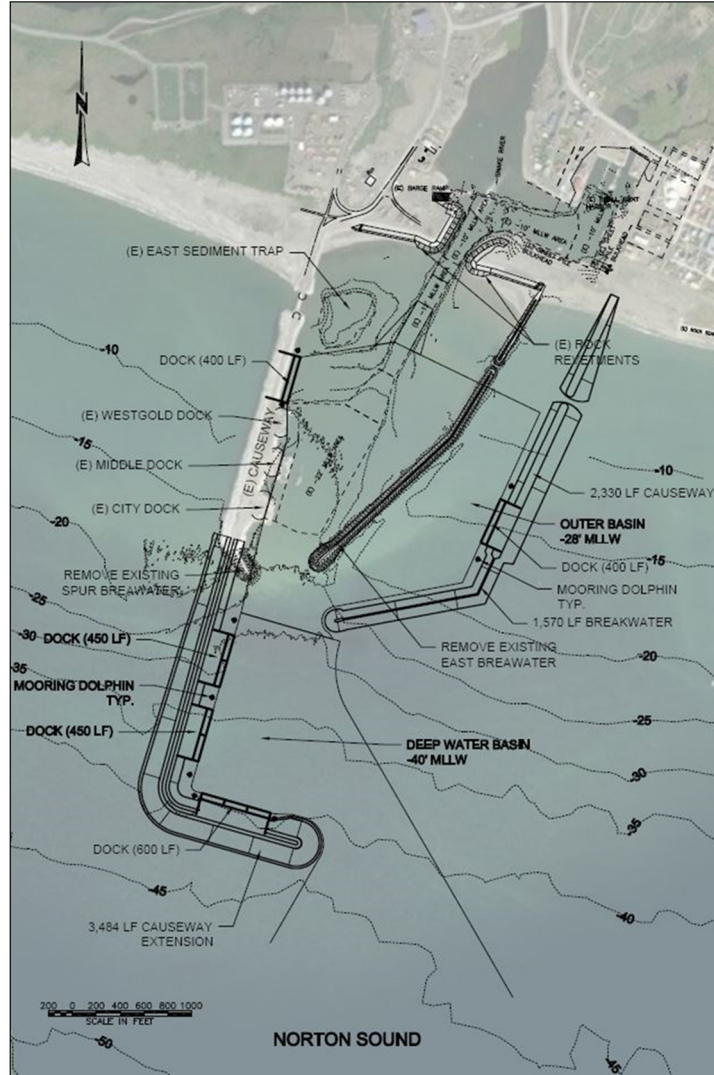


# Port of Nome Modification Feasibility Study

## Appendix B: Geotechnical Feasibility Report



### Nome, Alaska

9 December 2019  
P2 Number: 464170  
Status: Final Draft



**US Army Corps  
of Engineers®**  
Alaska District



**Department of the Army  
Alaska District, U.S. Army Corps of Engineers  
P.O. Box 6898  
JBER, AK 99506-0898**

CEPOA-EN-G-GM

9 December 2019

MEMORANDUM FOR CEPOA-PM-C (Attn: Jenipher Cate)

SUBJECT: Final Draft Geotechnical Feasibility Report for the Port of Nome Modification Feasibility Study, Nome, Alaska.

1. Enclosed is the Final Draft Geotechnical Feasibility Report for the Port of Nome Modification Feasibility Study. Included with this report are a discussion of existing geotechnical information pertaining to the project and a previous geotechnical report for the Port of Nome.
2. Questions should be addressed to Matthew Maher at 907-753-2850 or John Rajek at 907-753-5695.

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### APPENDIX B.2 – EXSISTING GEOTECHNICAL INFORMATION

Harding Lawson Associates. *Soil Investigation Port of Nome, Alaska*. 1982 105 Sheets



## **1. INTRODUCTION**

The purpose of this report is to summarize the results of existing geotechnical information at the Port of Nome and document anticipated geotechnical conditions as they pertain to the Tentatively Selected Plan (Alternative 8B) for the Port of Nome Modification. This report also provides preliminary geotechnical design criteria for proposed rubble-mound breakwater construction and dredging throughout the harbor. Information and assumptions in this report were developed through a desk study of existing geotechnical information, and it is intended for use by design engineers and planners to evaluate feasibility alternatives for new harbor improvements at the Port of Nome. Information in this report is not intended for use in construction contract documents. A geotechnical site investigation will be performed, and detailed geotechnical design criteria will be developed during the Preconstruction Engineering and Design (PED) phase.

## **2. LOCATION AND PROJECT DESCRIPTION**

The Port of Nome is a coastal marine port with a causeway to the west and a breakwater to the east, protecting the existing Outer and Inner Harbors from wind and wave action. The Port of Nome is at the terminus of the Snake River, which flows into the Inner Harbor from the north before flowing into the Outer Harbor and Norton Sound, as illustrated in Sheet B.1-1, located in Appendix B.1.

The proposed Tentatively Selected Plan (TSP), referenced as Alternative 8B in the Feasibility Report, is illustrated in Sheet B.1-2 along with a preliminary layout of soil borings to be considered for PED that is displayed in Appendix B.1. The TSP extends an L shape section approximately 3,484 feet (ft) off the existing causeway, with additional docks. The east breakwater is to be removed and replaced with a causeway/breakwater; approximately 3,900 ft long shifted further east to widen the current harbor. The current plan is for dredge depths to be increased to -40 ft mean lower low water (MLLW) within the Deep Water Basin, and deepening to -27 ft MLLW in the Outer Basin.

Alternative 8B shares the same conceptual cross-sectional breakwater design as the current causeway. These breakwaters would be exposed to the open ocean environment and designed as 3-layer rubble mound breakwaters constructed at slopes of 1.5 and 2 horizontal to 1 vertical with 10-ton armor stones to a crest elevation of +28 ft MLLW.

## **3. EXISTING GEOTECHNICAL INFORMATION**

The Port of Nome had five historical investigations completed over the years since 1982 for various developments. The first available historical geotechnical investigation report (most applicable for this study) was conducted in 1982 by Harding Lawson Associates (Port of Nome Soil Investigation Report, May 1982), which included the only offshore exploration. The other investigations occurred within the small boat harbor and outside the study footprint. These small boat harbor investigations are still beneficial resources to aid in understanding the overall geotechnical conditions within the general study area. The summary of relevant subsurface conditions given below will primarily focus on information provided in the 1982 offshore investigation conducted by Harding Lawson.

The Harding Lawson geotechnical investigation included seven test borings along the offshore causeway alignment, as illustrated in the boring location map (Sheet B.1-3). Their report provides information on particle size distribution, triaxial compressive strength, consolidation, and relative density of the soil samples, and associated geotechnical analyses.

Based on the Harding Lawson investigation, subsurface conditions below the causeway consist of four strata consisting of Holocene (recent deposits) sediment underlain by three identifiable Pleistocene deposits (glacial till, older marine deposits, and gravel rubble). Sediment at the mudline was classified as silty sand with a trace amount of gravel (recent deposits) to depths -5 to -37 ft MLLW, followed by gravelly silty sand (glacial till) to depths of approximately -15 ft to -47 ft MLLW, followed by silty fine sand (older marine deposits) to depths of approximately -35 ft to -71 ft MLLW. Sandy gravel underlies the silty fine sand to depths of approximately -45 ft to -72 ft MLLW. Below the sandy gravel, weathered micaceous schist bedrock was encountered to a maximum depth explored (-77 ft MLLW). The recent deposits, glacial till, and older marine deposits were determined to be medium dense to dense, medium dense to very dense, and dense to very dense, respectively, based on the Standard Penetration Test blow count results. The Harding Lawson investigation report with exploration logs is provided in Appendix B.2, with the boring locations provided on Sheet B.1-3.

Boring locations related to the small boat harbor investigations are shown on Sheets B.1-3 and B.1-4. Reports for these investigations, as listed below, can be provided upon request.

- Tippetts-Abbett-McCarthy-Stratton. Port Of Nome, Alaska Design Memorandum. 1982.
- Woodward-Clyde. Nome Harbor Site Investigation Report. 1997.
- USACE. Geotechnical Findings Report-Nome Harbor Sheet Pile Replacement. 2004.
- Shannon & Wilson. Preliminary Geotechnical Report Nome Harbor Sheet Pile Replacement. 2004.
- USACE. Geotechnical Findings Report-Nome Harbor Sheet Pile Replacement. 2006.
- USACE. Alaska Deep-Draft Arctic Port System. 2015.
- USACE. Geotechnical Data Report Nome Harbor Dredging. 2018.

#### **4. GEOTECHNICAL ANALYSIS AND RECOMMENDATIONS**

Performance of the current causeway and breakwater along with existing geotechnical information suggest favorable foundation conditions for Alternative 8B at the Nome Harbor.

##### **4.1 Breakwater Slope Stability and Settlement**

The foundation conditions for the proposed breakwater additions/modifications would most likely consist of stratified layers of medium dense to dense, fine to coarse sand with gravel and cobbles. Based on earlier site investigations, bedrock depths below the general study area range from approximately -46 to -72 ft MLLW. Given the existing data,

there are no anticipated changes required to the current proposed breakwater cross-section.

Breakwater slope stability, settlement, and seismic hazard analyses were not performed for the Port of Nome alternatives because the expected foundation conditions were assumed to be very similar to the existing causeway and breakwater structures. A brief seismic hazard assessment was conducted using an analysis software developed by the U.S. Geological Survey (USGS) – The Unified Hazard Tool. The primary seismic parameters that are of concern to geotechnical design are the peak ground acceleration (PGA) and the corresponding magnitude ( $M_w$ ), which were determined to be 0.207g and 6.13 in the Unified Hazard Tool for the Port of Nome. Slope stability, settlement, and seismic hazard analyses will be performed after subsurface soil conditions are investigated in detail during PED.

#### **4.2 Dredging**

The proposed harbor sections are to be dredged to depths -40 ft MLLW with 2 ft over dredge for the Deep Water Basin and -27 ft MLLW with 1 ft over dredge for the Outer Basin. The thickness and character of soil stratum above the bedrock are not completely certain without performing additional field explorations. However, the anticipated dredging methods considered throughout the dredge sections would primarily be mechanical, but hydraulic dredging would be considered in certain areas. Mechanical dredging is considered the primary method due to the in-place denseness of the soil layers and the presence of cobbles. Until further information can be obtained, mechanical dredging is the preferred approach when handling the dense material with an estimated volume of cobbles up to 25 percent. The high soil density will allow side slopes at 1.5 horizontal to 1 vertical, with bedrock not expected to be encountered.

#### **4.3 Future Geotechnical Site Investigation Recommendations**

Geotechnical investigations need to be performed during PED to properly characterize the proposed dredge material, evaluate and recommend the suitability of breakwater foundation material, and identify any geological conditions that would require special foundation treatment. Geotechnical information will also be used to establish the basis for accurate dredging cost estimates. Preliminary geotechnical exploration costs for both drilling and surveying have been determined and submitted for Alternative 8B, the Tentatively Selected Plan. The following geotechnical investigations are recommended in support of Alternative 8B design:

1. Conduct an offshore geotechnical site investigation consisting of drilling between 50 and 60 test borings below the proposed rubble mound breakwaters and the deep water basin. The preferred drilling method would consist of using standard penetration testing, large penetration testing (SPT/LPT), or sonic drill methods that would be able to penetrate dense, coarse-grained sediments with cobbles and boulders.
2. Conduct an offshore marine geophysical investigation to define sub-seafloor conditions further and complement the geotechnical drilling by providing a broader

understanding of subsurface stratigraphy and the depth to the top of bedrock within the dredging areas. The geophysical investigation should consist of survey track lines collected at a nominal spacing of 25-ft parallel and perpendicular to the proposed breakwater alignments and outer harbor sections.

3. Perform laboratory testing on selected soil samples from the geotechnical site investigation.

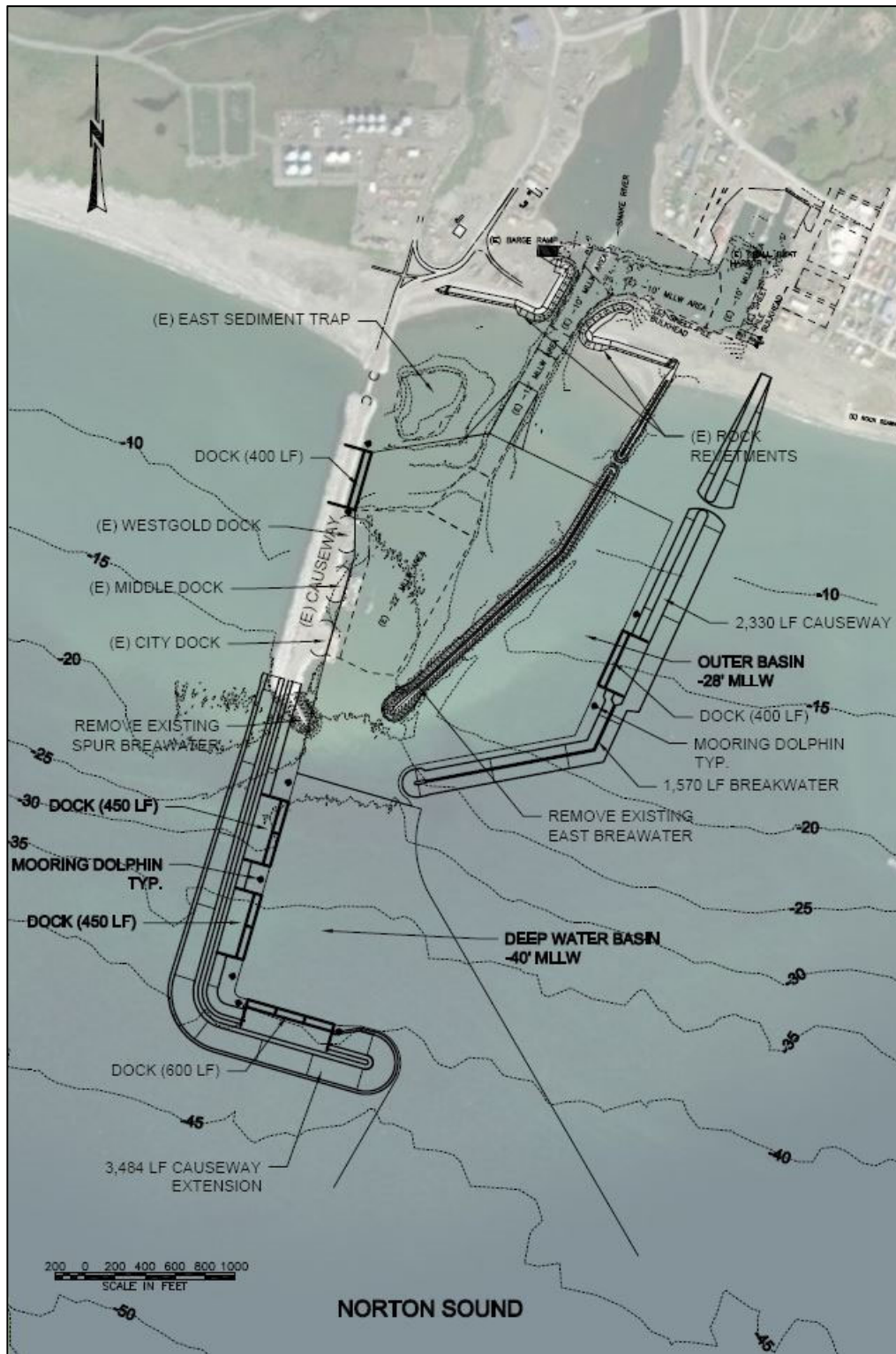
## **5. REFERENCES**

“Unified Hazard Tool.” *U.S. Geological Survey*, [earthquake.usgs.gov/hazards/interactive/](http://earthquake.usgs.gov/hazards/interactive/)

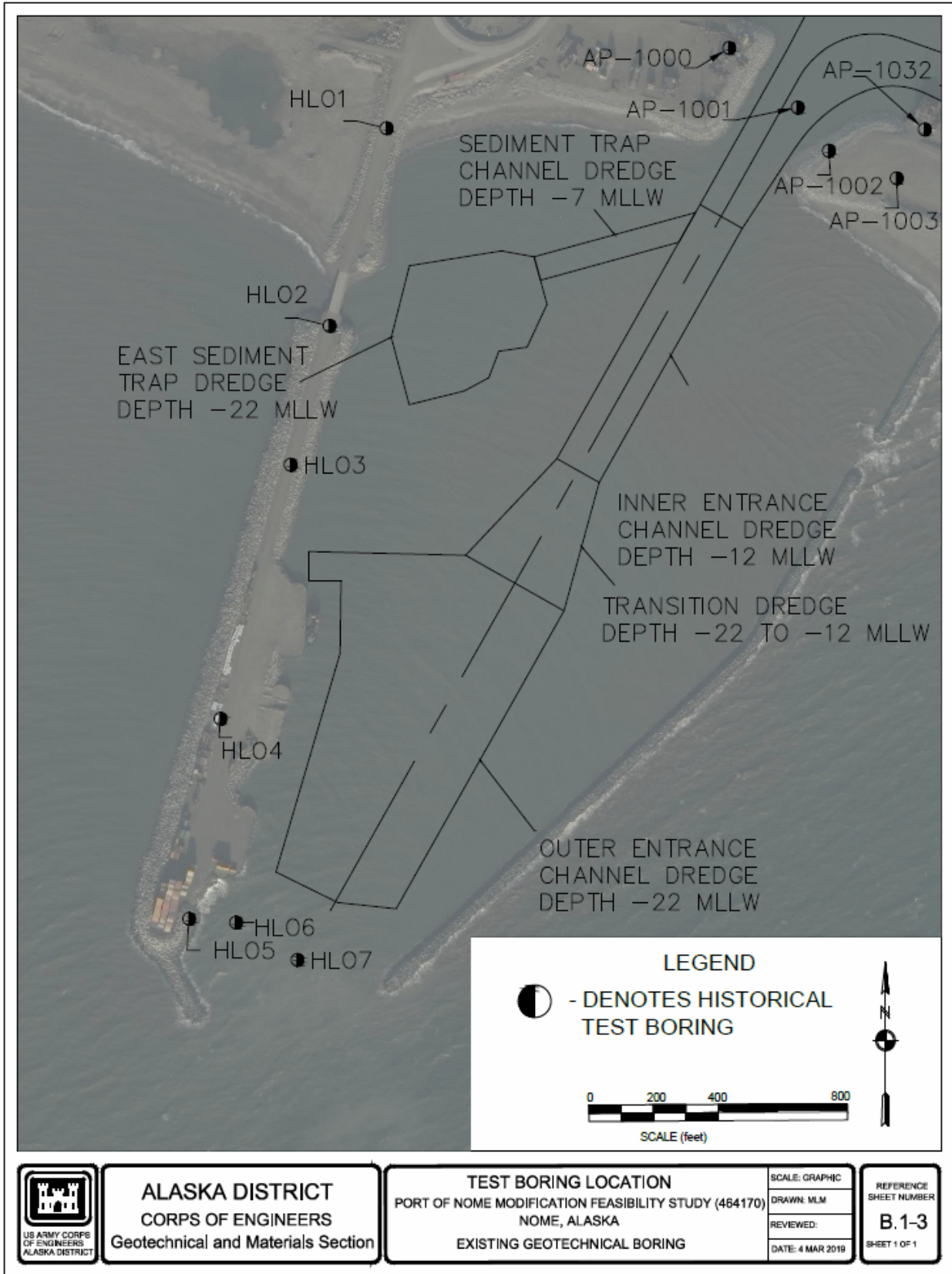
**APPENDIX B.1**

**MAPS AND SKETCHES**

Project Location Map and Alternative 8B .....	Sheet B.1-1
Test Boring Location Map – Outer Harbor .....	Sheet B.1-3
Test Boring Location Map – Small Boat Harbor .....	Sheet B.1-4



Sheet B-1.1 Project Location Map and Alternative 8B



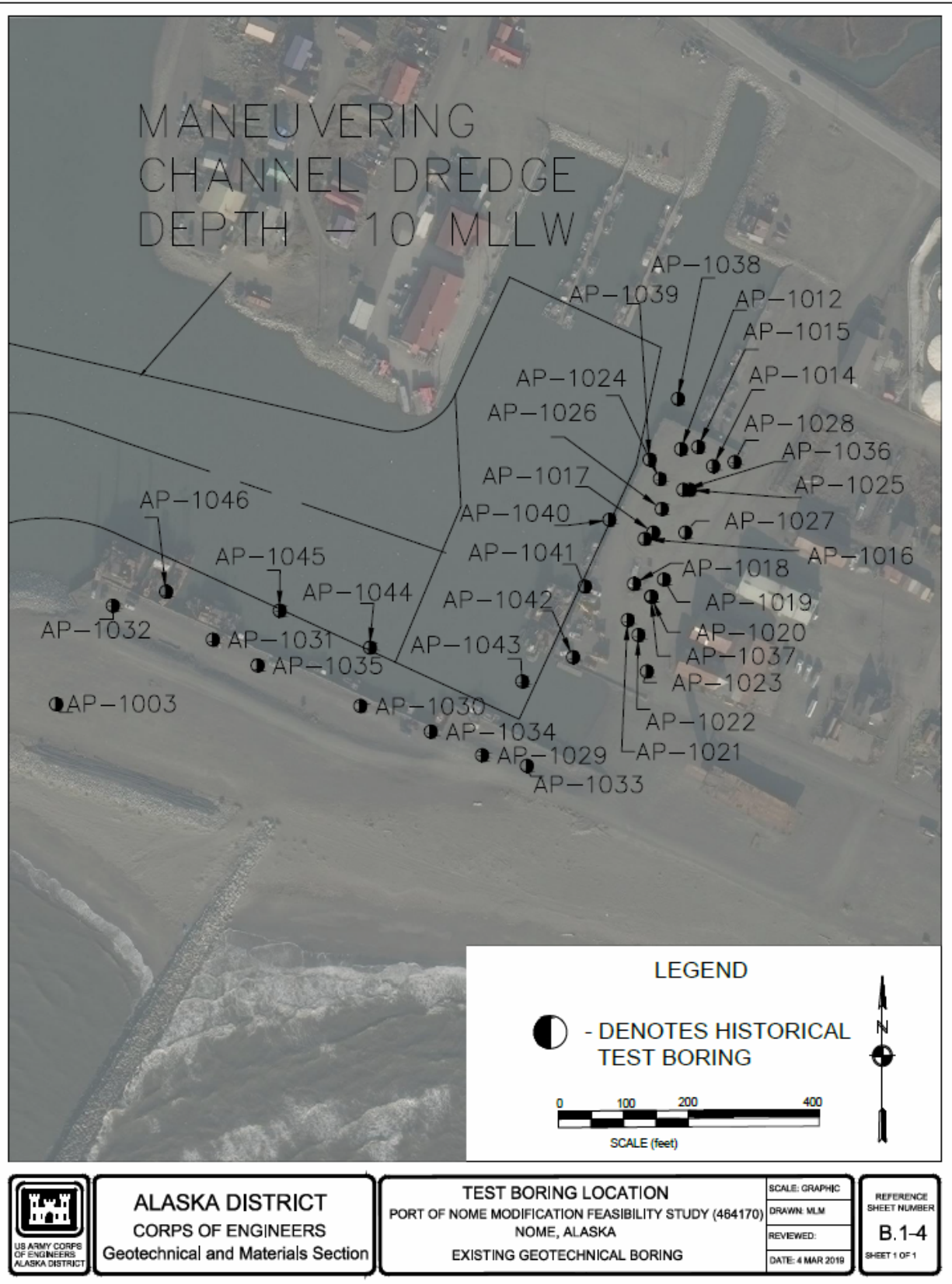
**ALASKA DISTRICT**  
 CORPS OF ENGINEERS  
 Geotechnical and Materials Section

**TEST BORING LOCATION**  
 PORT OF NOME MODIFICATION FEASIBILITY STUDY (464170)  
 NOME, ALASKA  
 EXISTING GEOTECHNICAL BORING

SCALE: GRAPHIC  
 DRAWN: MLM  
 REVIEWED:  
 DATE: 4 MAR 2019

REFERENCE SHEET NUMBER  
**B.1-3**  
 SHEET 1 OF 1







**APPENDIX B.2**

**EXSISTING GEOTECHNICAL INFORMATION**

**Harding Lawson Associates. *Soil Investigation Port of Nome, Alaska. 1982 105 Sheets***

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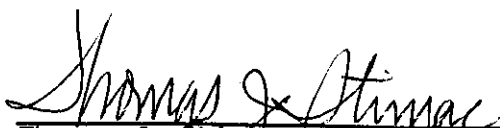
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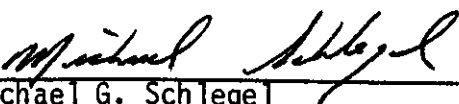
TAMS Engineers  
4791 Business Park Boulevard, Building H  
Anchorage, Alaska 99503

SOIL INVESTIGATION  
PORT OF NOME  
NOME, ALASKA

HLA Job No. 15001,002.08

by

  
Thomas J. Stimac  
Associate Engineer

  
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Geologist

Harding Lawson Associates  
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Anchorage, Alaska 99502  
907/276-8102

May, 1982

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DISTRIBUTION

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(continued)

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## SUMMARY

In February and March 1982, we performed a field and laboratory geotechnical investigation for the proposed Port of Nome in Nome, Alaska. The work consisted of drilling 7 test borings offshore in a causeway area, 13 borings in an onshore facilities area, and 4 borings at the tentative location of a small boat harbor. The offshore borings were drilled from the winter ice canopy using a helicopter-transported rotary wash drill rig. The other borings were drilled onshore with an air-rotary rig. Laboratory tests were performed on select samples to determine pertinent engineering properties of the soils.

Offshore, the soils generally consist of a 5- to 10-foot-thick mantle of medium dense granular Holocene (recent) sediments underlain by 30 to 40 feet of dense, granular glacial till and Pleistocene marine deposits. Bedrock was encountered within 50 feet of mudline and consisted of mica-ceous shist. The offshore soils are considered fairly competent, and absent of highly compressible organic and fine-grained deposits.

The onshore "upland tundra" (or upland) area is underlain by perennially frozen (permafrost) silt and sand. These soils appear to be thaw-unstable and settlement will occur if the permafrost melts. The "modified" area similarly consisted of sands; permafrost was encountered in only one boring and at a depth of 23 feet.

The small boat harbor area is underlain by loose to medium dense silt, sand and gravel deposited and reworked by the Snake River. Considering the more than 100 years of activity in Nome, it is likely that man-made fill exists in this area.

## I INTRODUCTION

This report presents the result of our investigation for the proposed Port of Nome in Nome, Alaska. The project planning and engineering, including detailed geotechnical analyses, is being performed by Tippetts-Abbet-McCarthy-Stratton, Engineers (TAMS).

The general layout of the port is presented on Plates 1 and 2. As described in our proposal of December 18, 1981 we understand that the facility will consist of a rubble mound causeway/berthing structure extending about 3600 feet offshore into Norton Sound. The top of the causeway will be at approximately Elevation 25<sup>(\*)</sup>. It will be topped with a road surface and will support a utilidor containing water, sewage and fuel lines. The causeway will connect to an 800-foot-long short-term general cargo storage and barge berthing area. Dock side depth at this location will be about 30 feet; no dredging is anticipated.

About 500 feet from the shoreline the causeway will be breached to permit salmon migration; the breach will be crossed via a single-span bridge.

Onshore storage and handling facilities will be about 600 feet north of the causeway terminus on a 60-acre parcel between the Snake River and the shoreline of Norton Sound. Two areas have been designated: the "upland tundra" and the "modified" areas, as shown on Plate 1. These areas will be filled to achieve final grade; fills up to nine feet thick, are anticipated. Structures will generally consist of transit sheds having slab-on-grade concrete floors.

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(\*) Feet above Mean Lower Low Water (MLLW).

The small boat harbor will be sited on the Snake River about 2000 feet northeast of the modified area (see Plate 2). Facilities will include a boat ramp and lift and about 1000 linear feet of cantilever sheetpile bulkheading. The area will be dredged to produce a minimum water depth of about eight feet at extreme low tide.



## II SCOPE OF SERVICES

The scope of our services was in accordance with our proposal of December 18, 1981 as modified in our letter of January 20, 1982. The objective of our services as discussed in our proposal was to explore the soil, permafrost and bedrock conditions in the project area. Representative soil samples obtained during the exploration program were tested in our Anchorage laboratory to determine their pertinent engineering properties. Selection of geotechnical design parameters was not a part of our scope. The field and laboratory data together with a description of the site conditions are presented herein.

To accomplish this objective:

1. We mobilized a Mobile Drill B-38 rotary wash drill rig from Anchorage to drill seven test borings up to 57 feet below mudline for the causeway structure. The rig operated from the sea-ice canopy; a helicopter was used to move the rig between borings
2. The onshore borings were drilled with a locally contracted rotary-air track-mounted rig. Thirteen test borings ranging from 26 to 73 feet deep were drilled in the storage area. Eight borings were cased with glycol-filled PVC pipe to permit continued ground temperature monitoring. Four borings about 20 feet deep were drilled at the small boat harbor site.
3. The horizontal location and ground or ice surface elevation at each test boring was determined by Silvers Engineering using conventional plane surveying techniques.
4. We completed a laboratory program that was prepared jointly with TAMS

During our field operations, Messrs. Michael G. Horton and Gregory P. Matthews, TAMS' project manager and project geotechnical engineer respectively, were on site to observe the work and assist as necessary. Copies of the field boring logs were submitted at the completion of the test drilling. Results of the laboratory data and copies of the surveyors notes were transmitted on March 30, 1982.

### III SITE CONDITIONS

#### A. Geographic Setting

Nome is located in the Norton Sound subregion of the Northwest Region of Alaska<sup>(\*)</sup>. This area is comprised of the western three fourths of the Seward Peninsula; Norton Sound (a part of the Bering Sea) is to the south. The city of Nome is on a coastal plain. The Snake River on the western edge of the city is the dominant drainage feature in the area. Landward is an "upland" area consisting of broad, convex hills and flat divides that range from 500 to 2000 feet in elevation. The Kigluaik Mountains are about 30 miles north of Nome and have V-shaped valleys and glaciated mountains.

Nome is located in relatively seismically inactive area. It is a Seismic Zone 1 on the Uniform Building Code (UBC) Seismic Zone Map of the United States.

Climatically Nome is in the transition zone between the moderate maritime and more extreme inland continental climates. Nome receives about 16 inches of precipitation per year, which includes 54 inches of snow. Mean summer temperatures vary from 36<sup>0</sup>F to 56<sup>0</sup>F; mean winter temperatures range from -3<sup>0</sup>F to 36<sup>0</sup>F. Extreme lows of -46<sup>0</sup>F and highs of 86<sup>0</sup>F have been recorded. Nome has freezing and thawing indices of about 4300, and 2000<sup>0</sup>F days, respectively.

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(\*) "Alaska Regional Profiles, Northwest Region," published by University of Alaska, Arctic Environmental Information and Data Center.

## B. Geology

The dominant geologic features at the site are the result of episodes of Pleistocene glaciation and attendant sea level changes. The effects of the Snake River and offshore coastal processes have also contributed to the present geologic condition. The bedrock underlying the site consists of Paleozoic micaceous schists. The rock is overlain by Pleistocene glacial and marine deposits.

The following depositional events could have occurred at the causeway site:

1. During the Pleistocene Epoch (10,000 to 1 million years b.p. (\*)), glaciers advanced several times through the mountain ranges of the Seward Peninsula. While the degree of these advances varied, they were greatest during early and middle Pleistocene when ice covered extensive parts of the Northwest Region.

The upper several feet of material over bedrock consist of a "rubble strata" remaining from one of these advances. The presence of igneous rocks within this strata suggest glacial transport from the Anvil Mountain, Newton Peak and Native Hill areas to the northeast.

2. As the glaciers advanced and retreated, frequent sea level changes occurred. When the area was submerged, well-sorted fine grain marine sands and silts were deposited.
3. During subsequent glacial periods, the sea level was lower and glacial till was subsequently deposited over the marine sediments. The till is a mixture of unsorted gravel, sand, silt and clay transported and deposited by glaciers, usually as moraines. The till has probably been reworked by streams and outwash water from the melting glacier.

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(\* ) b.p. = before present

4. Overlying the till is Holocene (recent to 10,000 years b.p.) silt and sand deposits derived from both the Snake River and coastal marine sources. Offshore sediments near the shoreline have been deposited and reworked by the Snake River and mining (dredging) operations.

The onshore Upland area is dominated by shallow perennially frozen (permafrost) sand and gravel. Permafrost was observed in only one boring (at a depth of 23 feet) in the Modified area and was not observed in the Small Boat Harbor area. However, permafrost may be present below the depths of our borings.

The permafrost is a remnant feature of the Pleistocene Epoch. The area between the permafrost table is the active layer. When winter freezing does not extend to the permafrost layer a "talik" (unfrozen zone) is created. Taliks are a common feature in the Nome area.

Climate and terrain influence the formation of permafrost. The age of permafrost varies; near Nome, permafrost probably formed 3,000 to 9,000 years ago<sup>(\*)</sup>. Due to thawing operations carried out by the mining companies prior to dredging, it is difficult to define the horizontal and vertical contacts between frozen and non-frozen ground in the Nome area. Thaw depths were highly variable, depending on the depth to the "pay streak" to be mined. In many areas thawing was not carried out to bedrock. As a result, a layer of frozen soil often remained above

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(\*) Hopkins, D. M., McNeil, F. S., and Leopold, E. B., 1960, "The Coastal Plain of Nome Alaska," in Proceedings of the 21st Geological Congress, Copenhagen, Denmark, pt 4, pp. 46-57.

the bedrock. Due to the difference in freezing and thawing indices (4300 versus 2000<sup>0</sup>F days) and the insulating effect of the tundra mat, permafrost is probably slowly reforming in those areas that were thawed but not dredged. Dredged areas will probably remain unfrozen below their active zones due to higher heat gain through the mineral soil exposed on their surfaces. Areas of discontinuous permafrost and/or areas of extensive taliks exist in undisturbed areas throughout the coastal plain at Nome.

The small boat harbor is within the banks of the Snake River and its tributaries. Recent alluvium is present to depths that will be influenced by development.

#### C. Soil Conditions

Engineering properties of the soils are discussed below. Specific geotechnical design parameters should be assigned by the choosing of the designers who will ultimately use them for analyses.

##### 1. Causeway Area

The subsurface soil conditions encountered in the causeway area are illustrated on the Cross Section, Plate 3. As discussed, three Pleistocene strata (rubble; marine sand and silt; glacial till) and a Holocene stratum overly bedrock. The soils above the rubble are predominantly silty sands; occasional layers of non-plastic sandy silt was observed in Borings 1 and 5.

The glacial till can be distinguished from the underlying marine sands on the basis of gradation as illustrated on Plate 4. As shown, the marine sand is fine grained, as opposed to the coarser grained and more well-graded till. Similarly, the gradation of the Holocene soils is different from the glacial deposits, as illustrated on Plate 5.

On the basis of blow-counts, the soils are considered medium to very dense. The ranges of blow counts are:

<u>Strata</u>	<u>Cross Section Symbol</u>	<u>Average Blows/Foot*</u>
Holocene	QHmn	15
Till	QPt	32
Marine	QPm	42
Rubble	QPr	not obtained

\* Based on a 300-pound hammer falling 30 inches; a 3.0-inch O.D. x 2.4-inch I.D. sampler was used. Equivalent standard penetration or N-values can be approximated by multiplying the above values by 1.4.

Effective strength parameters of the Holocene sediments determined by consolidated-undrained triaxial shear tests indicate effective friction angles of between 35 and 41 degrees and no effective cohesion. These values are comparable to published friction angles for similar soil types and densities<sup>(\*)</sup>. Strength tests were not performed in the Pleistocene soils. However, the Pleistocene soils are stronger than the Holocene soils and strength parameters should be obtained using blow counts or other appropriate correlations.

(\*) NAVFAC DM-7, Design Manual - Soil Mechanics, Foundations and Earth Structures, by Department of Navy, 1971.

In general, the Holocene soils are non-plastic silt and sand, and are considered only moderately compressible. Results of two consolidation tests indicate that the soils are overconsolidated by at least 2000 pounds per square foot. Compressible organic material was essentially absent. The underlying Pleistocene soils are judged to be dense and only slightly compressible under the anticipated loads.

## 2. Onshore Storage Area

The onshore storage area is comprised of the upland area and the modified area. The upland area is at Elevation 33 to 45 while the modified area is considerably lower, at Elevation 6 to 11.

The upland area is blanketed by up to 16 feet of silt and organic silt; the average thickness is 7 feet. This layer tends to be of low density and high moisture content. When unfrozen, it is generally very compressible. Underlying this silt and also at the modified area, the soil consists of sands and silty sands to the depth explored. Geologically, these sands are of the same origin as the offshore glacial till<sup>(\*)</sup>; this conclusion is supported by the similarities in soil classifications and particle size distribution.

Permafrost was present in all of the upland test borings. It was present in one boring drilled in the modified area. It is generally accepted that the permafrost was destroyed when gold was mined -- a process which required that the permafrost be thawed prior to dredging.

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(\*) Green, H. G. 1970, "Morphology, Sedimentation and Seismic Characteristics of an Arctic Beach, Nome Alaska -- with Economic Significances," U.S. Department of the Interior, Geological Survey, Open-file Report.



Eight of the upland borings were cased with plastic pipe to permit continued ground temperature measurements. Results of these readings including details of the well installation and thermistor instrumentation are presented in Appendix A. The freezing points (or freezing point depressions) are shown on the plots of temperature versus depth.

A primary geotechnical consideration of development in the upland area will be the effects on the permafrost and possible thaw-strain settlements. Based on the moisture content and silt/clay contents, the soils appear thaw unstable and will settle if thawed. For instance, typical, thaw-stable soils have moisture contents less than about 8 percent and less than about 5 percent "fines".

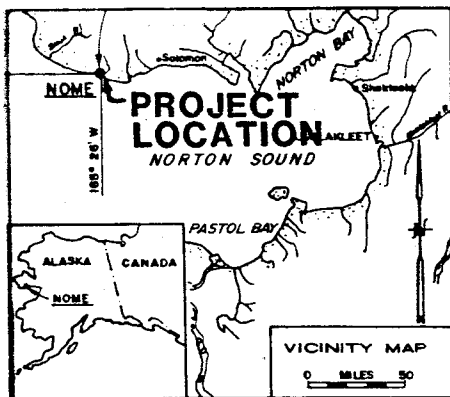
### 3. Small Boat Harbor

Soil conditions in the small boat harbor area consist of gravelly silt, silty sand and clean sand. Although silty, the sand tends to be well-graded, as indicated by the gradation test results.

Considering the proximity of the site to the Snake River and continuous activity in the area, it is likely that the area contains fill and/or has been reworked by river flows.

Design parameters should be developed using published correlations relating soil type, gradation and moisture content-dry density to strength and settlement parameters.

IV ILLUSTRATIONS



OFFSHORE TERMINAL AND CAUSEWAY

HLO-4

HLO-3

HLO-2

HLO-1

HLO-5

HLO-6

HLO-7

BRIDGE

HLB-10

HLB-1

HLB-13

HLB-11

UPLAND AREA

HLB-2

HLB-6

HLB-9

HLB-12

HLB-8

CONTAINER FREIGHT STATION

MAINT. SHOP

FUTURE EXPANSION

HLB-3

MODIFIED AREA

HLB-4

HLB-5

SNAKE RIVER

LEGEND

- 20- CONTOURS FROM BATHYMETRIC SURVEY, TETRA TECH 1984
- 10- CONTOURS ESTIMATED FROM SHELL OIL DRILL LOGS 1964
- ⊕ HLO SOIL TEST BORING - OFFSHORE
- ⊕ HLB SOIL TEST BORING - ON SHORE

DATUM

HORIZONTAL: CITY OF NOME CONTROL SURVEY 1973. 100000' ADDED IN NORTHING AND EASTING TO AVOID NEGATIVE NUMBERS.

VERTICAL: ALL ELEVATIONS IN FEET RELATIVE TO MLLW.

NOTES

1. PROJECT LOCATION: SEC 26 & 27, T11S, R34W, K.R.M.
2. TOPOGRAPHIC DETAIL BASED ON AERIAL TOPOGRAPHIC MAP OF THE CITY OF NOME BY AIR PHOTO TECH, INC. DATE OF PHOTOGRAPHY JULY 31, 1980.



**Harding Lawson Associates**  
Engineers, Geologists  
& Geophysicists

**SITE PLAN - CAUSEWAY & STORAGE AREAS**

Port of Nome  
Nome, Alaska

PLATE  
**1**

DRAWN

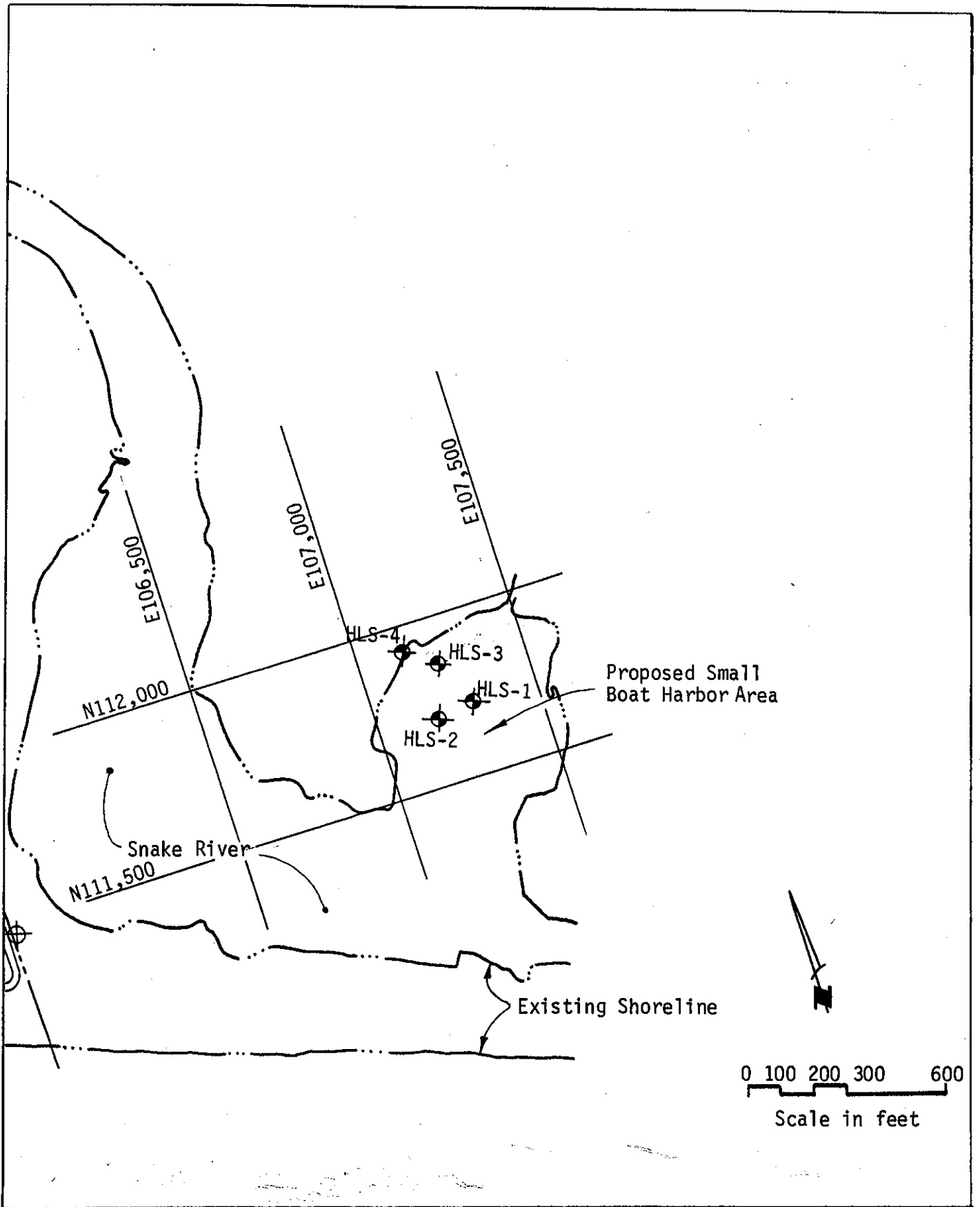
JOB NUMBER  
15,001,002.08

APPROVED

DATE  
4/82

REVISED

DATE

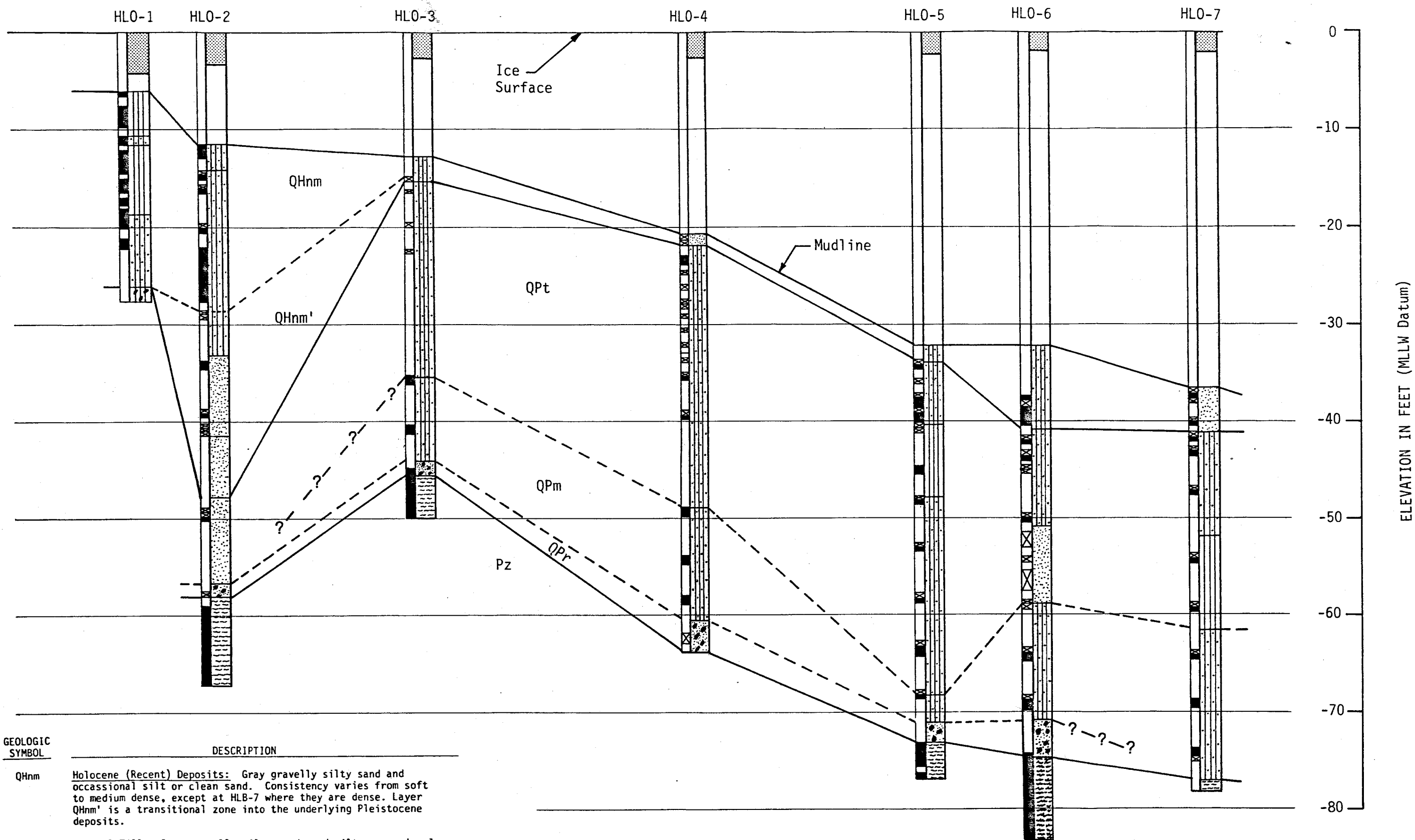


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**Site Plan - Small Boat Harbor**  
 Port of Nome  
 Nome, Alaska

PLATE  
**2**

DRAWN	JOB NUMBER 15,001,002.08	APPROVED <i>JS</i>	DATE 4/82	REVISED	DATE
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GEOLOGIC SYMBOL	DESCRIPTION
QHnm	<u>Holocene (Recent) Deposits:</u> Gray gravelly silty sand and occasional silt or clean sand. Consistency varies from soft to medium dense, except at HLB-7 where they are dense. Layer QHnm' is a transitional zone into the underlying Pleistocene deposits.
QPt	<u>Glacial Till:</u> Gray gravelly silty sands and silt; occasional clean sand and silty gravel. Medium dense to very dense. Contains angular rock fragments (gravels).
QPm	<u>Marine:</u> Gray silty sand; fine grain; dense to very dense.
QPr	<u>Glacial Rubble:</u> Gray sandy gravel; very dense; silty to clean.
Pz	<u>Bedrock:</u> Micaceous shist; highly weathered at surface.



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**SUBSURFACE CROSS-SECTION**

Port of Nome  
Nome, Alaska

PLATE  
**3**

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	15,001,002.08	TJS	4/82		

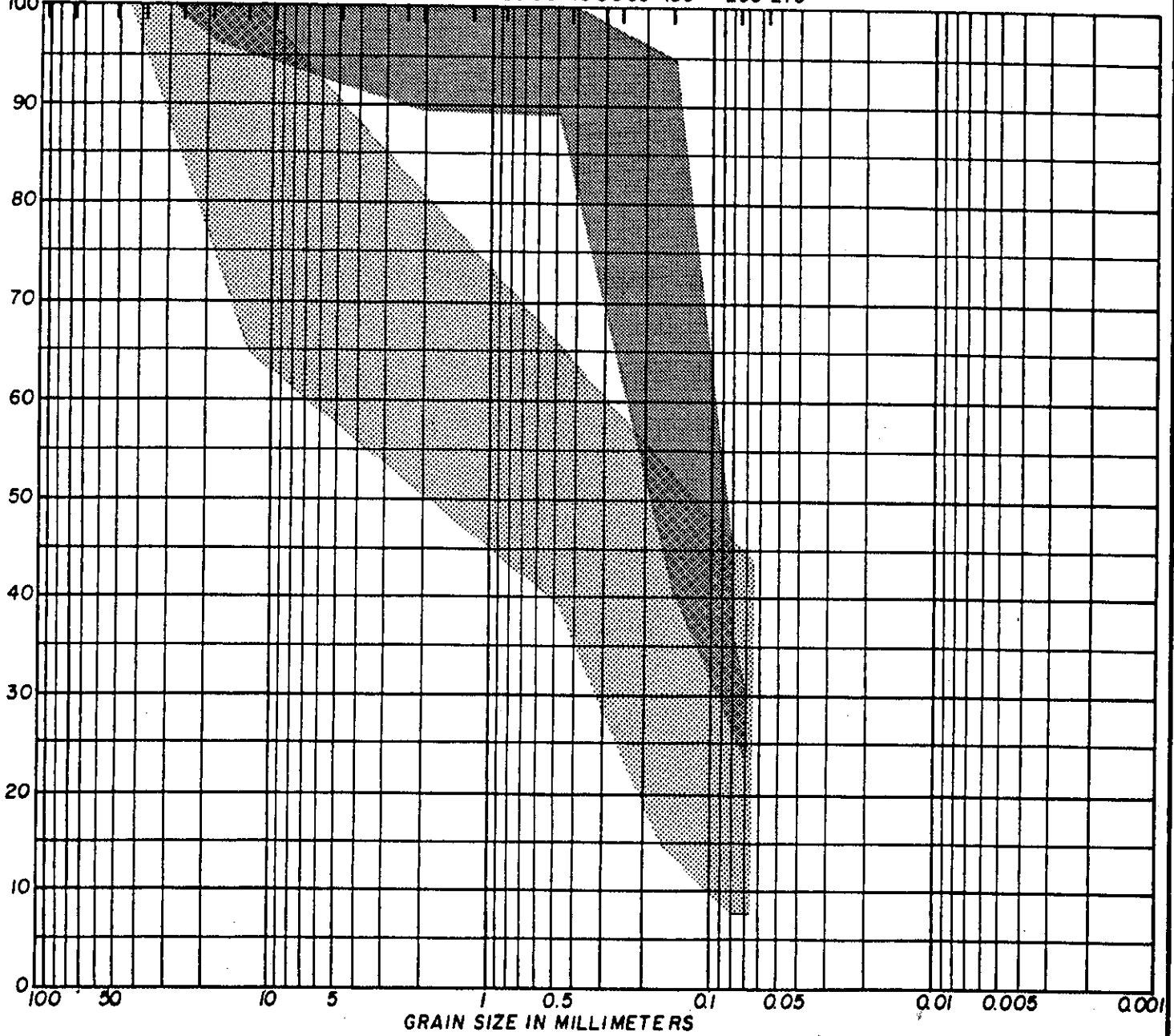
U.S. Standard Sieve Opening Size

U.S. Standard Sieve Numbers

Hydrometer

4 3 2 1/2 1 3/4 1/2 3/8 4 8 10 16 20 30 40 50 60 100 200 270

PERCENT FINER BY WEIGHT



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

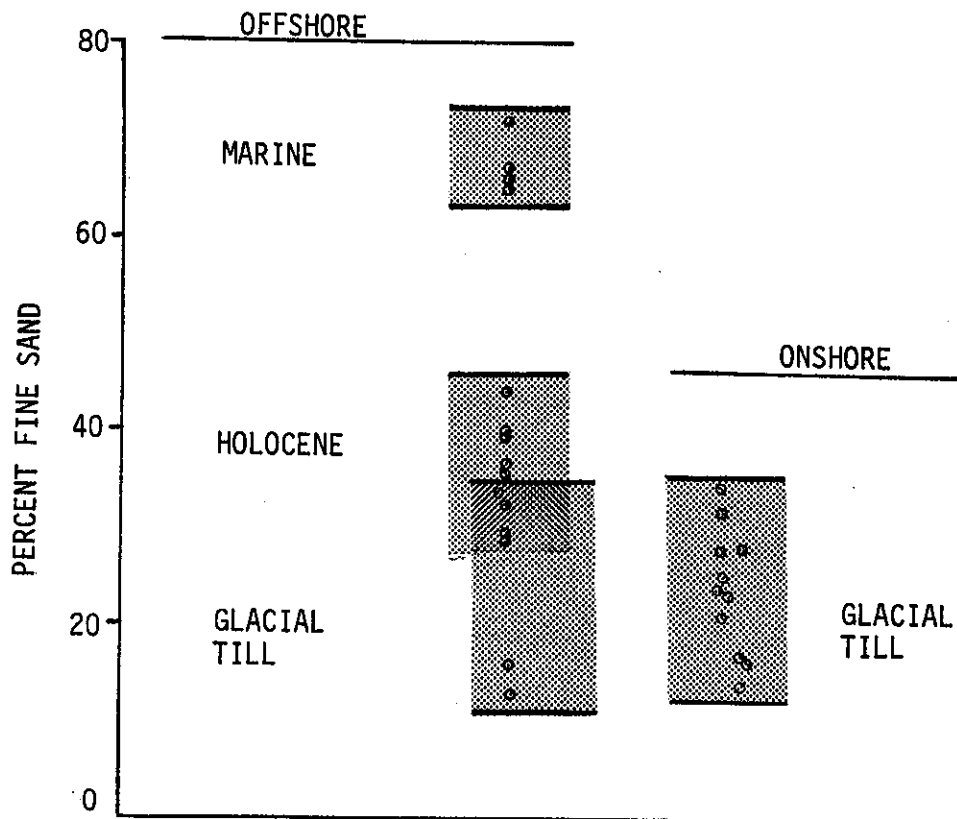
Symbol	Sample Source	Classification
	Offshore Boring	Marine- SILTY SAND (SM)
	Offshore Boring	Glacial Till - GRAVELLY SILTY SAND (SM)



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 & Geophysicists

**Particle Size Analysis Summary - Causeway**  
 Port of Nome  
 Nome, Alaska

PLATE  
**4**



Geologic Interpretation Based on  
Percent Fine Sand



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& Geophysicists

**Gradation Interpretation**

Port of Nome  
Nome, Alaska

PLATE  
**5**

DRAWN

JOB NUMBER  
15,001,002.08

APPROVED  
TSS

DATE  
4/82

REVISED

DATE

## APPENDIX A - FIELD EXPLORATION

The field exploration was performed between February 1 and 17, 1982 (excluding equipment mobilization and demobilization periods). Onshore and offshore drilling operations were conducted concurrently with separate drill rigs. All field work was coordinated by a senior engineer or geologist.

### A. Offshore Test Borings

#### 1. Drilling

The soil conditions were explored by drilling seven test borings ranging from 22 to 57 feet deep (measured from the mudline) along the causeway centerline at the locations shown on Plate 1. The borings penetrated bedrock or suitable, dense bearing strata. Prior to moving the rig onsite, the boring locations were staked by our surveyors, Silvers Engineering. A summary of the test borings is presented on the following table.



Table A-1. Offshore Test Boring Summary

Boring No.	Coordinates (feet)	Ice Surface Elevation (feet)	Depth to Mudline (feet)	Depth Drilled (feet)
*HLO-1	N 111,137 E 104,812	0.0	6.0	22
HLO-2	N 110,684 E 104,712	-0.1	11.3	56
HLO-3	N 109,934 E 104,478	0.0	12.5	37
HLO-4	N 108,898 E 104,172	0.0	20.5	43
HLO-5	N 107,987 E 104,061	0.0	32.5	45
HLO-6	N 107,883 E 104,400	0.0	32.0	57
HLO-7	N 107,417 E 105,012	-0.2	36.5	42

\* Adjusted by HLA to as-drilled location.

The test borings were drilled with a helicopter-supported Mobile Drill B-38 rotary wash rig. The rig was flown to Nome by Alaska International Air (AIA) cargo C-130 Hercules aircraft. Accompanying the rig was ancillary equipment, most of which was necessary to complete the work under arctic winter conditions: drill tools and samplers; portable work shed with heaters; mud pump and shed; wind screens; and miscellaneous cold weather equipment. A Bell 205 helicopter supplied by ERA Helicopters Inc., Anchorage was used to transport the crew, rig and equipment to each boring site.

The operation was staffed full time by a geologist, a driller/superintendent and two drill helpers. In addition, TAMS' geotechnical engineer was present during most of the drilling. In general, a 12-hour per day schedule was maintained. The geologist directed the drilling operation, logged the soil and rock encountered and obtained representative samples for laboratory testing. Logs of the test borings are presented on Plates A1 through A12. Soils are classified in accordance with the Unified Soil Classification System shown on Plate A32.

The borings were drilled using the rotary wash method. Sea water was used as the drilling fluid; drilling mud or other additives were not used. Initially, casing was placed from the ice surface to the sea floor at which time sampling began. In general, the casing continued for the full depth of the boring to prevent caving of the sands. The casing was advanced and removed with a 300-pound drive hammer.

## 2. Sampling

Sampling was performed throughout the depth of the borings. Generally, the upper 15 feet were sampled continuously; samples were obtained at five-foot intervals thereafter until bedrock was encountered or suitable depth was obtained. Typically, the boring extended several feet into bedrock. Sample locations are shown on the boring logs.

### a. Shelby Samples

Undisturbed samples were taken using Shelby tubes. The Shelby sampler used was a 2.87-inch I.D. by 36-inch-long steel tube. The tube was placed at the bottom of the boring and, using the drill rig to

advance the sampler, pushed into the soil approximately 34 inches or to refusal. This method was used on the fine-grain silts and the loose to medium dense silty sands.

b. Drive Samples

Most of the samples were obtained by drive sampling whereby a 2.4-inch I.D. by 3.0-inch O.D. split-spoon sampler is driven into the soil 18 inches or to practical refusal. The split-spoon sampler contained three, 6.0-inch-long brass liners to retain the sample. This sampler was used primarily in coarse-grain soils.

The split spoon was advanced using a 300-pound hammer falling 30 inches. The number of blow required to drive each six-inch increment was recorded. The number of blows required to drive the sampler the last 12 inches, or fraction thereof, is presented on the boring logs.

c. Standard Penetration Test Sampling (SPT)

On occasion, a standard penetration test was performed. A standard 2.0-inch O.D. by 1.5-inch I.D. sampler was advanced 18 inches by a 140-pound hammer free-falling 30 inches. The number of blows to advance the sampler the last 12 inches is recorded as the N-value in blows per foot.

d. NX Coring

Bedrock samples were obtained using a five-foot-long double-wall diamond-bit NX core barrel.

B. Onshore Test Borings

1. Drilling

The onshore test borings were drilled with a Mayhew 1000, 10-inch-diameter rotary-air drill subcontracted from Thrasher and Associates in Nome. Thirteen borings were drilled in the storage area. Of these, 10 borings were in the Upland and 3 in the Modified areas, respectively. The rig was mounted on an all-terrain track vehicle. As-drilled locations of the test borings were determined by Silvers Engineers and are presented on Plate 1 and listed below.

Table A-2. Storage Area Test Boring Summary

Boring No.	Coordinates (feet)	Ground Surface Elevation (feet)	Boring Depth (feet)
HLB-1	N 112,070 E 103,967	33.8	43
HLB-2	N 111,909 E 104,570	33.1	44
HLB-3	N 111,619 E 105,270	10.7	26
HLB-4	N 111,539 E 105,570	10.5	54
HLB-5	N 111,489 E 105,759	6.1	30
HLB-6	N 112,278 E 104,596	38.9	30
HLB-7	N 112,134 E 105,040	36.6	73

Table A-2. (continued)

Boring No.	Coordinates (feet)	Ground Surface Elevation (feet)	Boring Depth (feet)
HLB-8	N 112,509 E 105,100	40.2	32
HLB-9	N 112,590 E 140,790	41.0	31
HLB-10	N 112,583 E 103,498	36.8	43
HLB-11	N 112,991 E 104,238	41.1	30
HLB-12	N 113,150 E 104,969	44.5	31
HLB-13	N 112,535 E 104,084	38.4	44

HLB 3, HLB 4 and HLB 5 were not surveyed after drilling but were drilled in their original surveyed positions.

An additional four borings were drilled at the site of the small boat harbor with the Thrasher Rig. Locations of these borings are shown on Plate 2 and presented below.

Table A-3. Small Boat Harbor Test Boring Summary

Boring No.	Coordinates (feet)	Ice Ground Surface Elevation (feet)	Boring Depth (feet)
HLS-1	N 111,694 E 107,184	2.6	19
HLS-2	N 111,708 E 107,290	2.4	19
HLS-3	N 111,918 E 107,139	3.3	19
HLS-4	N 111,850 E 107,235	2.9	25

The onshore borings were drilled concurrent with the offshore borings. The operation was staffed by our engineer, driller and helper. A minimum 10 hours per day operation was maintained. The engineer directed the operation, logged the soil encountered and obtained samples for visual observation and laboratory testing. Logs of the test borings are presented on Plates A13 through A27. Detailed logs of four samples are shown on Plate A33.

## 2. Sampling

Predominantly grab (or disturbed) samples were obtained from the storage facility borings. These were obtained by trapping cuttings as they discharged out of the borehole. The samples were placed in moisture-proof plastic bags. In the small boat harbor and on occasion the storage area, 2.4-inch I.D. split-spoon samples were obtained using non-standard driving energy.

### C. Sample Handling

The soil samples were visually examined, classified, and logged in the field by our engineer and 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, and bonded (frozen) samples were kept frozen by storing them at either low temperatures or in cooler chests.

Periodically, samples were placed in foam-lined carriers and shipped via air freight to our laboratory in Anchorage. Bonded samples were shipped in insulated containers to prevent thawing; they were stored in our laboratory cold room at  $-4^{\circ}\text{C}$  until tested.

### D. Onshore Ground Temperatures

Thermistor wells consisting of 1-1/4-inch I.D. PVC pipe filled with propylene glycol were installed in eight of the onshore borings. A probe containing a precisely calibrated thermistor and a standard bead-in-glass thermistor was used to measure the glycol temperatures. The two thermistors were used to verify one another's performance.

#### 1. Equipment

The thermistors used were a standard YSI Model 44007 and a Victory Serial No. 50. The YSI thermistor has an interchangeability of  $0.2^{\circ}\text{C}$  from  $0^{\circ}\text{C}$  to  $80^{\circ}\text{C}$  and a resistance of 5000 ohms at  $25^{\circ}\text{C}$  and

exhibits a resistance change of approximately 860 ohms per degree centigrade. The precision calibrated Victory thermistor has an interchangeability of  $0.05^{\circ}\text{C}$  and a resistance of 4560 ohms at  $0^{\circ}\text{C}$  and exhibits a resistance change of approximately 220 ohms per degree centigrade.

The thermistors were installed side by side at the bottom of a probe approximately six inches long. A four-conductor cable manufactured by Berk-Teck Company (Model BT0NX-734-2F-Q) was used for leadout wire. One conductor was used for a common ground, one for measuring lead wire resistance, and the remaining two for measuring the thermistors.

## 2. Thermistor Readings and Data Reduction

The thermistor wells were read twice during the 10 days after installation. A third set of readings was made on April 14 and 15, 1982. Results of these readings are tabulated on Plates A34 through A37 and illustrated on temperature versus depth plots on Plates A38 through A41. Also shown are the freezing points, which can be considerably lower than that of fresh water, depending on the porewater salinity. However, results of laboratory tests indicate that the freezing point is very near that of fresh water.

The resistance readings were made using a Data Precision Model 248 multi-meter. When combined, the calibrated bead-in-glass thermistors and the Model 248 multi-meter have a precision of  $0.05^{\circ}\text{C}$  and an accuracy of  $0.1^{\circ}\text{C}$ .



Resistance readings were made at 3-foot intervals from the ground surface to a depth of 15 feet and then at 5-foot intervals to the bottom of the thermistor well. Depths were referenced to the ground surface surrounding the thermistor well. The thermistors were monitored at each depth until a stabilized reading was obtained. To avoid inducing heat into the thermistors, the multi-meter was turned off between readings. Once a stabilized value was obtained, the leadwire resistance was read and then the probe was lowered to the next depth.

The resistance values obtained in the field at given depths were corrected for leadwire resistance by subtracting the measured leadwire resistance from the total resistance. The resistance values were reduced to ground temperatures using the following relationship

$$\frac{1}{T} = A + B (\ln R) + C (\ln R)^3$$

where:            T        = temperature in degrees Kelvin  
                   A, B, C = constants for the thermistors  
                   R        = measured resistance in ohms

#### E. Drilling Operations Diary

The following is a brief daily description of our field operations.

<u>Date</u>	<u>Activity</u>
2/01/82	Mobilize personnel from Anchorage to Nome. (Equipment was shipped earlier) Sling Heli-rig to boring HLO-2.
2/02/82	Drill HLO-2 to 46 feet. Mobilize Thrasher air drill. Complete HLB-5 and begin HLB-4.
2/03/82	Complete HLO-2 and sling rig to HLO-7. Complete HLB-4; set PVC casing.

Date	Activity
2/04/82	Complete HLO-7 to 42 feet; sling rig to HLO-6. Complete HLB-3, 7, 8 and 6; set PVC in HLB-7 and 8.
2/05/82	Drill HLO-6 to 25 feet. Install PVC in HLB-6. Drill HLB-9, 12, 11. Install PVC in HLB-9 and 12.
2/06/82	Complete HLO-6 to 51 feet. Drill HLB-10, 1 and 2. Install PVC in HLB-10 and 2.
2/07/82	Standby in a.m. due to inclement weather. Drill HLB-5 to 12 feet.
2/08/82	Complete HLO-5 to 44 feet. Move Thrasher rig to small boat harbor and drill HLS-1 and 2.
2/09/82	Sling to HLO-4 and drill to 18 feet. Redrill HLS-2 and drill HLS-3 and 4.
2/10/82	Complete HLO-4 to 42 feet. Demobilize Thrasher rig.
2/11/82	Begin HLO-3; drill to 11 feet. Recon Cape Nome area for possible quarry development.
2/12/82	Complete HLO-3 to 37 feet. Begin ground temperature monitoring in Upland Tundra area.
2/13/82	Sling to HLO-1 and drill to 12 feet. Continue temperature monitoring.
2/14/82	Standby during inclement weather. Complete HLO-1 to 22 feet. Continue temperature monitoring.
2/15/82	Demobilize equipment. Personnel return to Anchorage. One engineer remains to continue ground temperature monitoring.
2/16/82	Complete initial ground temperature monitoring.
2/17/82	Complete demobilizing; remaining engineer returns to Anchorage.

N111, 137  
E104, 812

LOG OF BORING HLO-1

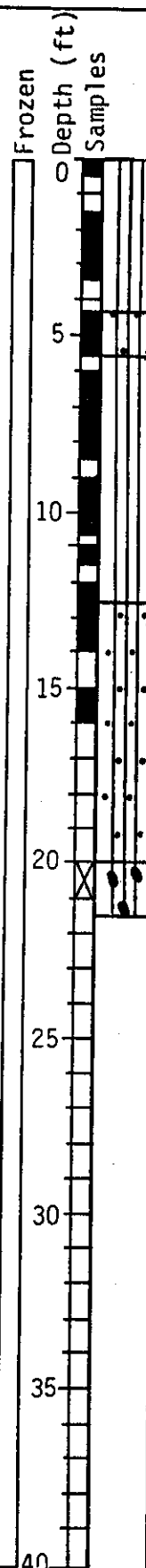
Equipment 4-inch Rotary Wash

Laboratory Tests

Elevation -2.8 ft. Date Drilled 02/13/82

MLLW

Sample	Temp (°F)	Moisture Content (%)	Blows/5 Foot	Dry Density (pcf)	Frozen
	34°				
		Push (Shelby)			
-#200 Sieve	33°	37.6	10	79	
TXCU, Consol					
LL=PL=NP					
	33°				
		Push (Shelby)			
SA, 3TXCU, Consol	33°	39.6		80	
-#200 Sieve		41.4		78	
LL=PL=NP					
SA	33°			108	
		Push (Shelby)			
SA	33°	17.4	10	116	
	33°	15			



BLACK SANDY SILT (ML)  
saturated, soft-medium stiff,  
with organic materials

GRAY SILTY SAND (SM)  
saturated, medium dense


GRAY BLACK SANDY SILT (ML)  
saturated, medium stiff with  
organic matters, strong  
organic odor

GRAY BLACK SILTY SAND (SM)  
saturated, medium dense,  
trace of fibrous organic  
material

GRAY SILTY GRAVEL (GM)  
saturated, dense (Till)

NOTES:

1. Blow counts are based on a 3-inch O.D. 2.43-inch I.D. split-spoon sampler with a 300-lb. hammer and 30-inch drops, unless otherwise specified.
2. Relative density test performed on combined samples from depths 1.5 to 3.5 feet and 9.0 to 14.0 feet.
3. Sample Temperatures were obtained immediately after sample was recovered.
4. Coordinates referenced to City of Nome Datum.

 **Harding Lawson Associates**  
Engineers, Geologists  
& Geophysicists

**Log of Boring HLO-1**  
PORT OF NOME  
Nome, Alaska

PLATE  
**A1**

N110,684

E104,712

Laboratory Tests  
-#200 Sieve

SA

SA  
LL=PL=NP

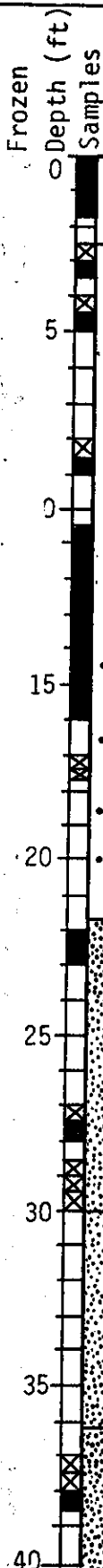
SA TXCU

-#200 Sieve  
TXCU

SA

\*SPT = Standard Penetration Test

Sample Temp (°F)	Moisture Content (%)	Blows/ Foot	Dry Density (pcf)
33°	20.1	Push (Shelby)	104
33°	22.1	11	104
32°		12	
32°	36.2	7	85
34°	35.2	Push (Shelby)	85
33°		Push (Shelby)	
		Push (Shelby)	
33°	22.1	14	103
31°		40 (SPT) *	



LOG OF BORING HLO-2  
 Equipment 4-inch Rotary Wash  
 Elevation -11.4 ft. Date Drilled 02/02/82  
 MLLW

GRAY SILTY SAND (SP-SM)  
 saturated, medium dense with occasional black organic material

GRAY SILTY SAND (SM)  
 saturated, medium dense with traces of fibrous organics

BLACK-BROWN SILTY SAND (SP-SM)  
 saturated, loose to medium dense

GRAY GRAVELLY SAND (SP)  
 saturated, medium dense to dense

GRAY GRAVELLY SAND (SP)  
 saturated, medium dense to dense (Till)



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**Log of Boring HLO-2**  
 PORT OF NOME  
 Nome, Alaska

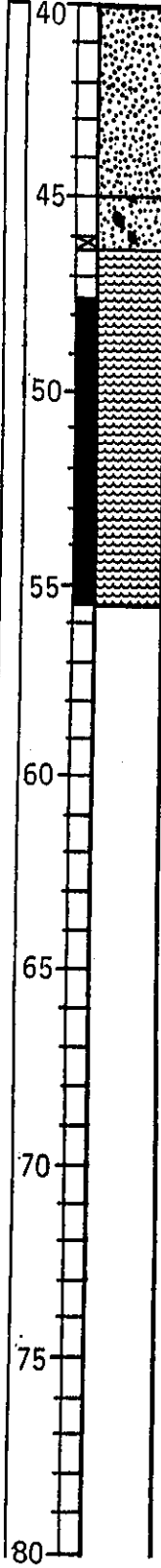
**A2**

Laboratory Tests

Sample Temp. (°F)  
 Blows/Foot (N-Value)  
 Moisture Content (%)  
 Dry Density (pcf)

Depth (ft)  
 Samples

40  
 NX\*



GRAY SANDY GRAVEL (GP)  
 saturated, very dense (rubble)

BLACK MICACEOUS SCHIST  
 moderately weathered and fractured. Fractures occur frequently along foliation perpendicular to core, RDQ approximately 70%\*\*

\* NX Rock Core  
 \*\* RQD = Rock Quality Designation



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**Log of Boring HLO-2 (CONT.)**  
 PORT OF NOME  
 Nome, Alaska

PLATE

**A3**

DRAWN

JOB NUMBER

15001,002.08

APPROVED

*PS*

DATE

3/82

REVISED

DATE

N 109, 934  
E 104, 478

Laboratory Tests

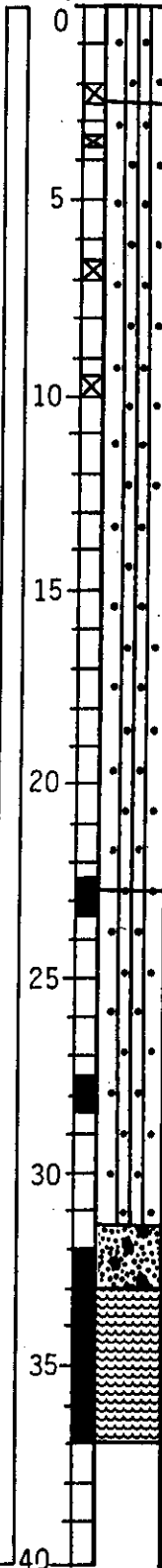
Sample Temp (°F)  
Moisture Content (%)  
Blows/ Foot  
Push (Shelby)  
Dry Density (pcf)

Frozen  
Depth (ft)  
Samples

LOG OF BORING HLO-3  
Equipment 4-inch Rotary Wash  
Elevation 12.5ft. Date Drilled 02/11/82

SA

34° 17  
24  
17  
33° 25  
28  
33° 23  
33° 18  
33° 17



GRAY SILTY SAND (SM)  
saturated, medium dense with occasional shells

GRAY GRAVELLY SILTY SAND (SM)  
saturated, medium dense to dense (Till)

GRAY SILTY SAND (SM)  
saturated, dense

GRAY BLACK GRAVEL (GP)  
saturated, very dense (rubble)

GRAY BLACK MICACEOUS SCHIST  
RQD approximately 75% to 80%,  
inclusions of pyrite and quartz  
foliation perpendicular to core

SA

33° 19.0 21 115  
50  
32° NX



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**Log of Boring HLO-3**  
PORT OF NOME  
Nome, Alaska

PLATE

**A4**

DRAWN

JOB NUMBER  
15001.002.08

APPROVED  
*RS*

DATE  
03/82

REVISED

DATE

N103,898  
E104,172

LOG OF BORING HLO-4

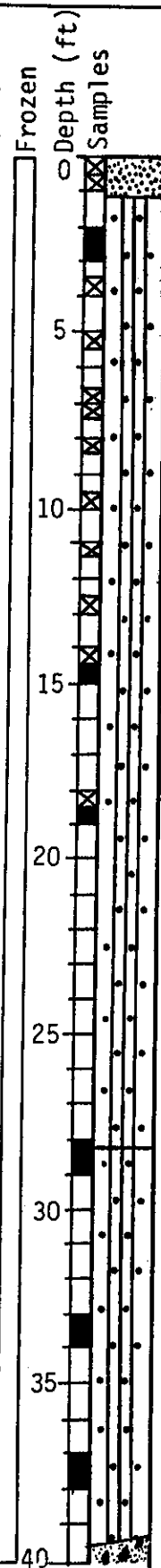
Equipment 4-inch Rotary Wash

Laboratory Tests  
SA

Elevation 20.5ft. Date Drilled 02/09/82

SA  
LL=PL=NP

Sample Temp (°F)  
Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)



GRAY SILTY SAND (SP)  
saturated, medium dense

GRAY GRAVELLY SILTY SAND (SM)  
saturated, medium dense to  
very dense (Till)

GRAY SILTY SAND (SM)  
saturated, dense

GRAY GRAVEL (GP)  
saturated, very dense (rubble)



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Log of Boring HLO-4  
PORT OF NOME  
Nome, Alaska

PLATE

A5

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED	DATE
	15001.002.08	RS	03/82		

LOG OF BORING HLO-4

Laboratory Tests  
Sample Temp (°F)  
Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)  
Frozen

Depth (ft)  
Samples



BEDROCK at 42'



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**Log of Boring HLO-4 (CONT.)**  
PORT OF NOME  
Nome, Alaska

PLATE  
**A6**

DRAWN

JOB NUMBER  
15001,002.08

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*RS*

DATE  
3/82

REVISED

DATE



N107,987  
E104,061

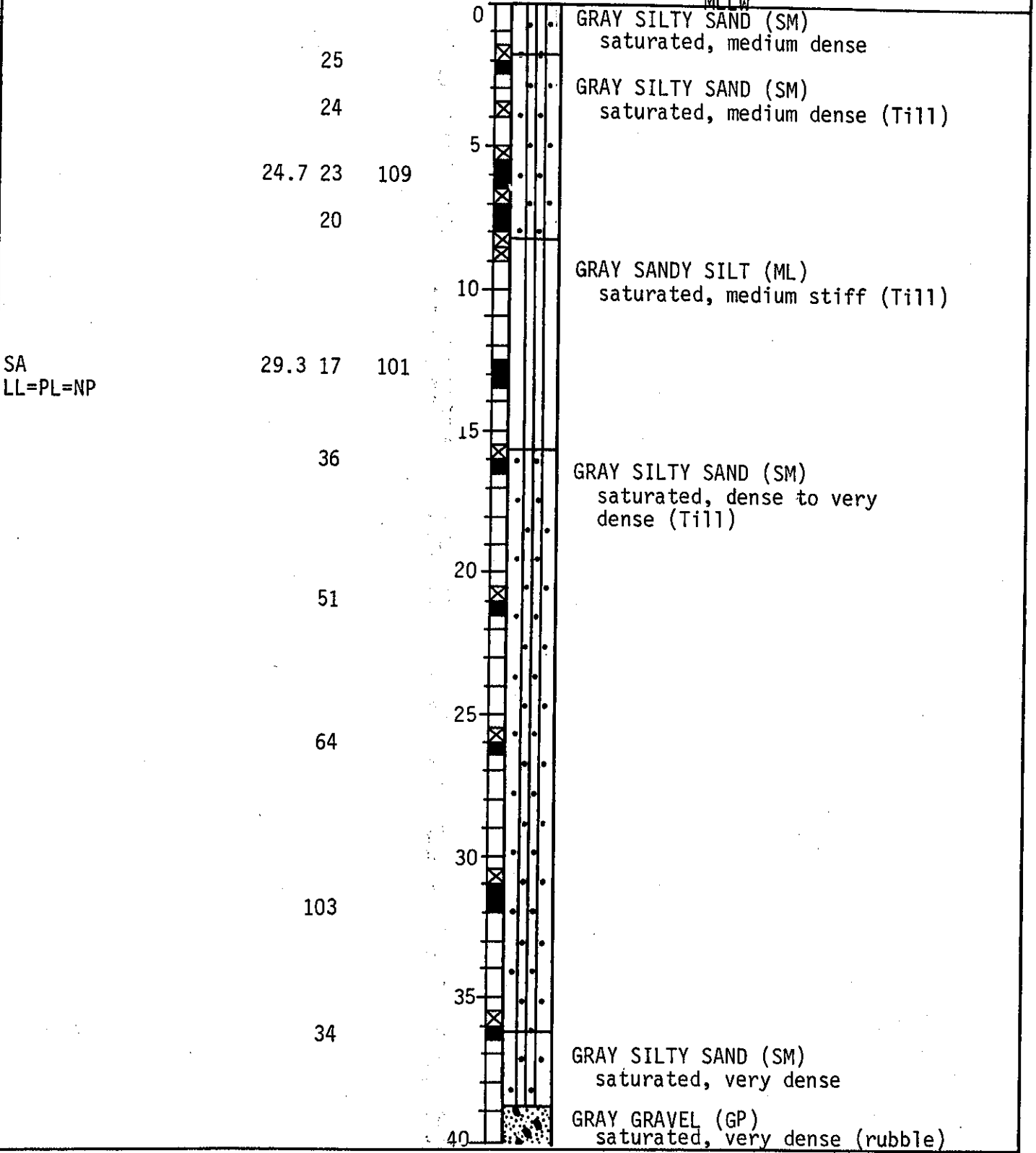
LOG OF BORING HLO-5

Equipment 4-inch Rotary Wash

Laboratory Tests

Elevation -32.5ft. Date Drilled 02/07/82

Sample Temp (°F)  
Moisture Content (%)  
Blows/Foot  
Dry Density (pcf)  
Frozen  
Depth (ft)  
Samples



SA  
LL=PL=NP



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**Log of Boring HLO-5**  
PORT OF NOME  
Nome, Alaska

PLATE

**A7**

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JOB NUMBER  
15001,002.08

APPROVED

*RS*

DATE

03/82

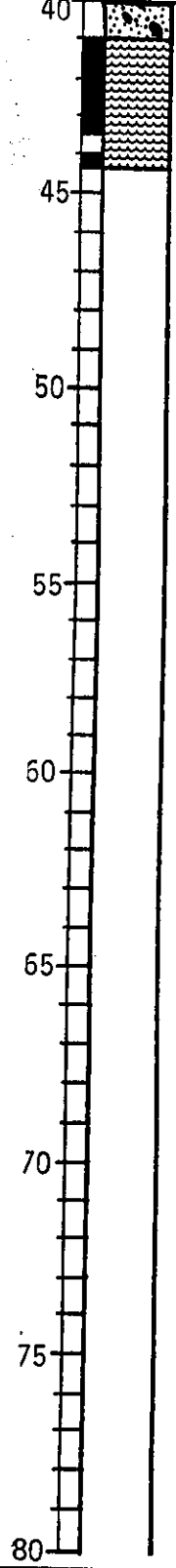
REVISED

DATE

Laboratory Tests

Sample Temp. (°F)  
Blows/Foot (N-Value)  
Moisture Content (%)  
Dry Density (pcf)

Depth (ft)  
Samples



GRAY MICACEOUS SCHIST  
highly weathered and fractured  
RDQ approximately 15%



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Engineers, Geologists  
& Geophysicists

**Log of Boring HLO-5 (CONT.)**  
PORT OF NOME  
Nome, Alaska

PLATE  
**A8**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED  
TJS

DATE  
3/82

REVISED

DATE

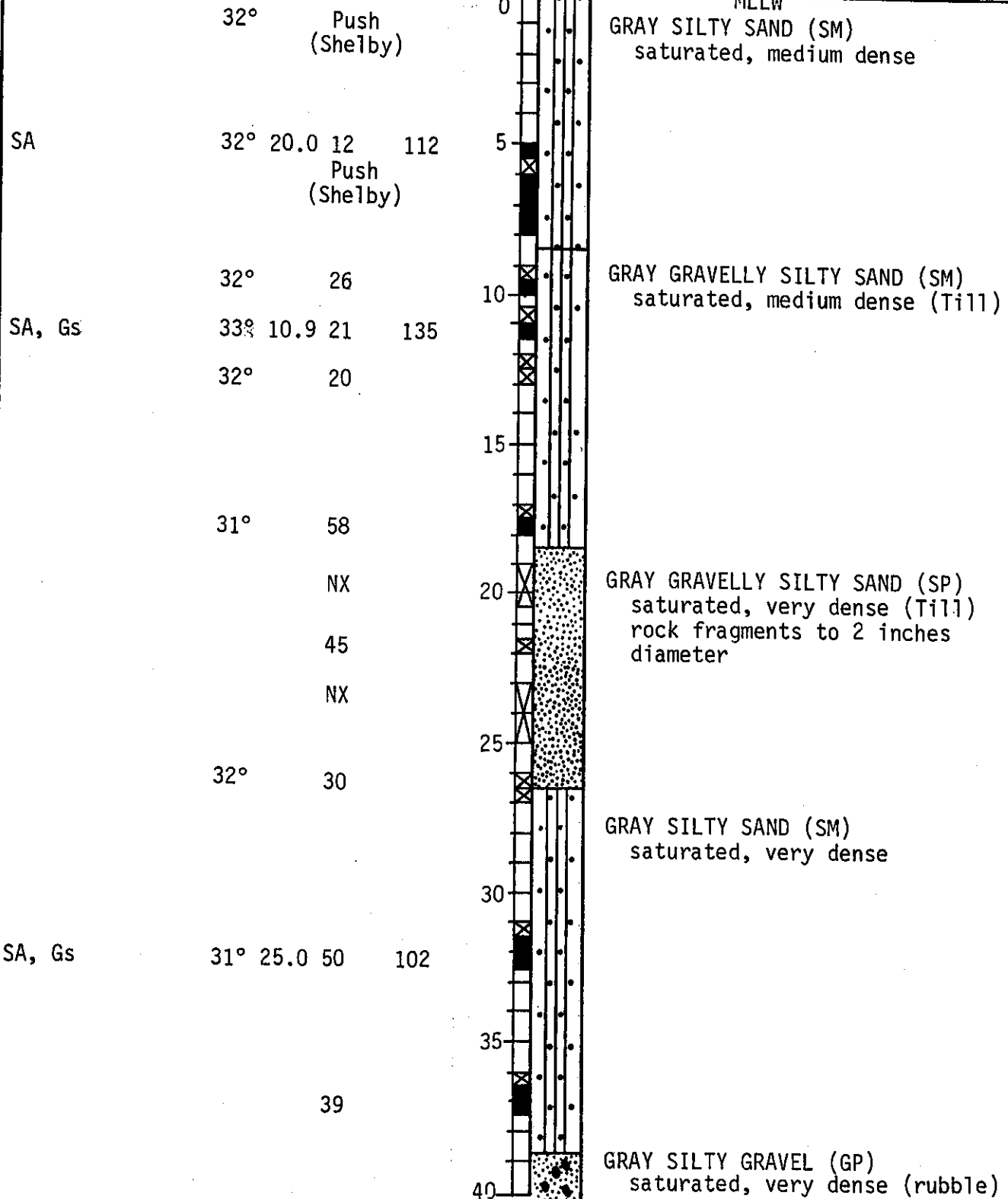
N107,883  
E107,417

LOG OF BORING HLO-6

Equipment 4-inch Rotary Wash

Laboratory Tests

Elevation -32 ft. Date Drilled 02/05/82



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**Log of Boring HLO-6**  
PORT OF NOME  
Nome, Alaska

PLATE

**A9**

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JOB NUMBER  
15001,002.08

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RS

DATE  
03/82

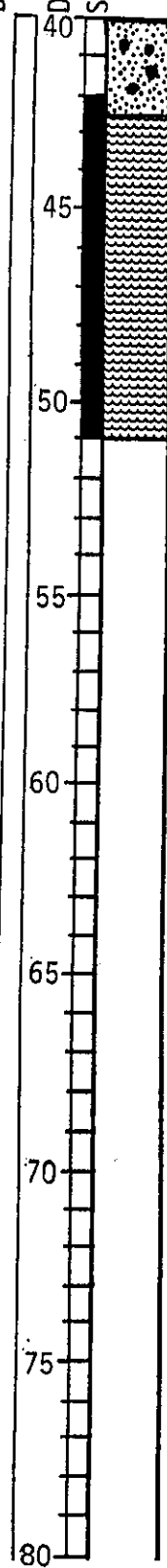
REVISED

DATE

Laboratory Tests

Sample Temp. (°F)  
 Blows/Foot (N-Value)  
 Moisture Content (%)  
 Dry Density (pcf)  
 Depth (ft)  
 Samples

NX  
 NX



BLACK GRAY SCHIST  
 foliated approximately 30°  
 from vertical; with inclusions  
 of pyrite and quartz RQD approx-  
 imately 35%

RQD approximately 65% with  
 foliation perpendicular to  
 core at 46.5 feet



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**Log of Boring HLO-6 (CONT.)**  
 PORT OF NOME  
 Nome, Alaska

PLATE

**A10**

DRAWN

JOB NUMBER  
 15001.002.08

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 KJS

DATE  
 3/82

REVISED

DATE

N 107,417  
E 105,012

LOG OF BORING HLO-7

Equipment 4-inch Rotary Wash

Laboratory Tests

Elevation 36.7 ft Date Drilled 02/03/82

Sample Temp (°F)  
Moisture Content (%)  
Blows/Foot

Dry Density (pcf)

Frozen  
Depth (ft)  
Samples

MLLW

SA, Gs

15.8 20 123

48

32

30

31

28

28

36

SA, Gs

27.0 53 98

BROWN GRAVELLY SILTY SAND (SM)  
saturated, dense to very dense

GRAY BLACK GRAVELLY SILTY SAND (SM)  
saturated, dense to very dense  
(Till)

GRAY GRAVELLY SILT (ML)  
saturated, very stiff (Till)

GRAY SILTY SAND (SM)  
saturated, very dense



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**Log of Boring HLO-7**  
PORT OF NOME  
Nome, Alaska

PLATE

**A11**

DRAWN

JOB NUMBER  
15001,002.08

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*PS*

DATE  
03/82

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DATE

Laboratory Tests

Sample Temp. (°F)

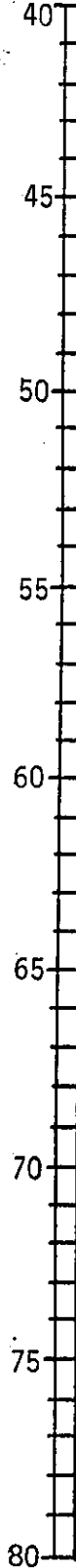
Blows/Foot (N-Value)

Moisture Content (%)

Dry Density (pcf)

Depth (ft)  
Samples

GRAY MICACEOUS SCHIST



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**Log of Boring HLO-7 (CONT.)**

PORT OF NOME  
Nome, Alaska

PLATE

**A12**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED  
*TJS*

DATE  
3/82

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DATE

N112,070

E103,967

Laboratory Tests

Org. Loss=47%

-#200 Sieve

Moisture Content (%)  
Blows/  
Foot

600.7

36.6

27.1

24.0

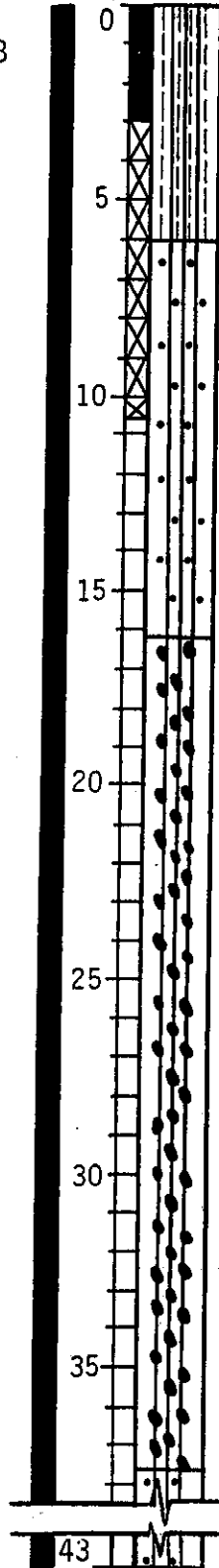
Dry Density (pcf)

8

Frozen

Depth (ft)

Samples



LOG OF BORING HLB-1

Equipment 10-inch Air Drill

Elevation 33.8 ft. Date Drilled 02/06/82

BROWN ORGANIC SILT (OL, N<sub>be</sub>)  
with occasional fibrous organics,  
top 1 foot very peaty

BROWN SILTY SAND (SM, N<sub>be</sub>)

DARK GRAY SILTY SANDY GRAVEL  
(GM, N<sub>be</sub>)

GRAY GRAVELLY SILTY SAND (SM, N<sub>bn</sub>)  
with occasional subrounded  
gravel cuttings to 2 inch  
diameter



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Log of Boring HLB-1  
PORT OF NOME  
Nome, Alaska

PLATE

A13

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JOB NUMBER  
15001,002.08

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DATE

N111,909  
E104,570

Laboratory Tests  
Org. Loss=87%

Elec. Cond.  
FPD

-#200 Sieve

SA

Moisture  
Content (%)  
Blows/  
Foot  
795.6

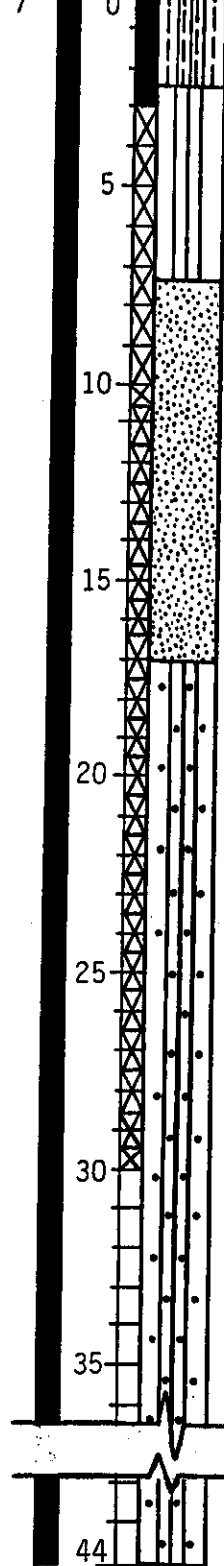
27.4

22.7

19.7

Dry  
Density  
(pcf)  
7

Frozen  
Depth (ft)  
Samples



LOG OF BORING HLB-2  
Equipment 10-inch Air Drill  
Elevation +33.1 ft Date Drilled 02/06/82  
MTW

BROWN ORGANIC SILT (OL, N<sub>be</sub>)  
with occasional v<sub>r</sub> and  
fibrous organics, top 1 foot very  
peaty

BROWN SANDY SILT (ML, N<sub>be</sub>)

BROWN SILTY SAND (SP-SM, N<sub>be</sub>)

GRAY GRAVELLY SILTY SAND, (SM, N<sub>bn</sub>)

Decreasing gravel content

Encounter gravel greater than  
4 inches diameter

NOTE:

1. Installed PVC pipe to 44 feet.



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**Log of Boring HLB-2**  
PORT OF NOME  
Nome, Alaska

PLATE

**A14**

DRAWN

JOB NUMBER  
15001,002.08

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DATE

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DATE



N111,619  
E105,270

LOG OF BORING HLB-3

Equipment 10-inch Air Drill

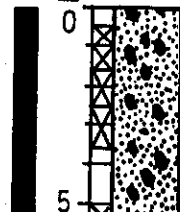
Laboratory Tests

Elevation 10.7 ft. Date Drilled 02/04/82  
MLLW

Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)  
Frozen  
Depth (ft)  
Samples

SA

66.0



BROWN SANDY GRAVEL (GP, NF)  
gravel to 2 inch diameter

SA

2.2

BROWN GRAVELLY SAND (SM)  
medium dense dry, occasional gravel  
to 2 inch diameter  
Becoming moist at 7.5 feet

10

BROWN SILTY GRAVELLY SAND (SM)  
saturated, dense

SA  
SA

12.5

15

20

25

Frozen at 24'

30

35

40

NOTE:

- 1. Installed PVC pipe to 25 feet.



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Log of Boring HLB-3  
PORT OF NOME  
Nome, Alaska

PLATE

A15

DRAWN

JOB NUMBER  
15001,002.08

APPROVED

TJS

DATE

03/82

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DATE

N111,539  
E105,570

LOG OF BORING -HLB-4

Equipment 10-inch Air Drill

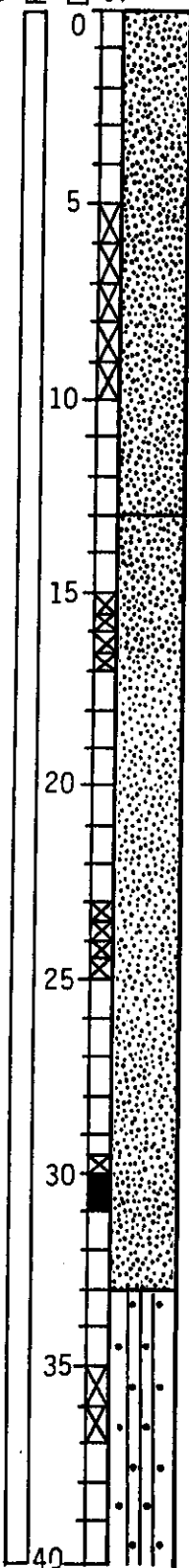
Laboratory Tests

Elevation 10.5 ft. Date Drilled 02/03/82  
MLLW

Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)

Frozen  
Depth (ft)  
Samples

	66.0		
SA	3.6	99	
SA	19.7		



BROWN SAND (SP)  
Moist, medium dense

Water Level 2/03/82

DARK GRAY SAND (SP-SM)  
saturated, medium dense to dense, with trace gravel to 1 inch diameter

Increasing gravel content

DARK GRAY SILTY SAND (SM)  
saturated, medium dense to dense



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Log of Boring HLB-4  
PORT OF NOME  
Nome, Alaska

PLATE

A16

DRAWN

JOB NUMBER  
15001,002.08

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DS

DATE  
03/82

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DATE

N111,539  
E105,570

LOG OF BORING HLB-4

Laboratory Tests

SA

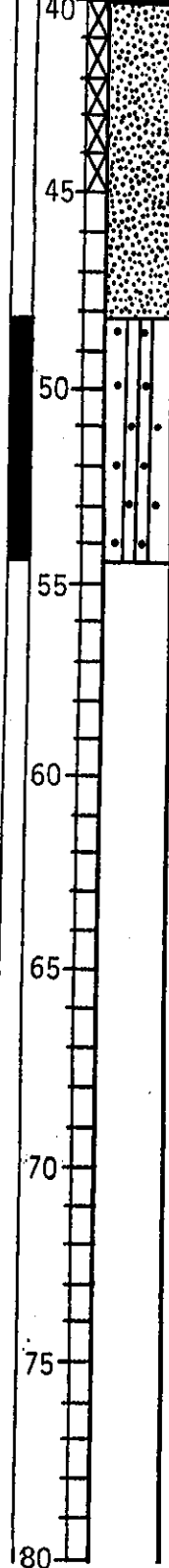
Blows/Foot  
(N-Value)

Moisture  
Content (%)  
19.3

Dry  
Density (pcf)

Depth (ft)

Samples



DARK GRAY SILTY SAND (SM)  
frozen

NOTE:

1. Installed PVC casing to 45 feet.



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**Log of Boring HLB-4 (CONT.)**

PORT OF NOME  
Nome, Alaska

PLATE

**A17**

DRAWN

JOB NUMBER  
15001,002.08

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DATE  
03/82

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DATE

N111,489  
E105,759

LOG OF BORING HLB-5

Equipment 10-inch Air Drill

Laboratory Tests

Elevation 6.1 ft. Date Drilled 02/02/82

Moisture  
Content (%)  
Blows/  
Foot

Dry  
Density  
(pcf)

Frozen

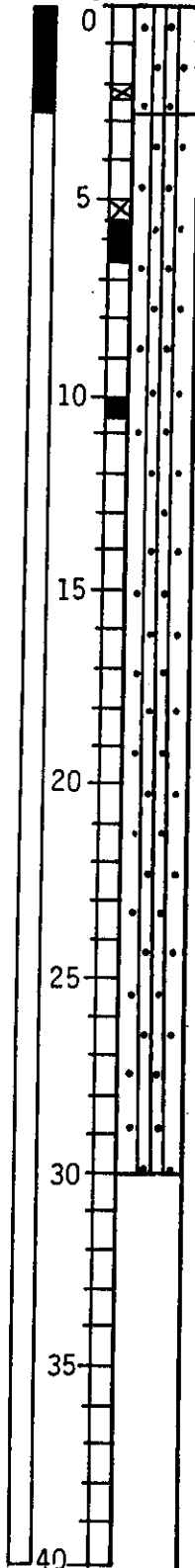
Depth (ft)

Samples

40.8

BLACK SILTY SAND (SM, N<sub>b</sub>)

BLACK SILTY SAND (SM),  
saturated, loose to medium dense



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**Log of Boring HLB-5**  
PORT OF NOME  
Nome, Alaska

PLATE

**A18**

DRAWN

JOB NUMBER  
15001,002.08

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03/82

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DATE

N112,278  
E104,596

LOG OF BORING HLB-6

Equipment 10-inch Air Drill

Laboratory Tests

Elevation +38.9 ft Date Drilled 02/04/82  
MLLW

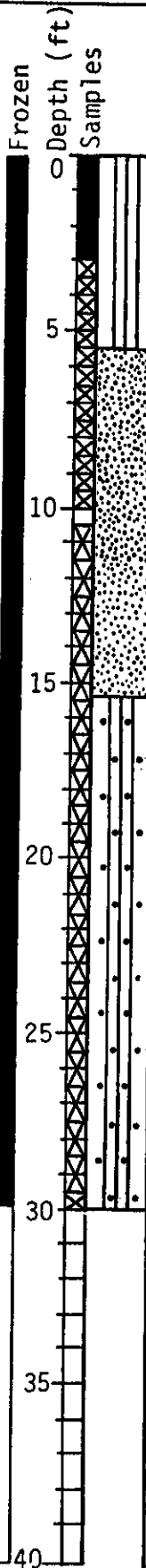
-#200 Sieve  
Org. Loss      99.2      40

Elec. Cond.  
FPD      21.5

-#200 Sieve      19.9

SA      13.0

12.0



LIGHT BROWN ORGANIC SILT (ML, V<sub>s</sub>)  
with 6 inches fibrous organics  
at surface

BROWN SILTY SAND (SP-SM, N<sub>be</sub>)

Becomes gravelly at 10.0 feet

DARK GRAY GRAVELLY SILTY SAND (SM, N<sub>bn</sub>)  
with interbedded gravel and  
sand layers

NOTE:

1. Installed PVC casing to 30 feet



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**Log of Boring HLB-6**

PORT OF NOME  
Nome, Alaska

PLATE

**A19**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED

DATE  
03/82

REVISED

DATE

N112,134  
E105,040

LOG OF BORING HLB-7

Equipment 10-inch Air Drill

Laboratory Tests

Elevation 36.6 ft. Date Drilled 02/04/82  
MLTW

Moisture Content (%)  
Blows/  
Foot

Dry Density (pcf)

Frozen  
Depth (ft)  
Samples

SA

26.4

5

BROWN ORGANIC SANDY SILT (ML, N<sub>be</sub>)  
with 6 inch fibrous organic material at surface

Elec. Cond.  
FPD

17.9

10

BROWN GRAY SILTY SAND (SM, N<sub>be</sub>)  
with occasional gravel

SA

22.1

20

12.5

25

BROWN GRAY SILTY SAND (SM, N<sub>bn</sub>)  
with occasional gravel

Probed to top of rock

70

TOP OF ROCK at 73'

75



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**Log of Boring HLB-7**  
PORT OF NOME  
Nome, Alaska

PLATE

**A20**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED

DATE  
03/82

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DATE

N112,509  
E105,100

LOG OF BORING HLB-8

Equipment 10-inch Air Drill

Laboratory Tests

Elevation 40.2 ft. Date Drilled 02/04/82

MLLW

Moisture Content (%)  
Blows/  
Foot  
Dry Density (pcf)  
Frozen  
Depth (ft)  
Samples

DARK BROWN ORGANIC SILT (OL, N<sub>be</sub>)  
with occasional fibrous organics

Elec. Cond. 20.2  
FPD

BROWN SILTY SAND (SP-SM, N<sub>be</sub>)

-#200 Sieve 17.6

Encountered gravel seams

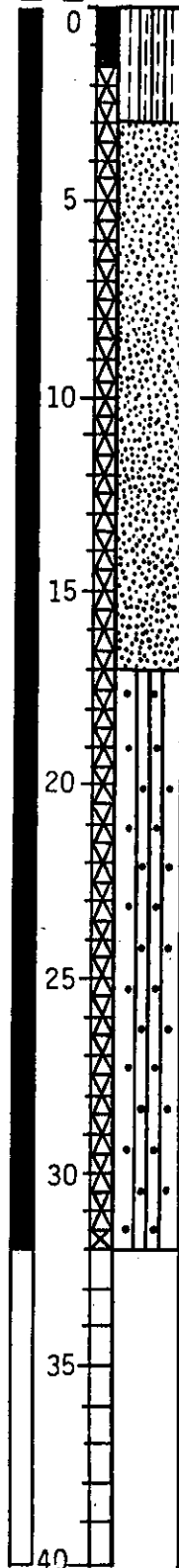
17.0

15.7

BROWN GRAY GRAVELLY SILTY SAND (SM, N<sub>bn</sub>)

NOTE:

Installed PVC casing to 32 feet.



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& Geophysicists

Log of Boring HLB-8  
PORT OF NOME  
Nome, Alaska

PLATE

A21

DRAWN

JOB NUMBER  
15001.002.08

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DATE  
03/82

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DATE

N112,590  
E140,790

LOG OF BORING HLB-9

Equipment 10-inch Air Drill  
Elevation 41.0 ft Date Drilled 02/05/82  
MLTW

Laboratory Tests

Moisture Content (%)  
Blows/Foot  
Dry Density (pcf)  
Frozen  
Depth (ft)  
Samples

492.4

LIGHT BROWN ORGANIC SILT (OL, N<sub>be</sub>)  
with occasional fibrous organics,  
top 1 foot very peaty

5

BROWN GRAY SILTY SAND (SM, V<sub>x</sub>)

SA

17.6

10

SA  
Elec. Cond.  
FPD

20

SA

15.4

25

30

35

40

NOTE:  
1. Installed PVC casing  
to 31 feet.



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**Log of Boring HLB-9**  
PORT OF NOME  
Nome, Alaska

PLATE

**A22**

DRAWN

JOB NUMBER  
15001,002.08

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03/82

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DATE



N 112,583  
E 103,498

LOG OF BORING HLB-10

Equipment 10-inch Air Drill

Laboratory Tests

Elevation 36.8 ft. Date Drilled 02/06/82  
MLLW

Org. Loss = 33%

Moisture Content (%)  
Blows/  
Foot

Dry Density (pcf)

Frozen  
Depth (ft)  
Samples

BROWN ORGANIC SILT (OL, N<sub>be</sub>)  
with occasional fibrous organics  
and individual ice inclusions  
Thawed zone from 1.5 to 2.0 feet

76.4

5

10

15

BROWN SILTY SAND (SM, N<sub>bn</sub>)  
with occasional gravel

20.1

20

Gravel greater than 4 inches  
at 23 feet

-#200 Sieve

27.3

25

30

35

Decreasing gravel content

SA

12.3

43



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Log of Boring HLB-10  
PORT OF NOME  
Nome, Alaska

PLATE

A23

DRAWN

JOB NUMBER  
15001,002.08

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*[Signature]*

DATE

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DATE

N 112,991  
E 104,238

LOG OF BORING HLB-11

Equipment 10-inch Air Drill

Laboratory Tests

Elevation +41.1 ft. Date Drilled 02/05/82  
MLLW

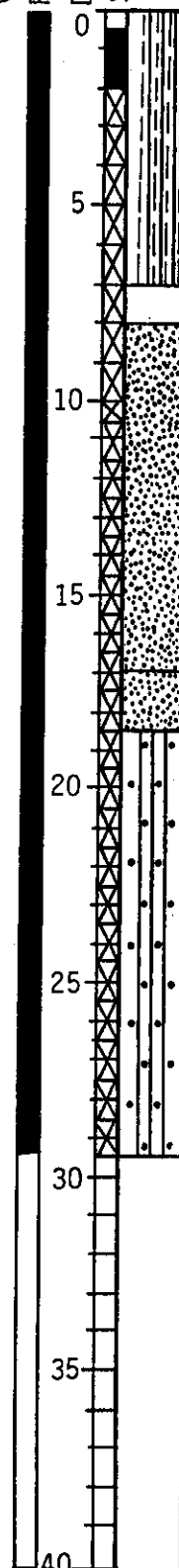
Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)  
Frozen  
Depth (ft)  
Samples

-#200 Sieve  
Elec. Cond.  
FPD

13.2

9.2

8.4



DARK BROWN ORGANIC SILT (OL,  $N_{be}$ )  
with occasional fibrous organics

1 foot layer of ice at 7 to 8 feet

BROWN SILTY SAND (SP-SM,  $N_{be}$ )  
with occasional gravel to 1 inch diameter

$N_{bn}$  at 15.0 feet

LIGHT GRAY SAND (SP,  $N_{bn}$ )

GRAY BROWN GRAVELLY SILTY SAND (SM,  $N_{bn}$ )



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Log of Boring HLB-11  
PORT OF NOME  
Nome, Alaska

PLATE

A24

DRAWN

JOB NUMBER  
15001,002.08

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N 113,150  
E 104,969

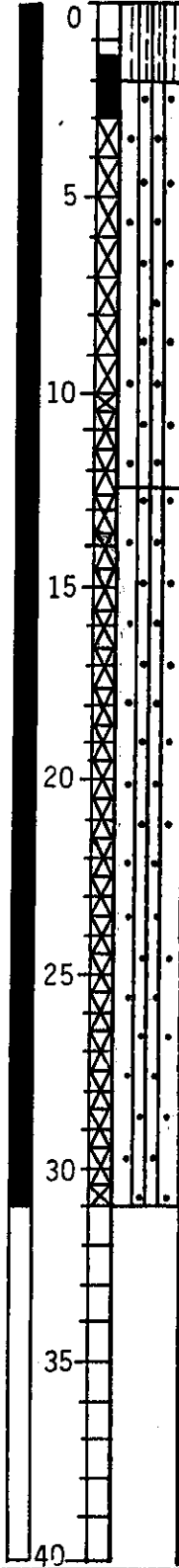
LOG OF BORING HLB-12

Equipment 10-inch Air Drill

Laboratory Tests

Elevation +44.5ft. Date Drilled 02/05/82  
MLLW

Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)  
Frozen  
Depth (ft.)  
Samples



-#200 Sieve

9.8

NOTE:

1. Installed PVC casing to 31.0 feet



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Log of Boring HLB-12

PORT OF NOME  
Nome, Alaska

PLATE

A25

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JOB NUMBER  
15001,002,08

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03/82

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N 112,535  
E 104,084

LOG OF BORING HLB-13

Equipment 10-inch Air Drill

Laboratory Tests  
Org. Loss

Moisture  
Content (%)  
Blows/  
Foot

Dry  
Density  
(pcf)

Frozen  
Depth (ft)  
Samples

Elevation +38.4 ft Date Drilled 02/06/82

SA

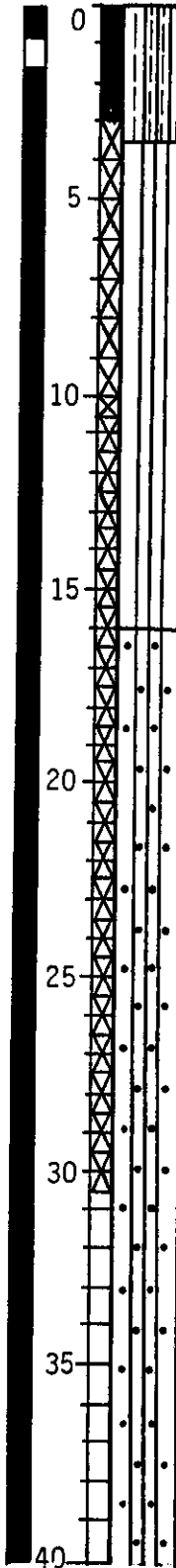
277.2

185.2

50.6

11.3

12.1



BROWN ORGANIC SILT (OL, N<sub>be</sub>)  
with occasional fibrous  
organics, top 1 foot very peaty

GRAY SILT (ML, N<sub>be</sub>)

Increasing sand content

DARK GRAY GRAVELLY SILTY SAND  
(SM, N<sub>be</sub>)

Decreasing gravel content



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**Log of Boring HLB-12**  
PORT OF NOME  
Nome, Alaska

PLATE

**A26**

DRAWN

JOB NUMBER

15001,002.08

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N 112,535  
E 104,084

Laboratory Tests

Blows/Foot  
(N-Value)

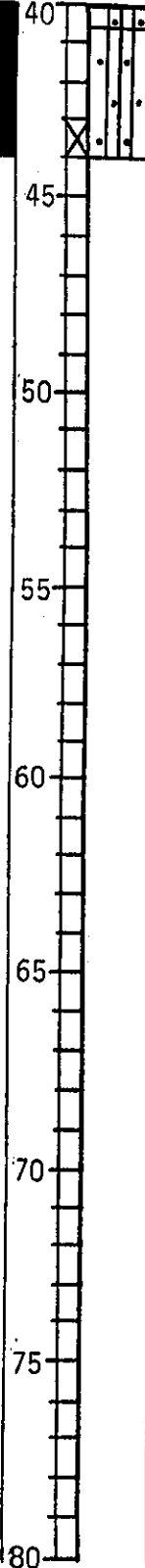
Moisture  
Content (%)

Dry  
Density (pcf)

Depth (ft)  
Samples

-#200 Sieve

DARK GRAY SILTY GRAVELLY SAND  
(SM, Nbn)



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**Log of Boring HLB-13 (CONT.)**  
PORT OF NOME  
Nome, Alaska

PLATE

**A27**

DRAWN

JOB NUMBER  
15001,002.08

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DATE

03/82

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DATE

NT11,694

E107,184

Laboratory Tests

Moisture Content (%)  
Blows/  
Foot

Dry Density (pcf)

Frozen  
Depth (ft)  
Samples

LOG OF BORING HLS-1

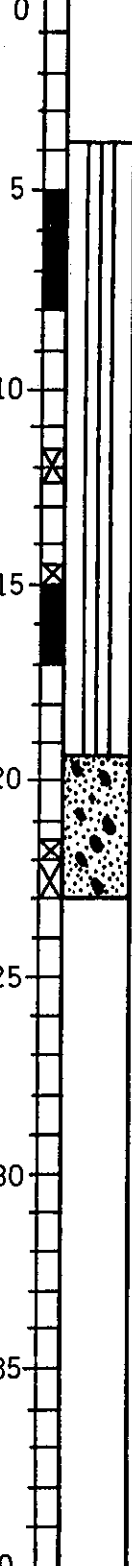
Equipment 10-inch Air Drill

Elevation +2.6 ft Date Drilled 02/08/82  
MLW

SA

53.2

69



ICE

BLACK GRAVELLY SANDY SILT (ML)  
saturated, loose to medium dense,  
top 1-foot is frozen

SA

34.9

80

DARK GRAY SANDY GRAVEL (GP)  
saturated, medium dense, with  
gravel to 2 inch diameter



**Harding Lawson Associates**  
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**Log of Boring HLS-1**  
PORT OF NOME  
Nome, Alaska

PLATE

**A28**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED

DATE

03/82

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DATE

N111,708  
E107,290

LOG OF BORING HLS-2

Equipment 10-inch Air Drill

Laboratory Tests

Elevation 2.4 ft. Date Drilled 02/09/82

Moisture  
Content (%)  
Blows/  
Foot

Dry  
Density  
(pcf)

Frozen

Depth (ft)  
Samples

SA

18.8

108

ICE

BLACK SILTY SAND (SM, N<sub>pe</sub>)  
with considerable fibrous  
organic materials

BLACK SILTY SAND (SM)  
saturated, loose

SA

BROWN GRAVELLY SAND  
saturated medium dense with  
occasional gravel to 3 inches  
diameter



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**Log of Boring HLS-2**

PORT OF NOME  
Nome, Alaska

PLATE

**A29**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED

PS

DATE  
03/82

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DATE

N111,918

E107,139

LOG OF BORING HLS-3

Equipment 10-inch Air Drill

Laboratory Tests

Elevation +3.3 ft. Date Drilled 02/09/82

MLTW

SA

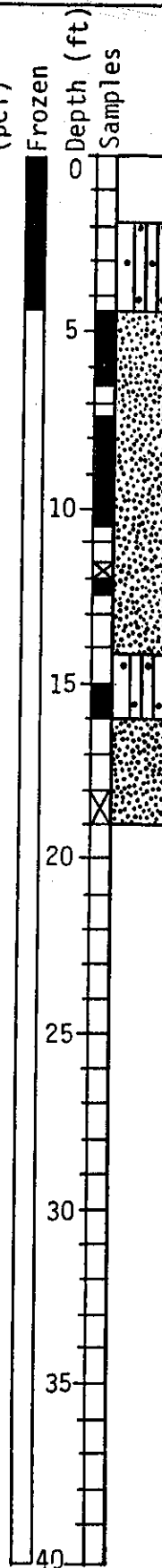
Moisture Content (%) 17.7  
Blows/Foot 107  
Dry Density (pcf) 107

17.2 110

SA

10.7 132

SA



ICE

BLACK SILTY SAND (SM, Nbe)

BLACK SILTY SAND (SP-SM)  
saturated, loose with occasional fibrous organic material

BROWN GRAVELLY SILTY SAND (SM)  
saturated, loose to medium dense

BROWN GRAVELLY SILTY SAND (SP-SM)  
saturated loose to medium dense with occasional gravel to 4 inches diameter



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**Log of Boring HLS-3**  
PORT OF NOME  
Nome, Alaska

PLATE

**A30**

DRAWN

JOB NUMBER  
15001,002.08

APPROVED

DATE  
03/82

REVISED

DATE



N111,850  
E107,235

LOG OF BORING HLS-4

Equipment 10-inch Air Drill

Laboratory Tests

Elevation +2.9 ft. Date Drilled 02/09/82  
MLLW

Moisture Content (%)  
Blows/ Foot  
Dry Density (pcf)  
Frozen  
Depth (ft)  
Samples

-#200 Sieve

25.2

103

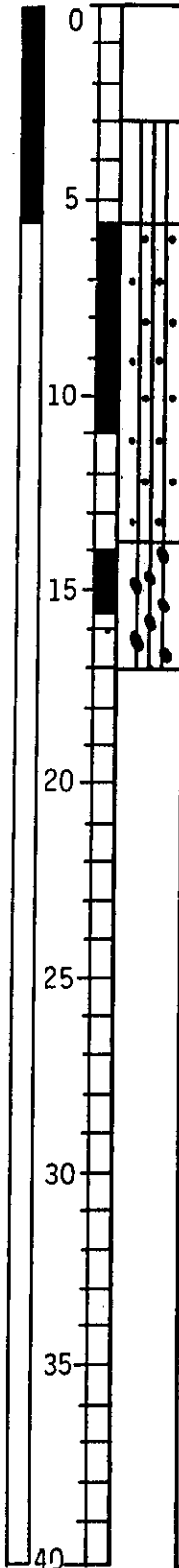
SA

19.8

106

41.0

79



ICE

BLACK SILTY SAND (SM, N<sub>be</sub>)  
with fibrous organic material  
throughout

BLACK SILTY SAND (SM)  
saturated, loose

BROWN SANDY, SILTY GRAVEL (GM)  
saturated, medium dense



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**Log of Boring HLS-4**  
PORT OF NOME  
Nome, Alaska

PLATE

**A31**

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DATE

## UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		TYPICAL NAMES			
<b>COARSE GRAINED SOILS</b> more than half is larger than no. 200 sieve	<b>GRAVELS</b> 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	
		gravels with over 12% fines	GP 	poorly graded gravels, gravel-sand mixtures	
		<b>SANDS</b> 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
			sands with over 12% fines	SP 	poorly graded sands, gravelly sands
	<b>FINE GRAINED SOILS</b> more than half is smaller than no. 200 sieve	<b>SILTS AND CLAYS</b> liquid limit less than 50	inorganic silts and very fine sands, rock flour, silty or clayey fine sands, or clayey silts with slight plasticity	ML 	
			inorganic clays of low to medium plasticity, gravelly clays, sandy clays,	CL 	
			organic clays and organic silty clays of low plasticity	OL 	
		<b>SILTS AND CLAYS</b> liquid limit greater than 50	inorganic silts, micaceous or diatomaceous fine sandy or silty soils, elastic silts	MH 	
			inorganic clays of high plasticity, fat clays	CH 	
			organic clays of medium to high plasticity, organic silts	OH 	
peat and other highly organic soils			Pt 		
<b>HIGHLY ORGANIC SOILS</b>		Pt			

### KEY TO TEST DATA

Consol - Consolidation LL - Liquid Limit (in %) PL - Plastic Limit (in %) SpG - Specific Gravity PSA - Particle Size Analysis OLI - Organic Loss by Ignition ■ "Undisturbed" Sample ☒ Bulk Sample -#200 Minus No.200 Sieve	Shear Strength, psf Confining Pressure, psf	Tx 320 (2600) Unconsolidated Undrained Triaxial TxCU 320 (2600) Consolidated Undrained Triaxial DS 2750 (2000) Consolidated Drained Direct Shear TxCD 320 (2600) Consolidated Drained Triaxial UC 2000 Unconfined Compression
--	--	---

## ICE DESCRIPTIONS

GROUP SYMBOL	ICE VISIBILITY AND CONTENT	SUBGROUP		
		DESCRIPTION	SYMBOL	
N	Segregated ice not visible by eye	Poorly bonded or friable	N <sub>f</sub>	
		Well bonded	No Excess ice	N <sub>b</sub>   N <sub>bn</sub>
			Excess ice microscopic	N <sub>be</sub>
N	Segregated ice is visible by eye, ice one inch or less in thickness	Individual ice crystals or inclusions	V <sub>x</sub>	
		Ice coatings on particles	V <sub>c</sub>	
		Random or irregularly oriented ice formations	V <sub>r</sub>	
		Stratified or distinctly oriented ice formations	V <sub>s</sub>	
		Ice with soil inclusions	ICE + soil type	
ICE	Ice greater than one inch in thickness	Ice with soil inclusions	ICE + soil type	
		Ice without soil inclusions	ICE	

## FROST DESIGN SOIL CLASSIFICATION

FROST GROUP	KIND OF SOIL	PERCENTAGE FINER THAN 0.02 MM BY WEIGHT	TYPICAL SOIL TYPES UNDER UNIFIED SOIL CLASSIFICATION SYSTEM
F1	Gravelly soils	3 to 10	GW, GP, GW-GM, GP-GM
F2	(a) Gravelly soils	10 to 20	GM, GW-GM, GP-GM SW, SP, SM, SW-SM, SP-SM
	(b) Sands	3 to 15	
F3	(a) Gravelly soils	Over 20	GM, GC
	(b) Sands, except very fine silty sands		
	(c) Clays, PI 12		
F4	(a) All silts	Over 15	ML, MH SM CL, CL-ML
	(b) Very fine silty sands		
	(c) Clays, PI 12		
	(d) Varved clays and other fine-grained, banded sediments		

Reference: Corps of Engineers, U.S. Army  
TM 5-818-2, 13 July 1965



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**Soil & Ice Classification and Key to Test Data**  
Port of Nome  
Nome, Alaska

JOB NUMBER

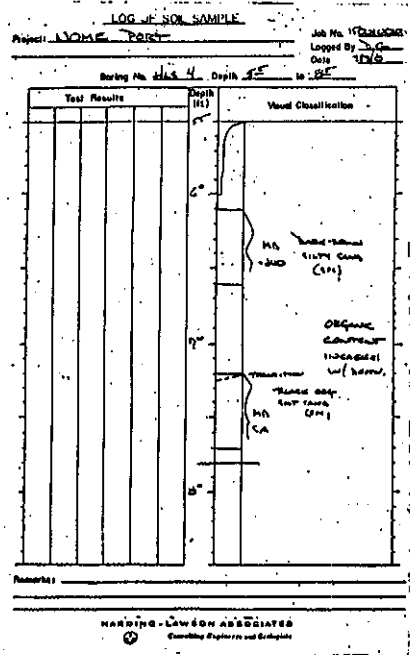
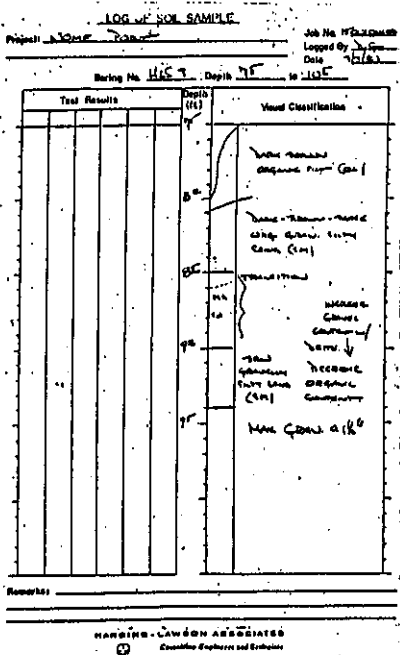
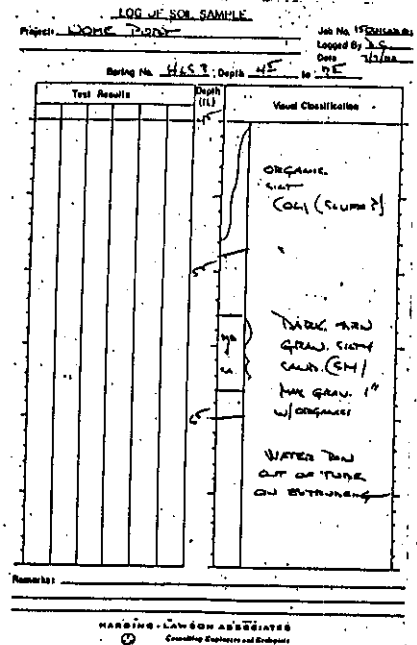
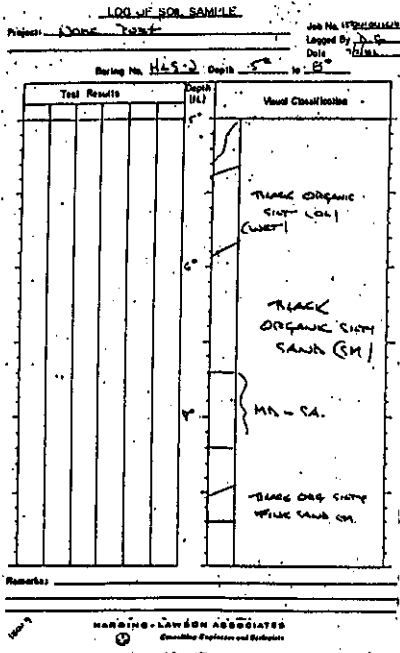
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A3



**Harding Lawson Associates**  
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**Detailed Logs of Samples**  
 Port of Nome  
 Nome, Alaska

PLATE  
**A33**

BORING HLB-2:

Depth	Date of Readings		
	15 Feb. 82	16 Feb. 82	14 April 82
0.0	---	---	---
3.0	-1.3	-1.4	-5.2
6.0	-1.2	-1.0	-3.2
9.0	-0.9	-1.0	-2.9
12.0	-0.7	-0.8	-2.7
15.0	-0.6	-0.7	-2.4
20.0	-0.7	-0.7	-2.0
25.0	-0.8	-0.8	-1.9
30.0	-0.9	-0.9	-1.8
35.0	-0.9	-0.9	-1.2
40.0	-1.0	-1.0	-1.2
44.5	-1.0	-1.0	-1.3

BORING HLB-4:

Depth	Date of Readings		
	15 Feb. 82	16 Feb. 82	14, 15 April 82
0.0	-3.7	-3.8	-4.7
3.0	-0.6	-2.1	-3.7
6.0	-0.6	-0.9	-2.5
9.0	0.4	-0.3	-0.6
12.0	0.8	0.6	-0.2
15.0	1.3	1.0	0.4
20.0	2.1	1.9	1.1
25.0	2.2	2.2	1.6
30.0	2.0	2.1	1.6
35.0	1.9	1.9	1.6
40.0	1.8	1.8	1.5
45.0	1.6	1.6	1.4
50.0	1.5	1.5	1.3
55.0	1.5	1.5	1.2

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.



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**Ground Temperature Observations**  
 Port of Nome  
 Nome, Alaska

PLATE

**A34**

DRAWN

JOB NUMBER  
 15,001,002.08

APPROVED

DATE  
 4/82

REVISED

DATE

BORING HLB-6:

Depth	Date of Readings		
	<u>13, 14 Feb. 82</u>	<u>16 Feb. 82</u>	<u>14 April 82</u>
0.0	-5.2	-8.2	-5.7
3.0	-5.5	-7.0	-5.1
6.0	-5.9	-6.5	-5.2
9.0	-4.5	-6.4	-4.9
12.0	-5.5	-6.4	-4.5
15.0	-0.9	-1.0	-4.3
20.0	-0.7	-0.7	-1.8
25.0	-0.8	-0.8	-1.2
30.0	-0.9	-0.9	-1.2
34.5	-0.9	---	1.2

BORING HLB-7:

Depth	Date of Readings		
	<u>12 Feb. 82</u>	<u>15 Feb. 82</u>	<u>14 April 82</u>
0.0	-6.8	-12.0	-10.7
3.0	-1.7	3.4	-5.0
6.0	-1.4	-1.5	-4.3
9.0	-1.1	-1.2	-3.9
12.0	-1.0	-1.0	-3.25
15.0	-0.9	-0.9	-3.0
20.0	-1.0	-0.9	-3.0
25.0	-1.1	-1.0	-2.4
30.0	-1.2	-1.1	-1.7

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.



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**Ground Temperature Observations**  
 Port of Nome  
 Nome, Alaska

PLATE

**A35**

DRAWN

JOB NUMBER  
 15,001,002.08

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DATE  
 4/82

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DATE

BORING HLB-8:

Depth	Date of Readings			
	13 Feb. 82	15 Feb. 82	16 Feb. 82	15 April 82
0.0	-2.3	-3.4	-3.1	-9.7
3.0	-1.7	-4.1	-4.0	-4.3
6.0	-1.3	-2.1	-3.6	-3.5
9.0	-1.2	-2.0	-1.6	-3.3
12.0	-1.1	-1.7	-1.5	-2.8
15.0	-0.7	-1.8	-1.5	-2.6
20.0	-0.9	-1.4	-1.6	-2.4
25.0	-1.0	-1.0	---	-2.3
30.0	-1.1	-1.1	---	-1.6

BORING HLB-9:

Depth	Date of Readings		
	14 Feb. 82	16 Feb. 82	15 April 82
0.0	-1.0	-12.3	(1 ft) -3.1
3.0	-0.4	-1.1	-2.8
6.0	-0.1	-1.0	-2.6
9.0	-0.2	-0.3	-2.2
12.0	-0.4	-0.4	-1.8
15.0	-0.5	-0.4	-1.8
20.0	-0.5	-0.5	-1.7
25.0	-0.6	-0.6	-1.4
30.0	-0.7	-0.7	-1.0

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.



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**Ground Temperature Observations**  
 Port of Nome  
 Nome, Alaska

PLATE

**A36**

DRAWN

JOB NUMBER  
 15,001,002.08

APPROVED

DATE  
 4/82

REVISED

DATE

BORING HLB-10:

Date of Readings

Depth	15 Feb. 82	16 Feb. 82
0.0	---	---
3.0	-1.6	-1.8
6.0	-1.1	-1.2
9.0	-0.3	-0.3
12.0	-0.3	-0.3
15.0	-0.3	-0.3
20.0	-0.3	-0.3
25.0	-0.4	-0.4
30.0	-0.4	-0.4
35.0	-0.4	-0.4
40.0	-0.5	-0.5
44.5	-0.5	-0.5

BORING HLB-12:

Date of Readings

Depth	14 Feb. 82	16 Feb. 82	15 April 82
0.0	---	---	---
3.0	-0.8	-0.7	-2.4
6.0	0.0	0.0	-2.0
9.0	0.0	-0.0	1.0
12.0	-0.0	-0.0	-0.6
15.0	-0.1	-0.1	-0.5
20.0	-0.1	-0.2	-0.5
25.0	-0.2	-0.2	-0.5
30.0	-0.2	-0.2	-0.5

Notes:

1. All temperatures are in degrees Celsius (°C).
2. Two thermistors were read at each depth; the highest of the two temperatures are presented.



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**Ground Temperature Observations**  
Port of Nome  
Nome, Alaska

PLATE

**A37**

DRAWN

JOB NUMBER  
15,001,002.08

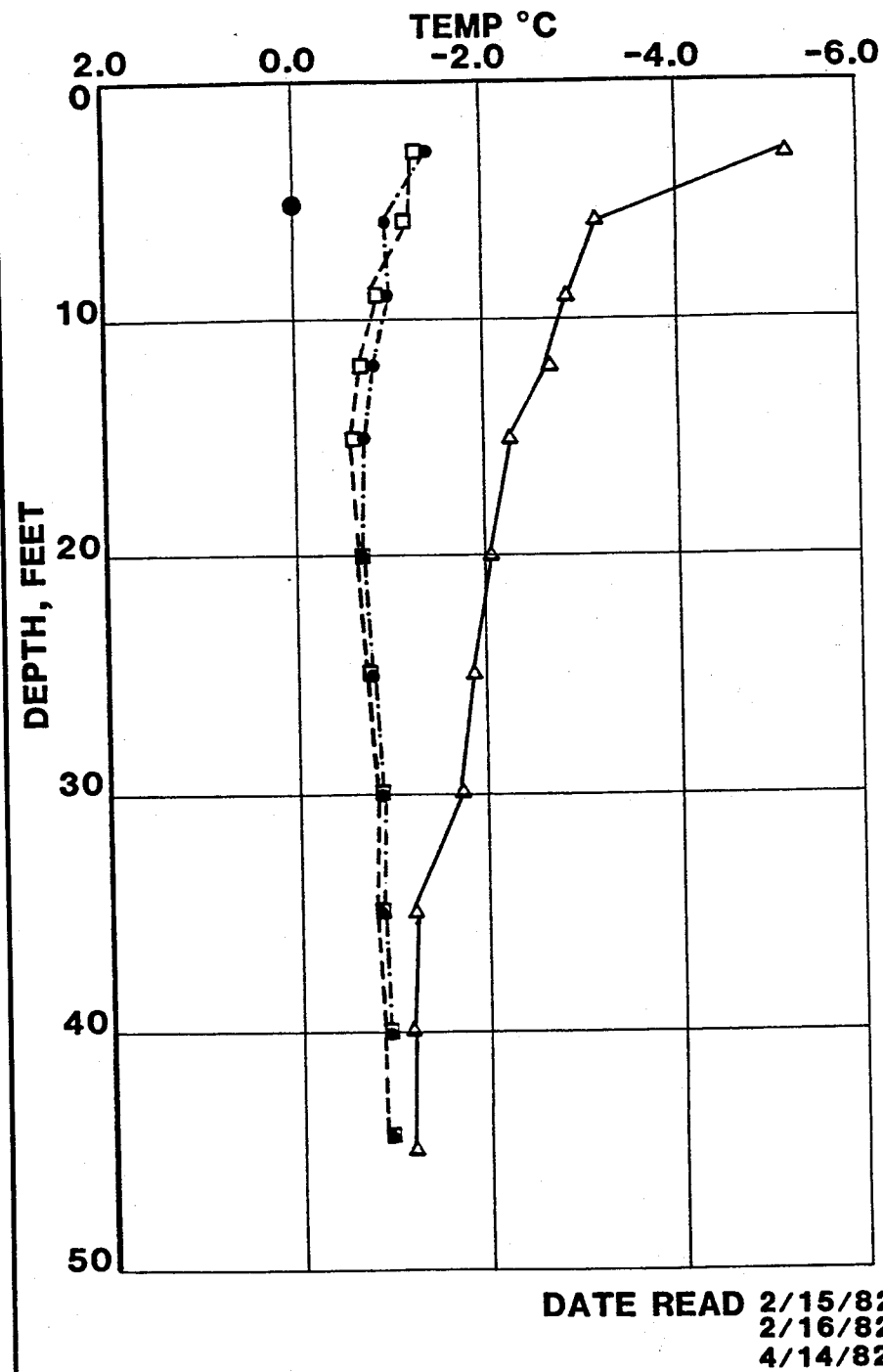
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4/82

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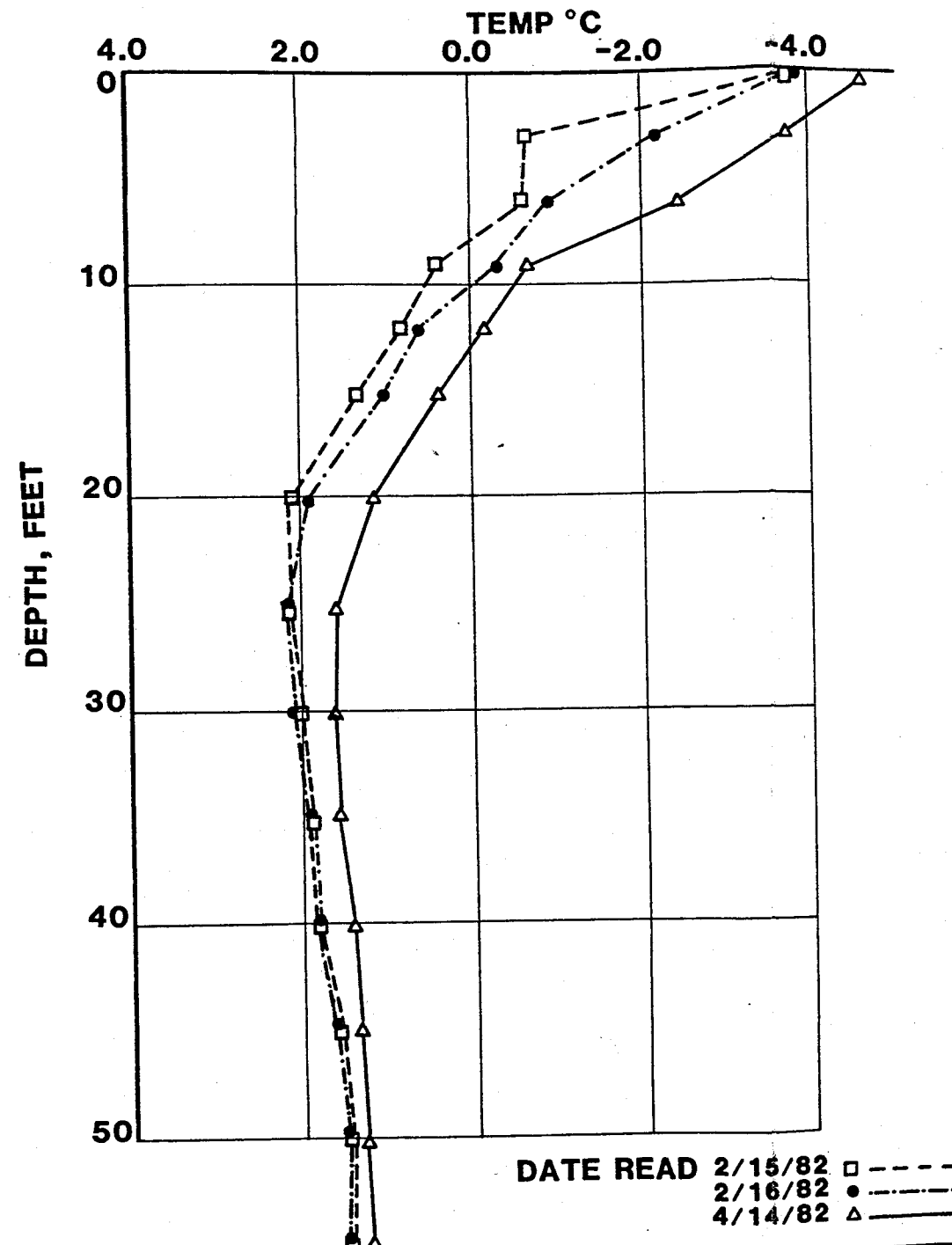
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**BORING  
HLB-2**



● FREEZING POINT, BASED ON LABORATORY TESTING

**BORING  
HLB-4**



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**Temperature Vs. Depth**  
Port of Nome  
Nome, Alaska

PLATE

**A38**

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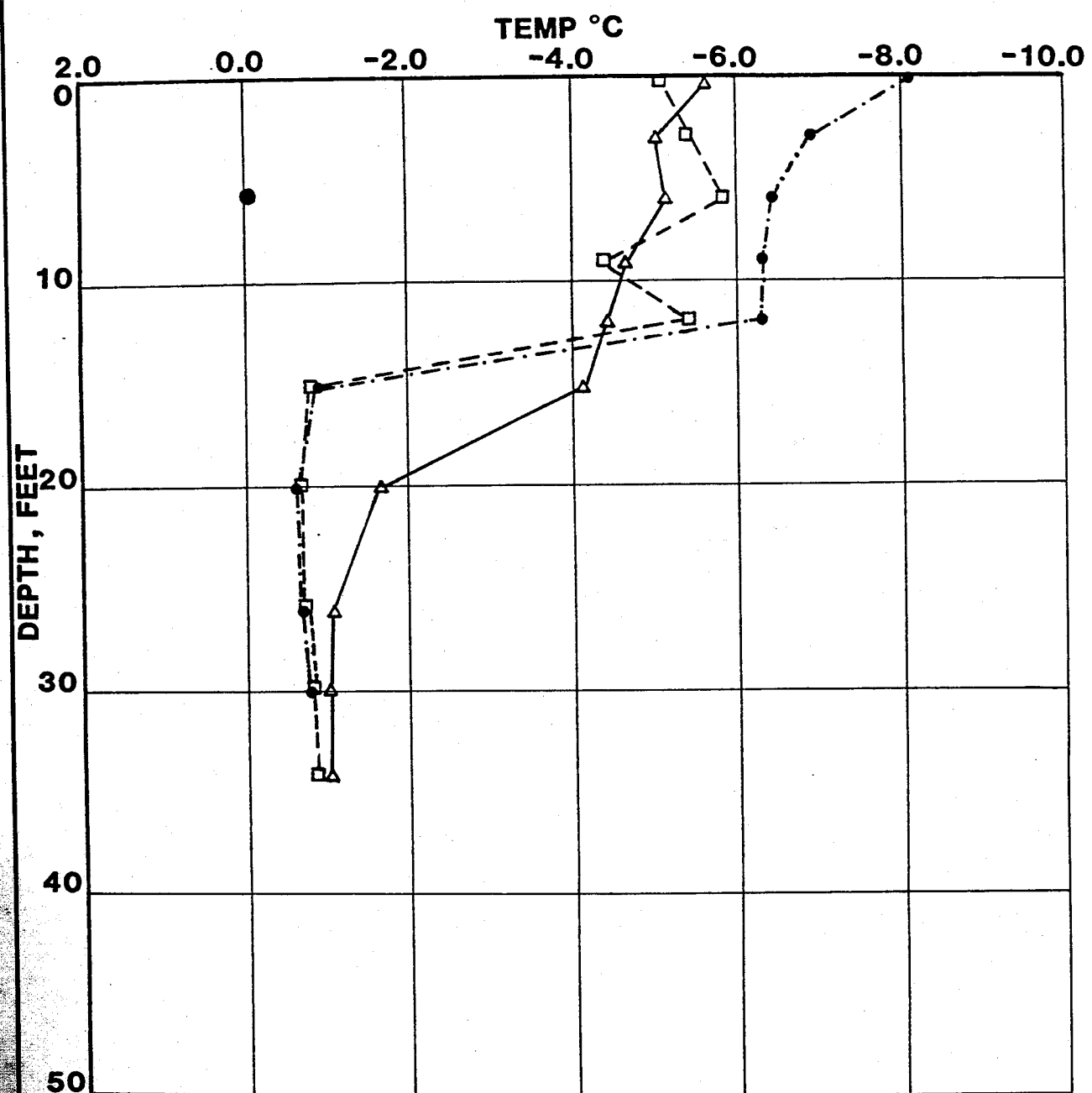
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15,001,002.08

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4/82

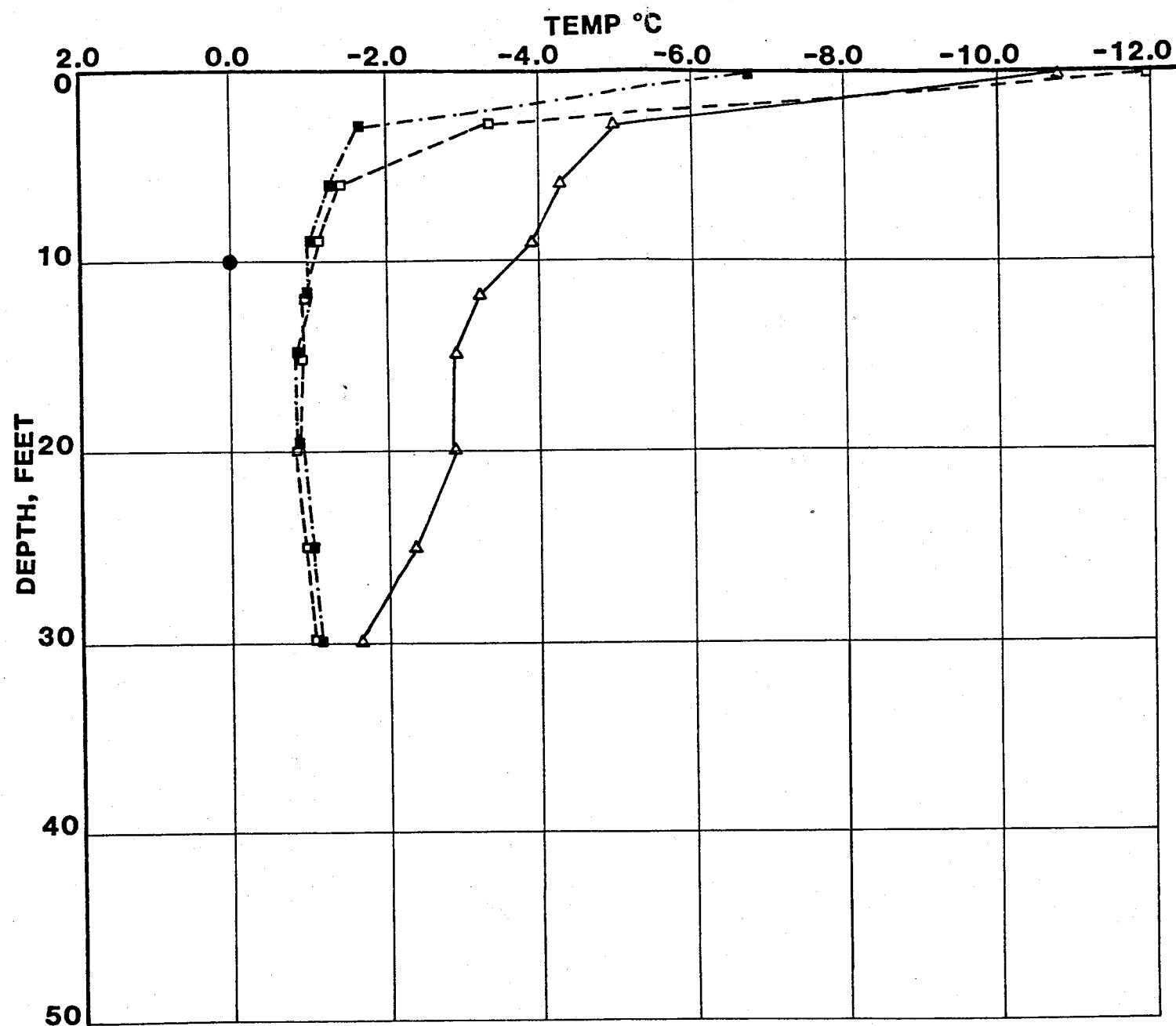


**BORING  
HLB-6**



DATE READ 2/15/82 □ - - - -  
 2/16/82 ● - - - -  
 4/14/82 △ - - - -

**BORING  
HLB-7**



DATE READ 2/12/82 ■ - - - -  
 2/15/82 □ - - - -  
 4/14/82 △ - - - -

● FREEZING POINT, BASED  
ON LABORATORY TESTING



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**Temperature Vs. Depth**  
 Port of Nome  
 Nome, Alaska

PLATE  
**A39**

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JOB NUMBER  
15,001,002.08

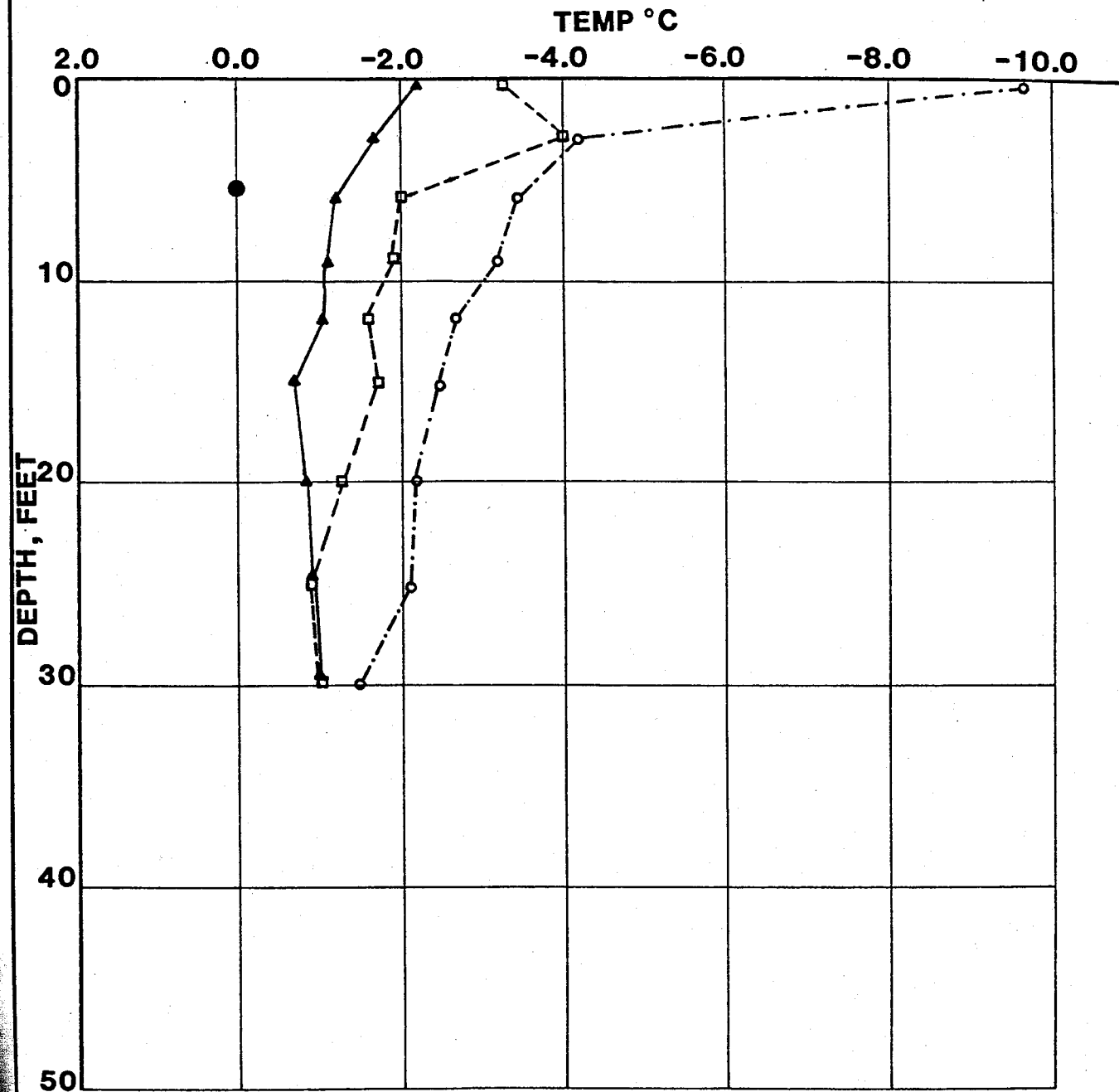
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4/82

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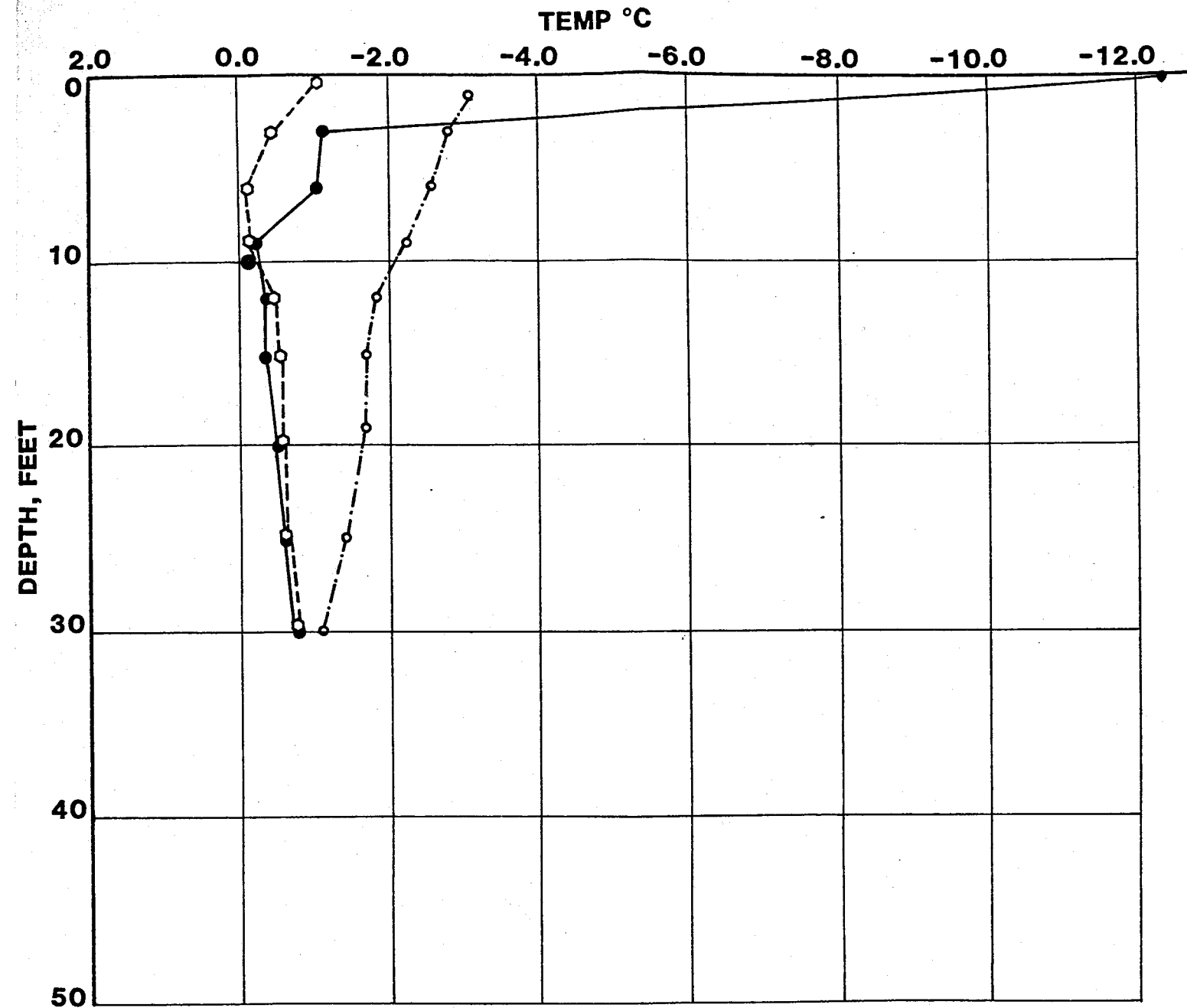
DATE

**BORING  
HLB-8**



DATE READ 2/13/82 ▲ ———  
 2/15/82 □ - - - -  
 4/15/82 ○ ·····

**BORING  
HLB-9**



DATE READ 2/14/82 ○ - - - -  
 2/16/82 ● ———  
 4/15/82 ○ ·····

● FREEZING POINT, BASED  
ON LABORATORY TESTING



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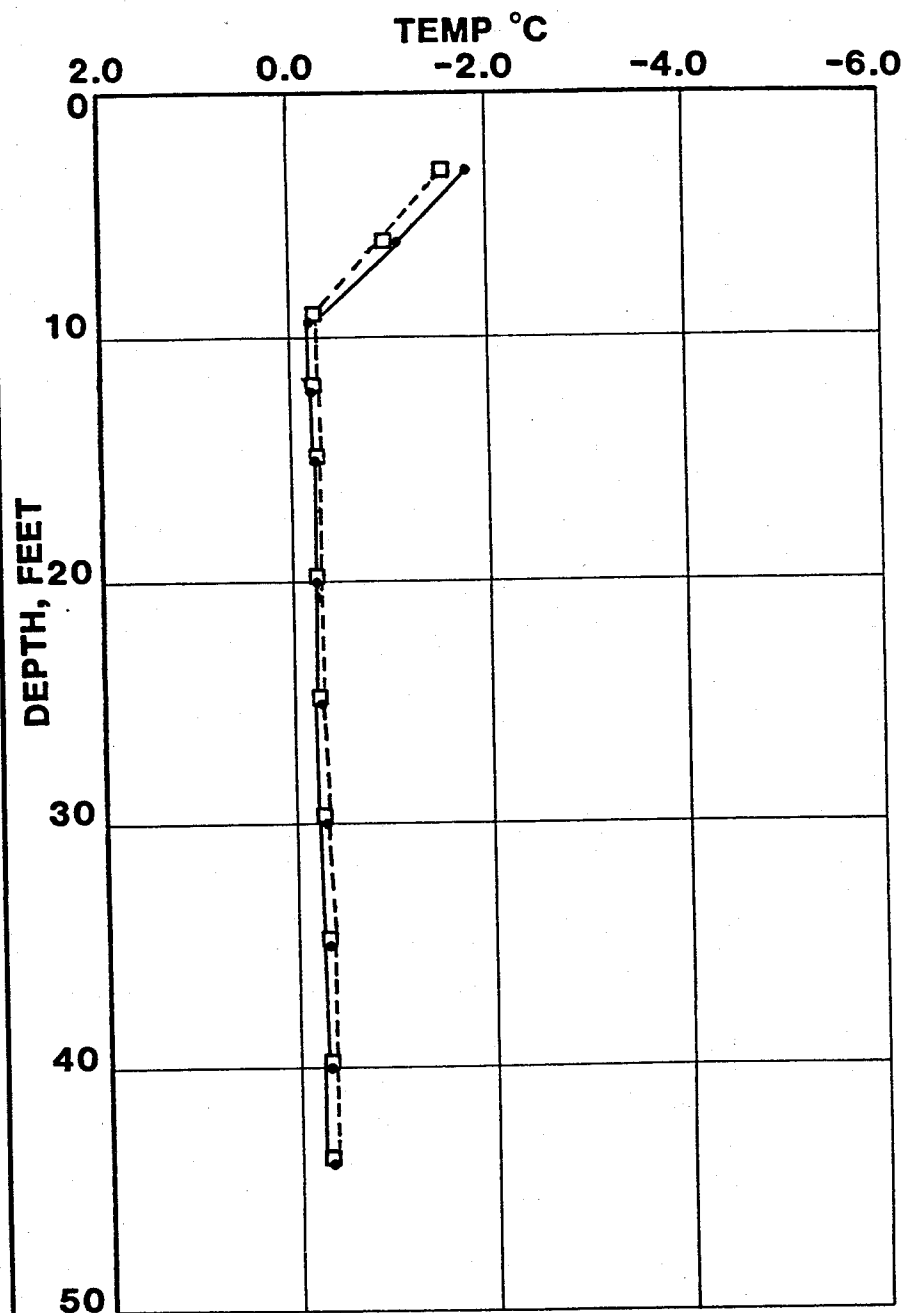
**Temperature Vs. Depth**  
 Port of Nome  
 Nome, Alaska

PLATE

**A40**

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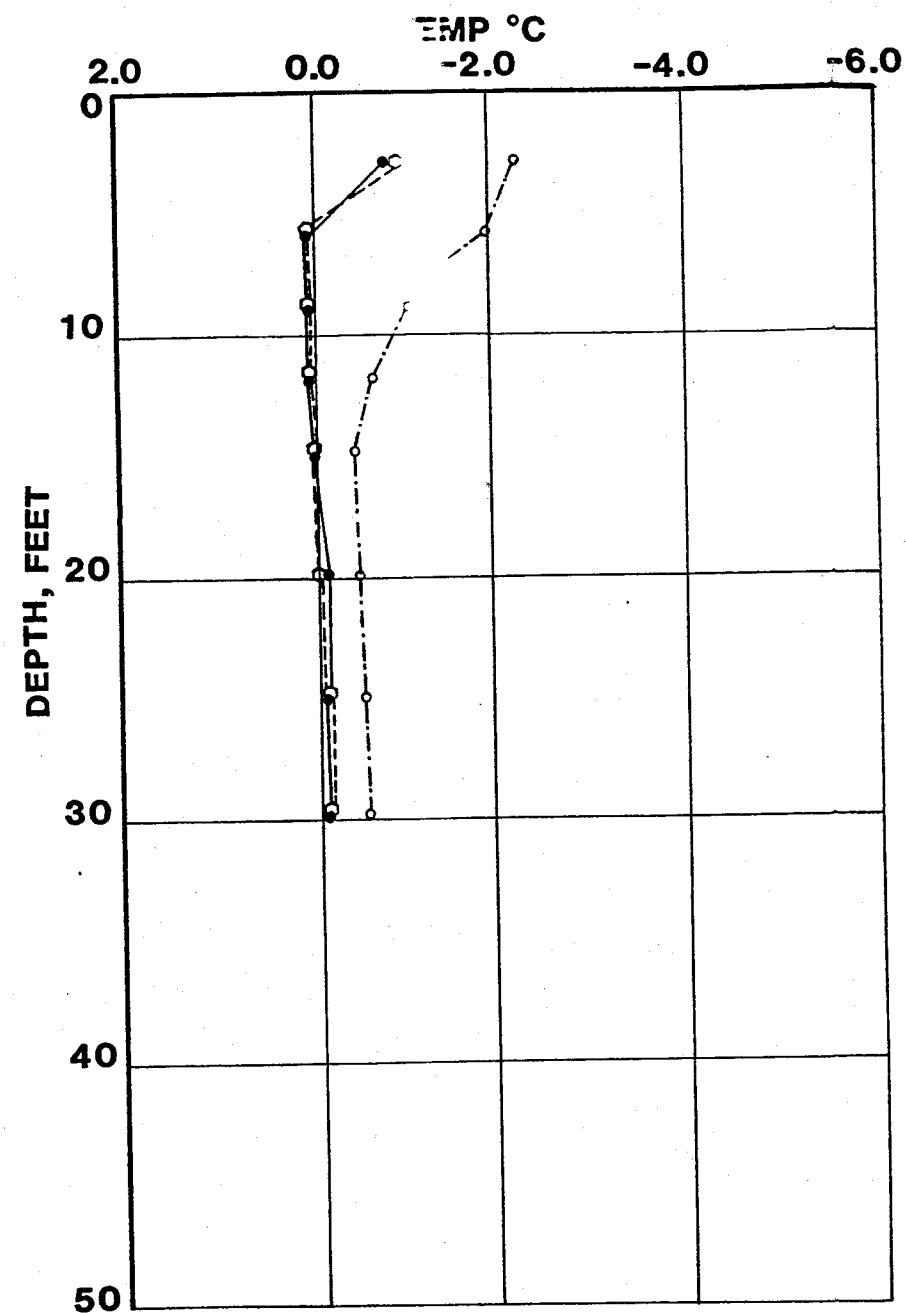
**BORING  
HLB-10**



DATE READ 2/15/82 □ -----  
2/16/82 • ———

**CASING AND  
WELL DESTROYED**

**BORING  
HLB-12**



DATE READ 2/14/82 ○ -----  
2/16/82 • ———  
4/15/82 ○ ·····



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**Temperature Vs. Depth**  
Port of Nome  
Nome, Alaska

PLATE

**A41**

DRAWN

JOB NUMBER  
15,001,002.08

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DATE  
4/82

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DATE

## APPENDIX B - LABORATORY TESTING

A laboratory testing program was performed on representative samples from the borings to measure pertinent physical properties of the soils. The program was developed jointly by HLA and TAMS. The testing program, as described below, was oriented to establish typical soil classification, strength, compressibility and thermal characteristics. A summary of the test results is presented on Plates B1 through B4.

### 1. Moisture Content / Dry Density (ASTM D-2216)

Moisture content and dry density determinations were performed to evaluate the natural water content and dry density of typical soil types encountered. These also serve as a basis for correlating soil engineering characteristics determined by other laboratory tests. Where possible, the wet density of the particular specimen was determined on the basis of the entire specimen volume, and the loss of weight upon drying was used for determining the moisture content. The moisture content was obtained by oven drying the wet soil to a constant weight. The results of the moisture content and dry density determinations are shown on the boring logs.

### 2. Organic Content (ASTM D2974)

The organic content of selected specimens was determined by loss of weight by ignition. The specimen to be tested was oven dried for 24 hours at 105°C and the dry weight recorded. The specimen was then saturated with alcohol, ignited, and an afterburn weight was observed.

The organic content was then determined as a percent of weight loss upon ignition. The results of these tests are presented on the boring logs.

3. Particle Size Analysis (ASTM D422 and D1140)

The quantitative distribution of particle sizes was determined from representative samples by performing sieve and hydrometer analyses. The results of the particle size analysis are presented on Plates B5 through B16.

4. Atterberg Limits (ASTM D423 and D424)

The liquid limit and plastic limit of selected representative samples of fine-grained soils were determined. The liquid limit was obtained in accordance with the ASTM standard three-point method D-423. The plastic limit and the plasticity index calculation were performed in accordance with ASTM standard method D-424. The results of these tests are listed on the boring logs. All the samples tested are non-plastic.

5. Specific Gravity (ASTM D-854)

The specific gravity of selected specimens was determined in accordance with ASTM specification D-854. The results of the specific gravity tests are presented on the Laboratory Test Summary.

6. Strength Tests - ASTM Procedures as Supplemented by the Procedures Presented in "Soil Testing for Engineers" by T. William Lambe, 1951

Soil strength parameters under static loading conditions were determined by Consolidated-Undrained Triaxial Shear Tests (TXCU) - ASTM D2850 (as modified for consolidation).

For the tests, a cylindrical specimen of soil encased in a rubber membrane was placed in a triaxial compression chamber, subjected to a chamber pressure, and then loaded axially to failure. Connections at the ends of the specimen permitted controlled drainage of pore water from the specimen.

In the TXCU test, drainage of the sample occurred during application of the chamber pressure. The sample was allowed to consolidate and saturate by seepage/backpressure. Once the sample had completed consolidation, the drain valve was closed and the axial load applied at a constant strain rate. The tests were performed at a strain rate of about one percent per minute. Two series of tests were performed on the sandy silt (ML) and silty sand (SM) samples from the offshore borings. Results of the tests are presented on Plates B17, B18 and B19.

#### 7. Consolidation Tests (ASTM D2435)

One-dimensional consolidation tests were performed on representative specimens of fine-grained soil 0.8 inch in height. Each load increment of the test was double the previous load and was applied for a period of approximately 24 hours unless all significant consolidation occurred within a shorter time span. Time-rate of compression readings were taken at every compression load increment after and a seating load was applied. Consolidation test results are shown on Plates B20 through B23.

#### 8. Relative Density Tests (ASTM D2049-69)

One relative density test was performed on samples combined from the upper ten feet of Boring 1. The tests were performed in accordance with ASTM Test Designation D2049-69. The results of these tests are presented on Plate B24. The corresponding particle size analysis is shown on Plate B25.

#### 9. Chemical Tests

Chemical testing of the pore fluids was performed by Chemical and Geological Laboratories of Alaska, Inc., Anchorage. The chemistry tests included determining pore water conductivity and total soluble salt concentration and calculating the freezing point (FP). The chemical tests were performed on samples from the borings drilled at onshore storage area. Interpretation of the test results was not within the scope of our services.

#### 10. Electrical Conductivity Tests

The electrical conductivity of selected specimens was measured to determine the freezing point of the interstitial fluids from samples obtained from the onshore storage area. The results are summarized on the Laboratory Test Summary.

Electrical conductivities were measured using a YSI Model Conductivity Bridge. The procedure for determining conductivity is as follows. First, the wet weight of a sample, approximately 100 grams, is determined. A solution is created by mixing approximately 100 grams of distilled water with the sample. The mixture is then placed in a bath

having a constant temperature of 24°C. The probe from the YSI Conductivity Bridge is inserted into the prepared solution, and a reading is recorded. The solution is weighted and oven dried to determine the moisture content. The conductivity is converted to salinity using the seawater equivalent salinity content, paraconductivity relationship presented in the Handbook of Chemistry and physics, 57th Edition (1976). This value is then corrected to represent the salinity of the natural moisture content by applying Equation 1. The freezing point depression value is then calculated by applying the relationship presented in Equation 2

$$C_1V_1 = C_2V_2 \quad \text{Equation 1}$$

where:

- C<sub>1</sub> = Salinity concentration before dilution (ppt)
- V<sub>1</sub> = Volume before dilution (gm)
- C<sub>2</sub> = Salinity concentration after dilution (ppt)
- V<sub>2</sub> = Volume after dilution (gm)



$$FPD = 0.00249 - 0.0533 (C_1) - 0.0000764 (C_1)^2 + 0.00000187 (C_1)^3 \quad \text{Equation 2}$$

where: FPD = freezing point depression (in degrees Centigrade)



SAMPLE DESIGNATION		PARTICLE SIZE ANALYSIS (% Passing)															CLASSIFICATION TESTS							SECONDARY TESTS			SOIL CLASSIFICATION				
BORING NO.	DEPTH (ft)	3"	2"	1-1/2"	1"	3/4"	1/2"	No. 4	No. 10	No. 20	No. 30	No. 40	No. 100	No. 200	.02 mm	.005 mm	Moist. Cont. (%)	Org. Loss by Ignition (%)	Atterberg Limits			Dry Density (PCF)	Spec. Grav.	Other	Shear Strength	Elec. Cond.	FPD	USCS	Ice Class	Frost Group	AASHTO Class
																			L.L.	P.L.	P.I.										
HLO-1	2.8													59			37.6			NP	79	2.68				ML					
	9.5							100	100	99	97	94	71	51			39.6				80	2.67				ML-SM					
	10.5													54			41.4			NP	78	2.61				ML					
	13.0			100	87	82	80	74	69	63	60	56	37	24			20.2				108					SM					
	15.0				100	98	97	92	85	77	73	68	48	35			17.4				116					SM					
HLO-2	0.5													7			20.1				104					SP-SM					
	1.0			100	98	96	96	92	82	61	49	37	12	8												SP-SM					
	3.0						100	98	94	80	69	53	20	13			22.1			NP	104					SM					
	8.5							100	100	99	98	96	62	33			36.2				85	2.66				SM					
	11.2													14			35.2				85	2.66				SM					
	22.0					100	100	90	78	63	55	45	15	9			22.1				103					SP-SM					
HLO-3	2.0			100	81	81	79	75	71	66	63	58	45	29													SM				
	27.5						100	99	98	96	94	91	40	25			19.0				115					SM					
HLO-4	0.0							100	100	100	99	32	4													SP					
	9.5			100	90	77	68	57	51	46	44	42	36	29						NP						SM					
	33.0						100	100	100	99	99	98	93	32			23.8				105					SM					
HLO-5	5.0																24.7				109					SM					
	12.5							100	100	100	100	100	100	99			29.3			NP	101					ML					
HLO-6	4.5				100	94	93	84	78	77	77	77	65	39			20.0				112					SM					
	11.0			100	96	90	86	76	70	64	62	60	51	43			10.9				135	2.68				SM					
	32.0							100	100	100	100	95	27				25.0				102	2.72				SM					
HLO-7	3.5				100	96	96	90	86	81	78	75	52	36			15.8				123	2.72				SM					
	37.0				100	97	97	92	91	90	90	89	81	22			27.0				98	2.67				SM					

NP = Non - Plastic  
 FPD = Freezing Point Depression, °C  
 Elec. Cond. = Electrical Conductivity in #MHOS / cm

	<b>Harding Lawson Associates</b> Engineers, Geologists & Geophysicists	<b>Laboratory Test Summary</b> Port of Nome Nome, Alaska	PLATE <b>B1</b>
	DRAWN _____	JOB NUMBER 15001.02.08	APPROVED 

SAMPLE DESIGNATION		PARTICLE SIZE ANALYSIS (% Passing)														CLASSIFICATION TESTS							SECONDARY TESTS			SOIL CLASSIFICATION					
BORING NO.	DEPTH (ft)	3"	2"	1-1/2"	1"	3/4"	1/2"	No. 4	No. 10	No. 20	No. 30	No. 40	No. 100	No. 200	.02 mm	.005 mm	Moist. Cont. (%)	Org. Loss by Ignition (%)	Atterberg Limits			Dry Density (PCF)	Spec. Grav.	Other	Shear Strength	Elec. Cond.	FPD	USCS	Ice Class	Frost Group	AASHTO Class
																			L.L.	P.L.	P.I.										
HLB-1	0.0																600.7	47				8								Pt	
	5.0																36.6													OL	
	10.0													14			27.1													SM	
	15.0																24.0													SM	
HLB-2	0.0																795.6	87				7								Pt	
	5.0																27.4							107	-0.014					ML	
	10.0													10			22.7													SP-SM	
	20.0														100	99	93	85	77	73	69	45	35							SM	
HLB-3	0.5																66.0													GP	
	3.0				100	86	77	68	50	39	29	24	18	6	4		2.2													GP	
	5.5		100	87	87	87	84	77	69	58	52	46	27	18																SM	
	16.0		100	83	78	69	66	58	53	46	43	41	31	24			12.5													SM	
	16.5				100	96	95	85	78	66	60	54	38	26																SM	
HLB-4	2.0																66.0													SM	
	5.0				100	94	94	90	75	58	37	29	20	5	3		3.6					99								SP	
	15.0					100	99	98	93	83	64	54	41	10	6		19.7													SP-SM	
	40.0					100	99	98	95	83	57	44	32	13	8		19.3													SP-SM	
HLB-5	2.0															40.8													SM		
HLB-6	1.5														63		99.2	29				40								ML	
	5.0																21.5							333	-0.046					ML	
	10.0													10			19.9													SP-SM	
	20.0														100	99	90	79	69	66	62	51	41							SM	
	25.0																12.0													SM	
HLB-7	5.0																26.4													SM	
	10.0																17.9													SM	
	20.0														100	100	96	93	90	89	87	45	20							SM	
	25.0																12.5													SM	

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in μMHOS / cm



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**Laboratory Test Summary**

Port of Nome  
Nome, Alaska

PLATE

**B2**

DRAWN

JOB NUMBER  
15001.02.08

APPROVED

DATE

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DATE

SAMPLE DESIGNATION		PARTICLE SIZE ANALYSIS (% Passing)														CLASSIFICATION TESTS							SECONDARY TESTS			SOIL CLASSIFICATION					
BORING NO.	DEPTH (ft)	3"	2"	1-1/2"	1"	3/4"	1/2"	No. 4	No. 10	No. 20	No. 30	No. 40	No. 100	No. 200	.02 mm	.005 mm	Moist. Cont. (%)	Org. Loss by Ignition (%)	Atterberg Limits			Dry Density (PCF)	Spec. Grav.	Other	Shear Strength	Elec. Cond.	FPD	USCS	Ice Class	Frost Group	AASHTO Class
																			L.L.	P.L.	P.I.										
HLB-8	5.0																20.2								71	-0.012	SP-SM				
	10.0													11			17.6											SP-SM			
	15.0																17.0											SP-SM			
	20.0																15.7											SM			
HLB-9	0.0																492.4											OL			
	10.0					100	99	83	67	52	45	39	22	16			17.6											SM			
	20.0				100	99	98	83	67	44	53	50	43	37											560	-0.158	SM				
	25.0				100	100	94	93	85	79	76	74	61	42			15.4											SM			
HLB-10	2.0																101.0	33			40							OL			
	5.0																76.4											OL			
	20.0																20.1											SM			
	25.0													30			27.3											SM			
	43.0					100	99	90	83	76	72	68	54	43			12.3											SM			
HLB-11	10.0													7			13.2									815	-0.168	SP-SM			
	20.0																9.2											SM			
	25.0																8.4											SM			
HLB-12	10.0																22.8											SM			
	25.0													33			9.8											SM			
HLB-13	0.0																277.2	65			17							OL			
	5.0																185.2											ML			
	10.0																50.6											ML			
	20.0				100	98	96	79	61	50	46	43	33	27			11.3											SM			
	25.0																12.1											SM			
HLS-1	1.0							100	99	97	95	93	83	63			53.2				69							ML			
	11.5					100	99	98	95	89	86	81	68	52			34.9				80							ML			

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in μMHOS / cm



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**Laboratory Test Summary**

Port of Nome  
Nome, Alaska

PLATE

**B3**

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JOB NUMBER  
15001.02.08

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DATE

SAMPLE DESIGNATION		PARTICLE SIZE ANALYSIS (% Passing)														CLASSIFICATION TESTS						SECONDARY TESTS			SOIL CLASSIFICATION																
BORING NO.	DEPTH (ft)	3"	2"	1-1/2"	1"	3/4"	1/2"	No. 4	No. 10	No. 20	No. 30	No. 40	No. 100	No. 200	.02 mm	.005 mm	Moist. Cont. (%)	Org. Loss by Ignition (%)	Atterberg Limits			Dry Density (PCF)	Spec. Grav.	Other	Shear Strength	Elec. Cond.	FPD	USCS	Ice Class	Frost Group	AASHTO Class										
																			L.L.	P.L.	P.I.																				
HLS-2	6.7					100	99	89	73	57	50	42	21	14			18.8																SM								
	17.5			100	93	88	78	52	38	24	17	11	3	1																					SP						
HLS-3	5.8			100	92	90	85	71	60	45	38	31	10	7			17.7																			SP-SM					
	8.5			100	98	95	87	68	53	40	34	29	12	9			17.2																				SM				
	15.0	100	85	85	78	73	67	58	52	44	41	37	27	19			10.7																				SP-SM				
	18.0	100	85	85	78	74	69	55	43	32	28	24	15	10																							SM				
HLS-4	6.0																25.2																					SM			
	7.2					100	100	95	86	68	58	48	28	18			19.8																								
	14.0																41.0																								

NP = Non - Plastic

FPD = Freezing Point Depression, °C

Elec. Cond. = Electrical Conductivity in #MHOS / cm



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**Laboratory Test Summary**  
Port of Nome  
Nome, Alaska

DRAWN

JOB NUMBER  
15001.02.08

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DATE

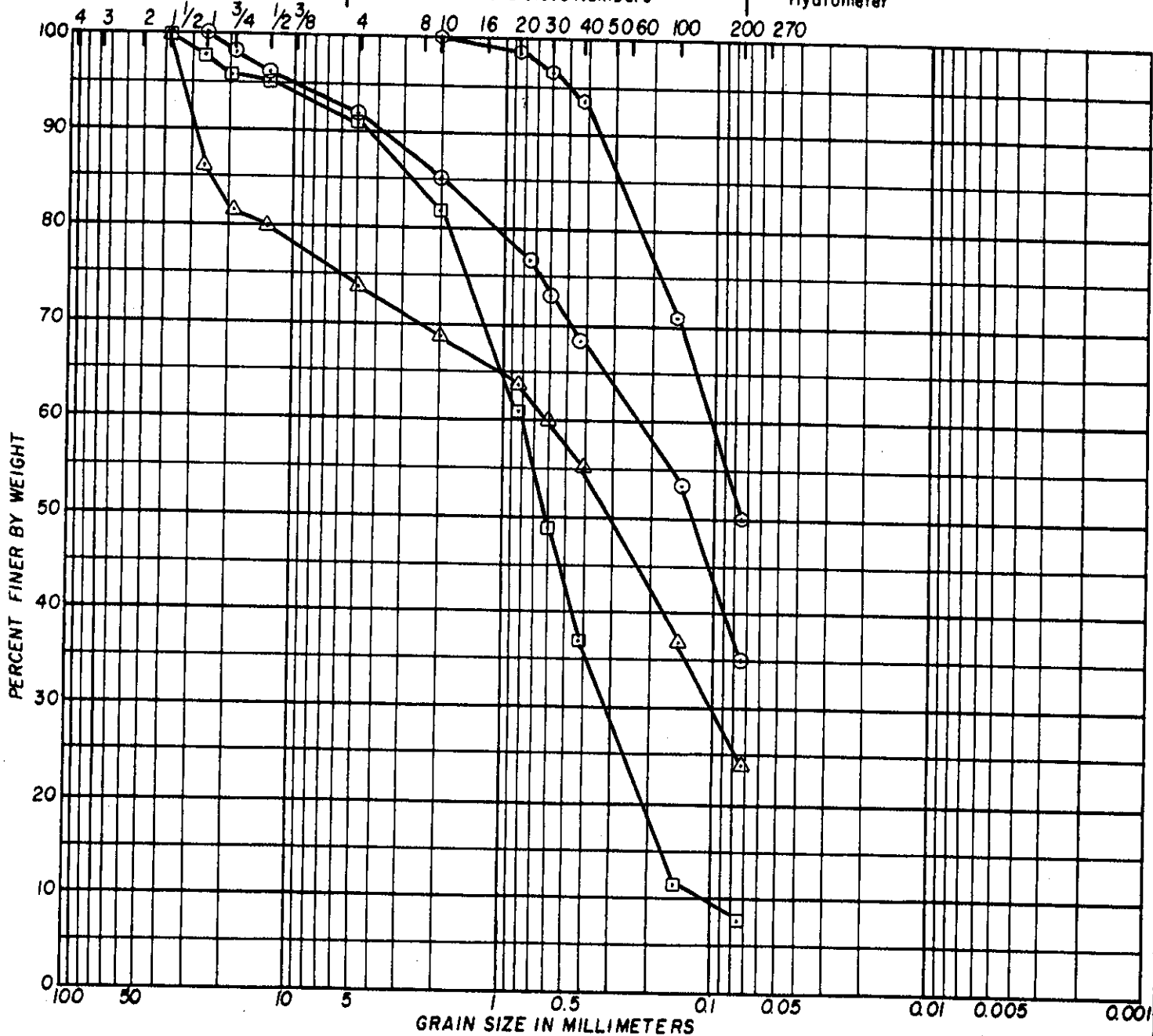
PLATE

**B4**

U.S. Standard Sieve Opening Size

U.S. Standard Sieve Numbers

Hydrometer



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

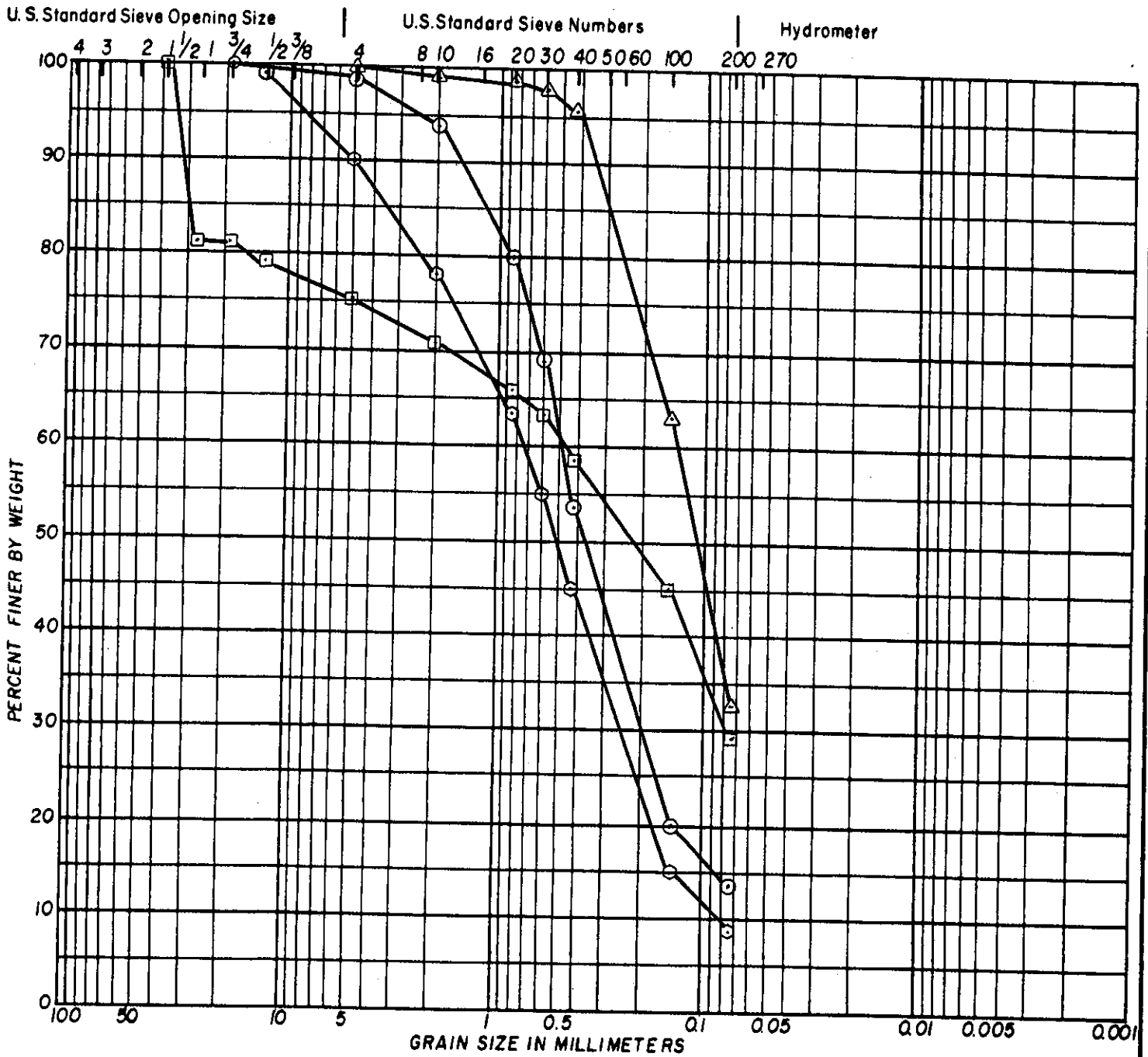
Symbol	Sample Source	Classification
⊙	HLO-1 at 10.0'	GRAY SANDY SILT (ML)
△	HLO-1 at 13.0'	GRAY SILTY GRAVELLY SAND (SM)
⊙	HLO-1 at 15.0'	GRAY GRAVELLY SILTY SAND (SM)
□	HLO-2 at 1.0'	GRAY SILTY GRAVELLY SAND (SP-SM)



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**Particle Size Analysis**  
 Port of Nome  
 Nome, Alaska

PLATE  
**B5**



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	HLO-2 at 3.0'	GRAY SILTY SAND (SM)
△	HLO-2 at 8.5'	GRAY SILTY SAND (SM)
⊙	HLO-2 at 22.0'	GRAY SILTY GRAVELLY SAND (SP-SM)
□	HLO-3 at 2.0'	GRAY GRAVELLY SILTY SAND (SM)



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**Particle Size Analysis**

Port of Nome  
 Nome, Alaska

PLATE  
**B6**

DRAWN

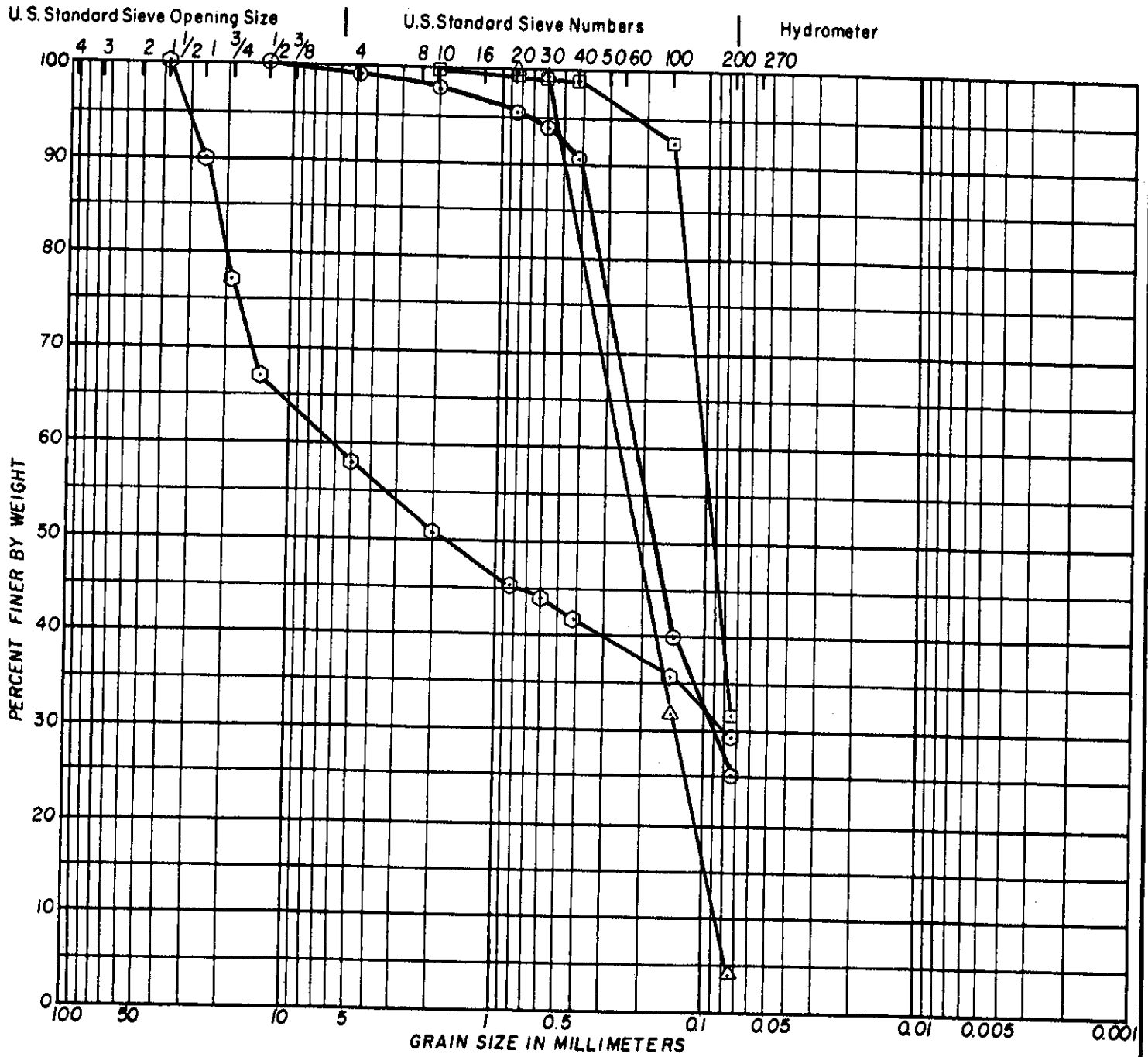
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 3/82

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DATE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
○	HLO-3 at 27.5'	GRAY SILTY SAND (SM)
△	HLO-4 at 0.0'	GRAY SAND (SP)
◇	HLO-4 at 9.5'	GRAY SILTY GRAVELLY SAND (SM)
□	HLO-4 at 33.0'	GRAY SILTY SAND (SM)



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### Particle Size Analysis

Port of Nome  
Nome, Alaska

PLATE

# B7

DRAWN

JOB NUMBER  
15001,002,08

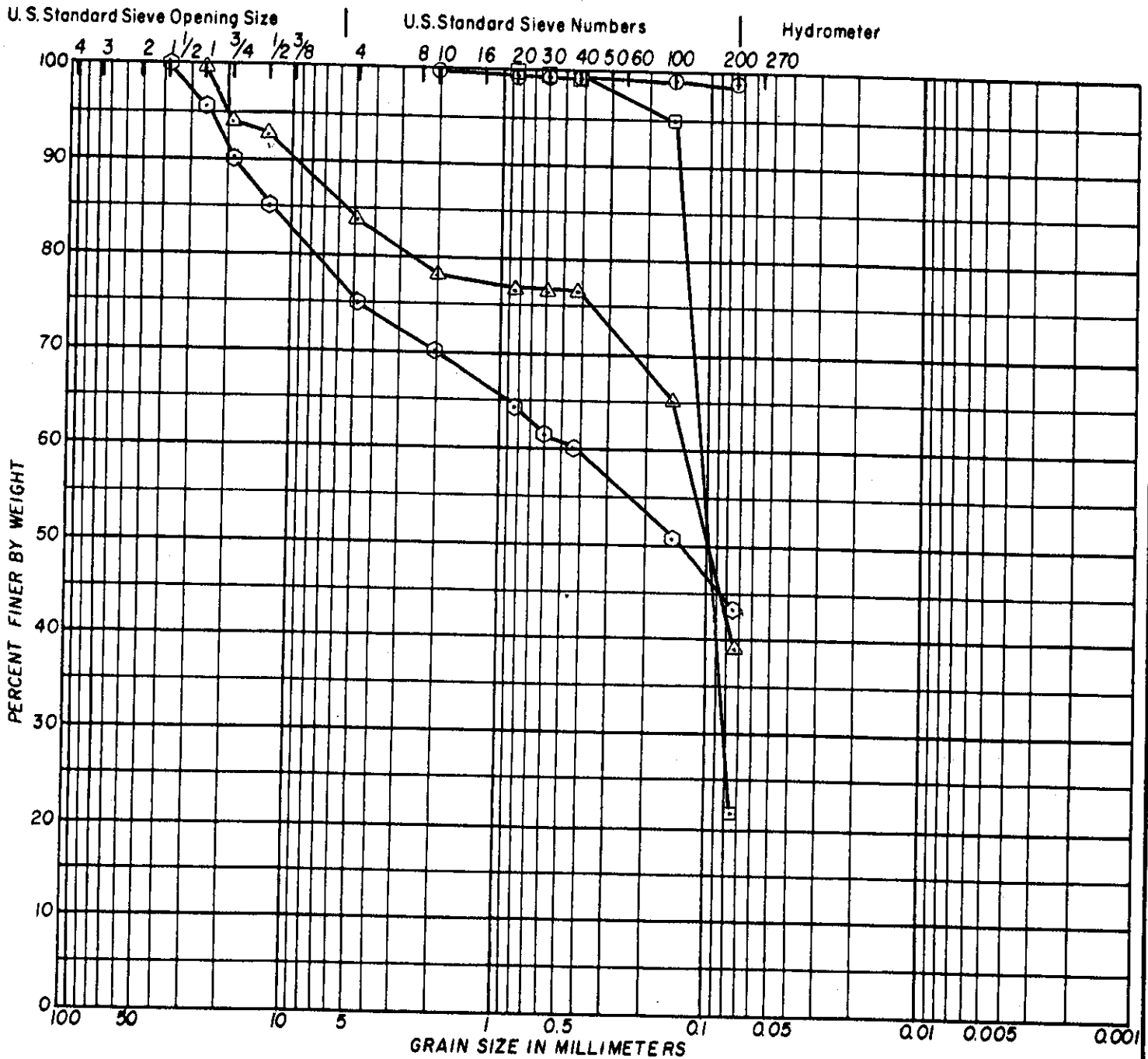
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DATE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	
Symbol	Sample Source					Classification
○	HLO-5 at 12.5'					DARK GRAY FINE SILT (ML)
△	HLO-6 at 4.5'					GRAY GRAVELLY SILTY SAND (SM)
◇	HLO-6 at 10.5'					GRAY GRAVELLY SILTY SAND (SM)
□	HLO-6 at 31.0'					GRAY SILTY SAND (SM)



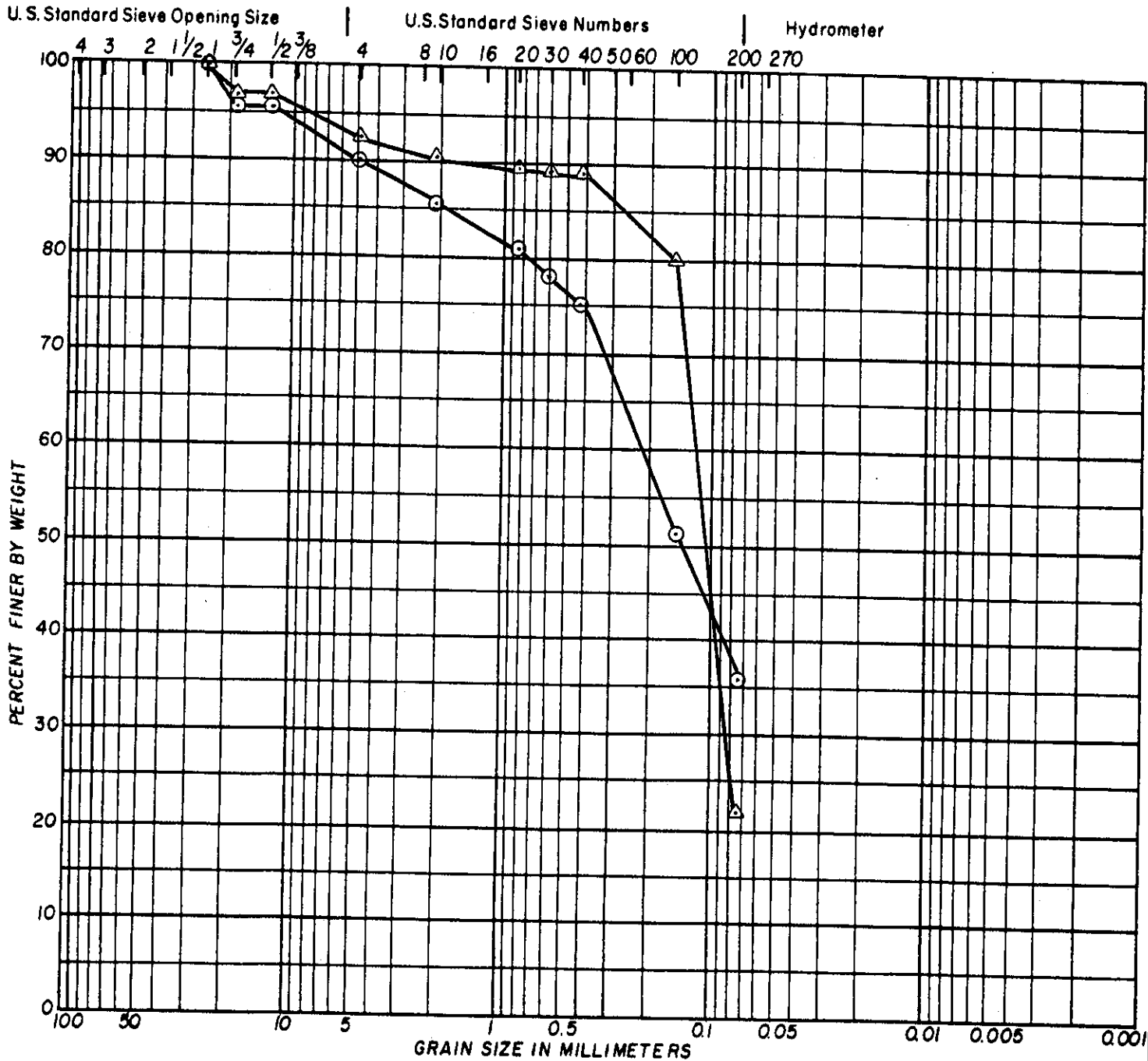
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**Particle Size Analysis**

Port of Nome  
 Nome, Alaska

PLATE  
**B8**





COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	
Symbol	Sample Source					Classification
○	HLO-7 at 3.5'					GRAY GRAVELLY SILTY FINE SAND (SM)
△	HLO-7 at 37.0'					GRAY GRAVELLY SILTY FINE SAND (SM)

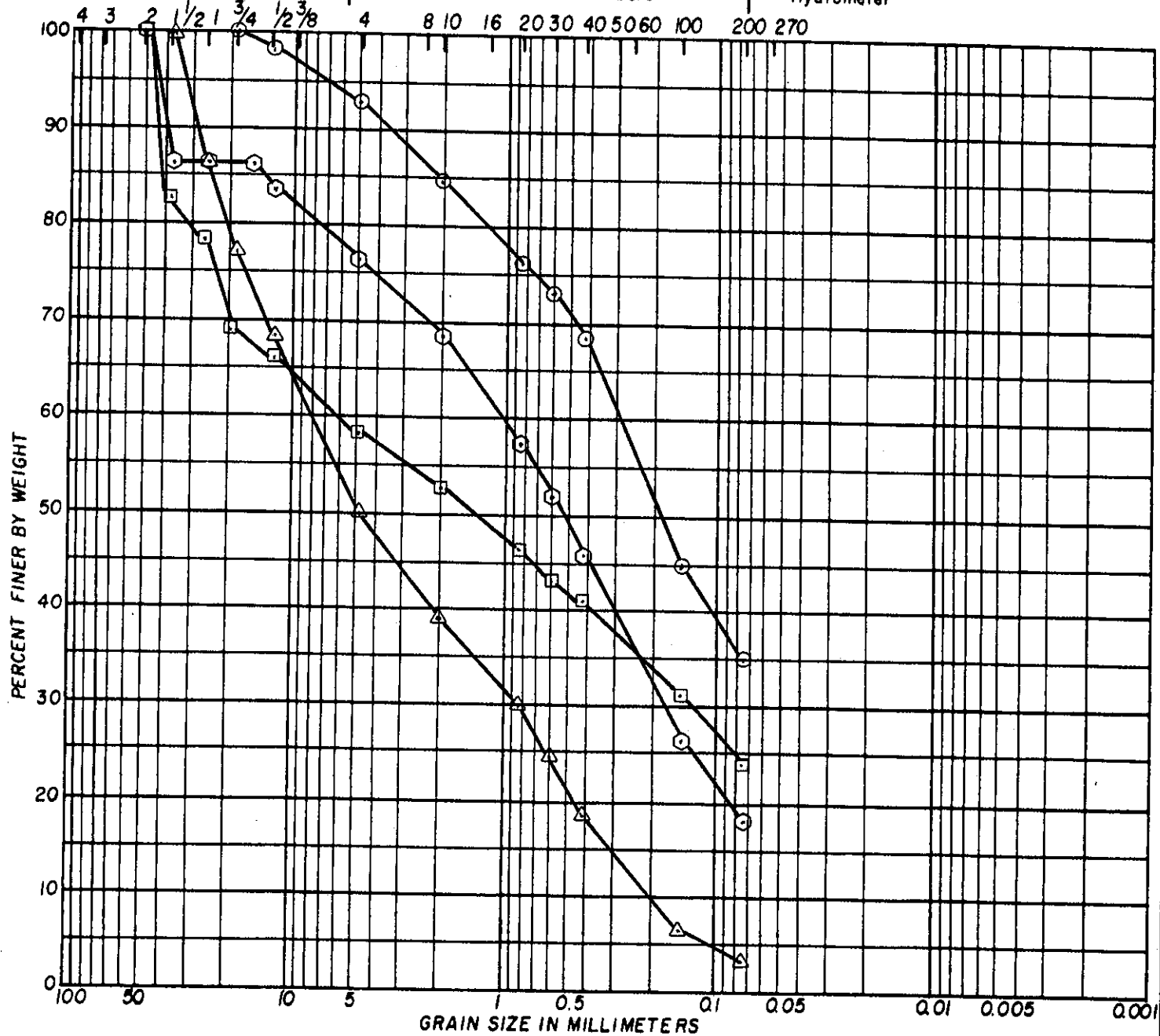


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**Particle Size Analysis**  
Port of Nome  
Nome, Alaska

PLATE  
**B9**

U.S. Standard Sieve Opening Size | U.S. Standard Sieve Numbers | Hydrometer



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	
Symbol	Sample Source					Classification
○	HLB-2 at 20.0'					GRAY GRAVELLY SILTY SAND (SM)
△	HLB-3 at 3.0'					BROWN SANDY GRAVEL (GP)
◇	HLB-3 at 5.5'					BROWN ORGANIC SILTY SAND (SM)
□	HLB-3 at 16.0'					BROWN SILTY GRAVELLY SAND (SM)



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**Particle Size Analysis**

Port of Nome  
Nome, Alaska

PLATE

**B10**

DRAWN

JOB NUMBER  
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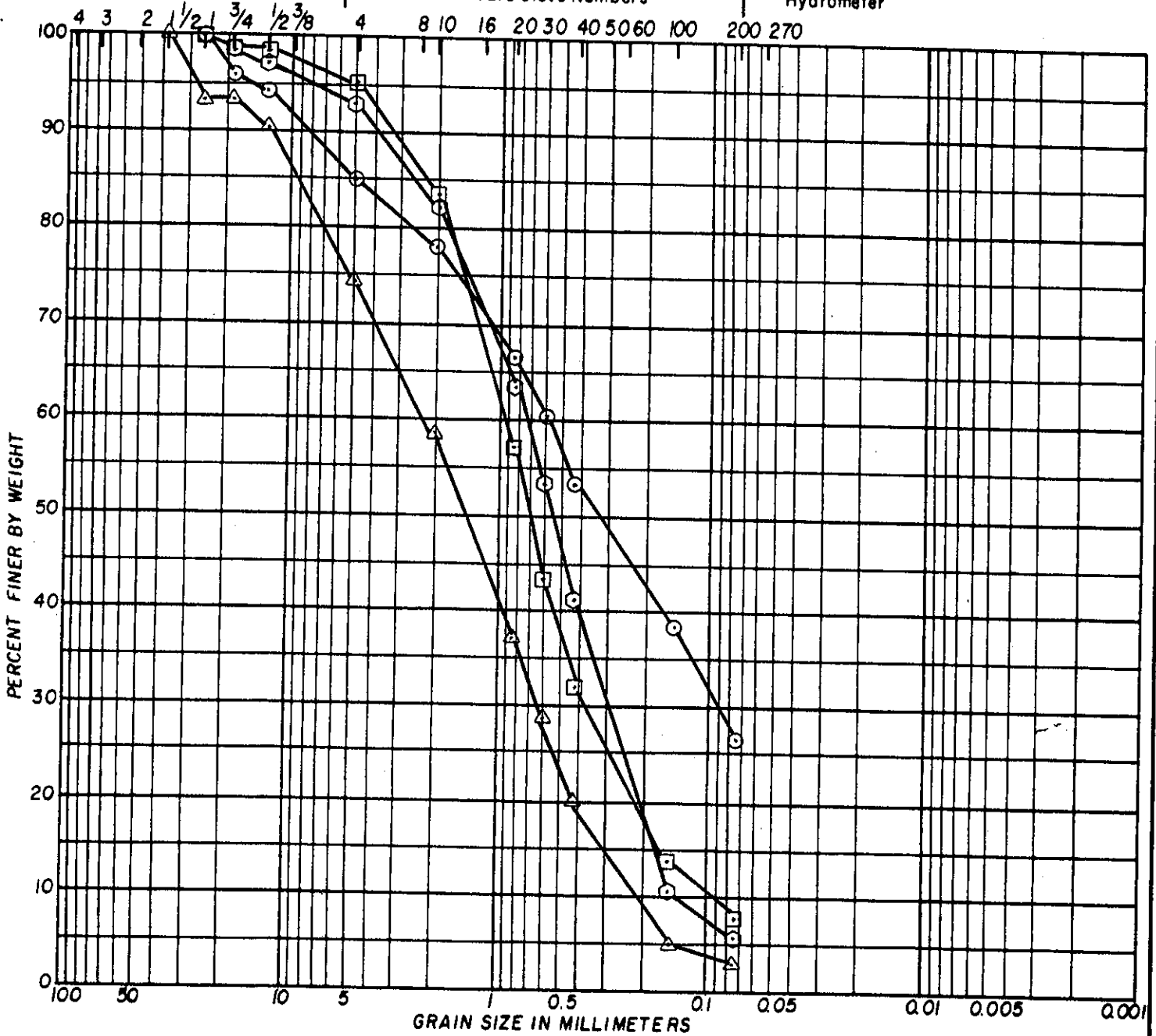
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U.S. Standard Sieve Opening Size

U.S. Standard Sieve Numbers

Hydrometer



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
○	HLB-3 at 16.5'	BROWN GRAVELLY SILTY SAND (SM)
△	HLB-4 at 5.0'	BROWN GRAVELLY SAND (SP)
◇	HLB-4 at 15.0'	GRAY GRAVELLY SAND (SP-SM)
□	HLB-4 at 40.0'	GRAY SAND (SP-SM)



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**Particle Size Analysis**

Port of Nome  
Nome, Alaska

PLATE

**B11**

DRAWN

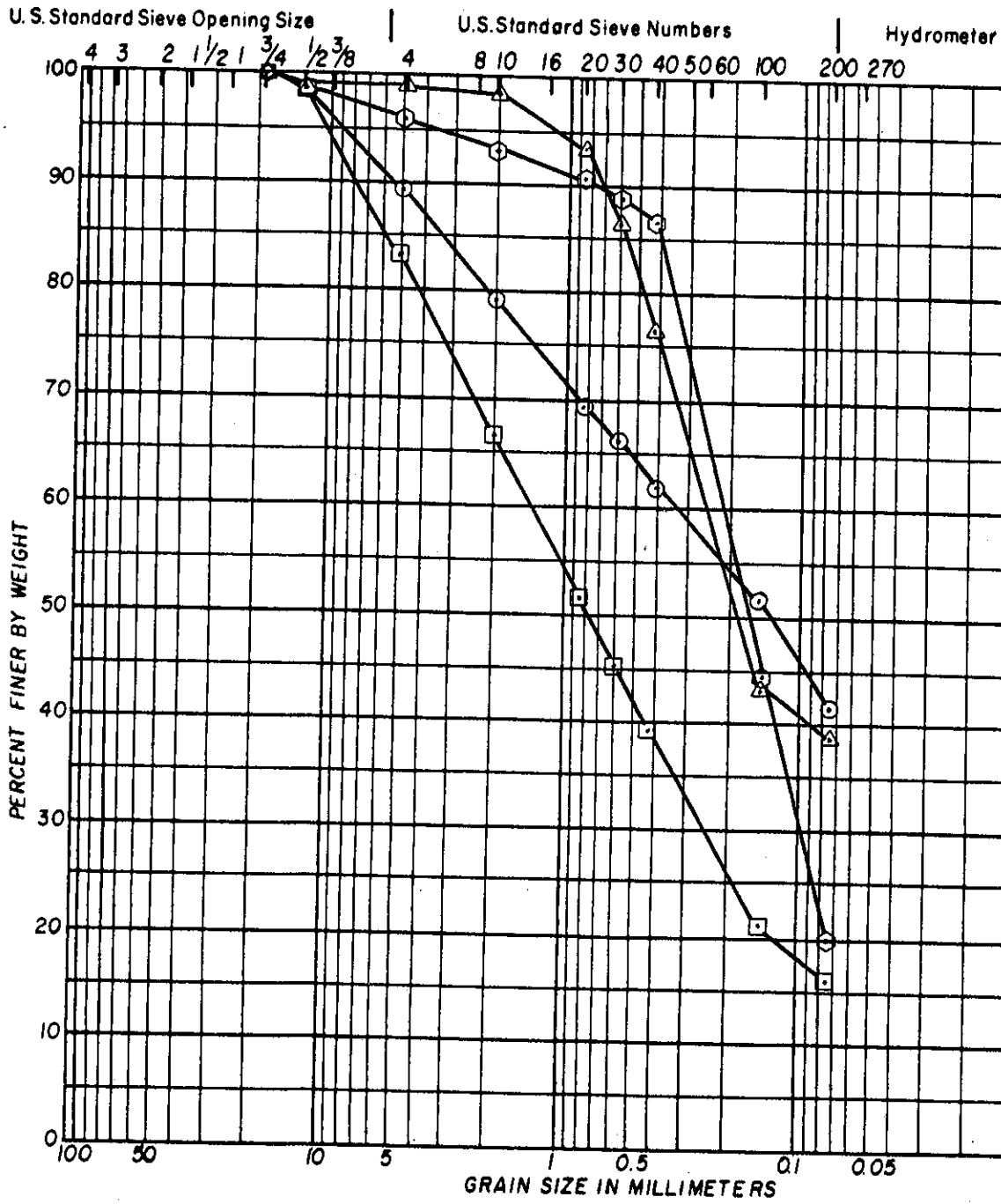
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3/82

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DATE



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	HLB-6 at 20.0'	DARK GRAY SILTY SAND (SM)
△	HLB-7 at 5.0'	BROWN-GRAY SILTY SAND (SM)
⊖	HLB-7 at 20.0'	BROWN-GRAY SILTY SAND (SM)
□	HLB-9 at 10.0'	BROWN SILTY GRAVELLY SAND (SM)



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**Particle Size Analysis**

Port of Nome  
 Nome, Alaska

PLATE

**B12**

DRAWN

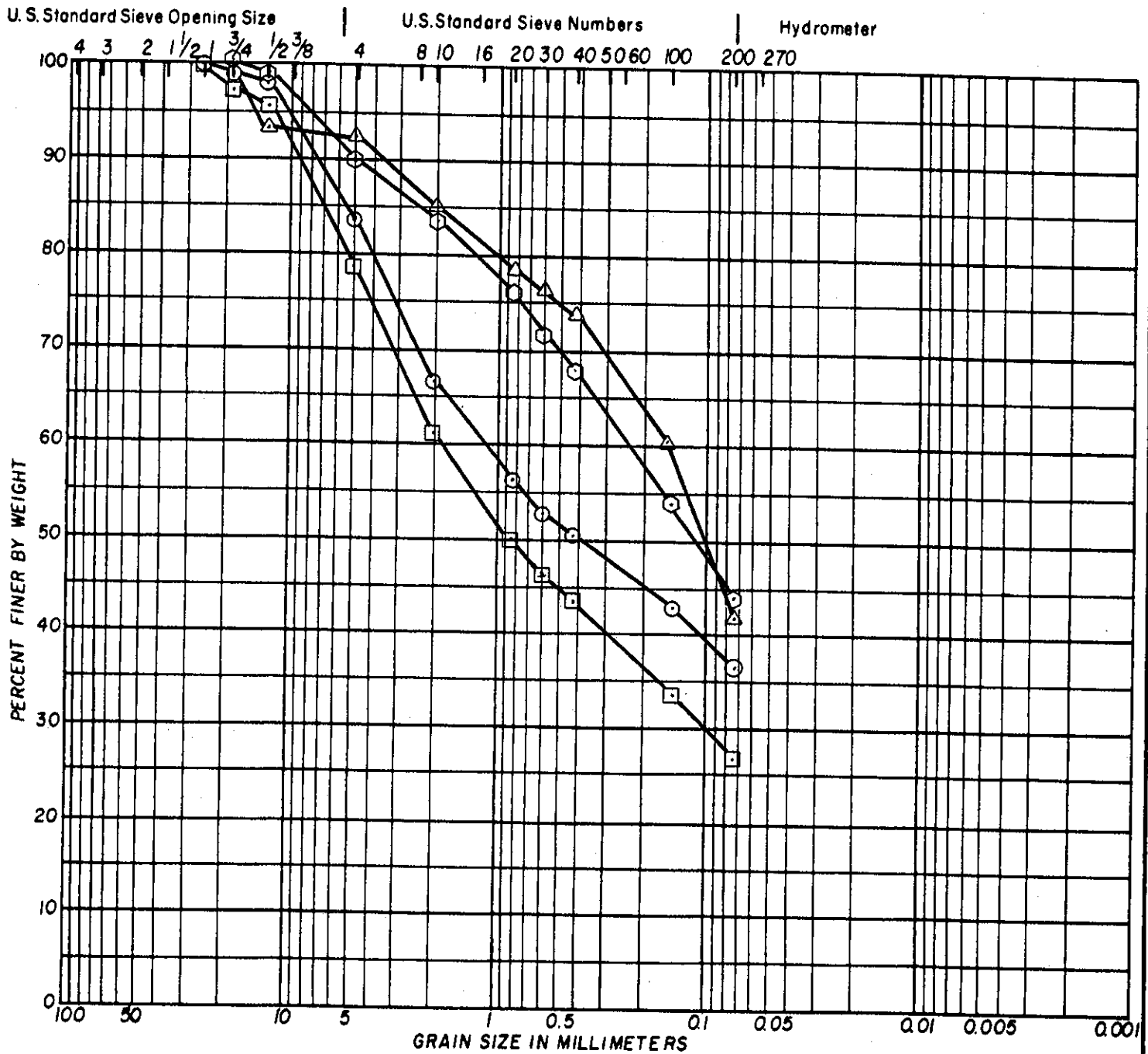
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COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	HLB-9 at 20.0'	BROWN GRAVELLY SILTY SAND (SM)
△	HLB-9 at 25.0'	BROWN SILTY SAND (SM)
⊕	HLB-10 at 43.0'	BROWN GRAVELLY SILTY SAND (SM)
□	HLB-13 at 20.0'	BROWN/GRAY GRAVELLY SILTY SAND (SM)



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**Particle Size Analysis**  
Port of Nome  
Nome, Alaska

PLATE

**B13**

DRAWN

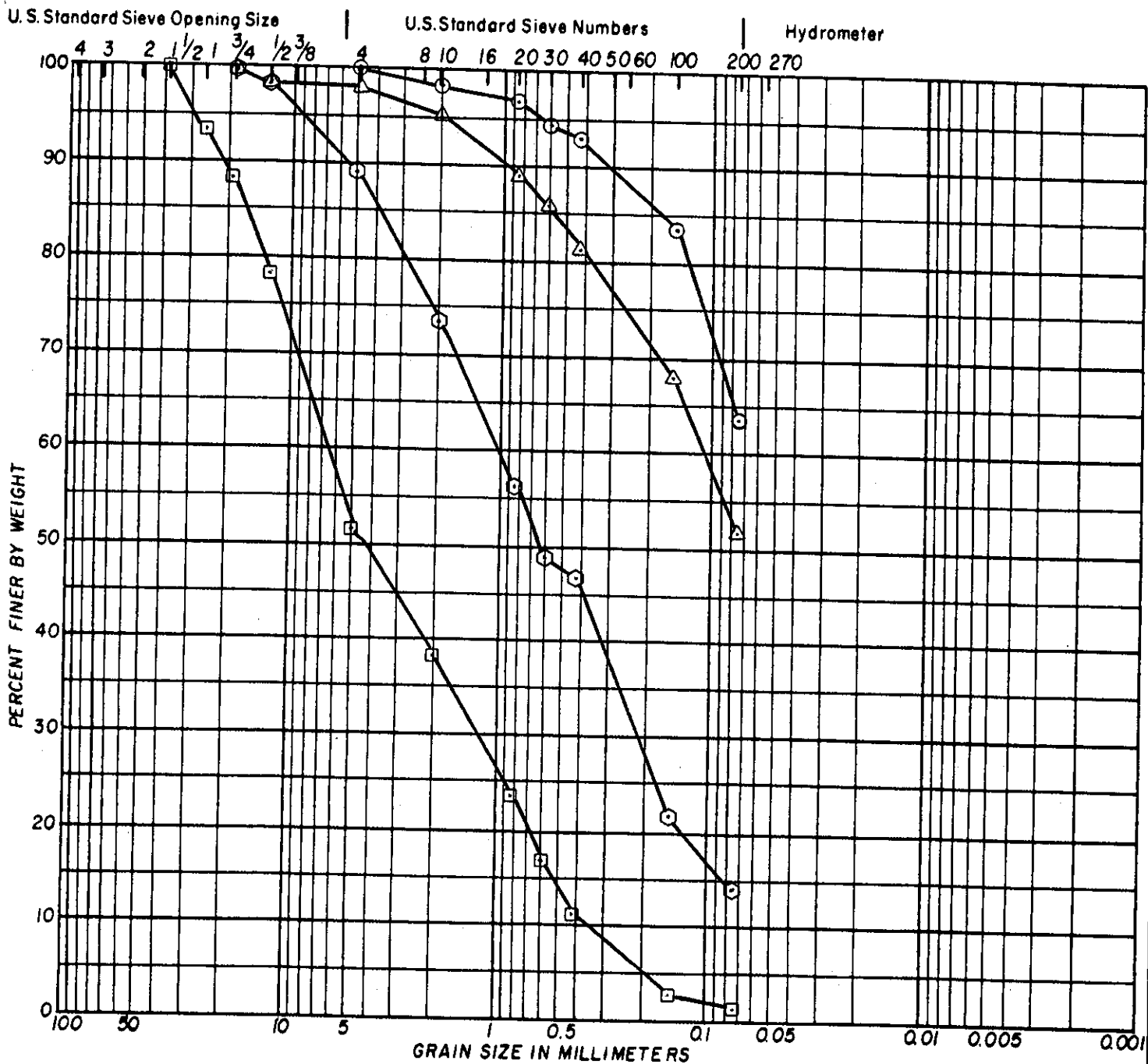
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COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
○	HLS-1 at 1.0'	BROWN SANDY SILT (ML)
△	HLS-1 at 11.5'	BROWN SANDY SILT (ML)
◇	HLS-2 at 6.7'	BLACK GRAVELLY SILTY SAND (SM)
□	HLS-2 at 17.5'	BROWN GRAVELLY SAND (SP)



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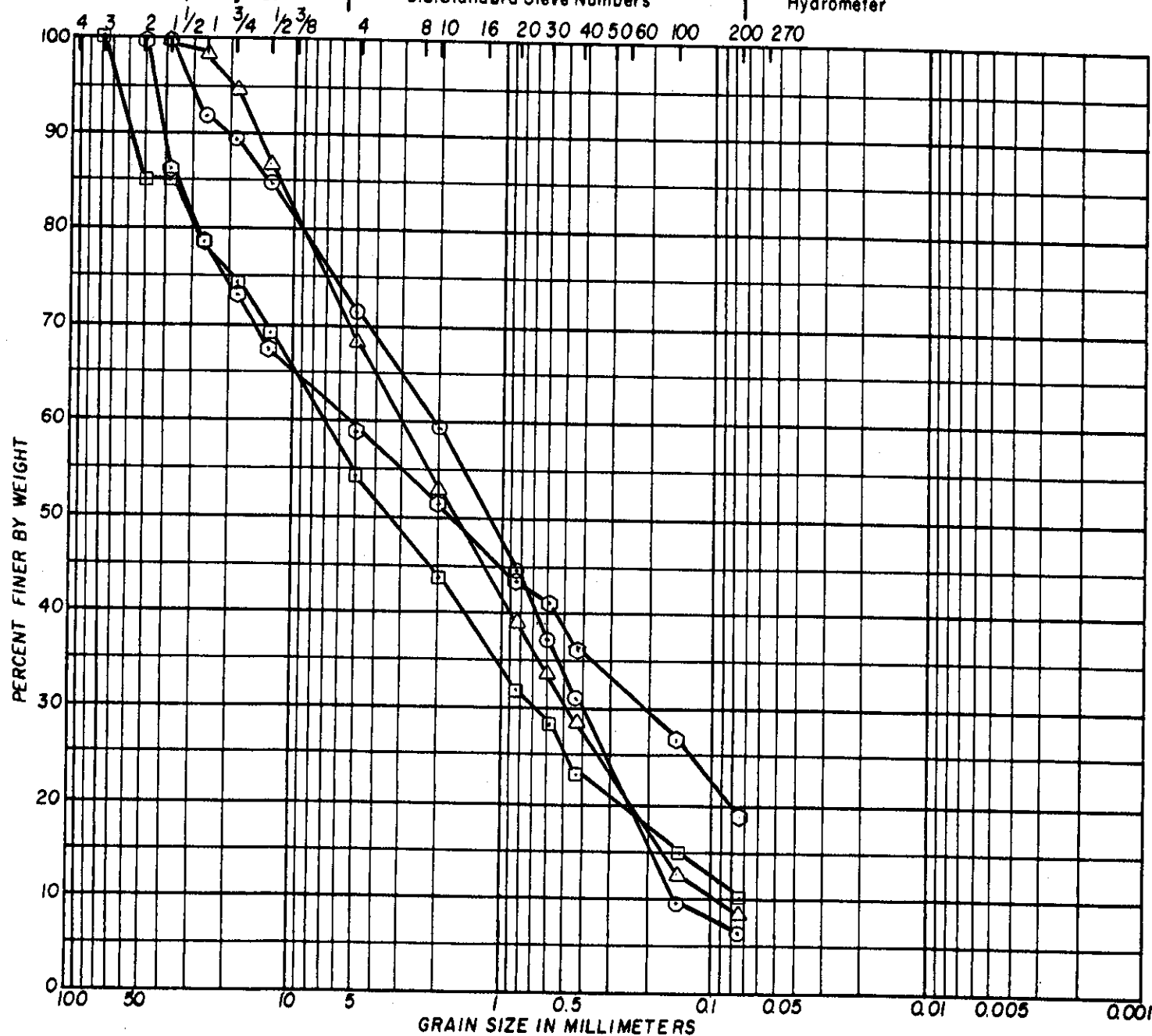
**Particle Size Analysis**  
 Port of Nome  
 Nome, Alaska

PLATE  
**B14**

U.S. Standard Sieve Opening Size

U.S. Standard Sieve Numbers

Hydrometer



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
○	HLS-3 at 5.8'	BROWN SILTY GRAVELLY SAND (SP-SM)
△	HLS-3 at 8.5'	DARK BROWN SILTY GRAVELLY SAND (SP-SM)
◇	HLS-3 at 15.0'	BROWN SILTY GRAVELLY SAND (SM)
□	HLS-3 at 18.0'	BROWN SILTY GRAVELLY SAND (SP-SM)



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**Particle Size Analysis**

Port of Nome  
Nome, Alaska

PLATE

**B15**

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JOB NUMBER  
15001,002.08

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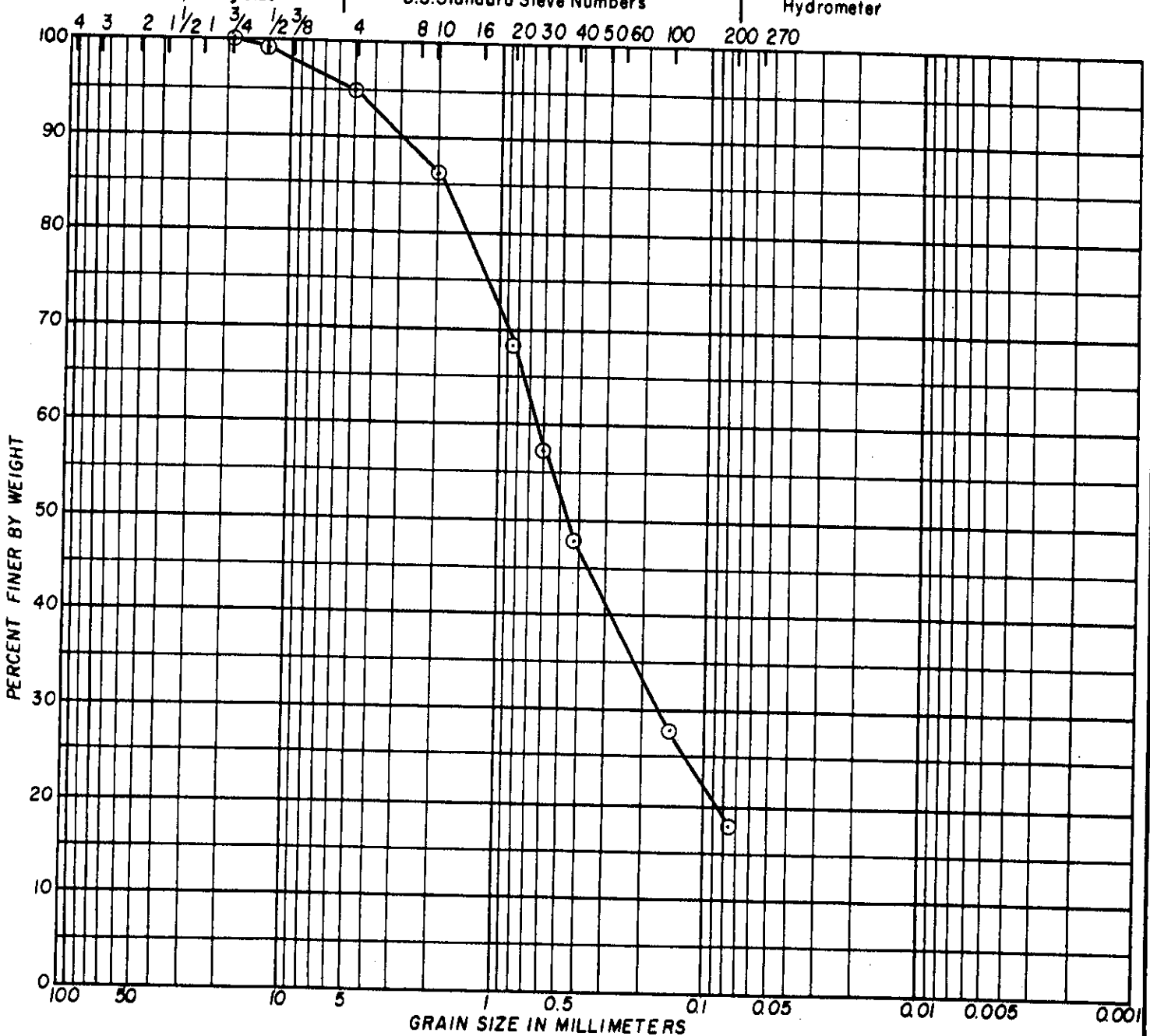
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U.S. Standard Sieve Opening Size

U.S. Standard Sieve Numbers

Hydrometer



COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	HLS-4 at 7.2'	BLACK ORGANIC SILTY SAND (SM)



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**Particle Size Analysis**  
Port of Nome  
Nome, Alaska

PLATE

**B16**

DRAWN

JOB NUMBER  
15001,002.08

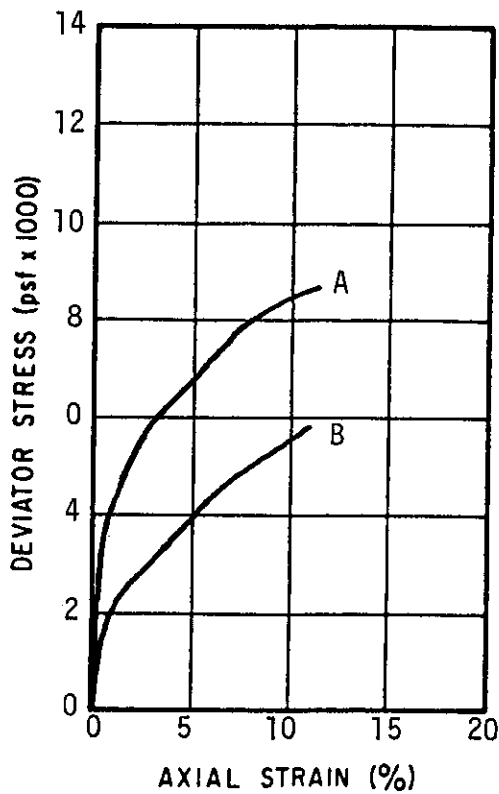
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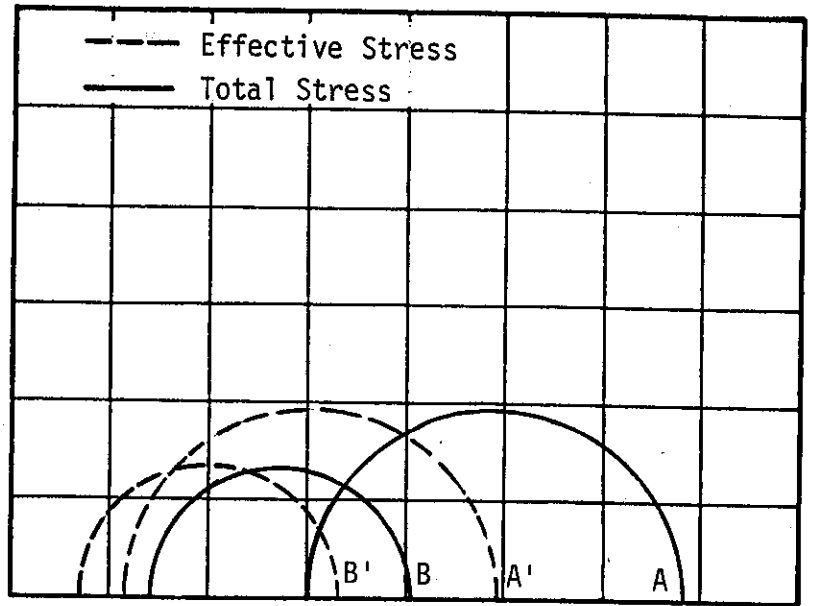
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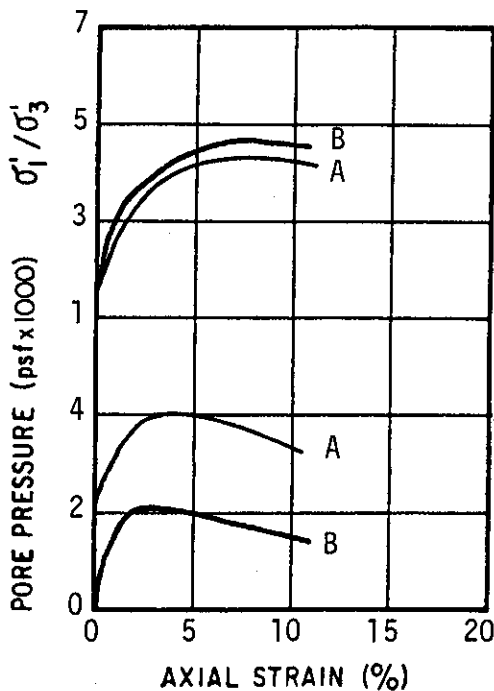


SHEAR STRESS (psf x 1000)



NORMAL STRESS (psf x 1000)

Test Type: Consolidated Undrained    Controlled: Strain  
 Saturation Method: Back Pressure     $G_s$  2.66



Test No.	A	B	C	
Initial	Diameter (in.)	2.43	2.43	
	Height (in.)	5.10	5.20	
	Moisture Content	35.2 %	36.2 %	%
	Void Ratio	0.949	0.956	
	Saturation	98.8 %	100 %	%
Before Test	Dry Density (pcf)	85	85	
	Moisture Content	31.9 %	31.4 %	%
	Void Ratio	0.840	0.827	
Final	Saturation	100 %	100 %	%
	Pressure (psf)	6010	3000	
	Moisture Content	31.9 %	31.4 %	%
	Void Ratio	0.840	0.827	
$\sigma_1$ Major Prin. Stress (psf)	13650	8280		
$\sigma_3$ Minor Prin. Stress (psf)	6010	3020		
Time to Failure (min.)	63	83		
Sample Source: Boring HLO-2 at 11.2' (A) & 8.5' (B)				
Classification: GRAY SILTY MICACEOUS SAND (SM)				



**Harding Lawson Associates**  
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**Triaxial Compression**  
**Test Report**  
 Port of Nome  
 Nome, Alaska

PLATE

**B17**

DRAWN

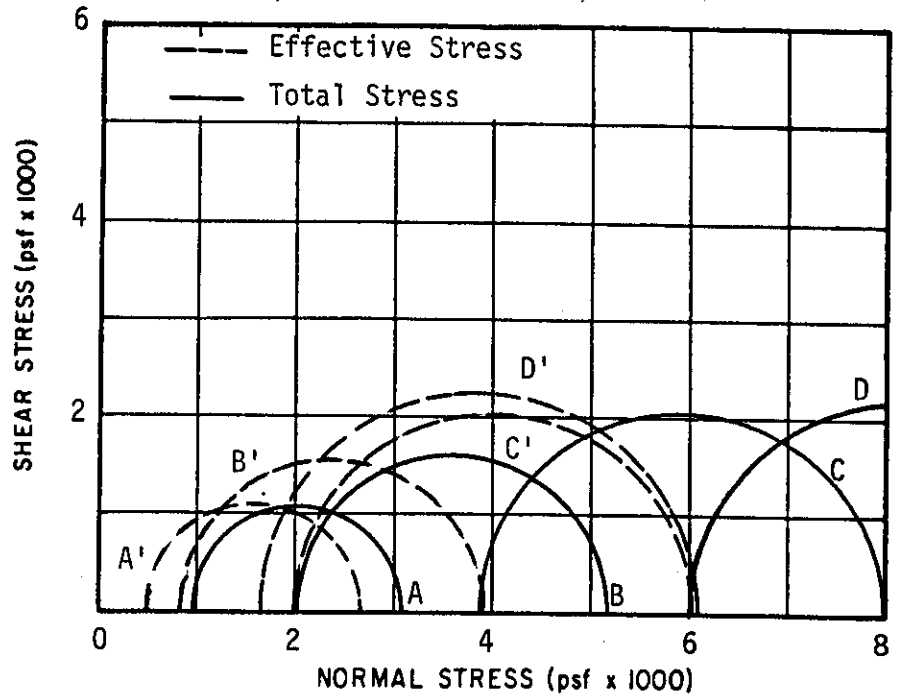
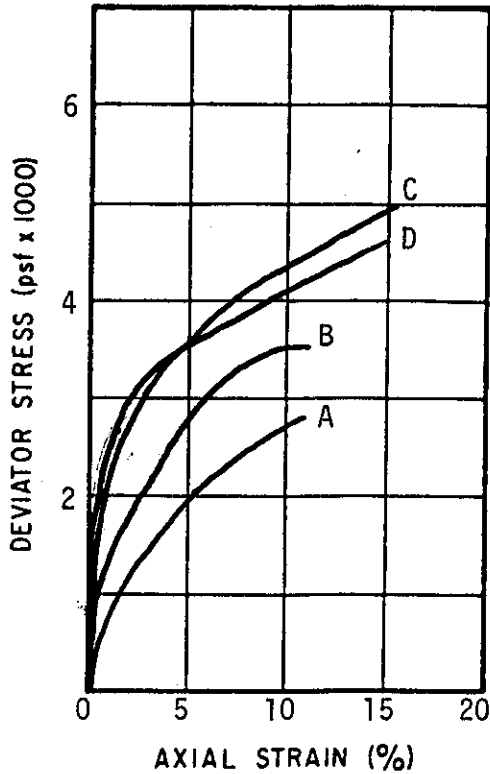
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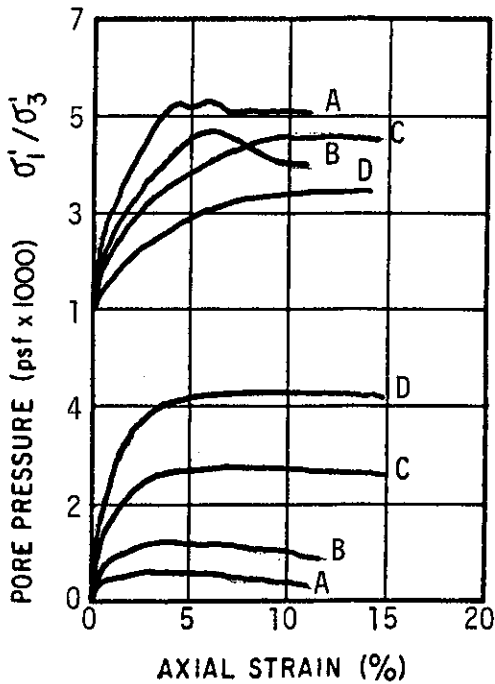
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Test Type: Consolidated Undrained Controlled: Strain  
 Saturation Method: Back Pressure  $G_s$  2.64 Average



Test No.		A	B	C
Initial	Diameter (in.)	2.43	2.43	2.43
	Height (in.)	5.85	6.00	5.65
	Moisture Content	39.6 %	37.6 %	41.4 %
	Void Ratio	1.081	1.132	1.078
	Saturation	98 %	89 %	100 %
	Dry Density (pcf)	80	79	73
Before Test	Moisture Content	39.1 %	37.8 %	36.6 %
	Void Ratio	1.047	1.016	0.948
	Saturation	100 %	100 %	100 %
Final	Pressure (psf)	1010	2050	4000
	Moisture Content	39.1 %	37.8 %	36.6 %
Final	Void Ratio	1.047	1.016	0.948
	$\sigma_1$ Major Prin. Stress (psf)	3170	5170	8140
	$\sigma_3$ Minor Prin. Stress (psf)	1010	2045	3960
	Time to Failure (min.)	60	59	85
Sample Source: Boring HL0-1 at 9.5' (A), 2.8' (B), 10.5' (C).				
Classification: GRAY MICACEOUS SANDY SILT (ML)				



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**Triaxial Compression  
 Test Report**  
 Port of Nome  
 Nome, Alaska

PLATE

**B18**

DRAWN

JOB NUMBER

15001,002.08

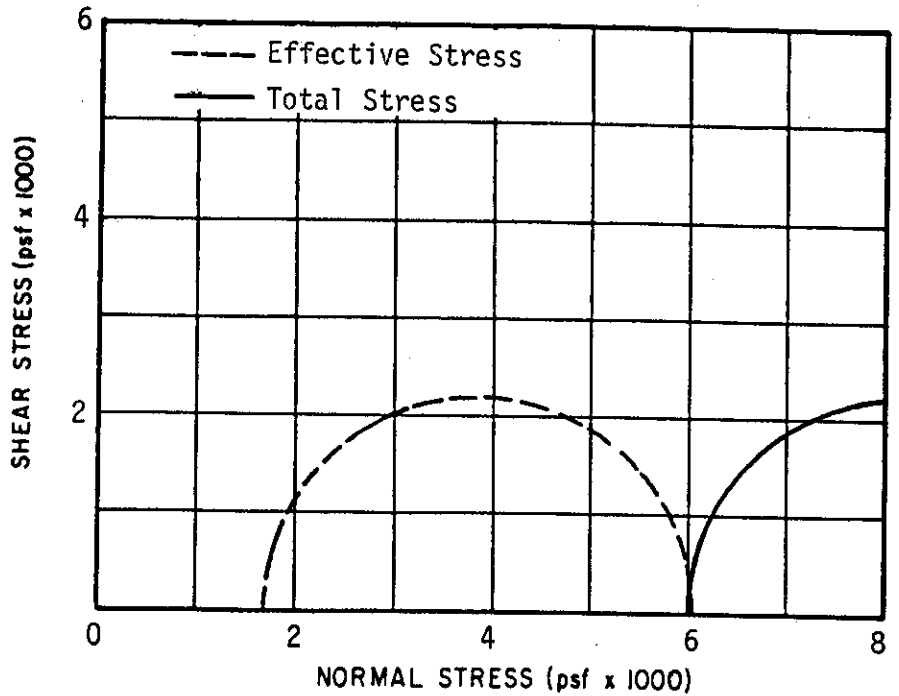
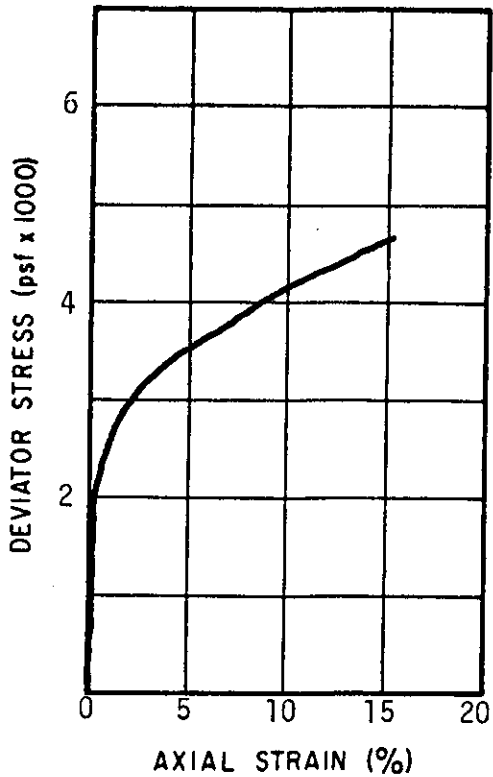
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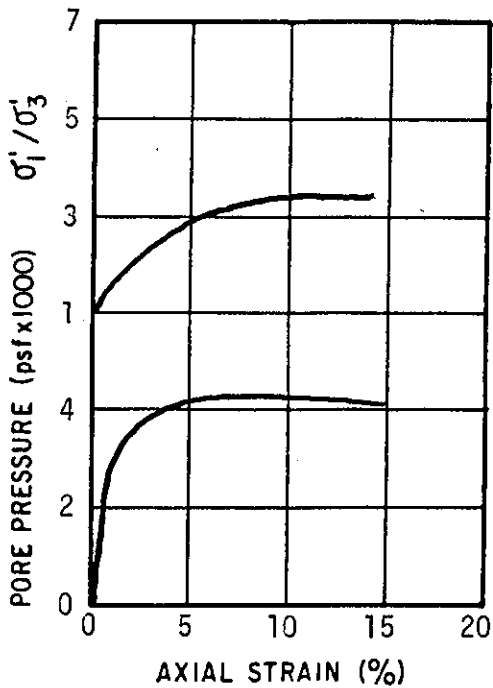
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DATE



Test Type: Consolidated Undrained Controlled: Strain  
 Saturation Method: Back Pressure  $G_s$  2.64 Average



$\sigma'_1 / \sigma'_3$

$\phi =$   
 $c =$

Test No:		D	E	F
Initial	Diameter (in.)	2.43		
	Height (in.)	6.00		
	Moisture Content	41.0 %	%	%
	Void Ratio	1.043		
	Saturation	100 %	%	%
Before Test	Dry Density (pcf)	79		
	Moisture Content	33.8 %	%	%
	Void Ratio	0.866		
	Saturation	100 %	%	%
Final	Pressure (psf)	6000		
	Moisture Content	33.8 %	%	%
	Void Ratio	0.866		
	$\sigma_1$ Major Prin. Stress (psf)	10290		
	$\sigma_3$ Minor Prin. Stress (psf)	5950		
	Time to Failure (min.)	105		
Sample Source: Boring HLO-1 at 10.0' (D)				
Classification: GRAY MICACEOUS SANDY SILT (ML)				



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**Triaxial Compression**  
**Test Report**  
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**B19**

DRAWN

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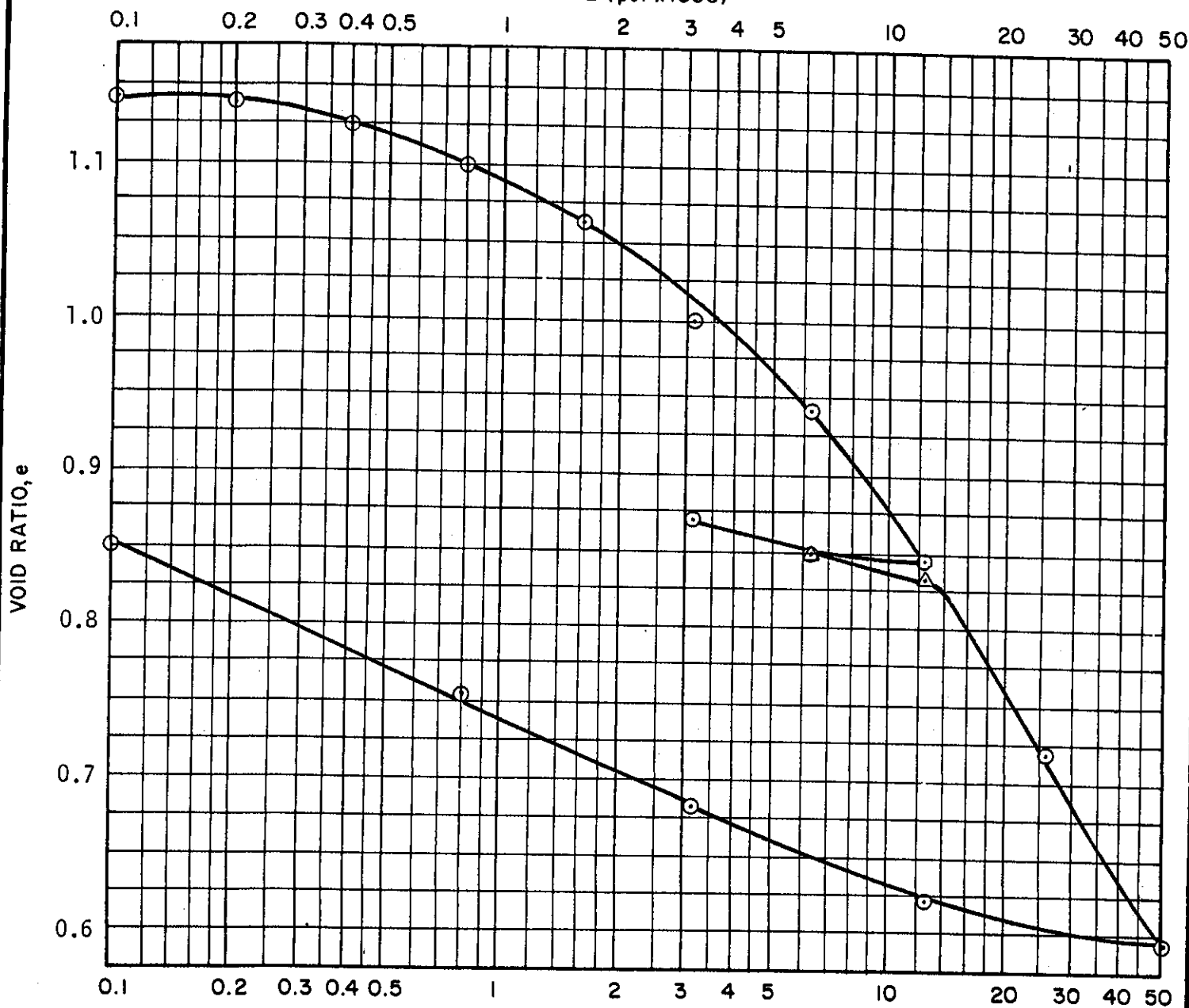
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PRESSURE (psf x 1000)



TYPE OF SPECIMEN		Undisturbed		BEFORE TEST			AFTER TEST	
DIAMETER (in.)	2.43	HEIGHT (in.)	0.80	MOISTURE CONTENT	$w_o$	44.0 %	$w_f$	34.8 %
OVERBURDEN PRESS., $P_o$	90	psf		VOID RATIO	$e_o$	1.152	$e_f$	0.853
PRECONSOL. PRESS., $P_c$	-	psf		SATURATION	$S_o$	96 %	$S_f$	100 %
COMPRESSION INDEX, $C_c$	0.42			DRY DENSITY	$\gamma_d$	73 pcf	$\gamma_d$	85 pcf
LL	NP	PL	NP	PI	NP	$G_s$	2.52	
CLASSIFICATION	GRAY BLACK SANDY SILT (ML)			SOURCE	Boring HLO-1 at 2.5'			



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**Consolidation Test Report**

Port of Nome  
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**B20**

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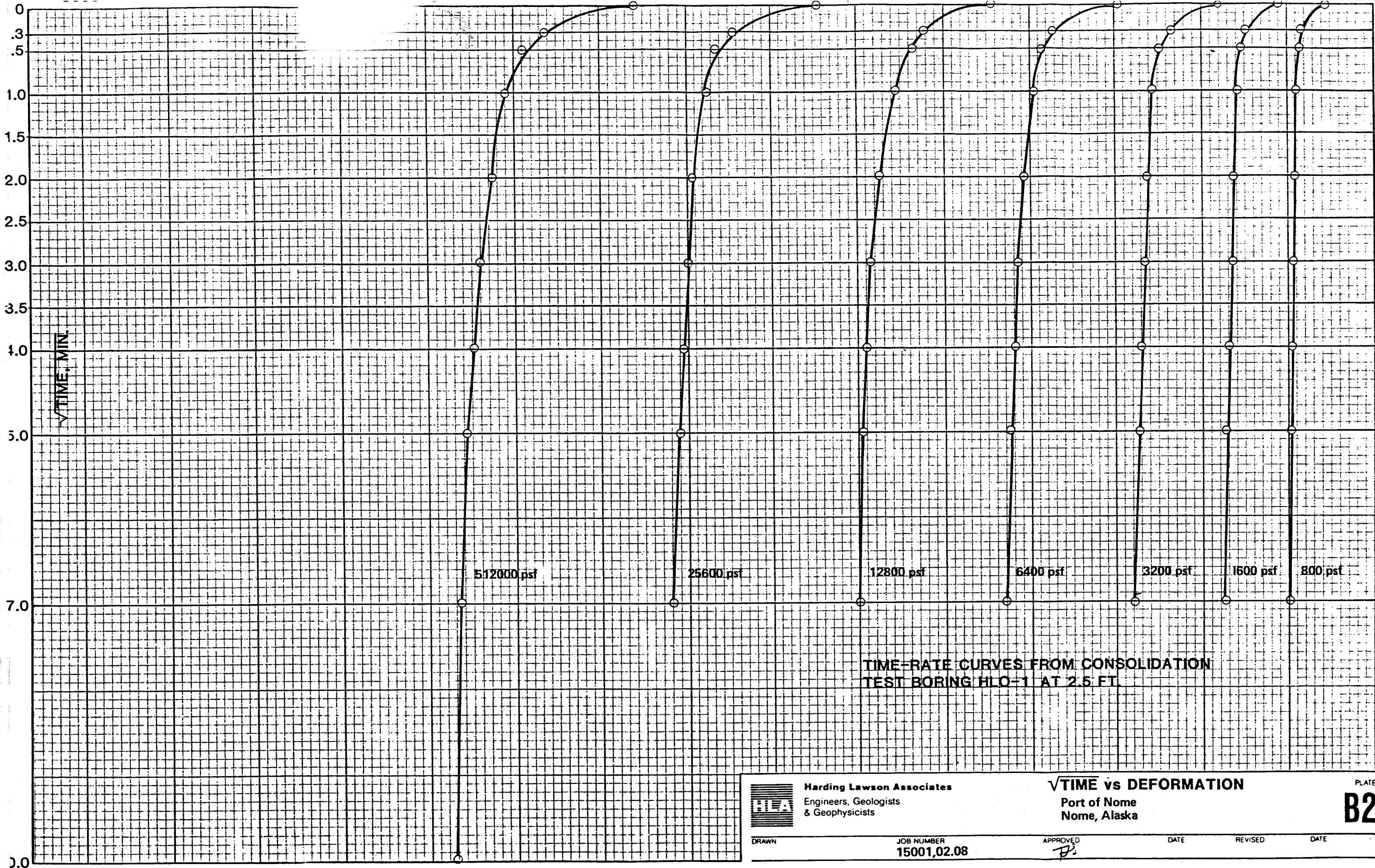
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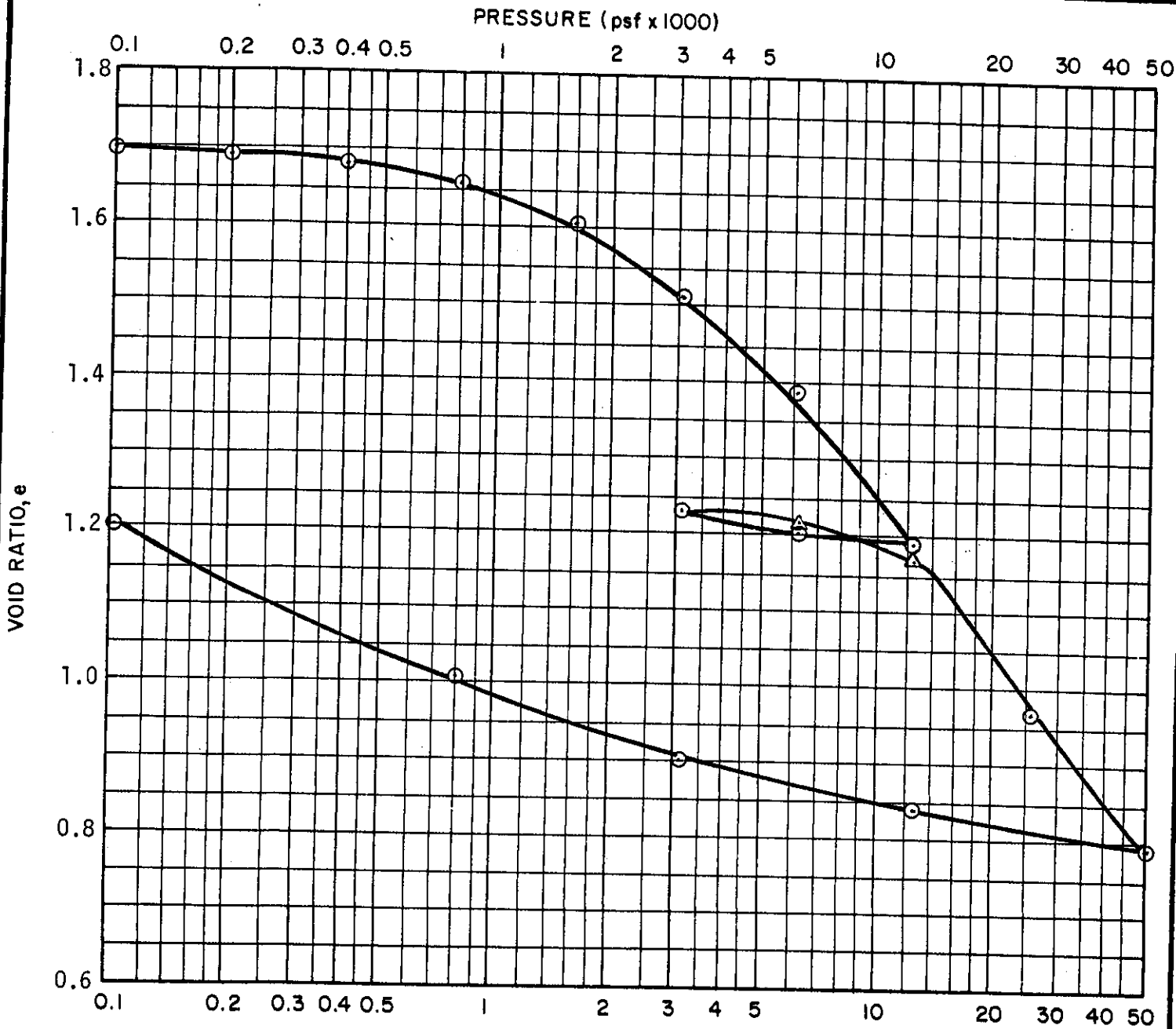


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**B21**

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TYPE OF SPECIMEN		Undisturbed		BEFORE TEST			AFTER TEST	
DIAMETER (in.)	2.43	HEIGHT (in.)	0.80	MOISTURE CONTENT	$w_0$	65.4 %	$w_f$	49.1 %
OVERBURDEN PRESS., $P_0$	400	psf		VOID RATIO	$e_0$	1.706	$e_f$	1.202
PRECONSOL. PRESS., $P_c$	-	psf		SATURATION	$S_0$	95 %	$S_f$	100 %
COMPRESSION INDEX, $C_c$	0.08			DRY DENSITY	$\gamma_d$	57 pcf	$\gamma_d$	70 pcf
LL	NP	PL	NP	PI	NP	$G_s$	2.47	
CLASSIFICATION				GRAY SANDY SILT (ML)		SOURCE Boring HLO-1 at 11.2'		



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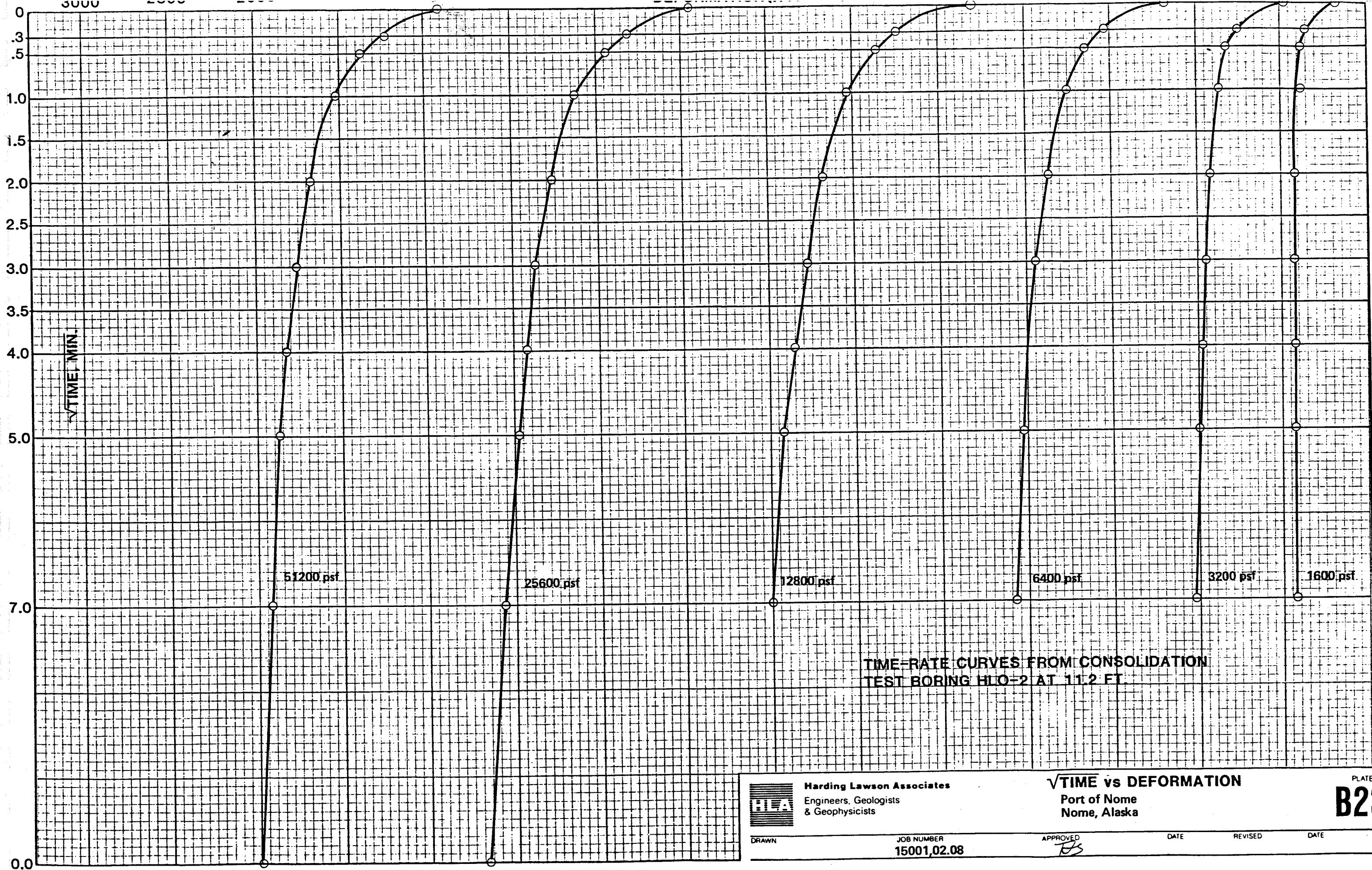
**Consolidation Test Report**

Port of Nome  
 Nome, Alaska

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**B22**



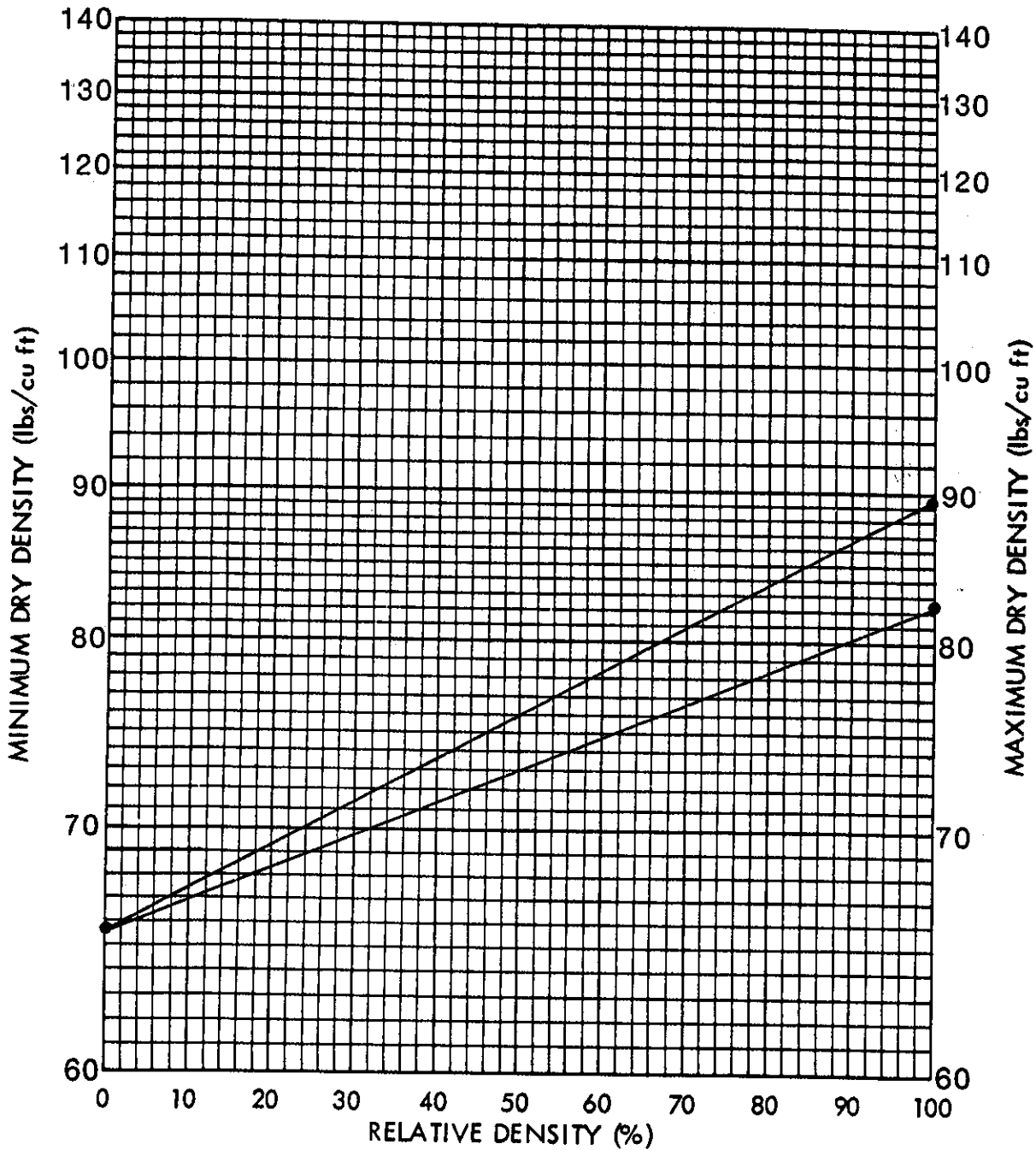


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**B23**

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	15001,02.08	<i>ES</i>			



Symbol	Sample Source	Classification	Dry Density (pcf)		
			Minimum	Max. Wet	Max. Dry
	HLO-1 Combined Samples: 1.5 - 3.5' 9.0 - 11.5' 12.0 - 14.0'	GRAY GRAVELLY SILTY SAND (SM)	65.7	82.4	89.5



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**Relative Density Test Data**  
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**B24**

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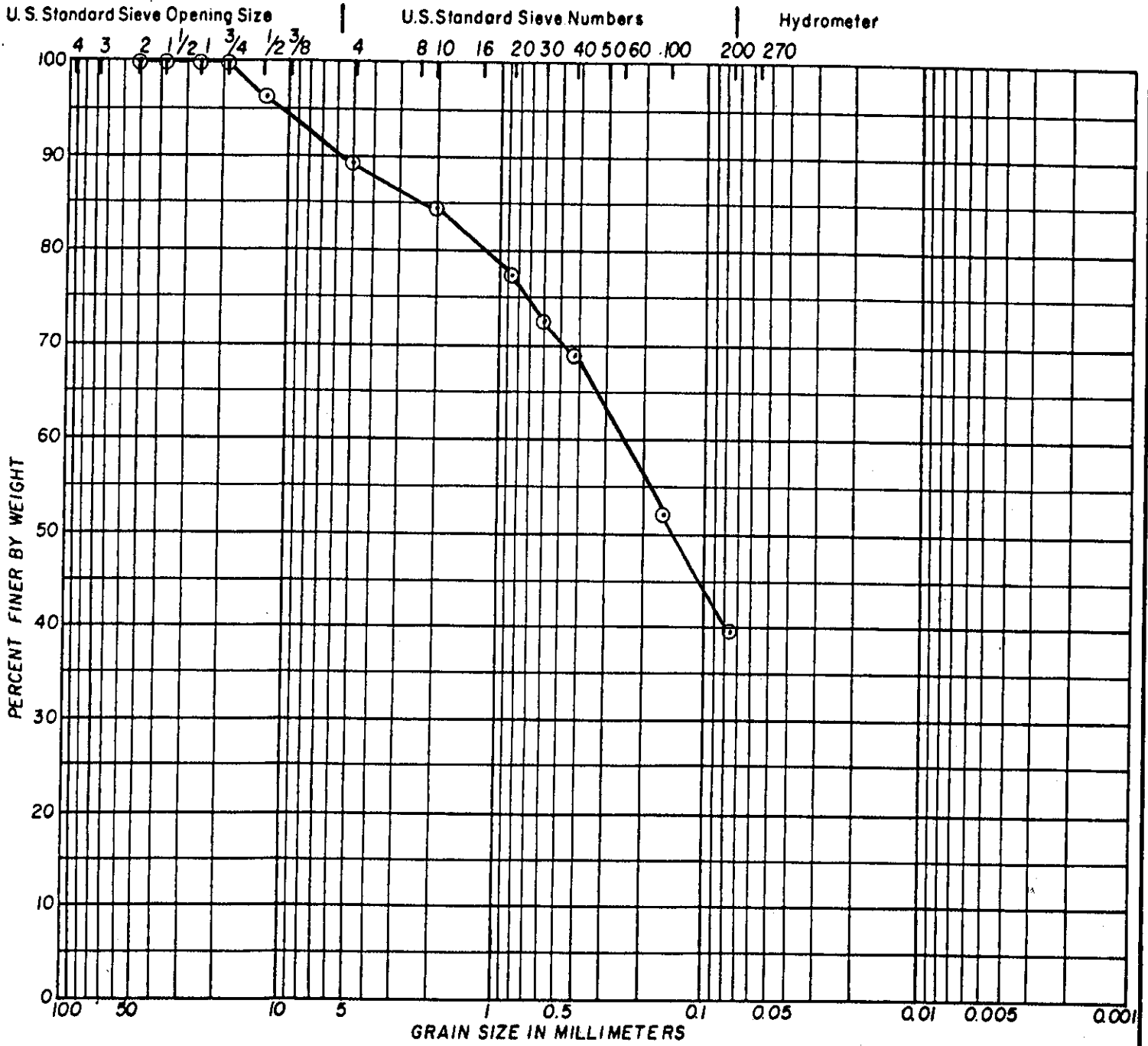
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COBBLES	GRAVEL		SAND			SILT OR CLAY
	COARSE	FINE	COARSE	MEDIUM	FINE	

Symbol	Sample Source	Classification
⊙	HLO-1 Combined Samples: 1.5 - 3.5 feet 9.0 - 11.5 feet 12.0 - 14.0 feet	GRAY GRAVELLY SILTY SAND (SM)



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**Particle Size Analysis**

PORT OF NOME  
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**B25**

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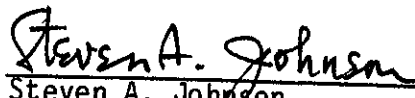
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