CENTRE FOR MARINE GEOLOGY
DALHOUSIE UNIVERSITY AND
ATLANTIC GEOSCIENCE CENTRE

1985 SABLE ISLAND BOREHOLE PROJECT

Project No. G042

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OTTAWA

PROJECT G042

REPORT

TO

CENTRE FOR MARINE GEOLOGY, DALHOUSIE UNIVERSITY

AND

ATLANTIC GEOSCIENCE CENTRE

ON

1985 SABLE ISLAND BOREHOLE PROJECT

Jacques, McClelland Geosciences inc.
October, 1985

"This work was supported by the Federal
Panel on Energy R & D [PERD]."

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1.0 STATEMENT OF OBJECTIVES

The 1985 Sable Island Borehole Project was conceived by Dr. David B. Scott in early 1984, as a unique research opportunity to provide the first complete Quaternary geological section from the Eastern Canadian Continental Shelf.

The overall objective for the project was to complete a 400 m continuously sampled borehole, with three specific objectives upon completion of the borehole; two scientific objectives and one engineering objective.

The first scientific objective is to examine in detail all suitable levels for foraminifera and pollen, to determine which levels are glacial marine or interglacial and to identifiy the Plio-Pleistocene boundary. The second scientific objective is to examine the sedimentology of the sand units and to try and correlate them with high resolution seismic reflectors.

The engineering objective of the project is to obtain geotechnical properties of the sediments encountered, which is addressed in this report. The geotechnical properties of the sediments can then be related to geological units and available acoustic stratigraphy. Geotechnical properties can also be related to sedimentology, age, and geological development of the Sable Bank section.

Specific geotechnical properties include blow count, moisture content, unit weight, percent fines, and visual description for cohesionless soils, and blow count, moisture content, unit weight, undrained shear strength testing-torvane, minivane, pocket penetrometer, unconsolidated undrained triaxial test, unconfined compression test and visual description, with Atterberg limits performed on selected samples. In addition, a natural gamma logger is included to provide estimates of sediment radioactivity and to provide correlation with the geotechnical sampling.

The geotechnical objectives outlined above were addressed during the program on Sable Island and are presented in the following sections and appendices of this report.

2.0 DISCUSSION OF INVESTIGATION RESULTS

2.1 Sampling and Testing

Samples were recovered by pushing sample tubes, driving sample tubes and rotary core drilling. The success of the sampling program is measured by the recovery and the degree of disturbance of sampled materials. Full recovery means that material from the whole of a sampled interval has been retrieved, although there may have been some re-arrangement of the soil structure and some changes in basic physical properties such as bulk density. Undisturbed sampling means that the in situ structure of the soil skeleton has not been affected and there have been no changes in physio-mechanical properties.

In the present program, sample recoveries met the standards of what is generally considered to be good practise in geotechnical engineering, and provided a sufficiently continuous record to meet geological logging requirements.

Assessment of degree of disturbance is more difficult. In our opinion, relatively good quality samples were obtained, except when there was difficulty in retrieving the whole sample and a second attempt was made, or when the sands flowed into the bottom of the drill string: under these conditions the samples were probably highly disturbed.

Even under ideal conditions, all sampling tools and retrieval methods cause some disturbance of the soil which alters its structure. This can be due to the physical intrusion of the sampler into the soil mass which must cause some displacement. It can also be due to changes in stresses both in the soil skeleton and in the pore fluid. The manifestations of disturbance are usually a decrease in soil strength and stiffness, and changes in bulk density. The absolute degree of disturbance can never be established with certainty--the classical check of compared sampled soils properties with results obtained from large bulk samples carved in test pits is obviously not applicable to deep borings.

In the absence of this kind of check, usual practise is to compare measured properties with certain well-established correlations, and with laboratory test results in which in-situ conditions are re-created as nearly as possible. This practise has been followed in the following sections.

Testing to date consists of work done in the on-site laboratory, before the samples were packed and stored for shipment to the mainland. Water contents, unit weights, percentage fines (<74 microns dia.), percentage gravel (>4.75 mm) a few Atterberg limits, and undrained shear strengths of cohesive soils were determined.

The major portion of all samples was retained by Dalhousie. Representative samples of granular soils, and short "undisturbed" samples of cohesive soils, were retained by JMGI. The latter are currently in storage at Dalhousie.

Details of sampling and testing are presented in Appendix A.

2.2 Boring Stratigraphy and Soil Properties

The stratigraphy encountered is described in detail on the Log and Test Results in Appendix A. Additional detail on the stratigraphy is shown on the gamma log in Appendix A. A tabulation of the stratigraphic groupings shown on the log follows:

Stratum	Depth Below Ground (m)	Description
I	0 - 40.0	Loose to compact grey medium to coarse sand
II	40.0-55.3 65.4-73.8	Dense grey medium to coarse sand
III	55.3-65.4 73.8-81.4	Compact to dense fine to medium sand with a trace to some silt
IV	81.4-84.9	Layered dense grey to olive grey sand, silty sand, and silt

Stratum	Depth Below Ground (m)	Description
V	84.9-86.9	Layered dense grey fine to medium sand, and very stiff olive grey clay
VI	86.9-145.6	Very stiff to hard dark olive grey silty clay
VII	145.6-149.5	Layered dark olive grey clayey sand, sandy silt, and silty clay
VIII	149.5-end of boring	Olive brown silty fine sand with silt and clay partings and seams

Strata I, II and III constitute a succession of sands, distinguished from one another by differences in grain size distribution, and in apparent relative density. Since the first of these distinctions is based on visual classification, and the second upon interpretation of sampler driving resistance, they are both subjective and the classifications are provisional in nature.

Strata I and II are, however, definitely characterized by a low content of fines (silt and clay <74 microns), generally less than 2 percent. Departures from the stratum descriptions occur frequently in seams and layers of finer and coarser particles, and in seams containing organic materials. Stratum I appears to be free of shells. In Stratum II shell fragments were encountered. Layering is generally horizontal, except as noted at 7.9 m, 25 m, and 26.3 m penetration. The sand is described as loose and liquefying at 72 m penetration because of very low blow count and appearance of the recovered sample: this may be a natural condition but is more probably a result of drilling procedures.

Stratum III has an overall finer texture than Strata I and II. The fines content is greater than 2 percent, and may be as high as 30 percent. Silt layers and seams, shell fragments, and occasional coarse sand are encountered in this stratum.

Strata IV and V consist of distinct layers. These two may represent a transitional sequence, which we have arbitrarily separated on the basis of clay layer presence.

Stratum VI is a continuous silty clay sequence, with only minor occurrences of clean sand or pure silt. The silty clay contains from 0.7 to about 25 percent sand, the average being 10 percent sand. The clay is of medium plasticity with average liquid and plastic limits of 45 and 21 respectively. Water contents range from 20.7 to 39.4 and increase slightly with depth. For the three intervals at which liquid and plastic limits were performed, the water content is a few percent above the plastic limit. The undrained shear strength, based on hand penetrometer and Torvane tests, increases moderately with depth from about 180 kPa at the top of the stratum to about 300 kPa at 105 m, remains constant to about 135 m, and then decreases with depth to about 250 kPa at the bottom of the stratum. These shear strength values indicate that the silty clay is of very stiff to hard consistency.

Stratum VII is a layered sequence, with contorted bedding at 147.5 m, and a pebble erratic. Shear strengths in the clay layers were found to be lower than in the overlying clay, which is attributed to a greater degree of sample disturbance, although there may be natural causes.

The boring was terminated in Stratum VIII after 2 m penetration, so that the thickness of this stratum is not known.

2.3 Interpretation of Data

In accordance with the purposes of the boring, the scope of laboratory testing performed is very limited, and there are no in-situ test data. Consequently, the interpretation of geotechnical properties is preliminary.

The soil profile disclosed by the boring can be divided into granular and cohesive for purposes of general discussion, as follows:

Granular: Strata I, II, III, IV and VIII
Cohesive: Stratum V, VI, and VII

Granular soils are characterized in the geotechnical context by in-situ density, grain size distribution, angle of internal friction, permeability and deformation moduli. The last three of these are strongly influenced by the in-situ density.

Cohesive soils are characterized by in situ water content and plasticity, undrained shear strength, effective angle of internal friction and effective cohesion, permeability, deformation moduli, and consolidation parameters.

The overall geological setting is characterized in a uniquely geotechnical context in terms of in situ vertical and horizontal stresses.

2.3.1 Granular Soils

By the time a granular soil is extruded from the sampler, it has undergone changes in volume. Generally, loose soils will have become denser, and dense soils looser. Consequently, in situ densities, and other parameters which depend on density, cannot be determined accurately from recovered samples; and the present investigation has not provided information which can be used to accurately characterize the granular strata. Additional laboratory testing, including complete grain size distributions, and tests on reconstituted samples, will be required for this purpose.

2.3.2 Cohesive Soils

Analysis of the water content profile, and the associated Atterberg Limits, provides some insight into the geotechnical/geological setting of the cohesive strata. The water contents suggest a condition of normal consolidation under present overburden stresses for the measured clay plasticity. Figure 1, taken from Lambe and Whitman 1967, illustrates this point. For effective overburden stresses in the range 1000 to 1300 kPa, consolidated clays are normally shown to possess water contents in the range 18 to 40 percent, depending on plasticity. The figure shows that average values from the present investigation also fall within this region.

The undrained shear strengths have also been used to assess the consolidation history. Using the empirical relationship

$$Su/p = 0.11 + 0.0037\ Ip$$

values of p, the effective vertical consolidation stress, can be obtained from the strength vs penetration data. Preliminary analyses yield values of p which are shown in Figure 2. The interpretation is that the upper 50 m of the clay is slightly preconsolidated. However, this hypothesis needs to be supported by more Atterberg Limits and strength testing.

The strengths in the bottom 15 m are lower. One explanation would be that excess pore fluid pressures exist in this part of the profile, resulting in a decrease in effective overburden pressure, as shown in Figure 2, and hence lower strength; however, there are insufficient data at this time to support this hypothesis.

The testing performed to date does not provide a basis for determining the other geotechnical parameters listed above.

3.0 RECOMMENDATIONS FOR LABORATORY TESTING

The following laboratory data would provide a much more complete picture of the soils encountered:

1. Complete grain size distributions of a representative number of granular samples, sufficient to give a profile of grain size distributions throughout strata I, II, III, IV and VIII.

2. Atterberg limit and hydrometer analysis on a representative number of samples of the cohesive soils, for general classification purposes.

3. One dimensional consolidation tests on the cohesive material of Stratum VI, sufficient to define the consolidation characteristics and to aid to assessing the stress history of the deposit.

4. Unconsolidated-undrained tests on representative samples from throughout the whole of the profile of stratum VI, to calibrate the strength profile obtained for the penetrometer and Torvane testing.

5. Consolidated-undrained triaxial compression tests on a selected suite of samples from Stratum VI, to explore the effective-stress strength characteristics of the clay.

A detailed proposal for laboratory testing is presented under separate cover.

4.0 SUMMARY AND CONCLUSIONS

1. The scope of this report includes factual descriptions of the soils encountered in the boring, and the procedures followed in the investigation. The report also includes an assessment and interpretation of the sampling procedures and data.

2. The boring indicates that compact to dense sands predominate from ground surface to 85 m penetration. Very stiff to hard clays predominate from 85 m - 146 m penetration. This was followed by a thin layered zone, and the boring terminated in sand at 151.5 m penetration. Organic matter was noted in the upper part of the sand sequence, to a depth of 43 m. Contorted structure was noted at 83 m penetration~~s~~. Contorted structure and a pebble erratic were also noted in the layered zone at about 148 m penetration.

3. Laboratory testing was limited to that performed on-site. The geotechnical parameters of the sands and clays have been characterized in only a very limited sense on the basis of this work.

4. Further laboratory testing, including consolidation and strength testing, is recommended.

- Void Ratio Corresponding to $\omega = \omega_p$

⊙ $\overline{\underline{\text{Vl}}}$(a)

◇ $\overline{\underline{\text{Vl}}}$(b)

+ $\overline{\underline{\text{Vl}}}$(c)

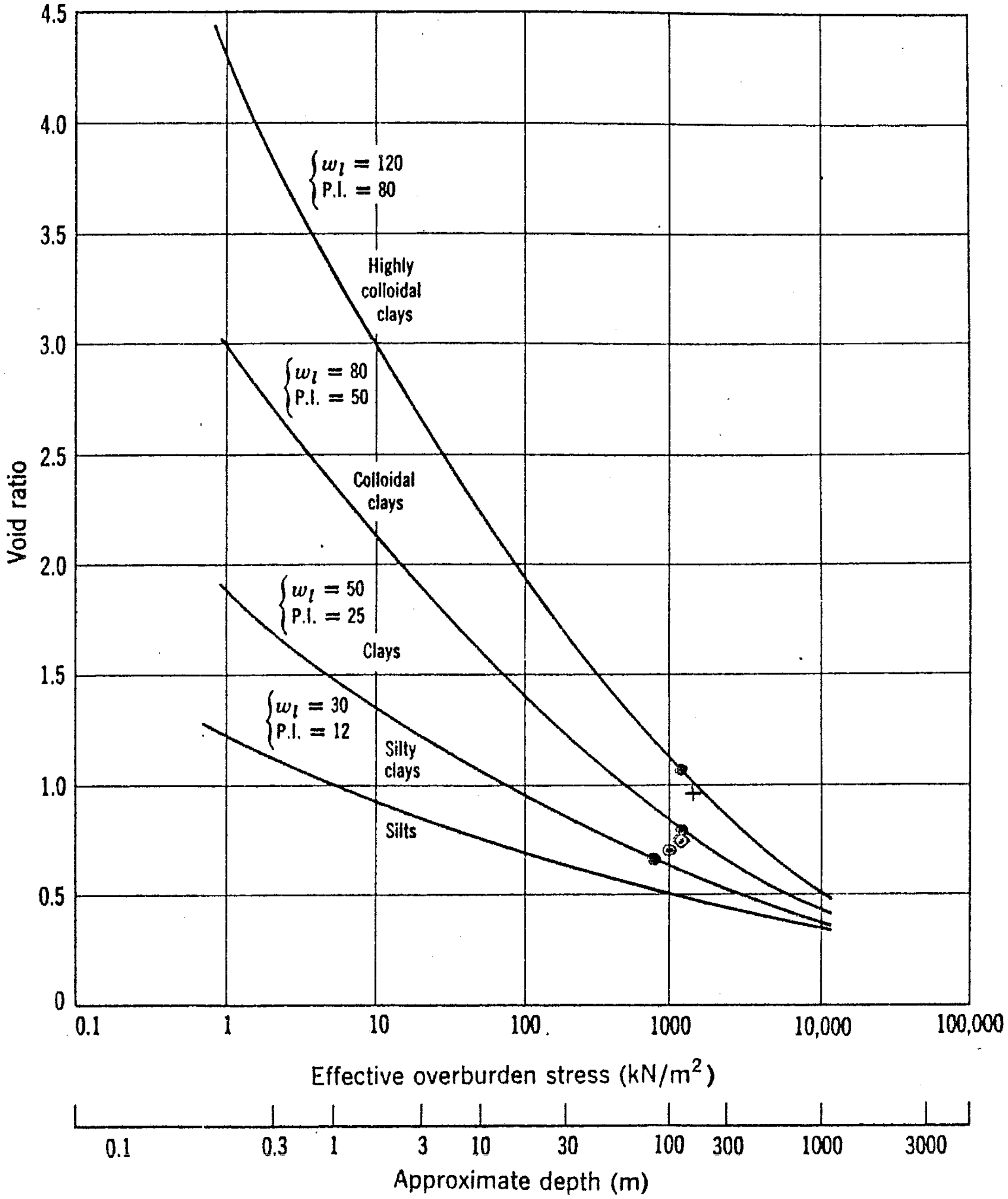


Figure 1

JACQUES/McCLELLAND

PLATE

Location : SABLE ISLAND
BORING 85 SAB

Loose to compact grey medium to coarse SAND

-greyish brown with light and dark layers 0 to 3.6m penetration

-10mm black organic sand seam at 3.0m penetration

-occasional pebbles from 4 to 5m penetration

-2mm light grey bands 7 to 7.8m penetration

-10mm light grey vertical band at 7.9m penetration

-200mm organic silt layer from 9.9 to 10.1m penetration

-trace of silt from 14 to 16m penetration

-2mm organic seam at 20m penetration

-vertical seam of silty sand 120m long at 25m penetration

-diagonal light brown sand seam at 26.3m penetration

-shell fragments at 27.5m penetration

-30mm dark olive grey organic silt seam at 28.5m penetration

-trace gravel at 30m penetration

-coarse sand seams and occasional gravel from 36 to 38m penetration

(-40.0m)

Dense grey medium to coarse SAND

-occasional organics and organic seams 40 to 43m penetration

-occasional shell fragments from 43 to 56m penetration

-150mm layers of fine to medium sand with trace of silt at 47m to 48m penetration

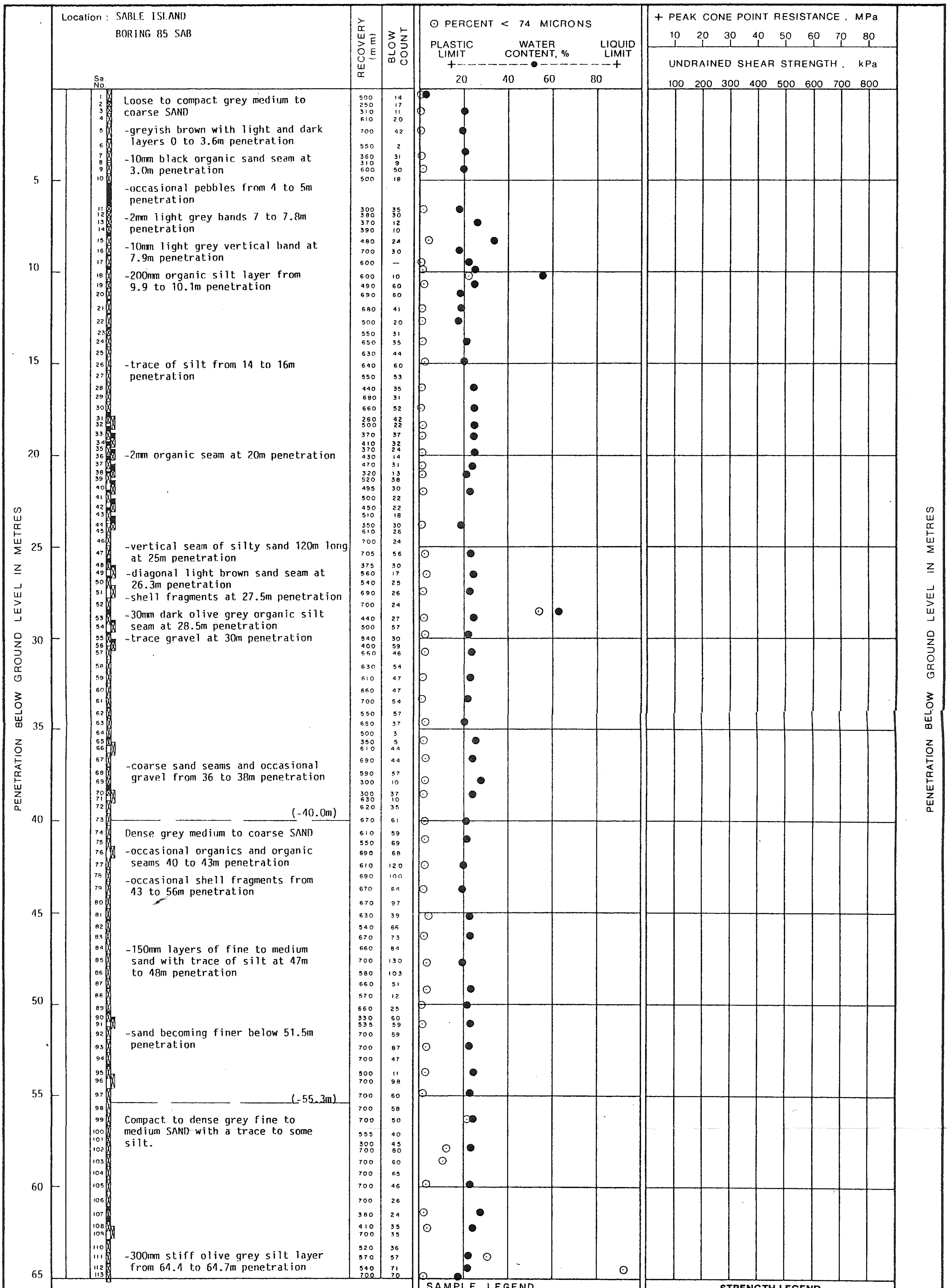
-sand becoming finer below 51.5m penetration

(-55.3m)

Compact to dense grey fine to medium SAND with a trace to some silt.

-300mm stiff olive grey silt layer from 64.4 to 64.7m penetration

Sa. No.	RECOVERY (mm)	BLOW COUNT
1	500	14
2	250	17
3	310	11
4	610	20
5	700	42
6	550	2
7	360	31
8	310	9
9	600	50
10	500	18
11	300	35
12	380	30
13	370	12
14	390	10
15	480	24
16	700	30
17	600	—
18	600	10
19	490	60
20	690	60
21	680	41
22	500	20
23	550	31
24	650	35
25	630	44
26	640	60
27	550	53
28	440	35
29	680	31
30	660	52
31	260	42
32	500	22
33	370	37
34	410	32
35	370	24
36	430	14
37	470	31
38	320	13
39	520	38
40	495	30
41	500	22
42	450	22
43	510	18
44	350	30
45	610	26
46	700	24
47	705	56
48	375	30
49	560	17
50	540	25
51	690	26
52	700	24
53	440	27
54	500	57
55	540	30
56	400	59
57	650	46
58	630	54
59	610	47
60	660	47
61	700	54
62	550	57
63	650	37
64	500	3
65	350	5
66	610	44
67	690	44
68	590	57
69	300	10
70	300	37
71	630	10
72	620	35
73	670	61
74	610	59
75	550	69
76	690	68
77	610	120
78	690	100
79	670	64
80	670	97
81	630	39
82	540	66
83	670	73
84	660	84
85	700	130
86	580	103
87	660	51
88	570	12
89	660	25
90	330	60
91	535	59
92	700	59
93	700	87
94	700	47
95	500	11
96	700	98
97	700	60
98	700	58
99	700	50
100	555	40
101	300	45
102	700	80
103	700	60
104	700	65
105	700	46
106	700	26
107	380	24
108	410	35
109	700	35
110	520	36
111	570	57
112	540	71
113	700	70



Job No. : G042
Date Completed :
Final Penetration :
Field Engineer :

Page 1 of3 0 to 65.34m

SAMPLE LEGEND

- ☒ RECOVERED
- ■ LOST
- ☐ NOT SAMPLED

STRENGTH LEGEND

- ⊗ HAND PENETROMETER
- ◆ MINIATURE VANE
- ⊕ TORVANE
- ▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
- ● UNCONFINED COMPRESSION
- MIN. ├─○─┤ MAX. C.P.T. CONE RESISTANCE

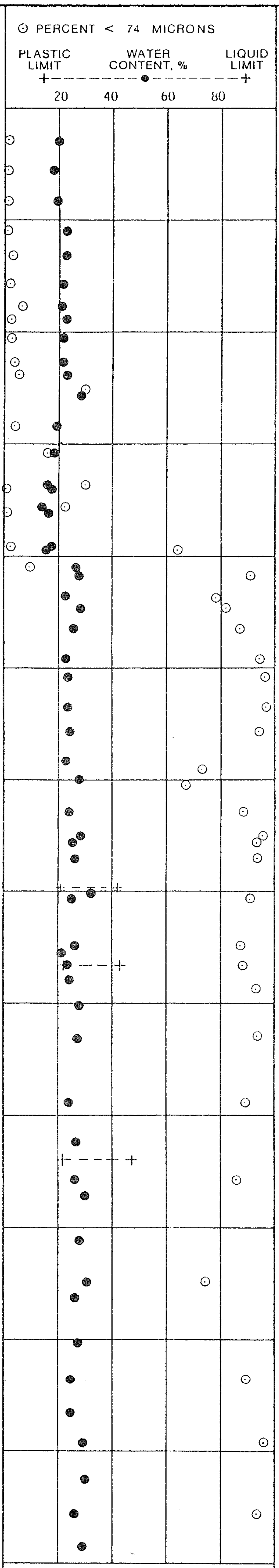
LOG AND TEST RESULTS

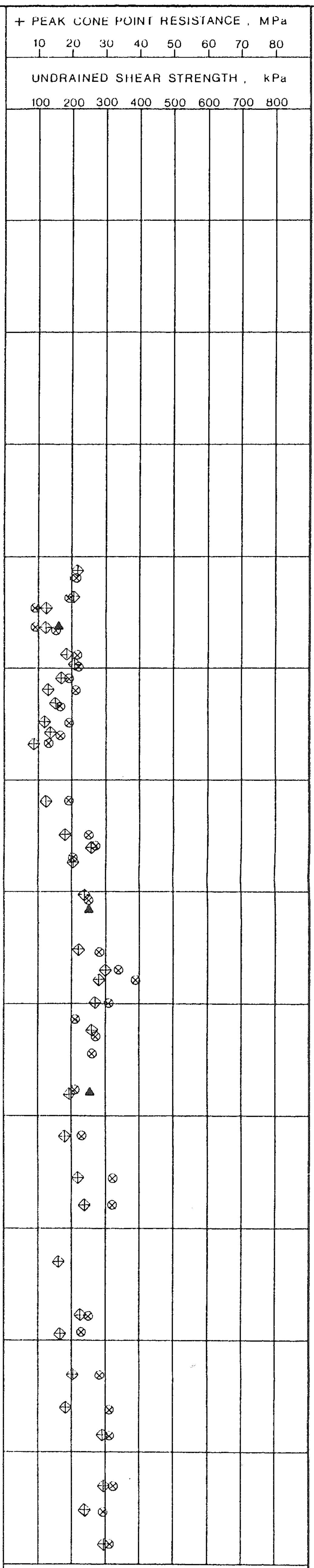
BORING 85 SAB LOCATION SABLE ISLAND

Location : SABLE ISLAND
BORING 85 SAB

PENETRATION BELOW GROUND LEVEL IN METRES

Depth (m)	Description	Sa No	RECOVERY (mm)	BLOW COUNT
65	(65.4)			
	Dense grey medium to coarse SAND	114	690	63
	-greenish grey from 66 to 68m penetration	115	550	28
		116	700	115
	-shell fragments increasing with depth from occasional to numerous	117	640	72
		118	660	92
	-brownish grey from 71 to 74m penetration	119	690	75
70		120	670	42
	-occasional light and dark bands	121	590	94
		122	630	82
	-silt seams at 65.5m and 70.6m penetration	123	600	86
		124	620	4
	-loose, liquefying at 72m	125	680	25
	(-73.8m)	126	430	97
		127	350	80
		128	570	25
75	Dense grey fine to medium SAND with a trace to some silt	129	540	80
		130	670	60
	-occasional shell fragments from 74 to 76m	131	650	71
		132	300	55
		133	510	63
	-occasional coarse sand	134	530	60
		135	630	51
	-occasional silt seams	136	630	77
		137	510	81
80		138	700	77
		139	690	86
	(-81.4m)	140	640	77
	Layered dense grey to olive grey sand, silty sand, and silt	141	680	86
		142	640	81
	-Contorted structure from 83 to 84m	143	690	81
	-layers 80 to 250mm thick	144	700	88
	(-84.9m)	145	640	87
85	Layered dense grey fine to medium sand, and very stiff olive grey clay	146	600	83
		147	700	82
	(-86.9m)	148	880	76
		149	665	54
	Very stiff to hard dark olive grey silty CLAY	150	370	P
		151	710	100
		152	500	100
	-silty sand or silt partings occuring at variable intervals	153	430	100
90		154	470	56
		155	470	100
		156	510	100
	-laminated/foliated structure	157	670	100
		158	640	120
		159	560	P
		160	480	P
		161	610	52
		162	560	61
95		163	700	75
		164	720	75
		165	630	80
		166	550	50
		167	450	100
		168	350	P
		169	360	50
		170	340	40
100		171	600	80
	-interbedded clay, silt and very fine sand with bedding dipping from about 50° to vertical, from 101 to 102.2m penetration	172	470	P
		173	700	P
		174	560	P
		175	670	P
		176	490	P
		177	610	HQ
105		178	1630	HQ
		179	1380	HQ
		180	80	HQ
110		181	1590	HQ
		182	1650	HQ
		183	1280	HQ
	-sand layer from 114.09 to 114.19m penetration	184	1670	HQ
115		185	1200	HQ
		186	350	HQ
		187	1620	HQ
120	-light brown fine sand layer from 120.52 to 120.85m penetration	188	1090	HQ
		189	1500	HQ
		190	1430	HQ
125	-sand partings at 45° dip at 125.0m penetration	191	1650	HQ
	-sand pockets from 127 to 130m penetration	192	650	HQ
		193	1310	HQ
130		194	1450	HQ





PENETRATION BELOW GROUND LEVEL IN METRES

Job No. : G042
Final Penetration :

Date Completed :
Field Engineer :

Page 2 of 3 65.34m to 130.10m

SAMPLE LEGEND

☒ RECOVERED

▮ LOST

☐ NOT SAMPLED

STRENGTH LEGEND

⊗ HAND PENETROMETER
◆ MINIATURE VANE
⊕ TORVANE
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
● UNCONFINED COMPRESSION
MIN ├─○─┤ MAX C P T CONE RESISTANCE

LOG AND TEST RESULTS

BORING 85 SAB LOCATION SABLE ISLAND

Location : SABLE ISLAND
BORING 85 SAB

PENETRATION BELOW GROUND LEVEL IN METRES

Hard dark olive grey silty CLAY (continued)

- -silt partings at 4mm to 50mm spacing, and sand seams, all dipping 10°, from 132.5 to 134.5m penetration
- -foliated structure
- -silt partings
- -horizontal cracks, due to stress relief (?), at 135m penetration
- -undrained shear strength decreasing from 131m to 143m penetration
- -400mm olive brown silty sand layer from 143m to 143.4m penetration
- -500mm olive brown silty sand layer from 144.6 to 145m

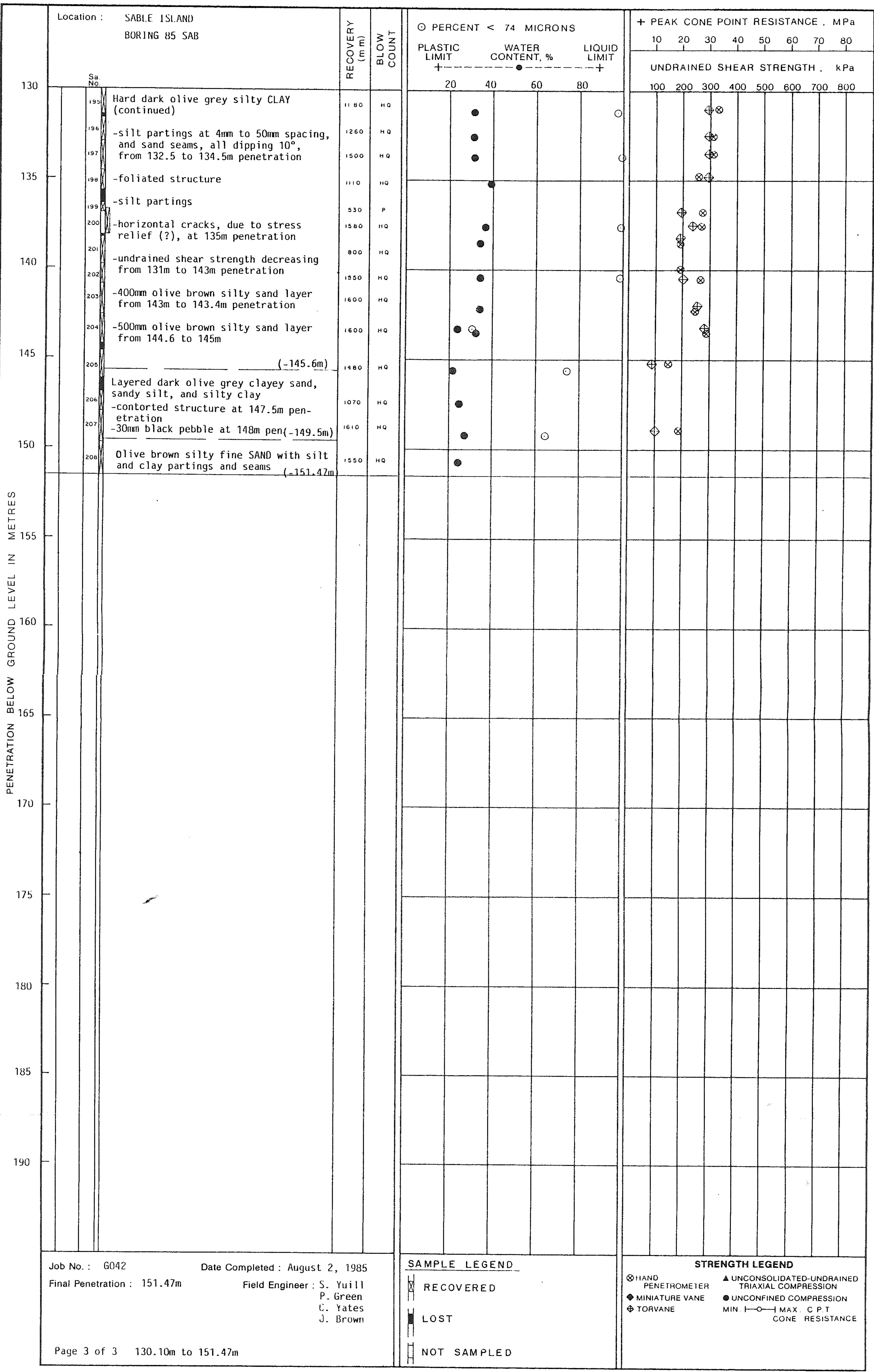
(-145.6m)

Layered dark olive grey clayey sand, sandy silt, and silty clay

- -contorted structure at 147.5m penetration
- -30mm black pebble at 148m pen (-149.5m)

Olive brown silty fine SAND with silt and clay partings and seams (-151.47m)

Sa No	RECOVERY (mm)	BLOW COUNT
195	1180	HQ
196	1260	HQ
197	1500	HQ
198	1110	HQ
199	530	P
200	1580	HQ
201	800	HQ
202	1550	HQ
203	1600	HQ
204	1600	HQ
205	1480	HQ
206	1070	HQ
207	1610	HQ
208	1550	HQ



Job No. : G042
Final Penetration : 151.47m
Date Completed : August 2, 1985
Field Engineer : S. Yuill
P. Green
C. Yates
J. Brown

Page 3 of 3 130.10m to 151.47m

SAMPLE LEGEND
☒ RECOVERED
■ LOST
☐ NOT SAMPLED

STRENGTH LEGEND
⊗ HAND PENETROMETER
◆ MINIATURE VANE
⊕ TORVANE
▲ UNCONSOLIDATED-UNDRAINED TRIAXIAL COMPRESSION
● UNCONFINED COMPRESSION
MIN ⊢○⊣ MAX. C P T CONE RESISTANCE

LOG AND TEST RESULTS

BORING 85 SAB LOCATION SABLE ISLAND

APPENDICES

A.1 - DESCRIPTION OF FIELD WORK

Personnel: A number of personnel were involved in this project, both on the island and ashore providing logistical support.

Dalhousie

Shorebased: J. Barrett, F.S. Medioli, T.E. Duffett, V. Baki, K. MacKinnon, L. Dobbin, C. Walls.

On the Island: D.B. Scott, M. Douma, R. Boyd, A. Giddy.

Jacques/McClelland

Shorebased: B. Taylor, J. Brown

On the Island: S. Yuill, C. Silliphant, J. Brown, H. Brown, G. Crouse, G. MacNeil, C. Yates, P. Green, B. Van Lingan.

Logan Drilling

Shorebased: E. Woodin, F. Logan.

On the Island: J. Whelan, R. Prosser, M. Woodin, B. Hiltz, R. Murphy, D. Fullerton, F. Logan

Schedule:

9 July 1985 - Scott, Douma, Giddy, Whelan - arrive on Island; P. Green on Balder Baffin.
16 July 1985 - Yuill, Silliphant, Van Lingan, Woodin, Fullerton, Murphy, and Hiltz arrive on Island.
24 July 1985 - Green comes ashore from Balder Baffin.
27 July 1985 - Logan arrives on Island.
28 July 1985 - Prosser arrives, Whelan leaves Island.
29 July 1985 - Yates, MacNeil, H. Brown, Boyd arrive; Douma, Green, Van Lingan leave Island.
1 August 1985 - J. Brown, Crouse, Douma arrive; Silliphant, Yuill, Giddy, Boyd leave.
8 August 1985 - Crouse leaves.
10 August 1985 - J. Brown, MacNeil, Yates, Fullerton, Murphy, Woodin, Prosser leave.
14 August 1985 - Hiltz, Douma, H. Brown, Scott leave; job completed.

Set Up:

Twenty-five helicopter lifts were required from the ship (*Balder Baffin*) to the drill site (lift list given in this Appendix). The lift list details the equipment but basically we had a complete drill and laboratory on site. Between 10 and 24 July, we spent time trying to get equipment from a Mobil supply boat to the island by helicopter. This operation was delayed by fog, faulty slings (resulting in loss of two loads into the ocean) and finally tropical storm *Anna* which almost washed away the entire operation on 18 July. There were two days of set up time required to get all the necessary facilities operating - electrical power, fully equipped field lab, water supply, auxiliary tents, drill shack, mud system, pipe slides, drill assembly. The drill was assembled and operating by 25 July. HW casing was initially run in the upper 20 m with thick walled Shelby tubes being used to obtain 50-70 cm samples in the sand. HQ rod was used below this with sampling done just ahead of the advancing HQ core barrel. Samplers were both hammered in and pushed in - hammered in sand, pushed in clays. The samples were extruded using hydraulics in direction of collection into pre-cut clear plastic tubing, labeled, described and stored in 1.5 m D-tubes for transport back to Halifax. Sampling was essentially continuous. Samples were split on site with both geological descriptions and photographs done together with geotechnical testing (fine fraction, moisture content, blow count, Torvane, minivane, some triaxials). Core was divided into archive and working halves. When the continuous hard clay was encountered at 90 m, we were able to use the wire line HQ inner core barrel to obtain 1.5 m core lengths and this procedure was used down to the completion of the hole at 151.47 m. At that point circulation was lost, the HQ drill rod became completely stuck and we could not drill further. A series of techniques (running casing, cementing, drilling out with NQ rod, dynamite) were tried to attempt to drill further but these were unsuccessful and on 6 August we abandoned the operation and began to demobilize. Twenty-four pieces of HQ drill rod, 16 of HW casing and assorted down hole bits and barrels were lost. The upper 15 pieces of HW casing were retrieved by blowing it off with dynamite. All equipment was off the island by 14 August and back in Halifax 15 August.

A.2 - DRILLING EQUIPMENT

Equipment:

Drill - Longyear model 38 drill equipped with 20 foot tower and 3-7/8" drill head; 5 cylinder Deutz diesel motor with hydraulic chuck. Drilling capability to 3000' with N-size rods. Drill set up with wire line sampling and coring capability.

Mud Pump - Model 435 Bean-Royal with 2 cylinder Petters diesel engine with 4 speed transmission.

Drill Pipes - Casing: Longyear HW seamless pipe (4-1/2" O.D., 4" I.D.); Drill Rod: Longyear HQ wire-line drill rod.

Samplers - 2-1/4" O.D. x 1.8" I.D. thick wall S.S. tubes were used in cohesionless soils and 2-1/4" O.D. x 2.1" I.D. Shelby thin walled tubes were used in cohesive sediments. In semi-consolidated sediments we were able to use HQ inner tube core barrels which retrieved 5 foot cores - 2.5" I.D. dia.

Gamma Logger - Neltronics Model KL.

Method:

We were not performing open hole drilling but using casing and drill rods to advance the hole. Continuous coring and sampling were carried out over the entire length of the borehole.

Push Sampling. Where suitable conditions prevailed samples were obtained with a latch-in push sampler. With the drill string near bottom, the sampler was lowered by wireline through the bore of the drill pipe and locked into the open centre bit. Using the hydraulic head on the drillrig, the sampling tube was pushed into the soil approximately 600 mm, or until the maximum allowable resistance to penetration was reached. After a brief pause the drill string was raised, and the sampler unlatched and retrieved by wireline. Push samples were obtained using thin-wall or heavy-wall tubes.

Hammer Sampling. The standard wireline hammer sampler was used when ground conditions precluded push sampling because of very dense or coarse materials which prevented satisfactory push samples from being recovered. The sampler was operated through the bore of the drill pipe after the boring had been advanced to the desired sampling depth. With the drill string at the bottom of the boring, the hammer sampler, which consists of a 100 kg sliding weight, slide pipe, perforated sleeve, sampler head and sample tube, was lowered to the bottom of the boring. The hammer was then raised by a wireline winch and allowed to fall 1.5 m on the sampler head a sufficient number of times to secure a soil sample. The sample was then retrieved by wireline. The sample tube consisted of either thin-wall or heavy-wall tube.

The mud system was a salt-water base using a mixture of salt-gel, polymer viscosifying agent and sodium hydroxide. As the hole got deeper, barite was added to provide weight and stabilize the hole. The mud system was a closed loop system that recovered, cleaned and recycled the mud using a shale shaker and multiple mud-tanks. All drill mud was non-toxic and biodegradable and approved for offshore use.

B. SUMMARY OF OPERATION

Date	Description
Tues 9 July	Advance Party to Sable
Wed 10 July	At Airport awaiting flight
Thurs 11 July	At Airport awaiting flight
Fri 12 July	-
Sat 13 July	-
Sun 14 July	Green leaves on Balder Baffin Whelan at Sable Island from 9-14 July
Mon 15 July	At Airport awaiting flight
Tues 16 July	At Airport - Fly to Sable
Wed 17 July	Started unloading - 2 loads in ocean
Thurs 18 July	Recovering & cleaning equipment (insurance)
Fri 19 July	Unloading equipment to Sable Island
Sat 20 July	Cleaning recovered equipment (insurance)
Sun 21 July	Standing by at Sable
Mon 22 July	Standing by at Sable
Tues 23 July	Standing by at Sable
Wed 24 July	Unloading to Sable completed
Thurs 25 July	Setting up on site & drilling to 3.9 m
Fri 26 July	Drilling to 15.3 m
Sat 27 July	Drilling to 41.5 m
Sun 28 July	Drilling to 71.3 m
Mon 29 July	Drilling to 87.6 m
Tues 30 July	Drilling to 96.0 m
Wed July 31	Drilling to 113.6 m
Thurs 1 Aug	Drilling to 142.5 m
Fri 2 Aug	Drilling to 151.5 m & running casing
Sat 3 Aug	Running casing & stuck rods
Sun 4 Aug	Running NQ rods & cementing hole
Mon 5 Aug	Cementing hole with cement fondue
Tues 6 Aug	Drilling out cement
Wed 7 Aug	Blasting casing
Thurs 8 Aug	Gamma Logging & Demob
Fri 9 Aug	Demob
Sat 10 Aug	Drill Crew left Sable Island
Sun 11 Aug	Standing by at Sable
Mon 12 Aug	Standing by at Sable
Tues 13 Aug	Standing by at Sable
Wed 14 Aug	All equipment lifted off to Balder Borkum and all project staff off Sable; job completed

C. HELICOPTER LIFTS REQUIRED

Lift No.	Description	L Ft	W Ft	H Ft	Approx. Weight Lbs
1	Drill Platform, Thiesen Mud Pump, Drill Head, Timber Blocking, Gas Diverter	18	8	6	2600
2	1 Pallet Salt Gel (60 bags)	6	6	4	3000
3	1 Pallet Salt Gel (60 bags)	6	6	4	3000
4	1 Pallet Salt Gel (60 bags)	6	6	4	3000
5	1 Pallet Barite (42 bags)	4	4	4	3700
6	1 Pallet DF Visc (35 bags)	4	4	4	3500
7	1 Pallet DF Visc (15) bags and Lime (40 bags)	4	4	4	3500
8	Longyear 38 drill and 4 cyl. Deutz motor	11	5	6	3200
9	Laboratory with Gamma Logger	10	8	8	3500
10	Mud tanks with hoses and tools	12	8	2	3500
11	400 ft HW casing	10	3	2	3600
12-17	Drill Pipe each	10	3	2	3500
18	Shale shaker & Derrick, gas generator	15	4	5	2500
19	Drill enclosure, sample tubes and spare parts	8	4	6	3000
20	435 Bean Royal pump & diesel generator	8	4	7	3500
21	4-Honda ATC's and Trailers	10	10	4	2000
22	Packaged dry goods	8	4	4	3000
23	Gasoline (5 bbls) & 2-100 lb propane	6	6	4	3000
24	Geophysical logging equipment	8	4	2	2000
25	Miscellaneous equipment - tent, shelving, etc.	8	8	4	2000

Notes:

1. Only 17 loads returning - no drilling mud or gas or dry goods.

2. Area required aboard supply boat is 800 sq. ft. of deck area plus allowance for securing (say 1.5 times the area) = total of 1200 sq. ft. of deck area. Drilling mud will be stacked, drill pipe and casing stacked, mud tanks on top of drill pipe, logging equipment on top of dry goods and miscellaneous equipment on top of ATC's.

D. SOIL SAMPLING

BORING 85 SAB

PROJECT NO. G042

LIST OF QUART SAMPLES

Sample No.	Depth (m)		Sample Type*	Shear Strength (kPa)			Remarks
	from	to		Tv	Pr	UU	
151B	88.24	88.46	HW-D	104	121	162	Field UU
155B	90.42	90.58	TW-D	140	180		
157B	91.59	91.76	HW-D	130	155		
159A	92.57	92.77	TW-P	115	150		
165B	96.48	96.65	TW-D	105	185		
167B	97.48	97.65	TW-D	160	245		
168B	97.82	98.00	TW-P	220	270		
171B	100.47	100.65	TW-D	200	255	254	Field UU
175B	102.48	102.66	TW-P	185	275		
178B	104.43	104.67	HQ	225	300		
179B	106.41	106.64	HQ	220	265		
181B	109.57	109.81	HQ	165	210	252	Field UU
182B	111.19	111.43	HQ	155	220		
183B	113.04	113.22	HQ	185	325		
184B	113.73	113.96	HQ	200	310		
187B	118.21	118.45	HQ	190	255		
187C	118.87	119.11	HQ	190	255		
188B	119.96	120.19	HQ	140	235		
189B	121.64	121.88	HQ	170	280		
190B	122.26	123.94	HQ	155	305		
191A	124.53	124.76	HQ	245	300		
192A	125.92	126.14	HQ	>245	315		
193A	127.55	127.76	HQ	210	280		
194A	129.17	129.41	HQ	>245	300		
195A	130.95	131.18	HQ	>245	315		
196A	132.31	132.51	HQ	>245	305		
197A	133.56	133.76	HQ	>245	290		
198A	134.83	135.06	HQ	>245	255		
200B	137.65	137.85	HQ	200	270		
202B	140.48	140.62	HQ	170	225		
203B	142.33	142.50	HQ	215	245		suitable for consolidation only
204B	143.47	143.69	HQ	235	285		
205B	145.63	145.87	HQ	75	160		sandy clay
207B	149.23	149.42	HQ	85	185		sandy silty clay
208B	150.81	151.02	HQ	--	--		sandy clayey silt

*HW - heavy wall tube
TW - thin wall tube
HQ - HQ core barrel
D - driven sample
P - push sample

Note: 35 quart samples taken, of which 3 were field tested

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										ADVANCED TESTS (3)
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION (1) TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m³	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, Su kPa	MINIATURE VANE, Su kPa	TORVANE Su kPa	Su kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m³	ε50 %	εf %	TYPE OF FAILURE	
1	HW		125	14	0	700	500			2.6			0.2											
2	HW		125	17	0.70	345	250																	
3	HW		125	11	0.95	320	310			20.3			0.2											
4	HW		125	20	1.27	620	610																	
5	SS		125	42	1.89	700	700			19.4			0.3											
6	HW		125	2	2.59	700	550																	
7	HW		125	31	3.29	450	360			21.6			0.3											
8	HW		125	9	3.60	310	310																	
9	HW		125	50	3.91	600	600			19.7			1.8											
10	HW		125	18	4.51	500	500																	
11	HW		125	35	6.31	300	300			18.1			1.5											
12	HW		125	30	6.61	380	380																	
13	HW		125	12	6.99	370	370			25.5														
14	HW		125	10	7.36	390	390																	
15	HW		125	24	7.75	700	480			33.9			4.4											
16	TW		125	30	8.23	700	700			18.4														
17	HW		125	34	8.93	700	600			22.0			0.7											
18	HW		125	10	9.70	700	600			25.2			1.6											
										56.7			22.8											
19	HW		125	60	10.30	600	490			24.4			1.5											
20	HW		125	60	10.79	700	686			18.3	20.79	-												
21	HW		125	41	11.56	700	680			19.3			0.4											
22	HW		125	20	12.24	700	500			18.1	20.71		0.6											
23	HW		125	31	12.74	700	550																	
24	HW		125	35	13.32	700	650			21.1	20.31		1.3											
25	HW		125	44	13.98	700	630																	
26	HW		125	60	14.61	700	640			20.5	22.57		2.1											
27	HW		125	53	15.25	700	550																	
28	HW		125	35	15.80	700	440			24.5	19.76		0.8											
29	HW		125	31	16.27	700	680																	
30	HW		125	52	16.95	700	660			24.3	20.38		0.3											
31	HW		125	42	17.61	700	260																	
32	HW		125	22	17.87	700	500			24.9			0.9											
33	HW		125	37	18.37	700	370																	
34	HW		125	32	18.74	700	410			24.3			0.8											

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
(2) GRAIN SIZE CURVE PRESENTED SEPARATELY
(3) ALL TESTS ON UNDISTURBED SAMPLES UNLESS OTHERWISE INDICATED
(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

PLATE

JACQUES/McCLELLAND

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION (1) TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m³	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, Sᵤ kPa	MINIATURE VANE, Sᵤ kPa	TORVANE Sᵤ kPa	Sᵤ kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m³	ε₅₀ %	εf %	TYPE OF FAILURE	ADVANCED TESTS (3)
35	HW		125	24	19.15	700	370																	
36	HW		125	14	19.52	700	430			24.5			0.9											
37	HW		125	31	19.99	700	470																	
38	HW		125	13	20.46	700	320			27.9			0.2											
39	HW		125	38	20.78	700	520			20.8	21.38		0.2											
40	HW		125	30	21.30	700	495																	
41	HW		125	22	21.80	700	500			22.8	23.24													
42	HW		125	22	22.30	700	450																	
43	HW		125	18	22.75	700	510				20.90		1.0											
44	HW		125	30	23.26	700	350																	
45	HW		125	26	23.61	700	610			18.9	19.32		0.8											
46	HW		125	24	24.22	700	700																	
47	HW		125	56	24.92	700	705			23.3	20.41		1.4											
48	HW		125	30	25.62	700	375																	
49	HW		125	17	26.00	700	560			23.7	18.04		2.3											
50	HW		125	25	26.56	700	540																	
51	HW		125	26	27.10	700	690			23.5	18.44		0.7											
52	HW		125	24	27.79	700	700																	
53	HW		125	27	28.49	700	440			62.5			54.5											
										24.1			1.5											
54	HW		125	57	28.99	700	500																	
55	HW		125	30	29.49	700	540			21.1	20.50		3.5											
56	HW		125	59	30.03	700	400																	
57	HW		125	46	30.43	700	660			23.0			2.5											
58	HW		125	54	31.09	700	630																	
59	HW		125	47	31.72	700	610			21.9	19.81		1.0											
60	HW		125	47	32.33	700	660																	
61	HW		125	54	32.99	700	700			21.5	18.83		0											
62	HW		125	57	33.69	700	550																	
63	HW		125	37	34.25	700	650			20.0	20.35		2.1											
64	HW		125	3	34.90	500	500																	
65	HW		125	5	35.40	500	350			26.1	18.58		1.8											
66	HW		125	44	35.75	700	610																	
67	HW		125	44	36.36	700	690			24.1	20.86		3.3											
68	HW		125	57	37.05	700	590																	

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
(2) GRAIN SIZE CURVE PRESENTED SEPARATELY
(3) ALL TESTS ON UNDISTURBED SAMPLES UNLESS OTHERWISE INDICATED
(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

JACQUES / McCLELLAND

PLATE

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION (1) TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m³	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, S_u kPa	MINIATURE VANE, S_u kPa	TORVANE S_u kPa	S_u kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m³	ϵ_{50} %	ϵ_f %	TYPE OF FAILURE	ADVANCED TESTS (3)
69	HW		125	10	37.72	300	300			27.9			2.4											
70	HW		125	37	38.02	700	300																	
71	HW		125	10	38.32	700	630			23.9	21.62		1.3											
72	HW		125	35	38.95	700	620																	
73	HW		125	61	39.57	700	670			20.7	20.46		1.6											
74	HW		125	59	40.24	700	610																	
75	HW		125	69	40.85	700	550			21.3	21.78		1.9											
76	HW		125	68	41.40	700	690																	
77	HW		125	120	42.09	650	610			19.7	19.77		2.7											
78	HW		125	100	42.70	700	690																	
79	HW		125	64	43.39	700	670			18.9	20.70		1.2											
80	HW		125	97	44.06	700	670																	
81	HW		125	39	44.73	700	630			22.6	20.58		4.1											
82	HW		125	66	45.36	700	540																	
83	HW		125	73	45.90	700	670			23.2	21.37		1.5											
84	HW		125	84	46.57	700	660																	
85	HW		125	130	47.23	700	700			19.6	21.25		3.0											
86	HW		125	103	47.93	700	580																	
87	HW		125	51	48.51	700	660			23.0	20.30		2.8											
88	HW		125	12	49.17	700	570																	
89	HW		125	25	49.74	700	660			21.0	20.23		0.5											
90	HW		125	60	50.40	600	330																	
91	HW		125	59	50.73	700	535			22.8	20.41		1.2											
92	HW		125	59	51.26	700	700																	
93	HW		125	87	51.96	700	700			22.8	20.59		3.3											
94	HW		125	47	52.66	700	700																	
95	HW		125	11	53.36	700	500			25.0	20.89		1.9											
96	HW		125	98	53.86	700	700																	
97	HW		125	60	54.56	700	700			22.8	20.40		0.9											
98	HW		125	58	55.26	700	700																	
99	HW		125	50	55.96	700	700			23.7	20.40		21.8											
100	HW		125	40	56.66	555	555																	
101	HW		125	45	57.22	300	300																	
102	HW		125	80	57.52	700	700			23.0			12.1											
103	HW		125	60	58.22	700	700				20.10		11.2											

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
(2) GRAIN SIZE CURVE PRESENTED SEPARATELY
(3) ALL TESTS ON UNDISTURBED SAMPLES UNLESS OTHERWISE INDICATED
(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION (1) TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m^3	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, S_u kPa	MINIATURE VANE, S_u kPa	TORVANE S_u kPa	S_u kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m^3	ϵ_{50} %	ϵ_f %	TYPE OF FAILURE	ADVANCED TESTS (3)
104	HW		125	65	58.92	700	700																	
105	HW		125	40	59.62	700	700			22.4	20.30		2.8											
106	HW		125	26	60.32	700	700																	
107	HW		125	24	61.02	700	380			28.3			2.2											
108	HW		125	35	61.72	700	410																	
109	HW		125	35	62.13	700	700			24.7	19.71		4.1											
110	HW		125	36	62.83	700	520																	
111	HW		125	57	63.53	610	570			22.0	20.99		30.7											
112	HW		125	71	64.10	700	540			21.2			96.8											
113	HW		125	70	64.64	700	700			17.7	20.93		1.3											
114	HW		125	63	65.34	700	690																	
115	HW		125	28	66.03	700	550			20.2	19.33		1.6											
116	HW		125	115	66.58	700	700																	
117	HW		125	72	67.28	700	640			17.4	20.42		1.2											
118	HW		125	92	67.92	700	660																	
119	HW		125	75	68.58	700	690			19.4	21.00		1.6											
120	HW		125	42	69.27	700	670																	
121	HW		125	94	69.94	700	590			22.6	20.43		1.4											
122	HW		125	82	70.53	700	630																	
123	HW		125	86	71.16	650	600			22.3	20.81		2.2											
124	HW		125	4	71.76	700	620																	
125	HW		125	25	72.38	700	680			20.6	20.57		1.1											
126	HW		125	97	73.06	650	430																	
127	HW		125	80	73.49	700	350			20.2			6.0											
128	HW		125	25	73.87	700	570			21.6	20.83		2.1											
129	HW		125	80	74.41	650	540																	
130	HW		125	60	74.95	700	670			21.6	20.20		2.3											
131	HW		125	71	75.62	650	650																	
132	HW		125	55	76.27	700	300			20.9			4.0											
133	HW		125	63	76.57	600	510			22.6	20.60		5.0											
134	HW		125	60	77.08	600	630																	
135	HW		125	51	77.61	700	630			28.0	20.99		29.8											
136	HW		125	77	78.24	700	630																	
137	HW		125	81	78.87	510	510			19.0	20.89		3.4											
138	HW		125	77	79.38	700	700																	

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
(2) GRAIN SIZE CURVE PRESENTED SEPARATELY
(3) ALL TESTS ON UNDISTURBED SAMPLES UNLESS OTHERWISE INDICATED
(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

JACQUES / McCLELLAND

PLATE

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										ADVANCED TESTS (3)
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION (1) TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m^3	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, S_u kPa	MINIATURE VANE, S_u kPa	TORVANE S_u kPa	S_u kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m^3	ϵ_{50} %	ϵ_f %	TYPE OF FAILURE	
139	HW		125	86	80.08	700	690			18.1	20.30		15.7											
140	HW		125	77	80.77	700	640																	
141	HW		125	86	81.41	680	680			16.3	21.28		29.9											
141										18.3			0											
142	HW		125	81	82.09	640	640																	
143	HW		125	81	82.73	690	690			13.9	21.18		22.8											
										16.0			1.2											
144	HW		125	88	83.42	700	700																	
145	HW		125	87	84.12	640	640			18.8	20.59		1.9											
145										15.7			64.3											
146	HW		125	83	84.76	600	600																	
147	HW		125	82	85.36	700	700			25.5	20.10		9.6											
147										27.2			95.6	210		216								
148	TW		125	76	86.06	880	880			21.7			77.7	190		204								
149	TW		125	54	86.94	665	665			27.7			80.6	85		126								
150	TW			Push	87.61	370	370																	
151	HW		125	100	87.98	710	710			25.3			86.5	120		126	162	414		19.54		9.9	A	
152	TW		125	100	88.69	500	500																	
153	TW		125	100	89.19	430	430			22.6			93.8	215		186								
154	TW		125	56	89.64	470	470							215		216								
155	TW		125	100	90.11	470	470			23.3			95.8	180		168								
156	TW		125	100	90.58	510	510							205		132								
157	HW		125	100	91.09	670	670			23.8			95.8	155		156								
158	HW		125	120	91.76	640	640							185		120								
159	TW		[illegible]	Push	92.40	560	560			23.8			94.4	150		138								
160	TW			Push	92.96	480	480							125		90								
161	HW		125	52	93.44	610	610			22.6			72.3											
162	HW		125	61	94.05	560	560																	
163	HW		125	75	94.61	700	700				20.50													
164	TW		125	75	95.30	720	720			27.2			66.6											
165	TW		125	80	96.02	630	630			24.1			88.4	185		126								
166	TW		125	50	96.65	550	550																	
167	TW		125	100	97.20	450	450			27.8			95.3	245		192								
168	TW			Push	97.65	350	350			25.0			93.3	270		264								
169	TW		125	50	98.00	360	360																	

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
(2) GRAIN SIZE CURVE PRESENTED SEPARATELY
(3) ALL TESTS ON UNDISTURBED SAMPLES UNLESS OTHERWISE INDICATED
(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

PLATE

JACQUES/McCLELLAND

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										ADVANCED TESTS (3)
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION (1) TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m³	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, S_u kPa	MINIATURE VANE, S_u kPa	TORVANE S_u kPa	S_u kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WT (III) kN/m³	ϵ_{50} %	ϵ_f %	TYPE OF FAILURE	
170	TW		125	40	98.36	700	340			25.6			95.1	195		204								
171	TW		125	80	100.15	700	600	43	21	31.2			90.8	255		240	254	550		20.97		19.9	8	
171										24.7														
172	TW			Push	100.75	470	470																	
173	TW			Push	101.22	700	700																	
174	TW			Push	101.92	560	560			25.9	19.56		87.7											
175	TW			Push	102.48	570	670			20.7				275		222								
176	TW			Push	103.15	490	490	44	22	22.8	19.32		88.5	335		300								
177	HQD			Core	103.64	610	690			24.5				285		282								
178	HQD			Core	104.25	1630	1630			27.7			93.7	300		270								
179	HQD			Core	105.88	1524	1380			27.2			93.6	265		264								
180	HQD			Core	107.40	1270	80																	
181	HQD			Core	108.67	1590	1590			24.4			89.7	210		168	252	550		19.78				
182	HQD			Core	110.20	1830	1650	48	21	26.9				220		186								
183	HQD			Core	112.03	1520	1280			25.4			85.9	325		272								
184	HQD			Core	113.55	1520	1670			30.1				310		240								
185	HQD			Core	115.07	2130	1200			27.8				175		162								
186	HQD			Core	117.20	1520	350			30.2			74.4											
187	HQD			Core	118.72	610	1620			26.0				255		228								
188	HQD			Core	119.33	1520	1090			26.6				235		168								
189	HQD			Core	120.85	1410	1500			24.7			89.8	280		204								
190	HQD			Core	122.26	1680	1430			24.4				305		186								
191	HQD			Core	123.81	1520	1650			29.8			96.1	300		294								
192	HQD			Core	125.46	1560	1630			30.2				315		294								
193	HQD			Core	127.02	1650	1310			27.1			93.9	280		252								
194	HQD			Core	128.67	1430	1450			29.3				300		294								
195	HQD			Core	130.10	1610	1180			32.4			97.6	315		294								
196	HQD			Core	131.71	1060	1260			32.8				305		294								
197	HQD			Core	132.77	1690	1500			31.9			99.7	290		294								
198	HQD			Core	134.46	1110	1110			39.4				255		294								
199	TW			Push	136.30	530	530							240		198								
200	HQD			Core	136.54	1620	1580			37.0			98.5	270		240								
201	HQD			Core	138.08	1700	800			34.1				190		192								
202	HQD			Core	139.78	1070	1550			33.3			99.3	225		204								
203	HQD			Core	140.85	1650	1600			33.9				245		258								

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
(2) GRAIN SIZE CURVE PRESENTED SEPARATELY
(3) ALL TESTS ON UNDISTURBED SAMPLES UNLESS OTHERWISE INDICATED
(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

JACQUES/McCLELLAND

PLATE

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										ADVANCED TESTS (3)
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	(1) PENETRATION TO TOP OF SAMPLE, m	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m³	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, Su kPa	MINIATURE VANE, Su kPa	TORVANE Su kPa	Su kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m³	ε50 %	εf %	TYPE OF FAILURE	
170	TW		125	40	98.36	700	340			25.6			95.1	195		170								
171	TW		125	80	100.15	700	600	43	21	31.2	24.7		90.8	255		200	254	550		97 20.95		19.9	B	
172	TW			Push	100.75	470	470																	
173	TW			Push	101.22	700	700																	
174	TW			Push	101.92	560	560			25.9	19.56		87.7											
175	TW			Push	102.48	570	670			20.7				275		185								
176	TW			Push	103.15	490	490	44	22	22.8	19.32		88.5	335		250								
177	HQD			Core	103.64	610	690			24.5				285		235								
178	HQD			Core	104.25	1630	1630			27.7			93.7	300		225								
179	HQD			Core	105.88	1524	1380			27.2			93.6	265		220								
180	HQD			Core	107.40	1270	80																	
181	HQD			Core	108.67	1590	1590			24.4			89.7	210		165	252	550		19.78				
182	HQD			Core	110.20	1830	1650	48	21	26.9				220		155								
183	HQD			Core	112.03	1520	1280			25.4			85.9	325		185								
184	HQD			Core	113.55	1520	1670			30.1				310		200								
185	HQD			Core	115.07	2130	1200			27.8				175		135								
186	HQD			Core	117.20	1520	350			30.2			74.4											
187	HQD			Core	118.72	610	1620			26.0				255		190								
188	HQD			Core	119.33	1520	1090			26.6				235		140								
189	HQD			Core	120.85	1410	1500			24.7			89.8	280		170								
190	HQD			Core	122.26	1680	1430			24.4				305		155								
191	HQD			Core	123.81	1520	1650			29.8			96.1	300		245								
192	HQD			Core	125.46	1560	1630			30.2				315		245								
193	HQD			Core	127.02	1650	1310			27.1			93.9	280		210								
194	HQD			Core	128.67	1430	1450			29.3				300		245								
195	HQD			Core	130.10	1610	1180			32.4			97.6	315		245								
196	HQD			Core	131.71	1060	1260			32.8				305		245								
197	HQD			Core	132.77	1690	1500			31.9			99.7	290		245								
198	HQD			Core	134.46	1110	1110			39.4				255		245								
199	TW			Push	136.30	530	530							240		165								
200	HQD			Core	136.54	1620	1580			37.0			98.5	270		200								
201	HQD			Core	138.08	1700	800			34.1				190		160								
202	HQD			Core	139.78	1070	1550			33.3			99.3	225		170								
203	HQD			Core	140.85	1650	1600			33.9				245		215								
204	HQD			Core	142.50	1680	1600			22.8	19.33		30.4	285		235								

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
OC	OEDOMETER CONSOLIDATION

NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
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SEAFLOOR AT
ELEV.

JACQUES/McCLELLAND

PLATE

SUMMARY OF SAMPLES AND TESTING

SAMPLE INFORMATION								CLASSIFICATION TESTS						UNDRAINED SHEAR STRENGTH TESTS (3)										ADVANCED TESTS (3)
																	UU TESTS							
SAMPLE NUMBER	TYPE OF SAMPLER	SAMPLER DIAMETER, mm	HAMMER WEIGHT, kg	BLOW COUNT	PENETRATION TO TOP OF SAMPLE, m (1)	SAMPLER ADVANCE mm	RECOVERY mm	LIQUID LIMIT	PLASTIC LIMIT	WATER CONTENT, %	WET UNIT WEIGHT kN/m³	PERCENT < 4.7 mm	PERCENT < 74 MICRONS	HAND PENETROMETER, S_u kPa	MINIATURE VANE, S_u kPa	TORVANE S_u kPa	S_u kPa	CONFINING STRESS kPa	WATER CONTENT %	TOTAL UNIT WEIGHT kN/m³	ϵ_{50} %	ϵ_f %	TYPE OF FAILURE	
204	HQD			Core	142.50	1680	1600			22.8	19.33		30.4	285		282								
204										32.5														
205	HQD			Core	144.18	1880	1480			21.1			74.0	160		90								
206	HQD			Core	146.06	1900	1070			24.5														
207	HQD			Core	147.96	1830	1610			26.8			64.8	185		102								
208	HQD			Core	149.79	1680	1550			24.2														

LEGEND AND NOTES:

TYPE OF SAMPLER:

SS	SPLIT SPOON
TW	THIN WALL
HW	HEAVY WALL
HQD	ROCK CORE, DOUBLE TUBE, 63.5 mm DIA.
HQT	ROCK CORE, TRIPLE TUBE, 63.5 mm DIA.
NQD	ROCK CORE, DOUBLE TUBE, 47.5 mm DIA.
NQT	ROCK CORE, TRIPLE TUBE, 47.5 mm DIA.

TYPE OF FAILURE:

A	BULGE
B	SINGLE SHEAR PLANE
C	MULTIPLE SHEAR PLANES
D	VERTICAL FRACTURE

TYPE OF TEST:

UU	UNCONSOLIDATED-UNDRAINED TRIAXIAL
CIU	ISOTROPICALLY CONSOLIDATED-UNDRAINED TRIAXIAL
CID	ISOTROPICALLY CONSOLIDATED-DRAINED TRIAXIAL
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NOTES:

(1) PENETRATION TO TOP OF SAMPLE CORRECTED FOR TIDAL VARIATION
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(4) STRESS-STRAIN CURVE PRESENTED SEPARATELY

SEAFLOOR AT
ELEV.

JACQUES/McCLELLAND

PLATE

JACQUES / McCLELLAND

NATURAL GAMMA LOG RECORD SHEET

PROJECT NAME: Sable Island Boring

PROJECT No. G -042

BORING No. 85- SAB

CLIENT: Department of Marine Geology, Dalhousie University

DATE: August 8, 1985

INSTRUMENTATION: Manufacturer: Neltronics Model No.: KL Probe No.:

Calibration Date: By:

PERSONNEL INFORMATION: Logged by: Grant Crouse

Witnessed by: Carl Yates

Drilling Contractor: Logan Drilling Ltd.

Surveyor:

Client Rep: David Scott

JMGI Project Manager: Suther Yuill

Time at start of set-up: 0730

Time at end of tear-down: 1220

Stand by/Down time:

Duration of equipment use: 4hr. 50min.

Ground / Seafloor Elevation:

Reference Datum:

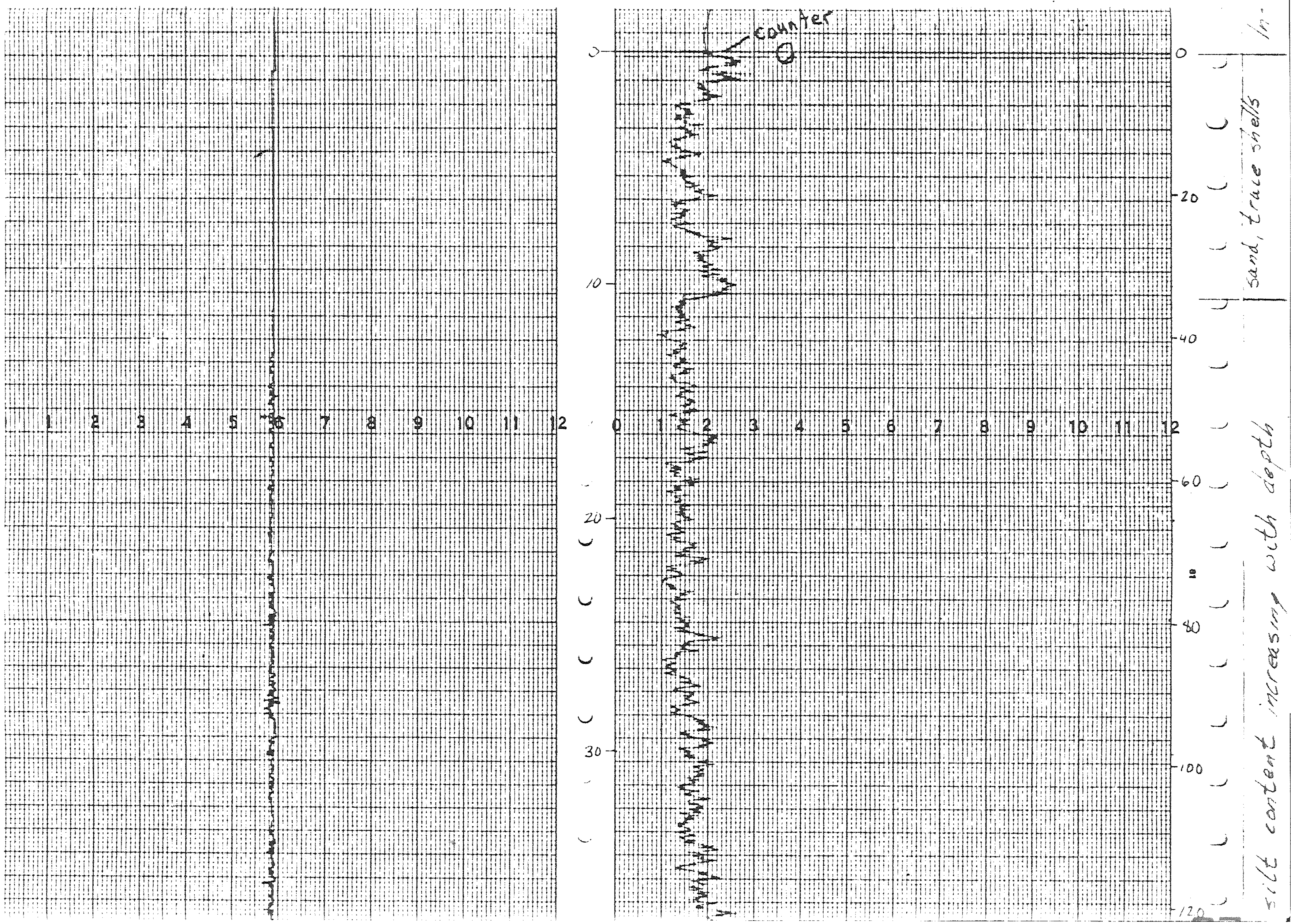
TIME AND EQUIPMENT LOG

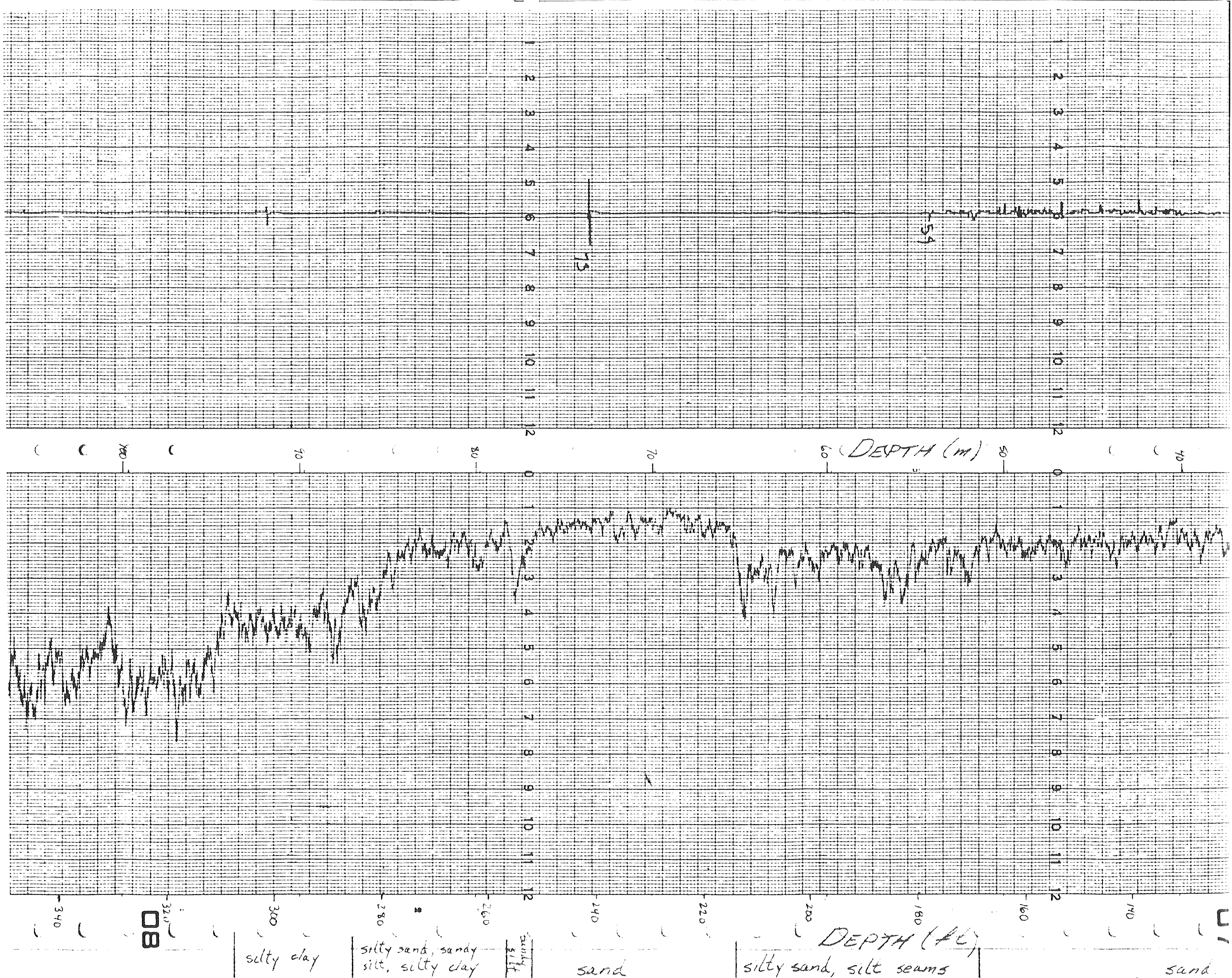
RUN No.	1	2	3	4
T.C.	2	2	1	1
Range (counts/sec.)	50	100	50	100
Line Speed	5 METRES / MIN.			
Start Downhole Time	9:05	10:02	10:39	11:21
Start Uphole Time	9:17	10:11	10:50	11:29
Finish Run Time	9:46	10:37	11:15	11:54
Logging Direction				
Notes				

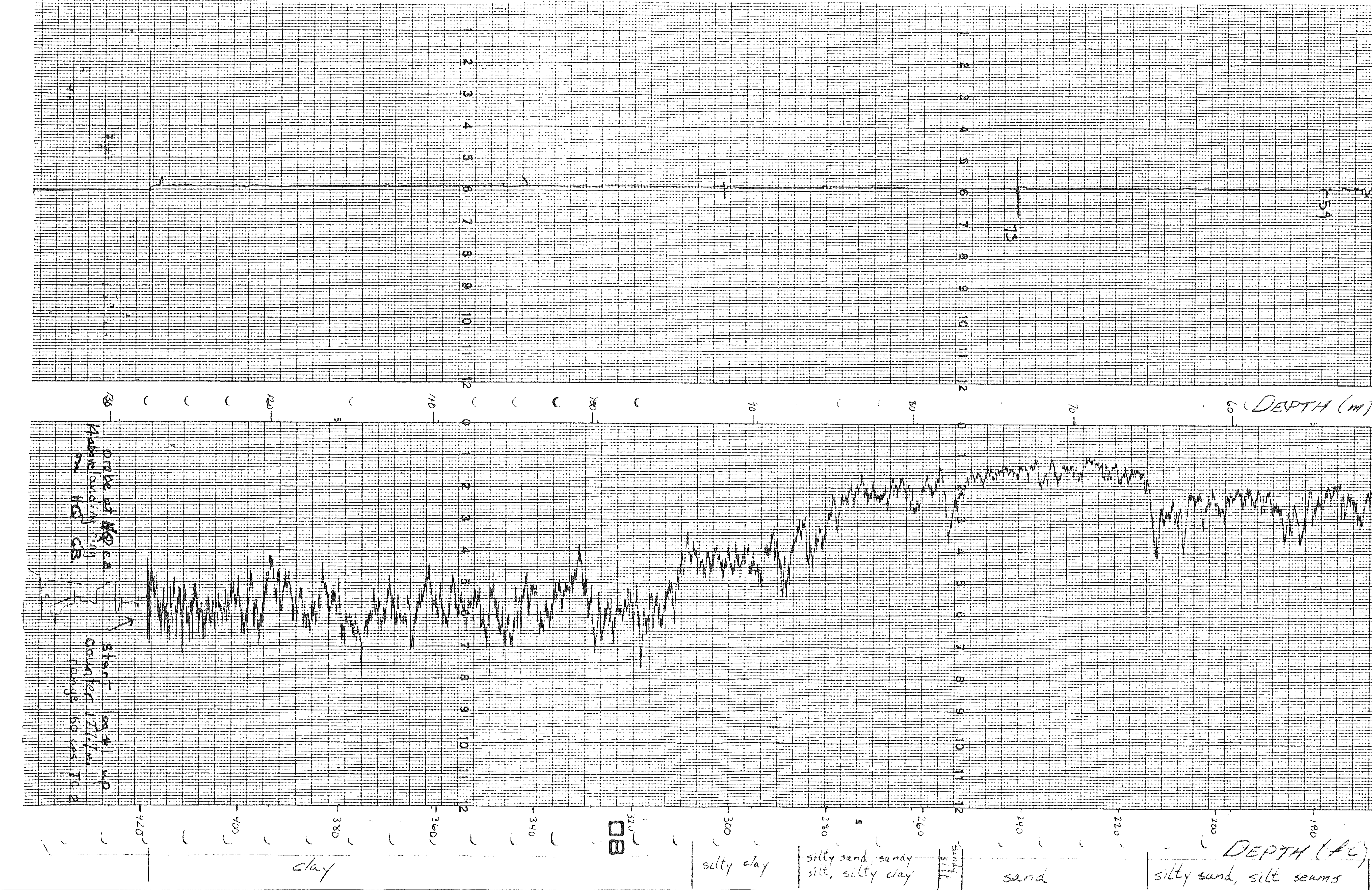
DEPTH LOG

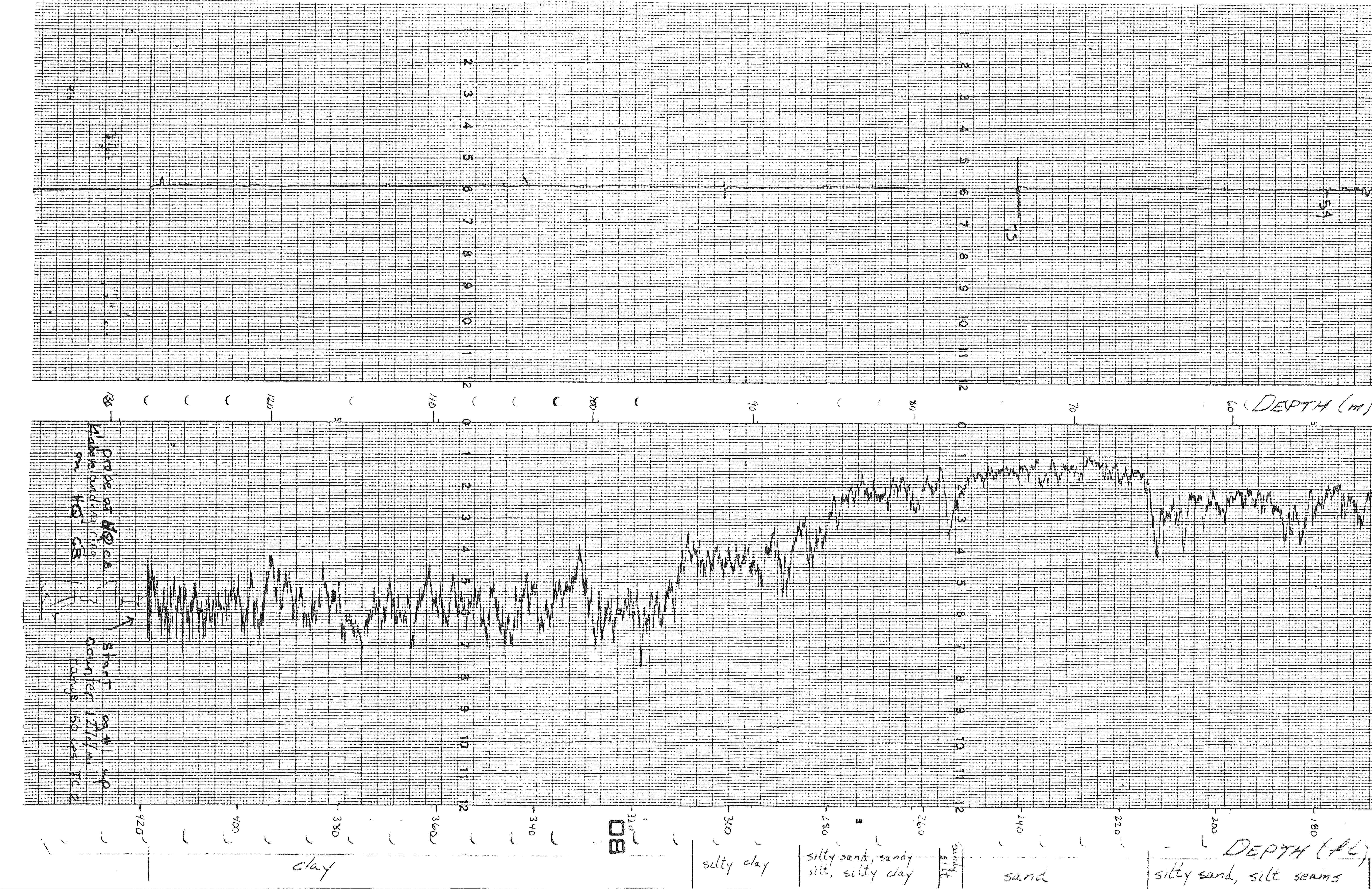
	RUN No.	1	2	3	4
A	Total Hole Depth	157.47			
B	Bottom Assembly Length	N/A			
C	Total Drill String Length	137.2			
D	Total Water Depth	N/A			
E	Air Gap	3.70	ELEVATION OF DRILL ABOVE GROUND		
F	Pipe Stickup	N/A			
G	Distance Bit Above Bottom (A + D + E + F - C)	17.97			
H	Cable Length to Bit (C- probe in pipe)				
I	Cable Length to Mudline (D + E + F - probe in pipe)				
J	Cable out: at start of log at end of log				

PLATE




13
54
DEPTH (m)
40
50
60
70
80
90
100
0
1
2
3
4
5
6
7
8
9
10
11
12
DEPTH (ft)
140
160
180
200
220
240
260
280
300
320
340
08
silty clay
silty sand, sandy silt, silty clay
sandy silt
sand
silty sand, silt seams
sand


Probe at HQ CB
[illegible]
on HQ CB
start log #1 up
counter 127/m
range 50 cps TC 2
73
54
DEPTH (m)
130
120
110
100
90
80
70
60
DEPTH (ft)
420
400
380
360
340
320
300
280
260
240
220
200
180
08
clay
silty clay
silty sand, sandy silt, silty clay
sandy silt
sand
silty sand, silt seams



73
59
130
120
110
100
90
80
70
60
DEPTH (m)
probe at HQ c.s.
4 abovelanding ring
on HQ CB
start log #1 up
counter 127.7 m.
range 50 cps TC 2
420
400
380
360
340
320
300
280
260
240
220
200
180
DEPTH (ft)
clay
silty clay
silty sand, sandy silt, silty clay
sandy silt
sand
silty sand, silt seams
0
1
2
3
4
5
6
7
8
9
10
11
12
08