APPENDIX D

Cone Penetration Testing and Soil Boring Logs

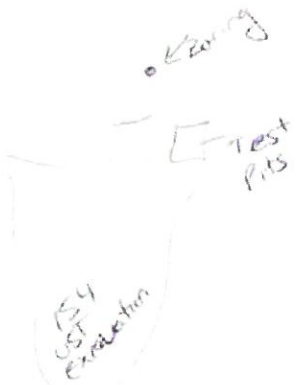
BROWN AND CALDWELL

BOREHOLE/WELL LOG

LOCATION OF BORING

N W E S

SCALE:



CLIENT	USACE
LOCATION	Benicia, CA
PROJECT NAME	Benicia Arsenal Expanded SI
JOB NUMBER	25952
DRILLING CONTRACTOR	Gregg Drilling
RIG TYPE (CIRCLE ONE)	HSA (DP) OTHER MUD ARCH NONE
DRILLING METHOD, FLUID USED	Direct Push - none
SOIL SAMPLING METHOD (CIRCLE ONE)	SPLIT SPOON CC ACETATE Brass Sleeves NONE OTHER X
MONITORING INSTRUMENT (CIRCLE ONE)	PID FID LEL RAD (NONE) OTHER
SURFACE CONDITIONS (CIRCLE ONE)	(ASPHALT) CONCRETE DIRT DRY WET OTHER

BORING NUMBER: B154SB001

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	1010	1025
DATE	8-9-04	8-9-04

WELL CONSTRUCTION	START	FINISH
TIME		
DATE		

WELL CONSTRUCTION: ANNULUS	CASING	SAMPLER USED	SOIL SAMPLING: BLOWS/6" INTERVAL	INTERVAL SAMPLED	RECOVERY	ANALYTICAL SAMPLE (A,B,C)	WATER LEVEL (INTIAL/STATIC)	DEPTH (FEET)	INSTRUMENT READING (ppm)	USCS GROUP SYMBOL
		Direct Push		X	X			0		
				X	X					ML
				X	X	A		5		SM
								0		
								5		
								0		

FINE GRAINED AND ORGANIC SOIL DESCRIPTION: GROUP NAME, MUNSELL COLOR, COLOR, SIZE DISTRIBUTION, PLASTICITY, DRY STRENGTH, DILATANCY, TOUGHNESS, MOISTURE, ODOR, STRUCTURE, CONSISTENCY, RELATIVE PERMEABILITY, LOCAL GEOLOGIC NAME, CONTACT DESCRIPTION

COARSE GRAINED SOIL DESCRIPTION: GROUP NAME, MUNSELL COLOR, COLOR, GRADATION (g/s/f), SIZE DISTRIBUTION, PLASTICITY, SHAPE, ANGULARITY, MOISTURE, ODOR, STRUCTURE, CEMENTATION, RELATIVE PERMEABILITY, LOCAL GEOLOGIC NAME, MINERALOGY, CONTACT DESCRIPTION

SAMPLE TYPE, INTERVAL, DESCRIPTION

0-0.5 Asphalt

0.5-4' ~~Silty Sand~~ Silty Sand (SM) ML dark brown (7.5YR 3/2) medium stiff ~~dense to loose~~; dry to slightly moist (0, 15, 85)

~3 ft slight petroleum odor, becoming moist; color change to dark brown mottled with dark olive brown (2.5Y 3/3)

4-5.5 ~~Sandy Silt~~ Silty Sand (SM) dark brown (7.5YR 3/2) mottled with dark olive brown (2.5Y 3/3); (0, ~~80~~ 75, 25) moist; fine grain sand

4-5 feet fell out of sampler - advanced another boring adjacent to get sample

5.5 End of boring

ANALYTICAL SAMPLE ID (SEE ABOVE FOR LOCATION)

A B154SB001-A-S01 1025

B

C

D

E

F

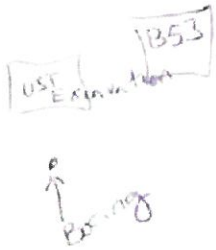
BROWN AND CALDWELL

BOREHOLE/WELL LOG

LOCATION OF BORING

N W E S

SCALE



CLIENT	USACE
LOCATION	Benicia Arsenal
PROJECT NAME	Benicia Arsenal Expanded Site
JOB NUMBER	25952
DRILLING CONTRACTOR	Gregg Drilling
RIG TYPE (CIRCLE ONE)	HSA, DP, MUD, ARCH, NONE; OTHER
DRILLING METHOD, FLUID USED	
SOIL SAMPLING METHOD (CIRCLE ONE)	SPLIT SPOON, CC, ACETATE, Brass liners, NONE; OTHER
MONITORING INSTRUMENT (CIRCLE ONE)	PID, FID, LEL, RAD, NONE; OTHER
SURFACE CONDITIONS (CIRCLE ONE)	ASPHALT, CONCRETE, DIRT, DRY, WET; OTHER

BORING NUMBER: B53SB003

SHEET 1 OF 1

DRILLING	START	FINISH
TIME	1040	1100
DATE	8-9-04	8-9-04

WELL CONSTRUCTION	START	FINISH
TIME		
DATE		

FINE GRAINED AND ORGANIC SOIL DESCRIPTION: GROUP NAME, MUNSELL COLOR, COLOR, SIZE DISTRIBUTION, PLASTICITY, DRY STRENGTH, DILATANCY, TOUGHNESS, MOISTURE, ODOR, STRUCTURE, CONSISTENCY, RELATIVE PERMEABILITY, LOCAL GEOLOGIC NAME, CONTACT DESCRIPTION

COARSE GRAINED SOIL DESCRIPTION: GROUP NAME, MUNSELL COLOR, COLOR, GRADATION (g/s/f), SIZE DISTRIBUTION, PLASTICITY, SHAPE, ANGULARITY, MOISTURE, ODOR, STRUCTURE, CEMENTATION, RELATIVE PERMEABILITY, LOCAL GEOLOGIC NAME, MINERALOGY, CONTACT DESCRIPTION

WELL CONSTRUCTION: ANNULUS	WELL CONSTRUCTION: CASING	SOIL SAMPLING: SAMPLER USED	BLOWS/6" INTERVAL	INTERVAL SAMPLED	RECOVERY	ANALYTICAL SAMPLE (A,B,C)	WATER LEVEL (INTIAL/STATIC)	DEPTH (FEET)	INSTRUMENT READING (ppm)	USCS GROUP SYMBOL	SAMPLE TYPE, INTERVAL, DESCRIPTION
								0		ML	0-0.5 Asphalt & road base
		Direct Risk		X	X					SP	0.5-1.0 Silt with Sand (ML) very dark grayish brown (10YR 3/2); (<5,15,85); non plastic medium stiff; dry to slightly moist
				X	X					CL	
				X	X	A	▽	5			1.0-3.0 Sand (SP), gray (10YR 5/1) and very dark grayish brown (10YR 3/2); (5,85,10) medium dense to loose some cemented up to 1/2" length; dry
											3.0' Lean clay (CL): very dark grayish (10YR 3/2), (<5,10,90); medium stiff; low plasticity; moist
								0			~3.5 becoming dark brown (7.5YR 3/4) mottled with very dark grayish brown (2.5Y 3/2); moist; slight Petroleum odor; trace 1" sandstone Pebbles
								5			5.0' Saturated/wet becoming (<5, 20, 80) sand content increases; petroleum odor ~~increases color change to~~
											5.5' end of boring
								0			

ANALYTICAL SAMPLE ID (SEE ABOVE FOR LOCATION)

A B53SB003-A-S01 1055

B

C

D

E

F

P:\Special\DACW05-97-D-0035A_E\Field Activities\boringlogform.xls

Cone Penetration Testing Procedure (CPT)

Gregg In Situ, Inc. carries out all Cone Penetration Tests (CPT) using an integrated electronic cone system, *Figure CPT*. The soundings were conducted using a 20 ton capacity cone with a tip area of 15 cm^2 and a friction sleeve area of 225 cm^2. The cone is designed with an equal end area friction sleeve and a tip end area ratio of 0.85.

The cone takes measurements of cone bearing (q_c), sleeve friction (f_s) and dynamic pore water pressure (u_2) at 5-cm intervals during penetration to provide a nearly continuous hydrogeologic log. CPT data reduction and interpretation is performed in real time facilitating on-site decision making. The above mentioned parameters are stored on disk for further analysis and reference. All CPT soundings are performed in accordance with revised (2002) ASTM standards (D 5778-95).

The cone also contains a porous filter element located directly behind the cone tip (u_2), *Figure CPT*. It consists of porous plastic and is 5.0mm thick. The filter element is used to obtain dynamic pore pressure as the cone is advanced as well as Pore Pressure Dissipation Tests (PPDT's) during appropriate pauses in penetration. It should be noted that prior to penetration, the element is fully saturated with silicon oil under vacuum pressure to ensure accurate and fast dissipation.

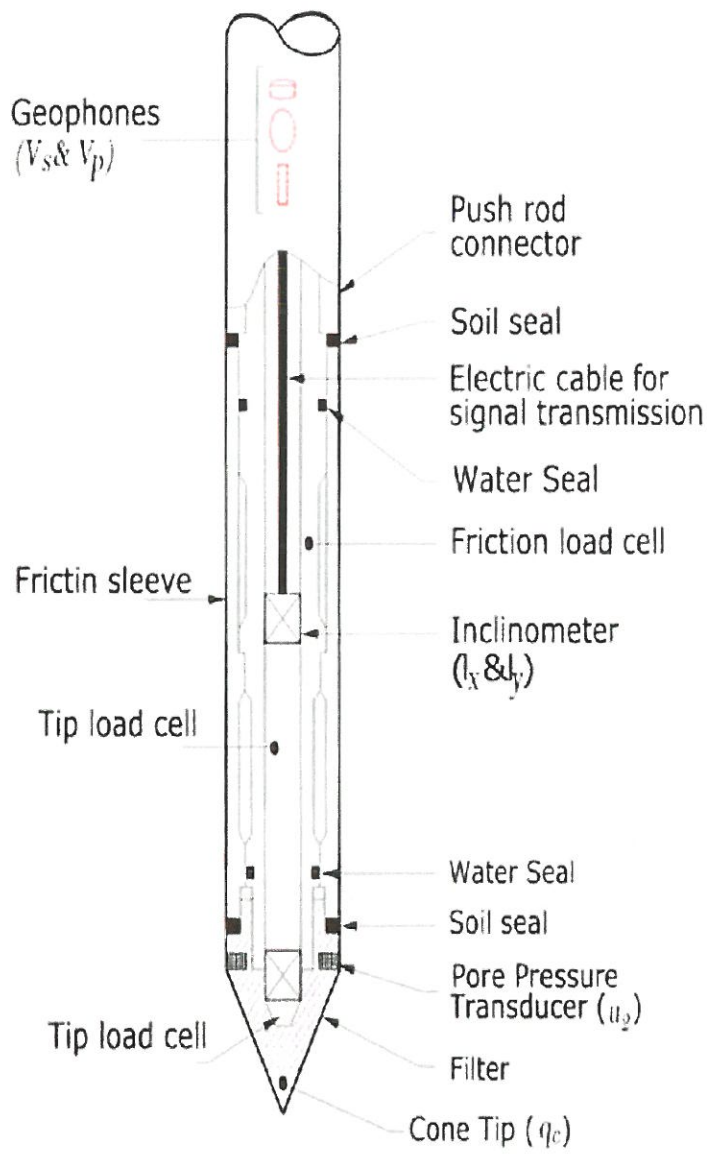


Figure CPT

When the soundings are complete, the test holes are grouted using a Gregg In Situ support rig. The grouting procedure consists of pushing a hollow CPT rod with a "knock out" plug to the termination depth of the test hole. Grout is then pumped under pressure as the tremie pipe is pulled from the hole. Disruption or further contamination to the site is therefore minimized.

Cone Penetration Test Data & Interpretation

Soil behavior type and stratigraphic interpretation is based on relationships between cone bearing (q_c), sleeve friction (f_s), and pore water pressure (u_2). The friction ratio (R_f) is a calculated parameter defined by $100 f_s/q_c$ and is used to infer soil behavior type. Generally:

Cohesive soils (clays)

- High friction ratio (R_f) due to small cone bearing (q_c)
- Generate large excess pore water pressures (u_2)

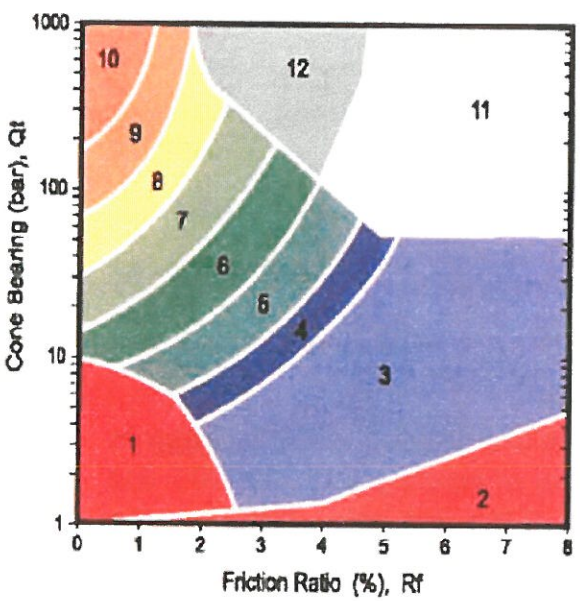
Cohesionless soils (sands)

- Low friction ratio (R_f) due to large cone bearing (q_c)
- Generate very little excess pore water pressures (u_2)

A complete set of baseline readings are taken prior to and at the completion of each sounding to determine temperature shifts and any zero load offsets. Corrections for temperature shifts and zero load offsets can be extremely important, especially when the recorded loads are relatively small. In sandy soils, however, these corrections are generally negligible.

The cone penetration test data collected from your site is presented in graphical form in Appendix CPT. The data includes CPT logs of measured soil parameters, computer calculations of interpreted soil behavior types (SBT), and additional geotechnical parameters. A summary of locations and depths is available in Table 1. Note that all penetration depths referenced in the data are with respect to the existing ground surface.

Soil interpretation for this project was conducted using recent correlations developed by Robertson et al, 1990, *Figure SBT*. Note that it is not always possible to clearly identify a soil type based solely on q_c, f_s, and u_2. In these situations, experience, judgment, and an assessment of the pore pressure dissipation data should be used to infer the soil behavior type.



ZONE	Qt/N	SBT
1	2	Sensitive, fine greained
2	1	Organic materials
3	1	Clay
4	1.5	Silty clay to clay
5	2	Clayey silt to silty clay
6	2.5	Sandy silt to clayey silt
7	3	Silty sand to sandy silt
8	4	Sand to silty sand
9	5	Sand
10	6	Gravely sand to sand
11	1	Very stiff fine grained*
12	2	Sand to clayey sand*

*over consolidated or cemented

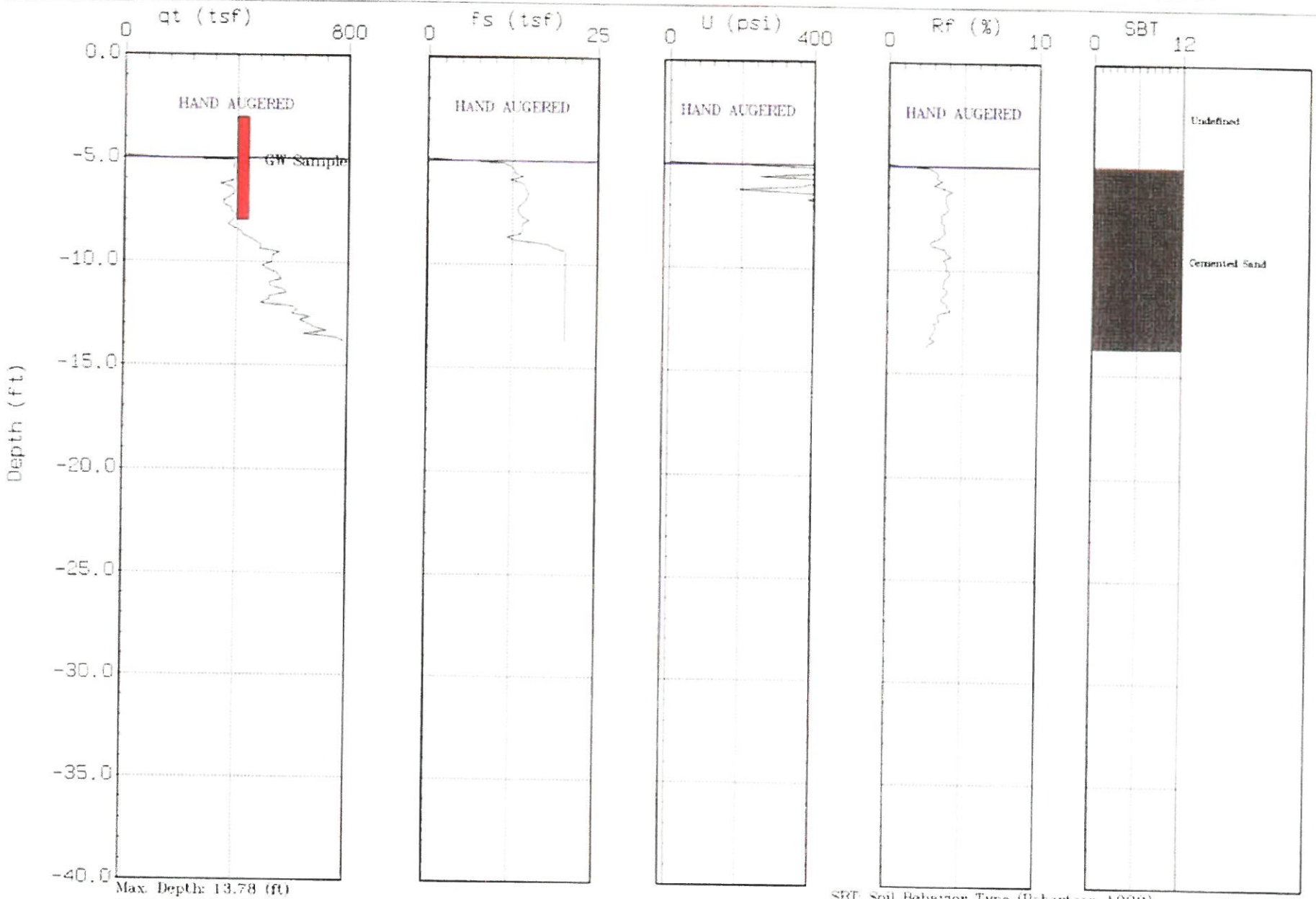
Figure SBT

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: AFU-SB-1

Geologist: R. GOLDBERG
Date: 11:07:04 10:11



Max. Depth: 13.78 (ft)
Depth Inc.: 0.164 (ft)

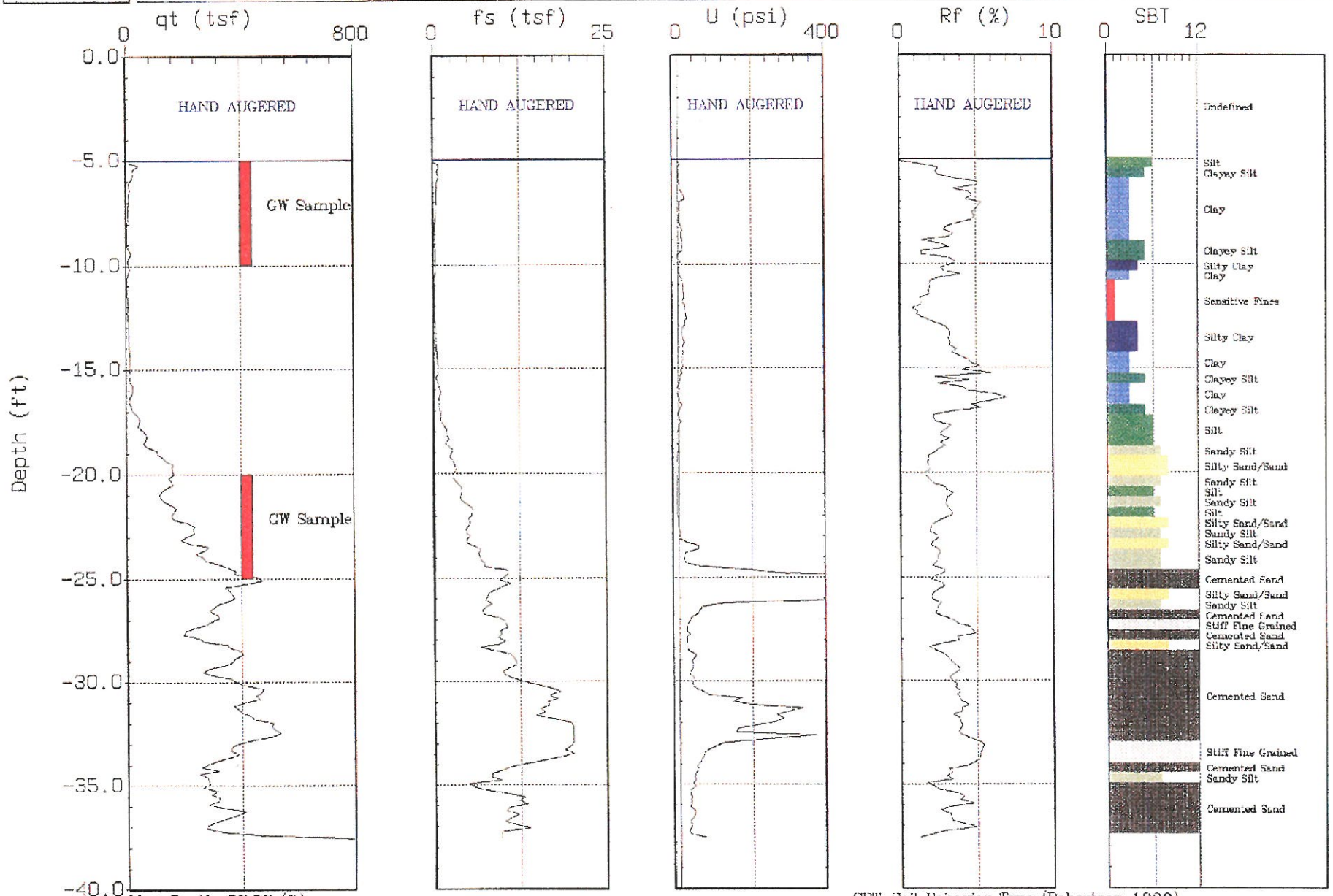
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: AFU-SB-2

Geologist: R. GOLDBERG
Date: 11:07:04 11:36



Max. Depth: 37.57 (ft)
Depth Inc.: 0.164 (ft)

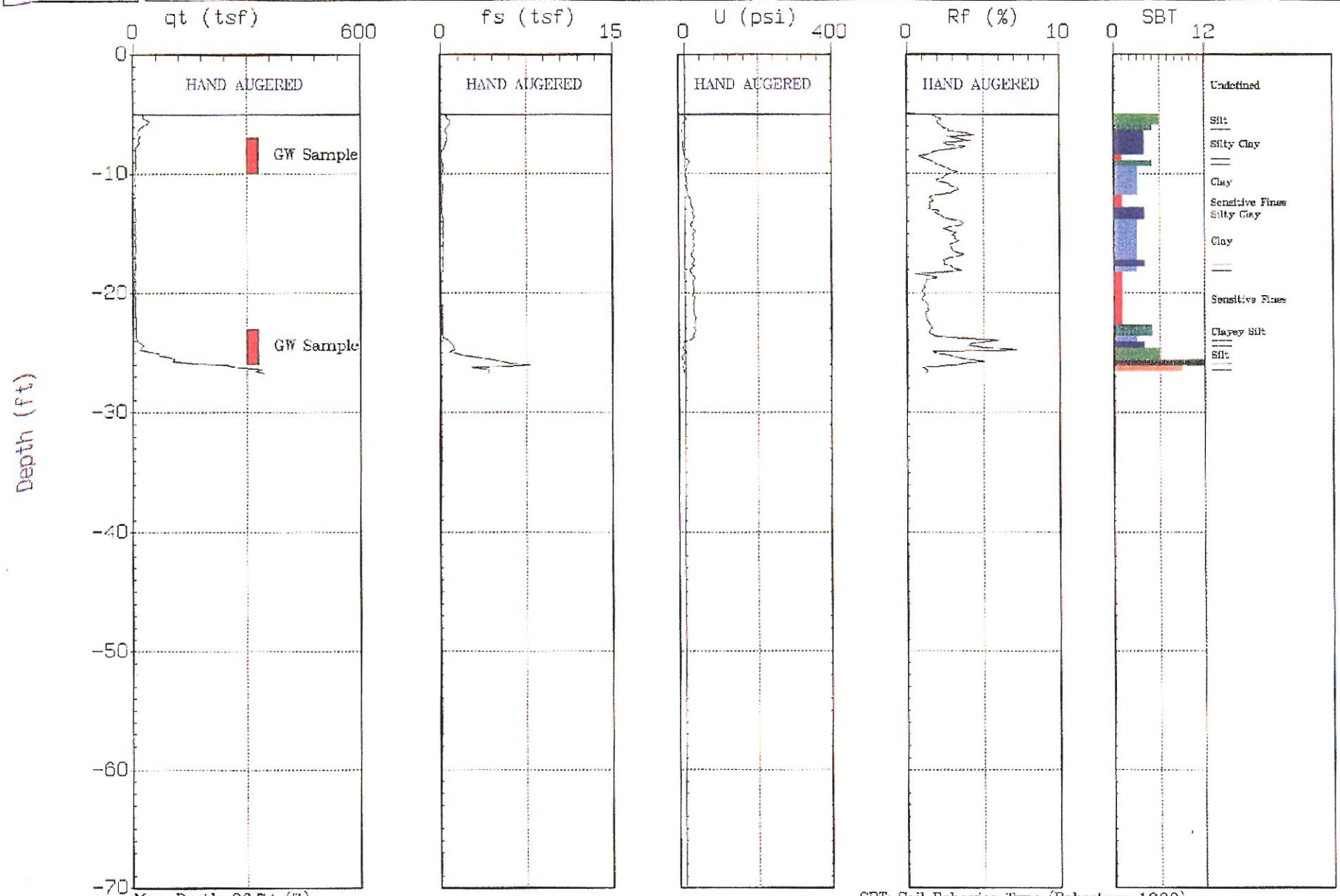
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B004HP1

Geologist: R. GOLDBERG
Date: 05:11:04 14:26



Max. Depth: 26.74 (ft)
Depth Inc.: 0.164 (ft)

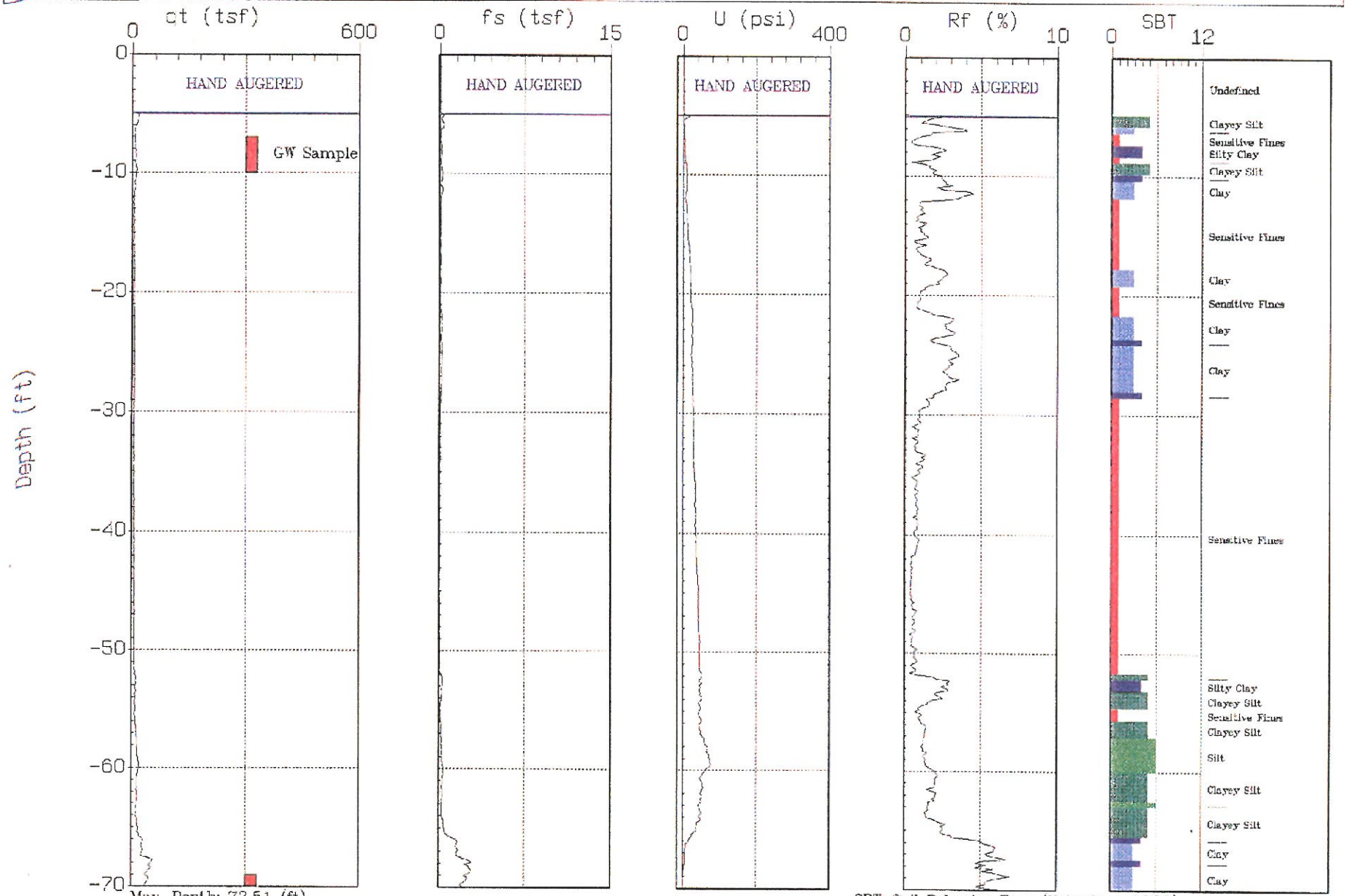
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B004HP2

Geologist: R. GOLDBERG
Date: 05:11:04 09:09



Max. Depth: 72.51 (ft)
Depth Inc.: 0.164 (ft)

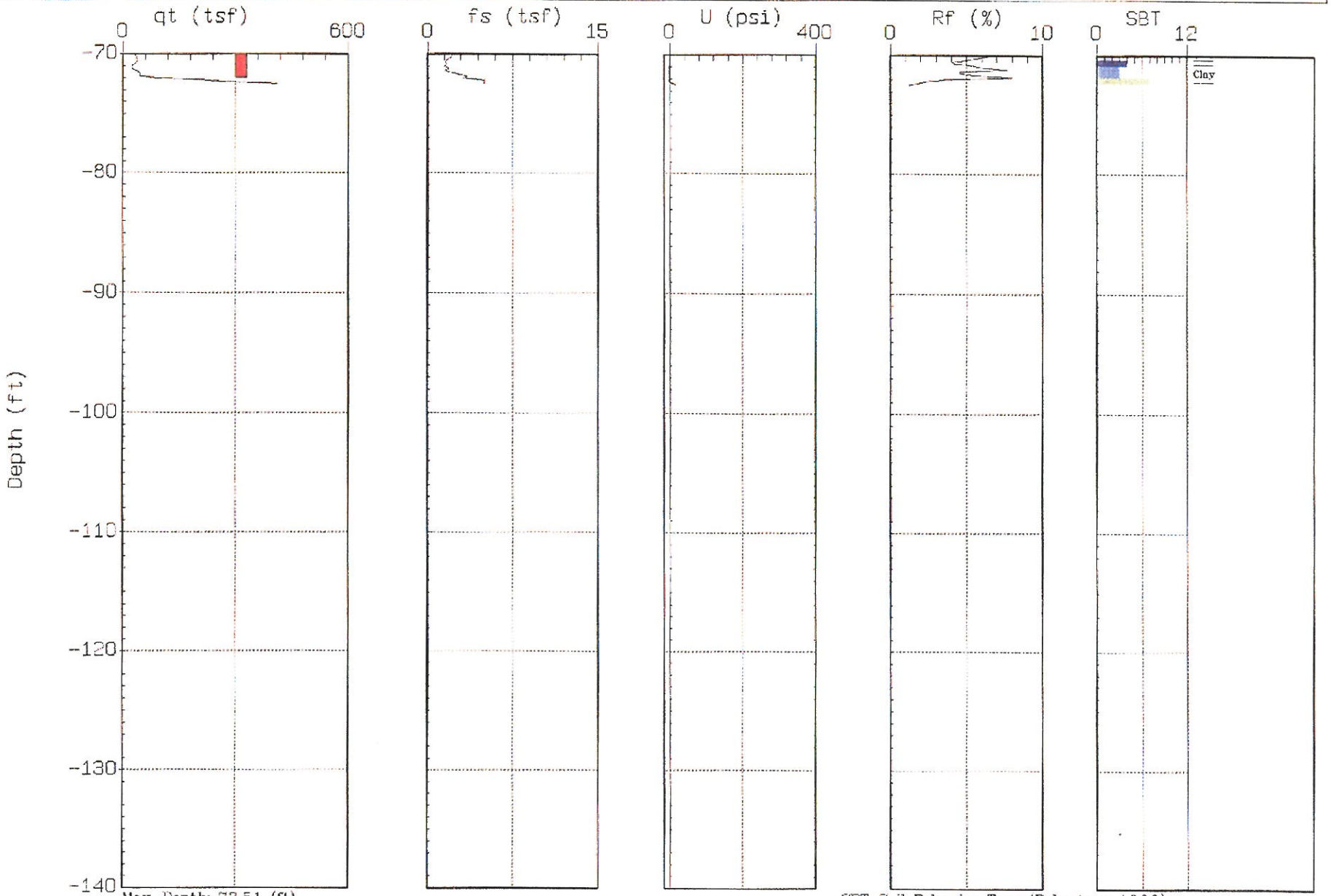
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-BC04HP2

Geologist: R. GOLDBERG
Date: 05:11:04 09:09



Max. Depth: 72.51 (ft)
Depth Inc.: 0.164 (ft)

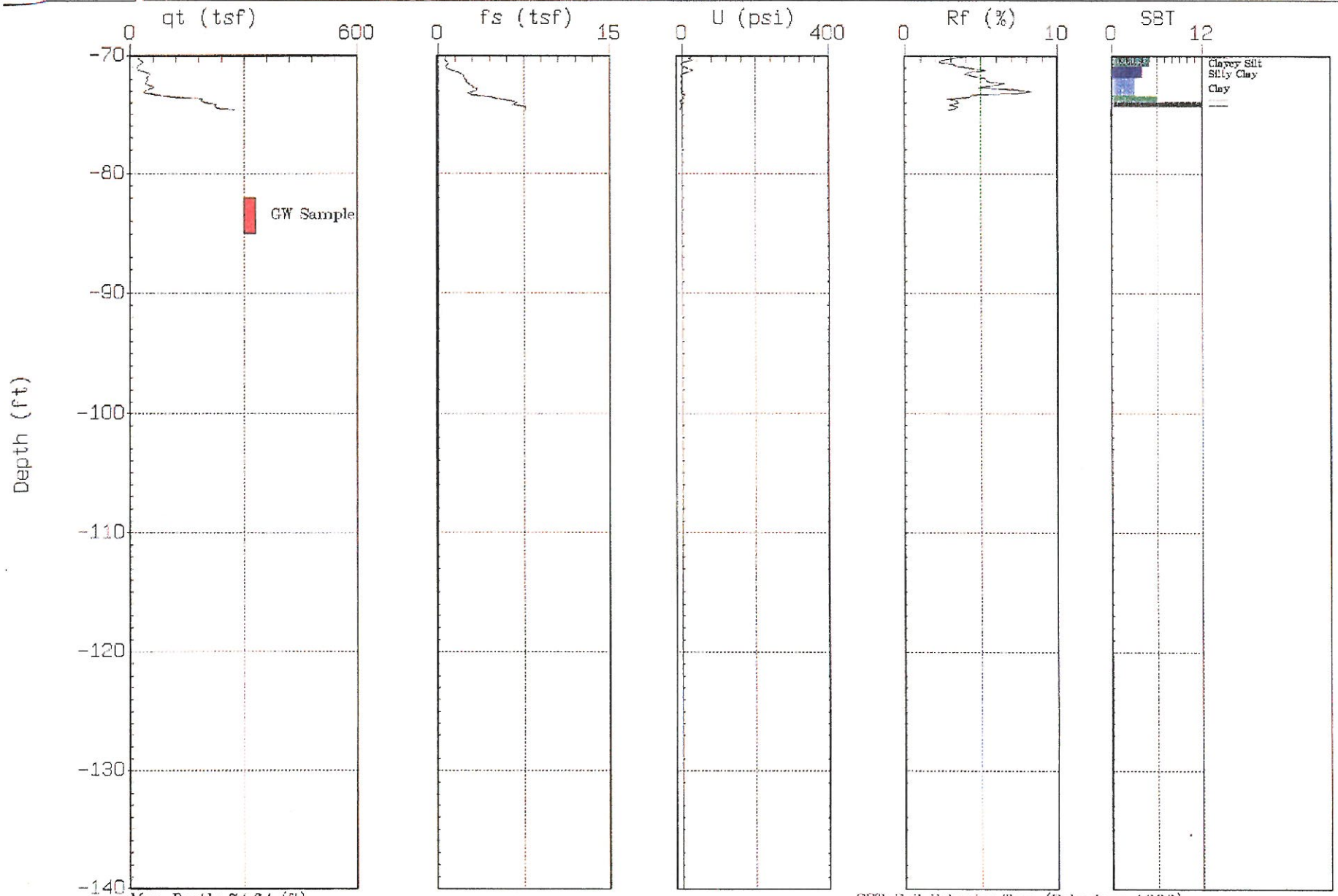
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B004HP3

Geologist: R. GOLDBERG
Date: 05:18:04 13:30



Max. Depth: 74.64 (ft)
Depth Inc.: 0.164 (ft)

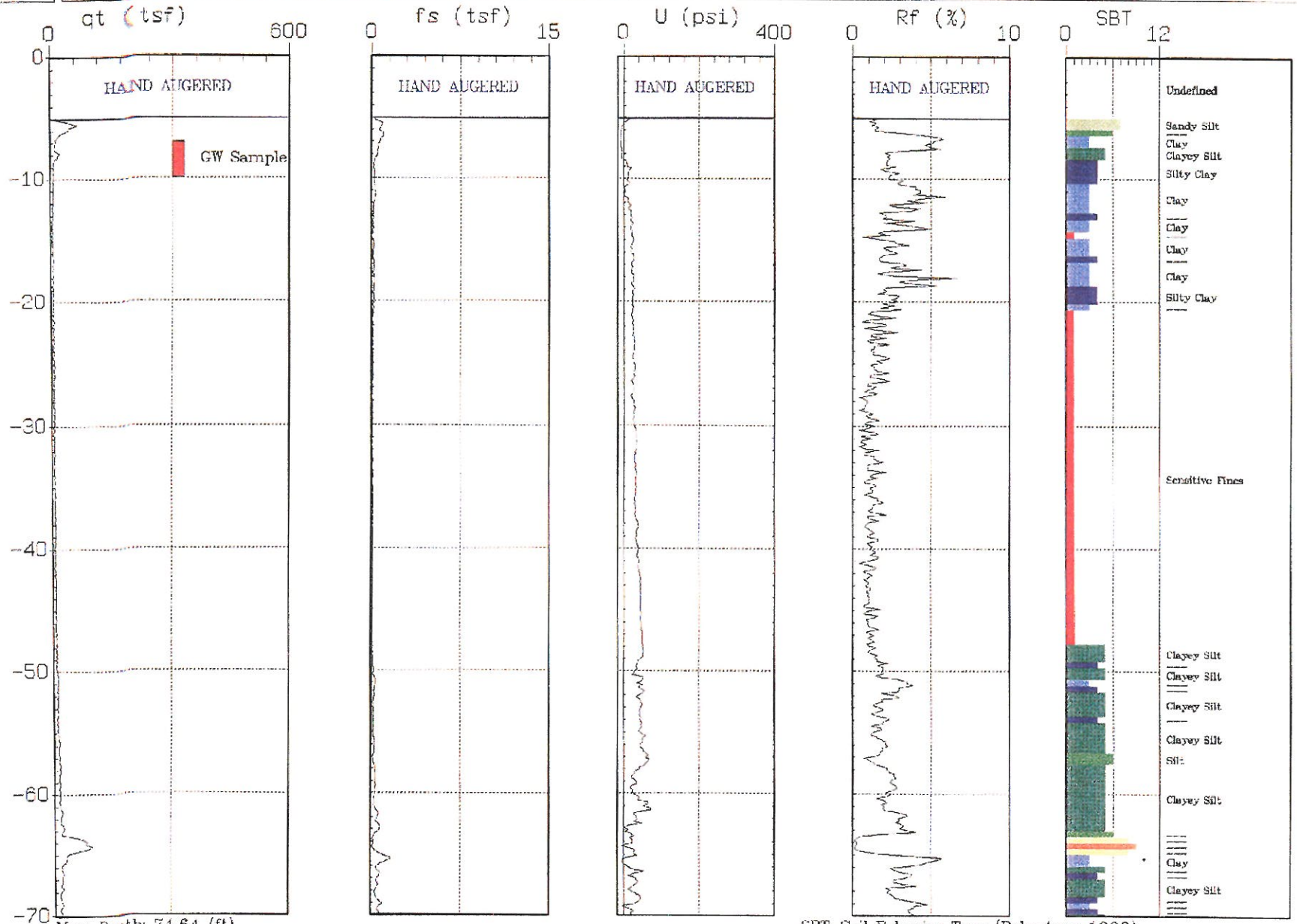
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B004HP3

Geologist: R. GOLDBERG
Date: 05:18:01 13:30



Max. Depth: 74.64 (ft)
Depth Inc.: 0.164 (ft)

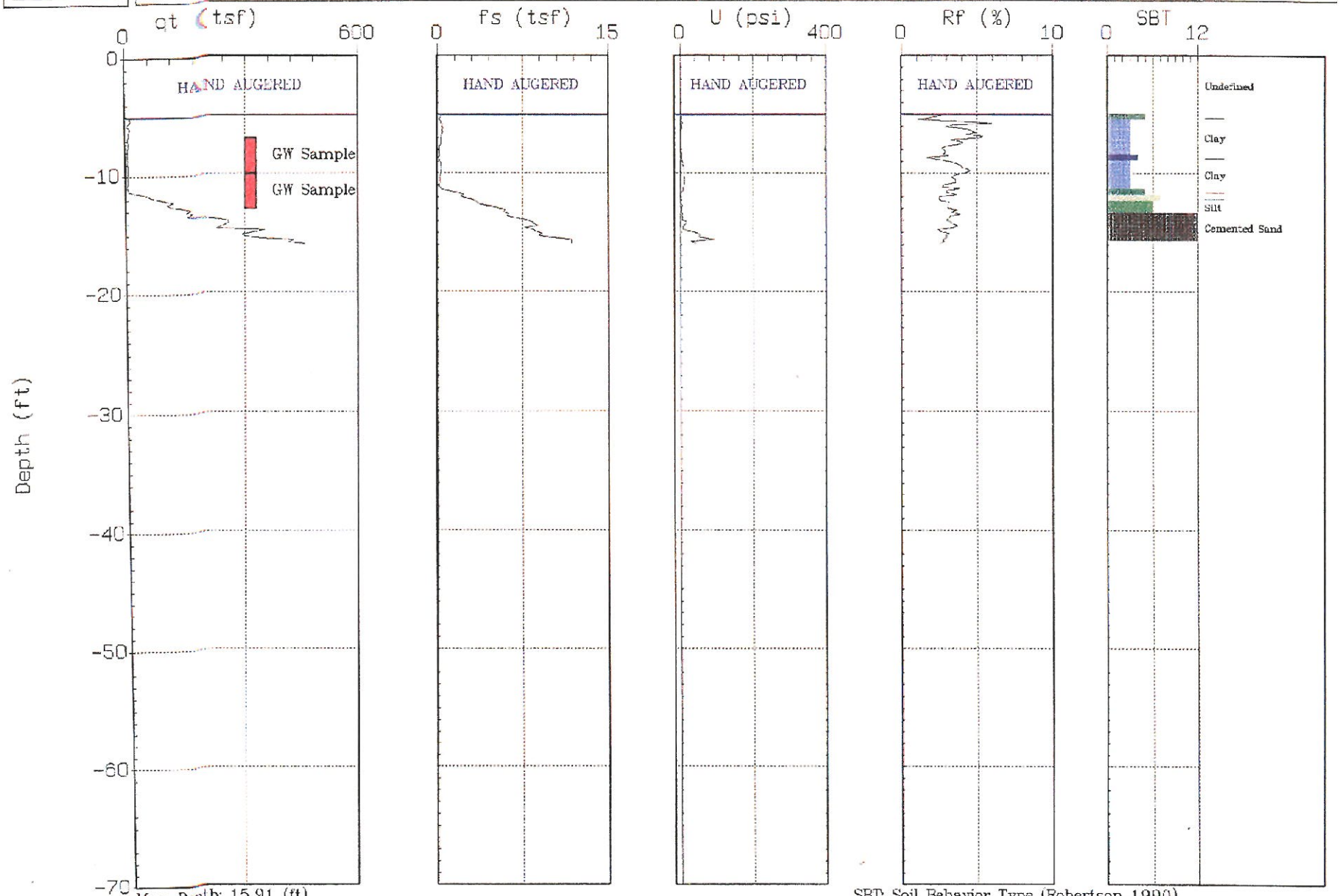
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B031HP1

Geologist: R. GOLDBERG
Date: 05:04:04 13:33



Max. Depth: 15.91 (ft)
Depth Inc.: 0.164 (ft)

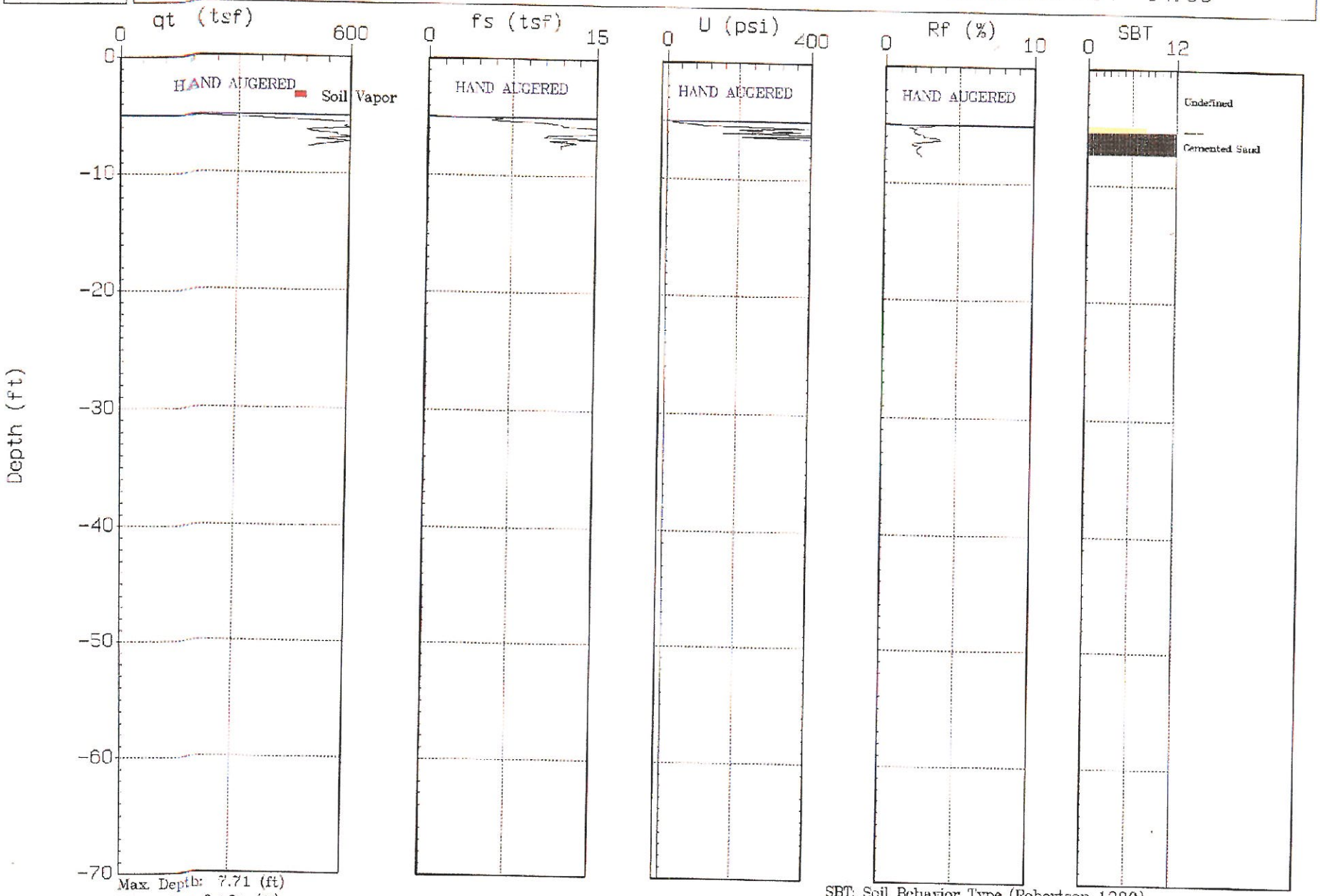
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B031HP2

Geologist: R. GOLDBERG
Date: 05:04:04 14:39



Max. Depth: 7.71 (ft)
Depth Inc.: 0.164 (ft)

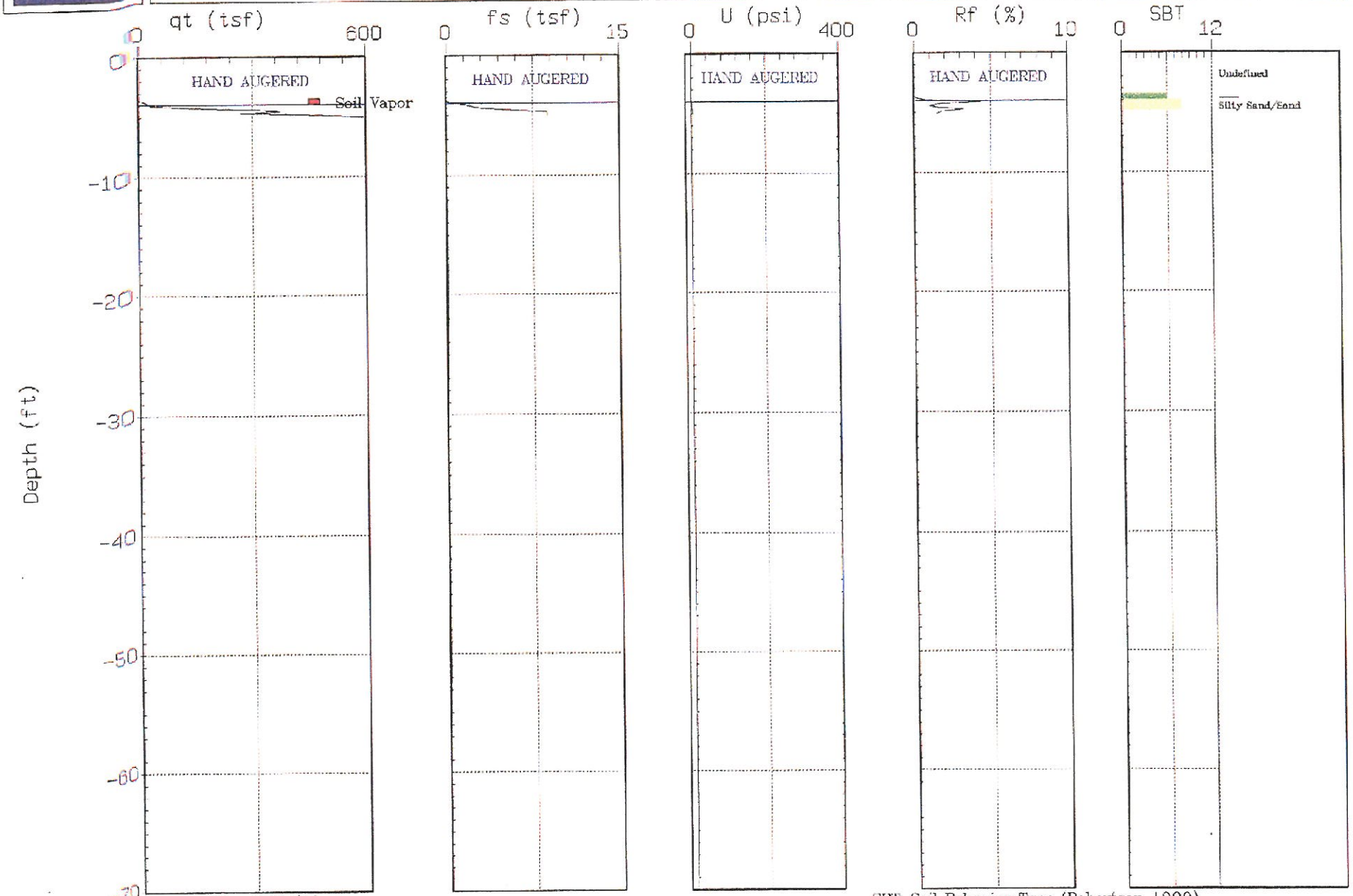
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B042HP1

Geologist: R. GOLDBERG
Date: 05:05:04 10:23



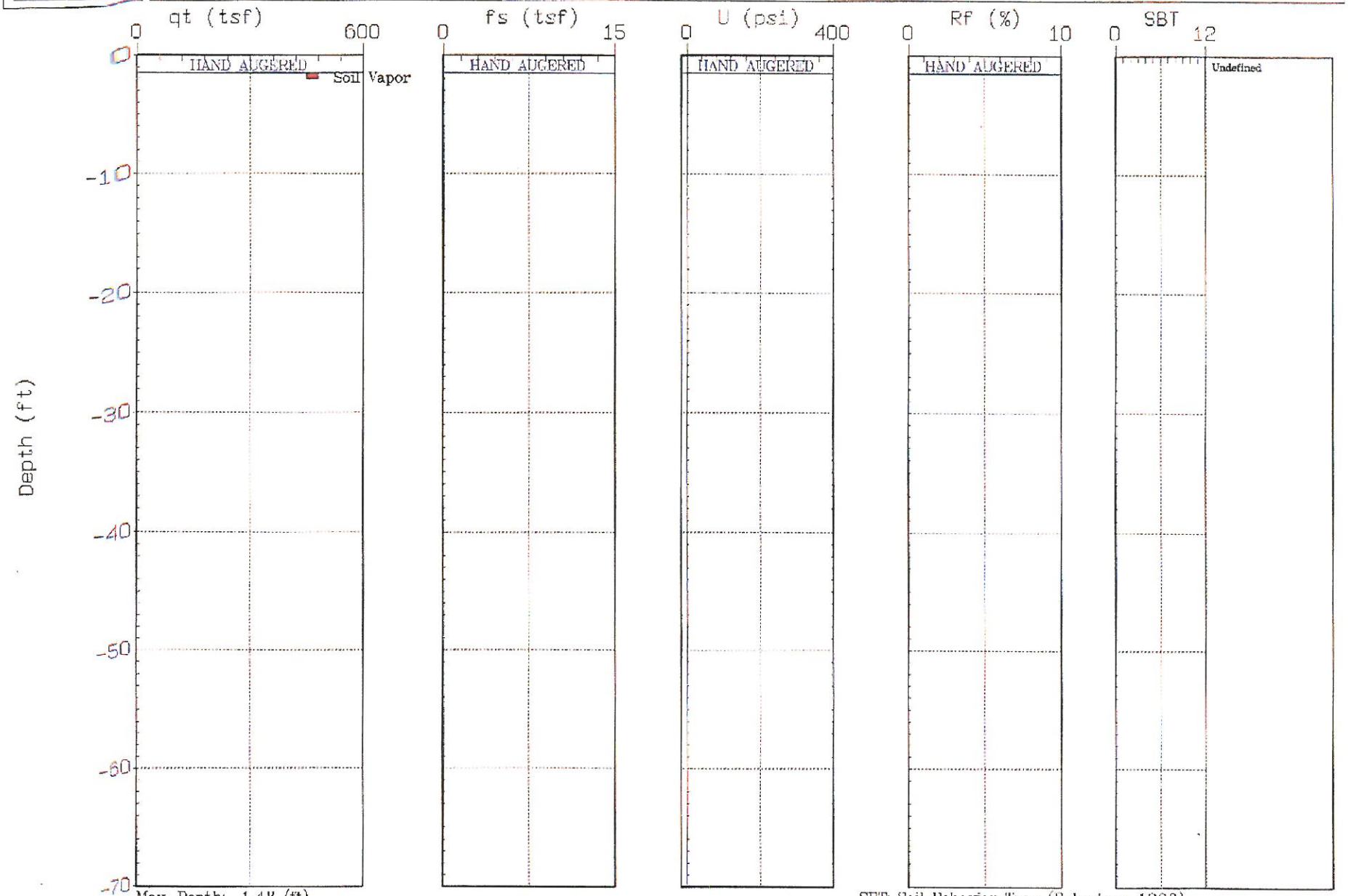
Max. Depth: 5.09 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B042HP2

Geologist: R. GOLDBERG
Date: 05:05:04 12:35



Max. Depth: 1.48 (ft)
Depth Inc.: 0.164 (ft)

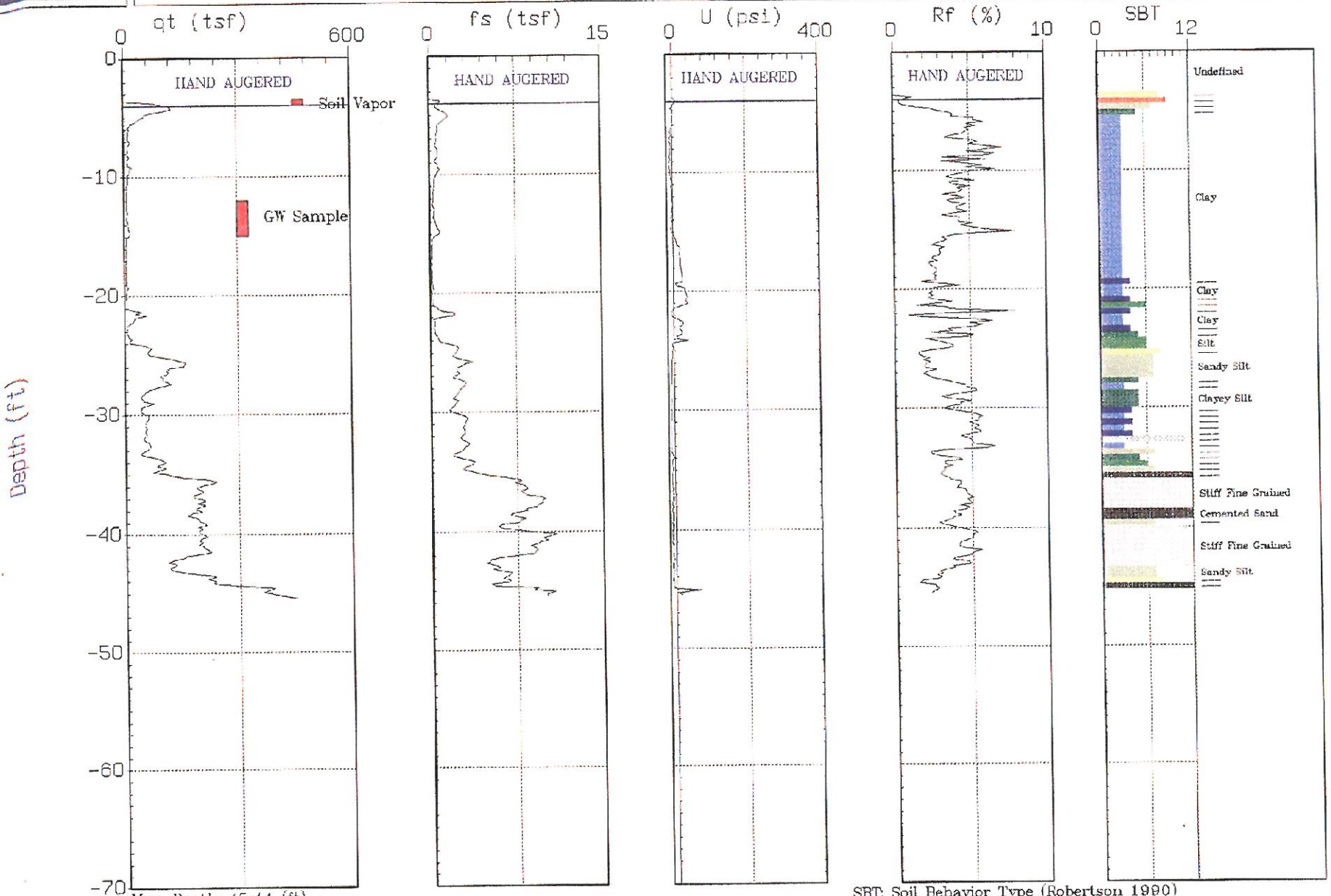
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B050HP001

Geologist: R. GOLDBERG
Date: 05:18:04 15:28



Max. Depth: 45.44 (ft)
Depth Inc.: 0.164 (ft)

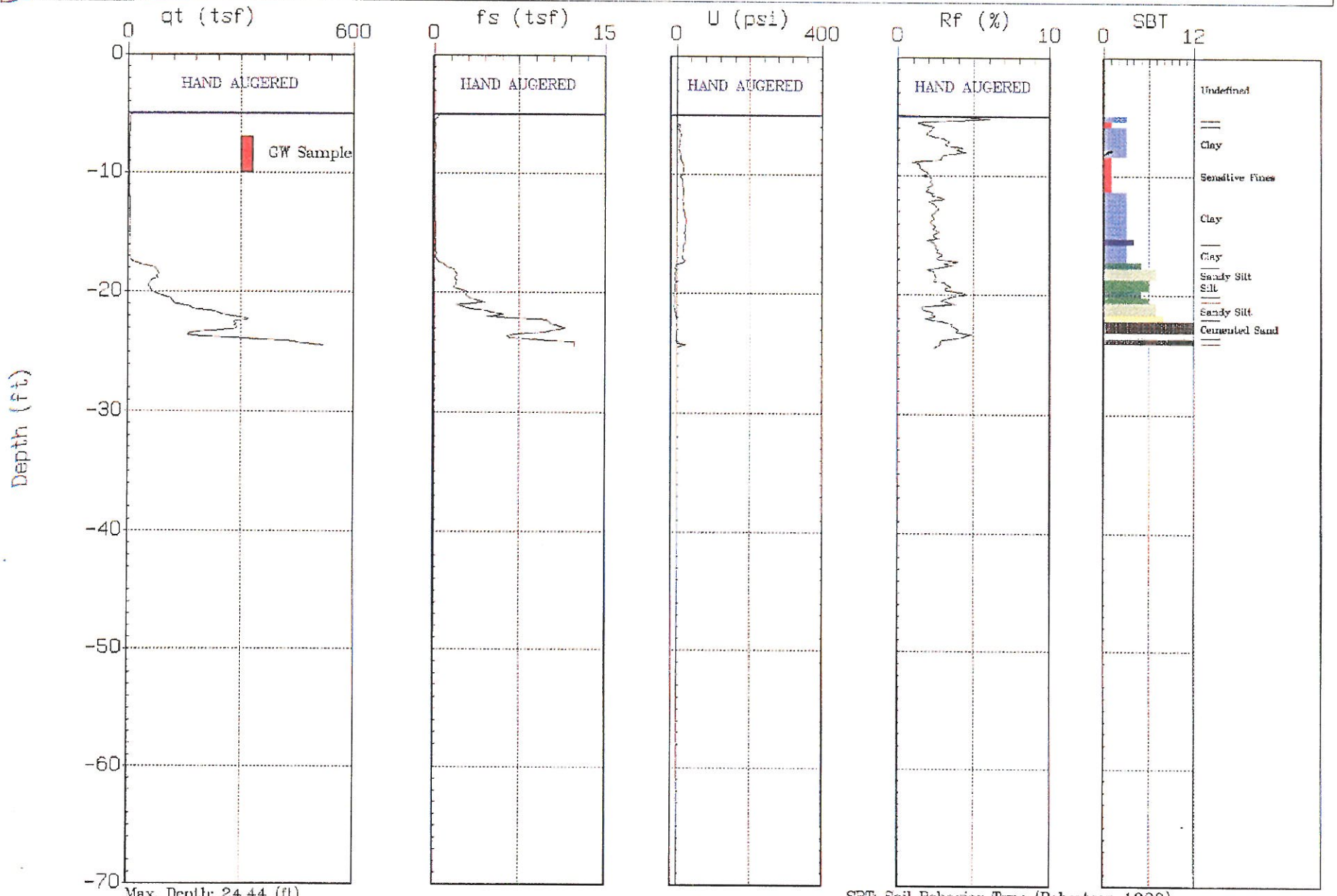
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B53HP1

Geologist: R. GOLDBERG
Date: 05:03:04 16:40



Max. Depth: 24.44 (ft)
Depth Inc.: 0.164 (ft)

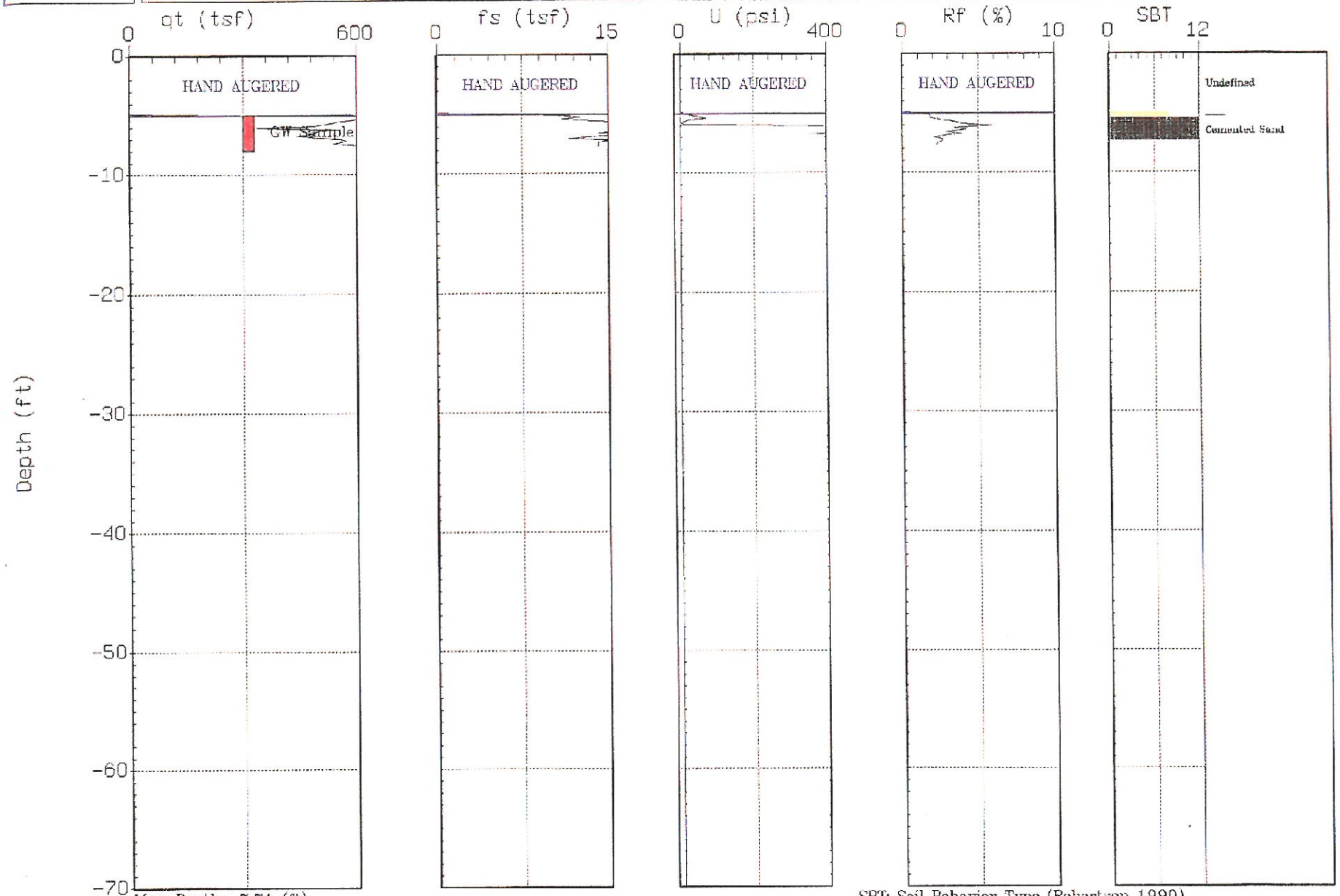
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B056HP1

Geologist: R. GOLDBERG
Date: 05:05:04 10:29



Max. Depth: 7.71 (ft)
Depth Inc.: 0.164 (ft)

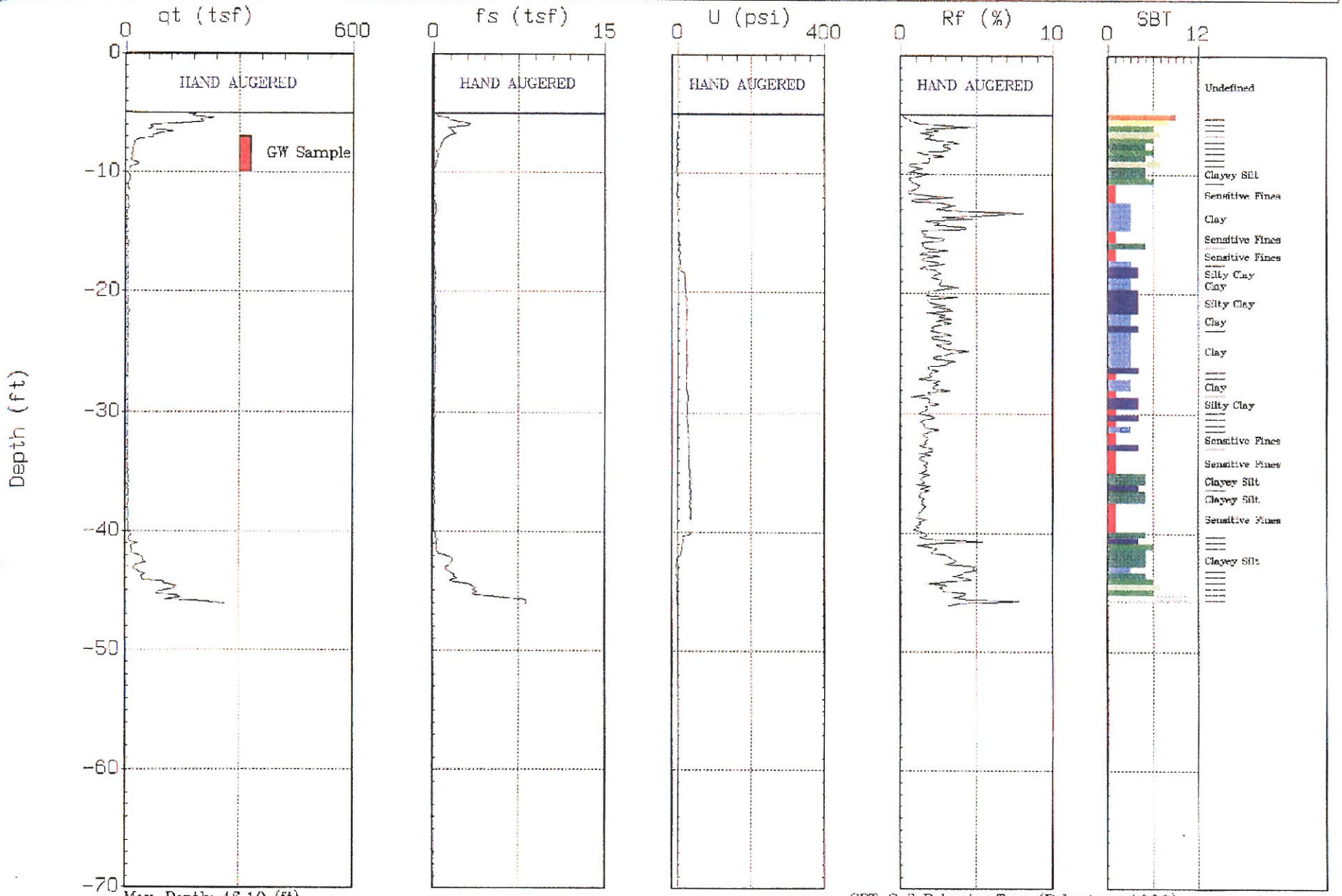
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B056AHP

Geologist: R. GOLDBERG
Date: 05:07:04 10:20



Max. Depth: 46.10 (ft)
Depth Inc.: 0.164 (ft)

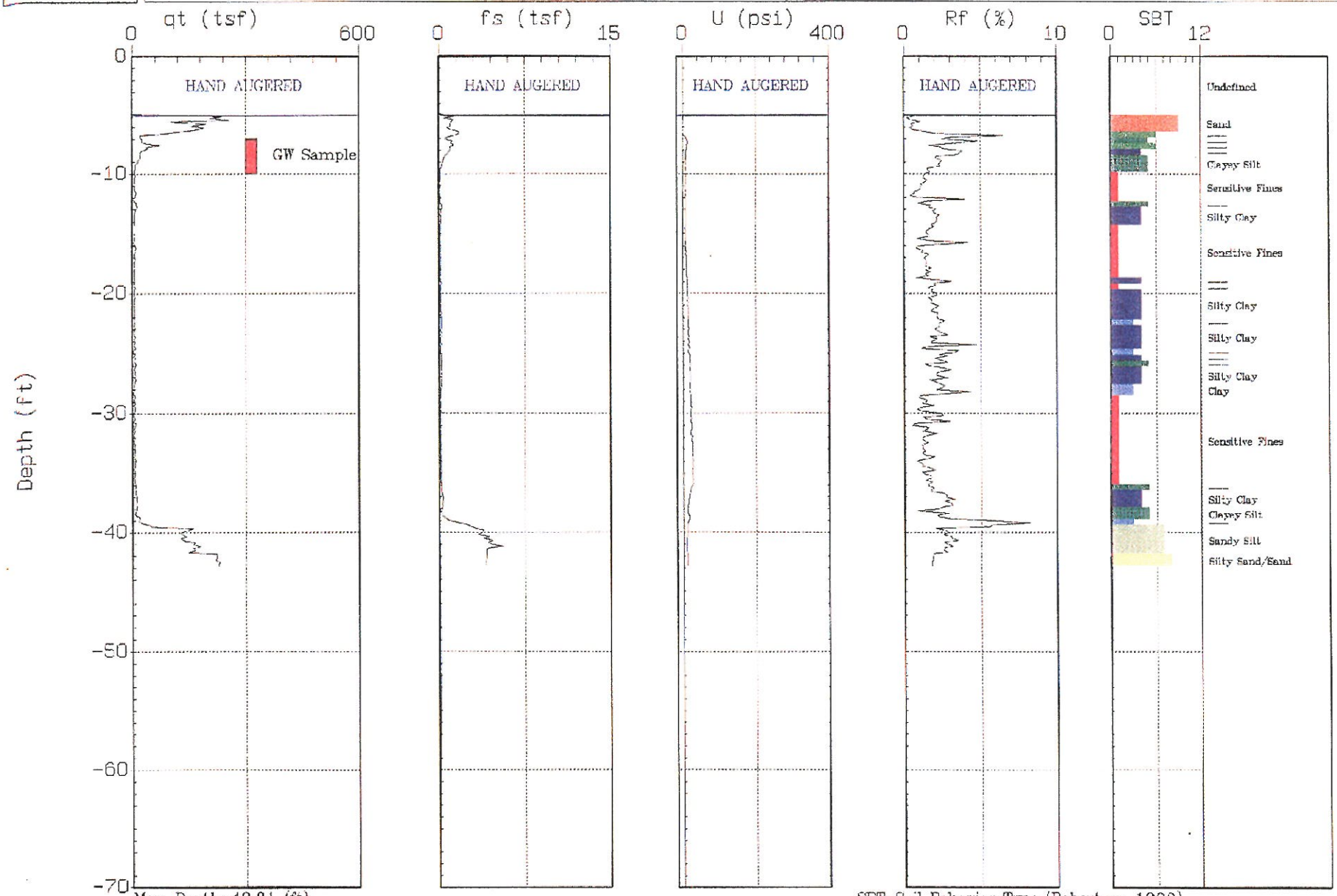
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSEN
Location: CPT-B0594P1

Geologist: R. GOLDBERG
Date: 05:06:04 14:40



Max. Depth: 42.81 (ft)
Depth Inc.: 0.164 (ft)

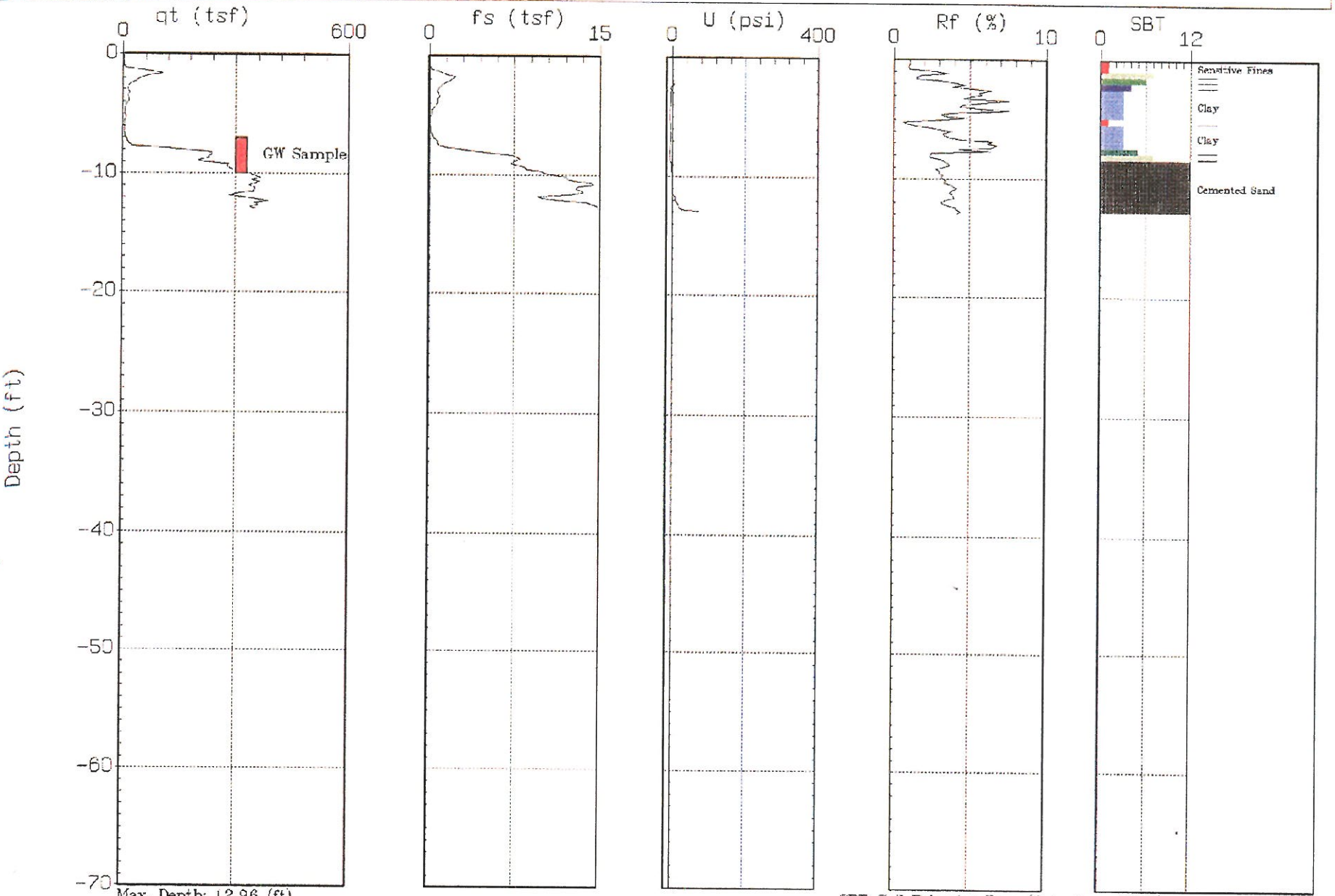
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B59HP1

Geologist: R. GOLDBERG
Date: 05:03:04 15:33



Max. Depth: 12.96 (ft)
Depth Inc.: 0.164 (ft)

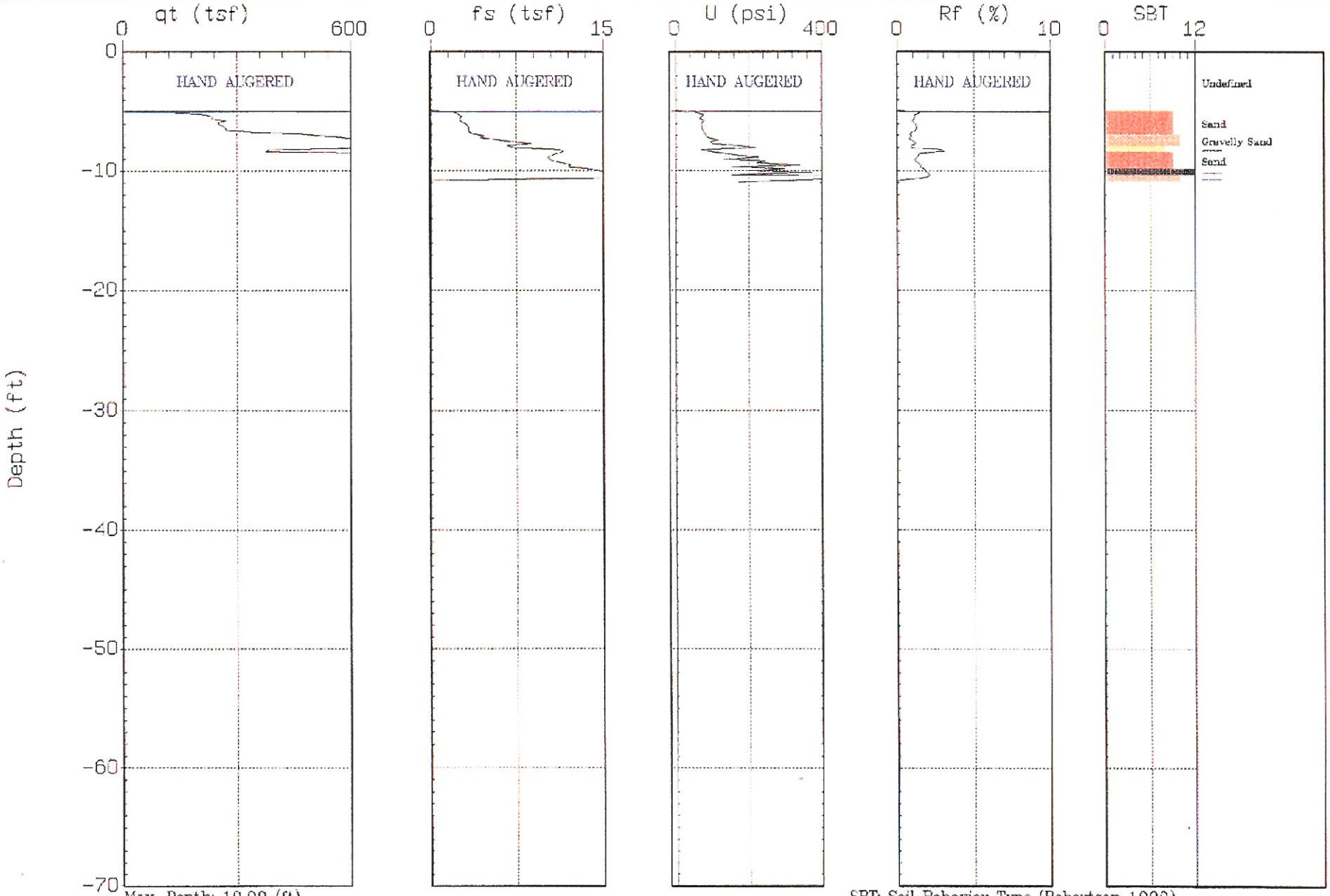
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B59HP1

Geologist: R. GOLDBERG
Date: 01:29:04 17:10



Max. Depth: 10.99 (ft)
Depth Inc.: 0.164 (ft)

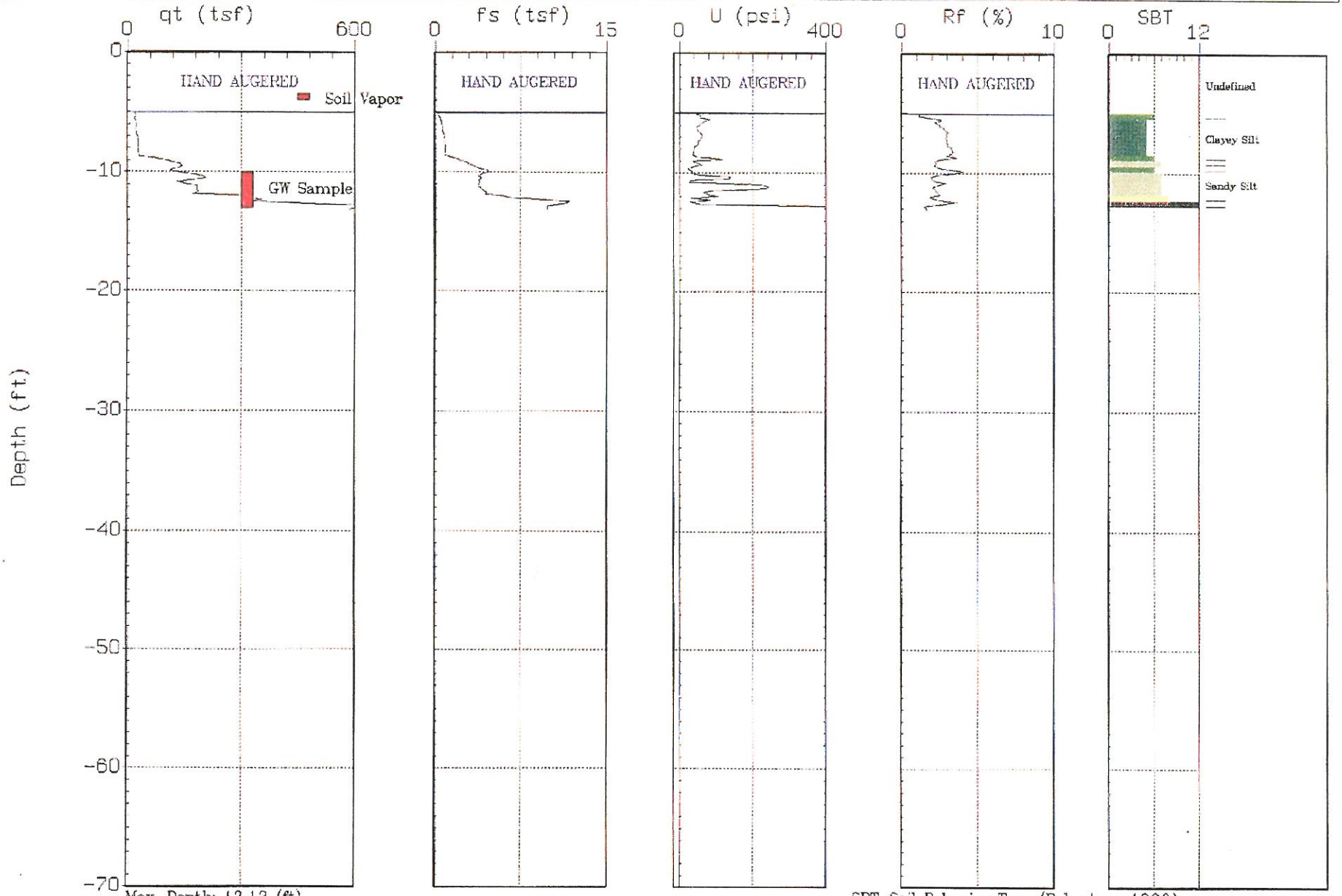
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-390HP1

Geologist: R. GOLDBERG
Date: 05:03:01 11:48



Max. Depth: 13.12 (ft)
Depth Inc.: 0.164 (ft)

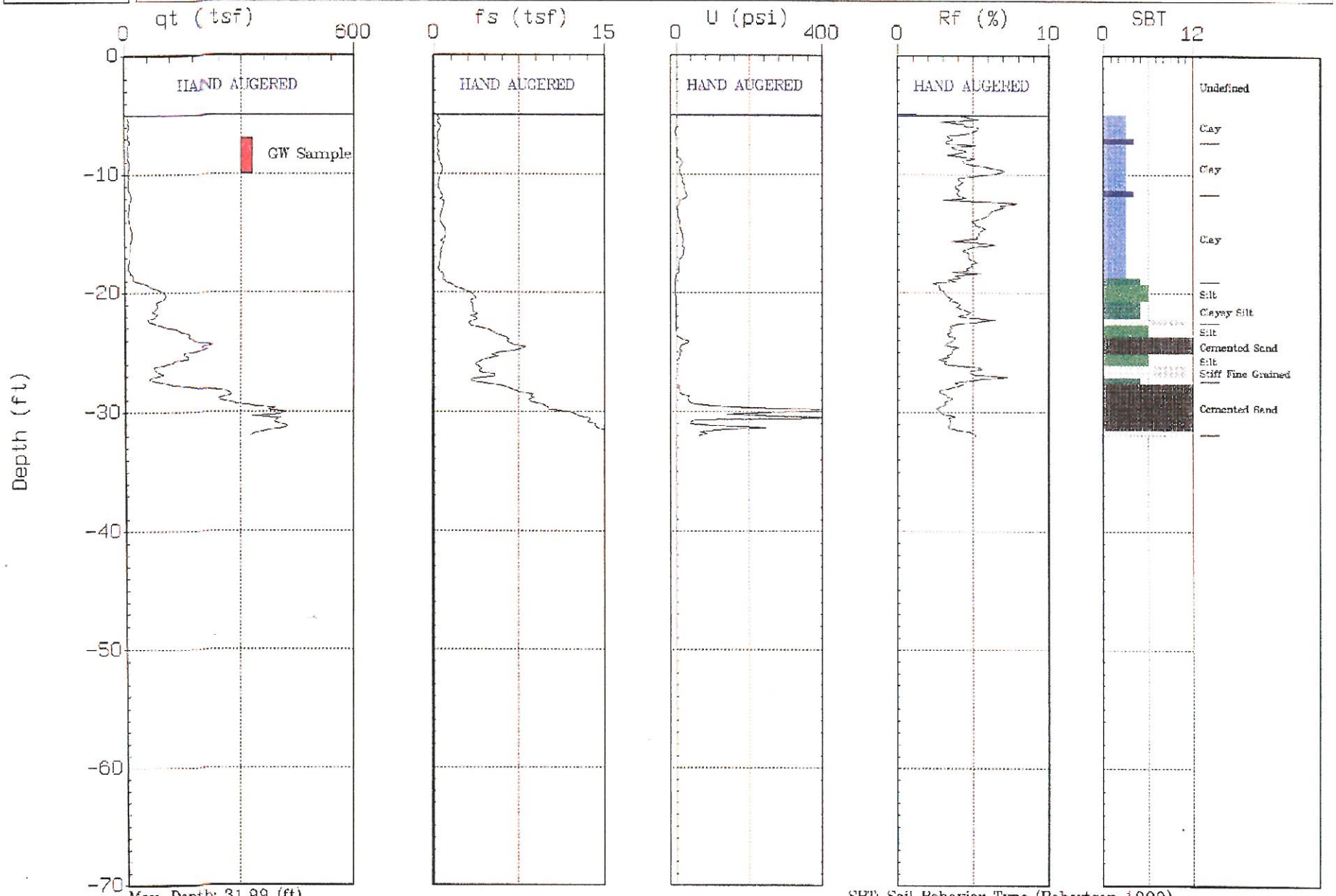
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B091HP1

Geologist: R. GOLDBERG
Date: 05:04:04 09:36



Max. Depth: 31.99 (ft)
Depth Inc.: 0.164 (ft)

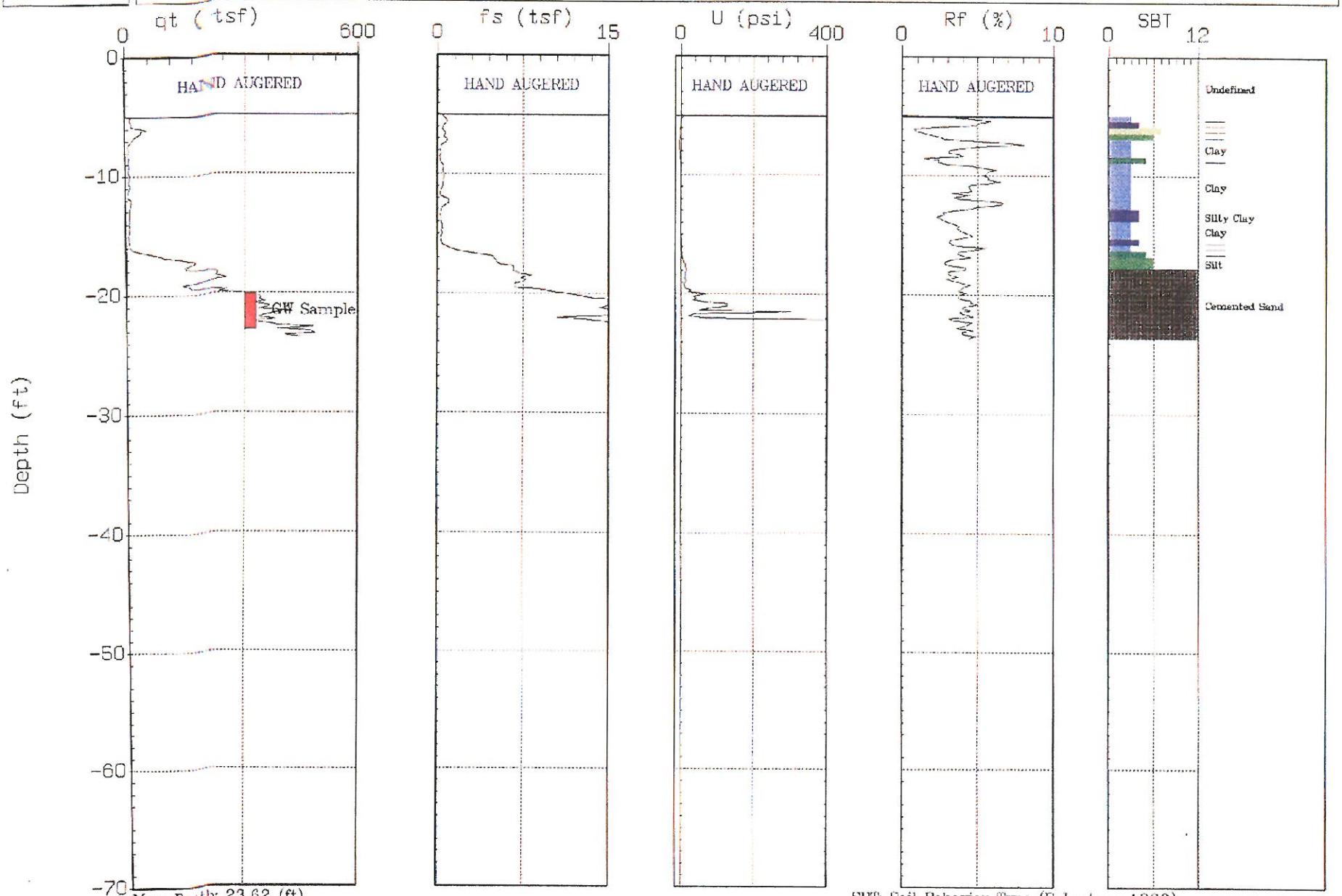
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B091AHP1

Geologist: R. GOLDBERG
Date: 05:04:04 11:33



Max. Depth: 23.62 (ft)
Depth Inc: 0.164 (ft)

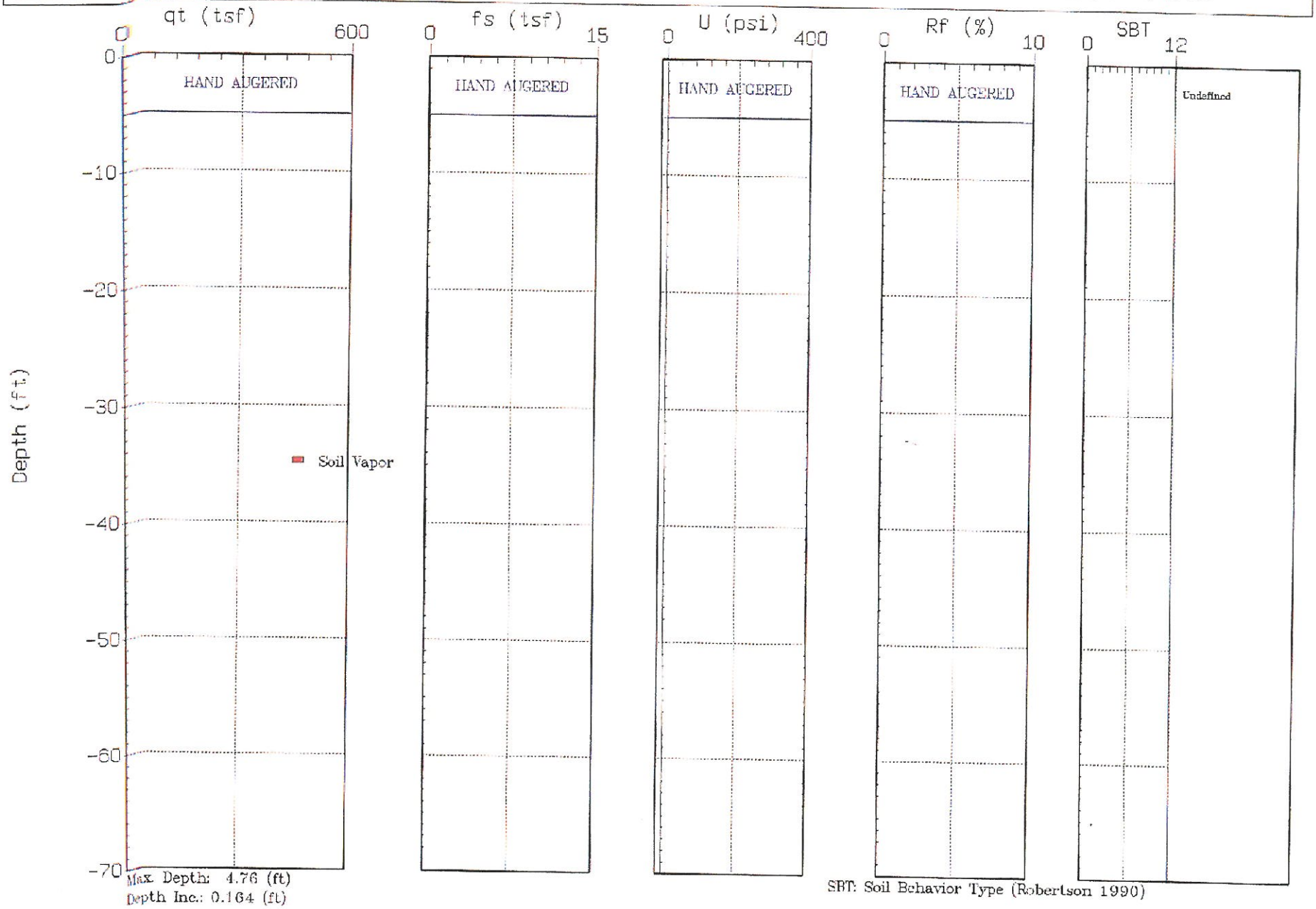
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B93HP1

Geologist: R. GOLDBERG
Date: 05:03:04 14:15

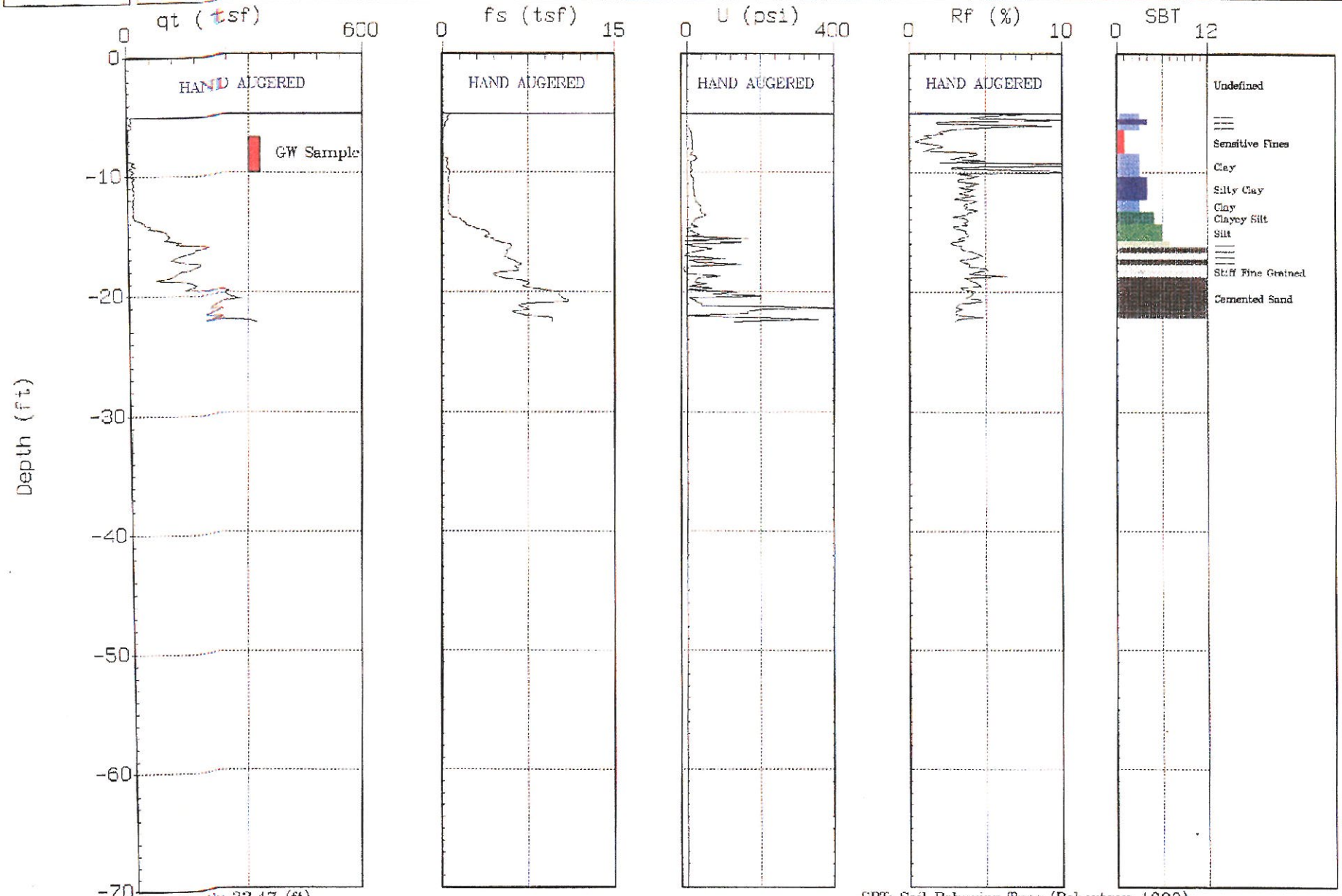


GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B101HP1

Geologist: R. GOLDBERG
Date: 05:12:04 09:01



Max. Depth: 22.47 (ft)
Depth Inc: 0.164 (ft)

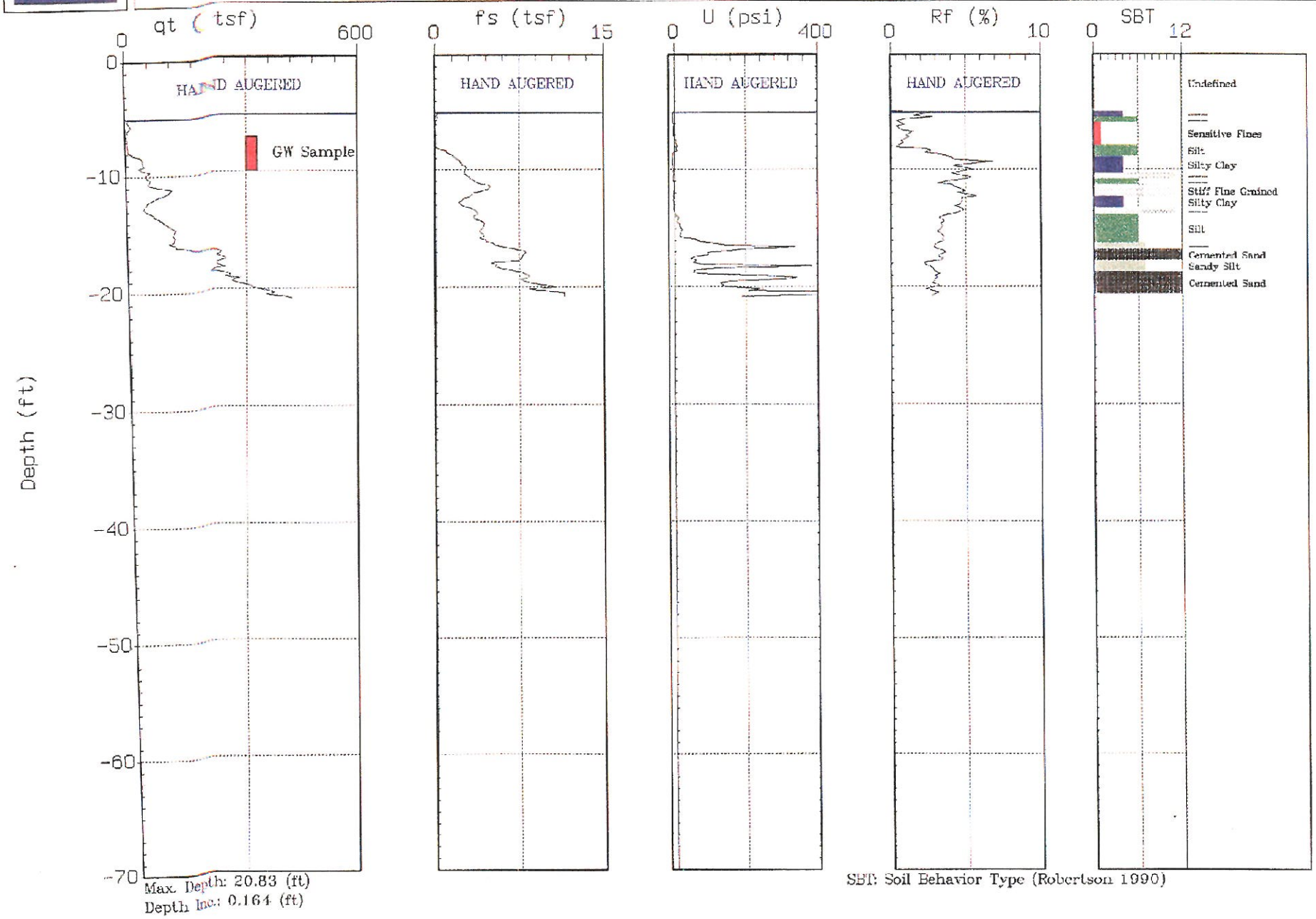
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B101HP2

Geologist: R. GOLDBERG
Date: 05:12:04 10:51



Max. Depth: 20.83 (ft)
Depth Inc.: 0.164 (ft)

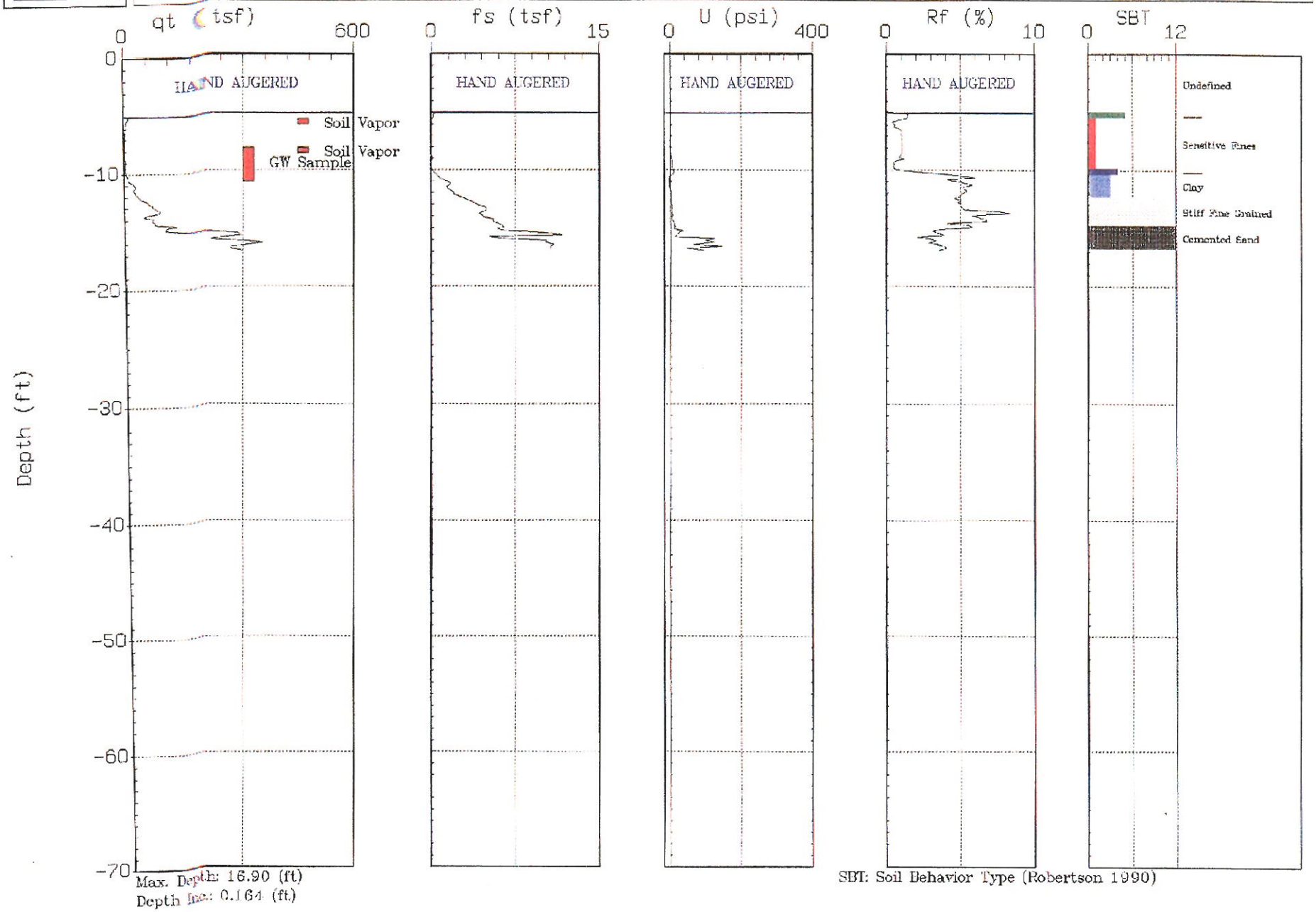
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B103HP1

Geologist: R. GOLDBERG
Date: 05:26:04 13:23



Max. Depth: 16.90 (ft)
Depth Inc: 0.164 (ft)

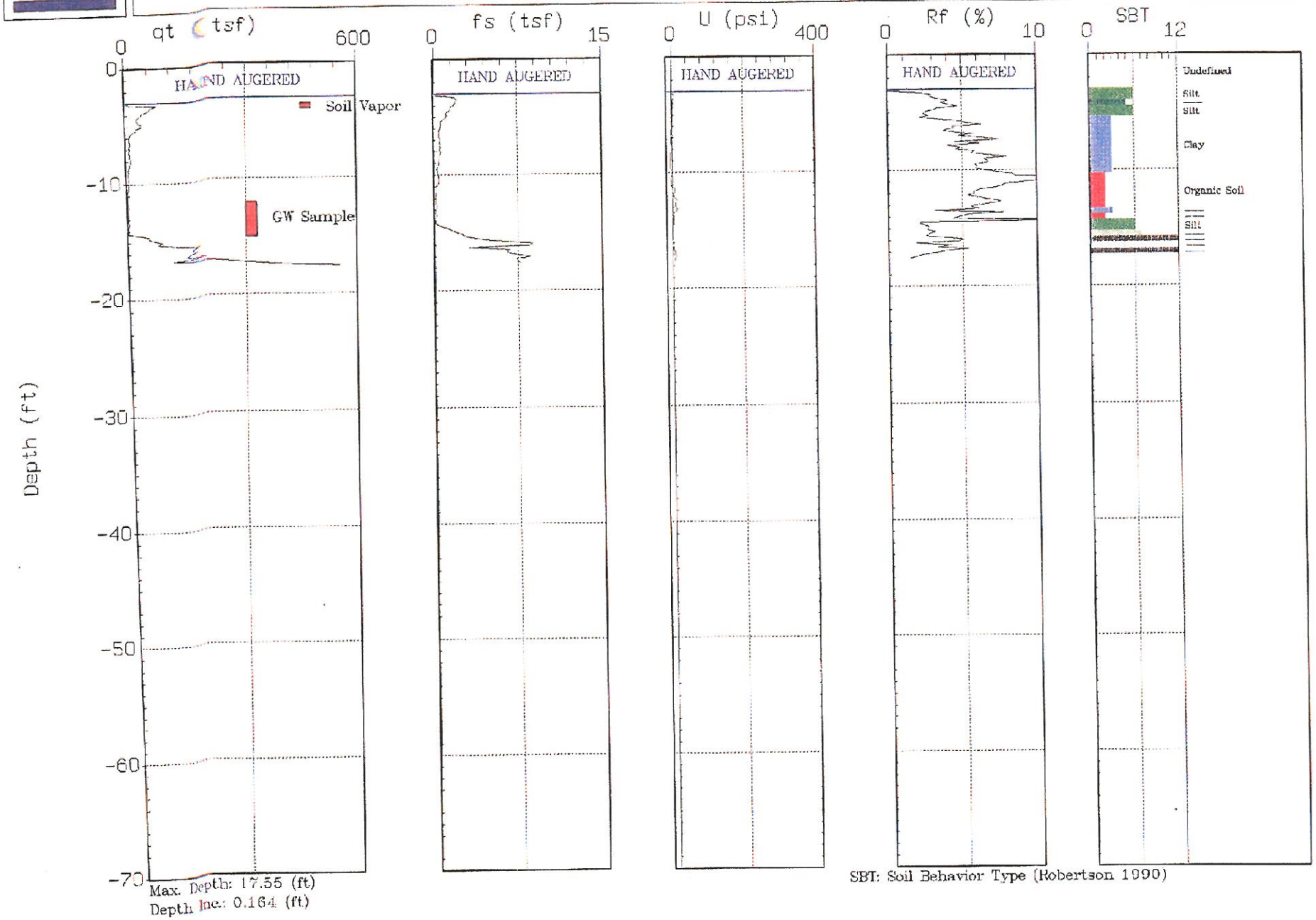
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B111HP001

Geologist: R. GOLDBERG
Date: 05:18:04 16:27



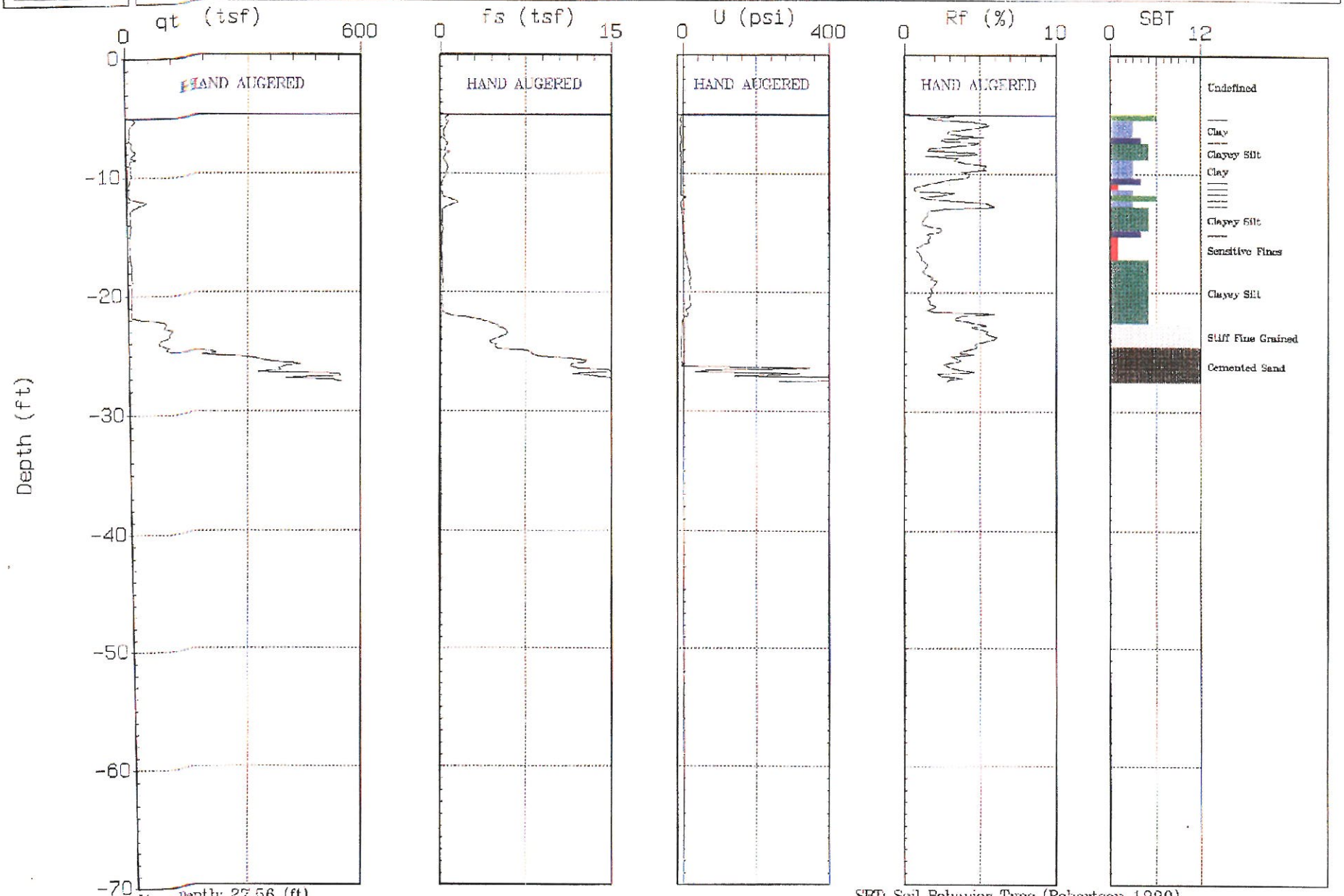
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B118AHP2

Geologist: R. GOLDBERG
Date: 05:05:04 09:19



Max. Depth: 27.56 (ft)
Depth Inc.: 0.164 (ft)

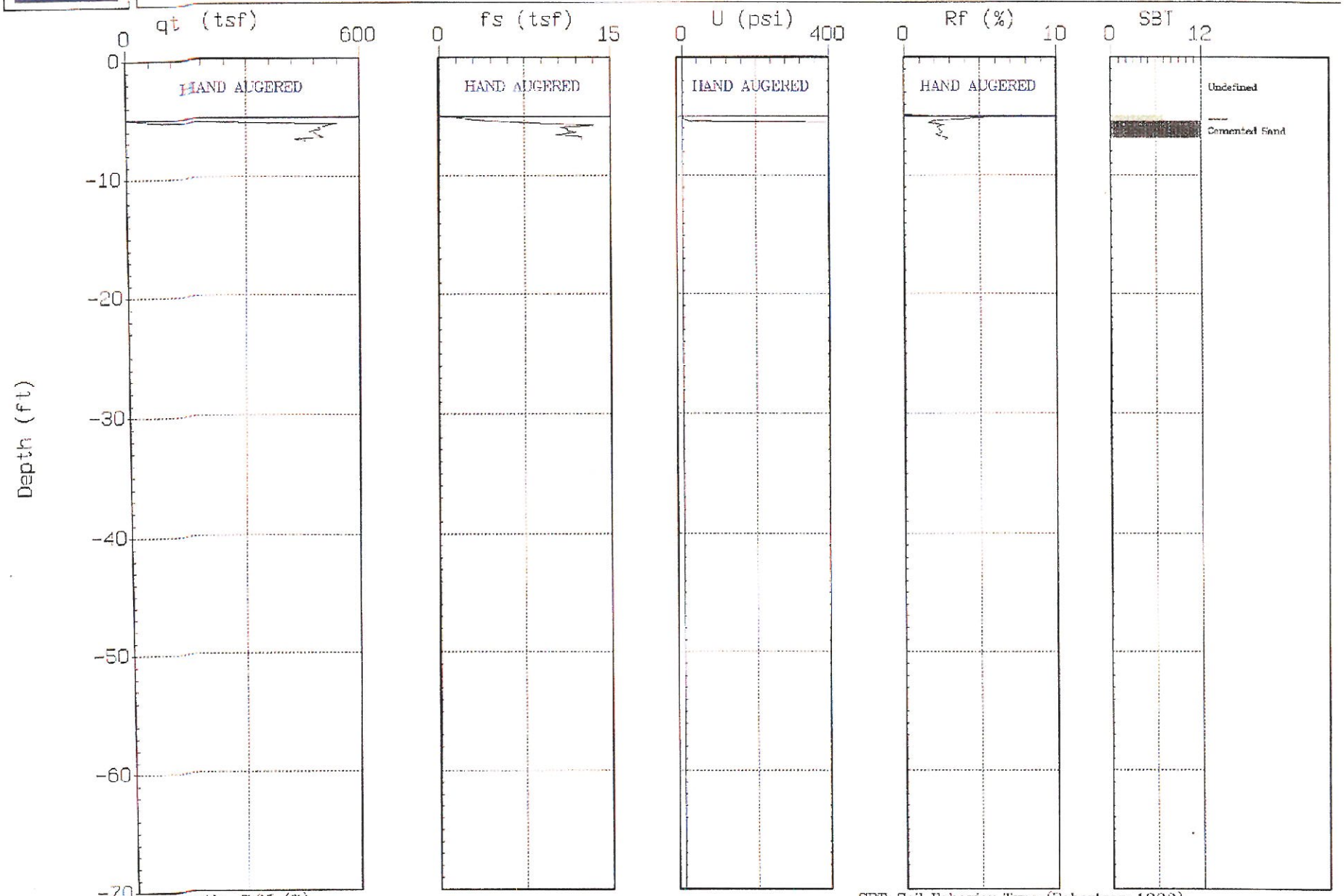
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B118AHP1

Geologist: R. GOLDBERG
Date: 05:11:04 13:47



Max. Depth: 7.05 (ft)
Depth Inc.: 0.164 (ft)

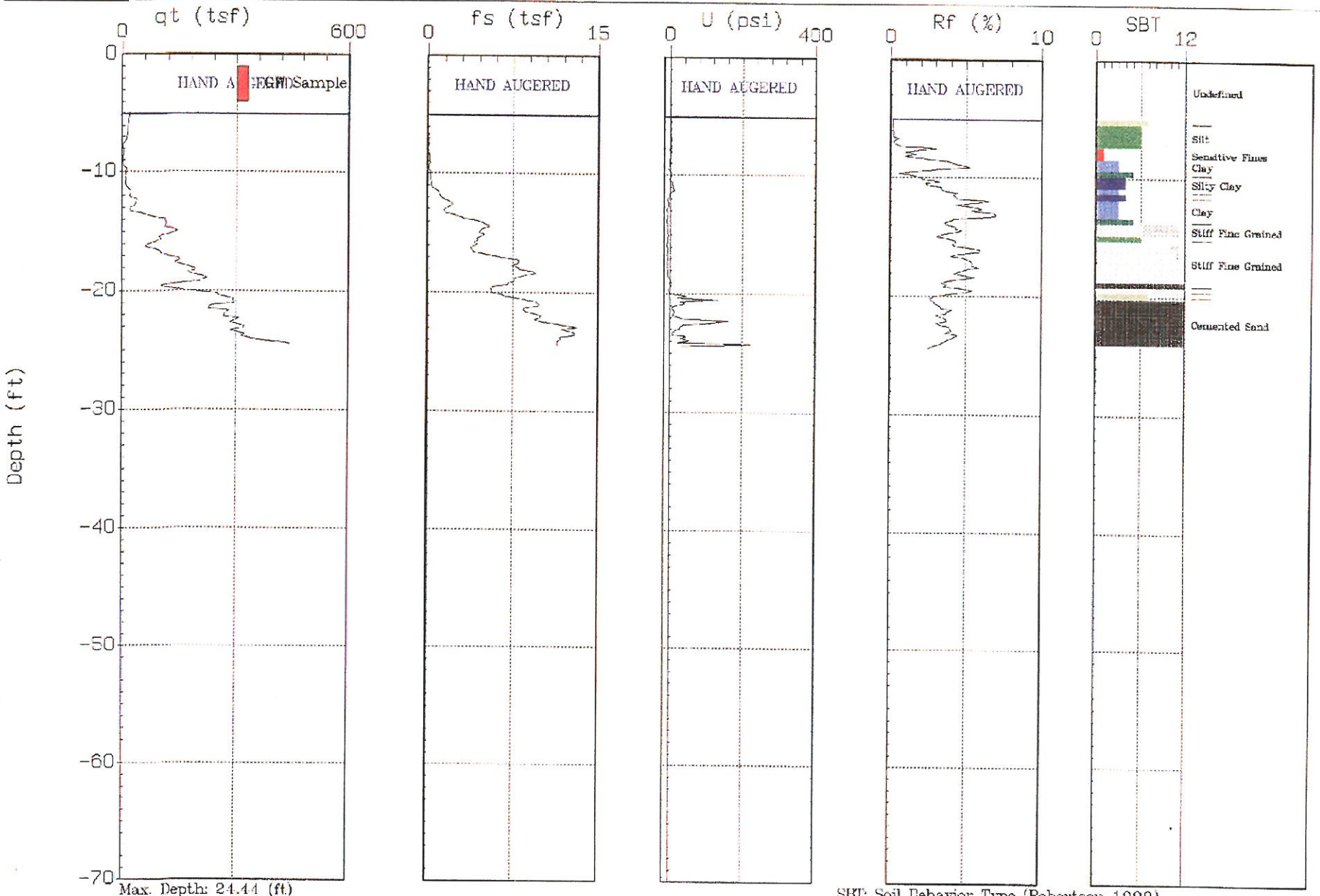
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B120HP1

Geologist: R. GOLDBERG
Date: 05:05:04 11:56



Max. Depth: 24.44 (ft)
Depth Inc.: 0.164 (ft)

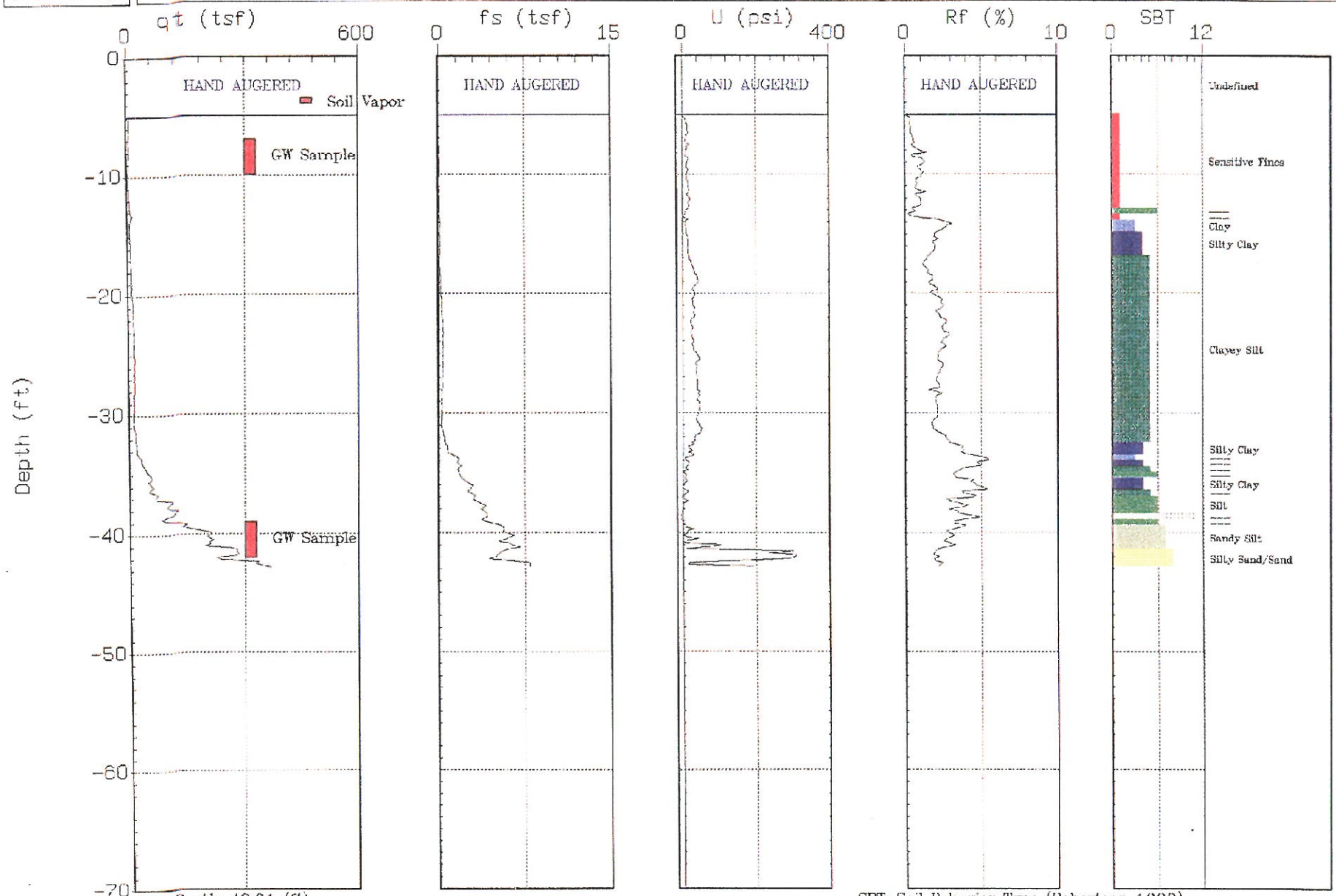
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B120HP2

Geologist: R. GOLDBERG
Date: 05:05:04 13:32



Max Depth: 42.81 (ft)
Depth Inc.: 0.164 (ft)

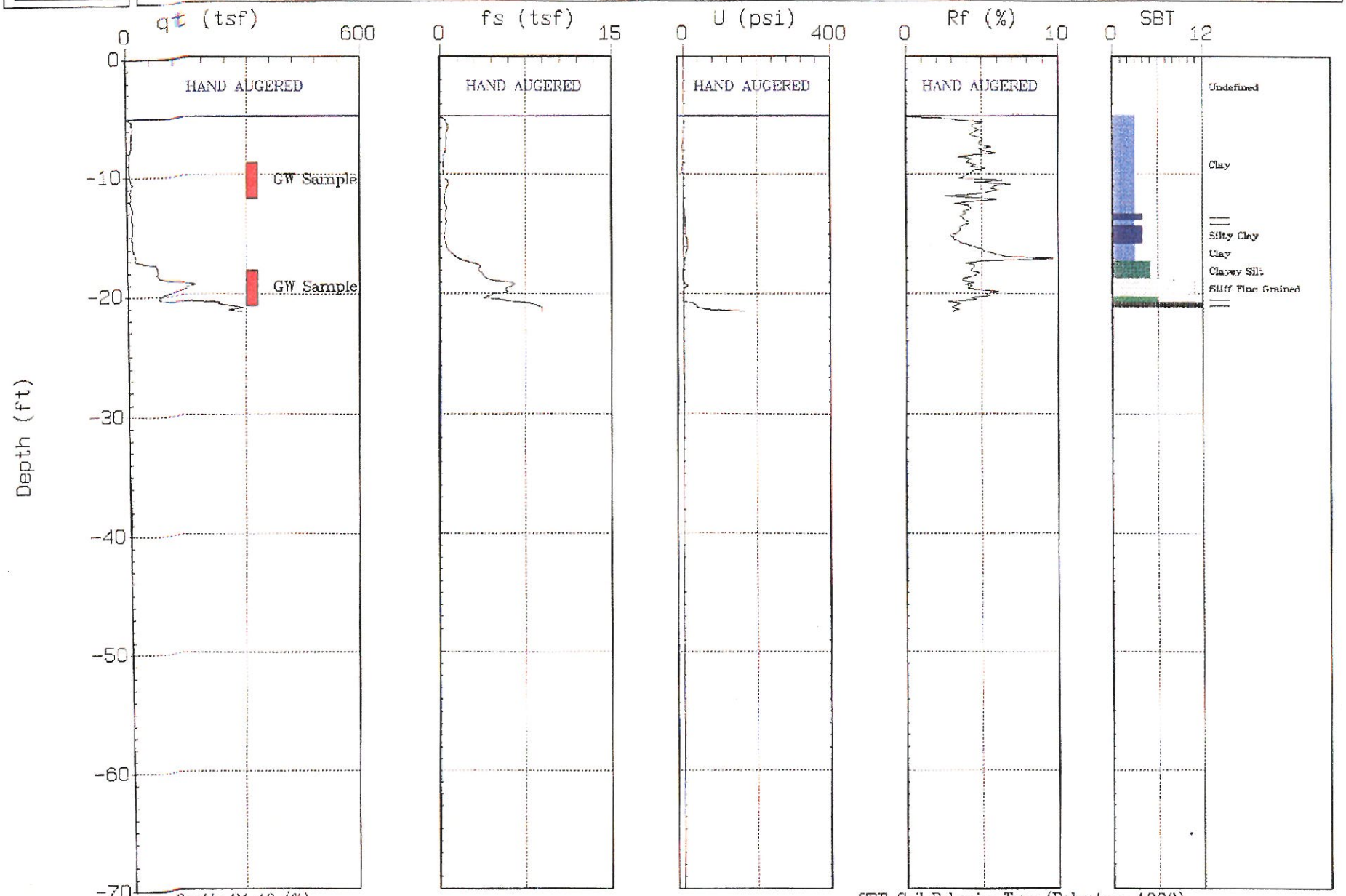
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-3120HP3

Geologist: R. GOLDBERG
Date: 05:24:04 09:31



Max. Depth: 21.49 (ft)
Depth Inc.: 0.164 (ft)

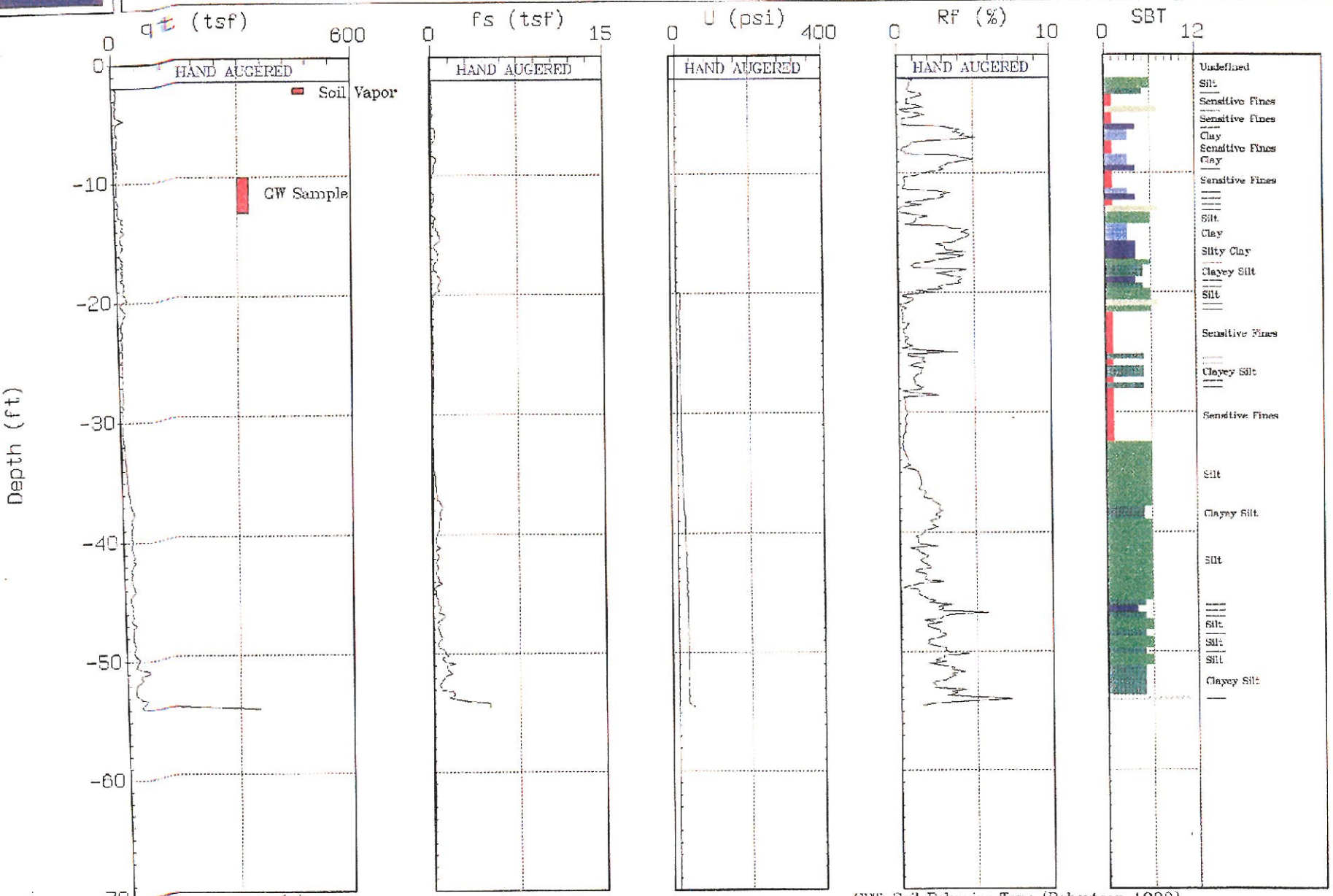
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-120HP4

Geologist: R. GOLDBERG
Date: 05:05:04 14:13



Max. Depth: 54.46 (ft)
Depth Inc.: 0.164 (ft)

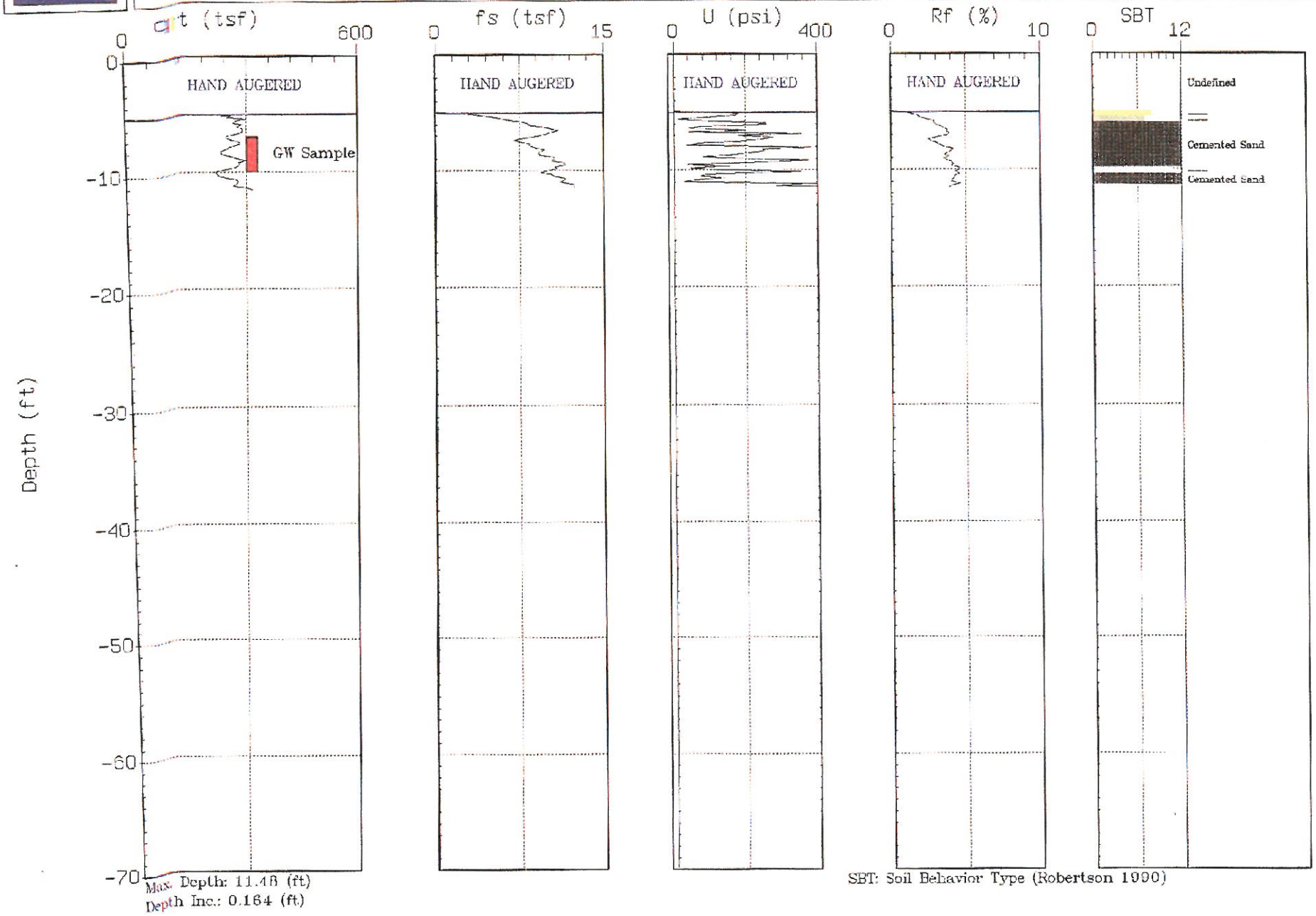
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B120HP5

Geologist: R. GOLDBERG
Date: 05:19:04 14:46



Max. Depth: 11.48 (ft)
Depth Inc.: 0.164 (ft)

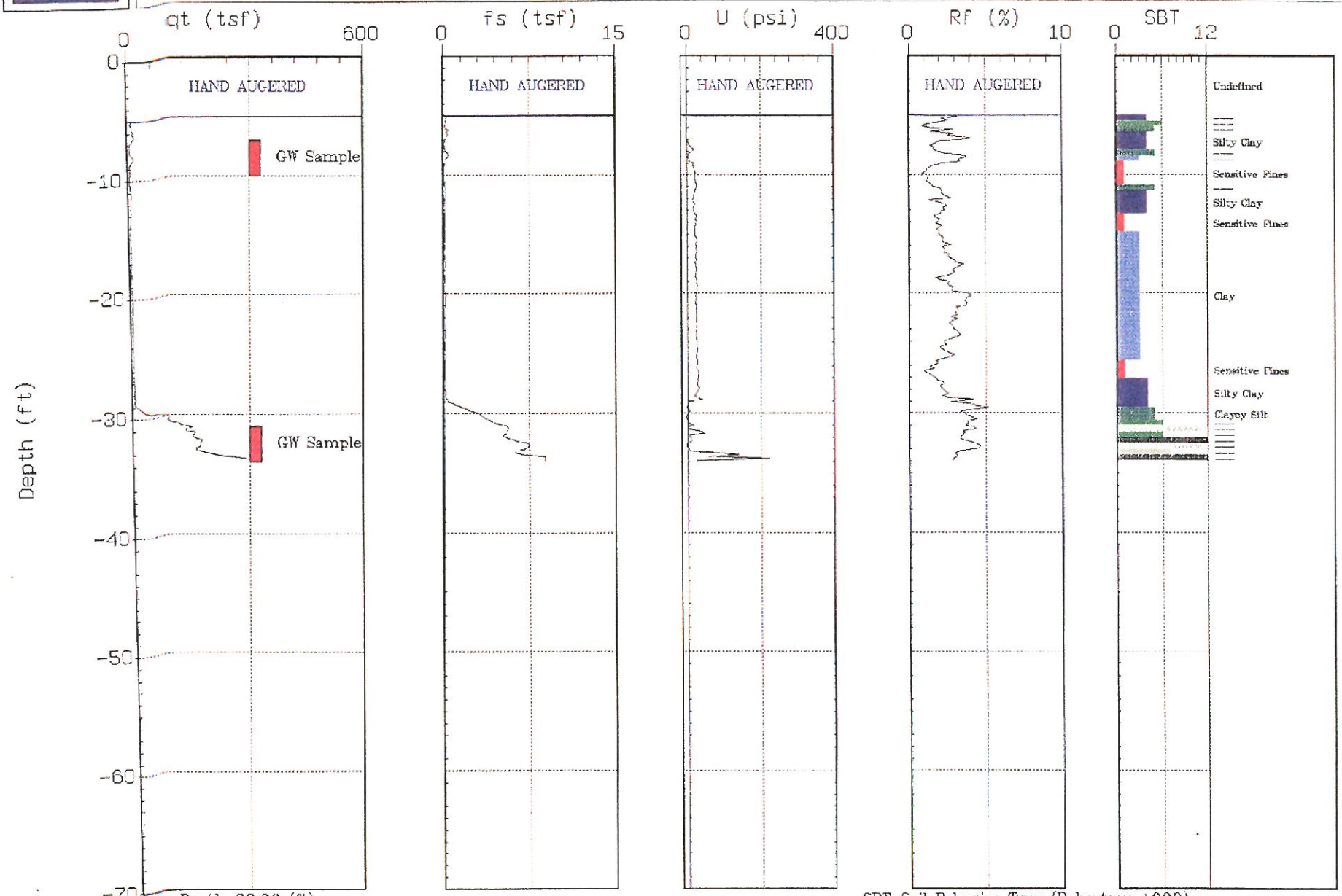
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B154HP1

Geologist: R. GOLDBERG
Date: 05:11:04 11:27



Max. Depth: 33.96 (ft)
Depth Inc.: 0.164 (ft)

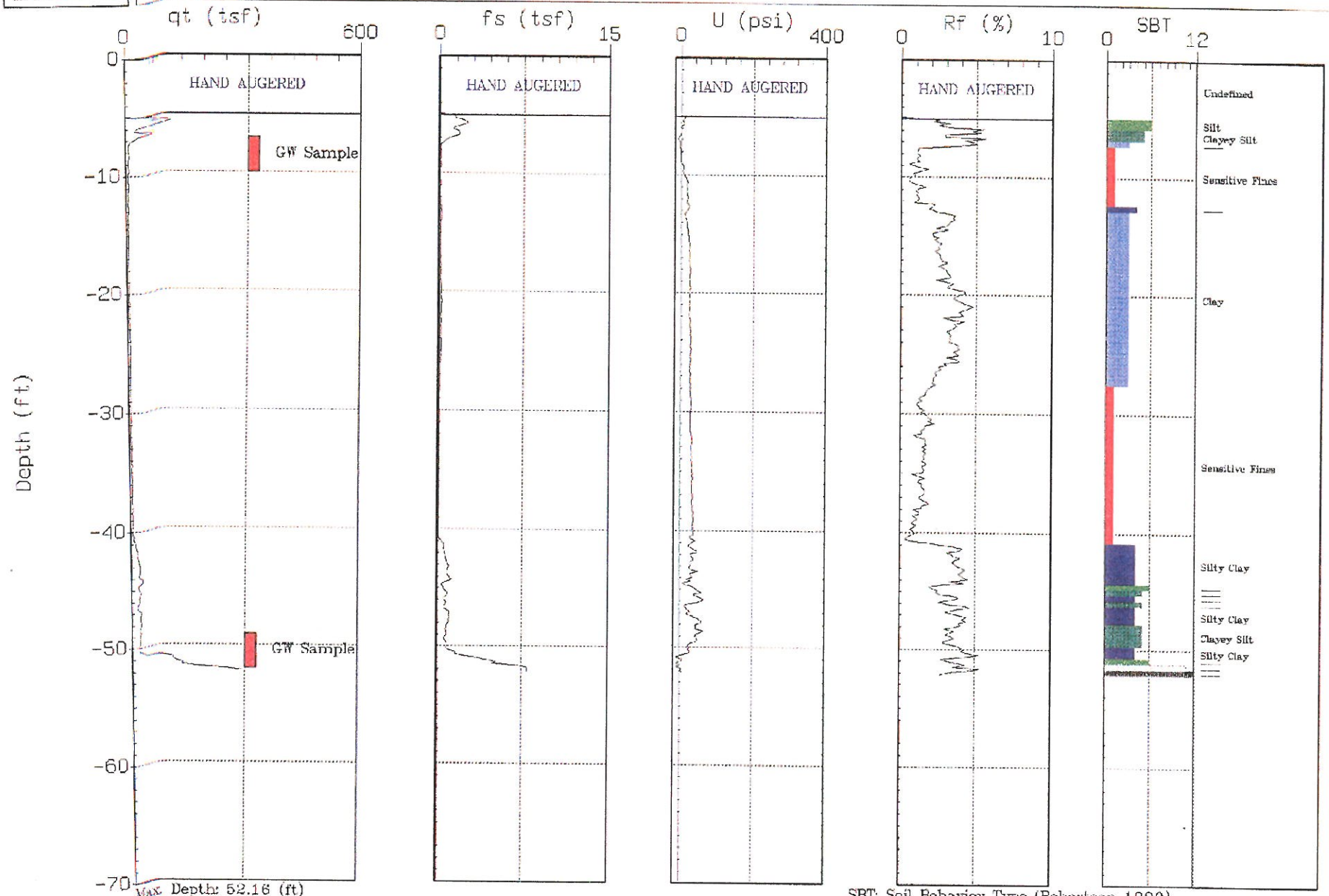
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B154HP2

Geologist: R. GOLDBERG
Date: 05:10:04 13:33



Max. Depth: 52.16 (ft)
Depth Inc.: 0.164 (ft)

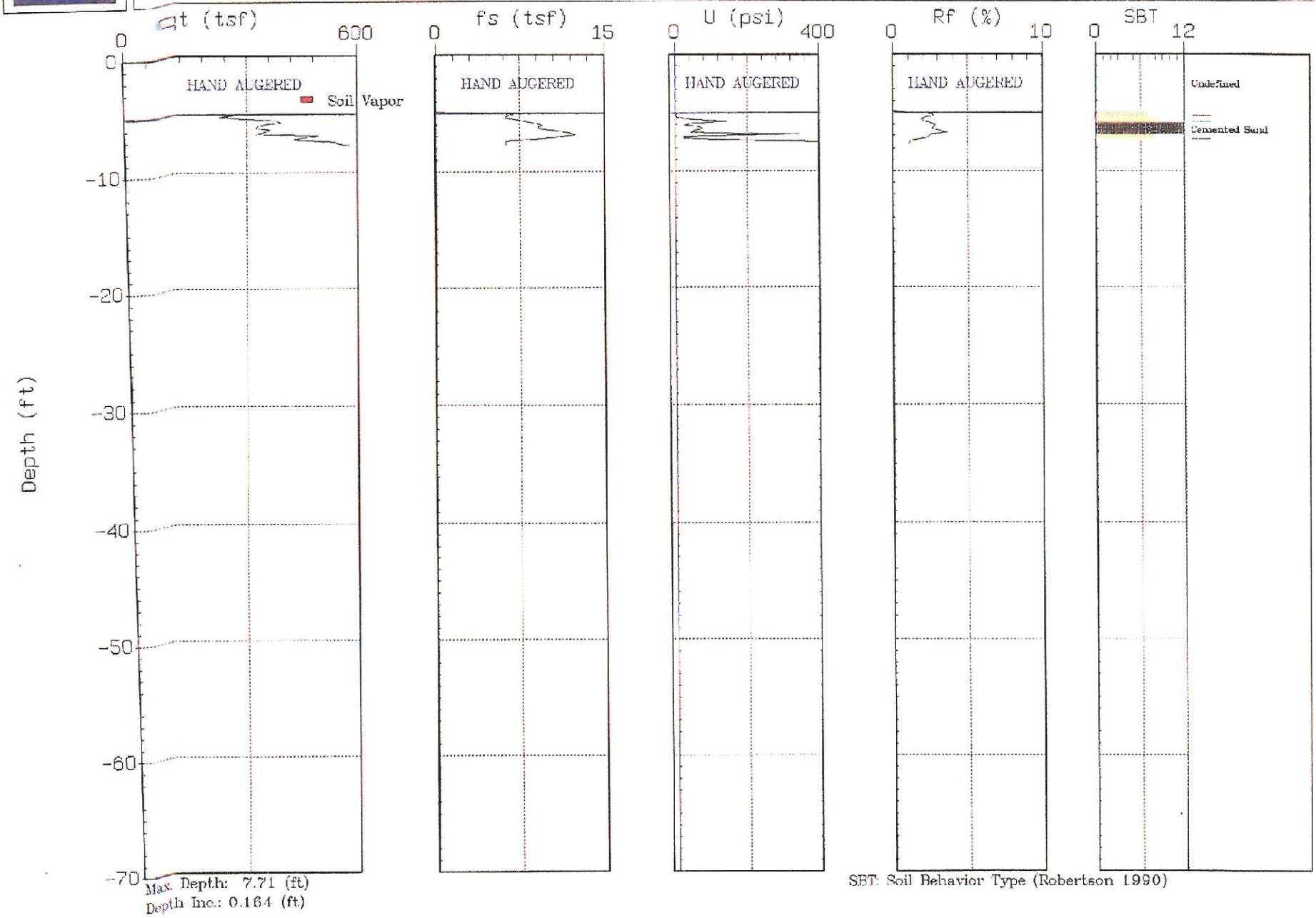
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-156HP1

Geologist: R. GOLDBERG
Date: 05:03:04 10:37

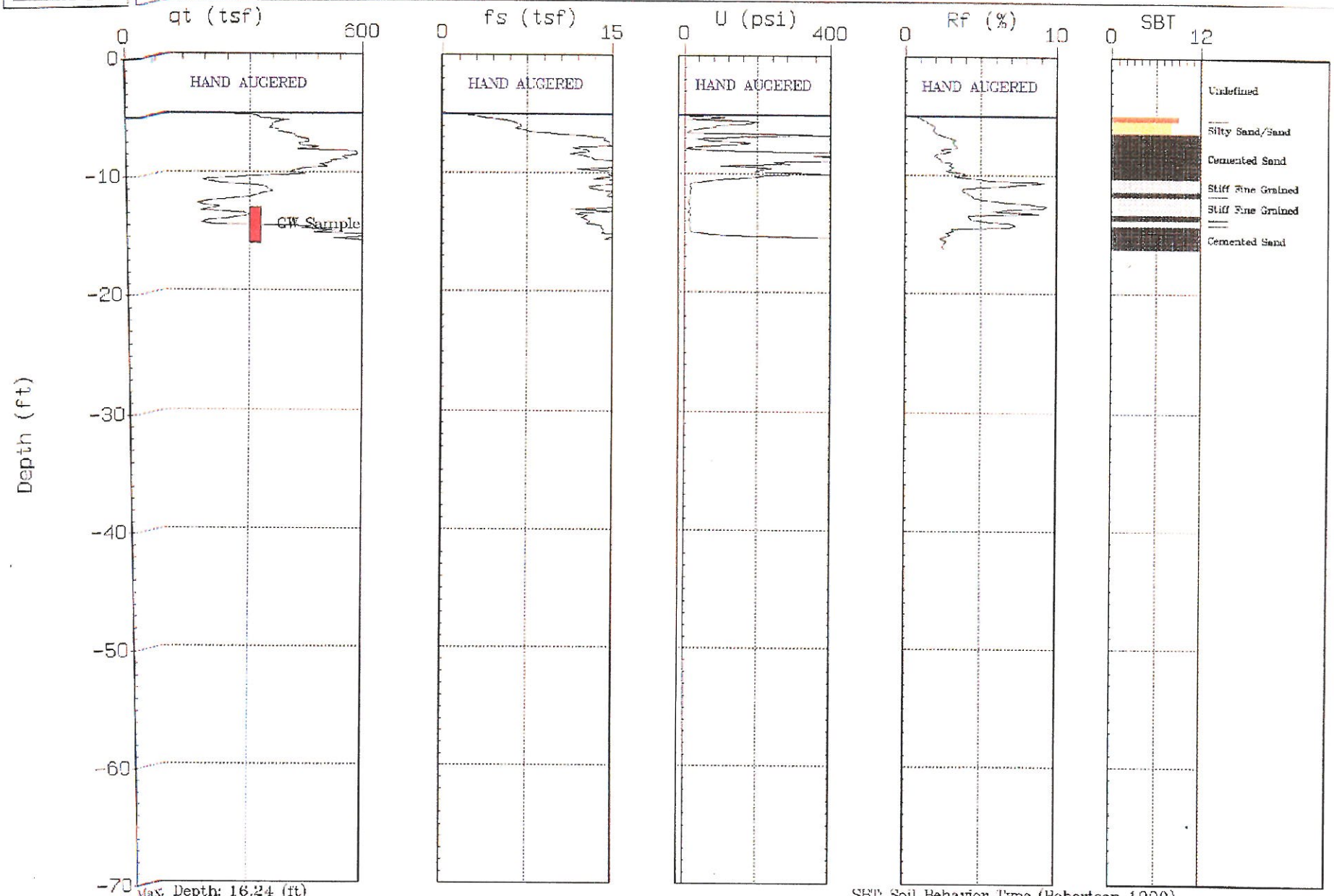


GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-B156-2

Geologist: R. GOLDBERG
Date: 04:30:04 13:26



Max. Depth: 16.24 (ft)
Depth Inc.: 0.164 (ft)

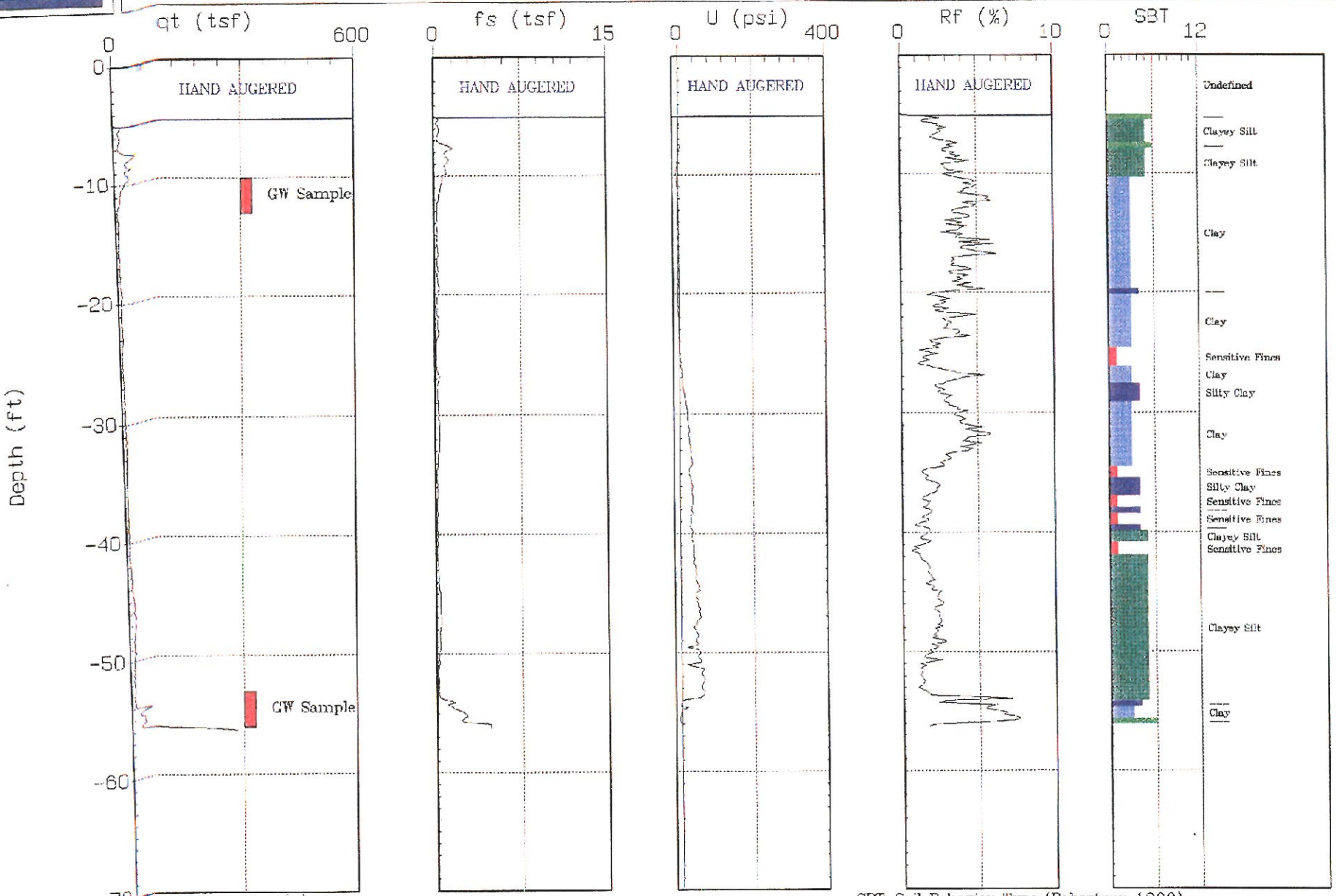
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B161HP1

Geologist: R. GOLDBERG
Date: 05:26:04 10:08



Max. Depth: 56.27 (ft)
Depth Inc.: 0.164 (ft)

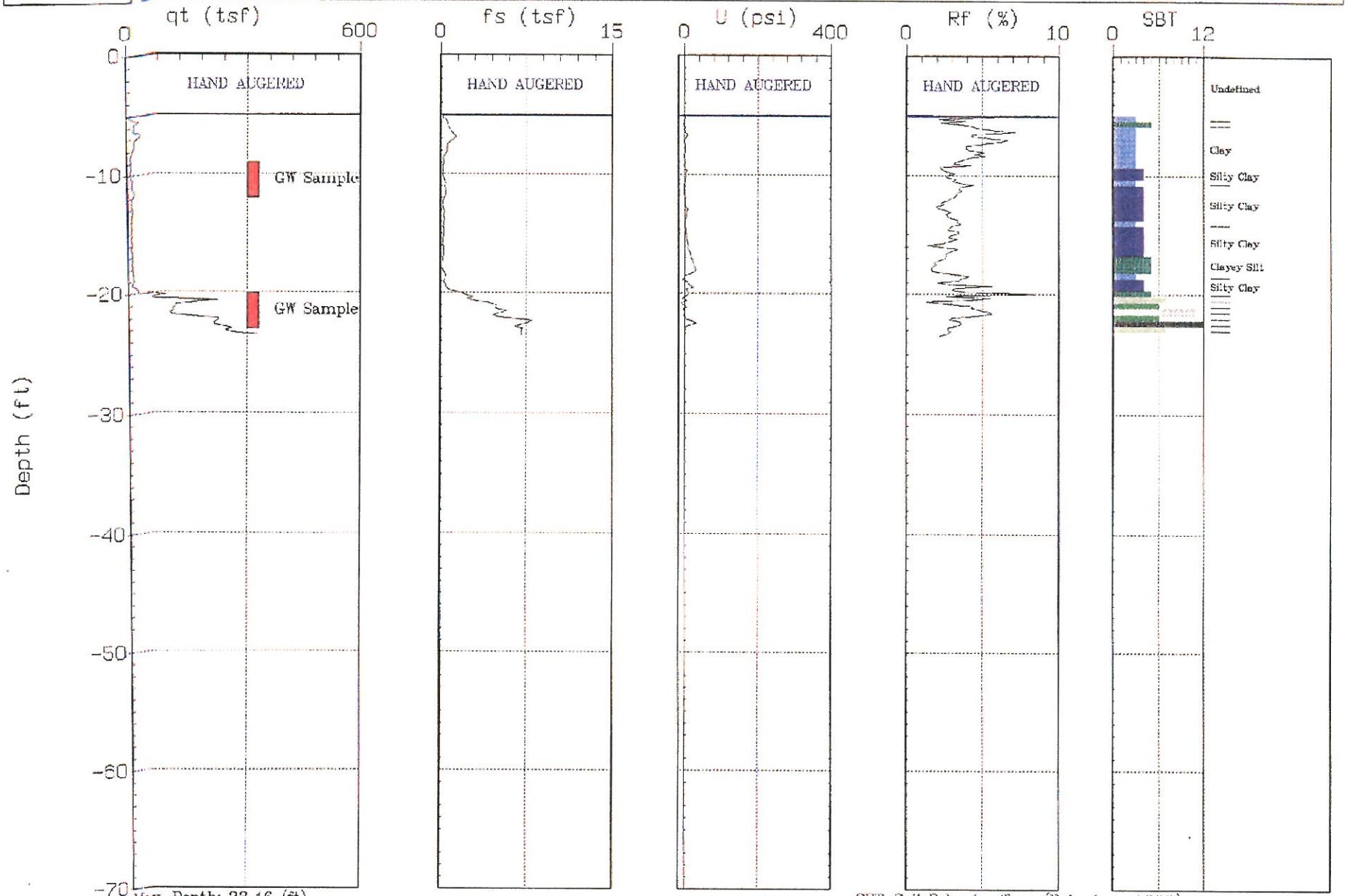
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-B161HP2

Geologist: R. GOLDBERG
Date: 05:24:04 11:55



Max. Depth: 23.46 (ft)
Depth Inc.: 0.164 (ft)

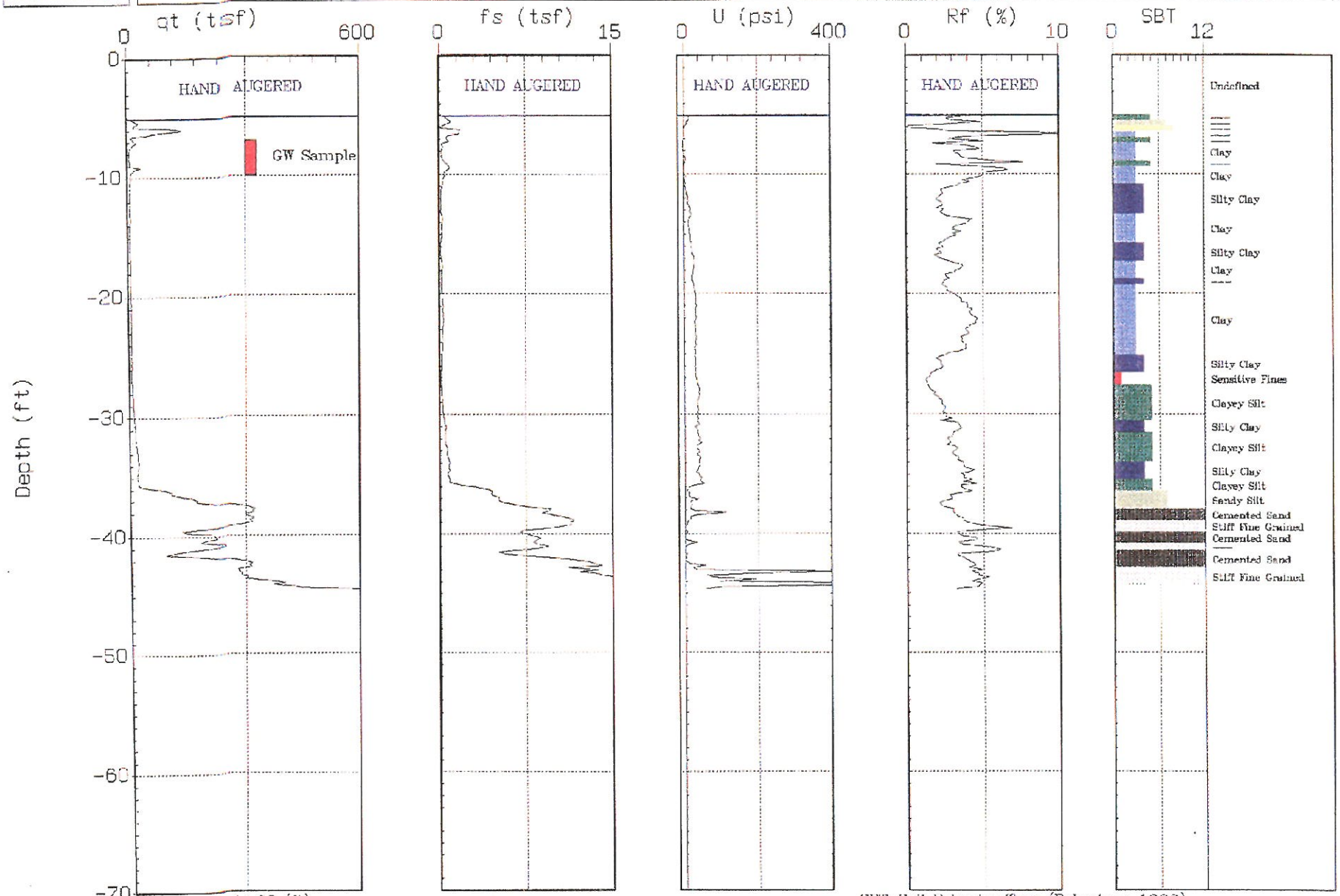
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-165-1

Geologist: R. GOLDBERG
Date: 04:30:04 10:35



Max. Depth: 44.62 (ft)
Depth Inc.: 0.164 (ft)

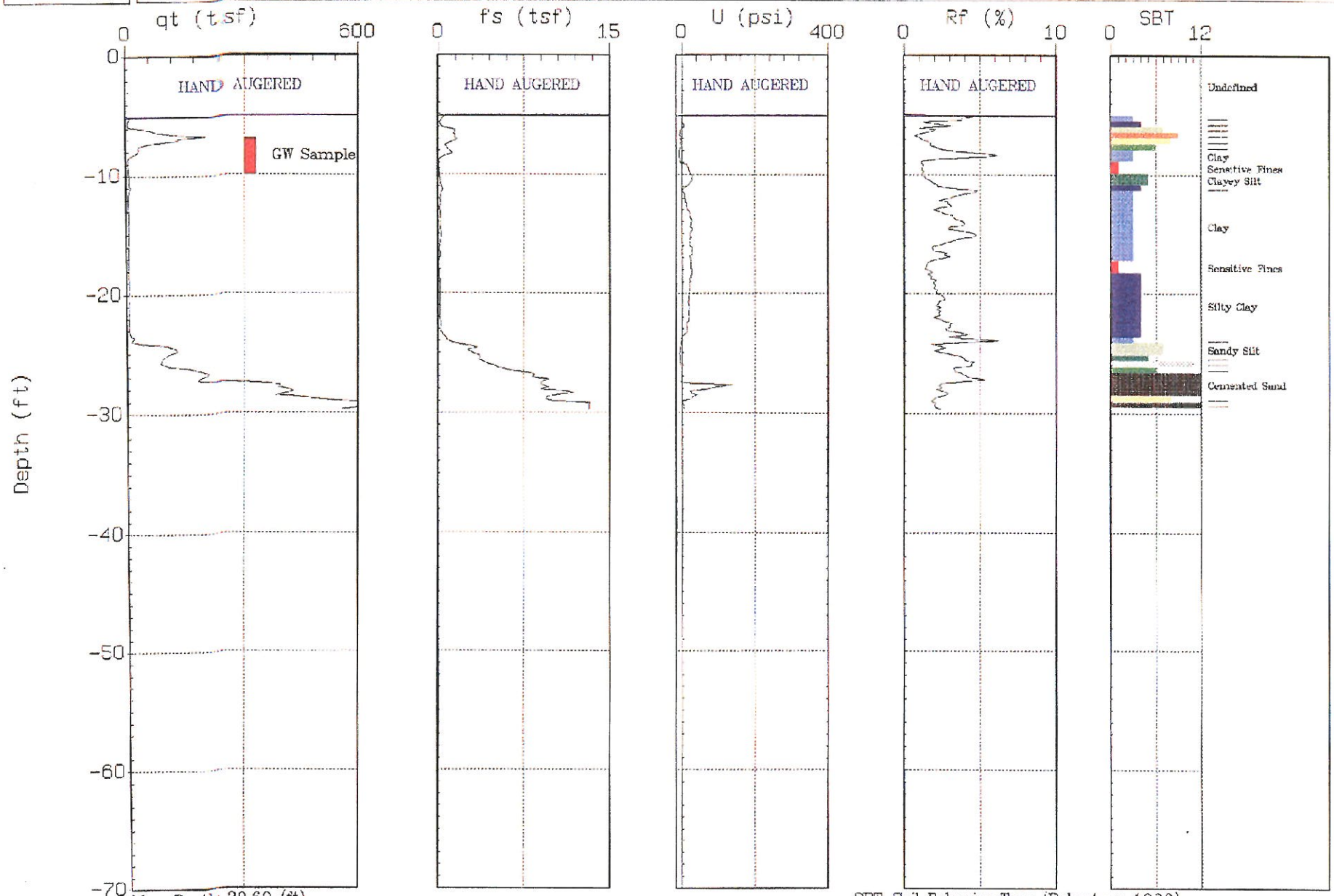
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENICIA ARSENAL
Location: CPT-165-2

Geologist: R. GOLDBERG
Date: 04:30:04 08:15



Max. Depth: 29.69 (ft)
Depth Inc.: 0.164 (ft)

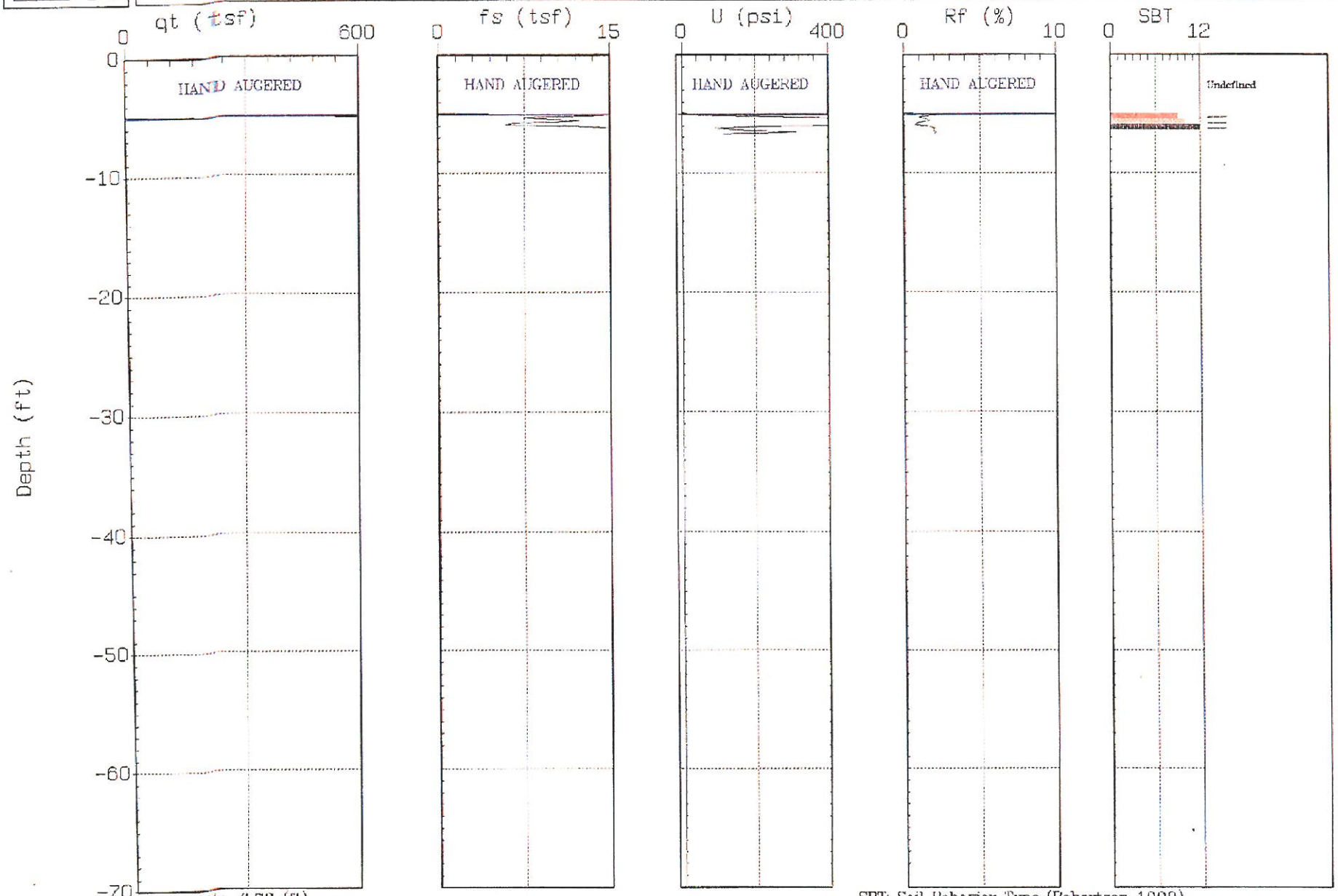
SBT: Soil Behavior Type (Robertson 1990)

GREGG

BROWN & CALDWELL

Site: BENECIA ARSENAL
Location: CPT-165HP3

Geologist: R. GOLDBERG
Date: 05:03:04 08:35



Max. Depth: 6.73 (ft)
Depth Inc.: 0.164 (ft)

SBT: Soil Behavior Type (Robertson 1990)