August 19, 2005
10077.011

Oregon Department of Environmental Quality
Northwest Region
2020 SW Fourth Avenue
Suite 400
Portland, Oregon 97201-4987

VIA Email/First Class

Attention: **Anna Coates**

Subject: **Technical Memorandum**
Slip 2 Hydrocarbon Seep Interim Removal Action Measures
Upland Data Collection
Astoria Area-Wide Petroleum Site
Astoria, Oregon
DEQ ECSI File #2277

Dear Ms. Coates:

This technical memorandum presents the methods, procedures, and data collected during additional characterization of the Astoria Area-Wide Petroleum Site in the area upland of the Slip 2 hydrocarbon seep. This technical memorandum also presents a work plan for additional characterization. The scope of this data-collection effort was described in the Remedial Investigation/Feasibility Study (RI/FS) Work Plan Addendum, Slip 2 Hydrocarbon Seep Interim Removal Action Measures, Upland Data Collection (*EnviroLogic Resources*, 2004). Standardized operating procedures for this project are presented in RI/FS and Interim Remedial Action Measures (IRAM) Work Plan, Phase 1 (RI/FS Work Plan)(*EnviroLogic Resources*, 2002). The site location is shown on Figure 1.

Phase 1 source/soil characterization field work was undertaken and largely completed in 2002. The Phase 1 ground-water assessment and Phase 2 source/soil characterization for the site were completed in 2003 and 2004 (*EnviroLogic Resources*, 2003, 2004). In addition, monthly ground water and/or free-product monitoring was conducted from August 2002 through December 2004, and four quarterly ground-water monitoring events were completed in October 2003 and January, April, and July 2004. Based on the results of these soil and ground water data, additional upland characterization was determined to be necessary to perform a risk assessment and to evaluate remedial alternatives for the hydrocarbon seep.

The upland data collection work included gathering additional information to assess the hydrocarbon seep, including the mobility and extent of light non-aqueous phase liquids (LNAPL) upland of Slip 2 and the aquifer parameters in the shallow water-bearing zone near the seep. An evaluation of the operation of the previous pump-and-treat system was planned but it will now be presented as part of the RI. Specifically this technical memorandum presents the results of the LNAPL and aquifer characterization and proposed additional LNAPL characterization in the vicinity of Pier 2.

LNAPL CHARACTERIZATION

The LNAPL investigation consisted of three phases. The first phase was vertical and lateral delineation of the LNAPL using a cone penetrometer testing/rapid optical screening tool (CPT/ROST™). The CPT/ROST™ activities were completely in-situ; no field sampling, screening or soil investigation waste were involved in the LNAPL investigation. The second phase was LNAPL sampling and analysis to characterize the type of LNAPL present in the ground water, and the third phase was to estimate the volume and mobility of LNAPL in ground water upland of the hydrocarbon seep.

Delineation of Extent of LNAPL

For the purpose of this technical memorandum it is important to clarify the definition of LNAPL in the context of the plume upgradient of Slip 2. As detected by the CPT/ROST™ instrument, the LNAPL zone consists of both residual and mobile free petroleum product. The residual petroleum product is bound to the soil within the zone of seasonal ground-water fluctuation, and is released into the aquifer as dissolved petroleum hydrocarbon constituents. The mobile free product portion of the LNAPL occupies the pore space between soil particles and is released into the aquifer as a separate phase, as is evidenced by the free product that accumulates in the monitoring wells and the sheen discharging at the head of Slip 2. It was hoped that the CPT/ROST™ data could be used to quantify the mobile free product portion of the LNAPL plume. Review of the CPT/ROST™ data has shown that some basic qualitative evaluation can be made but a quantitative definition of the mobile free product portion of the LNAPL plume cannot be made. However, the CPT/ROST™ data has been useful in assessing and confirming the lateral extent of the LNAPL plume

To delineate the extent of LNAPL upland of the hydrocarbon seep and to determine LNAPL continuity between upland monitoring wells, a CPT/ROST™ investigation was performed September 21, 2004, through September 23, 2004. The CPT is a “push probe” style tool commonly used in geotechnical explorations to assess the vertical stresses, friction angles, and soil consistency. In this application, the CPT is equipped with a ROST. The ROST is a tunable laser that emits ultraviolet (UV) light within the excitation wavelength of petroleum hydrocarbons. Measured responses to the ROST were used to define the vertical and lateral extent of LNAPL in soil and ground water. The CPT/ROST™ signal response provides real time soil and LNAPL data presented in a graph form that can be interpreted and used in the field. CPT/ROST™ exploration activities were performed by Fugro Geosciences, Inc., of Santa Fe Springs, California. The results of the CPT/ROST™ are included in a report by Fugro Geosciences, Inc., presented in Appendix A of this technical memorandum.

To further define the lateral and vertical extent of LNAPL and subsurface soil conditions upland of Slip 2, six transects consisting of a series of CPT borings were completed. Due to refusal in many areas some proposed CPT borings were either not completed or were completed in an area near the proposed location. Additional CPT holes were drilled in order to help define the edge of the LNAPL area. Monitoring well locations are shown on Figure 2. The CPT boring locations are presented on

Figure 3. Also shown on Figure 3 is the estimated lateral extent of LNAPL in Fall 2004. Data from both the monitoring wells and CPT borings were used in estimating the extent of LNAPL .

The initial explorations were drilled adjacent to monitoring wells with historical LNAPL detections. This allowed for a comparison of the ROST readings with the known LNAPL thickness and concentrations in the monitoring wells. The ROST testing was performed in multi-wavelength mode (mwl) in which several characteristics of the emitted fluorescence are measured and recorded simultaneously at four specific wavelengths (340, 390, 440, and 490 nanometers). The recorded data were presented as a color graph of fluorescence intensity (the combined fluorescence of all four monitored wavelengths) versus depth (Fugro, 2004).

CPT was used with the ROST in order to identify differing soil lithologies within both the saturated and unsaturated zones. Soil lithology is considered important to assess mobility and recoverability of LNAPL and vapor diffusion. The vertical resolution of the CPT data was used in further understanding the three dimensional extent of the LNAPL in the soil smear zone.

The maximum thickness of the LNAPL smear zone measured in the CPT borings was approximately 6 feet. A six-foot thick smear zone was observed in borings CPT-09, CPT-14, and CPT-36. The LNAPL smear zone as detected by the ROST data does not necessarily correlate to a similar thickness or presence of mobile LNAPL in a nearby monitoring well. These three CPT borings are all located near the edge of the LNAPL plume, where the average thickness of mobile free product that has historically accumulated in nearby monitoring wells is less than 0.1 feet thick.

A review of the CPT/ROST™ data and the free product thickness measurements in the site monitoring wells was conducted to determine if there is a useable correlation. Table 1 lists the site monitoring wells where LNAPL composition has been defined by Shell's hydrocarbon identification analysis, the results of the hydrocarbon identification, and the nearest CPT boring. The table also shows the maximum magnitude of the fluorescence at each CPT boring. The fluorescence is reported as percent reference emitter (%RE) of the reference solution used by Fugro. The reference solution is used to normalize the data to limit variations due to operating conditions. The table includes the average free product thickness in the site monitoring wells, based on the last four measurements in 2004. Figure 4 plots the maximum fluorescence magnitude from each CPT boring on the Y-axis, and the average free product thickness in the corresponding monitoring well on the X-axis.

Review of the data point scatter on the graph reveals that LNAPLs of similar composition are grouped together. The area where predominantly gasoline LNAPL has been identified in monitoring wells (CPT-15 and CPT-05) had as low as 13%RE associated with mobile LNAPL. CPT-06 and CPT-26 are associated with monitoring wells containing a near equal mix of gasoline and diesel and had a 25%RE associated with LNAPL. The CPT-ROST™ data points associated with monitoring wells containing predominantly diesel (CPT-1, CPT-3, CPT-4 and CPT-44) had a significantly higher %RE associated with LNAPL. For predominantly diesel product the range of %RE associated with LNAPL was 180 to 220. It is currently unknown if this association can be applied to other data points at the site. The grouping may be a result of the relative few data points or the fact that more monitoring wells are located in the central part of the diesel LNAPL area thus skewing the data. Although there may be a minimum %RE that indicates LNAPL there does not appear to be a useable correlation between the fluorescence magnitude and the average thickness of free product that has been recorded in nearby monitoring wells. The fluorescence measurements appear to be useful as a general indicator of the potential presence of LNAPL but further evaluation is required to determine if the data can be used to develop LNAPL volume estimates or to determine the percentage of mobile hydrocarbon product in the LNAPL plume area.

ROST™ fluorescence data identified gasoline as the dominant product type encountered in the CPT borings southeast of Portway. Diesel is the dominant product type encountered in CPT borings northwest of Portway continuing towards Pier 2. The fluorescence results for CPT-36 and CPT-37 suggest heavy range petroleum hydrocarbons (ie., $>C_{28}$) may be present in the area north of the Port Office building. These results corroborate data developed by sampling and analysis of LNAPL collected form monitoring wells as discussed later in this technical memorandum.

The distribution of petroleum hydrocarbon in the areas with free product is shown on cross-sections A-A' and B-B' (Figures 5 and 6, respectively). The cross-section locations are shown on Figure 3. In general, area soils from the surface to at least 15 feet below ground surface (bgs) consist of interbedded sands and silty sands to silts with discontinuous clayey silt lenses (dredge sands). ROST™ fluorescence indicative of LNAPL, ranging in depth from 7 to 13 feet bgs, was observed within the sands and silts. Seasonal ground-water fluctuations and the localized fine grained lenses have influenced the distribution of LNAPL. In general the smear zone is consistent with the seasonal range in depth to ground water, except where geologic controls exist.

LNAPL Sampling

LNAPL has been identified in monitoring wells MW-1(M), MW-3(M), MW-4(M), MW-8(M), MW-9(M), MW-37(A), MW-40(A), MW-41(A), MW-42(A), and MW-44(A) in the area of the hydrocarbon seep at Slip 2. Monitoring well MW-15(D) at the former Delphia Oil bulk plant has also been observed to contain LNAPL. As part of the LNAPL investigation, product samples were collected from several monitoring wells for forensic analyses.

LNAPL from monitoring wells MW-3(M), MW-4(M), MW-8(M) and MW-9(M) was sampled and analyzed for product differentiation parameters in 2003. In May 2004, LNAPL was recovered from monitoring wells MW-15(A), MW-37(A), MW-40(A), MW-41(A), MW-42(A), and MW-44(A) and submitted to Shell Global Solutions (US) Inc.'s Westhollow Technology Center in Houston, Texas, for chemical analysis for hydrocarbon identification and differentiation and other physical and chemical parameters. The results of the chemical analysis were used to identify the nature of the LNAPL found in the wells, and the results of the physical parameters will be used to estimate product mobility and recoverability. The hydrocarbon forensics analytical report by Shell Global Solutions (US) Inc., (2004) is presented in Appendix B

The analytical protocols used for LNAPL characterization are focused on the identification of components characteristic of fuels and the relative distribution of these compounds. The protocols used in this analysis are based on methodologies commonly applied to environmental investigations and are similar to the following methods:

- Modified EPA Method 8015M using gas chromatography with flame ionization detection (GC/FID)
- Modified EPA Method 8260 using gas chromatography with mass spectrometry detection (GC/MS)
- Total lead and total sulfur by ASTM D5059 (modified) and D2622, respectively. These are x-ray fluorescence methods.
- Product Density by ASTM Method 4052 (not on all samples)

. The results indicate that the samples from these wells contain weathered diesel/fuel oil and gasoline-range material in various proportions. Some samples contain primarily gasoline, some samples contain primarily diesel/fuel oil and the majority of the samples contain mixtures of both types of products in different proportions. No oxygenates were detected.

There are significant differences among the gasoline products found in the samples. For example, the gasoline in MW-37(A) is very different from all other samples both in terms of hydrocarbon distribution, high lead content, and type of lead package. Table 1 provides the percentages of diesel and gasoline in each of the samples.

Evaluation of LNAPL Volume and Mobility

The results of the LNAPL delineation will be used to evaluate the volume of LNAPL in the Slip 2 hydrocarbon seep upland area and presented in the RI. The extent of the LNAPL was not defined to the north or northeast due to utility clearance and time constraints. Further soil/LNAPL investigation will be performed to define the northern edge of the hydrocarbon seep upland area
The CPT/ROST™ data will be used along with existing information on the soil characteristics (e.g., porosity), measured physical properties of LNAPL, and product bail-down/recovery testing to evaluate the LNAPL mobility upland of the seep.

The actual and recoverable LNAPL volume will be estimated using the method proposed by Charbeneau, et al. (2000) and by American Petroleum Institute (API) (2003). Results of the evaluation will be presented as part of the RI for use in the Feasibility Study. Information that will be directly or indirectly used to estimate LNAPL volumes include:

- Observed free product thickness in monitoring wells;
- Observed oil/water interface elevations in monitoring wells;
- Bail down/recovery test data;
- CPT/ROST data;

- Soil type data from previous investigations and CPT soundings; and
- Historical recovery rates from the previous pump and treat system.

AQUIFER CHARACTERIZATION

An aquifer test was conducted in the upland area by Hahn & Associates in 1995 following the McCall Oil pipeline release. Limited information about the aquifer testing is included in a June 1996 package of information transmitted to McCall Oil and Chemical Corporation (HAI,1996). Included in this information are graphs of a step drawdown pumping test and a recovery test. Water levels from R-1(M), MW-1(M), MW-8(M) and MW-6(M) are presented in the graphs. Calculations for transmissivity and storage coefficient are presented as 3,000 gallons per day per square foot (gpd/ft^2) and 0.3, respectively. No field data or calculations are included in the 1996 package of information prepared by HAI. Additional aquifer characterization is essential in both determining risk and in selection of a remedial alternative. In the case of selecting a remedial alternative, this need is emphasized by the failed pump and treat system that was installed at the site in 1995. A detailed discussion of the pump and treat system will be presented as part of the RI.

Water Levels/Tidal Evaluation

Aquifer characteristics in the vicinity of the hydrocarbon seep can be determined by evaluating the damping of the tidal signal in monitoring wells. Collection of water level data and tidal data at the site has been on going. A surface water monument was established on Pier 2 prior to the commencement of the tidal evaluation fieldwork. A transducer was installed in the Pier 2 monument and has been continuously recording data since installation. The location of the “Pier 2” monument is shown on Figure 2. In order to help define the inland extent of the tidal influence and to provide actual surface water elevation readings to determine the tidal maxima and minima at the shoreline, additional transducers were temporarily installed in monitoring wells. Graphs displaying the change in ground-water levels with respect to time along with the supporting aquifer data and a table summarizing the maximum tidal influence are presented in Appendix C.

As part of the aquifer characterization program, data continued to be recorded by the transducer in the Pier 2 monument. Additionally, transducers were installed in MW-6(M), MW-9(M), and MW-10(M). To adequately characterize the tidal influence in the aquifer, the transducers collected data for approximately a 36-hour period. After approximately 1-½ tide cycles of recording water level data, the transducers were moved to wells MW-7(M), MW-34(A), and MW-42(A) for another 36-hour period. Finally, the transducers were removed from these wells, and installed in MW-11(M), MW-35(A), and MW-44(A). The transducers had vented cables so that barometric effects on water levels were compensated in the pressure readings. After an initial review of the recorded data, it was determined that additional measurements were necessary for complete characterization of the tidally influenced aquifer system. Transducers were reinstalled into monitoring wells MW-9(M), MW-10(M), and MW-34(A). During this recording period, the transducers recorded data for approximately 17 days. The longer time period allows for more accurate comparisons between ground-water levels and tide levels amongst the wells observed. A transducer was also installed in

MW-18(A) to gather data in a well further from the shoreline. The influence from tide is not apparent in this well as shown on the graph presented in Appendix C.

The influence from the tide on the aquifer is apparent in most of the monitoring wells. Figure 7 presents data recorded during December 2004 in MW-9(M). The graph shows both the fluctuating tide levels and the changing ground-water levels. Figures 8 and 9 show the graphs for monitoring wells MW-34(A) and MW-35(A) respectively. The data show that the tidal influence in MW-35(A), which is approximately 400 feet from the shoreline, is evident yet minimal (Figure 9). The observed tide fluctuation was 0.044 feet. The amount of change is approximately an order of magnitude less than the tide change observed in MW-9(M), which is approximately 300 feet closer to the shoreline.

Three of the ten monitoring wells [MW-6(M), MW-18(A), and MW-44(A)] included as part of the tidal evaluation exhibit atypical tidal influences. The ground-water elevations also appear to be atypical in monitoring wells MW-6(M) and MW-44(A). The distance between the shoreline and MW-18(A) may be great enough for there to be very minimal tidal influence.

Evaluation of the data from the above characterization will be used to assess risk and to assist in remedial alternative selection. The data evaluation will be performed and reported as part of the RI.

ADDITIONAL LNAPL CHARACTERIZATION

Borings CPT-31, 40, and 41 have maximum fluorescence readings exceeding 150%RE, indicating the possible presence of LNAPL. MW-10 (M) is the nearest monitoring well to the area of these borings, and it has not historically had any detections of mobile LNAPL, although groundwater samples from MW-10 have consistently contained moderate concentrations of diesel and gasoline range organics. To determine if there is a dissolved hydrocarbon plume or mobile free product in the vicinity of CPT-31, 40 and 41, additional assessment is needed.

The additional LNAPL investigation will consist of vertical and lateral delineation of the LNAPL along with sampling and analysis to characterize the type of LNAPL present in the soil beneath Pier 2. The results of the initial upland data collection showed both oil and diesel present near Pier 2. The heavier oil range LNAPL was observed in borings CPT-36 and CPT-37 (*EnviroLogic Resources*, 2005). These borings are located north of the Port office building. The CPT borings drilled furthest to the northwest, CPT-40 and CPT-41 showed an approximately two- to three-foot section of diesel-range LNAPL. The extent of LNAPL further north could not be defined at that time due to time and utility clearance constraints. Therefore, additional investigation is proposed.

Delineation of Extent of LNAPL

The aerial extent of LNAPL upland of the hydrocarbon seep was defined during the upland data collection except for the area to the north and northwest (near Pier 2). To further define the lateral and vertical extent of LNAPL and subsurface soil conditions, ten soil borings will be installed in the area around the south end of Pier 2. The proposed boring locations are shown on Figure 5.

Additional borings will be drilled if necessary in order to define the extent of LNAPL. Using the Geoprobe© drilling method, the borings will be drilled to depths of approximately 15 feet. The ROST data from the fieldwork completed in Fall 2004 shows the product layer extends to a depth of 13 feet below ground surface (CPT-40 and CPT-41). Three borings will be drilled next to CPT borings that were drilled in 2004 [CPT-40, CPT 37and CPT-03] to allow for a direct comparison to the ROST results via analytical and visual techniques. A photoionization detector will also be used during field activities.

Temporary standpipes with slotted screen (20 slot) will be installed in each borehole. The standpipe would remain in the borehole until the end of the day. At the end of the day each standpipe will be monitored for the presence of LNAPL with a disposable bailer or an interface probe. This information may be useful in selecting the proposed monitoring well locations.

General field procedures and methods presented in the Field Sampling Plan (Appendix A of the RI/FS Work Plan) and the Health & Safety Plan (Appendix B of the RI/FS Work Plan) are incorporated by reference.

Soil Sampling

Soil samples will be collected for laboratory analysis. One sample per boring will be analyzed for TPH. This sample will be selected on the basis of PID readings and/or visual observations. Approximately three samples total from representative borings will also be analyzed for volatile organic compounds (VOCs) and polynuclear aromatic hydrocarbons (PAHs). No ground-water sampling is proposed to be conducted.

Monitoring-Well Construction

Two new monitoring wells are proposed on Pier 2 at locations designed to define the extent of LNAPL. The new monitoring wells will be installed during the above-referenced fieldwork (i.e., single site mobilization) and the field screening results of the proposed direct-push borings and 2004 CPT-ROST data will guide their locations. The new monitoring wells will be constructed using a pre-packed well screen that can be installed using the Geoprobe drilling rig. To the extent possible, completion depths and screened intervals will be similar to the other monitoring wells installed at the Astoria Area-Wide site. The purpose of the wells will be to confirm the presence or absence of LNAPL at a downgradient location. Ground-water sampling is not currently proposed.

To further characterize the nature of the product in the vicinity of the former Mobil/Niemi bulk plant a third new monitoring well will be installed at the former Mobil/Niemi bulk plant. The location of this monitoring well will be compatible with new development that is proposed for that site. Thus the monitoring well location will not be finalized until final site development plans have been reviewed.

CLOSING COMMENTS

The data developed during the Upland Data Collection work provided us with detailed knowledge of the distribution of LNAPL in the subsurface at the Astoria Area-Wide petroleum site upland of Slip 2. The LNAPL plume is bounded on the south, east, and west sides. Uncertainties regarding the nature of the LNAPL at the former Mobil/Niemi bulk plant exist and uncertainties regarding the extent of LNAPL to the north onto Pier 2 exist. To address these uncertainties, additional characterization for delineating LNAPL on Pier 2 and for characterizing the nature of LNAPL at the former Mobil/Niemi bulk plant is planned. Field work will be scheduled as soon as DEQ approves the scope of the additional LNAPL characterization. Our understanding of the tidal influences on the ground-water system is improved and allowed for an evaluation of aquifer hydraulic characteristics in the upland vicinity of Slip 2 to be completed. Finally, information has been gathered to identify some of the site-specific pitfalls of ground-water pumping and product recovery This information will be evaluated as part of the RI and used during the feasibility study to evaluate remedial alternatives

Please call me at (503)768-5121 if you have any questions or comments regarding this technical memorandum.

Sincerely,
EnviroLogic Resources, Inc.

Thomas J. Calabrese, RG, CWRE
Principal/Hydrogeologist
Project Manager

cc: Distribution list attached

REFERENCES

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ATTACHMENTS

Table 1	CPT/ROST & Monitoring Well LNAPL Data
Figure 1	Site Location
Figure 2	Monitoring Well Locations
Figure 3	Estimated Lateral Extent of LNAPL Fall 2004
Figure 4	Florescence versus Monitoring Well LNAPL Thickness
Figure 5	Cross Section A-A’
Figure 6	Cross Section B-B’
Figure 7	MW-9(M) Water Level Graph
Figure 8	MW-34(A) Water Level Graph
Figure 9	MW-35(A) Water Level Graph
Figure 10	Proposed Soil Boring Locations
Appendix A	Fugro Geosciences, Inc Report

Appendix B Shell Global Solutions (US) Inc. Report
Appendix C Tidal Graphs and Supporting Data

ASTORIA AREA-WIDE PETROLEUM SITE
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TABLES

TABLE 1
CPT/ROST AND MONITORING WELL LNAPL DATA
Astoria Area Wide
Astoria, Oregon

CPT-ROST LOCATION IDENTIFICATION	CORRESPONDING MONITORING WELL IDENTIFICATION	[1]Diesel (%)	[1]Gasoline (%)	[2]Average Free Product Thickness (feet)	[3]Fluorescence (%RE)
CPT-44	MW-3(M)	81	19	0.5	182
CPT-1	MW-41(A)	87	13	0.06	179
CPT-4	MW-8(M)	92	8	0.11	224
CPT-3[4]	MW-9(M)	88	12	0.97	203
CPT-15	MW-37(A)	28	72	0.01	13
CPT-5	MW-40(A)	29	71	0.04	26
CPT-26	MW-42(A)	55	45	0.32	50
CPT-6	MW-44(A)	56	44	0.32	25

Notes:

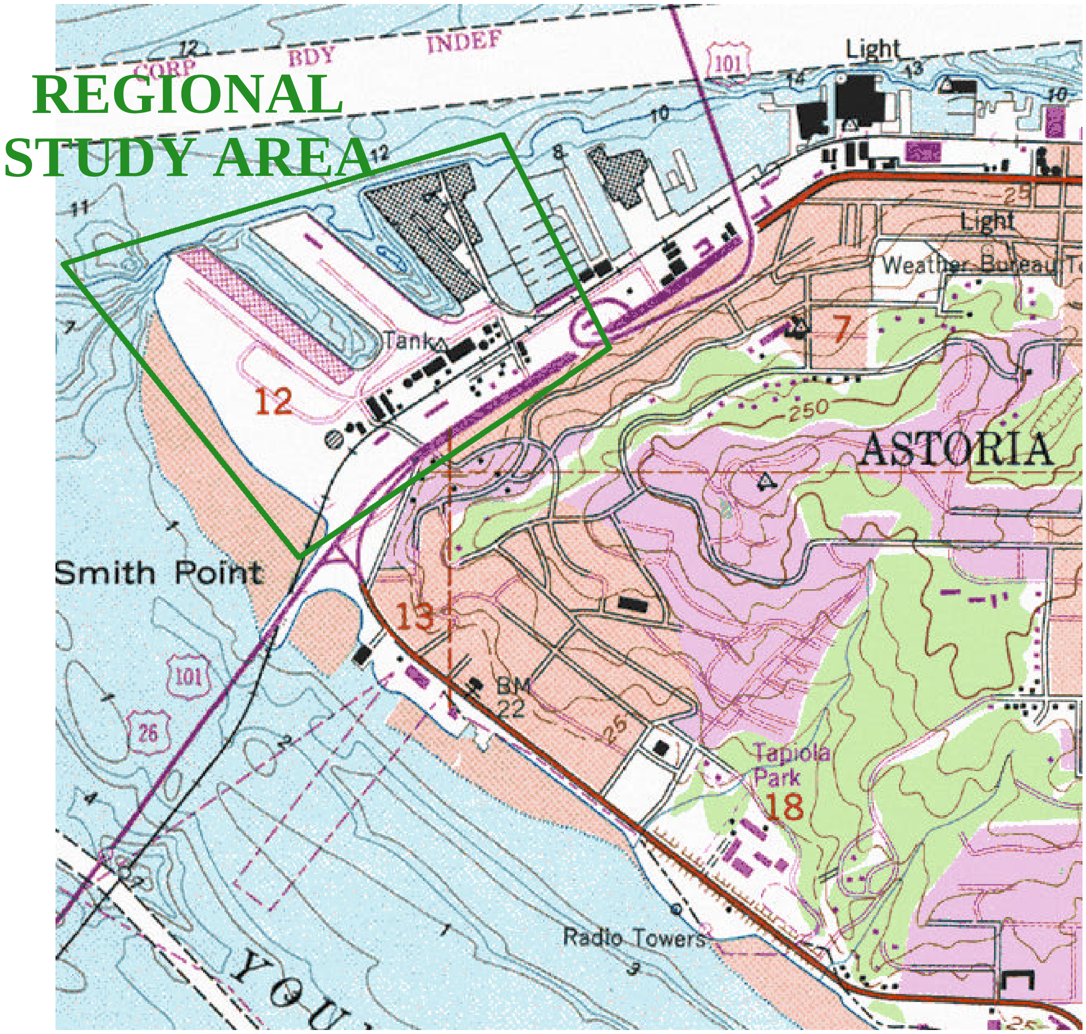
[1] Diesel and gasoline % of free product from monitoring well as reported by Shell

[2] Average free product based on last 4 measurements in 2004

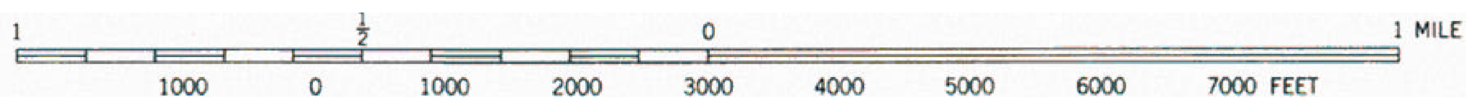
[3] % RE (percent reference emitter) refers to reference standard used by Fugro

[4] Due to equipment failure the %RE for CPT-3 is not available. The %RE used is an average of the %RE from the two nearest CPT's (CPT-4 and CPT-44)

FIGURES



(from USGS, Astoria {1984}, OR 7.5' Quadrangles)



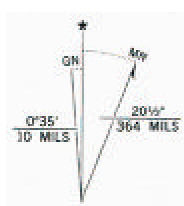


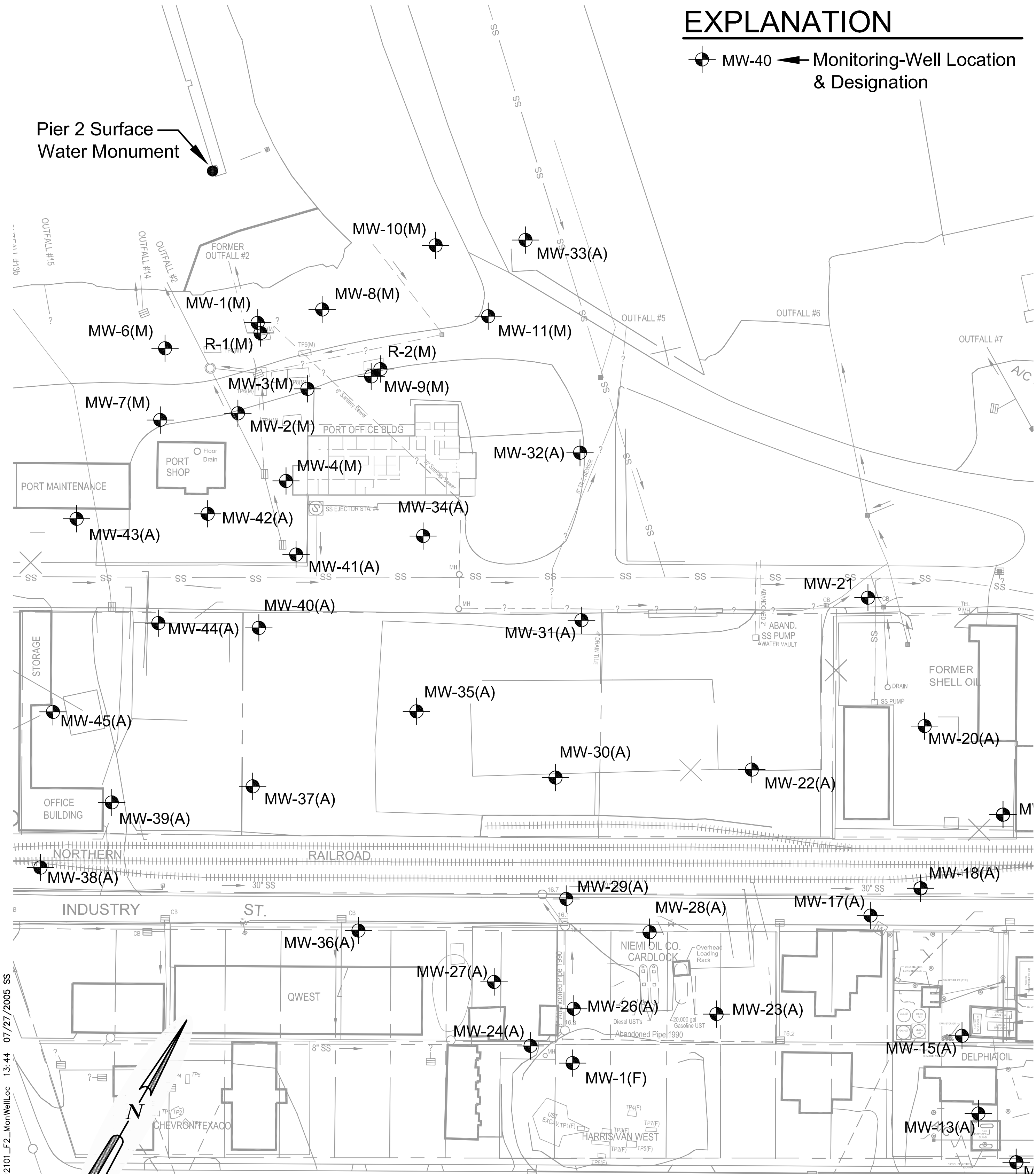
FIGURE 1

SITE LOCATION

Remedial Investigation/Feasibilty Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EnviroLogic Resources, Inc.

Consulting Environmental & Water Resources Scientists



0' 120' 240'

SCALE: 1" = 120'

FIGURE 2

MONITORING WELL LOCATIONS
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EnviroLogic Resources, Inc.
Consulting Environmental & Water Resources Scientists

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EXPLANATION

MW-40 Monitoring-Well Location & Designation

SVP-1 Soil Vapor Monitoring Point Location & Designation

CPT–30 CPT/ROST Location and Designation

Estimated Lateral Extent of LNAPL Based on Monitoring Wells Observations and September 2004 ROST Borings.

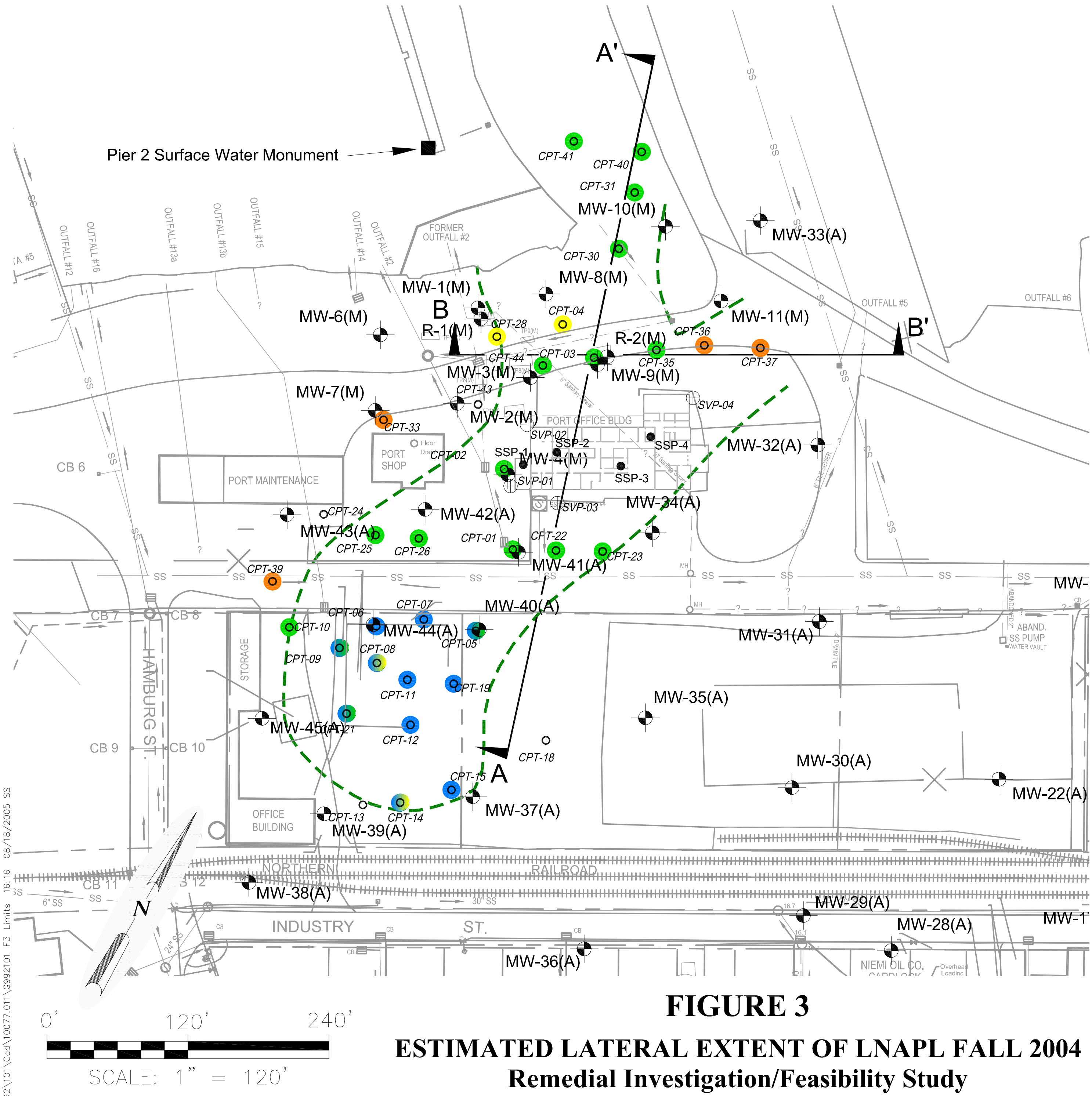
A' A Cross-Section Lines

Primarily Degraded Diesel Hydrocarbon Mixtrues.

Primarily Gasoline Hydrocarbon Mixtures.

Primarily Diesel Hydrocarbon Mixtures.

Primarily Oil Hydrocarbon Mixtures.



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EnviroLogic Resources, Inc.

Consulting Environmental & Water Resources Scientists

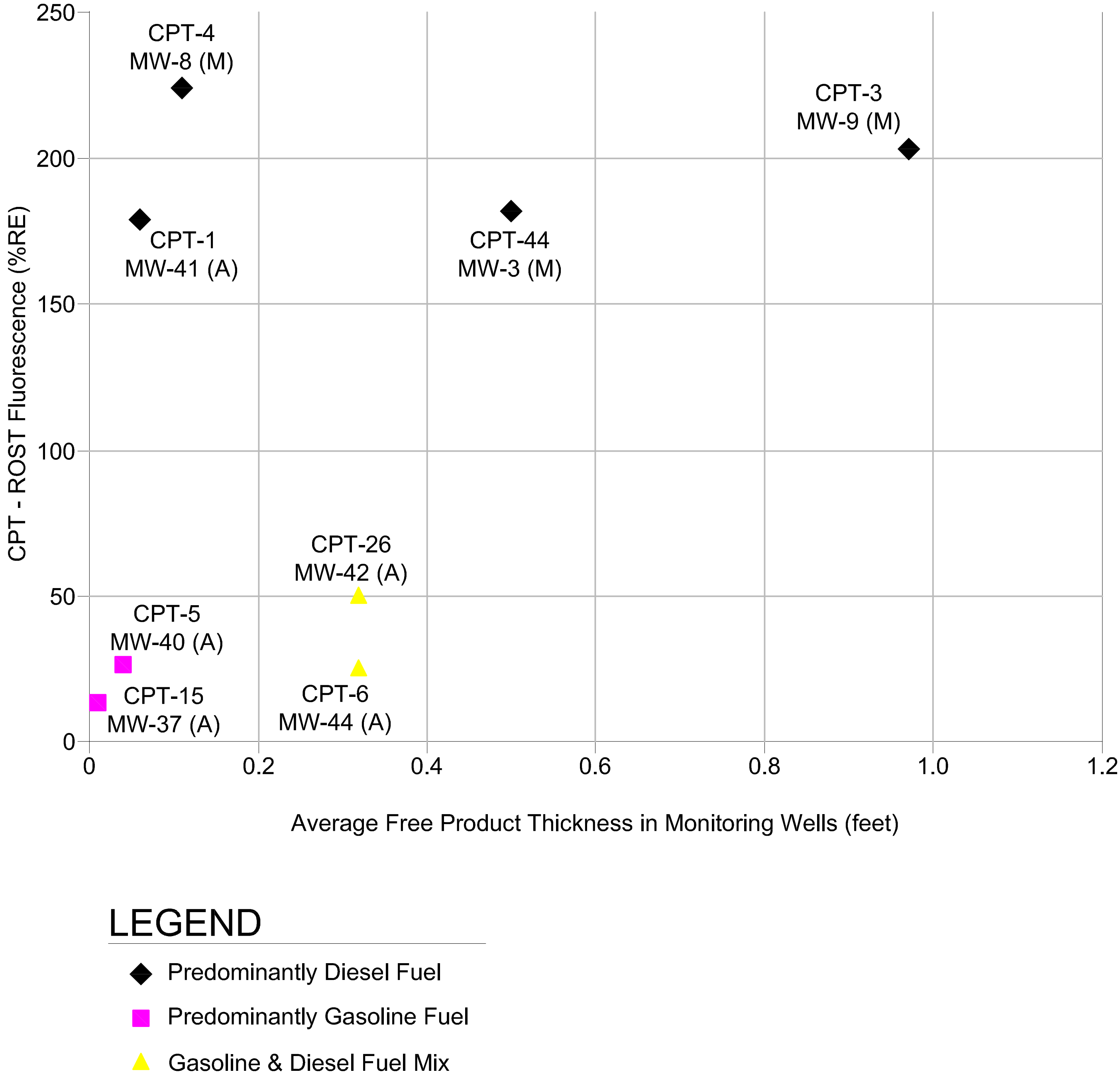
FIGURE 3

ESTIMATED LATERAL EXTENT OF LNAPL FALL 2004

Remedial Investigation/Feasibility Study

Astoria Area-Wide Petroleum Site

Astoria, Oregon



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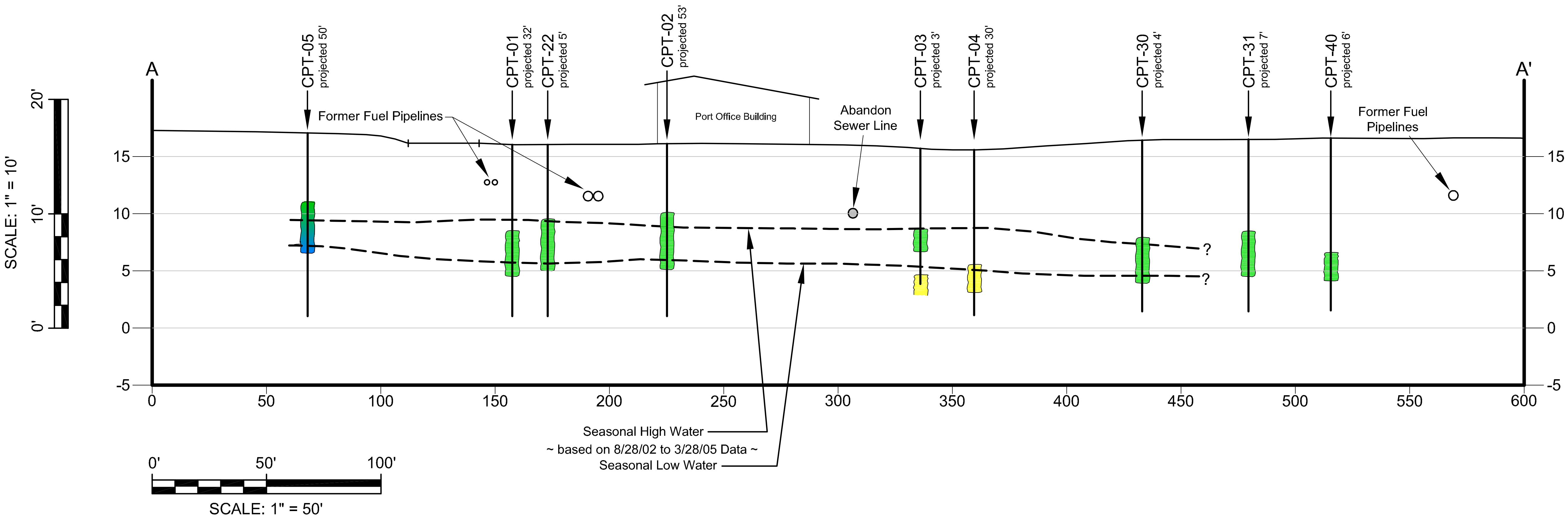
EnviroLogic Resources, Inc.

Consulting Environmental & Water Resources Scientists

FIGURE 4

FLUORESCENCE VERSUS MONITORING WELL LNAPL THICKNESS
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon



EXPLANATION

- CPT / ROST Flourescence
- Primarily Degraded Diesel Hydrocarbon Mixtrues.
- Primarily Gasoline Hydrocarbon Mixtures.
- Primarily Diesel Hydrocarbon Mixtures.

FIGURE 5

CROSS SECTION A-A'
CPT Borings
Astoria Area-Wide Petroleum Site
Astoria, Oregon

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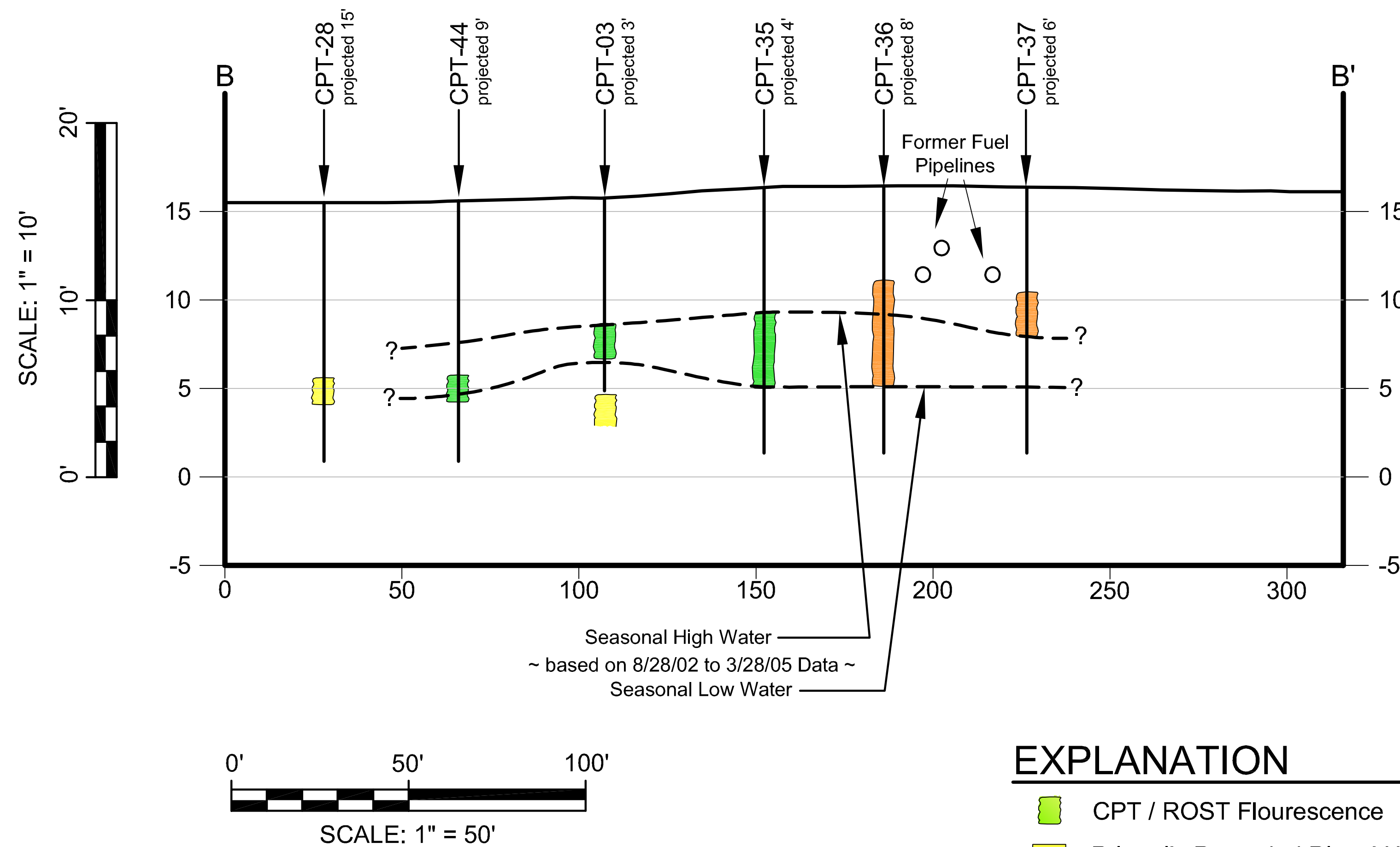

EXPLANATION

- CPT / ROST Flourescence
- Primarily Degraded Diesel Hydrocarbon Mixtrues.
- Primarily Gasoline Hydrocarbon Mixtures.
- Primarily Diesel Hydrocarbon Mixtures.
- Primarily Oil Hydrocarbon Mixtures.

FIGURE 6

CROSS SECTION B-B'
CPT Borings
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EnviroLogic Resources, Inc.
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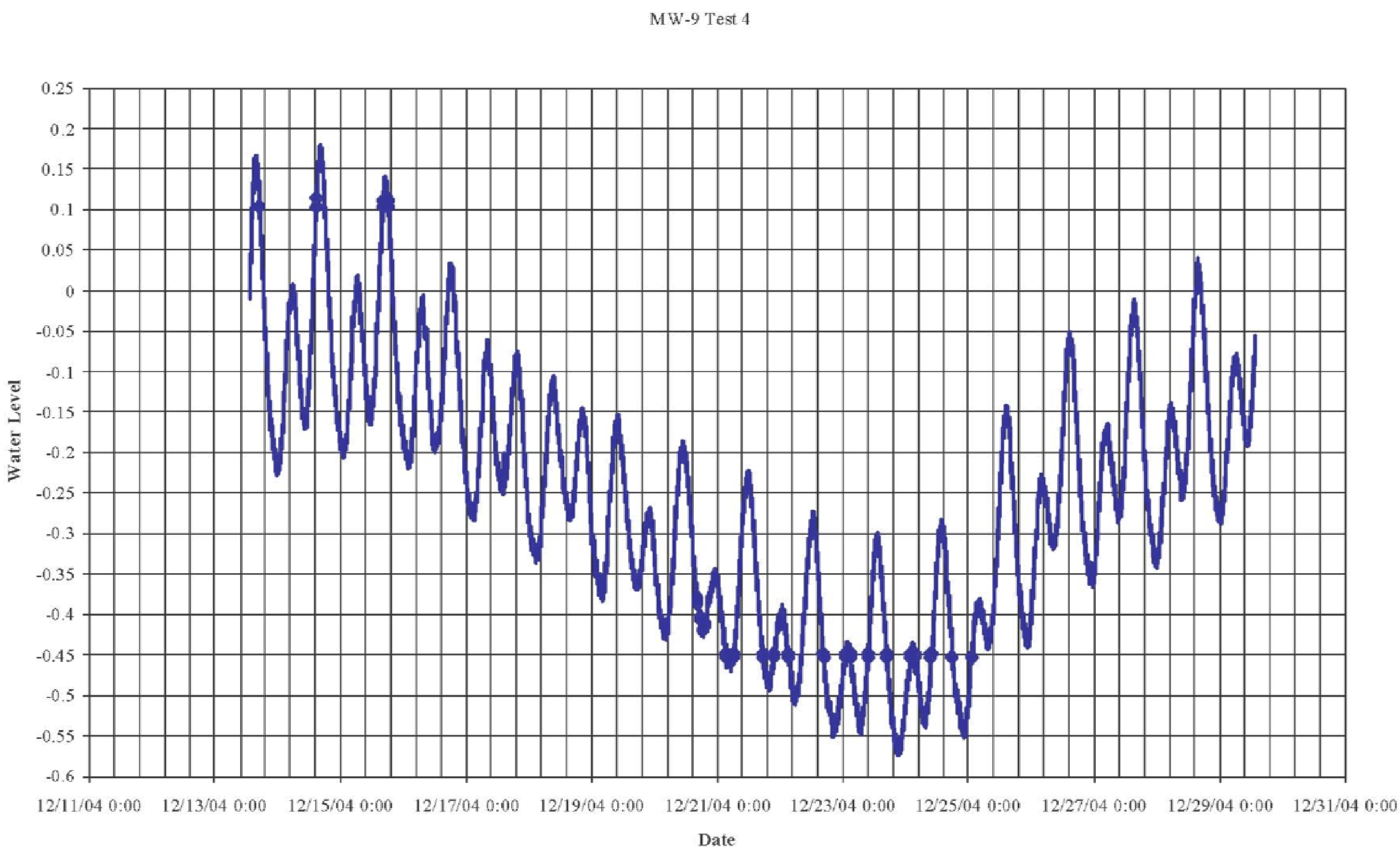

G:\0900\992\101\Cad\10077.011\G992101_F7_Grphs 13:18 07/27/2005 SS

EnviroLogic Resources, Inc.

Consulting Environmental & Water Resources Scientists

FIGURE 7

MW-9(M) WATER LEVEL GRAPH
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

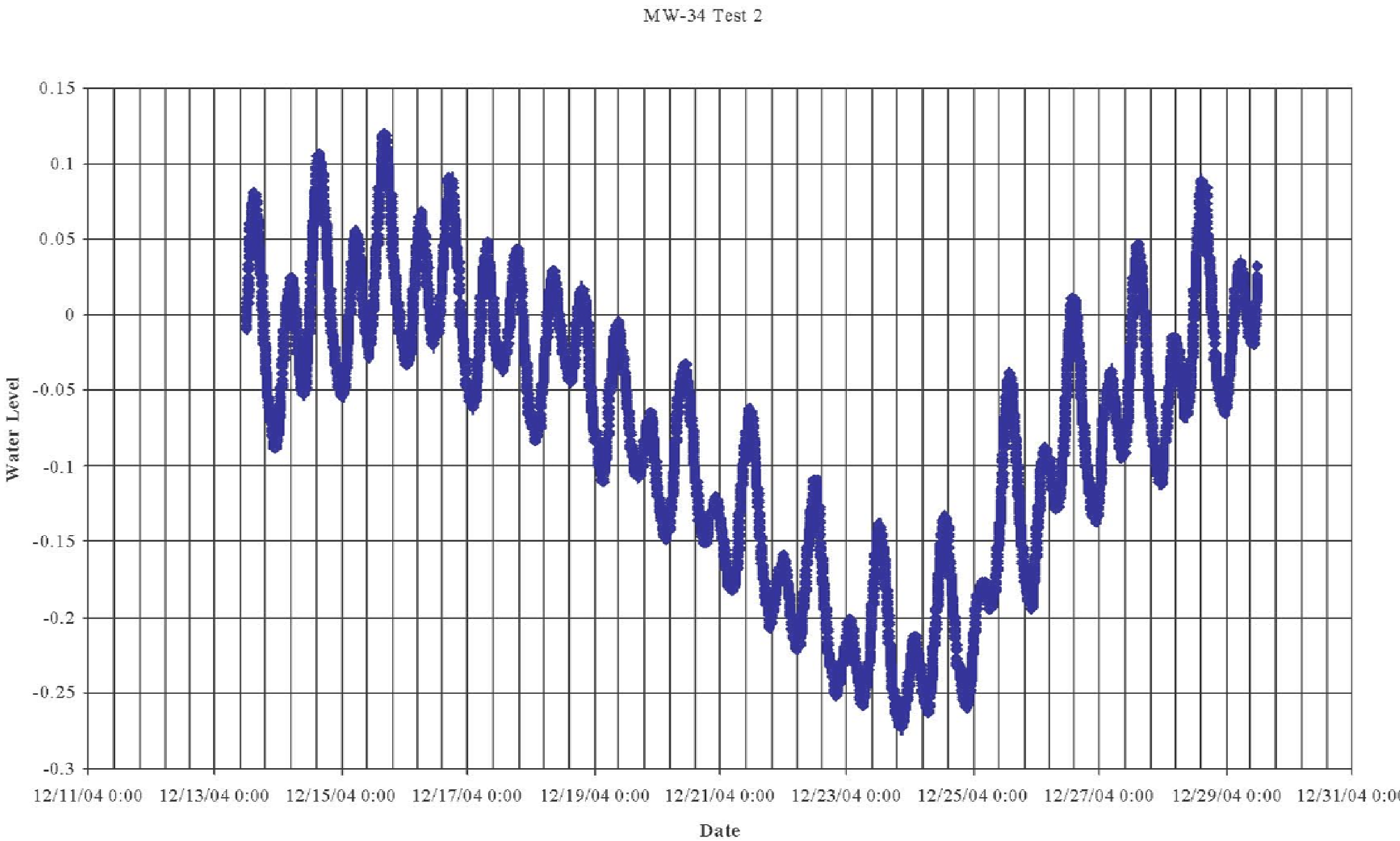

FIGURE 8

MW-34(A) WATER LEVEL GRAPH
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EnviroLogic Resources, Inc.
Consulting Environmental & Water Resources Scientists

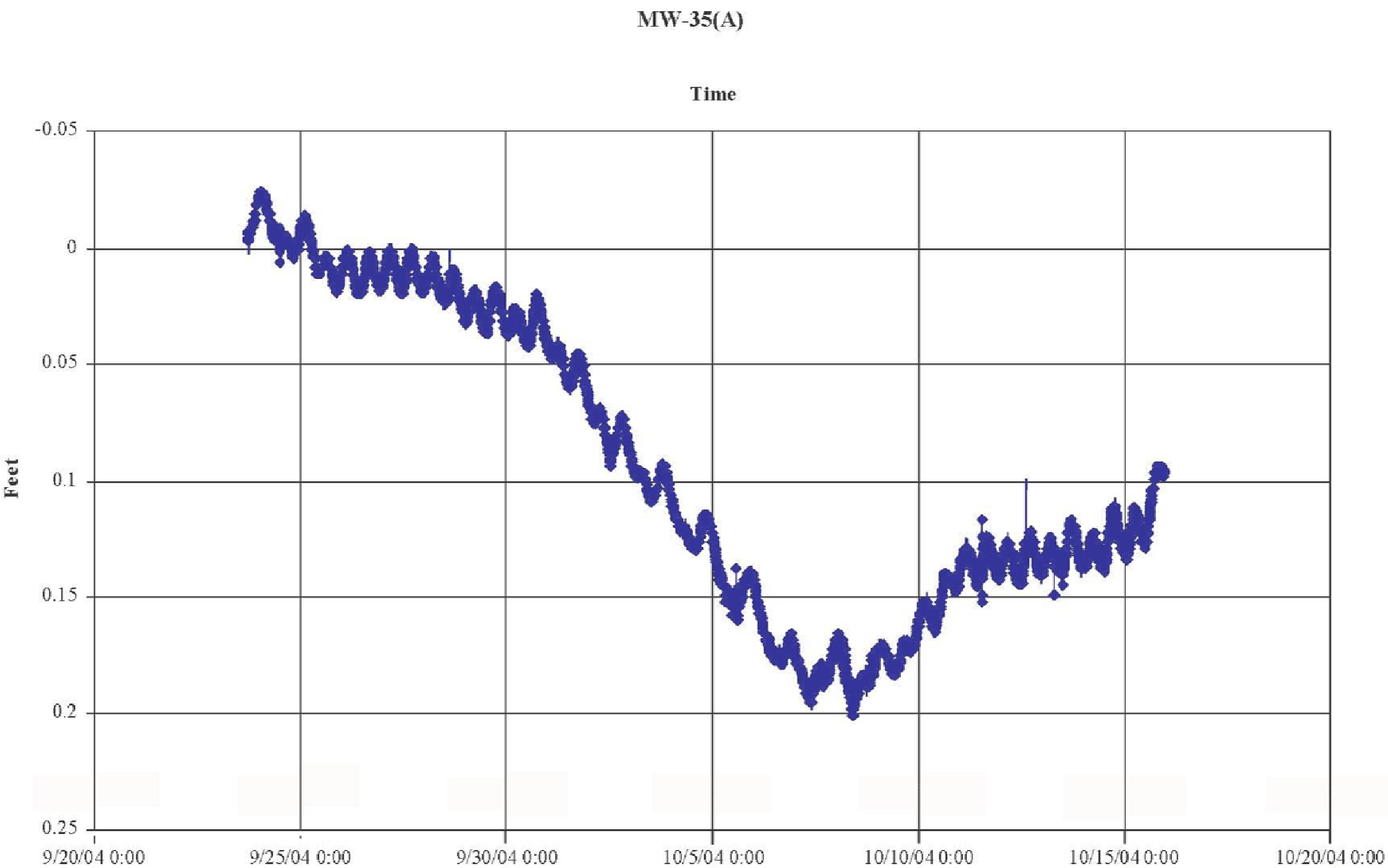

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FIGURE 9

MW-35(A) WATER LEVEL GRAPH
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EnviroLogic Resources, Inc.

Consulting Environmental & Water Resources Scientists

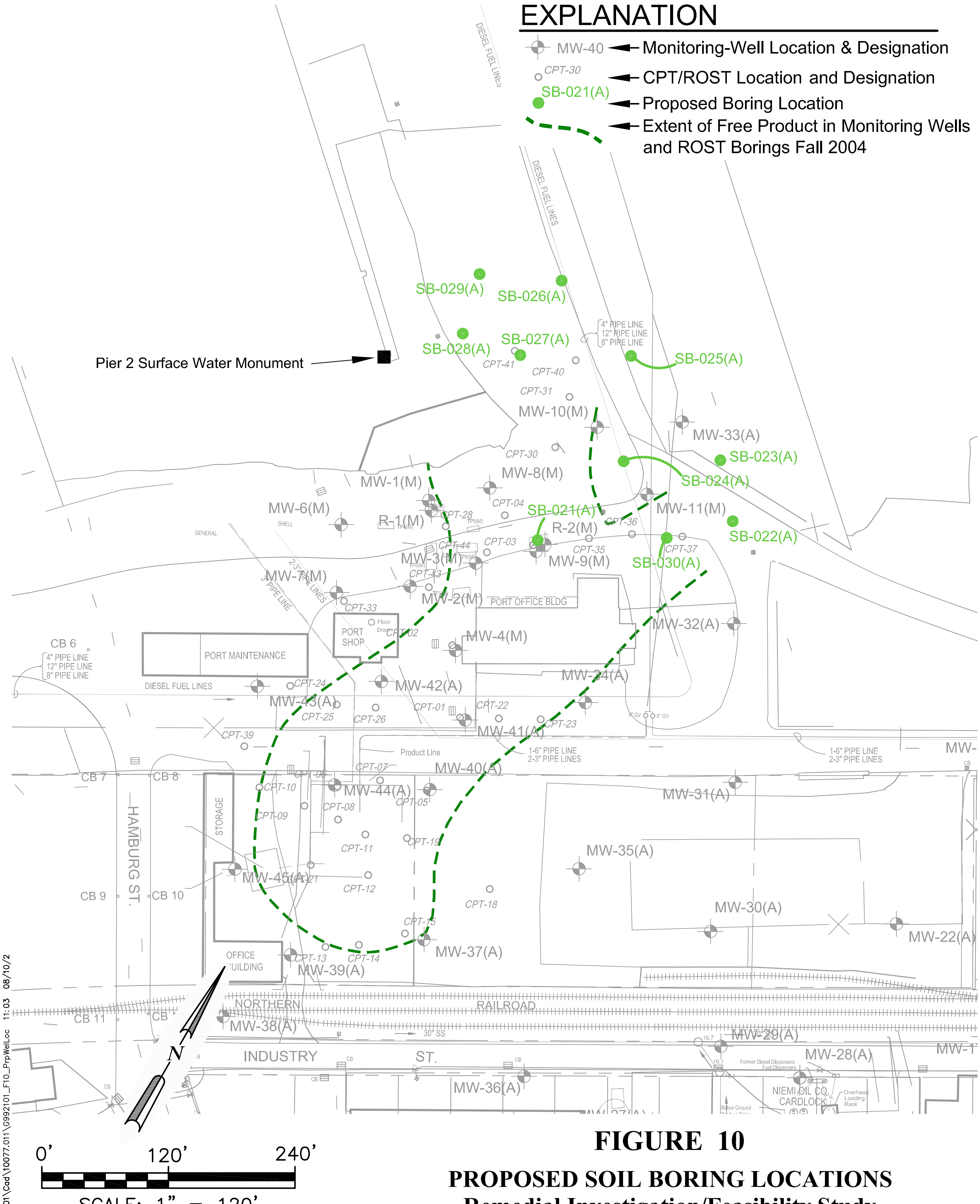


FIGURE 10

PROPOSED SOIL BORING LOCATIONS

Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

EnviroLogic Resources, Inc.
Consulting Environmental & Water Resources Scientists

G:\0900\992\101\Cad\10077.011\G992101_F10_PrpWelLoc 11:03 08/10/2

APPENDIX A

FUGRO GEOSCIENCES, INC. REPORT

13049 East Florence Avenue
Santa Fe Springs, CA 90670
Phone : 562-903-0055
Fax: 562-903-9005

October 6, 2004
Report Number: 0303-1090

Envirologic Resources, Inc.
15 82nd Drive
Suite 120
Gladstone, Oregon 97027

Attn.: Mr. Tom Calabrese

DATA REPORT
CONE PENETRATION AND
RAPID OPTICAL SCREENING TOOL TESTING
PORT OF ASTORIA, OREGON

Dear Mr. Calabrese:

Fugro Geosciences (Fugro) is pleased to present this data report for Cone Penetration (CPT) and Rapid Optical Screening Tool (ROST™) testing at the above-referenced site. CPT/ROST™ provided continuous characterization of stratigraphy and petroleum hydrocarbon distribution at the testing locations. A description of the CPT and ROST™ technologies and a discussion of general ROST™ data interpretation follows. CPT and ROST™ logs and electronic data CD are included as attachments.

Cone Penetration Testing

CPT was performed simultaneously with each ROST™ sounding and yielded real-time stratigraphic data. CPT is a proven method for rapidly evaluating the physical characteristics of unconsolidated soils. It is based on the resistance to penetration of an electronically-instrumented cone which is continuously advanced into the subsurface. In accordance with ASTM Standard D5778-95, the cone was advanced at a rate of two centimeters per second with the driving force provided by hydraulic rams.

The CPT cone used at this site had an apex angle of 60 degrees with a base area of 15 square centimeters (cm^2), and friction sleeve with a surface area of 200 cm^2. The standard geotechnical sensors within the cone measure tip resistance and sleeve friction in tons per square foot (TSF). The combined data from the tip resistance and sleeve friction form the basis of the soil classification (e.g., sand, silt, clay, etc.).

Soil stratigraphy was identified using Campanella and Robertson's Simplified Soil Behavior Chart. Please note that because of the empirical nature of the soil behavior chart, the soil identification should be verified locally.

ROST™ Testing

Fugro Geosciences' ROST™ Laser-Induced Fluorescence system was used for this investigation to screen soils for petroleum hydrocarbon materials containing aromatic hydrocarbon constituents. The system consists of a tunable laser mounted in the CPT truck that is connected to a down-hole sensor. The down-hole sensor consists of a small diameter sapphire window mounted flush with the side of the cone penetrometer probe.

The laser and associated equipment transmit 50 pulses of light per second to the sensor through a fiber optic cable. The wavelength of the pulsed excitation light is tunable and can be set to wavelengths of 266 nanometers (nm) or to wavelengths between 280 and 300 nm. An excitation wavelength of 290 nm was used for each test during this project.

The laser light passes through the sapphire window and is absorbed by aromatic hydrocarbon molecules in contact with the window, as the probe is advanced. This addition of energy (photons) to the aromatic hydrocarbons causes them to fluoresce. A portion of the fluorescence emitted from any encountered aromatic constituents is returned through the sapphire window and conveyed by a second fiber optic cable to a detection system within the CPT rig. The emission data resulting from the pulsed laser light is averaged into one reading per one second interval (approximately one reading per 2 cm vertical interval) and is recorded continuously. ROST™ may be operated in single or multi-wavelength mode, depending on project objectives. For this project, ROST™ was operated in multi-wavelength mode (MWL).

Multi-Wavelength Mode (MWL). In MWL mode, several characteristics of the emitted fluorescence are measured and recorded simultaneously at four (4) specific wavelengths (340, 390, 440, and 490 nm). These four wavelengths represent the spectrum of fluorescence typically produced by aromatic hydrocarbons ranging from light fuels through heavy contaminants such as coal tar and creosote. The recorded data is then presented as a color graph of fluorescence intensity (the combined fluorescence of all four monitored wavelengths) versus depth (FVD).

On the FVD graph, each of the four monitored wavelengths is assigned a color. These colors are combined based on the proportional fluorescence intensity of each of the individual wavelengths. The combined color is then used on the FVD graph. Changes in color on the FVD graph typically represent changes in product type. Similarly, like colors on the FVD graph typically represent the same product, regardless of the total fluorescence intensity. Changes in the total fluorescence intensity typically indicate changes in contaminant concentration, with higher fluorescence intensities representing proportionally higher concentrations when compared to lower fluorescence intensities.

In addition to the FVD graph, depth specific waveforms are presented at four (4) selected depths throughout the sounding. These waveform graphs are presented to the right of the FVD graph on each plot. In the waveform graphs, the fluorescence intensity and duration of fluorescence of each of the monitored wavelengths is represented by an individual peak, starting at 340 nm and increasing in 50 nm wavelengths as you move to the right. The intensity of each wavelength is represented by the height of the peaks, and the duration of fluorescence is represented by the width of each peak. For general interpretation purposes, lighter aromatic hydrocarbon molecules will emit fluorescence at the shorter wavelengths, and heavier, longer chained hydrocarbons will emit fluorescence at the longer wavelengths. The presented waveforms can be compared to waveforms typical of common hydrocarbon products to determine the likely product type that has been encountered. Please note that the waveforms are available at every two centimeter interval throughout the entire sounding. Additional waveforms can be generated at any time during or after testing is complete.

Reference Solution. The fluorescence intensity of a reference solution placed on the sapphire window was measured immediately prior to conducting each test. This reference solution measurement serves two purposes. First, as a quality control check, the solution is used to ensure that the performance of the system is within specifications. Second, it allows for normalization of the data from different test locations for variation in laser power, operating conditions, and monitored emission wavelength. The reference solution used for this project was the standard M1 reference, which is a proprietary PHC containing solution. M1 provides consistent fluorescence response across the portion of the spectrum analyzed by ROST and therefore, allows the fluorescence data collected to be consistently normalized to intensities recorded as a percentage of M1.

LIMITATIONS OF ENVIRONMENTAL SUBSURFACE WORK

Fugro Geosciences' report is based upon our observations made during field work, the information provided to Fugro and the results of the ROST/CPT survey. Given the inherent limitation of environmental subsurface work, Fugro cannot guarantee that the site is free of hazardous or potentially hazardous materials or conditions or that latent or undiscovered conditions will not become evident in the future. Fugro's report was prepared in accordance with our proposal and the General Conditions agreed to between Fugro and Client and no warranties, representations, or certifications are made.

Fugro Geosciences, Inc. appreciates the opportunity to be of service to your organization. Please do not hesitate to contact us if we can be of further assistance. We look forward to working with you in the future.

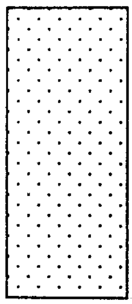
Sincerely,
FUGRO GEOSCIENCES, INC.

For.
Recep Yilmaz
President

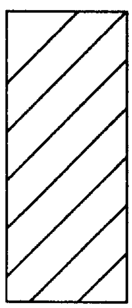
RY/jm

Enclosure: - 1 CD

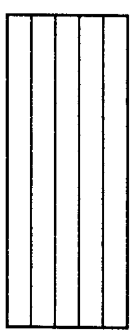
KEY TO SOIL BEHAVIOR TYPE



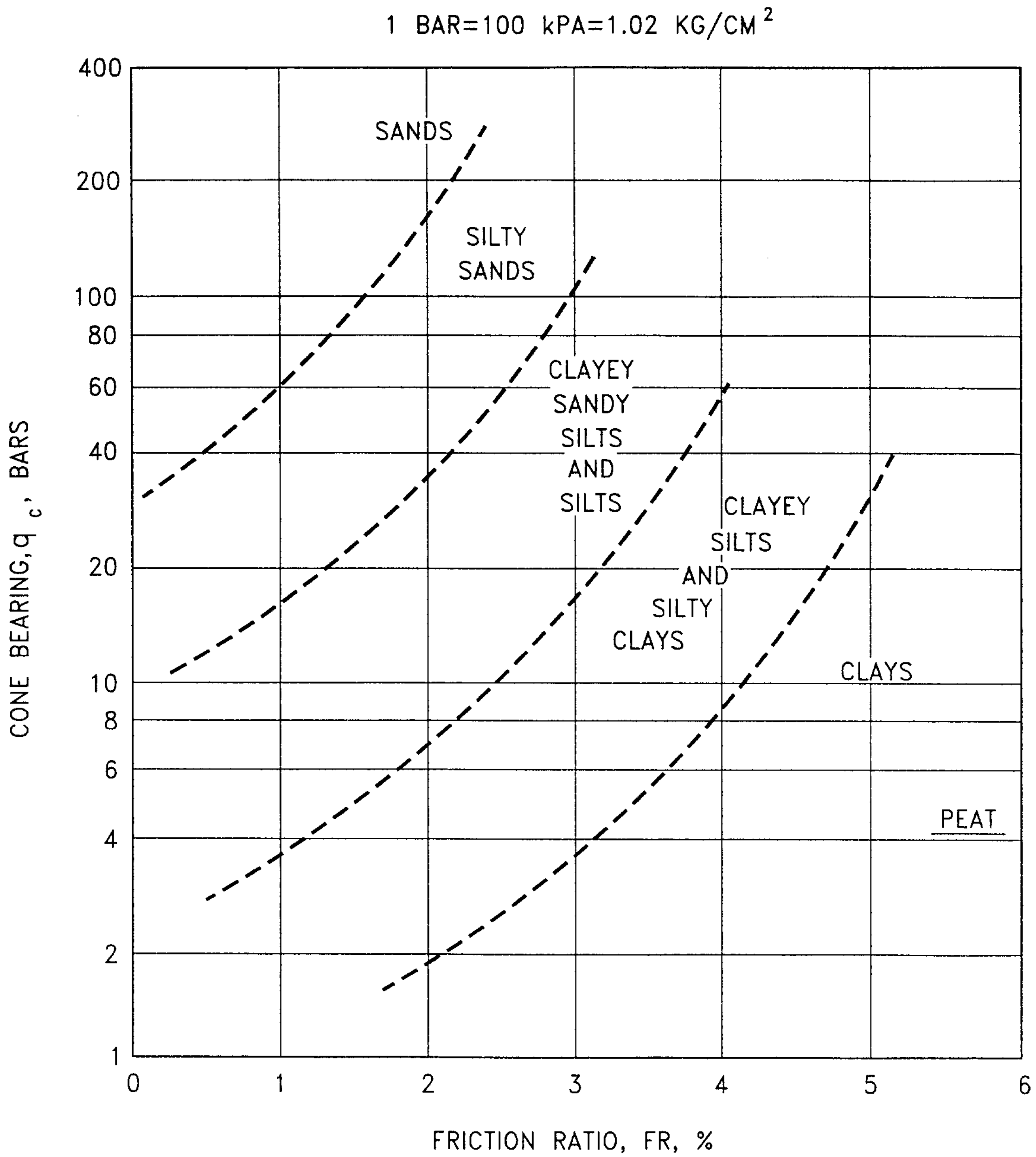
SAND AND SANDY SOIL



CLAY AND CLAYEY SOIL

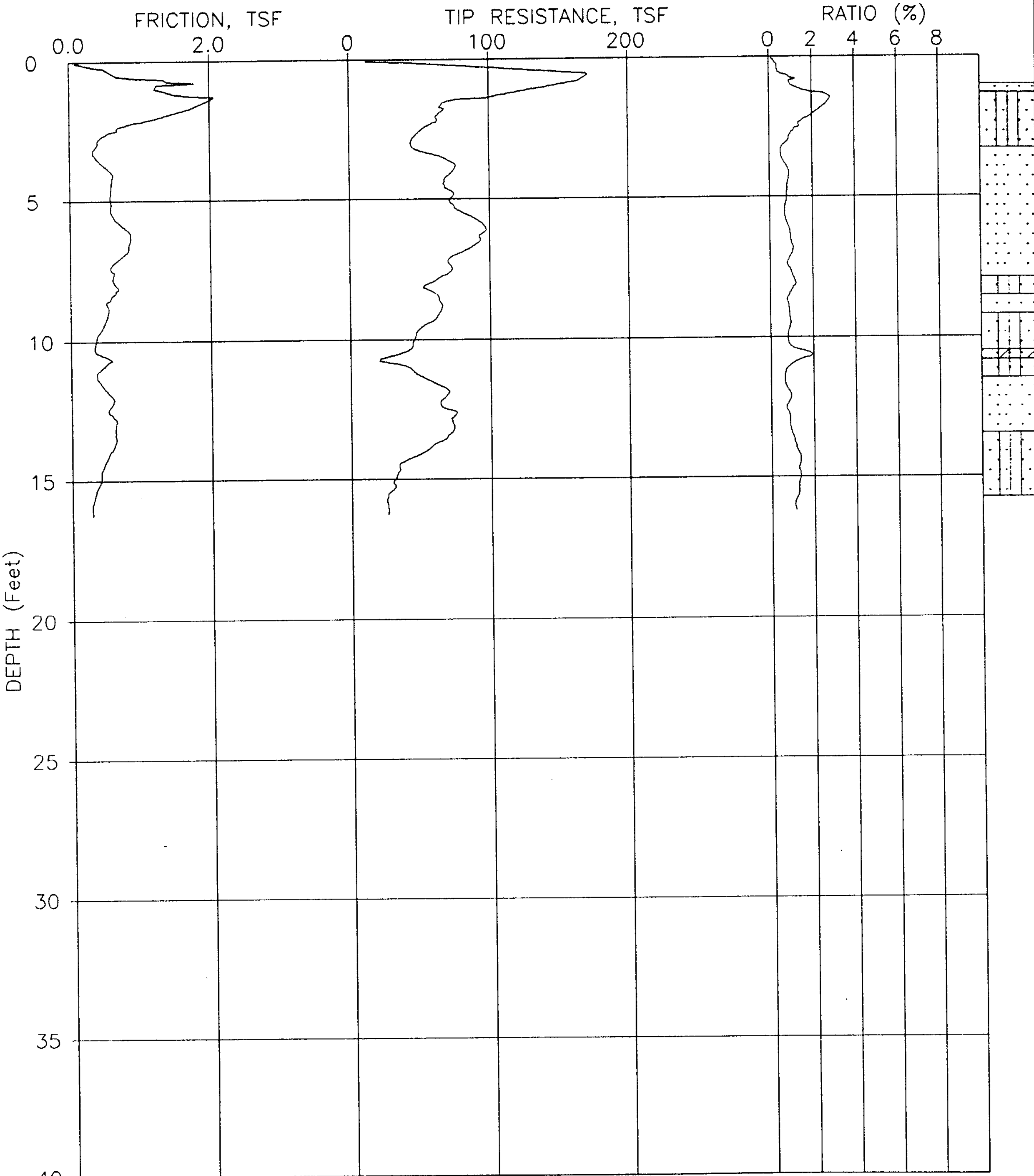


SILT AND SILTY SOIL



MODIFIED CAMPANELLA AND ROBERTSON SOIL BEHAVIOR CHART (1983)

CPT LOGS



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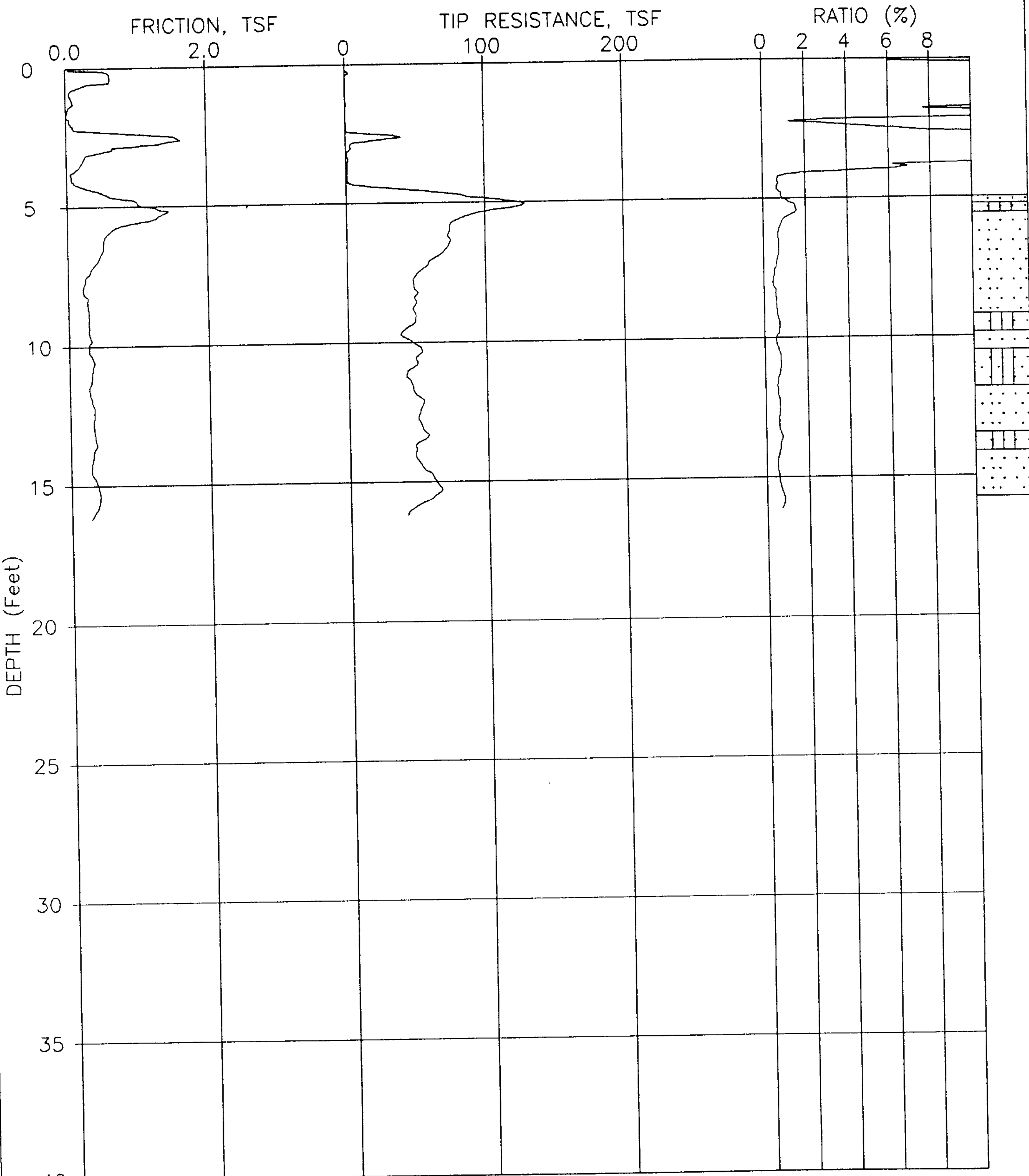
FUGRO GEOSCIENCES,INC



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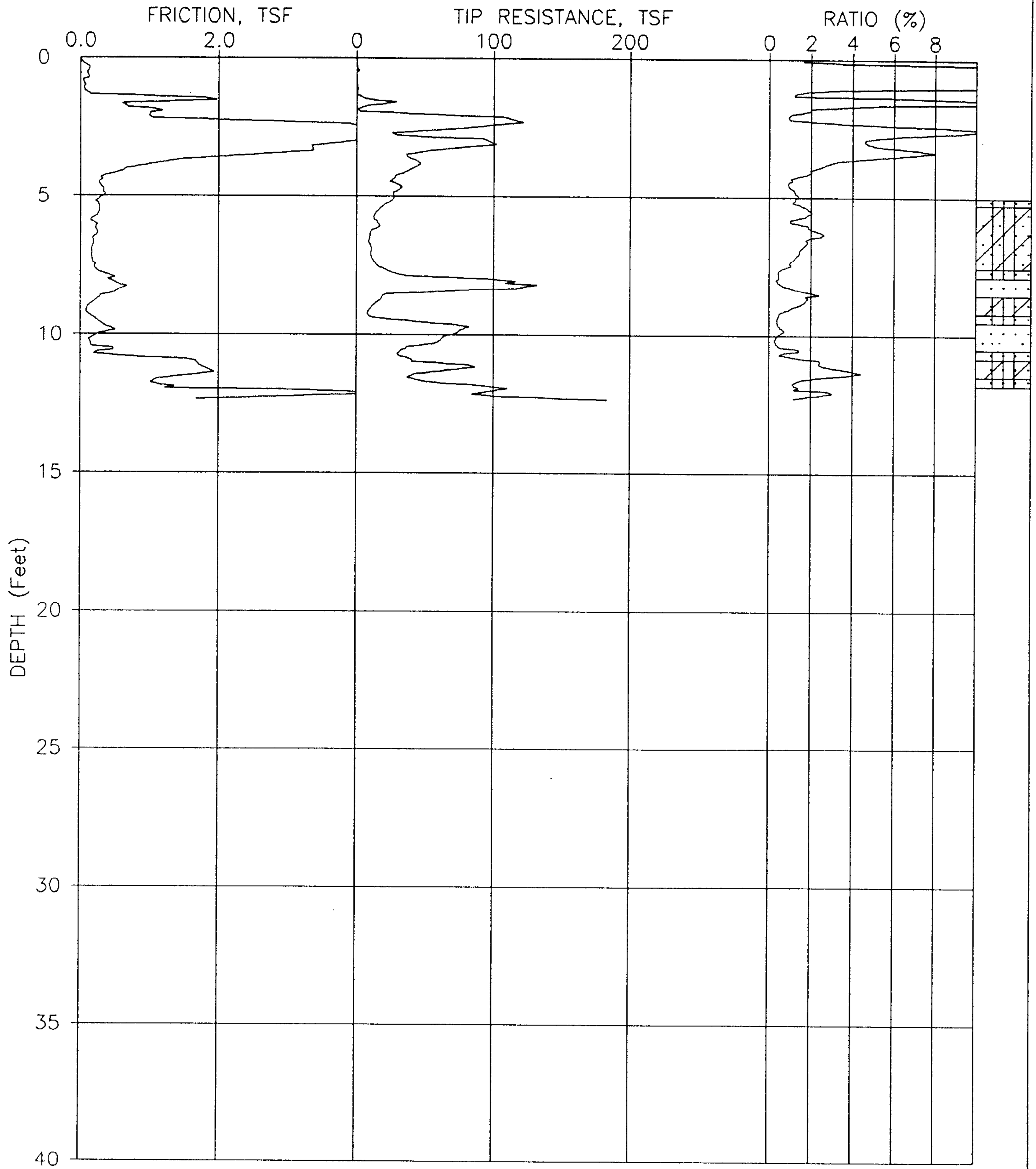
DATE: 09-23-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



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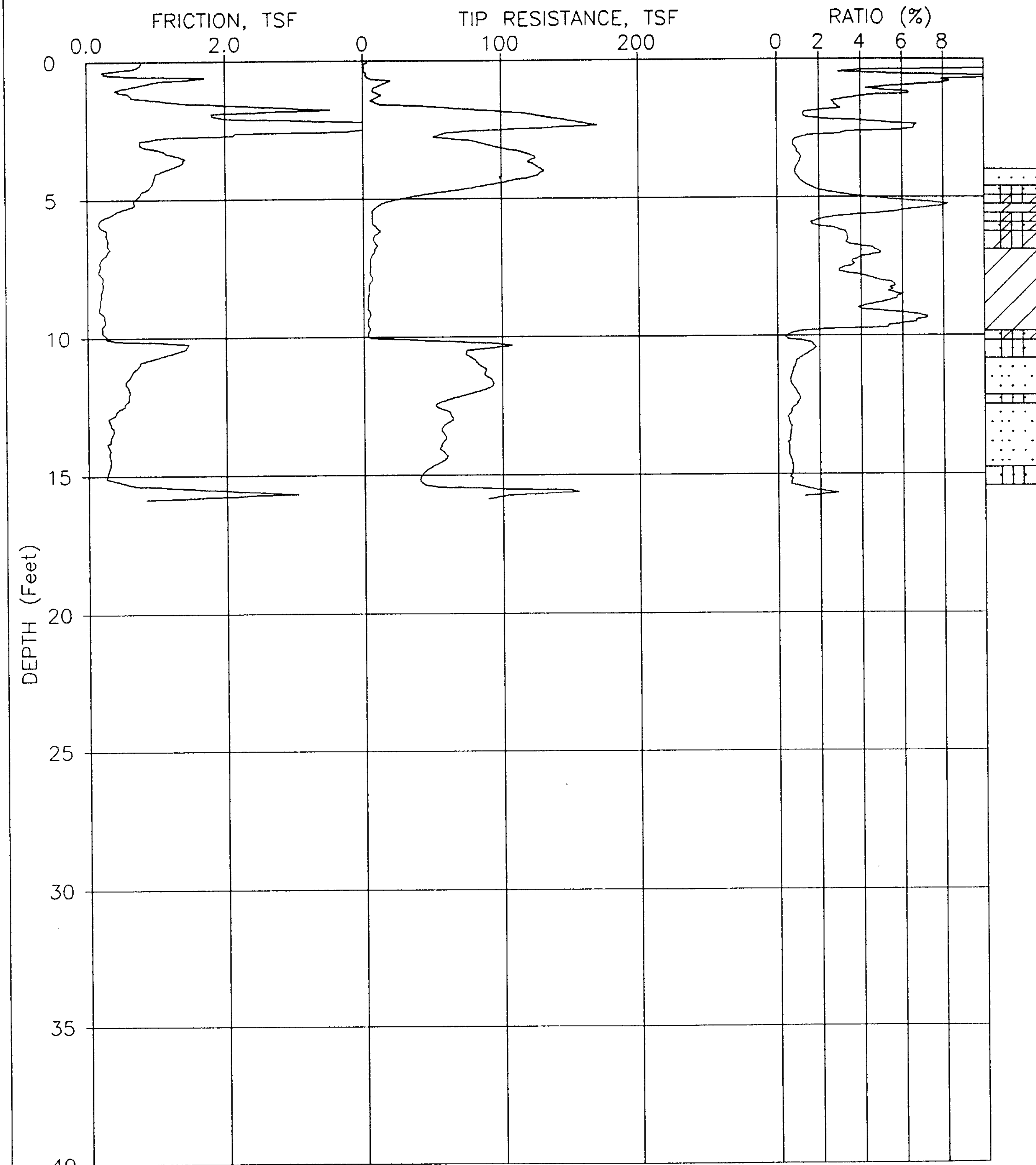
FUGRO GEOSCIENCES,INC



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DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

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DATE: 09-21-2004
PLATE: 1 OF 1

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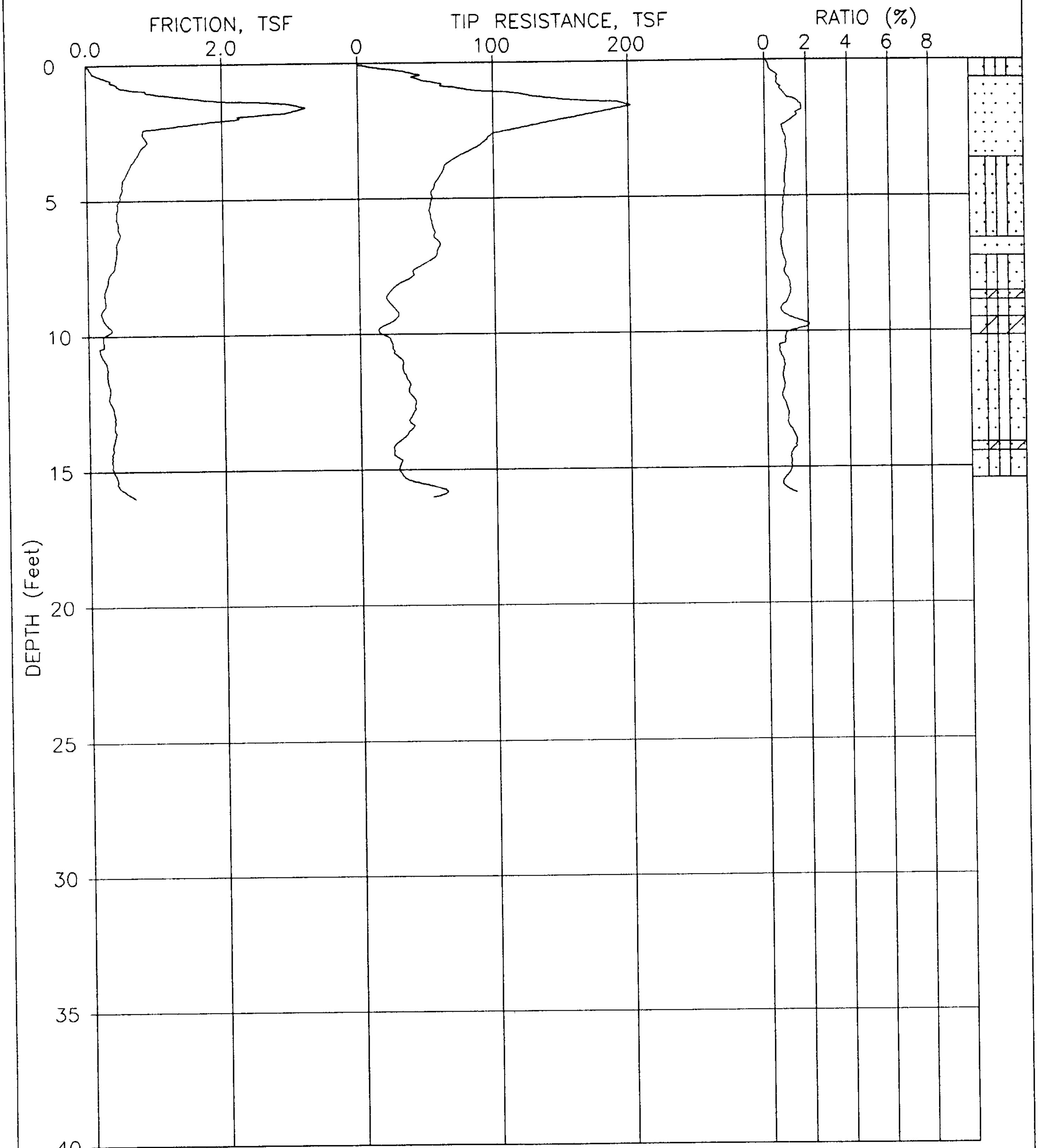

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PLATE: 1 OF 1

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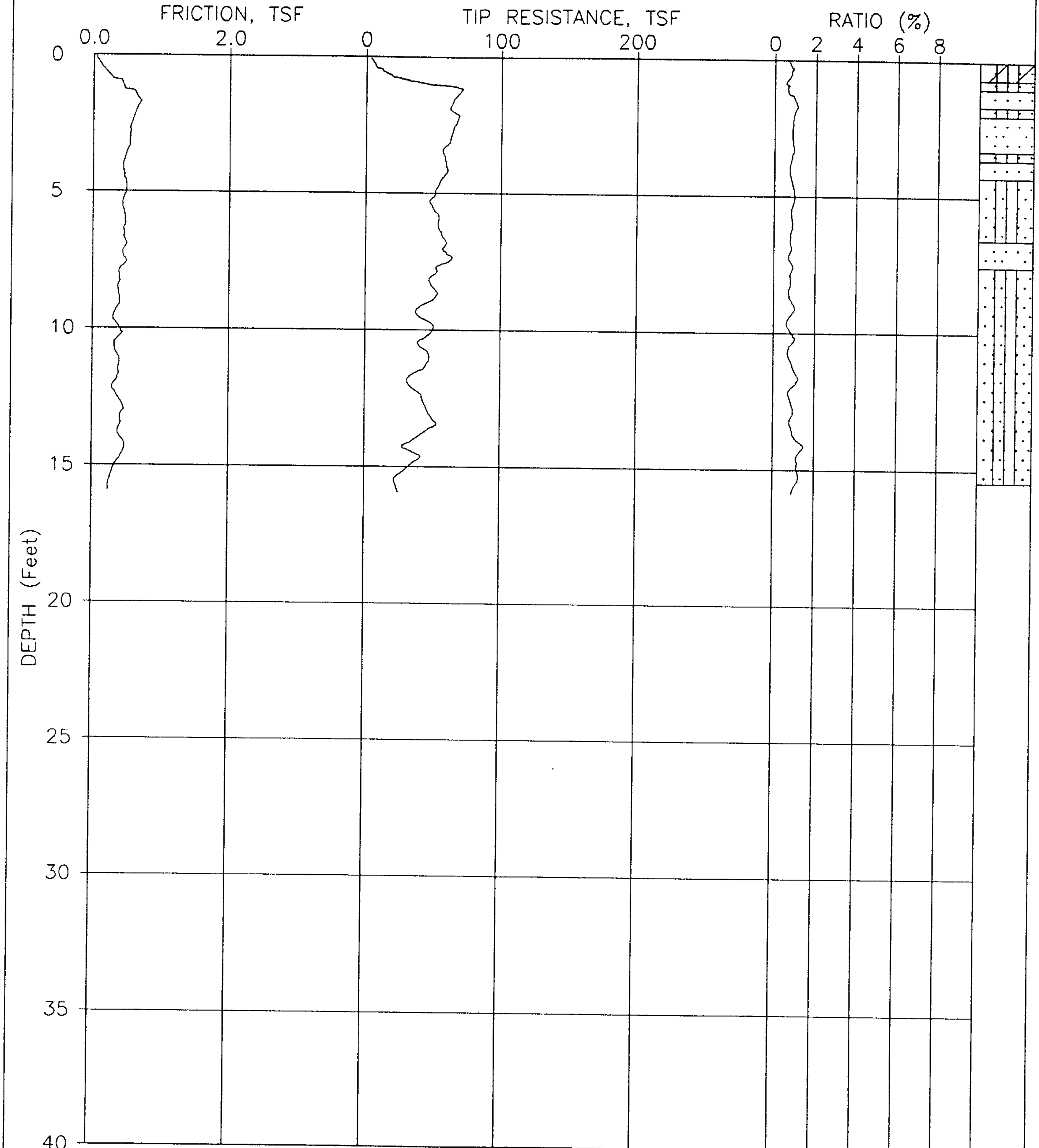

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DATE: 09-21-2004
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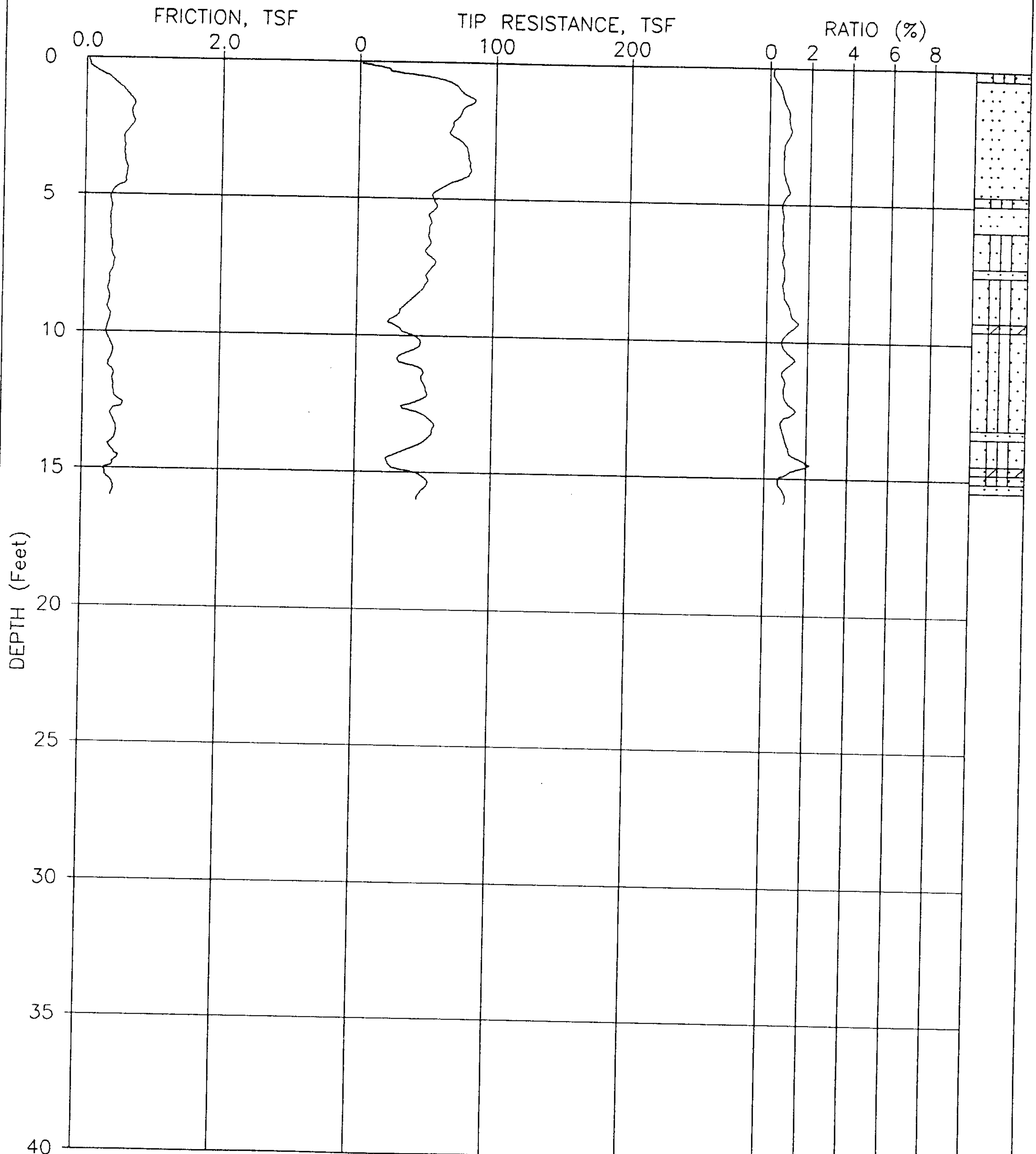

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PLATE: 1 OF 1

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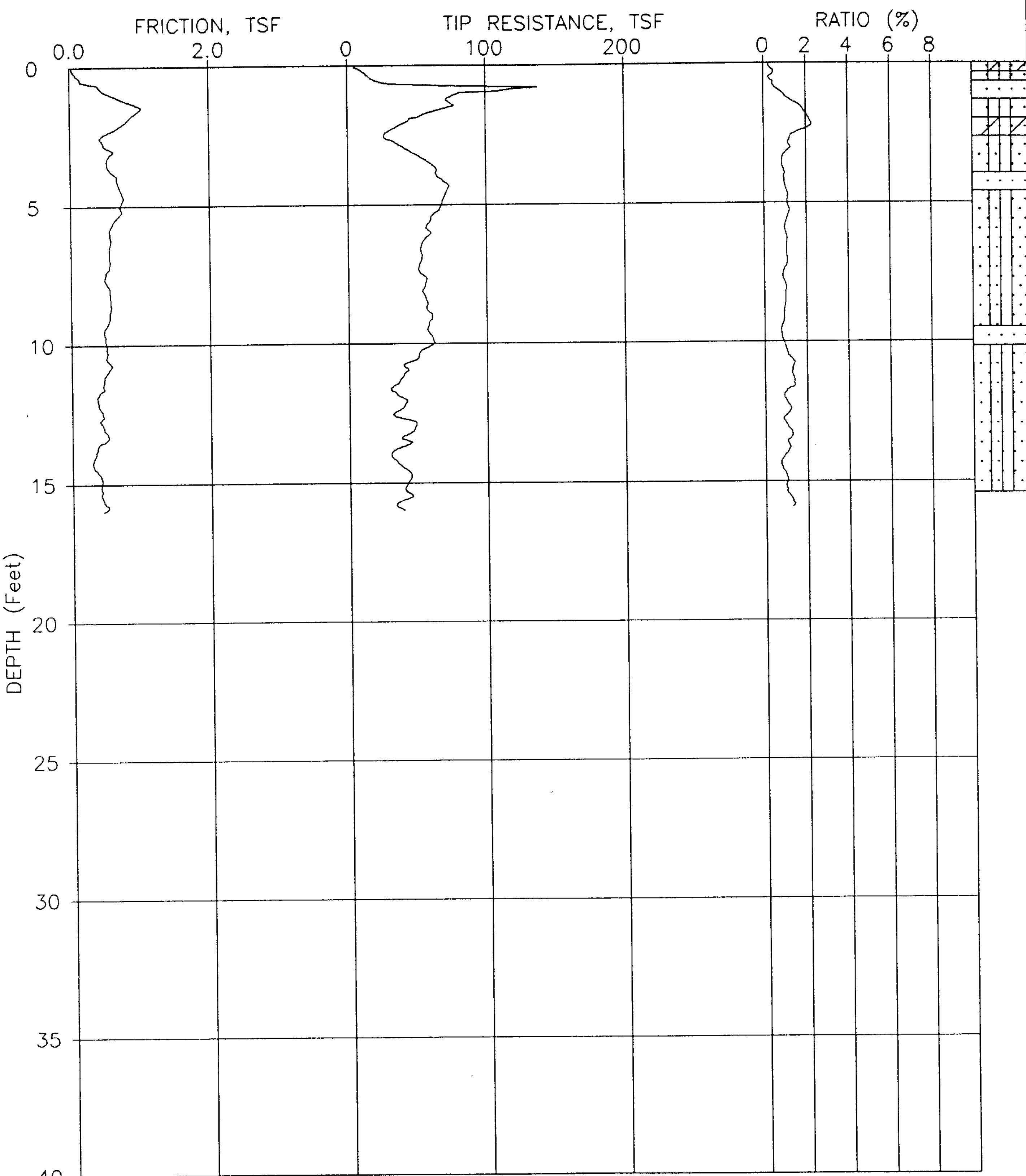

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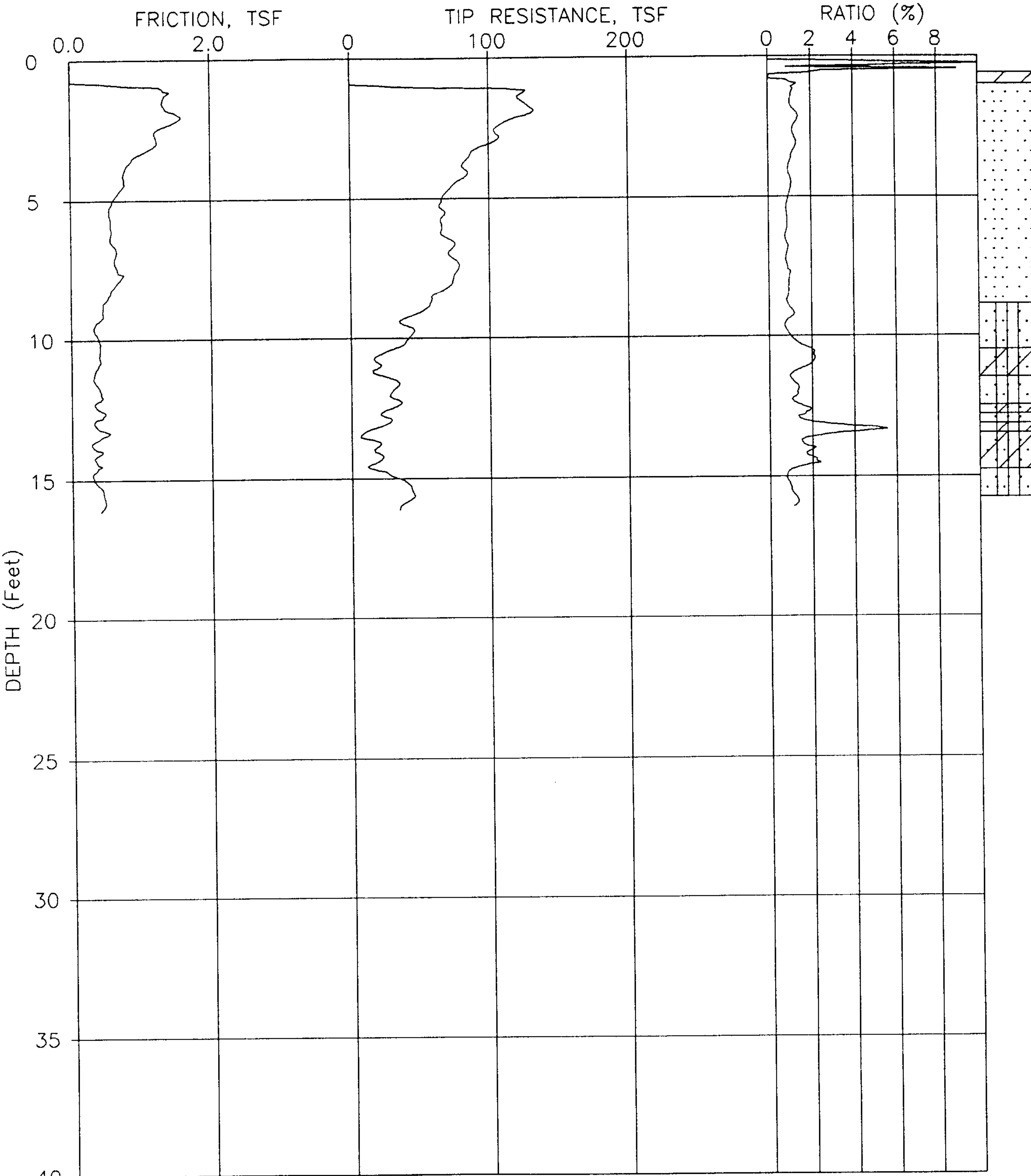

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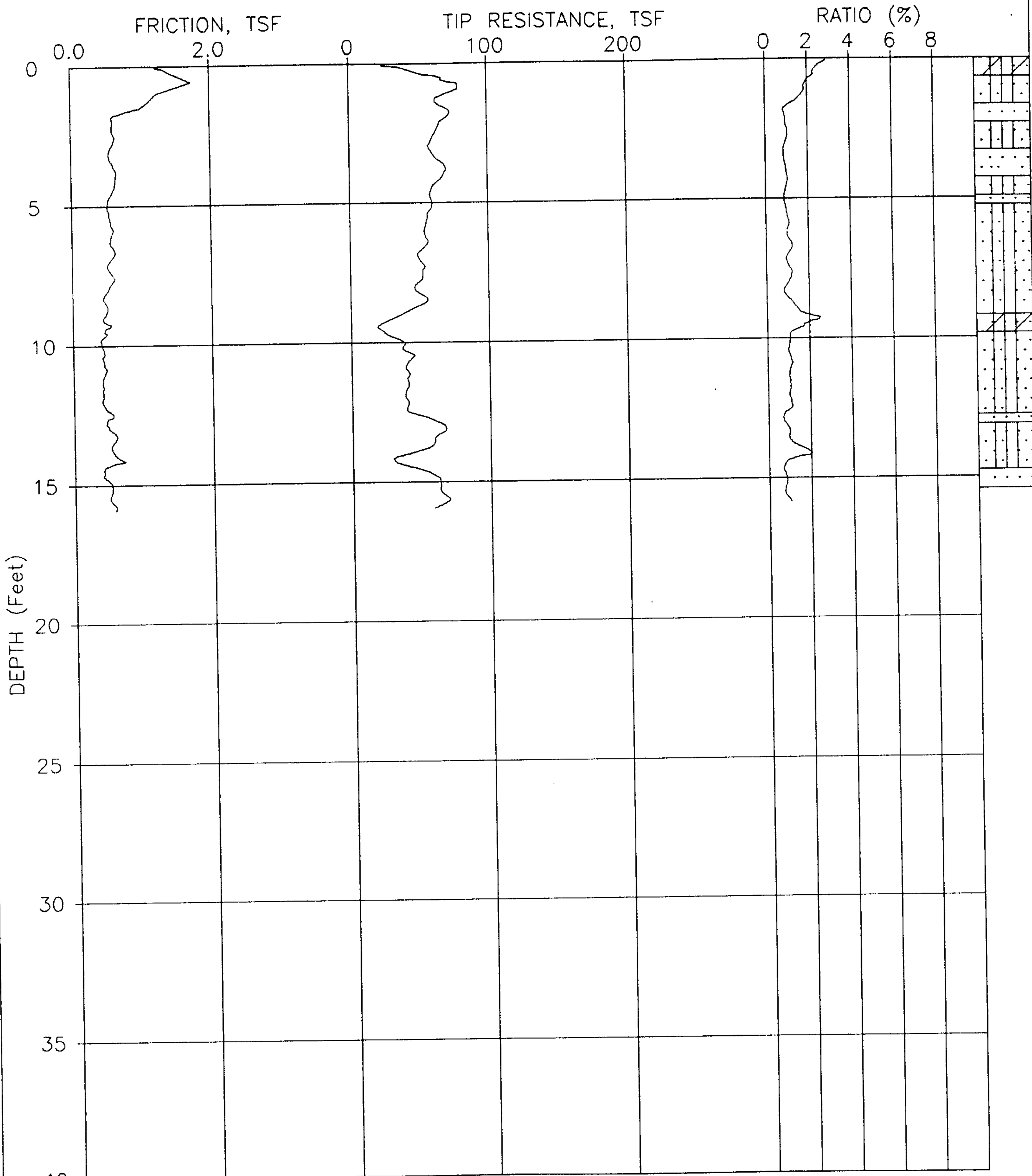

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PLATE: 1 OF 1

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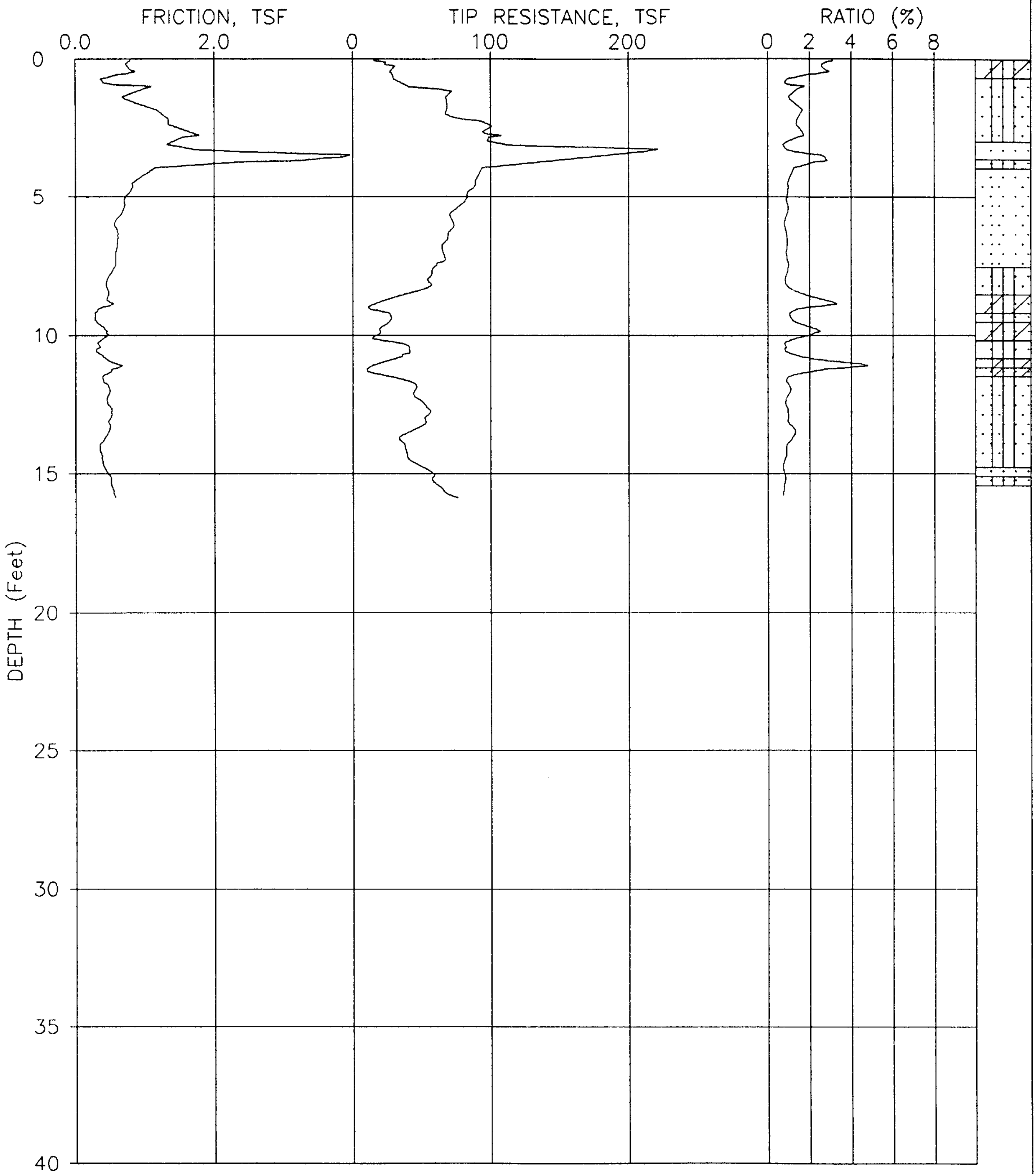

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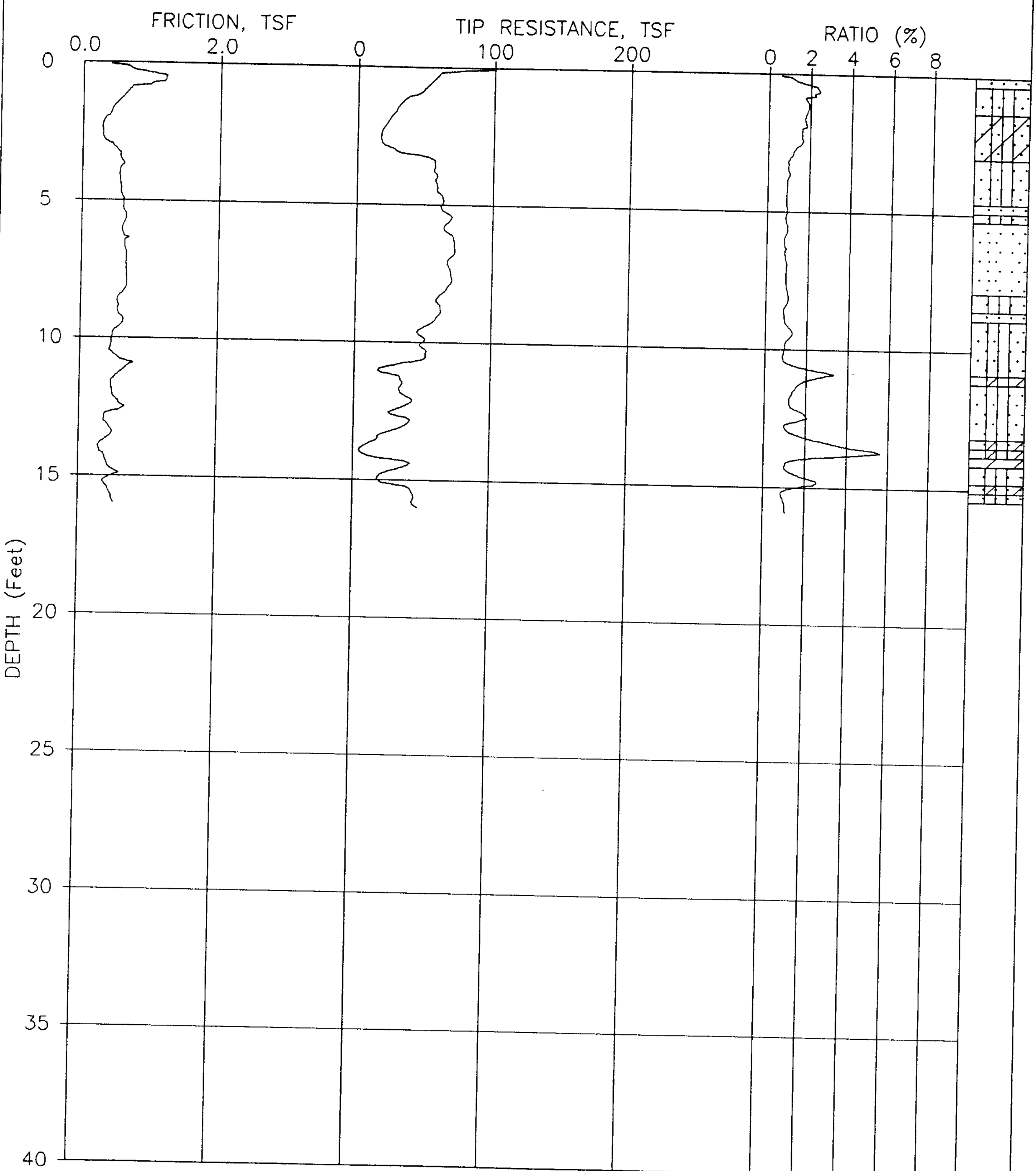

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PLATE: 1 OF 1

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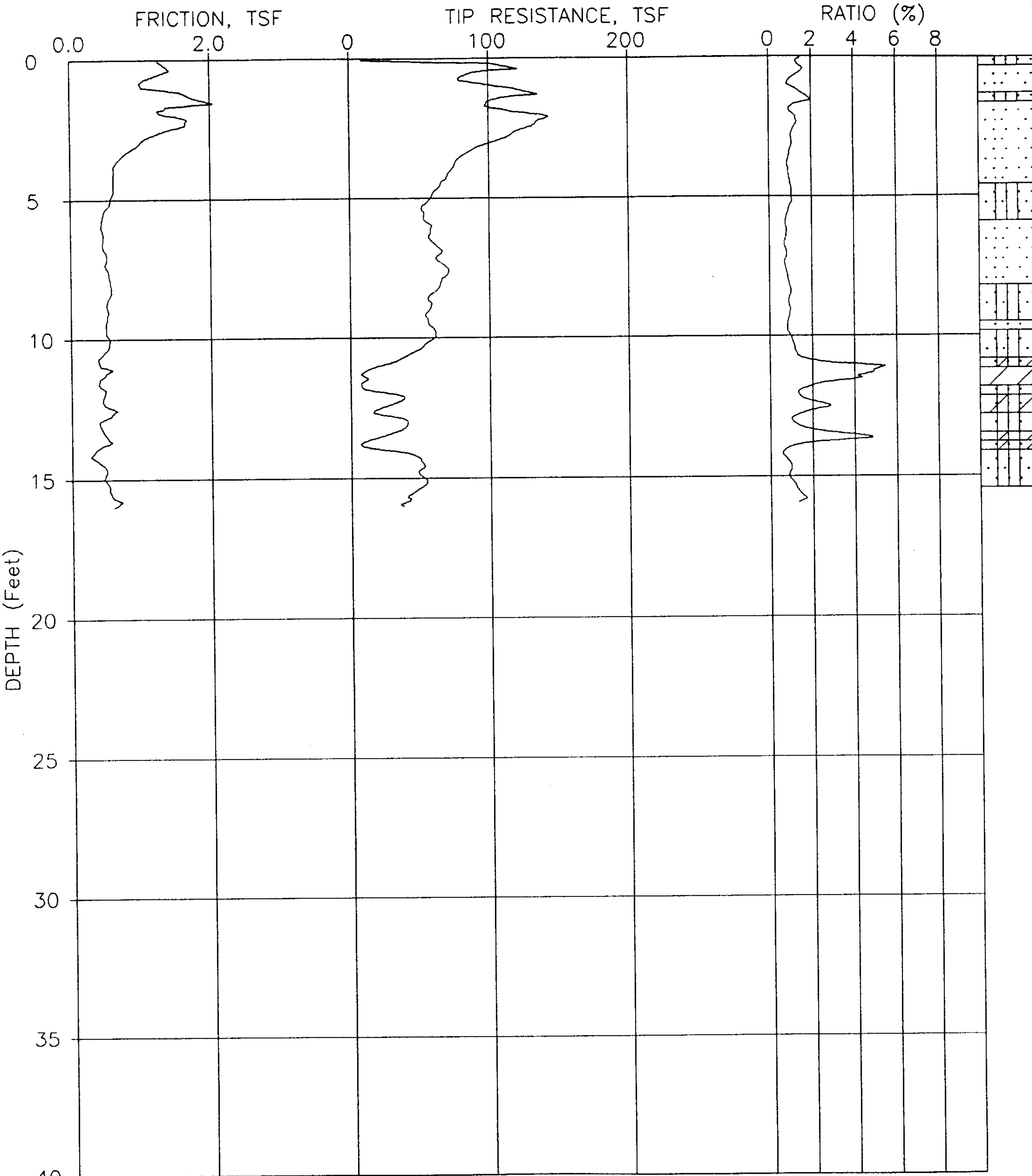

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PLATE: 1 OF 1

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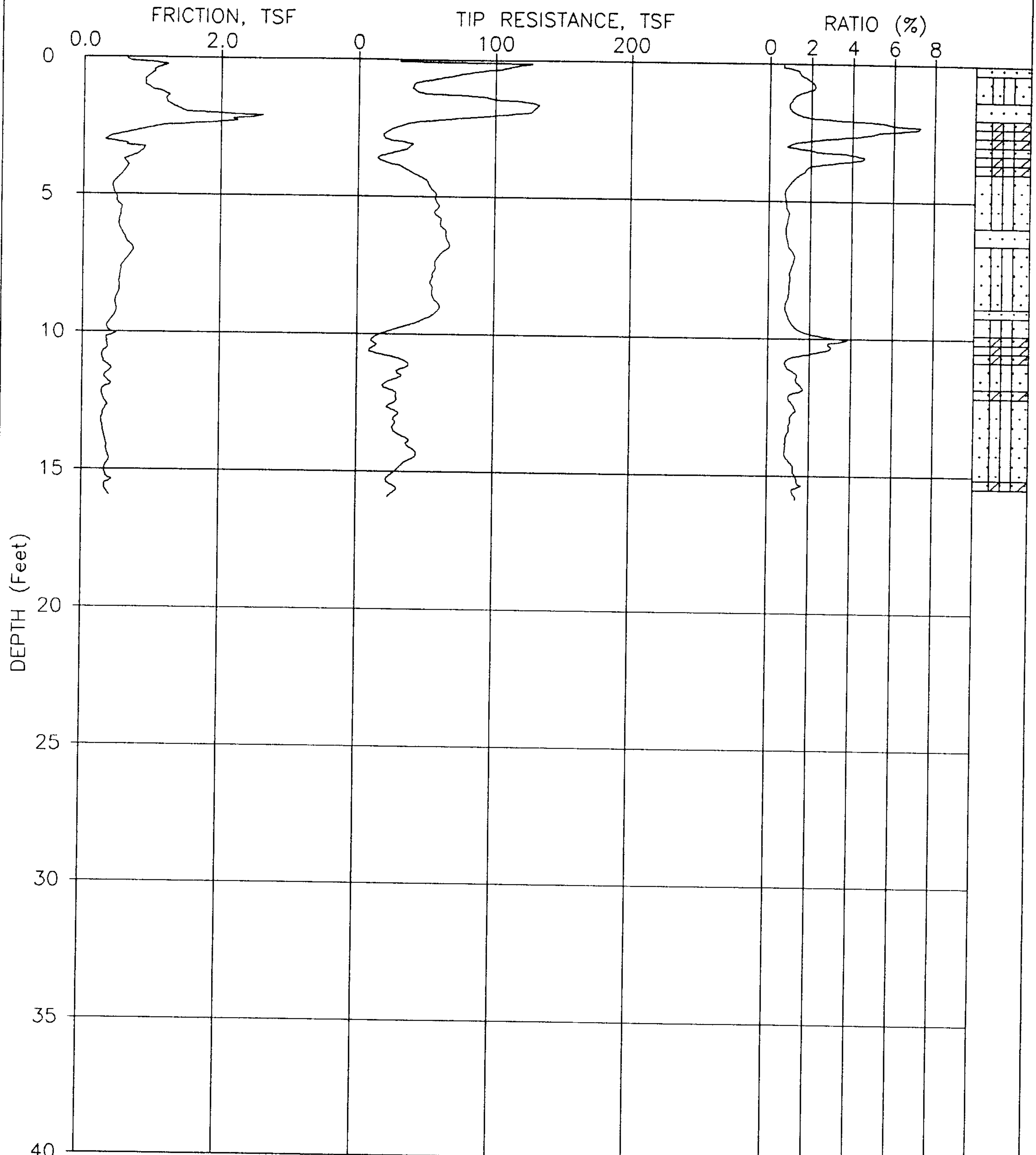

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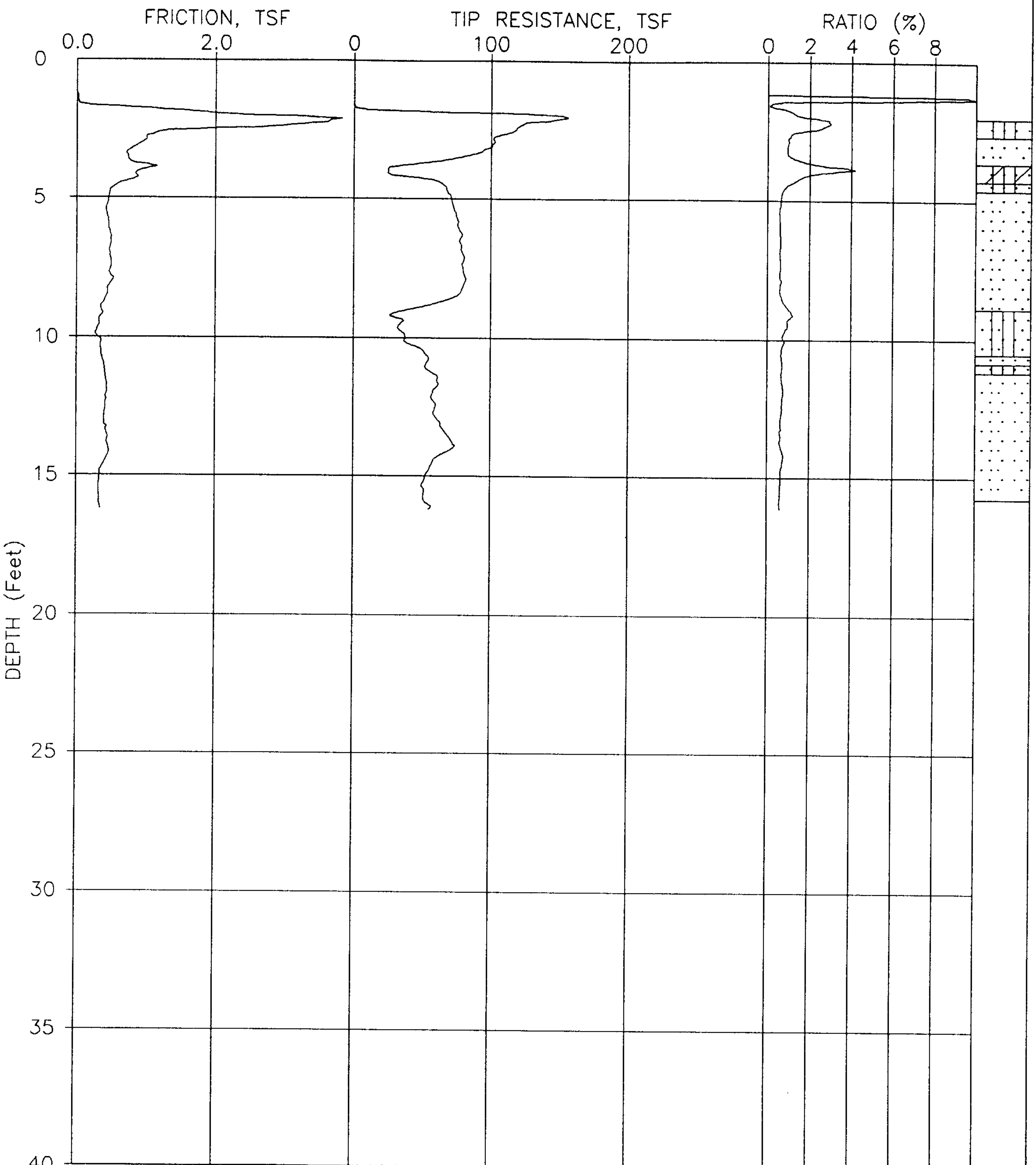

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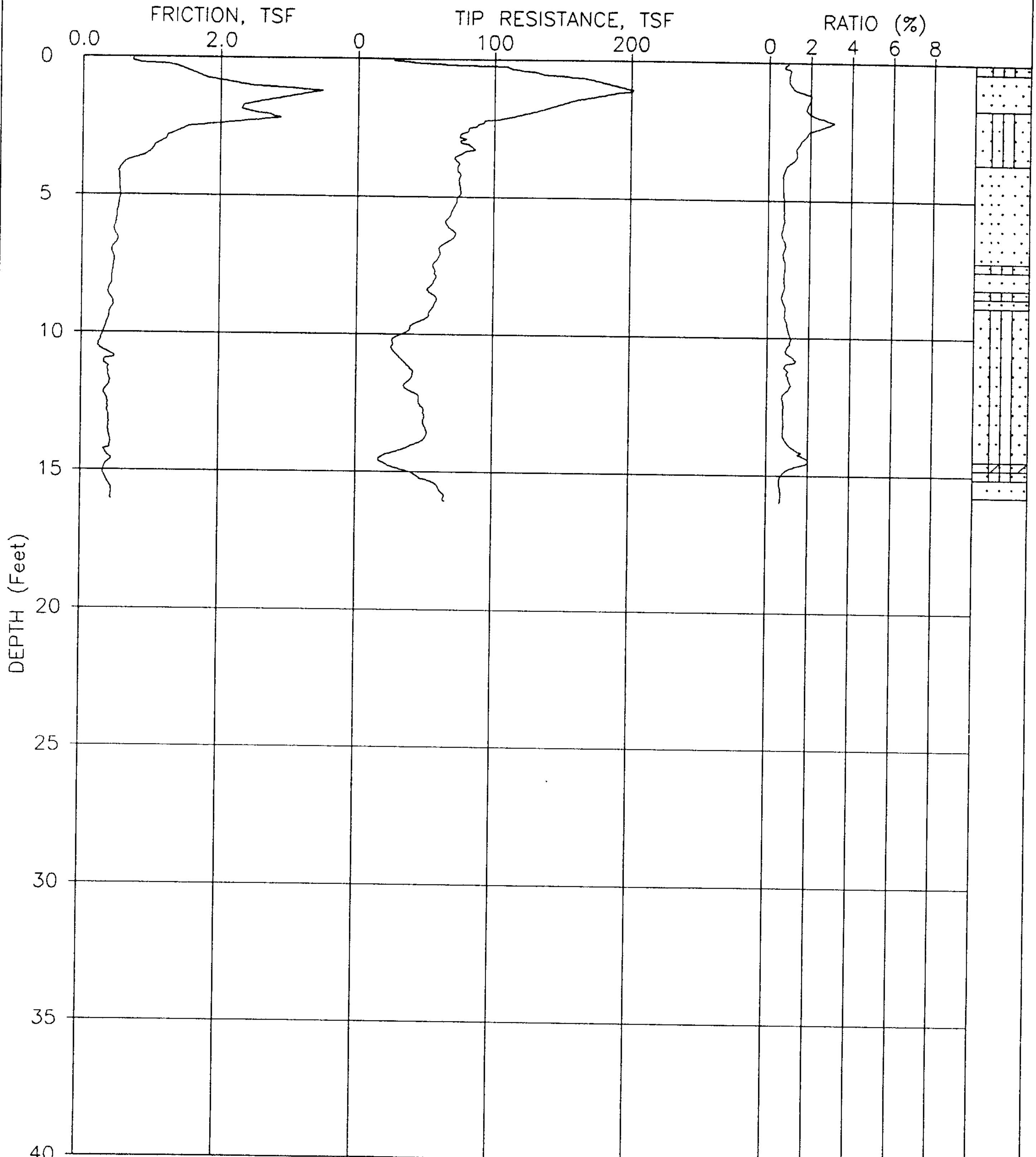

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PLATE: 1 OF 1

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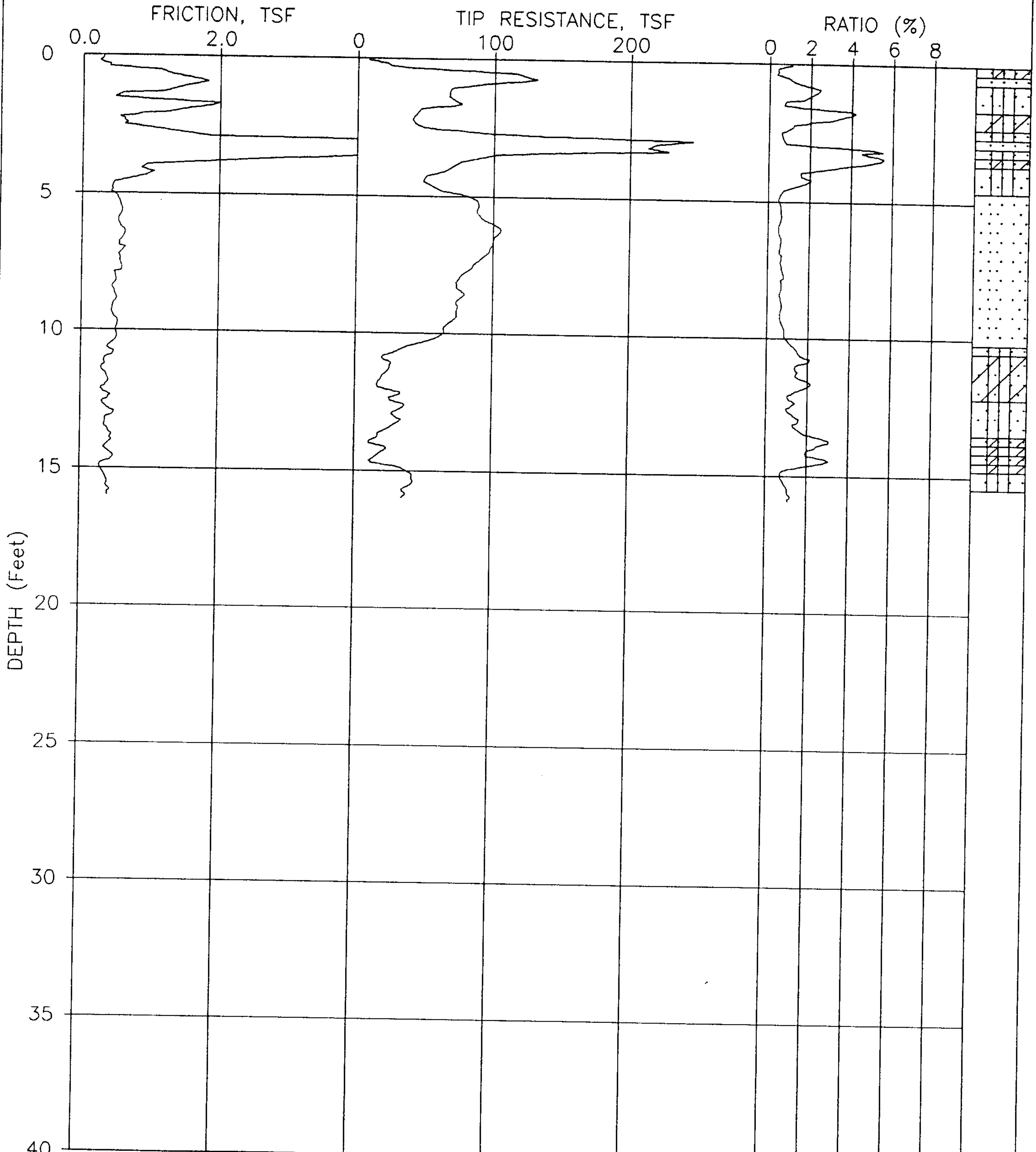

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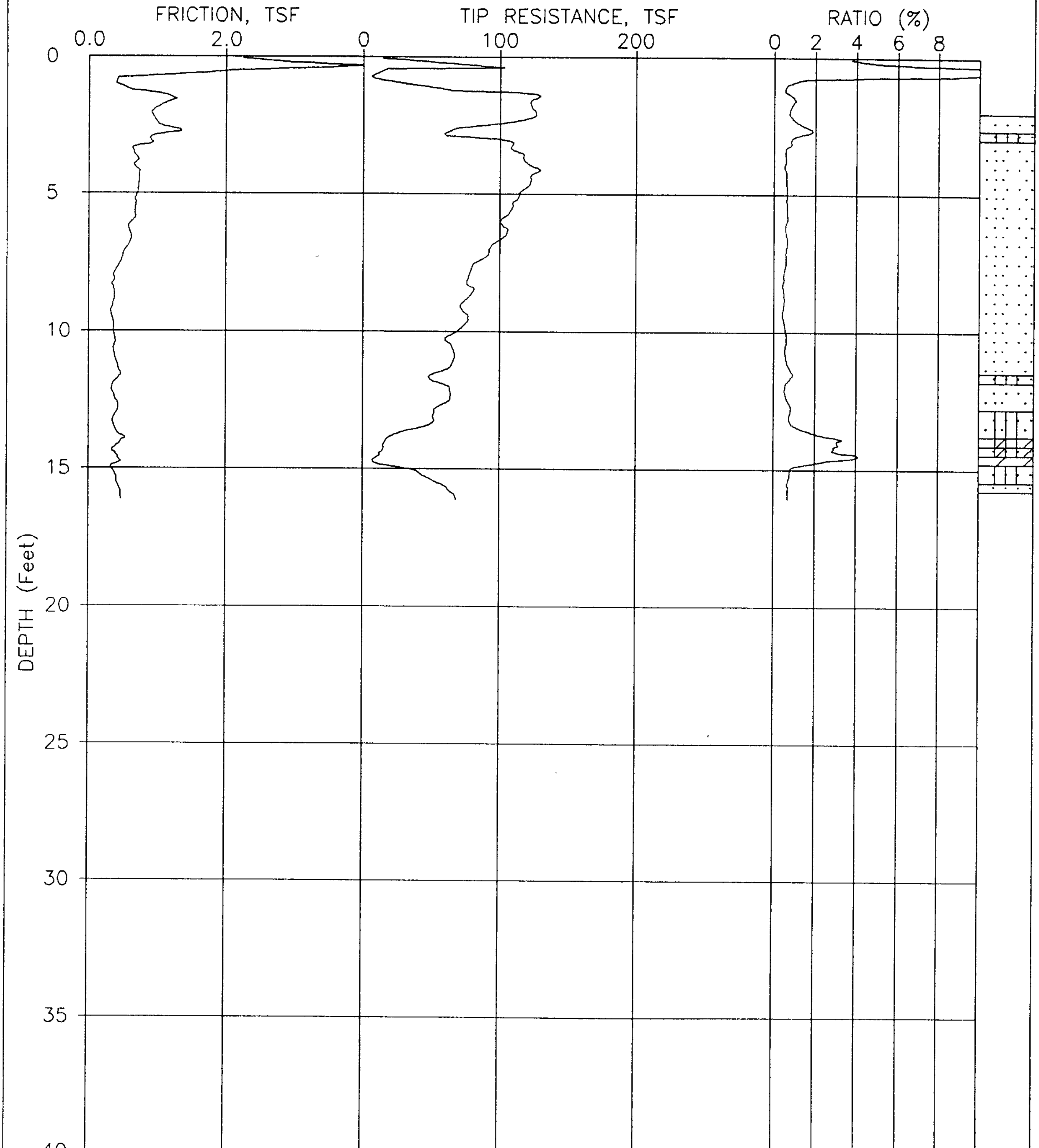

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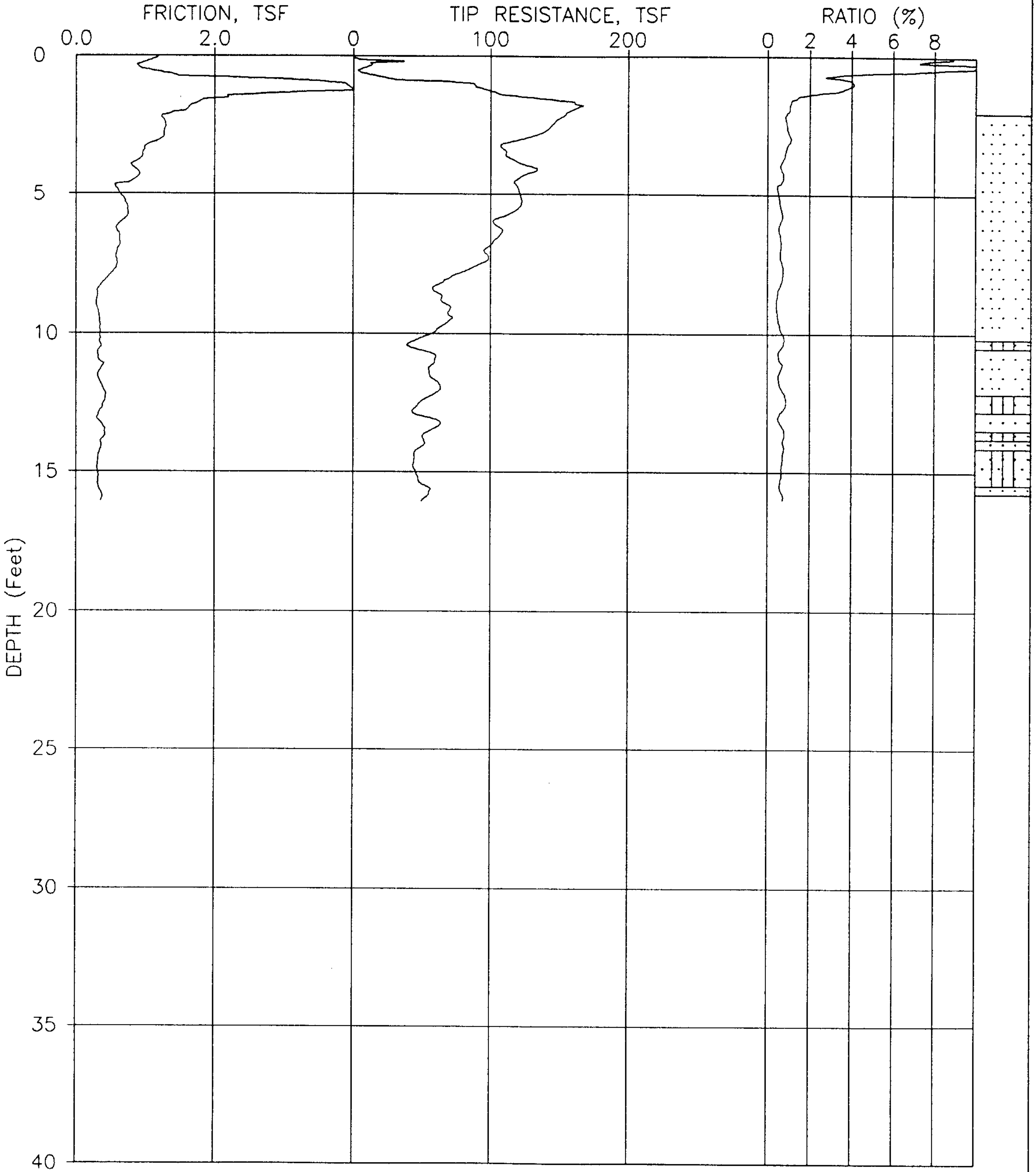

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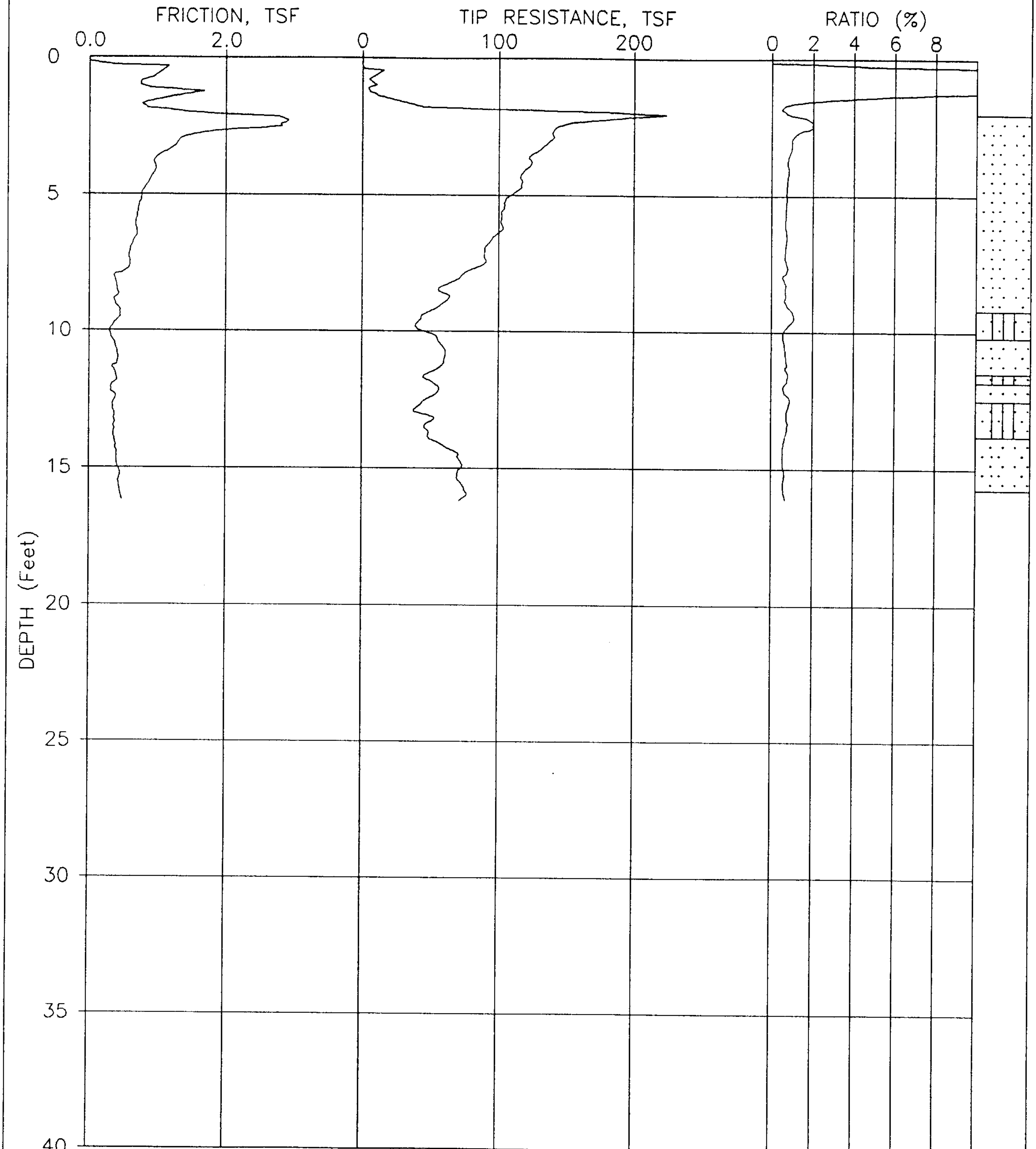
FUGRO GEOSCIENCES,INC



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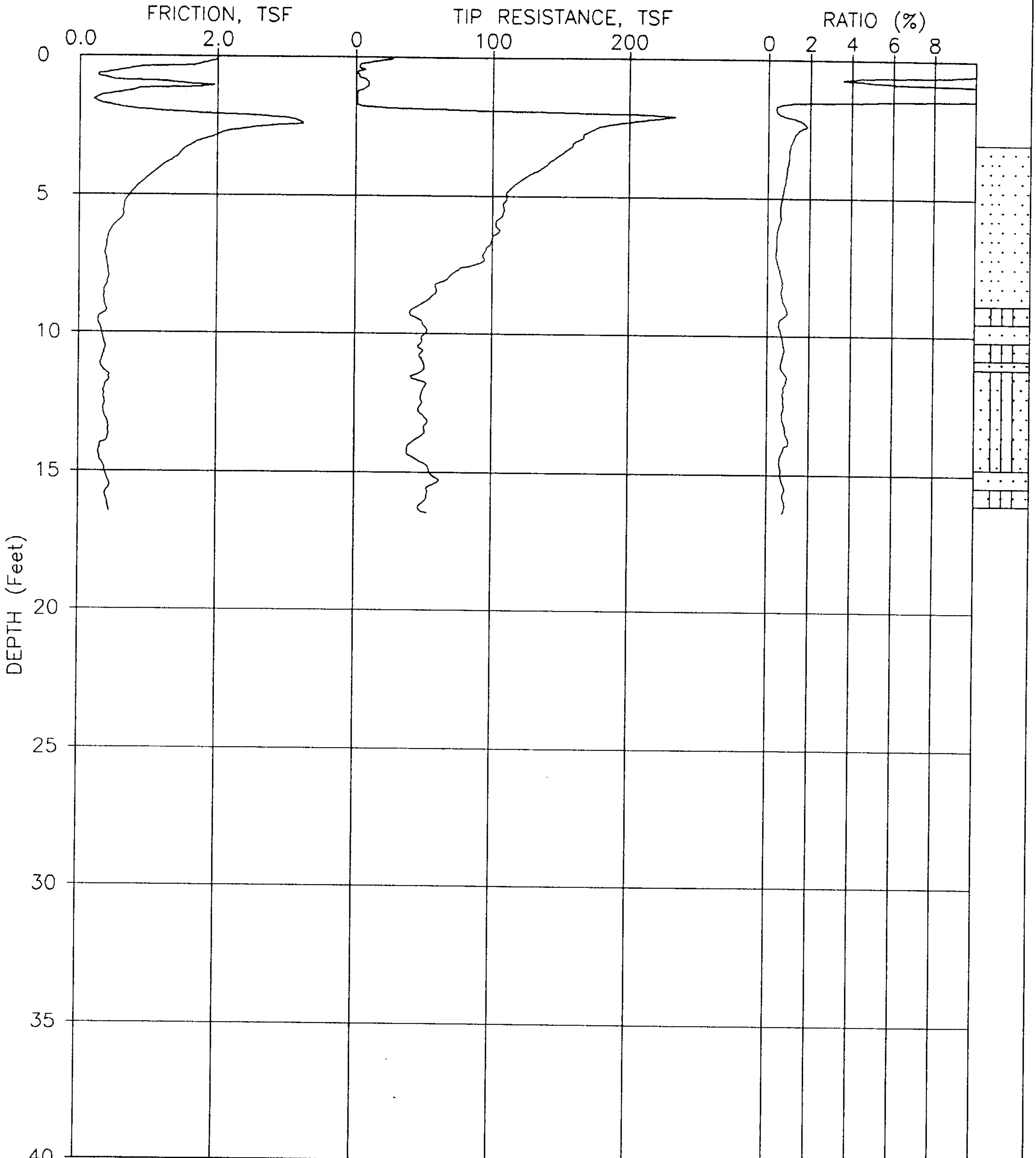
FUGRO GEOSCIENCES,INC



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DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

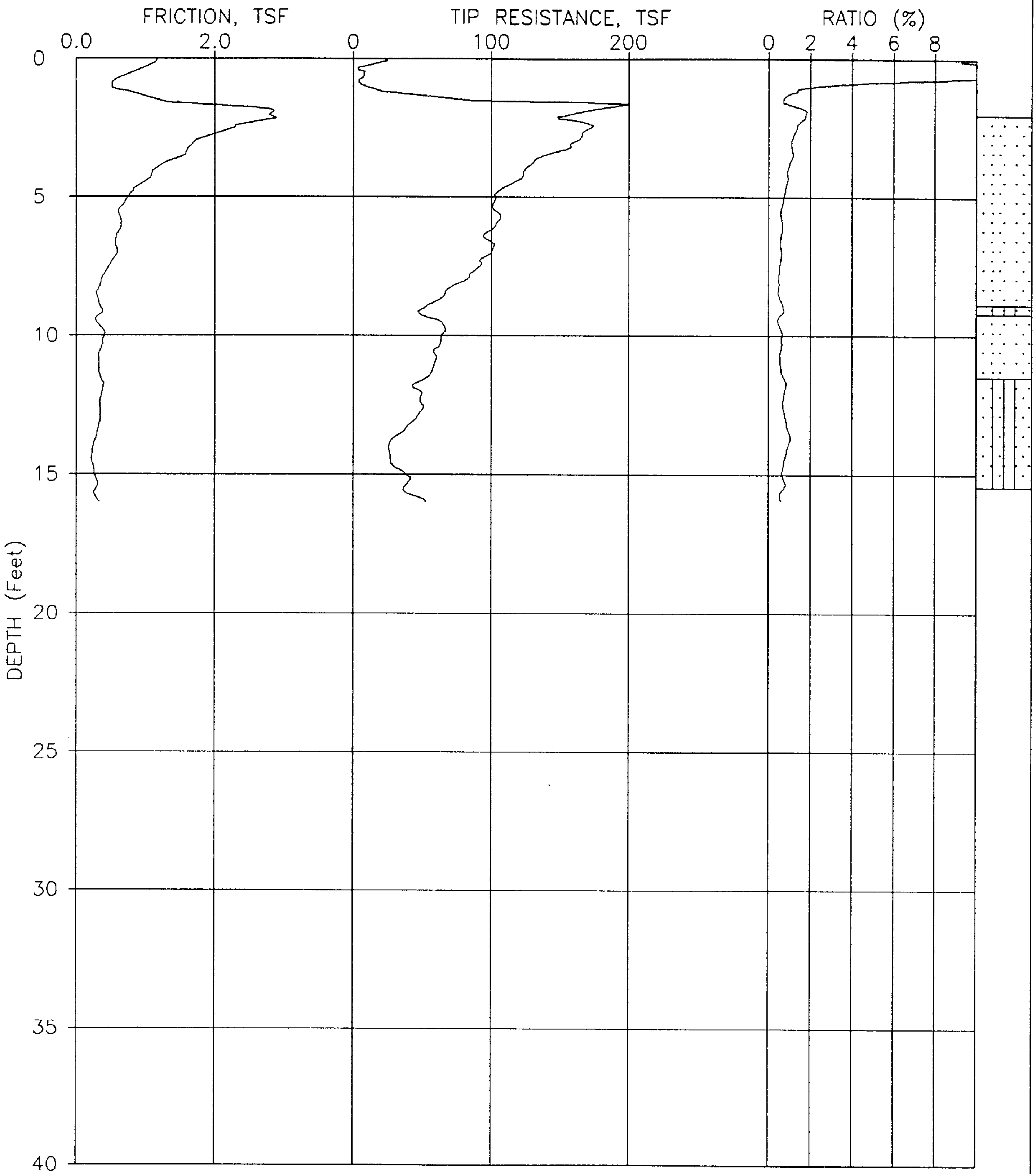

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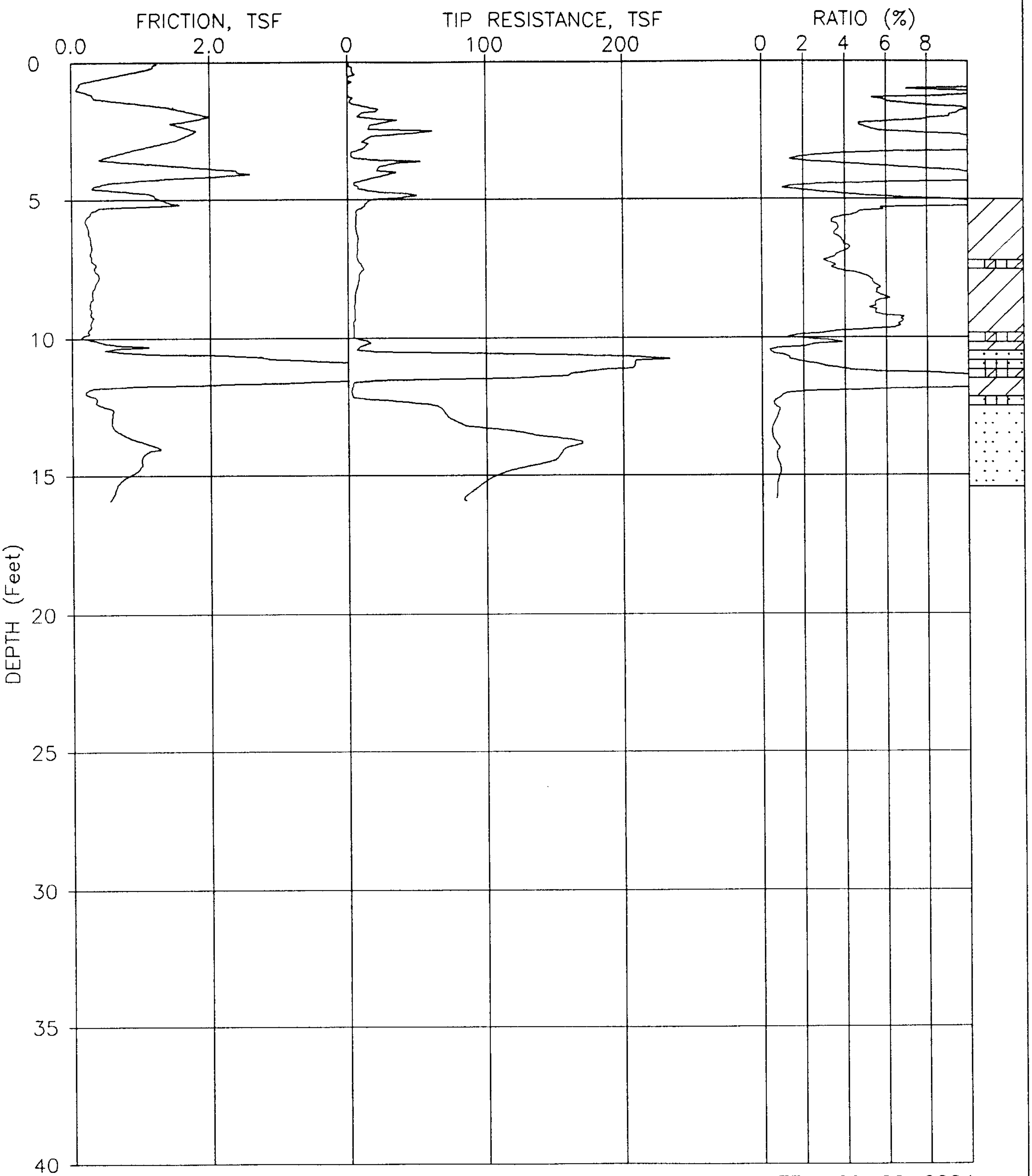
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



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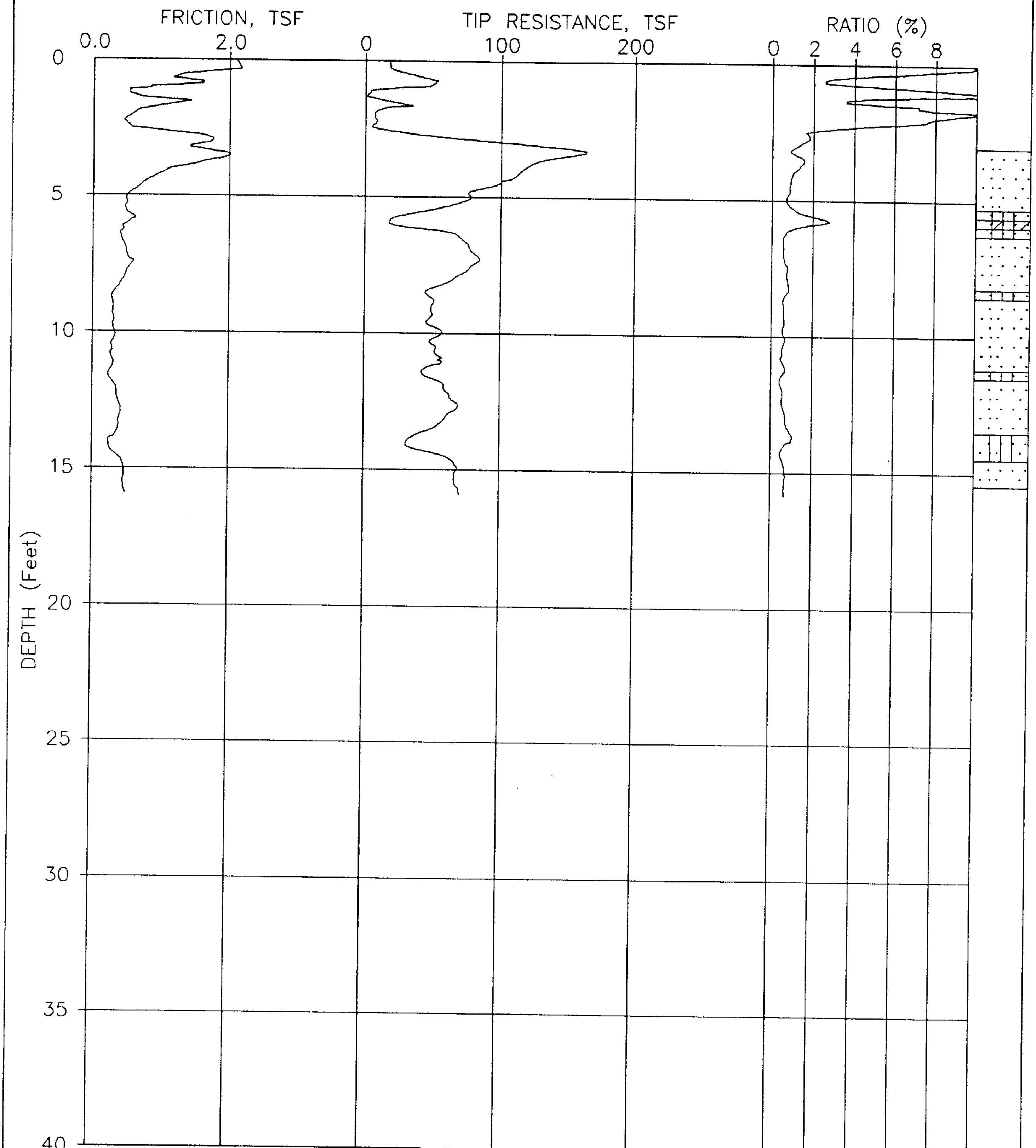
DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



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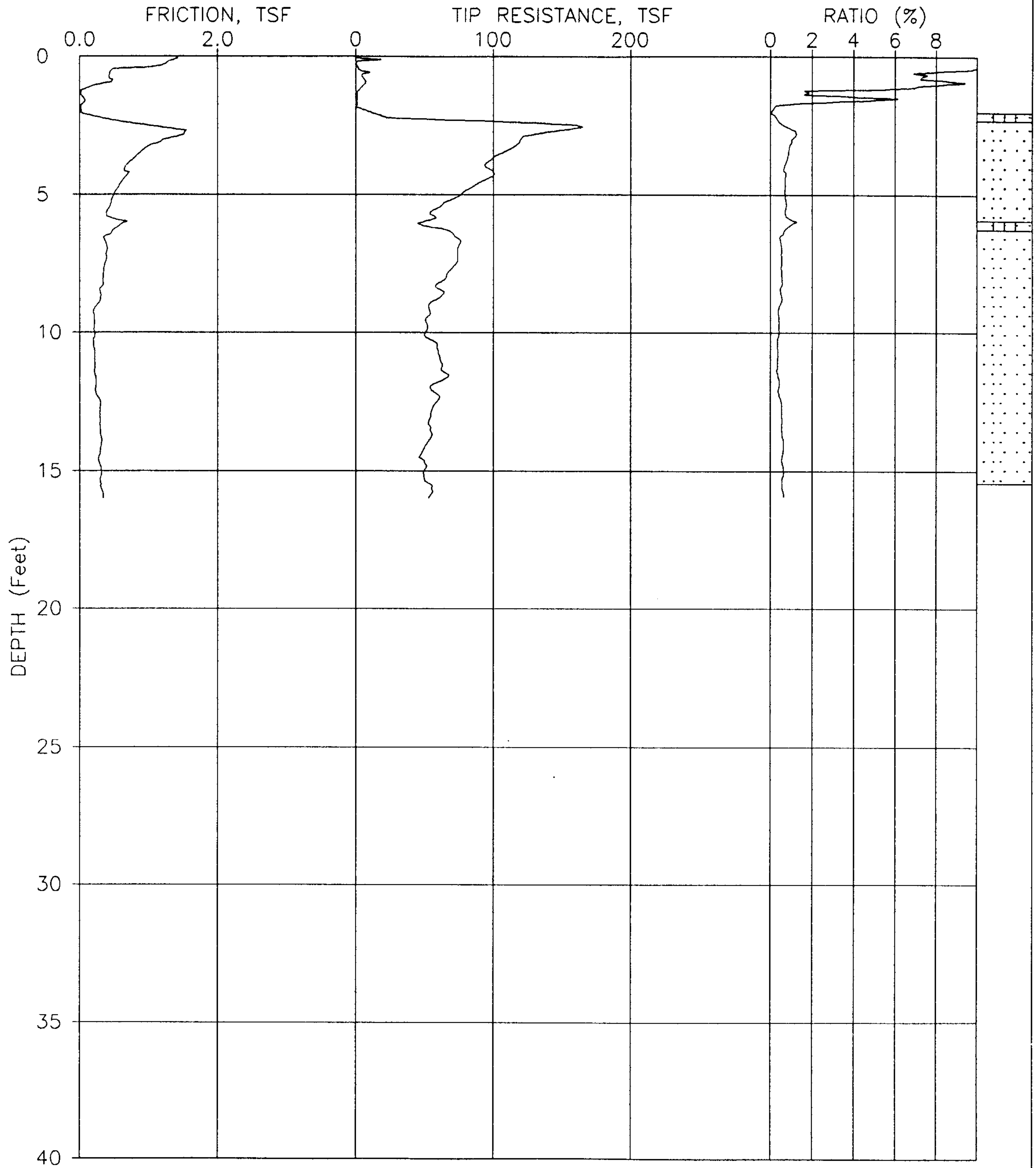
DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



JOB NUMBER: 033-1090
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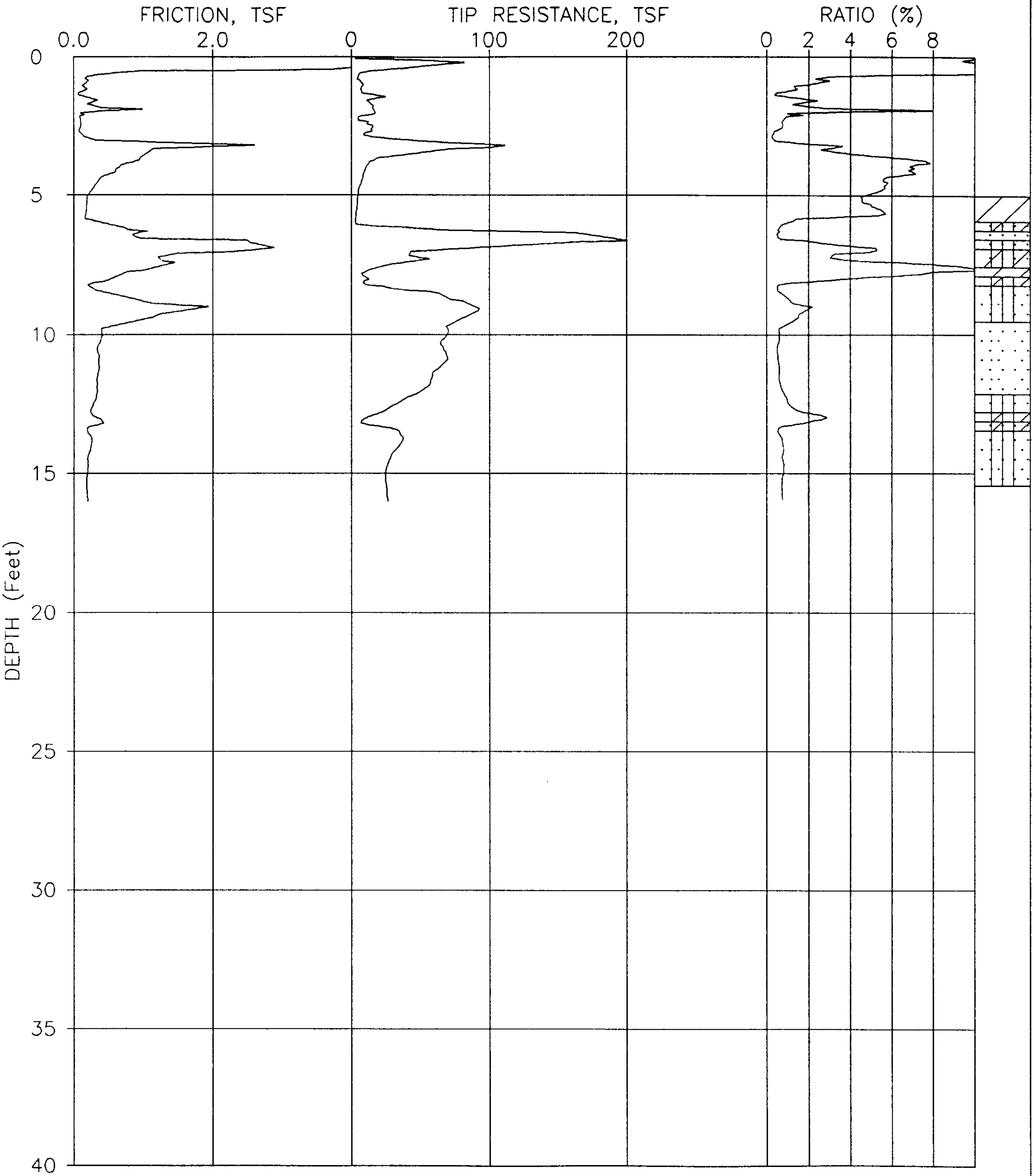
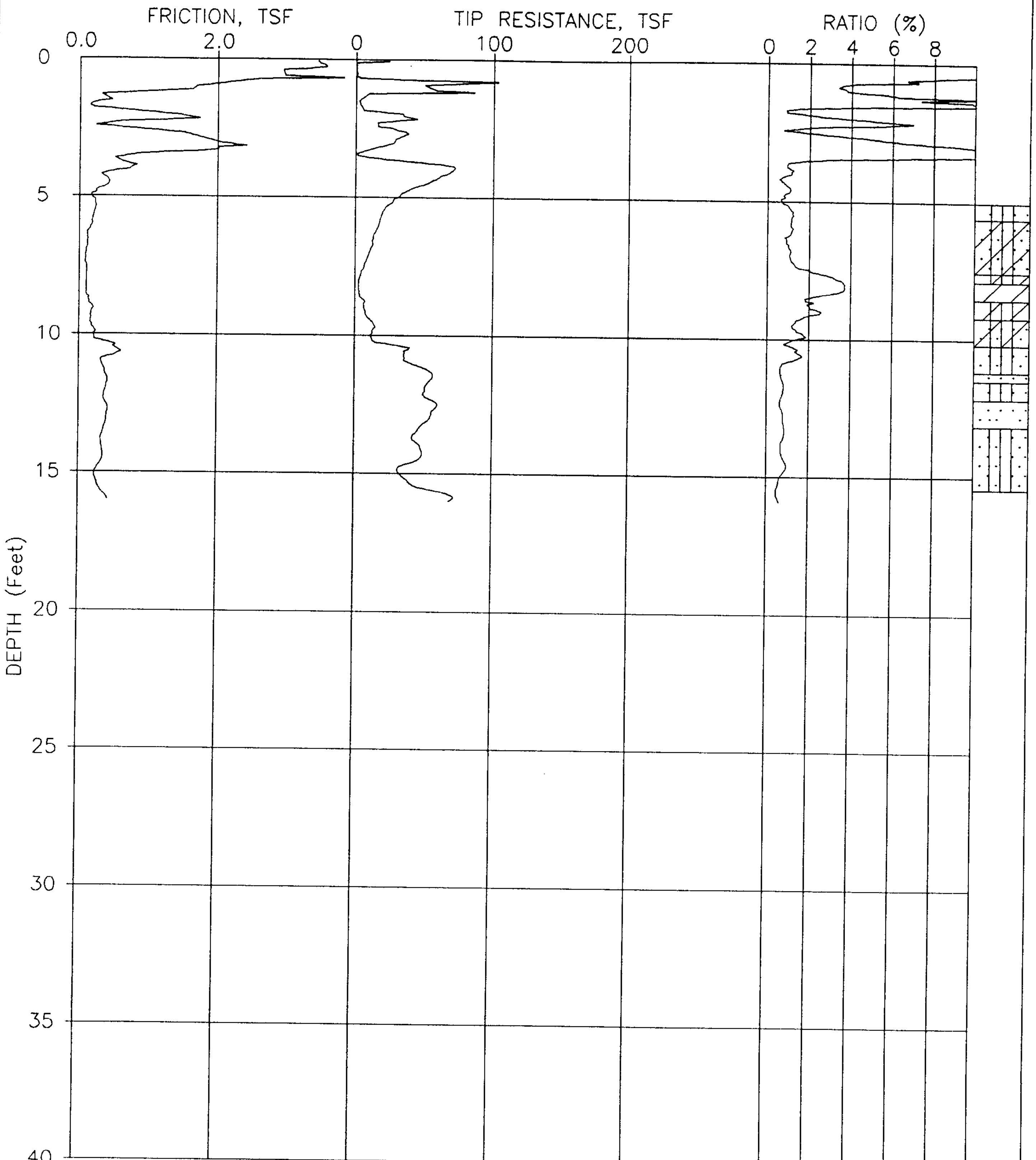
DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



JOB NUMBER: 030-1090
ELEVATION: 0.00
CPT NUMBER: CPT33
CONE NUMBER: F7.5CKEW1512
DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

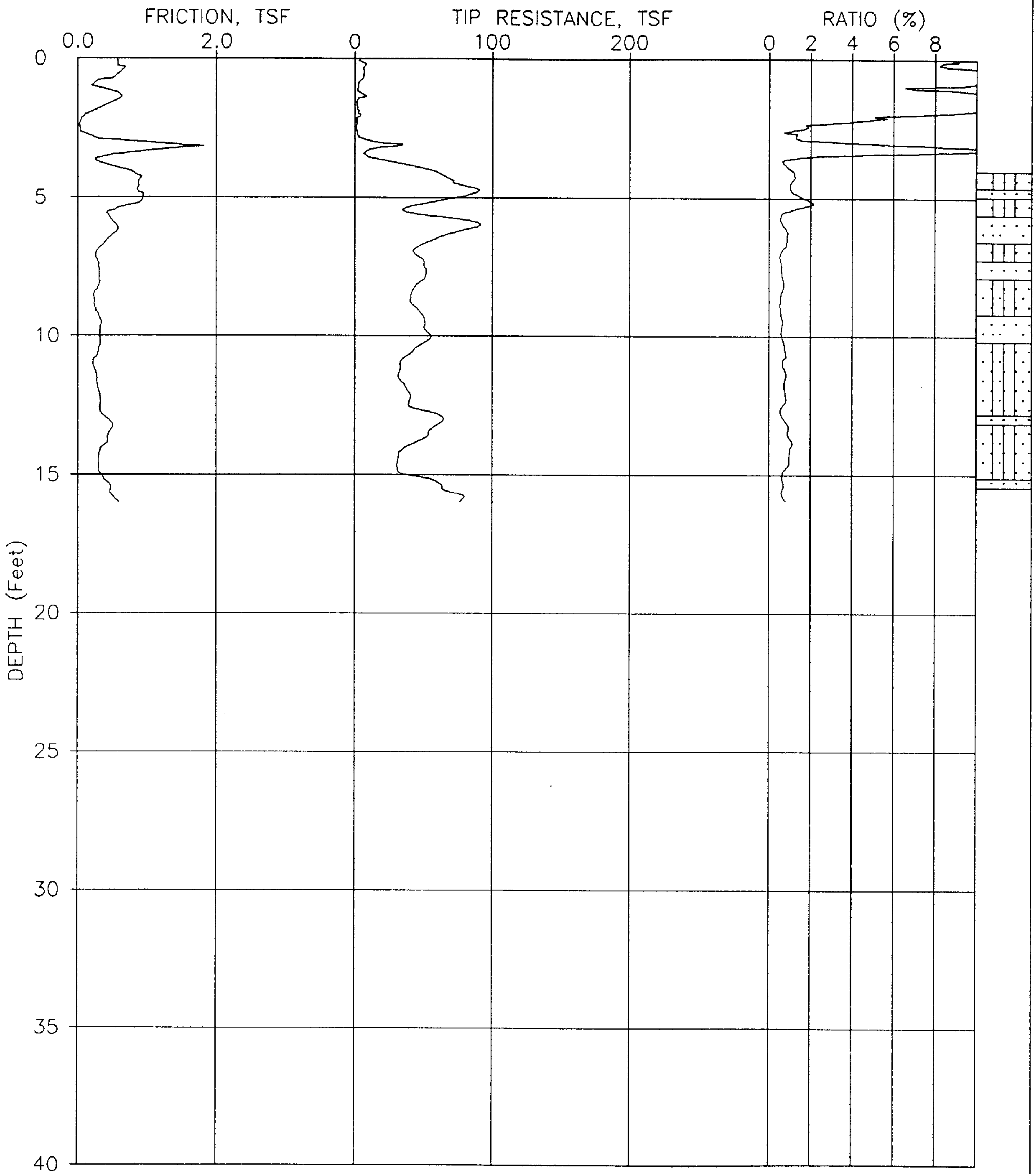


JOB NUMBER: 0303-1090
ELEVATION: 0.00

CPT NUMBER: CPT35
CONE NUMBER: F7.5CKEW1512

DATE: 09-22-2004
PLATE: 1 OF 1

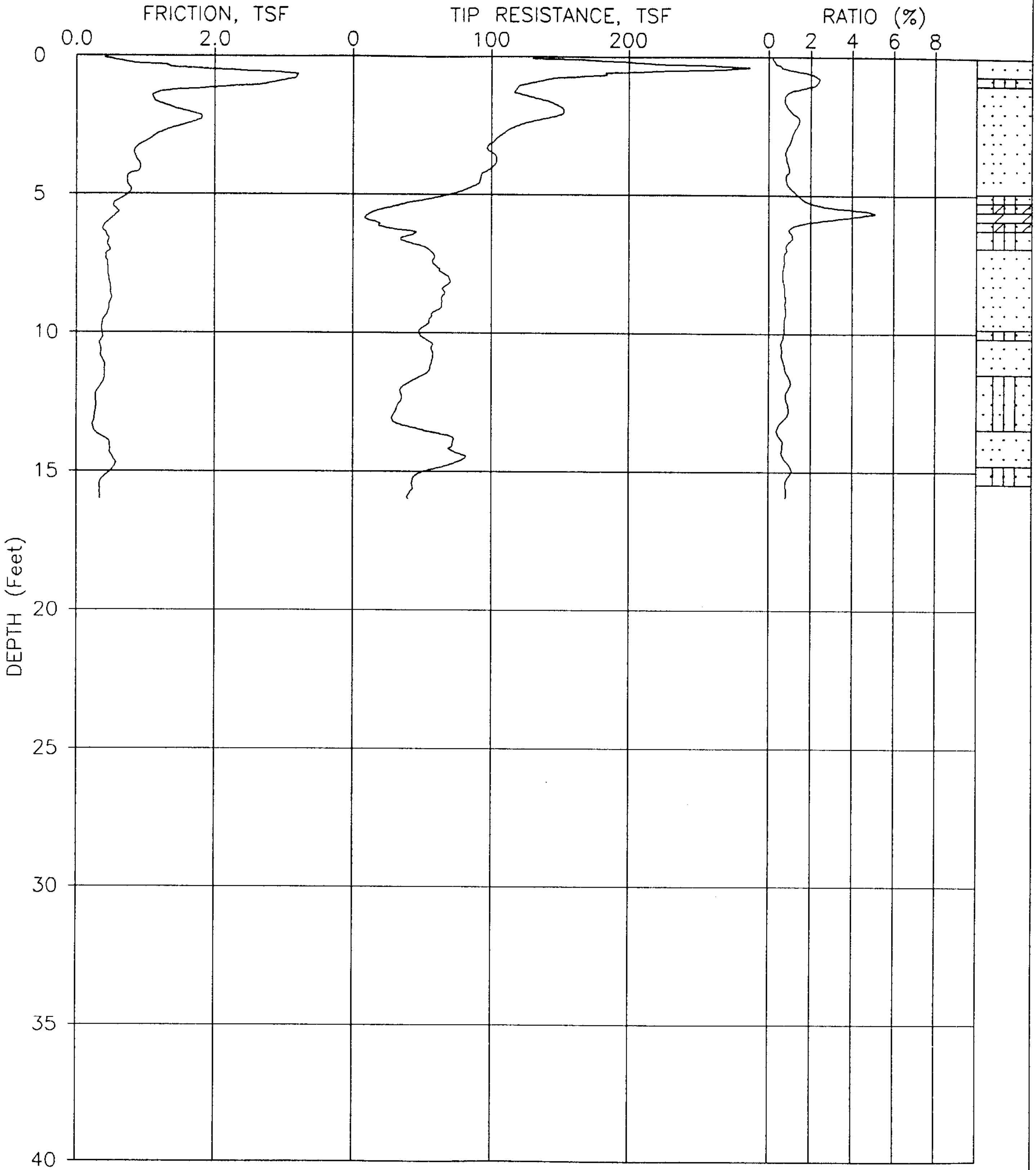
FUGRO GEOSCIENCES,INC



JOB NUMBER: 0303-1090 CPT NUMBER: CT36 DATE: 09-22-2004

ELEVATION: 0.00 CONE NUMBER: F7.5CKEW1512 PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

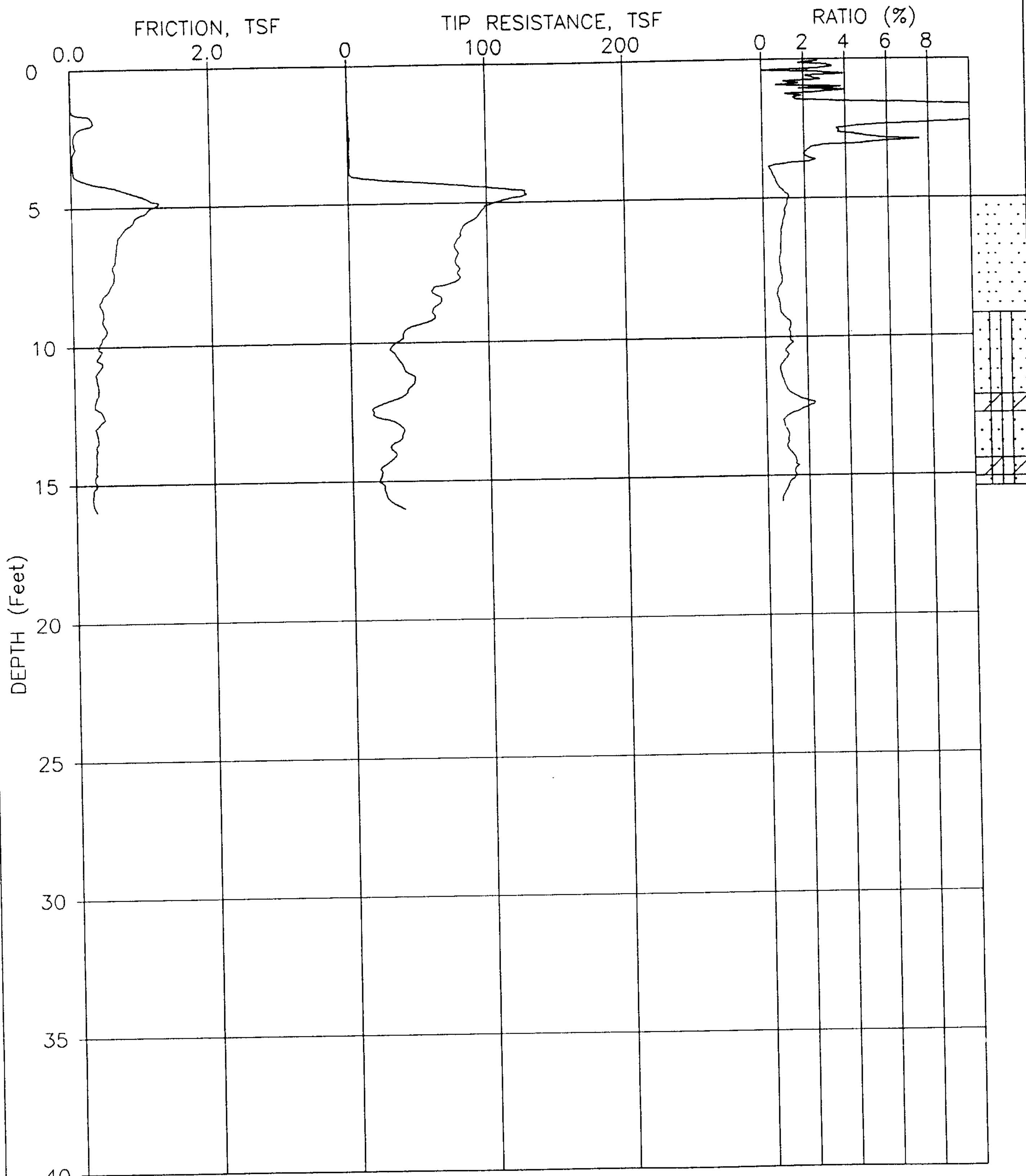


JOB NUMBER: 0303-1090
ELEVATION: 0.00

CPT NUMBER: CPT37
CONE NUMBER: F7.5CKEW1512

DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

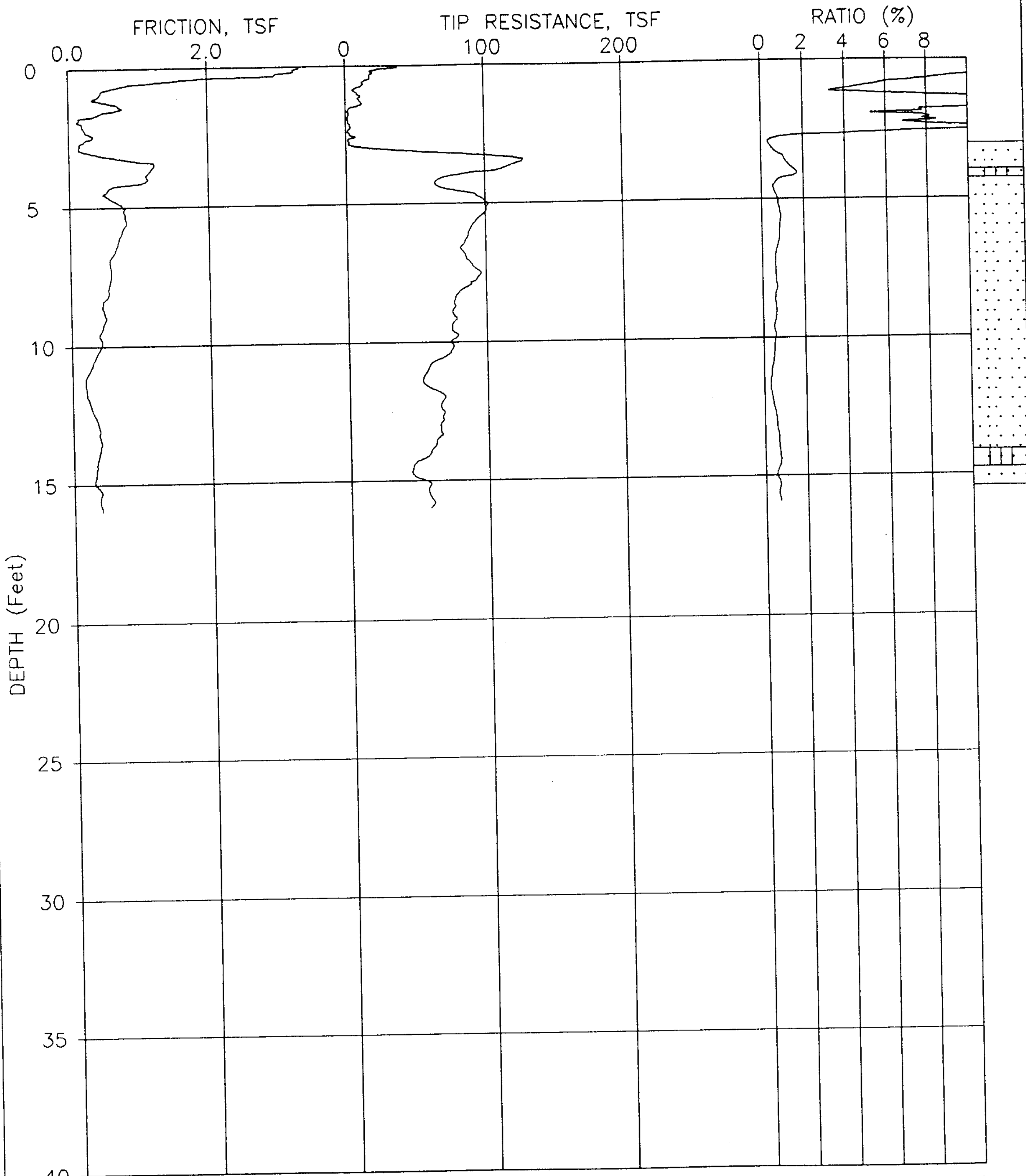


JOB NUMBER: 3030-1090
ELEVATION: 0.00

CPT NUMBER: CPT39
CONE NUMBER: F7.5CKEW1512

DATE: 09-23-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

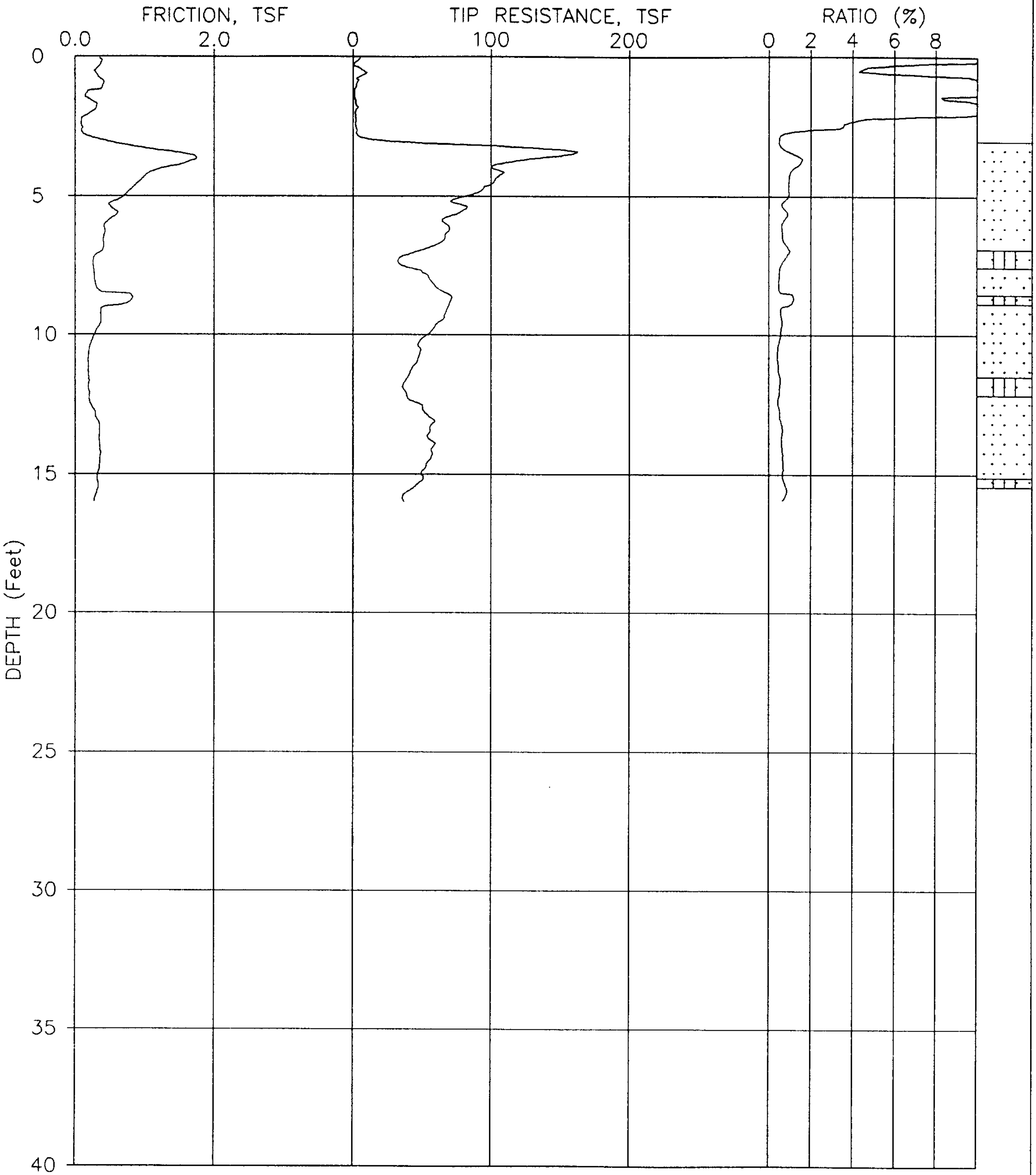


JOB NUMBER: 0303-1090
ELEVATION: 0.00

CPT NUMBER: CPT40
CONE NUMBER: F7.5CKEW1512

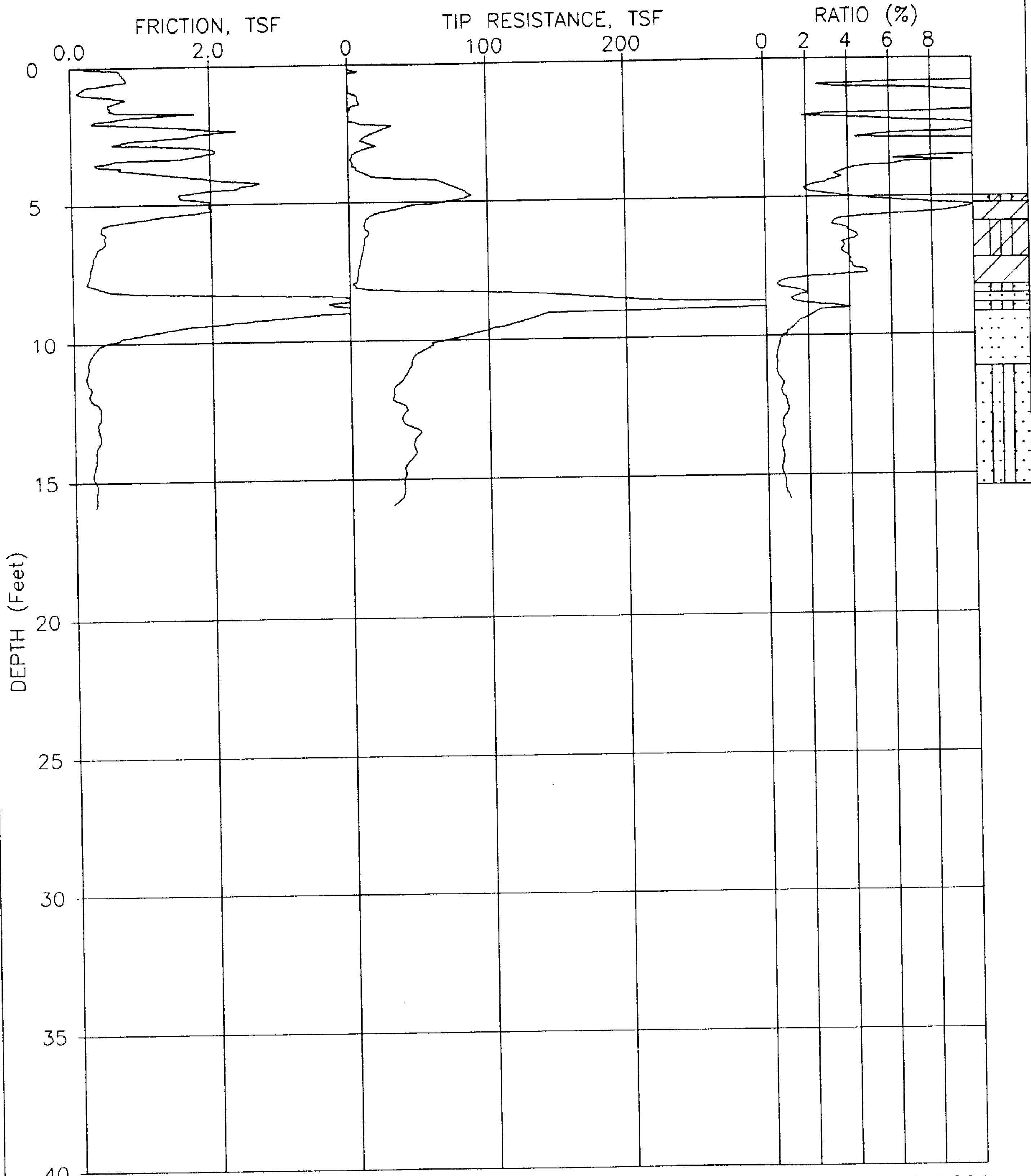
DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



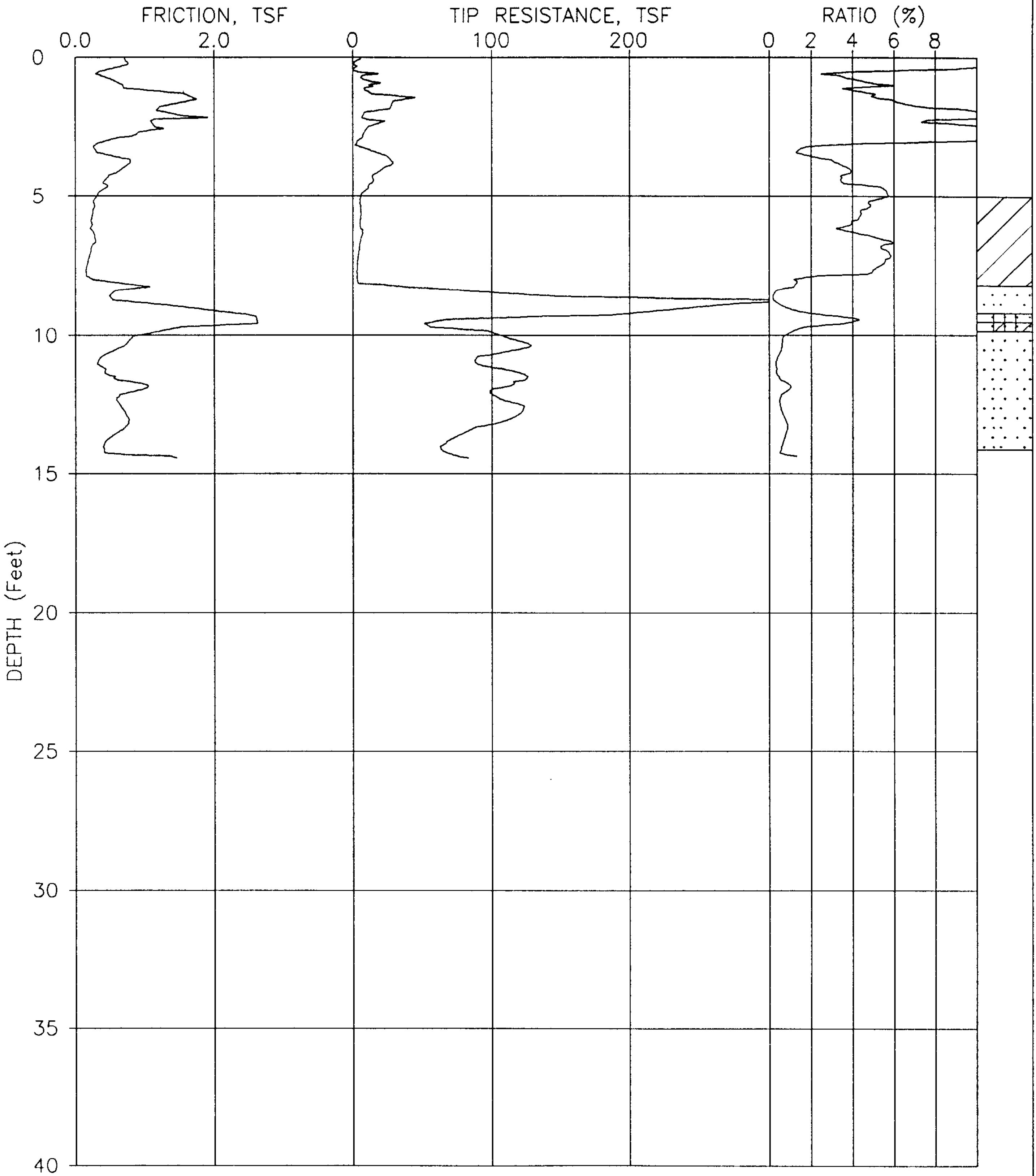
JOB NUMBER: 0303-1090
ELEVATION: 0.00
CPT NUMBER: CPT41
CONE NUMBER: F7.5CKEW1512
DATE: 09-22-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



JOB NUMBER: 0303-1090
ELEVATION: 0.00
CPT NUMBER: CPT43
CONE NUMBER: F7.5CKEW1512
DATE: 09-23-2004
PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC



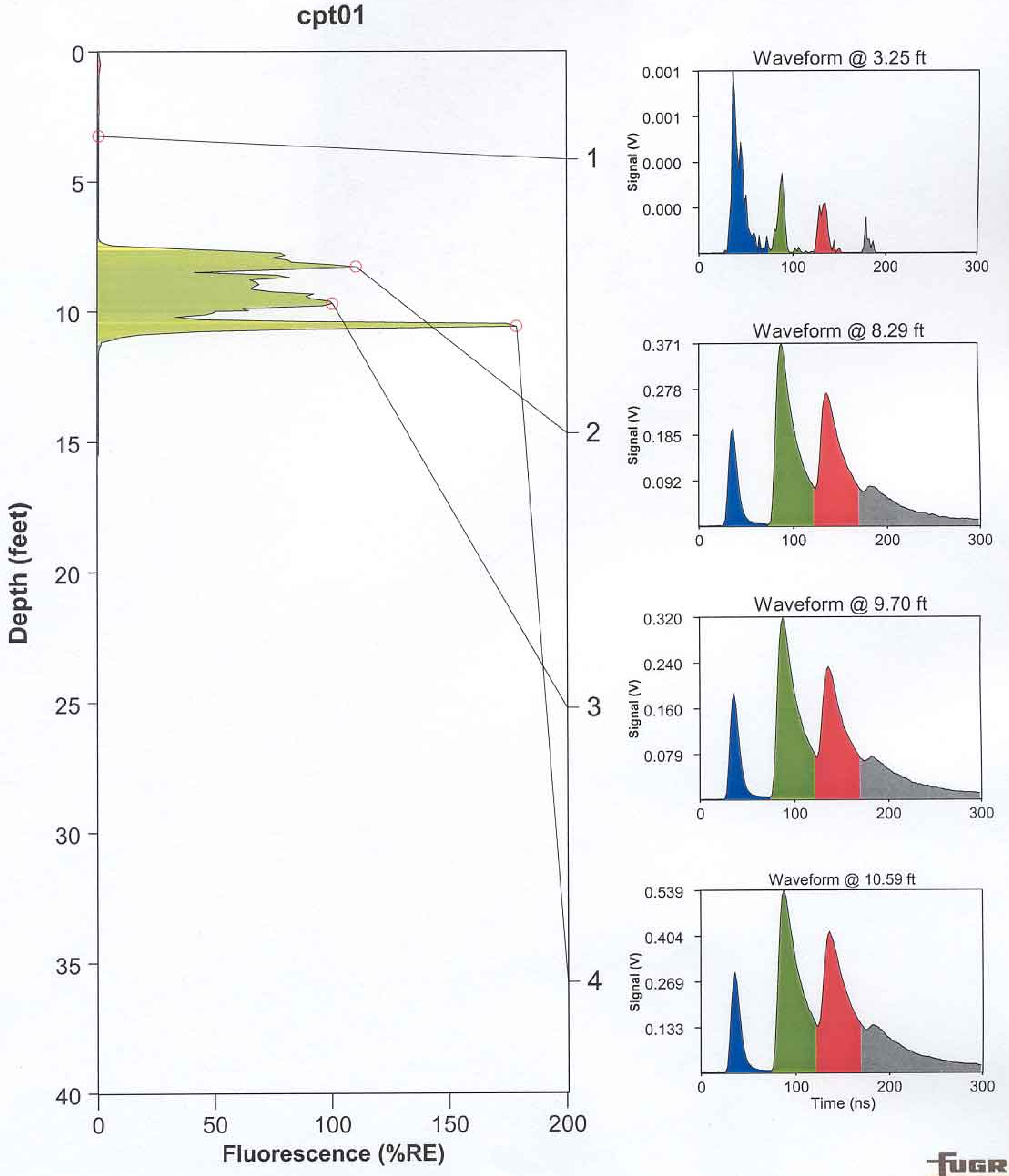
JOB NUMBER: 0303-1090 CPT NUMBER: CPT44 DATE: 09-23-2004
ELEVATION: 0.00 CONE NUMBER: F7.5CKEW1512 PLATE: 1 OF 1

FUGRO GEOSCIENCES,INC

ROST™
LOGS

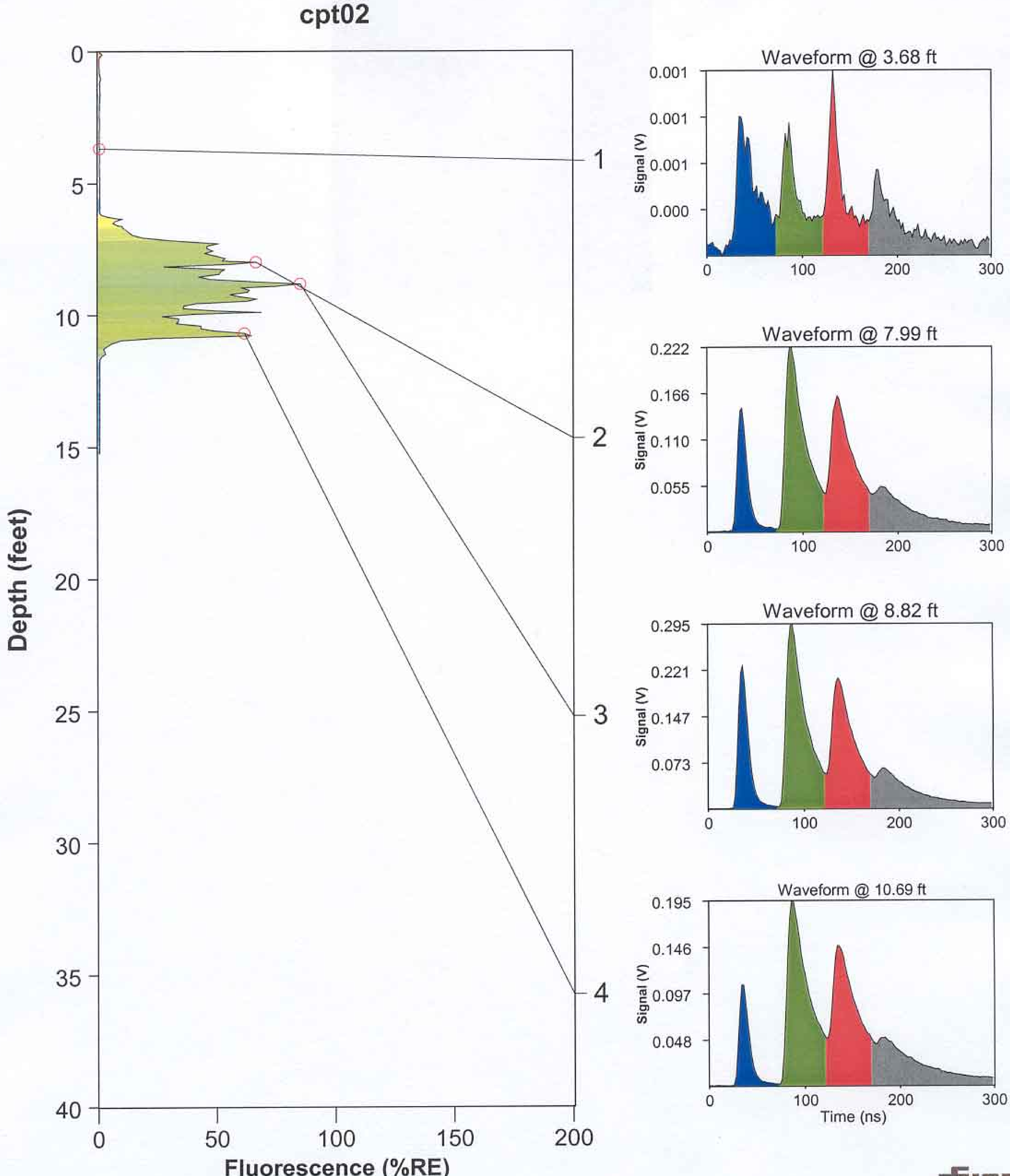
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 9:12:19 AM	Max fluorescence: 178.73% @ 10.59 ft
ROST Unit: 1	Final depth BGS: 15.50 ft



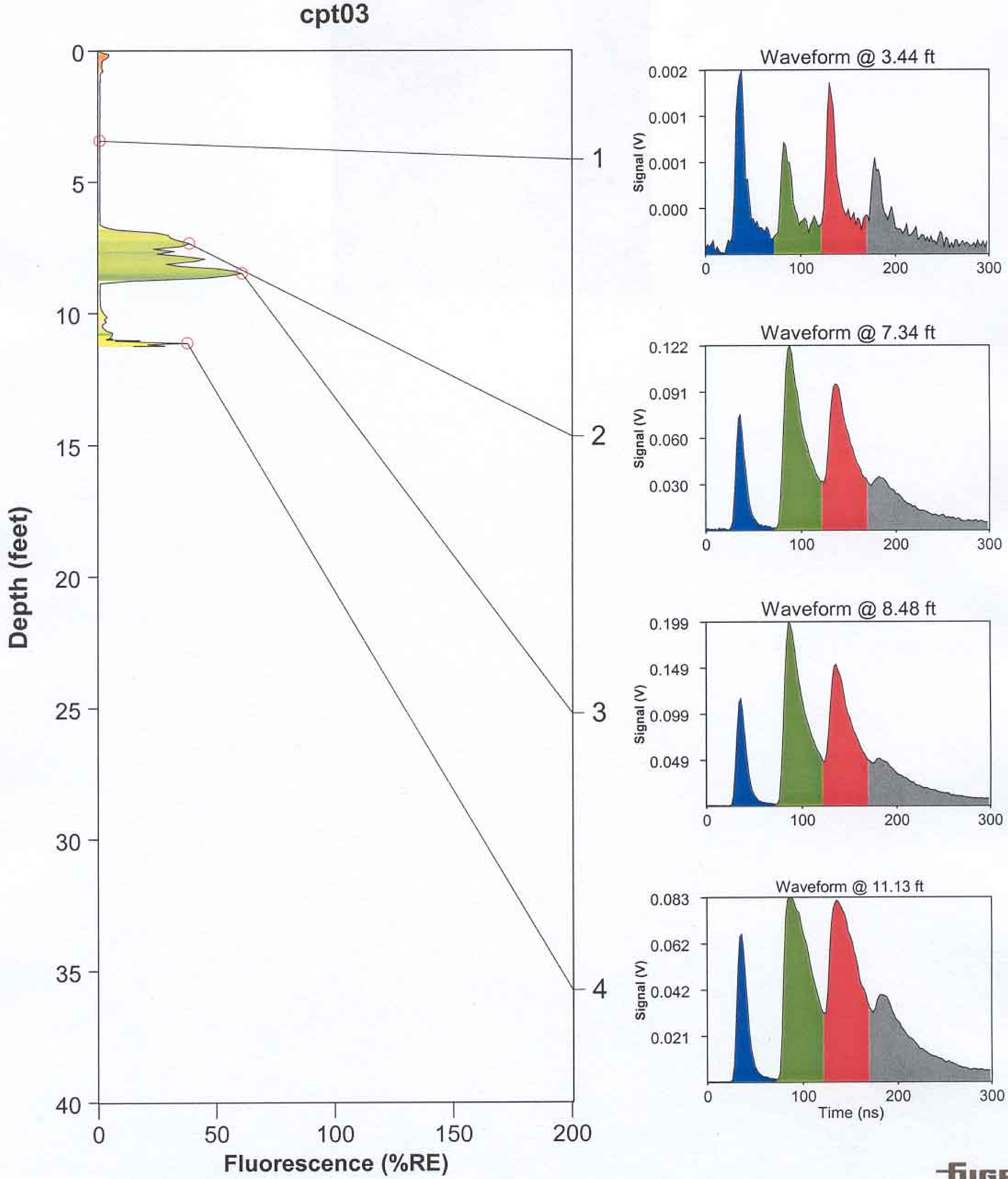
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/23/2004 @ 8:34:00 AM	Max fluorescence: 85.24% @ 8.82 ft
ROST Unit: 1	Final depth BGS: 15.24 ft



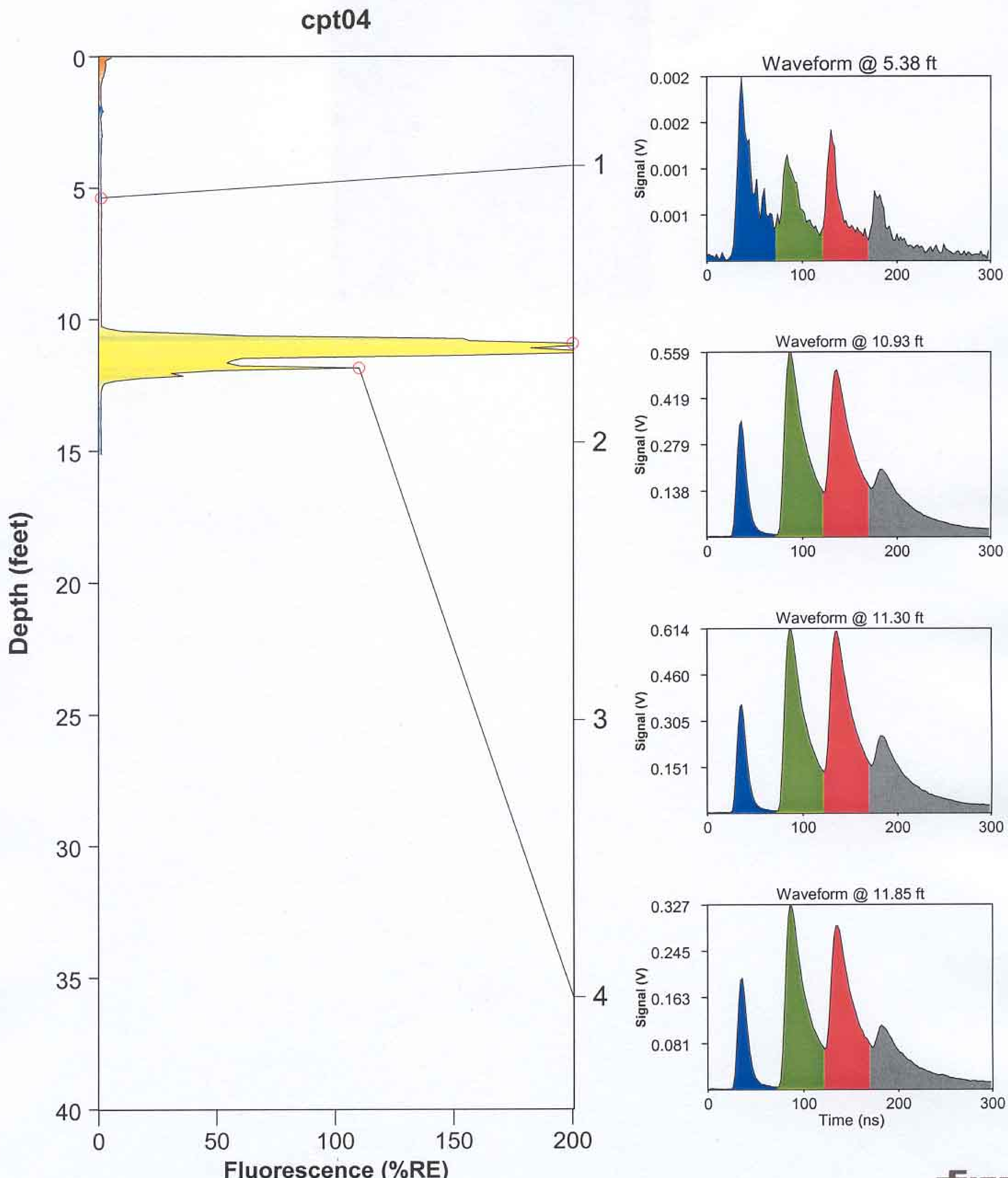
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/23/2004 @ 10:12:47 AM	Max fluorescence: 60.63% @ 8.48 ft
ROST Unit: 1	Final depth BGS: 11.25 ft



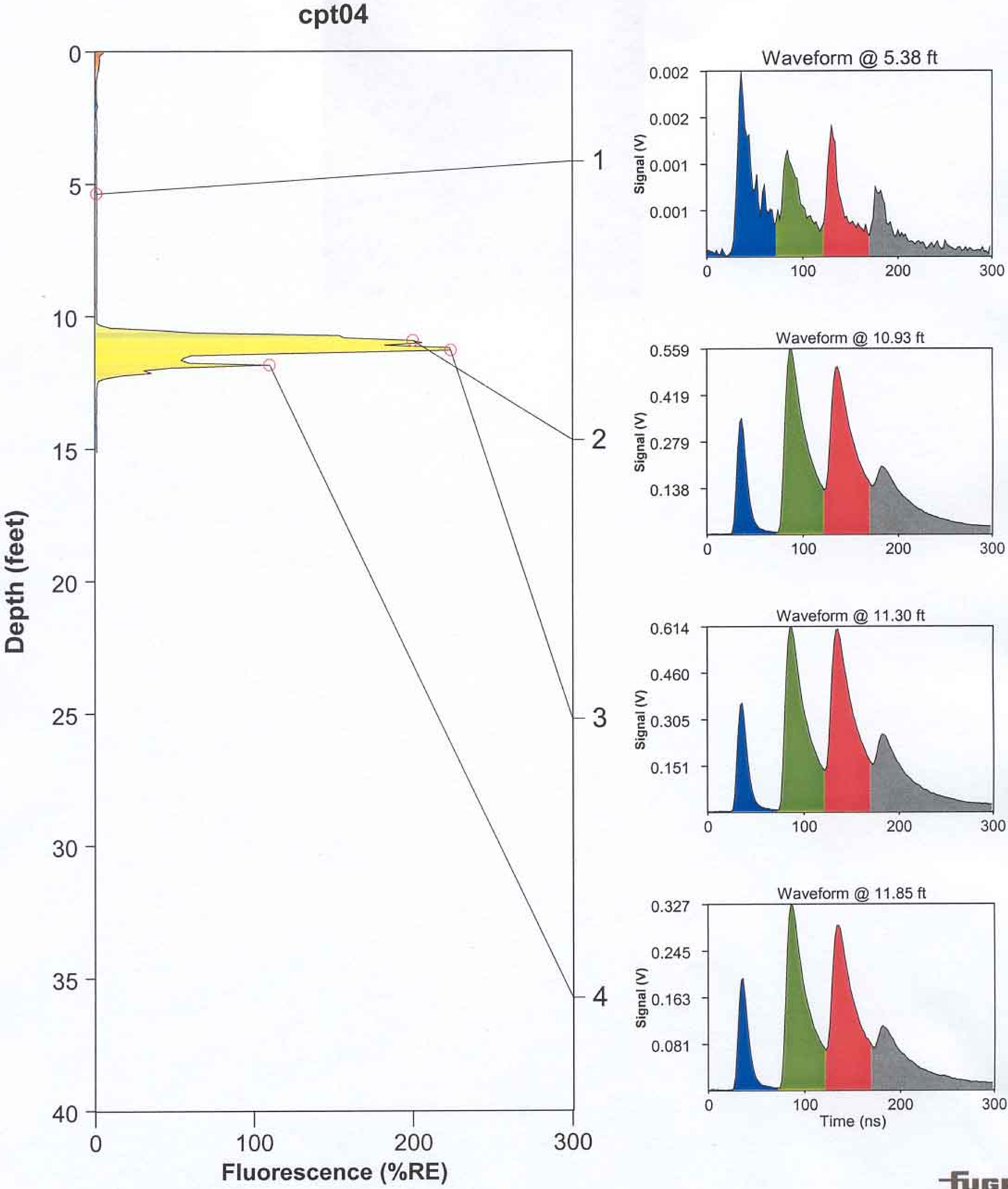
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 11:41:53 AM	Max fluorescence: 223.77% @ 11.30 ft
ROST Unit: 1	Final depth BGS: 15.12 ft



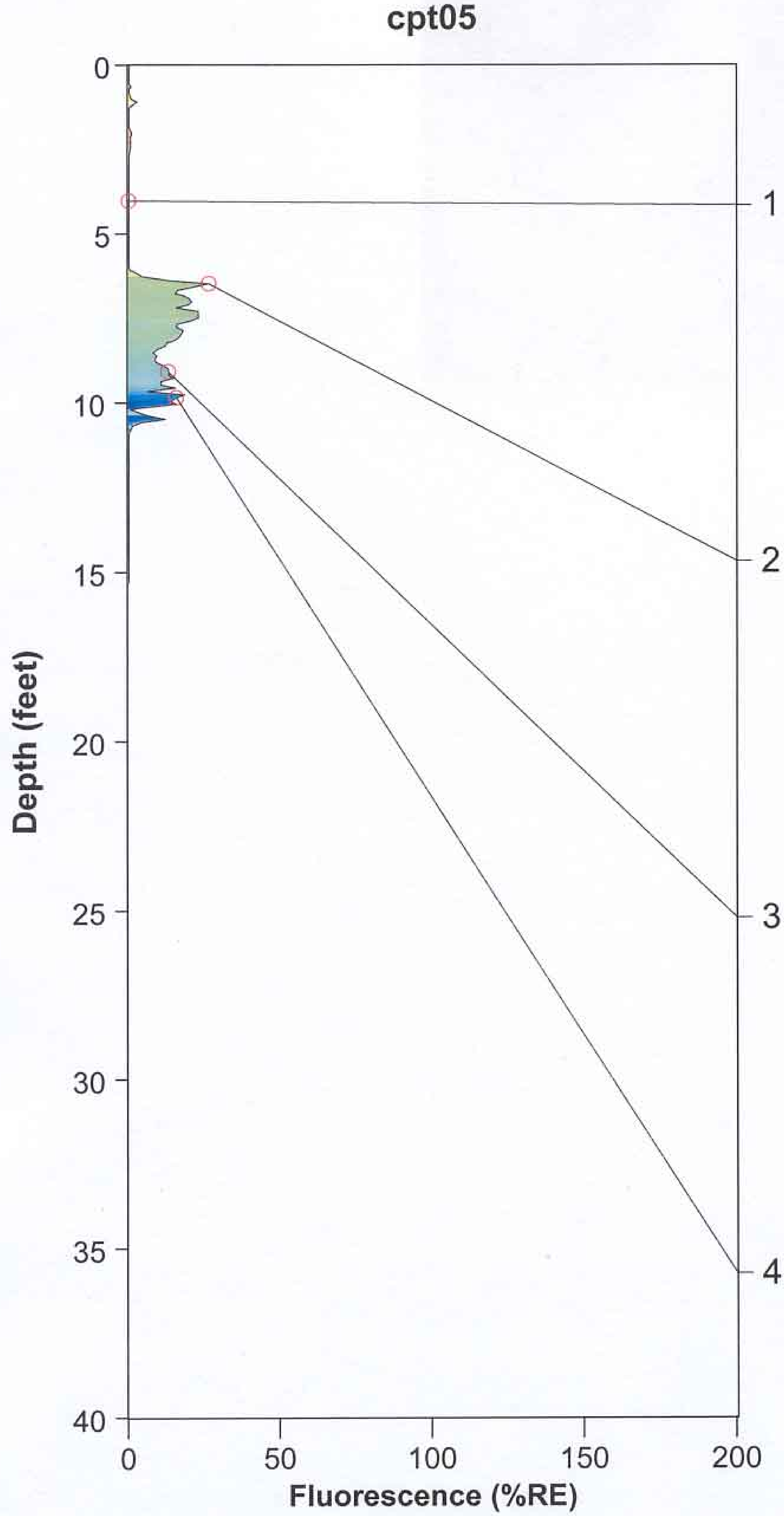
ROST Fluorescence Response Data

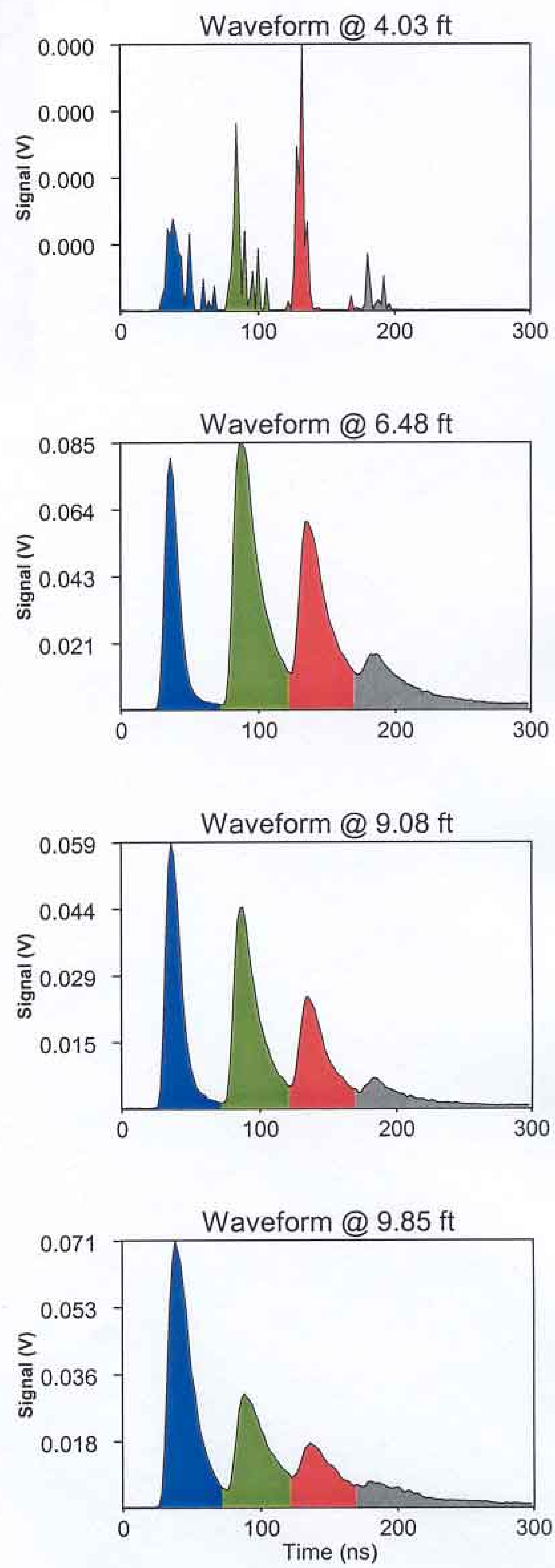
Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 11:41:53 AM	Max fluorescence: 223.77% @ 11.30 ft
ROST Unit: 1	Final depth BGS: 15.12 ft



ROST Fluorescence Response Data

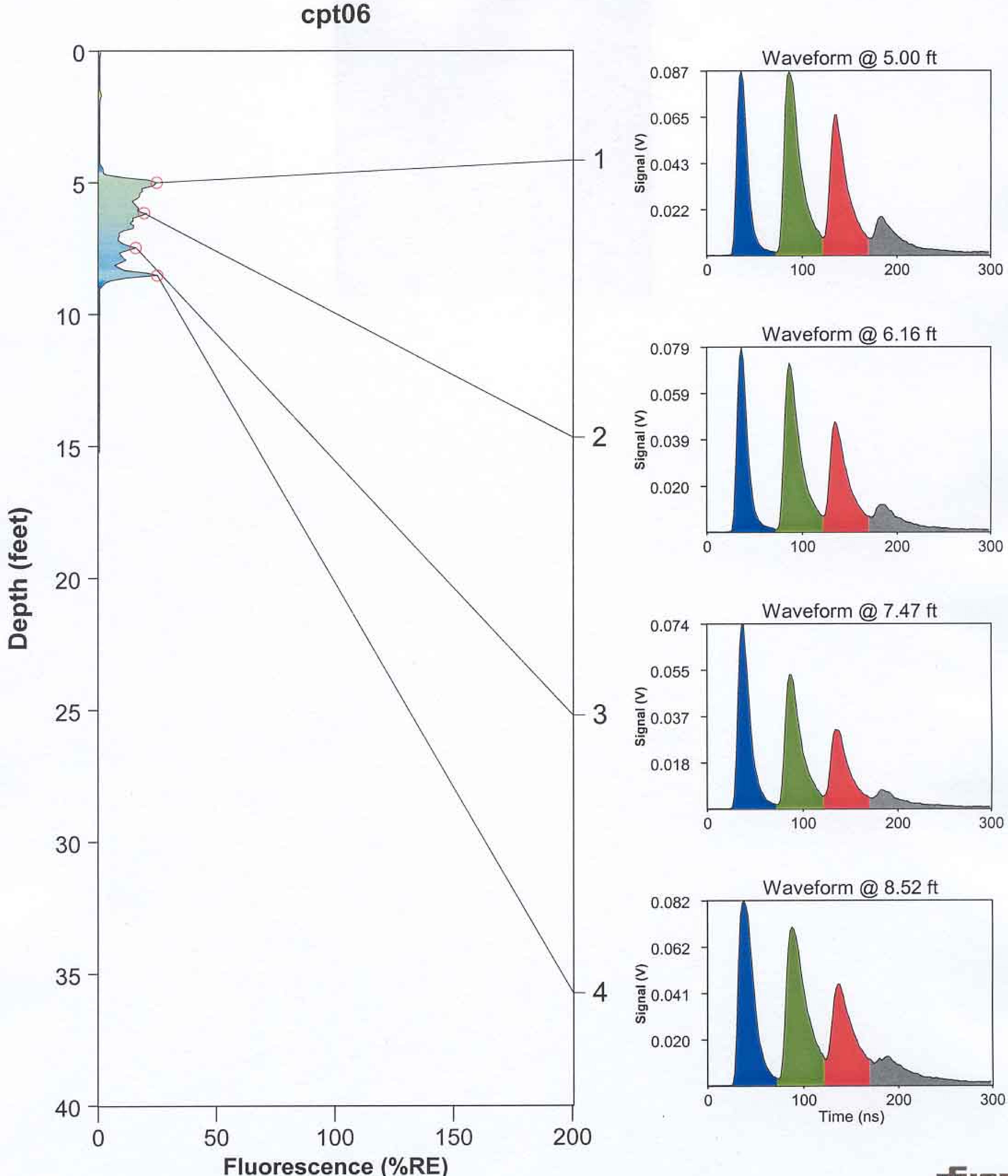
Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 10:47:57 AM	Max fluorescence: 26.48% @ 6.48 ft
ROST Unit: 1	Final depth BGS: 15.30 ft





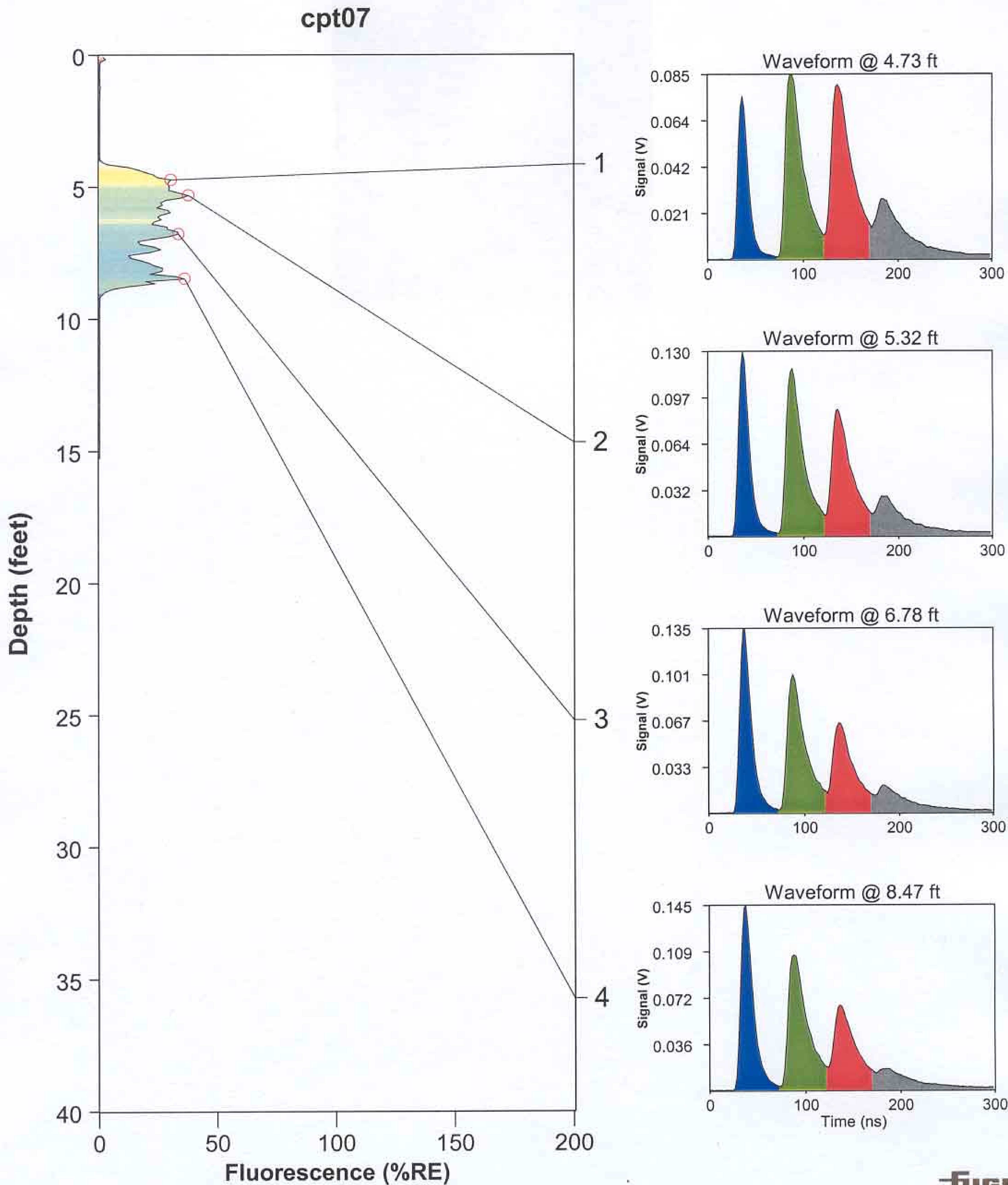
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 11:21:41 AM	Max fluorescence: 24.59% @ 8.52 ft
ROST Unit: 1	Final depth BGS: 15.25 ft



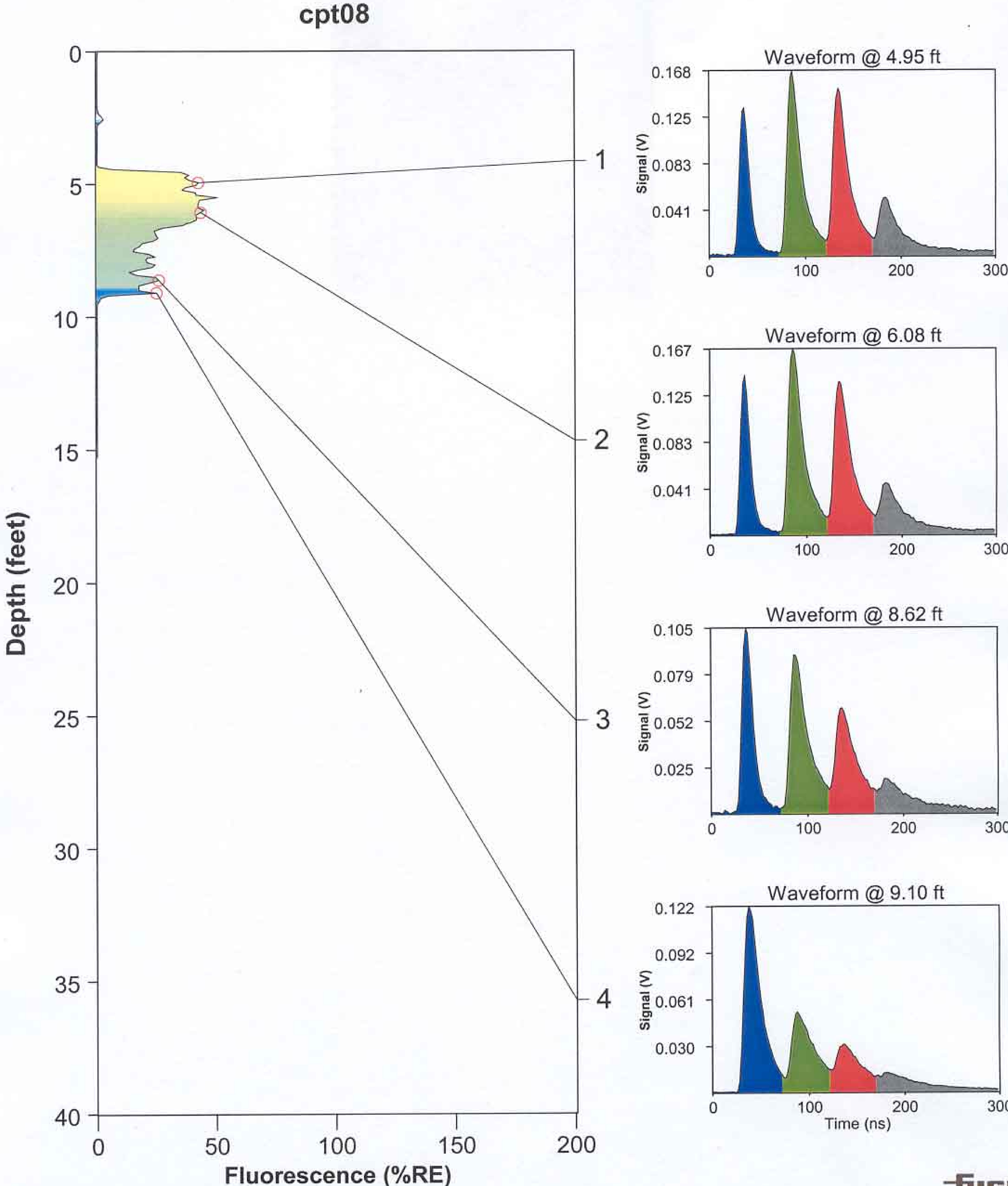
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 11:04:39 AM	Max fluorescence: 37.71% @ 5.32 ft
ROST Unit: 1	Final depth BGS: 15.27 ft



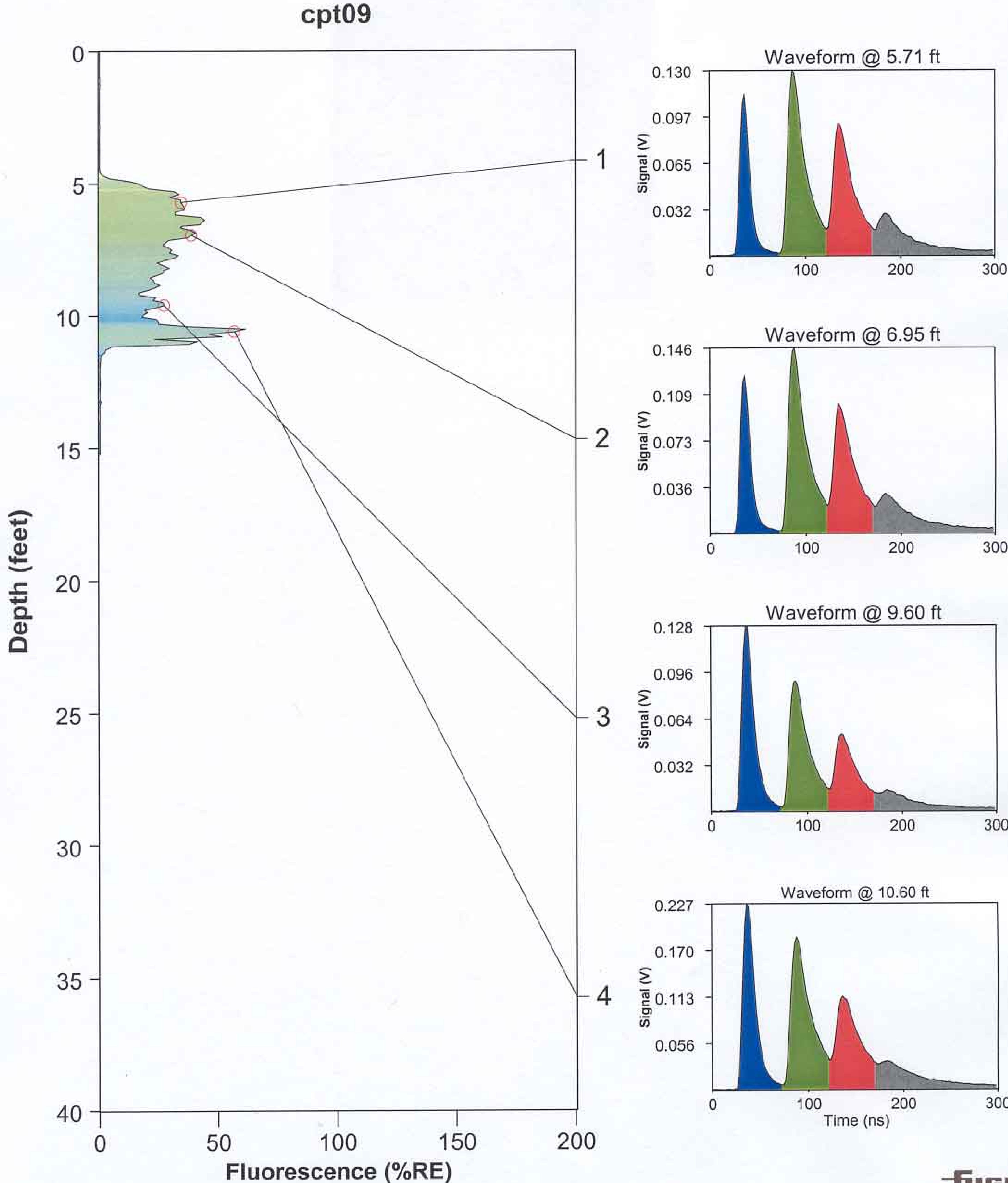
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 11:37:44 AM	Max fluorescence: 50.69% @ 5.52 ft
ROST Unit: 1	Final depth BGS: 15.28 ft



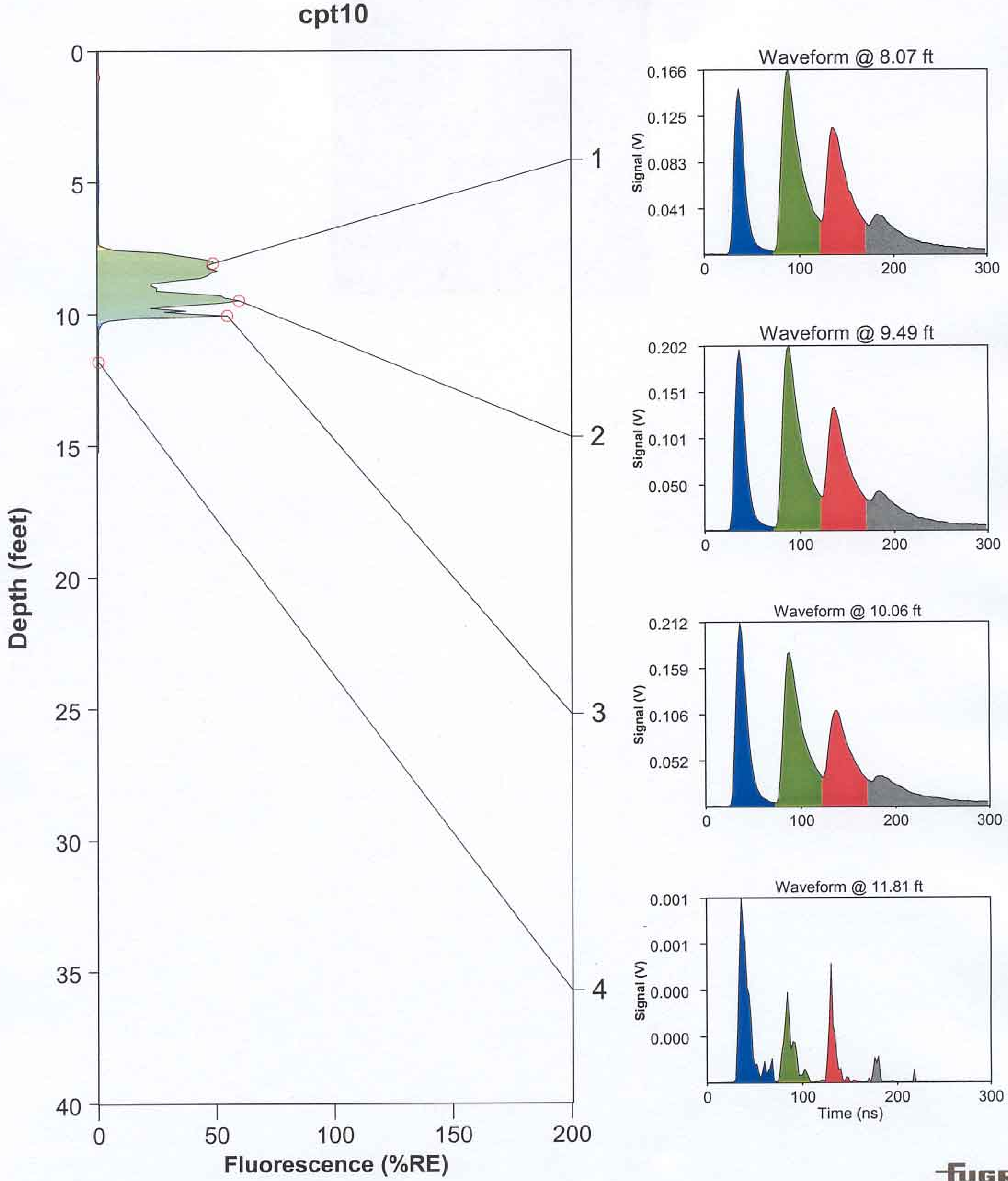
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 11:55:54 AM	Max fluorescence: 61.64% @ 10.50 ft
ROST Unit: 1	Final depth BGS: 15.23 ft



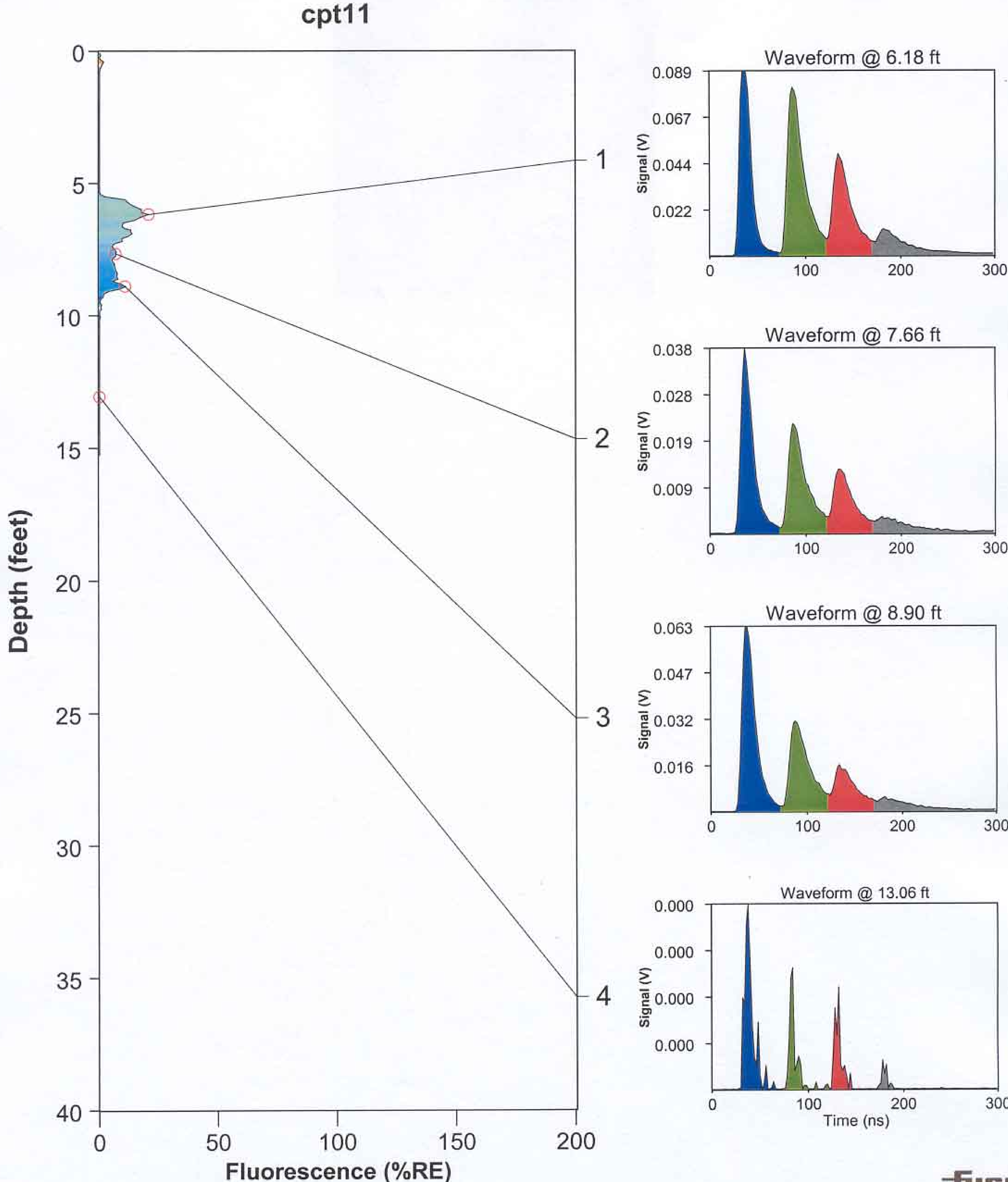
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 1:10:28 PM	Max fluorescence: 59.77% @ 9.49 ft
ROST Unit: 1	Final depth BGS: 15.25 ft



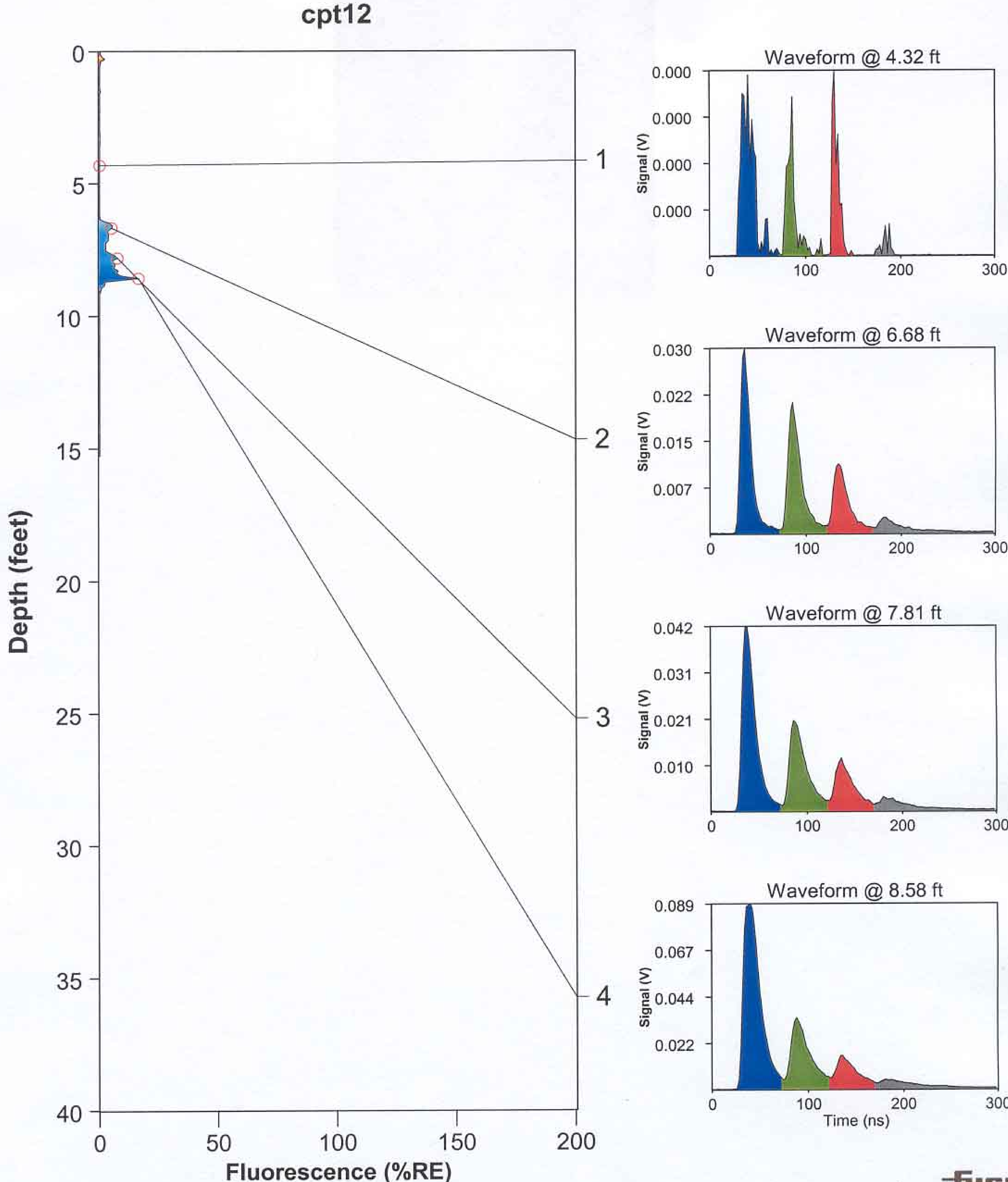
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 1:27:22 PM	Max fluorescence: 20.77% @ 6.18 ft
ROST Unit: 1	Final depth BGS: 15.27 ft



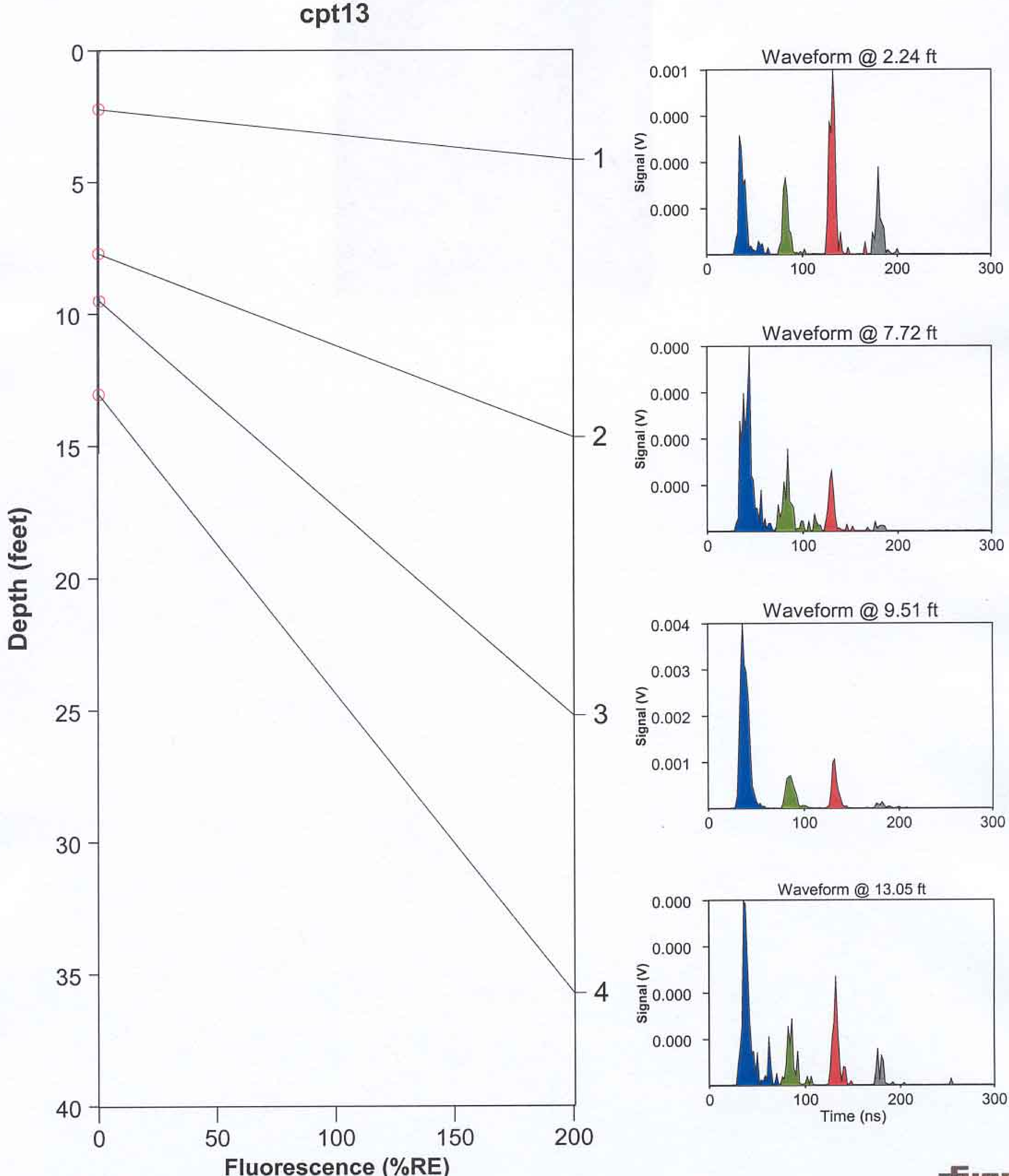
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 1:43:57 PM	Max fluorescence: 16.55% @ 8.58 ft
ROST Unit: 1	Final depth BGS: 15.28 ft



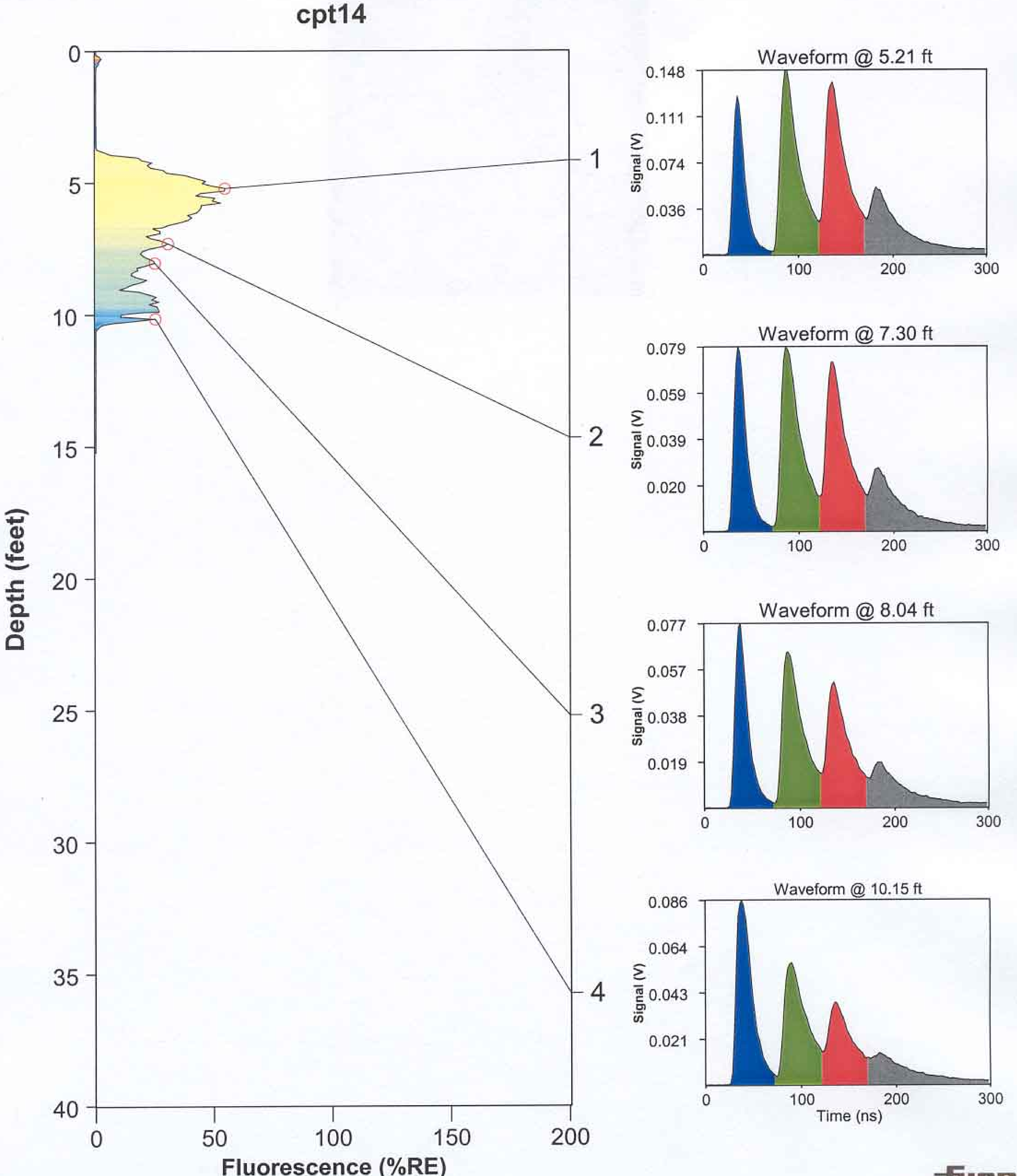
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 2:03:23 PM	Max fluorescence: 0.54% @ 0.04 ft
ROST Unit: 1	Final depth BGS: 15.27 ft



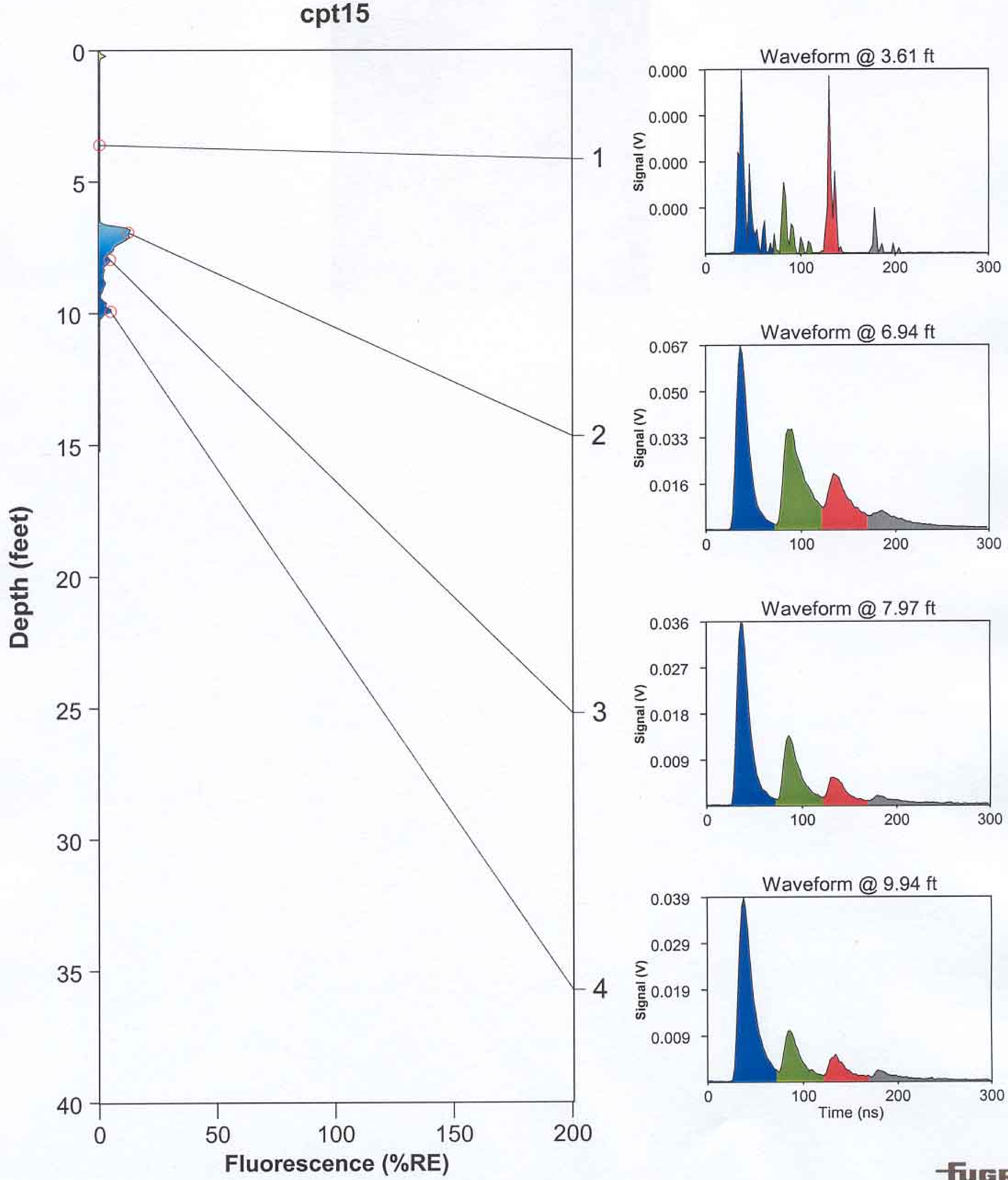
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 2:20:42 PM	Max fluorescence: 54.80% @ 5.21 ft
ROST Unit: 1	Final depth BGS: 15.24 ft



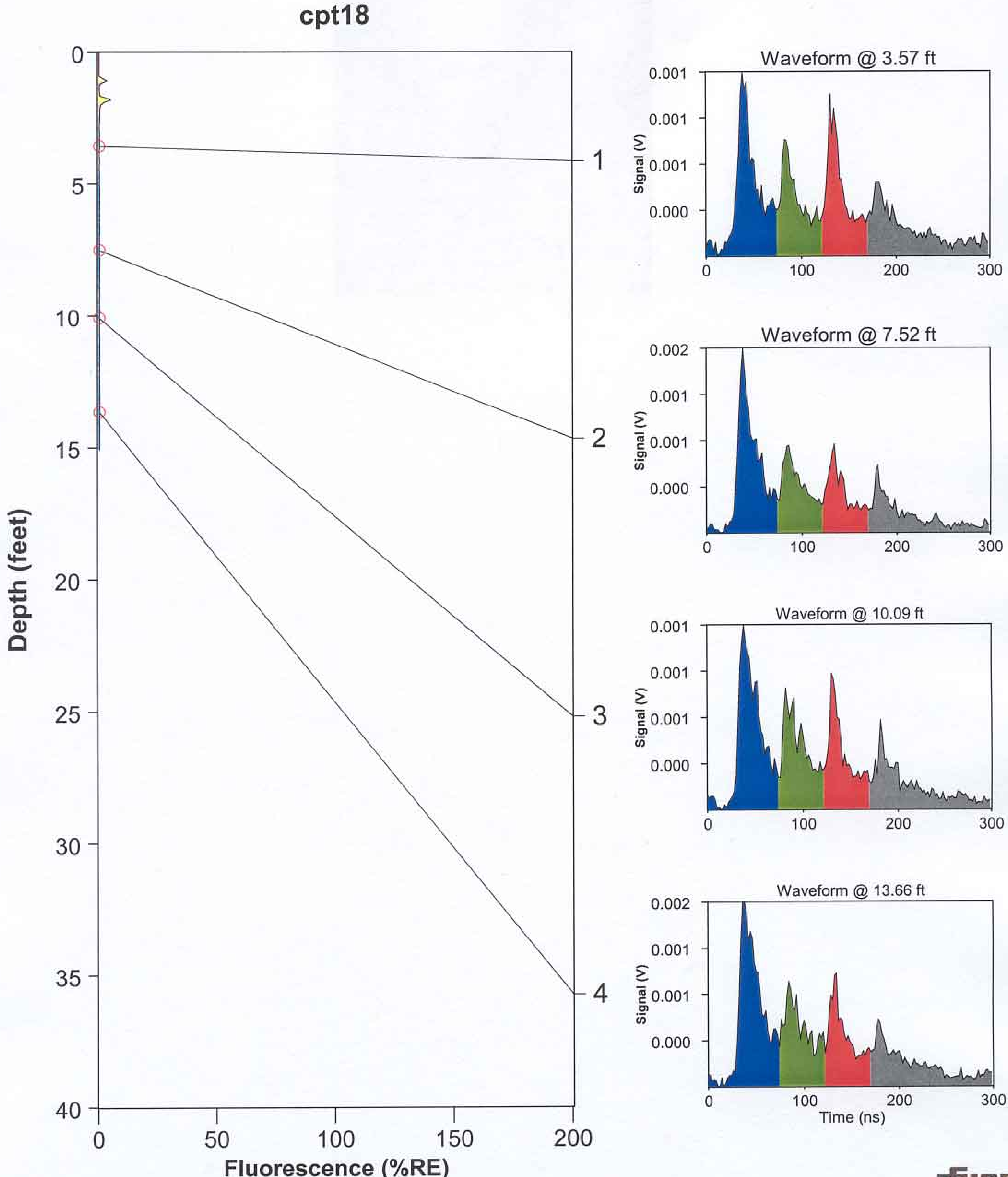
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 2:37:11 PM	Max fluorescence: 13.21% @ 6.84 ft
ROST Unit: 1	Final depth BGS: 15.25 ft



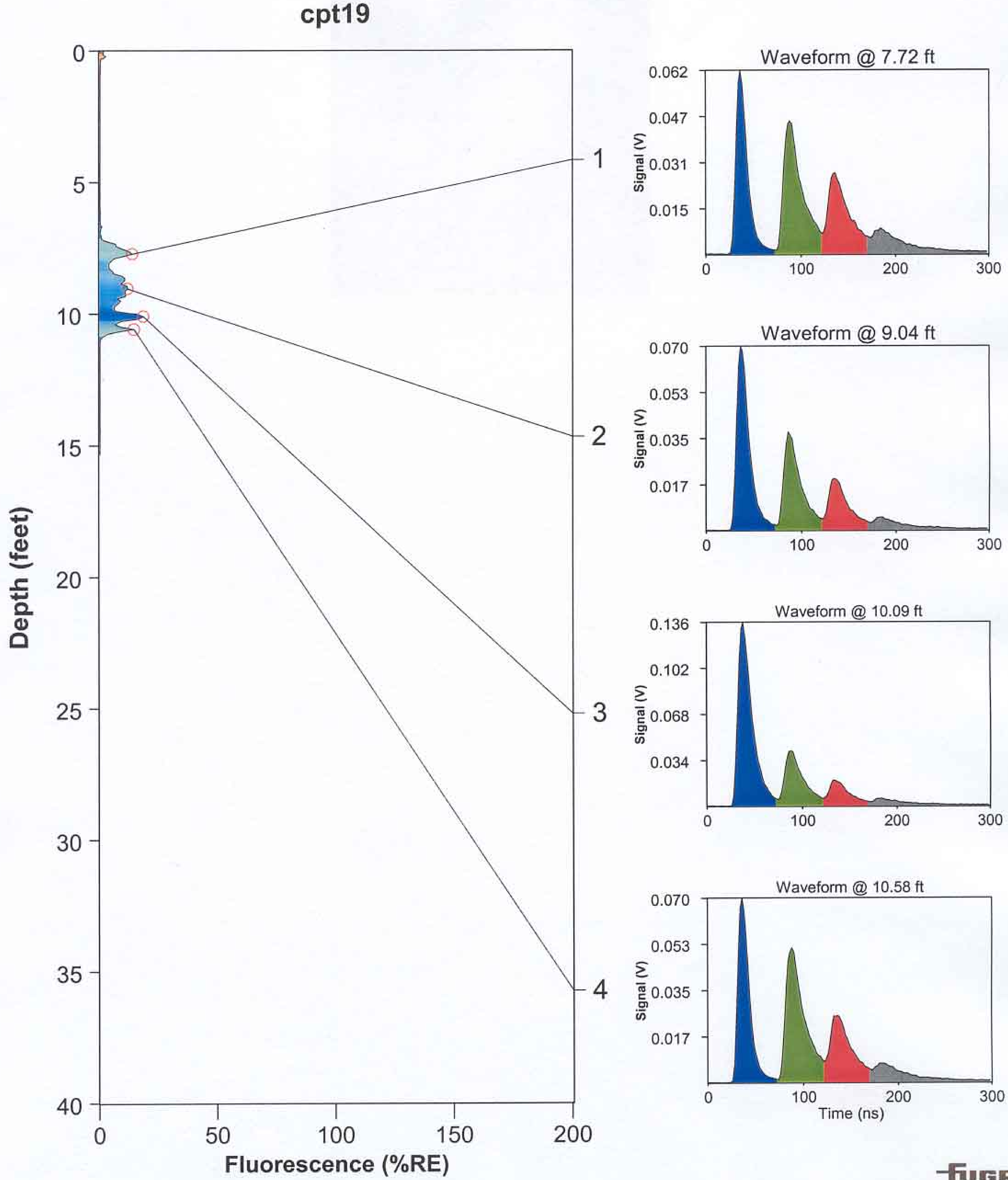
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/23/2004 @ 7:18:04 AM	Max fluorescence: 5.27% @ 1.81 ft
ROST Unit: 1	Final depth BGS: 15.09 ft



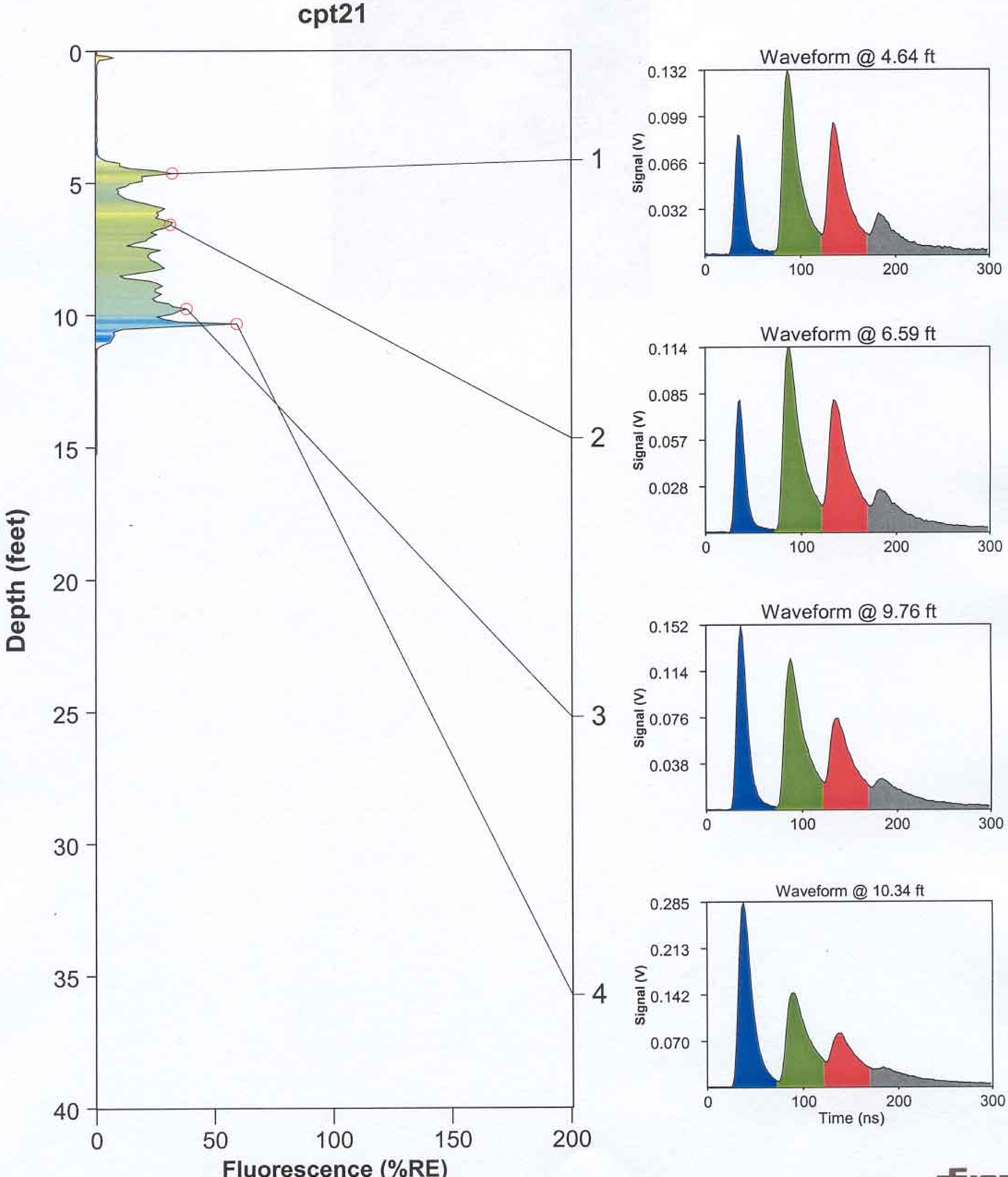
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 4:03:36 PM	Max fluorescence: 18.53% @ 10.09 ft
ROST Unit: 1	Final depth BGS: 15.33 ft



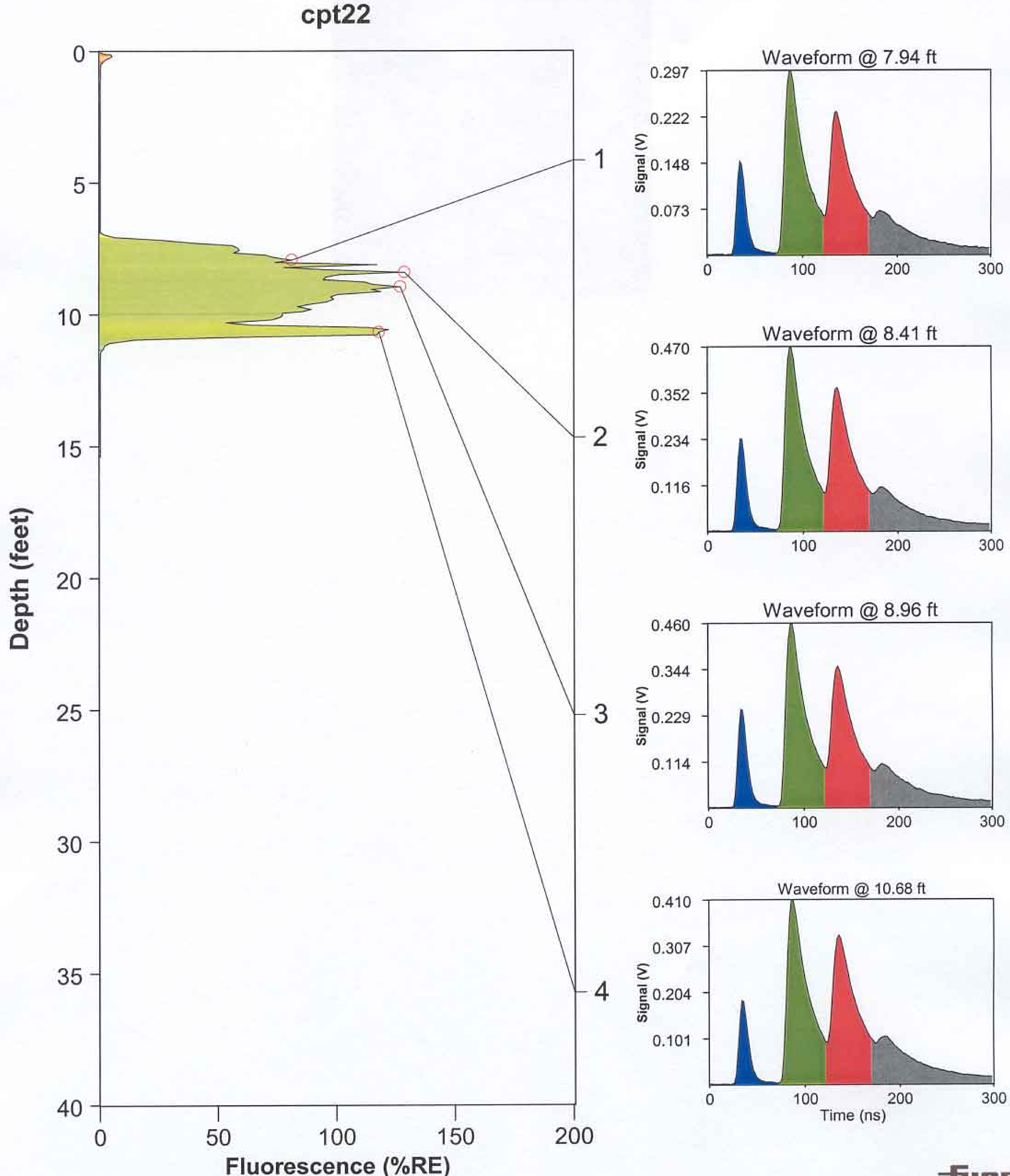
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 4:38:09 PM	Max fluorescence: 59.27% @ 10.34 ft
ROST Unit: 1	Final depth BGS: 15.26 ft



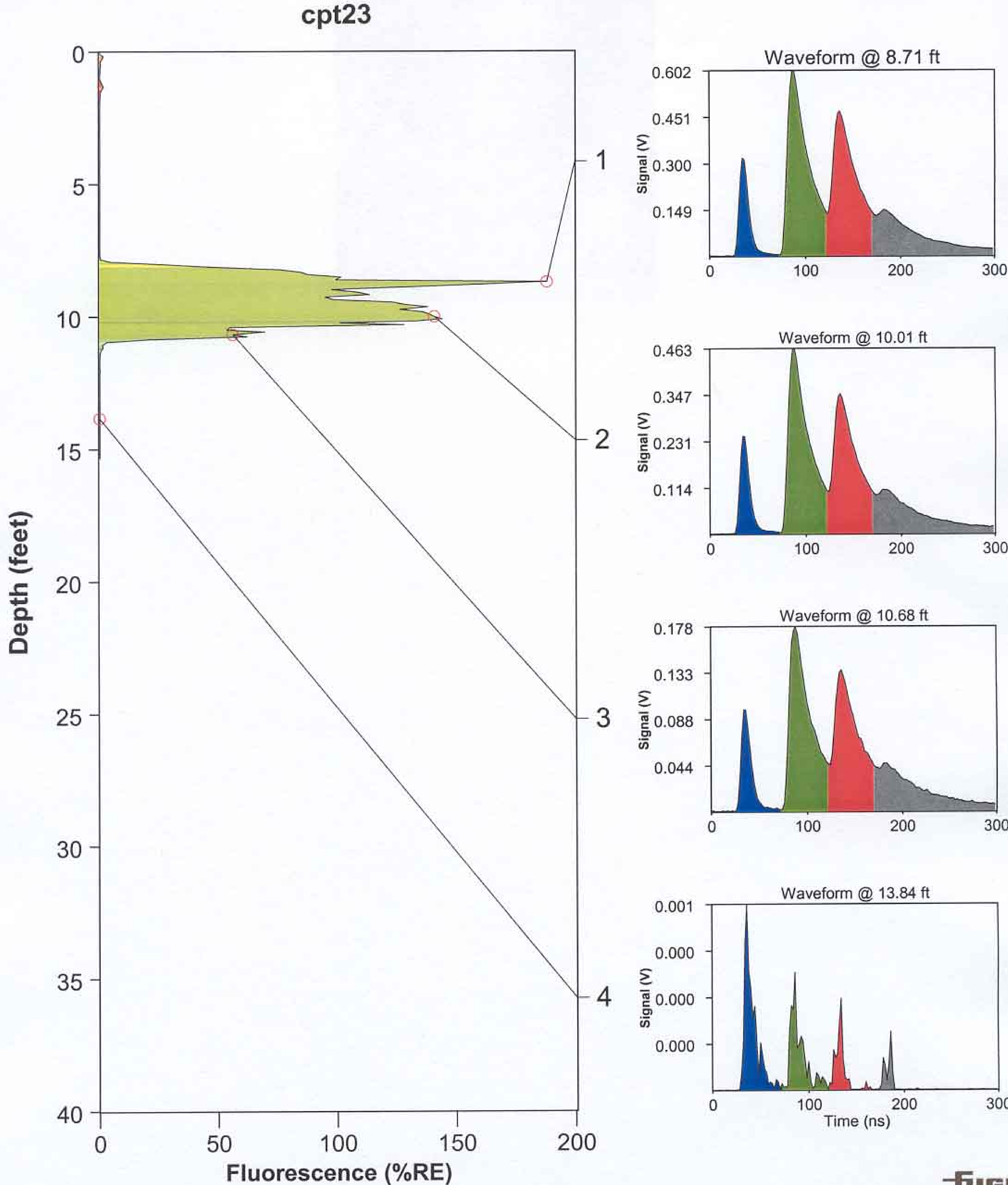
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 4:59:44 PM	Max fluorescence: 128.73% @ 8.41 ft
ROST Unit: 1	Final depth BGS: 15.40 ft



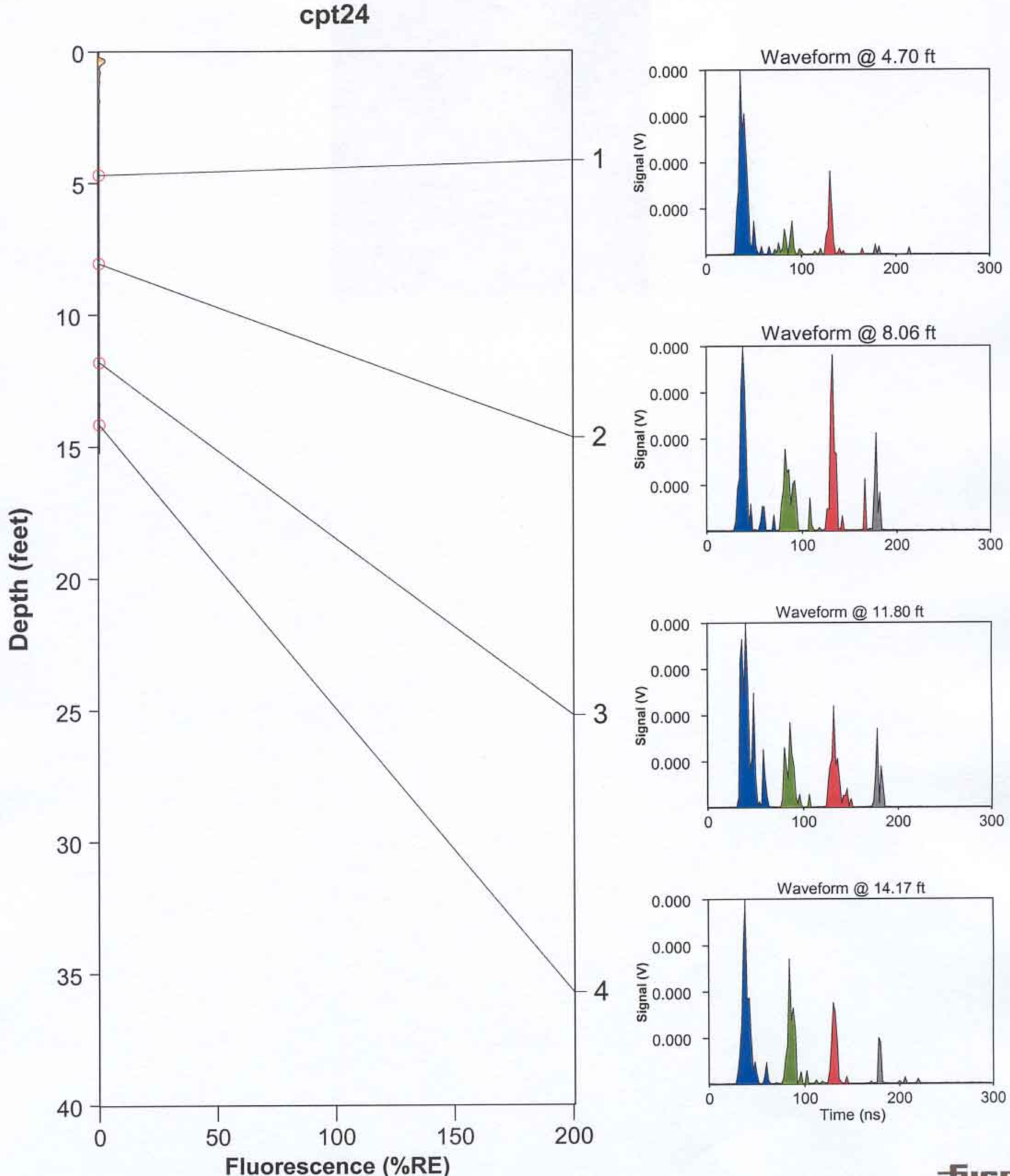
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 5:17:01 PM	Max fluorescence: 188.11% @ 8.71 ft
ROST Unit: 1	Final depth BGS: 15.34 ft



ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/21/2004 @ 5:40:36 PM	Max fluorescence: 2.50% @ 0.30 ft
ROST Unit: 1	Final depth BGS: 15.25 ft



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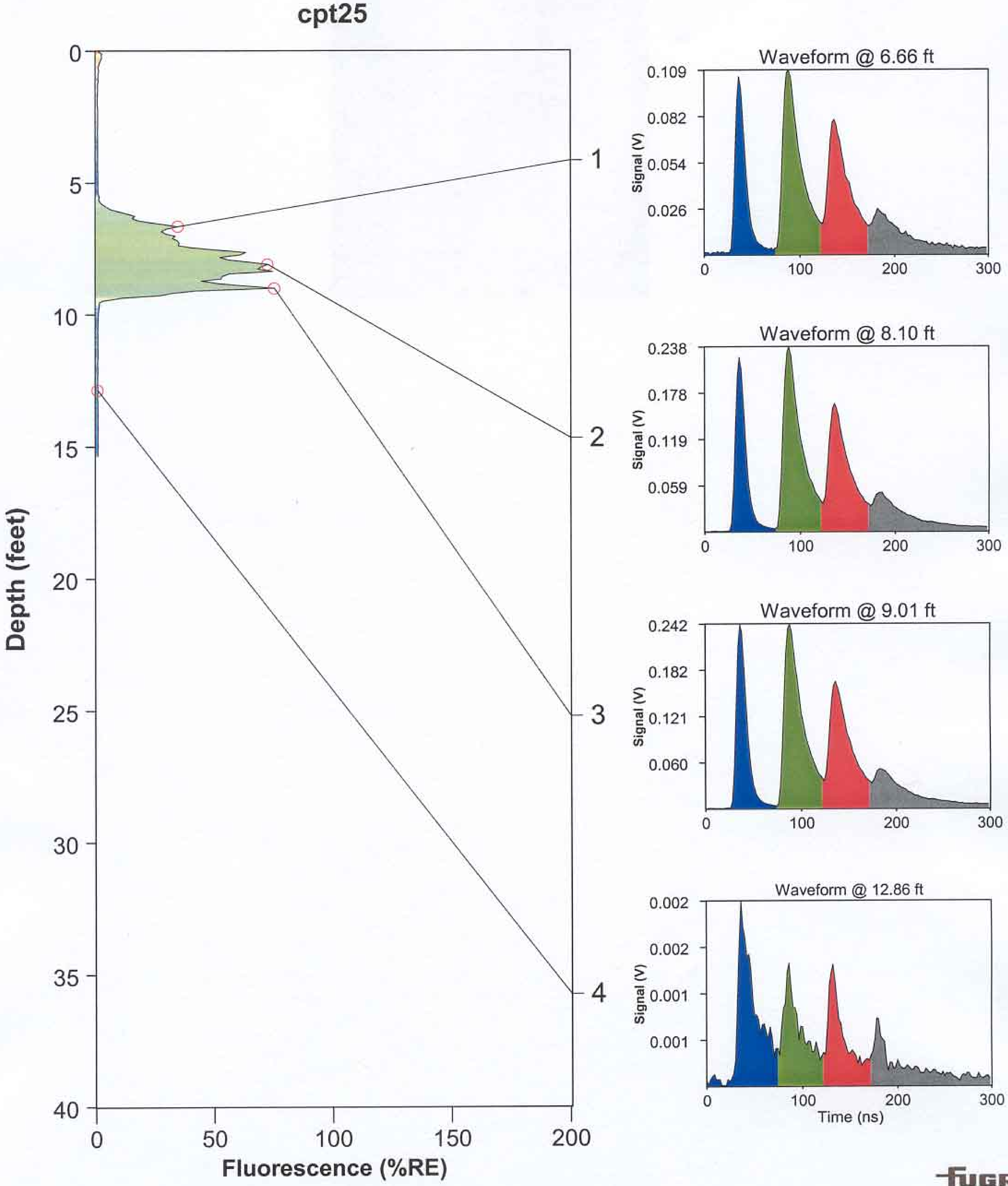
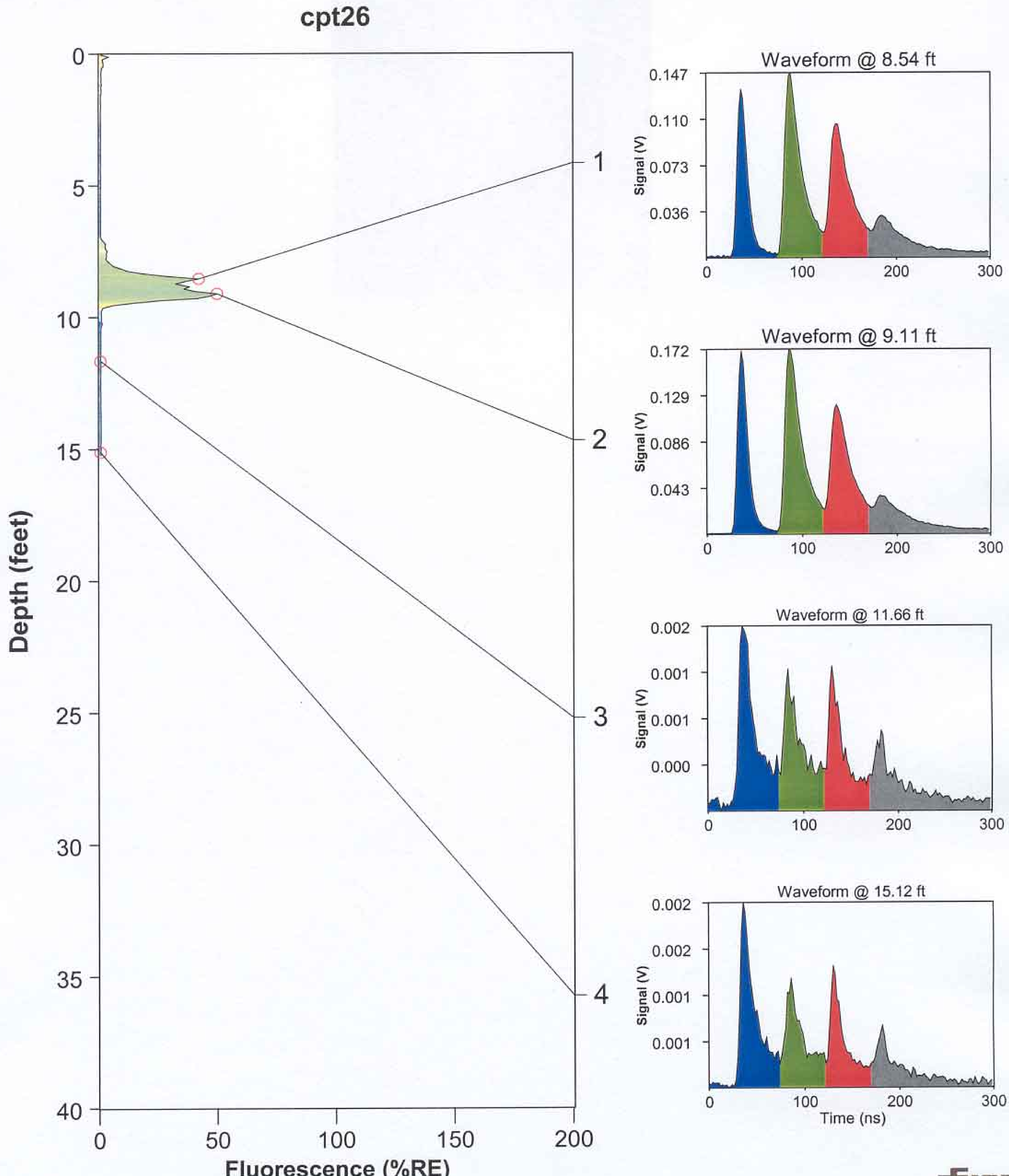
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 8:38:07 AM	Max fluorescence: 75.26% @ 9.01 ft
ROST Unit: 1	Final depth BGS: 15.35 ft



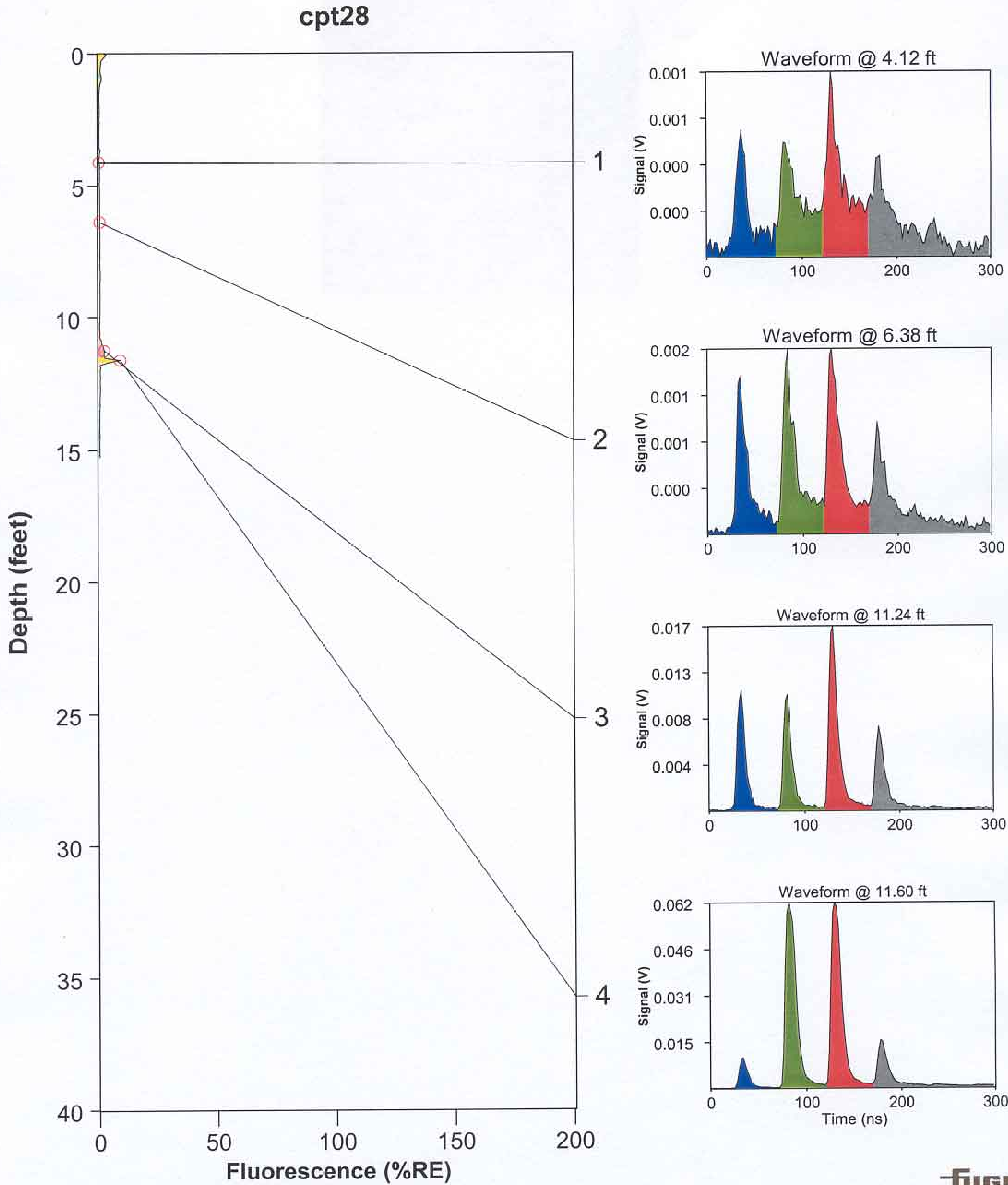
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 9:00:12 AM	Max fluorescence: 49.89% @ 9.11 ft
ROST Unit: 1	Final depth BGS: 15.24 ft



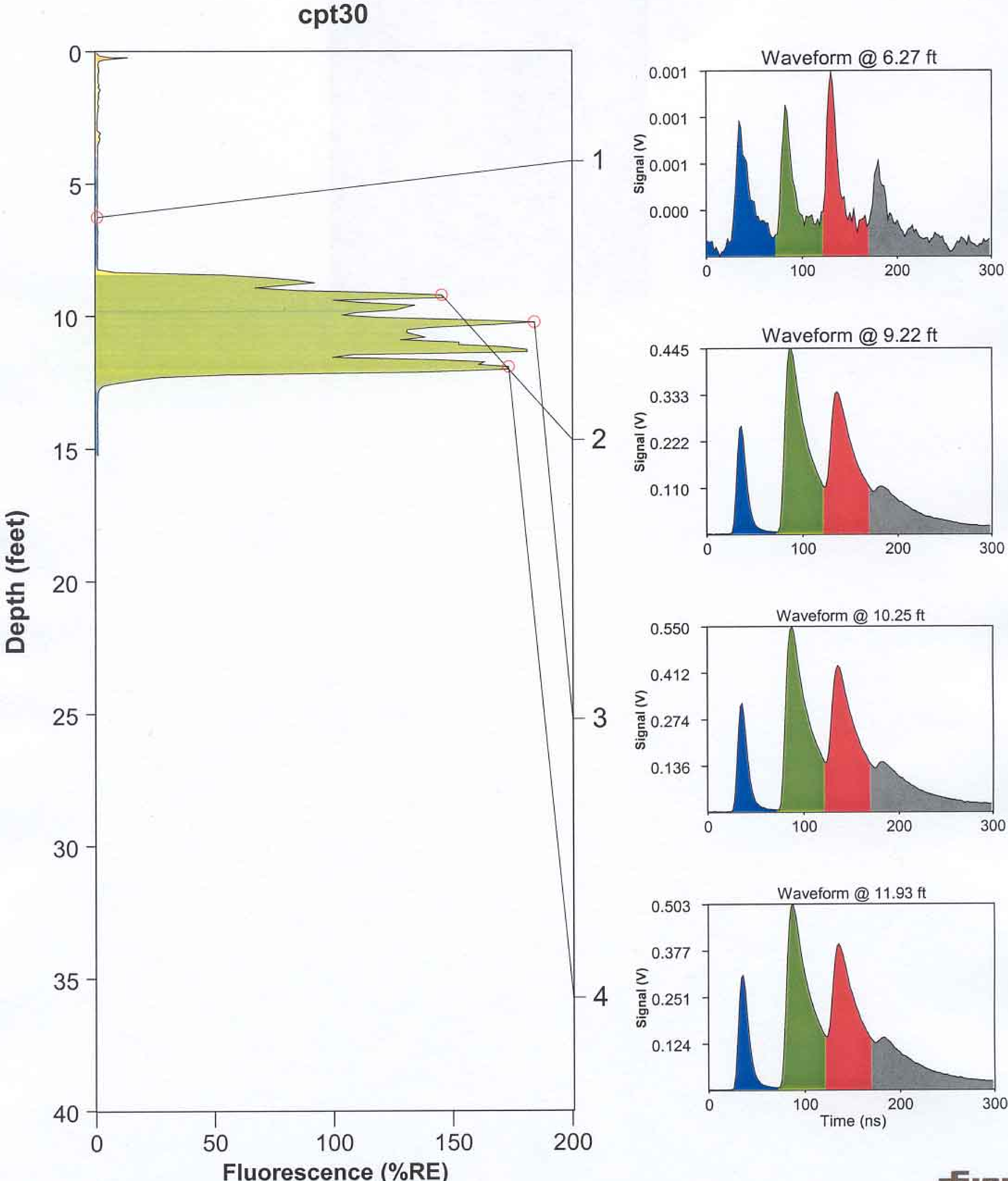
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 11:06:10 AM	Max fluorescence: 9.15% @ 11.60 ft
ROST Unit: 1	Final depth BGS: 15.26 ft



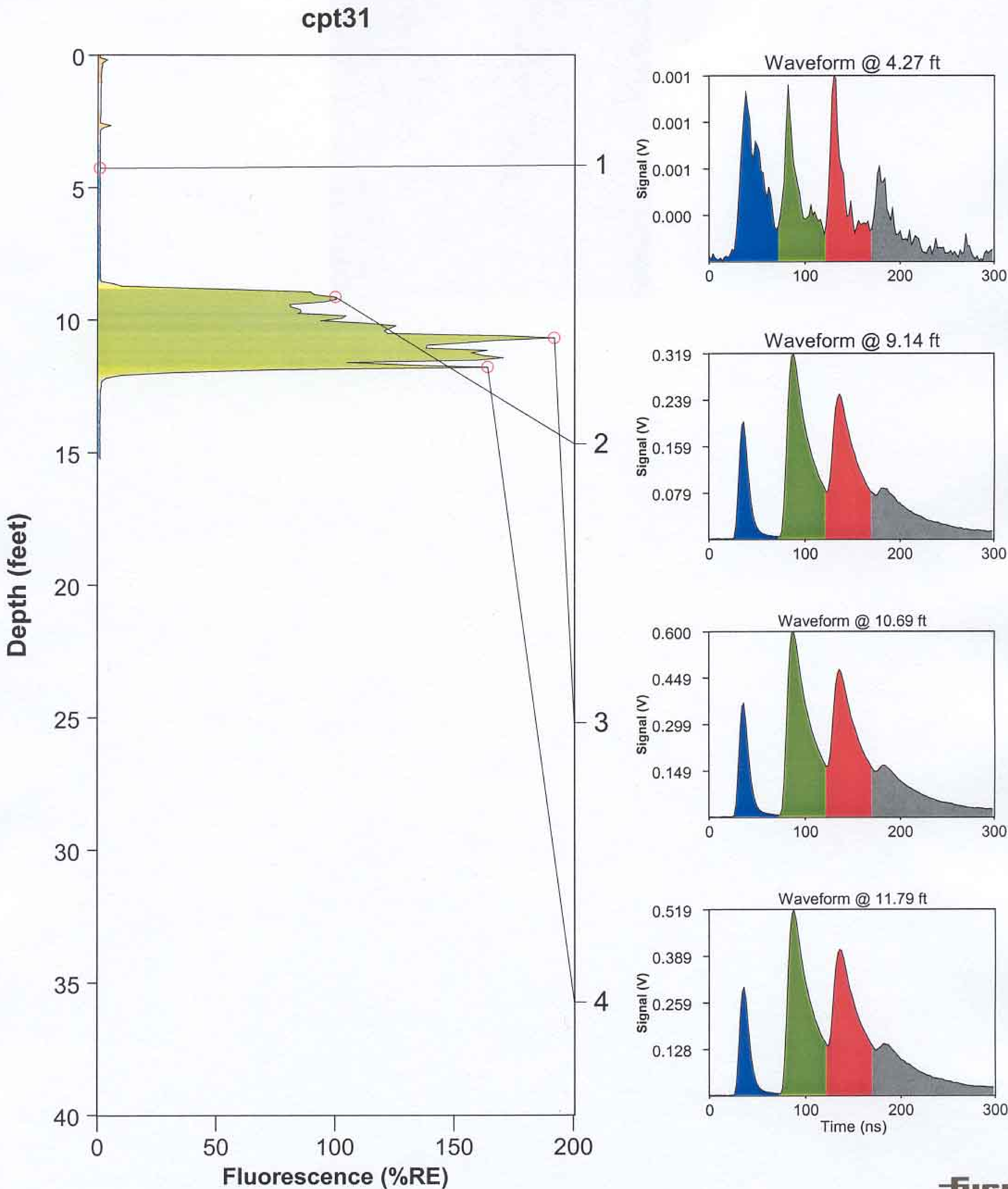
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 12:58:55 PM	Max fluorescence: 184.24% @ 10.25 ft
ROST Unit: 1	Final depth BGS: 15.25 ft



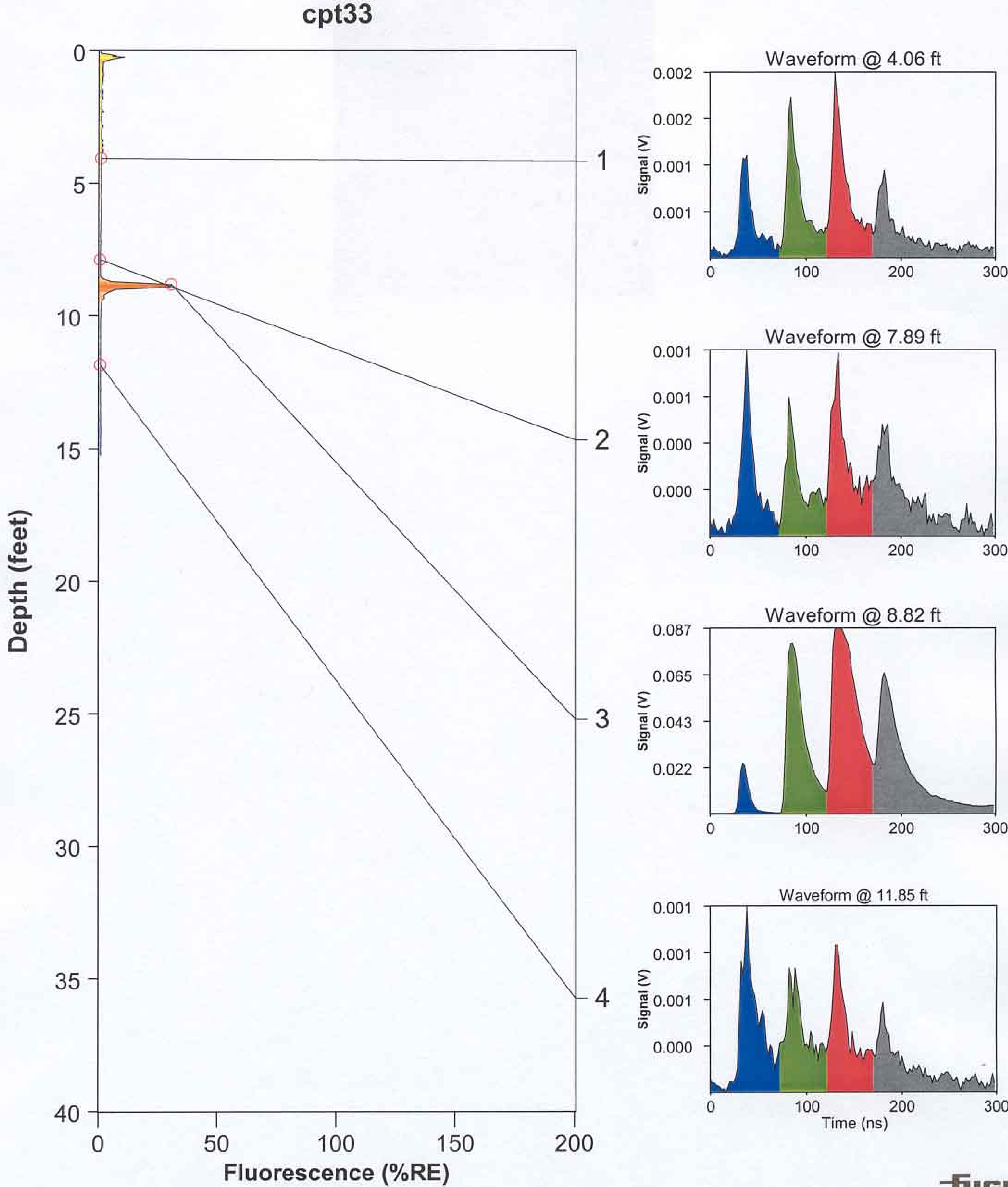
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 1:23:40 PM	Max fluorescence: 191.57% @ 10.69 ft
ROST Unit: 1	Final depth BGS: 15.24 ft



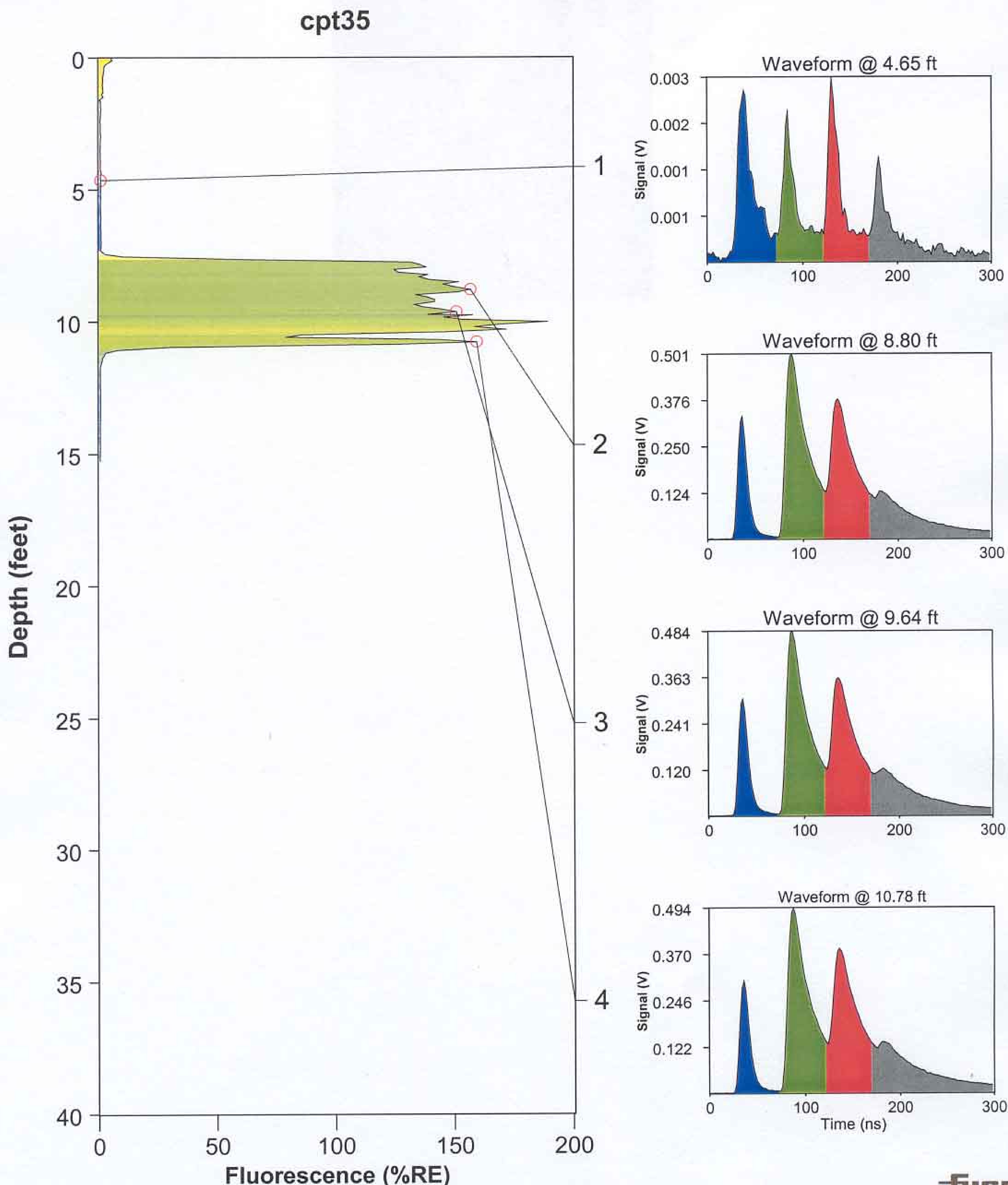
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 2:07:02 PM	Max fluorescence: 30.23% @ 8.82 ft
ROST Unit: 1	Final depth BGS: 15.26 ft



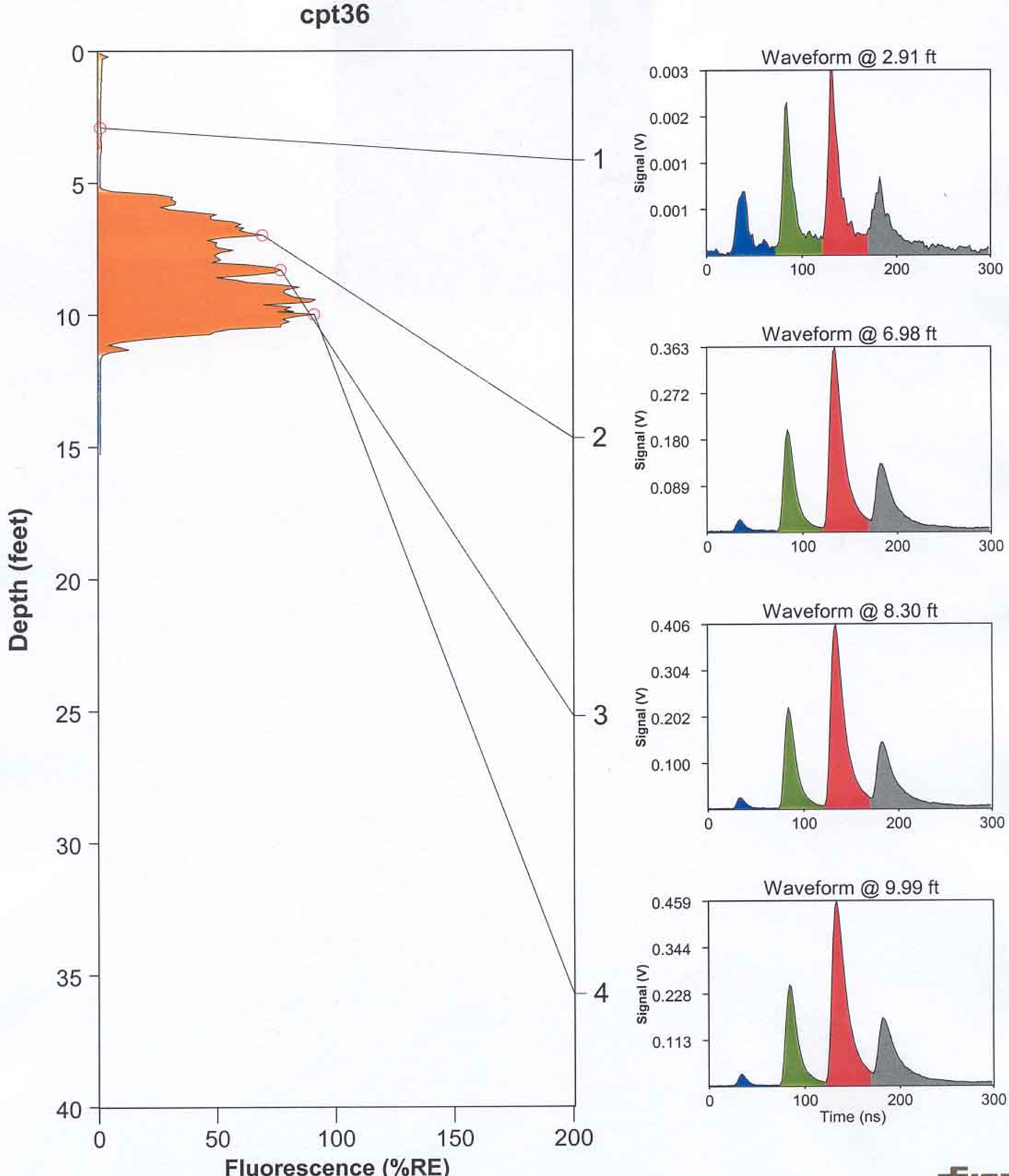
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 2:55:55 PM	Max fluorescence: 189.30% @ 10.02 ft
ROST Unit: 1	Final depth BGS: 15.26 ft



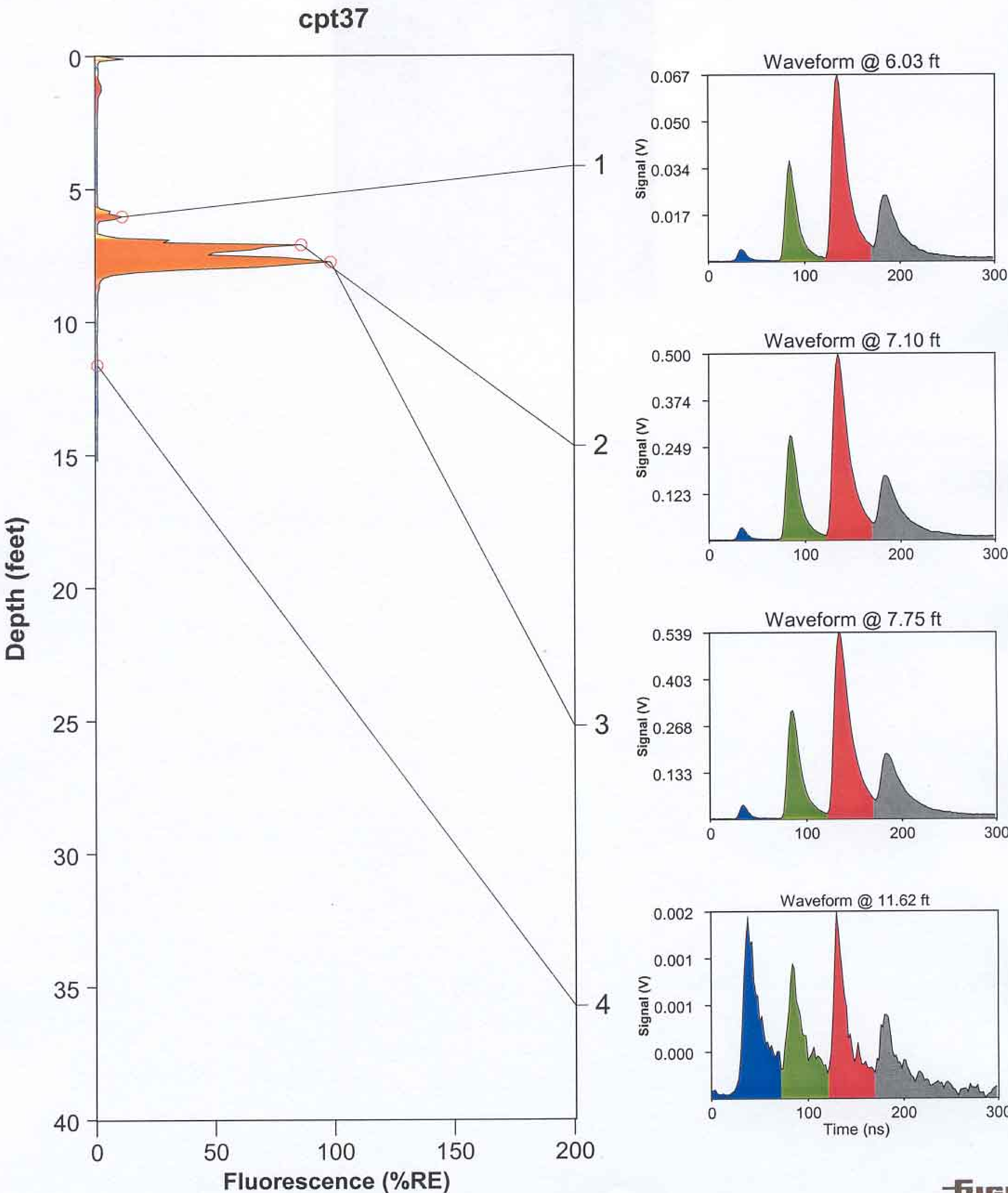
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 3:15:40 PM	Max fluorescence: 91.53% @ 9.43 ft
ROST Unit: 1	Final depth BGS: 15.27 ft



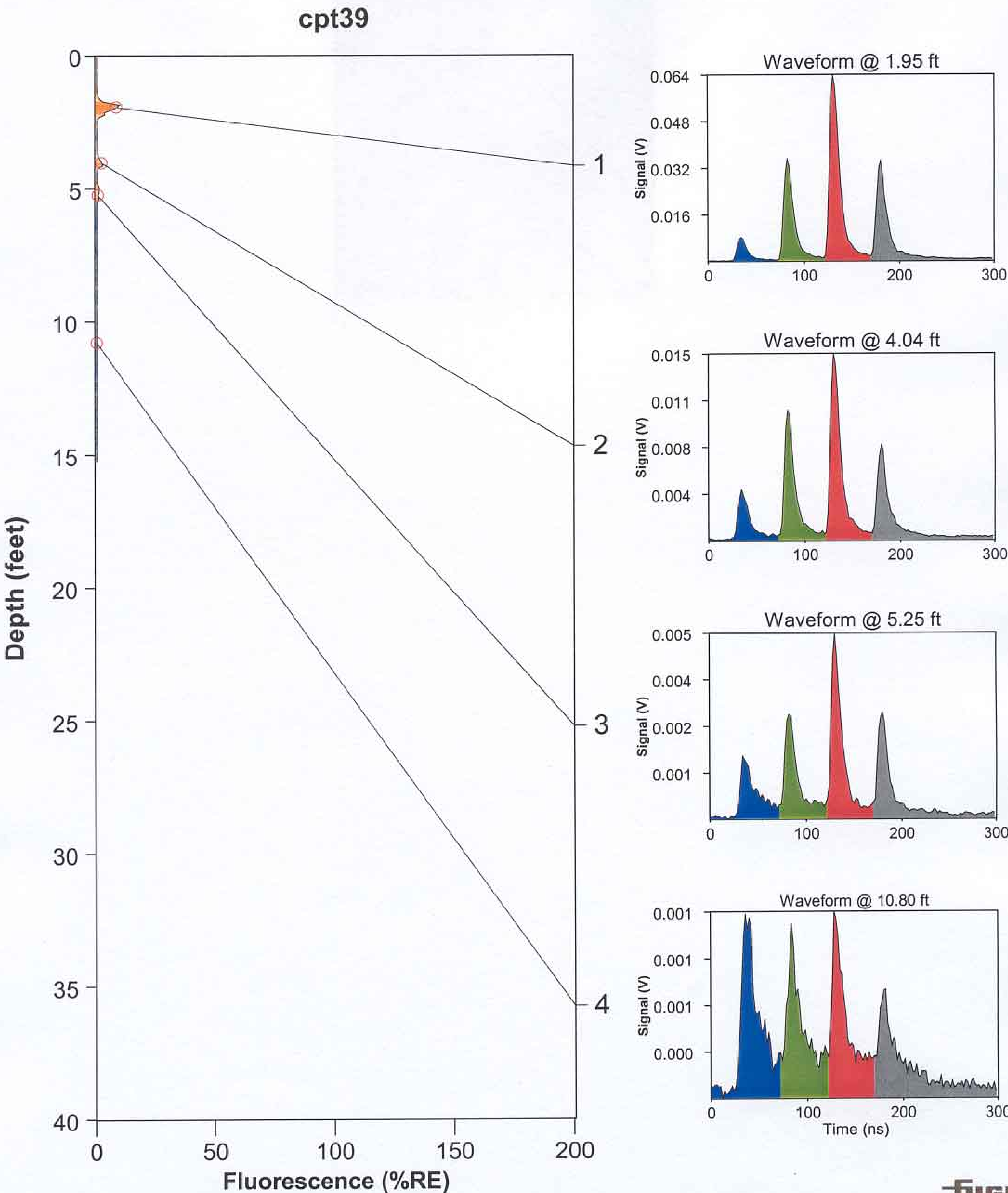
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 3:32:07 PM	Max fluorescence: 98.33% @ 7.75 ft
ROST Unit: 1	Final depth BGS: 15.22 ft



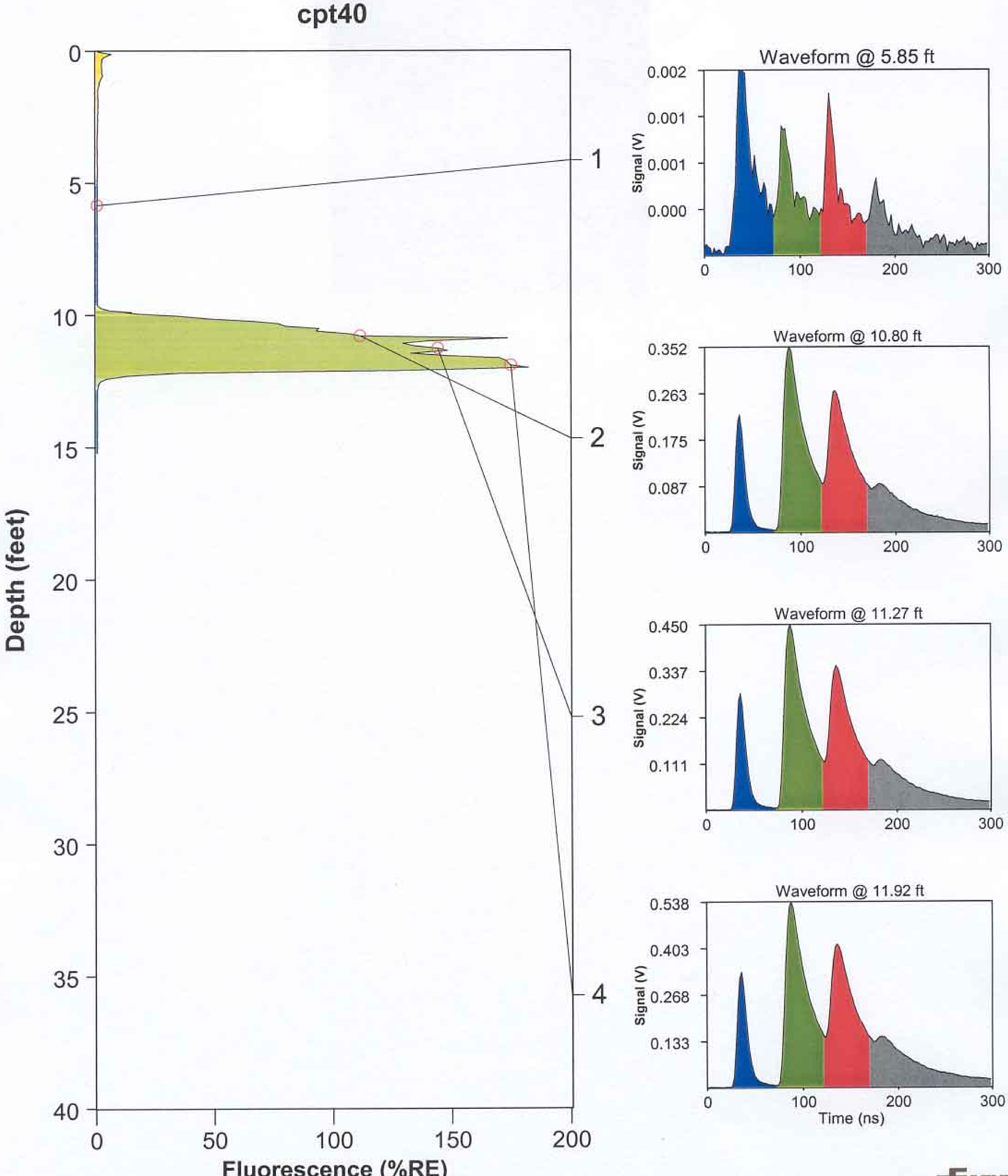
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/23/2004 @ 9:39:08 AM	Max fluorescence: 9.97% @ 1.85 ft
ROST Unit: 1	Final depth BGS: 15.26 ft



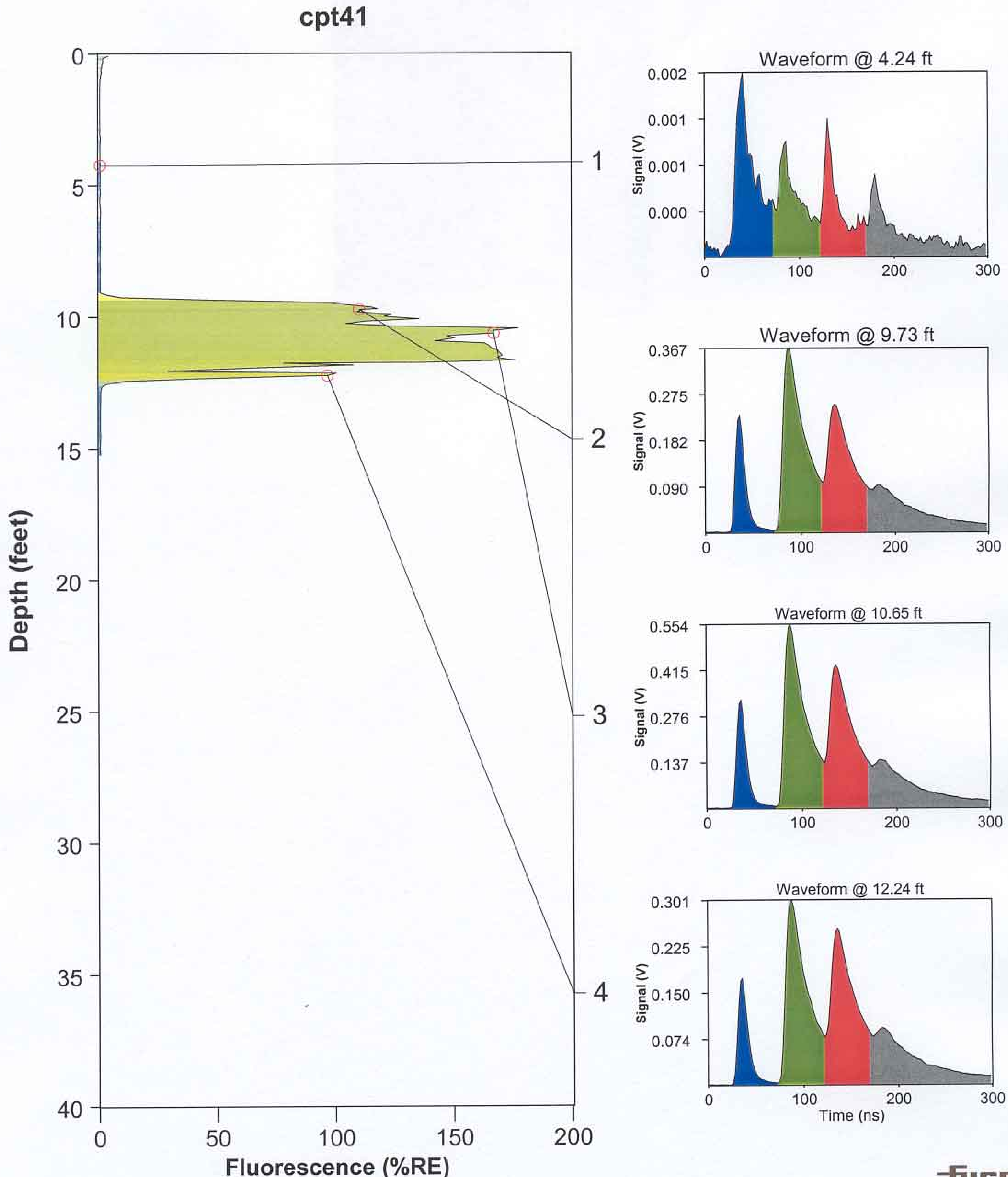
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 4:22:33 PM	Max fluorescence: 182.32% @ 12.01 ft
ROST Unit: 1	Final depth BGS: 15.23 ft



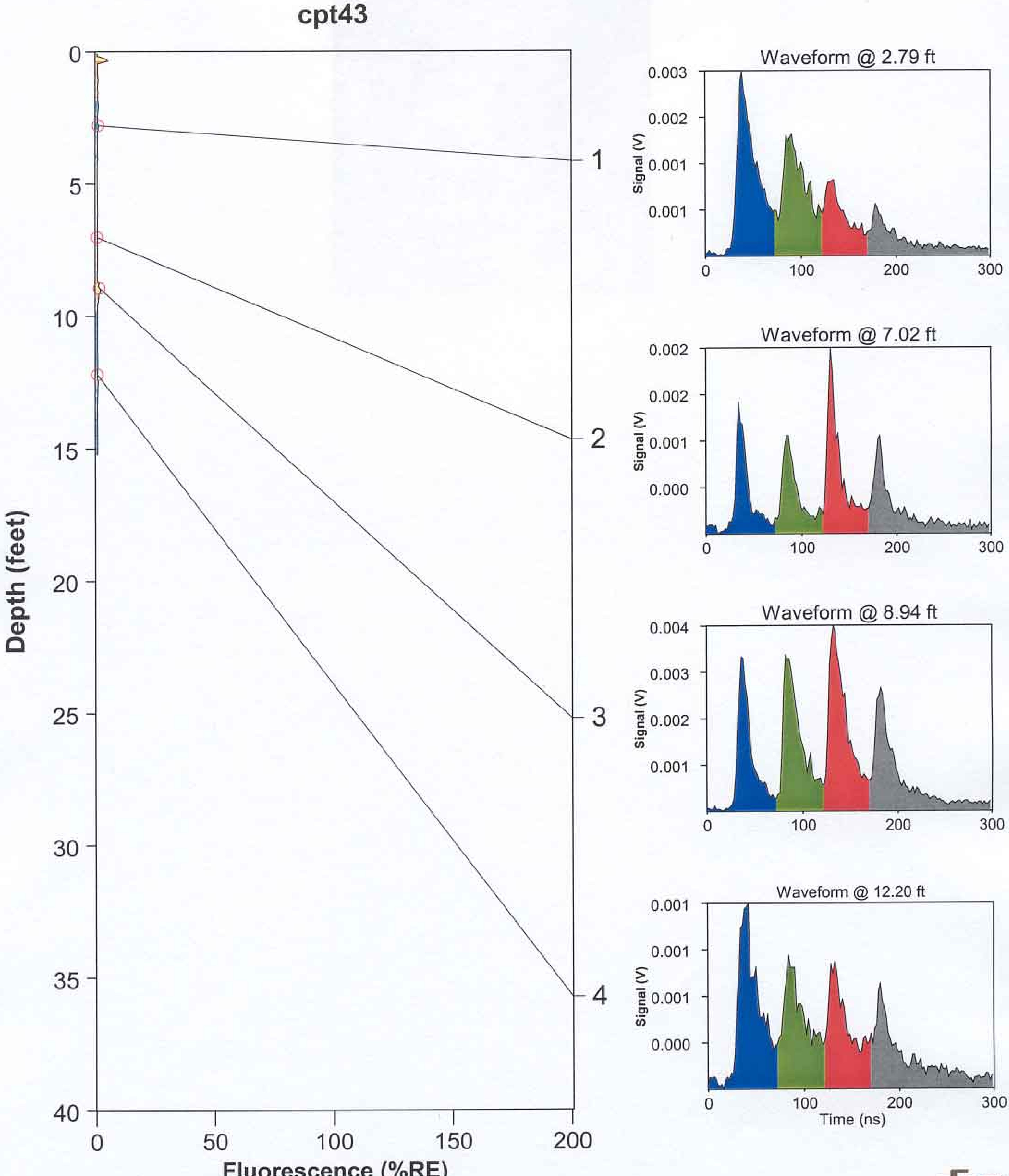
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/22/2004 @ 4:41:05 PM	Max fluorescence: 177.48% @ 10.46 ft
ROST Unit: 1	Final depth BGS: 15.24 ft



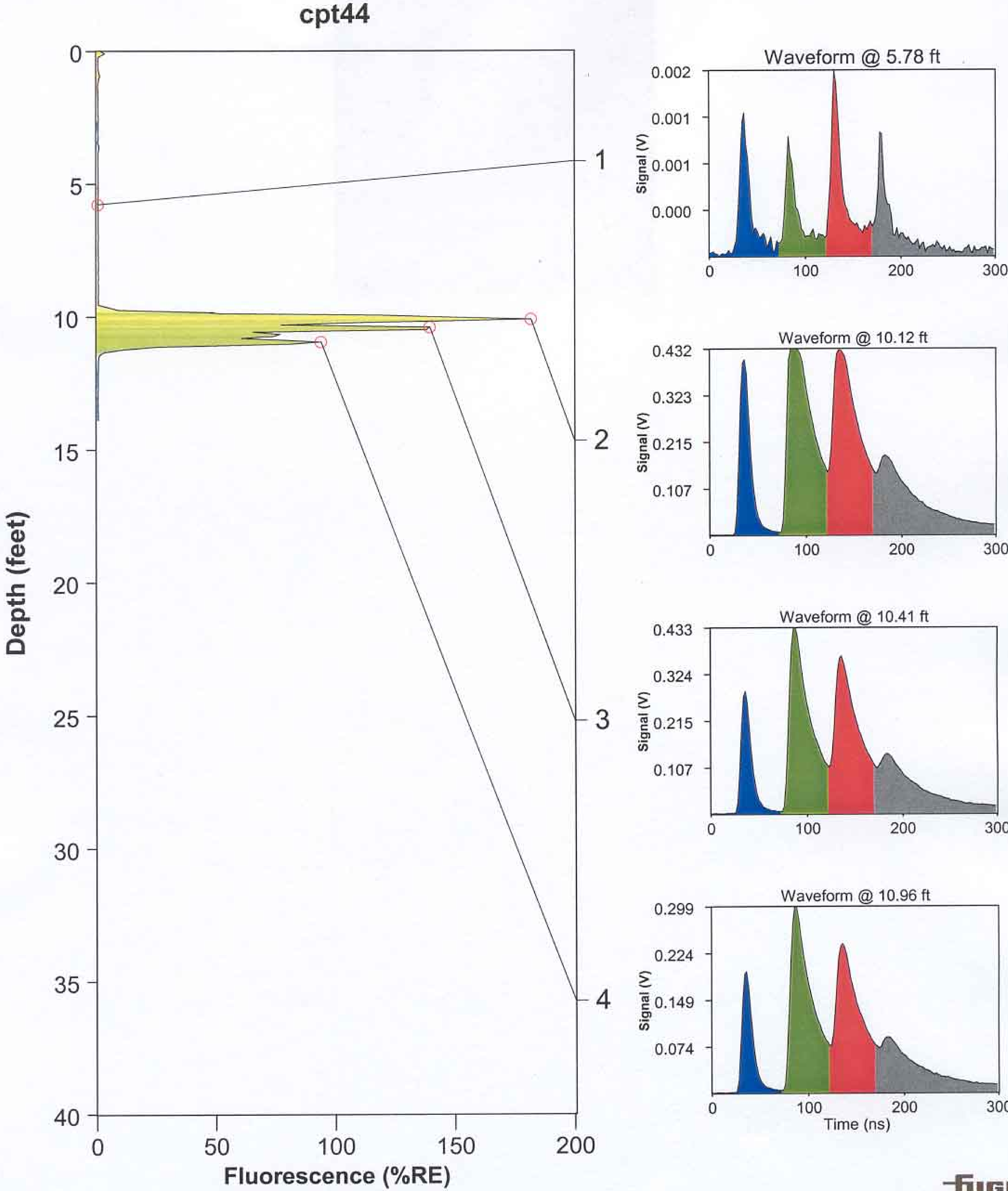
ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/23/2004 @ 8:09:35 AM	Max fluorescence: 5.02% @ 0.35 ft
ROST Unit: 1	Final depth BGS: 15.23 ft



ROST Fluorescence Response Data

Site: port of astoria, oregon	Operator: ddeleon
Client: envirologic	Fugro Job #: 03-1090
Date/Time: 9/23/2004 @ 9:00:42 AM	Max fluorescence: 181.87% @ 10.12 ft
ROST Unit: 1	Final depth BGS: 13.89 ft



APPENDIX B

SHELL GLOBAL SOLUTIONS (US) INC. REPORT

Shell Global Solutions

Mr. William E. Platt
Shell Oil Company
P.O. Box 2463
Houston TX 77252-2463

Shell Global Solutions (US) Inc.
Westhollow Technology Center
3333 Highway 6 South
Houston, TX 77082-3101
USA
Tel +1 281-544 8215
Fax +1 281-544 8727
Email Ileana.Rhodes@Shell.com

June 17, 2004

Re: Forensics Analysis of Samples of Separate–Phase Hydrocarbon from the Astoria Area-Wide Petroleum Site, Astoria, Oregon (2003 and 2004 Samples)

Dear Ed:

Samples of separate-phase hydrocarbons (SPH) from MW-15(A), MW-37(A), MW-40(A), MW-41(A), MW-42(A) and MW-44(A) were collected by NCA May 19, 2004 at the Astoria Area-Wide Petroleum Site in Astoria, Oregon. The samples were sent for characterization to Shell Global Solutions (US) Inc.'s Westhollow Technology Center in Houston, Texas. Samples from this site were previously analyzed in June 2003 from MW-4(M), MW-8(M) and MW-(9) and in November 2003 from MW-3(M). These samples are included in this report for comparison. Results from analysis of the June 2003 samples were previously reported in a letter to Frank Fossati dated August 12, 2003. The results from analysis of the November 2003 sample were reported to Jeff Goold by E-mail on January 13, 2004.
The analytical protocols used for SPH characterization are focused on identification of components characteristic of fuels and the relative distribution of these components ("fingerprint"). The protocols utilized in this fingerprinting analysis are based on methodologies commonly applied in environmental forensic investigations. These methods are similar to EPA methods as described below:

- Modified EPA Method 8015M using gas chromatography with flame ionization detection (GC/FID)

    This direct injection analysis is done to characterize the types of product that may be present in the samples, as well as distribution of selected diagnostic components and relative weathering. The hydrocarbons are determined from area percent normalization, since hydrocarbons have virtually the same FID response (all of the injected hydrocarbons in the SPH are detected and since their response on a mass basis is within 10%, normalized results provide accurate concentrations for all of the hydrocarbons in the SPH samples).

- Modified EPA Method 8260 using gas chromatography with mass spectrometry detection (GC/MS)

  This direct injection method is used for the detection and quantitation of selected components such as MTBE and BTEX in fuels with a reported limit of 0.01% (<100 ppm). In addition, organic lead can be determined at ppm levels using selective ion monitoring techniques.

- Determination of total Lead and total Sulfur by ASTM D5059 (modified) and D2622, respectively. These are x-ray fluorescence methods.

The results obtained from GC/FID and GC/MS analyses clearly indicate that the samples from these wells contain weathered diesel/fuel oil and gasoline range material in various proportions. Some samples contain primarily gasoline range material with different degrees of weathering and likely from several sources, while other samples contain primarily biodegraded diesel range material which appear to be of a similar type. In addition, the sample from MW-15(A) contains a significant contribution of a heavier material. Figure 1 shows the relative distribution of the product types in these samples. This breakdown (Table 1) is just for comparison purposes as a fresh diesel may have 10% in the gasoline range as defined by the carbon 12 cutoff and gasoline may have 5% in the diesel range when fresh and increases in "diesel range" as volatiles are lost without having any actual diesel/fuel oil in the sample.

Oxygenates (MTBE, TBA, ETBE, DIPE, TAME) were not detected (<0.01%) in any of the samples.

Table 1 includes a summary of lead and sulfur results. Some of the samples contain lead. Since lead is only present in gasoline, the fact that these samples range from little to no gasoline present (MW-8 and MW-9) to mostly gasoline (MW-37 and MW-40), should be considered in comparing the lead amounts detected. All of the samples containing lead have a mixture of lead alkyls except for the sample from MW-37 which contains only tetraethyllead.

There are significant differences among the gasolines found in the samples. The gasoline in MW-37(A) is very different from all other samples both in terms of hydrocarbon distribution, high lead content and type of lead package. The sample from MW-15(M) contains a gasoline range material that has a high alkylate content. Ratios of selected diagnostic compounds are useful for discerning differences among gasolines. These ratios are typically of compounds that are not easily degraded, that have similar physical properties and can be related to the refinery stream used in gasoline blending. Figure 2 shows a comparison of ratios of branched and cyclic compounds that are useful in comparing gasolines. It is clear that the samples from MW-15 and MW-37 are significantly different from each other and the other samples. The rest of the samples are not identical but they are relatively more similar in composition. The samples from MW-8 and MW9 are excluded from this plot because they do not contain gasoline in significant amounts.

Figures 3 through 12 include the chromatograms obtained from analysis of all of the samples. It is evident that the samples from MW-15(A) (Figure 3) and MW-37(A) (Figure 4) are significantly different from each other and all other samples. The sample from MW-40(A) shown in Figure 5 contains primarily gasoline range material with some loss of volatiles and aromatics and a small amount of biodegraded diesel. MW-42(A) and MW-44(A) shown in Figures 6 and 7, respectively, contain about equal amounts of gasoline and diesel range materials. The samples from MW-4(M), MW-3(M) and MW-41(A) shown in Figures 8 through 10, respectively, contain primarily biodegraded diesel and some gasoline range materials. As with the other samples, the gasoline range material has lost volatiles and aromatics and the diesel is biodegraded. Samples from MW-8(M) and MW-9(M) contains primarily biodegraded diesel.

Summary

Analysis of SPH samples from this site collected in 2003 and 2004 indicate the presence of leaded gasoline and biodegraded diesel. Some samples contain primarily gasoline, some samples contain primarily diesel/fuel oil and the majority of the samples contain mixtures of both types of products in different proportions. No oxygenates were detected.

No further work is planned for these samples. The samples will be retained for three months from the date of this report after which they will be discarded. If you have any questions and/or comments, please let me know.

Ileana Rhodes, Ph.D.
Principal Consultant

cc: Tim Franceschini
George Deeley
[redacted]

Sample ID	Date Sampled	Total Lead g/gallon	Organic Lead g/gallon	Sulfur wt%	Diesel (>C12) Relative %	Gasoline (<C12) Relative %
MW-37(A)	May-04	3.5	4.2	0.34	28	72
MW-40(A)	May-04	1.0	1.3	0.19	29	71
MW-42(A)	May-04	0.2	0.2	0.25	55	45
MW-44(A)	May-04	0.08	0.05	0.25	56	44
MW-15(A)	May-04	0.3	0.06	0.41	60	40
MW-4(M)	Jun-03	0.1	0.1	0.37	75	25
MW-3(M)	Nov-03	0.02	0.05	0.15	81	19
MW-41(A)	May-04	<0.01	<0.01	0.48	87	13
MW-9(M)	Jun-03	<0.01	<0.01	0.45	88	12
MW-8(M)	Jun-03	<0.01	<0.01	0.45	92	8

Table 1: Summary of results for lead, sulfur and approximate relative distribution of gasoline and diesel range material.

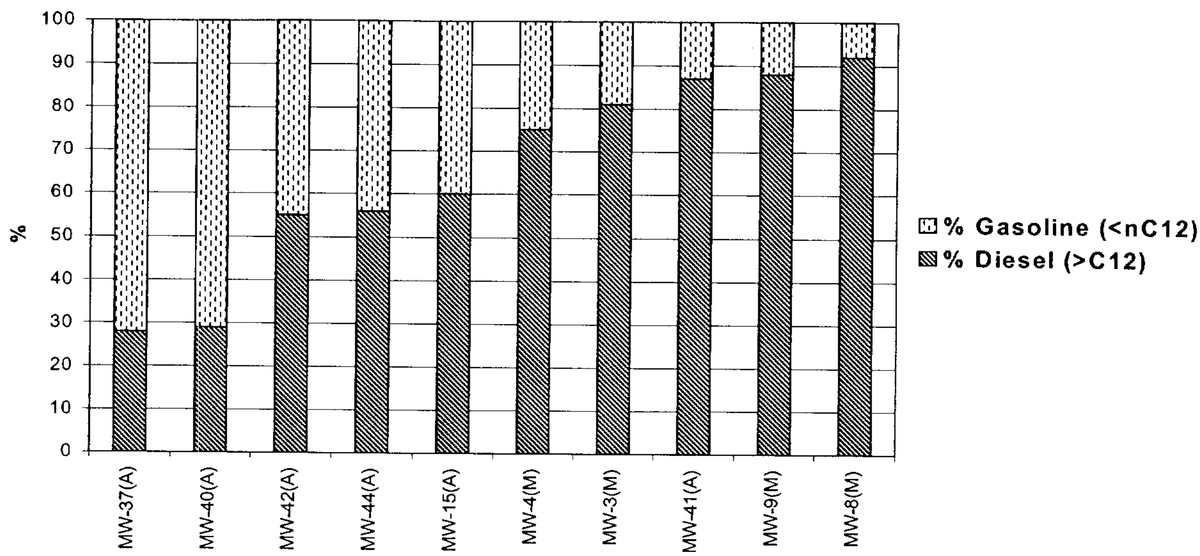


Figure 1: Relative distribution of gasoline range and diesel/fuel oil range material based on a cut off at carbon number 12. This is an approximate distribution for gross comparison among the samples as these types of products overlap so that a gasoline may have a portion above C12 and diesel has a portion below C12. As gasoline weathers and loses light ends, the relative proportion above C12 increases, therefore a weathered gasoline may have a significant portion above C12.

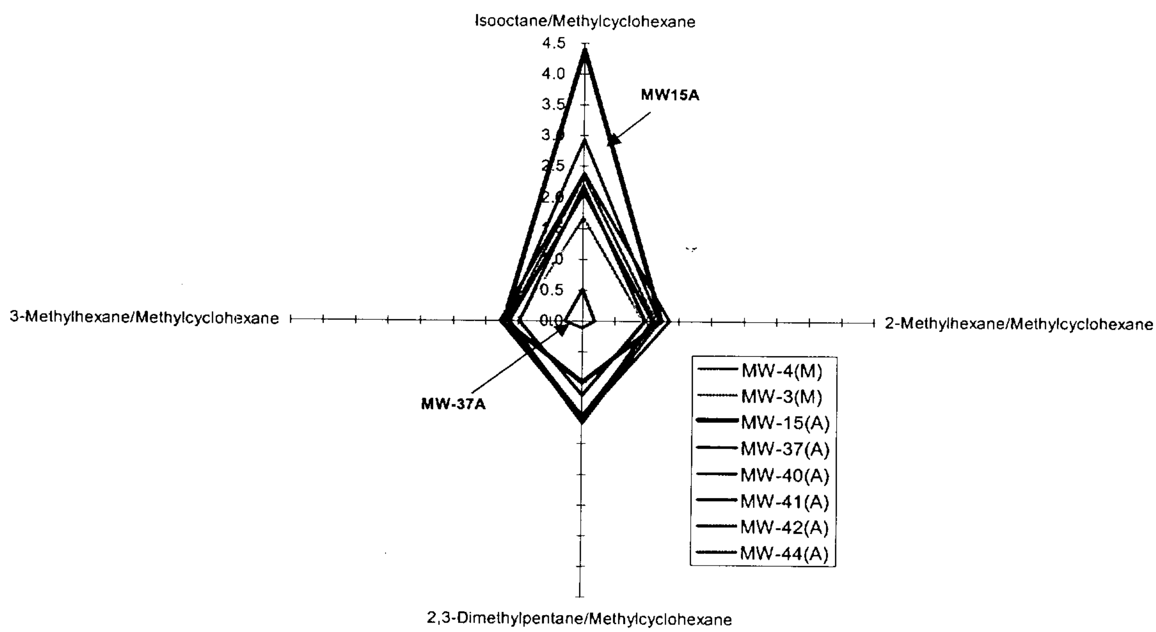


Figure 2: Comparison of diagnostic rations of gasoline range components. It is clear that MW-37A and MW-15A contain gasoline range materials significantly different. The samples from MW-8 and MW-9 are not included in this plot since they do not contain appreciable gasoline range material.

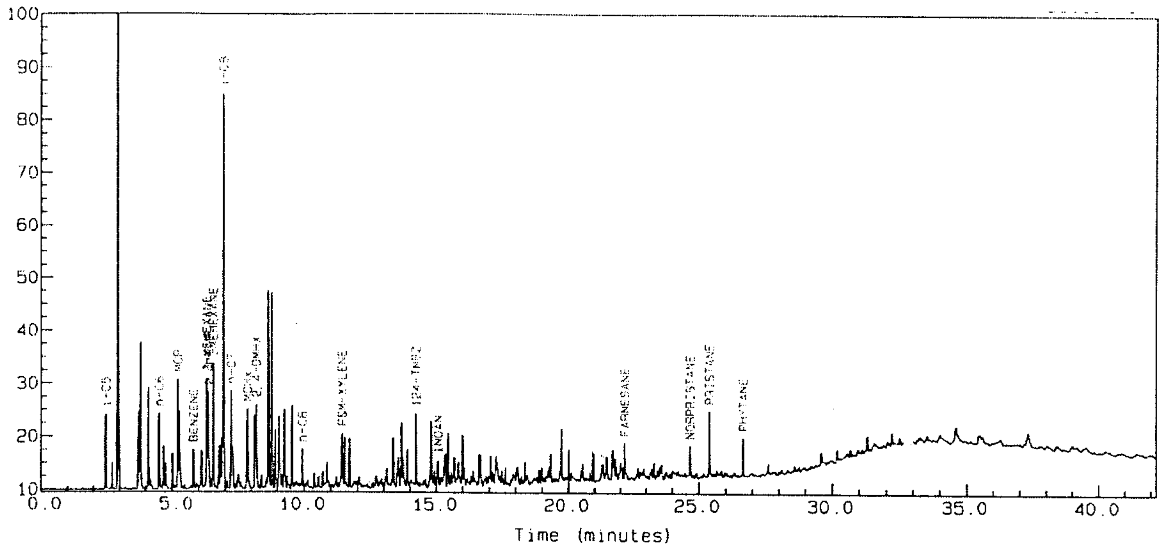


Figure 3: MW-15(A) contains primarily gasoline range material which is rich in alkylate as indicated by the relative high abundance of isooctane. There is a heavy range material as indicated by the "hump" after 30 minutes.

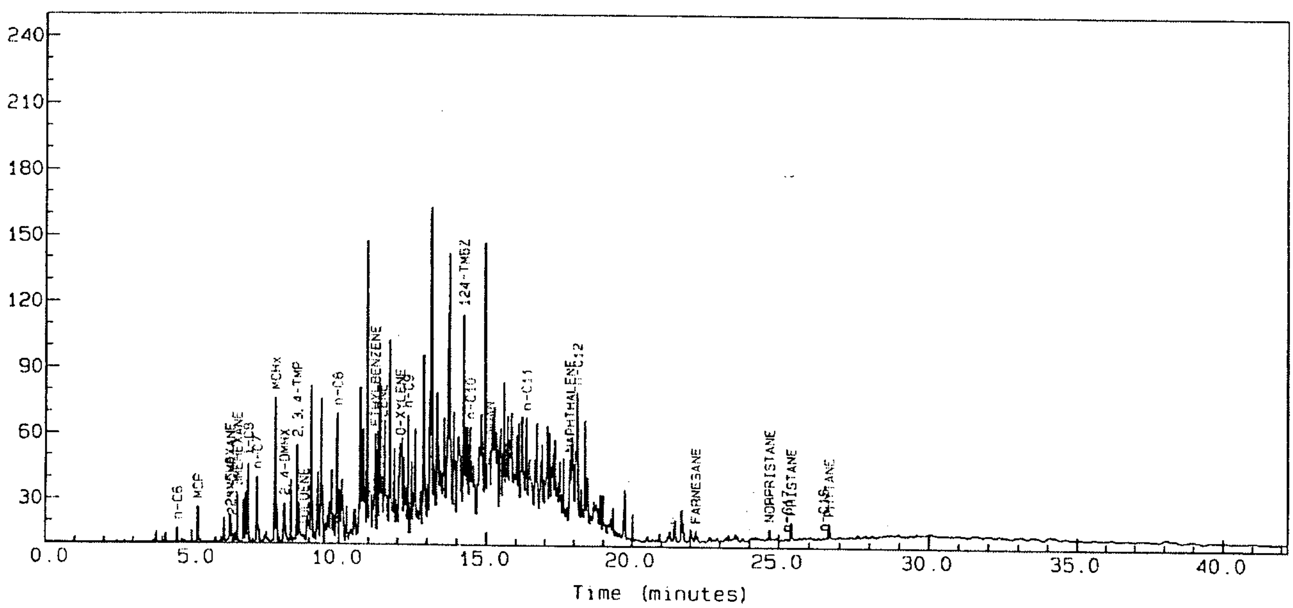


Figure 4: MW-37(A) contains primarily gasoline range material which is degraded with severe loss of volatiles and aromatics. It has very high lead. Only a trace of diesel range material is observed.

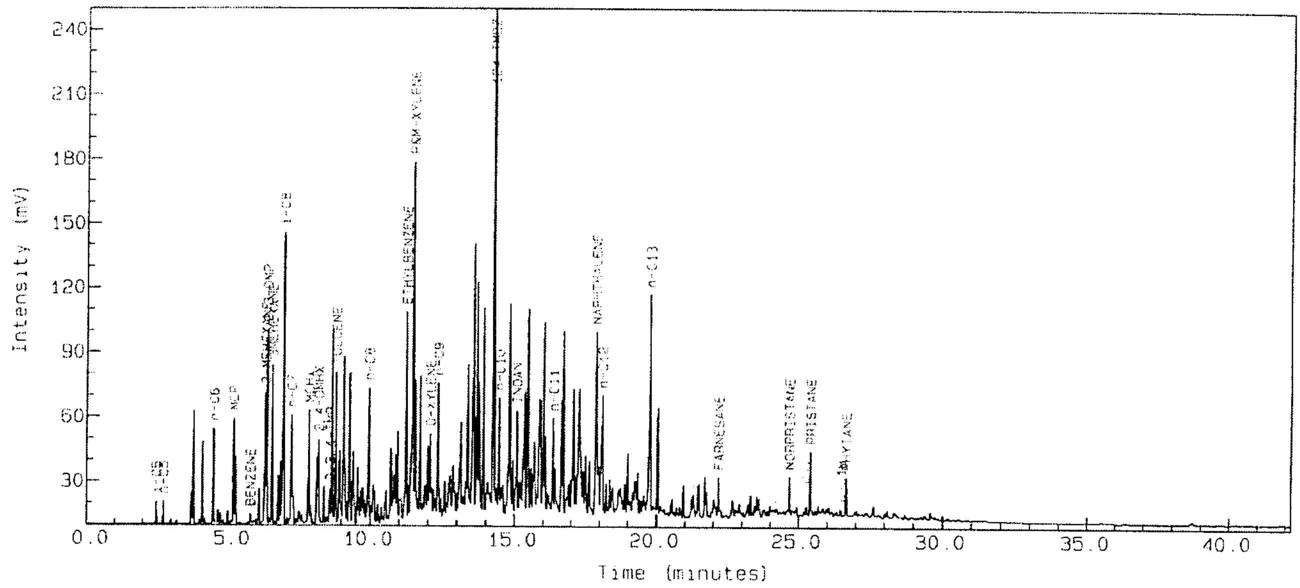


Figure 5: MW-40(A) contains primarily gasoline range material with some loss of volatiles and aromatics. A small amount of biodegraded diesel is observed.

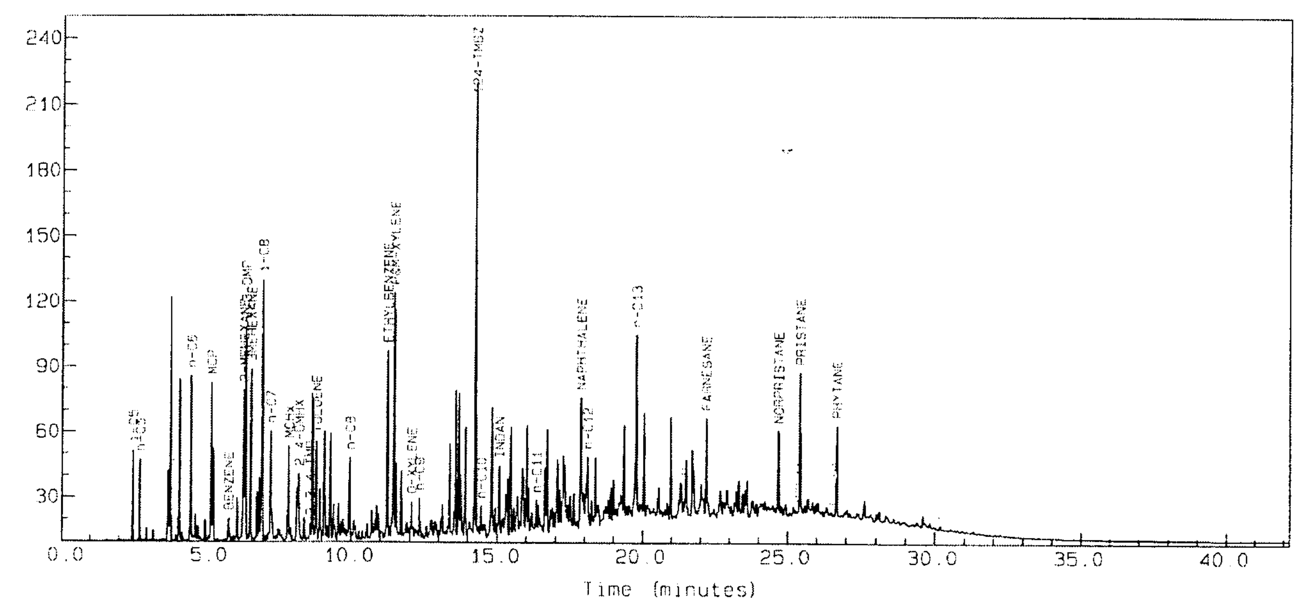


Figure 6: MW-42(A) contains about equal amounts of gasoline and diesel range materials. As with the other samples, the gasoline range material has lost volatiles and aromatics and the diesel is biodegraded.

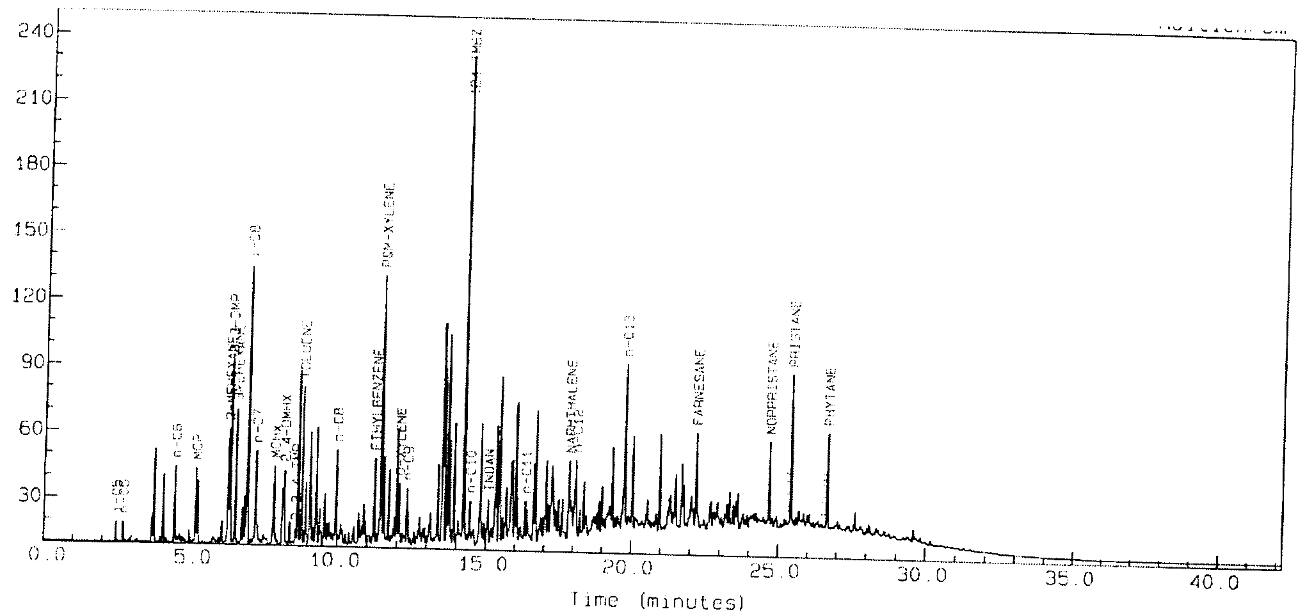


Figure 7: MW-44(A) contains about equal amounts of gasoline and diesel range materials. As with the other samples, the gasoline range material has lost volatiles and aromatics and the diesel is biodegraded.

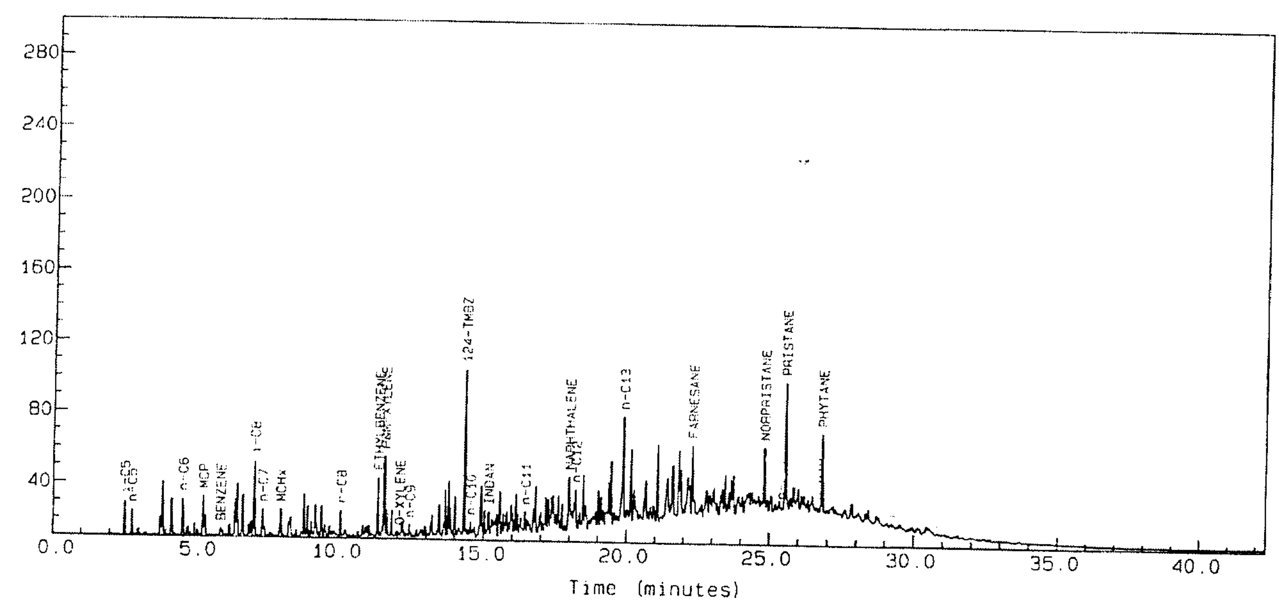


Figure 8: MW-4(M) contains primarily biodegraded diesel and some gasoline range materials. As with the other samples, the gasoline range material has lost volatiles and aromatics and the diesel is biodegraded.

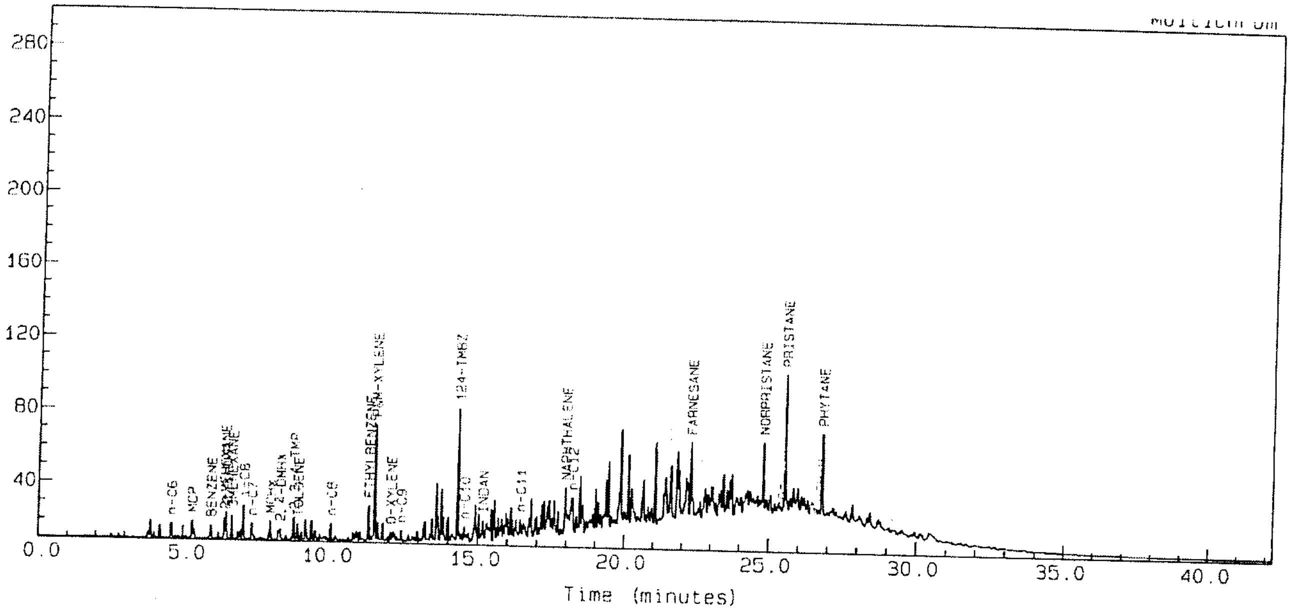


Figure 9: MW-3(M) contains primarily biodegraded diesel and some gasoline range materials. As with the other samples, the gasoline range material has lost volatiles and aromatics and the diesel is biodegraded.

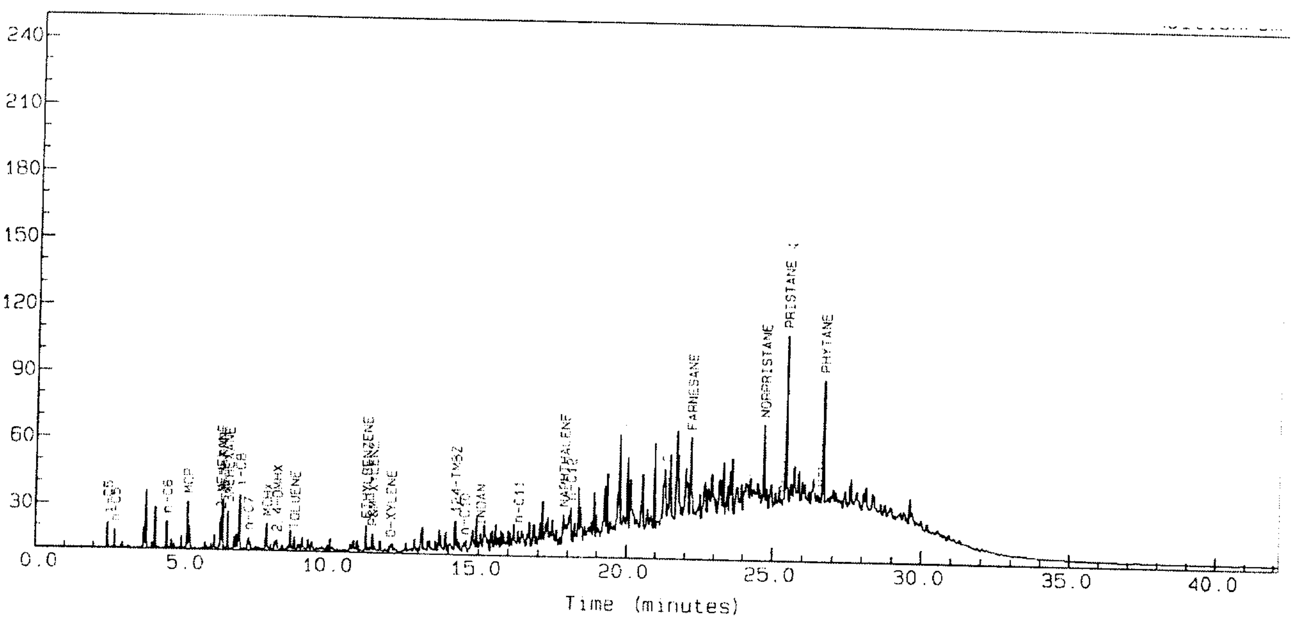


Figure 10: MW-41(A) contains primarily biodegraded diesel and some gasoline range materials. As with the other samples, the gasoline range material has lost volatiles and aromatics and the diesel is biodegraded.

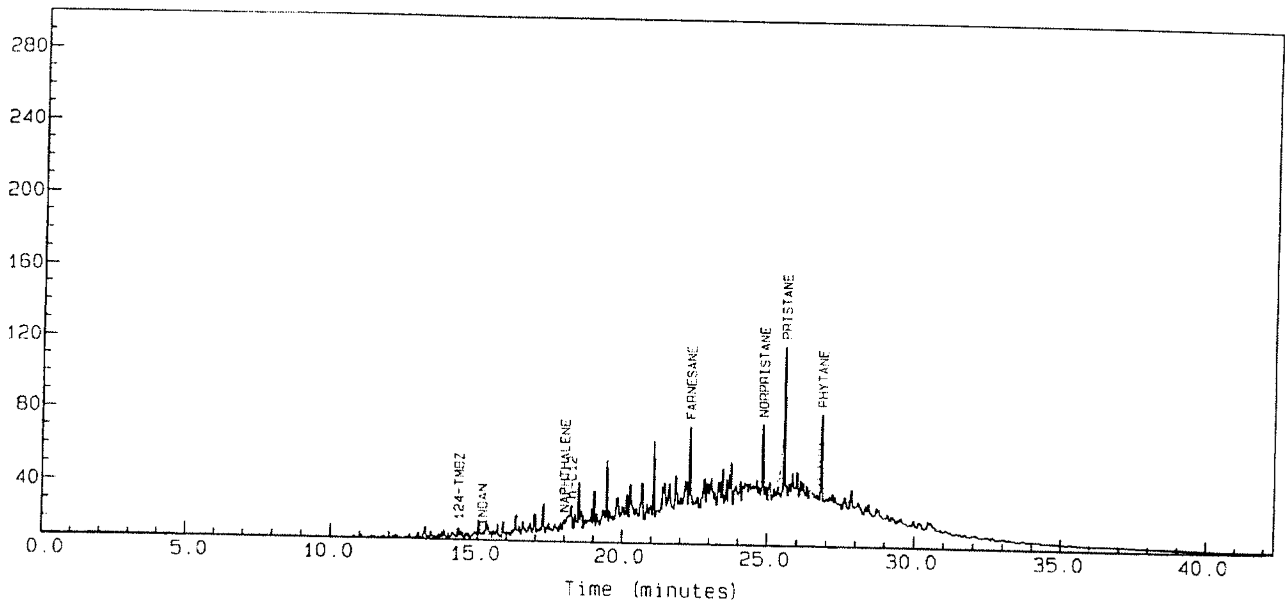


Figure 11: MW-8(M) contains primarily biodegraded diesel.

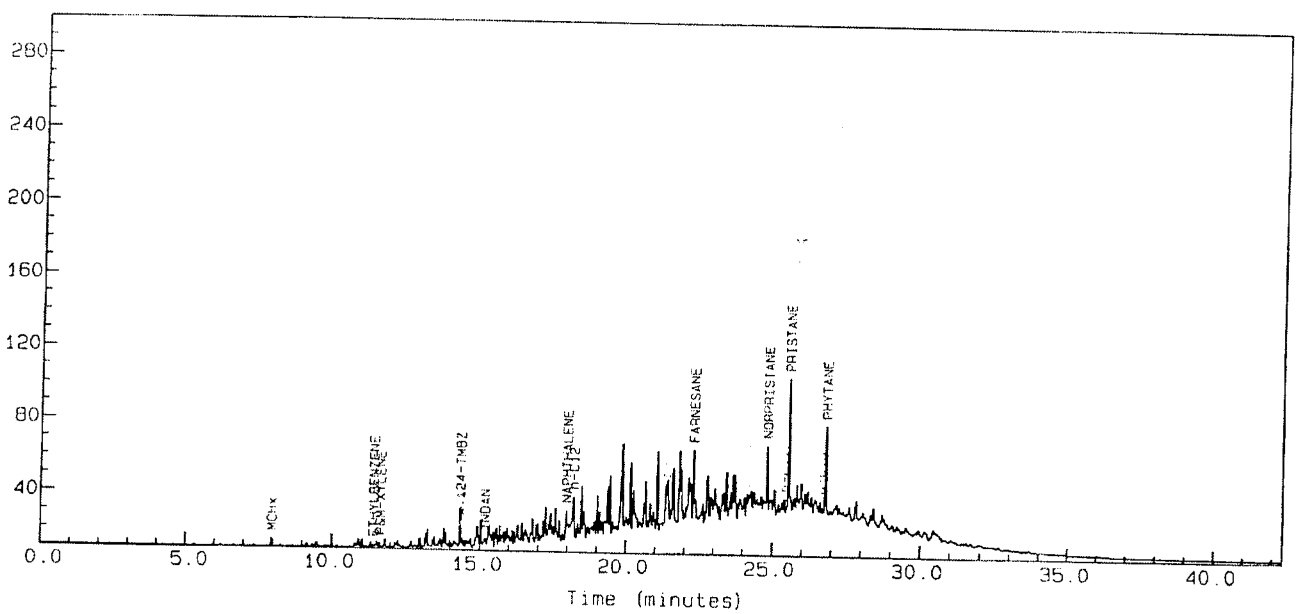


Figure 12: MW-9(M) contains primarily biodegraded diesel.

nca

9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210

50004987

ASTORIA AREA-WIDE PETROLEUM SITE CHAIN OF CUSTODY REPORT

Work Order #:

CLIENT: EnviroLogic Resources / Tom Calabrese @ hdrgreen.com
REPORT TO: TOM CALABRESE E-mail: @
ADDRESS: PO BOX 80762 PORTLAND, OR 97280-0762
PHONE: 503-768-5121 FAX: 503-768-5122
PROJECT NAME: Astoria Area-Wide Petro Site RI-1
PROJECT NUMBER: 10077.007
SAMPLED BY: TSC

INVOICE TO:

P.O. NUMBER: 10077.007

TURNAROUND REQUEST in Business Days *
Organic & Inorganic Analyses: 10 7 5 4 3 2 1 <1
Petroleum Hydrocarbon Analyses: 5 4 3 2 1 <1
OTHER Specify:
* Turnaround Requests less than standard may incur Rush Charges.

REQUESTED ANALYSES

	LOCATOR INDENTIFICATION	SAMPLE INDENTIFICATION	SAMPLING DATE/TIME	NWTPH-HCID	NWTPH-Dx	NWTPHGx	NWTPHG/BTEX	8260B RBCA	8270 SIM PAH	VOCs by 8260B	Pb TOTAL 6020	TCLP METALS (Cd, Cr)	RCRA METALS 6000 series				Hold for follow-up	MATRIX (gw, Soil)	# OF CONT.	COMMENTS
1	MW-8(M)	MW-8(M)	6/19/03 18:30															PRODUCT	1	
2	MW-9(M)	MW-9(M)	6/19/03 18:40															PRODUCT	1	
3	MW-4(M)	MW-4(M)	6/19/03 18:45															PRODUCT	1	
4			/ / :																	
5			/ / :																	
6			/ / :																	
7			/ / :																	
8			/ / :																	
9			/ / :																	
10			/ / :																	
11			/ / :																	
12			/ / :																	
13			/ / :																	
14			/ / :																	
15			/ / :																	

RELINQUISHED BY: [signature] DATE: 6-20-03 RECEIVED BY: [signature] DATE: 6/20/03
PRINT NAME: Marvin Hance FIRM: EnviroLogic Resources TIME: 1151 PRINT NAME: Kim Davis FIRM: NCA TIME: 1151
RELINQUISHED BY: [signature] DATE: 6/24/03 RECEIVED BY: Julia A. Milazzo DATE: 6/26/03
PRINT NAME: Kim Davis FIRM: NCA TIME: 1200 PRINT NAME: Julia A. Milazzo FIRM: SGS US TIME: 15:00
ADDITIONAL REMARKS:

TEMP:

PAGE OF

COC Rev 14, 8/02

nca

9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210

ASTORIA AREA-WIDE PETROLEUM SITE CHAIN OF CUSTODY REPORT

Work Order #:

CLIENT: Enviro Logic Resources
REPORT TO: Tom Calabrese
E-mail: @
ADDRESS: PO Box 5
Portland, OR
PHONE: 503 765
FAX: 503 765
INVOICE TO: Envirologic Resources
P.O. NUMBER: 10077.010
PROJECT NAME: Astoria Area-Wide Petro Site RI-1
PROJECT NUMBER: 10077.010
SAMPLED BY:

TURNAROUND REQUEST in Business Days *

Organic & Inorganic Analyses: 10 7 5 4 3 2 1 <1

STD. Petroleum Hydrocarbon Analyses: 5 4 3 2 1 <1

STD

OTHER Specify:

* Turnaround Requests less than standard may incur Rush Charges.

REQUESTED ANALYSES

	LOCATOR INDENTIFICATION	SAMPLE INDENTIFICATION	SAMPLING DATE/TIME	NWTPH-HCID	NWTPH-Dx	NWTPHGx/BTEX	NWTPHGx/BTEX +N	8260B RBCA	8270 SIM PAH	VOCs by 8260B	Pb TOTAL 6020	TCLP METALS (Cd, Cr)	RCRA METALS 6000 series				Hold for follow-up	MATRIX (gw, Soil)	# OF CONT.	COMMENTS
1	MW-43(A)	MW-43(A)	5-19-04 15:25															Free Product	1	
2	MW-40(A)	MW-40(A)	5-19-04 10:30															"	1	
3	MW-15(A)	MW-15(A)	5-19-04 14:05															"	1	
4	MW-37(A)	MW-37(A)	5-19-04 14:35															"	1	
5	MW-46(A)	MW-46(A)	5-19-04 15:00															"	1	
6	MW-44(A)	MW-44(A)	5-19-04 15:45															"	1	
7			/ / :																	
8			/ / :																	
9			/ / :																	
10			/ / :																	
11			/ / :																	Temp Blank = 4°C
12			/ / :																	Jam
13			/ / :																	5/25/04
14			/ / :																	
15			/ / :																	

RELINQUISHED BY: [signature] DATE 5-20-04 RECEIVED BY: [signature] DATE 5-20-04
PRINT NAME: FIRM: Envirologic Resources TIME 1317 PRINT NAME: Sudan Russey FIRM: NCA TIME 1317
RELINQUISHED BY: [signature] DATE 5-21-04 RECEIVED BY: Julia a Milano DATE 5/25/04
PRINT NAME: FIRM: NCA TIME 1300 PRINT NAME: Julia A Milano FIRM: TIME 11:30
ADDITIONAL REMARKS:

COC Rev 10/02

TEMP: 24.3 PAGE OF

cc client.

11720 North Creek Pkwy N., Suite 400, Bothell, WA 98011-8244 (425) 420-9200 FAX 420-9210
East 11115 Montgomery, Suite B, Spokane, WA 99206-4779 (509) 924-9200 FAX 924-9290
9405 S.W. Nimbus Avenue, Beaverton, OR 97008-7132 (503) 906-9200 FAX 906-9210
20332 Empire Avenue, Suite F-1, Bend, OR 97708-5711 (541) 383-9310 FAX 382-7588

ASTORIA AREA-WIDE PETROLEUM SITE CHAIN OF CUSTODY REPORT

Work Order #:

CLIENT: [illegible] Resources
REPORT TO: Tom [illegible]
E-mail: @[illegible]
ADDRESS: PO Box [illegible]
[illegible], OR [illegible]
PHONE: 503- 768-[illegible]
FAX: 503- 765-[illegible]
PROJECT NAME: Astoria Area-Wide Petro Site RI-1
PROJECT NUMBER: 10077.007
SAMPLED BY: MNB

INVOICE TO: [illegible] Resources
P.O. NUMBER: 10077.007

TURNAROUND REQUEST in Business Days *
Organic & Inorganic Analyses: 10 | 7 | 5 | 4 | 3 | 2 | 1 | <1 (STD.)
Petroleum Hydrocarbon Analyses: 5 | 4 | 3 | 2 | 1 | <1 (STD.)
OTHER Specify:
* Turnaround Requests less than standard may incur Rush Charges.

REQUESTED ANALYSES

	LOCATOR ID	SAMPLE ID	SAMPLING DATE/TIME	NWTPH-Dx	NWTPHGx	8260B RBCA	8270 SIM PAH	RCRA 8 METALS Total	RCRA 8 METALS Dissolved	Total Cations: Na,K,Ca,Mg,Fe,Mn	Chloride 300.0	Sulfate 300.0	Alk/HCO3/CO3 SM2320B	Nitrate/Nitrite 353.2			MATRIX (gw, Soil)	# OF CONT.	COMMENTS
1	MW-3(M)	MW-3(M)	11-3-03 / 1 15:[illegible]														[illegible]	2	For [illegible]
2			/ / :																
3			/ / :																
4			/ / :																
5			/ / :																
6			/ / :																
7			/ / :																
8			/ / :																
9			/ / :																
10			/ / :																
11			/ / :																
12			/ / :																
13			/ / :																
14			/ / :																
15			/ / :																

RELINQUISHED BY: [illegible signature]
PRINT NAME: [illegible] FIRM: [illegible] Resources DATE: 11-3-03 TIME: 9:41
RECEIVED BY: Joy [illegible signature]
PRINT NAME: Joy Chang FIRM: NCA DATE: 11/3/03 TIME: [illegible]
RELINQUISHED BY: Bob Fa[illegible] (signature)
PRINT NAME: Bob Fabel[illegible]z FIRM: NCA DATE: 11/18/03 TIME: 16:00
RECEIVED BY: Julia A. Milazzo (signature)
PRINT NAME: Julia A. Milazzo FIRM: Shell Global Solutions DATE: 11/25/03 TIME: 11:30
ADDITIONAL REMARKS:

TEMP:
PAGE OF

COC Rev 12, 2002

APPENDIX C

TIDAL GRAPHS AND SUPPORTING DATA

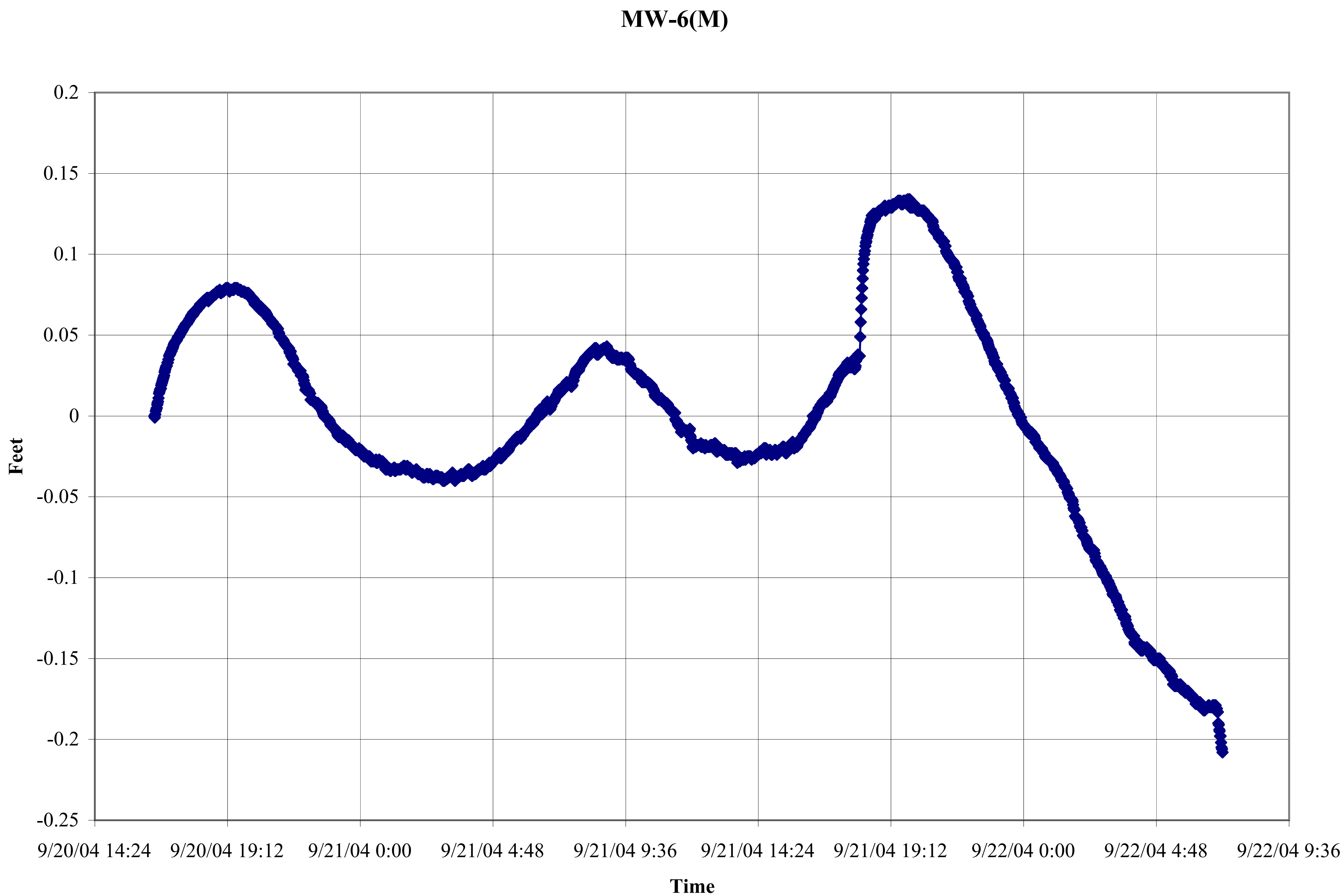
TABLE C-1

MAXIMUM RECORDED TIDAL RANGE

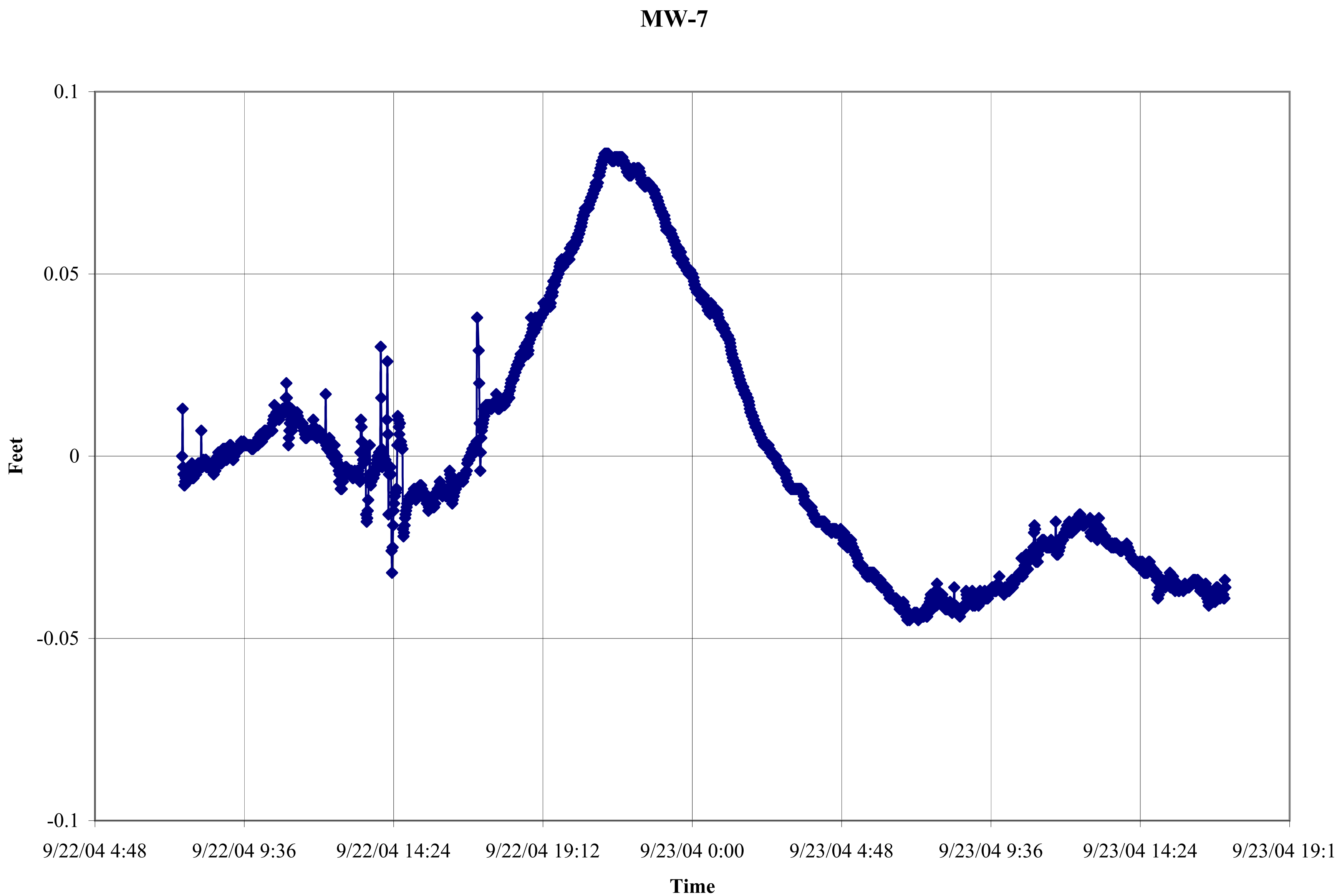
Remedial Investigation/Feasibility Study
Astoria Area-Wide Petroleum Site
Astoria, Oregon

Locator ID	Maximum Recorded Tidal Range (feet)
MW-6	0.159
MW-7	0.128
MW-9	0.379
MW-10	0.316
MW-11	0.401
MW-18*	0.388
MW-34	0.168
MW-35	0.044
MW-42	0.094
MW-44*	0.413
Pier 2	10.8

Notes:
*Data is suspect. Value should not be considered representative of tidal influence.



MW-6(M)
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
Feet
9/20/04 14:24
9/20/04 19:12
9/21/04 0:00
9/21/04 4:48
9/21/04 9:36
9/21/04 14:24
9/21/04 19:12
9/22/04 0:00
9/22/04 4:48
9/22/04 9:36
Time


MW-7
0.1
0.05
0
-0.05
-0.1
Feet
9/22/04 4:48
9/22/04 9:36
9/22/04 14:24
9/22/04 19:12
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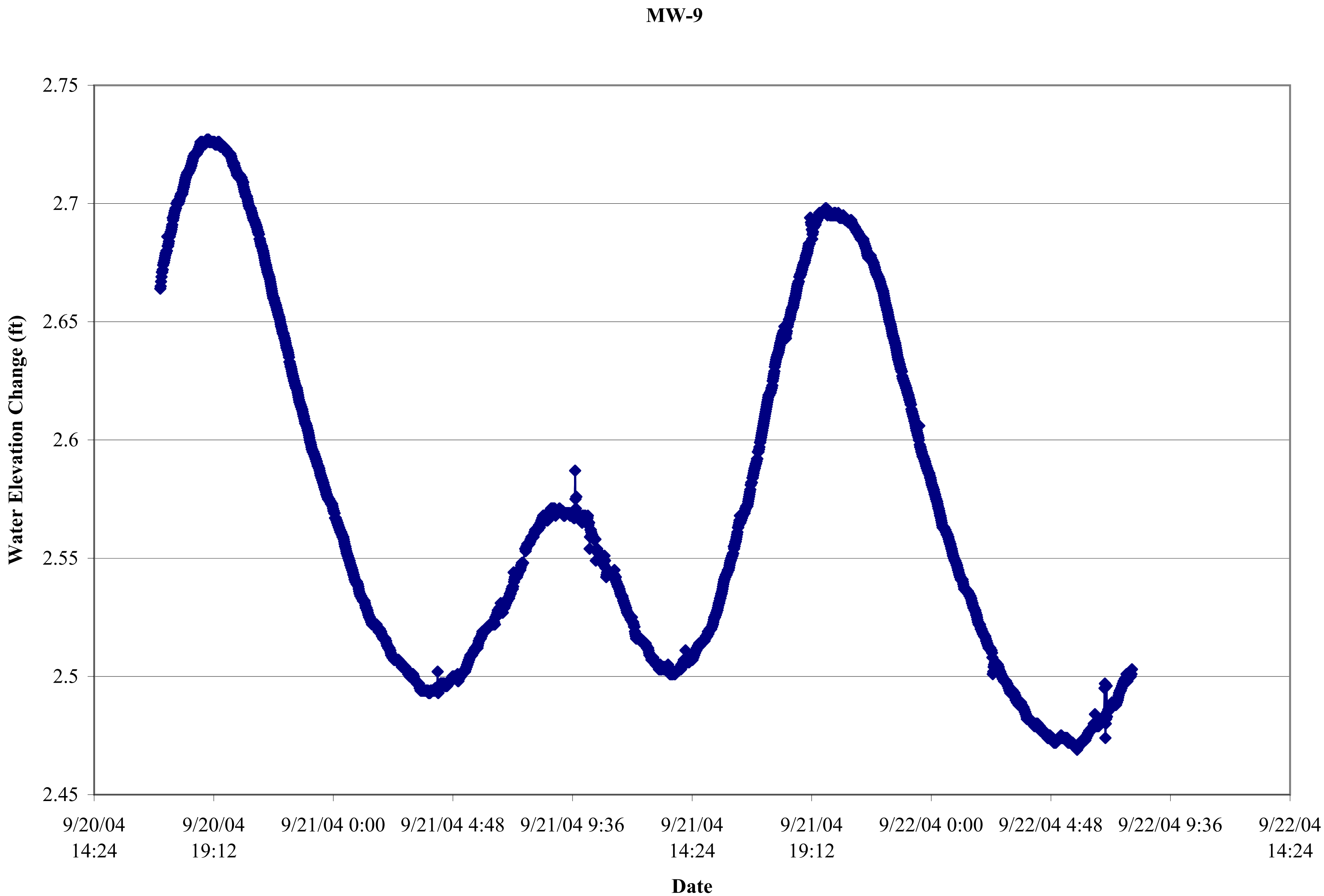
9/23/04 9:36
9/23/04 14:24
9/23/04 19:12
Time


MW-9
Water Elevation Change (ft)
2.75
2.7
2.65
2.6
2.55
2.5
2.45
9/20/04 14:24
9/20/04 19:12
9/21/04 0:00
9/21/04 4:48
9/21/04 9:36
9/21/04 14:24
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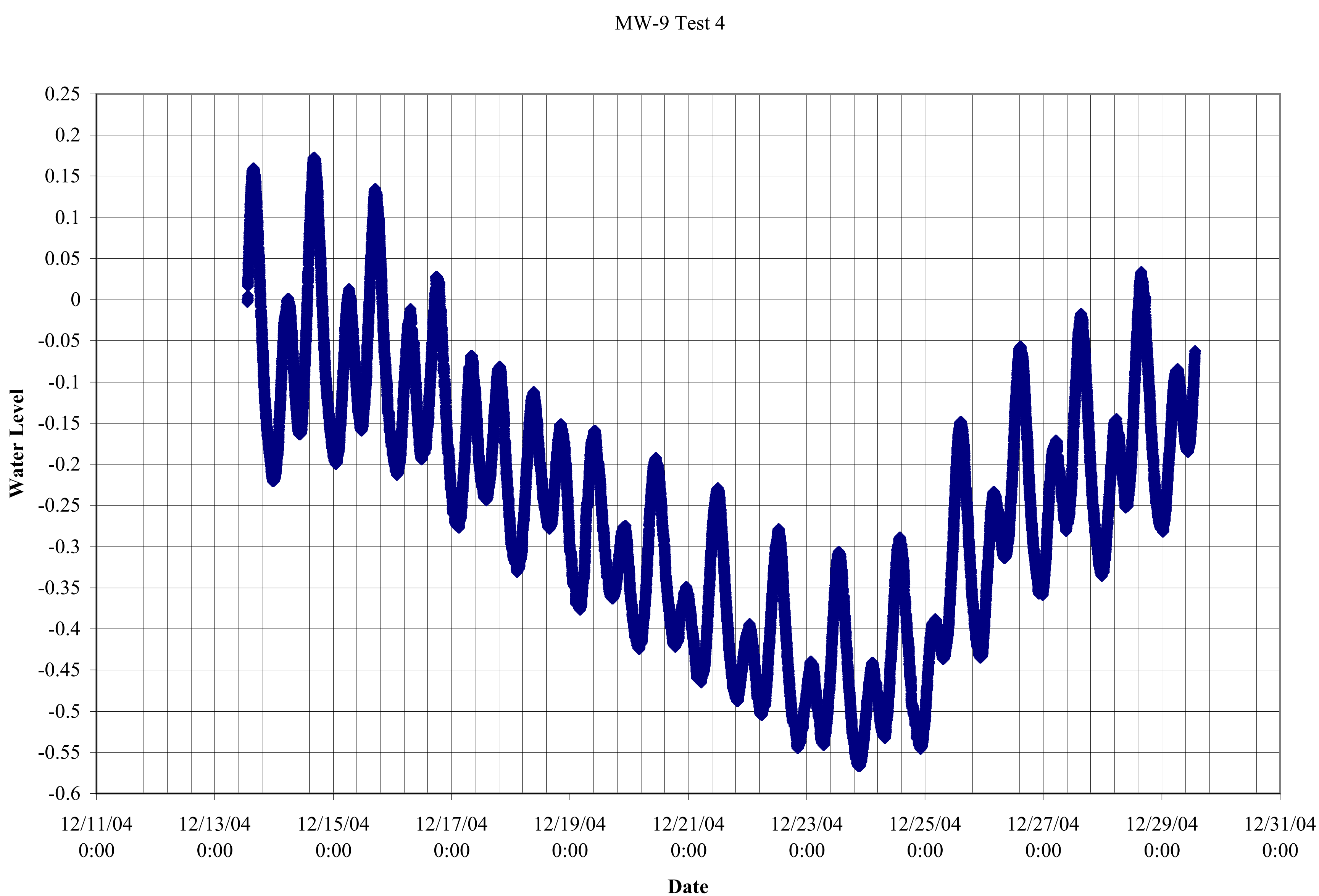
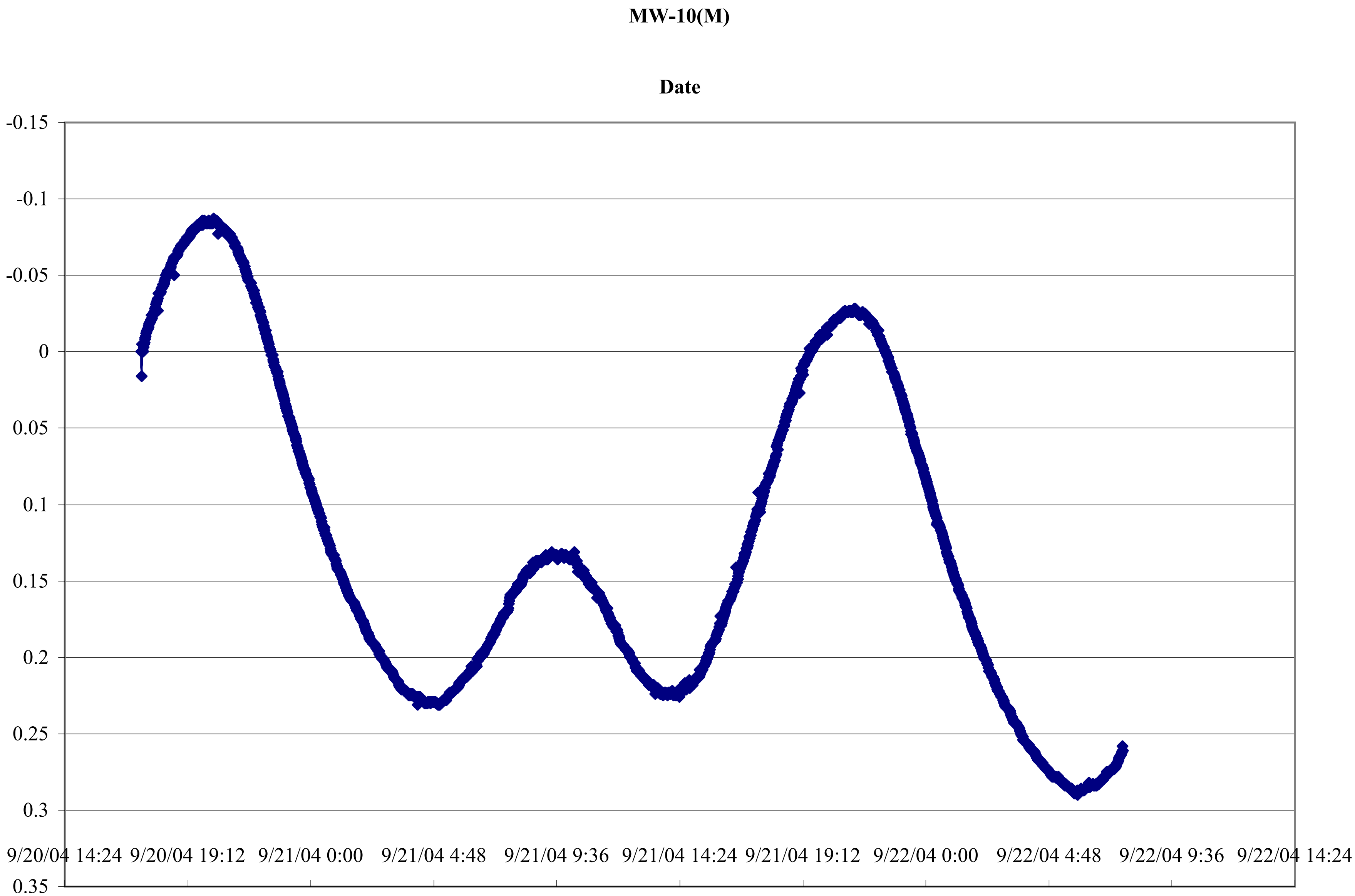
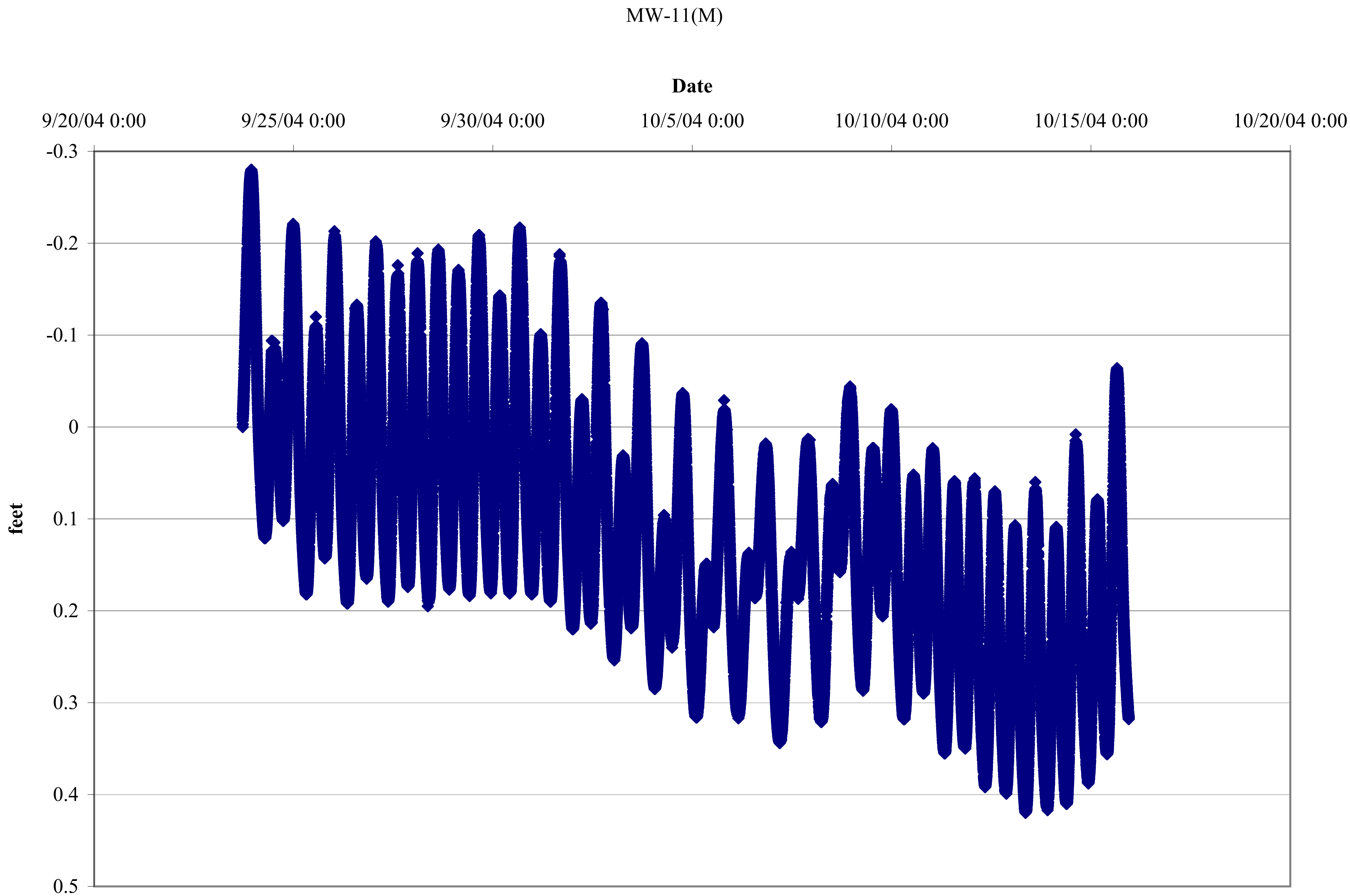
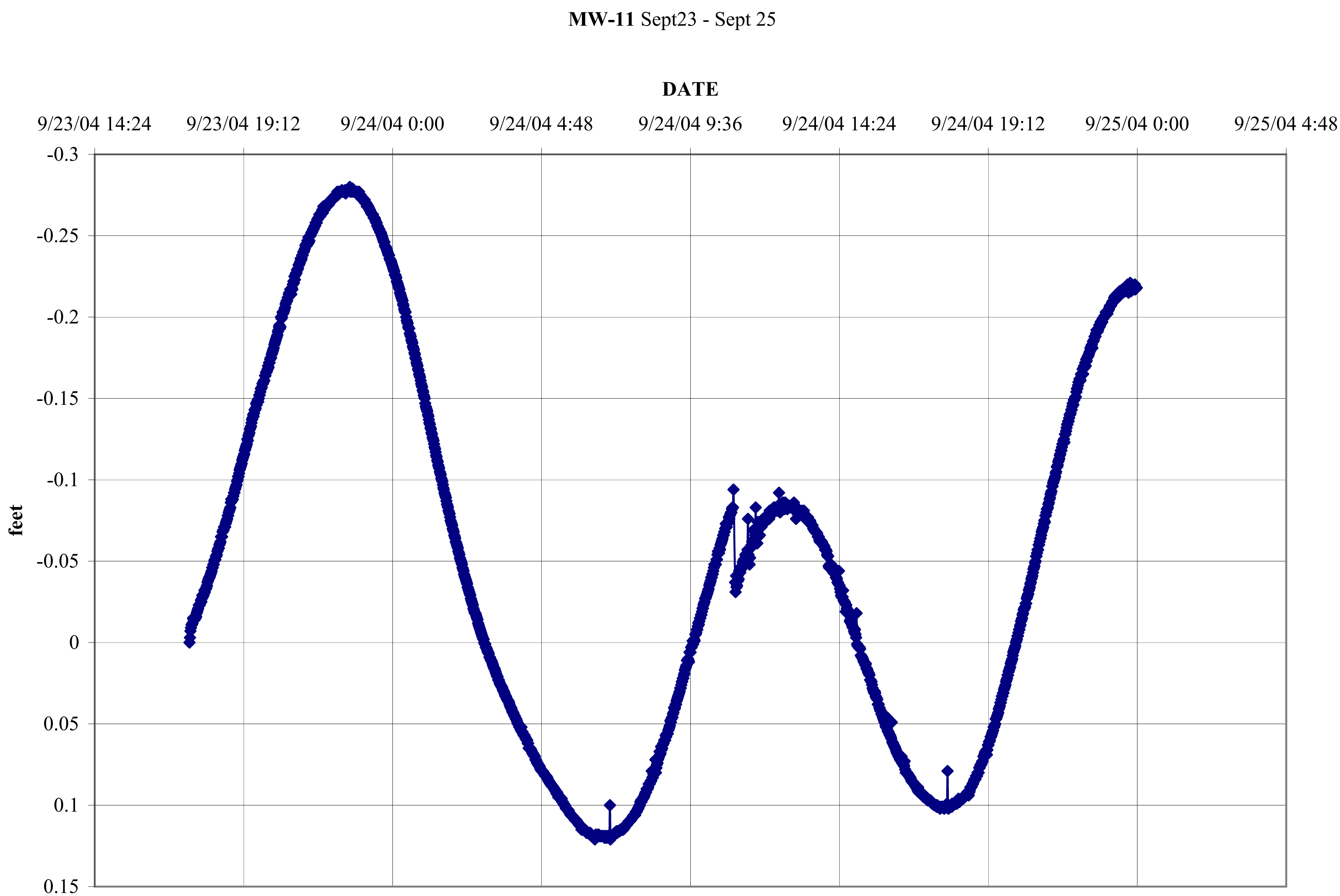
9/22/04 14:24
Date

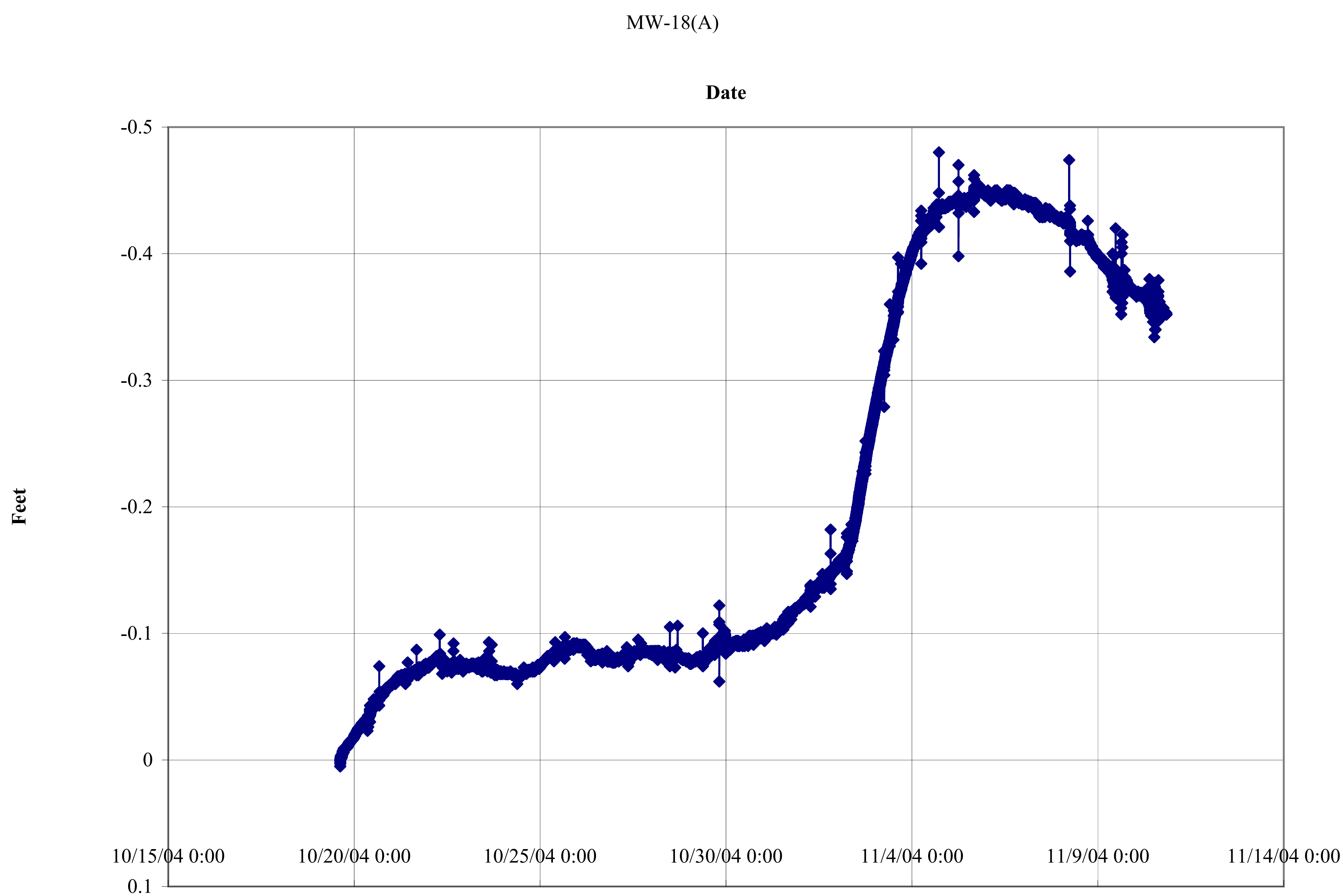


MW-9 Test 4
Water Level
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
-0.35
-0.4
-0.45
-0.5
-0.55
-0.6
12/11/04 0:00
12/13/04 0:00
12/15/04 0:00
12/17/04 0:00
12/19/04 0:00
12/21/04 0:00
12/23/04 0:00
12/25/04 0:00
12/27/04 0:00
12/29/04 0:00
12/31/04 0:00
Date

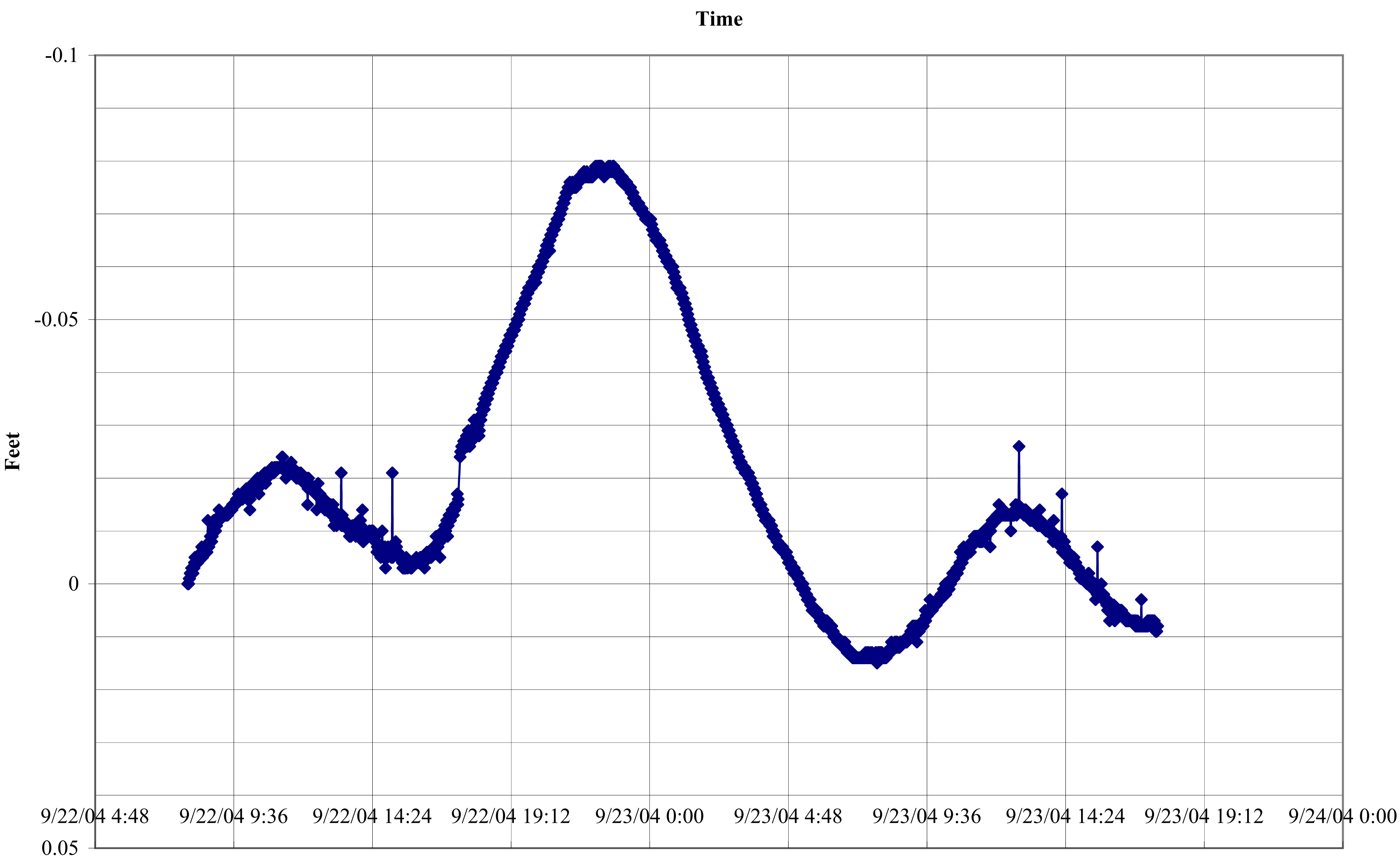

MW-10(M)
Date
-0.15
-0.1
-0.05
0
0.05
0.1
0.15
0.2
0.25
0.3
0.35
9/20/04 14:24
9/20/04 19:12
9/21/04 0:00
9/21/04 4:48
9/21/04 9:36
9/21/04 14:24
9/21/04 19:12
9/22/04 0:00
9/22/04 4:48
9/22/04 9:36
9/22/04 14:24


MW-11(M)
Date
9/20/04 0:00
9/25/04 0:00
9/30/04 0:00
10/5/04 0:00
10/10/04 0:00
10/15/04 0:00
10/20/04 0:00
-0.3
-0.2
-0.1
0
0.1
0.2
0.3
0.4
0.5
feet

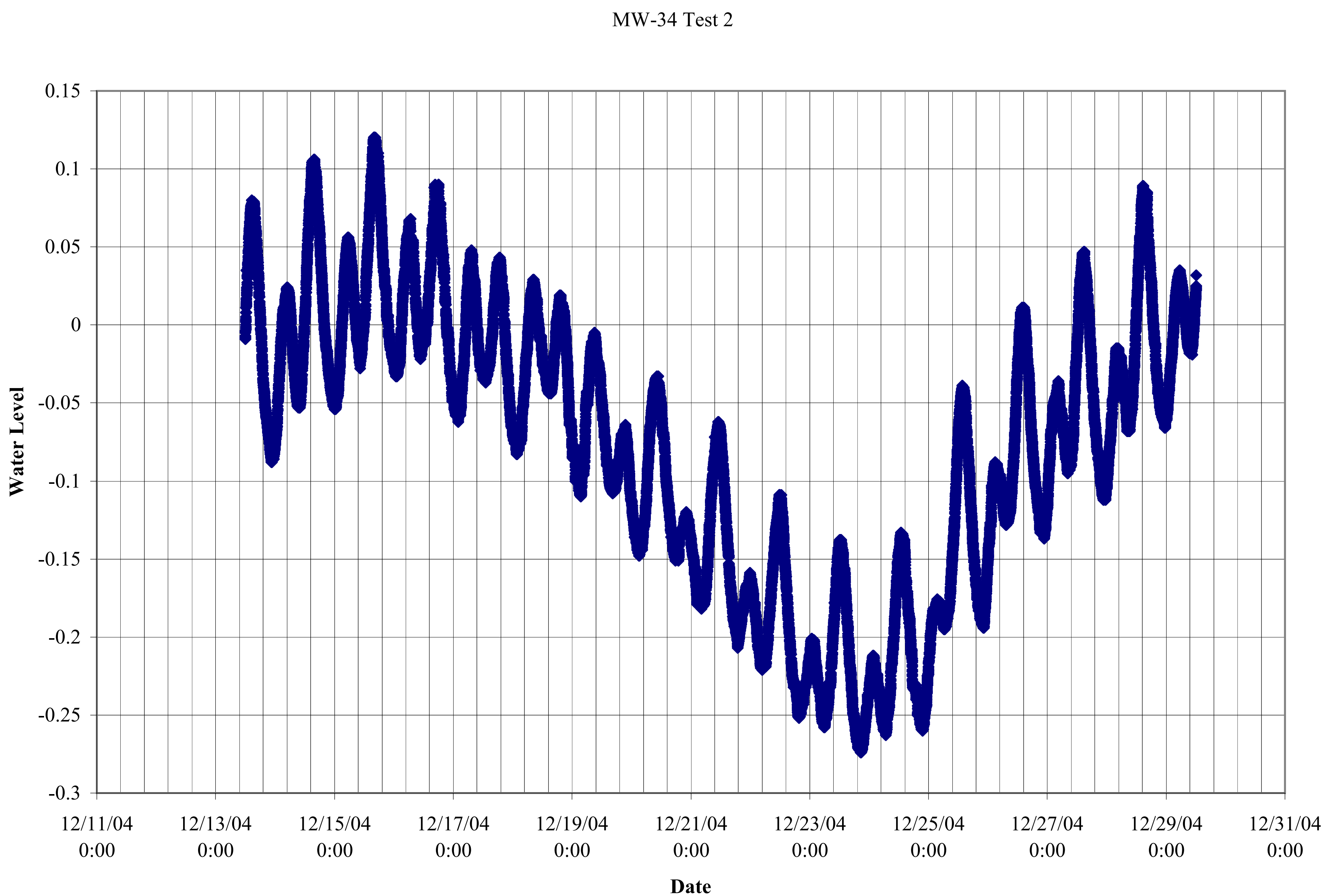

MW-11 Sept23 - Sept 25
DATE
9/23/04 14:24
9/23/04 19:12
9/24/04 0:00
9/24/04 4:48
9/24/04 9:36
9/24/04 14:24
9/24/04 19:12
9/25/04 0:00
9/25/04 4:48
feet
-0.3
-0.25
-0.2
-0.15
-0.1
-0.05
0
0.05
0.1
0.15


MW-18(A)
Date
Feet
-0.5
-0.4
-0.3
-0.2
-0.1
0
0.1
10/15/04 0:00
10/20/04 0:00
10/25/04 0:00
10/30/04 0:00
11/4/04 0:00
11/9/04 0:00
11/14/04 0:00

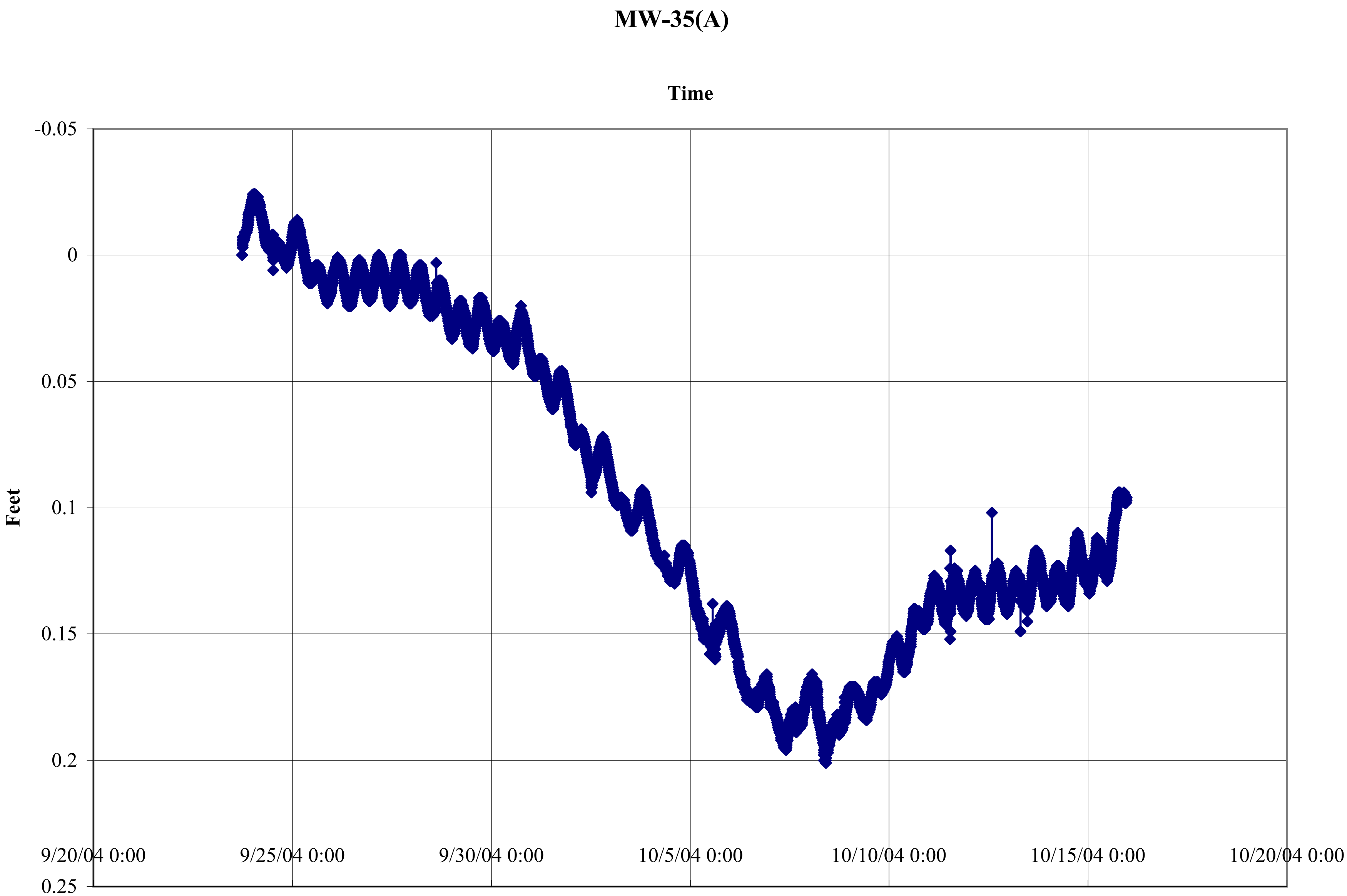
MW-34(A)

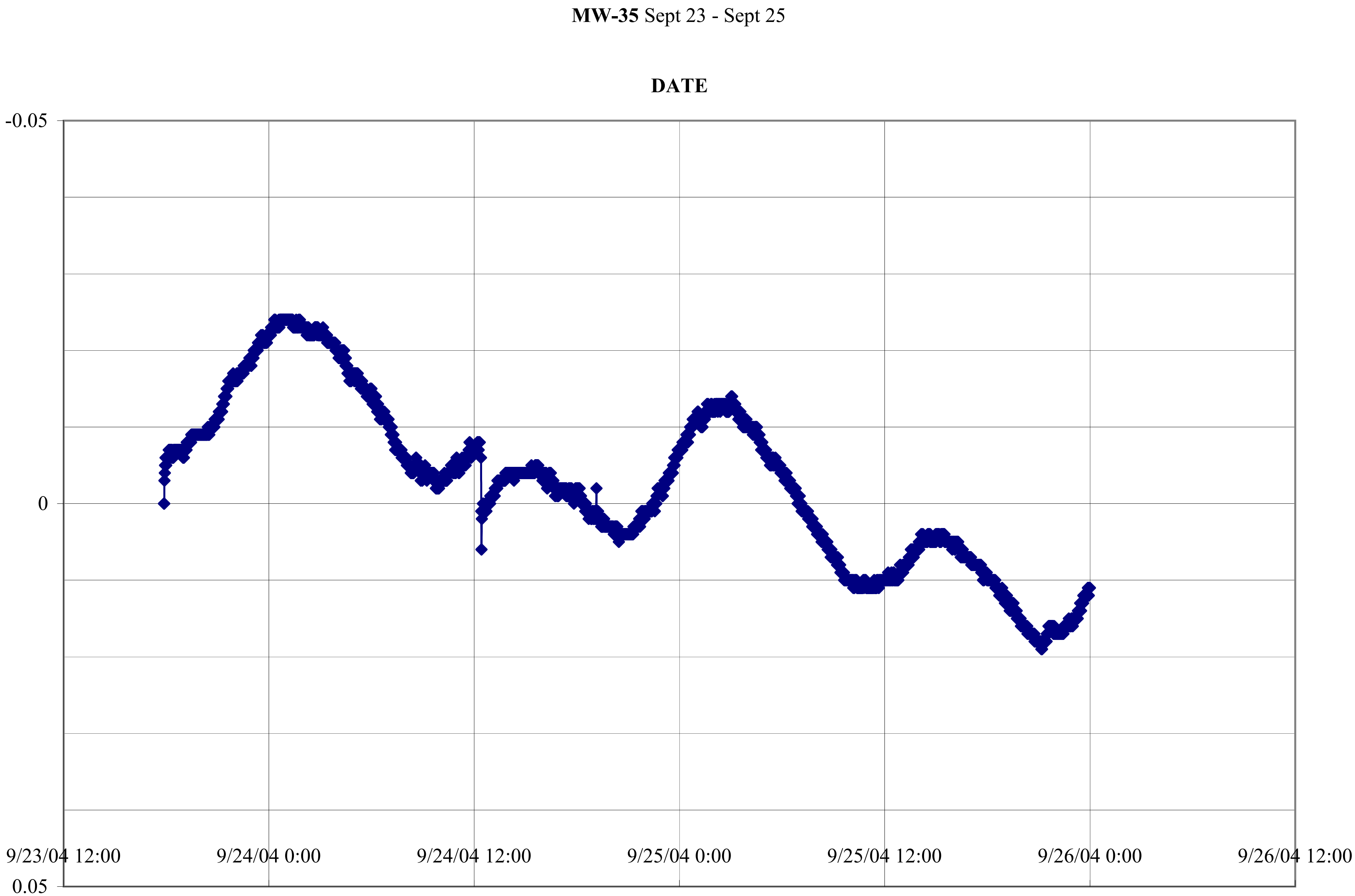


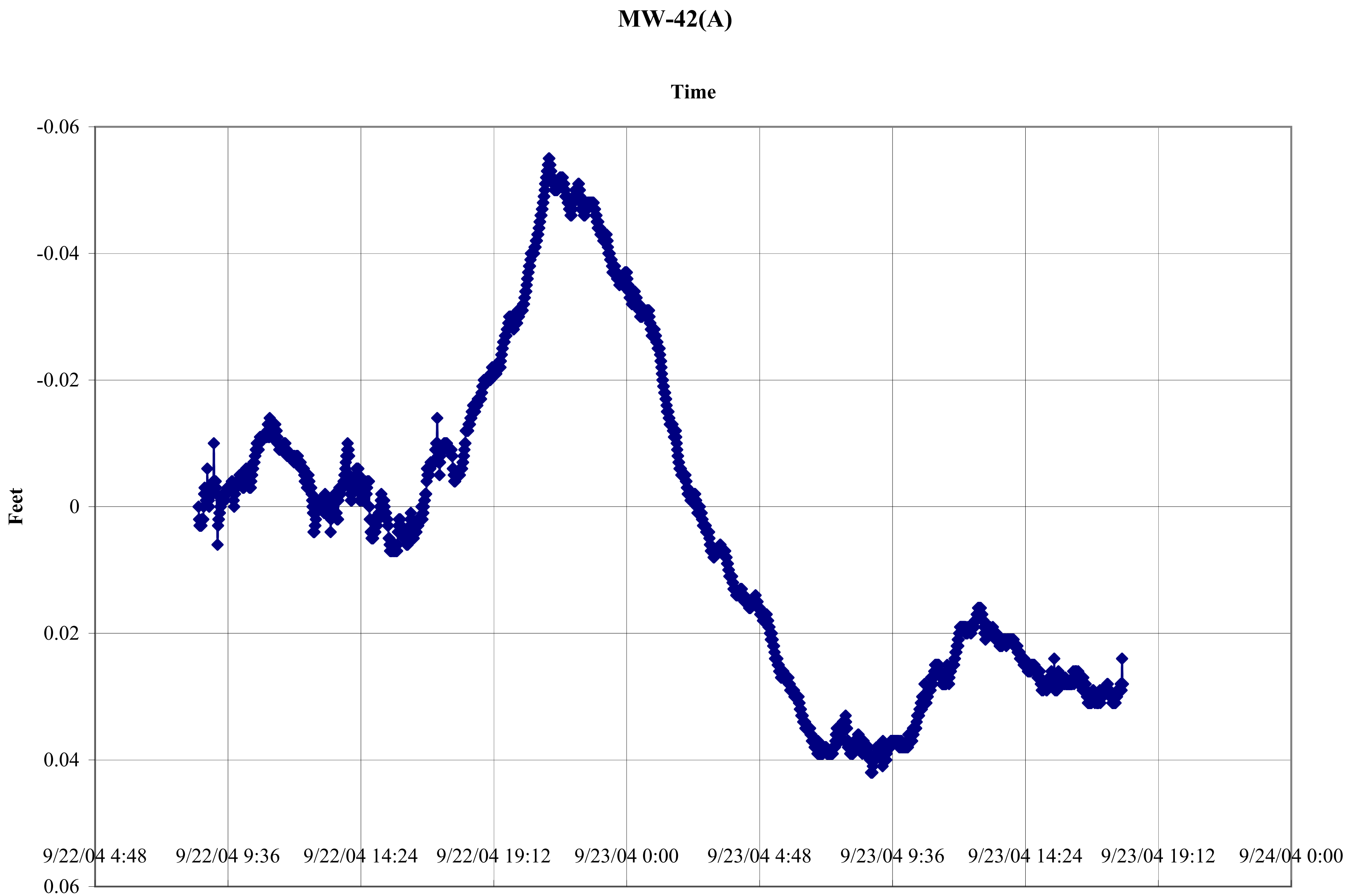
Time
Feet
-0.1
-0.05
0
0.05
9/22/04 4:48
9/22/04 9:36
9/22/04 14:24
9/22/04 19:12
9/23/04 0:00
9/23/04 4:48
9/23/04 9:36
9/23/04 14:24
9/23/04 19:12
9/24/04 0:00

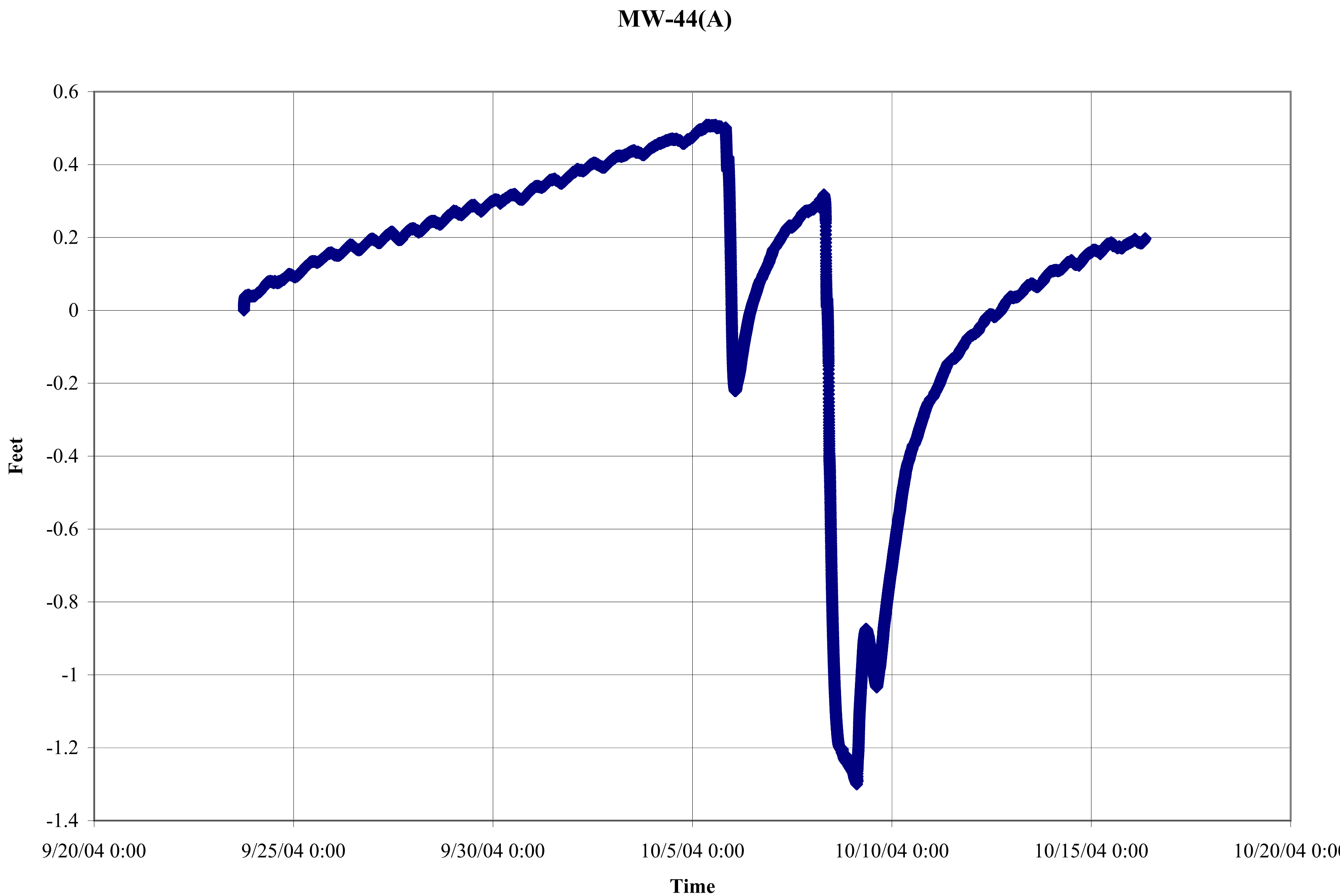


MW-34 Test 2
Water Level
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
-0.25
-0.3
12/11/04 0:00
12/13/04 0:00
12/15/04 0:00
12/17/04 0:00
12/19/04 0:00
12/21/04 0:00
12/23/04 0:00
12/25/04 0:00
12/27/04 0:00
12/29/04 0:00
12/31/04 0:00
Date


MW-35(A)
Time
Feet
-0.05
0
0.05
0.1
0.15
0.2
0.25
9/20/04 0:00
9/25/04 0:00
9/30/04 0:00
10/5/04 0:00
10/10/04 0:00
10/15/04 0:00
10/20/04 0:00

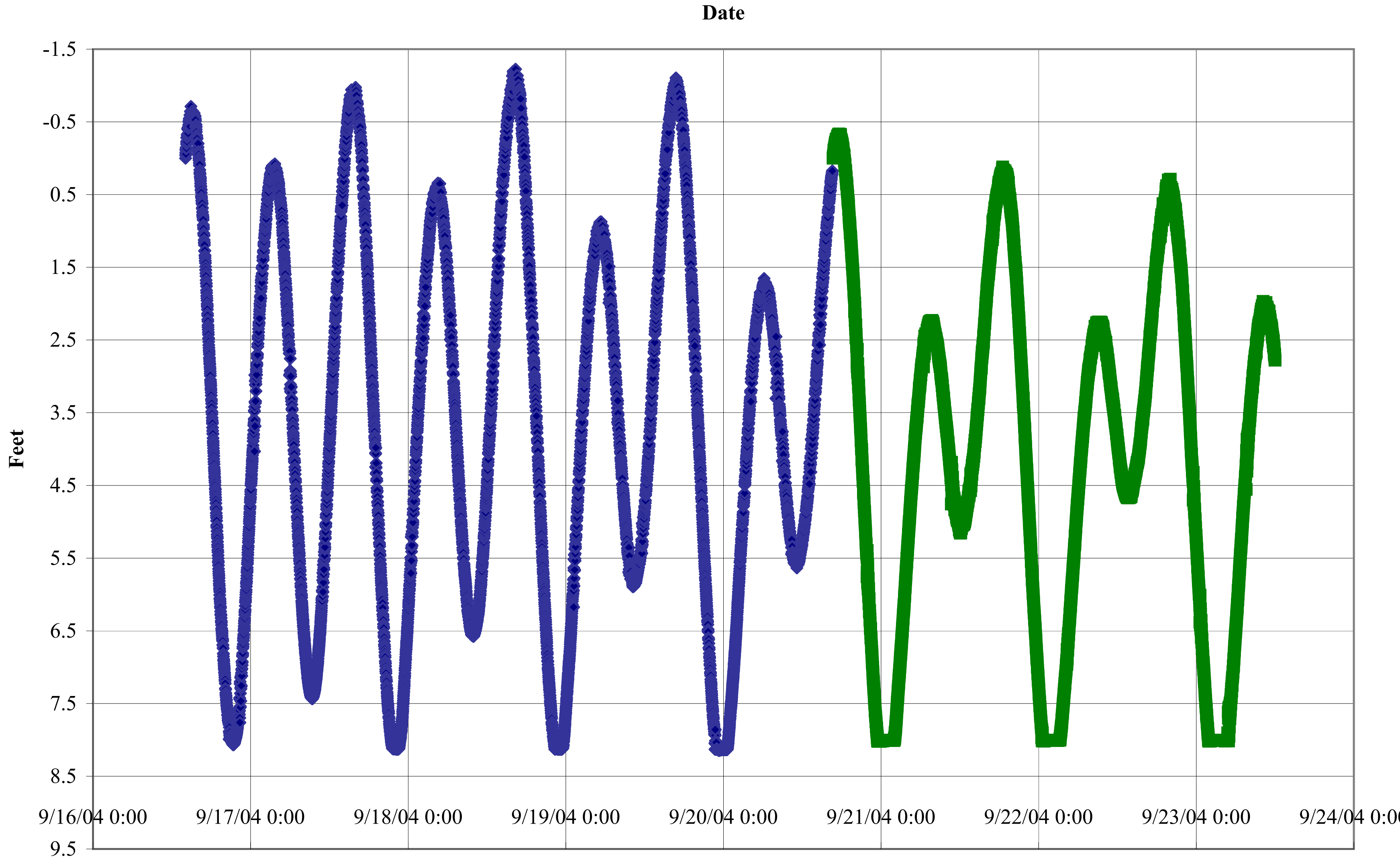

MW-35 Sept 23 - Sept 25
DATE
-0.05
0
0.05
9/23/04 12:00
9/24/04 0:00
9/24/04 12:00
9/25/04 0:00
9/25/04 12:00
9/26/04 0:00
9/26/04 12:00


MW-42(A)
Time
Feet
-0.06
-0.04
-0.02
0
0.02
0.04
0.06
9/22/04 4:48
9/22/04 9:36
9/22/04 14:24
9/22/04 19:12
9/23/04 0:00
9/23/04 4:48
9/23/04 9:36
9/23/04 14:24
9/23/04 19:12
9/24/04 0:00

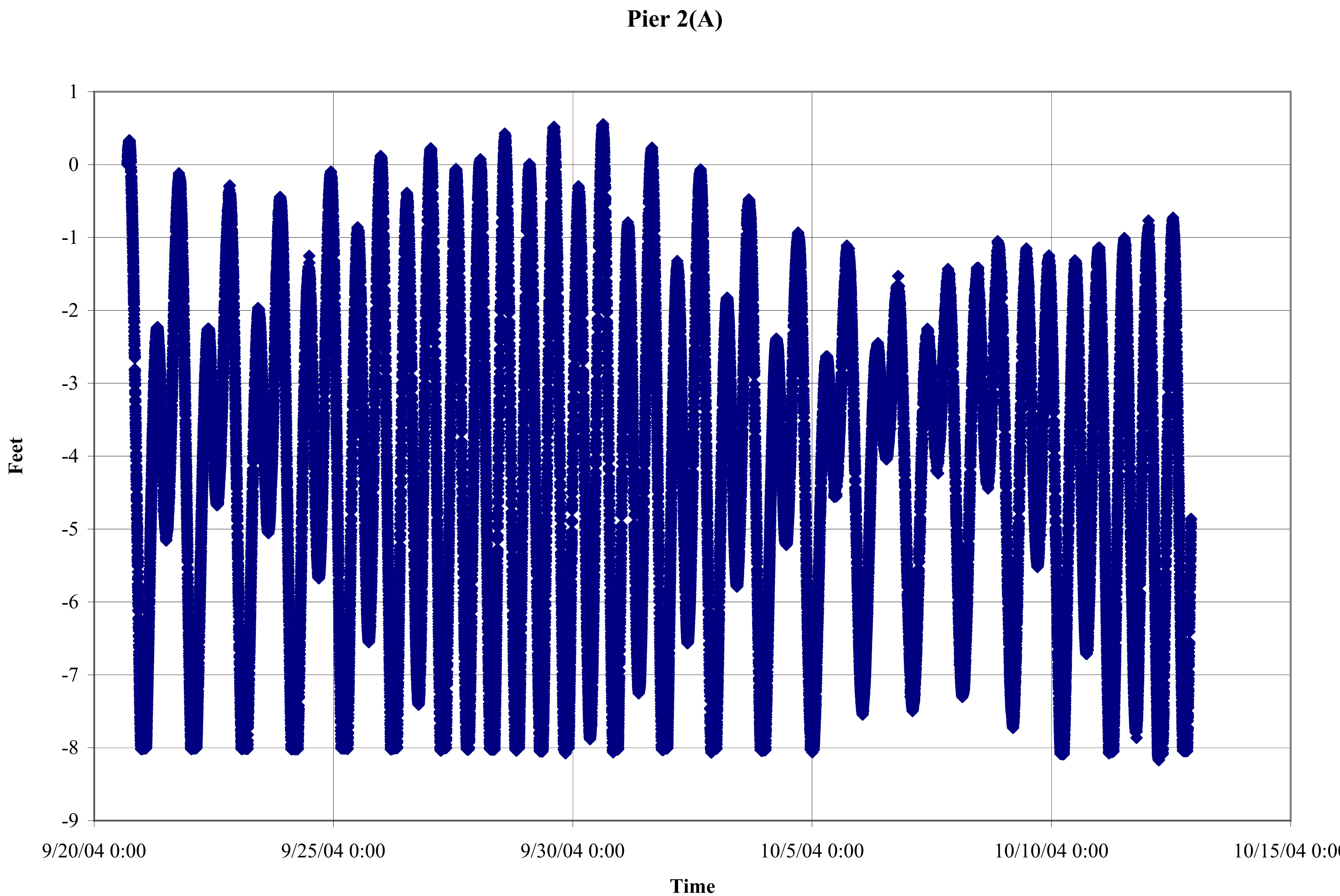


MW-44(A)
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
-1.2
-1.4
Feet
9/20/04 0:00
9/25/04 0:00
9/30/04 0:00
10/5/04 0:00
10/10/04 0:00
10/15/04 0:00
10/20/04 0:00
Time

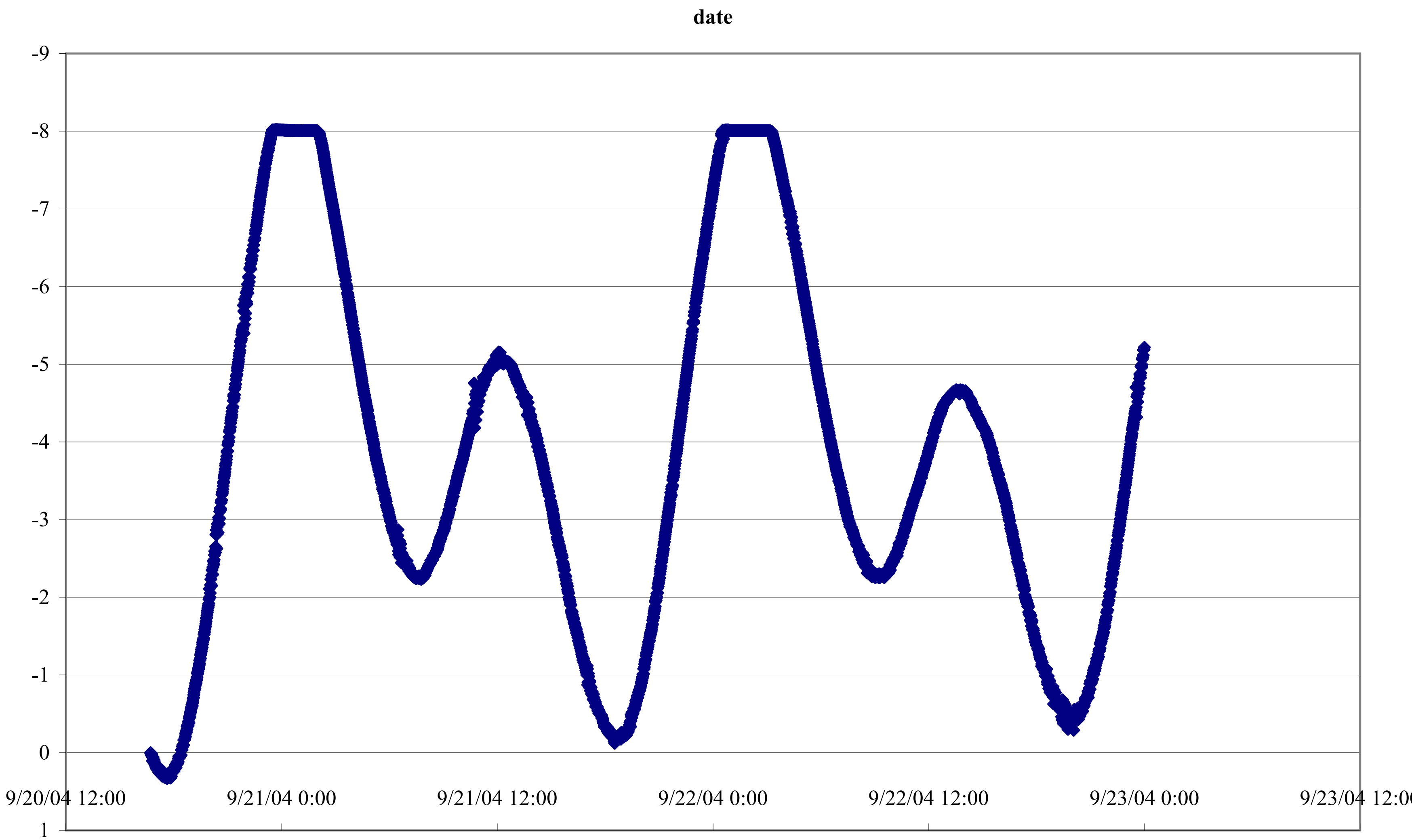
PIER 2



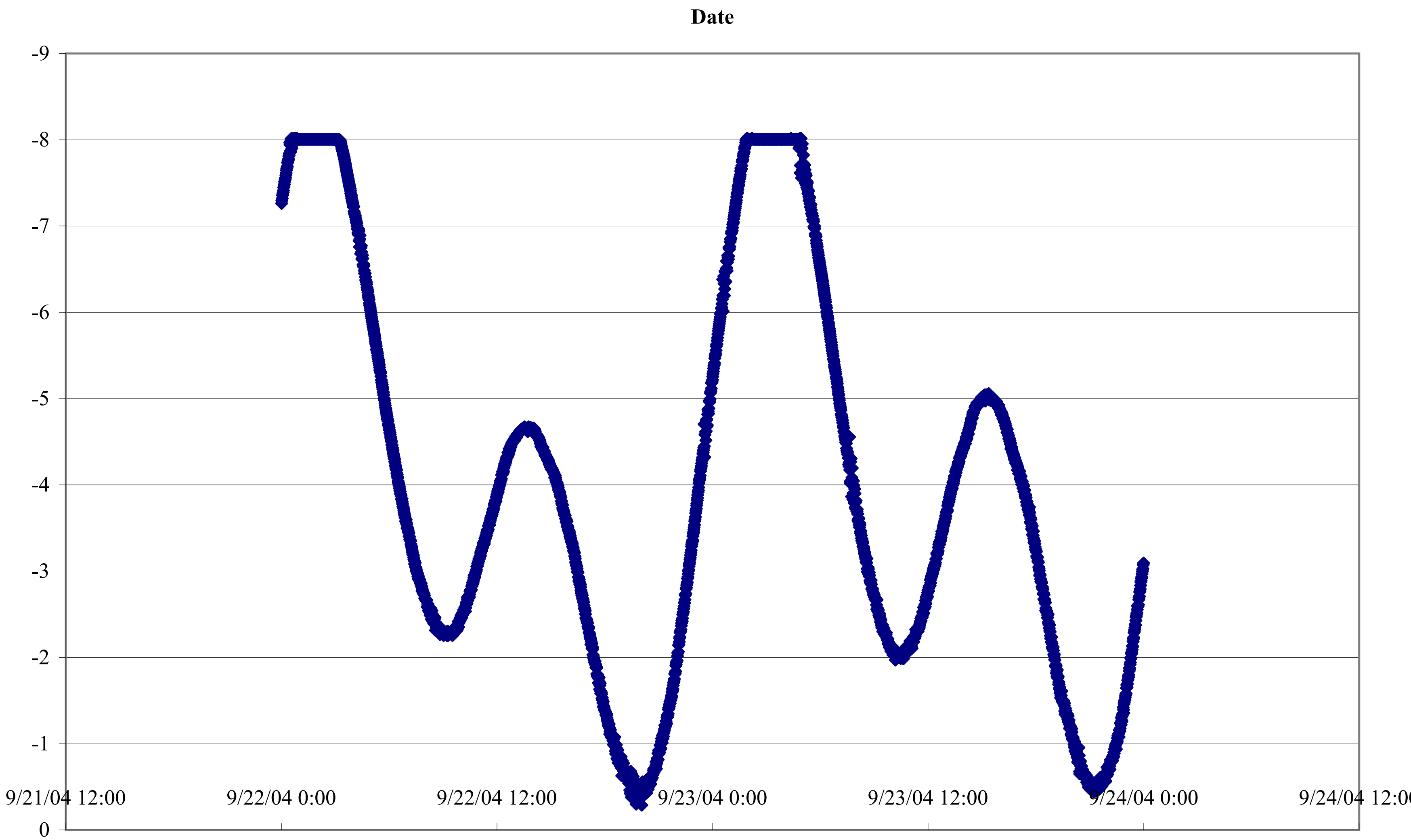
Date
Feet
-1.5
-0.5
0.5
1.5
2.5
3.5
4.5
5.5
6.5
7.5
8.5
9.5
9/16/04 0:00
9/17/04 0:00
9/18/04 0:00
9/19/04 0:00
9/20/04 0:00
9/21/04 0:00
9/22/04 0:00
9/23/04 0:00
9/24/04 0:00

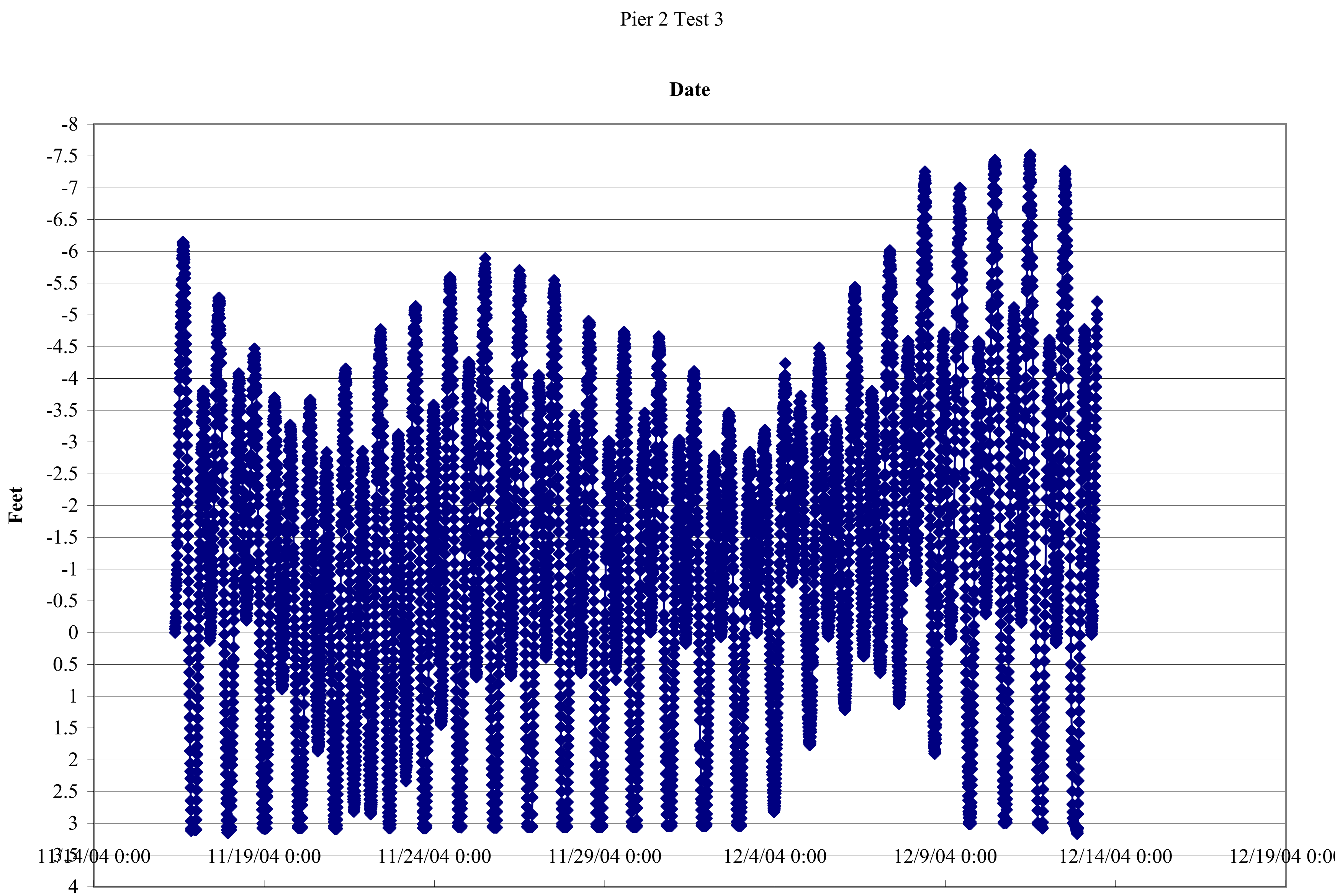

Pier 2(A)
1
0
-1
-2
-3
-4
-5
-6
-7
-8
-9
Feet
9/20/04 0:00
9/25/04 0:00
9/30/04 0:00
10/5/04 0:00
10/10/04 0:00
10/15/04 0:00
Time

PIER 2
Sept-20 thru Sept 22

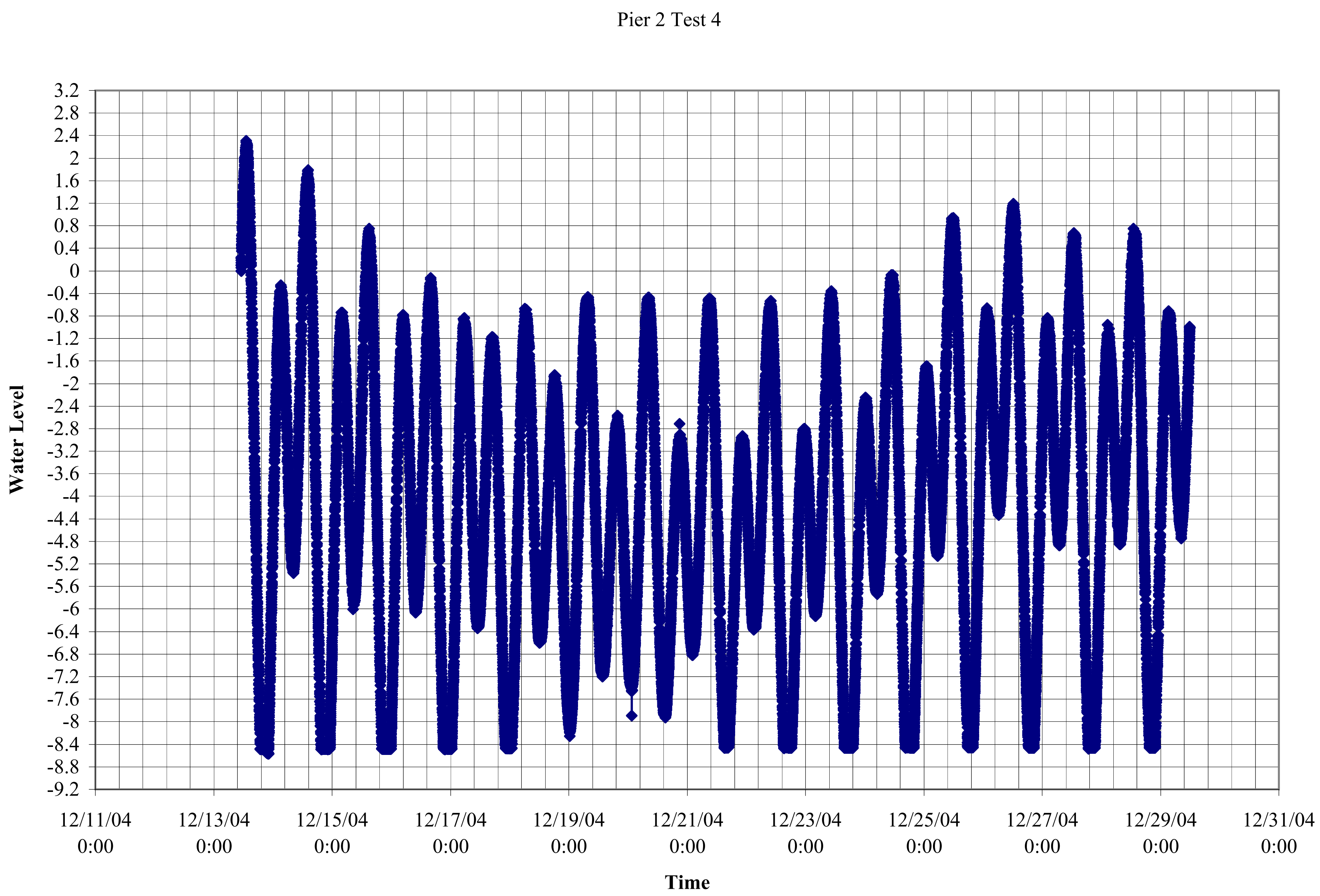


PIER 2
Sept 22 thru Sept 23





Pier 2 Test 3
Date
Feet
-8
-7.5
-7
-6.5
-6
-5.5
-5
-4.5
-4
-3.5
-3
-2.5
-2
-1.5
-1
-0.5
0
0.5
1
1.5
2
2.5
3
3.5
4
11/14/04 0:00
11/19/04 0:00
11/24/04 0:00
11/29/04 0:00
12/4/04 0:00
12/9/04 0:00
12/14/04 0:00
12/19/04 0:00


Pier 2 Test 4
Water Level
3.2
2.8
2.4
2
1.6
1.2
0.8
0.4
0
-0.4
-0.8
-1.2
-1.6
-2
-2.4
-2.8
-3.2
-3.6
-4
-4.4
-4.8
-5.2
-5.6
-6
-6.4
-6.8
-7.2
-7.6
-8
-8.4
-8.8
-9.2
12/11/04 0:00
12/13/04 0:00
12/15/04 0:00
12/17/04 0:00
12/19/04 0:00
12/21/04 0:00
12/23/04 0:00
12/25/04 0:00
12/27/04 0:00
12/29/04 0:00
12/31/04 0:00
Time