HDL ENGINEERING Consultants LLC

Civil Engineering
Geotechnical Engineering
Transportation Engineering
Aviation Engineering
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Environmental Services
Surveying & Mapping
Construction Administration
Material Testing

June 26, 2025

John Rowe, PLA, ASLA
Design Alaska, Inc.
601 College Road
Fairbanks, AK 99701

Subject: Geotechnical Engineering Services
PMC Seed House Addition

In accordance with the request of Design Alaska, Inc. (Client), HDL Engineering Consultants, LLC (HDL) conducted a geotechnical engineering evaluation for the proposed development located at 5310 Bodenburg Spur Road in Butte, Alaska (Site). This letter report (Report) provides the findings, conclusions, and recommendations that HDL derived from the geotechnical evaluation. This Report includes a description of the project, description and results of the subsurface exploration and laboratory testing, and geotechnical recommendations. This Report is subject to the attached limitations.

BACKGROUND

The proposed development is located at the Alaska Plant Materials Center in Butte, Alaska. HDL understands the proposed development consists of an addition to the existing seed house. The conceptual plan provided by the Client indicates the proposed addition will be approximately 60 feet long and 12 feet wide and located on the east side of the existing seed house. HDL understands a shallow, insulated, thickened edge slab-on-grade foundation will support the proposed heated addition.

Historical explorations performed near the Site generally encountered silty soils extending from the ground surface to depths ranging from 2 feet to 6 feet below the existing ground surface (bgs) followed by sand and gravel extending to the depths explored. The explorations encountered free groundwater at depths ranging from 7 feet to 12.5 feet bgs. The Client informed HDL that the property owner previously cleared most of the Site and removed and replaced surface organics with granular fill.

SETTING

The following section provides information about the geologic and climatic setting for the Site.

General Geology

The project area is located within the Cook Inlet-Susitna Lowland Section of the Coastal Trough physiographic province of Alaska. The Talkeetna Mountains border the province on the east, the Alaska Range lies to the north and west, and the Cook Inlet lies to the south. Glacial features including ground moraines, drumlins, eskers, and outwash plains characterize the Cook Inlet-Susitna Lowlands. Kame and kettle topography, indicative of glacial outwash plains, is common and forms many of the hills and small rounded lakes that exist in the project area. The Quaternary Period included five major glacial advances across the area (Wahrhaftig, 1965).

The project is located in a region of moderate seismicity and large-scale earthquakes may cause ground ruptures in some areas. Based on the United States Geologic Survey (USGS) earthquake catalog, there were 123 events above Richter Magnitude 5 within 100 miles of the Site from 1898 through 2024, of which 23 were above Richter Magnitude 6. The 1964 Great Alaska Earthquake affected this area as well and had a Richter Magnitude of 9.2.

Climatology

The project area is located in a transitional climatic zone varying between continental and maritime climates. Pronounced diurnal and annual temperature variations, moderate annual precipitation, and moderate surface winds characterize the zone (Shulski et. al, 2007). The average January temperatures in the area range between 9.0°F and 22.6°F, while average July temperatures range between 47.8°F and 65.7°F. Average annual precipitation is 17.99 inches and average annual snowfall is 82.5 inches (Alaska Climate Research Center, 2020). The data provided is for the Lazy Mountain monitoring station and conditions at the Site may vary.

SUBSURFACE EXPLORATION

HDL evaluated the subsurface conditions near the proposed development on March 12, 2025. The subsurface evaluation consisted of 3 borings, designated HDL-01 through HDL-03. HDL located the borings in the field using a recreational-grade GPS. Boring elevations were approximated using elevation data from Google Earth. The attached Boring Location Map illustrates the approximate boring locations.

Discovery Drilling, Inc. (Discovery) provided drilling services using a truck-mounted CME-75 and hollow stem augers to drill the borings to a maximum depth of 42.0 feet bgs. Discovery conducted split-spoon sampling (designated by LSS, Large Split Spoon, on the boring logs) using the Modified Penetration Test procedure. In the Modified Penetration Test, blows of a 340-pound hammer free-falling 30 inches onto the drill rod drive a 24-inch-long, 3-inch outside diameter split spoon sampler into the bottom of the advancing hole to recover samples. The number of blows required to advance the sampler the second and third 6-inch interval is termed the Penetration Resistance, or N-value. Onsite personnel recorded the N-value for each sample. The N-values give a measure of the relative density (compactness) or consistency (stiffness) of cohesionless and cohesive soils, respectively.

HDL performed fieldwork in general accordance with the procedures outlined in the Alaska Department of Transportation and Public Facilities (DOT&PF) "Alaska Geotechnical Procedures Manual". An experienced HDL geotechnical engineering assistant located the borings, collected samples, and logged subsurface conditions. We described the subsurface conditions in accordance with the following methods and standards:

- ASTM International Standard (ASTM) D2488 for field description of soils;
- Frost Design Soil Classification using the US Army Corps of Engineers (USACE) methodology;
- Description and Classification of Frozen Soils from the DOT&PF Alaska Field Guide for Soil Classification; and,
- Unified Soil Classification System (ASTM D2487) to confirm or modify soil classifications based on laboratory test results.

The attached Boring Log Key, Frost Design Soil Classification Key, Description and Classification of Frozen Soils, and boring logs provide further reference.

LABORATORY TESTING

HDL conducted the following laboratory tests on select soil samples at our AASHTO accredited and USACE validated laboratory:

- Twenty-one (21) natural moisture content tests (ASTM D2216);
- Three (3) grain size distribution tests (ASTM D6913); and,
- One (1) hydrometer tests (ASTM D7928).

The attached boring logs and grain size distribution curves present the results of the laboratory tests.

SUBSURFACE CONDITIONS

In general, the borings encountered a thin organic mat at the surface underlain by a layer of silty gravel followed by well-graded gravel with sand and varying amounts of cobbles extending to the depths explored.

Silty Gravel

The borings generally encountered silty gravel with sand beneath the organic mat to depths ranging from approximately 1.5 feet to 2.5 feet bgs. Table 1 provides a summary of laboratory testing results in this layer.

Table 1: Silty Gravel Laboratory Results Summary

Boring	Depth	Grain Size Distribution		
	(ft)	% Gravel	% Sand	% P200
HDL-02	0.3	41.4	32.0	26.6

Well-Graded Gravel

The borings generally encountered well-graded gravel with sand and varying amounts of cobbles beneath the silty gravel extending to the depths explored. The N-values of the sand and gravel ranged from 5 to 30, indicating loose to medium dense soils, with most of the soils classifying as medium dense. The gravel generally classified as non-frost susceptible (NFS). Table 2 provides a summary of laboratory testing results in this layer.

Table 2: Well-Graded Gravel Laboratory Results Summary

Boring	Depth	Grain Size Distribution		
	(ft)	% Gravel	% Sand	% P200
HDL-02	2.9	64.9	31.3	3.8
HDL-03	2.0	60.6	36.6	2.8

Groundwater

HDL-02 encountered free groundwater at 10.8 feet bgs at the time of drilling. Groundwater levels at the Site may fluctuate depending on the season, temperature, and precipitation. Groundwater levels during construction may be higher or lower than those encountered.

ENGINEERING ANALYSIS & RECOMMENDATIONS

Design of the proposed development must consider the bearing support capabilities of the Site soils as well as seismic loading, expected settlements, and effects of seasonal frost action. The sections below provide a summary of the geotechnical considerations and preliminary recommendations.

Site Preparation and Fill

Remove and replace soft or unstable soils or other deleterious materials encountered during excavation with compacted Structural Fill. We recommend the exposed subgrade be proof-rolled to provide a level, firm, uniform, and unyielding surface prior to the placement of fill or construction.

The borings encountered organic and silt-rich soils in the upper 2.5 feet. If left in place, these soils will increase the risk of frost related issues and differential settlement at the Site. Remove the silt-rich soils beneath the proposed addition and within the foundation influence zone and replace it with compacted fill. The foundation influence zone is the area defined by extending a line outward and downward from the bottom edges of the footing on a slope of 1 (horizontal) to 1 (vertical).

Structural Fill placed within 12 inches of the proposed footings should consist of a reasonably well graded mixture of sand and gravel meeting the DOT&PF Standard Specifications for Highway Construction (Specifications) requirements for Structural Fill, as detailed in Section 703-2.13. The well-graded gravel encountered beneath the silty surface soils generally does not meet these requirements.

Fill placed more than 12 inches beneath the proposed foundations and within the foundation influence zone should consist of a reasonably well graded mixture of sand and gravel meeting the Specifications requirements for Selected Material, Type A, as detailed in Section 703-2.07. The well-graded gravel encountered beneath the silty soils generally meets these requirements.

HDL recommends fill placed less than 6 inches beneath the slab should meet the Specifications requirements for Base Course, Gradation D-1 to support construction.

Fill placed outside of the foundation influence zone should consist of a reasonably well graded mixture of sand and gravel meeting the DOT&PF Specifications requirements for Selected Material, Type C or better. The granular soil encountered beneath the organic mat generally meets these requirements.

Place fill in lifts with a maximum loose thickness of 10 to 12 inches, and compact the lifts to a density of at least 95 percent of the maximum dry density as determined by ASTM D1557. During fill placement, remove cobbles and boulders with dimensions in excess of 2/3 the lift thickness.

Foundations

Design of the proposed structure's foundation must consider the bearing capability of the supporting soils, behavior during a seismic event, the effects of seasonal frost action, and the expected total and differential settlements. The foundation system must also consider the risk of failure and the cost of construction.

Shallow Insulated Foundation

Assuming the proposed addition meets the assumptions outlined in this Report and based on conditions encountered, an insulated shallow spread footing foundation system can support the proposed addition. The Client indicated that a thickened edge slab-on-grade is the preferred foundation configuration. Insulate the foundations and heat the structure to account for potential effects of seasonal frost action.

Foundation Recommendations

Footings should bear a minimum of 16 inches below finished grade and be a minimum of 16 inches wide.

Construct foundations immediately after subgrade preparation to protect the soil bearing surface and backfill foundation excavations as soon as possible after foundation construction.

Bearing Capacity

The proposed addition foundations will bear upon compacted Structural Fill. If the soils beneath the proposed foundations are consistent with and prepared in accordance with the requirements provided in this Report, we recommend using an allowable soil bearing capacity provided in Table 3.

Table 3: Thickened Edge Slab Foundation Bearing Capacity

Footing Width (in)	Footing Depth (in)	Allowable Bearing Capacity (psf)
16	16	3,000
18	18	3,500

Increase the above bearing values by one-third for seismic or wind loading conditions.

Insulation

Place a minimum of 3 inches of hydrophobic rigid foam board insulation vertically along the foundation and horizontally along the exterior of the foundation extending a minimum of 4 feet beyond the building. The horizontal insulation requirement includes the area adjacent to the existing building near the northwest corner of the proposed addition foundation. If sub-slab insulation is added, increase the thickness of the vertical and horizontal insulation by the thickness of the sub-slab insulation. The insulation board should meet AASHTO M 230, Type VI, except that extrusion is not required and the maximum water absorption should not exceed 0.3% by volume, as determined by ASTM C272. Compressive strength at yield of 10% deformation should not be less than 40 pounds per square inch (psi). Thermal resistance (R-value) should not be less than 4.5 (°F·ft2·hr/Btu) per inch at 75°F as determined by ASTM C177.

Prior to placing the insulation, the exposed subgrade soils and structural fill should be smooth, compacted, unyielding, and free of snow, ice, deleterious material, debris, and rocks exceeding 3-inches in diameter. Butt all joints tightly and cover the insulation with a minimum of 12 inches of material to reduce the potential for damage. The contractor should be responsible for ensuring the equipment used does not damage the insulation during construction.

Refer to ASCE 32 for further recommendations regarding design and construction of the insulated foundations.

Seismic Analysis

HDL recommends the use of the site characterization criteria found in the 2021 International Building Code (IBC) for design. Chapter 16, Section 1613 of the IBC holds the seismic design criteria. The IBC requires that soil and rock parameters determine the site characterization. Based on the subsurface conditions encountered, we considered the Site to be Seismic Site Class "D". We obtained the maximum considered earthquake ground motion spectral response accelerations for short period and for one-second peaks using the Seismic Design Maps created by Structural Engineers Association of California and California's Office of Statewide Health Planning and Development. Seismic Design Maps is a web interface that uses USGS web services to retrieve seismic design data; results of which we have summarized in Table 4.

Table 4: Seismic Design Criteria

IBC Seismic Design Criteria	Value
Spectral Response at Short Periods, Ss	1.5
Spectral Response at 1-Second Period, S_1	0.695
Site Modified Peak Ground Acceleration, PGA_m	0.6
Site Class	D
Site Coefficient Fa	1.2
Site Coefficient Fv	1.7
Site Adjusted Spectral Response at Short Periods, S_{MS}	1.8
Site Adjusted Spectral Response at 1-Second Periods, S_{M1}	1.182

Liquefaction Potential and Cyclic Softening

The extent of liquefaction and potential for cyclic softening is dependent on the groundwater elevation, which fluctuates depending on the season, temperature, and precipitation. Generally, the risk of seismically induced settlement or seismically induced cyclic softening decreases as the groundwater lowers and increases as it raises. Liquefaction analyses using the methods of Youd and Idriss (2001), Idriss and Boulanger (2014), and groundwater levels at the time of drilling indicate that a zone of potentially liquefiable sand and gravel is present at the Site extending from a depth of 10 feet bgs to the depths explored. Based on the conditions encountered and methods of Tokimatsu and Seed (1987) and Idriss and Boulanger (2014) we estimate the building may experience approximately 5 inches to 7.5 inches of seismically induced settlements during the design earthquake. The quantity of settlement could be greater if the potentially liquefiable soils extend deeper than explored or groundwater levels raise.

Static Settlement

The total settlements experienced by the proposed improvements are dependent upon the actual loads that are applied and the care of the placement and compaction of structural fills. For the foundations designed as recommended above, we estimate that total settlements of approximately 1-inch could be realized and differential settlements will be approximately one-half the total.

Frost Susceptibility

Butte is in a region of moderate freeze and thaw cycles. The well-graded gravel encountered beneath silty surface soils are considered non-frost susceptible (NFS); however, borings encountered silt-rich soils in the shallow subsurface. If left in place, these silt-rich soils will increase the risk of frost related issues at the Site. Heat the structure and remove the silt-rich soils to reduce the potential effects of seasonal frost action on the proposed addition. Frost related movement may occur if the building is not heated.

Drainage and Dewatering

HDL-02 encountered groundwater at 10.8 feet bgs. Based on the drilling conducted, groundwater is not likely to be encountered during typical foundation construction but the groundwater level will likely vary from that encountered during drilling. If groundwater is present in excavations, the soils will be prone to collapse and construction may be difficult. The subgrade soils may become difficult to compact due to natural moisture or exposure to additional rainfall or runoff. Dewater excavations as needed to place and compact fill and protect them from adjacent runoff.

HDL recommends grading the Site to promote positive drainage away from the structure and compacting the near surface soils to reduce permeability.

Excavations and Shoring

HDL assumes the need for temporary excavations to support the foundation construction and removal of silt rich soils. We recommend that the contractor be responsible for the trench side slopes, trench bottom conditions, and dewatering efforts as they are present on a day-to-day basis and can adjust efforts to obtain the needed stability and meet the applicable Alaska and Federal Occupational Safety and Health Administration (OSHA) safety regulations. Deviation from the OSHA stipulations requires the approval of a licensed Professional Geotechnical Engineer.

Shoring may be required if unstable soils are encountered. Account for additional loads from adjacent equipment, hydrostatic pressure, and structures in the pressure distribution for shoring design.

Heavy precipitation may cause soils to become saturated and less stable. The contractor should phase construction to minimize exposure of the subgrade and direct surface water away from the excavations.

LIMITATIONS

This Report is subject to the attached limitations.

We appreciate the opportunity to assist you with this important project. If you have any questions, please contact Jeremy Dvorak at jdvorak@hdlalaska.com or 907.564.2121.

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Attach:
- Limitations – 2 Pages
- Boring Location Map – 1 Page
- Boring Log Key – 1 Page
- Frost Design Soil Classification – 1 Page
- Description and Classification of Frozen Soils – 1 Page
- Boring Logs – 5 Pages
- Grain Size Distribution Test Results – 1 Page

GEOTECHNICAL LIMITATIONS

Use of Report

1. HDL Engineering Consultants, LLC (HDL) prepared this report on behalf of, and for the exclusive use of our Client for the stated purpose(s) and location(s) identified in the Proposal for Services and/or Report. Use of this report, in whole or in part, at other locations, or for other purposes, may lead to inappropriate conclusions; and we do not accept any responsibility for the consequences of such use(s). Further, reliance by any party not expressly identified in the agreement, for any use, without our prior written permission, shall be at that party's sole risk, and without any liability to HDL.

2. If substantial time has elapsed between submission of this report and the start of work at the site, or if conditions have changed because of natural causes or construction operations at or adjacent to the site, we recommend that HDL be retained to review this report to determine the applicability of the conclusions considering the time lapse or changed conditions.

Standard of Care

3. HDL's findings and conclusions are based on the work conducted as part of the Scope of Services set forth in the Proposal for Services and/or Report, and reflect our professional judgment. These findings and conclusions must be considered not as scientific or engineering certainties, but rather as our professional opinions concerning the limited data gathered during the course of our work. If conditions other than those described in this report are found at the subject location(s), or the design has been altered in any way, HDL shall be so notified and afforded the opportunity to revise the report, as appropriate, to reflect the unanticipated changed conditions.

4. HDL's services were performed using the degree of skill and care ordinarily exercised by qualified professionals performing the same type of services, at the same time, under similar conditions, at the same or a similar property. No warranty, expressed or implied, is made.

Subsurface Conditions

5. The generalized soil profile(s) provided in our Report are based on widely-spaced subsurface explorations and are intended only to convey trends in subsurface conditions. The boundaries between strata are approximate and idealized, and were based on our assessment of subsurface conditions. The composition of strata, and the transitions between strata, may be more variable and more complex than indicated. For more specific information on soil conditions at a specific location refer to the exploration logs.

6. Unanticipated soil conditions are commonly encountered and cannot be fully determined by merely taking soil samples or advancing borings. Such unexpected conditions frequently require additional expenditure to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs.

7. In preparing this report, HDL relied on certain information provided by the Client, state

and local officials, and other parties referenced therein which were made available to HDL at the time of our evaluation. HDL did not attempt to independently verify the accuracy or completeness of all information reviewed or received during the course of this evaluation.

8. Water level readings have been made in test holes (as described in the Report) and monitoring wells at the specified times and under the stated conditions. These data have been reviewed and interpretations have been made in this Report. Fluctuations in the level of the groundwater occur due to temporal or spatial variations in areal recharge rates, soil heterogeneities, the presence of subsurface utilities, and/or natural or artificially induced perturbations. The water encountered in the course of the work may differ from that indicated in the Report.

9. HDL's services did not include an assessment of the presence of oil or hazardous materials at the property. Consequently, we did not consider the potential impacts (if any) that contaminants in soil or groundwater may have on construction activities, or the use of structures on the property.

10. Recommendations for foundation drainage, waterproofing, and moisture control address the conventional geotechnical engineering aspects of seepage control. These recommendations may not preclude an environment that allows the infestation of mold or other biological pollutants.

<u>Compliance with Codes and Regulations</u>

11. We used reasonable care in identifying and interpreting applicable codes and regulations. These codes and regulations are subject to various, and possibly contradictory, interpretations. Compliance with codes and regulations by other parties is beyond our control.

<u>Additional Services</u>

12. HDL recommends that we be retained to provide services during any future: site observations, design, implementation activities, construction and/or property development/redevelopment. This will allow us the opportunity to: i) observe conditions and compliance with our design concepts and opinions; ii) allow for changes in the event that conditions are other than anticipated; iii) provide modifications to our design; and iv) assess the consequences of changes in technologies and/or regulations.

HDL ENGINEERING Consultants LLC	PREPARED BY	PROJECT	LOCATION	SYMBOL KEY
	HDL Engineering Consultants, LLC Anchorage, AK	Name: PMC Seed House Addition Number: 25-104	61.522136, -149.080743 Palmer, AK	Soil Boring

BORING LOG KEY

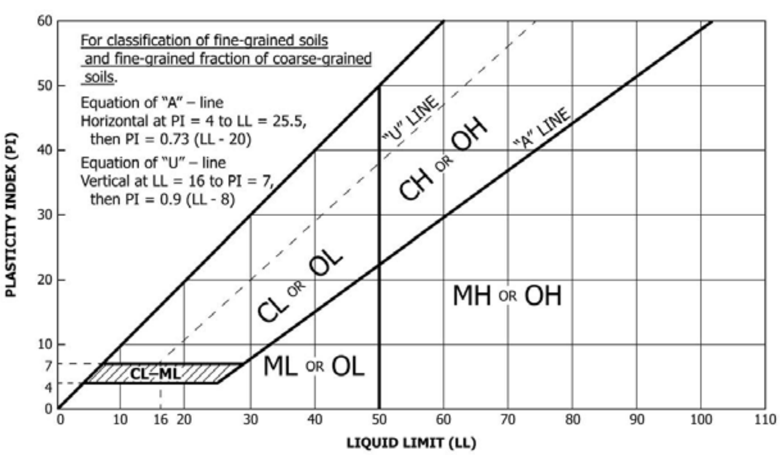
Summary of the Unified Soil Classification System (from ASTM International Standard D2487)[A]				Soil Classification	
				Group Symbol	**Group Name**[B]
Coarse-grained Soils *(More than 50% retained on No. 200 sieve)*	Gravels *(More than 50% of coarse fraction retained on No. 4 sieve)*	Gravels with < 5% fines[C]	$C_u \geq 4$ and $1 \leq C_c \leq 3$ [D]	GW	Well-graded gravel[E]
			$C_u < 4$ and/or $[C_c < 1$ or $C_c > 3]$ [D]	GP	Poorly graded gravel[E]
		Gravels with > 12% fines[C]	Fines classify as ML or MH	GM	Silty gravel[E,F,G]
			Fines classify as CL or CH	GC	Clayey gravel[E,F,G]
	Sands *(50% or more of coarse fraction passes No. 4 sieve)*	Sands with < 5% fines[H]	$C_u \geq 6$ and $1 \leq C_c \leq 3$ [D]	SW	Well-graded sand[I]
			$C_u < 6$ and/or $[C_c < 1$ or $C_c > 3]$ [D]	SP	Poorly graded sand[I]
		Sands with > 12% fines[H]	Fines classify as ML or MH	SM	Silty sand[F,G,I]
			Fines classify as CL or CH	SC	Clayey sand[F,G,I]
Fine-grained Soils *(More than 50% passes the No. 200 sieve)*	Silts and Clays *(LL<50)*	Inorganic	PI>7 and plots on or above "A" line[J]	CL	Lean clay[K,L,M]
			PI<4 or plots below "A" line[J]	ML	Silt[K,L,M]
		Organic	LL - Oven dried/LL - Not dried <0.75	OL	Organic clay/silt[K,L,M,N/O]
	Silts and Clays *(LL≥50)*	Inorganic	PI plots on or above "A" line	CH	Fat clay[K,L,M]
			PI plots below "A" line	MH	Elastic silt[K,L,M]
		Organic	LL - Oven dried/LL - Not dried <0.75	OH	Organic clay/silt[K,L,M,P/Q]
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor			PT	Peat

NOTES:
Visual soil descriptions performed in accordance with ASTM D2488
Lowercase USCS abbreviation indicates field classification
Uppercase USCS abbreviation indicates laboratory classification

[A]Based on the material passing the 3-in. (75-mm) sieve
[B]If field sample contained cobble 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] $C_u = D_{60}/D_{10}$, $C_c = (D_{30})^2/(D_{10} \times D_{60})$
[E]If soil contains ≥ 15% sand, add "with sand" to group name
[F]If fines classify as CL-ML, use dual symbol GC-GM, or SC-SM
[G]If fines are organic, add "with organic fines" to group name
[H]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

[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 < 30% 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, predominatly 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



GRAIN SIZE		
Size Class	**Inches**	**mm**
Boulders	>12 inches	>300
Cobbles	3 to 12	75 - 300
Gravel		
Coarse	3/4 - 3	19.0 - 75
Fine	3/16 - 3/4	4.76 - 19.0
Sand		
Coarse	1/16 - 3/16	2.0 - 4.76
Medium	1/64 - 1/16	0.42 - 2.0
Fine	1/256 - 1/64	0.074 - 0.42
Silt and Clay	<1/256	<0.074

SOIL CONSISTENCY*		
Description	**N-Value**	**Pocket Pen.**
Very Soft	<2	<0.25
Soft	2 - 4	0.25 - 0.5
Medium	5 - 8	0.5 - 1.0
Stiff	9 - 15	1.0 - 2.0
Very Stiff	16 - 30	2.0 - 4.0
Hard	>30	>4.0

RELATIVE SOIL DENSITY*	
Description	**N-Value**
Very Loose	0 - 4
Loose	5 - 10
Medium Dense	11 - 30
Dense	31 - 50
Very Dense	>50

*Soil Consistency and Relative Soil Density Tables based on values provided in the Alaska Geotechnical Procedures Manual

FROST DESIGN SOIL CLASSIFICATION

US Army Corps of Engineers (USACE) Methodology

The following frost design soil classification was developed by the USACE for describing the potential frost susceptibility of soils. The standard is published in USACE, EM 1110-3-138, "Pavement Criteria for Seasonal Frost Conditions," April 1984.

FROST GROUP	GENERAL SOIL TYPE	% FINER THAN 0.02 mm BY WEIGHT	TYPICAL USCS SOIL CLASS
NFS[(1)]	(a) Gravels Crushed Stone Crushed Rock (b) Sands	0-1.5 0-3	GW, GP SW, SP
PFS[(2)]	(a) Gravels Crushed Stone Crushed Rock (b) Sands	1.5 -3 3-10	GW, GP SW, SP
S1	Gravelly Soils	3-6	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC
S2	Sandy Soils	3-6	SW, SP, SW-SM, SP-SM, SW-SC, SP-SC
F1	Gravelly Soils	6-10	GM, GC, GW-GM, GP-GM, GW-GC, GP-GC
F2	(a) Gravelly Soils (b) Sands	10-20 6-15	GW, GP, GW-GM, GP-GM, GW-GC, GP-GC SM, SW-SM, SP-SM, SC, SW-SC, SP-SC, SM-SC
F3	(a) Gravelly Soils (b) Sands, except very fine silty sands (c) Clays, PI>12	Over 20 Over 15 --	GM, GC, GM-GC SM, SC, SM-SC CL, CH
F4	(a) Silts (b) Very fine silty sands (c) Clays, PI<12 (d) Varied clays or other fine-grained banded sediments	-- Over 15 -- --	ML, MH, ML-CL SM, SC, SM-SC CL, ML-CL CL or CH layered with ML, MH, ML-CL, SM, SC, or SM-SC

(1) Non-frost susceptible

(2) Possibly frost susceptible, requires lab test for void ratio to determine frost design soil classification. Gravel with void ratio > 0.25 would be NFS; Gravel with void ratio < 0.25 would be S1; Sands with void ratio > 0.30 would be NFS; Sands with void ratio < 0.30 would be S2 or F2

Municipality of Anchorage (MOA) and Federal Aviation Administration (FAA) Methodology

MOA and FAA use simplifications of the USACE methodology noted above. The Design Criteria Manual details the MOA method and Section 207 of FAA Advisory Circular 150/5320-6G details the FAA method. Both are summarized below.

FROST GROUP	SOIL TYPE	PERCENTAGE FINER THAN 0.02 mm BY WEIGHT	TYPICAL SOIL TYPES UNDER UNIFIED SOIL CLASSIFICATION SYSTEM
NFS[a]	a. Gravels b. Sands	0 to 3 0 to 3	GW, GP SW, SP
F-1[a] or FG-1[b]	Gravelly soils	3 to 10	GW, GP, GW-GM, GP-GM
F-2[a] or FG-2[b]	a. Gravelly soils b. Sands	10 to 20 3 to 15	GM, GW-GM, GP-GM SW, SP, SM, SW-SM, SP
F-3[a] or FG-3[b]	a. Gravelly soils b. Sands, except very fine silty sands c. Clays, PI>12	Over 20 Over 15 --	GM, GC SM, SC CL, CH
F-4[a] or FG-4[b]	a. All silts b. Very fine silty sands c. Clays, PI<12 d. Varved clays and other fine-grained, banded sediments	-- Over 15 -- -- --	ML, MH SM, SC CL, CL-ML CL, CL-ML CL, CH, ML, SM

[a] Municipality of Anchorage, Project Management & Engineering Department, Design Criteria Manual, January 2007.

[b] Federal Aviation Authority, FAA Advisory Circular 150/5320-6G.

DESCRIPTION AND CLASSIFICATION OF FROZEN SOILS

(Summarized from the Alaska Field Guide for Soil Classification)

PART I: Description of Soil Phase—Independent of Frozen State(a)

	Major Group		Sub-Group		Field Identification	Pertinent Properties of Frozen Materials which may be measured by physical tests to supplement field identification.	Guide for Construction on Soils Subject to Freezing and Thawing	
	Description	Designation	Description	Designation			Thaw Characteristics	Criteria
Part II: Description of Frozen Soil	Segregated ice is not visible by eye (b)	N	Poorly Bonded or Friable	Nf	Identify by visual examination. To determine presence of excess ice, use procedure under note (c) below 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 coating around larger particles.	In-Place Temperature Density and Void Ratio a) In Frozen State b) After Thawing in Place Water Content (Total H_2O, including ice) a) Average b) Distribution Strength a) Compressive b) Tensile c) Shear d) Adfreeze Elastic Properties Plastic Properties Thermal Properties Ice Crystal Structure (using optional instruments.) a) Orientation of Axes b) Crystal size c) Crystal shape d) Pattern of Arrangement	Usually Thaw-Stable	The potential intensity of ice segregation in a soil is dependent to a large degree on its void sizes and may be expressed as an empirical function of grain size as follows: Most inorganic soils containing 3 percent or more of grains finer than 0.02 mm in diameter by weight are frost-susceptible. Gravels, well graded sands and silty sands, especially those approaching the theoretical maximum density curve, which contain 1.5 to 3 percent finer than 0.02 mm by weight without being frost-susceptible. However, their tendency to occur interbedded with other soils usually makes it impractical to consider them separately. Soils classed as frost-susceptible under the above criteria are likely to develop significant ice segregation and frost heave if frozen at normal rates with free water readily available. Soils so frozen will fall into the thaw-unstable category. However, they may also be classed as thaw-stable if frozen with insufficient water to permit ice segregation. Soils classed as non-frost-susceptible (*NFS) under the above criteria usually occur without significant ice segregation and are not exact and may be inadequate for some structure applications: exceptions may also result from minor soil variations. In permafrost areas, ice wedges, pockets, veins, or other ice bodies may be found whose mode of origin is different from that described above. Such ice may be the result of long-time surface expansion and contraction phenomena or may be glacial or other ice which has been buried under a protective earth cover.
			Well Bonded — *No excess ice*	Nb — n				
			Well Bonded — *Excess Ice*	Nb — e				
	Segregated ice is visible by eye. (Ice 1 inch or less in thickness) (b)	V	Individual ice crystals or inclusions	Vx	For ice phase, record the following as applicable: Location — Size Orientation — Shape Thickness Spacing — Pattern of arrangement Length Hardness } Structure } per part III Below Color } Estimate volume of visible segregated ice present as percent of total sample volume		Usually Thaw-Unstable	
			Ice coatings on particles	Vc				
			Random or irregularly oriented ice formations	Vr				
			Stratified or distinctly oriented ice formations	Vs				
Part III: Description of Substantial Ice Strata	Ice (Greater than 1 inch in thickness)	Ice	Ice with soil inclusions	Ice + Soil Type	Designate material as ICE (d) and use descriptive terms as follows, usually one item from each group, as applicable: (see below)			
			Ice without soil inclusions	Ice				

Hardness	Structure	Color	Admixtures
Hard Soft (mass, not indi-crystals)	Clear Cloudy Porous Candled Granular Stratified	e.g.: Color-less Gray Blue	e.g.: Contains Thin Silt Inclusions

DEFINITIONS:

Ice Coatings on Particles are discernible layers of ice found on or below the larger soil particles in a frozen soil mass. They are sometimes associated with hoarfrost crystals, which have grown into voids produced by the freezing action.

Ice Crystal is a very small individual ice particle visible in the face of a soil mass. Crystals may be present alone or in a combination with other ice formations.

Clear Ice is transparent and contains only a moderate number of air bubbles. (e)

Cloudy Ice is translucent, but essentially sound and non-pervious.

Porous Ice 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.

Candled Ice is ice which has rotted or otherwise formed long columnar crystals, very loosely bonded together.

Granular Ice is composed of coarse, more or less equidimensional, ice crystals weakly bonded together.

Ice Lenses are lenticular ice formations in soil occurring essentially parallel to each other, generally normal to the direction of heat loss and commonly in repeated layers.

Ice Segregation is the growth of ice as distinct lenses, layers, veins, and masses in soils, commonly but not always oriented normal to direction of heat loss.

Well-bonded signifies that the soil particles are strongly held together by the ice and that the frozen soil possesses relatively high resistance to chipping or breaking.

Poorly-bonded signifies that the soil particles are weakly held together by the ice and that the frozen soil consequently has poor resistance to chipping or breaking.

Friable denotes a condition in which material is easily broken up under light to moderate pressure.

Thaw-Stable frozen soils do not, on thawing, show loss of strength below normal, long-time thawed values nor produce detrimental settlement.

Thaw-Unstable frozen soils show on thawing, significant loss of strength below normal, long-time thawed values and/or significant settlement, as a direct result of the melting of the excess ice in the soil.

NOTES:

(a) When rock is encountered, standard rock classification terminology should be used.

(b) 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. However, the impression to the unaided eye 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.

(c) When visual methods may be inadequate, a simple field test to aid evaluation of 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 percent of total volume.

(d) Where special forms of ice, such as hoarfrost, can be distinguished, more explicit description should be given.

(e) Observer should be careful to avoid being misled by surface scratches or frost coating on the ice.

Modified from: Linell, K.A. and Kaplar, C.W., 1966, *Description and Classification of Frozen Soils*, Proc. International Conference on Permafrost (1963), Lafayette, IN, U.S. National Academy of Sciences, Publ. 1287, pp 481-487.

HDL

HDL ENGINEERING Consultants LLC SOIL BORING: HDL-01

Project Name: PMC Seed House Addition
Project Number: 25-104
Client: Design Alaska, Inc.
Date Drilled: 03/12/2025
Total Depth: 6 ft

Drilling Firm: Discovery Drilling, Inc.
Equipment: CME-75
Hammer Type: Auto
Hammer Weight: 340 lbs
Field Staff: K. Taylor

Station/Offset: - / - -
Lat/Long: 61.52222, -149.08078
Boring Elevation: 46.5 ft
Location: Northern portion of proposed addition

Comments -

Depth (ft)	Water Levels	Drilling Method	Sample Number	Sample Graphic	Recovery Length (ft)	Blow Counts	Uncorrected N-Value	USCS	Bonded	Graphic Log	USCS Description	% Gravel	% Sand	% Fines	% Finer than 0.02mm	Moisture Content (%)	% Organic Material	Atterberg Limits
0–0.2		LSS	S-1	LSS	2	7 9 8 8				organic mat	**ORGANIC MAT** 0.2							
0.2–1.7		LSS						gm	Bonded	gm	**SILTY GRAVEL WITH SAND (GM)**, fine to coarse grained; brown, Nbn to Nbe 1.7					22.6		
1.7–2.0		LSS						sp		sp	**POORLY GRADED SAND (SP)**, fine grained; brown, dry 2.0					5.2		
2.0–4.0		LSS	S-2	LSS	1.7	14 12 10 8	22	gw		gw	**WELL-GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, angular to subrounded; gray, dry, medium dense					2.4		
4.0–6.0		LSS	S-4	LSS	1.6	7 8 7 8	15			gw	6.0					2.0		

Terminated boring at 6.0 feet bgs.

Graphics Legend

- sp
- gw
- organic mat
- gm
- LSS - Large Split Spoon

Water Levels

- No free groundwater encountered.
- -

SOIL BORING: HDL-02

HDL ENGINEERING Consultants LLC

Project Name: PMC Seed House Addition
Project Number: 25-104
Client: Design Alaska, Inc.
Date Drilled: 03/12/2025
Total Depth: 42 ft

Drilling Firm: Discovery Drilling, Inc.
Equipment: CME-75
Hammer Type: Auto
Hammer Weight: 340 lbs
Field Staff: K. Taylor

Station/Offset: - / - -
Lat/Long: 61.52216, -149.08076
Boring Elevation: 46.4 ft
Location: Central portion of proposed addition

Comments -

Depth (ft)	Water Levels	Drilling Method	Sample Number	Recovery Length (ft)	Blow Counts	Uncorrected N-Value	USCS	USCS Description	% Gravel	% Sand	% Fines	% Finer than 0.02mm	Moisture Content (%)	% Organic Material	Atterberg Limits
0–0.3		Hollow Stem Auger						**ORGANIC MAT** (0.3)							
0.3–2.5			S-1	1.6	4, 7, 12, 12		gm	**SILTY GRAVEL WITH SAND (GM)**, fine to coarse grained; brown, Nbn to Nbe, trace root hairs, fractured cobbles in shoe (2.5)	41.4	32	26.6		27.8		
2.5–4			S-2	1.7	5, 9, 11, 13	20	GW	**WELL-GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, angular to subrounded; gray, dry, medium dense	64.9	31.3	3.8		2.7		
5–7			S-3	1.8	5, 13, 17, 15	30		fractured cobbles in sample					1.8		
7.5–9.5			S-4	1.8	6, 14, 14, 13	28							1.7		
10–12	▽ (10.8)		S-5	1.2	11, 6, 9, 5	15		wet					2.3, 5.3		
12.5–14.5			S-6	0.7	6, 2, 3, 1	5		loose					7.2		
15–17			S-7	0.7	2, 3, 3, 4	6		loss of fractured cobbles					9.3		

Graphics Legend

- ▽ At Time of Drilling (ATD)
- GW
- organic mat
- gm
- LSS - Large Split Spoon

Water Levels

- ▽ Free groundwater encountered at 10.8 feet bgs.
- ▼ -

HDL ENGINEERING Consultants LLC SOIL BORING: HDL-02

Project Name: PMC Seed House Addition
Project Number: 25-104
Client: Design Alaska, Inc.
Date Drilled: 03/12/2025
Total Depth: 42 ft

Drilling Firm: Discovery Drilling, Inc.
Equipment: CME-75
Hammer Type: Auto
Hammer Weight: 340 lbs
Field Staff: K. Taylor

Station/Offset: - / - -
Lat/Long: 61.52216, -149.08076
Boring Elevation: 46.4 ft
Location: Central portion of proposed addition

Comments -

Depth (ft)	Water Levels	Drilling Method	Sample Number	Sample Graphic	Recovery Length (ft)	Blow Counts	Uncorrected N-Value	USCS	Bonded	Graphic Log	USCS Description	% Gravel	% Sand	% Fines	% Finer than 0.02mm	Moisture Content (%)	% Organic Material	Atterberg Limits
17–20		Hollow Stem Auger						GW		GW								
20–22			S-8	LSS	1.1	13 7 7 9	14				medium dense, fractured cobbles in sample					9.3		
22–25																		
25–27			S-9	LSS	1.3	11 10 10 5	20									7.6		
27–30																		
30–32			S-10	LSS	0.8	42 11 12 12	23				approximately 5 inches of heave prior to sampling, loss of fractured cobbles					8.6		
32–34																		

Graphics Legend

GW

LSS - Large Split Spoon

Water Levels

Free groundwater encountered at 10.8 feet bgs.

-

HDL ENGINEERING Consultants LLC — SOIL BORING: HDL-02

Project Name: PMC Seed House Addition
Project Number: 25-104
Client: Design Alaska, Inc.
Date Drilled: 03/12/2025
Total Depth: 42 ft

Drilling Firm: Discovery Drilling, Inc.
Equipment: CME-75
Hammer Type: Auto
Hammer Weight: 340 lbs
Field Staff: K. Taylor

Station/Offset: - / - -
Lat/Long: 61.52216, -149.08076
Boring Elevation: 46.4 ft
Location: Central portion of proposed addition

Comments -

Depth (ft)	Water Levels	Drilling Method	Sample Number	Sample Graphic	Recovery Length (ft)	Blow Counts	Uncorrected N-Value	USCS	Bonded	Graphic Log	USCS Description	% Gravel	% Sand	% Fines	% Finer than 0.02mm	Moisture Content (%)	% Organic Material	Atterberg Limits
35–37		Hollow Stem Auger	S-11	LSS	0.9	46 16 14 13	30	GW		GW	approximately 4 inches of heave prior to sampling, fractured cobbles in sample					7.6		
40.0–42.0		Hollow Stem Auger	S-12	LSS	0.9	10 13 16 18	29	gw-gm		gw-gm	**WELL-GRADED GRAVEL WITH SILT AND SAND** (**GW-GM**), fine to coarse grained, angular to subrounded; gray, wet, medium dense					6.2		

Terminated boring at 42.0 feet bgs.

Graphics Legend

- GW
- gw-gm
- LSS - Large Split Spoon

Water Levels

- ▽ Free groundwater encountered at 10.8 feet bgs.
- ▼ -

SOIL BORING: HDL-03

HDL ENGINEERING Consultants LLC

Project Name: PMC Seed House Addition
Project Number: 25-104
Client: Design Alaska, Inc.
Date Drilled: 03/12/2025
Total Depth: 6 ft

Drilling Firm: Discovery Drilling, Inc.
Equipment: CME-75
Hammer Type: Auto
Hammer Weight: 340 lbs
Field Staff: K. Taylor

Station/Offset: - / - -
Lat/Long: 61.52210, -149.08075
Boring Elevation: 46.2 ft
Location: Southern portion of proposed addition

Comments -

Depth (ft)	Water Levels	Drilling Method	Samples: Sample Number	Sample Graphic	Recovery Length (ft)	Blow Counts	Uncorrected N-Value	USCS	Bonded	Graphic Log	USCS Description	Lab: % Gravel	% Sand	% Fines	% Finer than 0.02mm	Moisture Content (%)	% Organic Material	Atterberg Limits
0											**ORGANIC MAT** 0.2							
1		LSS	S-1		1.8	3 6 7 10		gm			**SILTY GRAVEL WITH SAND (GM)**, fine to coarse grained; brown, Nbn to Nbe 1.5					35.1		
2								GW			**WELL-GRADED GRAVEL WITH SAND (GW)**, fine to coarse grained, angular to subrounded; gray, dry, NFS					2.7		
3			S-2		1.5	6 12 10 11	22				medium dense	60.6	36.6	2.8	1.3	2.1		
4											fractured cobbles in sample							
5			S-3		1.8	8 13 14 16	27									1.5		
6											6.0							

Terminated boring at 6.0 feet bgs

Graphics Legend

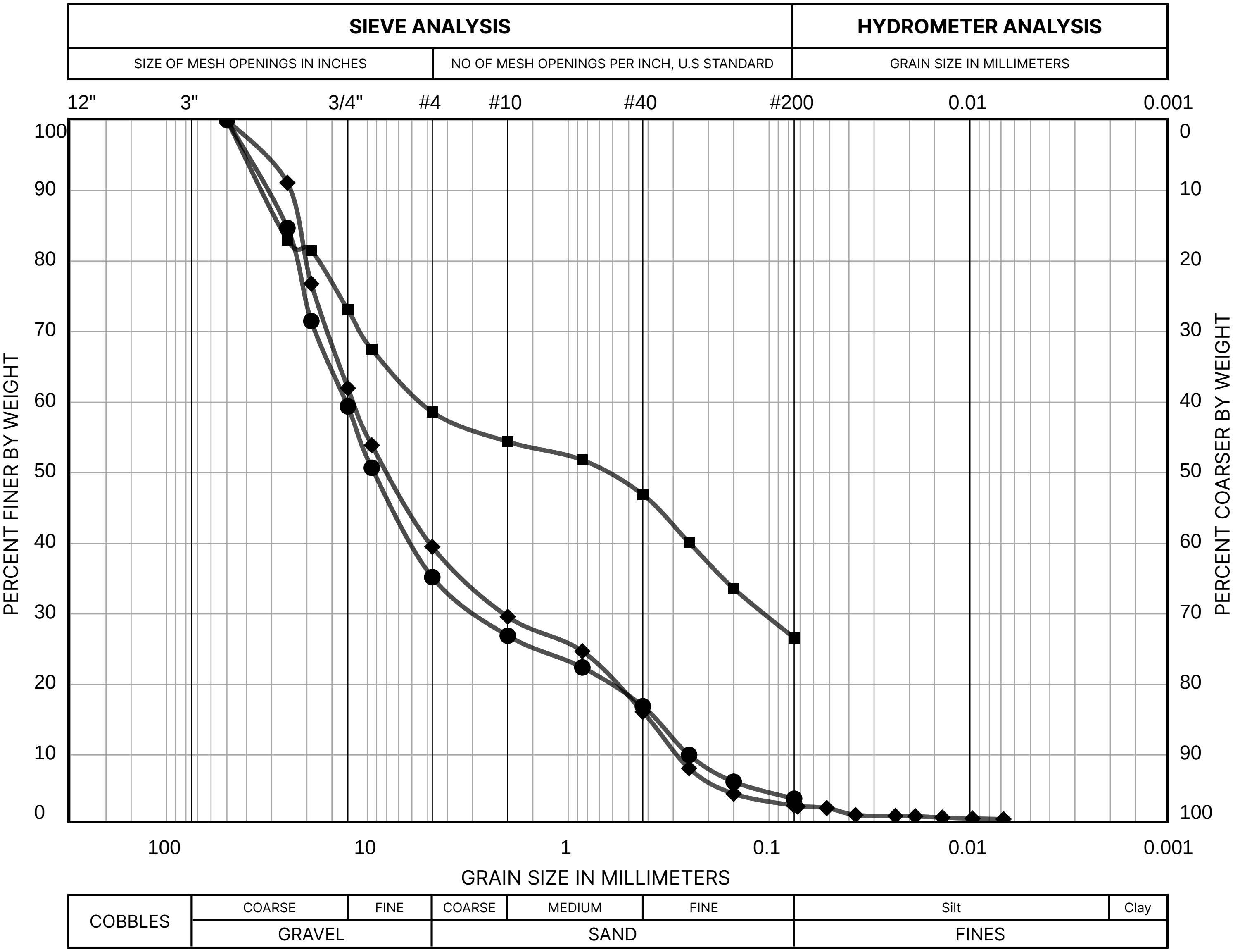
- gm
- organic mat
- GW
- LSS - Large Split Spoon

Water Levels

- No free groundwater encountered.
- -

GRAIN SIZE DISTRIBUTION TEST RESULTS

PMC Seed House Addition
Butte, Alaska



	EXPLORATION	SAMPLE NUMBER	DEPTH	USCS SYMBOL	GRAVEL (%)	SAND (%)	FINES (%)	D10	D30	D60	CU	CC
■	HDL-02	S-1	0.3	gm	41.4	32	26.6		0.11	5.54		
●	HDL-02	S-2	2.9	GW	64.9	31.3	3.8	0.25	3.12	12.85	51.4	3.03
◆	HDL-03	S-2	2	GW	60.6	36.6	2.8	0.3	2.13	11.8	39.33	1.28