Geotechnical Data Report
Gary Paxton Industrial Park Multi-Use Dock
Sawmill Cove, Sitka, Alaska

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GEOTECHNICAL AND ENVIRONMENTAL CONSULTANTS

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SAWMILL COVE, SITKA, ALASKA

1.0 INTRODUCTION

This report presents the results of subsurface explorations and laboratory testing conducted by Shannon & Wilson, Inc. for a proposed new dock in Sawmill Cove near Sitka, Alaska. At the time of this report, we understand that the proposed improvements will generally consist of a new dock structure to support industrial activities at the Gary Paxton Industrial Park (GPIP). The purpose of this geotechnical study was to explore subsurface conditions and provide geotechnical engineering recommendations needed for design of the proposed dock structure. To accomplish this, five soil borings were advanced at the site. Soil samples recovered from the borings were tested in our geotechnical laboratory and engineering studies were performed to support design. Presented in this report are descriptions of the site and project, subsurface explorations and laboratory test procedures, an interpretation of subsurface conditions, and conclusions and recommendations from our engineering studies.

Authorization to proceed with this work was received in the form of a Subconsultant Agreement signed by Mr. Shaun McFarlane of Moffat & Nichol (M&N), on May 5, 2014. Our work was conducted in general accordance with our revised proposal dated April 14, 2014, with some exceptions. Two of the proposed offshore borings and the test pit explorations (presented as Deductive Alternates in our proposal) were excluded from the field program at the request of the project owner after relatively uniform conditions had been encountered in the first three offshore borings. In addition, our borings were advanced deeper than anticipated due to deep, loose soil deposits that were encountered during our explorations.

At the time of this report, the City and Borough of Sitka (CBS) was still in the process of selecting a dock design alternative. As such, our engineering report will be presented under separate cover once a dock design is selected.

2.0 SITE DESCRIPTION

The GPIP is an approximately 20-acre, waterfront industrial park located along the west side of Sawmill Cove near the north end of Silver Bay and is accessible via Sawmill Creek Road approximately 5 miles south of Sitka, Alaska. The site has been developed since the 1940's, serving as a dairy until the mid 1950's. Alaska Pulp Corporation purchased the property in 1956 and developed the former pulp mill soon after. Pulp mill development included construction of a large fill pad and numerous structures, including several tanks, the utility dock, and the pulp storage dock. The mill was closed in the early 1990's and most of the former mill structures have been demolished. The CBS took ownership of the site in 1999 and currently leases portions of the property to various tenants. The proposed multi-use dock structure is located between the existing utility and pulp storage docks. A vicinity map showing the general project area is presented in Figure 1.

The upland portions of the project area are generally situated on a relatively flat fill pad. Most of the structures previously occupying the fill pad have been demolished and removed with the exception of a warehouse structure located on the property to the west of the proposed new dock. The offshore topography in the area of the proposed dock structure generally slopes downward to the east into Sawmill Cove. Based on measurements taken from available topographic/ bathymetric contours (see Section 3.0), the existing sea floor slopes are on the order of 1.7 to 2.7 horizontal (H) to 1 vertical (V). The cove bottom in the area just east of the proposed structure extends to a depth of about -54 feet mean lower low water (MLLW) and appears to have a relatively flat bottom. Just south of the project area another slope, which slopes downward to the south to depths greater than -140 feet MLLW, truncates the flat bottom trough at the head of the cove. Based on the bathymetric contours, this slope appears generally concave in profile with the upper portion of the slope approaching 1.5 H to 1V.

3.0 PROJECT DESCRIPTION

The project generally consists of constructing a new multi-use industrial dock structure at the site described above. Based on M&N's June 13, 2014 *GPIP Dock Alternatives Analysis Report (DRAFT)* and the May 29, 2014 Basis of Design (BOD) document we understand that the general dock design includes approximately 225 feet of moorage and that the dock face will extend seaward to a minimum elevation of -35 feet MLLW. The alternatives evaluation identified three possible dock systems: pile-supported dock, anchored sheetpile-supported dock, and cellular sheetpile-supported dock. We understand that the northern portion the dock may be configured to carry loads from a single row of wheels from a 250T travel lift. The alternatives analysis report also indicates that a riprap slope will be placed under the dock (pile-supported option) to protect the slope from raveling due to wave and tidal action. The preliminary riprap slope design indicates that riprap would extend to a minimum elevation of -35 feet MLLW at a 2 horizontal (H) to 1 vertical (V) slope. A site plan showing the project area including proposed improvements, prominent site features, and our approximate boring locations is included as Figure 2.

A topographic/bathymetric survey was conducted on May 22 and 23, 2014 by DOWL HKM (DOWL) as part of the project to establish ground and seafloor elevations in the project area. The results of the survey were used by DOWL to prepare the topographic/bathymetric contours shown in Figure 2. The DOWL survey assumes an elevation datum of MLLW. Unless otherwise stated, references to elevation in this report are stated in feet relative to this standard.

4.0 REGIONAL GEOLOGY, TECTONICS, AND SEISMICITY

Southeast Alaska lies within the active tectonic belt that rims the northern Pacific Basin. Plate tectonic activity since the late Paleozoic time has resulted in northwesterly trending bands of folded sedimentary, igneous and metamorphic rocks. Granitic batholiths emplaced during the mid to late Cretaceous period, are widespread throughout southeast Alaska and form the backbone of the Coast Range. The major lineaments in southeast Alaska, such as fjords and river valleys are believed to be controlled by major faults or fault zones.

4.1 Regional Geology

The regional geology is dominated by the Chugach Terrane which is a lower-Jurassic to Upper-Cretaceous flysch and includes intensely folded and weakly metamorphosed graywackes, shales and volcanic rocks. The Kelp Bay Group and the Sitka Group are included in this terrane. There are also numerous Tertiary plutons which provide occasional igneous rocks including gabbro and quartz diorite. The local rocks are generally both sedimentary and volcanic metamorphosed rocks which have been subjected to low to moderate pressures and temperatures during mountain building and terrain accretion processes. The Kelp Bay Group is a tectonic patchwork of late Mesozoic, metamorphosed sedimentary and volcanic rock including greenschist, phyllite, greenstone, tuff, and graywacke. The Sitka Group consists mainly of slate and Sitka graywacke, but also includes minor amounts of conglomerate, greenstone, and limestone. It is characterized by thin to medium bedded interstratified graywacke, argillite, and slaty argillite. The Sitka graywacke is a poorly sorted, fine to coarse grained, low grade metamorphic interbedded with hard mudstone. Hornfels is also found at contact areoles between the plutonic intrusions and the Sitka graywacke.

Mount Edgecumbe is a dormant composite cone volcano on Kruzof Island, visible from Sitka and approximately 19 miles away from Sawmill Cove. An eruption 9,000 years ago deposited 1 to 2 inches of ash in Sitka and thinner layers in Juneau. Mount Edgecumbe has been inactive for the past 200 years. The Mount Edgecumbe volcanic field is about 100 square miles and contains basalt, andesite and rhyolite domes.

Glaciers advanced over the region during the Pleistocene Epoch (~10,000 to 2 million years ago) leaving undifferentiated drift deposits that typically consist of till and other glacially deposited material. These deposits typically have a wide range of grain size and may be classified as sands, gravels, silts or even clays depending upon the exact mechanism of deposition. Many of the landforms in this area have been influenced by glacial advance and retreat. Quaternary deposits also include lacustrine, fluvial, beach, and shallow marine sediments. Other shoreline surficial deposits consist of modern beach sediment, estuarine, stream alluvium, muskeg, and colluvium.

4.2 Tectonics

An intricate network of reverse, normal and strike-slip faults dissects southeastern Alaska. On the west, the Queen Charlotte-Fairweather fault system is shown in Figure 3. This system is known to be an "active" right-lateral strike slip fault with large displacements. The location of this fault, which represents the transform boundary between North America and the Pacific Plate, is approximately 25 to 50 miles west of Sitka and boasts four major earthquakes in the last century. On the east side of Baranof Island is the Chatham Strait fault, which is the second largest right lateral strike-slip fault in southeast Alaska and was active in the Tertiary Period (2 to 65 million years ago). This fault has shown right lateral displacement of up to 93 miles and is thought to truncate in the south into the Queen Charlotte-Fairweather fault. Numerous other faults crisscross the region but are thought to be inactive.

The project is located within the Silver Bay segment of the Sitka fault zone, one of several major fault zones in northern Southeast Alaska. According to Brew (1991), the Sitka fault zone is a high angle fault zone approximately 200-kilometers in length, and containing several faults and fault segments. The Silver Bay segment, the southern portion of the larger Neva Strait fault, is about 40 kilometers long and ranges between 0.4 and 2 kilometers wide. The segment contains between two and five discernible fault strands and includes a wide variety of rock types and units, which illustrate the complexity of faulting in the region. Although obscured by multiple periods of movement, inferred displacements within the Silver Bay segment are thought to be on the order of about 20 km left-lateral (sinistral) separation. The history of movements in the fault zone are thought to begin with mid-Cretaceous compression of the Chugach terrane rocks against Wrangellia terrane rocks, with the most recent movements thought to be long-lived but intermittent Tertiary transcurrent (steeply inclined strike-slip) movements.

4.3 Seismicity

The region is among the most seismically active areas in the United States and historically subjected to large (greater than 6.0 Magnitude) earthquakes. Alaska experiences approximately 22,000 earthquakes of any given magnitude per year, which accounts for 52 percent of the earthquakes in the United States (AEIC no date). Figure 3 presents the locations of the major faults and earthquakes in southeast Alaska in the panhandle region.

Large earthquakes in the region include a 1927 magnitude 7.1 earthquake near the northern portion of Chichagof Island, a 1949 magnitude 8.1 event recorded along the Queen Charlotte fault near the Queen Charlotte Islands (Haida Gwaii), a 1958 magnitude 7.9 earthquake along the Fairweather fault near Lituya Bay, a 1972 magnitude 7.4 earthquake near Sitka, a 2004 magnitude 6.8 earthquake along the Fairweather fault south of Sitka, a 2012 magnitude 7.8 near the southern end of the Haida Gwaii, and in 2013 a magnitude 7.5 north of Haida Gwaii. These events appear to be located in and associated with the plate transform boundary to the west of Sitka and are presented on the Panhandle seismicity map in Figure 3. Reports indicate that Sitka experienced Modified Mercalli Intensity VI ground shaking for the 1949 event and an Intensity III for the 2004 event. Although a magnitude 5.3 event was located near the Chatham Strait fault in 1987, very few earthquakes in the area appear to have been directly related to this fault.

5.0 EXISTING SUBSURFACE DATA

Subsurface data from the project area was limited and largely consisted of partial pile driving records from the construction of the former pulp storage dock (now the Silver Bay Seafoods wharf), information contained in the Dames and Moore *Engineering Bulletin 6, Experiences with Piles in Coarse Granular Soil,* and pile driving records for several piles installed in 2005, all provided by Moffat & Nichol. We also searched our in-house database, the Alaska Division of Geological and Geophysical Surveys (DGGS) website, and contacted the Alaska Department of Transportation & Public Facilities (ADOT&PF) for available subsurface information in the project area.

The Dames and Moore bulletin describes pile load testing and modifications that were needed after the initial piling for the utility dock were not achieving the expected resistances or capacities. The bulletin also briefly and generally describes the subsurface condition at the site based on Dames and Moore's 1955 and 1957 explorations. According to the Dames and Moore bulletin, 34 borings were advanced at the site as part of foundation investigations for the pulp mill. The boring logs or geotechnical report were not available, however the bulletin indicates that the soils encountered generally consisted of dense "sand and gravel or gravel with sand or sandy loam binder." The synopsis did not indicate the depth of the borings or whether or not the borings encountered bedrock. Descriptions in the bulletin and pile driving records from construction at the pulp storage dock suggest that the thickness of the soils over bedrock may be highly variable with some piles apparently experiencing refusal within 10 to 20 feet and others being driven to 165+ feet (192 feet was the deepest) before refusal. The driving records do not indicate whether refusal is on bedrock or due to exceedance in blows as set forth in the driving criteria. Except for a portion of the utility dock, pile grids or layouts were not available and we were not able to relate the driving records to actual pile locations. Likewise, the pile driving records from W.S Construction's 2005 work at the site for the "mill fenders" indicate a similarly variable bedrock surface with several piles experiencing refusal within 10 feet of driving due to bedrock, one pile driven to 20 feet (no refusal notes), and couple of piles driven to 35 feet (no refusal notes).

The site was added to the Alaska Department of Environmental Conservation (ADEC) contaminated sites database in 1993 due to potential area-wide contamination introduced by operation of the former APC pulp mill. According to the database, contaminants of concern primarily included heavy metals and dioxin. Other potential contaminants included various hydrocarbons, ammonia, and wood waste degradation compounds. As a result of initial remedial action studies at the site in the mid-90's an approximately 100-acre Area of Concern (AOC) was designated for the portion Sawmill Cove that remained adversely affected from past operations. Subsequent monitoring in 2000 and 2011 has indicated that approximately 54 percent of the AOC has completely recovered. According to the proposed adjustments to the AOC indicated in the most recent monitoring report (2011), the proposed dock project is located just outside of the AOC.

6.0 SUBSURFACE EXPLORATIONS

Subsurface explorations for the project were conducted between June 12 and 19, 2014. Explorations consisted of advancing three offshore borings, designated Borings B-1, B-2, and B-3, and two onshore borings, designated Borings B-4 and B-5, to evaluate the subsurface conditions in the vicinity of the proposed dock. Drilling services for the project were provided by Discovery Drilling of Anchorage, Alaska. Barge services were provided by the Poundstone (a mechanized landing craft) of Juneau, Alaska, under subcontract to Discovery Drilling.

Prior to conducting explorations, Shannon & Wilson contacted the Call Locate Center to coordinate utility locates and clear the boring locations of potential conflicts with buried utilities.

Mr. John Flory, the GPIP project manager for CBS, coordinated locates with CBS utilities. We also coordinated with the USACE Regulatory Division to obtain permission to conduct the offshore drilling under a Nationwide #6 Permit and with Alaska Department of Fish & Game to determine when our work could be accomplished to minimize disturbance to out-migrating fish.

An experienced representative from our office was present continuously during the field work to locate the borings, observe drilling operations, recover soil and rock samples, log the subsurface conditions, and observe groundwater levels where appropriate. Boring locations were recorded with a handheld GPS with differential corrections from wide area augmentation system (WAAS) satellites. GPS locations were verified with swingtie measurements to prominent site features using a cloth tape or laser rangefinder. The elevations shown on the boring logs were extrapolated from topographic/bathymetric contours shown on the DOWL survey map. Boring locations and elevations should be considered approximate. The locations of the borings are shown on Figure 2. Logs of our borings are presented in Appendix A, Figures A-3 through A-7 and subsurface profiles summarizing the soil conditions encountered during these explorations are summarized in Figures 4 and 5.

6.1 Subsurface Explorations

The offshore borings (Borings B-1 through B-3) were drilled using a truck mounted, CME-75 drill rig parked on the deck of the Poundstone. The drill was modified to advance solid casing and equipped with rotary wash drilling tools. These borings extended to depths ranging from approximately 87 to 127 feet below mudline (bml). Water depths during drilling ranged from approximately 15 to 45 feet. Drilling was accomplished through an opening or "moon pool" on the landing craft's loading ramp. The loading ramp also served as a work area for the drill crew. The landing craft was generally held in place during drilling using a three- to four-point mooring system that consisted lines tied to existing pile supports and mooring dolphins.

In general, the offshore borings were initiated by setting 4-inch inside diameter (ID), threaded, conductor casing through the water and seating it into the soil at mudline. The borings were then advanced using rotary techniques and a 3 $^{7}/_{8}$-inch tricone bit. Seawater was flushed down the casing to return cuttings to the surface. The casing was advanced with the drilling to control caving of the borehole walls. Soil sampling was conducted using the procedures outlined in the following section. At the completion of drilling the casing was removed and the boreholes were allowed to backfill by natural caving of the borehole walls.

Borings B-4 and B-5 were advanced onshore using a truck mounted, CME-75 drill rig (the same drill rig used in the offshore drilling). Boring B-4 was drilled to auger refusal (presumably on bedrock) at approximately 109 feet bgs using 3 ¼-inch ID hollow stem auger. In an attempt to confirm and recover bedrock, the auger was removed and threaded casing was driven to the bottom of the boring to facilitate rock coring. Boring B-5 was drilled to a depth of 30 feet bgs using hollow stem auger methods and then advanced to a total depth of approximately 141 feet bgs using the techniques described for the offshore borings. The onshore borings were generally backfilled with auger cuttings removed during drilling except the upper portions (about 5 to 10 feet), which were backfilled by a representative from CBS with granular materials from onsite stockpiles.

6.2 Soil and Rock Sampling

As the borings were advanced penetration resistance samples were generally collected at 5-foot intervals in soil. In addition, a grab sample was collected from the auger cuttings in the upper 2 feet in the onshore borings. Note, that sample intervals were varied to accommodate tidal fluctuations or other drilling and sampling conditions. Samples were recovered using modified penetration test (MPT) or standard penetration test (SPT) or methods. In the MPT method, samples are recovered by driving a 3-inch OD split-spoon sampler into the bottom of the advancing hole with blows of a 340-pound hammer free falling 30 inches onto the drill rod. In the SPT method, samples are recovered by driving a 2-inch outer diameter (OD) split-spoon sampler into the bottom of the advancing hole with blows of a 140-pound hammer free falling 30 inches onto the drill rod. For both methods, the number of blows required to advance the sampler the final 12 inches of an 18-inch penetration or the middle 12 inches of a 24-inch penetration is termed the penetration resistance. Blow counts are shown graphically on the boring log figures as "penetration resistance" and are displayed adjacent to sample depth. Sampler refusal is indicated on the boring logs by noting the number of blows and total penetration of the spilt-spoon. The penetration resistance values give a measure of the relative density (compactness) or consistency (stiffness) of cohesionless or cohesive soils, respectively.

When casing refusal was encountered (Borings B-1 through B-4), we attempted to confirm the presence of bedrock by penetrating into the rock using a 5-foot long, NQ (1 ⁷/₈ -inch ID) core barrel with a diamond impregnated bit. The rock core extracted from each 5 foot or less run was classified in the field by our representative and placed in 2-foot long core boxes for transport. The depths of the top and bottom of each run, percent recovery, and other drilling notes were recorded. Core samples were shipped to our Anchorage laboratory for more detailed classification.

The soil samples recovered during drilling were observed and described in the field in general accordance with the classification system described by ASTM International (ASTM) D2488. Selected samples recovered during drilling were tested in our laboratory to refine our soil descriptions in general accordance with the Unified Soil Classification System (USCS) described in Appendix A, Figure A-1. Rock classifications were made in general accordance with classification system presented in Appendix A, Figure A-2. Summary logs of the borings are presented in Appendix A, Figures A-3 through A-7. Rock core logs for Borings B-1 and B-3 are included in Appendix A, Figures A-10 and A-11.

7.0 LABORATORY TESTING

Laboratory tests were performed on soil and rock samples recovered from the borings to confirm our field classifications and to estimate the strength and index properties of the typical materials encountered at the site. The following sections describe the types of testing performed.

7.1 Soil Testing

Water content tests were performed on selected samples returned to our laboratory. Water content tests were performed in general accordance with ASTM D2216. The results of the water content measurements are presented graphically on the boring logs in Appendix A, Figures A-3 through A-7.

Grain size classification (gradation) testing was performed to estimate the particle size distribution of selected samples from the borings. The gradation testing generally followed the procedures described in ASTM C117/C136 and ASTM D421/422. The test results are presented in Appendix A, Figure A-8 and summarized on the boring logs as percent gravel, percent sand, and percent fines. Tests were also conducted on selected samples to estimate the amount of material passing the Number 200 sieve (P-200). This test was performed in general accordance with ASTM C117. The P-200 test provides an estimate of the fines (silt and/or clay) content. The results of this test are presented on the boring logs, indicated as percent fines. Percent fines on the boring logs are equal to the sum of the silt and clay fractions indicated by the percent passing the No. 200 sieve. Note that hydrometer testing indicates particle size only and visual classification under USCS designates the entire fraction of soil finer than the No. 200 sieve as silt. Plasticity characteristics (Atterberg Limits results) are required to differentiate between silt and clay soils under USCS.

Atterberg limits were evaluated on two samples of predominantly fine-grained materials recovered during drilling. The tests were performed in accordance with ASTM D4318. This analysis provides information on the plasticity characteristics of the silt or clay. The results of these tests are summarized on Appendix A, Figure A-9 and included on the boring logs.

7.2 Rock Testing

Testing on rock core samples recovered from our borings focused on estimating the rocks structural (ie. joint spacing, orientation, and frequency) and physical (ie. hardness, reaction to acid solution) properties. Results of this testing are included on the rock core logs in Appendix A.

The Rock Quality Designation (RQD) was measured for each core sample recovered during drilling. In the measurement, core specimens longer than 4 inches are measured in each run with RQD calculated as the ratio of the sum of the length of core fragments longer than 4 inches to the total drilled footage per run, expressed as a percentage. This value is used to estimate the rock mass quality (i.e.: low values are indicative of low quality while RQD values approaching 100 percent reflect high quality). The results of these measurements along with the percent recovery are included on the rock core logs.

The general hardness of the recovered rock samples was estimated by scratching along the surface of the samples with a Hardness 6 stylus based on Mohs scale of hardness. The effort required to scratch the rock surface was described as easy, moderate, or hard. The relative hardness is described on the rock core logs.

Portions of rock samples were exposed to a 0.1 molar hydrochloric acid (HCl) solution, and the reaction was observed. The nature of the reaction (degree of effervescence) was described as high, moderate, low, or no reaction to HCl. Reactions to HCl are reported on the rock core logs.

8.0 SUBSURFACE CONDITIONS

The subsurface conditions described below are depicted graphically on the boring logs in Appendix A, Figures A-3 through A-7. Our borings in the project area generally encountered relatively uniform conditions comprising complexly interbedded sands and gravels (predominantly gravels) with varying amounts of fines overlying estuarine deposits primarily consisting of silty, fine sand and sandy silt. Bedrock was encountered beneath the estuarine deposits at depths ranging from about 78 to 141 feet bml/bgs. Note that we were only able to confirm bedrock by sampling in Borings B-1 and B-3 and the presence of bedrock in the remaining borings was inferred by drill action and the judgment of our representative at the time of drilling. Borings B-1 and B-3 also encountered a 1 to 3 foot layer of silty sand with wood chips and other organic matter at mudline.

8.1 Soil Conditions

Borings B-1 through B-3 were advanced offshore and Borings B-4 and B-5 were advanced onshore through the existing GPIP fill pad. The fills encountered generally consisted of gravels and sands with various amounts of fines and extended to approximate depths of 19 and 34 feet bgs in Borings B-4 and B-5, respectively. Based on penetration resistance values ranging from 7 to 17 bpf, the fill soils encountered would be considered loose to medium dense. According to our laboratory testing, fines contents in the fills generally ranged between 6 and 12 percent and moisture contents in unsaturated samples ranged between 2 and 9 percent.

Directly beneath the mantle of silty sand (seafloor sediment in Borings B-1 through B-3) or granular fill (Borings B-4 and B-5), our borings encountered complexly interbedded gravel and sand alluvium to depths ranging between 59 and 98 feet bgs/bml. Based on typical penetration resistance values ranging from 5 to 20 bpf, the alluvial soils encountered would be considered loose to medium dense. Trace amounts of shell fragments and wood particles were also observed throughout the alluvium in recovered samples and drill cuttings.

An estuarine deposit of silty sand and silty silt was encountered below the alluvium in each boring. According to our borings, this layer ranged between 19 and 43 feet thick, and extended to depths ranging between 78 and 141 feet bgs/bml. Numerous wood particles, along with a trace of shell fragments, and strong organic/sulfur odors were noted in the drill cuttings and in samples recovered during drilling in this stratum. Occasional, thin (probably less than about 1 foot) gravelly lenses were noted during drilling and were also observed periodically in samples recovered during drilling. Based on typical penetration resistance values ranging from 9 to 29 bpf, the estuarine soils encountered would be considered loose to medium dense.

According to our laboratory testing, fines contents in the coarser sands and gravels (alluvium) generally ranged between 3 and 15 percent and fines contents in the finer sands and silts (estuarine deposits) ranged between 24 and 38 percent. Atterberg limits were evaluated on two samples of the estuarine deposits recovered during drilling (Boring B-3 and B-5). The tests indicated that the materials were non-plastic and thus classified as silt or silty sand.

A 4 to 7-foot thick layer of sand and gravel was encountered beneath the estuarine deposits in B-2, B-3, and B-4. Due to poor or no sample recovery in these strata it was difficult to determine the nature of the deposits; however, it is possible that the materials represent weathered bedrock.

8.2 Bedrock Conditions

Bedrock was encountered or inferred beneath the estuarine deposits at depths ranging from about 78 to 141 feet bgs/bml (El. -91 to -137 feet). Note that confirmation samples by coring were only obtained in Borings B-1 and B-3 and bedrock depths in the remaining borings were inferred based on drill action, casing/auger refusal, and professional judgment. The confirmed depth to bedrock in Borings B-1 and B-3 borings was 78.3 and 111 feet bml (El. -120 and -128 feet), respectively. The bedrock observed in core samples recovered from Boring B-1 consisted of dark gray to black argillite or shale. The rock appeared to be moderately metamorphosed and displayed a slight flow texture. Numerous quartz stringers and occasional calcitic inclusions were observed in the core. Rock recovered from Boring B-3 consisted of a dark gray-green quartz-serpentinite. This rock contained numerous calcitic stringers and joint infillings generally appeared calcitic. In general accordance with the rock classification system presented in Figure 5, the rock was generally fresh to slightly weathered, weak to very strong, and displayed close to moderately close jointing. The rock quality designation (RQD) for the bedrock samples taken ranged from 42 to 88 percent and the percent recovery ranged from 72 to 100 percent, indicating that the rock quality across the site is variable.

8.3 Groundwater

Groundwater was encountered during drilling at 8 and 13 feet bgs (8 and 3 feet MLLW) in Borings B-4 and B-5, respectively. These levels are approximately 2 to 3 feet above the approximate tidal elevation (based on NOAA tide predictions) at the time water was encountered during drilling. Due to the granular nature of the soils encountered in our borings, we anticipate that groundwater levels in the project area will be tidally influenced.

9.0 SEISMIC CONDITIONS

As discussed in Sections 4.2 and 4.3, the project site is located in a zone of active seismicity. As such, the most significant geologic hazards at the site, in our opinion, are related to seismic activity and its effects. These effects include seismically induced ground failure (ie. surface rupture, faulting, lateral spreading, liquefaction, and landslides) and tsunami.

It is our opinion that the project and its associated structures should be designed to mitigate the potential damages associated with geologic hazards. In some cases, the geologic hazards represent catastrophic events and it may not be feasible or even possible to design structures that can withstand the effects of such events. However, we believe that if these contingencies are planned for, potential damages may be reduced and design features to minimize risk to human life can be incorporated into the project.

9.1 Site Class and Peak Ground Acceleration

Based on our explorations and engineering judgment, the site class according to the 2009 International Building Code (IBC) will be D for a stiff soil profile based on the blow count (N) method and typical blow counts between 15 and 50 blows per foot. Based on Section 1613.5 of IBC 2009, S_s and S_1 for the Maximum Considered Earthquake were estimated at 0.829g and 0.463g, respectively. The site specific modifying coefficients for the spectral response accelerations are $F_a = 1.17$ and $F_v = 1.54$ for the short and long periods, respectively. The S_{MS} and S_{M1} were calculated to be 0.968g and 0.712g respectively. The computed S_{DS} and S_{D1} are 0.646g and 0.474g.

An assessment of the peak ground acceleration at the site often provides useful general information to the designers of the project. Values of peak ground acceleration (PGA) may be estimated for the project site based upon regional seismicity studies performed by others or from a site-specific seismic analysis. We used methods generally consistent with the 2014 American Society of Civil Engineers (ASCE) *Seismic Design of Piers and Wharves* (ASCE/COPRI 61-14) for estimating the seismic acceleration values. According to the ASCE guidelines, and assuming the structure is assigned a "low" design classification with a level of seismic performance of life safety protection, only the design earthquake (DE), as defined by ASCE 7 (2005), seismic event is considered. ASCE 7 (2005) defines the DE as 2/3 the Maximum Considered Earthquake (MCE) which has a 2 percent probability of exceedance in a 50 years (2,475 year return period). There is a noted ambiguity in ASCE 7 (2005) as to whether liquefaction should be evaluated using the MCE or DE event. Due to this ambiguity, ASCE 7 (2010) and other design codes (IBC 2009) now explicitly require that liquefaction be evaluated for MCE ground motions. Therefore, our analyses were conducted using MCE ground motions adjusted for site effects, as described below.

Ground motions at the site, in the form of PGA and earthquake magnitude, were estimated from probabilistic seismic hazard analyses (PSHA) performed by the USGS (Frankel et al., 1996). The PSHA is a method for estimating ground motions that takes into account uncertainties and randomness in potential earthquake source, size, location, recurrence, and source-to-site attenuation. Values obtained from the PSHA estimate peak ground acceleration on rock (PGA_{rock}). According to this software, the calculated PGA_{rock} for the site is 0.32 times the gravitational coefficient (g). This value is roughly equivalent to what would be calculated using probabilistic estimates of ground motions with a 2 percent probability of exceedance in 50 years (2,475-year return period). Based on the expected average soil conditions at the site, the peak rock ground acceleration obtained was then modified by empirical amplification factor of 1.18, as determined by AASHTO Table 3.10.3.2-1, to obtain a PGA_{soil} of 0.38g. The corresponding earthquake magnitude (M) is M7.9.

9.2 Faulting

In a review of existing geological data we found that the project is located within the Silver Bay segment of the Sitka Fault zone. The Silver Bay segment has a complex history of faulting with mapped exposures in the immediate project area. It is possible that the project lies on or near a fault line; however it is thought that the faults in the Silver Bay Segment (and most of the faults in the region) have not been active since the Tertiary period and studies by others did not indicate displacement of the Silver Bay faults in Holocene soil deposits. Therefore, it is reasonable to conclude that the potential hazard for surface faulting or ground rupture is low within the 50-year design life of the project.

9.3 Tsunamis

Tsunamis are a phenomenon caused by seismic events located in or near submarine environments. The DGGS and the Geophysical Institute of the University of Alaska Fairbanks, in coordination with the Division of Homeland Security and Emergency Management, identified Sitka as a level 2 priority on Alaska's tsunami hazard list. In 2013, the DGGS published the results of tsunami modeling and inundation mapping in *Tsunami Inundation Maps of Sitka, Alaska, Report of Investigations RI 2013-3* (RI 2013-3). According to the report, because of Sitka's geographic location, the city is exposed to potential tsunami waves coming from multiple directions from both near- and far field sources. The 1964 Alaskan earthquake produced the largest recorded tsunami in the history of Sitka with an estimated wave height of 7.8 feet in the Sitka area. According to the inundation map included in RI 2013-3, a maximum inundation of approximately 3 to 6 feet at the GPIP dock site is projected. It is important to note that the intent of the inundation mapping is to provide a guideline for state and local agencies to plan emergency response actions in the event of a major tsunamigenic earthquake. The depths and limits of projected inundation may vary from those included in RI 2013-3.

With its steep-sided fjord coastline and numerous stream delta sediment wedges, Southeast Alaska is also prone to submarine and subaerial landslide generated tsunami. Landslide generated tsunami hazard was discussed in RI 2013-3, but insufficient data and lack of historical tsunamigenic landslides in the Sitka area made it impossible to develop a credible landslide generated tsunami scenario for Sitka.

Based on the history of tsunami in Sitka and its listing as a priority community on Alaska's tsunami hazard list, we believe there is risk for tsunamis at the project area and that development at the site be conducted in accordance with local codes and standards to protect personnel that will operate the new facility. The Alaska Tsunami Warning Center in Palmer, Alaska monitors tsunami activity and issues warnings to the City of Sitka.

9.4 Liquefaction

Liquefaction of loose, saturated, cohesionless soils due to seismic loading has been studied over the past 35 years, resulting in methods based on both laboratory and field procedures to evaluate liquefaction potential. The most widely used methods are empirical, and based on correlations between Standard Penetration Test (SPT) resistance (N-value), peak ground acceleration (PGA), and earthquake magnitude.

We used three methods to conduct a preliminary evaluation of the liquefaction potential at the sites:

- Youd et al. (2001)
- Seed et al. (2003)
- Idriss and Boulanger (2004)

An important factor in evaluating liquefaction potential is the fines content (percent of soil by weight smaller than 0.075 millimeter [mm] or a No. 200 sieve) of the soil deposit. We performed grain size analyses and fines content tests to estimate the fines content of the typical subsurface soils encountered at the site. Where we did not perform laboratory tests, we visually estimated the fines content.

Liquefaction is generally associated with loose, saturated, cohesionless soils. The methods above are specifically intended for cohesionless soils, which are generally granular in nature. However some fine-grained soils exhibit cohesionless or "sand-like" behavior. Soft, cohesive soil layers may be subject to strength loss from ground shaking; however, if they exhibit cohesionless behavior, they could be considered "liquefiable." Seed et al. (2003) and Boulanger and Idriss (2006) provide recommendations to evaluate whether a fine-grained soil is liquefiable. Their recommendations are based on experimental research and liquefaction field case studies.

We analyzed the liquefaction potential at each boring using the ground motion parameters discussed Section 9.1. In our analyses, liquefaction is considered as likely when the factor of safety (FS) against liquefaction is less than 1.0. The analyses show widespread triggering of liquefaction throughout the borings. Of the 102 samples analyzed from below the water table approximately 90 of them may be susceptible to liquefaction under the MCE event. Brief analyses using ground motions associated with higher probability events resulted in similar findings with the majority of samples indicating potential susceptibility to liquefaction. Results of our analyses are plotted in Appendix B, Figures B-1 through B-5 as factor of safety (FS) against liquefaction versus depth.

It should be noted that liquefaction analyses are generally based on SPT blow count correlations and our analyses are based on MPT blow counts. Efforts to correlate MPT and SPT blow counts (by others) have showed that correction factors ranging between 1.1 and 1.5 can be applied to convert MPT to SPT blow counts. These correlations are typically based on clean sands and cohesive, fine-grained soils. Based on the generally gravelly nature of the alluvial soils encountered by our borings, it is our opinion that applying a correction factor to the MPT results is not appropriate. Note that periodic SPT samples were mostly taken in the estuarine (predominantly silty sand) deposits in Borings B-3 and B-4. Penetration resistance in SPT samples taken in this stratum was markedly higher suggesting that the estuarine deposits may be more compact than indicated by MPT penetration resistance values. Based on this comparison and the depth at which this stratum was encountered, the typical estuarine deposits (typically found below approximate Elevation -70 to -90 feet in our borings) may have a greater resistance to liquefaction than indicated by our analyses.

It should also be noted that theoretically, liquefaction could happen at any depth in the soil column, however, empirical evidence suggests that there is a lower bound (in terms of depth below ground surface) that liquefaction occurs regardless of soil conditions. It is thought that at these depths, there is enough overburden and confining pressures on the soil particles to counteract the rapid rise in pore pressure. Historically, the Alaska Department of Transportation has assumed that liquefaction does not occur deeper 60 feet below the ground surface. Other departments of transportation in the United States assume depths ranging between 60 and 120 feet below the ground surface.

9.5 Lateral Spreading and Slope Stability

Typically, lateral spreading occurs in concert with liquefaction and/or slope failures adjacent to a given site. Lateral spreading is a phenomenon that can occur in loose to dense, saturated sandy and/or gravelly soils beneath sloping ground surfaces and on level ground near slopes (i.e. free face) such as submarine slopes, riverbanks or lakes. Lateral spreading results from the softening and weakening of liquefied soil; it differs from flow sliding in that it occurs in soils whose residual strength does not exceed the shear stresses required for static equilibrium. As a result, lateral spreading deformations generally occur during the period of earthquake ground shaking; the deformations develop in an incremental manner. Lateral spreading caused considerable, widespread damage to infrastructure in Central Alaska during the 2002 Denali Fault earthquake.

According to our liquefaction analyses and the subsurface information gathered during our explorations, it is evident that some of the soils within the project area could be prone to liquefaction if subjected to the MCE seismic event. We believe that widespread areas of lateral spreading may occur in the project area, particularly in the near-shore marine environment. Widespread areas of lateral spreading of sloping shoreline or seafloor may occur. Soil displacement magnitudes will vary depending on the intensity and duration of shaking.

The steeply sloped topography surrounding the project area also makes the area prone to terrestrial and submarine landslides and rockfalls. In our opinion, the proposed project is not located within an area likely to be subjected to debris avalanches from terrestrial landslides and the risks associated with such incidents are likely indirect and associated with landslide generated tsunami's; however, there is no historical evidence of landslide generated tsunami in the Sitka Area (RI 2013-3).

10.0 DESIGN CONSIDERATIONS

Design alternatives for the proposed new dock structure generally consist of a pile-supported structure or an anchored or cellular sheetpile bulkhead. Based on our explorations and analyses, the soils at the site are likely susceptible to liquefaction and design of either type of structure will need to accommodate the effects of liquefaction, which may include strength loss in support soils, seismic induced settlements, and lateral spreading. Structure selection should also consider the effects the structure may have on the global stability of local submarine slopes. We recommend developing seismic performance criteria for the proposed new structure that will establish the level of acceptable damage to the facility given various seismic events.

ASCE/COPRI 61-14 provides further guidance regarding design seismic events and structure performance levels.

Based on our analyses, the predominantly granular, alluvial and estuarine sediments below the site may undergo significant strength loss during higher seismic events due to liquefaction. As such, the type of structure used at this site and its design should accommodate these effects to reduce their impacts on the performance of the structure to the extent practicable. For areas that are highly susceptible to liquefaction, deep foundation (pile) supports for dock structures are preferred because support can be gained from bedrock or deeper soils that are not susceptible to liquefaction. It should be noted that driving piles to bedrock may not overcome all effects of lateral spreading or lateral movement as a result of a more significant failure of the nearby submarine slope. However, pile supported structures are favorable under these conditions because of the inherent redundancy built into them (i.e. the dock structure may not suffer total loss if not all piles are damaged or destroyed).

It is our opinion that developing the new structure as some form of earthen fill bulkhead (such as an anchored wall or closed-cell sheet pile structure) is not appropriate at this site. These types of structures impart significant loading on shallow soils and as a results will have a significantly detrimental effect on the global stability of the site and submarine slopes adjacent to the structure. For this reason, a significant amount of reinforcement would be needed to mitigate the effects of liquefaction. Such reinforcement would result in high construction costs and would only be effective in mitigating stability conditions within the immediate vicinity of the structure. An earthen fill structure would contribute to the instability of the marginally stable submarine slopes to the south of the structure and would be highly susceptible to damage and potential total loss during the design seismic event. N.B.

11.0 CLOSURE/LIMITATIONS

This report was prepared for the exclusive use of our client and their representatives for evaluating the site as it relates to the geotechnical aspects discussed herein. The conclusions contained in this report are based on information provided from the observed site conditions and other conditions described herein. The conclusions contained in this report are also based on site conditions as they presently exist. It is assumed that the exploratory borings are representative of the subsurface conditions throughout the site, i.e., the subsurface conditions everywhere are not significantly different from those disclosed by the explorations.

If subsurface conditions are found to be different from those encountered in these explorations are observed or appear to be present, Shannon & Wilson, Inc. should be advised at once so that these conditions can be reviewed and our conclusions can be reconsidered where necessary. If there is a substantial lapse of time between the submittal of this report and the start of work at the site, or if conditions have changed due to natural causes or construction operations at or adjacent to the site, it is recommended that this report be reviewed to determine the applicability of the conclusions considering the changed conditions and time lapse.

Unanticipated soil conditions are commonly encountered and cannot fully be determined by merely taking soil samples or advancing borings. Such unexpected conditions frequently require that additional expenditures be made to attain a properly constructed project. Therefore, some contingency fund is recommended to accommodate such potential extra costs. Shannon & Wilson has prepared the attachments in Appendix C *Important Information About Your Geotechnical/Environmental Report* to assist you and others in understanding the use and limitations of the reports.

Copies of documents that may be relied upon by our client are limited to the printed copies (also known as hard copies) that are signed or sealed by Shannon & Wilson with a wet, blue ink signature. Files provided in electronic media format are furnished solely for the convenience of the client. Any conclusion or information obtained or derived from such electronic files shall be at the user's sole risk. If there is a discrepancy between the electronic files and the hard copies, or you question the authenticity of the report please contact the undersigned.

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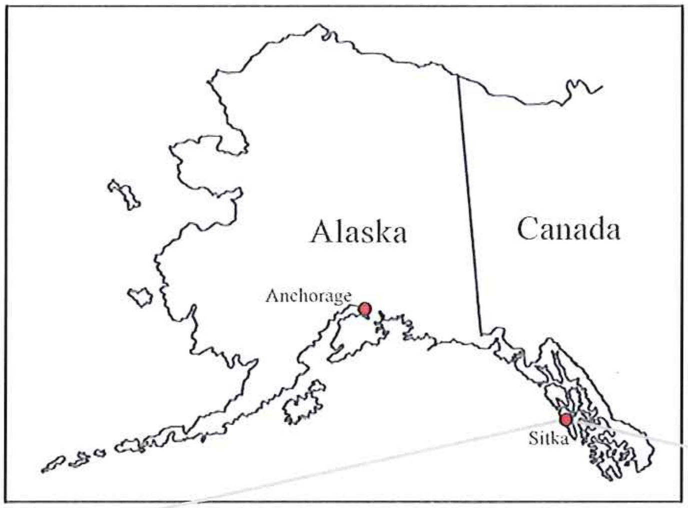

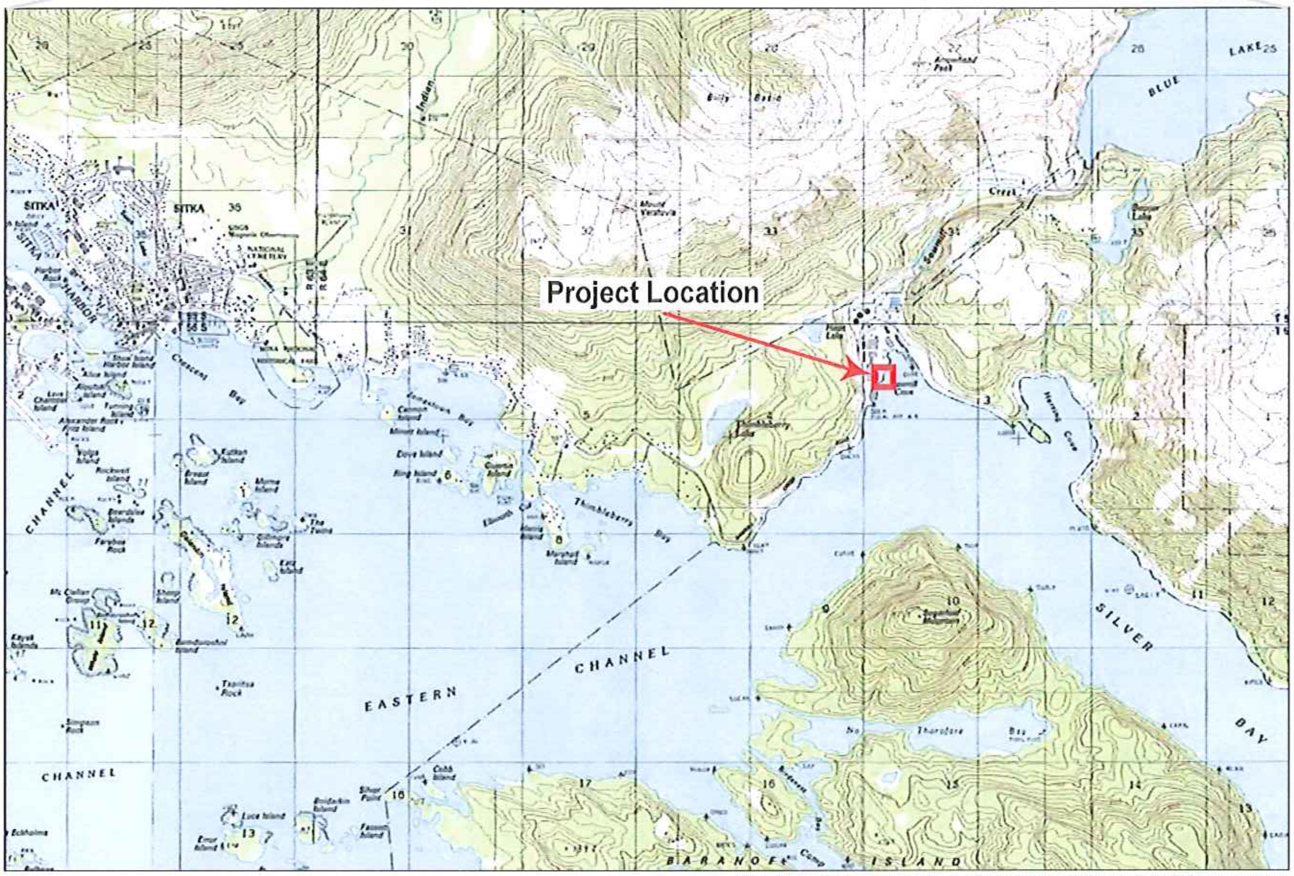

Map adapted from All Topo Maps, USGS Sitka A-4 SW & A-5 SE 25K Quadrangles

N

0 0.5 1 2

APPROXIMATE SCALE IN MILES

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Multi-Use Dock
Sawmill Cove, Sitka, Alaska

VICINITY MAP

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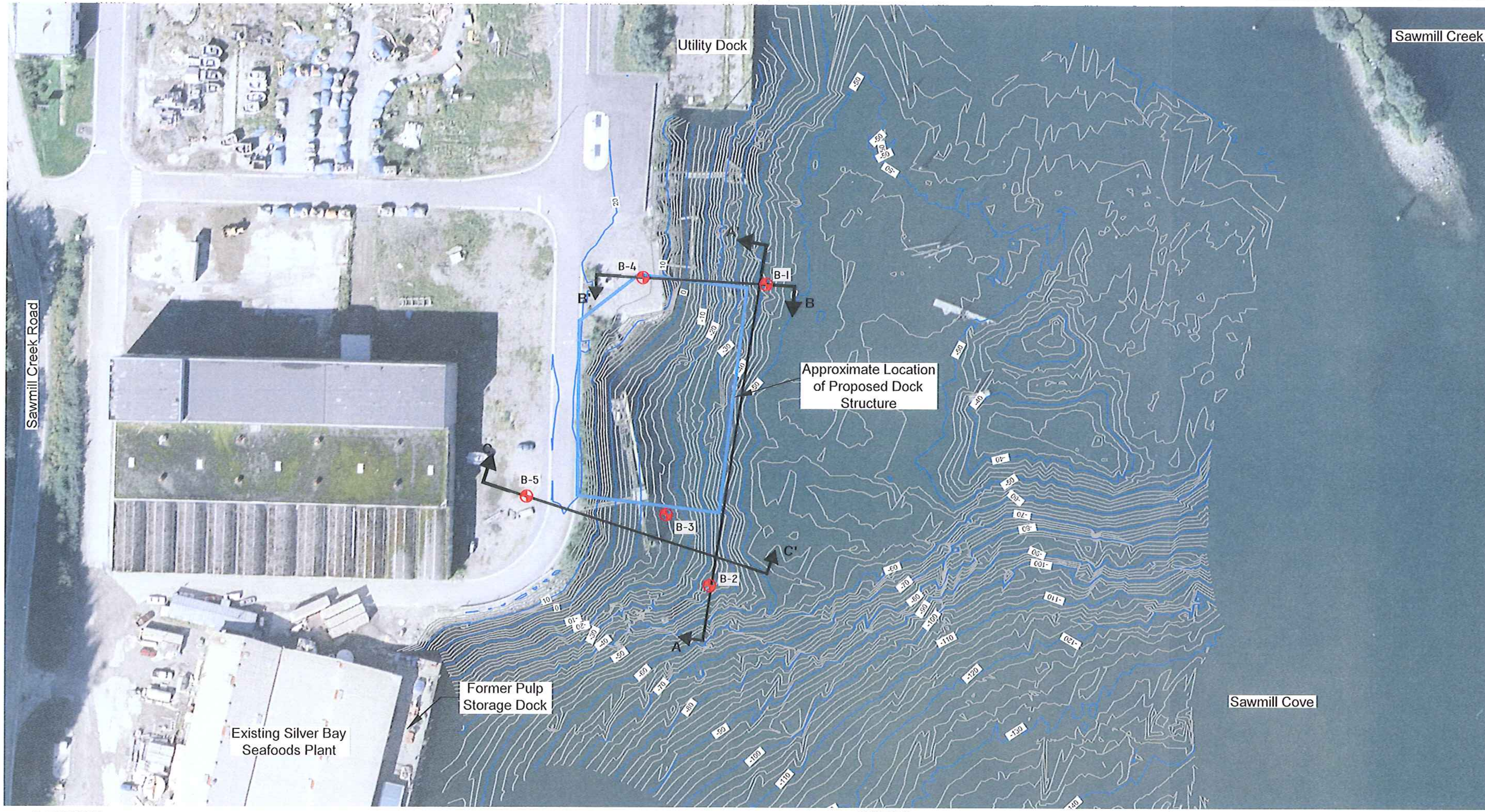
FIG. 1



LEGEND

B-I Approximate Location of Boring B-1, Advanced by Shannon & Wilson, June 2014.

Topographic/Bathymetric Contours (Feet MLLW) - 2 Foot Interval

A — A' Generalized Subsurface Profile A - A' (See Figures 4 and 5)

N

0 50 100 200
APPROXIMATE SCALE IN FEET

NOTES

1. Topography / Bathymetry provided by City & Borough of Sitka based on May 2014 survey by DOWL HKM.
2. Basemap imagery provided by City & Borough of Sitka.
3. Proposed dock outline adapted from drawings provided in Moffatt & Nichol's June 13, 2014 *Sawmill Cove Industrial Park Dock, Alternative Analysis Report (DRAFT).*

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SITE PLAN

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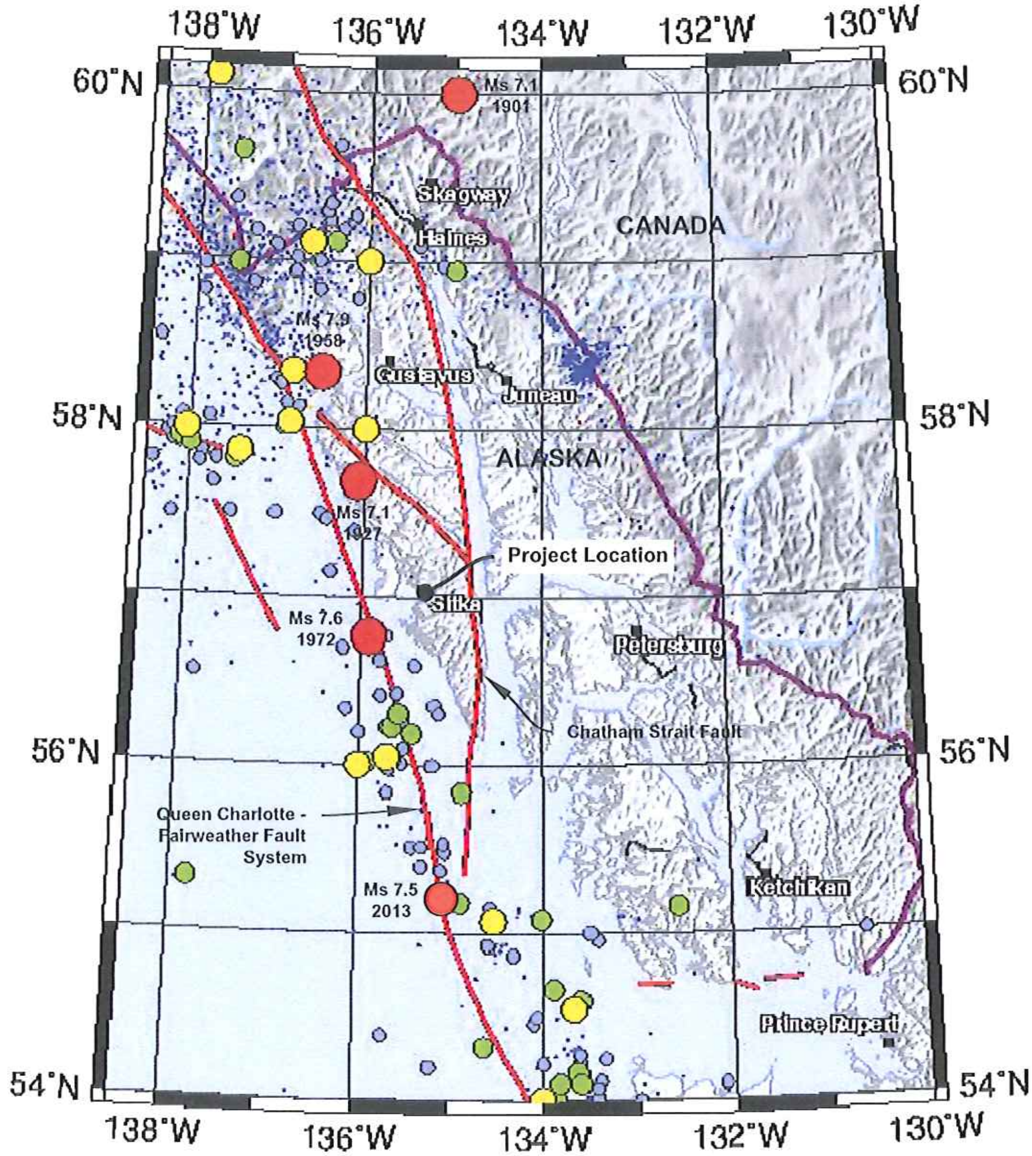
FIG. 2

Alaska Panhandle Seismicity

1899 to December 2004

(Adapted from Alaska Earthquake Information Center.
www.aeic.alaska.edu)



LEGEND

- 7.0<=Ms<8.0
- 6.0<=Ms<7.0
- 5.0<=Ms<6.0
- 4.0<=Ms<5.0
- Ms / Year
- Fault (approx.)

Ms = Moment Magnitude

Note: Major earthquakes (greater than Ms 6.0) occurring after 2004 were added to the map based on locations approximated from event-specific maps by AEIC. Small dots indicate background seismicity.

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HISTORICAL SEISMICITY

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FIG. 3

LEGEND

B-1 — Approximate Location of Boring B-1, Advanced by Shannon & Wilson, June 2014.

S3: 32% Gr, 56% Sa, 12% Fi — Sample S3 laboratory testing results indicating 32 percent gravel, 56 percent sand, and 12 percent fines (silt and clay) by weight.

4 — MPT/SPT Values (blows per foot) at approximate sample depth.

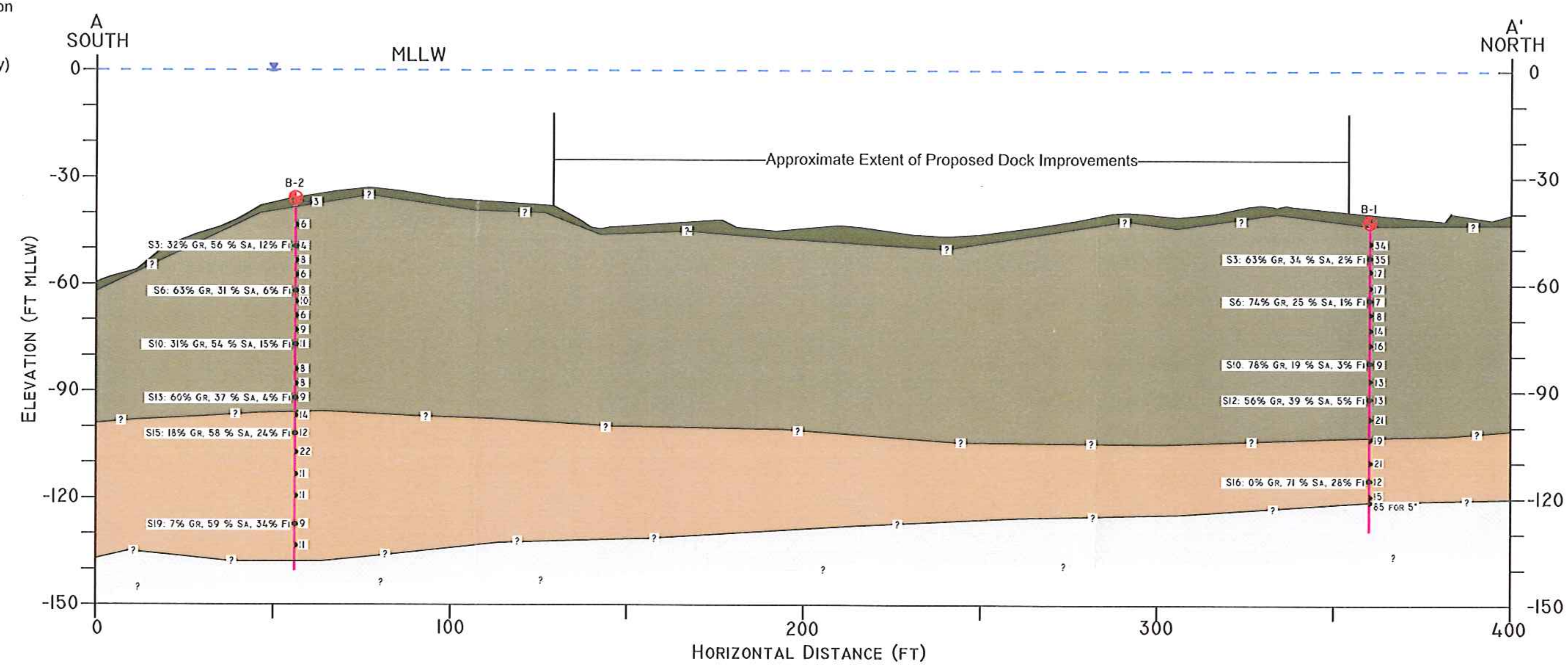
Approximate water level as estimated during drilling.

OCEAN FLOOR - Typically Silty Sand containing various amounts of organics (wood).

ALLUVIAL - Typically Gravel containing varying amounts of Sand, generally <10% fines.

ESTUARINE - Silty Sand with trace amounts of Gravel and various amounts of organics content. Exhibits strong organic odor.

BEDROCK - Fresh to slightly weathered Shale and Serpentinite.



0 20 40 80

APPROXIMATE SCALE IN FEET

NOTES

1. Profile taken along the A - A' line as shown on the Site Plan, Figure 2.
2. Stratigraphy interpreted from observations made during drilling (see Appendix A for graphical logs).
3. Soil contacts on profile between boring locations are interpreted from our understanding of local conditions and should be considered approximate.
4. Borings shown above may not lie exactly on profile line shown on Figure 2. Subsurface conditions in some areas may be projected from borings near the profile line.
5. Proposed site configuration adapted from conceptual drawings provided by the Moffatt & Nichol.
6. Ground surface profile based topographic/bathymetric contours provided by DOWL HKM.

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GENERALIZED SUBSURFACE PROFILE A-A'

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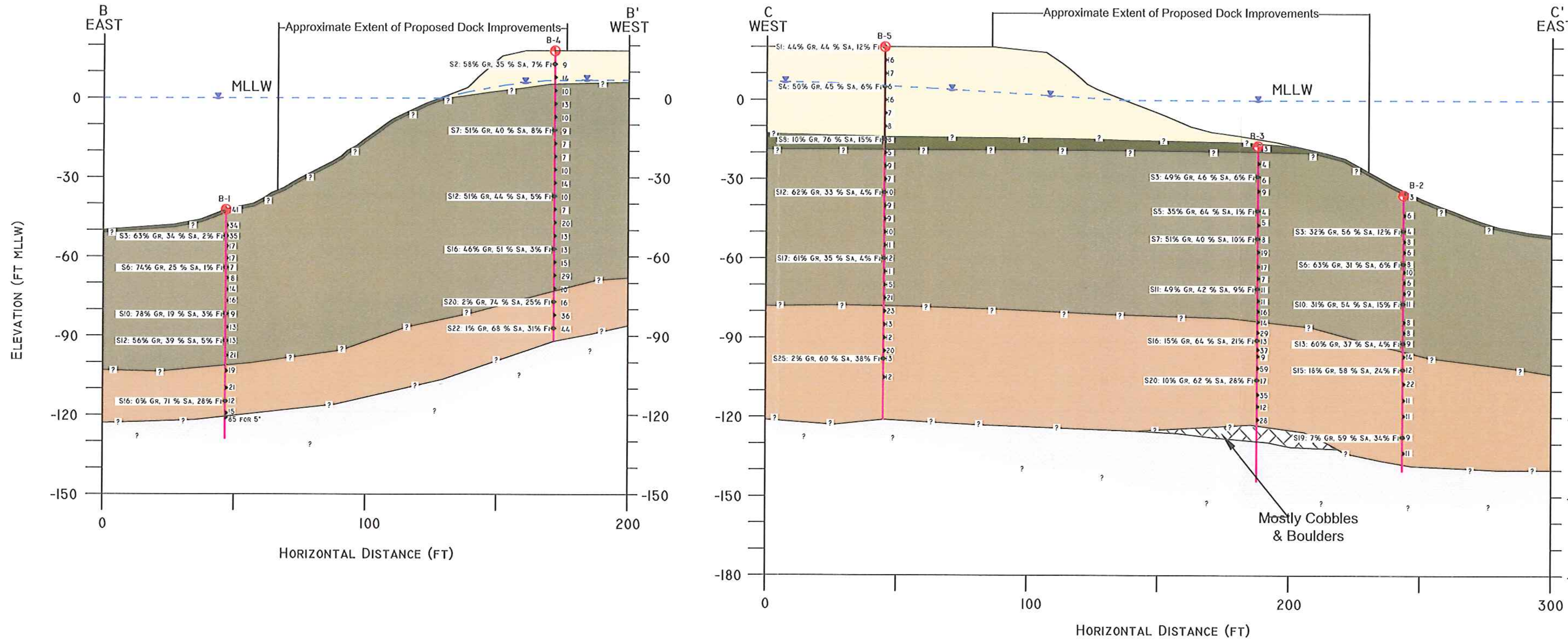
FIG. 4



LEGEND

B-1 — Approximate Location of Boring B-1, Advanced by Shannon & Wilson, June 2014.

S3: 32% GR, 56% SA, 12% FI — Sample S3 laboratory testing results indicating 32 percent gravel, 56 percent sand, and 12 percent fines (silt and clay) by weight.

24 — MPT/SPT Values (blows per foot) at approximate sample depth.

Approximate water level as estimated during drilling.

FILL - Sand and Gravel, typically containing <10% fines..

OCEAN FLOOR -Typically Silty Sand containing various amounts of organics (wood).

ALLUVIAL - Typically Gravel containing varying amounts of Sand, generally <10% fines.

ESTUARINE - Silty Sand with trace amounts of Gravel and various amounts of organics content. Exhibits strong organic odor.

BEDROCK - Fresh to slightly weathered Shale and Serpentinite.

0 20 40 80
APPROXIMATE SCALE IN FEET

NOTES

1. Profile taken along the B - B' and C - C' line as shown on the Site Plan, Figure 2.
2. Stratigraphy interpreted from observations made during drilling (see Appendix A for graphical logs).
3. Soil contacts on profile between boring locations are interpreted from our understanding of local conditions and should be considered approximate.
4. Borings shown above may not lie exactly on profile line shown on Figure 2. Subsurface conditions in some areas may be projected from borings near the profile line.
5. Proposed site configuration adapted from conceptual drawings provided by the Moffatt & Nichol.
6. Ground surface profile based topographic/bathymetric contours provided by DOWL HKM.

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Sawmill Cove, Sitka, Alaska

GENERALIZED SUBSURFACE PROFILES B-B' AND C-C'

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FIG. 5

APPENDIX A

BORING LOGS AND GEOTECHNICAL LABORATORY TEST RESULTS

FIGURES

Shannon & Wilson, Inc. (S&W), uses a soil identification system modified from the Unified Soil Classification System (USCS). Elements of the USCS and other definitions are provided on this and the following pages. Soil descriptions are based on visual-manual procedures (ASTM D2488) and laboratory testing procedures (ASTM D2487), if performed.

S&W INORGANIC SOIL CONSTITUENT DEFINITIONS

CONSTITUENT[2]	FINE-GRAINED SOILS (50% or more fines)[1]	COARSE-GRAINED SOILS (less than 50% fines)[1]
Major	***Silt, Lean Clay, Elastic Silt,*** or ***Fat Clay***[3]	***Sand*** or ***Gravel***[4]
Modifying (Secondary) Precedes major constituent	30% or more coarse-grained: ***Sandy*** or ***Gravelly***[4]	More than 12% fine-grained: ***Silty*** or ***Clayey***[3]
Minor Follows major constituent	15% to 30% coarse-grained: ***with Sand*** or ***with Gravel***[4]	5% to 12% fine-grained: ***with Silt*** or ***with Clay***[3]
	30% or more total coarse-grained *and* lesser coarse-grained constituent is 15% or more: ***with Sand*** or ***with Gravel***[5]	15% or more of a second coarse-grained constituent: ***with Sand*** or ***with Gravel***[5]

[1]All percentages are by weight of total specimen passing a 3-inch sieve.
[2]The order of terms is: *Modifying Major with Minor.*
[3]Determined based on behavior.
[4]Determined based on which constituent comprises a larger percentage.
[5]Whichever is the lesser constituent.

MOISTURE CONTENT TERMS

Dry	Absence of moisture, dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water, from below water table

STANDARD PENETRATION TEST (SPT) SPECIFICATIONS

Hammer:	140 pounds with a 30-inch free fall. Rope on 6- to 10-inch-diam. cathead 2-1/4 rope turns, > 100 rpm NOTE: If automatic hammers are used, blow counts shown on boring logs should be adjusted to account for efficiency of hammer.
Sampler:	10 to 30 inches long Shoe I.D. = 1.375 inches Barrel I.D. = 1.5 inches Barrel O.D. = 2 inches
N-Value:	Sum blow counts for second and third 6-inch increments. Refusal: 50 blows for 6 inches or less; 10 blows for 0 inches.

NOTE: Penetration resistances (N-values) shown on boring logs are as recorded in the field and have not been corrected for hammer efficiency, overburden, or other factors.

PARTICLE SIZE DEFINITIONS

DESCRIPTION	SIEVE NUMBER AND/OR APPROXIMATE SIZE
FINES	< #200 (0.075 mm = 0.003 in.)
SAND	
Fine	#200 to #40 (0.075 to 0.4 mm; 0.003 to 0.02 in.)
Medium	#40 to #10 (0.4 to 2 mm; 0.02 to 0.08 in.)
Coarse	#10 to #4 (2 to 4.75 mm; 0.08 to 0.187 in.)
GRAVEL	
Fine	#4 to 3/4 in. (4.75 to 19 mm; 0.187 to 0.75 in.)
Coarse	3/4 to 3 in. (19 to 76 mm)
COBBLES	3 to 12 in. (76 to 305 mm)
BOULDERS	> 12 in. (305 mm)

RELATIVE DENSITY / CONSISTENCY

COHESIONLESS SOILS		COHESIVE SOILS	
N, SPT, BLOWS/FT.	RELATIVE DENSITY	N, SPT, BLOWS/FT.	RELATIVE CONSISTENCY
< 4	Very loose	< 2	Very soft
4 - 10	Loose	2 - 4	Soft
10 - 30	Medium dense	4 - 8	Medium stiff
30 - 50	Dense	8 - 15	Stiff
> 50	Very dense	15 - 30	Very stiff
		> 30	Hard

WELL AND BACKFILL SYMBOLS

Bentonite Cement Grout	Surface Cement Seal
Bentonite Grout	Asphalt or Cap
Bentonite Chips	Slough
Silica Sand	Inclinometer or Non-perforated Casing
Perforated or Screened Casing	Vibrating Wire Piezometer

PERCENTAGES TERMS [1, 2]

Trace	< 5%
Few	5 to 10%
Little	15 to 25%
Some	30 to 45%
Mostly	50 to 100%

[1]Gravel, sand, and fines estimated by mass. Other constituents, such as organics, cobbles, and boulders, estimated by volume.

[2]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

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SOIL DESCRIPTION AND LOG KEY

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FIG. A-1
Sheet 1 of 3

UNIFIED SOIL CLASSIFICATION SYSTEM (USCS)
(Modified From USACE Tech Memo 3-357, ASTM D2487, and ASTM D2488)

MAJOR DIVISIONS			GROUP/GRAPHIC SYMBOL	TYPICAL IDENTIFICATIONS
COARSE-GRAINED SOILS *(more than 50% retained on No. 200 sieve)*	Gravels *(more than 50% of coarse fraction retained on No. 4 sieve)*	Gravel *(less than 5% fines)*	GW	Well-Graded Gravel; Well-Graded Gravel with Sand
			GP	Poorly Graded Gravel; Poorly Graded Gravel with Sand
		Silty or Clayey Gravel *(more than 12% fines)*	GM	Silty Gravel; Silty Gravel with Sand
			GC	Clayey Gravel; Clayey Gravel with Sand
	Sands *(50% or more of coarse fraction passes the No. 4 sieve)*	Sand *(less than 5% fines)*	SW	Well-Graded Sand; Well-Graded Sand with Gravel
			SP	Poorly Graded Sand; Poorly Graded Sand with Gravel
		Silty or Clayey Sand *(more than 12% fines)*	SM	Silty Sand; Silty Sand with Gravel
			SC	Clayey Sand; Clayey Sand with Gravel
FINE-GRAINED SOILS *(50% or more passes the No. 200 sieve)*	Silts and Clays *(liquid limit less than 50)*	Inorganic	ML	Silt; Silt with Sand or Gravel; Sandy or Gravelly Silt
			CL	Lean Clay; Lean Clay with Sand or Gravel; Sandy or Gravelly Lean Clay
		Organic	OL	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
	Silts and Clays *(liquid limit 50 or more)*	Inorganic	MH	Elastic Silt; Elastic Silt with Sand or Gravel; Sandy or Gravelly Elastic Silt
			CH	Fat Clay; Fat Clay with Sand or Gravel; Sandy or Gravelly Fat Clay
		Organic	OH	Organic Silt or Clay; Organic Silt or Clay with Sand or Gravel; Sandy or Gravelly Organic Silt or Clay
HIGHLY-ORGANIC SOILS	Primarily organic matter, dark in color, and organic odor		PT	Peat or other highly organic soils (see ASTM D4427)

NOTE: No. 4 size = 4.75 mm = 0.187 in.; No. 200 size = 0.075 mm = 0.003 in.

NOTES

1. Dual symbols *(symbols separated by a hyphen, i.e., SP-SM, Sand with Silt)* are used for soils with between 5% and 12% fines or when the liquid limit and plasticity index values plot in the CL-ML area of the plasticity chart. Graphics shown on the logs for these soil types are a combination of the two graphic symbols (e.g., SP and SM).

2. Borderline symbols *(symbols separated by a slash, i.e., CL/ML, Lean Clay to Silt; SP-SM/SM, Sand with Silt to Silty Sand)* indicate that the soil properties are close to the defining boundary between two groups.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

SOIL DESCRIPTION AND LOG KEY

September 2014 | 32-1-02389

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-1
Sheet 2 of 3

2013 BORING CLASS2 02389 GINT.GPJ SWNEW.GDT 9/18/14

GRADATION TERMS

Poorly Graded	Narrow range of grain sizes present or, within the range of grain sizes present, one or more sizes are missing (Gap Graded). Meets criteria in ASTM D2487, if tested.
Well-Graded	Full range and even distribution of grain sizes present. Meets criteria in ASTM D2487, if tested.

CEMENTATION TERMS[1]

Weak	Crumbles or breaks with handling or slight finger pressure
Moderate	Crumbles or breaks with considerable finger pressure
Strong	Will not crumble or break with finger pressure

PLASTICITY[2]

DESCRIPTION	VISUAL-MANUAL CRITERIA	APPROX. PLASITICTY INDEX RANGE
Nonplastic	A 1/8-in. thread cannot be rolled at any water content.	< 4
Low	A thread can barely be rolled and a lump cannot be formed when drier than the plastic limit.	4 to 10
Medium	A thread is easy to roll and not much time is required to reach the plastic limit. The thread cannot be rerolled after reaching the plastic limit. A lump crumbles when drier than the plastic limit.	10 to 20
High	It take considerable time rolling and kneading to reach the plastic limit. A thread can be rerolled several times after reaching the plastic limit. A lump can be formed without crumbling when drier than the plastic limit.	> 20

ADDITIONAL TERMS

Mottled	Irregular patches of different colors.
Bioturbated	Soil disturbance or mixing by plants or animals.
Diamict	Nonsorted sediment; sand and gravel in silt and/or clay matrix.
Cuttings	Material brought to surface by drilling.
Slough	Material that caved from sides of borehole.
Sheared	Disturbed texture, mix of strengths.

PARTICLE ANGULARITY AND SHAPE TERMS[1]

Angular	Sharp edges and unpolished planar surfaces.
Subangular	Similar to angular, but with rounded edges.
Subrounded	Nearly planar sides with well-rounded edges.
Rounded	Smoothly curved sides with no edges.
Flat	Width/thickness ratio > 3.
Elongated	Length/width ratio > 3.

[1]Reprinted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.
[2]Adapted, with permission, from ASTM D2488 - 09a Standard Practice for Description and Identification of Soils (Visual-Manual Procedure), copyright ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428. A copy of the complete standard may be obtained from ASTM International, www.astm.org.

ACRONYMS AND ABBREVIATIONS

ATD	At Time of Drilling
Diam.	Diameter
Elev.	Elevation
ft.	Feet
FeO	Iron Oxide
gal.	Gallons
Horiz.	Horizontal
HSA	Hollow Stem Auger
I.D.	Inside Diameter
in.	Inches
lbs.	Pounds
MgO	Magnesium Oxide
mm	Millimeter
MnO	Manganese Oxide
NA	Not Applicable or Not Available
NP	Nonplastic
O.D.	Outside Diameter
OW	Observation Well
pcf	Pounds per Cubic Foot
PID	Photo-Ionization Detector
PMT	Pressuremeter Test
ppm	Parts per Million
psi	Pounds per Square Inch
PVC	Polyvinyl Chloride
rpm	Rotations per Minute
SPT	Standard Penetration Test
USCS	Unified Soil Classification System
q_u	Unconfined Compressive Strength
VWP	Vibrating Wire Piezometer
Vert.	Vertical
WOH	Weight of Hammer
WOR	Weight of Rods
Wt.	Weight

STRUCTURE TERMS[1]

Interbedded	Alternating layers of varying material or color with layers at least 1/4-inch thick; singular: bed.
Laminated	Alternating layers of varying material or color with layers less than 1/4-inch thick; singular: lamination.
Fissured	Breaks along definite planes or fractures with little resistance.
Slickensided	Fracture planes appear polished or glossy; sometimes striated.
Blocky	Cohesive soil that can be broken down into small angular lumps that resist further breakdown.
Lensed	Inclusion of small pockets of different soils, such as small lenses of sand scattered through a mass of clay.
Homogeneous	Same color and appearance throughout.

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FIG. A-1
Sheet 3 of 3

2013 BORING CLASS3 02389 GINT.GPJ SWNEW.GDT 9/18/14

Federal Highway Administration (FHWA) Generalized Rock Classification System:

1. **Rock Type:**
   Written descriptions of rock types in geological or engineering logs, as described below, present a uniform approach, allowing continuity of description from location to location, and project to project. The following standard sequence of systematic description is used on the boring logs.

   Weathered state, structure, color, grain size, rock material strength, ROCK TYPE

2. **Weathering:**
   The following terminology was used to describe degrees of weathering. These descriptions refer primarily to chemical weathering which results in discoloration of the rock and leads to eventual descomposition of silicates to clay mineral. Some minerals, notably quartz, resist this action and may survive unchanged.

Term	Description	Grade
Fresh	No visible sign of rock material weathering; perhaps slight discoloration on major discontinuity surfaces.	I
Slightly Weathered	Discoloration indicates weathering of rock material and discontinuity surfaces. All the rock material may be discolored by weathering and may be somewhat weaker externally than in its fresh condition.	II
Moderately Weathered	Less than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or discolored rock is present either as a continuous framework or as corestones.	III
Highly Weathered	More than half of the rock material is decomposed and/or disintegrated to a soil. Fresh or disolored rock is present either as a discontinuous framework or as corestones	IV
Completely Weathered	All rock material is decomposed and/or disintegrated to a soil. The original mass structure is still largely intact.	V
Residual Soil	All rock material is converted to soil. The mass structure and material fabric are destroyed. There is a large change in volume, but the soil has not been significantly transported.	VI

3. **Strength:**
   The rock strength classifications are referenced to simple field hardness tests shown below.

Grade	Description	Field Identification	Approx. Range of Uniaxial Compressive Strength (psi)
R0	Extremely Weak Rock	Indented by thumbnail.	50 - 150
R1	Very Weak Rock	Crumbles under fim blows with point of geological hammer, can be peeled by a pocket knife.	150 - 750
R2	Weak Rock	Can be peeled by a pocket knife with difficulty, shallow indentation made by firm blow with point of geologic hammer.	750 - 3,500
R3	Medium Strong Rock	Cannot be scraped or peeled with a pocket knife, specimen can be fractured with single firm blow of geological hammer.	3,500 - 7,500
R4	Strong Rock	Specimen requires more than one blow of geological hammer to fracture it.	7,500 - 15,000
R5	Very Strong Rock	Specimen requires many blows of a geological hammer to fracture it.	15,000 - 35,000
R6	Extremely Strong Rock	Speciman can only be chipped with geological hammer.	> 35,000

4. **Core Recovery:**
   Core recovery is determined as the ratio of core recovered to the total drilled run length expressed as a percentage; the value may be recorded on a run by run basis, or over a normalized core length. The recovery percent is plotted in order to highlight weaker zones or core. From the point of view of most geotechnical drilling, it is the core that is the most difficult to recover which will indicate most clearly the weakest parts of the rock fabric, and is usually the most important to design.

5. **Rock Quality Designation (RQD):**
   RQD defines the fraction of solid core recovered greater than 100 millimeters in length as the Rock Quality Designation. It is calculated as the ratio of the sum of the length of core fragments longer than 4 inches to the total drilled footage per run, expressed as a percentage. The core is measured along the centerline from fracture to fracture. Cores containing discontinuities parallel to the core axis should be given an RQD of zero.

   RQD may be used to classify the rock mass as follows:

RQD	Rock Classification
0% - 25%	Very Poor
25% - 50%	Poor
50% - 75%	Fair
75% - 90%	Good
90% - 100%	Excellent

Gary Paxton Industrial Park
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FHWA ROCK CLASSIFICATION SYSTEM

September 2014 | 32-1-02389

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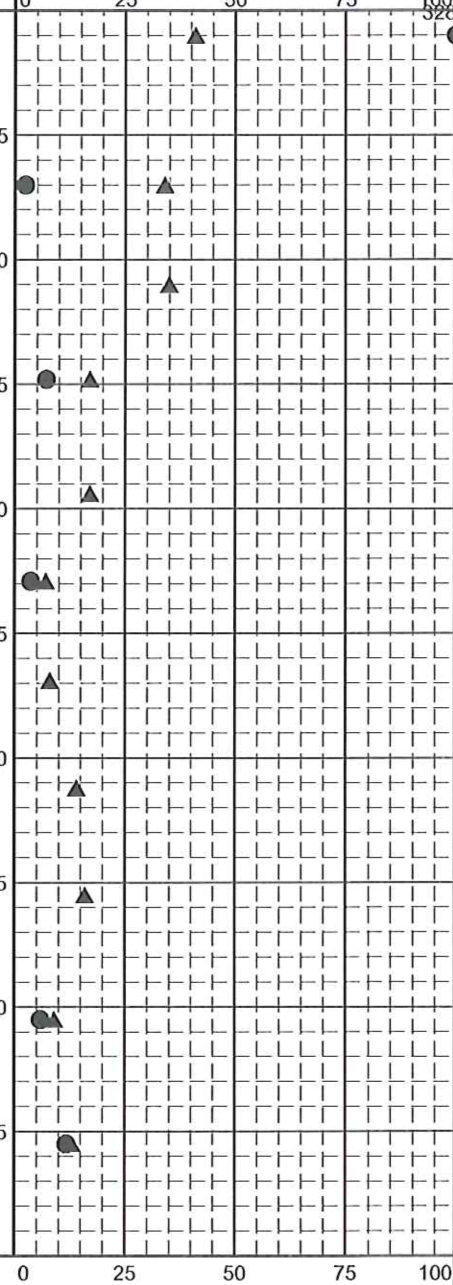
FIG. A-2

MATERIAL DESCRIPTION Approx. Elevation: -42 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Medium dense, dark brown, *Sandy Silt (ML)*; wet; some wood chips	1.0		S1	6/12/2014 ▽	
Loose to medium dense, dark gray, *Well-Graded Gravel with Sand (GW) to Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; trace cobbles; trace shells and organics (wood and roots)					5
			S2		
S3: 63% Gravel, 34% Sand, 2% Fines			S3		10
			S4		15
			S5 *		20
S6: 74% Gravel, 25% Sand, 1% Fines			S6		25
			S7		30
			S8		35
			S9		40
S10: 78% Gravel, 19% Sand, 3% Fines			S10		45
			S11		

CONTINUED NEXT PAGE

Penetration Resistance
(2-inch split-spoon, 140 lb. weight, 30" drop)
(3-inch split-spoon, 340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ▽ Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-1

September 2014 — 32-1-02389

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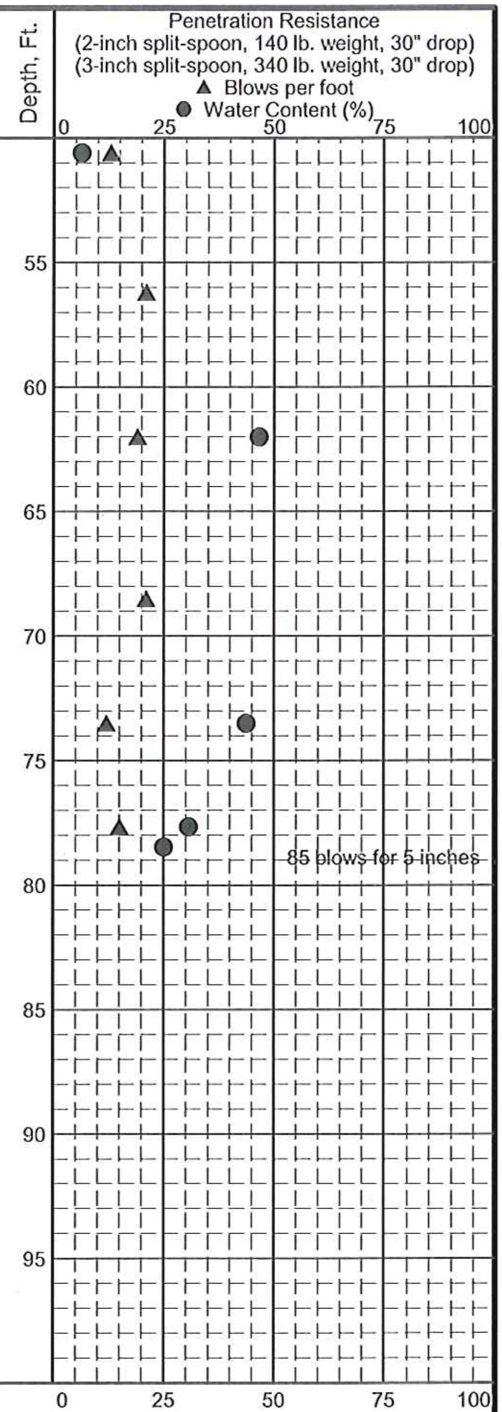
FIG. A-3
Sheet 1 of 2

MATERIAL DESCRIPTION Approx. Elevation: -42 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water
Loose to medium dense, dark gray, *Well-Graded Gravel with Sand (GW) to Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; trace cobbles; trace shells and organics (wood and roots) S12: 56% Gravel, 39% Sand, 5% Fines			S12 S13	
Medium dense, gray, *Poorly Graded Sand with Silt (SP-SM)*; wet; interbedded with silty sand in 1/2-inch to 4-inch layers; trace shells, few organics (mostly wood); strong organic/sulfur odor	59.0		S14	
Medium dense, gray to gray-brown, *Silty Sand (SM)*; wet; interbedded with 1/4-inch to 1-inch silt layers greater than 2 inches apart; trace to few organics (wood and peat); organic/sulfur odor S16: 0% Gravel, 71% Sand, 28% Fines	65.0		S15 * S16 S17A	
Shale/Argillite; black, low to medium strength, fresh to slightly weathered, occasional quartz veins S19: REC = 50%, RQD = 0% S20: REC = 91%, RQD = 61%	78.3		S17B S18 S19 S20	
Bottom of Boring Boring Completed 6/12/2014	86.7			



LEGEND

* Sample Not Recovered
Grab Sample
3" O.D. Split Spoon Sample
2" O.D. Split Spoon Sample
Rock Core Sample
∇ Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Sawmill Cove, Sitka, Alaska

LOG OF BORING B-1

September 2014 32-1-02389

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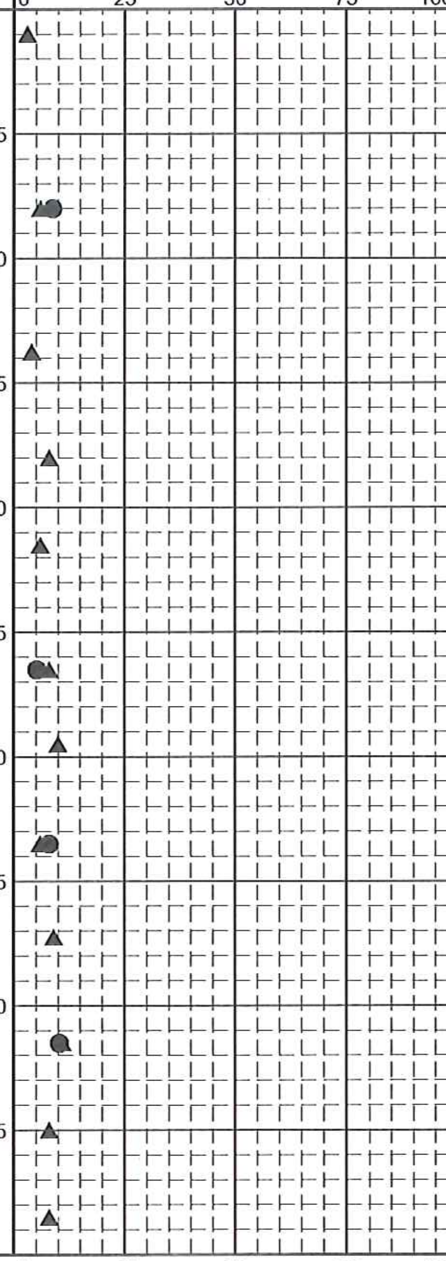
FIG. A-3
Sheet 2 of 2

MATERIAL DESCRIPTION Approx. Elevation: -35 Ft. MLLW	Depth, Ft.	Samples	Ground Water
Very loose to loose, gray, *Well and Poorly Graded Gravel with Sand (GP/GW)*; wet		S1 * S2	∇ 6/13/2014
Loose, gray, *Well-Graded Sand with Silt and Gravel (SW-SM)*; wet; trace shells and wood; moderate organic odor S3: 32% Gravel, 56% Sand, 12% Fines	10.0	S3	
Loose to medium dense, dark gray, *Poorly Graded Gravel with Silt and Sand (GP-GM)* to *Poorly Graded Gravel with Sand (GP)*; wet; trace cobbles; trace wood and shells; strong sulfur odor to 20 feet bgs S6: 63% Gravel, 31% Sand, 6% Fines	15.0	S4 S5 S6 S7 S8 S9 *	
Medium dense, gray, *Silty Sand with Gravel (SM)*; wet S10: 31% Gravel, 54% Sand, 15% Fines	40.0	S10	
Loose to medium dense, *Well- and Poorly Graded Gravel with Sand (GW/GP)*; wet; trace wood; gravel content decreases with depth	43.0	S11 * S12	

CONTINUED NEXT PAGE

Penetration Resistance
(2-inch split-spoon, 140 lb. weight, 30" drop)
(3-inch split-spoon, 340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

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Sawmill Cove, Sitka, Alaska

LOG OF BORING B-2

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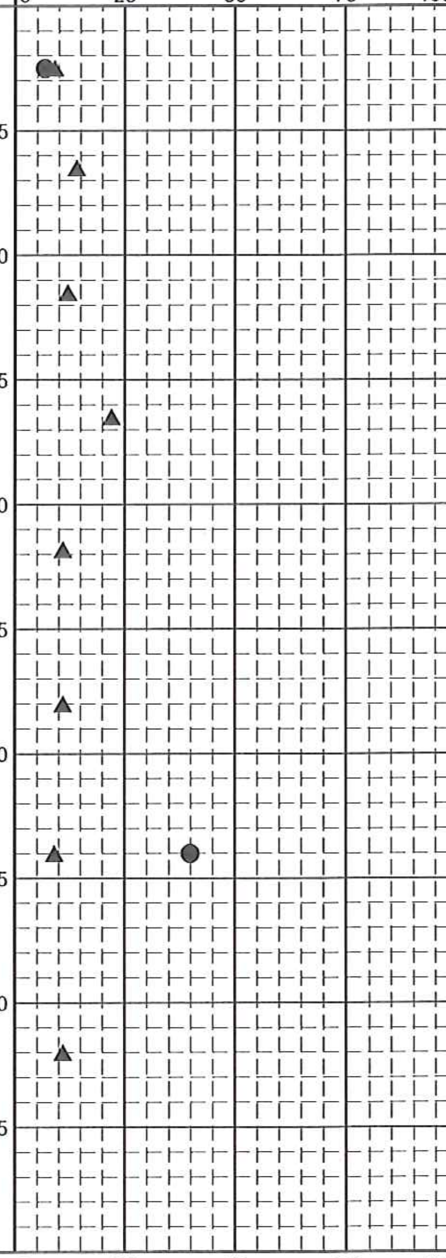
FIG. A-4
Sheet 1 of 3

MATERIAL DESCRIPTION Approx. Elevation: -35 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Loose to medium dense, *Well- and Poorly Graded Gravel with Sand (GW/GP)*; wet; trace wood; gravel content decreases with depth					
S13: 60% Gravel, 37% Sand, 4% Fines			S13		55
			S14		
	60.0				60
S15: 18% Gravel, 58% Sand, 24% Fines			S15		
Loose to medium dense, gray to gray-brown, *Silty Sand (SM)*; wet; interbedded with occasional lenses of *Silty Sand with Gravel (SM)* and *Poorly Graded Silt with Sand (SP-SM)*; trace shells and organics; sulfur odor					65
			S16 *		
					70
			S17		
					75
			S18		
					80
S19: 7% Gravel, 59% Sand, 34% Fines			S19		
					85
					90
			S20		
	95.0				95
Medium dense, gray, *Well-Graded Sand with Gravel (SW)*; wet; trace organics and shells			S21		

Penetration Resistance
(2-inch split-spoon, 140 lb. weight, 30" drop)
(3-inch split-spoon, 340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



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LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Sawmill Cove, Sitka, Alaska

LOG OF BORING B-2

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FIG. A-4
Sheet 2 of 3

MATERIAL DESCRIPTION Approx. Elevation: -35 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.	Penetration Resistance (2-inch split-spoon, 140 lb. weight, 30" drop) (3-inch split-spoon, 340 lb. weight, 30" drop) ▲ Blows per foot ● Water Content (%) 0 25 50 75 100
Medium dense, gray, *Well-Graded Sand with Gravel (SW)*; wet; trace organics and shells	102.0					
Weathered Bedrock (inferred by cuttings and drill action)	104.5				105	
Bottom of Boring Boring Completed 6/13/2014					110 115 120 125 130 135 140 145	

0 25 50 75 100

LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

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Sawmill Cove, Sitka, Alaska

LOG OF BORING B-2

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FIG. A-4
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GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: -17 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Very loose, gray-brown, *Silty Sand (SM)*; wet; trace cobbles; few to little organics			S1	6/14/2014 ∇	
Loose, gray, *Well-Graded Gravel with Silt and Sand (GW-GM)*; wet	3.0				5
			S2		
					10
S3: 49% Gravel, 46% Sand, 6% Fines			S3		
Loose, gray, *Poorly Graded Sand with Gravel (SP)* to *Well-Graded Sand (SW)*; wet	15.0		S4A S4B		15
					20
S5: 35% Gravel, 64% Sand, 1% Fines			S5		25
Loose to medium dense, gray, *Poorly Graded and Well-Graded Gravel with Silt and Sand (GP-GM/GW-GM)*; wet; trace shells and wood	28.0		S6 *		30
S7: 51% Gravel, 40% Sand, 10% Fines			S7		35
			S8		40
			S9		45

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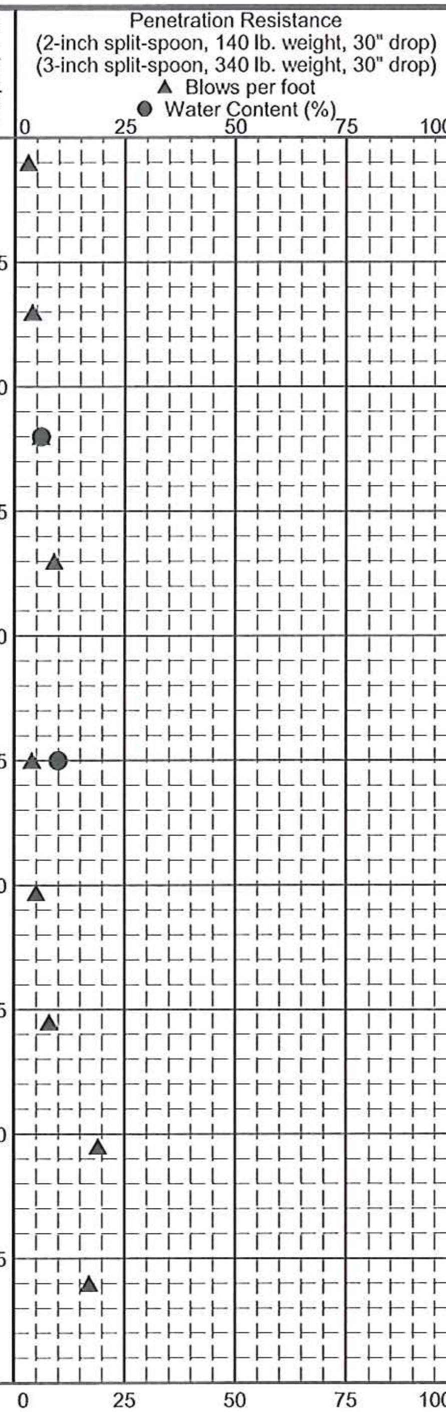

LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

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Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-3

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FIG. A-5
Sheet 1 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: -17 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Loose to medium dense, gray, *Poorly Graded and Well-Graded Gravel with Silt and Sand (GP-GM/GW-GM)*; wet; trace shells and wood S11: 49% Gravel, 42% Sand, 9% Fines			S10, S11, S12 *, S13 *		55, 60
Medium dense, dark gray, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet; trace shells	65.0		S14		65
Medium dense to dense, gray and gray-brown, *Silty Sand (SM)*; interbedded with 1/2-inch to 1-inch thick layers of *Sand with Silt (SP-SM)* and *Silty Sand with Gravel (SM)*; wet; trace to little organics (wood particles), trace shells; strong sulfur odor S16: 15% Gravel, 64% Sand, 21% Fines S20: 10% Gravel, 62% Sand, 28% Fines S22: Non-plastic by Atterberg Limits,56.6% Fines	70.0		S15, S16, S17, S18, S19, S20, S21, S22		70, 75, 80, 85, 90, 95

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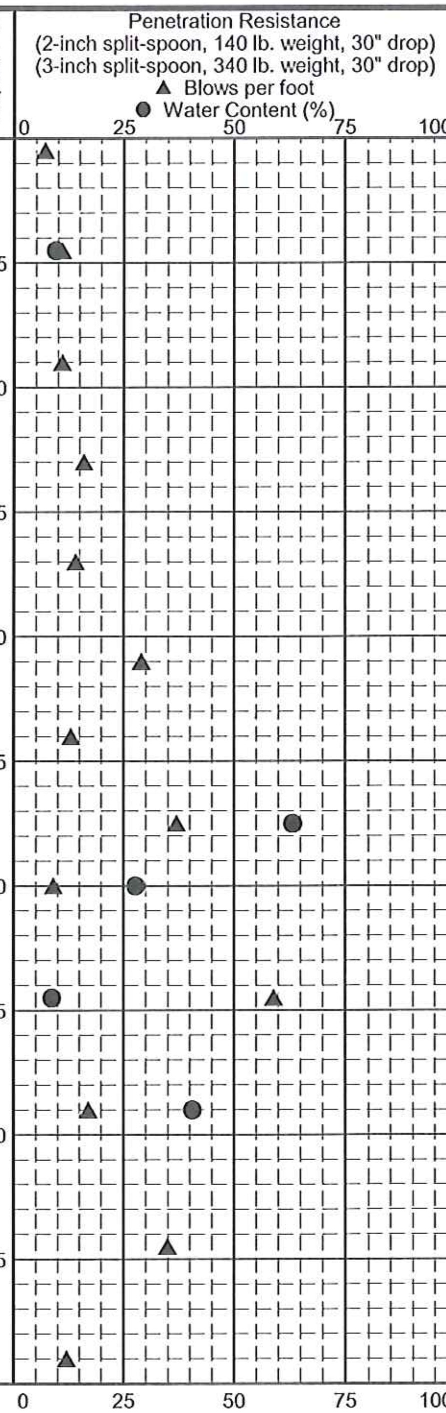

LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

NOTES

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2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-3

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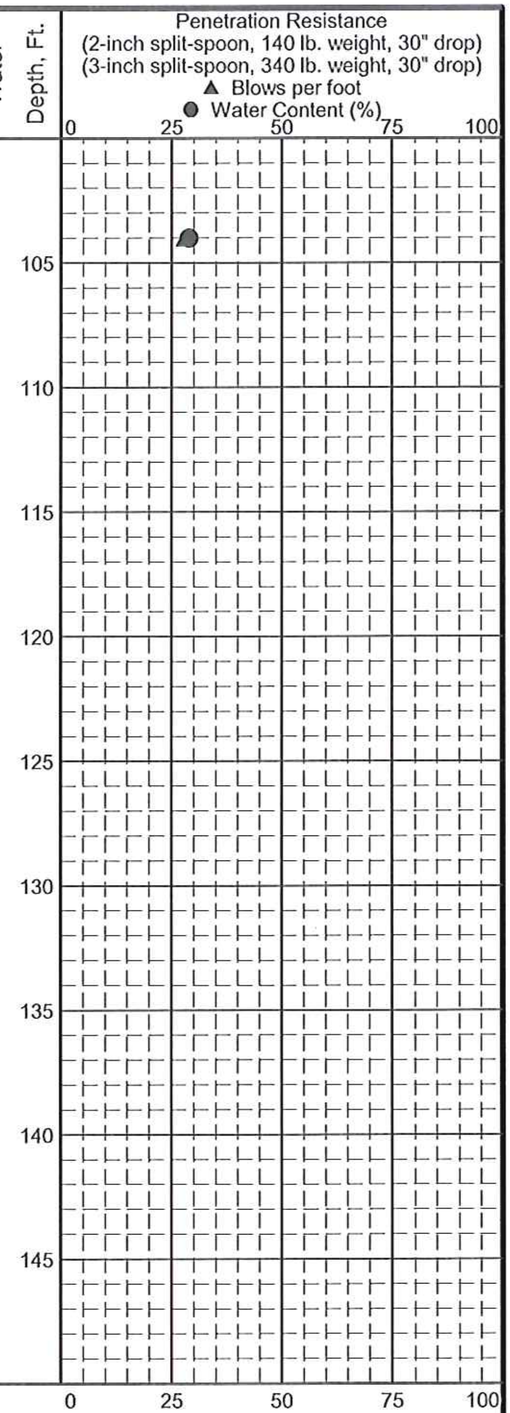
FIG. A-5
Sheet 2 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: -17 Ft. MLLW	Depth, Ft.	Samples
Medium dense to dense, gray and gray-brown, *Silty Sand (SM)*; interbedded with 1/2-inch to 1-inch thick layers of *Sand with Silt (SP-SM)* and *Silty Sand with Gravel (SM)*; wet; trace to little organics (wood particles), trace shells; strong sulfur odor	105.0	S23
Dense, gray, *Poorly Graded Gravel (GP)*; wet; mostly cobbles and boulders [Weathered Bedrock?] S25: REC = 40%, RQD = 0%	111.5	S24 *, S25
Serpentinite; light gray-green to dark green, slightly weathered, medium strength, numerous quartz veins and stringers to approximately 1/2-inch thick S26: REC = 100%, RQD = 91% S27: REC = 100%, RQD = 100% S28: REC = 100%, RQD = 99% S29: REC = 100%, RQD = 100% S30: REC = 100%, RQD = 15% S31: REC = 79%, RQD = 31%	128.0	S26, S27, S28, S29, S30, S31

Bottom of Boring
Boring Completed 6/14/2014

Ground Water



LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-3

September 2014 — 32-1-02389

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FIG. A-5
Sheet 3 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: 19 Ft. MLLW	Depth, Ft.
Loose to medium dense, brown to gray, *Poorly Graded Gravel with Sand (GP)*,*Well-Graded Gravel with Silt and Sand (GP-GM)* and *Silty Gravel (GM)*; moist to wet; trace cobbles; wood from railroad tie approximately 1 foot bgs [FILL] S2: 58% Gravel, 35% Sand, 7% Fines	
Medium dense, brown to dark gray, *Silty Sand with Gravel (SM)* to *Well-Graded Sand with Silt and Gravel (SW-SM)*; wet; trace cobbles [FILL to 19 feet bgs?]	13.0
Loose to medium dense, dark gray, *Poorly Graded Gravel with Sand (GP)* to *Well-Graded Gravel with Silt and Sand (GW-GM)*; wet S7: 51% Gravel, 40% Sand, 8% Fines	23.0
Loose, dark gray, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet; grading to brown, *Silty Sand (SM)*; little organics (wood)	33.0
Loose to medium dense, *Poorly and Well-Graded Gravel with Sand (GP/GW)* to *Well-Graded Gravel with Silt and Sand (GW-GM)*; wet; trace cobbles	43.0

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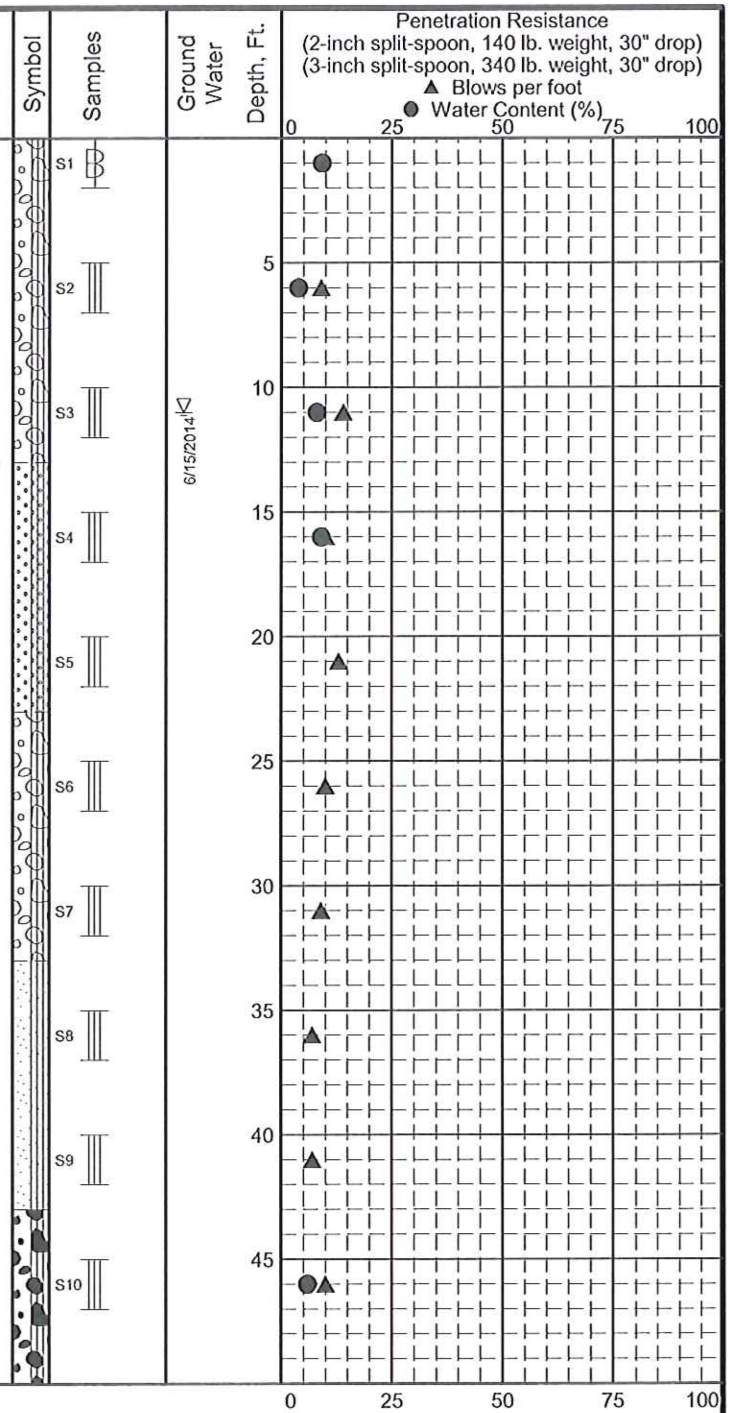

LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-4

September 2014 | 32-1-02389

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

FIG. A-6
Sheet 1 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: 19 Ft. MLLW	Depth, Ft.	Samples
Loose to medium dense, *Poorly and Well-Graded Gravel with Sand (GP/GW)* to *Well-Graded Gravel with Silt and Sand (GP-GM)*; wet; trace cobbles S12: 51% Gravel, 44% Sand, 5% Fines		S11, S12, S13
Medium dense, gray-brown, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet	62.0	S14
Medium dense, dark gray, *Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet	69.0	S15
Medium dense, dark gray, *Well-Graded Sand with Gravel (SW)*; wet S16: 46% Gravel, 51% Sand, 3% Fines	73.0	S16
Medium dense, dark gray, *Poorly Graded Gravel with Sand (GP)*; wet; trace cobbles	78.0	S17
Medium dense, dark gray, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet; trace shells, few wood; strong sulfur odor	84.0	S18
Medium dense, gray-brown, *Silty Sand (SM);* wet; interbedded with occasional 1/2-inch to 6-inch layers of *Poorly Graded Sand (SP)* and *Sand with Silt (SP-SM)*; trace to few woody organics, trace shells; strong sulfur odor S20: 2% Gravel, 74% Sand, 25% Fines	90.8	S19, S20

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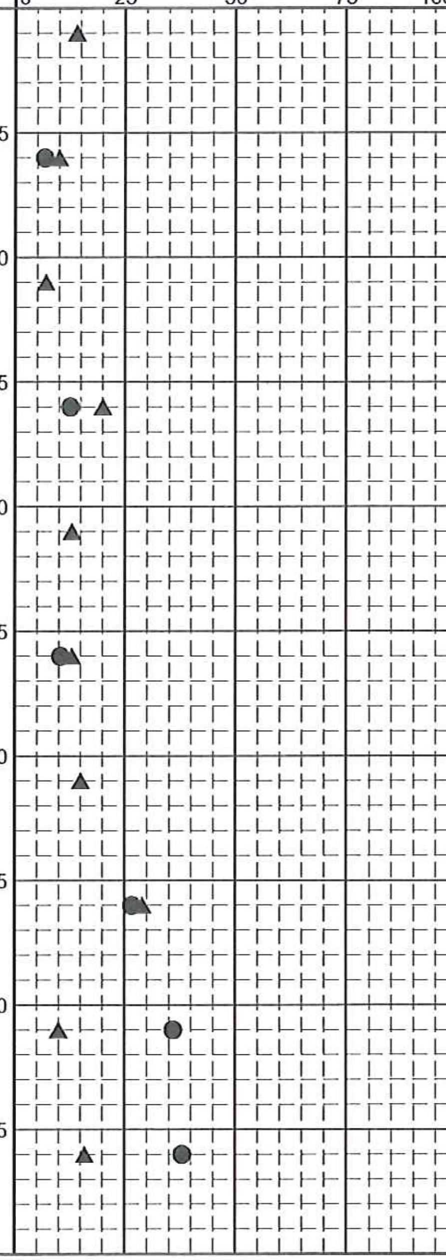
Penetration Resistance
(2-inch split-spoon, 140 lb. weight, 30" drop)
(3-inch split-spoon, 340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

* Sample Not Recovered
Grab Sample
3" O.D. Split Spoon Sample
2" O.D. Split Spoon Sample
Rock Core Sample
Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit ├─●─┤ Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-4

September 2014 | 32-1-02389

SHANNON & WILSON, INC.
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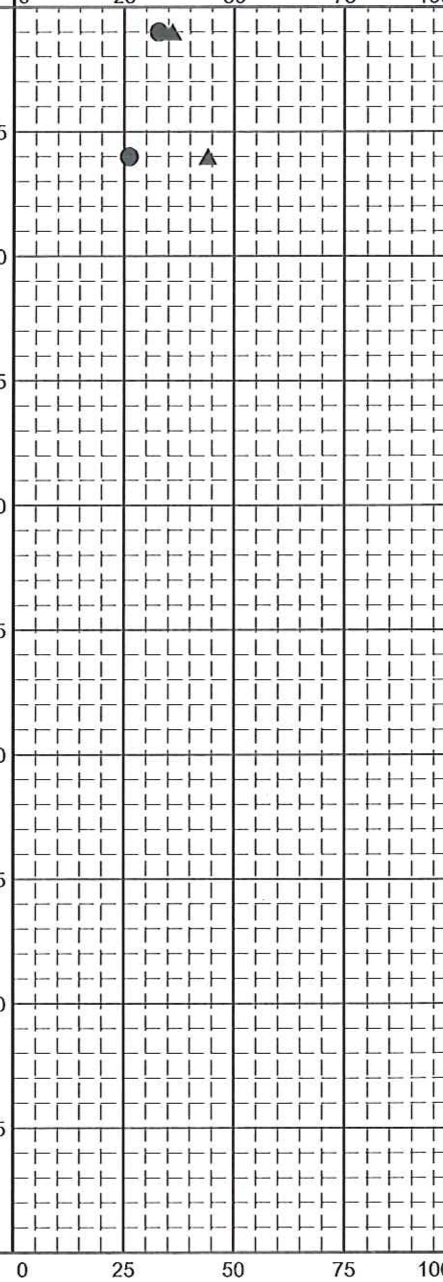
FIG. A-6
Sheet 2 of 3

MATERIAL DESCRIPTION Approx. Elevation: 19 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
S22: 1% Gravel, 68% Sand, 31% Fines Medium dense, gray-brown, *Silty Sand (SM);* wet; interbedded with occasional 1/2-inch to 6-inch layers of *Poorly Graded Sand (SP)* and *Sand with Silt (SP-SM)*; trace to few woody organics, trace shells; strong sulfur odor	106.3		S21 S22		105
Dense, Silty Gravel with Sand (GM); wet; [Weathered Bedrock] (inferred by drill action and cuttings stuck to auger bit) Boring terminated after drill tooling breaks while attempting to rock core	110.0		S23 *		110
Bottom of Boring Boring Completed 6/15/2014					115, 120, 125, 130, 135, 140, 145

Penetration Resistance
(2-inch split-spoon, 140 lb. weight, 30" drop)
(3-inch split-spoon, 340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
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Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-4

September 2014 | 32-1-02389

SHANNON & WILSON, INC.
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FIG. A-6
Sheet 3 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: 19 Ft. MLLW	Depth, Ft.	Samples	Ground Water
S1: 44% Gravel, 44% Sand, 12% Fines Medium dense, gray-brown, *Silty Sand with Gravel (SM)*; moist [FILL]		S1	
Loose to medium dense, brown to dark brown, *Poorly and Well-Graded Gravel with Silt and Sand (GP-GM/GW-GM)* to *Well-Graded Gravel with Sand (GW)*; moist to wet; trace cobbles [FILL] S4: 50% Gravel, 45% Sand, 6% Fines	3.0	S2, S3, S4	6/18/2014 ∇
Medium dense, dark brown and gray, *Poorly Graded Sand with Silt and Gravel (SP-SM)*; wet [FILL]	18.0	S5	
Loose, gray, *Poorly Graded Gravel with Sand (GP)*; wet; trace cobbles [FILL]	23.0	S6, S7	
S8: 10% Gravel, 76% Sand, 15% Fines Loose, gray to black, *Silty Sand (SM)*; wet; trace wood; small copper wire observed at 36.5 feet bgs	34.0	S8	
Loose, gray, *Poorly and Well-Graded Gravel with Sand (GP/GW)* to *Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; trace cobbles; trace wood	39.0	S9, S10	

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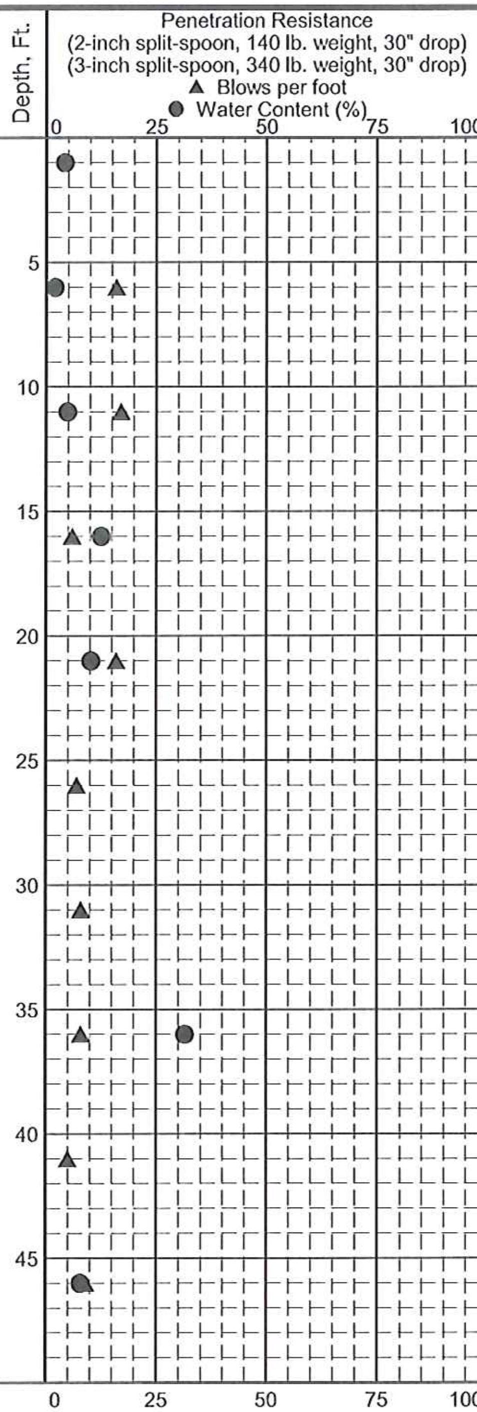

LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit |—●—| Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-5

September 2014 | 32-1-02389

SHANNON & WILSON, INC.
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FIG. A-7
Sheet 1 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION

Approx. Elevation: 19 Ft. MLLW

Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.

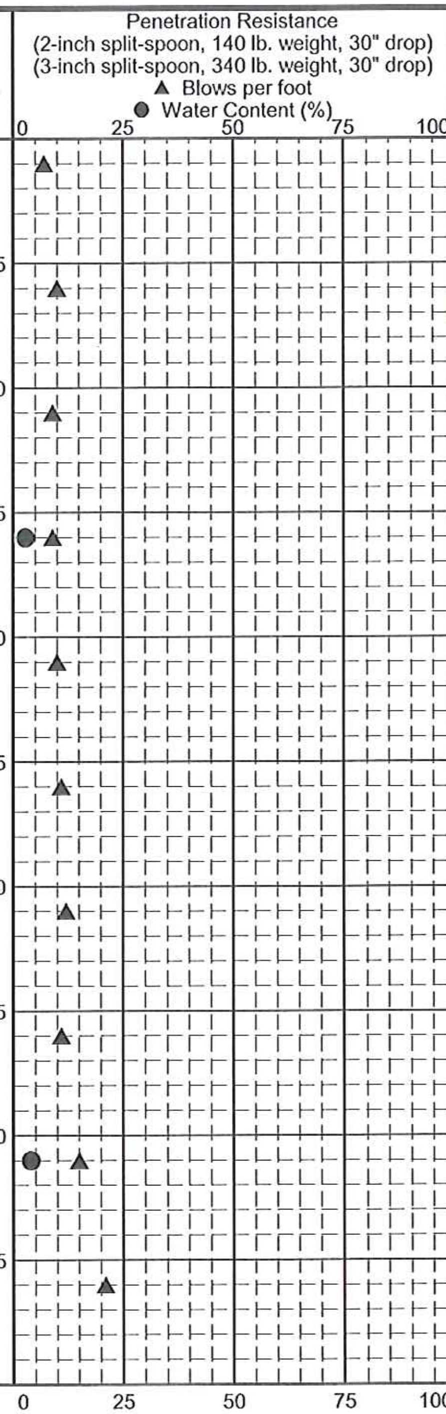
Loose, gray, *Poorly and Well-Graded Gravel with Sand (GP/GW)* to *Poorly Graded Gravel with Silt and Sand (GP-GM)*; wet; trace cobbles; trace wood

S12: 62% Gravel, 33% Sand, 4% Fines

S17: 61% Gravel, 35% Sand, 4% Fines

98.0

Samples: S11, S12, S13, S14, S15, S16, S17, S18, S19, S20 *



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0 25 50 75 100

LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)

Plastic Limit ├──●──┤ Liquid Limit

Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-5

September 2014 | 32-1-02389

SHANNON & WILSON, INC.
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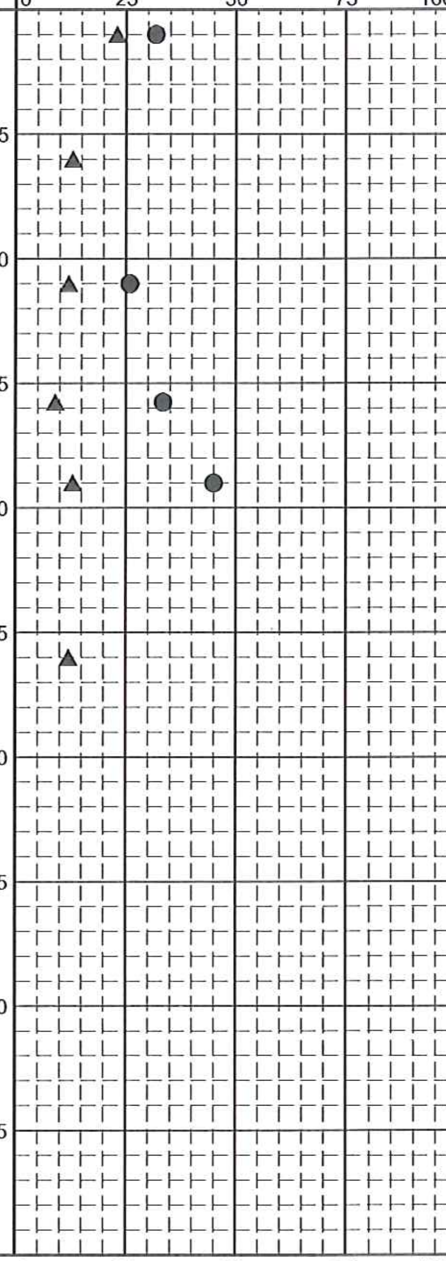
FIG. A-7
Sheet 2 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14

MATERIAL DESCRIPTION Approx. Elevation: 19 Ft. MLLW	Depth, Ft.	Symbol	Samples	Ground Water	Depth, Ft.
Medium dense, gray-brown, *Silty Sand (SM)*; interbedded with *Poorly Graded Sand with Silt (SP-SM)* in 4-inch to 6-inch layers and occasional layers of *Poorly Graded Gravel with Silt and Sand (GP-GM)*; few organics (wood and peat), trace shells; strong sulfur odor S22: Non-plastic by Atterberg Limits,31.9% Fines S25: 2% Gravel, 60% Sand, 38% Fines Casing refusal at 125 feet bml and borehole walls cave when attempting to sample in open hole. Therefore soil conditions below 127 feet were inferred by drill action and cuttings.	141.0		S21, S22, S23, S24, S25, S26		105, 110, 115, 120, 125, 130, 135, 140, 145
Bottom of Boring Boring Completed 6/18/2014					

Penetration Resistance
(2-inch split-spoon, 140 lb. weight, 30" drop)
(3-inch split-spoon, 340 lb. weight, 30" drop)
▲ Blows per foot
● Water Content (%)



LEGEND

- * Sample Not Recovered
- Grab Sample
- 3" O.D. Split Spoon Sample
- 2" O.D. Split Spoon Sample
- Rock Core Sample
- ∇ Ground Water Level At Time Of Drilling

● Water Content (%)
Plastic Limit |—●—| Liquid Limit
Natural Water Content

NOTES

1. The stratification lines represent the approximate boundaries between soil types, and the transition may be gradual.
2. The discussion in the text of this report is necessary for a proper understanding of the nature of subsurface materials.
3. Water level, if indicated above, is for the date specified and may vary.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

LOG OF BORING B-5

September 2014 32-1-02389

SHANNON & WILSON, INC.
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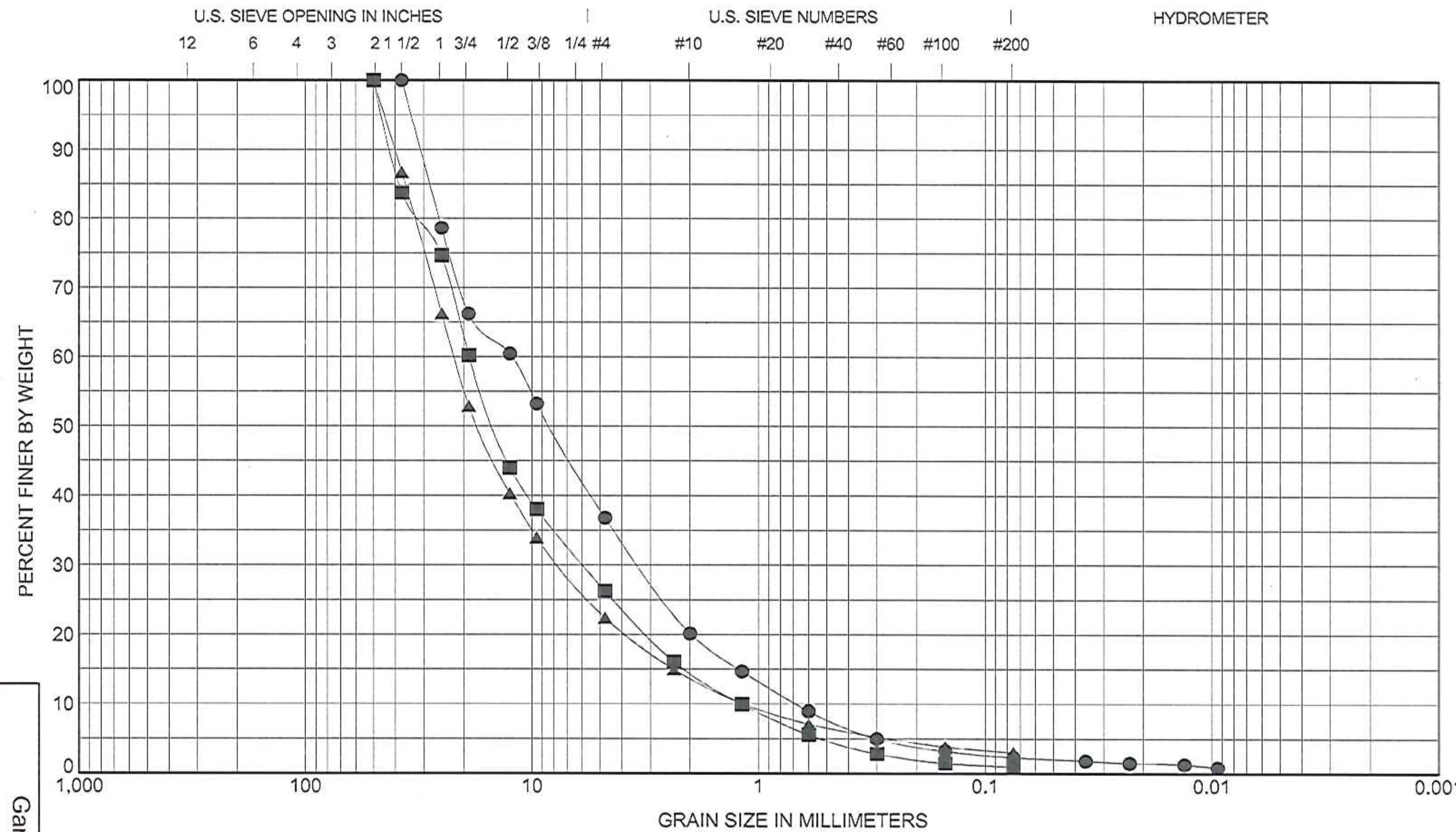
FIG. A-7
Sheet 3 of 3

GEOTECHNICAL LOG 02389 GINT.GPJ S&W GEO1.GDT 9/22/14



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-1 S3	10.0 - 11.5	**Well-Graded Gravel with Sand (GW)**				1.3	18.1
■ B-1 S6	21.9 - 23.4	**Well-Graded Gravel with Sand (GW)**				1.6	15.9
▲ B-1 S10	39.5 - 41.0	**Well-Graded Gravel with Sand (GW)**				2.2	19.0

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-1 S3	10.0 - 11.5	37.5	12.28	3.33	0.68	63	34	2	
■ B-1 S6	21.9 - 23.4	50	18.89	5.93	1.19	74	25	1	
▲ B-1 S10	39.5 - 41.0	50	21.98	7.49	1.16	78	19	3	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014

32-1-02389

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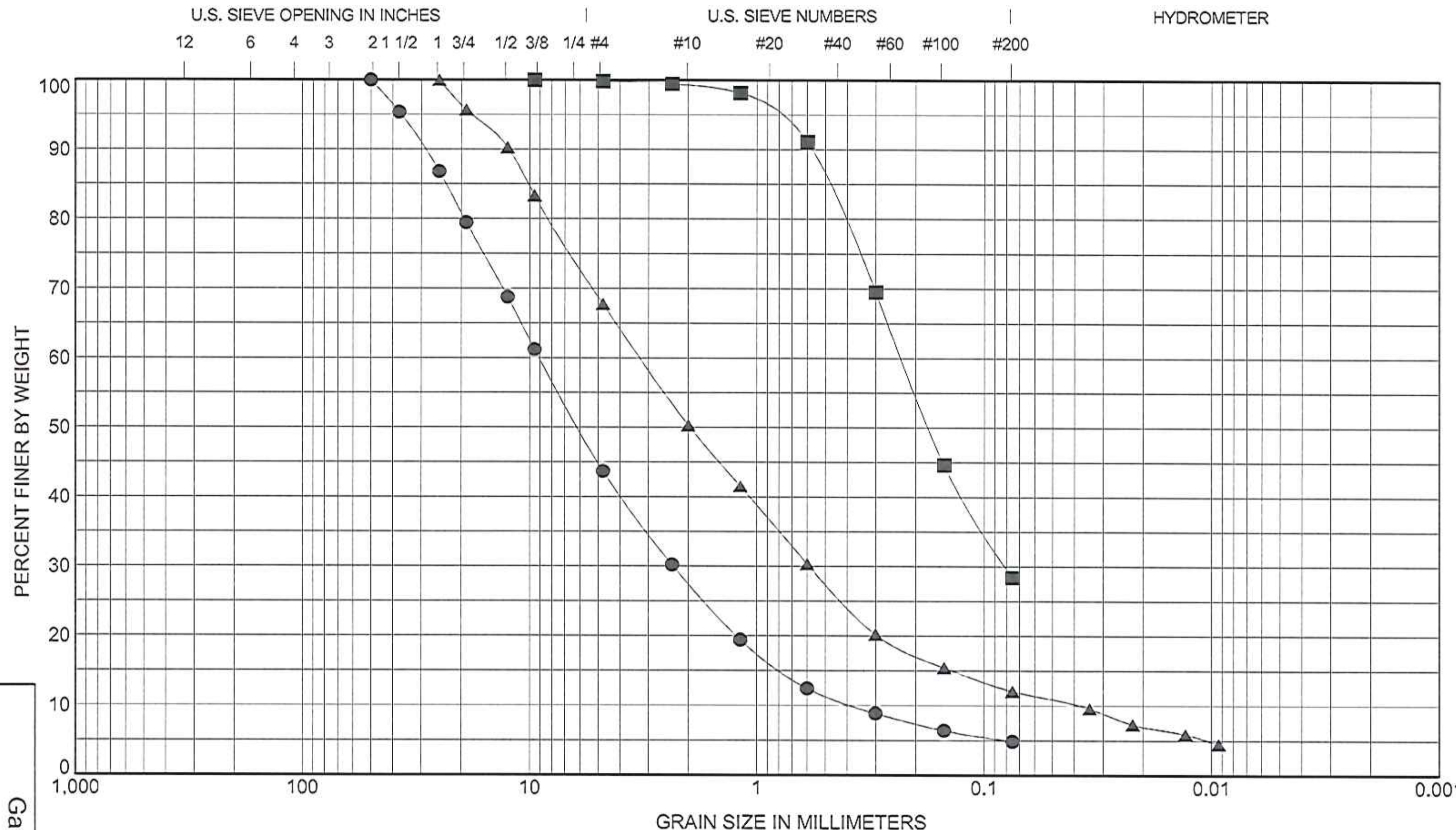
FIG. A-8
Sheet 1 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-1 S12	49.6 - 51.1	**Well-Graded Gravel with Silt and Sand (GW-GM)**				1.6	24.3
■	B-1 S16	72.5 - 74.0	**Silty Sand (SM)**					
▲	B-2 S3	13.0 - 14.5	**Well-Graded Sand with Silt and Gravel (SW-SM)**				2.7	83.1

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-1 S12	49.6 - 51.1	50	9.04	2.32	0.37	56	39	5	
■	B-1 S16	72.5 - 74.0	9.5	0.23	0.08		0	71	28	
▲	B-2 S3	13.0 - 14.5	25	3.23	0.58	0.04	32	56	12	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014 | 32-1-02389

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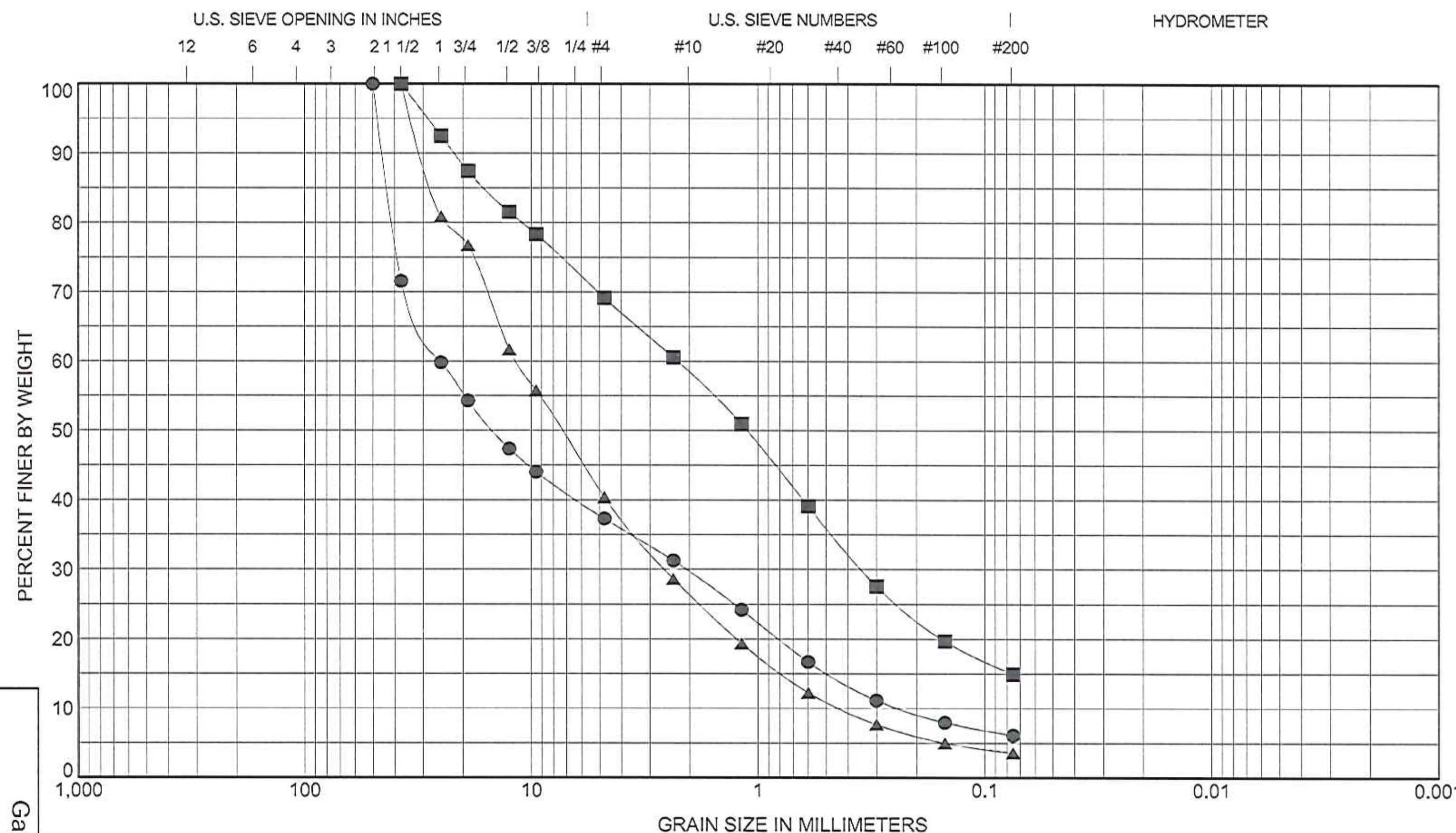
FIG. A-8
Sheet 2 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-2 S6	25.5 - 27.0	Poorly Graded Gravel with Silt and Sand (GP-GM)				0.7	108.3
■	B-2 S10	40.5 - 42.0	Silty Sand with Gravel (SM)					
▲	B-2 S13	51.5 - 53.0	Well-Graded Gravel with Sand (GW)				1.3	27.3

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2 S6	25.5 - 27.0	50	25.16	2.08	0.23	63	31	6	
■	B-2 S10	40.5 - 42.0	37.5	2.26	0.35		31	54	15	
▲	B-2 S13	51.5 - 53.0	37.5	11.56	2.56	0.42	60	37	4	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014 | 32-1-02389

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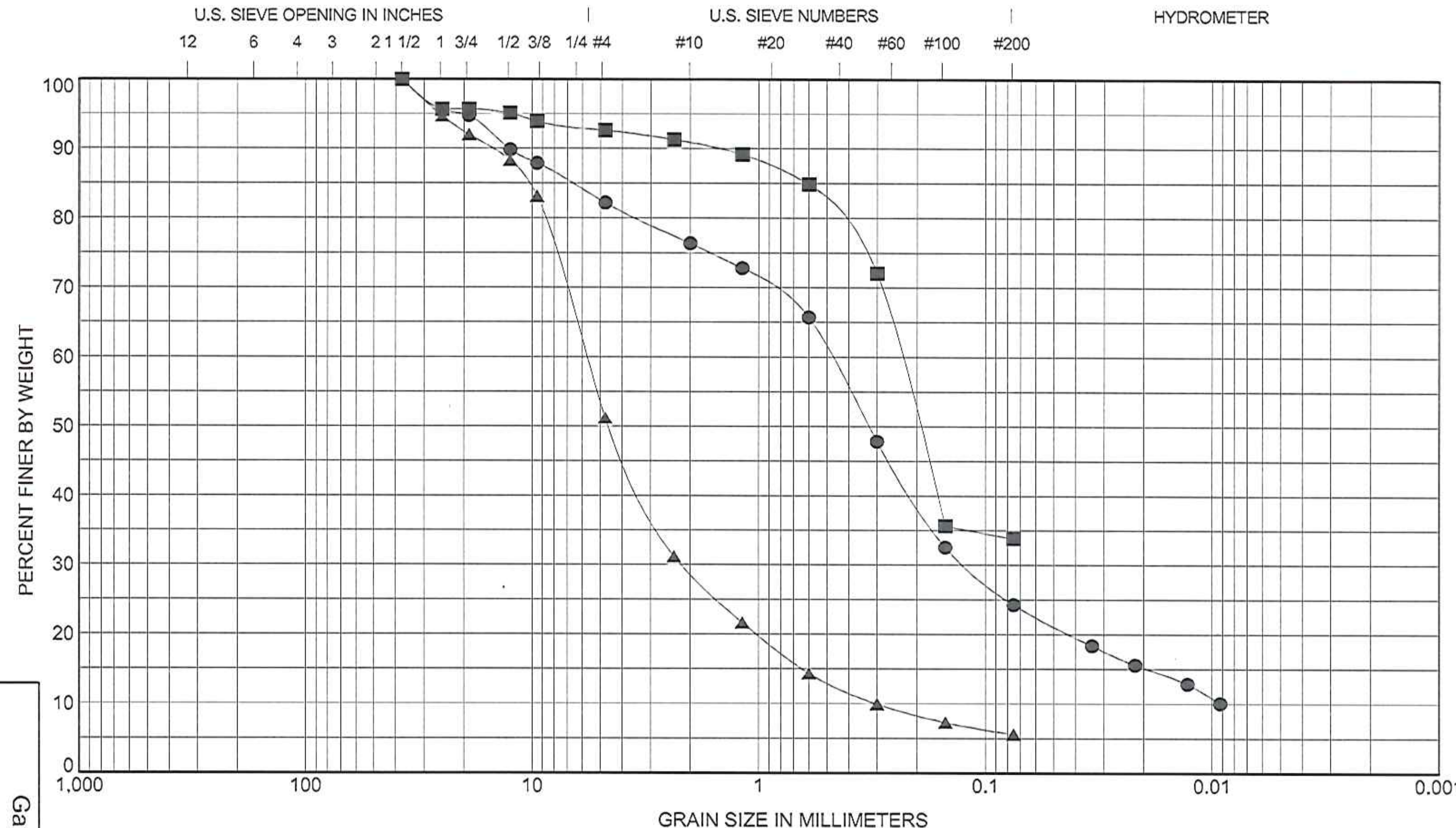
FIG. A-8
Sheet 3 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-2 S15	60.5 - 62.0	**Silty Sand with Gravel (SM)**					
■	B-2 S19	83.0 - 84.5	**Silty Sand (SM)**					
▲	B-3 S3	11.0 - 12.5	**Well-Graded Gravel with Silt and Sand (GW-GM)**				2.7	19.0

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-2 S15	60.5 - 62.0	37.5	0.48	0.12		18	58	24	
■	B-2 S19	83.0 - 84.5	37.5	0.24			7	59	34	
▲	B-3 S3	11.0 - 12.5	37.5	5.75	2.16	0.3	49	46	6	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014

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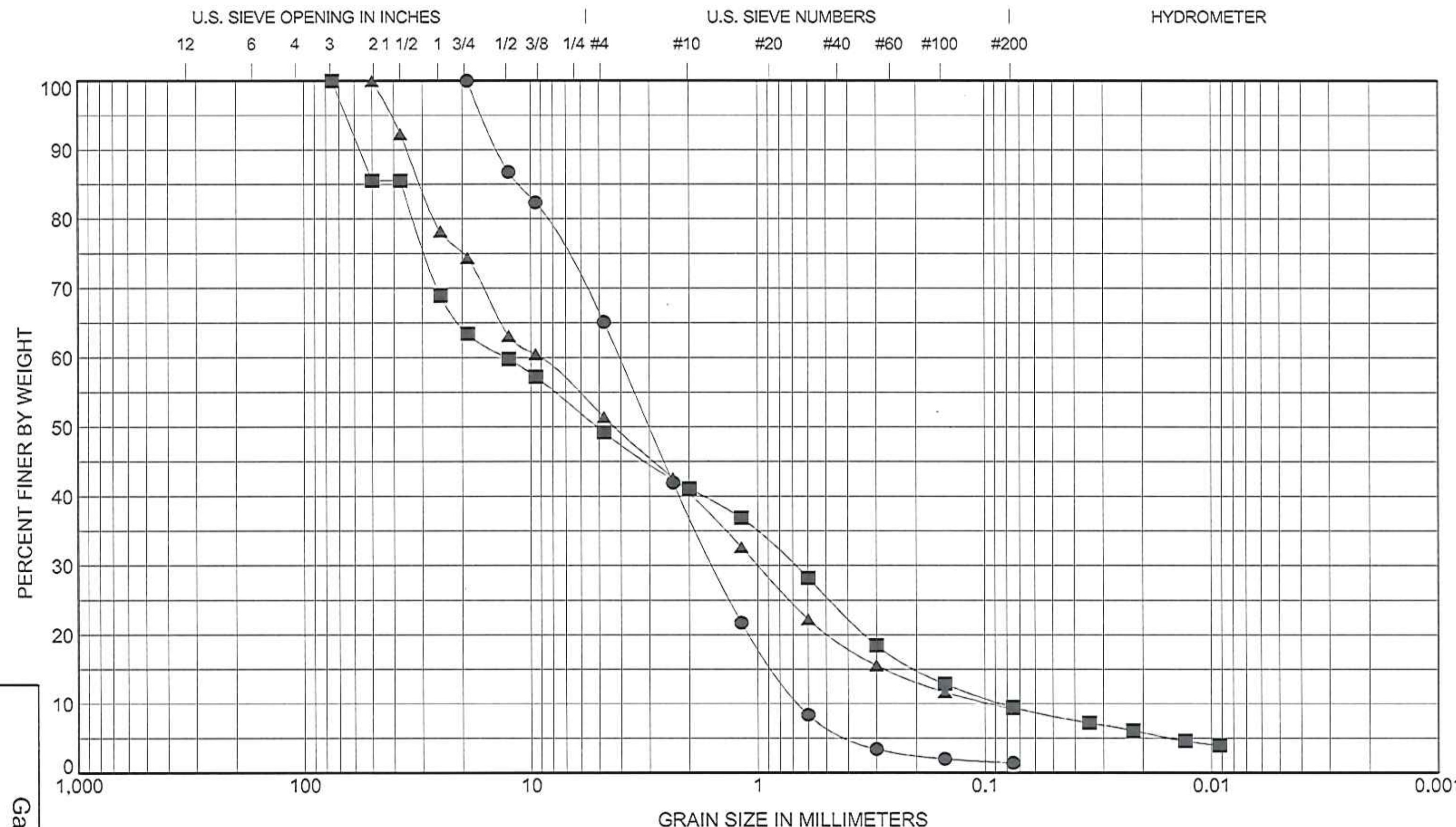
FIG. A-8
Sheet 4 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-3 S5	24.0 - 25.5	**Poorly Graded Sand with Gravel (SP)**				0.9	6.3
■ B-3 S7	34.5 - 36.5	**Poorly Graded Gravel with Silt and Sand (GP-GM)**				0.4	154.9
▲ B-3 S11	53.5 - 55.0	**Well-Graded Gravel with Silt and Sand (GW-GM)**				1.2	98.8

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3 S5	24.0 - 25.5	19	4.07	1.56	0.65	35	64	1	
■ B-3 S7	34.5 - 36.5	75	12.82	0.69	0.08	51	40	10	
▲ B-3 S11	53.5 - 55.0	50	9.15	0.99	0.09	49	42	9	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014

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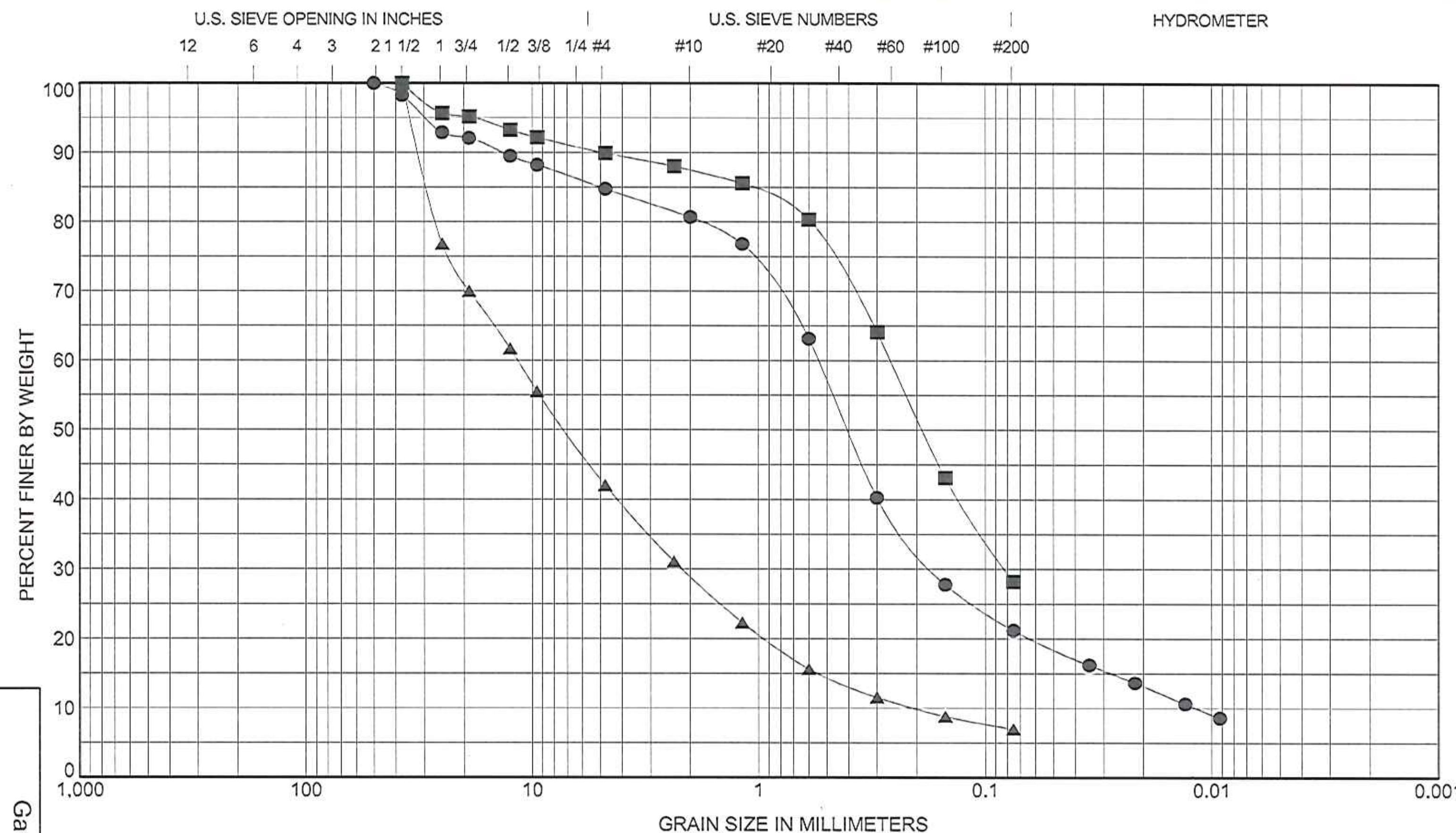
FIG. A-8
Sheet 5 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-3 S16	73.0 - 75.0	**Silty Sand with Gravel (SM)**				4.5	46.6
■ B-3 S20	88.0 - 89.5	**Silty Sand (SM)**					
▲ B-4 S2	5.0 - 6.5	**Well-Graded Gravel with Silt and Sand (GW-GM)**				2.0	57.8

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-3 S16	73.0 - 75.0	50	0.54	0.17	0.01	15	64	21	
■ B-3 S20	88.0 - 89.5	37.5	0.26	0.08		10	62	28	
▲ B-4 S2	5.0 - 6.5	37.5	11.6	2.16	0.2	58	35	7	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

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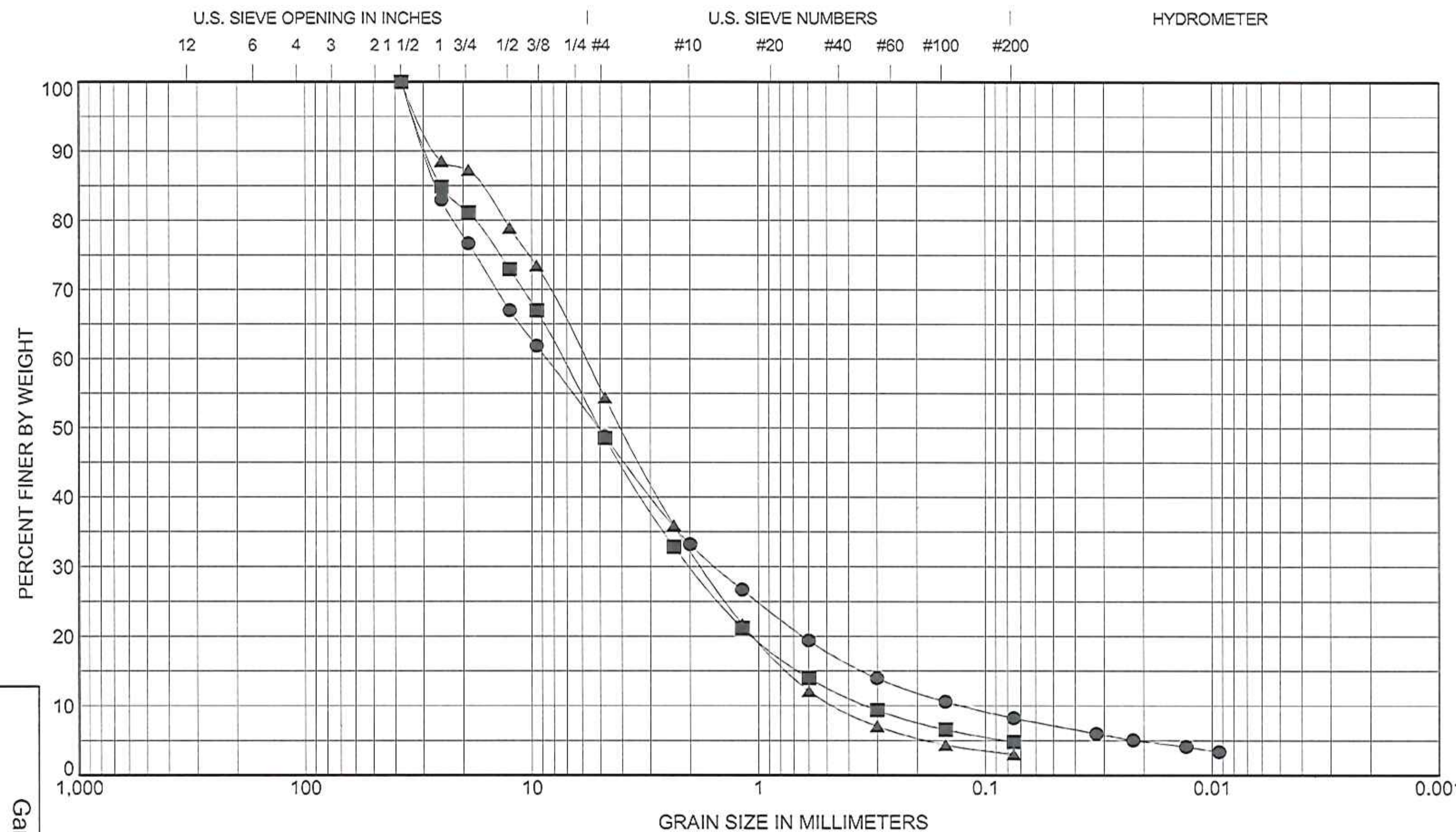
FIG. A-8
Sheet 6 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-4 S7	30.0 - 32.0	**Well-Graded Gravel with Silt and Sand (GW-GM)**				2.2	68.8
■ B-4 S12	55.0 - 56.5	**Well-Graded Gravel with Silt and Sand (GW-GM)**				1.6	22.1
▲ B-4 S16	75.0 - 76.5	**Well-Graded Sand with Gravel (SW)**				1.2	13.0

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt / %Clay
● B-4 S7	30.0 - 32.0	37.5	8.61	1.54	0.13	51	40	8
■ B-4 S12	55.0 - 56.5	37.5	7.3	1.99	0.33	51	44	5
▲ B-4 S16	75.0 - 76.5	37.5	5.82	1.76	0.45	46	51	3

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014

32-1-02389

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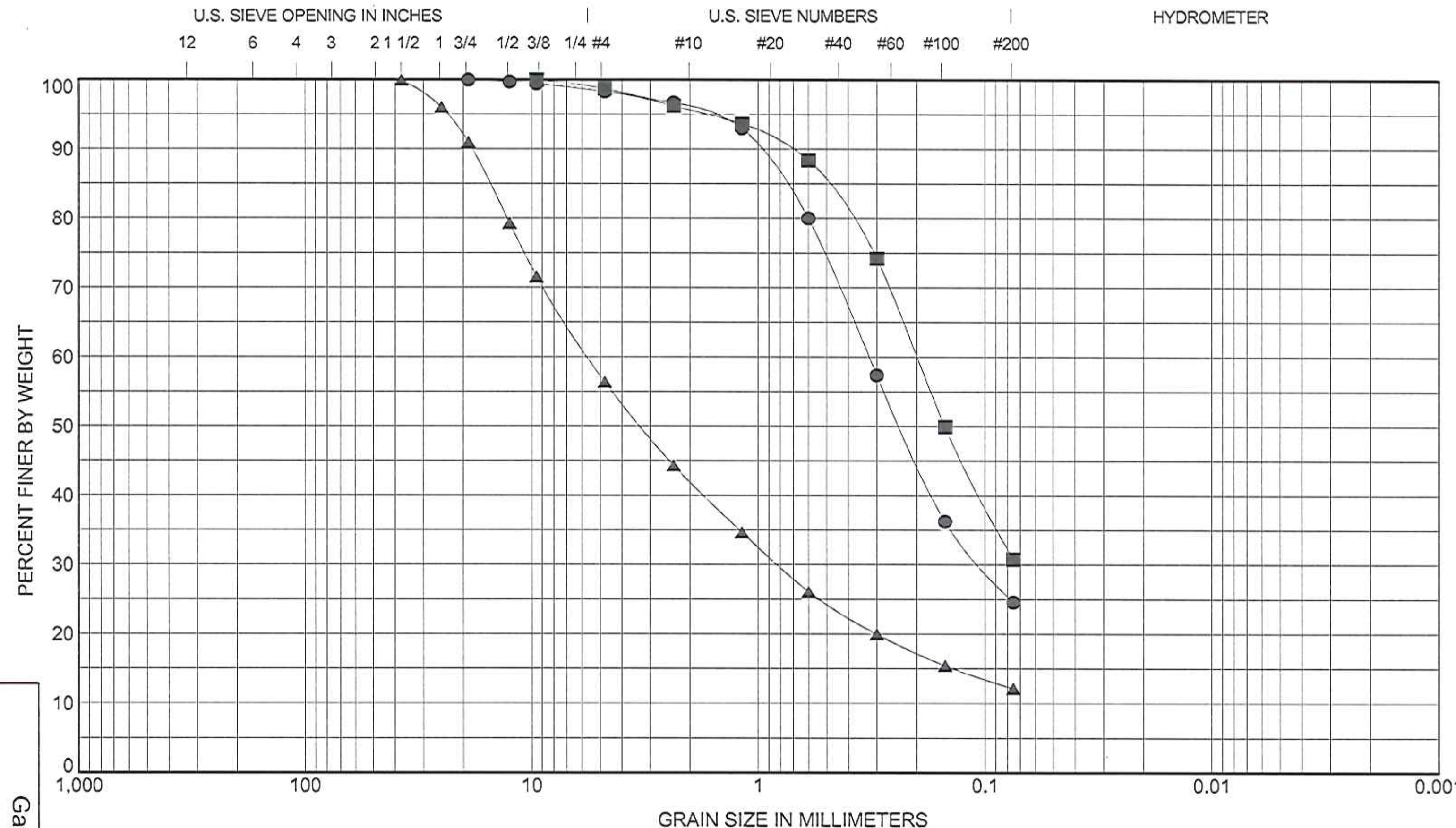
FIG. A-8
Sheet 7 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
● B-4 S20	95.0 - 96.5	**Silty Sand (SM)**					
■ B-4 S22	105.0 - 106.5	**Silty Sand (SM)**					
▲ B-5 S1	0.0 - 1.5	**Silty Sand with Gravel (SM)**				2.5	117.6

Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
● B-4 S20	95.0 - 96.5	19	0.32	0.1		2	74	25	
■ B-4 S22	105.0 - 106.5	9.5	0.2			1	68	31	
▲ B-5 S1	0.0 - 1.5	37.5	5.6	0.82		44	44	12	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

September 2014

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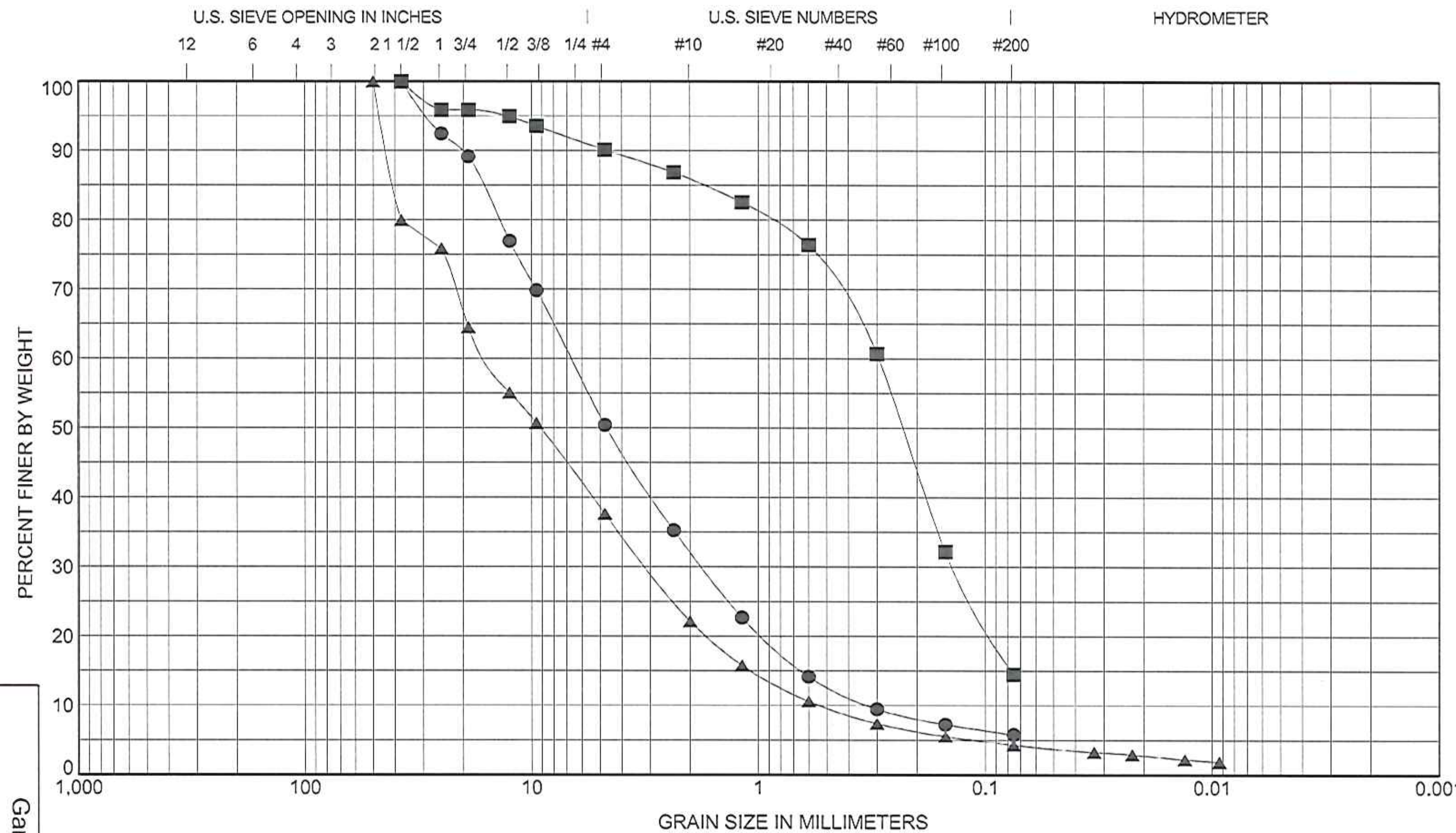
FIG. A-8
Sheet 8 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

Sample		Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-5 S4	15.0 - 16.5	**Well-Graded Gravel with Silt and Sand (GW-GM)**				1.4	20.6
■	B-5 S8	35.0 - 36.5	**Silty Sand (SM)**					
▲	B-5 S12	55.0 - 56.5	**Well-Graded Gravel with Sand (GW)**				1.2	29.5

Sample		Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-5 S4	15.0 - 16.5	37.5	6.68	1.77	0.32	50	45	6	
■	B-5 S8	35.0 - 36.5	37.5	0.29	0.14		10	76	15	
▲	B-5 S12	55.0 - 56.5	50	15.57	3.1	0.53	62	33	4	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

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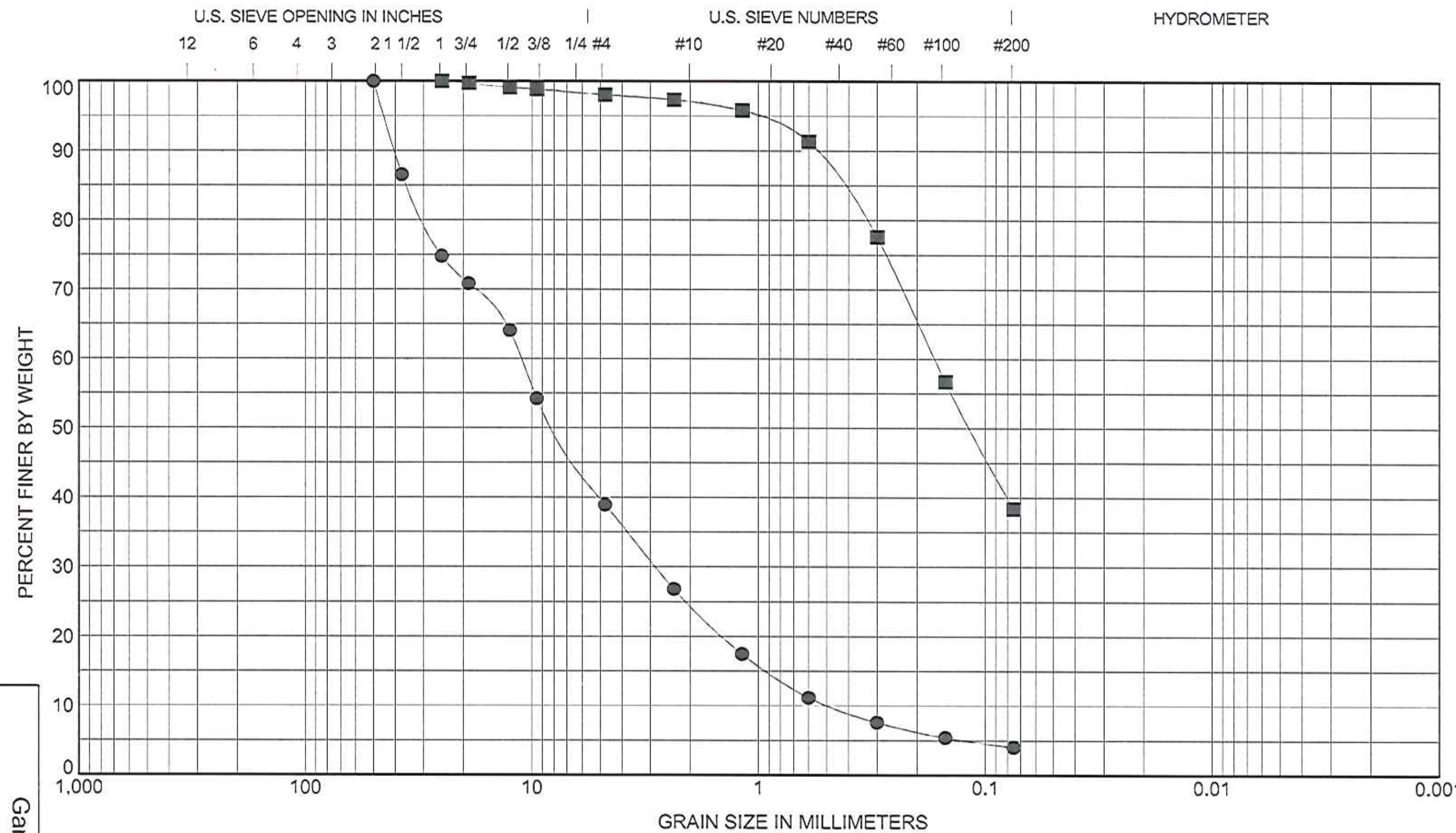
FIG. A-8
Sheet 9 of 10



COBBLES	GRAVEL		SAND			SILT OR CLAY
	coarse	fine	coarse	medium	fine	

	Sample	Depth, Ft	Classification	LL	PL	PI	Cc	Cu
●	B-5 S17	80.0 - 81.5	**Well-Graded Gravel with Sand (GW)**				1.5	23.5
■	B-5 S25	118.0 - 119.5	**Silty Sand (SM)**					

	Sample	Depth, Ft	D100	D60	D30	D10	%Gravel	%Sand	%Silt	%Clay
●	B-5 S17	80.0 - 81.5	50	11.16	2.83	0.48	61	35	4	
■	B-5 S25	118.0 - 119.5	25	0.17			2	60	38	

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

GRAIN SIZE CLASSIFICATION

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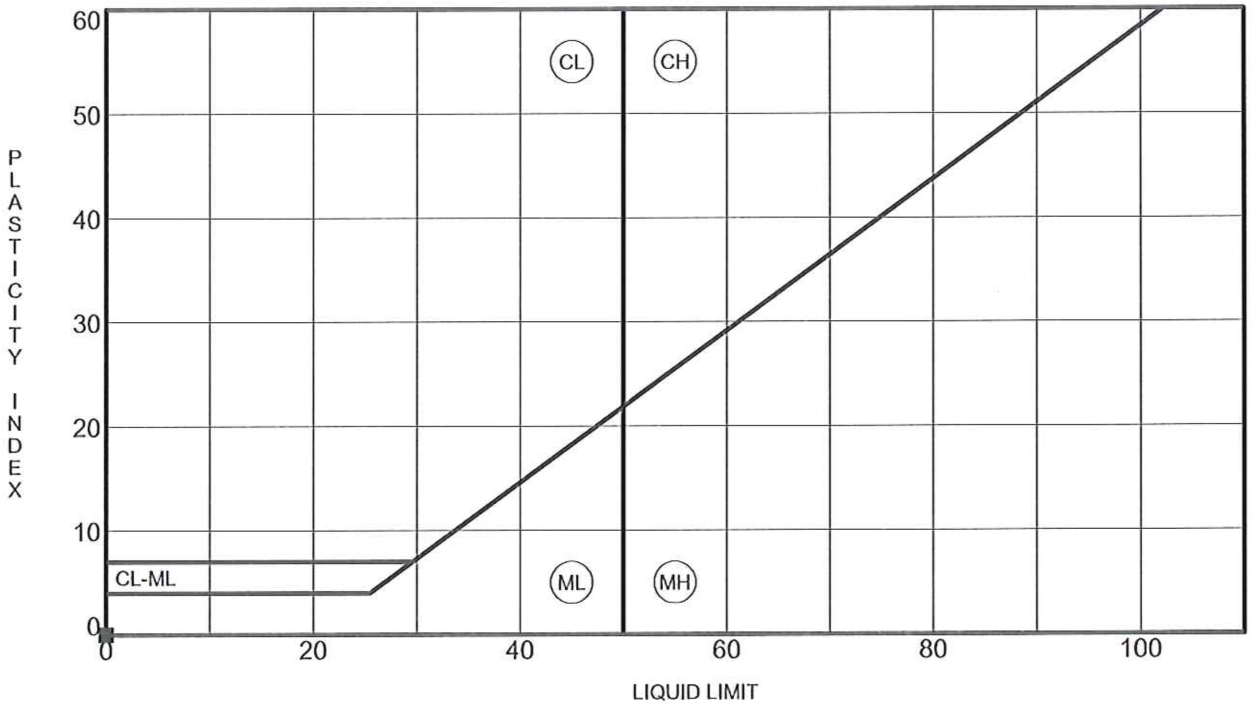
FIG. A-8
Sheet 10 of 10



	Boring	Depth, Ft	LL	PL	PI	Fines	Classification
●	**B-3**	**98.0 - 99.5**	**NP**	**NP**	**NP**		**ML**
■	**B-5**	**105.0 - 106.5**	**NP**	**NP**	**NP**		**SM**

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

ATTERBERG LIMITS RESULTS

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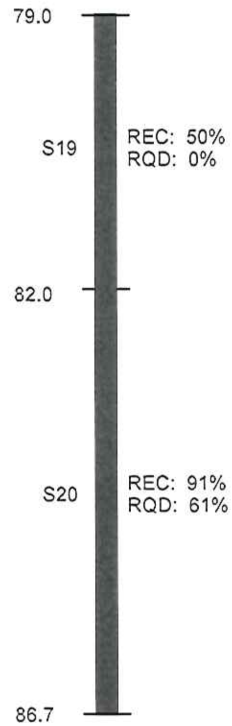
FIG. A-9

Core Log for Boring B-1: 79.0 - 86.7 feet bml

CORE SUMMARY



DESCRIPTION	*Fresh to slightly weathered, black, medium strong, SHALE/ARGILLITE*
Average Joint Spacing	8 to 12 inches
Dominant Joint Angles	25 to 50°
Foliation/Bedding	Closely bedded
Foliation/Bedding Angles	75 to 80°
Joint Smoothness[1]	Smooth to rough
Joint Filling	Quartz and minor calcite
Relative Hardness[2]	Moderate
Effervescence[3]	None; moderate in joint and vesicle infillings
Degree of Weathering[4]	Fresh to slightly
Comments	Rock has numerous quartz stringers and displays minor flow texture

REC = Core Recovery
RQD = Rock Quality Designation

Notes:

1. Visual classification of smoothness of joint surfaces (slickensided, smooth, rough).
2. Indicates effort required to scratch core surface with Hardness 6 stylus (easy, moderate, hard).
3. Visual classification of effervescence when 10:1 HCl is applied to core (low, moderate, high).
4. Visual classification of apparent weathering of core (fresh, slightly weathered, moderately weathered, highly weathered, completely weathered, residual soil).

See Figure A-2 for FHWA Rock Classification System

Gary Paxton Industrial Park Multi-use Dock Sawmill Cove, Sitka, Alaska	
CORE LOG BORING B-1 **79.0 - 86.7 feet bml**	
September 2014	32-1-02389
SHANNON & WILSON, INC. Geotechnical & Environmental Consultants	**FIG. A-10**

Core Log for Boring B-3: 110.0 - 117.0 feet bml

CORE SUMMARY

Depth	Sample	REC	RQD
110.0 - 111.5	S25	40%	0%
111.5 - 112.5	S26	100%	91%
112.5 - 113.0	S27	100%	100%
113.0 - 117.0	S28	100%	99%

DESCRIPTION	*Fresh to slightly weathered, gray-green to dark gray medium strong to strong, Serpentinite*
Average Joint Spacing	10 inches on lower angled joint set and 24 inches on high angled joints
Dominant Joint Angles	30/40 (lower angled joints); 60° (high-angled joints)
Foliation/Bedding	NA
Foliation/Bedding Angles	NA
Joint Smoothness[1]	Smooth
Joint Filling	Calcite; minor Quartz
Relative Hardness[2]	Easy to moderate
Effervescence[3]	None. Strong in joints and calcitic stringers
Degree of Weathering[4]	Fresh to slightly
Comments	Rock core recovered in Sample S25 (approximately 110 - 111.5) was linterpreted as fragments likely derived from cobbles and/or boulders

REC = Core Recovery
RQD = Rock Quality Designation

Notes:

1. Visual classification of smoothness of joint surfaces (slickensided, smooth, rough).
2. Indicates effort required to scratch core surface with Hardness 6 stylus (easy, moderate, hard).
3. Visual classification of effervescence when 10:1 HCl is applied to core (low, moderate, high).
4. Visual classification of apparent weathering of core (fresh, slightly weathered, moderately weathered, highly weathered, completely weathered, residual soil).

See Figure A-2 for FHWA Rock Classification System

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

CORE LOG BORING B-3
110.0 - 117.0 feet bml

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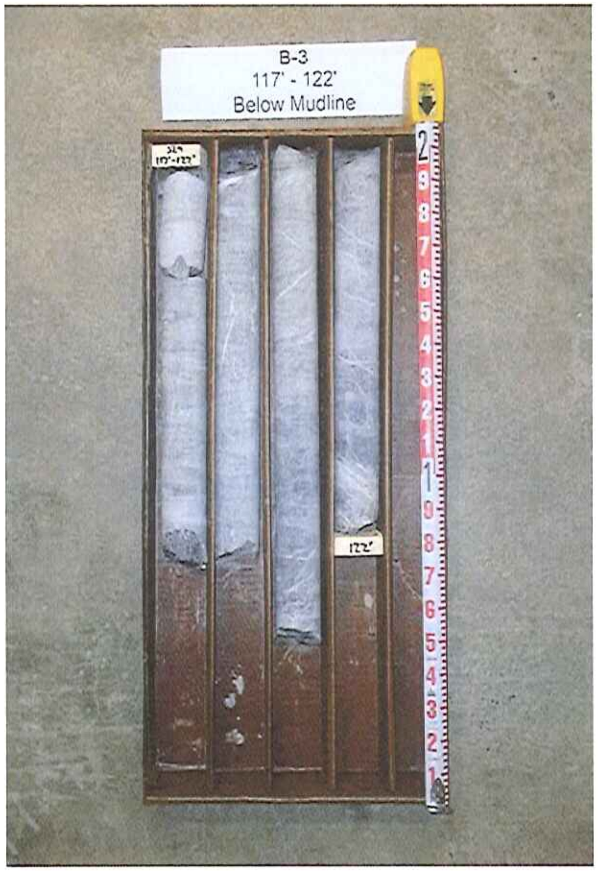
FIG. A-11
Sheet 1 of 3

Core Log for Boring B-3: 117.0 - 122.0 feet bml



CORE SUMMARY

117.0

S29 — REC: 100% RQD: 100%

122.0

DESCRIPTION	*Fresh to slightly weathered, gray-green to dark gray medium strong to strong, Serpentinite*
Average Joint Spacing	16 inches
Dominant Joint Angles	20 and 50°
Foliation/Bedding	NA
Foliation/Bedding Angles	NA
Joint Smoothness[1]	Smooth
Joint Filling	Calcite; minor Quartz
Relative Hardness[2]	Moderate to hard
Effervescence[3]	Slight/none. Strong in veins and stringers
Degree of Weathering[4]	Fresh to slightly
Comments	Rock type transitions to Serpentinite below about 121.5 feet bml

REC = Core Recovery
RQD = Rock Quality Designation

Notes:

1. Visual classification of smoothness of joint surfaces (slickensided, smooth, rough).
2. Indicates effort required to scratch core surface with Hardness 6 stylus (easy, moderate, hard).
3. Visual classification of effervescence when 10:1 HCl is applied to core (low, moderate, high).
4. Visual classification of apparent weathering of core (fresh, slightly weathered, moderately weathered, highly weathered, completely weathered, residual soil).

See Figure A-2 for FHWA Rock Classification System

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

CORE LOG BORING B-3
117.0 - 122.0 feet bml

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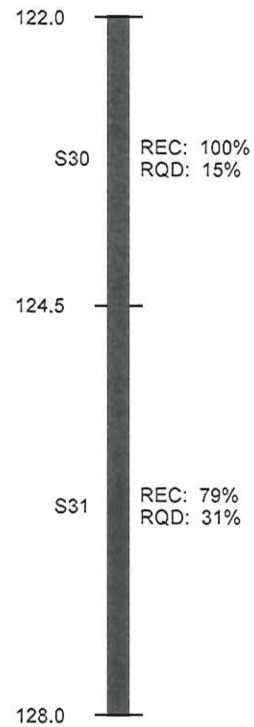
FIG. A-11
Sheet 2 of 3

Core Log for Boring B-3: 122.0 - 128.0 feet bml

CORE SUMMARY



DESCRIPTION	*Fresh to slightly weathered, dark green to black, striated, weak to medium strong, SERPENTINITE*
Average Joint Spacing	2 inches
Dominant Joint Angles	30 and 70°
Foliation/Bedding	NA
Foliation/Bedding Angles	NA
Joint Smoothness[1]	Smooth
Joint Filling	Calcite
Relative Hardness[2]	Easy
Effervescence[3]	Slight/none. Strong in veins and stringers
Degree of Weathering[4]	Fresh to slightly
Comments	

REC = Core Recovery
RQD = Rock Quality Designation

Notes:

1. Visual classification of smoothness of joint surfaces (slickensided, smooth, rough).
2. Indicates effort required to scratch core surface with Hardness 6 stylus (easy, moderate, hard).
3. Visual classification of effervescence when 10:1 HCl is applied to core (low, moderate, high).
4. Visual classification of apparent weathering of core (fresh, slightly weathered, moderately weathered, highly weathered, completely weathered, residual soil).

See Figure A-2 for FHWA Rock Classification System

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

CORE LOG BORING B-3
122.0 - 128.0 feet bml

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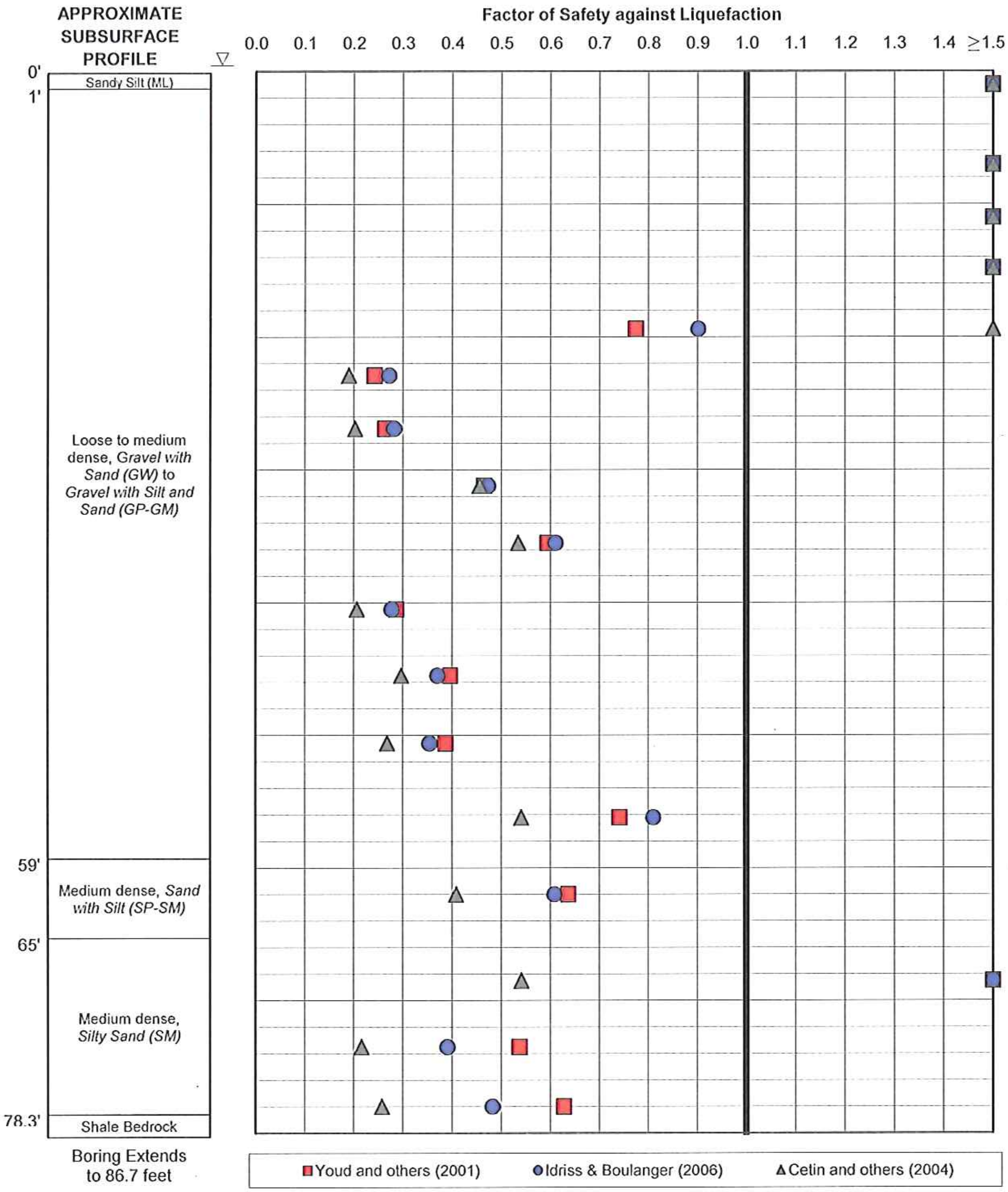
FIG. A-11
Sheet 3 of 3

APPENDIX B

RESULTS OF LIQUEFACTION ANALYSES

FIGURES



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

RESULTS OF LIQUEFACTION ANALYSES
BORING B-1
M = 7.9, PGA = 0.38

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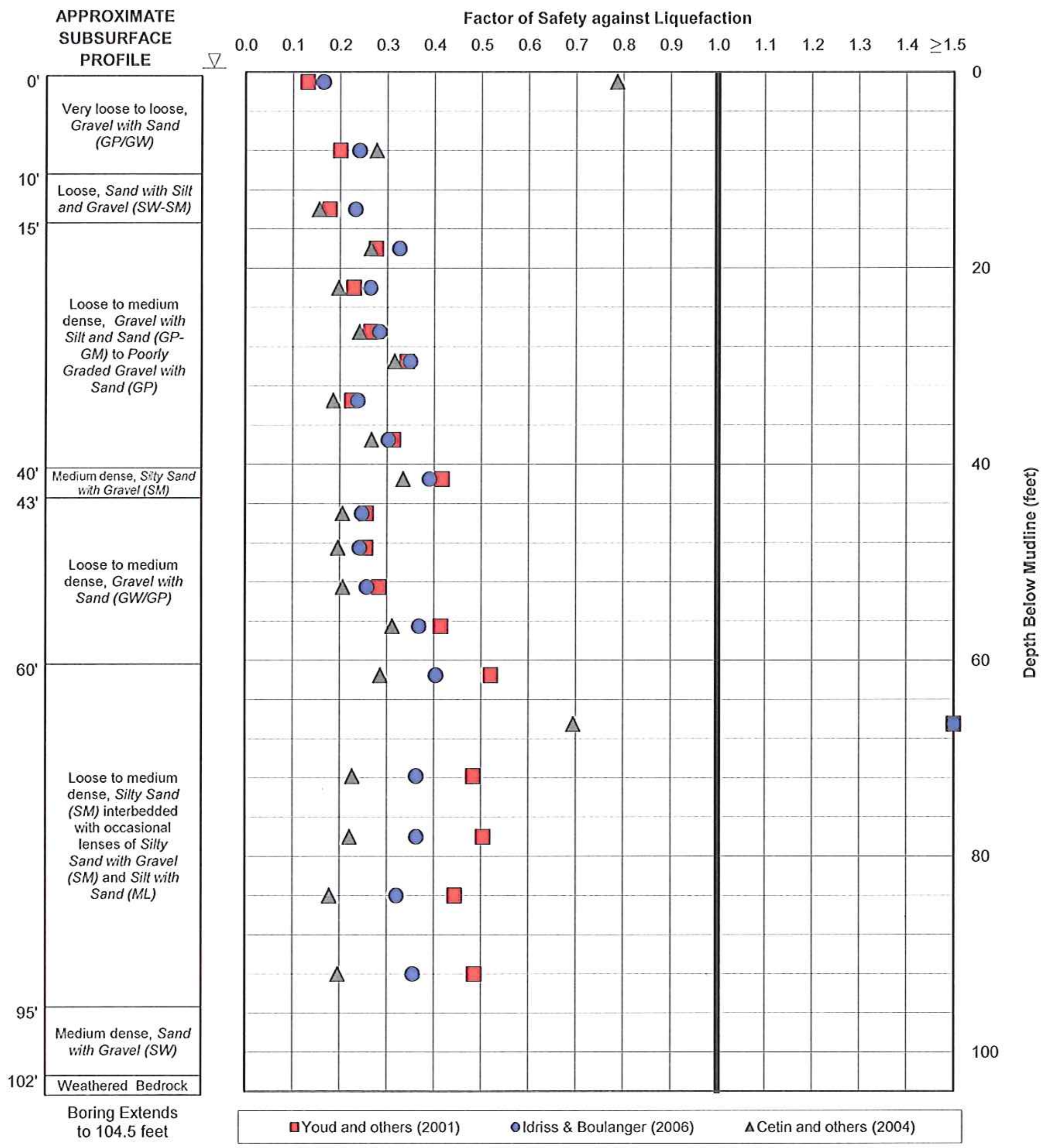
FIG. B-1

B-2 SPT_Liquefaction_v2.2.5 9/22/2014



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.

Gary Paxton Industrial Park
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Sawmill Cove, Sitka, Alaska

RESULTS OF LIQUEFACTION ANALYSES
BORING B-2
M = 7.9, PGA = 0.38

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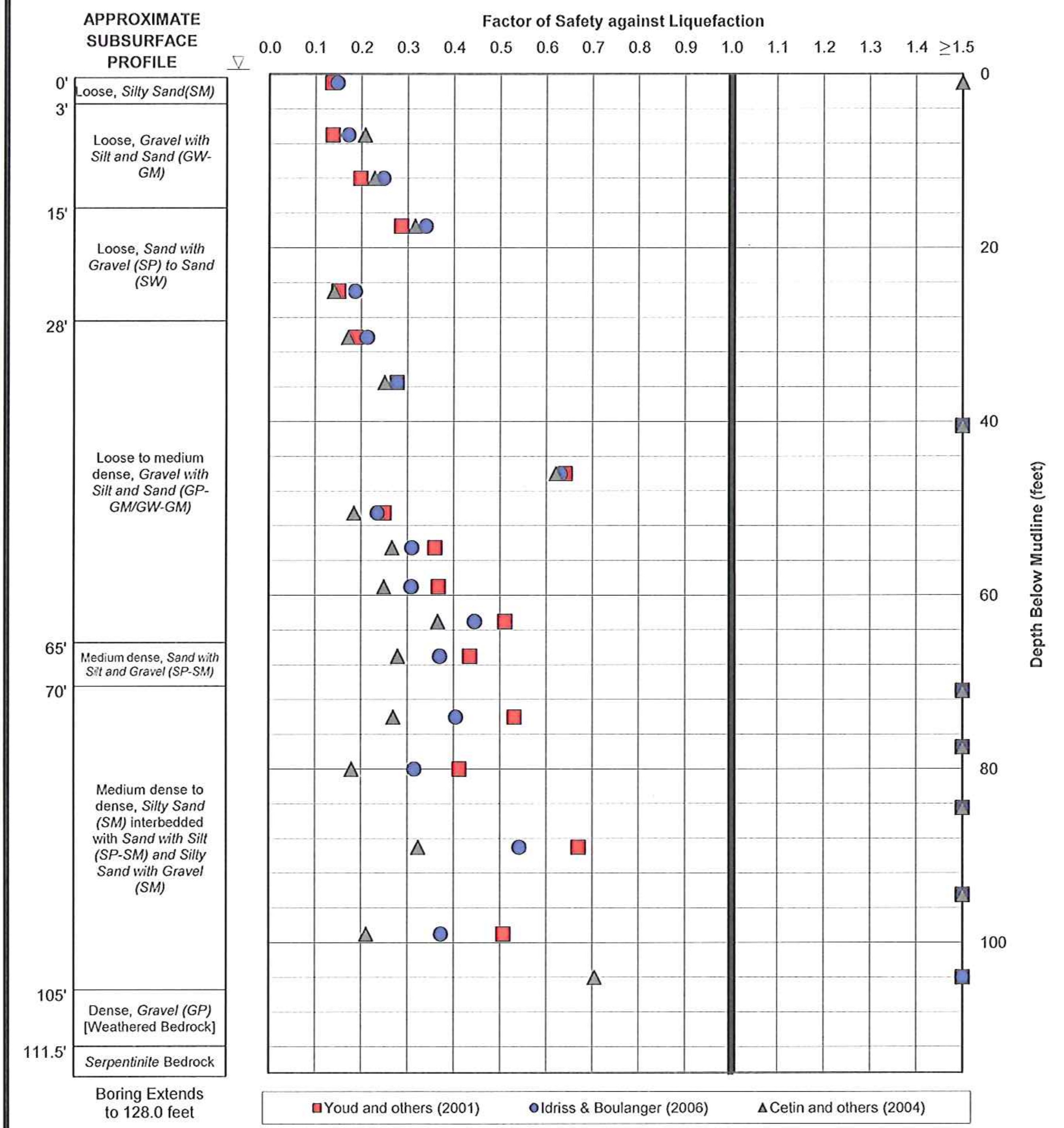
FIG. B-2



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

RESULTS OF LIQUEFACTION ANALYSES
BORING B-3
M = 7.9, PGA = 0.38

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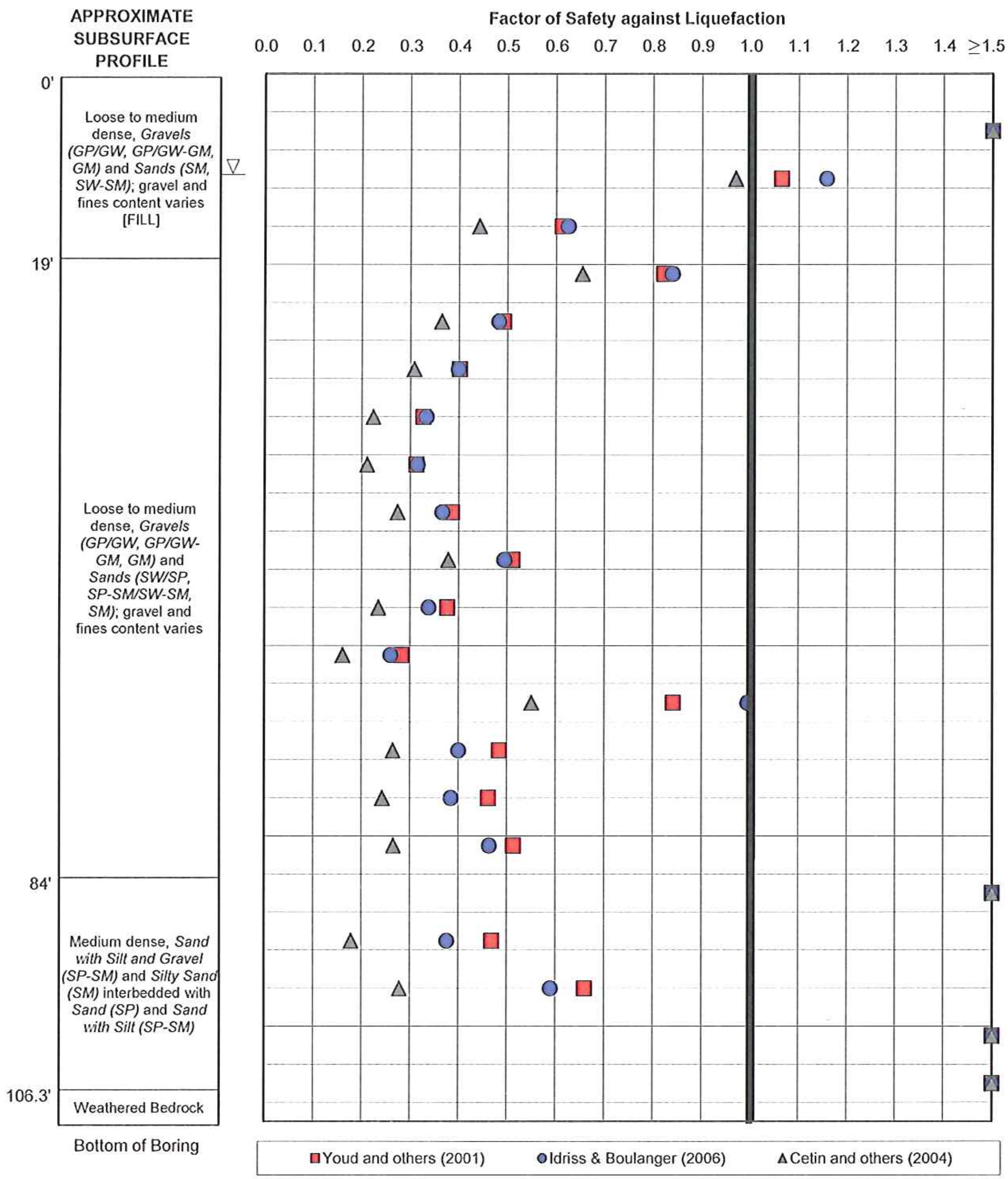
FIG. B-3



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.

Gary Paxton Industrial Park
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Sawmill Cove, Sitka, Alaska

RESULTS OF LIQUEFACTION ANALYSES
BORING B-4
M = 7.9, PGA = 0.38

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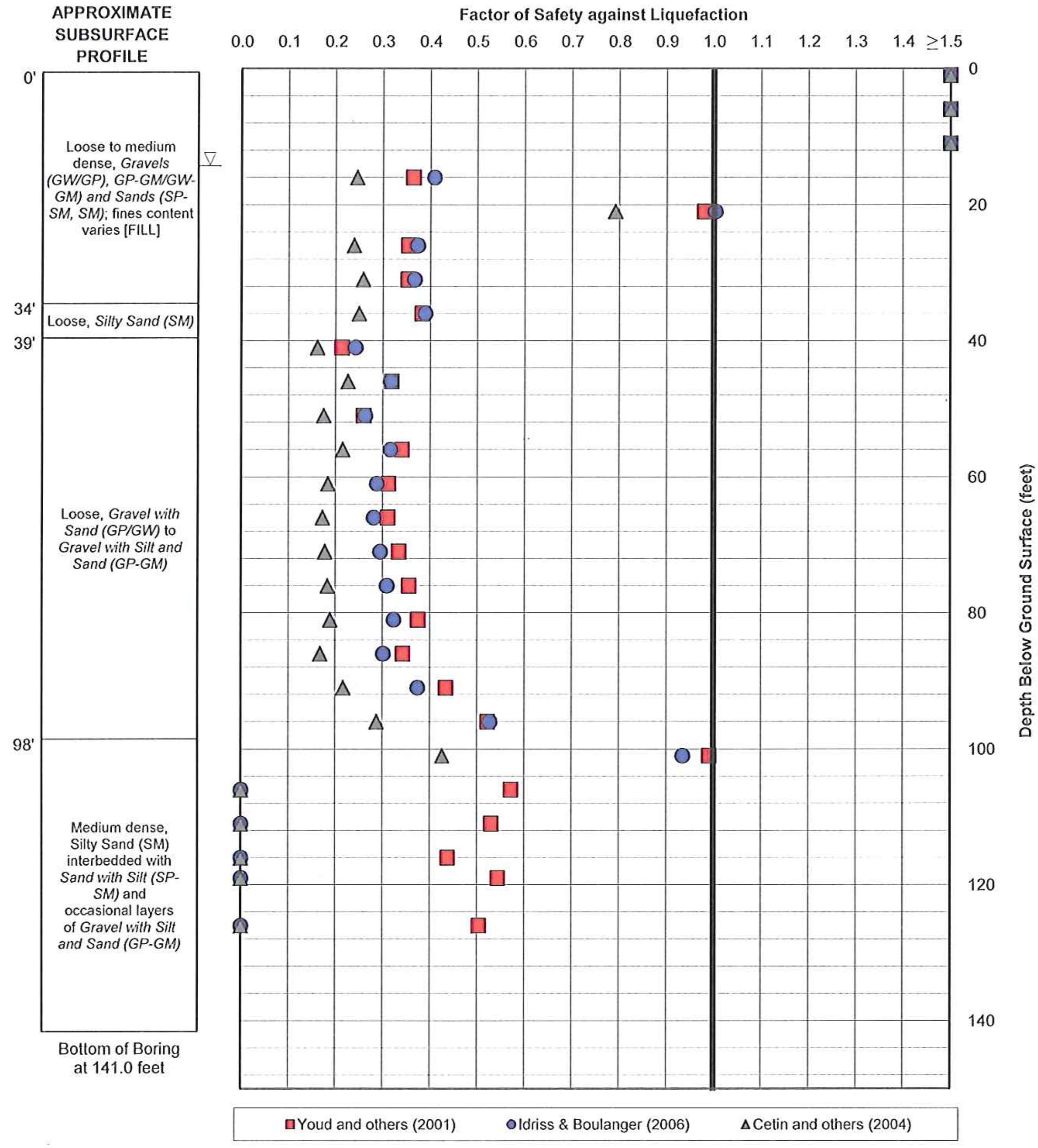
FIG. B-4



NOTES

1. See main text for references.
2. The liquefaction resistance of a soil is based on its density and fines content. We used the results of the standard penetration testing to estimate the density, and the results of selected laboratory tests to estimate the fines content.

Gary Paxton Industrial Park
Multi-Use Dock
Sawmill Cove, Sitka, Alaska

RESULTS OF LIQUEFACTION ANALYSES
BORING B-5
M = 7.9, PGA = 0.38

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FIG. B-5

APPENDIX C

IMPORTANT INFORMATION ABOUT YOUR GEOTECHNICAL/ENVIRONMENTAL REPORT

SHANNON & WILSON, INC.
Geotechnical and Environmental Consultants

Attachment to 32-1-02389

Date: September 2014
To: Moffatt & Nichol
Re: Gary Paxton Industrial Park Multi-Use Dock, Sawmill Cove, Sitka, Alaska

Important Information About Your Geotechnical/Environmental Report

CONSULTING SERVICES ARE PERFORMED FOR SPECIFIC PURPOSES AND FOR SPECIFIC CLIENTS.

Consultants prepare reports to meet the specific needs of specific individuals. A report prepared for a civil engineer may not be adequate for a construction contractor or even another civil engineer. Unless indicated otherwise, your consultant prepared your report expressly for you and expressly for the purposes you indicated. No one other than you should apply this report for its intended purpose without first conferring with the consultant. No party should apply this report for any purpose other than that originally contemplated without first conferring with the consultant.

THE CONSULTANT'S REPORT IS BASED ON PROJECT-SPECIFIC FACTORS.

A geotechnical/environmental report is based on a subsurface exploration plan designed to consider a unique set of project-specific factors. Depending on the project, these may include: the general nature of the structure and property involved; its size and configuration; its historical use and practice; the location of the structure on the site and its orientation; other improvements such as access roads, parking lots, and underground utilities; and the additional risk created by scope-of-service limitations imposed by the client. To help avoid costly problems, ask the consultant to evaluate how any factors that change subsequent to the date of the report may affect the recommendations. Unless your consultant indicates otherwise, your report should not be used: (1) when the nature of the proposed project is changed (for example, if an office building will be erected instead of a parking garage, or if a refrigerated warehouse will be built instead of an unrefrigerated one, or chemicals are discovered on or near the site); (2) when the size, elevation, or configuration of the proposed project is altered; (3) when the location or orientation of the proposed project is modified; (4) when there is a change of ownership; or (5) for application to an adjacent site. Consultants cannot accept responsibility for problems that may occur if they are not consulted after factors, which were considered in the development of the report, have changed.

SUBSURFACE CONDITIONS CAN CHANGE.

Subsurface conditions may be affected as a result of natural processes or human activity. Because a geotechnical/environmental report is based on conditions that existed at the time of subsurface exploration, construction decisions should not be based on a report whose adequacy may have been affected by time. Ask the consultant to advise if additional tests are desirable before construction starts; for example, groundwater conditions commonly vary seasonally.

Construction operations at or adjacent to the site and natural events such as floods, earthquakes, or groundwater fluctuations may also affect subsurface conditions and, thus, the continuing adequacy of a geotechnical/environmental report. The consultant should be kept apprised of any such events, and should be consulted to determine if additional tests are necessary.

MOST RECOMMENDATIONS ARE PROFESSIONAL JUDGMENTS.

Site exploration and testing identifies actual surface and subsurface conditions only at those points where samples are taken. The data were extrapolated by your consultant, who then applied judgment to render an opinion about overall subsurface conditions. The actual interface between materials may be far more gradual or abrupt than your report indicates. Actual conditions in areas not sampled may differ from those predicted in your report. While nothing can be done to prevent such situations, you and your consultant can work together to help reduce their impacts. Retaining your consultant to observe subsurface construction operations can be particularly beneficial in this respect.

A REPORT'S CONCLUSIONS ARE PRELIMINARY.

The conclusions contained in your consultant's report are preliminary because they must be based on the assumption that conditions revealed through selective exploratory sampling are indicative of actual conditions throughout a site. Actual subsurface conditions can be discerned only during earthwork; therefore, you should retain your consultant to observe actual conditions and to provide conclusions. Only the consultant who prepared the report is fully familiar with the background information needed to determine whether or not the report's recommendations based on those conclusions are valid and whether or not the contractor is abiding by applicable recommendations. The consultant who developed your report cannot assume responsibility or liability for the adequacy of the report's recommendations if another party is retained to observe construction.

THE CONSULTANT'S REPORT IS SUBJECT TO MISINTERPRETATION.

Costly problems can occur when other design professionals develop their plans based on misinterpretation of a geotechnical/environmental report. To help avoid these problems, the consultant should be retained to work with other project design professionals to explain relevant geotechnical, geological, hydrogeological, and environmental findings, and to review the adequacy of their plans and specifications relative to these issues.

BORING LOGS AND/OR MONITORING WELL DATA SHOULD NOT BE SEPARATED FROM THE REPORT.

Final boring logs developed by the consultant are based upon interpretation of field logs (assembled by site personnel), field test results, and laboratory and/or office evaluation of field samples and data. Only final boring logs and data are customarily included in geotechnical/environmental reports. These final logs should not, under any circumstances, be redrawn for inclusion in architectural or other design drawings, because drafters may commit errors or omissions in the transfer process.

To reduce the likelihood of boring log or monitoring well misinterpretation, contractors should be given ready access to the complete geotechnical engineering/environmental report prepared or authorized for their use. If access is provided only to the report prepared for you, you should advise contractors of the report's limitations, assuming that a contractor was not one of the specific persons for whom the report was prepared, and that developing construction cost estimates was not one of the specific purposes for which it was prepared. While a contractor may gain important knowledge from a report prepared for another party, the contractor should discuss the report with your consultant and perform the additional or alternative work believed necessary to obtain the data specifically appropriate for construction cost estimating purposes. Some clients hold the mistaken impression that simply disclaiming responsibility for the accuracy of subsurface information always insulates them from attendant liability. Providing the best available information to contractors helps prevent costly construction problems and the adversarial attitudes that aggravate them to a disproportionate scale.

READ RESPONSIBILITY CLAUSES CLOSELY.

Because geotechnical/environmental engineering is based extensively on judgment and opinion, it is far less exact than other design disciplines. This situation has resulted in wholly unwarranted claims being lodged against consultants. To help prevent this problem, consultants have developed a number of clauses for use in their contracts, reports and other documents. These responsibility clauses are not exculpatory clauses designed to transfer the consultant's liabilities to other parties; rather, they are definitive clauses that identify where the consultant's responsibilities begin and end. Their use helps all parties involved recognize their individual responsibilities and take appropriate action. Some of these definitive clauses are likely to appear in your report, and you are encouraged to read them closely. Your consultant will be pleased to give full and frank answers to your questions.

The preceding paragraphs are based on information provided by the
ASFE/Association of Engineering Firms Practicing in the Geosciences, Silver Spring, Maryland