Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Volume II

Point Thomson Development Project Winter 1982 Geotechnical Investigation

prepared for
EXXON COMPANY, U.S.A.
Production Department Western Divison

№ 012

VOLUME II

POINT THOMSON DEVELOPMENT PROJECT WINTER 1982 GEOTECHNICAL INVESTIGATION EXXON COMPANY, U.S.A

HLA JOB NO. 9612,031.08

A Report Prepared for

EXXON COMPANY, U.S.A.
1800 Avenue Of The Stars
Los Angeles, CA 90067

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JUNE, 1982

REPORT COPY № 012

This is a proprietory report prepared for Exxon Company USA for the Point Thomson Development Project.

APPENDIX A
EXISTING INFORMATION

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EXISTING INFORMATION

Previous soil investigations for the development of the Point Thomson Development (PTD) area have produced a collection of geotechnical data. This chapter summarizes the available onshore and offshore geotechnical information sources pertinent to development of the PTD area.

The studies cited were performed for either government agencies or partners in the PTD area. The list is limited to data available to Harding Lawson Associates (HLA) and used in the current investigation. The locations of the studies along with the boring locations for this study are shown on Plate A-1.

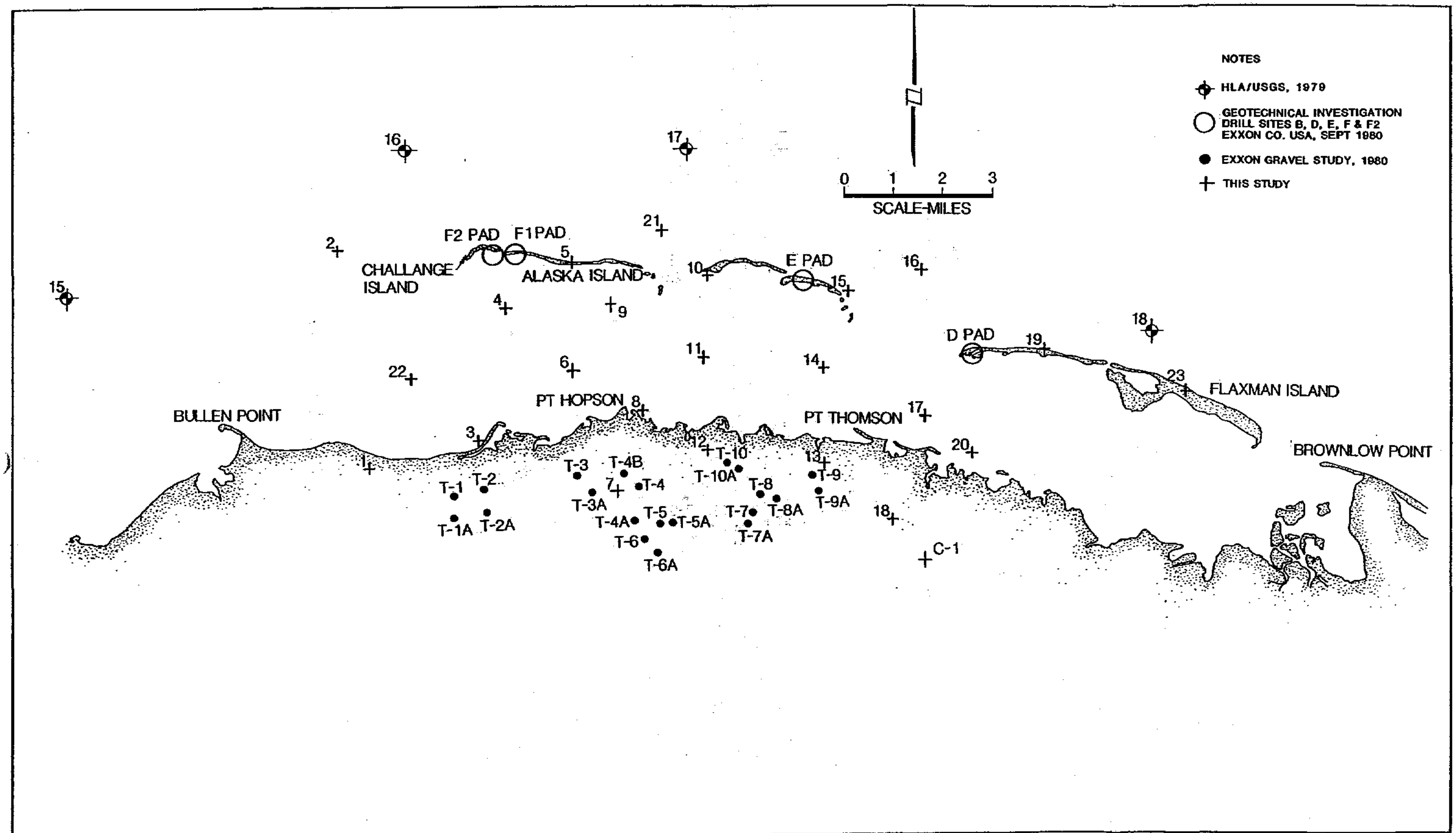
A. Offshore Soil Investigations

1. Geotechnical Investigation Beaufort Sea

HLA performed this investigation in February and March, 1979 for the United States Geological Survey (USGS). Four borings for this USGS investigation were drilled within the proposed PTD area to depths of 42 to 103 feet below mudline. Logs for these four borings were generalized in the Alaska Oil and Gas Association study and are shown on Plates A-2 through A-5.

2. Interpretation of Geophysical, Geologic and Engineering Data Beaufort Sea, Alaska

This study was performed in November, 1979 for eight oil companies by HLA. This paper presented an interpretation of geophysical and geotechnical data available in the Prudhoe Bay-Point Thomson region from 1971-1977 and involved the geotechnical data generated in the 1979 USGS investigation.



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Locations of Area Studies

Pt. Thomson Development Project
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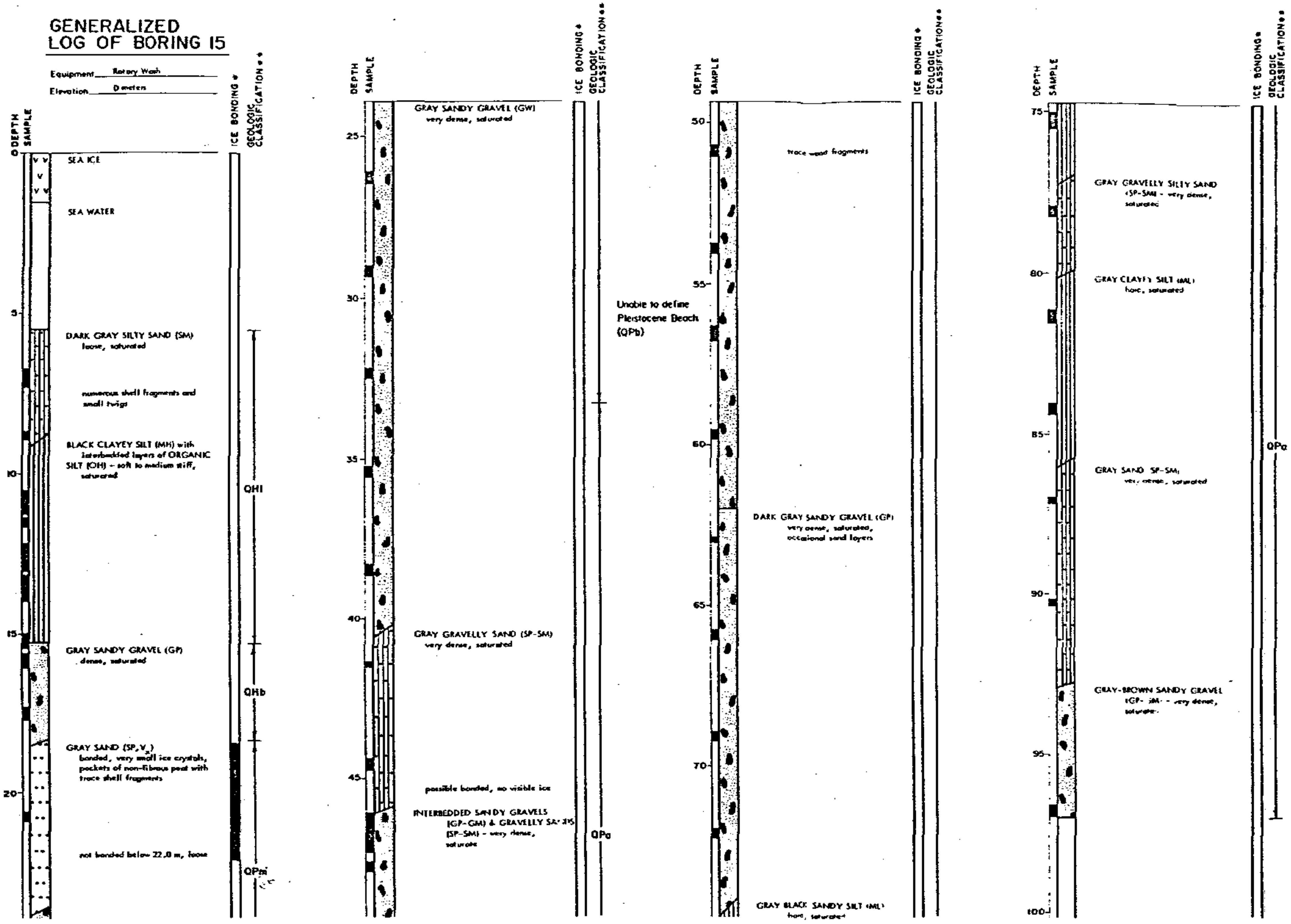
PLATE
A-1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DGB	4/82		

GENERALIZED LOG OF BORING 15



Reference:

Interpretation of Geophysical, Geologic and Engineering Data Beaufort Sea, Alaska, HLA 1979

* Refer to Plate A2L Bonding index
** Refer to Plate 11, Explanation of Geologic Map Symbols

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USGS/HLA Boring 15
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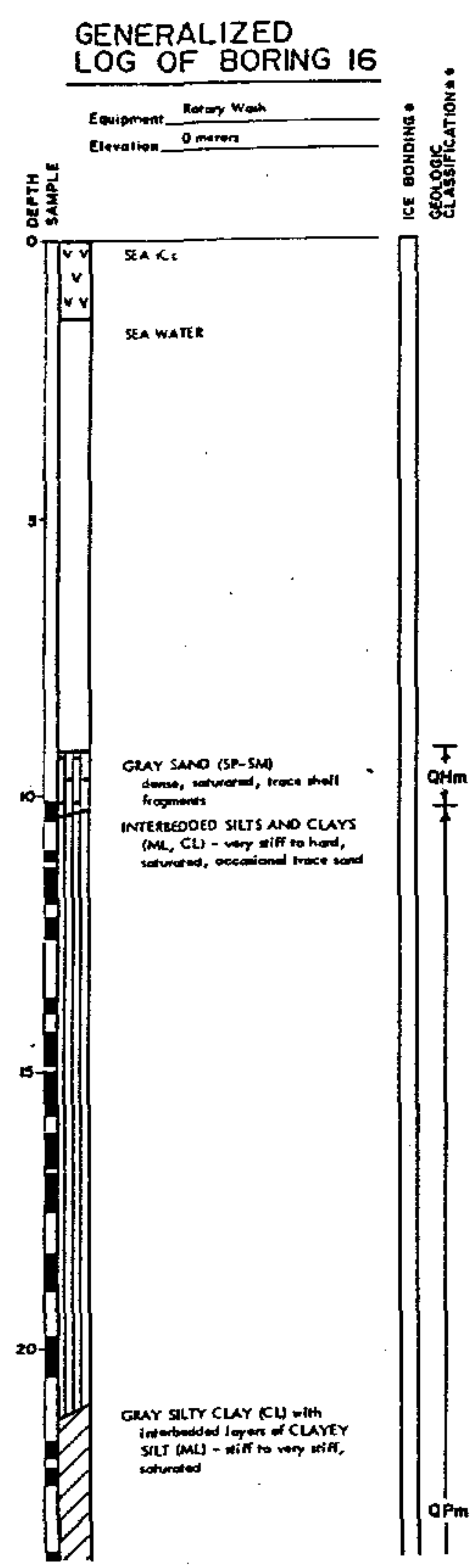
PLATE
A-2

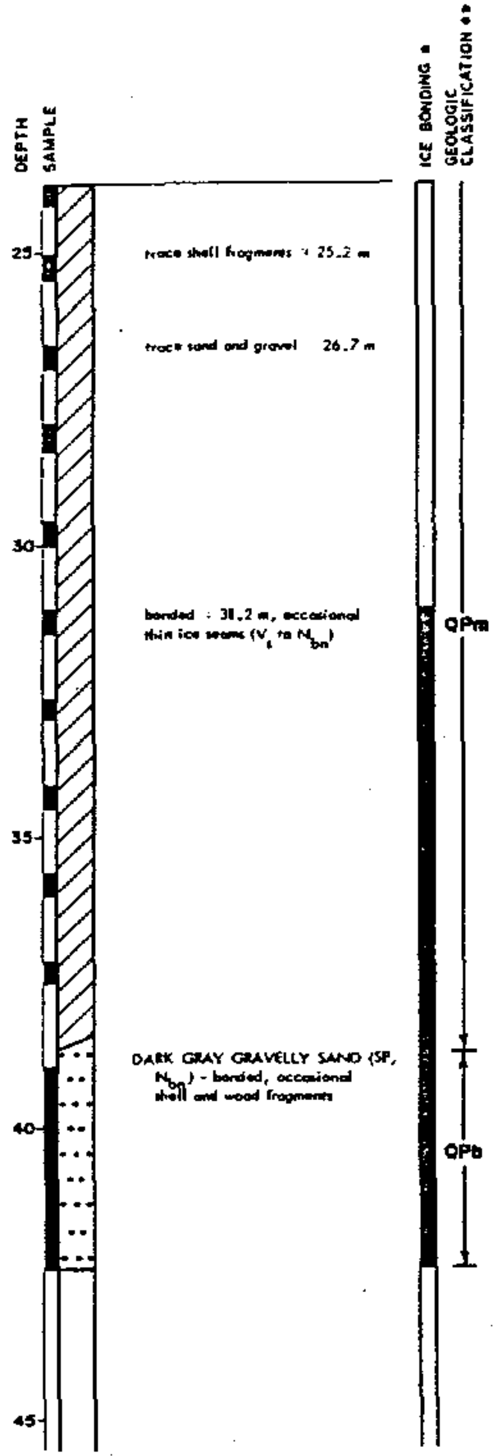
DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DEB	4/82		

GENERALIZED LOG OF BORING 16

Equipment Rotary Wash

Elevation 0 meters





Reference:

Interpretation of Geophysical, Geologic and Engineering Data Beaufort Sea, Alaska, HLA 1979

* Refer to Plate A21, Bonding index

** Refer to Plate II, Explanation of Geologic Map Symbols

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USGS/HLA Boring 16
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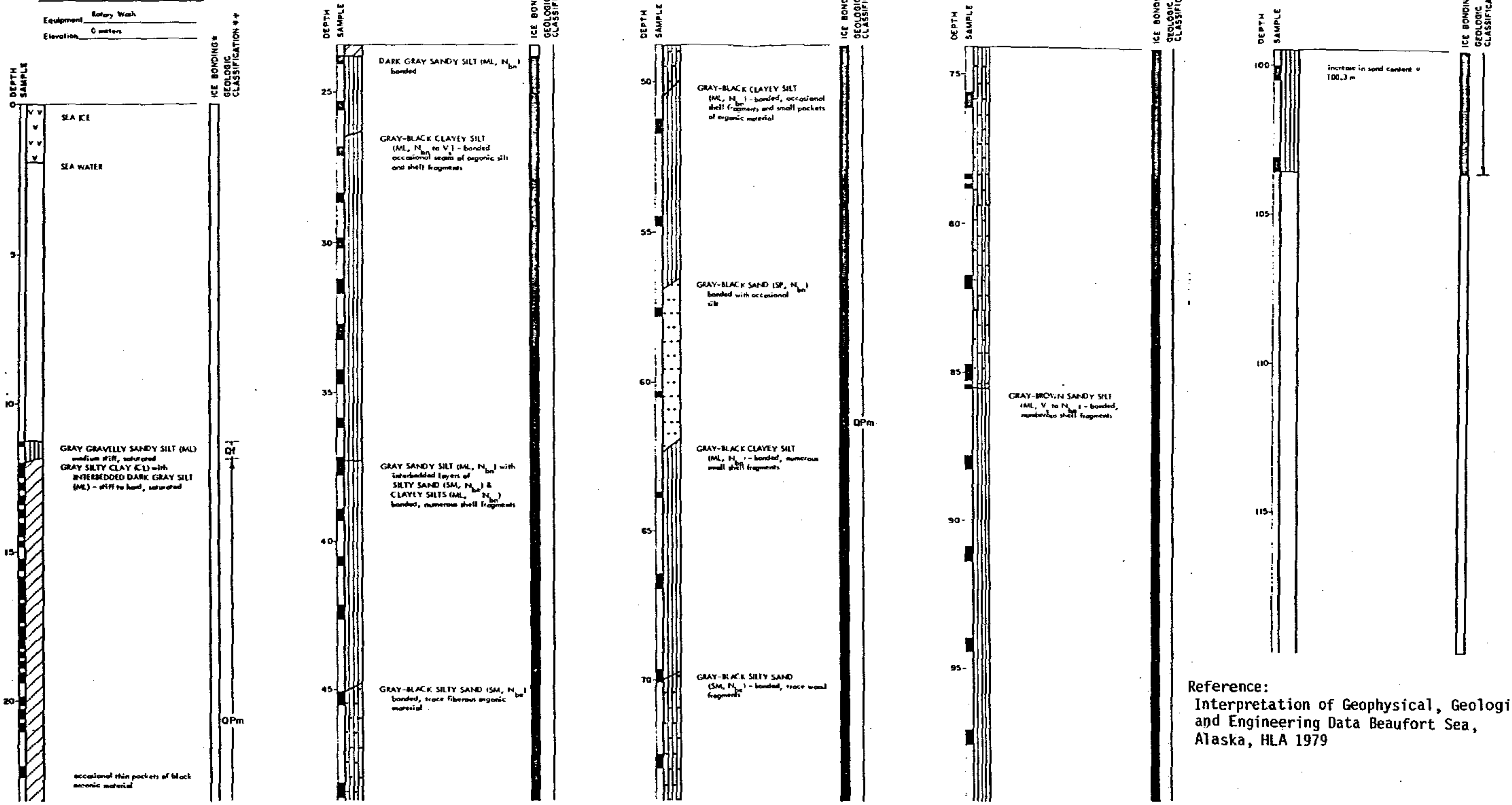
PLATE
A-3

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DAB	4/82		

GENERALIZED LOG OF BORING 18

Equipment Rotary Wash
Elevation 0 meters



Reference:
Interpretation of Geophysical, Geologic and Engineering Data Beaufort Sea, Alaska, HLA 1979

* Refer to Plate A21, Bonding index
** Refer to Plate 11, Explanation of Geologic Map Symbols

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USGS/HLA Boring 18
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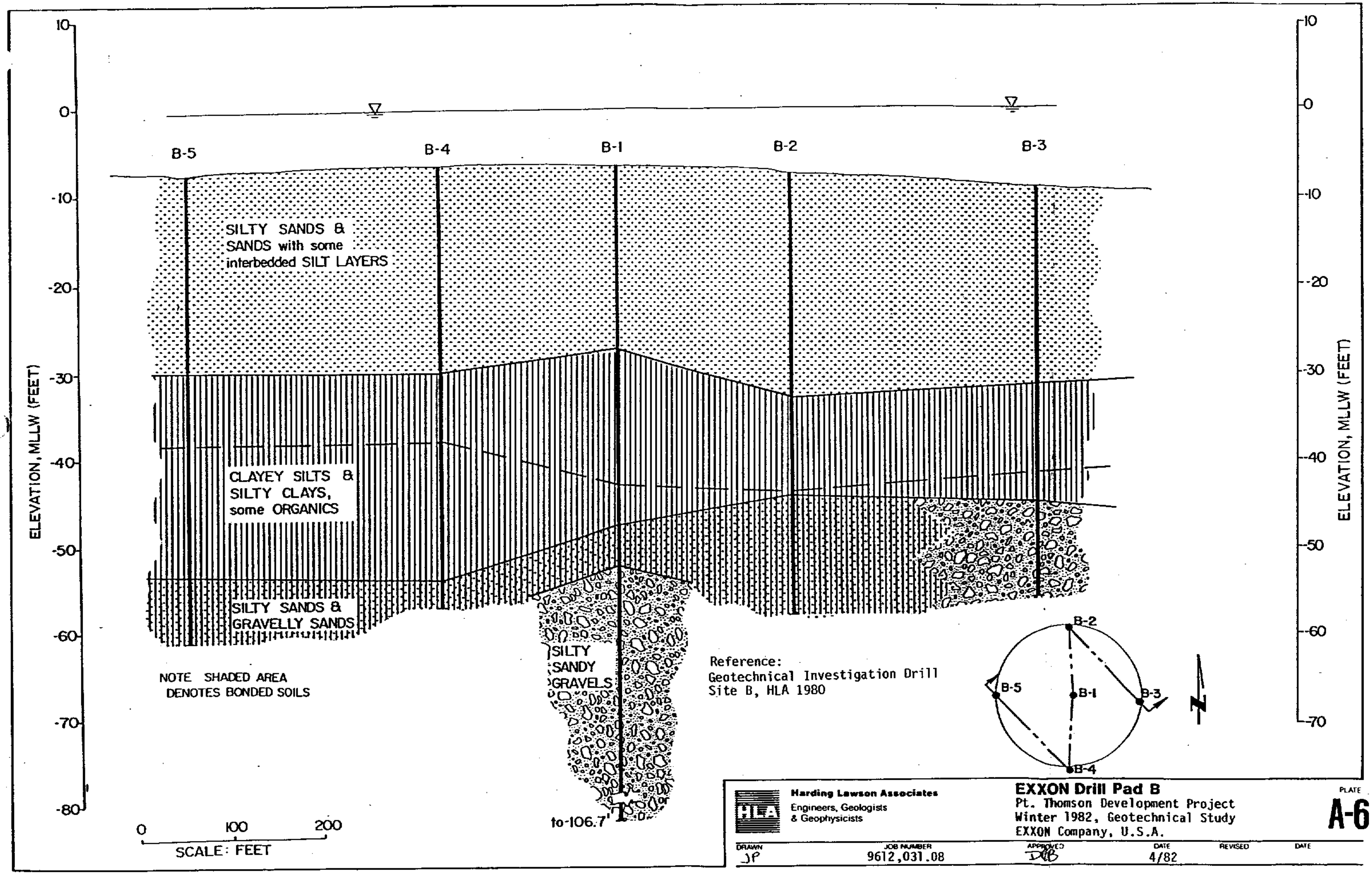
PLATE **A-5**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DGB	4/82		



NOTE SHADED AREA
DENOTES BONDED SOILS

Reference:
Geotechnical Investigation Drill
Site B, HLA 1980

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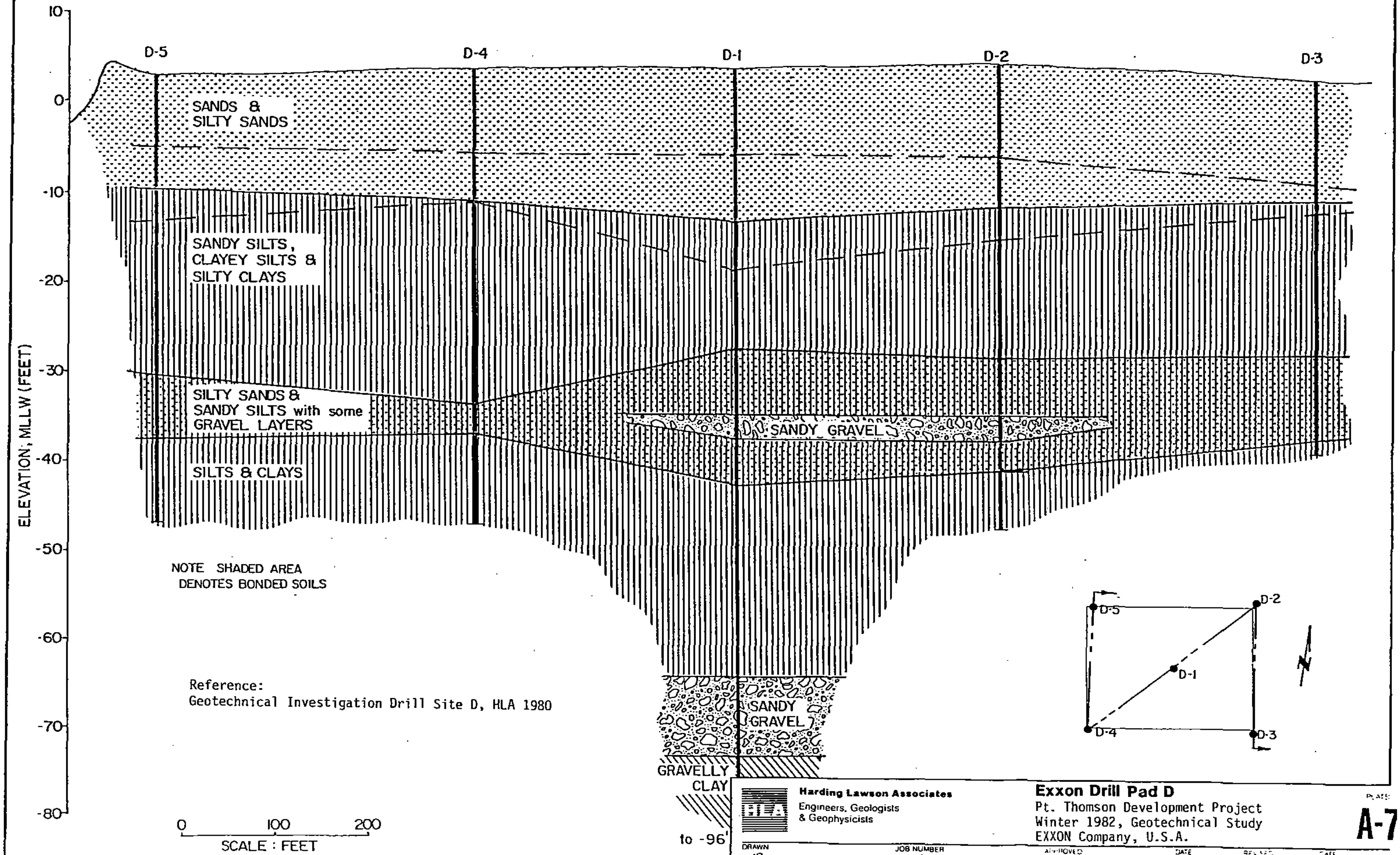
EXXON Drill Pad B
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
A-6

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08		4/82		



NOTE SHADED AREA DENOTES BONDED SOILS

Reference:
Geotechnical Investigation Drill Site D, HLA 1980

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Exxon Drill Pad D
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
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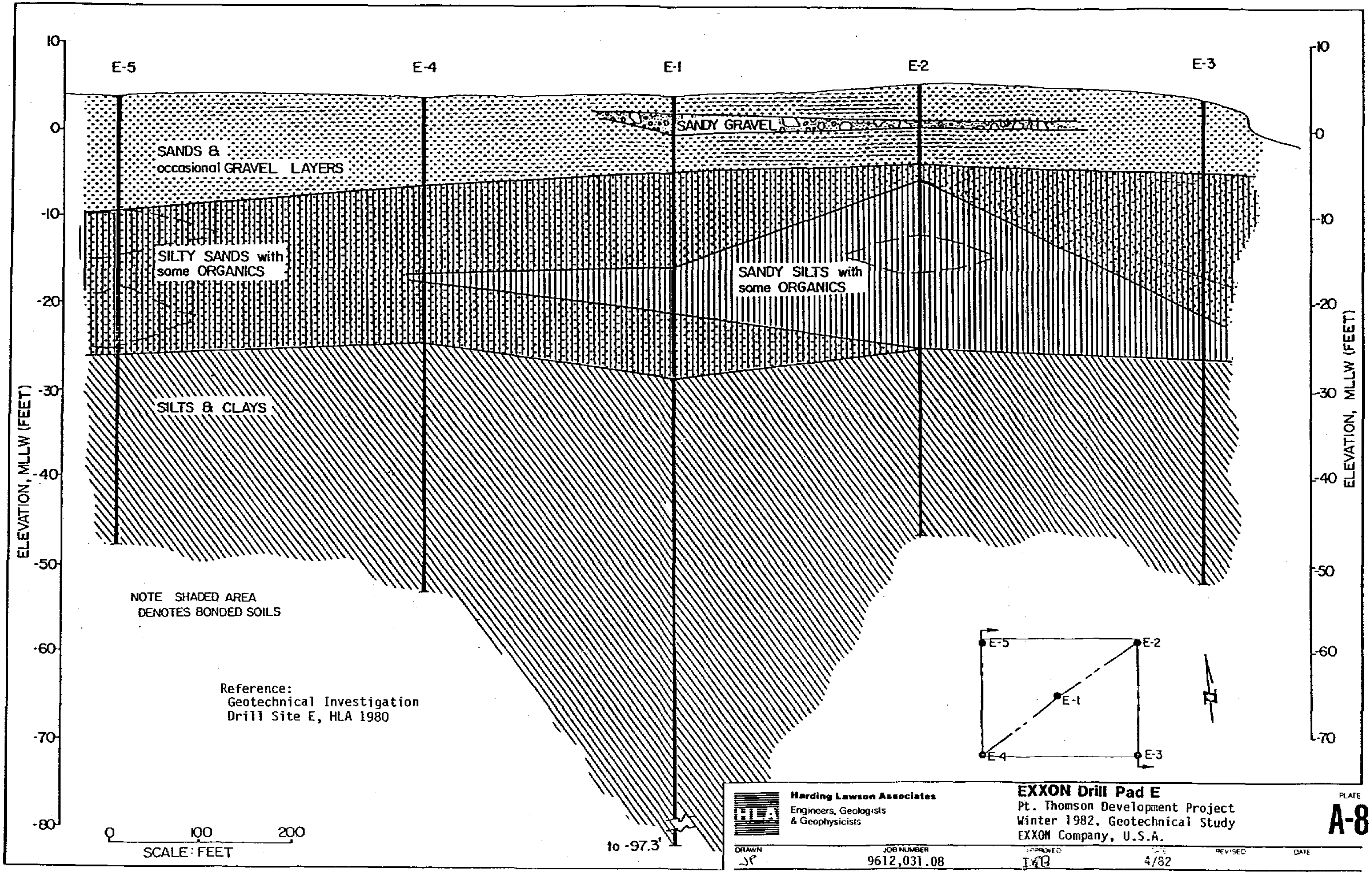
PLATE
A-7

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DB	4/82		



NOTE SHADED AREA
DENOTES BONDED SOILS

Reference:
Geotechnical Investigation
Drill Site E, HLA 1980

Harding Lawson Associates
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EXXON Drill Pad E
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
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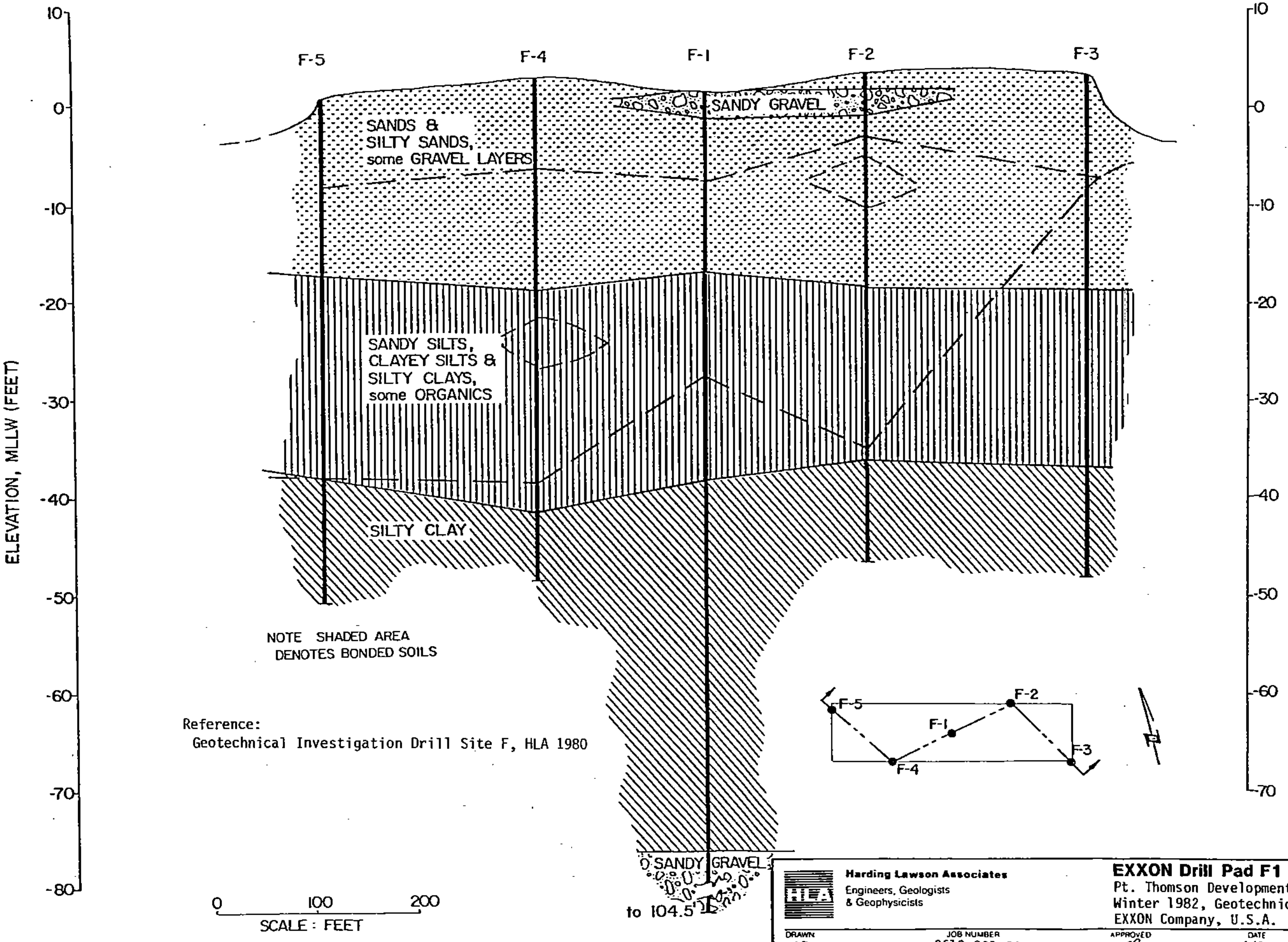
PLATE
A-8

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	TGB	4/82		



NOTE SHADED AREA
DENOTES BONDED SOILS

Reference:
Geotechnical Investigation Drill Site F, HLA 1980

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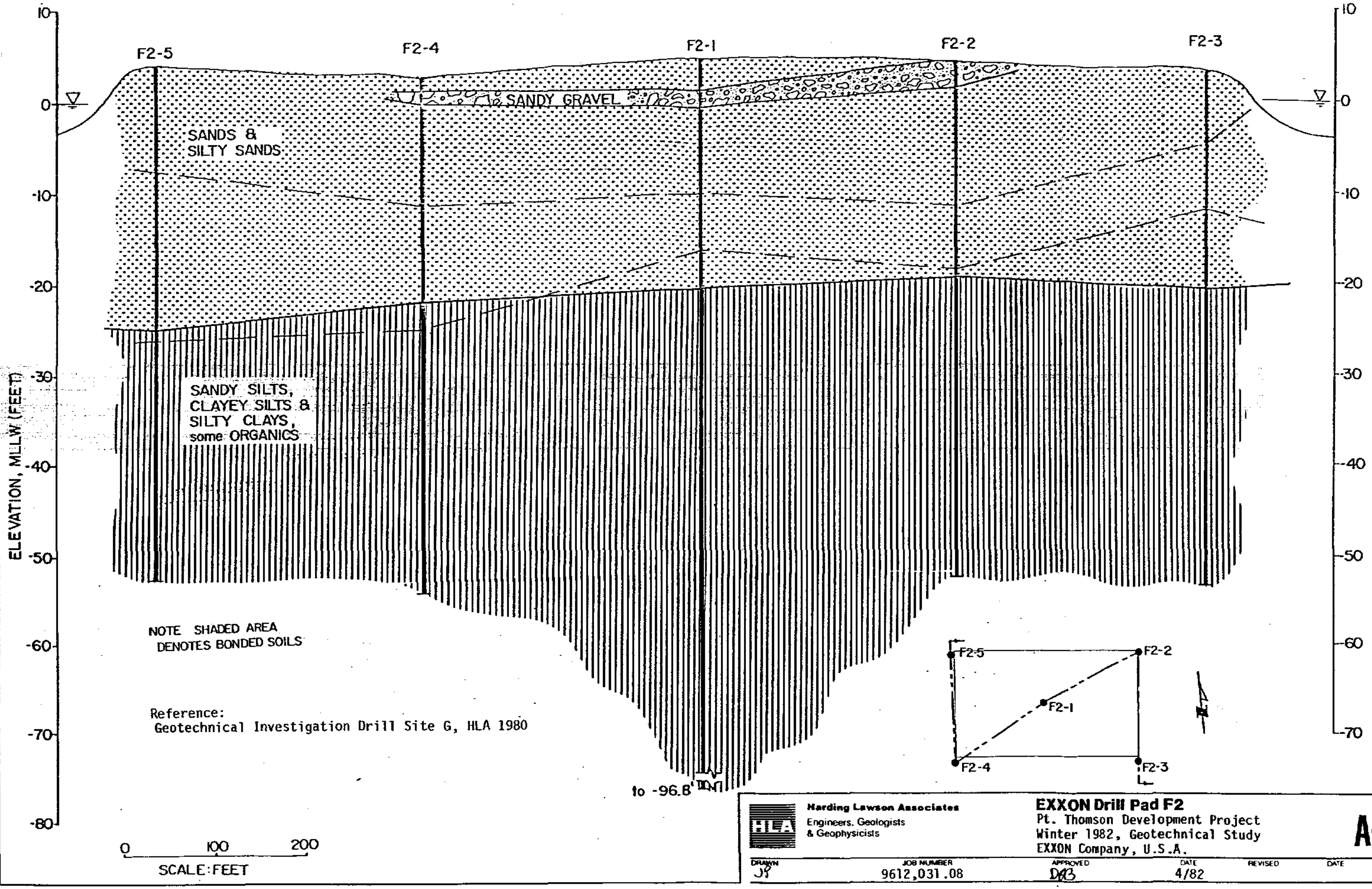
EXXON Drill Pad F1
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
A-9

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DAB	4/82		



NOTE SHADED AREA DENOTES BONDED SOILS

Reference:
Geotechnical Investigation Drill Site G, HLA 1980

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EXXON Drill Pad F2
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
A-10

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
JP	9612,031.08	DAB	4/82		

3. Drill Sites B, D, E, F1, F2 - Soil Investigation

These five sites were investigated in February and March, 1980 by HLA for Exxon Company, U.S.A. Several borings were drilled at each site. Generalized subsurface profiles of conditions encountered at each site are presented on Plates A-6 through A-10 and are described below.

a. Drill Site B

Drilling operations were conducted on the ice from February 29 through March 2, 1980. Five test borings were drilled at the locations shown on Plate A-6. Ice thickness at boring locations varied from 4.0 to 4.8 feet and the water depth (top of ice to mudline) ranged from 6.6 to 9.4 feet. The test borings ranged in depth from 47.0 to 100.3 feet below mudline. A generalized subsurface profile of the site is presented on Plate A-6.

The upper stratum extending from the mudline to a depth of 20 to 25 feet is a Holocene unit. This unit is comprised of sand, silty sand and thin interbedded layers of sandy and clayey silt. The sand is fine-grained and loose to medium dense. The silt layers are medium stiff and have medium plasticity.

A late Pleistocene stratum of silt and clay underlies the surficial Holocene deposit. This stratum extends to depths of 35 to 46 feet and ranges in thickness from 14 to 24 feet. The stratum contains occasional, discontinuous silty sand and gravel lenses, some organic silt layers, and occasional thin seams of peat. The silt and clay are overconsolidated and medium stiff to stiff.

The silt and clay are underlain by a glaciofluvial Pleistocene deposit of silty sand and gravel. This deposit extended to the depths penetrated by the borings.

At the time of our investigations, the soils were unbonded(*) from the mudline to depths ranging from 31 to 36 feet. Below these depths the soil is bonded.

The ground temperatures were measured in Boring B-1 using downhole thermistors. The ground temperatures measured approximately 44 hours after completion of the boring ranged from -1.6°C to -0.6°C.

b. <u>Drill Site D</u>

Drilling operations were conducted at the "D" site from March 3 through 6, 1980. The island is approximately 430 feet in width (bank-to-bank) at the proposed drill pad location. Surface elevations vary across the drill pad site from 2.6 to 4.3(**). Five test borings were drilled at the locations shown on Plate A-7 to depths of 41.5 to 100.0 feet. A generalized subsurface profile of the site is presented on Plate A-7.

A Holocene unit consisting of sand and silty sand extends from the ground surface to depths of 12 to 17 feet. The sand is fine to medium grained with occasional fine gravel and thin gravel lenses. The unbonded sand is medium dense to dense.

The surficial sand is underlain by a late Pleistocene deposit consisting predominantly of clayey silt with some silty clay layers. Generally, the silt and clay have medium plasticity and the unbonded soils are medium stiff to stiff. At depths ranging from 30 to 45 feet the silt and clay contain interbedded silty sand and gravel.

(*) "Unbonded" soil denotes soils which exhibit temperatures below 0°C but behave in a thawed manner due primarily to saline concentrations in the pore water. "Bonded" soil denotes soils which exhibit temperatures below 0°C and behave as an ice-cemented soil mass having frozen pore water.

(**) All elevations refer to feet above Mean Lower Low Water (MLLW).

In Boring D-1 sandy gravel, gravelly clay, and sand were encountered beginning at a depth of 68 feet and extending to the 100-foot depth penetrated by the boring.

At the time of our investigation the soils were bonded from the ground surface to depths ranging 8 to 11 feet. Underlying the surficial bonded soils is an unbonded zone ranging in thickness from 3 feet in Boring D-3 to 13 feet in Boring D-1. Ground-water seepage occurred in several of these unbonded zones. Beneath this zone the soils were bonded to a depth of approximately 79 feet. From 79 to 100 feet the soil was unbonded. The bonded soils encountered during our investigation are denoted on the boring logs and on the design and subsurface profiles.

The ground temperatures were measured in Borings D-1 and D-2 using down-hole thermistors. In Boring D-1 the ground temperatures, measured approximately 84 hours after the boring was completed, varied from -9.2°C at a depth of 5.7 feet to -2.5°C at a depth of 51.7 feet. In Boring D-2 the ground temperatures, measured approximately 71 hours after completion of the boring, varied from -13.3°C at a depth of 4.0 feet to -3.4°C at a depth of 49 feet.

c. Drill Site E

Drilling operations were conducted at the "E" site from March 6 through 8, 1980. At the proposed drill pad site the island varies in width (bank-to-bank) from approximately 480 to 600 feet. The surface elevation varies across the pad from 3.2 to 5.3 feet. Five test borings were drilled at the locations shown on Plate A-8 to depths of 51.5 to 101.5 feet. A generalized subsurface profile of the site is presented on Plate A-8.

The borings encountered Holocene deposits extending from the ground surface to depths of 28 to 33 feet. The surficial 9 to 13 feet of this deposit consists of fine to medium grained sand with occasional thin gravel layers in the upper five feet. The lower portion of the deposit consists of silty sand and sandy silt with some organics. The deeper sand is also fine to medium grained and the silt has a low plasticity.

The Holocene unit is underlain by late Pleistocene silt and clay which extend to the depths penetrated by the borings with the exception of a sand pocket or layer encountered in Boring E-1 at a depth of 86 feet.

In Borings E-1, E-3, and E-4 the subsurface soils were bonded from the ground surface to the depth penetrated by the borings. In Boring E-2 an unbonded zone was encountered from approximately 18 to 22 feet; seepage water was also encountered in this zone. In Boring E-5, unbonded zones were encountered from 13 to 18 feet and 22 to 29 feet.

The ground temperatures were measured in Boring E-1 using down-hole thermistors. The ground temperatures, measured approximately 50 hours after completion of the boring, varied from -19.4°C at the ground surface to -4.2°C at a depth of 50.5 feet.

d. Drill Site F

Drilling operations were conducted at the "F" site from March 9 through 12, 1980. The island is approximately 150 feet in width (bank-to-bank) at the proposed drill pad location. Surface elevations vary across the drill pad site from 0.9 to 4.9 feet. Five test borings drilled at the site ranged in depth from 50.0 to 104.5 feet at the locations shown on Plate A-9. A generalized subsurface profile of the site is presented on Plate A-9.

A Holocene unit consisting of sand and silty sand extends from the ground surface to a depth of approximately 20 feet. The sand is fine to medium grained and the unbonded sand is dense to very dense. A gravel layer 1.5 to 3.0 feet thick was encountered in the upper 5 feet of several test borings.

The sand is underlain by late Pleistocene deposits consisting of interbedded silt, clay and organic silt to a depth of approximately 40 feet, and gray silty clay below a depth of 40 feet. The silt and clay generally have medium to low plasticity and the unbonded materials are soft to medium stiff. The gray silty clay extended to the depths penetrated by Borings F-2 through F-5 and to a depth of 77 feet in Boring F-1. Below 77 feet and extending to the depth penetrated, Boring F-1 encountered a later to middle Pleistocene stratum of gray sandy silty gravel.

The surficial soils were bonded to depths of 6 to 10 feet. Beneath the surficial bonded zone, an unbonded zone was encountered. The thickness of the unbonded zone varied from 3 feet in Boring F-3 to 33 feet in Boring F-2.

The ground temperatures were measured in Boring F-1 using down-hole thermistors. The ground temperatures measured approximately 156 hours after completion of the boring ranged from $-21.1^{o}C$ at the ground surface to $-2.7^{o}C$ at a depth of 53 feet.

e. Drill Site F2

Drilling operations were conducted at the "F2" site from March 12 through 14, 1980. At the proposed drill pad location the width of the island varies from approximately 290 to 340 feet (bank-to-bank). Surface elevations vary across the drill pad site from 2.6 to 4.9 feet. Five test borings were drilled at the locations shown on Plate A-10 to depths of 56.5 to 101.5 feet. A generalized subsurface profile of the site is presented on Plate A-10.

A Holocene unit consisting of sand and silty sand extends from the ground surface to a depth of approximately 24 feet. The sand is fine to medium grained and medium dense in the unbonded zones. A thin gravel layer was encountered in the upper five feet of several of the borings.

Underlying the sand is late Pleistocene silt and clay. The silt has a plasticity ranging from low to medium, while the clay plasticity ranges from medium to high. The upper portion of the stratum contains some organics. The silt and clay extended to a depth of 90 feet in Boring F2-1 where a sandy gravel was encountered to the depth penetrated by the boring.

The surficial soils were bonded from the ground surface to depths of 8 to 16 feet. The bonded soils are underlain by an unbonded zone varying in thickness from 6 feet in Borings F2-1 to 16 feet in Boring F2-5. Below this zone the soils were bonded to the depth penetrated by the borings.

The ground temperatures were measured in Boring F2-5 using down-hole thermistors. The ground temperatures, measured approximately 28 hours after the boring was completed, ranged from -20.8^{o}C at the ground surface to -2.6^{o}C at a depth of 55.8 feet.

B. Onshore Soil Investigations

1. Gravel Study - Field Exploration and Laboratory Tests

This onshore study was performed in March, April and May 1980 by HLA for Exxon Company, U.S.A. The purpose of the study was to locate sources of gravel material which could be used as construction material. A total of 118 borings were drilled. Various laboratory tests were performed on samples recovered from the borings.

The test borings drilled in the Point Thomson area in general encountered a surficial layer of organic soil (peat). Beneath the organic soil, a thin layer of sandy silt and silty sand were generally present. Usually, the silt and silty sand were common in the three to six-foot depth range. Beneath the silt and silty sand, gravelly sand and sandy gravel with variable amounts of silt were encountered to the depths explored.

In general, the ice content was greatest in the borings between the 3-foot and 10-foot depth and decreased below 15 feet. Massive ice layers were encountered in the 3 to 15-foot range in 22 of the borings. Ground ice constituted as much as 50 percent of the total soil volume in the upper 10 to 15 feet where fine-grained soils, such as silt, were present.

2. Field Density Tests - Field construction observation of frozen gravel fill placement at three drill sites in the Point Thomson area

HLA performed testing in March and April, 1980 for Exxon Company, U.S.A. in the project area. Field density and water content tests were performed on frozen gravel hauled from the Point Thomson C-1 material source located as shown on Plate A-1. Test results indicate that this material had an average dry density of 70 pounds per cubic foot and a water (ice) content of 25 percent.

APPENDIX B
DRILLING INVESTIGATION

LIST OF TABLES

LIST OF ILLUSTRATIONS

APPENDIX B
DRILLING INVESTIGATION

A. Surveying

Besse, Epps & Potts of Anchorage, Alaska provided horizontal control for the test boring program using a Motorola Mini Ranger III system. This system includes a range console, a receiver/transmitter, two reference stations, and peripheral equipment for data recording and range computations. One surveyor assisted occasionally by HLA personnel completed the survey program.

1. Horizontal Control

The position of each test boring was fixed relative to the positions of benchmarks and known survey locations near the project area. Initially, battery-powered remote stations were established at these sites. The distance between each test boring and the various control points were determined using the Mini Ranger III system. Given these known distances, and using the method of resection, the locations and coordinates of the test borings were established.

As each remote station answers to interrogations from the range console, the two-way travel time of radar frequency pulses is used to compute the distance between points. The system is accurate to ± 3 meters for a station separation of up to 40 nautical miles. The measured distances are continuously displayed on LED read-outs on the range console. Additionally, the information is supplied to peripheral equipment that provides hard copy records of time and distance data and computes the XY coordinates of the station.

2. Survey Program

The survey program was conducted in three phases. During the first phase, remote stations were established at the five survey control points listed in Table B-1. In phase two, the test borings were located and staked. Test Borings 1 to 17, 21, and 22 were located with a helicopter-mounted range console prior to the commencement of the drilling program. The remaining four sites, Test Borings 18, 19, 20, and 23, were established using the range console and data recording system mounted in a Rolligon. The final phase of the program involved determining the as-drilled locations of the test borings. The Rolligon-mounted unit was used to determine these locations, which are summarized in Table B-2.

TABLE B-1. UTM ZONE 6 COORDINATES FOR THE SURVEY CONTROL POINTS

Control Point	East (X, feet)	North (Y, feet)
Hopson	1 699 321.65	25 542 594.67
Nygren	1 741 125.23	25 532 682.12
Thin	1 694 111.09	25 563 542.99
Point Thomson 4	1 688 925.76	25 543 214.63
Point Thomson 3	1 733 219.53	25 541 585.22

TABLE B-2. AS-DRILLED UTM ZONE 6 COORDINATES

Test Boring	East (X, feet)	North (Y, feet)
1	1 672 981	25 541 221
2	1 670 030	25 565 015
3	1 685 051	25 544 025
4	1 687 992	25 558 492
5	1 695 221	25 563 165
6	1 695 409	25 551 822
7	1 699 991	25 538 242
8	1 702 499	25 546 772
9	1 702 473	25 558 836
10	1 709 962	25 562 119
11	1 709 919	25 552 762
12	1 710 000	25 542 511
13	1 722 914	25 540 930
14	1 722 995	25 551 633
15	1 725 699	25 559 893
16	1 733 529	25 562 005
17	1 733 344	25 546 035
18	1 730 229	25 534 749
19	1 747 696	25 552 953
20	1 739 000	25 541 749
21	1 705 180	25 566 788
22	1 677 694	25 551 551
23	1 763 017	25 548 668

B. Offshore Drilling Investigation

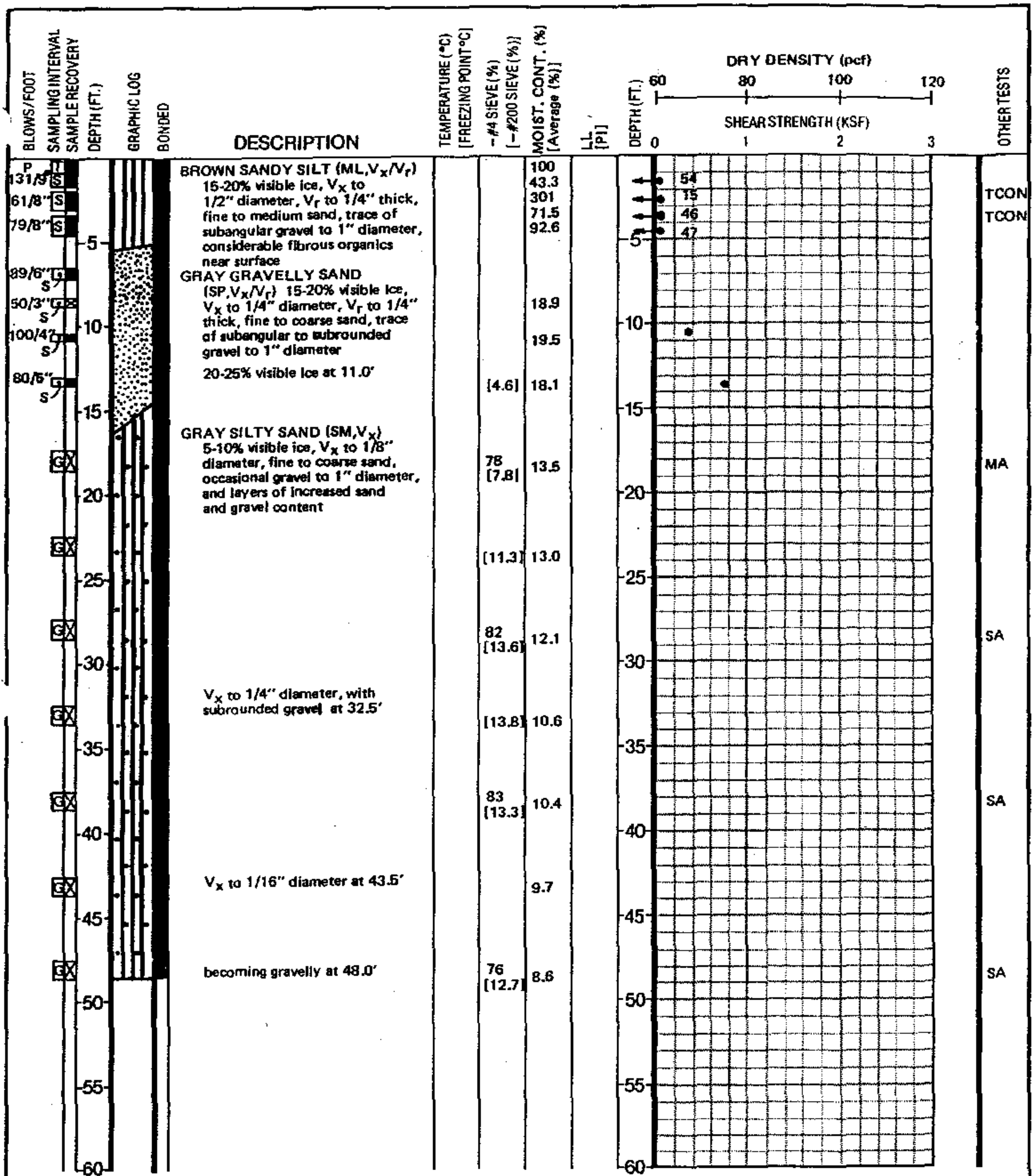
The soil conditions within the offshore area were investigated between March 3 and March 15, 1982 by drilling 18 test borings, ranging in depth from 25 to 80 feet. Additionally, pipe for ground temperature monitoring was installed in five test borings, as described in Appendix C.

The locations of the offshore test borings are shown on Plate II-2; the test boring logs are presented as Plates B-1 through 23 with the explanation of the symbols used on the test boring logs presented on Plate B-24.

HLA personnel involved in the offshore drilling included a geologist, a soil engineer, a drilling foreman, two drillers, and two drill helpers. Two drill crews, consisting of a geologist or engineer, a driller, and a drill helper, worked alternate 12-hour shifts to maintain around-the-clock drilling. The engineer or geologist directed the drilling operation, logged the soils encountered, and obtained representative samples for laboratory testing. The drilling foreman served as a Cat operator, back-up driller and a mechanic.

The offshore test borings were drilled using a sled-mounted Mobile Drill B-61 that was fully enclosed in a heated and insulated framed structure. The drill rig was equipped with casing, drill rods, and a mud pump for rotary wash rilling. Additionally, eight-inch O.D. hollow stem auger and a mud pit were available. Extra support equipment, including a 5 kw generator and a survival shed, was mounted on a support sled.

A Rolligon with a water-shack and driver was provided by Crowley All-Terrain Corporation (CATCO) to support the drilling operations. The Rolligon was used to transport crews, drag trails, and carry the surveying equipment.



DESCRIPTION

BROWN SANDY SILT (ML,V_x/V_r)
15-20% visible ice, V_x to 1/2" diameter, V_r to 1/4" thick, fine to medium sand, trace of subangular gravel to 1" diameter, considerable fibrous organics near surface

GRAY GRAVELLY SAND (SP,V_x/V_r) 15-20% visible ice, V_x to 1/4" diameter, V_r to 1/4" thick, fine to coarse sand, trace of subangular to subrounded gravel to 1" diameter

20-25% visible ice at 11.0'

GRAY SILTY SAND (SM,V_x)
5-10% visible ice, V_x to 1/8" diameter, fine to coarse sand, occasional gravel to 1" diameter, and layers of increased sand and gravel content

V_x to 1/4" diameter, with subrounded gravel at 32.5'

V_x to 1/16" diameter at 43.5'

becoming gravelly at 48.0'

−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	OTHER TESTS
	100	
	43.3	
	301	TCON
	71.5	TCON
	92.6	
	18.9	
	19.5	
[4.6]	18.1	
78 [7.8]	13.5	MA
[11.3]	13.0	
82 [13.6]	12.1	SA
[13.8]	10.6	
83 [13.3]	10.4	SA
	9.7	
76 [12.7]	8.6	SA

UTM Coordinates: N 25 541 221
E 1 672 981

Water Depth: ---

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲ —Torvane
△ — Compression Test

HLA

Date Completed: 3-5-82
Logged By: P.J. Ondra

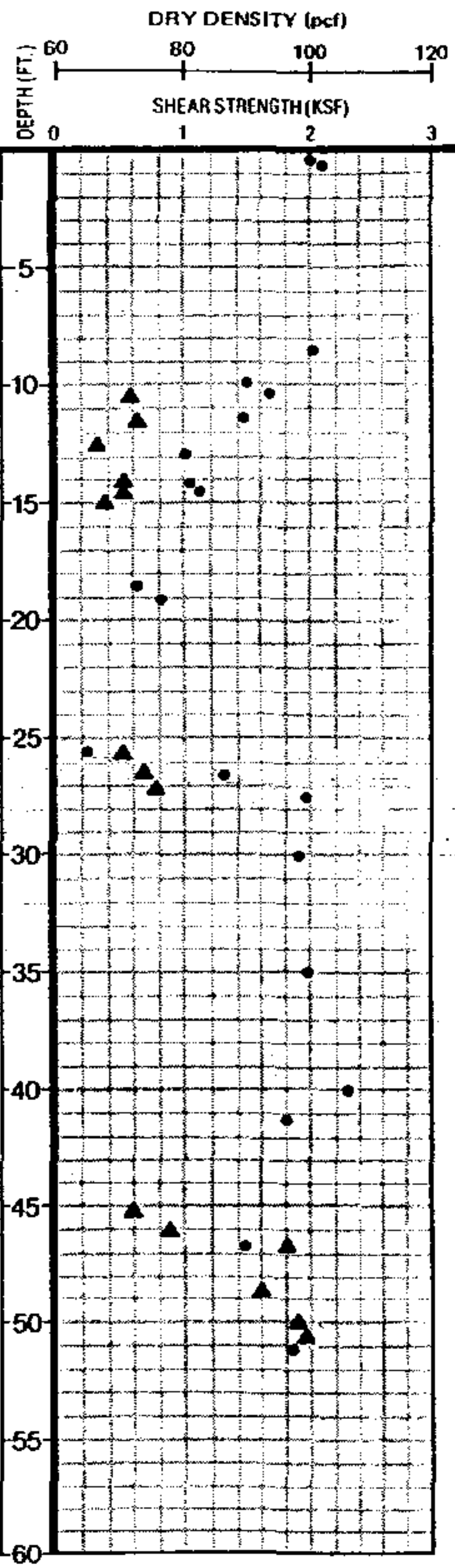
Job Number: 9612,031.08

Approved: DEB
Date: 4-82

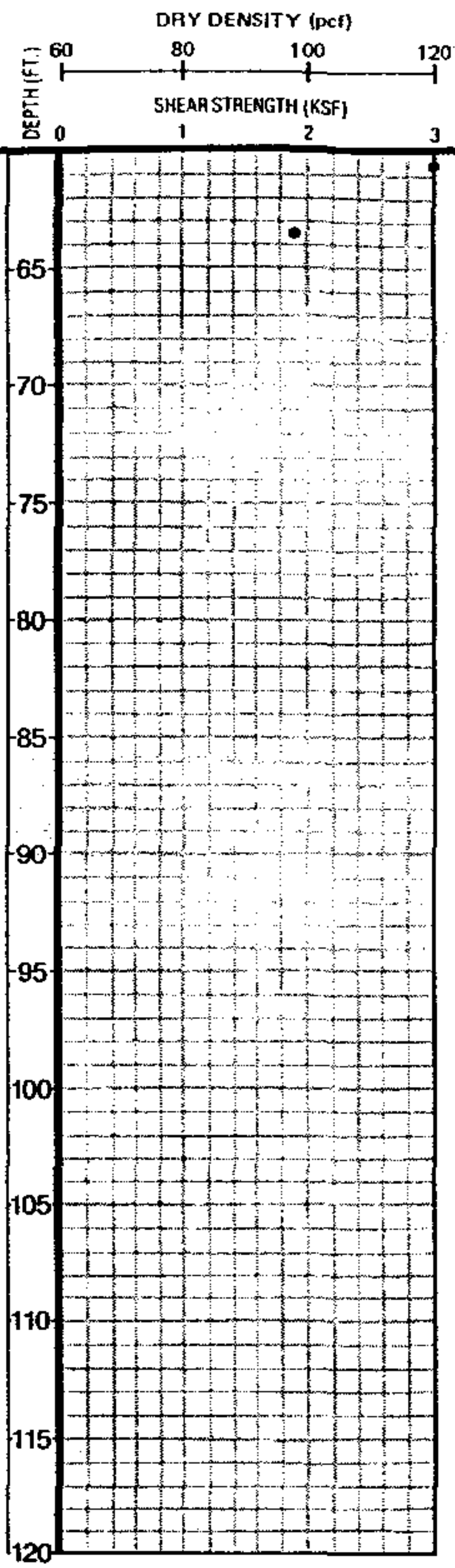
LOG OF BORING NO. 1
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-1

BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	– #4 SIEVE (%) [– #200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
P	T		**GRAY SAND (SP)** loose, medium to fine sand, occasional rounded gravels to 1-1/2" diameter, and increasing silt content with depth	[-2.1]	[2.3]	[22.8]		CON
								MA
				[-1.9]	89			
P	T			[-2.0]	[13.5	23.0		CD,EC
					[3.9]	22.8		SA,EC
		5			[10.9]			CHEM
P	T							EC,SA
18	S							
5	S		**DARK GRAY CLAYEY SILT (ML)** soft to medium stiff, with occasional fine sand and gravel, and a trace of organics	[-2.1]		[26.3]	NP	EC
								CON
		10		[-1.9]	[84.4]	[30.3]		CD
P	T					32.5		EC,MA
								CD
						38.6		CD
P	T							UU
		15		[-1.6]		[35.7]		CON
								EC
								UU
P	T							
				[-1.2]		[50.1]		EC
1	S			[-1.4]		[44.3]		EC
		20						
		25				55.5		
P	S		**GRAY SILTY SAND (SM)** loose to medium dense, fine sand		[92.6]	29.0		SA
						23.4		
36	S	30	**GRAY SANDY SILT (ML)** very stiff, with very fine sand	[-1.4]		16.0		EC
						15.0		
22	S	35	color becoming darker at 35.0'			26.3		
		40		[-1.2]		21.2		CU
P	T					8.2		EC
						21.1		CU
						26.3		CU
		45						
P						32.5		UU
P	T	50	occasional gravel to 3/8" diameter and fibrous organics to 3/8" long at 51.0'			26.0		UU
P	T	55	**GRAY SILTY SAND (SM)** medium dense, with occasional fibrous organics and gravel to 1/2" diameter					
		60						



BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	– #4 SIEVE (%) [– #200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
23/9"	S			[-2.0]	90	13.0		EC
					[30.7	14.8		SA
			GRAY SANDY GRAVEL (GP) very dense, occasional gravel to 1-1/4" diameter, with interbedded layers of sand					
		65		[-2.0]	[1.8]	17.7		EC
79	Ss					9.1		
		70						
		75						
		80						
		85						
		90						
		95						
		100						
		105						
		110						
		115						
		120						



UTM Coordinates: N 25 565 015
E 1 670 030

Water Depth: 12.3'

Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH

▲ — Torvane

△ — Compression Test

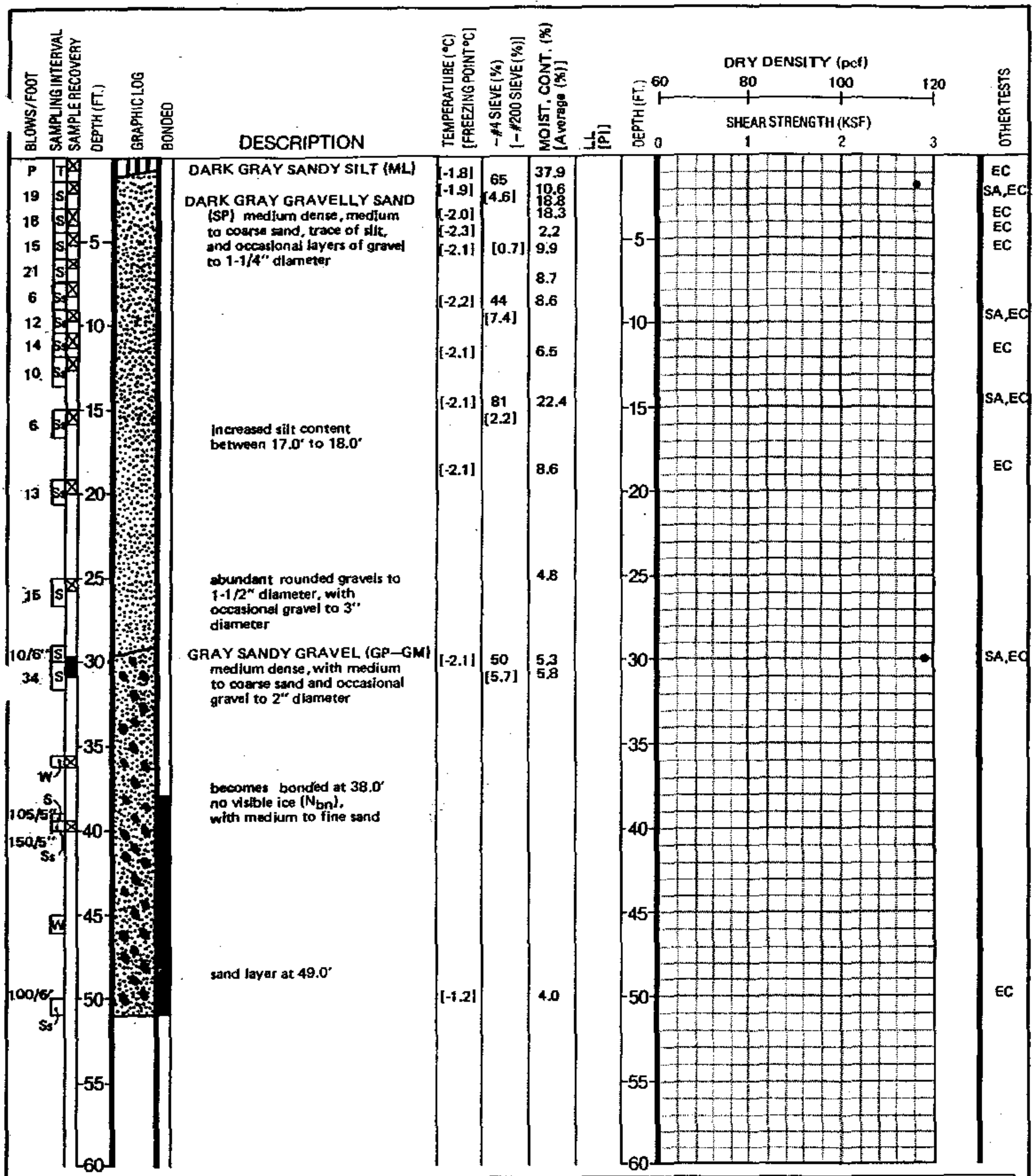
HLA

Date Completed: 3-7-82
Logged By: M.R. Musial
R.H. Prescott
Job Number: 9612,031.08

Approved: PEB
Date: 4-82

LOG OF BORING NO. 2
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-2



BLOWS/FOOT	SAMPLING INTERVAL / SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	OTHER TESTS
P	T		DARK GRAY SANDY SILT (ML)	[-1.8]	65	37.9	EC
19	S		DARK GRAY GRAVELLY SAND (SP) medium dense, medium to coarse sand, trace of silt, and occasional layers of gravel to 1-1/4" diameter	[-1.9]	[4.6]	10.6 18.8	SA,EC
18	S			[-2.0]		18.3	EC
				[-2.3]		2.2	EC
15	S	5		[-2.1]	[0.7]	9.9	EC
21	S					8.7	
6	S			[-2.2]	44	8.6	
12	S	10			[7.4]		SA,EC
14	S			[-2.1]		6.5	EC
10	S						
		15		[-2.1]	81 [2.2]	22.4	SA,EC
6	S		increased silt content between 17.0' to 18.0'				
				[-2.1]		8.6	EC
13	S	20					
		25	abundant rounded gravels to 1-1/2" diameter, with occasional gravel to 3" diameter			4.8	
15	S						
10/6"	S		GRAY SANDY GRAVEL (GP—GM) medium dense, with medium to coarse sand and occasional gravel to 2" diameter	[-2.1]	50 [5.7]	5.3 5.8	SA,EC
34	S	30					
	W	35					
105/5"	S		becomes bonded at 38.0' no visible ice (N_{bn}), with medium to fine sand				
150/5"	Ss	40					
	W	45					
			sand layer at 49.0'				
100/6"	Ss	50		[-1.2]		4.0	EC
		55					
		60					

UTM Coordinates: N 25 544 025
E 1 685 051

Water Depth: 5.8'

Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

HLA

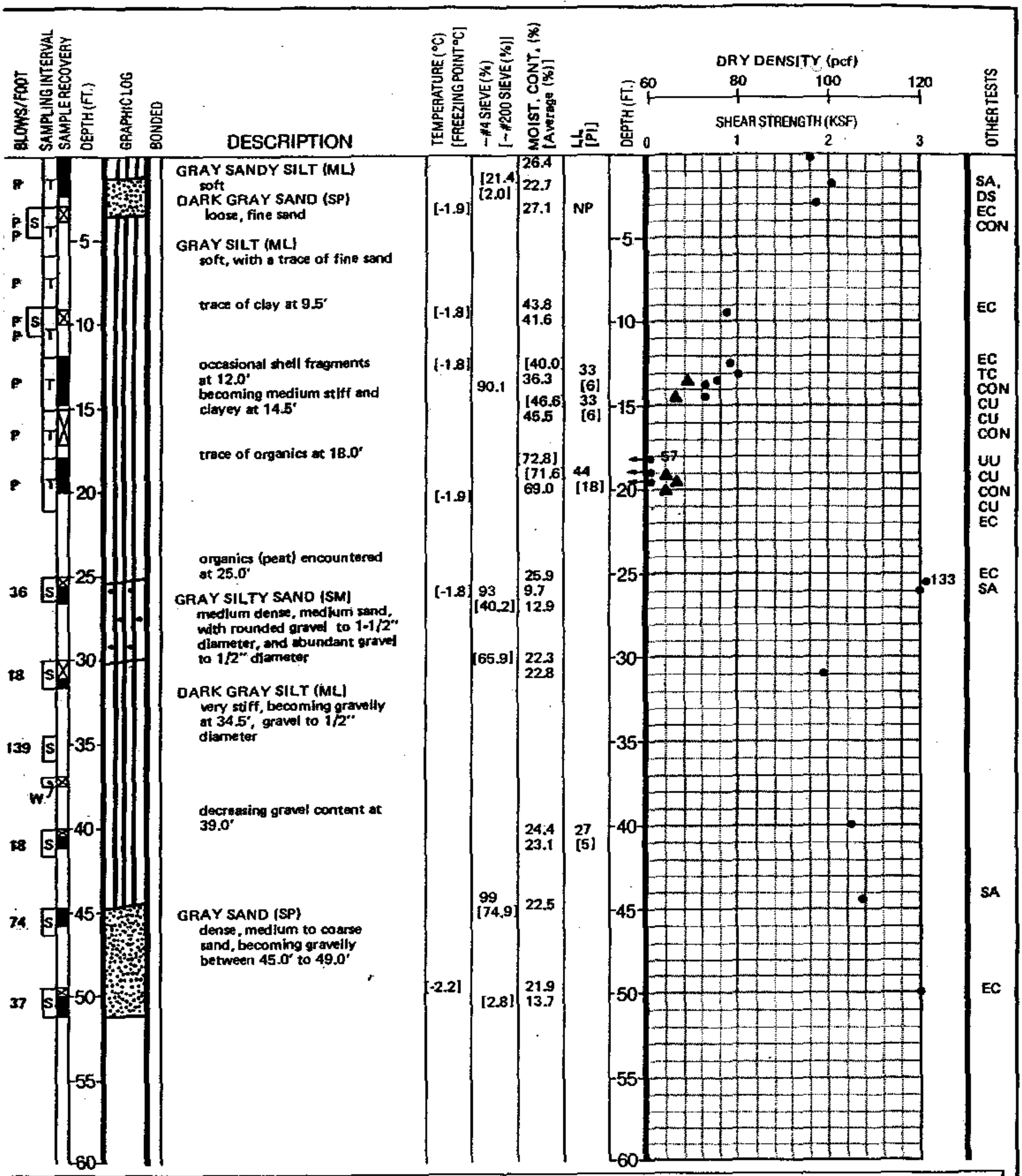
Date Completed: 3-5-82
Logged By: M.R. Musial
R.H. Prescott

Job Number: 9612,031.08

Approved: DEB
Date: 4-82

LOG OF BORING NO. 3
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-3



BLOWS/FOOT	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
P	GRAY SANDY SILT (ML) soft		[21.4] [2.0]	26.4 22.7		SA, DS EC CON
P P	DARK GRAY SAND (SP) loose, fine sand	[-1.9]		27.1	NP	
P	GRAY SILT (ML) soft, with a trace of fine sand					
P P	trace of clay at 9.5'	[-1.8]		43.8 41.6		EC
P	occasional shell fragments at 12.0' becoming medium stiff and clayey at 14.5'	[-1.8]	90.1	[40.0] 36.3 [46.6] 45.5	33 [6] 33 [6]	EC TC CON CU CU CON
P P	trace of organics at 18.0'	[-1.9]		[72.8] [71.6] 69.0	44 [18]	UU CU CON CU EC
36	organics (peat) encountered at 25.0' GRAY SILTY SAND (SM) medium dense, medium sand, with rounded gravel to 1-1/2" diameter, and abundant gravel to 1/2" diameter	[-1.8]	93 [40.2]	25.9 9.7 12.9		EC SA
18			[65.9]	22.3 22.8		
139	DARK GRAY SILT (ML) very stiff, becoming gravelly at 34.5', gravel to 1/2" diameter					
18	decreasing gravel content at 39.0'			24.4 23.1	27 [5]	
74	GRAY SAND (SP) dense, medium to coarse sand, becoming gravelly between 45.0' to 49.0'		99 [74.9]	22.5		SA
37		[-2.2]	[2.8]	21.9 13.7		EC

UTM Coordinates: N 25 558 492
E 1 687 992

Water Depth: 11.8'

Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-7-82
Logged By: M.R. Musial
R.H. Prescott

Approved: DEB
Date: 4-82

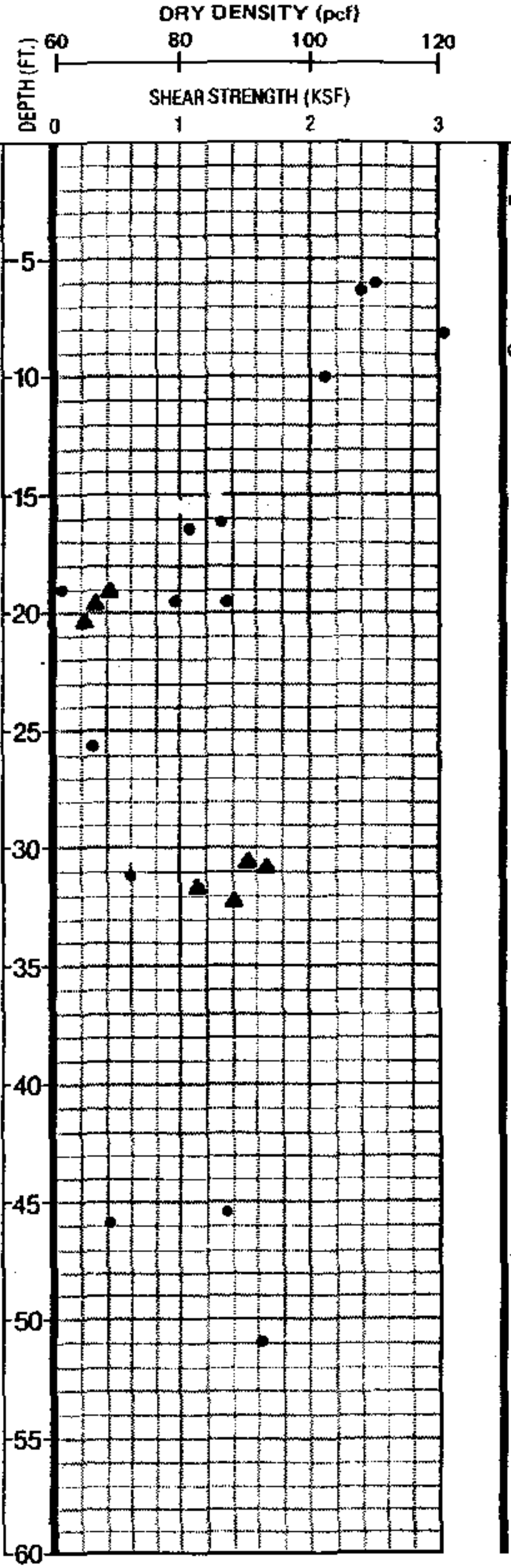
Job Number: 9612,031.08

LOG OF BORING NO. 4

Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-4

BLOWS/FOOT	SAMPLING INTERVAL	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
180 113 25	Ss Ss Ss	5	**BROWN GRAVELLY SAND** (SP-SM,V_x/V_c) up to 5% visible ice, occasional subrounded gravel to 3/4" diameter	-19.4 [-2.5] [-2.2] -12.9 [-1.0] -11.6	86 [9.6 [3.5]	27.1 16.2 14.0 36.4		EC. SA CHEM EC
23 -18	S S		**GRAY SILTY SAND** (SM,N_f/N_{bn}) fine sand	[-4.0] -10.1 [-5.0]	[22.0	18.0 18.3 18.9 13.5		EC EC CHEM
19 10	S S	10	**BROWN GRAVELLY SAND (SP)** medium dense, abundant rounded to subrounded fine gravel	-9.0 [-0.8] -7.6	[1.1]	6.9 6.2		EC
P P 11 P	S T S T	15 20	**DARK GRAY SILT (ML)** soft to medium stiff, with a trace of gravel and occasional lenses of organic silt clay seam at 19.0'	-6.6 [-3.4] [-0.7] -6.1 -5.9 [-3.2]		33.0 34.8 52.0 35.5 39.5 36.6 42.3	31 [10]	EC EC UU TC CON
	W							
P P	S T	25	V_r to 1/4" diameter and a trace of clay at 26.0'	-6.0		52.4		
P	T	30	Vs/Vx with occasional gravel to 1-1/2" diameter at 30.0'	-6.1 [-1.7]		43.6 46.3		EC
P	T	35	**GRAY SILTY CLAY** (CL,N_{bn})	-6.1				
P	T	40		-6.1				
P	S T	45	V_r to 1/16" thick at 45.5'	-6.0 [-1.1]	[98.4] [99.0]	41.9 33.6 36.2		EC TCON MA TCON MA
D	T	50		-5.9 [-1.6]		27.0 28.8		EC
		55 60	Temperature measurements recorded on 4-17-82					



SHEAR STRENGTH

▲—Torvane

△—Compression Test

UTM Coordinates: N 25 563 165
E 1 695 221

Water Depth: 3.5'

Equipment: Mobile B-61, Rotary Wash

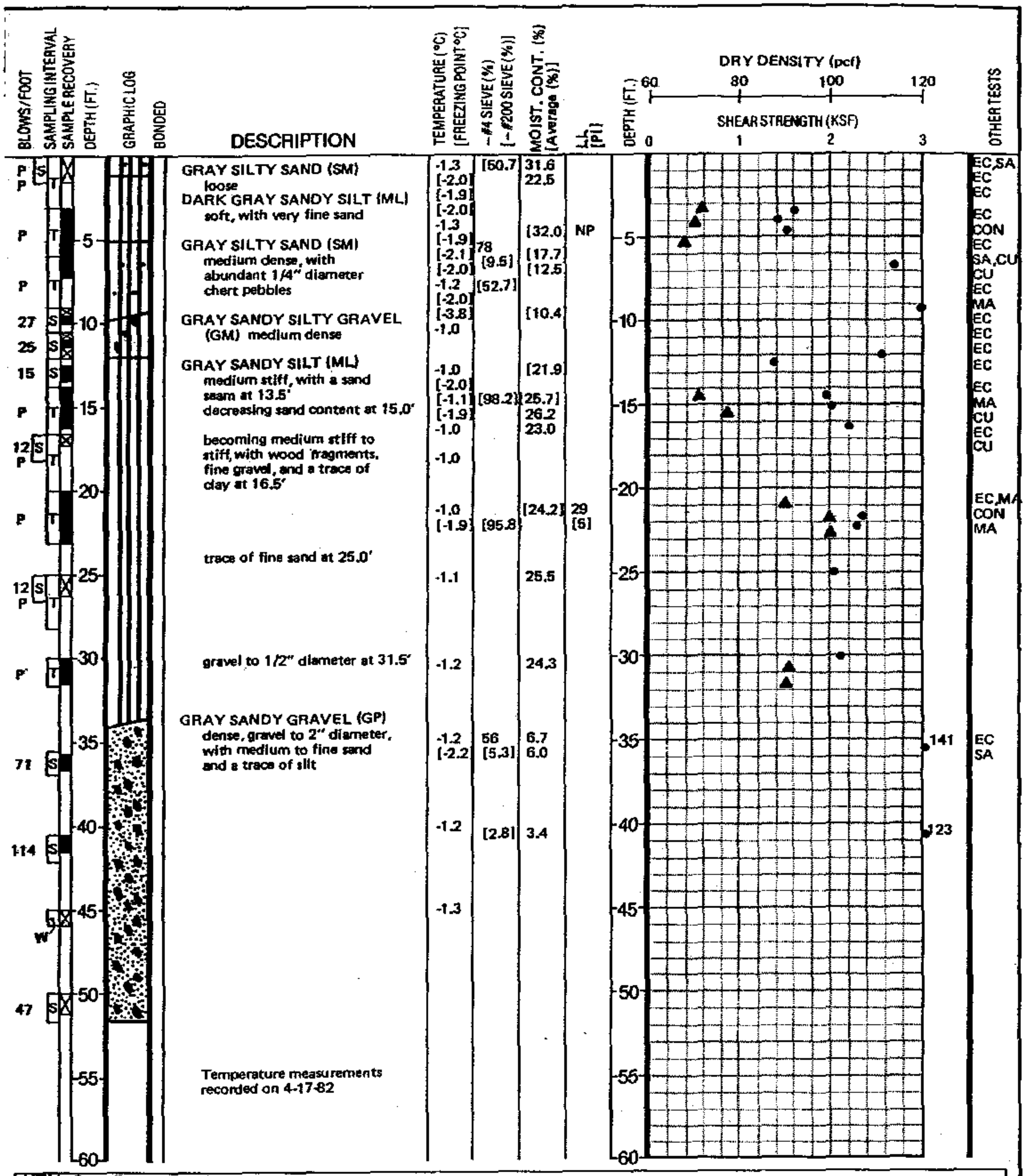
Date Completed: 3-8-82
Logged By: M.R. Musial
R.H. Prescott

Job Number: 9612,031.08

Approved: DEB
Date: 4-82

LOG OF BORING NO. 5
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-5



BLOWS/FOOT	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	–#4 SIEVE (%) [–#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	L.L. [PI]	OTHER TESTS
P	GRAY SILTY SAND (SM)	-1.3	[50.7	31.6		EC,SA
P	loose	[-2.0]		22.5		EC
	DARK GRAY SANDY SILT (ML)	[-1.9]				EC
	soft, with very fine sand	[-2.0]				EC
		-1.3		[32.0]	NP	CON
P		[-1.9]				EC
	GRAY SILTY SAND (SM)	[-2.1]	78	[17.7]		SA,CU
	medium dense, with	[-2.0]	[9.5]	[12.5]		CU
	abundant 1/4" diameter					
P	chert pebbles	-1.2	[52.7]			EC
		[-2.0]				MA
27	GRAY SANDY SILTY GRAVEL	[-3.8]		[10.4]		EC
	(GM) medium dense	-1.0				EC
25						EC
15	GRAY SANDY SILT (ML)	-1.0		[21.9]		EC
	medium stiff, with a sand	[-2.0]				EC
	seam at 13.5'	[-1.1]	[98.2]	[25.7]		MA
P	decreasing sand content at 15.0'	[-1.9]		26.2		CU
		-1.0		23.0		EC
	becoming medium stiff to					CU
12	stiff, with wood fragments,	-1.0				
P	fine gravel, and a trace of					
	clay at 16.5'					
						EC,MA
		-1.0		[24.2]	29	CON
P		[-1.9]	[95.8]		[5]	MA
	trace of fine sand at 25.0'					
		-1.1		25.5		
12						
P						
	gravel to 1/2" diameter at 31.5'	-1.2		24.3		
P'						
	GRAY SANDY GRAVEL (GP)					
	dense, gravel to 2" diameter,	-1.2	56	6.7		EC
	with medium to fine sand	[-2.2]	[5.3]	6.0		SA
71	and a trace of silt					
		-1.2	[2.8]	3.4		
114						
		-1.3				
W						
47						
	Temperature measurements recorded on 4-17-82					

UTM Coordinates: N 25 551 822
E 1 695 409
Water Depth: 16.2'
Equipment: Mobile B-61, Rotary Wash

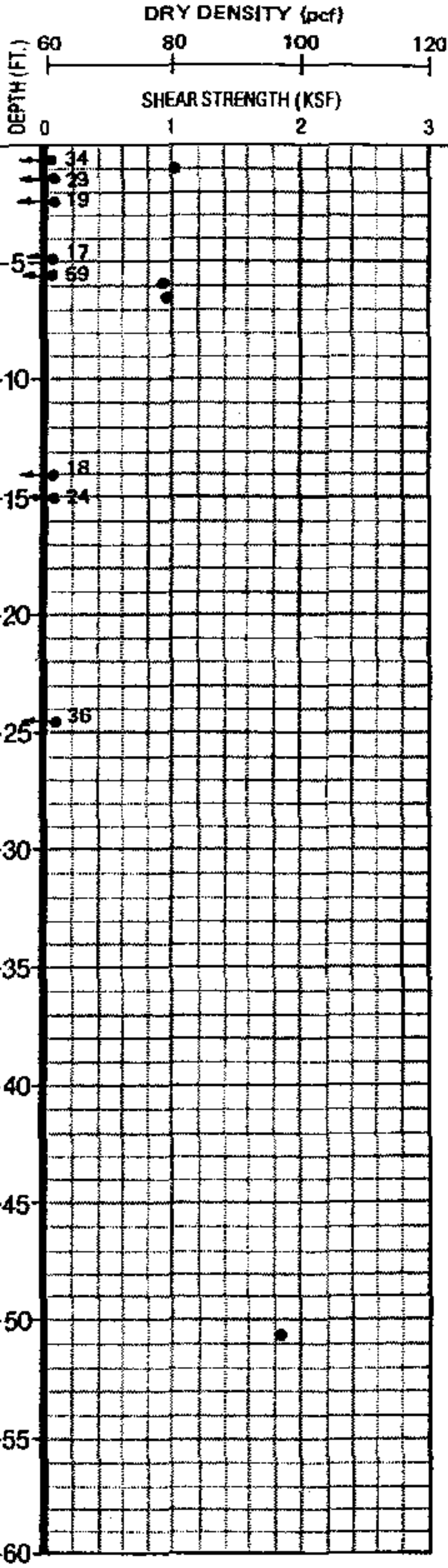
Date Completed: 3-4-82
Logged By: M.R. Musial
R.H. Prescott
Job Number: 9612,031.08

Approved: DGB
Date: 4-82

LOG OF BORING NO. 6
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-6

BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
P	S S		**BROWN ORGANIC SILT** (OL,V_x/V_r) V_x to 1/4" diameter, V_r to 1/8" thick, with fibrous organics and a trace of gravel to 1/4" diameter			108 31.3 138		TCON TCON
114/7"			**MASSIVE ICE (ICE)**	-15.4		260		
100/5" 115/9"	S S	5 10	**GRAY GRAVELLY SAND** (SP-SM, V_x) 5% V_x to 1/4" diameter, fine to medium sand, with occasional subrounded gravel to 1/2" diameter	-14.4 -13.3 -12.4 -12.1	92 [21.7	220 43.1 23.6		SA
99	S	15	**ICE with GRAVELLY SAND** (ICE + SP,V_x/V_r) up to 70% visible ice, V_x to 1/2" diameter, V_r to 1/2" thick	-11.2		245 190		
50/3"	S	20	**GRAY GRAVELLY SAND** (SP-SM,V_x) V_x to 1/4" diameter, fine to medium sand, with a trace of gravel to 1" diameter	-10.3 -9.9		12.9		
51/9"	S	25	**BROWN SILT** (ML,V_x/V_r) 20 to 30% visible ice, V_x to 1/2" diameter, V_r to 1/4" thick, with a trace of fine sand	-8.9		114		
50/1"	S	30	**BROWN GRAVELLY SILTY SAND** (SM,V_x) 10% visible ice, V_x to 1/16" diameter, fine to coarse sand, with occasional subrounded gravel to 1" diameter	-8.4		7.3		
50/3"	S	35	V_x to 1/4" diameter at 34.0'	-8.5	[7.4]	12.8		
	G	40		-8.4	76 [17.7]	16.6		SA
	G	45	V_x to 1/8" diameter at 43.0'	-8.5	[19.4	14.8		
	G	50		-8.6	59 [15.6]	11.9		SA
		55	Temperature measurements recorded on 4-17-82					
		60						



UTM Coordinates: N 25 538 242
E 1 699 991

Water Depth: - - -

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH

▲ — Torvane

△ — Compression Test

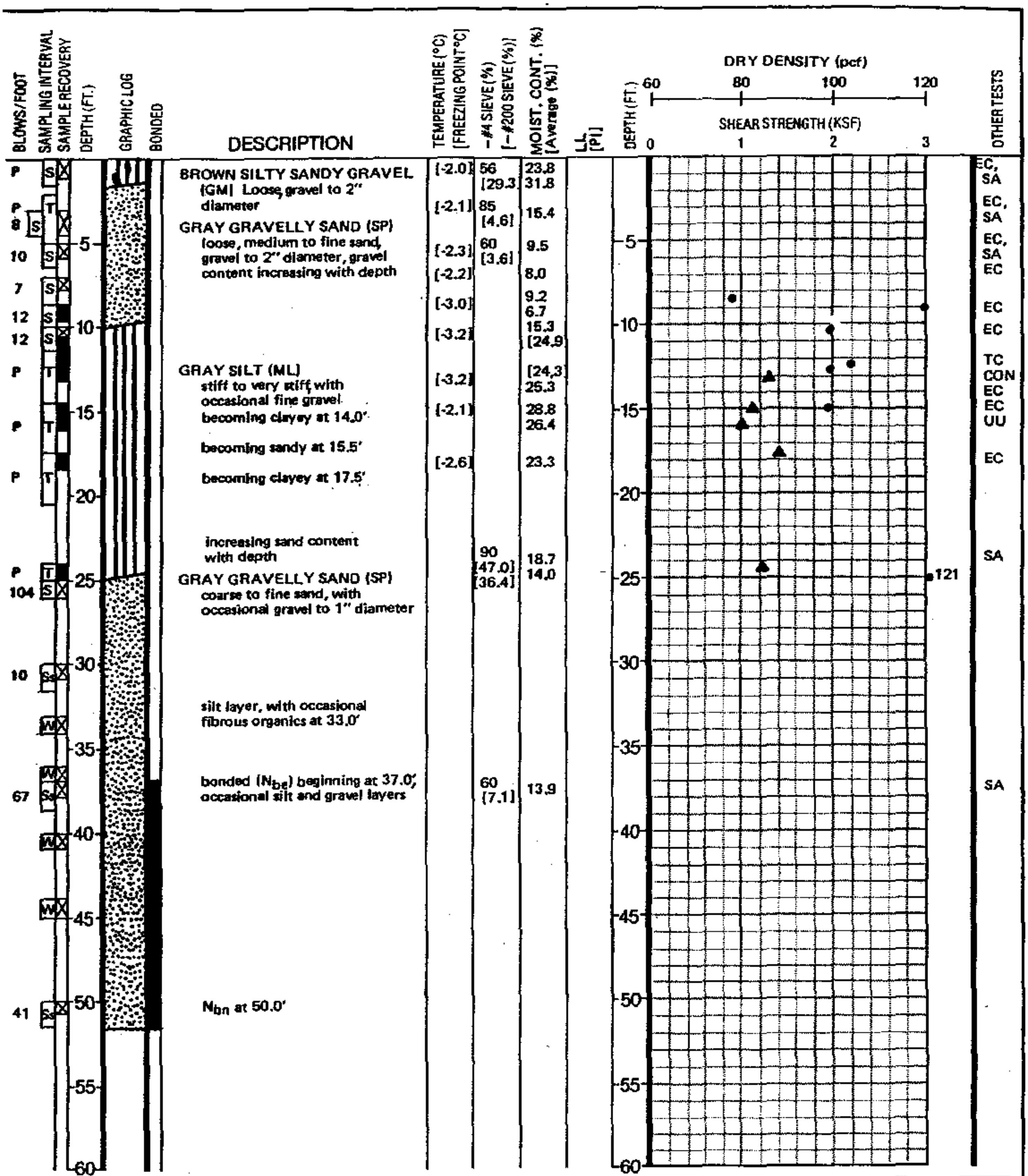
Date Completed: 3-4-82
Logged By: P.J. Ondra

Job Number: 9612,031.08

Approved: DEB
Date: 4-82

LOG OF BORING NO. 7
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-7



UTM Coordinates: N 25 546 772
E 1 702 499

Water Depth: 8.5'

Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
Δ — Compression Test

Date Completed: 3-11-82
Logged By: M.R. Musial
R.H. Prescott

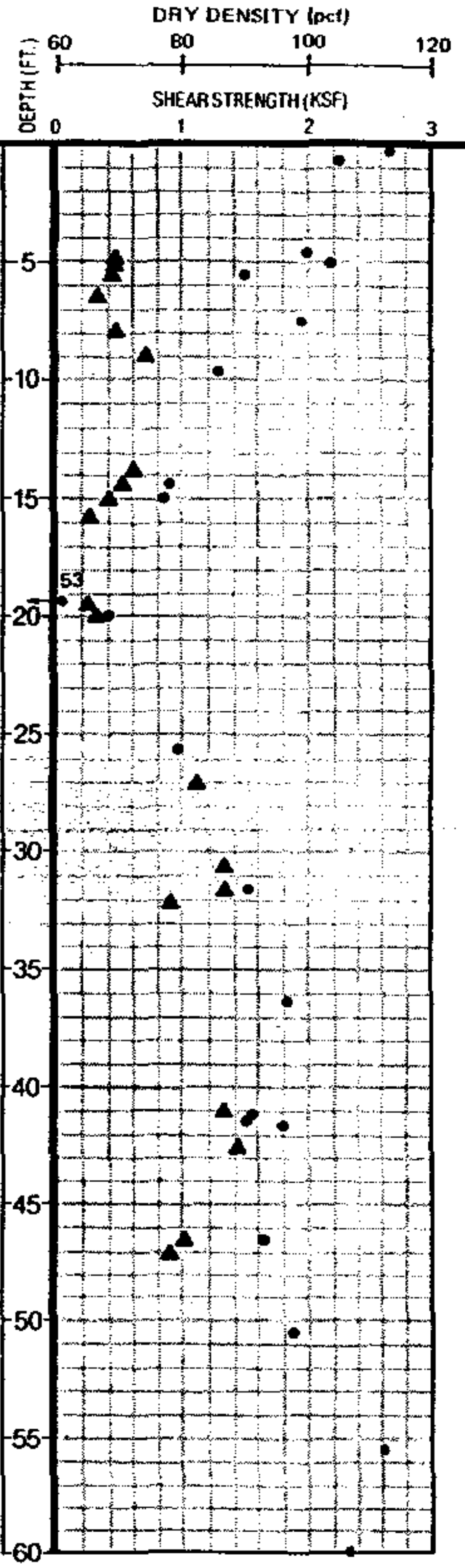
Job Number: 9612,031.08

Approved: DEB
Date: 4-82

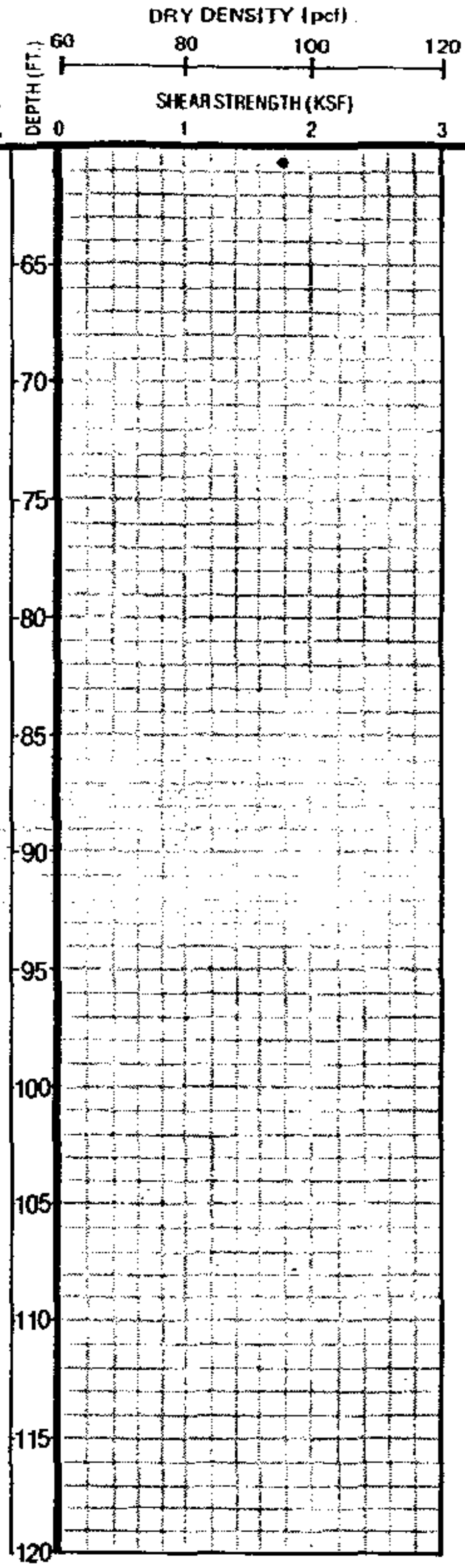
LOG OF BORING NO. 8
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-8

BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
P	S		**DARK GRAY SILTY SAND (SM)** loose, fine sand	[-2.1]	[36.5]	[22.7]		EC TC
								EC CHEM
P	T	5	**DARK GRAY SILT (ML)** soft to medium stiff, with a trace of sand, and occasional wood fragments at 7.0'	[-2.1] [-2.1] [-2.0] [-2.2]	[59.4]	[23.1] 32.1 28.2		CU EC CU EC
P	T			[-1.6] [-2.2]		[29.3 27.4		CON EC
		10				35.0 28.2		EC CU
P	T							EC CU
P	T	15		[-2.1]		37.0 41.8 40.7		CU EC, CON
			occasional shell fragments to 1/8" diameter at 16.0'					EC EC
P	T		increasing sand content at 19.0'			80.4		UU
P	T	20		[-1.9]		51.3 37.0		UU CON UU
			GRAY SILTY SAND (SM) medium dense, · sand					EC
P	T	25		[-1.7]	[67.4	33.2 35.7		EC
		30	sand layer at 30.0'		[38.8			
P	T		1 foot clayey silt layer with occasional fibrous organics at 31.0'			30.2		UU
P	T	35			[23.6]	27.8		
			DARK GRAY SILTY CLAY (CL) stiff to hard					
P	T	40		[-1.5]	[98.2]	[31.8]	35 [8]	EC CON MA UU UU
P	T	45				29.3		TC
P	S	50	**DARK GRAY SANDY SILT (ML)** stiff, with occasional gravel to 1/2" diameter			25.1		
			becoming clayey at 51.5'					
			increasing sand content at 53.0'					
91	S	55	**GRAY SANDY GRAVEL (GP)** dense to very dense, gravel to 2" diameter, with medium to coarse sand			16.5		
		60				2.8		



BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
118	S				96 [0.2]	6.2		SA
		65						
		70						
		75						
		80						
		85						
		90						
		95						
		100						
		105						
		110						
		115						
		120						



UTM Coordinates: N 25 558 836
E 1 702 473

Water Depth: 9.5'
Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ – Torvane
Δ – Compression Test

HLA

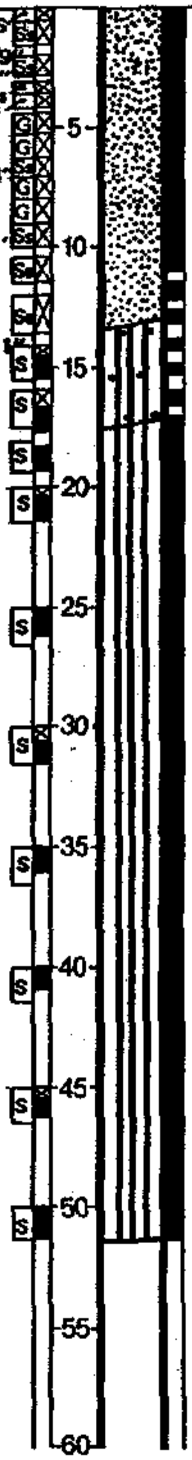
Date Completed: 3-10-82
Logged By: M.R. Musial
R.H. Prescott

Approved: DGG
Date: 4-82

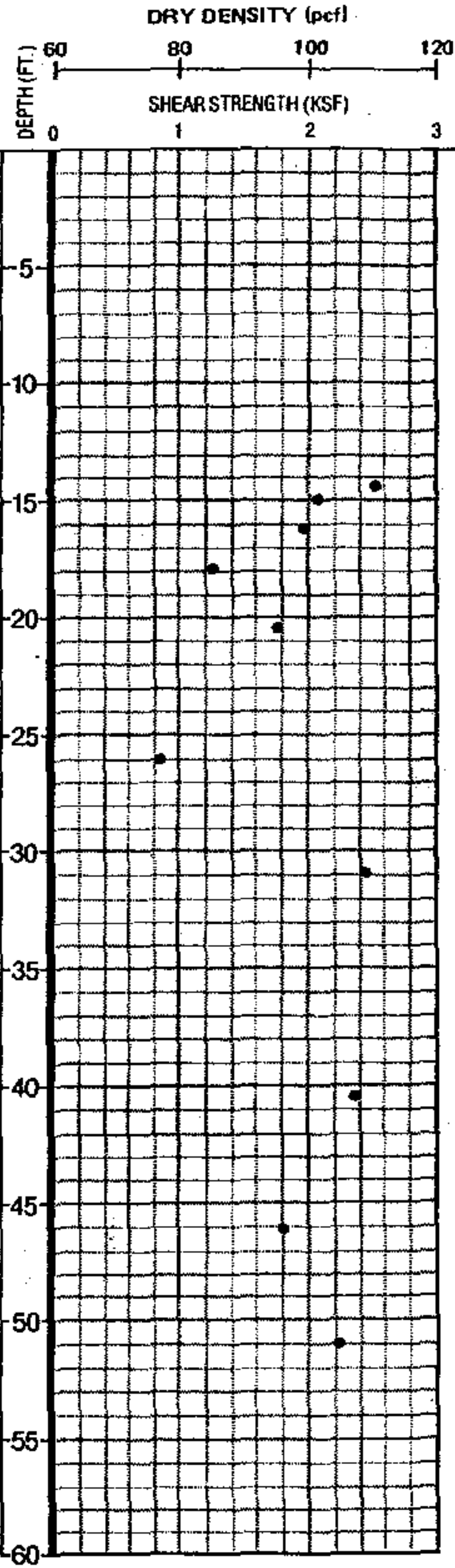
Job Number: 9612,031.08

LOG OF BORING NO. 9
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-9



BLOWS/FOOT	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
100 5" 182		GRAY SAND (SP-SM,V_c) medium sand	[-0.4]	[8.9]	23.3		SA EC
142/9" 74/6"		2-1/2" of massive ice at 2.5', becoming N_{be} at 3.5'	[-0.9]	[10.2]	111 23.8		EC EC
	5		[-0.4]		23.2		EC
113/6"			[-0.4]		25.1		EC
141/11"	10		[-1.1]	100 [10.7]	26.9		SA EC
116		N_f at 12.0', becoming marginally bonded	[-4.1]		23.5		EC
85 91/11"		GRAY SILTY SAND (SM) fine sand, silt content decreasing with depth	[-4.0] [-3.9]		19.4 23.2		EC EC
	15						CHEM EC
51					24.4		
19		DARK GRAY CLAYEY SILT (ML,V_r) V_r to 1/16" thick 5% visible ice,			28.1		
17	20	becoming N_{be} and sandy, with occasional shell fragments and fibrous organics at 20.0'			28.9		
12	25	becoming clayey, with V_x to 1/8" diameter and V_r to 1/16" thick at 25.0'			42.7		
28	30	becoming lighter, with V_r to 1/4" thick and a trace of clay at 31.5'			21.6	27 [6]	TCON
33	35						
38	40	15% visible ice, V_r at 40.0'			19.6		
44	45				27.3		
57	50	increasing clay content at 50.0'			22.7		
	55						
	60						



UTM Coordinates: N 25 562 119
E 1 709 962
Water Depth: ---
Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-9-82
Logged By: R.H. Prescott
Job Number: 9612,031.08

Approved: DCB
Date: 4-82

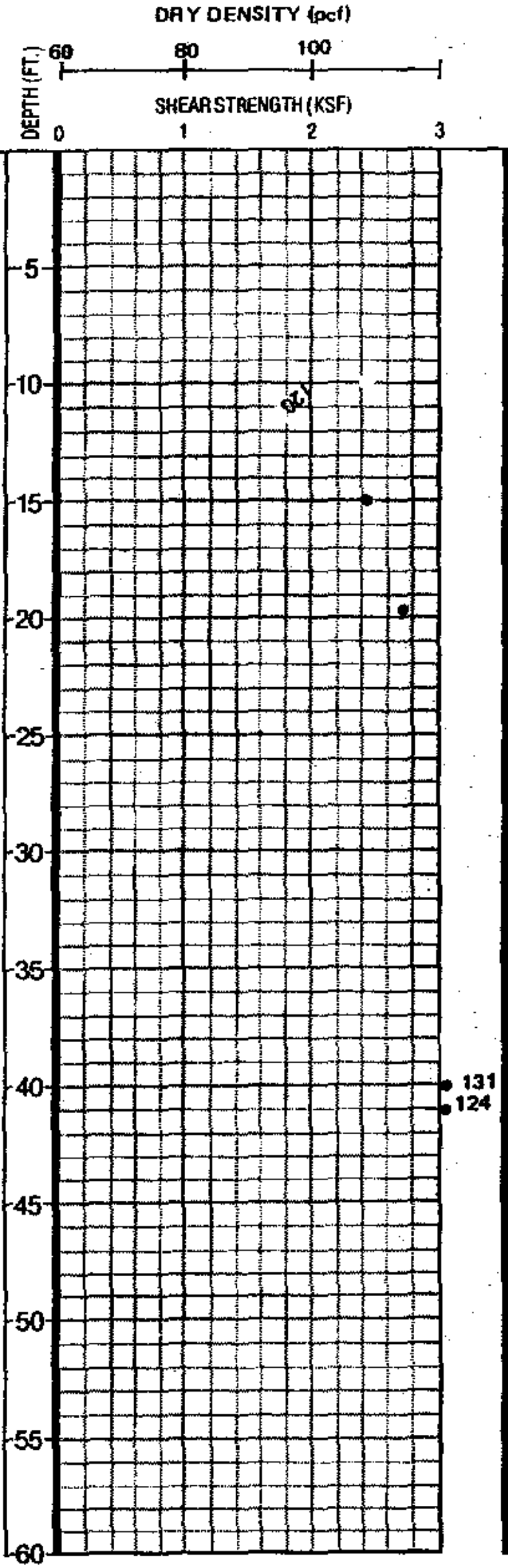
HLA

LOG OF BORING NO. 10
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-10

BLOWS/FOOT	SAMPLING INTERVAL
[illegible]	S
[illegible]	T
26	S
26	S
33	S
44	S
33	S
38	S
50	S
61	S
75	S
	W
26	S
	W
6	S
	W
3	S
09	Ss

DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	–#4 SIEVE (%) [–#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
GRAY GRAVELLY SAND (SP) loose	[-1.8]		12.2		EC
GRAY SANDY GRAVEL (GP) medium dense to dense, gravel to 1-1/2" diameter, with coarse to fine sand		23 [1.0]			SA
gravel to 2-1/4" diameter at 11.0'	[-2.0]	18 [0.9]	8.4		SA,EC
		49 [3.6]	8.1		SA
becoming dense, with a trace of silt at 17.0'		[2.3]			
sand layer at 19.0'	[-2.0]		8.5 8.3		EC
		32 [0.7]			SA
sand layer at 30.0'		[0.6]			
GRAY GRAVELLY SAND (SP) dense, fine to coarse sand, with occasional gravel to 2" diameter		[1.1] [9.7]			
GRAY SILTY SANDY GRAVEL (GM) very dense, gravel to 1" diameter, with occasional sandy layers	[-2.0]	42 [8.1]	8.0 7.1 5.6		SA,EC
		59 [3.9]			SA



SHEAR STRENGTH

▲ – Torvane

△ – Compression Test

UTM Coordinates: N 25 552 762
E 1 709 919

Water Depth: 9.5'

Equipment: Mobile B-61, Rotary Wash

Date Completed: 3-11-82

Logged By: M.R. Musial
R.H. Prescott

Approved: DGB

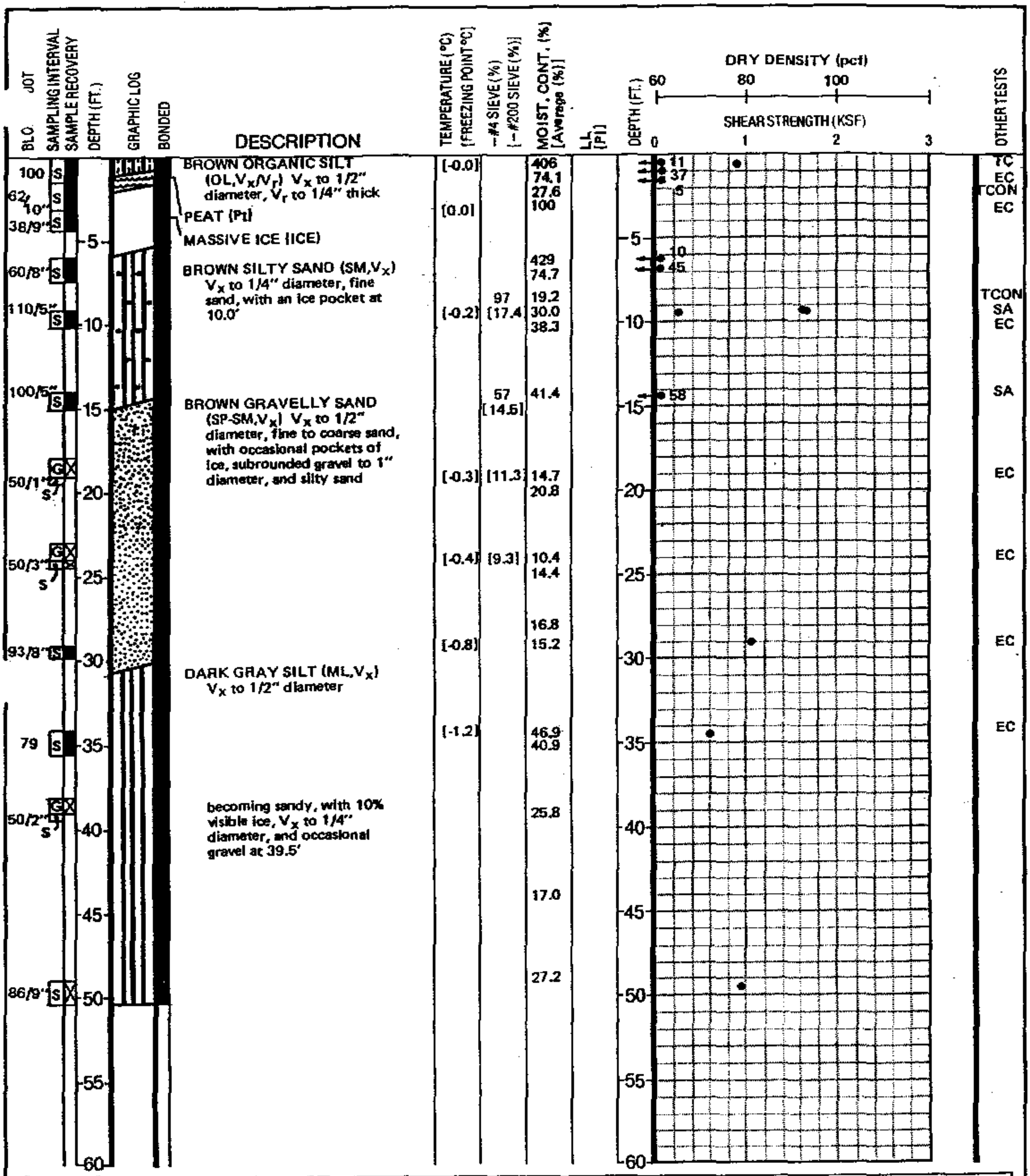
Date: 4-82

Job Number: 9612,031.08

LOG OF BORING NO. 11
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE

B-11



BLO. JOT	SAMPLING INTERVAL	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
100	S		BROWN ORGANIC SILT (OL,V_x/V_r) V_x to 1/2" diameter, V_r to 1/4" thick	[-0.0]		406		TC
62/10"	S					74.1		EC
						27.6		TCON
38/9"	S		PEAT (Pt)	[0.0]		100		EC
		5	MASSIVE ICE (ICE)					
60/8"	S		BROWN SILTY SAND (SM,V_x) V_x to 1/4" diameter, fine sand, with an ice pocket at 10.0'			429 74.7		
110/5"	S	10		[-0.2]	97 [17.4]	19.2 30.0 38.3		TCON SA EC
100/5"	S	15	BROWN GRAVELLY SAND (SP-SM,V_x) V_x to 1/2" diameter, fine to coarse sand, with occasional pockets of ice, subrounded gravel to 1" diameter, and silty sand		57 [14.6]	41.4		SA
50/1"	G S	20		[-0.3]	[11.3]	14.7 20.8		EC
50/3"	G S	25		[-0.4]	[9.3]	10.4 14.4		EC
93/8"	S			[-0.8]		16.8 15.2		EC
		30	DARK GRAY SILT (ML,V_x) V_x to 1/2" diameter					
79	S	35		[-1.2]		46.9 40.9		EC
50/2"	G S	40	becoming sandy, with 10% visible ice, V_x to 1/4" diameter, and occasional gravel at 39.5'			25.8		
		45				17.0		
86/9"	S	50				27.2		

UTM Coordinates: N 25 542 511
E 1 710 000

Water Depth: - - -

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

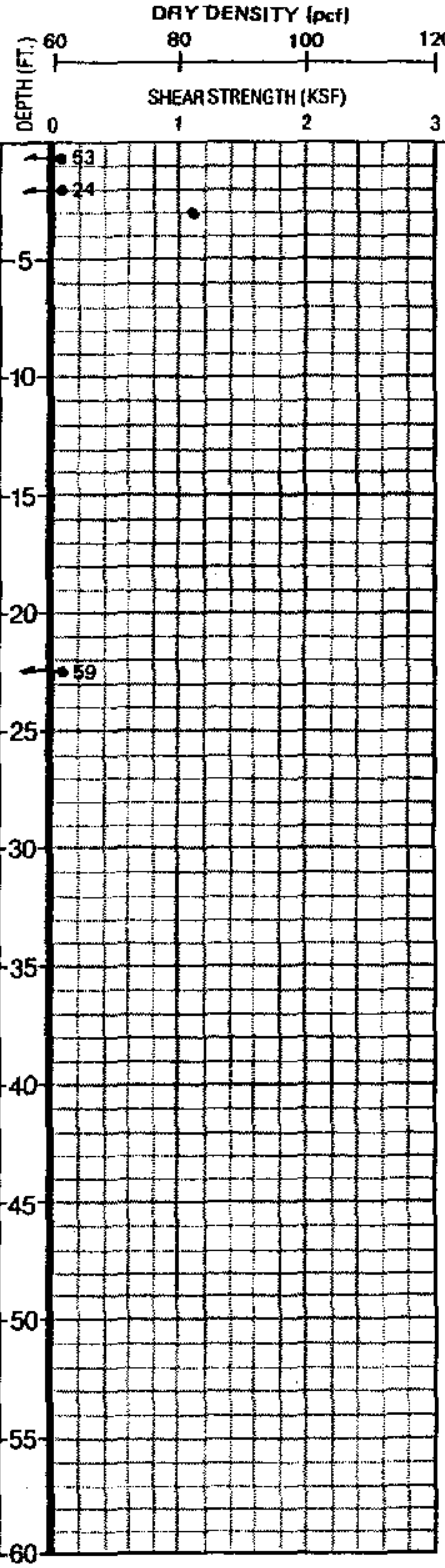
Date Completed: 3-6-82
Logged By: P.J.Ondra
Job Number: 9612,031.08

Approved: JGG
Date: 4-82

LOG OF BORING NO. 12
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-12

BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT°C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
79/8"	S		BROWN SANDY SILT (ML,V_x/V_r) V_x to 1/4" diameter, with massive ice at 2.0', fibrous organics near surface	[-0.0] -19.4		60.1 54.9 153		TCON EC
50/4"	S			-16.0	51 [7.2]	21.0		SA,
50/3"	S		GRAY GRAVELLY SAND (SP-SM,V_x) 10-20% visible ice V_x to 1/2" diameter, fine to coarse sand, with occasional gravel to 1" diameter	[-0.3]		8.3		TCON EC
50/2"	S	5		-13.4				
50/4"	S				[16.1]			
50/3"	S			-13.1				
	G							
50/3"	S	10		[-0.2] -12.5	78 [12.5]	15.8		SA,EC
50/3"	S			[-0.2] -12.1		20.0		EC
		15		-11.4				
61	S		DARK GRAY SANDY SILT (ML,V_x/V_r) 20% visible ice, V_x to 1/2" diameter, V_r to 1/4" thick, with fine sand	-10.7		76.1 154	34 [9]	TCON TC
		20		-10.2				
50/3"	S		pockets of massive ice at 22.5'	[-1.2]		48.8 58.6		EC
		25		-9.0				
50/2"	S		BROWN GRAVELLY SAND (SP-SM,V_x) 10% visible ice, V_x to 1/16" diameter, fine to coarse sand, with occasional subrounded gravel to 2" diameter		[11.5]	6.9		
		30		-8.3				
50/2"	S			[-0.9]	55 [13.3]	12.9		SA, EC
		35		-8.5				
50/2"	S		V_x to 1/4" diameter at 37.0'			11.0		
		40		-8.3				
50/2"	G S				[12.6]	9.8		
		45		-8.4				
	G	50		[-0.6] -8.5	66 [10.9]	9.6		SA, EC
			Temperature measurements recorded on 4-17-82					
		55						
		60						



UTM Coordinates: N 25 540 930
E 1 722 914

Water Depth: ---

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

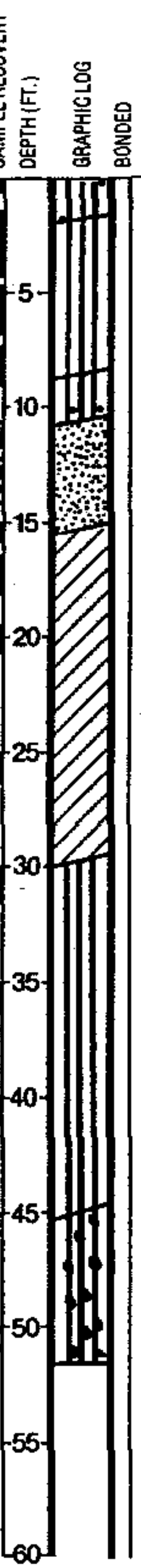
Date Completed: 3-8-82
Logged By: P.J. Ondra
Job Number: 9612.031.08

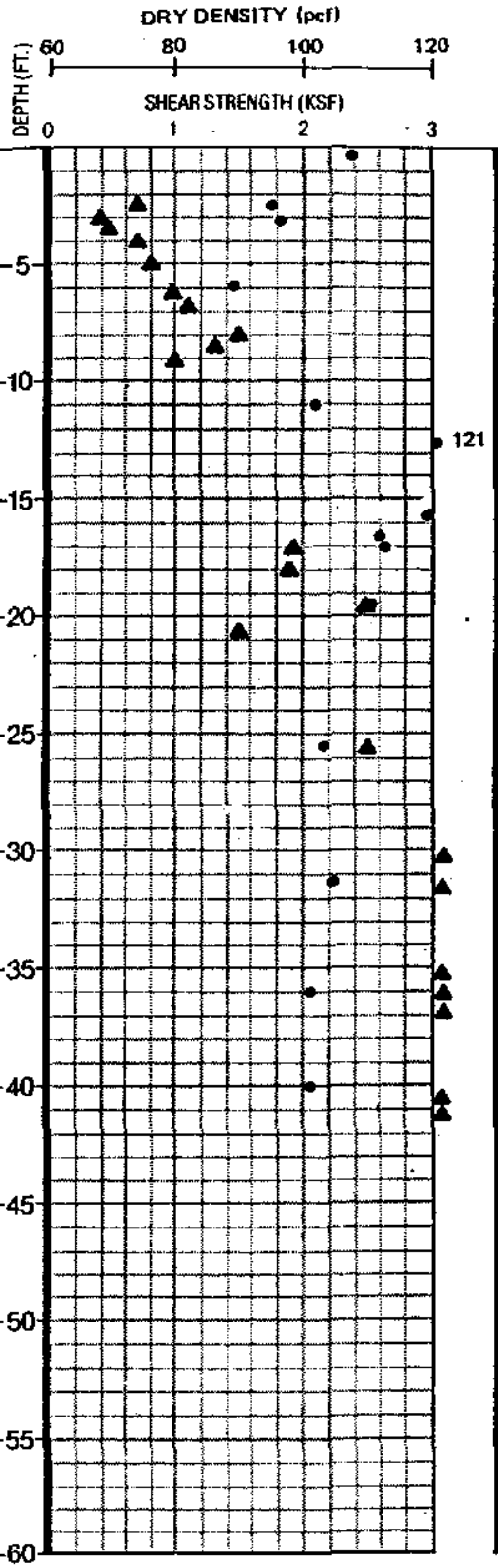
Approved: DGB
Date: 4-82

LOG OF BORING NO. 13
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-13

BLOWS/FOOT	SAMPLING INTERVAL / SAMPLE RECOVERY	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	L.L. [P.I.]	OTHER TESTS
P	S	**GRAY SILTY SAND (SM)**	[-1.9]	99	21.7		EC
		loose, fine sand	[-1.9]	[27.5]	21.6		SA
					27.1		EC
P	T	**DARK GRAY SILT (ML)**			26.7		CU
		soft to medium stiff					CU
P	T		[-1.8]		31.1	32	EC
			[-1.8]		33.1	[6]	CON
					31.1		EC
P	T	**GRAY SILTY SAND (SM)** loose, with occasional gravel to 3/4" diameter					
P	S		[-2.1]	89	25.2		SA,
		GRAY GRAVELLY SAND (SP)		[27.9]	23.6		EC
33	S	medium dense, rounded gravel to 1" diameter	[-2.0]		16.1		EC
					14.2		
22	S				6.2		
					9.5		
25	S	**GRAY CLAY (CL)** stiff to hard			15.1		
					19.5	33	CON
P	T				18.1	[14]	UU
					20.4		
P	T						
							UU
P	T						
		DARK GRAY CLAYEY SILT (ML)					
P	T	stiff to hard			22.8		TC
					25.1	40	
P	T				25.1	[14]	UU
		becoming sandy, with occasional gravel to 3/8" diameter at 40.0'					
P	T				25.1		UU
	S			53			
44/6"		**DARK GRAY GRAVEL (GM)**		[31.4]	18.9		SA
84/6"	S	very dense, gravel to 1" diameter					
		becoming sandy at 48.0'					
				36			SA
60/5"	S			[2.0]	8.7		





UTM Coordinates: N 25 551 633
E 1 722 995

Water Depth: 9.6'

Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH

▲ — Torvane

△ — Compression Test

Date Completed: 3-12-82
Logged By: M.R. Musial

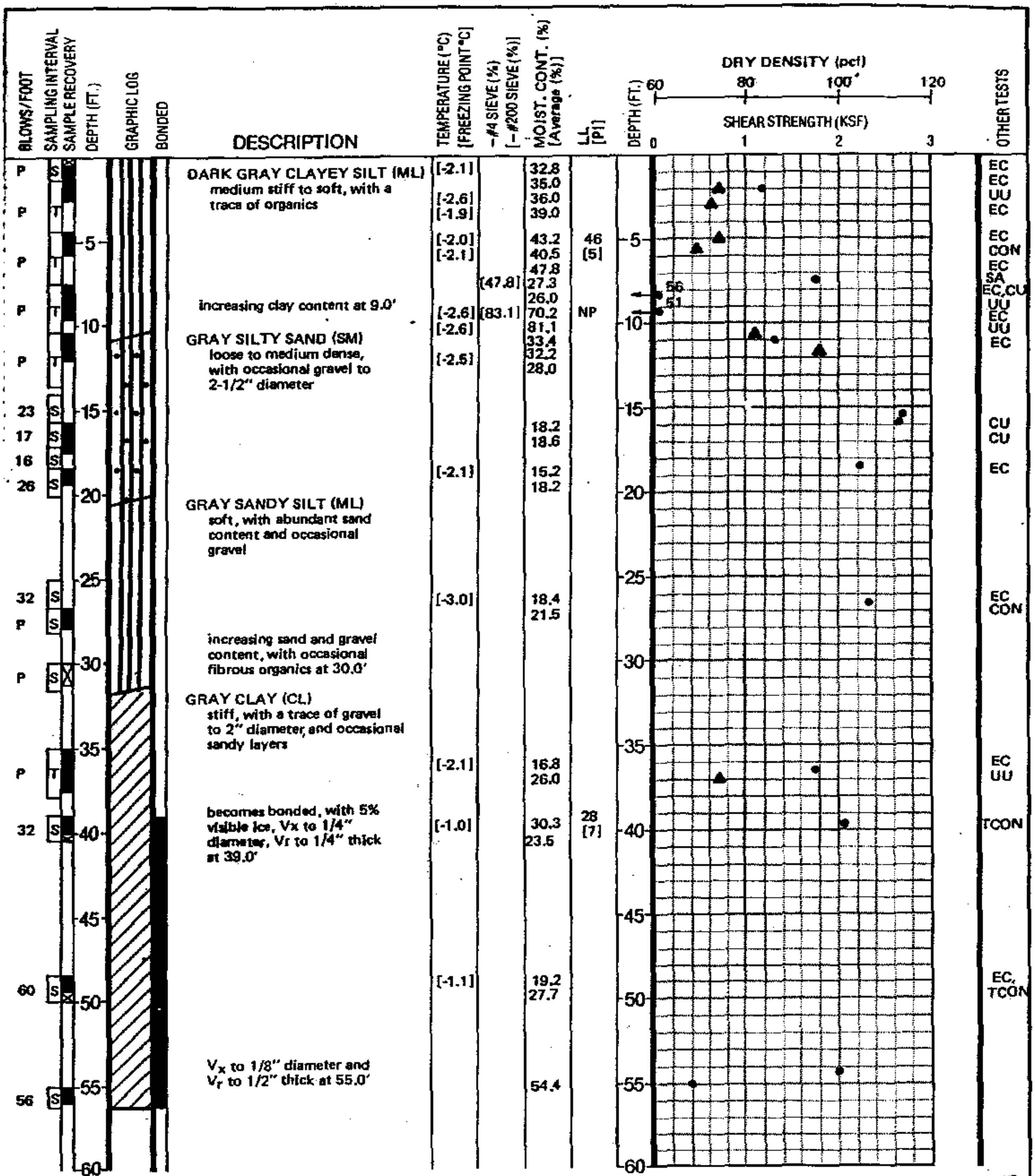
Job Number: 9612,031.08

Approved: DEB
Date: 4-82

LOG OF BORING NO. 14
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE

B-14



DESCRIPTION

DARK GRAY CLAYEY SILT (ML)
medium stiff to soft, with a trace of organics

increasing clay content at 9.0'

GRAY SILTY SAND (SM)
loose to medium dense, with occasional gravel to 2-1/2" diameter

GRAY SANDY SILT (ML)
soft, with abundant sand content and occasional gravel

increasing sand and gravel content, with occasional fibrous organics at 30.0'

GRAY CLAY (CL)
stiff, with a trace of gravel to 2" diameter, and occasional sandy layers

becomes bonded, with 5% visible ice, Vx to 1/4" diameter, Vr to 1/4" thick at 39.0'

V_x to 1/8" diameter and V_r to 1/2" thick at 55.0'

BLOWS/FOOT	SAMPLING INTERVAL	TEMPERATURE (°C) [FREEZING POINT °C]	–#4 SIEVE (%) [–#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
P	S	[-2.1]		32.8		EC
				35.0		EC
		[-2.6]		36.0		UU
P	T	[-1.9]		39.0		EC
		[-2.0]		43.2	46	EC
		[-2.1]		40.5	[5]	CON
P	T			47.8		EC
			[47.8]	27.3		SA
				26.0		EC,CU
P	T	[-2.6]	[83.1]	70.2	NP	UU EC
		[-2.6]		81.1		UU
				33.4		EC
		[-2.5]		32.2		
P	T			28.0		
23	S					
17	S			18.2		CU
				18.6		CU
16	S	[-2.1]		15.2		EC
26	S			18.2		
32	S	[-3.0]		18.4		EC
				21.5		CON
P	S					
P	S					
P	T	[-2.1]		16.8		EC
				26.0		UU
32	S	[-1.0]		30.3	28	TCON
				23.5	[7]	
60	S	[-1.1]		19.2		EC,
				27.7		TCON
56	S			54.4		

UTM Coordinates: N 25 559 893
E 1 725 699
Water Depth: 16.5'
Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-13-82
Logged By: M.R. Musial
R.H. Prescott

Job Number: 9612,031.08

Approved: DGB
Date: 4-82

LOG OF BORING NO. 15
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-15

BLOWS/FOOT	SAMPLING INTERVAL
P	T
P	T
27	S
23	S
49	S
72	S
83	S
79	S
31	S
31	S
46	S
80	S
37	S

DEPTH (FT.) 5, 10, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60

DESCRIPTION

GRAY SILTY SAND (SM)
loose, fine sand, with occasional gravel to 1-1/2" diameter

5% visible ice, V_s to 1/16" thick, with V_c at 2.5'

silt layer at 4.5'

fine to medium sand, with subhorizontal V_s to 1/32" thick at 5.5'

silt layer at 8.5'

becoming V_c at 10.5'

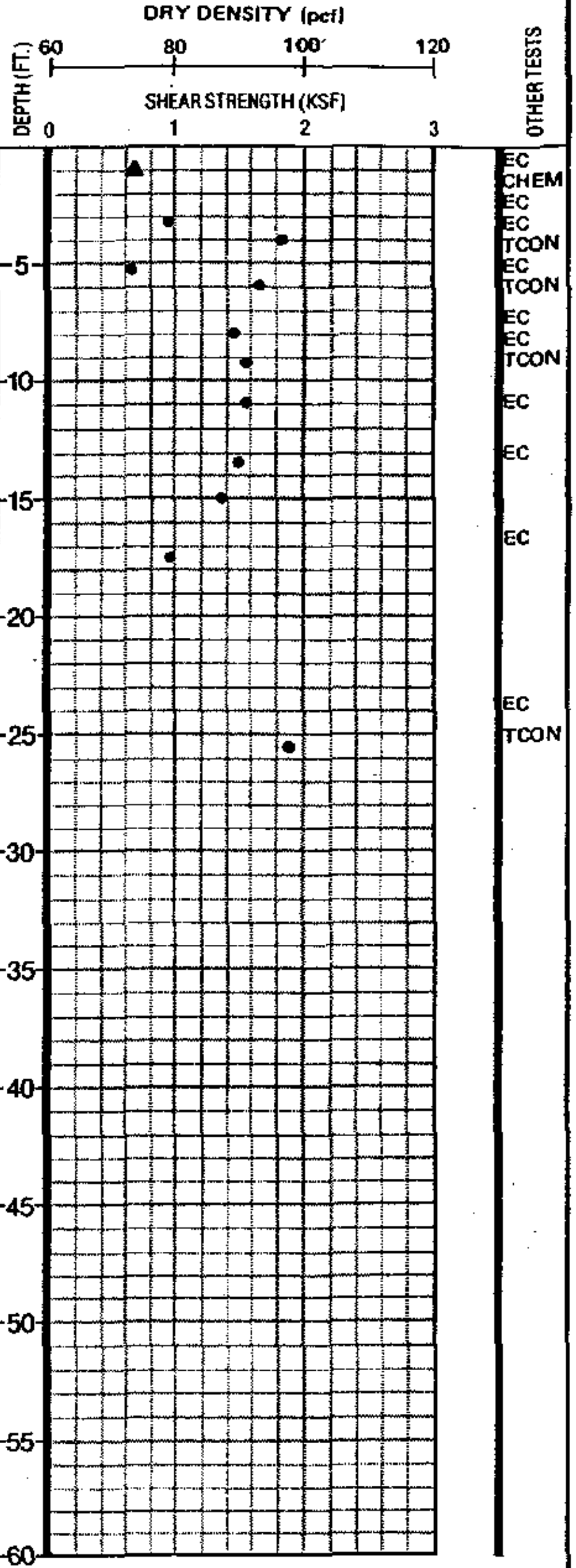
GRAY SANDY SILT (ML,V_r)
5% visible ice, V_r to 1/4" thick

GRAY SILTY SAND (SM,V_c)
fine sand, with less than 6% visible ice, with thin interbeds of N_{be} silt

GRAY SILT (ML,V_r)
with less than 5% visible ice, V_r to 1/32" thick

Temperature measurements recorded on 4-17-82

TEMPERATURE (°C) [FREEZING POINT °C]	–#4 SIEVE (%) [–#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]
-1.8	77		
[-1.7]	[8.7]	25.1	
[-1.5]		31.9	
-1.8		32.9	
[-0.7]		48.9	
[-0.5]	[93.1]	[26.6]	
-1.8		42.6	
[-1.0]		[25.3]	
[-0.3]	[39.1]	30.1	
-1.8		[29.2]	
[-0.3]		27.7	
-1.7		29.0	
			23
[-0.6]		[30.6]	[6]
		30.7	24
-1.6	[67.4]	30.1	[6]
[-0.3]		33.8	
	[48.8]	29.6	
-1.5			
-1.5			
[-0.4]		33.1	
		25.6	



OTHER TESTS
EC
CHEM
EC
EC
TCON
EC
TCON
EC
EC
TCON
EC
EC
EC
EC
TCON

UTM Coordinates: N 25 562 005
E 1 733 529
Water Depth: 31.0'
Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

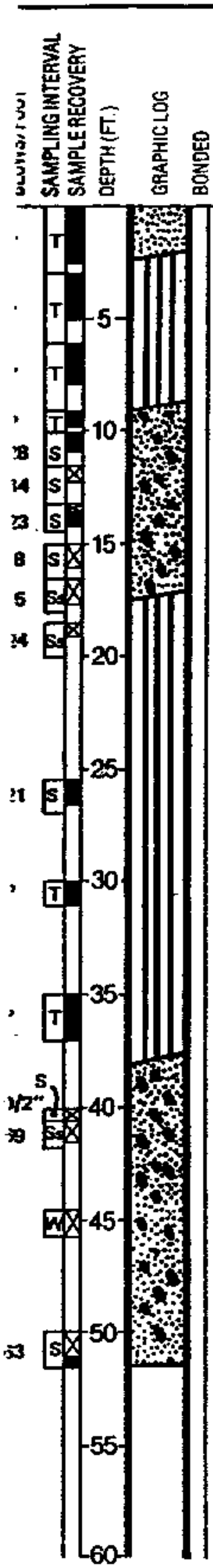
Date Completed: 3-12-82
Logged By: M.R. Musial
R.H. Prescott

Job Number: 9612,031.08

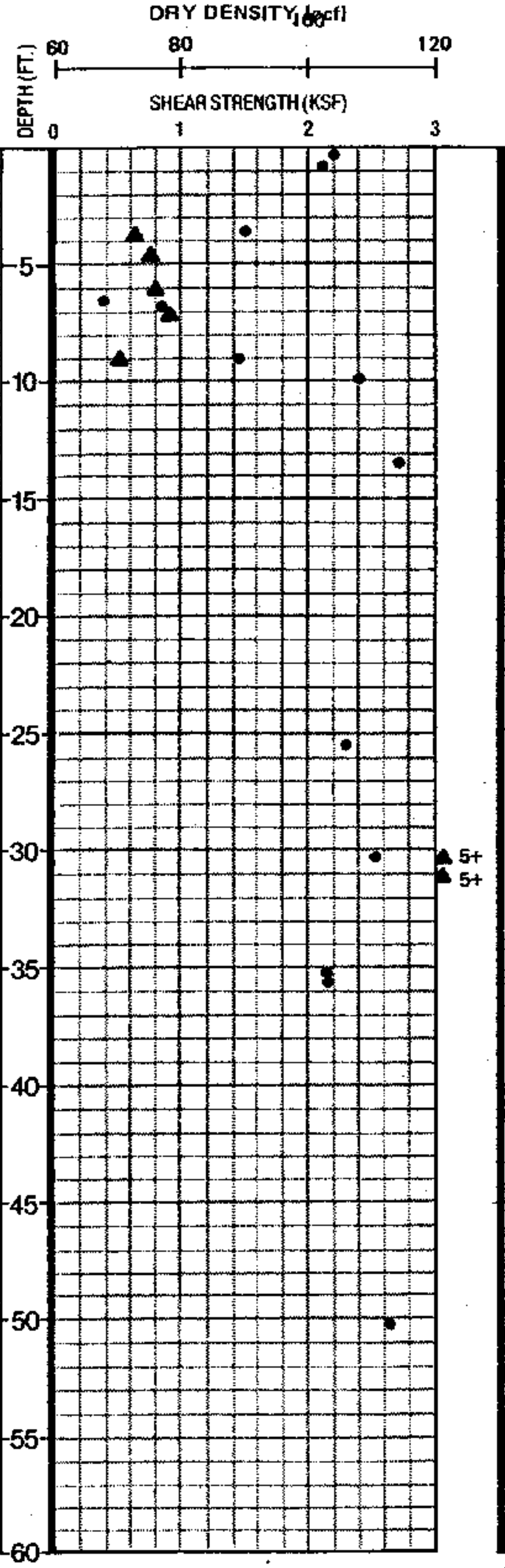
Approved: DGB
Date: 4-82

LOG OF BORING NO. 16
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-16



DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
GRAY SAND (SP) loose, with a trace of silt	-1.9		[20.9]		EC
	[-1.9]				EC
	[-1.8]				CON
DARK GRAY CLAYEY SILT (ML)	-1.5		[31.6]	25	EC
medium stiff to stiff	[-2.0]		43.4	[5]	EC
	[-1.9]	1			EC
	[-1.5]	[93.3]	33.1		UU
occasional rounded, coarse sand at 7.5'	-1.3		52.5		UU
	[-1.5]		[45.5]		EC
DARK GRAY GRAVEL (GP)	-1.2			44	
medium dense, gravel to 2" diameter, with interbedded sandy and silty layers to 2' thick	[-2.0]		[20.0]	[39.6]	EC
	[-2.0]				EC
		[0.4]	3.1		
	-1.2		7.2		
	-1.1				
			8.6		
DARK GRAY CLAYEY SILT (ML) very stiff to hard	-1.0		18.1		
	-1.1				
	-1.1		22.7		EC
	[-2.8]		21.4		
	-1.1		18.4		UU
sand and gravel layers at 35.5'	-1.2		24.7	43	CU
			23.9	[17]	CON CU
DARK GRAY SANDY GRAVEL (GP-GM) dense, gravel to 1" diameter, with a trace of silt	-1.3	58 [7.1]	6.6		
	-1.3				
			9.8 5.2		
Temperature measurements recorded on 4-17-82					



UTM Coordinates: N 25 546 035
E 1 733 344
Water Depth: 9.0'
Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ —Torvane
△ — Compression Test

HLA

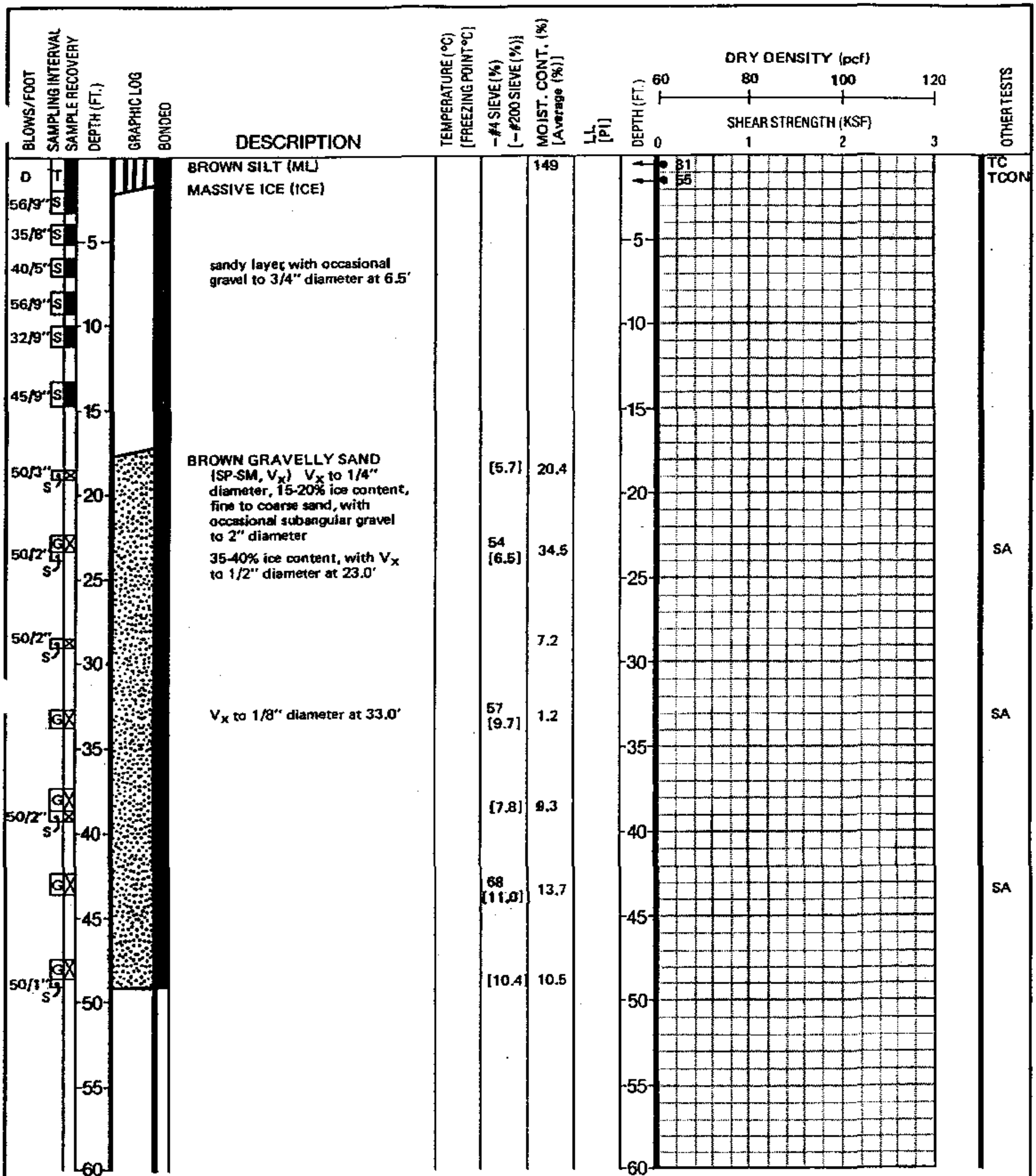
Date Completed: 3-13-82
Logged By: M.R. Musial
R.H. Prescott

Job Number: 9612,031.08

Approved: DEB
Date: 4-82

LOG OF BORING NO. 17
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-17



BLOWS/FOOT	SAMPLING INTERVAL	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
D	T	BROWN SILT (ML)			149		TC
		MASSIVE ICE (ICE)					TCON
56/9"	S						
35/8"	S						
40/5"	S	sandy layer with occasional gravel to 3/4" diameter at 6.5'					
56/9"	S						
32/9"	S						
45/9"	S						
50/3"	G S	BROWN GRAVELLY SAND (SP-SM, V_x) V_x to 1/4" diameter, 15-20% ice content, fine to coarse sand, with occasional subangular gravel to 2" diameter		[5.7]	20.4		
50/2"	G S	35-40% ice content, with V_x to 1/2" diameter at 23.0'		54 [6.5]	34.5		SA
50/2"	S				7.2		
	G	V_x to 1/8" diameter at 33.0'		57 [9.7]	1.2		SA
50/2"	G S			[7.8]	9.3		
	G			68 [11.0]	13.7		SA
50/1"	G S			[10.4]	10.5		

UTM Coordinates: N 25 534 749
E 1 730 229

Water Depth: ---

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-9-82
Logged By: P.J. Ondra

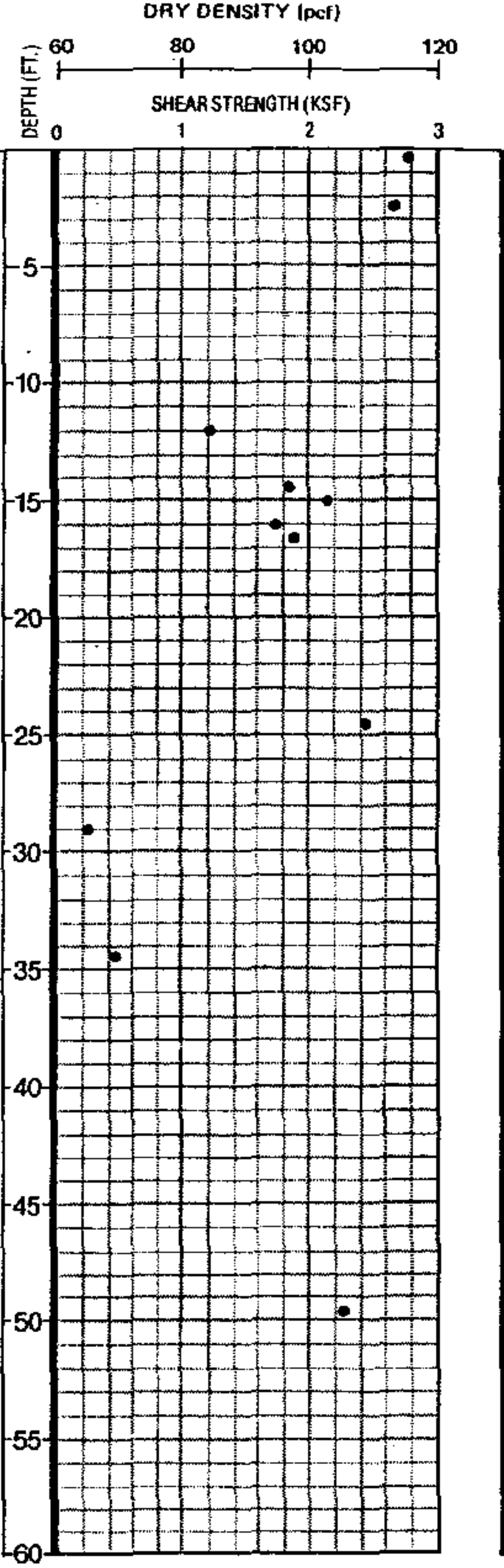
Approved: DEG
Date: 4-82

Job Number: 9612,031.08

LOG OF BORING NO. 18
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-18

BLOWS/FOOT	SAMPLING INTERVAL SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	-#4 SIEVE (%) [-#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
24 107/8" 80/5"	S S G S	5	BROWN SAND (SP,N_f/N_{bn}) medium to coarse sand, gravelly, with occasional subrounded gravel to 3/4" diameter at 2.5'	-19.4 [-0.4] -13.2 [-0.1] -12.8	91 [1.1] 14 [3.0]	2.8 2.2 8.8 15.0		EC CHEM EC
50/3" 97/10" 50/4"	G S S S G	10	V_x to 1/16" diameter at 4.0' silt layer, with V_x to 1/8" diameter at 8.0' becoming gray, with increasing silt content at 8.5'	[-0.3] [-3.3] -12.1 [-1.9] -11.5		22.6 24.8 28.3 20.2		EC EC EC
50/4" 29	S G S	15	marginally bonded 14' to 16', saturated	[-3.6] -10.3 [-3.7] -9.1	[5.5]	21.3 24.8 41.2 [23.1]		EC EC EC
15	S S	20	GRAY SANDY SILT (ML,V_r) 5% visible ice, V_r to 1/8" thick, with fine sand	[-4.3] [-4.1] [-4.1] -7.8 -7.4		[28.6]		EC EC
16	S	25		[-3.0] -7.3		21.6 [36.7]	38 [12]	TCON EC
24	S	30	V_x to 1/8" diameter at 29.0'	[-2.6] -7.2		[51.9]		EC
18	S	35	organic material to 1/8" diameter at 34.0'	-7.0		51.1		
23	S	40	pockets of fibrous organics and wood pieces at 39.5'	-6.6				
70/6"	G S	45	gravelly, with occasional gravel to 3/4" diameter at 44.0'	-6.3		12.1		
61	S	50	V_x to 1/4" diameter, with 30% ice content at 49.5'	[-2.5] -6.1		21.8 21.0		EC
		55	Temperature measurements recorded on 4-17-82					
		60						



UTM Coordinates: N 25 552 953
E 1 747 696

Water Depth: ---

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲—Torvane
△—Compression Test

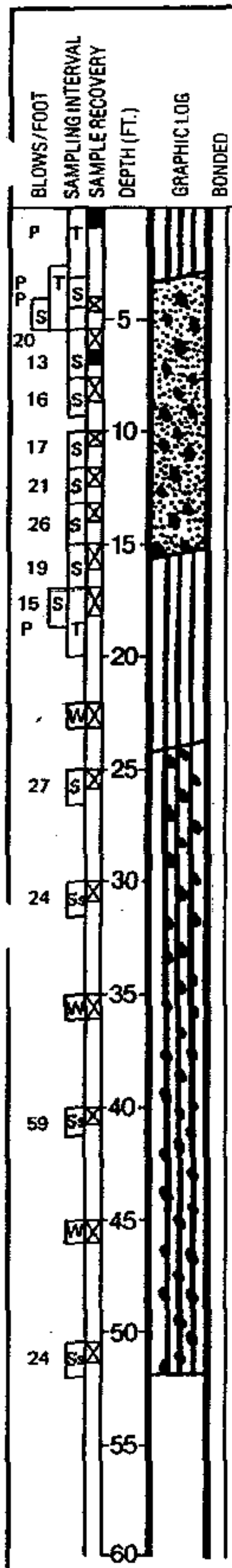
Date Completed: 3-10-82
Logged By: P.J. Ondra

Job Number: 9612,031.08

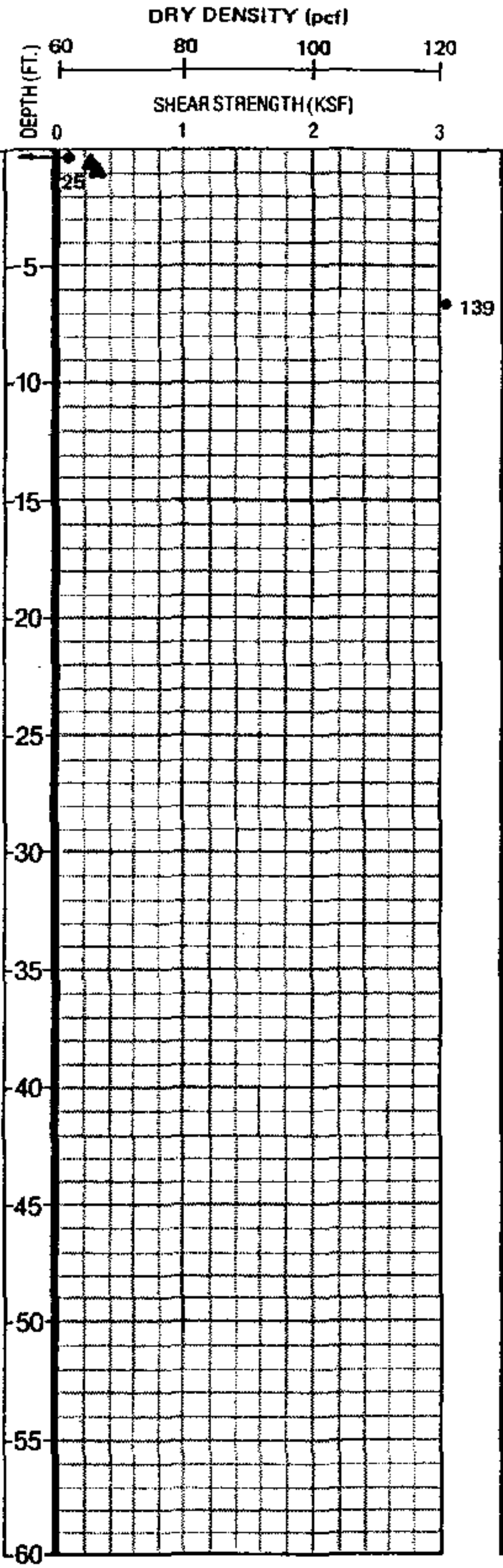
Approved: DGB
Date: 4-82

LOG OF BORING NO. 19
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-19



DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
GRAY SILT (ML) soft, with occasional gravel to 3" diameter, and a sand layer at 2.0'	[-1.9]	96 [90.7]	336 53.8		EC, SA
	[-1.8]		42.9		EC
	[-2.3]		6.6		EC
GRAY SANDY GRAVEL (GP) medium dense, occasional gravel to 1-1/2" diameter, medium to fine sand	[-1.9]	51 [6.7]	6.5 5.1		SA, EC
	[-2.1]		8.0		EC
increasing silt content between 5.5' to 9.5'	[-2.1]		4.8		EC
		25 [0.9]	3.2		SA
DARK GRAY CLAYEY SILT (ML) medium stiff, with occasional gravel to 1" diameter			7.8		
GRAY SILTY SANDY GRAVEL (GM) medium dense, subround to subangular gravel to 1-1/4" diameter					
increasing silt content between 37.0' to 38.0'					
increasing sand content at 40.0'		59 [6.1]	7.9		SA
gravel to 3/4" diameter, with fine to medium sand at 50.5'					



UTM Coordinates: N 25 541 749
E 1 739 000
Water Depth: 8.8'
Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-15-82
Logged By: M.R. Musial
R.H. Prescott

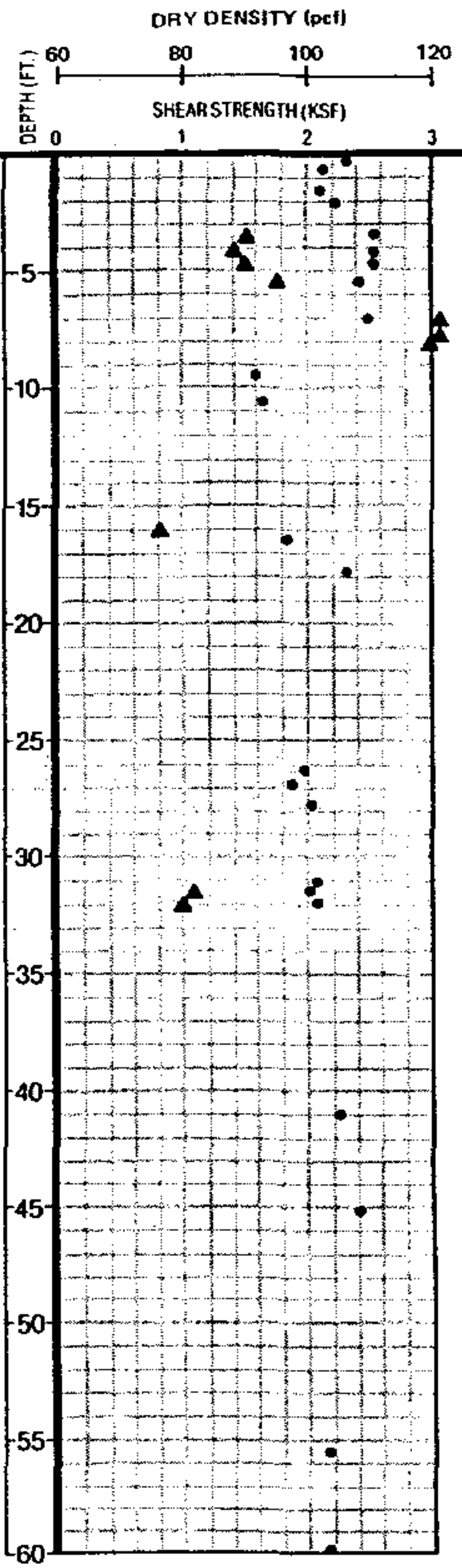
Job Number: 9612,031.08

Approved: DGB
Date: 4-82

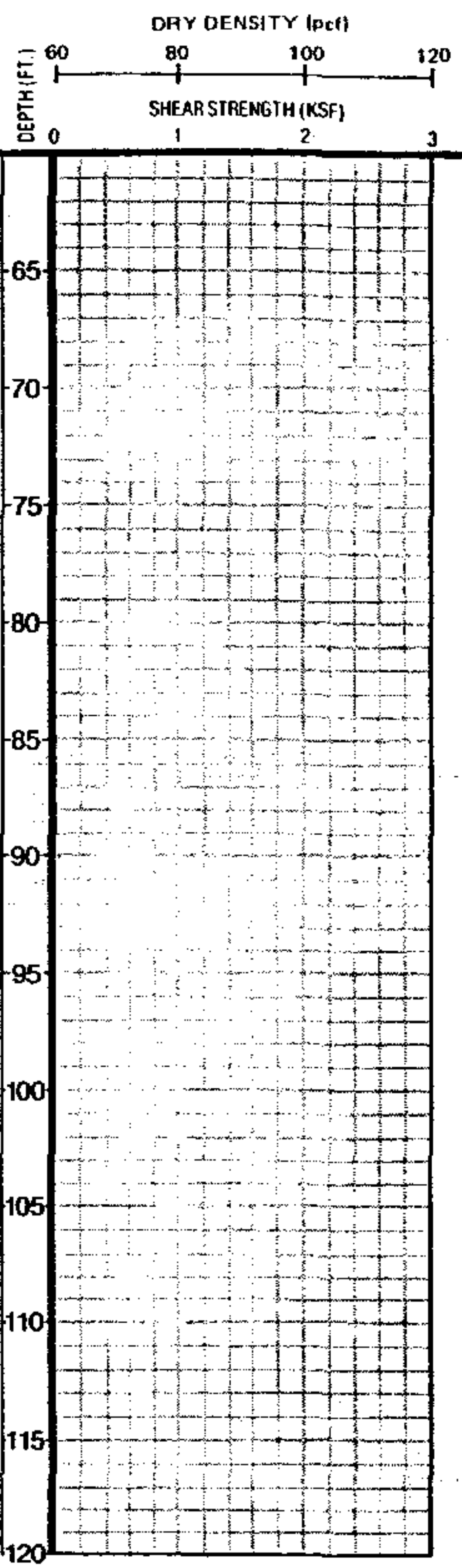
LOG OF BORING NO. 20
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-20

BLOWS/FOOT	SAMPLING INTERVAL / SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]		OTHER TESTS
11	S		GRAY SAND (SP-SM) loose, fine sand	[-2.0] [-1.5]	[6.4]	[22.5]		EC EC
28	S			[-2.0] [-1.4]	[7.9] [9.0]	[21.5] [20.4]	26	DS EC
P	T	5	GRAY SANDY SILT (ML) stiff to very stiff, with very fine sand	[-1.6] [-2.0]	[97.9]	[19.8]	[7]	CHEM EC CON
P	T			[-1.5] [-2.2] [-2.5] [-2.6]		[20.4 16.8		CU EC CU CU
P	T	10				[29.9]		EC
P	T		silty sand layers at 12.0' and 15.0' to 1.5' thick			25.7		UU EC EC EC
P	T	15		[-2.9]		[28.8]		EC
P	T			[-2.6]		[24.3		EC CU CU
		20						
		25		[-3,1]	[94.4]	25.2	22	MA
P	T		GRAY SILTY CLAY (CL) medium stiff to hard			25.9 27.0	[1]	EC CU CU CON
P	T	30		[-2.9]		[23.7] 26.2		UU UU
P	T	35						
P	T	40		[-1.5]		24.1 22.5		
39/9"	S	45				18.7		
	☒ W	50						
44	S	55	occasional pockets of black organic silt at 55.0'			44.2 22.0	26 [6]	
		60				22.6		



BLOWS/FOOT	SAMPLING INTERVAL / SAMPLE RECOVERY	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL (PI)	OTHER TESTS
60/4"	S ☒		GRAY CLAYEY GRAVEL (GC) dense, increasing sand content with depth	[-2.1]	2 [25.5]	18.7		EC
22	Ss ☒							
		65						
		70						
		75						
		80						
		85						
		90						
		95						
		100						
		105						
		110						
		115						
		120						



UTM Coordinates: N 25 566 788
E 1 705 180

Water Depth: 25.0'

Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH

▲ — Torvane

△ — Compression Test

HLA

Date Completed: 3-9-82

Logged By: M.R. Musial
R.H. Prescott

Job Number: 9612,031.08

Approved: DEB

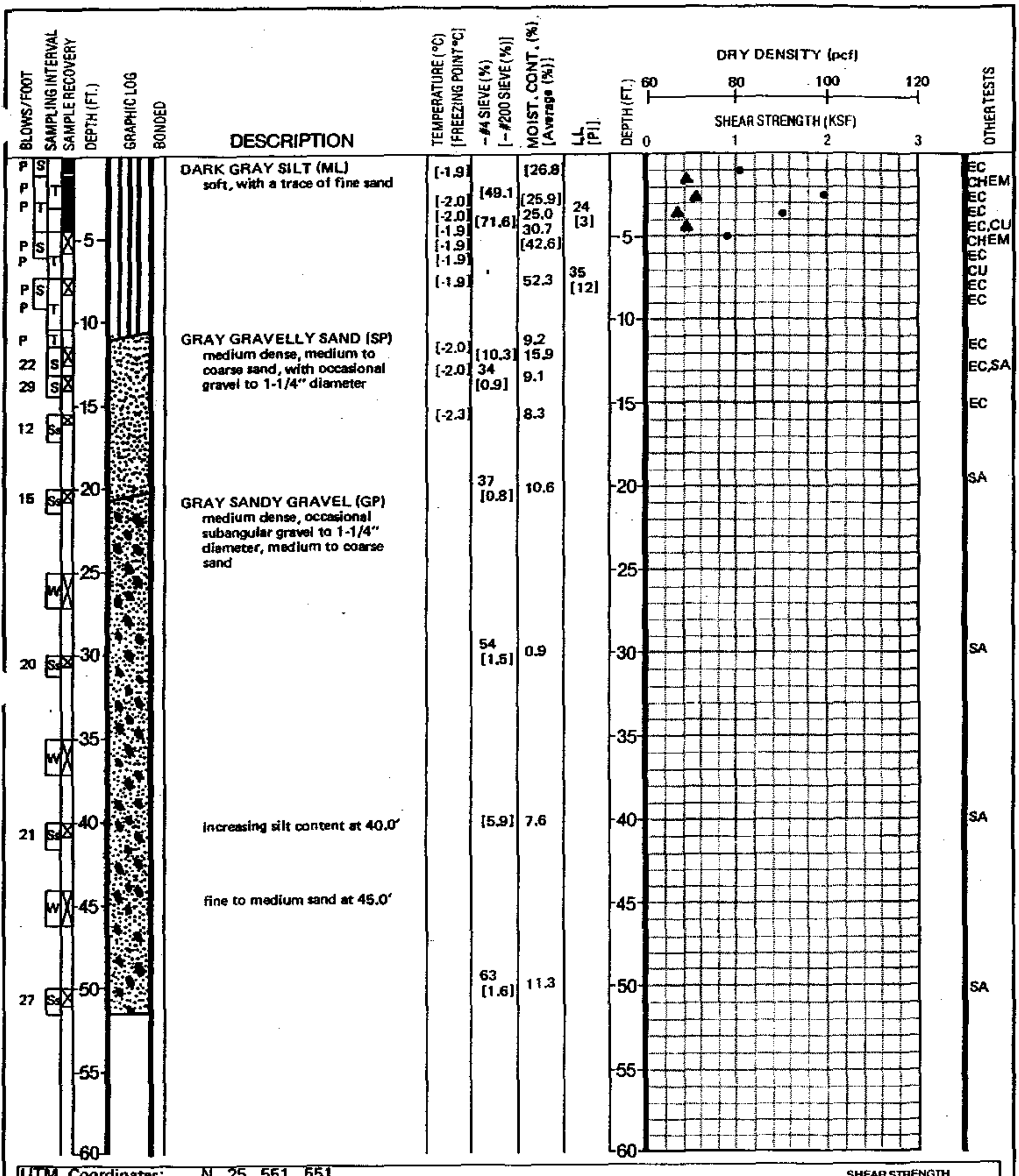
Date: 4-82

LOG OF BORING NO. 21

Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE

B-21



BLOWS/FOOT	SAMPLING INTERVAL	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
P	S	**DARK GRAY SILT (ML)** soft, with a trace of fine sand	[-1.9]		[26.8]		EC
P	T			[49.1			CHEM
P	T		[-2.0]		[25.9]	24	EC
			[-2.0]	[71.6]	25.0	[3]	EC
			[-1.9]		30.7		EC,CU
P	S		[-1.9]		[42.6]		CHEM
P	T		[-1.9]				EC
						35	CU
P	S		[-1.9]		52.3	[12]	EC
P	T						EC
P	T	**GRAY GRAVELLY SAND (SP)** medium dense, medium to coarse sand, with occasional gravel to 1-1/4" diameter	[-2.0]		9.2		EC
22	S			[10.3]	15.9		EC,SA
29	S		[-2.0]	34 [0.9]	9.1		
12	Ss		[-2.3]		8.3		EC
15	Ss			37 [0.8]	10.6		SA
		GRAY SANDY GRAVEL (GP) medium dense, occasional subangular gravel to 1-1/4" diameter, medium to coarse sand					
	W						
20	Ss			54 [1.5]	0.9		SA
	W						
21	Ss	increasing silt content at 40.0'		[5.9]	7.6		SA
	W	fine to medium sand at 45.0'					
27	Ss			63 [1.6]	11.3		SA

UTM Coordinates: N 25 551 551
E 1 677 694
Water Depth: 15.0'
Equipment: Mobile B-61, Rotary Wash

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-6-82
Logged By: M.R. Musial
R.H. Prescott

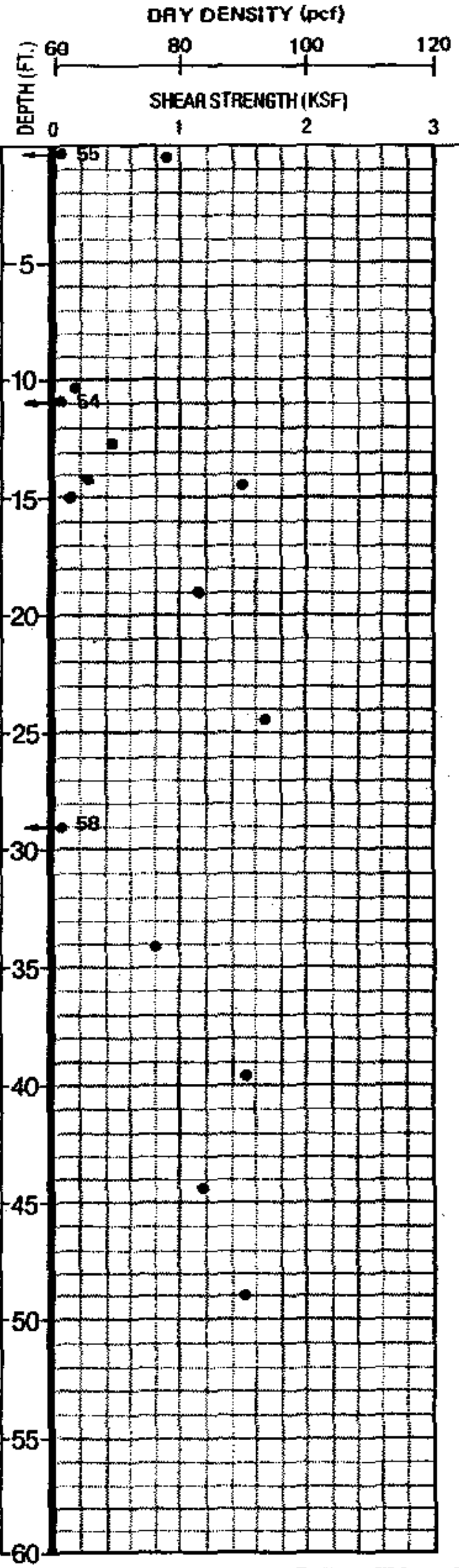
Job Number: 9612,031.08

Approved: DGB
Date: 4-82

LOG OF BORING NO. 22
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-22

BLOWS/FOOT	DEPTH (FT.)	DESCRIPTION	TEMPERATURE (°C) [FREEZING POINT °C]	−#4 SIEVE (%) [−#200 SIEVE (%)]	MOIST. CONT. (%) [Average (%)]	LL [PI]	OTHER TESTS
133		**BROWN SILT (ML,V_x)** V_x to 1/4" diameter, 20-25% visible ice	[-0.1]		42.9 29.5	21 [8]	TCON TC,EC
83/9"					30.3 23.2		TCON
67/9"	5	**MASSIVE ICE (ICE)**					
34/9"			[0.0]				EC
47/9"			[0.0]				EC
102/9"	10	**BROWN SANDY SILT (ML,V_x)** 15-20% visible ice content, V_x to 1/4" diameter	[0.6]	[88.4]	41.6 47.4		EC TCON
100		**GRAY SILTY CLAY (CL,V_r)** V_r to 1" thick, with 20-40% visible ice			64.6 49.1	33 [11]	TC
80	15		[-1.5]		30.8 37.8 56.7		EC
83	20				31.9		
		less ice below 20 feet					
102	25						
107/6"	30	**BROWN SILTY SAND (SM,N_{be})** fine to medium sand	[-0.4]	[15.5]	23.7 22.8		EC
		GRAY SILTY CLAY (CL,V_x/V_r) V_x to 1/4" diameter, V_r to 1/4" thick, 5-10% visible ice					
98	35				32.5		
76	40	V_r to 1/8" thick at 39.0'			27.7	27 [7]	TCON
30/10"	45				27.2		
56	50		[-1.4]		29.3 25.5		EC
	55						
	60						



UTM Coordinates: N 25 548 668
E 1 763 017

Water Depth: - - -

Equipment: Mobile B-61, 8" Hollow Stem Auger

SHEAR STRENGTH
▲ — Torvane
△ — Compression Test

Date Completed: 3-11-82
Logged By: P.J. Ondra

Approved: DEB
Date: 4-82

Job Number: 9612,031.08

LOG OF BORING NO. 23
Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
B-23

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS					TYPICAL NAMES
COARSE GRAINED SOILS MORE THAN HALF IS LARGER THAN #200 SIEVE	GRAVELS MORE THAN HALF COARSE FRACTION IS LARGER THAN NO. 4 SIEVE SIZE	CLEAN GRAVELS WITH LITTLE OR NO FINES	GW	⁘	WELL GRADED GRAVELS, GRAVEL - SAND MIXTURES
			GP	⁘	POORLY GRADED GRAVELS, GRAVEL - SAND MIXTURES
		GRAVELS WITH OVER 12% FINES	GM	▥	SILTY GRAVELS, POORLY GRADED GRAVEL - SAND - SILT MIXTURES
			GC	▨	CLAYEY GRAVELS, POORLY GRADED GRAVEL - SAND - CLAY MIXTURES
	SANDS MORE THAN HALF COARSE FRACTION IS SMALLER THAN NO. 4 SIEVE SIZE	CLEAN SANDS WITH LITTLE OR NO FINES	SW	⁘	WELL GRADED SANDS, GRAVELLY SANDS
			SP	⁘	POORLY GRADED SANDS, GRAVELLY SANDS
		SANDS WITH OVER 12% FINES	SM	▥	SILTY SANDS, POORLY GRADED SAND - SILT MIXTURES
			SC	▩	CLAYEY SANDS, POORLY GRADED SAND - CLAY MIXTURES
FINE GRAINED SOILS MORE THAN HALF IS SMALLER THAN #200 SIEVE	SILTS AND CLAYS LIQUID LIMIT LESS THAN 50		ML	▥	INORGANIC SILTS AND VERY FINE SANDS, ROCK FLOUR, SILTY OR CLAYEY FINE SANDS, OR CLAYEY SILTS WITH SLIGHT PLASTICITY
			CL	▨	INORGANIC CLAYS OF LOW TO MEDIUM PLASTICITY, GRAVELLY CLAYS, SANDY CLAYS, SILTY CLAYS, LEAN CLAYS
			OL	▥	ORGANIC CLAYS AND ORGANIC SILTY CLAYS OF LOW PLASTICITY
	SILTS AND CLAYS LIQUID LIMIT GREATER THAN 50		MH	▥	INORGANIC SILTS, MICACEOUS OR DIATOMACIOUS FINE SANDY OR SILTY SOILS, ELASTIC SILTS
			CH	▨	INORGANIC CLAYS OF HIGH PLASTICITY, FAT CLAYS
			OH	▩	ORGANIC CLAYS OF MEDIUM TO HIGH PLASTICITY, ORGANIC SILTS
HIGHLY ORGANIC SOILS			Pt	▤	PEAT AND OTHER HIGHLY ORGANIC SOILS

KEY TO TEST DATA

CON - Consolidation
TCON - Thaw Consolidation
LL - Liquid Limit (in %)
PL - Plastic Limit (in %)
G_s - Specific Gravity
SA - Sieve Analysis
MA - Mechanical Analysis
UU - Unconsolidated Undrained Triaxial
CU - Consolidated Undrained Triaxial
CD - Consolidated Drained Triaxial
UC, F - Unconfined Compression, frozen
EC - Electrical Conductivity
TC - Thermal Conductivity
PI* - Nonplastic

KEY TO SAMPLE TYPE

T - Shelby Tube
S - 3" Split Spoon
S_s - 2" Split Spoon
W - Rotary Wash
G_b - Driven Thickwalled Tube
G - Grab
P - Pushed
■ - "Undisturbed" Sample
☒ - Bulk or Grab Sample

ICE DESCRIPTIONS

GROUP SYMBOL	ICE VISIBILITY AND CONTENT	SUBGROUP			
		DESCRIPTION		SYMBOL	
N	Segregated ice not visible by eye	Poorly bonded or friable		N_f	
		Well bonded	No Excess Ice	N_b	N_{bn}
			Excess ice microscopic		N_{be}
V	Segregated ice is visible by eye, ice one inch or less in thickness	Individual ice crystals or inclusions		V_x	
		Ice coatings on particles		V_c	
		Random or irregularly oriented ice formations		V_r	
		Stratified or distinctly oriented ice formations		V_s	
ICE	Ice greater than one inch in thickness	Ice with soil inclusions		ICE + soil type	
		Ice without soil inclusions		ICE	

Harding Lawson Associates
Engineers, Geologists
& Geophysicists

Unified Soil Classification and Key to Test Data
Pt. Thomson Development Project, Winter 1982
Geotechnical Study, EXXON Company, U.S.A.

PLATE
B-24

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9612,031.08	DOB	4/82		

It was also used on occasion to move the drill rig between test borings. Because rough ice conditions necessitated slow travel time, most rig moves were accomplished using the D-6 Cat. A Tucker "Sno-cat" was occasionally used to transport crews.

The drill crews were quartered in a 16-person sled-camp stationed on the ice at Point Hopson. The camp was equipped with sleeping units, kitchen, shower, water shack, and a diesel generator for electrical power. Communications were maintained between the camp and drilling enclosure and between the camp and CATCO operations office using radios.

1. Drilling Methods

With the exception of Borings 19 and 23, the offshore test borings were drilled with rotary wash techniques utilizing sea water drilling fluid. The criteria for determining the total depth of drilling were as follows:

1. In all cases, a minimum depth of 50 feet below the ground surface or mudline
2. Five feet into coarse-grained soil (gravels or gravelly soil)
3. Fifteen feet into ice-bonded soil

Each test boring was cased with 4-inch I. D. casing from the enclosure deck to at least 10 feet below mudline. Additional casing was used when the test boring would not stay open during either the drilling or sampling operations. The casing was advanced and retracted using a 300-pound safety drop hammer. Borings 19 and 23 were drilled with 8-inch O.D. hollow stem auger and a Nodwell-mounted B-61 drill rig as described in Section C of this Appendix.

2. Sampling Methods

Sampling was performed continuously to at least 15 feet below mudline and at 5 to 10 foot intervals throughout the remaining depth of the test borings. The four types of samples and the procedures used to obtain samples are discussed in the following sections. The symbol in parentheses following the sample type appears on the test boring logs and designates the sampling method used. The symbol corresponds to those presented on the Test Boring Key Sheet, Plate B-24.

a. Undisturbed Samples (T)

Undisturbed samples were taken with Shelby tubes in accordance with ASTM Test Method D 1587-74. The Shelby sampler was a 2.87-inch I.D. by 36-inch long steel tube. The tube was placed at the bottom of the test boring and pushed (P) by the hydraulic system of the drill rig approximately 34 inches into the soil or to refusal. This method was used in soft to stiff silts and clays and in loose to medium dense sands.

b. Drive Samples (S) and (Ss)

Drive sampling was performed by driving a split-spoon sampler either 18 inches into the soil or to refusal. Two sizes of split-spoon were used depending upon the soil conditions. A 2.4-inch I.D. by 3.0-inch O.D. sampler (S), containing three 6.0-inch brass liners to retain the sample, was primarily used to sample coarse-grained soil and hard silts and clays that could not be sampled using a Shelby tube. The 2.4-inch I.D. sampler was also used to recover disturbed specimens that were not recovered when using a Shelby tube. Where dense or ice-bonded coarse-grained soils were encountered, drive samples were taken with a 1.4-inch I.D. by 2.0-inch O.D. (Ss) split-spoon sampler.

Both sizes of samplers were advanced by either a 300-pound hammer falling 30 inches, or by the hydraulic system of the drill rig. When the hammer was used, the number of blows required to drive each 6-inch increment was recorded. This driving information is presented on the test boring logs as the number of blows required to drive the sampler the last 12 inches, or fraction thereof.

c. Grab Samples (G)

Grab samples were occasionally taken during auger drilling on the barrier islands. Samples were either taken from the auger cuttings or directly from the augers as they were pulled from the hole.

d. Rotary Wash Samples (W)

Rotary wash samples consist of soil particles that have settled out of the circulating wash water after it has been run through a sieve. This technique was primarily used if representative samples of gravel could not be obtained by using the split-spoon sampler. The wash technique was also used to obtain intermediate samples when the sampling interval was greater than five feet. Since the grinding action of the bit within the casing breaks down the larger gravel particles, the in situ materials are probably more coarsely graded than these specimens indicate.

C. Onshore Drilling Investigation

Five test borings were drilled to explore the onshore soil conditions between March 4 and 8, 1982. The depths drilled varied between 48.5 to 50.5 feet; the conditions encountered are shown on the Test Boring Logs. Thermistor wells were installed in Test Borings 7 and 13.

The onshore borings and the two borings on Flaxman Island were drilled with a Mobile Drill B-61 rig that was equipped with eight-inch O.D. hollow-stem auger and mounted on a Nodwell carrier. A Tucker Sno-cat was used to transport the crew to the rig, as a work station for the geologist, and as a shelter from the weather.

The onshore drill crew worked a single 12-hour shift and consisted of a geologist, a driller, and a drill helper. The geologist directed the drilling operation, logged the soils encountered in the borings, and obtained representative samples for laboratory testing.

The majority of the samples that were taken were either type (S) or type (G), as discussed in the offshore investigation section. Modified Shelby tubes (T) were also used occasionally. These samplers are standard Shelby tubes with hardened cutting teeth. They are drilled (D) into bonded, fine-grained soil by slowly rotating the sampler while applying pressure by the drill rig hydraulic system.

D. Sample Handling

The soil samples were visually examined, classified and logged in the field by our engineer/geologist. Whenever possible, sample temperatures as well as torvane and/or pocket penetrometer readings were taken. Shelby tubes and split-spoon liners were sealed with electrical tape to prevent moisture loss and then tagged. Bulk and grab samples were placed in heavy-duty plastic bags, sealed, and tagged. In the field, unbonded samples were protected against freezing by storing them in either a cooler chest or heated enclosure. Bonded samples were kept frozen by storing them in either a cooler chest that was packed with blue-ice or a chest freezer.

All of the samples from the onshore borings were returned to our operations base at Deadhorse on a regular basis. The bonded samples from the offshore borings were stored in a chest freezer at -10^0C until the end of the drilling program. Unbonded offshore samples were transported daily to the camp, where they were stored in a heated room until they could be transferred to Deadhorse. In Deadhorse, all of the bonded samples were stored in a chest freezer for a minimum amount of time until they could be shipped via air freight to our laboratory in Anchorage. To protect the bonded specimens from thermal shock, they were shipped in insulated containers and stored in our laboratory cold room at -6^0C until tested.

E. Drilling Operations Diary

Date	Activity
3/03/82	Moved drill rigs, sled-camp and crew to PTD project area, offshore rig began drilling Test Boring 6 (TB 6).
3/04/82	Completed TB 6 and installed a thermistor string. Moved to and began drilling TB 3. Onshore rig (Nodwell) moved to and completed TB 7 and installed thermistor well.
3/05/82	Completed TB 3. Moved to and began drilling TB 22. Nodwell moved to and completed TB 1.
3/06/82	Completed TB 22. Moved to and began drilling TB 2. Nodwell moved to and completed TB 12.
3/07/82	Completed TB 2. Moved to and completed TB 4. Moved to TB 5. Nodwell - mechanical standby - starter malfunctioned.
3/08/82	Completed TB 5 and installed thermistor well. Moved to and began drilling TB 21. Nodwell moved to and completed TB 13 and installed thermistor well.
3/09/82	Completed TB 21. Moved to and completed TB 10. Moved to and began drilling TB 9. Nodwell moved to and completed TB 18.
3/10/82	Completed TB 9. Moved to and began drilling TB 8. Nodwell moved to and completed TB 19 and installed thermistor well.

E. Drilling Operations Diary (continued)

3/11/82	Completed TB 8. Moved to and completed TB 11. Moved to and began drilling TB 14. Nodwell moved to and completed TB 23.
3/12/82	Completed TB 14. Moved to and began drilling TB 16. TB 16 terminated at 25.5 feet due to ice movement and high winds. Installed thermistor string. Moved to and began drilling TB 15. Nodwell drill rig and crews demobilized.
3/13/82	Completed TB 15. Moved to and began drilling TB 17.
3/14/82	Completed TB 17 and installed thermistor string. Moved to and began drilling TB 20.
3/15/82	Completed TB 20. Demobilized enclosed drill rig, sled-camp and crews.

APPENDIX C
GROUND TEMPERATURE MEASUREMENTS

LIST OF TABLES

LIST OF ILLUSTRATIONS

APPENDIX C
GROUND TEMPERATURE MEASUREMENTS

A. General

Three thermistor strings and four thermistor wells were installed in the test borings listed in Table C-1.

TABLE C-1. THERMISTOR INSTALLATIONS

Test Boring	Location of Installation	Depth of Test Boring (ft)	Date Boring Completed	Total Depth of Temperature Data (ft)
5	Barrier Island	51.5	03/08/82	50.0
6	Offshore	51.5	03/04/82	45.0
7	Onshore	49.0	03/04/82	49.0
13	Onshore	50.0	03/08/82	50.0
16	Offshore	25.5	03/12/82	21.0
17	Offshore	50.5	03/13/82	45.0
19	Barrier Island	50.5	03/10/82	50.0

B. Equipment

1. Offshore

Hard-wired thermistor strings were used to obtain ground temperature measurements in the offshore test borings. The strings were constructed using 20-gauge, 52-conductor cable and YSI Model 44034 bead-in-glass thermistors. The Model 44034 thermistor has an interchangeability of $\pm 0.1^{o}C$ between $-10^{o}C$ to $80^{o}C$, a resistance of 5000 ohms at $25^{o}C$, and exhibits a resistance change of approximately 860 ohms per degree centigrade.

Each thermistor string was 175 feet long, including a 75-foot lead-wire, and contained 24 thermistors spaced at 3-foot intervals for the first 21 feet and 5-foot intervals to 100 feet. The thermistors were installed through an incision in the cable sheath and individually grounded. They were then sealed into the cable with heat shrink tubing, and silicone caulk and the incision was covered with heat-shrink tubing. Finally, a 41-pin, male plug was installed on the lead-out end of the thermistor string and covered with a waterproof cap. The thermistors were placed in an ice bath held at a constant $0^{o}C$ and the corresponding resistance was compared to the manufacturers' values.

2. Onshore and Barrier Islands

Ground temperature measurements for the barrier islands and onshore test borings were recorded using a retractable probe that contained a YSI Model 44007 thermistor and a Victory, Serial No. 50 thermistor. The interchangeability of the YSI thermistor is $\pm 0.2^{o}C$ for the temperature range $0^{o}C$ to $80^{o}C$. Also, it has a resistance of 5000 ohms at $25^{o}C$ and exhibits a resistance change of approximately 860 ohms per degree centigrade. The precision calibrated Victory thermistor has an interchangeability of $\pm 0.05^{o}C$ and a resistance of 4560 ohms at $0^{o}C$ and exhibits a resistance change of approximately 220 ohms per degree centigrade.

The thermistors were placed side by side at the bottom of a six-inch-long probe that was attached to a four-conductor lead-out wire manufactured by Berk-Teck Company (Model BTONX-734-2F-Q). One conductor was used for a common ground, one for measuring lead-wire resistance, and the remaining two for measuring the thermistors. The calibration of the probe was performed by Dr. Robert I. Lewellen of Lewellen Arctic Research and can be traced back to the National Bureau of Primary Standards.

C. Thermistor Installation

1. Offshore

The procedure for installing the offshore thermistor strings was as follows:

1. After washing the test boring to remove all of the cuttings, the boring was sounded with a weighted line to confirm that it was open for its entire depth.
2. A length of 1-inch I.D. steel pipe, equal to the total depth of the hole, was attached to flexible hose whose length was equal to the depth from the mudline to the top of the ice. This entire assembly was then set on the bottom of the hole and filled with propylene glycol.
3. The thermistor string and lead-out assembly were trimmed to a length so that the first of the 3-foot interval thermistors was located at the mudline when placed down the pipe. The string was then lowered to the bottom of the steel pipe. An additional 25 feet of flexible hose was attached to the installed hose. This was done so that small ice movement would not destroy the temperature well.
4. The drill casing was pulled from around the thermistor installation and the drill sled was moved off of the site.

2. Onshore and Barrier Islands

The onshore and barrier islands thermistor wells consist of 1-1/4-inch I.D. PVC pipe that is filled with propylene glycol. First, PVC pipe was installed in a completed test boring which was then backfilled. The pipe was then filled with propylene glycol and capped until ground temperature readings are taken.

D. Thermistor Readings and Data Reduction

The resistance values were reduced to ground temperatures using the following relationship:

1. Offshore

The thermistor strings were allowed to equilibrate for periods ranging from 10 days to 4 weeks before the ground temperatures were recorded. These readings were obtained using a switchbox and a Data Precision Model 248 multi-meter. The multi-meter displays 4.5 digits and is capable of measuring and resolving resistance to 1 ohm. When combined, the YSI thermistors and the multi-meter have a precision of $\pm 0.1^{\circ}$C and an accuracy of $\pm 0.2^{\circ}$.

2. Onshore and Barrier Islands Ground Temperatures

The thermistor wells were allowed to equilibrate for up to 4 weeks before the final ground temperatures were measured. The resistance readings were taken by using a Data Precision Model 248 multi-meter, as described above. When combined, the calibrated bead-in-glass thermistors and the Model 248 multi-meter have a precision of $\pm 0.05^{\circ}$C and an accuracy of $\pm 0.1^{\circ}$C.

Resistance readings were taken at 2-foot to 5-foot intervals from the ground surface to the bottom of the thermistor well. All of the depths were referenced to the ground surface surrounding the thermistor well. The thermistors were monitored at each depth until a stabilized reading was obtained. Stabilization time varied from up to 30 minutes in the upper 10 feet and 1 to 3 minutes in the lower portion of the boring. To avoid inducing heating in the thermistors, the multi-meter was turned off between readings. Once a stabilized value was obtained, the lead-wire resistance was recorded and the probe was lowered to the next depth. It took approximately 60 minutes to monitor the borings.

3. Data Reduction

The resistance values obtained in the field were corrected for lead-wire resistance by subtracting the measured lead-wire resistance from the total resistance. The resistance values were reduced to ground temperatures using the relationships in Equation C-1.

$$(1/T) = A + B\ (\ln R) + C\ (\ln R)^3 \qquad \text{(C-1)}$$

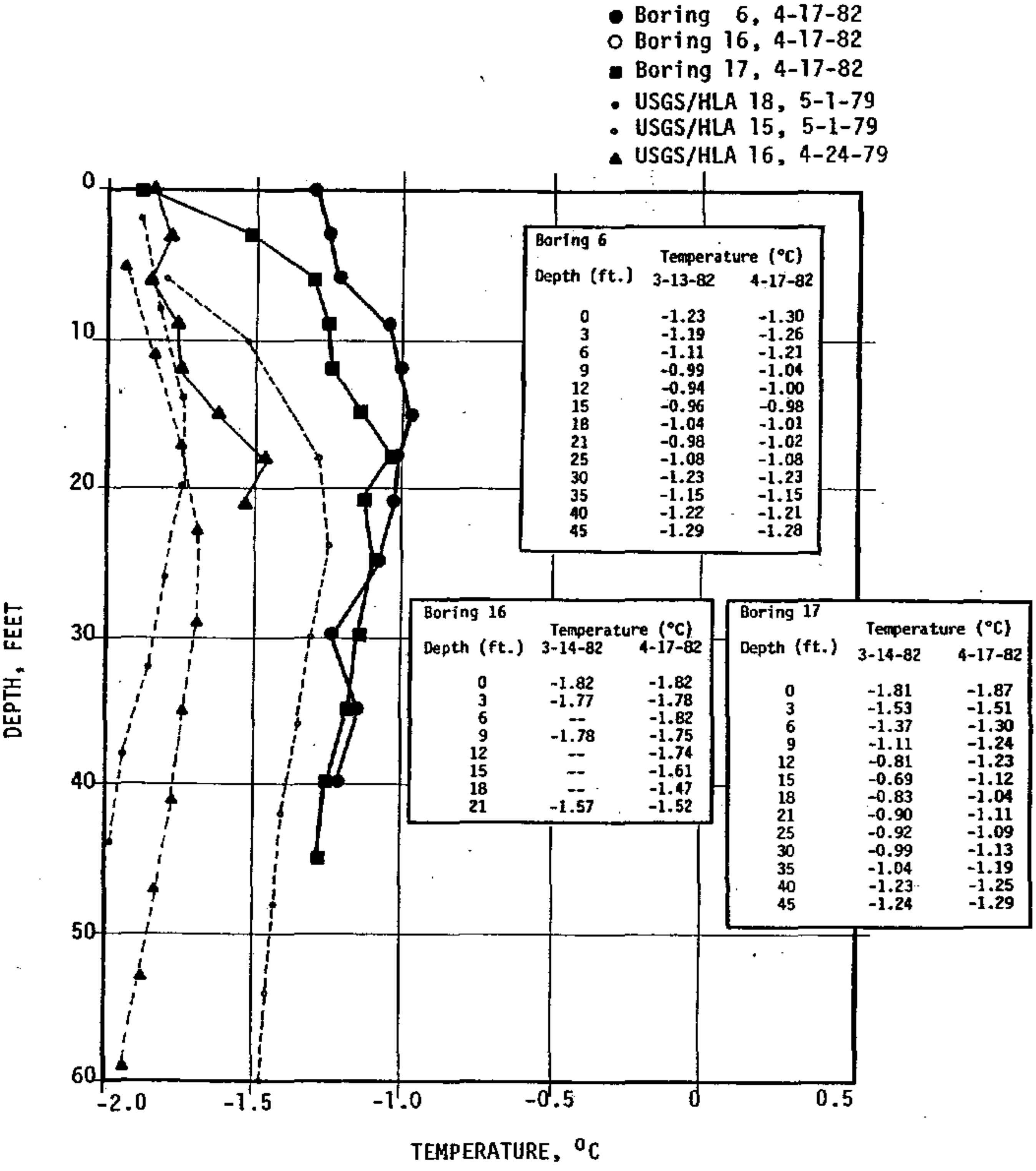
Where:
T = temperature degrees Kelvin
A, B, C = constants for the thermistors based on calibration curves
R = measured resistance in ohms

E. Findings

Plate C-1 shows the data obtained from the offshore Test Borings 6, 16, and 17. Furthermore, ground temperature data that were obtained in 1979 from HLA/USGS Test Borings 15, 16 and 18 are shown for purposes of comparison. The level of zero annual temperature change appears at a depth of 30 to 40 for the test borings.

Ground temperature data that were obtained from the onshore test borings are presented on Plate C-2. The data indicate that there is very little difference in onshore ground temperatures between the two borings. The level of zero temperature change appears at a depth of 30 to 50 feet in both test borings.

Barrier islands ground temperature data are shown on Plate C-3. Data obtained in 1980 from Drilling Pads F and D are also shown for comparison. The data for Test Borings 5 and 19 yield well-defined curves that appear to converge to a line of zero temperature change at a depth of 40 to 50 feet.



Boring 6

Depth (ft.)	Temperature (°C) 3-13-82	4-17-82
0	-1.23	-1.30
3	-1.19	-1.26
6	-1.11	-1.21
9	-0.99	-1.04
12	-0.94	-1.00
15	-0.96	-0.98
18	-1.04	-1.01
21	-0.98	-1.02
25	-1.08	-1.08
30	-1.23	-1.23
35	-1.15	-1.15
40	-1.22	-1.21
45	-1.29	-1.28

Boring 16

Depth (ft.)	Temperature (°C) 3-14-82	4-17-82
0	-1.82	-1.82
3	-1.77	-1.78
6	--	-1.82
9	-1.78	-1.75
12	--	-1.74
15	--	-1.61
18	--	-1.47
21	-1.57	-1.52

Boring 17

Depth (ft.)	Temperature (°C) 3-14-82	4-17-82
0	-1.81	-1.87
3	-1.53	-1.51
6	-1.37	-1.30
9	-1.11	-1.24
12	-0.81	-1.23
15	-0.69	-1.12
18	-0.83	-1.04
21	-0.90	-1.11
25	-0.92	-1.09
30	-0.99	-1.13
35	-1.04	-1.19
40	-1.23	-1.25
45	-1.24	-1.29

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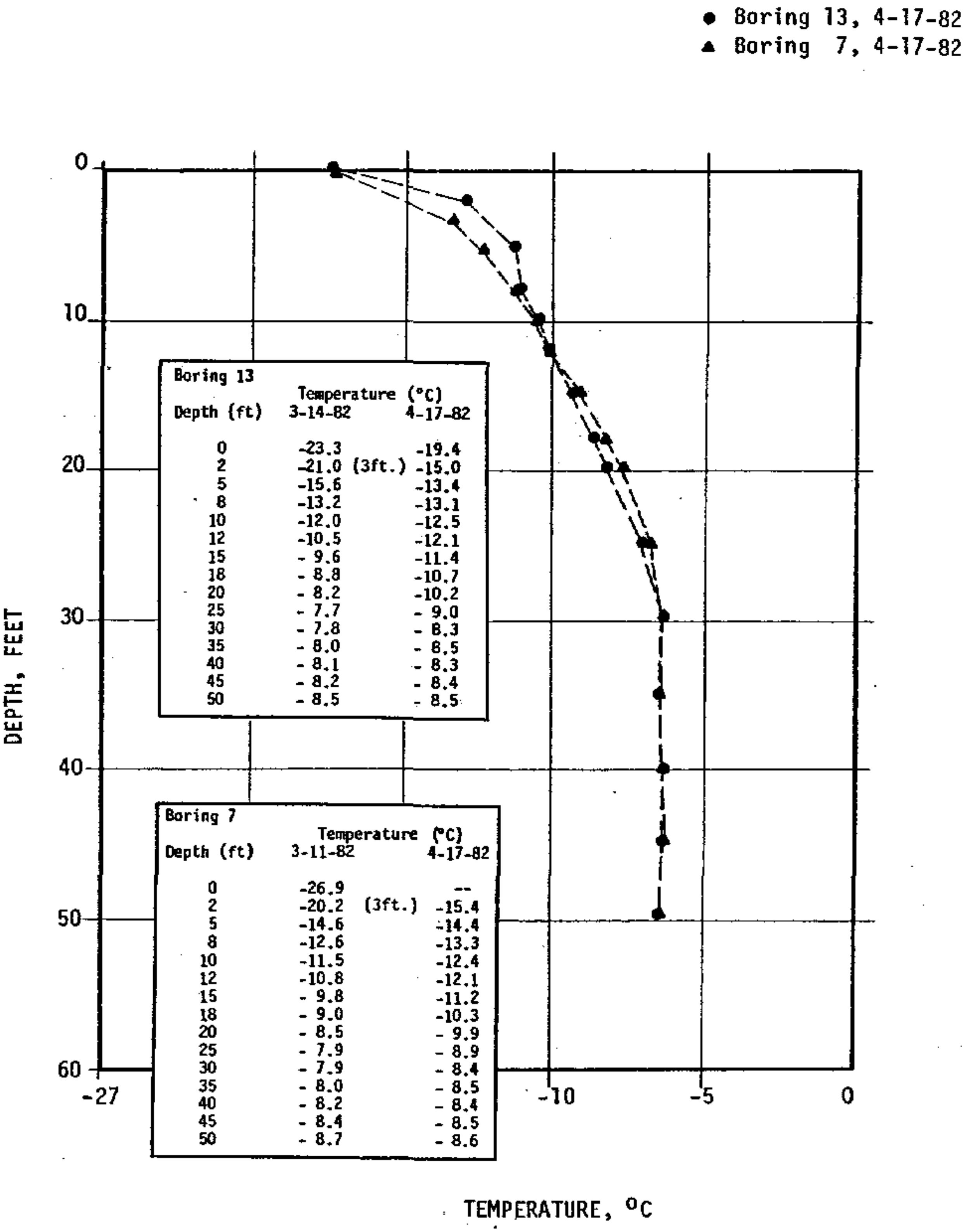
Ground Temperature vs Depth ,Offshore

Pt. Thomson Development Project
Winter 1982, Geotechnical Study
EXXON Company, U.S.A.

PLATE
C-1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9612,031.08		4/82		



Boring 13

Depth (ft)	Temperature (°C) 3-14-82	Temperature (°C) 4-17-82
0	-23.3	-19.4
2	-21.0 (3ft.)	-15.0
5	-15.6	-13.4
8	-13.2	-13.1
10	-12.0	-12.5
12	-10.5	-12.1
15	- 9.6	-11.4
18	- 8.8	-10.7
20	- 8.2	-10.2
25	- 7.7	- 9.0
30	- 7.8	- 8.3
35	- 8.0	- 8.5
40	- 8.1	- 8.3
45	- 8.2	- 8.4
50	- 8.5	- 8.5

Boring 7

Depth (ft)	Temperature (°C) 3-11-82	Temperature (°C) 4-17-82
0	-26.9	--
2	-20.2 (3ft.)	-15.4
5	-14.6	-14.4
8	-12.6	-13.3
10	-11.5	-12.4
12	-10.8	-12.1
15	- 9.8	-11.2
18	- 9.0	-10.3
20	- 8.5	- 9.9
25	- 7.9	- 8.9
30	- 7.9	- 8.4
35	- 8.0	- 8.5
40	- 8.2	- 8.4
45	- 8.4	- 8.5
50	- 8.7	- 8.6

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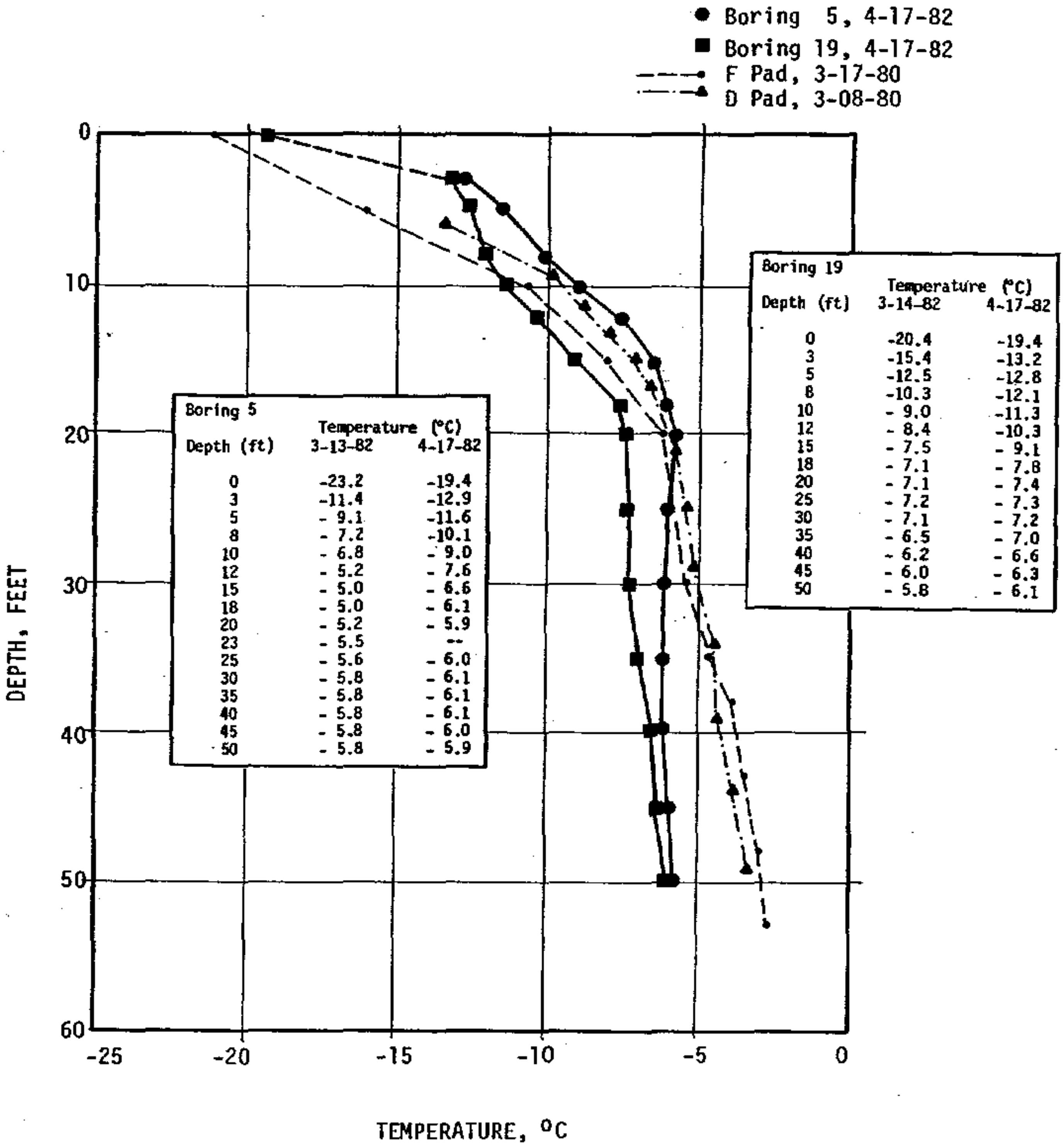
Ground Temperature vs Depth
Onshore Borings

Pt. Thomson Development Project, Winter 1982
Geotechnical Study, EXXON Company, U.S.A.

PLATE
C-2

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	9612,031.08		4/82		



Boring 5

Depth (ft)	Temperature (°C) 3-13-82	4-17-82
0	-23.2	-19.4
3	-11.4	-12.9
5	- 9.1	-11.6
8	- 7.2	-10.1
10	- 6.8	- 9.0
12	- 5.2	- 7.6
15	- 5.0	- 6.6
18	- 5.0	- 6.1
20	- 5.2	- 5.9
23	- 5.5	--
25	- 5.6	- 6.0
30	- 5.8	- 6.1
35	- 5.8	- 6.1
40	- 5.8	- 6.1
45	- 5.8	- 6.0
50	- 5.8	- 5.9

Boring 19

Depth (ft)	Temperature (°C) 3-14-82	4-17-82
0	-20.4	-19.4
3	-15.4	-13.2
5	-12.5	-12.8
8	-10.3	-12.1
10	- 9.0	-11.3
12	- 8.4	-10.3
15	- 7.5	- 9.1
18	- 7.1	- 7.8
20	- 7.1	- 7.4
25	- 7.2	- 7.3
30	- 7.1	- 7.2
35	- 6.5	- 7.0
40	- 6.2	- 6.6
45	- 6.0	- 6.3
50	- 5.8	- 6.1

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Ground Temperature vs Depth for Barrier Islands

Pt. Thomson Development Project, Winter 1982
Geotechnical Study, EXXON Company, U.S.A.

PLATE
C-3

DRAWN
JOB NUMBER 9612,031.08
APPROVED
DATE 4/82
REVISED
DATE

The warmer temperatures recorded in Test Boring 5 are a direct result of the insulation provided by the thick layer of ice and snow at the boring. Below 20 to 30 feet, ground temperatures recorded at Drilling Pads F and D in 1980 were about $1^{0}C$ to $3.5^{o}C$ warmer than those observed during our investigation. This implies that subsea ground temperatures are getting colder due to the presence of the barrier islands.

APPENDIX D
LABORATORY TESTING

LIST OF ILLUSTRATIONS

LIST OF ILLUSTRATIONS
(continued)

APPENDIX D
LABORATORY TESTING

A. General

A comprehensive laboratory testing program was conducted by Harding Lawson Associates to evaluate the properties of soil samples obtained from test borings drilled for the Point Thomson Development, Winter 1982 Geotechnical Study. Details of the field investigation program are given in Appendix B.

Soil index tests were performed to classify the sampled soils and to determine their in situ moisture contents, dry unit weights, grain size distributions, plasticity indexes, specific gravities and organic contents.

Soil strength parameters under static loading conditions were determined by unconsolidated-undrained triaxial shear tests (TXUU), consolidated-undrained triaxial shear tests (TXCU), consolidated-drained triaxial shear tests (TXCD), and direct shear tests (DS).

One-dimensional consolidation tests were used to analyze the soil stress history and deformation behavior of unfrozen samples, while thaw-strain tests were used to analyze the behavior of frozen samples.

The pore water chemistry and freezing point depression of selected samples were determined by conducting both chemistry and salinity tests. Thermal conductivity measurements were made on both frozen and thawed samples for use in performing heat transfer analyses.

The procedures employed in the laboratory testing program were generally in accordance with those suggested by the American Society for Testing and Materials (ASTM). The ASTM designations for the various tests are tabulated below:

Laboratory Test	ASTM Test Method
Visual Classification	D 2488-69
Laboratory Classification	D 2487-69
Moisture Content	D 2216-71
Liquid Limit	D 423-66
Plastic Limit	D 424-59
Particle Size Analysis	D 422-63
Specific Gravity	D 854-58
Triaxial Shear	D 2850-70
Direct Shear	D 3080-72
Consolidation	D 2435-70

Furthermore, several tests were conducted for which there are no suggested ASTM methods. These are as follows:

Laboratory Test

- Sedimentation
- Thaw Consolidation
- Thermal Conductivity
- Geochemical Analysis
- Electrical Conductivity

All of the above test procedures are described in the following sections of this appendix. The laboratory testing program is summarized by test boring on Plates D-1 through D-23.

B. Sample Handling and Visual Classification

1. Sample Storage

Upon arrival at Anchorage International Airport, the soil samples were picked up and delivered to our Anchorage laboratory where they were stored until testing. Four types of samples were received: Shelby tube, brass liner, jar and grab.