal Hill, CA 90755
(562) 597-1055

Figure 7

TABLES

TABLE 1
Summary of CPT/UVOST Profiling
Defense Fuel Support Point, Norwalk, California

	First LNAPL occurence				Second LNAPL occurrence				Third LNAPL occurence			
UVOST Location (1)	Depth (Range) to Detection, Ft-bg (2)	Thickness (feet)	In Fine Grained Lithology (Y/N) (4)	Max %RE (5)	Depth (Range) to Detection, Ft-bg (6)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE	Depth (Range) to Detection, Ft-bg (7)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE
UV1	23 - 27	5	N	13.8	~ (3)	~	~	~	~	~	~	~
UV2	29 - 30	2	Y	94	~	~	~	~	~	~	~	~
UV3	19 - 24	6	Y & N	8.2	~	~	~	~	~	~	~	~
UV4	19 - 21.5	3.5	Y	21.5	~	~	~	~	~	~	~	~
UV5	25	1	Y	15.4	27 - 28.5	1.5	Y	79.5	~	~	~	~
UV6	26.5	1	Y	3.5	~	~	~	~	~	~	~	~
UV7	None	~	~	~	~	~	~	~	~	~	~	~
UV8	None	~	~	~	~	~	~	~	~	~	~	~
UV9	28 - 30	3	Y & N	2.5	~	~	~	~	~	~	~	~
UV10	24.2 - 26.8	2.5	N	7.5	28 - 33	6	Y & N	13.5	~	~	~	~
UV11	28 - 31	4	Y	1.6	~	~	~	~	~	~	~	~
UV12	28 - 31	4	Y	49.5	~	~	~	~	~	~	~	~
UV13	19 - 25	7	Y	2	~	~	~	~	~	~	~	~
UV14	28.5 - 31	2.5	Y & N	60.5	31.5 - 33	2.5	N	58.5	~	~	~	~
UV15	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-1	24.5-25.5	2	N & Y	3.5	26.5 - 28.5	2	Y	3.8	30.7-34	3.3	N	2.7
UV-CPT-2	25-27.5	2.5	Y & N	19	28.5 - 30	1.5	Y	1.4	32 - 36	5	N	5.5
UV-CPT-3	24.5-25.3	1	Y & N	0.5	28.5 - 34.5	6	N	3.4	~	~	~	~
UV-CPT-4	29.5 - 35	5.5	N	4.5	~	~	~	~	~	~	~	~
UV-CPT-5	30-32	3	N	3.8	~	~	~	~	~	~	~	~
UV-CPT-6	28-29.5	1.5	Y & N	6.7	32-37	6	N	10.2	~	~	~	~
UV-CPT-7	29 -32	3	Y & N	0.5	~	~	~	~	~	~	~	~
UV-CPT-8	24 - 24.8	0.8	Y	0.7	~	~	~	~	~	~	~	~
UV-CPT-9	25 - 30.5	5.5	Y	37.7	~	~	~	~	~	~	~	~
UV-CPT-10	25 - 26.5	1.5	Y	7.3	29-35	7	N	8.7	~	~	~	~
UV-CPT-11	27.5-31	4.5	Y	3.4	~	~	~	~	~	~	~	~
UV-CPT-12	None	~	~	~	~	~	~	~	~	~	~	~

Table 1- Summary of CPT&UVOST Profiling

TABLE 1
Summary of CPT/UVOST Profiling
Defense Fuel Support Point, Norwalk, California

UVOST Location (1)	First LNAPL occurence				Second LNAPL occurrence				Third LNAPL occurence			
	Depth (Range) to Detection, Ft-bg (2)	Thickness (feet)	In Fine Grained Lithology (Y/N) (4)	Max %RE (5)	Depth (Range) to Detection, Ft-bg (6)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE	Depth (Range) to Detection, Ft-bg (7)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE
UV-CPT-13	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-14	**30.5-36.5**	6	N	6.8	~	~	~	~	~	~	~	~
UV-CPT-15	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-16	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-17	29.5-34	4.5	N	10.5	~	~	~	~	~	~	~	~
UV-CPT-18	32 - 34.5	2.5	N	1.3	~	~	~	~	~	~	~	~
UV-CPT-19	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-20	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-21	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-22	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-23	**35-37**	3	N	5.3	~	~	~	~	~	~	~	~
UV-CPT-24	None				~	~	~	~	~	~	~	~
UV-CPT-25	28.5-30	1.5	Y	5.9	~	~	~	~	~	~	~	~
UV-CPT-26	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-27	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-28	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-29	30-33	4	Y	39	33.5-35	2.5	N	2	~	~	~	~
UV-CPT-30	**28.5 - 37**	8.5	Y & N	0.6	~	~	~	~	~	~	~	~
UV-CPT-31	30 - 32.5	2.5	Y & N	0.48	~	~	~	~	~	~	~	~
UV-CPT-32	20 - 22	3	N	0.58	~	~	~	~	~	~	~	~
UV-CPT-33	none	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-34	29 - 30.5	1.5	N	9.5	~	~	~	~	~	~	~	~
UV-CPT-35	30 - 31	2	Y & N	0.4	~	~	~	~	~	~	~	~
UV-CPT-36	26 - 27.5	1.5	Y & N	6.1	~	~	~	~	~	~	~	~
UV-CPT-37	22.5 - 25	2.5	Y	5.8	~	~	~	~	~	~	~	~
UV-CPT-38	25.5 - 33	8.5	Y & N	19.5	~	~	~	~	~	~	~	~
UV-CPT-39	26 - 27.7	1.7	Y & N	5.8	~	~	~	~	~	~	~	~

TABLE 1
Summary of CPT/UVOST Profiling
Defense Fuel Support Point, Norwalk, California

	First LNAPL occurence				Second LNAPL occurrence				Third LNAPL occurence			
UVOST Location (1)	Depth (Range) to Detection, Ft-bg (2)	Thickness (feet)	In Fine Grained Lithology (Y/N) (4)	Max %RE (5)	Depth (Range) to Detection, Ft-bg (6)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE	Depth (Range) to Detection, Ft-bg (7)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE

Footnotes:

1) UV-1 through UV-15 completed in October 2010. UV-CPT-1 through UV-CPT-29 completed in November and December 2015. UV-CPT-30 through UV-CPT-39 completed in August 2016. Conditions at sounding locations are expected to change over time. In particular water and LNAPL saturation will change with time.
2) Depth pick-offs to establish maximum smear zone thickness for LNAPL detection(s) below 20 ft-bg. If multiple separate horizons of LNAPL indicated, then this column is reserved for the shallowest.
3) A tilda (~) indicates that due to lack of a significant UVOST signature, the indicated data cell is intentionally left blank.
4) Fine grained lithology means sediment that has average or dominant grain-size smaller than fine sand.
5) Max % RE for this table means maximum percent of Reference Emitter adjusted for baseline noise, where RE is standard calibration fluid (and not site specific LNAPL).
6) Max depth range of LNAPL detection below 20 ft-bg. If multiple horizons of LNAPL indicated then this is reserved for the second shallowest horizon.
7) Max depth range of LNAPL detection below 20 ft-bg. If multiple horizons of LNAPL indicated then this is reserved for the third shallowest horizon.

APPENDIX A

Well Permits

ENVIRONMENTAL HEALTH

Drinking Water Program

COUNTY OF LOS ANGELES
Public Health

5050 Commerce Drive, Baldwin Park, CA 91706
Telephone: (626) 430-5420 • Facsimile: (626) 813-3013 • Email: waterquality@ph.lacounty.gov
http://publichealth.lacounty.gov/eh/ep/dw/dw_main.htm

Well Permit Approval

TO BE COMPLETED BY APPLICANT:

WORK SITE ADDRESS	CITY	ZIP	EMAIL ADDRESS FOR WELL PERMIT APPROVAL
15306 Norwalk Blvd	Norwalk	90650	droberts@thesourcegroup.net

NOTICE:

- WORK PLAN APPROVALS ARE VALID FOR 180 DAYS 30 DAY EXTENSIONS OF WORK PLAN APPROVALS ARE CONSIDERED ON AN INDIVIDUAL (CASE-BY-CASE) BASIS AND MAY BE SUBJECT TO ADDITIONAL PLAN REVIEW FEES (HOURLY RATE AS APPLICABLE).
- WORK PLAN MODIFICATIONS MAY BE REQUIRED IF WELL AND GEOLOGIC CONDITIONS ENCOUNTERED AT THE SITE INSPECTION ARE FOUND TO DIFFER FROM THE SCOPE OF WORK PRESENTED TO THE DEPARTMENT OF PUBLIC HEALTH—DRINKING WATER PROGRAM.
- THIS WELL PERMIT APPROVAL IS LIMITED TO COMPLIANCE WITH THE CALIFORNIA WELL STANDARDS AND THE LOS ANGELES COUNTY CODE AND DOES NOT GRANT ANY RIGHTS TO CONSTRUCT, RENOVATE, OR DECOMMISSION ANY WELL. THE APPLICANT IS RESPONSIBLE FOR SECURING ALL OTHER NECESSARY PERMITS SUCH AS WATER RIGHTS, PROPERTY RIGHTS, COASTAL COMMISSION APPROVALS, USE COVENANTS, ENCROACHMENT PERMISSIONS, UTILITY LINE SETBACKS, CITY/COUNTY PUBLIC WORKS RIGHTS OF WAY, ETC.
- ALL FIELD WORK MUST BE CONDUCTED UNDER THE DIRECT SUPERVISION OF A PROFESSIONAL GEOLOGIST LICENSED IN THE STATE OF CALIFORNIA
- THIS PERMIT IS NOT COMPLETE UNTIL ALL OF THE FOLLOWING REQUIREMENTS ARE SIGNED BY THE DEPUTY HEALTH OFFICER. WORK SHALL NOT BE INITIATED WITHOUT A WORK PLAN APPROVAL STAMPED BY THE DEPARTMENT OF PUBLIC HEALTH—DRINKING WATER PROGRAM.
- **NOTIFY THE DRINKING WATER PROGRAM BY EMAIL 3 BUSINESS DAYS BEFORE WORK IS SCHEDULED TO BEGIN.**

Juan Rodriguez 626-430-5386 or JuRodriguez@ph.lacounty.gov

TO BE COMPLETED BY DEPARTMENT OF PUBLIC HEALTH—DRINKING WATER PROGRAM:

☐ WORK PLAN INCOMPLETE; SUBMIT THE FOLLOWING:

☑ WORK PLAN APPROVED

DATE: 12/22/15

Los Angeles County Drinking Water stamp

REGISTERED ENVIRONMENTAL HEALTH SPECIALIST — COUNTY OF LOS ANGELES — CALIFORNIA

R.E.H.S. NO: 6330

Juan Rodriguez

ADDITIONAL APPROVAL CONDITIONS:

on 12/18/15 $2,595.00 was paid for Permit #SR0054842 to install 5 monitoring wells at above-mentioned site.

☐ ANNULAR SEAL FINAL INSPECTION REQUIRED

DATE ACCEPTED:	REHS signature

☐ WELL COMPLETION LOG REQUIRED

DATE ACCEPTED:	REHS signature

☐ WATER QUALITY—BACTERIOLOGICAL STANDARDS REQUIRED

DATE ACCEPTED:	REHS signature

☐ WATER QUALITY—CHEMICAL STANDARDS REQUIRED

DATE ACCEPTED:	REHS signature

☐ WATER SUPPLY YIELD REQUIRED

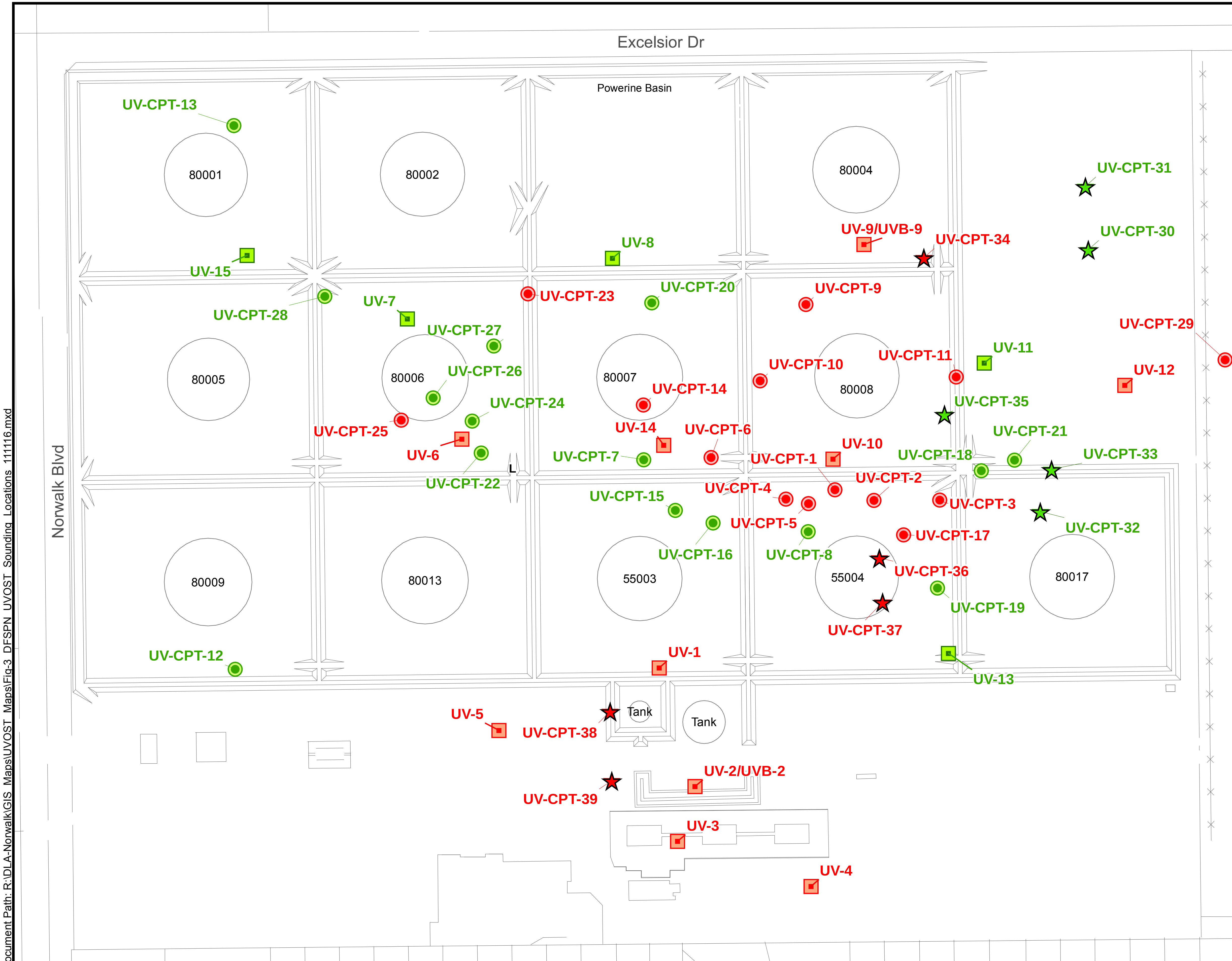
DATE ACCEPTED	REHS signature

☐ OTHER REQUIREMENT

DATE ACCEPTED:	REHS signature

APPENDIX B

UVOST Logs and Location Map



Legend

- Former Above Ground Storage Tanks
- DFSP Norwalk Border
- SGI UVOST Locations with TPH Detection at 25-40 ft bgs (>2%RE); 2016
- SGI UVOST Locations without TPH Detection at 25-40 ft bgs (≤2%RE); 2016
- SGI UVOST Locations with TPH Detection at 25-40 ft bgs (>2%RE); 2015
- SGI UVOST Locations without TPH Detection at 25-40 ft bgs (≤2%RE); 2015
- Parsons UVOST Locations with TPH Detection at 25-40 ft bgs (>2%RE); 2010
- Parsons UVOST Locations without TPH Detection at 25-40 ft bgs (≤2%RE); 2010

Notes:

TPH = Total Petroleum Hydrocarbons
ft bgs = Feet Below Ground Surface
RE = Reference Emitter

DFSP Norwalk
15306 Norwalk Boulevard
Norwalk, California

Project Number:	Date:	Drawn By:	Approved By:
04-NDLA-007	11/11/2016	PW	PP

0 70 140 280 Feet

UVOST Sounding Locations

SGI environmental APEX

1962 Freeman Avenue
Signal Hill, CA 90755
(562) 597-1055

Figure 2

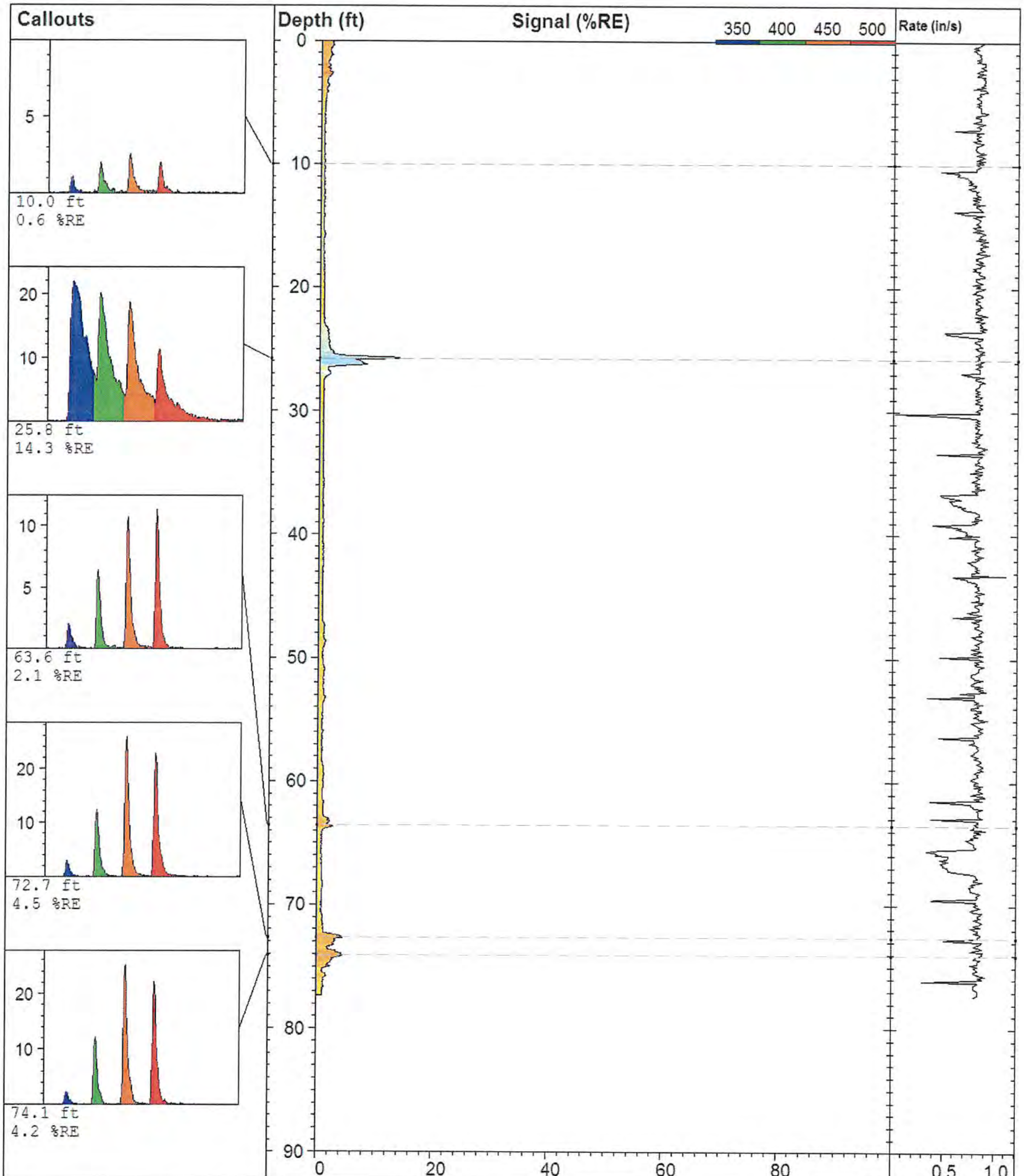
Document Path: R:\DLA-Norwalk\GIS Maps\UVOST Maps\Fig-3 DFSPN UVOST Sounding Locations 111116.mxd

Note on CPT Locations Numbering

To avoid duplication of labels, UV-CPT-1 t UV -CPT-10 completed in August 2016 were renamed in September 2016

UV-CPT-1 to UV-CPT-6 (completed 8/17/2016) re-named as UV-CPT-30 to UV-CPT-35

UV-CPT 7 to UV-CPT-10 (completed 8/18/2016) renamed as UC-CPT-36 to UV-CPT-39



www.greggdrilling.com

UV-1		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.33 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **14.3 % @ 25.77 ft**
Job: **10-344**	*Operator/Unit:* **CHRIS/UVOST1007**	*Date & Time:* **2010-10-26 14:41 PDT**

GREGG

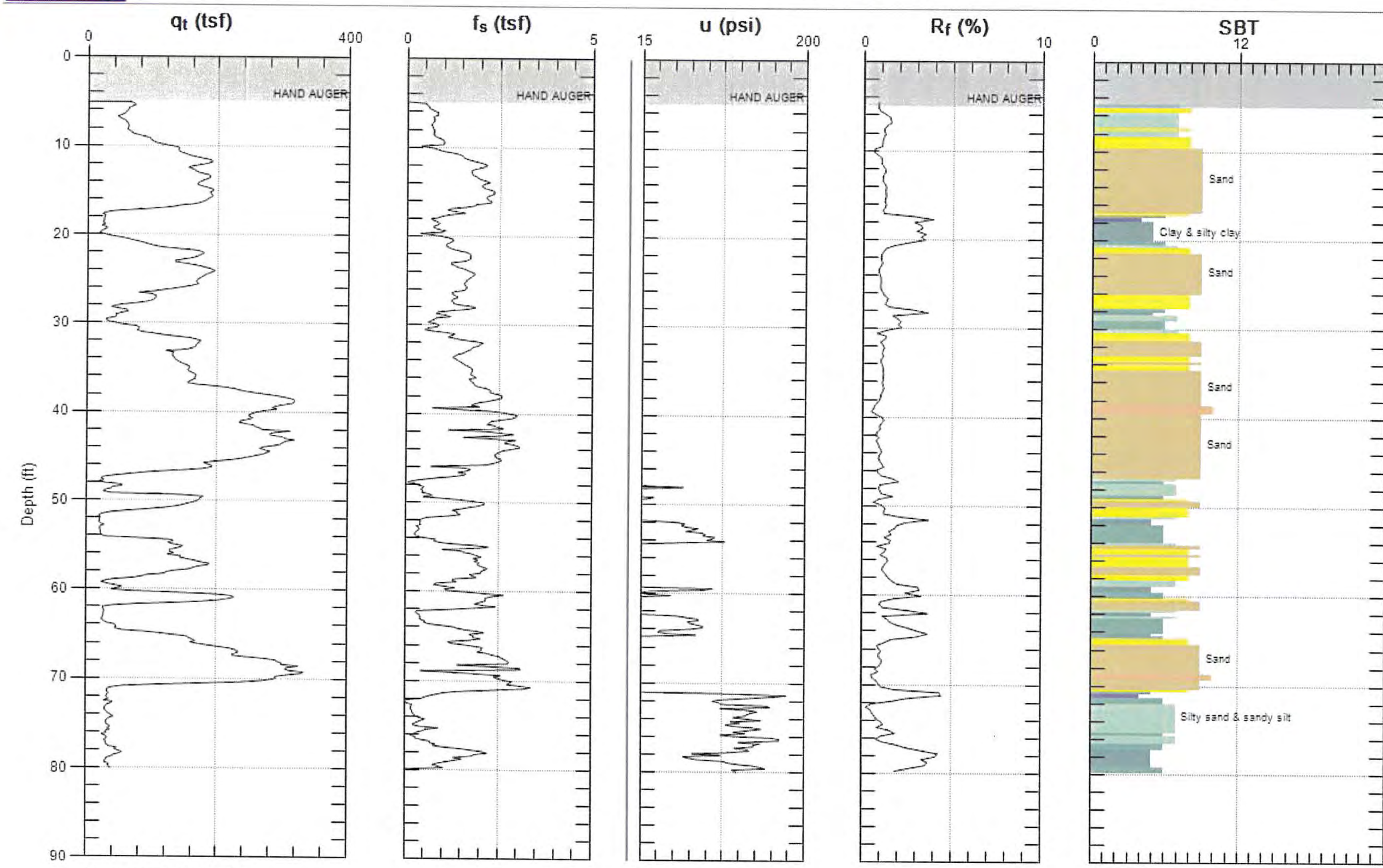
PARSONS

Site: DFSP

Sounding: UV-1

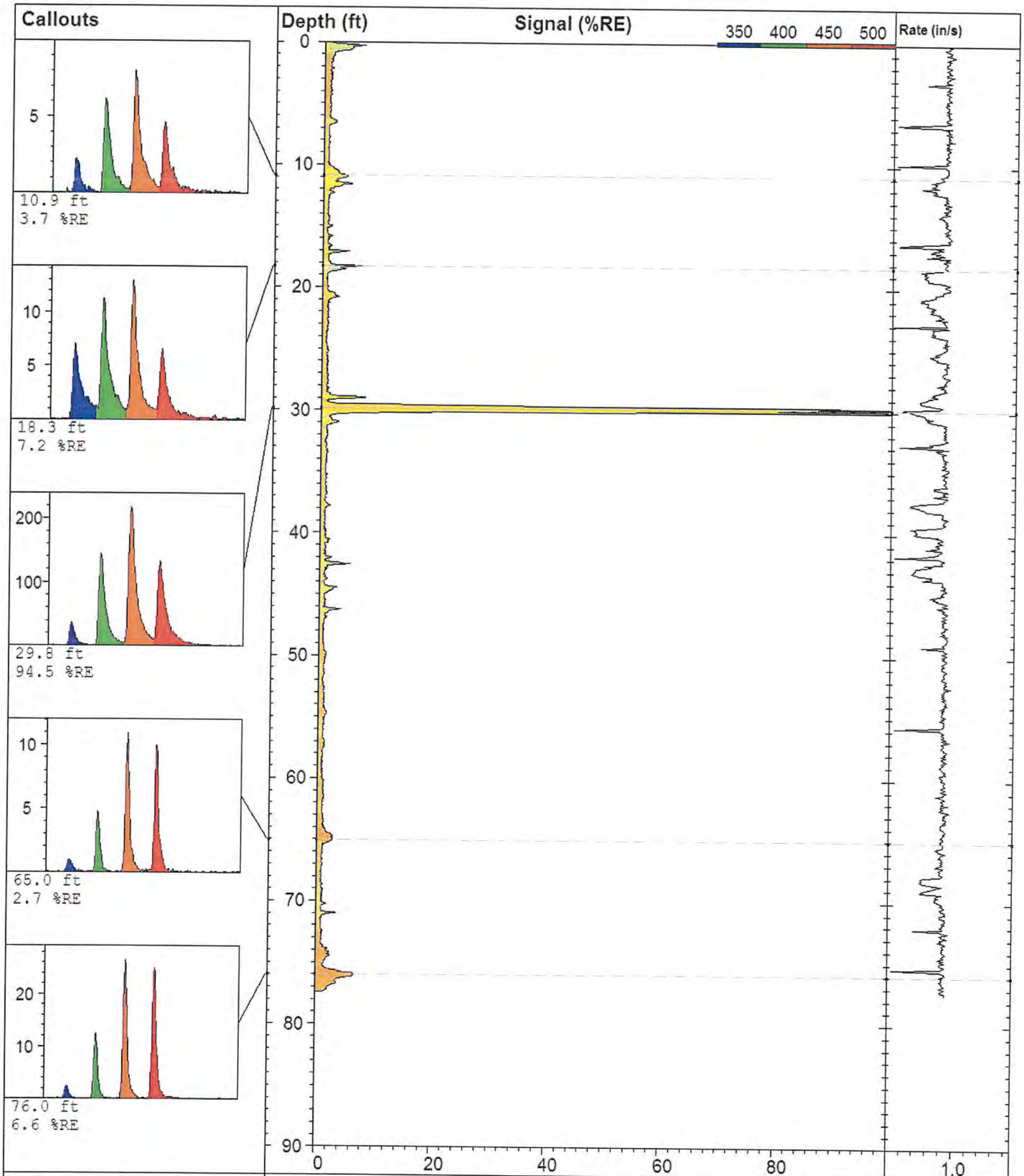
Engineer: Q.KINNEBREW

Date: 10/26/2010 02:18



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-2		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.39 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **109.7 % @ 29.69 ft**
Job: **344**	*Operator/Unit:* **EC/UVOST1007**	*Date & Time:* **2010-10-25 13:38 PDT**

GREGG

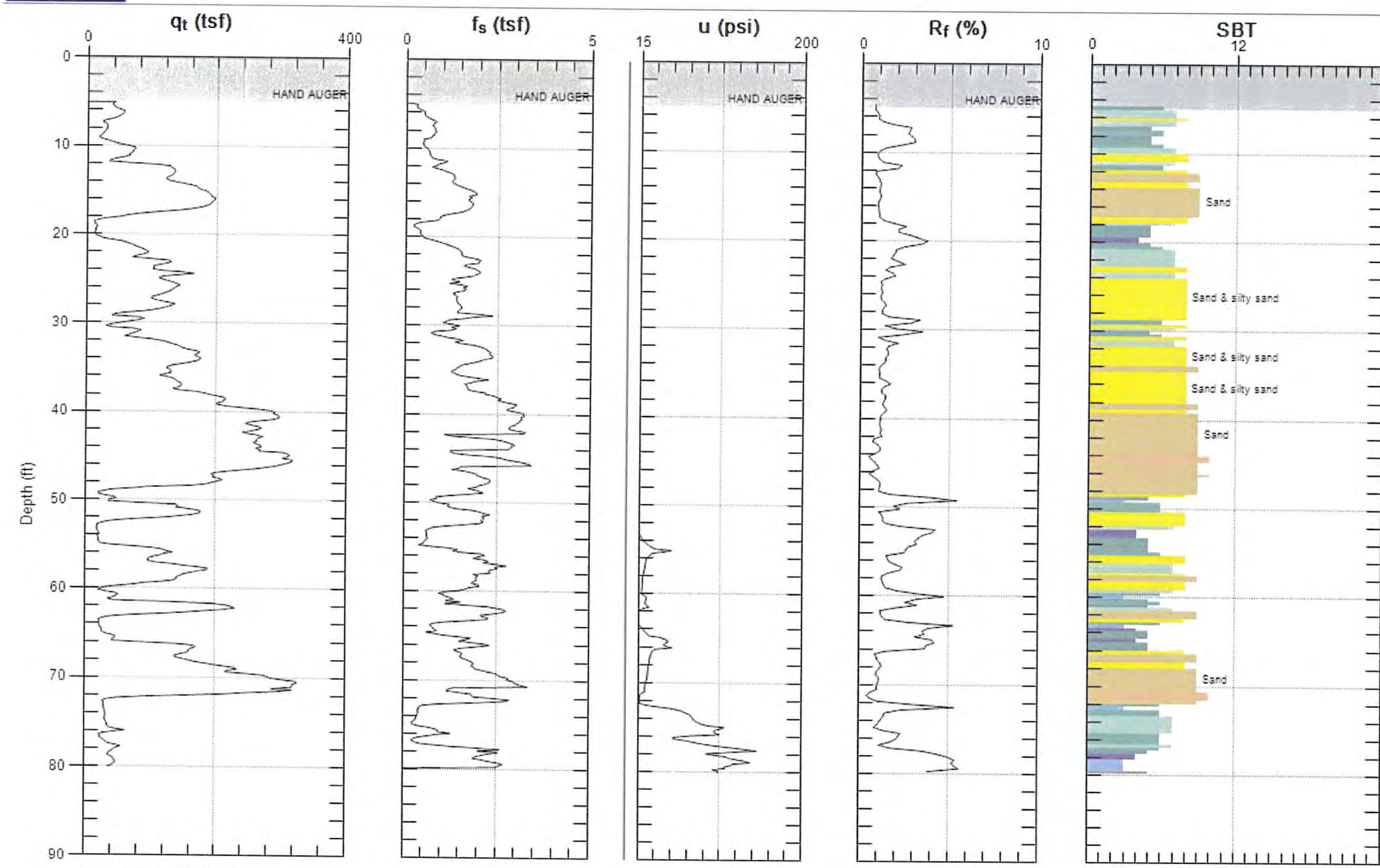
PARSONS

Site: DFSP

Sounding: UV-2

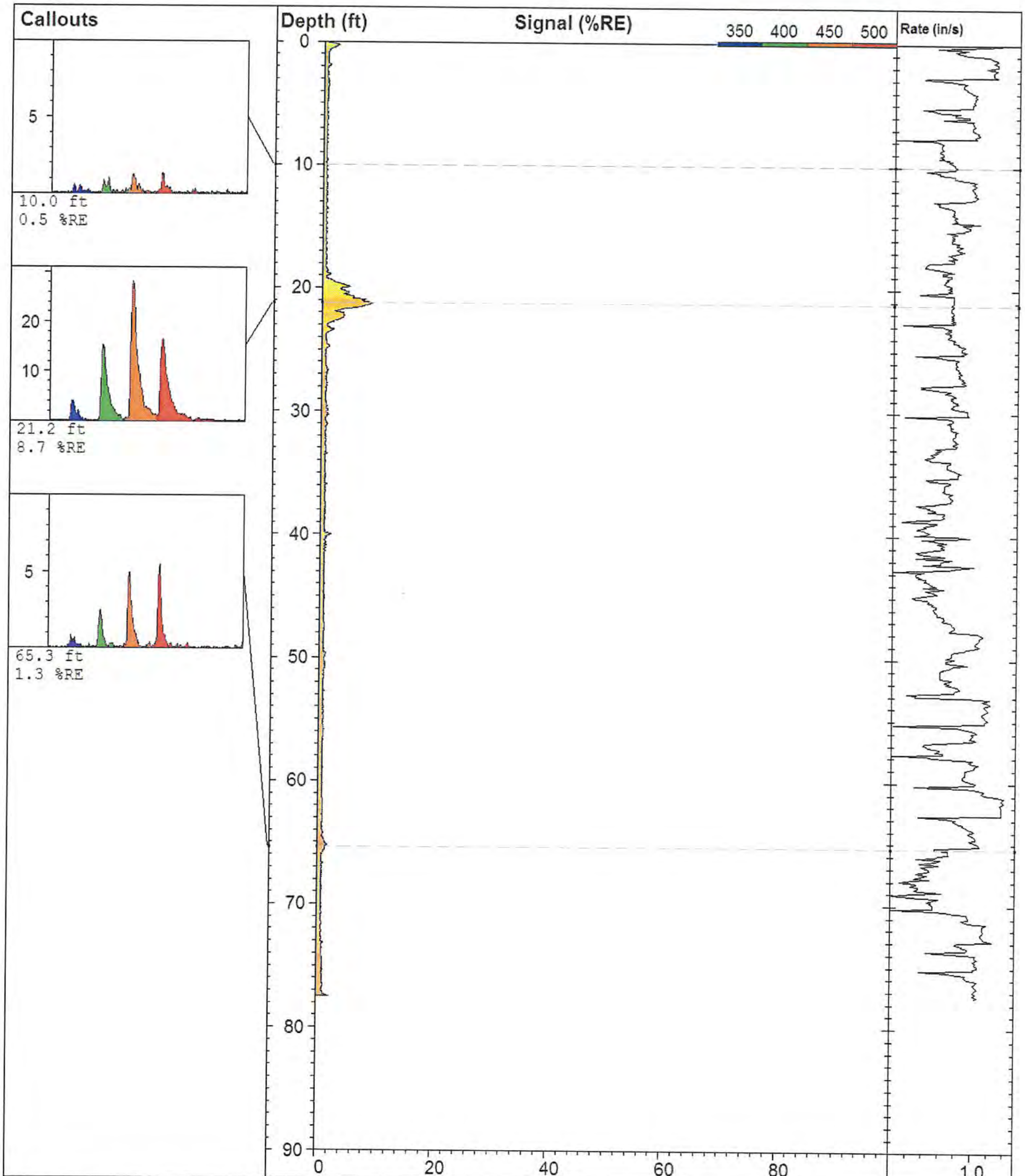
Engineer: Q.KINNEBREW

Date: 10/25/2010 01:37



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-3		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.48 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **8.7 % @ 21.23 ft**
Job: **10-344**	*Operator/Unit:* **CHRIS/UVOST1009**	*Date & Time:* **2010-10-25 09:32 PDT**

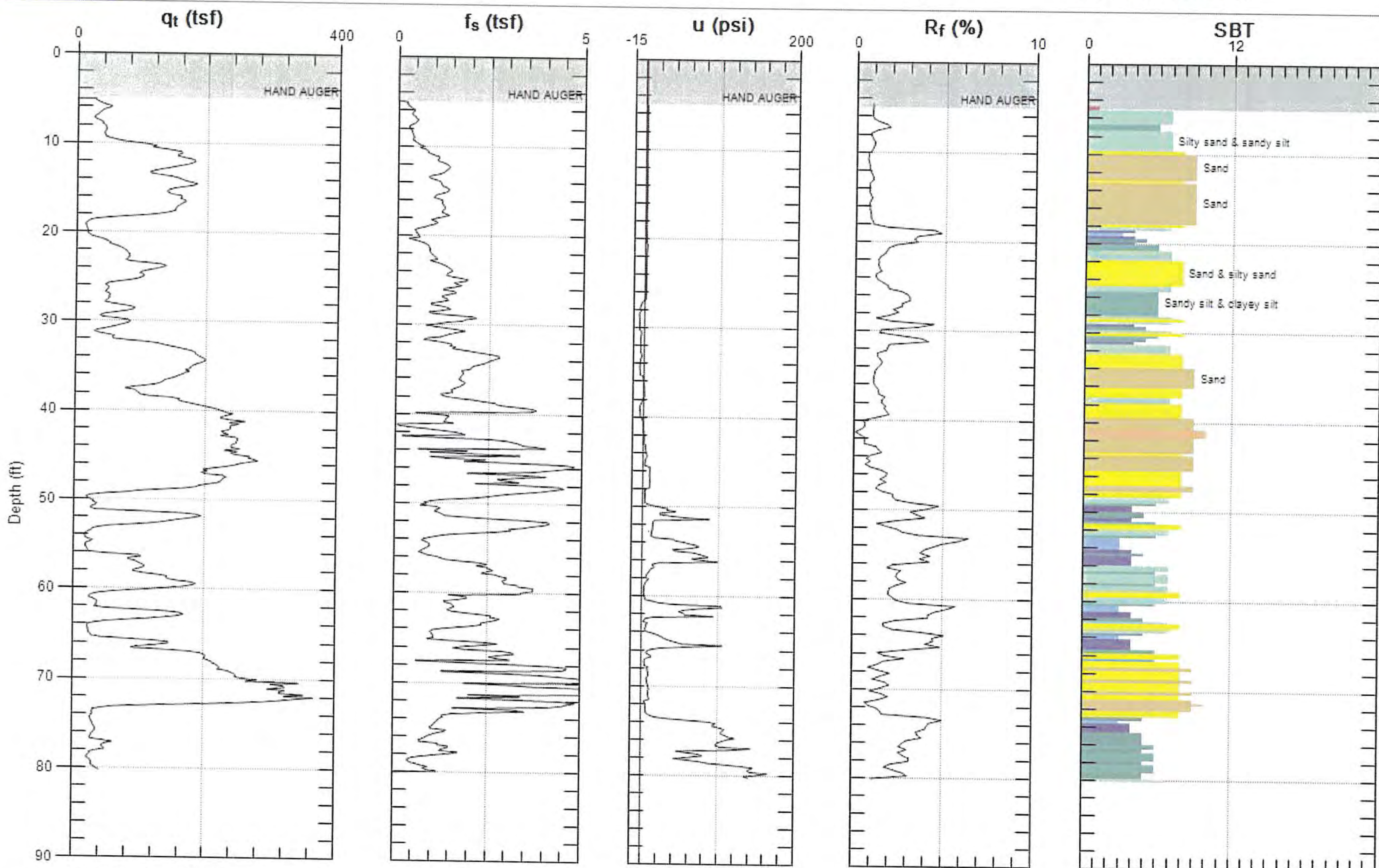
GREGG PARSONS

Site: DFSP

Sounding: UV-3

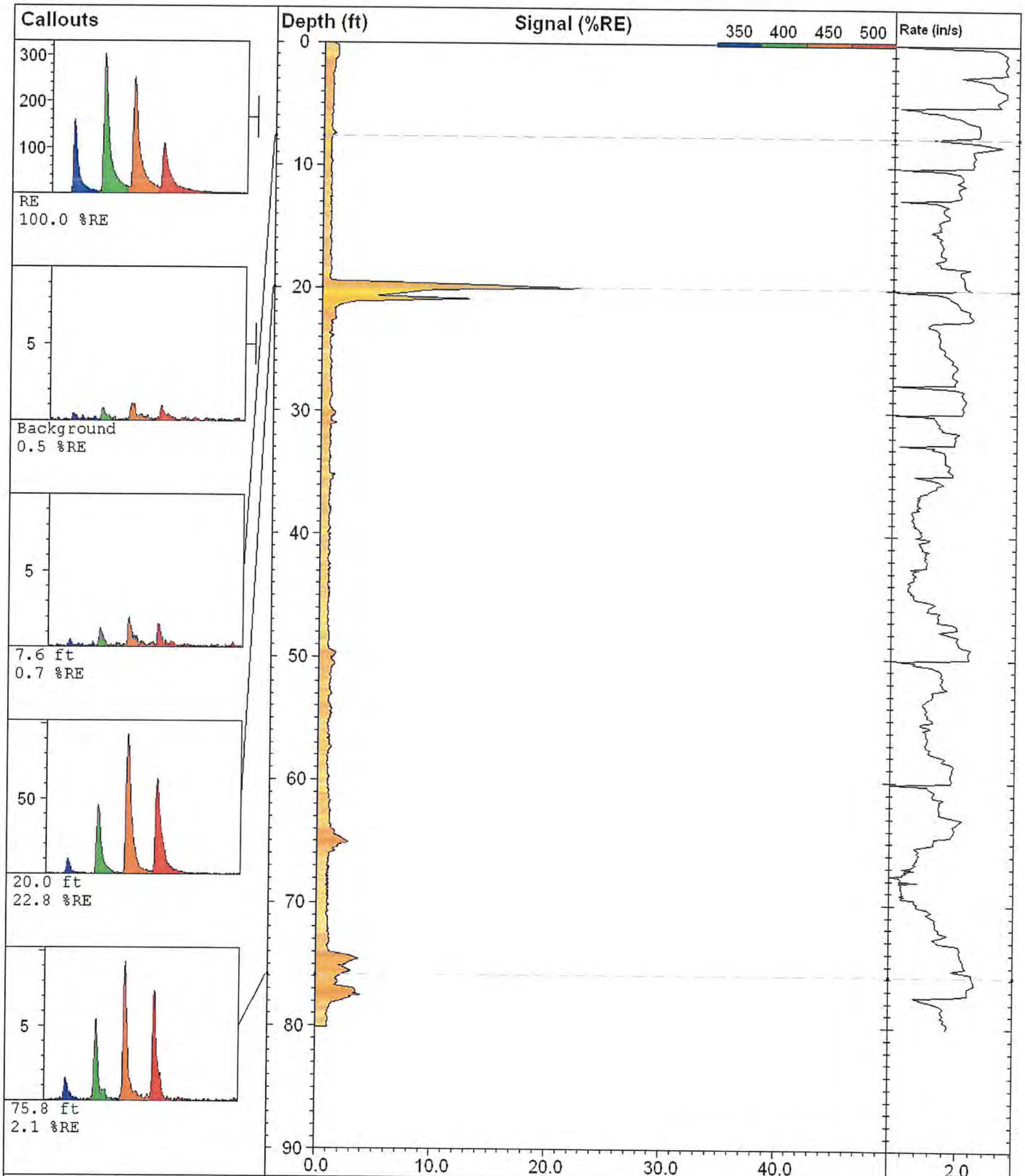
Engineer: Q.KINNEBREW

Date: 1/1/2000 01:17



Max. Depth: 80.217 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-4		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP	*Latitude / Datum:* Unavailable / NA	*Final depth:* 80.11 ft
Client: PARSONS	*Longitude / Fix:* Unavailable / NA	*Max signal:* 22.8 % @ 19.96 ft
Job: 10-344	*Operator/Unit:* CHRIS/UVOST1009	*Date & Time:* 2010-10-25 15:01 PDT

GREGG

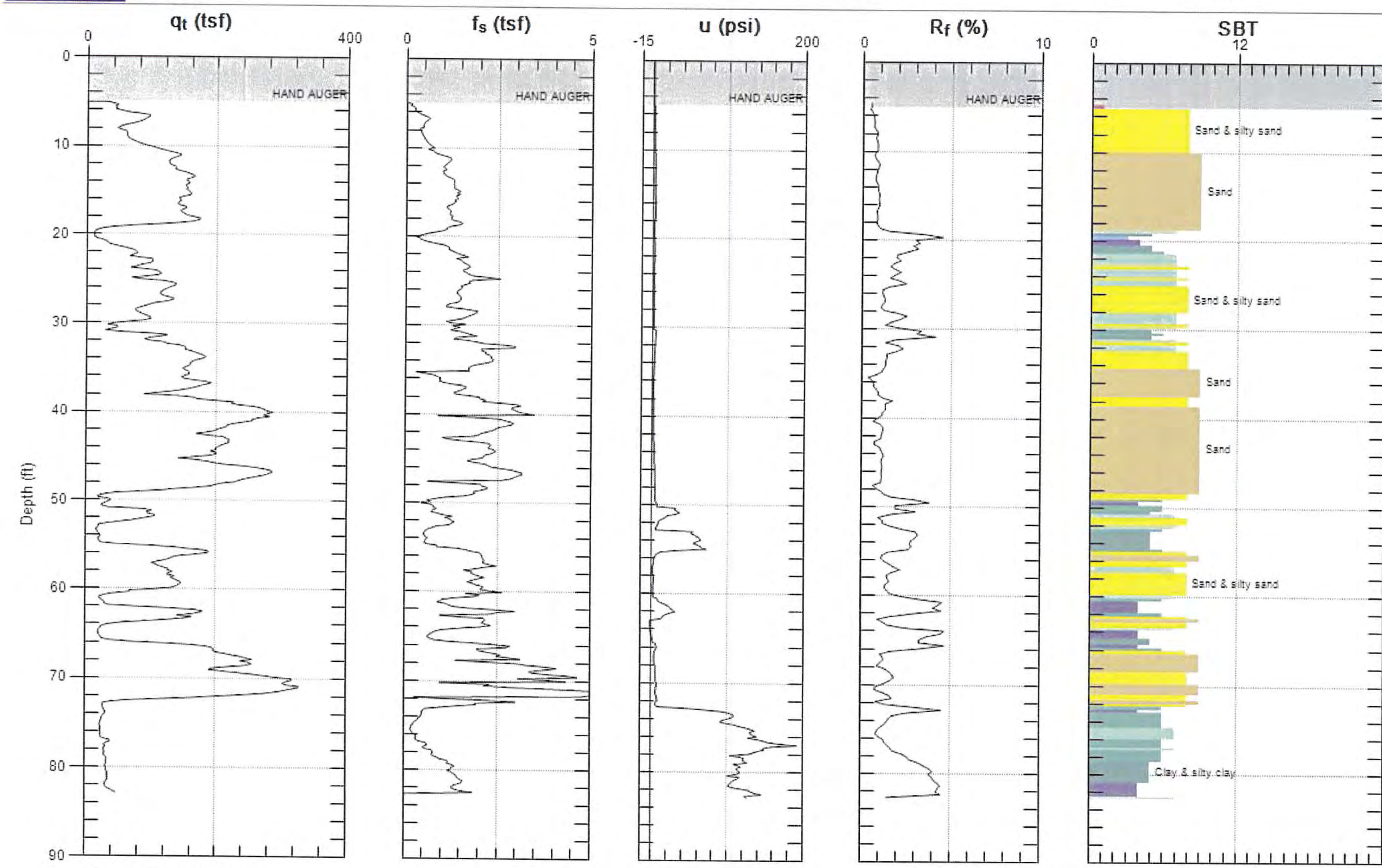
PARSONS

Site: DFSP

Sounding: UV-4

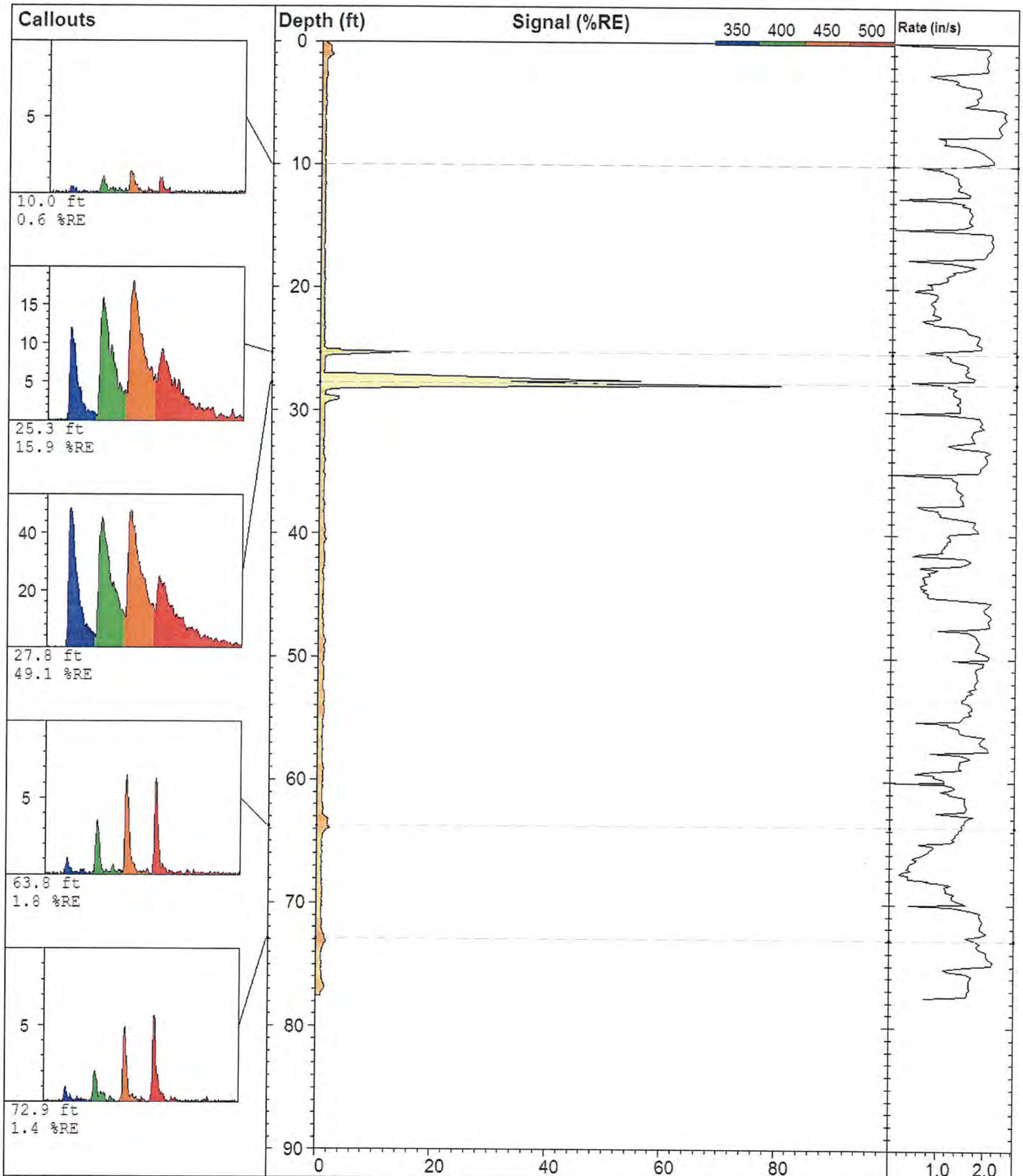
Engineer: Q.KINNEBREW

Date: 10/25/2010 03:01



Max. Depth: 82.841 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



www.greggdrilling.com

UV-5

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.52 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **80.8 % @ 27.91 ft**
Job: **10-344**	*Operator/Unit:* **CHRIS/UVOST1009**	*Date & Time:* **2010-10-25 13:25 PDT**

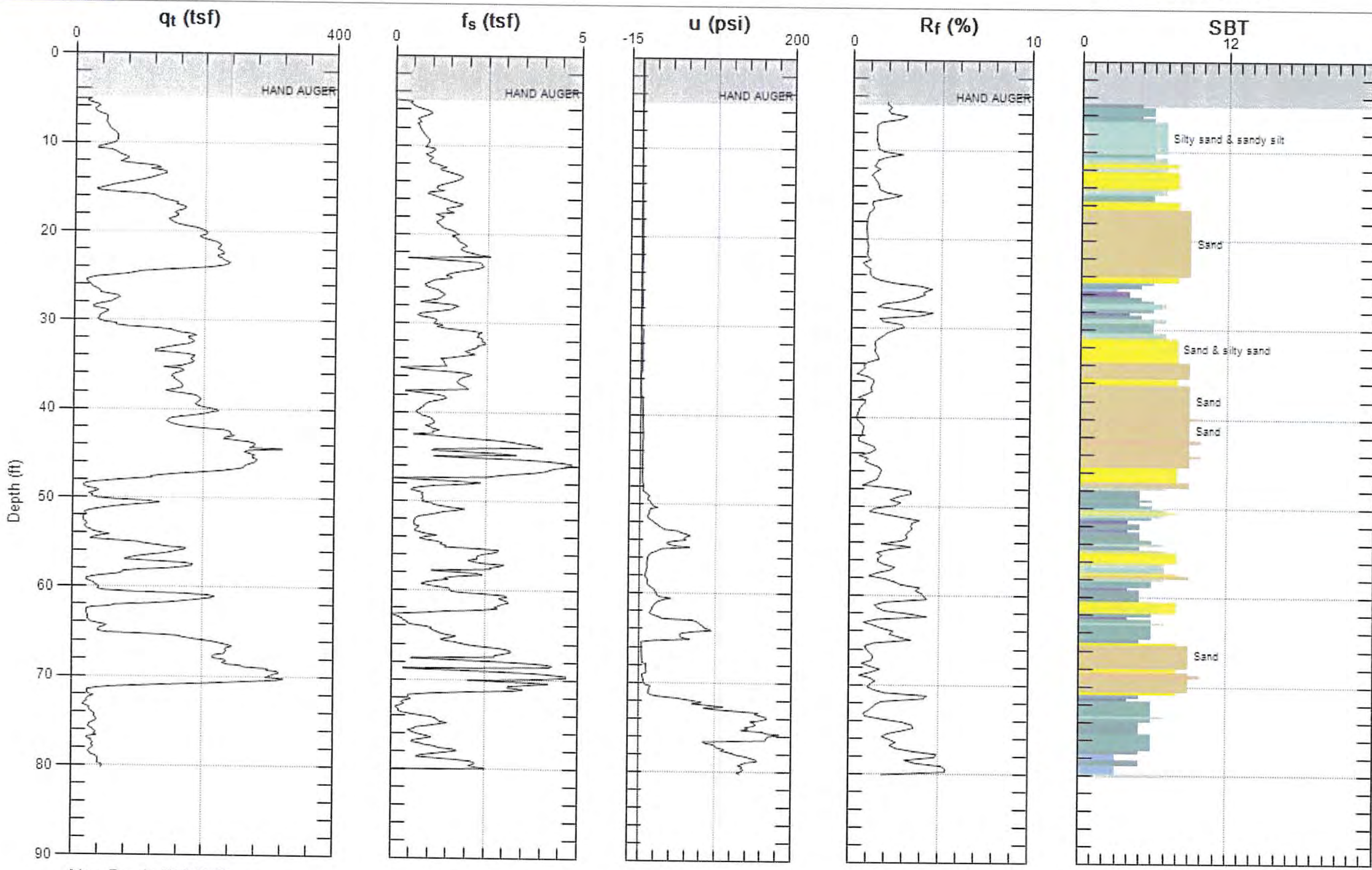
GREGG PARSONS

Site: DFSP

Sounding: UV-5

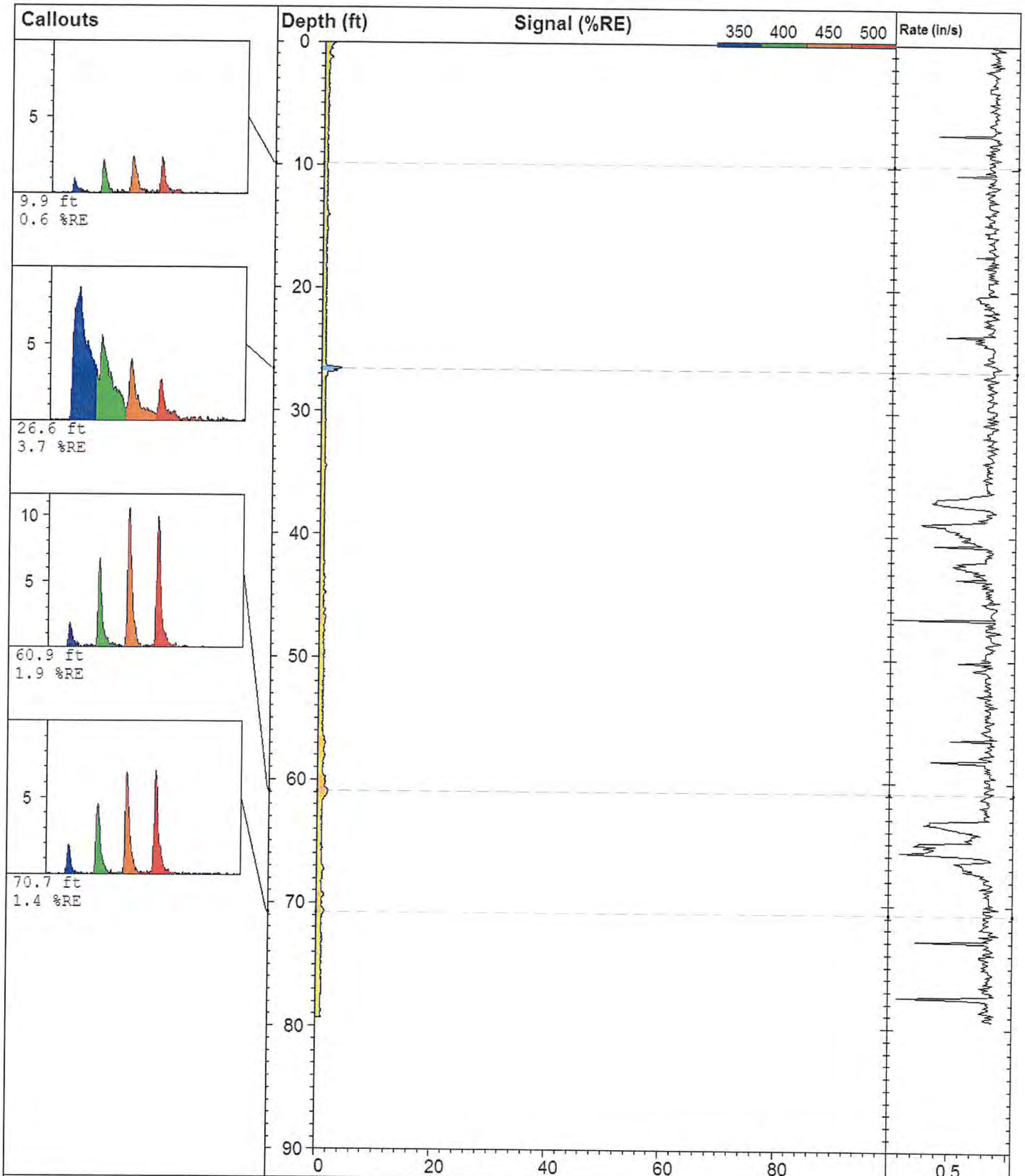
Engineer: Q.KINNEBREW

Date: 10/25/2010 01:12



Max. Depth: 80.217 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-6		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **79.33 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **3.7 % @ 26.58 ft**
Job: **10-344**	*Operator/Unit:* **CHRIS/UVOST1007**	*Date & Time:* **2010-10-26 16:12 PDT**

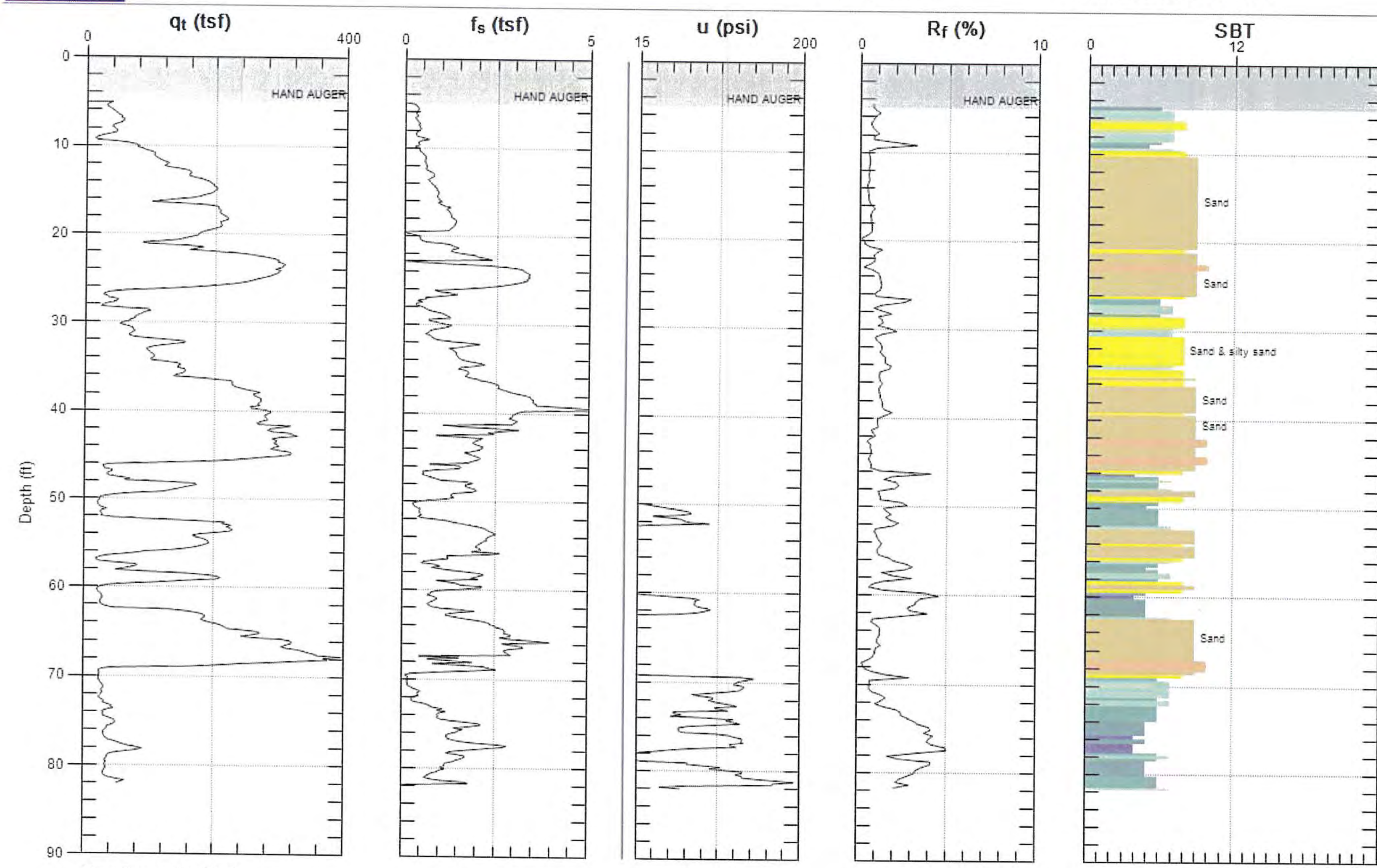
GREGG **PARSONS**

Site: DFSP

Sounding: UV-6

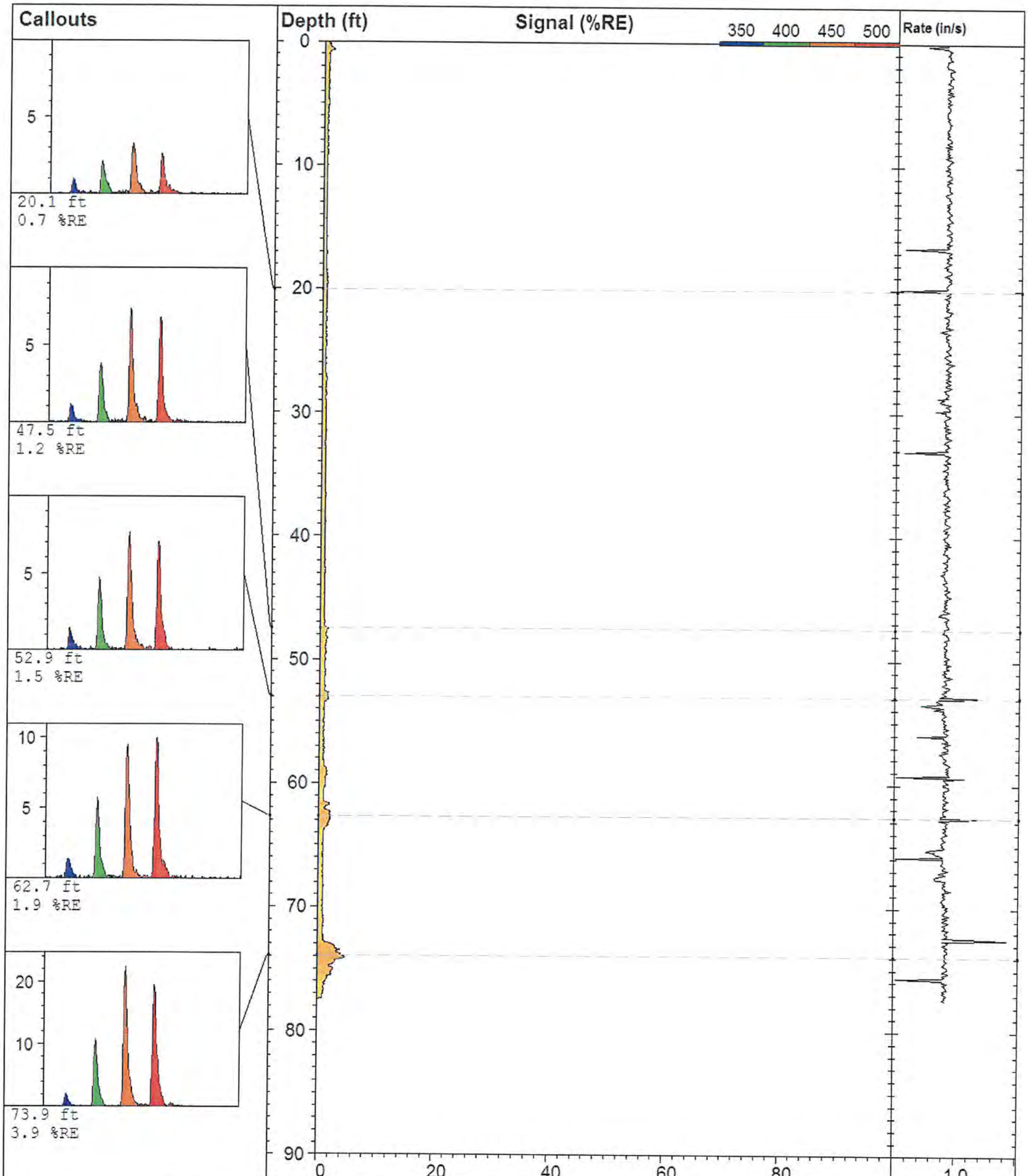
Engineer: Q.KINNEBREW

Date: 10/26/2010 04:13



Max. Depth: 82.021 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



www.greggdrilling.com

UV-7		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.44 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **4.8 % @ 74.13 ft**
Job: **344**	*Operator/Unit:* **EC/UVOST1007**	*Date & Time:* **2010-10-27 09:54 PDT**

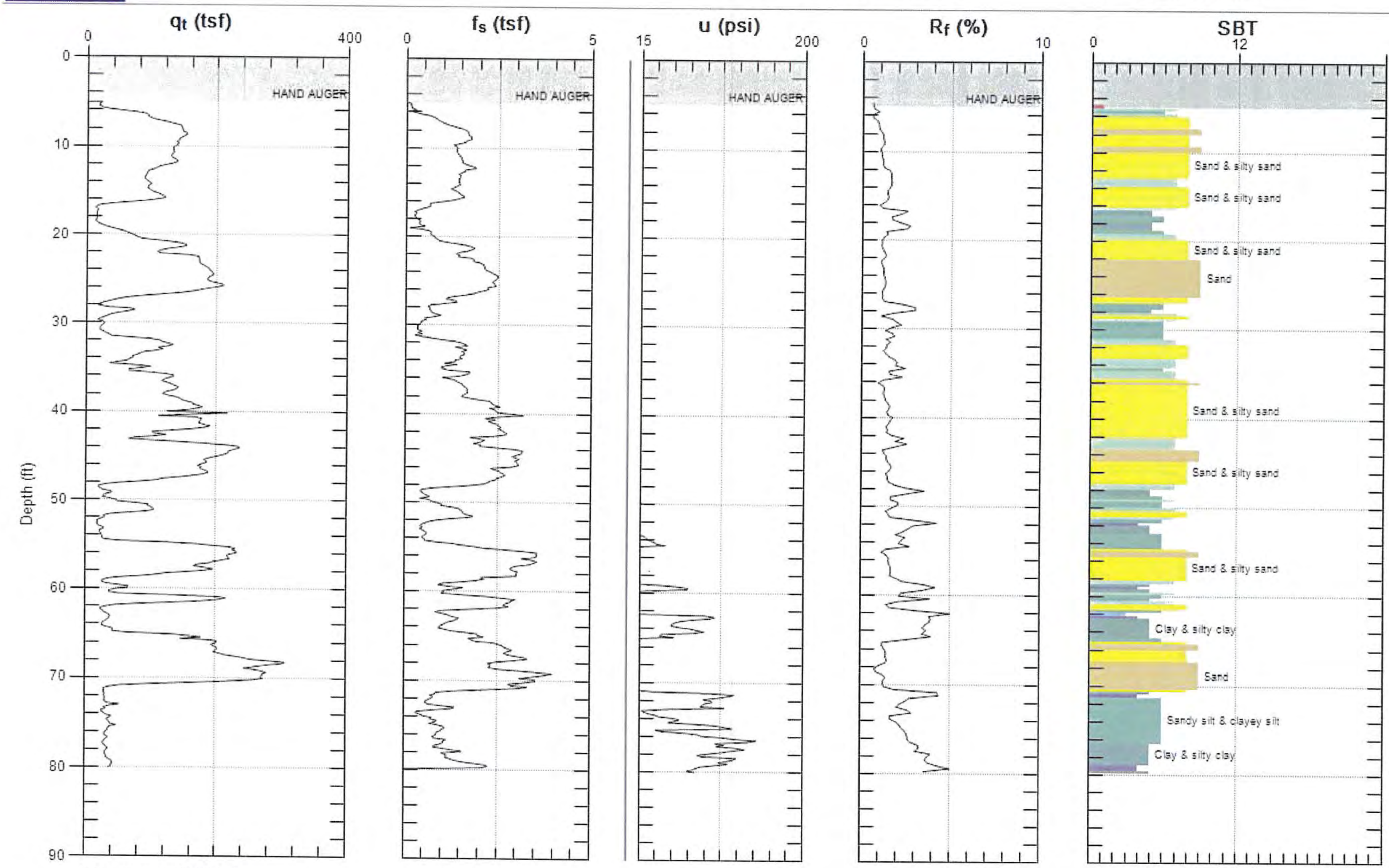
GREGG **PARSONS**

Site: DFSP

Sounding: UV-7

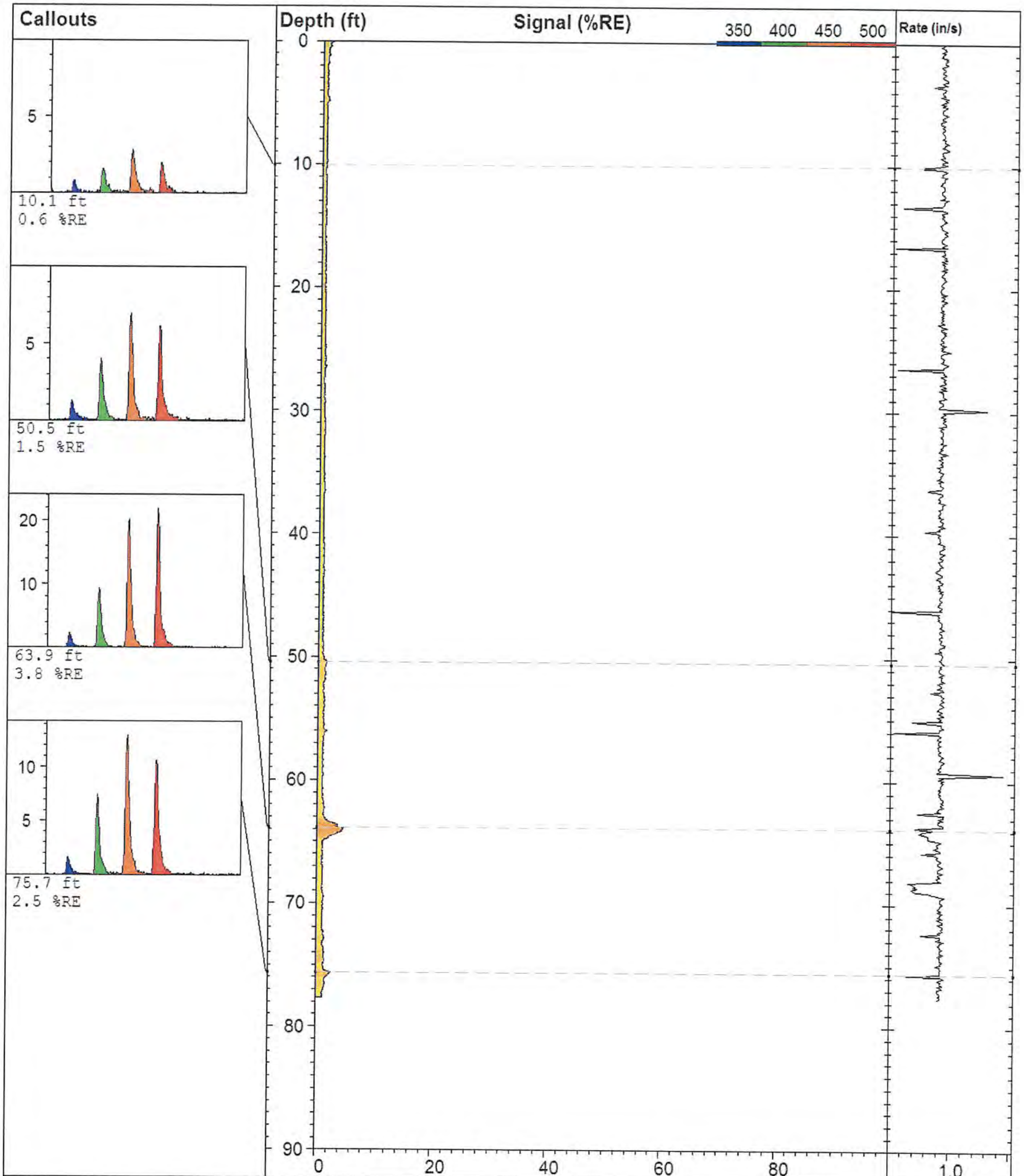
Engineer: Q.KINNEBREW

Date: 10/27/2010 09:58



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-8		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.68 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **4.6 % @ 63.96 ft**
Job: **344**	*Operator/Unit:* **EC/UVOST1007**	*Date & Time:* **2010-10-27 08:47 PDT**

GREGG

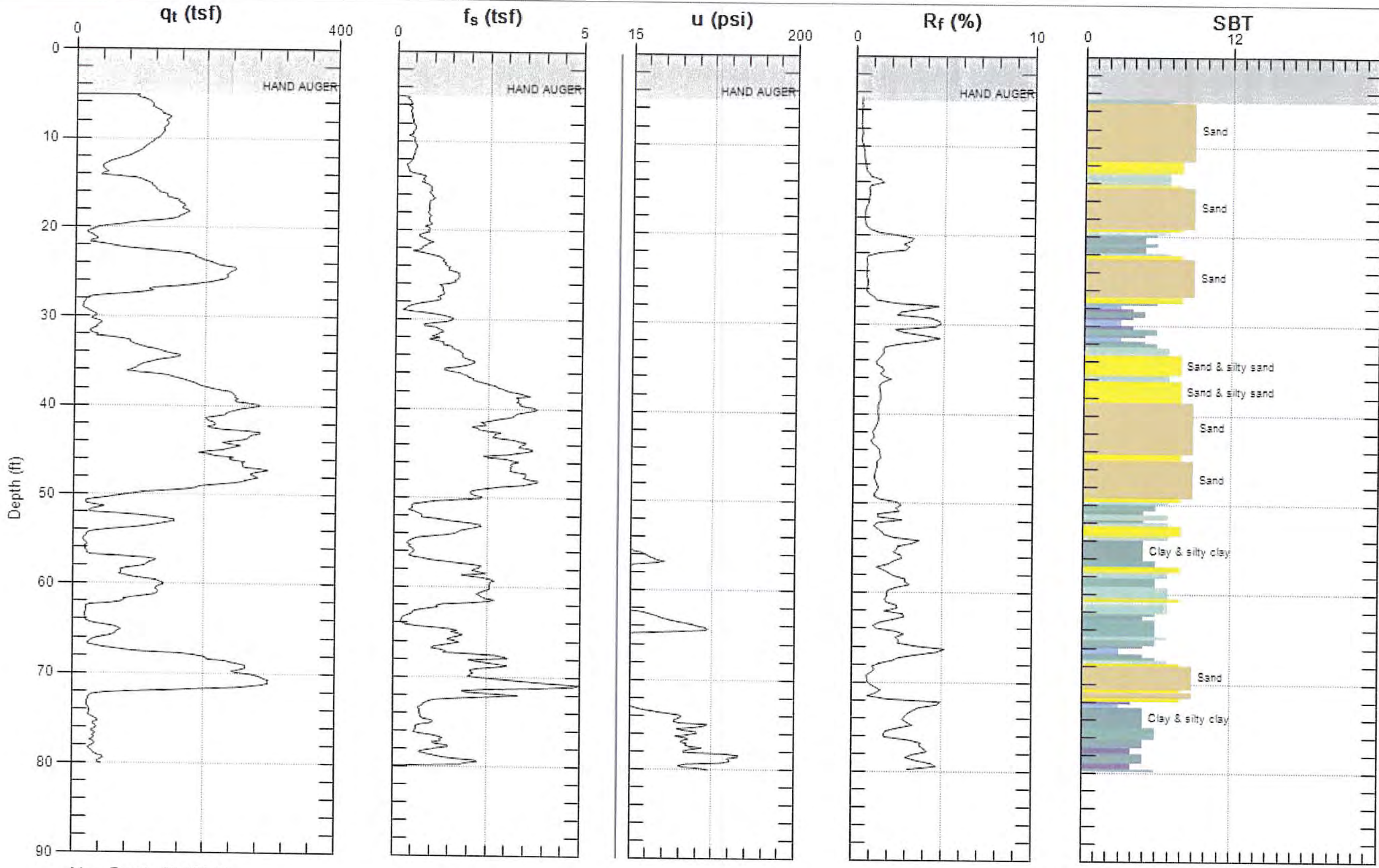
PARSONS

Site: DFSP

Sounding: UV-8

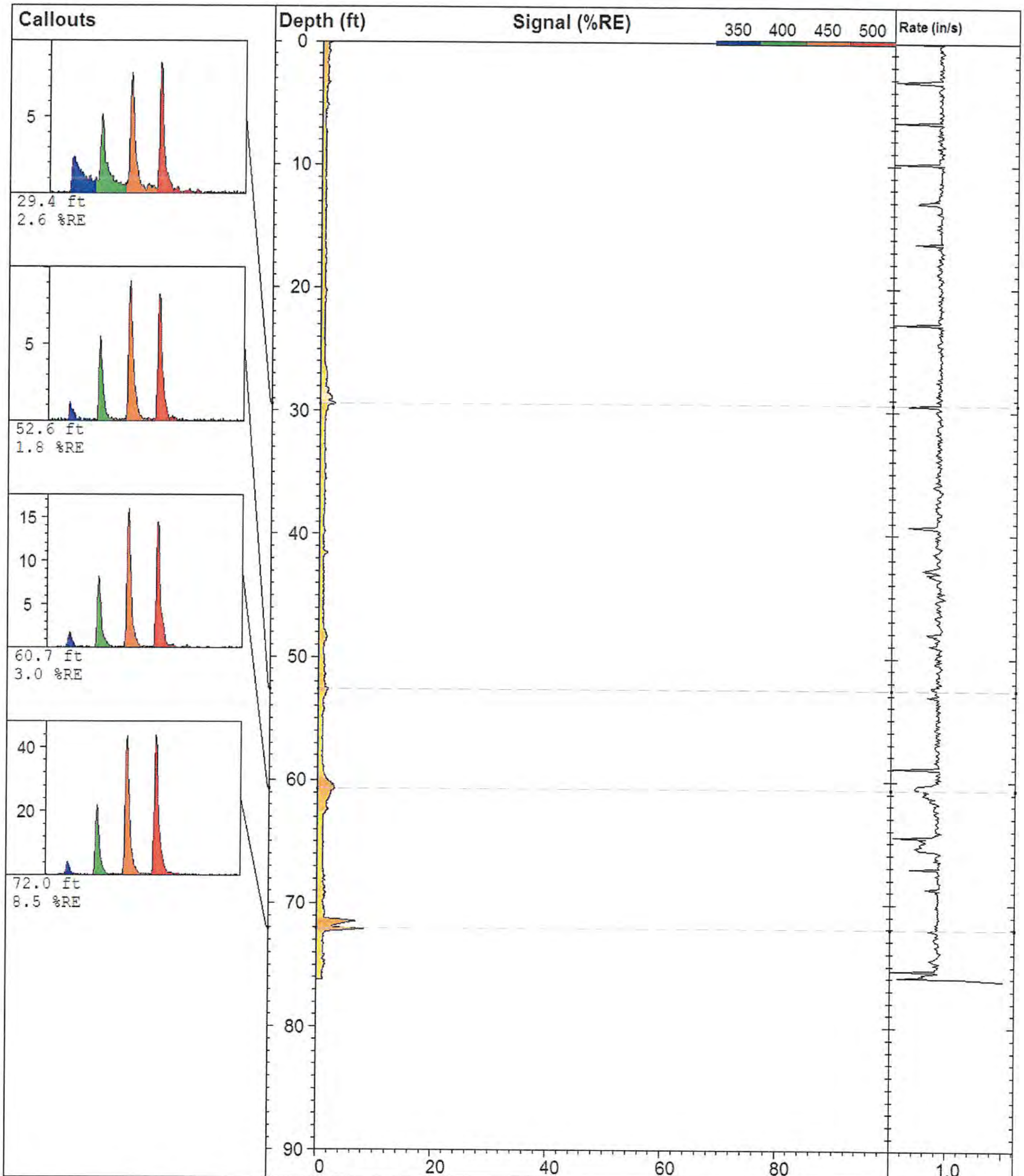
Engineer: Q.KINNEBREW

Date: 10/27/2010 08:42



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-9		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **76.17 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **8.5 % @ 72.04 ft**
Job: **344**	*Operator/Unit:* **EC/UVOST1007**	*Date & Time:* **2010-10-27 07:48 PDT**

GREGG

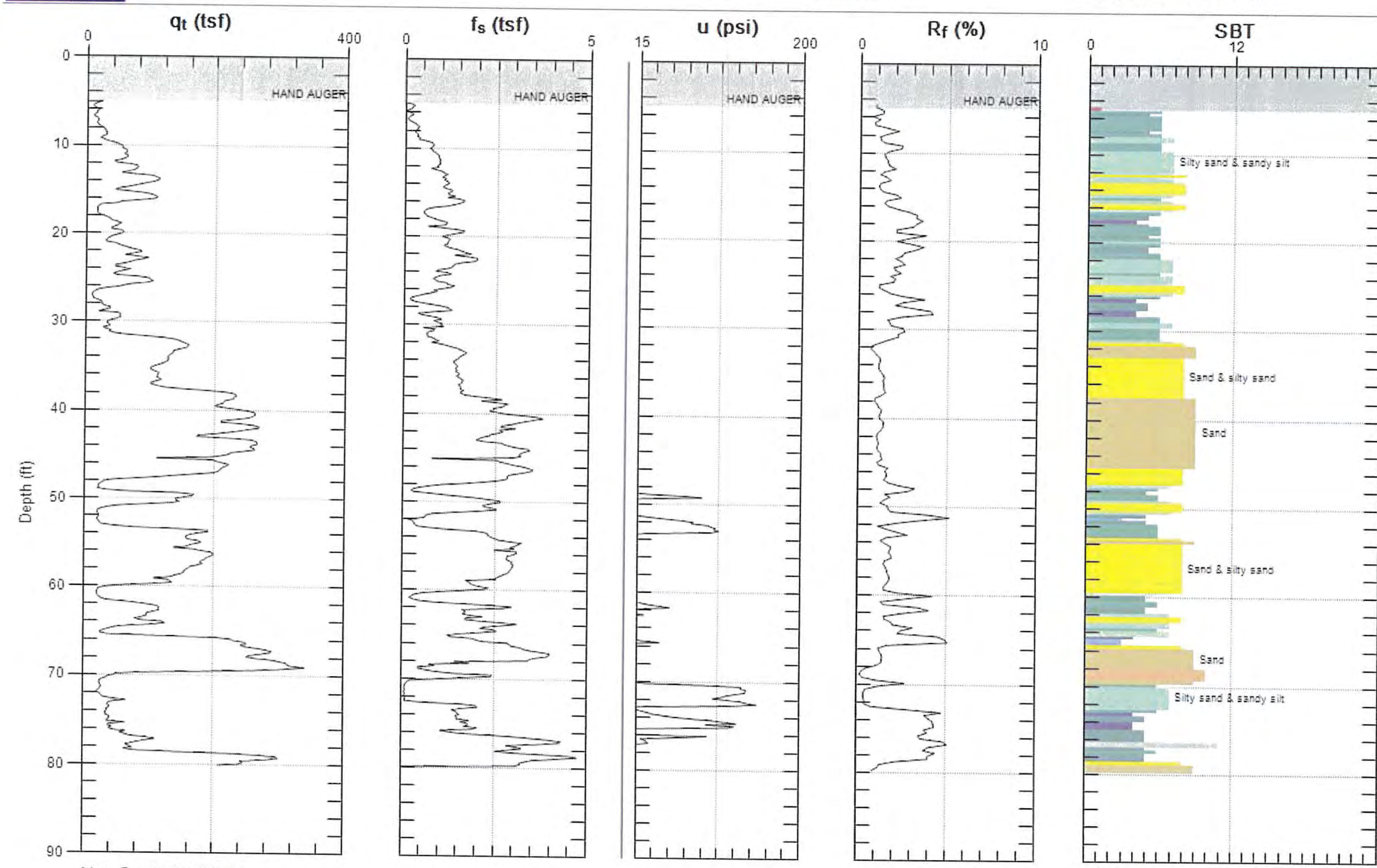
PARSONS

Site: DFSP

Sounding: UV-9

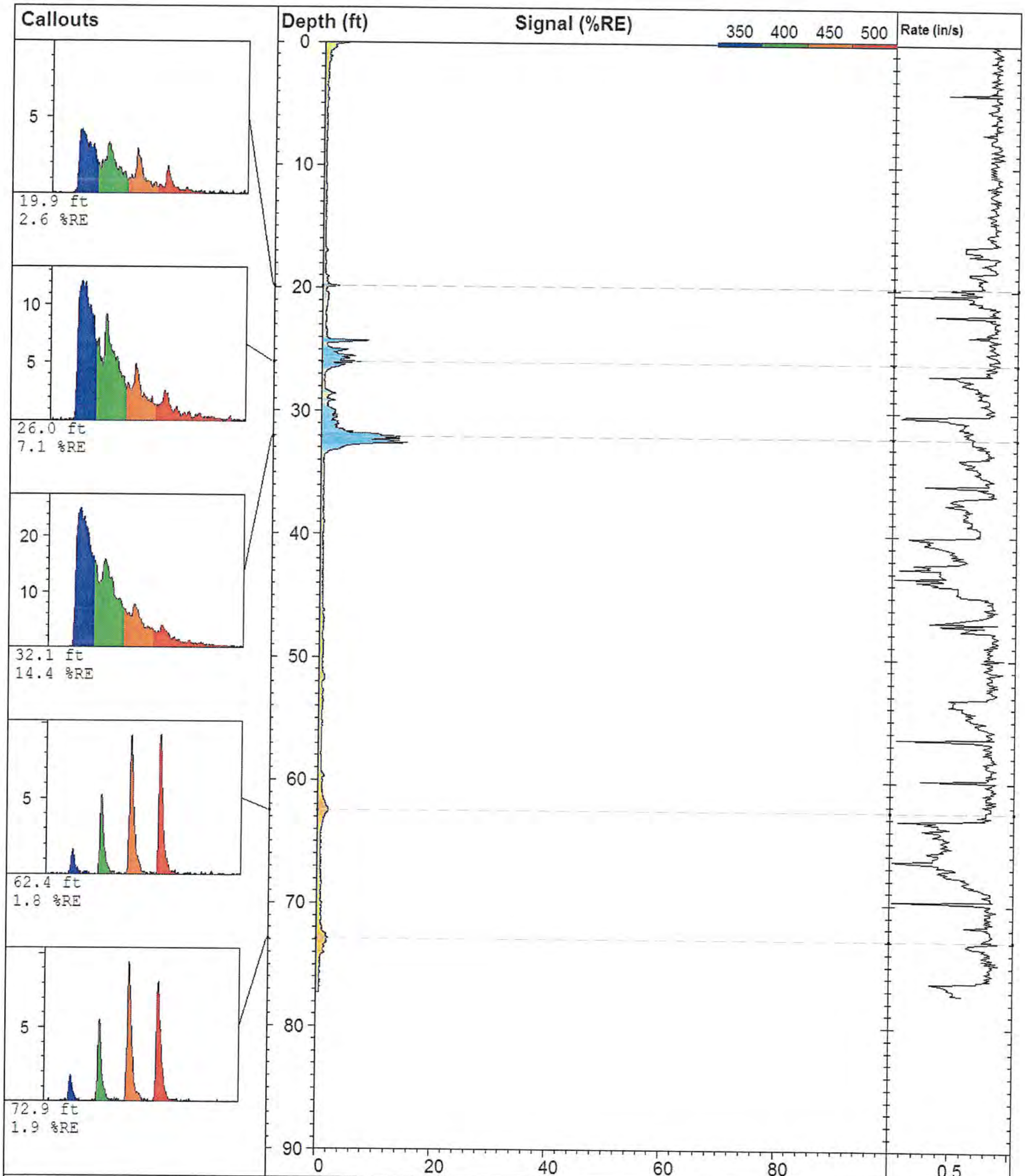
Engineer: Q.KINNEBREW

Date: 10/27/2010 07:49



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-10

UVOST By Dakota
www.DakotaTechnologies.com

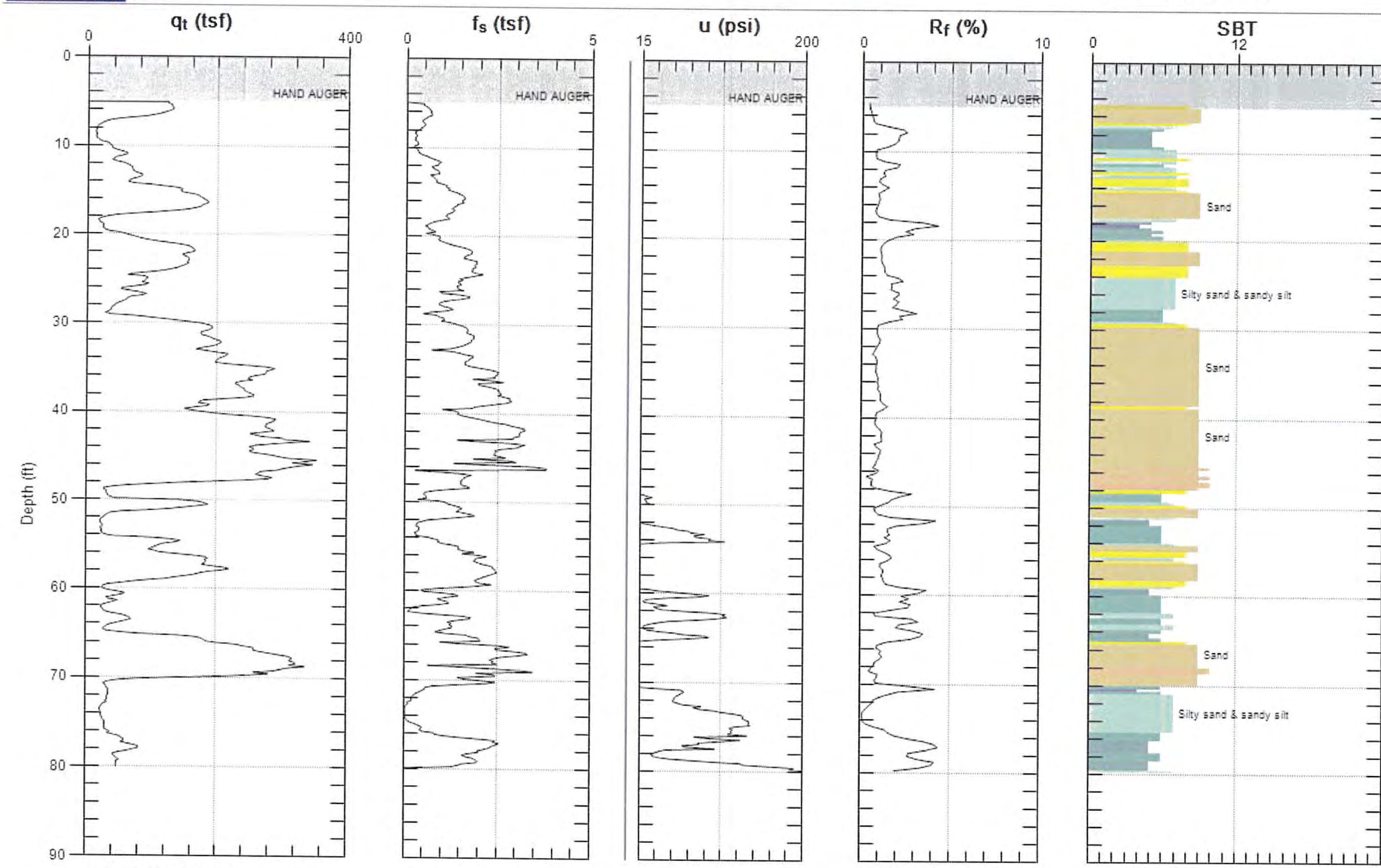
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.26 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **15.3 % @ 32.59 ft**
Job: **10-344**	*Operator/Unit:* **CHRIS/UVOST1007**	*Date & Time:* **2010-10-26 11:36 PDT**

GREGG

PARSONS

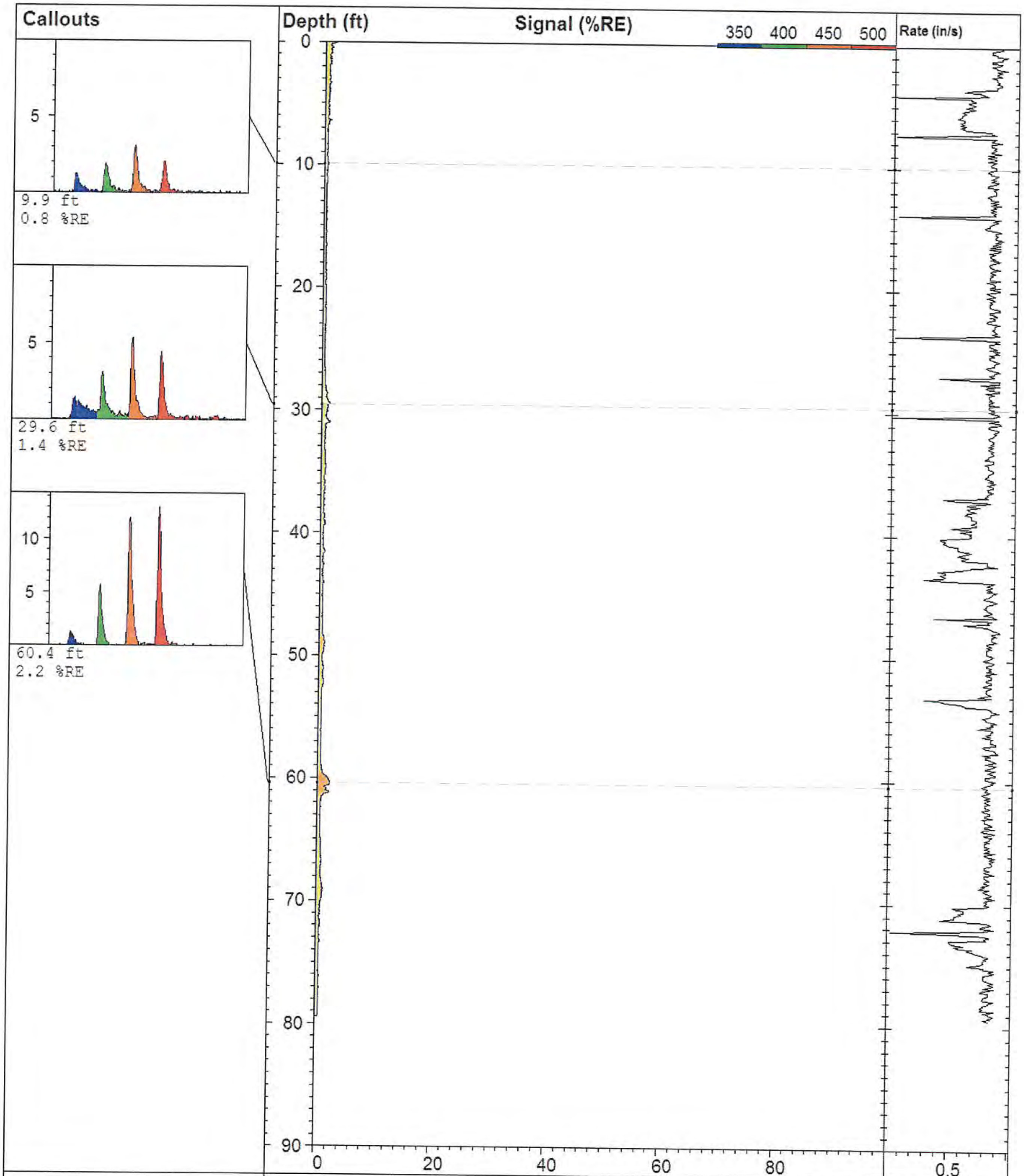
Site: DFSP
Sounding: UV-10

Engineer: Q.KINNEBREW
Date: 10/26/2010 11:30



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



www.greggdrilling.com

UV-11		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **79.43 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **2.2 % @ 60.53 ft**
Job: **10-344**	*Operator/Unit:* **CHRIS/UVOST1007**	*Date & Time:* **2010-10-26 08:42 PDT**

GREGG

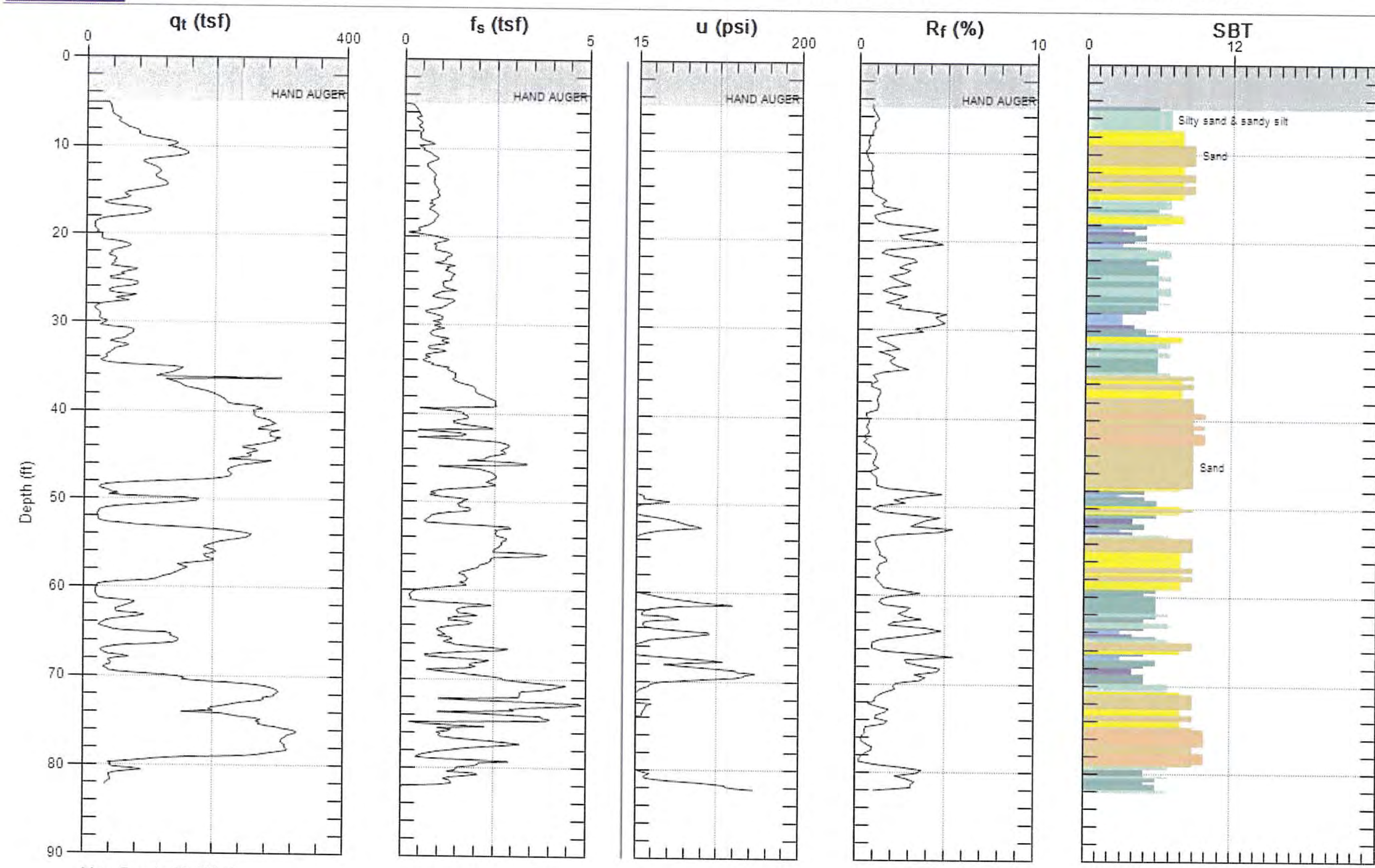
PARSONS

Site: DFSP

Sounding: UV-11

Engineer: Q.KINNEBREW

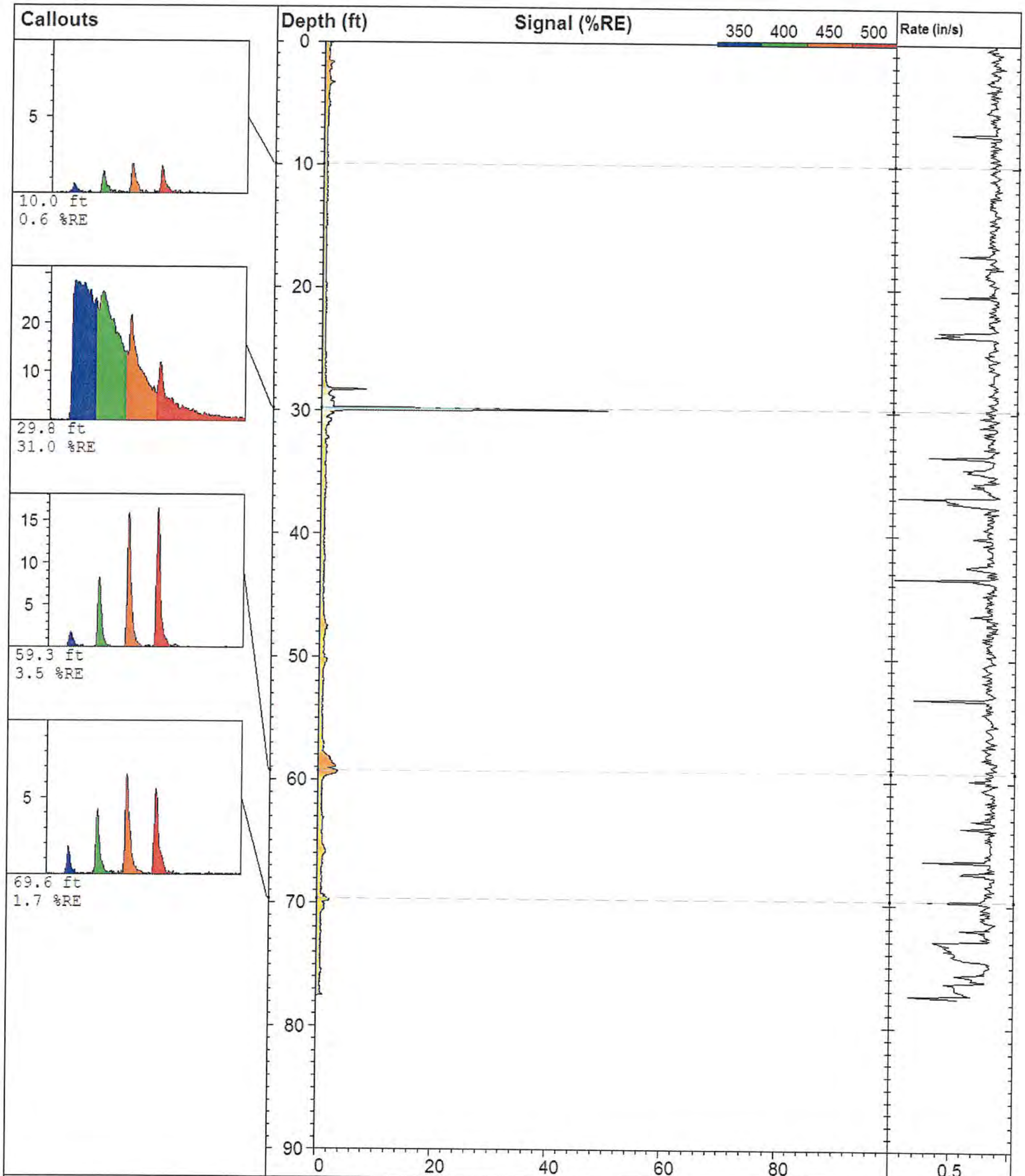
Date: 10/26/2010 08:40



Max. Depth: 82.185 (ft)

Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-12		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP	*Latitude / Datum:* Unavailable / NA	*Final depth:* 77.51 ft
Client: PARSONS	*Longitude / Fix:* Unavailable / NA	*Max signal:* 50.6 % @ 29.90 ft
Job: 10-344	*Operator/Unit:* CHRIS/UVOST1007	*Date & Time:* 2010-10-26 09:48 PDT

GREGG

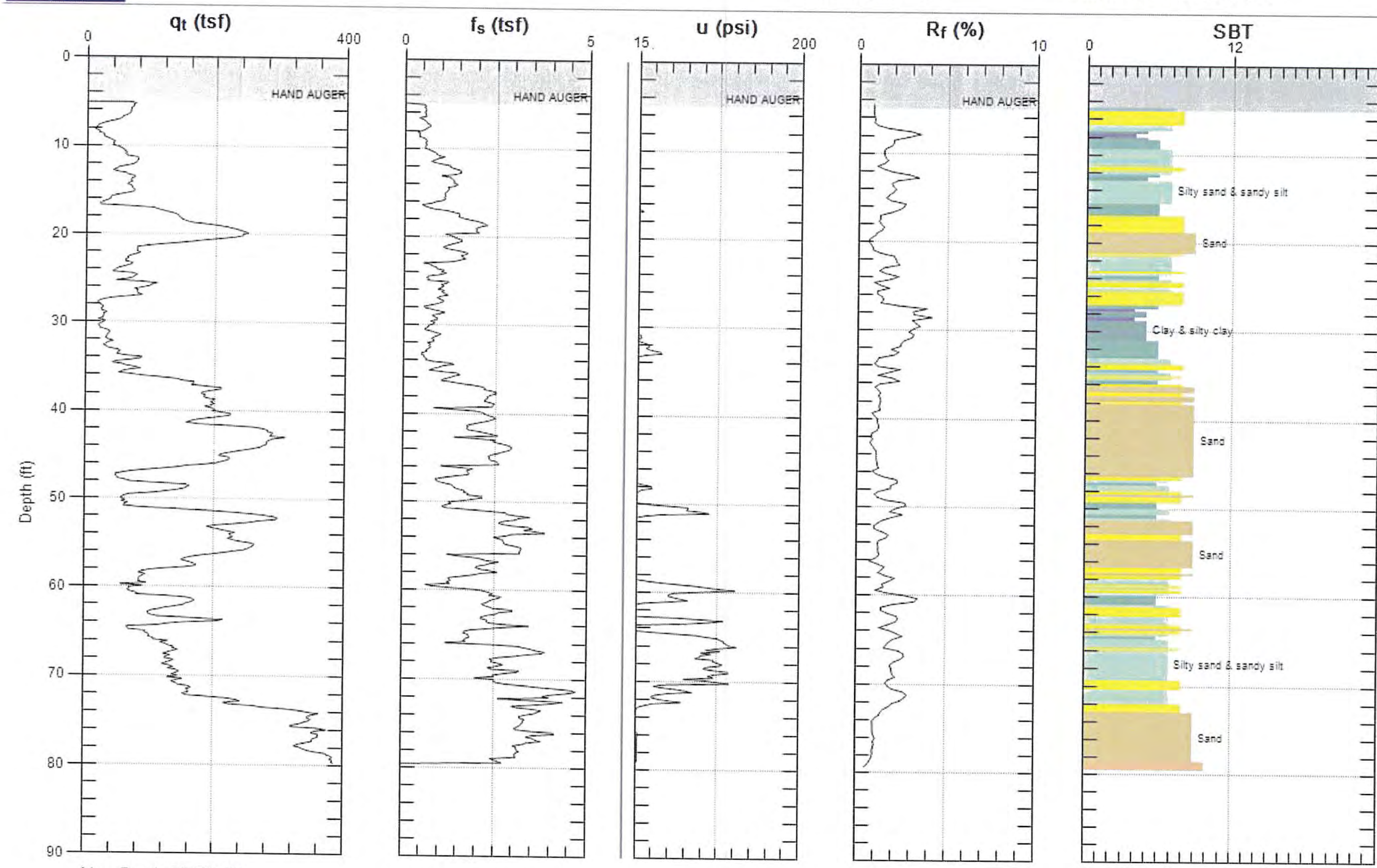
PARSONS

Site: DFSP

Sounding: UV-12

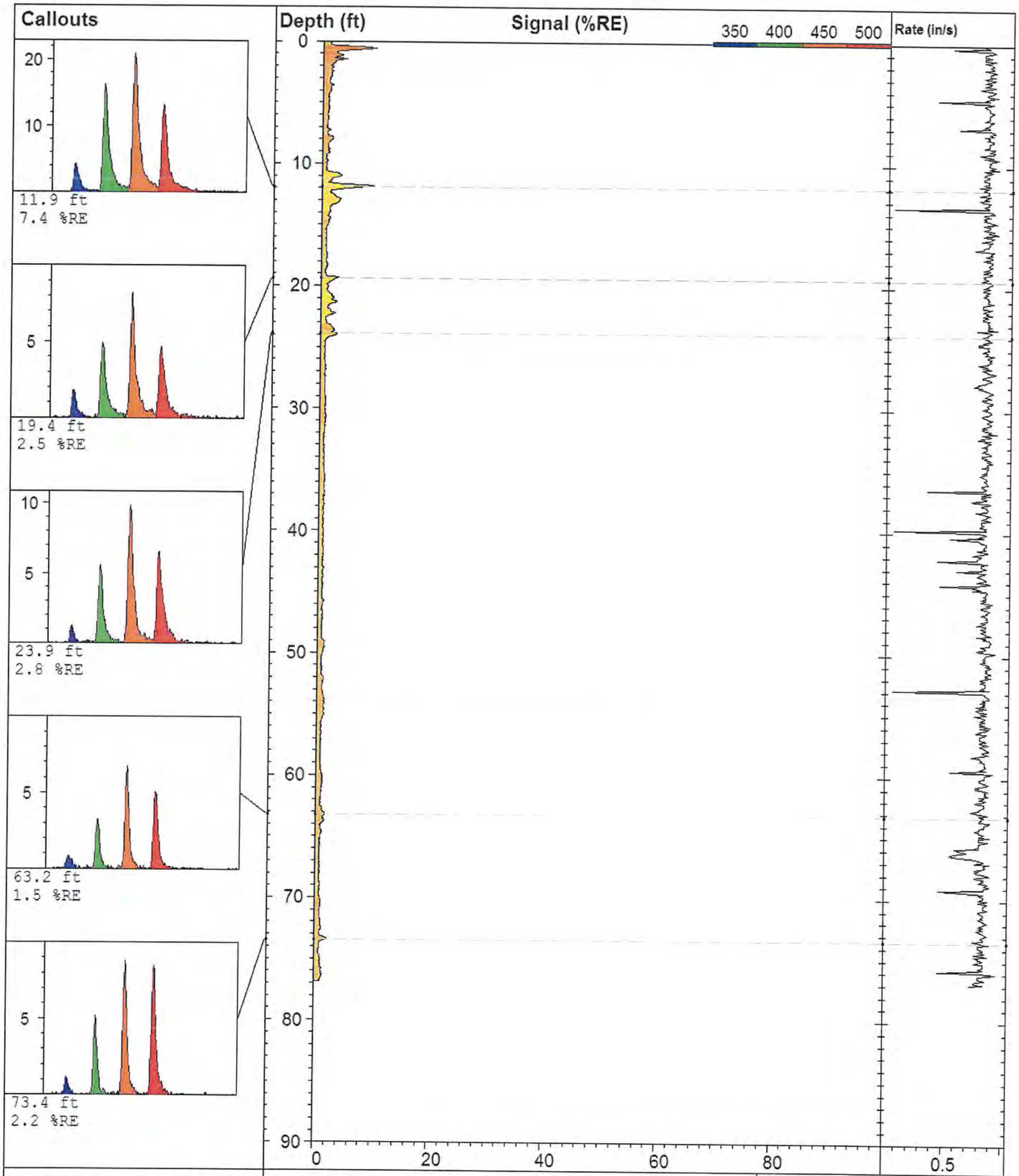
Engineer: Q.KINNEBREW

Date: 10/26/2010 09:50



Max. Depth: 79.724 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-13

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **76.88 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **9.4 % @ 0.58 ft**
Job: **344**	*Operator/Unit:* **EC/UVOST1007**	*Date & Time:* **2010-10-25 14:55 PDT**

GREGG

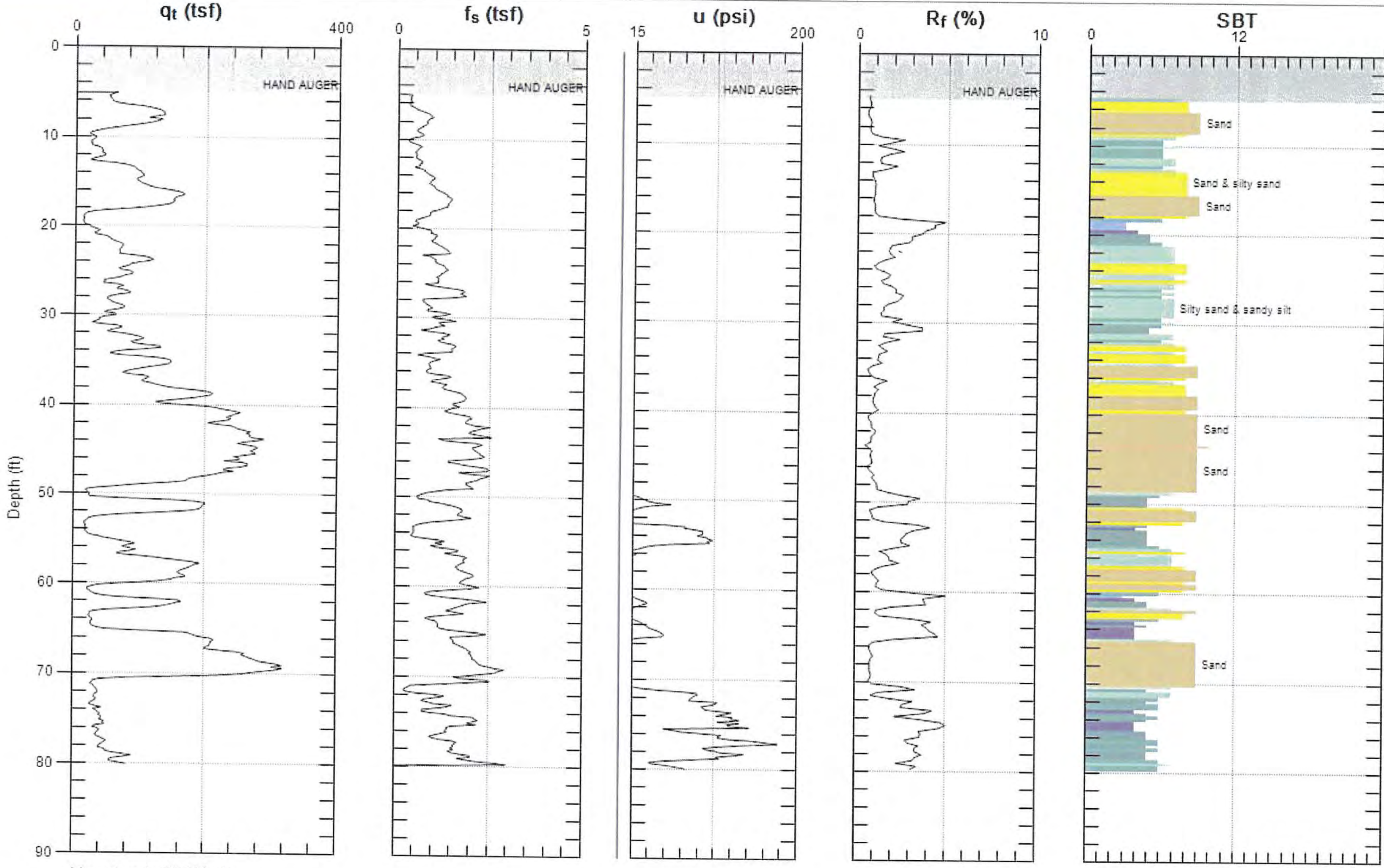
PARSONS

Site: DFSP

Sounding: UV-13

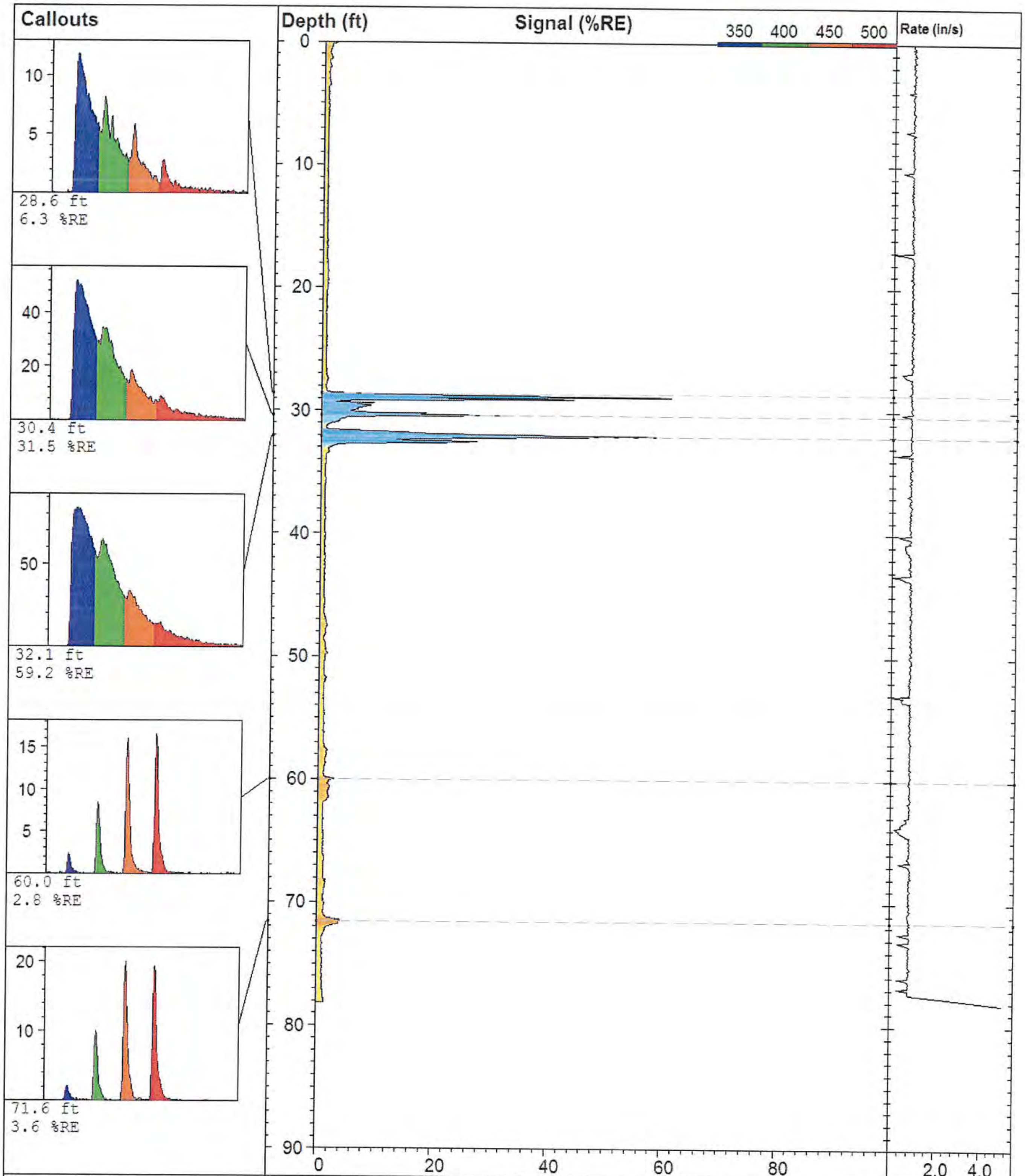
Engineer: Q.KINNEBREW

Date: 10/25/2010 02:58



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

www.greggdrilling.com

UV-14		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP	Latitude / Datum: Unavailable / NA	Final depth: 78.17 ft
Client: PARSONS	Longitude / Fix: Unavailable / NA	Max signal: 62.7 % @ 28.87 ft
Job: 10-344	Operator/Unit: CHRIS/UVOST1007	Date & Time: 2010-10-26 12:54 PDT

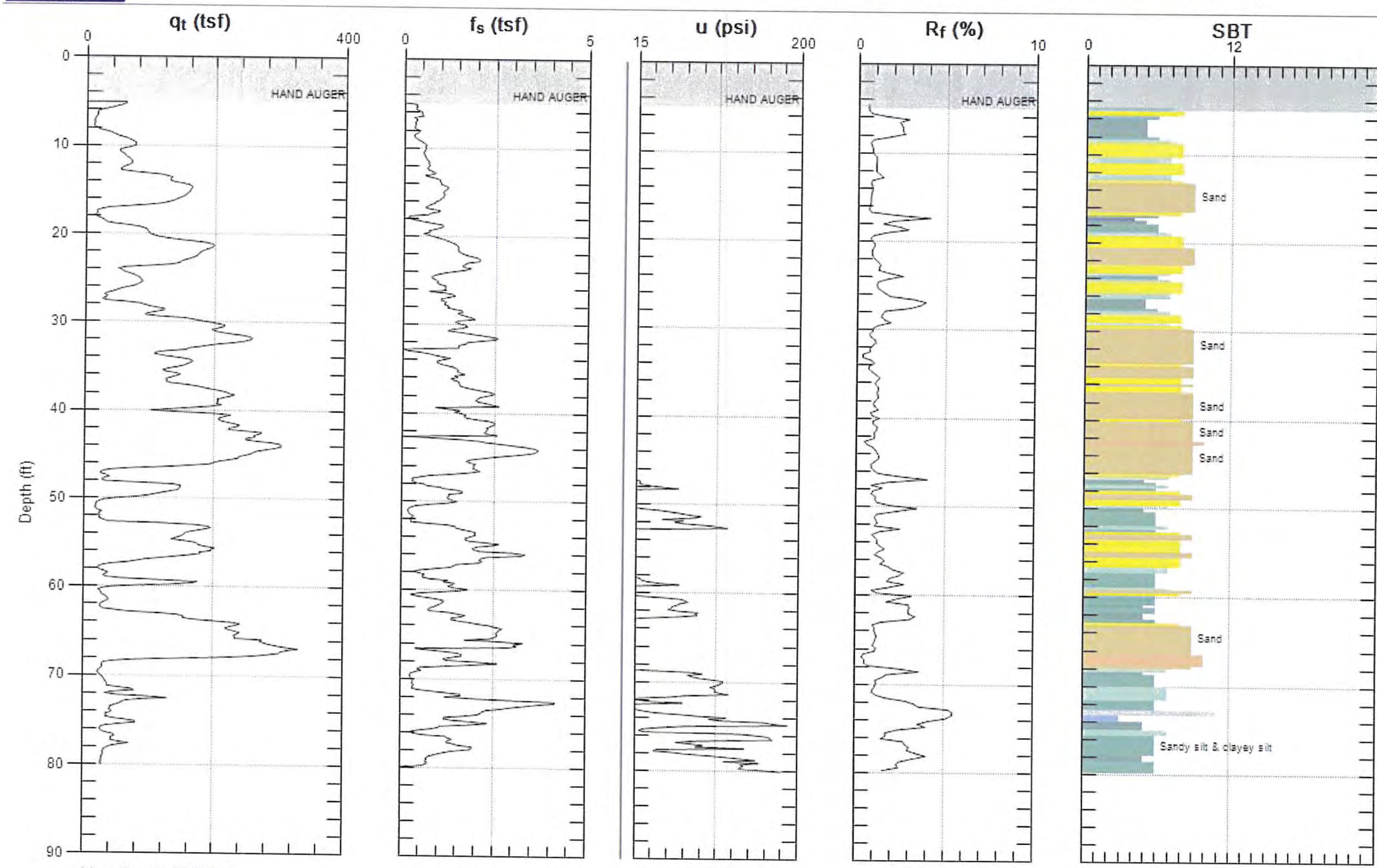
PARSONS

Site: DFSP

Sounding: UV-14

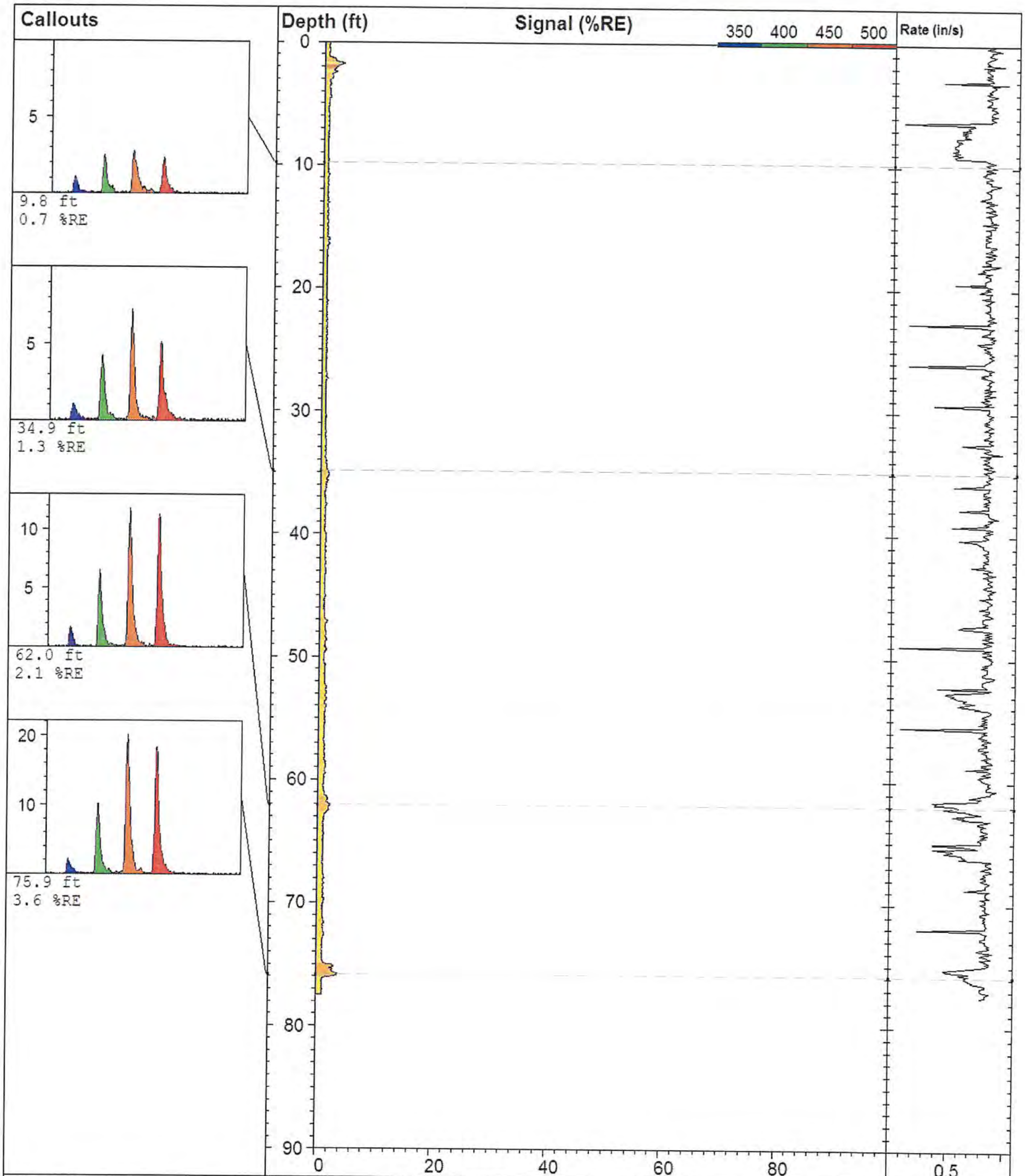
Engineer: Q.KINNEBREW

Date: 10/26/2010 12:49



Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

www.greggdrilling.com

UV-15		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Latitude / Datum:* **Unavailable / NA**	*Final depth:* **77.50 ft**
Client: **PARSONS**	*Longitude / Fix:* **Unavailable / NA**	*Max signal:* **3.7 % @ 75.78 ft**
Job: **344**	*Operator/Unit:* **EC/UVOST1007**	*Date & Time:* **2010-10-27 06:56 PDT**

GREGG

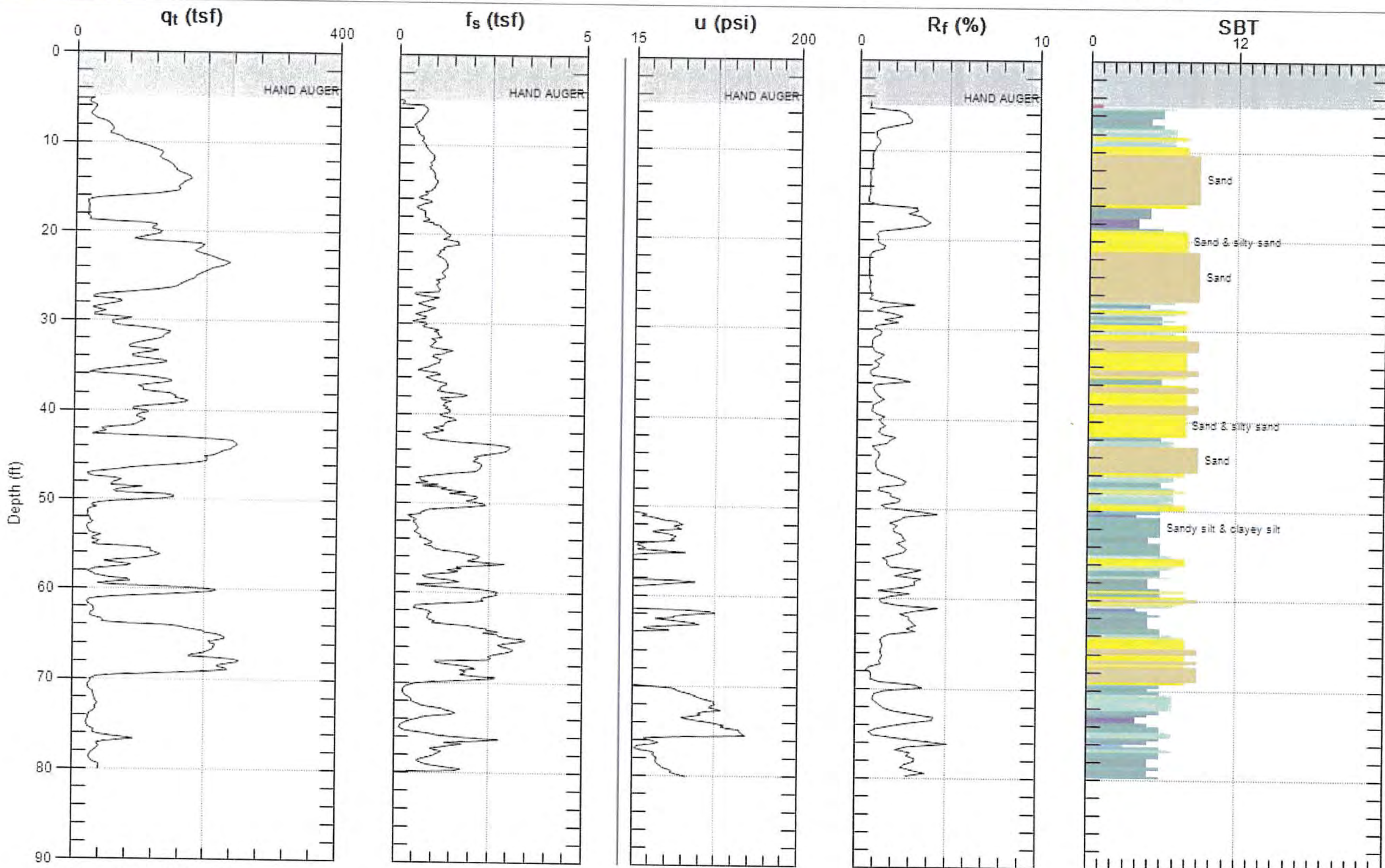
PARSONS

Site: DFSP

Sounding: UV-15

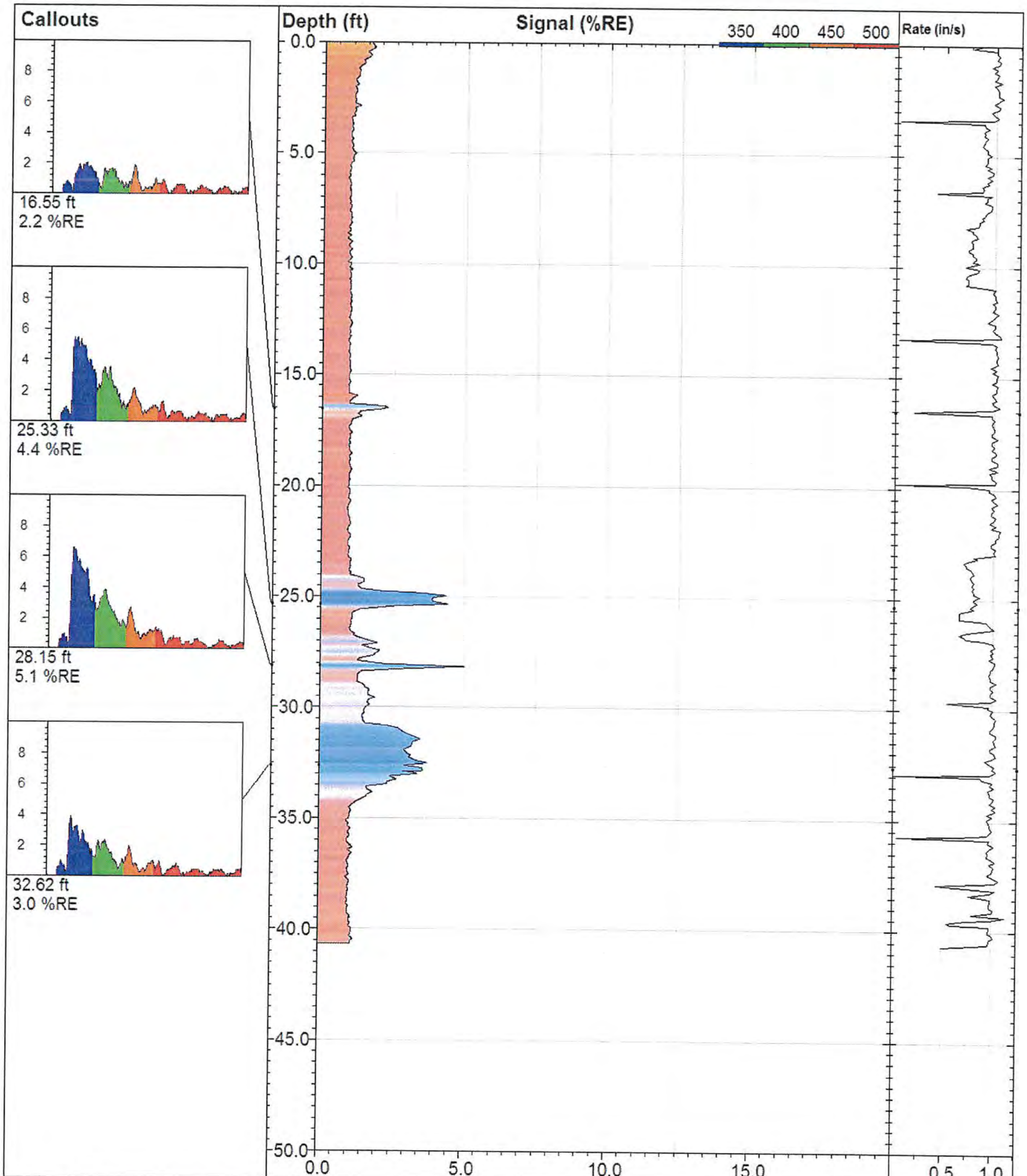
Engineer: Q.KINNEBREW

Date: 10/27/2010 06:57



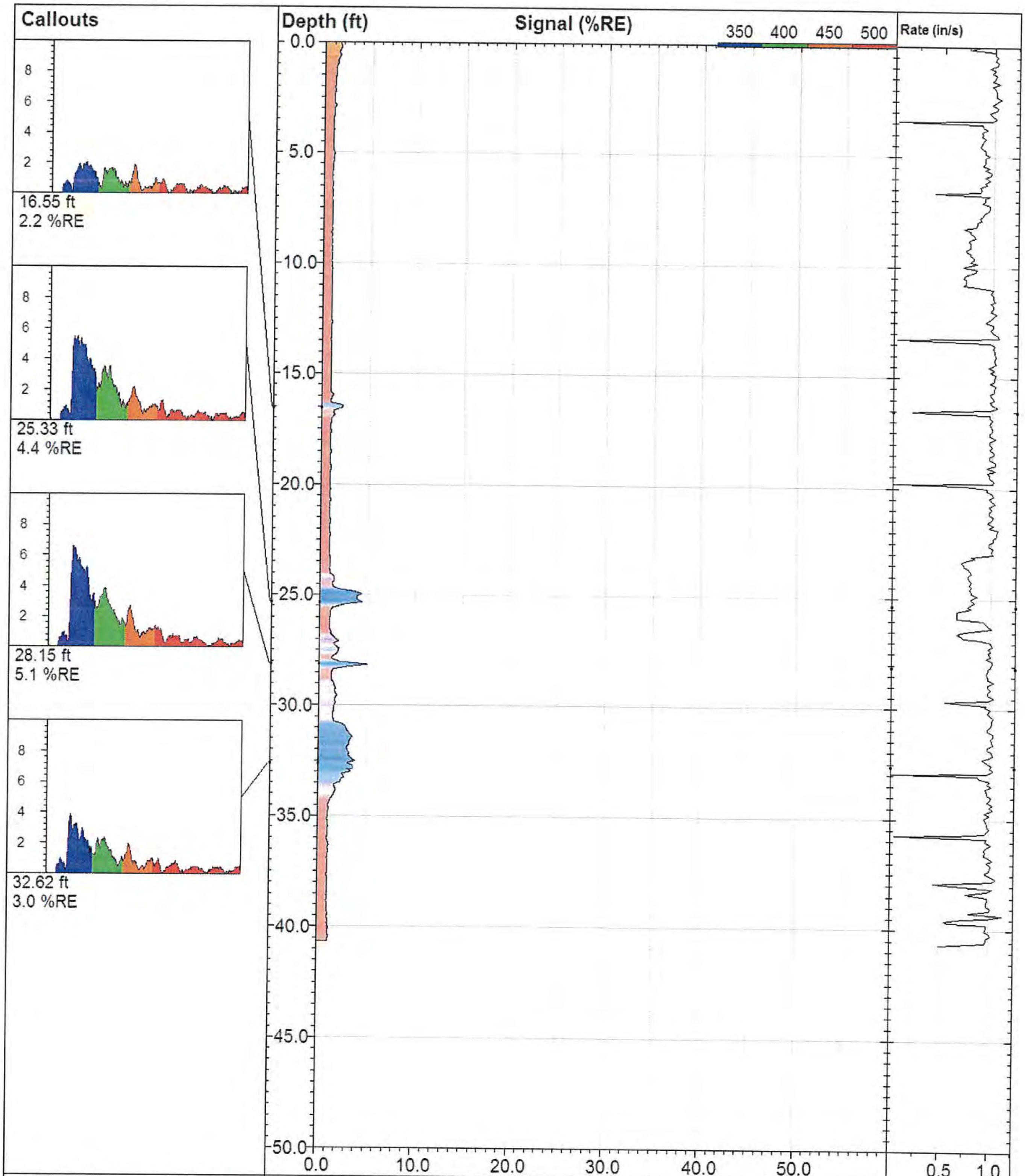
Max. Depth: 80.052 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-1		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.67 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.1 %RE @ 28.15 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 07:48 PST**



GREGG

UV-CPT-1

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.67 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.1 %RE @ 28.15 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 07:48 PST**

GREGG

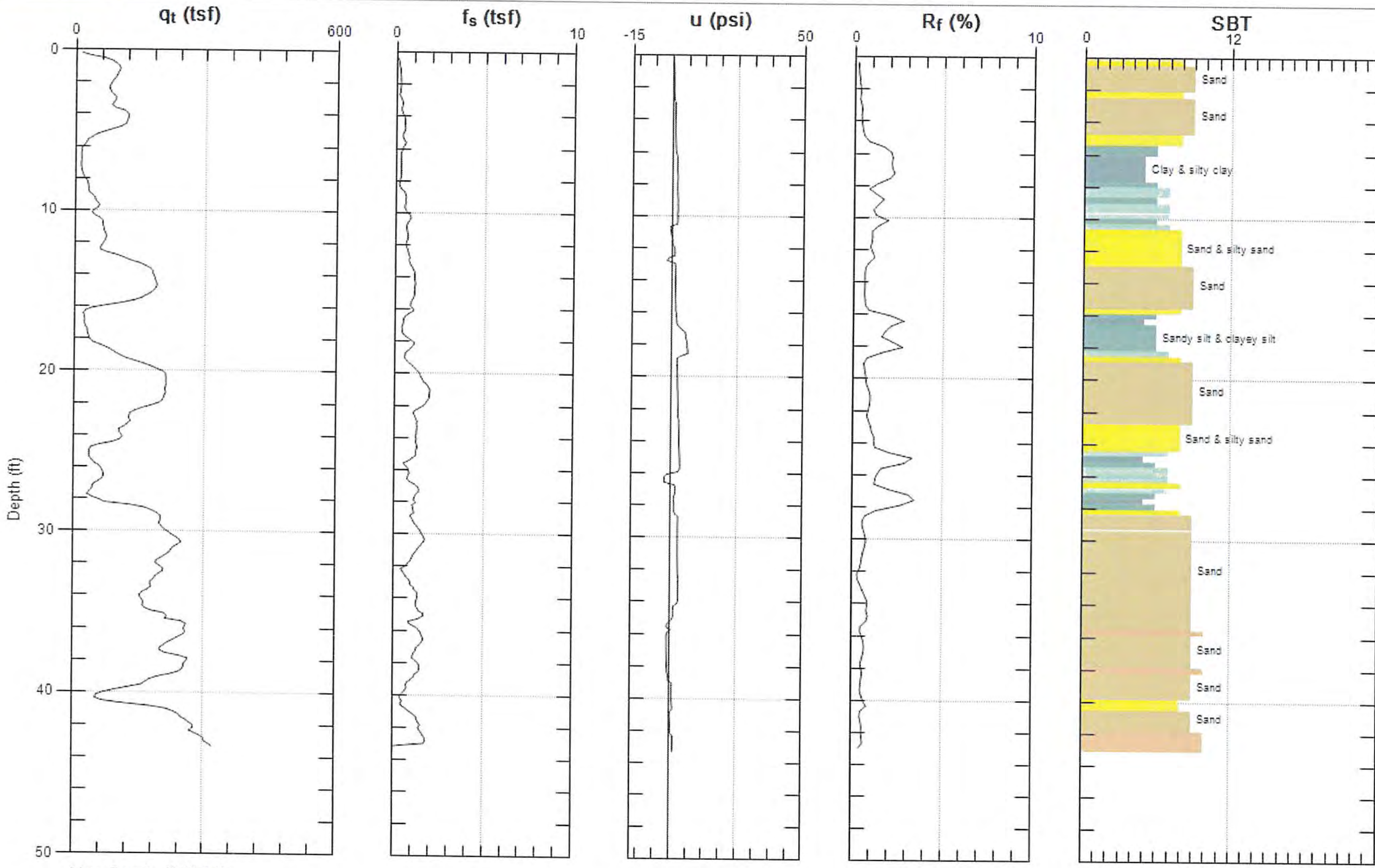
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-1

Engineer: P.PARMENTIER

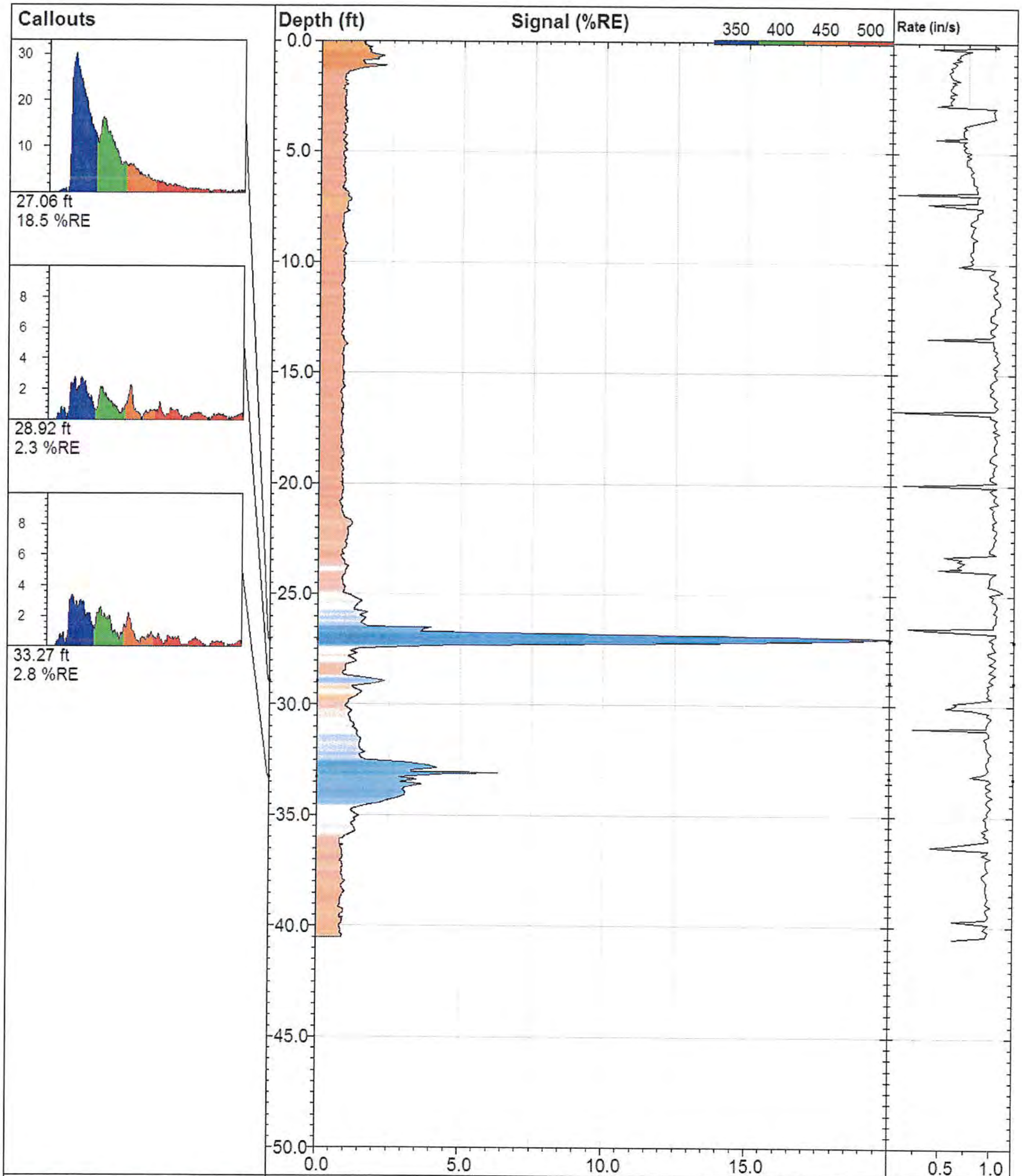
Date: 11/23/2015 07:59



Max. Depth: 43.307 (ft)

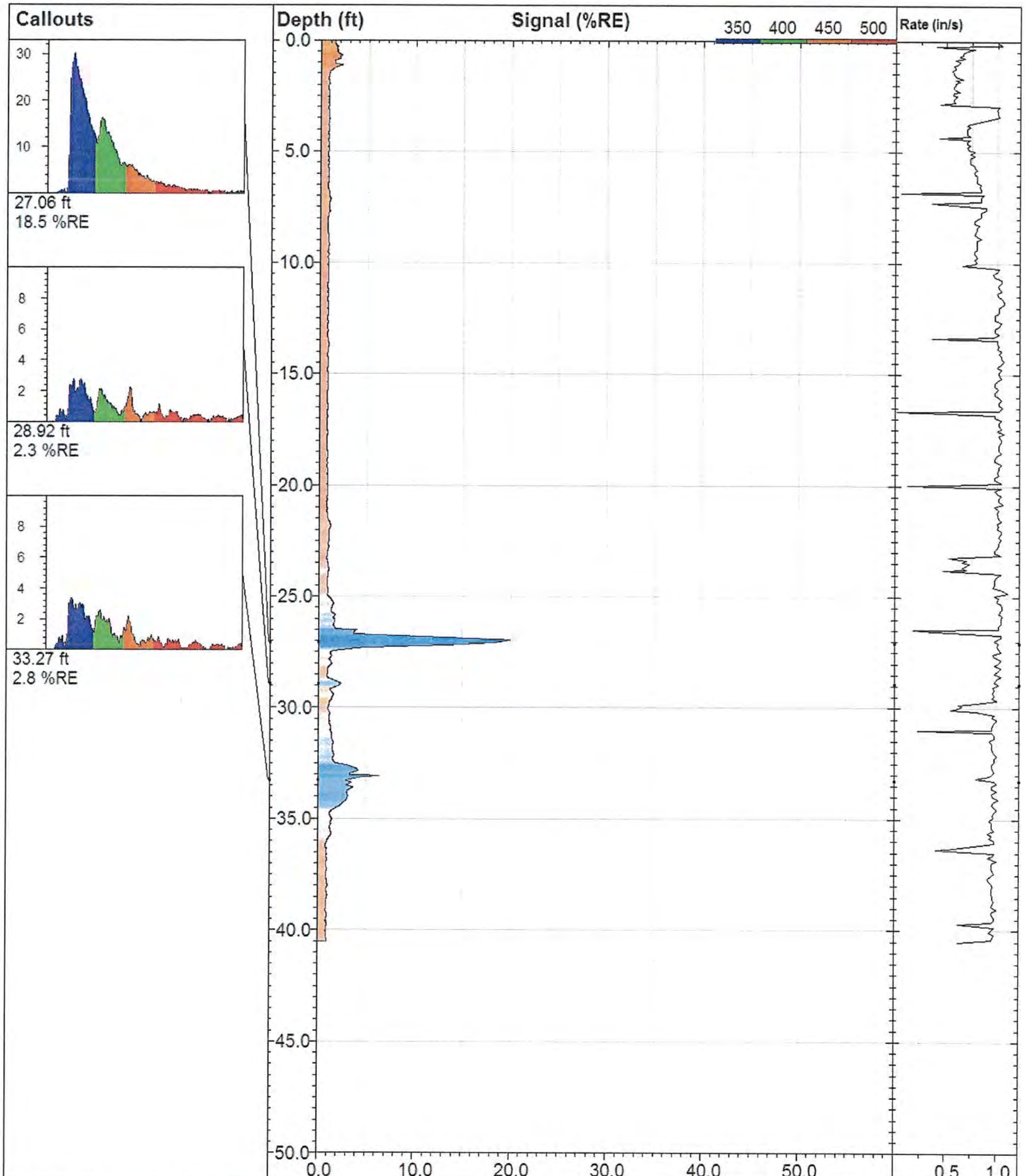
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-2		UVOST By Dakota www.DakotaTechnologies.com
Site: DLA Norwalk	*Y Coord.(Lat-N) / System:* Unavailable / NA	*Final depth:* 40.51 ft
Client / Job: The Source Group / UV-D1	*X Coord.(Lng-E) / Fix:* Unavailable / NA	*Max signal:* 20.0 %RE @ 26.95 ft
Operator / Unit: Alex S / UVOST1007	*Elevation:* Unavailable	*Date & Time:* 2015-11-23 08:43 PST



GREGG

UV-CPT-2		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.51 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **20.0 %RE @ 26.95 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 08:43 PST**

GREGG

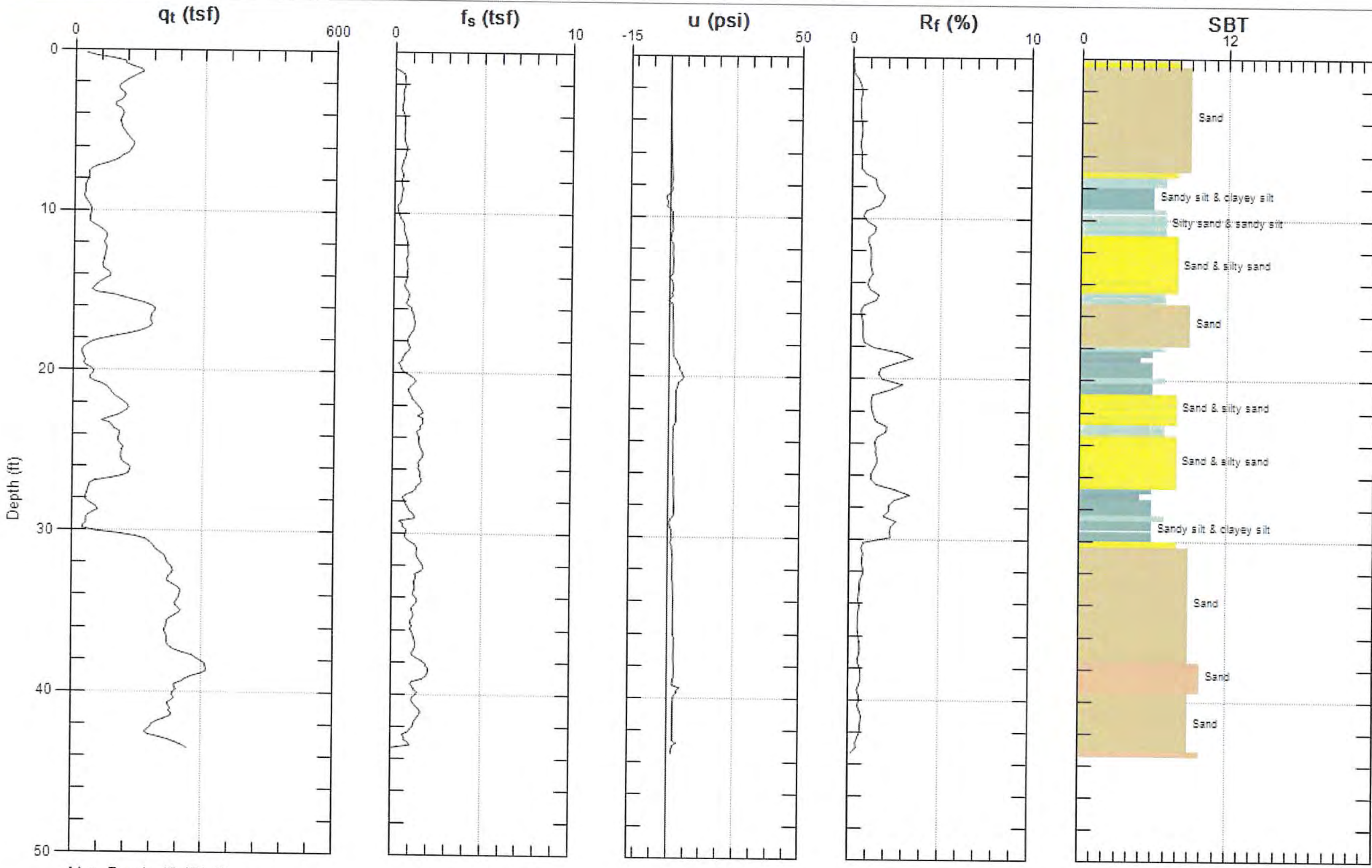
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-2

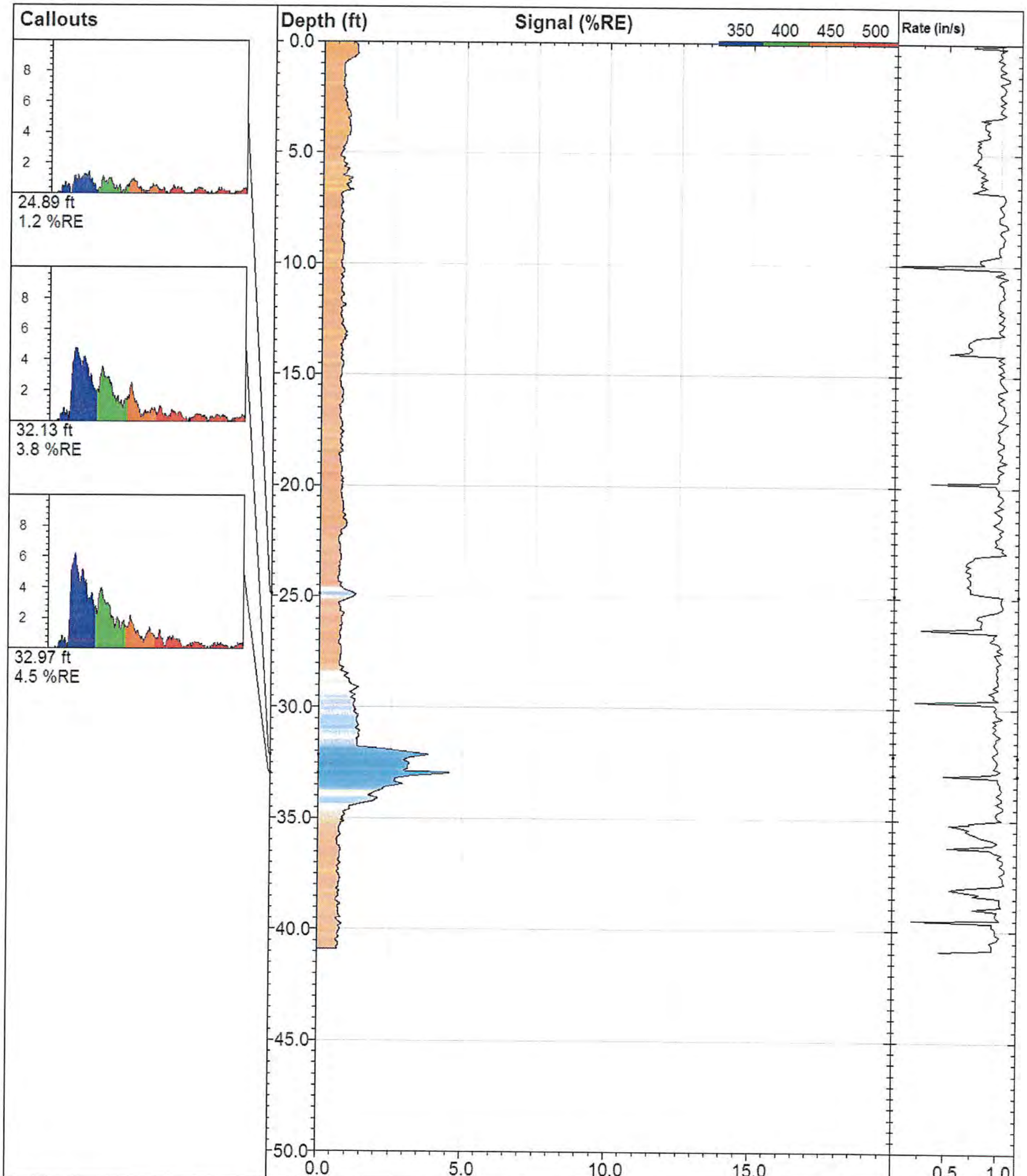
Engineer: P.PARMENTIER

Date: 11/23/2015 08:58



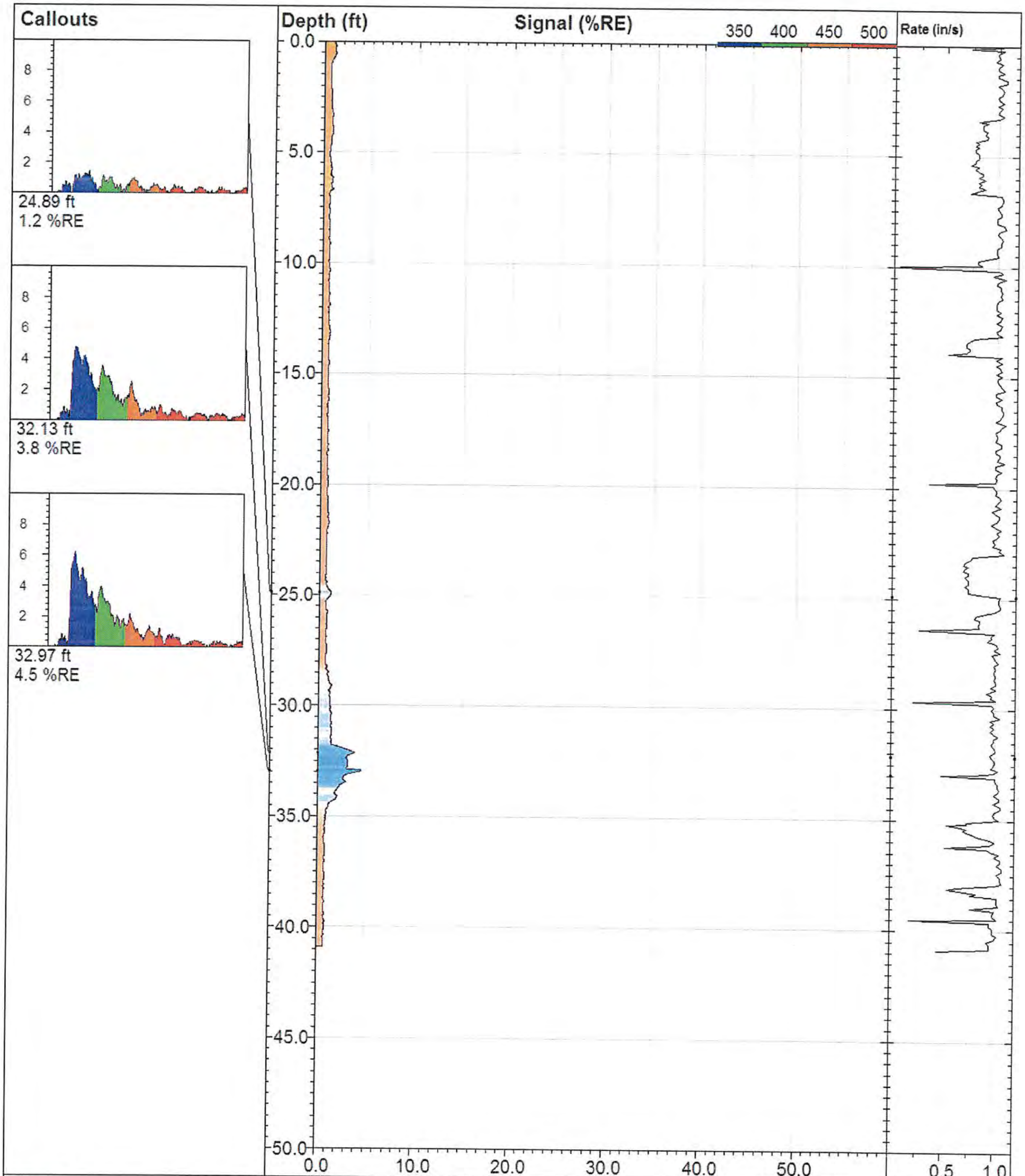
Max. Depth: 43.471 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-3		UVOST By Dakota www.DakotaTechnologies.com
Site:	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.90 ft**
Client / Job: /	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **4.5 %RE @ 32.97 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 10:31 PST**



GREGG

UV-CPT-3		**UVOST By Dakota** www.DakotaTechnologies.com
Site:	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.90 ft**
Client / Job: /	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **4.5 %RE @ 32.97 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 10:31 PST**

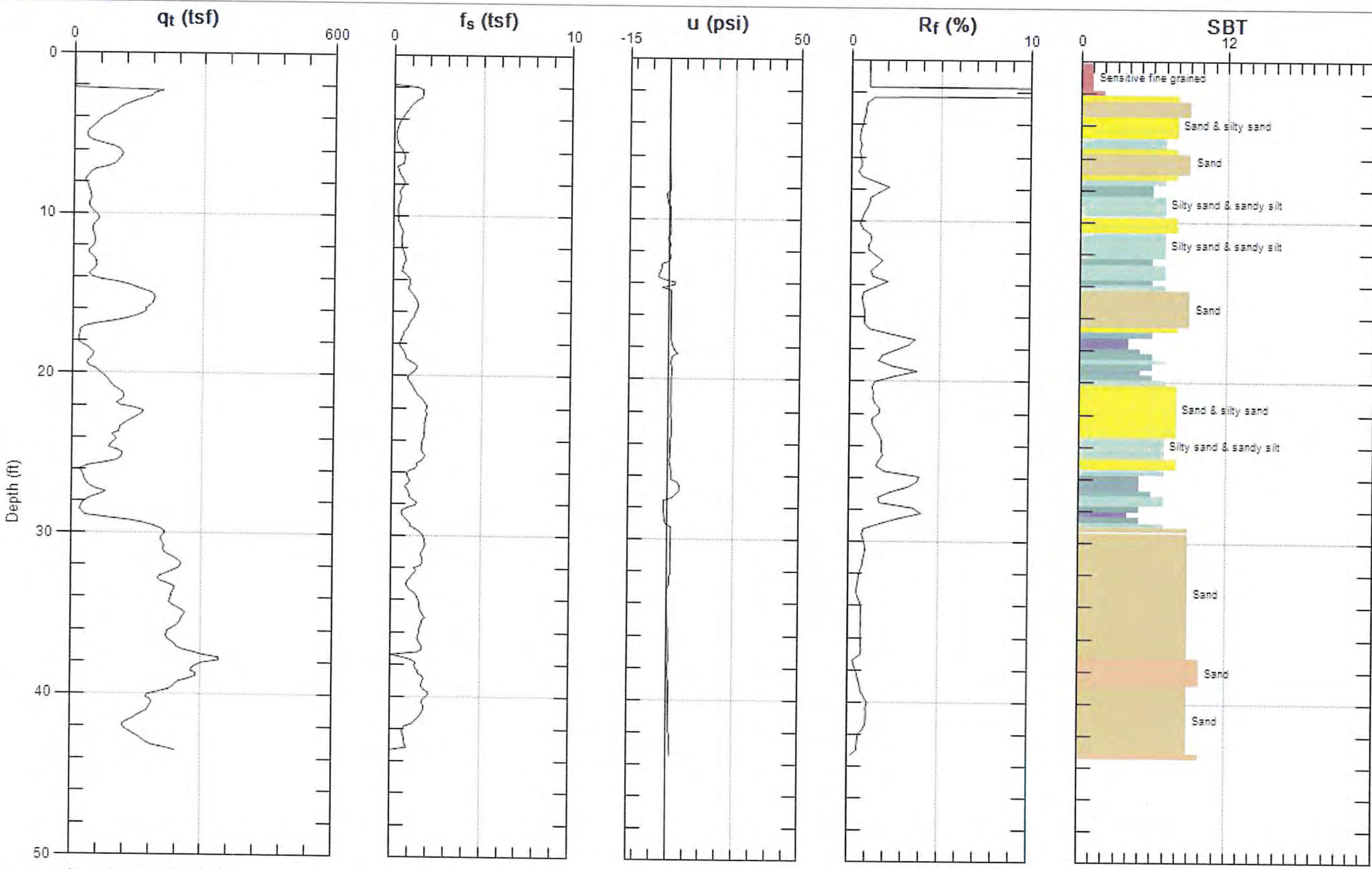
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-3

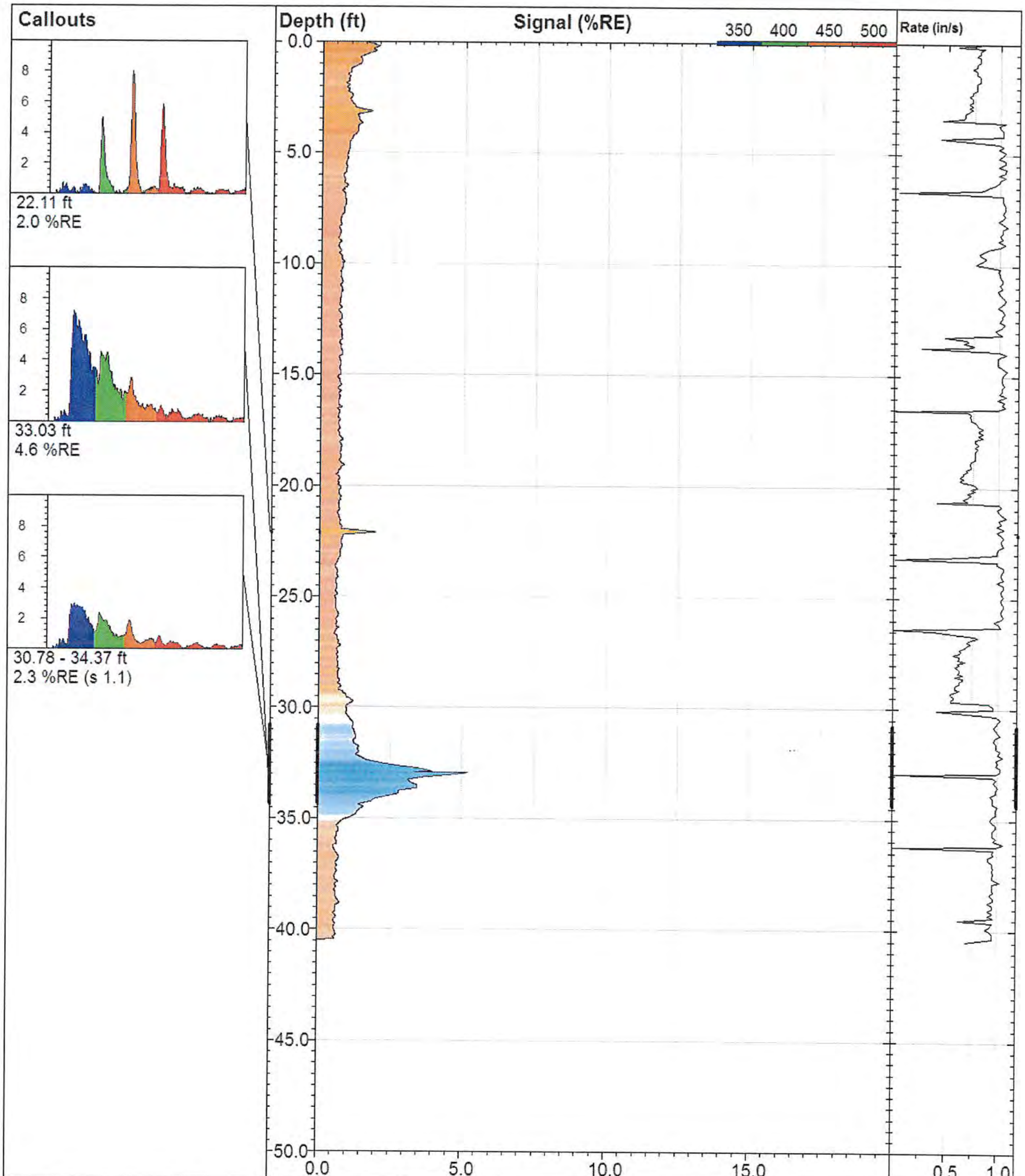
Engineer: P.PARMENTIER

Date: 11/23/2015 10:43



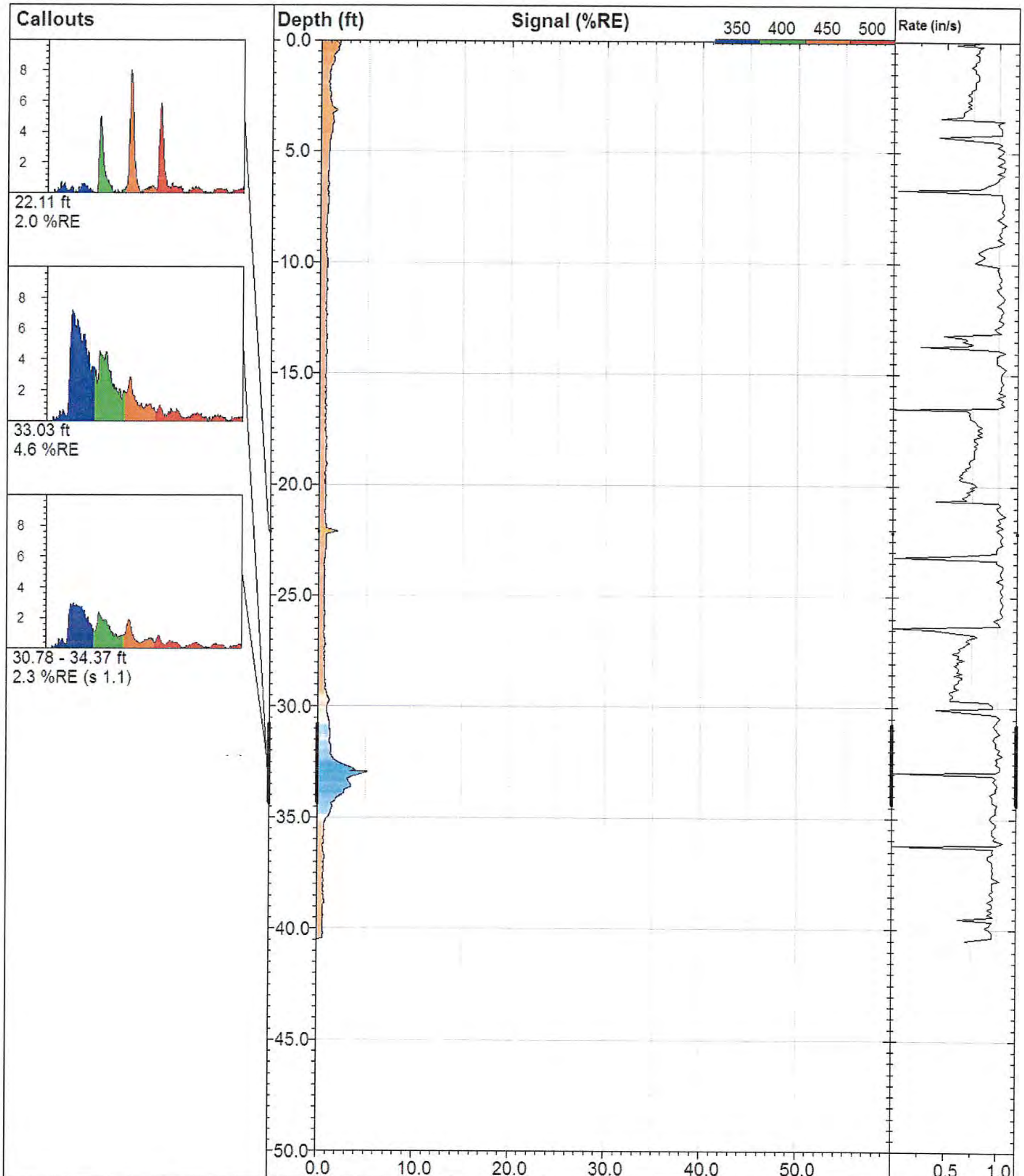
Max. Depth: 43.471 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-4		UVOST By Dakota www.DakotaTechnologies.com
Site:	Y Coord.(Lat-N) / System: **Unavailable / NA**	Final depth: **40.46 ft**
Client / Job: /	X Coord.(Lng-E) / Fix: **Unavailable / NA**	Max signal: **5.2 %RE @ 32.93 ft**
Operator / Unit: **/ UVOST1007**	Elevation: **Unavailable**	Date & Time: **2015-11-23 11:41 PST**



UV-CPT-4		UVOST By Dakota www.DakotaTechnologies.com
Site:	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.46 ft**
Client / Job: /	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.2 %RE @ 32.93 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 11:41 PST**

GREGG

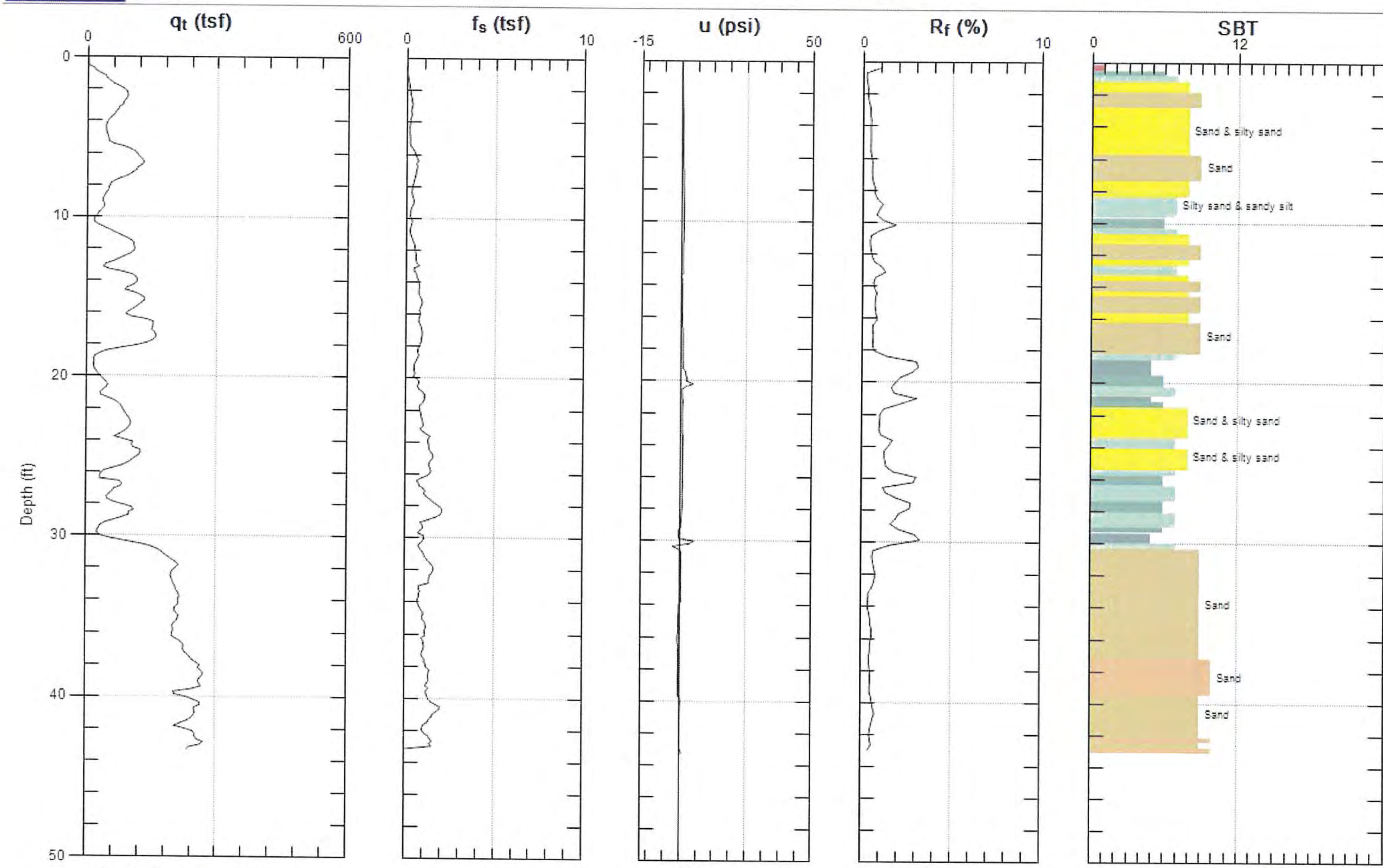
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-4

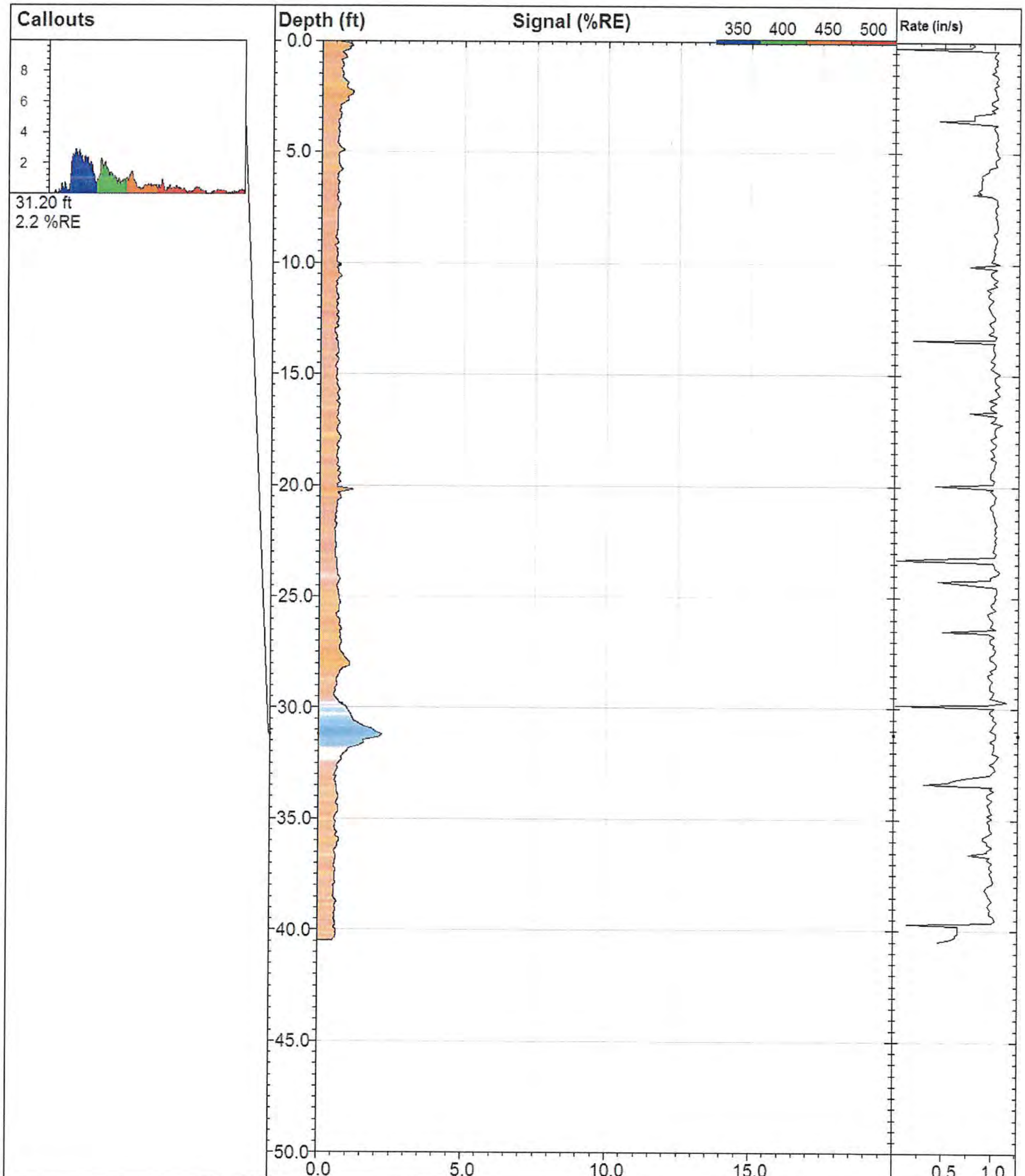
Engineer: P.PARMENTIER

Date: 11/23/2015 11:45



Max. Depth: 43.307 (ft)
Avg. Interval: 0.328 (ft)

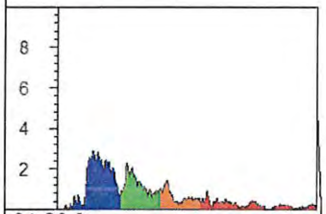
SBT: Soil Behavior Type (Robertson 1990)

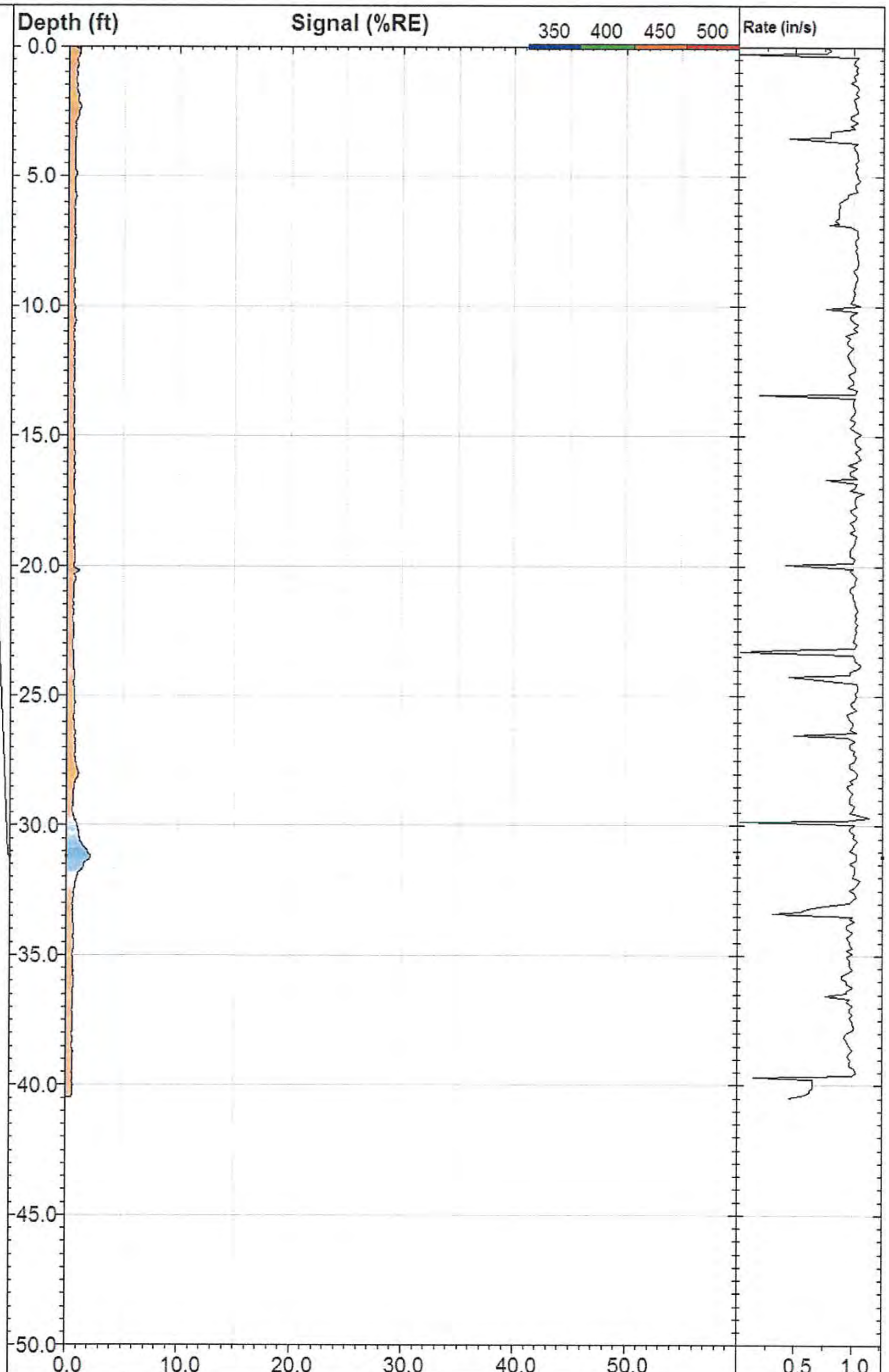


GREGG

UV-CPT-5		UVOST By Dakota www.DakotaTechnologies.com
Site:	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.46 ft**
Client / Job: /	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **2.2 %RE @ 31.20 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 12:41 PST**

Callouts





GREGG

UV-CPT-5		UVOST By Dakota www.DakotaTechnologies.com
Site:	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.46 ft**
Client / Job: /	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **2.2 %RE @ 31.20 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-23 12:41 PST**

GREGG

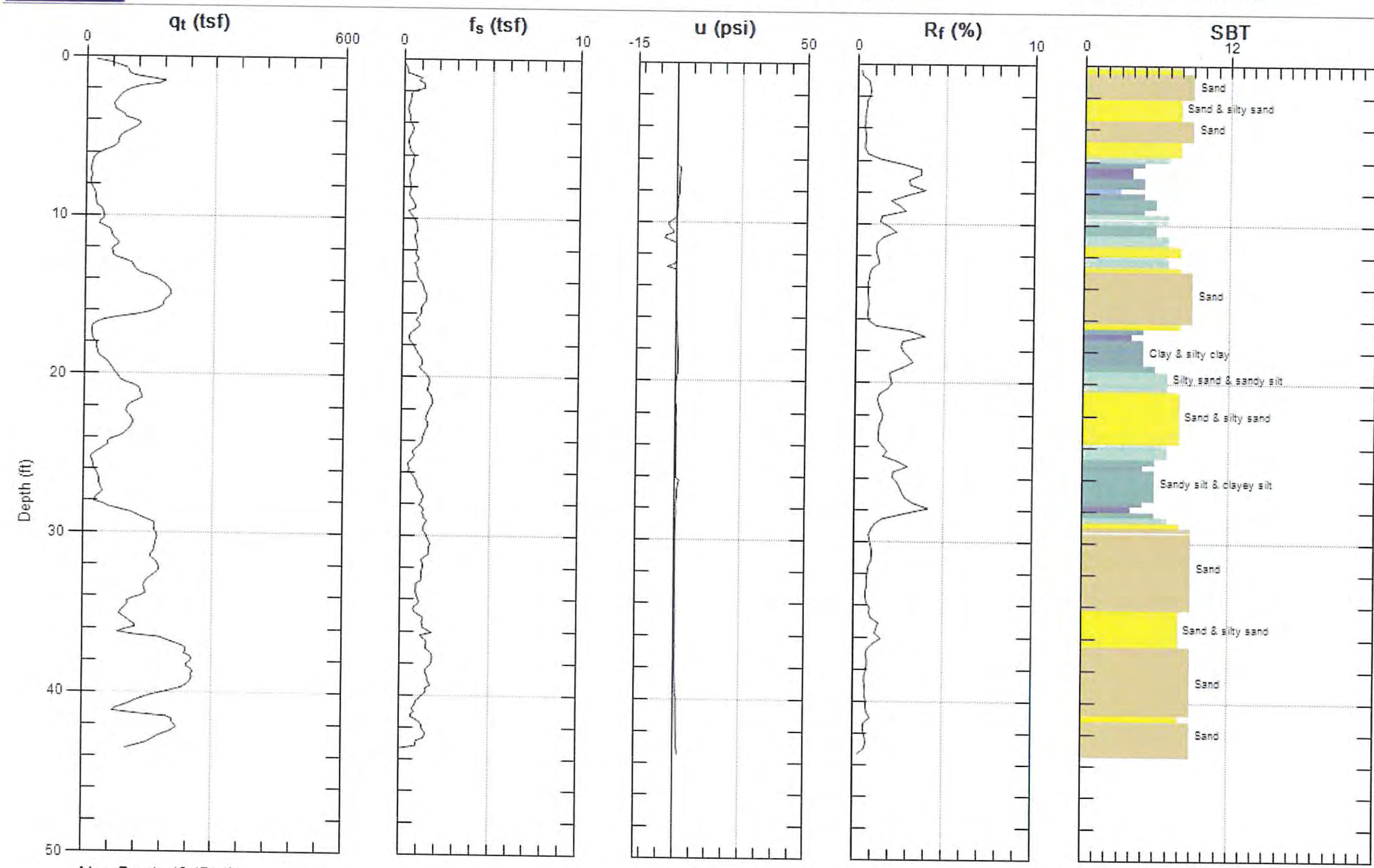
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-5

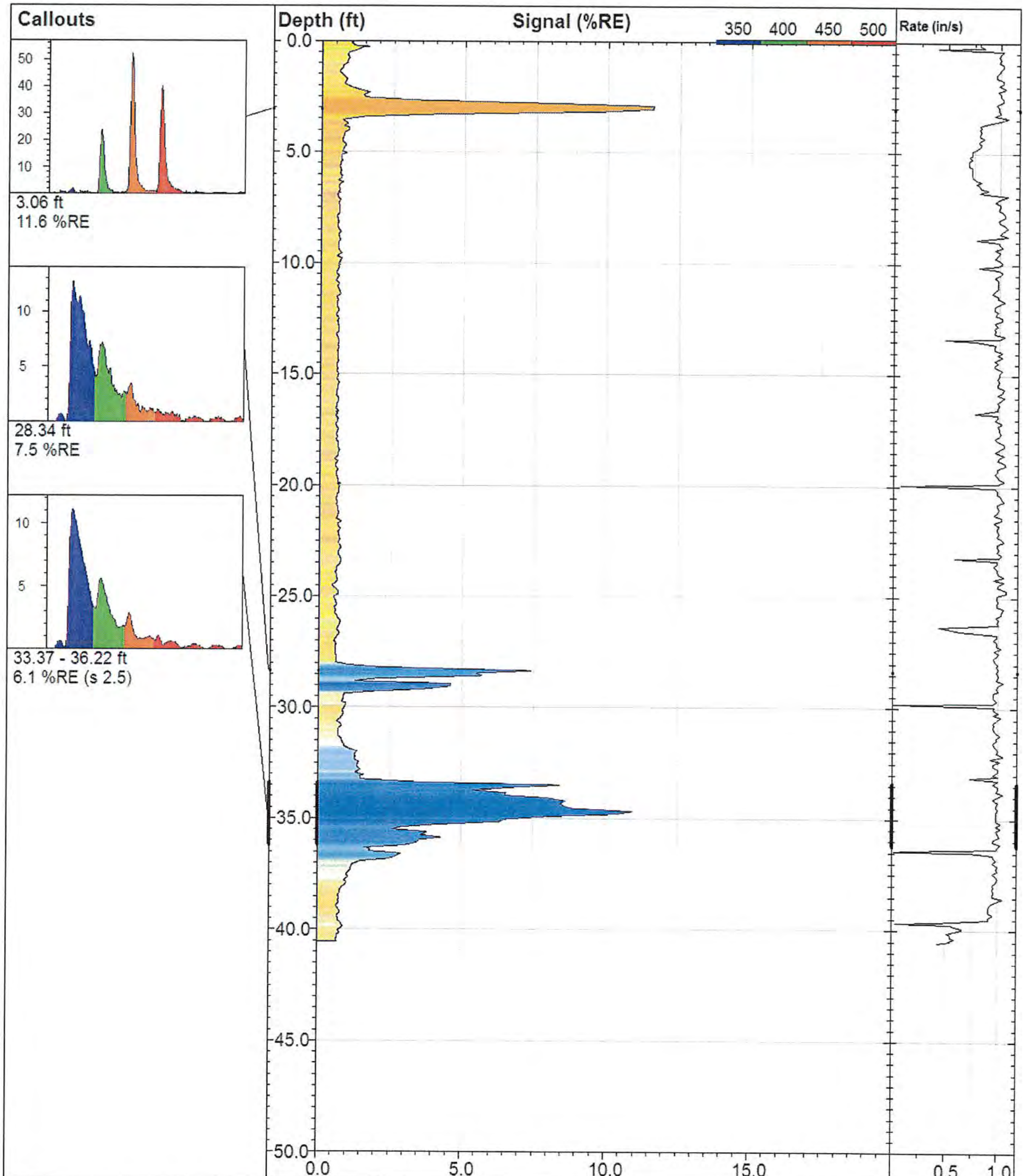
Engineer: P.PARMENTIER

Date: 11/23/2015 12:57

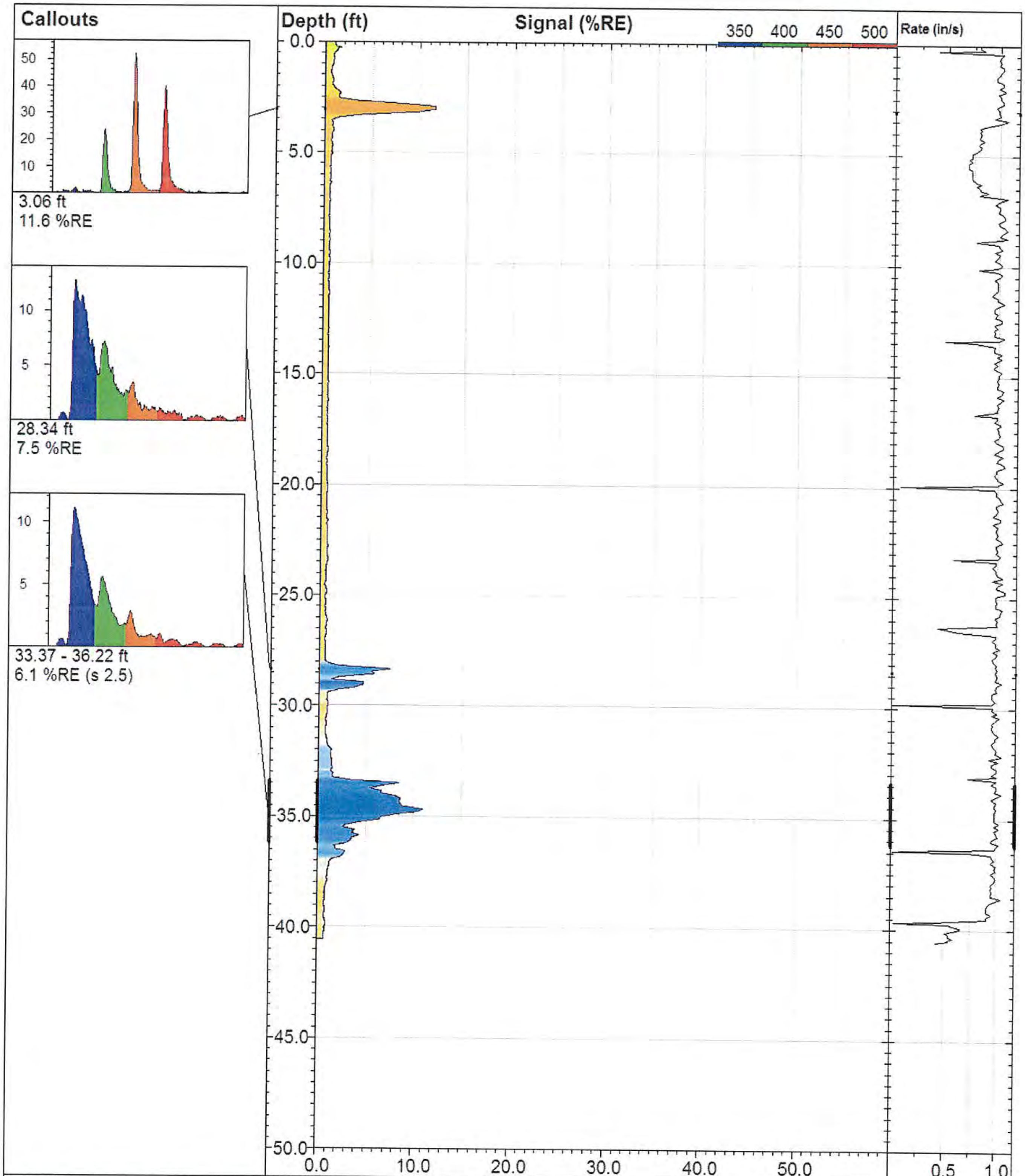


Max. Depth: 43.471 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



UV-CPT-6		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.56 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **11.6 %RE @ 2.92 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 07:53 PST**



GREGG

UV-CPT-6		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.56 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **11.6 %RE @ 2.92 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 07:53 PST**

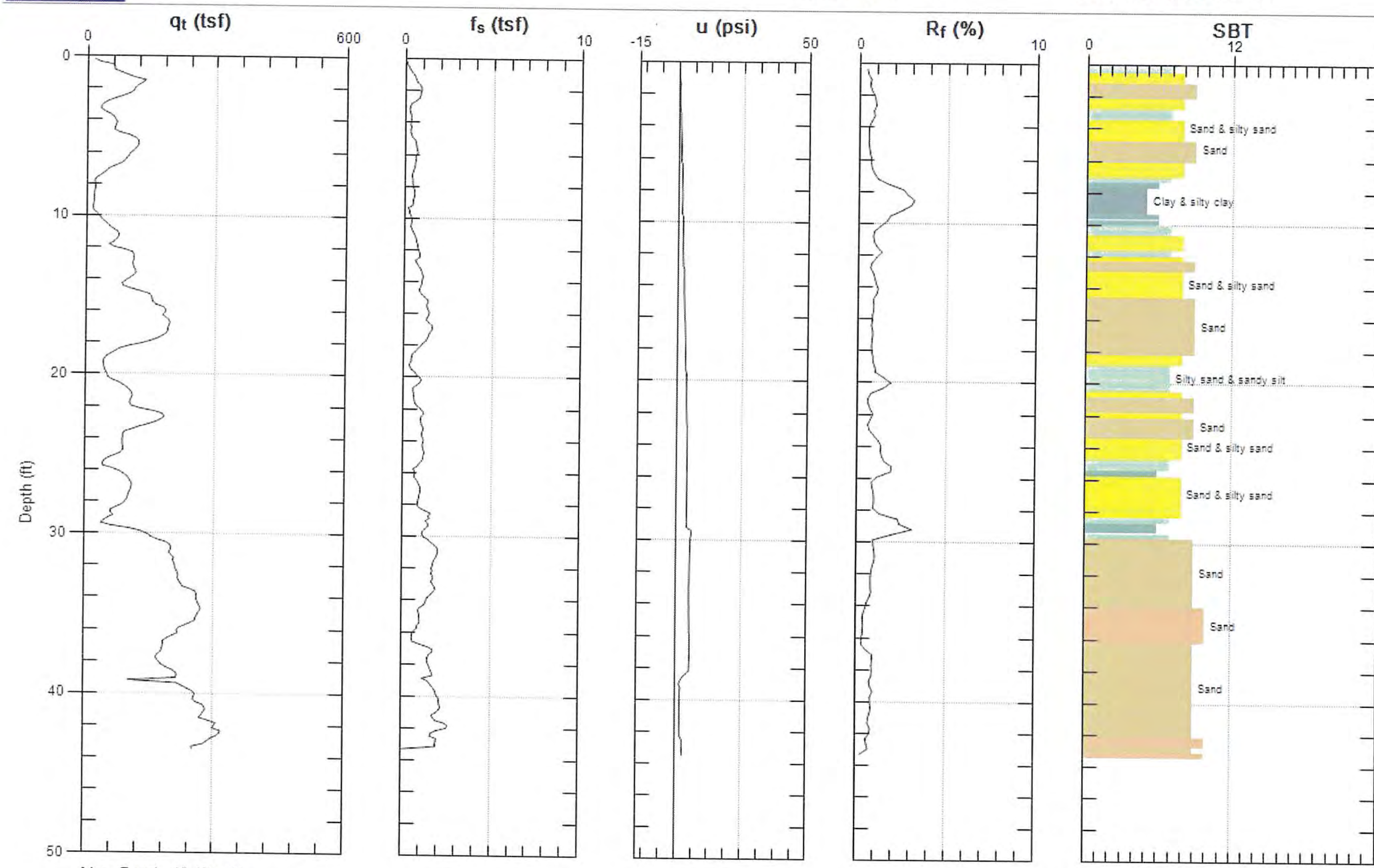
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-6

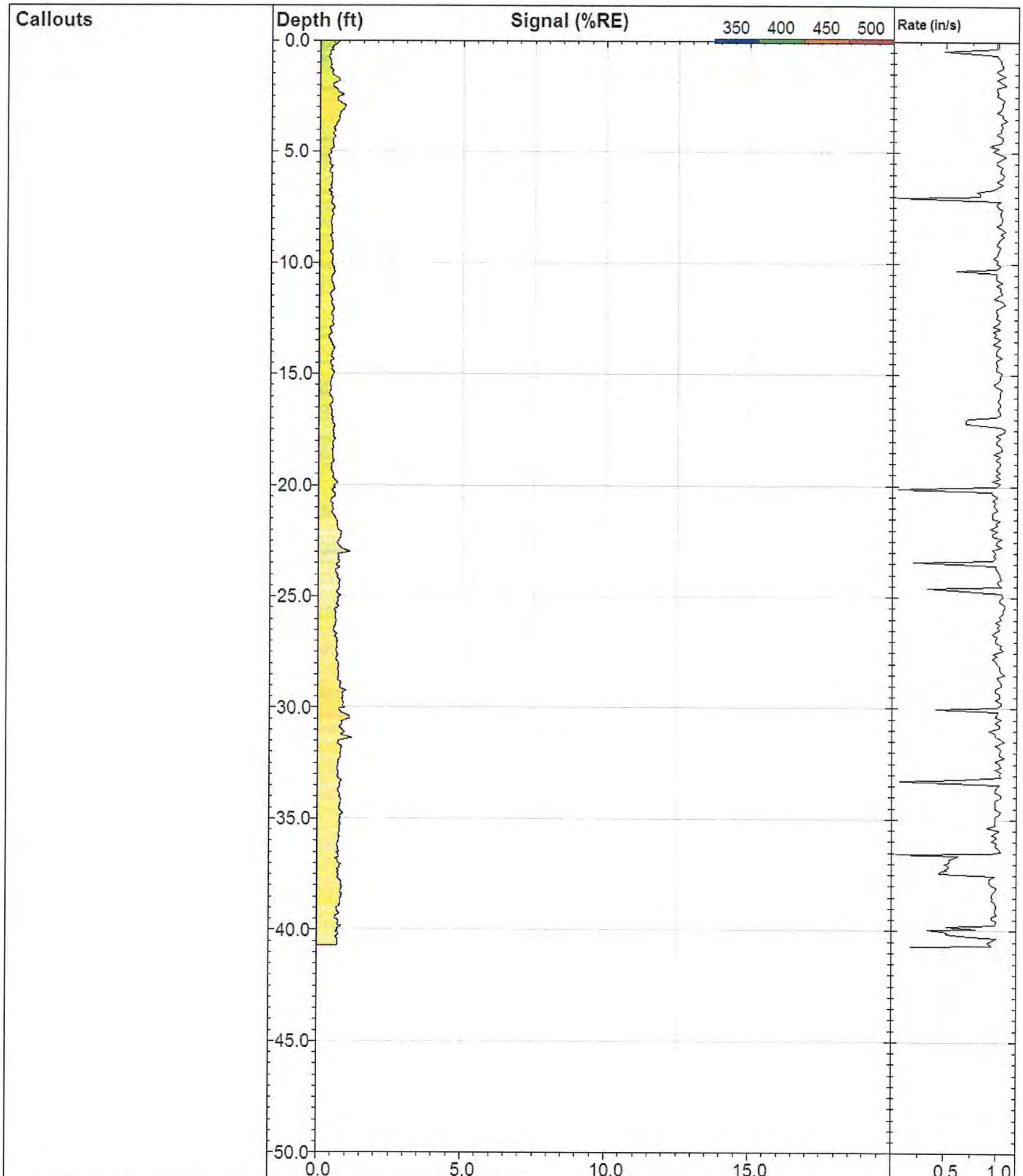
Engineer: P.PARMENTIER

Date: 11/24/2015 08:08

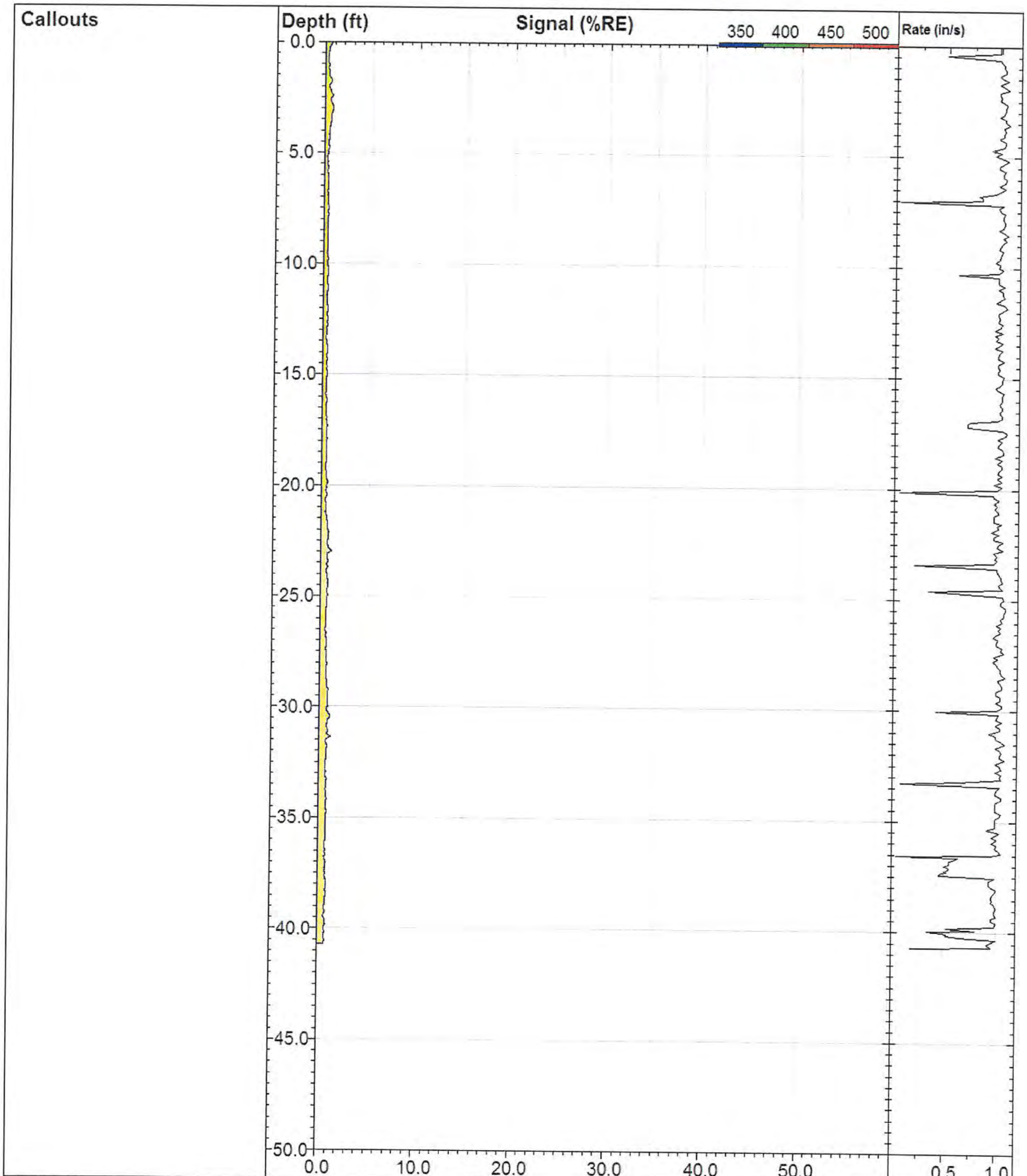


Max. Depth: 43.471 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



UV-CPT-7		**UVOST By Dakota** www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.71 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.2 %RE @ 31.37 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 08:34 PST**



GREGG

UV-CPT-7		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.71 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.2 %RE @ 31.37 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 08:34 PST**

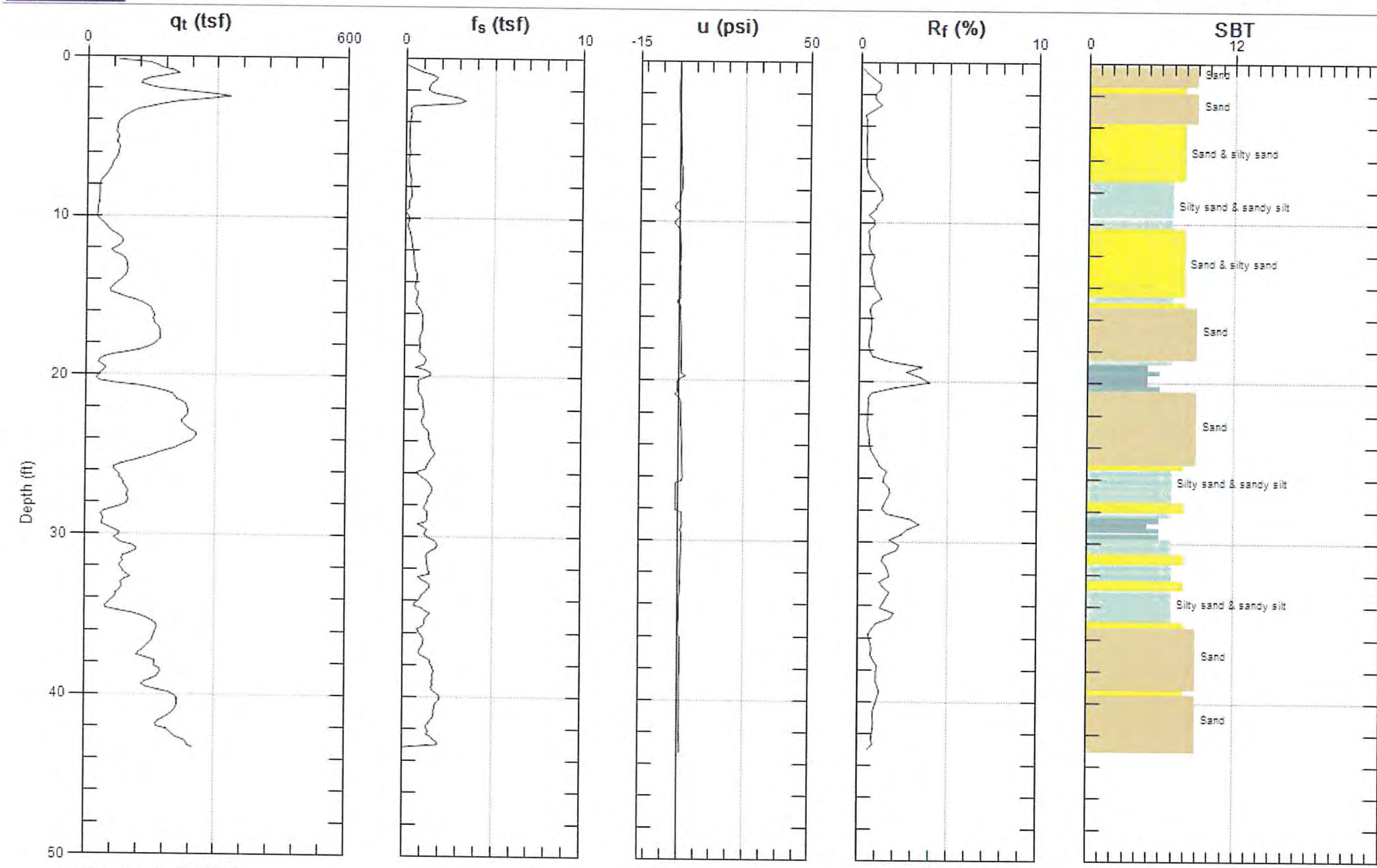
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-7

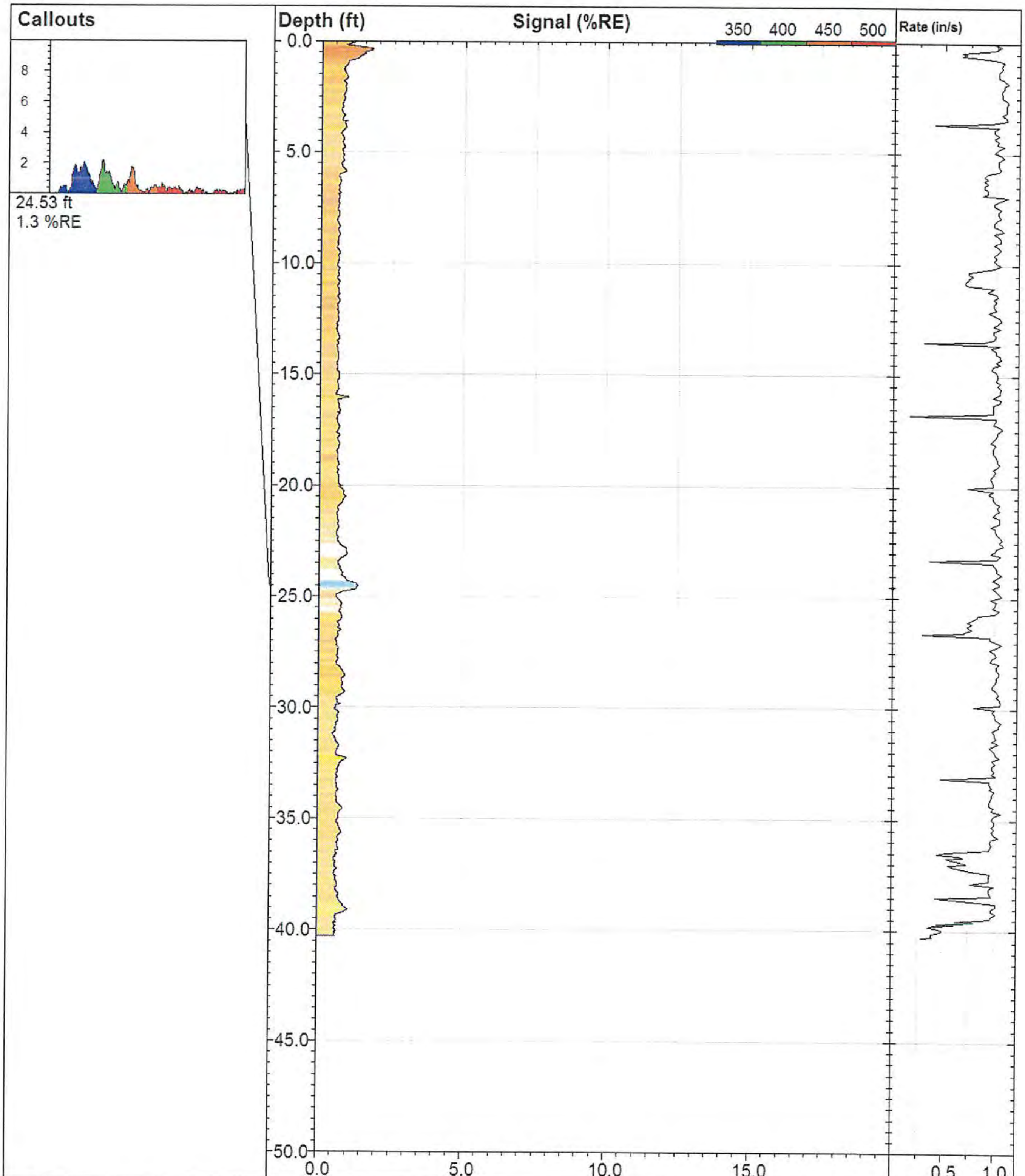
Engineer: P.PARMENTIER

Date: 11/24/2015 08:49



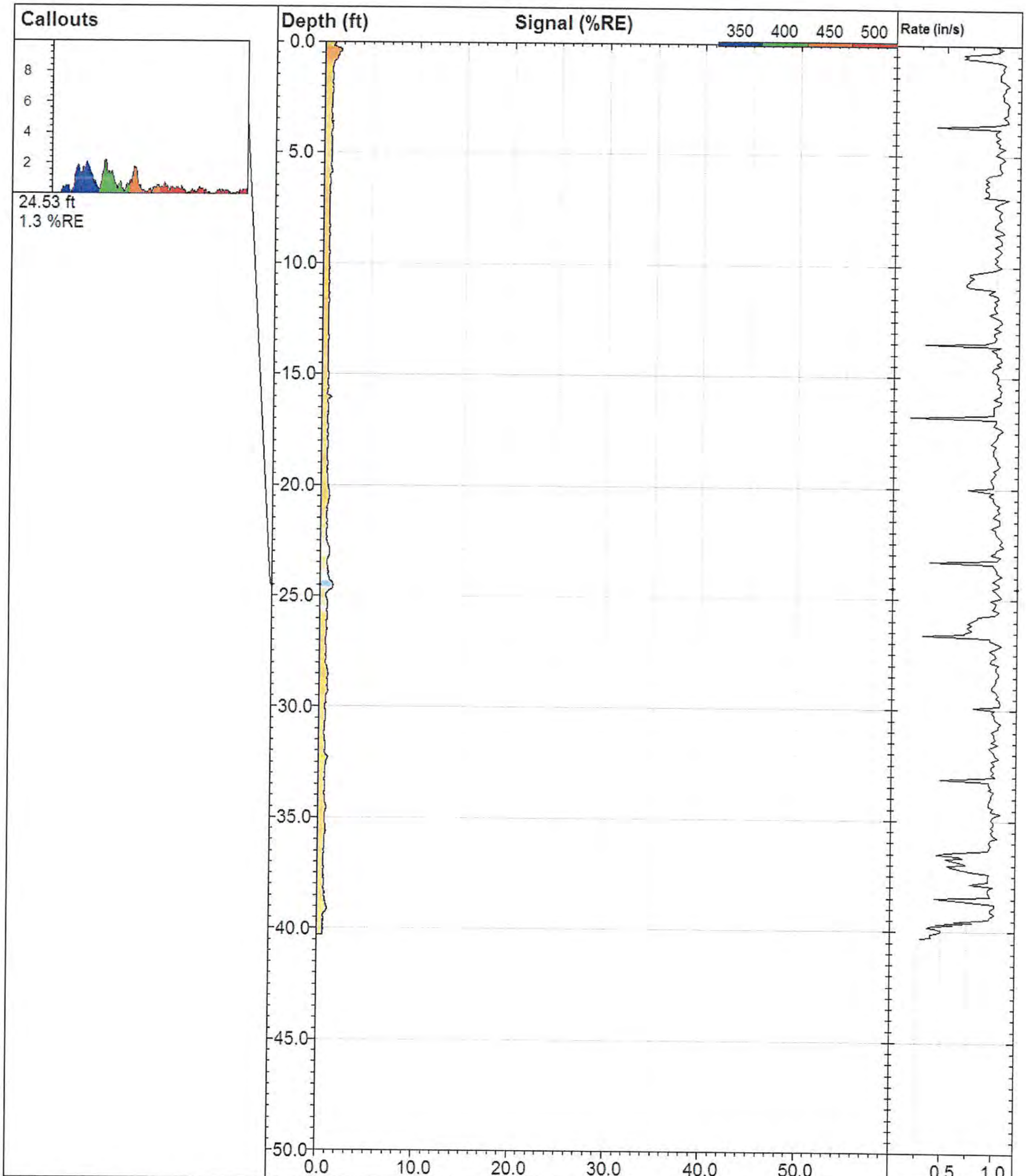
Max. Depth: 43.307 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-8		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.30 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.8 %RE @ 0.34 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 09:35 PST**



UV-CPT-8		**UVOST By Dakota** www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.30 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.8 %RE @ 0.34 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 09:35 PST**

GREGG

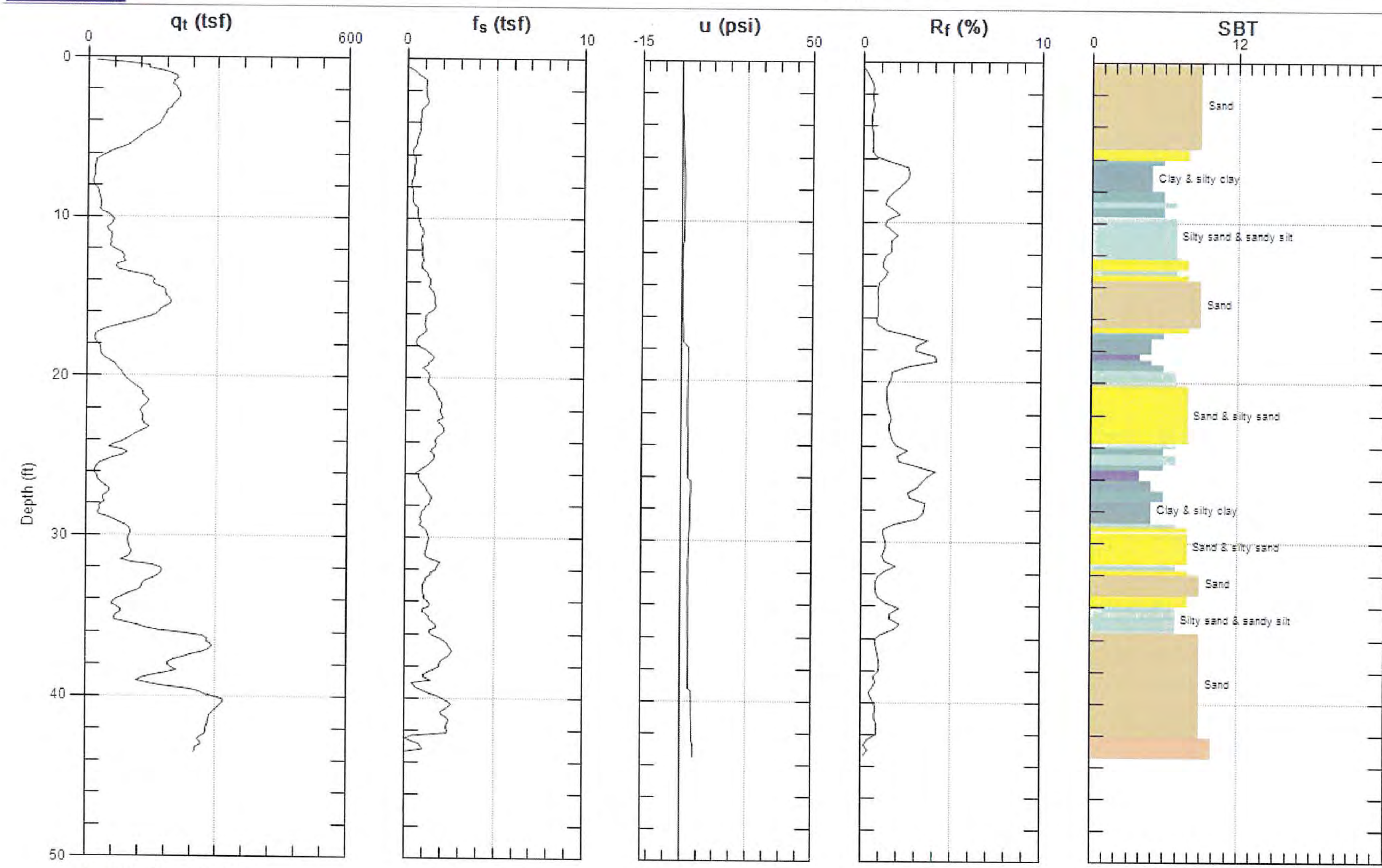
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-8

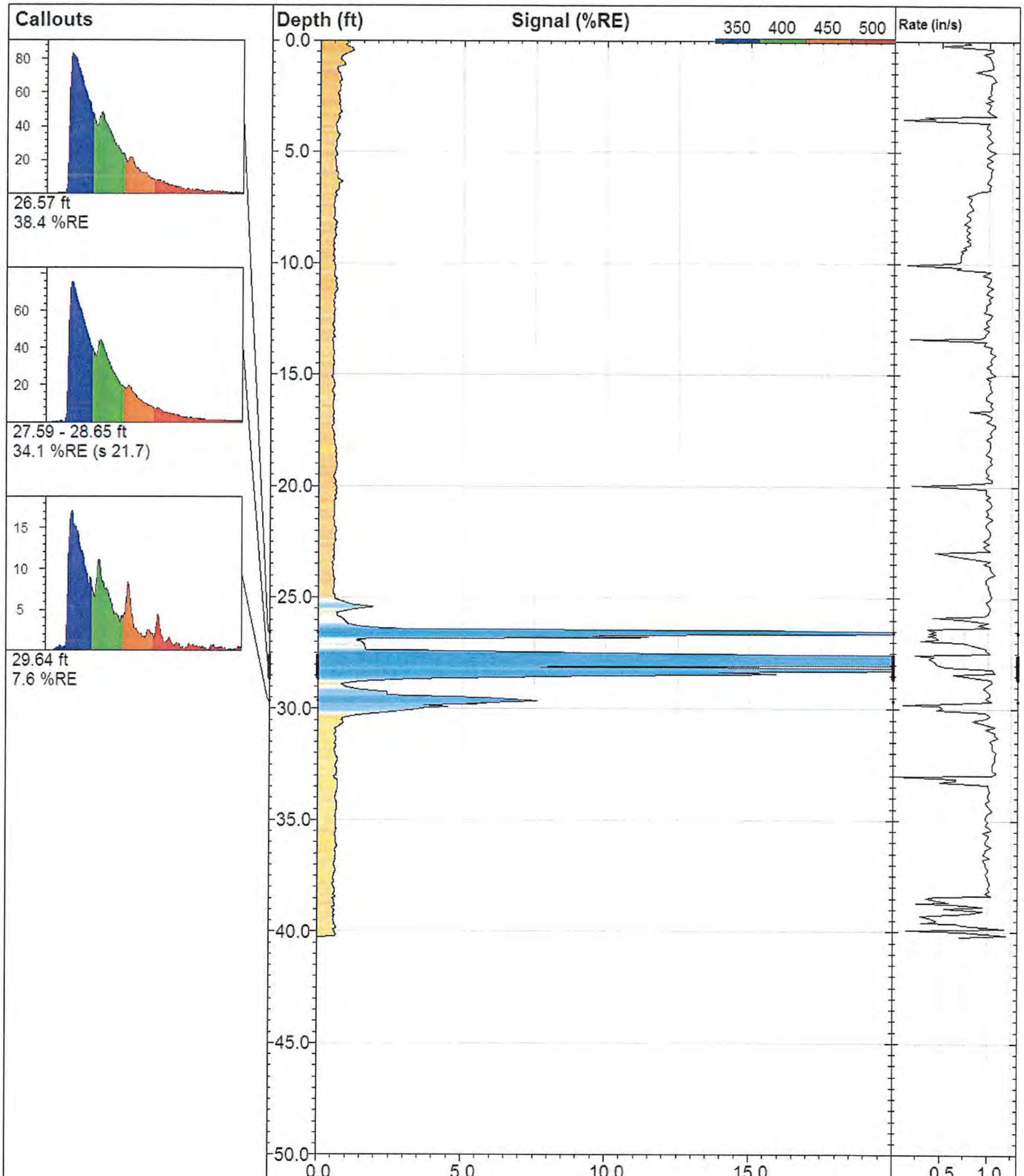
Engineer: P.PARMENTIER

Date: 11/24/2015 09:49

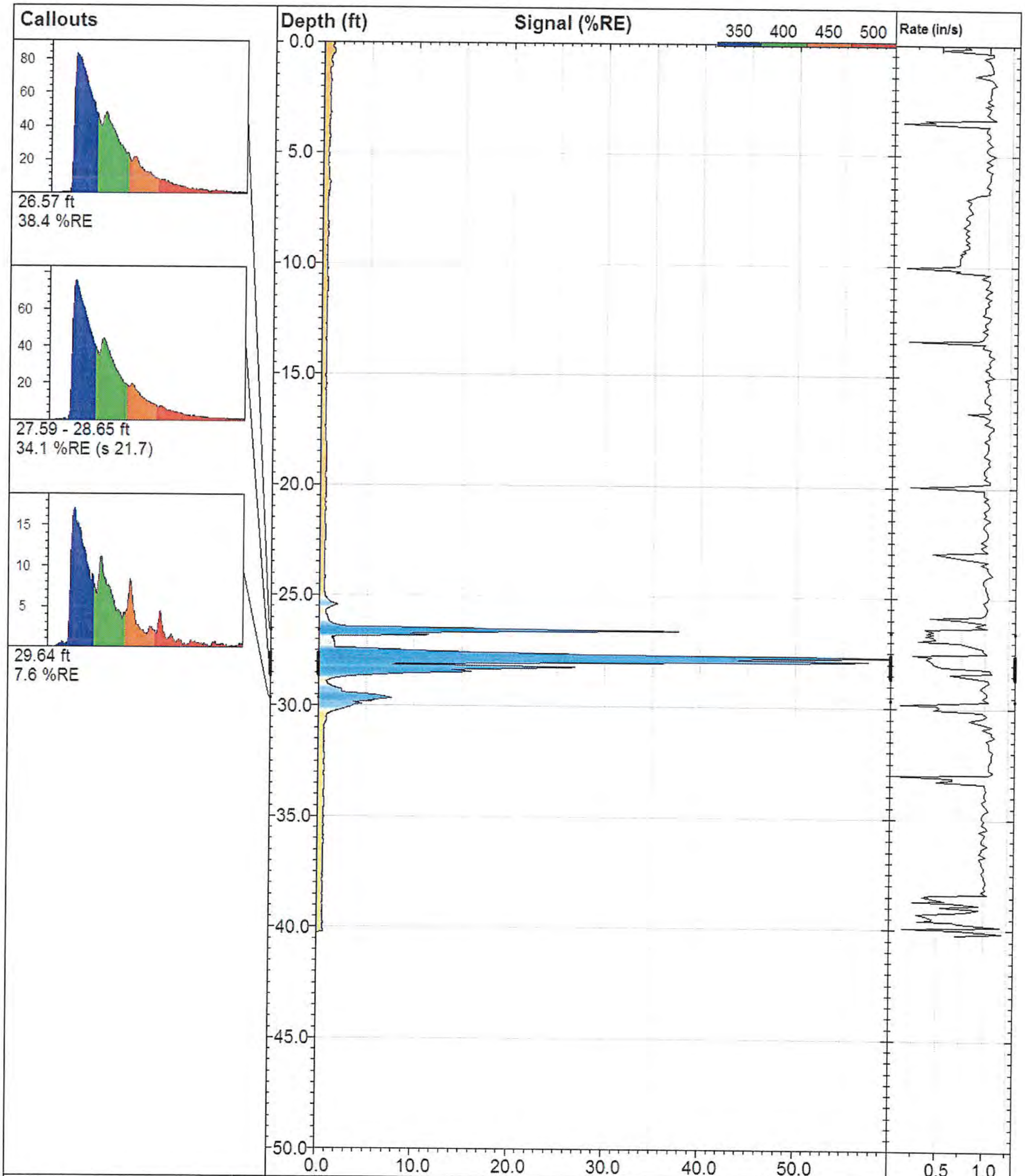


Max. Depth: 43.471 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



UV-CPT-9		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.23 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **69.0 %RE @ 27.71 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 10:15 PST**



GREGG

UV-CPT-9		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.23 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **69.0 %RE @ 27.71 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 10:15 PST**

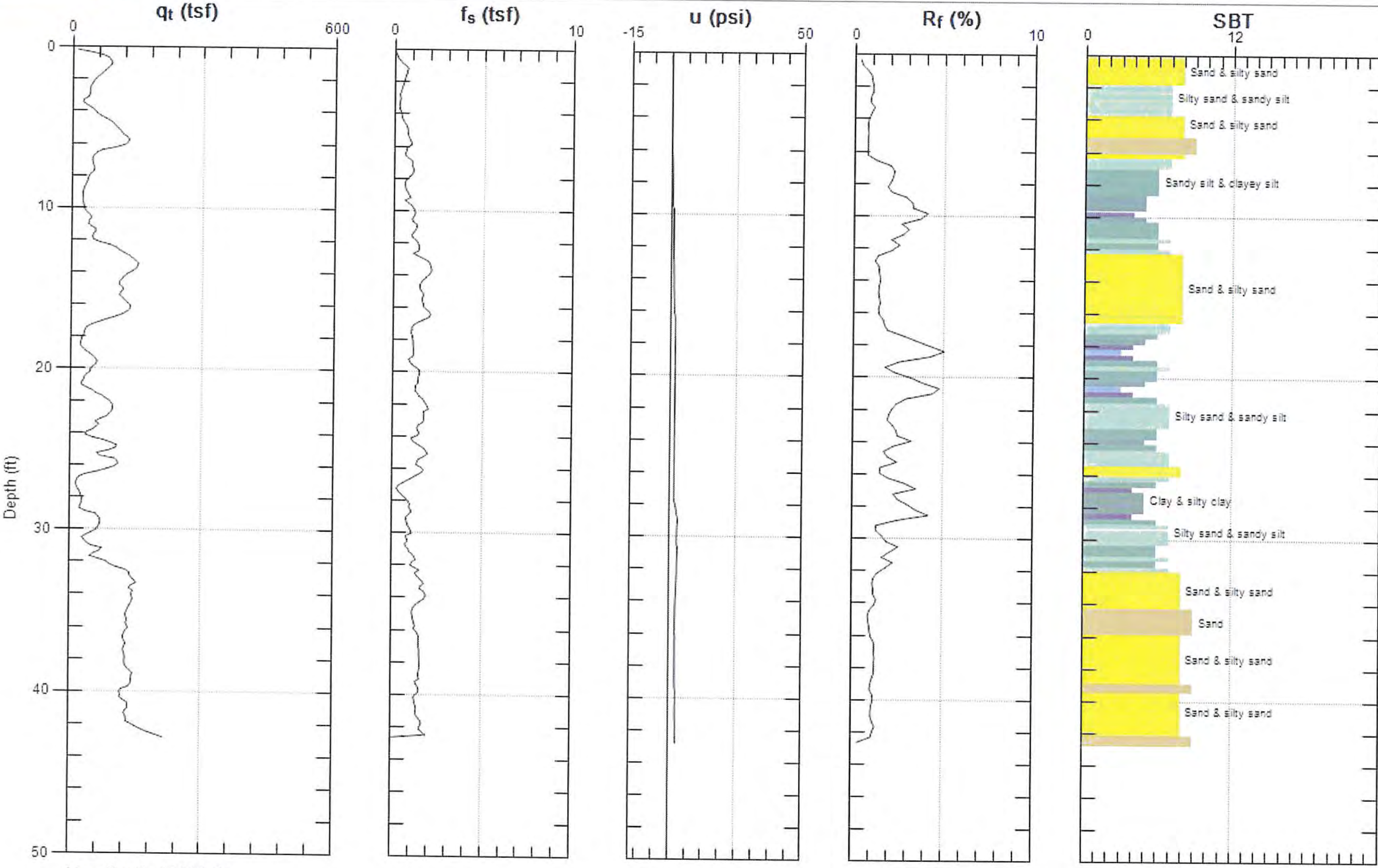
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-9

Engineer: P.PARMENTIER

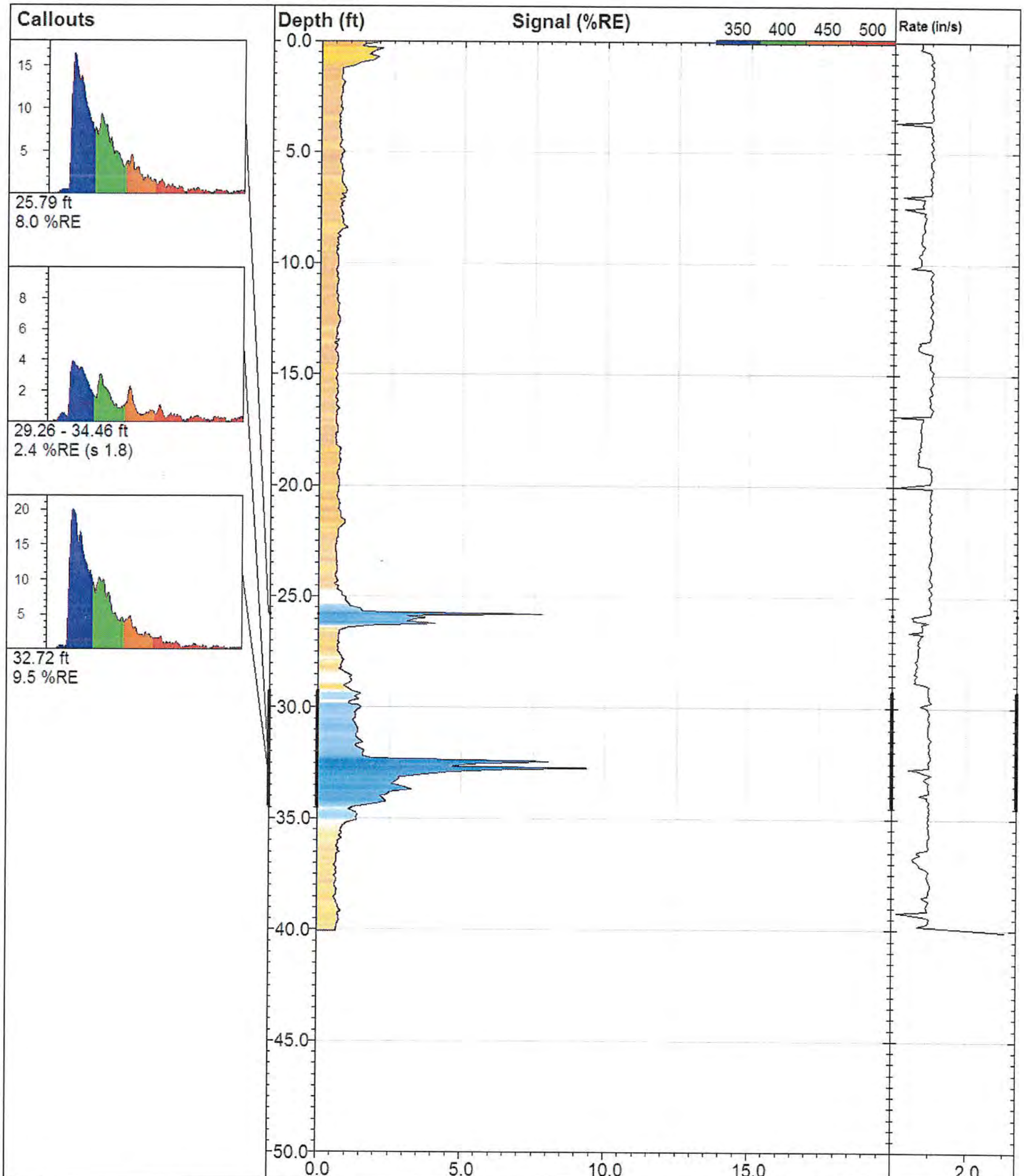
Date: 11/24/2015 10:30



Max. Depth: 42.815 (ft)

Avg. Interval: 0.328 (ft)

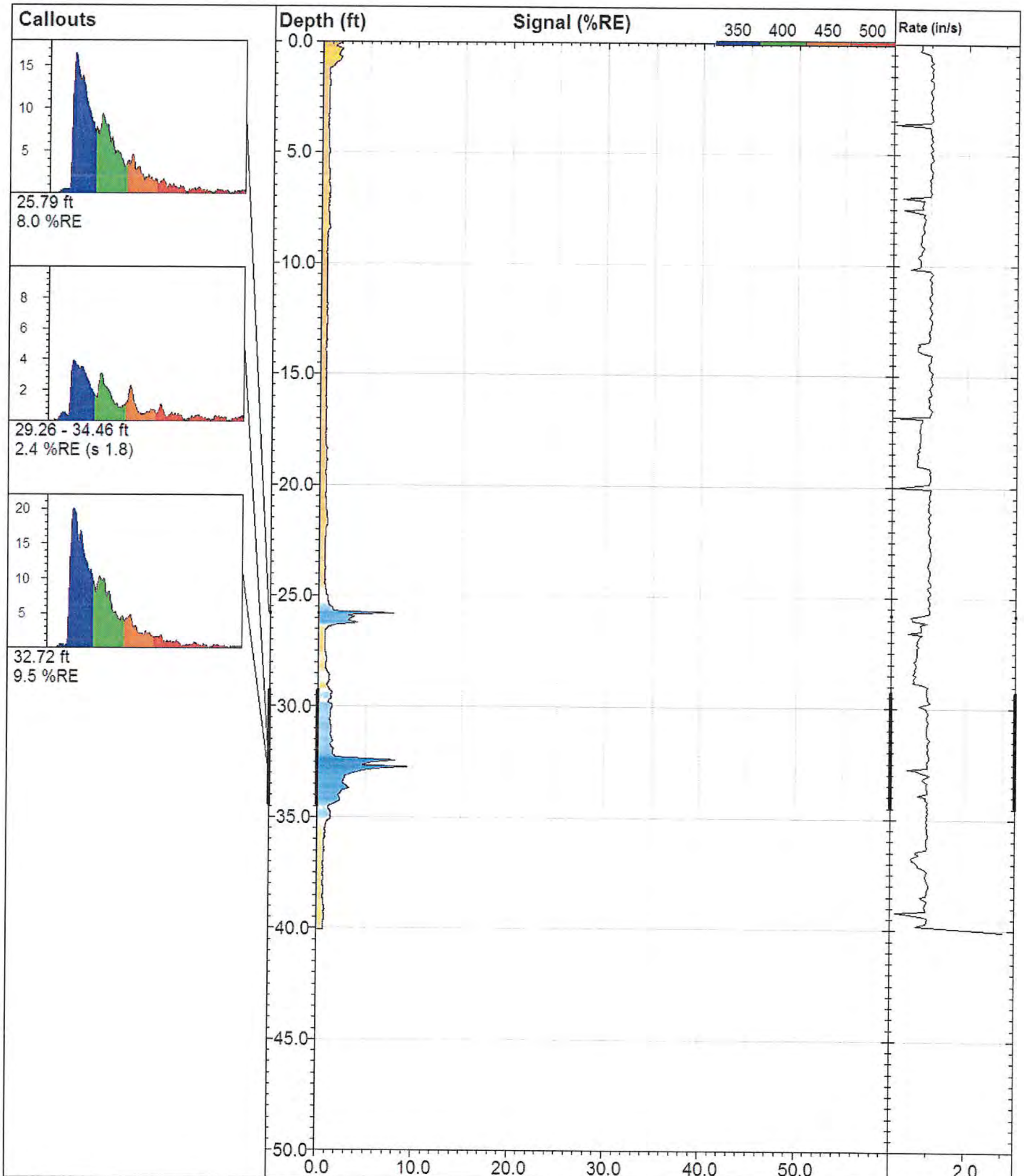
SBT: Soil Behavior Type (Robertson 1990)



UV-CPT-10

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.05 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **9.5 %RE @ 32.72 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 11:30 PST**



GREGG	UV-CPT-10		UVOST By Dakota www.DakotaTechnologies.com
	Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.05 ft**
	Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **9.5 %RE @ 32.72 ft**
	Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 11:30 PST**

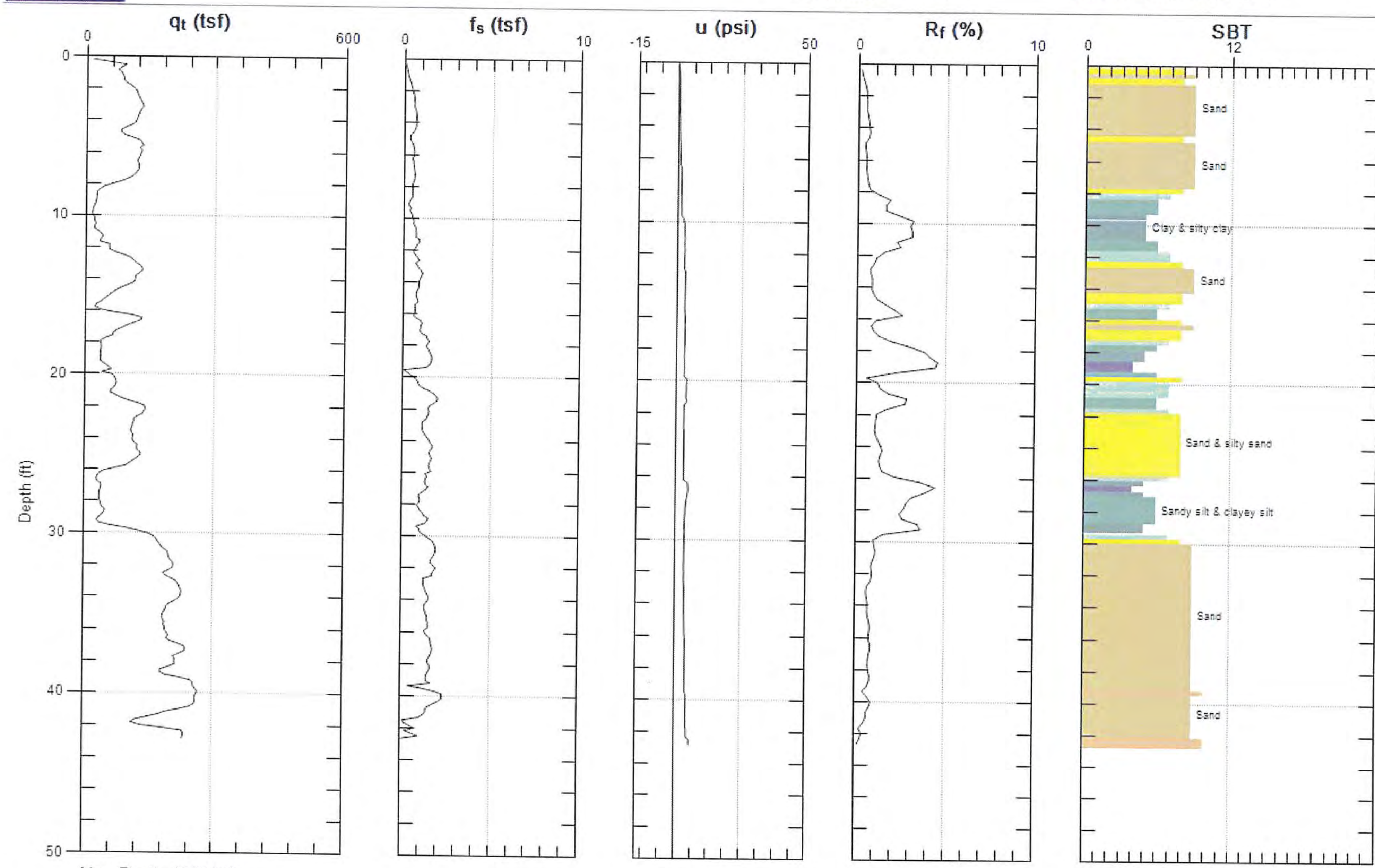
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-10

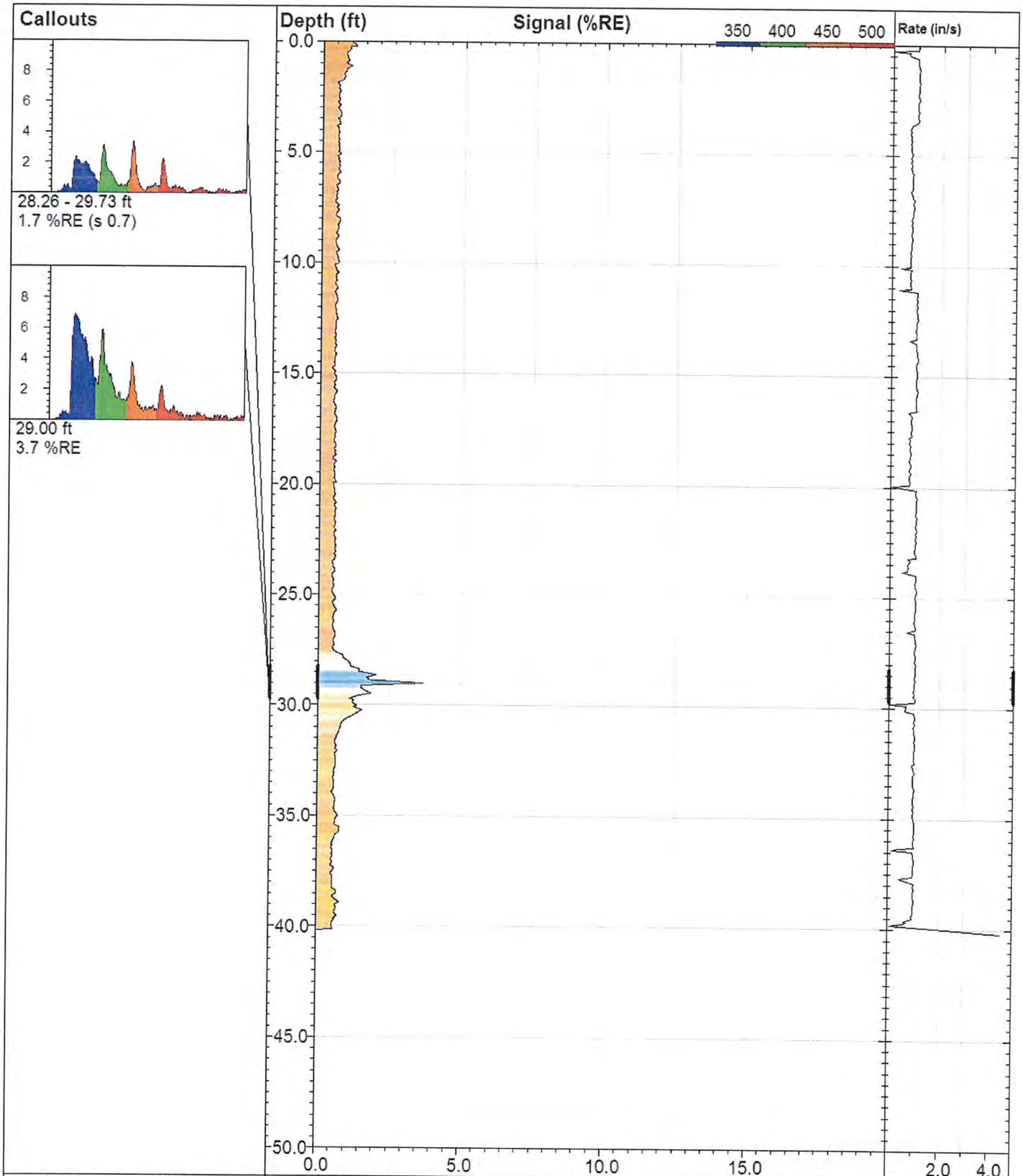
Engineer: P.PARMENTIER

Date: 11/24/2015 11:45



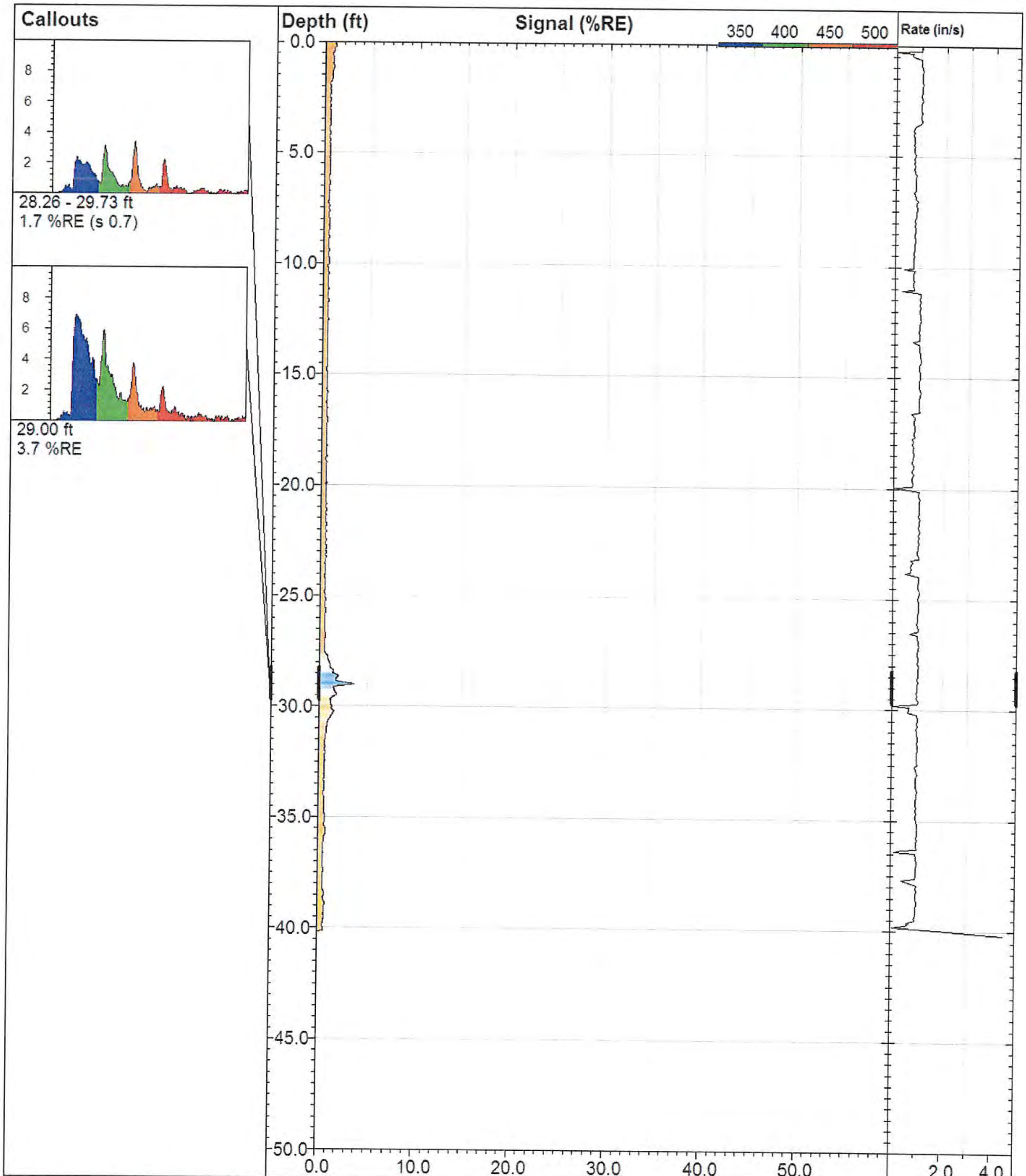
Max. Depth: 42.815 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-11		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.16 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **3.7 %RE @ 29.00 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 12:14 PST**



GREGG

UV-CPT-11

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.16 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **3.7 %RE @ 29.00 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 12:14 PST**

GREGG

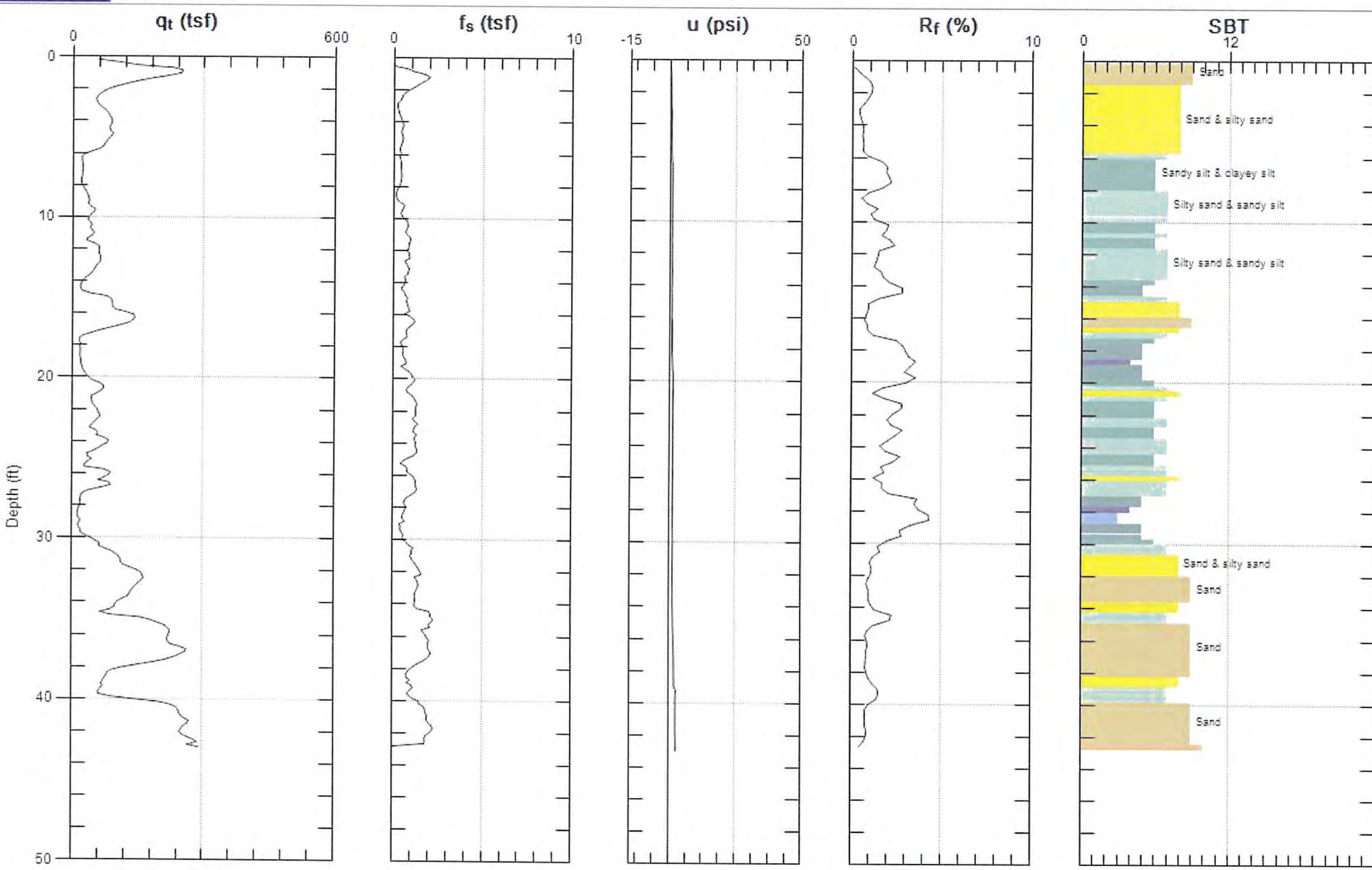
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-11

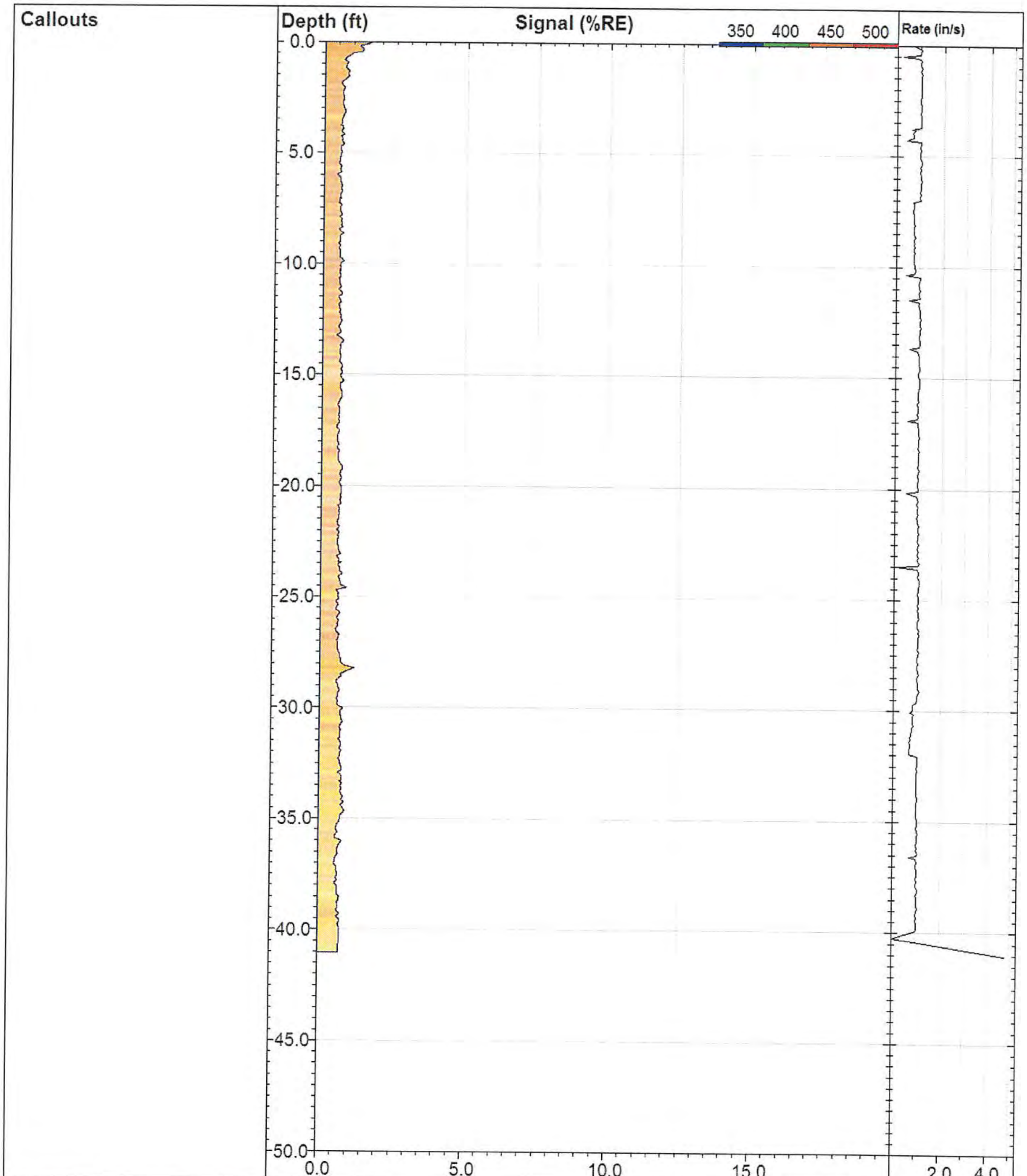
Engineer: P.PARMENTIER

Date: 11/24/2015 12:30



Max. Depth: 42.979 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

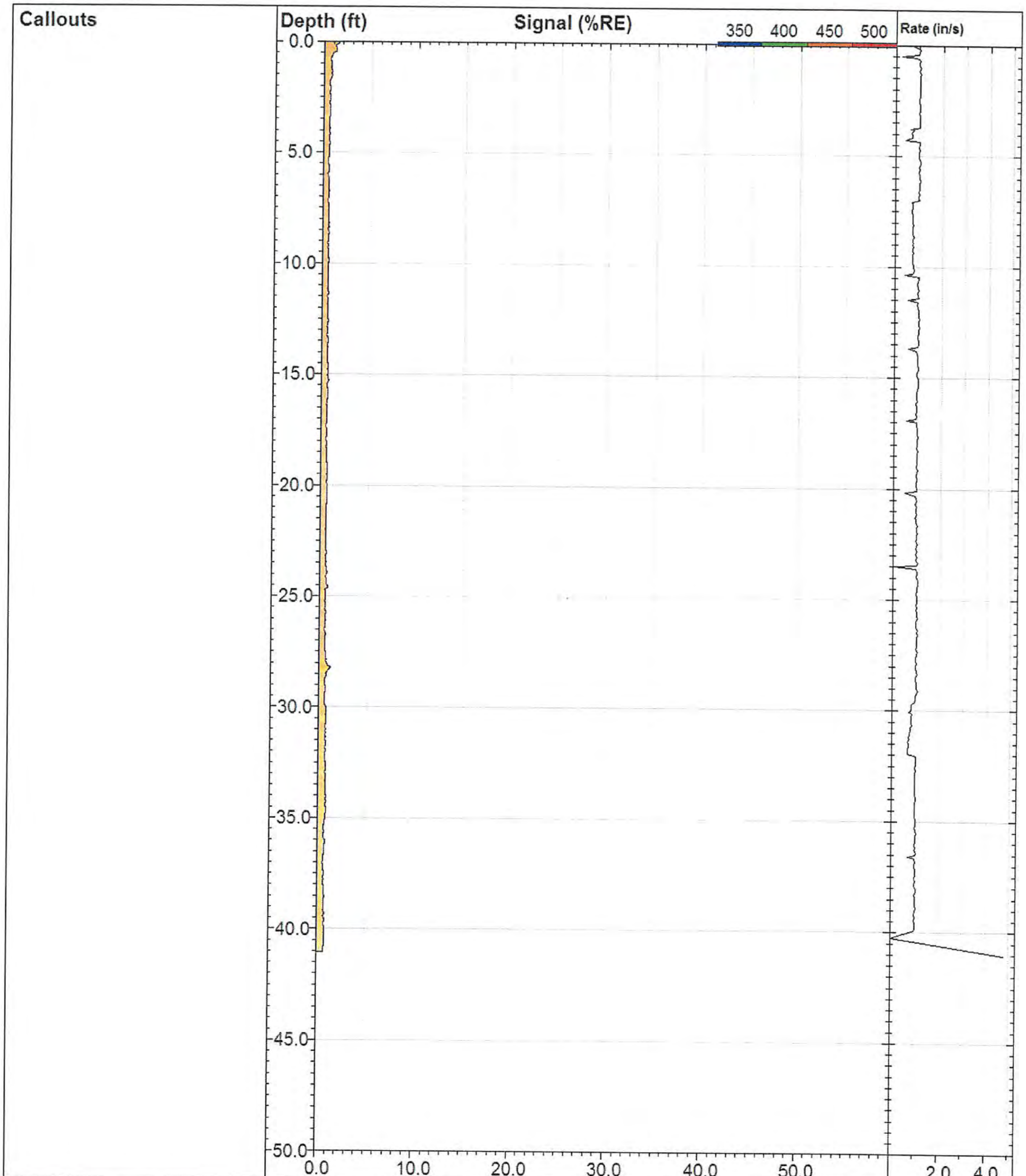


GREGG

UV-CPT-12

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **41.05 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.6 %RE @ 0.00 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 12:55 PST**



GREGG

UV-CPT-12

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **41.05 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.6 %RE @ 0.00 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 12:55 PST**

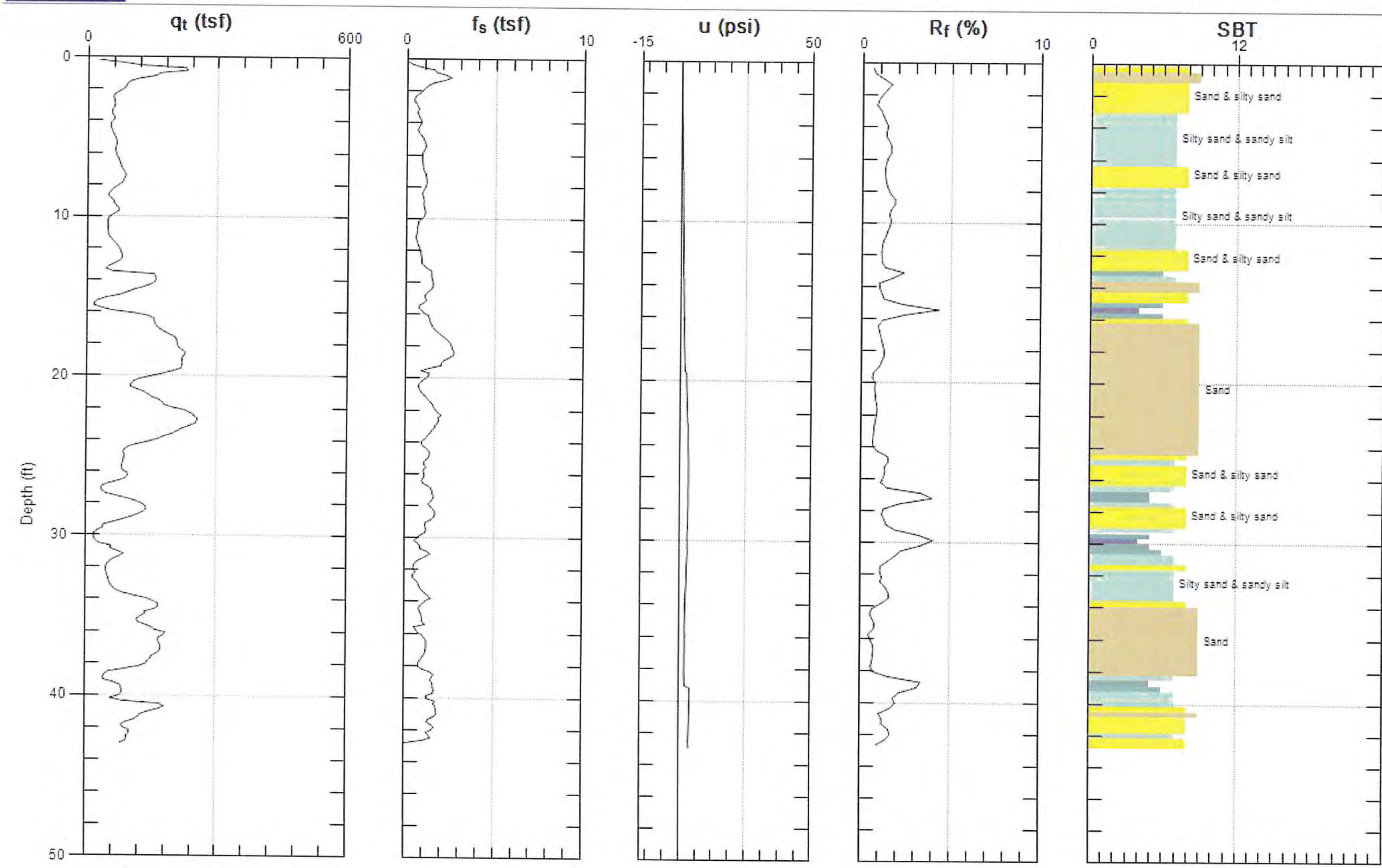
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-12

Engineer: P.PARMENTIER

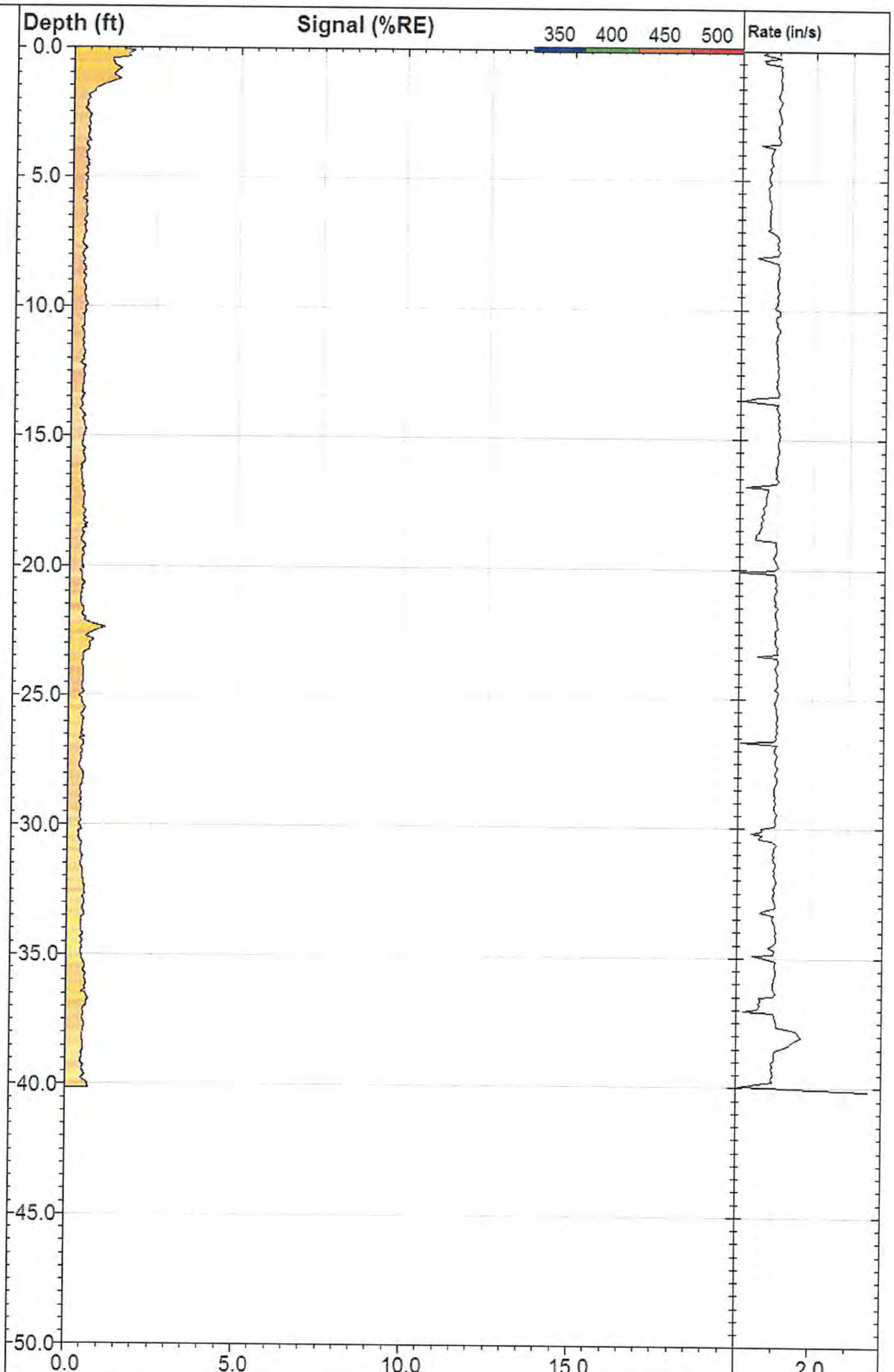
Date: 11/24/2015 01:09



Max. Depth: 42.979 (ft)
Avg. Interval: 0.328 (ft)

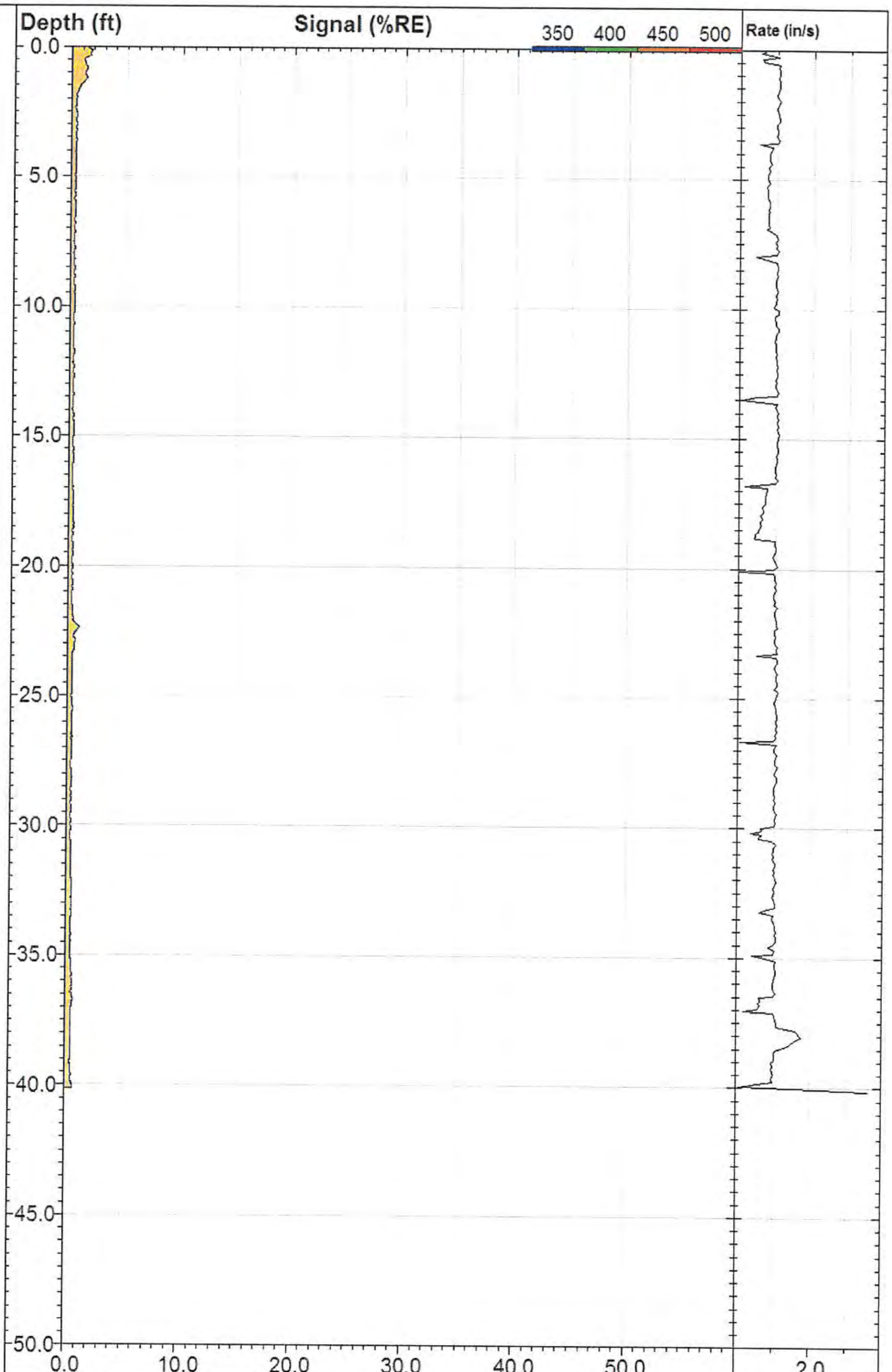
SBT: Soil Behavior Type (Robertson 1990)

Callouts



GREGG	UV-CPT-13		UVOST By Dakota www.DakotaTechnologies.com
	Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.14 ft**
	Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.8 %RE @ 0.14 ft**
	Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 13:50 PST**

Callouts



GREGG

UV-CPT-13

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.14 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **1.8 %RE @ 0.14 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 13:50 PST**

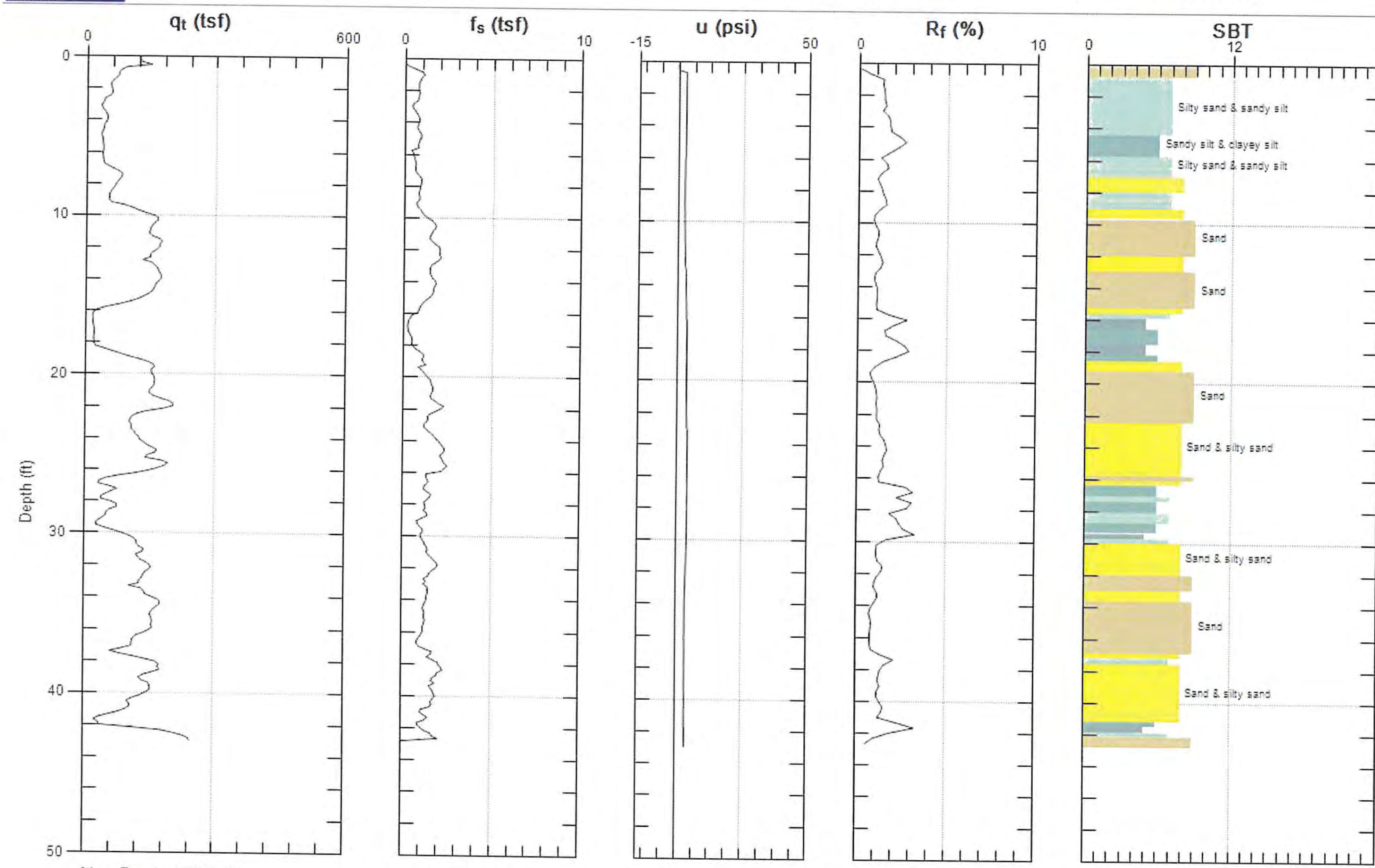
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-13

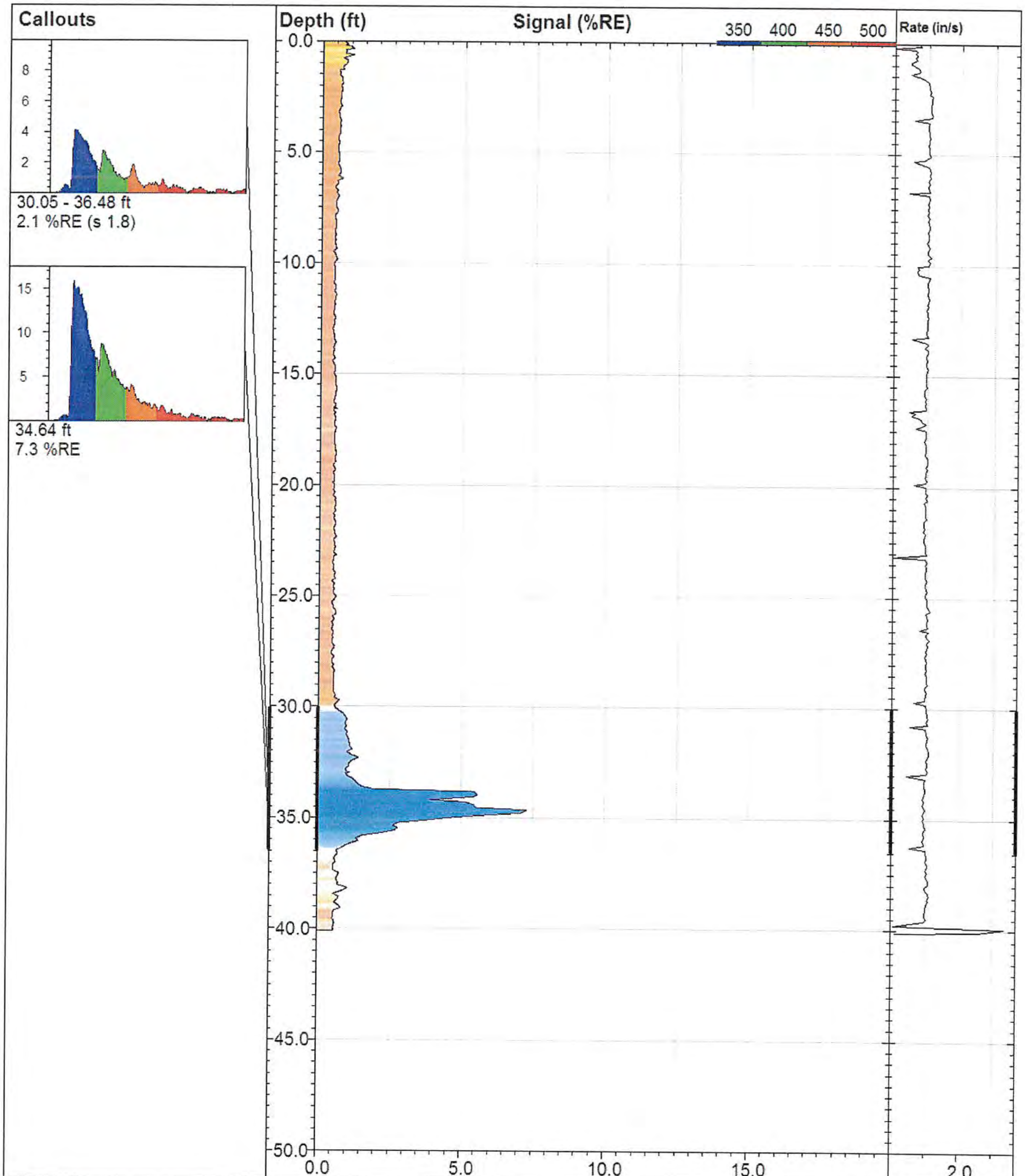
Engineer: P.PARMENTIER

Date: 11/24/2015 01:56

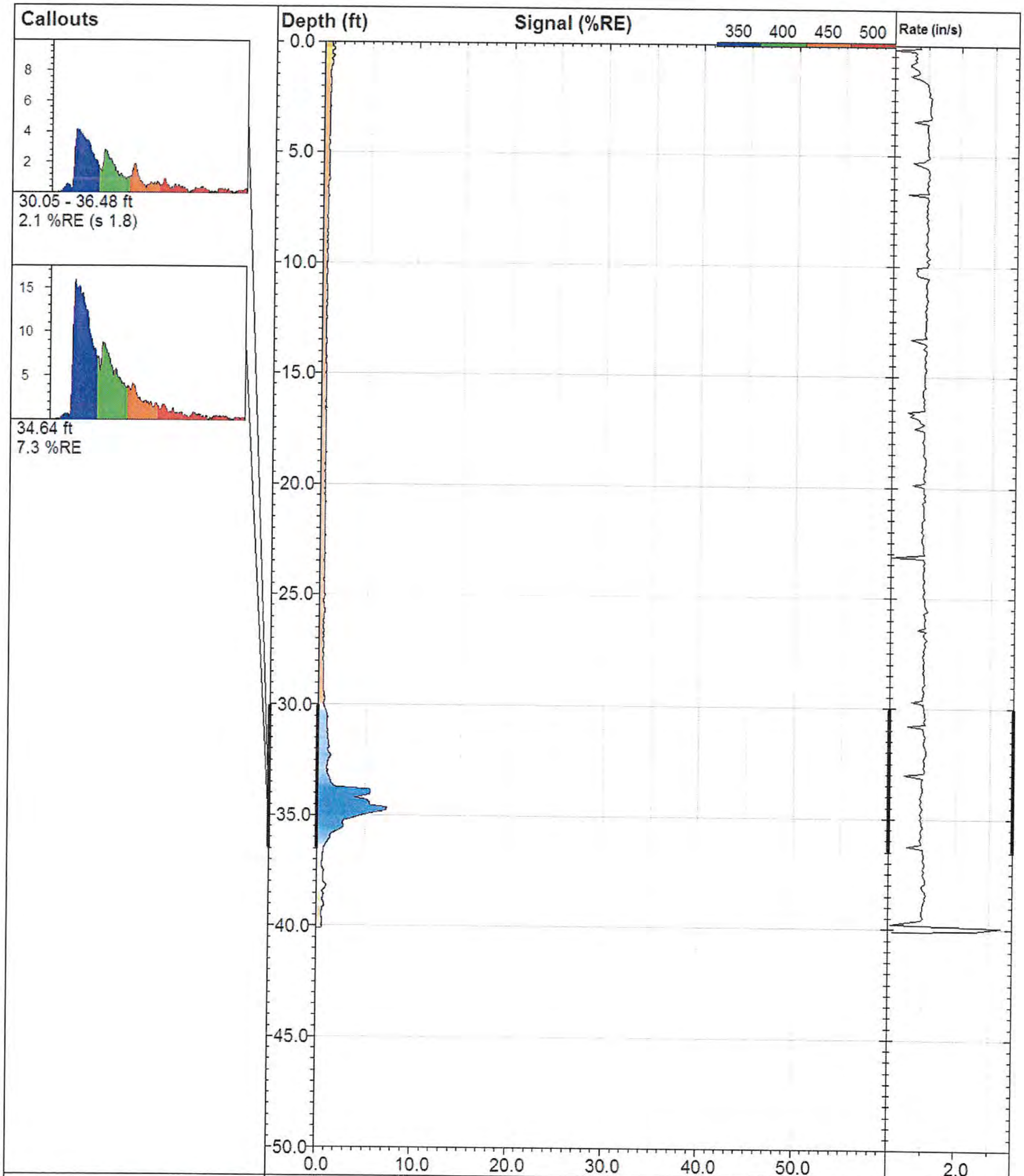


Max. Depth: 42.979 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



UV-CPT-14		UVOST By Dakota www.DakotaTechnologies.com
Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.11 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **7.3 %RE @ 34.64 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 14:13 PST**



GREGG

UV-CPT-14

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DLA Norwalk**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.11 ft**
Client / Job: **The Source Group / UV-D1**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **7.3 %RE @ 34.64 ft**
Operator / Unit: **Alex S / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-11-24 14:13 PST**

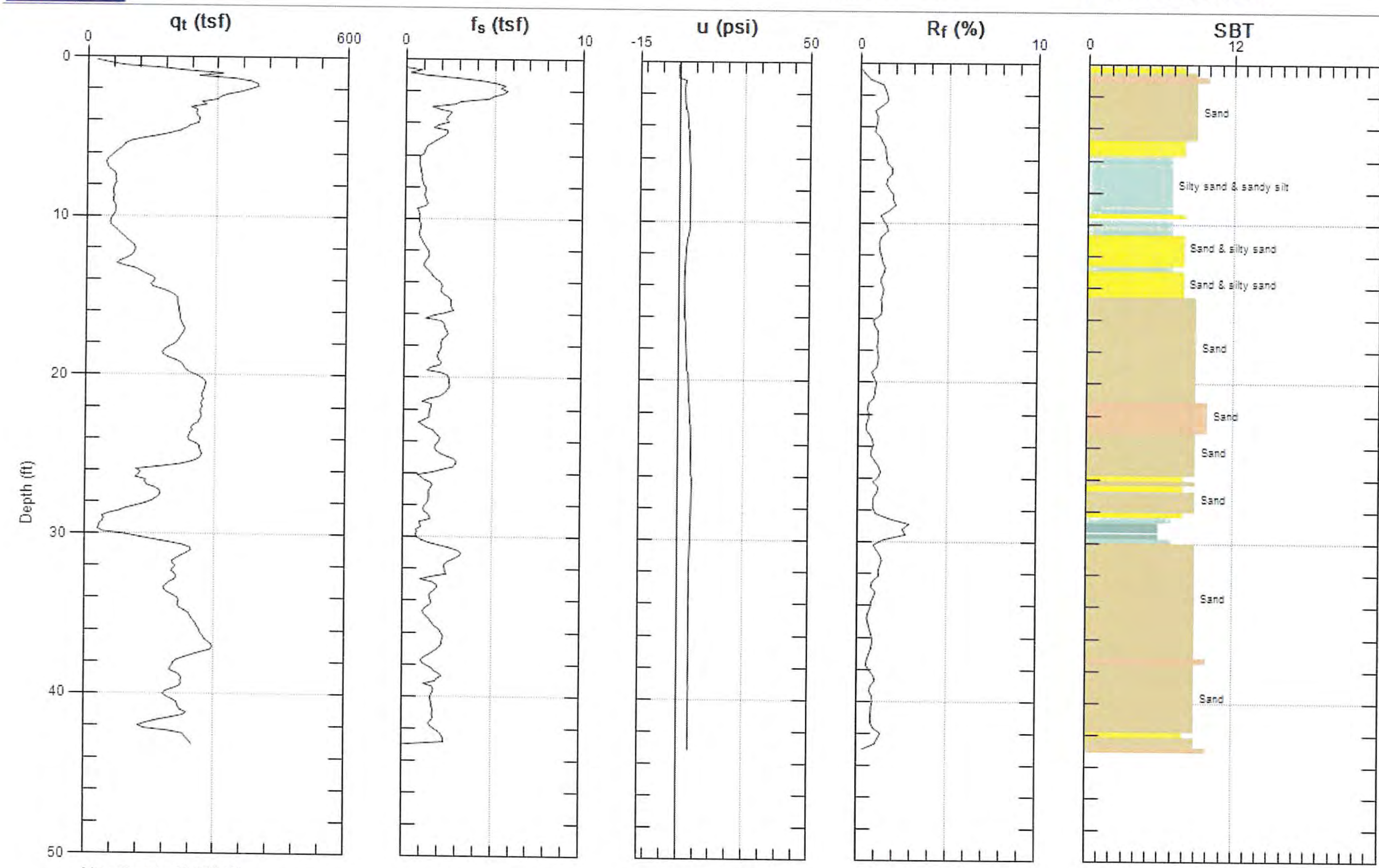
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: CPT-14

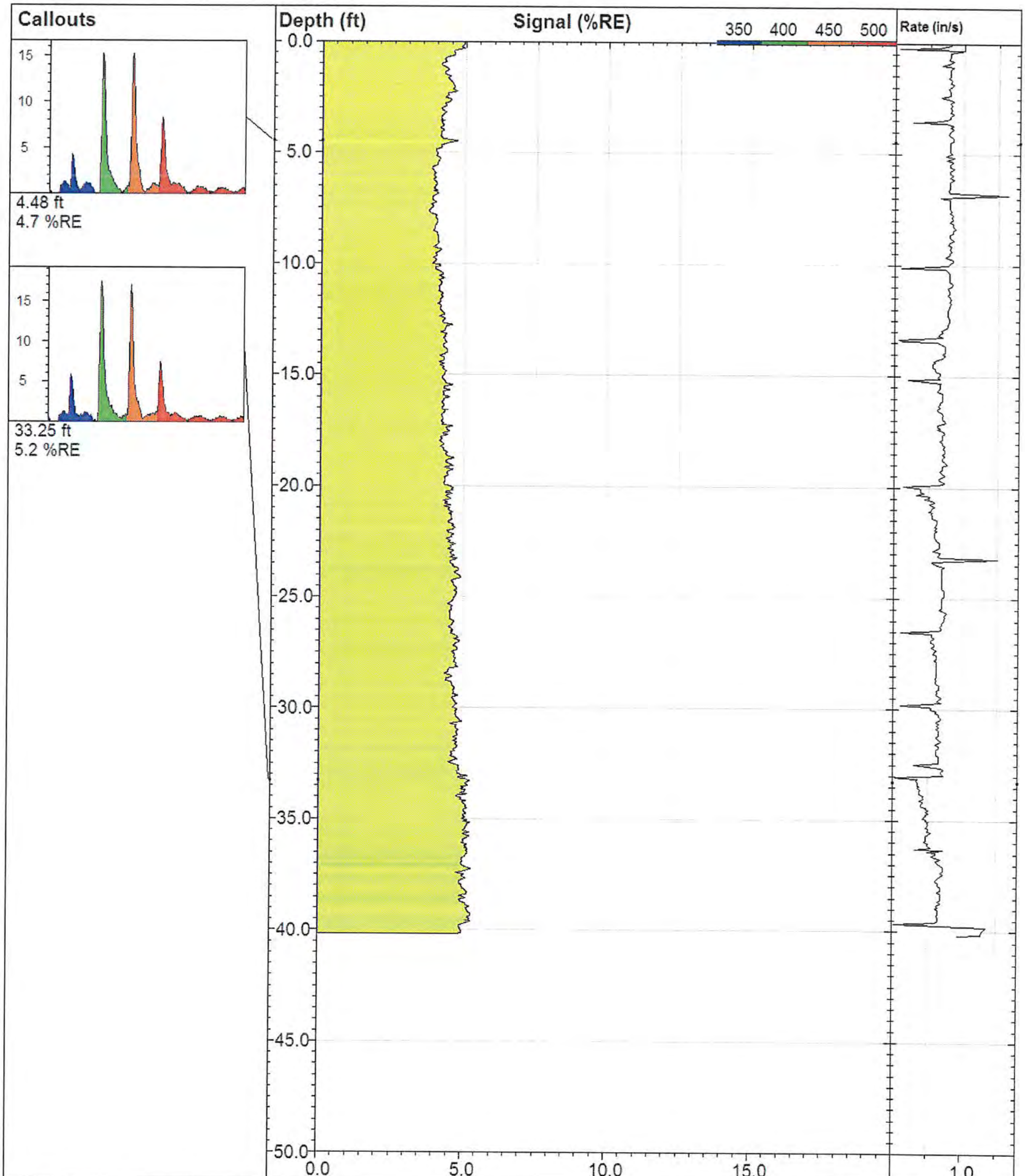
Engineer: P.PARMENTIER

Date: 11/24/2015 02:40



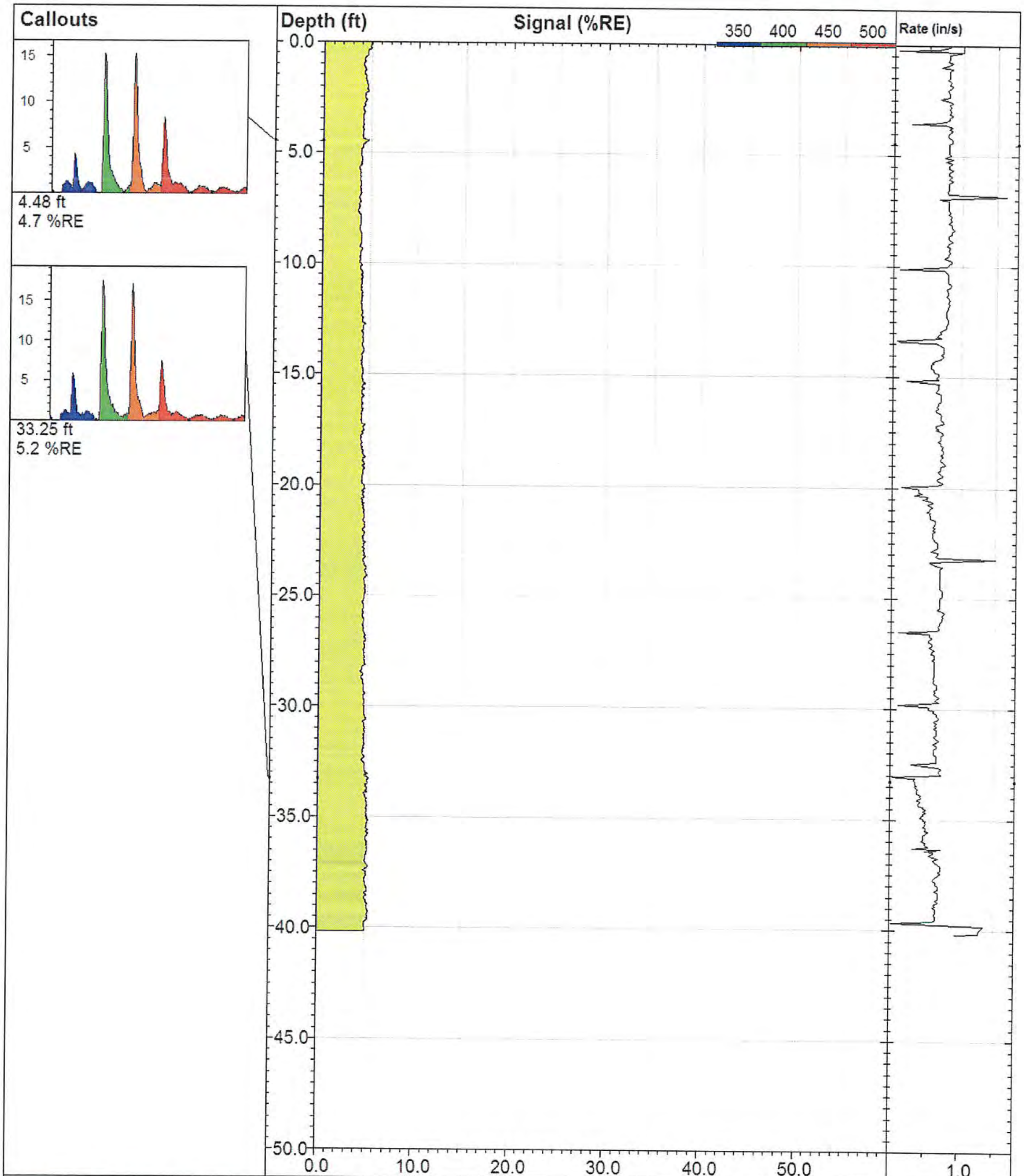
Max. Depth: 43.143 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-15		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.18 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.3 %RE @ 39.26 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 07:22 PST**



GREGG

UV-CPT-15		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **40.18 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.3 %RE @ 39.26 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 07:22 PST**

GREGG

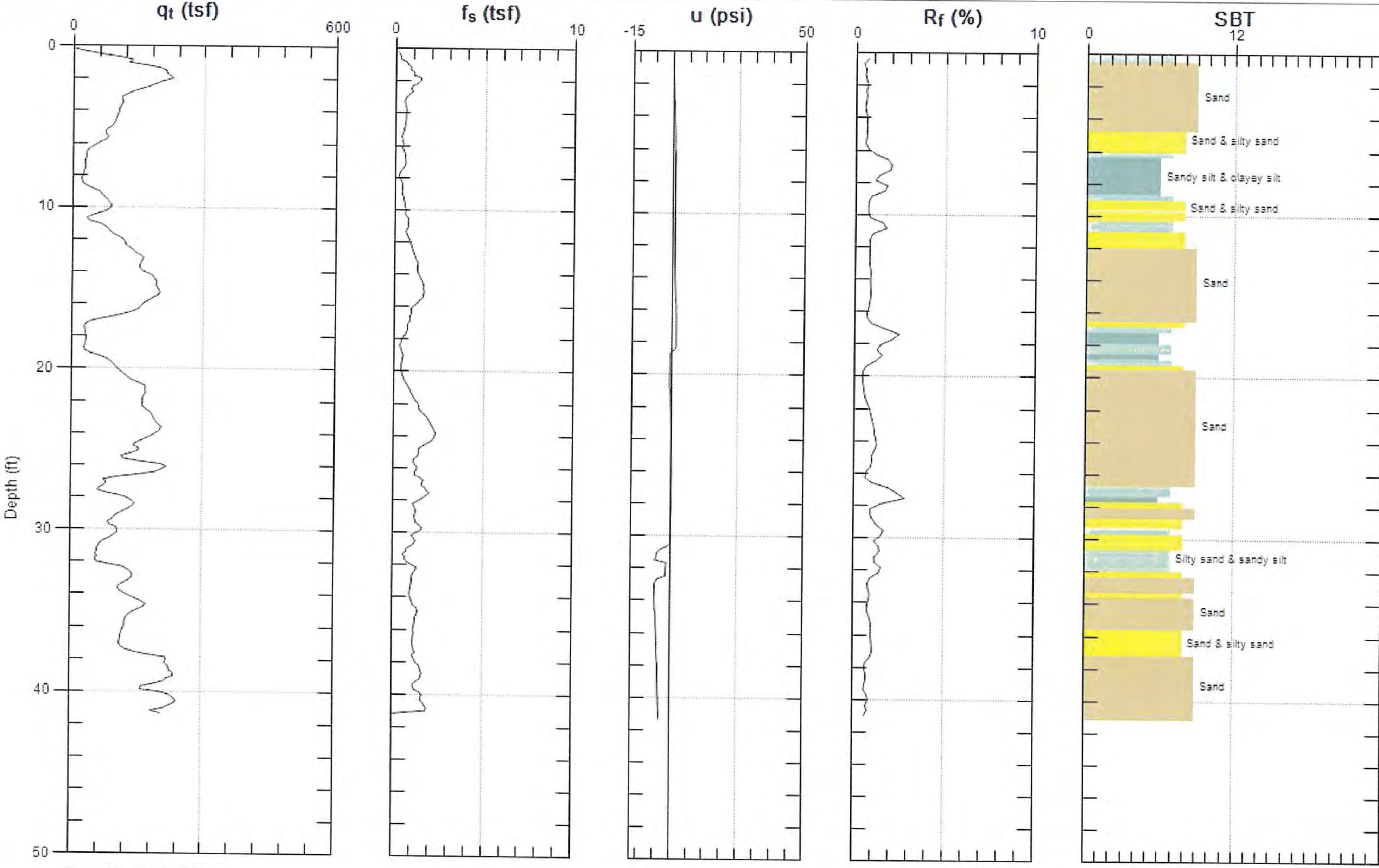
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-15

Engineer: P.PARMENTIER

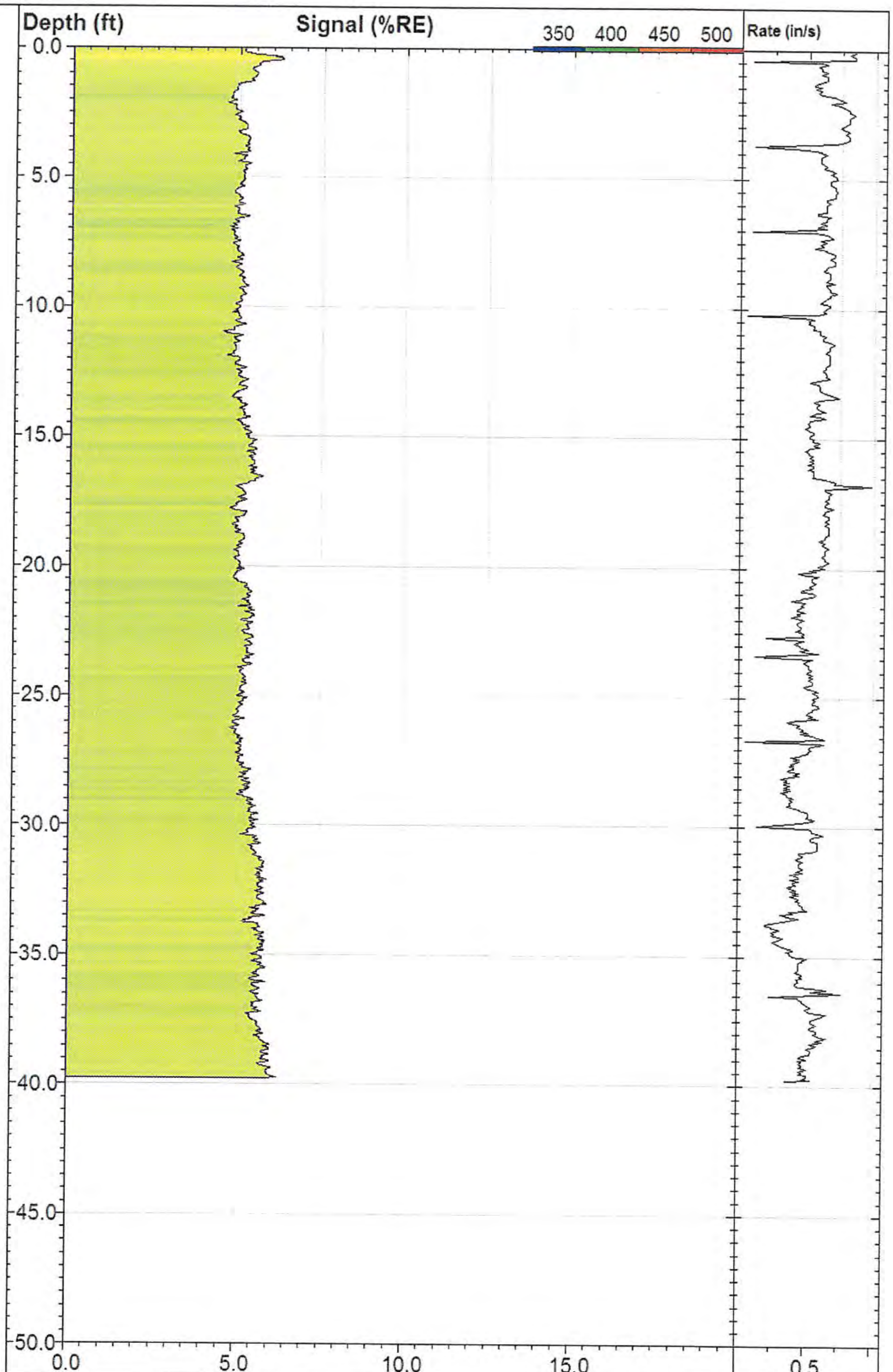
Date: 12/3/2015 07:38



Max. Depth: 41.339 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

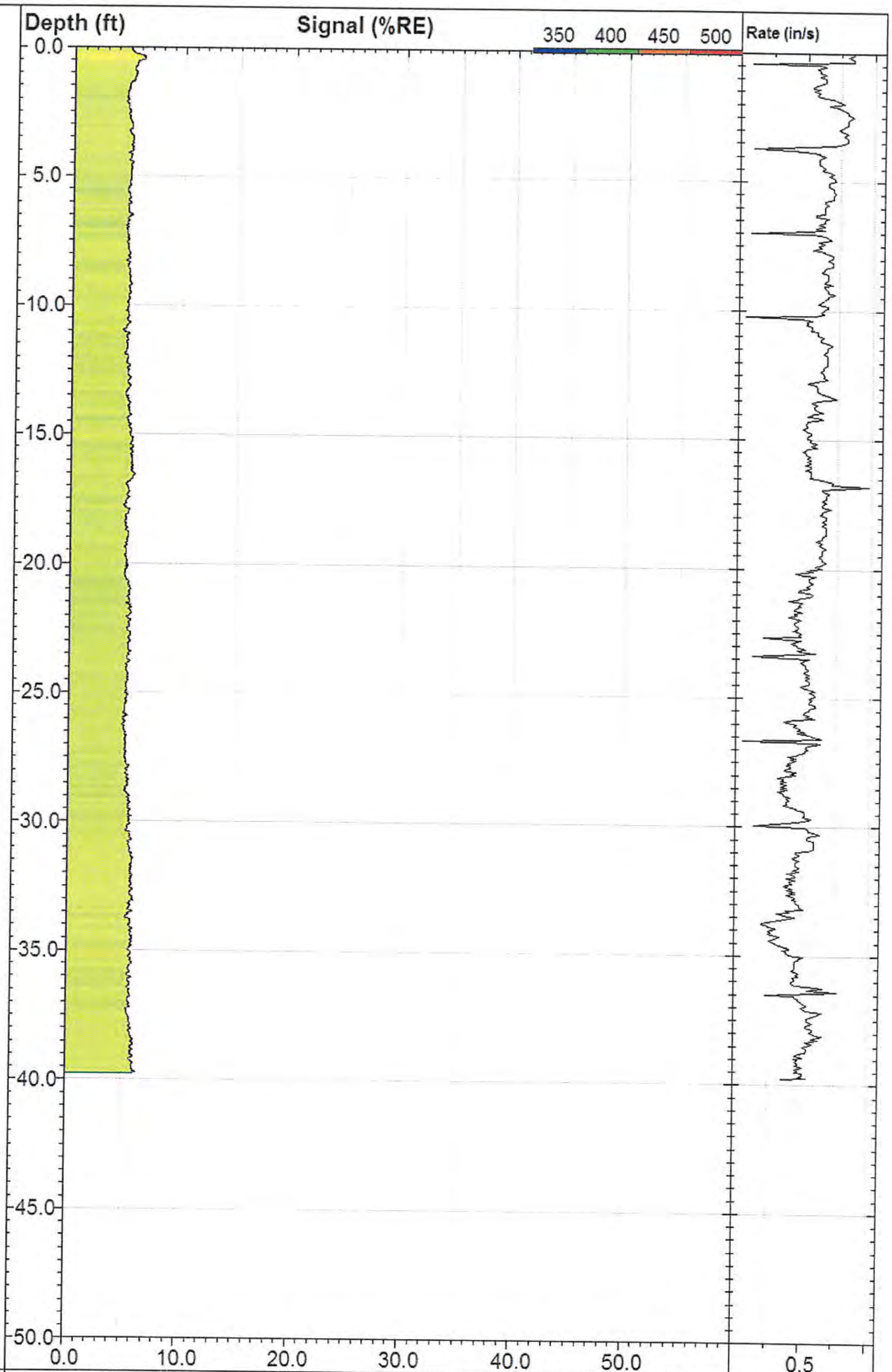
Callouts



GREGG

UV-CPT-16		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.77 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.3 %RE @ 39.72 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 08:07 PST**

Callouts



GREGG

UV-CPT-16		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.77 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.3 %RE @ 39.72 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 08:07 PST**

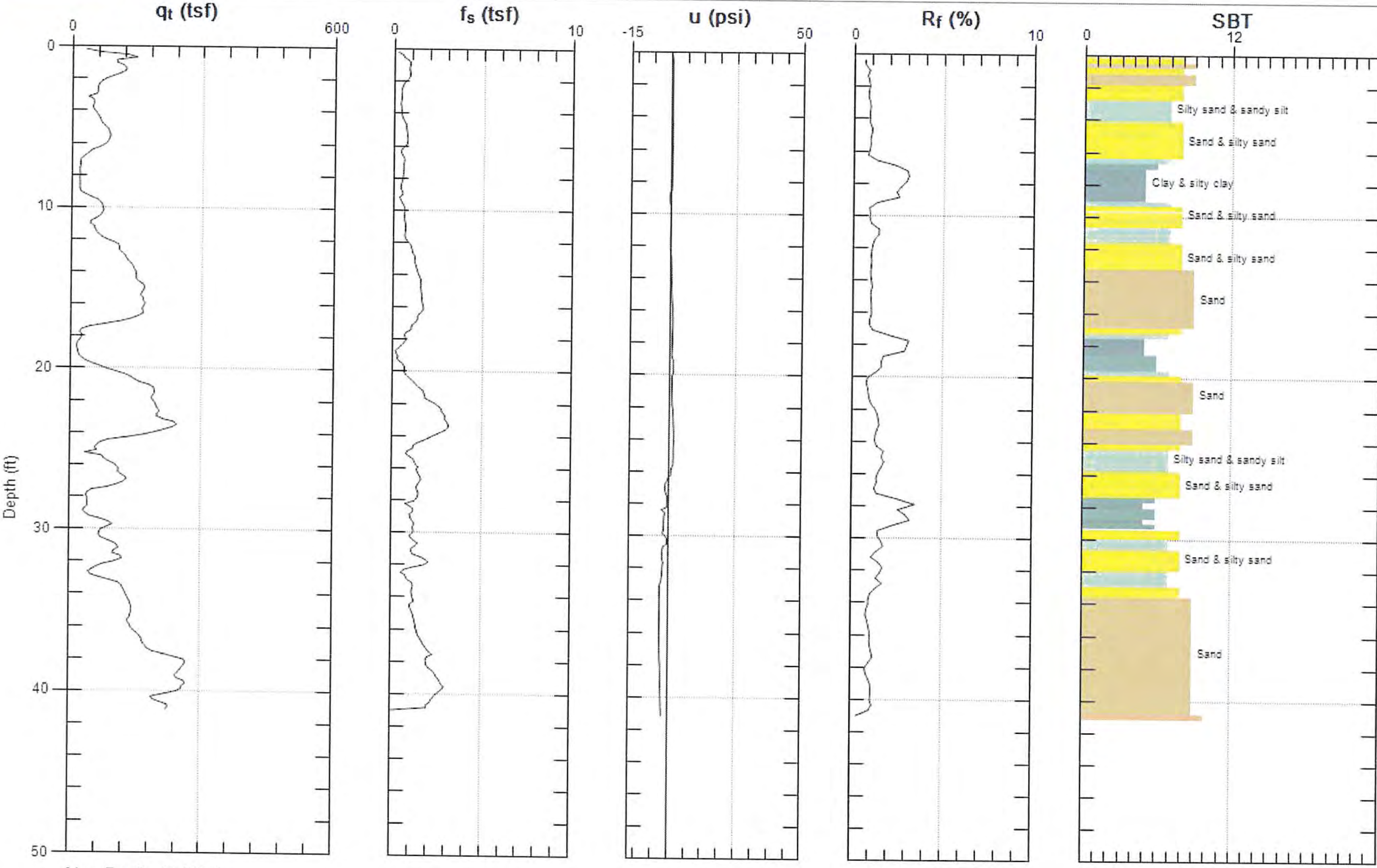
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-16

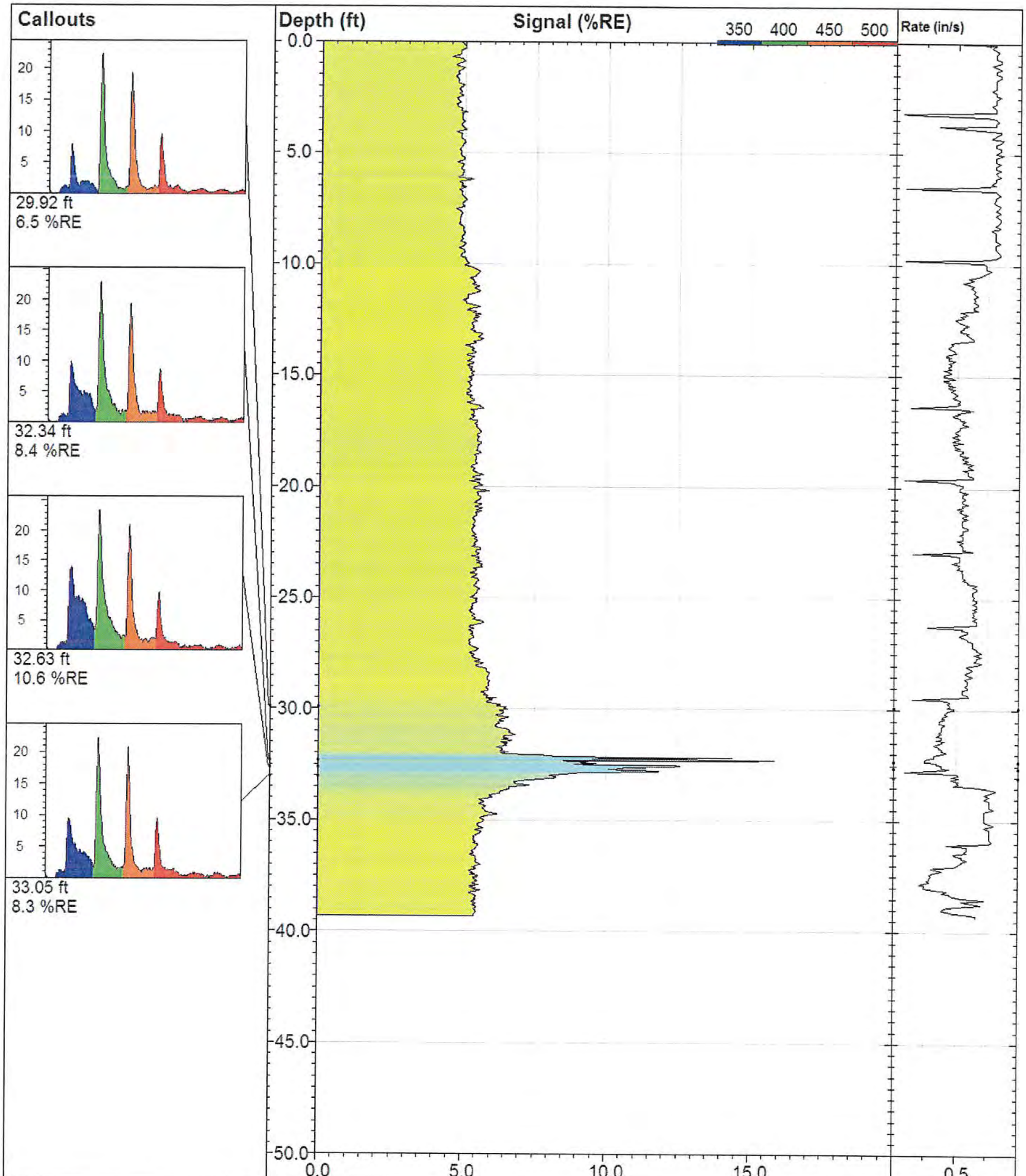
Engineer: P.PARMENTIER

Date: 12/3/2015 08:14



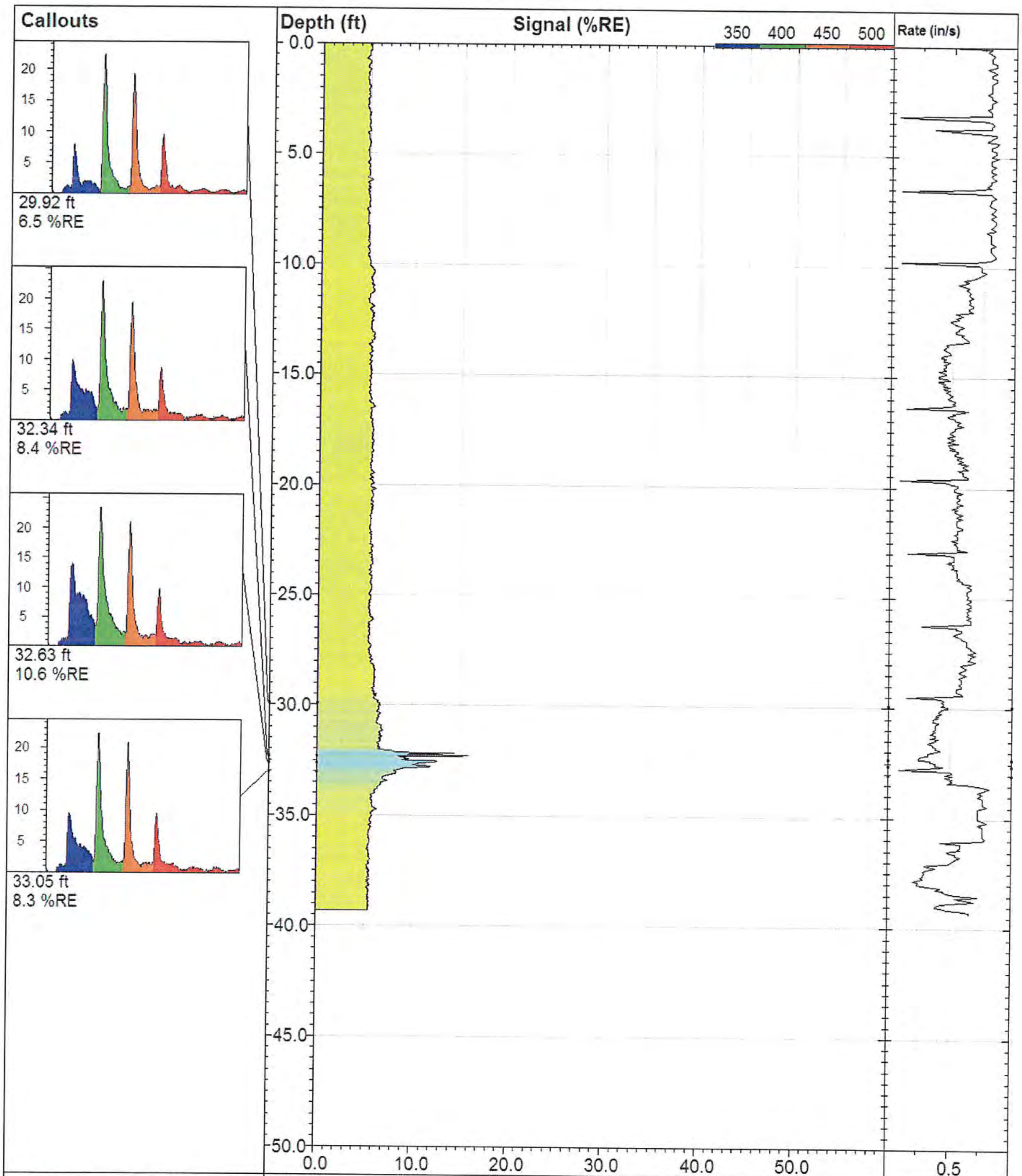
Max. Depth: 41.175 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-17		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.31 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **16.0 %RE @ 32.30 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 08:47 PST**



GREGG

UV-CPT-17

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.31 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **16.0 %RE @ 32.30 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 08:47 PST**

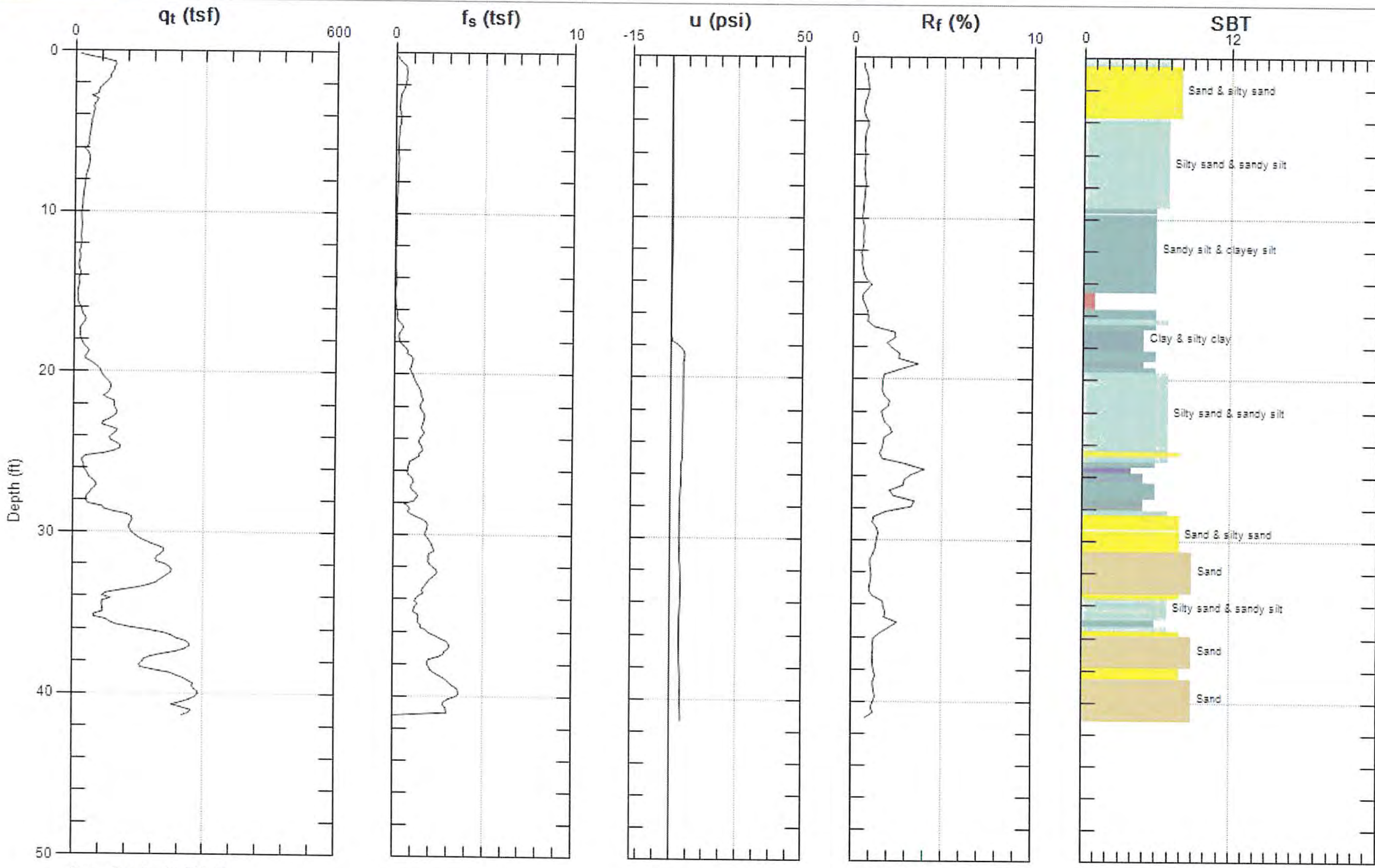
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-17

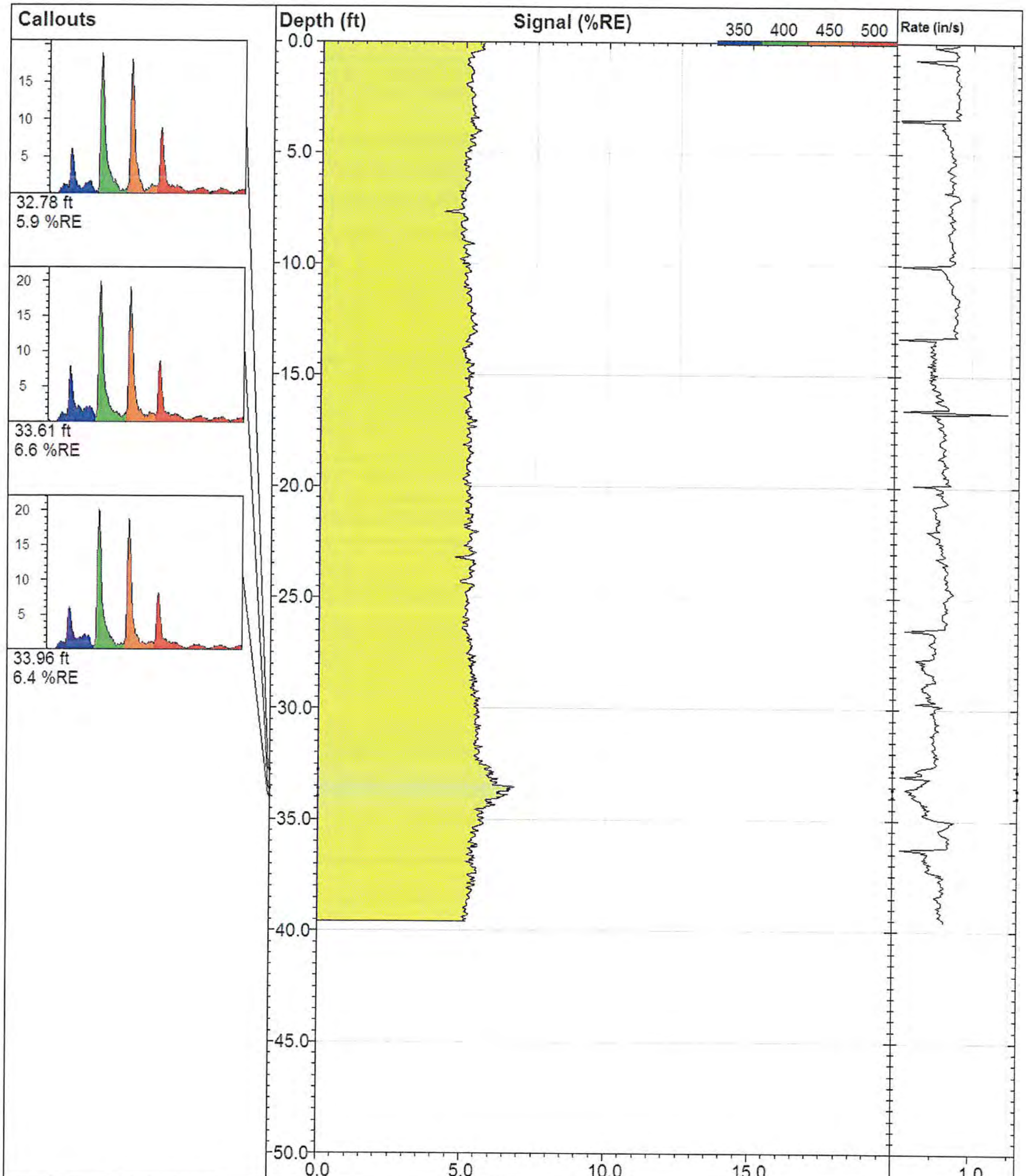
Engineer: P.PARMENTIER

Date: 12/3/2015 08:57



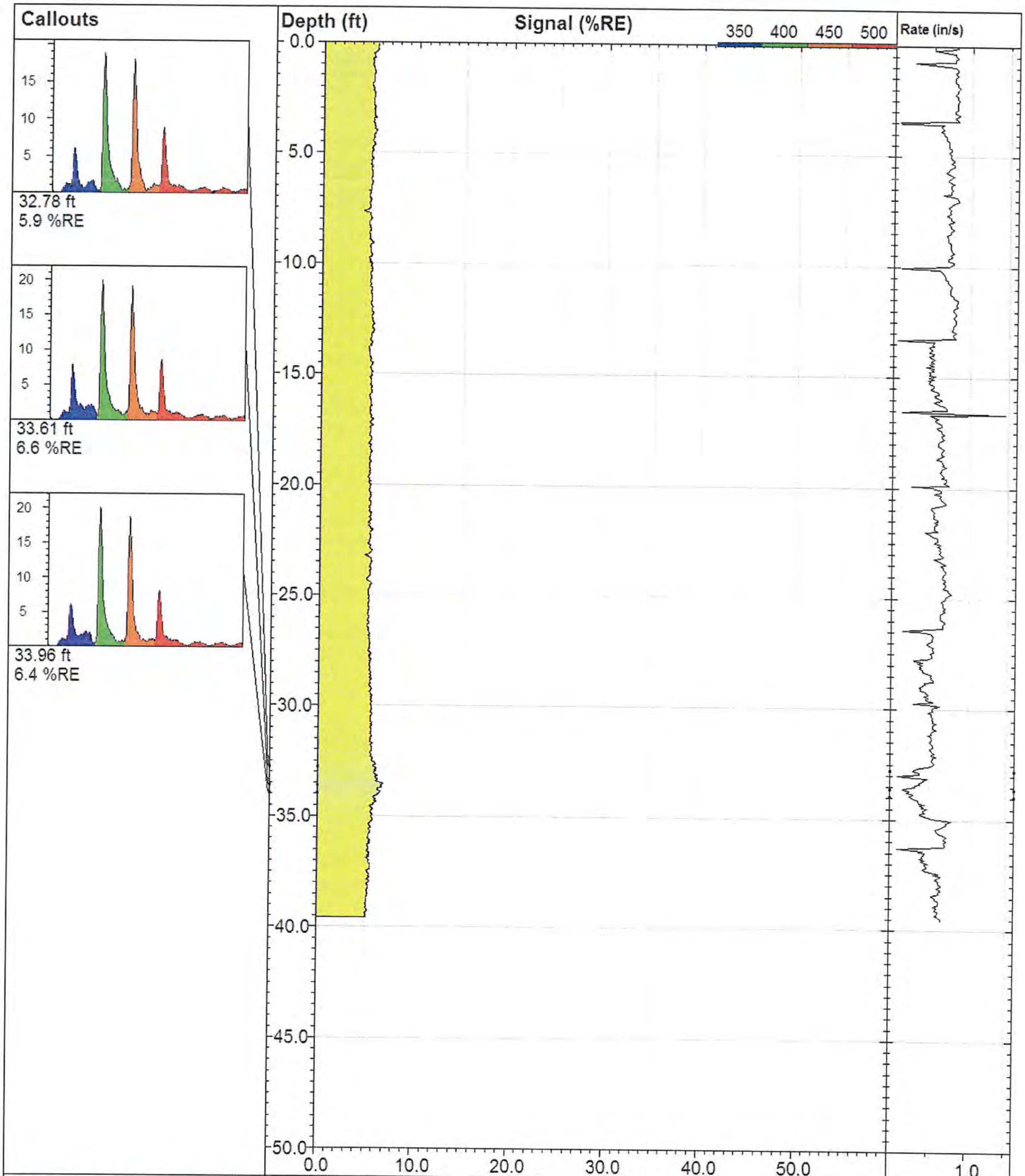
Max. Depth: 41.339 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-18		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.57 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.9 %RE @ 33.53 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 09:34 PST**



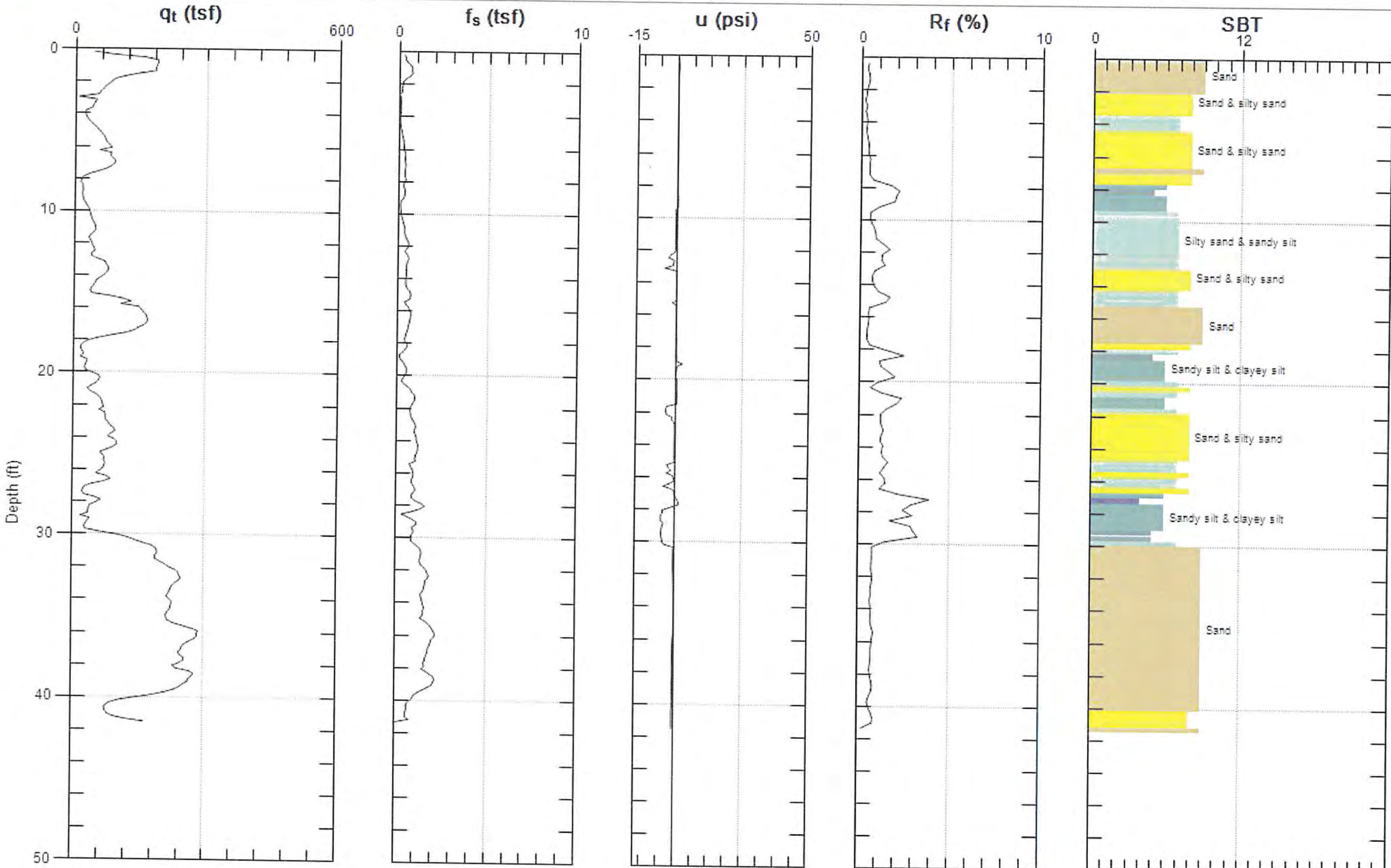
GREGG

UV-CPT-18		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.57 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.9 %RE @ 33.53 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 09:34 PST**

GREGG THE SOURCE GROUP

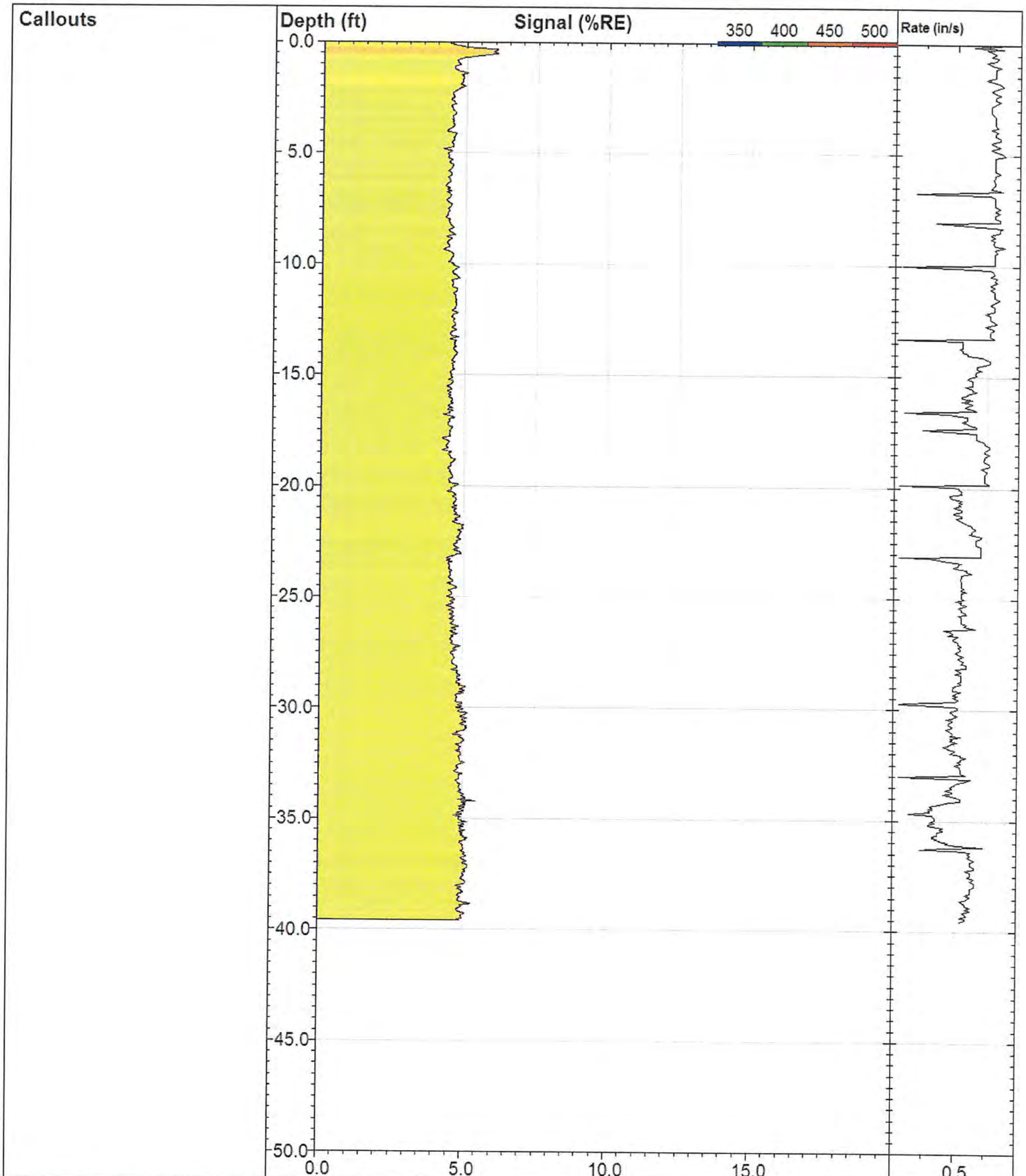
Site: NORWALK DFSP
Sounding: UV-CPT-18

Engineer: P.PARMENTIER
Date: 12/3/2015 09:40



Max. Depth: 41.503 (ft)
Avg. Interval: 0.328 (ft)

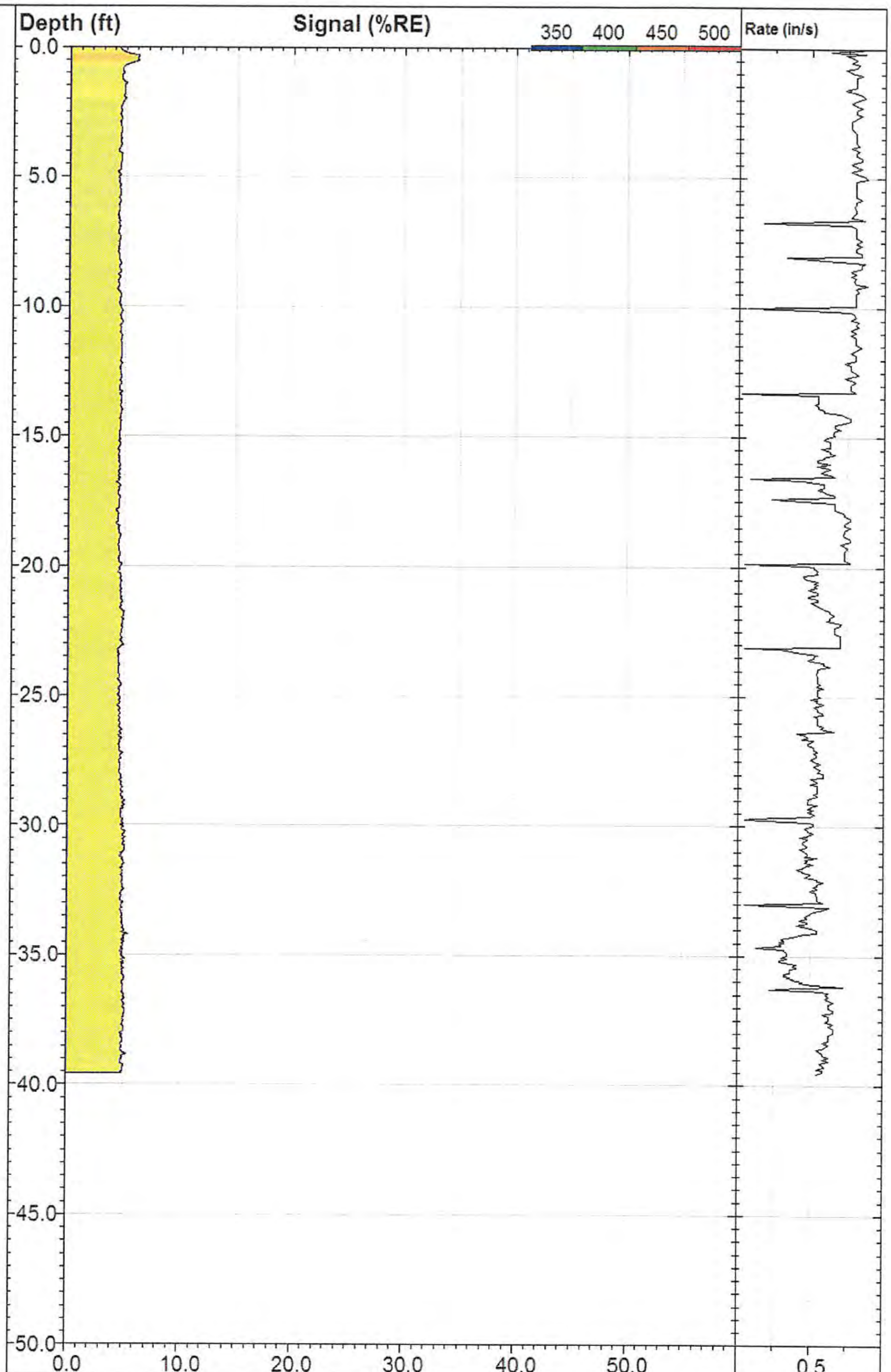
SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-19		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.57 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.1 %RE @ 0.33 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 10:12 PST**

Callouts



GREGG

UV-CPT-19

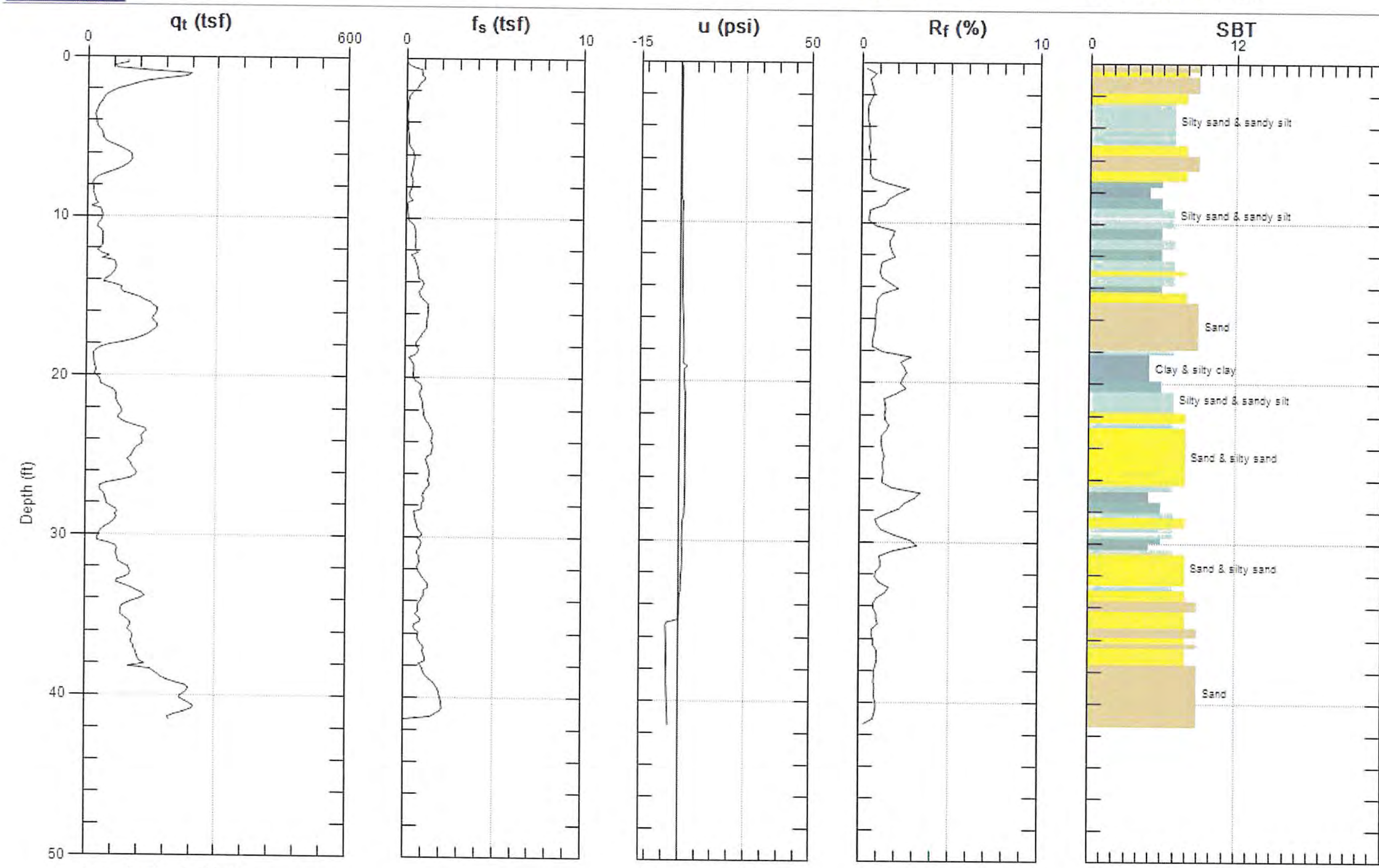
UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.57 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.1 %RE @ 0.33 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 10:12 PST**

GREGG THE SOURCE GROUP

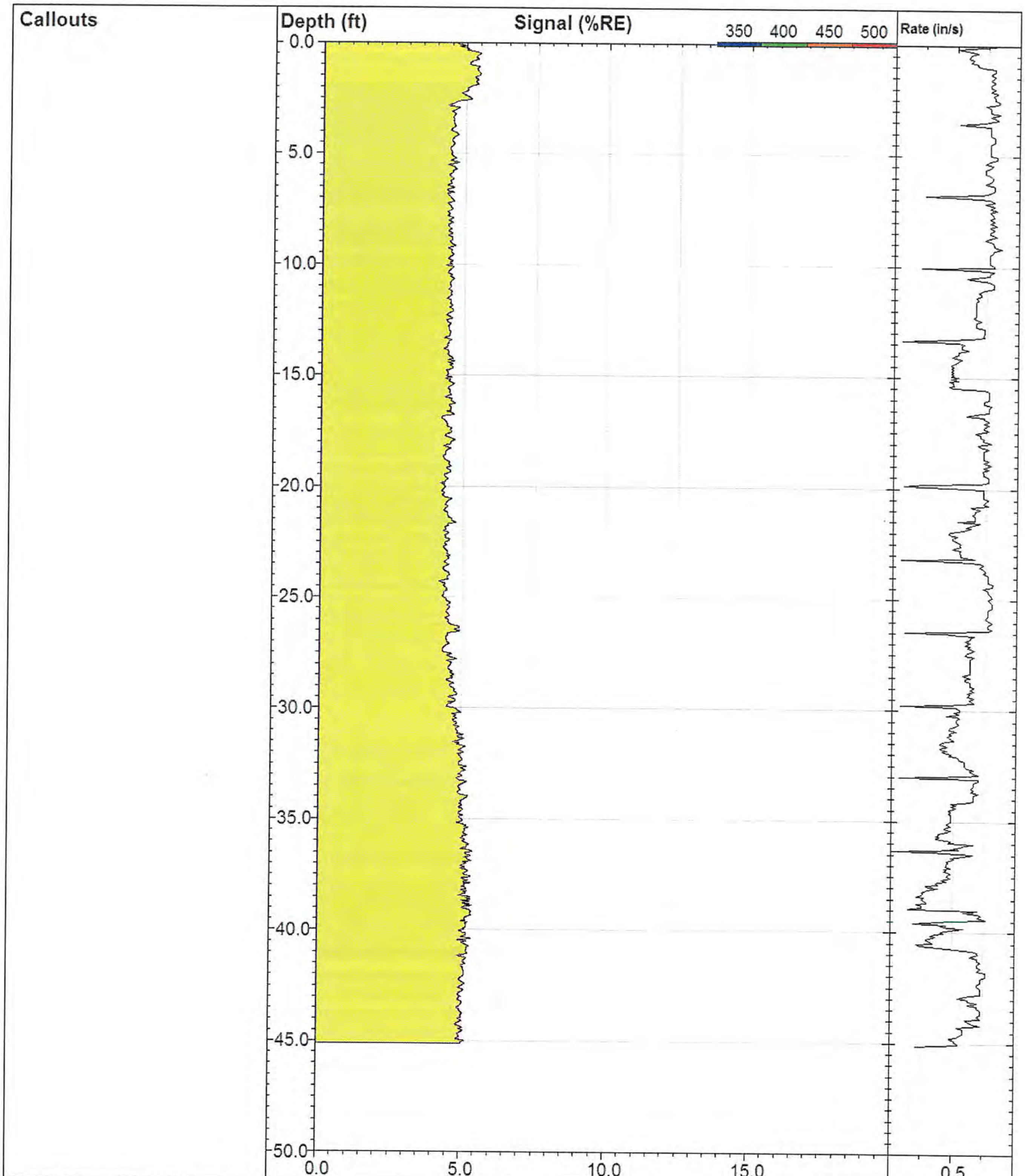
Site: NORWALK DFSP
Sounding: UV-CPT-19

Engineer: P.PARMENTIER
Date: 12/3/2015 10:27



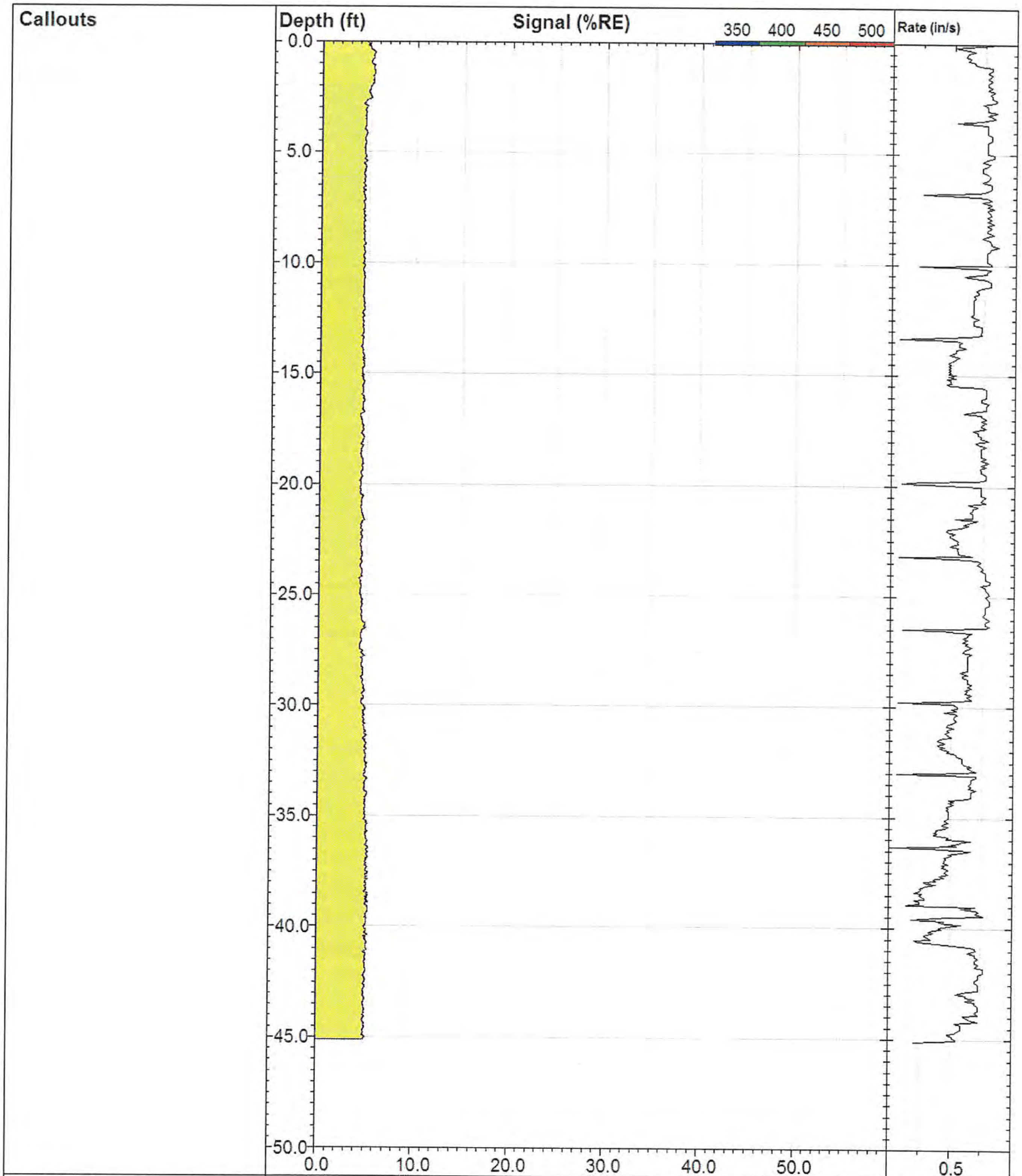
Max. Depth: 41.503 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

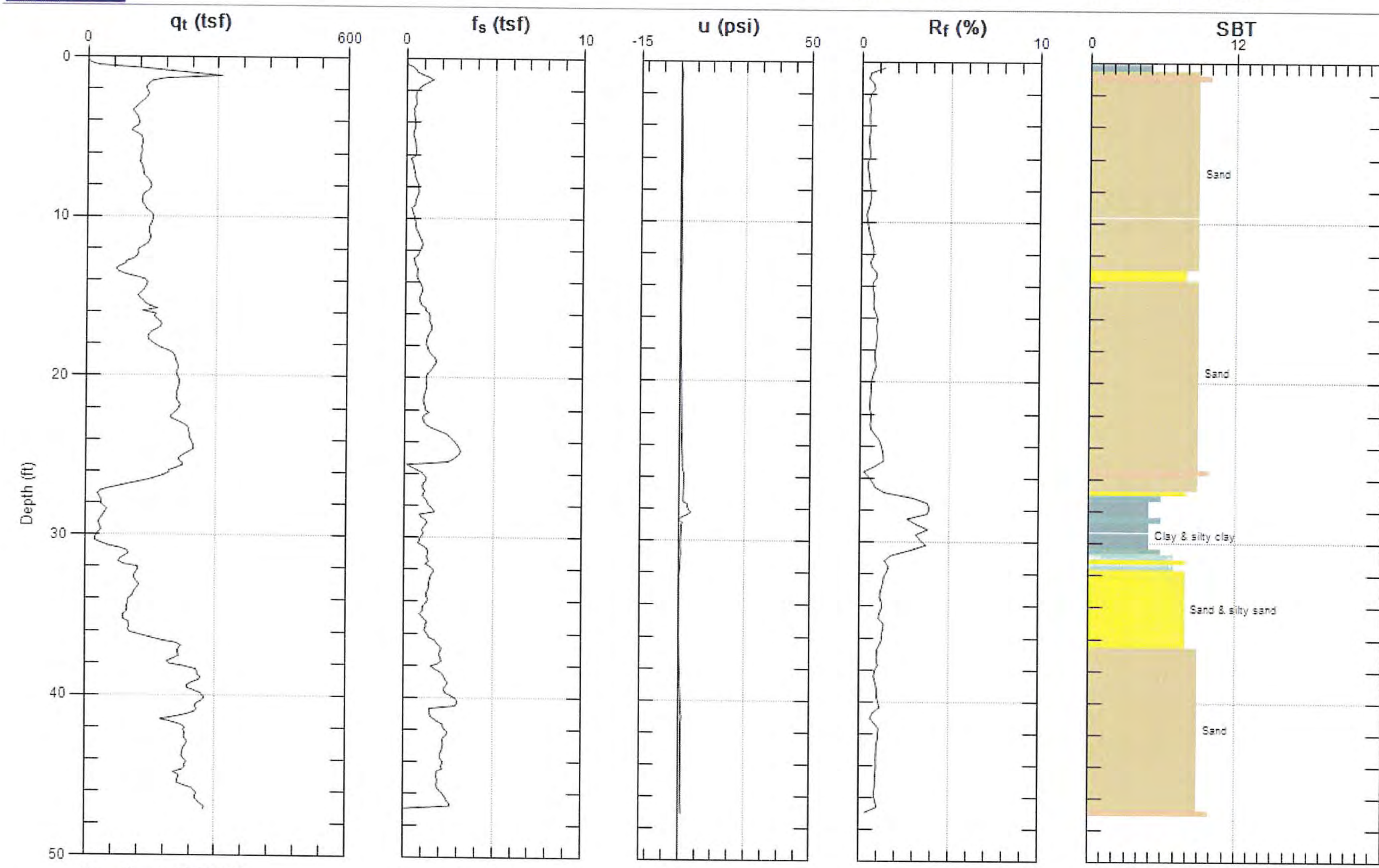
UV-CPT-20		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **45.11 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.5 %RE @ 0.51 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 11:37 PST**



GREGG	UV-CPT-20		UVOST By Dakota www.DakotaTechnologies.com
	Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **45.11 ft**
	Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.5 %RE @ 0.51 ft**
	Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 11:37 PST**

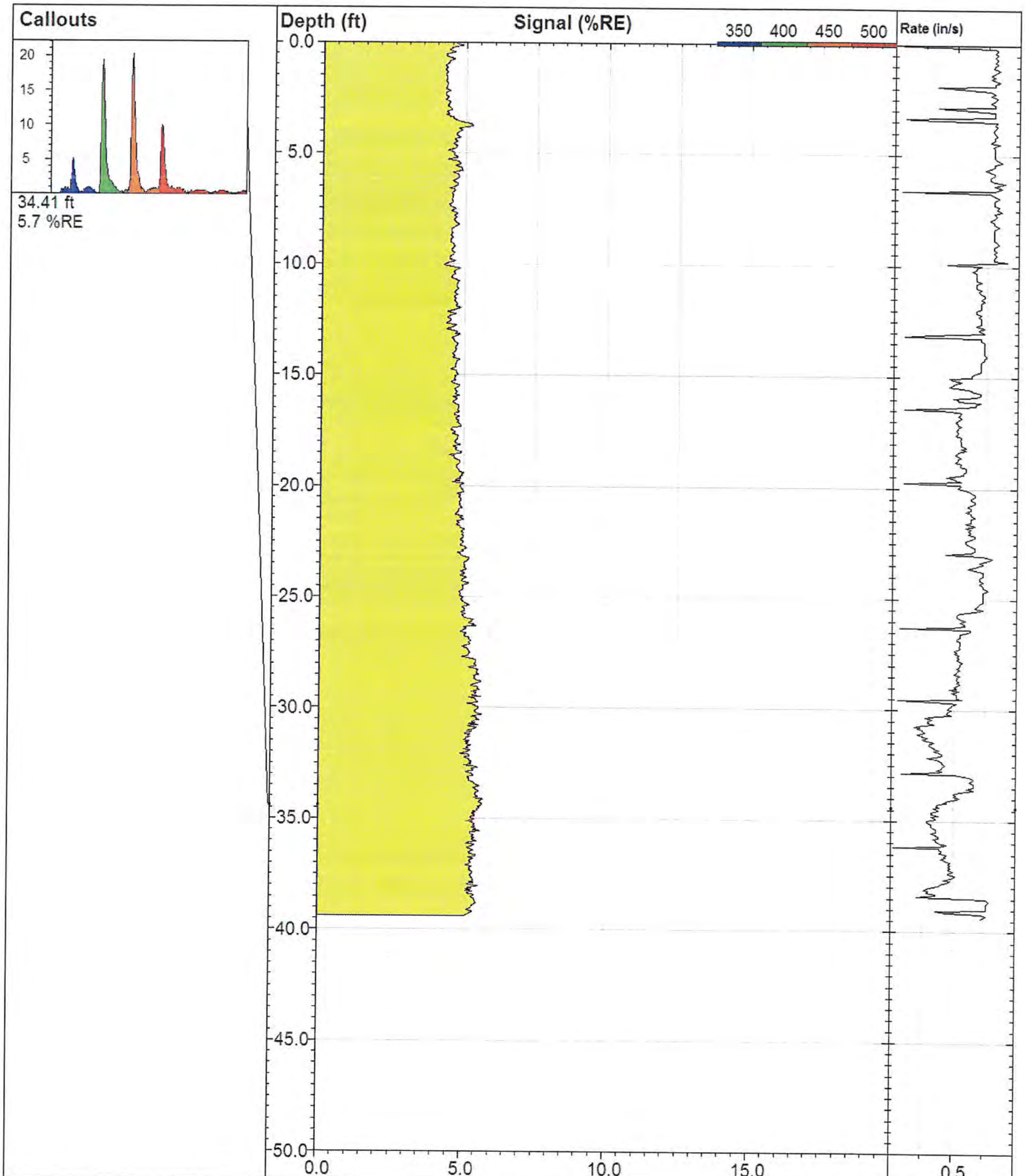
GREGG THE SOURCE GROUP

Site: NORWALK DFSP
Sounding: UV-CPT-20
Engineer: P.PARMENTIER
Date: 12/3/2015 11:50



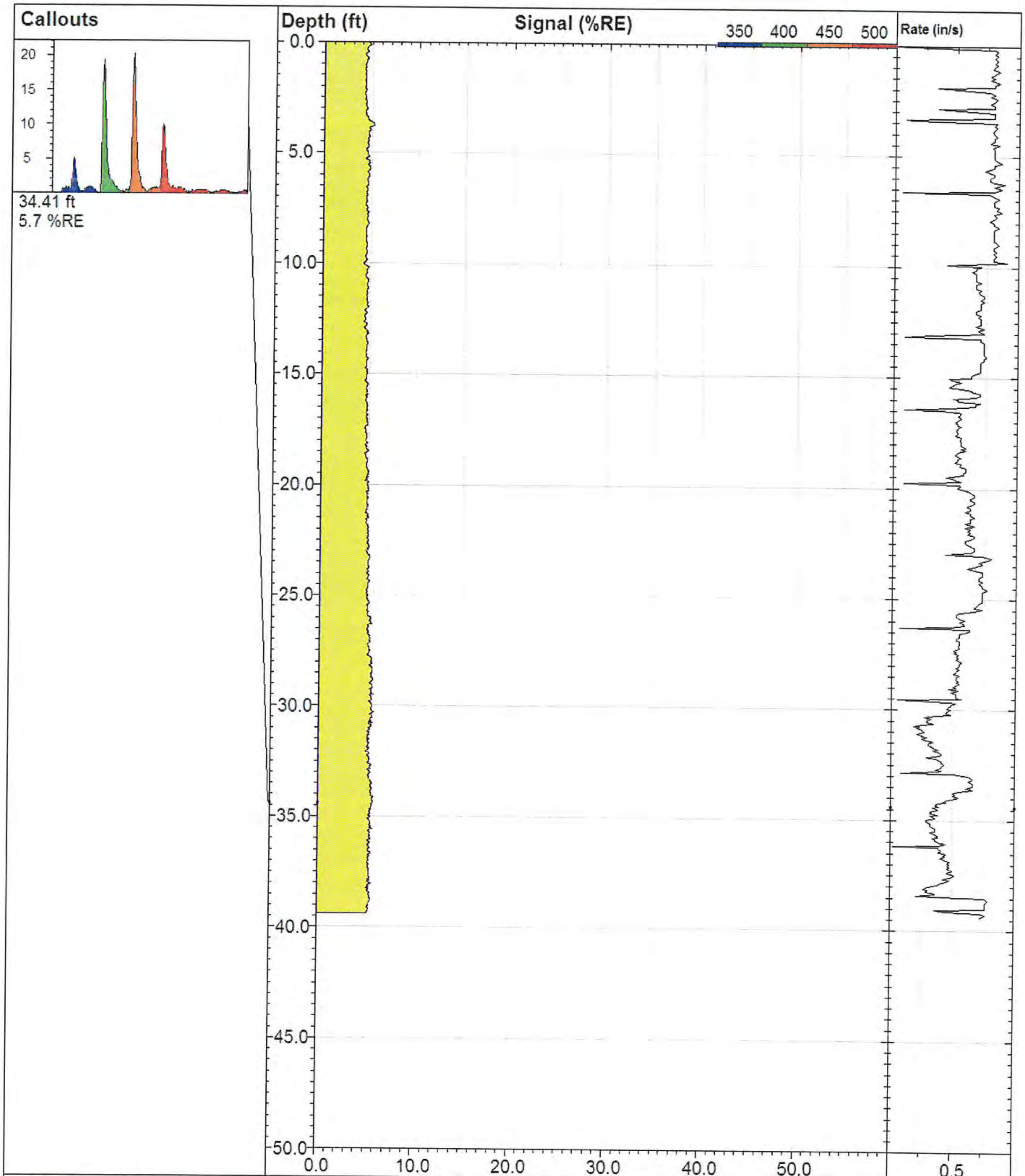
Max. Depth: 47.080 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-21		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.37 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.8 %RE @ 34.12 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 12:52 PST**



GREGG

UV-CPT-21

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.37 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.8 %RE @ 34.12 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 12:52 PST**

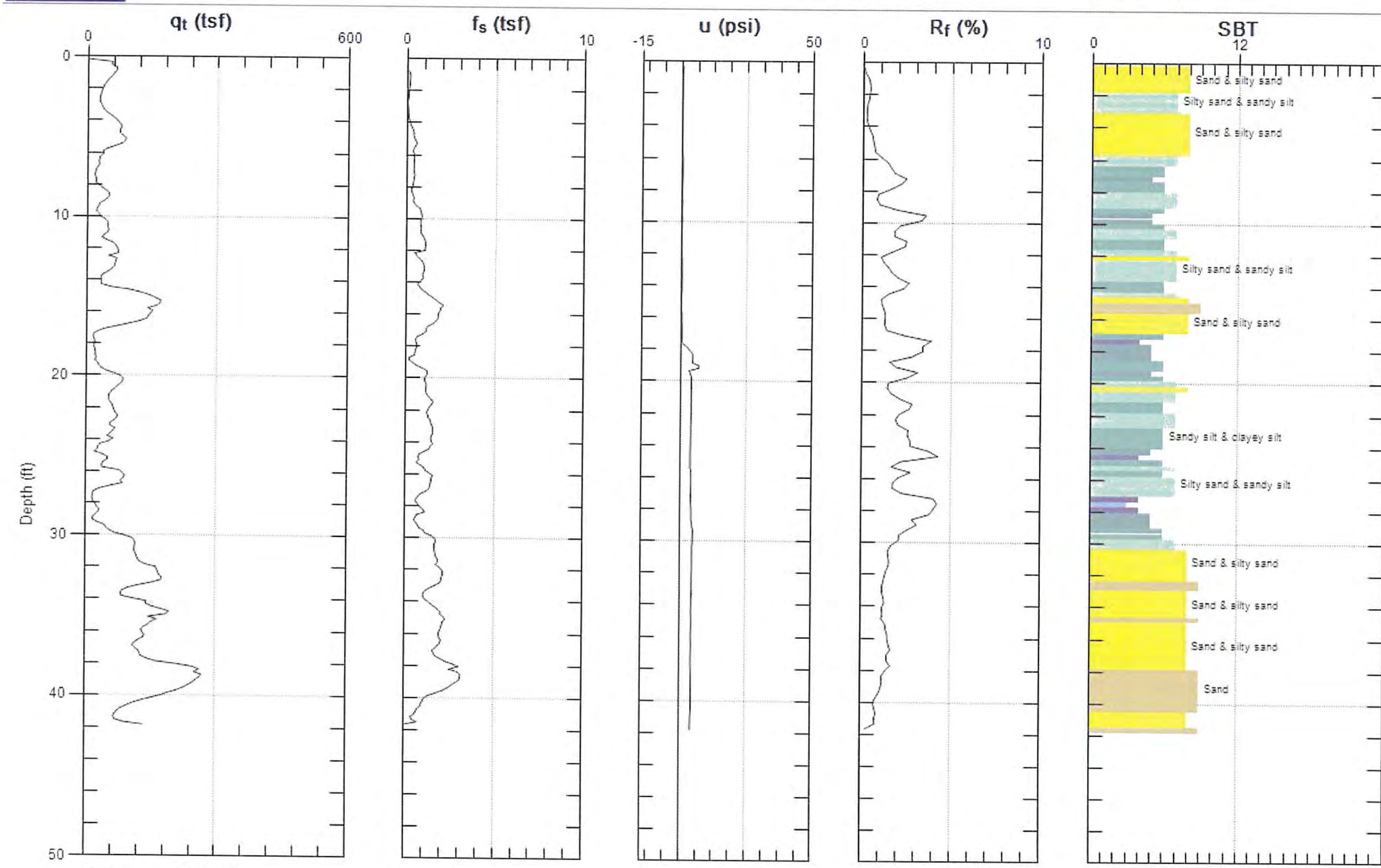
GREGG THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-21

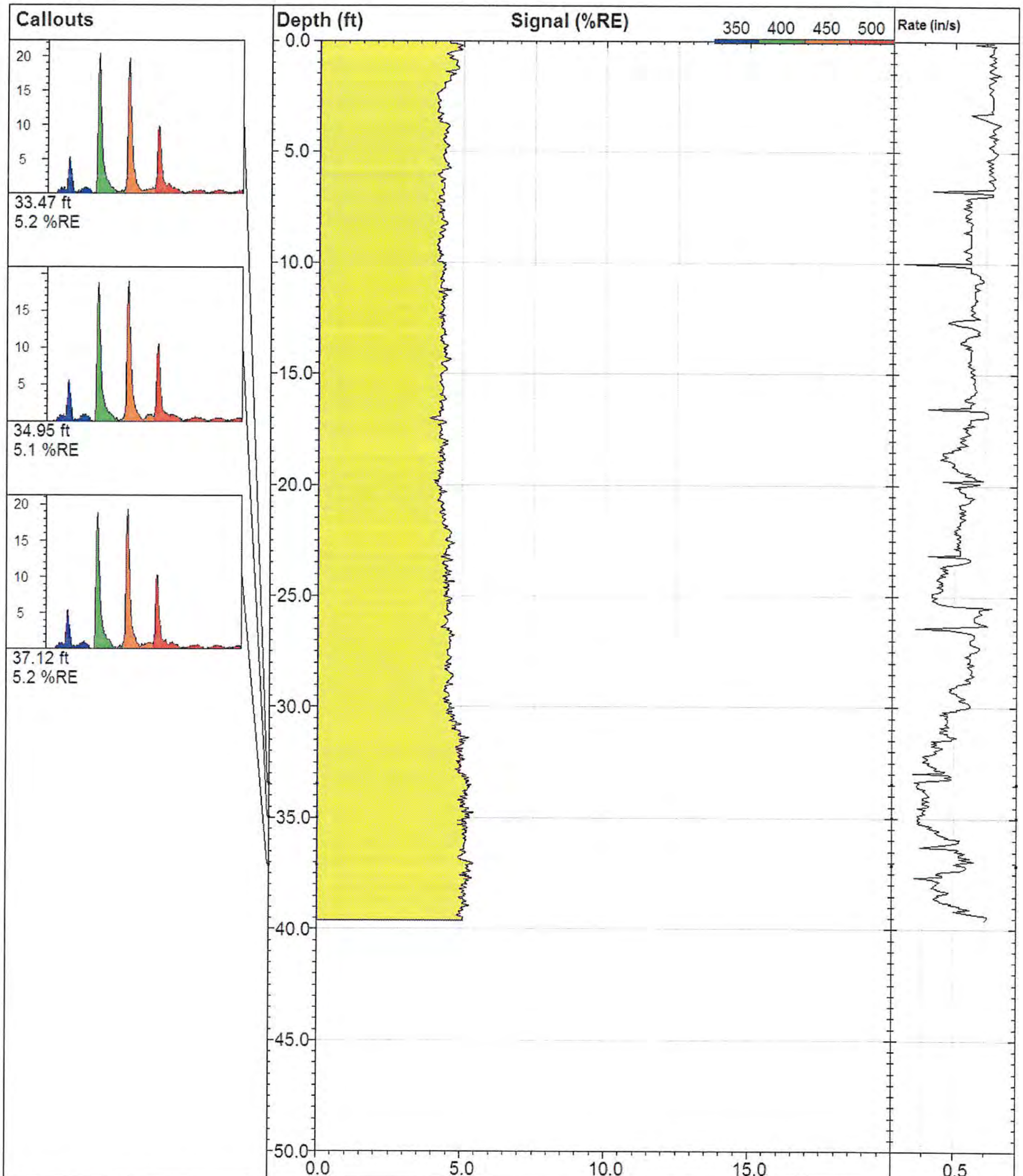
Engineer: P.PARMENTIER

Date: 12/3/2015 01:06

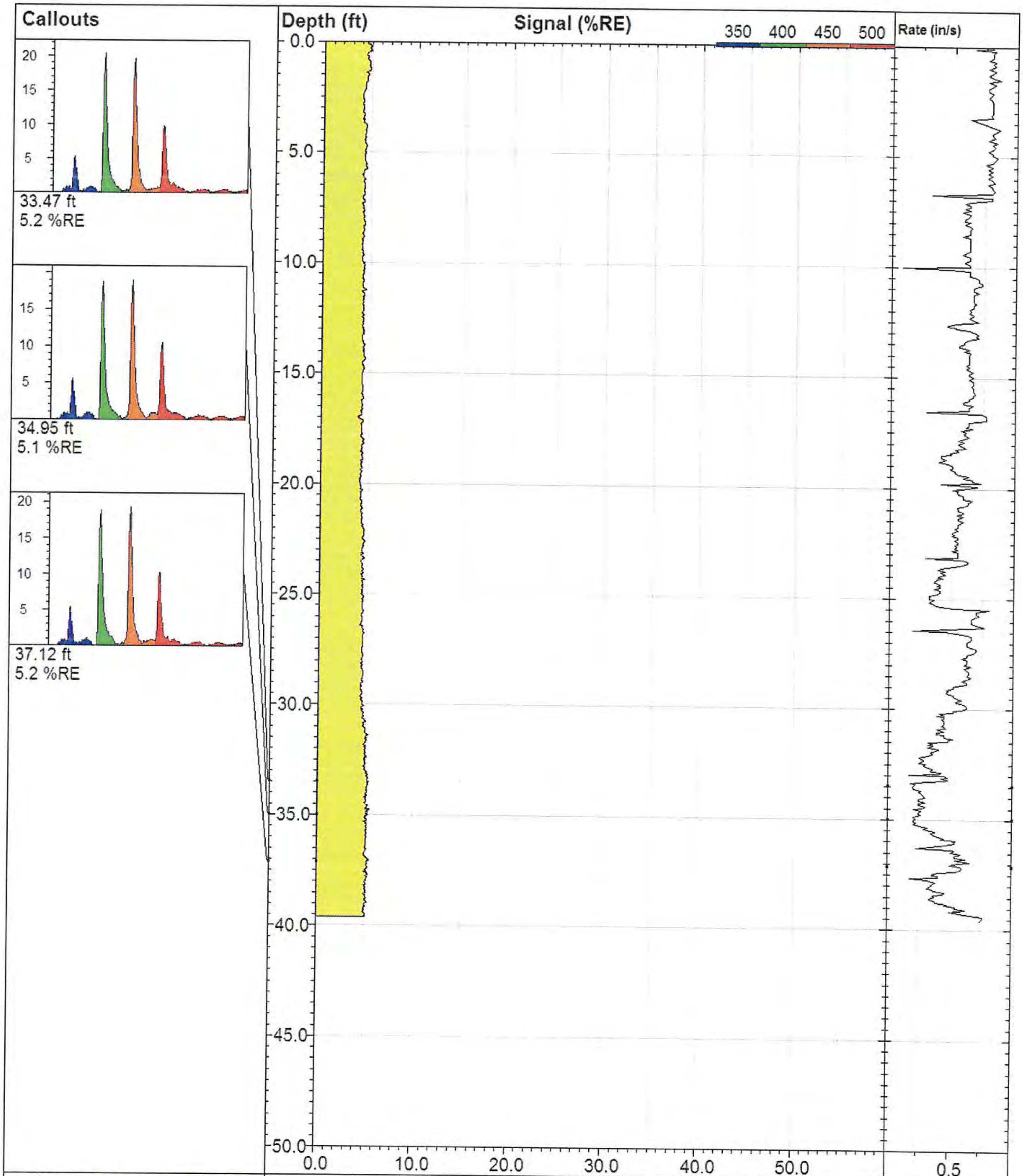


Max. Depth: 41.831 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



UV-CPT-22		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.61 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.5 %RE @ 34.75 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 13:34 PST**



GREGG

UV-CPT-22		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.61 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.5 %RE @ 34.75 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 13:34 PST**

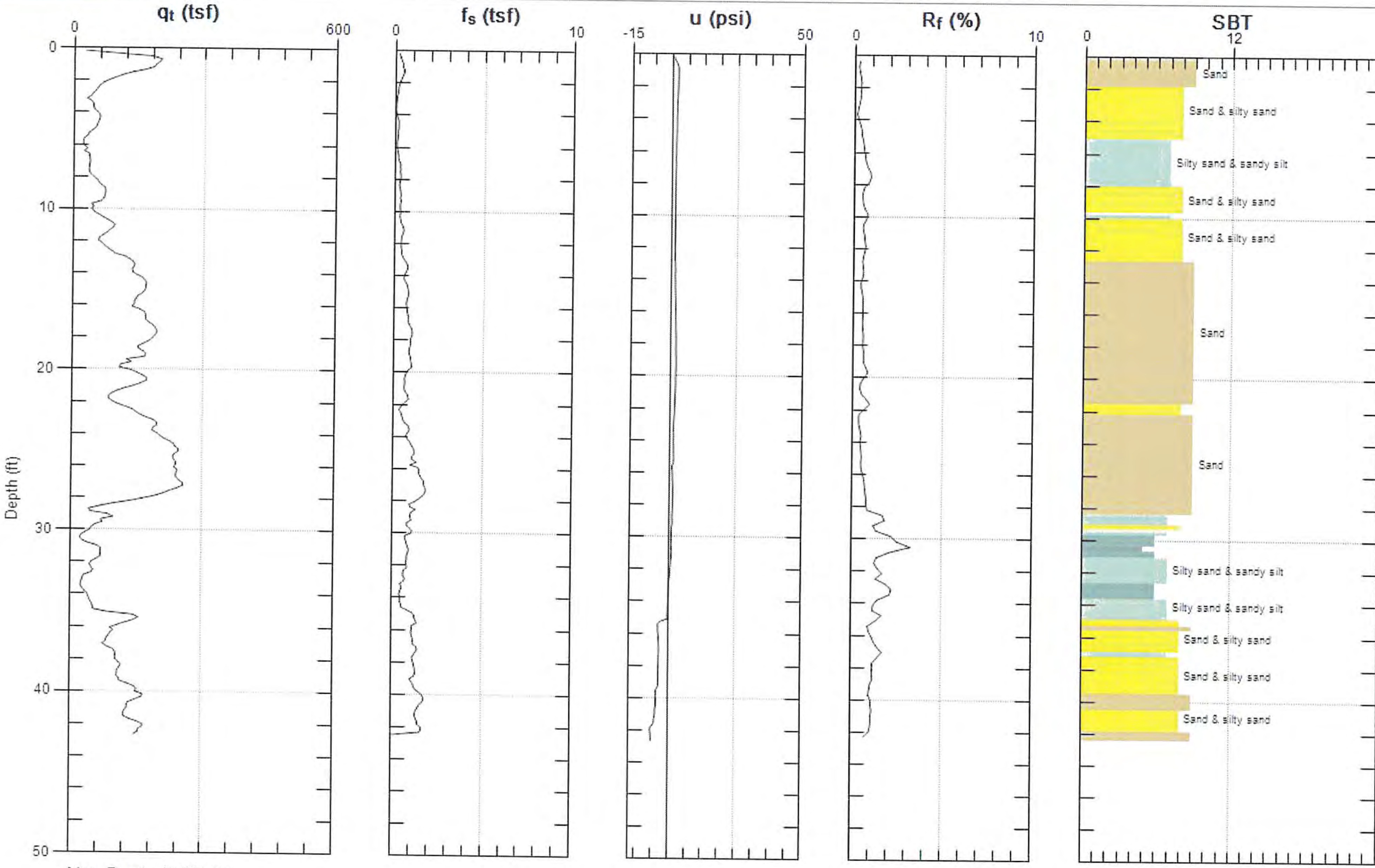
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-22

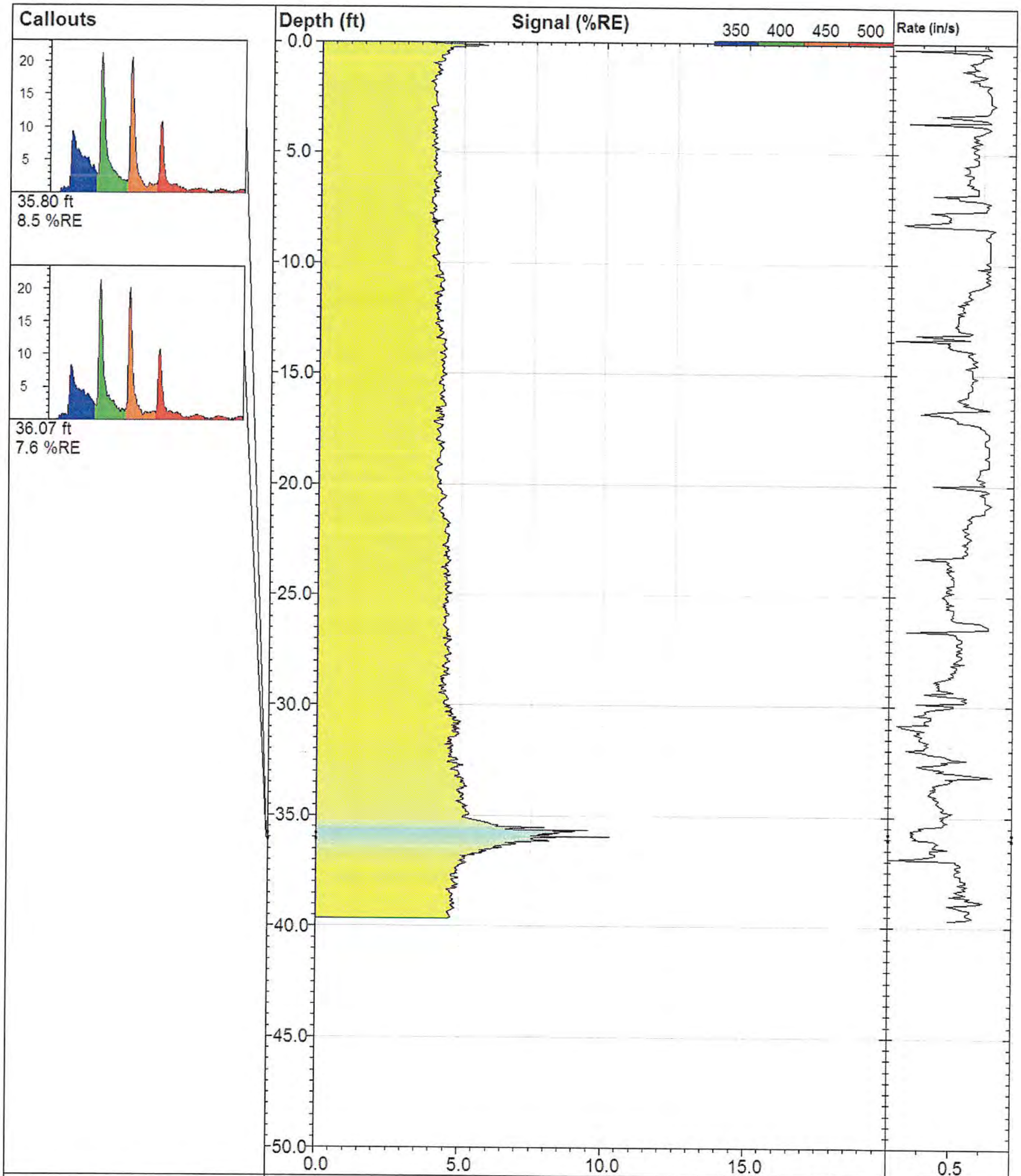
Engineer: P.PARMENTIER

Date: 12/3/2015 01:47



Max. Depth: 42.651 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

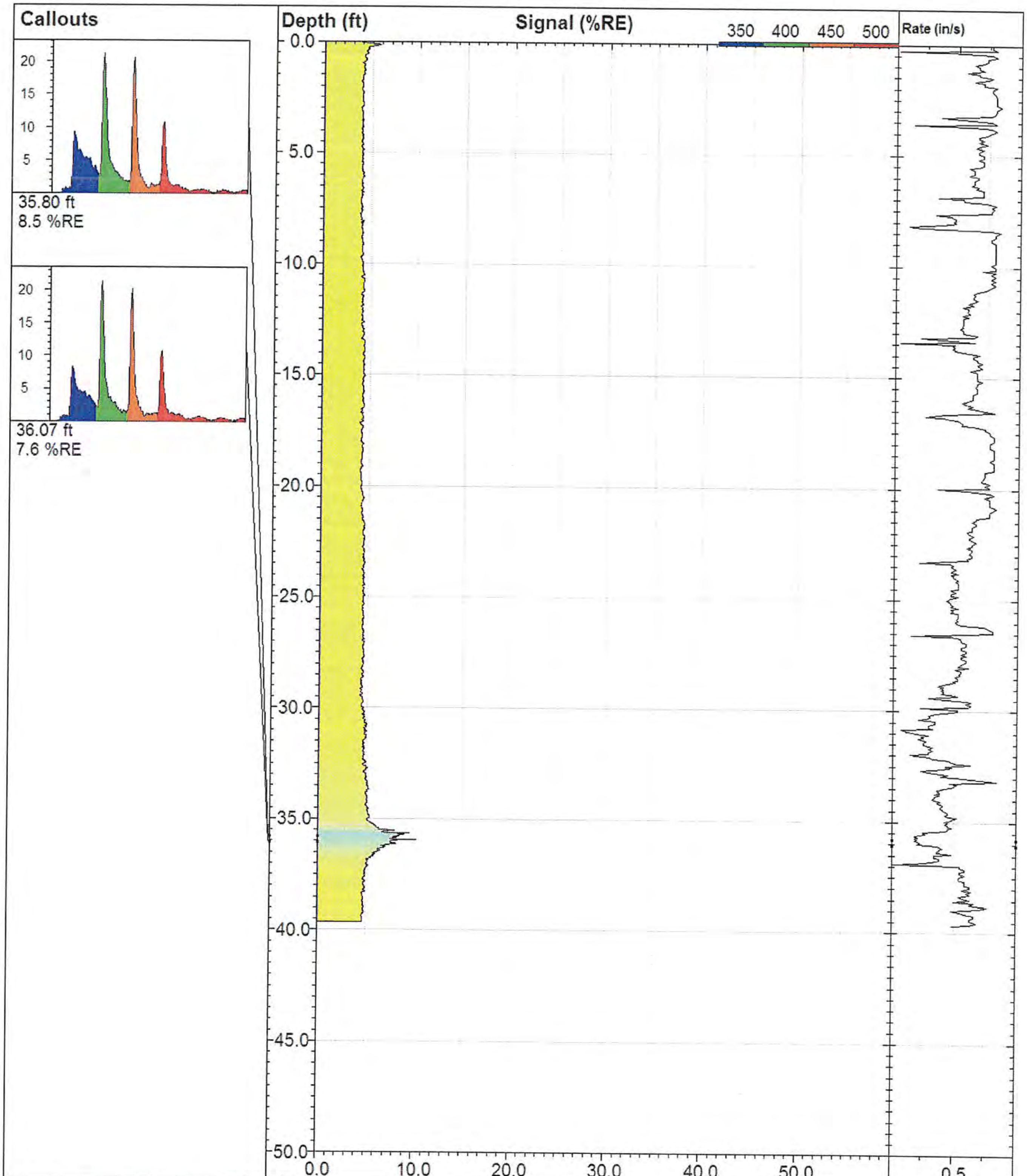


GREGG

UV-CPT-23

UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.63 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **10.5 %RE @ 35.95 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 14:16 PST**



GREGG

UV-CPT-23		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.63 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **10.5 %RE @ 35.95 ft**
Operator / Unit: **EC / UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-03 14:16 PST**

GREGG

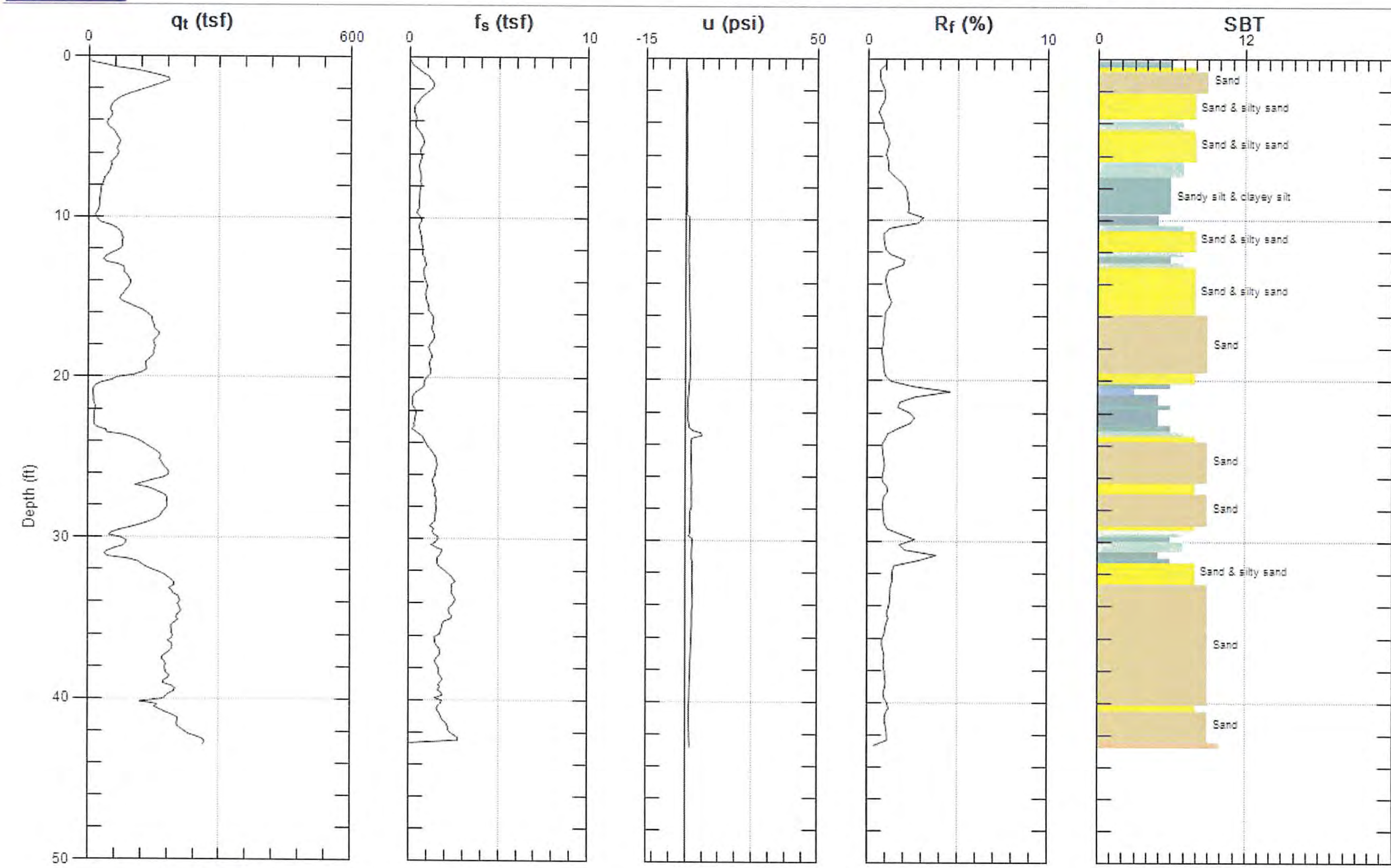
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-23

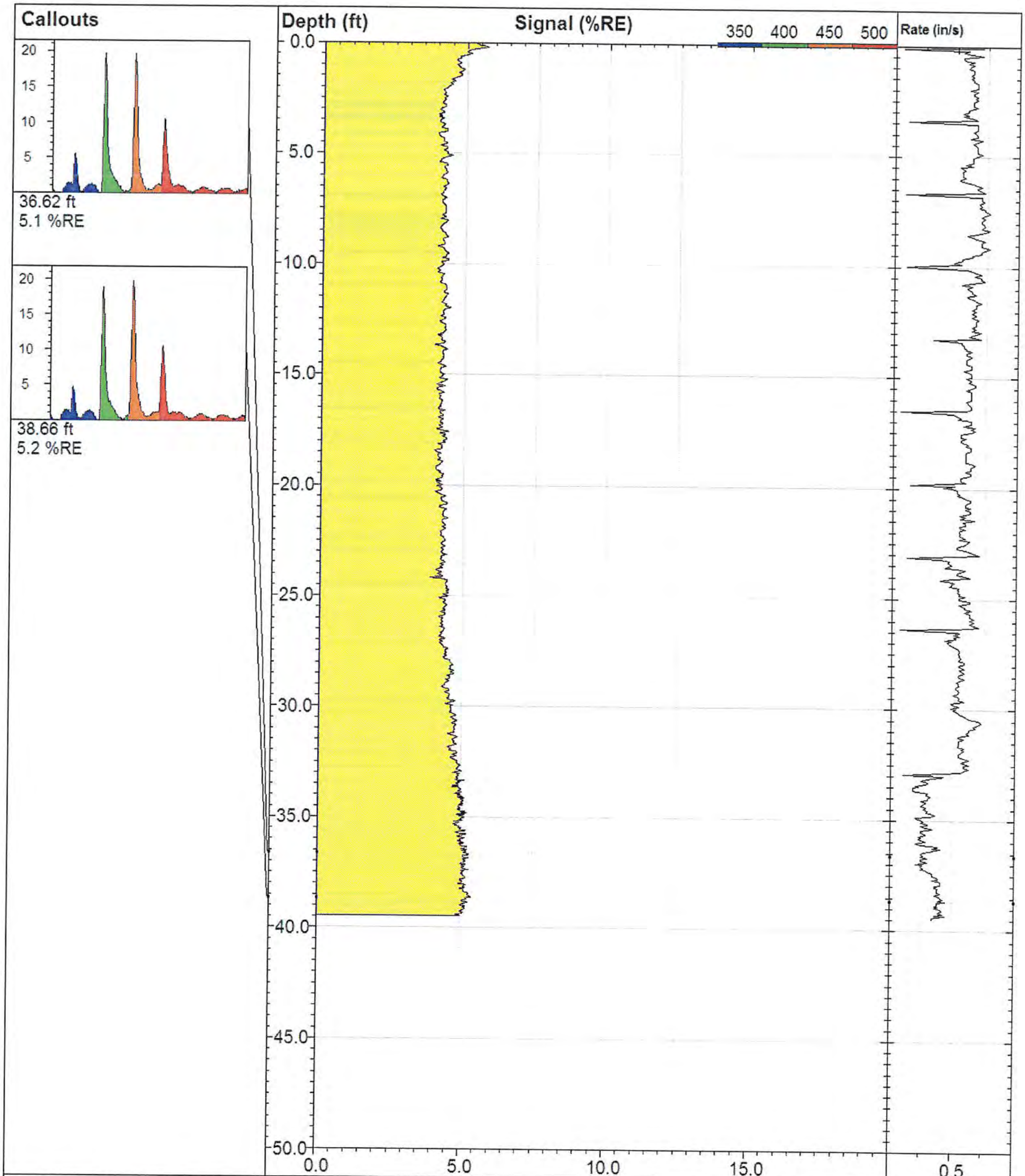
Engineer: P.PARMENTIER

Date: 12/3/2015 02:27



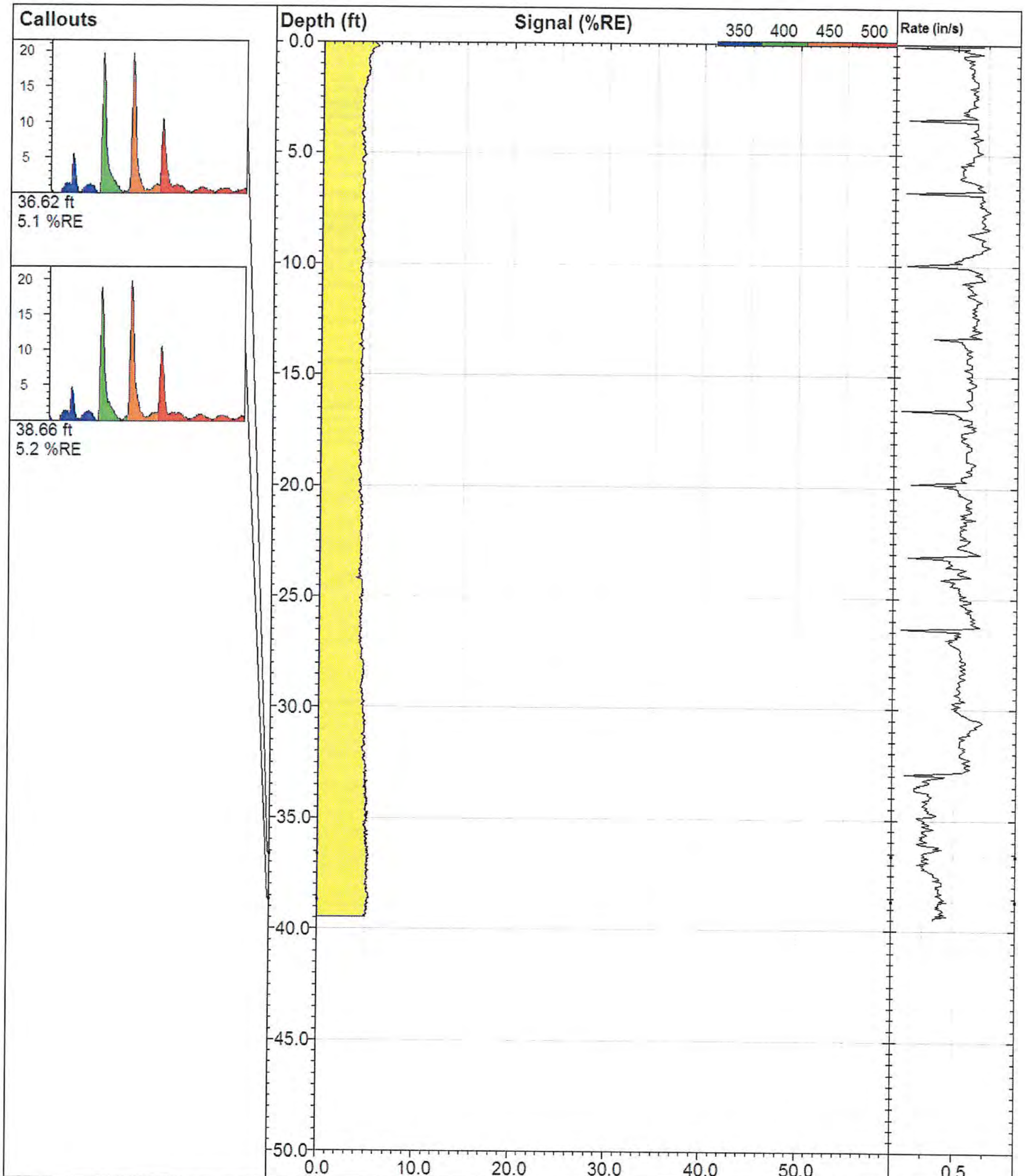
Max. Depth: 42.815 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-24		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.45 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.7 %RE @ 0.21 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 07:12 PST**



GREGG

UV-CPT-24

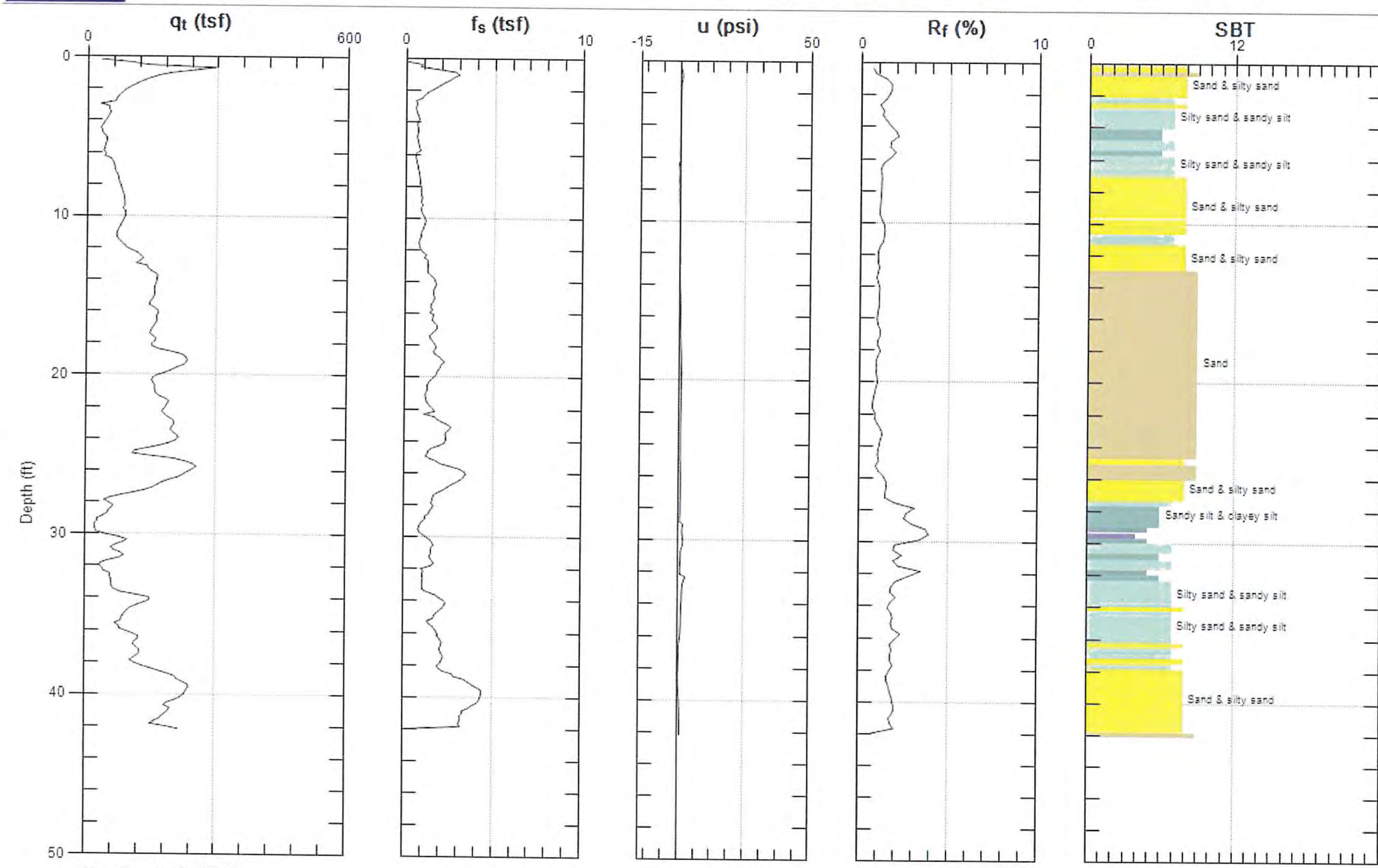
UVOST By Dakota
www.DakotaTechnologies.com

Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **39.45 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **5.7 %RE @ 0.21 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 07:12 PST**

GREGG THE SOURCE GROUP

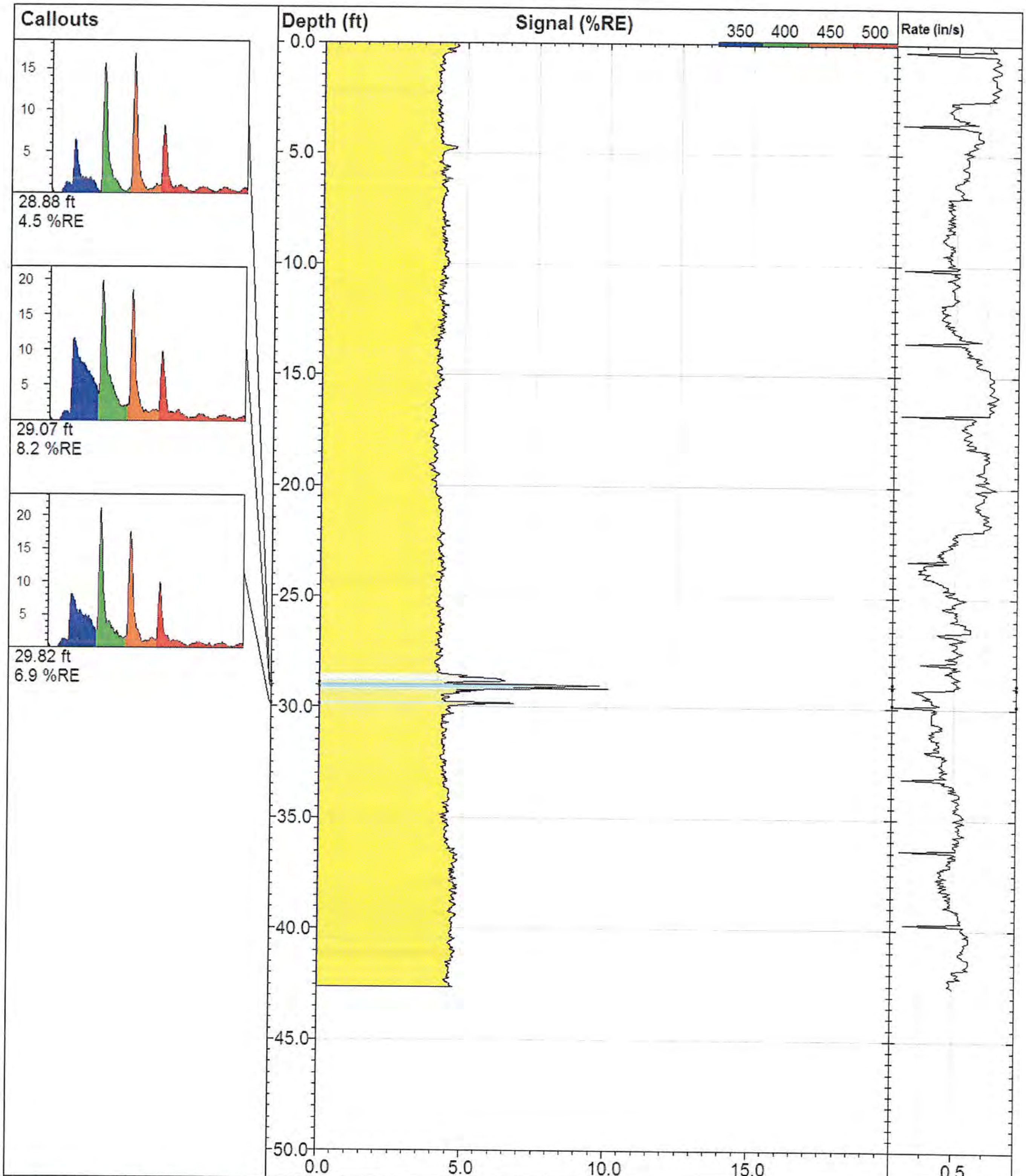
Site: NORWALK DFSP
Sounding: UV-CPT-24

Engineer: P.PARMENTIER
Date: 12/4/2015 06:33



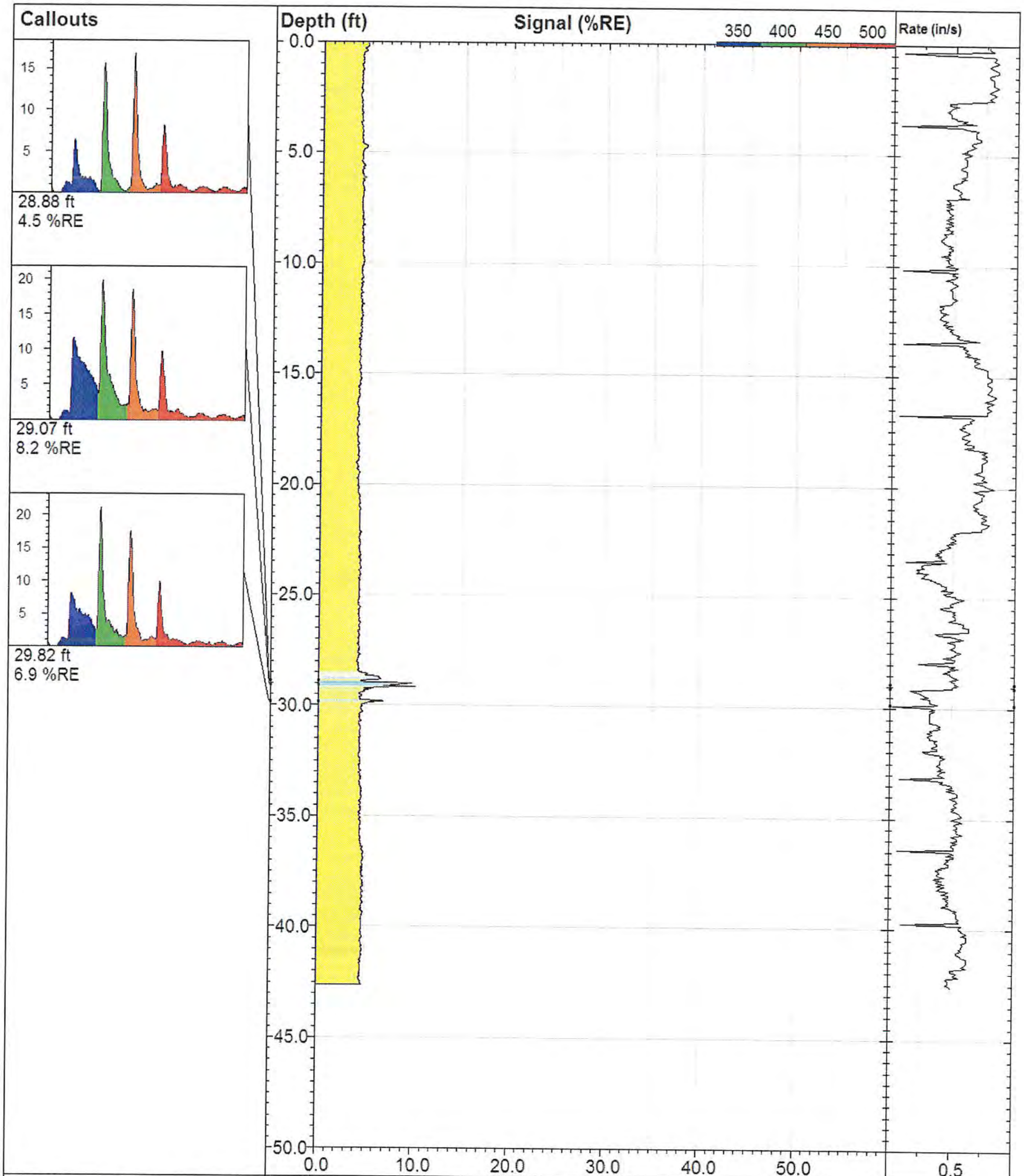
Max. Depth: 42.159 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-25		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.63 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **10.3 %RE @ 29.15 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 07:50 PST**



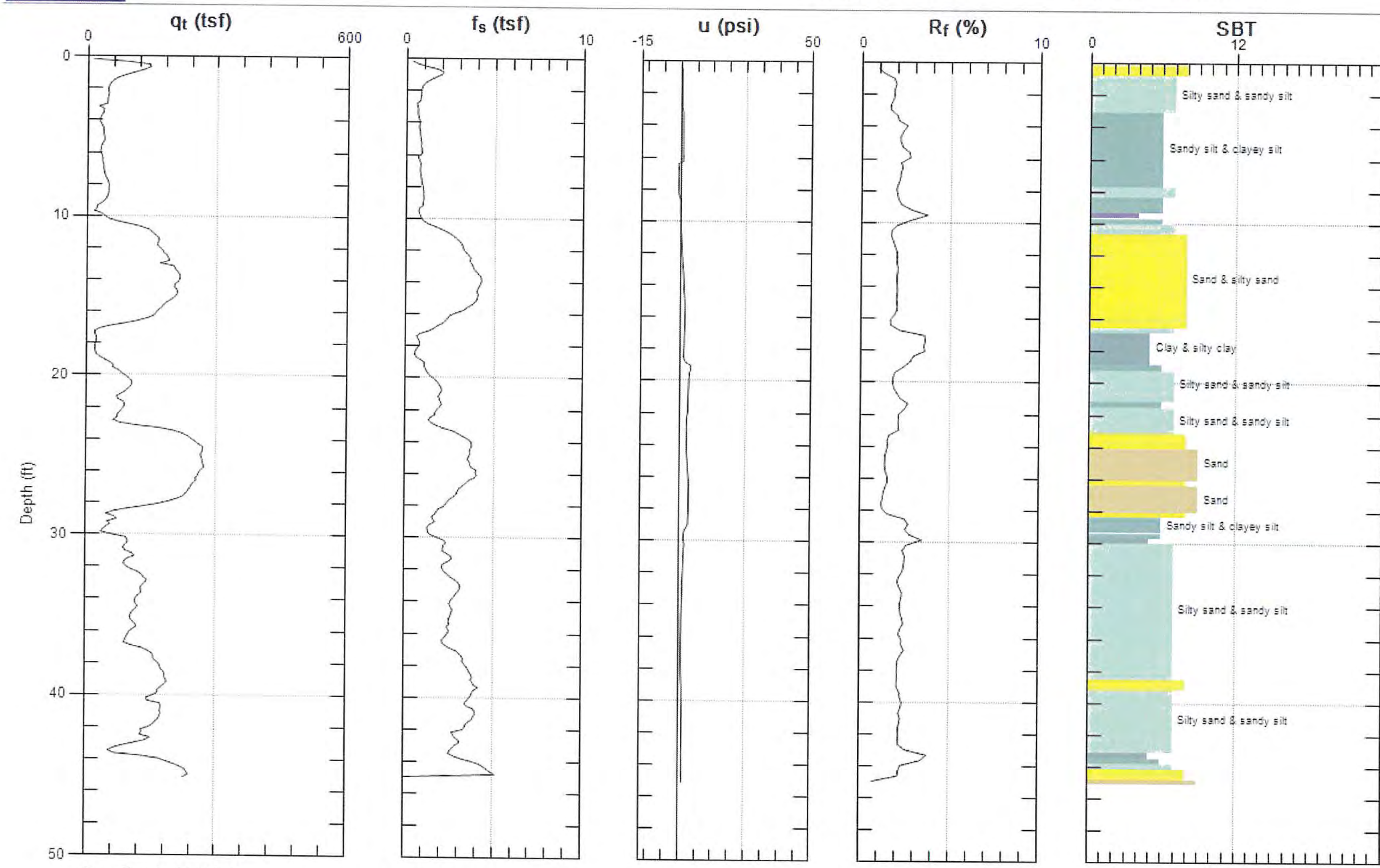
GREGG

UV-CPT-25		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.63 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **10.3 %RE @ 29.15 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 07:50 PST**

GREGG **THE SOURCE GROUP**

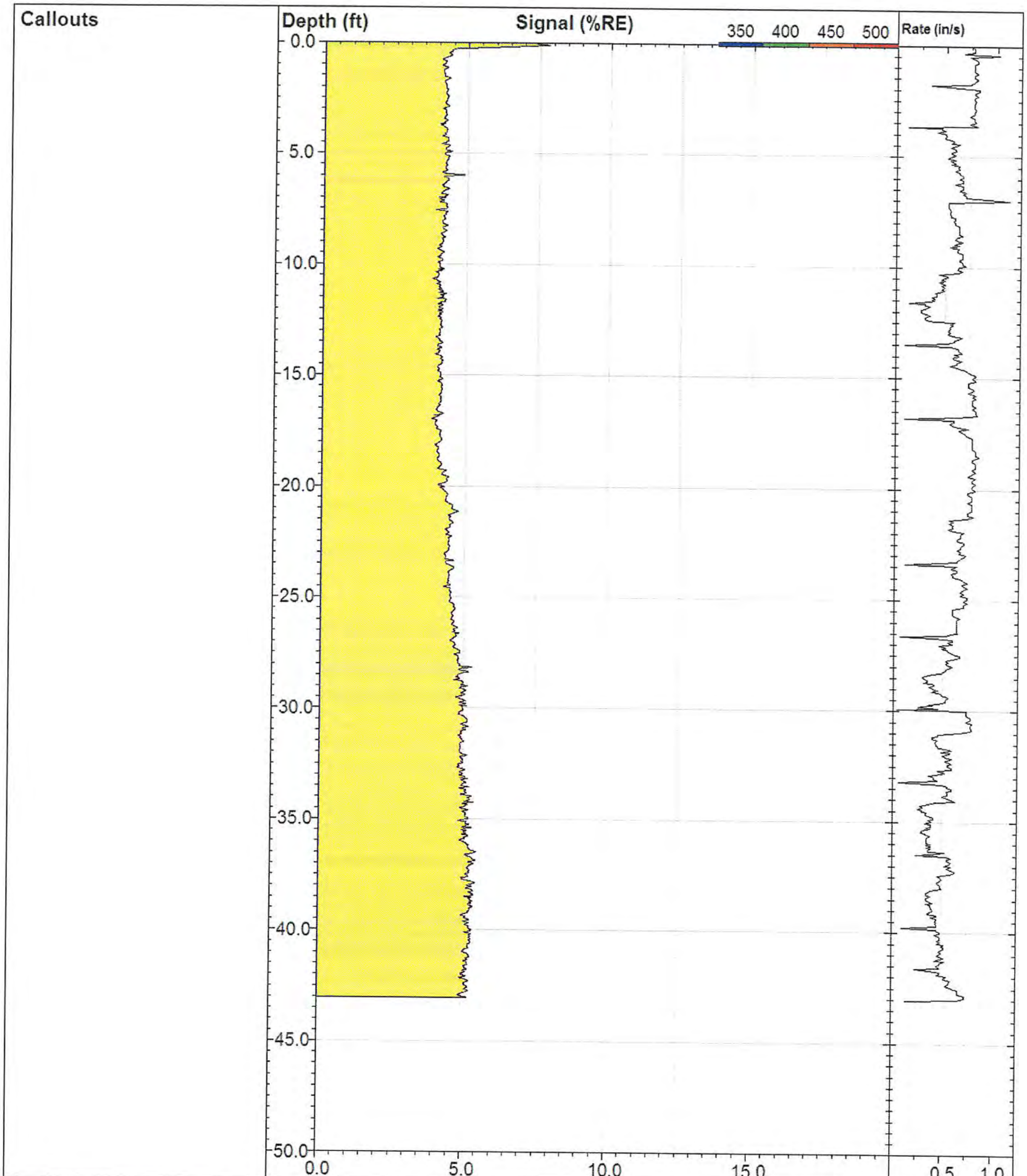
Site: NORWALK DFSP
Sounding: UV-CPT-25

Engineer: P.PARMENTIER
Date: 12/4/2015 07:48



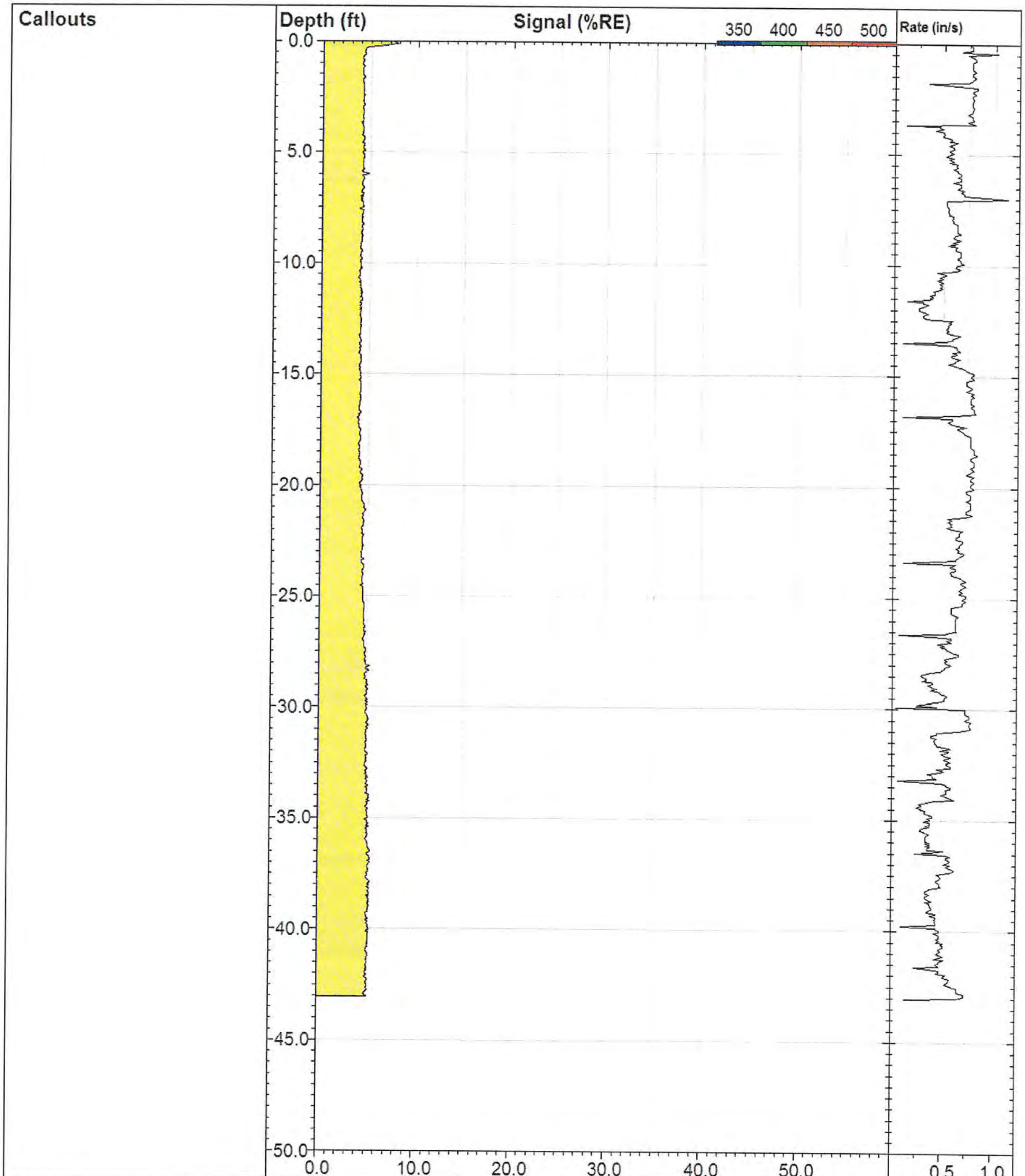
Max. Depth: 45.112 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-26		**UVOST By Dakota** www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **43.03 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **7.8 %RE @ 0.12 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 10:25 PST**



GREGG

UV-CPT-26		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **43.03 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **7.8 %RE @ 0.12 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 10:25 PST**

GREGG

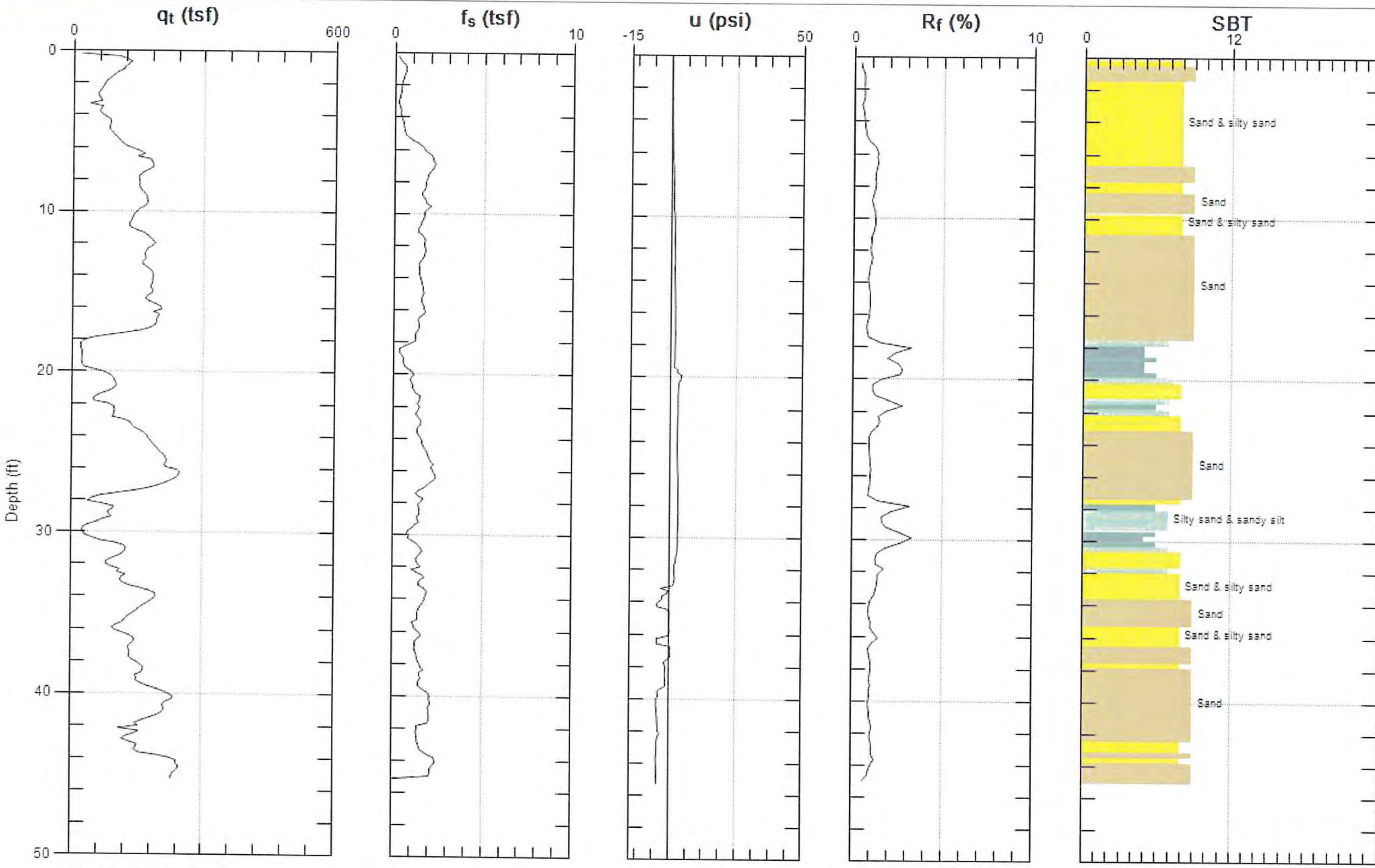
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-26

Engineer: P.PARMENTIER

Date: 12/4/2015 10:29

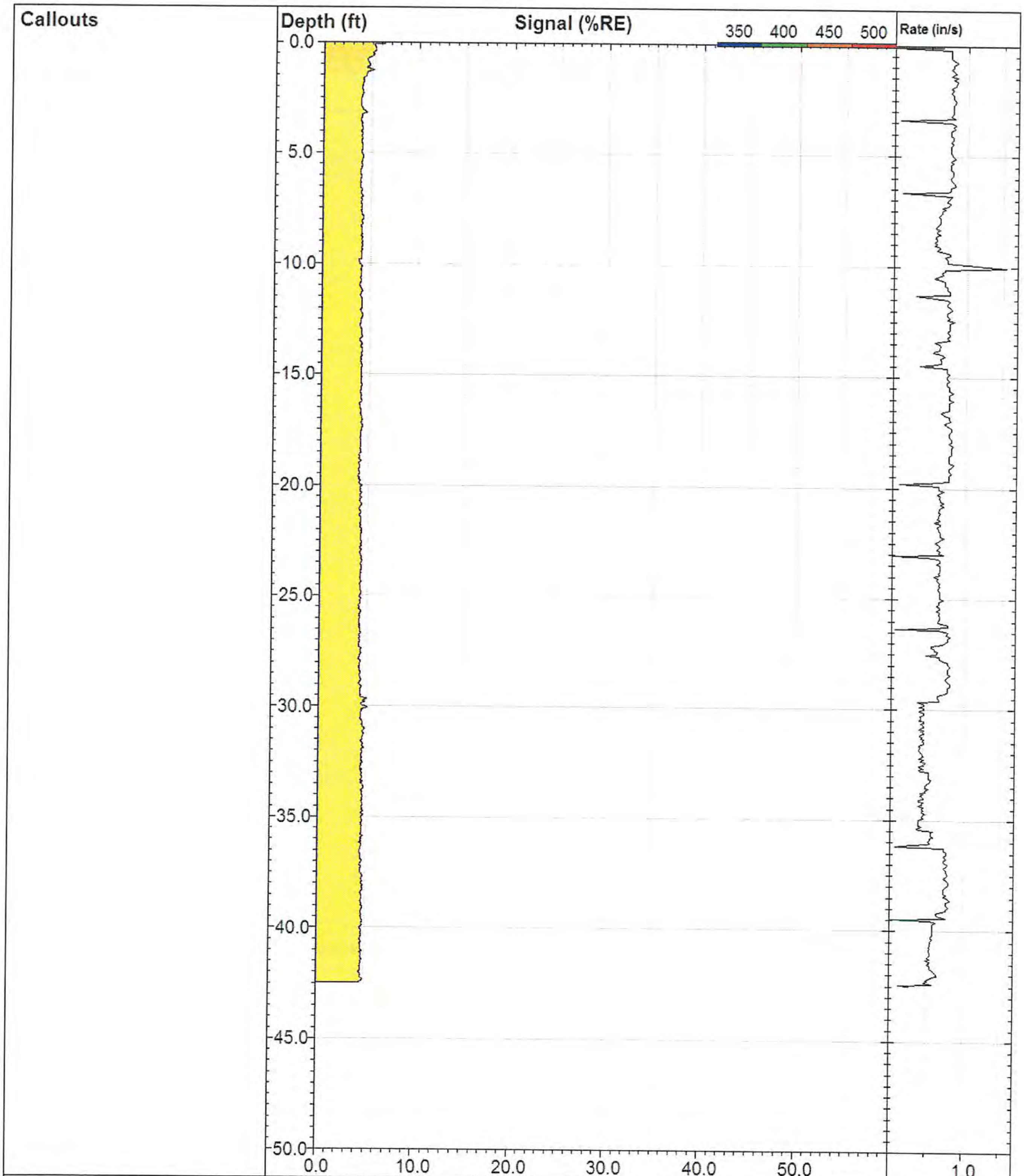


Max. Depth: 45.276 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

GREGG

UV-CPT-27		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.47 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.3 %RE @ 0.08 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 11:04 PST**



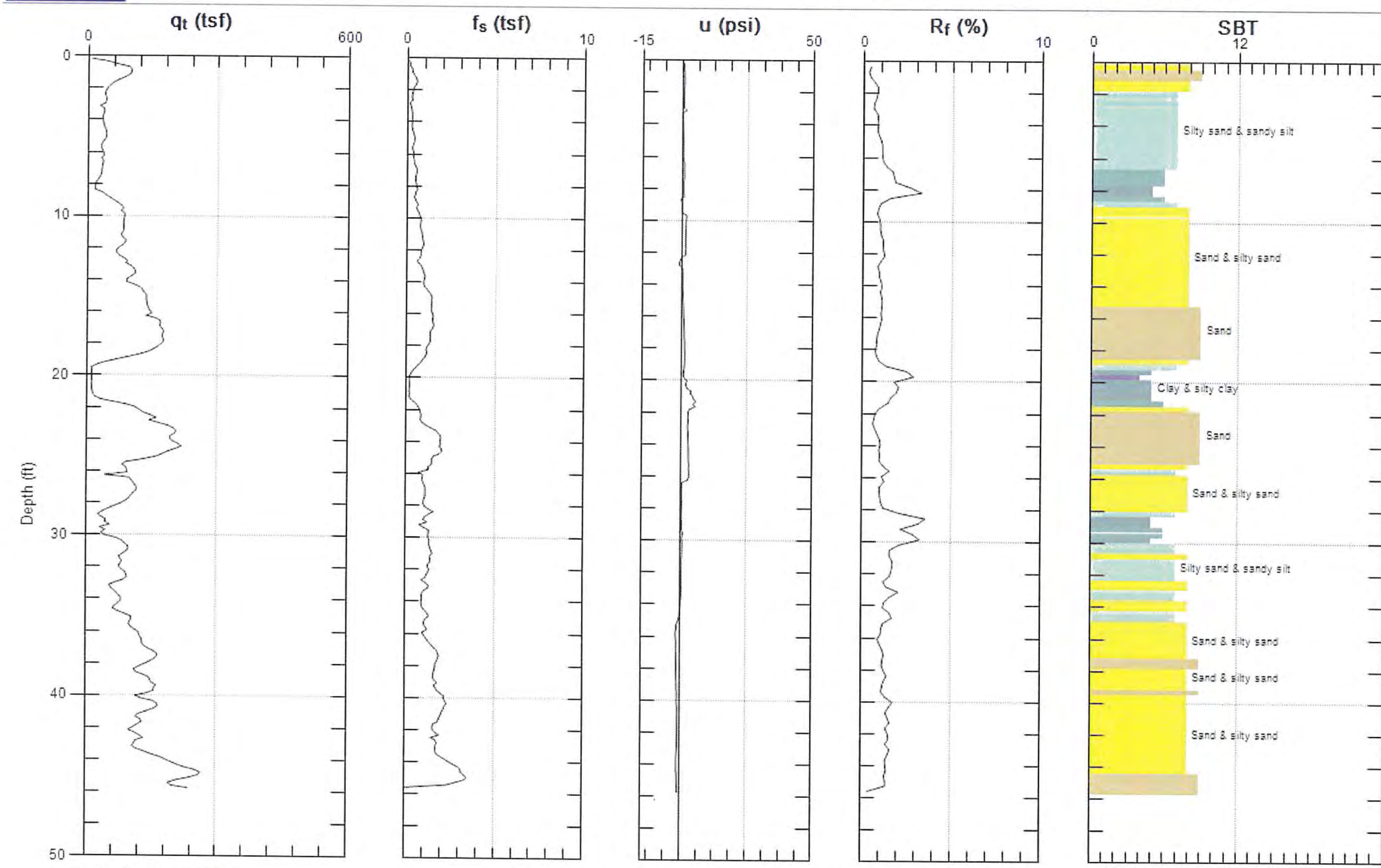
GREGG

UV-CPT-27		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.47 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **6.3 %RE @ 0.08 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 11:04 PST**

GREGG THE SOURCE GROUP

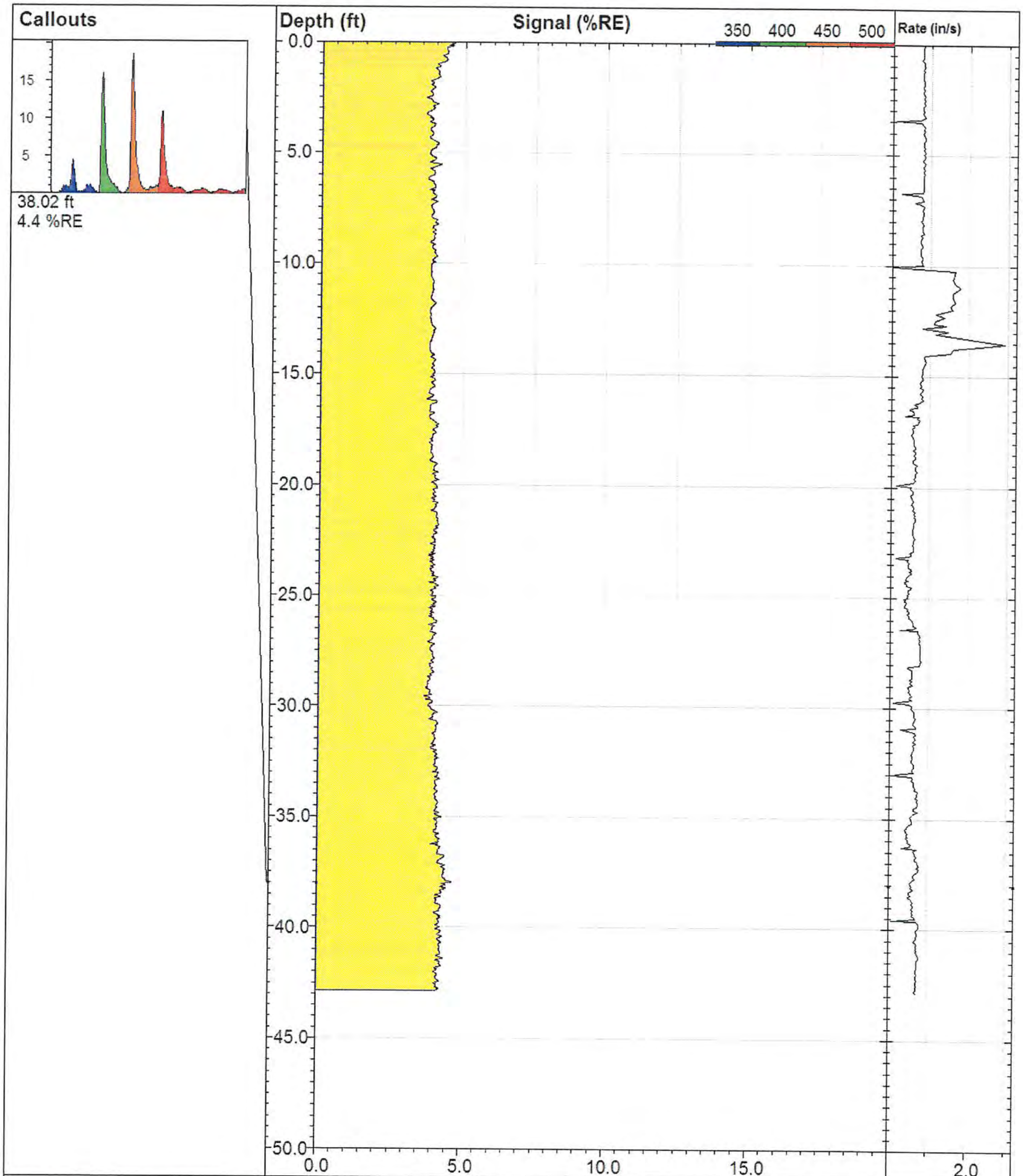
Site: NORWALK DFSP
Sounding: UV-CPT-27

Engineer: P.PARMENTIER
Date: 12/4/2015 11:10



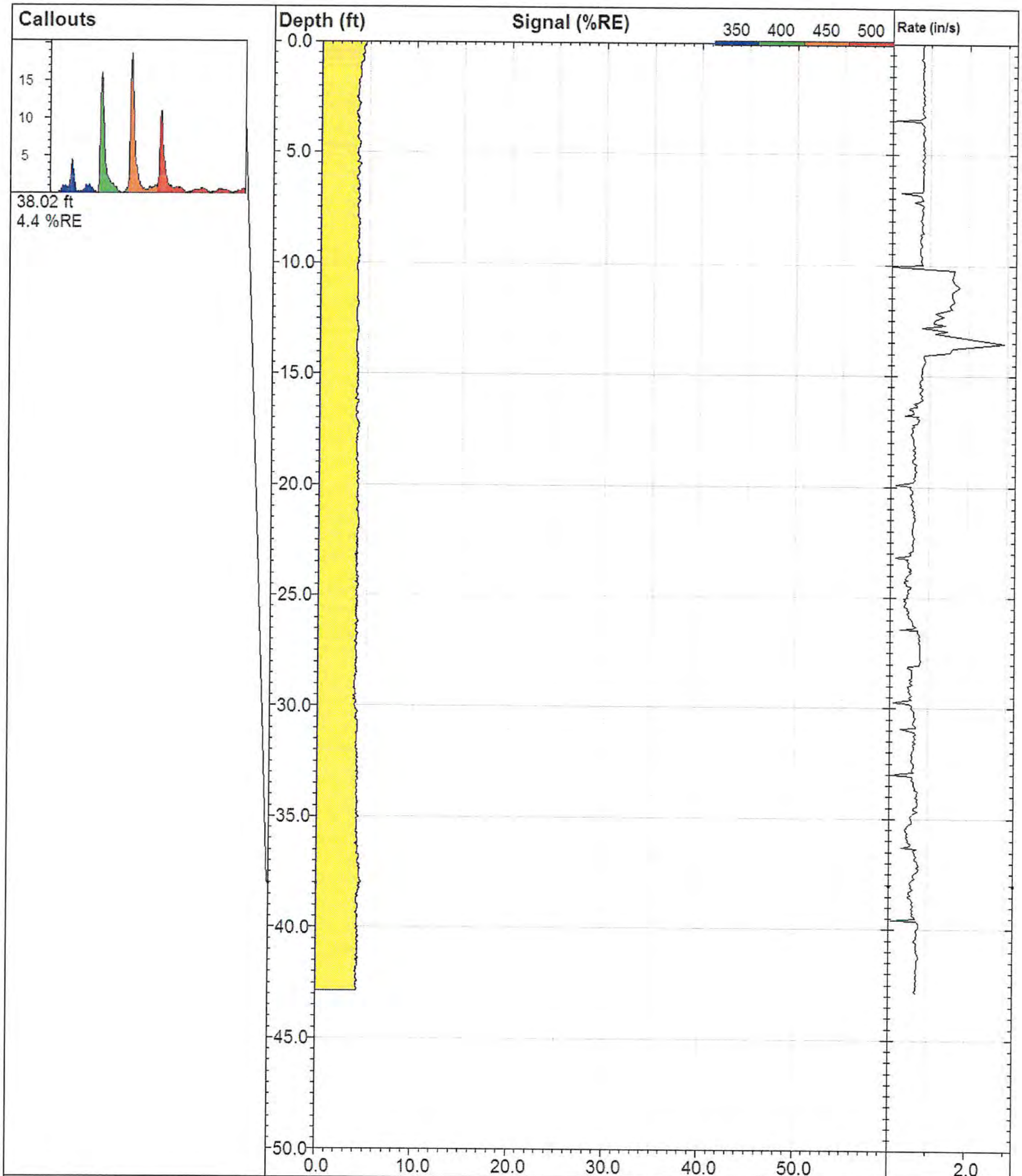
Max. Depth: 45.768 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-28		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.85 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **4.7 %RE @ 37.96 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 11:46 PST**



GREGG

UV-CPT-28		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.85 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **4.7 %RE @ 37.96 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 11:46 PST**

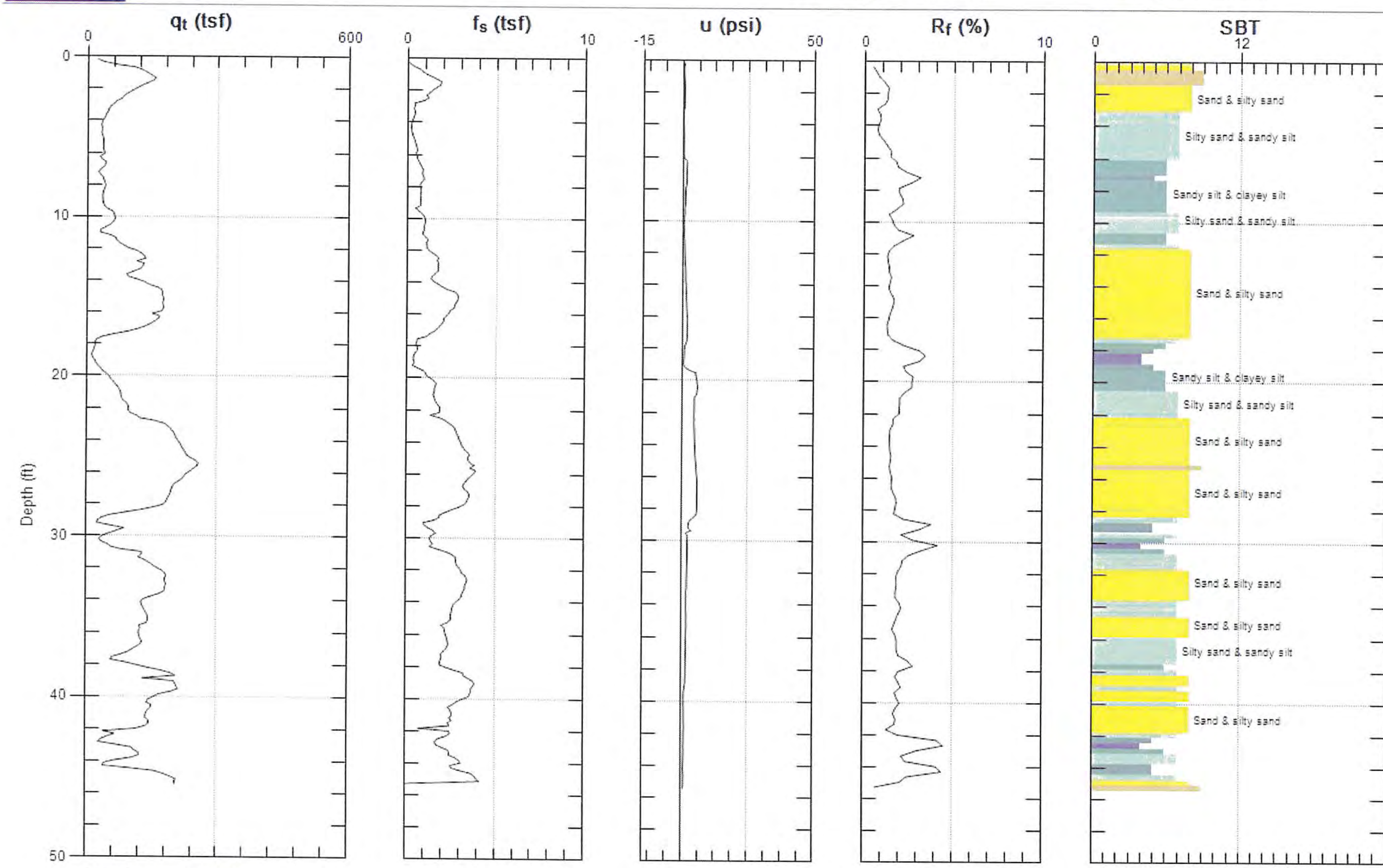
THE SOURCE GROUP

Site: NORWALK DFSP

Sounding: UV-CPT-28

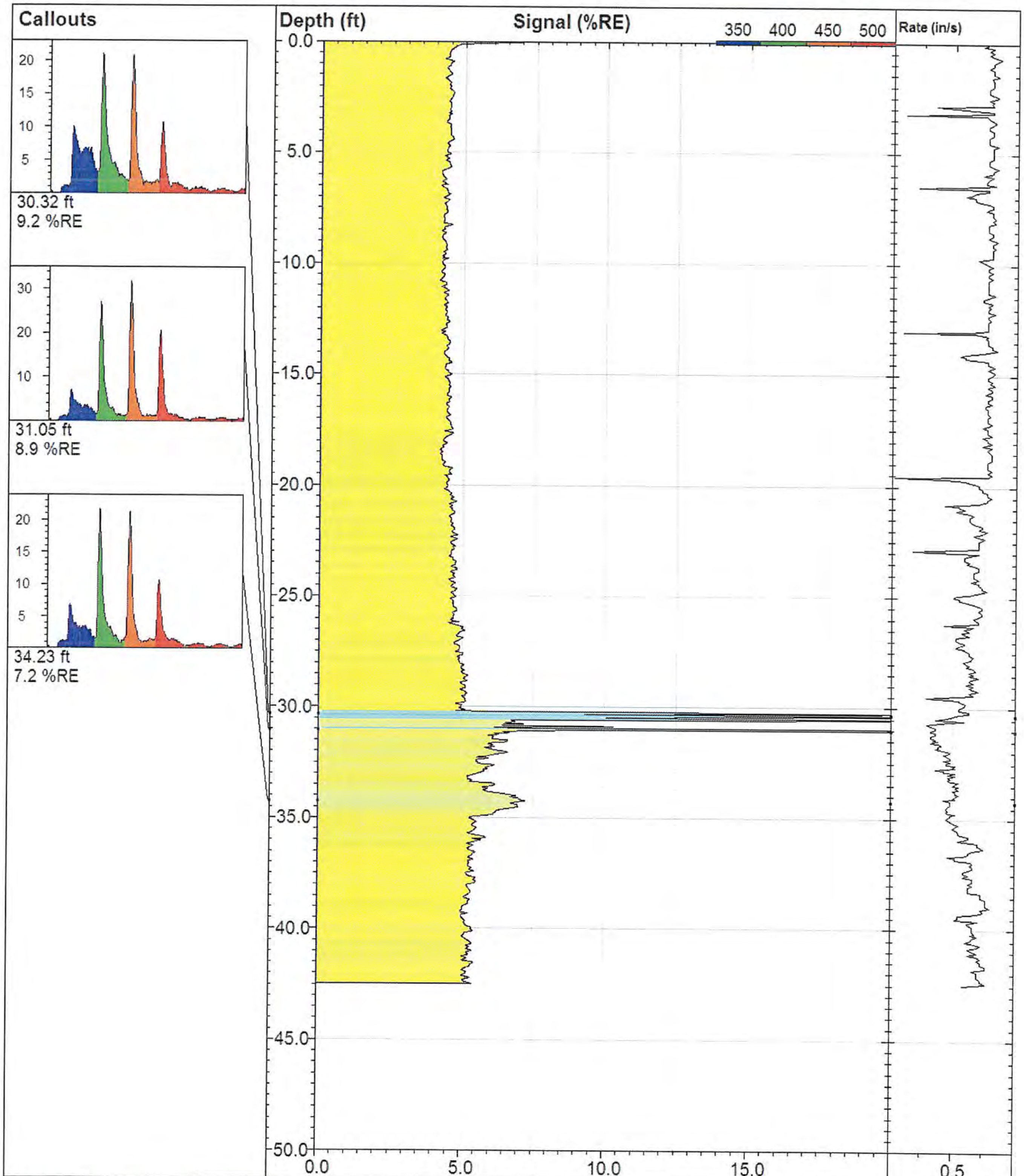
Engineer: P.PARMENTIER

Date: 12/4/2015 11:50



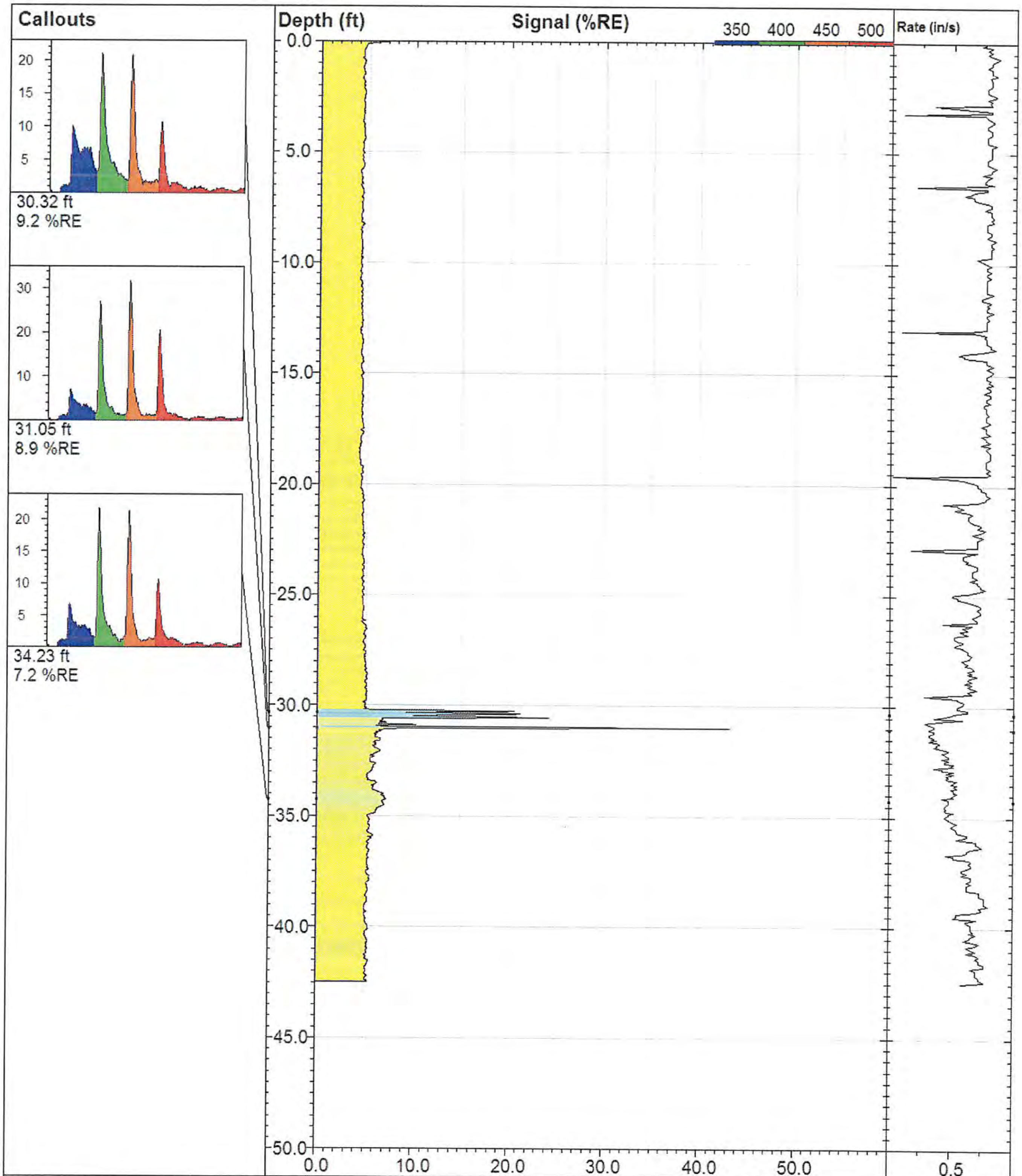
Max. Depth: 45.440 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

UV-CPT-29		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.48 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **44.7 %RE @ 31.00 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 09:31 PST**



GREGG

UV-CPT-29		UVOST By Dakota www.DakotaTechnologies.com
Site: **DFSP**	*Y Coord.(Lat-N) / System:* **Unavailable / NA**	*Final depth:* **42.48 ft**
Client / Job: **TSG / 659**	*X Coord.(Lng-E) / Fix:* **Unavailable / NA**	*Max signal:* **44.7 %RE @ 31.00 ft**
Operator / Unit: **/ UVOST1007**	*Elevation:* **Unavailable**	*Date & Time:* **2015-12-04 09:31 PST**

THE SOURCE GROUP

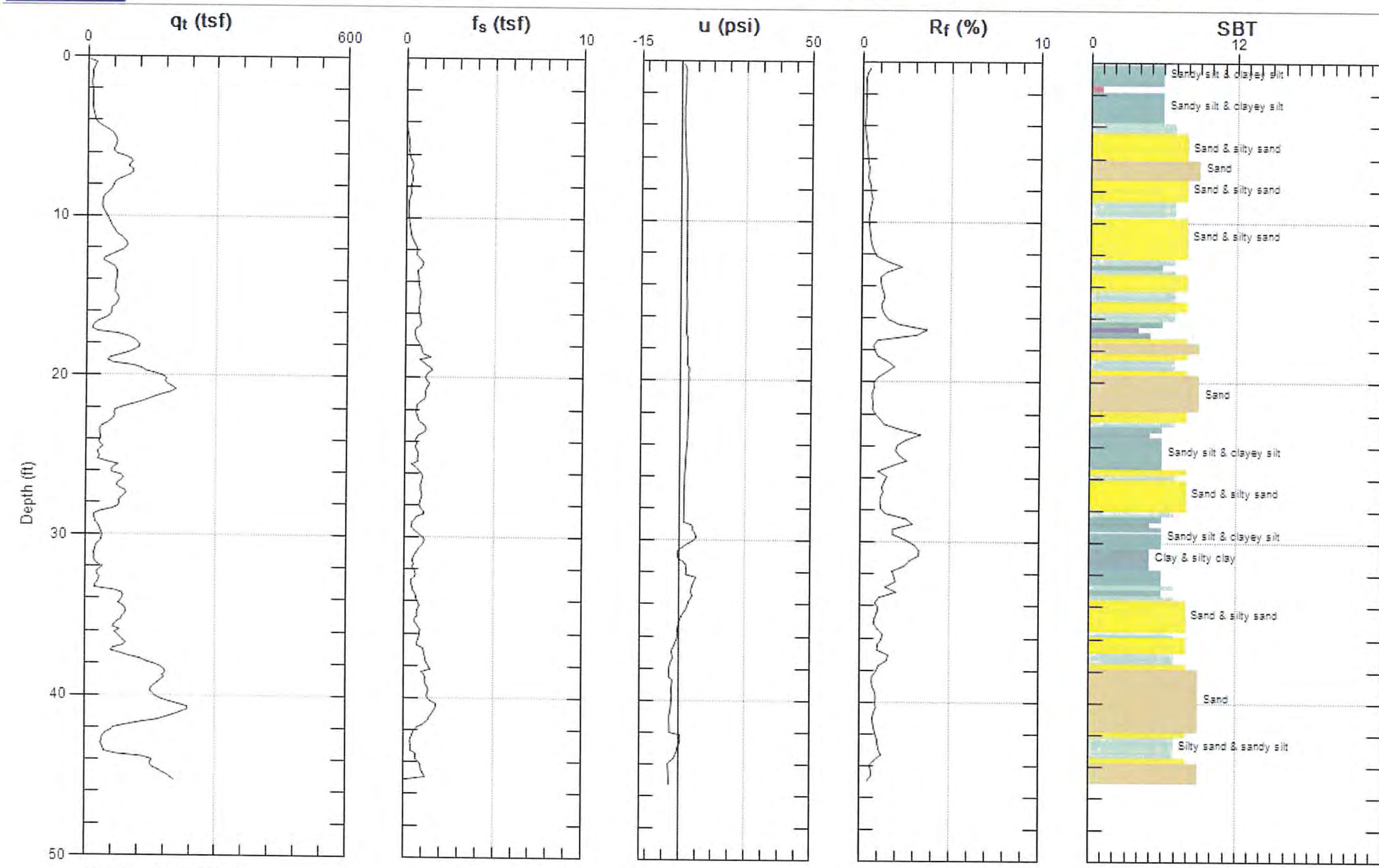
GREGG

Site: NORWALK DFSP

Sounding: UV-CPT-29

Engineer: P.PARMENTIER

Date: 12/4/2015 09:28



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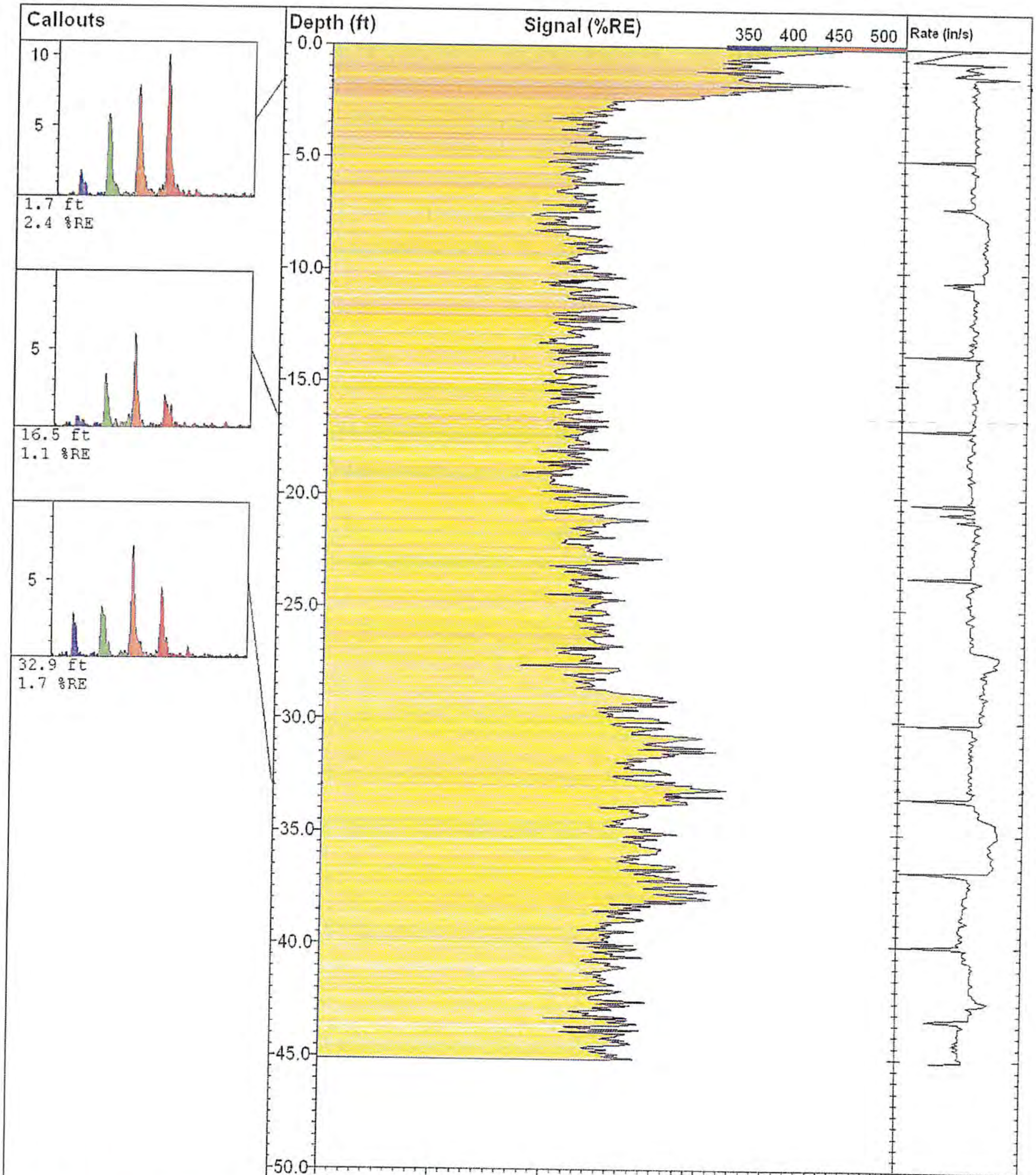


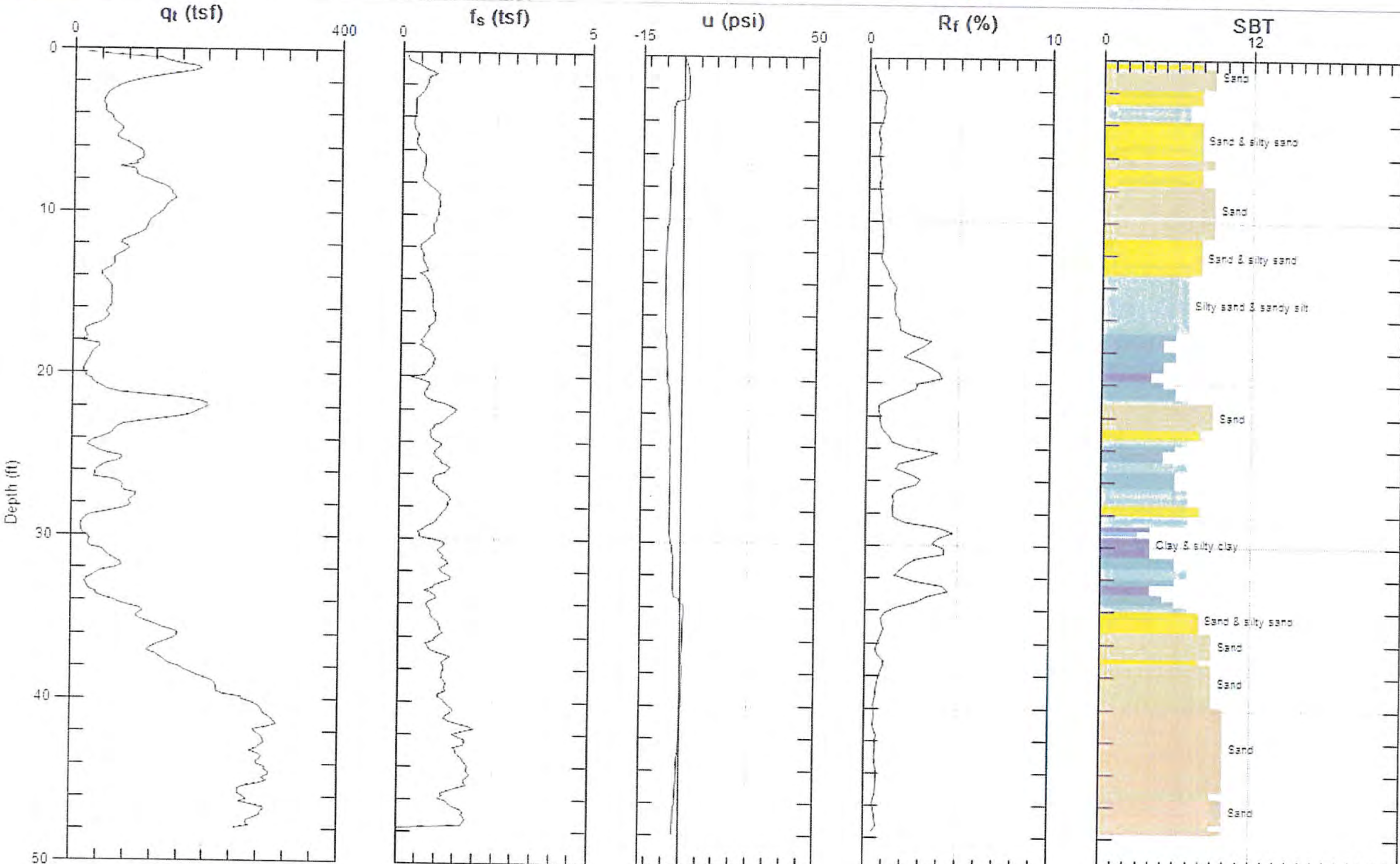
UV-CPT-~~1~~30		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.13 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 2.4 % @ 1.68 ft
Job: D11606114	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-17 08:21 PDT

GREGG
www.greggdrilling.com

GREGG THE SOURCE GROUP

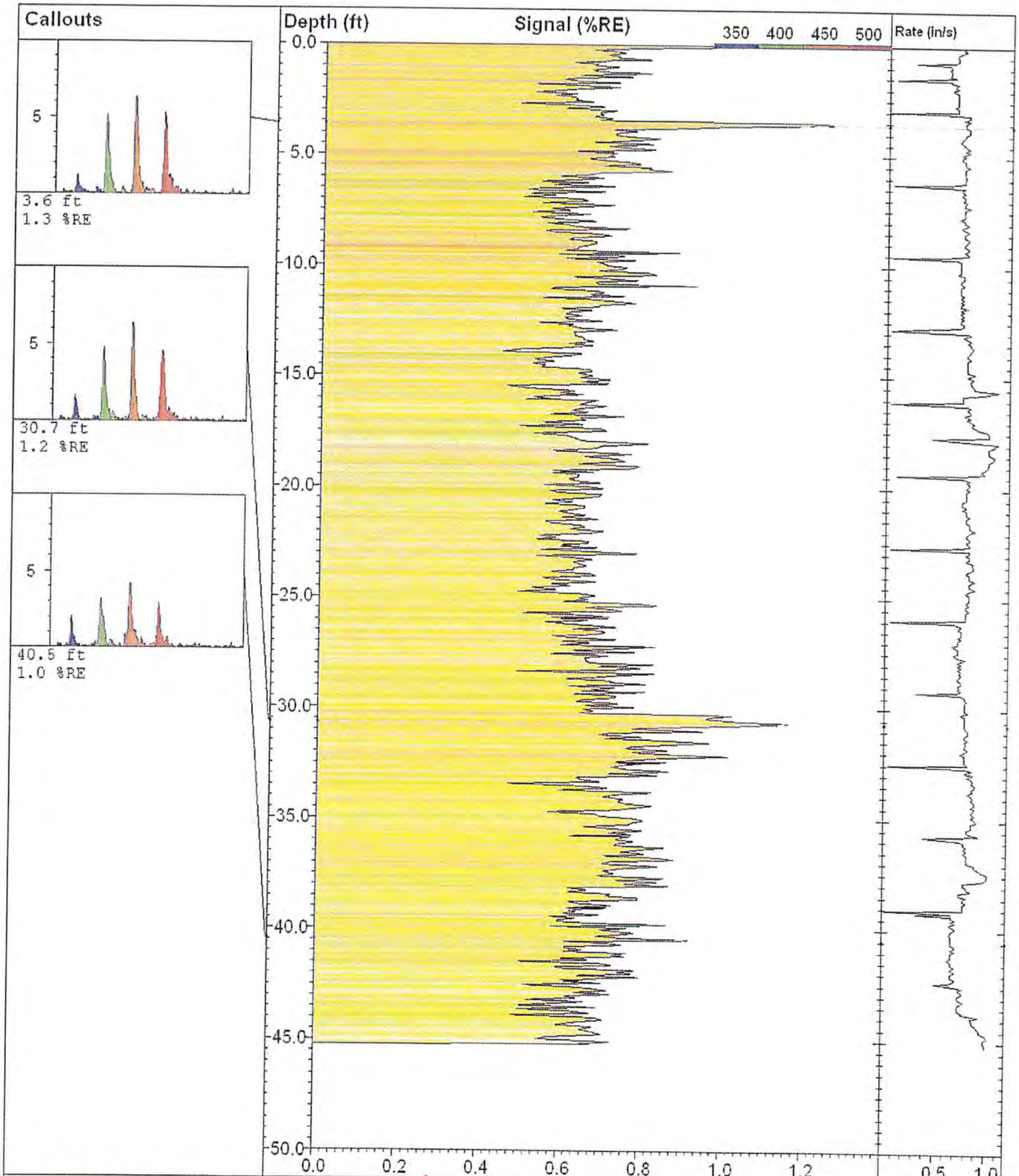
Site: DFSP NORWALK
Sounding: UV-CPT-~~1~~30

Engineer: P.WU
Date: 8/17/2016 08:38



Max Depth: 47.900 (ft)
Avg Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG www.greggdrilling.com	UV-CPT-2 31		UVOST By Dakota www.DakotaTechnologies.com
	Site: DFSP Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.21 ft
	Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.3 % @ 3.59 ft
	Job: D11606114	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-17 09:23 PDT

GREGG

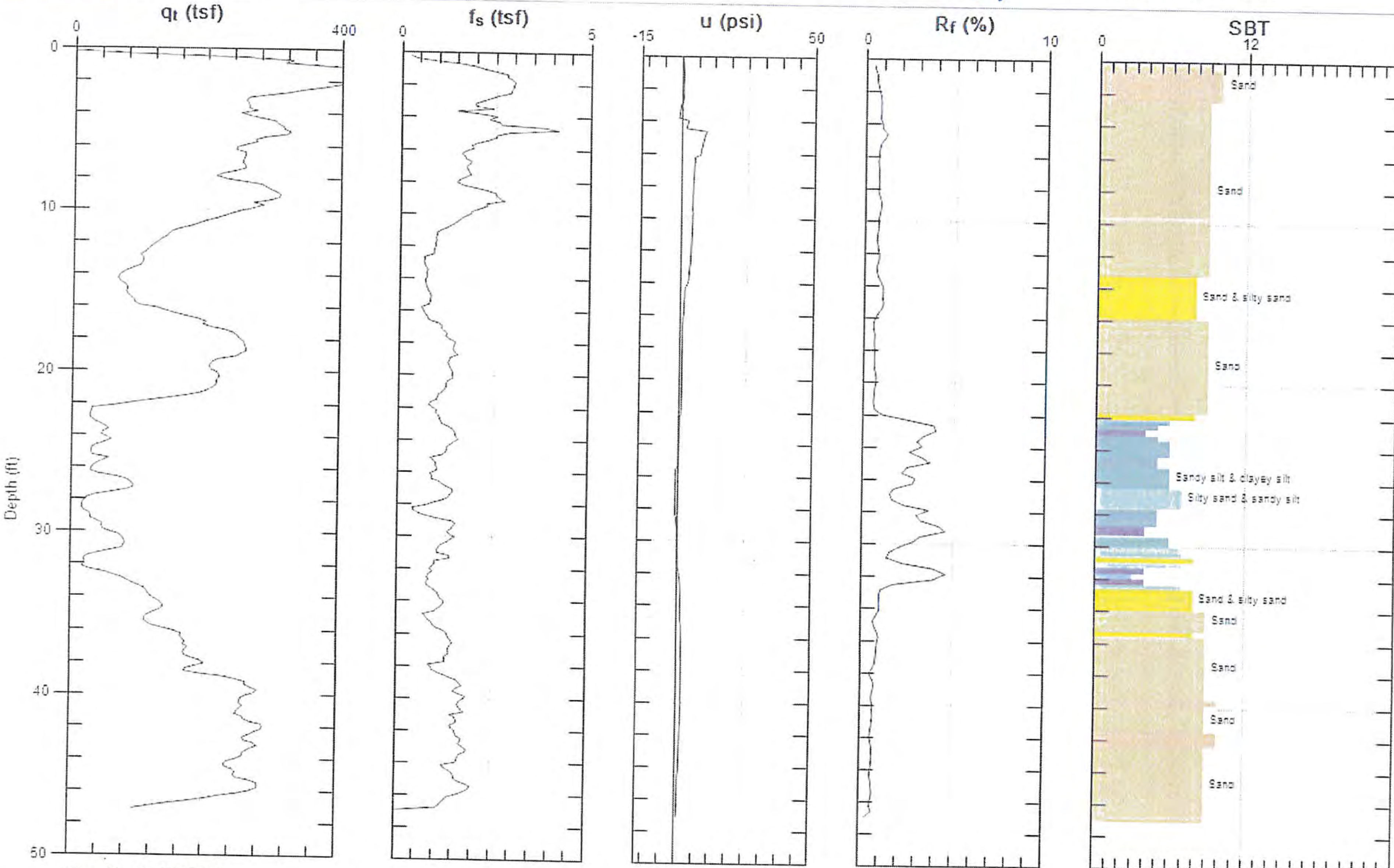
THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-31

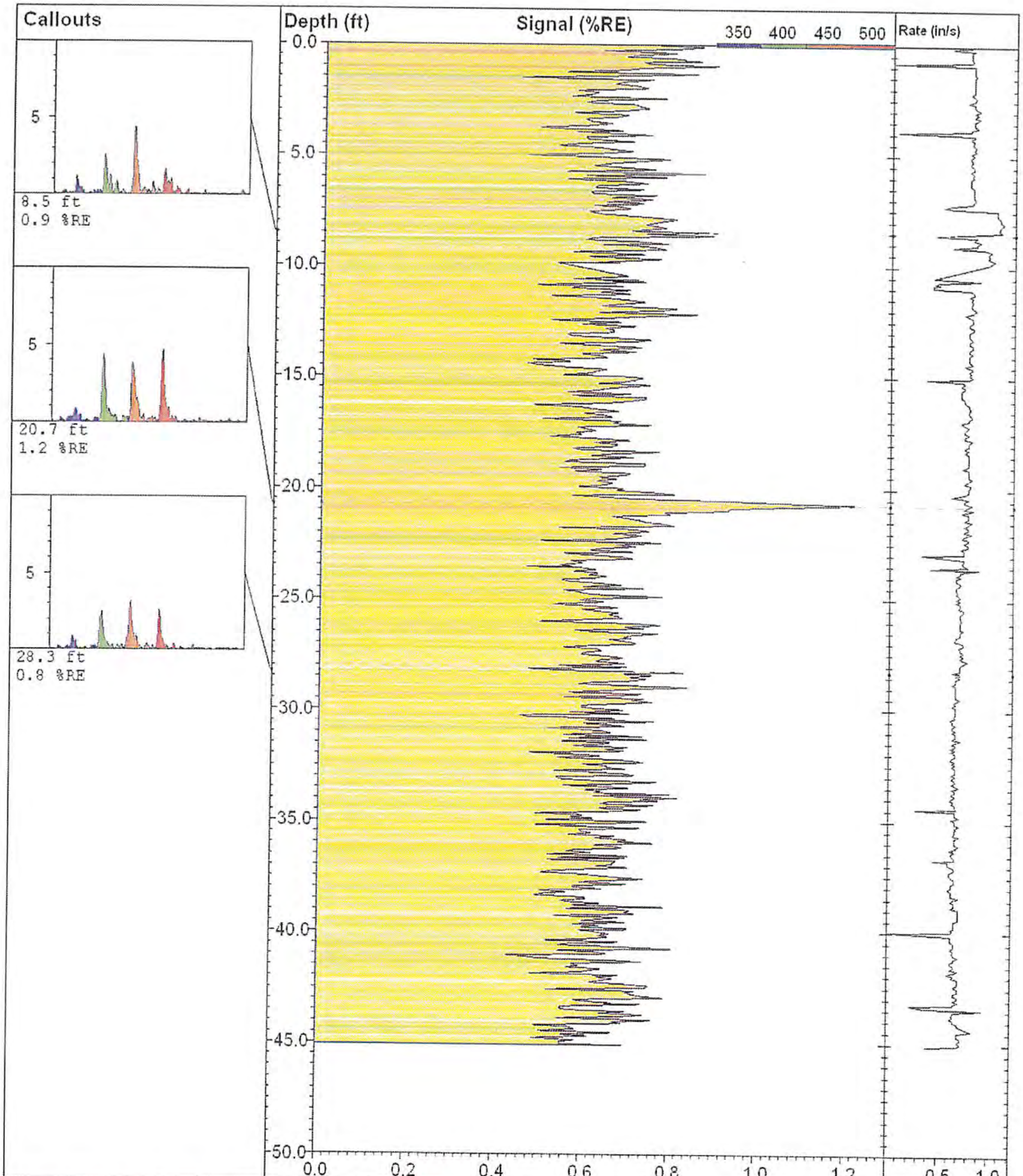
Engineer: P.WU

Date: 8/17/2016 09:37



Max. Depth: 47.080 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-CPT-~~3~~ 32

UVOST By Dakota
www.DakotaTechnologies.com

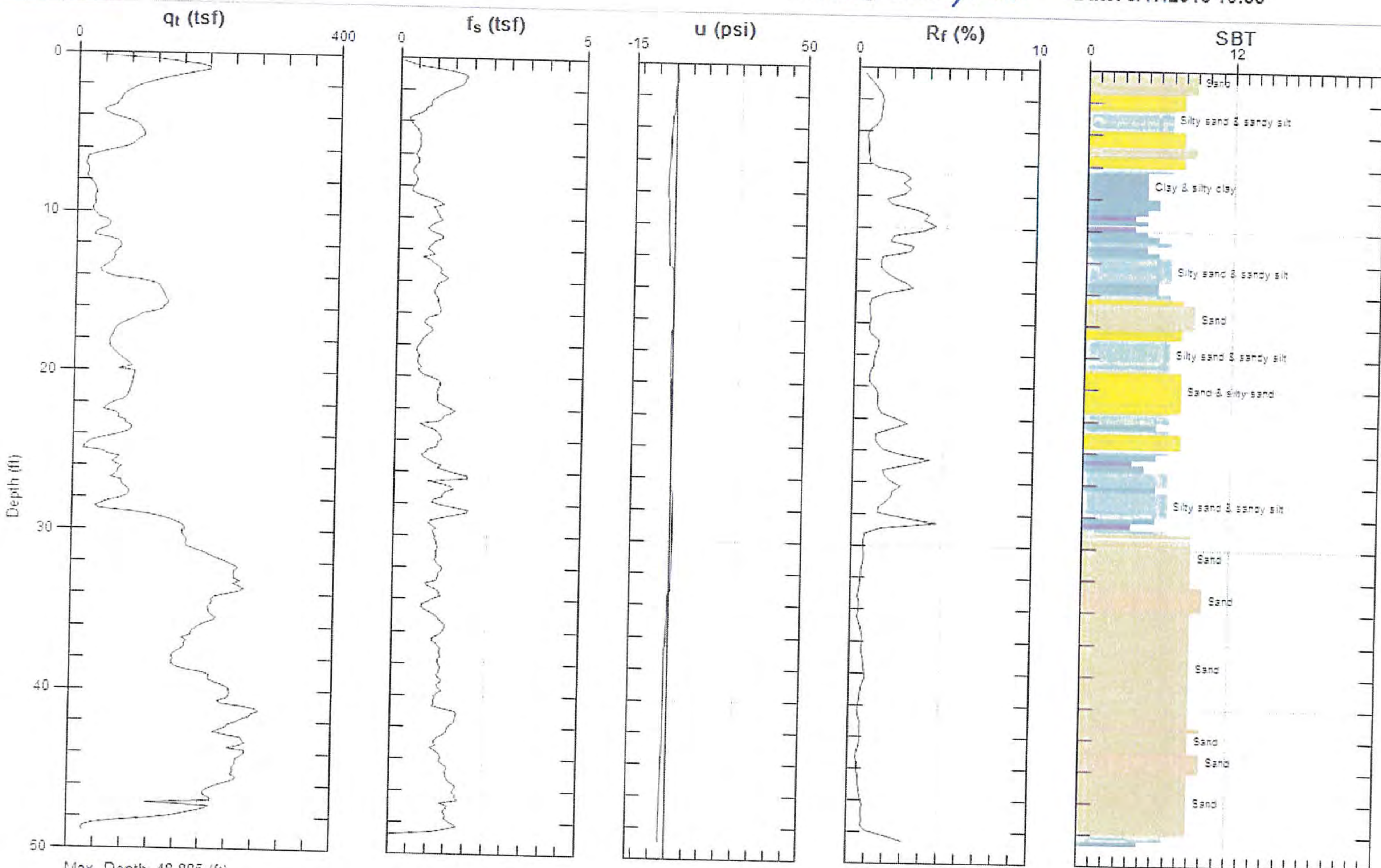
Site: DFSP Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.09 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.2 % @ 20.73 ft
Job: D11606114	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-17 10:15 PDT

GREGG

THE SOURCE GROUP

Site: DFSP NORWALK
Sounding: UV-CPT-~~5~~ 32

Engineer: P.WU
Date: 8/17/2016 10:33



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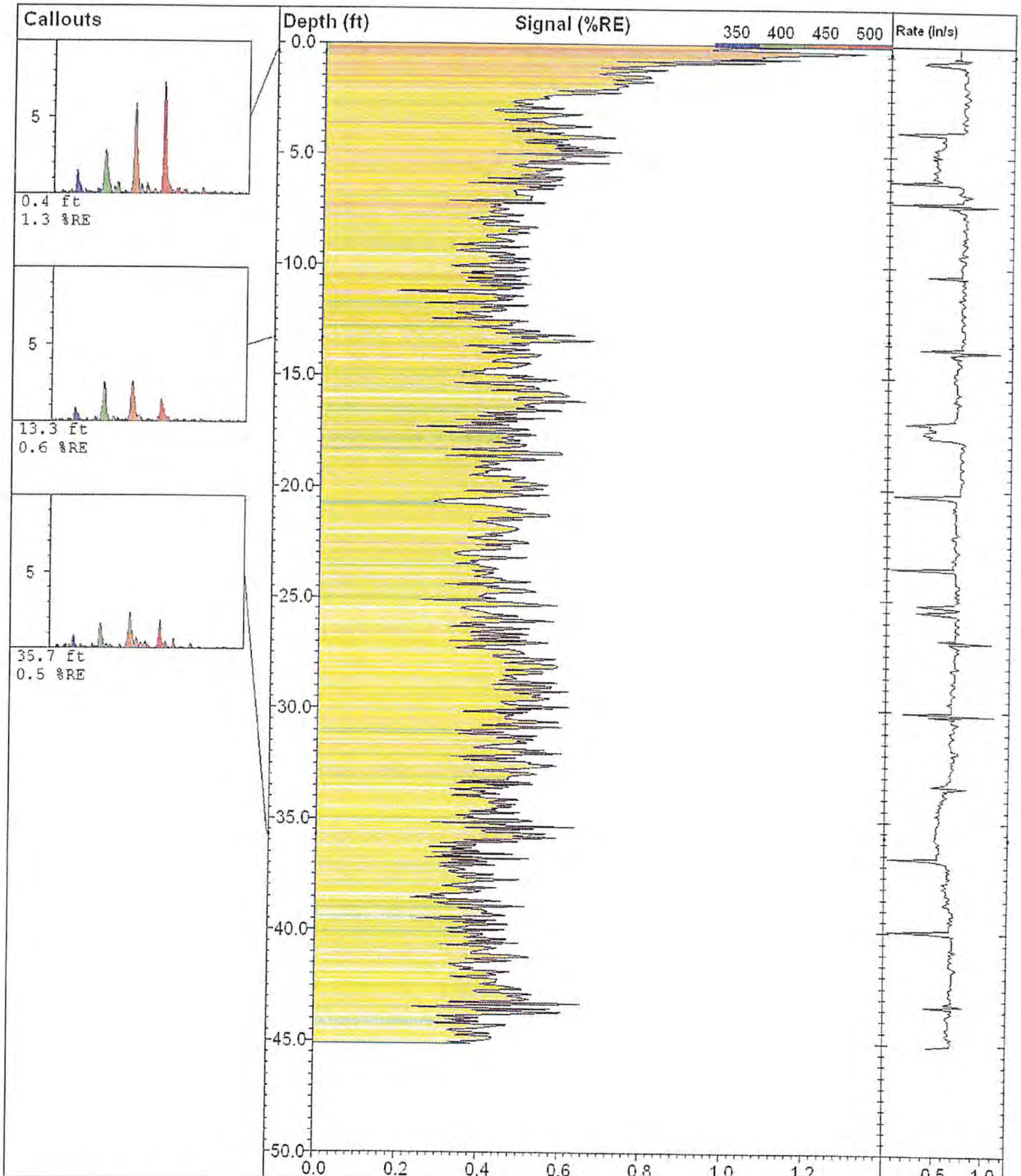
SBT: Soil Behavior Type (Robertson 1990)



www.greggdrilling.com

UV-CPT-~~4~~33

UVOST By Dakota
www.DakotaTechnologies.com

Site: DFSP Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.11 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 1.3 % @ 0.38 ft
Job: D11606114	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-17 12:11 PDT

GREGG

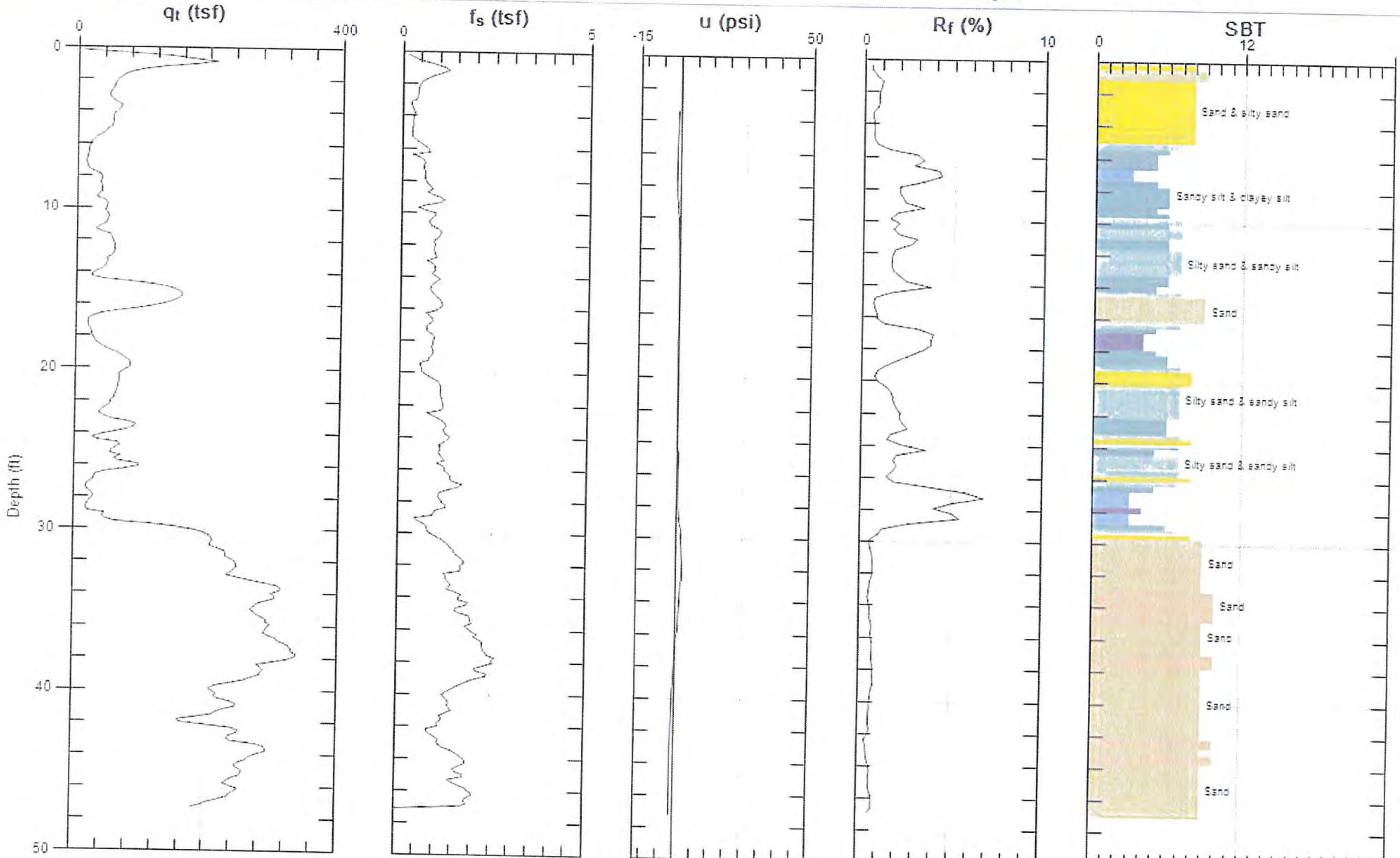
THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-~~4~~ 33

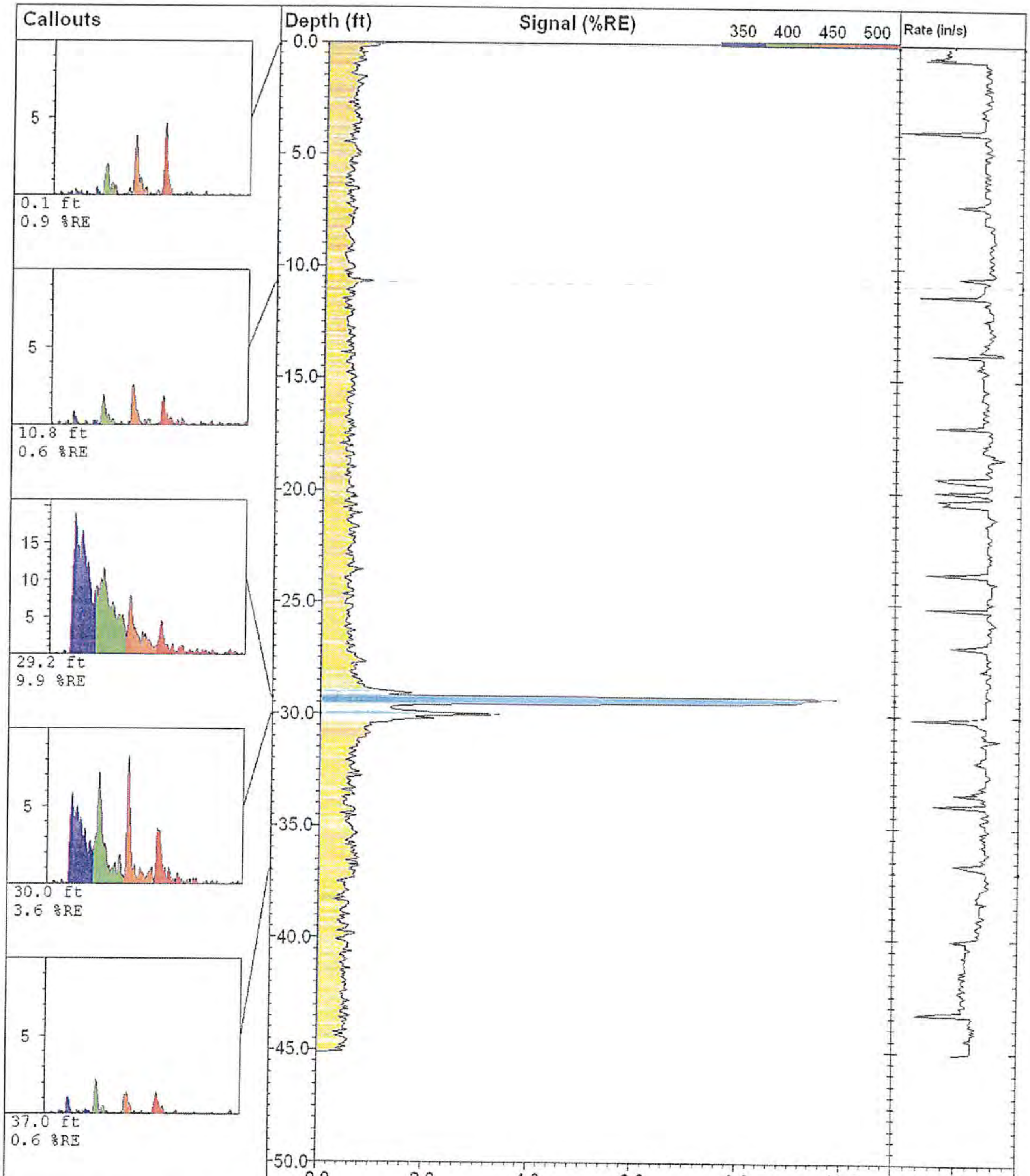
Engineer: P.WU

Date: 8/17/2016 12:28



Max. Depth: 47.244 (ft)
Avg. Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

www.greggdrilling.com

UV-CPT-~~5~~34		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.10 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 9.9 % @ 29.25 ft
Job: D11606114	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-17 13:08 PDT

GREGG

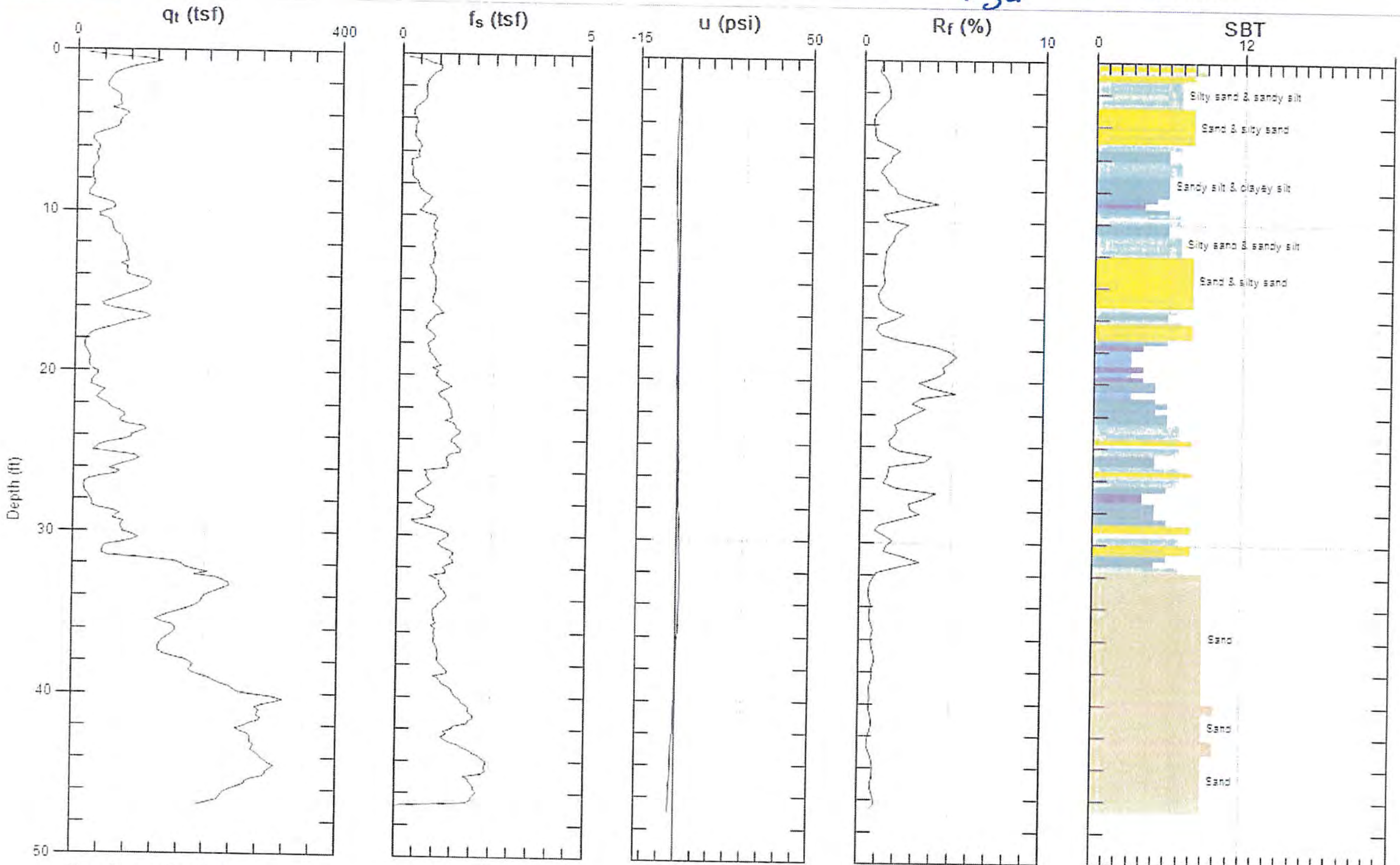
THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-~~5~~ 34

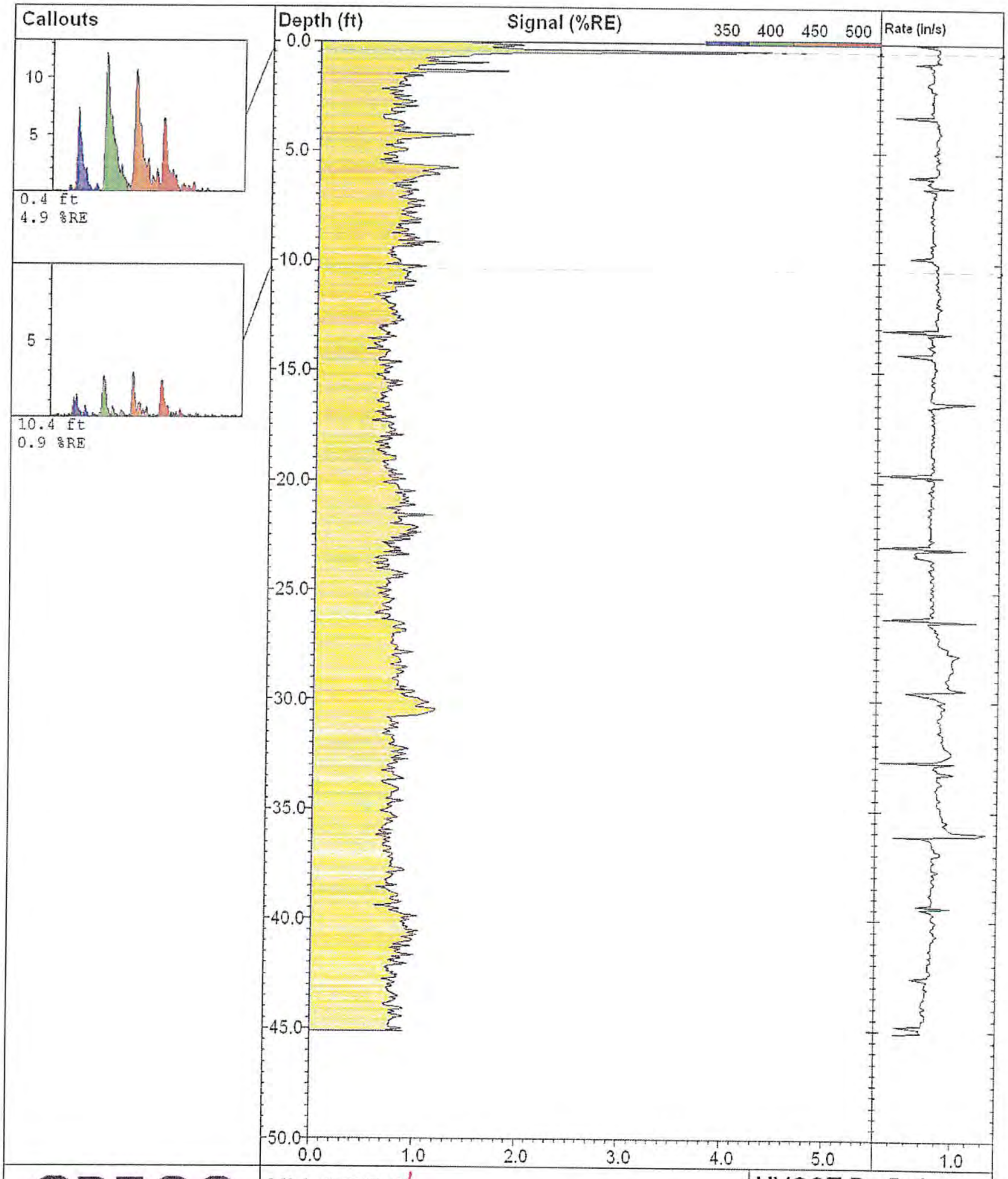
Engineer: P.WU

Date: 8/17/2016 01:24



Max Depth 46.916 (ft)
Avg Interval 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG www.greggdrilling.com	UV-CPT-~~6~~35		UVOST By Dakota www.DakotaTechnologies.com
	Site: DFSP-Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.13 ft
	Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 4.9 % @ 0.43 ft
	Job: D1160614	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-18 07:08 PDT

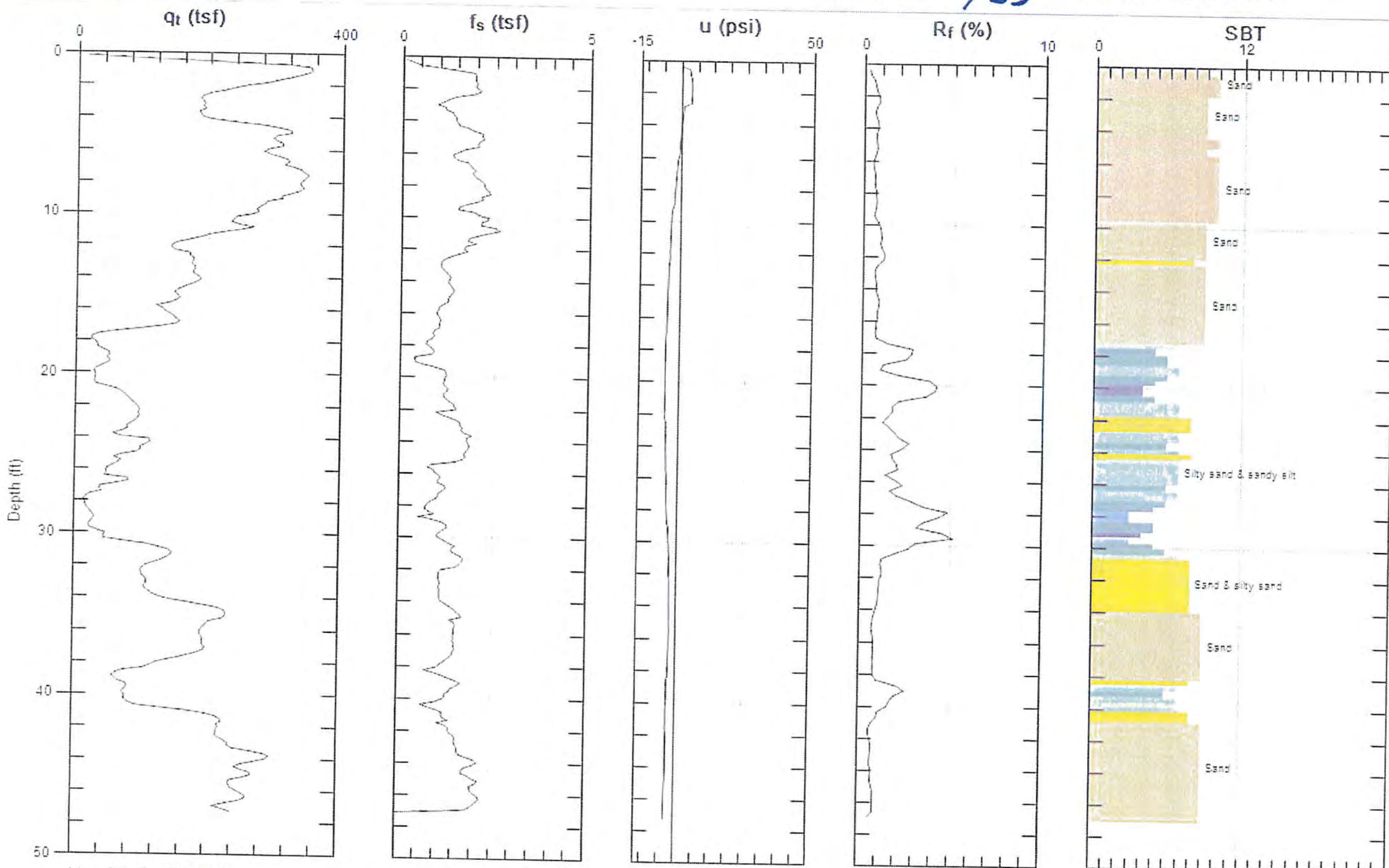
THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-6 35

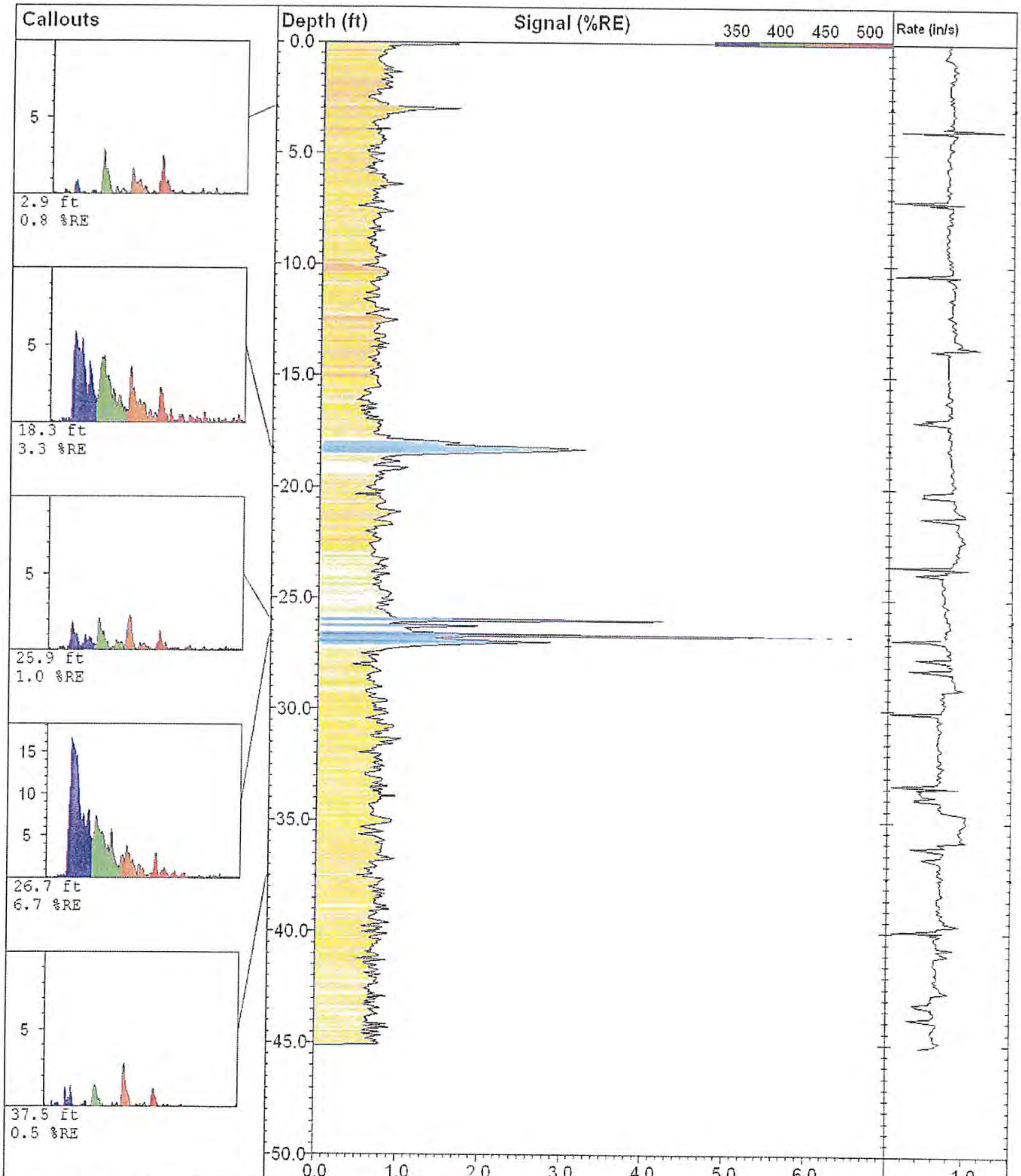
Engineer: P.WU

Date: 8/18/2016 07:14



Max Depth 47.244 (ft)
Avg Interval 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG
www.greggdrilling.com

UV-CPT-~~7~~ 36		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP-Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.10 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 6.7 % @ 26.70 ft
Job: D1160614	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-18 08:10 PDT

GREGG

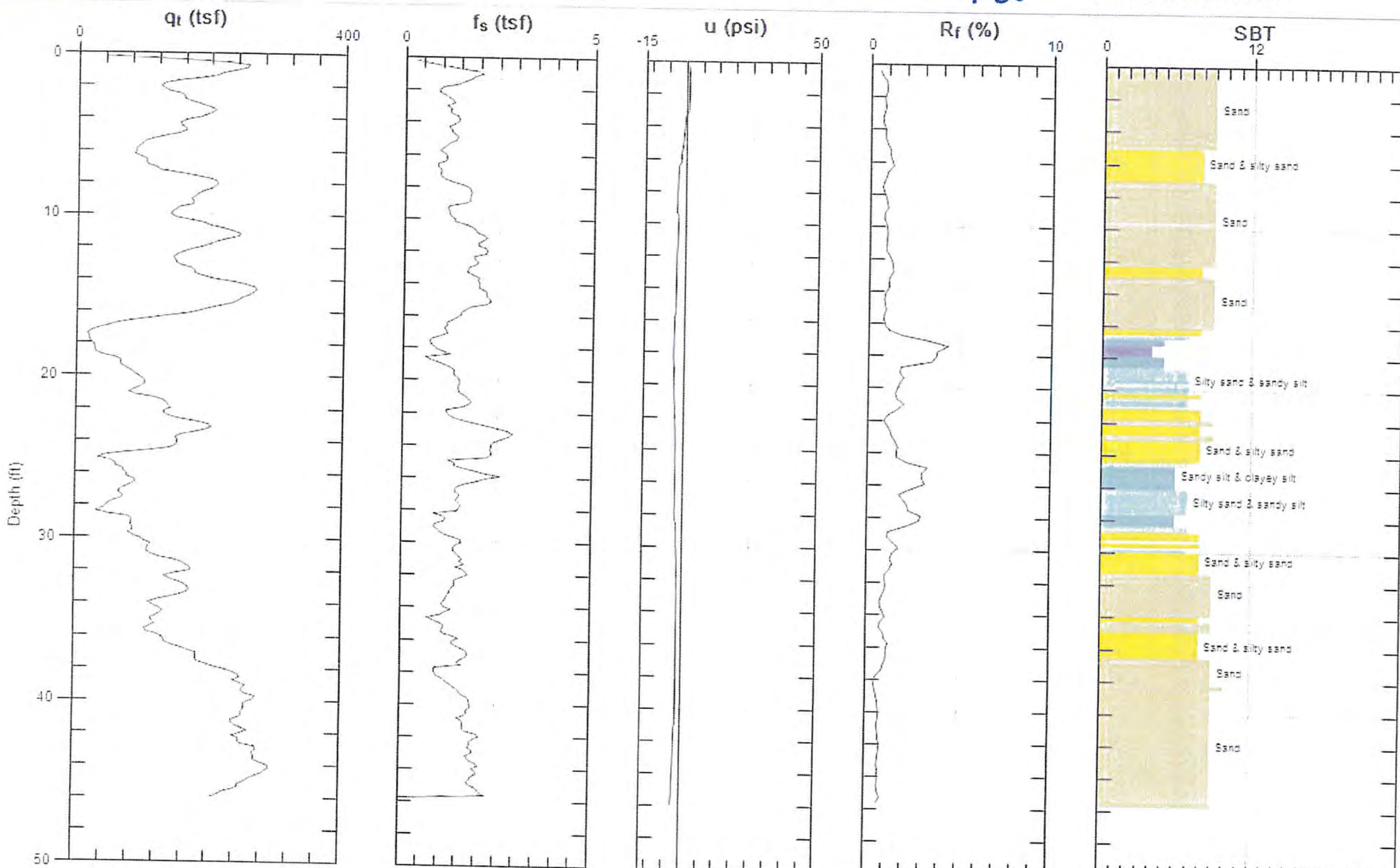
THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-~~7~~36

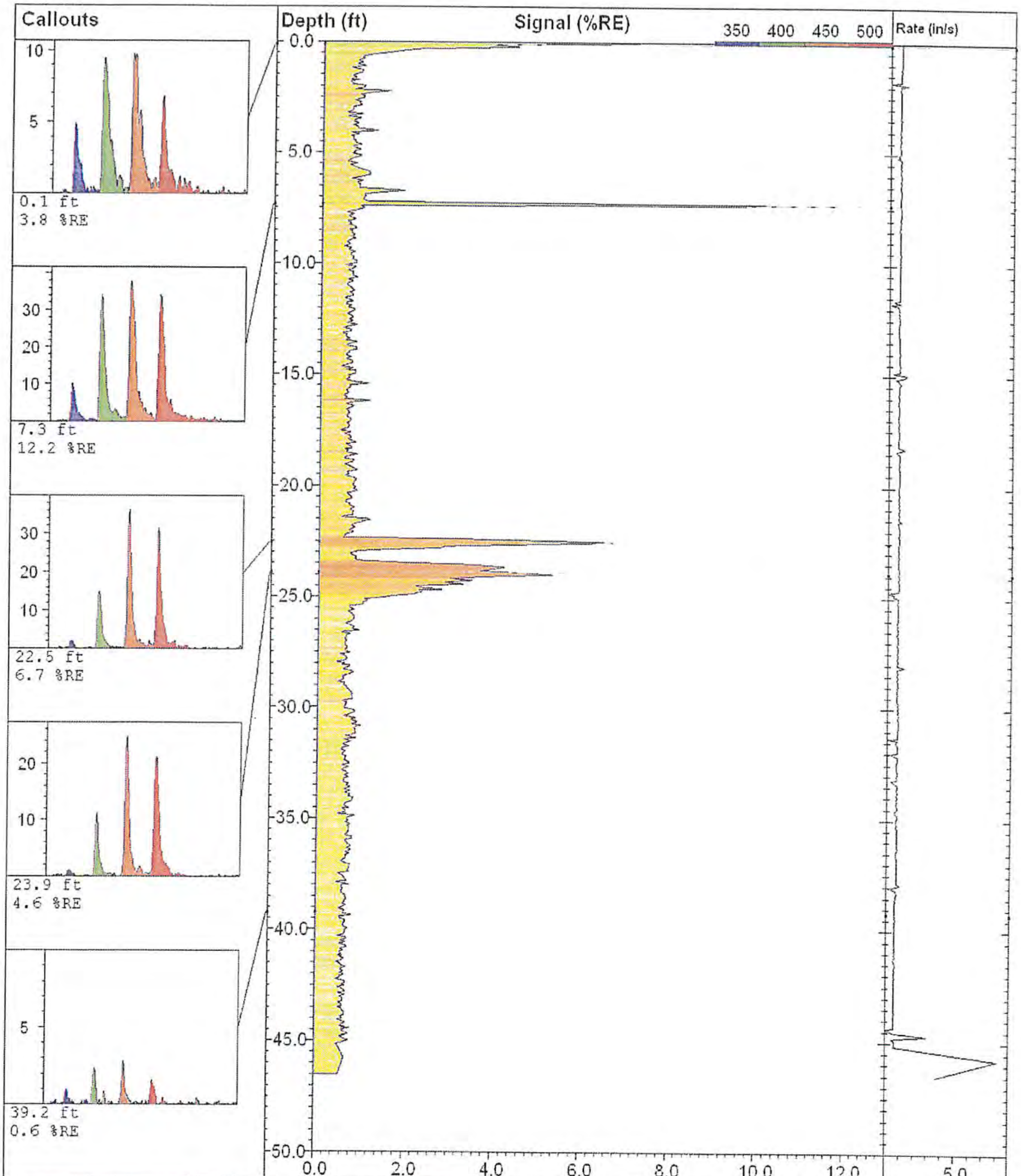
Engineer: P.WU

Date: 8/18/2016 08:13



Max Depth 45.932 (ft)
Avg Interval 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

www.greggdrilling.com

UV-CPT-~~8~~37		UVOST By Dakota www.DakotaTechnologies.com
Site: DFSP-Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 46.52 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 12.2 % @ 7.34 ft
Job: D1160614	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-18 08:55 PDT

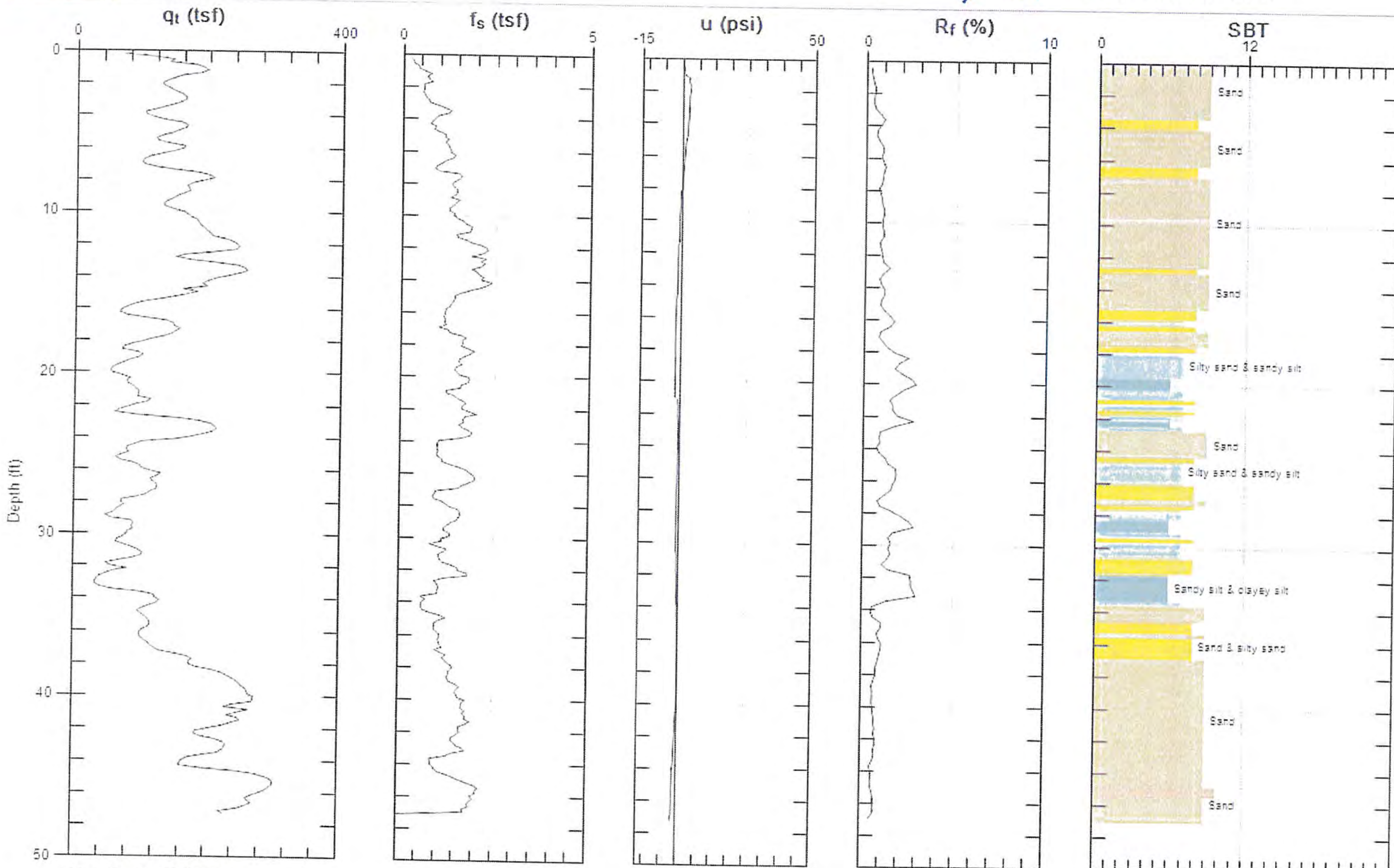
GREGG THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-~~8~~ 37

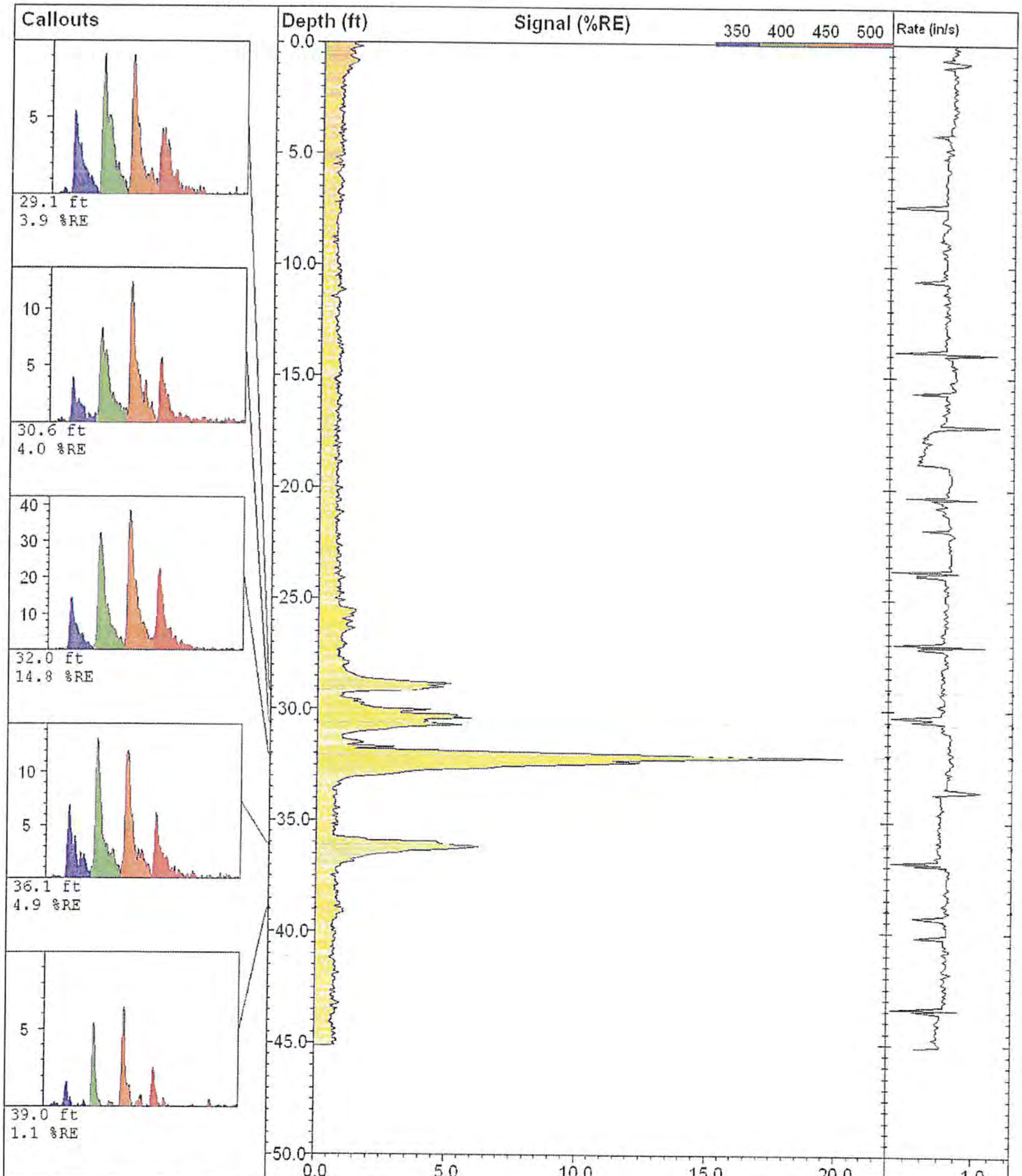
Engineer: P.WU

Date: 8/18/2016 09:16



Max Depth: 47.244 (ft)
Avg Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG www.greggdrilling.com	UV-CPT-9/38		UVOST By Dakota www.DakotaTechnologies.com
	Site: DFSP-Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.13 ft
	Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 20.4 % @ 32.13 ft
	Job: D1160614	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-18 10:04 PDT

GREGG

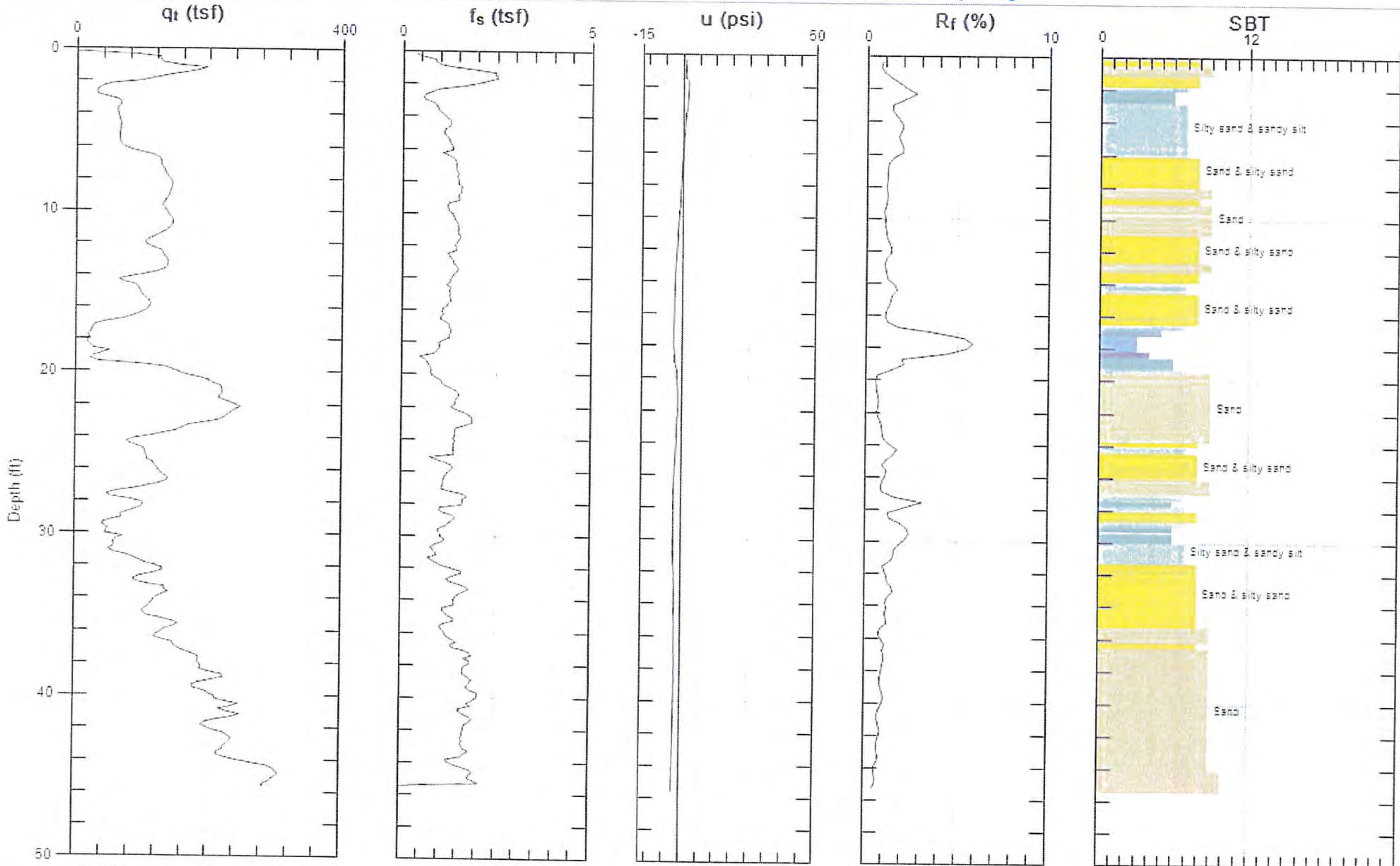
THE SOURCE GROUP

Site: DFSP NORWALK

Sounding: UV-CPT-~~9~~38

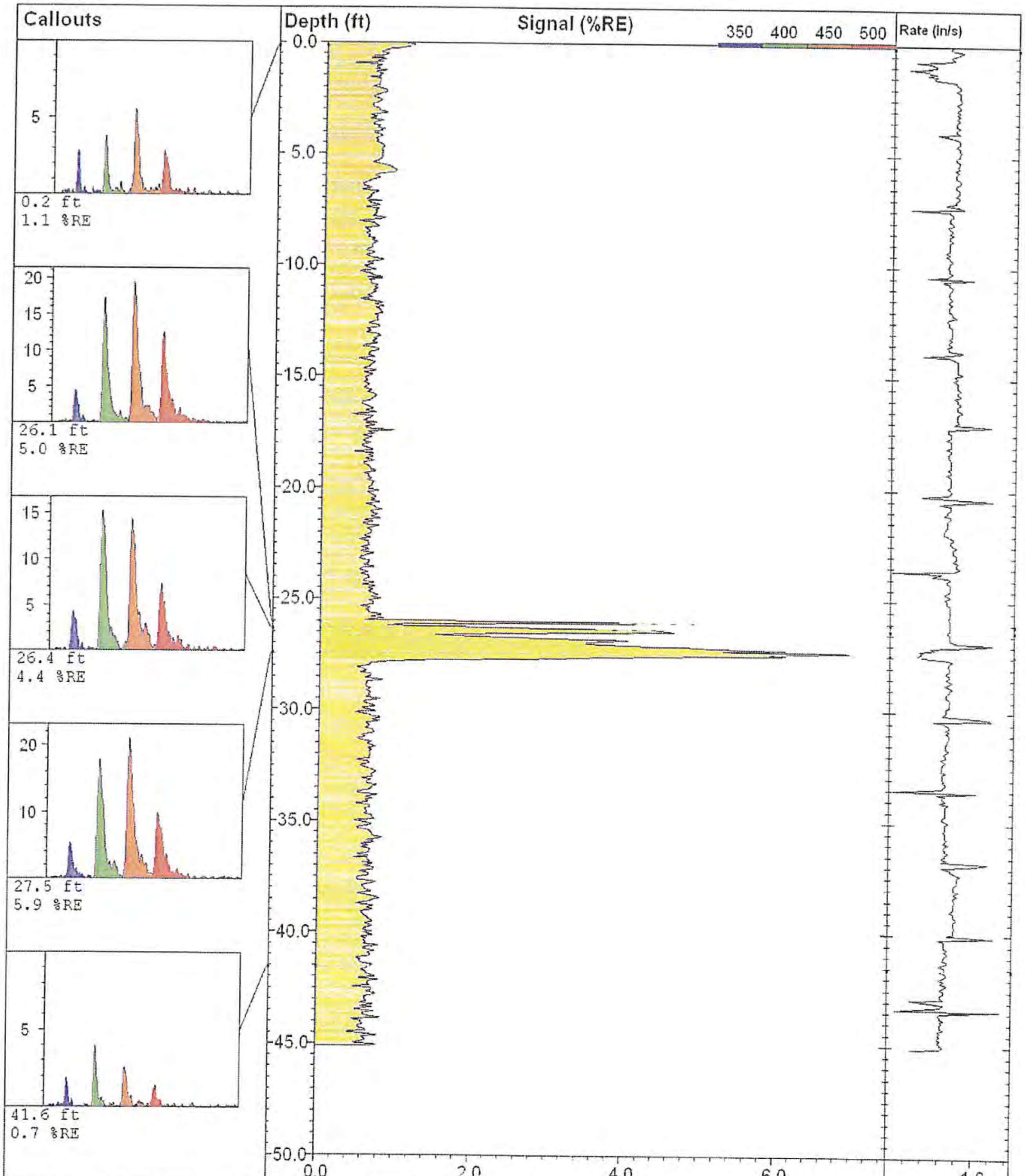
Engineer: P.WU

Date: 8/18/2016 10:09



Max Depth: 45.604 (ft)
Avg Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)



GREGG

www.greggdrilling.com

UV-CPT-~~10~~ 39

UVOST By Dakota
www.DakotaTechnologies.com

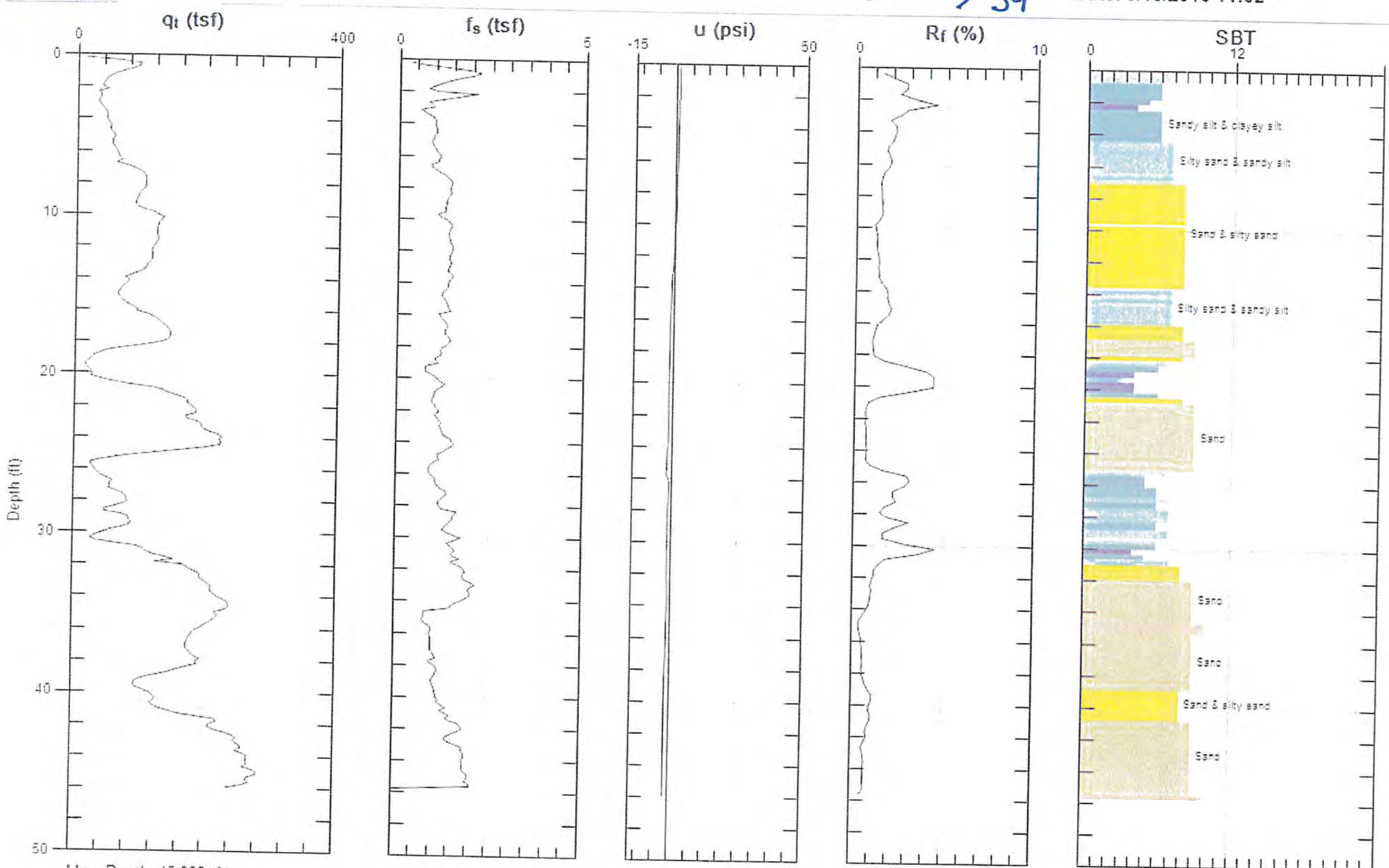
Site: DFSP-Norwalk	*Latitude / Datum:* Unavailable / NA	*Final depth:* 45.12 ft
Client: The Source Group	*Longitude / Fix:* Unavailable / NA	*Max signal:* 7.0 % @ 27.36 ft
Job: D1160614	*Operator/Unit:* Mike Haske/UVOST1007	*Date & Time:* 2016-08-18 10:48 PDT

GREGG

THE SOURCE GROUP

Site: DFSP NORWALK
Sounding: UV-CPT-~~10~~ 39

Engineer: P.WU
Date: 8/18/2016 11:02



Max Depth: 45.932 (ft)
Avg Interval: 0.328 (ft)

SBT: Soil Behavior Type (Robertson 1990)

APPENDIX C

Updated LNAPL Source Characterization and LNAPL Recoverability Evaluation for Tf-18 Area, InfraSUR

Environment & Infrastructure

<u>Transmitted by Email</u>

To: Paul Parmentier, CHG (SGI)
From: Jim Studer
Date: November 14, 2016
Subject: Updated LNAPL Source Characterization and LNAPL Recoverability Evaluation for TF-18 Area, Defense Fuel Support Point (DFSP) Norwalk Facility

The Source Group Inc. (SGI) retained InfraSUR LLC (InfraSUR) to conduct an analysis of selected DFSP Norwalk (Site) characterization data for the purposes of 1) estimating the volume of petroleum hydrocarbon (PHC) light non-aqueous phase liquid (LNAPL) that may be recoverable using saturated zone remediation techniques, 2) predicting possible recovery rates of LNAPL in the TF-18 Area, and 3) recommending data collection activities to support LNAPL recovery planning and optimization in the TF-18 Area. InfraSUR conducted a multi-step analysis to address these information needs. This memorandum presents the data analysis and results and is structured as follows:

- Background
- Interpretation of LNAPL Nature and Extent from CPT/UVOST Profiling Data
- Estimate of Limits of TF-18 Area LNAPL Plume
- Estimate of LNAPL Volume in TF-18 Area
- Summary of LNAPL Transmissivity (T_n) Testing of TF-18 Area Recovery Wells
- Correlation between CPT/UVOST Profiling Data and T_n Testing Results
- Prediction of LNAPL Recovery at TF-18 Area Recovery Wells
- Summary.

The analysis work was initiated in late 2015 and a memorandum dated January 11, 2016 and titled “LNAPL Source Characterization and LNAPL Recoverability in TF-18 Area, Defense Fuel Support Point (DFSP) Norwalk Facility” was prepared for SGI. This was submitted to Los Angeles Regional Water Quality Control Board (LARWQCB) as Appendix A to the SGI May 31, 2016 document titled “Addendum to Shallow Soil Closure Report DLA-Energy Responsible Area of the Eastern Portion”. An updated analysis has recently been completed that includes additional information (e.g, CPT/UVOST profiles UV-CPT-30 through – 39, LNAPL recovery by skimming) and applies an updated analysis methodology. This memorandum presents the updated analysis and supercedes the January 11, 2016 memorandum.

Background

SGI, with regulatory oversight by LARWQCB, is assessing the nature and extent of petroleum hydrocarbon (PHC) light non-aqueous phase liquid LNAPL beneath the former tank farm area of the subject facility (**Figure 1**), as well as assessing exposure risks to future users of the property and to groundwater supplies. To assess the nature and extent of LNAPL, SGI is periodically gauging and sampling monitoring wells and remediation wells, drilling and installing additional groundwater monitoring wells in select locations, conducting specialized laboratory tests on sediment core containing LNAPL, conducting Cone Penetrometer Tool/Ultraviolet Optical Screening Tool (CPT/UVOST) soundings, and conducting LNAPL transmissivity bail-down testing of selected wells.

Interim efforts are also underway to accelerate LNAPL recovery at, and in the vicinity of, existing well TF-18. The TF-18 Area of LNAPL recovery wells is located between former above grade PHC fuel storage tanks 80008 and 55004 (Figure 1). The TF-18 Area dimensions are generally 200 feet east to west and 80 feet north to south. This area is considered an area of special interest due to:

1. A transmissive sand layer(s) of a combined thickness of at least twelve feet, the top of which starts at approximately 29 to 31 feet below grade (ft-bg), containing what appears to be a significant volume of LNAPL (weathered jet fuel),

2. Proximity to the recently transferred parcel of the former facility to the City of Norwalk.

Early efforts to accelerate LNAPL recovery in the TF-18 Area include installation, in December 2015 of five (5) LNAPL recovery wells near TF-18 (Figure 2), followed by LNAPL transmissivity (T_n) bail-down testing (April 2016) and subsequent LNAPL recovery operations at the six (6) wells using automated skimming. As a group, the six recovery wells are heretofore referred to as the RTF-series recovery wells.

The CPT/UVOST profiles, and T_n testing and LNAPL removal performance data/outcomes for the RTF-series recovery wells are valuable inputs for enhancing the collective understanding of LNAPL nature and extent and in evaluating and predicting LNAPL recoverability at the Site. Ultimately, this kind of information should be useful for remedial planning and optimizing use of resources for achieving facility closure.

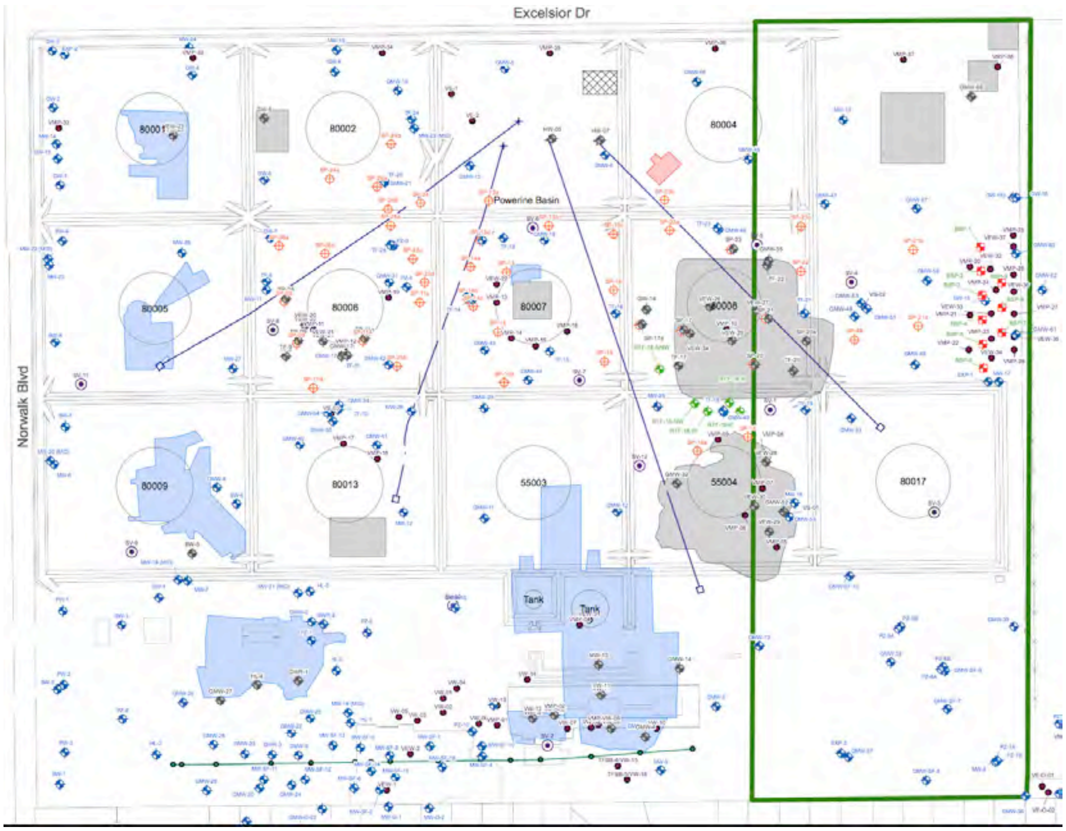


Figure 1. DFS Norwalk – former bulk fuel storage and dispensing facility. Private fuels pipeline transmission operations along the east and south periphery. Green rectangle delimits facility property recently transferred to the City of Norwalk for use as parkland. Each of the former tank basins is approximately 280 feet on a side (base modified from SGI, 2016).

Figure 2. TF-18 Area LNAPL recovery wells as of October 31, 2016. Five recovery wells shown in green. TF-18, the original recovery well, is shown in blue. RTF-18-N is the closest new recovery well to TF-18. (detail of Figure 1, modified from SGI, 2016).

Interpretation of LNAPL Nature and Extent from CPT/UVOST Profiling Data

Three rounds of CPT/UVOST profiling have been completed as of this writing. The first CPT/UVOST investigation was conducted by Parsons in October 2010. CPT/UVOST soundings were conducted at fifteen (15) locations across the Site. Those locations are identified as UV-1 through UV-15. The second CPT/UVOST investigation was performed by SGI in November and December 2015. In this case, 29 soundings were completed (locations UV-CPT-1 through UV-CPT-29). A third, supplemental, investigation was completed in August 2016 and involved 10 sounding locations identified as UV-CPT-30 through UV-CPT- 39. Sounding locations for the three rounds of CPT/UVOST profiling are shown on Figure 3. The CPT and UVOST profiles for each location are presented by SGI elsewhere.

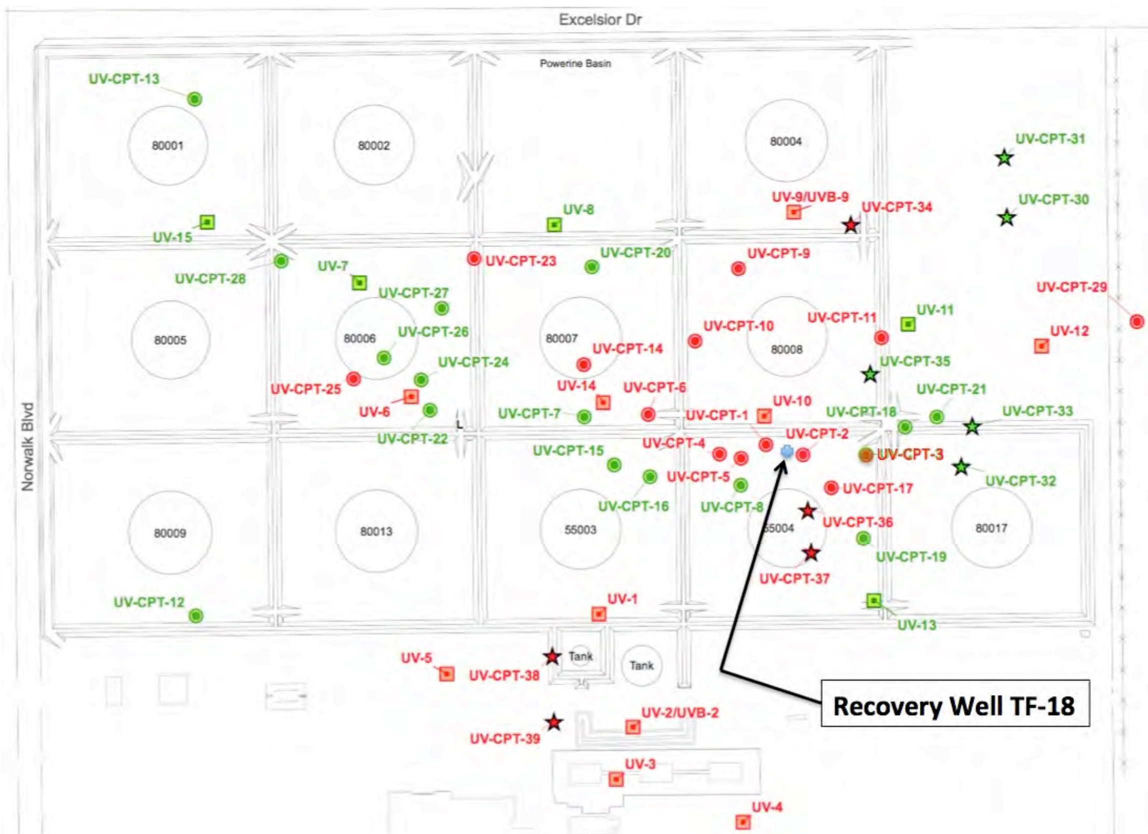


Figure 3. CPT-UVOST sounding locations across the former facility. The red symbols indicate that TPH in the form of LNAPL was detected and the green indicate that TPH was not detected. Re-evaluation of UV-CPT-3 response (shown in green) indicates LNAPL was present (modified from SGI, 2016).

For each CPT and UVOST profile, InfraSUR evaluated the data acquired from 20 to 40 ft-bg to develop a summary of potentially important attributes with respect to:

1. UVOST signal deviation indicative of LNAPL presence or absence, or relatively high concentration of adsorbed polyaromatic hydrocarbons (PAH), at the chosen profiling location on the date the sounding took place.
2. The number of LNAPL horizons (i.e., smear zones), for each profile with LNAPL detection. Detection of high concentration of adsorbed PAH may indicate the existence of a former smear zone rather than LNAPL.
3. The depth to top and bottom of each smear zone or former smear zone.
4. The type of LNAPL present or formerly present (e.g., jet fuel, gasoline, mix, unknown).
5. The dominant lithology within the horizon of LNAPL or former smear zone.
6. UVOST signal response as percent of reference emitter, or calibration, signal (%RE).
7. UVOST signal noise level above and below the LNAPL smear zone or former smear zone horizon (as %RE). “Smear zone” and “former smear zone” are heretofore referred to as “smear zone”.

Here, the goal was to establish the maximum smear zone vertical dimension and maximum signal response (%RE) recorded for each smear zone within the general 20 to 40 ft-bg horizon, adjusted for signal noise. Attachment 1 presents the summary.

The summary is useful for assessing smear zone presence in the vadose zone and saturated zone at various locations across the former facility. It is also useful for developing a sense of relative LNAPL pore saturation and volume at specific horizons and over areas of interest. The representativeness and usefulness of Attachment 1 and derivative interpretations are heavily influenced by numerous factors that influence the UVOST sensor system performance and the results are semi-quantitative.

It is known that the three rounds of CPT/UVOST soundings did not benefit from site-specific calibration and thus the UVOST sensor output must be considered semi-quantitative with subsequent opportunity to relate signal response to site-specific LNAPL conditions somewhat impaired.

InfraSUR proceeded with a more in-depth evaluation of the data to develop attributes potentially more useful for LNAPL mobility/recoverability evaluation within the TF-18 Area. Here, the goal was to isolate on those CPT/UVOST profiles indicating the presence of a continuous sand horizon, at and below the water table, storing and transmitting LNAPL of a composition similar to that for a TF-18 Area well with significant history (well TF-18). A second more focused summary was developed that includes interpretation of 12 CPT/UVOST profiles that satisfied the following five criteria:

1. NAPL must be detected and associated with an appreciably thick and (apparently) continuous sand layer.

2. Sand layer containing LNAPL must be positioned at or below the capillary fringe or water table (since nominally 2015, the minimum depth below grade of 30 ft-bg).

3. NAPL must be comprised completely or primarily of jet fuel, fresh or weathered.

4. Maximum sensor signal (%RE as adjusted for background noise) must exceed 2 percent. Signal magnitude between noise and 2 percent %RE may point to significant PAH adsorption if the depth position and shape of the signal response is consistent with the conceptual understanding of LNAPL nature and extent.

5. CPT/UVOST profile should be within, or relatively near, the TF-18 Area (i.e., within approximately 150 feet of well TF-18).

Instead of recording maximum smear zone thickness and maximum signal response, the focus here was on the portion of the smear zone likely to support lateral LNAPL mobility under forced hydraulic gradient conditions (b_{eff}). An adjusted maximum signal response ($\%RE_m$) for that portion of the smear zone was calculated as well as a signal response more representative of the average ($\%RE_a$). These profile attributes are graphically defined in Figure 4. Interpretations for the 12 profiles are presented in Table 1.

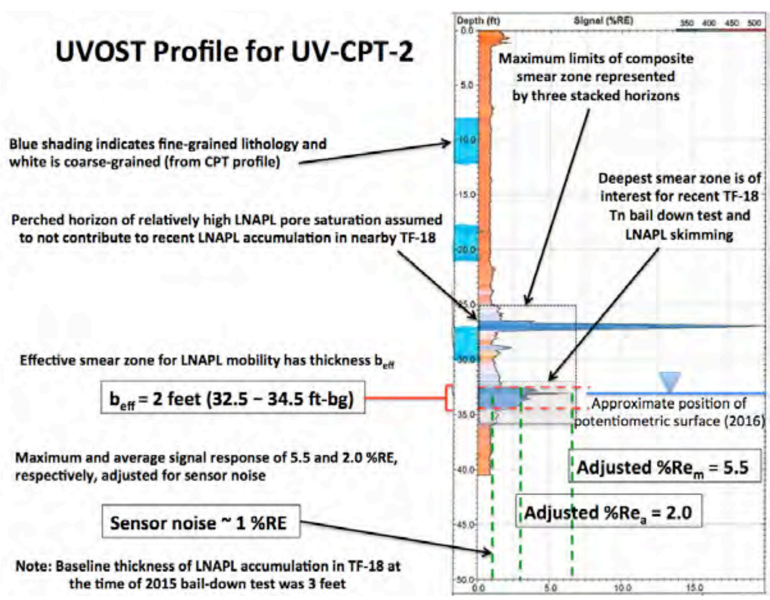


Figure 4. Profile UV-CPT-2 (ca. 2015, second round of CPT/UVOST soundings) with inferred LNAPL smear zone attributes.

Table 1. Interpreted CPT/UVOST Profiling Attributes for Comparison to TF-18 Area LNAPL Occurrence and Mobility at Recovery Wells

UVOST Location	Effective Horizon of Detection, Ft-bg (1)	Effective Smear Zone Thickness beff (ft)	Jet Fuel (Y, N, ?) (2)	In Fine Grained Lithology (Y/N) (3)	Signal %RE max (4)	Response %RE avg (5)
UV-10 *	30 - 33	3	Y	Y & N	13.5	9.75
UV-14	30 - 33	3	Y	N	58.5	19.75
UV-CPT-1 *	30.7-34	3.3	Y	N	2.7	2.2
UV-CPT-2 *	32.5 - 34.5	2	Y	N	5.5	2
UV-CPT-3	32 - 34	2	Y	N	3.4	2.3
UV-CPT-4	32 - 34	2	Y	N	4.5	2.3
UV-CPT-5 *	30.5-31.5	1	Y	N	3.8	1.3
UV-CPT-6	33.5-37	3.5	Y	N	10.2	4.7
UV-CPT-10	32.5-34.5	2	Y	N	8.7	3
UV-CPT-14	33.5-36	2.5	Y	N	6.8	4
UV-CPT-17	32 -33	1	Y ?	N	10.5	4.5
UV-CPT-23	35.0-36.5	1.5	Y?	N	5.3	3

*** - CPT/UVOST sounding located adjacent to TF-18 Area LNAPL Recovery Well(s)**

Use of the five down-select criteria guarantees that the 12 isolated profiling locations are at least generally comparable to the near-field TF-18 subsurface conditions from nominally 30 ft-bg to 37 ft-bg. Smear zone thickness ranges from as little as one (1) foot to 3.5 feet. Sand dominates the lithology in each case. The maximum noise adjusted signal response within b_{eff} (%$RE_{m)}$ ranges from 2.7 to 58.5. The range in the more subjective average noise adjusted signal response within b_{eff} (%RE_a) is 1.3 to 19.7. Each of the profiling locations exhibited significant evidence of LNAPL and confidence in data set comparability is enhanced by the knowledge that all six recovery wells and a couple of monitoring wells in the same area have been documented to accumulate significant LNAPL (e.g., 3 feet). This is consistent with the current conceptualization of the sand layer as transmissive and hydraulically unconfined with LNAPL accumulation within a smear zone(s) that is laterally continuous across the TF-18 Area and into adjacent areas to the west and northwest.

Estimate of Limits of TF-18 Area LNAPL Plume

The CPT/UVOST profiling data and a range of other information sources were used to delimit the lateral extent of what is believed to be a main body of LNAPL that underlies much of the former tank farm, including the TF-18 Area. The basis for the LNAPL interpretation includes:

- CPT/UVOST profiles
- Monitoring and remediation well boring logs

- Data on groundwater and LNAPL gauging at wells
- Well LNAPL bailing data
- Groundwater sampling and analysis data, including natural attenuation data.

An interpretation of the plan-view limits of the main body of the LNAPL plume underlying TF-18 and contiguous-areas is presented in Figure 5.

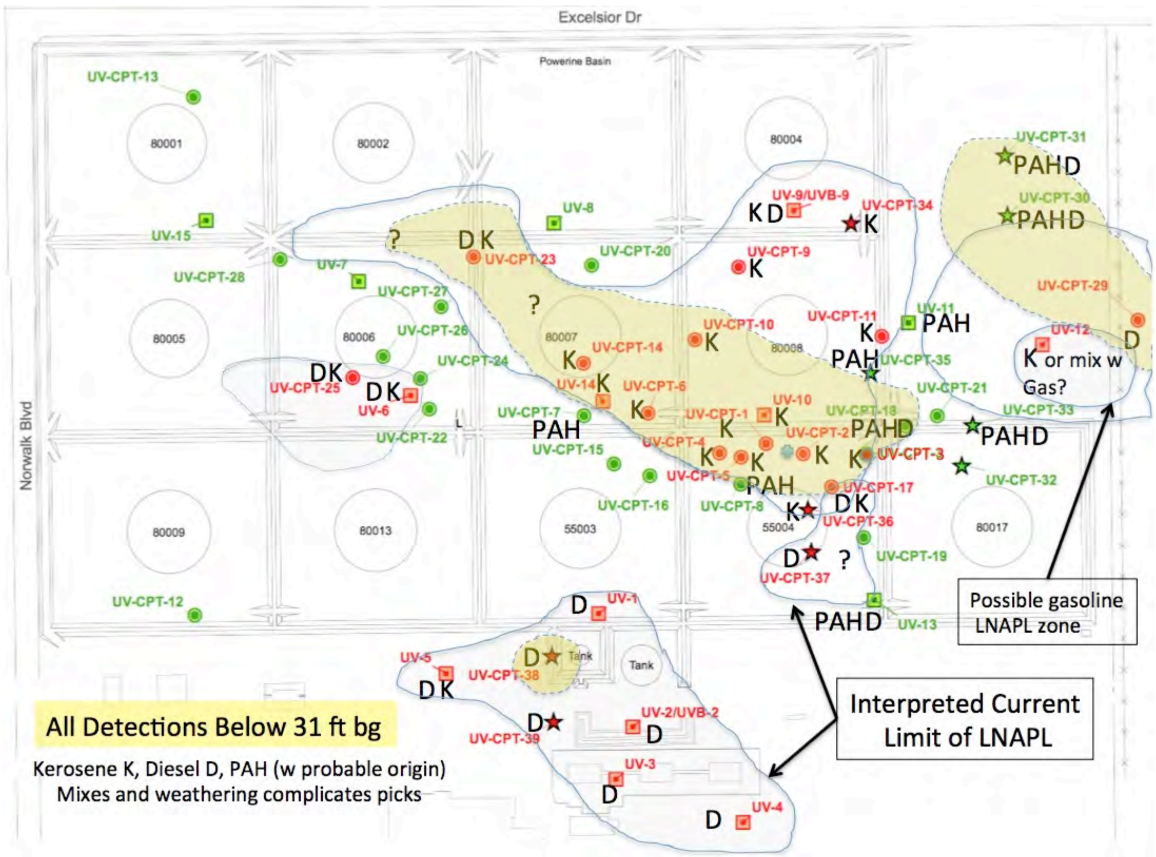


Figure 5. Interpreted lateral extent of a LNAPL body beneath the TF-18 Area and extending primarily to the northwest (base modified from SGI, 2015).

The delimited area includes LNAPL at a depth of at least 30 ft-bg (the general depth to the water table as of November 2016) with the maximum depth of 37 ft-bg but more typically 34 to 35 ft-bg. Depending on the location, LNAPL may be present above the water table as shallow as 20 ft-bg. The average thickness of the generalized smear zone is 5.6 feet. This estimate applies across all the CPT/UVOST locations and, for each location, summing all individual smear zones at 25 ft-bg or deeper.

A comparison of LNAPL accumulation observations at well TF-18 with the CPT and UVOST profiling data for the CPT/UVOST sounding closest to TF-18 is useful in providing “ground truth” that the UVOST signal relates directly to LNAPL presence in sediment pores. The CPT/UVOST location that is closest to TF-18 is UV-CPT-2, a few feet east of TF-18. UV-CPT-1 is approximately twice the distance to the northwest. Per Attachment 1 the lowermost of the three smear zones covers 32 to 36 ft-bg and per Table

1 the interpreted core of the LNAPL smear zone is approximately two (2) feet thick and the associated maximum and average adjusted signal response (%RE_m and %RE_a) are 5.5 and 2 %RE, respectively. Recent experience with TF-18 indicates a persistent LNAPL accumulation thickness of 2.5 to 3 feet at the same general depth interval as the smear zone indicated by UV-CPT-2.

Other LNAPL plumes are known to exist across the facility but are not shown in this figure. For example, it is known that at least one LNAPL plume exists in the vicinity of GMW-62, in the vicinity of the former loading rack and water tank area, and locally beneath the footprints and adjacent areas of two or three other storage tanks located some distance from the TF-18 Area. These LNAPL plumes appear to be smaller then the LNAPL plume underlying TF-18 Area. The 10 most recently completed CPT/UVOST profiles provide evidence that the these other zones of LNAPL accumulation are not mere extensions of the LNAPL body beneath and northwest of TF-18 Area. For example, the LNAPL plume associated with GMW-62 area appears to have a plume axis oriented to the northwest (not shown but similar to the axis orientation of the TF-18 Area LNAPL plume) and there may be some overlap of LNAPL smear zones but it appears the two LNAPL plumes are unique and separate.

Estimate of LNAPL Volume in TF-18 Area

As depicted in Figure 5, a relatively large LNAPL plume zone is present beneath the central portion of the former tank farm parcel, including the TF-18 Area. Within the general limits of the plume LNAPL is present, in most locations, within the capillary fringe and within the upper few feet of the groundwater-saturated zone (nominally 30 to 37 ft-bg). Some LNAPL is also present within the vadose zone from approximately 10 to 30 ft-bg but the distribution is much more patchy. As discussed previously, the potential for lateral mobility of LNAPL is higher in those portions of continuous smear zones exhibiting relatively higher LNAPL pore saturations. Using the sub-30 ft-bg sections of the CPT/UVOST profiles from the 12 soundings located within the limits of the LNAPL plume (Figure 5), InfraSUR developed estimated values for indicators of effective smear zone thickness and LNAPL pore saturation (Table 1). While LNAPL is present above and in some cases below this “core” of the plume, estimation of the LNAPL volume present within this fraction is important for establishing a baseline for future saturated zone remediation operations. The LNAPL volume present within the entire plume, both within the saturated zone and vadose zone, has not been estimated here.

An estimate of the LNAPL volume within the core of the LNAPL body beneath and contiguous with the TF-18 Area was developed using the following process and assumptions:

- The LNAPL body in which TF-18 Area (Figure 5) represents a sub-area has maximum dimensions of 870 feet x 240 feet but is irregular in shape. The surface area is estimated to be 136,000 ft^2 (a little over three acres).
- The surface area of TF-18 Area (which includes several UVOST locations) is 150 feet x 75 feet or 11,250 ft^2 (a little over one-quarter acre).

- The information value of each UVOST profile location is assumed to be equal and a uniform weighting is assigned. Thus, each profile location within the limits of the interpreted LNAPL plume represents the same surface area of the LNAPL source zone (136,000 ft^2 / 12 = 11,333 ft^2 per location). Estimation error is clearly introduced with this simplifying assumption (for example, note UV-CPT-23 in the northwestern part of the plume),
- The total porosity of the sandy sediment at 29 – 40 ft-bg is constant across the entire LNAPL source zone (30 percent).
- The LNAPL layer thickness b_{eff} and “average” LNAPL pore saturation is estimated at the 12 CPT/UVOST sounding locations within the LNAPL plume (Figure 5). The attribute values summarized in Table 1 are leveraging for this purpose. This assumption hinges on conversion of adjusted average signal response (%RE_a) into a reliable average pore saturation value.
- The adjusted average signal response (%RE_a) derived from UV-CPT-2 is equated to an average LNAPL pore saturation across the inferred b_{eff} of 35 percent (i.e., 30 percent total porosity x 35 percent LNAPL saturation = 10.5 percent of the total volume is occupied by LNAPL). The average LNAPL pore saturation of the smear zone at nearby TF-18 is therefore taken as 35 percent.
- The average pore saturation for each of the other 11 UVOST locations is derived by adjusting the UV-CPT-2/TF-18 assignment (35 percent) up or down according to the signal response at the other UVOST location of interest. Adjusted average signal response (%RE_a) is normalized to the UV-CPT-2 signal response (a value of 2 as shown in Table 1). Then the normalized value is applied to a non-linear function developed by InfraSUR for this project to convert normalized adjusted average signal response (%RE_a) to average pore saturation (Figure 6).
- The estimated LNAPL volume within each of the twelve equal sub-areas of the LNAPL body is calculated using the following general equation:

Surface Area x Smear Zone Thickness x Total Porosity x Average Pore Saturation = LNAPL volume

- Finally, the total LNAPL is calculated by summing the 12 individual LNAPL volume estimates.

The outcome of this process is presented in Table 2.

The LNAPL volume estimates for each CPT/UVOST sounding sub-area range between 6,200 and 68,700 gallons. The overall volume in the saturated core is estimated at 369,900 gallons. The overall LNAPL volume in the vadose zone and entire saturated zone combined may be significantly higher. The LNAPL volume within the 150 feet by 75 feet TF-18 Area was estimated by summing one-third of the LNAPL volume values indicated for UV-CPT-1, UV-CPT-2, and UV-CPT-17. The estimated total LNAPL volume in the vicinity of TF-18 is thus indicated to be approximately 20,400 gallons. The overall LNAPL volume in the vadose zone and entire saturated zone combined may be significantly more than this estimate.

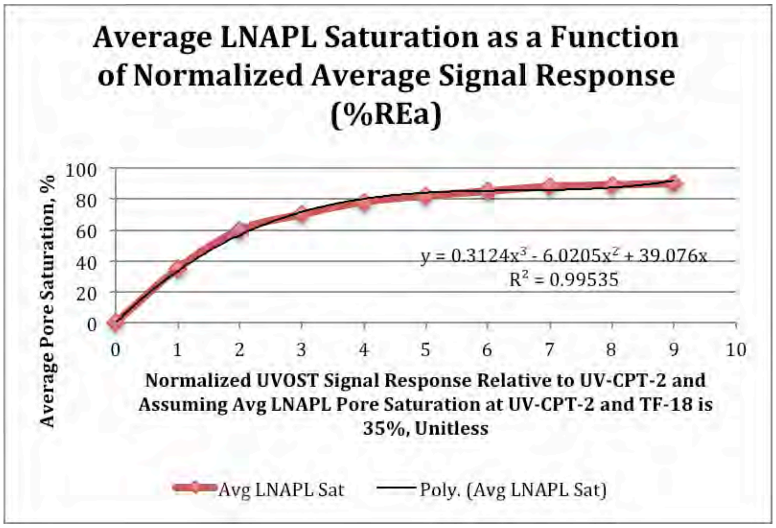


Figure 6. Function for translating UV-CPT-2 normalized UVOST signal response (adjusted average for b_{eff}) to average LNAPL pore saturation of b_{eff} at 11 companion UVOST profiling locations.

The polynomial function (Figure 6) is specific to this project and was developed using professional judgment and the following assumptions:

- the UVOST signal response is influenced by several factors and their complex linear and non-linear interactions,
- LNAPL pore saturation is more influential than small differences in LNAPL composition (i.e., PAH type and concentration) and other factors individually and in combination,
- the signal response is non-linearly proportional to LNAPL pore saturation between zero (0) and an assumed maximum pore saturation of 90 percent,
- the response is proportional but it is not linear due to the multivariate condition, and the UVOST sensor is biased or more sensitive to LNAPL pore saturation at low saturation levels and less likely to fully detect changes at higher saturation levels,
- subsurface conditions at UV-10 and UV-14 have not changed since 2010 sounding and the pore saturation function can be applied directly to these profiles.

The UVOST sensor system manufacturer has documented that the system signal response is proportional to LNAPL pore saturation. However, especially for this Site where site-specific LNAPL was not used with the reference emitter to calibrate, the signal response is expected to be non-linear and data are not sufficient to quantify associated error.

Table 2. Estimated LNAPL Volumes within Core of Central Plume including TF-18

UVOST ID	Effective Smear Zone Upper ft-bg	Effective Smear Zone Lower ft-bg	Lithology Fine/Coarse	Effective Smear Zone Thickness (b_{eff}) ft	Adjusted Avg Signal %REa	Normalized Avg Signal (N%REa)	Represented Sub-Area ft2	Total Porosity	LNAPL Avg Sat %	LNAPL Volume ft3	LNAPL Volume gal
UV-CPT-1	31	34	Coarse	3	2.2	1.1	11,333	0.3	36.1	3,682	27,543
UV-CPT-2	32.5	34.5	Coarse	2	**2**	**1.0**	11,333	0.3	**35.0**	2,380	17,802
UV-CPT-3	32	34	Coarse	2	2.3	1.2	11,333	0.3	38.8	2,638	19,735
UV-CPT-4	32	34	Coarse	2	2.3	1.2	11,333	0.3	38.8	2,638	19,735
UV-CPT-5	30.5	31.5	Coarse	1	1.3	0.7	11,333	0.3	24.5	833	6,231
UV-CPT-6	33.5	37	Coarse	3.5	4.7	2.4	11,333	0.3	60.2	7,164	53,585
UV-CPT-10	32.5	34.5	Coarse	2	3	1.5	11,333	0.3	46.1	3,135	23,448
UV-CPT-14	33.5	36	Coarse	2.5	4	2.0	11,333	0.3	56.6	4,811	35,986
UV-CPT-17	32	33	Coarse	1	4.5	2.3	11,333	0.3	61.8	2,101	15,717
UV-CPT-23	35	36.5	Coarse	1.5	3	1.5	11,333	0.3	46.1	2,351	17,586
UV-10	30	33	Coarse	3	9.75	4.9	11,333	0.3	83.7	8,537	63,860
UV-14	30	33	Coarse	3	19.8	9.9	11,333	0.3	**90.0**	9,180	68,666
					Estimated Total LNAPL Volume in Core of Central Plume (> 30 ft-bg) >>						**369,896**

Significant error is certainly associated with these LNAPL volume estimates. Some of the sources of error include: 1) the total porosity likely various at any point from 20 to 40 percent or more, 2) the LNAPL body geometry is uneven and the CPT-UVOST profile locations are unevenly distributed within the LNAPL body, 3) assignment of TF-18 and UV-CPT-2 as a baseline pair representative for the subsurface conditions at the other profile locations, 4) the assumption that pore saturation and not PAH fluorescence is the dominant factor influencing signal response, 5) the assignment of LNAPL pore saturation of 35 percent to the UV-CPT-2 signal response (and TF-18), 6) the polynomial function (and assumptions as discussed below), and 7) estimates of smear zone thickness.
The assumption that total porosity across the sand unit is 30 percent and average LNAPL pore saturation at TF-18 is 35 percent may be reasonable but are essentially arbitrary as of this writing. With respect to LNAPL pore saturation, the residual saturation must be exceeded where LNAPL is mobile under natural to modest induced hydraulic gradient conditions. InfraSUR suspects residual saturation ranges between 10 and 20 percent for the sand layer.

To establish the 35 percent average pore saturation assignment, InfraSUR consulted a USEPA cost and performance report based on LNAPL recovery work conducted over a period of years at a large former refinery. That USEPA funded study was conducted some years after this author led LNAPL recovery operations at the former refinery that were partially responsible for recovery of 2,000,000 gallons of out of potentially 4,000,000 gallons of LNAPL in ground (mostly sandy sediment). That study documented average LNAPL saturation levels in intervals of LNAPL occurrence that are generally less than 38 percent (Cost and Performance Report for LNAPL Characterization and Remediation, EPA 542-R-05-016. March 2005). The study outcome is interesting as one might reasonably expect average LNAPL pore saturation at that former refinery to have been higher given the magnitude of LNAPL presence and the LNAPL recovery achieved up to the reporting period. In any event, InfraSUR made an assignment of 35 percent to equate to conditions observed at UV-CPT-2 and TF-18, an assignment that appears generally consistent with the USEPA study findings. It is possible that the average pore saturation could be less than 35 percent. The reality is that LNAPL at the Site is likely migrating in discrete (i.e., thin) zones within the larger "smear zone" indicated by

UVOST (and monitoring wells) to contain LNAPL. These thin zones likely exhibit pore saturations significantly higher than 35 percent.

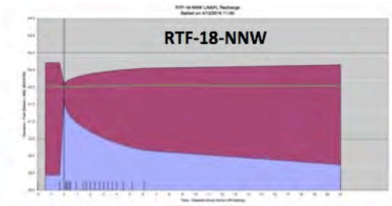
Summary of LNAPL Transmissivity (T_n) Testing of TF-18 Area Recovery Wells

SGI previously requested that InfraSUR assist SGI with planning for and conducting a LNAPL transmissivity (T_n) bail-down test at TF-18, and then analyze the data and report on the findings. The TF-18 Tn testing was conducted from November 16 through 24, 2015 in general accordance with ASTM Standard Guide for Estimation of LNAPL Transmissivity (E2856 − 13). The summary memorandum for TF-18 is titled "LNAPL Transmissitivy Test Summary and Results for TF-18, DFSP Norwalk" and is dated November 29, 2015 (see Attachment 2). That memorandum summarizes the testing and data analysis and interpretation process followed for TF-18. The general T_n value reported from this work is 3.7 ft^2/day, indicating significant LNAPL mobility and recoverability using simple hydraulic manipulation techniques such as skimming.

Following the TF-18 (T_n) bail down test, SGI constructed five new recovery wells around TF-18 and InfraSUR assisted in the planning and completion of T_n bail down tests at these new wells. The five tests were completed in April 2016 following field procedures similar to that employed for TF-18. InfraSUR conducted an analysis of the data, using a similar approach to that employed for TF-18, resulting in estimated T_n values for the five wells. At the same time, the 2015 test data for TF-18 was re-evaluated for consistency and an updated T_n value was obtained for TF-18 as well (4.04 ft^2/day).

The results are summarized in Figure 7. This figure presents graphical illustrations of the fluid level response versus time for each of the five RTF recovery wells and a summary table with key test conditions and analysis results for all the tests including TF-18. The range in T_n values is 0.29 to 15.12 ft^2/day or approximately two orders of magnitude. The updated T_n estimate for TF-18, using the same assumptions and process as applied to the other five wells, is 4.04 ft^2/day. This value is slightly higher than the initial 3.7 ft^2/day value and supercedes that original estimate.

According to ITRC guidance, T_n values above 0.1 to 0.8 ft^2/day are indicative of conditions that will readily support simple hydraulic recovery of LNAPL such as skimming. Decisions made to terminate simple hydraulic recovery based on the T_n range listed above typically result in significant LNAPL remaining in the formation. If the formation is relatively permeable, more advanced LNAPL recovery techniques such as surfactant and polymer flushing can be employed to achieve remedial objectives.



LNAPL Transmissivity (T_n) Data Analysis Summary Table
TF-18 and Five Nearby RTF Recovery Wells, DFS Norwalk
InfraSUR LLC for SGI, 6/12/16

Well ID	Tn Test Date	Baseline Gauging Time	Baseline Bn, feet (1)	Duration of Bailing, min	NAPL Removed (gal) (2)	Water Removed (gal)	Elapsed Time, min (3)	Ratio (4)	Ending Bn, feet (1)	Avg Tn Ft2/day	Std Dev and COV	Suitability for Tn Analysis
RTF-18-NNW	4/13/16	0900	3.27	20	~6	~1.5	366 / 1260	0.05	2.91	**2.46**	**0.65 / 0.27**	Instantaneous NAPL removal assumption not met but monitoring frequency at early times may have been light.
RTF-18-NW	4/28/16	0930	2.07	27	~8.5	~2.0	285	0.09	2.01	**10.81**	**2.64 / 0.24**	Instantaneous NAPL removal assumption not met but second bailing at 1750 nearly replicated the post-bailing starting fluid levels. However, less volume was removed.
RTF-18-W	4/13/16	0900	2.85	13	~3	<1.0	430 / 1317	0.03	1.98	**0.29**	**0.01 / 0.03**	Instantaneous NAPL removal assumption met but response sufficiently non-ideal that analysis was difficult.
TF-18	11/23/15	936	3.00	NA	~3.25	NA	341 / 1449	NA	2.98	**4.04**	**0.60 / 0.15**	Instantaneous NAPL removal assumption likely not met but conditions appeared stable. Updated assumptions and optimization, result is 10 percent higher than 2015 estimate.
RTF-18-N	4/13/16	0900	2.83	22	~4	<1.0	452 / 1342	0.05	3.14	**4.88**	**NA**	Instantaneous NAPL removal assumption not met and starting quasi-equilibrium condition may not have been met. Possible poor NAPL to well communication at start. Complex three stage curve. Inflow rate per unit drawdown increasing in middle stage.
RTF-18-E	4/28/16	0930	2.08	30	~5.5	~1.0	325	0.09	2	**15.12**	**2.96 / 0.20**	Instantaneous NAPL removal assumption not met but second bailing at 1604 nearly replicated the post-bailing starting fluid levels. However, less volume was removed.

Table Footnotes: 1) NAPL thickness did not exceed fluid column length and therefore groundwater was not crowded out of well. Desirable condition for all wells documented.
2) NAPL removed during bailing should exceed the estimated NAPL readily drainable from filter pack. Maximum drainable NAPL expected in filter packis ~2.25 gal and NAPL removed from each well easily exceeded this value.
3) Elapsed Time - is the duration in minutes from the termination of bailing to the last measurement of recovery. If two values then first is elapsed time to last measurement within frequent measurement block and second is elapsed time to last
4) Ratio of Bail-Down Duration divided by Elapsed Time. A value less than 0.03 or three percent suggests the instantaneous NAPL removal assumption is satisified.
General) NAPL was removed from wells with combination of The Spill Buddy NAPL skimmer pump and a high capacity bailer. Bailer was used exclusively at wells NNW and NW.
5) NA = Not Recorded, not available, or could not be calculated.

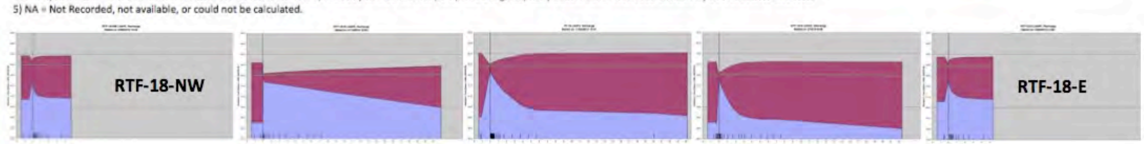


Figure 7. T_n results for RTF-series of recovery wells based on bail-down tests conducted in 2015 and 2016

Correlation between CPT/UVOST Profiling Data and T_n Testing Results

An analysis was conducted to investigate whether a correlation exists between the CPT/UVOST indicator information developed previously and LNAPL transmissivity T_n as measured during two bail-down testing periods. If a correlation exists it might be possible to use the correlation to reliably predict time-dependent LNAPL recovery potential at existing or future recovery wells co-located with CPT/UVOST profiling locations.

The analysis process involved several assumptions or steps:

1. Assume that field data for recovery well and profiling pair TF-18 and UV-CPT-2 are accurate, representative, and mutually compatible and the interplay between the two sets of information can be extended to all CPT/UVOST locations where subsurface conditions are very similar to that at UV-CPT-2 and TF-18.
2. Assume that the estimated T_n values summarized in Figure 7 are the true measure of T_n at each location and that T_n has not changed as a result of recent LNAPL skimming operations.

3. Using the maximum and effective smear zone thickness indicators and the maximum and average signal response values (Attachment 1 and Table 1), investigate whether a positive or negative correlation exists with recovery well T_n estimates based on bail-down testing.
4. If a reasonably significant correlation exists then develop a predictive algorithm that returns a T_n estimate for each of the 12 CPT/UVOST locations based on the TF-18 T_n estimate coupled to UV-CPT-2 indicator information.

Maximum and effective smear zone thickness (for horizon at and below 30 ft-bg) for each UV-CPT profile paired with a RTF-series well was plotted against the corresponding T_n estimate from bail-down testing. The resulting chart of b_{max} and b_{eff} versus T_n is shown in Figure 8. No correlation is evident.

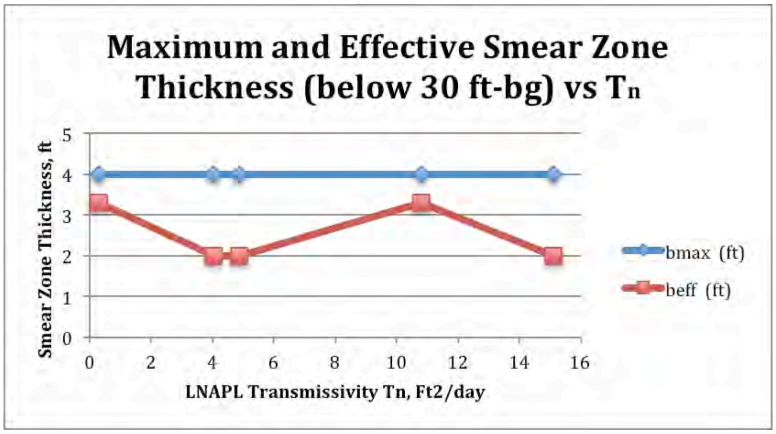


Figure 8. Assessing for correlation between smear zone thickness and T_n estimates.

Maximum and average signal response for b_{max} and b_{eff}, respectively, for each UV-CPT profile paired with a RTF-series well was plotted against the corresponding T_n estimate from bail-down testing. The resulting chart is shown in Figure 9. No correlation is evident.

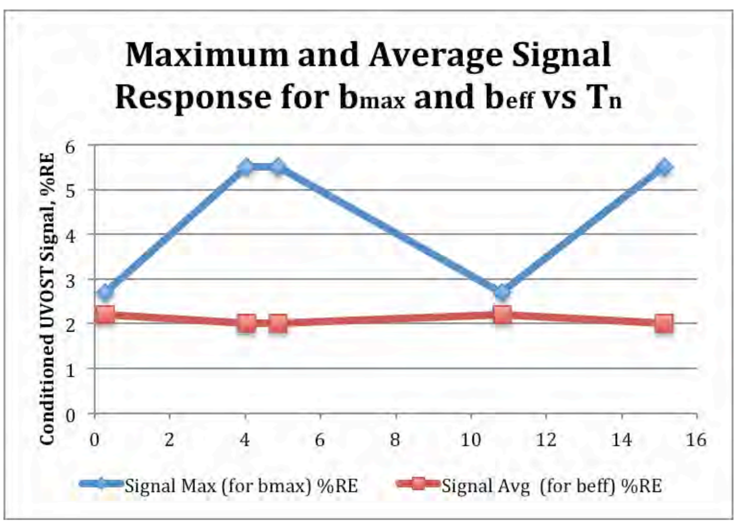


Figure 9. Assessing for correlation between signal response and T_n estimates.

Based on the available data, no correlation exists between the recovery well T_n estimates based on bail-down testing and CPT/UVOST indicators. Additional pairings of T_n estimates (based on bail-down or other procedure) with CPT/UVOST profiles are necessary to increase the data set and potential for establishing a useful correlation(s). At this time, it is not clear why no correlation exists when clearly there should be at least a weak correlation between one or both of the indicator sets and the bail-down test results.

Prediction of LNAPL Recovery at TF-18 Area Recovery Wells

InfraSUR developed predictions of LNAPL recovery by skimming technique for TF-18 and the five surrounding recovery wells. A decision was made to use a combined theoretical-empirical estimation tool developed by BP for this purpose (**Figure 10**). Important assumptions are:

- the T_n estimates are accurate,
- skimming is the recovery method at each location,
- only LNAPL is recovered,
- an infinite LNAPL source exists,
- the skimming induced drawdown is a consistent 0.5 feet at each location, and
- the LNAPL and groundwater cones of depression generated by LNAPL recovery at one recovery well do not intercept any adjacent recovery well.

The T_n estimate of 4.04 ft2/day applied to the tool is shown in Figure 10. The predicted production rate for TF-18 is approximately 16 gallons per day (gpd) or 5,800 gallons per year (gpy). InfraSUR interprets the 16-gpd rate to be an early stage or short-term rate that may be sustainable for a few months under optimal recovery operational conditions.

The predicted early stage rates for the other locations are presented in Table 3 and range from a low of approximately 2 gpd (for T_n of 0.3 ft^2/day at RTF-18-W) to a high of approximately 90 gpd (for T_n of 15.1 ft^2/day at RTF-18-E). The near term performance eventually experienced is expected to vary significantly from these predictions for various reasons. The inherent unreliability of the T_n metric (as documented in the BP document referenced previously) encompasses several of those reasons.

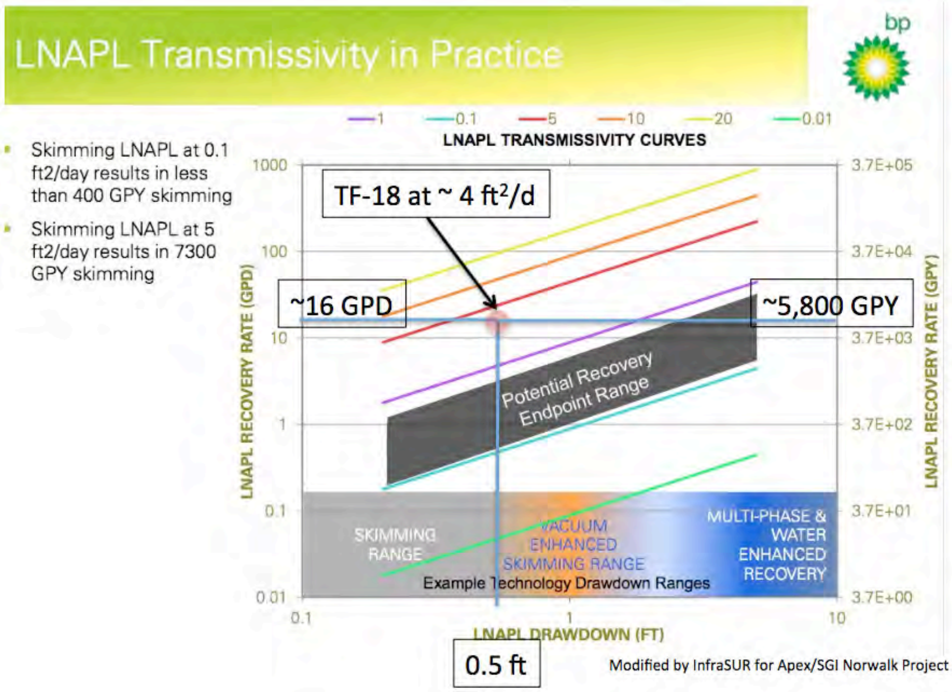


Figure 10. Use of T_n to estimate LNAPL recoverability (modified from presentation by A. Kirkman of BP titled "LNAPL Transmissivity Application and Estimation").

Table 3. Predictions of Early Stage LNAPL Recovery at TF-18 Area Wells

Well ID	T_n, Ft^2/day	Recovery Rate, GPD	Recovery Rate, GPY
TF-18	4.0	16	5,800
RTF-18-E	15.1	90	32,800
RTF-18-N	4.9	18	6,600
RTF-18-W	0.3	2	700
RTF-18-NW	10.8	80	2,900
RTF-18-NNW	2.5	10	3,600

The reasonableness of these estimates derived from the BP estimator was checked at the scoping level by application of the Thiem equation:

$$s_i = Q_i \ (Ln\ (R_o/r_w) / 2\pi\ (K_i k_r b_i)$$

where,

s_i is the drawdown in the i_{th} fluid phase (in this case LNAPL layer), feet

Q_i is the recovery flow rate, feet3/day

R_o is the radius of influence to zero drawdown, feet

r_w is the well radius, feet

$K_ik_rb_i$ are the hydraulic conductivity x relative permeability x flow layer thickness (assumed to be constant), ft2/day.

We will assume that the T_n bail down values can be substituted for $K_ik_rb_i$.

For a T_n value of 4.0 ft2/day (TF-18), a 0.166 ft well radius, assumed R_o of 70 feet, and s_i of 0.5 feet and solving for Q:

$$Q = 2\pi(4)(0.5)/Ln(70.0/0.166) = 2.08 \text{ ft3/day}$$

$$2.08 \text{ ft3/day x } 7.48 \text{ gal/ft3} = 15.6 \text{ gal/day}$$

The result is equivalent to the BP estimator output.

The predictions are sensitive to assumed R_o and r_w and of course the T_n. Drawdown can be controlled. The assumed values have not been validated for the Site.

The predictions are compared to SGI's recent field operations experience. During the summer of 2016 SGI constructed an automated LNAPL skimmer system with dedicated skimmer pumps in each of the six RTF-series wells. Operations began in the July and August 2016 timeframe. SGI observed that there is a narrow window of operation at each well that achieves a balance between extracted fluids and incoming LNAPL. Week long system shut-in results in LNAPL accumulated thicknesses returning to two feet or greater.

Approximately 2,000 gallons LNAPL have been removed as of early November. A rough production rate on a daily basis for the system and individual typical well is estimated by assuming 60 days of consistent operation amongst the six wells. A rough estimate of 33 gal/day and 5.5 gal/day/well was derived. The actual daily response was likely different than this rough estimate but the general nature of recovery is indicated. SGI anticipates the production rate to rise as the operation is optimized.

The LNAPL skimming operations described above have confirmed the presence of a continuous LNAPL body of significant volume within a transmissive zone in the immediate vicinity of the RTF-series recovery wells. The production results also provide a first approximation of short-term LNAPL recovery potential and are be used here to compare to the early T_n based recovery rates.

The field observed early stage LNAPL recovery potential appears to be in the general range of 5 to 10 gal/day/well.

The long term LNAPL recovery rate must decline from early stage rates because there is a finite volume of LNAPL around the recovery wells. Decline in performance will likely not be linear but should accelerate with increasing cumulative recovery. A rough estimate of the <u>minimum</u> time to recover 50 percent (10,200 gal) of the estimated volume of

20,400 gallons in the saturated core of the LNAPL plume in the TF-18 Area (presented previously) is calculated as follows.

For a simple average T_n value of 6.3 ft^2/day for the area, use of Figure 10 gives a short term production estimate of approximately 20 gpd/well and if this rate is assumed to hold for the duration of recovery operations then:

$$10{,}200 \text{ gal} / (20 \text{ gpd/well} \times 6 \text{ wells}) = 85 \text{ days or } 0.23 \text{ years}$$

Due to difficulties in maintaining the optimal LNAPL skimming schedule for each recovery well, it is not likely that LNAPL skimming operations with the six recovery wells will achieve a sustained 120-gpd rate for 85 days and it is unlikely that skimming under any circumstances will recover 50 percent of the LNAPL that is present.

Summary

InfraSUR was tasked to:

- Estimate *in situ* LNAPL volume,
- Predict possible recovery rates of LNAPL across a representative region of the former tank farm area, with emphasis on the TF-18 Area, and
- Recommend data collection activities to support LNAPL recovery planning and optimization in the TF-18 Area.

InfraSUR completed these tasks by:

- Interpreting the three rounds of CPT/UVOST profiling data,
- Defining the spatial limits of the central LNAPL plume including the TF-18 Area,
- Developing an estimate of the LNAPL volume comprising the saturated core of central LNAPL plume, including TF-18 Area,
- Developing LNAPL transmissivity (T_n) estimates for the TF-18 Area recovery wells,
- Assessing the potential correlation between CPT/UVOST profiling data and T_n testing results for the TF-18 Area wells (thus evaluating the reliability of T_n as a predictor of LNAPL recovery performance),
- Estimating short-term and long-term LNAPL recovery rates at the TF-18 Area wells and comparing to recent field operations results.

The saturated zone core of the LNAPL plume may contain 370,000 gallons of LNAPL. Site-specific indicators of LNAPL smear zone thickness and pore saturation developed from the CPT/UVOST profiles were leverage to generate the volume estimate. The central LNAPL plume was delimited using a range of information sources including the three rounds of CPT/UVOST profiling. The total volume of LNAPL within both the saturated and vadose zone portions of the plume combined may be significantly more than indicated for the plume core. Estimation error is likely significant.

InfraSUR attempted to estimate future LNAPL recovery potential by leveraging both T_n estimates from well testing and CPT/UVOST indicators. No correlation was found between select CPT/UVOST indicators and bail-down test results. Thus, only T_n estimates from well testing was available for predictive purposes.

T_n estimates for the RTF-series of wells ranges from 0.29 to 15.12 ft^2/day, a spread of almost two orders of magnitude. Using the BP estimation tool, this T_n range suggests a short-term (or early stage) LNAPL production range of 2 to 90 gal/day per well. SGI experience to date is that the six recovery wells are performing in a similar way with non-optimized skimming production rates on the low end of the range suggested by the T_n values and BP estimation tool.

A LNAPL recovery rate per well of 5 to 15 gpd may be expected on average for a series of months, but a significant decline curve is expected. Actual recovery outcomes have been generally 5-10 gpd/well.

InfraSUR suspects that only a fraction of the LNAPL volume in the central LNAPL plume is recoverable using skimming technique. Perhaps as much as 40 or 50 percent of the mobile fraction may be recoverable under natural and induced hydraulic gradients. Eighty to ninety percent (80 to 90 percent) or more of the entire LNAPL volume in the saturated sand may be recoverable using chemical enhanced oil-phase recovery methods, particularly surfactant and polymer flushing. A significant fraction of the LNAPL not recovered by LNAPL skimming and flushing is likely susceptible to biosparging and vacuum extraction techniques.

Appendix C Attachment 1

Attachment 1 to Appendix C (InfraSUR memorandum to SGI dated 11/14/16)
Summary of CPT/UVOST Profiling
Defense Fuel Support Point, Norwalk, California

	First LNAPL occurence				Second LNAPL occurrence				Third LNAPL occurence			
UVOST Location (1)	Depth (Range) to Detection, Ft-bg (2)	Thickness (feet)	In Fine Grained Lithology (Y/N) (4)	Max %RE (5)	Depth (Range) to Detection, Ft-bg (6)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE	Depth (Range) to Detection, Ft-bg (7)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE
UV1	23 - 27	5	N	13.8	~ (3)	~	~	~	~	~	~	~
UV2	29 - 30	2	Y	94	~	~	~	~	~	~	~	~
UV3	19 - 24	6	Y & N	8.2	~	~	~	~	~	~	~	~
UV4	19 - 21.5	3.5	Y	21.5	~	~	~	~	~	~	~	~
UV5	25	1	Y	15.4	27 - 28.5	1.5	Y	79.5	~	~	~	~
UV6	26.5	1	Y	3.5	~	~	~	~	~	~	~	~
UV7	None	~	~	~	~	~	~	~	~	~	~	~
UV8	None	~	~	~	~	~	~	~	~	~	~	~
UV9	28 - 30	3	Y & N	2.5	~	~	~	~	~	~	~	~
UV10	24.2 - 26.8	2.5	N	7.5	28 - 33	6	Y & N	13.5	~	~	~	~
UV11	28 - 31	4	Y	1.6	~	~	~	~	~	~	~	~
UV12	28 - 31	4	Y	49.5	~	~	~	~	~	~	~	~
UV13	19 - 25	7	Y	2	~	~	~	~	~	~	~	~
UV14	28.5 - 31	2.5	Y & N	60.5	31.5 - 33	2.5	N	58.5	~	~	~	~
UV15	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-1	24.5-25.5	2	N & Y	3.5	26.5 - 28.5	2	Y	3.8	30.7-34	3.3	N	2.7
UV-CPT-2	25-27.5	2.5	Y & N	19	28.5 - 30	1.5	Y	1.4	32 - 36	5	N	5.5
UV-CPT-3	24.5-25.3	1	Y & N	0.5	28.5 - 34.5	6	N	3.4	~	~	~	~
UV-CPT-4	29.5 - 35	5.5	N	4.5	~	~	~	~	~	~	~	~
UV-CPT-5	30-32	3	N	3.8	~	~	~	~	~	~	~	~
UV-CPT-6	28-29.5	1.5	Y & N	6.7	32-37	6	N	10.2	~	~	~	~
UV-CPT-7	29 -32	3	Y & N	0.5	~	~	~	~	~	~	~	~
UV-CPT-8	24 - 24.8	0.8	Y	0.7	~	~	~	~	~	~	~	~
UV-CPT-9	25 - 30.5	5.5	Y	37.7	~	~	~	~	~	~	~	~
UV-CPT-10	25 - 26.5	1.5	Y	7.3	29-35	7	N	8.7	~	~	~	~
UV-CPT-11	27.5-31	4.5	Y	3.4	~	~	~	~	~	~	~	~
UV-CPT-12	None	~	~	~	~	~	~	~	~	~	~	~

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UV-CPT-13	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-14	**30.5-36.5**	6	N	6.8	~	~	~	~	~	~	~	~
UV-CPT-15	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-16	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-17	29.5-34	4.5	N	10.5	~	~	~	~	~	~	~	~
UV-CPT-18	32 - 34.5	2.5	N	1.3	~	~	~	~	~	~	~	~
UV-CPT-19	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-20	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-21	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-22	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-23	**35-37**	3	N	5.3	~	~	~	~	~	~	~	~
UV-CPT-24	None				~	~	~	~	~	~	~	~
UV-CPT-25	28.5-30	1.5	Y	5.9	~	~	~	~	~	~	~	~
UV-CPT-26	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-27	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-28	None	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-29	30-33	4	Y	39	33.5-35	2.5	N	2	~	~	~	~
UV-CPT-30	**28.5 - 37**	8.5	Y & N	0.6	~	~	~	~	~	~	~	~
UV-CPT-31	30 - 32.5	2.5	Y & N	0.48	~	~	~	~	~	~	~	~
UV-CPT-32	20 - 22	3	N	0.58	~	~	~	~	~	~	~	~
UV-CPT-33	none	~	~	~	~	~	~	~	~	~	~	~
UV-CPT-34	29 - 30.5	1.5	N	9.5	~	~	~	~	~	~	~	~
UV-CPT-35	30 - 31	2	Y & N	0.4	~	~	~	~	~	~	~	~
UV-CPT-36	26 - 27.5	1.5	Y & N	6.1	~	~	~	~	~	~	~	~
UV-CPT-37	22.5 - 25	2.5	Y	5.8	~	~	~	~	~	~	~	~
UV-CPT-38	25.5 - 33	8.5	Y & N	19.5	~	~	~	~	~	~	~	~
UV-CPT-39	26 - 27.7	1.7	Y & N	5.8	~	~	~	~	~	~	~	~

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Defense Fuel Support Point, Norwalk, California

	First LNAPL occurence				Second LNAPL occurrence				Third LNAPL occurence			
UVOST Location (1)	Depth (Range) to Detection, Ft-bg (2)	Thickness (feet)	In Fine Grained Lithology (Y/N) (4)	Max %RE (5)	Depth (Range) to Detection, Ft-bg (6)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE	Depth (Range) to Detection, Ft-bg (7)	Thickness (feet)	In Fine Grained Lithology (Y/N)	Max %RE

Footnotes:

1) UV-1 through UV-15 completed in October 2010. UV-CPT-1 through UV-CPT-29 completed in November and December 2015. UV-CPT-30 through UV-CPT-39 completed in August 2016. Conditions at sounding locations are expected to change over time. In particular water and LNAPL saturation will change with time.
2) Depth pick-offs to establish maximum smear zone thickness for LNAPL detection(s) below 20 ft-bg. If multiple separate horizons of LNAPL indicated, then this column is reserved for the shallowest.
3) A tilda (~) indicates that due to lack of a significant UVOST signature, the indicated data cell is intentionally left blank.
4) Fine grained lithology means sediment that has average or dominant grain-size smaller than fine sand.
5) Max % RE for this table means maximum percent of Reference Emitter adjusted for baseline noise, where RE is standard calibration fluid (and not site specific LNAPL).
6) Max depth range of LNAPL detection below 20 ft-bg. If multiple horizons of LNAPL indicated then this is reserved for the second shallowest horizon.
7) Max depth range of LNAPL detection below 20 ft-bg. If multiple horizons of LNAPL indicated then this is reserved for the third shallowest horizon.

Appendix C Attachment 2

InfraSUR
Environment &
Infrastructure

Transmitted by Email

To: Paul Parmentier, SGI
From: Jim Studer
Date: November 29, 2015
Subject: LNAPL Transmissitivy Test Summary and Results for TF-18, DFSP Norwalk

Introduction

The Defense Fuel Support Point (DFSP) Norwalk is located in Norwalk, California and historically stored and dispensed large quantities of petroleum hydrocarbon (PHC) fuels such as various grades of jet fuel. Historical operations resulted in significant uncontrolled releases of the PHC fuels as Light Non-Aqueous Phase Liquid (LNAPL) to the subsurface with impacts in certain areas extending below the vadose zone and into the saturated sediments and groundwater. Commercial PHC fuels transportation and dispensing operations at and around the facility have also resulted in uncontrolled PHC LNAPL releases. Despite a series of subsurface investigation and remediation activities having taken place at the facility (led by both defense and commercial contractors), LNAPL persists and appears to exist in potentially significant volume at depth (e.g., approximately 25 to 35 feet below grade (ft-bg)) in spatially limited areas on and around the facility. The Source Group Inc. (SGI) is tasked to conduct environmental remediation activities at DFSP Norwalk and is actively engaged in quantifying the presence and character of LNAPL, estimating LNAPL mobility and recoverability, and planning and executing actions that efficiently mitigate potential risks associated with subsurface distributions of LNAPL. The facility is being closed and will undergo re-use. For example, a significant portion of the facility is planned for transfer to the City of Norwalk for use as a public park. Other portions will likely be developed for light commercial or perhaps even residential use.

To support development of the conceptual site model and remedal alternatives for the facility, SGI is evaluating subsurface hydraulics including what is referred to as “LNAPL Transmissivity or Tn.” Tn is fundamentally different than conventionally understood hydraulic transmissivity or T and represents a metric that, essentially, helps to communicate the ease with which LNAPL will flow towards and into a recovery well undergoing some form of fluids pumping to establish an internally-directed hydraulic gradient field. Chemical and/or thermal assist to increase LNAPL mobility and recoverability is not included in a Tn evaluation. A variety of field tests are available to assess and estimate Tn for a specific combination of hydrogeologic, LNAPL, and test well conditions and one of these tests, the Tn bail-down test, has been used in the past at the subject facility. SGI has decided to conduct one or more additional Tn tests using the bail-down procedure and has retained InfraSUR LLC to assist in planning and analysis. This assistance includes review of prior Tn bail-down test attempts at the facility and recommendation of a future course of action (InfraSUR memo dated October 20, 2015), and to prepare an abbreviated field procedure for conducting a Tn bail down test at remediation well TF-18 (InfraSUR memo dated November 22, 2015). On November 23, 2015, SGI initiated LNAPL removal from TF-18 using the bail-down procedure for the express purpose of acquiring field data for estimating Tn. The fluid level gauging effort terminated on November 24 and SGI requested that InfraSUR conduct an analysis of the test data for the purpose of estimating Tn for well TF-18. Figure 1 shows the location of test well TF-18.

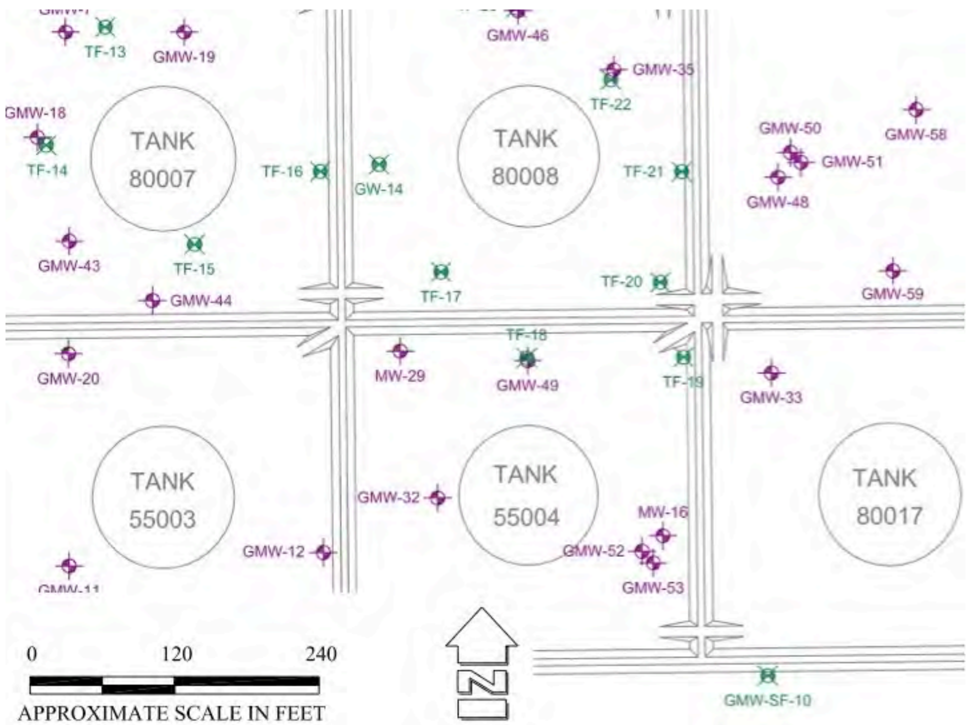


Figure 1. Plan view of east-central area of facility with test well TF-18 between former Tanks 80008 and 55004 (modified from SGI, 2015)

In response to the request, InfraSUR conducted the analysis and prepared this technical memorandum presenting background information, TF-18 test conditions, data interpretation, and results. However, to start, an overview of the data interpretation and analysis effort and proposed Tn estimate for TF-18 is summarized in the following section.

Summary of Tn Estimates for TF-18

SGI conducted a Tn bail-down test at TF-18 from November 23 to November 24, 2015. More accurately, the test started on November 16 with the gauging of fluid levels and removal of a finite volume of LNAPL. The test was conducted in general accordance with an abbreviated procedure based on ASTM Standard Guide for Estimation of LNAPL Transmissivity (E2856 − 13). Test data were provided to InfraSUR for analysis and estimation of Tn at TF-18 for the test period. InfraSUR used the American Petroleum Institute (API) LNAPL Transmissivity Workbook (published on-line May 2012) to:

1. summarize various sources of pertinent information and data concerning the test,
2. perform diagnostic analyses for checking compliance with test and analysis assumptions,
3. make significant adjustments to the data inputs to improve Tn estimate outcomes,
4. select a conceptual model of test conditions, and
5. calculate estimates of Tn.

Figure 2 is a graph created using the SGI field data from November 23 and 24. The chart shows, as a function of increasing time, the depth to groundwater (or NAPL-Water interface), depth to potentiometric surface (water table), and depth to product or LNAPL (Air-NAPL interface). Time is elapsed time since LNAPL removal was terminated, depth is the distance below the measuring point (assumed to be the top of casing).The red and blue dashed lines can be ignored.

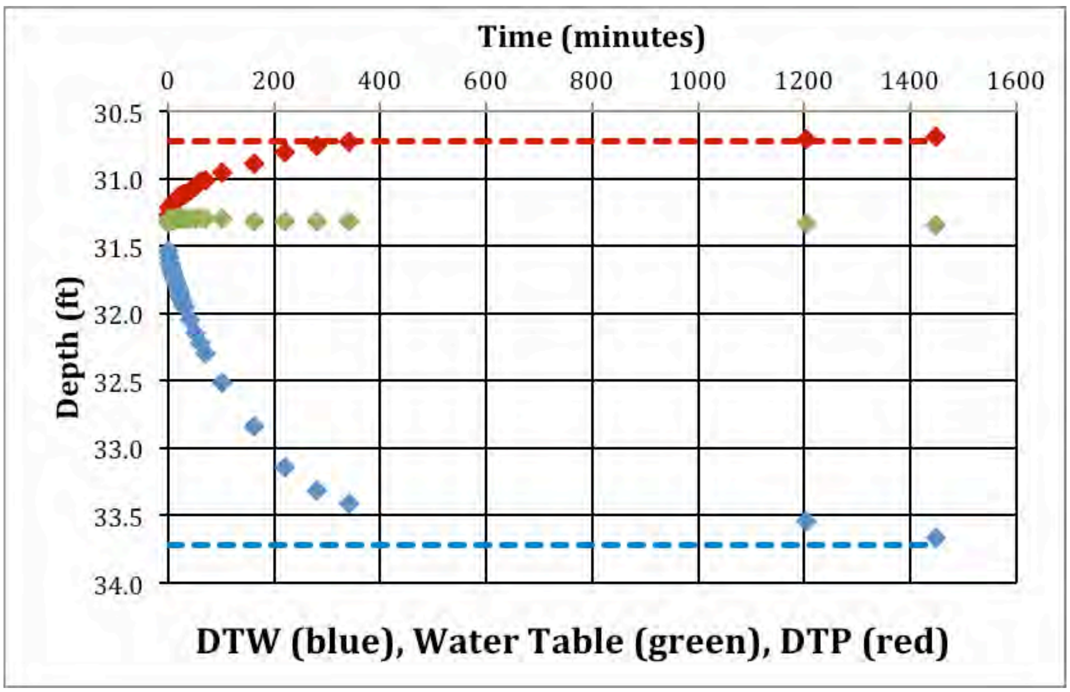


Figure 2. SGI field gauging data for TF-18. DTW = Depth to Water. Water Table = Potentiometric Surface. DTP = Depth to Product.

InfraSUR determined that required test conditions and data quality were reasonably satisfied to proceed to into an iterative process of diagnostic evaluation of the data inputs > conceptual model/analysis procedure selection > analytical calculation of Tn estimates > reviewing for reasonableness and magnitude of error between analytical methodologies. Initially, InfraSUR utilized the field data with certain elapsed time assumptions and other assumptions concerning well construction and LNAPL character. The only modification to the test data was the removal of early time data to reduce the effect of delayed filter pack drainage and other non-ideal fluid level response. InfraSUR identified issues with the field data that prevented full application of the algorithms. InfraSUR identified possible root causes and made adjustments involving truncation of late time data which were succesful in making the algorithms fully operational. Moving forward with the modified field data set, InfraSUR selected an unconfined LNAPL layer conceptual model (as opposed to perched or confined models) to represent mobile LNAPL in the sand layer at approximately 32 feet-below grade (discussed later) and proceeded to calculation of the first set of Tn estimates using three analytical methods. These methods are:

- Generalized Bouwer and Rice (1976, referred to here as GBR),
- Cooper and Jacob (1946, referred to here as CJ), and
- Cooper, Bredehoeft, and Papadopulos (1967, referred to here as CBP).

InfraSUR then conducted sensivity analyses (described later). Analytical method output and inter-method variability statistics were recorded and the apparent “most representative” Tn outcome was identified. The following Tn estimate is presented as most representative of the data inputs for TF-18 as of November 23 and 24, 2015:

TF-18 T_n = 3.7 ft^2/day
(plus or minus one standard deviation ~ 1.2 ft^2/day)

This estimate is generally consistent with a range of Tn estimates derived for five other test wells across the facility, mostly along the southern property area. This range is 0.05 to 3.18 ft^2/day.

The result from application of the GBR, CJ, and CBP analytical methods suggest that, as of late November 2015, the Tn at TF-18 is significantly above 0.1 to 0.8 ft^2/day, a Tn range published by ITRC (2009) to represent fluid recovery impracticability. Important caveats are that this Tn value is representative of a very limited volume of the formation around the test well and that this published range is associated with simple hydraulic recovery approaches that do not incorporate chemical and/or thermal enhanced recovery technology.

Significant error or uncertainty may be associated with the estimated Tn value reported here for TF-18 with possible sources of error listed as follows:

- Incomplete understanding of subsurface conditions immediately at and around TF-18.
- Possible non-equilibrium fluid hydrodynamic conditions prior to and during the test period.
- Inaccurate information on composition/density of LNAPL at and near TF-18.
- Measurement error.
- Inaccurate information on TF-18 construction and development history including borehole diameter, filter pack composition, quality of prior well development and redevelopment, and ground surface elevation.

Notwithstanding the potentially significant sources of error and associated uncertainty, it is InfraSUR’s opinion that SGI may act in confidence that Tn at TF-18 is of sufficient magnitude at this time to support a variety of moderately to highly aggressive LNAPL removal actions in the vicinity of the test well, whether enhanced by chemicals (and/or heat) or otherwise.

Background Information

In 2013, ASTM published a Standard Guide (E2856 − 13) titled Standard Guide for Estimation of LNAPL Transmissivity. An earlier version was published in 2011. This guide identifies four techniques for Tn estimation:

1. Bail Down and Slug Testing

2. Manual LNAPL Skimming Tests

3. Recovery Data-Based Methods

4. Tracer Test-Based Methods.

While each of these approaches may have applicability at Norwalk facility for future applications, the first technique listed has been of primary interest historically for the facility and was applied to well TF-18. The bail-down test procedure is popular due to perceived ease of application and low cost compared to the other procedures. Slugs, bailers, and LNAPL pumps can be used to create an “instantaneous” pressure change in the LNAPL layer in the well filter pack and formation. The volume of fluid recovered (must be mostly LNAPL) is recorded and fluid level recovery (LNAPL and groundwater) is recorded. An instantaneous pressure change is required by the several data analytical methods that are typically employed. A five minute duration LNAPL removal activity can be considered instantaneous if the overall bail-down test duration is at least five times that duration or 500 minutes. With critical information on test well construction details in hand the test data are then reviewed using various diagnostic approaches to determine data quality and adherence to one of several possible conceptualizations of LNAPL-formation-test well interaction. Data analysis approaches are selected based on the selected conceptualization and then the calculations are conducted. API provides an Excel® based workbook that helps to improve efficiency of data summarization, review, and Tn calculations.

The target test well TF-18 was installed in 1984 by contractor GTI for use as a total fluids recovery well. This well is located south of former Above Ground Storage Tank 80008. Although a boring log / well completion report is not available, historical information indicates that the well has a total depth of 50.5 ft-bg and has a four inch diameter PVC casing and screen. The screen is positioned from 20 to 50 ft-bg and has 20 slot openings. The borehole diameter is not known and the nature of the filter pack is not known. The top of casing elevation is reported as 73.94 feet (datum not specified). The elevation of the ground surface is not known. Numerous vertical and angle boreholes have been drilled near TF-18 and wells have been installed in some of the boreholes. Wells located near TF-18 include (but are not limited to) GMW-49, TF-17, MW-29, MW-16, and GMW-48. As discussed later, the latter three wells were gauged periodically during the bail-down test at TF-18.

Profiling using Cone Penetrometer (CPT) in conjunction with an Ultraviolet Optical Scanning Tool (UVOST) technology has been conducted in the vicinity of TF-18. In 2011, CPT and UVOST profiling was conducted by Parsons approximately 60 feet northwest of TF-18 (location UV-10). A modest signal indicating jet fuel impact was detected at approximately 28 – 30 ft-bg. On November 23, 2015, SGI conducted CPT/UVOST profiling very close to TF-18 (exact location not available). This profiling borehole is referred to as UV-CPT-1. A draft version of the graphical summary for UV-CPT1 was provided by SGI and this version is included at Attachment 1. Signals suggestive of jet fuel were recorded at horizons centered on 16.6, 25.3, 28.1, and 32.5 ft-bg. The narrow but relatively intense signal at 28.1 ft-bg seems to correlate with detections of LNAPL at various locations east of TF-18. Corresponding earth materials at this depth horizon are typically dominated by silt or clay. An interesting signal was detected in a horizon centered on 32.5 ft-bg indicating a horizon of LNAPL impact from 30.8 to 33.5 ft-bg. The CPT data indicates this horizon is fully within a sand layer. The CPT data indicate that fine-grained materials overlie the sand layer with an interface at 28 ft-bg. During the bail-down test, the potentiometric surface was positioned in the sand layer and the fine-grained materials do not appear to have influenced hydraulic or LNAPL flow behavior.

Well TF-18 has been used over a period of years for LNAPL gauging and recovery including use of manually operated LNAPL recovery pumps and vacuum trucks. Prior testing of a LNAPL sample obtained from the well suggests that the LNAPL consists of some combination of kerosene and gasoline (more accurately naphtha, which is a higher octane component of gasoline blends). For reference, JP-4 is a 50:50 kerosene and gasoline mix and JP-5 is primarily kerosene. JP-4 and JP-5 were introduced across the military complex in 1951 and 1952, respectively. An email from SGI Daniel Swensson on September 18, 2015 states that the LNAPL sample was biodegraded JP-4. The product sample density is not known but the density of fresh gasoline and kerosene, relative to water at standard conditions are 0.71 – 0.77 and 0.78 - 0.81, respectively. The relative density of fresh JP-4 and fresh JP-5 at 20 C is approximately 0.76 and 0.82, respectively. A biodegraded JP-4 might have a relative density of around 0.78.

Bail-Down Test and Data Analysis Results

On November 16, SGI conducted an initial LNAPL gauging and bail-out event at TF-18. This event established the air-NAPL and NAPL-water fluid levels (30.66 and 33.44 ft-bg, respectively), the apparent LNAPL thickess (2.78 ft), and also demonstrated hydraulic connection between LNAPL in the formation and the screened casing. Approximately three (3) gallons of LNAPL with very little water was removed while operating a Still Buddy™ LNAPL pump with interface detector, the duration estimated to be approximately five minutes. By November 20, the two fluid interfaces had recovered to within 0.10 ft of the November 16 baseline and 2.90 ft of LNAPL accumulation was recorded. The apparent water table elevation was stable between the two dates.

Three days later, on November 23, the main bail-down test was initiated with fluid level gauging at TF-18. Three and one-quarter (3.25) gallons of LNAPL were removed using a Still Buddy™ LNAPL pump with interface detector and then manual gauging of the two interfaces was conducted 33 times over approximately 24 hours to document fluid level recovery. Images of the original field data in tabulated form are presented as Attachment 2.

For TF-18, the air-NAPL interface, NAPL-water interface, and apparent LNAPL thickness was measured to be 30.72 ft-bg, 33.72 ft-bg, and 3.0 ft, respectively. The apparent position of the water table was 0.13 ft lower than suggested by the prior gauging data. Interestingly, the apparent LNAPL thickness increased by 0.22 ft from November 16 to the 20th and then the 23rd with most or all of the additional LNAPL accumulation probably occurring during the recovery periods.

In an attempt to document that fluids were in general equilibrium with the formation and test well, fluid level gauging was conducted at three nearby wells MW-29, MW-16, and GMW-48 immediately prior to LNAPL bailing and then on November 24. These three wells form a triangle around TF-18 and are located approximately 105, 200, and 270 ft from the test well, respectively. Baseline depth to groundwater was documented to be 36.88, 34.48. and 32.63 ft-bg for MW-29, MW-16, and GMW-48, respectively. No LNAPL accumulation was observed in these wells. These same wells were gauged after it was observed that the LNAPL column in TF-18 had recovered approximately 90 percent from the initial thickness of three feet. The second set of depth to water measurements are 37.56, 34.47, and 31.74 ft-bg, respectively. Interestingly, the groundwater level at MW-29 was significantly lower, the level at MW-16 flat, and the level at GMW-48 slightly lower compared to their initial measurements. The depth to water at TF-18 was 33.67 ft-bg with accumulated product thickness of 2.98 ft. The water level was 0.05 ft higher than that measured immediately before LNAPL pumping. These data taken together suggest that the subsurface hydrology at and around TF-18 was not static during the bail-down test and that

LNAPL, distributed between one or more zones, was not static. Equilibrium conditions may not have existed at the start of the bailing operation to remove the LNAPL.

InfraSUR determined that the general uniformity of the field data and uncertainty over well construction and LNAPL properties were acceptable for proceeding into detailed data interpretation and calculation of Tn estimates. The TF-18 gauging data for November 23 and 24 were entered into the API workbook along with other information on the test well and the LNAPL present in the well. Of particular importance, InfraSUR assumed that the borehole diameter is 8.25 inches (guided by prior scoping calculations by InfraSUR) and that the relative density was 0.78 (water = 1). A series of ten graphs were generated to support visualization of the spatial and temporal relationships that were observable and to aid in selecting the most appropriate conceptual model and analytical approaches to data interpretation and Tn estimation. Significant deviation from ideal recovery response for an unconfined LNAPL layer conceptualization was observed but the deviations did not appear to be prohibitive to attempts at Tn estimation. The unconfined conceptual model was selected and three analytical models provided by the API workbook, previously introduced as GBR, CJ, and CBP were engaged to estimate Tn. Features, benefits, and limitations of each method are discussed in the ASTM standard as well as the API workbook user guide and will not be repeated here. Our goal was to derive at least one Tn estimate for TF-18 from each of the three methods without dedicating an undue amount of time to data corrections and iterations aimed at seeking lowest apparent error and method variability.

The first application of the three analytical methods produced results for the CH and CBP methods but the GBR method failed. Upon detailed inspection, InfraSUR determined that the late time data from 282 minutes (elapsed time) and later were not compatible with the linear regression function of the GBR method. Early time data out to 25 minutes (elapsed time) had already been removed to reduce filter pack drainage effects but it appeared that late time truncation was necessary, at least for the GBR method. To achieve the goal of at least one Tn estimate from each method, InfraSUR re-ran the calculations for each method using the field data, modified by removal of late time data. With the data set adjustment, the GBR method became operational and results from the three methods were generated, along with inter-method variability statistics. Using professional judgment, including comparing the results to Tn values derived from historical Tn testing at the facility, InfraSUR deemed the results reasonable.

Having succeeded in adjusting the field data to better match algorithm requirements/limitations and producing what appeared to be reasonable Tn estimates, InfraSUR then conducted a limited sensitivity analysis by independently varying borehole diameter (8.25 to 12.00 inches) and the value of the elapsed time assignment associated with the first fluid level gauging event “post-bailing” (1 minute to 0.1 minute). The latter resulted in required changes to elapsed time assignments for all subsequent gauging events. For each iteration beyond the initial iteration, individual method Tn estimates and a mean Tn estimate were generated along with inter-method variability statistics. Table 1 summarizes the workbook output by iteration, starting with the initial application where no late time data truncation was applied. A cursory review of the results for the four iterations clearly indicate that only the GBR method was sensitive to the specific changes made in late time data values used, borehole diameter, and initial elapsed time assigment.

Table 1. Summary of Tn Estimates for Various Assumptions

Iteration	1	2	3	4
Variable/Value				
Truncated Late Data	No	Yes	Yes	Yes
Borehole Dia. (in)	8.25	8.25	12	8.25
Initial Elapsed Time Assignment (min)	1	1	1	0.1
Method/Tn (ft2/day)				
GBR	Not Available (NA)	5.0	7.0	5.1
CJ	3.5	3.5	3.5	3.5
CBP	2.6	2.6	2.6	2.6
Variability Statistics				
Mean (ft2/day)	3.1	3.7	4.4	3.8
SD (ft2/day)	NA	1.2	2.3	1.2
COV (unitless)	NA	0.3	0.5	0.3

The iteration deemed most representative of test conditions is iteration #2 with truncated data, 8.25 inch diameter borehole, and initial gauging data post-bailing representing an elapsed time of 1 minute. The mean Tn estimate is 3.73 ft^2/day with a standard deviation (SD) of 1.19 and coefficient of variation (COV) of 0.32. The ten graphs associated with iteration 2 are presented in Attachment 3.

Seven (7) Tn bail-down tests have previously been attempted by other contractors at and near the facility. Data for two of the tests could not be analyzed and the remaining five tests resulted in estimated Tn values and they range from 0.05 to 3.18 ft^2/day. This range is potentially representative for test wells located along the facility property boundary to the southeast and south of TF-18. While we are compelled to compare our estimate to this range to help establish reasonableness (such comparison appearing to be favorable), InfraSUR cautions that the Tn bail-down test is highly sensitive to specific test conditions that are variable in space and time.

A systems level assessment of possible sources of error suggests that significant uncertainty is associated with each of the derived Tn values including the value we deem most representative. Possible sources of error are listed as follows:

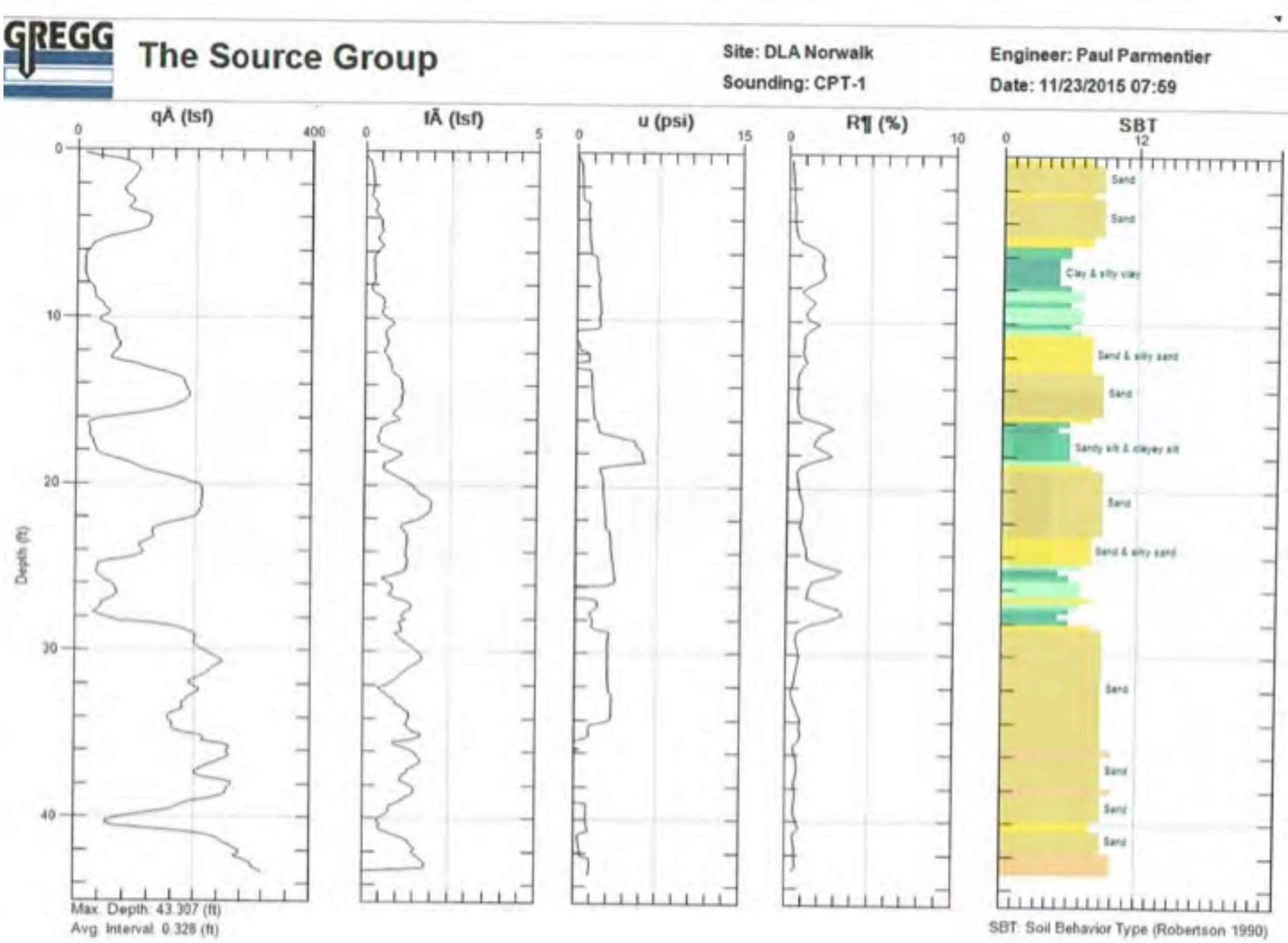
- Incomplete understanding of subsurface conditions immediately at and around TF-18.
- Possible non-equilibrium fluid hydrodynamic conditions prior to, and during, the test period.
- Inaccurate information on composition/density of LNAPL at and near TF-18.
- Measurement error.
- Inaccurate information on TF-18 construction and development history including borehole diameter, filter pack composition, quality of prior well development and redevelopment, and ground surface elevation.

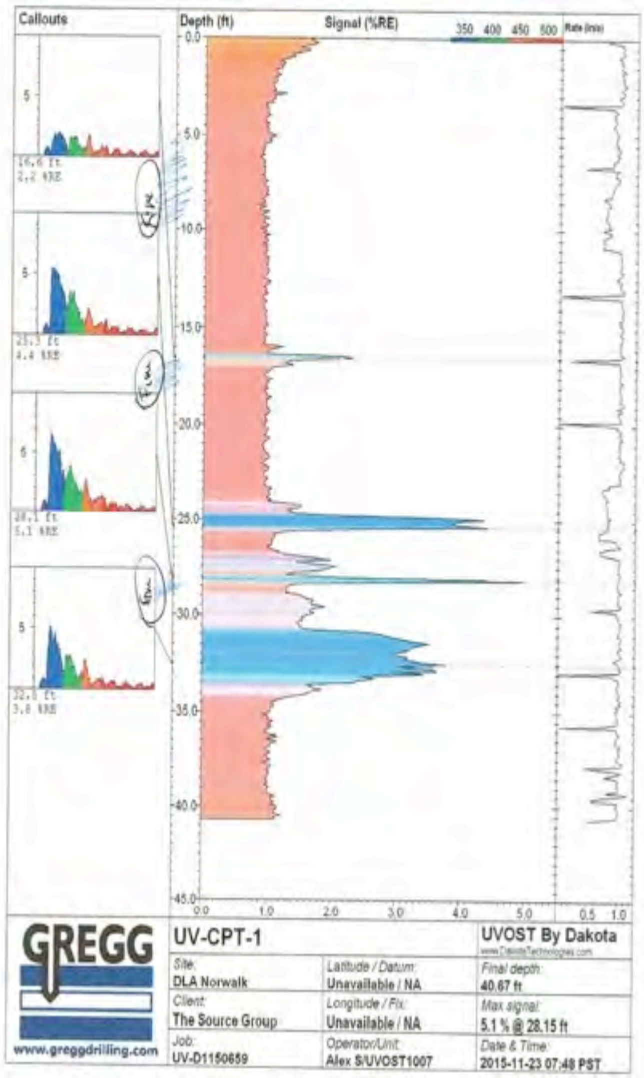
The uncertainty can not be eliminated by iterative adjustment to values for variables important to each data interpretation method. Possibly only modest improvement in estimation reliability can be expected but even a goal of achieving a modest improvement would require careful field observations addressing the above sources of error.

Notwithstanding the potentially significant sources of error and uncertainty, it is InfraSUR's opinion that SGI may act in confidence with the knowledge that sufficient LNAPL and formation permeability is present at TF-18 (and as of late November 2015) to support a variety of moderately to highly aggressive LNAPL removal actions, whether enhanced by chemicals (and/or heat) or otherwise. InfraSUR's opinion is based on the observed recovery response of test well TF-18 to rapid LNAPL removal and a corresponding Tn estimated value of 3.7 ft^2/day. This value along with the other values summarized in Table 3 suggest that, as of November 2015, the Tn at TF-18 was significantly above 0.1 to 0.8 ft^2/day, a Tn range published by ITRC (2009) to represent fluid recovery impracticability (for simple hydraulic recovery approaches).

Attachment 1

Draft CPT and UVOST Profiling Information for Location Near TF-18




Callouts
Depth (ft)
Signal (%RE)
350 400 450 500
UV-CPT-1
UVOST By Dakota
Site:
DLA Norwalk
Latitude / Datum:
Unavailable / NA
Final depth:
40.67 ft
Client:
The Source Group
Longitude / Fix:
Unavailable / NA
Max signal:
5.1 % @ 28.15 ft
Job:
UV-D1150659
Operator/Unit:
Alex S/UVOST1007
Date & Time:
2015-11-23 07:48 PST
www.greggdrilling.com

Attachment 2

Field Data

LNAPL Field Sheet
TF-18 Bail Down Test
Norwalk Tank Farm, DLA - Energy
15306 Norwalk Blvd.
Norwalk, CA 90650

Start Date: Mon 11-23-15 **Completed By:** ____________________

Weather: Sunny 80°

Well ID	Date	Time	Depth to LNAPL (ft btoc)	Depth to Water (ft btoc)	Measured LNAPL Thickness (ft)	Notes:
mw-29	11-23-15	0919		36.88		
mw-16	11-23-15	0922		34.48		
Gmw-48	11-23-15	0926		31.63		
TF-18	11-23-15	0936	30.72	33.72	3.00	
		1041	31.27	31.54	0.37	bailed 3.25 gallons
		1043	31.22	31.59	0.37	
		1044	31.22	31.62	0.40	
		1045	31.22	31.64	0.42	
		1046	31.21	31.66	0.45	
		1047	31.21	31.68	0.47	
		1048	31.20	31.69	0.49	
		1049	31.20	31.69	0.49	
		1050	31.19	31.72	0.52	
		1051	31.18	31.72	0.54	
		1052	31.18	31.74	0.56	
		1054	31.18	31.76	0.58	
		1056	31.17	31.77	0.60	
		1058	31.16	31.80	0.64	
		110~~6~~0	31.15	31.82	0.67	
		1102	31.14	31.84	0.70	
		1104	31.13	31.87	0.74	

Comments:

LNAPL Field Sheet
TF-18 Bail Down Test
Norwalk Tank Farm, DLA - Energy
15306 Norwalk Blvd.
Norwalk, CA 90650

Start Date: Mon 11-23-15 **Completed By:** ______

Weather: Sunny 80°

Well ID	Date	Time	Depth to LNAPL (ft btoc)	Depth to Water (ft btoc)	Measured LNAPL Thickness (ft)	Notes:
TF-18	11-23-18	1106	31.13	31.90	0.77	
		1108	31.12	31.92	0.80	
		1110	31.12	31.95	0.83	
		1112	31.12	31.96	0.84	
		1122	31.09	32.05	0.96	
		1132	31.06	32.15	1.09	
		1142	31.03	32.22	1.19	
		1152	31.02	32.30	1.28	
		1222	30.96	32.52	1.56	
		1322	30.89	32.84	1.95	
		1422	30.81	33.15	2.34	
		1522	30.76	33.32	2.56	
		1622	30.73	33-41	2-68	
MW-29	11-24-15	6:32	~~37.56~~	37.56		from edge of square steel box top
MW-16		6:35	~~34.47~~	34.47		from mark on PVC, north side
GMW-48		6:40	~~31.74~~	31.74		from edge of PVC
TF-18		6:45	30.71	~~[illegible]~~ 33.55	2.84	
TF-19		6:50	–	33.15		No product - 2" Ø TF19 PVC
TF-18		10:50	30.69	33.67	2.98	

Comments:

Attachment 3

Graphs for Iteration 2

Figure A3-1

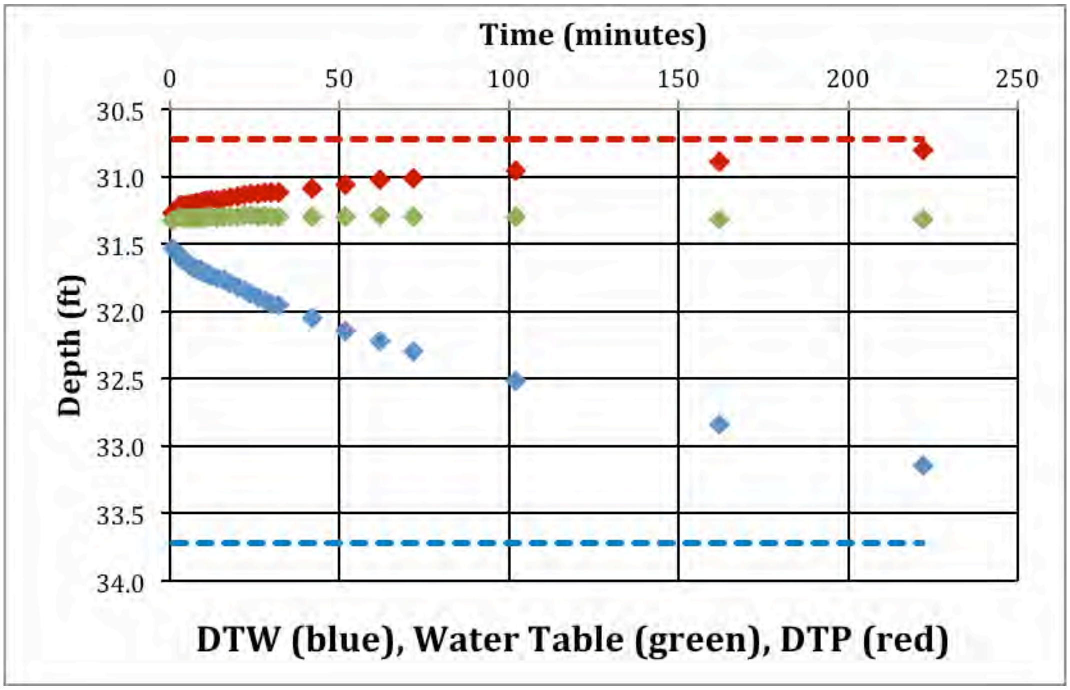


Figure A3-2

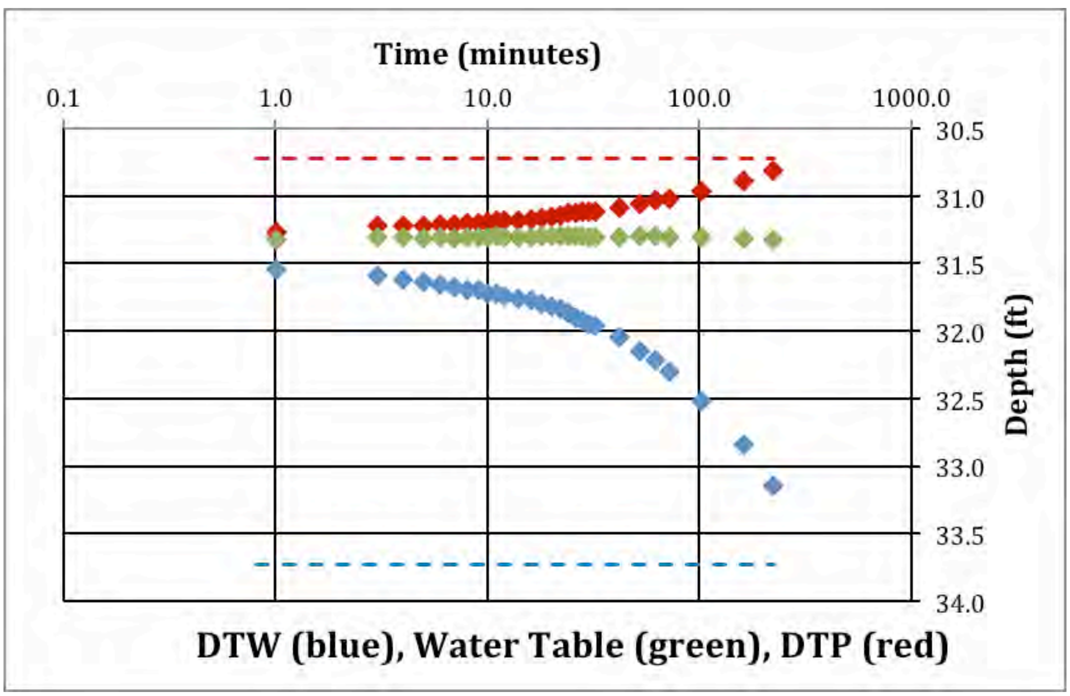


Figure A3-3

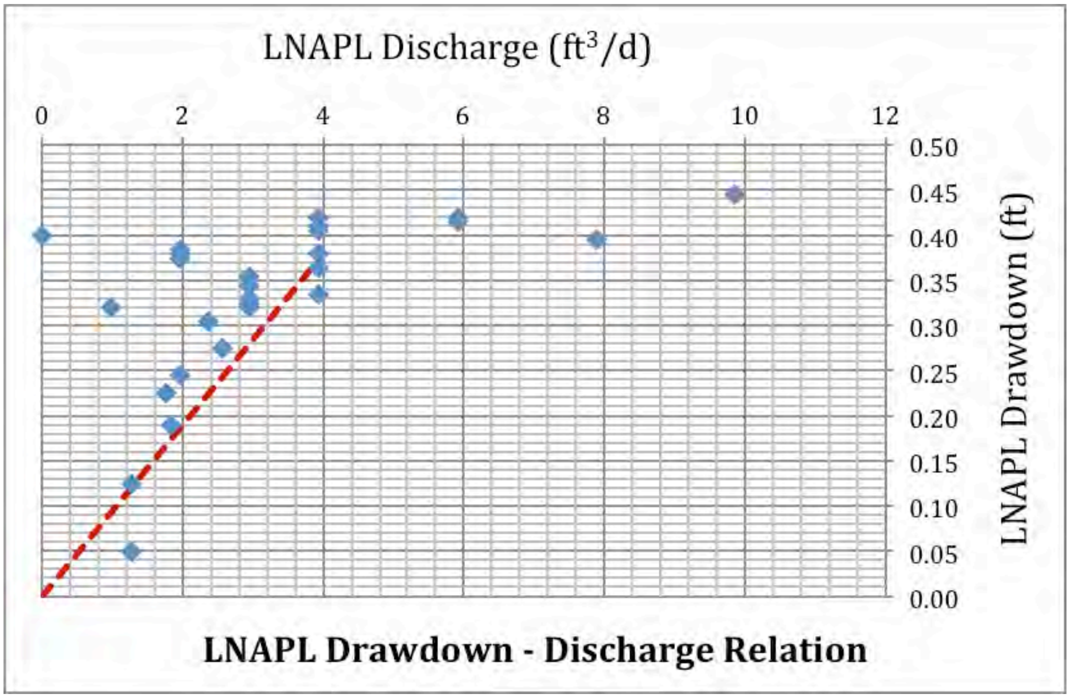


Figure A3-4

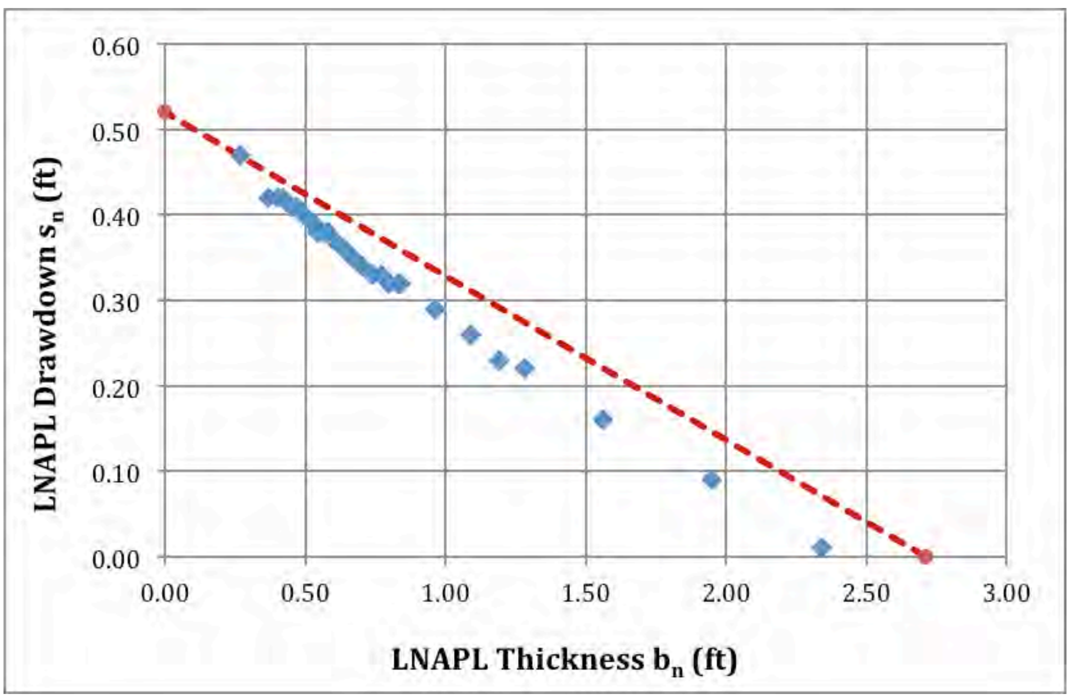


Figure A3-5

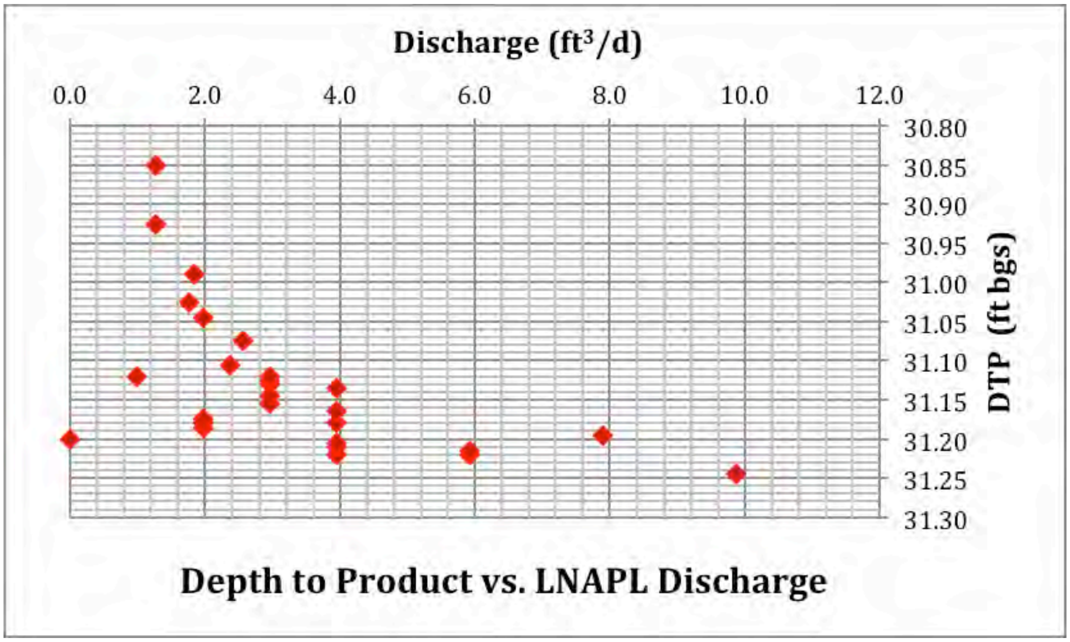


Figure A3-6

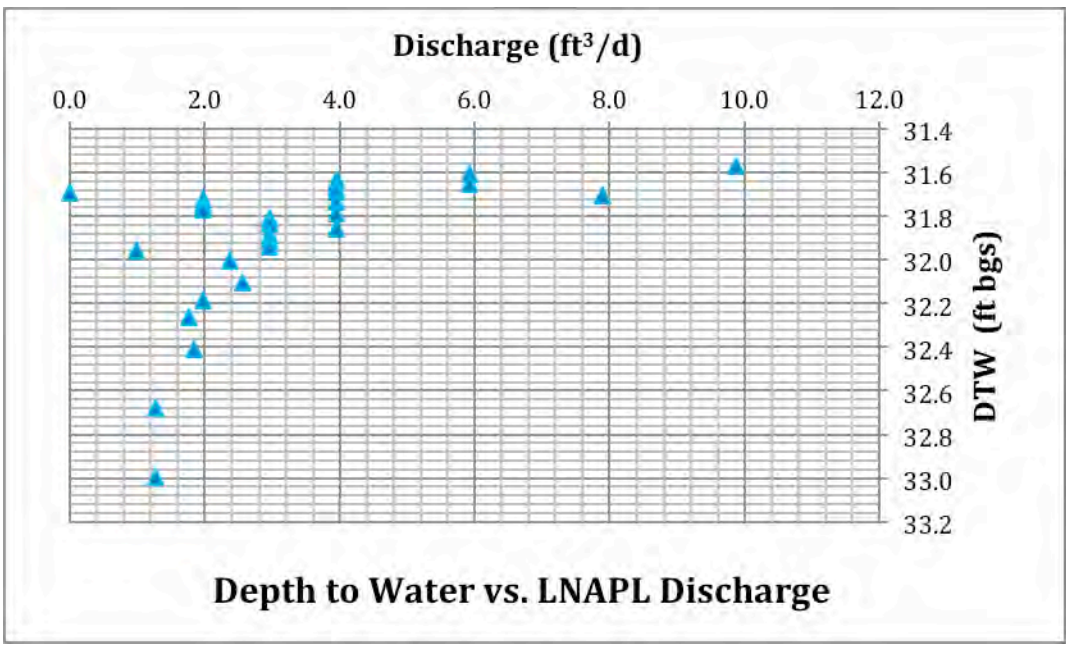


Figure A3-7

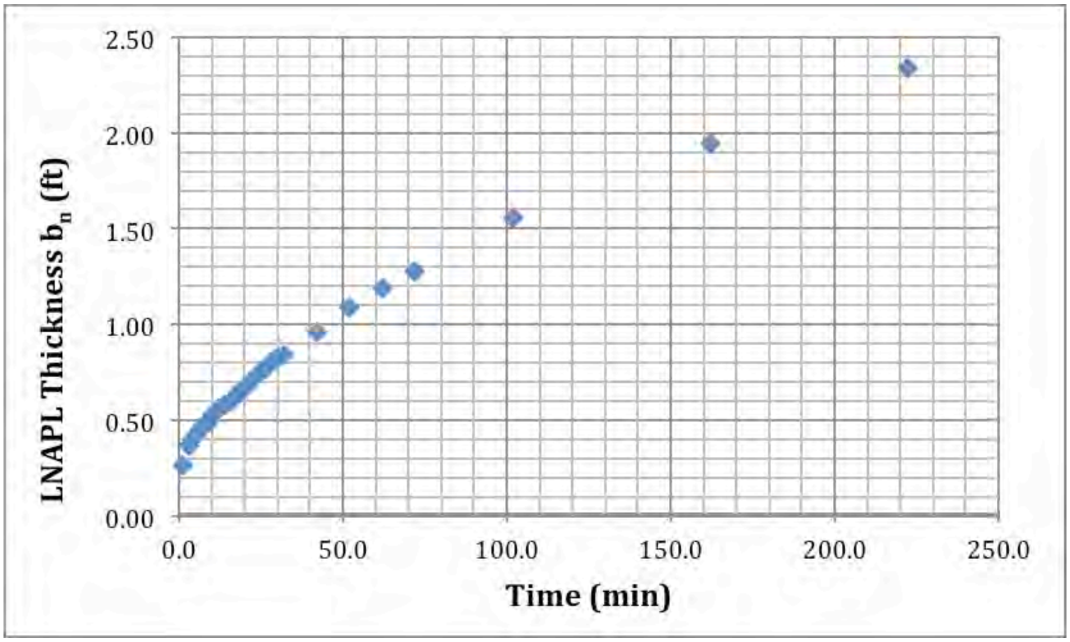


Figure A3-8

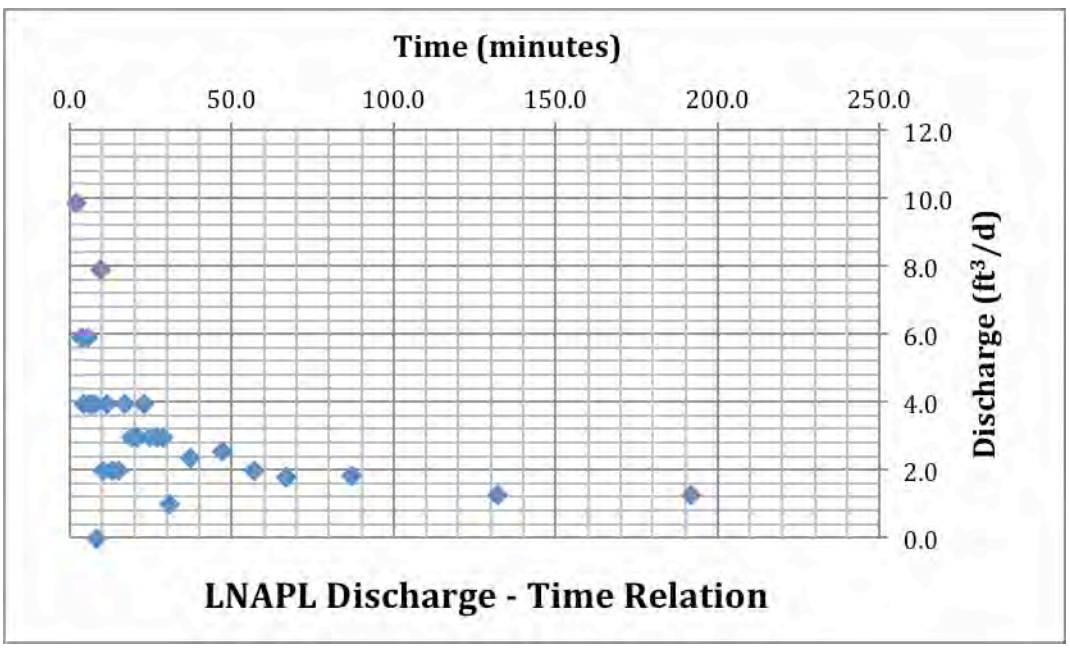


Figure A3-9

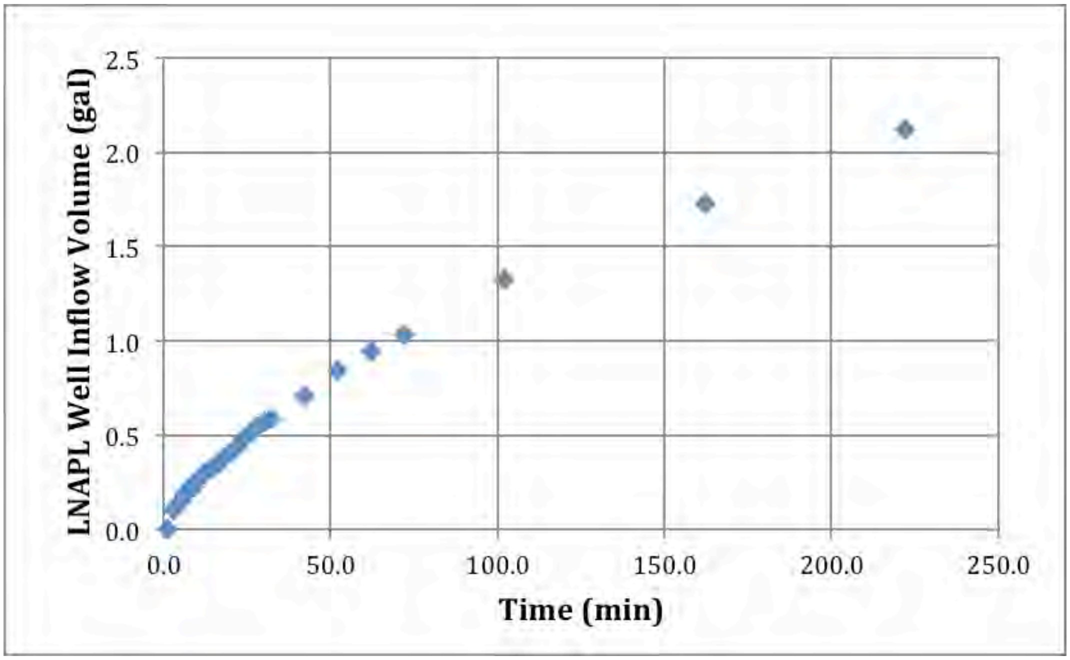
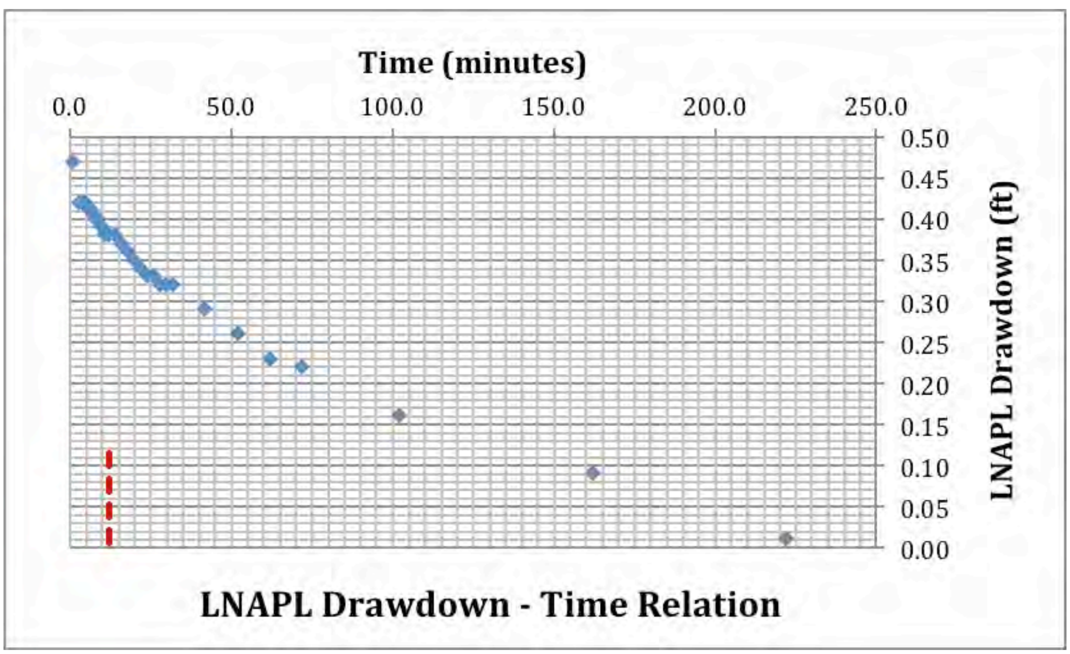


Figure A3-10



APPENDIX D

Tf-18 Area Well Logs

The Source Group, Inc.

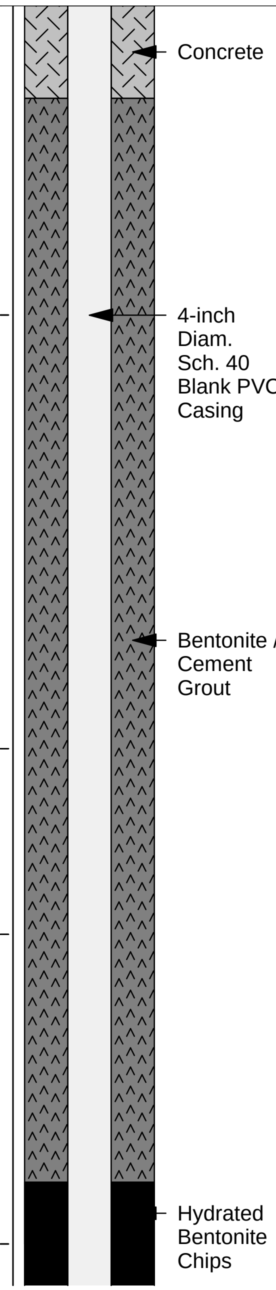
WELL NO. [BORING ID]: **RTF-18-E**

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, east of TF-18

START DATE:	12-28-15	FINISH DATE:	12-28-15	CASING TOP ELEV. (FT MSL):	
DRILLER:	BC2 Environmental	SURFACE ELEV. (FT MSL):		GW DEPTH (FT BGS):	35'
DRILL EQUIP:	CME-95	NORTHING:		SCREEN INTERVAL (FT BGS):	25-40 ft bgs
DRILL METHOD:	Hollow-stem Auger	EASTING:		SCREEN DIAM/SLOT SIZE (INCHES):	0.020"
SAMPLE METHOD:	Steel Sleeves with 5035	**BORE ANGLE:**	Vertical	TOTAL WELL DEPTH (FT BGS):	40'
CONTRACTOR:	BC2 Environmental; C-57 #959758	HOLE DIAM. (IN.)/DEPTH (FT BGS):	10"/41'	LOGGED BY:	Katie Reich
MONITORING DEVICE:	Mini Rae 3000 PID	BACKFILL MATERIAL:	#2/12 Sand/ Hyd. Bent. Chips/Grout	CHECKED BY:	Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	LITH. SYMBOL	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
0.0	7:25			0		ML	Boring cleared to 5 feet bgs with hand auger and/or posthole digger.
-1.0 to -5.0						ML	SILT [0;10;90;0], brown, dry, fine- to medium-grained, no hydrocarbon odor.
-5.0	7:35			0		SP	POORLY GRADED SAND [0;100;0;0], tan, slightly moist, medium- to coarse-grained, no hydrocarbon odor.
-10.0	8:00	4 6 7		0		SP	
-12.0	8:02			3.2		CL	CLAY [0;10;0;90], olive-gray, moist, stiff, fine-grained, poorly graded, low plasticity, no hydrocarbon odor.
-15.0	8:04	6 7 11		0		SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, medium dense, medium- to coarse-grained, no hydrocarbon odor.
-20.0	8:06	7 9		991			

WELL CONSTRUCTION



The Source Group, Inc.

WELL NO. [BORING ID]: RTF-18-E

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, east of TF-18

START DATE: 12-28-15
DRILLER: BC2 Environmental
DRILL EQUIP: CME-95
DRILL METHOD: Hollow-stem Auger
SAMPLE METHOD: Steel Sleeves with 5035
CONTRACTOR: BC2 Environmental; C-57 #959758
MONITORING DEVICE: Mini Rae 3000 PID

FINISH DATE: 12-28-15
SURFACE ELEV. (FT MSL):
NORTHING:
EASTING:
BORE ANGLE: Vertical
HOLE DIAM. (IN.)/DEPTH (FT BGS): 10"/41'
BACKFILL MATERIAL: #2/12 Sand/ Hyd. Bent. Chips/Grout

CASING TOP ELEV. (FT MSL):
GW DEPTH (FT BGS): 35'
SCREEN INTERVAL (FT BGS): 25-40 ft bgs
SCREEN DIAM/SLOT SIZE (INCHES): 0.020"
TOTAL WELL DEPTH (FT BGS): 40'
LOGGED BY: Katie Reich
CHECKED BY: Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
-21.0		13				
-22.0 to -25.0					ML	SILT [0;5;95;0], olive-gray, slightly moist, fine-grained, poorly graded, low plasticity, hydrocarbon odor
-25.0	8:11	10 14 20		3,500	SW/ML	SAND AND SILT [0;50;50;0], brown/tan, slightly moist, dense/hard, fine- to medium-grained, well-graded, medium plasticity, hydrocarbon odor.
-27.0					SW	WELL-GRADED SAND [0;100;0;0], gray, dry, dense, fine-grained, hydrocarbon odor.
-30.0	8:17	9 12		187 >15,000	SP	POORLY GRADED SAND [0;100;0;0], brown, slightly moist, medium dense, medium-grained, hydrocarbon odor.
-31.0	8:17	17	RTF-18-E-31'	>15,000	SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, medium dense, medium-grained, hydrocarbon odor.
-32.0					SM	SILTY SAND [0;70;30;0], gray, slightly moist, medium-dense, fine- to medium-grained, poorly graded, low plasticity, hydrocarbon odor. Groundwater encountered at 35' bgs.
-35.0	8:23	8 12 16		21	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, fine- to medium-grained, hydrocarbon odor.
-40.0	8:29	9 11 15	RTF-18-E-40'	145 40.9 7.4	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, fine- to medium-grained, hydrocarbon odor.
-41.0						

WELL CONSTRUCTION

#2/12 Sand

4-inch Diam. 0.020" Screened Sch. 40 PVC Casing

Threaded End Cap

The Source Group, Inc.

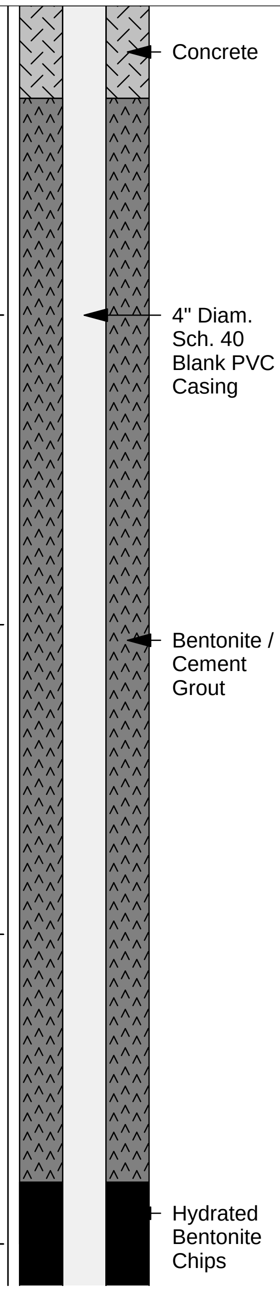
WELL NO. [BORING ID]: RTF-18-N

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007
LOCATION: DFSP Norwalk, north of TF-18

START DATE: 12-28-15	FINISH DATE: 12-28-15	CASING TOP ELEV. (FT MSL):	
DRILLER: BC2 Environmental	SURFACE ELEV. (FT MSL):	GW DEPTH (FT BGS): 35'	
DRILL EQUIP: CME-95	NORTHING:	SCREEN INTERVAL (FT BGS): 25-40 ft bgs	
DRILL METHOD: Hollow-stem Auger	EASTING:	SCREEN DIAM/SLOT SIZE (INCHES): 0.020"	
SAMPLE METHOD: Steel Sleeves with 5035	**BORE ANGLE:** Vertical	TOTAL WELL DEPTH (FT BGS): 40'	
CONTRACTOR: BC2 Environmental; C-57 #969758	HOLE DIAM. (IN.)/DEPTH (FT BGS): 10"/41'	LOGGED BY: Katie Reich	
MONITORING DEVICE: Mini Rae 3000 PID	BACKFILL MATERIAL: #2/12 Sand/ Hyd. Bent. Chips/Grout	CHECKED BY: Daniel Swensson	

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	LITH. SYMBOL	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
0.0	12:00			0			Boring cleared to 5 feet bgs with hand auger and/or posthole digger.
0.0 to -5.0						SP-SM	POORLY GRADED SAND WITH SILT [0;90;10;0], tan, dry, medium dense, fine- to medium-grained, poorly graded, no hydrocarbon odor.
-5.0	12:12	6 7 14		0		SP	POORLY GRADED SAND [0;100;0;0], tan, dry, medium dense, medium- to coarse-grained, no hydrocarbon odor.
-10.0	12:16 12:18	8 10 12		11.1 7.7		ML	SILT WITH SAND [0;15;85;0], olive-gray, moist, very stiff, fine-grained, poorly graded, medium plasticity, no hydrocarbon odor.
-15.0	12:21	11 14 21		20.1		SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, dense, medium-grained, no hydrocarbon odor.
-20.0	12:25	10 12		60.0			

WELL CONSTRUCTION



The Source Group, Inc. WELL NO. [BORING ID]: **RTF-18-N**

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, north of TF-18

START DATE: 12-28-15
DRILLER: BC2 Environmental
DRILL EQUIP: CME-95
DRILL METHOD: Hollow-stem Auger
SAMPLE METHOD: Steel Sleeves with 5035
CONTRACTOR: BC2 Environmental; C-57 #969758
MONITORING DEVICE: Mini Rae 3000 PID

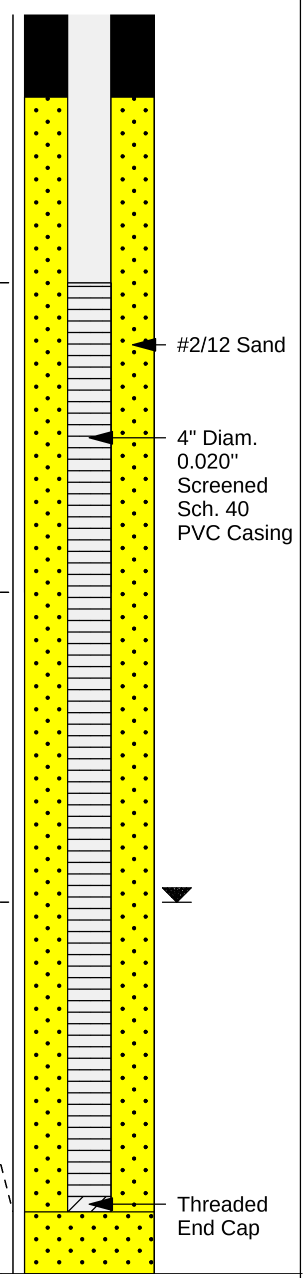
FINISH DATE: 12-28-15
SURFACE ELEV. (FT MSL):
NORTHING:
EASTING:
BORE ANGLE: Vertical
HOLE DIAM. (IN.)/DEPTH (FT BGS): 10''/41'
BACKFILL MATERIAL: #2/12 Sand/ Hyd. Bent. Chips/Grout

CASING TOP ELEV. (FT MSL):
GW DEPTH (FT BGS): 35'
SCREEN INTERVAL (FT BGS): 25-40 ft bgs
SCREEN DIAM/SLOT SIZE (INCHES): 0.020"
TOTAL WELL DEPTH (FT BGS): 40'
LOGGED BY: Katie Reich
CHECKED BY: Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
-21.0 to -25.0		18			ML	SILT [0;10;90;0], olive-gray, slightly moist, very stiff to hard, fine-grained, poorly graded, medium plasticity, hydrocarbon odor
-25.0 to -30.0	12:29	10 13 19		7,900	SP	POORLY GRADED SAND [0;100;0;0], gray, dry, dense, fine-grained, hydrocarbon odor.
-30.0 to -35.0	12:52	13 19 23		>15,000	SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, dense, fine-grained, hydrocarbon odor. Groundwater encountered at ~35' bgs.
-35.0 to -39.7	12:36	12 16 21	RTF-18-N-35'	250	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, dense, medium-grained, hydrocarbon odor.
-39.7 to -41.0	12:40	16 19 25	RTF-18-N-40'	6.0		POORLY GRADED SAND [0;100;0;0], gray, saturated, dense, medium-grained, no hydrocarbon odor.

Depth scale: -21.0, -22.0, -23.0, -24.0, -25.0, -26.0, -27.0, -28.0, -29.0, -30.0, -31.0, -32.0, -33.0, -34.0, -35.0, -36.0, -37.0, -38.0, -39.0, -40.0, -41.0

WELL CONSTRUCTION



The Source Group, Inc.

WELL NO. [BORING ID]: RTF-18-NNW

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, north-northwest of TF-18

START DATE:	12-29-15	FINISH DATE:	12-29-15	CASING TOP ELEV. (FT MSL):	
DRILLER:	BC2 Environmental	SURFACE ELEV. (FT MSL):		GW DEPTH (FT BGS):	38'
DRILL EQUIP:	CME-95	NORTHING:		SCREEN INTERVAL (FT BGS):	25-40 ft bgs
DRILL METHOD:	Hollow-stem Auger	EASTING:		SCREEN DIAM/SLOT SIZE (INCHES):	0.020"
SAMPLE METHOD:	Steel Sleeves with 5035	**BORE ANGLE:**	Vertical	TOTAL WELL DEPTH (FT BGS):	40'
CONTRACTOR:	BC2 Environmental; C-57 #969758	HOLE DIAM. (IN.)/DEPTH (FT BGS):	10"/41'	LOGGED BY:	Katie Reich
MONITORING DEVICE:	Mini Rae 3000 PID	BACKFILL MATERIAL:	#2/12 Sand/ Hyd. Bent. Chips/Grout	CHECKED BY:	Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	LITH. SYMBOL	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]	WELL CONSTRUCTION
0.0	7:35			0		SP-SM	Boring cleared to 5 feet bgs with hand auger and/or posthole digger. POORLY GRADED SAND WITH SILT [0;90;10;0], tan, dry, fine- to medium-grained, poorly graded, no plasticity, no hydrocarbon odor.	Concrete
-5.0	7:40	7 9 19		1.0		ML	SILT [0;5;95;0], brown, slightly moist, very stiff, fine-grained, poorly graded, medium plasticity, no hydrocarbon odor.	4-inch Diam. Sch. 40 Blank PVC Casing
-10.0	7:47	8 9 11		3.9		ML	SILT [0;10;90;0], brown, slightly moist, very stiff, fine-grained, well-graded, medium plasticity, no hydrocarbon odor.	Bentonite / Cement Grout
-15.0	7:50	9 12 13		4.3		SP	POORLY GRADED SAND [0;100;0;0], gray/tan, slightly moist, medium dense, medium-grained, no hydrocarbon odor.	
-20.0	7:52	6 10		91.9				Hydrated Bentonite Chips

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0, -16.0, -17.0, -18.0, -19.0, -20.0

The Source Group, Inc. **WELL NO. [BORING ID]: RTF-18-NNW**

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, north-northwest of TF-18

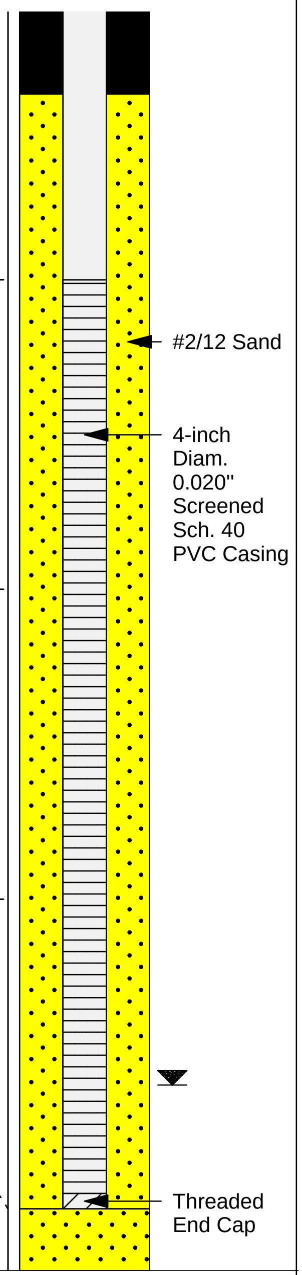
START DATE: 12-29-15
DRILLER: BC2 Environmental
DRILL EQUIP: CME-95
DRILL METHOD: Hollow-stem Auger
SAMPLE METHOD: Steel Sleeves with 5035
CONTRACTOR: BC2 Environmental; C-57 #969758
MONITORING DEVICE: Mini Rae 3000 PID

FINISH DATE: 12-29-15
SURFACE ELEV. (FT MSL):
NORTHING:
EASTING:
BORE ANGLE: Vertical
HOLE DIAM. (IN.)/DEPTH (FT BGS): 10"/41'
BACKFILL MATERIAL: #2/12 Sand/ Hyd. Bent. Chips/Grout

CASING TOP ELEV. (FT MSL):
GW DEPTH (FT BGS): 38'
SCREEN INTERVAL (FT BGS): 25-40 ft bgs
SCREEN DIAM/SLOT SIZE (INCHES): 0.020"
TOTAL WELL DEPTH (FT BGS): 40'
LOGGED BY: Katie Reich
CHECKED BY: Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
-21.0 to -25.0		13			ML	SILT [0;10;90;0], gray/tan, moist, very stiff, fine-grained, medium plasticity, hydrocarbon odor.
-25.0 to -30.0	7:56	8 11 16		1,781	SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, medium dense, medium-grained, hydrocarbon odor.
-30.0 to -35.0	8:00	5 8 13		8,400	SP	POORLY GRADED SAND [0;100;0;0], gray, moist, medium dense, medium-grained, hydrocarbon odor.
-35.0 to -40.0	8:04 8:05	6 8 10	RTF-18-NNW-36'	40	SP	POORLY GRADED SAND [0;100;0;0], gray, very moist, medium dense, medium-grained, hydrocarbon odor. Groundwater encountered at ~38' bgs.
-40.0 to -41.0	8:07	7 7 11	RTF-18-NNW-40'	400	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, hydrocarbon odor.

WELL CONSTRUCTION



The Source Group, Inc. **WELL NO. [BORING ID]: RTF-18-NW**

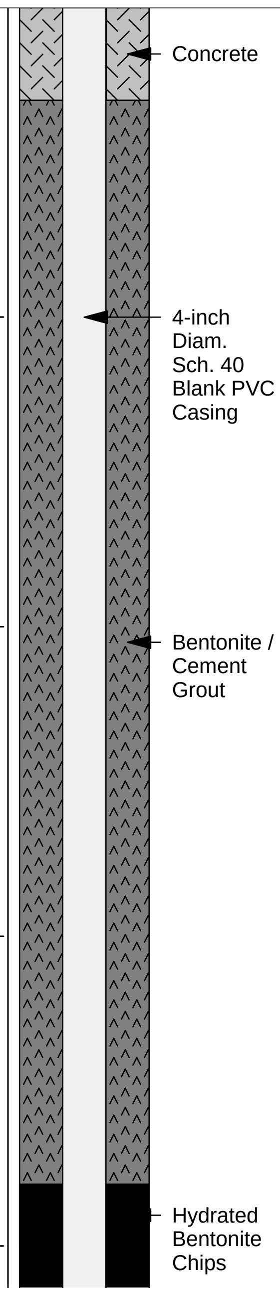
PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, northwest of TF-18

START DATE:	12-29-15	FINISH DATE:	12-29-15	CASING TOP ELEV. (FT MSL):	
DRILLER:	BC2 Environmental	SURFACE ELEV. (FT MSL):		GW DEPTH (FT BGS):	35'
DRILL EQUIP:	CME-95	NORTHING:		SCREEN INTERVAL (FT BGS):	25-40 ft bgs
DRILL METHOD:	Hollow-stem Auger	EASTING:		SCREEN DIAM/SLOT SIZE (INCHES):	0.020"
SAMPLE METHOD:	Steel Sleeves with 5035	**BORE ANGLE:**	Vertical	TOTAL WELL DEPTH (FT BGS):	40'
CONTRACTOR:	BC2 Environmental; C-57 #969758	HOLE DIAM. (IN.)/DEPTH (FT BGS):	10"/41'	LOGGED BY:	Katie Reich
MONITORING DEVICE:	Mini Rae 3000 PID	BACKFILL MATERIAL:	#2/12 Sand/ Hyd. Bent. Chips/Grout	CHECKED BY:	Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	LITH. SYMBOL	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
0.0	9:10			0		SM	Boring cleared to 5 feet bgs with hand auger and/or posthole digger. SILTY SAND [0;85;15;0], tan, dry, fine- to medium-grained, poorly graded, no plasticity, no hydrocarbon odor.
-5.0	9:14	7 10 11		0		ML	SILT WITH SAND [0;20;80;0], brown, slightly moist, very stiff, fine- to medium-grained, poorly graded, medium plasticity, no hydrocarbon odor.
-10.0	9:19	8 9 11		0.8		ML	SILT WITH SAND [0;20;80;0], brown, slightly moist, very stiff, fine- to medium-grained, poorly graded, medium plasticity, no hydrocarbon odor.
-15.0	9:22	8 12 17		0.9		SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, medium dense, medium-grained, no plasticity, no hydrocarbon odor.
-20.0	9:24	9 7		23.3			

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0, -16.0, -17.0, -18.0, -19.0, -20.0

WELL CONSTRUCTION



The Source Group, Inc. WELL NO. [BORING ID]: **RTF-18-NW**

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, northwest of TF-18

START DATE: 12-29-15
DRILLER: BC2 Environmental
DRILL EQUIP: CME-95
DRILL METHOD: Hollow-stem Auger
SAMPLE METHOD: Steel Sleeves with 5035
CONTRACTOR: BC2 Environmental; C-57 #969758
MONITORING DEVICE: Mini Rae 3000 PID

FINISH DATE: 12-29-15
SURFACE ELEV. (FT MSL):
NORTHING:
EASTING:
BORE ANGLE: Vertical
HOLE DIAM. (IN.)/DEPTH (FT BGS): 10"/41'
BACKFILL MATERIAL: #2/12 Sand/ Hyd. Bent. Chips/Grout

CASING TOP ELEV. (FT MSL):
GW DEPTH (FT BGS): 35'
SCREEN INTERVAL (FT BGS): 25-40 ft bgs
SCREEN DIAM/SLOT SIZE (INCHES): 0.020"
TOTAL WELL DEPTH (FT BGS): 40'
LOGGED BY: Katie Reich
CHECKED BY: Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]	WELL CONSTRUCTION
-21.0		11					
-22.0 to -25.0					ML	SILT [0;5;95;0], olive-gray, slightly moist, very stiff, fine-grained, medium plasticity, hydrocarbon odor	
-25.0	9:27	8 11 14		1,239			#2/12 Sand
-25.0 to -30.0					SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, medium dense, medium-grained, hydrocarbon odor.	4-inch Diam. 0.020" Screened Sch. 40 PVC Casing
-30.0	9:30	6 9		>15,000			
-31.0	9:31	11	RTF-18-NW-31'				
-30.0 to -35.0					SP	POORLY GRADED SAND [0;100;0;0], gray, moist, medium dense, medium-grained, hydrocarbon odor. Groundwater encountered at ~35' bgs.	
-35.0	9:34	5 6 9		719			
-35.0 to -40.0					SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, medium-grained, hydrocarbon odor.	
-40.0	9:40	4 6 7	RTF-18-NW-40'	12,000	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, hydrocarbon odor.	Threaded End Cap
-41.0							

The Source Group, Inc.

WELL NO. [BORING ID]: **RTF-18-W**

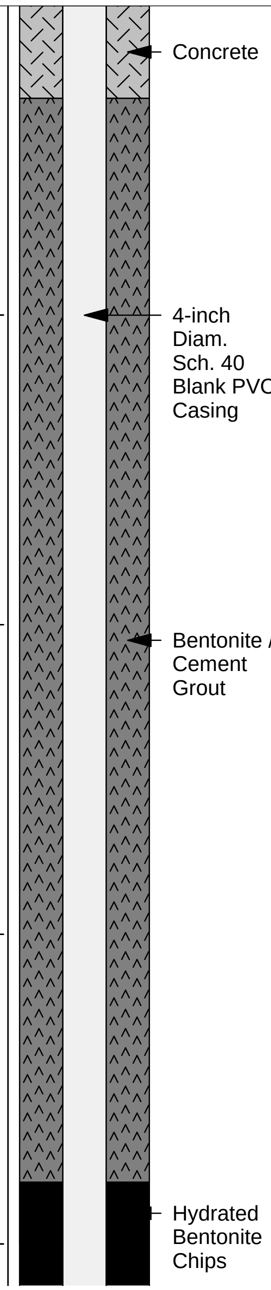
PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, east of TF-18

START DATE:	12-28-15	FINISH DATE:	12-28-15	CASING TOP ELEV. (FT MSL):	
DRILLER:	BC2 Environmental	SURFACE ELEV. (FT MSL):		GW DEPTH (FT BGS):	35'
DRILL EQUIP:	CME-95	NORTHING:		SCREEN INTERVAL (FT BGS):	25-40 ft bgs
DRILL METHOD:	Hollow-stem Auger	EASTING:		SCREEN DIAM/SLOT SIZE (INCHES):	0.020"
SAMPLE METHOD:	Steel Sleeves with 5035	**BORE ANGLE:**	Vertical	TOTAL WELL DEPTH (FT BGS):	40'
CONTRACTOR:	BC2 Environmental; C-57 #969758	HOLE DIAM. (IN.)/DEPTH (FT BGS):	10"/41'	LOGGED BY:	Katie Reich
MONITORING DEVICE:	Mini Rae 3000 PID	BACKFILL MATERIAL:	#2/12 Sand/ Hyd. Bent. Chips/Grout	CHECKED BY:	Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	LITH. SYMBOL	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
0.0 to -5.0	9:20			0		SP-SM	Boring cleared to 5 feet bgs with hand auger and/or posthole digger. POORLY GRADED SAND WITH SILT [0;90;10;0], tan, dry, medium-grained, no plasticity, no hydrocarbon odor.
-5.0 to -10.0	9:30			0		SP	POORLY GRADED SAND [0;100;0;0], tan, dry, medium-grained, no hydrocarbon odor.
-10.0 to -15.0	9:45	7, 11, 11		75.4		ML	SANDY SILT [0;30;70;0], brown, slightly moist, very stiff, fine-grained, poorly graded, medium plasticity, hydrocarbon odor.
-15.0 to -20.0	9:50	11, 17, 21		4.1		SP	POORLY GRADED SAND [0;100;0;0], gray, slightly moist, dense, medium-grained, no hydrocarbon odor.
-20.0	9:58	7, 9		20.6			

Depth scale: 0.0, -1.0, -2.0, -3.0, -4.0, -5.0, -6.0, -7.0, -8.0, -9.0, -10.0, -11.0, -12.0, -13.0, -14.0, -15.0, -16.0, -17.0, -18.0, -19.0, -20.0

WELL CONSTRUCTION



The Source Group, Inc. WELL NO. [BORING ID]: **RTF-18-W**

PROJECT NAME/NO.: DFSP Norwalk; 04-NDLA-007 **LOCATION:** DFSP Norwalk, east of TF-18

START DATE:	12-28-15	FINISH DATE:	12-28-15	CASING TOP ELEV. (FT MSL):	
DRILLER:	BC2 Environmental	SURFACE ELEV. (FT MSL):		GW DEPTH (FT BGS):	35'
DRILL EQUIP:	CME-95	NORTHING:		SCREEN INTERVAL (FT BGS):	25-40 ft bgs
DRILL METHOD:	Hollow-stem Auger	EASTING:		SCREEN DIAM/SLOT SIZE (INCHES):	0.020"
SAMPLE METHOD:	Steel Sleeves with 5035	**BORE ANGLE:**	Vertical	TOTAL WELL DEPTH (FT BGS):	40'
CONTRACTOR:	BC2 Environmental; C-57 #969758	HOLE DIAM. (IN.)/DEPTH (FT BGS):	10"/41'	LOGGED BY:	Katie Reich
MONITORING DEVICE:	Mini Rae 3000 PID	BACKFILL MATERIAL:	#2/12 Sand/ Hyd. Bent. Chips/Grout	CHECKED BY:	Daniel Swensson

DEPTH (FT.)	Time	Blow Counts	SAMPLE ID	VOCs (PPM) PID	USCS	SOIL DESCRIPTION [% Gravel; % Sand; % Silt; % Clay]
-21.0		12				
-22.0 to -25.0					ML	SILT WITH SAND [0;20;80;0], gray, slightly moist, very stiff, fine-grained, poorly graded, medium plasticity, hydrocarbon odor
-25.0	10:03	8		57.8		
		9				
-26.0		11				
-27.0 to -30.0					ML	SILT [0;10;90;0], gray, moist, very stiff, fine- to medium-grained, poorly graded, medium plasticity, hydrocarbon odor.
-30.0	10:05	11				
		13				
-31.0	10:06	16	RTF-18-W-31'			
-32.0	10:07			>15,000	SP	POORLY GRADED SAND [0;100;0;0], gray, moist, medium dense, medium-grained, hydrocarbon odor.
-34.0						Groundwater encountered at ~35' bgs.
-35.0	10:10	10		>15,000		
		11				
-36.0	10:11	14		261		
-37.0	10:12			140	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, medium-grained, hydrocarbon odor.
-38.0						
-39.0						
-40.0	10:18	10	RTF-18-W-40'	218	SP	POORLY GRADED SAND [0;100;0;0], gray, saturated, medium dense, fine-grained, hydrocarbon odor.
		12				
		15				
-41.0						

WELL CONSTRUCTION