#133

A report prepared for

ExxonMobil Production Company
Facilities Engineering and Operations Support
PO Box 2180
Houston, TX 77252

GEOTECHNICAL EXPLORATION
Embankment Material Source
Point Thomson Development Area
North Slope, Alaska

by

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DM&A Job No. 4178.02

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SUMMARY

During March 2000, Duane Miller & Associates (DM&A) drilled and sampled 14 geotechnical borings to explore a potential material site for the development of the Point Thomson Unit. The vicinity of the work is shown on Plate 1. The borings were drilled at the locations shown on Plate 2 and are summarized on Plate 3.

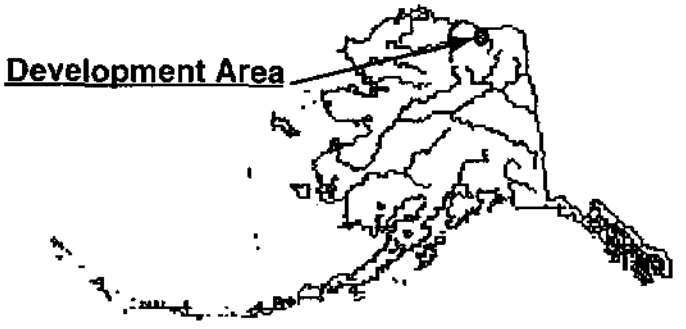
The geotechnical borings were drilled to a maximum depth of 47 feet below the tundra, using a CME-55 drill rig equipped with hollow stem augers. Representative samples of the soil were obtained at regular intervals as the holes were being drilled. The samples were sealed in plastic bags and 5-gallon buckets and shipped to the laboratory in Anchorage where they were tested for ice content, particle size distribution and other index properties.

The borings show that soil and permafrost conditions are quite uniform in the proposed material site area. Tundra organics, silt and ice overlie the sand and gravel material which is found at depths of 3.5 to 12 feet. The average moisture (ice) content in the sand and gravel is about 11% but some very icy zones are present. When the sand and gravel is mined and placed and compacted in the winter, the settlement the following summer after compaction of the thawed material will be 20% to 25% of the winter placed thickness. Larger settlements should be expected if only moderate compaction is applied during the winter placement, and in that case, a thicker embankment should be built in the winter. Additional settlement will occur from melting of snow and ice that was on the tundra when the material was placed.

The lake at the abandoned mine site near Alaska State C-1 was probed for depth and found to have water depths varying from 18 to 35 feet. The probe depths are shown on page 6.

INTRODUCTION

This report presents the results of a geotechnical investigation for the identification of a potential material source for the development of the Pt. Thomson Unit in the eastern area of the north slope of Alaska. The development area is to the west of the Staines River and south of the coastline of the Arctic Ocean and 50 miles east of the Deadhorse Airport at Prudhoe Bay.



In 1998 DM&A compiled existing geotechnical data from previous work in the area and drilled and sampled 14 widely spaced geotechnical borings. The location of much of the 1998 work is shown on Plate 1, and the results of that exploration were presented in our report to BP Exploration (Alaska), Inc., dated August 26, 1998.

In March 2000 we were authorized by ExxonMobil to perform additional geotechnical work in accordance with our proposal to ExxonMobil dated January 9, 2000. The work was coordinated with Mr. Mike Whitehead of ExxonMobil Production Company.

The object of the geotechnical investigation was to provide the data needed for permitting the use of gravel in the development area. The geotechnical work is divided into the following tasks:

- Review and comment on the pit location(s) selected on the basis of fill quantities and haul distances and a review of aerial photography,
- Obtain the necessary permits to perform the field work,
- Drill and sample borings at each material site,
- Check water depths at the lake in the abandoned material site,
- Perform laboratory testing in Anchorage, and,
- Analyze the data and prepare a report.

INVESTIGATION

Exploration plan

The investigation started with a review of existing data from previous explorations in the area and the analysis of gravel requirements by Alaska Interstate Constructors (AIC). AIC performed a gravel use study that identified options for gravel requirements and identified several locations for the "center of mass" of required gravel for different development options. AIC estimated that about 1.5 million cubic yards of material are needed for the development.

An additional criteria for the gravel site was the conversion of the pit after mining to a deep water lake that would provide overwintering habitat for fish. Filling the lake is most easily accomplished from an existing stream rather than relying on surface sheet flow. To avoid possible salt contamination in the deep water lake, the material site should be above the potential storm surges, about elevation 13 feet.

A third criteria is to have the material site near a road that is needed for other purposes.

Considering the most likely development scenarios and existing drainages and the elevation for potential for storm surges, an area was selected for exploration to the south and west of the mine site used for the construction of Alaska State C-1. A road is planned to the area for a runway and to allow water hauling from the lake at the old Alaska State C-1 mine site. A small stream bounds the easterly side of the area that was explored. The regional location of the site is shown on Plate 1, and small scale topography is shown on Plate 2, Boring Locations.

The proposed mine site shown on Plate 2 was the initially selected target, but as indicated by the distribution of borings, the exploration was extended as far north as Boring XX-1 near elevation 16 feet and as far south as XX-10, 900 feet west of the Alaska State C-1 Lake. The 1065-foot by 1590-foot mine site would provide about 60,000 cubic yards of material per foot of depth of usable gravel.

Following the selection of a general area for exploration, DM&A assisted ExxonMobil in obtaining the permits needed for the field work.

Subsurface exploration

Between March 23 and March 26, 2000, fourteen holes were drilled and sampled at the locations shown on Plate 2.

The coordinates of the proposed borings were calculated before the field work began and the hole locations were established in the field using a hand held Trimble Global Positioning System (GPS).

The drill was mounted on a sled, and the drill and operating area were protected from the weather by a framed tent enclosure. The drill equipment was supplied and operated by Discovery Drilling of Anchorage. Logistical support was provided by CATCO from their base of operations at Prudhoe Bay. A roller-driven Rolligon (CATCO RD-85) with 8 supporting air bags was used for transport. The drill rig was moved from site to site by the Rolligon. A 3000-gallon tank, mounted on the Rolligon, served as a fuel supply. The RD-85 also served as crew carrier.

The crews were housed at the CATCO Camp located on the gravel drill pad at Point Thomson 3. No other field camp facilities were utilized.

The work was performed on a double shift basis with crews working 12 hours at the drill rig. Each shift had a 4 person crew consisting of a DM&A geologist or engineer, a Discovery Drilling driller and a drill helper, and a CATCO operator.

The borings were drilled to depths of 29 to 47 feet using a CME-55 soils drill rig equipped with eight-inch OD hollow stem augers. As the borings were drilled, the soil and permafrost conditions were noted and recorded by Mr. Walt Phillips, PG, and Mr. Tom Culkin, geologist. Samples of the soil were obtained by driving split-barrel samplers and by grabbing material off the augers. Sampling was generally attempted at five-foot intervals.

The split-barrel samplers were advanced into the soil below the tip of the auger by driving with an above ground hammer. The CME-55 was equipped

with an automatic hammer system (samples designated as Sh) so all of the blow counts are free-falling without the influence of a cathead. The hammer weighed 340 pounds and had a drop of 30 inches. The drive samples were obtained in a 3-inch OD by 2.5-inch ID split barrel. Blow counts for each 6-inch increment of the drive were recorded. The ice content and soil type of each sample was logged and the samples were sealed in doubled plastic bags. One bulk sample of the gravel material was collected from the auger flights and was packed in a 5-gallon bucket for shipment.

A 3/4-inch PVC pipe was installed in seven of the holes to facilitate future temperature monitoring. The tube extends about 4-feet above the ground or ice surface and was marked by a plastic snow pole. The hole was then backfilled. The locations and conditions at the 14 borings are summarized on Plate 3.

A graphic log of each boring is presented on Plates 4 through 24. The soils and ice have been classified in accordance with the Unified Soil Classification System presented on Plates 25.

Lake probes

The mine site near Alaska State C-1 is now a lake and is proposed as a water source for drilling and camp support. At the end of our exploration work, we drilled through the lake ice and sounded the water depth at seven locations in the area of the lake north of the snow drift that accumulates near the spoil pile. Ice thicknesses varied from 5.5 to 6 feet. The water depths are shown on the following page.

Laboratory testing

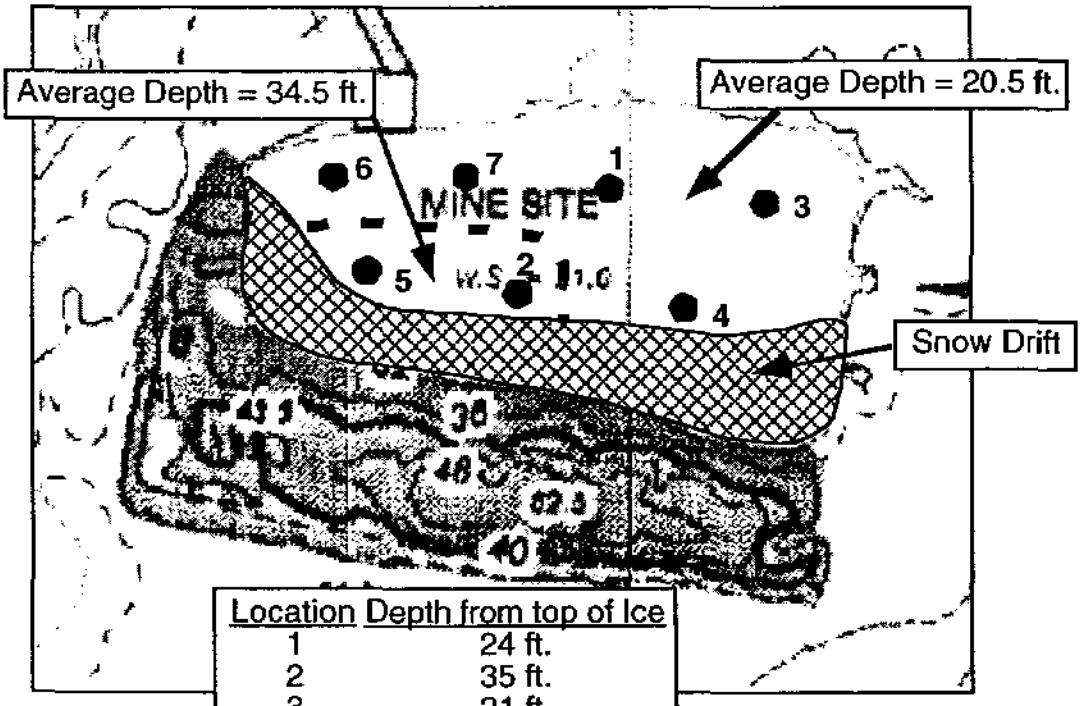
Laboratory testing in Anchorage consisted of primary testing which included moisture contents on most samples, salinity tests and classification tests such as sieve analysis, hydrometer tests and organic content. Salinities were determined by measuring the electrical conductivity of diluted pore fluid and correlating the conductivity to salinity using published values for sea water.

The results of the salinity and moisture contents are graphically shown on the boring logs and are tabulated on the Summary of Samples on Plates 26

through 30. The results of the particle size determinations are shown on Plates 31 through 36.

The one bulk sample was shipped frozen to Anchorage and then allowed to thaw. The measured thaw strain was 34% of the initial height. The sample was then tested for minimum dry density and maximum dry density by pouring the dry material into a mold and by performing a modified Proctor Compaction test. The results are shown on Plate 37.

Water Depth Measurements - March 2000



Location	Depth from top of Ice
1	24 ft.
2	35 ft.
3	21 ft.
4	20 ft.
5	34 ft.
6	18 ft.
7	19 ft.

SITE and SUBSURFACE CONDITIONS

The project area has an arctic coastal climate. The mean annual temperature is 9 °F. Precipitation is light with most occurring during the short summer season and the fall. Wind is generally from the northeast, but strong westerly and southwesterly winds can occur during storms. More detailed review of climate is presented in our report dated August 26, 1998.

The borings were drilled in an area typified by gentle topography, ice bonded permafrost soils and wet tundra. The stream that defines the easterly boundary of the exploration area was drifted full of snow and not obvious when the work was done in March. Elevations vary from 15.5 feet at Boring XX-1 to 32.5 feet at Boring XX-10.

The conditions found in the 14 borings are similar to the conditions found in previous explorations. Soils beneath the tundra consist of a surficial layer of organic soil and silt with sand and gravel at depth. As indicated in the Summary of Borings, Plate 3, the surface of the clean sand and gravel is at depths of 3.5 to 12 feet.

Large amounts of ground ice are present from the top of permafrost to the base of the siltier soils or surface of the sand and gravel. Most of the ground ice is suspected to be wedge ice which forms the perimeters of polygons. However, massive ice was also found within the sand and gravel at depths below where wedge ice would be expected; massive ice was found at 19 feet in Boring XX-2 and at 15 feet in Boring XX-11.

The underlying outwash material is composed primarily of sandy gravel and gravelly sand with a trace to some silt. This material is all ice bonded. In general, ice contents are intergranular; however as discussed above, large masses of segregated ice are occasionally found within the sand and gravel.

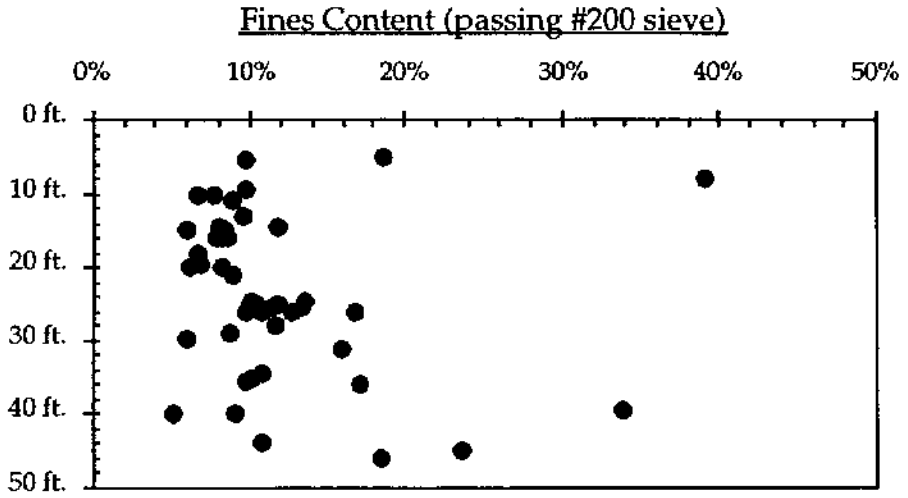
CONCLUSIONS

The outwash material that underlies the area will serve as a source of granular material for the construction of roads, runway and pads for drilling and other production facilities.

The overburden depth of material above the sand and gravel varies from 3.5 feet to 12 feet. The deepest overburden depths were found at the southerly three holes near the creek and at Boring XX-14 west of the proposed access road.

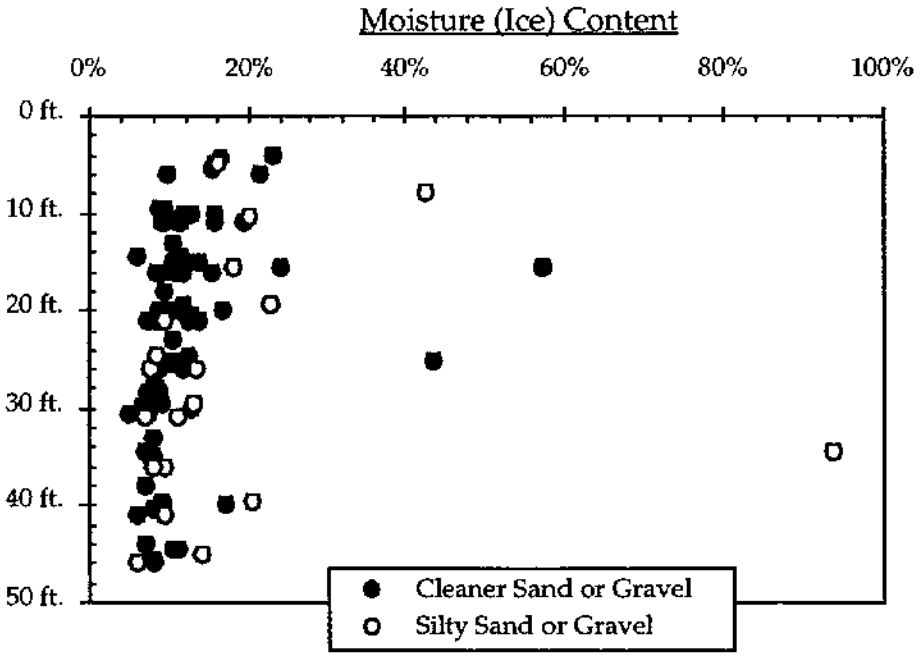
Depth to Sand/Gravel	Borings
< 5 feet	XX-1, XX-2, XX-3, XX-5 and XX-13
5 to 10 feet	XX-4, XX-6, XX-9, XX-11 and XX-12
> 10 feet	XX-7, XX-8, XX-10 and XX-14

The plot below shows the fines content for sand and gravel samples tested for grain size distribution or percentage passing the number 200 sieve size. Excluding the three samples with more than 20% passing the number 200 sieve, the fines content averages 10%; cleaner material appears to be present in the top 22 feet. The material contains more fines than the sources used for the construction of either Badami or Endicott.



The natural moisture content (ice content) controls the densities that can be achieved when the material is placed frozen in the winter, and the greater the ice

content, the greater the shrinkage that occurs during the first summer when the embankment thaws. The following chart shows the variation in moisture contents measured in the sand and gravel samples from the borings. The silty sand or gravel has a fines content of more than 12%.

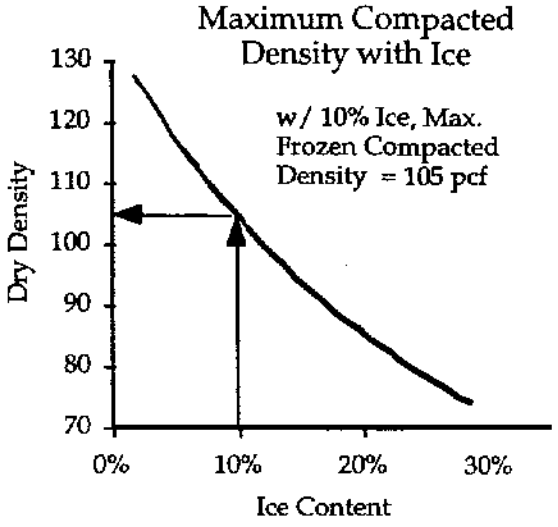


Most of the moisture contents are in the range of 7% to 14%. If the few values over 20% are ignored (these are suspected of being isolated pockets of very icy material) the average moisture content of the clean sand and gravel is 10%. The average for the silty sand or gravel is 11% for the samples with less than 20% ice.

The natural density of the material in place can be calculated using the moisture content and assuming that the voids are saturated (completely filled) with ice. Using the specific gravity of 2.64 for the mineral solids measured in the 1998 exploration, the 10% to 11% average ice content results in an average dry density of 125 to 128 pounds per cubic foot (pcf). Adding the weight of ice increases the total "wet" weight to 139 pcf to 141 pcf for the in place materials.

When this material is mined in the winter by blasting, the resultant aggregate mass of mineral soil and ice has a large void content. A sample of auger cuttings from a depth of 18 feet in Boring XX-6 was tamped by hand into a five-gallon bucket and returned to the laboratory. When frozen, the total density

was only 94 pcf. After the material thawed in the bucket, a total settlement of 34% occurred. Compaction tests of the material showed that the minimum dry density when dry and unfrozen is 119 pcf and the maximum compacted dry density is 144 pcf (see Plate 37). These values are close to those measured in the early 1980's for materials in the Point Thomson area by Harding Lawson Associates.



Higher frozen densities than in the hand tamped bucket can be achieved in the winter with heavy compaction equipment. The adjacent plot shows a curve of maximum dry density that can be achieved for various ice contents. The curve is appropriate for the gravelly sand and is based on past testing of materials from the Point Thomson and Duck Island pits.

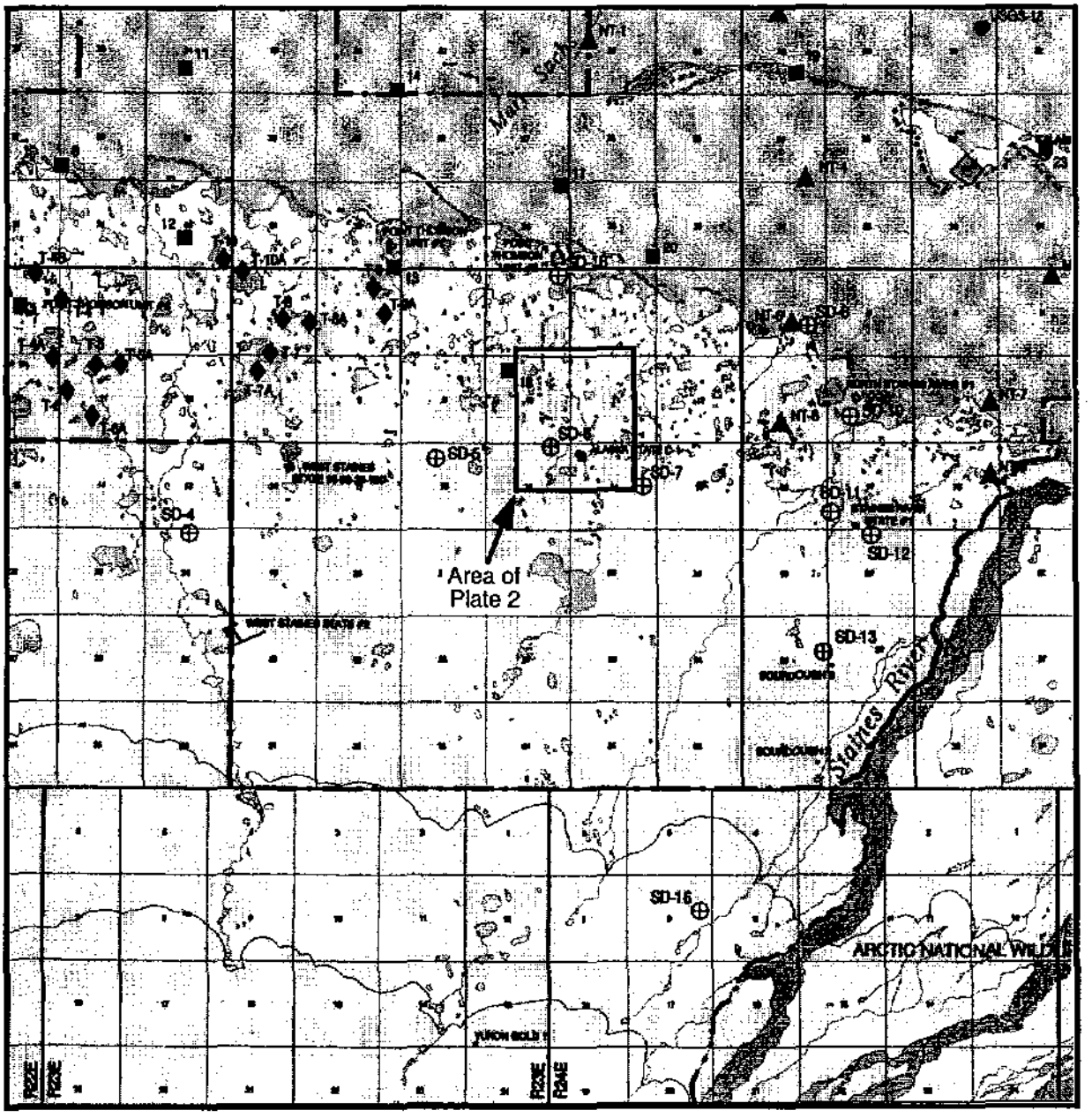
The curve shows that when ice contents exceed about 5%, the frozen material can't be placed and compacted to a dry density even equal to the minimum unfrozen loose density (119 pcf). Therefore, for ice contents greater than 5%, the material will settle when it thaws the first summer. Subsequent compaction after it thaws will lead to a further reduction in volume. For the average ice content of 10%, the winter compacted density will be about 105 pcf. If the material is compacted to 95% relative compaction (137 pcf) the following summer after it thaws, the change in volume would be a shrinkage of about 23%. Therefore, a heavily compacted frozen gravel fill needs to be about 16 inches thick in the winter to result in a 12-inch thick layer after thaw and compaction the following summer. If only moderate compaction is applied during the winter placement, larger thaw settlements will occur the first summer. As shown by our "bucket test", an 18-inch thickness of winter placed fill could be needed to result in a 12-inch loose thickness after thawing. In addition, snow and ice on the tundra at the base of the fill will also melt and add to the settlement that occurs in the first or second summer after winter placement.

The natural moisture contents of the sand and gravel will require drainage or air drying in the first summer in order to achieve a dense compacted material. As shown by the compaction curve on Plate 37, the maximum dry density is 144 pcf. If the material is to be compacted to 95% of this maximum, a dense condition, a dry density of 137 pcf needs to be achieved. The curve shows that 137 pcf cannot be achieved if the moisture content is above about 9%. Because of the higher fines content than materials used on past projects to the west, the time for drainage and drying will be slower than previously experienced.

Considering a natural in place dry density of 125 to 128 pcf and a final compacted dry density of 137 pcf, about 1.1 cubic yards of sand and gravel in the material site will be needed to create 1 cubic yard of final compacted embankment. After blasting and loading, the frozen material bulks to a dry density of 80 to 85 pcf. Therefore, between 1.6 and 1.7 cubic yards of material needs to be hauled by truck for every cubic yard of final compacted embankment.

ILLUSTRATIONS

Plate 1	Project Setting and Previous Data
Plate 2	Boring Locations
Plate 3	Summary of Borings
Plates 4 through 24	Logs of Borings
Plate 25	Soil and Ice Classification Chart and Key to Data
Plates 26 through 30	Summary of Samples
Plates 31 through 36	Particle Size Data
Plate 37	Fill Material Data



0 1 2 3

Scale 1" = 2 miles

- ● 1979 Boring by USGS/HLA
- ◆ 1980 Boring by HLA
- ■ 1982 Boring by HLA
- ▲ 1983 Boring by Nortech
- ⊕ 1998 Boring by DM&A

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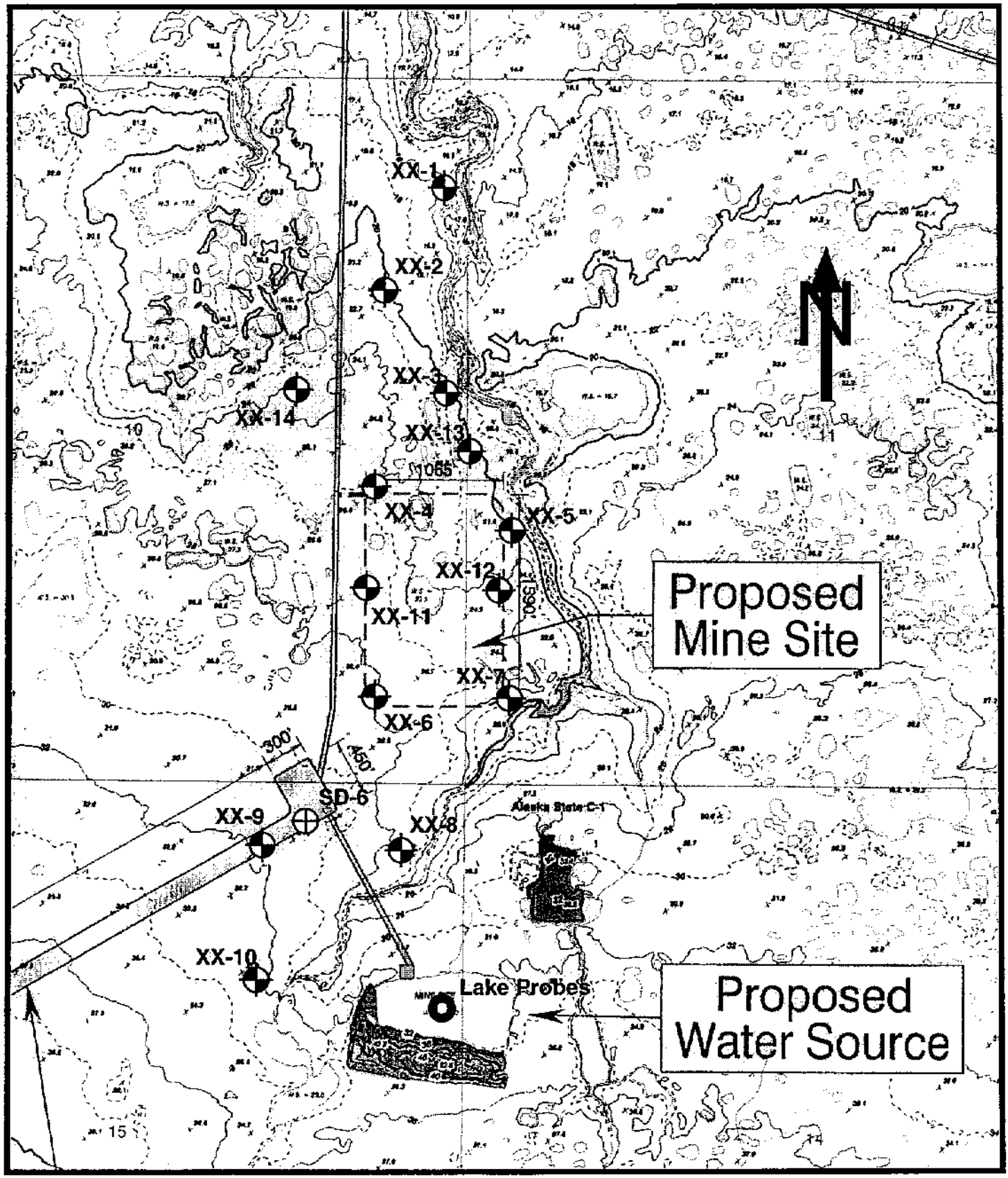
Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : December 2000

PROJECT SETTING and PREVIOUS DATA
Material Source
Pt. Thomson Unit, Alaska

Plate
1



Reference: Point Thomson Planning Map, Sheet 1, BPXA Cartography, February 4, 2000.

0 500 1000 1500

Scale in Feet

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Job No.: 4178.01
Date : Dec. 2000

BORING LOCATIONS
Point Thomson Material Exploration
North Slope, Alaska

Plate
2

Test Hole	Latitude	Longitude	Elevation*	Date Drilled	Snow Depth	Hole Depth	Surface Organics & Silt	Massive Ice	Clean Sand/ Gravel	PVC Depth
XX-1	N 70° 09' 12.7"	W 146° 14' 57.0"	15.5 ft	3/23/00	-	29.5 ft	3.5 ft	-	3.5 ft	29.5 ft
XX-2	N 70° 09' 06.5"	W 146° 15' 10.2"	21.0 ft	3/24/00	-	29.2 ft	3.5 ft	19 to 22 ft	3.5 ft	-
XX-3	N 70° 08' 59.4"	W 146° 14' 53.0"	20.5 ft	3/24/00	-	30.0 ft	4.5 ft	-	4.5 ft	-
XX-4	N 70° 08' 51.6"	W 146° 15' 06.6"	24.5 ft	3/24/00	1.0 ft	45.8 ft	5.5 ft	-	5.5 ft	45.0 ft
XX-5	N 70° 08' 48.7"	W 146° 14' 40.0"	20.5 ft	3/24/00	1.3 ft	30.0 ft	4.0 ft	-	4.0 ft	-
XX-6	N 70° 08' 35.6"	W 146° 15' 06.9"	28.5 ft	3/24/00	1.0 ft	45.0 ft	2.0 ft	2 to 6 ft	6.0 ft	45.0 ft
XX-7	N 70° 08' 36.4"	W 146° 14' 39.9"	24.0 ft	3/24/00	-	45.0 ft	3.3 ft	3.3 to 5.5 ft	12.0 ft	45.0 ft
XX-8	N 70° 08' 27.5"	W 146° 15' 03.7"	27.0 ft	3/25/00	-	29.9 ft	1.5 ft	1.5 to 11 ft	11.0 ft	-
XX-9	N 70° 08' 27.3"	W 146° 15' 22.8"	31.5 ft	3/25/00	-	29.7 ft	1.5 ft	1.5 to 7.3 ft	7.3 ft	-
XX-10	N 70° 08' 15.3"	W 146° 15' 33.3"	32.5 ft	3/25/00	1.2 ft	31.0 ft	2.0 ft	2 to 11 ft	11.0 ft	30.0 ft
XX-11	N 70° 08' 42.5"	W 146° 15' 10.3"	27.0 ft	3/25/00	0.5 ft	46.0 ft	1.5 ft	1.5 to 5.5 ft &10.5 to12 ft &14.5 to 15.5	5.5 ft	-
XX-12	N 70° 08' 43.3"	W 146° 14' 38.3"	24.5 ft	3/25/00	-	46.7 ft	1.0 ft	1 to 6 ft	6.0 ft	-
XX-13	N 70° 08' 52.2"	W 146° 14' 42.3"	20.0 ft	3/26/00	-	46.9 ft	1.5 ft	1.5 to 3.5 ft	3.5 ft	46.0 ft
XX-14	N 70° 08' 58.4"	W 146° 15' 25.6"	24.0 ft	3/26/00	-	45.9 ft	3.0 ft	3 to 10 ft	10.0 ft	45.0 ft

* Elevations are interpolated from the contours on the Pt. Thomson Planning Map by BPXA Cartography, 2/4/2000

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Dec. 2000
Job No. 4178.01

SUMMARY OF BORINGS
Pt. Thomson Material Exploration
North Slope, Alaska

Plate
3

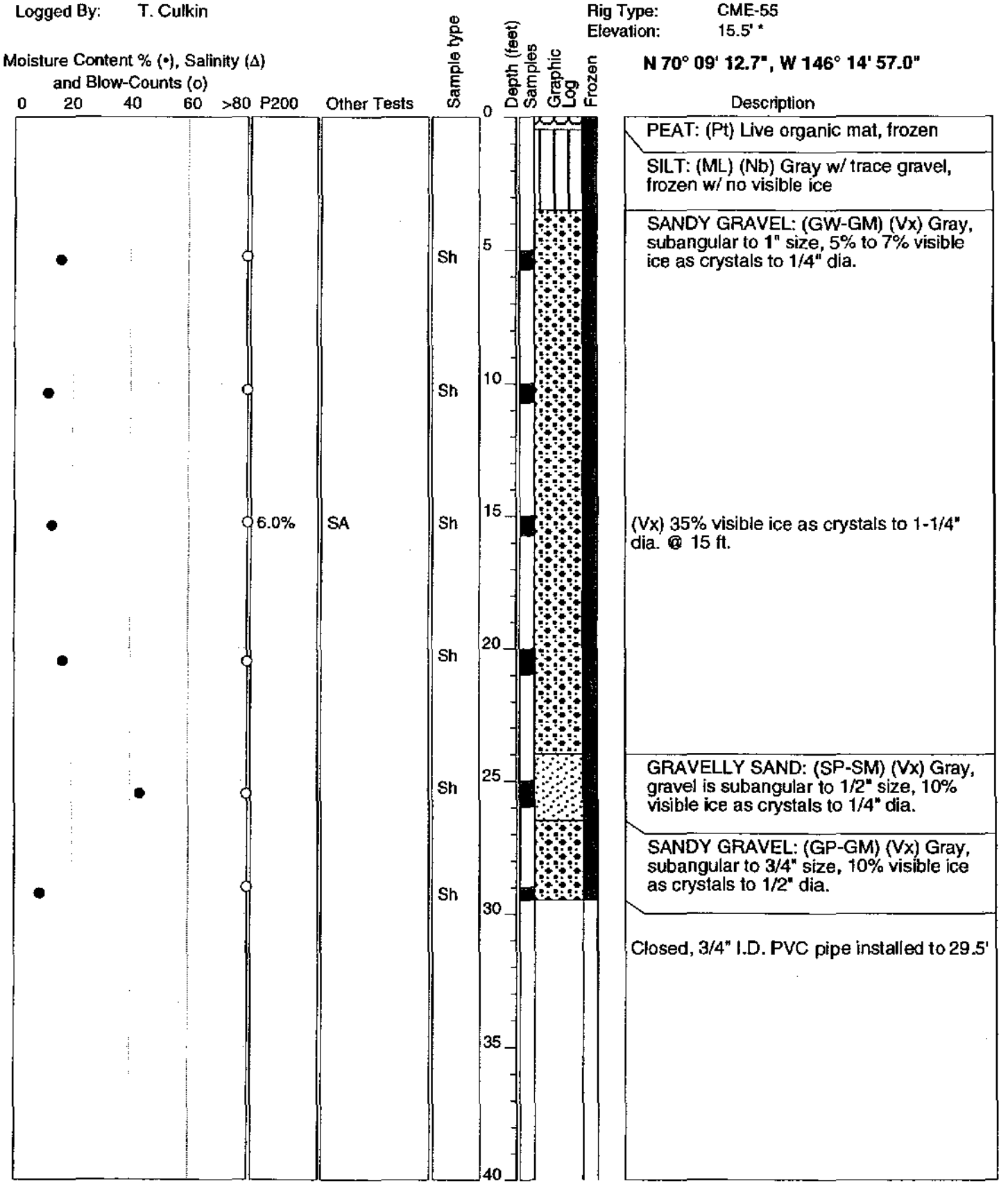
DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-1

Date Drilled: March 23, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 15.5' *

N 70° 09' 12.7", W 146° 14' 57.0"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

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Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-1
Pt. Thomson
North Slope, Alaska

Plate
4

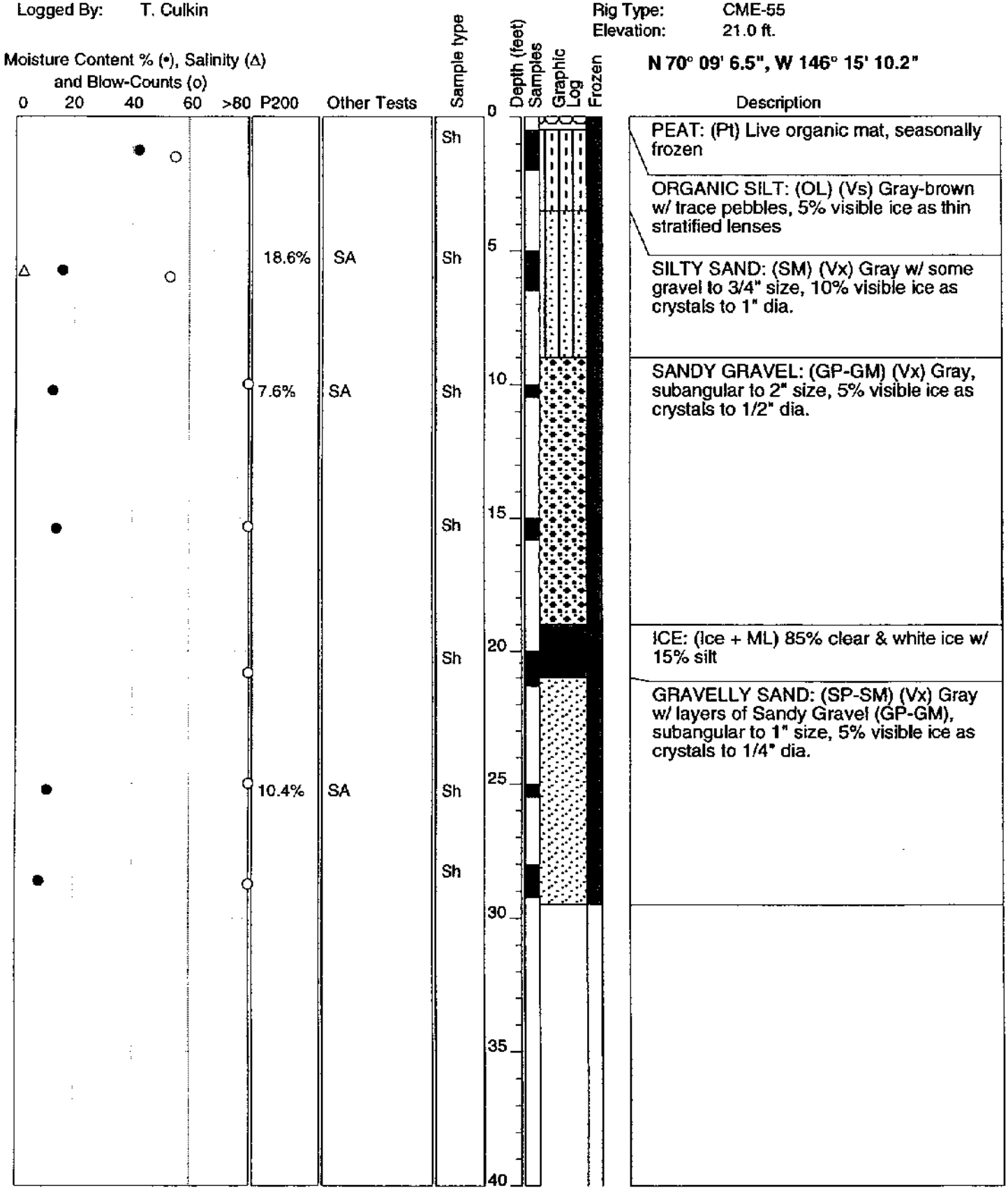
DUANE MILLER & ASSOCIATES

Project: Pt. Thomson
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-2

Date Drilled: March 23, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 21.0 ft.

N 70° 09' 6.5", W 146° 15' 10.2"



Description

PEAT: (Pt) Live organic mat, seasonally frozen

ORGANIC SILT: (OL) (Vs) Gray-brown w/ trace pebbles, 5% visible ice as thin stratified lenses

SILTY SAND: (SM) (Vx) Gray w/ some gravel to 3/4" size, 10% visible ice as crystals to 1" dia.

SANDY GRAVEL: (GP-GM) (Vx) Gray, subangular to 2" size, 5% visible ice as crystals to 1/2" dia.

ICE: (Ice + ML) 85% clear & white ice w/ 15% silt

GRAVELLY SAND: (SP-SM) (Vx) Gray w/ layers of Sandy Gravel (GP-GM), subangular to 1" size, 5% visible ice as crystals to 1/4" dia.

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

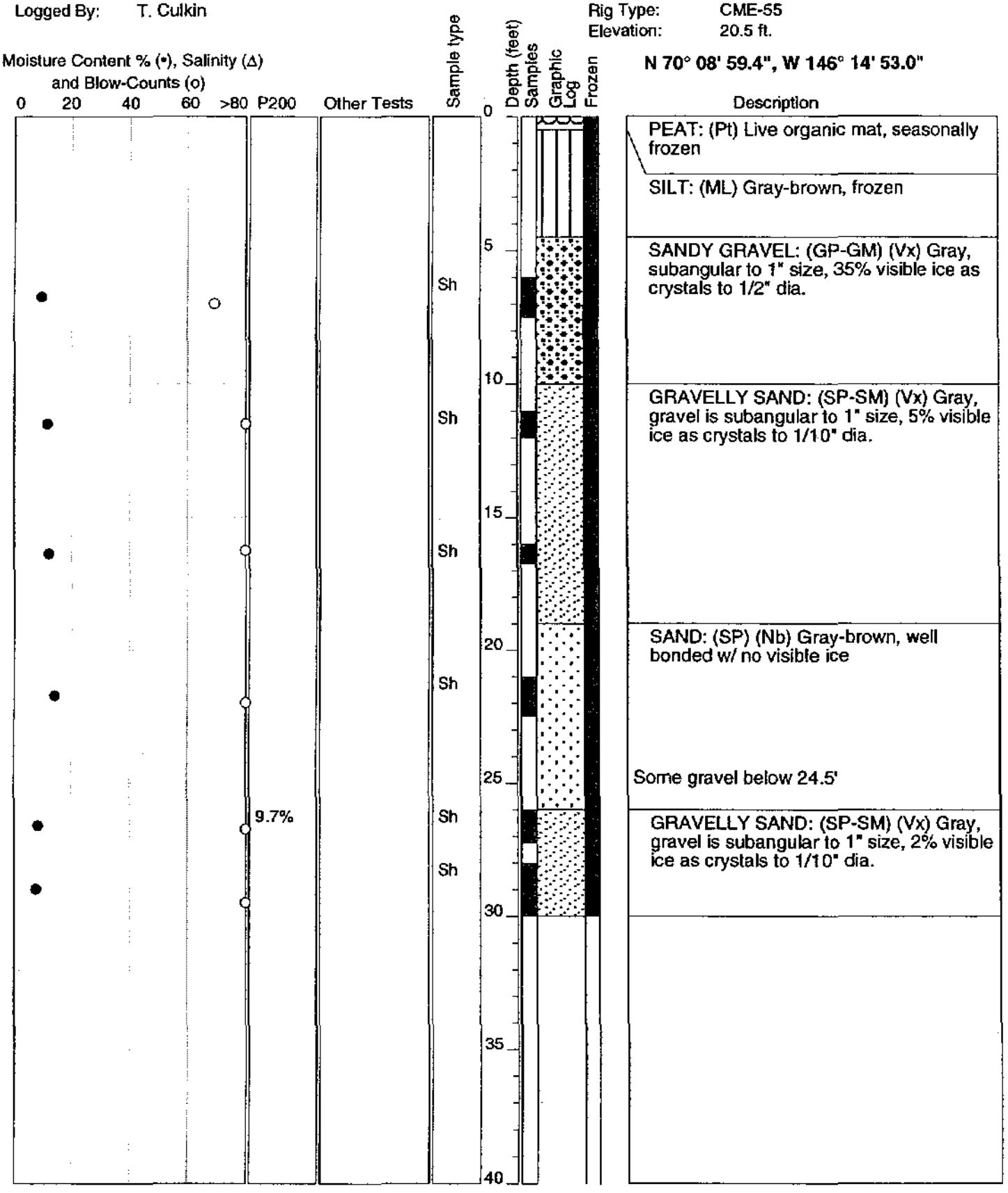
DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-3

Date Drilled: March 24, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 20.5 ft.

N 70° 08' 59.4", W 146° 14' 53.0"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

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Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-3
Pt. Thomson
North Slope, Alaska

Plate
6

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: W. Phillips

Log of HOLE : XX-4

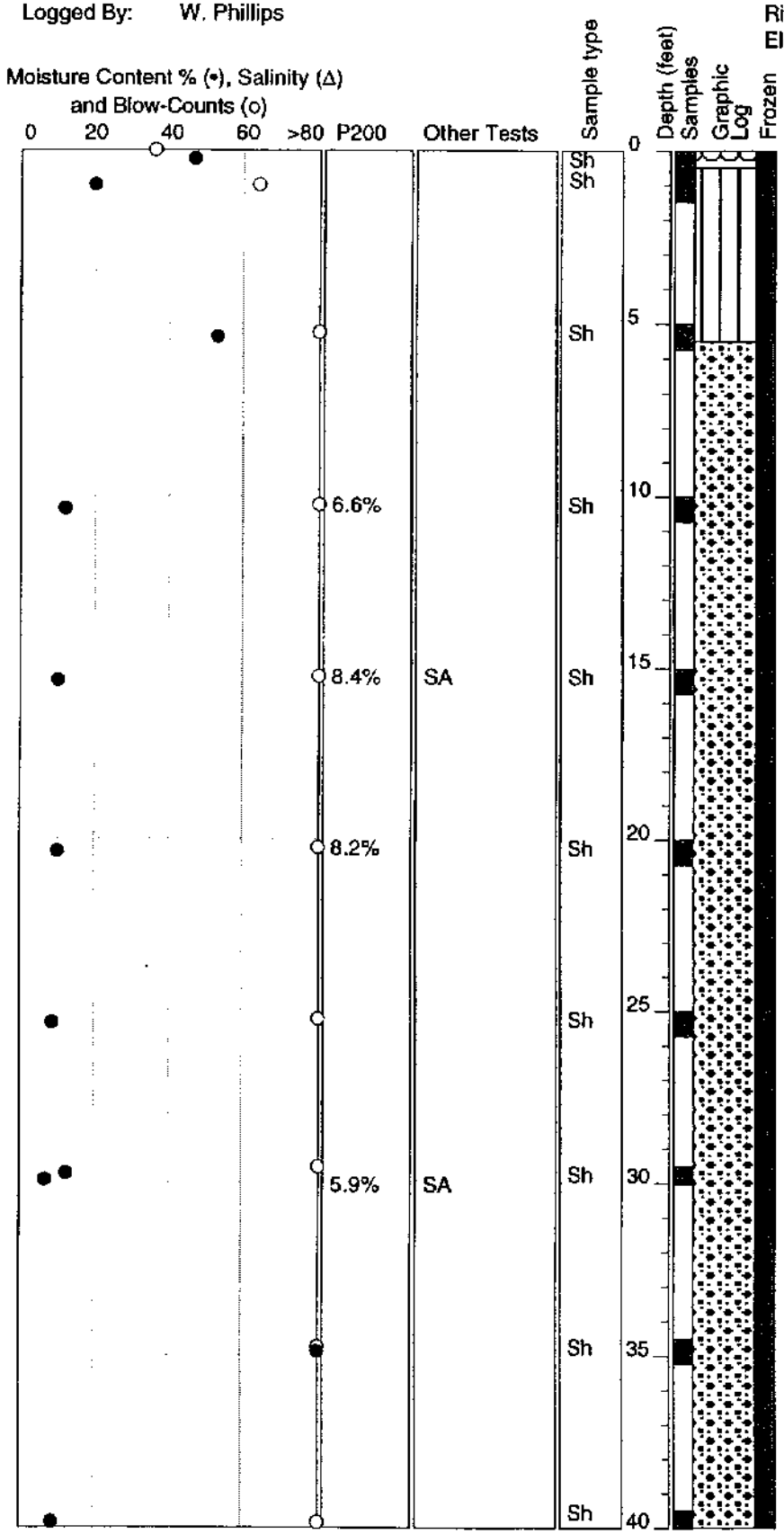
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 24.5 ft. *

N 70° 08' 51.6", W 146° 15' 6.6"



Description
PEAT: (Pt) Live organic mat, seasonally frozen
SANDY SILT: (ML) (Nb) Gray w/ trace gravel & Organic Silt (OL) layers, well bonded w/ no visible ice
SANDY GRAVEL: (GW-GM) (Vx) Gray w/ layers of Gravelly Sand (SP-SM) & Silty Sand (SM), subangular to 1.5" size, 10% to 25% visible ice as crystals
(Vx) 3% visible ice as crystals below 30'
Log of Boring XX-4 is continued on Plate 8

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

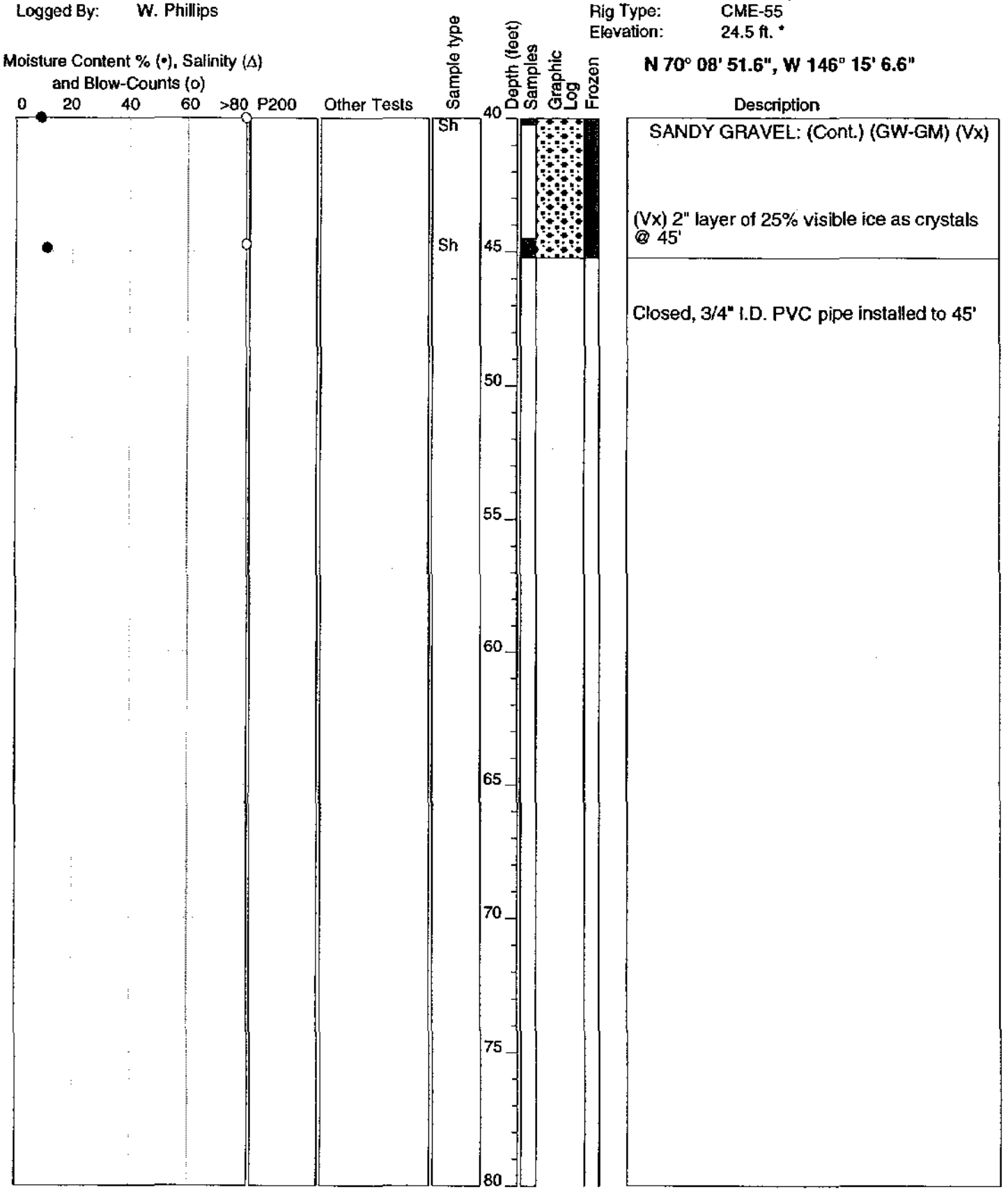
DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**
DM&A Job No. :4178.01
Logged By: W. Phillips

Log of HOLE : XX-4 (Cont.)

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 24.5 ft. *

N 70° 08' 51.6", W 146° 15' 6.6"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

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Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-4 (Cont.)
Pt. Thomson
North Slope, Alaska

Plate
8

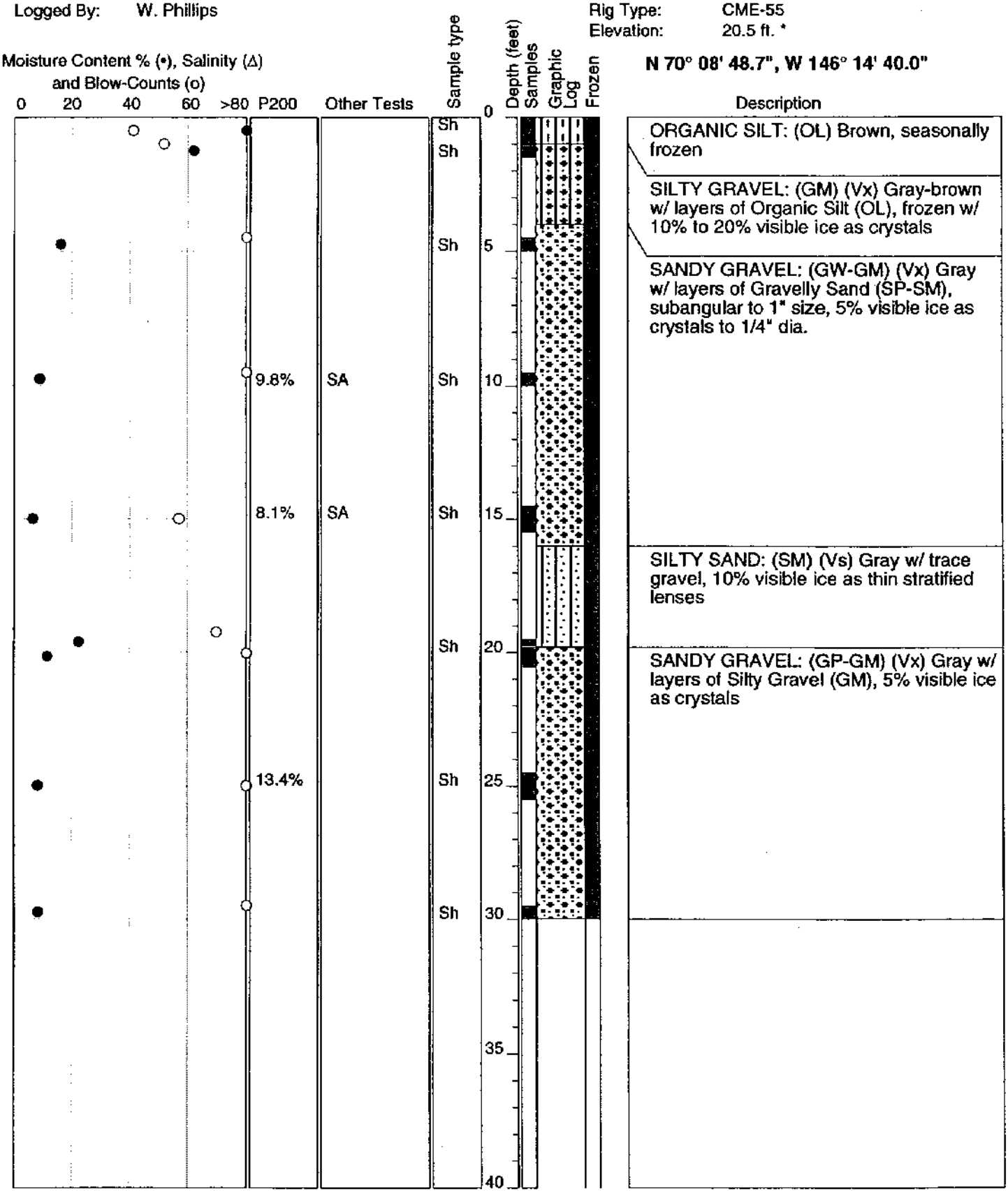
DUANE MILLER & ASSOCIATES

Project: Pt. Thomson
DM&A Job No. :4178.01
Logged By: W. Phillips

Log of HOLE : XX-5

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 20.5 ft. *

N 70° 08' 48.7", W 146° 14' 40.0"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-5
Pt. Thomson
North Slope, Alaska

Plate
9

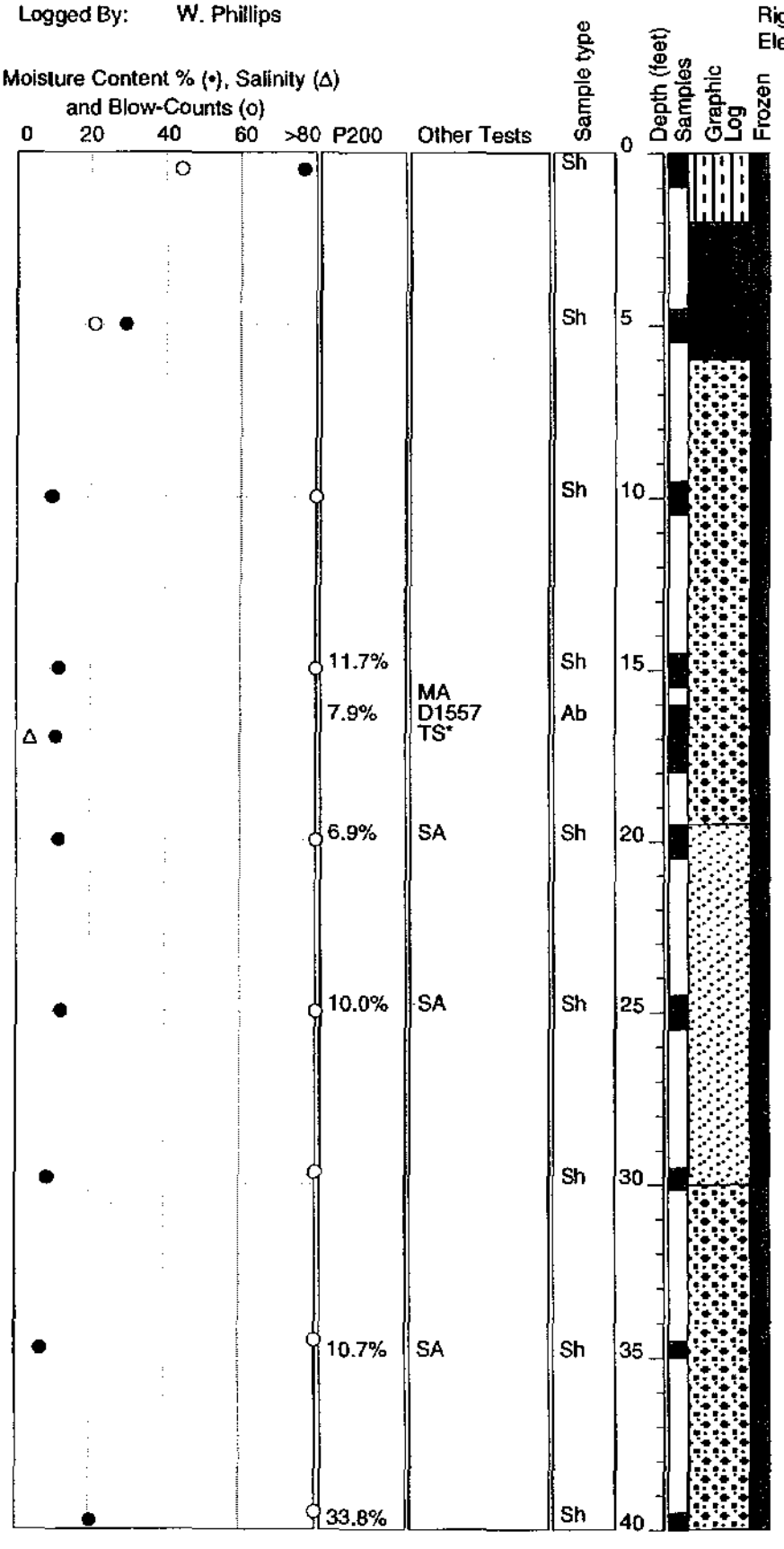
DUANE MILLER & ASSOCIATES

Project: Pt. Thomson
DM&A Job No. :4178.01
Logged By: W. Phillips

Log of HOLE : XX-6

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 28.5 ft. *

N 70° 08' 35.6", W 146° 15' 6.9"



Description

ORGANIC SILT: (OL) (Vs) Brown, seasonally frozen w/ visible ice as thin stratified lenses

ICE: (Ice + ML) White & clear ice w/ layers of Sandy Silt (ML)

SANDY GRAVEL: (GW-GM) (Vx) Gray, subangular to 2" size, 10% to 25% visible ice as crystals

GRAVELLY SAND: (SP-SM) (Vx) Gray, 10% to 15% visible ice as crystals

(SW-SM) Well graded below 24'

SANDY GRAVEL: (GW-GM) (Vx) Dark gray, 5% to 10% visible ice as crystals

(GM) 12" layer of Silty Gravel @ 39.5'

Log of Boring XX-6 is continued on Plate 11

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: W. Phillips

Log of HOLE : XX-6 (Cont.)

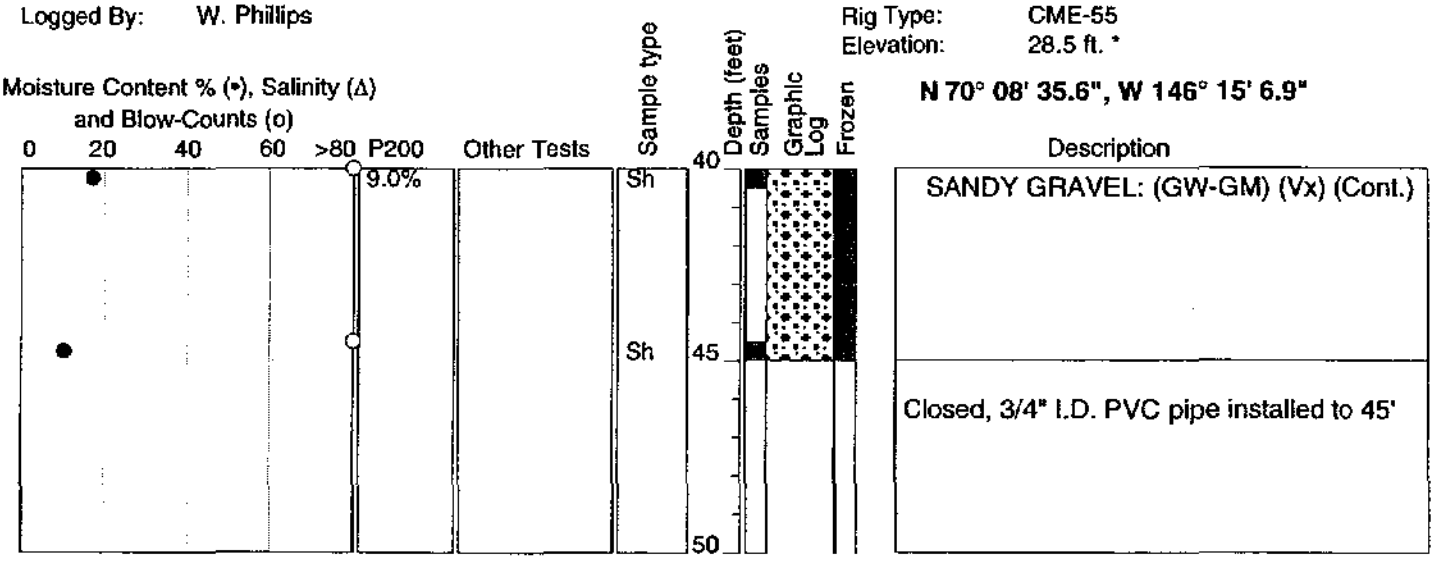
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 28.5 ft. *

N 70° 08' 35.6", W 146° 15' 6.9"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

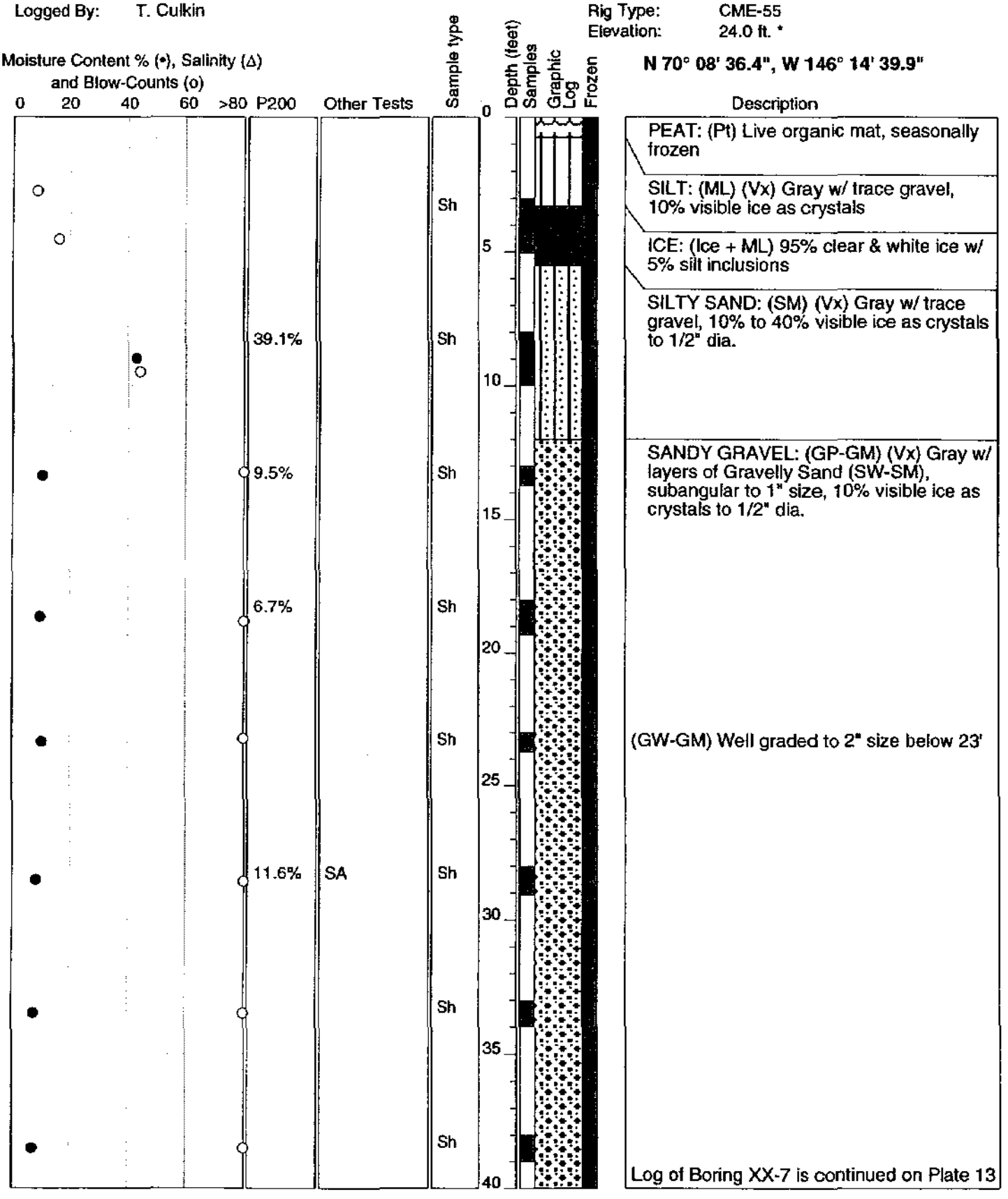
DUANE MILLER & ASSOCIATES

Project: Pt. Thomson
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-7

Date Drilled: March 24, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 24.0 ft. *

N 70° 08' 36.4", W 146° 14' 39.9"



Description

PEAT: (Pt) Live organic mat, seasonally frozen

SILT: (ML) (Vx) Gray w/ trace gravel, 10% visible ice as crystals

ICE: (Ice + ML) 95% clear & white ice w/ 5% silt inclusions

SILTY SAND: (SM) (Vx) Gray w/ trace gravel, 10% to 40% visible ice as crystals to 1/2" dia.

SANDY GRAVEL: (GP-GM) (Vx) Gray w/ layers of Gravelly Sand (SW-SM), subangular to 1" size, 10% visible ice as crystals to 1/2" dia.

(GW-GM) Well graded to 2" size below 23'

Log of Boring XX-7 is continued on Plate 13

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: T. Culkin

Log of HOLE : XX-7 (Cont.)

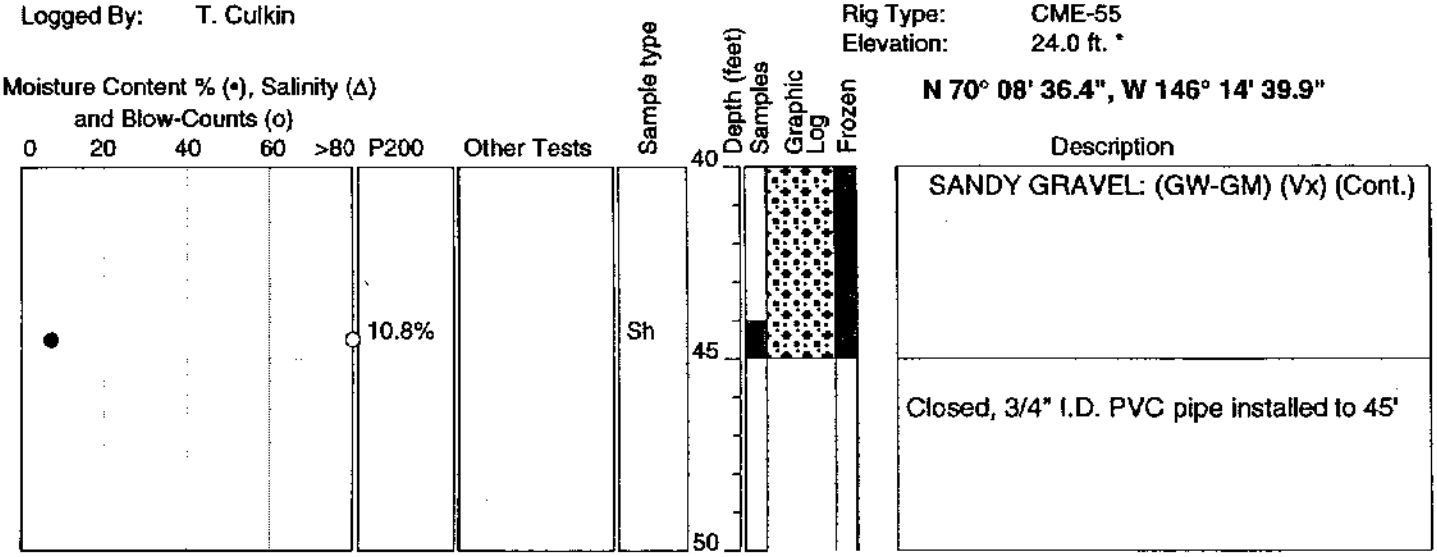
Date Drilled: March 24, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 24.0 ft. *

N 70° 08' 36.4", W 146° 14' 39.9"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: T. Culkin

Log of HOLE : XX-8

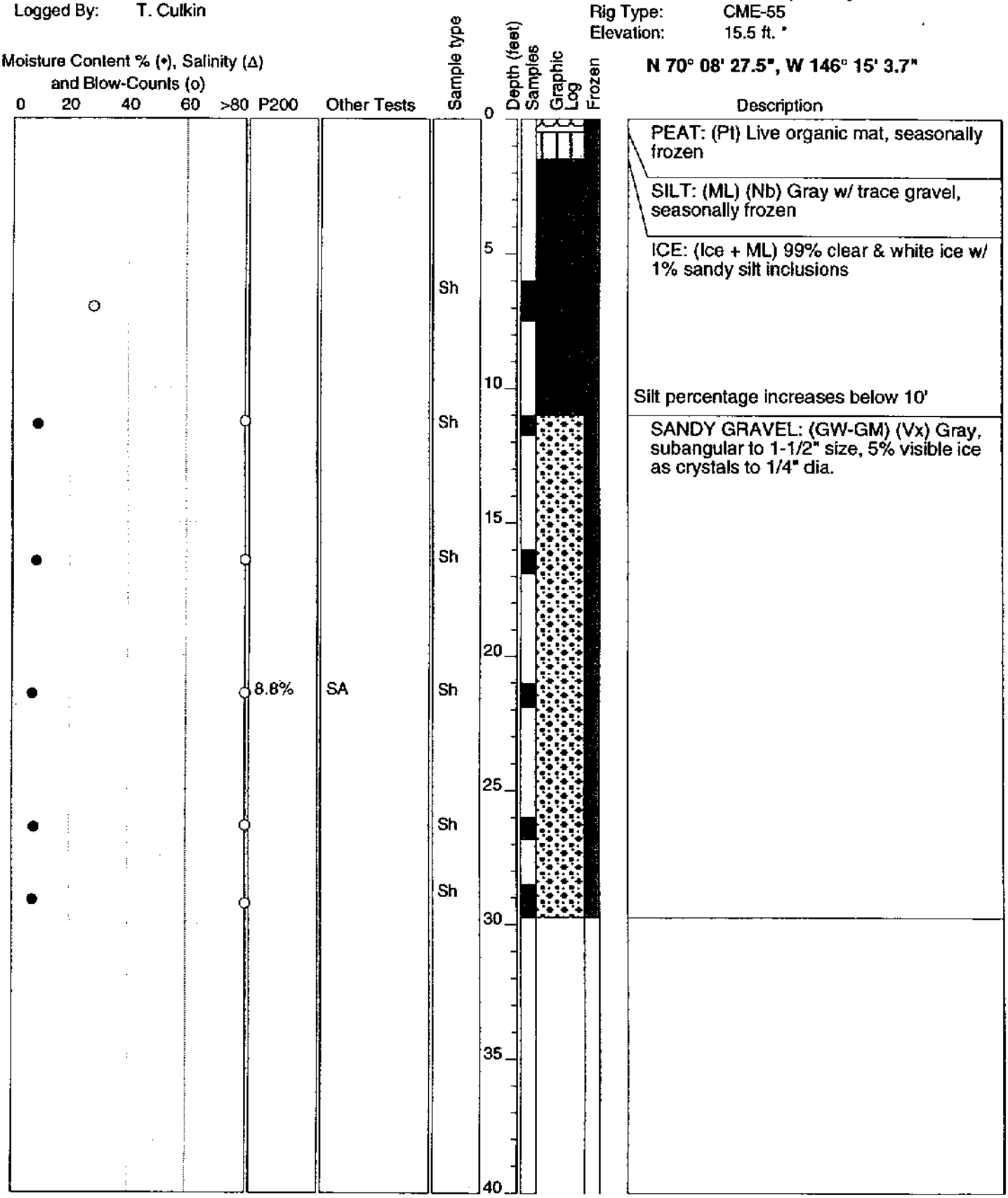
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 15.5 ft. *

N 70° 08' 27.5", W 146° 15' 3.7"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-8
Pt. Thomson
North Slope, Alaska

Plate
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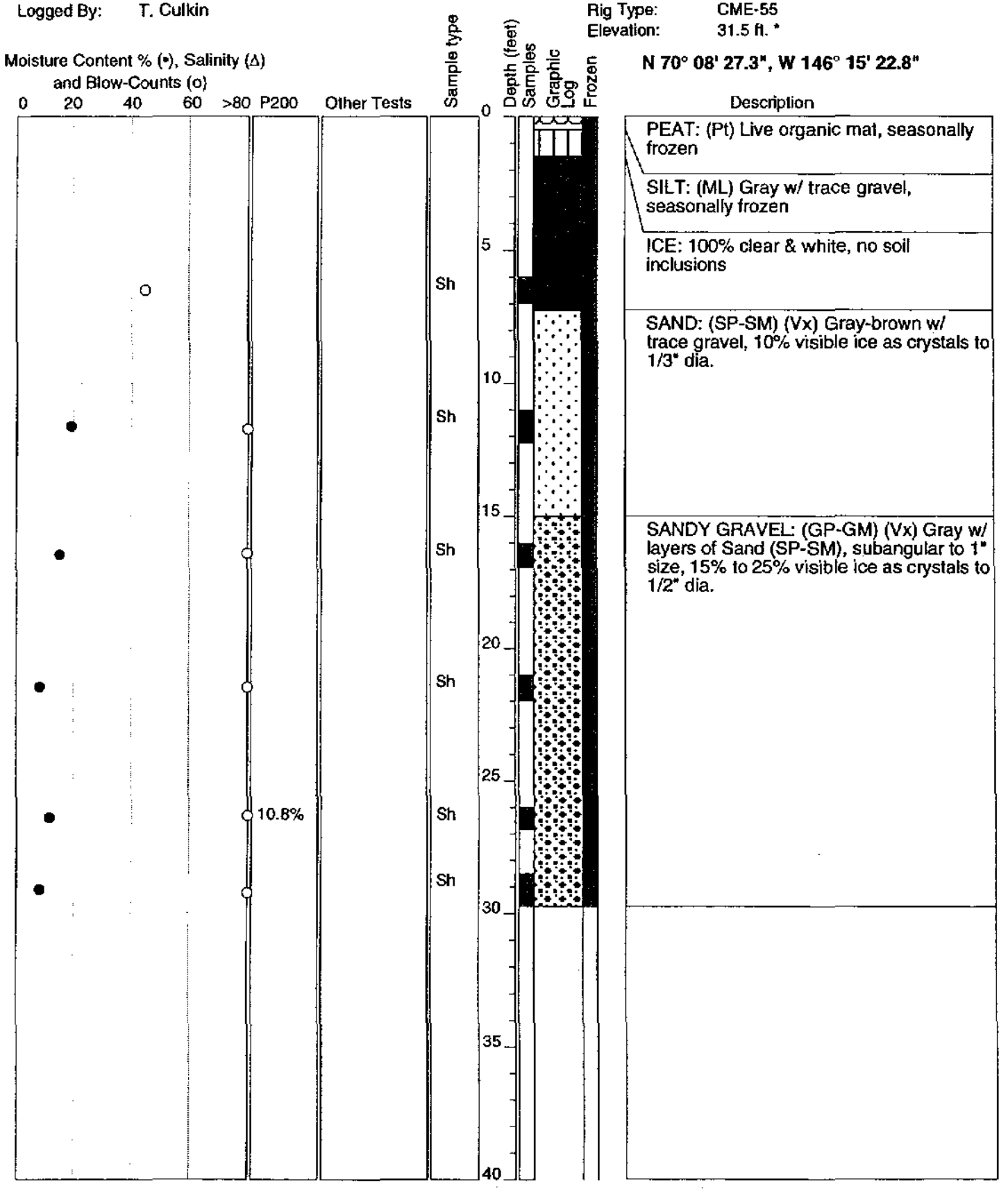
DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-9

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 31.5 ft. *

N 70° 08' 27.3", W 146° 15' 22.8"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-9
Pt. Thomson
North Slope, Alaska

Plate
15

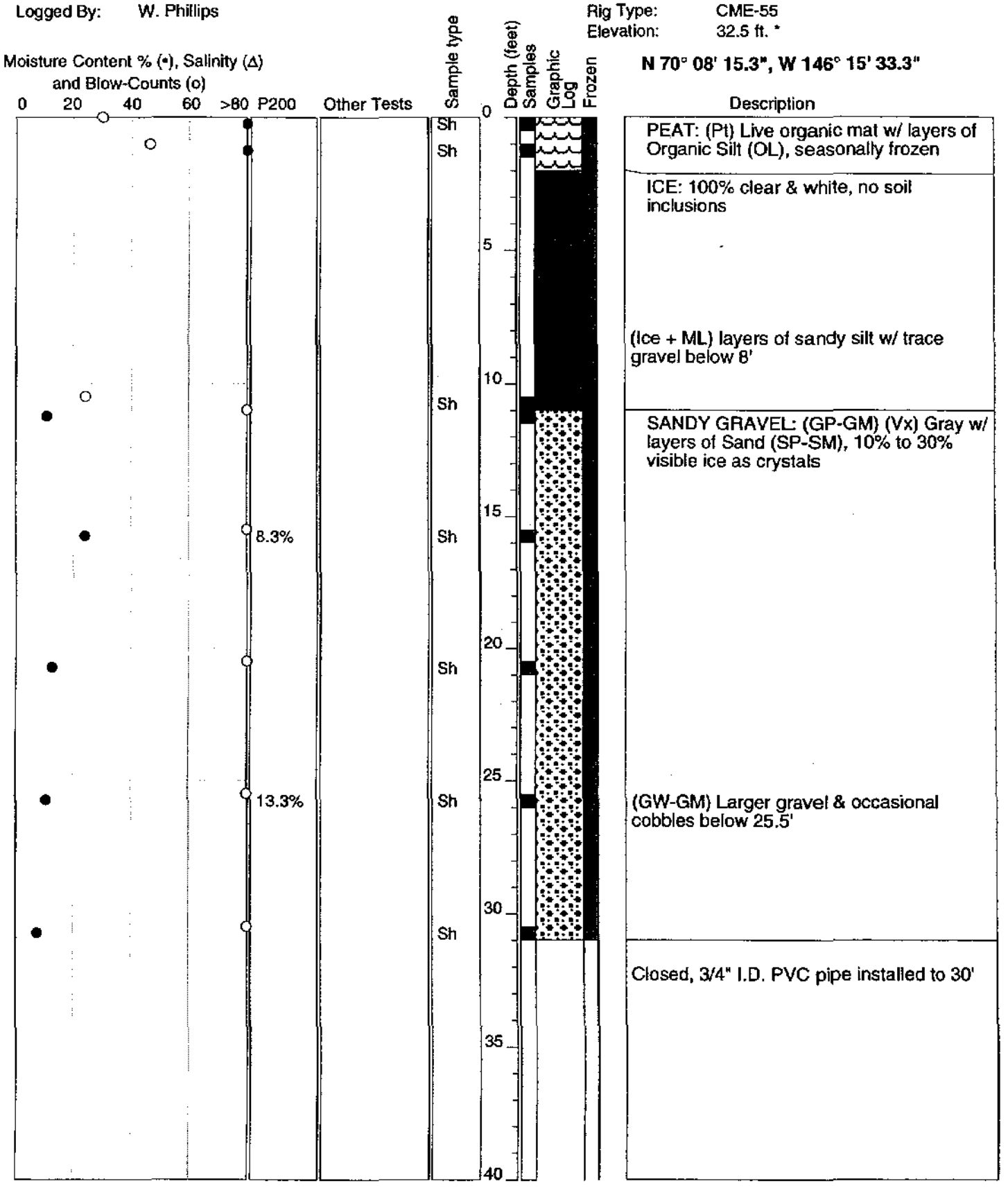
DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**
DM&A Job No. :4178.01
Logged By: W. Phillips

Log of HOLE : XX-10

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 32.5 ft. *

N 70° 08' 15.3", W 146° 15' 33.3"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4178.01
Date : Dec. 2000

LOG of BORING XX-10
Pt. Thomson
North Slope, Alaska

Plate
16

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: W. Phillips

Log of HOLE : XX-11

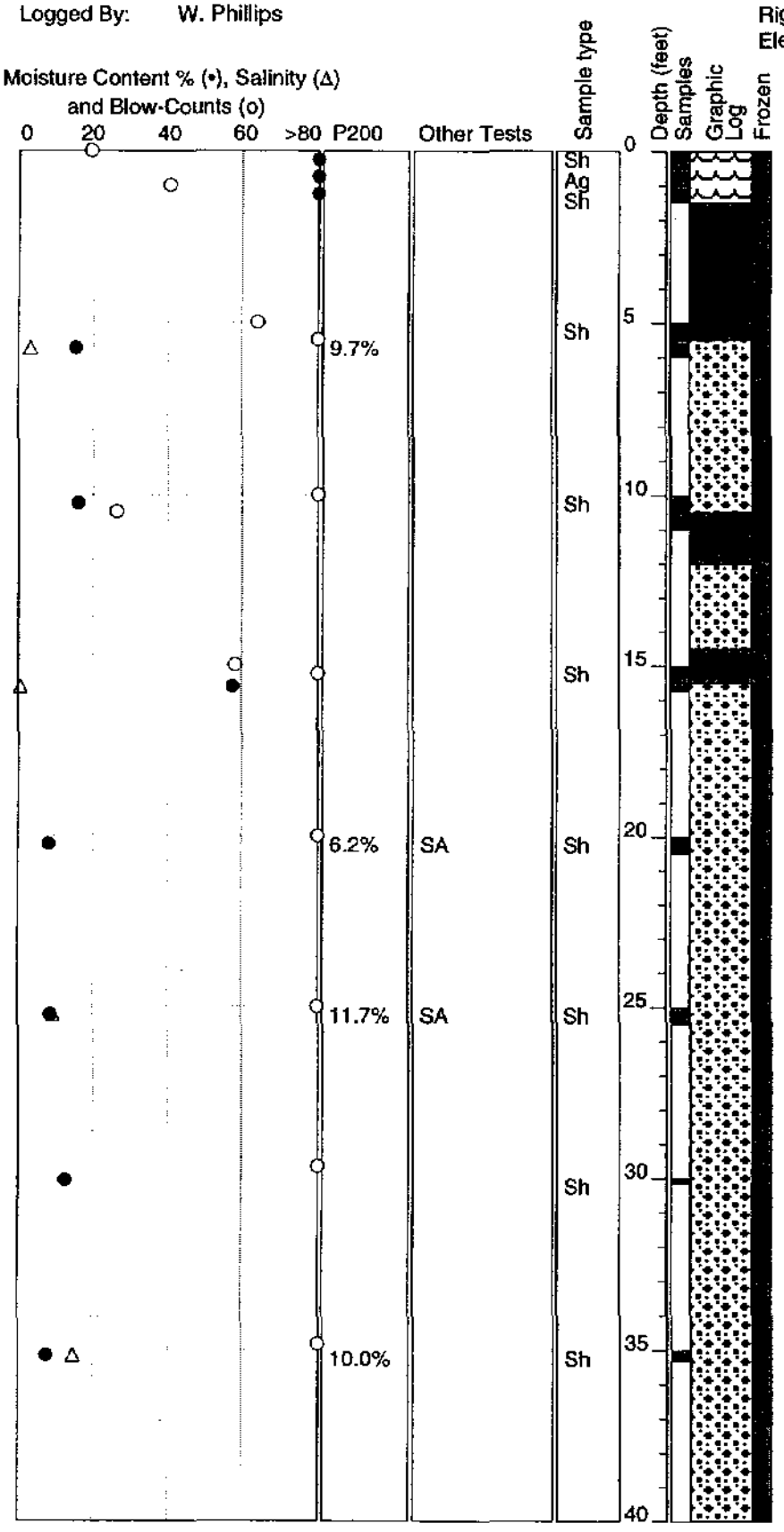
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 27.0 ft. *

N 70° 08' 42.5", W 146° 15' 10.3"



Description

PEAT: (Pt) Live organic mat & Organic Silt (OL), seasonally frozen

ICE: (Ice + ML) Gray w/ scattered pebbles

SANDY GRAVEL: (GP-GM) (Vx) Gray, 10% to 20% visible ice as crystals

ICE: Clear & white, no soil inclusions

SANDY GRAVEL: (GW-GM) (Vx) Gray, subangular to 2" size, 10% to 30% visible ice as crystals

ICE: (Ice + GP) 50% ice, 50% gravel

SANDY GRAVEL: (GW-GM) (Vx) Gray w/ layers of Gravelly Sand (SP-SM) & Silty Sand (SM), subangular to 2" size, 5% to 10% visible ice as crystals

Log of Boring XX-11 is continued on Plate 18

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: W. Phillips

Log of HOLE : XX-11 (Cont.)

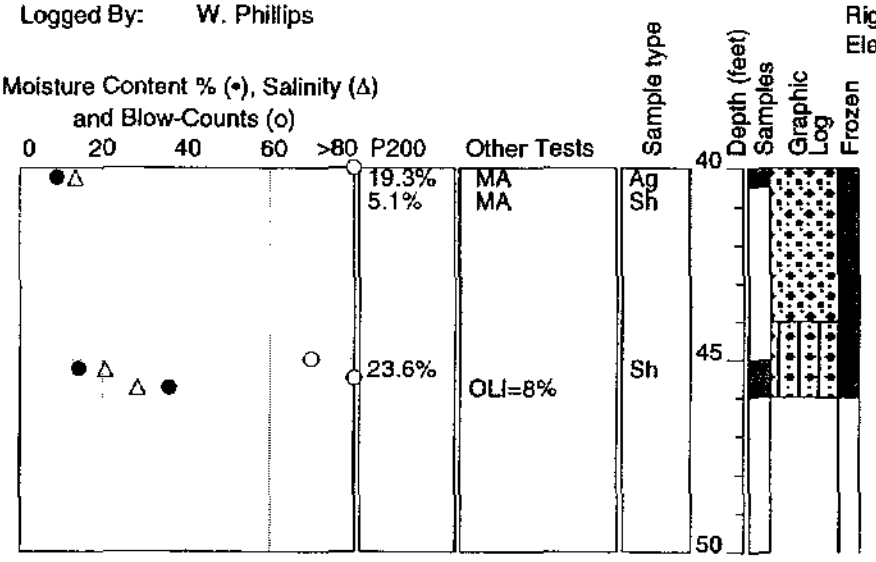
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 27.0 ft. *

N 70° 08' 42.5", W 146° 15' 10.3"



Description

SANDY GRAVEL: (GW-GM) (Vx) (cont.)

SILTY GRAVEL: (GM) (Vs) Black w/ layers of Organic Silt (OL), 5% to 10% visible ice as thin stratified lenses

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

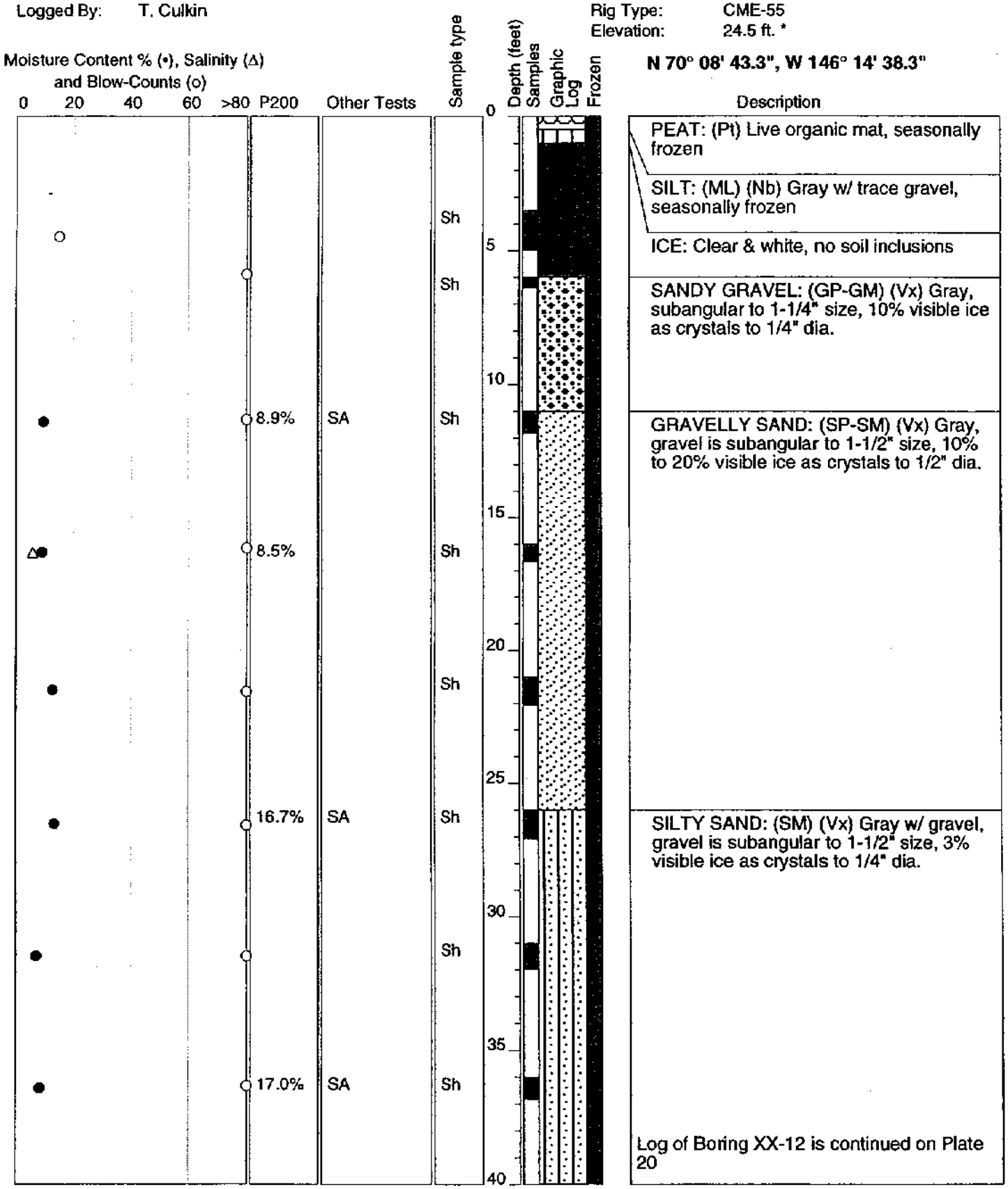
DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-12

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 24.5 ft. *

N 70° 08' 43.3", W 146° 14' 38.3"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: T. Culkin

Log of HOLE : XX-12 (Cont.)

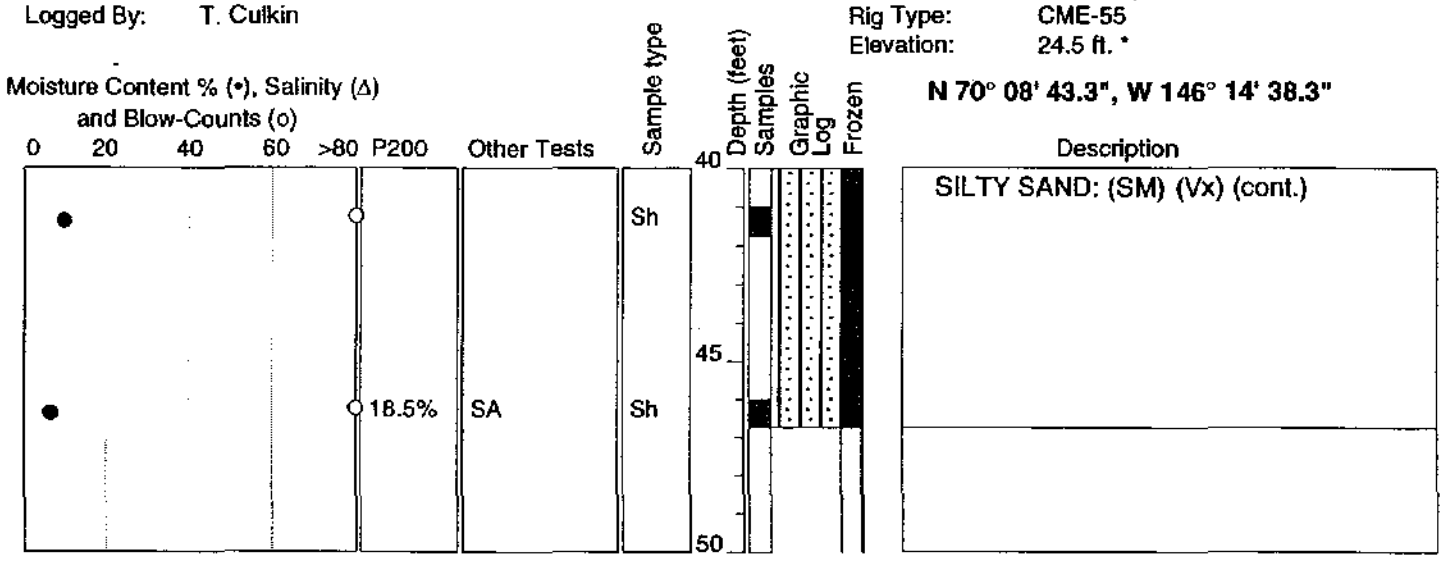
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 24.5 ft. *

N 70° 08' 43.3", W 146° 14' 38.3"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

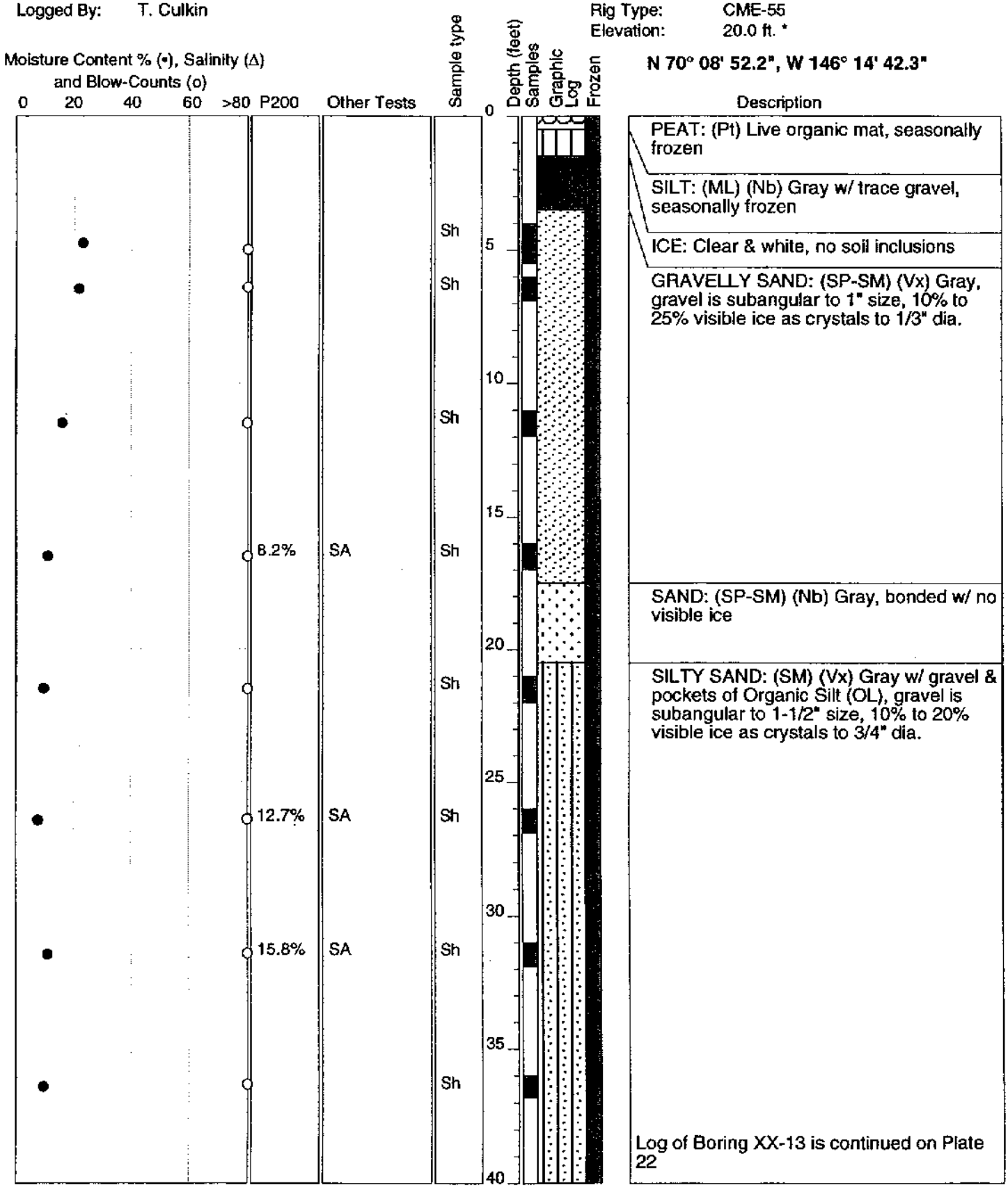
DUANE MILLER & ASSOCIATES

Project: Pt. Thomson
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-13

Date Drilled: March 25, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 20.0 ft. *

N 70° 08' 52.2", W 146° 14' 42.3"



Description

PEAT: (Pt) Live organic mat, seasonally frozen

SILT: (ML) (Nb) Gray w/ trace gravel, seasonally frozen

ICE: Clear & white, no soil inclusions

GRAVELLY SAND: (SP-SM) (Vx) Gray, gravel is subangular to 1" size, 10% to 25% visible ice as crystals to 1/3" dia.

SAND: (SP-SM) (Nb) Gray, bonded w/ no visible ice

SILTY SAND: (SM) (Vx) Gray w/ gravel & pockets of Organic Silt (OL), gravel is subangular to 1-1/2" size, 10% to 20% visible ice as crystals to 3/4" dia.

Log of Boring XX-13 is continued on Plate 22

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: T. Culkin

Log of HOLE : XX-13 (Cont.)

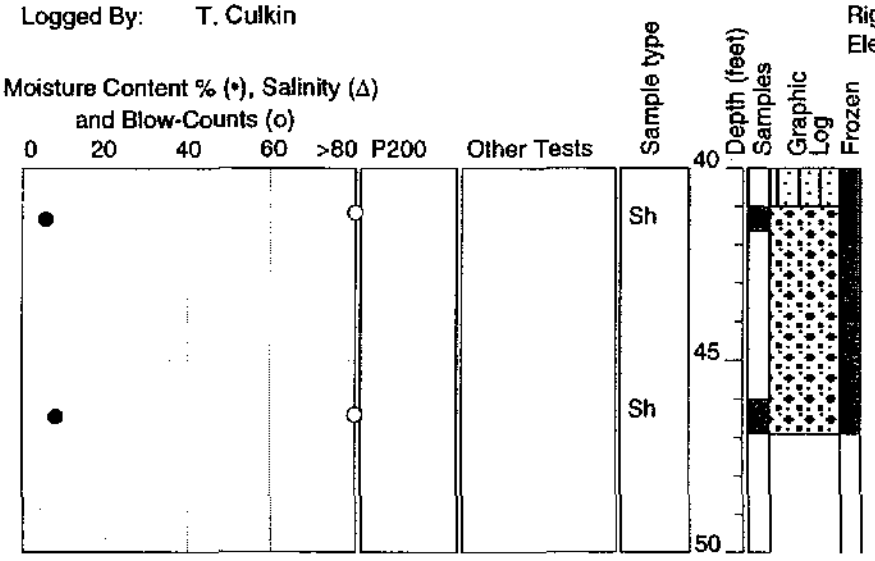
Date Drilled: March 25, 2000

Contractor: Discovery Drilling, Inc.

Rig Type: CME-55

Elevation: 20.0 ft. *

N 70° 08' 52.2", W 146° 14' 42.3"



Description
SILTY SAND: (SM) (Vx) (cont.)
SANDY GRAVEL: (GP-GM) (Vx) Gray, subangular to 2" size, 20% visible ice as crystals to 1/2" dia.
Closed, 3/4" I.D. PVC pipe installed to 46.9'

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

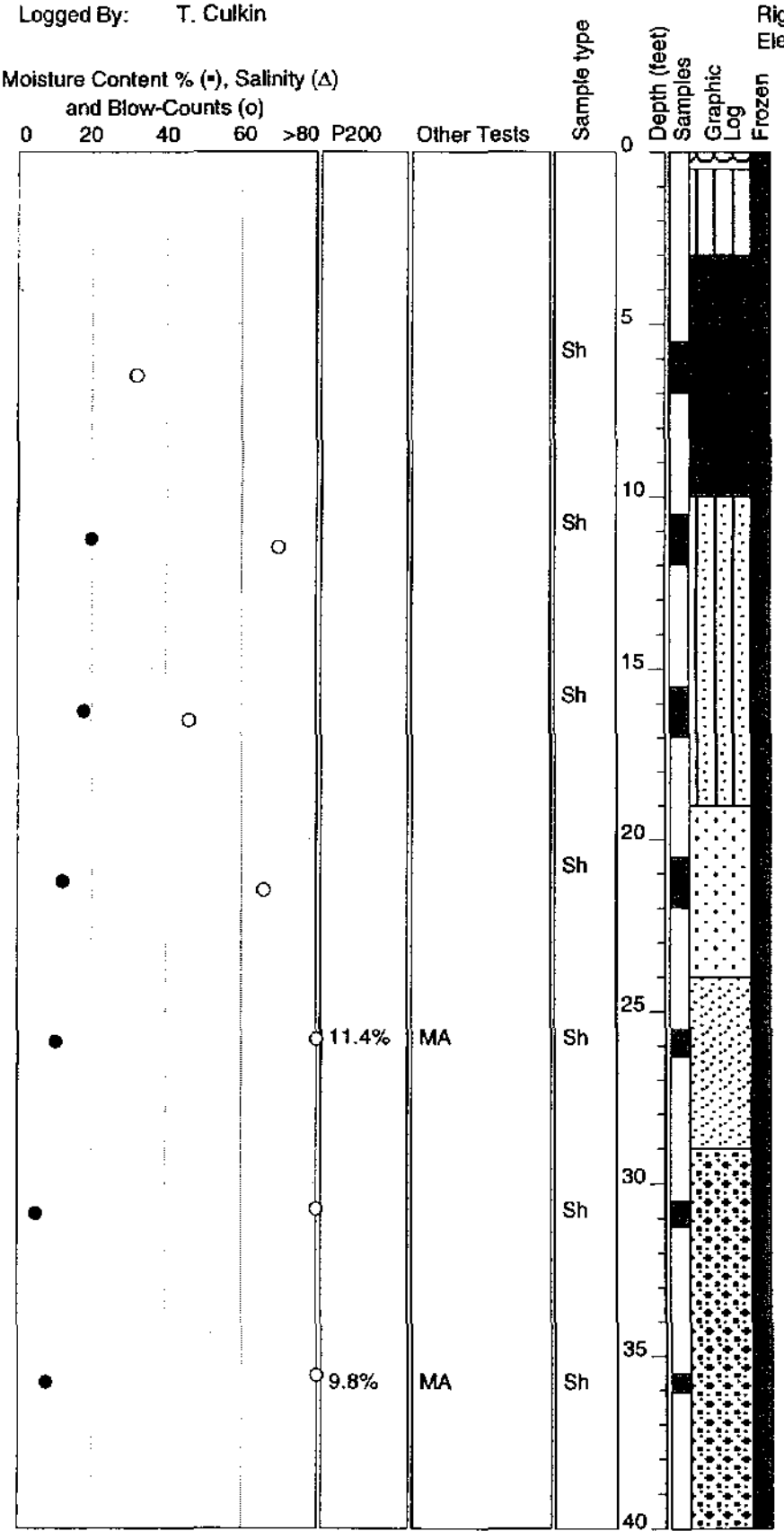
DUANE MILLER & ASSOCIATES

Project: Pt. Thomson
DM&A Job No. :4178.01
Logged By: T. Culkin

Log of HOLE : XX-14

Date Drilled: March 26, 2000
Contractor: Discovery Drilling, Inc.
Rig Type: CME-55
Elevation: 24.0 ft. *

N 70° 08' 58.4", W 146° 15' 25.6"



Description

PEAT: (Pt) Live organic mat, seasonally frozen

SILT: (ML) (Nb) Gray w/ trace gravel, seasonally frozen

ICE: (Ice + ML) 95% clear & white ice, 5% silt inclusions

SILTY SAND: (SM) (Nb) Gray, well bonded w/ no visible ice

SAND: (SP-SM) (Vx) Gray w/ trace gravel, 35% visible ice as crystals to 2" dia.

GRAVELLY SAND: (SW-SM) (Vx) Gray, gravel is subangular to 1" size, 10% visible ice as crystals to 1/2" dia.

SANDY GRAVEL: (GP-GM) (Vx) Gray, subangular to 2" size, 5% visible ice as crystals to 1/3" dia.

Log of Boring XX-14 is continued on Plate 24

* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

DUANE MILLER & ASSOCIATES

Project: **Pt. Thomson**

DM&A Job No. :4178.01

Logged By: T. Culkin

Log of HOLE : XX-14 (Cont.)

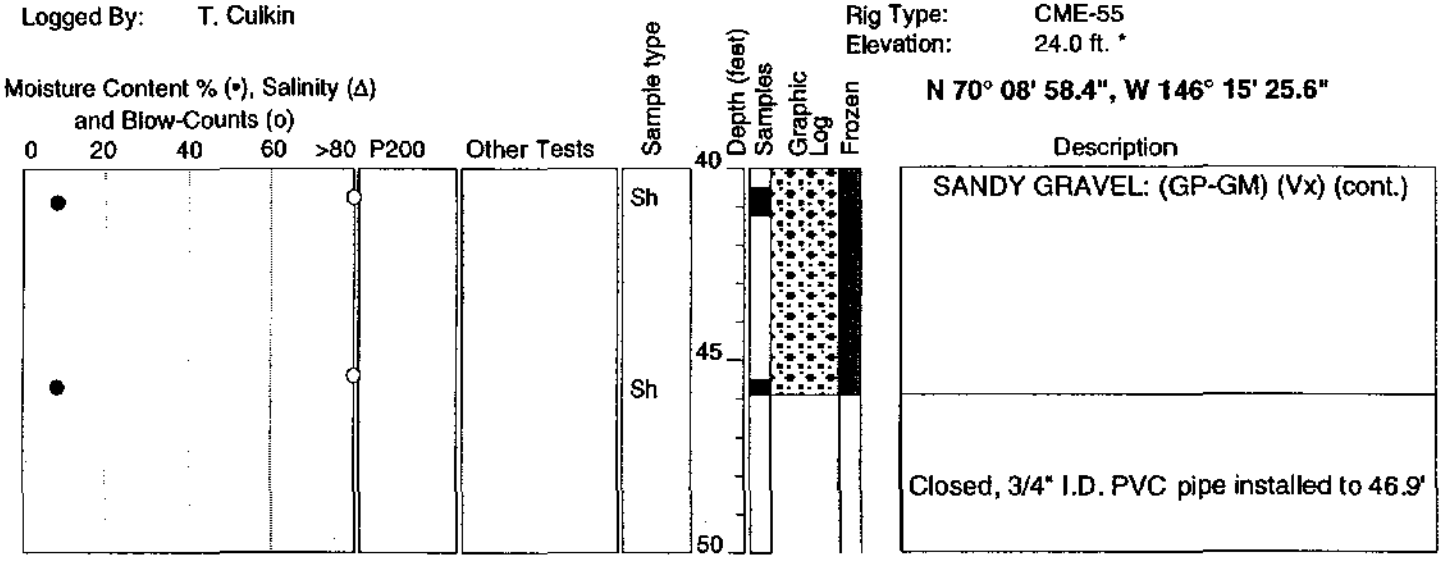
Date Drilled: March 26, 2000

Contractor: Discovery Drilling, Inc.

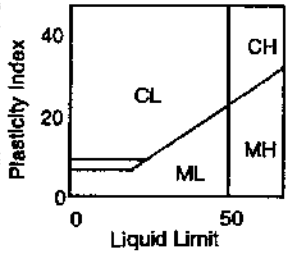
Rig Type: CME-55

Elevation: 24.0 ft. *

N 70° 08' 58.4", W 146° 15' 25.6"



* Elevation is interpolated from Topographic Map by BPXA Cartography, Feb. 4, 2000.

MAJOR DIVISIONS			SYMBOL	TYPICAL NAMES
COARSE GRAINED SOILS More than 50% larger than #200 sieve, 0.07 mm	**GRAVELS** More than half of the coarse fraction is larger than #4 sieve size, > 4.75 mm.	Clean gravels with little or no fines	GW	Well graded gravels, sandy gravel
			GP	Poorly graded gravels, sandy gravel
		Gravels with more than 12% fines	GM	Silty gravels, silt sand gravel mixtures
			GC	Clayey gravels, clay sand gravel mixtures
	SANDS More than half of the coarse fraction is smaller than #4 sieve size	Clean sands with little or no fines	SW	Well graded sand, gravelly sand
			SP	Poorly graded sands, gravelly sand
		Sands with more than 12% fines	SM	Silty sand, silt gravel sand mixtures
			SC	Clayey sand, clay gravel sand mixtures
FINE GRAINED SOILS >50%finer than #200 sieve, 0.07 mm	Plasticity Chart 	**SILTS and CLAYS** Liquid limit less than 50	ML	Inorganic silt and very fine sand, rock flour
			CL	Inorganic clay, gravelly and sandy clay, silty clay
			OL	Organic silts and clay of low plasticity
		SILTS and CLAYS Liquid limit greater than 50	MH	Inorganic silt
			CH	Inorganic clay, fat clay
			OH	Organic silt and clay of high plasticity
HIGHLY ORGANIC SOILS			Pt	Peat and other highly organic soil

KEY TO TEST DATA

Dd = Dry Density (pcf)
LL = Liquid Limit
PL = Plastic Limit
PI = Plastic Index
NP = non Plastic
SpG = Specific Gravity
SA = Sieve Analysis
MA = Sieve and Hydrometer Analysis
OLI = Organic Loss
RD = Relative Density
D1557 = modified Proctor
TS = Thaw Consolidation
Con = Consolidation
TXUU = Unconsolidated Undrained Triaxial
TXCU = Consolidated Undrained Triaxial
TXCD = Consolidated Drained Triaxial

Strength Data
XXX(YYY), where
XXX = $(\sigma_1-\sigma_3)/2$
YYY = σ_3

KEY TO SAMPLE TYPE

Ag = Auger grab
Ab = Auger bulk
Ac = Air chip
Sh = 2.5" ID split barrel w/ 340 lb. automatic hammer
Tw = Shelby tube
Ss = 1.4" ID split barrel w/ 140 lb. manual hammer
Cc = 3.25" continuous core barrel

UNIFIED SOIL CLASSIFICATION SYSTEM

GROUP	ICE VISIBILITY	DESCRIPTION		SYMBOL	
N	Segregated ice not visible by eye	Poorly bonded or friable		Nf	
		Well bonded	No excess ice	Nb	Nbn
			Excess microscopic ice		Nbe
V	Segregated ice is visible by eye and is one inch or less in thickness	Individual ice crystals or inclusions		Vx	
		Ice coatings on particles		Vc	
		Random or irregularly oriented ice		Vr	
		Stratified or distinctly oriented ice		Vs	
ICE	Ice greater than one inch in thickness	Ice with soil inclusions		ICE + soil type	
		Ice without soil inclusions		ICE	

ICE CLASSIFICATION SYSTEM

Duane Miller & Associates
Arctic & Geotechnical Engineering
Job No.: 4178.01
Date: Dec. 2000

SOIL and ICE CLASSIFICATION and KEY TO DATA
Pt. Thomson Material Sources
North Slope, Alaska

Plate **25**

Boring	Sample Depth	Soil Type (USCS)	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss	Salinity	Gravel +#4	Sand	Passing #200	Other Tests
XX-1	5.0 ft.	GW-GM	Sh	106	15.7%						
XX-1	10.0 ft.	GW-GM	Sh	83	11.6%						
XX-1	15.0 ft.	GW-GM	Sh	102	12.5%			52%	42%	6.0%	SA
XX-1	20.0 ft.	GW-GM	Sh	102	16.7%						
XX-1	25.0 ft.	SP-SM	Sh	87	43.7%						
XX-1	29.0 ft.	GP-GM	Sh	144	8.8%					8.7%	
XX-2	0.5 ft.	OL	Sh	55	42.0%						
XX-2	5.0 ft.	SM	Sh	53	16.1%		3 ppt	23%	58%	18.6%	SA
XX-2	10.0 ft.	GP-GM	Sh	142	12.7%			47%	45%	7.6%	SA
XX-2	15.0 ft.	GP-GM	Sh	91	13.9%						
XX-2	20.0 ft.	ICE + ML	Sh	100							
XX-2	25.0 ft.	SP-SM	Sh	166	10.7%			42%	48%	10.4%	SA
XX-2	28.0 ft.	GP-GM	Sh	120	8.3%						
XX-3	6.0 ft.	GP-GM	Sh	69	9.8%						
XX-3	11.0 ft.	SP-SM	Sh	85	11.3%						
XX-3	16.0 ft.	SP-SM	Sh	124	11.9%						
XX-3	21.0 ft.	SP	Sh	106	13.8%						
XX-3	26.0 ft.	SP-SM	Sh	126	8.6%					9.7%	
XX-3	28.0 ft.	SP-SM	Sh	120	7.9%						
XX-4	0.0 ft.	Pt	Sh	36	46.5%						
XX-4	0.5 ft.	ML	Sh	64	19.9%						
XX-4	5.0 ft.	ML	Sh	200	53.3%						
XX-4	10.0 ft.	SP-SM	Sh	200	12.1%					6.6%	
XX-4	15.0 ft.	GW-GM	Sh	200	10.5%			46%	46%	8.4%	SA
XX-4	20.0 ft.	GW-GM	Sh	200	10.5%					8.2%	
XX-4	25.0 ft.	GW-GM	Sh	200	9.0%						
XX-4	29.5 ft.	SM	Sh	N/A	13.1%						
XX-4	29.8 ft.	GW-GM	Sh	200	6.8%			55%	39%	5.9%	SA
XX-4	34.5 ft.	SM	Sh	200	93.7%						
XX-4	39.5 ft.	GW-GM	Sh	200	9.1%						
XX-4	44.5 ft.	GW-GM	Sh	83	11.2%						

Duane Miller & Associates
Job No. 4178.01
Dec. 2000

SUMMARY OF SAMPLES
Pt. Thomson
North Slope, Alaska

Plate
26

Boring	Sample Depth	Soil Type (USCS)	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss	Salinity	Gravel +#4	Sand	Passing #200	Other Tests
XX-5	0.0 ft.	OL	Sh	41	125.5%						
XX-5	1.0 ft.	GM	Sh	52	62.0%						
XX-5	4.5 ft.	GW-GM	Sh	190	16.3%						
XX-5	9.5 ft.	SP-SM	Sh	200	8.8%			44%	46%	9.8%	SA
XX-5	14.5 ft.	GW-GM	Sh	57	6.1%			50%	42%	8.1%	SA
XX-5	19.5 ft.	SM	Sh	70	22.7%						
XX-5	19.8 ft.	GP-GM	Sh	200	11.6%						
XX-5	24.5 ft.	GM	Sh	200	8.5%					13.4%	
XX-5	29.5 ft.	GP-GM	Sh	200	8.3%						
XX-6	0.0 ft.	OL	Sh	44	77.1%						
XX-6	4.5 ft.	ML	Sh	21	29.2%						
XX-6	9.5 ft.	GW-GM	Sh	100	9.5%						
XX-6	14.5 ft.	GW-GM	Sh	200	11.3%					11.7%	
XX-6	16.0 ft.	GW-GM	Ab		10.8%		4 ppt	49%	43%	7.9%	MA, D1557, TS*
XX-6	19.5 ft.	SP-SM	Sh	200	11.6%			41%	52%	6.9%	SA
XX-6	24.5 ft.	SW-SM	Sh	200	12.3%			43%	47%	10.0%	SA
XX-6	29.5 ft.	SW-SM	Sh	200	9.1%						
XX-6	34.5 ft.	GW-GM	Sh	200	7.0%			49%	40%	10.7%	SA
XX-6	39.5 ft.	GM	Sh	96	20.6%					33.8%	
XX-6	40.0 ft.	GW-GM	Sh	190	17.0%					9.0%	
XX-6	44.5 ft.	GW-GM	Sh	200	10.3%						
XX-7	3.0 ft.	ICE + ML	Sh	8							
XX-7	3.3 ft.	ICE + ML	Sh	16							
XX-7	8.0 ft.	SM	Sh	44	42.7%					39.1%	
XX-7	13.0 ft.	GP-GM	Sh	200	10.3%					9.5%	
XX-7	18.0 ft.	SW-SM	Sh	372	9.5%					6.7%	
XX-7	23.0 ft.	GW-GM	Sh	280	10.5%						
XX-7	28.0 ft.	SW-SM	Sh	248	8.4%			44%	44%	11.6%	SA
XX-7	33.0 ft.	GW-GM	Sh	360	7.9%						
XX-7	38.0 ft.	GW-GM	Sh	300	7.2%						
XX-7	44.0 ft.	GW-GM	Sh	192	7.2%					10.8%	

*Thaw settlement test on compacted bulk sample - See Plate 37

Boring	Sample Depth	Soil Type (USCS)	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss	Salinity	Gravel +#4	Sand	Passing #200	Other Tests
XX-8	6.0 ft.	ICE + ML	Sh	28							
XX-8	11.0 ft.	GW-GM	Sh	262	8.9%						
XX-8	16.0 ft.	GW-GM	Sh	240	8.4%						
XX-8	21.0 ft.	GW-GM	Sh	240	7.3%			51%	40%	8.8%	SA
XX-8	26.0 ft.	GW-GM	Sh	308	7.9%						
XX-8	28.5 ft.	GW-GM	Sh	240	7.3%						
XX-9	6.0 ft.	ICE	Sh	45							
XX-9	11.0 ft.	SP-SM	Sh	120	19.3%						
XX-9	16.0 ft.	GP-GM	Sh	144	15.3%						
XX-9	21.0 ft.	GP-GM	Sh	83	8.5%						
XX-9	26.0 ft.	GP-GM	Sh	150	11.8%					10.8%	
XX-9	28.5 ft.	GP-GM	Sh	200	8.6%						
XX-10	0.0 ft.	Pt	Sh	30	131.9%						
XX-10	1.0 ft.	OL	Sh	46	111.6%						
XX-10	10.5 ft.	ICE + ML	Sh	24							
XX-10	11.0 ft.	GP-GM	Sh	156	11.1%						
XX-10	15.5 ft.	GP-GM	Sh	300	24.3%					8.3%	
XX-10	20.5 ft.	GP-GM	Sh	300	12.8%						
XX-10	25.5 ft.	GW-GM	Sh	300	11.2%					13.3%	
XX-10	30.5 ft.	GW-GM	Sh	300	7.4%						
XX-11	0.0 ft.	Pt	Sh	19	151.0%						
XX-11	0.5 ft.	Pt	Ag		195.2%						
XX-11	1.0 ft.	OL	Sh	40	141.0%						
XX-11	5.0 ft.	ICE + ML	Sh	64							
XX-11	5.5 ft.	GP-GM	Sh	240	15.3%		4 ppt			9.7%	
XX-11	10.0 ft.	GP-GM	Sh	84	15.9%						
XX-11	10.5 ft.	ICE	Sh	26							
XX-11	15.0 ft.	ICE + GP	Sh	58							
XX-11	15.5 ft.	GW-GM	Sh	200	57.4%		1 ppt				
XX-11	20.0 ft.	GW-GM	Sh	200	8.6%			54%	40%	6.2%	SA
XX-11	25.0 ft.	SP-SM	Sh	200	8.8%		10 ppt	38%	50%	11.7%	SA

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SUMMARY OF SAMPLES
Pt. Thomson
North Slope, Alaska

Plate
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Boring	Sample Depth	Soil Type (USCS)	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss	Salinity	Gravel +#4	Sand	Passing #200	Other Tests
XX-11	30.0 ft.	GW-GM	Sh	300	12.6%						
XX-11	35.0 ft.	GW-GM	Sh	230	7.9%		15 ppt			10.0%	
XX-11	40.0 ft.*	SM	Ag		9.0%			16%	65%	19.3%	MA
XX-11	40.0 ft.	GW-GM	Sh	300	8.9%		14 ppt	53%	42%	5.1%	MA
XX-11	45.0 ft.	GM	Sh	70	14.2%		21 ppt			23.6%	
XX-11	45.5 ft.	OL	Sh	400	35.8%	8%	28 ppt				
XX-12	3.5 ft.	ICE	Sh	15							
XX-12	6.0 ft.	GP-GM	Sh	200							
XX-12	11.0 ft.	SP-SM	Sh	300	9.3%			42%	49%	8.9%	SA
XX-12	16.0 ft.	SP-SM	Sh	300	8.9%		6 ppt			8.5%	
XX-12	21.0 ft.	SP-SM	Sh	300	12.5%						
XX-12	26.0 ft.	SM	Sh	480	13.4%			31%	52%	16.7%	SA
XX-12	31.0 ft.	SM	Sh	200	7.2%						
XX-12	36.0 ft.	SM	Sh	240	8.2%			34%	49%	17.0%	SA
XX-12	41.0 ft.	SM	Sh	320	9.3%						
XX-12	46.0 ft.	SM	Sh	420	6.2%			33%	49%	18.5%	SA
XX-13	4.0 ft.	SP-SM	Sh	80	23.2%						
XX-13	6.0 ft.	SP-SM	Sh	120	21.5%						
XX-13	11.0 ft.	SP-SM	Sh	120	15.8%						
XX-13	16.0 ft.	SP-SM	Sh	120	10.9%			39%	53%	8.2%	SA
XX-13	21.0 ft.	SM	Sh	110	9.3%						
XX-13	26.0 ft.	SM	Sh	180	7.7%			38%	49%	12.7%	SA
XX-13	31.0 ft.	SM	Sh	160	11.0%			42%	42%	15.8%	SA
XX-13	36.0 ft.	SM	Sh	150	9.3%						
XX-13	41.0 ft.	GP-GM	Sh	300	5.9%						
XX-13	46.0 ft.	GP-GM	Sh	220	8.2%						

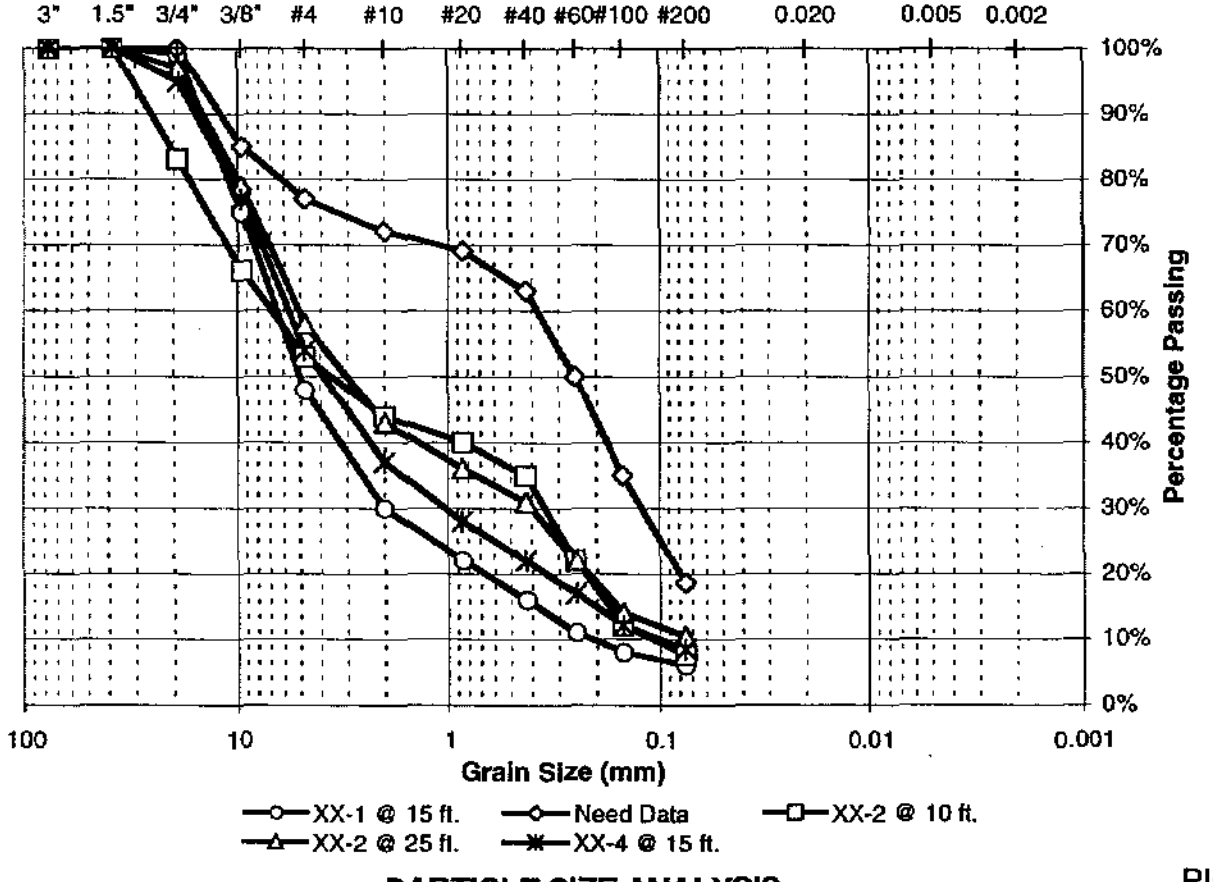
*Auger loosened material

Boring	Sample Depth	Soil Type (USCS)	Sampler Type	Sampling Blows/ ft	Moisture Content	Organic Loss	Salinity	Gravel +#4	Sand	Passing #200	Other Tests
XX-14	5.5 ft.	ICE + ML	Sh	32							
XX-14	10.5 ft.	SM	Sh	70	20.1%						
XX-14	15.5 ft.	SM	Sh	46	18.1%						
XX-14	20.5 ft.	SP-SM	Sh	66	12.2%						
XX-14	25.5 ft.	SW-SM	Sh	180	10.4%			44%	45%	11.4%	MA
XX-14	30.5 ft.	GP-GM	Sh	180	5.2%						
XX-14	35.5 ft.	GP-GM	Sh	240	7.9%			52%	38%	9.8%	MA
XX-14	40.5 ft.	GP-GM	Sh	220	8.1%						
XX-14	45.5 ft.	GP-GM	Sh	320	8.0%						

Boring =>	XX-1	XX-2	XX-2	XX-2	XX-4
Depth =>	15.0 ft.	5.0 ft.	10.0 ft.	25.0 ft.	15.0 ft.
3" =>	100%	100%	100%	100%	100%
1 1/2" =>	100%	100%	100%	100%	100%
3/4" =>	99%	100%	83%	97%	95%
3/8" =>	75%	85%	66%	79%	77%
#4 =>	48%	77%	53%	58%	54%
#10 =>	30%	72%	44%	43%	37%
#20 =>	22%	69%	40%	36%	28%
#40 =>	16%	63%	35%	31%	22%
#60 =>	11%	50%	22%	22%	17%
#100 =>	8%	35%	12%	14%	12%
#200 =>	6.0%	18.6%	7.6%	10.4%	8.4%
0.02 mm					
0.005 mm					
0.002 mm					

Analysis of Data drive sampledrive sampledrive sampledrive sampledrive sample

D10 size =>	0.211 mm	0.041 mm	0.109 mm	0.071 mm	0.102 mm
D30 size =>	2.000 mm	0.121 mm	0.347 mm	0.401 mm	1.028 mm
D50 size =>	5.000 mm	0.250 mm	3.560 mm	2.995 mm	3.875 mm
D60 size =>	6.464 mm	0.376 mm	6.899 mm	5.074 mm	5.691 mm
Coeff. of Uniformity, Cu =	30.65	9.24	63.03	71.18	55.77
Coeff. of Curvature, Cc =	2.93	0.96	0.16	0.44	1.82
Gravel (+#4) percentage =	52.0%	23.0%	47.0%	42.0%	46.0%
AASHTO Gravel (+#10) =	70.0%	28.0%	56.0%	57.0%	63.0%
Sand percentage =	42.0%	58.4%	45.4%	47.6%	45.6%
Fines percentage =	6.0%	18.6%	7.6%	10.4%	8.4%
Unified Soil Class Symbol =	GW-GM	SM	GP-GM	SP-SM	GW-GM



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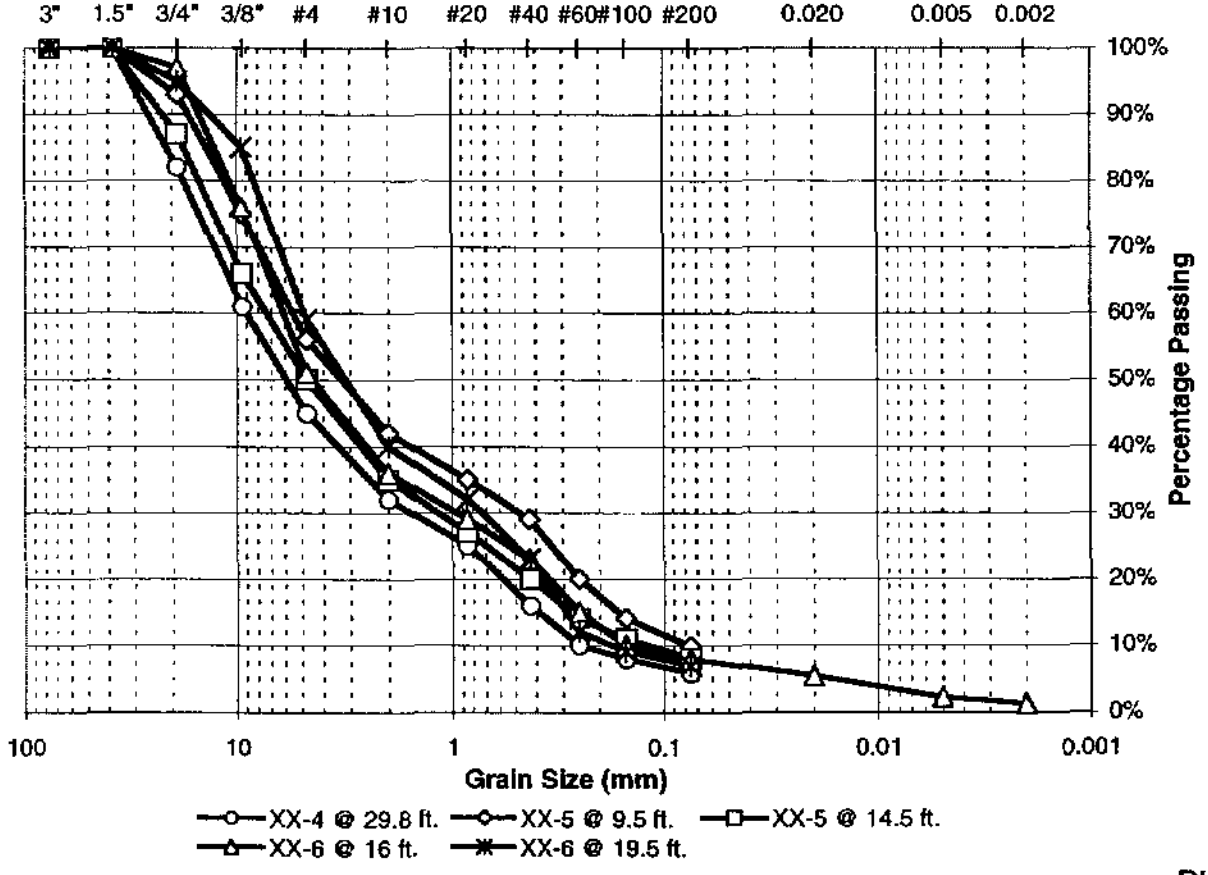
PARTICLE SIZE ANALYSIS
Pt. Thomson
North Slope, Alaska

Plate
31

Boring =>	XX-4	XX-5	XX-5	XX-6	XX-6
Depth =>	29.8 ft.	9.5 ft.	14.5 ft.	16.0 ft.	19.5 ft.
3" =>	100%	100%	100%	100%	100%
1 1/2" =>	100%	100%	100%	100%	100%
3/4" =>	82%	93%	87%	97%	95%
3/8" =>	61%	75%	66%	76%	85%
#4 =>	45%	56%	50%	51%	59%
#10 =>	32%	42%	35%	36%	40%
#20 =>	25%	35%	27%	29%	32%
#40 =>	16%	29%	20%	23%	23%
#60 =>	10%	20%	14%	15%	12%
#100 =>	8%	14%	11%	10%	9%
#200 =>	5.9%	9.8%	8.1%	7.9%	6.9%
0.02 mm				5.4%	
0.005 mm				2.2%	
0.002 mm				1.3%	
Analysis of Data	drive sample	drive sample	drive sample	auger bulk	drive sample
D10 size =>	0.250 mm	0.078 mm	0.118 mm	0.150 mm	0.178 mm
D30 size =>	1.566 mm	0.477 mm	1.172 mm	0.961 mm	0.729 mm
D50 size =>	5.899 mm	3.279 mm	4.750 mm	4.484 mm	3.153 mm
D60 size =>	9.097 mm	5.496 mm	7.326 mm	6.096 mm	4.878 mm
Coeff. of Uniformity, Cu =	36.39	70.90	62.02	40.64	27.43
Coeff. of Curvature, Cc =	1.08	0.53	1.59	1.01	0.61
Gravel (+#4) percentage =	55.0%	44.0%	50.0%	49.0%	41.0%
AASHTO Gravel (+#10) =	68.0%	58.0%	65.0%	64.0%	60.0%
Sand percentage =	39.1%	46.2%	41.9%	43.1%	52.1%
Fines percentage =	5.9%	9.8%	8.1%	7.9%	6.9%
Unified Soil Class Symbol =	GW-GM	SP-SM	GW-GM	GW-GM	SP-SM



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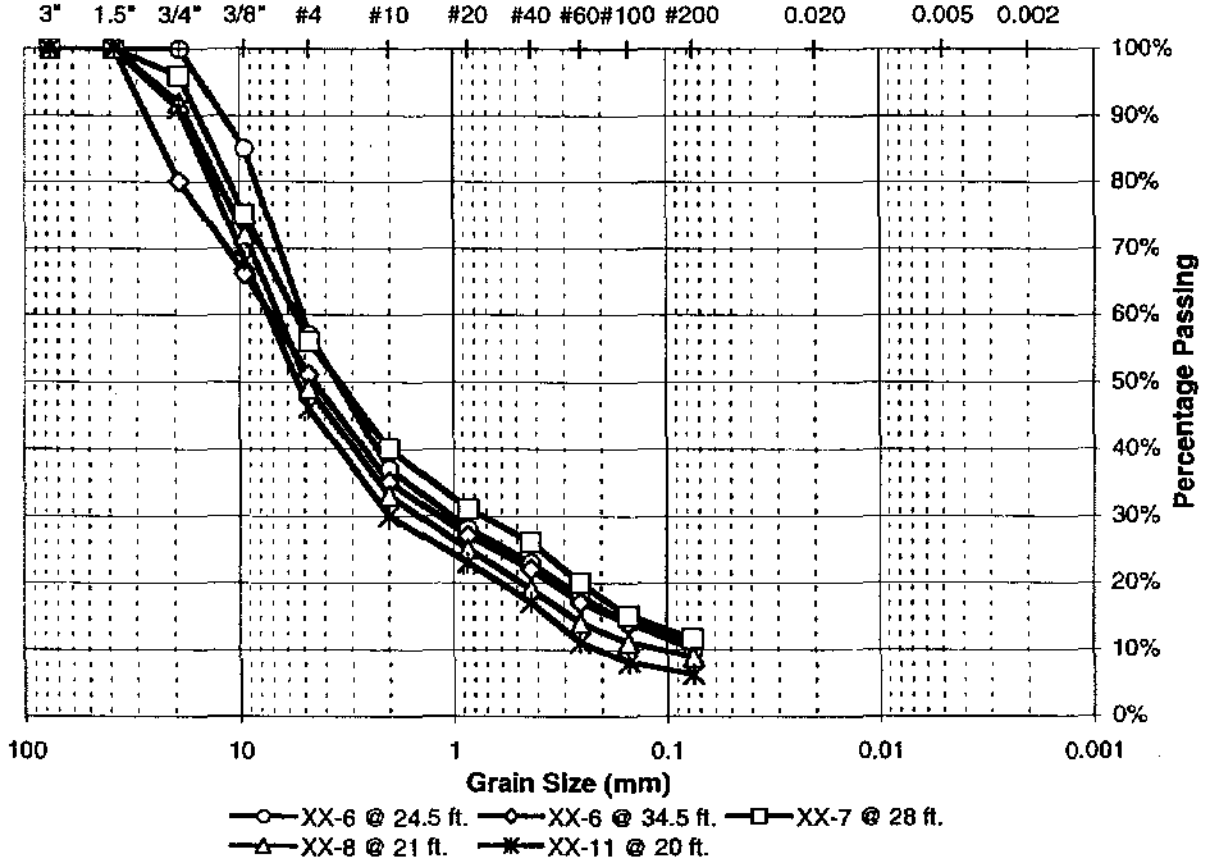
PARTICLE SIZE ANALYSIS
Pt. Thomson
North Slope, Alaska

Plate
32

Boring =>	XX-6	XX-6	XX-7	XX-8	XX-11
Depth =>	24.5 ft.	34.5 ft.	28.0 ft.	21.0 ft.	20.0 ft.
3" =>	100%	100%	100%	100%	100%
1 1/2" =>	100%	100%	100%	100%	100%
3/4" =>	100%	80%	96%	92%	91%
3/8" =>	85%	66%	75%	72%	68%
#4 =>	57%	51%	56%	49%	46%
#10 =>	37%	35%	40%	33%	30%
#20 =>	28%	27%	31%	25%	23%
#40 =>	23%	22%	26%	19%	17%
#60 =>	18%	17%	20%	14%	11%
#100 =>	14%	14%	15%	11%	8%
#200 =>	10.0%	10.7%	11.6%	8.8%	6.2%
0.02 mm					
0.005 mm					
0.002 mm					

Analysis of Data	drive sample	drive sample	drive sample	drive sample	drive sample
D10 size =>	0.075 mm	0.069 mm	0.063 mm	0.109 mm	0.211 mm
D30 size =>	1.028 mm	1.172 mm	0.740 mm	1.451 mm	2.000 mm
D50 size =>	3.509 mm	4.500 mm	3.434 mm	4.895 mm	5.388 mm
D60 size =>	5.116 mm	7.200 mm	5.496 mm	6.617 mm	7.383 mm
Coeff. of Uniformity, Cu =	68.22	104.67	87.94	60.45	35.02
Coeff. of Curvature, Cc =	2.75	2.77	1.59	2.91	2.57
Gravel (+#4) percentage =	43.0%	49.0%	44.0%	51.0%	54.0%
AASHTO Gravel (+#10) =	63.0%	65.0%	60.0%	67.0%	70.0%
Sand percentage =	47.0%	40.3%	44.4%	40.2%	39.8%
Fines percentage =	10.0%	10.7%	11.6%	8.8%	6.2%
Unified Soil Class Symbol =	SW-SM	GW-GM	SW-SM	GW-GM	GW-GM



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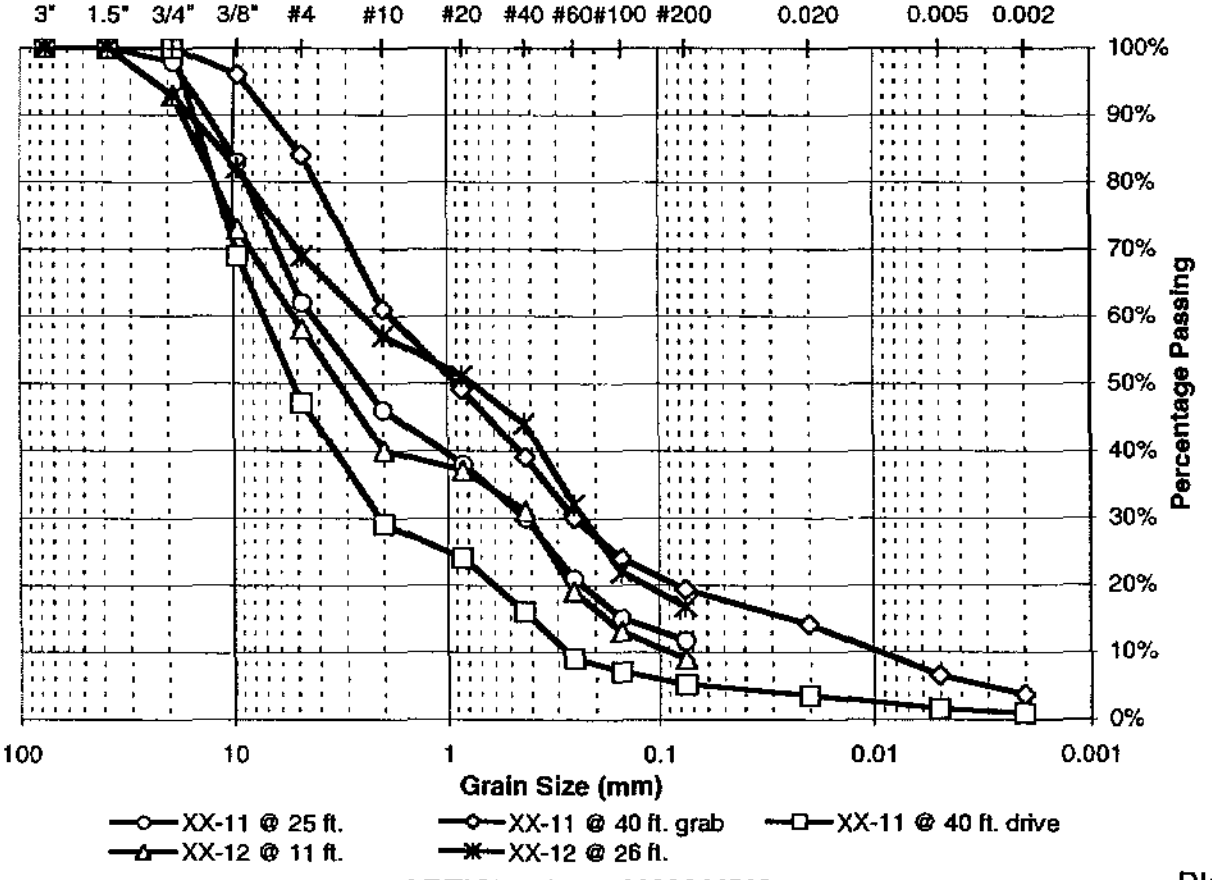
PARTICLE SIZE ANALYSIS

Pt. Thomson
North Slope, Alaska

Plate
33

Boring =>	XX-11	XX-11	XX-11	XX-12	XX-12
Depth =>	25.0 ft.	40.0 ft.	40.0 ft.	11.0 ft.	26.0 ft.
3" =>	100%	100%	100%	100%	100%
1 1/2" =>	100%	100%	100%	100%	100%
3/4" =>	98%	100%	100%	93%	93%
3/8" =>	83%	96%	69%	73%	82%
#4 =>	62%	84%	47%	58%	69%
#10 =>	46%	61%	29%	40%	57%
#20 =>	38%	49%	24%	37%	51%
#40 =>	30%	39%	16%	31%	44%
#60 =>	21%	30%	9%	19%	32%
#100 =>	15%	24%	7%	13%	22%
#200 =>	11.7%	19.3%	5.1%	8.9%	16.7%
0.02 mm		14.1%	3.5%		
0.005 mm		6.5%	1.6%		
0.002 mm		3.6%	0.9%		

Analysis of Data	drive sample	auger bulk	drive sample	drive sample	drive sample
D10 size =>	0.062 mm	0.010 mm	0.270 mm	0.090 mm	0.044 mm
D30 size =>	0.425 mm	0.250 mm	2.098 mm	0.407 mm	0.226 mm
D50 size =>	2.483 mm	0.913 mm	5.221 mm	3.234 mm	0.770 mm
D60 size =>	4.263 mm	1.862 mm	7.154 mm	5.210 mm	2.483 mm
Coeff. of Uniformity, Cu =	68.88	195.75	26.53	57.68	56.26
Coeff. of Curvature, Cc =	0.68	3.53	2.28	0.35	0.46
Gravel (+#4) percentage =	38.0%	16.0%	53.0%	42.0%	31.0%
AASHTO Gravel (+#10) =	54.0%	39.0%	71.0%	60.0%	43.0%
Sand percentage =	50.3%	64.7%	41.9%	49.1%	52.3%
Fines percentage =	11.7%	19.3%	5.1%	8.9%	16.7%
Unified Soil Class Symbol =	SP-SM	SM	GW-GM	SP-SM	SM



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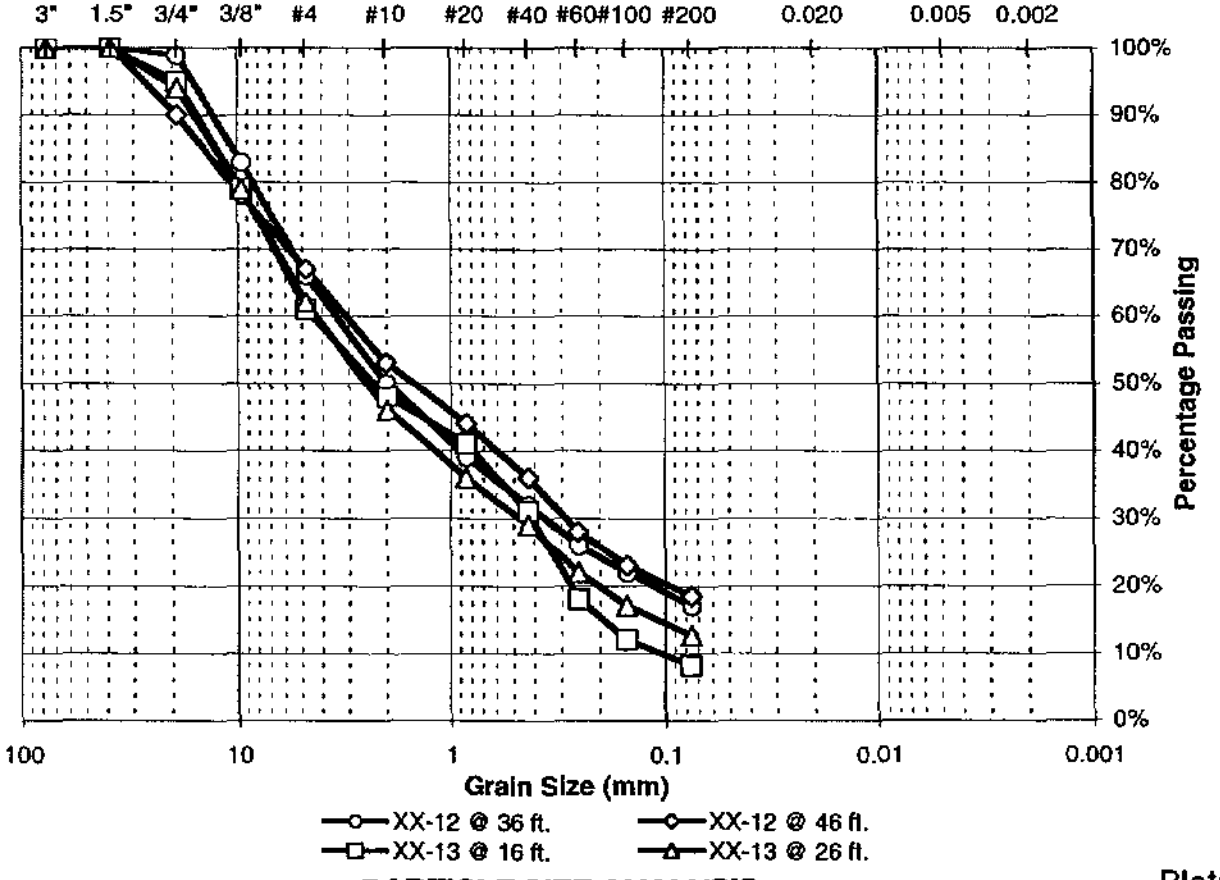
PARTICLE SIZE ANALYSIS
Pt. Thomson
North Slope, Alaska

Plate
34

Boring =>	XX-12	XX-12	XX-13	XX-13
Depth =>	36.0 ft.	46.0 ft.	16.0 ft.	26.0 ft.
3" =>	100%	100%	100%	100%
1 1/2" =>	100%	100%	100%	100%
3/4" =>	99%	90%	95%	94%
3/8" =>	83%	78%	79%	79%
#4 =>	66%	67%	61%	62%
#10 =>	50%	53%	48%	46%
#20 =>	39%	44%	41%	36%
#40 =>	32%	36%	31%	29%
#60 =>	26%	28%	18%	22%
#100 =>	22%	23%	12%	17%
#200 =>	17.0%	18.5%	8.2%	12.7%
0.02 mm				
0.005 mm				
0.002 mm				

Analysis of Data drive sampledrive sampledrive sampledrive sample

D10 size =>	0.044 mm	0.041 mm	0.104 mm	0.057 mm
D30 size =>	0.356 mm	0.285 mm	0.408 mm	0.469 mm
D50 size =>	2.000 mm	1.504 mm	2.285 mm	2.483 mm
D60 size =>	3.434 mm	3.082 mm	4.444 mm	4.263 mm
Coeff. of Uniformity, Cu =	78.91	75.43	42.67	75.29
Coeff. of Curvature, Cc =	0.85	0.65	0.36	0.91
Gravel (+#4) percentage =	34.0%	33.0%	39.0%	38.0%
AASHTO Gravel (+#10) =	50.0%	47.0%	52.0%	54.0%
Sand percentage =	49.0%	48.5%	52.8%	49.3%
Fines percentage =	17.0%	18.5%	8.2%	12.7%
Unified Soil Class Symbol =	SM	SM	SP-SM	SM



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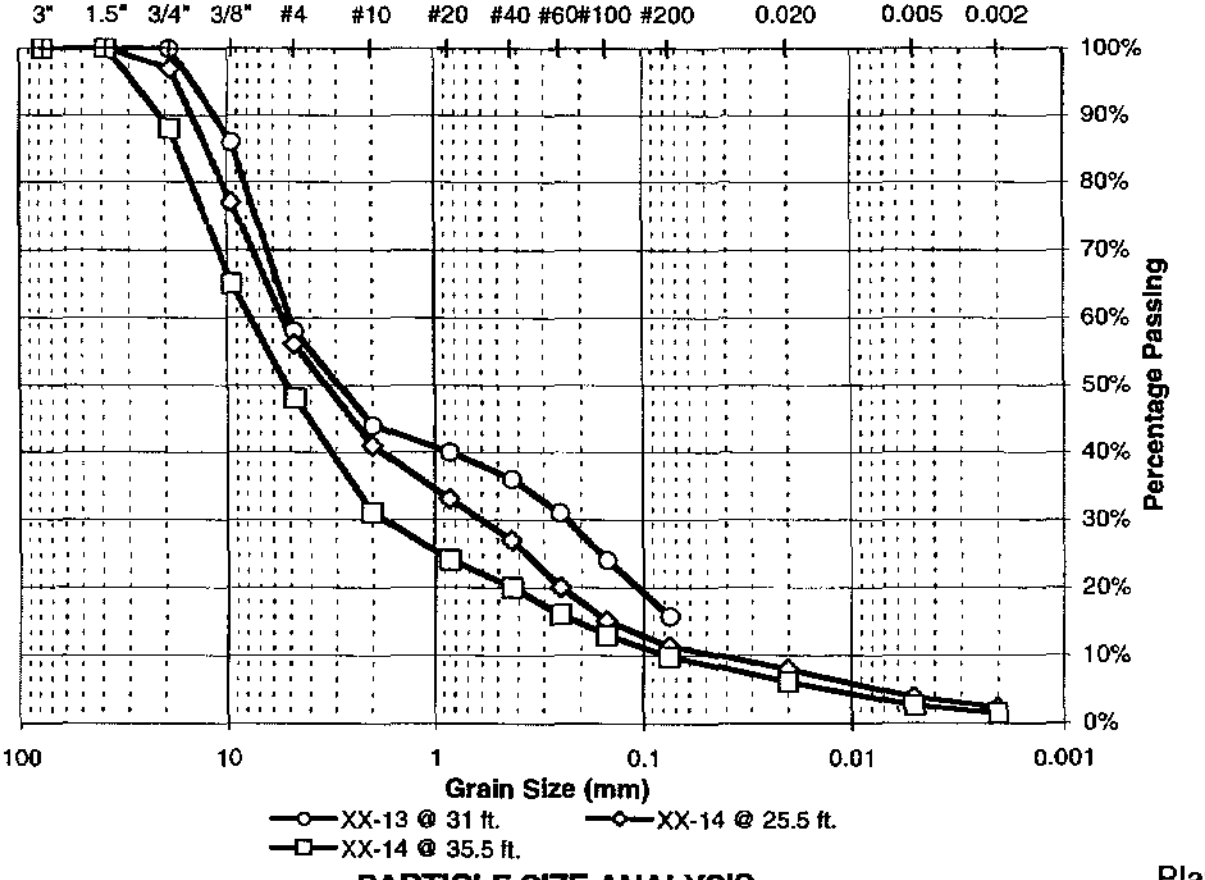
PARTICLE SIZE ANALYSIS
Pt. Thomson
North Slope, Alaska

Plate
35

Boring =>	XX-13	XX-14	XX-14
Depth =>	31.0 ft.	25.5 ft.	35.5 ft.
3" =>	100%	100%	100%
1 1/2" =>	100%	100%	100%
3/4" =>	100%	97%	88%
3/8" =>	86%	77%	65%
#4 =>	58%	56%	48%
#10 =>	44%	41%	31%
#20 =>	40%	33%	24%
#40 =>	36%	27%	20%
#60 =>	31%	20%	16%
#100 =>	24%	15%	13%
#200 =>	15.8%	11.4%	9.8%
0.02 mm		7.9%	6.1%
0.005 mm		3.8%	2.6%
0.002 mm		2.3%	1.5%

Analysis of Data drive sampledrive sampledrive sample

D10 size =>	0.046 mm	0.044 mm	0.078 mm
D30 size =>	0.232 mm	0.601 mm	1.770 mm
D50 size =>	2.898 mm	3.361 mm	5.154 mm
D60 size =>	4.991 mm	5.420 mm	7.748 mm
Coeff. of Uniformity, Cu =	108.11	122.63	98.93
Coeff. of Curvature, Cc =	0.23	1.51	5.16
Gravel (+#4) percentage =	42.0%	44.0%	52.0%
AASHTO Gravel (+#10) =	56.0%	59.0%	69.0%
Sand percentage =	42.2%	44.6%	38.2%
Fines percentage =	15.8%	11.4%	9.8%
Unified Soil Class Symbol =	SM	SW-SM	GP-GM



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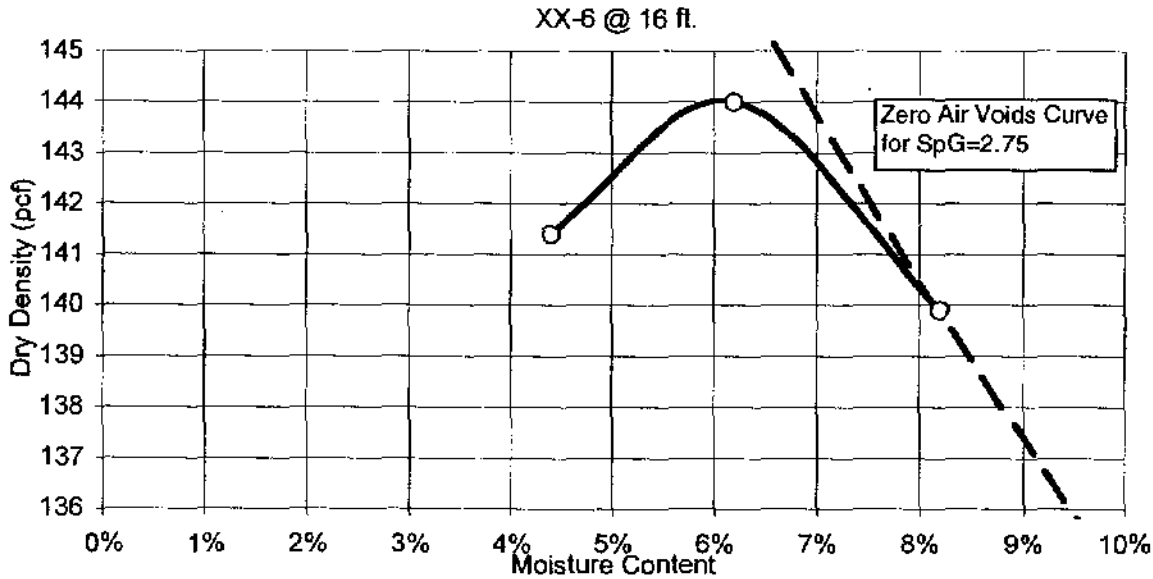
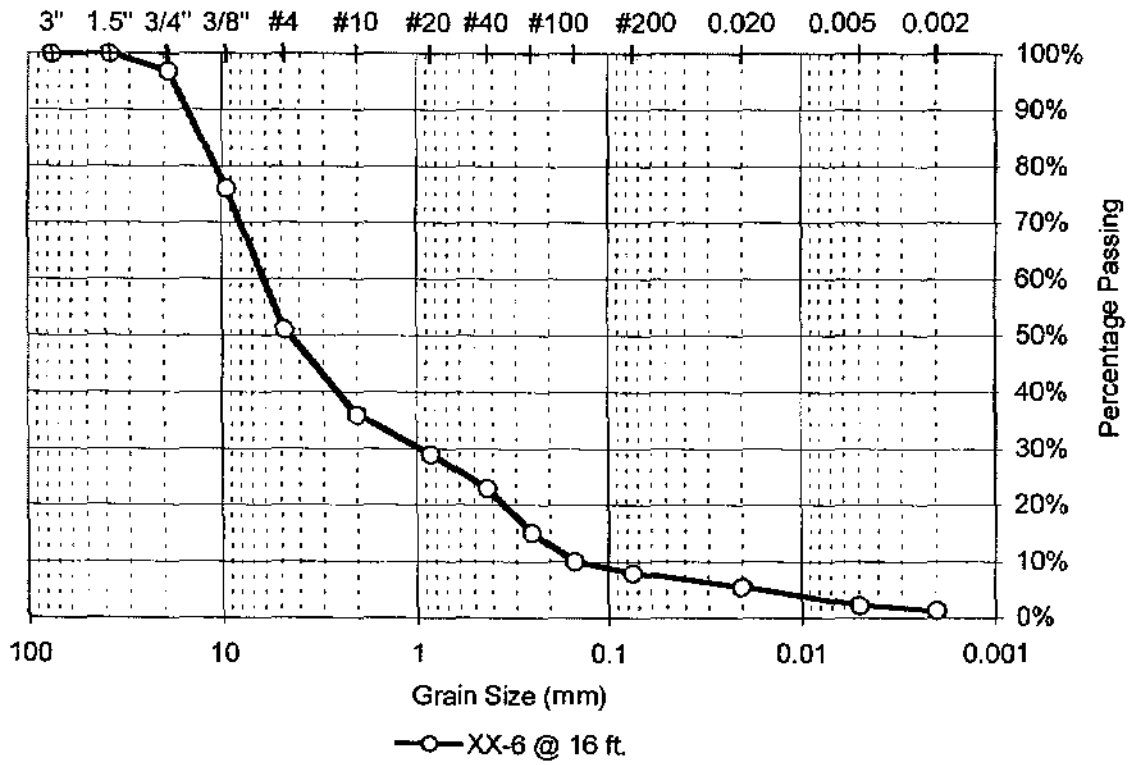
PARTICLE SIZE ANALYSIS
Pt. Thomson
North Slope, Alaska

Plate
36

		Frozen Bulk Sample				Thawed Sample		
Sample	USCS	Frozen Bulk Density	Frozen Dry Density	Thaw Strain of Bulk Sample	Moisture Content	Min Dry Density	Max Dry Density (D1557c)	Optimum Moisture Content
XX-6 @ 16 ft.	GW-GM	94 pcf	85 pcf	34%	10.8%	119 pcf	144 pcf	6.5%

Laboratory testing performed by Terra Firma, Inc.





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Job No. 4119.24
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FILL MATERIAL DATA
Pt. Thomson
North Slope, Alaska

Plate
37