Prepared for:

October 2022

WOLF ARCHITECTURE

Kodiak Fire Station

Geotechnical Report

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1 INTRODUCTION

PND Engineers, lnc. (PND), together with Discovery Drilling, Inc. (Discovery), performed a geotechnical investigation to characterize surface and subsurface soil conditions at the location of the future Kodiak Fire Station (KFS) in Kodiak, Alaska. The geotechnical investigation was performed in support of a design and construction of a fire station structure and parking area at 1240 Mill Bay Road (Figure 2-1).

This Data and Recommendations Report contains six appendices:

- ✓ **Appendix A – Borehole Logs** presents the complete borehole log set from the exploratory borings of this investigation.
- ✓ **Appendix B – Summary of Lab and Field Characteristics** presents the complete summary of results from the lab testing program and field/ice characteristics for all the samples.
- ✓ **Appendix C – Particle Size Distribution Plot** showing the complete set of particle size distribution plots (gradations) as performed in the lab program.
- ✓ **Appendix D – Moisture Content by Depth Plot**
- ✓ **Appendix E – Corrected SPT Blow Counts**
- ✓ **Appendix F – Atterberg Limits**

2 BACKGROUND

The following sections summarize the findings of the geotechnical investigation at the site.

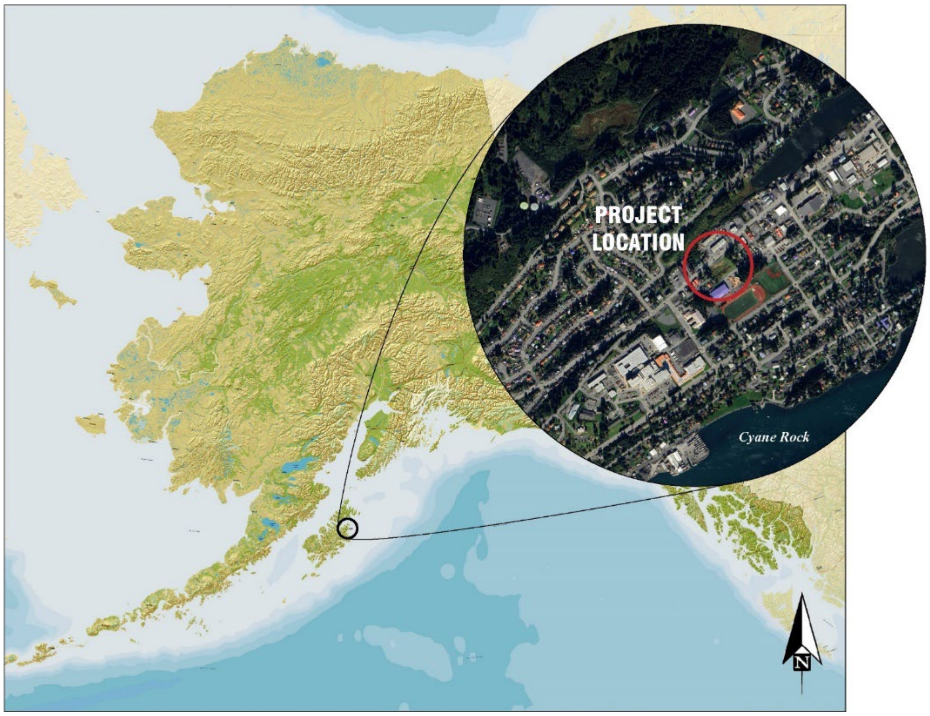

Figure 2-1. Project Location Vicinity Map

2.1 HISTORIC LAND USE

The lot at 1240 Mill Bay Road was previously developed for residential use from at least the 1950s. The most recent available aerial image showing residential use was taken in 1978. Historical records provided by the City of Kodiak show that the site previously consisted of several lots, similar in dimension and orientation to neighboring lots, before being re-platted into a single lot in 1979. No historical aerial images were recovered for the period from 1978 to 2004 with sufficient resolution to determine the use of the property. By 2004, the concrete retaining wall had been constructed to its current state and all other structures were absent.

2.2 BOREHOLE LOCATIONS

Nine boreholes covering the building footprint and parking area were advanced to depths between 14.3 and 25.3 feet below-ground-surface (bgs). Bedrock was encountered in all boreholes. The approximate elevation, latitude, and longitude of the Kodiak Fire Station boreholes are provided in Table 2-1. These locations were determined by hand-held GPS in the field. Elevations are provided in Mean Lower Low Water (MLLW) and were determined by PND Surveying from 2022. As-built locations are presented in Figure 2-2.

Table 2-1. As-built Borehole Locations

*Borehole	†Elevation (ft)	Latitude	Longitude
BH-1	123.3	57.79714°N	152.38970°W
BH-2	122.9	57.79704°N	152.38990°W
BH-3	120.3	57.79703°N	152.38974°W
BH-4	116.2	57.79691°N	152.38974°W
BH-5	117.3	57.79699°N	152.38960°W
BH-6	111.7	57.79678°N	152.38968°W
BH-7	107.4	57.79688°N	152.38934°W
BH-8	120.3	57.79712°N	152.38949°W
BH-9	121.1	57.79693°N	152.39011°W

† Measured from Mean Lower Low Water (MLLW)

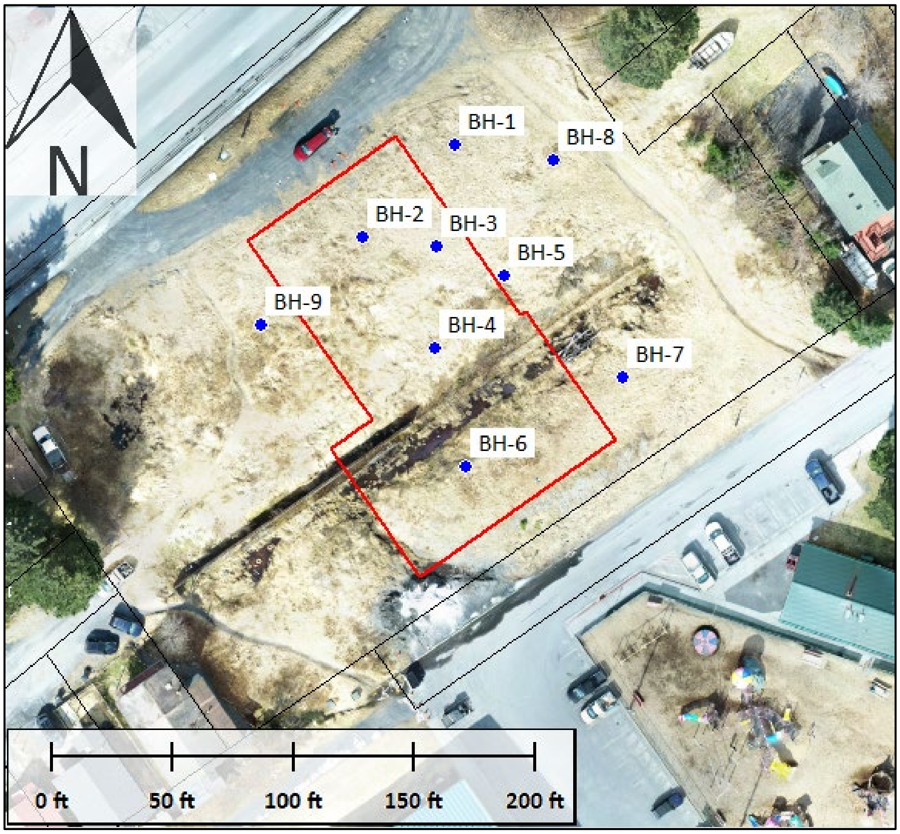

Figure 2-2. As-built Borehole Locations with building footprint in red and property lot lines in black.

2.3 INVESTIGATION DESCRIPTION

The drilling program took place on June 1 and 2, 2022. The drilling was performed using a Geoprobe 6712 DT. The field sampling advanced a 3-inch outside diameter (O.D.) Modified Standard Penetration Test (SPT) split spoon sampler. The sampler was advanced 18 to 24 inches using a 340-pound automatic drop-hammer free-falling 30 inches per stroke. The number of blows required to drive the sampler each 6-inch interval was recorded on the borehole logs. The blow counts shown on the borehole logs are field values that have not been corrected for overburden, rod length, sample size, or other factors.

Samples were collected every 2.5 feet to 10 feet bgs, then every 5 feet for the remainder of the borings to obtain representative samples of the subsurface soil conditions. The recovered soils were field-classified following the United Soils Classification System (USCS) according to ASTM D2487. Representative samples were transported to PND's AASHTO certified Anchorage Soil-Material Lab for field verification and lab testing.

2.4 EXPLORATION AREAS

Boreholes were completed June 2, 2021, and were advanced to depths of 14.3 to 25.3 feet bgs depending on subsurface conditions and bedrock depth. The project site slopes downward in the direction from Mill Bay Road to Chichenoff Street. There is approximately 45 feet of level terrain from Mill Bay Road to top-of-slope. From Mill Bay Road, level with top of slope (Elev. 125 ft.), to Chichenoff Street (Elev. 100 ft.) the slope is on a 14% grade. The lot has two pedestrian trails on the east and west ends to travel from Mill Bay Road to Chichenoff Street. A derelict retaining wall structure bisects the lot from west to east for approximately 240 feet up to the east pedestrian trail traveling from north to south. Along Chichenoff Street, there is approximately 9 ft. of overburden from ground surface to street elevation. PND understands that the City of Kodiak plans to excavate overburden along Chichenoff Street and bring it to street level elevation.

The borehole logs are shown in Appendix A. The following is a general description of subsurface soil, depth to bedrock, and groundwater conditions at each location during the field investigation.

3 SUBSURFACE CHARACTERIZATION

This section summarizes the soil characteristics of the geotechnical exploration advanced at KFS. The characterizations are based on field logging observations and lab testing of field collected samples performed for this investigation. The following sections present and discuss the laboratory testing program and results.

3.1 LABORATORY CLASSIFICATION

Representative samples from the SPT sampler were collected and sealed in freezer bags to maintain in-situ moisture content. The samples were then transported to PND's Soil Material Laboratory in Anchorage for testing. All tests were performed to ASTM standards where applicable. A total of 63 lab tests were performed (Table 3-1).

Lab characterizations included the following tests:

- Moisture Content/Classification *(ASTM D4318)*
- Description and Identification of Soils—Visual-Manual Procedure *(ASTM D2487, D2488)*
- Particle Size Analysis *(ASTM D422)*
- Fines Wash *(ASTM D1140)*
- Atterberg Limits *(ASTM D4318)*

Table 3-1. Summary of Laboratory Tests

Test Type	Quantity
Moisture Content with Classification (ASTM D2487 / D2488 / D2216)	53
Gradation of Soils (ASTM D6913)	4
Fines Wash (ASTM D1140)	4
Atterberg Limits (ASTM D4318)	2

The results of the laboratory testing program are shown in Appendix B, C, D, and G. The appendices include a comprehensive tabulated summary of test results and classifications. The appendices also include grain size distribution plots, moisture contents by depth, and Atterberg Limits plots. Lab results are shown in the borehole logs at corresponding columns with given soil lithologies.

3.2 SOIL PROPERTIES IN SUMMARY

The following sections describe the soils encountered at the Kodiak Fire Station and summary descriptions of soil properties, such as moisture content and lithologies. Lithologies are described in tabulated format with idealized soil type by depth, moisture content, and representative gradations of coarse-grained soils. Lithology descriptions for the Kodiak Fire Station subsurface are shown as a graphical cross-section along the slope and across the upper elevation boreholes. These cross-sections were developed from field observations, interpreted borehole logs, laboratory tests, and professional judgement (Figure 3-2 and Figure 3-3).

3.2.1 SOIL TYPE AND GRADATIONS

Table 3-2 shows representative gravel, sand, and fines fraction of the gradations performed on the soils. D_{50} defines the particle size at which 50% of the soil is smaller than. P_{10} describes the percent passing the #10 sieve (2-mm), a useful value in characterizing gravel behavior. Although the P_{10} particle size is classified as coarse sand, when present in sufficient quantity in the gravel matrix it behaves synergistically with the gravel particles to increase strength and stiffness in compacted fill materials. Nominal average gravel particle size was approximately 1-inch.

Table 3-2. Representative Gradation Properties

Material Type	Soil Type Fractions (%)			D50 (mm)	P10 (%)
	Gravel	Sand	Fines		
Silty Clayey Sand with Gravel, (SC-SM)g	19	37	44	0.2	70
Silty Clayey Sandy Gravel, s(GC-GM)	37	36	27	1.4	54
Silty Clayey Sand, SC-SM	12	42	46	0.1	76

The majority of the particles were sub-angular in their angularity description. Angular aggregate encountered during sampling was likely fractured during drilling action and not representative of actual conditions. Weathered bedrock fragments were typical prior to encountering refusal. The gradation curves for the samples are shown in Appendix C.

3.2.2 MOISTURE CONTENT

Table 3-3 provides a summary of the average representative moisture contents by soil type at the project site. Moisture content (MC) by depth for individual boreholes are shown in Appendix D, the attached lab Summary of Sample Characteristics in Appendix B, and Borehole Logs in Appendix A.

Table 3-3. Average Moisture Content of Project Site

Soil Type (USCS)	MC Range (%)	MC Average (%)
OL	32.0 – 153.4	62.0
CL-ML	-	31.0
SC-SM/SP	10.1 – 33.7	21.9
g(SC-SM)/(SC-SM)g	6.5 – 13.3	9.0
s(GC-GM)/(GC-GM)s	5.2 – 10.2	7.7

3.2.3 ATTERBERG LIMITS

Two Atterberg tests were completed on BH-4, Sample 3 and BH-7, Sample 3 to determine the fines material. The samples varied in color and soil type. The test results are provided in Appendix D. Material displayed properties on the interface of CL-ML and CL. A final Atterberg result of CL-ML was assigned to the soil material tested.

3.3 BEDROCK

Bedrock was encountered in all boreholes ranging from 14.3 to 25.3 feet bgs. Effort was made by Discovery to verify bedrock if auger drilling stalled by advancing the auger annulus plug bit with the 340-lb hammer to try to knock through potential cobbles. If the plug bit advanced then the augur was drilled further until modified SPT sample met refusal and verified with recovered bedrock sample or from drilling observations such as grinding sounds, drill rig lifting, and/or vibrations felt at ground surface. Recovered bedrock samples were brittle and fractured along planes, indicative of shale material. Bedrock elevation varied across the project site with the deepest between 68 and 98-foot elevation MLLW. There is a depression around BH-3 where the bedrock elevation is lowest relative to surrounding borehole bedrock elevations. Table 3-4 provides the competent depth bgs and elevation of bedrock across the project site. Figure 3-1 is a rendering of bedrock elevation to show approximate surface detail on the slope.

Table 3-4. Depth and elevation to bedrock at the project site. Elevation shown with vertical datum of MLLW.

Borehole	Competent Bedrock Depth bgs (ft)	Competent Bedrock Elevation (ft)
BH-1	14.3	109.1
BH-2	15.2	107.7
BH-3	22.6	97.7
BH-4	15.2	101.0
BH-5	18.7	98.7
BH-6	25.3	86.4
BH-7	16.2	91.2
BH-8	19.2	101.1
BH-9	17.8	103.3

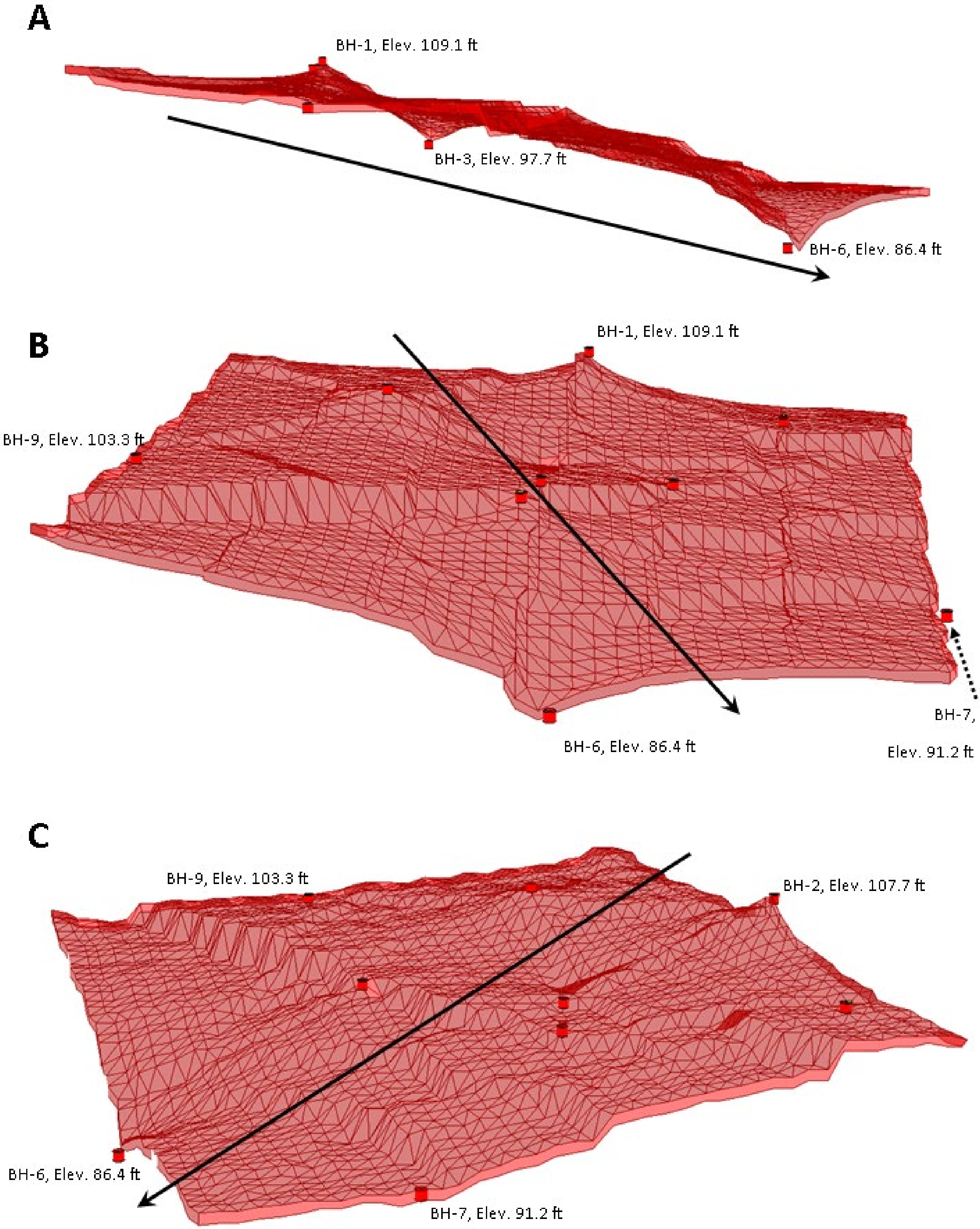

Figure 3-1. Rendering of potential bedrock surface with elevation noted at peripheral borehole locations. Panel A is a profile view looking northeast. Panel B is a profile view looking north. Panel C is a profile view looking northwest. The bold arrow indicates the slope direction. Elevation shown in MLLW vertical datum.

3.4 DESIGN SOIL PROFILES

Based on the corrected SPT blow counts and lab results, the determined soil profile and properties are provided in Table 3-5 and Table 3-6. Appendix E shows corrected SPT blow counts versus elevation for all boreholes located at the project site. Blow counts were corrected to $(N_1)_{70}$ using standard correlations found in most geotechnical texts. An idealized soil profile was determined for upper and lower elevation boreholes due to soil encountered during investigation. The upper elevation boreholes are BH-1, -2, -3, -8, and -9. These boreholes are located below the firetruck bay and upper driveway and parking area. The lower elevation boreholes are BH-4, -5, -6, and -7. These boreholes are at the transition from the firetruck bays to the administrative building at the retaining wall location and where the lower parking lot is located. The City of Kodiak intends to remove the overburden along Chichenoff Street to road elevation, which reflects the change in elevation at BH-6 and -7, removing 11 and 6 feet, respectively, from subsurface soils encountered. The soil profiles presented consider the nominal depth of the boreholes advanced in each section with a depth range presented for bedrock.

3.4.1 UPPER ELEVATION

The soil profile can be generally described as:

> *1-foot of ground cover consisting of grass and very loose Peat (PT) overlying 2 feet of loose Organic Silt (OL). This is underlain by 5 feet of dense Silty Clayey Gravelly Sand (g(SC-SM)) on top of 5 feet of dense Silty Clayey Sandy Gravel (s(GC-GM)) over dense Silty Clayey Sand with Gravel ((SC-SM)g) extending to bedrock (Bx) at sporadic depth.*

Table 3-5. The Kodiak Fire Station Idealized Soil Profile at Upper Elevations

Depth (ft)	Layer	Design $(N_1)_{70}$ (blows/ft)	Assumed Bulk Unit Weight (pcf)	ϕ'peak (deg)	Cohesion (psf)
0 – 1	PT	—	50	10	—
1 – 3	OL	5	75	25	—
3 – 9	g(SC-SM)	35	130	32	1000
9 – 14	s(GC-GM)	32	130	34	1000
14 – varies	(SC-SM)g	35	130	32	1000
11.5 – 22	Bx	—	140	40	—

3.4.2 LOWER ELEVATION

The soil profile can be generally described as:

> *0.5-foot of ground cover consisting of grass and very loose Peat (PT) overlying 1-foot of loose Organic Silt (OL) over dense Silty Clayey Sand with Gravel ((SC-SM)g) to dense Silty Clayey Gravelly Sand (g(SC-SM)) extending to bedrock (Bx) at sporadic depth.*

Table 3-6. The Kodiak Fire Station Idealized Soil Profile at Lower Elevations

Depth (ft)	Layer	Design $(N_1)_{70}$ (blows/ft)	Assumed Bulk Unit Weight (pcf)	ϕ'peak (deg)	Cohesion (psf)
0 – 0.5	PT	—	50	10	—
0.5 – 1.5	OL	5	75	25	—
1.5 – varies	g(SC-SM)/(SC-SM)g	35	130	32	1000
10 – 17	Bx	—	140	40	—

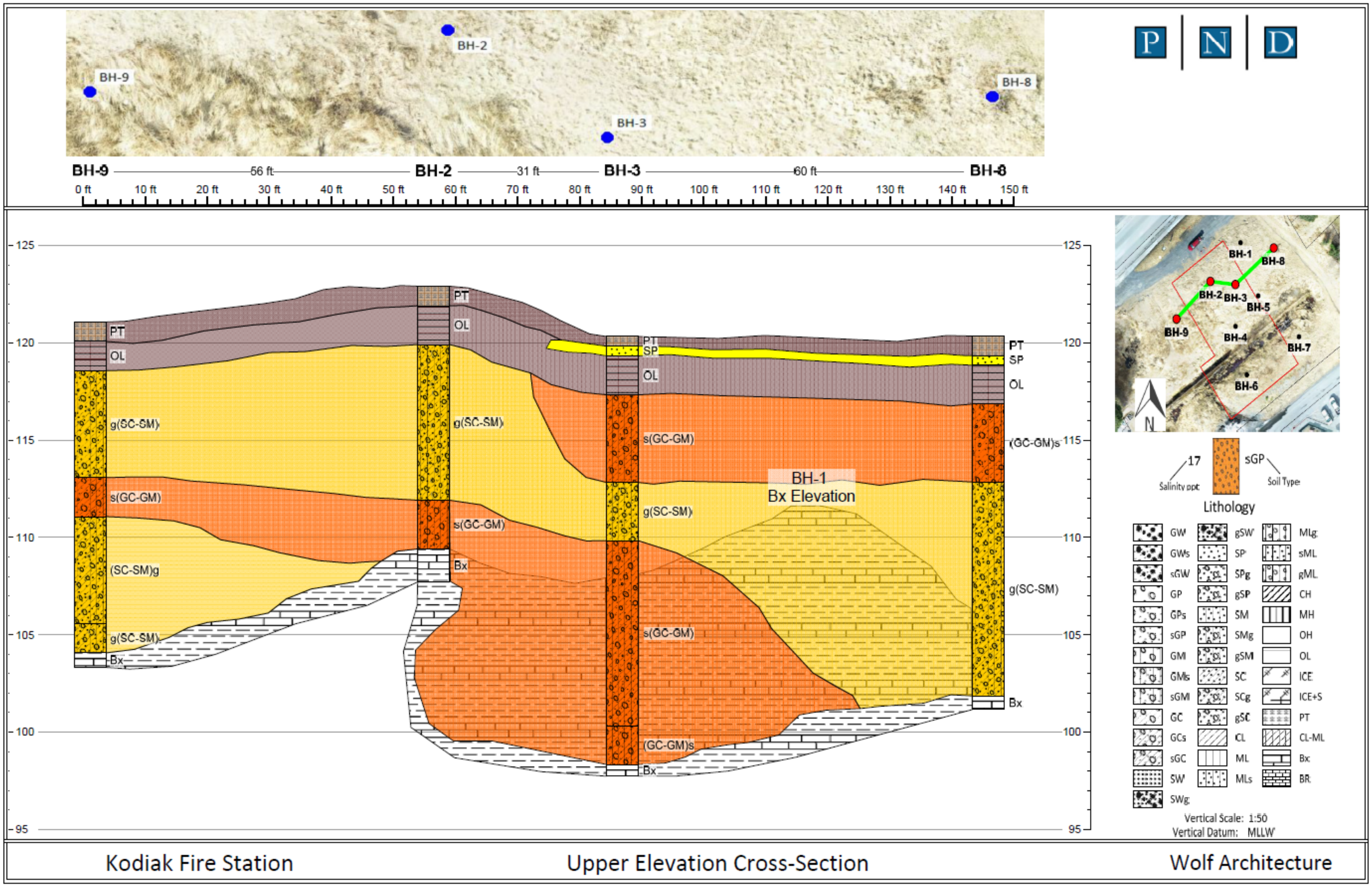

Figure 3-2. Cross-Section of the upper elevation boreholes below the proposed firetruck bay and driveway. BH-3 is in the foreground with BH-1 bedrock elevation shown in the background between BH-3 and BH-8.

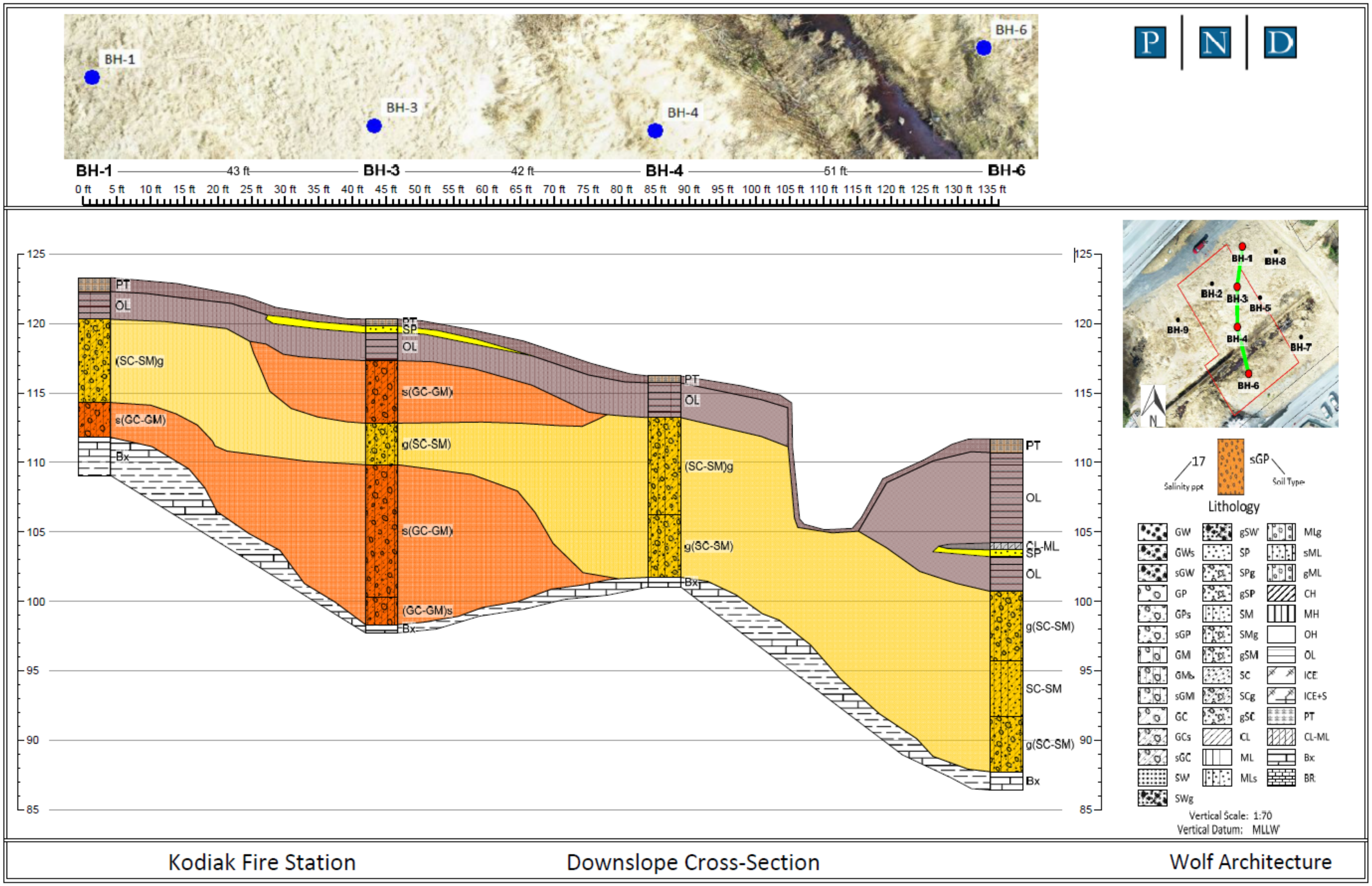

Figure 3-3. Cross-section of the downslope from BH-1 to BH-6 showing the trench where the abandoned retaining wall structure is at the project site.

3.5 GROUNDWATER DEPTH

Groundwater was encountered in three boreholes, BH-6, -8, and -9. In BH-8 and -9, groundwater was identified at 18 and 15 feet bgs, respectively. The groundwater flowed at the interface between soil and bedrock at these two locations. BH-6 was located near the bottom of the slope along a drainage area created by the abandoned retaining wall structure. Groundwater level in BH-6 was a result of this ponded area.

3.6 SEISMIC DESIGN

Seismic design parameters based on maps/data provided by United States Geological Survey (USGS, www.usgs.gov/) are provided in Table 3-7. The design response spectra is shown in Figure 3-4.

Table 3-7. Seismic Design Parameters

Return Period	2475 years (2% in 50 years)
Risk Category	IV
Soil Site Class	C
Peak Ground Acceleration (PGA)	0.770
Site Adjusted Peak Ground Acceleration (PGA_M)	0.636
S_s (0.2 sec period acceleration)	1.529
S_1 (1.0 sec period acceleration)	0.903
Seismic Design Category	F
Moment Magnitude, M_w	8.0

The site class was determined based upon the blow counts and the procedure as outlined in American Society of Civil Engineer's *ASCE 7-10 Minimum Design Loads for Buildings and Other Structures*.

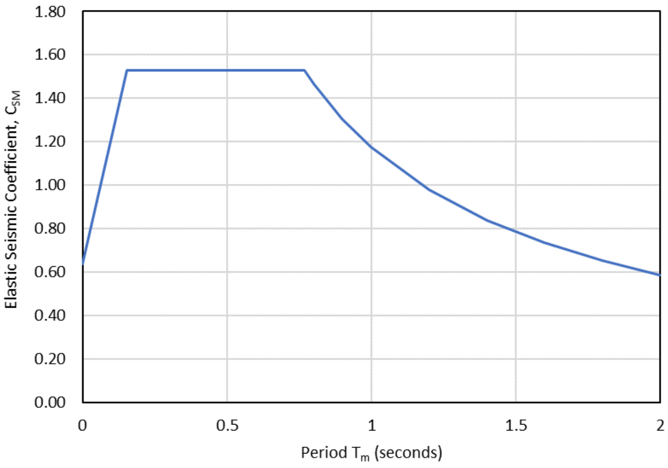

Figure 3-4. Design Response Spectra at project site.

3.6.1 LIQUEFACTION ANALYSIS

Liquefaction is a phenomenon where a saturated or partially saturated soil loses its strength and behaves like a liquid due to ground movement or other sudden changes in stress. Soils that have liquefied have functionally zero strength and can undergo large vertical and lateral displacements. Earthquake-induced liquefaction generally occurs only under particular conditions, including a high groundwater table, strong earthquake ground shaking with long duration, and loose uniform sands. Below the peat and organic silt layers, blow counts corrected to $(N_1)_{70}$, ranged from 21 to 72 indicating a dense to very dense material at the project site. BH-6 had the highest groundwater table and field blow counts of 0 blows per foot in the upper 12 feet of material. As mentioned, however, the City of Kodiak plans to excavate approximately 10 feet at BH-6 to bring the ground surface to street elevation, which will remove this very loose material. On top of the approximately 10 feet of excavation, there will be an additional 4 feet of excavation to account for strip footing depth and structural fill replacement to fully remove the potentially liquefiable material at the site. All other boreholes at the site do not indicate a potential for liquefaction.

3.7 GLOBAL STABILITY

A global stability analysis was performed based on the existing site geometry and the soil lithology encountered in this investigation. The software program Slide2, by Rocscience, was used to conduct the stability analyses. Two sections were analyzed: (1) a transect from BH-2 to BH-7 where the slope was intact and, (2) the same slope with the proposed Mechanically Stabilized Earth (MSE) wall in place.

Analysis (1) considered three load cases: static (long-term), pseudo-static/seismic (short-term with seismic accelerations), and a Newmark analysis. The seismic loads are applied in terms of horizontal seismic coefficients, typically PGA as a percentage of gravity. A design horizontal seismic coefficient equal to the site-adjusted peak ground acceleration (PGA_M), was applied to the analysis.

Analysis (1) yielded factors of safety in excess of the minimums required. It should be noted that this analysis broadly applied soil conditions at one borehole across a relatively large area. Consideration of this should be given when assessing the analysis accuracy. Results using the seismic design parameters defined in Table 3-7 indicated no slope failure with Factors of Safety against slope failure ranging from a static 6.0 to a pseudo-static/seismic FS = 1.5. Slope failure was confined to the surficial peat and organic silt layer leaving the remaining slope intact. The Newmark analysis suggested deformation confined to the surficial peat and organic silt layer, which will be excavated at the site.

The MSE wall design under Analysis (2) will support the upper west and east driveways and parking areas at Mill Bay Road elevation. Below the MSE wall will be additional parking at Chichenoff Street elevation. The design and analysis follow AASHTO LRFD Bridge Design Specifications, 8th Edition, Section 11.10 Mechanically Stabilized Earth Walls and the FHWA Design and Construction of MSE Walls and Reinforced Soil Slopes. The reinforced soil area is contained by a 15-foot wall face that extends 30 feet north towards Mill Bay Road. The design live load vehicle is an emergency vehicle, type EV3, with a combined load of 0.554 ksf. This is the live load applied to the upper driveway and parking area supported by the MSE wall. Geotechnical texts (Day, 2002) and design codes (AASHTO, 2017; NCHRP, 2008) suggest a design horizontal seismic coefficient equal to one half of the site-adjusted peak ground acceleration (PGA_M), for earthen slopes that are considered non-rigid or yielding (i.e., allowed to move). Implementation of this reduced seismic coefficient assumes that some deformation, on the order of inches, is allowed to occur during the design seismic event which is anticipated to be acceptable for this project. Therefore, a horizontal seismic acceleration of 0.32g was used for the MSE wall seismic analysis.

Analysis (2) yielded factors of safety in excess of the minimums required, which were taken as 1.5 for the static condition and 1.1 for the seismic condition. Similar to Analysis (1), this analysis broadly applied soil conditions at one borehole across a relatively large area. Consideration of this should be given when assessing the analysis accuracy.

4 GEOTECHNICAL DESIGN RECOMMENDATIONS

4.1 FOUNDATION RECOMMENDATIONS

A shallow foundation is recommended for this project. Design of a shallow foundation must consider the bearing capacity of the underlying soils, as well as the potential for settlement and the effects of seasonal frost action. Fines contents ranged from 27 to 52 percent in sands and gravels at the site. Based on the fines content and low water table elevation, the in-situ material can be considered to have moderate frost susceptibility (Frost group F-3) as per the USACE frost design soil classification. A 36-inch frost depth design is suggested for Kodiak, Alaska. As such, footings must be embedded below frost level to resist frost action on the structure. It is recommended that warm footings be used and placed on at least 18 inches of non-frost susceptible (NFS) soils. In general, foundation designs should be consistent with the current edition of the International Building Code (IBC) with any local amendments or requirements for footing depths. PND recommends excavating a minimum of 4.5 feet of the surficial soils to include all deleterious soil material at the perimeter strip footing location and replacing it with a NFS fill material. The 4.5-foot total excavation shall be from grade to bottom of NFS layer below footing and will vary across the site. The slab-on-grade and interior spread footings shall bear on 18 inches of NFS material over supporting dense insitu material. Excavation depth below pavement surface is provided in Section 4.3.

Additionally, the project site is located on a 14% slope and does not require special instruction on foundation setback from descending slope surface. However, the firetruck bay structure will be constructed on the slope and a separate bearing capacity calculation was completed (Figure 4-1, Panel A). Figure 4-1, Panel B provides the bearing capacity for the administration building below the slope, level with Chichenoff Street.

Perimeter strip footings and interior spread footings should bear on a minimum of 18 inches of classified, compacted structural fill prepared in accordance with our recommendations. If footing preparations follow our recommendations, they may be designed according to the following criteria:

4.1.1 MAXIMUM ALLOWABLE BEARING PRESSURE

o Static Loads (Dead and Normal Live):	See Figure 4-1
o Transient Loads (Wind and Seismic):	Increase Static Loads by 33%

The effective bearing area of eccentrically loaded footings will be less than the actual footing dimensions, and may vary depending on anticipated design loads and eccentricity. The allowable bearing capacity can be estimated from Figure 4-1 for different footing widths. Expected settlements will depend on footing dimensions and loads applied to the structure. The bearing capacity analysis should be updated after structural loads, footing types and dimensions have been determined by the structural engineer.

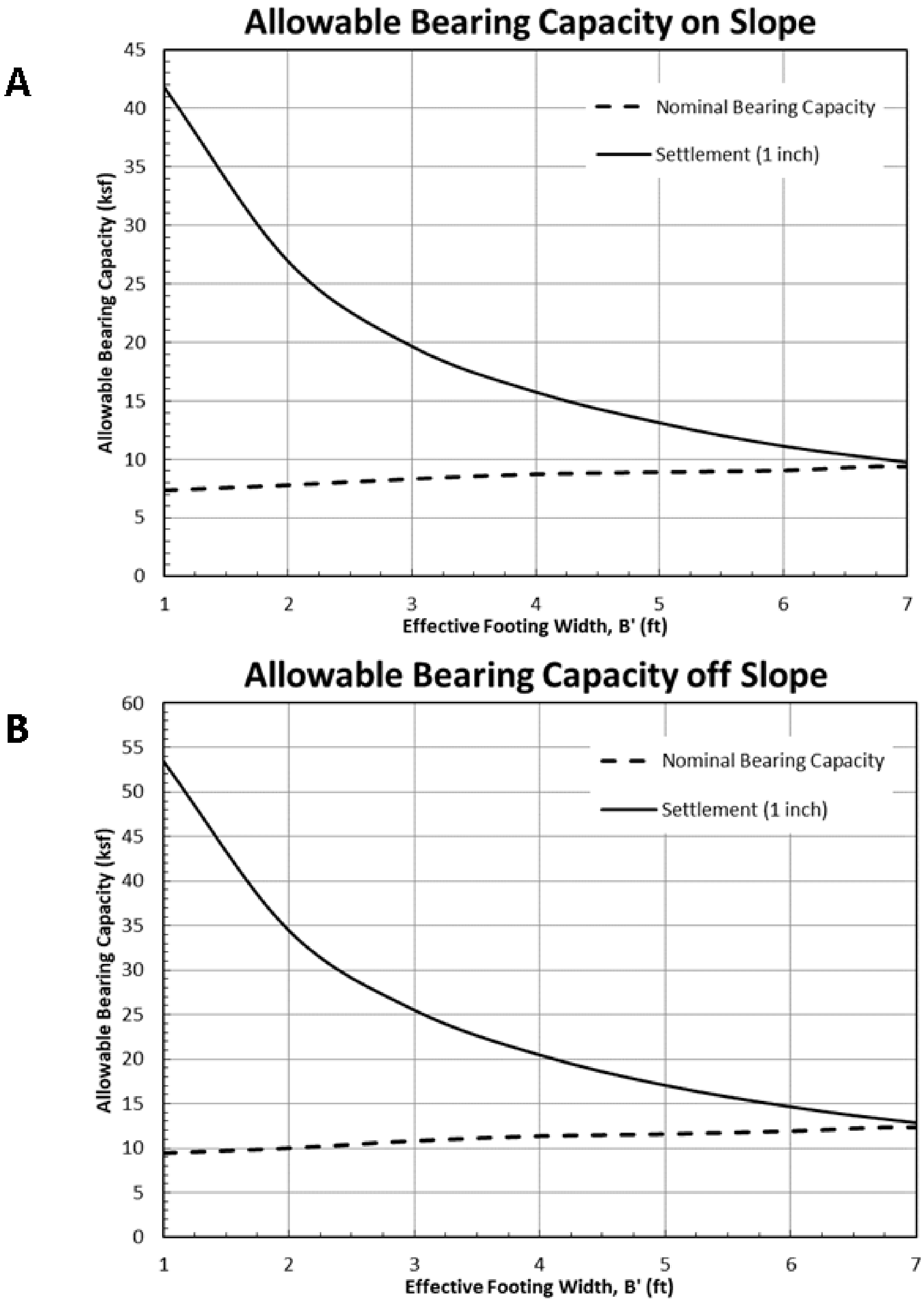

Figure 4-1. Allowable Bearing Capacity of Continuous Footing on slope (Panel A) and off slope (Panel B) at project site.

4.1.2 DEPTH OF EMBEDMENT

o	Perimeter Strip Footing:	36 inches, min.
o	Isolated, Interior Spread Footing:	12 inches

Perimeter footings are assumed to be warm footings. Depth is measured from the adjacent grade to the bottom of the footing.

4.1.3 SETTLEMENT (NON-LIQUEFACTION)

- Total Settlement: 1 inch
- Differential Settlement: 0.75 inch

Settlement from normally occurring static, live, and transient loads.

4.1.4 SETTLEMENT (LIQUEFACTION)

- Differential Settlement: 1 inch over 98 feet (longest wall in building design)

These recommended bearing capacities assume that the footings bear on structural fill material and not any organic or peat material.

4.1.5 LATERAL LOAD RESISTANCE

Lateral loads on footings will be resisted by passive earth pressures developed against the footing block and frictional resistance against the base of the footing. PND recommends a passive resistance (equivalent fluid pressure) of 200 pcf that includes a factor of safety of 2. A coefficient of friction of 0.45 is recommended to be used for resistance of footings to lateral sliding, assuming concrete footings cast directly against sand and gravel.

4.2 SOIL PARAMETERS FOR MSE WALL

Soil parameters for use in design of a retaining wall are provided in Table 4-1.

Table 4-1. Recommended Soil Parameters for MSE Wall Design

Parameter	Design Value
Moist Unit Weight of Reinforced Soil Mass , (lbs/ft^3)	130
Angle of Internal Friction in Reinforced Soil Mass (°)	34
Moist Unit Weight of Soil behind Reinforced Mass , (lbs/ft^3)	125
Angle of Internal Friction of Soil behind Reinforced Mass (°)	32
Angle of Internal Friction of Soil below Reinforced Mass (°)	34
Wall-Backfill Interface Friction Angle, δ (°)	21.3
Reinforced Soil Mass (Tencate Miragrid 10XT), $K_{a\text{-retained}}$	0.307

4.3 PAVEMENT DESIGN

Frost classification testing of on-site soils indicated moderate frost susceptibility (F-4). Assuming that traffic traversing the driveway and parking areas will be primarily lightly loaded passenger vehicles and heavier service vehicles or snow removal equipment, PND recommends a minimum 3 inches of asphalt pavement, 4 inches of D-1 base, and 16 inches of non-frost susceptible Type IIA subbase. Subbase will overlay NFS gravel fill of varying depth. At lower elevation, where Silty Clayey Gravelly Sand is between 1.5 and 2 feet bgs, PND recommends a total pavement structure of 3 inches of asphalt pavement, 4 inches of D-1 base, and 16 inches of NFS Type IIA subbase overlaying NFS gravel fill ranging in depth to dense Silty Clayey Gravelly Sand layer or directly overlaying dense Silty Clayey Gravelly Sand layer.

5 CONSTRUCTION RECOMMENDATIONS

5.1 SITE RECOMMENDATIONS

All earthworks should be performed according to the project specifications and in accordance with local, state, and federal laws and regulations.

5.2 SITE PREPARATION

All trees, small brush, fencing, existing concrete barriers and rebar should be removed prior to starting any earthwork. Any observed organic material at the surface should be removed and wasted off site or used as landscaping. The remaining subgrade soils should be proof rolled and compacted prior to further site construction work. Care should be exercised that organic matter is not contained in any subgrade that footings or pavements bear on.

5.3 EXCAVATIONS

Temporary excavations into soil should be performed with care and follow OSHA or other agency guidelines and recommendations for trenching and slope angles based on soil type encountered in the geotechnical investigations and as observed during construction. Permanent excavations into soil should either be retained or sloped to meet long term stability requirements.

Any peaty, debris, or frozen soil must be removed from subgrades beneath the footings and slabs and replaced with material as recommended in this report and following all project specifications.

Excavations should be performed utilizing a backhoe with a smooth-bladed bucket from outside the excavation to minimize disturbance of the subgrade soils. Soils that are disturbed, pumped, or rutted by construction activity should be reworked and re-compacted prior to placement of structural member.

5.4 DRAINAGE AND CONTROL OF WATER

Excavations may encounter seepage due to recent rain events at the site. The gradual slope only had groundwater at the bedrock-soil interface encountered in two boreholes (BH-8, and -9). Fines content in the soil is CL-ML, which is considerably dense when dry, but very difficult to work with when wet. The weather should be monitored during excavation and construction when in-situ silty clayey material is exposed. It is the contractor's responsibility to determine the appropriate dewatering technique(s) for the construction method chosen and for the soil and water conditions encountered in the geotechnical explorations and during construction.

Site grading should be established to provide drainage of surface water or roof drainage away from the proposed building and toward suitable drainage structures. Ground adjacent to the building's foundation should be graded to slope away from the building. Parking areas should have positive gradients toward drainage structures and away from buildings.

Permeability testing was not completed on the in-situ soils, but a typical coefficient of permeability for the existing in-situ soils is 0.028 ft/day.

5.5 FILL AND COMPACTION

Structural fill material should have a maximum particle size of 6 inches and less than 6% passing the No. 200 sieve size. Structural fill shall be placed in lifts not exceeding 12 inches in loose thickness. Compaction of structural fill shall be achieved by performing a minimum level of effort consisting of six complete passes with a 15-ton vibratory steel drum roller. In areas of any structural fill that are too small to accommodate a roller, compaction shall be accomplished by a minimum level of effort of six complete passes with a vibratory plate compactor with a minimum rated centrifugal force of 15,000 lbs.

A vibratory steel drum roller should be utilized to compact the subgrade for slabs and walkways. For footings, at a minimum a plate compactor should be used to compact the subgrade. However, lightweight or hand operated compactors should be used when compacting near existing structures, utilities and/or new footings to avoid distressing and/or causing settlement below the structure.

Soils containing a higher fines content are moisture sensitive which can lead to difficulty with compaction if the soils are too wet therefore control of water is critical. Care must be taken to prevent native soils, which will be exposed during construction, from becoming too wet. It is the responsibility of the contractor to ensure proper moisture content control of the silty clayey sands and perform drying processes like disking or tilling of the subgrade as needed to ensure proper subgrade preparation. Any loose, disturbed, soft, or saturated soils should be re-work and re-compacted prior to placing footings or slabs. Any loosing of fill material by hauling or other equipment should be re-compacted as needed.

No hauling or grading equipment should be used in lieu of appropriate compaction equipment. The number of passes required to meet the compaction requirement will depend upon the size of compaction equipment used. Each layer should be compacted as recommended in this report and field verification of compaction requirements is recommended.

Foundation soil should be protected from freezing during construction. No frozen soil should be used as fill, nor should any fill be placed over frozen soil. Any frozen soil should be removed and replaced with appropriate fill prior to construction of any footings or slabs.

5.5.1 FOOTINGS AND SLABS

Fill placed within 12 inches of the bottom of footings or slabs should have a maximum particle size of 6 inches. Fill should be placed in loose lifts not exceeding 12 inches in thickness if a large vibratory compactor is used, or not exceed 4 inches in thickness if a hand compactor is used. Each lift of fill shall be compacted to at least 95 percent of the Modified Proctor Maximum Density (ASTM D1557). We recommend the optimum moisture content of the compacted subgrade not vary more than ±2 percent.

5.5.2 UTILITIES AND OPEN AREAS

Fill placed as bedding material, in trenches, and in open areas should have a maximum particle size of 3 inches. Fill should be placed in loose lifts not exceeding 12 inches in thickness if a large vibratory compacted is used, or not exceed 4 inches in thickness if a hand compactor is used. Each lift of fill shall be compacted to at least 90 percent of the Modified Proctor Maximum Density (ASTM D1557). We recommend the optimum moisture content of the compacted subgrade not vary more than ±2 percent.

6 LIMITATIONS

The information submitted in this report is based on our interpretation of data from a field and lab geotechnical investigation conducted for this project and other sources discussed in this report. Effort was made to obtain information which is representative of the actual conditions at the site. However, actual subsurface conditions will vary and additional information may be discovered that could impact our recommendations. If conditions significantly different from those indicated in this report are encountered by subsequent investigations or during construction, the recommendations of this report should be reviewed by PND.

This report was prepared by PND Engineers, Inc. for use on this project only. PND is not responsible for conclusions, opinions or recommendations made by others based on data presented in this report. This report is submitted to Wolf Architecture.

We appreciate the opportunity to work with Wolf Architecture on this project.

Sincerely,

PND Engineers, Inc. | Anchorage

Torsten Mayrberger

Torsten Mayrberger, PhD, PE
Principal

Kannon Lee, EIT
Staff Geotechnical Engineer

APPENDIX A — BOREHOLE LOGS

SOILS CLASSIFICATION, CONSISTENCY AND SYMBOLS

CLASSIFICATION

Identification and classification of soil samples is accomplished in general accordance with the ASTM version of the Unified Soil Classification System (USCS) as presented in ASTM Standard D2487. The standard is a qualitative method of classifying soil into the following major divisions (1) coarse grained soil, (2) fine grained soil, and (3) highly organic soils. Classification is performed on a soil sample which passes the 75 mm (3 inch) sieve, oversize material (> 75 mm particles) is noted on the soil logs as well. Classification of oversize material is not always possible because the oversize particles are typically too large to be captured in the sampling equipment. Oversize materials greater than 300 mm (12 inches) are termed boulders, while materials between 75 mm and 300 mm are termed cobbles. Coarse grained soils are described as having 50% or more of the sample retained on the No. 200 sieve (0.075 mm) while fine grained soils will have 50% or more of the sample passing the No. 200 sieve. Coarse samples containing >50% material retained on the No. 4 sieve is classified as gravel. If a majority of the sample is retained on the No. 200 sieve but passes the No. 4 sieve it is classified as a sand. Fine grained soils are those having more than 50% of the sample passing the No. 200 sieve; these may be classified as silt or clay depending their Atterberg limits or observations of field consistency. Refer to the most recent version of ASTM D2487 for a complete discussion of the classification method.

SOIL CONSISTENCY - CRITERIA

Soil consistency as defined below and determined by normal field and laboratory methods applies only to non-frozen material. For these materials, the influence of such factors as soil structure, i.e., Fissure systems, shinkage cracks, slickensides, etc., must be taken into consideration in making any correlation with the consistency values listed below. In permafrost zones, the consistency and strength of frozen soils may vary significantly and unexplainably with ice content, thermal regime and soil type.

STANDARD PENETRATION TEST (BLOWS/FT) RELATIVE TO DENSTIY/CONSISTENCY

UNDRAINED SHEAR STRENGTH

N_{60}	Density	Relative Density	N_{60}	Consistency	psf
0-4	Very Loose	0-15%	< 2	Very Soft	< 250
4-10	Loose	15-35%	2 - 4	Soft	250 - 500
10-30	Medium Dense	35-65%	4 - 8	Medium Stiff	500 - 1000
30-50	Dense	65-85%	8 - 15	Stiff	1000 - 2000
> 50	Very Dense	>85%	15 - 30	Very Stiff	2000 - 4000
			> 30	Hard	> 4000

(*correlations based upon standard 1.4" O.D. split spoon and 140 lb manual hammer dropped from a height of 30 inches)

(*Adjust as required for other sampler types)

Ref: Terzaghi and Peck, Soil Mechanics in Engineering Practice, 3rd Edition, pg 60-63
ASTM D1586 Standard Test Method for Penetration Test and Split-Barrel Sampling of Soils
ASTM D2487 Standard Practice for Classification of Soils for Engineering Purposes (USCS)

LIST OF ABBREVIATIONS

Drill Methods:

AR	Air Rotary
CC60	Continuous Coring (RS-60)
CD	Case and Drill
CCm	Continuous Coring (Macro Core)
CME	Continuous Augering
CWR	Casing with Wash Rotary
DH	Down-hole hammer
HSA	Hollow Stem Auger
MR	Mud Rotary
NQ3	NQ3 Triple Tube
MC7	MC7 Coring
WR	Wash Rotary
TP	Test Pit
DP	Direct Push
SC	Sonic Core
SCC	Sonic Core with Wash Rotary
SSA	Solid Stem Auger

Sample Methods:

AR	Air Rotary
Cc	Continuous Core
GR	Grab Sample
Sh	Oversize Split-Spoon
Ss	Standard Split-Spoon
ST	Shelby Tube
Cs	Core Sample
SC	Sonic Core

Color:

BK	Black
BN	Brown
DG	Dark Brown
DG	Dark Gray
G	Gray
GG	Greenish Gray
LB	Light Brown
LG	Light Gray
OG	Olive Gray
P	Pink
R	Reddish
RO	Rusty Orange
TN	Tan
YO	Yellowish Orange
BG	Brownish Gray

Particle Angularity

A	Angular
R	Rounded
SA	Sub-Angular
SR	Sub-Rounded

Particle Shape:

E	Elongated
F	Flat

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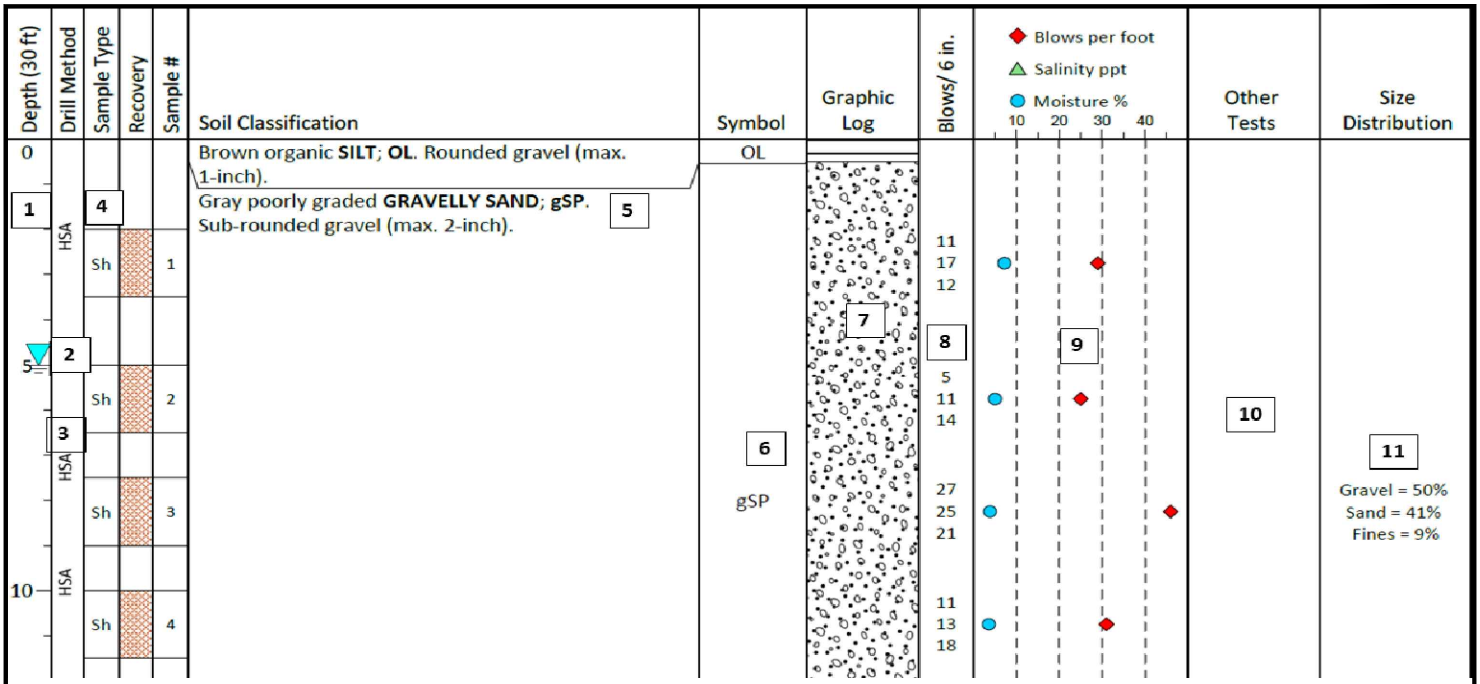
Date: June 2022

STANDARD
GEOTECHNICAL EXPLORATION
BOREHOLE LEGEND



1	Depth	Depth (in feet) below the mudline.
2	Water Table	Water Table depth.
3	Drill Method	Drilling methods recorded in depth intervals. Symbols explained on Fig. B-01.
4	Sample Type	Type of soil sample collected at depth interval depicted; symbols explained on Fig. B-04.
5	Material Description - General	General description of soil encountered in a lithological layer.
6	Symbol	Group symbols for soil and ice classification for each specimen.
7	Graphic Log	Graphic depiction of lithological layers encountered. Graphic symbols explained in Fig. B-03 and B-04.
8	Blows/ 6 in	Number of blows to advance sampler each 6-inch interval using sampler type specified with a 30-inch drop.
9	Graphs	Graphic log depicting moisture content and blow count per foot of soil specimens.
10	Other Tests	Results of other tests including hydrometer, Atterberg limits, etc.
11	Size Distribution	Results of particle size distribution analysis.

GENERAL NOTES

1. Field descriptions may have been modified to reflect laboratory test results.
2. Descriptions on these boring logs apply only at the specific locations at the time the borings were drilled. They are not warranted to be representative of subsurface conditions at other locations or times.
3. Split spoon blow counts shown are uncorrected raw data. Various hammer sizes and split spoon sizes were used and have not been corrected to a Standard Penetration Test (SPT). Blow counts may vary substantially between SPT and these methods.

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STANDARD
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BOREHOLE LEGEND

SOIL LEGEND - (1 of 3)

GW
WELL GRADED GRAVEL

GWs
WELL GRADED GRAVEL WITH SAND

sGW
WELL GRADED SANDY GRAVEL

GP
POORLY GRADED GRAVEL

GPs
POORLY GRADED GRAVEL WITH SAND

sGP
POORLY GRADED SANDY GRAVEL

GW-GM
WELL GRADED GRAVEL WITH SILT

(GW-GM)s
WELL GRADED GRAVEL WITH SILT AND SAND

s(GW-GM)
WELL GRADED SANDY GRAVEL WITH SILT

GW-GC
WELL GRADED GRAVEL WITH CLAY

(GW-GC)s
WELL GRADED GRAVEL WITH CLAY AND SAND

s(GW-GC)
WELL GRADED SANDY GRAVEL WITH CLAY

GP-GM
POORLY GRADED GRAVEL WITH SILT

(GP-GM)s
POORLY GRADED GRAVEL WITH SILT AND SAND

s(GP-GM)
POORLY GRADED SANDY GRAVEL WITH SILT

GP-GC
POORLY GRADED GRAVEL WITH CLAY

(GP-GC)s
POORLY GRADED GRAVEL WITH CLAY AND SAND

GM
SILTY GRAVEL

GMs
SILTY GRAVEL WITH SAND

sGM
SILTY, SANDY GRAVEL

GC
CLAYEY GRAVEL

GCs
CLAYEY GRAVEL WITH SAND

sGC
CLAYEY, SANDY GRAVEL

GC-GM
SILTY, CLAYEY GRAVEL

(GC-GM)s
SILTY, CLAYEY GRAVEL WITH SAND

s(GC-GM)
SILTY, CLAYEY, SANDY GRAVEL

SW
WELL GRADED SAND

SWg
WELL GRADED SAND WITH GRAVEL

gSW
WELL GRADED GRAVELLY SAND

SP
POORLY GRADED SAND

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STANDARD GEOTECHNICAL EXPLORATION BOREHOLE LEGEND

SOIL LEGEND - (2 of 3)

▨ **SPg**
POORLY GRADED SAND WITH GRAVEL

▨ **gSP**
POORLY GRADED GRAVELLY SAND

▨ **SW-SM**
WELL GRADED SAND WITH SILT

▨ **(SW-SM)g**
WELL GRADED SAND WITH SILT AND GRAVEL

▨ **g(SW-SM)**
WELL GRADED GRAVELLY SAND WITH SILT

▨ **SW-SC**
WELL GRADED SAND WITH CLAY

▨ **(SW-SC)g**
WELL GRADED SAND WITH CLAY AND GRAVEL

▨ **g(SW-SC)**
WELL GRADED GRAVELLY SAND WITH CLAY

▨ **SP-SM**
POORLY GRADED SAND WITH SILT

▨ **(SP-SM)g**
POORLY GRADED SAND WITH SILT AND GRAVEL

▨ **g(SP-SM)**
POORLY GRADED GRAVELLY SAND WITH SILT

▨ **SP-SC**
POORLY GRADED SAND WITH CLAY

▨ **(SP-SC)g**
POORLY GRADED SAND WITH CLAY AND GRAVEL

▨ **g(SP-SC)**
POORLY GRADED GRAVELLY SAND WITH CLAY

▨ **SM**
SILTY SAND

▨ **SMg**
SILTY SAND WITH GRAVEL

▨ **gSM**
SILTY, GRAVELLY SAND

▨ **SC**
CLAYEY SAND

▨ **SCg**
CLAYEY SAND WITH GRAVEL

▨ **gSC**
CLAYEY, GRAVELLY SAND

▨ **SC-SM**
SILTY, CLAYEY SAND

▨ **(SC-SM)g**
SILTY, CLAYEY SAND WITH GRAVEL

▨ **g(SP-SC)**
POORLY GRADED GRAVELLY SAND WITH CLAY

▨ **CL**
CLAY

▨ **CLs**
CLAY WITH SAND

▨ **CLg**
CLAY WITH GRAVEL

▨ **sCL**
SANDY LEAN CLAY

▨ **gCL**
GRAVELLY LEAN CLAY

▨ **sCLg**
SANDY LEAN CLAY WITH GRAVEL

▨ **gCLs**
GRAVELLY LEAN CLAY WITH SAND

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STANDARD
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BOREHOLE LEGEND

SOIL LEGEND - (3 of 3)

▨ **ML** *SILT*

▨ **MLs** *SILT WITH SAND*

▨ **MLg** *LEAN SILT WITH GRAVEL*

▨ **sML** *SANDY SILT*

▨ **gML** *GRAVELLY SILT*

▨ **sMLg** *SANDY SILT WITH GRAVEL*

▨ **gMLs** *GRAVELLY SILT WITH SAND*

▨ **CH** *FAT CLAY*

▨ **CHs** *FAT CLAY WITH SAND*

▨ **CHg** *FAT CLAY WITH GRAVEL*

▨ **sCH** *SANDY FAT CLAY*

▨ **gCH** *GRAVELLY FAT CLAY*

▨ **gCHs** *GRAVELLY FAT CLAY WITH SAND*

▨ **MH** *ELASTIC SILT*

▨ **MHs** *ELASTIC SILT WITH SAND*

▨ **MHg** *ELASTIC SILT WITH GRAVEL*

▨ **sMH** *SANDY ELASTIC SILT*

▨ **gMH** *GRAVELLY ELASTIC SILT*

▨ **sMHg** *SANDY ELASTIC SILT WITH GRAVEL*

▨ **gMHs** *GRAVELLY ELASTIC SILT WITH SAND*

▨ **OL** *ORGANIC SILT*

▨ **OH** *ORGANIC CLAY*

▨ **ICE** *ICE*

▨ **ICE+S** *ICE WITH SOIL*

▨ **PT** *PEAT*

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STANDARD
GEOTECHNICAL EXPLORATION
BOREHOLE LEGEND

LOG OF BOREHOLE BH-1

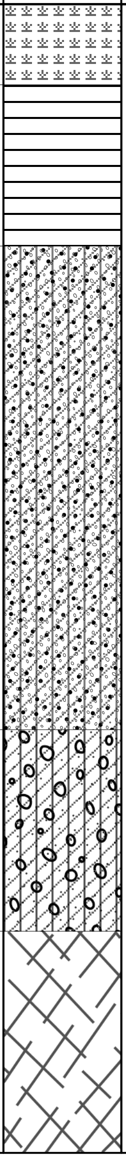
Project: Kodiak Fire Station
Project Number: 221042

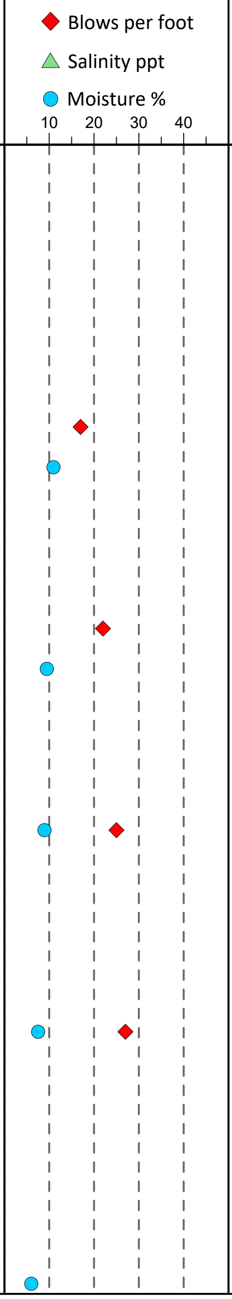
Elevation: 123.3 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79714 °N Longitude: 152.38970 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (14.3 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Blows/ 6 in.	Other Tests	Size Distribution
0					Very loose **PEAT**; **PT**.	PT			
1	HSA				Loose, brown organic **SILT**; **OL**. With GRASS and ROOTS.	OL			
3	HSA				Dense, brownish gray **SILTY, CLAYEY SAND with GRAVEL**; **(SC-SM)g**. Sub-rounded/sub-angular gravel (max. 2-inch). With SHALE Fragments and COBBLES.	(SC-SM)g			
4	HSA	Sh	▨	1			2 7 10 12		Fines = 33.5%
6	HSA	Sh	▨	2			4 10 12 13		
8	HSA	Sh	▨	3			5 10 15 17		Gravel = 19% Sand = 36% Fines = 45%
9	HSA				Dense, brownish gray **SILTY, CLAYEY, SANDY GRAVEL**; **s(GC-GM)**. Sub-angular gravel (max. 1-inch). With SHALE Fragments.	s(GC-GM)			
11	HSA	Sh	▨	4			6 13 14 15		
11.5					**SHALE**; **Bx**.	Bx			
13	HSA								
14		Sh	▨	5			50/3"		

Graphic Log





Borehole terminated at 14.3 ft
Client: Wolf Architecture
Drill Start: 6/1/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

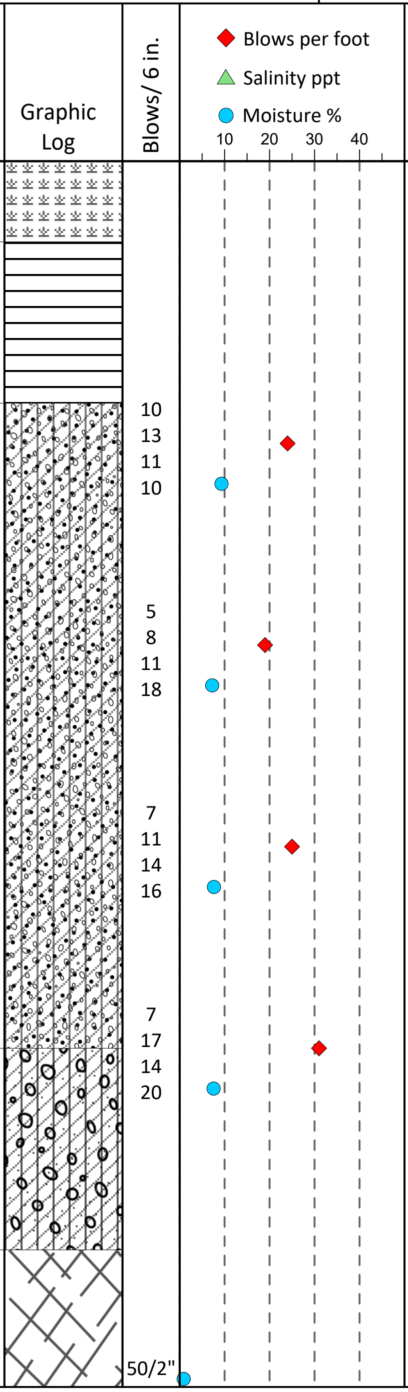
LOG OF BOREHOLE BH-2

Project: Kodiak Fire Station
Project Number: 221042

Elevation: 122.9 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79704 °N Longitude: 152.38990 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (15.2 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Blows/ 6 in.	Other Tests	Size Distribution
0					Very loose **PEAT**; **PT**.	PT			
1	HSA				Loose, dark brown organic **SILT**; **OL**.	OL			
3	HSA				Dense, gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-rounded/sub-angular gravel (max. 2-inch). With SHALE Fragments and COBBLES beginning at 5'.	g(SC-SM)	10 13 11 10		
4	HSA	Sh		1					Fines = 39.8%
6	HSA	Sh		2			5 8 11 18		
8	HSA								
9	HSA	Sh		3	Dense, dark gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-rounded/sub-angular gravel (max. 1-inch). With SHALE Fragments.		7 11 14 16		
11	HSA	Sh		4	Dense, brownish gray **SILTY, CLAYEY, SANDY GRAVEL**; **s(GC-GM)**. Sub-angular gravel (max. 1-inch). With SHALE Fragments.	s(GC-GM)	7 17 14 20		
13	HSA								
14					Dark gray **SHALE**; **Bx**.	Bx			
15	HSA	Sh		5			50/2"		



Borehole terminated at 15.2 ft
Client: Wolf Architecture
Drill Start: 6/1/2022

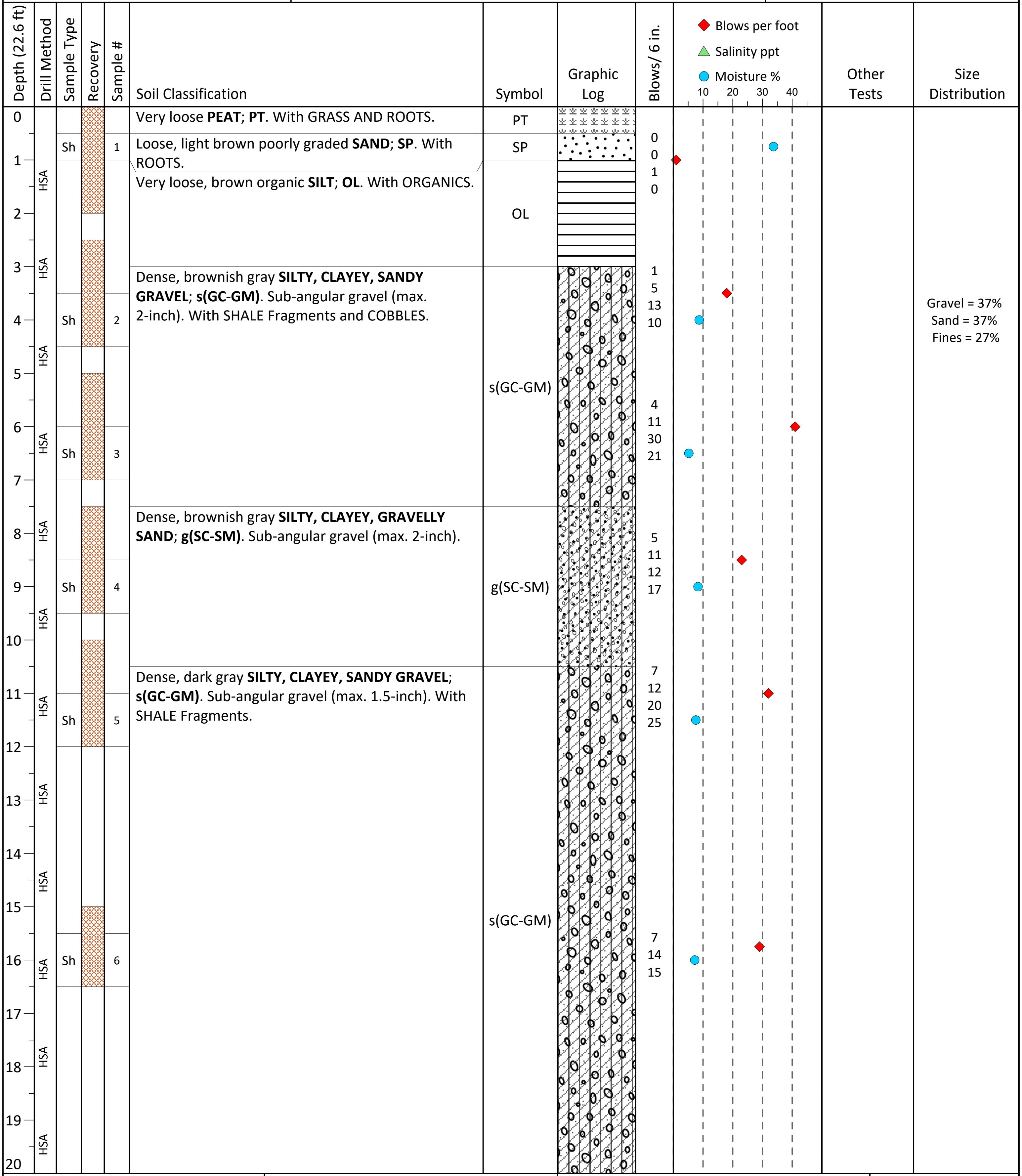
Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

LOG OF BOREHOLE BH-3

Project: Kodiak Fire Station
Project Number: 221042

Elevation: 120.3 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79702 °N Longitude: 152.38974 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022



Drill Method	Sample Type	Sample #	Soil Classification	Symbol	Blows/ 6 in.	Other Tests	Size Distribution
HSA			Very loose **PEAT**; **PT**. With GRASS AND ROOTS.	PT			
HSA	Sh	1	Loose, light brown poorly graded **SAND**; **SP**. With ROOTS.	SP	0 0 1 0		
HSA			Very loose, brown organic **SILT**; **OL**. With ORGANICS.	OL			
HSA	Sh	2	Dense, brownish gray **SILTY, CLAYEY, SANDY GRAVEL**; **s(GC-GM)**. Sub-angular gravel (max. 2-inch). With SHALE Fragments and COBBLES.	s(GC-GM)	1 5 13 10		Gravel = 37% Sand = 37% Fines = 27%
HSA	Sh	3			4 11 30 21		
HSA	Sh	4	Dense, brownish gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 2-inch).	g(SC-SM)	5 11 12 17		
HSA	Sh	5	Dense, dark gray **SILTY, CLAYEY, SANDY GRAVEL**; **s(GC-GM)**. Sub-angular gravel (max. 1.5-inch). With SHALE Fragments.	s(GC-GM)	7 12 20 25		
HSA	Sh	6			7 14 15		

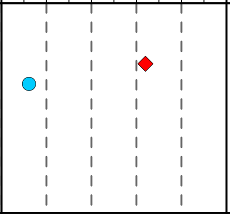
P | N | D

Borehole terminated at 22.6 ft
Client: Wolf Architecture
Drill Start: 6/1/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

LOG OF BOREHOLE BH-3

Project: Kodiak Fire Station Project Number: 221042	Elevation: 120.3 ft MLLW Horizontal Datum: NAD83 AKSP Zone 5 Latitude: 57.79702 °N Longitude: 152.38974 °W	Logged By: KL Reviewed By: CK Review Date: 6/27/2022

Depth (22.6 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	◆ Blows per foot ▲ Salinity ppt ● Moisture % 10 20 30 40	Other Tests	Size Distribution
20 21	HSA	Sh	▨	7	Very dense, dark gray **SILTY, CLAYEY GRAVEL with SAND**; **(GC-GM)s**. Sub-angular gravel (max. 2-inch). With SHALE Fragments and COBBLES.	(GC-GM)s		9 16 16			
22					**SHALE**; **Bx**.	Bx		50/1"			

Borehole terminated at 22.6 ft
Client: Wolf Architecture
Drill Start: 6/1/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

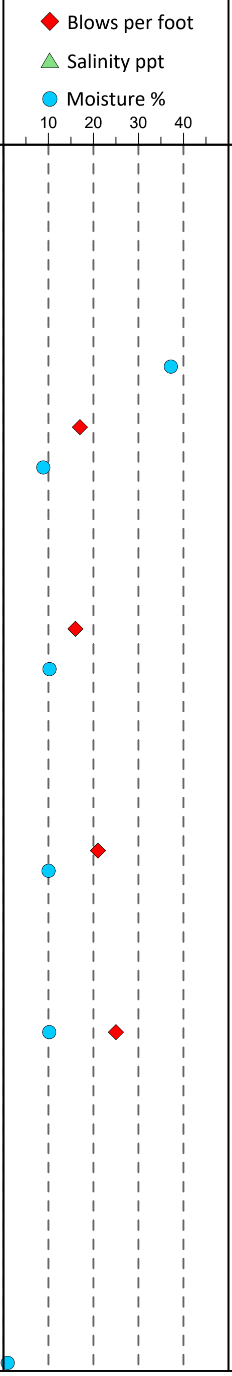
LOG OF BOREHOLE BH-4

Project: Kodiak Fire Station
Project Number: 221042

Elevation: 116.2 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79691 °N Longitude: 152.38974 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (15.2 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Blows/ 6 in.	Other Tests	Size Distribution
0	HSA				Very loose **PEAT**; **PT**.	PT			
0.5	HSA				Loose, brown organic **SILT**; **OL**.	OL			
2.5	HSA	Sh	▨	1					
3	HSA		▨		Dense, brownish gray **SILTY, CLAYEY SAND with GRAVEL**; **(SC-SM)g**. Sub-angular gravel (max. 1.5-inch). With Fractured SHALE and COBBLES.	(SC-SM)g			
3.5	HSA	Sh	▨	2			1 5 12 13		
5.5	HSA	Sh	▨	3			5 8 8 10	LL = 24 PL = 19	
8.5	HSA	Sh	▨	4			4 9 12		Gravel = 19% Sand = 37% Fines = 44%
10	HSA		▨		Dense, brownish gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. With Fractured SHALE.	g(SC-SM)			
10.5	HSA	Sh	▨	5			5 12 13 15		
14.5	HSA				**SHALE**; **Bx**.	Bx			
15	HSA	Sh	▨	6			50/2"		



Borehole terminated at 15.2 ft
Client: Wolf Architecture
Drill Start: 6/1/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

LOG OF BOREHOLE BH-5

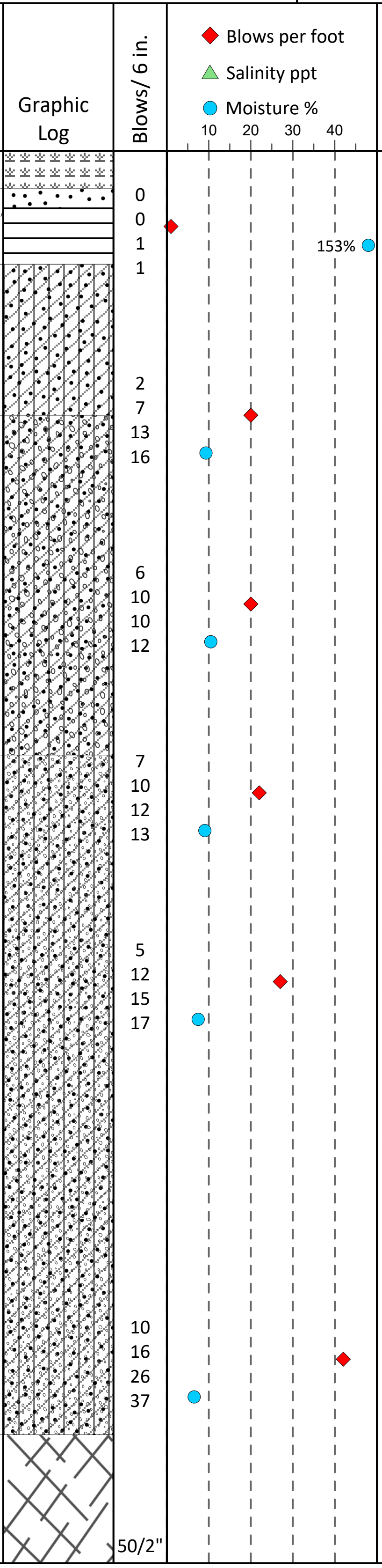
Project: Kodiak Fire Station
Project Number: 221042

Elevation: 117.3 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79699 °N Longitude: 152.38960 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (18.7 ft)	Soil Classification	Symbol
0	Very loose **PEAT**; **PT**.	PT
	Very loose, light brown poorly graded **SAND**; **SP**.	SP
1	Loose, dark brown organic **SILT**; **OL**. With ROOTS and ORGANICS.	OL
	Dense, light brown **SILTY, CLAYEY SAND**; **SC-SM**. With COBBLES.	SC-SM
4	Dense, gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. (max. 1.5-inch). With SHALE Fragments and COBBLES.	g(SC-SM)
8	Dense, brownish gray **SILTY, CLAYEY SAND with GRAVEL**; **(SC-SM)g**. Angular gravel (max. 1-inch). With COBBLES.	(SC-SM)g
10	Dense, dark gray **SILTY, CLAYEY SAND with GRAVEL**; **(SC-SM)g**. Sub-angular gravel (max. 2-inch). With COBBLES.	
17	**SHALE**; **Bx**.	Bx

Drill Method	Sample Type	Sample #	Blows/ 6 in.
HSA	Sh	1	0 0 1 1
HSA	Sh	2	2 7 13 16
HSA	Sh	3	6 10 10 12
HSA	Sh	4	7 10 12 13
HSA	Sh	5	5 12 15 17
HSA	Sh	6	10 16 26 37
HSA	Sh	7	50/2"



Other Tests

Size Distribution

Borehole terminated at 18.7 ft
Client: Wolf Architecture
Drill Start: 6/2/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

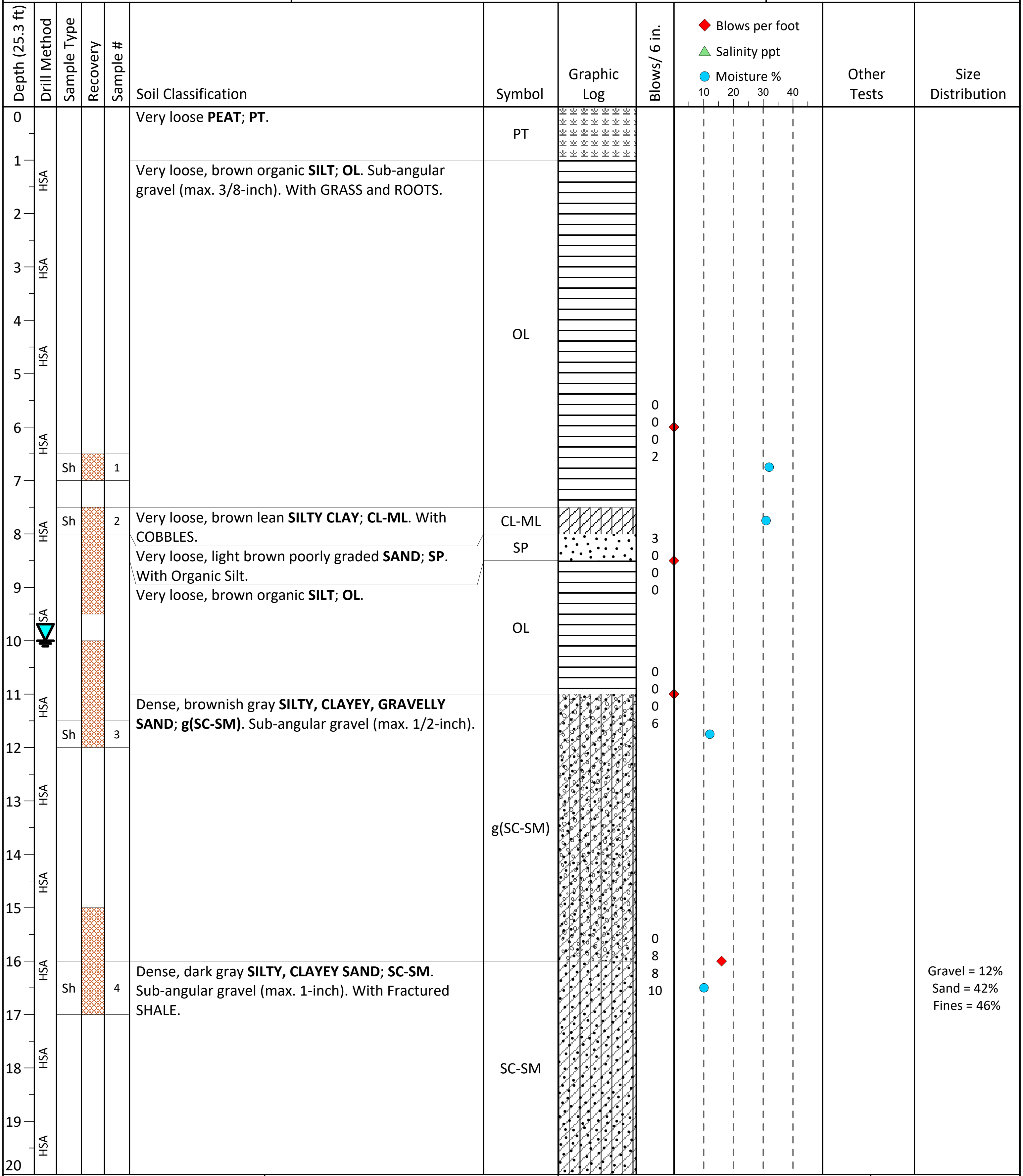
Page: 1 of 1

LOG OF BOREHOLE BH-6

Project: Kodiak Fire Station
Project Number: 221042

Elevation: 111.7 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79678 °N Longitude: 152.38968 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022



Sample Type	Sample #	Soil Classification	Symbol	Blows/ 6 in.	Other Tests	Size Distribution
		Very loose **PEAT**; **PT**.	PT			
Sh	1	Very loose, brown organic **SILT**; **OL**. Sub-angular gravel (max. 3/8-inch). With GRASS and ROOTS.	OL	0 0 0 2		
Sh	2	Very loose, brown lean **SILTY CLAY**; **CL-ML**. With COBBLES.	CL-ML			
		Very loose, light brown poorly graded **SAND**; **SP**. With Organic Silt.	SP	3 0 0 0		
		Very loose, brown organic **SILT**; **OL**.	OL			
Sh	3	Dense, brownish gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 1/2-inch).	g(SC-SM)	0 0 0 6		
Sh	4	Dense, dark gray **SILTY, CLAYEY SAND**; **SC-SM**. Sub-angular gravel (max. 1-inch). With Fractured SHALE.	SC-SM	0 8 8 10		Gravel = 12% Sand = 42% Fines = 46%

Borehole terminated at 25.3 ft
Client: Wolf Architecture
Drill Start: 6/2/2022

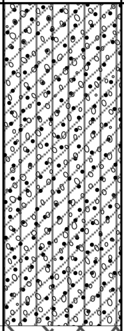
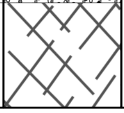
Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

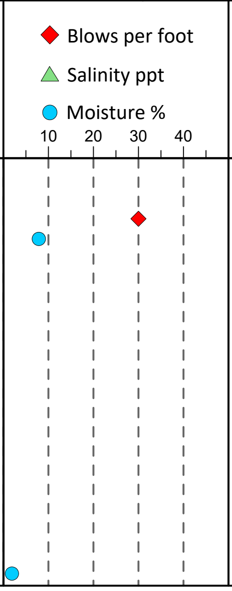
LOG OF BOREHOLE BH-6

Project: Kodiak Fire Station
Project Number: 221042

Elevation: 111.7 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79678 °N Longitude: 152.38968 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (25.3 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	Other Tests	Size Distribution
20 21 22 23	HSA HSA	Sh	▨	5	Dense, dark gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 1-inch). With Fractured SHALE.	g(SC-SM)		6 12 18		Fines = 51.9%
24 25	HSA	Sh	▨	6	**SHALE**; **Bx**.	Bx		60/4"		



Borehole terminated at 25.3 ft
Client: Wolf Architecture
Drill Start: 6/2/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

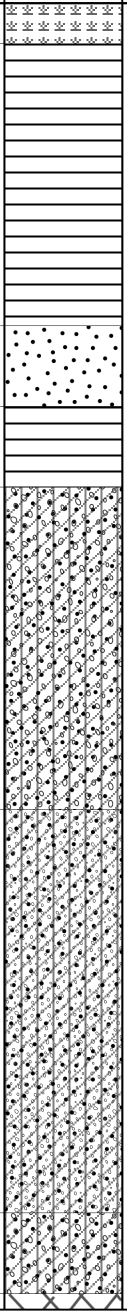
LOG OF BOREHOLE BH-7

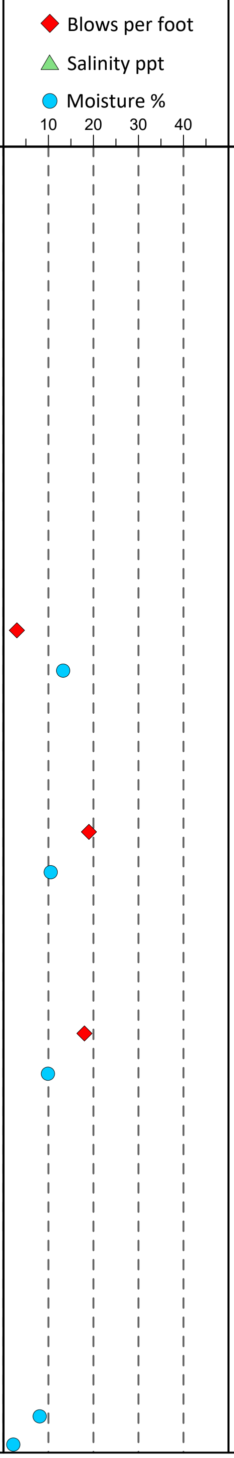
Project: Kodiak Fire Station
Project Number: 221042

Elevation: 107.4 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79688 °N Longitude: 152.38934 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (16.2 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Blows/ 6 in.	Other Tests	Size Distribution
0					Very loose **PEAT**; **PT**.	PT			
	HSA				Very loose, brown organic **SILT**; **OL**.	OL			
4	HSA				Very loose, light brown poorly graded **SAND**; **SP**.	SP			
5			▨		Loose, brown organic **SILT**; **OL**.	OL	0 0		
6	HSA	Sh	▨	1	Dense, dark gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 2-inch). With Fractured SHALE.	g(SC-SM)	3 4		
8	HSA	Sh	▨	2			4 9 10 9		
10	HSA		▨		Dense, dark gray **SILTY, CLAYEY SAND with GRAVEL**; **(SC-SM)g**. Sub-angular gravel (max. 1-inch). With Fractured SHALE.	(SC-SM)g			
11	HSA	Sh	▨	3			6 8 10 11	LL = 22 PL = 15	
15	HSA	Sh	▨	4	Dense, dark gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. With Fractured SHALE.	g(SC-SM)	5 15 50/2"		
16	SA	Sh	▨	5	**SHALE**; **Bx**.	Bx			





P N D

Borehole terminated at 16.2 ft
Client: Wolf Architecture
Drill Start: 6/2/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

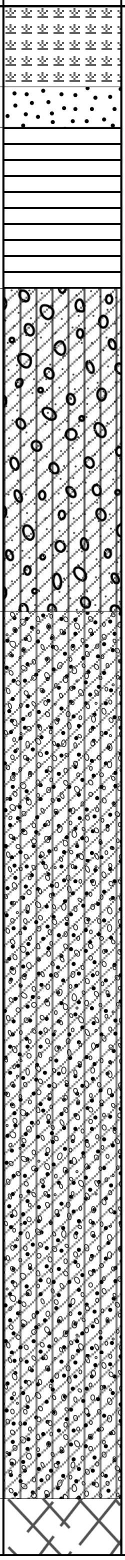
LOG OF BOREHOLE BH-8

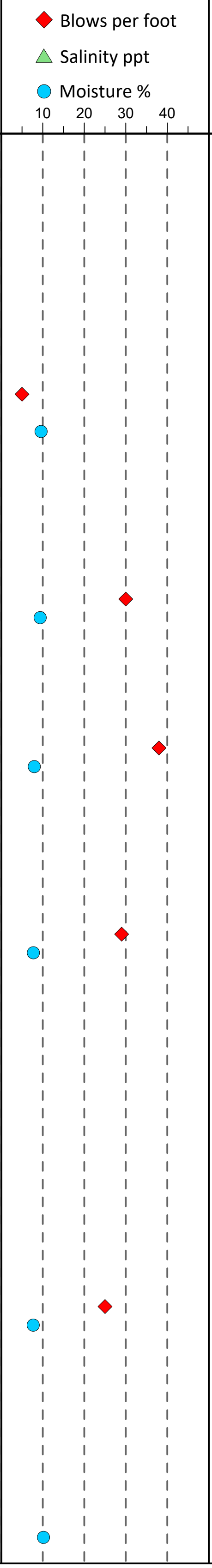
Project: Kodiak Fire Station
Project Number: 221042

Elevation: 120.3 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79712 °N Longitude: 152.38949 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (19.2 ft)	Drill Method	Sample Type	Recovery	Sample #	Soil Classification	Symbol	Graphic Log	Blows/ 6 in.	Other Tests	Size Distribution
0					Very loose **PEAT**; **PT**.	PT				
1	HSA				Very loose, light brown poorly graded **SAND**; **SP**.	SP				
2					Loose, dark brown organic **SILT**; **OL**. With SHALE fragments.	OL				
3	HSA							0 0		
4	HSA	Sh		1	Dense, brownish gray **SILTY, CLAYEY GRAVEL with SAND**; **(GC-GM)s**. Sub-angular gravel (max. 3/4-inch). With Fractured SHALE and COBBLES.	(GC-GM)s		5 9		
6	HSA	Sh		2				9 15 15		
8	HSA	Sh		3	Dense, brownish gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 2-inch). With Fractured SHALE and COBBLES.	g(SC-SM)		14 23 15		Fines = 37.7%
10	HSA									
11	HSA	Sh		4				6 13 16		
13	HSA									
15	HSA									
16	HSA	Sh		5				7 10 15		
18	▽									
19		Sh		6	**SHALE**; **Bx**.	Bx		38 15 50/2"		





Borehole terminated at 19.2 ft
Client: Wolf Architecture
Drill Start: 6/2/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

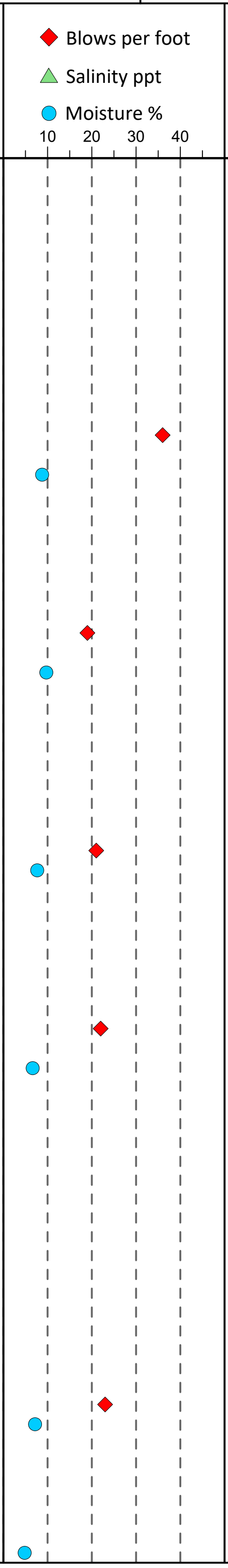
LOG OF BOREHOLE BH-9

Project: Kodiak Fire Station
Project Number: 221042

Elevation: 121.1 ft MLLW
Horizontal Datum: NAD83 AKSP Zone 5
Latitude: 57.79693 °N Longitude: 152.39011 °W

Logged By: KL
Reviewed By: CK
Review Date: 6/27/2022

Depth (17.8 ft)	Drill Method	Sample Type	Sample #	Soil Classification	Symbol	Blows/ 6 in.
0–1	HSA			Very loose **PEAT**; **PT**.	PT	
1–2.5	HSA			Loose, brown organic **SILT**; **OL**. With ROOTS.	OL	
2.5–3.5	HSA			Dense, brownish gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 1.5-inch). With COBBLES.	g(SC-SM)	
3.5–8	HSA	Sh Sh	1 2	Dense, dark gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 2-inch). With COBBLES.	g(SC-SM)	3 19 17 10 4 9 10 12
8–10	HSA	Sh	3	Dense, brownish gray **SILTY, CLAYEY, SANDY GRAVEL**; **s(GC-GM)**. (max. 2-inch). With Fractured SHALE.	s(GC-GM)	6 9 12
10–15.5	HSA	Sh	4	Dense, brownish gray **SILTY, CLAYEY SAND with GRAVEL**; **(SC-SM)g**. Sub-angular gravel (max. 2-inch). With Fractured SHALE.	(SC-SM)g	4 9 13 18
15.5–17	HSA	Sh	5	Dense, dark gray **SILTY, CLAYEY, GRAVELLY SAND**; **g(SC-SM)**. Sub-angular gravel (max. 1-inch). With Fractured SHALE.	g(SC-SM)	4 10 13
17–17.8	HSA	Sh	6	SHALE; **Bx**.	Bx	50/3"



Other Tests

Size Distribution

Borehole terminated at 17.8 ft
Client: Wolf Architecture
Drill Start: 6/2/2022

Drilling Contractor: Discovery Drilling
Drill Equipment: Geoprobe 6712DT
Driller: BV

APPENDIX B — SUMMARY OF SAMPLE CHARACTERISTICS

Summary of Sample Characteristics

Client: Wolf Architecture
Project: Kodiak Fire Station
Project #: 221042

PND ENGINEERS, INC.

Borehole	Sample #	From	To	Sample Method	Liquid Limit (%)	Plastic Limit (%)	Gradation (%)			Max Particle Size (in)	Laboratory Classification*	Salinity (ppt)	Moisture (%)	Particle Shape	Angularity	Other Tests**
							Gravel	Sand	Fines*							
BH-1	1	3.5	4.5	Sh						1/2	(SC-SM)g		11		A	
BH-1	2	6	7	Sh						3/4	(SC-SM)g		9		SA	
BH-1	3	8	9	Sh			19.4	35.9	44.7	1/2	(SC-SM)g		9		A	
BH-1	4	10.5	11.5	Sh						1.5	s(GC-GM)		8		SA	
BH-1	5	14	14.3	Sh						1	Bx		6		A	
BH-2	1	3.5	4.5	Sh						3/4	g(SC-SM)		9		SA	
BH-2	2	6	7	Sh						1	g(SC-SM)		7		SA	
BH-2	3	8.5	9.5	Sh						1.5	g(SC-SM)		8		A	
BH-2	4	11	12	Sh						1.5	s(GC-GM)		8		SA	
BH-2	5	15	15.2	Sh						1.5	Bx		1		SA	
BH-3	1	0.5	1	Sh							SP		34			
BH-3	2	3.5	4.5	Sh			36.7	36.5	26.8	2.5	s(GC-GM)		9		A	
BH-3	3	6	7	Sh						2	s(GC-GM)		5		SA	
BH-3	4	8.5	9.5	Sh						1.5	g(SC-SM)		8		SA	
BH-3	5	11	12	Sh						1	s(GC-GM)		8		SA	
BH-3	6	15.5	16.5	Sh						1	s(GC-GM)		7		SA	
BH-3	7	20.5	21.5	Sh						2	(GC-GM)s		6		SA	
BH-4	1	2.5	3	Sh							OL		37			
BH-4	2	3.5	4.5	Sh						1.5	(SC-SM)g		9		SA	
BH-4	3	6	7	Sh	24	19				1	(SC-SM)g		10		SA	
BH-4	4	8.5	9.5	Sh			19.1	37.3	43.6	1	(SC-SM)g		10		SA	
BH-4	5	10.5	11.5	Sh						1	g(SC-SM)		10		SR-SA	
BH-4	6	15	15.2	Sh							Bx		1			
BH-5	1	1	1.5	Sh							OL		153			
BH-5	2	3.5	4.5	Sh						1.5	g(SC-SM)		9		SA	
BH-5	3	6	7	Sh						3/4	g(SC-SM)		10		SA	
BH-5	4	8.5	9.5	Sh						1	(SC-SM)g		9		SA	
BH-5	5	11	12	Sh						1.5	(SC-SM)g		7		SA	
BH-5	6	16	17	Sh						1.5	(SC-SM)g		7		SA	

*Fines type and content estimated with ASTM D2488 when ASTM D422 or D4318 were not performed

**Other tests: DEN = Bulk Density, SPG = Specific Gravity, HYD = Hydrometer, CONSL = Consolidation, UCS = Unconfined Compression Strength, TRIAX = Triaxial

Summary of Sample Characteristics

Client: Wolf Architecture
Project: Kodiak Fire Station
Project #: 221042

PND ENGINEERS, INC.

Borehole	Sample #	From	To	Sample Method	Liquid Limit (%)	Plastic Limit (%)	Gradation (%)			Max Particle Size (in)	Laboratory Classification*	Salinity (ppt)	Moisture (%)	Particle Shape	Angularity	Other Tests**
							Gravel	Sand	Fines*							
BH-5	7	18.5	18.7	Sh							Bx					
BH-6	1	6.5	7	Sh							OL		32			
BH-6	2	7.5	8	Sh							CL-ML		31			
BH-6	3	11.5	12	Sh						1	g(SC-SM)		12		SR-SA	
BH-6	4	16	17	Sh			11.6	42.4	46.0	1/2	SC-SM		10		SA	
BH-6	5	20.5	21.5	Sh						1.5	g(SC-SM)		8		SR-SA	
BH-6	6	25	25.3	Sh						3/4	Bx		2		A	
BH-7	1	6	7	Sh						1	g(SC-SM)		13		SA	
BH-7	2	8.5	9.5	Sh						1	g(SC-SM)		11		SR-SA	
BH-7	3	11	12	Sh	22	15				1	(SC-SM)g		10		SR-SA	
BH-7	4	15.5	16	Sh						1.5	g(SC-SM)		8		SA	
BH-7	5	16	16.2	Sh						1	Bx		2		SA	
BH-8	1	3.5	4.5	Sh						2	g(SC-SM)		10		SA	
BH-8	2	6	7	Sh						2	(GC-GM)s		9		SA	
BH-8	3	8	9	Sh						2	g(SC-SM)		8		SR-SA	
BH-8	4	10.5	11.5	Sh						1.5	g(SC-SM)		8		SR-SA	
BH-8	5	15.5	16.5	Sh						1	g(SC-SM)		8		SR-SA	
BH-8	6	18.5	19.2	Sh						1	(GC-GM)s		10		A	
BH-9	1	3.5	4.5	Sh						1.5	g(SC-SM)		9		SA	
BH-9	2	6	7	Sh						1	g(SC-SM)		10		SA	
BH-9	3	8.5	9.5	Sh						1.5	s(GC-GM)		8		SA	
BH-9	4	11	12	Sh						2.5	(SC-SM)g		7		SA	
BH-9	5	15.5	16.5	Sh						1	g(SC-SM)		7		SR-SA	
BH-9	6	17.5	17.8	Sh						1	Bx		5		SA	

53 samples

*Fines type and content estimated with ASTM D2488 when ASTM D422 or D4318 were not performed

**Other tests: DEN = Bulk Density, SPG = Specific Gravity, HYD = Hydrometer, CONSL = Consolidation, UCS = Unconfined Compression Strength, TRIAX = Triaxial

APPENDIX C — GRAIN SIZE DISTRIBUTION

Grain Size Distribution

Client: Wolf Architecture
Project: Kodiak Fire Station
Project #: 221042

P | N | D
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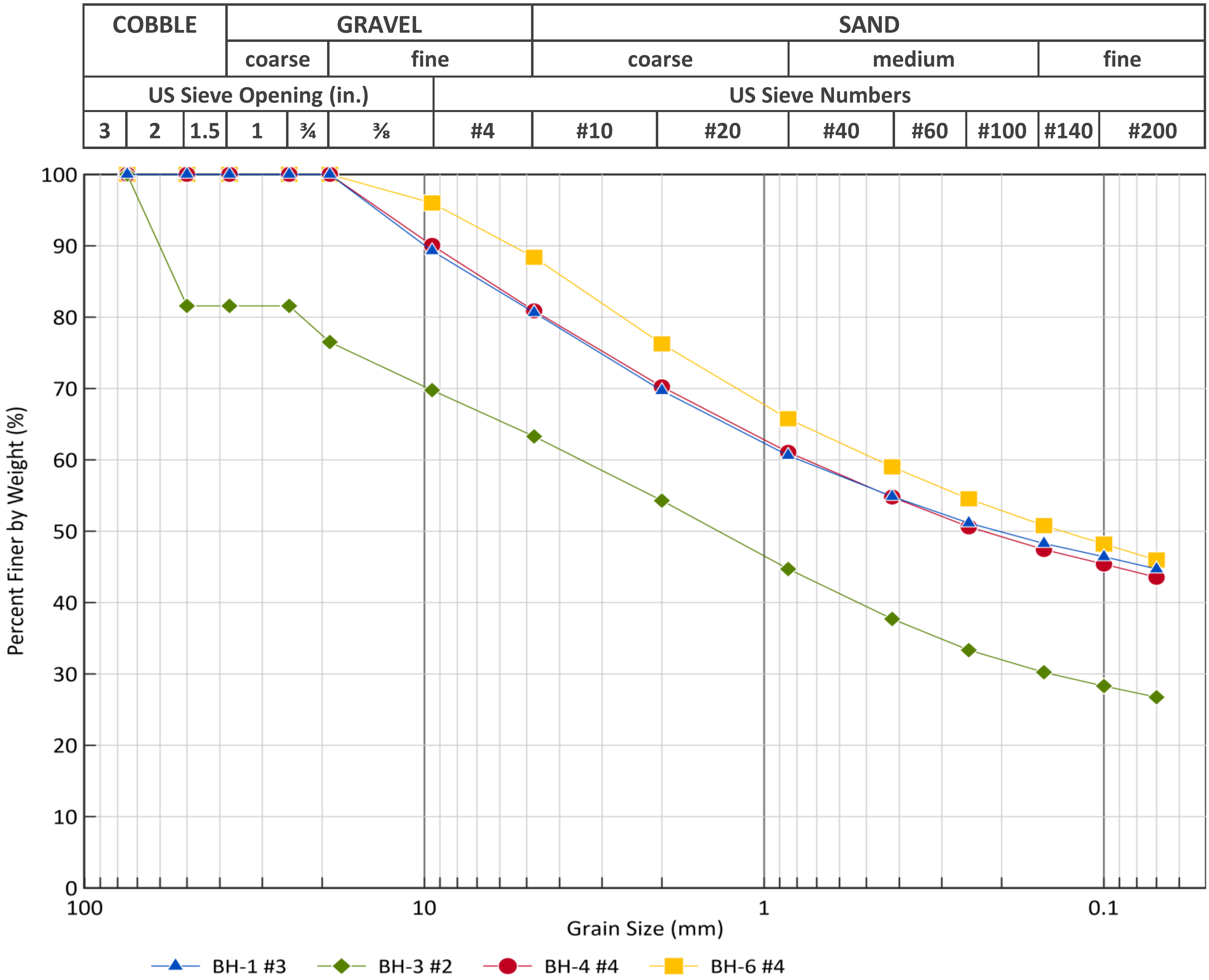


Borehole	Sample #	From	To	Laboratory Classification*	Gradation (%)			D50	P10
					Gravel	Sand	Fines		
BH-1	3	8	9	(SC-SM)g	19.4	35.9	44.7	0.2	69.7
BH-3	2	3.5	4.5	s(GC-GM)	36.7	36.5	26.8	1.4	54.3
BH-4	4	8.5	9.5	(SC-SM)g	19.1	37.3	43.6	0.2	70.3
BH-6	4	16	17	SC-SM	11.6	42.4	46.0	0.1	76.3

*Fines type estimated with ASTM D2488 when ASTM D422 or D4318 were not performed

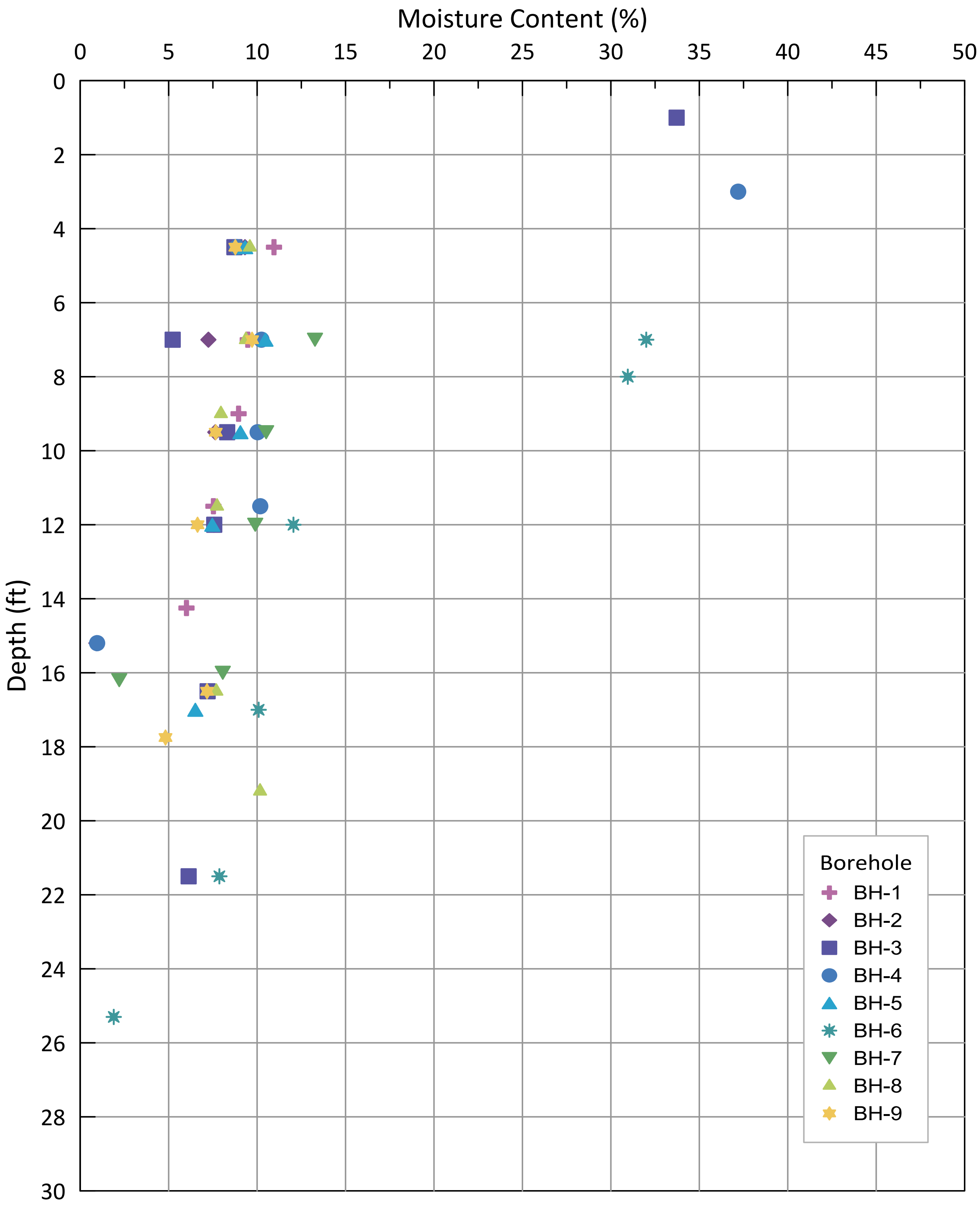
APPENDIX D — MOISTURE CONTENT BY DEPTH

PND ENGINEERS, INC.

Client: Wolf Architecture
Project: Kodiak Fire Station
Project #: 221042

MOISTURE CONTENT BY DEPTH
Kodiak Fire Station

Location: **Kodiak, Alaska**
Reviewed By: CK
Review Date: 6/30/2022



APPENDIX E — CORRECTED SPT BLOW COUNTS

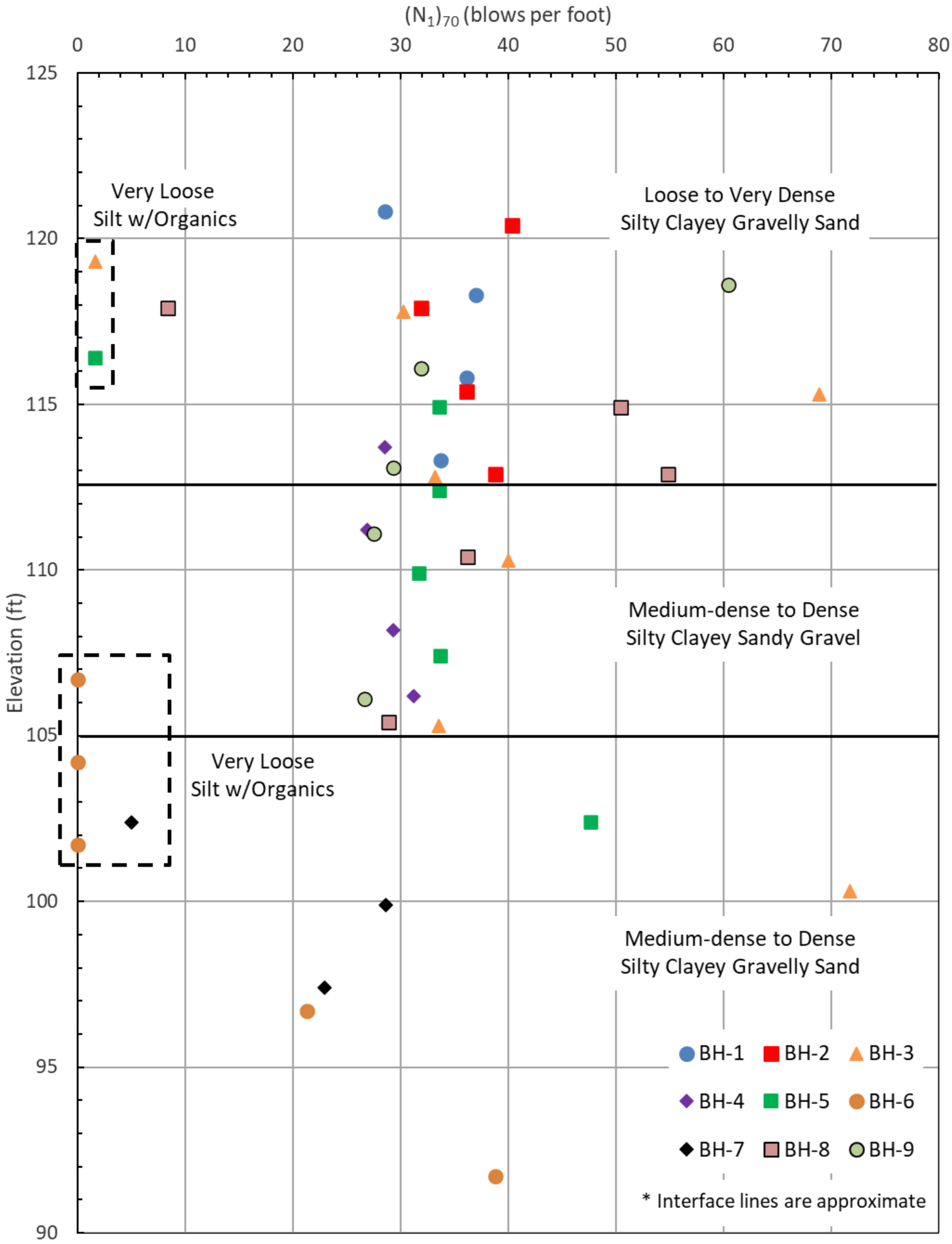


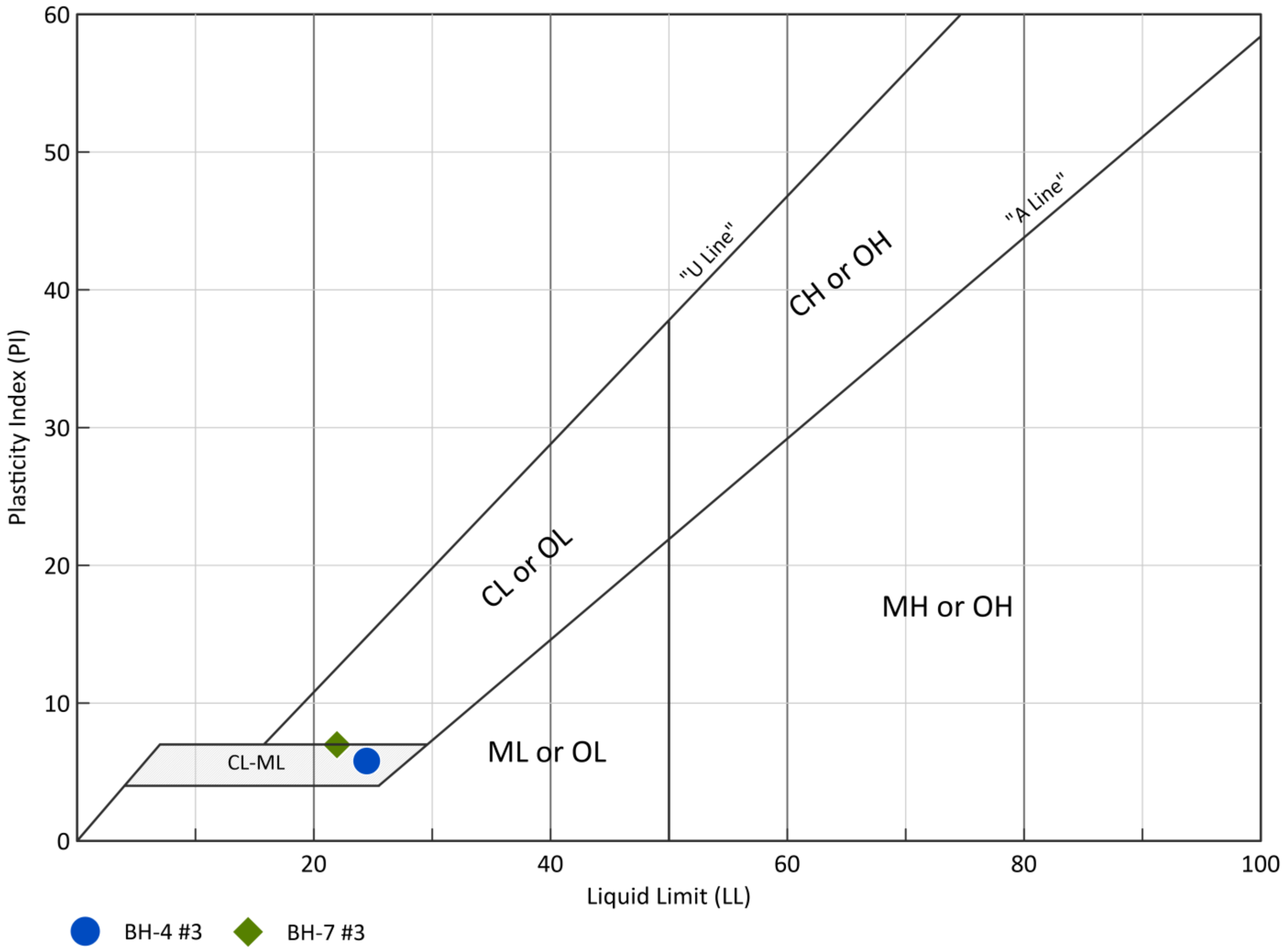
Figure E- 1. Corrected SPT Blow Counts $(N_1)_{70}$ vs. Elevation at the project site.

APPENDIX F — ATTERBERG LIMITS

Atterberg Test Results

Client: Wolf Architecture
Project: Kodiak Fire Station
Project #: 221042

PND ENGINEERS, INC.



Borehole	Sample #	From	To	Moisture %	LL	PL	PI	Soil Type
BH-4	3	6	7	10.25%	24.5	18.67	5.8	CL-ML
BH-7	3	11	12	9.89%	21.9	14.96	7.0	CL-ML

PND
ENGINEERS, INC.

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Seattle, WA 98134
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832-930-4830

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503-912-4615