PanGEO
INCORPORATED
Geotechnical & Earthquake
Engineering Consultants

March 3, 2017
File No. 17-014

Ms. Suzanne Zahr
1441 76th Avenue SE, Suite 160
Mercer Island, WA 98040

Subject: **Geotechnical Engineering Report**
Niederman Residence Remodel
6800 – 96th Avenue SE, Mercer Island, Washington

Dear Ms. Zahr,

As requested, PanGEO, Inc. has completed a geotechnical engineering study for the proposed residence remodel project at the above-referenced site. This study was performed in general accordance with our mutually agreed scope of work outlined in our proposal dated November 18, 2016, and was subsequently approved by you on January 22, 2017. Our service scope included reviewing readily-available geologic and geotechnical data in the site vicinity, reviewing preliminary design plans, drilling two test borings, conducting a site reconnaissance, and developing the conclusions and recommendations presented in this report.

SITE AND PROJECT DESCRIPTION

The subject site is an approximately 0.38-acre waterfront lot located at 6800 – 96th Avenue NE in Mercer Island, Washington (see Vicinity Map, Figure 1). The subject property is roughly trapezoidal in shape, and is bordered by Lake Washington approximately on the east, and by existing single-family residences on other three sides. The site is occupied by an existing two-story house in the western portion of the site and a detached garage in the middle portion of the site (see Figure 2). The western portion of the site is vacant with a driveway for the adjacent property to the south. The subject property gently slopes down from the west to east with an average gradient of about 25 percent.

We understand that the proposed project consists of adding one more floor above the existing house and a portion of the garage. We also understand that the main house will be expanded approximately 7 to 8 feet to the west, and an elevated walkway will connect the house and the garage. We anticipate that site grading for the proposed construction will likely consist of cuts and fill on the order of 5 to 6 feet for the house expansion.

According to the City of Mercer Island Geologic Hazards maps, the site contains three geological hazards: Potential Landslide, Erosion, and Seismic Hazards. As a result, a geotechnical report will be required as part of the building permit application.

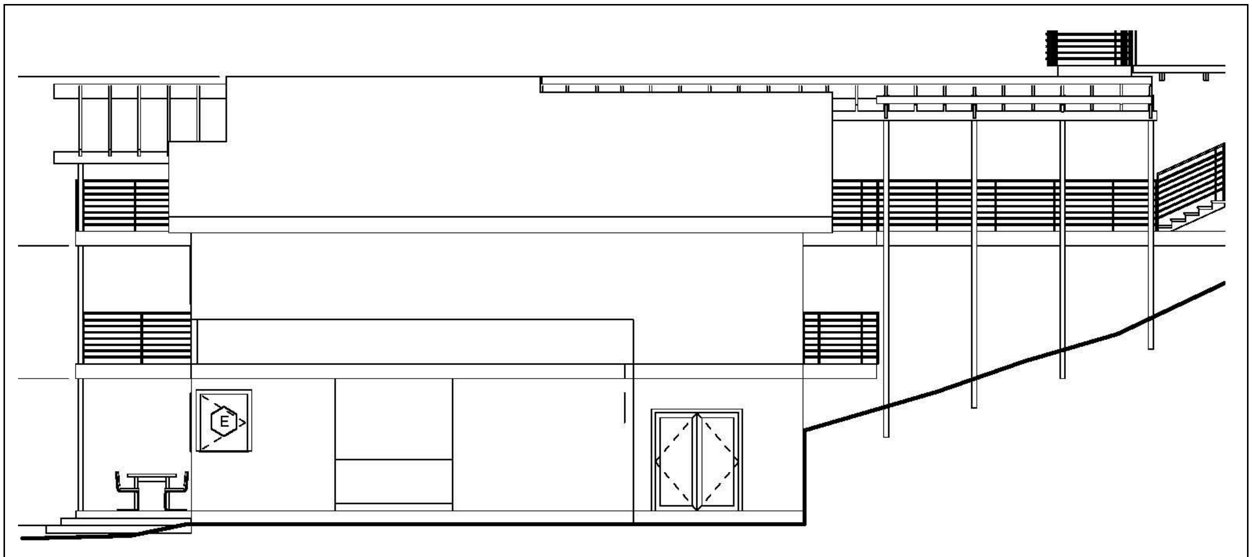

Plate 1. Proposed Building North Elevation.

The conclusions and recommendations outlined in this report are based on our understanding of the proposed development, which is in turn based on the project information provided. If the above project description is incorrect, or the project information changes, we should be consulted to review the recommendations contained in this study and make modifications, if needed.

SUBSURFACE EXPLORATIONS

Two test borings (PG-1 and PG-2) were drilled at the site on February 9, 2017, using a hand-operated portable drill rig owned and operated by CN Drilling, Inc. of Seattle, Washington. The approximate boring locations were located in the field from on-site features, and are shown on Figure 2. The borings were drilled to depths of about 21½ and 11 ½ feet in PG-1 and PG-2, respectively.

The portable drill rig was equipped with 4-inch outside diameter hollow stem augers. Soil samples were obtained from the borings at 2½- and 5-foot depth intervals in general accordance with Standard Penetration Test (SPT) sampling methods (ASTM test method D-1586) in which the samples are obtained using a 2-inch outside diameter split-spoon sampler. The sampler was driven into the soil a distance of 18 inches using a 140-pound weight freely falling a distance of 30 inches. The number of blows required for each 6-inch increment of sampler penetration was recorded. The number of blows required to achieve the last 12 inches of sample penetration is defined as the SPT N-value. The N-value provides an empirical measure of the relative density of cohesionless soil, or the relative consistency of fine-grained soils.

A geologist from PanGEO were present to observe the drilling, assist in sampling, and to describe and document the soil samples obtained from the borings. The soil samples were described and field classified in general accordance with the symbols and terms outlined in Figure A-1, and the summary boring logs are included as Figures A-2 and A-3.

In addition to the two test borings, probing with a 6-foot long T-Probe was conducted on the slope areas east of the garage and south of the existing stairs. Our probing indicated that loose soils extend to at least 5 to 6 feet below the surface on the slopes.

SITE GEOLOGY AND SUBSURFACE CONDITIONS

SITE GEOLOGY

The Geologic Map of Mercer Island (Troost and Wisher, 2006) mapped the surficial geologic unit at the subject site as Pre-Olympia Nonglacial Fine-Grained Deposits (Qponf) with Lake Deposits (Ql) mapped along the lakeshore. Pre-Olympia Nonglacial Fine-Grained deposits are described by Troost, et al. as laminated to massive, silt and clay with sandy interbeds and peat that had been overridden by Olympia Interglaciation. Lake Deposit (Ql) typically consists of very loose to loose sand to very soft to medium stiff silt and clay with peat and other organic sediments deposited adjacent to Lake Washington.

SUBSURFACE AND GROUNDWATER CONDITIONS

The soils observed in the borings generally consisted of fill over Lake Deposits over Pre-Olympia Fine-Grained Deposits. The following is a brief description of the soils encountered in the test borings advanced at the site. Please refer to the boring summary logs (Figures A-2 and A-3) for a detailed description of the conditions encountered at each boring location.

UNIT 1: Fill – Below the topsoil, loose, moist to wet, silty sand and silt with some organics was encountered to about 5 and 7½ feet below the surface in PG-1 and PG-2, respectively. We interpret this unit as fill.

UNIT 1: Lake Deposits – Below the Unit 1, boring PG-1 encountered loose to medium dense, wet, silty sand with clay, occasional wood fibers and fine organics to about 18 feet below the surface. We interpret this unit as Lake Deposits. This unit is not encountered in boring PG-2.

UNIT 3: Pre-Olympia Fine-Grained Deposits **–** Below the Unit 2 in PG-1 and Unit 1 in PG-2, both borings encountered very stiff to hard, moist, clayey silt that extended to the maximum depths drilled of 21½ and 11½ feet below existing grades in PG-1 and PG-2, respectively. We interpret this unit as mapped Pre-Olympia Fine-Grained Deposits.

Groundwater was encountered from about 2½ feet to 18 feet in boring PG-1 during drilling. Perched groundwater was encountered from about 2½ feet to 7½ feet in PG-2 during drilling. It should be noted that groundwater elevations and seepage rates are likely to vary depending on the season, local subsurface conditions, tides, and other factors. Groundwater levels and seepage rates are normally highest during the winter and early spring.

GEOLOGY HAZARDS ASSESSMENT

POTENTIAL LANDSLIDE HAZARDS

The subject site is mapped within a potential landslide hazard area according to the City of Mercer Island's Geologic Hazards Map. A site reconnaissance of the areas around the existing house and garage was conducted on February 9, 2017. During our site reconnaissance, we did not observe obvious evidence of slope instability or ground movement at the site. Based on our field observations, the general flat topography at the site and vicinity, and the results of our subsurface explorations, in our opinion, the areas where the house and garage are located appear to be globally stable in its current configuration. Furthermore, it is our opinion that the proposed development as currently planned will not adversely affect the overall stability of the site or adjacent properties, provided the recommendations outlined herein are followed and the proposed development is properly design and constructed. However, it should be noted that future surficial sloughing and colluvium failures cannot be ruled out in the steep slope portions of the site.

SEISMIC HAZARDS

Based on our review of the City of Mercer Island's Geologic Hazards Maps, the subject site is mapped within a seismic hazard area. The City of Mercer Island Code defines seismic hazard areas as those areas subject to risk of damage as a result of earthquake-induced ground shaking, slope failure, and soil liquefaction or surface faulting.

Soil liquefaction is a condition where saturated cohesionless soils undergo a substantial loss of strength due to the build-up of excess pore water pressures resulting from cyclic stress applications induced by earthquakes. Soils most susceptible to liquefaction are typically cohesionless, predominantly silt and sand sized, must be loose, and be below the groundwater table.

The existing wood frame buildings at the site and in the site vicinity appeared to have performed well during the 2001 Nisqually earthquake. In addition, they were no reported signs of liquefaction such as sand boils in the area during 2001 earthquake. As such, it is our opinion that the wood frame structures, such as the existing house, will perform reasonably well during future earthquakes with the magnitude similar to 2001 Nisqually earthquake.

For the purpose of soil liquefaction assessment for the flat areas where the main house is located, we assume the site soils will consist of loose to medium dense sandy soils to a maximum depth of approximately 18 feet. We also assume that the groundwater may be as shallow as about 3 feet. As such, the soils between about 3 and 18 feet will have a potential for soil liquefaction during a 2,475-year IBC-code level earthquake. As a result of soil liquefaction, ground settlement may likely occur and the ground settlement due to soil liquefaction for this event is estimated to be on the order of about 3 to 4 inches, and the differential foundation settlement is estimated to be about 2 to 3 inches. In our opinion, the soils in the areas west of the main house will not likely subject to soil liquefaction during a design earthquake.

We understand that the main house are founded on conventional footings. As such, if liquefaction occurs at the site, it would likely result in differential settlement of the house foundations. In our opinion, the potential foundation settlement due to a design-level earthquake would not pose a life safety issue for the occupants and would not significantly impede entrance or egress from the structure following an earthquake. However, it should be noted that the estimated differential foundation settlement during future strong earthquakes will likely result in cracking of interior or exterior walls, settlement of sidewalks, and may require re-leveling of doors, windows or columns. The owner should be aware of this risk and is willing to accept such risk. If a higher level of performance is desired, use of deep foundations, such as pin piles, will be required and PanGEO can provide additional input if needed.

Based on the site topography and soil conditions, the potential for seismic-induced landsliding and lateral spreading is considered to be low. And it is our opinion that special design considerations associated with seismic-induced landsliding and lateral spreading are not necessary for this project.

GEOTECHNICAL DESIGN RECOMMENDATIONS

SEISMIC DESIGN PARAMETERS

The Table 1 below provides seismic design parameters for the site that are in conformance with the 2012/2015 edition of the International Building Code (IBC), which specifies a design earthquake having a 2% probability of occurrence in 50 years (return interval of 2,475 years), and the 2008 USGS seismic hazard maps:

Table 1 – 2012/2015 IBC Seismic Design Parameters

Site Class	Spectral Acceleration at 0.2 sec. (g)	Spectral Acceleration at 1.0 sec. (g)	Site Coefficients		Design Spectral Response Parameters	
	S_S	S_1	F_a	F_v	S_{DS}	S_{D1}
D	1.448	0.553	1.0	1.50	0.965	0.553

BUILDING FOUNDATIONS

Existing Footings – Based on the borings drilled at the site, in our opinion, an allowable soil bearing pressure of 2,000 psf may be used to evaluate the adequacy of the existing footings due to the added structural loads. The existing footings may be enlarged to account for the added structural loads. The recommended bearing pressure should not be increased when evaluating the seismic conditions.

As previous indicated, probing along the existing east garage footings indicated loose/soft 6 feet or deeper. As such, the existing footing depth and subgrade soil conditions along the east garage should be evaluated. If the existing footings are found not bear on the native competent soils, new footings will be needed along the east garage wall.

New Footings - An allowable soil bearing pressure of 2,000 psf may also be used for sizing the new building footings. The recommended bearing pressure should not be increased when design for seismic conditions. The new footings should have a minimum width of 18 inches. The footings should be placed at a minimum depth of 18 inches below final grade.

Lateral Resistance

Lateral loads acting on the foundations may be resisted by passive earth pressure developed against the embedded portion of the foundation system and by frictional resistance at the bottom of the footings. For footings bearing on the compacted structural fill, a frictional coefficient of 0.3 may be used to evaluate sliding resistance. Passive soil resistance may be calculated using an equivalent fluid unit weight of 250 pcf, assuming properly re-compacted native sandy soil or compacted structural fill will be placed against the footings. The above values include a factor of safety of 1.5. Unless covered by pavements or slabs, the passive resistance in the upper 12 inches of soil should be neglected.

Footing Subgrade Preparation

All footing subgrades should be carefully prepared. Any fill, loose/soft, or organic-rich subgrade soil should be removed from the footing excavations. The footing subgrade may need to be recompacted to a dense, unyielding condition using a jumping jack or other heavy compaction equipment, prior to form setting and rebar placement. The adequacy of footing subgrade should be verified by a representative of PanGEO, prior to placing forms or rebar. If the on-site native soil is still loose and yielding after re-compaction, they should be over-excavated to expose the bearing soil. The over-excavation should be backfilled with compacted structural fill or lean-mix concrete. The over-excavation width should extend at least one-half the over-excavation depth beyond the edge of footing.

Foundation Performance

Settlement for the existing and new footings under static loading conditions is estimated to be less than about 1 inch with differential settlement to be on the order of ½ inch. Most of the anticipated settlements are likely to occur during construction as dead loads are applied. Total settlement for main house footings due to seismic shaking may be as much as 3 to 4 inches during an IBC code-level design earthquake. Differential post-liquefaction foundation settlement for the main house is estimated to be on the order of 2 to 3 inches. As previously indicated, if a higher level of foundation performance is desired, use of deep foundations, such as pin pile foundation, will be required. PanGEO can provide additional design recommendations as requested.

RETAINING AND BASEMENT WALL DESIGN PARAMETERS

Retaining and basement walls should be properly designed to resist the lateral earth pressures exerted by the soils behind the wall. Proper drainage provisions should also be provided behind the walls to intercept and remove groundwater that may be present behind the wall. Our geotechnical recommendations for the design and construction of the retaining/basement walls are presented below.

Lateral Earth Pressures

Concrete cantilever walls should be designed for an equivalent fluid pressure of 35 pcf for level backfills behind the walls assuming the walls are free to rotate. If walls are to be restrained at the top from free movement, such as below-grade building walls, equivalent fluid pressures of 45 pcf should be used for level backfills behind the walls. Walls with a maximum 2H:1V backslope should be designed for an active and at rest earth pressure of 45 and 55 pcf, respectively.

Permanent walls should be designed for an additional uniform lateral pressure of 7H psf for seismic loading, where H corresponds to the buried depth of the wall. The recommended lateral pressures assume that the backfill behind the wall consists of a free draining and properly compacted fill with adequate drainage provisions.

Surcharge

Surcharge loads, where present, should also be included in the design of retaining walls. We recommend that a lateral load coefficient of 0.3 be used to compute the lateral pressure on the wall face resulting from surcharge loads located within a horizontal distance of one-half wall height.

Lateral Resistance

Lateral forces from seismic loading and unbalanced lateral earth pressures may be resisted by a combination of passive earth pressures acting against the embedded portions of the foundations and by friction acting on the base of the foundations. Passive resistance values may be determined using an equivalent fluid weight of 250 pcf. This value includes a factor of safety of 1.5, assuming the footing is poured against dense native sand, re-compacted on-site sandy soil or properly compacted structural fill adjacent to the sides of footing. A friction coefficient of 0.3 may be used to determine the frictional resistance at the base of the footings. The coefficient includes a factor safety of 1.5.

Wall Drainage

Provisions for wall drainage should consist of a 4-inch diameter perforated drainpipe behind and at the base of the wall footings, embedded in 12 to 18 inches of clean crushed rock and pea gravel wrapped with a layer of filter fabric. A minimum 18-inch wide zone of free draining granular soils (i.e. pea gravel or washed rock) is recommended to be placed adjacent to the wall for the full height of the wall. Alternatively, a composite drainage material, such as Miradrain 6000, may be used in lieu of the clean crushed rock or pea gravel. The drainpipe at the base of the wall should be graded to direct water to a suitable outlet.

The exterior of all basement walls should be protected with a damp proofing compound. We also recommend the designers consider utilizing a waterproofing material, such as prefabricated clay mats, on the exterior of all below grade walls to reduce the potential for moisture intrusion into the below-grade portion of the building.

Wall Backfill

In our opinion, the relatively clean on-site sandy soil may be re-used as wall backfill. Imported wall backfill, if needed, should consist of granular material, such as WSDOT Gravel Borrow or approved equivalent. In areas where the space is limited between the wall and the face of excavation, pea gravel or clean crushed rock may be used as backfill without compaction.

Wall backfill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557. Within 5 feet of the wall, the backfill should be compacted with hand-operated equipment to at least 90 percent of the maximum dry density.

CONSTRUCTION CONSIDERATIONS

SITE PREPARATION

Site preparation for the proposed project mainly includes site clearing and excavations to the design subgrade. All debris resulted from site clearing should be hauled away from the site. The stripped surface materials should be properly disposed off-site or be "wasted" on site in non-structural landscaping areas.

Following site clearing and excavations, the adequacy of the subgrade where structural fill, foundations, slabs, or pavements are to be placed should be verified by a representative of PanGEO. The subgrade soil in the improvement areas, if recompacted and still yielding, may need to be over-excavated and replaced with compacted structural fill or lean-mix concrete. The need for overexcavation should be determined by PanGEO.

TEMPORARY EXCAVATIONS

As currently planned, the proposed construction may require excavations up to about 5 feet deep for the new foundation construction. We anticipate the excavations to mainly encounter loose to medium dense silty sand. All temporary excavations should be performed in accordance with Part N of WAC (Washington Administrative Code) 296-155. The contractor is responsible for maintaining safe excavation slopes and/or shoring.

All temporary excavations with a total overall depth greater than 4 feet should be sloped or shored. Based on the soil conditions at the site, for planning purposes, it is our opinion that temporary excavations for the proposed construction may be sloped 1H:1V or flatter. Based on our preliminary design plans, in our opinion, unsupported open cut excavation is likely feasible for the proposed project. In the event that space is not available for unsupported open cuts and temporary shoring is needed to to support excavations, PanGEO can provide additional design recommendations if needed.

The temporary excavations and cut slopes should be re-evaluated in the field during construction based on actual observed soil conditions, and may need to be modified in the wet reasons. The cut slopes should be covered with plastic sheets in the raining season. We also recommend that heavy construction equipment, building materials, excavated soil, and vehicular traffic should not be allowed within a distance equal to 1/3 the slope height from the top of any excavation.

CONSTRUCTION DEWATERING

Based on the borings drilled at the site, we anticipate groundwater will be present 2 to 3 feet below the existing grade at the main house, especially in the wet season. As such, the contractor should be prepared to provide temporary construction dewatering to facilitate foundation construction. Based on our understanding of the project and site conditions, we anticipate that a conventional dewatering system consisting of trenches, and sumps and pumps will be adequate.

MATERIAL REUSE

In the context of this report, structural fill is defined as compacted fill placed under footings, concrete stairs and landings, and slabs, or other load-bearing areas. In our opinion, the on-site soil is not suitable as structural fill. The structural fill should consist of imported, well-grade, granular material, such as WSDOT Gravel Borrow (WSDOT 9-03.14(1)) or approved equivalent. The on-site fill may be used as general fill in the non-structural and landscaping areas. If use of the on-site soil is planned, the excavated soil should be stockpiled and protected with plastic sheeting to prevent softening from rainfall in the wet season.

STRUCTURAL FILL PLACEMENT AND COMPACTION

Structural fill should be moisture conditioned to within about 3 percent of optimum moisture content, placed in loose, horizontal lifts less than 8 inches in thickness, and systematically compacted to a dense and relatively unyielding condition and to at least 95 percent of the maximum dry density, as determined using test method ASTM D 1557.

Depending on the type of compaction equipment used and depending on the type of fill material, it may be necessary to decrease the thickness of each lift in order to achieve adequate compaction. PanGEO can provide additional recommendations regarding structural fill and compaction during construction.

WET WEATHER EARTHWORK

In our opinion, the proposed site construction may be accomplished during wet weather (such as in winter) without adversely affecting the site stability. However, earthwork construction performed during the drier summer months likely will be more economical. Winter construction will require the implementation of best management erosion and sedimentation control practices to reduce the risk of off-site sediment transport. Most of the site soils within the anticipated depth of excavation contain a high percentage of fines and are moisture sensitive. Any footing subgrade soils that become softened either by disturbance or rainfall should be removed and replaced with structural fill, Controlled Density Fill (CDF), or lean-mix concrete. General recommendations relative to earthwork performed in wet conditions are presented below:

- Site stripping, excavation and subgrade preparation should be followed promptly by the placement and compaction of clean structural fill or CDF;
- The size and type of construction equipment used may have to be limited to prevent soil disturbance;
- The ground surface within the construction area should be graded to promote run-off of surface water and to prevent the ponding of water;
- Geotextile silt fences should be strategically located to control erosion and the movement of soil;
- Structural fill should consist of less than 5% fines; and
- Excavation slopes should be covered with plastic sheets.

Surface Drainage Considerations

Surface runoff can be controlled during construction by careful grading practices. Typically, this includes the construction of shallow, upgrade perimeter ditches or low earthen berms in conjunction with silt fences to collect runoff and prevent water from entering excavations or to prevent runoff from the construction area from leaving the immediate work site.

Permanent control of surface water should be incorporated in the final grading design. Adequate surface gradients and drainage systems should be incorporated into the design such that surface runoff is directed away from slopes and structures. Water from roof drains and other impervious areas should be properly collected and discharged into a storm drain system, and should not be discharged on to the slope areas.

ADDITIONAL SERVICES

To confirm that our recommendations are properly incorporated into the design and construction of the proposed residence, PanGEO should be retained to conduct a review of the final project plans and specifications, and to monitor the construction of geotechnical elements. The City of Mercer Island, as part of the permitting process, will also require geotechnical construction inspection services. PanGEO can provide you a cost estimate for construction monitoring services at a later date.

We anticipate that the following additional services will be required:

- Review final project plans and specifications
- Verify implementation of erosion control measures;
- Verify adequacy of footing subgrade;
- Monitor temporary excavation;
- Verify the adequacy of subsurface drainage installation;
- Confirm the adequacy of the compaction of structural backfill; and
- Other consultation as may be required during construction

Modifications to our recommendations presented in this report may be necessary, based on the actual conditions encountered during construction.

CLOSURE

We have prepared this report for Suzanne Zahr Inc., and the project design team. Recommendations contained in this report are based on a site reconnaissance, a subsurface exploration program, review of pertinent subsurface information, and our understanding of the project. The study was performed using a mutually agreed-upon scope of work.

Variations in soil conditions may exist between the locations of the explorations and the actual conditions underlying the site. The nature and extent of soil variations may not be evident until construction occurs. If any soil conditions are encountered at the site that are different from those described in this report, we should be notified immediately to review the applicability of our recommendations. Additionally, we should also be notified to review the applicability of our recommendations if there are any changes in the project scope.

The scope of our work does not include services related to construction safety precautions. Our recommendations are not intended to direct the contractors' methods, techniques, sequences or procedures, except as specifically described in our report for consideration in design. Additionally, the scope of our work specifically excludes the assessment of environmental characteristics, particularly those involving hazardous substances. We are not mold consultants nor are our recommendations to be interpreted as being preventative of mold development. A mold specialist should be consulted for all mold-related issues.

This report has been prepared for planning and design purposes for specific application to the proposed project in accordance with the generally accepted standards of local practice at the time this report was written. No warranty, express or implied, is made.

This report may be used only by the client and for the purposes stated, within a reasonable time from its issuance. Land use, site conditions (both off and on-site), or other factors including advances in our understanding of applied science, may change over time and could materially affect our findings. Therefore, this report should not be relied upon after 24 months from its issuance. PanGEO should be notified if the project is delayed by more than 24 months from the date of this report so that we may review the applicability of our conclusions considering the time lapse.

It is the client's responsibility to see that all parties to this project, including the designer, contractor, subcontractors, etc., are made aware of this report in its entirety. The use of information contained in this report for bidding purposes should be done at the contractor's option and risk. Any party other than the client who wishes to use this report shall notify PanGEO of such intended use and for permission to copy this report. Based on the intended use of the report, PanGEO may require that additional work be performed and that an updated report be reissued. Noncompliance with any of these requirements will release PanGEO from any liability resulting from the use this report.

We appreciate the opportunity to be of service.

Sincerely,

3/3/2017

Nels Reese, G.I.T.
Engineering Geologist

H. Michael Xue, P.E.
Senior Geotechnical Engineer

Enclosures:

Figure 1 Vicinity Map
Figure 2 Site and Exploration Plan

Appendix A Summary Boring Logs
- Figure A-1 Terms and Symbols for Boring and Test Pit Logs
- Figure A-2 Log of Test Boring PG-1
- Figure A-3 Log of Test Boring PG-2

REFERENCES

International Code Council, 2012/2015, *International Building Code (IBC).*

Troost, K.G., and Wisher, A. P, 2006. *Geologic Map of Mercer Island, Washington, scale 1:24,000*.

WSDOT, 2016, *Standard Specifications for Road, Bridge and Municipal Construction, M 41-10.*

Base Map: Google Maps

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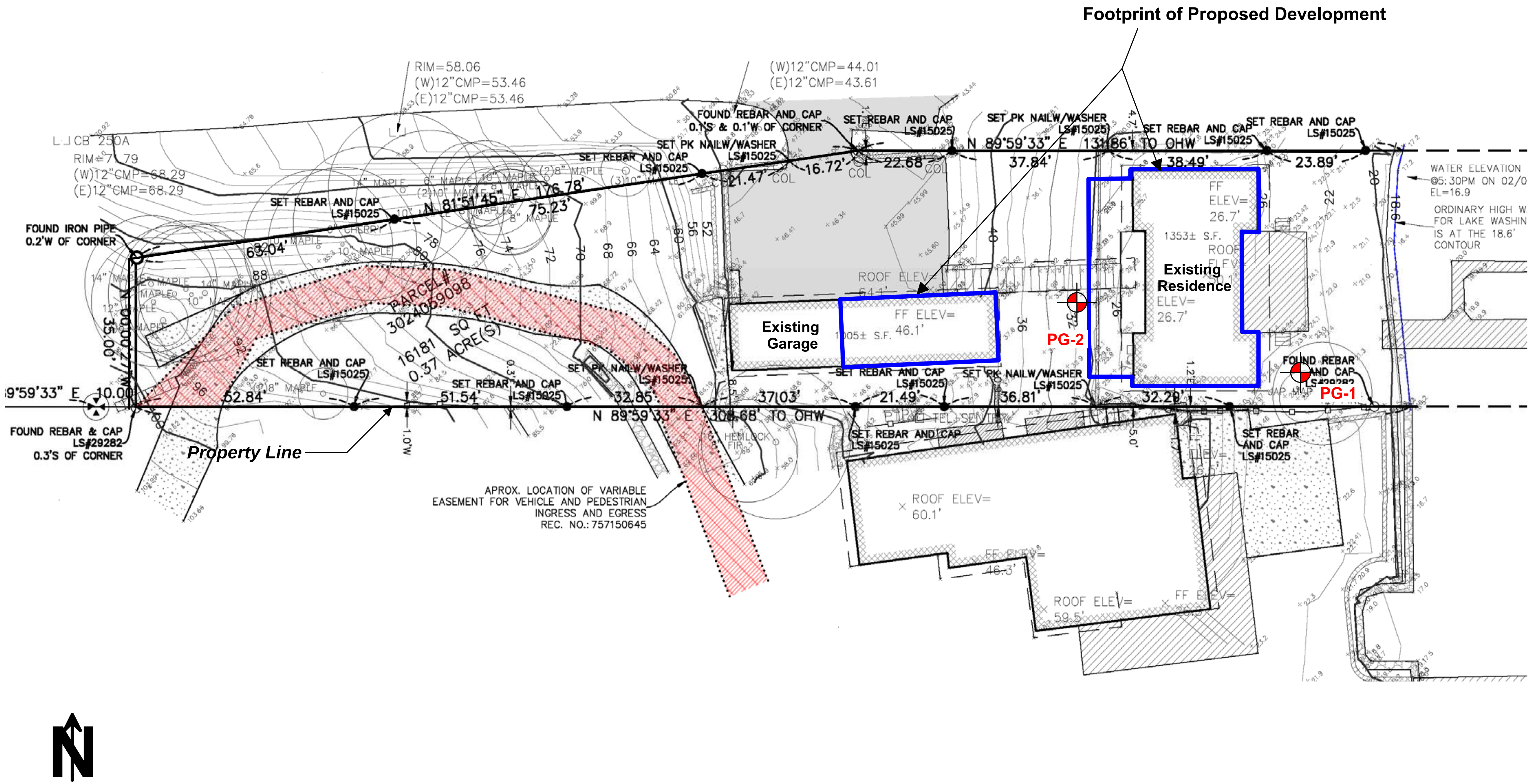
PanGEO INCORPORATED	Niederman Residence Remodel 6800 - 96th Avenue SE Mercer Island, Washington	VICINITY MAP	
		Project No. 17-014	Figure No. 1



Approx. Scale (feet)

1" = 25'

Legend:

PG-1 Approx. Boring Location

Note: Site plan modified from topographic survey by Terrane, provided by the client, dated September 13, 2016.

PanGEO INCORPORATED	Niederman Residence Remodel 6800 - 96th Avenue SE Mercer Island, WA	SITE AND EXPLORATION PLAN Project No. 17-014 · Figure No. 2

17-014_Fig 2 Site & Exploration Plan.grf 3/2/17 NER

APPENDIX A

SUMMARY TEST BORING LOGS

RELATIVE DENSITY / CONSISTENCY

SAND / GRAVEL			SILT / CLAY		
Density	SPT N-values	Approx. Relative Density (%)	Consistency	SPT N-values	Approx. Undrained Shear Strength (psf)
Very Loose	<4	<15	Very Soft	<2	<250
Loose	4 to 10	15 - 35	Soft	2 to 4	250 - 500
Med. Dense	10 to 30	35 - 65	Med. Stiff	4 to 8	500 - 1000
Dense	30 to 50	65 - 85	Stiff	8 to 15	1000 - 2000
Very Dense	>50	85 - 100	Very Stiff	15 to 30	2000 - 4000
			Hard	>30	>4000

UNIFIED SOIL CLASSIFICATION SYSTEM

MAJOR DIVISIONS		GROUP DESCRIPTIONS	
Gravel 50% or more of the coarse fraction retained on the #4 sieve. Use dual symbols (eg. GP-GM) for 5% to 12% fines.	GRAVEL (<5% fines)	GW	Well-graded GRAVEL
		GP	Poorly-graded GRAVEL
	GRAVEL (>12% fines)	GM	Silty GRAVEL
		GC	Clayey GRAVEL
Sand 50% or more of the coarse fraction passing the #4 sieve. Use dual symbols (eg. SP-SM) for 5% to 12% fines.	SAND (<5% fines)	SW	Well-graded SAND
		SP	Poorly-graded SAND
	SAND (>12% fines)	SM	Silty SAND
		SC	Clayey SAND
Silt and Clay 50%or more passing #200 sieve	Liquid Limit < 50	ML	SILT
		CL	Lean CLAY
		OL	Organic SILT or CLAY
	Liquid Limit > 50	MH	Elastic SILT
		CH	Fat CLAY
		OH	Organic SILT or CLAY
Highly Organic Soils		PT	PEAT

Notes:

1. Soil exploration logs contain material descriptions based on visual observation and field tests using a system modified from the Uniform Soil Classification System (USCS). Where necessary laboratory tests have been conducted (as noted in the "Other Tests" column), unit descriptions may include a classification. Please refer to the discussions in the report text for a more complete description of the subsurface conditions.

2. The graphic symbols given above are not inclusive of all symbols that may appear on the borehole logs. Other symbols may be used where field observations indicated mixed soil constituents or dual constituent materials.

DESCRIPTIONS OF SOIL STRUCTURES

Layered:	Units of material distinguished by color and/or composition from material units above and below	Fissured:	Breaks along defined planes
Laminated:	Layers of soil typically 0.05 to 1mm thick, max. 1 cm	Slickensided:	Fracture planes that are polished or glossy
Lens:	Layer of soil that pinches out laterally	Blocky:	Angular soil lumps that resist breakdown
Interlayered:	Alternating layers of differing soil material	Disrupted:	Soil that is broken and mixed
Pocket:	Erratic, discontinuous deposit of limited extent	Scattered:	Less than one per foot
Homogeneous:	Soil with uniform color and composition throughout	Numerous:	More than one per foot
		BCN:	Angle between bedding plane and a plane normal to core axis

COMPONENT DEFINITIONS

COMPONENT	SIZE / SIEVE RANGE	COMPONENT	SIZE / SIEVE RANGE
Boulder:	> 12 inches	Sand	
Cobbles:	3 to 12 inches	Coarse Sand:	#4 to #10 sieve (4.5 to 2.0 mm)
Gravel		Medium Sand:	#10 to #40 sieve (2.0 to 0.42 mm)
Coarse Gravel:	3 to 3/4 inches	Fine Sand:	#40 to #200 sieve (0.42 to 0.074 mm)
Fine Gravel:	3/4 inches to #4 sieve	Silt	0.074 to 0.002 mm
		Clay	<0.002 mm

TEST SYMBOLS

for In Situ and Laboratory Tests listed in "Other Tests" column.

ATT	Atterberg Limit Test
Comp	Compaction Tests
Con	Consolidation
DD	Dry Density
DS	Direct Shear
%F	Fines Content
GS	Grain Size
Perm	Permeability
PP	Pocket Penetrometer
R	R-value
SG	Specific Gravity
TV	Torvane
TXC	Triaxial Compression
UCC	Unconfined Compression

SYMBOLS

Sample/In Situ test types and intervals

- 2-inch OD Split Spoon, SPT (140-lb. hammer, 30" drop)
- 3.25-inch OD Spilt Spoon (300-lb hammer, 30" drop)
- Non-standard penetration test (see boring log for details)
- Thin wall (Shelby) tube
- Grab
- Rock core
- Vane Shear

MONITORING WELL

- Groundwater Level at time of drilling (ATD)
- Static Groundwater Level
- Cement / Concrete Seal
- Bentonite grout / seal
- Silica sand backfill
- Slotted tip
- Slough
- Bottom of Boring

MOISTURE CONTENT

Dry	Dusty, dry to the touch
Moist	Damp but no visible water
Wet	Visible free water

LOG KEY 13-104_LOGS.GPJ PANGEO.GDT 6/18/13

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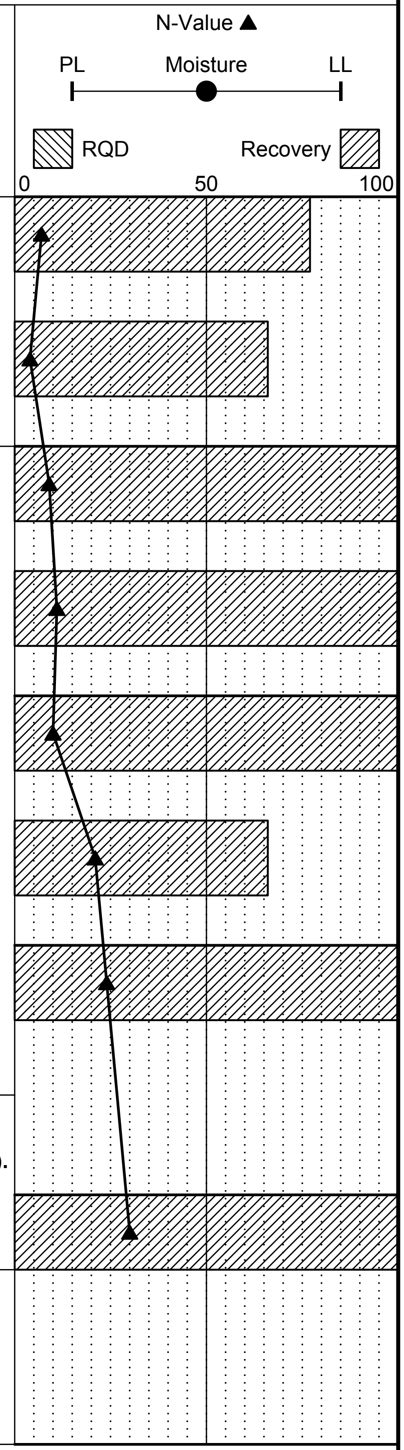
Terms and Symbols for Boring and Test Pit Logs

Figure A-1

Project:	6800 - 96th Ave SE	Surface Elevation:	23.0ft
Job Number:	17-014	Top of Casing Elev.:	
Location:	6800 - 96th Ave SE, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0	S-1	X	3 3 4			Grass and around 6 inches of topsoil at the surface over loose, moist to wet, dark brown to gray silty SAND and SILT (SM-ML); trace clay, occasional organics. **(Fill).**
	S-2	X	2 2 2		▽	-Becomes wet.
5	S-3	X	5 5 4			Loose to medium dense, wet, gray silty SAND with clay (SM); occasional wood fibers and fine organics, iron oxide staining in upper portion of unit. **(Lake Deposits).**
	S-4	X	4 5 6			
10	S-5	X	4 5 5			-Increased SILT.
	S-6	X	9 10 11			-Becomes medium dense.
15	S-7	X	9 11 13			-Decreased fines.
						Hard, gray, moist, clayey SILT (ML-CL); moist, medium plastic, massive. **(Pre-Olympia Fine-Grained Deposit).**
20	S-8	X	11 14 16			
						Boring terminated at 21.5 feet below grade. Groundwater was encountered from 2.5' to 18' at the time of drilling.
25						



Completion Depth:	21.5ft
Date Borehole Started:	2/9/17
Date Borehole Completed:	2/9/17
Logged By:	Nels R.
Drilling Company:	CN Drilling

Remarks: Borings drilled using an Acker hand portable drill rig. Standard penetration test (SPT) sampler driven with a 140 lb hammer operated with a rope and cathead mechanism. Boring elevation estimated from a topographic survey provided to PanGEO

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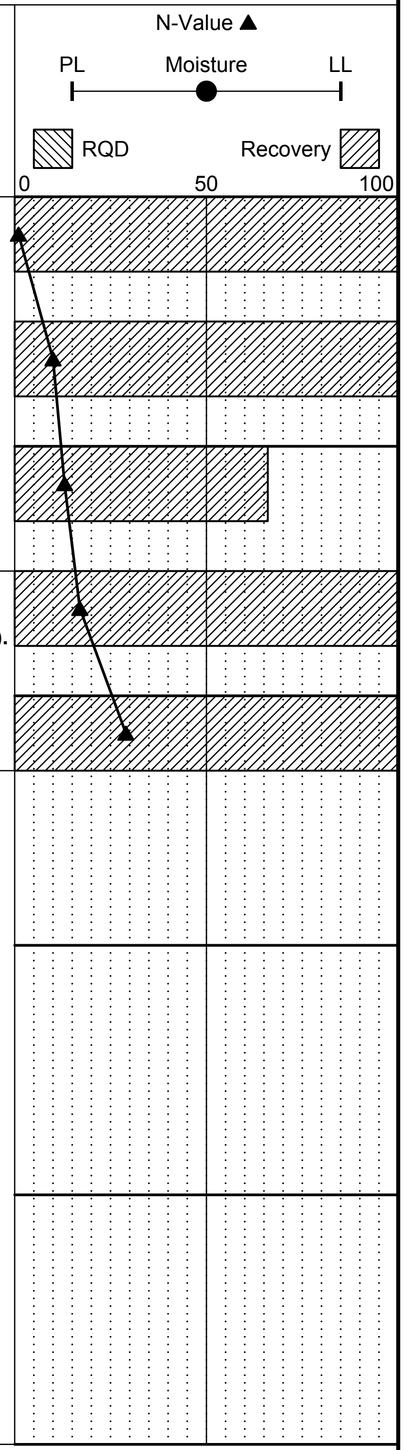
LOG OF TEST BORING PG-1

Figure A-2

The stratification lines represent approximate boundaries. The transition may be gradual.

Project:	6800 - 96th Ave SE	Surface Elevation:	31.0ft
Job Number:	17-014	Top of Casing Elev.:	
Location:	6800 - 96th Ave SE, Mercer Island, WA	Drilling Method:	HSA
Coordinates:	Northing: , Easting:	Sampling Method:	SPT

Depth, (ft)	Sample No.	Sample Type	Blows / 6 in.	Other Tests	Symbol	MATERIAL DESCRIPTION
0	S-1	SPT	1 0 1		SM	Loose, moist to wet, dark brown silty SAND (SM); trace clay, numerous organics in upper 2 feet of unit. **(Fill).**
	S-2	SPT	2 4 6		▽	-Becomes wet, medium dense.
5	S-3	SPT	4 6 7			-Becomes gray, increased clay, trace gravel.
	S-4	SPT	5 7 10		ML-CL	Very stiff, moist, gray, clayey SILT (ML-CL); medium plastic, blocky texture to massive below upper portion of unit. **(Pre-Olympia Fine-Grained Deposit).**
10	S-5	SPT	11 14 15			
						Boring terminated at 11.5 feet below grade. Perched groundwater was encountered from 2.5' to 7.5' at the time of drilling.
15						
20						
25						



Completion Depth:	11.5ft
Date Borehole Started:	2/9/17
Date Borehole Completed:	2/9/17
Logged By:	Nels R.
Drilling Company:	CN Drilling

Remarks: Borings drilled using an Acker hand portable drill rig. Standard penetration test (SPT) sampler driven with a 140 lb hammer operated with a rope and cathead mechanism. Boring elevation estimated from a topographic survey provided to PanGEO

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LOG OF TEST BORING PG-2

Figure A-3

The stratification lines represent approximate boundaries. The transition may be gradual.