Installation and Verification Results
Work Area 2 Stone Column Test Areas
Third Runway Embankment Phase 4
SeaTac, Washington

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Prepared for
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July 24, 2001
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Prepared by
Hart Crowser, Inc.

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INSTALLATION AND VERIFICATION RESULTS
WORK AREA 2 STONE COLUMN TEST AREAS
THIRD RUNWAY EMBANKMENT PHASE 4
SEATAC, WASHINGTON

INTRODUCTION

This report provides a description of the installation and verification of stone columns in four Test Areas of Work Area 2 at the Third Runway Project. Work Area 2 is part of the Embankment Phase 4, and is located to the north of South 156th Street, and to the west of abandoned 12th Avenue South in SeaTac, Washington. Figure 1 is a Vicinity Map of the project area.

This report contains the following:

- Summary;
- Purpose and scope of this report;
- Overview of the stone column test program;
- Discussion of the individual Test Areas; and
- Appendices providing boring logs and cone penetrometer logs recorded before and after the installation of stone columns within each Test Area, as well as pertinent laboratory soil test data.

SUMMARY

Stone column installation tests were completed in Work Area 2 in June 2001. Four test areas were evaluated to assess changes in stone column installation procedure, spacing, and soil variability.

Based on our review, we conclude that while much of the data shows the stone column installations are consistent with expectations, there is significant variability between test results at close spacing. In our opinion, the ambiguity in the verification test data is unacceptable to justify reliance on this method of subgrade improvement for the Third Runway.

Since the four test sections represent the soil conditions we expect for much of the subgrade improvement areas, the results show it would not be practical to

rely on the verification test results to assure adequate quality control for this project. We note that both the contractor's methods and the verification test procedures in the specs are industry standard for this method of ground improvement, and there is no other generally accepted alternative for quality control. (For instance, it is conceivable but would be problematic to implement a performance spec based on shear wave velocity or load tests, on a production basis).

PURPOSE AND SCOPE OF THIS REPORT

The purpose of this report is to provide a summary and analysis of the Stone Column Test Program that was performed as part of the Phase 4 Embankment work for Third Runway.

The scope of this report includes:

- A general description of the test program;
- A description of each test area;
- A discussion of observations during stone column construction;
- A discussion of the verification program consisting of SPT-N borings and CPT probes, and conclusions drawn from verification testing; and
- Collection of data relative to stone column installation and verification testing.

OVERVIEW OF TEST PROGRAM

Background on Stone Column Work

Stone columns were proposed as an alternative to overexcavation and replacement of potentially liquefiable soils and compressible soils within the embankment subgrade. The intent of stone columns is to densify loose sands and/or provide additional stiffness by vibrating crushed rock into the ground in a regular pattern. Stone columns are designed using the concept of "Area Replacement Ratio," a number represented as A_r, and calculated as the percentage of stone emplaced within the tributary area of one stone column. The test patterns in Work Area 2 were designed for A_r values of 17 and 35 percent.

Four separate test areas were completed in Work Area 2. The locations of Test Areas 1 through 4 are shown on Figure 2. Verification testing was performed before and after stone column installation, which allowed evaluation of changes in subgrade density resulting from the stone column work. Verification testing included SPT-N blowcounts recorded at 2.5-foot-depth intervals in hollow-stem auger borings, as well as continuous cone tip resistance measured during cone penetration (CPT) tests. In addition, pore pressure dissipation tests were performed at various depths in CPT-05, CPT-06, and CPT-08. Results of these tests are included following the CPT logs, which have been attached with the boring logs in Appendices A through D.

Specifications for the store column work state that acceptance criteria include a measured corrected cone tip resistance of at least 110 tons per square foot, or a measured SPT-N value of at least 22 blows per foot in the verification explorations performed after stone column work. These minimum values are shown as red lines on the summary plots provided in the appendices.

Selected samples taken from borings in Test Areas 1 and 2 were submitted for laboratory grain size analysis. A discussion of these analyses and the test results are presented in Appendix E.

As part of ongoing work for the Third Runway project, Hart Crowser performed several studies in the general area of Work Area 2 that involved test pit explorations and borings. Selected soil samples from these explorations underwent laboratory grain size analyses and Atterberg limits tests. Appendix F presents the results of these tests from previous work in the area.

Hart Crowser Performed Construction QA during Column Installation

During installation of Stone Columns in Test Areas 1 through 4, a Hart Crowser representative was continuously present to record the following data for each stone column:

- Stone column depth of penetration and tip elevation;
- Amount of stone (weight) placed in each column;
- Power demand (in amps) from the probe vibrator; and
- Time required for probe penetration and column construction.

These data allowed us to compute an average column diameter for a given depth interval, as well as an overall average column diameter. Based on our observations, it appears that the contractor was successful in achieving the required minimum diameter for stone columns in Work Area 2.

Probe Amperage Monitored and Recorded

As part of the installation monitoring process, a Hart Crowser field representative observed the amperage required to power the vibrating probe during initial probe penetration and subsequent stone column construction (probe withdrawal and repenetration).

It is commonly accepted that higher amperage is related to denser ground conditions, and in some cases stone column contracts require that a minimum amperage be attained while building the column up from the base. In addition, amperage is used to define probe refusal. The contractor for the Third Runway project submitted a work plan that stated maximum probe amperage would be 280 amps for this project.

During typical stone column construction in soft ground, we would normally expect relatively low amperage (on the order of about 150 to 180 amps) at the start of column construction, with the amperage increasing to about 250 amps or higher as compacted stone is continually placed in successive lifts during column construction. Where the probe encounters dense ground refusal at its tip elevation, amperage could be greater than 200 amps at the base of the column, increasing up to over 300 amps during subsequent column construction.

DISCUSSION OF INDIVIDUAL TEST AREAS

Test Area 1

Stone Column Layout

Test Area 1, shown on Figure 2, was completed near the southeast corner of Work Area 2, and had an average ground surface elevation of about 291 feet before stone column work commenced. The test pattern in this area consisted of 32 42-inch-diameter stone columns in a triangular pattern at 8 foot center to center spacing as shown on Figure 3. With the exception noted in the following paragraph, this pattern resulted in a minimum A_r for Test Area 1 of 17 percent. Column depths ranged from 17 to 19 feet below ground surface, corresponding to a stone column tip elevation ranging from about 272 to about 274 feet.

In the southeast corner of Test Area 1, nine additional 28-inch-diameter columns were installed to depths ranging from 15 to 18 feet below ground surface in the center of the triangular pattern to achieve a minimum A_r of 35 percent in this area.

Installation Observations

During installation of stone columns in Test Area 1, water was observed flowing from newly constructed columns up to the ground surface. This phenomenon led to softening of the upper soils, a problem which was exacerbated by rainy weather that soaked the ground around the site. Because the upper soils in the work area became very soft, the front-end loader used during the stone column installation caused deep rutting in the ground surface. The ground surface surrounding the stone columns heaved on the order of about 1 to 3 feet, and this soil was continuously removed during installation to facilitate work activities. In addition to heave at the ground surface, the probe was observed to have substantial cohesive soils sticking to it as it was withdrawn from the hole. This relatively "dirty" probe could be attributed to either the upper soft native soils, or disturbance of relatively stiff native cohesive soils at depth.

During construction of the columns in Test Area 1, the amperage of the probe was observed to remain relatively steady at about 160 to 200 amps as the column was being built to the ground surface. These amp readings are lower than we would normally expect to see as crushed rock in the column is compacted. We attribute the low amp readings to soft ground conditions encountered during construction, which may have resulted in lateral spread of the crushed rock as it was dropped from the base of the probe.

Verification Test Program and Results

Test Program Description. Within Test Area 1, two borings and two cone penetrometers were advanced prior to the installation of stone columns. After completing columns in this area, about 1 foot of ground heave was bladed off the top of the Test Area to try to locate the tops of the stone columns. The ground was allowed to dry for several days to facilitate access for the testing equipment. Six days after columns were complete, three borings were advanced in Test Area 1. Seven days after columns were completed, two cone penetrometers were advanced in this area. Fifteen days after completion of stone columns, one additional boring and one additional cone penetrometer were advanced in Test Area 1. Table 1 lists the numerical designation and location of explorations in Work Area 2, relative to their respective Test Areas.

Figure 3 provides a map of the stone column layout relative to the explorations advanced before and after column installation. Appendix A contains a summary plot of the borings and cone penetrometers, as well as the individual logs recorded for each of the borings and cone penetrometers in Test Area 1.

Test Program Results. CPT data recorded after stone column installation indicate that some densification occurred from 0 to 6 feet below the ground surface where clean sand is present. The CPT data did not indicate significant change in density for the silty sands present from 6 to 10 feet below the ground surface.

In contrast to the CPT data, the SPT data indicated little improvement in the 0- to 6-foot-depth range after 7 days, and some possible improvement in this area 15 days after column completion. Below 6 feet, SPT data indicated that density might have actually decreased during stone column installation.

Prior to stone column installation, CPT refusal occurred at a depth of 14 feet. After stone column installation, CPT refusal occurred between depths of 16 to 18 feet. This suggests that the deeper soils may have been disturbed during stone column installation.

Test Area 2

Stone Column Layout

Test Area 2 was completed immediately to the north of Test Area 1, as shown on Figure 2, and had an average ground surface elevation of about 291 feet before stone column work commenced. The test pattern in this area consisted of 32 36-inch-diameter stone columns in a triangular pattern at 7-foot center to center spacing. With the exception noted in the following paragraph, this pattern resulted in a minimum A_r for Test Area 2 of 17 percent. Column depths ranged from 18 to 19 feet below ground surface, corresponding to a stone column tip elevation ranging from about 272 to about 273 feet.

Similar to Test Area 1, in the southeast corner of Test Area 2, nine additional 25-inch-diameter columns were installed to depths ranging from 18 to 19 feet below ground surface in the center of the triangular pattern to achieve a design A_r of 35 percent.

Installation Observations

As in Test Area 1, during installation of stone columns in Test Area 2 water was observed flowing from newly constructed columns up to the ground surface.

This phenomenon led to softening of the upper soils, a problem which was exacerbated by rainy weather that soaked the ground around the site. Because the upper soils in the work area became very soft, the front-end loader used during the stone column installation caused deep rutting in the ground surface. The ground surface surrounding the stone columns heaved on the order of about 1 to 3 feet, and this soil was continuously removed during installation to facilitate work activities. Again as in Area 1, the probe was relatively dirty during withdrawal.

During construction of the columns in Test Area 2, the amperage of the probe was observed to range between about 140 to 220 amps as the column was being built to the ground surface. Again we attribute the low amp readings to soft ground conditions encountered during construction, which may have resulted in lateral spread of the gravel as it was dropped from the base of the probe.

Verification Test Program and Results

Test Program Description. Within Test Area 2, two borings and two cone penetrometers were advanced prior to the installation of stone columns. After completing columns in this area, about 1 foot of ground heave was bladed off the top of the Test Area to try to locate the tops of the stone columns. The ground was allowed to dry for several days to facilitate access for the testing equipment. Five days after columns were complete, two borings were advanced in Test Area 2. Six days after columns were completed, two cone penetrometers were advanced in this area. Fourteen days after completion of stone columns, one additional boring, and one additional cone penetrometer were advanced in Test Area 2. Table 1 lists the numerical designation and location of explorations in Work Area 2, relative to their respective Test Areas.

Figure 3 provides a map of the stone column layout relative to the explorations advanced before and after column installation. Appendix B contains a summary plot of the borings and cone penetrometers, as well as the individual logs recorded for each of the borings and cone penetrometers in Test Area 2.

Test Program Results. Data recorded by CPT-10 after stone column installation indicate apparent densification of sand from 0 to 5 feet below ground surface where clean sand is present. The other two CPT tests (CPT-7 and CPT-8) show that the density of this upper soil, interpreted to be silty and clayey sand, was not much improved by the stone columns. The CPT tests show good improvement from depths of 5 to 9 feet, but between 8 and 18 feet, the tip resistance recorded in CPT-10 is in sharp contrast to that recorded in CPT-7 and CPT-8.

Overall, the SPT blowcounts appear to have not changed, or to be somewhat reduced following stone column work.

Prior to stone column installation, CPT refusal occurred at a depth of 14 feet. After stone column installation, CPT refusal occurred at 17 feet. This suggests that the deeper soils may have been disturbed during stone column installation.

Test Area 3

Stone Column Layout

Test Area 3 was completed along the western edge of Work Area 2, near N21018/E10709, and had an average ground surface elevation of about 283 feet before stone column work commenced. The test pattern in this area consisted of 41 42-inch-diameter stone columns in a triangular pattern at 5.8-foot center to center spacing. This pattern resulted in a minimum A_r for Test Area 3 of 35 percent. Column depths ranged from 9 to 12 feet below ground surface, corresponding to a stone column tip elevation ranging from about 271 to about 274 feet.

Installation Observations

During installation of stone columns in Test Area 3, the ground surface remained dry, and very little water was brought to the surface through existing columns. Hart Crowser's field representative worked closely with the stone column crane operator to define refusal criteria that were intended to limit any disturbance of the stiff to hard cohesive soils that were present below depths of about 12 feet. These criteria were relatively subjective and required close observation of the behavior and sound of the vibrator probe. Although amperage was continuously monitored during the initial probe advance, the presence of the stiff to hard underlying soils was not definitively indicated by consistent higher amperage. Based on the cleanliness of the probe, as well as the lack of heave at the ground surface, it is likely that there was not significant penetration of the vibrator probe into the stiff to hard underlying soils.

During construction of the columns in Test Area 3, the amperage of the probe was observed to range from about 250 to 300 amps as the column was being built up to the ground surface. These higher amperage readings indicate higher compaction within the stone column, which suggests that the surrounding soils were also being densified.

Verification Test Program and Results

Test Program Description. Within Test Area 3, two borings and four cone penetrometers were advanced prior to the installation of stone columns. After completing columns in this area, about 6 inches of the ground surface was bladed off the top of the Test Area to locate the tops of the stone columns. Six days after columns were complete, two borings and two cone penetrometers were advanced in this area. Table 1 lists the numerical designation and location of explorations in Work Area 2, relative to their respective Test Areas.

Figure 4 provides a map of the stone column layout relative to the explorations advanced before and after column installation. Appendix C contains a summary plot of the borings and cone penetrometers, as well as the individual logs recorded for each of the borings and cone penetrometers in Test Area 3.

Test Program Results. The four CPT tests performed prior to stone column work show inconsistent tip resistance in the depth interval from 2 to 6 feet. Comparing CPT results after stone column installation, CPT-21 indicates that density decreased in this interval, while CPT-22 indicates large improvement in tip resistance from depths of 2 to 6 feet. In the depth range of 6 to 12 feet, results from CPT-21 and CPT-22 contrast one another, and alternatively indicate lower tip resistance when compared to the four CPT tests performed prior to stone column construction.

The SPT results indicate no improvement in density in the depth interval from 0 to 10 feet, while below a depth of 10 feet, blowcounts decreased following stone column installation, indicating looser subgrade conditions.

Test Area 4

Stone Column Layout

Test Area 4 was completed near the northern limit of Work Area 2, as shown on Figure 2, and had an average ground surface elevation of about 287 feet before stone column work commenced. The test pattern in this area consisted of 41 42-inch-diameter stone columns in a triangular pattern at 8-foot center to center spacing. This pattern resulted in a minimum A_r for Test Area 4 of 17 percent. Column depths ranged from 13 to 16 feet below ground surface, corresponding to a stone column tip elevation ranging from about 271 to about 275 feet, with the majority of columns tipped at 274 feet.

Installation Observations

During installation of stone columns in Test Area 4, the ground surface remained dry, and very little water was brought to the surface through existing columns. At some column locations, a cone of depression formed around the probe during initial penetration, indication densification of the sands surrounding the probe. As in Test Area 3, Hart Crowser's field representative worked closely with the stone column crane operator to define refusal criteria that were intended to limit any disturbance of the stiff to hard cohesive soils that were present below a depth of about 15 feet. These criteria were relatively subjective and required close observation of the behavior and sound of the vibrator probe. Although amperage was continuously monitored during the initial probe advance, the presence of the stiff to hard underlying soils was not definitively indicated by consistent higher amperage. Based on the cleanliness of the probe, as well as the lack of heave at the ground surface, it is likely that there was not significant penetration of the vibrator probe into the stiff to hard underlying soils.

During construction of the columns in Test Area 4, the amperage of the probe was observed to range from about 220 to 300 amps as the column was being built up to the ground surface. These higher amperage readings indicate denser soil conditions within the stone column, which suggests that the surrounding soils were also being densified.

Verification Test Program and Results

Test Program Description. Within Test Area 4, two borings and four cone penetrometers were advanced prior to the installation of stone columns. After completing columns in this area, about 6 inches of the ground surface was bladed off the top of the Test Area to locate the tops of the stone columns. Two days after columns were complete, two borings and two cone penetrometers were advanced in this area. Table 1 lists the numerical designation and location of explorations in Work Area 2, relative to their respective Test Areas.

Figure 5 provides a map of the stone column layout relative to the explorations advanced before and after column installation. Appendix D contains a summary plot of the borings and cone penetrometers, as well as the individual logs recorded for each of the borings and cone penetrometers in Test Area 4.

Test Program Results. The four CPT tests performed prior to stone column work show significant variability in tip resistance in the depth interval from 0 to 8 feet. Comparing CPT results after stone column installation, CPT-20 shows no improvement in tip resistance compared with CPT-11 down to a depth of 5 feet, with some improvement from depths of 5 to 7 feet. CPT-19 indicates improvement in tip resistance from 0 to 6 feet when compared to CPT-14, but no change in tip resistance in the silts and clays down to depths of about 13 feet. CPT-19 had deeper refusal after stone column work compared to CPT-14, indicating that there was potentially some disturbance of the stiff to hard cohesive soils at the base of the stone columns.

The SPT results suggest some improvement has occurred in the density of the sand and silty sand subgrade.

USE OF THIS REPORT

Hart Crowser's work on this project was performed, and this report prepared, in accordance with generally accepted geotechnical engineering practices for the nature and conditions of the work completed in the same or similar localities at the time the work was performed. This report is intended for the exclusive use of HNTB Corporation and the Port of Seattle for specific application to the site described herein. No other warranty, express or implied, is made.

Please call if you have any questions.

F:\Docs\Jobs\497844\WorkArea2(rpt).doc

Table 1 - Summary of Explorations in Test Areas

Test Area 1 - Completed 6/5/2001

Borings before stone column installation	Borings after stone column installation	Interval between completion of columns and exploration
B-1	B-1a	6 days
B-2	B-2a	6 days
	B-5a	6 days
	B-7a	15 days

Cones before stone column installation	Cones after stone column installation	Interval between completion of columns and exploration
CPT-3	CPT-5	7 days
CPT-4	CPT-6	7 days
	CPT-9	15 days

Test Area 2 - Completed 6/6/2001

Borings before stone column installation	Borings after stone column installation	Interval between completion of columns and exploration
B-3	B-3a	5 days
B-4	B-4a	5 days
	B-6a	14 days

Cones before stone column installation	Cones after stone column installation	Interval between completion of columns and exploration
CPT-1	CPT-7	6 days
CPT-2	CPT-8	6 days
	CPT-10	14 days

Test Area 3 - Completed 6/21/2001

Borings before stone column installation	Borings after stone column installation	Interval between completion of columns and exploration
B-12	B-22a	6 days
B-13	B-23a	6 days

Cones before stone column installation	Cones after stone column installation	Interval between completion of columns and exploration
CPT-15	CPT-21	6 days
CPT-16	CPT-22	6 days
CPT-17		
CPT-18		

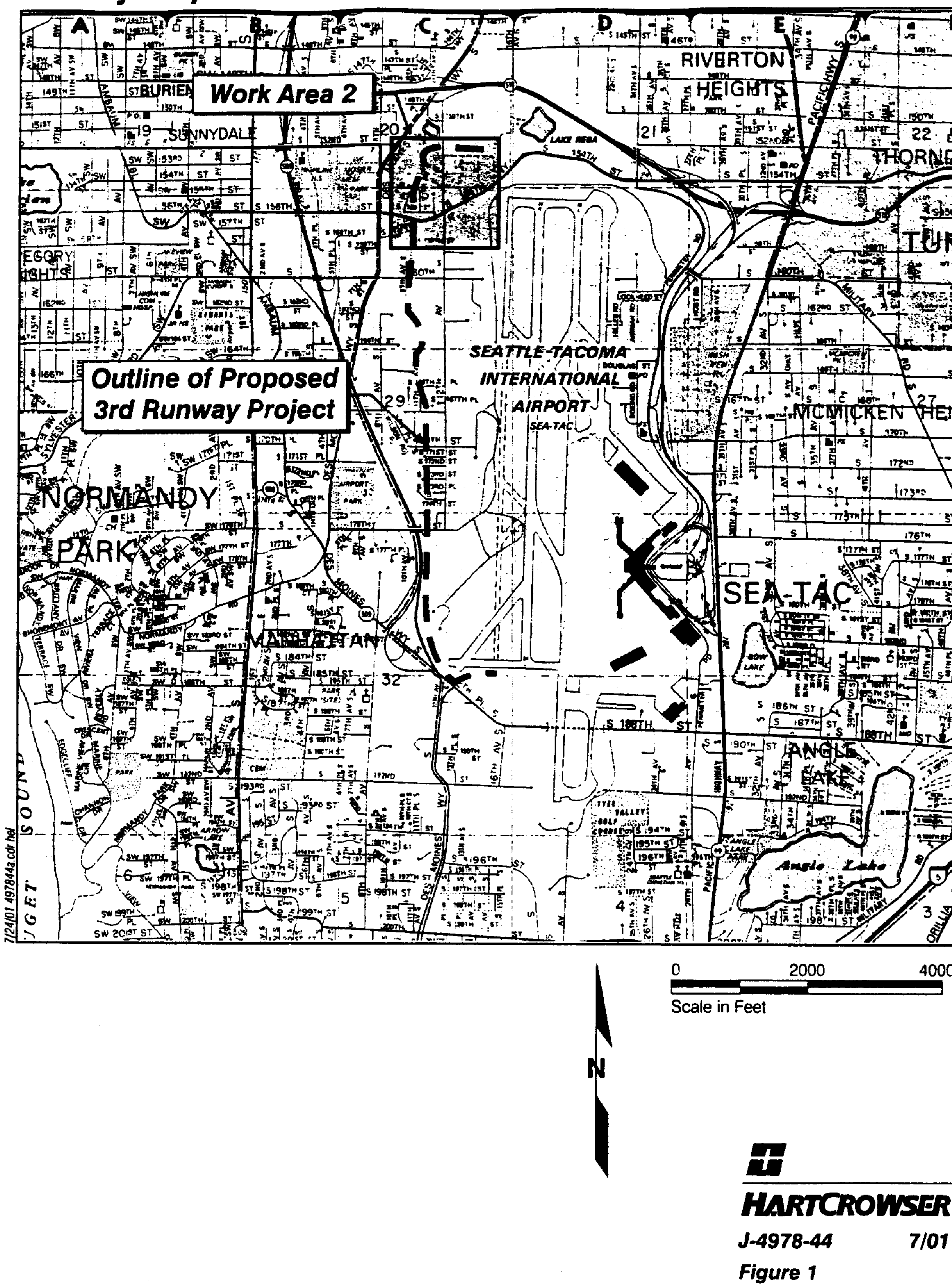
Table 1 - Summary of Explorations in Test Areas

Test Area 4 - Completed 6/25/2001

Borings before stone column installation	Borings after stone column installation	Interval between completion of columns and exploration
B-10	B-20a	2 days
B-11	B-21a	2 days

Cones before stone column installation	Cones after stone column installation	Interval between completion of columns and exploration
CPT-11	CPT-19	2 days
CPT-12	CPT-20	2 days
CPT-13		
CPT-14		

Vicinity Map



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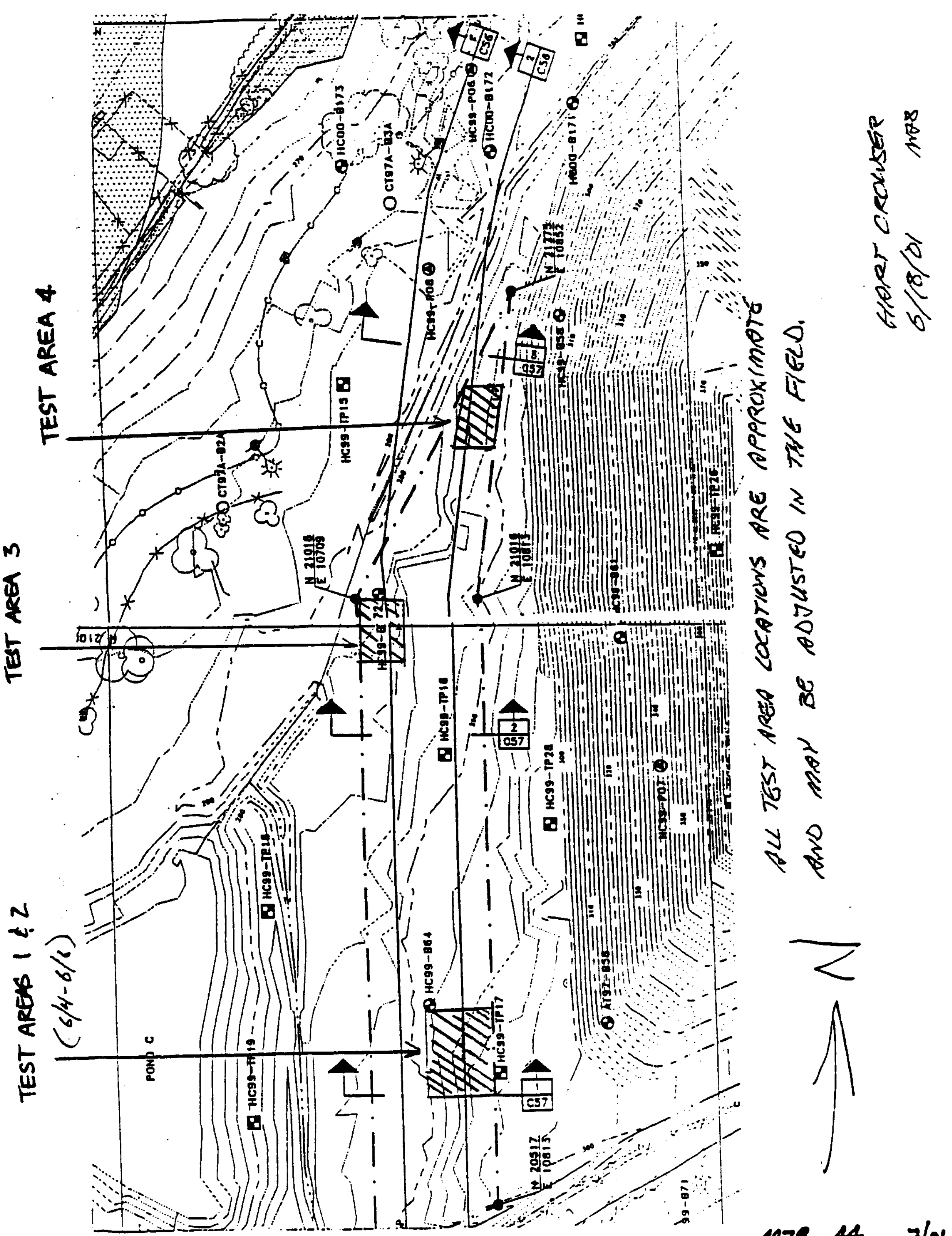
J-4978-44 7/01

Figure 1

AR 050708

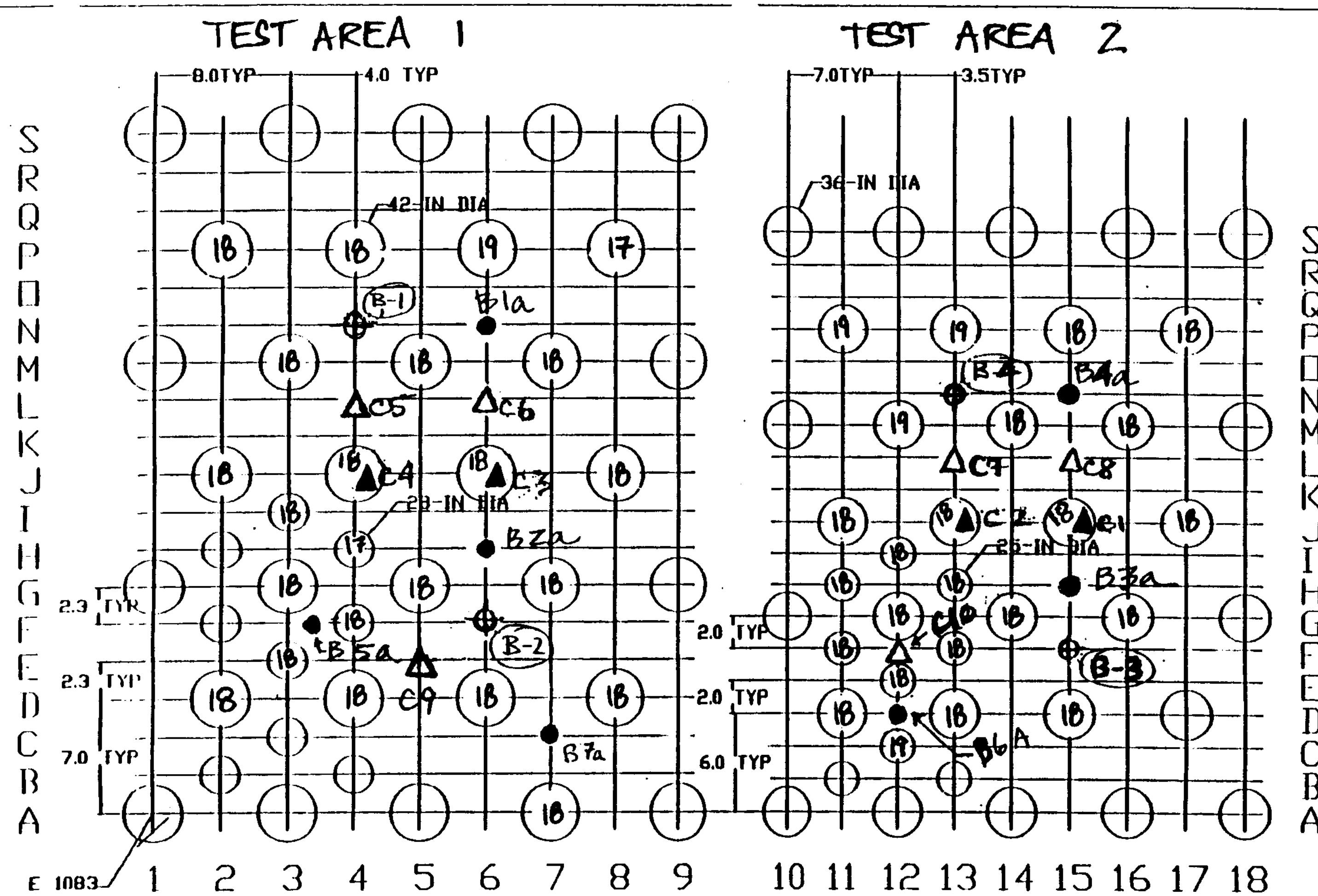


4478-44 7/01

FIGURE 2

AR 050709

TEST AREA 1 / TEST AREA 2



⊕ Pre stone column boring
▲ Pre stone column cone penetrometer
● Post stone column boring
△ Post stone column cone penetrometer

NOTE: FIELD LOCATE TEST SECTION 1
BETWEEN N 20517 AND N 21016.

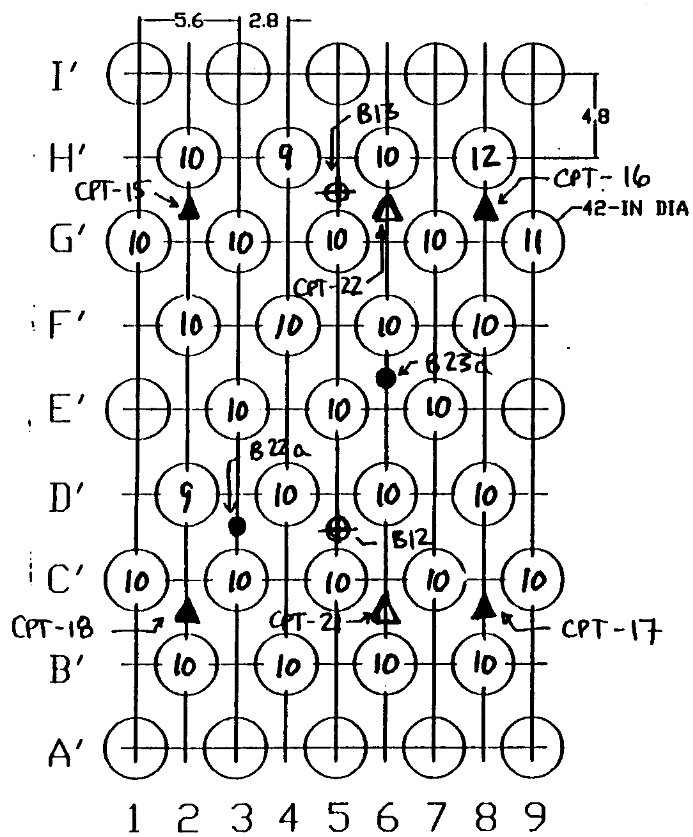
(18) Stone column depth in feet

→ N

PROJECT:	SHEET TITLE:		REVISIONS	
THIRD RUNWAY EMBANKMENT CONSTRUCTION PHASE 4 PORT OF SEATTLE SEA-TAC INTERNATIONAL AIRPORT	STONE COLUMN TEST LOCATION 1 & 2 WORK AREA 2	DRWG NO. HBI-TS1 SCALE 1" = 10' DRWG BY DMP DATE 05-31-01 APRVD BY MAK	NO / DRAWN BY / DATE	HAYWARD BAKER A KELLER COMPANY

FIGURE 3
4978-44 7/01

TEST AREA 3



NOTES:
1) LOCATE TEST SECTION NO. 3 SOUTH/SOUTHEAST OF BORING HC99-B72.

2) STONE COLUMNS TO BE 42" DIAMETER.

3) 5.6-FT CENTER TO CENTER TRIANGULAR PATTERN

⊕ B12 - Pre stone column boring

▲ CPT-15 - Pre stone column cone penetrometer

● B22a - Post stone column boring

△ CPT-21 Post stone column cone penetrometer

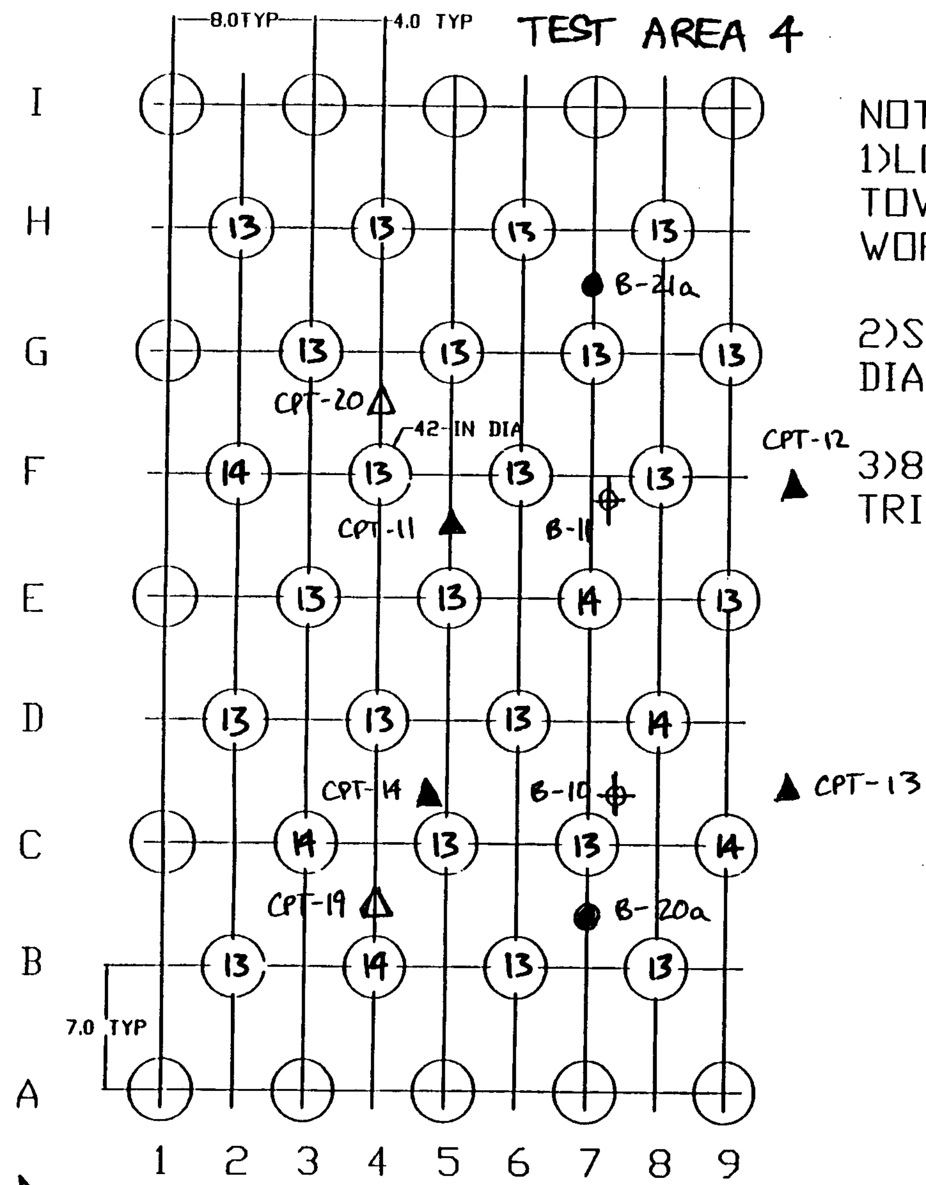
(10) Stone column depth in feet

PROJECT: THIRD RUNWAY EMBANKMENT CONSTRUCTION PHASE 4 PORT OF SEATTLE SEA-TAC INTERNATIONAL AIRPORT	SHEET TITLE: STONE COLUMN TEST LOCATION 3 WORK AREA 2	DRWG NO. HBI-TS2 SCALE 1" = 10' DRWG BY DMP DATE 06-20-01 APPVD BY MAK	REVISIONS: NO / DRAWN BY / DATE

HAYWARD BAKER
A [illegible] COMPANY
Western Region

4978-44 7/01
FIGURE 4

AR 050711



NOTES:
1) LOCATE TEST SECTION NO. 4 TOWARD NORTHERN LIMIT OF WORK AREA 2.

2) STONE COLUMNS TO BE 42" DIAMETER.

3) 8-FT CENTER TO CENTER TRIANGULAR PATTERN

▲ CPT-12 Pre-column cone penetrometer
⌖ B-11 Pre-column boring
△ CPT-19 Post-column cone penetrometer
● B-20a Post-column boring

(13) Stone column depth in feet

NORTH

PROJECT: THIRD RUNWAY EMBANKMENT CONSTRUCTION PHASE 4 PORT OF SEATTLE SEA-TAC INTERNATIONAL AIRPORT	SHEET TITLE: STONE COLUMN TEST LOCATION 4 WORK AREA 2	DRWG NO. HBI-TS1 SCALE: 1" = 10' DRWG BY DMP DATE 06-20-01 APPVD BY MAK	REVISIONS: NO / DRAWN BY / DATE

HAYWARD BAKER
A KELLER COMPANY
Western Region
1780 Lemonwood Drive
Santa Paula, California 93060

4478-44 7/.
FIGURE 5

APPENDIX A
TEST AREA 1

TEST AREA #1

Boring Location: N 4 NSA Area 2

Elevation: Datum:

Obs. Well Install. Yes No

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Boring B-1 Date 6/1/01 Sheet 1 of 1
Job [illegible] Area 2 Job No. 4978-30
Logged By JPL Weather Cloudy 60°
Drilled By HOLT - MIKE
Drill Type/Method HSA
Sampling Method SPT
Bottom of Boring 16' ATD Water Level Depth 7.5 No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
–	29	71		2	3.5	S1			1, 2, 3 (5)	MOIST, BROWN GRAY w/ ORANGE MOTTLING SANDY SILT		
				4.5	6	S-2			4, 5, 8* (13)	*ROCK IN SAMPLER TIP WET, GRAY, SL. SILTY F-M SAND		
				7	8.5	S3A / S3B			5, 2, 4 (6)	WET, GRAY, GRAVELLY M-C SAND / M. STIFF, WET, GRAY, SL GRAVELLY, SL. SANDY SILT	▽	GRAVELLY [illegible]
4	46	60		9.5	11	S4			1, 1, 3 (4)	M. STIFF, MOIST, BLUE GRAY VERY SANDY SILT		
				12	13.5	S5			11, 16, 24 (40)	V. DENSE WET, GRAY, SL. SILTY M-C SAND		
10	80	10		14.5	16	S6			19, 26, 33 (59)	V. DENSE, SL. SILTY, to silty GRAVELLY SAND (TILL		

B.O.B @ 16' 0919 6/1/01

AR 050714

TEST AREA #1

HARTCROWSER

Boring Location: F6 NSA Area 2

Elevation: Datum:

Obs. Well Install. Yes [No]

Boring B2 Date 6/1/01 Sheet 1 of 2
Job 3R STONE Co AREA 2 Job No. 4978-30
Logged By JPL Weather CLOUDY 60°
Drilled By HOLT - MIKE
Drill Type/Method HSA
Sampling Method SPT
Bottom of Boring 21 ATD Water Level Depth 7.0 No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
–	58	42		2.0	3.5	X	S1	1, 2, 3 (5)	LOOSE, LT BROWN, MOIST, VERY SILTY Fine SAND		
				4.5	6.0	X	S2	4, 5, 7 (12)	M. DENSE, WET, GRAY & BROWN, SL. GRAVELLY F-C SAND to GRAVELLY		▽ ?
				7.0	8.5	X	S3	3, 4, 7 (11)	M. STIFF, WET, BROWN SL. GRAVELLY, SANDY SILT		
				9.5	11.0	X	S4	9, 15, 15 (30)	DENSE, WET, GRAY GRAVELLY, SILTY SAND		
				12.0	13.5	X	S5	9, 16, 29 (45)	V. DENSE, WET, GRAY, SL SILTY TO SILTY, SL. GRAVELLY SAND		
				14.5	16.0	X	S6	9, 18, 17 (35)	DENSE, MOIST, BLUE GRAY, SL. SILTY SAND W/ TRACE GRAVEL		
				17.0	18.5	X	S7	9, 9, 12 (21)	M. DENSE, MOIST, BLUE GRAY SILTY SAND TO SANDY SILT		
				19.5	21	X	S8				

TEST AREA #1

Location: F6 NSA AREA 2

Elevation: Datum:

Obs. Well Install. Yes No

HART CROWSER

Boring B2 Date 6/1/01 Sheet 2 of 2

Job SR STONE COL AREA 2 Job No. 4978-30

Logged By JPL Weather CLOUDY 60°

Drilled By HOLT

Drill Type/Method HSA

Sampling Method SPT

Bottom of Boring 21' ATD Water Level Depth No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
				19.5	21	X	S8	20	26 45	(71) V. DENSE, WET, GRAY, SILTY, GRAVELLY SAND. (LARGE GRAVEL IN SAMPLER)		
								21			BOB AT 21' 1028 6/1/01	
								22				
								23				
								24				
								25				
								26				
								27				
								28				
								29				
								30				
								1				
								2				
								3				
								4				
								5				
								6				
								7				
								8				
								9				
								0				

Boring Location: TEST AREA #1
Western location
Southern test group

HARTCROWSER

Boring: B-1a | Date: 6-11-01 | Sheet 1 of 1
Job: 3rd Runway Stone Columns | Job No. 4978-30
Logged By: BES | Weather: Showers
Drilled By: BES
Drill Type/Method: Holt ; mike
Sampling Method: 2" SPT ; auto hammer
Elevation: ______ Datum: ______
Bottom of Boring: 20.5 | ATD Water Level Depth: ≈7' | NC
Obs. Well Install. Yes / ~~No~~

G Max.	S Range	F	PID or other	Depth From	Depth To	Sample Type	Sample Number	Penetration Resistance	Description	Remarks	Summary Log
										up @ 1255	
–	95 F	5		4	5.5	X	1	2, 4, 5 (9)	loose, moist-wet, brown, sl. silty fine SAND		sl. silty fine SAND
30-40	50 FC	10		6.5	8	X	2	8, 10, 9 (19)	m. dense, wet, brown, sl. silty gravelly - v. gravelly SAND	▽ - spoon is wet (H2O) - gravels are crushed; looks like column rock	sl. silty grav. to v. grav SAND
TR	70 F	30		9	10.5	X	3	1, 2, 2 (4)	loose, wet, grey, very silty fine SAND	- trace gravs.	very silty fine SAND
10	60 Fm	30		11.5	13	X	4	5, 7, 10 (17)	m. dense, moist, grey, sl. gravelly silty SAND	- TILELIKE	sl. grav silty SAND
10	60 Fm	30		14	15.5	X	5	5, 10, 11 (21)	m. dense, moist, grey, sl. gravelly silty SAND		
15	65 C	20		16.5	18	X	6	11, 11, 12 (23)	m. dense, moist, grey	- N looks low for material	gravelly silty SAND
				19	20.5	X	7	6, 14, 16 (30)			

AR 050717

TEST AREA #1

HARTCROWSER

Boring Location: Eastern location Southern Test group

Elevation: ±291' Datum:

Obs. Well Install. Yes / No (No marked)

Boring: B-2a Date: 6-11-01 Sheet 1 of 1

Job: 3rd Runway Stone Columns Job No. 4978-30

Logged By: BES Weather: Showers

Drilled By: Mike @ Holt

Drill Type/Method: B 59 HSA

Sampling Method: 2" SPT autohammer

Bottom of Boring: 20.5' ATD Water Level Depth: [illegible] ±9' / Not

Size (%) G Max.	S Range	F Alt.	PID or other	DEPTH From	To	SAMPLE Type	Number	Sample Recovery	Penetration Resistance	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave, ...etc.	SUMMARY LOG (Water and Date)
											up @ 1150 have to start @ 4' due to mud, rig had to be towed into position	sl. silty f-m SAND
—	95 FM	5		4	5.5	X	1		4 / 5 / 5 (10)	m. dense, moist, brn, sl. silty f-m SAND		
20	70 FM	10		6.5	8	X	2		8 / 8 / 9 (17)	m. dense, moist-wet, brown, sl. silty gravelly SAND	- min recovery	sl. silty gravelly SAND
											∇ likely H_2O perch. here	
20	55 Fm	25		9	10.5	X	3		3 / 2 / 1 (3)	v. loose, wet brown gravelly silty SAND	- min recovery - weath. TILL?	grav. silty SAND
20	55 FM	25		11.5	13.0	X	4		2 / 5 / 7 (12)	m. dense, moist-wet, grey, gravelly silty SAND	- definitely TILLISH	
20	55 FM	25		14	15.5	X	5		8 / 10 / 13 (23)	m. dense, moist, grey, gravelly silty SAND		
20	45 Fm	35		16.5	18.0	X	6		18 / 20 / 21 (41)	Dense, moist, grey, gravelly silty SAND		
25	40 Fm	35		19.0	20.5	X	7		12 / 30 / 45 (75)	v. dense, moist, grey, gravelly silty SAND		

AR 050718

TEST AREA #1

HARTCROWSER

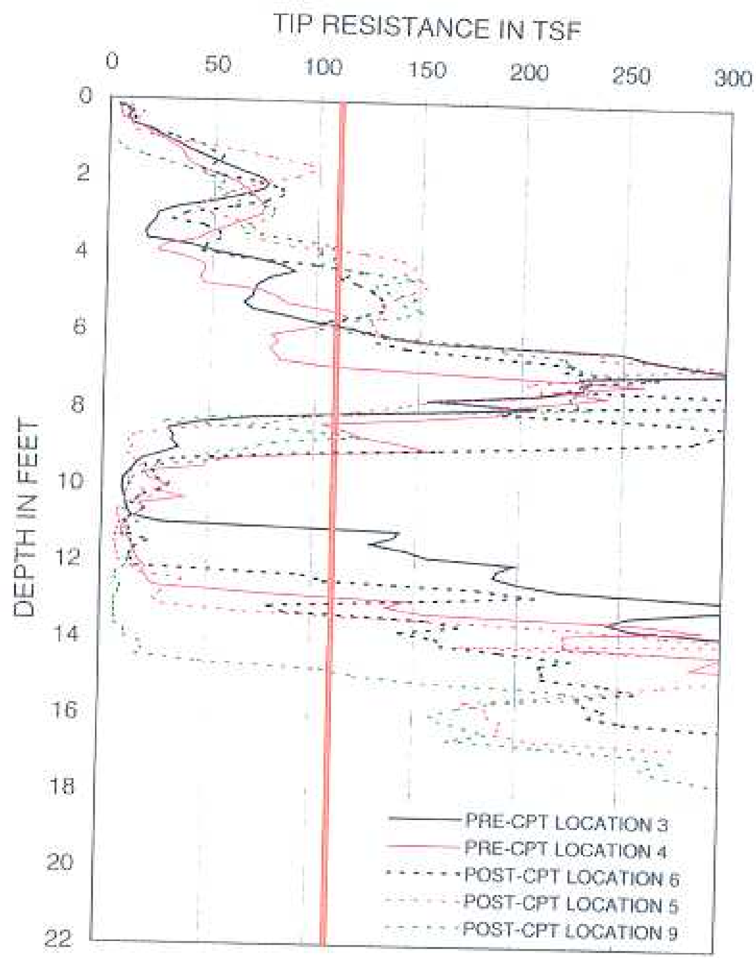
Boring Location	
Boring	B-5a
Date	6-1-01
Sheet	1 of 1
Job	Third Runway Stone Columns
Job No.	4978-3[illegible]
Logged By	BES
Weather	miserable - rain
Drilled By	Holt ; Mike
Drill Type/Method	B-59 HSA
Sampling Method	2" SPT autohammer
Elevation	
Datum	
Obs. Well Install.	Yes / ~~No~~ (No marked)
Bottom of Boring	
ATD Water Level Depth	≈6'

G Max.	S Range	F	PID or other	Depth From	Depth To	Sample Type	Sample Number	Sample Recovery	Penetration Resistance	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES, Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave....etc.	SUMMARY LOG (Water and Date)
											up @ 1410	
—	85 F	15		4	5.5	X	1	(10)	3, 4, 6	m dense, wet, brown silty fine SAND		silty fine SAND
25	55 F-C	20		6.5	8	X	2	(8)	2, 4, 4	loose, wet, brown, silty gravelly SAND	- spoon is wet - possibly some gravels are from columns? or in fill	silty gravelly SAND
—	30 F	70		9	10.5	X	3	(3)	1, 2, 1	soft, wet, gray-brown sandy SILT	- color Δ @ 9.5'	fine sandy SILT
—	30 F	70		11.5	13	X	4	(2)	1, 1, 1	v soft, wet, gray, sandy SILT		
15	60 F-M	25		14	15.5	X	5	[illegible]	6, 9, [illegible]	m dense, wet, gray, silty gravelly SAND	— [illegible]	silty gravelly SAND
20	55 F	25		16.5	18	X	6	[illegible]	[illegible], [illegible], 2	m dense, wet, gray, silty gravelly SAND	✓	✓
20	5[illegible]	2[illegible]		19	20.5	X	7	(6)	19, 24, 3[illegible]	v dense, wet, gray, [illegible] silty SAND		✓

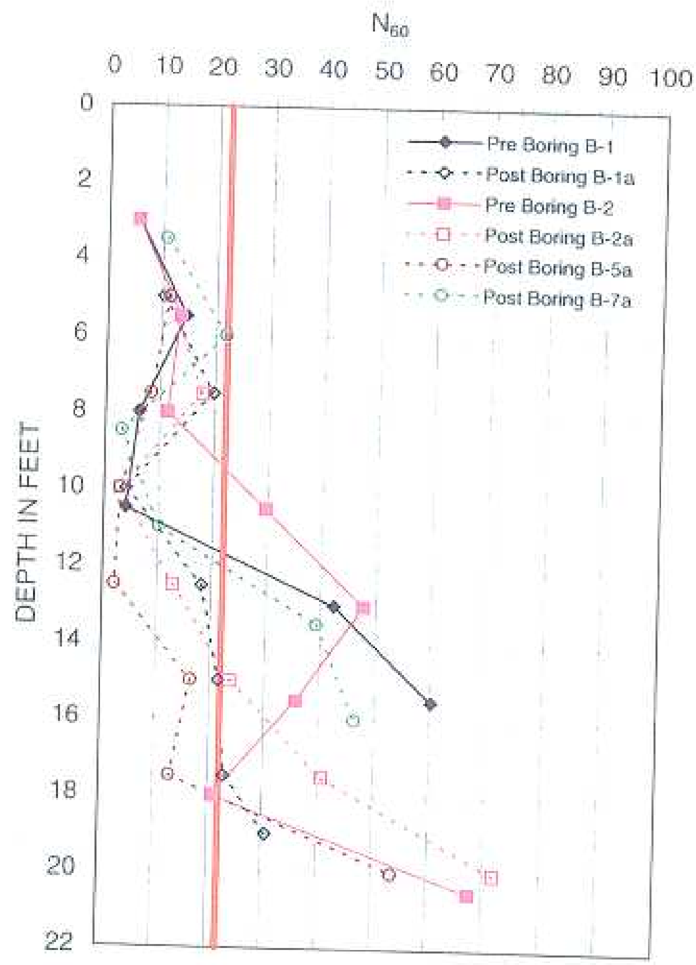
[illegible]forms\boring_log

AR 050719

CPT TEST DATA
AREA 1



SPT VALUES VS DEPTH
AREA 1



6/29/01

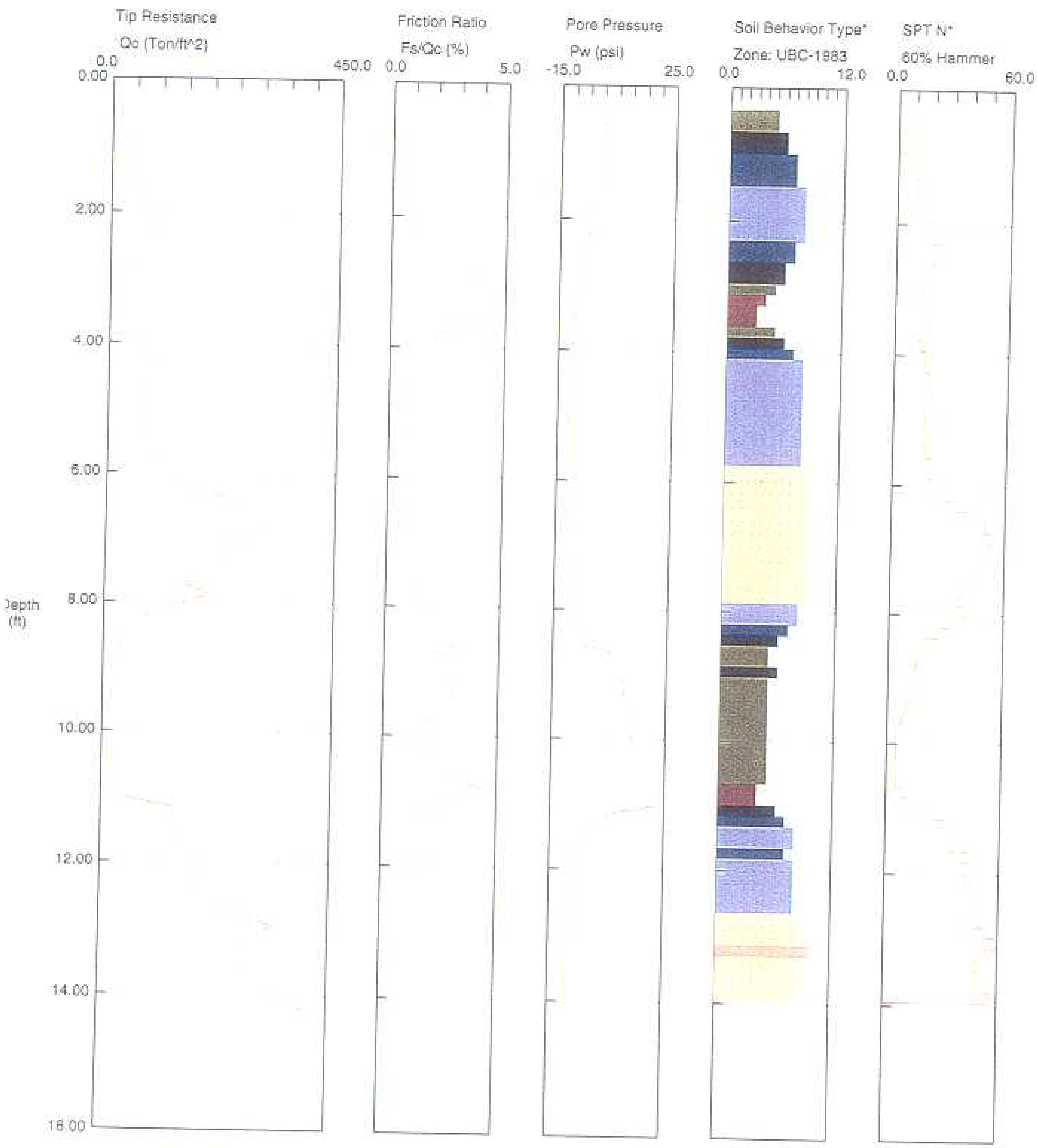
Third Runway - SeaTac Airport
Stone Columns - In-Situ Soil Testing
J-4978-30

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-03
Cone Used: 581

CPT Date/Time: 06-01-81 09:21
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 14.27 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

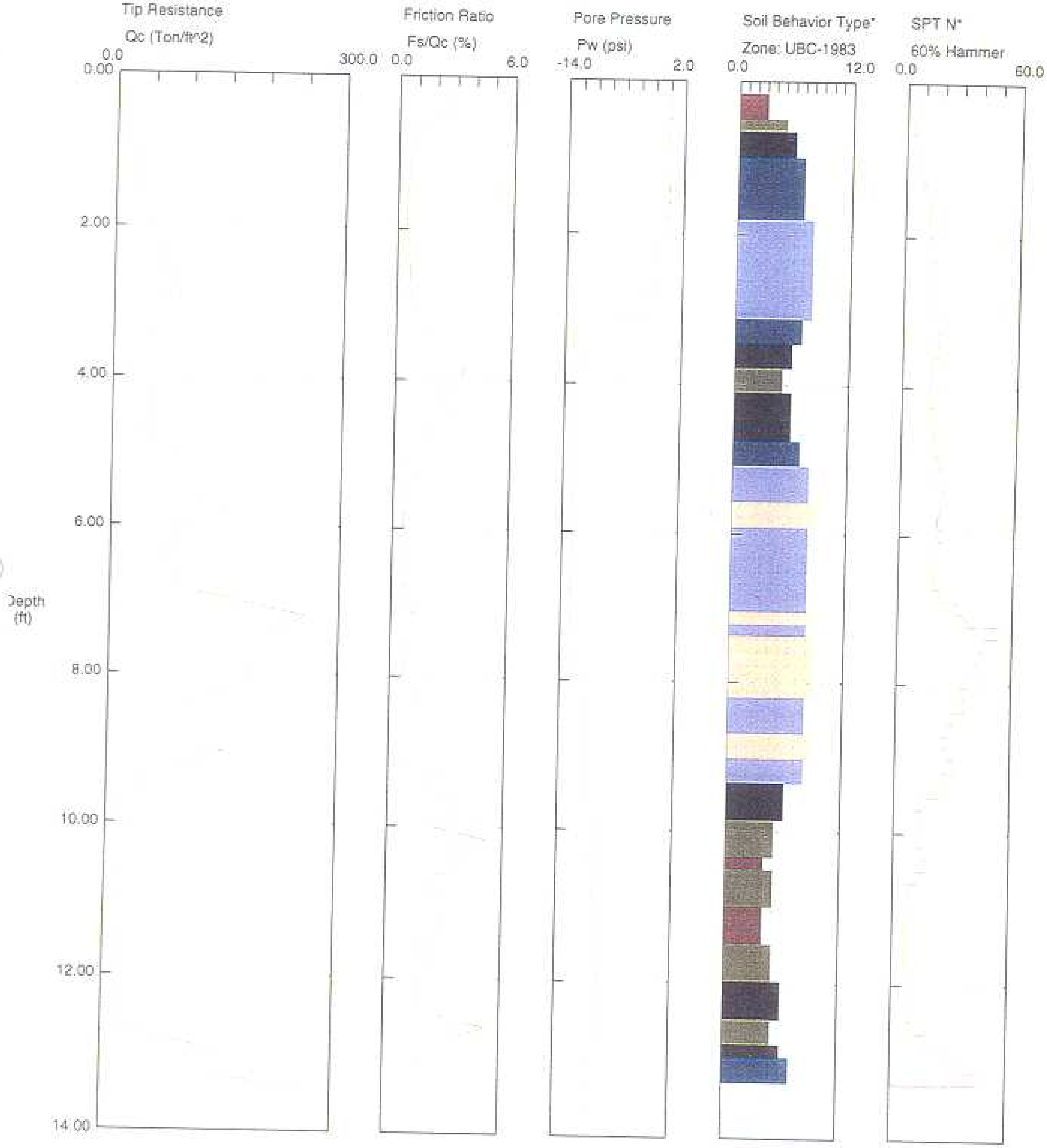
AR 050721

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-04
Cone Used: 581

CPT Date/Time: 06-01-81 09:42
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 13.62 feet

Depth Increment = 0.16 feet

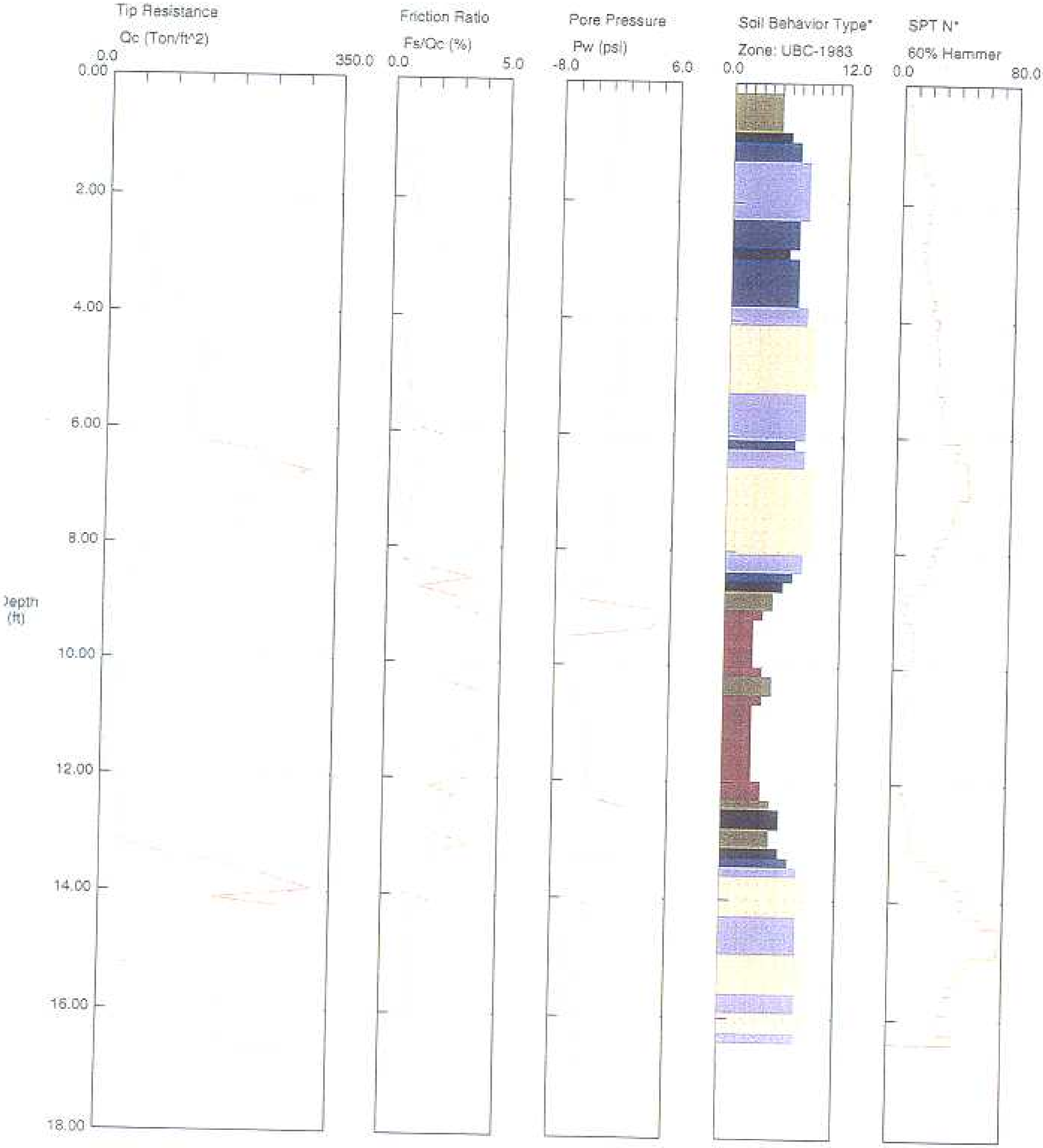
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-05
Cone Used: 581

CPT Date/Time: 06-12-81 11:35
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 16.73 feet

Depth Increment = 0.16 feet

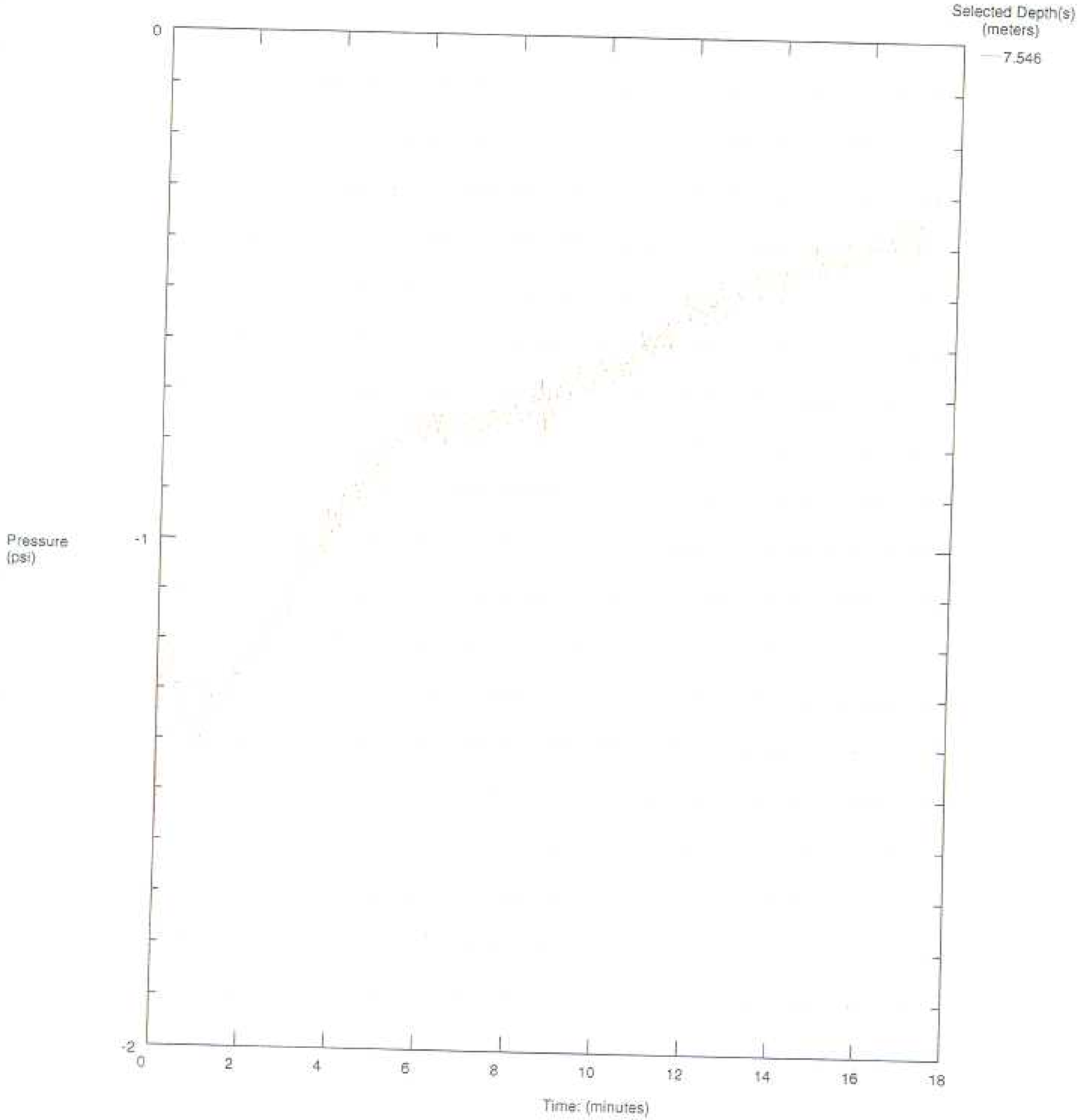
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050723

Hart Crowser

Operator: K.Brown
Sounding: CPT-05
Cone Used: 581

CPT Date/Time: 06-12-81 11:35
Location: Third Runway
Job Number: 4978-44



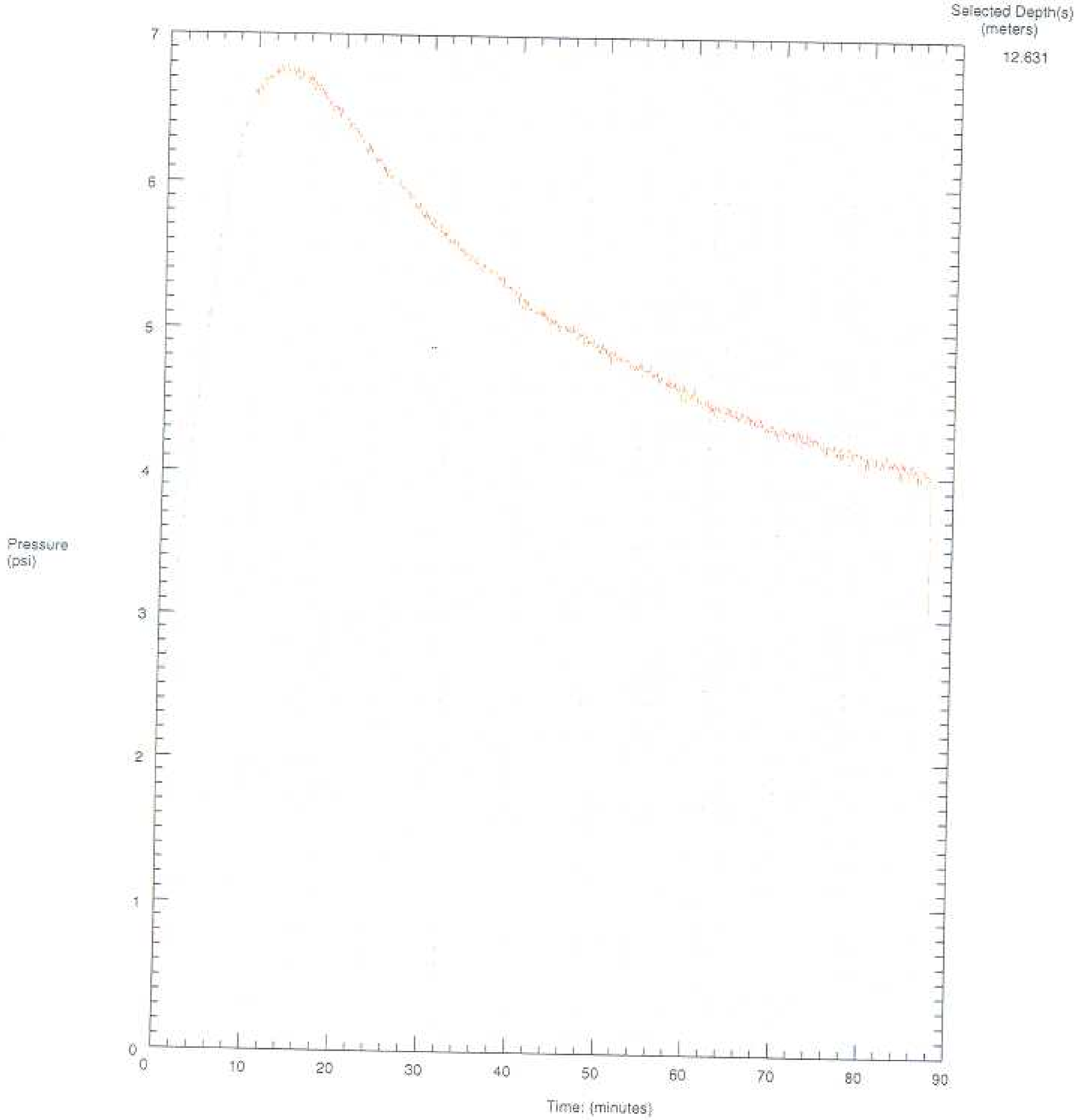
Maximum Pressure = -0.346 psi
Hydrostatic Pressure = 3.275 psi

AR 050724

Hart Crowser

Operator K.Brown
Sounding: CPT-05
Cone Used: 581

CPT Date/Time: 06-12-81 11:35
Location: Third Runway
Job Number: 4978-44



Maximum Pressure = 6.785 psi
Hydrostatic Pressure = 5.482 psi

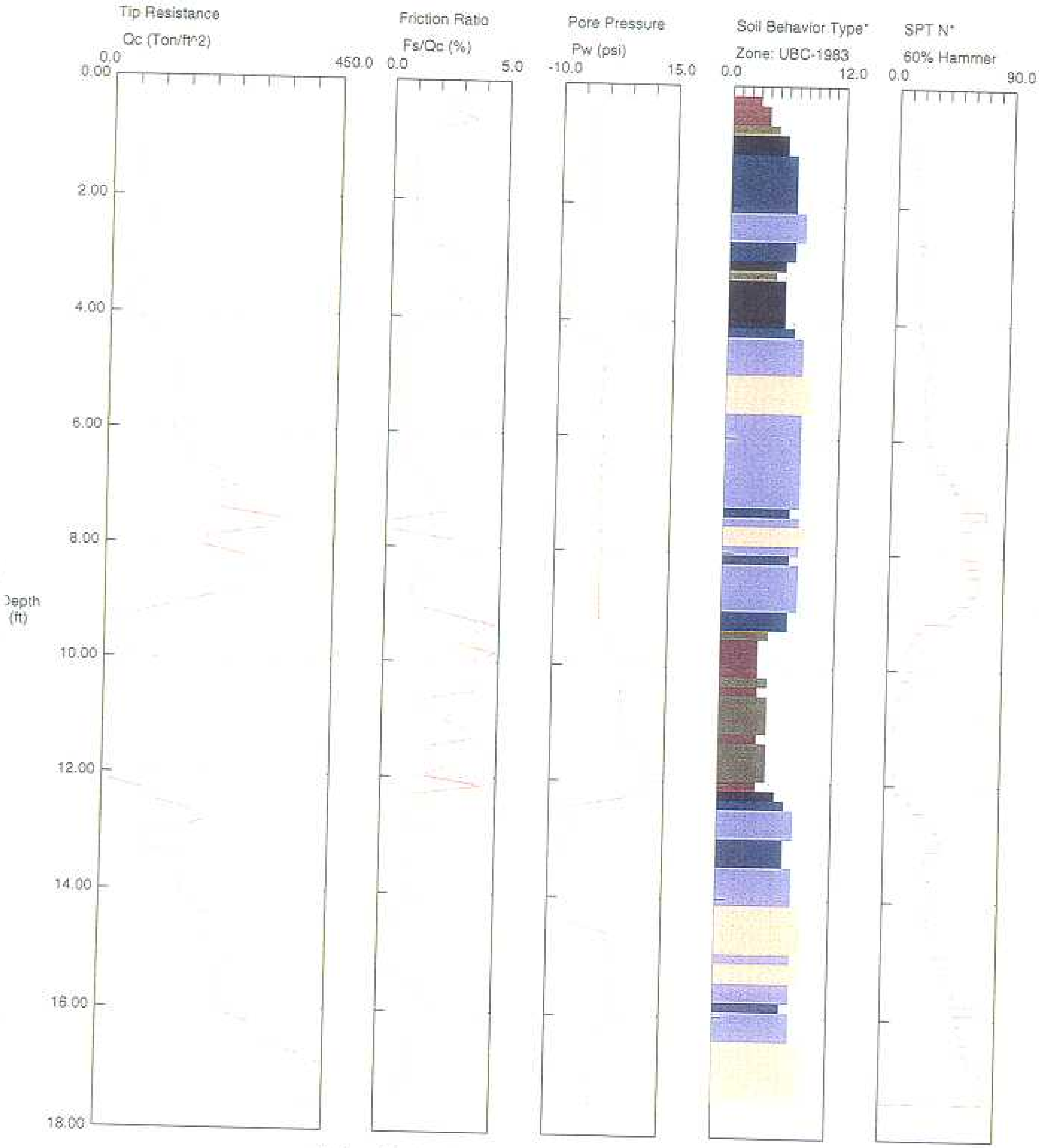
AR 050725

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-06
Cone Used: 581

CPT Date/Time: 06-12-81 13:54
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 17.72 feet

Depth Increment = 0.16 feet

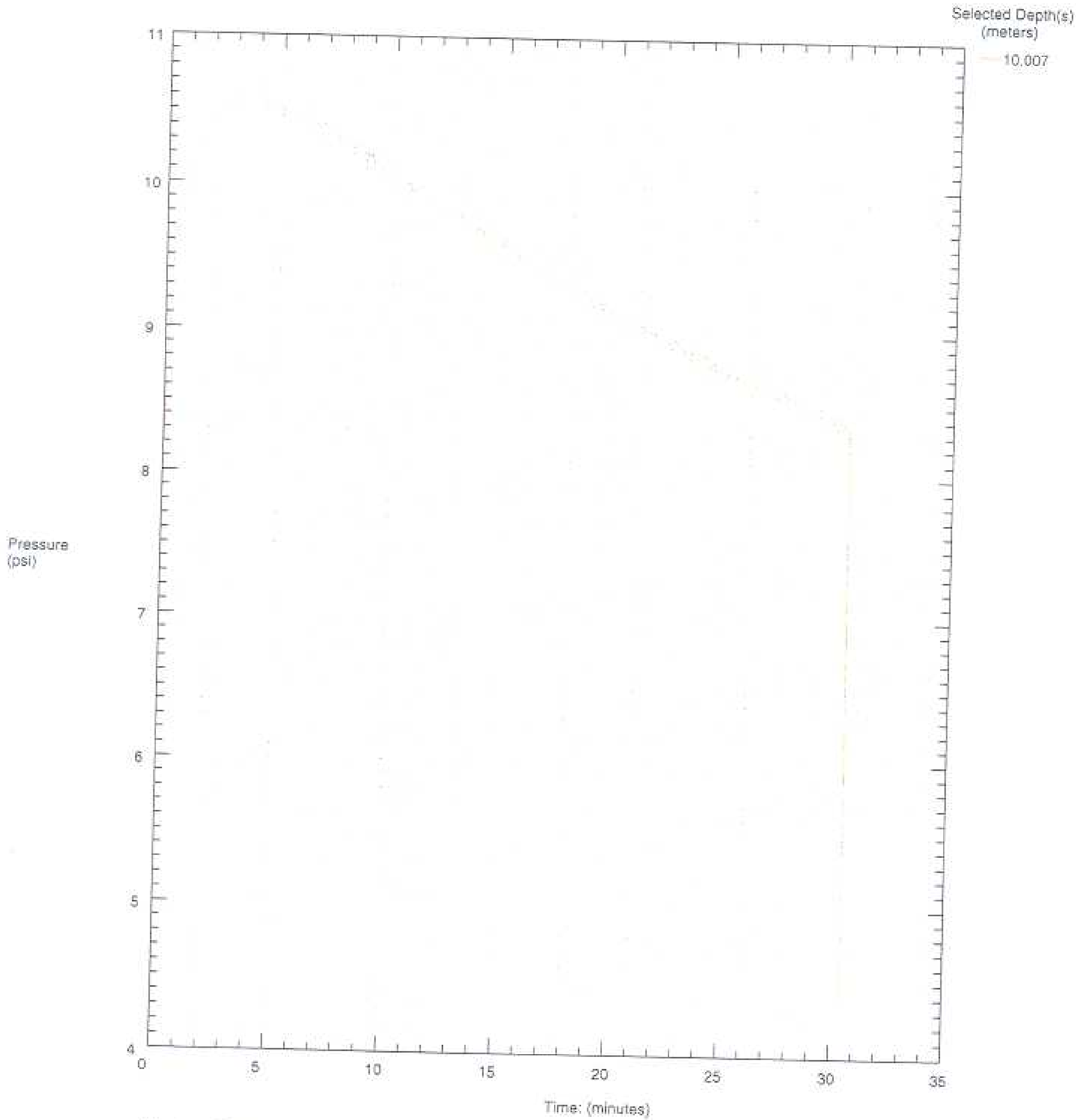
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050726

Hart Crowser

Operator: K.Brown
Sounding: CPT-06
Cone Used: 581

CPT Date/Time: 06-12-81 13:54
Location: Third Runway
Job Number: 4978-44



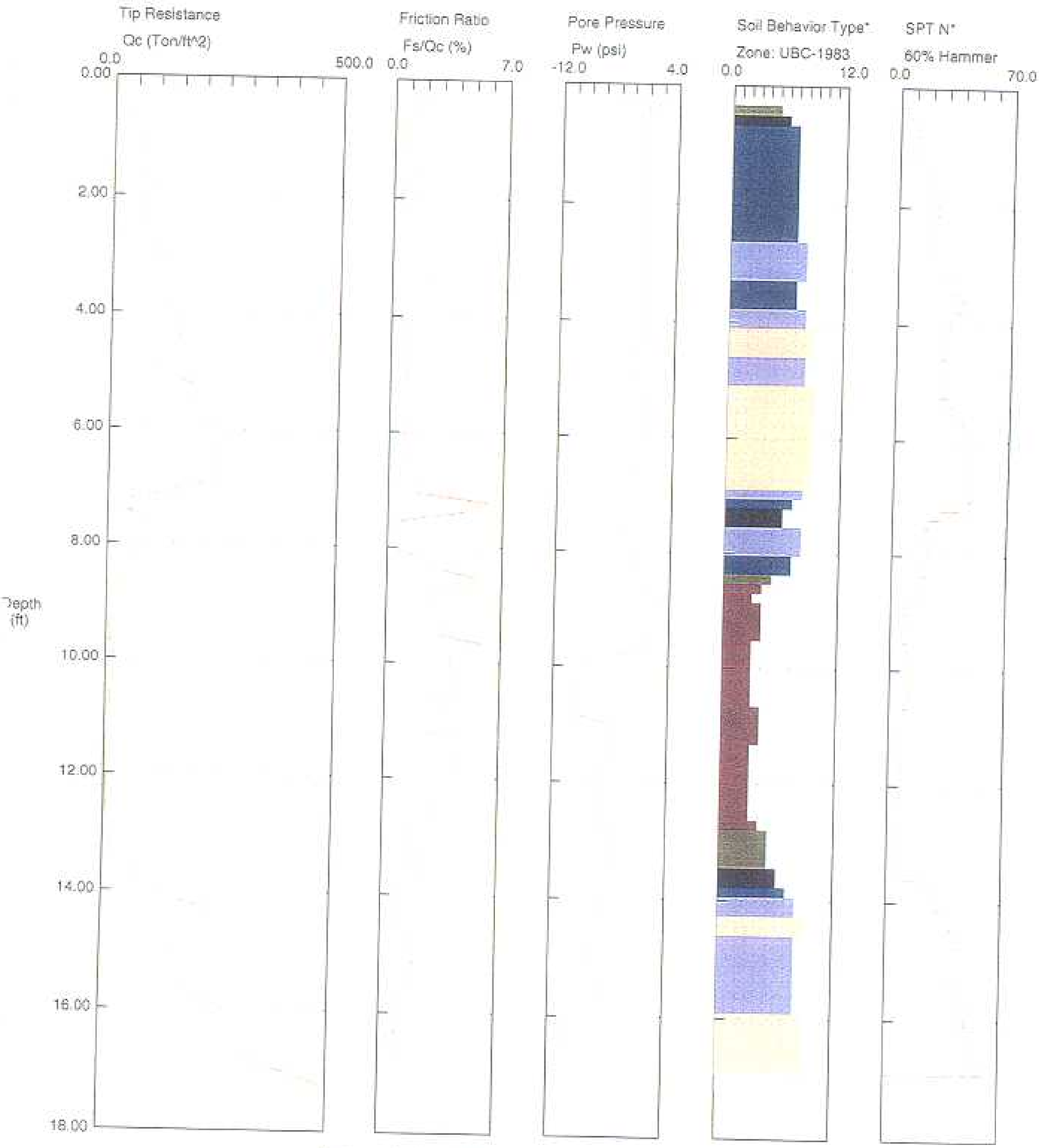
Maximum Pressure = 10.579 psi
Hydrostatic Pressure = 4.343 psi

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-09
Cone Used: 581

CPT Date/Time: 06-20-81 10:37
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 17.22 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050728

Boring Location: TEST SECTION #1
DRILLED AT STAKED LOCATION

Elevation: Datum:

Obs. Well Install. Yes / No (No marked)

HARTCROWSER

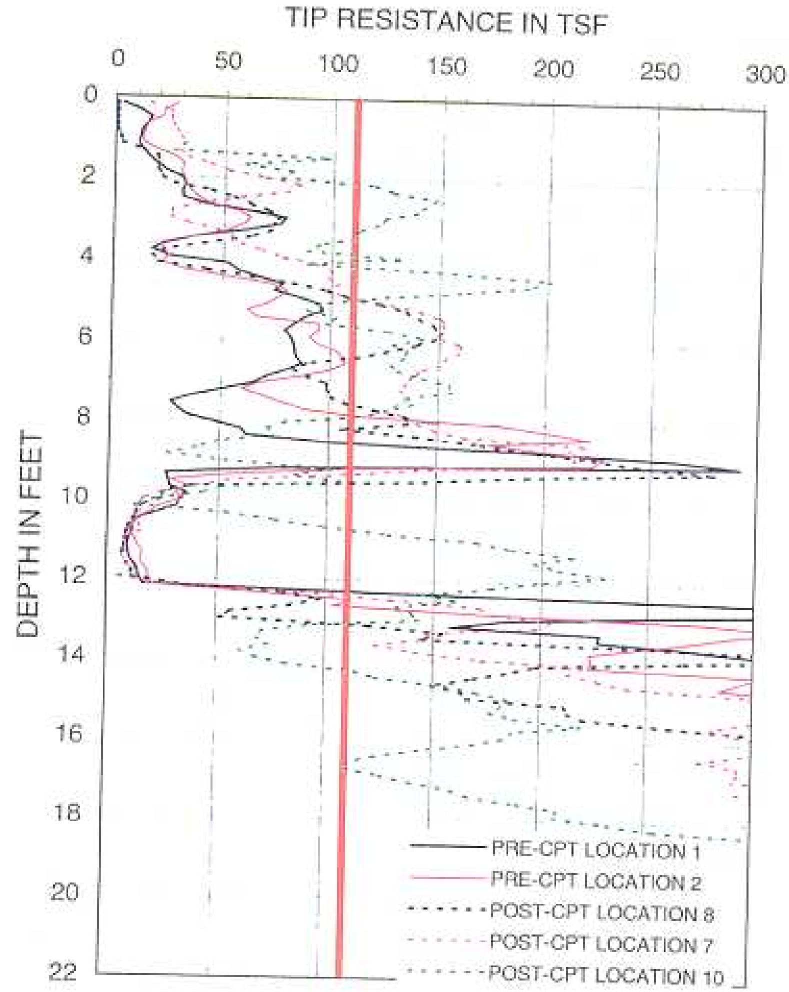
Boring B-7A Date 6-20-01 Sheet 1 of 1
Job SEATAC Job No. J-4978-44
Logged By B. McDONALD Weather CLEAR ~65°F
Drilled By HOLT DRILLING (MIKE & MARK)
Drill Type/Method MOBILE B-59 / 4" I.D. HSA
Sampling Method SPT WITH 140 lb. AUTOMATIC HAMMER
Bottom of Boring 17.5 ATD Water Level Depth No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	To	SAMPLE Type	Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS. Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
				0	3					Cuttings: BROWN, SILT		BROWN SILT
—	F 80	20		3.5	5.0	SPT	S-1 0748		3, 5, 5 (10)	LOOSE, MOIST, BROWN, SILTY, FINE SAND		LOOSE BROWN SILTY FINE SAND
FC 5	FC 45	10		6.0	7.5	SPT	S-2 0752	10	7, 10, 10 (20)	MEDIUM DENSE, MOIST, BROWN, slightly SILTY, SANDY GRAVEL to GRAVELLY SAND		MEDIUM DENSE BROWN slightly SILTY SANDY GRAVEL / GRAVELLY SAND
SCATTERED	F 20	80		8.5	10.0	SPT	S-3 0757	18	2, 1, 2 (3)	SOFT, VERY MOIST, BROWN TO GRAY, FINE SANDY SILT WITH SCATTERED GRAVEL	PERCHED WATER? AT CONTACT	SOFT FINE SANDY SILT
OCC	MF 70	30		11.0	12.5	SPT	S-4 0800	18"	7, 3, 8 (11)	MEDIUM DENSE, MOIST, GRAY, VERY SILTY, MEDIUM to FINE SAND OCC. SCATTERED GRAVEL	"STIFFER" DRILL ACTION AT 12.5'	MEDIUM DENSE VERY SILTY M-F SAND
20	MF 60	20		13.5	15.0	SPT	S-5 0805	12	6, 17, 24 (41)	DENSE, MOIST, GRAY, SILTY, GRAVELLY, M-F SAND (TILL LIKE)		DENSE to VERY DENSE SILTY GRAVELLY M-F SAND
[illegible]	F 75	25		16.0	17.5	SPT	S-6 0812	10"	27, 24, 28 (52)	VERY DENSE, MOIST, GRAY, SILTY FINE SAND FEW SCATTERED GRAVEL		TILL LIKE

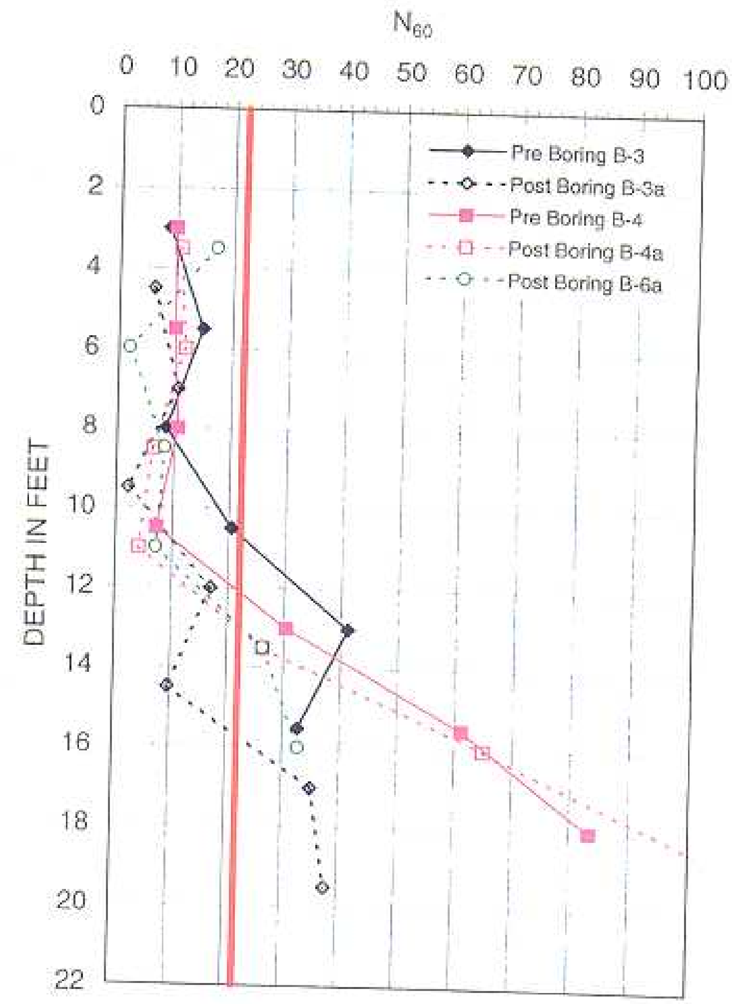
AR 050729

APPENDIX B
TEST AREA 2

CPT TEST DATA
AREA 2



SPT VALUES VS DEPTH
AREA 2



6/29/01

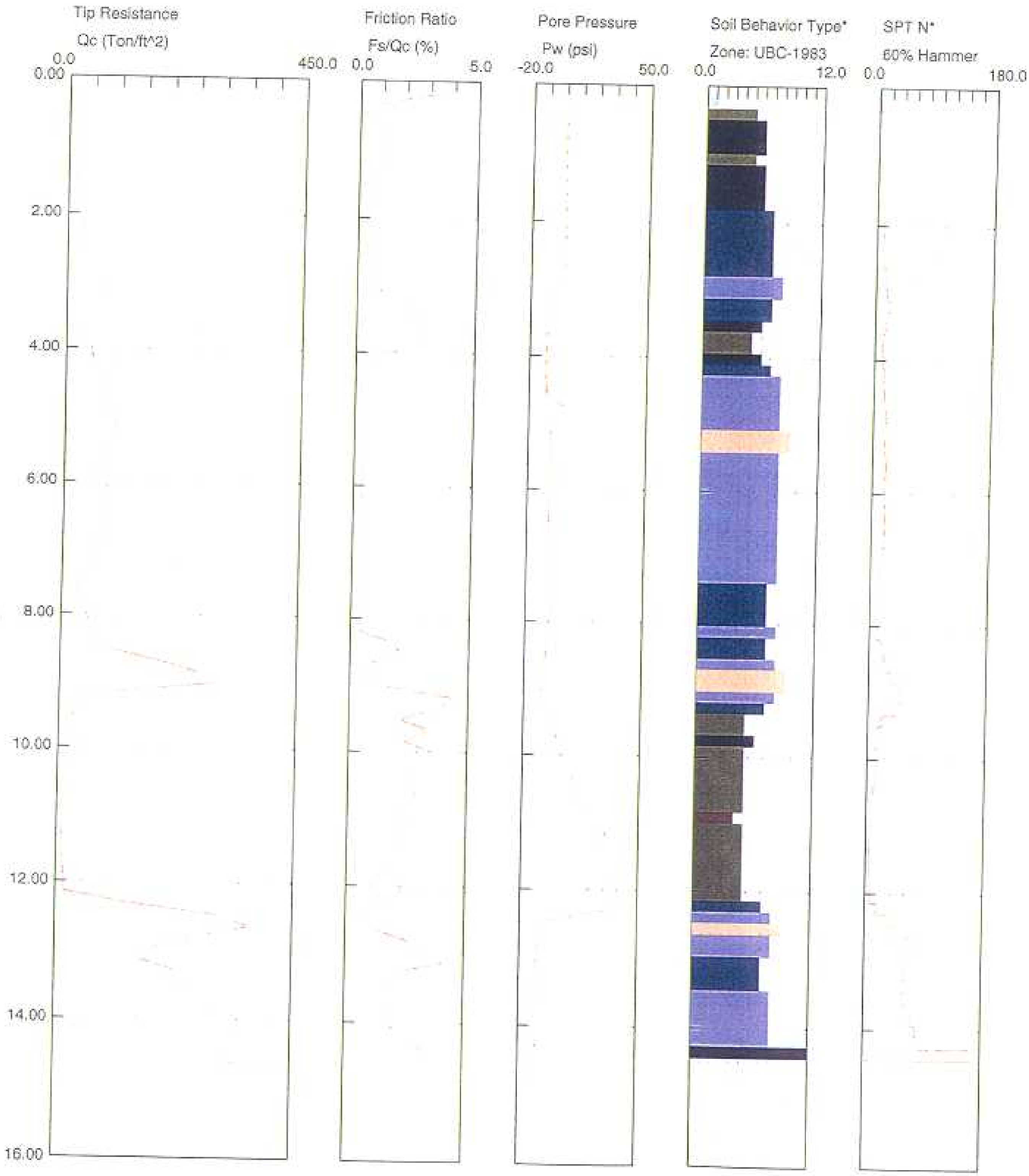
Third Runway - SeaTac Airport
Stone Columns - In-Situ Soil Testing
J-4978-30

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-01
Cone Used: 581

CPT Date/Time: 06-01-81 08:37
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 14.76 feet

Depth Increment = 0.16 feet

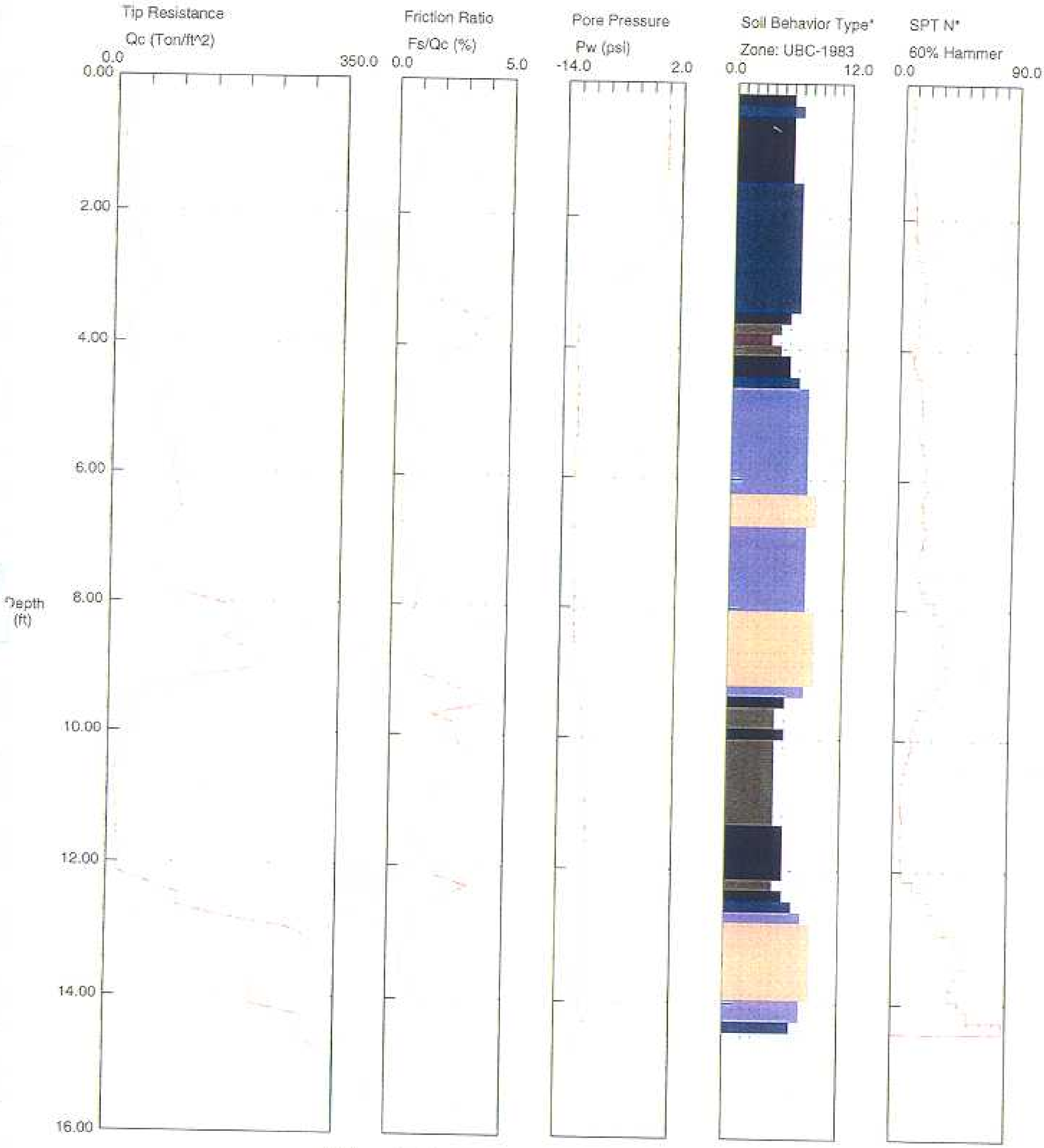
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-02
Cone Used: 581

CPT Date/Time: 06-01-81 09:01
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 14.76 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

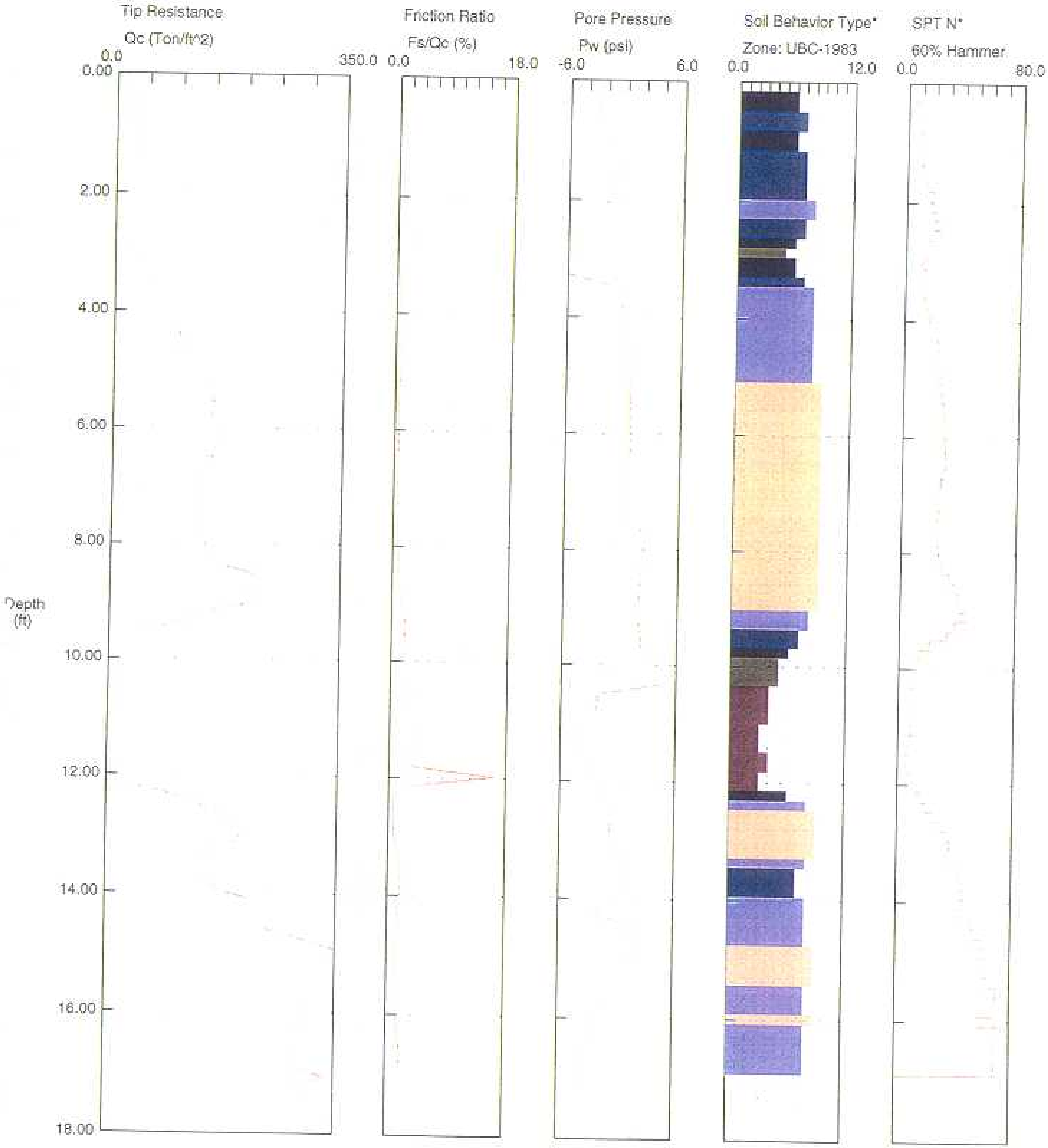
AR 050733

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-07
Cone Used: 581

CPT Date/Time: 06-12-81 14:46
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 17.22 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

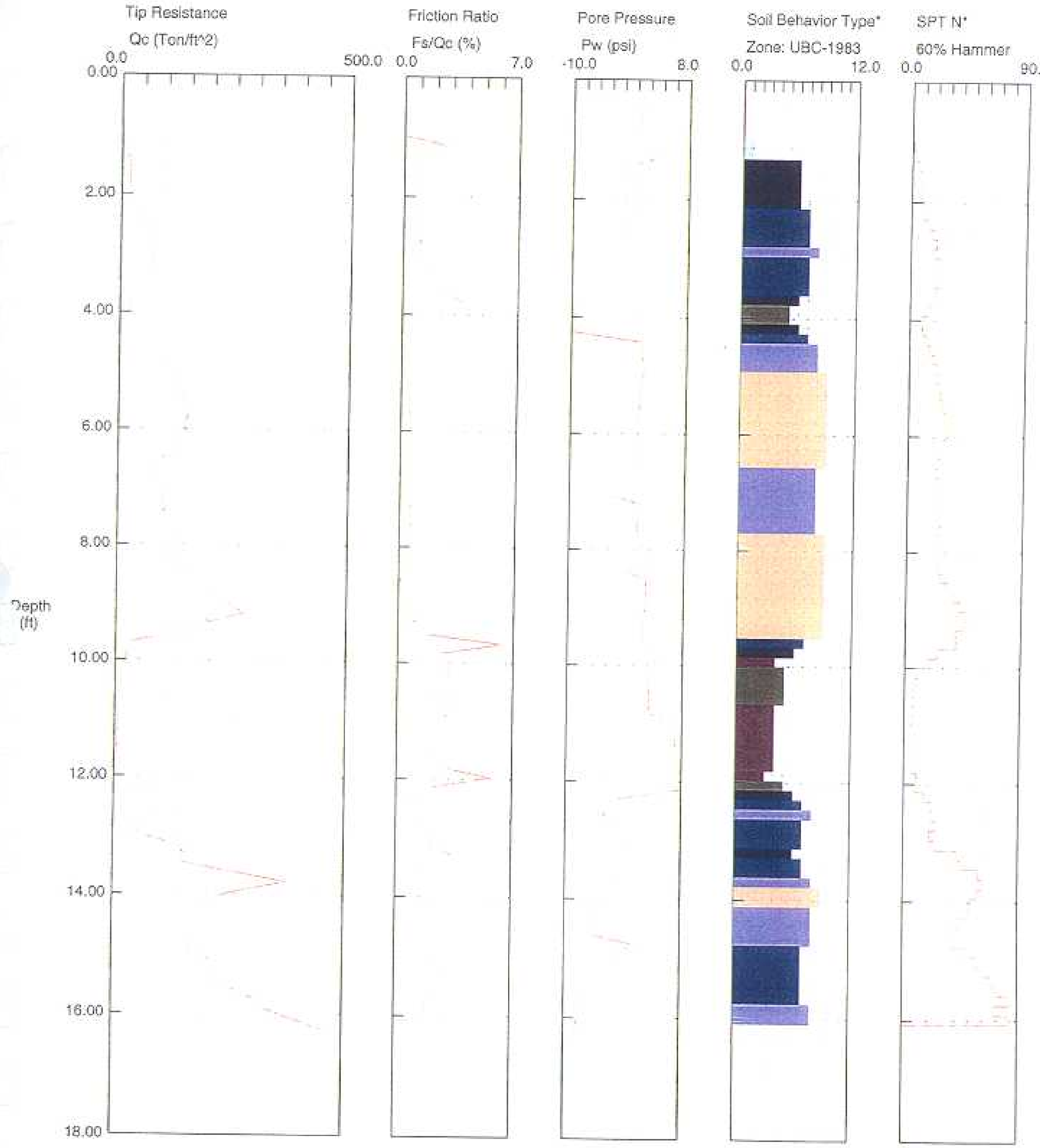
AR 050734

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-08
Cone Used: 581

CPT Date/Time: 06-12-81 15:18
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 16.40 feet

Depth Increment = 0.16 feet

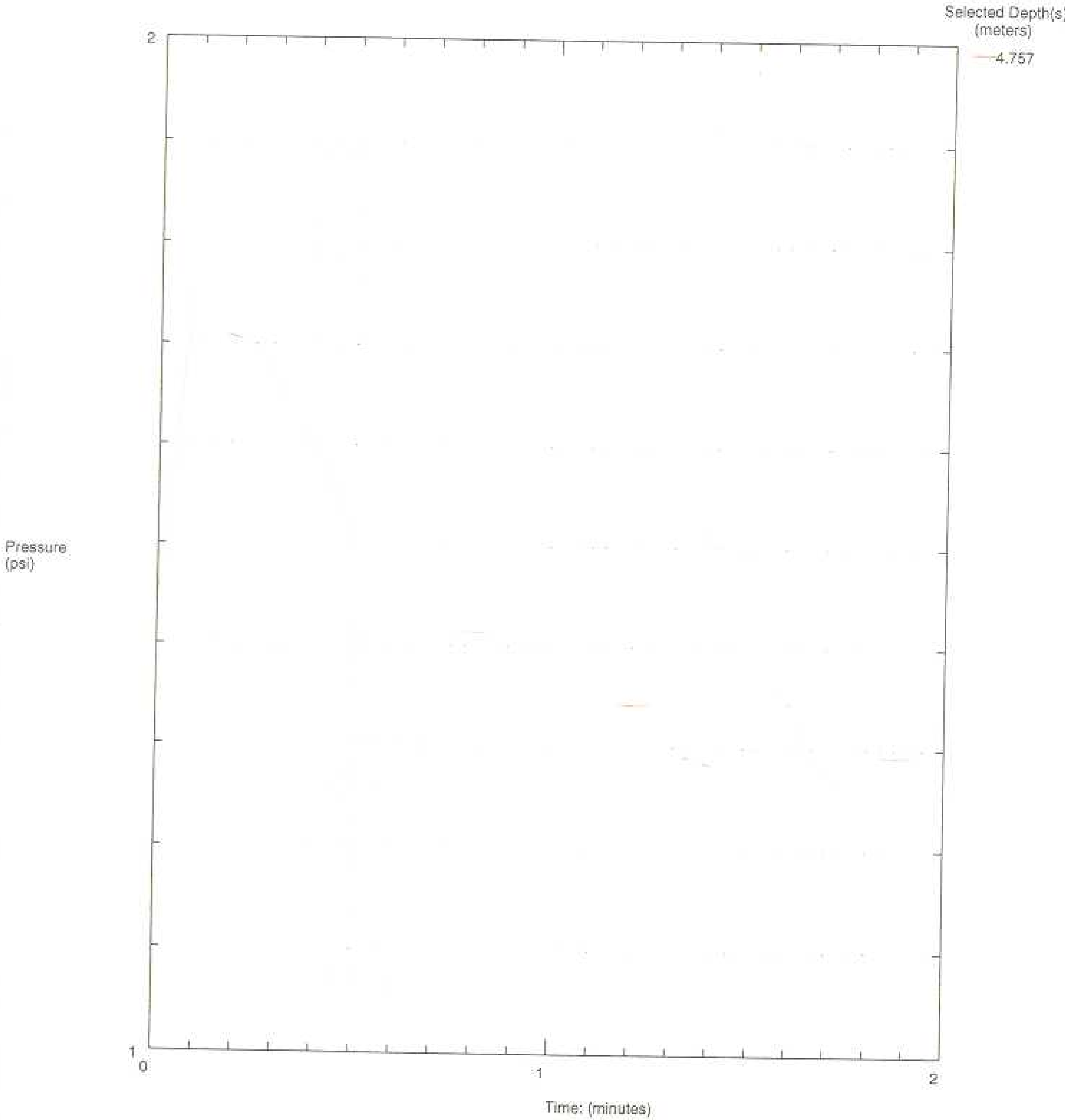
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050735

Hart Crowser

Operator K.Brown
Sounding: CPT-08
Cone Used: 581

CPT Date/Time: 06-12-81 15:18
Location: Third Runway
Job Number: 4978-44



Maximum Pressure = 1.75 psi
Hydrostatic Pressure = 2.065 psi

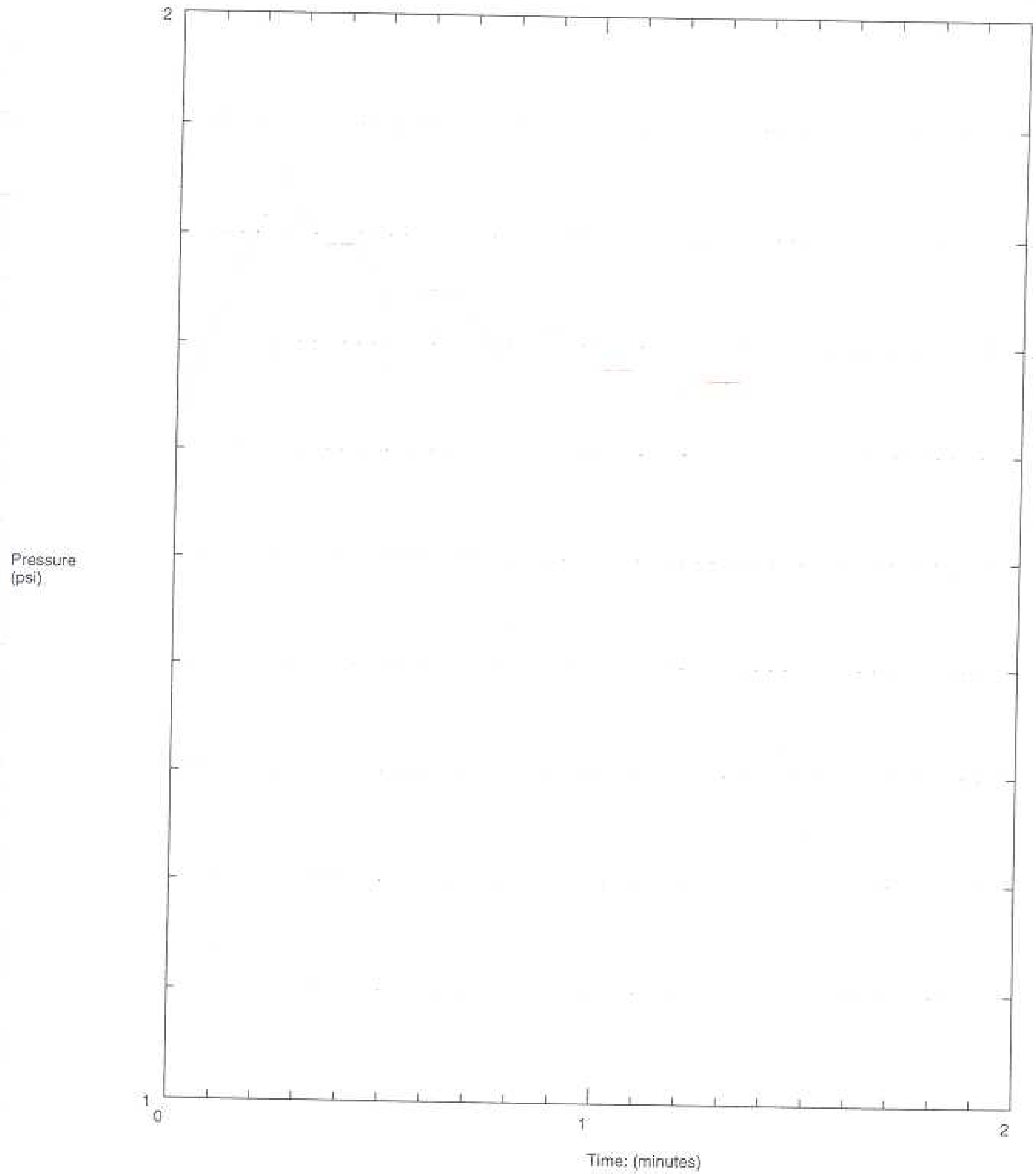
AR 050736

Hart Crowser

Operator: K.Brown
Sounding: CPT-08
Cone Used: 581

CPT Date/Time: 06-12-81 15:18
Location: Third Runway
Job Number: 4978-44

Selected Depth(s)
(meters)
6.398



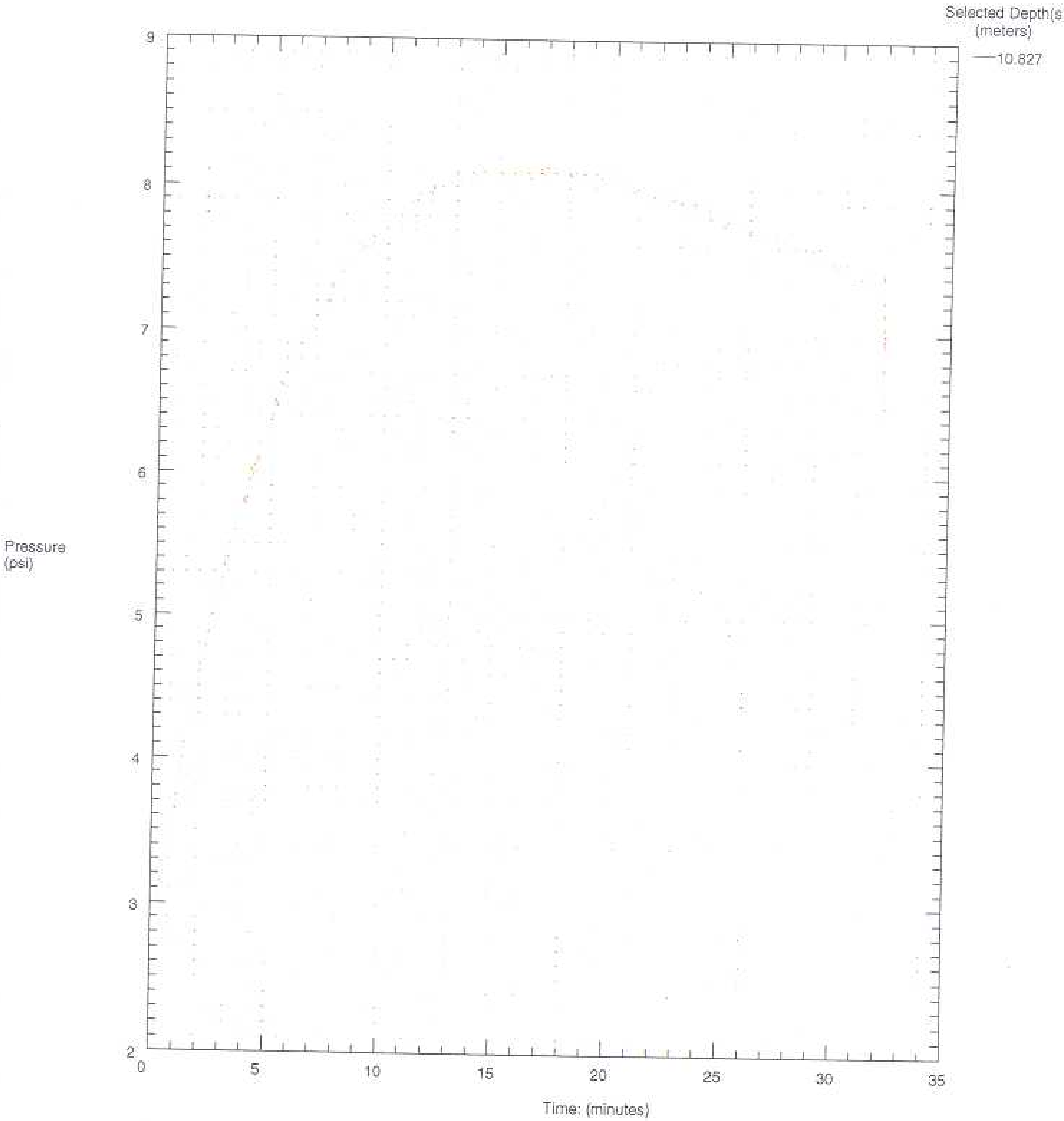
Maximum Pressure = 1.851 psi
Hydrostatic Pressure = 2.777 psi

AR 050737

Hart Crowser

Operator K.Brown
Sounding: CPT-08
Cone Used: 581

CPT Date/Time: 06-12-81 15:18
Location: Third Runway
Job Number: 4978-44



Maximum Pressure = 8.148 psi
Hydrostatic Pressure = 4.699 psi

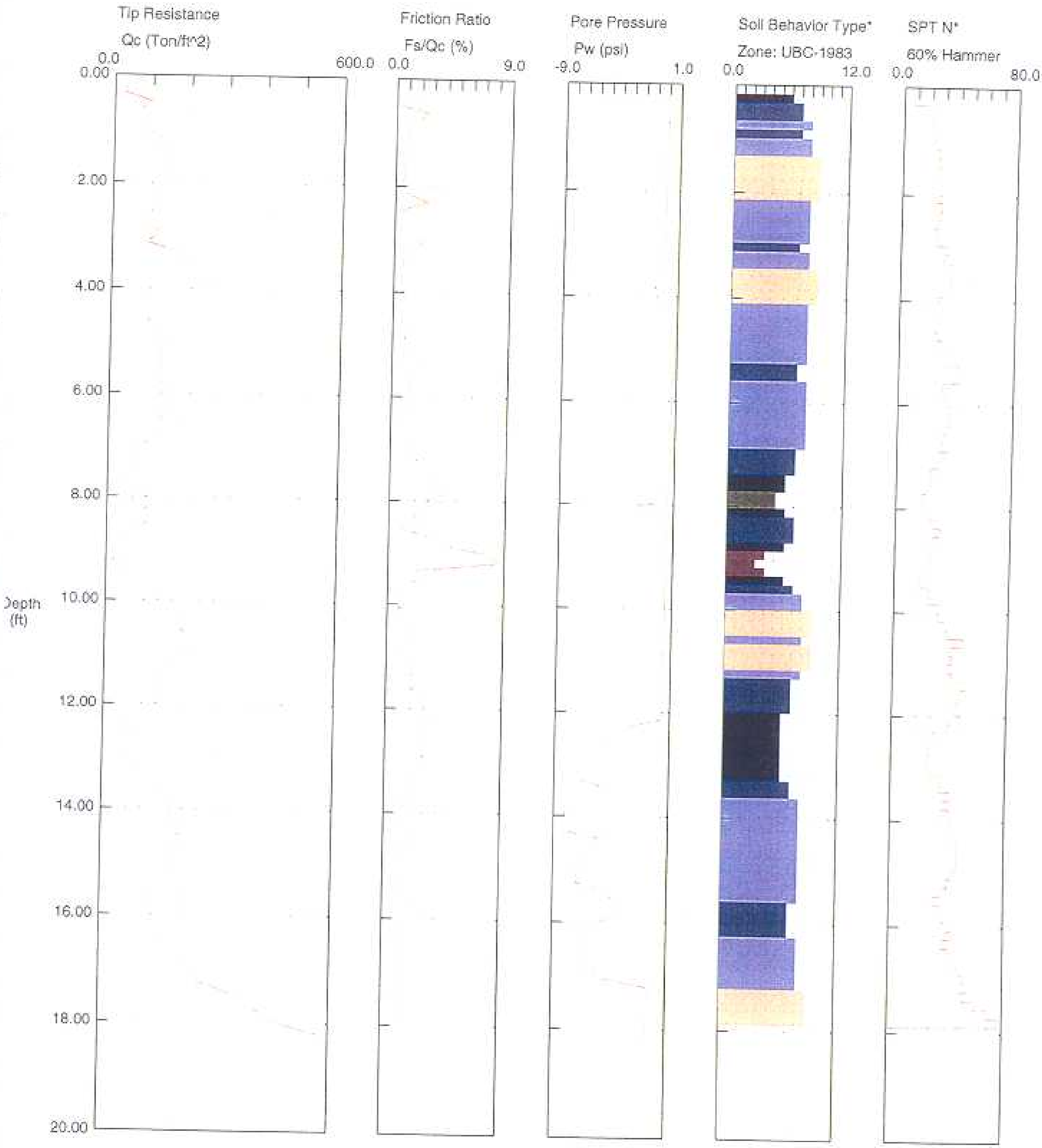
AR 050738

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-10
Cone Used: 581

CPT Date/Time: 06-20-81 10:56
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 18.21 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050739

TEST AREA #2

HARTCROWSER

Boring Location: F'15 NSA Area 2

Elevation: Datum:

Obs. Well Install. Yes No

Boring B3 Date 6/1/01 Sheet 1 of 2
Job 3R STONE COL AREA 2 Job No. 4978-30
Logged By JPL Weather RAIN 60°
Drilled By HOLT
Drill Type/Method HSA
Sampling Method SPT
Bottom of Boring 21 ATD Water Level Depth 5.5 No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS; Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
										5 INCHES GRAY (ORANGE SANDY SILT OVER		
–	95	5		2.0	3.5	X	S1		1, 3, 5 (8)	LOOSE, BROWN, MOIST, SL. SILTY M. SAND		
27	62	11		4.5	6.0	X	S2		4, 8, 7 (15)	M. DENSE, MOIST TO WET, BROWN SL. SILTY GRAVELLY SAND	*	▽
				7.0	8.5	X	S3		2, 5, 3 (8)	M. STIFF, WET, BROWN/GRAY SL. GRAVELLY, SANDY CLAYEY SILT		
				9.5	11.0	X	S4		10, 10, 10 (20)	M. DENSE, WET, DARK GRAY, SL. SILTY, SL. GRAVELLY SAND (OUTWASH?)		
5	60	35		12.0	13.5	X	S5		11, 17, 25 (42)	DENSE, MOIST, GRAY, SL GRAVELLY V.SILTY SAND TO V.SANDY SILT (TILL)		
10	55	35		14.5	16.0	X	S6		10, 15, 16 (31)	DENSE. MOIST, GRAY GRAVELLY, SILTY TO V. SILTY SAND (TILL)		
	65	35		17.0	18.5	X	S7		10, 9, 10 (19)	M. DENSE, MOIST, GRAY, SL. GRAVELLY, SILTY F-M SAND		
						X			12			

AR 050740

TEST AREA #2

HARTCROWSER

Boring Location: UJA Area 2

F' 15

Elevation: Datum:

Obs. Well Install. Yes No

Boring B3 Date 6/1/01 Sheet 2 of 2

Job 3R STONE COL AREA 2 Job No. 4978-30

Logged By JPC Weather RAIN 60°

Drilled By HOLT

Drill Type/Method HSA

Sampling Method SPT

Bottom of Boring ______ ATD Water Level Depth No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	To	SAMPLE Type	Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION; Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS; Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
5	70	25		19.5	21	X	S8	20–21	18 / 30 / 33 (63)	V. DENSE, WET, GRAY, SL SILTY, TO SILTY, SL GRAVELLY M-C SAND	~~(TILL)~~	
											BOB @ 21.0 6/1/01 1135	

Depth scale: 20, 21, 22, 23, 24, 25, 26, 27, 28, 29, 30, 1, 2, 3, 4, 5, 6, 7, 8, 9, 0

AR 050741

TEST AREA #2

HARTCROWSER

Boring Location: N'13 NSA AREA #2

Elevation: Datum:

Obs. Well Install. Yes ~~No~~

Boring B4 Date 6/1/01 Sheet 1 of 1

Job SR NSA AREA 2 STONE COL Job No. 4478-30

Logged By JPL Weather CLOUDY 60°

Drilled By HOLT

Drill Type/Method HSA

Sampling Method SPT

Bottom of Boring ATD Water Level Depth No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	To	SAMPLE Type	Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION; Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS; Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
1	~~67~~ ~~85~~	33 ~~15~~		2.0	3.5	X	S1		2, 4, 5 (9)	5 INCHES GRAY, ORANGE SANDY SILT OVER VERY LOOSE, WET, BROWN SILTY F-M SAND		
-	90	10		4.5	6.0	X	S2		3, 5, 5 (10)	LOOSE TO M. DENSE, WET, BROWN-GRAY, SL. SILTY TO SILTY F-M SAND WITH INTERBEDDED GRAY/ORANGE SANDY SILT LENSE		
				7.0	8.5	X	S3A S3B		6, 5, 5 (10)	LOOSE TO M. DENSE, WET, BROWN, SL SILTY SAND STIFF, WET, BROWN TO GRAY SANDY SILT		GRAVEL AT CONTACT
-	55	45		9.5	11.0	X	S4		0, 2, 5 (7)	LOOSE, WET, GRAY V. SILTY SAND		
5	75	20		12.0	13.5	X	S5		8, 12, 19 (33)	DENSE, WET, GRAY, SL. GRAVELLY, SL. SILTY to silty SAND		
				14.5	16.0	X	S6		16, 19, 39 (58)	V. DENSE, WET, GRAY, GRAVELLY, SILTY SAND (TILL)		
				17.0	18.5	X	S7		18, 32, 50 (82)	V. DENSE, DAMP TO MOIST, GRAY, GRAVELLY, SILTY SAND (TILL)		
										BOB @ 18.5' 6/1/01 1229		

AR 050742

TEST AREA #2

HARTCROWSER

Boring Location: Eastern location Northern test group

Elevation: ±291' Datum:

Obs. Well Install. Yes ~~No~~

Boring: B-3a Date: 8.11.01 Sheet 1 of 1

Job: Third Runway Stone Columns Job No. 4978-30

Logged By: BES Weather: Showers; 55°

Drilled By: HOLT;

Drill Type/Method: HSA; 2" SPT - Autohammer

Sampling Method:

Bottom of Boring: 20' ATD Water Level Depth: ±7.5' No

Size (%) G Max.	S Range	F Att. Limits	PID or other	Depth From	Depth To	Sample Type	Sample Number	Penetration Resistance	Description	Remarks	Summary Log
										up @ 0900	wet + muddy @ G.S. etc
											silty fine SAND
—	75 F	25		3.5	5		1	(6) 2, 3, 3	Loose, wet, brn, silty fine SAND		
TR?	90 FM	10		6	7.5		2	(11) 5, 6, 5	m. dense, wet, brn, sl. silty f-m SAND	- coarse sand in shoe; - gravelly @ 7' (driller)	sl. silty f-m SAND
—	15 F	85		8.5	10		3	(2) 1, 1, 1	v. soft, grey, moist, sl. sandy SILT	- looks native	sl. sandy SILT
—				11	12.5		4	(17) 6, 8, 9	- NO recovery - ?		
15 1"	65 FM	20		13.5	15		5	(10) 3, 5, 5	M. dense, grey, moist, gravelly silty SAND	- looks till-like	grav. silty SAND
20	60	20		16	17.5		6	(34) 11, 16, 18	Dense, grey, moist, grav. silty SAND	- tillish	
20	60	20		18.5	20		7	(38) 9, 19, 19	Dense, grey, moist, grav. silty SAND	- till	

AR 050743

TEST AREA # 2

HARTCROWSER

Boring Location: western location Northern test group	Boring: B-4a; Date: 6/11/01; Sheet 1 of 1
	Job: 3 Runway Stone Columns; Job No. 4978 37
	Logged By: BES; Weather: Rain
	Drilled By: Holt; Mike
	Drill Type/Method: B-59 HSA
Elevation: ±291'; Datum:	Sampling Method: 24 SPT Autohammer
Obs. Well Install. Yes / No (No marked)	Bottom of Boring: 19.5; ATD Water Level Depth: 16.0

Size (%) G Max.	S Range	F Att. Limits	PID or other	Depth From	Depth To	Sample Type	Sample Number	Penetration Resistance (blows)	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave...etc.	SUMMARY LCG (Water and Date)
										up @ 1000	
—	95 FM	5		3.5	5	S	1	4, 6, 4 (10)	Loose, wet, brown, sl. silty f-m SAND		sl. silty f-m SAND
—	90 FM	10		6	7.5	S	2	5, 6, 6 (12)	m. dense, brown, wet-moist, sl. silty f-m SAND	- some gravel in shoe; - small gravels (@ [illegible])	
				8.5	10	S	3	2, 4, 2 (6)	loose, wet, brown, very gravelly SAND	- prob. fill? or native outwash?	very gravelly SAND (fill?)
10	65 FM	25		11	12.5	S	4	2, 2, 2 (4)	loose, wet, grey, [illegible] gravelly v. silty SAND	- looks weath. till-like	sl. grav. very silty SAND
25, 1"	65 FM	20		13.5	15	S	5	8, 13, 14 (27)	m. dense, moist, grey, gravelly silty SAND	- till-like	gravelly silty SAND
25	50 FM	25		16	17.5	S	6	13, 26, 36 (62)	v. dense, moist, grey, gravelly, silty SAND	- def. TILL	
—				19.5	20	S	7	30, 50 (50/4)	TOOK H_2O @ 19.5' = 16.0' ATD	- no recovery (on rock) (def. TILL)	

[illegible] sealed [illegible]

AR 050744

Boring Location: TEST SECTION #2
DRILLED AT STAKED LOCATION

Elevation: Datum:

Obs. Well Install. Yes No

HARTCROWSER

Boring B-6A Date 6/20/01 Sheet 1 of 1
Job SEATAC Job No. J-4978-44
Logged By B. McDONALD Weather CLEAR ~ 70°F
Drilled By HOLT DRILLING (MIKE & MARK)
Drill Type/Method MOBILE B-59 / 4" I.D. HSA
Sampling Method SPT WITH 140lb. AUTOMATIC HAMMER
Bottom of Boring 17.5 ATD Water Level Depth NO

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	To	SAMPLE Type	Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION; Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS; Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
				0	3.5					Cuttings: BROWN SILT AND fine SANDY SILT (very moist)		VERY MOIST BROWN SILT AND fine SANDY SILT
FC 45	FC 45	10		3.5	5.0	SPT	S-1 0830	13"	4, 6, 10 (16)	MEDIUM DENSE, MOIST, BROWN, slightly SILTY, SANDY GRAVEL to GRAVELLY SAND		SANDY GRAVEL to GRAVELLY SAND
SCATTERED	F 20	80		6.0	7.5	SPT	S-2 0835	12"	3, 1, 1 (2)	SOFT, VERY MOIST, BROWN TO GRAY, fine SANDY SILT WITH SCATTERED fine GRAVEL		SOFT VERY MOIST BROWN TO GRAY F-SANDY SILT
SCATTERED	F 50	50 — 100		8.5	10.0	SPT	S-3 0839	18"	2, 3, 6 (9)	STIFF, VERY MOIST, GRAY, SILT AND SILTY fine SAND few SCATTERED GRAVEL		STIFF
F	F 60	40		11.0	12.5	SPT	S-4 0843	14"	3, 3, 5 (8)	LOOSE, VERY MOIST, GRAY, VERY SILTY fine SAND TRACE SCATTERED fine GRAVEL	"STIFFER DRILL ACTION @ 12.5'	LOOSE
F	F 55	45		13.5	15.0	SPT	S-5 0848	15"	11, 12, 15 (27)	MEDIUM DENSE, MOIST, GRAY, VERY SILTY fine SAND few SCATTERED v. fine GRAVEL		MEDIUM DENSE TO DENSE MOIST VERY SILTY fine SAND
—	F 55	45		16.0	17.5	SPT	S-6 0858	18"	9, 15, 20 (35)	DENSE, MOIST, GRAY, VERY SILTY fine SAND		few SCATTERED fine GRAVEL

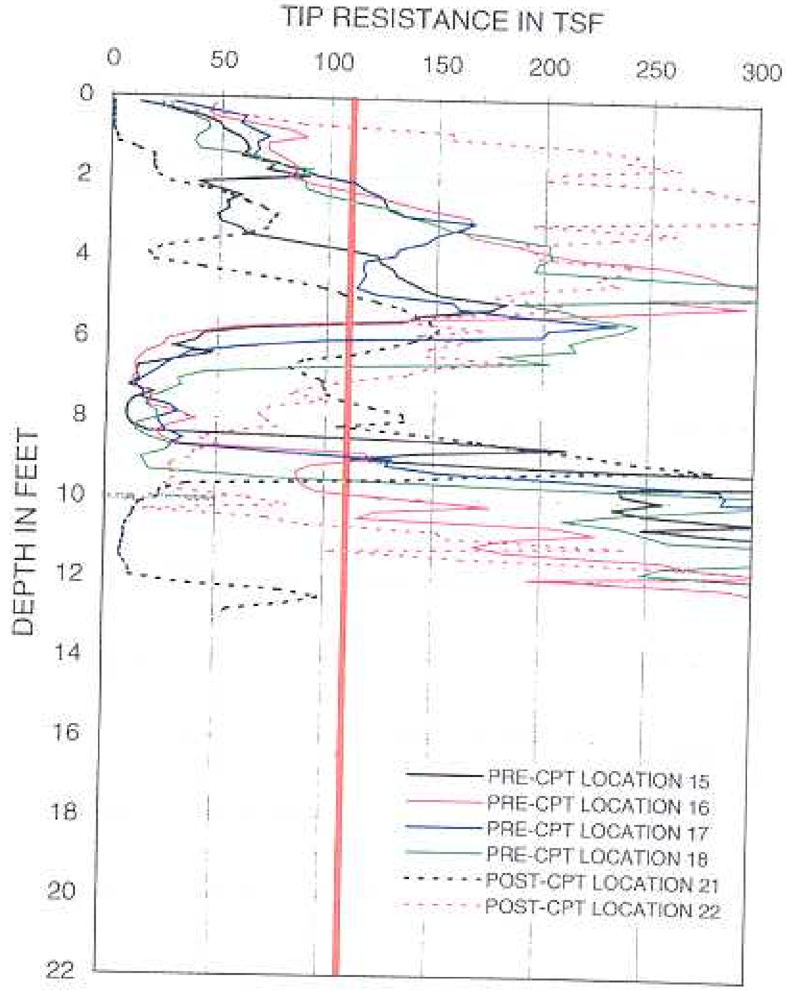
Bottom of Boring 17.5 FEET
COMPLETED 6/20/01

No Noticeable Perched WATER
Relatively Dry Drill cuttings

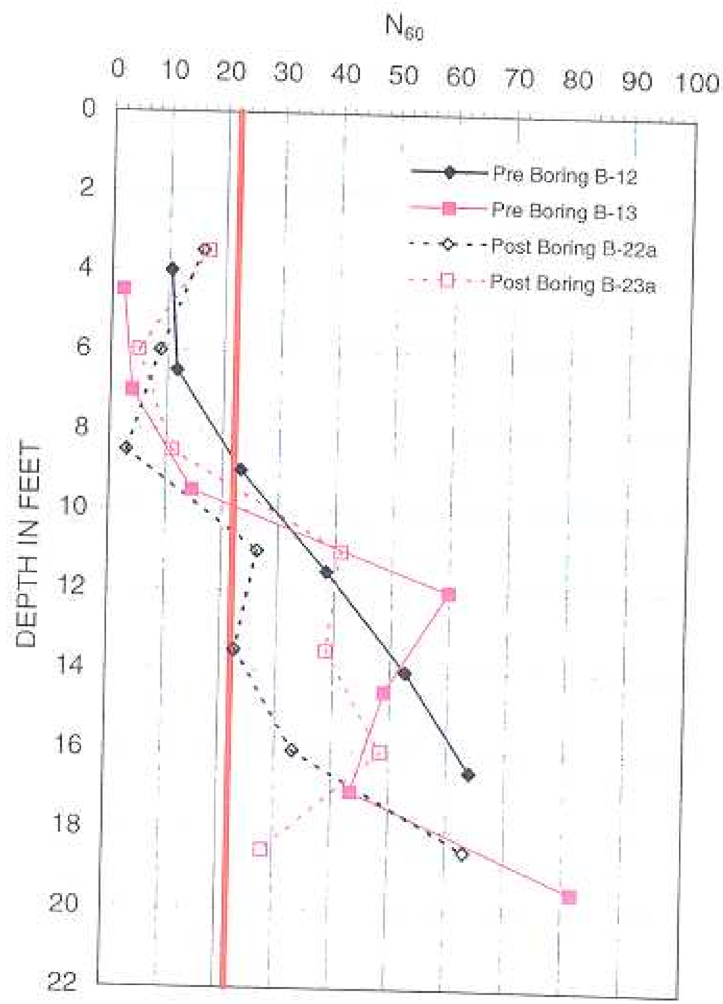
AR 050745

APPENDIX C
TEST AREA 3

CPT TEST DATA
AREA 3



SPT VALUES VS DEPTH
AREA 3



6/29/01

Third Runway - SeaTac Airport
Stone Columns - In-Situ Soil Testing
J-4978-30

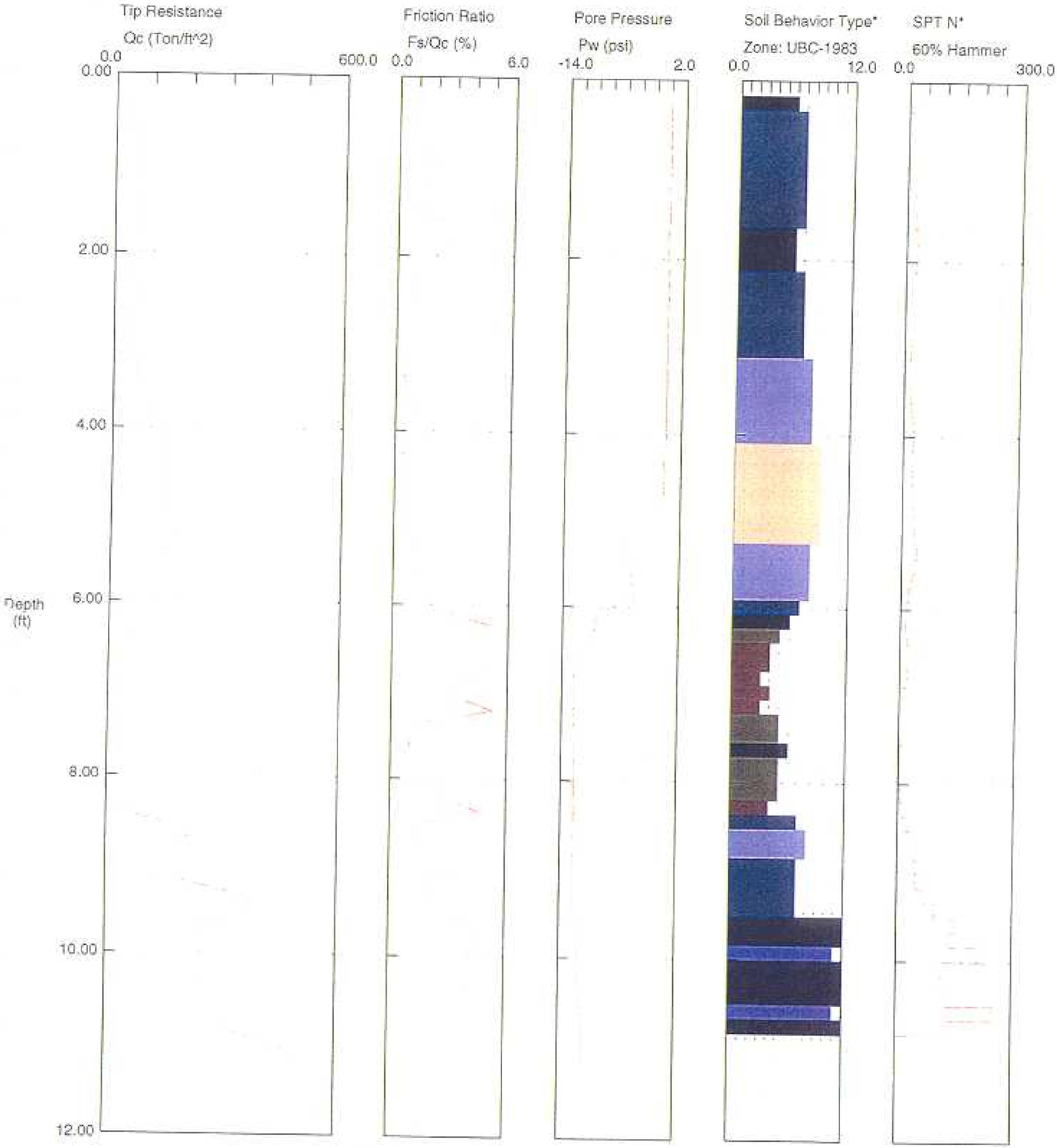
AR 050747

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-15
Cone Used: 581

CPT Date/Time: 06-20-81 12:31
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 11.15 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

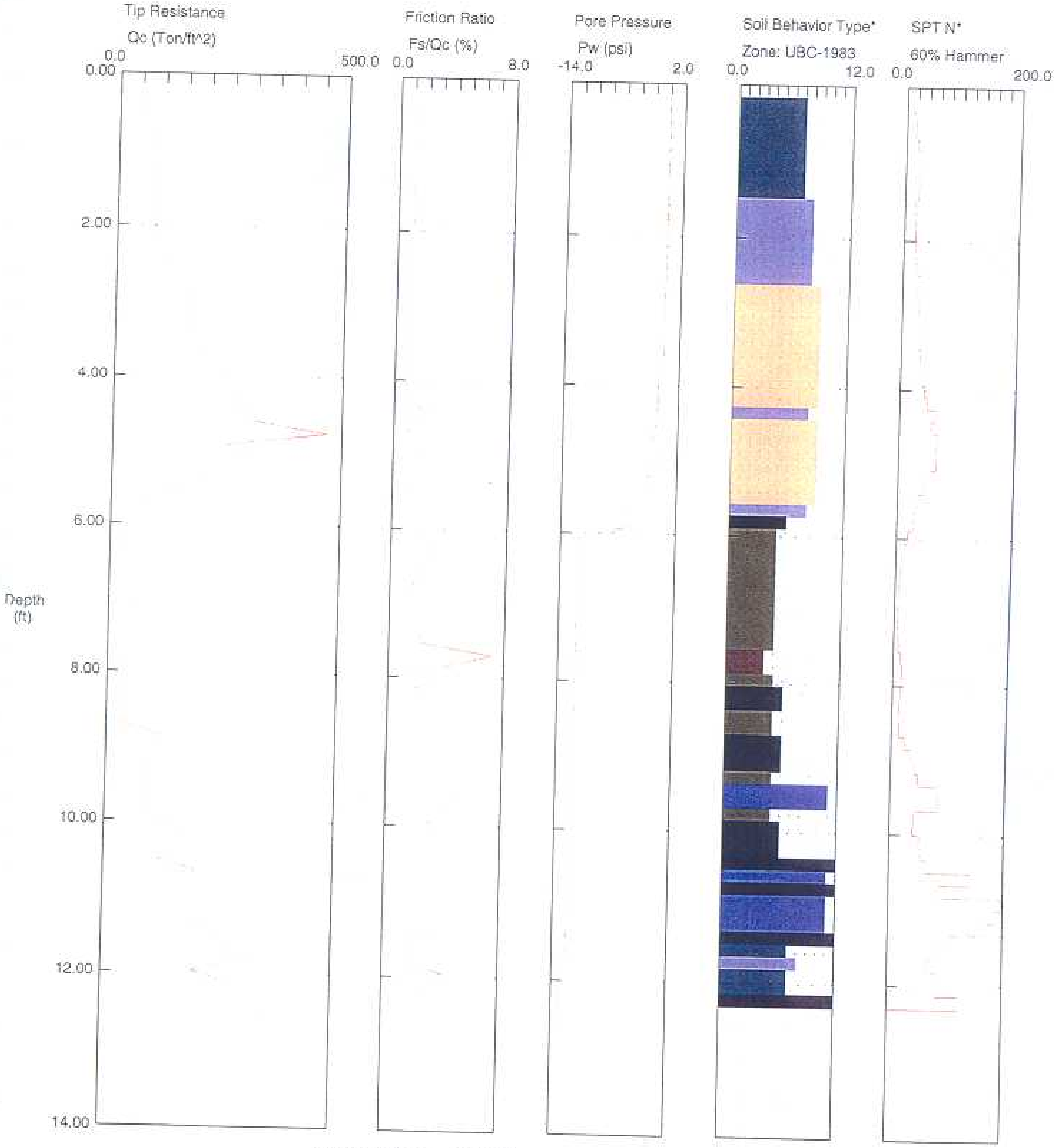
AR 050748

Soil Behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-16
Cone Used: 581

CPT Date/Time: 06-20-81 12:44
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 12.63 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

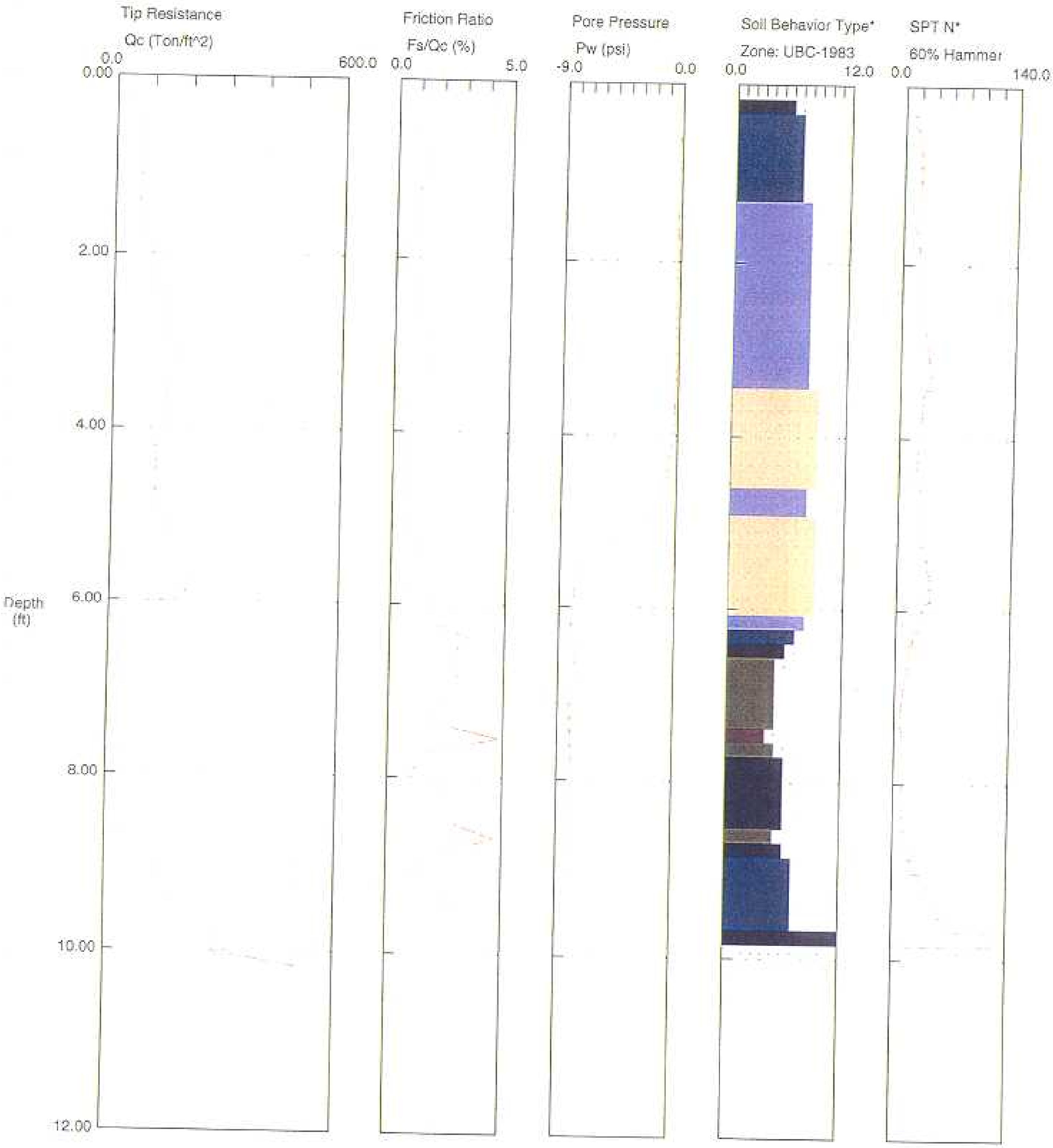
AR 050749

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-17
Cone Used: 581

CPT Date/Time: 06-20-81 12:57
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 10.17 feet

Depth Increment = 0.16 feet

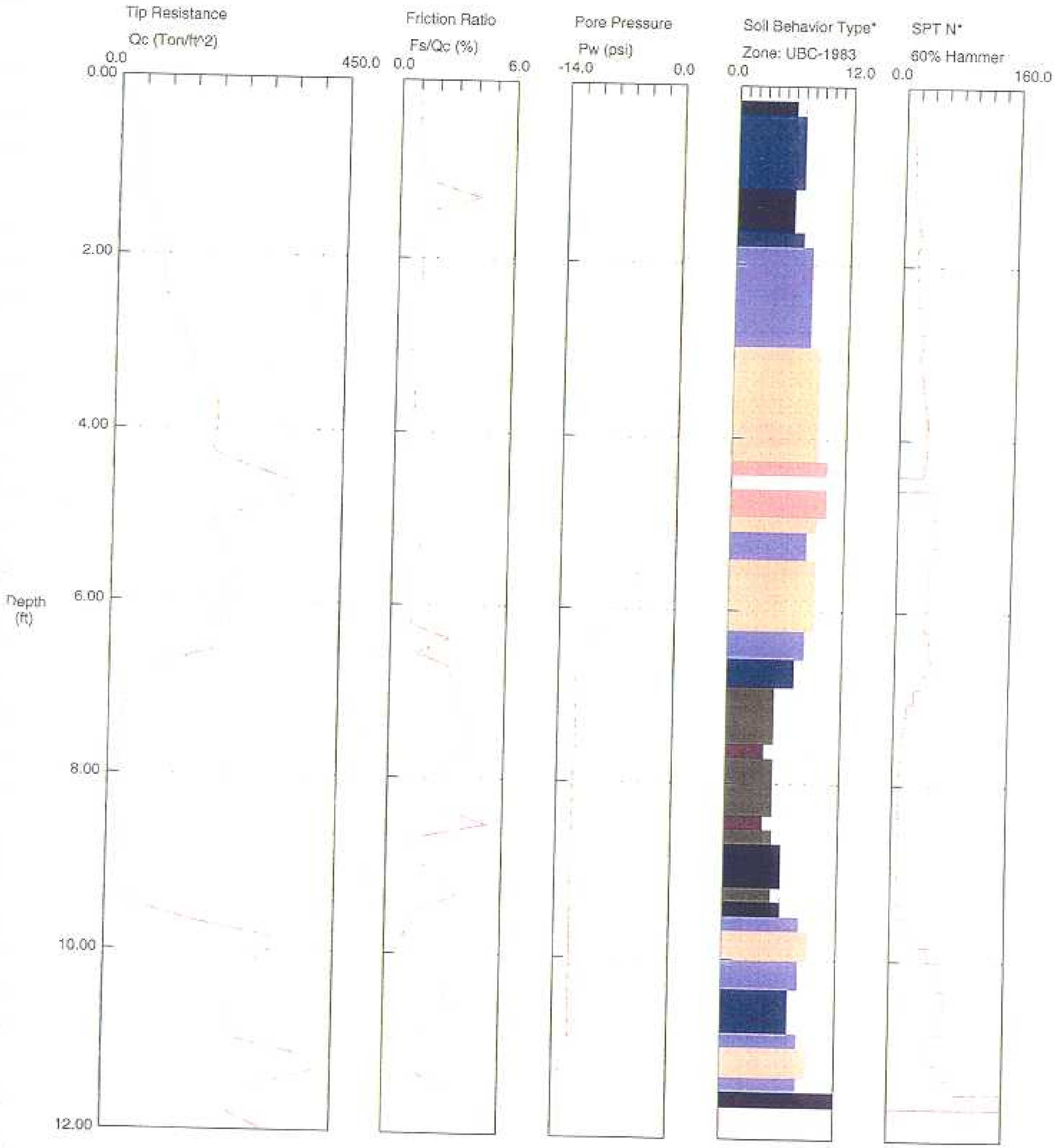
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050750

Hart Crowser

Operator: K.Brown
Sounding: CPT-18
Cone Used: 581

CPT Date/Time: 06-20-81 13:09
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 11.98 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

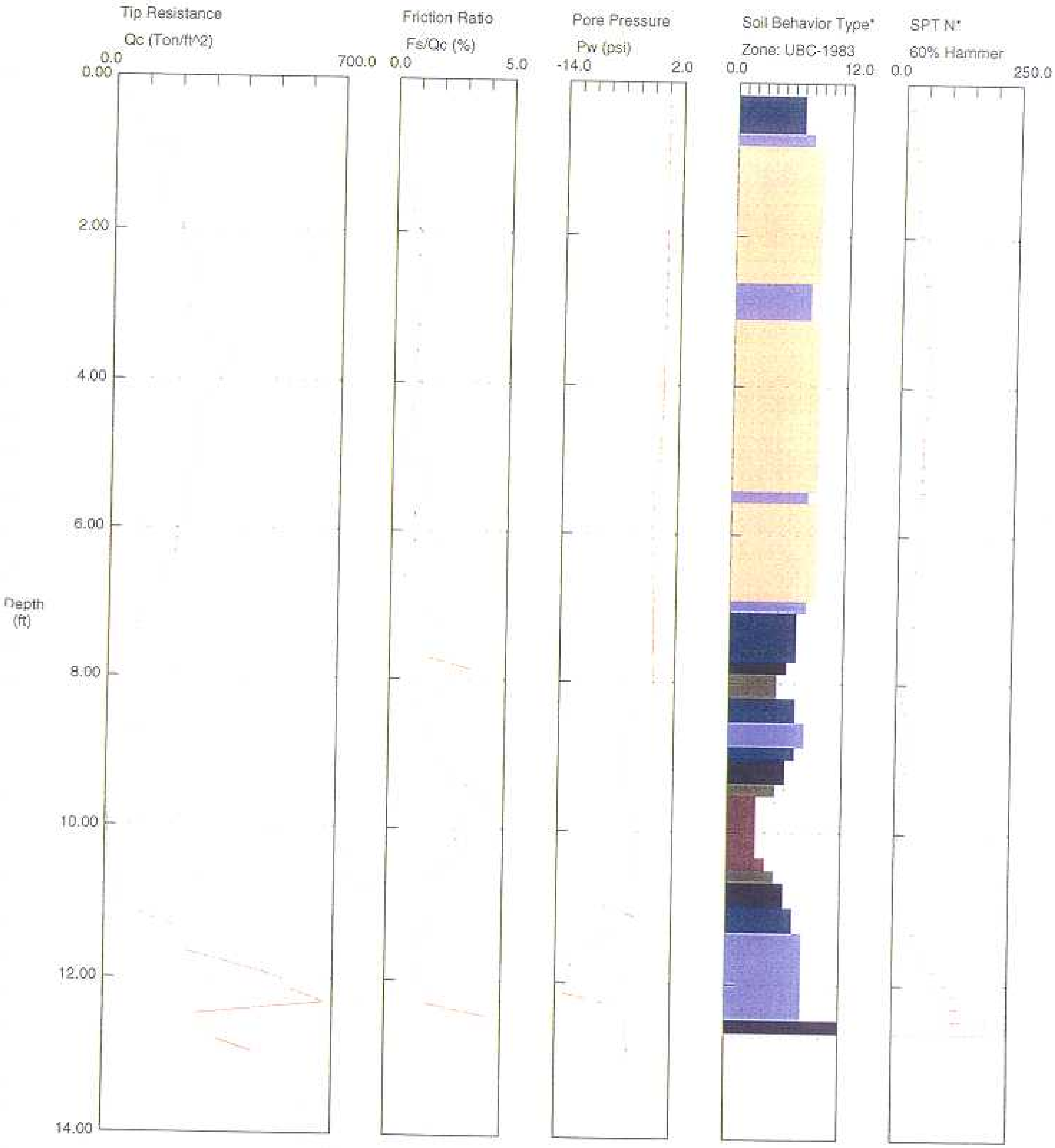
AR 050751

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-21
Cone Used: 581

CPT Date/Time: 06-27-81 11:09
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 12.96 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

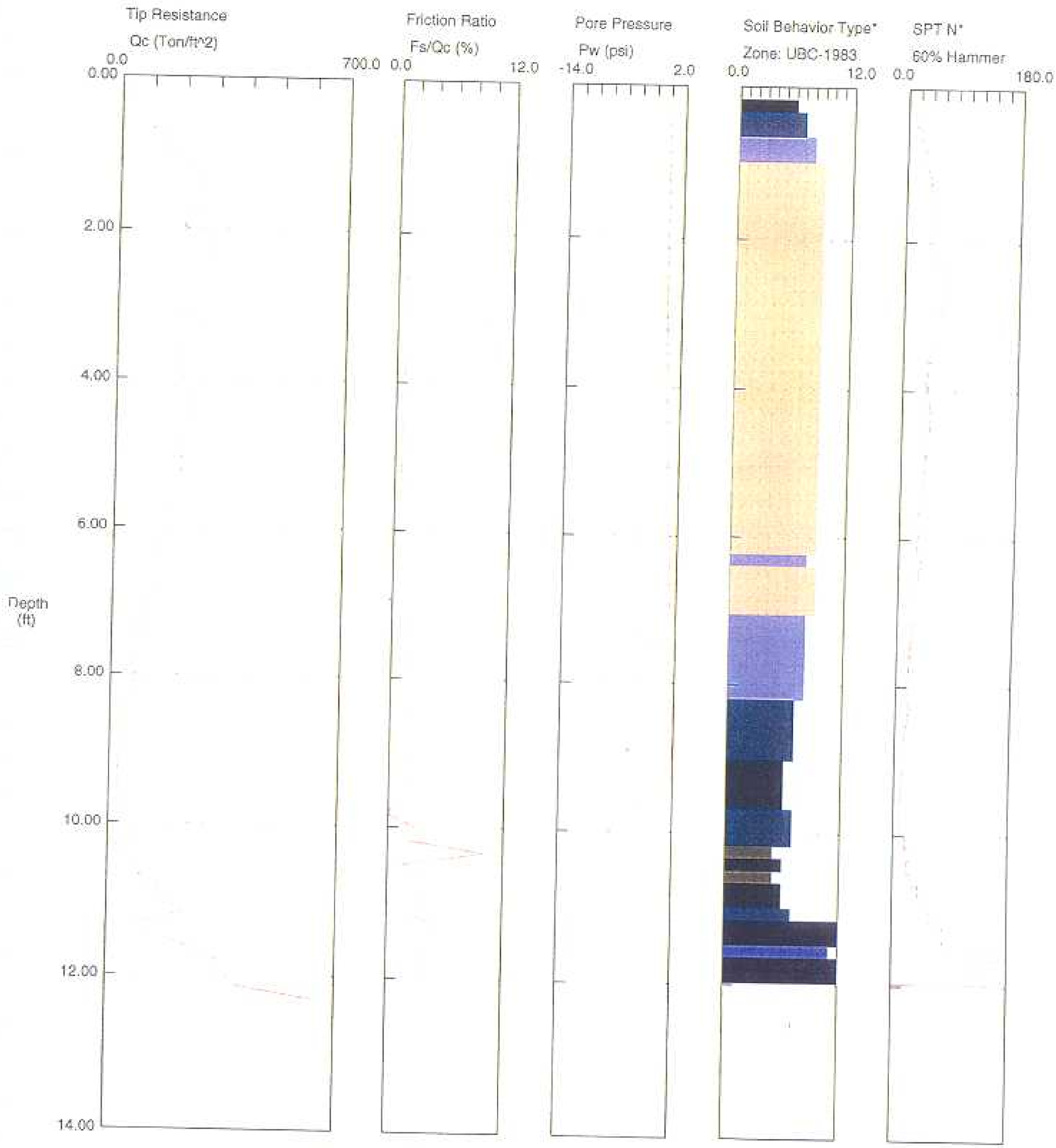
AR 050752

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-22
Cone Used: 581

CPT Date/Time: 06-27-81 11:22
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 12.30 feet

Depth Increment = 0.16 feet

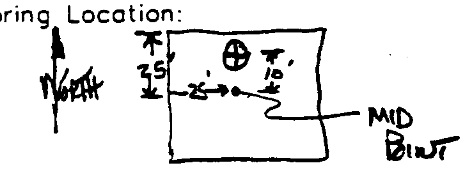
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050753

TEST SECTION # 3 10' NORTH OF TEST SECTION MID POINT

HARTCROWSER

Boring Location:



Elevation: Datum:

Obs. Well Install. Yes ~~No~~

Boring B-12 Date 6-19-01 Sheet 1 of 1
Job SEATAC Job No. 4978-44
Logged By B. McDONALD Weather CLEAR ~65°F
Drilled By HOLT DRILLING
Drill Type/Method MOBILE B-59 / 4" I.D. HSA
Sampling Method SPT w/ 140 lb. AUTOMATIC HAMMER
Bottom of Boring 17.0 ATD Water Level Depth 5.0

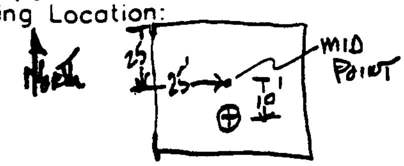
SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
										CONCRETE DEBRIS		(LOOSE) MOIST BROWN FINE SAND TRACE SCATTERED GRAVEL
										CUTTINGS: (LOOSE), MOIST, BROWN, FINE SAND TRACE SCATTERED FINE GRAVEL		
FC 2	F 95	3		3.0	4.5	SPT	S-1 1055	12"	3, 5, 5 (10)	(LOOSE), MOIST, BROWN, FINE SAND WITH TRACE SCATTERED GRAVEL (APPEARS SLIGHTLY MOTTLED)	PERCHED WATER CONDITION @ 5.0'	
FC SCATTERED		100		5.5	7.0	SPT	S-2 1100	18"	3, 6, 6 (12)	STIFF, DAMP, BROWN TO GRAY, SILT WITH SCATTERED GRAVEL (WEATHERED) — GRAY		STIFF TO VERY STIFF BROWN TO GRAY SILT SCATTERED GRAVEL
	—	100		8.0	9.5	SPT	S-3 1104	18"	1, 8, 14 (22)	VERY STIFF, DAMP, GRAY, SILT WITH SCATTERED GRAVEL		
FEW SCATTERED	F 70	30		10.5	12.0	SPT	S-4 1108	15"	9, 14, 24 (38)	DENSE, MOIST, GRAY, VERY SILTY, FINE SAND FEW SCATTERED GRAVEL		DENSE TO VERY DENSE MOIST GRAY SILTY FINE SAND SCATTERED GRAVEL (TILL LIKE)
	F 70	30		13.5	14.5	SPT	S-5 1115	15"	27, 27, 27 (54)	VERY DENSE, MOIST, GRAY, VERY SILTY FINE SAND FEW SCATTERED GRAVEL (TILL LIKE)	COBBLE? @ ~13'	
SCATTERED	F 75	25		15.5	17.0	SPT	S-6 1124	15"	50, 26, 35 (61)	VERY DENSE, MOIST, GRAY, SILTY FINE SAND SCATTERED GRAVEL (TILL LIKE)		

BOTTOM OF BORING 17.0 FEET
COMPLETED 6-19-01.

TEST SECTION # 3 10' SOUTH of TEST SECTION MID-POINT

HARTCROWSER

Boring Location:



Elevation: Datum:

Obs. Well Install. Yes No

Boring B-13 Date 6-19-01 Sheet 1 of 1

Job SEATAC Job No. J-4978-44

Logged By B. McDONALD Weather CLEAR ~70°F

Drilled By HOLT DRILLING

Drill Type/Method MOBILE B-59 / 4" I.D. HSA

Sampling Method SPT w/ 140lb. AUTOMATIC HAMMER

Bottom of Boring 20.0 ATD Water Level Depth 5.5 No

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	To	SAMPLE Type	Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date
SCATTERED	FM 90	10		0.0	3.5	GRAB	S-1 1200			cuttings: (loose), MOIST, BROWN, slightly SILTY, fine to medium SAND, FEW SCATTERED gravel	TRACE ORGANICS	(loose) moist Brown slightly silty F-M sand trace gravel
—	FC 100	—		3.5	5.0	SPT	S-2 1203	10"	2, 1, 1 (2)	VERY LOOSE, VERY MOIST to WET, BROWN fine to COARSE SAND	PERCHED WATER CONDITION @ ~5.5'	Brown F-C sand
FC SCATTERED	—	100		6.0	7.5	SPT	S-3 1206	6"	3, 2, 2 (4)	MEDIUM STIFF, DAMP, BROWN TO GRAY SILT SCATTERED gravel (MOTTLED)		MEDIUM STIFF BROWN TO GRAY SILT
	FM 50	50		8.5	10.0	SPT	S-4 1210		5, 5, 9 (14)	MEDIUM DENSE, DAMP, GRAY, MEDIUM to fine sandy SILT to silty M-F SAND TRACE SCATTERED gravel	DRILLER REPORTS "GRAVELS @ 9.0'"	GRADES to SILTY M-F SAND
	F 60	40		11.0	12.5	SPT	S-5 1216	15"	24, 26, 34 (60)	VERY DENSE, MOIST, GRAY, VERY SILTY, MEDIUM TO FINE SAND TRACE gravel		VERY DENSE VERY SILTY M-F SAND TRACE GRAVEL
	F 60	40		13.5	15.0	SPT	S-6 1225	12"	14, 21, 30 (51)	VERY DENSE, MOIST, GRAY, VERY SILTY fine SAND TRACE SCATTERED gravel trace organics		
FC 45	FM 35	20		16.0	17.5	SPT	S-7 1235	12"	8, 17, 25 (42)	DENSE, VERY MOIST, GRAY, SILTY, fine to medium SANDY GRAVEL	LARGE GRAVEL @ 16.0 FEET	DENSE SILTY F-M SANDY GRAVEL
SCATTERED	M-F 80	20		18.5	20.0	SPT	S-8 1244	12"	6, 32, 50/6" (82)	VERY DENSE, MOIST, GRAY SILTY, MEDIUM TO fine SAND WITH SCATTERED gravel		VERY DENSE SILTY M-F SAND SCATTERED GRAVEL

AR 050755

HARTCROWSER

Boring Location: TEST AREA # 3 ⊕ B-22a	Boring: B-22a Date: 6/?/? Sheet 1 of 1
	Job: [illegible] Job No. [illegible]
	Logged By: W. [illegible] Weather: 58° / RAIN
	Drilled By: [illegible]
	Drill Type/Method: B-59 [illegible] / 4" HSA
Elevation: ______ Datum: ______	Sampling Method: SPT w/ 140 lb Auto Hammer
Obs. Well Install. Yes / No	Bottom of Boring ______ ATD Water Level Depth 10.0'

G Max.	S Range	F Att. Limits	PID or other	Depth From	Depth To	Sample Type	Sample Number	Penetration Resistance	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave, ...etc.	SUMMARY LOG (Water and Date)
											1235 - Start
25	75	∅		2.5	4.0	X	S-1	3, 6, 9 (15)	M. dense, moist, brown, gravelly, coarse SAND	12" recovery	
25	75	∅		5.0	6.5	X	S-2	6, 5, 4 (9)	Loose, moist, brown, gravelly, coarse SAND		
10 / 20	30 / 55	60 / 25		7.5	9.0	X	S-3	1, 2, 1 (3)	Soft, moist-wet, gray, sl. gravelly sandy SILT grading to v. loose, silty SAND, gravelly		10.0 ▽
20	60	20		10.0	11.5	X	S-4	7, 11, 12 (23)	M. dense, moist, gray, gravelly, silty, F-SAND; coarse gravel at ~10.0'	12" recovery	
25	70	5		12.5	14.0	X	S-5	6, 11, 14 (25)	M. dense wet gray, gravelly SAND, trace silt		
12	63	25		15.0	16.5	X	S-6	?, 14, 20 (34)	Dense moist gray, sl. gravelly, silty, F. SAND		
5	95	∅		17.5	18.9	X	S-7	10, 12, 38/5 (50/5)	V. dense moist gray, M. SAND / trace gravel		1325 End
10	30	10		20.0	21.?	X	S-8	22, 50 (72/5?)	V. dense, moist, gray, sl. gravelly, silty, F. SAND		

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AR 050756

HARTCROWSER

Boring Location: Test Area #3

CT B-23a CT

(B-22a)

Elevation: ______ Datum: ______

Obs. Well Install. Yes | No

Boring: B-23a Date: 6/2?/?? Sheet 1 of 1

Job: 3rd Runway / Stone Columns Job No. 4978-30

Logged By: [illegible] Weather: 54° / Rain

Drilled By: [illegible]

Drill Type/Method: B-59 Mobile / 4" HSA

Sampling Method: SPT, w/ 140 lb. Auto Hammer

Bottom of Boring: 20.9'

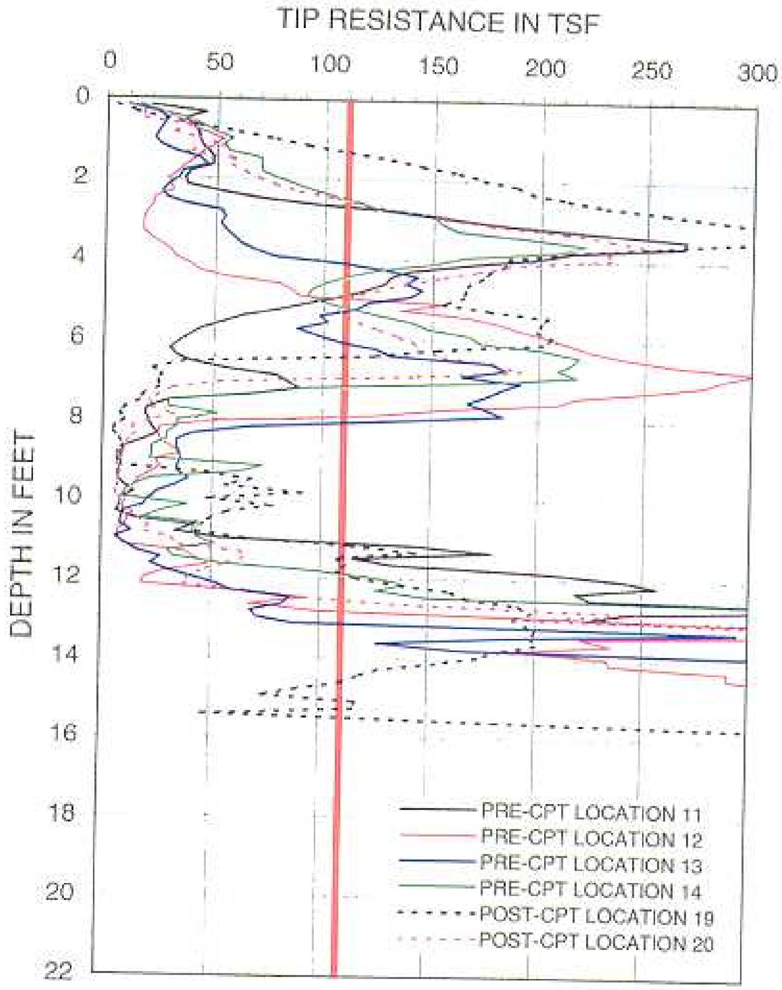
ATD Water Level Depth: 10.5

G Max.	S Range	F Att. Limits	PID or other	Depth From	Depth To	Sample Type	Sample Number	Penetration Resistance	Description	Remarks	Summary Log (Water and Date)
											1336 - Start
15	85	ø		2.5	4.0	X	S-1	7, 9, 7 (16)	M. Dense, Moist, Brown Gravelly SAND		
10	90	ø		5.0	6.5	X	S-2	4, 2, 3 (5)	Loose, Moist, Brown Sl. Gravelly, [illegible] SAND	8" Recovery	
ø	30	70		7.5	9.0	X	S-3	2, 5, 6 (11)	Stiff, Moist, Gray F. Sandy SILT	3" Recovery	
20	20	60		10.0	11.5	X	S-4	3, 15, 20 (44)	Hard, [illegible], Moist, Blue Gray Gravelly, F. Sandy SILT (Till)		(10.5) ▽
20	55	25		12.5	14.0	X	S-5	13, 23, 20 (43)	Dense, Moist, Gray, Gravelly, Silty, F. SAND		
20	35	45		15.0	16.5	X	S-6	2, 15, 32 (75?)	Hard, Wet, Gray, Gravelly, V. Sandy SILT	9" Recovery	
				17.5	19.0	X	S-7	4, 12, 18 (30)	Dense, Wet, Gray Sl. Silty, [illegible] SAND		
				20.0	20.9	X	S-8	50/5" (150)	V. Dense, Moist, Gray Gravelly V. Silty SAND		1435 - Finish

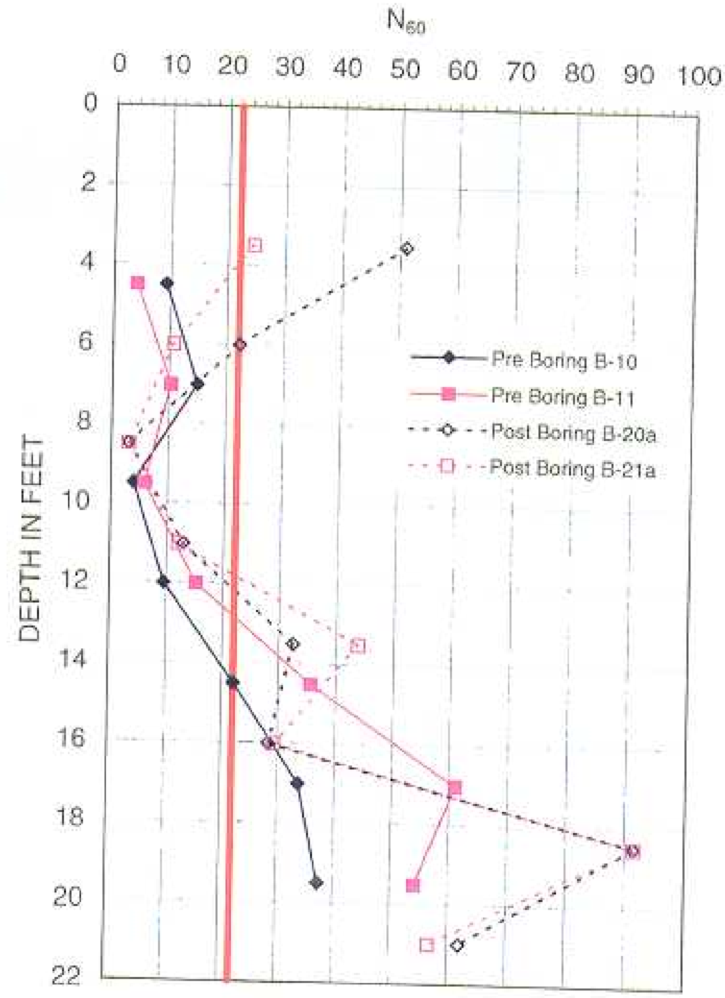
AR 050757

APPENDIX D
TEST AREA 4

CPT TEST DATA
AREA 4



SPT VALUES VS DEPTH
AREA 4



AR 050759

6/29/01

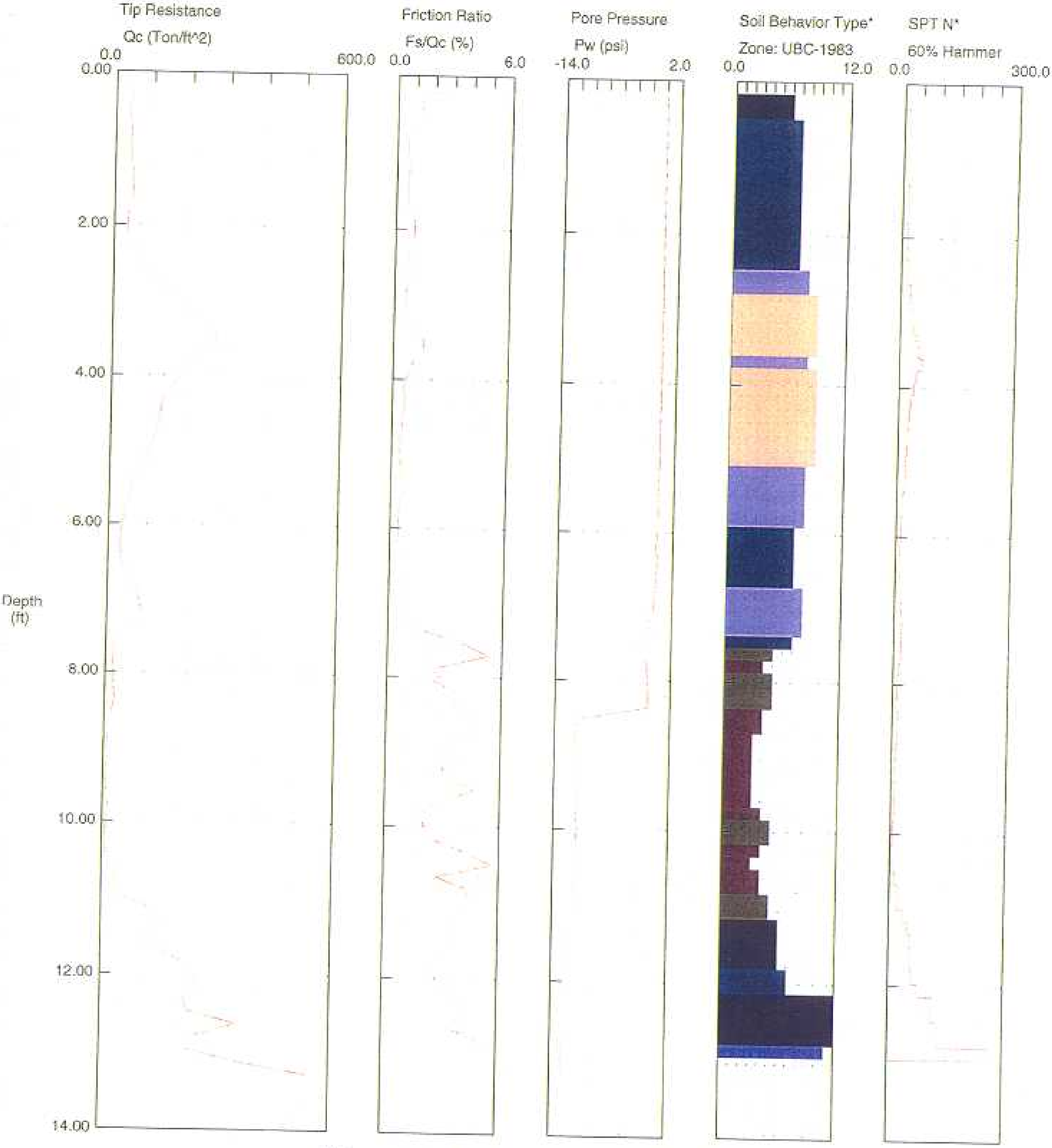
Third Runway - SeaTac Airport
Stone Columns - In-Situ Soil Testing
J-4978-30

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-11
Cone Used: 581

CPT Date/Time: 06-20-81 11:15
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 13.29 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

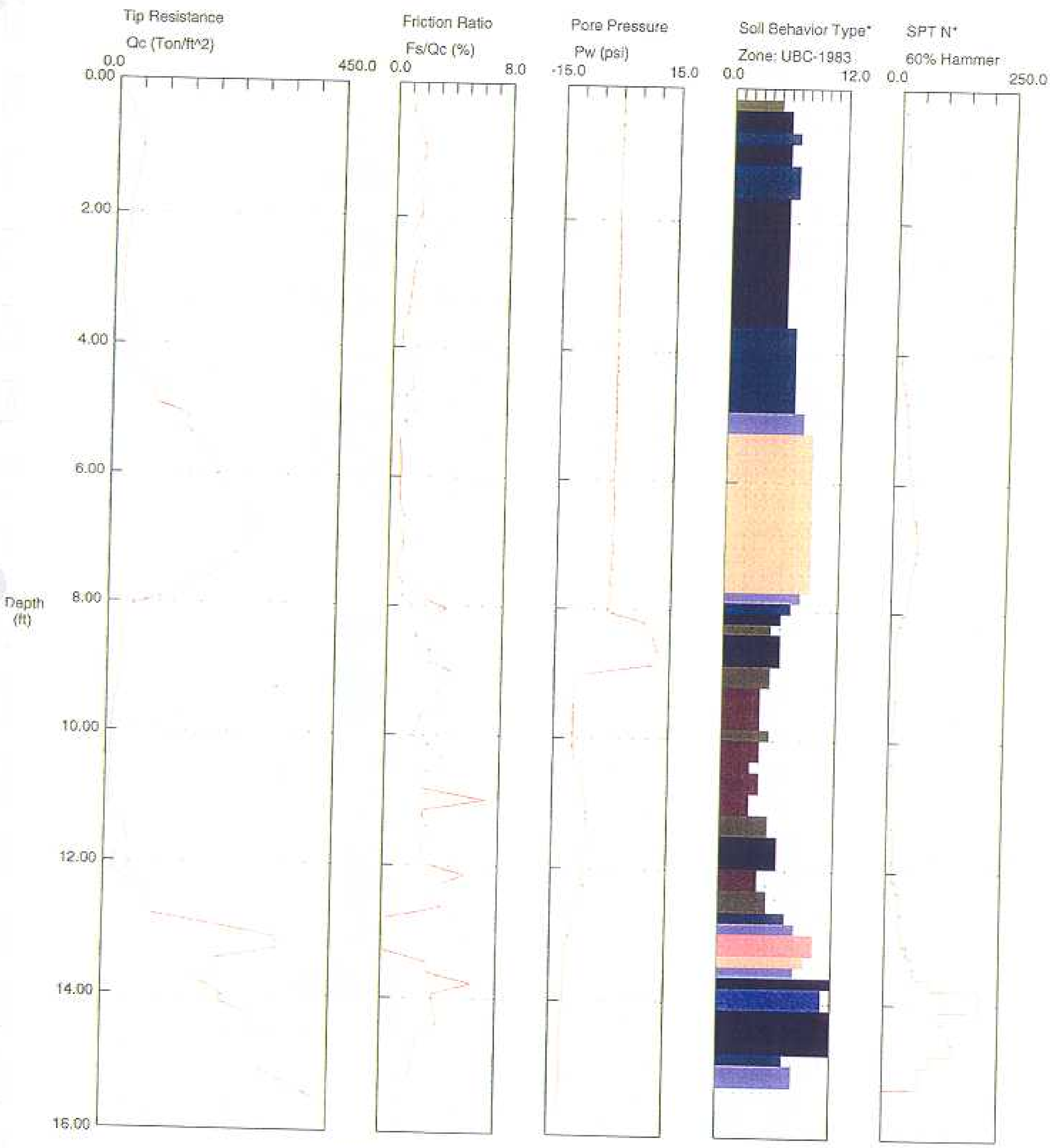
AR 050760

Soil Behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-12
Cone Used: 581

CPT Date/Time: 06-20-81 11:39
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 15.58 feet

Depth Increment = 0.16 feet

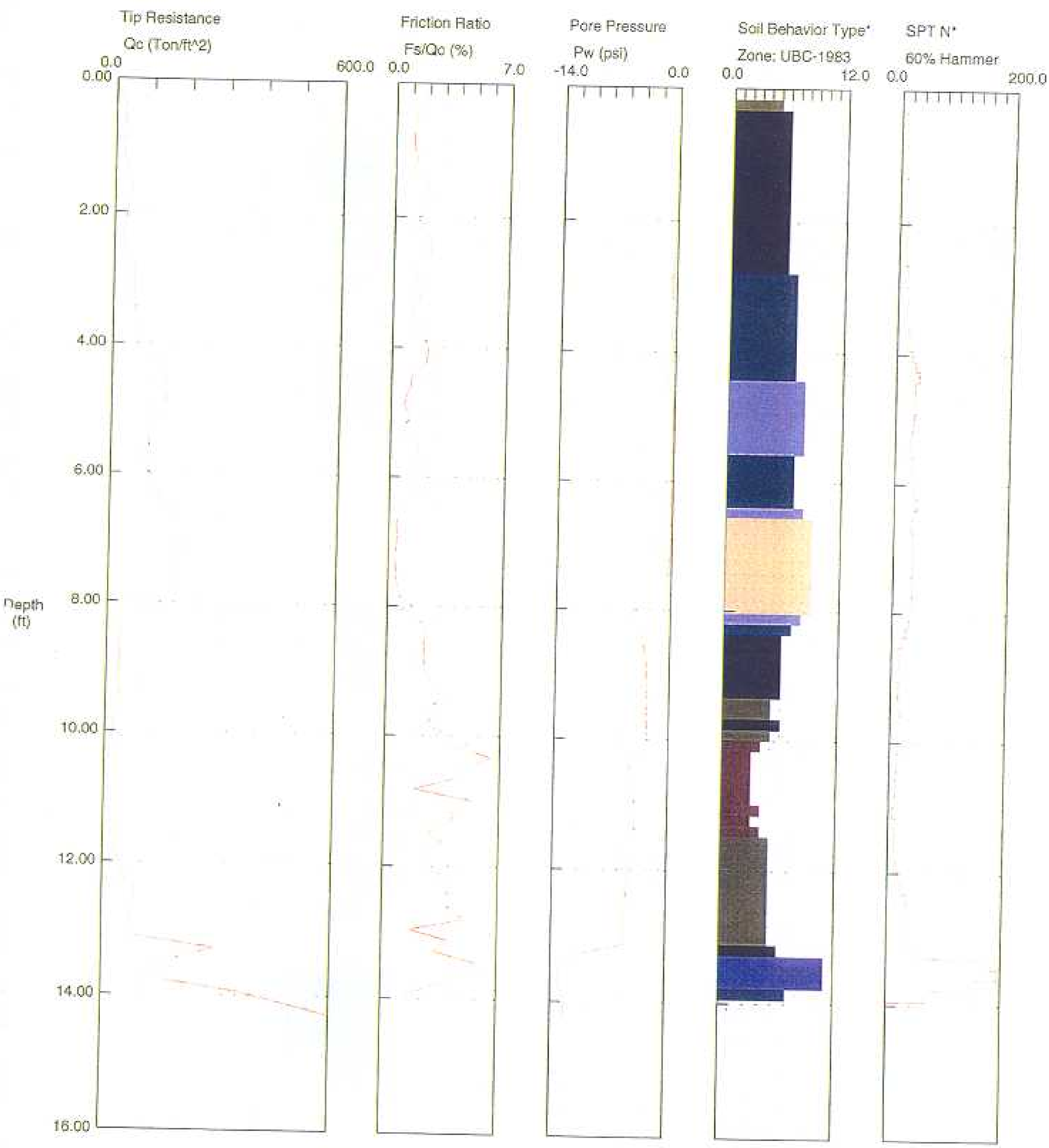
1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-13
Cone Used: 581

CPT Date/Time: 06-20-81 11:54
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 14.27 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

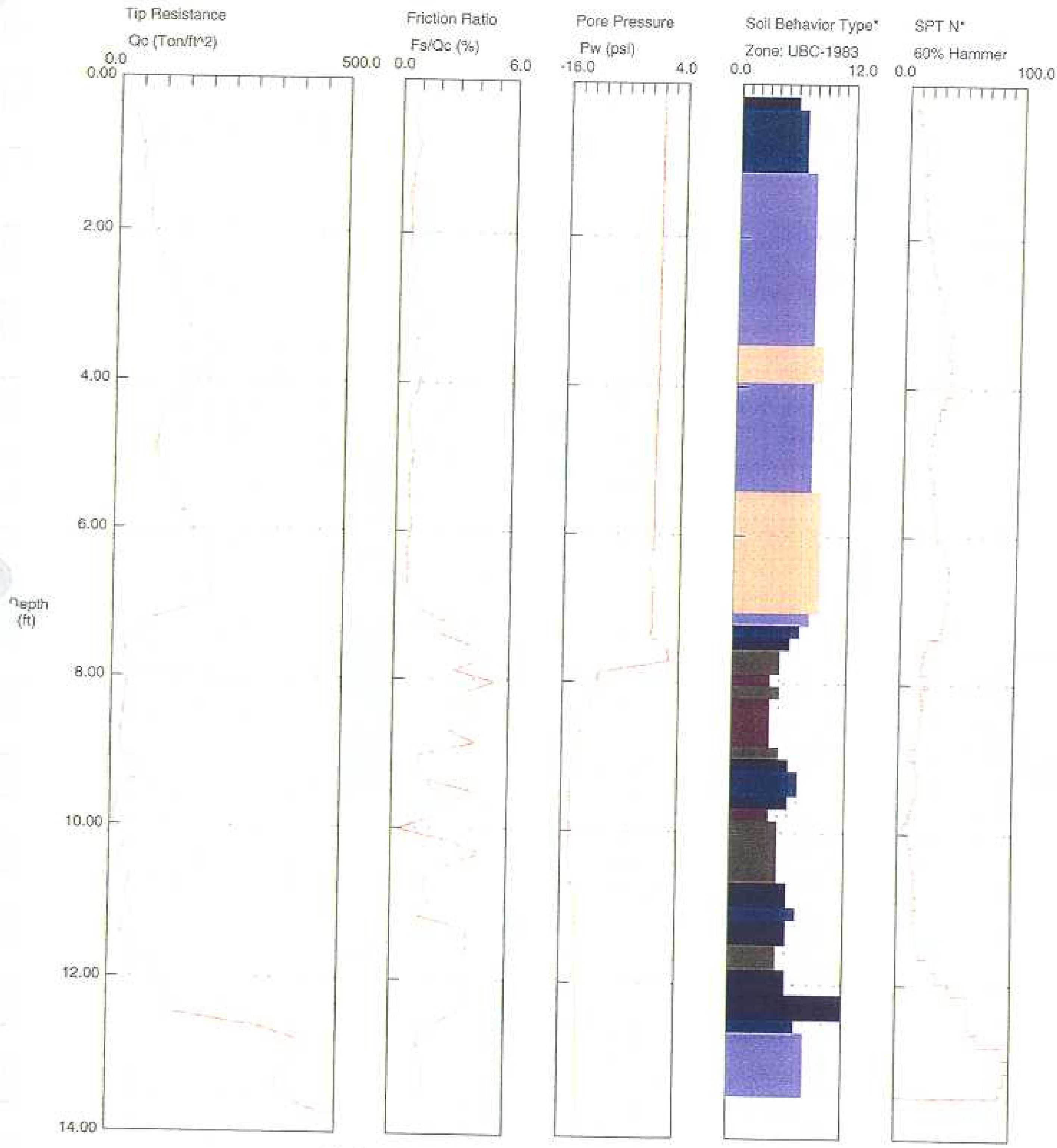
AR 050762

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-14
Cone Used: 581

CPT Date/Time: 06-20-81 12:15
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 13.78 feet

Depth Increment = 0.16 feet

1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

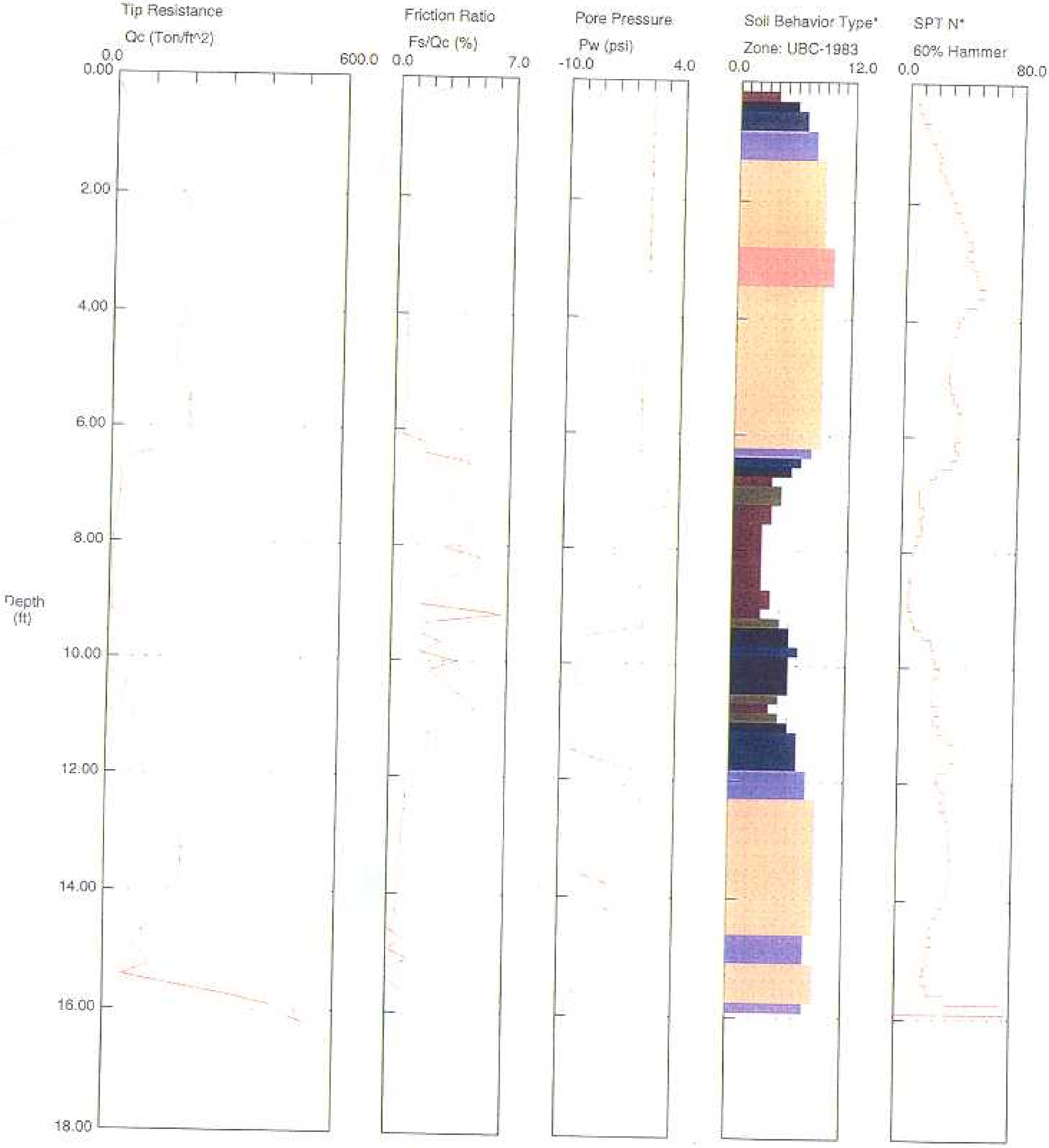
AR 050763

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-19
Cone Used: 581

CPT Date/Time: 06-27-81 10:25
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 16.24 feet

Depth Increment = 0.16 feet

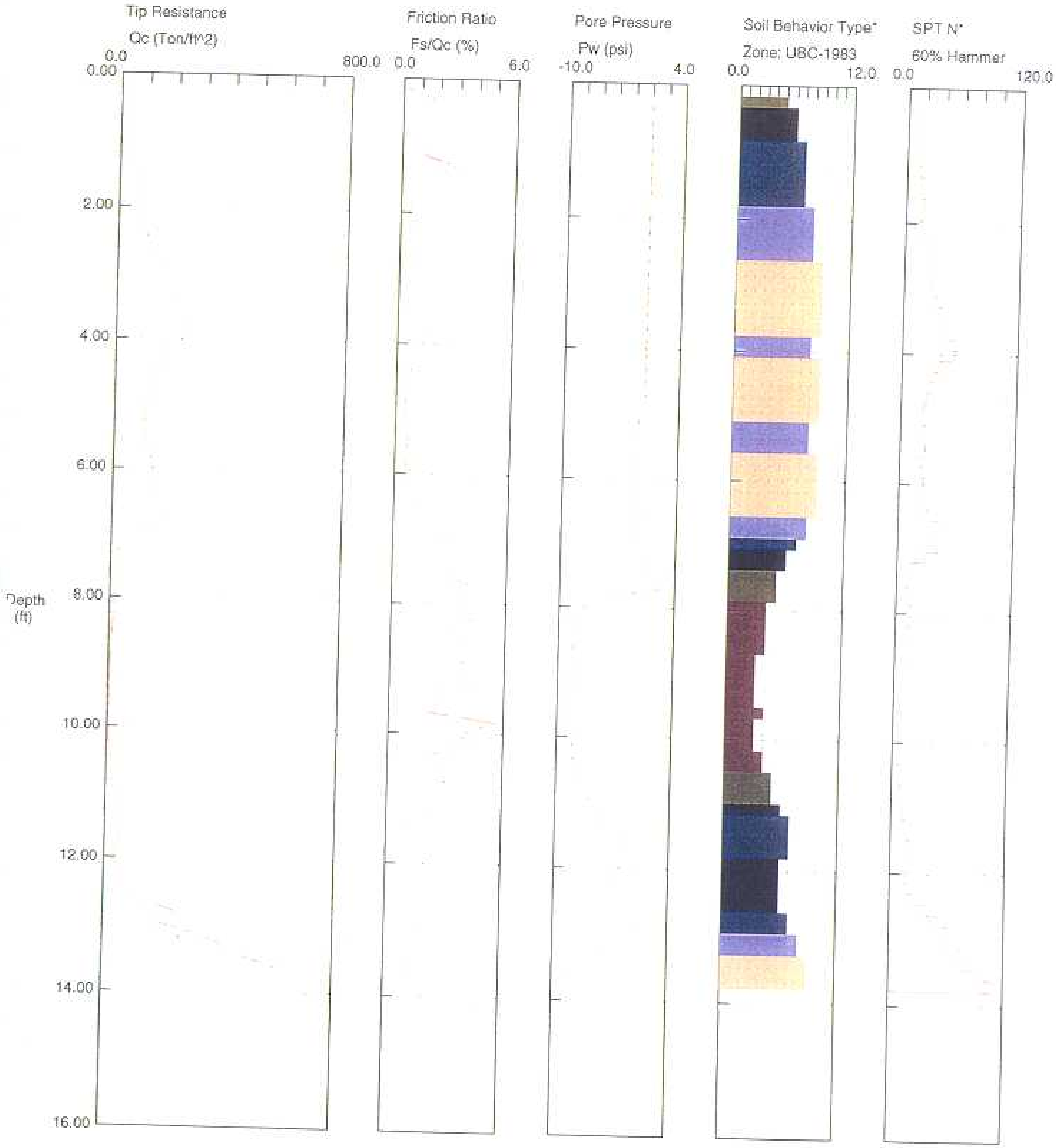
1 sensitive fine grained	4 silty clay to clay	7 silty sand to sandy silt	10 gravelly sand to sand
2 organic material	5 clayey silt to silty clay	8 sand to silty sand	11 very stiff fine grained (*)
3 clay	6 sandy silt to clayey silt	9 sand	12 sand to clayey sand (*)

*Soil behavior type and SPT based on data from UBC-1983

Hart Crowser

Operator: K.Brown
Sounding: CPT-20
Cone Used: 581

CPT Date/Time: 06-27-81 10:46
Location: Third Runway
Job Number: 4978-44



Maximum Depth = 14.11 feet

Depth Increment = 0.16 feet

1 sensitive fine grained
2 organic material
3 clay
4 silty clay to clay
5 clayey silt to silty clay
6 sandy silt to clayey silt
7 silty sand to sandy silt
8 sand to silty sand
9 sand
10 gravelly sand to sand
11 very stiff fine grained (*)
12 sand to clayey sand (*)

AR 050765

TEST SECTION #4 10' North of TEST SECTION MIDPOINT

HARTCROWSER

Boring Location: 25' North

MIDPOINT 10'

Elevation: Datum:

Obs. Well Install. Yes No

Boring B-10 Date 6-19-01 Sheet 1 of 1

Job SEATAC Job No. J-4978-44

Logged By B. McDonald Weather Clear ~ 75°F

Drilled By HOLT DRILLING (MIKE & MARK)

Drill Type/Method MOBILE B-59 / 4" I.D. HSA

Sampling Method SPT with 140 lb. AUTOMATIC HAMMER

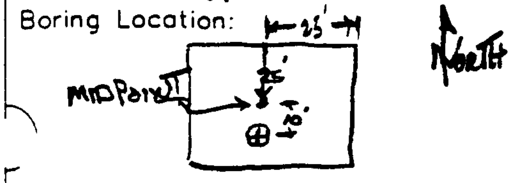
Bottom of Boring 20.0 ATD Water Level Depth 9.0

SIZE (%) G Max.	SIZE (%) S Range	SIZE (%) F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS, Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
occ.	F 85	15		0.0	3.5	GRAB	S-1 1425			(loose), moist, brown, silty, fine SAND few scattered gravel/organics		(loose) Silty fine SAND scattered gr
fc 20	FM 65	15		3.5	5.0	SPT	S-2 1430	12"	5 4 5 (9)	Loose, moist, brown to dark brown silty gravelly, F-M SAND trace organics		Loose silty gravelly F-M SAND trace org
fc	fc 40	10		6.0	7.5	SPT	S-3 1435	11"	3 6 10 (16)	Medium dense, wet, brown, slightly silty, sandy GRAVEL	PERCHED WATER CONDITION	Medium dense Sl. silty sandy GRAVEL
occ.	f 25	75		8.5	10.0	SPT	S-4 1438	18"	2 2 2 (4)	Soft, very moist, brown to gray, fine sandy SILT few scattered gravel		Soft very moist F-sandy SILT
–	MF 75	25		11.0	12.5	SPT	S-5 1443	15"	1 3 7 (10)	Loose, very moist, brown to gray, silty M-F SAND		Loose to medium dense silty M-F SAND scattered gravel
trace	MF 75	25		13.5	15.0	SPT	S-6 1448	15"	5 9 15 (24)	Medium dense, moist, gray, silty, M-F SAND trace scattered gravel		
fc 20	MF 60	20		16.0	17.5	SPT	S-7 1500	12"	34 15 19 (34)	Dense, moist, brown to gray, silty, gravelly MF-SAND (Till like)		Dense silty gravelly M-F SAND Till like
fc 20	MF 60	20		18.5	20.0	SPT	S-8 1505	15"	13 17 22 (39)	Dense, moist, brown to grayish brown, silty, gravelly M-F SAND (Till like)		

AR 050766

TEST SECTION # 4   10' SOUTH OF TEST SECTION MIDPOINT

Boring Location:



HARTCROWSER

Boring B-11 Date 6-19-01 Sheet 1 of 1
Job SEATAC Job No. J-4978-44
Logged By B. McDonald Weather Clear ~ 70°F
Drilled By Holt Drilling
Drill Type/Method Mobile B-59 / 4" I.D. HSA
Sampling Method SPT w/ 140 lb. Automatic Hammer
Elevation: Datum:
Obs. Well Install. Yes [✓ No]
Bottom of Boring 20.0' ATD Water Level Depth 8.5

SIZE (%) G Max.	S Range	F Att. Limits	PID or other	DEPTH From	DEPTH To	SAMPLE Type	SAMPLE Number	SAMPLE RECOVERY	Penetration Resistance	DESCRIPTION: Den., moist., color, minor, MAJOR CONSTITUENT. NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill action, drill and sample procedures, water conditions, heave,...etc...	SUMMARY LOG (Water & Date)
occ	F 85	15		0.0	3.5	(Grab)	S-1 1330			(Loose), moist, brown, silty fine SAND, trace scattered small roots		Loose moist brown silty fine sand
occ	F 80	20		3.5	5.0	SPT	S-2 1333	12"	2 2 2 (4)	Loose, moist, brown, silty fine SAND few scattered small roots		
FC	FC 45	15		6.0	7.0	SPT	S-3 1335	15"	2 4 7 (11)	Medium dense, very moist to wet brown, silty, gravelly SAND	Perched water @ 8.5 feet	Medium dense brown silty gravelly sand
—	—	100		8.5	10.0	SPT	S-4 1339	18"	(6)	Medium stiff, damp, brown to gray, SILT trace scattered gravel		Medium stiff brown to gray silt
occ	MF 75	25		11.0	12.5	SPT	S-5 1342	18"	2 6 10 (16)	Medium dense, moist, gray, silty medium to fine SAND occasional scattered gravel		Grades to silty M-F sand occ. gravel
FC 10	MF 65	25		13.5	15.0	SPT	S-6 1347	16"	4 16 23 (39)	Dense, moist, gray, slightly gravelly, silty medium to fine SAND (TILL LIKE)		Dense to very dense silty gravelly M-F sand
FC 25	MF 50	25		16.0	17.5	SPT	S-7 1353	12"	21 40 22 (62)	Very dense, moist, gray, silty, gravelly medium to fine SAND		
FC 25	MF 60	20		18.5	20.0	SPT	S-8 1405	8"	14 28 29 (57)	Very dense, moist, brownish gray, silty, gravelly M-F SAND (TILL LIKE)		Till like

HARTCROWSER

Boring Location: TEST AREA #4

* B-20A

Elevation: 20 Datum:

Obs. Well Install. Yes | No

Boring: B-20a Date: 6/27/61 Sheet 1 of 1

Job: [illegible] Job No. [illegible]

Logged By: Will [illegible] Weather: 52°/ Rain

Drilled By: Holt [illegible]

Drill Type/Method: B-59 Mobile / 4" HSA

Sampling Method: SPT w/ 140 lb. ~~Auto-Hammer~~

Bottom of Boring: 21.5' ATD Water Level Depth: 12.0'

Size (%) G Max.	S Range	F Att. Limits	PID or other	Depth From	To	Sample Type	Number	Depth	Penetration Resistance	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES: Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave....etc.	SUMMARY LOG (Water and Date)
25	55	20		2.5	4.0	X	S-1	3–4	9, 34, 9 (43)	Dense, damp, brown gravelly, silty SAND; pieces of brick & organics	(15" Recovery)	
								4–5			Rough drill action	
90	–	10		5.0	6.5	X	S-2	5–6.5	21, 9, 14 (23)	Crushed concrete	6" Recovery	
0	0	100 (30/70)		7.5	9.0	X	S-3	7.5–9	4, 2, 1 (3)	Soft, moist, lt. brown gravelly SILT	12" Recovery	
10	20	70		10.0	11.5	X	S-4	10–11.5	1, 4, 10 (14)	Stiff, moist, gray-brown sl. gravelly sandy SILT		(12.0') ATD ▽
25	65	10		12.5	14.0	X	S-5	12.5–14	3, 16, 21 (37)	Dense, moist-wet, gray sl. silty, gravelly SAND		
25	70	5		15.0	16.5	X	S-6	15–16.5	2, 11, 19 (30)	Dense, wet, gray gravelly SAND; trace silt		
15	35	50		17.5	18.4	X	S-7	17.5–18.4	30, 50/5" (50)	Hard, dry-damp, gray, gravelly, v. sandy SILT (TILL)		
								19			(21.5' = B.O.H.)	1025 – Finished
15	70	15		20.0	21.5	X		20–21.5	17, 25, 45 (70)	V. dense, wet, gray, ~~[illegible]~~ ~~[illegible]~~ [illegible] gravelly SAND		

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AR 050768

HARTCROWSER

Boring Location: Test Area #4

B-21a, CT 20, CT 19

Elevation: ______ Datum: ______

Obs. Well Install. Yes No

Boring: B-21a   Date: 6/7/05   Sheet 1 of 1

Job: 3rd Runway / Stone Culverts   Job No. [illegible]

Logged By: Will [illegible]   Weather: 56° / Rain

Drilled By: Holt

Drill Type/Method: B-59 Mobile / 4" HSA

Sampling Method: SPT, w/ 140 lbs, Auto-Hammer

Bottom of Boring: 21.5'   ATD Water Level Depth: 12.0'

G Max.	S Range	F All	PID or other	Depth From	Depth To	Sample Type	Sample Number	Sample Recovery	Penetration Resistance	DESCRIPTION: Den., moist, color, minor, MAJOR CONSTITUENT, NON-SOIL SUBSTANCES, Odor, staining, sheen, scrap, slag, etc.	REMARKS: Drill Action, drill and sample procedures, water conditions, heave....etc.	SUMMARY LOG Water and Date
												11:05 – Start
20	80	∅		2.5	4.0	X	S-1		8, 12, 11 (23)	M. dense, moist, brown gravelly, c. SAND	6" Recovery	
∅	100	∅		5.0	6.5	X	S-2		3, 5, 6 (11)	M. dense, moist, c. brown clean, M. SAND		
10	∅	90 (20/70)		7.5	9.0	X	S-3		1, 1, 2 (3)	Soft, moist-wet, blue-gray, sl. gravelly, clayey SILT		
10	25	65		10.0	11.5	X	S-4		7, 3, 10 (13)	Stiff wet, gray, sl. gravelly, sandy SILT (silty, gravelly SAND) in shoe		(12.0') ▽
20	60	20		[illegible]	14.0	X	S-5		[illegible], 12, 34 (>50)	V. dense, wet, gray, silty gravelly f. SAND		
10	10	80		15.0	16.5	X	S-6 (A)		21, [illegible]	Hard, moist, gray, sl. gravelly sl. sandy SILT	Contact	
∅	100	∅					S-6 (B)		[illegible] (3[illegible])	M. dense, wet, gray, c. SAND		
10	60	30		17.5	18.42	X	S-7		[illegible] (>50)	V. dense, wet, gray, sl. gravelly, v. silty SAND		
20	60	20		20.0		X	S-8		[illegible], 20, 30 (>50)	V. dense, moist, gray, silty gravelly SAND		11:5[illegible] Finish

AR 050769

APPENDIX E
LABORATORY TESTING PROGRAM

APPENDIX E
LABORATORY TESTING PROGRAM

A laboratory testing program was performed for this study to evaluate the basic index and geotechnical engineering properties of the site soils. Disturbed samples were tested. The tests performed and the procedures followed are outlined below.

Soil Classification

Field Observation and Laboratory Analysis. Soil samples from the explorations were visually classified in the field and then taken to our laboratory where the classifications were verified in a relatively controlled laboratory environment. Field and laboratory observations include density/consistency, moisture condition, and grain size and plasticity estimates.

The classifications of selected samples were checked by laboratory grain size analyses. Classifications were made in general accordance with the Unified Soil Classification (USC) System, ASTM D 2487.

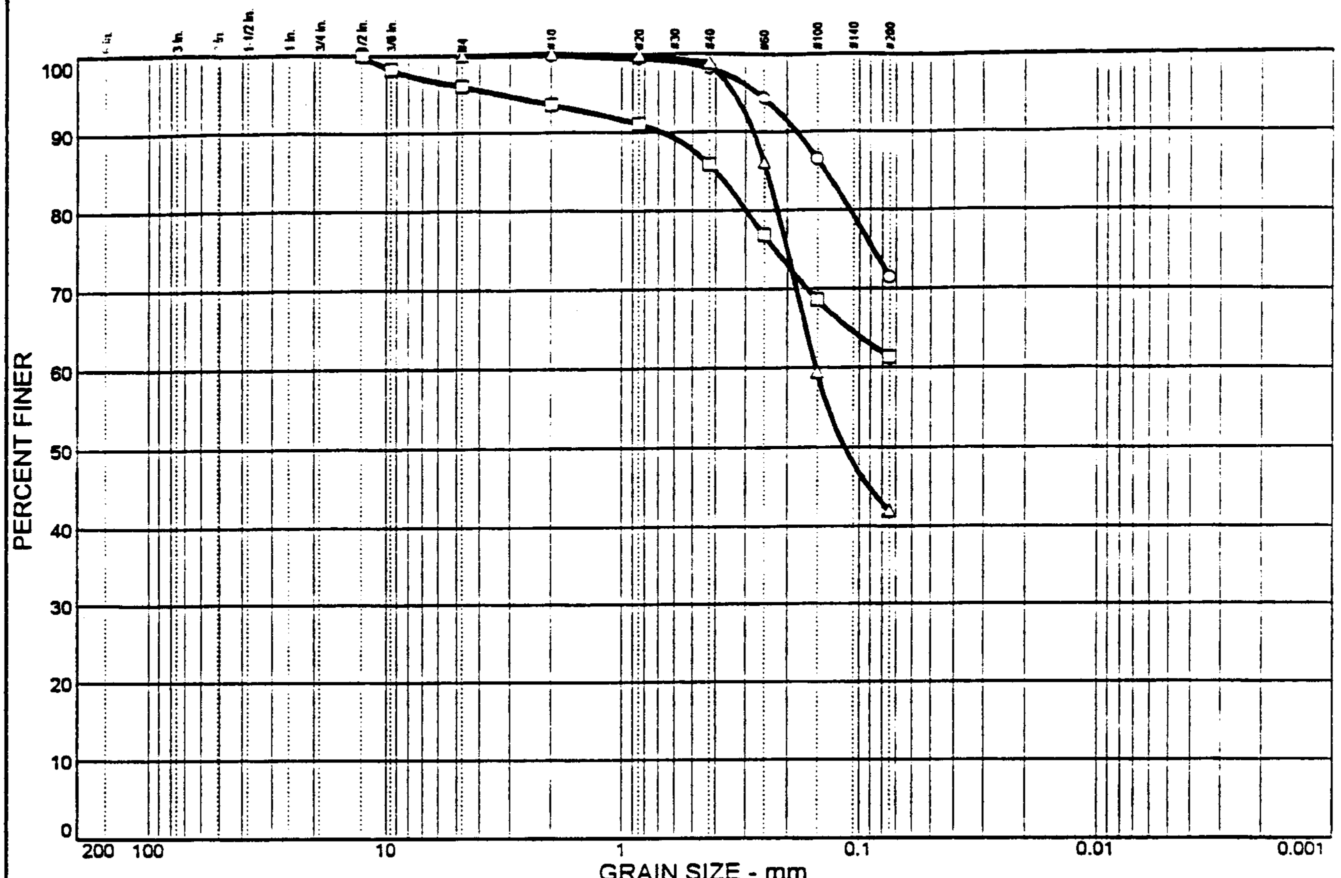
Water Content Determinations

Water contents were determined for specific samples recovered in the explorations in general accordance with ASTM D 2216, as soon as possible following their arrival in our laboratory. Water contents were not determined for samples that were not subject to grain size analyses. The results of these tests are provided with the grain size results.

Grain Size Analysis (GS)

Grain size distribution was analyzed on representative samples in general accordance with ASTM D 422. Wet sieve analysis was used to determine the size distribution greater than the U.S. No. 200 mesh sieve. The size distribution for particles smaller than the No. 200 mesh sieve was determined by the hydrometer method for a selected number of samples. The results of the tests are presented as curves on Figures E-1 and E-2 plotting percent finer by weight versus grain size.

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	0.0	0.0	0.2	1.6	26.8	71.4	
□	0.0	0.0	3.9	2.5	7.7	24.6	61.3	
△	0.0	0.0	0.0	0.0	1.1	57.0	41.9	

	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			0.139							
□			0.399							
△			0.243	0.152	0.115					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
○ Sandy SILT	ML	29%
□ Very sandy SILT	ML	18%
△ Very silty, fine SAND	SM	24%

Remarks:

○

□

△

Project: Third Runway

Client: HNTB

○ **Source:** B-1 **Sample No.:** S-1

□ **Source:** B-1 **Sample No.:** S-4

△ **Source:** B-2 **Sample No.:** S-1

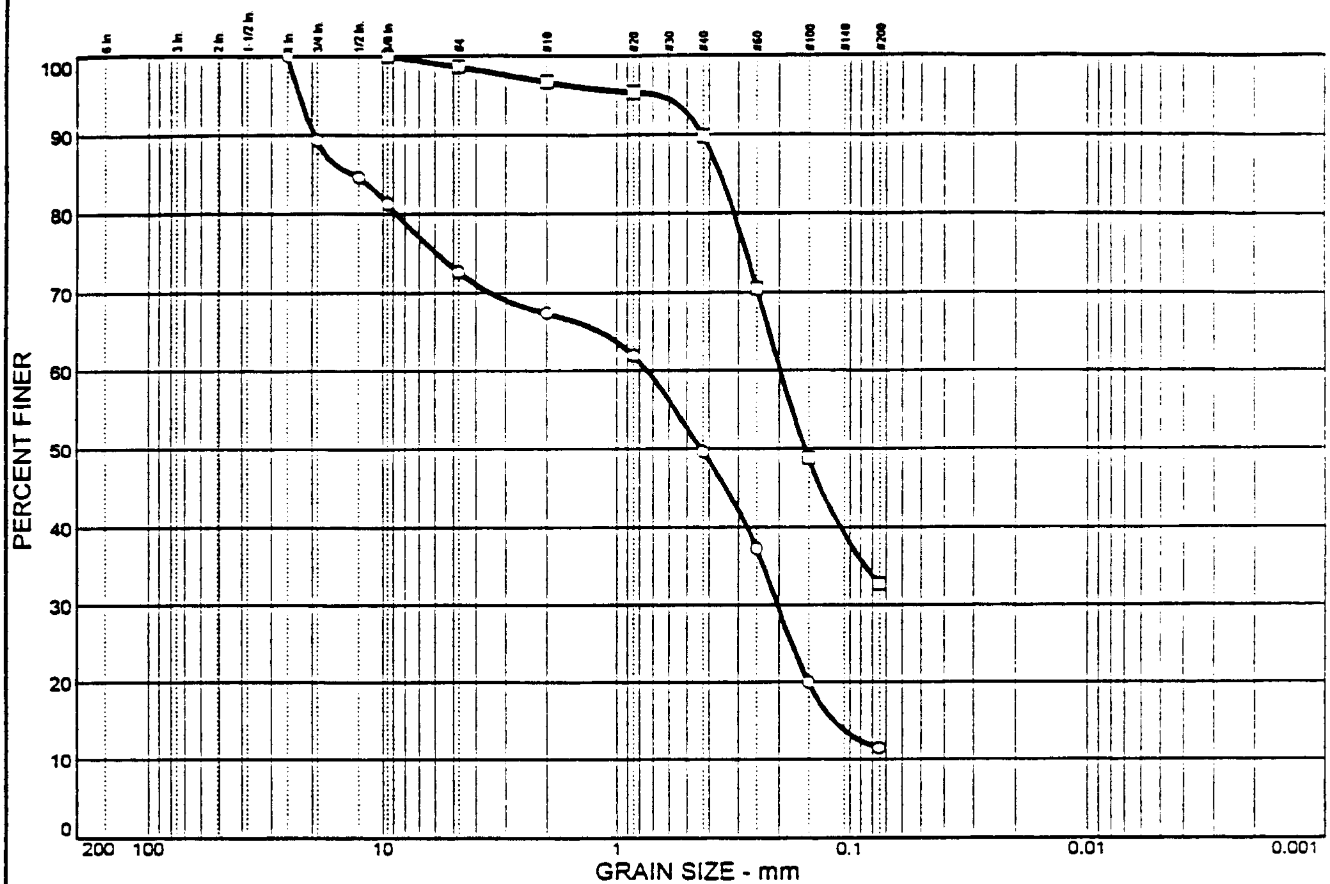
HARTCROWSER

4978-30 6/4/2001

Figure No. E-1

AR 050772

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○	0.0	10.6	16.8	5.3	17.7	38.1	11.5	
□	0.0	0.0	1.4	1.9	6.9	57.1	32.7	

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○			13.2	0.743	0.434	0.202	0.117			
□			0.359	0.198	0.155					

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
○ Slightly silty, gravelly SAND	SP-SM	20%
□ Very silty, medium to fine SAND	SM	22%

Remarks:
○
□

Project: Third Runway

Client: HNTB

○ **Source:** B-3 **Sample No.:** S-2

□ **Source:** B-4 **Sample No.:** S-1

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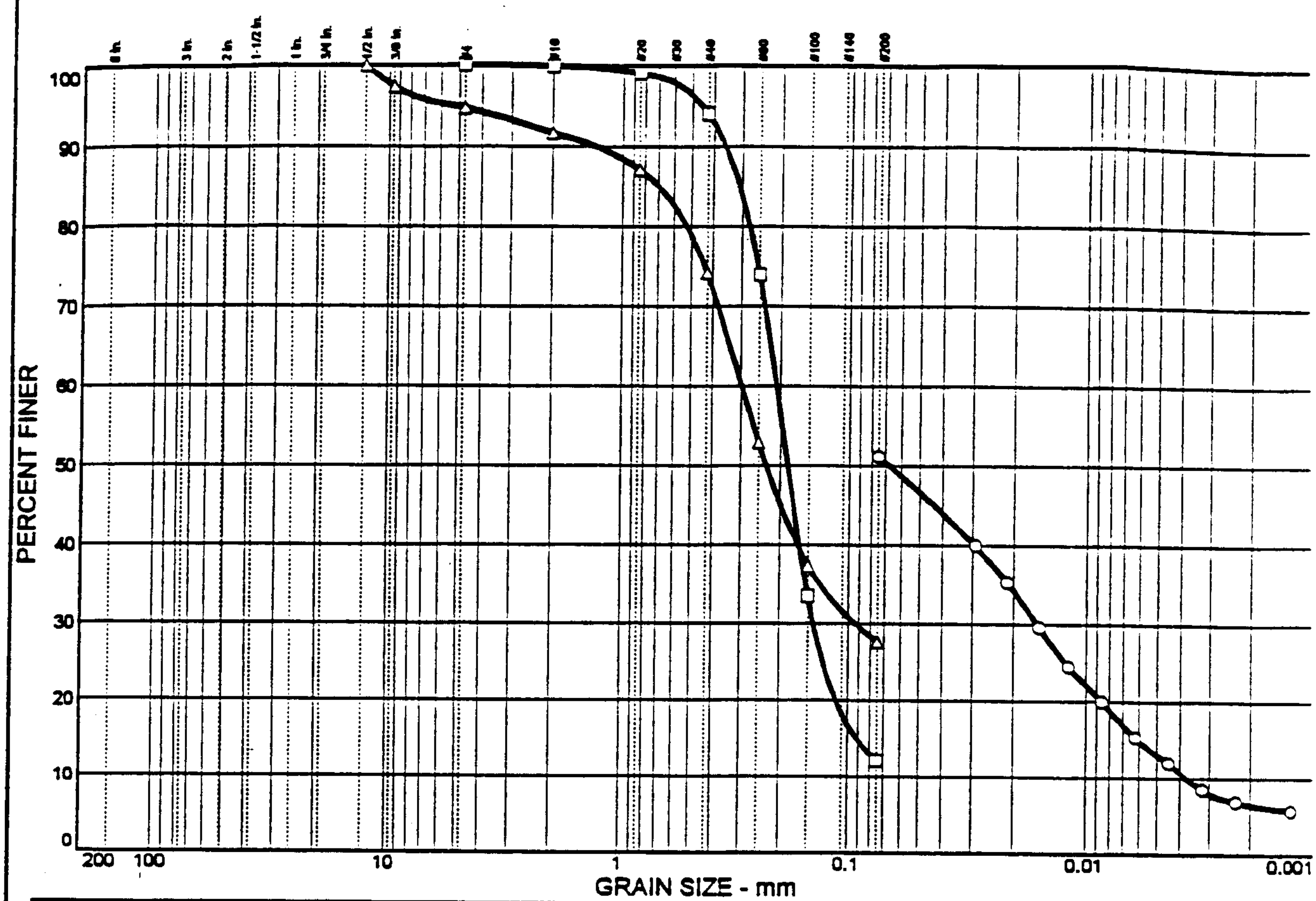
4978-30 6/4/2001

Figure No. E-2

APPENDIX F
PREVIOUS LABORATORY ANALYSES IN WORK AREA 2

PARTICLE SIZE DISTRIBUTION TEST REPORT



	% + 3"	% GRAVEL		% SAND			% FINES	
		CRS.	FINE	CRS.	MEDIUM	FINE	SILT	CLAY
○							38.1	13.1
□	0.0	0.0	0.0	0.1	5.9	81.8	12.2	
△	0.0	0.0	5.3	3.0	17.5	46.5	27.7	

☒	LL	PI	D_{85}	D_{60}	D_{50}	D_{30}	D_{15}	D_{10}	C_c	C_u
○					0.0674	0.0160	0.0060	0.0038		
□			0.307	0.209	0.186	0.142	0.0909			
△			0.695	0.297	0.231	0.0935				

MATERIAL DESCRIPTION	USCS	NAT. MOIST.
○		15%
□ Silty, medium to fine SAND	SM	6%
△ Slightly gravelly, silty, medium to fine SAND	SM	15%

Remarks:

○

□

△

Project: Third Runway

Client: HNTB

○ **Source:** HC00-B302 **Sample No.:** S-5

□ **Source:** HC00-B303 **Sample No.:** S-2

△ **Source:** HC00-B303 **Sample No.:** S-7

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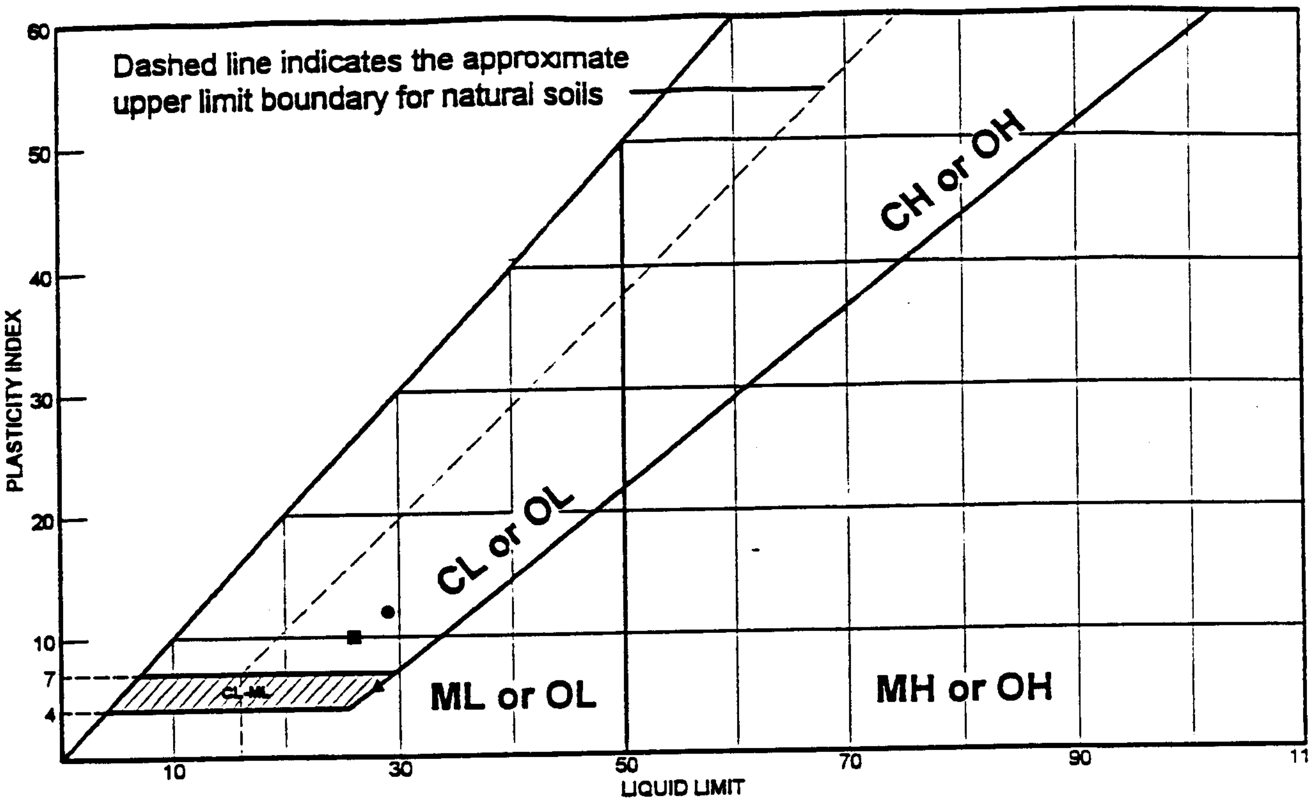
J-4978-44 8/18/2000

Figure No. F-1

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description		LL	PL	PI	-200	USCS
● Source: HC00-B302	Sample No.: S-4	29	17	12		
■ Source: HC00-B305	Sample No.: S-4	26	16	10	66.4	CL
▲ Source: HC00-B306	Sample No.: S-3	28	22	6	77.7	CL-ML

Remarks:
●
■
▲

Project: Third Runway

Client: HNTB

Location:

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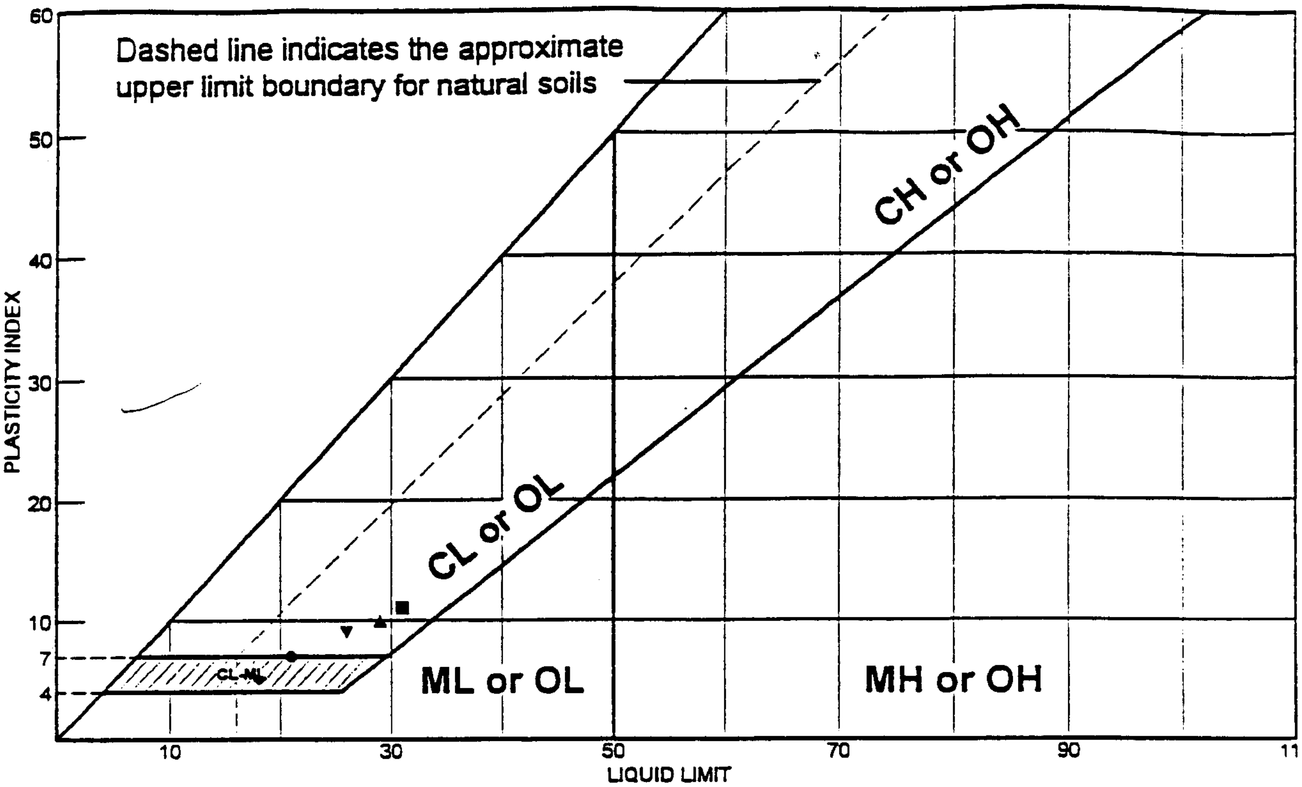
J-4978-44 8/18/2000

Figure No. F-2

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description		LL	PL	PI	-200	USCS
● Source: HC99-B54b Lean CLAY	Sample No.: S-1B	21	14	7		CL
■ Source: HC99-B54c Lean CLAY	Sample No.: S-1C	31	20	11		CL
▲ Source: HC99-B58 Sandy, very silty, lean CLAY	Sample No.: S-3	29	19	10	70.1	CL
◆ Source: HC99-B64 Silty CLAY	Sample No.: S-5	18	13	5		CL-ML
▼ Source: HC00-B160 Lean CLAY	Sample No.: S-4	26	17	9		CL

Remarks:
●
■
▲
◆
▼

Project: Third Runway North Safety Area

Client: Port of Seattle

Location:

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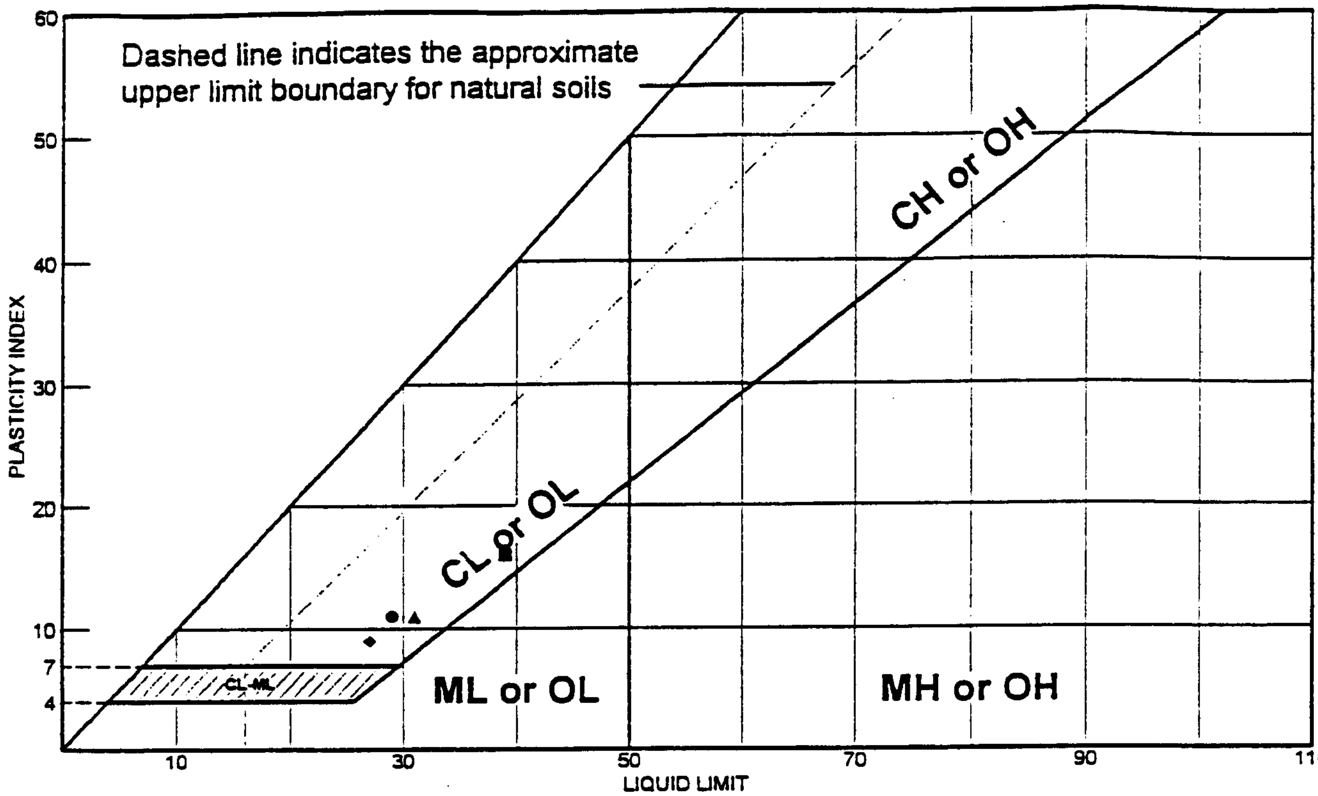
Figure No. F-3

AR 050777

LIQUID AND PLASTIC LIMITS TEST REPORT



Location + Description		LL	PL	PI	-200	USC
● Source: HC99-TP36 Silty CLAY	Sample No.: S-4	29	18	11		CL
■ Source: HC99-TP36D Slightly sandy, silty CLAY	Sample No.: S-3	39	23	16		CL
▲ Source: HC99-B61 Slightly sandy, silty CLAY	Sample No.: S-3	31	20	11		CL
◆ Source: HC99-B73 Slightly sandy, silty CLAY	Sample No.: S-2	27	18	9		CL

Remarks:

●

■

▲

◆

Project: Third Runway Embankment

Client: The Port of Seattle

Location: Sea-Tac International Airport

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J-4978-. 44 11/12/99

Figure No. F-4

AR 050778

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