DOWL HKM

SUBSURFACE EXPLORATION

NOATAK MATERIAL SITE INVESTIGATION

NOATAK, ALASKA

August 2014

DOWL HKM

August 6, 2014
W.O. 61683.01
Area 8
Report No. 5532

Ms. Jackie Hill
Director, Native Services
Maniilaq Association.
PO Box 256
Kotzebue, AK 99752

Subject: Subsurface Exploration
Noatak Material Site Investigation, Noatak, Alaska

Dear Ms. Hill:

The attached report presents the results of our subsurface exploration for the Noatak Material Site Investigation in Noatak, Alaska. This report includes the logs of 15 test borings drilled during the current exploration, the results of laboratory tests, and interpretations regarding the extent of gravel resources available within the boundaries of the proposed material site.

If you have any questions regarding this report or its use, or if we may provide additional services, please call.

Sincerely,
DOWL HKM

Paul Pribyl
Geologist

Reviewed by:
DOWL HKM

Keri Ann Nutter, CPG
Manager, Geotechnical Engineering

Attachment: As stated

SUBSURFACE EXPLORATION
NOATAK MATERIAL SITE INVESTIGATION
NOATAK, ALASKA

Prepared for:

Maniilaq Association
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Kotzebue, Alaska 99752

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W.O. 61683.01
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1.0 INTRODUCTION

The Native Village of Noatak intends to establish a new gravel resource site on the west bank of the Noatak River. The site location is shown on Figure 1. This report presents the results of our field exploration, laboratory soil testing program, and interpretations of the extent of gravel resources within the boundaries of the proposed material site. This work was performed for Maniilaq Association on behalf of the Native Village of Noatak.

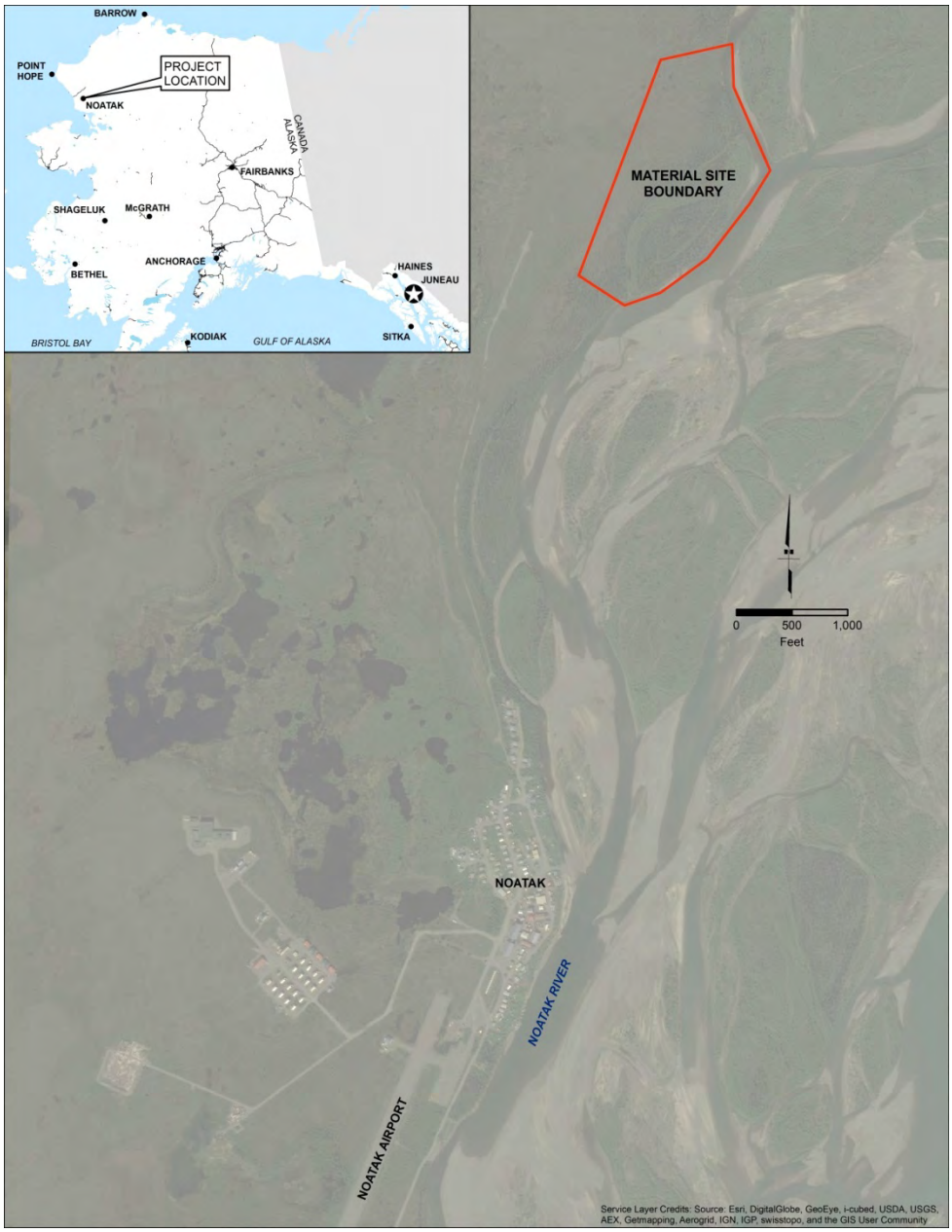


Figure 1: Vicinity Map

1.1 Planned Development

The proposed project includes the development of an open pit gravel quarry in the alluvial and/or glacial till sediments near the westernmost channel of the Noatak River, approximately 0.75 miles north of the Village of Noatak. Material from the proposed site would be used to extend the current cemetery road, road maintenance within the village, and potentially as a material source for the Department of Transportation and Public Facilities (DOT&PF) airport facility and runway.

1.2 Purpose of Exploration

The purpose of this exploration is to determine subsurface soil, permafrost, and groundwater conditions at the site; to perform laboratory soil tests to determine physical properties of the site soils; analyze the findings; and to make geologic interpretations regarding the extent of gravel resources within the boundaries of the proposed material site.

1.3 Scope of Work

DOWL HKM submitted a proposal dated November 12, 2013, to conduct a geotechnical exploration consisting of drilling and sampling test borings, geotechnical laboratory testing, analysis of the findings, and preparation of a report.

In brief, the scope included:

- Drilling and sampling of as many test borings as possible over a five day period to depths of 20 to 30 feet within the proposed material site boundaries;
- Placement of sealed PVC standpipe in select bore holes where ground ice is present to measure subsurface temperatures;
- Placement of slotted PVC standpipe in select test bore holes where groundwater was encountered to measure depth to the top of the water table;
- Performance of various laboratory soils testing;
- Analysis of the geotechnical aspects of the planned development with respect to the site soils and groundwater; and
- Preparation of a report of findings.

Our proposal was accepted and we received Notice-to-Proceed on April 3, 2014.

2.0 PHYSICAL SETTING

Noatak is located on the west bank of the Noatak River approximately 48 air miles north of Kotzebue. The proposed material site is located 0.75 miles to the north of Noatak centered on the coordinates 67.58763° N latitude and 162.95925° W longitude. The site is approximately 1,500 feet east-northeast of the end of the existing cemetery road. Noatak lies near the western boundary of the Noatak National Preserve and is the only village located on the Noatak River.

Bluffs along the Noatak River expose lacustrine and fine-grained deposits laid over glacial till, as well as terraced river gravels and floodplain deposits. These deposits vary in thickness from a few feet to several hundred feet and rest on volcanic and andesitic bedrock. There are generally layers of peat, organic soil, and/or silt overlying the glacial till and alluvial deposits. Noatak lies within an area of continuous permafrost. To the west and to the north of Noatak, the land surface contains many small lakes formed from the uppermost portions of the permafrost thawing and additional water accumulating in the depression.

2.1 Climate

Noatak is located in the transitional climate zone; Kotzebue is the nearest community with historical climate data available. The climatological data presented below for Kotzebue and vicinity was taken from a range of sources including the Department of Commerce, Community, and Economic Development Community Database, and the National Weather Service.

Mean Annual Precipitation	10 in
Mean Annual Snowfall	50 in
Mean Maximum Temperature July	60°F
Mean Maximum Temperature January	5°F
Mean Minimum Temperature July	50°F
Mean Minimum Temperature January	-10°F
Average Summer Temperature Range	45°F – 55°F
Average Winter Temperature Range	5°F – 35°F
Freezing Degree Days (°F-day)	~5,750
Thawing Degree Days (°F-day)	~350
Heating Degree Days (°F-day)	~15,500

The climatological data presented in Table 1 below, from the Alaska Climate Research Center, shows average monthly temperatures and precipitation for Kotzebue and vicinity, for the period between 1981 and 2010.

Table 1: Average Monthly Temperatures and Precipitation

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec
Temperature (°F)	-2.8	-0.8	1.1	13.3	31.9	45.7	54.6	51.7	42.3	24.3	9.1	2.3
Precipitation (in)	0.62	0.66	0.44	0.41	0.41	0.58	1.45	2.18	1.58	1.01	0.77	0.76

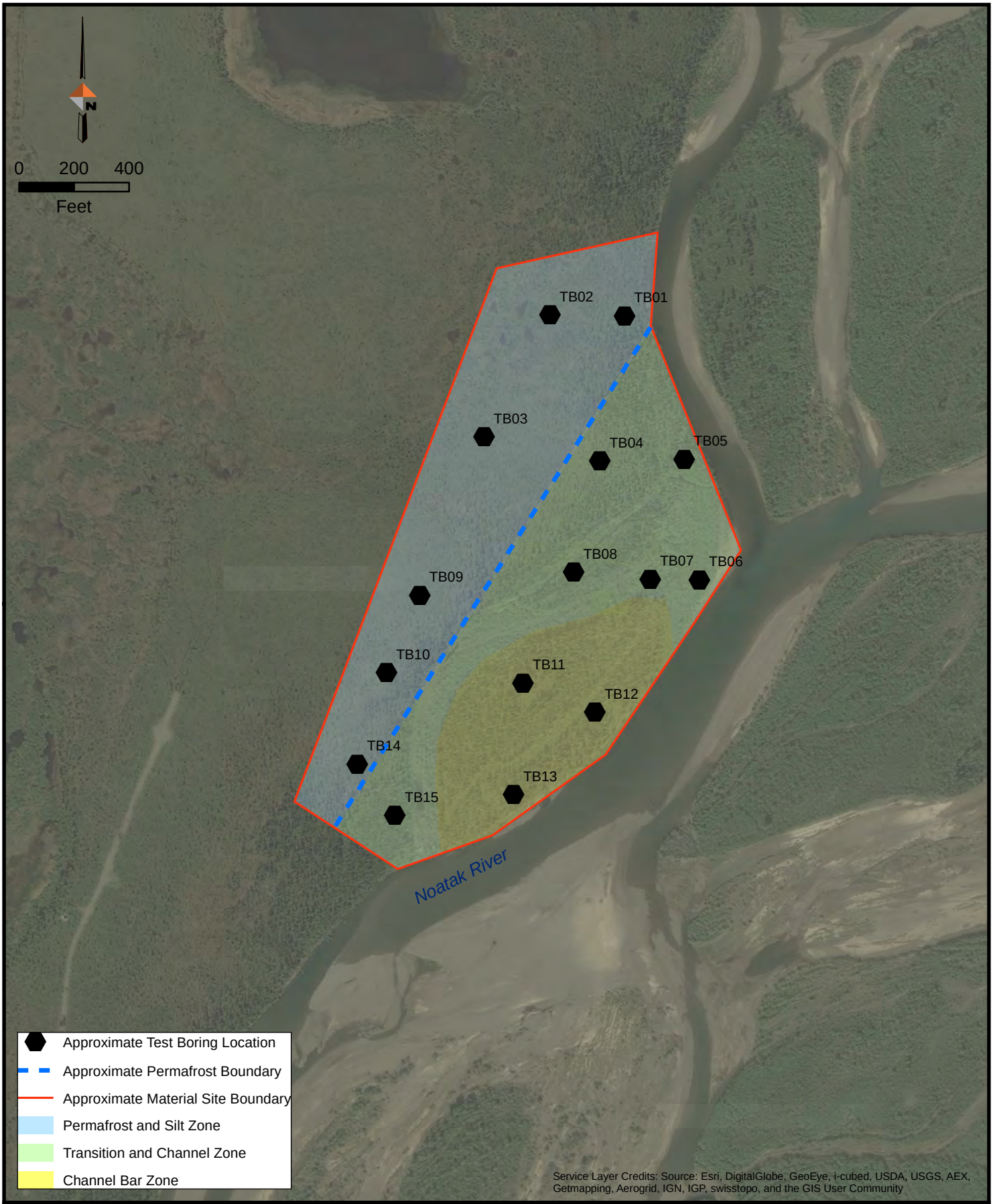
3.0 SITE CONDITIONS

This section reports interpretations and opinions concerning the surface and subsurface soil and groundwater conditions at the site. The site conditions described are valid for the data collected within the scope of work. If additional data becomes available, some or all of the interpretations and opinions expressed herein could change. We should be notified immediately if the conditions found at the site are different from those encountered during this investigation.

The soil descriptions and stratigraphy contained herein and the classifications shown on the test boring logs are the project geologist's *interpretation* of the field logs and the results of the laboratory soil testing. The location of test borings are shown in Appendix A, Test Boring Location Map. Refer to the Test Boring Log - Descriptive Guide in Appendix B immediately following the test boring logs for a more detailed presentation on sample sizes, sample quality, frost classifications, soil types, and the soil classification procedures.

The largest particle size that can be recovered with standard drill hole samplers is often smaller than the maximum particle size in a gravelly soil deposit. Therefore, the soil descriptions and test results for gravelly soils tend to be biased toward the finer particle sizes. The gradation test results are presented in Appendix C, Laboratory Test Results.

The proposed material site can be roughly broken into three distinct geomorphic zones or landforms; each zone has different surface and subsurface attributes. These zones can be divided approximately between the western third, the southeastern area, and the central strip dividing them. Within this report these zones will be referred to as the permafrost and silt zone, the transition and channel zone, and the channel bar zone, respectively. A geomorphic zone map showing the approximate delineation of each area is shown in Figure 2.



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Geomorphic Zone Map

NOATAK MATERIAL SITE INVESTIGATION

Noatak, Alaska

PROJECT	D61683
DATE	Jul 24, 2014

FIGURE 2

3.1 Surface

Characteristics of subsurface deposits are often expressed on the surface through variation in topography, vegetation, and surficial waters. A summary of the surficial characteristics for the three geomorphic zones observed at the site follows. Surface features described below are shown in Figure 3.

3.1.1 Permafrost and Silt Zone

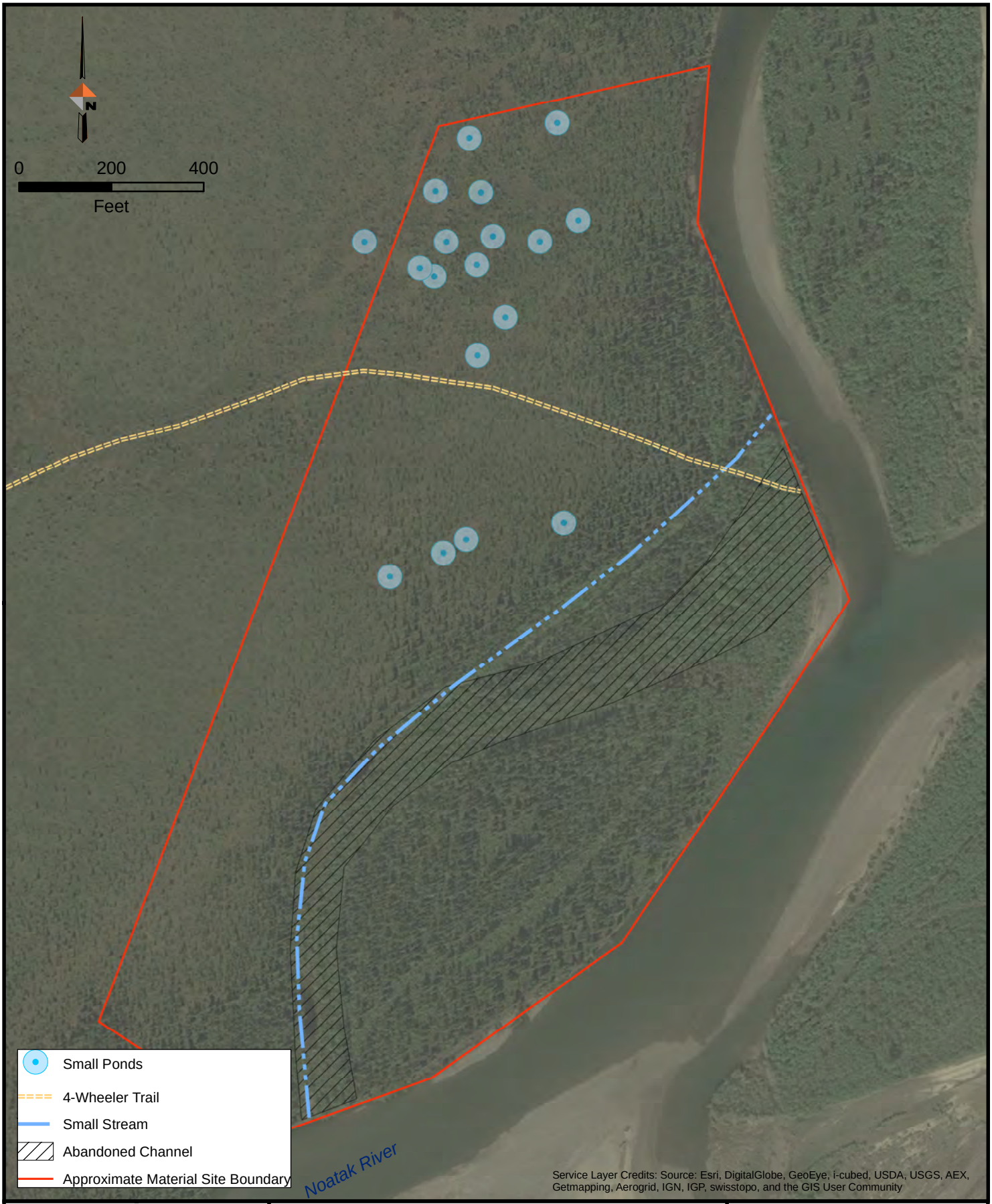
The surface of the permafrost and silt zone displays tundra vegetation typified by tussocks and stunted spruce. The elevation decreases from the ridge on which cemetery road is located toward the river; and there is a bench where the landscape flattens out on the northeastern side of this zone. Scattered across this bench are small surficial bodies of water generally less than 5 feet deep. These small ponds increase in abundance in the northwestern region of the proposed material site. A 4-wheeler trail runs east to west across the material site to the south of the majority of the small ponds. The western boundary of this zone is represented by a small topographic drop of approximately 2 to 5 feet; this boundary coincides with the approximate boundary of permafrost and is shown in Figure 2.

3.1.2 Transition and Channel Zone

The surface cover of the transition and channel zone progresses from tundra vegetation to dense alder and larger spruce trees. A crescent-shaped abandoned river channel starts at the point bar near the easternmost point of the proposed material site and curves back to the west and then to the south before terminating in the southeastern corner of the proposed site. This feature is most easily seen in satellite or aerial photography. A small stream was observed at the time of the investigation running along the western edge of the abandoned channel, which varied in depth from approximately 1 to 4 feet and varied in width from approximately 3 to 20 feet. The eastern edge of the abandoned channel forms the boundary with the third zone and is topographically defined by an approximately 5- to 8-foot increase in elevation on the eastern edge of the abandoned channel.

3.1.3 Channel Bar Zone

The surface of the channel bar zone displays a mossy surface cover below large spruce trees with spacing that varies from dense to scattered. This area is interpreted to be an old/abandoned, channel gravel bar. The topography of this area is fairly flat and is bounded on the eastern side by an approximately 8- to 12-foot abrupt topographic drop into the river.



DOWL HKM

Surface Features Map

NOATAK MATERIAL SITE INVESTIGATION

Noatak, Alaska

PROJECT	D61683
DATE	Jul 24, 2014

FIGURE 3

3.2 Subsurface

The soils present vary between the three zones observed within the proposed material site, but the material within each zone was fairly consistent. An individual description of each zone follows:

3.2.1 Permafrost and Silt Zone

Test borings TB01, TB02, TB03, TB09, TB10, and TB14 were drilled in this zone. The peat and silt layer varied in thickness from 5.5 to 12.5 feet. Below this layer the soils were generally consistent. Underlying the frozen silt and peat are frozen gravels with silt, which extend to unknown depth.

Peat. The surficial peat extends from the ground surface to depths of one to two feet. The peat is amorphous to fibrous, saturated, and soft when thawed. Interbedded silt layers up to approximately 6 inches thick were also observed within the peat. The peat was frozen at the time of our investigation.

Silt and Silt with Sand. The peat is underlain by silt which extends to depths of 6.5 to 13 feet below the ground surface. This deposit generally ranges in classification from Silt (ML) to Silt with Sand (ML). The sand content varies from 0 to 23 percent and the moisture content of the silt ranges from 44 to 214 percent by weight with the higher values associated with interbedded peat and ice-rich soils. Random and irregularly orientated ice formations up to one-half-inch-thick were observed. The silt is frost susceptible (F4).

Gravel with Silt and Sand. The silt deposit is underlain by Poorly- to Well-Graded Gravel with Silt and Sand (GP-GM, GW-GM) that extends to depths of at least 10 to 20 feet below the ground surface, which is the extent of our exploration, and likely extends further to an unknown depth. The silt content varies from as low as 6 to 10 percent and the moisture content ranges from 5 to 18 percent. The gravel content ranges from 40 to 55 percent. This deposit was frozen with ice ranging from well bonded with no excess ice to segregated ice present as individual ice crystals and inclusions. This deposit is frost susceptible with the frost class ranging from F1 to F2. This deposit was tested for degradation of aggregates and sodium sulfate soundness. The results of those tests are presented in Section 5, Laboratory Tests.

3.2.2 Transition and Channel Zone

Test borings TB04, TB05, TB06, TB07, TB08, and TB15 were drilled within the transition and channel zone. Poorly- and Well-Graded Sands and Gravels were encountered below one to four feet of peat. A general description of the soil units follows:

Peat. The surficial peat extends from the ground surface to depths of one to four feet. The peat is amorphous to fibrous, saturated, and soft when thawed. Roots layers several inches thick were

encountered in the upper foot of peat. Interbedded silt layers up to 5 inches thick were also observed. The peat was frozen at the time of our investigation

Sand. The peat in borings TB05 and TB08 is underlain by sand with gravel which extends to depths of five to six feet below the ground surface. This deposit generally ranges in classification from Poorly- to Well-Graded Sand with Gravel (SP, SM) to Silty Sand (SM). The silt content varies from 5 to 16 percent and the moisture content ranges from 1 to 18 percent. The Well-Graded Sand with Gravel has a gravel content of about 30 percent and is not frost susceptible. The Silty Sand has a gravel content of seven percent and has a frost classification of F3.

Gravel with Sand. The sands are underlain by gravels which extend to depths of at least 20 to 25 feet below the ground surface. This deposit generally ranges in classification from Poorly- to Well-Graded Gravel with Sand (GP, GW). The silt content varies from one to three percent and the moisture content ranges from 3 to 15 percent. The gravel content of this unit ranges from 50 to 65 percent and is not frost susceptible. This unit was not frozen at the time of our investigation and groundwater as observed. This deposit was tested for degradation of aggregates, sodium sulfate soundness, and percent loss by Los Angeles (LA) abrasion. The results of those tests are presented in Section 5, Laboratory Tests.

3.2.3 Channel Bar Zone

Test Borings TB11NO, TB12NO, and TB13NO were drilled within the channel bar zone; a similar stratigraphy was encountered in all test borings within this zone. Below the approximate 1-foot-thick layer of peat and minor silt, gravel with sand is present to the depth of the exploration.

Peat. The surficial peat extends to depths of one to two feet. The peat is amorphous to fibrous, saturated, and soft when thawed. Root mats several inches thick were encountered in the upper foot of peat. Interbedded silt layers up to five inches thick were also observed. The peat was frozen at the time of our investigation.

Gravel with Sand. The peat is underlain by gravel with sand, which extends to depths of at least 20 to 25 feet below the ground surface. This deposit generally ranges in classification from Poorly- to Well-Graded Gravel with Sand (GP, GW). The silt content varies from one to two percent and the moisture content of the gravel with sand ranges from 3 to 10%. The gravel content in this deposit ranges from 60 to 68% and is not frost susceptible. This unit was not frozen and groundwater was observed. This deposit was tested for degradation of aggregates, sodium sulfate soundness, and percent loss by LA abrasion. The results of those tests are presented in Section 5, Laboratory Tests.

3.3 Groundwater

Slotted PVC standpipes were installed in seven of the test borings. Groundwater levels were measured in the standpipes 24 hours after drilling. The depth to groundwater was measured to be 7.5 to 14 feet below surface elevation in the transition zone. Groundwater was observed measured down open casing in two test borings where PVC could not be installed. The groundwater in the channel bar zone was measured at a depth of approximately 8 to 9 feet below surface elevation. Groundwater was not observed within the permafrost and silt zone. The approximate groundwater elevations above sea level are tabulated in Table 2. Groundwater measurements were obtained between April 30 and May 4, 2014. This is likely a seasonal spring thaw water level. Groundwater elevations at the proposed site are likely influenced by the Noatak River.

Table 2: Observed and Measured Groundwater Levels of Test Borings

Zone	Boring	Approximate Groundwater Elevation (ft)	Depth to Groundwater (ft)	Date
Permafrost and Silt	TB01	N.O.	N.O.	5-4-14
	TB02	N.O.	N.O.	5-4-14
	TB03	N.O.	N.O.	4-30-14
	TB09	N.O.	N.O.	5-4-14
	TB10	N.O.	N.O.	5-3-14
	TB14	N.O.	N.O.	5-3-14
Transition and Channel	TB04	68	14	5-1-14
	TB05	67.5	7.5	5-1-14
	TB06	66	6.5	5-1-14
	TB07	67	6	5-1-14
	TB08	71	8	5-2-14
	TB15	69.5	8.5	5-4-14
Channel Bar	TB11	67	9	5-3-14
	TB12	66	8	5-3-14
	TB13	66	8	5-3-14

3.4 Permafrost

Permafrost was only observed in the permafrost and silt zone. The near-surface, frozen soils encountered in the upper few feet of the transition and channel bar zones are part of the active layer that freezes and thaws each year. It is expected that these near surface soils will be thawed by the end of the summer season before freezing again during the winter.

Within the permafrost and silt zone, frozen soils were encountered to the depth of our exploration. Sealed PVC standpipes were installed in Test Borings TB03, TB14, and TB10 to depths of 19, 14, and 13 feet, respectively. Thermistor strings with nodes at two-foot intervals were installed in these three borings and left for 24 hours to allow for temperatures to equilibrate

before measurements were made. The measured temperatures are shown tabulated in Table 3 and graphically in Appendix D: Thermistor Measurements.

Table 3: Measured Ground Temperatures

TB03 *Air Temp. 44°*		**TB10** *Air Temp. 34°*		**TB14** *Air Temp. 31°*	
Depth (ft)	Temperature (°F)	Depth (ft)	Temperature (°F)	Depth (ft)	Temperature
1	31.8	0	32.7	0	32.5
3	31.9	2	32	2	32
5	31.9	4	31.9	4	32
7	32	6	31.7	6	32
9	31.9	8	31.9	8	32
11	32	10	31.9	10	32
13	32	12	31.9	12	32
15	31.6			14	31.8
17	31.8				
19	29.8				

3.5 Cross Sections

Three generalized geologic cross sections were prepared for this investigation that show the interpretation of the subsurface soils between test borings, the approximate boundary of the permafrost, and the groundwater level at the time of investigation. Geologic cross sections are two dimensional projections of the subsurface along a plane. Cross sections are the project geologist's interpretation of the test boring logs and the surficial features observed on-site. Generalized geologic cross sections show the approximate positions of the deposits and ignore minor variations in soil within a deposit. The actual soil stratigraphy may differ somewhat due to natural variations in the deposition of the soils. A map showing the location of the projections is located in Appendix E: Generalized Geologic Cross Sections Map. The three cross sections prepared for this investigation can be found in Appendix F: Generalized Geologic Cross Sections.

4.0 SITE OBSERVATIONS AND CONCLUSIONS

We found material that would be appropriate to be used for extending the current cemetery road, road maintenance within the village, and a material source for the DOT&PF airport facility and runway. The DOT&PF's quality and selected material specifications are discussed within this section. Here we also present our quantity estimates for the proposed material site.

4.1 Material Quality

Material quality refers to the materials resistance to breaking down due to wear and weathering. The tests most commonly used and specified by the DOT&PF for aggregates to determine quality include L.A. Abrasion, Degradation of Aggregates, and Soundness of Aggregate by Use of Sodium Sulfate. The DOT&PF specifications for aggregates in airport and highway construction are shown in Table 4. In general, the gravels tested met the DOT&PF material quality specifications.

Table 4: DOT&PF Aggregate Quality Specifications

		Minimum Specified Values		
	Airport Materials	**LA Abrasion**	**Degradation of Aggregates**	**Sodium Sulfate Soundness**
Airport Materials	Subbase Coarse	< 50 %	> 40	Not Specified
	Aggregate Surface Coarse	< 50 %	> 45	< 12 %
	Crushed Aggregate Base Coarse	< 45 %	> 45	< 12 %
	Hot Mix Asphalt Pavement	< 40 %	> 30	< 13 %
Highway Materials	Subbase Coarse	< 50 %	> 40	Not Specified
	Base Coarse	< 50 %	> 45	< 9 %
	Aggregate Surface Course	< 45 %	> 45	< 9 %
	Hot Mix Asphalt Pavement	< 45 %	> 30	< 9 %

4.2 Selected Materials

Selected Materials are generally aggregate containing no muck, frozen material, roots, sod, or other deleterious matter and must meet specific gradation requirements. Gravel material from 14 of the 15 test borings were tested for gradation. The gradation specifications met for gravel and sand material from each zone can be found in Table 5.

Table 5: DOT&PF Selected Materials by Zone

Zone	Number of Borings Tested	Number Meeting Type A	Number Meeting Type B	Number Meeting Type C
Permafrost and Silt	5	-	4	1
Transition and Channel	6	6	1	1
Channel Bar	3	3	-	-

The silts are not suitable to be used in road or airport construction, but could possibly be used for berms around landfills, sewage lagoons, and other similar applications.

4.2.1 Material Quantities

The quantity of gravel available depends on a number of factors including excavation method and depth of excavation. Quantities have been calculated using an excavation depth of 25 feet as that is the extent of the majority of the test borings completed during this investigation. In the permafrost zone we expect that the ground will be continually frozen for the full depth of excavation. However, permafrost is likely to degrade quickly once the insulating peat layer is removed and excavation begins. If gravel from the permafrost and silt zone is selected for use, it must be thawed before being placed as compaction cannot be obtained using frozen material. The dimensions and estimated thickness of overburden, sand and gravel are shown in Table 6. In the permafrost and silt zone, few borings reached 25 feet depth and it is assumed that the Silty Gravel with Sand and Gravel with Silt and Sand continues to at least 25 feet. Overburden includes Peat and Silt materials. Groundwater elevation at the proposed site is influenced by the Noatak River and is likely variable annually and seasonally.

Table 6: Estimated Area Dimensions/Thicknesses

Zone	Average Elevation (ft)	Area with 100' River Buffer (ft^2)	Average Thickness			
			Overburden (ft)	Sand (ft)	Gravel (ft)	Average Groundwater Elevation
Permafrost and Silt	85	883,600	9.3	0	15.7	N.O.
Transition and Channel	77	603,100	2.2	1.7	21.1	68
Channel Bar	75	347,800	1.2	2.6	21.2	66

Material quantities shown in Table 7, Estimated Quantities, were calculated by:

- Using the dimensions shown in Table 6;
- Using the areas shown in Figure 2 minus an assumed 100-foot buffer along the Noatak River;
- Assuming side walls are sloped 2:1 along the perimeter above the water table and 3:1 below the water table,
- Reducing gravel and sand quantities by 5% to account for organic contamination of material from clearing and grubbing and during removal of the overburden, and
- Rounding all volumes down to the nearest thousand.

Table 7: Estimated Quantities

Zone	Total Quantity			Total Quantity		
	Overburden	Sand	Gravel	Overburden	Sand	Gravel
	(cubic feet)			(cubic yards)		
Permafrost and Silt	7,948,000	0	11,572,000	294,000	0	428,000
Transition and Channel	1,315,000	962,000	10,695,000	48,000	35,000	396,000
Channel Bar	415,000	836,000	6,251,000	15,000	30,000	231,000
TOTALS	**9,678,000**	**1,798,000**	**28,518,000**	**357,000**	**65,000**	**1,055,000**
Zone	**Quantity Above Water Table**			**Quantity Above Water Table**		
	Overburden	**Sand**	**Gravel**	**Overburden**	**Sand**	**Gravel**
	(cubic feet)			**(cubic yards)**		
Permafrost and Silt	7,948,000	0	11,572,000	294,000	0	428,000
Transition and Channel	1,315,000	962,000	2,850,000	48,000	35,000	105,000
Channel Bar	415,000	836,000	1,643,000	15,000	30,000	60,000
TOTALS A.W.T.	**9,678,000**	**1,798,000**	**16,065,000**	**357,000**	**65,000**	**593,000**
Zone	**Quantity Below Water Table**			**Quantity Below Water Table**		
	Overburden	**Sand**	**Gravel**	**Overburden**	**Sand**	**Gravel**
	(cubic feet)			**(cubic yards)**		
Permafrost and Silt	0	0	0	0	0	0
Transition and Channel	0	0	7,844,000	0	0	290,000
Channel Bar	0	0	4,608,000	0	0	170,000
TOTALS B.W.T	**0**	**0**	**12,452,000**	**0**	**0**	**460,000**

4.2.2 Excavation and Development Considerations

These preliminary quantities are based on the available elevation data and observations made during this investigation. Site survey resulting in generation of a true topographic map, as well as additional test borings, could result in significant changes in the quantities calculated.

5.0 FIELD EXPLORATION

This section presents the technical data obtained from the field exploration. The methods and procedures used in obtaining the data are presented. The data should be considered accurate only at the locations specified and only to the degree implied by the methods used. The data presented was obtained specifically to address the needs of the design, and may not be adequate for construction purposes.

5.1 Field Exploration

The test boring exploration for the Noatak Material Site Investigation project was conducted on April 30 through May 4, 2014. Fifteen test borings were drilled, sampled, and logged to depths of 10 to 25 feet within the proposed material site boundaries; greater depths were achieved in areas absent of permafrost. Within the permafrost and silt zone, the frozen soils created difficult and slow drilling conditions, causing test borings to be terminated at shallower depths, allowing more test borings to be completed in the limited time frame to better define the area conditions.

The test borings were located in the field using a hand-held Garmin Global Positioning System (GPS) eTrex-10 unit and recorded in the NAD83 datum. Test boring locations were initially selected through satellite photograph interpretation with the intention of characterizing the three major landforms/zones occurring within the proposed material site. The accuracy of the GPS unit is dependent on several factors including the number of satellites available, the position of the satellites, and the amount of tree cover at the location. Location coordinates are generally only accurate to +/- 20 feet. Location elevations are generally only accurate to +/- 50 feet. For that reason, test boring elevations were determined through the use of the Interferometric Synthetic Aperture Radar (IFSAR) Alaska data set processed in a Global Information System (GIS) software package. This data set contains a Digital Terrain Model (DTM) of bare earth elevations with a 3-meter confidence level of 90 percent and a 1-meter confidence level of 60 percent.

The test borings were performed by the direct push method using a GeoProbe 6712 DT drill rig equipped with a percussion hammer and 3-inch diameter steel Macro-Core sampler barrel. The rig is owned and operated by Discovery Drilling, Inc. of Anchorage. Direct push sampling is performed by advancing a sampling device into the subsurface soils by applying static pressure, by applying impacts, or by applying vibration or any combination thereof, to advance the sampler to the desired sampling depth. The sampler is recovered from the boring and the sample, contained in a PVC liner, is removed from the sampler. The drilling was supervised and the samples logged by Paul Pribyl, a geologist with our firm.

Direct push sampling allowed for continuous samples to be obtained from the surface to bottom of the test boring. Samples were obtained in 5-foot intervals except where frozen soils demanded shorter sampling intervals to prevent damage to the sampling barrel.

As the soil samples were recovered, they were visually classified and sealed in plastic bags to preserve the natural water content. The samples were then transported to DOWL HKM's laboratory in accordance with ASTM D4220, for further testing.

A slotted PVC standpipe was installed in 7 of the test borings and the depth to the groundwater was measured 24 hours after drilling to allow the water levels to stabilize. Sealed PVC standpipe was installed in 3 of the test borings and the subsurface temperatures were measured 24 to 30 hours after installation to allow the temperatures to equilibrate.

No environmental testing or monitoring was conducted as a part of this investigation

6.0 LABORATORY TESTS

This section of the report presents the technical data obtained during the soil laboratory testing in narrative, tabular, and graphic form. The methods and procedures used in obtaining the data are described herein. The data should be considered accurate only to the degree implied by the methods used.

The natural water content of nearly all the recovered samples was measured. Index testing consisting of grain size analysis was on selected samples. To determine if material from the proposed site would meet DOT&PF quality specifications for use within airport facilities, the additional analyses of LA abrasion, degradation of aggregates, and sodium sulfate soundness were performed on selected samples. Soil samples will be stored until November, 1, 2014, after which time they will be discarded unless other arrangements are made.

6.1 Moisture Content

The natural water content was determined in accordance with ASTM D2216, Standard Test Method for Laboratory Determination of Water (Moisture) Content of Soil and Rock, except due to limited sample sizes, some tests may have been performed on samples smaller than the minimum test size required by the standard. The water content is reported on the graphic test boring logs in Appendix B.

6.2 Particle Size Distribution Tests

Twenty-three particle-size distribution tests were performed on selected soil samples in accordance with ASTM D6913. These tests consisted of mechanical sieving; the results are presented graphically in Appendix C.

6.3 LA Abrasion Tests

Material from five test borings was selected for LA Abrasion testing following the AASHTO test method T 96, Resistance to Degradation of Small-Size Coarse Aggregate by Abrasion and Impact in the Los Angeles Machine. Material had to be combined from several sample intervals within a single test boring (as opposed to a single sample interval) to meet the minimum sample size requirements. This test method is a measurement of particle resistance to breaking and wearing by mechanical abrasion, impact, and grinding in a rotating steel drum containing a specific number of steel spheres. The greater the resistance to abrasion, the less wear and breakdown is likely to occur during service. The LA abrasion test is an indicator of the relative competence or quality of the material tested. The lower the percent loss, the better and more resistant the material will respond to abrasion, impact, and grinding. The results of the tests are shown in Table 8.

Table 8: Los Angeles Abrasion of Aggregate Test Results

Sample ID	Percent Loss
TB05 Depth 5'-20'	20
TB06 Depth 5'-25'	20
TB11 Depth 0.5'-25'	21
TB12 Depth 1'-25'	21
TB15 Depth 1'-25'	19

6.4 Degradation of Aggregates Test

Two degradation of aggregate tests were performed on combined samples from two test borings. The degradation value is an indication of the durability of an aggregate. The test uses a mechanical sieve shaker and a container of distilled water over a prescribed time interval and set oscillation speed. Degradation values range from 0 to 100, with higher values indicating higher quality material. This test is most applicable to crushed aggregate base course materials and their resistance to produce clay-size fines. The test is performed in accordance with Alaska Test Method 313, Standard Method of Test for Determining the Degradation Value of Aggregates. The results of the tests are shown in Table 9.

Table 9: Degradation of Aggregate Test Results

Sample ID	Deg. Value
TB02 Depth 10'-16'	85
TB11 Depth 0.5'-25'	87

6.5 Sodium Sulfate Soundness

Three sodium sulfate soundness analyses were performed on selected soil samples. This test determines aggregates' resistance to disintegration by weathering. The test uses immersion of the aggregate in a saturated sodium sulfate solution for 5 cycles of 17 hours each and subsequent drying. The formation of salt crystals during drying mimics the formation of ice crystals during freeze-thaw cycles. Lower percentages of disintegration indicate a higher level of soundness within the aggregate. The test is performed in accordance with AASHTO T104, Soundness of Aggregate by Use of Sodium or Magnesium Sulfate. The results of the tests are shown in Table 10.

Table 10: Soundness of Aggregate by Use of Sodium Sulfate Test Results

Sample Name	Aggregate Size	Percent Loss
TB02 Depth 10'-13'	Coarse	2.9
	Fine	1.8
TB06 Depth 5'-9'	Coarse	0.2
	Fine	0.6
TB11 Depth 0.5'-25'	Coarse	0.9
	Fine	0.4

7.0 REFERENCES

Alaska Climate Research Center, Climate Normals, retrieved from: http://climate.gi.alaska.edu/Climate/Normals

DOT&PF. (2014) *Standard Specifications for Highway Construction.*

DOT&PF. (2014) *Standard Specifications for Airport Construction*

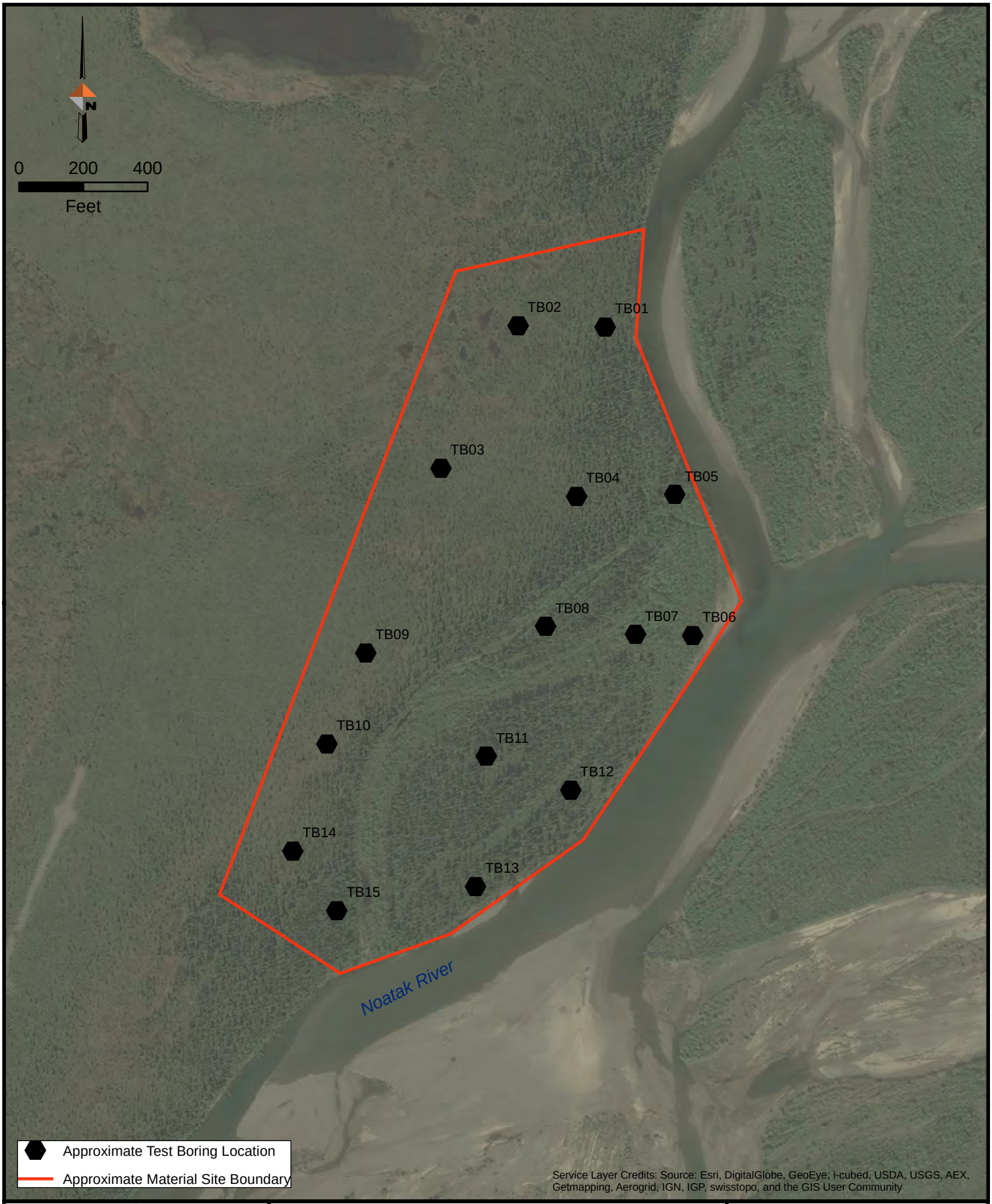
Hartman, C.W. and Johnson, P.R. (1984). *Environmental Atlas of Alaska*. Second Edition. Revised. Fairbanks, Alaska: Institute of Water Resources, University of Alaska, Fairbanks, p. 95.

Pewe, T.L. (1975). *Quaternary Geology of Alaska, U.S. Geological Survey, Professional Paper 835*. Washington, D.C.: United States Government Printing Office, p. 145, one map, two tables in pocket.

Wahrhaftig, Clyde. (1965). *Physiographic Divisions of Alaska, US Geological Survey Professional Paper 482*. Washington, D.C.: United States Government Printing Office, p. 52, six plates.

APPENDIX A

Test Boring Location Map



DOWL HKM

Test Boring Location Map

NOATAK MATERIAL SITE INVESTIGATION

Noatak, Alaska

PROJECT	D61683
DATE	Jul 28, 2014

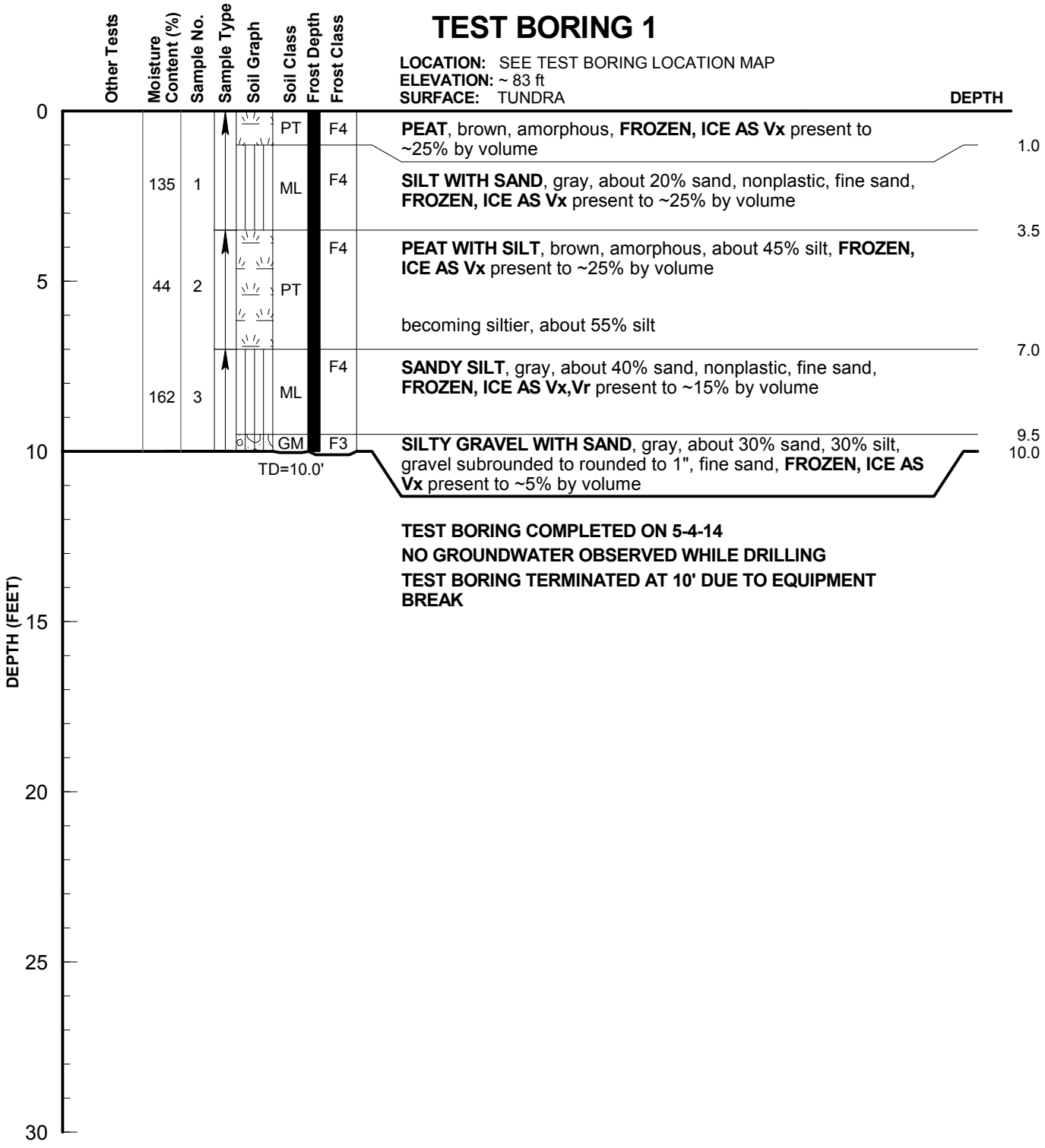
FIGURE A - 1

APPENDIX B

Test Boring Logs and Descriptive Guide

TEST BORING 1

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 83 ft
SURFACE: TUNDRA



PEAT, brown, amorphous, **FROZEN, ICE AS Vx** present to ~25% by volume

SILT WITH SAND, gray, about 20% sand, nonplastic, fine sand, **FROZEN, ICE AS Vx** present to ~25% by volume

PEAT WITH SILT, brown, amorphous, about 45% silt, **FROZEN, ICE AS Vx** present to ~25% by volume

becoming siltier, about 55% silt

SANDY SILT, gray, about 40% sand, nonplastic, fine sand, **FROZEN, ICE AS Vx,Vr** present to ~15% by volume

SILTY GRAVEL WITH SAND, gray, about 30% sand, 30% silt, gravel subrounded to rounded to 1", fine sand, **FROZEN, ICE AS Vx** present to ~5% by volume

TEST BORING COMPLETED ON 5-4-14
NO GROUNDWATER OBSERVED WHILE DRILLING
TEST BORING TERMINATED AT 10' DUE TO EQUIPMENT BREAK

KEY
TD = Total Depth
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊡ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-4-14
W.O. 1131.61683.01

DOWL HKM

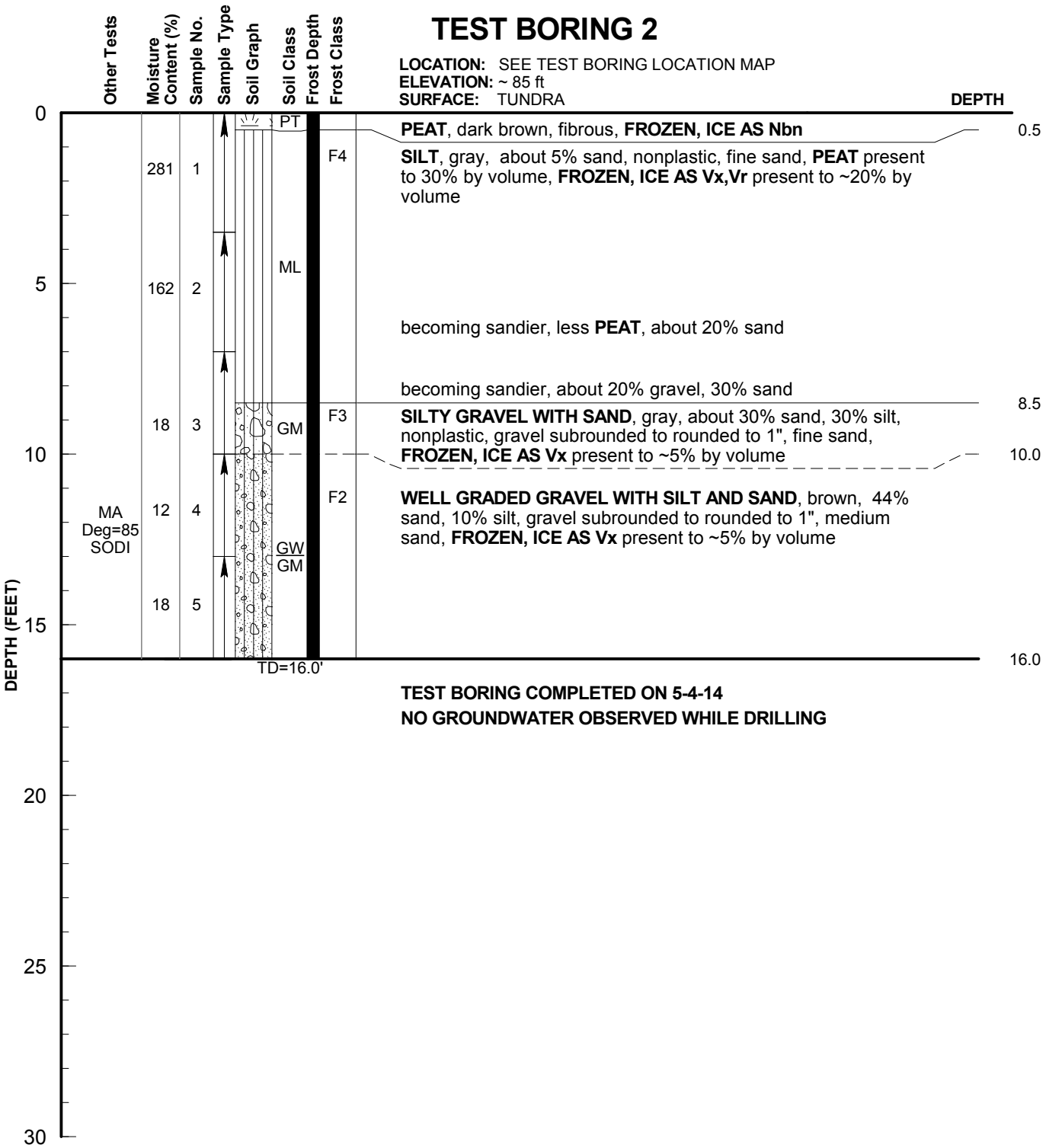
LOG OF TEST BORING 1

FIGURE B-1

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 2

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 85 ft
SURFACE: TUNDRA



TEST BORING COMPLETED ON 5-4-14
NO GROUNDWATER OBSERVED WHILE DRILLING

KEY
MA = Mechanical Analysis
Deg = Degradation of Aggregates
TD = Total Depth
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊤ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-4-14
W.O. 1131.61683.01

DOWL HKM

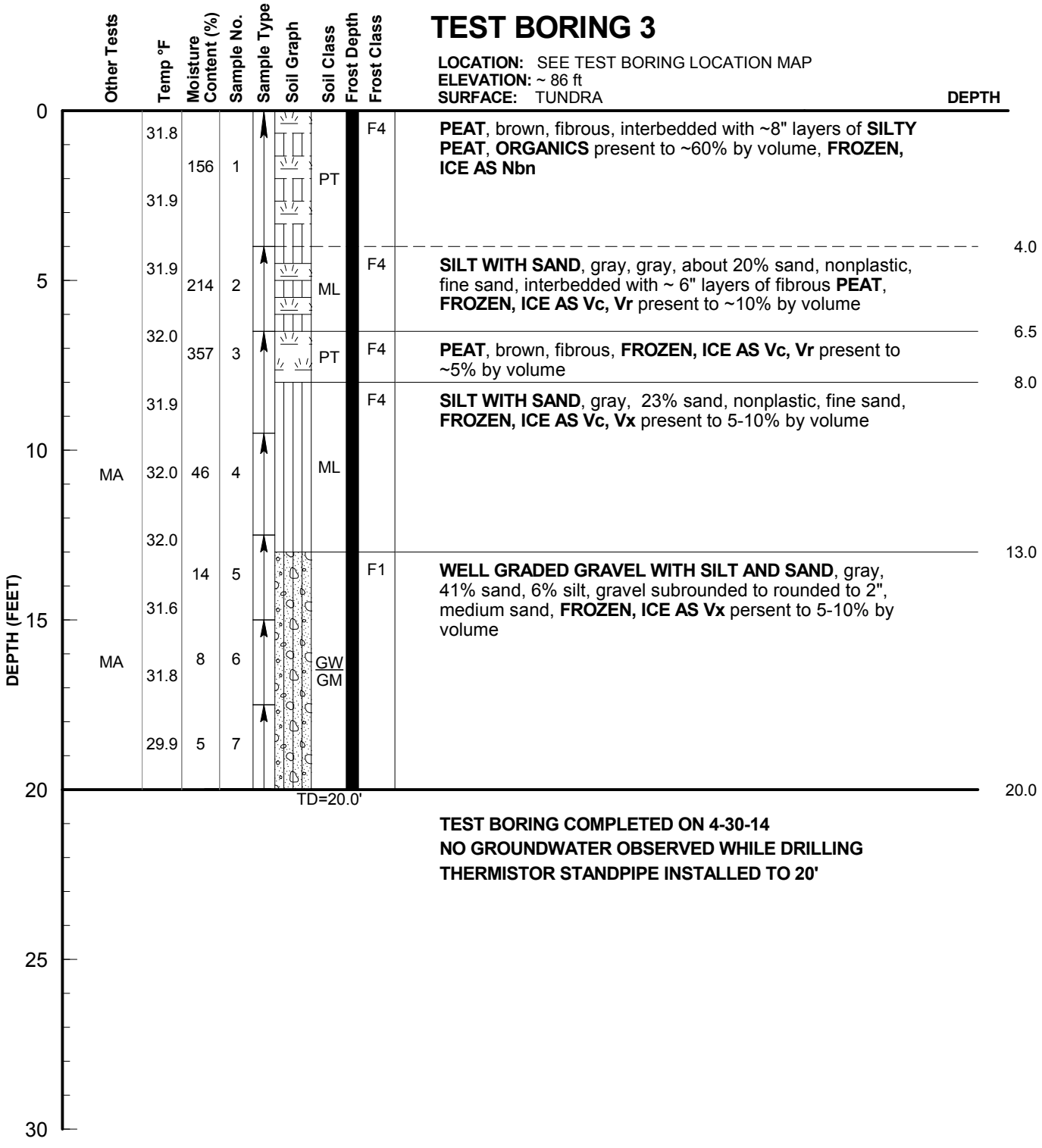
LOG OF TEST BORING 2

FIGURE B-2

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 3

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 86 ft
SURFACE: TUNDRA



PEAT, brown, fibrous, interbedded with ~8" layers of **SILTY PEAT**, **ORGANICS** present to ~60% by volume, **FROZEN, ICE AS Nbn**

SILT WITH SAND, gray, gray, about 20% sand, nonplastic, fine sand, interbedded with ~ 6" layers of fibrous **PEAT**, **FROZEN, ICE AS Vc, Vr** present to ~10% by volume

PEAT, brown, fibrous, **FROZEN, ICE AS Vc, Vr** present to ~5% by volume

SILT WITH SAND, gray, 23% sand, nonplastic, fine sand, **FROZEN, ICE AS Vc, Vx** present to 5-10% by volume

WELL GRADED GRAVEL WITH SILT AND SAND, gray, 41% sand, 6% silt, gravel subrounded to rounded to 2", medium sand, **FROZEN, ICE AS Vx** persent to 5-10% by volume

TEST BORING COMPLETED ON 4-30-14
NO GROUNDWATER OBSERVED WHILE DRILLING
THERMISTOR STANDPIPE INSTALLED TO 20'

KEY
MA = Mechanical Analysis
TD = Total Depth
= Grab Sample
= SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
= 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 4-30-14
W.O. 1131.61683.01

DOWL HKM

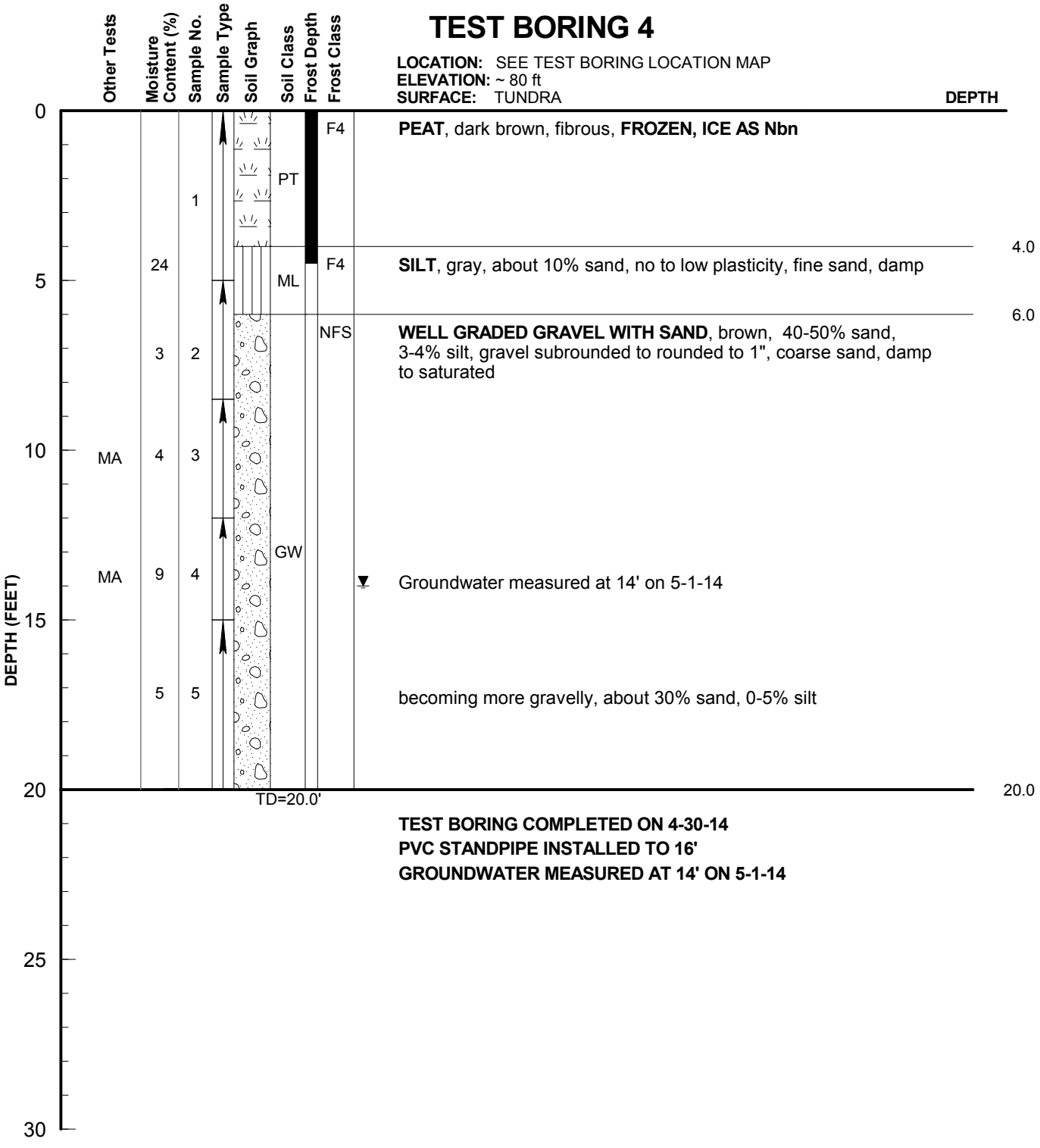
LOG OF TEST BORING 3

FIGURE B-3

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 4

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 80 ft
SURFACE: TUNDRA



TEST BORING COMPLETED ON 4-30-14
PVC STANDPIPE INSTALLED TO 16'
GROUNDWATER MEASURED AT 14' ON 5-1-14

KEY
MA = Mechanical Analysis
TD = Total Depth
▼ = Groundwater After Drilling
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊤ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 4-30-14
W.O. 1131.61683.01

DOWL HKM

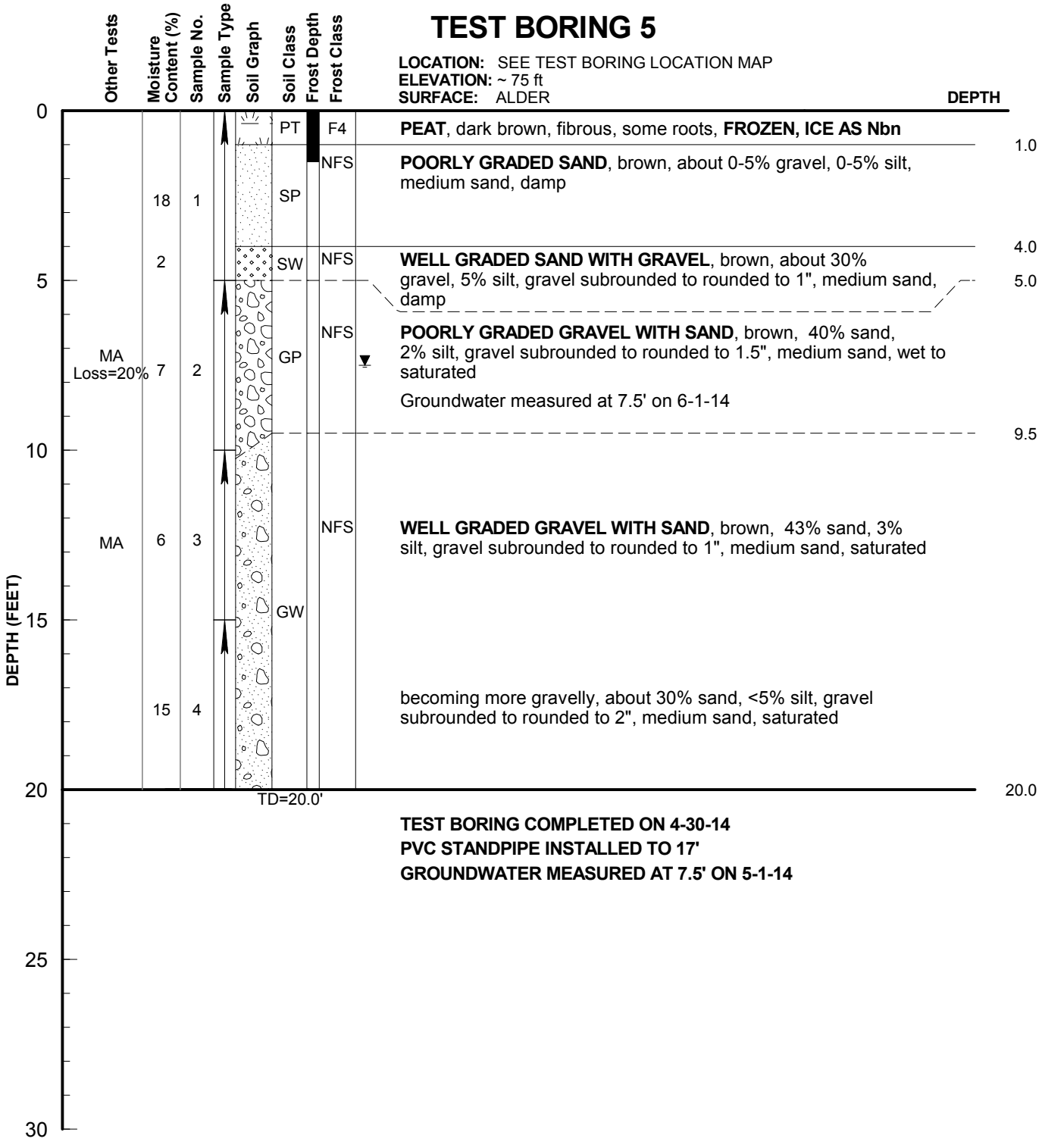
LOG OF TEST BORING 4

FIGURE B-4

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 5

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 75 ft
SURFACE: ALDER



TEST BORING COMPLETED ON 4-30-14
PVC STANDPIPE INSTALLED TO 17'
GROUNDWATER MEASURED AT 7.5' ON 5-1-14

KEY
MA = Mechanical Analysis
Loss = L.A. Abrasion Test (%)
TD = Total Depth
▼ = Groundwater After Drilling
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊡ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 4-30-14
W.O. 1131.61683.01

DOWL HKM

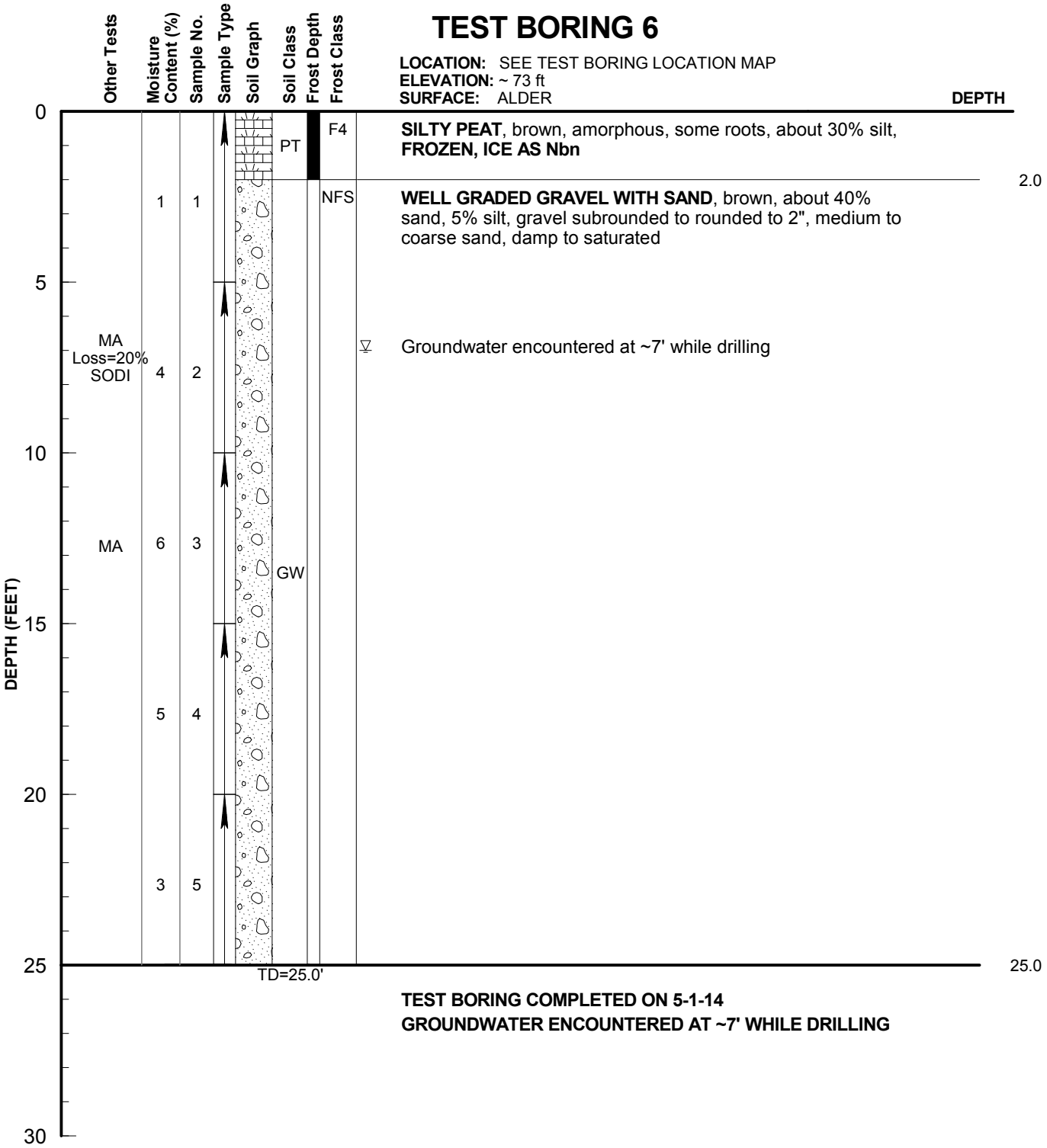
LOG OF TEST BORING 5

FIGURE B-5

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 6

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 73 ft
SURFACE: ALDER



SILTY PEAT, brown, amorphous, some roots, about 30% silt, **FROZEN, ICE AS Nbn**

WELL GRADED GRAVEL WITH SAND, brown, about 40% sand, 5% silt, gravel subrounded to rounded to 2", medium to coarse sand, damp to saturated

Groundwater encountered at ~7' while drilling

TEST BORING COMPLETED ON 5-1-14
GROUNDWATER ENCOUNTERED AT ~7' WHILE DRILLING

KEY
MA = Mechanical Analysis
Loss = L.A. Abrasion Test (%)
TD = Total Depth
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊡ = Direct Push Sample
⊠ = 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-1-14
W.O. 1131.61683.01

DOWL HKM

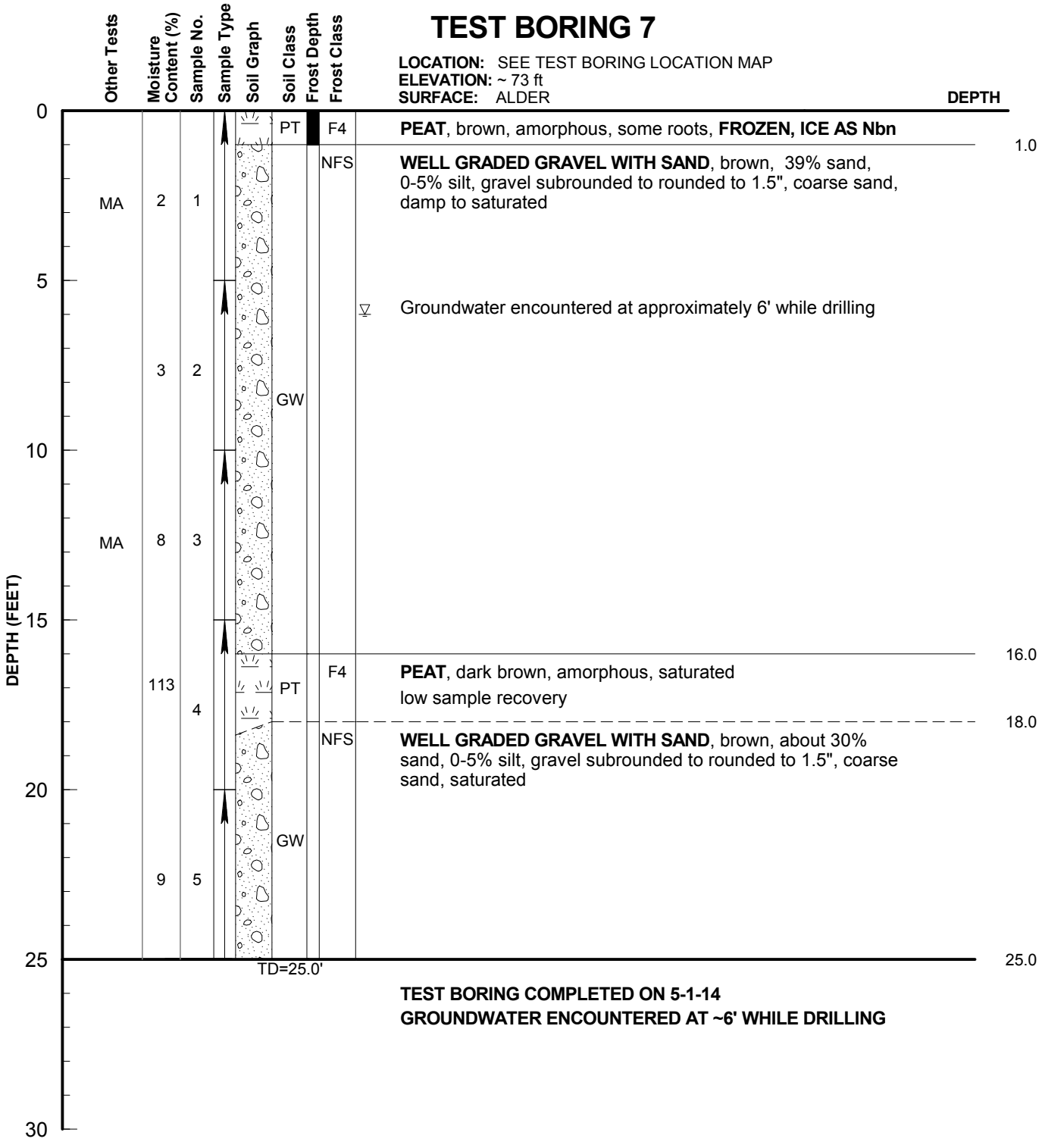
LOG OF TEST BORING 6

FIGURE B-6

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 7

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~ 73 ft
SURFACE: ALDER



TEST BORING COMPLETED ON 5-1-14
GROUNDWATER ENCOUNTERED AT ~6' WHILE DRILLING

KEY
MA = Mechanical Analysis
TD = Total Depth
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊡ = Direct Push Sample
⊠ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-1-14
W.O. 1131.61683.01

DOWL HKM

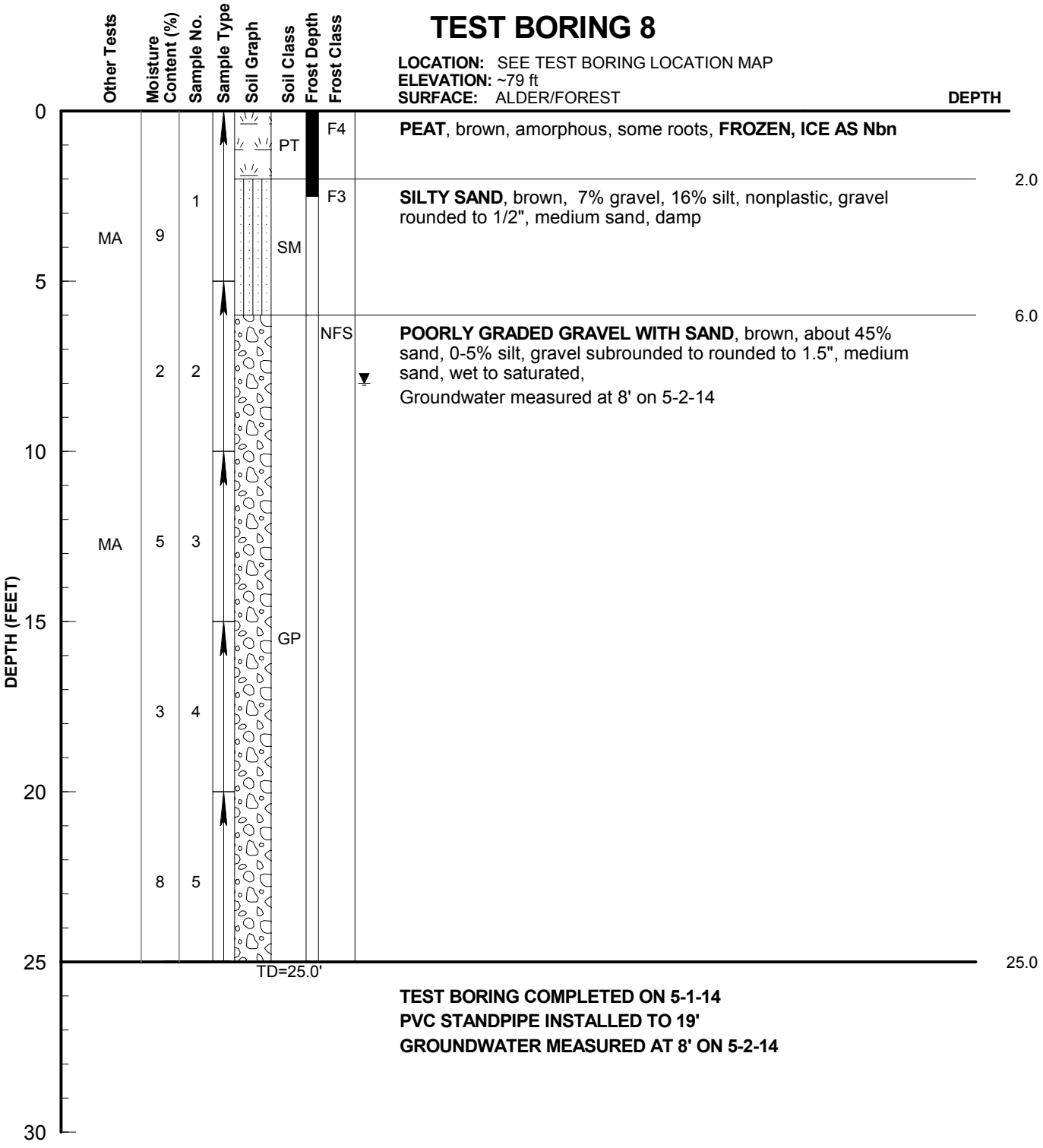
LOG OF TEST BORING 7

FIGURE B-7

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 8

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~79 ft
SURFACE: ALDER/FOREST



KEY
MA = Mechanical Analysis
TD = Total Depth
▼ = Groundwater After Drilling
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊤ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Directi Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-1-14
W.O. 1131.61683.01

DOWL HKM

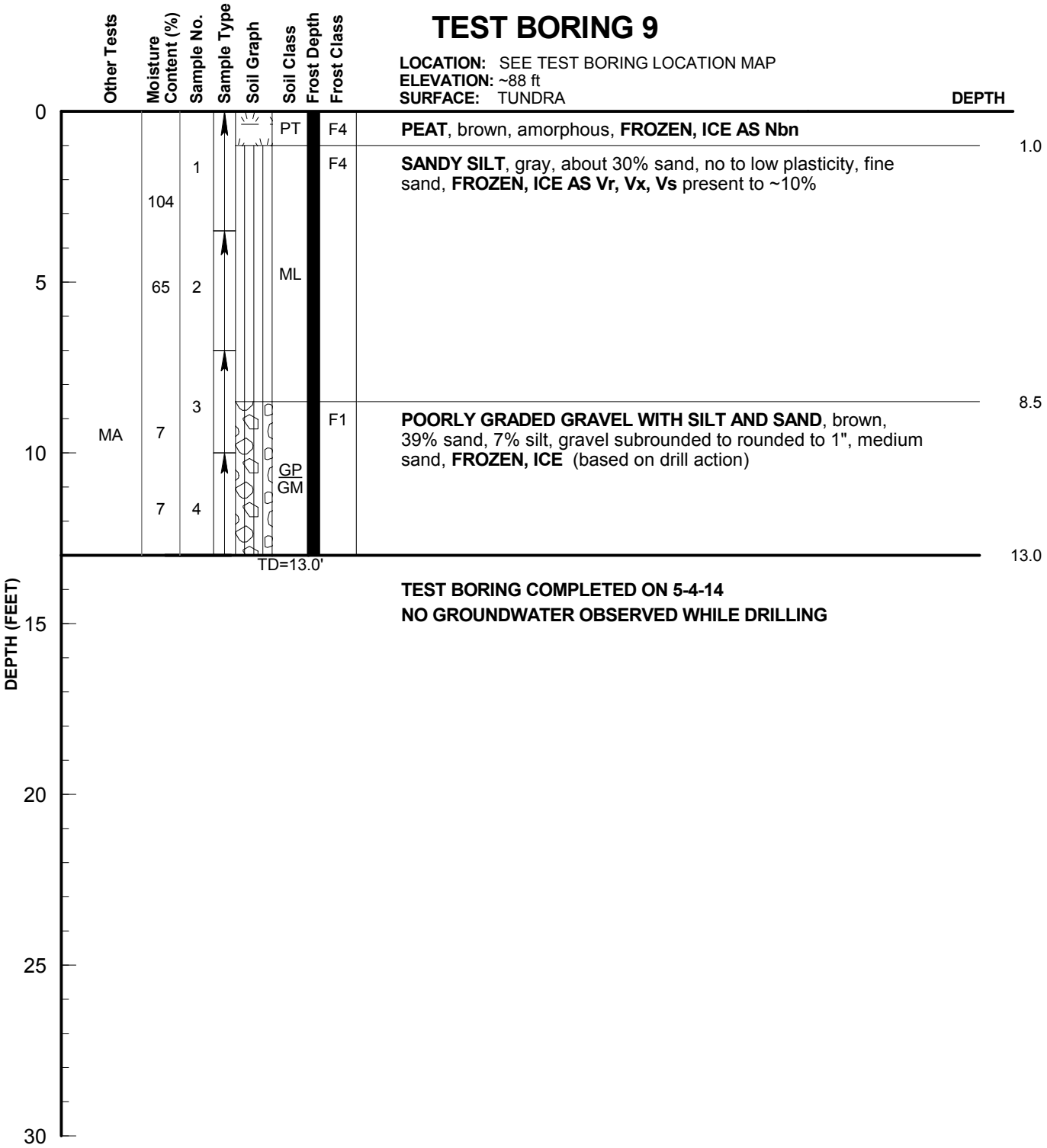
LOG OF TEST BORING 8

FIGURE B-8

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 9

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~88 ft
SURFACE: TUNDRA



TEST BORING COMPLETED ON 5-4-14
NO GROUNDWATER OBSERVED WHILE DRILLING

KEY
MA = Mechanical Analysis
TD = Total Depth
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊡ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-4-14
W.O. 1131.61683.01

DOWL HKM

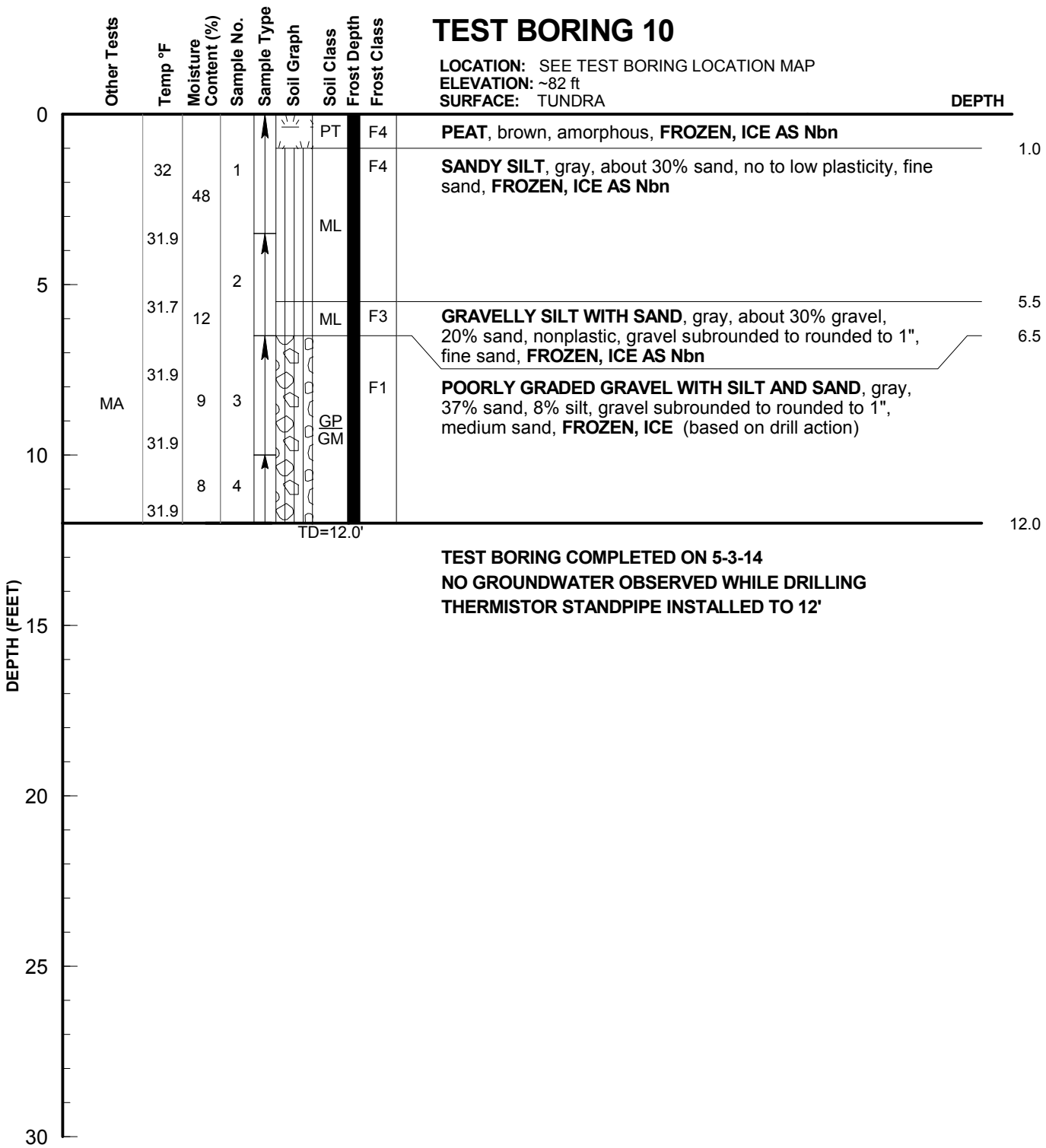
LOG OF TEST BORING 9

FIGURE B-9

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 10

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~82 ft
SURFACE: TUNDRA



TEST BORING COMPLETED ON 5-3-14
NO GROUNDWATER OBSERVED WHILE DRILLING
THERMISTOR STANDPIPE INSTALLED TO 12'

KEY
MA = Mechanical Analysis
TD = Total Depth
= Grab Sample
= SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
= 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-3-14
W.O. 1131.61683.01

DOWL HKM

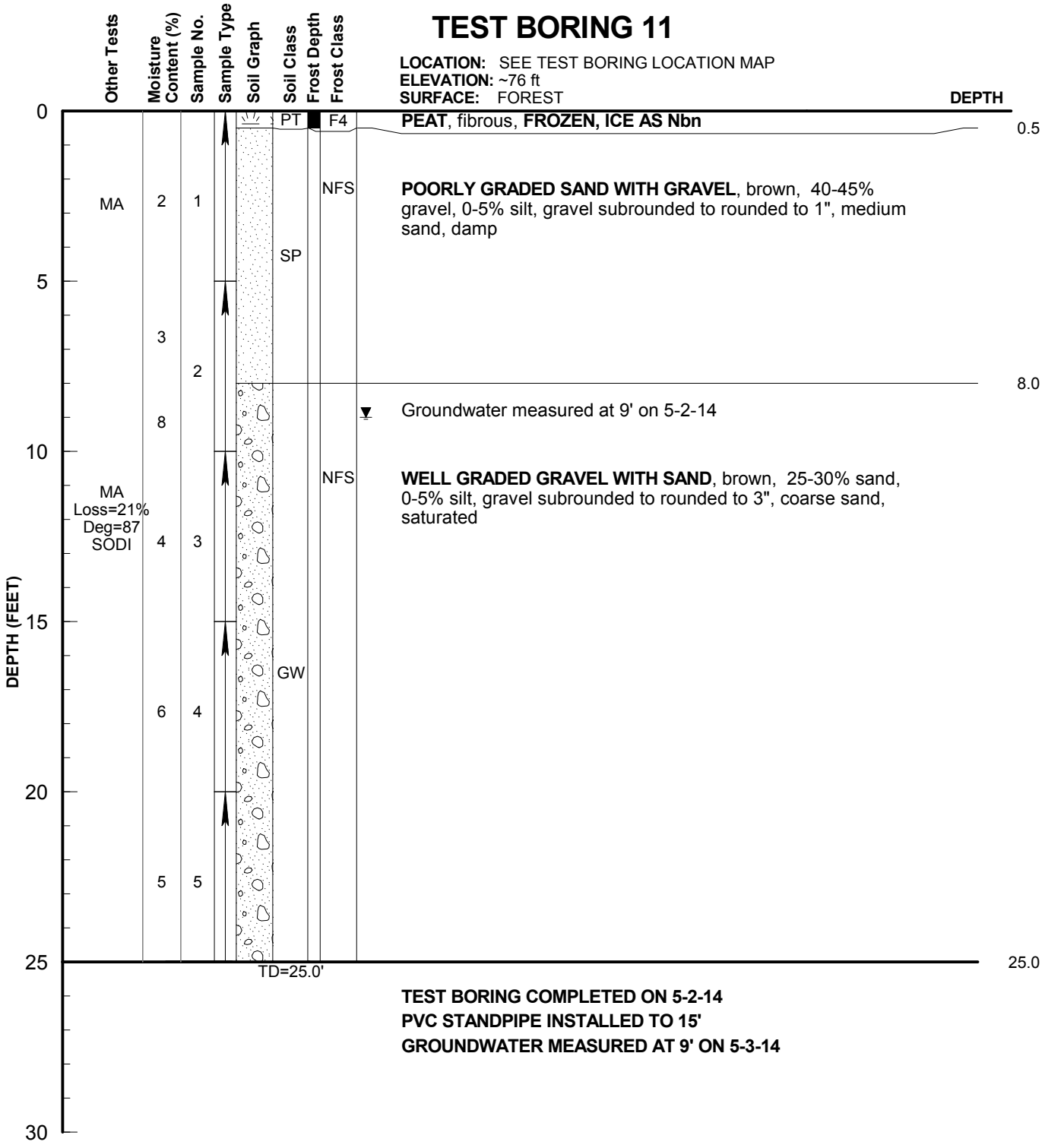
LOG OF TEST BORING 10

FIGURE B-10

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 11

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~76 ft
SURFACE: FOREST



PEAT, fibrous, **FROZEN, ICE AS Nbn**

POORLY GRADED SAND WITH GRAVEL, brown, 40-45% gravel, 0-5% silt, gravel subrounded to rounded to 1", medium sand, damp

Groundwater measured at 9' on 5-2-14

WELL GRADED GRAVEL WITH SAND, brown, 25-30% sand, 0-5% silt, gravel subrounded to rounded to 3", coarse sand, saturated

TEST BORING COMPLETED ON 5-2-14
PVC STANDPIPE INSTALLED TO 15'
GROUNDWATER MEASURED AT 9' ON 5-3-14

KEY
MA = Mechanical Analysis
Loss = L.A. Abrasion Test (%)
Deg = Degradation of Aggregates
TD = Total Depth
= Groundwater After Drilling
= Grab Sample
= SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
= 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Micro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-2-14
W.O. 1131.61683.01

DOWL HKM

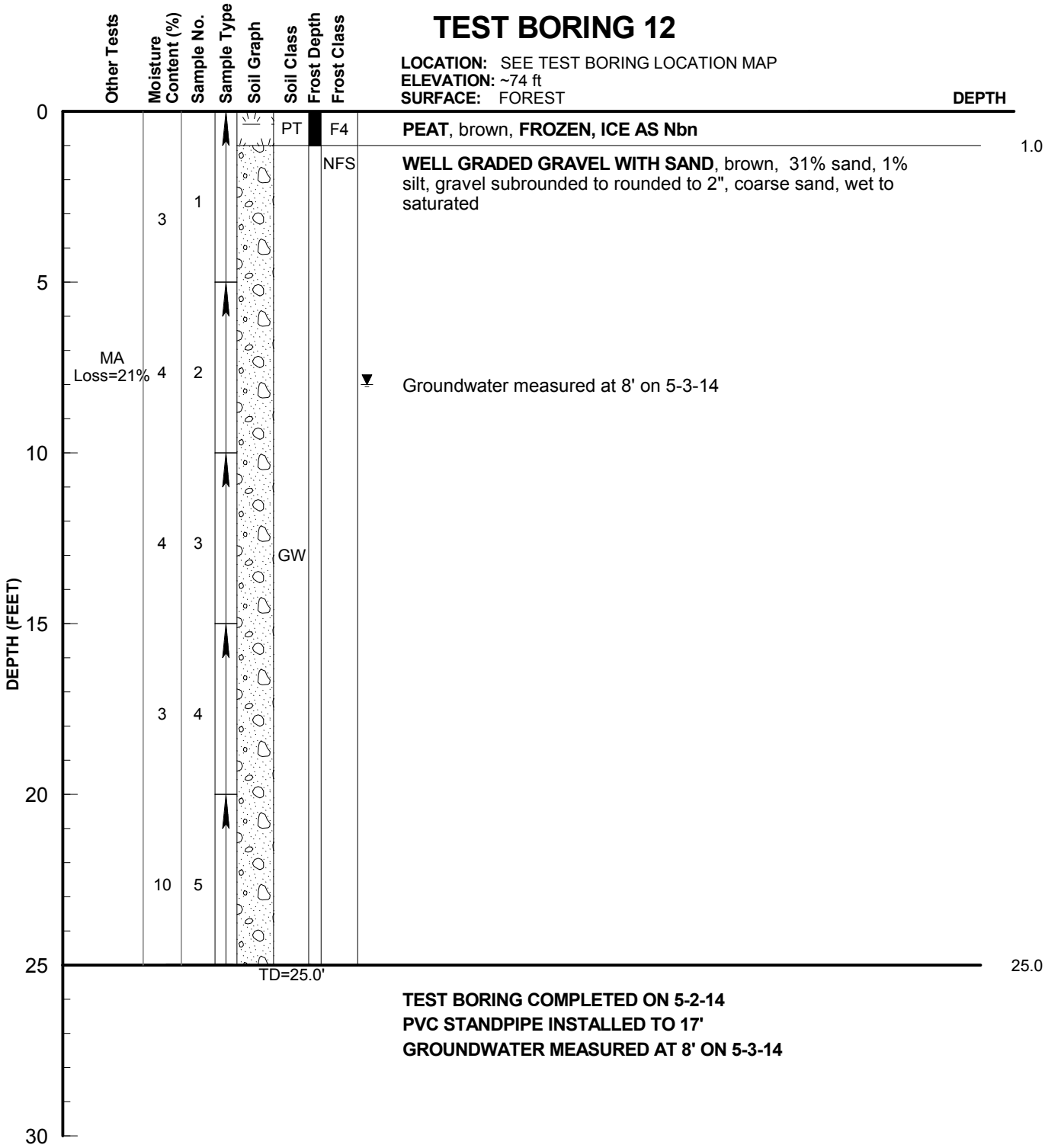
LOG OF TEST BORING 11

FIGURE B-11

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 12

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~74 ft
SURFACE: FOREST



KEY
MA = Mechanical Analysis
Loss = L.A. Abrasion Test (%)
TD = Total Depth
▼ = Groundwater After Drilling
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊤ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-2-14
W.O. 1131.61683.01

DOWL HKM

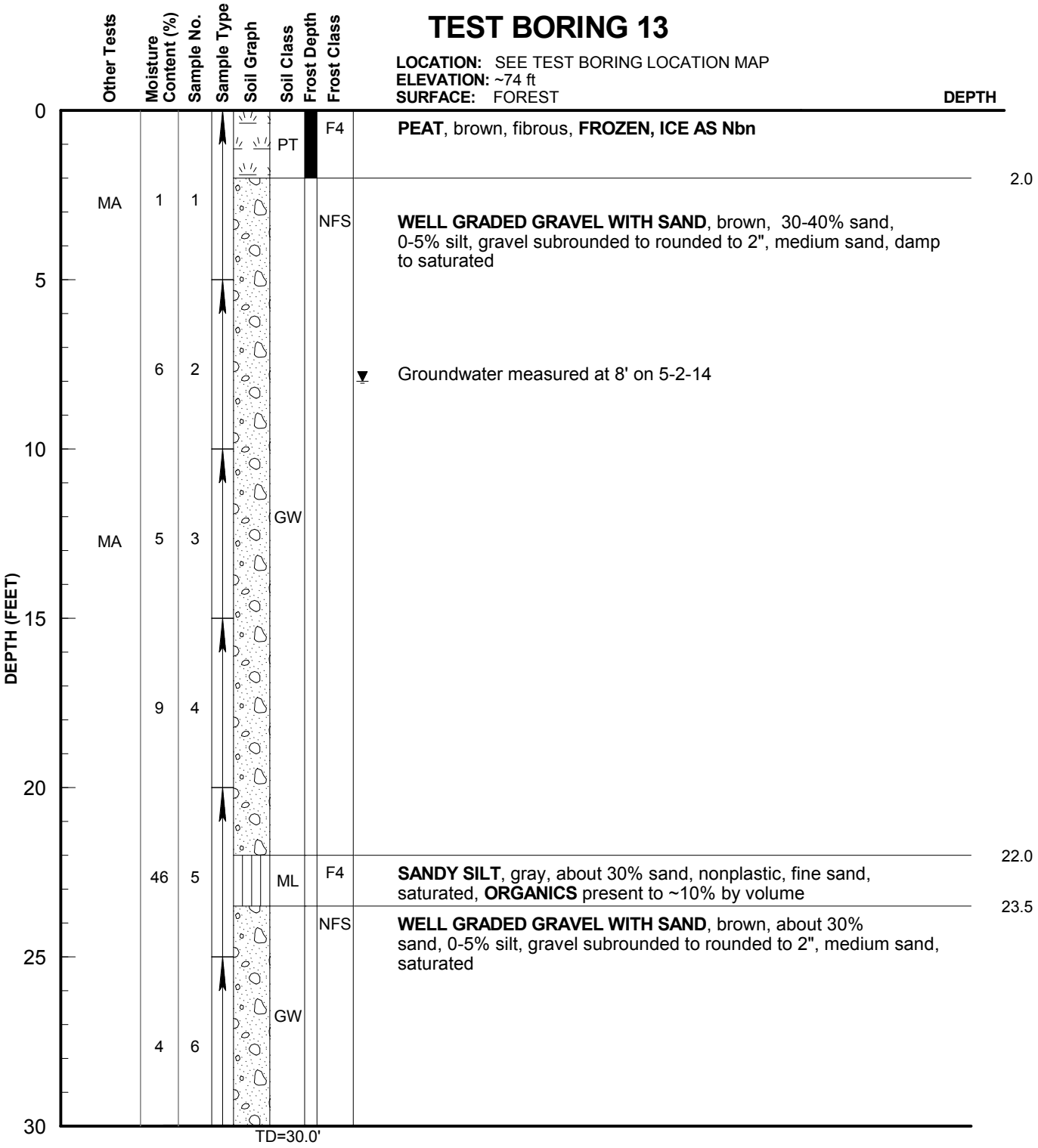
LOG OF TEST BORING 12

FIGURE B-11

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 13

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~74 ft
SURFACE: FOREST



TEST BORING COMPLETED ON 5-2-14
PVC STANDPIPE INSTALLED TO 15'
GROUNDWATER MEASURED AT 8' ON 5-2-14

KEY
MA = Mechanical Analysis
TD = Total Depth
▼ = Groundwater After Drilling
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊤ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-2-14
W.O. 1131.61683.01

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

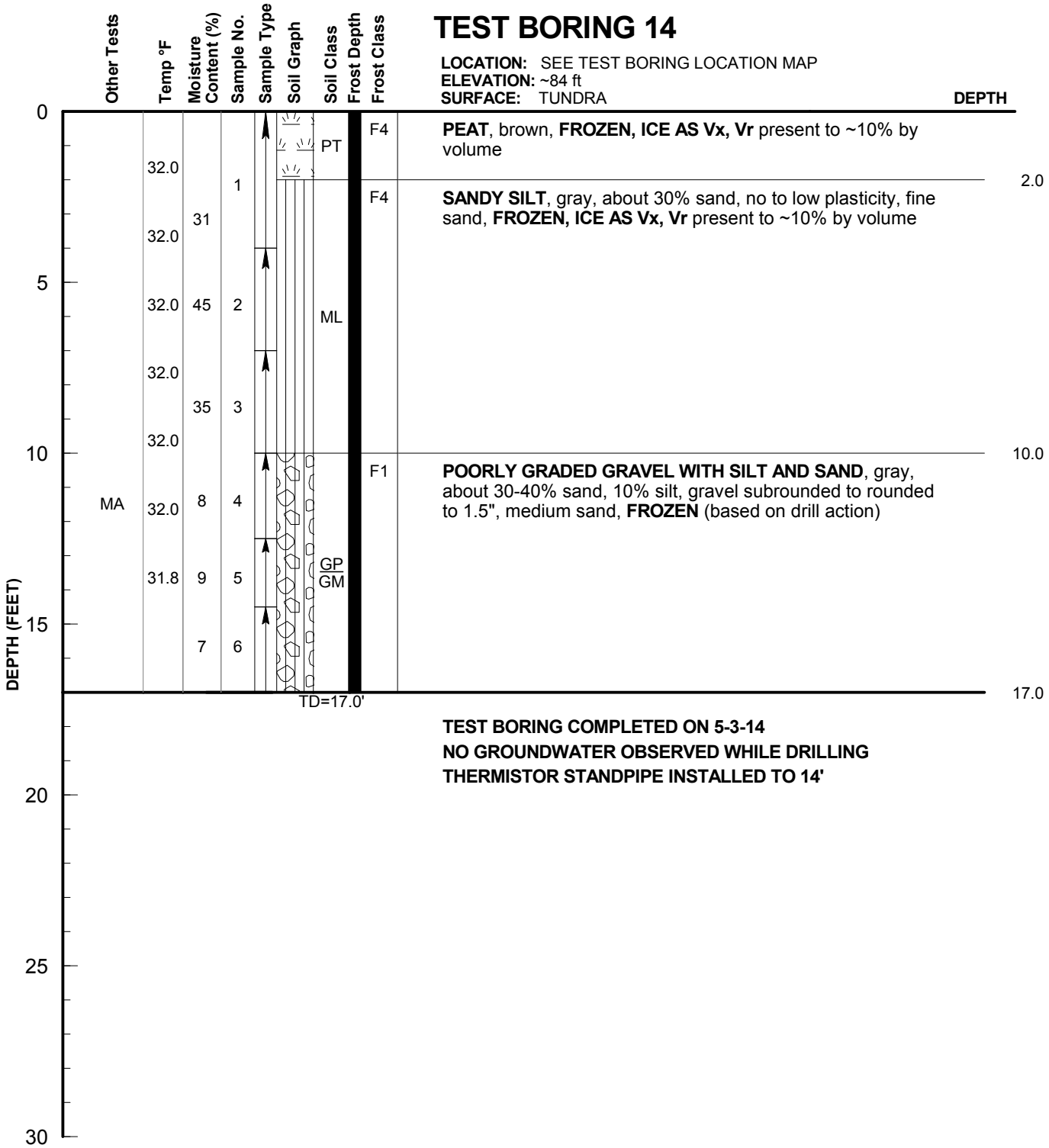
DOWL HKM

LOG OF TEST BORING 13

FIGURE B-13

TEST BORING 14

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~84 ft
SURFACE: TUNDRA



PEAT, brown, **FROZEN, ICE AS Vx, Vr** present to ~10% by volume

SANDY SILT, gray, about 30% sand, no to low plasticity, fine sand, **FROZEN, ICE AS Vx, Vr** present to ~10% by volume

POORLY GRADED GRAVEL WITH SILT AND SAND, gray, about 30-40% sand, 10% silt, gravel subrounded to rounded to 1.5", medium sand, **FROZEN** (based on drill action)

TEST BORING COMPLETED ON 5-3-14
NO GROUNDWATER OBSERVED WHILE DRILLING
THERMISTOR STANDPIPE INSTALLED TO 14'

KEY
MA = Mechanical Analysis
TD = Total Depth
= Grab Sample
= SPT Sample
= Shelby Tube - pushed
= Direct Push Sample
= 2.5" I.D. Spoon Sample 340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-3-14
W.O. 1131.61683.01

DOWL HKM

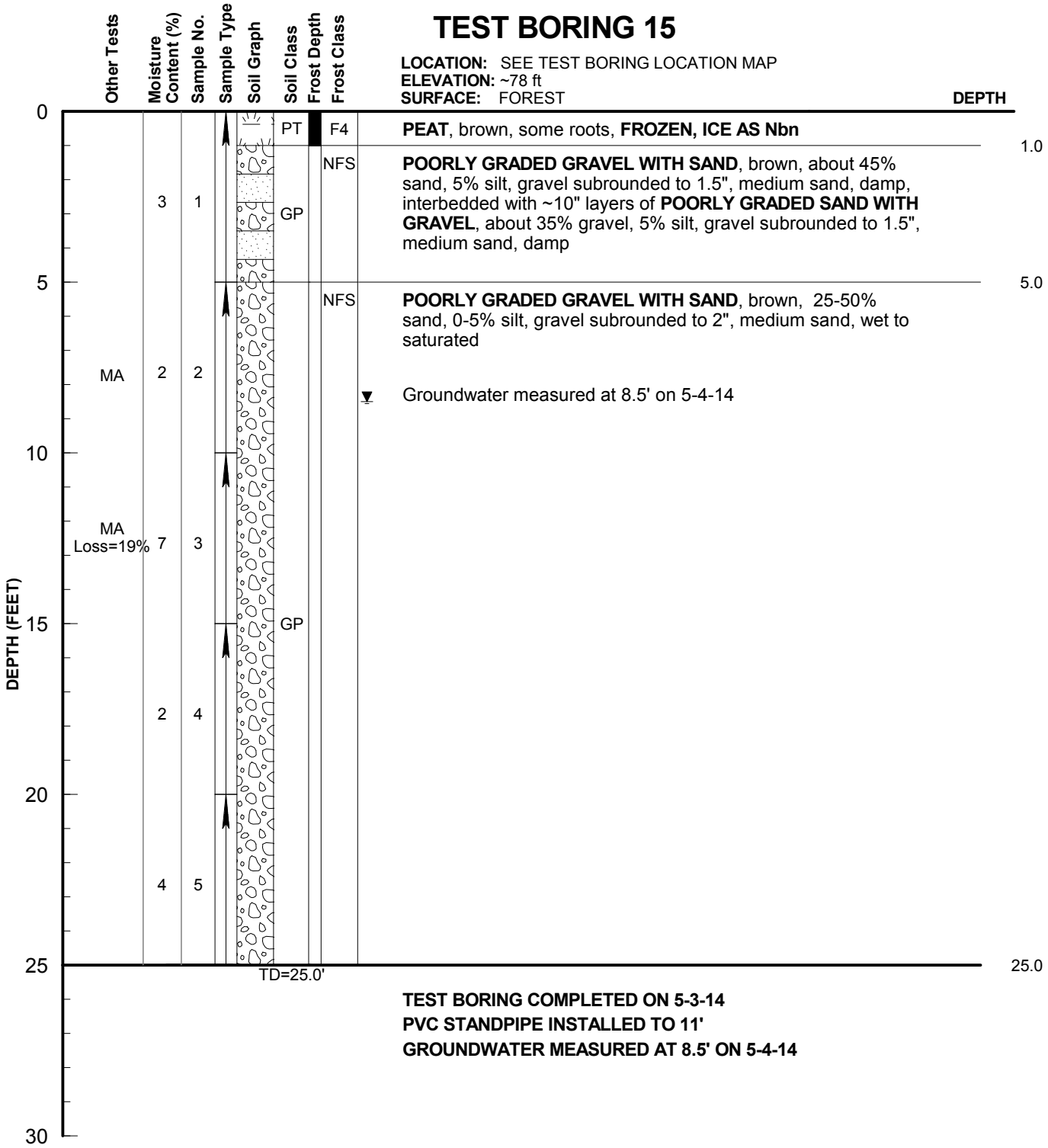
LOG OF TEST BORING 14

FIGURE B-14

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

TEST BORING 15

LOCATION: SEE TEST BORING LOCATION MAP
ELEVATION: ~78 ft
SURFACE: FOREST



PEAT, brown, some roots, **FROZEN, ICE AS Nbn**

POORLY GRADED GRAVEL WITH SAND, brown, about 45% sand, 5% silt, gravel subrounded to 1.5", medium sand, damp, interbedded with ~10" layers of **POORLY GRADED SAND WITH GRAVEL**, about 35% gravel, 5% silt, gravel subrounded to 1.5", medium sand, damp

POORLY GRADED GRAVEL WITH SAND, brown, 25-50% sand, 0-5% silt, gravel subrounded to 2", medium sand, wet to saturated

▼ Groundwater measured at 8.5' on 5-4-14

TEST BORING COMPLETED ON 5-3-14
PVC STANDPIPE INSTALLED TO 11'
GROUNDWATER MEASURED AT 8.5' ON 5-4-14

KEY
MA = Mechanical Analysis
Loss = L.A. Abrasion Test (%)
TD = Total Depth
▼ = Groundwater After Drilling
□ = Grab Sample
◪ = SPT Sample
▨ = Shelby Tube - pushed
⊤ = Direct Push Sample
⧓ = 2.5" I.D. Spoon Sample
340# weight, 30" fall

DRILLING CO.: Discovery Drilling
EQUIPMENT: 6712 DT
OPERATOR: Darrin Vandehey
METHOD: Direct Push 3" MC7 Macro-Core

CLIENT: Maniilaq Association
PROJECT: Noatak Material Site Invest.
LOGGED BY: Paul E. Pribyl
TEST BORING COMPLETED: 5-3-14
W.O. 1131.61683.01

LOG OF EXPLORATION 61683.GPJ BLANK2.GDT 7/28/14

DOWL HKM

LOG OF TEST BORING 15

FIGURE B-15

TEST BORING LOG - DESCRIPTIVE GUIDE

Soil Descriptions - The soil is classified visually in the field based on drill action, auger cuttings, and sample information. The recovered soil samples are classified visually again in the laboratory. The soil description on the boring log is based on an interpretation of the field and laboratory visual classifications, along with the results of laboratory particle-size distribution analyses and Atterberg Limits tests which may have been performed.

The soil classification is based on ASTM Designation D2487 "Standard Test Method for Classification of Soils for Engineering Purposes" and ASTM D2488 "Standard Practice for Description and Identification of Soils (Visual - Manual Procedure)". The soil frost classification is based on the system developed by the U.S. Army Corps of Engineers and is performed in accordance with the Departments of the Army and Air Force Publication TM 5-822-5 "Pavement Design for Roads, Streets, Walks, and Open Storage Areas". Outlines of these classification procedures are presented on the following pages.

The soil color is the subjective interpretation of the individual logging the test boring.

The plasticity of the minus No. 40 fraction of the soil is described and the fine-grained soils are identified from manual tests using the following table as a guide:

Soil Symbol	Dry Strength	Dilatancy	Toughness
ML	none to low	slow to rapid	low or thread cannot be formed
CL	medium to high	none to slow	medium
MH	low to medium	none to slow	low to medium
CH	high to very high	none	high

Plasticity Description	Criteria
Nonplastic	A 1/8" (3.2mm) thread cannot be rolled at any water content.
Low	A thread can barely be rolled and the lump cannot be formed when drier than the plastic limit.
Medium	The thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. The lump crumbles when drier than the plastic limit.
High	It takes considerable time rolling and kneading to reach the plastic limit. The thread can be rerolled several times after reaching the plastic limit. The lump can be formed without crumbling when drier than the plastic limit.

Laboratory Atterberg Limits tests usually are performed on a few of the plastic soils and results are reported on the test boring log. These laboratory tests are performed in accordance with ASTM D4318 "Standard Test Method for Liquid Limit, Plastic Limit, and Plasticity Index of Soils."

The shape of the gravel particles is described based on this guide:

Angular: particles have sharp edges and relatively plane sides with unpolished surfaces.

Subangular: particles are similar to angular but have somewhat rounded edges.

Subrounded:	particles exhibit nearly plane sides but have well-rounded corners and edges.
Rounded:	particles have smoothly curved sides and no edges.

The size of gravel and sand particles is described using this guide:

	Gravel	Sand
Coarse:	Passes 3" (75 mm) sieve, retained on 3/4" (19 mm) sieve	Passes No. 4 sieve, retained on No. 10 sieve
Medium:	N/A	Passes No. 10 sieve, retained on No. 40 sieve
Fine:	Passes 3/4" (19 mm) sieve, retained on No. 4 sieve	Passes No. 40 sieve, retained on No. 200 sieve

The soil moisture is described as:

dry:	powdery, dusty, no visible moisture.
damp:	enough moisture to affect the color of the soil; moist.
wet:	water in pores but not dripping; capillary zone above water table.
saturated:	dripping wet, contains significant free water, or sampled below water table.

The subjective estimate of the density of coarse-grained soils is based on the observed drill action and on drive sample data. The guide below is used for sands with minor amounts of fine gravel; however, blowcounts can be affected strongly by gravel content, thermal state, drilling procedures, condition of equipment and performance of the test.

Standard Penetration Resistance N (blows / foot) or N (blows / 300 mm)	Soil Density
0 - 5	Very loose
6 - 10	Loose
11 - 30	Medium dense
31 - 50	Dense
More than 50	Very dense

An estimate of the consistency of fine-grained soils is based on the observed drill action and on drive sample data. The guide below is used:

Standard Penetration Resistance N (blows / foot) or N (blows / 300 mm)	Soil Consistency
0 - 2	Very soft
3 - 4	Soft
5 - 8	Firm
9 - 15	Stiff
15 - 30	Very stiff
More than 30	Hard

Soil Layer Boundaries - Generally, there is a gradual transition from one soil type to another in a natural soil deposit, and it is difficult to determine accurately the boundaries of the soil layers.

- A *diagonal line* between soil layers on the graphic boring log indicates the general region of transition from one soil layer to another.
- A *dashed diagonal line* indicates the soil boundary was detected only by a change in the recovered samples and the actual boundary may be anywhere between the indicated sample depths.
- A *horizontal line* between soil layers indicates a relatively distinct transition between soil types was observed in the recovered samples and / or by a distinct change in drill action.

Sample Interval - The sample interval is shown graphically on the test boring log and generally is accurate to about 0.5 foot (0.15 meter).

Frost Depth and Soil Temperatures - If frozen ground is encountered during drilling, the interval of frozen soil is shown graphically on the test boring log. Generally, the temperature of a few soil samples is measured and shown on the boring log. These sample temperatures only give a qualitative indication of the *in situ* soil temperatures. The temperature of samples can be influenced significantly by the ambient air temperature and friction during drilling and sampling.

Soil Moisture Content - Generally, laboratory soil moisture content tests are performed on all recovered samples. Only about 30 grams of the minus No. 4 material typically is used for the moisture content test, so results reported on the log may not reflect accurately the *in situ* moisture content of gravelly soils.

Soil Density - The soil density shown on the test boring logs generally is determined by measuring the wet weight, moisture content, and physical dimensions of relatively undisturbed specimens.

Ground Water - The depth to ground water observed during drilling generally is shown on the test boring log. The depth to ground water observed during drilling can differ significantly from the depth to the actual ground water table, particularly in fine-grained soils. When more accurate water level measurements are desired, we typically install perforated PVC pipe in a boring to monitor the ground water level.

Penetration Resistance, N - Standard penetration tests (SPT) are performed in accordance with ASTM Designation D1586 "Standard Method for Penetration Test and Split-Barrel Sampling of Soils." A modified penetration test using a 2.5-inch (63.5 mm) I.D. split spoon driven with a 340-pound (154.2 kg) hammer falling 30 inches (.76 m) is performed to obtain larger samples, particularly in gravelly soils. The boring log key describes the graphic symbols used to differentiate between sample types.

Undisturbed Samples - Undisturbed Shelby tube samples are obtained in accordance with ASTM Designation D1587, "Standard Practice for Thin-Walled Tube Sampling of Soils." Generally, 3-inch (76.2 mm) O.D. Shelby tubes are used. Relatively undisturbed liner samples are obtained in accordance with ASTM Designation D3550, "Standard Practice for Ring-Lined Barrel Sampling of Soils," except a thick-walled cutting shoe is used. Typically, the sampler is driven using a 340-pound (154.2 kg) weight falling 30 inches (.76 m). The typical brass liner has an I.D. of 2.4 inches (91 mm).

Grab Samples - Grab samples are obtained from the auger flights. The sample depth and interval indicated on the test boring log should be considered a rough approximation. The grab samples may not be representative of *in situ* soils, particularly in layered soil deposits.

CLASSIFICATION OF SOILS FOR ENGINEERING PURPOSES
ASTM DESIGNATION: D2487
Based on the Unified Soil Classification System

Criteria for Assigning Group Symbols and Group Names Using Laboratory Tests[A]				Soil Classification	
				Group Symbol	Group Name[B]
Coarse-Grained Soils	Gravels	Clean Gravels	$Cu \geq 4$ and $1 \leq Cc \leq 3$[E]	GW	Well-graded gravel[F]
More than 50% retained on #200 sieve	More than 50% of coarse fraction retained on #4 sieve	Less than 5% fines[C]	$Cu < 4$ and/or $1 > Cc > 3$[E]	GP	Poorly graded gravel[F]
		Gravel with Fines	Fines classify as ML or MH	GM	Silty gravel [F,G,H]
		More than 12% fines[C]	Fines classify as CL or CH	GC	Clayey gravel [F, G, H]
	Sands	Clean Sands	$Cu \geq 6$ and $1 \leq Cc \leq 3$[E]	SW	Well-graded sand[I]
	50% or more of coarse fraction passes #4 sieve	Less than 5% fines[D]	$Cu < 6$ and/or $1 > Cc > 3$[E]	SP	Poorly graded sand[I]
		Sands with Fines	Fines classify as ML or MH	SM	Silty Sand [G,H,I]
		More than 12% fines[D]	Fines classify as CL or CH	SC	Clayey Sand [G,H,I]
Fine-Grained Soils	Silts and Clays	Inorganic	PI > 7 and plots on or above "A" line [J]	CL	Lean Clay [K,L,M]
50% or more passes the #200 sieve	Liquid limit less than 50		PI < 4 or plots below "A" Line [J]	ML	Silt[K,L,M]
		Organic	Liquid limit - oven dried <0.75	OL	Organic Clay [K,L,M,N]
			Liquid limit - not dried	OL	Organic silt [K,L,M,O]
	Silts and Clays	Inorganic	PI plots on or above "A" line	CH	Fat clay [K,L,M]
	Liquid limit 50 or more		PI plots below "A" line	MH	Elastic silt [K,L,M]
		Organic	Liquid limit - oven dried <0.75	OH	Organic clay[K,L,M,P]
			Liquid limit - not dried	OH	Organic clay[K,L,M,Q]
Highly organic soils		Primarily organic matter,	dark in color, and organic odor	PT	Peat

A Based on the material passing the 3-in. (75mm) sieve.

B If field sample contained cobbles or boulders, or both, add "with cobbles or boulders, or both" to group name.

C Gravels with 5 to 12% fines require dual symbols:
- GW-GM well-graded gravel with silt
- GW-GC well-graded gravel with clay
- GP-GM poorly graded gravel with silt
- GP-GC poorly graded gravel with clay

D Sands with 5 to 12% fines require dual symbols:
- SW-SM well-graded sand with silt
- SW-SC well-graded sand with clay
- SP-SM poorly graded sand with silt
- SP-SC poorly graded sand with clay

E $Cu = \frac{D60}{D10}$ $Cc = \frac{(D30)^2}{D10 * D60}$

F If soil contains ≥ 15% sand, add "with sand" to group name.

G If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM.

H If fines are organic, add "with organic fines" to group name.

I If soil contains ≥ 15% gravel, add "with gravel" to group name.

J If Atterberg Limits plot in hatched area, soil is a CL-ML, silty clay.

K If soil contains 15 to 29% plus No. 200, add "with sand" or "with gravel", whichever is predominant.

L If soil contains ≥ 30% plus No. 200, predominantly sand, add "sandy" to group name.

M If soil contains ≥30% plus No. 200, predominantly gravel, add "gravelly" to group name.

N PI ≥ 4 and plots on or above "A" line.

O PI < 4 or plots below "A" line.

P PI plots on or above "A" line.

Q PI plots below "A" line.

DESCRIPTION OF FROZEN SOILS (Visual-Manual Procedure) ASTM Designation: D4083

Part I Description of Soil Phase	Classify Soil Phase by ASTM D2487 or D2488				
Part II Description of Frozen Soil	Segregated ice is not visible by eye	N	Poorly bonded or friable	N_f	Identify by visual examination. To determine presence of excess ice, use procedures under Note 2 and hand magnifying lens as necessary. For soils not fully saturated, estimate degree of ice saturation; medium, low. Note presence of crystals or of ice coatings around larger particles.
			No excess ice Well-bonded Excess ice	N_b N_{bn} N_{be}	
	Segregated ice is visible by eye (ice 1-inch (25 mm) or less in thickness)	V	Individual ice crystal or inclusions	V_x	For ice phase, record the following when applicable: Location Structure Orientation Color Thickness Size Length Shape Spacing Hardness Pattern of arrangement
			Ice coatings on particles	V_c	
			Random or irregularly oriented ice formations	V_r	
			Stratified or distinctly oriented ice formations	V_s	
			Uniformly distributed ice	V_u	Estimate volume of visible segregated ice present as percentage of total sample volume.
Part III Description of Substantial Ice	Ice (greater than 1-inch (25 mm) in thickness)	ICE	Ice with soil inclusions	ICE + Soil Type	Designate material as ICE (Note 3) and use descriptive terms as follows, usually one item from each group, where applicable: **Hardness** HARD SOFT [of mass, not individual crystals] **Color** (Examples): COLORLESS GRAY BLUE **Structure** (Note 4) CLEAR CLOUDY POROUS CANDLED GRANULAR STRATIFIED **Admixtures** (Examples) CONTAINS FEW THIN SILT INCLUSIONS
			Ice without soil inclusions	ICE	

Note 1: Frozen soils in the N group may, on close examination, indicate presence of ice within the voids of the material by crystalline reflections or by a sheen on fractured or trimmed surfaces. The impression received by the unaided eye, however, is that none of the frozen water occupies space in excess of the original voids in the soil. The opposite is true of frozen soils in the V group.

Note 2: When visual methods may be inadequate, a simple field test to aid in evaluation of the volume of excess ice can be made by placing some frozen soil in a small jar, allowing it to melt, and observing the quantity of supernatant water as a percentage of total volume.

Note 3: Where special forms of ice such as hoarfrost can be distinguished, more explicit description should be given.

Note 4: Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

DEFINITIONS

1) Ice coatings on Particles - discernible layers of ice found on or below the larger soil particles in a frozen soil mass.
2) Ice Crystal - a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in combination with other ice formations.
3) Clear Ice - ice that is transparent and contains only a moderate number of air bubbles.
4) Cloudy Ice - ice that is translucent or relatively opaque due to the content of air or for other reasons, but which is essentially sound and impervious.
5) Porous Ice - ice that contains numerous voids, usually interconnected and usually resulting from melting at air bubbles or along crystal interfaces from presence of salt or other materials in the water, or from the freezing of saturated snow. Though porous, the mass retains its structural unity.
6) Candled Ice - ice that has rotted or otherwise formed into long columnar crystals, very loosely bonded together.
7) Granular Ice - ice that is composed of coarse, more or less equidimensional crystals weakly bonded together.
8) Ice Lenses - lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss, and commonly in repeated layers.
9) Ice Segregation - the growth of ice within soil in excess of the amount that may be produced by the in-place conversion of the original void moisture to ice. Ice segregation occurs most often as distinct lenses, layers, veins, and masses, commonly, but not always, oriented normal to the direction of heat loss.
10) Well-Bonded - a condition in which the soil particles are strongly held together by the ice so that the frozen soil possesses relatively high resistance to chipping or breaking.
11) Poorly-Bonded - a condition in which the soil particles are weakly held together by the ice so that the frozen soil has poor resistance to chipping and breaking.
12) Thaw Stable - the characteristics of frozen soils that, upon thawing, do not show loss of strength in comparison to normal, long-time thawed values nor produce detrimental settlement.

FROST DESIGN SOIL CLASSIFICATION[1]

Frost[2] Group	Kind of Soil	Percentage Finer than 0.02 mm by Weight	Typical Soil Types Under Unified Soil Classification System
NFS[3]	(a) Gravels Crushed stone Crushed rock	0 to 1.5	GW and GP
	(b) Sands	0 to 3	SW and SP
PFS[4] (MOA NFS)	(a) Gravels Crushed stone Crushed rock	1.5 to 3	GW and GP
(MOA F2)	(b) Sands	3 to 10	SW and SP
S1 (MOA F1)	Gravelly soils	3 to 6	GW, GP, GW-GM, and GP-GM
S2 (MOA F2)	Sandy soils	3 to 6	SW, SP, SW-SM, and SP-SM
F1	Gravelly soils	6 to 10	GM, GW-GM, and GP-GM
F2	(a) Gravelly soils	10 to 20	GM, GW-GM, and GP-GM
	(b) Sands	6 to 15	SM, SW-SM, and SP-SM
F3	(a) Gravelly soils	Over 20	GM and GC
	(b) Sands, except very fine silty sands	Over 15	SM and SC
	(c) Clays, P1>12		CL and CH
F4	(a) All silts		ML and MH
	(b) Very fine silty sands	Over 15	SM
	(c) Clays, P1<12		CL and CL-ML
	(d) Varved clays and other fine-grained, banded sediments		CL and ML CL, ML, and SM CL, CH, and ML CL, CH, ML and SM

1

[1] Departments of the Army and Air Force Publication TM 5-822-5/AFM 88-7, "Pavement Design for Roads, Streets, Walks, and Open Storage Areas", Table 18-2.
[2] Corps of Engineers Frost groups directly correspond to the Municipality of Anchorage soil frost classification groups, except as noted.
[3] Non Frost-Susceptible.
[4] Possibly frost-susceptible, but requires laboratory test to determine frost design soil classification.

APPENDIX C

Laboratory Test Results

DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

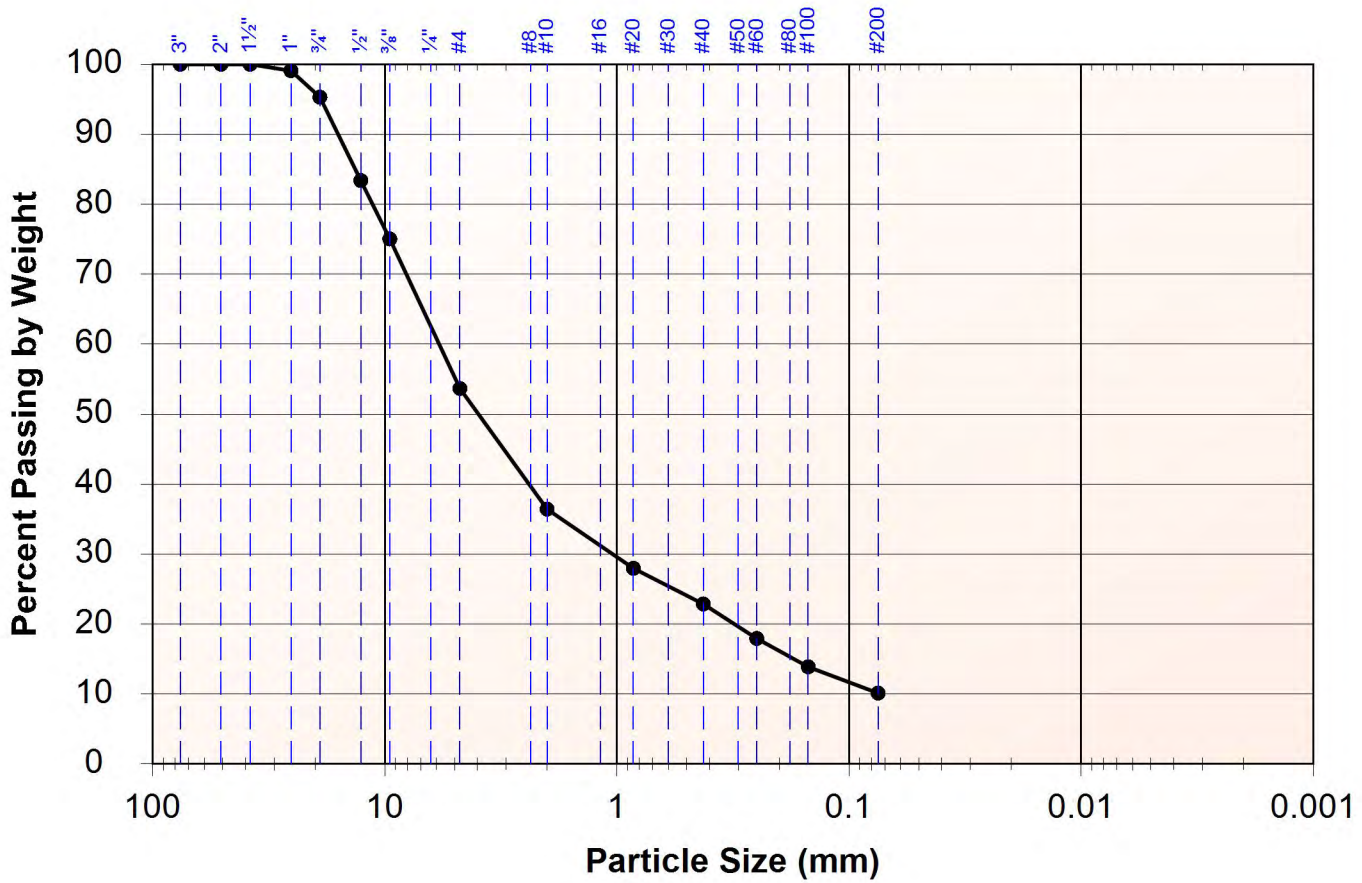
ASTM D422

Location: Test Boring 02
Sample 4
Depth 10'-13'

Lab Number	2014-439
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Silt and Sand, GW-GM**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	99%	
¾"	95%	
½"	83%	
⅜"	75%	
#4	54%	
Total Weight of Sample 7167g		
#10	36%	
#20	28%	
#40	23%	
#60	18%	
#100	14%	
#200	10.1%	
Total Weight of Fine Fraction 326.4g		

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DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

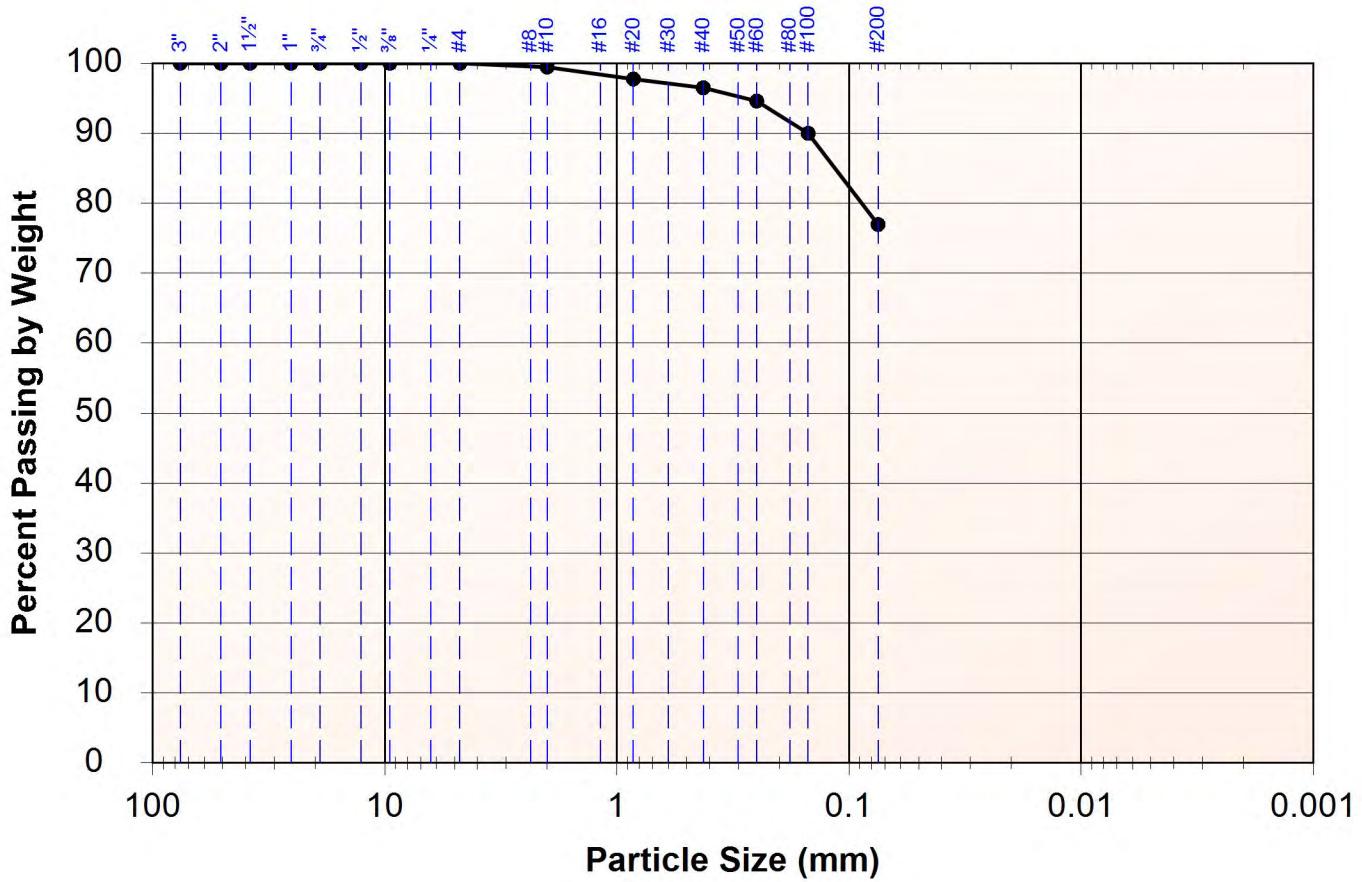
ASTM D422

Location: Test Boring 03
Sample 5
Depth 9.5'-12.5'

Lab Number	2014-440
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Silt with Sand, ML**

Frost Classification: **F4**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	100%	
¾"	100%	
½"	100%	
⅜"	100%	
#4	100%	
Total Weight of Sample 1442.3g		
#10	99%	
#20	98%	
#40	96%	
#60	95%	
#100	90%	
#200	77.0%	
Total Weight of Fine Fraction 305.4g		

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DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

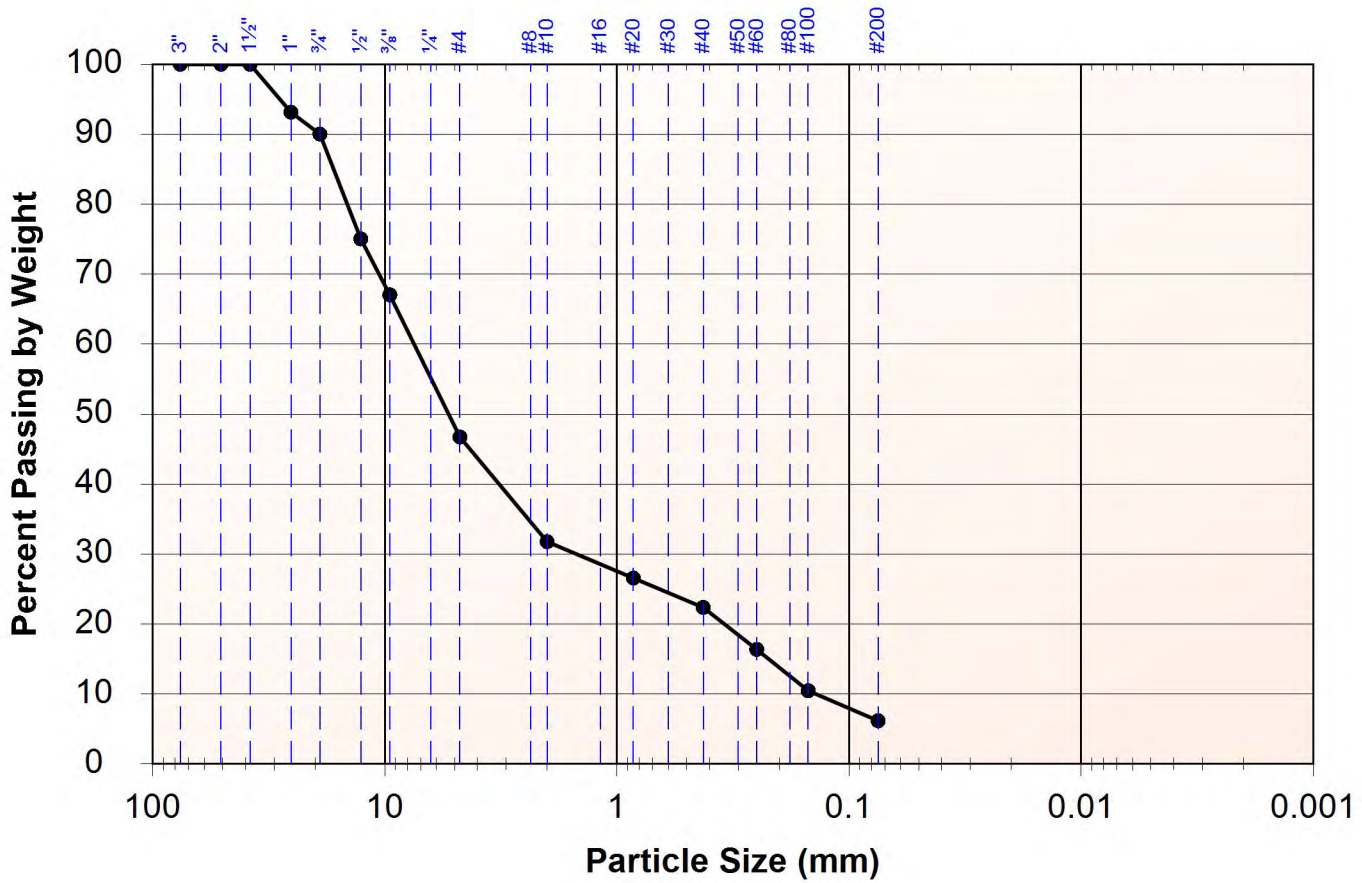
ASTM D422

Location: Test Boring 03
Sample 6
Depth 13'-15'

Lab Number	2014-441
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Silt and Sand, GW-GM**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	93%	
¾"	90%	
½"	75%	
⅜"	67%	
#4	47%	
Total Weight of Sample 3542.7g		
#10	32%	
#20	27%	
#40	22%	
#60	16%	
#100	10%	
#200	6.2%	
Total Weight of Fine Fraction 392.7g		

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DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

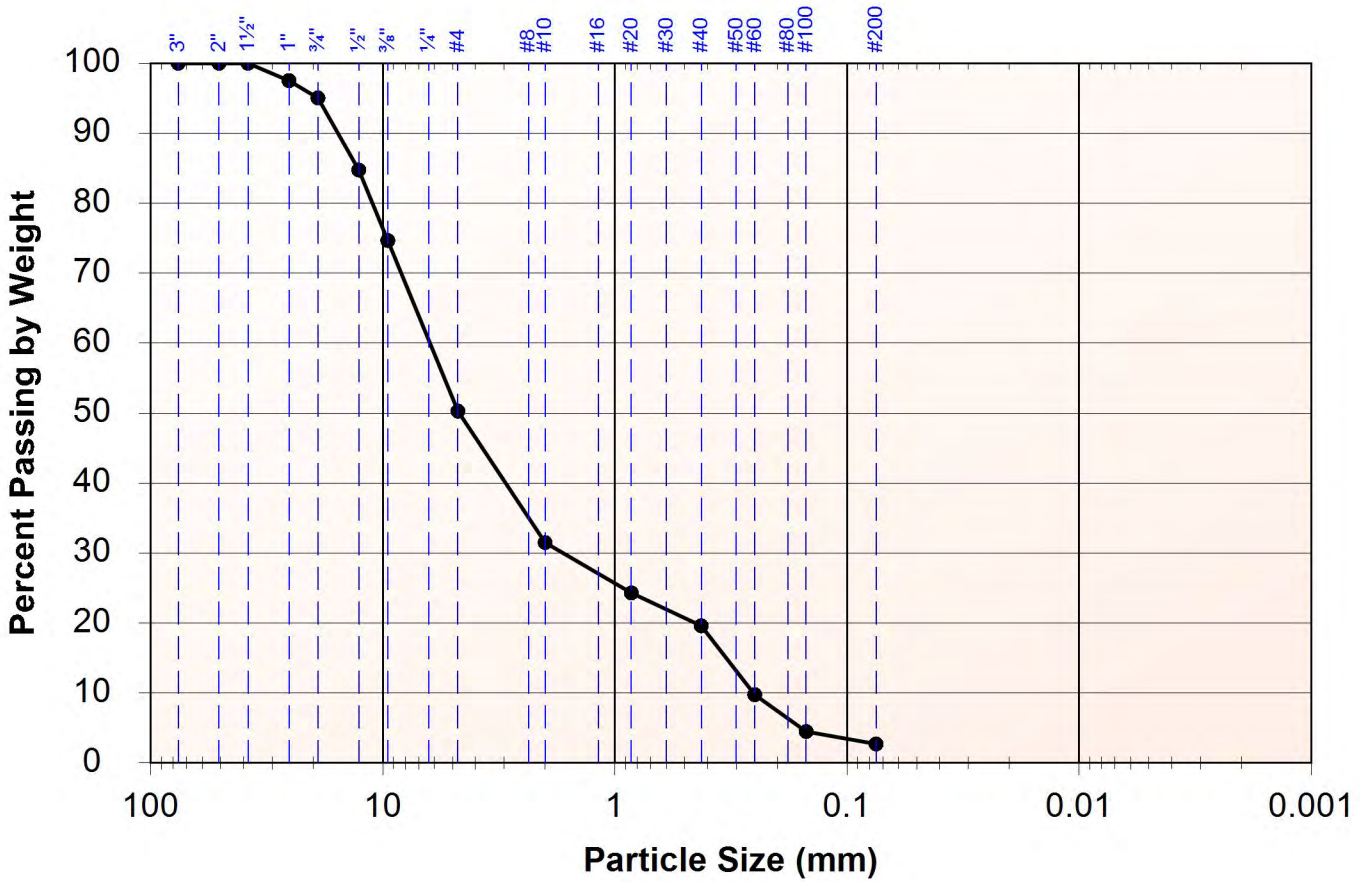
ASTM D422

Location: Test Boring 04
Sample 3
Depth 8.5'-12'

Lab Number	2014-442
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	98%	
¾"	95%	
½"	85%	
⅜"	75%	
#4	50%	
Total Weight of Sample 5304g		
#10	31%	
#20	24%	
#40	20%	
#60	10%	
#100	4%	
#200	2.7%	
Total Weight of Fine Fraction 397.8g		

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DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

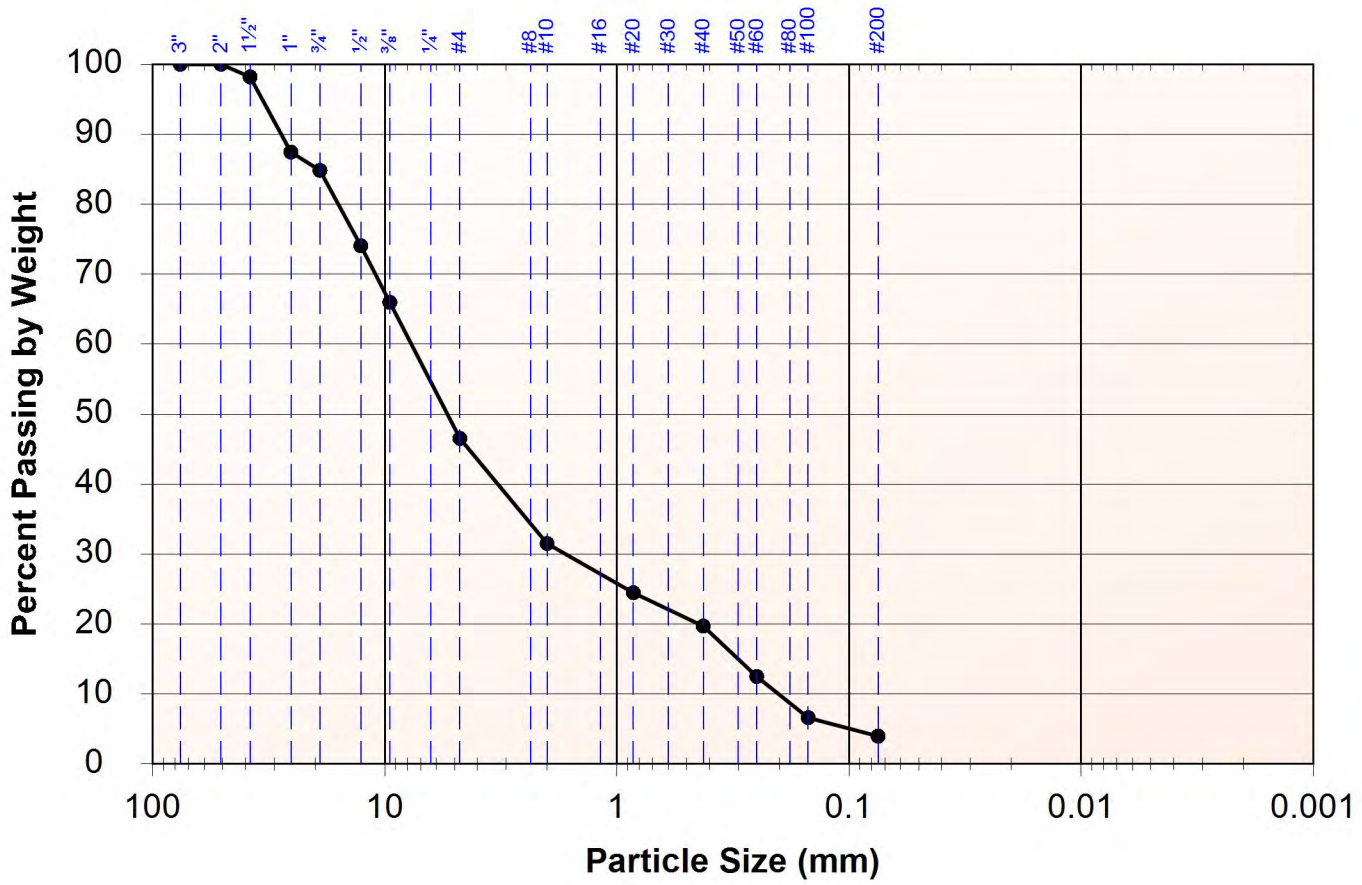
ASTM D422

Location: Test Boring 04
Sample 4
Depth 12'-15'

Lab Number	2014-443
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	98%	
1"	87%	
¾"	85%	
½"	74%	
⅜"	66%	
#4	47%	
Total Weight of Sample 5710.0g		
#10	31%	
#20	24%	
#40	20%	
#60	13%	
#100	7%	
#200	4.0%	
Total Weight of Fine Fraction 401.6g		

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DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

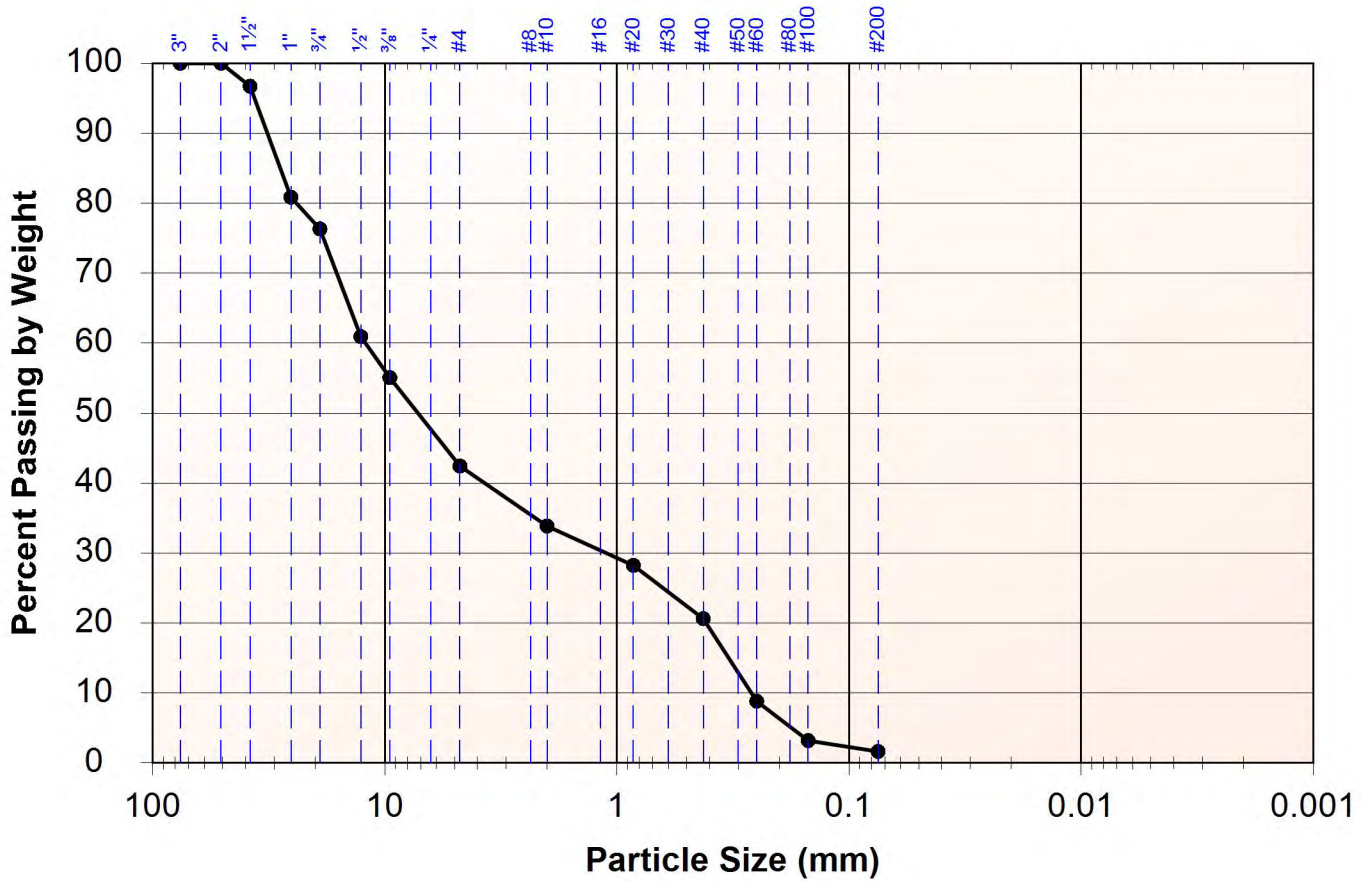
ASTM D422

Location: Test Boring 05
Sample 3
Depth 5'-8.5'

Lab Number	2014-444
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Sand, GP**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	97%	
1"	81%	
¾"	76%	
½"	61%	
⅜"	55%	
#4	42%	
Total Weight of Sample 6033g		
#10	34%	
#20	28%	
#40	21%	
#60	9%	
#100	3%	
#200	1.6%	
Total Weight of Fine Fraction 341.6g		

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Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

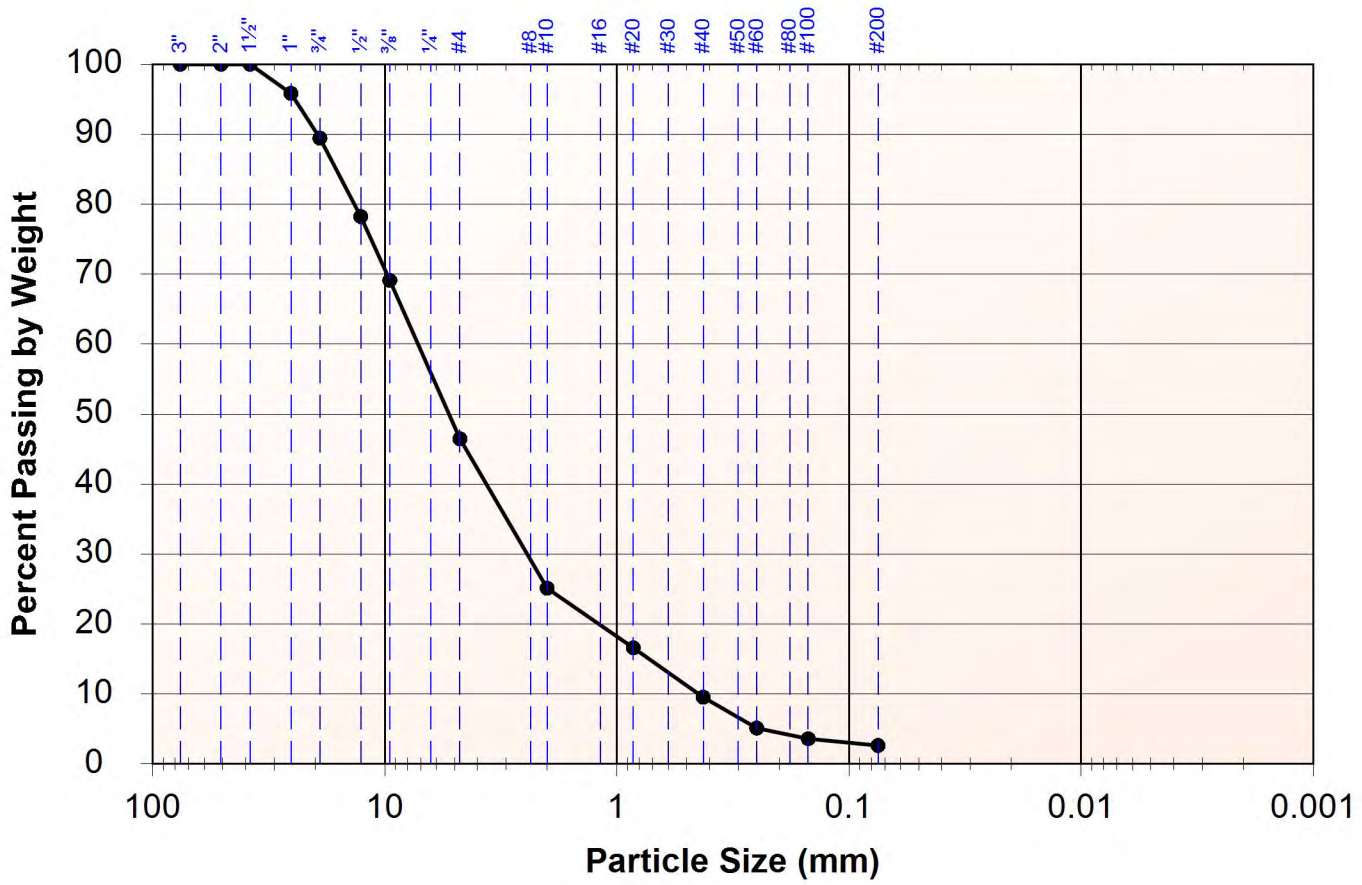
ASTM D422

Location: Test Boring 05
Sample 4
Depth 10'-13'

Lab Number	2014-445
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	96%	
¾"	89%	
½"	78%	
⅜"	69%	
#4	46%	
Total Weight of Sample 6512g		
#10	25%	
#20	17%	
#40	10%	
#60	5%	
#100	4%	
#200	2.6%	
Total Weight of Fine Fraction 327.3g		

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Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

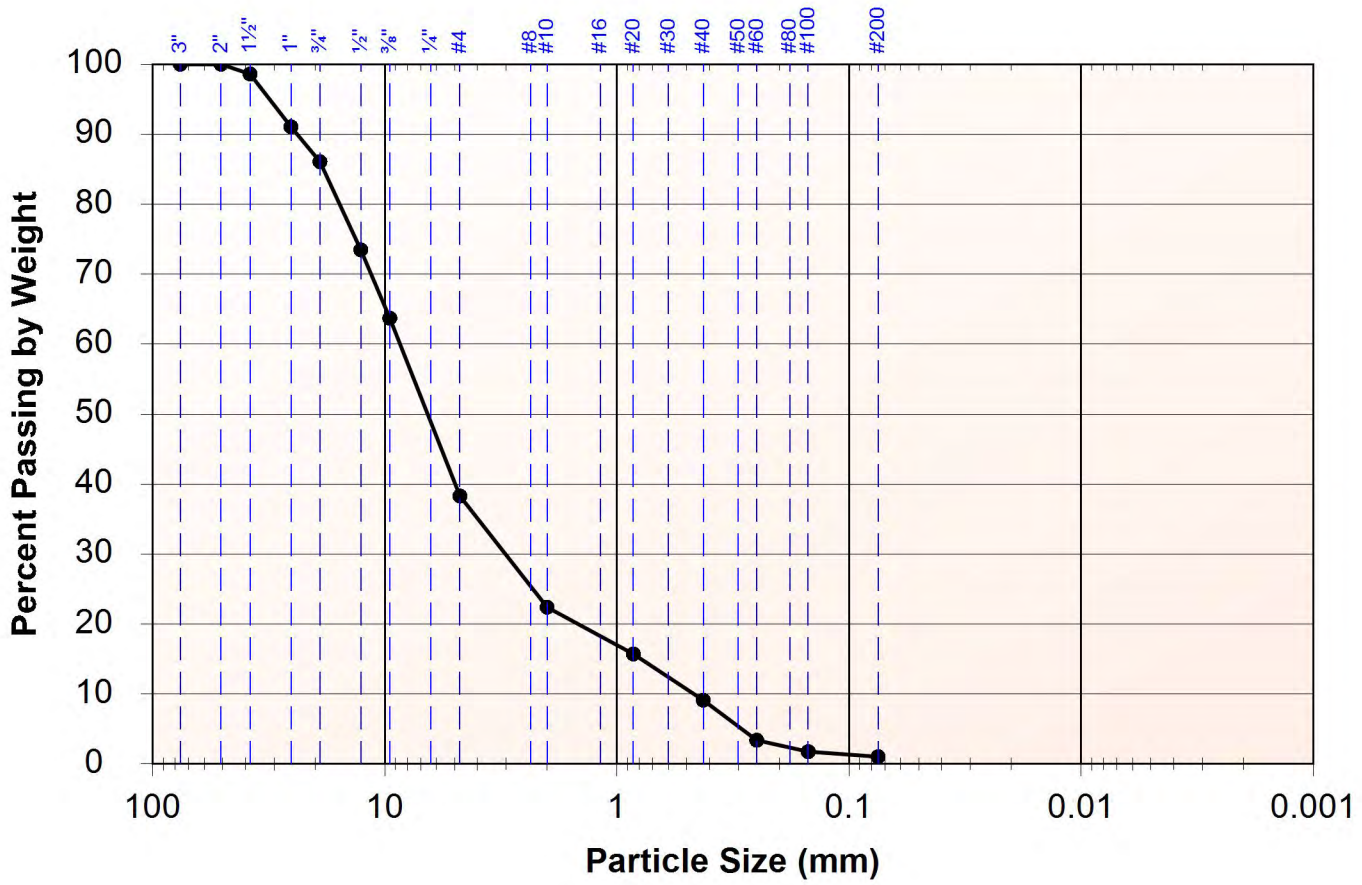
ASTM D422

Location: Test Boring 06
Sample 2
Depth 5'-9'

Lab Number	2014-446
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	99%	
1"	91%	
¾"	86%	
½"	73%	
⅜"	64%	
#4	38%	
Total Weight of Sample 6737g		
#10	22%	
#20	16%	
#40	9%	
#60	3%	
#100	2%	
#200	1.0%	
Total Weight of Fine Fraction 353g		

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Particle Size Distribution

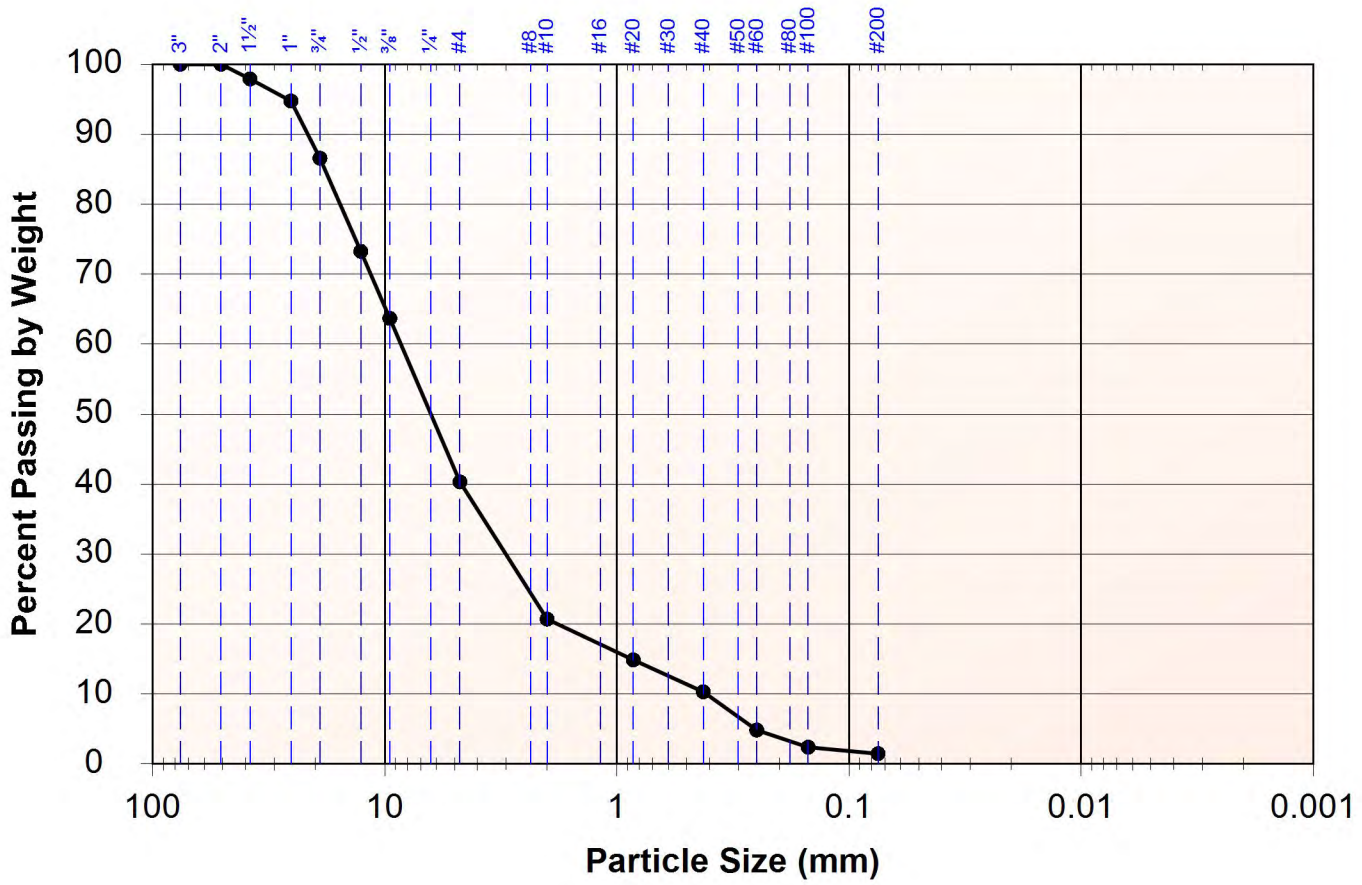
ASTM D422

Location: Test Boring 06
Sample 3
Depth 10'-12'

Lab Number	2014-447
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	98%	
1"	95%	
¾"	87%	
½"	73%	
⅜"	64%	
#4	40%	
Total Weight of Sample 5147g		
#10	21%	
#20	15%	
#40	10%	
#60	5%	
#100	2%	
#200	1.5%	
Total Weight of Fine Fraction 569.7g		

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Particle Size Distribution

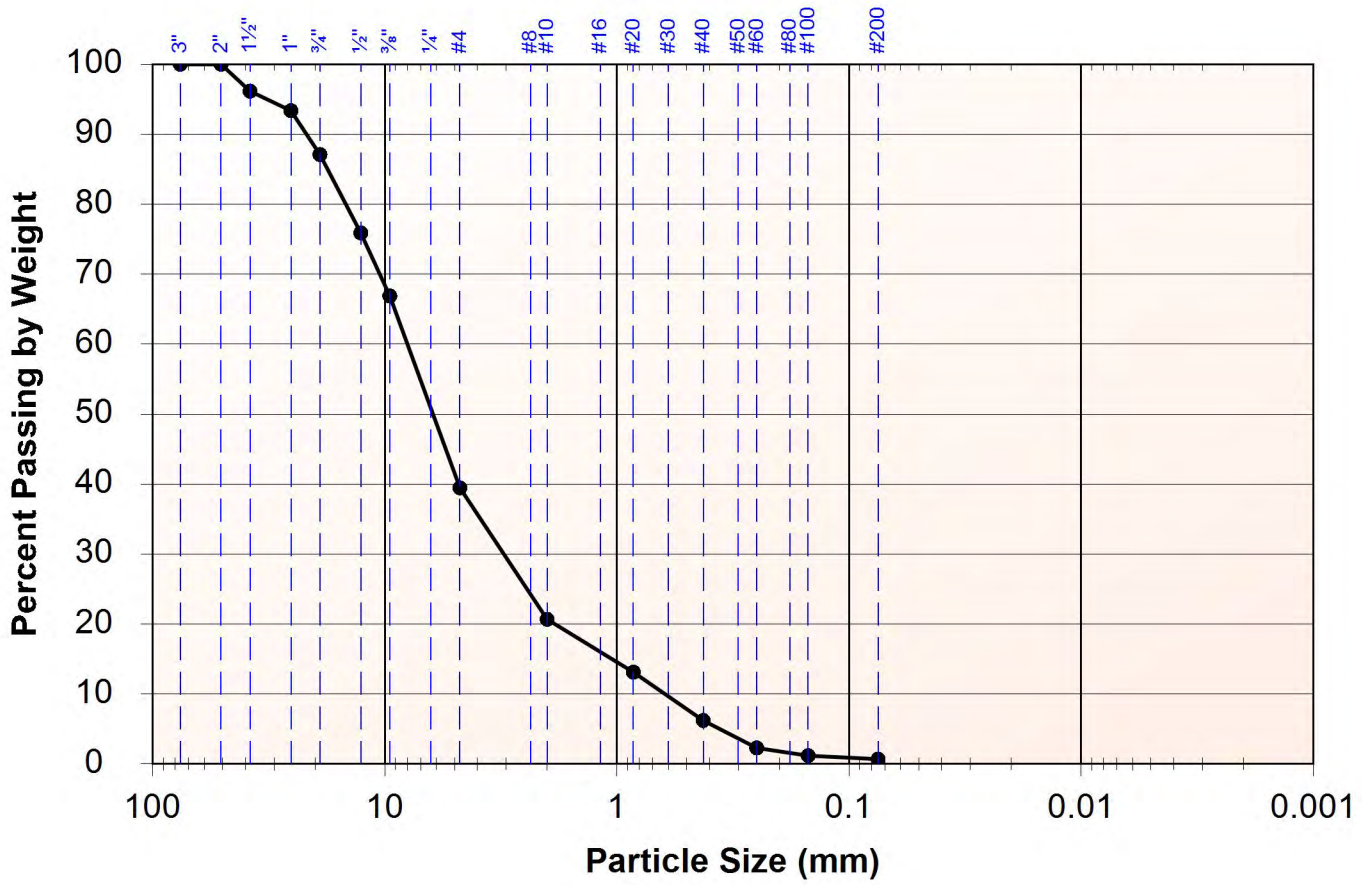
ASTM D422

Location: Test Boring 07
Sample 1
Depth 1'-4'

Lab Number	2014-448
Received	5/19/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	96%	
1"	93%	
¾"	87%	
½"	76%	
⅜"	67%	
#4	39%	
Total Weight of Sample 3766g		
#10	21%	
#20	13%	
#40	6%	
#60	2%	
#100	1%	
#200	0.7%	
Total Weight of Fine Fraction 311.8g		

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Particle Size Distribution

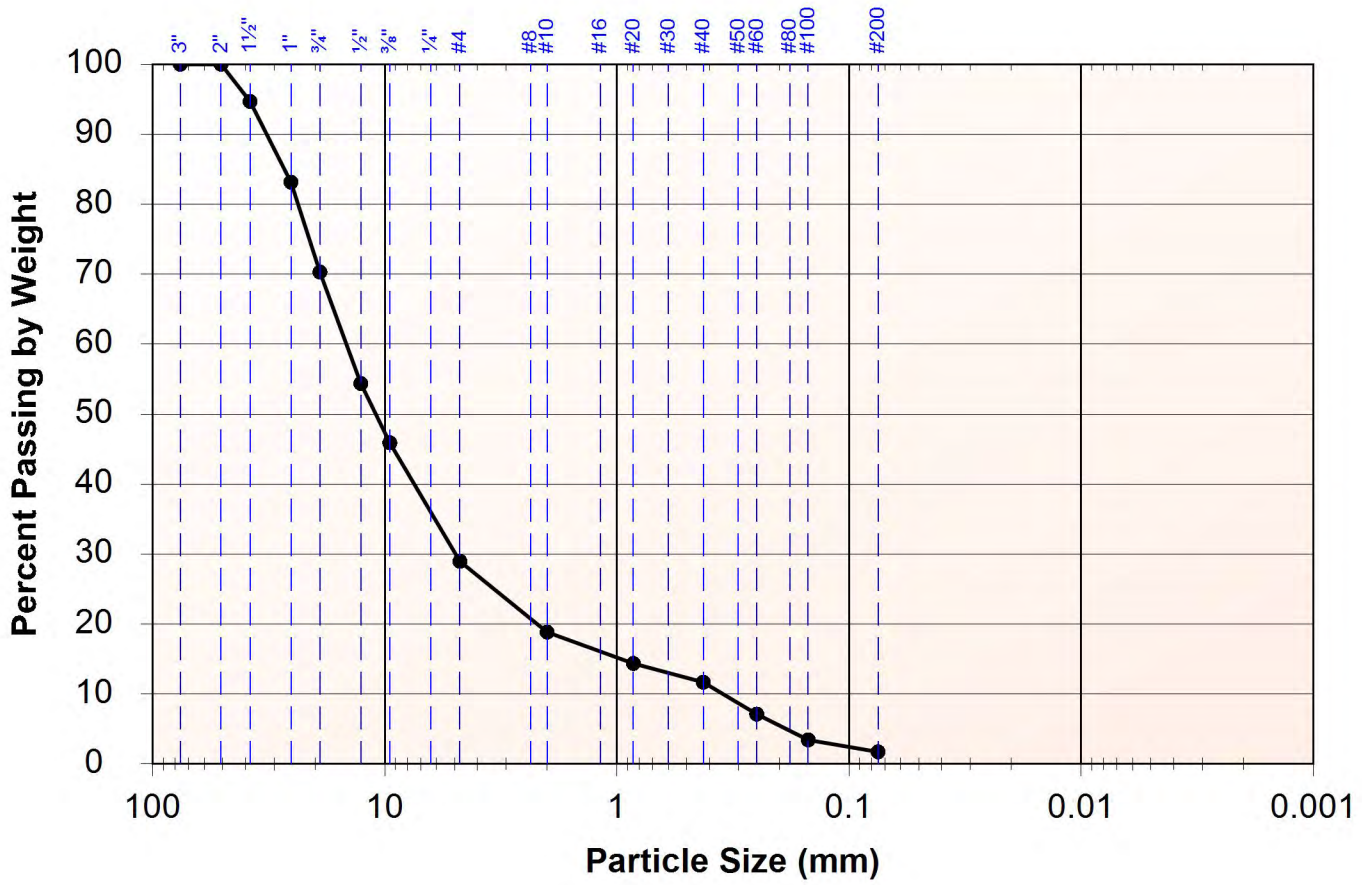
ASTM D422

Location: Test Boring 07
Sample 3
Depth 10'-13'

Lab Number	2014-449
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Sand, GP**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	95%	
1"	83%	
¾"	70%	
½"	54%	
⅜"	46%	
#4	29%	
Total Weight of Sample 6416g		
#10	19%	
#20	14%	
#40	12%	
#60	7%	
#100	3%	
#200	1.7%	
Total Weight of Fine Fraction 329.8g		

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Project: Noatak Material Site Investigation
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Particle Size Distribution

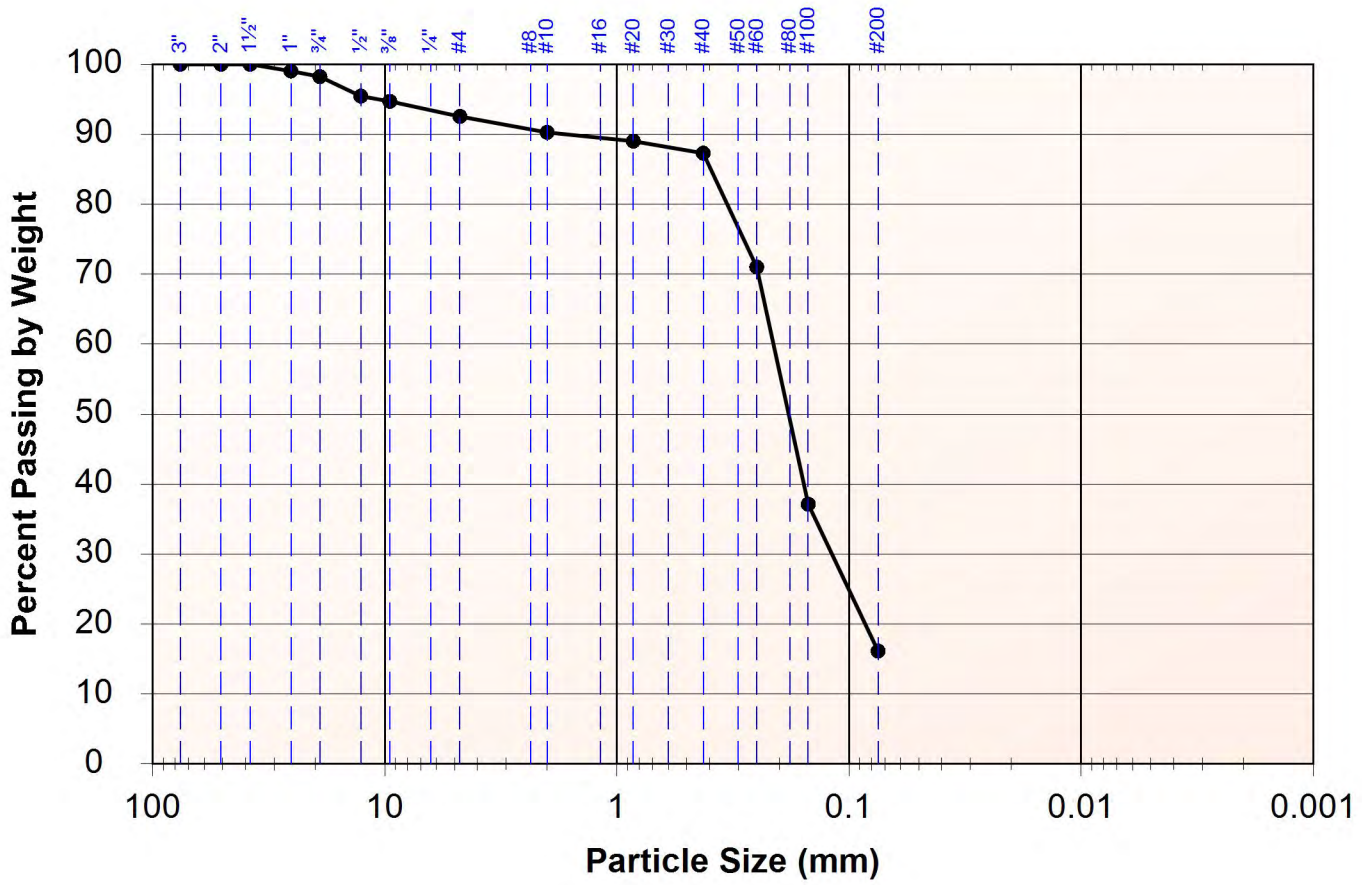
ASTM D422

Location: Test Boring 08
Sample 1
Depth 2'-5'

Lab Number	2014-450
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Silty Sand, SM**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	99%	
¾"	98%	
½"	95%	
⅜"	95%	
#4	93%	
Total Weight of Sample 2255.6g		
#10	90%	
#20	89%	
#40	87%	
#60	71%	
#100	37%	
#200	16.1%	
Total Weight of Fine Fraction 301.8g		

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Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

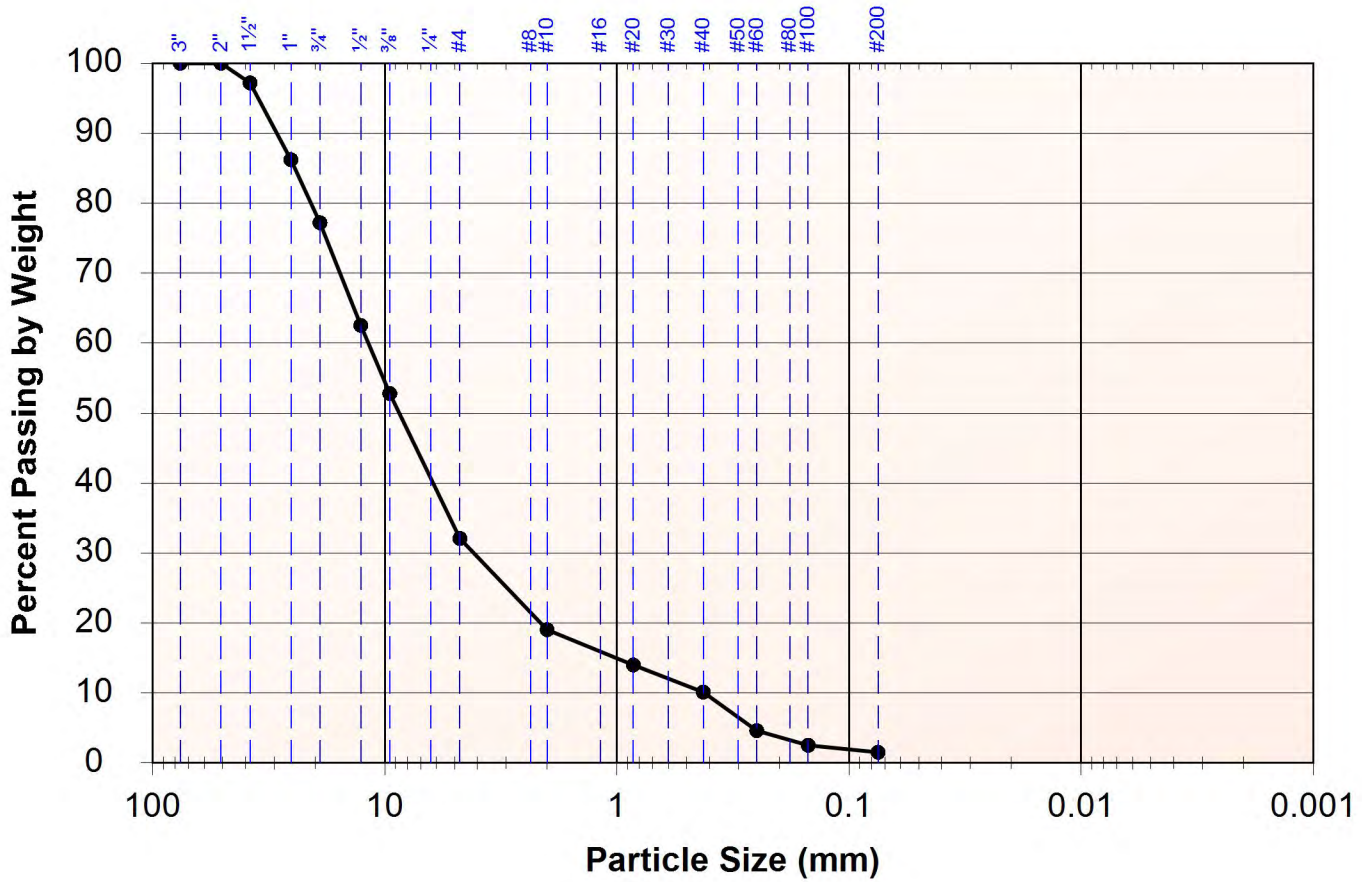
ASTM D422

Location: Test Boring 08
Sample 3
Depth 10'-15'

Lab Number	2014-451
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Sand, GP**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	97%	
1"	86%	
¾"	77%	
½"	63%	
⅜"	53%	
#4	32%	
Total Weight of Sample 4157.8g		
#10	19%	
#20	14%	
#40	10%	
#60	5%	
#100	3%	
#200	1.5%	
Total Weight of Fine Fraction 381.6g		

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Particle Size Distribution

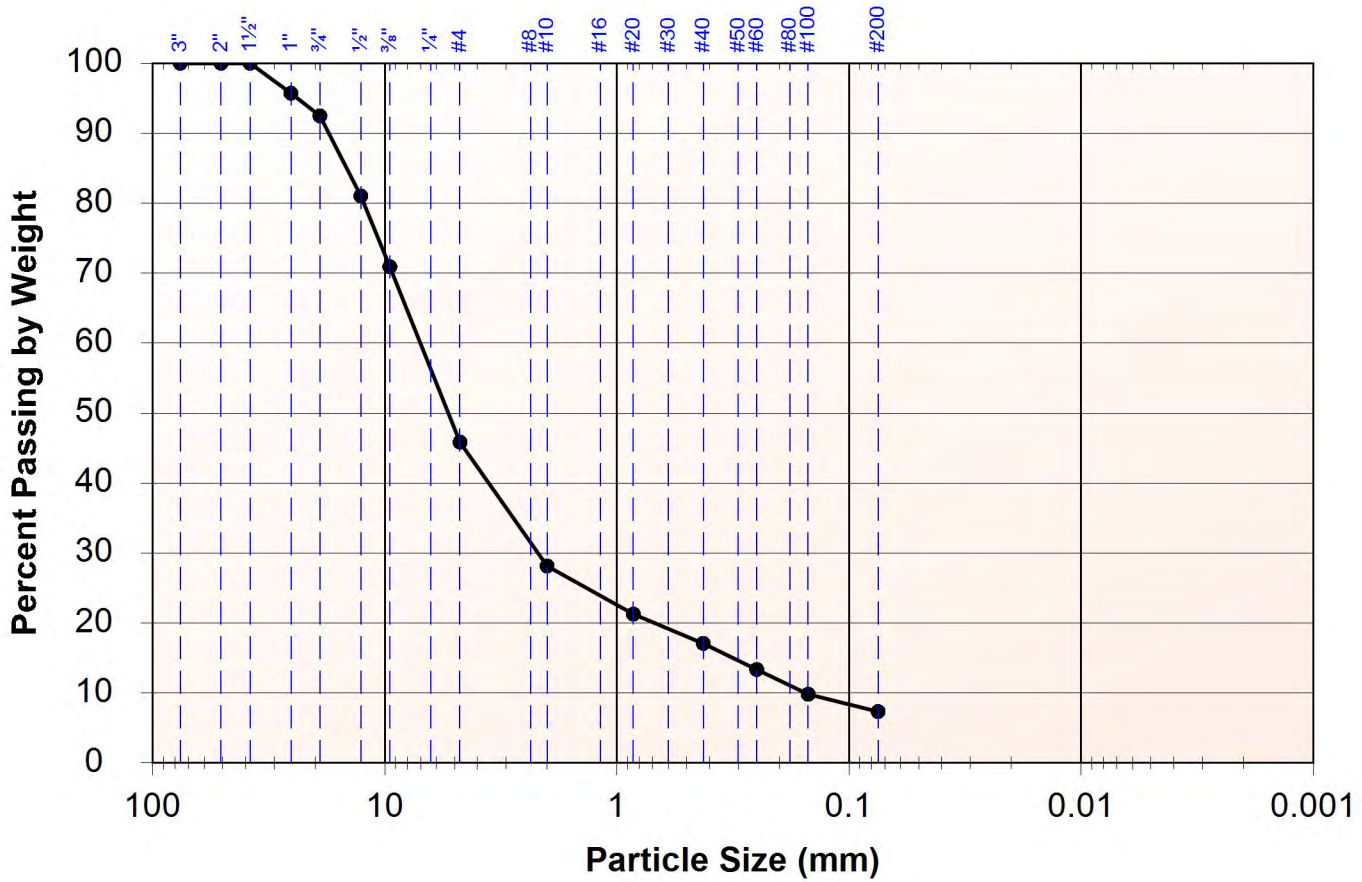
ASTM D422

Location: Test Boring 09
Sample 2
Depth 8.5'-10'

Lab Number	2014-452
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Silt and Sand, GP-GM**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	96%	
¾"	92%	
½"	81%	
⅜"	71%	
#4	46%	
Total Weight of Sample 7106g		
#10	28%	
#20	21%	
#40	17%	
#60	13%	
#100	10%	
#200	7.3%	
Total Weight of Fine Fraction 477.6g		

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Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

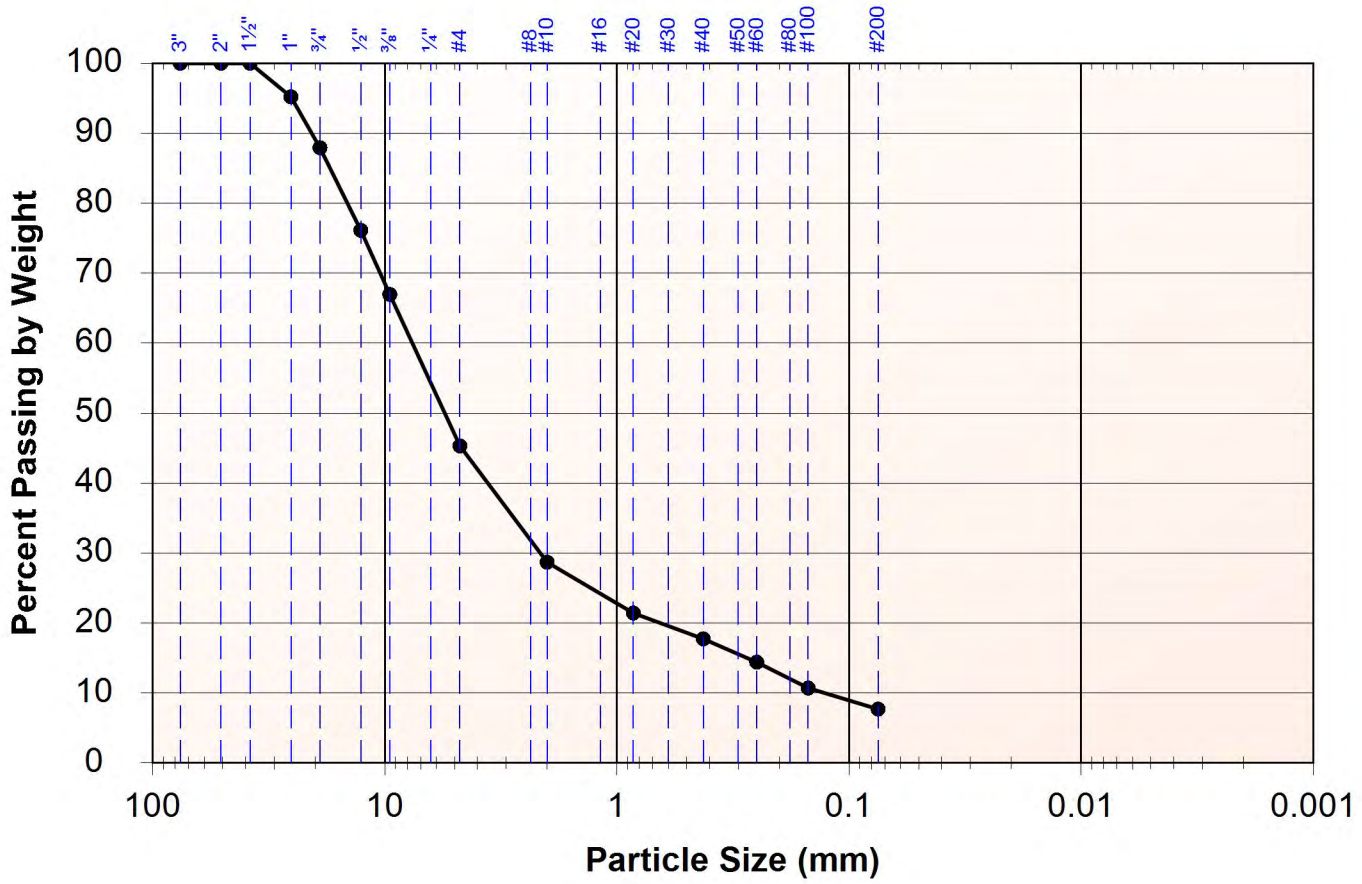
ASTM D422

Location: Test Boring 10
Sample 3
Depth 6.5'-10'

Lab Number	2014-453
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Silt and Sand, GP-GM**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	95%	
¾"	88%	
½"	76%	
⅜"	67%	
#4	45%	
Total Weight of Sample 5110g		
#10	29%	
#20	21%	
#40	18%	
#60	14%	
#100	11%	
#200	7.7%	
Total Weight of Fine Fraction 355.8g		

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Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

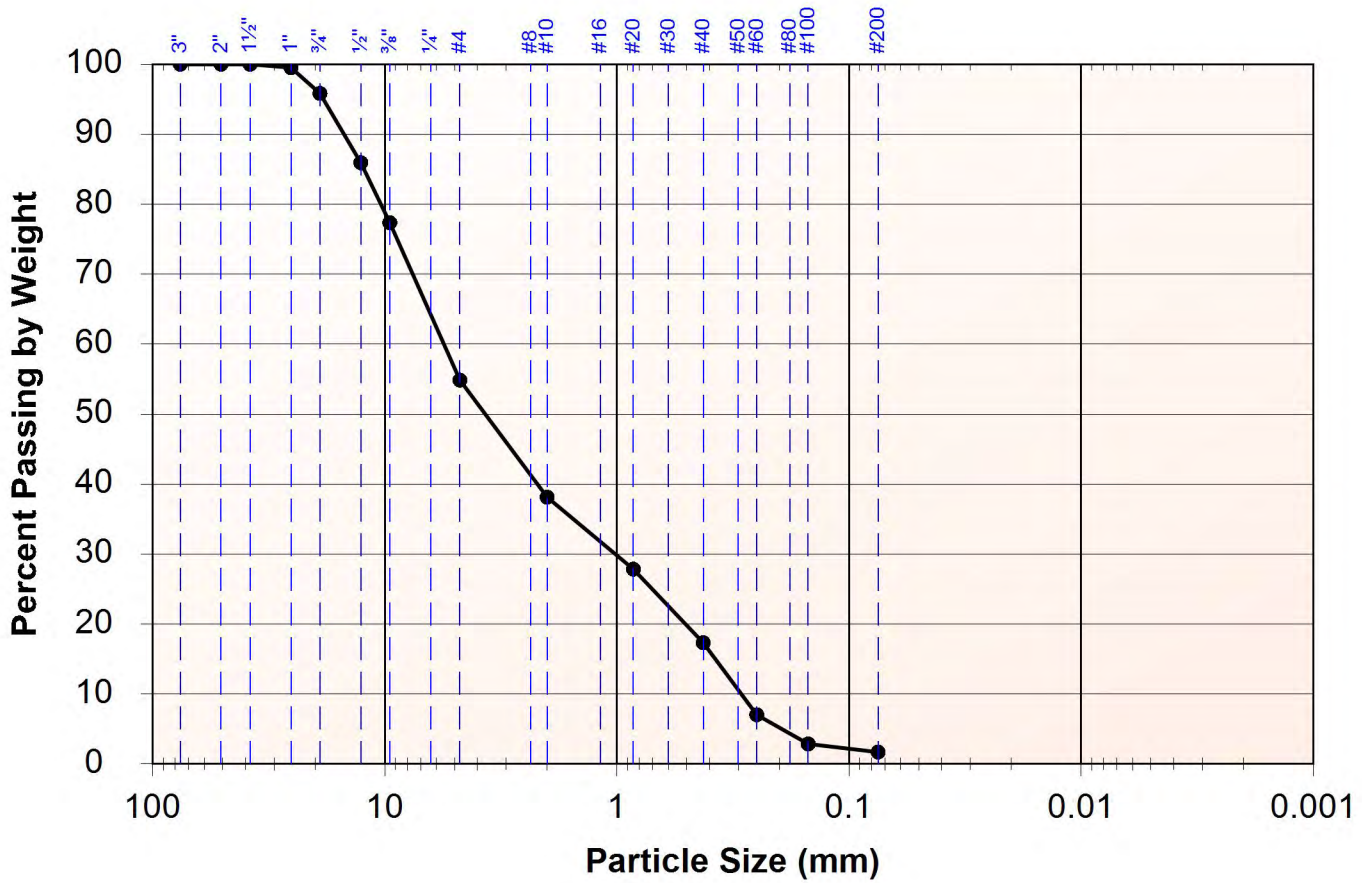
ASTM D422

Location: Test Boring 11
Sample 1
Depth 0.5'-5'

Lab Number	2014-454
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Sand with Gravel, SP**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	100%	
¾"	96%	
½"	86%	
⅜"	77%	
#4	55%	
Total Weight of Sample 7108g		
#10	38%	
#20	28%	
#40	17%	
#60	7%	
#100	3%	
#200	1.7%	
Total Weight of Fine Fraction 384.6g		

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Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

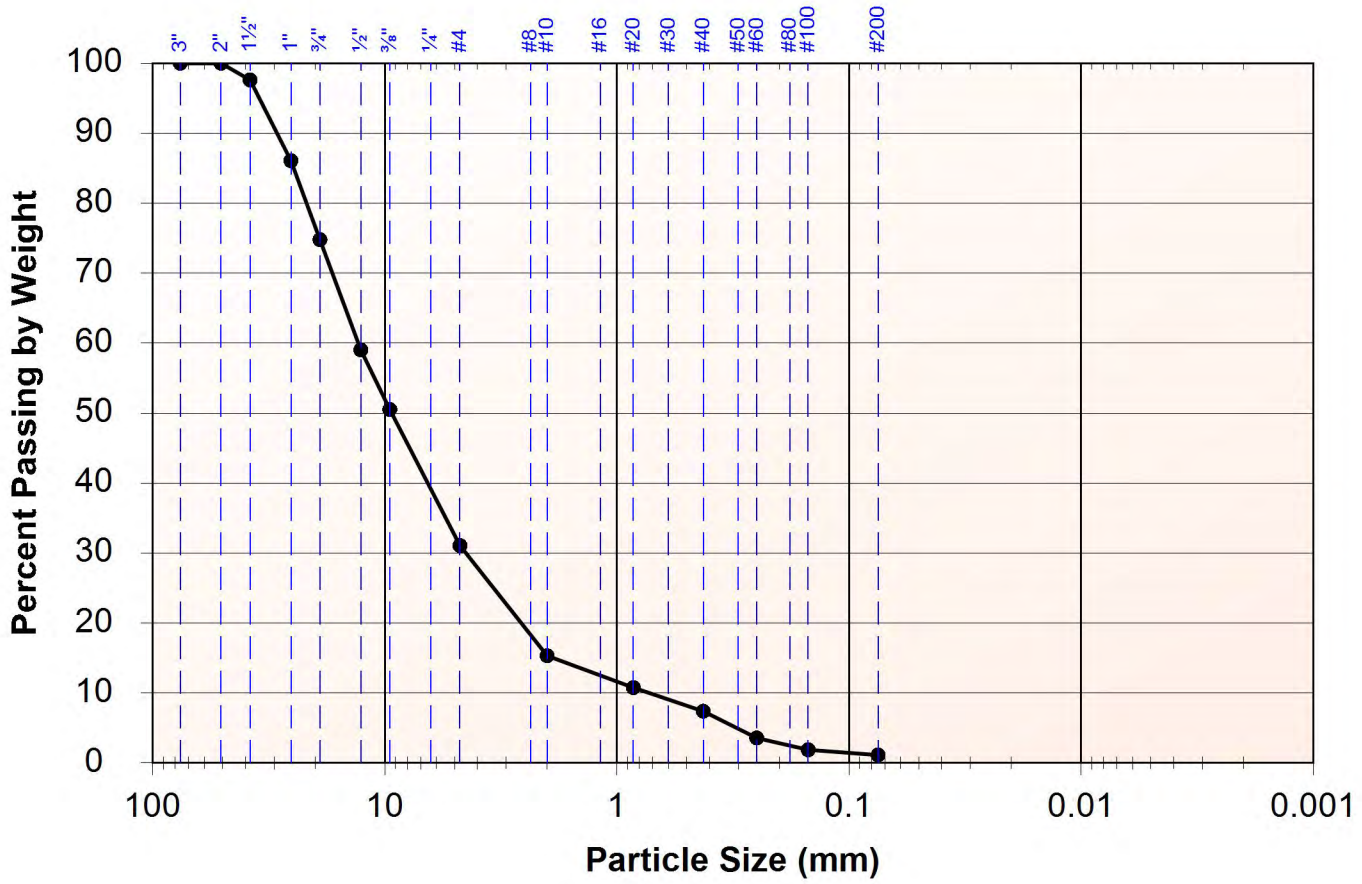
ASTM D422

Location: Test Boring 11
Sample 4
Depth 10'-15'

Lab Number	2014-455
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	98%	
1"	86%	
¾"	75%	
½"	59%	
⅜"	51%	
#4	31%	
Total Weight of Sample 6210g		
#10	15%	
#20	11%	
#40	7%	
#60	4%	
#100	2%	
#200	1.1%	
Total Weight of Fine Fraction 300.1g		

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Work Order: D61683

Particle Size Distribution

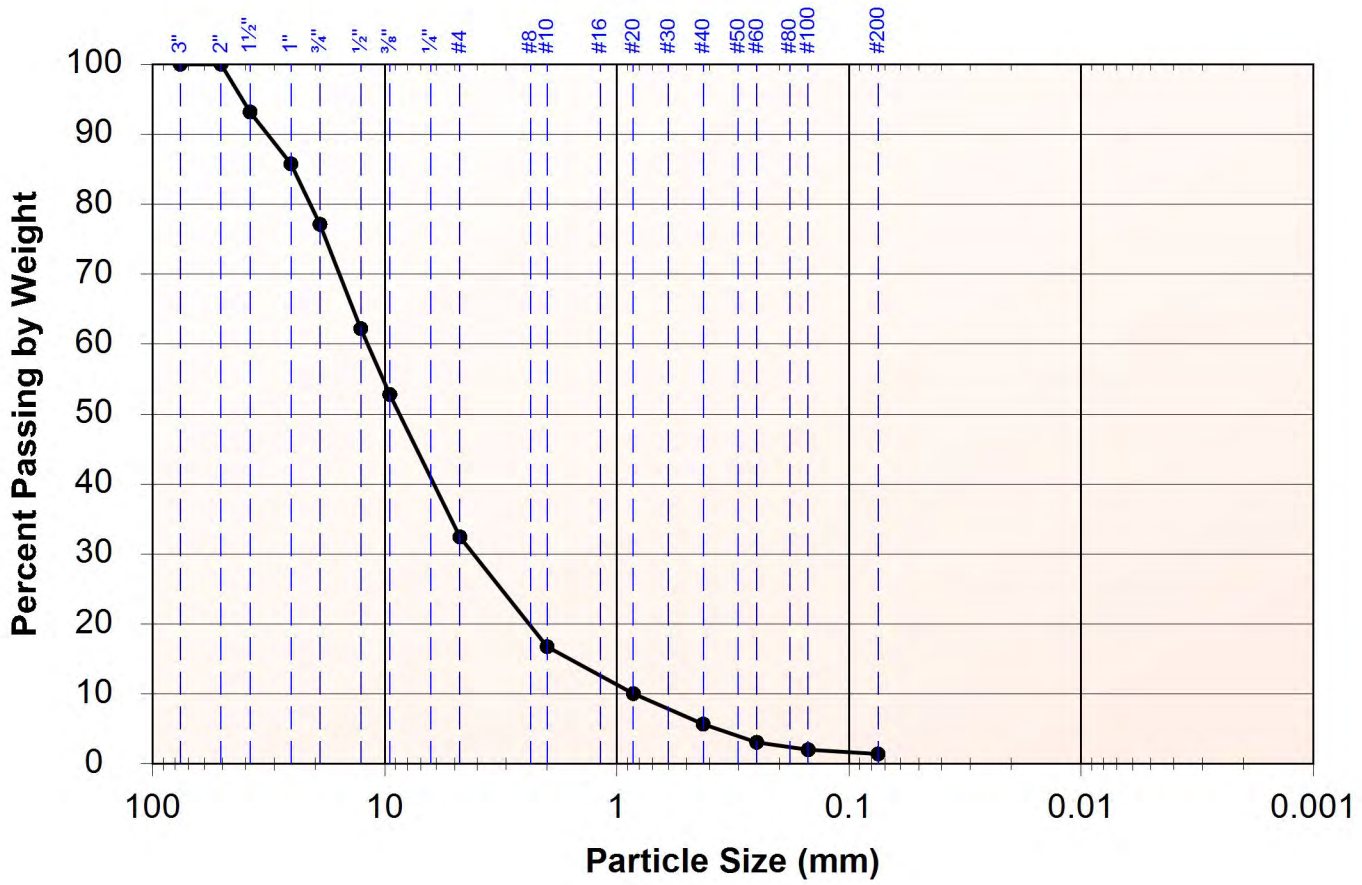
ASTM D422

Location: Test Boring 12
Sample 2
Depth 5'-10'

Lab Number	2014-456
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	93%	
1"	86%	
¾"	77%	
½"	62%	
⅜"	53%	
#4	32%	
Total Weight of Sample 5577g		
#10	17%	
#20	10%	
#40	6%	
#60	3%	
#100	2%	
#200	1.4%	
Total Weight of Fine Fraction 426.1g		

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Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

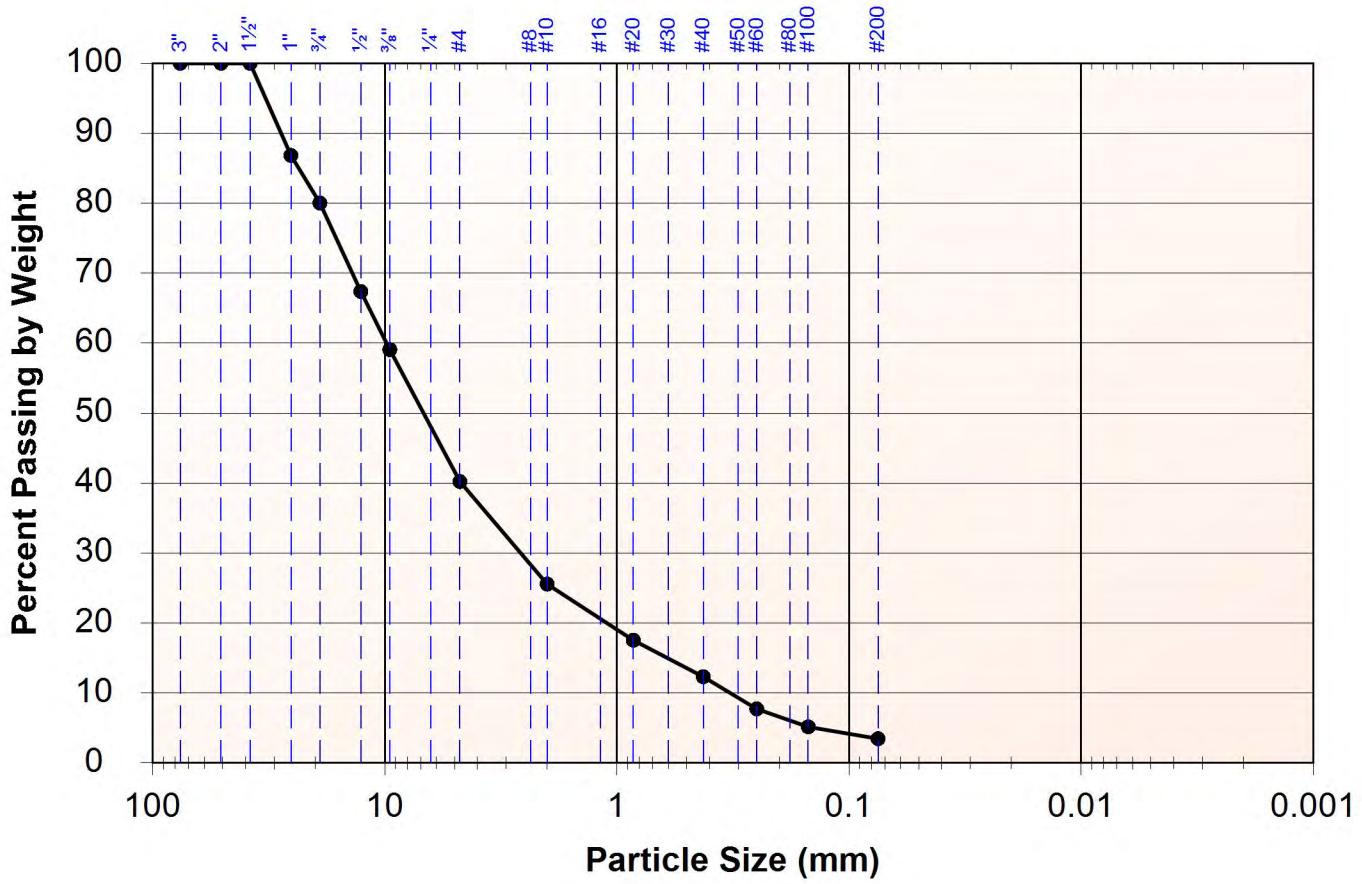
ASTM D422

Location: Test Boring 13
Sample 1
Depth 2'-5'

Lab Number	2014-457
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	87%	
¾"	80%	
½"	67%	
⅜"	59%	
#4	40%	
Total Weight of Sample 6224g		
#10	26%	
#20	18%	
#40	12%	
#60	8%	
#100	5%	
#200	3.5%	
Total Weight of Fine Fraction 301.4g		

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Work Order: D61683

Particle Size Distribution

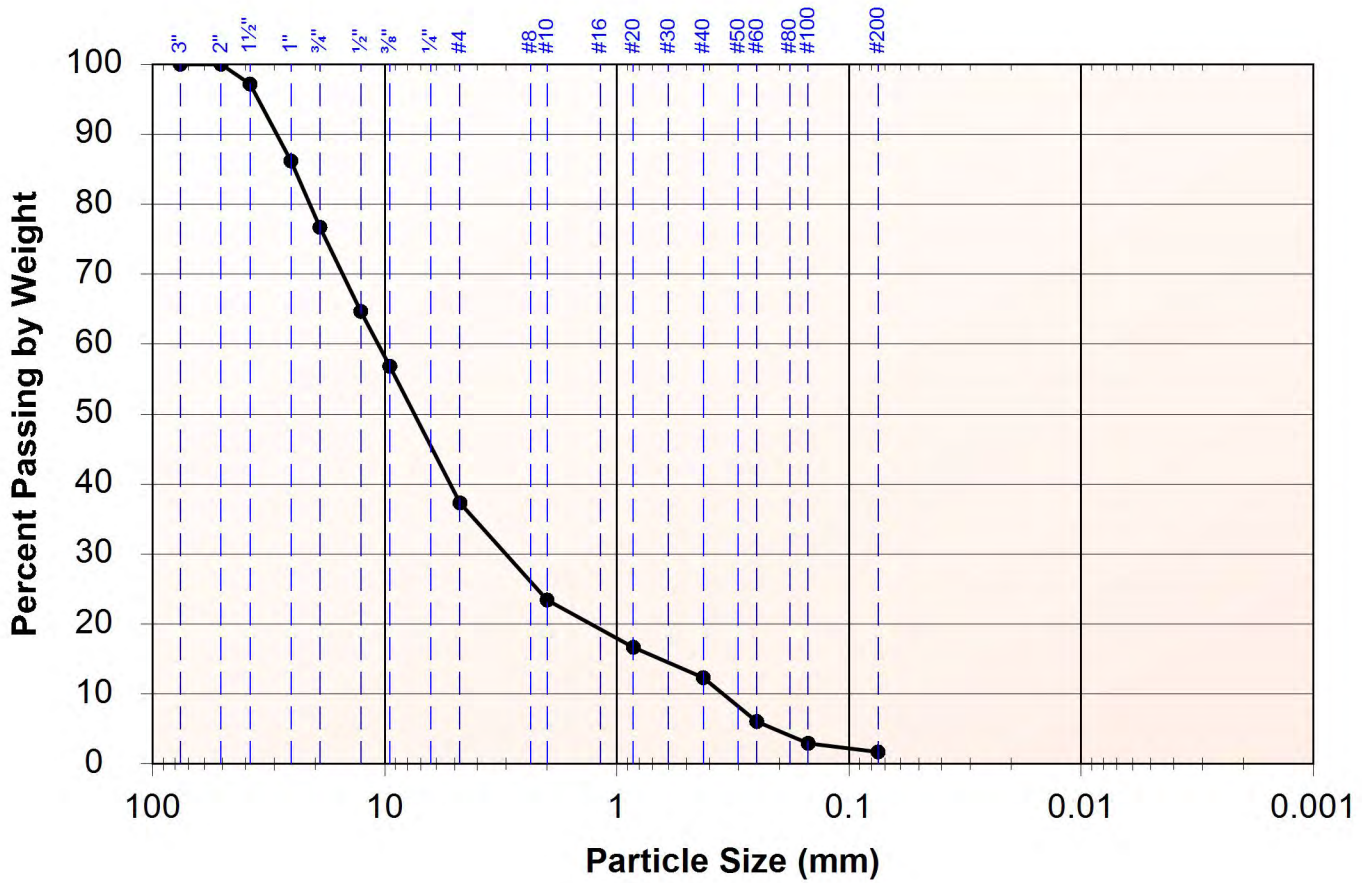
ASTM D422

Location: Test Boring 13
Sample 3
Depth 10'-15'

Lab Number	2014-458
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	97%	
1"	86%	
¾"	77%	
½"	65%	
⅜"	57%	
#4	37%	
Total Weight of Sample 5755.3g		
#10	23%	
#20	17%	
#40	12%	
#60	6%	
#100	3%	
#200	1.7%	
Total Weight of Fine Fraction 325.5g		

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Work Order: D61683

Particle Size Distribution

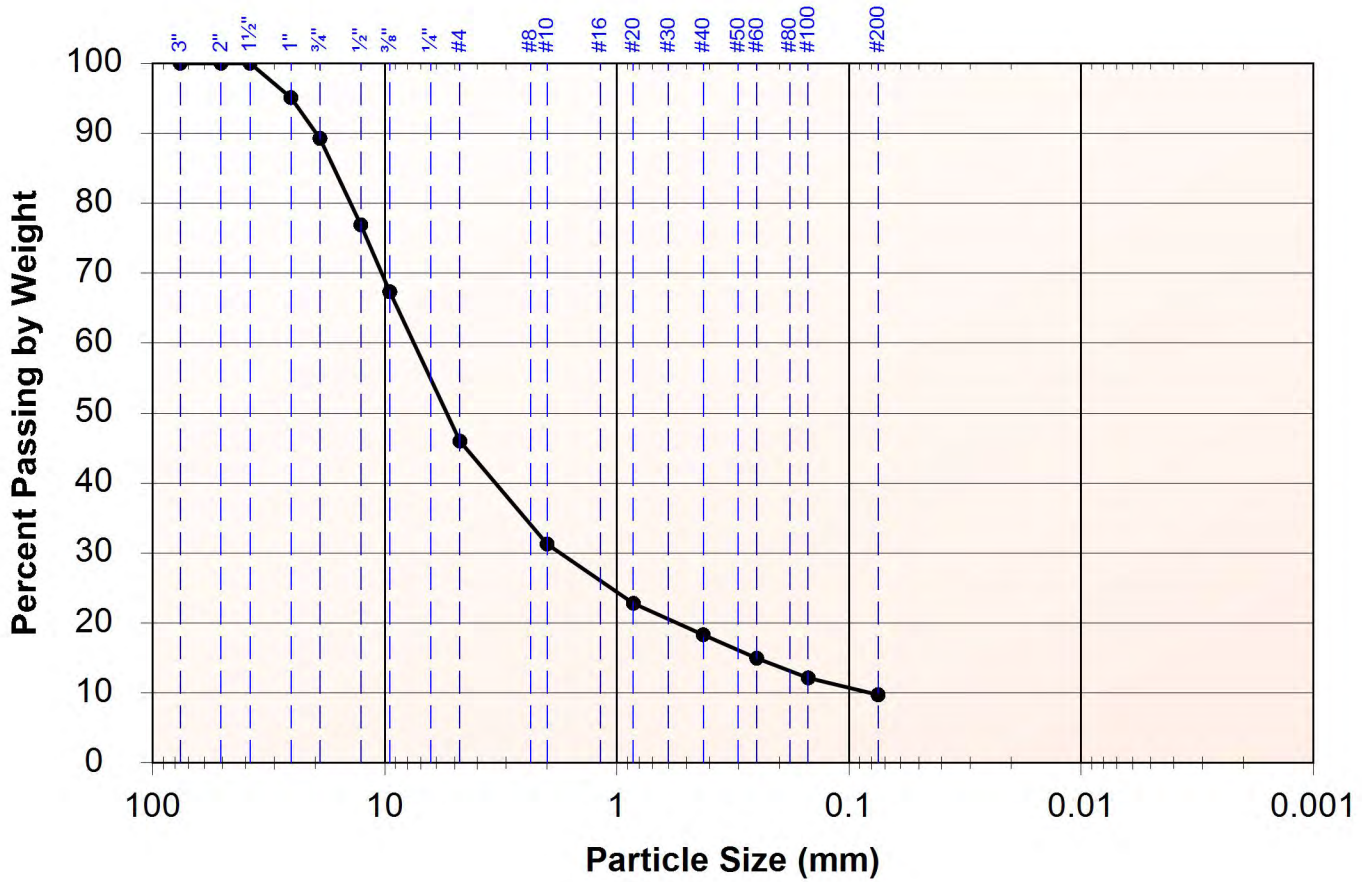
ASTM D422

Location: Test Boring 14
Sample 4
Depth 10'-12.5'

Lab Number	2014-459
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Silt and Sand, GP-GM**

Frost Classification: **Not Measured**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	100%	
1"	95%	
¾"	89%	
½"	77%	
⅜"	67%	
#4	46%	
Total Weight of Sample 5677g		
#10	31%	
#20	23%	
#40	18%	
#60	15%	
#100	12%	
#200	9.8%	
Total Weight of Fine Fraction 421.7g		

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Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

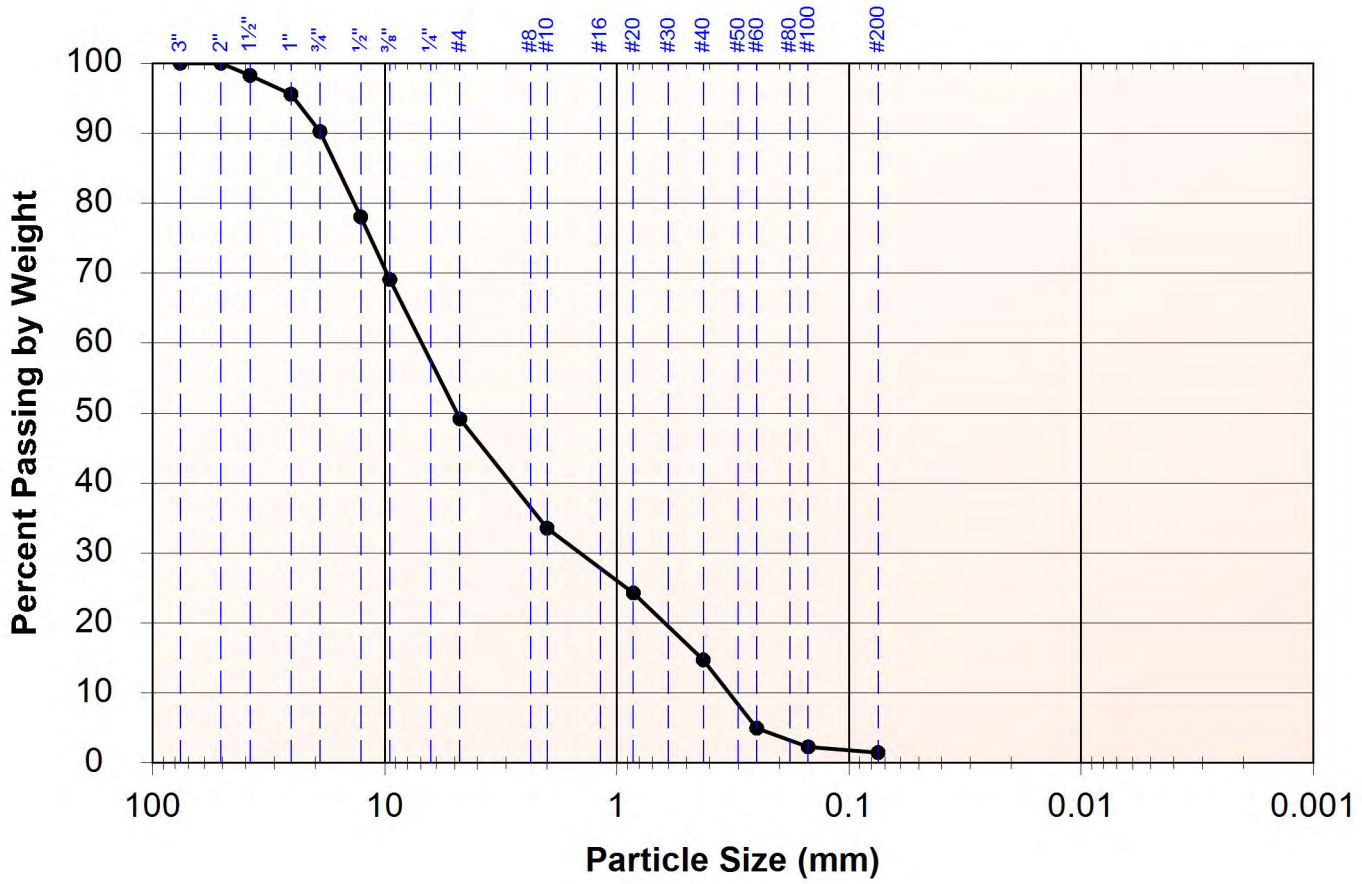
ASTM D422

Location: Test Boring 15
Sample 2
Depth 5'-10'

Lab Number	2014-460
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Poorly Graded Gravel with Sand, GP**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	98%	
1"	96%	
¾"	90%	
½"	78%	
⅜"	69%	
#4	49%	
Total Weight of Sample 7306g		
#10	34%	
#20	24%	
#40	15%	
#60	5%	
#100	2%	
#200	1.5%	
Total Weight of Fine Fraction 315.0g		

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DOWL HKM

Client: Maniilaq Association
Project: Noatak Material Site Investigation
Work Order: D61683

Particle Size Distribution

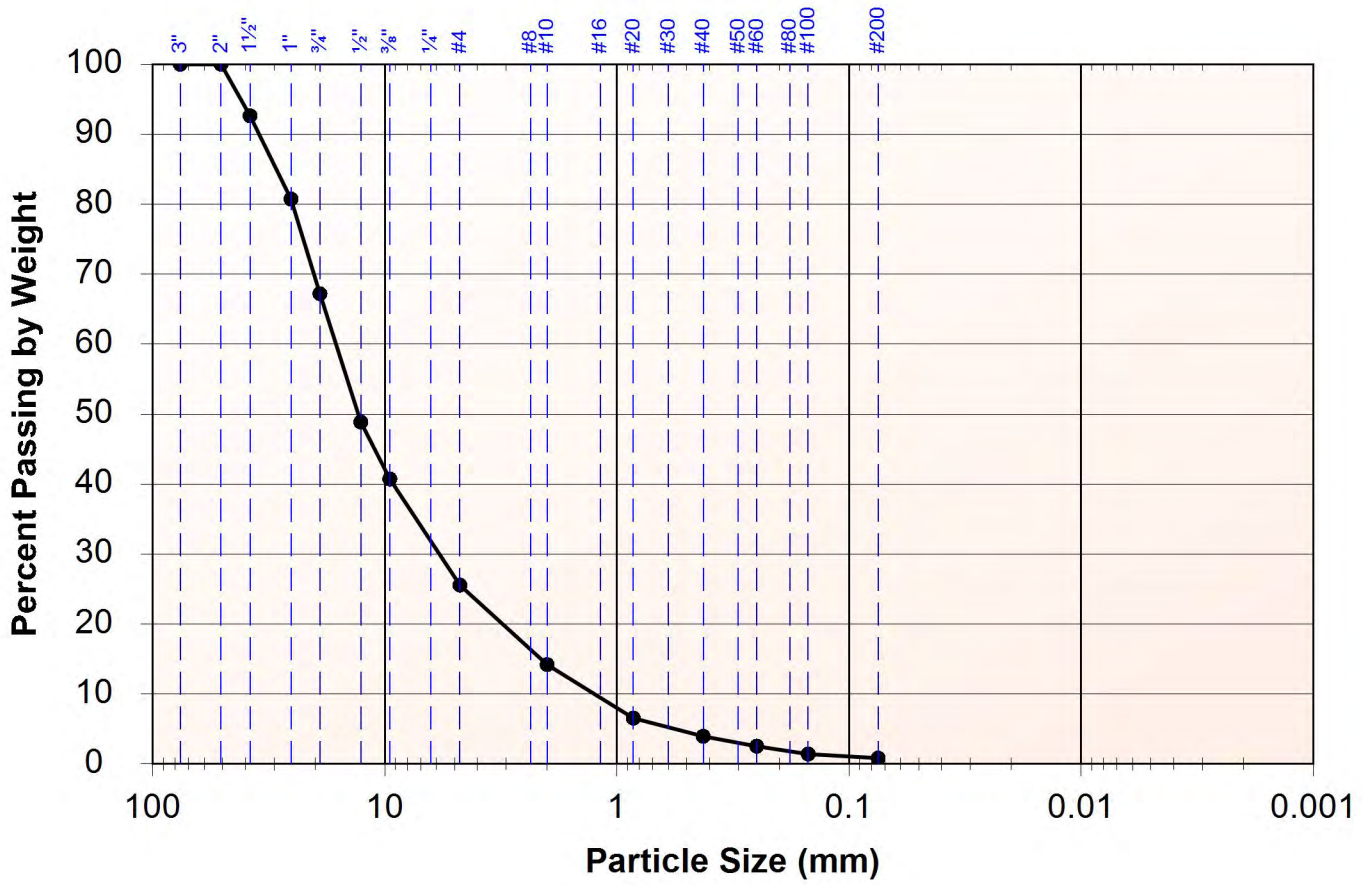
ASTM D422

Location: Test Boring 15
Sample 3
Depth 10'-15'

Lab Number	2014-461
Received	5/9/2014
Reported	6/5/2014

Engineering Classification: **Well Graded Gravel with Sand, GW**

Frost Classification: **NFS**



Size	Passing	Specification
3"	100%	
2"	100%	
1½"	93%	
1"	81%	
¾"	67%	
½"	49%	
⅜"	41%	
#4	26%	
Total Weight of Sample 4995g		
#10	14%	
#20	7%	
#40	4%	
#60	3%	
#100	1%	
#200	0.8%	
Total Weight of Fine Fraction 364.3g		

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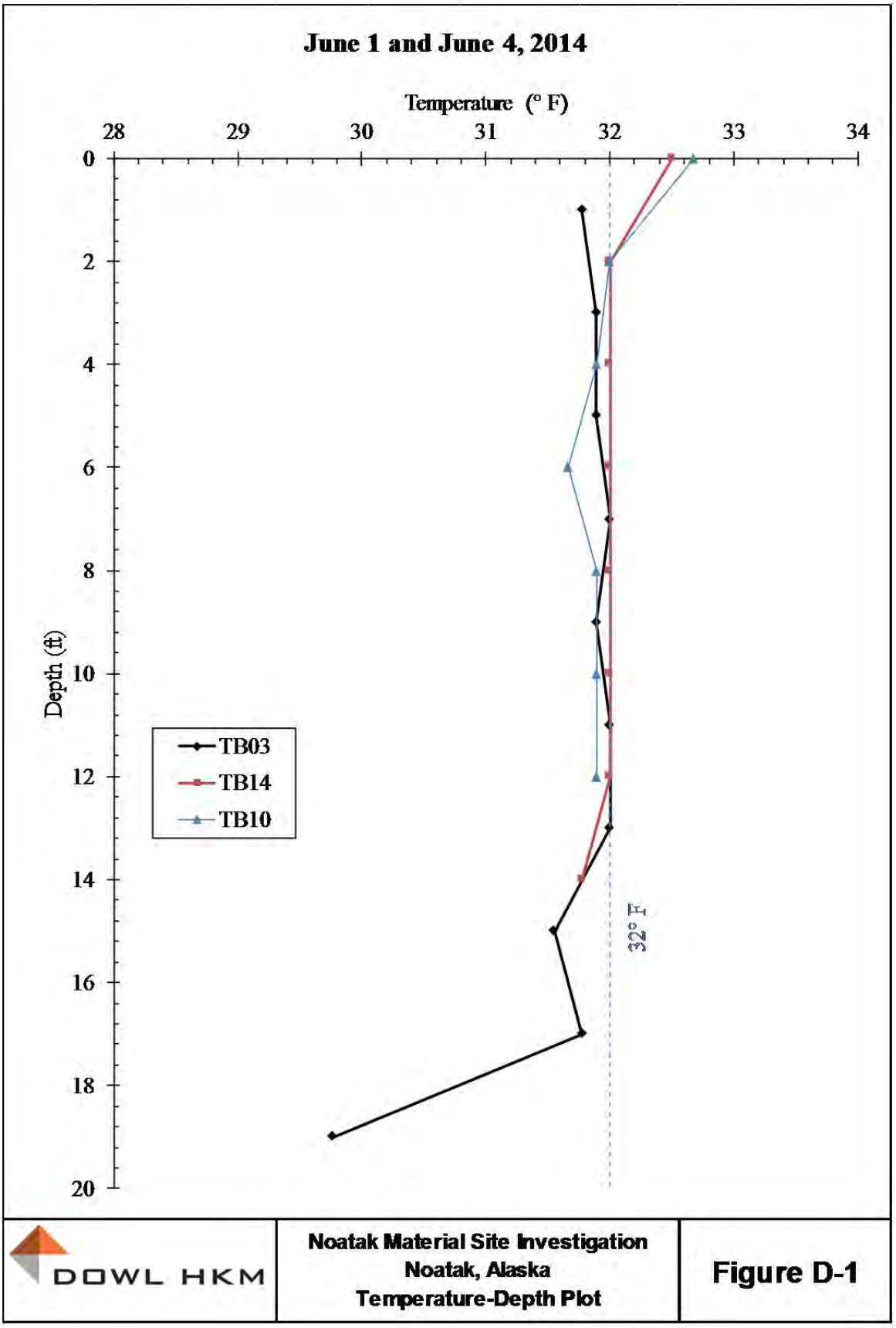
APPENDIX D

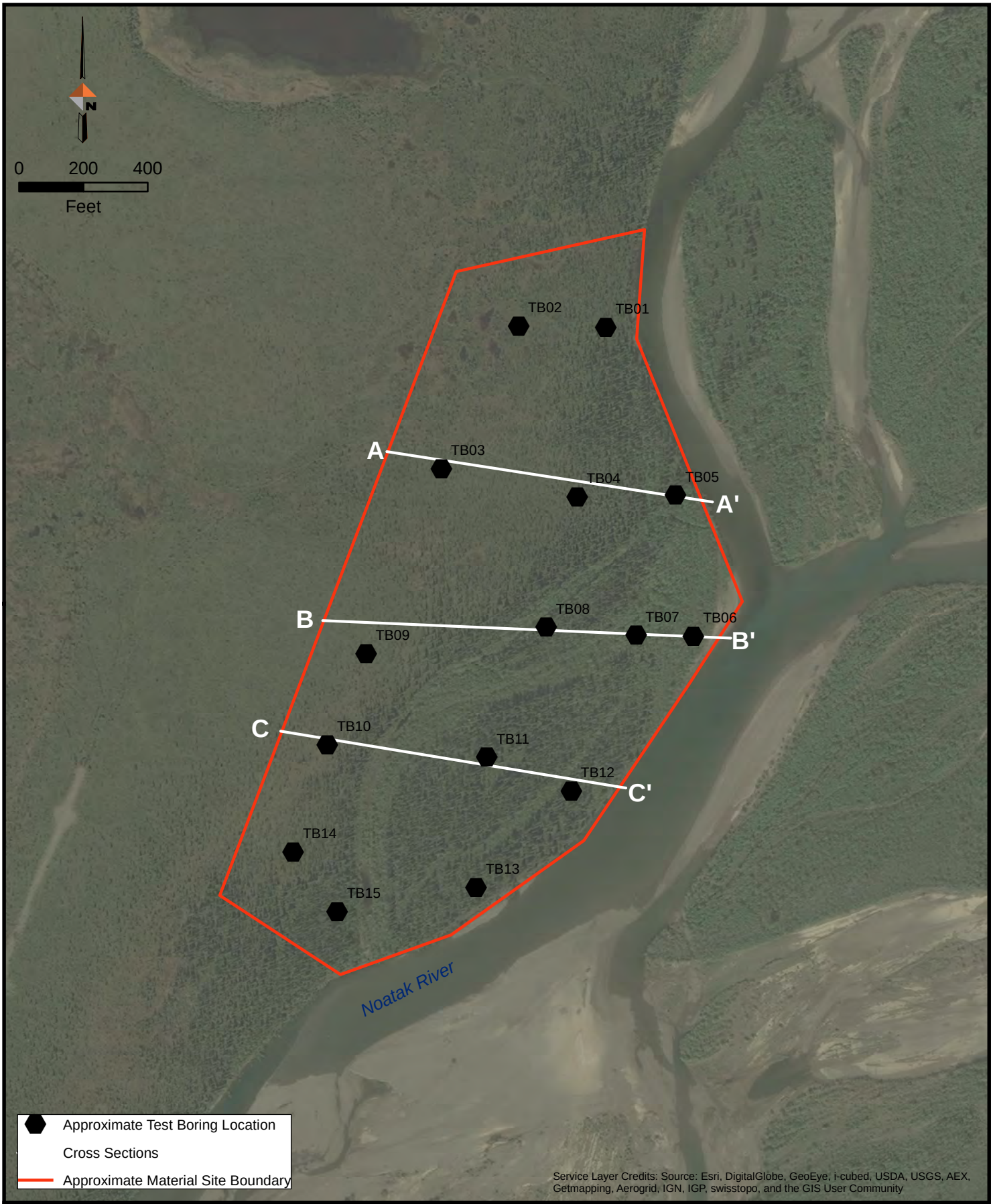
Thermistor Measurements



DOWL HKM	Noatak Material Site Investigation Noatak, Alaska Temperature-Depth Plot	Figure D-1

APPENDIX E

Generalized Geologic Cross Sections Map



DOWL HKM

Test Boring Location Map

NOATAK MATERIAL SITE INVESTIGATION

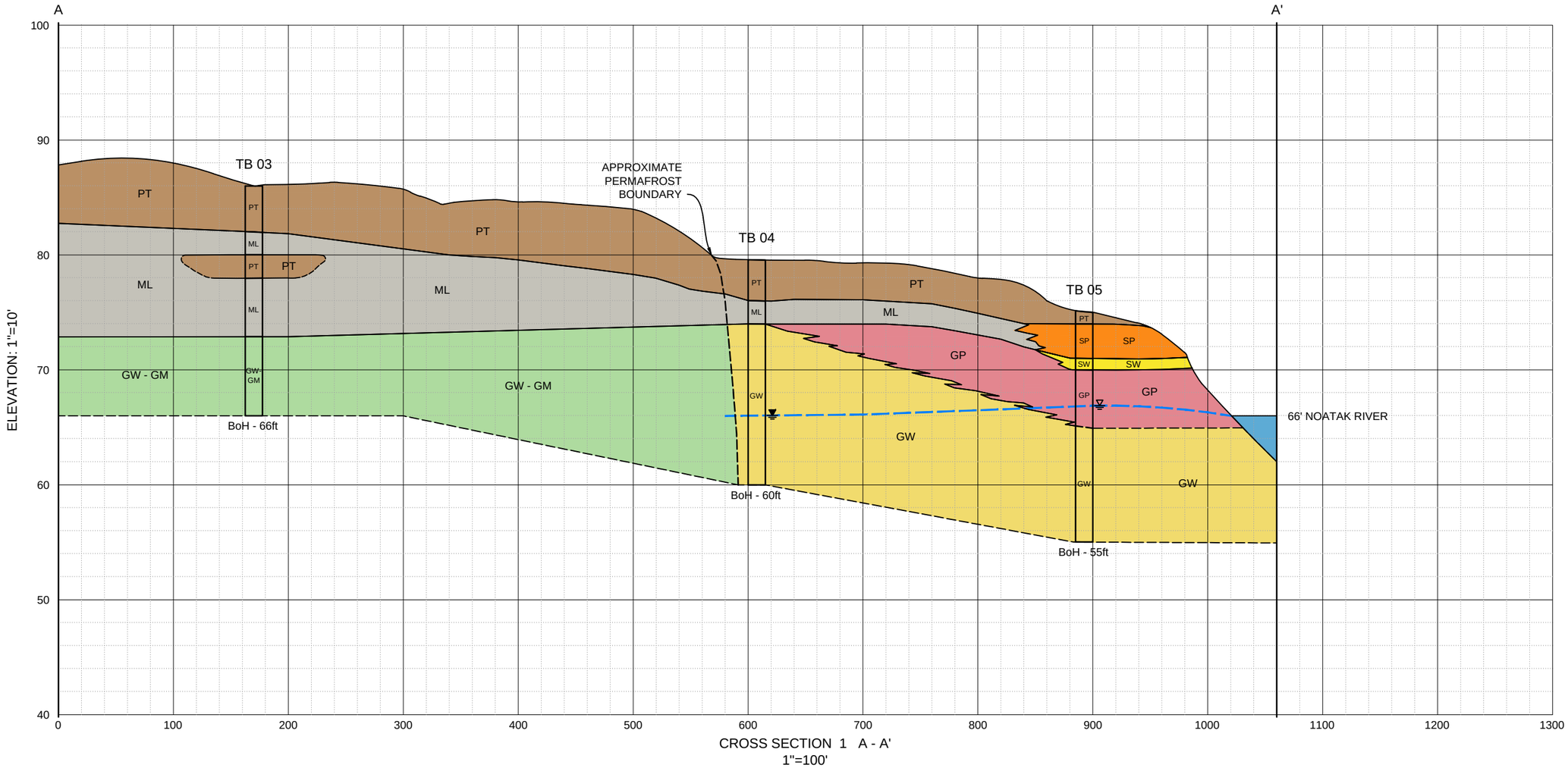
Noatak, Alaska

PROJECT	D61683
DATE	Jul 28, 2014

FIGURE E-1

APPENDIX F

Generalized Geologic Cross Sections



CROSS SECTION 1 A - A'
1"=100'

LEGEND

- GP = POORLY GRADED GRAVEL - Gravel and gravel-sand mixtures.
- GW = WELL GRADED GRAVEL - Gravel and gravel-sand mixtures.
- GW-GM = WELL GRADED SILTY GRAVEL - Silty gravel and gravel-sand-silt mixtures.
- PT = PEAT - Primarily organic matter.
- ML = SILT - Inorganic silts.
- SP = POORLY GRADED SAND - Sands and gravelly sands.
- SW = WELL GRADED SAND - Sands and gravelly sands.
- NOATAK RIVER
- MEASURED GROUNDWATER LEVEL
- OBSERVED GROUNDWATER LEVEL

REV	DATE	DESCRIPTION	BY
		REVISIONS	

Vertical Datum:

DOWL HKM
4041 "B" Street Anchorage, Alaska 99503
PHONE (907) 562-2000 FAX (907) 563-3953

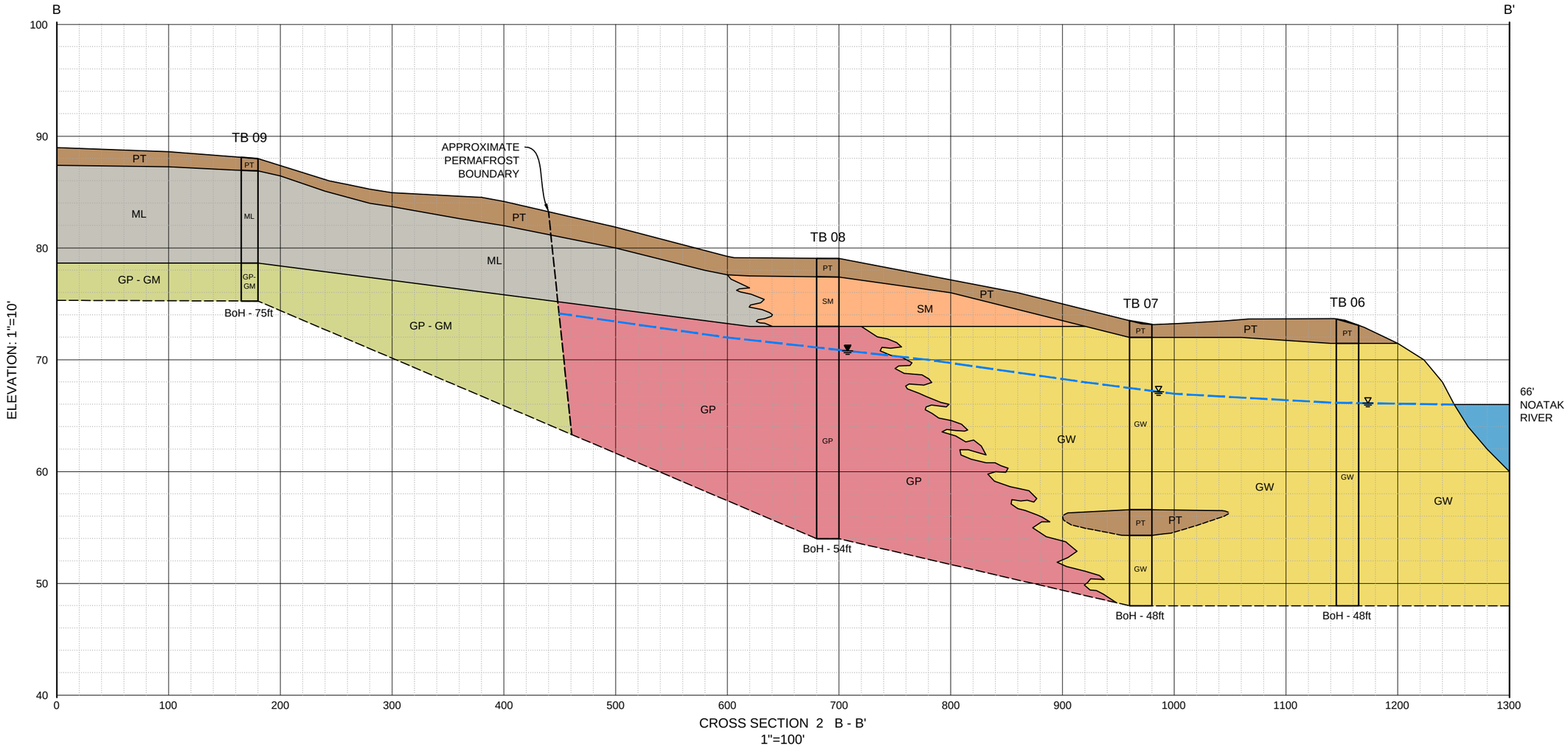
CROSS SECTION 1 A–A'
NOATAK MATERIAL SITE INVESTIGATION
NOATAK, ALASKA

CHECKED BY	---
DESIGNED BY	PEP
DRAWN BY	ZDR
DATE	07-16-2014
PROJECT NO.	61683
F.B. NO.	---
REF. DWG	---
LOCATION	NOATAK ALASKA

SCALE
HORZ. 1"=100'
VERT. 1"=10'

FIGURE
F-1

FILE NO. ---



CROSS SECTION 2 B - B'
1"=100'

LEGEND

- GP = POORLY GRADED GRAVEL - Gravel and gravel-sand mixtures.
- GP-GM = POORLY GRADED SILTY GRAVEL - Silty gravel and gravel-sand-silt mixtures.
- GW = WELL GRADED GRAVEL - Gravel and gravel-sand mixtures.
- PT = PEAT - Primarily organic matter.
- ML = SILT - Inorganic silts.
- SM = SILTY SANDS - Silty sands and sand-silt mixtures.
- NOATAK RIVER
- MEASURED GROUNDWATER LEVEL
- OBSERVED GROUNDWATER LEVEL

REV	DATE	DESCRIPTION	BY
		REVISIONS	

Vertical Datum:

DOWL HKM
4041 "B" Street Anchorage, Alaska 99503
PHONE (907) 562-2000 FAX (907) 563-3953

CROSS SECTION 2 B–B'
NOATAK MATERIAL SITE INVESTIGATION
NOATAK, ALASKA

CHECKED BY	---
DESIGNED BY	PEP
DRAWN BY	ZDR
DATE	07-16-2014
PROJECT NO.	61683
F.B. NO.	---
REF. DWG	---
LOCATION	NOATAK ALASKA

SCALE
HORZ. 1"=100'
VERT. 1"=10'

FIGURE
F-2

FILE NO. ---

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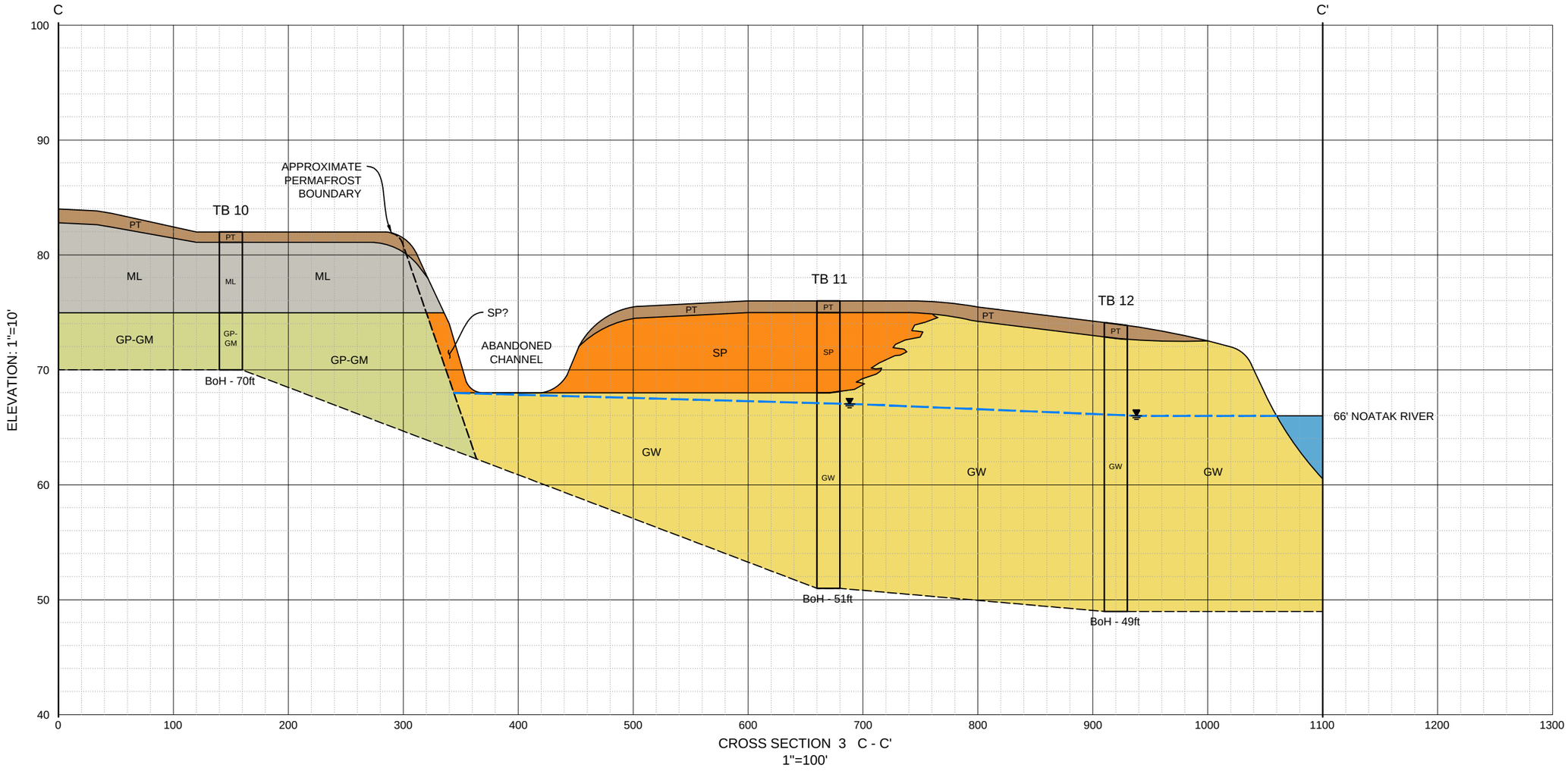

CROSS SECTION 3 C - C'
1"=100'

LEGEND

- GP-GM = POORLY GRADED SILTY GRAVEL - Silty gravel and gravel-sand-silt mixtures.
- GW = WELL GRADED GRAVEL - Gravel and gravel-sand mixtures.
- PT = PEAT - Primarily organic matter.
- ML = SILT - Inorganic silts.
- SP = POORLY GRADED SAND - Sands and gravelly sands.
- NOATAK RIVER
- MEASURED GROUNDWATER LEVEL

REV	DATE	DESCRIPTION	BY
		REVISIONS	

Vertical Datum:

DOWL HKM
4041 "B" Street Anchorage, Alaska 99503
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CROSS SECTION 3 C–C'
NOATAK MATERIAL SITE INVESTIGATION
NOATAK, ALASKA

CHECKED BY	---
DESIGNED BY	PEP
DRAWN BY	ZDR
DATE	07-16-2014
PROJECT NO.	61683
F.B. NO.	---
REF. DWG	---
LOCATION	NOATAK ALASKA
SCALE	
HORZ.	1"=100'
VERT.	1"=10'

FIGURE
F-3

FILE NO. ---

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